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EUROPEAN RESEARCH EXECUTIVE AGENCY (REA)

REA.A – Marie Skłodowska-Curie Actions & Support to Experts
A.1 – MSCA Doctoral Networks

GRANT AGREEMENT

Project 101072637 — QSI

PREAMBLE

This **Agreement** ('the Agreement') is **between** the following parties:

on the one part,

the **European Research Executive Agency (REA)** ('EU executive agency' or 'granting authority'), under the powers delegated by the European Commission ('European Commission'),

and

on the other part,

1. 'the coordinator':

UNIVERSIDAD DE VIGO (UVIGO), PIC 999630494, established in LG CAMPUS LAGOAS MARCOSENDE, VIGO PONTEVEDRA 36310, Spain,

and the following other beneficiaries, if they sign their 'accession form' (see Annex 3 and Article 40):

2. **SORBONNE UNIVERSITE (SU)**, PIC 909875521, established in 21 RUE DE L'ECOLE DE MEDECINE, PARIS 75006, France,

3. **UNIVERSITA DEGLI STUDI DI PADOVA (UNIPD)**, PIC 999995602, established in VIA 8 FEBBRAIO 2, PADOVA 35122, Italy,

4. **RUHR-UNIVERSITAET BOCHUM (RUB)**, PIC 999988812, established in UNIVERSITAETSSTRASSE 150, BOCHUM 44801, Germany,

5. **UNIVERSITEIT VAN AMSTERDAM (UvA)**, PIC 999985708, established in SPUI 21, AMSTERDAM 1012WX, Netherlands,

6. **TECHNISCHE UNIVERSITEIT EINDHOVEN (TU/e)**, PIC 999977269, established in GROENE LOPER 3, EINDHOVEN 5612 AE, Netherlands,

7. **DANMARKS TEKNISKE UNIVERSITET (DTU)**, PIC 999990655, established in ANKER ENGELUNDSVEJ 1 BYGNING 101 A, KGS LYNGBY 2800, Denmark,

Unless otherwise specified, references to 'beneficiary' or 'beneficiaries' include the coordinator and affiliated entities (if any).

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If only one beneficiary signs the grant agreement (‘mono-beneficiary grant’), all provisions referring to the ‘coordinator’ or the ‘beneficiaries’ will be considered — mutatis mutandis — as referring to the beneficiary.

The parties referred to above have agreed to enter into the Agreement.

By signing the Agreement and the accession forms, the beneficiaries accept the grant and agree to implement the action under their own responsibility and in accordance with the Agreement, with all the obligations and terms and conditions it sets out.

The Agreement is composed of:

Preamble

Terms and Conditions (including Data Sheet)

Annex 1	Description of the action[1]
Annex 2	Estimated budget for the action
Annex 2a	Additional information on unit costs and contributions (if applicable)
Annex 3	Accession forms (if applicable)[2]
Annex 3a	Declaration on joint and several liability of affiliated entities (if applicable)[3]
Annex 4	Model for the financial statements
Annex 5	Specific rules (if applicable)

[1] Template published on Portal Reference Documents.
[2] Template published on Portal Reference Documents.
[3] Template published on Portal Reference Documents.

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TERMS AND CONDITIONS

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DATA SHEET

1. General data

Project summary:

Project summary
QSI aims at training a world-class cohort of doctoral candidates (DCs) capable of taking the next essential steps in the highly demanding area of cybersecurity. We aim to build strong lasting links between strategically selected industry and academic partners, in different disciplines, via the development of novel technologies for practical applications in data security. In parallel, we will also combine, via a collaborative long-term interdisciplinary approach, expertise in all relevant communities to address key fundamental problems in secure communications in the quantum era, and the important applications therein. The planned training network will provide research and training opportunities to a new generation of DCs, who, in the long-run, shall address the Grand Challenge of providing "Quantum-Safe Internet", i.e., a communication infrastructure that is secure against not only classical attacks but also those enabled by quantum technologies. Today's Internet security heavily relies on computational complexity assumptions, and as such is seriously threatened by advancements in quantum computing technologies. Indeed, we have recently witnessed a wave of key developments in this direction by a number of IT giants, e.g., Google, IBM, Microsoft, and Intel. This particularly jeopardizes applications that require long-term security. The number of such applications is continuously growing as more and more of our private information is stored and communicated in a digital way, e.g., electronic health records, which are now required by European legislation to remain secure for a long time. This requires us to urgently develop and implement new solutions, as we plan to do in this Doctoral Network (DN).

Keywords:

- Quantum Technologies (e.g. computing and communication)
- Complexity and cryptography, electronic security, privacy, biometrics
- Quantum optics and quantum information
- Scientific computing and data processing

Project number: 101072637

Project name: Quantum-Safe-Internet

Project acronym: QSI

Call: HORIZON-MSCA-2021-DN-01

Topic: HORIZON-MSCA-2021-DN-01-01

Type of action: HORIZON TMA MSCA Doctoral Networks

Granting authority: European Research Executive Agency

Grant managed through EU Funding & Tenders Portal: Yes (eGrants)

Project starting date: fixed date: 1 October 2022

Project end date: 30 September 2026

Project duration: 48 months

Consortium agreement: Yes

2. Participants

List of participants:

N°	Role	Short name	Legal name	Ctry	PIC	Total eligible contrib.	Max grant amount
1	COO	UVIGO	UNIVERSIDAD DE VIGO	ES	999630494	503 942.40	503 942.40
2	BEN	SU	SORBONNE UNIVERSITE	FR	909875521	282 693.60	282 693.60
3	BEN	UNIPD	UNIVERSITA DEGLI STUDI DI PADOVA	IT	999995602	259 437.60	259 437.60

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N°	Role	Short name	Legal name	Ctry	PIC	Total eligible contrib.	Max grant amount
4	BEN	RUB	RUHR-UNIVERSITAET BOCHUM	DE	999988812	260 539.20	260 539.20
5	BEN	UvA	UNIVERSITEIT VAN AMSTERDAM	NL	999985708	274 370.40	274 370.40
6	BEN	TU/e	TECHNISCHE UNIVERSITEIT EINDHOVEN	NL	999977269	274 370.40	274 370.40
7	BEN	DTU	DANMARKS TEKNISKE UNIVERSITET	DK	999990655	301 788.00	301 788.00
8	AP	CWI	STICHTING NEDERLANDSE WETENSCHAPPELIJK ONDERZOEK INSTITUTEN	NL	999624092	0.00	0.00
9	AP	TTBE	UNIVERSITY OF OTTAWA	CA	999885216	0.00	0.00
10	AP	UT	University of Toyama	JP	940379596	0.00	0.00
11	AP	VERIQLOUD	VERIQLOUD	FR	909315637	0.00	0.00
12	AP	genua	genua mbh	DE	950615521	0.00	0.00
13	AP	SIG	SERVICES INDUSTRIELS DE GENEVE	CH	904037091	0.00	0.00
14	AP	INRIM	ISTITUTO NAZIONALE DI RICERCA METROLOGICA	IT	998627805	0.00	0.00
15	AP	NXP	NXP SEMICONDUCTORS NETHERLANDS BV	NL	999995020	0.00	0.00
16	AP	NTT	NIPPON TELEGRAPH AND TELEPHONE CORPORATION	JP	962822486	0.00	0.00
17	AP	CISCO	CISCO SYSTEMS, INC	US	950586615	0.00	0.00
18	AP	EUTELSAT	EUTELSAT	FR	997257971	0.00	0.00
19	AP	UNIGE	UNIVERSITE DE GENEVE	CH	999974650	0.00	0.00
20	AP	ID QUANTIQUE SA	ID QUANTIQUE SA	CH	999662892	0.00	0.00
21	AP	ULEEDS	UNIVERSITY OF LEEDS	UK	999975426	0.00	0.00
22	AP	TOSHEU	TOSHIBA EUROPE LIMITED	UK	999958548	0.00	0.00
Total						2 157 141.60	2 157 141.60

Coordinator:

– UNIVERSIDAD DE VIGO (UVIGO)

3. Grant

Maximum grant amount, total estimated eligible costs and contributions and funding rate:

Total eligible contributions (unit, flat-rate and lump sum contributions and financing not linked to costs)	Maximum grant amount (Annex 2)	Maximum grant amount (award decision)
2 157 141.60	2 157 141.60	2 157 141.60

Grant form: Unit

Grant mode: Action grant

Budget categories/activity types:

- A. Contributions for recruited researchers
  - A.1 Living allowance
  - A.2 Mobility allowance
  - A.3 Family allowance
  - A.4 Long-term leave allowance
  - A.5 Special needs allowance

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- B. Institutional contributions
  - B.1 Research, training and networking contribution
  - B.2 Management and indirect contribution

Cost eligibility options:

- In-kind contributions eligible costs

Budget flexibility: Yes (flexibility with conditions)

4. Reporting, payments and recoveries

4.1 Continuous reporting (art 21)

Deliverables: see Funding & Tenders Portal Continuous Reporting tool

4.2 Periodic reporting and payments

Reporting and payment schedule (art 21, 22):

Reporting					Payments	
Reporting periods			Type	Deadline	Type	Deadline (time to pay)
RP No	Month from	Month to				
					Initial prefinancing	30 days from entry into force/10 days before starting date – whichever is the latest
1	1	24	Periodic report	60 days after end of reporting period	Interim payment	90 days from receiving periodic report
2	25	48	Periodic report	60 days after end of reporting period	Final payment	90 days from receiving periodic report

Prefinancing payments and guarantees:

Prefinancing payment	
Type	Amount
Prefinancing 1 (initial)	1 725 713.28

Reporting and payment modalities (art 21, 22):

Mutual Insurance Mechanism (MIM): Yes

MIM contribution: 5% of the maximum grant amount (107 857.08), retained from the initial prefinancing

Restrictions on distribution of initial prefinancing: The prefinancing may be distributed only if the minimum number of beneficiaries set out in the call condititions (if any) have acceded to the Agreement and only to beneficiaries that have acceded.

Interim payment ceiling (if any): 90% of the maximum grant amount

No-profit rule: n/a

Late payment interest: ECB + 3.5%

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Bank account for payments:

ES9102388103150660001660

Conversion into euros: n/a

Reporting language: Language of the Agreement

4.3 Certificates (art 24): n/a

4.4 Recoveries (art 22)

First-line liability for recoveries:

Beneficiary termination: Beneficiary concerned

Final payment: Each beneficiary for their own debt

After final payment: Beneficiary concerned

Joint and several liability for enforced recoveries (in case of non-payment):

Individual financial responsibility: Each beneficiary is liable only for its own debts (and those of its affiliated entities, if any)

5. Consequences of non-compliance, applicable law & dispute settlement forum

Suspension and termination:

Additional suspension grounds (art 31)

Additional termination grounds (art 32)

Applicable law (art 43):

Standard applicable law regime: EU law + law of Belgium

Dispute settlement forum (art 43):

Standard dispute settlement forum:

EU beneficiaries: EU General Court + EU Court of Justice (on appeal)

Non-EU beneficiaries: Courts of Brussels, Belgium (unless an international agreement provides for the enforceability of EU court judgements)

6. Other

Specific rules (Annex 5): Yes

Standard time-limits after project end:

Confidentiality (for X years after final payment): 5

Record-keeping (for X years after final payment): 5 (or 3 for grants of not more than EUR 60 000)

Reviews (up to X years after final payment): 2

Audits (up to X years after final payment): 2

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Extension of findings from other grants to this grant (no later than X years after final payment): 2

Impact evaluation (up to X years after final payment): 5 (or 3 for grants of not more than EUR 60 000)

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CHAPTER 1 GENERAL

ARTICLE 1 — SUBJECT OF THE AGREEMENT

This Agreement sets out the rights and obligations and terms and conditions applicable to the grant awarded for the implementation of the action set out in Chapter 2.

ARTICLE 2 — DEFINITIONS

For the purpose of this Agreement, the following definitions apply:

Actions — The project which is being funded in the context of this Agreement.

Grant — The grant awarded in the context of this Agreement.

EU grants — Grants awarded by EU institutions, bodies, offices or agencies (including EU executive agencies, EU regulatory agencies, EDA, joint undertakings, etc.).

Participants — Entities participating in the action as beneficiaries, affiliated entities, associated partners, third parties giving in-kind contributions, subcontractors or recipients of financial support to third parties.

Beneficiaries (BEN) — The signatories of this Agreement (either directly or through an accession form).

Affiliated entities (AE) — Entities affiliated to a beneficiary within the meaning of Article 187 of EU Financial Regulation 2018/1046[4] which participate in the action with similar rights and obligations as the beneficiaries (obligation to implement action tasks and right to charge costs and claim contributions).

Associated partners (AP) — Entities which participate in the action, but without the right to charge costs or claim contributions.

Purchases — Contracts for goods, works or services needed to carry out the action (e.g. equipment, consumables and supplies) but which are not part of the action tasks (see Annex 1).

Subcontracting — Contracts for goods, works or services that are part of the action tasks (see Annex 1).

In-kind contributions — In-kind contributions within the meaning of Article 2(36) of EU Financial

[4] For the definition, see Article 187 Regulation (EU, Euratom) 2018/1046 of the European Parliament and of the Council of 18 July 2018 on the financial rules applicable to the general budget of the Union, amending Regulations (EU) No 1296/2013, (EU) No 1301/2013, (EU) No 1303/2013, (EU) No 1304/2013, (EU) No 1309/2013, (EU) No 1316/2013, (EU) No 223/2014, (EU) No 283/2014, and Decision No 541/2014/EU and repealing Regulation (EU, Euratom) No 966/2012 ('EU Financial Regulation') (OJ L 193, 30.7.2018, p. 1): "**affiliated entities** [are]:
(a) entities that form a sole beneficiary [(i.e. where an entity is formed of several entities that satisfy the criteria for being awarded a grant, including where the entity is specifically established for the purpose of implementing an action to be financed by a grant)];
(b) entities that satisfy the eligibility criteria and that do not fall within one of the situations referred to in Article 136(1) and 141(1) and that have a link with the beneficiary, in particular a legal or capital link, which is neither limited to the action nor established for the sole purpose of its implementation".

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Regulation 2018/1046, i.e. non-financial resources made available free of charge by third parties to a beneficiary.

Fraud — Fraud within the meaning of Article 3 of EU Directive 2017/1371[5] and Article 1 of the Convention on the protection of the European Communities' financial interests, drawn up by the Council Act of 26 July 1995[6], as well as any other wrongful or criminal deception intended to result in financial or personal gain.

Irregularities — Any type of breach (regulatory or contractual) which could impact the EU financial interests, including irregularities within the meaning of Article 1(2) of EU Regulation 2988/95[7].

Grave professional misconduct — Any type of unacceptable or improper behaviour in exercising one's profession, especially by employees, including grave professional misconduct within the meaning of Article 136(1)(c) of EU Financial Regulation 2018/1046.

Applicable EU, international and national law — Any legal acts or other (binding or non-binding) rules and guidance in the area concerned.

Portal — EU Funding & Tenders Portal; electronic portal and exchange system managed by the European Commission and used by itself and other EU institutions, bodies, offices or agencies for the management of their funding programmes (grants, procurements, prizes, etc.).

CHAPTER 2 ACTION

ARTICLE 3 — ACTION

The grant is awarded for the action **101072637 — QSI** ('action'), as described in Annex 1.

ARTICLE 4 — DURATION AND STARTING DATE

The duration and the starting date of the action are set out in the Data Sheet (see Point 1).

CHAPTER 3 GRANT

ARTICLE 5 — GRANT

5.1 Form of grant

The grant is an action grant[8] which takes the form of a unit grant.

[5] Directive (EU) 2017/1371 of the European Parliament and of the Council of 5 July 2017 on the fight against fraud to the Union's financial interests by means of criminal law (OJ L 198, 28.7.2017, p. 29).
[6] OJ C 316, 27.11.1995, p. 48.
[7] Council Regulation (EC, Euratom) No 2988/95 of 18 December 1995 on the protection of the European Communities financial interests (OJ L 312, 23.12.1995, p. 1).
[8] For the definition, see Article 180(2)(a) EU Financial Regulation 2018/1046: '**action grant**' means an EU grant to finance "an action intended to help achieve a Union policy objective".

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5.2 Maximum grant amount

The maximum grant amount is set out in the Data Sheet (see Point 3) and in the estimated budget (Annex 2).

5.3 Funding rate

Not applicable

5.4 Estimated budget, budget categories and forms of funding

The estimated budget for the action is set out in Annex 2.

It contains the estimated eligible contributions for the action (unit contributions), broken down by participant and budget category.

Annex 2 also shows the types of contributions (forms of funding)[9] to be used for each budget category.

The details on the calculation of the unit contributions will be explained in Annex 2a.

5.5 Budget flexibility

The budget breakdown may be adjusted — without an amendment (see Article 39) — by transfers of units between participants, as long as this does not imply any substantive or important change to the description of the action in Annex 1. Transfers between budget categories are not allowed.

ARTICLE 6 — ELIGIBLE AND INELIGIBLE CONTRIBUTIONS

6.1 General eligibility conditions

The **general eligibility conditions** for the unit contributions are the following:

(a) the units must:

- be actually used or produced by the beneficiary in the period set out in Article 4 (with the exception of units relating to the submission of the final periodic report, which may be used or produced afterwards; see Article 21)
- be necessary for the implementation of the action and

(b) the number of units must be identifiable and verifiable, in particular supported by records and documentation (see Article 20).

6.2 Specific eligibility conditions for each budget category

For each budget category, the **specific eligibility conditions** are as follows:

A. Contributions for recruited researchers

Contributions for recruited researchers (A.1 Living allowance, A.2 Mobility allowance, A.3 Family

[9] See Article 125 EU Financial Regulation 2018/1046.

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allowance, A.4 Long-term leave allowance and A.5 Special needs allowance) are eligible, if they fulfil the general eligibility conditions and are calculated as unit contributions in accordance with the method set out in Annex 2a, and if:

for A.1 Living allowance and A.2 Mobility allowance:

(a) the number of units declared:

(i) corresponds to the number of months spent by the recruited researchers on the research training activities

(ii) does not exceed the maximum number of months (per researcher) set out in the call conditions and

(iii) comply with the requirements for non-academic exposure set out in the call conditions (for industrial doctorates only)

(b) the recruited researchers comply with the following conditions:

(i) be — at the date of recruitment — a doctoral candidate (i.e. not already in possession of a doctoral degree[10])

(ii) be enrolled in a doctoral programme leading to the award of a (for joint doctorates: joint, multiple or double) degree in at least one EU Member State or Horizon Europe associated country (for joint doctorates: at least two)

(iii) be recruited by the beneficiaries under an employment contract (or other direct contract with equivalent benefits, including social security coverage) or — if not otherwise possible under national law — under a fixed amount fellowship agreement with minimum social security coverage, including during periods of secondment

(iv) be employed full-time, unless the granting authority has approved a part-time employment for personal or family reasons

(v) be working exclusively for the action

(vi) not have resided or carried out their main activity (work, studies, etc.) in the country of the recruiting beneficiary for more than 12 months in the 36 months immediately before the recruitment date — unless as part of a compulsory national service or a procedure for obtaining refugee status under the Geneva Convention[11]

For beneficiaries that are international European research organisations or international organisations: not have spent with the beneficiary more than 12 months in the 36 months immediately before the recruitment date

(c) the contributions have been fully incurred for the benefit of the recruited researchers

This condition is met if:

[10] As defined in the call conditions.
[11] 1951 Refugee Convention and the 1967 Protocol.

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{{**total remuneration costs** (salaries, social security contributions, taxes and other costs included in the remuneration under the employment contract or other direct contract) or **total fixed-amount fellowship costs** for the researcher during the action

plus

total mobility costs (household, relocation and travel expenses and, if they must be paid under national law, taxes, duties and social security contributions) for the researcher during the action}

divided by

the number of actual units}.

is equal to or higher than the following amount:

{amount per unit contribution set out in Annex 2 as living allowance

plus

amount per unit contribution set out in Annex 2 as mobility allowance}.

for A.3 Family allowance:

(a) the recruited researchers have a family.

'Family' means persons linked to the researcher by marriage (or a relationship with equivalent status to a marriage recognised by the legislation of the country where this relationship was formalised) or dependent children who are actually being maintained by the researcher.

(b) the number of units declared:

(i) corresponds to the number of months spent by the recruited researchers with a family on the research training activities and

(ii) does not exceed the maximum number of months (per researcher) set out in the call conditions.

(c) the contributions have been incurred for the benefit of the recruited researchers

This condition is met if they have been fully used for the recruited researchers for whom they are claimed.

for A.4 Long-term leave[12] allowance:

(a) the general and specific eligibility conditions for the living and mobility allowances were fulfilled before the long-term leave and

(b) the number of units declared corresponds to the number of months paid by the beneficiary.

for A.5 Special needs allowance:

(a) they are used for recruited researchers with disabilities whose long-term physical, mental, intellectual or sensory impairments are certified by a competent national authority and of such

[12] Long-term leave includes maternity, paternity, parental, sick or special leave of more than 30 days.

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nature that their participation in the action would not be possible without the special needs items or services

(b) the special needs items or services are not already covered from another source (such as social security or health insurance)

(c) the number of units declared corresponds to the number of special needs units that were needed for implementing the action.

B. Institutional contributions

Institutional contributions (B.1 Research, training and networking contribution and B.2 Management and indirect contribution) are eligible, if they are calculated as unit contributions in accordance with the method set out in Annex 2a, and if the living and mobility allowances are eligible.

Moreover, no more than 40% of the maximum grant amount may be allocated to beneficiaries located in the same country or to any one international European research organisation or international organisation.

6.3 Ineligible contributions

'Ineligible contributions' are:

(a) units that do not comply with the conditions set out above (see Article 6.1 and 6.2)

(b) units implemented during grant agreement suspension (see Article 31) and

(c) units for activities already funded under other EU grants (or grants awarded by an EU Member State, non-EU country or other body implementing the EU budget), except for the following case:

(i) Synergy actions: not applicable

(d) other:

(i) country restrictions for eligible costs: not applicable.

6.4 Consequences of non-compliance

If a beneficiary declares unit contributions that are ineligible, they will be rejected (see Article 27).

This may also lead to other measures described in Chapter 5.

CHAPTER 4 GRANT IMPLEMENTATION

SECTION 1 CONSORTIUM: BENEFICIARIES, AFFILIATED ENTITIES AND OTHER PARTICIPANTS

ARTICLE 7 — BENEFICIARIES

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The beneficiaries, as signatories of the Agreement, are fully responsible towards the granting authority for implementing it and for complying with all its obligations.

They must implement the Agreement to their best abilities, in good faith and in accordance with all the obligations and terms and conditions it sets out.

They must have the appropriate resources to implement the action and implement the action under their own responsibility and in accordance with Article 11. If they rely on affiliated entities or other participants (see Articles 8 and 9), they retain sole responsibility towards the granting authority and the other beneficiaries.

They are jointly responsible for the *technical* implementation of the action. If one of the beneficiaries fails to implement their part of the action, the other beneficiaries must ensure that this part is implemented by someone else (without being entitled to an increase of the maximum grant amount and subject to an amendment; see Article 39). The *financial* responsibility of each beneficiary in case of recoveries is governed by Article 22.

The beneficiaries (and their action) must remain eligible under the EU programme funding the grant for the entire duration of the action. Unit contributions will be eligible only as long as the beneficiary and the action are eligible.

The **internal roles and responsibilities** of the beneficiaries are divided as follows:

(a) Each beneficiary must:

(i) keep information stored in the Portal Participant Register up to date (see Article 19)

(ii) inform the granting authority (and the other beneficiaries) immediately of any events or circumstances likely to affect significantly or delay the implementation of the action (see Article 19)

(iii) submit to the coordinator in good time:

- the prefinancing guarantees (if required; see Article 23)
- the financial statements and certificates on the financial statements (CFS) (if required; see Articles 21 and 24.2 and Data Sheet, Point 4.3)
- the contribution to the deliverables and technical reports (see Article 21)
- any other documents or information required by the granting authority under the Agreement

(iv) submit via the Portal data and information related to the participation of their affiliated entities.

(b) The coordinator must:

(i) monitor that the action is implemented properly (see Article 11)

(ii) act as the intermediary for all communications between the consortium and the granting authority, unless the Agreement or granting authority specifies otherwise, and in particular:

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- submit the prefinancing guarantees to the granting authority (if any)
- request and review any documents or information required and verify their quality and completeness before passing them on to the granting authority
- submit the deliverables and reports to the granting authority
- inform the granting authority about the payments made to the other beneficiaries (report on the distribution of payments; if required, see Articles 22 and 32)

(iii) distribute the payments received from the granting authority to the other beneficiaries without unjustified delay (see Article 22).

The coordinator may not delegate or subcontract the above-mentioned tasks to any other beneficiary or third party (including affiliated entities).

However, coordinators which are public bodies may delegate the tasks set out in Point (b)(ii) last indent and (iii) above to entities with 'authorisation to administer' which they have created or which are controlled by or affiliated to them. In this case, the coordinator retains sole responsibility for the payments and for compliance with the obligations under the Agreement.

Moreover, coordinators which are 'sole beneficiaries'[13] (or similar, such as European research infrastructure consortia (ERICs)) may delegate the tasks set out in Point (b)(i) to (iii) above to one of their members. The coordinator retains sole responsibility for compliance with the obligations under the Agreement.

The beneficiaries must have **internal arrangements** regarding their operation and co-ordination, to ensure that the action is implemented properly.

If required by the granting authority (see Data Sheet, Point 1), these arrangements must be set out in a written **consortium agreement** between the beneficiaries, covering for instance:

- the internal organisation of the consortium
- the management of access to the Portal
- different distribution keys for the payments and financial responsibilities in case of recoveries (if any)
- additional rules on rights and obligations related to background and results (see Article 16)
- settlement of internal disputes
- liability, indemnification and confidentiality arrangements between the beneficiaries.

The internal arrangements must not contain any provision contrary to this Agreement.

ARTICLE 8 — AFFILIATED ENTITIES

[13] For the definition, see Article 187(2) EU Financial Regulation 2018/1046: "Where several entities satisfy the criteria for being awarded a grant and together form one entity, that entity may be treated as the **sole beneficiary**, including where it is specifically established for the purpose of implementing the action financed by the grant."

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Not applicable

ARTICLE 9 — OTHER PARTICIPANTS INVOLVED IN THE ACTION

9.1 Associated partners

The following entities which cooperate with a beneficiary will participate in the action as 'associated partners':

- **STICHTING NEDERLANDSE WETENSCHAPPELIJK ONDERZOEK INSTITUTEN (CWI)**, PIC 999624092
- **UNIVERSITY OF OTTAWA (TTBE)**, PIC 999885216
- **University of Toyama (UT)**, PIC 940379596
- **VERIQLOUD (VERIQLOUD)**, PIC 909315637
- **genua mbh (genua)**, PIC 950615521
- **SERVICES INDUSTRIELS DE GENEVE (SIG)**, PIC 904037091
- **ISTITUTO NAZIONALE DI RICERCA METROLOGICA (INRIM)**, PIC 998627805
- **NXP SEMICONDUCTORS NETHERLANDS BV (NXP)**, PIC 999995020
- **NIPPON TELEGRAPH AND TELEPHONE CORPORATION (NTT)**, PIC 962822486
- **CISCO SYSTEMS, INC (CISCO)**, PIC 950586615
- **EUTELSAT (EUTELSAT)**, PIC 997257971
- **UNIVERSITE DE GENEVE (UNIGE)**, PIC 999974650
- **ID QUANTIQUE SA (ID QUANTIQUE SA)**, PIC 999662892
- **UNIVERSITY OF LEEDS (ULEEDS)**, PIC 999975426
- **TOSHIBA EUROPE LIMITED (TOSHEU)**, PIC 999958548

Associated partners must implement the action tasks attributed to them in Annex 1 in accordance with Article 11. They may not charge contributions to the action (no unit contributions) and the costs for their tasks are not eligible.

The tasks must be set out in Annex 1.

The beneficiaries must ensure that their contractual obligations under Articles 11 (proper implementation), 12 (conflict of interests), 13 (confidentiality and security), 14 (ethics), 17.2 (visibility), 18 (specific rules for carrying out action), 19 (information) and 20 (record-keeping) also apply to the associated partners.

The beneficiaries must ensure that the bodies mentioned in Article 25 (e.g. granting authority, OLAF, Court of Auditors (ECA), etc.) can exercise their rights also towards the associated partners.

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9.2 Third parties giving in-kind contributions to the action

Other third parties may give in-kind contributions to the action (i.e. personnel, equipment, other goods, works and services, etc. which are free-of-charge) if necessary for the implementation.

Third parties giving in-kind contributions do not implement any action tasks. They may not charge contributions to the action (no unit contributions) and their costs are considered entirely covered by the unit contributions paid to the beneficiaries.

The third parties and their in-kind contributions should be set out in Annex 1.

9.3 Subcontractors

Subcontractors may participate in the action, if necessary for the implementation.

Subcontractors must implement their action tasks in accordance with Article 11. The beneficiaries' costs for subcontracting are considered entirely covered by the unit contributions (irrespective of the actual subcontracting costs incurred, if any).

The beneficiaries must ensure that their contractual obligations under Articles 11 (proper implementation), 12 (conflict of interest), 13 (confidentiality and security), 14 (ethics), 17.2 (visibility), 18 (specific rules for carrying out action), 19 (information) and 20 (record-keeping) also apply to the subcontractors.

The beneficiaries must ensure that the bodies mentioned in Article 25 (e.g. granting authority, OLAF, Court of Auditors (ECA), etc.) can exercise their rights also towards the subcontractors.

9.4 Recipients of financial support to third parties

If the action includes providing financial support to third parties (e.g. grants, prizes or similar forms of support), the beneficiaries must ensure that their contractual obligations under Articles 12 (conflict of interest), 13 (confidentiality and security), 14 (ethics), 17.2 (visibility), 18 (specific rules for carrying out action), 19 (information) and 20 (record-keeping)also apply to the third parties receiving the support (recipients).

The beneficiaries must also ensure that the bodies mentioned in Article 25 (e.g. granting authority, OLAF, Court of Auditors (ECA), etc.) can exercise their rights also towards the recipients.

ARTICLE 10 — PARTICIPANTS WITH SPECIAL STATUS

10.1 Non-EU participants

Participants which are established in a non-EU country (if any) undertake to comply with their obligations under the Agreement and:

- to respect general principles (including fundamental rights, values and ethical principles, environmental and labour standards, rules on classified information, intellectual property rights, visibility of funding and protection of personal data)

- for the submission of certificates under Article 24: to use qualified external auditors which

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are independent and comply with comparable standards as those set out in EU Directive 2006/43/EC[14]

- for the controls under Article 25: to allow for checks, reviews, audits and investigations (including on-the-spot checks, visits and inspections) by the bodies mentioned in that Article (e.g. granting authority, OLAF, Court of Auditors (ECA), etc.).

Special rules on dispute settlement apply (see Data Sheet, Point 5).

10.2 Participants which are international organisations

Participants which are international organisations (IOs; if any) undertake to comply with their obligations under the Agreement and:

- to respect general principles (including fundamental rights, values and ethical principles, environmental and labour standards, rules on classified information, intellectual property rights, visibility of funding and protection of personal data)

- for the submission of certificates under Article 24: to use either independent public officers or external auditors which comply with comparable standards as those set out in EU Directive 2006/43/EC

- for the controls under Article 25: to allow for the checks, reviews, audits and investigations by the bodies mentioned in that Article, taking into account the specific agreements concluded by them and the EU (if any).

For such participants, nothing in the Agreement will be interpreted as a waiver of their privileges or immunities, as accorded by their constituent documents or international law.

Special rules on applicable law and dispute settlement apply (see Article 43 and Data Sheet, Point 5).

10.3 Pillar-assessed participants

Pillar-assessed participants (if any) may rely on their own systems, rules and procedures, in so far as they have been positively assessed and do not call into question the decision awarding the grant or breach the principle of equal treatment of applicants or beneficiaries.

'Pillar-assessment' means a review by the European Commission on the systems, rules and procedures which participants use for managing EU grants (in particular internal control system, accounting system, external audits, financing of third parties, rules on recovery and exclusion, information on recipients and protection of personal data; see Article 154 EU Financial Regulation 2018/1046).

Participants with a positive pillar assessment may rely on their own systems, rules and procedures, in particular for:

- record-keeping (Article 20): may be done in accordance with internal standards, rules and procedures

[14] Directive 2006/43/EC of the European Parliament and of the Council of 17 May 2006 on statutory audits of annual accounts and consolidated accounts or similar national regulations (OJ L 157, 9.6.2006, p. 87).

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- currency conversion for financial statements (Article 21): may be done in accordance with usual accounting practices

- guarantees (Article 23): for public law bodies, prefinancing guarantees are not needed

- certificates (Article 24):

    - certificates on the financial statements (CFS): may be provided by their regular internal or external auditors and in accordance with their internal financial regulations and procedures

    - certificates on usual accounting practices (CoMUC): are not needed if those practices are covered by an ex-ante assessment

and use the following specific rules, for:

- recoveries (Article 22): in case of financial support to third parties, there will be no recovery if the participant has done everything possible to retrieve the undue amounts from the third party receiving the support (including legal proceedings) and non-recovery is not due to an error or negligence on its part

- checks, reviews, audits and investigations by the EU (Article 25): will be conducted taking into account the rules and procedures specifically agreed between them and the framework agreement (if any)

- impact evaluation (Article 26): will be conducted in accordance with the participant's internal rules and procedures and the framework agreement (if any)

- grant agreement suspension (Article 31): certain costs incurred during grant suspension are eligible (notably, minimum costs necessary for a possible resumption of the action and costs relating to contracts which were entered into before the pre-information letter was received and which could not reasonably be suspended, reallocated or terminated on legal grounds)

- grant agreement termination (Article 32): the final grant amount and final payment will be calculated taking into account also costs relating to contracts due for execution only after termination takes effect, if the contract was entered into before the pre-information letter was received and could not reasonably be terminated on legal grounds

- liability for damages (Article 33.2): the granting authority must be compensated for damage it sustains as a result of the implementation of the action or because the action was not implemented in full compliance with the Agreement only if the damage is due to an infringement of the participant's internal rules and procedures or due to a violation of third parties' rights by the participant or one of its employees or individual for whom the employees are responsible.

Participants whose pillar assessment covers procurement and granting procedures may also do purchases, subcontracting and financial support to third parties (Article 6.2) in accordance with their internal rules and procedures for purchases, subcontracting and financial support.

Participants whose pillar assessment covers data protection rules may rely on their internal standards, rules and procedures for data protection (Article 15).

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The participants may however not rely on provisions which would breach the principle of equal treatment of applicants or beneficiaries or call into question the decision awarding the grant, such as in particular:

- eligibility (Article 6)
- consortium roles and set-up (Articles 7-9)
- security and ethics (Articles 13, 14)
- IPR (including background and results, access rights and rights of use), communication, dissemination and visibility (Articles 16 and 17)
- information obligation (Article 19)
- payment, reporting and amendments (Articles 21, 22 and 39)
- rejections, reductions, suspensions and terminations (Articles 27, 28, 29-32)

If the pillar assessment was subject to remedial measures, reliance on the internal systems, rules and procedures is subject to compliance with those remedial measures.

Participants whose assessment has not yet been updated to cover (the new rules on) data protection may rely on their internal systems, rules and procedures, provided that they ensure that personal data is:

- processed lawfully, fairly and in a transparent manner in relation to the data subject
- collected for specified, explicit and legitimate purposes and not further processed in a manner that is incompatible with those purposes
- adequate, relevant and limited to what is necessary in relation to the purposes for which they are processed
- accurate and, where necessary, kept up to date
- kept in a form which permits identification of data subjects for no longer than is necessary for the purposes for which the data is processed and
- processed in a manner that ensures appropriate security of the personal data.

Participants must inform the coordinator without delay of any changes to the systems, rules and procedures that were part of the pillar assessment. The coordinator must immediately inform the granting authority.

Pillar-assessed participants that have also concluded a framework agreement with the EU, may moreover — under the same conditions as those above (i.e. not call into question the decision awarding the grant or breach the principle of equal treatment of applicants or beneficiaries) — rely on the provisions set out in that framework agreement.

SECTION 2 RULES FOR CARRYING OUT THE ACTION

ARTICLE 11 — PROPER IMPLEMENTATION OF THE ACTION

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11.1 Obligation to properly implement the action

The beneficiaries must implement the action as described in Annex 1 and in compliance with the provisions of the Agreement, the call conditions and all legal obligations under applicable EU, international and national law.

11.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 28).

Such breaches may also lead to other measures described in Chapter 5.

ARTICLE 12 — CONFLICT OF INTERESTS

12.1 Conflict of interests

The beneficiaries must take all measures to prevent any situation where the impartial and objective implementation of the Agreement could be compromised for reasons involving family, emotional life, political or national affinity, economic interest or any other direct or indirect interest (‘conflict of interests’).

They must formally notify the granting authority without delay of any situation constituting or likely to lead to a conflict of interests and immediately take all the necessary steps to rectify this situation.

The granting authority may verify that the measures taken are appropriate and may require additional measures to be taken by a specified deadline.

12.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 28) and the grant or the beneficiary may be terminated (see Article 32).

Such breaches may also lead to other measures described in Chapter 5.

ARTICLE 13 — CONFIDENTIALITY AND SECURITY

13.1 Sensitive information

The parties must keep confidential any data, documents or other material (in any form) that is identified as sensitive in writing (‘sensitive information’) — during the implementation of the action and for at least until the time-limit set out in the Data Sheet (see Point 6).

If a beneficiary requests, the granting authority may agree to keep such information confidential for a longer period.

Unless otherwise agreed between the parties, they may use sensitive information only to implement the Agreement.

The beneficiaries may disclose sensitive information to their personnel or other participants involved in the action only if they:

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(a) need to know it in order to implement the Agreement and

(b) are bound by an obligation of confidentiality.

The granting authority may disclose sensitive information to its staff and to other EU institutions and bodies.

It may moreover disclose sensitive information to third parties, if:

(a) this is necessary to implement the Agreement or safeguard the EU financial interests and

(b) the recipients of the information are bound by an obligation of confidentiality.

The confidentiality obligations no longer apply if:

(a) the disclosing party agrees to release the other party

(b) the information becomes publicly available, without breaching any confidentiality obligation

(c) the disclosure of the sensitive information is required by EU, international or national law.

Specific confidentiality rules (if any) are set out in Annex 5.

13.2 Classified information

The parties must handle classified information in accordance with the applicable EU, international or national law on classified information (in particular, Decision 2015/444[15] and its implementing rules).

Deliverables which contain classified information must be submitted according to special procedures agreed with the granting authority.

Action tasks involving classified information may be subcontracted only after explicit approval (in writing) from the granting authority.

Classified information may not be disclosed to any third party (including participants involved in the action implementation) without prior explicit written approval from the granting authority.

Specific security rules (if any) are set out in Annex 5.

13.3 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 28).

Such breaches may also lead to other measures described in Chapter 5.

ARTICLE 14 — ETHICS AND VALUES

14.1 Ethics

[15] Commission Decision 2015/444/EC, Euratom of 13 March 2015 on the security rules for protecting EU classified information (OJ L 72, 17.3.2015, p. 53).

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The action must be carried out in line with the highest ethical standards and the applicable EU, international and national law on ethical principles.

Specific ethics rules (if any) are set out in Annex 5.

14.2 Values

The beneficiaries must commit to and ensure the respect of basic EU values (such as respect for human dignity, freedom, democracy, equality, the rule of law and human rights, including the rights of minorities).

Specific rules on values (if any) are set out in Annex 5.

14.3 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 28).

Such breaches may also lead to other measures described in Chapter 5.

ARTICLE 15 — DATA PROTECTION

15.1 Data processing by the granting authority

Any personal data under the Agreement will be processed under the responsibility of the data controller of the granting authority in accordance with and for the purposes set out in the Portal Privacy Statement.

For grants where the granting authority is the European Commission, an EU regulatory or executive agency, joint undertaking or other EU body, the processing will be subject to Regulation 2018/1725[16].

15.2 Data processing by the beneficiaries

The beneficiaries must process personal data under the Agreement in compliance with the applicable EU, international and national law on data protection (in particular, Regulation 2016/679[17]).

They must ensure that personal data is:

- processed lawfully, fairly and in a transparent manner in relation to the data subjects
- collected for specified, explicit and legitimate purposes and not further processed in a manner that is incompatible with those purposes

[16] Regulation (EU) 2018/1725 of the European Parliament and of the Council of 23 October 2018 on the protection of natural persons with regard to the processing of personal data by the Union institutions, bodies, offices and agencies and on the free movement of such data, and repealing Regulation (EC) No 45/2001 and Decision No 1247/2002/EC (OJ L 295, 21.11.2018, p. 39).

[17] Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (‘GDPR’) (OJ L 119, 4.5.2016, p. 1).

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- adequate, relevant and limited to what is necessary in relation to the purposes for which they are processed
- accurate and, where necessary, kept up to date
- kept in a form which permits identification of data subjects for no longer than is necessary for the purposes for which the data is processed and
- processed in a manner that ensures appropriate security of the data.

The beneficiaries may grant their personnel access to personal data only if it is strictly necessary for implementing, managing and monitoring the Agreement. The beneficiaries must ensure that the personnel is under a confidentiality obligation.

The beneficiaries must inform the persons whose data are transferred to the granting authority and provide them with the Portal Privacy Statement.

15.3 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 28).

Such breaches may also lead to other measures described in Chapter 5.

ARTICLE 16 — INTELLECTUAL PROPERTY RIGHTS (IPR) — BACKGROUND AND RESULTS —ACCESS RIGHTS AND RIGHTS OF USE

16.1 Background and access rights to background

The beneficiaries must give each other and the other participants access to the background identified as needed for implementing the action, subject to any specific rules in Annex 5.

‘Background’ means any data, know-how or information — whatever its form or nature (tangible or intangible), including any rights such as intellectual property rights — that is:

(a) held by the beneficiaries before they acceded to the Agreement and

(b) needed to implement the action or exploit the results.

If background is subject to rights of a third party, the beneficiary concerned must ensure that it is able to comply with its obligations under the Agreement.

16.2 Ownership of results

The granting authority does not obtain ownership of the results produced under the action.

‘Results’ means any tangible or intangible effect of the action, such as data, know-how or information, whatever its form or nature, whether or not it can be protected, as well as any rights attached to it, including intellectual property rights.

16.3 Rights of use of the granting authority on materials, documents and information received for policy, information, communication, dissemination and publicity purposes

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The granting authority has the right to use non-sensitive information relating to the action and materials and documents received from the beneficiaries (notably summaries for publication, deliverables, as well as any other material, such as pictures or audio-visual material, in paper or electronic form) for policy, information, communication, dissemination and publicity purposes — during the action or afterwards.

The right to use the beneficiaries' materials, documents and information is granted in the form of a royalty-free, non-exclusive and irrevocable licence, which includes the following rights:

(a) **use for its own purposes** (in particular, making them available to persons working for the granting authority or any other EU service (including institutions, bodies, offices, agencies, etc.) or EU Member State institution or body; copying or reproducing them in whole or in part, in unlimited numbers; and communication through press information services)

(b) **distribution to the public** (in particular, publication as hard copies and in electronic or digital format, publication on the internet, as a downloadable or non-downloadable file, broadcasting by any channel, public display or presentation, communicating through press information services, or inclusion in widely accessible databases or indexes)

(c) **editing or redrafting** (including shortening, summarising, inserting other elements (e.g. meta-data, legends, other graphic, visual, audio or text elements), extracting parts (e.g. audio or video files), dividing into parts, use in a compilation)

(d) **translation**

(e) **storage** in paper, electronic or other form

(f) **archiving**, in line with applicable document-management rules

(g) the right to authorise **third parties** to act on its behalf or sub-license to third parties the modes of use set out in Points (b), (c), (d) and (f), if needed for the information, communication and publicity activity of the granting authority

(h) **processing**, analysing, aggregating the materials, documents and information received and **producing derivative works**.

The rights of use are granted for the whole duration of the industrial or intellectual property rights concerned.

If materials or documents are subject to moral rights or third party rights (including intellectual property rights or rights of natural persons on their image and voice), the beneficiaries must ensure that they comply with their obligations under this Agreement (in particular, by obtaining the necessary licences and authorisations from the rights holders concerned).

Where applicable, the granting authority will insert the following information:

> "© – [year] – [name of the copyright owner]. All rights reserved. Licensed to the [name of granting authority] under conditions."

16.4 Specific rules on IPR, results and background

Specific rules regarding intellectual property rights, results and background (if any) are set out in Annex 5.

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16.5 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 28).

Such a breach may also lead to other measures described in Chapter 5.

ARTICLE 17 — COMMUNICATION, DISSEMINATION AND VISIBILITY

17.1 Communication — Dissemination — Promoting the action

Unless otherwise agreed with the granting authority, the beneficiaries must promote the action and its results by providing targeted information to multiple audiences (including the media and the public), in accordance with Annex 1 and in a strategic, coherent and effective manner.

Before engaging in a communication or dissemination activity expected to have a major media impact, the beneficiaries must inform the granting authority.

17.2 Visibility — European flag and funding statement

Unless otherwise agreed with the granting authority, communication activities of the beneficiaries related to the action (including media relations, conferences, seminars, information material, such as brochures, leaflets, posters, presentations, etc., in electronic form, via traditional or social media, etc.), dissemination activities and any infrastructure, equipment, vehicles, supplies or major result funded by the grant must acknowledge EU support and display the European flag (emblem) and funding statement (translated into local languages, where appropriate):

Funded by the
European Union

Co-funded by the
European Union

The emblem must remain distinct and separate and cannot be modified by adding other visual marks, brands or text.

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Apart from the emblem, no other visual identity or logo may be used to highlight the EU support.

When displayed in association with other logos (e.g. of beneficiaries or sponsors), the emblem must be displayed at least as prominently and visibly as the other logos.

For the purposes of their obligations under this Article, the beneficiaries may use the emblem without first obtaining approval from the granting authority. This does not, however, give them the right to exclusive use. Moreover, they may not appropriate the emblem or any similar trademark or logo, either by registration or by any other means.

17.3 Quality of information — Disclaimer

Any communication or dissemination activity related to the action must use factually accurate information.

Moreover, it must indicate the following disclaimer (translated into local languages where appropriate):

> "Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or [name of the granting authority]. Neither the European Union nor the granting authority can be held responsible for them."

17.4 Specific communication, dissemination and visibility rules

Specific communication, dissemination and visibility rules (if any) are set out in Annex 5.

17.5 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 28).

Such breaches may also lead to other measures described in Chapter 5.

ARTICLE 18 — SPECIFIC RULES FOR CARRYING OUT THE ACTION

18.1 Specific rules for carrying out the action

Specific rules for implementing the action (if any) are set out in Annex 5.

18.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 28).

Such a breach may also lead to other measures described in Chapter 5.

SECTION 3 GRANT ADMINISTRATION

ARTICLE 19 — GENERAL INFORMATION OBLIGATIONS

19.1 Information requests

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The beneficiaries must provide — during the action or afterwards and in accordance with Article 7 — any information requested in order to verify eligibility of the unit contributions declared, proper implementation of the action and compliance with the other obligations under the Agreement.

The information provided must be accurate, precise and complete and in the format requested, including electronic format.

19.2 Participant Register data updates

The beneficiaries must keep — at all times, during the action or afterwards — their information stored in the Portal Participant Register up to date, in particular, their name, address, legal representatives, legal form and organisation type.

19.3 Information about events and circumstances which impact the action

The beneficiaries must immediately inform the granting authority (and the other beneficiaries) of any of the following:

(a) **events** which are likely to affect or delay the implementation of the action or affect the EU's financial interests, in particular:

(i) changes in their legal, financial, technical, organisational or ownership situation (including changes linked to one of the exclusion grounds listed in the declaration of honour signed before grant signature)

(ii) linked action information: not applicable

(b) **circumstances** affecting:

(i) the decision to award the grant or

(ii) compliance with requirements under the Agreement.

19.4 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 28).

Such breaches may also lead to other measures described in Chapter 5.

ARTICLE 20 — RECORD-KEEPING

20.1 Keeping records and supporting documents

The beneficiaries must — at least until the time-limit set out in the Data Sheet (see Point 6) — keep records and other supporting documents to prove the proper implementation of the action in line with the accepted standards in the respective field (if any).

In addition, the beneficiaries must — for the same period — keep adequate records and supporting documents to prove the number of units declared; beneficiaries do not need to keep specific records on the actual costs incurred.

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The records and supporting documents must be made available upon request (see Article 19) or in the context of checks, reviews, audits or investigations (see Article 25).

If there are on-going checks, reviews, audits, investigations, litigation or other pursuits of claims under the Agreement (including the extension of findings; see Article 25), the beneficiaries must keep these records and other supporting documentation until the end of these procedures.

The beneficiaries must keep the original documents. Digital and digitalised documents are considered originals if they are authorised by the applicable national law. The granting authority may accept non-original documents if they offer a comparable level of assurance.

20.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, unit contributions insufficiently substantiated will be ineligible (see Article 6) and will be rejected (see Article 27), and the grant may be reduced (see Article 28).

Such breaches may also lead to other measures described in Chapter 5.

ARTICLE 21 — REPORTING

21.1 Continuous reporting

The beneficiaries must continuously report on the progress of the action (e.g. **deliverables, milestones, outputs/outcomes, critical risks, indicators,** etc; if any), in the Portal Continuous Reporting tool and in accordance with the timing and conditions it sets out (as agreed with the granting authority).

Standardised deliverables (e.g. progress reports not linked to payments, reports on cumulative expenditure, special reports, etc; if any) must be submitted using the templates published on the Portal.

21.2 Periodic reporting: Technical reports and financial statements

In addition, the beneficiaries must provide reports to request payments, in accordance with the schedule and modalities set out in the Data Sheet (see Point 4.2):

- for additional prefinancings (if any): an **additional prefinancing report**
- for interim payments (if any) and the final payment: a **periodic report**.

The prefinancing and periodic reports include a technical and financial part.

The technical part includes an overview of the action implementation. It must be prepared using the template available in the Portal Periodic Reporting tool.

The financial part of the additional prefinancing report includes a statement on the use of the previous prefinancing payment.

The financial part of the periodic report includes:

- the financial statements (individual and consolidated; for all beneficiaries/affiliated entities)

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- the explanation on the use of resources (or detailed cost reporting table, if required)
- the certificates on the financial statements (CFS): not applicable.

The **financial statements** must detail the contributions for the units implemented in the reporting period.

Unit contributions which are not declared in a financial statement will not be taken into account by the granting authority.

By signing the financial statements (directly in the Portal Periodic Reporting tool), the beneficiaries confirm that:

- the information provided is complete, reliable and true
- the unit contributions declared are eligible (see Article 6)
- the contributions can be substantiated by adequate records and supporting documents (see Article 20) that will be produced upon request (see Article 19) or in the context of checks, reviews, audits and investigations (see Article 25)

Beneficiaries will have to submit also the financial statements of their affiliated entities (if any). In case of recoveries (see Article 22), beneficiaries will be held responsible also for the financial statements of their affiliated entities.

21.3 Currency for financial statements and conversion into euros

The financial statements must be drafted in euro.

21.4 Reporting language

The reporting must be in the language of the Agreement, unless otherwise agreed with the granting authority (see Data Sheet, Point 4.2).

21.5 Consequences of non-compliance

If a report submitted does not comply with this Article, the granting authority may suspend the payment deadline (see Article 29) and apply other measures described in Chapter 5.

If the coordinator breaches its reporting obligations, the granting authority may terminate the grant or the coordinator's participation (see Article 32) or apply other measures described in Chapter 5.

ARTICLE 22 — PAYMENTS AND RECOVERIES — CALCULATION OF AMOUNTS DUE

22.1 Payments and payment arrangements

Payments will be made in accordance with the schedule and modalities set out in the Data Sheet (see Point 4.2).

They will be made in euro to the bank account indicated by the coordinator (see Data Sheet, Point 4.2)

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and must be distributed without unjustified delay (restrictions may apply to distribution of the initial prefinancing payment; see Data Sheet, Point 4.2).

Payments to this bank account will discharge the granting authority from its payment obligation.

The cost of payment transfers will be borne as follows:

- the granting authority bears the cost of transfers charged by its bank
- the beneficiary bears the cost of transfers charged by its bank
- the party causing a repetition of a transfer bears all costs of the repeated transfer.

Payments by the granting authority will be considered to have been carried out on the date when they are debited to its account.

22.2 Recoveries

Recoveries will be made, if — at beneficiary termination, final payment or afterwards — it turns out that the granting authority has paid too much and needs to recover the amounts undue.

Each beneficiary's financial responsibility in case of recovery is in principle limited to their own debt and undue amounts of their affiliated entities.

In case of enforced recoveries (see Article 22.4), affiliated entities will be held liable for repaying debts of their beneficiaries, if required by the granting authority (see Data Sheet, Point 4.4).

22.3 Amounts due

22.3.1 Prefinancing payments

The aim of the prefinancing is to provide the beneficiaries with a float.

It remains the property of the EU until the final payment.

For **initial prefinancings** (if any), the amount due, schedule and modalities are set out in the Data Sheet (see Point 4.2).

For **additional prefinancings** (if any), the amount due, schedule and modalities are also set out in the Data Sheet (see Point 4.2). However, if the statement on the use of the previous prefinancing payment shows that less than 70% was used, the amount set out in the Data Sheet will be reduced by the difference between the 70% threshold and the amount used.

The contribution to the Mutual Insurance Mechanism will be retained from the prefinancing payments (at the rate and in accordance with the modalities set out in the Data Sheet, see Point 4.2) and transferred to the Mechanism.

Prefinancing payments (or parts of them) may be offset (without the beneficiaries' consent) against amounts owed by a beneficiary to the granting authority — up to the amount due to that beneficiary.

For grants where the granting authority is the European Commission or an EU executive agency, offsetting may also be done against amounts owed to other Commission services or executive agencies.

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Payments will not be made if the payment deadline or payments are suspended (see Articles 29 and 30).

22.3.2 Amount due at beneficiary termination — Recovery

At beneficiary termination there will be no payment, but the grant must be provisionally closed for the beneficiary which leaves the consortium (and the affiliated entities which had to end their participation together with the beneficiary, if any).

Payments (if any) will be made with the next interim or final payment.

The **amount due** will be calculated in the following step:

Step 1 — Calculation of the total accepted EU contribution

Step 1 — Calculation of the total accepted EU contribution

The granting authority will first calculate the 'accepted EU contribution' for the beneficiary for all reporting periods, by calculating the unit contributions for the accepted units.

After that, the granting authority will take into account grant reductions (if any). The resulting amount is the 'total accepted EU contribution' for the beneficiary.

The **balance** is then calculated by deducting the payments received (if any; see report on the distribution of payments in Article 32), from the total accepted EU contribution:

{total accepted EU contribution for the beneficiary

minus

{prefinancing and interim payments received (if any)}}.

If the balance is **positive**, the amount will be included in the next interim or final payment to the consortium.

If the balance is **negative**, it will be **recovered** in accordance with the following procedure:

The granting authority will send a **pre-information letter** to the beneficiary concerned:

- formally notifying the intention to recover, the amount due, the amount to be recovered and the reasons why and
- requesting observations within 30 days of receiving notification.

If no observations are submitted (or the granting authority decides to pursue recovery despite the observations it has received), it will confirm the amount to be recovered and ask this amount to be paid to the coordinator (**confirmation letter**).

If payment is not made to the coordinator by the date specified in the confirmation letter, the granting authority may call on the Mutual Insurance Mechanism to intervene, if continuation of the action is guaranteed and the conditions set out in the rules governing the Mechanism are met.

In this case, it will send a **beneficiary recovery letter**, together with a **debit note** with the terms and date for payment.

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The debit note for the beneficiary will include the amount calculated for the affiliated entities which also had to end their participation (if any).

If payment is not made by the date specified in the debit note, the granting authority will **enforce recovery** in accordance with Article 22.4.

The amounts will later on also be taken into account for the next interim or final payment.

22.3.3 Interim payments

Interim payments reimburse the eligible contributions claimed for the units implemented during the reporting periods (if any).

Interim payments (if any) will be made in accordance with the schedule and modalities set out the Data Sheet (see Point 4.2).

Payment is subject to the approval of the periodic report. Its approval does not imply recognition of compliance, authenticity, completeness or correctness of its content.

The **interim payment** will be calculated by the granting authority in the following steps:

Step 1 — Calculation of the total accepted EU contribution

Step 2 — Limit to the interim payment ceiling

Step 1 — Calculation of the total accepted EU contribution

The granting authority will first calculate the 'accepted EU contribution' for the action for the reporting period, by calculating the unit contributions for the accepted units.

After that, the granting authority will take into account grant reductions from beneficiary termination (if any). The resulting amount is the 'total accepted EU contribution'.

Step 2 — Limit to the interim payment ceiling

The resulting amount is then capped to ensure that the total amount of prefinancing and interim payments (if any) does not exceed the interim payment ceiling set out in the Data Sheet (see Point 4.2).

Interim payments (or parts of them) may be offset (without the beneficiaries' consent) against amounts owed by a beneficiary to the granting authority — up to the amount due to that beneficiary.

For grants where the granting authority is the European Commission or an EU executive agency, offsetting may also be done against amounts owed to other Commission services or executive agencies.

Payments will not be made if the payment deadline or payments are suspended (see Articles 29 and 30).

22.3.4 Final payment — Final grant amount — Revenues and Profit — Recovery

The final payment (payment of the balance) reimburses the eligible contributions claimed for the remaining units implemented (if any).

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The final payment will be made in accordance with the schedule and modalities set out in the Data Sheet (see Point 4.2).

Payment is subject to the approval of the final periodic report. Its approval does not imply recognition of compliance, authenticity, completeness or correctness of its content.

The **final grant amount for the action** will be calculated in the following steps:

Step 1 — Calculation of the total accepted EU contribution

Step 2 — Limit to the maximum grant amount

Step 3 — Reduction due to the no-profit rule

Step 1 — Calculation of the total accepted EU contribution

The granting authority will first calculate the 'accepted EU contribution' for the action for all reporting periods, by calculating the unit contributions for the accepted units.

After that, the granting authority will take into account grant reductions (if any). The resulting amount is the 'total accepted EU contribution'.

Step 2 — Limit to the maximum grant amount

If the resulting amount is higher than the maximum grant amount set out in Article 5.2, it will be limited to the latter.

Step 3 — Reduction due to the no-profit rule

Not applicable

The **balance** (final payment) is then calculated by deducting the total amount of prefinancing and interim payments already made (if any), from the final grant amount:

{final grant amount

minus

{prefinancing and interim payments made (if any)}}.

If the balance is **positive**, it will be **paid** to the coordinator.

The amount retained for the Mutual Insurance Mechanism (see above) will be released and **paid** to the coordinator (in accordance with the rules governing the Mechanism).

The final payment (or part of it) may be offset (without the beneficiaries' consent) against amounts owed by a beneficiary to the granting authority — up to the amount due to that beneficiary.

For grants where the granting authority is the European Commission or an EU executive agency, offsetting may also be done against amounts owed to other Commission services or executive agencies.

Payments will not be made if the payment deadline or payments are suspended (see Articles 29 and 30).

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If — despite the release of the Mutual Insurance Mechanism contribution — the balance is **negative**, it will be **recovered** in accordance with the following procedure:

The granting authority will send a **pre-information letter** to the coordinator:

- formally notifying the intention to recover, the final grant amount, the amount to be recovered and the reasons why
- requesting a report on the distribution of payments to the beneficiaries within 30 days of receiving notification and
- requesting observations within 30 days of receiving notification.

If no observations are submitted (or the granting authority decides to pursue recovery despite the observations it has received) and the coordinator has submitted the report on the distribution of payments, it will calculate the **share of the debt per beneficiary**, by:

(a) identifying the beneficiaries for which the amount calculated as follows is negative:

{{{total accepted EU contribution for the beneficiary

divided by

total accepted EU contribution for the action}

multiplied by

final grant amount for the action},

minus

{prefinancing and interim payments received by the beneficiary (if any)}}

and

(b) dividing the debt:

{{amount calculated according to point (a) for the beneficiary concerned

divided by

the sum of the amounts calculated according to point (a) for all the beneficiaries identified according to point (a)}

multiplied by

the amount to be recovered}.

and confirm the amount to be recovered from each beneficiary concerned (**confirmation letter**), together with **debit notes** with the terms and date for payment.

The debit notes for beneficiaries will include the amounts calculated for their affiliated entities (if any).

If the coordinator has not submitted the report on the distribution of payments, the granting authority will **recover** the full amount from the coordinator (**confirmation letter** and **debit note** with the terms and date for payment).

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If payment is not made by the date specified in the debit note, the granting authority will **enforce recovery** in accordance with Article 22.4.

22.3.5 Audit implementation after final payment — Revised final grant amount — Recovery

If — after the final payment (in particular, after checks, reviews, audits or investigations; see Article 25) — the granting authority rejects unit contributions (see Article 27) or reduces the grant (see Article 28), it will calculate the **revised final grant amount** for the beneficiary concerned.

The **beneficiary revised final grant amount** will be calculated in the following step:

Step 1 — Calculation of the revised total accepted EU contribution

Step 1 — Calculation of the revised total accepted EU contribution

The granting authority will first calculate the 'revised accepted EU contribution' for the beneficiary, by calculating the 'revised accepted contributions'.

After that, it will take into account grant reductions (if any). The resulting 'revised total accepted EU contribution' is the beneficiary revised final grant amount.

If the revised final grant amount is lower than the beneficiary's final grant amount (i.e. its share in the final grant amount for the action), it will be **recovered** in accordance with the following procedure:

The **beneficiary final grant amount** (i.e. share in the final grant amount for the action) is calculated as follows:

{{total accepted EU contribution for the beneficiary

divided by

total accepted EU contribution for the action}

multiplied by

final grant amount for the action}.

The granting authority will send a **pre-information letter** to the beneficiary concerned:

- formally notifying the intention to recover, the amount to be recovered and the reasons why and
- requesting observations within 30 days of receiving notification.

If no observations are submitted (or the granting authority decides to pursue recovery despite the observations it has received), it will confirm the amount to be recovered (**confirmation letter**), together with a **debit note** with the terms and the date for payment.

Recoveries against affiliated entities (if any) will be handled through their beneficiaries.

If payment is not made by the date specified in the debit note, the granting authority will **enforce recovery** in accordance with Article 22.4.

22.4 Enforced recovery

If payment is not made by the date specified in the debit note, the amount due will be recovered:

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(a) by offsetting the amount — without the coordinator or beneficiary's consent — against any amounts owed to the coordinator or beneficiary by the granting authority.

In exceptional circumstances, to safeguard the EU financial interests, the amount may be offset before the payment date specified in the debit note.

For grants where the granting authority is the European Commission or an EU executive agency, debts may also be offset against amounts owed by other Commission services or executive agencies.

(b) financial guarantee(s): not applicable

(c) joint and several liability of beneficiaries: not applicable

(d) by holding affiliated entities jointly and severally liable (if any, see Data Sheet, Point 4.4)

(e) by taking legal action (see Article 43) or, provided that the granting authority is the European Commission or an EU executive agency, by adopting an enforceable decision under Article 299 of the Treaty on the Functioning of the EU (TFEU) and Article 100(2) of EU Financial Regulation 2018/1046.

If the Mutual Insurance Mechanism was called on by the granting authority to intervene, recovery will be continued in the name of the Mutual Insurance Mechanism. If two debit notes were sent, the second one (in the name of the Mutual Insurance Mechanism) will be considered to replace the first one (in the name of the granting authority). Where the MIM intervened, offsetting, enforceable decisions or any other of the above-mentioned forms of enforced recovery may be used mutatis mutandis.

The amount to be recovered will be increased by **late-payment interest** at the rate set out in Article 22.5, from the day following the payment date in the debit note, up to and including the date the full payment is received.

Partial payments will be first credited against expenses, charges and late-payment interest and then against the principal.

Bank charges incurred in the recovery process will be borne by the beneficiary, unless Directive 2015/2366[18] applies.

For grants where the granting authority is an EU executive agency, enforced recovery by offsetting or enforceable decision will be done by the services of the European Commission (see also Article 43).

22.5 Consequences of non-compliance

22.5.1 If the granting authority does not pay within the payment deadlines (see above), the beneficiaries are entitled to **late-payment interest** at the rate applied by the European Central Bank (ECB) for its main refinancing operations in euros ('reference rate'), plus the rate specified in the Data Sheet (Point 4.2). The reference rate is the rate in force on the first day of the month in which the payment deadline expires, as published in the C series of the *Official Journal of the European Union*.

[18] Directive (EU) 2015/2366 of the European Parliament and of the Council of 25 November 2015 on payment services in the internal market, amending Directives 2002/65/EC, 2009/110/EC and 2013/36/EU and Regulation (EU) No 1093/2010, and repealing Directive 2007/64/EC (OJ L 337, 23.12.2015, p. 35).

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If the late-payment interest is lower than or equal to EUR 200, it will be paid to the coordinator only on request submitted within two months of receiving the late payment.

Late-payment interest is not due if all beneficiaries are EU Member States (including regional and local government authorities or other public bodies acting on behalf of a Member State for the purpose of this Agreement).

If payments or the payment deadline are suspended (see Articles 29 and 30), payment will not be considered as late.

Late-payment interest covers the period running from the day following the due date for payment (see above), up to and including the date of payment.

Late-payment interest is not considered for the purposes of calculating the final grant amount.

22.5.2 If the coordinator breaches any of its obligations under this Article, the grant may be reduced (see Article 29) and the grant or the coordinator may be terminated (see Article 32).

Such breaches may also lead to other measures described in Chapter 5.

ARTICLE 23 — GUARANTEES

Not applicable

ARTICLE 24 — CERTIFICATES

Not applicable

ARTICLE 25 — CHECKS, REVIEWS, AUDITS AND INVESTIGATIONS — EXTENSION OF FINDINGS

25.1 Granting authority checks, reviews and audits

25.1.1 Internal checks

The granting authority may — during the action or afterwards — check the proper implementation of the action and compliance with the obligations under the Agreement, including assessing unit contributions, deliverables and reports.

25.1.2 Project reviews

The granting authority may carry out reviews on the proper implementation of the action and compliance with the obligations under the Agreement (general project reviews or specific issues reviews).

Such project reviews may be started during the implementation of the action and until the time-limit set out in the Data Sheet (see Point 6). They will be formally notified to the coordinator or beneficiary concerned and will be considered to start on the date of the notification.

If needed, the granting authority may be assisted by independent, outside experts. If it uses outside experts, the coordinator or beneficiary concerned will be informed and have the right to object on grounds of commercial confidentiality or conflict of interest.

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The coordinator or beneficiary concerned must cooperate diligently and provide — within the deadline requested — any information and data in addition to deliverables and reports already submitted (including information on the use of resources). The granting authority may request beneficiaries to provide such information to it directly. Sensitive information and documents will be treated in accordance with Article 13.

The coordinator or beneficiary concerned may be requested to participate in meetings, including with the outside experts.

For **on-the-spot visits**, the beneficiary concerned must allow access to sites and premises (including to the outside experts) and must ensure that information requested is readily available.

Information provided must be accurate, precise and complete and in the format requested, including electronic format.

On the basis of the review findings, a **project review report** will be drawn up.

The granting authority will formally notify the project review report to the coordinator or beneficiary concerned, which has 30 days from receiving notification to make observations.

Project reviews (including project review reports) will be in the language of the Agreement.

25.1.3 Audits

The granting authority may carry out audits on the proper implementation of the action and compliance with the obligations under the Agreement.

Such audits may be started during the implementation of the action and until the time-limit set out in the Data Sheet (see Point 6). They will be formally notified to the beneficiary concerned and will be considered to start on the date of the notification.

The granting authority may use its own audit service, delegate audits to a centralised service or use external audit firms. If it uses an external firm, the beneficiary concerned will be informed and have the right to object on grounds of commercial confidentiality or conflict of interest.

The beneficiary concerned must cooperate diligently and provide — within the deadline requested — any information (including complete accounts, individual salary statements or other personal data) to verify compliance with the Agreement. Sensitive information and documents will be treated in accordance with Article 13.

For **on-the-spot** visits, the beneficiary concerned must allow access to sites and premises (including for the external audit firm) and must ensure that information requested is readily available.

Information provided must be accurate, precise and complete and in the format requested, including electronic format.

On the basis of the audit findings, a **draft audit report** will be drawn up.

The auditors will formally notify the draft audit report to the beneficiary concerned, which has 30 days from receiving notification to make observations (contradictory audit procedure).

The **final audit report** will take into account observations by the beneficiary concerned and will be formally notified to them.

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Audits (including audit reports) will be in the language of the Agreement.

25.2 European Commission checks, reviews and audits in grants of other granting authorities

Where the granting authority is not the European Commission, the latter has the same rights of checks, reviews and audits as the granting authority.

25.3 Access to records for assessing simplified forms of funding

The beneficiaries must give the European Commission access to their statutory records for the periodic assessment of simplified forms of funding which are used in EU programmes.

25.4 OLAF, EPPO and ECA audits and investigations

The following bodies may also carry out checks, reviews, audits and investigations — during the action or afterwards:

- the European Anti-Fraud Office (OLAF) under Regulations No 883/2013[19] and No 2185/96[20]
- the European Public Prosecutor's Office (EPPO) under Regulation 2017/1939
- the European Court of Auditors (ECA) under Article 287 of the Treaty on the Functioning of the EU (TFEU) and Article 257 of EU Financial Regulation 2018/1046.

If requested by these bodies, the beneficiary concerned must provide full, accurate and complete information in the format requested (including complete accounts, individual salary statements or other personal data, including in electronic format) and allow access to sites and premises for on-the-spot visits or inspections — as provided for under these Regulations.

To this end, the beneficiary concerned must keep all relevant information relating to the action, at least until the time-limit set out in the Data Sheet (Point 6) and, in any case, until any ongoing checks, reviews, audits, investigations, litigation or other pursuits of claims have been concluded.

25.5 Consequences of checks, reviews, audits and investigations — Extension of results of reviews, audits or investigations

25.5.1 Consequences of checks, reviews, audits and investigations in this grant

Findings in checks, reviews, audits or investigations carried out in the context of this grant may lead to rejections (see Article 27), grant reduction (see Article 28) or other measures described in Chapter 5.

Rejections or grant reductions after the final payment will lead to a revised final grant amount (see Article 22).

[19] Regulation (EU, Euratom) No 883/2013 of the European Parliament and of the Council of 11 September 2013 concerning investigations conducted by the European Anti-Fraud Office (OLAF) and repealing Regulation (EC) No 1073/1999 of the European Parliament and of the Council and Council Regulation (Euratom) No 1074/1999 (OJ L 248, 18/09/2013, p. 1).

[20] Council Regulation (Euratom, EC) No 2185/1996 of 11 November 1996 concerning on-the-spot checks and inspections carried out by the Commission in order to protect the European Communities' financial interests against fraud and other irregularities (OJ L 292, 15/11/1996, p. 2).

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Findings in checks, reviews, audits or investigations during the action implementation may lead to a request for amendment (see Article 39), to change the description of the action set out in Annex 1.

Checks, reviews, audits or investigations that find systemic or recurrent errors, irregularities, fraud or breach of obligations in any EU grant may also lead to consequences in other EU grants awarded under similar conditions (‘extension to other grants’).

Moreover, findings arising from an OLAF or EPPO investigation may lead to criminal prosecution under national law.

25.5.2 Extension from other grants

Results of checks, reviews, audits or investigations in other grants may be extended to this grant, if:

(a) the beneficiary concerned is found, in other EU grants awarded under similar conditions, to have committed systemic or recurrent errors, irregularities, fraud or breach of obligations that have a material impact on this grant and

(b) those findings are formally notified to the beneficiary concerned — together with the list of grants affected by the findings — within the time-limit for audits set out in the Data Sheet (see Point 6).

The granting authority will formally notify the beneficiary concerned of the intention to extend the findings and the list of grants affected.

If the extension concerns **rejections of unit contributions**: the notification will include:

(a) an invitation to submit observations on the list of grants affected by the findings

(b) the request to submit revised financial statements for all grants affected

(c) the correction rate for extrapolation, established on the basis of the systemic or recurrent errors, to calculate the amounts to be rejected, if the beneficiary concerned:

(i) considers that the submission of revised financial statements is not possible or practicable or

(ii) does not submit revised financial statements.

If the extension concerns **grant reductions**: the notification will include:

(a) an invitation to submit observations on the list of grants affected by the findings and

(b) the **correction rate for extrapolation**, established on the basis of the systemic or recurrent errors and the principle of proportionality.

The beneficiary concerned has **60 days** from receiving notification to submit observations, revised financial statements or to propose a duly substantiated **alternative correction method/rate**.

On the basis of this, the granting authority will analyse the impact and decide on the implementation (i.e. start rejection or grant reduction procedures, either on the basis of the revised financial statements or the announced/alternative method/rate or a mix of those; see Articles 27 and 28).

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25.6 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, unit contributions insufficiently substantiated will be ineligible (see Article 6) and will be rejected (see Article 27), and the grant may be reduced (see Article 28).

Such breaches may also lead to other measures described in Chapter 5.

ARTICLE 26 — IMPACT EVALUATIONS

26.1 Impact evaluation

The granting authority may carry out impact evaluations of the action, measured against the objectives and indicators of the EU programme funding the grant.

Such evaluations may be started during implementation of the action and until the time-limit set out in the Data Sheet (see Point 6). They will be formally notified to the coordinator or beneficiaries and will be considered to start on the date of the notification.

If needed, the granting authority may be assisted by independent outside experts.

The coordinator or beneficiaries must provide any information relevant to evaluate the impact of the action, including information in electronic format.

26.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the granting authority may apply the measures described in Chapter 5.

CHAPTER 5 CONSEQUENCES OF NON-COMPLIANCE

SECTION 1 REJECTIONS AND GRANT REDUCTION

ARTICLE 27 — REJECTION OF CONTRIBUTIONS

27.1 Conditions

The granting authority will — at beneficiary termination, interim payment, final payment or afterwards — reject any unit contributions which are ineligible (see Article 6), in particular following checks, reviews, audits or investigations (see Article 25).

The rejection may also be based on the extension of findings from other grants to this grant (see Article 25).

Ineligible unit contributions will be rejected.

27.2 Procedure

If the rejection does not lead to a recovery, the granting authority will formally notify the coordinator or beneficiary concerned of the rejection, the amounts and the reasons why. The coordinator or

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beneficiary concerned may — within 30 days of receiving notification — submit observations if it disagrees with the rejection (payment review procedure).

If the rejection leads to a recovery, the granting authority will follow the contradictory procedure with pre-information letter set out in Article 22.

27.3 Effects

If the granting authority rejects unit contributions, it will deduct them from the contributions declared and then calculate the amount due (and, if needed, make a recovery; see Article 22).

ARTICLE 28 — GRANT REDUCTION

28.1 Conditions

The granting authority may — at beneficiary termination, final payment or afterwards — reduce the grant for a beneficiary, if:

(a) the beneficiary (or a person having powers of representation, decision-making or control, or person essential for the award/implementation of the grant) has committed:

  (i) substantial errors, irregularities or fraud or

  (ii) serious breach of obligations under this Agreement or during its award (including improper implementation of the action, non-compliance with the call conditions, submission of false information, failure to provide required information, breach of ethics or security rules (if applicable), etc.), or

(b) the beneficiary (or a person having powers of representation, decision-making or control, or person essential for the award/implementation of the grant) has committed — in other EU grants awarded to it under similar conditions — systemic or recurrent errors, irregularities, fraud or serious breach of obligations that have a material impact on this grant (see Article 25).

The amount of the reduction will be calculated for each beneficiary concerned and proportionate to the seriousness and the duration of the errors, irregularities or fraud or breach of obligations, by applying an individual reduction rate to their accepted EU contribution.

28.2 Procedure

If the grant reduction does not lead to a recovery, the granting authority will formally notify the coordinator or beneficiary concerned of the reduction, the amount to be reduced and the reasons why. The coordinator or beneficiary concerned may — within 30 days of receiving notification — submit observations if it disagrees with the reduction (payment review procedure).

If the grant reduction leads to a recovery, the granting authority will follow the contradictory procedure with pre-information letter set out in Article 22.

28.3 Effects

If the granting authority reduces the grant, it will deduct the reduction and then calculate the amount due (and, if needed, make a recovery; see Article 22).

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SECTION 2 SUSPENSION AND TERMINATION

ARTICLE 29 — PAYMENT DEADLINE SUSPENSION

29.1 Conditions

The granting authority may — at any moment — suspend the payment deadline if a payment cannot be processed because:

(a) the required report (see Article 21) has not been submitted or is not complete or additional information is needed

(b) there are doubts about the amount to be paid (e.g. ongoing audit extension procedure, queries about eligibility, need for a grant reduction, etc.) and additional checks, reviews, audits or investigations are necessary, or

(c) there are other issues affecting the EU financial interests.

29.2 Procedure

The granting authority will formally notify the coordinator of the suspension and the reasons why.

The suspension will **take effect** the day the notification is sent.

If the conditions for suspending the payment deadline are no longer met, the suspension will be **lifted** — and the remaining time to pay (see Data Sheet, Point 4.2) will resume.

If the suspension exceeds two months, the coordinator may request the granting authority to confirm if the suspension will continue.

If the payment deadline has been suspended due to the non-compliance of the report and the revised report is not submitted (or was submitted but is also rejected), the granting authority may also terminate the grant or the participation of the coordinator (see Article 32).

ARTICLE 30 — PAYMENT SUSPENSION

30.1 Conditions

The granting authority may — at any moment — suspend payments, in whole or in part for one or more beneficiaries, if:

(a) a beneficiary (or a person having powers of representation, decision-making or control, or person essential for the award/implementation of the grant) has committed or is suspected of having committed:

(i) substantial errors, irregularities or fraud or

(ii) serious breach of obligations under this Agreement or during its award (including improper implementation of the action, non-compliance with the call conditions, submission of false information, failure to provide required information, breach of ethics or security rules (if applicable), etc.), or

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(b) a beneficiary (or a person having powers of representation, decision-making or control, or person essential for the award/implementation of the grant) has committed — in other EU grants awarded to it under similar conditions — systemic or recurrent errors, irregularities, fraud or serious breach of obligations that have a material impact on this grant.

If payments are suspended for one or more beneficiaries, the granting authority will make partial payment(s) for the part(s) not suspended. If suspension concerns the final payment, the payment (or recovery) of the remaining amount after suspension is lifted will be considered to be the payment that closes the action.

30.2 Procedure

Before suspending payments, the granting authority will send a **pre-information letter** to the beneficiary concerned:

- formally notifying the intention to suspend payments and the reasons why and
- requesting observations within 30 days of receiving notification.

If the granting authority does not receive observations or decides to pursue the procedure despite the observations it has received, it will confirm the suspension (**confirmation letter**). Otherwise, it will formally notify that the procedure is discontinued.

At the end of the suspension procedure, the granting authority will also inform the coordinator.

The suspension will **take effect** the day after the confirmation notification is sent.

If the conditions for resuming payments are met, the suspension will be **lifted**. The granting authority will formally notify the beneficiary concerned (and the coordinator) and set the suspension end date.

During the suspension, no prefinancing will be paid to the beneficiaries concerned. For interim payments, the periodic reports for all reporting periods except the last one (see Article 21) must not contain any financial statements from the beneficiary concerned (or its affiliated entities). The coordinator must include them in the next periodic report after the suspension is lifted or — if suspension is not lifted before the end of the action — in the last periodic report.

ARTICLE 31 — GRANT AGREEMENT SUSPENSION

31.1 Consortium-requested GA suspension

31.1.1 Conditions and procedure

The beneficiaries may request the suspension of the grant or any part of it, if exceptional circumstances — in particular *force majeure* (see Article 35) — make implementation impossible or excessively difficult.

The coordinator must submit a request for **amendment** (see Article 39), with:

- the reasons why
- the date the suspension takes effect; this date may be before the date of the submission of the amendment request and

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- the expected date of resumption.

The suspension will **take effect** on the day specified in the amendment.

Once circumstances allow for implementation to resume, the coordinator must immediately request another **amendment** of the Agreement to set the suspension end date, the resumption date (one day after suspension end date), extend the duration and make other changes necessary to adapt the action to the new situation (see Article 39) — unless the grant has been terminated (see Article 32). The suspension will be **lifted** with effect from the suspension end date set out in the amendment. This date may be before the date of the submission of the amendment request.

During the suspension, no prefinancing will be paid. Moreover, no units may be implemented. Ongoing units must be interrupted and no new units may be started. Unit contributions for activities implemented during grant suspension are not eligible (see Article 6.3).

31.2 EU-initiated GA suspension

31.2.1 Conditions

The granting authority may suspend the grant or any part of it, if:

(a) a beneficiary (or a person having powers of representation, decision-making or control, or person essential for the award/implementation of the grant) has committed or is suspected of having committed:

(i) substantial errors, irregularities or fraud or

(ii) serious breach of obligations under this Agreement or during its award (including improper implementation of the action, non-compliance with the call conditions, submission of false information, failure to provide required information, breach of ethics or security rules (if applicable), etc.), or

(b) a beneficiary (or a person having powers of representation, decision-making or control, or person essential for the award/implementation of the grant) has committed — in other EU grants awarded to it under similar conditions — systemic or recurrent errors, irregularities, fraud or serious breach of obligations that have a material impact on this grant

(c) other:

(i) linked action issues: not applicable

(ii) the action has lost its scientific or technological relevance

31.2.2 Procedure

Before suspending the grant, the granting authority will send a **pre-information letter** to the coordinator:

- formally notifying the intention to suspend the grant and the reasons why and
- requesting observations within 30 days of receiving notification.

If the granting authority does not receive observations or decides to pursue the procedure despite the

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observations it has received, it will confirm the suspension (**confirmation letter**). Otherwise, it will formally notify that the procedure is discontinued.

The suspension will **take effect** the day after the confirmation notification is sent (or on a later date specified in the notification).

Once the conditions for resuming implementation of the action are met, the granting authority will formally notify the coordinator a **lifting of suspension letter**, in which it will set the suspension end date and invite the coordinator to request an amendment of the Agreement to set the resumption date (one day after suspension end date), extend the duration and make other changes necessary to adapt the action to the new situation (see Article 39) — unless the grant has been terminated (see Article 32). The suspension will be **lifted** with effect from the suspension end date set out in the lifting of suspension letter. This date may be before the date on which the letter is sent.

During the suspension, no prefinancing will be paid. Moreover, no units may be implemented Ongoing units must be interrupted and no new units may be started. Unit contributions for activities implemented during suspension are not eligible (see Article 6.3).

The beneficiaries may not claim damages due to suspension by the granting authority (see Article 33).

Grant suspension does not affect the granting authority's right to terminate the grant or a beneficiary (see Article 32) or reduce the grant (see Article 28).

ARTICLE 32 — GRANT AGREEMENT OR BENEFICIARY TERMINATION

32.1 Consortium-requested GA termination

32.1.1 Conditions and procedure

The beneficiaries may request the termination of the grant.

The coordinator must submit a request for **amendment** (see Article 39), with:

- the reasons why
- the date the consortium ends work on the action ('end of work date') and
- the date the termination takes effect ('termination date'); this date must be after the date of the submission of the amendment request.

The termination will **take effect** on the termination date specified in the amendment.

If no reasons are given or if the granting authority considers the reasons do not justify termination, it may consider the grant terminated improperly.

32.1.2 Effects

The coordinator must — within 60 days from when termination takes effect — submit a **periodic report** (for the open reporting period until termination).

The granting authority will calculate the final grant amount and final payment on the basis of the

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report submitted and taking into account the unit contributions for activities implemented before the end of work date (see Article 22).

If the granting authority does not receive the report within the deadline, only unit contributions which are included in an approved periodic report will be taken into account (no contributions if no periodic report was ever approved).

Improper termination may lead to a grant reduction (see Article 28).

After termination, the beneficiaries' obligations (in particular Articles 13 (confidentiality and security), 16 (IPR), 17 (communication, dissemination and visibility), 21 (reporting), 25 (checks, reviews, audits and investigations), 26 (impact evaluation), 27 (rejections), 28 (grant reduction) and 42 (assignment of claims)) continue to apply.

32.2 Consortium-requested beneficiary termination

32.2.1 Conditions and procedure

The coordinator may request the termination of the participation of one or more beneficiaries, on request of the beneficiary concerned or on behalf of the other beneficiaries.

The coordinator must submit a request for **amendment** (see Article 39), with:

- the reasons why
- the opinion of the beneficiary concerned (or proof that this opinion has been requested in writing)
- the date the beneficiary ends work on the action ('end of work date')
- the date the termination takes effect ('termination date'); this date must be after the date of the submission of the amendment request.

If the termination concerns the coordinator and is done without its agreement, the amendment request must be submitted by another beneficiary (acting on behalf of the consortium).

The termination will **take effect** on the termination date specified in the amendment.

If no information is given or if the granting authority considers that the reasons do not justify termination, it may consider the beneficiary to have been terminated improperly.

32.2.2 Effects

The coordinator must — within 60 days from when termination takes effect — submit:

(i) a **report on the distribution of payments** to the beneficiary concerned

(ii) a **termination report** from the beneficiary concerned, for the open reporting period until termination, containing an overview of the progress of the work, the financial statement and the explanation on the use of resources

(iii) a second **request for amendment** (see Article 39) with other amendments needed (e.g.

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reallocation of the tasks and the estimated budget of the terminated beneficiary; addition of a new beneficiary to replace the terminated beneficiary; change of coordinator, etc.).

The granting authority will calculate the amount due to the beneficiary on the basis of the report submitted and taking into account the unit contributions for activities implemented before the end of work date (see Article 22).

The information in the termination report must also be included in the periodic report for the next reporting period (see Article 21).

If the granting authority does not receive the termination report within the deadline, only unit contributions which are included in an approved periodic report will be taken into account (no contributions if no periodic report was ever approved).

If the granting authority does not receive the report on the distribution of payments within the deadline, it will consider that:

- the coordinator did not distribute any payment to the beneficiary concerned and that
- the beneficiary concerned must not repay any amount to the coordinator.

If the second request for amendment is accepted by the granting authority, the Agreement is **amended** to introduce the necessary changes (see Article 39).

If the second request for amendment is rejected by the granting authority (because it calls into question the decision awarding the grant or breaches the principle of equal treatment of applicants), the grant may be terminated (see Article 32).

Improper termination may lead to a reduction of the grant (see Article 31) or grant termination (see Article 32).

After termination, the concerned beneficiary's obligations (in particular Articles 13 (confidentiality and security), 16 (IPR), 17 (communication, dissemination and visibility), 21 (reporting), 25 (checks, reviews, audits and investigations), 26 (impact evaluation), 27 (rejections), 28 (grant reduction) and 42 (assignment of claims)) continue to apply.

32.3 EU-initiated GA or beneficiary termination

32.3.1 Conditions

The granting authority may terminate the grant or the participation of one or more beneficiaries, if:

(a) one or more beneficiaries do not accede to the Agreement (see Article 40)

(b) a change to the action or the legal, financial, technical, organisational or ownership situation of a beneficiary is likely to substantially affect the implementation of the action or calls into question the decision to award the grant (including changes linked to one of the exclusion grounds listed in the declaration of honour)

(c) following termination of one or more beneficiaries, the necessary changes to the Agreement (and their impact on the action) would call into question the decision awarding the grant or breach the principle of equal treatment of applicants

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(d) implementation of the action has become impossible or the changes necessary for its continuation would call into question the decision awarding the grant or breach the principle of equal treatment of applicants

(e) a beneficiary (or person with unlimited liability for its debts) is subject to bankruptcy proceedings or similar (including insolvency, winding-up, administration by a liquidator or court, arrangement with creditors, suspension of business activities, etc.)

(f) a beneficiary (or person with unlimited liability for its debts) is in breach of social security or tax obligations

(g) a beneficiary (or person having powers of representation, decision-making or control, or person essential for the award/implementation of the grant) has been found guilty of grave professional misconduct

(h) a beneficiary (or person having powers of representation, decision-making or control, or person essential for the award/implementation of the grant) has committed fraud, corruption, or is involved in a criminal organisation, money laundering, terrorism-related crimes (including terrorism financing), child labour or human trafficking

(i) a beneficiary (or person having powers of representation, decision-making or control, or person essential for the award/implementation of the grant) was created under a different jurisdiction with the intent to circumvent fiscal, social or other legal obligations in the country of origin (or created another entity with this purpose)

(j) a beneficiary (or person having powers of representation, decision-making or control, or person essential for the award/implementation of the grant) has committed:

  (i) substantial errors, irregularities or fraud or

  (ii) serious breach of obligations under this Agreement or during its award (including improper implementation of the action, non-compliance with the call conditions, submission of false information, failure to provide required information, breach of ethics or security rules (if applicable), etc.)

(k) a beneficiary (or person having powers of representation, decision-making or control, or person essential for the award/implementation of the grant) has committed — in other EU grants awarded to it under similar conditions — systemic or recurrent errors, irregularities, fraud or serious breach of obligations that have a material impact on this grant (extension of findings from other grants to this grant; see Article 25)

(l) despite a specific request by the granting authority, a beneficiary does not request — through the coordinator — an amendment to the Agreement to end the participation of one of its affiliated entities or associated partners that is in one of the situations under points (d), (f), (e), (g), (h), (i) or (j) and to reallocate its tasks, or

(m) other:

  (i) linked action issues: not applicable

  (ii) the action has lost its scientific or technological relevance

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32.3.2 Procedure

Before terminating the grant or participation of one or more beneficiaries, the granting authority will send **a pre-information letter** to the coordinator or beneficiary concerned:

- formally notifying the intention to terminate and the reasons why and
- requesting observations within 30 days of receiving notification.

If the granting authority does not receive observations or decides to pursue the procedure despite the observations it has received, it will confirm the termination and the date it will take effect (**confirmation letter**). Otherwise, it will formally notify that the procedure is discontinued.

For beneficiary terminations, the granting authority will — at the end of the procedure — also inform the coordinator.

The termination will **take effect** the day after the confirmation notification is sent (or on a later date specified in the notification; 'termination date').

32.3.3 Effects

(a) for **GA termination**:

The coordinator must — within 60 days from when termination takes effect — submit a **periodic report** (for the last open reporting period until termination).

The granting authority will calculate the final grant amount and final payment on the basis of the report submitted (see Article 22). Only units implemented until termination will be accepted.

If the grant is terminated for breach of the obligation to submit reports, the coordinator may not submit any report after termination.

If the granting authority does not receive the report within the deadline, only unit contributions which are included in an approved periodic report will be taken into account (no contributions if no periodic report was ever approved).

Termination does not affect the granting authority's right to reduce the grant (see Article 28) or to impose administrative sanctions (see Article 34).

The beneficiaries may not claim damages due to termination by the granting authority (see Article 33).

After termination, the beneficiaries' obligations (in particular Articles 13 (confidentiality and security), 16 (IPR), 17 (communication, dissemination and visibility), 21 (reporting), 25 (checks, reviews, audits and investigations), 26 (impact evaluation), 27 (rejections), 28 (grant reduction) and 42 (assignment of claims)) continue to apply.

(b) for **beneficiary termination**:

The coordinator must — within 60 days from when termination takes effect — submit:

(i) a **report on the distribution of payments** to the beneficiary concerned

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(ii) a **termination report** from the beneficiary concerned, for the open reporting period until termination, containing an overview of the progress of the work, the financial statement, and the explanation on the use of resources

(iii) a **request for amendment** (see Article 39) with any amendments needed (e.g. reallocation of the tasks and the estimated budget of the terminated beneficiary; addition of a new beneficiary to replace the terminated beneficiary; change of coordinator, etc.).

The granting authority will calculate the amount due to the beneficiary on the basis of the report submitted (see Article 22). Only units implemented until termination will be accepted.

The information in the termination report must also be included in the periodic report for the next reporting period (see Article 21).

If the granting authority does not receive the termination report within the deadline, only unit contributions included in an approved periodic report will be taken into account (no contributions if no periodic report was ever approved).

If the granting authority does not receive the report on the distribution of payments within the deadline, it will consider that:

- the coordinator did not distribute any payment to the beneficiary concerned and that
- the beneficiary concerned must not repay any amount to the coordinator.

If the request for amendment is accepted by the granting authority, the Agreement is **amended** to introduce the necessary changes (see Article 39).

If the request for amendment is rejected by the granting authority (because it calls into question the decision awarding the grant or breaches the principle of equal treatment of applicants), the grant may be terminated (see Article 32).

After termination, the concerned beneficiary's obligations (in particular Articles 13 (confidentiality and security), 16 (IPR), 17 (communication, dissemination and visibility), 21 (reporting), 25 (checks, reviews, audits and investigations), 26 (impact evaluation), 27 (rejections), 28 (grant reduction) and 42 (assignment of claims)) continue to apply.

SECTION 3 OTHER CONSEQUENCES: DAMAGES AND ADMINISTRATIVE SANCTIONS

ARTICLE 33 — DAMAGES

33.1 Liability of the granting authority

The granting authority cannot be held liable for any damage caused to the beneficiaries or to third parties as a consequence of the implementation of the Agreement, including for gross negligence.

The granting authority cannot be held liable for any damage caused by any of the beneficiaries or other participants involved in the action, as a consequence of the implementation of the Agreement.

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33.2 Liability of the beneficiaries

The beneficiaries must compensate the granting authority for any damage it sustains as a result of the implementation of the action or because the action was not implemented in full compliance with the Agreement, provided that it was caused by gross negligence or wilful act.

The liability does not extend to indirect or consequential losses or similar damage (such as loss of profit, loss of revenue or loss of contracts), provided such damage was not caused by wilful act or by a breach of confidentiality.

ARTICLE 34 — ADMINISTRATIVE SANCTIONS AND OTHER MEASURES

Nothing in this Agreement may be construed as preventing the adoption of administrative sanctions (i.e. exclusion from EU award procedures and/or financial penalties) or other public law measures, in addition or as an alternative to the contractual measures provided under this Agreement (see, for instance, Articles 135 to 145 EU Financial Regulation 2018/1046 and Articles 4 and 7 of Regulation 2988/95[21]).

SECTION 4 FORCE MAJEURE

ARTICLE 35 — FORCE MAJEURE

A party prevented by force majeure from fulfilling its obligations under the Agreement cannot be considered in breach of them.

'Force majeure' means any situation or event that:

- prevents either party from fulfilling their obligations under the Agreement,
- was unforeseeable, exceptional situation and beyond the parties' control,
- was not due to error or negligence on their part (or on the part of other participants involved in the action), and
- proves to be inevitable in spite of exercising all due diligence.

Any situation constituting force majeure must be formally notified to the other party without delay, stating the nature, likely duration and foreseeable effects.

The parties must immediately take all the necessary steps to limit any damage due to force majeure and do their best to resume implementation of the action as soon as possible.

CHAPTER 6 FINAL PROVISIONS

ARTICLE 36 — COMMUNICATION BETWEEN THE PARTIES

36.1 Forms and means of communication — Electronic management

[21] Council Regulation (EC, Euratom) No 2988/95 of 18 December 1995 on the protection of the European Communities financial interests (OJ L 312, 23.12.1995, p. 1).

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EU grants are managed fully electronically through the EU Funding & Tenders Portal ('Portal').

All communications must be made electronically through the Portal, in accordance with the Portal Terms and Conditions and using the forms and templates provided there (except if explicitly instructed otherwise by the granting authority).

Communications must be made in writing and clearly identify the grant agreement (project number and acronym).

Communications must be made by persons authorised according to the Portal Terms and Conditions. For naming the authorised persons, each beneficiary must have designated — before the signature of this Agreement — a 'legal entity appointed representative (LEAR)'. The role and tasks of the LEAR are stipulated in their appointment letter (see Portal Terms and Conditions).

If the electronic exchange system is temporarily unavailable, instructions will be given on the Portal.

36.2 Date of communication

The sending date for communications made through the Portal will be the date and time of sending, as indicated by the time logs.

The receiving date for communications made through the Portal will be the date and time the communication is accessed, as indicated by the time logs. Formal notifications that have not been accessed within 10 days after sending, will be considered to have been accessed (see Portal Terms and Conditions).

If a communication is exceptionally made on paper (by e-mail or postal service), general principles apply (i.e. date of sending/receipt). Formal notifications by registered post with proof of delivery will be considered to have been received either on the delivery date registered by the postal service or the deadline for collection at the post office.

If the electronic exchange system is temporarily unavailable, the sending party cannot be considered in breach of its obligation to send a communication within a specified deadline.

36.3 Addresses for communication

The Portal can be accessed via the Europa website.

The address for paper communications to the granting authority (if exceptionally allowed) is the official mailing address indicated on its website.

For beneficiaries, it is the legal address specified in the Portal Participant Register.

ARTICLE 37 — INTERPRETATION OF THE AGREEMENT

The provisions in the Data Sheet take precedence over the rest of the Terms and Conditions of the Agreement.

Annex 5 takes precedence over the Terms and Conditions; the Terms and Conditions take precedence over the Annexes other than Annex 5.

Annex 2 takes precedence over Annex 1.

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ARTICLE 38 — CALCULATION OF PERIODS AND DEADLINES

In accordance with Regulation No 1182/71[22], periods expressed in days, months or years are calculated from the moment the triggering event occurs.

The day during which that event occurs is not considered as falling within the period.

'Days' means calendar days, not working days.

ARTICLE 39 — AMENDMENTS

39.1 Conditions

The Agreement may be amended, unless the amendment entails changes to the Agreement which would call into question the decision awarding the grant or breach the principle of equal treatment of applicants.

Amendments may be requested by any of the parties.

39.2 Procedure

The party requesting an amendment must submit a request for amendment signed directly in the Portal Amendment tool.

The coordinator submits and receives requests for amendment on behalf of the beneficiaries (see Annex 3). If a change of coordinator is requested without its agreement, the submission must be done by another beneficiary (acting on behalf of the other beneficiaries).

The request for amendment must include:

- the reasons why
- the appropriate supporting documents and
- for a change of coordinator without its agreement: the opinion of the coordinator (or proof that this opinion has been requested in writing).

The granting authority may request additional information.

If the party receiving the request agrees, it must sign the amendment in the tool within 45 days of receiving notification (or any additional information the granting authority has requested). If it does not agree, it must formally notify its disagreement within the same deadline. The deadline may be extended, if necessary for the assessment of the request. If no notification is received within the deadline, the request is considered to have been rejected.

An amendment **enters into force** on the day of the signature of the receiving party.

An amendment **takes effect** on the date of entry into force or other date specified in the amendment.

[22] Regulation (EEC, Euratom) No 1182/71 of the Council of 3 June 1971 determining the rules applicable to periods, dates and time-limits (OJ L 124, 8/6/1971, p. 1).

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ARTICLE 40 — ACCESSION AND ADDITION OF NEW BENEFICIARIES

40.1 Accession of the beneficiaries mentioned in the Preamble

The beneficiaries which are not coordinator must accede to the grant by signing the accession form (see Annex 3) directly in the Portal Grant Preparation tool, within 30 days after the entry into force of the Agreement (see Article 44).

They will assume the rights and obligations under the Agreement with effect from the date of its entry into force (see Article 44).

If a beneficiary does not accede to the grant within the above deadline, the coordinator must — within 30 days — request an amendment (see Article 39) to terminate the beneficiary and make any changes necessary to ensure proper implementation of the action. This does not affect the granting authority's right to terminate the grant (see Article 32).

40.2 Addition of new beneficiaries

In justified cases, the beneficiaries may request the addition of a new beneficiary.

For this purpose, the coordinator must submit a request for amendment in accordance with Article 39. It must include an accession form (see Annex 3) signed by the new beneficiary directly in the Portal Amendment tool.

New beneficiaries will assume the rights and obligations under the Agreement with effect from the date of their accession specified in the accession form (see Annex 3).

Additions are also possible in mono-beneficiary grants.

ARTICLE 41 — TRANSFER OF THE AGREEMENT

In justified cases, the beneficiary of a mono-beneficiary grant may request the transfer of the grant to a new beneficiary, provided that this would not call into question the decision awarding the grant or breach the principle of equal treatment of applicants.

The beneficiary must submit a request for **amendment** (see Article 39), with

- the reasons why
- the accession form (see Annex 3) signed by the new beneficiary directly in the Portal Amendment tool and
- additional supporting documents (if required by the granting authority).

The new beneficiary will assume the rights and obligations under the Agreement with effect from the date of accession specified in the accession form (see Annex 3).

ARTICLE 42 — ASSIGNMENTS OF CLAIMS FOR PAYMENT AGAINST THE GRANTING AUTHORITY

The beneficiaries may not assign any of their claims for payment against the granting authority to

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any third party, except if expressly approved in writing by the granting authority on the basis of a reasoned, written request by the coordinator (on behalf of the beneficiary concerned).

If the granting authority has not accepted the assignment or if the terms of it are not observed, the assignment will have no effect on it.

In no circumstances will an assignment release the beneficiaries from their obligations towards the granting authority.

ARTICLE 43 — APPLICABLE LAW AND SETTLEMENT OF DISPUTES

43.1 Applicable law

The Agreement is governed by the applicable EU law, supplemented if necessary by the law of Belgium.

Special rules may apply for beneficiaries which are international organisations (if any; see Data Sheet, Point 5).

43.2 Dispute settlement

If a dispute concerns the interpretation, application or validity of the Agreement, the parties must bring action before the EU General Court — or, on appeal, the EU Court of Justice — under Article 272 of the Treaty on the Functioning of the EU (TFEU).

For non-EU beneficiaries (if any), such disputes must be brought before the courts of Brussels, Belgium — unless an international agreement provides for the enforceability of EU court judgements.

For beneficiaries with arbitration as special dispute settlement forum (if any; see Data Sheet, Point 5), the dispute will — in the absence of an amicable settlement — be settled in accordance with the Rules for Arbitration published on the Portal.

If a dispute concerns administrative sanctions, offsetting or an enforceable decision under Article 299 TFEU (see Articles 22 and 34), the beneficiaries must bring action before the General Court — or, on appeal, the Court of Justice — under Article 263 TFEU.

For grants where the granting authority is an EU executive agency (see Preamble), actions against offsetting and enforceable decisions must be brought against the European Commission (not against the granting authority; see also Article 22).

ARTICLE 44 — ENTRY INTO FORCE

The Agreement will enter into force on the day of signature by the granting authority or the coordinator, depending on which is later.

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SIGNATURES

For the coordinator

María Belén Rubio Armesto with ECAS id nlongogm signed in the Participant Portal on 22/06/2022 at 09:15:37 (transaction id SigId-200948-TnqihjaotZpFFFM7MPQQMDLtKwcFL5Pxu4NMRskYVMmUy39L9CUqzpKlzTCQgpAxX6tubYyxhT1pzytUrrCzzcj-yntOf97TTHq9QCab4GzIaj-gZwUBW4WkYb5KuZhF72AID8qG0hGjgEeEi5CEExViGrNR4K01T7XEt5kQfL9vLk5mcQ2x3L68go9HpLVKT7Pvm). Timestamp by third party at 2022.06.22 10:15:43 CEST

For the granting authority

Signed by Klaus HAUPT with ECAS id hauptkl as an authorised representative on 22-06-2022 13:24:30 (transaction id SigId-204791-SE7IXNBlxR171eSEsNrxWhx0o8dmpIHHzdmiKXWPcagmv9ufGa8lHVIviR9FsgQjBaTygmCMw91A78nrkW0OzS-yntOf97TTHq9QCab4GzIaj-zqW6oXSUKziaT8MWcmgX0GmqdjP8ijK5YtYzg49Y3dds6FhB0DUiNUt6sjycROpzzwDiJu44msofKzQSzH5kzkBW)
2022.06.22 13:24:54 CEST

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ANNEX 1

Horizon Europe (HORIZON)

Description of the action (DoA)

Part A

Part B

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DESCRIPTION OF THE ACTION (PART A)

COVER PAGE

Part A of the Description of the Action (DoA) must be completed directly on the Portal Grant Preparation screens.

PROJECT *Grant Preparation (General Information screen) — Enter the info.*	
Project number:	101072637
Project name:	Quantum-Safe-Internet
Project acronym:	QSI
Call:	HORIZON-MSCA-2021-DN-01
Topic:	HORIZON-MSCA-2021-DN-01-01
Type of action:	HORIZON-TMA-MSCA-DN
Service:	REA/A/01
Project starting date:	fixed date: 1 October 2022
Project duration:	48 months

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PROJECT SUMMARY

Project summary

Grant Preparation (General Information screen) — Provide an overall description of your project (including context and overall objectives, planned activities and main achievements, and expected results and impacts (on target groups, change procedures, capacities, innovation etc)). This summary should give readers a clear idea of what your project is about.

Use the project summary from your proposal.

QSI aims at training a world-class cohort of doctoral candidates (DCs) capable of taking the next essential steps in the highly demanding area of cybersecurity. We aim to build strong lasting links between strategically selected industry and academic partners, in different disciplines, via the development of novel technologies for practical applications in data security. In parallel, we will also combine, via a collaborative long-term interdisciplinary approach, expertise in all relevant communities to address key fundamental problems in secure communications in the quantum era, and the important applications therein. The planned training network will provide research and training opportunities to a new generation of DCs, who, in the long-run, shall address the Grand Challenge of providing "Quantum-Safe Internet", i.e., a communication infrastructure that is secure against not only classical attacks but also those enabled by quantum technologies. Today's Internet security heavily relies on computational complexity assumptions, and as such is seriously threatened by advancements in quantum computing technologies. Indeed, we have recently witnessed a wave of key developments in this direction by a number of IT giants, e.g., Google, IBM, Microsoft, and Intel. This particularly jeopardizes applications that require long-term security. The number of such applications is continuously growing as more and more of our private information is stored and communicated in a digital way, e.g., electronic health records, which are now required by European legislation to remain secure for a long time. This requires us to urgently develop and implement new solutions, as we plan to do in this Doctoral Network (DN).

LIST OF PARTICIPANTS

PARTICIPANTS

Grant Preparation (Beneficiaries screen) — Enter the info.

Number	Role	Short name	Legal name	Country	PIC
1	COO	UVIGO	UNIVERSIDAD DE VIGO	ES	999630494
2	BEN	SU	SORBONNE UNIVERSITE	FR	909875521
3	BEN	UNIPD	UNIVERSITA DEGLI STUDI DI PADOVA	IT	999995602
4	BEN	RUB	RUHR-UNIVERSITAET BOCHUM	DE	999988812
5	BEN	UvA	UNIVERSITEIT VAN AMSTERDAM	NL	999985708
6	BEN	TU/e	TECHNISCHE UNIVERSITEIT EINDHOVEN	NL	999977269
7	BEN	DTU	DANMARKS TEKNISKE UNIVERSITET	DK	999990655
8	AP	CWI	STICHTING NEDERLANDSE WETENSCHAPPELIJK ONDERZOEK INSTITUTEN	NL	999624092
9	AP	TTBE	UNIVERSITY OF OTTAWA	CA	999885216
10	AP	UT	University of Toyama	JP	940379596
11	AP	VERIQLOUD	VERIQLOUD	FR	909315637
12	AP	genua	genua mbh	DE	950615521
13	AP	SIG	SERVICES INDUSTRIELS DE GENEVE	CH	904037091

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PARTICIPANTS

Grant Preparation (Beneficiaries screen) — Enter the info.

Number	Role	Short name	Legal name	Country	PIC
14	AP	INRIM	ISTITUTO NAZIONALE DI RICERCA METROLOGICA	IT	998627805
15	AP	NXP	NXP SEMICONDUCTORS NETHERLANDS BV	NL	999995020
16	AP	NTT	NIPPON TELEGRAPH AND TELEPHONE CORPORATION	JP	962822486
17	AP	CISCO	CISCO SYSTEMS, INC	US	950586615
18	AP	EUTELSAT	EUTELSAT	FR	997257971
19	AP	UNIGE	UNIVERSITE DE GENEVE	CH	999974650
20	AP	ID QUANTIQUE SA	ID QUANTIQUE SA	CH	999662892
21	AP	ULEEDS	UNIVERSITY OF LEEDS	UK	999975426
22	AP	TOSHEU	TOSHIBA EUROPE LIMITED	UK	999958548

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LIST OF WORK PACKAGES

Work packages

Grant Preparation (Work Packages screen) — Enter the info.

Work Package No	Work Package name	Lead Beneficiary	Effort (Person-Months)	Start Month	End Month	Deliverable No(s)
WP1	Quantum-Safe Cryptography Protocols	4 - RUB	271.00	1	48	D1.5, D1.3, D1.4, D1.2, D1.1
WP2	Quantum-Safe Communications Networks	3 - UNIPD	162.00	1	48	D2.4, D2.1, D2.2, D2.3
WP3	Management	1 - UVIGO	39.00	1	48	D3.2, D3.3, D3.4, D3.1
WP4	Science & Technology (S&T) Training	5 - UvA	36.00	1	48	D4.5, D4.4, D4.3, D4.1, D4.2
WP5	Complementary-Skill (CS) Training	6 - TU/e	34.00	1	45	D5.3, D5.2, D5.1
WP6	Dissemination and Impact (DIC)	2 - SU	29.00	1	48	D6.4, D6.2, D6.8, D6.5, D6.3, D6.1, D6.7, D6.6, D6.9
WP7	Outreach Activities	7 - DTU	27.00	6	48	D7.4, D7.1, D7.2, D7.3

Associated with document Ref. Ares(2022)4533596 - 20/06/2022

Work package WP1 – Quantum-Safe Cryptography Protocols

Work Package Number	WP1	Lead Beneficiary	4. RUB
Work Package Name	Quantum-Safe Cryptography Protocols		
Start Month	1	End Month	48

Objectives
To develop novel QS protocols and enhance existing ones; To evaluate their security against quantum adversaries

Description
The thrust of this WP is to study cryptographic protocols that exploit quantum, post-quantum and hybrid techniques, and to evaluate their security against an adversary with quantum computing capabilities. It consists of 54 theory (DRs 1, 2, 4, and 5 and 12), and 1 joint theory-experiment (DR 3) projects, on which 165 partners, overall, will collaborate. At the theory level, UV (DR 1) develops security proof techniques able to tackle typical device imperfections in interference-based QKD setups, and designs novel schemes with enhanced performance and practicality. DR 2 (led by TUE) investigates models for KE protocols secure against quantum attacks for various practical scenarios without pre-shared information, and investigates if the use of quantum communication could be advantageous in this setting. DR 3 designs efficient quantum subroutine protocols with a quantum advantage for novel post-quantum functionalities, supported by proof-of-principle experimental photonic demonstrations (led by SU). DR 4 (led by UA) defines quantum security notions of MHFs and their derivatives and investigates which ROM proofs can be upgraded to the post-quantum setting. DR 5 (led by RUB) investigates the security of recently proposed PQC schemes for encryption based on e.g., decoding random linear codes, and lattice problems, against quantum attacks. DR 12 (lead by DTU) studies the PQC security of the FO transform with focus on lattice and code-based schemes. Research in WP1 is done in collaboration with UT, UG, TE, NTT, UO, Genua, CWI, VQ, IDQ, and NXP, who provide, via secondments, additional theoretical and experimental support for the projects in WP1.

Work package WP2 – Quantum-Safe Communications Networks

Work Package Number	WP2	Lead Beneficiary	3. UNIPD
Work Package Name	Quantum-Safe Communications Networks		
Start Month	1	End Month	48

Objectives
To develop techniques to incorporate QS protocols in current network infrastructures; To design and build novel devices, prototypes, systems, and network architectures for QS networks

Description
This WP consists of 4 experimental projects (DRs 6-8, and 10), and 21 theory projects (DRs 9 and 11), and will engage a total of 143 partners in a collaborative way. The experimental projects develop an autonomous prototype system for high-rate TF-QKD and deploy it in a field trial over installed fibre (led by TE), novel solutions for the seamless integration of quantum-classical networks and next-generation QKD protocols for network operation (led by UG), an efficient interface for hybrid wireless-fibre QKD links suitable for satellite quantum communications (led by UP), and network architectures combining QRNGs, PUFs, QKD as well as PQC to meet the security needs of end users in complex communication networks (led by IDQ). At the theory level, UL (DR 9) designs feasible quantum repeater networks aligned with the concept of packet switching, and UV (DR 11) investigates multi-user quantum cryptographic schemes over quantum networks.. These projects will receive the theoretical and experimental support provided by UT, UV, INRIM, SIG, SU, EUT, NTT, TUE, DTU, and Cisco, via secondments

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Work package WP3 – Management

Work Package Number	WP3	Lead Beneficiary	1. UVIGO
Work Package Name	Management		
Start Month	1	End Month	48

Objectives
To coordinate and ensure the delivery of all network tasks and commitments; report back to European Commission (EC)

Description
The coordinator, Prof Curty, will oversee the proper conduct of the programme. He will be supported by various committees, as well as by the local admin team at UV. A Supervisory Board (SB) will be established in the first month of the programme, with representatives from all beneficiary and APs, which will be the main decision making body of the network. To provide agility in time sensitive matters, temporary decisions could be made by the management executive group (MEG) consisting of the Coordinator, the Directors of Research and Training, and the Chairs of the IAB and DIC (see Sec. 3.1.6.1). These decisions should be later on ratified by the SB. The SB oversees all network activities, and via regular meetings with other stakeholders, ensures the delivery of all planned activities.

Work package WP4 – Science & Technology (S&T) Training

Work Package Number	WP4	Lead Beneficiary	5. UvA
Work Package Name	Science & Technology (S&T) Training		
Start Month	1	End Month	48

Objectives
To design and deliver a structured model for doctoral training in the S&T area of QS technologies

Description
This WP ensures that all DCs will receive appropriate doctoral training to successfully complete their research projects. To support this, two scientific Schools (SQC led by UP, and SPQC led by TUE) will be organised. This WP also coordinates our shared online resources, and oversees the research seminar activities. Career development plans will be developed by the supervisory teams under this WP. The Director of Training will monitor all the activities in WP4.

Work package WP5 – Complementary-Skill (CS) Training

Work Package Number	WP5	Lead Beneficiary	6. TU/e
Work Package Name	Complementary-Skill (CS) Training		
Start Month	1	End Month	45

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Objectives
To design and deliver transferrable skills to DRs

Description
WP5 ensures that all DCs acquire the required soft-skill training to enhance their future professional career. For this, three CS workshops are designed at the network level. In particular, CS1 (led by UA) covers project management, team working and open science practices at the doctoral level. It also has a session on web-page development; CS2 covers writing and presentation skills to different groups (led by RUB); CS3 covers entrepreneurship and commercialisation (led by UL; outsourced to Quantum Technology Enterprise Centre at the University of Bristol).

Work package WP6 – Dissemination and Impact (DIC)

Work Package Number	WP6	Lead Beneficiary	2. SU
Work Package Name	Dissemination and Impact (DIC)		
Start Month	1	End Month	48

Objectives
To disseminate the results of the network to scientific and industrial communities; to identify and manage exploitation routes

Description
This WP covers our dissemination strategy toward scientific communities and industry, and it includes active publication in journals and conferences, as well as organising two major symposiums, QSIW (led by DTU) and QSIC (led by SU). Both symposiums will be organised by some/all of DCs. A DMP will also be developed. This WP will be responsible for the creation and maintenance of the QSI web page, as well as of the digital newsletters, and will manage IP. Active use of modern media will be pursued throughout the programme lifetime and beyond.

Work package WP7 – Outreach Activities

Work Package Number	WP7	Lead Beneficiary	7. DTU
Work Package Name	Outreach Activities		
Start Month	6	End Month	48

Objectives
To disseminate the results of the network to different target audiences including the general public and policy makers

Description
This WP covers our dissemination strategy toward public communities, and it includes active participation by DCs in contributing to the public understanding of science, and informing the policy

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makers about the importance of their research. Each year, DCs will engage in at least 1 public event: In year 1, they help with their local
public science events; In year 2, they will give a public lecture and organize a science art contest; and in year 3, they organise an open-day
event. From year 2 onward, they also generate a web story of the month about their projects, and engage with local/ regional politicians to
promote QS technologies

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STAFF EFFORT

Staff effort per participant

Grant Preparation (Work packages - Effort screen) — Enter the info.

Participant	WP1	WP2	WP3	WP4	WP5	WP6	WP7	Total Person-Months
1 - UVIGO	40.00	6.00	12.00	2.00	2.00	1.00	1.00	64.00
2 - SU	40.00	3.00	2.00	2.00	2.00	6.00	1.00	56.00
3 - UNIPD		40.00	2.00	3.00	2.00	1.00	2.00	50.00
4 - RUB	40.00		2.00	2.00	3.00	1.00	1.00	49.00
5 - UvA	40.00		2.00	6.00	3.00	1.00	1.00	53.00
6 - TU/e	40.00	3.00	2.00	3.00	5.00	1.00	1.00	55.00
7 - DTU	40.00	6.00	2.00	3.00	2.00	3.00	5.00	61.00
8 - CWI	3.00		1.00	1.00	1.00	1.00	1.00	8.00
9 - TTBE	3.00		1.00	1.00	1.00	1.00	1.00	8.00
10 - UT	3.00		1.00	1.00	1.00	1.00	1.00	8.00
11 - VERIQLOUD	3.00		1.00	1.00	1.00	1.00	1.00	8.00
12 - genua	3.00		1.00	1.00	1.00	1.00	1.00	8.00
13 - SIG		3.00	1.00	1.00	1.00	1.00	1.00	8.00
14 - INRIM		3.00	1.00	1.00	1.00	1.00	1.00	8.00
15 - NXP	3.00		1.00	1.00	1.00	1.00	1.00	8.00
16 - NTT	3.00	3.00	1.00	1.00	1.00	1.00	1.00	11.00
17 - CISCO		3.00	1.00	1.00	1.00	1.00	1.00	8.00
18 - EUTELSAT		3.00	1.00	1.00	1.00	1.00	1.00	8.00
19 - UNIGE	3.00	46.00	1.00	1.00	1.00	1.00	1.00	54.00

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Staff effort per participant

Grant Preparation (Work packages - Effort screen) — Enter the info.

Participant	WP1	WP2	WP3	WP4	WP5	WP6	WP7	Total Person-Months
20 - ID QUANTIQUE SA	3.00	40.00	1.00	1.00	1.00	1.00	1.00	48.00
21 - ULEEDS	2.00		1.00	1.00	1.00	1.00	1.00	7.00
22 - TOSHEU	2.00	3.00	1.00	1.00	1.00	1.00	1.00	10.00
Total Person-Months	271.00	162.00	39.00	36.00	34.00	29.00	27.00	598.00

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LIST OF DELIVERABLES

Deliverables

Grant Preparation (Deliverables screen) — Enter the info.

The labels used mean:

Public — fully open (⚠ automatically posted online)
Sensitive — limited under the conditions of the Grant Agreement
EU classified —RESTREINT-UE/EU-RESTRICTED, CONFIDENTIEL-UE/EU-CONFIDENTIAL, SECRET-UE/EU-SECRET under Decision 2015/444

Deliverable No	Deliverable Name	Work Package No	Lead Beneficiary	Type	Dissemination Level	Due Date (month)
D1.1	Scientific Deliverable 1: Quantum Protocols Projects State of Play	WP1	4 - RUB	R — Document, report	SEN - Sensitive	16
D1.2	Scientific Del. 3: Quantum Protocols Projects State of Play	WP1	4 - RUB	R — Document, report	SEN - Sensitive	32
D1.3	Scientific Del. 5: Quatum Protocols Projects State of Play	WP1	4 - RUB	R — Document, report	SEN - Sensitive	48
D1.4	Scientific Del. 7: Quantum Protocols Demonstrator	WP1	2 - SU	DEM — Demonstrator, pilot, prototype	SEN - Sensitive	48
D1.5	Scientific Del. 9: roadmap for future QS technologies	WP1	4 - RUB	R — Document, report	SEN - Sensitive	48
D2.1	Scientific Del. 2: Communication Networks Projects State of Play	WP2	3 - UNIPD	R — Document, report	SEN - Sensitive	16
D2.2	Scientific Del. 4: Communication Networks Projects State of Play	WP2	3 - UNIPD	R — Document, report	SEN - Sensitive	32
D2.3	Scientific Del. 6: Communication Networks Projects State of Play	WP2	3 - UNIPD	R — Document, report	SEN - Sensitive	48
D2.4	Scientific Del. 8: Communication Network Demonstrator	WP2	3 - UNIPD	DEM — Demonstrator, pilot, prototype	SEN - Sensitive	48

Associated with document Ref. Ares(2022)4533596 - 20/06/2022

Deliverables

Grant Preparation (Deliverables screen) — Enter the info.

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Deliverable No	Deliverable Name	Work Package No	Lead Beneficiary	Type	Dissemination Level	Due Date (month)
D3.1	Supervisory Board of the network	WP3	1 - UVIGO	OTHER	SEN - Sensitive	2
D3.2	Progress Report	WP3	1 - UVIGO	R — Document, report	SEN - Sensitive	13
D3.3	Mid-term check meeting at month 13-15	WP3	1 - UVIGO	R — Document, report	SEN - Sensitive	15
D3.4	Regular meetings	WP3	1 - UVIGO	R — Document, report	SEN - Sensitive	48
D4.1	Training Del. 2	WP4	3 - UNIPD	R — Document, report	PU - Public	15
D4.2	Career Development Plans	WP4	5 - UvA	R — Document, report	SEN - Sensitive	13
D4.3	Training Del. 3	WP4	6 - TU/e	R — Document, report	PU - Public	18
D4.4	Training Del. 5	WP4	5 - UvA	R — Document, report	SEN - Sensitive	24
D4.5	Training Del. 7	WP4	5 - UvA	R — Document, report	PU - Public	48
D5.1	Training Del. 1	WP5	5 - UvA	R — Document, report	SEN - Sensitive	9
D5.2	Training Del. 4	WP5	4 - RUB	R — Document, report	SEN - Sensitive	18
D5.3	Training Del. 6	WP5	5 - UvA	R — Document, report	SEN - Sensitive	32
D6.1	Website Completion	WP6	2 - SU	DEC —Websites, patent filings, videos, etc	PU - Public	2
D6.2	Data Management Plan	WP6	2 - SU	DMP — Data Management Plan	SEN - Sensitive	13
D6.3	Plan for dissemination and exploitation of	WP6	2 - SU	R — Document, report	SEN - Sensitive	13

Associated with document Ref. Ares(2022)4533596 - 20/06/2022

Deliverables

Grant Preparation (Deliverables screen) — Enter the info.

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Deliverable No	Deliverable Name	Work Package No	Lead Beneficiary	Type	Dissemination Level	Due Date (month)
	results, including communication activities (interim)					
D6.4	D&I Del. 1	WP6	7 - DTU	DEM — Demonstrator, pilot, prototype	PU - Public	32
D6.5	D&I Del. 2	WP6	2 - SU	DEC —Websites, patent filings, videos, etc	PU - Public	48
D6.6	D&I Del. 3	WP6	2 - SU	R — Document, report	PU - Public	48
D6.7	D&I Del. 4	WP6	2 - SU	R — Document, report	PU - Public	48
D6.8	D&I Del. 5	WP6	2 - SU	R — Document, report	PU - Public	48
D6.9	Plan for dissemination and exploitation of results, including communication activities (final)	WP6	2 - SU	R — Document, report	SEN - Sensitive	48
D7.1	Outreach Del. 1	WP7	7 - DTU	R — Document, report	PU - Public	24
D7.2	Outreach Del. 2	WP7	7 - DTU	R — Document, report	PU - Public	36
D7.3	Outreach Del. 3	WP7	7 - DTU	DEC —Websites, patent filings, videos, etc	PU - Public	48
D7.4	Outreach Del. 4	WP7	2 - SU	R — Document, report	PU - Public	48

Associated with document Ref. Ares(2022)4533596 - 20/06/2022

Deliverable – Scientific Deliverable 1: Quantum Protocols Projects State of Play

Deliverable Number	D1.1	**Lead Beneficiary**	4. RUB
Deliverable Name	Scientific Deliverable 1: Quantum Protocols Projects State of Play		
Type	R — Document, report	**Dissemination Level**	SEN - Sensitive
Due Date (month)	16	**Work Package No**	WP1

Description
Evolution reports: Each DC, from DC1 to DC5, will submit a report of his/her progress to the supervisory team; Instructions will be specified by SB

Deliverable – Scientific Del. 3: Quantum Protocols Projects State of Play

Deliverable Number	D1.2	**Lead Beneficiary**	4. RUB
Deliverable Name	Scientific Del. 3: Quantum Protocols Projects State of Play		
Type	R — Document, report	**Dissemination Level**	SEN - Sensitive
Due Date (month)	32	**Work Package No**	WP1

Description
Evolution reports: Each DC, from DC1 to DC5, will submit a report of his/her progress to the supervisory team; Instructions will be specified by SB

Deliverable – Scientific Del. 5: Quatum Protocols Projects State of Play

Deliverable Number	D1.3	**Lead Beneficiary**	4. RUB
Deliverable Name	Scientific Del. 5: Quatum Protocols Projects State of Play		
Type	R — Document, report	**Dissemination Level**	SEN - Sensitive
Due Date (month)	48	**Work Package No**	WP1

Description
Final reports: Each DC, from DC1 to DC5, will submit a final report on his/her project to the supervisory team; Instructions will be specified by SB.

Deliverable – Scientific Del. 7: Quantum Protocols Demonstrator

Deliverable Number	D1.4	**Lead Beneficiary**	2. SU
Deliverable Name	Scientific Del. 7: Quantum Protocols Demonstrator		
Type	DEM — Demonstrator, pilot, prototype	**Dissemination Level**	SEN - Sensitive
Due Date (month)	48	**Work Package No**	WP1

Description
Demonstrators/prototypes for MPC protocols

Associated with document Ref. Ares(2022)4533596 - 20/06/2022

Deliverable – Scientific Del. 9: roadmap for future QS technologies

Deliverable Number	D1.5	**Lead Beneficiary**	4. RUB
Deliverable Name	Scientific Del. 9: roadmap for future QS technologies		
Type	R — Document, report	**Dissemination Level**	SEN - Sensitive
Due Date (month)	48	**Work Package No**	WP1

Description
Roadmap/White Paper for future QS technologies

Deliverable – Scientific Del. 2: Communication Networks Projects State of Play

Deliverable Number	D2.1	**Lead Beneficiary**	3. UNIPD
Deliverable Name	Scientific Del. 2: Communication Networks Projects State of Play		
Type	R — Document, report	**Dissemination Level**	SEN - Sensitive
Due Date (month)	16	**Work Package No**	WP2

Description
Evaluation reports: Each DC, from Dc6 to DC10, will submit a report of his/her progress to the supervisory team; Instructions will be specified by SB

Deliverable – Scientific Del. 4: Communication Networks Projects State of Play

Deliverable Number	D2.2	**Lead Beneficiary**	3. UNIPD
Deliverable Name	Scientific Del. 4: Communication Networks Projects State of Play		
Type	R — Document, report	**Dissemination Level**	SEN - Sensitive
Due Date (month)	32	**Work Package No**	WP2

Description
Evaluation reports: Each DC, from DC6 to DC10, will submit a report of his/her progress to the supervisory team; Instructions will be specified by SB

Deliverable – Scientific Del. 6: Communication Networks Projects State of Play

Deliverable Number	D2.3	**Lead Beneficiary**	3. UNIPD
Deliverable Name	Scientific Del. 6: Communication Networks Projects State of Play		
Type	R — Document, report	**Dissemination Level**	SEN - Sensitive
Due Date (month)	48	**Work Package No**	WP2

Description
Final reports: Each DC, from DC6 to DC10, will submit a final report on his/her project to the supervisory team; Instructions will be specified by SB.

Associated with document Ref. Ares(2022)4533596 - 20/06/2022

Deliverable – Scientific Del. 8: Communication Network Demonstrator

Deliverable Number	D2.4	Lead Beneficiary	3. UNIPD
Deliverable Name	Scientific Del. 8: Communication Network Demonstrator		
Type	DEM — Demonstrator, pilot, prototype	Dissemination Level	SEN - Sensitive
Due Date (month)	48	Work Package No	WP2

Description
Demonstrators/prototypes for high-rate long-distance QKD in free-space and telecom fibre

Deliverable – Supervisory Board of the network

Deliverable Number	D3.1	Lead Beneficiary	1. UVIGO
Deliverable Name	Supervisory Board of the network		
Type	OTHER	Dissemination Level	SEN - Sensitive
Due Date (month)	2	Work Package No	WP3

Description
Document establishing the supervisory board and defining the way of working (see Table 3.1(e)).

Deliverable – Progress Report

Deliverable Number	D3.2	Lead Beneficiary	1. UVIGO
Deliverable Name	Progress Report		
Type	R — Document, report	Dissemination Level	SEN - Sensitive
Due Date (month)	13	Work Package No	WP3

Description
Progress Report submitted to the REA covering the first year implementation of the project.

Deliverable – Mid-term check meeting at month 13-15

Deliverable Number	D3.3	Lead Beneficiary	1. UVIGO
Deliverable Name	Mid-term check meeting at month 13-15		
Type	R — Document, report	Dissemination Level	SEN - Sensitive
Due Date (month)	15	Work Package No	WP3

Description
Project mid-term check (Meeting between REA and consortium)

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Deliverable – Regular meetings

Deliverable Number	D3.4	**Lead Beneficiary**	1. UVIGO
Deliverable Name	Regular meetings		
Type	R — Document, report	**Dissemination Level**	SEN - Sensitive
Due Date (month)	48	**Work Package No**	WP3

Description
SB, RM, RC, TC, DIC, IAB, DF meetings

Deliverable – Training Del. 2

Deliverable Number	D4.1	**Lead Beneficiary**	3. UNIPD
Deliverable Name	Training Del. 2		
Type	R — Document, report	**Dissemination Level**	PU - Public
Due Date (month)	15	**Work Package No**	WP4

Description
School on Quantum Cryptography

Deliverable – Career Development Plans

Deliverable Number	D4.2	**Lead Beneficiary**	5. UvA
Deliverable Name	Career Development Plans		
Type	R — Document, report	**Dissemination Level**	SEN - Sensitive
Due Date (month)	13	**Work Package No**	WP4

Description
Document describing how the individual Career Development Plans have been established (listing also the researchers for whom such plans have been put in place). To be submitted before the mid-term meeting. To be developed by the supervisory team, and approved by SB.

Deliverable – Training Del. 3

Deliverable Number	D4.3	**Lead Beneficiary**	6. TU/e
Deliverable Name	Training Del. 3		
Type	R — Document, report	**Dissemination Level**	PU - Public
Due Date (month)	18	**Work Package No**	WP4

Description
School on Post-Quantum Cryptography

Associated with document Ref. Ares(2022)4533596 - 20/06/2022

Deliverable – Training Del. 5

Deliverable Number	D4.4	Lead Beneficiary	5. UvA
Deliverable Name	Training Del. 5		
Type	R — Document, report	Dissemination Level	SEN - Sensitive
Due Date (month)	24	Work Package No	WP4

Description
Providing shared online resources

Deliverable – Training Del. 7

Deliverable Number	D4.5	Lead Beneficiary	5. UvA
Deliverable Name	Training Del. 7		
Type	R — Document, report	Dissemination Level	PU - Public
Due Date (month)	48	Work Package No	WP4

Description
PhD awards for graduating DCs

Deliverable – Training Del. 1

Deliverable Number	D5.1	Lead Beneficiary	5. UvA
Deliverable Name	Training Del. 1		
Type	R — Document, report	Dissemination Level	SEN - Sensitive
Due Date (month)	9	Work Package No	WP5

Description
CS Workshop 1 + OM

Deliverable – Training Del. 4

Deliverable Number	D5.2	Lead Beneficiary	4. RUB
Deliverable Name	Training Del. 4		
Type	R — Document, report	Dissemination Level	SEN - Sensitive
Due Date (month)	18	Work Package No	WP5

Description
CS Workshop 2

Associated with document Ref. Ares(2022)4533596 - 20/06/2022

Deliverable – Training Del. 6

Deliverable Number	D5.3	Lead Beneficiary	5. UvA
Deliverable Name	Training Del. 6		
Type	R — Document, report	Dissemination Level	SEN - Sensitive
Due Date (month)	32	Work Package No	WP5

Description
CS Workshop 3

Deliverable – Website Completion

Deliverable Number	D6.1	Lead Beneficiary	2. SU
Deliverable Name	Website Completion		
Type	DEC —Websites, patent filings, videos, etc	Dissemination Level	PU - Public
Due Date (month)	2	Work Package No	WP6

Description
To be developed by professional designers.

Deliverable – Data Management Plan

Deliverable Number	D6.2	Lead Beneficiary	2. SU
Deliverable Name	Data Management Plan		
Type	DMP — Data Management Plan	Dissemination Level	SEN - Sensitive
Due Date (month)	13	Work Package No	WP6

Description
Data Management Plan submitted to the REA (updated towards the end of the project if needed). The plan specifies the type of generated data, and means of exploitation, access & archiving.

Deliverable – Plan for dissemination and exploitation of results, including communication activities (interim)

Deliverable Number	D6.3	Lead Beneficiary	2. SU
Deliverable Name	Plan for dissemination and exploitation of results, including communication activities (interim)		
Type	R — Document, report	Dissemination Level	SEN - Sensitive
Due Date (month)	13	Work Package No	WP6

Description

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Plan for the dissemination and exploitation of results, including communication activities submitted at mid-term (M13).

Deliverable – D&I Del. 1

Deliverable Number	D6.4	**Lead Beneficiary**	7. DTU
Deliverable Name	D&I Del. 1		
Type	DEM — Demonstrator, pilot, prototype	**Dissemination Level**	PU - Public
Due Date (month)	32	**Work Package No**	WP6

Description
Quantum-Safe Internet Workshop

Deliverable – D&I Del. 2

Deliverable Number	D6.5	**Lead Beneficiary**	2. SU
Deliverable Name	D&I Del. 2		
Type	DEC —Websites, patent filings, videos, etc	**Dissemination Level**	PU - Public
Due Date (month)	48	**Work Package No**	WP6

Description
Digital newsletter distribution

Deliverable – D&I Del. 3

Deliverable Number	D6.6	**Lead Beneficiary**	2. SU
Deliverable Name	D&I Del. 3		
Type	R — Document, report	**Dissemination Level**	PU - Public
Due Date (month)	48	**Work Package No**	WP6

Description
International Conference presentations

Deliverable – D&I Del. 4

Deliverable Number	D6.7	**Lead Beneficiary**	2. SU
Deliverable Name	D&I Del. 4		
Type	R — Document, report	**Dissemination Level**	PU - Public
Due Date (month)	48	**Work Package No**	WP6

Description

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Quantum-Safe Internet Conference

Deliverable – D&I Del. 5

Deliverable Number	D6.8	**Lead Beneficiary**	2. SU
Deliverable Name	D&I Del. 5		
Type	R — Document, report	**Dissemination Level**	PU - Public
Due Date (month)	48	**Work Package No**	WP6

Description
Publications in high-impact journals

Deliverable – Plan for dissemination and exploitation of results, including communication activities (final)

Deliverable Number	D6.9	**Lead Beneficiary**	2. SU
Deliverable Name	Plan for dissemination and exploitation of results, including communication activities (final)		
Type	R — Document, report	**Dissemination Level**	SEN - Sensitive
Due Date (month)	48	**Work Package No**	WP6

Description
Plan for the dissemination and exploitation of results including communication activities submitted at the end of the project.

Deliverable – Outreach Del. 1

Deliverable Number	D7.1	**Lead Beneficiary**	7. DTU
Deliverable Name	Outreach Del. 1		
Type	R — Document, report	**Dissemination Level**	PU - Public
Due Date (month)	24	**Work Package No**	WP7

Description
Outreach Day 1: local public-science events

Deliverable – Outreach Del. 2

Deliverable Number	D7.2	**Lead Beneficiary**	7. DTU
Deliverable Name	Outreach Del. 2		
Type	R — Document, report	**Dissemination Level**	PU - Public
Due Date (month)	36	**Work Package No**	WP7

Associated with document Ref. Ares(2022)4533596 - 20/06/2022

Description
Outreach Day 2: Public talks and science art contest

Deliverable – Outreach Del. 3

Deliverable Number	D7.3	**Lead Beneficiary**	7. DTU
Deliverable Name	Outreach Del. 3		
Type	DEC —Websites, patent filings, videos, etc	**Dissemination Level**	PU - Public
Due Date (month)	48	**Work Package No**	WP7

Description
Story of the month on web site

Deliverable – Outreach Del. 4

Deliverable Number	D7.4	**Lead Beneficiary**	2. SU
Deliverable Name	Outreach Del. 4		
Type	R — Document, report	**Dissemination Level**	PU - Public
Due Date (month)	48	**Work Package No**	WP7

Description
Outreach Day 3: QSI Open Day

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LIST OF MILESTONES

Milestones

Grant Preparation (Milestones screen) — Enter the info.

Milestone No	Milestone Name	Work Package No	Lead Beneficiary	Means of Verification	Due Date (month)
1	Security analysis of practical quantum-interference based QKD	WP1	1-UVIGO	Key rate analysis includes typical transmitter flaws	26
2	Design of quantum-interference based QKD protocols with enhanced performance	WP1	1-UVIGO	The protocols outperform state-of-the-art schemes	40
3	Formal model for KE is developed	WP1	6-TU/e	The model for KE considers quantum adversaries	26
4	A secure KE protocol is obtained	WP1	6-TU/e	The protocol achieves the model of milestone 3	40
5	Analysis of quantum-enhanced MPC	WP1	2-SU	Includes definition of hybrid MPC scheme	26
6	Proof-of-principle all-photonic client-server MPC experiment	WP1	2-SU	Experimental results validating theory	40
7	Quantum security definition of MHF	WP1	5-UvA	The definition includes quantum adversaries	26
8	Security analysis of Memory-Hard Functions	WP1	5-UvA	Proof techniques consider quantum adversaries	40
9	Design new quantum attacks against PQC cryptosystems	WP1	4-RUB	The attacks improve the state of the art	26
10	Develop quantum security bit estimator software for coding- and lattice-based PQC	WP1	4-RUB	The software estimates the quantum bit-security level	40
11	Autonomous prototype for TF-QKD	WP2	3-UNIPD	Continuous operation of TF-QKD prototype (>1hr)	26
12	Continuous operation of TF-QKD prototype over installed fibres	WP2	3-UNIPD	Stable operation in field conditions over 24 hours	40
13	Assessment of different network-compatible protocols	WP2	1-UVIGO	Analysis includes devices present in the established network architecture	26

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Milestones

Grant Preparation (Milestones screen) — Enter the info.

Milestone No	Milestone Name	Work Package No	Lead Beneficiary	Means of Verification	Due Date (month)
14	Network compatible QKD device built and tested	WP2	1-UVIGO	Lab prototype works	40
15	Design of an intermodal quantum communications interface	WP2	3-UNIPD	It includes free-space and fibre-based QKD	26
16	Experimental demonstration of a free-space-fibre QKD link	WP2	3-UNIPD	Lab prototype works	40
17	Design quantum repeater protocols for packet-switched networks	WP2	3-UNIPD	The protocols are compatible with packet-switched networking	26
18	Benchmark the performance of the proposed repeater setups	WP2	3-UNIPD	Analysis includes secret key generation rate	40
19	Design of next-generation hybridisation methods for authentication and data integrity	WP2	1-UVIGO	The methods use QRNG, PUFs, QKD and PQC	26
20	Network architectures for QS Internet	WP2	1-UVIGO	The network architectures combine quantum and modern cryptography primitives	40
21	All recruited fellows enrolled in PhD programme	WP3	1-UVIGO	All 10 DCs have started their PhD	12
22	Developing web page	WP6, WP3	2-SU	Web page is up and running	3
23	Offering CS Workshops	WP5	6-TU/e	CS workshops held	32
24	Organising Schools	WP4	3-UNIPD	All Schools held	18
25	Organising Conferences	WP6	2-SU	All conferences held, and DRs present their work	48
26	Organising Outreach activities	WP7	7-DTU	All DRs participate in 1 or more activity/year	48
27	Holding regular management meetings	WP3	1-UVIGO	Regular SB meetings, and its committees	48
28	Secondments completed	WP4	5-UvA	All DCs have been on planned visits	48

Milestones

Grant Preparation (Milestones screen) — Enter the info.

Milestone No	Milestone Name	Work Package No	Lead Beneficiary	Means of Verification	Due Date (month)
29	Consortium Agreement	WP3	1-UVIGO	CA signed	2
30	Planned recruitments completed	WP3	1-UVIGO	Planned recruitments completed	12
31	Project mid-term check	WP3	1-UVIGO	Project mid-term check (Meeting between REA and consortium)	15
32	Kick-off meeting	WP3	1-UVIGO	Minutes of the meeting	1
33	Security reductions for correctness error finding in FO KEMs	WP1	7-DTU	The security reduction technique yields a security bound for FO KEMs	26
34	Improved security proof of the PQC FO transform in the QROM	WP1	7-DTU	The obtained security bound allows for more efficient provably secure KEMs	40
35	Design multi-user cryptographic schemes for quantum networks	WP2	1-UVIGO	The schemes involve more than two users	26
36	Security analysis of multi-user cryptographic schemes in a practical setting	WP2	1-UVIGO	Security analysis includes typical device imperfections	40

LIST OF CRITICAL RISKS

Critical risks & risk management strategy

Grant Preparation (Critical Risks screen) — Enter the info.

Risk number	Description	Work Package No(s)	Proposed Mitigation Measures
1	Committee chairs absence (Likelihood:Low; Severity: Low)	WP3	We have assigned deputy roles for each important managerial position of QSI

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Critical risks & risk management strategy

Grant Preparation (Critical Risks screen) — Enter the info.

Risk number	Description	Work Package No(s)	Proposed Mitigation Measures
2	Urgent issues that require SB approval (Likelihood: Medium; Severity:Low)	WP3	In the case of emergencies, where the SB cannot be called on short notice, MEG has the right to devise temporary action plans. Such decisions must be ratified by the SB in its next formal meeting
3	Technical and non-technical risks of achieving the objectives of individual projects (Likelihood: Medium; Severity: Medium)	WP2, WP1	For each individual project, mitigation measures have already been specified in Table 1.2(a). Alternative plans will be sought from the supervisory team if any additional changes are required. Any major changes in the project must be approved by RC (or MEG, if immediate action is needed), in coordination with the EC Project Officer (ECPO), and reported to SB for final ratification.
4	Training events cannot be run as planned (Likelihood: Low; Severity: High)	WP4	Alternative plans must be provided by the stakeholders and/or MEG. Any changes in the training plan must be approved by TC (or MEG, if immediate action is needed), in coordination with ECPO, and reported to SB for final ratification
5	Late recruitment up to m12 (Likelihood: Medium; Severity: Low)	WP3	Contingency plans are in place for late starters such as video recording of some workshops and/or the possibility of delivering individual components at other times
6	Unfilled positions after m12, or if a DR leaves early (Likelihood: Low; Severity: High)	WP3	The scope of the relevant projects will be downsized by the supervisory team, and if approved by RC/MEG and ECPO, the post will be re-advertised for the shorter time
7	AP leaves the consortium mid-way through (Likelihood: Low; Severity: Low)	WP2, WP4, WP1, WP3	Alternative APs and secondment options will be sought from the main supervisor. Changes to be approved by RC/MEG and SB, and eventually by the ECPO.
8	The main Supervisor of a DC leaves the consortium early (Likelihood: Low; Severity: High)	WP2, WP4, WP1, WP3	Alternative supervisors, especially from the co-supervisory team will be offered by the RC/MEG to the DR, and if needed a reformulation of the project will be sought. Approval needed from RC/MEG and SB, and the ECPO
9	Restricted access to workplace and/or travelling (Likelihood: Low; Severity: High)	WP2, WP4, WP7, WP1, WP5, WP6, WP3	Online platforms and teleconferencing tools will be used to redesign planned activities. The scope of projects will be monitored and adjusted if needed via the mitigation measures listed in R3. If needed, no-cost extension will be requested. Any measure will be approved by SB in coordination with the EC.

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Horizon Europe (HORIZON)
Marie Skłodowska-Curie Actions
Doctoral Networks (MSCA-DN)

ANNEX 1

Description of the action (DoA)

Part B

101072637– QSI

HORIZON – MSCA – 2021 – DN

Quantum-Safe-Internet

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History of Changes

DATE	Change/ justification	Page
13.04.2022	**Initial version of DoA:**	
	- Tables of Work packages, Deliverables, Milestones and Critical Risks deleted as per template	In the portal
	- New Deliverables in WP1 and WP2 have been added, and their names have been clarified	In the portal
	- New Milestones have been added	In the portal
10.05.2022	- ULEEDS and TOSHEU have been deleted as beneficiaries and became "associated partners"	7
	- DTU has been added as a new beneficiary	5
	- Two new DCs have been added, DC11 and DC2 (hosted by UVIGO and DTU)	10
	- New Milestones, related to these 2 DCs, have been added (M33, M34 led by DTU and M35 and M36, led by UVIGO)	In the portal
	- WP2 leader changed from TOSHEU to UNIPD	In the portal
	- WP4 leader changed from ULEEDS to UvA	In the portal
	- WP7 leader changed from UNIPD to DTU	In the portal
	- The Deliverables managed by ULEEDS and TOSHEU have been changed to be responsible of a beneficiary (UNIPD became responsible for D2.1, D2.2, D2.3, D2.4 instead of TOSHEU; UvA for D4.2 and D5.3 instead of ULEEDS; DTU for D6.4 instead of TOSHEU; and DTU for D7.1, D7.2, D7.3)	In the portal
	- The Milestones managed by associated partners have been changed to be responsible of a beneficiary (UNIPD for M11 and M12 instead of TOSHEU; UVIGO for M13 and M14 instead of UNIGE; UVIGO for M19 and M20 instead of IDQUANTIQUESA; UNIPD for M17 and M18 instead of ULEEDS; UvA for M28 instead of ULEEDS)	In the portal
	- Section 1.1.2 title has been changed	9
	- Table 1.1(a) has been put inside 1.1.3 section	11
	- DRs have been replaced by DCs in all the document	All
	- Table 1.3(a) recruitment has been put inside 1.3.2 section	17
	- Table 1.2(a) List of proposed projects has been updated	30
	- 1.4.1 Qualifications and supervision experience of supervisors has been updated to include new beneficiary's supervisor (DTU)	21-22
	- Table 3.1(d) Fellows' individual projects has been updated to include new projects	30
	- Supervisory board has been updated	35
	- 3.2 Quality, capacity and role of each participant, including hosting arrangements and extent to which the consortium as a whole brings together the necessary expertise, has been updated	39

13.05.2022	- Scientist in Charge for DTU has been changed - The end date of WP3 has been changed to 48 - Ethics section has been added - Short names have been corrected - Typos have been corrected - Tentative programmes for WP4 Schools have been removed (1.3.2.1 Network-wide training events section) - Table 1.1(c) Main innovative aspects of each project with respect to the state of the art has been removed - Table 1.2(a) has been deleted and replaced by table 3.1(d), and all references made to that table in the text are now about table 3.1(d) - Table 3.1(d) has been updated - Table 1.2(b) has been deleted - Table 1.3(a) Recruitment Deliverables per participant has been updated	5 11 41 All All 17 13 30 30 14 17
16.05.2022	- Table 1.3(a) Recruitment Deliverables per participant has been reduced	17
17.05.2022	- Table 3.1 (d) has been renamed table 3.1 (a) - Ethics section has been modified to include portal “screenshot” - Table 1.2 (c) has been renamed table 1.2 (a)	30 41 15

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LIST OF PARTICIPATING ORGANISATIONS

Consortium Member	Legal Entity Short Name	Academic	Non-Academic	Awards Doctoral Degree	Country	Dept. / Division / Laboratory	Scientist-in-Charge	Role of associated Partner or link to beneficiary
Beneficiaries[1]								
1- Universidad de Vigo	UVIGO	✓		✓	Spain	School of Telecommunications Engineering	**M**arcos **C**urty (**MC**)	
2- Sorbonne Université	SU	✓		✓	France	Faculty of Science and Engineering, LIP6	**Eleni Diamanti (ED)**	
3- Università Degli Studi di Padova	UNIPD	✓		✓	Italy	Department of Information Engineering	**Paolo Villoresi (PV)**	
4- Ruhr-Universität Bochum	RUB	✓		✓	Germany	Fakultät für Informatik	**Alexander May (AM)**	
5- Universiteit van Amsterdam	UvA	✓		✓	Netherlands	Institute for Logic, Language and Computation	**Christian Schaffner (CS)**	
6- Technische Universiteit Eindhoven	TU/e	✓		✓	Netherlands	Coding theory and Cryptology Group	**Andreas Hülsing (AH)**	
7- Danmarks Tekniske Universitet	DTU	✓		✓	Denmark	Department of Applied Mathematics and Computer Science	**Nicola Dragoni (ND)**	
Associated Partners								
8- STICHTING NEDERLANDSE WETENSCHAPPELIJK ONDERZOEK INSTITUTEN	CWI	✓			Netherlands	Algorithms and Complexity Group	**Stacey Jeffery (SJ)**	Hosting DCs 3 & 4 secondments; Involvement in training workshops and network symposiums; Supervisory Board (SB) and its committees' member by rotation
9- University of Ottawa	TTBE	✓		✓	Canada	Department of Mathematics and Statistics	**Anne Broadbent (AB)**	Hosting DC 2 secondments; Involvement in training workshops and network symposiums; SB and its committees' member by rotation
10- University of Toyama	UT	✓		✓	Japan	Graduate School of Science and Engineering Research	**Kiyoshi Tamaki (KT)**	Hosting DC 1 secondments; Involvement in training workshops and network symposiums; SB and its

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								committees' member by rotation
11- VERIQLOUD	VERIQLOUD		✓		France	Research and Development Department	**Marc Kaplan (MK)**	Hosting DC 3 secondments; Member of the Industrial Advisory Board (IAB); Involvement in training workshops and network symposiums; SB and its committees' member by rotation
12- Genua mbh	Genua		✓		Germany	Research Department	**Simon Daum (SD)**	Hosting DCs 2 & 5 secondments; Member of IAB; Involvement in training workshops and network symposiums; SB and its committees' member by rotation
13- Services Industriels de Geneva	SIG		✓		Switzerland	Network Fiber & Lighting and Smart Metering	**Oliver Gudet (OG)**	Hosting DC 7 secondments; Member of IAB; Involvement in training workshops and network symposiums; SB and its committees' member by rotation
14- Istituto Nazionale di Ricerca Metrologica	INRIM	✓			Italy	Quantum Technology and Nanotechnology	**Davide Calonico (DC)**	Hosting DC 6 secondments; Involvement in training workshops and network symposiums; SB and its committees' member by rotation
15- NXP Semicondutors Netherlands BV	NXP		✓		Netherlands	Research, Development and Innovation Department	**Joppe W. Bos (JB)**	Hosting DCs 4 & 12 secondments; Member of IAB; Involvement in training workshops and network symposiums; SB and its committees' member by rotation
16- Nippon Telegraph and Telephone Corporation	NTT		✓		Japan	Basic Research Laboratory	**William Munro (WM)**	Hosting DCs 1, 9 & 11 secondments; Member of IAB; Involvement in training workshops and network symposiums; SB and its committees' member by rotation
17- Cisco Systems, Inc.	CISCO		✓		United States	Quantum Research Group	**Alireza Shabani (AL)**	Hosting DC 9 secondments; Member of IAB; Involvement in training workshops and network symposiums; SB and its committees' member by rotation
18- EUTELSAT	EUTELSAT		✓		France	Technical Department	**Daniele Finocchiaro (DF)**	Hosting DC 8 secondments; Member of IAB; Involvement in training workshops and network symposiums; SB and its committees' member by rotation
19- UNIVERSITE DE GENEVE	UNIGE	✓		✓	Switzerland	Group of Applied Physics	**Hugo Zbinden (HZ)**	Supervising DC 7 (financed by Switzerland's government); Hosting DCs 1 & 10 secondments; Involvement in training workshops and network symposiums; Supervisory Board (SB) and its committees' member by rotation; Deputy Chair of the Dissemination and Impact Committee (DIC)

20- ID Quantique SA	ID QUANTIQUE SA		✓		Switzerland	R&D Division	**Kevin Layat (KL)**	Supervising DC 10 (financed by Switzerland's government); Hosting DCs 3 & 7 secondments; Involvement in training workshops and network symposiums; Supervisory Board (SB) and its committees' member by rotation
21- University of Leeds	ULEEDS	✓		✓	UK	School of Electronic and Electrical Engineering	**Mohsen Razavi (MR)**	Supervising DC 9 (financed by UK's government); Hosting DCs 6, 8 & 11 secondments; Involvement in training workshops and network symposiums; Supervisory Board (SB) and its committees' member by rotation; Chair of DIC; Member of the Recruitment Committee (RTC)
22- Toshiba Europe Limited	TOSHEU		✓		UK	Quantum Information Group	**Andrew Shields (AS)**	Supervising DC 6 (financed by UK's government); Hosting DCs 1 & 2 secondments; Involvement in training workshops and network symposiums; Supervisory Board (SB) and its committees' member by rotation; Chair of IAB; Member of the Research Committee (RC), of DIC and of RTC

Data for non-academic beneficiaries:

Name	Location of research premises (city/country)	Type of R&D activities	No. of full-time employees	No. of employees in R&D	Web site	Annual turnover (approx, in Euro)	Enterprise status (Yes/No)	SME status (Yes/No)
-	-	-	-	-	-	-	-	-

Declaration

Name (institution /individual)	Nature of inter-relationship
Prof. Elham Kashefi from the beneficiary SU	Prof Kashefi is a co-founder and shareholder of the company VeriQloud (VERIQLOUD), which is an associated partner of this proposal, but she does not have any operational role in the company.
UvA and CWI	The Dutch research centre QuSoft was launched by CWI, University of Amsterdam and Vrije Universiteit Amsterdam in December 2015. QuSoft is located at CWI and hosts researchers from both UvA and CWI. Many CWI researchers also have affiliations with UvA.

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1. EXCELLENCE

1.1 Quality and pertinence of the project's research and innovation objectives (and the extent to which they are ambitious, and go beyond the state of the art)

1.1.1 Introduction and objectives: Transformative nature of QSI

QSI aims at training a world-class cohort of doctoral researchers (DCs) capable of taking the next essential steps in the highly demanding area of **cybersecurity**. We aim to build strong *lasting* links between strategically selected industry and academic partners, in different disciplines, via the development of novel technologies for practical applications in data security. In parallel, we will also combine, via a collaborative long-term interdisciplinary approach, expertise in all relevant communities to address key fundamental problems in secure communications in the quantum era, and the important applications therein. The planned training network will provide research and training opportunities to a new generation of DCs, who, in the long-run, shall address the **Grand Challenge** of providing "***Q**uantum-**S**afe **I**nternet*", i.e., a communication infrastructure that is secure against not only classical attacks but also those enabled by quantum technologies.

Today's Internet security heavily relies on computational complexity assumptions, and as such is seriously threatened by advancements in quantum computing technologies. Indeed, we have recently witnessed a wave of key developments in this direction by a number of IT giants, e.g., Google, IBM, Microsoft, and Intel. This particularly jeopardizes applications that require long-term security. The number of such applications is continuously growing as more and more of our private information is stored and communicated in a digital way, e.g., electronic health records, which are now required by European legislation to remain secure for a long time. This requires us to urgently develop and implement new solutions, as we plan to do in this Doctoral Network (DN). This includes solutions based on:

- **Quantum cryptography (QC):** QC offers a new suite of solutions to achieve long-term security of data in many scenarios. In particular, quantum key distribution (QKD) provides a secure mechanism—*irrespective of any future technological advancement*—for cryptographic key expansion. This makes QKD particularly interesting to guarantee long-term security. Large-scale deployment of QKD will, however, face certain practical challenges. For instance, an economically viable approach to QKD deployment is to integrate it with existing communications infrastructure. But this would require us to deploy new hardware and resolve arising compatibility issues that enable the two systems to work alongside each other. QKD should also allow any two remote network users to efficiently establish a key. For that to happen, we need to improve the rate-versus-distance performance of QKD systems. In this DN, we will address these questions by developing novel QKD protocols, as well as satellite-based and repeater-based quantum technologies.
- **Post-quantum cryptography (PQC):** A problem that cannot be solved by QKD alone is the establishment of keys between two parties that do not already share a common secret. This so-called key exchange (KE) problem requires additional means to be solved. A solution is offered by PQC, which follows the traditional approach of public-key cryptography, on which Internet security is based. In PQC, however, the current set of mathematical problems is replaced with new ones that are believed to be resilient to quantum computing attacks. This allows a more manageable migration to a new set of standards compared to QKD, but it will still require a lot of changes in applications. The required changes include new hardware-accelerators for CPUs and microcontrollers (e.g., on smartcards), and modifications of existing Internet protocols to deal with new performance characteristics and functionalities. The selection of PQC primitives for standardization is currently in progress via the NIST competition, in which a number of our beneficiary partners are involved. That said, the security of PQC algorithms has not yet been fully established against quantum technologies. In this DN, we will develop novel KE protocols secure against quantum adversaries, and analyse the security of PQC algorithms from a quantum angle.
- **Hybrid technologies (HT):** A new set of solutions is expected to emerge by combining relevant techniques in engineering and science, including but not limited to QC and PQC. In this DN, we will explore whether quantum communication could enhance the performance of certain subroutines within PQC. For instance, we will develop and implement efficient secure multiparty computation (MPC)

solutions by combining quantum and modern cryptographic techniques. We would also benefit from the involvement of major telecom industry in our consortium to facilitate the deployment of these solutions on existing communications infrastructures. As a result, we will put together a synergic effort to design network architectures that account for security, functionality and usability.

One of the key opportunities offered by QSI is to combine the merits of the above solutions as key elements of the future quantum-safe Internet. This is particularly enabled by bringing together, in our consortium, the R&D and research expertise from the relevant communities in engineering, computer science, mathematics and physics, in industry and academia. This is a unique opportunity as interactions at this scale, while much needed, are not well developed yet. We will explore new research directions in which these disciplines can empower each other or result in new hybrid solutions combining various technologies. We will train a nucleus of DCs, equipped with pertinent knowledge to provide secure communications for European citizens and for our connections worldwide. This objective is crucial in this particular moment, in which not only threats but large-scale violations of the privacy in the European exchange of information have been discovered and exposed to the public. The crucial aspect, as has been recognised by the European Union Agency for Cybersecurity (ENISA), by the Quantum Flagship Programme, and by the European Quantum Communications Infrastructure programme (EuroQCI), is to devise, at the continental level, and to the benefit of every EU citizen, the most general systems and concepts for the realisation of quantum-safe networks. This will significantly increase the EU's innovation capacity, in terms of future researchers, improve the knowledge transfer between disciplines, sectors, and countries, and help the EU remain at the frontier of research on secure communications. All this is achieved via our carefully planned training programme, which includes components from focused scientific schools and complementary-skill (CS) workshops, supplemented by secondment opportunities and innovative outreach and dissemination activities. In short, **QSI's main objectives** are:

- To bring together experts in engineering, computer science, mathematics, and physics to train the DCs in the state-of-the-art, as well as future directions, of quantum-safe cybersecurity;
- To enable DCs to combine inputs from different disciplines and apply these to design novel solutions necessary for a quantum-safe Internet, and facilitate their widespread exploitation;
- To expose DCs to the private R&D sector, via secondments, and prepare them for the challenges of intersectoral communication, to ensure proper dissemination and exploitation of results;
- To engage the public/policy-makers with these developing fields, using outreach activities planned for each DC;
- To push the frontiers of quantum-safe cryptography, and to take a new approach to cybersecurity by *integrating* a wide range of expertise and facilities at our partner institutes; and
- To develop structural mechanisms via which *lasting* collaborations and industrial uptakes are pursued and a *structured model* for doctoral training, at the EU level, is laid out.

1.1.2 Introduction, objectives and overview of the research programme

QSI is inherently interdisciplinary by bringing together researchers in engineering, computer science, mathematics and physics. It aims to further advance the field of quantum-safe communications by integrating quantum and classical technologies in a highly collaborative approach. Table 1.1(a) provides a list of work packages (WPs) proposed by QSI. In order to advance the state of the art, we have defined our research projects within two research WPs: "quantum-safe cryptography protocols" **(WP1)**, and "quantum-safe communications networks" **(WP2)**. Security is the underlying notion present in these WPs, and they all serve the *Grand Goal* of creating a communications network secure against future quantum computing attacks. WP1 and WP2 are briefly explained below; a more detailed description of all WPs is given in Table 3.1(a). Note that we are fortunate to have two Swiss funded DCs, 7 and 10, and two UK funded DCs, 6 and 9, in our consortium, who contribute to and complement the range of topics covered by our network, and enrich its collaborative spirit.

WP1 on quantum-safe cryptography protocols: In this WP, we devise a suite of protocols that exploit quantum, post-quantum and hybrid techniques towards the final goal of achieving a quantum-safe Internet, and we study their security and performance by combining our expertise in quantum and modern cryptography, quantum algorithms, computer science, and mathematics. In particular, DC 1 will improve the

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security proofs of QKD protocols by considering the most relevant device imperfections of the users' apparatus, which may result in side-channels compromising the security of the real implementations [Nature Photonics 8, 595-604 (2014)]. DC 1 will also design novel QKD protocols with enhanced performance. One further limitation of QKD is its requirement to pre-share secret information between the legitimate users of the system. DC 2 will study KE protocols that do not have this requirement, and investigate if the use of quantum communications could be advantageous in a post-quantum setting. Indeed, developing hybrid techniques that can keep the best functionalities of quantum and post-quantum cryptography, namely, the long-term security provided by QKD and the versatility of implementation and high performance of PQC, is a necessity for many applications to improve the performance and security of existing solutions [Nature Phys. **13**, 3 (2017)]. DC 3 will investigate the possibility of implementing certain functionalities/subroutines within PQC algorithms more efficiently by means of quantum communications protocols. Here, special attention will be paid to secure multiparty computation (MPC) algorithms. WP1 will also address the security of a large class of modern cryptography schemes that rely on the assumed hardness of certain mathematical problems. To assess the security level of such protocols, one needs to understand and/or find the best classical and quantum algorithms for solving these problems. Indeed, quantum attacks pose a great threat to both secret-key and public-key cryptography. DC 4 will take on the challenge of finding techniques to upgrade existing security proofs of hash-based constructions such as memory-hard functions (MHFs) [ACM Trans. Internet Techn. **5**, 299 (2005)] against classical adversaries to quantum adversaries. DC 5 and DC 12, on the other hand, are concerned with the quantum security of the coding- and lattice-based post-quantum cryptosystems and their key encapsulation mechanisms in the NIST standardization competition, by investigating the effectiveness of quantum attacks against them. Being involved in 2 out of the remaining 4 NIST round 3 finalists for post-quantum public-key encryption and KE algorithms, will give us an edge in properly addressing this problem[3].

WP2 on quantum-safe communications networks: Ultimately, quantum-safe cryptography protocols are used in communications networks, and must enable any two network users, *at any distance*, to communicate securely. This, in the first generation of quantum networks, is expected to be achieved by means of trusted nodes, including satellite links. Such a trust requirement could later be removed by using repeater technologies. DC 6 will take on the challenges of developing an autonomous prototype of twin-field (TF) QKD [Nature 557, 400 (2018); npj Quantum Inform. **5**, 64 (2019); Nature Photon. **13**, 334 (2019)] able to operate continuously on a deployed fibre-based network. To further simplify the integration and enhance the rate-versus-distance performance of QKD in optical networks, DC 7 will design novel QKD network architectures for existing telecom networks. DC 8, on the other hand, aims at improving the rate and versatility of satellite-based QKD as well as those of hybrid wireless-fibre QKD networks. To further extend the transmission distance of quantum communication schemes to a global scale, DC 9 will work on advanced quantum repeater protocols compatible with packet-switched networking. DC 10 will determine optimal solutions for service providers and various use cases, and embed next-generation QKD setups in a global security ecosystem composed of quantum and post-quantum protocols. Finally, DC 11 will study the security and performance of quantum cryptographic schemes implemented over quantum networks with multiple users.

To ensure that the objectives defined for each research project are measurable and verifiable we have identified a list of milestones and means of verification for each project, at mid-term and final stage of the project. These milestones have been chosen carefully based on our expertise in the relevant disciplines to make sure that they are realistic and achievable during the course of the network.

1.1.3 Pertinence and innovative aspects of the research programme

To identify the innovative aspects, we first summarise the state of the art and the key research gaps in the main enabling technologies for QSI, as have been specified in Sec. 1.1.1.

[3] https://csrc.nist.gov/Projects/post-quantum-cryptography/round-3-submissions

WP No.	Work Package Title	Lead Beneficiary No.	Start month	End month	Activity Type	Lead Participant Short Name	Researcher involvement
WP1	Quantum-Safe Cryptography Protocols	4	m1	m48	Research	RUB (May)	DCs 1-5, 12
WP2	Quantum-Safe Communications Networks	3	m1	m48	Research	UNIPD (Villoresi)	DCs 6-11
WP3	Management	1	m1	m48	Management	UVIGO (Curty)	All, by rotation
WP4	Science & Technology (S&T) Training	5	m1	m48	Training	UvA (Schaffner)	All
WP5	Complementary Skill (CS) Training	6	m1	m45	Training	TU/e (Hülsing)	All
WP6	Dissemination & Impact (DIC)	2	m1	m48	Dissemination	SU (Diamanti)	All
WP7	Outreach Activities	7	m6	m48	Outreach	DTU (Dragoni)	All

Table 1.1(a) List of work packages

QKD has reached an exciting milestone in its development that, now, one can plan for its widespread deployment. Initiatives in this direction are currently being taken worldwide, including large scale quantum networks in Japan, US, South Korea, China, UK, and in the EU with its ambitious EuroQCI programme, whose first phase is being implemented via the OpenQKD (www.openqkd.eu) project. Over the past few years, mainly based on the work of our partners, secure QKD systems have reached new distance records beyond 400 km using point-to-point fibre links [Phys. Rev. Lett. **121**, 190502 (2018)] and beyond 600 km using fibre links with untrusted middle nodes [Nature Photonics 15, 530-535 (2021)], been demonstrated alongside optical telecom systems [Phys. Rev. X **2,** 041010 (2012); Appl. Phys. Lett. 104, 051123 (2014); Scientific Rep. **6**, 35149 (2016)], supported multiple users [Opt. Exp. **19,** 10387 (2011); Nature **501,** 69 (2013)], distributed secure keys at rates exceeding 10 Mb/s [J. Lightwave Technol. **36**, 3427 (2018)], been operated in daylight conditions over free-space channels with chip-based transmitters and receivers [npj Quantum Information 7, 93 (2021)], and been implemented in metropolitan networks [New J. Phys. **13**, 123001 (2011); npj Quantum Inform. **5**, 101 (2019)] and in satellite to ground links [Phys. Rev. Lett. **115**, 040502 (2015); Nature 549, 43 (2017); Nat. Photon. **11**, 502 (2017)]. New protocols have also made QKD implementation more reliable and secure against side-channel attacks [Phys. Rev. Lett. **108,** 130503 (2012); Nature **557**, 400 (2018)].

Despite all the progress thus far, QKD must still overcome certain **key challenges** (**KC**s) before its versatile deployment becomes possible. These challenges include: (**KC1) Integrating classical and quantum networks:** This is a necessity to cut costs for service providers and end users, and it requires an aligned approach, between different stakeholders, particularly the telecom industry, to upgrade software, including the network architecture, and hardware elements of the infrastructure; (**KC2) Improving the rate-versus-distance performance of QKD:** Most existing QKD implementations offer rather low key rates when it comes to long distances. This must be improved to match the ever-increasing demand for secure data transmission; (**KC3) Enabling large-scale QKD networks:** Relying on weak optical signals, it is very challenging to cover a global QKD network without trusting intermediate nodes including satellite nodes; and (**KC4) Ensuring the security of QKD implementations:** While QKD is provably secure under nominal conditions, we must ensure that all relevant conditions hold in a realistic demonstration of QKD.

PQC is, at the moment, in the process of developing standards for public-key encryption and digital signatures algorithms via the NIST post-quantum standardization project. While the initial set of proposals has already been narrowed down considerably, our partners are involved in almost half of the remaining ones. The first standards are expected around 2022, and PQC is a natural solution to applications currently relying on public-key cryptography in classical networks. For example, proposals by beneficiary partners have been experimented with by Google and Cloudflare for their use in TLS[4,5]. However, PQC and modern cryptography must also overcome certain key challenges. These challenges include (**KC5) Finding efficient solutions** to handle increases in the size of keys for encryptions and signatures, network traffic, and computational delays; and (**KC6) Proving security against quantum adversaries:** Security of PQC is based on the assumed hardness of certain mathematical problems, but its actual resilience to quantum

[4] https://blog.cloudflare.com/towards-post-quantum-cryptography-in-tls/

[5] https://www.imperialviolet.org/2018/12/12/cecpq2.html

computers has not been well established yet. Although less in focus so far, quantum computers sometime also threaten the security of secret-key cryptography, thus it is essential to extend existing security proofs to protect against quantum adversaries.

To build on progress to date, the further advancement of the above technologies requires a highly interdisciplinary, intersectoral, and collaborative approach. It will need strong collaborations between experimentalists and theoreticians, as well as between academia and industry, and involve experts in various disciplines in physics, engineering, computer science, and mathematics. At the heart of this proposal is the ambition to unleash the opportunities that arise by combining such expertise; they could empower each other by integrating their merits into novel applications with enhanced performance and security [Nature Phys. 13, 3 (2017)]. We consider this a fundamental KC, which has not yet adequately been addressed, (**KC7) to develop hybrid technologies** for quantum-safe communications.

In QSI we have defined twelve research projects as listed in Table 3.1(a) to address the above KCs. Eight research projects will be funded by EU, two by the Swiss Government and two by the UK Government. Table 1.1(b) summarises the KCs considered by each project. Each KC is tackled from different angles, by 4-7 projects. This also ensures and motivates constructive collaborations between all groups and individuals involved. The KCs are distributed in a balanced way between our two main scientific WPs

Table 1.1(b) Key challenges (KC) addressed by each DC. DCs 7 & 10 will be financed by the Swiss Government, and DCs 6 & 9 by the UK Government.

KC	DC1	DC2	DC3	DC4	DC5	DC6	DC7	DC8	DC9	DC10	DC11	DC12	#DCs
KC1						✓	✓	✓	✓	✓			5
KC2	✓					✓	✓	✓	✓		✓		6
KC3						✓		✓	✓	✓	✓		5
KC4	✓					✓	✓		✓	✓	✓		6
KC5		✓	✓	✓	✓							✓	5
KC6		✓	✓	✓	✓							✓	5
KC7	✓	✓	✓				✓	✓	✓	✓			7

About the state of the art advances in an innovative way, note that, while individual DCs each undertake a specific interdisciplinary project, all the DCs will experience the full depth and breadth of QSI through the wider network activities, as will be explained in the following sections. In particular, DC 1 will extend current security analysis of QKD such that they can account for additional device imperfections typically present in practical implementations; DC 2 will introduce novel hybrid KE protocols secure in a post-quantum setting; DC 3 will develop new PQC schemes that exploit quantum communication; DC 4 will prove the security of symmetric-key cryptography based on memory-hard functions against quantum adversaries; DC 5 will explore attacking strategies enabled by quantum computers against PQC schemes; DC 6 will develop a prototype of TF-QKD for network operation over deployed infrastructure; DC 7 will design novel network architectures combining quantum and classical communication; DC 8 will design efficient interfaces between free-space and fibre links; DC 9 will devise new resource-efficient repeater protocols; DC 10 will put together different solutions investigated in this programme to develop a generic framework for end-to-end security; DC 11 will study quantum cryptographic schemes over quantum networks; and DC 12 will investigate the security of post-quantum key encapsulation schemes against quantum adversaries.

QSI is distinct in training a cohort of DCs in QS technologies, and it complements other existing EU programmes and innovative training network (ITNs) in related areas, with which we share certain research interests. In all cases, our work programmes can mutually benefit from collaborations. For example, the AppQInfo ITN studies the utilization of photonic integrated circuits to efficiently generate, manipulate and readout photonic quantum states. This will be of interest to our partners UVIGO, SU, TOSHEU, UNIGE, UNIPD, and IDQUANTIQUESA, with respect to DCs 1, 3, 6, 7, 8 and 10, and efforts will be made, via the common partners SU, UNIPD and IDQUANTIQUESA, to ensure inter-network collaborations. QSI also adds value to the current Quantum Flagship Programme, focused only on quantum technologies, by addressing the problem of the future quantum-safe Internet with a much broader and integrated approach, which combines the merits of several relevant disciplines. QSI will benefit from the experience of its partners involvement in quantum flagship programme, which are about to end in 2022. For instance, SU,

UNIGE and VERIQLOUD are members of the EU Flagship project "Quantum Internet Alliance" that aims at establishing a blueprint for a pan-European entanglement-based Quantum Internet; SU is a member of CiViQ, which aims towards a cost-effective integration of CV-QKD into optical telecommunications networks; IDQUANTIQUESA and UNIGE are members of QRANGE on quantum random number generators; and TOSHEU, IDQUANTIQUESA, SU, UNIGE, UNIPD are members of OpenQKD, which develops testbed facilities where QKD equipment and applications can be tested by end users. Also, UVIGO, SU and IDQUANTIQUESA are part of QSAFE on system architecture for the future EuroQCI; RUB and TU/e are members of the DFG Cluster of Excellence CASA (Cyber security in the Age of large-Scale Adversaries) whose focus is on countermeasures against large-scale attackers. All DCs within QSI will benefit from the considerable investment in capital equipment made by all these projects, as well as from the expertise of postdoctoral researchers they employ. For example, we aim to use the OpenQKD testbed for prototypes developed in QSI, thereby giving the DCs the opportunity to experience implementation of the technology in real world.

1.2 **Soundness of the proposed methodology, (including interdisciplinary approaches, consideration of the gender dimension and other diversity aspects if relevant for the research project, and the quality and appropriateness of open science practices)**

1.2.1 Overall methodology

1.2.1.1 Research projects

This section provides detailed descriptions of the proposed research projects. It includes information on the "**objectives**" and "**expected results**" of each project, as well as a full description, *including methodology*, and "**planned secondments**" (times are with reference to the start of PhD) for each project. The default duration for secondments is 2-4 weeks. Based on our experience with previous ITNs, it is often more beneficial to DCs to have shorter but more frequent secondments to other partners. Longer secondments can nevertheless be arranged throughout the course of the project via mutual agreements. The local supervisors for each DC together with the main contacts during the secondments form a supervisory team for the DC who will closely monitor the work progress. Table 3.1(a) in Sec. 3 provides a detailed description of each project. The first supervisor on the list is the main supervisor at the host partner.

We have a combination of experimental and theoretical projects. The theory projects are mostly concerned with the security of a certain QS solution. In some of them, the common methodology includes modelling the system in an abstract way, and then applying techniques from (quantum) information theory to assess a security statement. Others require to use techniques from quantum computing to evaluate the complexity of certain mathematical functions. The experimental projects follow standard procedures in experimental quantum optics, which include characterizing the required devices and assembling them in a complex optical setup, where measurements are performed, and data is collected and analysed. These methodologies will help us deliver the objectives listed in Table 3.1(a), which contains detailed information about the models and assumptions that underpin our work, and main risks/challenges therein.

Note that the project descriptions given in Table 3.1(a) may need to be updated as we progress towards the end of the programme. To address this issue, and to capitalize on and enhance the collaborations enabled by this network, each DC will be offered to propose an update to their third year of funded research. We particularly encourage them to define collaborative research tasks with other partners of the network. Given that the DCs have been involved in many collaborative network activities (e.g. the network seminar series, the schools, and workshops) by this stage of their career, they are well positioned to define such projects. Once approved by the SB and, if needed, the project officer, the network will provide all required resources, in the form of e.g. unplanned secondments, to ensure the success of the activity. This is one of several initiatives we take to further promote collaborations among partners.

1.2.2 Integration of methods and disciplines to pursue the objectives

At QSI, we employ an interdisciplinary approach to *integrate* our strengths in different disciplines and apply them collectively to each problem. This is achieved via **(1)** a set of projects, each at the intersection of several areas of research: On average, the projects require the expertise in around 7 different subjects in

physics, mathematics, computer science, cryptography and engineering. This clearly shows the interdisciplinary nature of our proposed projects; (**2)** assigning supervisors, with different but complementing, expertise to each DC's project, as listed in Table 3.1(a); and (**3)** offering a range of network-wide training events that prepare DCs for successfully taking on such projects.

To further enhance the collaborative aspects of the programme, we establish a monthly online seminar series in which all researchers involved in the beneficiary and associated partners (APs) will describe their research to others in an accessible manner. These talks will be recorded and made available in the QSI web site so that the DCs who join later can benefit from them. We expect that this activity will foster collaborations between the partners beyond what is already envisaged in the programme, and beyond its lifetime. This, and the range of expertise available to us, is what scientifically makes QSI a unique programme that ***underpins future QS cryptography solutions***. With a team of DCs trained via QSI, the EU can remain at the ***forefront of research*** in this area, securing our data communication.

QSI offers intersectoral experience to the participating DCs via secondment opportunities as well as outreach activities. Each DC is provided with project-specific secondments in leading industrial companies (TOSHEU, IDQUANTIQUESA, SIG, NXP, Genua, VERIQLOUD, Cisco, NTT, EUTELSAT), international research institutes (CWI, INRIM), and/or university-based theory/experimental research groups (UVIGO, ULEEDS, SU, UNIPD, RUB, UNIGE, UvA, TU/e, TTBE, UT, DTU). At QSI, all DCs will experience conducting research in the two relevant work environments, i.e., both in the public and in the private sector. Additional short visits, from/to other participating organisations, or external ones, will be considered, if necessary, throughout the course of the project, to further enrich this experience. Moreover, to ensure the right balance between different sectors, QSI has representative members from the *public* and the *private* sectors in its supervisory board (SB), and committees therein.

1.2.3 Gender dimension and other diversity aspects

QSI considers the integration of the gender dimension in its R&I content of paramount importance. While the programme does not involve human beings as subjects of the investigation, we will monitor whether research outcomes have a different effect on individuals depending on their gender, and, if they do, necessary measures will be taken to ensure that gender dimension is properly integrated in the analysis. For instance, we will evaluate if there is a gender dimension to cybersecurity or cryptographic attacks. This will primarily be implemented for each project defined in Table 3.1(a) by the corresponding DC and supervisory team, and will be reported to the Research Committee.

Also, QSI promotes a bottom-up model where it is the outcome of one's contribution to a team rather than their personal characteristics, such as gender, that determine their reputation. However, gender balance can represent an issue when concerning the composition of the working team, especially in a scientific sector where males are preponderant. This will be addressed in the recruitment process; see Section 3.1.7. Also, specific attention will be devoted to the design and implementation of gender-neutral interfaces in the technologies used by the programme.

1.2.4 Open science practices

QSI commits to providing open access to all its research results, data and tools as early as possible and no later than the publication date of the corresponding research articles, to ensure that third parties can verify, validate, and reproduce them with minimum effort of duplication, unless there is a well justified reason not to do so, e.g. IP or privacy concerns. In short, we follow the principle of "as open as possible, but as closed as necessary". The Consortium Agreement (CA) ensures all beneficiaries have sufficient time to review other proposed submissions and identify possible IP issues or lost opportunities; the Supervisory Board (SB) and the Dissemination and Impact Committee (DIC) will guarantee that this is conducted in a timely fashion to make sure there are no unreasonable barriers to have open access to the programme's research results. Participants will strive to publish their results in high impact journals or high-ranked peer reviewed international conference proceedings, and will also upload a copy of the manuscript to open access repositories such as arXiv.org, eprint.iacr.org, or INVESTIGO (the institutional repository at UVIGO). Publications in open access magazines, or in the Open Research Europe (ORE) publishing platform, will be actively pursued as well. All research results and data will be hosted or linked to via the programme web site.

The DIC will devise the details of the Data Management Plan (DMP) based on the Table 1.2(a), which will be ratified by the SB, and be responsible for overseeing its proper implementation; see Section 1.2.5.

In addition, we will support the development of appropriate open science practices among DCs by offering training opportunities and assisting them with their use. In particular, our first complementary skill workshop covers and fosters open science competencies, as discussed in Section 1.3.2.1. We will also envisage that such open science practices will result in increased research collaboration. During the pandemic, we have extensively used new digital platforms for information-sharing, and we will ensure that they are properly used throughout the programme.

1.2.*5* Research data management and management of other research outputs

At QSI, we will use relevant research data repositories and take measures to ensure efficient data sharing, not only among the network members, but also third parties, to access, mine, exploit, reproduce and disseminate the data, free of charge. The SB will ensure that procedures are in place to ensure data security whilst also providing open-access. To make QSI research data findable, accessible, interoperable and re-usable (FAIR), a detailed DMP will be generated, including a list of all significant types of research outputs of QSI besides article publications (e.g. experimental datasets, images, software, algorithms), and information on all aspects of the data life cycle (research planning, active research and sharing of results). By default, we will make all research outputs available to external users according to the DMP, which will also explain the exceptions, e.g. IP related issues, to this generic rule. The DMP will specify as well which approach is most likely to maximize the adoption and use of the output by the wider community, and when and where the outputs will be made available. The DMP will provide clear instructions on the preparation of data and metadata (e.g., formats & precision) and their submission to selected archives and dissemination portals. As part of the dissemination activities, the DMP will be delivered as soon as possible and no later than mid-term, following the Horizon Europe DMP template, and updated during the execution of the project as needed.

Table 1.2(a) Description of how the data generated by QSI will be managed in line with the FAIR principles

Issues	Description
Types	Experimental datasets, images, software, algorithms, estimated to be of several Gbyte size.
Findability	The project research data and outputs will be deposited and described in institutional/multidisciplinary public data repository, e.g. INVESTIGO at UVIGO, that guarantee long-term data preservation and can attribute persistent unique identifiers (such as DOI) to the deposited items. The repositories will comply with the European Open Science Cloud policy.
Accessibility	All research data from QSI will be provided in open access format and/or will be uploaded to open access repositories, following the EC guidelines. Specific user management will be foreseen in the DMP to allow local users to access the databases and have access to the QSI data. If relevant, further project data will be deposited by the end of the project and a digital dashboard will be developed to make the open access data and model available to interested users. Restrictions to access will be applied only on account of privacy, ethical issues, confidentiality, IP rights and exploitation issues.
Interoperability	QSI data and research outputs will be described using standard descriptive metadata and, whenever possible, terms from controlled vocabularies and ontologies will be associated with the data to enhance semantic interoperability.
Reusability	QSI will distribute their data in open access formats, and by adopting licenses that allow full data re-use (e.g. Creative Commons Attribution 4.0 International Public License, or Creative Commons Public Domain Dedication, or a licence with rights equivalent to the above, under the principle “as open as possible as closed as necessary”). The deposited data/research outputs will be made available along with relevant documentation explaining data processes and instructions about any tool/software/model that may be necessary for data/research output validation, interpretation, and re-use. Each partner generating or reusing research data is responsible for their quality, organization, management, publication, preservation and secure storage during QSI, according to the DMP.
Curation and storage /preservation costs	Costs of data collection, quality check, cleaning and conversion to open formats, anonymization, pseudo-anonymization, description, and documentation (e.g. codebooks, instructions, tools) can be estimated as 3% of the research activities costs. Moreover, the activities related to the DMP (such as providing guidance to partners on data management and open access issues and preparing the DMP) will cost about 0.5 person-month per year for the whole duration of the project. No costs are expected for the deposit and preservation of research outputs as the chosen repositories do not apply fees. DIC will be responsible for data management and quality assurance.

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1.3 Quality and credibility of the training programme

1.3.1 Overview of the doctoral training programme

QSI aims to train 12 DCs, see Table 1.3(a), all enrolled as PhD students, in a broad sweep of scientific and technical skills covering a full range of emerging QS technologies. Their training will prepare them to work on practical, exploitable systems for the emergent and disruptive QS technology markets. Such researchers require detailed technical skills and experience in their specific technology area, along with a much wider knowledge and understanding in quantum and post-quantum cryptography, as well as in implementations ranging from optical systems in communications networks through to post-quantum cryptographic hardware. For the EU to remain competitive in secure communications and in the quest to develop commercially viable high-value products in this area, a supply of highly-trained researchers, with flexible and practical skills, must be sustained. In addition to the broadest possible research skill-set, these researchers must be ready to understand and exploit the knowledge that they generate, and be trained in the steps that bring research successfully from laboratory to marketplace. To fulfil this vision, QSI has been designed with the following *principal training objectives*:

- To train DCs in relevant QS technologies (through their project) suited to their specific talents *and* in a broad range of advanced technologies pertinent to future QS applications;
- To provide DCs with an enhanced appreciation for implementing scientific results into new technology within the private sector, and with skills in the management of scientific and industrial projects;
- To secure the career prospects of DCs by offering them training in transferable skills and a diverse experience in the public and private sectors as well as in academic and industrial environments; and
- To enhance the competitiveness of the EU by developing a model for *structured doctoral training* that will endure beyond the life of the project and address the challenges of future QS technologies.

In order to achieve our training objectives, QSI has envisaged two training WPs for its DCs: **S&T Training (WP4):** detailed technical training in their specific area *plus* an understanding of, and experience in, quantum, post-quantum, and hybrid technologies necessary for exploitable devices and applications, and critically in the integration of these technologies with each other; **and Complementary Skill Training (WP5):** skills required to manage projects and present research results in various forms and to different audiences, and knowledge about commercialization, entrepreneurship, and intellectual property (IP).

These WPs will be complemented by our dissemination and outreach activities in WP6 and WP7, as will be described in Sec. 2. DCs will have the opportunity to not only practice project management and presentation skills but also how to organise an international symposium. Via **industrial** secondments, DCs will experience work in the private sector, and, via outreach activities, they will engage with the public and policy-makers. The academic training also features a combination of traditional course-based teaching, *not part of many existing doctoral programmes*, with advanced focused schools and workshops not currently available across Europe. The SB ensures that industrial input in planning and in action will be used. Overall, QSI offers a ***multi-faceted intersectoral training*** programme not only in *science and technology* but also in complementary skills, such as *management* and *entrepreneurship,* and then puts all in action.

To ensure the overall integrity of the training programme, QSI will appoint Prof Christian Schaffner as the **Director of Training**, benefiting from his experience as the chairman of Quantum.Amsterdam, an innovation hub for quantum software, technology and applications, and as the chairman of the Talent & Outreach Committee of the Quantum Software Consortium. The role of the Director of Training is described in detail in Sec. 3.1.6.

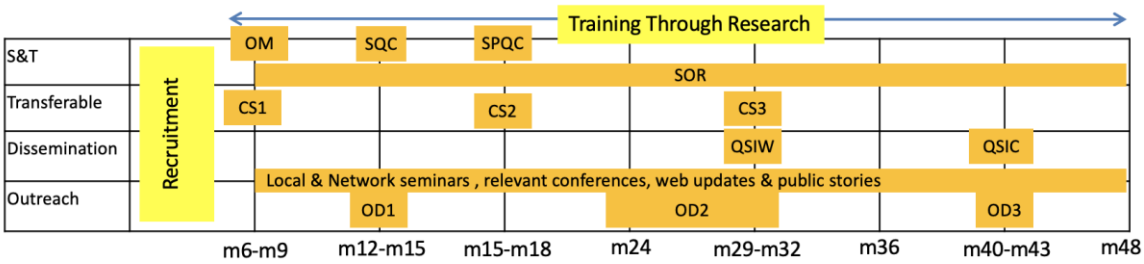

Fig. 1. **Tentative timetable for network-wide training activities. Acronyms correspond to Table 1.3(b).**

1.3.2 Content structure of the doctoral training programme

Table 1.3(a) Recruitment Deliverables per participant

Researcher Nº	Recruiting Participant	PhD awarding	Planned Start	Duration (Months)
DC1	UVIGO	UVIGO	M6	36
DC2	TU/e	TU/e	M6	36
DC3	SU	SU	M6	36
DC4	UvA	UvA	M6	36
DC5	RUB	RUB	M6	36
DC6*	TOSHEU	ULEEDS	M6	36
DC7*	UNIGE	UNIGE	M6	36
DC8	UNIPD	UNIPD	M6	36
DC9*	ULEEDS	ULEEDS	M6	36
DC10*	IDQUANTIQUESA	UNIGE	M6	36
DC11	UVIGO	UVIGO	M6	36
DC12	DTU	DTU	M6	36

***** *DC 7 & DC 10 will be funded by the Swiss Government, DC 6 & DC 9 by the UK Government*

Within QSI, the training will be provided ***through research*** via a series of activities at the local and network levels. At the local level, DCs participate in relevant seminar series and attend formal taught courses, if necessary, in their corresponding organisations. This is supplemented by shared online resources (SOR), and by network-wide focused schools organised by the beneficiary and APs with the help of external experts in these fields. This will provide a general common knowledge about all required disciplines. We also offer relevant complementary skill (CS) training at *network* and *local* levels at appropriate times corresponding to the activities that DCs undertake.

Table 1.3(b) gives a list of main network-wide activities. Each activity relates to one or more WPs. For instance, while CS training (WP5) provides the DCs with the knowledge of presentation and management skills, it is during the secondments and/or the dissemination/outreach WPs that DCs find the opportunity to implement and practice this training. Below, we describe the **network-wide** components of our training programme within WPs 4-5, as well as the local training facilities at each host institute. Figure 1 shows a tentative time plan for all network-wide elements.

1.3.2.1 Network-wide training events

Below we describe activities 1-7 in Table 1.3(b) corresponding to WPs 4-5; Section 2 will cover activities 8-12.

Table 1.3(b) Main network-wide training events, conferences and contribution of beneficiaries

	Main Training Events & Conferences	ECTS (if any)	Lead Institution	Action Month (estimated)
1	Orientation Meeting (**OM**)	0	UvA (**C Schaffner**)	6-9
2	School on Quantum Cryptography (**SQC**)	0	UNIPD (**P Villoresi**)	12-15
3	School on Post-Quantum Cryptography (**SPQC**)	0	TU/e (**A Hülsing**)	15-18
4	Complementary Skill Workshop 1 (**CS1**)	0	UvA (**C Schaffner**)	6-9

5	Complementary Skill Workshop 2 (**CS2**)	0	RUB (**A May**)	15-18
6	Complementary Skill Workshop 3 (**CS3**)	0	ULEEDS (**M Razavi**)	29-32
7	QSI Monthly Seminar Series	0	UVIGO (**M Curty**)	2-48
8	Quantum-Safe Internet Workshop (**QSIW**)	0	DTU (**N Dragoni**)	29-32
9	Quantum-Safe Internet Conference (**QSIC**)	0	SU (**E Diamanti**)	40-43
10	Outreach Day 1 (**OD1**)	0	ALL (overseen by **N Dragoni**)	12-15
11	Outreach Day 2 (**OD2**)	0	RUB (**A May**)	24-32
12	Outreach Day 3 (**OD3**)	0	SU (**E Diamanti**)	40-43

WP4: Science and technology training components

- **Orientation Meeting (OM)**: This will occur once the DCs are recruited and arrive (within the first 6-9 months). It will provide the DCs with: (i) an overview and context of the QSI programme; (ii) an opportunity to develop a *spirit de corps* and form a strong and effective network; (iii) an overview and introduction to all aspects of being a PhD student. This event is designed to include CS1 and be concurrent with an SB meeting, giving DCs the opportunity to meet with their network and secondment supervisors as well. A sandpit meeting will also be organized to discuss how to implement and enhance research collaborations within the network.

- **Shared Online Resources (SOR):** In order to solidify the basic understanding of all relevant disciplines, and to create a common background among DCs, QSI has envisaged to share appropriate online resources/courses, offered at the postgraduate level, among the network members. The set of resources/courses to be used will depend on the individual backgrounds of the DCs and the projects to which they are recruited. Each individual's programme of study will be agreed with the Director of Training and their specific supervisory team. Examples of online resources that will be made available to the DCs include several video lectures, e.g., from the two Schools on Quantum Secure Communications (http://www.qcall-itn.eu/sqc-school/) and Quantum Communication Networks (http://www.qcall-itn.eu/sqcn/) organized by the ITN QCALL, where some of our beneficiary organizations contributed to; from the Schools on PQC organized by TU/e (https://www.pqcschool.org); those about modern cryptography generated by the ITN ECRYPT-NET, where our beneficiary organizations RUB and TU/e participated in; as well as the lectures notes on quantum computing by Ronald de Wolf from UvA/CWI.

- **School on Quantum Cryptography (SQC):** The DCs will attend a 5-day-long scientific school to be held in Italy in the first year of their studies, which covers QKD technologies and the challenges of integrating quantum and classical networks. The school will benefit from industrial speakers as well as theoreticians, and the lectures will be made accessible to researchers with computer-science background. We will welcome out-of-network participation from closely related research groups at a minimal fee. SQC will cover the following topics: (1) Various QKD protocols ranging from the Bennett-Brassard 1984 (BB84) QKD protocol and entanglement-based QKD through to device-independent, MDI, TF, memory-enhanced, and continuous variable (CV) QKD; (2) Sketch of security proofs and the underlying theory for main QKD protocols; (3) Experimental challenges facing the implementation of each system; (4) Beyond-QKD QC primitives; (5) Challenges of integration of quantum and classical networks; (6) Satellite QKD; and (7) Industrial outlook. To enhance collaborations among participants, various creative activities will be planned, including a competition to pitch for commercial QC products.

- **School on Post-Quantum Cryptography (SPQC):** Having learned about QC in SQC, in this 4-day-long scientific school to be held in the Netherlands in the first year of their projects, the DCs are exposed to PQC technologies. During this event the DCs will attend lectures given by scientists within the programme and external experts in the field. The lectures will be made accessible to researchers with physics background, and will be accompanied by exercises for self-studies. The school will be open to participants outside our network at a small fee, and cover the following topics: (1) PQC models & challenges; (2) Symmetric cryptography in PQC; (3) Lattice-based cryptography; (4) Code-based cryptography; (5) Multivariate cryptography; (6) Hash-based cryptography; (7) Isogeny-based cryptography.

SQC and SPQC provide a common technical understanding for all QSI projects to all DCs. By doing so they enable DCs to contribute effectively to each other's projects and it fosters team work among them. The accessibility to researchers from different backgrounds is what makes both schools *unique* in their intent and content and distinct from other schools that might have been previously organised. The Schools provide the same level of training to closely related researchers elsewhere. They have been timed (months 12-15 and 15-18, respectively) such that all DCs have obtained the foundation knowledge via their taught courses, and are ready to appreciate more advanced material. During the same week as SPQC, DCs are also offered CS training as described below. DCs are expected to present a poster on their research projects during these schools. That will be the first dissemination activity aimed at external speakers and APs, as well as to other participants in the Schools.

- **QSI Monthly Seminar Series:** To promote collaborations, to learn about the latest developments in the field, and to enhance DCs presentation skills, we organize a monthly online seminar series where all QSI researchers present their work to the consortium. We use online platforms to avoid unnecessary travel and keep a record of the talks.
- **WP5: Complementary skills training components**

  Complementary Skill Workshop 1 (CS1). We will deliver the first part of the network-wide complementary skill training (CS1) through the provision of training courses, over three days, during the OM, in Amsterdam. Topics of training in this session include:
  - research ***project management***; carrying out a PhD; experiential, interactive activities, culminating in producing a project plan for the QSI web site (half a day);
  - ***Open science practices***, including training on collaborative tools, open access to publications and research data, FAIR data management, public engagement and citizen science (half a day);
  - ***team working*** and communicating among individual researchers; (half a day)
  - ***academic ethics*** and integrity; good scientific practice (half a day); and
  - managing and developing a project ***web site*** (1 day).

  This course will be designed and given by the Staff of the Reflect Academy who are running a successful course on "mastering your PhD" at the Natural Science Faculty of UvA. CS1 will be video recorded to be used for potential late starters as well as other members of the cohort.

  Complementary Skill Workshop 2 (CS2). For maximum effectiveness of training, the DCs will attend a one-day dedicated CS training workshop delivered by staff members at RUB during the same week as SPQC. Topics of training in this session will supplement the existing local training and will include
  - Hands-on sessions on scientific ***writing and presentation skills*** (half a day), and
  - Communicating to the public; writing ***popular articles*** & engagement with ***outreach*** activities (half a day).

  The elements learned in CS1-2 will be put in practice to deliver dissemination objectives as outlined in Sec. 2.3.1. There we explain how DCs (**1)** will organise two conferences, via which they will apply and enhance their organisational and management as well as their presentation skills; (**2)** will provide material, technical and non-technical, for updating the project web page; and (**3)** participate in several outreach activities planned for the network.

  Complementary Skill Workshop 3 (CS3). This workshop on business and start-up skills will be outsourced to the Quantum Technology Enterprise Centre (QTEC) at the University of Bristol, which has the expertise in commercializing quantum products. It will be over two days, and it covers
  - Reviewing the **commercialisation** process, including the importance of market research, protection of IP and business models (half a day);
  - **Business project management**, including the practicalities of finance and contracts, **responsible business** practices and **sustainability** in business (half a day);
  - **Pitching** exercises to potential investors (half a day).

1.3.2.2 Complementarity with local training facilities

QSI offers a training programme that no single institute can offer to its DCs. Our shared online database will provide all DCs with the collective wealth of knowledge in all academic partners. Our CS workshops also

complement the existing training in each participant organisation. While certain experimental facilities may be exclusive to some partners, by the secondment mechanism, several DCs will find the chance to visit and learn about such disruptive technologies. The supervisory team allocated to each DC also provides an interdisciplinary team of experts all overseeing the progress of each individual project and providing specialized direction from their own unique angle. Finally, through various network events, the DCs will share their expertise to create a cohort whose span of skills not only covers individual projects but it extends to the entire programme. In addition, QSI will benefit from and complement existing PhD programmes in participating organizations, as explained below.

- **Formal taught course training**. Each of our academic beneficiary partners already delivers postgraduate programmes in disciplines relevant to QSI. Whenever necessary, we will utilise selected components of these programmes to develop further the scientific knowledge of DCs.
- **Soft-skill training:** In addition to the three CS workshops, *all* academic beneficiary members (and some APs) offer CS courses on a regular basis. Examples are the ODPL at ULEEDS, the "Area de Formación e Innovación Educativa" at UVIGO, or the skills development courses at UvA. Supervisory teams will be vigilant to recommend such courses whenever necessary. If a local host organisation does not provide complimentary training in a specific subject, arrangements will be made for DCs to visit other organisations who may offer it.
- **Local seminar programme**. Each research group contributing to QSI maintains an on-going programme of academic seminars by *external/local experts*. The supervisory team for each DC will identify and recommend appropriate seminar series in their organisation. Whenever possible, seminar talks can be broadcast/recorded for the use of other DCs. In addition to S&T benefits, this will provide training in disseminating the output of research. At UVIGO, this includes the AtlanTTic Research Seminars, at ULEEDS we have the Theoretical Physics Seminars as well as the regular White Rose Meetings between ULEEDS, York, and Sheffield universities, at UNIPD we have the weekly seminars in the Quantum Future research group, and at RUB the CASA Distinguished Lectures on Cybersecurity. Also, we will benefit from the Paris Centre for Quantum Computing hub, which brings together leading groups in quantum information in and around Paris. At QuSoft, the Dutch research centre for Quantum Software, located at our partner organization CWI, has many international visitors and a weekly QuSoft seminar. At TU/e we have the weekly EIPSI seminar, and we will also benefit from the Netherlands-wide Crypto-Working-Group seminar in Utrecht organized by TU/e in collaboration with Radboud University. UNIGE has a weekly journal club and research seminar, where PhD students and postdocs from three research groups working in quantum physics discuss their work. Finally, TOSHEU organizes a weekly journal club and research talks, and participates in the seminars of the collaborating quantum research groups at Cambridge University.
- **Experimental facilities and training.** TOSHEU hosts ten optical laboratories with facilities for characterising quantum light sources, single photon detectors and fibre optic components, high speed electronics, fibre optic system development and characterization; SU conducts experiments on QC, including CV QKD and beyond QKD protocols, and develops entangled-photon sources at telecom wavelengths; ULEEDS hosts advanced special fabrication facilities; UNIPD offers experimental facilities for satellite quantum communications; and UNIGE and IDQUANTIQUESA have advanced quantum optical laboratories. All DCs involved with experimental projects will receive specialized training to work with relevant equipment. Health and safety regulations will be strictly enforced throughout.

1.3.3 Role of non-academic sector in the training programme

QSI is fortunate to have several leading members of industry, namely, TOSHEU, IDQUANTIQUESA, VERIQLOUD, Genua, NXP, Cisco, NTT, SIG, and EUTELSAT as AP members. We have selected these members strategically to cover all the relevant expertise to QSI. We will use the following mechanisms to fully assimilate the industrial expertise into the design and conduct of our training programme:

- The SB will be advised by an **Industrial Advisory Board (IAB)**, led by Dr. Andrew Shields from TOSHEU, with over 20 years of industrial R&D experience, who will also be a member of the *Management Executive Group* (MEG). The IAB will oversee the progress of each DC and will make

individualized recommendations on the *career development plan* of each DC to the SB. They will also oversee the overall conduct of the programme and will make suggestions to improve its industrial uptake.

- All industry partners provide **secondment** opportunities to the DCs, and two will also host DCs; see Table above. TOSHEU will host one DC, who will be fully funded by the UK Government, and receive two DCs for secondment. IDQUANTIQUESA will host one DC, who will be fully funded by the Swiss government, and will second also two DCs. Being the main provider of end-to-end QKD, this will be a valuable experience for these DCs. SIG will supervise one DC during their secondment to work on QKD, VERIQLOUD will supervise one DC during their secondment to work on protocols for quantum networks, Genua and NXP will each supervise 2 DCs during their secondment to work on PQC, and Cisco, NTT, and EUTELSAT, as large telecom companies, will also supervise 4 DCs in total.

Our non-academic partners contribute to the **training events**, e.g. by offering industrial and experimental (hands-on) sessions at the planned schools and conferences

Non-academic supervision

Partner	Hosts	Researchers
TOSHEU	DC 6	DCs 1, 2
IDQUANTIQUESA	DC 10	DCs 3, 7
VERIQLOUD		DC 3
Genua		DCs 2, 5
NXP		DC 4, 12
SIG		DC 7
Cisco		DC 9
NTT		DCs 1, 9, 11
EUTELSAT		DC 8

1.4 Quality of the supervision

1.4.1 Qualifications and supervision experience of supervisors

QSI benefits from a sweep of experienced researchers and academics on its supervisory teams. We have ensured that each supervisory team involves, at *both* local and network levels, senior supervisors from academia and industry. Over the past 10 years, **Andrew Shields**, Chair of the IAB, has supervised over 20 PhD students in the field of quantum information devices and applications. He is a close collaborator of several of the Doctoral Training Centres in the UK**. Eleni Diamanti**, our Director of Research, is a CNRS Research Director at SU, has a 20-year experience in experimental QC and quantum communications, and has supervised 20 PhD and 12 postdoctoral researchers. She is the Vice Director of the Paris Centre for Quantum Computing and was a steering committee member of the major international conference on QC, QCRYPT. **Hugo Zbinden** has more than 25 years of experience in QKD. He supervised and co-supervised more than 20 PhD students, and was more than 25 times member of a PhD jury all over the world. **Paolo Villoresi** is a Professor of Experimental Physics at the Faculty of Engineering, where he currently teaches Quantum Electronics and Quantum Optics. He is the Group Leader of the Quantum Future research group, which is active in quantum information and communications. He has supervised and co-supervised more than 30 PhD students. **Mohsen Razavi** has successfully coordinated another ITN (QCALL) and is the Director of Postgraduate Research Studies at the School of Electronic and Electrical Engineering at ULEEDS. He has ~ 20 years of research experience in classical and quantum optical communications and has been involved with postgraduate-postdoctoral research supervision of ~15 researchers during his time at the University of Waterloo and ULEEDS. **Marcos Curty**, the Coordinator, is an Associate Professor and Coordinator of the Graduate Studies at the Telecommunication Engineering School at UVIGO. He has more than 20 years of experience in optical communications and QC, and has supervised nearly 20 graduate researchers, and currently 4 postdocs support his team. He was a member and chair of the QCRYPT steering committee. **Kevin Layat**, is a Security Architect at IDQUANTIQUESA with ~10 years of research experience in QC; he has supervision experience with MSCA fellows. **Andreas Hülsing,** Assistant Professor at TU/e, has 10 years of experience in PQC and has successfully supervised over 10 graduate students. Right now, he independently leads a team of 3 PhD students and a postdoc. **Christian Schaffner**, our Director of

Training, is Professor in Theoretical Computer Science at the University of Amsterdam. He has ~15 years of research experience in QC and was a member and chair of the QCRYPT steering committee; he has supervised nearly 15 graduate researchers, and is currently supervising 1 PhD student and 2 postdocs. **Alexander May** is Full Professor for Cryptology at RUB working in cryptology and quantum algorithms. He has already supervised 12 PhD students, and is currently supervising 6 PhDs and 1 postdoc. **Nicola Dragoni** is Professor at DTU with 15 years of experience in cybersecurity research. He has supervised 4 postdocs, 6 PhD students and tens of MSc students. Right now, he leads a team of 2 PhD students and 2 postdocs. These main supervisors are assisted locally by a group of co-supervisors with experience in optical communications and networks, quantum devices, QKD, quantum algorithms and PQC, including, for instance, Dragan Indjin at ULEEDS, Giuseppe Vallone at UNIPD, Elham Kashefi at SU, Mirko Pittaluga at TOSHEU, Tim Güneysu and Michael Walter at RUB, Tanja Lange and Boris Skoric at TU/e, Florian Speelman at UvA, Robert Thew at UNIGE, Félix Bussières at IDQUANTIQUESA, and Christian Majenz at DTU.

Most QSI supervisors already have been involved in previous Innovative Training Networks (ITN). For instance, MR coordinated the ITN QCALL ("Quantum Communications for All"), AS participated in the ITNs SAWTRAIN, PICQUE, QRNG, and 4PHOTON; AM, TG, and TL participated in the ITN ECRYPT-NET on modern cryptography. ED and HZ participated, together with IDQUANTIQUESA, in the FP7 ITN QCERT on "Quantum Key Distribution Certification", ND was involved in the ITN FORA; and IDQUANTIQUESA was member of the FP7 ITN PROMIS.

1.4.2 Quality of the joint supervision arrangements

At QSI, the network-wide supervision capacity is fully used. Each DC, in addition to local supervisors at the host institute, is allocated a team of supervisors from other relevant partners; see Table 3.1(a). Table 1.4(a) shows all collaboration activities that arise because of this joint supervisory arrangement. As illustrated in the table, in their projects, each DC collaborates on average with about five partners. Also, each partner hosting a DC collaborates on average with about ten other partners within various projects. The allocation of a team of supervisors to each DC, in addition to creating collaborative projects, will enable a multi/interdisciplinary and intersectoral approach to each project. This is a necessity for QSI's projects considering the wide range of expertise each project needs. It also ensures a high quality of supervision for each DC. Members of the supervisory team will be in regular contact via online media, and discuss the progress of the project, in person, and in each network's event. If needed, short visits will be arranged too.

Table 1.4(a): Collaboration chart via individual projects. Collaboration score/project: The number of institutes contributing to the supervision of each project; Collaboration score/partner: The number of partners each partner is collaborating with via project supervision as main supervisor (red ticks), or as member of the supervisory team. For instance, ULEEDS is collaborating with 10 partners, TOSHEU, UVIGO, INRIM, UNIPD, SU, EUTELSAT, NTT, RUB, DTU and CISCO via DCs 6, 8, 9 & 11, so its collaboration score is 10. Note that DCs 7&10 will be funded by the Swiss government, and DCs 6&9 by the UK Government.

Partner / **Project**	**Beneficiaries**									**Partner Organisations**													**Collaboration score/project**
	TU/e	**DTU**	**UVIGO**	**SU**	**UNIPD**	**UvA**	**RUB**	TOSHEU	ULEEDS	UNIGE	IDQUANTIQUESA	Cisco	SIG	UT	TTBE	Genua	VERIQLOUD	INRIM	NXP	CWI	NTT	EUTELSAT	
DC1	✓		✓					✓		✓				✓							✓		**6**
DC2	✓					✓		✓							✓	✓							**6**
DC3				✓		✓					✓						✓			✓			**5**
DC4	✓					✓	✓												✓	✓			**5**
DC5				✓		✓	✓									✓							**4**
DC6			✓					✓	✓									✓					**4**
DC7			✓		✓					✓	✓		✓										**5**
DC8				✓	✓				✓													✓	**4**
DC9							✓		✓			✓									✓		**4**
DC10				✓			✓			✓	✓												**4**
DC11		✓	✓						✓					✓							✓		**5**
DC12	✓	✓				✓	✓												✓				**5**
Collaboration score/partner	**12**	**7**	**11**	**10**	**7**	**11**	**12**	**10**	**10**	**10**	**9**	**3**	**4**	**7**	**4**	**6**	**4**	**3**	**5**	**7**	**9**	**3**	**Avg = 4.7** / **Host Partners Avg = 9.9**

2. IMPACT

2.1 Contribution to structuring doctoral training at the European level and to strengthening European innovation capacity, including the potential for:

2.1.1 Meaningful contribution of the non-academic sector to the doctoral training

The non-academic partners of QSI constitute a crucial and integral part of the project's structure. They are involved in all training activities and events and play a central role in all relevant management boards (MEG, IAB, DIC & SB; see Sec. 3). These are partners that strongly believe in the potential of our objectives and are committed to contribute to career evolution of the network's DCs and economic exploitation of the outcomes of their work. QSI will have a large impact by bridging classical communications and modern cryptography tools with quantum technologies, which brings the EU to the forefront of adopting these changes in our daily communications. This is a great advantage created by the DN structure, which is impossible to assure at such a large scale for stand-alone institutions. Please see Sec. 1.3.3 for further details.

QSI will expose DCs to as many meaningful environments as possible pertinent to their projects, which importantly includes the private sector (R&D companies). For instance, DC 2 will do a theory project at TU/e, and will be seconded to TOSHEU and Genua, which have expertise in IT security; DC 3 will do a theory-experimental project at SU, and has secondments at IDQUANTIQUESA and VERIQLOUD, two successful companies in quantum technologies; or DC9 will do a theory project at ULEEDS, while doing secondments at Cisco and NTT, which are leading companies in networking technologies.

2.1.2 Developing sustainable elements of doctoral programmes

QSI offers a unique structure of doctoral training by using collaborative network-wide supervision, shared facilities and knowledge databases, advanced technical and CS schools, and intersectoral secondments. It is our objective to make the best use of this unique structure, not only for the duration of the project, but also for years to come. To ensure **lasting benefits** of our consortium, in addition to ongoing collaborations and applying for joint funding, QSI will employ a *structured mechanism* to **(1)** keep the developed teaching resources available to all network participants, and their future graduate students; **(2)** continue holding the scientific schools in both QKD and PQC, supported by a fee, every other year; **(3)** organise a regular workshop on Quantum-Safe Internet, to continue the promotion and the dissemination of activities in this area; **(4**) explore the opportunity to create joint doctoral degrees among participants; **(5)** build in intersectoral secondments and exchange visits into future PhD training; **(6)** liaise with non-academic partners to gain their input into new graduate programmes; **(7)** maintain and enhance collaborations to deliver the objectives set by the roadmaps generated by QSI, and **(8)** be vigilant of other opportunities, e.g. via Quantum Flagship Programme, that may arise to develop a ***sustainable structured model*** of PhD training in EU.

2.2 Credibility of the measures to enhance the career perspectives and employability of researchers and contribution to their skills development

Within QSI, DCs will have the opportunity to fully develop their potential for innovation and invention. The broad field of QS technologies is particularly well suited for this purpose. It is possible within the time-frame of a PhD to see an abstract idea becoming reality in practice. The close and established links with industry (TOSHEU, IDQUANTIQUESA, VERIQLOUD, Genua , NXP, SIG, EUTELSAT, Cisco and NTT) will provide DCs with ample opportunities to shape their views on R&D careers in industry, in addition to their exposure to academic life. The broad training in abstract problem-solving as well as in tackling implementation challenges will make DCs excellent candidates for jobs in EU and international companies with innovative potentials, including TOSHEU, IDQUANTIQUESA, VERIQLOUD, Genua, NXP, SIG, EUTELSAT, Cisco and NTT which are involved with QSI as APs. Moreover, with the entrepreneurial mindset developed via secondments and CS courses, and the assistance that they will receive from technology transfer centres in participant organisations, DCs will be able to take on the challenge of developing their own start-up companies and transfer their knowledge directly into practice.

To help DCs achieve their most ambitious potentials, they are given a central role in QSI management by involvement at all levels of decision making and event organisation. This will motivate them to exploit their potential for playing an active role in their research and also for shaping their future careers, by taking on project responsibilities at an early stage of their career. The acquired organisation skills will be useful in any other non-academic work environment as well. The intensive interchange during workshops, seminars, and

network meetings allows the supervisory team to identify and strengthen the key competences of DCs, while also developing their CSs.

To document DCs' progress toward their career ambitions, on appointment, the DCs will have a formal meeting with their local supervisors to discuss the implementation of their research project and to undertake a Training Needs Analysis, which will result, in consultation with other members of the supervisory team, in the identification of training opportunities for the DC. As a result of the meeting, a personal *Career Development Plan* will be prepared for the individual DC. This plan will be submitted to the SB and reviewed and amended as required throughout the fellowship. The progress of each DC will be monitored regularly and will be reported to relevant SB committees on a biannual basis. The SB will ensure that each DC receives a balanced intersectoral training, which will enable them to contribute to both academia and industry. The supervisors will ensure the DCs are given access to all relevant facilities, equipment and training they need throughout the fellowship, and provide ongoing support to the DC, even beyond the end of the project within the norms in academia/industry.

QSI DCs will find many employment opportunities in the QS technology supply chain spanning devices and components, QKD systems, QS telecom applications, software development and system integration. The broad education of the DCs will lead to a strong background in quantum optics, quantum communications and modern cryptography, and detailed knowledge about theoretical communications networks and their security concepts. The latter are the basic grounds in the whole R&D area of secure communications. QSI has multiple industrial partners, who will be involved in the training activities at all levels and will have close links with the DCs. This is a unique environment for fostering career perspectives in the EU industrial sector, and QSI will exploit this opportunity via different work sectors: (1) The growing quantum communications industry will certainly attract many DCs. Companies like Quside, LuxQuanta, InfiniQuant, Single Quantum, KeeQuant, Alpine Quantum Technologies, Qtlabs, and our AP VERIQLOUD *inter alia*, are candidates that our DCs can consider joining; (2) Modern telecom industry will need security tools based on quantum information primitives and PQC. Some telecom companies, e.g., Telefónica (links to UVIGO), Deutsche Telekom, Telecom Italia Mobile, Orange, Swisscom (links to UNIGE and IDQUANTIQUESA), Thales (links to SU), and our AP SIG *inter alia*, are already involved with this technology. Certainly, these are fast growing fields, which need excellent educated scientists especially if these concepts need to enter our daily life and be integrated with existing infrastructure. (3) IT companies such as Infineon, Cryptonext, FragmentiX, Rohde & Schwarz, ADVA, and our APs NXP and Genua *inter alia*, as well as aerospace companies like ThalesAlenia (links to SU), Hispasat (links to UVIGO), OHB, SES, Airbus, and our AP EUTELSAT *inter alia*, have also great interest in QS technologies, and will attract many DCs as well; (4) Government bodies that set the policy for communications security, e.g., BSI in Germany, CNI in Spain, and ANSSI in France provide other job opportunities where technical knowledge of QS systems is required for policy making; (5) Industries that rely on security such as banking will also be keen in hiring our DCs to help them deploy QS technologies; and, last, but not least, as mentioned before, (6) QSI will create ample potential for start-up companies to emerge and that will be an immediate route to realise the impact of our projects. QSI is a perfect investment in this direction, with all our DCs working on topics of interest to these sectors.

QSI will also provide its DCs with career opportunities in academia. QS technologies have attracted considerable attention in the past years, due to their large potential for altering our communication practices in the near future. Especially after the wiretapping operations of the NSA, new strategies are urgently needed to ensure communication security in our modern societies. Research and training in these fields are supported globally by funding sponsors across the world, e.g., in Canada, US, Japan, China, Russia and Singapore, among other countries. In Europe and abroad, these fields have seen a young and dynamic group of tenured academics forming, which plays a crucial role for bringing advancements in these fields, hence new academic jobs at all levels.

2.3 Suitability and quality of the measures to maximise expected outcomes and impacts, as set out in the dissemination and exploitation plan, including communication activities

2.3.1 Plan for the dissemination and exploitation activities, including communication activities

We have two WPs for an effective delivery of our dissemination objectives: **WP6 on Dissemination & Impact,** which concerns organising events, participating in conferences, publishing in high-impact journals

and conference proceedings, and securing other exploitation routes; and **WP7 on Outreach** activities, which concerns the dissemination of scientific results to different target audiences including a non-specialist audience; see Sec. 2.3.1.3.

2.3.1.1 Dissemination of the research results

Successful completion of the project objectives will lead to several high-profile results that will be duly published in high-impact peer reviewed international journals, e.g., the family of Nature, Science & Physical Review, or high-ranked peer reviewed international conference proceedings like CRYPTO, EUROCRYPT, ASIACRYPT, or the IACR conferences. In addition, results will be presented at international meetings e.g., QCRYPT, PQCrypto, QIP, PKC or QCMC, *inter alia*. The publication in highly rated open access journals, e.g., Science Advances, npj Quantum Information, Quantum, New Journal of Physics, or in the ORE publishing platform will also be pursued to ensure the high visibility of the scientific results. All our partners have previously published in such high-impact journals and proceedings of the conferences above. We will ensure that the EU policies on open-access are strictly followed and that all scientific publications will be available on open-access repositories, such as arXiv.org or eprint.iacr.org, at latest at the time of publication; see Section 1.2.4. Moreover, we will deposit the research data needed to reproduce and validate the published results in public data repositories such as INVESTIGO at UVIGO. A DMP will be developed as early as possible and no later than mid-term, and reviewed regularly, to provide guidelines in this regard. We ensure open access, via the repository, to the bibliographic metadata that identify the deposited publications. In addition to journal publications and conference papers, we pursue the following routes to maximize our impact and to put DCs' training into action:

- **QSI web site:** QSI will have a ***dedicated web page*** with an ***intranet facility*** *and* ***public pages***. The web site will be used as a ***training and dissemination platform*** where the intranet area will contain student presentations, teaching materials, the **DC Forum** (DF), and other admin sections. The public area will provide space for the DCs to publicise themselves and their research to the European job market and the wider public. The web site will be developed by a professional team within the first three months of the programme, and it will initially be used for QSI recruitment and advertisement. The DIC of SB will oversee the proper implementation of the initial web site, which will include sections related to different research strands present at QSI. Once DCs are recruited and have completed CS1 (within their first year), which includes web site management skills, DCs will gain access to relevant parts of the web site. From month 24, DCs will take charge, each for a month in rotation, and write and highlight a first-page story on their own research for public audience. This is in line with the material offered by CS2, where technical writing skills will be taught. Each DC will also be allocated space on the site for personal academic web pages, where they will be expected to provide regular updates for their part of the project, including formal (e.g., short scientific reports) and informal written postings (e.g., blogs) and interactive video broadcasts. All public web material will be linked to pre-existing web sites to maximise exposure of QSI's research and DCs, as well as our public outreach efforts.
- **Digital newsletter:** To further disseminate the highlights of the programme to scientists, policy-makers and industrial players, the DIC will produce a digital newsletter every 6 months with inputs from all partners. From month 24, two DCs in rotation will be in charge of this task under the guidance of DIC. The newsletter will be posted on the QSI web site and distributed to a mailing list of registered stakeholder contacts.
- **QSI workshop (QSIW)**: A network-wide workshop to showcase the mid-term achievements of the programme will be organised by DTU with the support of all DCs, in which each DC presents his/her latest results. We welcome participation from other related external research groups at a minimal fee. The meeting will fill in an existing gap in the scientific community that studies QS technologies, and will also complement the Quantum Safe Cryptography workshop, which mainly targets the less technical audience in industry and policy making. The latter is currently organized on a yearly basis by the European Telecommunications Standards Institute (ETSI) and the Institute for Quantum Computing (IQC). If possible, we will try to align the two meetings. QSIW will last over 3 days covering several technical tracks, and will attract a large group of researchers in the field. QSIW will be followed by CS3; An SB meeting, and its corresponding committee meeting, will also be arranged during QSIW.

- **QSI conference (QSIC)**: Towards the end of their terms, and, under the guidance of DIC, the DCs will jointly organise the final network conference at which they will give extended research presentations on their work. They will also select and invite appropriate external plenary speakers and will arrange the programme. If possible, the conference will be aligned with the Quantum Safe Cryptography workshop and will be open to researchers outside the network. Strong efforts will be made to encourage active participation from our collaborators and our professional bodies. In addition to providing our DCs with opportunities to disseminate their research through extended presentations, the conference will provide invaluable training in the organisation and budgeting of a scientific conference. Careful planning will be exercised to attract a large audience.

  The dissemination activities shall be compatible with all legitimate interests and aligned with the exploitation strategy described in the next section.

2.3.1.2 Exploitation of results

With major leading industry in QS technologies on-board, QSI ensures the direct exploitation of its results by its industry partners and other external organisations. In particular, IDQUANTIQUESA will directly benefit from the work of DC 10 in its commercial products, and DC 6 will contribute to the forefront of research at TOSHEU. The feasibility, characterization, and security assessment of various quantum cryptography schemes will also influence the telecom industry, helping them to make informed decisions and appropriate investments.

QSI will contribute effectively to the ongoing standardization initiatives in the field. Our associated partners, TOSHEU and IDQUANTIQUESA, are members of the Industry Specification Group (ISG) on QKD of ETSI, where TOSHEU is currently its chair. Current work focuses on developing standards that assure customers of the security of practical QKD systems. QSI, via its collaborative projects, will address issues that directly affect the implementation of future quantum-classical networks and will contribute to the development of such standards. In QSI, we will also take into account that many relevant standardization bodies for Internet cryptography (e.g. CFRG & NIST process) favour that modern cryptographic communication protocols are patent free or allow for royalty-free use to be considered for standardization. Therefore, we may not necessarily aim for IP for all our research outcomes, but they instead may be fed back into the ongoing international standardization processes of NIST, ISO, ETSI, and IETF, in each of which QSI partners are involved. The results will provide the involved industry partners with a knowledge advantage of the workings of these protocols and the ability to efficiently integrate these into their own higher level protocols. For example, the KE protocols developed by DC 2 will enable partners from classical IT security (NXP and Genua) as well as industry partners with a QKD background to provide secure communication protocols to their customers.

Moreover, to further enhance the impact of QSI and to directly exploit its outcomes, IDQUANTIQUESA will share high-potential results with the industry working group on QS security (https://cloudsecurityalliance.org/group/quantum-safe-security/). This group belongs to the Cloud Security Alliance and has been set up by IDQUANTIQUESA. This information sharing will be performed in ways that guarantee the protection of the IP developed within QSI. We will seek exploitation routes via the EuroQCI programme.

2.3.1.3 Communication and public engagement strategy

Outreach and public engagement will be an important part of this DN. QSI partners have an outstanding track record and engagement in media coverage of their research, such as press releases, articles in public science magazines *e.g.* Physics Today, Physics World, interviews and podcasts on public radio, and participation in public events *e.g.* showcase events, general public conferences or career fairs. All DCs will be offered training in communicating their research to a broad audience via CS1-3. All DCs will put this training into practice by engaging in outreach activities.

During their doctoral career, each DC at QSI will be involved with at least one outreach activity per year. Some of these activities occur at a regular frequency throughout the programme. For instance, via QSI web site (see Sec. 2.3.1.1), there will be regular *story-of-the-month* updates, posted by DCs, pitched at the public audience. These public posts will benefit from all sorts of modern communication technology in the form of multi-media releases and interactive platforms. Also, via the regular digital newsletter, DCs will have the opportunity to inform scientists, policymakers and industrial players on the scientific advances achieved in

their projects. In addition, each DC will approach the local/regional government to promote the importance of QS technologies and their impact on our society.

Throughout their PhD, DCs will be keen in using all communication means to engage with the public. In particular, they will take the opportunity to make press releases about the results of their projects and how these results could be relevant to the general public. They will be distributed worldwide in well-known and established media, such as CORDIS Wire as well as through each partner institution's press office, and will cultivate print and online coverage, television and radio interviews, and other publicity. A press release will be launched immediately after the start of the programme. Additional press releases will be given on a regular basis aligned to the progress of the DC's projects. DCs will also engage in Open Day activities in their own Schools to publicise the QS technologies to undergraduate and postgraduate students. In addition to the above continuous efforts, DCs will deliver three outreach activities, which will all be overseen by WP7 leader:

- **Outreach Day 1 (OD1), Engaging in local public-science events.** In their first year of study, DCs will partake in local science festivals and events in their regions, e.g., the 'Be Curious' British Science Week, the Fête de la Science in Paris (http://www.fetedelascience.fr/), the "La note dei Ricercatori" in Padova (https://venetonightpadova.it), the "Pint of Science Festival" in the Netherlands (https://www.pintofscience.nl), and the Nuit de la Science Geneva, the UNIGE's Physiscope (http://www.physiscope.ch/), to attract a broad range of people to the fascinations of science. The main objective is to present basic scientific phenomena to an audience of different ages in a simple, exciting, and tangible way. To prepare for this event, DCs are encouraged to visit similar events throughout the year, and plan in advance for their role in and contribution to their local event.
- **Outreach Day 2 (OD2), Science art contest.** With the help of local Outreach Officers at each partner, in the second year of study, DCs will give a public talk (*e.g.* in secondary schools in and around their city of residence), and encourage participants to take part in a science art contest organized by QSI. Participants should submit, possibly in digital format, any art form (*e.g.*, poetry, music, design, painting, sculpture, and video) on a related scientific subject. All submissions will be shown throughout the week that QSIW holds, and based on the votes from the members of the public, the best three contributions will be awarded. This art competition will engage the public with the frontiers of science in an exciting and engaging way.
- **Outreach Day 3 (OD3), QSI open day.** In conjunction with the QSIC, there will be an Open Day, where members of the public will be invited to public lectures, given by lead scientists in the field, demonstrations, and (virtual) laboratory tours based on the QSI's research and industrial partners. They will have the opportunity to talk one-on-one with all the DCs and scientists involved and learn about their work first hand.

2.3.2 Strategy for the management of intellectual property, foreseen protection measures

QSI will lead to new protocols, devices, patents, and standards in connection to network architectures, their security, and applications therein. For example, the work by DCs 1, 3, and 6-11 will lead to new designs/prototypes for next-generation of fibre-based QKD systems, TF-QKD systems, satellite-QKD protocols and devices, advanced quantum-repeater networks, QKD systems robust against side-channels, and hybrid security architectures and devices combining QC and PQC techniques. For these, and all other projects, IP opportunities will be identified at the DIC as well as IAB, and will be forwarded to relevant Patent Offices of the beneficiary partners for possible filing. In addition to IP, we will also contribute to developing standards to facilitate the wide-spread use of the developed results via *e.g.* our involvement with NIST, ISO, ETSI, and IETF standardization groups. The CA will provide relevant guidelines and detailed procedures to disseminate, protect and exploit the IP generated by the network to maximise mutual benefits from collaborations with external partners. It will also include a procedure to be followed should disputes arise between any of the parties. This document details the ownership of background and foreground IP and outlines the procedures to go through for partners wishing to exploit any foreground IP generated by the project. The agreement will balance the requirements to publish results as widely as possible, and/or use them in developing standards, with the need to protect results capable of commercial exploitation. During DIC and IAB meetings, we will consider potential IP opportunities and exploitation routes arising from recent experimental and theoretical results. If necessary, appropriate representatives from IP-related

UVIGO's offices, will attend and advise. The CA will protect all IP developed during the programme, through filing and licensing patents, prior to presenting their results at international meetings, or any other publications.

2.4 The magnitude and importance of the project's contribution to the expected scientific, societal and economic impacts (project's pathways towards impact)

2.4.1 Expected scientific impact(s)

QSI advances the field of secure communications resulting in short-term and long-term scientific impact. Each project within QSI is defined at the forefront of research in its respective field, and has been designed to address certain key challenges; see Table 1.1(b). For instance, DCs 6, and 8-11 will each offer solutions to the challenge of quantum communications at long distances; DCs 2-5 and 12 improve the resistance of communications protocols against quantum attacks; or DCs 6-8 and 10 will develop secure solutions for fibre- and satellite-based telecom networks. Via the envisaged dissemination plans, such as QSIW and QSIC, these results will be communicated to the wider scientific community. QSI also contributes to training professional workforce for the EU via organising schools, which are also accessible to external participants. Going beyond the project lifetime, both these aspects, i.e., research and training, are expected to continue: Training and dissemination events will be offered in alternate years to make sure the scientific community can keep up with the latest in the field and train new researchers for work in academia and industry; and, more importantly, the four years of interactive collaborations enabled by QSI will surely continue by the involved partners resulting in a stream of new solutions for years to come. This will be the key scientific impact of this project as the particular disciplines involved in QSI have historically rarely worked together. We will look forward to breaking this barrier, and establishing constructive collaborations of long-lasting nature.

2.4.2 Expected economic/technological impact(s)

Cybersecurity Ventures predict that the global financial losses due to hacking attacks and insecurities in today's communication networks will be about 5.2 trillion EUR in 2021 [Cyber2020]. The widespread use of QS cryptography protocols and networks, such as those developed by QSI, should reduce and prevent these losses significantly, particularly with the prospect of the collapse of classical public key encryption once large-scale quantum computers are available. Not only that, revenues from PQC products and services are expected to be about 2 billion EUR in 2026 reaching to 6.5 billion EUR by 2030, according to IQT Research. Similarly, Yole Développement [Yole2021] predicts that secure quantum network infrastructures will produce a 1 billion EUR market by 2030. These infrastructures use photonic devices as core components, whose market is expected to rise to about 0.8 trillion EUR in 2025, as reported by the European Technology Platform Photonics21 [Phot21]. All of this will only be successful if the security of QS protocols is properly assessed, and the underlying components and systems of QS networks are developed, tested and verified, as QSI is offering to do. With the training offered by QSI, our DCs will be in a position to develop new technologies via their own start-ups and be part of the above undertaking. Our planned outreach activities and demonstration will also inform interested parties of the latest development. At QSI we will welcome enquiries from relevant industry and will assist them within our capacity. Importantly, QSI will also contribute to the standardization of QS technologies and algorithms as detailed in Section 2.3.1.2.

Indirectly, QSI also empowers further innovation in other fields, as secure communication increases the trust of people in IT systems to handle critical information. Such a missing trust is a damaging factor to economy and innovation as demonstrated by the slow increase in the adoption of new payment methods in many countries.

2.4.3 Expected societal impact(s)

QSI will make an important contribution towards increasing the long-term security of data by developing cryptographic protocols and networks that meet this requirement. This has wide societal and economic impact, by protecting our critical national infrastructure such as energy supply networks, government communications, companies and private entities from data compromise. QS technologies can reassure people that their personal data such as health records is safe, their government is operating more safely and securely against external threats, or online voting systems are fair and free from interference.

The value of personal privacy has become an important topic of public discussion partly due to some recent disclosures by whistle-blowers about mass surveillance programmes by various secret services. It is expected

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that privacy concerns to further intensify with the continuous digitalization of society. Innovative cryptographic solutions like those develop by QSI will become essential to address these concerns. Such considerations not only apply to individual persons, but also to companies. One of the main driving forces of the surveillance activities is industrial espionage. Protecting company secrets from foreign digital spying will become even more relevant in the future, and essential to ensure that they remain highly competitive globally.

A better understanding of the possibilities and limitations of quantum-safe cryptography is also relevant to policy makers and public administration, which have to handle very sensitive and/or classified information which has to be kept secret for a pre-defined time period (say 10, 20, or even 50 years). In order to provide security guarantees for such long timespans, it is important to be aware of cryptographic developments well ahead of time. At the moment, it is a highly relevant question when large-scale quantum computers can be built which are able to break the currently employed (public-key) cryptography. Furthermore, experience has shown that it takes many years until new cryptographic techniques are widely adopted. All the above will initially be addressed via the planned outreach and dissemination activities, including engagement with local policy makers. We will also get engaged with other activities, such as the QuantumDelta programme in Netherlands, which have dedicated programmes for societal impacts (https://quantumdelta.nl/societal-impact/), to further promote QSI objectives even beyond the lifetime of the project.

3. QUALITY AND EFFICIENCY OF THE IMPLEMENTATION

3.1 Quality and effectiveness of the work plan, assessment of risks and appropriateness of the effort assigned to work packages

Various activities have strategically been planned for the success of QSI. The network activities will be delivered through two *research* WPs on quantum-safe cryptography protocols (WP1), and on quantum-safe communications networks (WP2), accompanied by two for *training* (WP4 and WP5), one for *dissemination & impact* (WP6), and one for *outreach* (WP7) and *management* (WP3) activities. The training WPs will address both scientific-technical needs (WP4), and the desired CS (WP5). Table 1.1(a) lists all the WPs, with further details in Table 3.1(a).

The programme officially starts with a kick-off meeting (KM), including SB and Recruitment meetings, in month 1 to maximize the chance of recruiting all DCs, and, in particular, top international students, by month 6. Members of the recruitment committee will coordinate advertising the DC openings via various means. Section 3.1.8 details our recruitment strategy. The QSI web site will be made accessible within 3 months, to further enhance the recruitment process. An orientation activity (OM) is planned in month 6-9, in conjunction with the first of the 3 CS workshops offered by QSI. The other two CS workshops will be given in months 15-18 and 29-32, and altogether they will cover a range of soft skills such as project management, technical writing and presentation skills, open science practices and ethics, web page design, and industrial R&D *inter alia*.

Throughout the project, DCs will have access to a collection of shared online resources (SOR) across the network. This S&T training will be complemented by two focused schools in months 12-15 & 15-18, in which research-level expertise in all relevant S&T WPs will be offered to all DCs. This will create a common, shared background among DCs, on which future collaborative work will be based. The Schools will include industry and experimental sessions, as well as networking components and designated times for managerial meetings.

Throughout their 36-month funded PhD, each DC will participate in regular local-network seminar series, will be involved with at least one outreach activity per year, will update the QSI web site (by rotation), will contribute to the newsletters (by rotation), will attend one/more managerial board meetings, will participate in relevant conferences and workshops, will organise and participate in two network symposiums, and will undertake up to 30% of their time in secondments in industrial and research organisations

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3.1.2 Fellow's individual projects, including secondment plan

3.1(a) Fellows' individual projects. Note that DRs 7 & 10 will be funded by the Swiss Government, and DRs 6 & 9 by the UK Government.

Fellow	**Host institution**	**PhD enrolment**	**Start date**	**Duration**	**Deliverables**
DC 1	UVIGO	Y	M6	36	1.1 to 1.3, 1.5, 3.3, 4.5, 6.4 to 6.8, 7.1 to 7.4
Project title: Quantum Key Distribution with Enhanced Security and Performance					**WP1**
Supervisors: Curty (UVIGO), Tamaki (UT), Zbinden (UNIGE), Shields (TOSHEU), Azuma (NTT), Hülsing (TU/e)					
Objectives: Improve the implementation security and performance of prepare-and-measure QKD setups, particularly those based on quantum interference. Investigate methods to address the authentication problem in QKD.					
Expected Results: Security proof techniques that incorporate device imperfections of QKD transmitters. Novel twin-field QKD schemes with improved performance. Efficient solutions to authenticate the first QKD round.					
Description: The principal merit of QKD is that, in theory, it allows to securely expand an initial secret key shared between distant users. In practice, however, device imperfections of real QKD implementations could open security loopholes, or so-called side-channels, that might compromise the security of the key. One main goal of this project is to develop methods to efficiently tackle device imperfections in the security proofs of QKD. For this, we will consider QKD setups based on quantum interference, e.g., measurement-device-independent (MDI) and twin-field (TF) QKD, and prove their security in a realistic setting. These setups have the advantage of being immune against any side-channel from the measurement unit, and, thus, only transmitter's imperfections must be considered. Also, we shall investigate variants of TF-QKD which might improve the performance and/or practicality of current leading approaches, which include the CAL19 and the sending-and-not-sending TF-QKD protocols as prominent examples. Finally, we will study efficient solutions to authenticate the first QKD round, which currently requires that the legitimate users of the system pre-share initial short secret keys (e.g. these keys could be pre-installed in the QKD equipment) in order to authenticate the classical communication channel between them. This might be particularly problematic when the number of users increases. **Methodology:** The DC will use the reference technique to account for the security loopholes due to side channels; improvements to reference technique will also be considered. Key features responsible for the performance of TF-QKD variants will be determined, and the feasibility of novel schemes combining the best features will be studied. **Risks:** If analytical security proof techniques are loose, numerical methods will be used. If no TF-QKD variant is found to outperform current schemes, we study restricted parameter regimes.					
Secondments: UT to study the "reference technique" QKD security framework (Year 1); UNIGE to study side-channels in QKD transmitters (Year 2); TOSHEU to study experimental implementations of TF-QKD and NTT to study its security analysis (Year 2); TU/e to study modern cryptography solutions to provide authentication (Year 3).					

Fellow	**Host institution**	**PhD enrolment**	**Start date**	**Duration**	**Deliverables**
DC 2	TU/e	Y	M6	36	1.1 to 1.3, 1.5, 3.3, 4.5, 6.4 to 6.8, 7.1 to 7.4
Project title: Secure Key-Exchange in a Quantum World					**WP1**
Supervisors: Hülsing (TU/e), Skoric (TU/e), Lange (TU/e), Schaffner (UvA), Broadbent (TTBE), Daum (Genua), Shields (TOSHEU)					
Objectives: Modelling and developing secure KE protocols in a setting with quantum adversaries. Understanding the impact of quantum communications in this setting.					
Expected Results: Sound models for KE in a setting where some parties have quantum computing capabilities. KE protocols with formally proven security in these models.					
Description: One of the most challenging tasks of modern cryptography is to establish a commonly known secret between two parties, without pre-shared information, using only publicly known information. This is a setting that everyone faces multiple times a day when securely connecting to servers on the Internet. The KE mechanisms used today are all vulnerable to attacks using Shor's algorithm and consequently will all be broken by quantum computers. This setting is also not solved by standard QKD protocol, which require pre-shared information and is therefore of no use in this scenario. Different applications have different requirements on KE mechanisms. Most importantly, KE mechanisms are distinguished by which parties are authenticated (authenticated or partially authenticated KE), if no parties are authenticated (anonymous KE), or if parties can even deny having participated in a KE although being authenticated towards the other party (deniable authenticated KE). The first step of the project will be to define appropriate security models for these different flavours of KE for settings in which adversaries and possibly also honest parties have quantum computing capabilities. So far there only exist models that consider quantum adversaries for the most basic flavour of KE; models for the more advanced flavours of KE are still lacking in this setting. In the case of honest parties with quantum computing capabilities, models are limited to the more basic primitives of secret key encryption, message authentication, and digital signatures. After defining sound models, the DC will do research in protocols that are secure in these models and will analyse advantages and disadvantages of using quantum communications to achieve KE in this setting. **Methodology:** The project takes the approach of exact provable security, where reductionist proofs relate the security of protocols to the complexity of solving a (supposedly hard) mathematical problem, or of breaking a smaller building block, like an encryption scheme. In this approach, the given bounds are given exactly, which allows us to later justify parameter choices using these proofs. **Risks:** It might be impossible to develop KE mechanisms with the discussed special properties, even when considering quantum communications. If the research points in this direction, the project will aim at proving this instead. This would be a major result demonstrating what is achievable (and what is not) in a world with quantum computers.					
Secondments: UvA to study various KE mechanisms (Year 1); TTBE to study security models for quantum communications (Year 2); Genua to study IT security (Year 2); and TOSHEU to study the experimental feasibility of the protocols designed (Year 3).					

Fellow	Host institution	PhD enrolment	Start date	Duration	Deliverables
DC 3	SU	Y	M6	36	1.1 to 1.5, 3.3, 4.5, 6.4 to 6.8, 7.1 to 7.4
Project title: Quantum-Enhanced Secure Multiparty Computing					**WP1**
Supervisors: Diamanti (SU), Kashefi (SU), Speelman (UvA), Jeffery (CWI), Kaplan (VERIQLOUD), Layat (IDQUANTIQUESA)					
Objectives: Developing efficient quantum-safe functionalities by embedding quantum subroutines in PQC schemes					
Expected Results: A methodological approach to identifying quantum subroutines within post-quantum schemes for distributed quantum computing and communications tasks, supported by a proof-of-principle photonic demonstration for MPC.					
Description: Classical and quantum worlds each offer a distinct feature when it comes to security. Classical solutions offer solid mathematical foundations and easiness of implementation, while quantum ones can enhance the security of cryptographic techniques by making them unbreakable against future technological advancements. A hybrid QS infrastructure should then offer the best of both worlds. To enable the transition to such an infrastructure, it is necessary to put in place a concrete methodology combining theoretical, simulation and experimental techniques. In this project, we propose a step-by-step approach to solve this problem. We first establish the security and efficiency bottlenecks associated with novel post-quantum functionalities, e.g., in multiparty computing, verification and delegation. Afterwards, we design quantum subroutine protocols for these bottlenecks. Finally, we implement these protocols by constructing purpose-built devices. We use as a basis the quantum protocol zoo (https://wiki.veriqloud.fr), an open repository of protocols for quantum networks. This provides a suitable platform to decompose the protocols under study into building blocks that can be benchmarked as possible subroutines within classical schemes. Our focus and case study will be quantum MPC, which we will analyse and implement in an all-photonic client-server setting. We will also consider an extension of this implementation to quantum networks with small processors. **Methodology:** We develop efficient and practical hybrid cryptographic techniques, currently missing in the literature, by identifying a case study. We define and benchmark building blocks for subroutines in classical schemes in view of a realistic photonic implementation. **Risks:** The main challenge is how to benchmark the identified protocols and demonstrate quantum advantage. We expect that the strong interplay between theory and experiment in this project, and the extended experience of our group in verification techniques, and in the demonstration of quantum advantage with practical photonic systems, will mitigate these risks and lead to realistic solutions for a hybrid infrastructure.					
Secondments: CWI to study post-quantum functionalities (Year 1); VERIQLOUD to study protocols for quantum networks (Year 1); IDQUANTIQUESA to study applications where QKD is employed as a subroutine within classical infrastructures (Year 2).					

Fellow	Host institution	PhD enrolment	Start date	Duration	Deliverables
DC 4	UvA	Y	M6	36	1.1 to 1.3, 1.5, 3.3, 4.5, 6.4 to 6.8, 7.1 to 7.4
Project title: Quantum Security of Memory-Hard Functions					**WP1**
Supervisors: Schaffner (UvA), Speelman (UvA), Jeffery (CWI), May (RUB), Huelsing (TU/e), Vredendaal (NXP)					
Objectives: Investigate and establish the quantum security of memory-hard functions.					
Expected Results: Framework of post-quantum security definitions and proofs for memory-hard functions, proofs of space, proofs of sequential work and verifiable delay functions.					
Description: Memory-hard functions (MHFs) are moderately hard to evaluate when using a large amount of memory, but in case only a small amount of memory is available, they are slow to evaluate. Such functions are useful for the application of password hashing in order to prevent brute-force attacks when password hashes are stolen. MHFs can also be used to build proofs of space, proofs of sequential work or verifiable-delay functions. Partly fueled by the rise of cryptocurrencies, there has been a lot of (non-quantum) research in this area over the last few years. However, we are not aware of any post-quantum analysis of these primitives. The underlying principle for constructing MHFs are evaluations of hash functions, therefore, security proofs are usually given in the random-oracle model (ROM) where the hash functions are assumed to be perfectly random functions. It is a very natural and timely problem to investigate the post-quantum security of these constructions against quantum attackers. In practice, if fully specified hash functions such as SHA2 or SHA3 are used, a quantum attacker can run these functions in superposition on its quantum computer. Hence, it is imperative to revisit the security proofs in the quantum ROM (QROM) [ASIACRYPT, 41-69 (2011), EUROCRYPT, 552-586 (2018)]. **Methodology:** In this project, the DC will define quantum security notions of MHFs as well as their derivatives. We then investigate which ROM proofs can be upgraded to the QROM. **Risks:** The current QROM proof techniques might be insufficient to analyze all of the existing constructions. If the development of stronger tools turns out to be infeasible during the project period, the schemes will be modified (at the cost of efficiency) in order to be able to prove QROM security.					
Secondments: CWI and RUB to study quantum proof techniques (Year 1); TU/e to study PQC schemes (Year 2); NXP to study IT security and the practicability of the developed methods (Year 3).					

Fellow	Host institution	PhD enrolment	Start date	Duration	Deliverables
DC 5	RUB	Y	M6	36	1.1 to 1.3, 1.5, 3.3, 4.5, 6.4 to 6.8, 7.1 to 7.4
Project title: From Classical to Quantum Cryptoanalysis of Post-Quantum Cryptography					**WP1**
Supervisors: May (RUB), Walter (RUB), Güneysu (RUB), Schaffner (UvA), Kashefi (SU), Daum (Genua)					
Objectives: Design new quantum attacks for the post-quantum cryptosystems in NIST standardization.					
Expected Results: Precise definition of quantum bit-security level, possibly requiring adaptation of current parameter settings.					
Description: NIST will soon announce winners of their post-quantum cryptographic standardization process. For encryption, these will be coding- and lattice-based cryptosystems. While the classic hardness of these schemes has been studied thoroughly, their hardness against quantum attacks is way less understood. As an example, classical decoding algorithms have seen tremendous improvements within the last decade with implications to McEliece parameter selection, while the best known quantum attack on McEliece is still a simple Grover-version of a decoding algorithm from 1962. Also in lattices, in the last decade there were plenty of algorithmic improvements on the classical side, including sieving and locality sensitive hashing, while the speedup from quantum algorithms is almost negligible. We will design new quantum attacks directly on PQC, and provide a concrete quantum security bit estimator software for coding- and lattice-based cryptosystems. **Methodology:** We build on typical quantum tools for algorithm design, such as quantum random walks.					

Whenever possible, we focus on algorithmic tools with small quantum memory consumption. **Risks:** If we fail to find asymptotic improvements for quantum cryptanalytic algorithms, as a fallback, we will concentrate on second order improvements and on improved implementations. Improvements in these areas are also highly relevant to the current post-quantum standardization process.
Secondments: UvA to study quantum algorithms (Years 1, 2 & 3) and SU (Year 2); Genua to study IT security and the practicability of the developed methods (Year 3).

Fellow	**Host institution**	**PhD enrolment**	**Start date**	**Duration**	**Deliverables**	
DC 6	TOSHEU	Y (at ULEEDS)	M6	36	1.5, 2.1 to 2.4, 3.3, 4.5, 6.4 to 6.8, 7.1 to 7.4	
Project title: Twin-Field Quantum Key Distribution on Installed Fibre Networks						**WP2**
Supervisors: Shields (TOSHEU), Pittaluga (TOSHEU), Woodward (TOSHEU), Razavi (ULEEDS), Curty (UVIGO), Calonico (INRIM)						
Objectives: Autonomous prototype system for Twin-Field Quantum Key Distribution						
Expected Results: Operation of TF-QKD on installed networks						
Description: Twin-Field QKD is a novel protocol to greatly increase the rate-vs-distance performance of QKD. Most interestingly the bit rate of TF-QKD has better resilience to channel loss than conventional QKD. In fact, it can allow key rates above the secret key capacity of a point-to-point quantum channel. Recently we demonstrated intermittent operation of TF-QKD over 600km fiber spools in the lab. In this project we plan to greatly extend this work to realize an autonomous prototype that can operate continuously on installed fiber. In TF-QKD, the two parties (Alice and Bob) send encoded laser pulses to a central measurement station Charlie. The main challenge in TF-QKD is to ensure phase stability between the pulses from Alice and Bob, even after propagation in fibers which are 100's of km in length. We will achieve this using the interference of stabilization pulses sent from Alice and Bob, as a feedback signal to fix the relative phase difference between the fibers. We target building a prototype system and deploying it in a field trial by the end of the project. **Methodology:** We first establish a continuously running prototype under lab conditions; we then implement field trials for first >1h operation, and then >24h operation. **Risks:** If continuous operation is not possible over long distances, we reduce the link distance, or use shorter time periods.						
Secondments: ULEEDS to study novel TF-QKD protocols (Year 1); UVIGO to study TF-QKD security proofs (Year 2); INRIM to implement a field trial of TF-QKD on installed fibre (Year 3).						

Fellow	**Host institution**	**PhD enrolment**	**Start date**	**Duration**	**Deliverables**	
DC 7	UNIGE	Y	M6	36	1.5, 2.1 to 2.4, 3.3, 4.5, 6.4 to 6.8, 7.1 to 7.4	
Project title: QKD in Modern Telecommunications Networks.						**WP2**
Supervisors: Zbinden (UNIGE), Thew (UNIGE), Gudet (SIG), Layat (IDQUANTIQUESA), Curty (UVIGO), Villoresi (UNIPD)						
Objectives: Study telecom network designs and the co-existence of quantum and classical signals in optical networks. Develop QKD systems to simplify the integration and standard their performance in optical networks. Study trusted repeater implementations with standard security.						
Expected Results: New designs of QKD devices and networks that allow for a seamless integration in existing telecom networks.						
Description: Point to point QKD over dark fiber has become a mature technology for years. One of the remaining challenges is to produce QKD network equipment that can easily be integrated with modern communications networks. A key figure is the total cost of ownership, which is currently too high also due to expensive installations and maintenance as well as the need for dark fibers. To avoid the latter, we need co-existence of classical and quantum channels, as well as a quantum network multiplexing many channels between many different transmitters and receivers. Co-existence and standardization are studied in the current OpenQKD project. In this experimental project, the DC will study the telecom networks and benefit from the OpenQKD experience, in particular, with the use-cases in Geneva over the fiber network of the Services Industries de Genève (SIG). The results of these studies will feed back into the design of quantum and classical signal integration. The DC will work out how QKD can optimally deal with rerouting, amplifiers and switches, which are present in the established infrastructure. Another aspect is the optimal architecture of a QKD network, integrating eventual trusted nodes. All this is done considering the latest notions in network architectures such as software-defined networking and recent requirements coming from the smart-grid Internet of Things and 5G applications. The latter require cheap and compact devices, in line with on-going efforts at UNIGE of implementing QKD with photonic integrated circuits. During the project, the DC will test the performance of latest QKD devices at UNIGE in different configurations, in the lab and in the telecom environment, and implement necessary changes. **Methodology:** It is based on extensive exchanges with the telecom specialists from SIG and the QKD manufacturer IDQ (both in Geneva) to learn about their practical constraints in order to find solutions that allow for seamless integration of QKD in a telecom environment. **Risks:** Implementing QKD on live fibers, in the presence of amplifiers and switches, requires coordination with different stakeholders; if this causes delay the scope of the project will be adjusted appropriately.						
Secondments: SIG to study QKD use-cases over SIG network (Years 1 and 2); IDQUANTIQUEA to study quantum and classical signal integration (Years 1, 2 and 3); UVIGO to study QKD security (Year 2); UNIPD to study free-space based QKD networks.						

Fellow	**Host institution**	**PhD enrolment**	**Start date**	**Duration**	**Deliverables**	
DC 8	UNIPD	Y	M6	36	1.5, 2.1 to 2.4, 3.3, 4.5, 6.4 to 6.8, 7.1 to 7.4	
Project title: Intermodal Quantum Communications in Free-Space and Fibre						**WP2**
Supervisors: Villoresi (UNIPD), Vallone (UNIPD), Razavi (ULEEDS), Diamanti (SU), Finocchiaro (EUTELSAT)						
Objectives: Experimental study and modelling of intermodal quantum communications, aiming at bridging free-space and fibre links.						
Expected Results: Efficient free-space to fibre quantum interfaces, qubit preparation, measurement, synchronization, and QBER mitigation. The channel multiplexing and the matching of QKD with fibre network standards for high speed communications will be implemented.						
Description: The envisaged framework for global-scale quantum communications networks will comprise various nodes interconnected via optical fibres or free-space channels, depending on the link distance. The free-space segment of such a network should guarantee certain key requirements, such as daytime operation and the compatibility with the complementary telecom-based fibre infrastructure. In addition, space-to-ground links will require light and compact quantum devices to be placed in orbit. For these reasons, investigating solutions satisfying all the above requirements is necessary. This requires to conceive and develop ways to leverage the benefit of both fibre and free-						

space channels. The intermodal exchange plays a crucial role in QKD between different continental networks, to provide redundancy on the network and to advance the paradigm of untrusted nodes. Recent progress in daylight QKD by UNIPD has extended the application domain and the overlap with the usage of fibre links. In addition, the modelling of key rate in a network of mixed link types will be developed for assessing the capacity of mutual connection with different users even considering the peculiarities of the free-space links. The study of the free-space to fibre integration will be the next necessary ingredient. The expertise and experience of secondment partners are used to increase the chance of success. **Methodology:** Initial prototypes will be designed for optical table demonstration, with investigations under real conditions to follow; facilities in Matera and Asiago Observatories will be used appropriately. **Risks:** The satellite link is already quite lossy; it is possible that the additional loss because of the interface makes the overall QKD link insecure. We consider using adaptive optics and different types of fiber if needed.

Secondments: ULEEDS to study efficient QKD protocols for a free space quantum communication link (Year 1); SU to study intermodal applications of CV-QKD protocols (Year 2); EUTELSAT to study the satellite use cases (Year 3)

Fellow	**Host institution**	**PhD enrolment**	**Start date**	**Duration**	**Deliverables**
DC 9	ULEEDS	Y	M6	36	1.5, 2.1 to 2.3, 3.3, 4.5, 6.4 to 6.8, 7.1 to 7.4

Project title: Trust-Free Packet-Switched Quantum Communications Networks **WP2**

Supervisors: Razavi (ULEEDS), Indjin (ULEEDS), Munro (NTT), Walter (RUB), Shabani (Cisco)

Objectives: Designing quantum communications networks, at different layers, compatible with current packet-switched networks

Expected Results: New quantum repeater protocols compatible with packet-switched networking; Performance analysis, e.g., entanglement generation rates and secret key rates in QKD applications, over such repeaters; New network and transport layer protocols

Description: A functional quantum Internet is the holy grail of quantum communications technologies. While there are plenty of proposals for building scalable quantum repeaters, most of which work on a circuit-switched basis. That is, we need to secure resources over different segments of an end-to-end link before being able to generate an entangled state between two remote users. This means that all required resources for that link has to be allocated to those two users for the entirety of the protocol, and other network users cannot use those resources. The only exception to this is the so-called third generation quantum repeaters, which, similar to their classical counterpart, transfer quantum states hop-by-hop by using excessive amount of quantum error correction to combat loss and noise. These repeaters, however, face several technological challenges, including the need to have intermittent nodes in close proximity on the order of a few kms. This can effectively make them incompatible with existing infrastructure for the Internet, which crucially works on the basis of packet switching. This project aims at designing feasible, in near to mid-term, quantum repeaters in an aligned way with the concept of packet switching. That is, we generate entangled states between two far end nodes by starting from one end and extending the entanglement, node by node, in a similar fashion that a packet finds its way in the Internet. Similar to classical networks one could then optimize the path based on availability of resources, e.g., entangled states, or reliability of the links. This requires revisiting network layer protocols for this application. End-to-end reliable quantum data transfer can then be managed in such networks by updating the relevant transport layer protocols. **Methodology:** We explore the use of simple quantum error correction codes for distillation purposes. It has recently been shown that even a simple 3-qubit repetition code could offer advantage in QKD applications [Phys. Rev. Appl. 15, 044027 (2021)]. We benchmark the performance of our proposed repeater setups by calculating the corresponding secret key generation rate when you run trust-free QKD protocols. **Risks:** Simulating large quantum systems is time consuming; efficient numerical techniques will be developed if analytical solutions are intractable.

Secondments: NTT to discuss packet-switched QKD networks (Year 1), RUB and Cisco to study the routing protocols and network architecture (Years 2 and 3).

Fellow	**Host institution**	**PhD enrolment**	**Start date**	**Duration**	**Deliverables**
DC 10	IDQUANTIQUESA	Y (at UNIGE)	M6	36	1.5, 2.1 to 2.3, 3.3, 4.5, 6.4 to 6.8, 7.1 to 7.4

Project title: Hybridisation of Physical and Mathematical Cryptographic Primitives for a Quantum-Safe Internet **WP2**

Supervisors: Layat (IDQUANTIQUESA), Bussières (IDQUANTIQUESA), May (RUB), Zbinden (UNIGE), Kashefi (SU)

Objectives: Practical solutions for QS Internet that optimally address the needs for security, functionality and usability.

Expected Results: Proposals for security and network architectures that combine quantum random number generators (QRNG), physical unclonable functions (PUF) and QKD as well as modern cryptography techniques to take advantage of both cryptographic paradigms.

Description: The value of transferred data is constantly increasing as the unwanted disclosure or loss of integrity can even have an impact on human lives. At the same time, the technology to threaten current communication security (with the quantum computer as prominent example) is constantly improving. New cybersecurity solutions are therefore in order. Up to now, two major security paradigms, algorithmic cryptography (legacy and post-quantum cryptography) and physical crypto primitives (QKD, QRNG, PUF), are only partially used together. However, there is evidence that further hybridization and seeking for synergies between physics and mathematics will lead to superior security than what is achieved with one paradigm or the other alone. In this interdisciplinary project, the DC will work on next-generation hybridization methods to combine individual cryptographic primitives (algorithmic and physical) to achieve high-end security in the QS Internet. Functionality, performance, costs, use cases, certifiability as well as ease of implementation and operation will be the guiding principles under which the security for the end user is maximized. The research will be done on questions like: How to optimally combine PQC, QRNG and PUF to guarantee authentication and data integrity in various application scenarios and use cases? How to combine QKD and PQC best in contemporary network architectures, which consists of several parts like backbone, aggregation, and access networks? What are best security practices for hybridization of keys from PQC and QKD? The answers found by the DC will contribute to a higher security and better adapted business cases of the cybersecurity industry. **Methodology:** The DC will first study the state of the art of the existing cybersecurity concepts. The new hybrid solutions will be first worked out on a conceptual level and then later tested with simulations, where a security analysis will be performed. Depending on the outcome of these studies, an experiment will be set up, either within the R&D of IDQUANTIQUESA or with UNIGE. **Risks:** If formal security analysis is too complex, the DC will identify a new set of assumption within which the problem can be solved. If requirements from cybersecurity authorities are missing, we will seek input from

relevant authorities (BSI, ANSSI, NCSC).
Secondments: RUB to study post-quantum algorithms (Year 1 and 2); UNIGE to study the performance of state of the art QKD solutions (Years 1, 2 and 3); SU to study PUFs (Year 2).

Fellow	**Host institution**	**PhD enrolment**	**Start date**	**Duration**	**Deliverables**	
DC 11	UVIGO	Y	M6	36	1.5, 2.1 to 2.3, 3.3, 4.5, 6.4 to 6.8, 7.1 to 7.4	
Project title: Quantum cryptographic schemes for quantum networks						**WP2**
Supervisors: Curty (UVIGO), Razavi (ULEEDS), Azuma (NTT), Tamaki (UT), Majenz (DTU)						
Objectives: Designing efficient multi-user quantum cryptographic schemes for entanglement-based quantum networks						
Expected Results: Proposals for quantum cryptographic schemes with multiple users over quantum networks. Performance and security analysis of such schemes in a practical setting.						
Description: Most quantum cryptographic schemes assume a two-user setting in a point-to-point network configuration, which do not fully exploit the richness of complex quantum networks. Moreover, to extend the achievable distance between end users, they typically rely on the use of trusted nodes. A principal goal of this project is to design efficient quantum cryptographic schemes—such as e.g. those achieving conference key agreement or distributed quantum computing—for various entanglement-based quantum network topologies with multiple users and untrusted nodes, and evaluate their security in a practical setting. Moreover, we shall investigate their performance and robustness against typical device imperfections of the users' apparatuses, as well as those of the untrusted networks nodes. **Methodology:** The DC will study conference key agreement and beyond QKD multi-user cryptographic schemes suitable for entanglement-based quantum networks. Efficient techniques to establish different kinds of entanglement between the end users will be explored. The security and robustness of the designed schemes against side-channels will be investigating by adapting known QKD methods to this scenario. **Risks:** If obtaining analytical results turn out to be too complex to achieve, or they provide loose security bounds, numerical methods will be used. If a quantum cryptographic scheme does not provide advantages over classical solutions, or over a combination of multiple two-users setups, alternative schemes will be considered.						
Secondments: ULEEDS to study entanglement-based quantum networks (Years 1, 2 and 3); DTU to study quantum cryptographic schemes beyond QKD (Year 2), NTT and UT to study the practical security of multi-user cryptographic schemes (Years 2 and 3).						

Fellow	**Host institution**	**PhD enrolment**	**Start date**	**Duration**	**Deliverables**	
DC 12	DTU	Y	M6	36	1.1 to 1.3, 1.5, 3.3, 4.5, 6.4 to 6.8, 7.1 to 7.4	
Project title: Efficient security for post-quantum key encapsulation with correctness errors						**WP1**
Supervisors: Dragoni (DTU), Majenz (DTU), Hülsing (TU/e), Walter (RUB), Schaffner (UvA), Vredendaal (NXP)						
Objectives: Establish and tighten the PQC security of the Fujisaki-Okamoto (FO) transform with focus on Lattice and Code-based schemes.						
Expected Results: Security reductions for correctness error finding in lattice-based and code-based chosen ciphertext attack (CCA)-secure key encapsulation mechanisms (KEMs). Attack algorithms for finding failures in lattice-based and code-based public key encryption (PKE). Improved security proof or attack for FO-based PKE derandomization in the QROM.						
Description: PQC-secure KEMs have received a lot of attention due to the ongoing NIST standardization efforts. All important PQC KEMs with chosen ciphertext security use the FO transformation whose security needs to be established in the QROM. Security proofs have improved steadily over the years, but leave two important loose ends: 1) The way decryption errors have been handled in security proofs involved heuristics and suffered from arguably unnatural security losses. 2) A central technique for QROM security proofs of FO, the one-way-to-hiding (O2H) lemma suffers from unexplained security losses despite many improvements. Recent progress for 1) has provided a framework for a heuristic-free and tightened security reduction technique dealing with decryption errors. It requires, however, two additional security properties from the underlying PKE. After familiarizing themselves with different code-based and lattice-based PKE schemes, the DC will work on the characterization of lattice- and code-based PKE with respect to the two security properties needed for conclusively tying up loose end 1). In addition, the DC will study the O2H lemma and its application to PQC security proofs for FO and work on tightening those proofs. **Methodology:** The project will exploit the complexity theory of lattice problems. Crucially, the DC will develop analytical tools to handle discretized versions of classic random matrix ensembles. **Risks:** It might be the case that the current application of the O2H lemma to FO is tight due to a uniquely quantum attack. To mitigate this risk, the DC will pivot to researching attack avenues in case the provable security effort stalls.						
Secondments: TU/e to study PQC schemes (Years 1 & 2); RUB to study random matrix theory (Year 2); UvA to study QROM tools (Year 3); NXP to study IT security and the practicability of the developed methods (Year 3).						

3.1.3 Network organisation

QSI will be coordinated by the UVIGO. All administrative tasks related to the negotiation of the grant agreement and the setup of the DN account will be provided by UVIGO's International Projects Office (IPO). At the start of the programme the coordinator will meet with representatives from this office to ensure that everyone involved understands the programme conduct and its associated auditing and reporting commitments. During the negotiation process, the Contracts Team, at IPO, will work with all participants to prepare a Consortium Agreement (CA), which they will endorse. Among other management issues, the CA will include formal network procedures for conflict resolution, IP management, and strategies for dealing with *scientific misconducts*. While the risk of the latter is low, should the problem arise, it will be the responsibility of the research WP leaders to report any instances of scientific misconduct to the Coordinator. The Coordinator, in consultation with Directors of Research and Training and the corresponding WP leader,

will agree on an appropriate action and report the incident to the SB.

Prof. Curty will be the **Network Coordinator** and take the overall responsibility for the implementation of the programme and reporting the project's progress to the European Commission (EC). In the absence of the Coordinator, Prof May will act as the *Deputy Coordinator* for the network. The Coordinator will be helped by the Director of Training, Prof. Schaffner, the Director of Research, Dr. Prof. Diamanti, the Chair of the IAB, Dr. Shields, and the Chair of the DIC, Prof. Razavi, to oversee the overall progress of the programme. These five constitute the MEG, which conduct ongoing assessment of progress and outcome, and monitor the proper conduct of the project. They will also organise and collect data for the SB meetings. The SB will be the main decision-making group, which will be advised by several committees as explained next.

There will be a DC Forum (DF) throughout the life of the network, in which each DC will be a member. The purpose of DF is to ensure that the DCs are represented at all levels of the network. The DF will hold regular meetings by video conferencing and there will be a secure forum on the project's web site to enable DCs to discuss any issues they wish to feed into the network's management team. They will also choose representatives to attend the SB's committee meetings on which they are represented. The DCs' representatives will rotate to ensure that all DCs gain some committee work experience during the life of the network. The secure online forum will provide the platforms for representatives to report back from the meeting to the other DC. There will be an opportunity for DF to meet during each network event.

The project will employ a part time **project manager** to oversee the day-to-day administrative duties associated with the project including maintaining the project accounts, supporting committees, making arrangements for network events *inter alia*. UVIGO's IPO will continue to provide administrative support and advice throughout the project. At QSI, we follow a green policy to use computer-based reporting and documentation as much as possible for managerial tasks; see Sec. 3.1.11. QSI intranet will be designed properly and used extensively to facilitate this objective.

Financial management at QSI is conducted by the Finance Group (FG), which will include the network Coordinator, the project manager and an administrator from UVIGO, School of Telecommunication Engineering. Input will also be provided by the IPO to ensure all audit and financial reporting requirements are met. The FG will be responsible for disseminating the network funds among partners, monitoring the network budget, advising partners on funding issues, and providing financial reports to the SB. The FG will meet formally every 6 months but will have frequent informal interactions.

3.1.4 Supervisory board

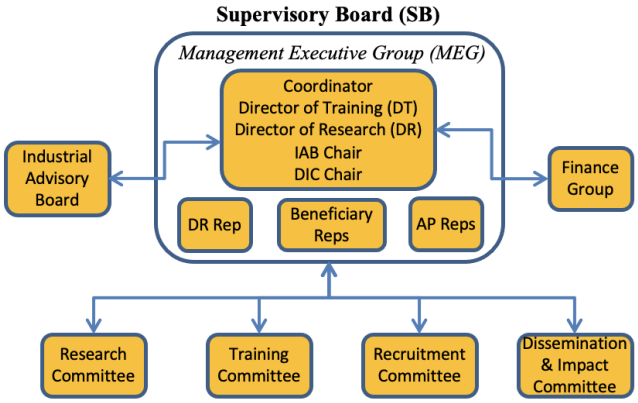
Table 3.1(b) SB Membership. Note that because of the instrumental role of Swiss and UK APs, UNIGE, IDQUANTIQUESA, ULEEDS and TOSHEU, in supervising Swiss and UK funded DCs, we have listed them individually in the table below.

Member	Role	Description
Prof Marcos Curty	Coordinator; UVIGO Rep; MEG member	Responsible for arranging and chairing SB meetings; Coordinating and scheduling different planned training events with the help of the Director of Training and local organisers; SB Chair; Chair of the Recruitment Committee (RTC); Leads WP3
Prof. Christian Schaffner	Director of Training; UvA Rep; MEG member	Responsible for proper conduct of the training plan, and, via a biannual monitoring system, that of the individual DCs. He will coordinate with supervisory teams to ensure that personal development and training plans are in place for each DC; Training Committee (TC) Chair; Member of RTC; Leads WP4
Prof Eleni Diamanti Dr	Director of Research; SU Rep; MEG member	Responsible for proper conduct of S&T aspects of QSI; Chairs the Research Committee (RC); Member of Dissemination and Impact Committee (DIC); Deputy Chair and Member of RTC; Leads WP6
Dr Andrew Shields	Chair of the IAB; TOSHEU Rep; MEG member	Chairs the Industrial Advisory Board (IAB); Member of RC; Member of DIC; Member of RTC
Prof Mohsen Razavi	Chair of DIC; ULEEDS Rep; MEG member	Chair of DIC; Member of RTC
Prof Alexander May	Deputy Coordinator; RUB Rep	In the absence of the coordinator, he will chair the SB session and contributes to MEG; Member of RC; Leads WP1
Prof Paolo Villoresi	UNIPD Rep	Deputy Director of Research; Leads WP2
Dr Andreas Hülsing	TU/e Rep	Deputy Director of Training; Leads WP5
Prof Hugo Zbinden	UNIGE Rep	Deputy Chair of DIC
Dr Félix Bussières	IDQUANTIQUESA Rep	Deputy Chair of IAB
Prof Nicola Dragoni	DTU Rep	Member of TC; Leads WP7
APs Scientific Contacts	AP Reps	Represent partner organisations in SB; Members of RC/TC/DIC by rotation
DC	DC Rep	Representative of DCs on rotation chosen by the DF; Member of RC/TC/DIC

The SB will oversee the entire programme conduct and have overall responsibility for decision making in all areas related to network-wide training and research activities and for all communication with the EC. The SB will be responsible for ensuring that the needs of each DC are met through provision of high quality scientific and technical training, CS training, individual research projects and meaningful exposure to industry and other sectors. An important role of the SB will be to formally ratify the individual career development plans of the DCs and to review the progress of the DCs against these plans. In addition, the SB will review progress against the stated objectives, milestones and deliverables, and approve variations of the plans as required and as opportunities arise. The network Coordinator will chair the SB and the deputy chair will be the deputy coordinator. Membership of the SB will include a representative from each beneficiary and AP, which includes representatives from the IAB, and one DC on a rotating basis. This ensures a balanced contribution from different expertise in industry (9 members) and academia (4 experimental and 9 theory groups). We benefit from the contribution of 8 female scientists in our consortium. Decisions will be made by consensus, with voting mechanisms where appropriate. In the event of a tie the Coordinator will have the casting vote. The DC representative would be asked to withdraw, where appropriate, if confidential information about an individual DC needs to be discussed. The SB will meet in the first month of the programme to draw up the terms of reference for each committee and regularly thereafter concurrent with the network's other major events, unless additional meetings prove necessary. The SB, via its recruitment committee, will oversee the initial recruitment process of the DCs, ensuring that a consistent recruitment process is applied to every DC. The SB will take overall responsibility for ethics, ensuring all necessary approvals are obtained and offering advice as necessary. The SB will actively seek to develop ways of ensuring continued cooperation between the partners *after the life of the project*, including exploring opportunities to maintain and develop training and research activities.

3.1.4.1 Committees of the supervisory board

The SB will be supported by several principal committees: Industrial Advisory Board (IAB), Research Committee, Training Committee, as well as Dissemination & Impact Committee. Other important units are for recruitment (see Sec. 3.1.7) and finance management (Sec. 3.1.5). The management structure is illustrated in Fig. 2.



(a) Industrial Advisory Board (IAB) will be formed from key participants with strong industrial links (**AS**, **FB**, **MK**, **OG**, **JB**, **AL**, **WM**, **SD**, **DF**; see the table in page 5 for individuals' short names), with **AS** being the Chair, and **FB** as the deputy chair. The IAB will have the opportunity to review the progress, and to comment on individual DCs at each SB meeting, via the IAB Chair, which is also a member of the MEG. Alongside direct QSI's engagement with companies throughout the programme, the long-term sustainability of our work will be maximized by developing new collaborations with industry and academia. The impact strategy of QSI will be regularly reviewed by IAB, among other committees, considering the scientific developments made on the programme as it progresses. Our impact plans will be achieved using exploitation routes described in Sec. 2.3.1.2.

(b) Research Committee (RC) will be chaired by the Director of Research (**ED**) with a Deputy Director of Research (**PV**). Other members will be other S&T WP leads (**AM**), the project manager, and representatives from APs and DCs (both by rotation). The WP leaders will help the Director of Research to collect/prepare all required documents needed for RC meetings. The remit for the research committee will be to ensure the

research is correctly focused and provide oversight of direction and risk management. It will monitor the progress of the research undertaken, and suggest to the SB any adjustments needed to the overall work plan to ensure the project remains on target and optimises its research outputs. The Director of Research will report to the SB to keep it fully informed and allow it to exercise oversight over the research programme and have a view on the wider career development of the DCs. The RC will meet biannually, but ongoing contact, predominantly via e-mail, online communications or informal discussions, will be maintained throughout the project. Meetings will be timed flexibly to fit with international participants, or use will be made of video-conferencing tools.

(c) Training Committee (TC) will be chaired by the Director of Training (**CS**), assisted by a Deputy Director of Training (**AH**), who is also the CS training WP leader. The TC includes as well the outreach work package leader (**ND**), and the project manager along with representatives of the APs and DCs (both by rotation). The aim will be to ensure that we provide a broad and balanced spectrum of opportunities and training for the DCs involved so that they are adequately prepared for future career opportunities. The TC will coordinate all network-wide training activities and monitor all training undertaken by individual DCs including reviewing their Personal Career Development Plans and secondments. It will maintain a two-way communication with the SB to ensure the Board is both kept fully informed of, and can have a direct input into, the training and career development of the DCs. The TC will meet biannually under the same conditions as RC mentioned above.

(d) Dissemination and Impact Committee (DIC) will be chaired by **MR**, who is also a member of the MEG, with **HZ**, as deputy chair. It will also include the Director of Research, IAB Chair, the project manager, and representatives of the APs and DCs (both by rotation). It will co-opt other members as appropriate to the stage of the programme. This is to ensure that representatives from all different sectors are involved in dissemination and impact activities. DC representatives will attend each committee meeting to ensure they learn about the importance of all types and levels of dissemination activities from publication in scientific magazines to interacting with the general public through outreach activities. The DIC will also oversee the design and maintenance of the project's web site, planning and monitoring of outreach activities, monitoring IP issues, implementing publication policy and the DMP and updating it, and overseeing arrangements for network symposiums. It will meet biannually, possibly online, but will keep in regular ongoing e-mail contact and will establish outreach/conference subcommittees if required, particularly during the later stages of the network.

3.1.5 Recruitment strategy

Recruitment is overseen by the Recruitment Committee (RTC), chaired by the Coordinator (**MC**), and the deputy chair will be **ED**. Other committee members will be the other members of MEG (**MR**, **CS** and **AS**). The first action of the RTC will be to recruit the part time project manager and a web page developer, which should be complete by m3. RTC's key task is to oversee the recruitment of all DCs. There will be a centralised recruitment process to ensure timely competitive international recruitment and promote equal opportunities. As the recent EU "She Figures 2021" report highlights, women are particularly underrepresented in STEM fields, despite overall progress in the gender balance of research careers as a whole. As such, QSI recognises the importance of targeted advertising to women-in-science groups such as the European Platform of Women Scientists. Whilst QSI's recruitment policy will predominantly be based on merit, in the case of equal candidacy, priority will be given to the gender balance of the cohort. The DCs recruitment will be conducted in three phases: (1) Posts will be advertised and applications will be made; (2) The supervisory teams, in coordination with RTC, will go through all applications and do an initial short listing; and (3) Selected candidates will be interviewed and ranked by relevant supervisory teams. The successful candidates will be made an offer, and a reserve list will also be created.

DC posts will be advertised, as soon as and as widely as possible, including through EU employment sites, the European Researcher Mobility Portal (EURAXESS), the Marie Curie Fellowship Association web site, the European Platform of Women Scientists, the QSI web site, and the web sites of beneficiaries and academic partners. The DC advertisements will include the project description, its secondment opportunities and supervisory teams, the fellowship conditions and benefits within the DN framework, as well as strict entry requirements, e.g. first-grade degrees/qualifications, and the procedure for a fair selection of qualified candidates, including the list of documents required for application. The latter will be specified by RTC, and it will include QSI-specific and the general documents required by each recruiting partner. The DC posts will

be advertised for a specified period before applications can be returned. If no suitable candidate is found for a particular position, the post will be re-advertised.

The RTC will review all applications to ensure all DCs short-listed meet the mobility and experience criteria of the DN scheme. Candidates will be short-listed by accounting for their potential for generating high-impact results, the relevance of their experience/background to the advertised project, as well as communication skills, to ensure only the best quality candidates are accepted. The short-listed candidates will then be interviewed and ranked by the supervisory teams (possibly via online means) according to specific criteria for each project. In the case of equal candidacy, as mentioned earlier, we aim to recruit a gender balanced mix of DCs. The recruitment is anticipated to be complete by m4-6, with all DCs in post by m6-9.

The RTC will ensure recruitment and employment processes comply with the Code of Conduct for the Recruitment of Researchers and the European Charter for Researchers and is fully transparent. The UVIGO's Human Resources Office will provide advice to the RTC on all aspects of employment law throughout the project. All recruitment practices and procedures will comply with equal-opportunity principles and legislation and will ensure the gender equality regulations are met. For example, provision of flexible working hours to facilitate careers' responsibilities or to accommodate mobility or other relevant issues. All DCs will be employed on a full contract of employment, by their host organisation, for the duration of their fellowships.

3.1.6 Progress monitoring and evaluation of individual projects

At QSI we have envisaged a multi-layer progress monitoring system. The key person in direct charge of the DCs' progress is their main supervisor, who, in collaboration with other local and secondment co-supervisors, will oversee the progress of each project and report it, every 6 months, to the relevant WP leader, which will in turn report back to the relevant SB committees including IAB, RC, and DIC. Each of these committees will assess the progress of the DC with respect to their project objectives, and based on that will make recommendations to the SB. SB will then take necessary actions on a case-by-case basis. As deliverables, all DCs are required to submit two midterm (by m16 and m32) and final reports (by m48) to SB. These reports will be evaluated by the supervisory teams, and assessment reports will be sent to WP leaders, the Director of Research, and the SB.

3.1.7 Gender Aspects

The network will not tolerate discrimination against individuals on the basis of gender, gender identity or gender reassignment status, race, colour or ethnic or national origin, religion or equivalent belief system, disability, sexual orientation, social class, age (subject to the usual conventions on retirement), marital/civil partnership status, pregnancy/maternity or family responsibilities or as a result of any conditions or requirements that do not accord with the principles of fairness and natural justice. The QSI's **recruitment policy** is mainly on the basis of merit; in the case of equally qualified candidates, gender balance of the whole cohort will be pursued, as we explain in Sec. 3.1.7. The recruitment committee has members from both genders to make sure all relevant factors are taken into account. With a range of international supervisors on our Co-I list, with mixed genders, we expect to attract, and welcome, candidates from different ethnicities and genders. Despite the inherited gender imbalance in the various disciplines considered in QSI, half of the DC's supervisory teams include at least one woman. Altogether, we benefit from the contribution of 8 female supervisors. Our main **decision-making** body, the MEG, has members from both genders. Finally, the Director of Research is a female scientist, who also sits in the DIC as a member, and in the RTC as a member and Deputy Chair.

3.1.8 Environmental aspects in light of the MSCA Green Charter

While respecting the key feature of this programme, which is the physical mobility of researchers, we plan our activities in accordance with the general principles defined in the MSCA Green Charter: (i) promote teleconferencing whenever possible; (ii) use low-emission forms of transport; (iii) promote green purchasing for project-related materials; (iv) ensure the sustainability of project events; (v) whenever possible, use sustainable and renewable forms of energy; (vi) reduce, reuse and recycle; and (vii) share examples of best practices. All measures foreseen in that Charter implemented in QSI will be advertised in the web site.

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3.2 Quality, capacity and role of each participant, including hosting arrangements and extent to which the consortium as a whole brings together the necessary expertise

3.2.1 Appropriateness of the infrastructure and capacity of each participating organisation

Below, the appropriateness of our infrastructure and facilities are explained with respect to the following aspects:

Experimental Capacity: We have all the required expertise and facilities for our experimental projects. In particular, DC 3 will be at SU, which hosts experiments on QC and beyond QKD protocols; DC 6 will be at TOSHEU with facilities for characterising quantum light sources, single-photon detectors and fiber optic components, high-speed analogue and digital electronics, and fabrication facilities required for QKD experiments; DC 7 will be hosted at UNIGE, which hosts well equipped quantum optical laboratories, with a large variety of state of the art single photon detectors, and well trained electronic and mechanical engineers; and DC 8 will be at UNIPD with facilities for satellite QKD. UNIPD's collaboration with Italian Space Agency provides it access to dedicated observatory for space communications. All DCs will also be supported by our theory groups and APs via direct/network-wide supervision.

Training Capacity: We have the expertise and facilities to implement all aspects of our training programme. Our academic participants offer a wide range of courses and online resources relevant to QSI, some of which will be shared among all participants, including lectures on quantum information, quantum computing, QKD, modern cryptography, PQC, and communications networks. All participants have contributed to running scientific meetings and/or schools, and are supported by professional teams in their institutions. In particular, **CS** was one of the main organizers of the International Conference on Quantum Cryptography (QCRYPT 2020 & 2021), and will organize OM. **PV** has been the General Chair for the Quantum Information Science Conference 2012 in Padova, and has co-chaired several other events. He has chaired several Schools on Quantum Communications, in the site of UNIPD and at the Asiago Observatory, and has organized the School of Quantum Communications Networks in the ITN QCALL. He will be the organizer for SQC. **AH** has organized a summer school on modern cryptography (https://www.pqcschool.org) and will be the local organizer for SPQC. Our CS schools are offered by professionals from the Staff of the Reflect Academy at UvA (CS1), from RUB (CS2), and from the Quantum Technology Enterprise Centre at the University of Bristol (CS3). QSIW is organized by **ND** with the local support of **CM**, who have experience in organizing similar workshops, like e.g. the 6th Cryptocurrencies and Blockchain Technology Workshop (CBT'22), the 13th International Symposium on Cyberspace Safety and Security (CSS'21), or the "Quantum Techniques for Provable Security (QUIQUES)" workshop in 2021 inter alia. **ED**, with the experience of hosting QCRYPT 2014 (220 participants), the Trustworthy Quantum Information Workshop 2017 (150 participants), and the International Conference on Integrated Quantum Photonics 2018 (120 participants), will be in charge of QSIC.

Management Capacity: QSI will be coordinated by UVIGO, a top university for research and teaching in Spain, participating in more than 60 European Projects over the last 10 years, including more than 15 projects from H2020, several of them coordinated by UVIGO. Specialist staffs in the IPO at UVIGO, plus the employed project manager, provide advice and administrative support to QSI. Also, the lead scientists in the beneficiary partners are all experienced scientists with years of involvement in EU projects. All DCs, regardless of their host institute, will benefit from office space, library, internet, and computational services. Special facilities will be shared between all participants if needed.

3.2.2 Consortium composition and exploitation of participating organizations' complementarities

QSI brings together, in a balanced way, key expertise needed to address the key challenges of quantum-safe Internet; see Table 1.1(b). It consists of 7 beneficiary and 15 APs. This includes 9 leading industries, 11 universities, and 2 research institutes with essential experimental facilities and supporting theoretical groups. Our expertise ranges from computer science, modern cryptography, and PQC (RUB, UvA, TU/e, DTU, CWI, VERIQLOUD, Genua, NXP), through to quantum information science, quantum computing, mathematics (UvA, CWI, TTBE), and QKD security (UVIGO, ULEEDS, TOSHEU, SU, UNIGE, IDQUANTIQUESA, UT, NTT), from optical communication networks (ULEEDS, UVIGO, TOSHEU, SU, UNIPD, UNIGE, IDQUANTIQUESA, SIG, INRIM, NTT, Cisco, EUTELSAT) to fibre-based (TOSHEU, SU, UNIGE, IDQUANTIQUESA, SIG, NTT) and free-space (ULEEDS, UNIPD, EUTELSAT) QKD, quantum repeaters and quantum memories (ULEEDS, UNIGE, NTT), and from theoretical (UVIGO,

ULEEDS) to experimental (TOSHEU, UNIGE, IDQUANTIQUESA, SIG, INRIM, NTT, Cisco, EUTELSAT) long-distance quantum networks. QSI will enable a huge collaborative effort, see Table 1.4(a), to address the security needs of EU by training a high-calibre cadre working at the intersection of multiple disciplines.

QSI will exploit the existing complementarities in its members at its fullest, via network-wide supervision, management and secondments, to ensure the delivery of all its objectives. For instance, while CWI and TTBE provide additional theoretical support for the underpinning problems related to the security of PQC solutions, our established AP companies, i.e., NXP and Genua, as well as the start-up company VERIQLOUD will facilitate the exploitation routes and will contribute to our proposed research. UT and NTT offer support in advanced security analysis for QKD implementations, while NTT and Cisco offer solutions and expertise about packet-switched networks, routing protocols, and network architectures. This will then be complemented by the contributions from SIG and EUTELSAT, which, respectively, hold the key to a vast network of deployed optical fibres and satellites that can be used for various use cases. Our AP, INRIM, also helps with providing tools and facilities for high-precision measurements, which will be necessary for channel stabilisation in advanced QKD systems.

All our beneficiary and associated partners pay special attention to gender equality and open science policies. They have dedicated departments to ensure compliance with the requirements of various funding agencies. For instance, the Faculty of Engineering and Physical Sciences of ULEEDS holds the Silver Athena Swan award for gender equality and its Research and Innovation Services offers advice on open science practices. UVIGO, SU, TU/e, RUB, and UvA also have similar initiatives in their organisations. All these capacities will be fully exploited in QSI.

3.2.3 Commitment of beneficiaries and associated partners to the programme

All beneficiaries of QSI are committed to contributing to **(1)** DC supervision, as both main and secondment supervisors (Table 3.1(a)); **(2)** the training programme by either leading at least one network-wide training event and/or contributing to others (Table 1.3(b)); and **(3)** the management of QSI by membership in SB and its committees (Sec. 3.1.6). During the negotiation process, the Contracts Team at UVIGO will work with all participants to prepare a consortium agreement, in which the above commitments, among other things will be formally addressed.

The APs of QSI are chosen strategically to complement our expertise and to offer added value to the programme. All APs will offer secondments, contribute to the training events such as schools or planned dissemination activities, and be engaged with management aspects via their scientist-in-charge's membership in SB and its committees. In addition, two of our Swiss APs, i.e., UNIGE and IDQUANTIQUESA, and our two UK APs, i.e., ULEEDS and TOSHEU, each will host a DC. DCs 7 and 10 will be fully funded by the Swiss government, and DCs 6 and 9 will be fully funded by the UK government. Our industrial APs will advise the SB via the IAB. Pages 2-3 and Section 4 provide a summary of the specific roles each AP will have. Section 5 also includes support letters.

3.2.4 Funding of non-associated third countries (if applicable)

QSI does not fund any non-associated third country. We have, however, strategically chosen two partners from Switzerland and two partners from UK. Among which, IDQUANTIQUESA and TOSHEU, are key players in commercial QKD, and the other two, UNIGE and ULEEDS, host internationally recognised research groups in QC. The Swiss and UK governments will cover all the costs associated with the studentships allocated to these four partners. This offers us, and the EU funded part of the network, a great opportunity to benefit from the experience and expertise that these four partners will bring to our doctoral network. We are therefore confident that their contribution highly enriches the experience that the 8 EU-funded DCs of the network will have. In addition, several APs from Canada, Japan and US are supporting our DCs to make sure they can benefit from the expertise in other international organisations. Importantly, none of these APs will receive direct funding from EU. Instead, via the secondment mechanism and also their contribution to our training events, our DCs will benefit from the expertise that these partners offer in, e.g., QKD security (UT), quantum repeater technologies (NTT), Internet infrastructure and switching (Cisco, SIG), satellite communications (EUTELSAT), quantum algorithms and computing (CWI, TTBE, VERIQLOUD), modern cryptography (NXP, Genua), and measurement standards (INRIM).

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Putting together the expertise offered by the beneficiaries and APs, QSI offers a unique doctoral network that will deliver its research and training goals, and will have a lasting effect on the deployment of quantum-secure communications technologies in the EU. This is an important undertaking considering how EU has recently invested in such technologies. This doctoral network will be an instrumental part of such activities and will join efforts with other initiatives to provide EU citizens with the data security and privacy needed in the 21st century.

4. Ethics issues

The consortium confirms that compliance with ethical principles and applicable international, EU and national law in the implementation of research activities not originally envisaged (or not described in detail) in the DoA will be ensured and any ethical concerns raised by those activities will be handled following rigorously the recommendations provided in the European Commission Ethics Self-Assessment Guidelines.

The proposal has been subject to an Ethics Screening and is “ethics ready'. There are no additional ethics requirements.

Ethics Self-Assessment

Ethical dimension of the objectives, methodology and likely impact
Explain in detail the identified issues in relation to: - objectives of the activities (e.g. study of vulnerable populations, etc.) - methodology (e.g. clinical trials, involvement of children, protection of personal data, etc.) - the potential impact of the activities (e.g. environmental damage, stigmatisation of particular social groups, political or financial adverse consequences, misuse, etc.)

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Compliance with ethical principles and relevant legislations
Describe how the issue(s) identified in the ethics issues table above will be addressed in order to adhere to the ethical principles and what will be done to ensure that the activities are compliant with the EU/national legal and ethical requirements of the country or countries where the tasks are to be carried out. It is reminded that for activities performed in a non-EU countries, they should also be allowed in at least one EU Member State.

HE Unit MGA — Multi & Mono: v1.0
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ANNEX 2

ESTIMATED BUDGET FOR THE ACTION

Forms of funding	Estimated EU contribution								
	Estimated eligible unit contributions (per budget category)							Total	Maximum grant amount[1]
	A. Contributions for recruited researchers					B. Institutional contributions			
	A.1 Living allowance	A.2 Mobility allowance	A.3 Family allowance	A.4 Long-term leave allowance	A.5 Special needs allowance	B.1 Research, training and networking contribution	B.2 Management and indirect contribution		
	Unit contribution[2]	Unit contribution[2]	Unit contribution[2]	Unit contribution[2]	Unit contribution[2]	Unit contribution[2]	Unit contribution[2]	h = a + b + c + d + e + f + g	i
	a	b	c	d	e	f	g		
1 - UVIGO	223 502.40	43 200.00	35 640.00	0.00	0.00	115 200.00	86 400.00	503 942.40	503 942.40
2 - SU	142 473.60	21 600.00	17 820.00	0.00	0.00	57 600.00	43 200.00	282 693.60	282 693.60
3 - UNIPD	119 217.60	21 600.00	17 820.00	0.00	0.00	57 600.00	43 200.00	259 437.60	259 437.60
4 - RUB	120 319.20	21 600.00	17 820.00	0.00	0.00	57 600.00	43 200.00	260 539.20	260 539.20
5 - UvA	134 150.40	21 600.00	17 820.00	0.00	0.00	57 600.00	43 200.00	274 370.40	274 370.40
6 - TU/e	134 150.40	21 600.00	17 820.00	0.00	0.00	57 600.00	43 200.00	274 370.40	274 370.40
7 - DTU	161 568.00	21 600.00	17 820.00	0.00	0.00	57 600.00	43 200.00	301 788.00	301 788.00
8 - CWI									
9 - TTBE									
10 - UT									
11 - VERIQLOUD									
12 - genua									
13 - SIG									
14 - INRIM									
15 - NXP									
16 - NTT									
17 - CISCO									
18 - EUTELSAT									
19 - UNIGE									
20 - ID QUANTIQUE SA									
21 - ULEEDS									
22 - TOSHEU									
Σ consortium	1 035 381.60	172 800.00	142 560.00	0.00	0.00	460 800.00	345 600.00	2 157 141.60	2 157 141.60

[1] The 'maximum grant amount' is the maximum grant amount fixed in the grant agreement (on the basis of the sum of the beneficiaries' estimated units).
[2] See Annex 2a 'Additional information on the estimated budget' for the details (units, amount per unit).

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ANNEX 2a

ADDITIONAL INFORMATION ON UNIT COSTS AND CONTRIBUTIONS

HE MSCA Doctoral Networks/Post-doctoral Fellowships and HE ERA Fellowships[1]

Contributions for recruited researchers — Living allowance

Type: unit contributions

Units: months spent by the researcher(s) on the research training activities (person-months)

Amount per unit*: see Annex 2

* Amount calculated as follows:
{the monthly living allowance for researchers in MSCA-PF/MSCA-DN and ERA Fellowship actions
multiplied by
country-specific correction coefficient of *[OPTION by default:* the country in which the researcher is recruited*][OPTION for PF-Global Fellowships:* the country where the associated partner hosting the researcher during the outgoing phase is located and the country in which the researcher is recruited (for the return phase and placements)*]*}

The monthly living allowance and the country-specific correction coefficients are set out in the Horizon Europe Work Programme (MSCA Work Programme part) in force at the time of the call:

- for the monthly living allowance:
  - PF and ERA Fellowships: EUR 5 080
  - DN: EUR 3 400
- for the country-specific correction coefficients: see Work Programme (available on the Funding & Tenders Portal Reference Documents page).

Contributions for recruited researchers — Mobility allowance

Type: unit contributions

Units: months spent by the researcher(s) on the research training activities (person-months)

Amount per unit[2]: see Annex 2

Contributions for recruited researchers — Family allowance

Type: unit contributions

Units: months spent by the researcher(s) on the research training activities (person-months)

Amount per unit[3]: see Annex 2

Contributions for recruited researchers — Long-term leave allowance

Type: unit contributions

Units: months spent by the researcher(s) on long-term leave (person-months)

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1 Decision of 16 March 2021 authorising the use of lump sum contributions and unit contributions for Marie Skłodowska-Curie actions under the Horizon Europe Programme.

2 Same amount for all beneficiaries.
Amount for the mobility allowance set out in the Horizon Europe Work Programme (MSCA Work Programme part) in force at the time of the call (available on the Funding & Tenders Portal Reference Documents page).

3 Same amount for all beneficiaries.
Average based on the amount for the family allowance set out in the Horizon Europe Work Programme (MSCA Work Programme part) in force at the time of the call (75% of the number of units with family, 25% without).

Amount per unit*: see Annex 2

*Amount calculated as follows:
{long-term leave allowance (i.e. the sum of the applicable living allowance and mobility allowance)
multiplied by
percentage of long-term leave allowance incurred by the beneficiary (i.e. costs incurred by the beneficiary divided by the long-term leave allowance)
multiplied by
number of months}

Contributions for recruited researchers — Special needs allowance

Type: unit contributions

Units: number of special needs units (per recruited researcher) that were needed for implementing the action (person-months)

Amount per unit*: see Annex 2

*Amount calculated as follows:
{requested special needs unit
multiplied by
(1/number of months)}

The pre-defined special needs units are: EUR 3 000, EUR 4 500, EUR 6 000, EUR 9 500, EUR 13 000, EUR 18 500, EUR 27 500, EUR 35 500, EUR 47 500 and EUR 60 000.

Institutional contributions — Research, training and networking contribution

Type: unit contributions

Units: months spent by the researcher(s) on the research training activities (person-months)

Amount per unit[4]: see Annex 2

Institutional contributions — Management and indirect contribution

Type: unit contributions

Units: months spent by the researcher(s) on the research training activities (person-months)

Amount per unit[5]: see Annex 2

HE MSCA Staff Exchanges[6]

Contributions for seconded staff — Top-up allowance

Type: unit contributions

Units: months spent by the seconded staff member(s) on the research and innovation activities (person-months)

Amount per unit[7]: see Annex 2

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4 Same amount for all beneficiaries.
Amount for research, training and networking contribution set out in the Horizon Europe Work Programme (MSCA Work Programme part) in force at the time of the call (available on the Funding & Tenders Portal Reference Documents page).

5 Same amount for all beneficiaries.
Amount for management and indirect contribution set out in the Horizon Europe Work Programme (MSCA Work Programme part) in force at the time of the call (available on the Funding & Tenders Portal Reference Documents page).

6 Decision of 16 March 2021 authorising the use of lump sum contributions and unit contributions for Marie Skłodowska-Curie actions under the Horizon Europe Programme.

7 Same amount for all beneficiaries.
Amount for the top-up allowance set out in the Horizon Europe Work Programme (MSCA Work Programme part) in force at the time of the call (available on the Funding & Tenders Portal Reference Documents page).

Contributions for seconded staff — Special needs allowance

Type: unit contributions

Units: number of special needs units (per seconded staff member) that were needed for implementing the action (person-months)

Amount per unit*: see Annex 2

*Amount calculated as follows:
{requested special needs unit
multiplied by
(1/number of months)}

The pre-defined special needs units are: EUR 3 000, EUR 4 500, EUR 6 000, EUR 9 500, EUR 13 000, EUR 18 500, EUR 27 500, EUR 35 500, EUR 47 500 and EUR 60 000.

Institutional contributions — Research, training and networking contribution

Type: unit contributions

Units: months spent by the seconded staff member(s) on the research and innovation activities (person-months)

Amount per unit[8]: see Annex 2

Institutional contributions — Management and indirect contribution

Type: unit contributions

Units: months spent by the seconded staff member(s) on the research and innovation activities (person-months)

Amount per unit[9]: see Annex 2

HE MSCA COFUND[10]

COFUND contributions — COFUND allowance

Type: unit contributions

Units: months spent by the researchers on the research training activities (person-months)

Amount per unit[11]: see Annex 2

COFUND contributions — Long-term leave allowance

Type: unit contributions

Units: months spent by the researcher(s) on long-term leave ('person-months')

Amount per unit*: see Annex 2

*Amount calculated as follows:
{long-term leave allowance (i.e. the applicable COFUND allowance)

---

8 Same amount for all beneficiaries.
Amount for research, training and networking contribution set out in the Horizon Europe Work Programme (MSCA Work Programme part) in force at the time of the call (available on the Funding & Tenders Portal Reference Documents page).

9 Same amount for all beneficiaries.
Amount for management and indirect contribution set out in the Horizon Europe Work Programme (MSCA Work Programme part) in force at the time of the call (available on the Funding & Tenders Portal Reference Documents page).

10 Decision of 16 March 2021 authorising the use of lump sum contributions and unit contributions for Marie Skłodowska-Curie actions under the Horizon Europe Programme.

11 Same amount for all beneficiaries.
Amount for the COFUND allowance set out in the Horizon Europe Work Programme (MSCA Work Programme part) in force at the time of the call (available on the Funding & Tenders Portal Reference Documents page).

multiplied by
percentage of long-term leave allowance incurred by the beneficiary (i.e. costs incurred by the beneficiary divided by the long-term leave allowance)
multiplied by
number of months}

COFUND contributions — Special needs allowance

Type: unit contributions

Units: number of special needs units (per recruited researcher) that were needed for implementing the action ('person-months')

Amount per unit*: see Annex 2

*Amount calculated as follows:
{requested special needs unit
multiplied by
(1/number of months)}

The pre-defined special needs units are: EUR 3 000, EUR 4 500, EUR 6 000, EUR 9 500, EUR 13 000, EUR 18 500, EUR 27 500, EUR 35 500, EUR 47 500 and EUR 60 000.

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ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

SORBONNE UNIVERSITE (SU), PIC 909875521, established in 21 RUE DE L'ECOLE DE MEDECINE, PARIS 75006, France,

hereby agrees

to become beneficiary

in Agreement No 101072637 — QSI ('the Agreement')

between UNIVERSIDAD DE VIGO (UVIGO) **and** the **European Research Executive Agency (REA)** ('EU executive agency' or 'granting authority'), under the powers delegated by the European Commission ('European Commission'),

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 39.

By signing this accession form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and terms and conditions it sets out.

SIGNATURE

For the beneficiary

Julie Zittel with ECAS id n005aou9 signed in the Participant Portal on 22/06/2022 at 16:20:41 (transaction id SigId-209227-fZTlqFzqrCnaZ098uZGlpt2zubzgxEaItx0VjRB7029R10UHga1gmKop5alqseLp14mIwgY8oZXzZQxAGhBuYsi-yntOf97TTHq9QCab4GzIaj-OzVw3p4RgJGer8zORqM4lI6yI4zJTLAkbGfGzKliufsgJOxsR8lO92zLhumDqOEDSaj7aKzoB3se5BO0HfwCzaQ0). Timestamp by third party at 2022.06.22 17:20:45 CEST

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ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

UNIVERSITA DEGLI STUDI DI PADOVA (UNIPD), PIC 999995602, established in VIA 8 FEBBRAIO 2, PADOVA 35122, Italy,

hereby agrees

to become beneficiary

in Agreement No 101072637 — QSI ('the Agreement')

between UNIVERSIDAD DE VIGO (UVIGO) **and** the **European Research Executive Agency (REA)** ('EU executive agency' or 'granting authority'), under the powers delegated by the European Commission ('European Commission'),

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 39.

By signing this accession form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and terms and conditions it sets out.

SIGNATURE

For the beneficiary

Gaudenzio MENEGHESSO with ECAS id nmeneggo signed in the Participant Portal on 22/06/2022 at 12:51:46 (transaction id SigId-205254-AEwAvU1mxHNYrGeTpOwtEqLUhYOYzYLQAVHmcOAiJ31uGLzzVP3J8aiFi0ybbFtLcFxeU7nNfW0YznKXvk4sT6C-yntOf97TTHq9QCab4GzIaj-5ht2E6pcRHErb0qp51Tf9zw0ZkCxGwDVvUX7KUg6JuNqxMX6ITifNFBrzZnEQfACT74ouWjGnM2zqEEumeRuuXm). Timestamp by third party at 2022.06.22 13:51:50 CEST

Associated with document Ref. Ares(2022)4533596 - 20/06/2022

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

RUHR-UNIVERSITAET BOCHUM (RUB), PIC 999988812, established in UNIVERSITAETSSTRASSE 150, BOCHUM 44801, Germany,

hereby agrees

to become beneficiary

in Agreement No 101072637 — QSI ('the Agreement')

between UNIVERSIDAD DE VIGO (UVIGO) **and** the **European Research Executive Agency (REA)** ('EU executive agency' or 'granting authority'), under the powers delegated by the European Commission ('European Commission'),

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 39.

By signing this accession form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and terms and conditions it sets out.

SIGNATURE

For the beneficiary

Christina REINHARDT with ECAS id nrnharch signed in the Participant Portal on 27/06/2022 at 13:05:57 (transaction id SigId-242462-tJfO8oF83vQ40798zXdpZhwghntalgTmRoEnlHTCgQFRTPOTx7zHI6kIgPdwhOQxEZQrZPwqyZMBPCsAzqcGq7m-yntOf97TTHq9QCab4GzIaj-CqzybQhMd3vpwhK3Kk8kqE5LczzaNeQbchuCUKFjRW6OVfpQzVvqEoByWiu5XzJHhIBzbQoWhBSarxAh9zn9IzyO). Timestamp by third party at 2022.06.27 14:06:03 CEST

Associated with document Ref. Ares(2022)4533596 - 20/06/2022

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

UNIVERSITEIT VAN AMSTERDAM (UvA), PIC 999985708, established in SPUI 21, AMSTERDAM 1012WX, Netherlands,

hereby agrees

to become beneficiary

in Agreement No 101072637 — QSI ('the Agreement')

between UNIVERSIDAD DE VIGO (UVIGO) **and** the **European Research Executive Agency (REA)** ('EU executive agency' or 'granting authority'), under the powers delegated by the European Commission ('European Commission'),

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 39.

By signing this accession form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and terms and conditions it sets out.

SIGNATURE

For the beneficiary

Chris Marcelis with ECAS id n00332g7 signed in the Participant Portal on 22/06/2022 at 17:17:17 (transaction id SigId-209914-traHnlDw78BMk3MxxDYkV0811CNlJR0mZuSa75RgRbczW8JJbOF2BDzJKZCVXsm4LJF6vYSzve7IC99G29flEum-yntOf97TTHq9QCab4GzIaj-4ZKphwnZooGK91ZsGkFzgzTp6TDEnyVFXVzZMtIPHaupEMzkbzory1EVrPUUYfj5IWr5szzvyzPc6dWAqmb6uzOsW). Timestamp by third party at 2022.06.22 18:17:22 CEST

Associated with document Ref. Ares(2022)4533596 - 20/06/2022

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

TECHNISCHE UNIVERSITEIT EINDHOVEN (TU/e), PIC 999977269, established in GROENE LOPER 3, EINDHOVEN 5612 AE, Netherlands,

hereby agrees

to become beneficiary

in Agreement No 101072637 — QSI ('the Agreement')

between UNIVERSIDAD DE VIGO (UVIGO) **and** the **European Research Executive Agency (REA)** ('EU executive agency' or 'granting authority'), under the powers delegated by the European Commission ('European Commission'),

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 39.

By signing this accession form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and terms and conditions it sets out.

SIGNATURE

For the beneficiary

Robert VAN DER DRIFT with ECAS id ndrirobe signed in the Participant Portal on 22/06/2022 at 12:51:04 (transaction id SigId-205232-TZYxQCVaKHnNfWeekeczQOSMIzmXJd3DqFdF7kSTy3NQSQ0cUMuy2nf3qjiEQJsFsBfgga4MVjpNpcIgibzRaAG-yntOf97TTHq9QCab4GzIaj-R1QHtgd5M5A4vkzcA2m6s9qOiwohfOFSonVNtnHJaZpzIruAi2LzHvA8HmXxlsqobixjzi4UXZIENG1Ng8YySgu). Timestamp by third party at 2022.06.22 13:51:11 CEST

Associated with document Ref. Ares(2022)4533596 - 20/06/2022

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

DANMARKS TEKNISKE UNIVERSITET (DTU), PIC 999990655, established in ANKER ENGELUNDSVEJ 1 BYGNING 101 A, KGS LYNGBY 2800, Denmark,

hereby agrees

to become beneficiary

in Agreement No 101072637 — QSI ('the Agreement')

between UNIVERSIDAD DE VIGO (UVIGO) **and** the **European Research Executive Agency (REA)** ('EU executive agency' or 'granting authority'), under the powers delegated by the European Commission ('European Commission'),

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 39.

By signing this accession form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and terms and conditions it sets out.

SIGNATURE

For the beneficiary

Per BROCKHOFF with ECAS id nbrocper signed in the Participant Portal on 22/06/2022 at 13:24:24 (transaction id SigId-205831-JAyiEqc836aX7kzw0gESHDlbl7sBKgPiiXjFSMf1x1V2JwR3RUrenzhqitRMHEjcyGlifUVT1K3Lo1M7SWdyEm-yntOf97TTHq9QCab4GzIaj-55qoEyIypqgwGV9Uh5Cxx0dCIUewA1RXeQU9LzhzwuFfBDEeo6L8ERBcIumZuPLzjLTKzO6QYrq81s91dx5hZUi). Timestamp by third party at 2022.06.22 14:24:29 CEST

Associated with document Ref. Ares(2022)4533596 - 20/06/2022

FINANCIAL STATEMENT FOR [PARTICIPANT NAME] FOR REPORTING PERIOD [NUMBER]

	EU contribution								
	Eligible unit contributions (per budget category)								**Requested EU contribution**
	[OPTION for all MSCA ToA except COFUND: **A. . Contributions for** *[* **recruited researchers***]* *[* **seconded staff members***]][OPTION for COFUND:* **A. COFUND contributions***]*					*[OPTION for all MSCA ToA except COFUND:* **B. Institutional contributions***]*		**Total**	
	[OPTION for DN and PF : A.1 Living allowance*]* *[OPTION for SE:* A.1 Top - up allowance*]* *[OPTION for COFUND:* A.1 COFUND allowance*]*	*[OPTION for DN and PF:* A.2 Mobility allowance*]*	*[OPTION for DN and PF:* A.3 Family allowance*]*	*[OPTION for all MSCA ToA except SE:* A.4 Long-term leave allowance*]*	A.5 Special needs allowance	*[* B.1 Research, training and networking contribution*]*	*[* B.2 Management and indirect contribution*]*		
Forms of funding	Unit contribution[1]	*[* Unit contribution[1] *]*	*[* Unit contribution[1] *]*	*[* Unit contribution[1] *]*	Unit contribution[1]	*[* Unit contribution[1] *]*	*[* Unit contribution[1] *]*	h = a *[* + b *][* + c*]* *[* + d*]* + e *[* + f*]* *[* + g*]*	i
	a	*[* b*]*	*[* c*]*	*[* d*]*	e	*[* f*]*	*[* g*]*		
XX – [short name beneficiary/affiliated entity]									

The beneficiary/affiliated entity hereby confirms that:

The information provided is complete, reliable and true.

The unit contributions declared are eligible (see Article 6).

The contributions can be substantiated by adequate records and supporting documentation that will be produced upon request or in the context of checks, reviews, audits and investigations (see Articles 19, 20 and 25).

[1] See Annex 2a 'Additional information on the estimated budget' for the details (units, amount per unit).

Associated with document Ref. Ares(2022)4533596 - 20/06/2022

ANNEX 5

SPECIFIC RULES

CONFIDENTIALITY AND SECURITY (— ARTICLE 13)

Sensitive information with security recommendation

Sensitive information with a security recommendation must comply with the additional requirements imposed by the granting authority.

Before starting the action tasks concerned, the beneficiaries must have obtained all approvals or other mandatory documents needed for implementing the task. The documents must be kept on file and be submitted upon request by the coordinator to the granting authority. If they are not in English, they must be submitted together with an English summary.

For requirements restricting disclosure or dissemination, the information must be handled in accordance with the recommendation and may be disclosed or disseminated only after written approval from the granting authority.

EU classified information

If EU classified information is used or generated by the action, it must be treated in accordance with the security classification guide (SCG) and security aspect letter (SAL) set out in Annex 1 and Decision 2015/444[1] and its implementing rules — until it is declassified.

Deliverables which contain EU classified information must be submitted according to special procedures agreed with the granting authority.

Action tasks involving EU classified information may be subcontracted only with prior explicit written approval from the granting authority and only to entities established in an EU Member State or in a non-EU country with a security of information agreement with the EU (or an administrative arrangement with the Commission).

EU classified information may not be disclosed to any third party (including participants involved in the action implementation) without prior explicit written approval from the granting authority.

ETHICS (— ARTICLE 14)

Ethics and research integrity

The beneficiaries must carry out the action in compliance with:

- ethical principles (including the highest standards of research integrity)

[1] Commission Decision 2015/444/EC, Euratom of 13 March 2015 on the security rules for protecting EU classified information (OJ L 72, 17.3.2015, p. 53).

and

- applicable EU, international and national law, including the EU Charter of Fundamental Rights and the European Convention for the Protection of Human Rights and Fundamental Freedoms and its Supplementary Protocols.

No funding can be granted, within or outside the EU, for activities that are prohibited in all Member States. No funding can be granted in a Member State for an activity which is forbidden in that Member State.

The beneficiaries must pay particular attention to the principle of proportionality, the right to privacy, the right to the protection of personal data, the right to the physical and mental integrity of persons, the right to non-discrimination, the need to ensure protection of the environment and high levels of human health protection.

The beneficiaries must ensure that the activities under the action have an exclusive focus on civil applications.

The beneficiaries must ensure that the activities under the action do not:

- aim at human cloning for reproductive purposes
- intend to modify the genetic heritage of human beings which could make such modifications heritable (with the exception of research relating to cancer treatment of the gonads, which may be financed)
- intend to create human embryos solely for the purpose of research or for the purpose of stem cell procurement, including by means of somatic cell nuclear transfer, or
- lead to the destruction of human embryos (for example, for obtaining stem cells).

Activities involving research on human embryos or human embryonic stem cells may be carried out only if:

- they are set out in Annex 1 or
- the coordinator has obtained explicit approval (in writing) from the granting authority.

In addition, the beneficiaries must respect the fundamental principle of research integrity — as set out in the European Code of Conduct for Research Integrity[2].

This implies compliance with the following principles:

- reliability in ensuring the quality of research reflected in the design, the methodology, the analysis and the use of resources
- honesty in developing, undertaking, reviewing, reporting and communicating research in a transparent, fair and unbiased way

[2] European Code of Conduct for Research Integrity of ALLEA (All European Academies).

- respect for colleagues, research participants, society, ecosystems, cultural heritage and the environment

- accountability for the research from idea to publication, for its management and organisation, for training, supervision and mentoring, and for its wider impacts

and means that beneficiaries must ensure that persons carrying out research tasks follow the good research practices including ensuring, where possible, openness, reproducibility and traceability and refrain from the research integrity violations described in the Code.

Activities raising ethical issues must comply with the additional requirements formulated by the ethics panels (including after checks, reviews or audits; see Article 25).

Before starting an action task raising ethical issues, the beneficiaries must have obtained all approvals or other mandatory documents needed for implementing the task, notably from any (national or local) ethics committee or other bodies such as data protection authorities.

The documents must be kept on file and be submitted upon request by the coordinator to the granting authority. If they are not in English, they must be submitted together with an English summary, which shows that the documents cover the action tasks in question and includes the conclusions of the committee or authority concerned (if any).

VALUES (— ARTICLE 14)

Gender mainstreaming

The beneficiaries must take all measures to promote equal opportunities between men and women in the implementation of the action and, where applicable, in line with the gender equality plan. They must aim, to the extent possible, for a gender balance at all levels of personnel assigned to the action, including at supervisory and managerial level.

INTELLECTUAL PROPERTY RIGHTS (IPR) — BACKGROUND AND RESULTS — ACCESS RIGHTS AND RIGHTS OF USE (— ARTICLE 16)

Definitions

Access rights — Rights to use results or background.

Dissemination — The public disclosure of the results by appropriate means, other than resulting from protecting or exploiting the results, including by scientific publications in any medium.

Exploit(ation) — The use of results in further research and innovation activities other than those covered by the action concerned, including among other things, commercial exploitation such as developing, creating, manufacturing and marketing a product or process, creating and providing a service, or in standardisation activities.

Fair and reasonable conditions — Appropriate conditions, including possible financial terms or royalty-free conditions, taking into account the specific circumstances of the request for access, for example the actual or potential value of the results or background to which access is requested and/or the scope, duration or other characteristics of the exploitation envisaged.

FAIR principles — ‘findability’, ‘accessibility’, ‘interoperability’ and ‘reusability’.

Open access — Online access to research outputs provided free of charge to the end-user.

Open science — An approach to the scientific process based on open cooperative work, tools and diffusing knowledge.

Research data management — The process within the research lifecycle that includes the organisation, storage, preservation, security, quality assurance, allocation of persistent identifiers (PIDs) and rules and procedures for sharing of data including licensing.

Research outputs — Results to which access can be given in the form of scientific publications, data or other engineered results and processes such as software, algorithms, protocols, models, workflows and electronic notebooks.

Scope of the obligations

For this section, references to ‘beneficiary’ or ‘beneficiaries’ do not include affiliated entities (if any).

Agreement on background

The beneficiaries must identify in a written agreement the background as needed for implementing the action or for exploiting its results.

Where the call conditions restrict control due to strategic interests reasons, background that is subject to control or other restrictions by a country (or entity from a country) which is not one of the eligible countries or target countries set out in the call conditions and that impact the exploitation of the results (i.e. would make the exploitation of the results subject to control or restrictions) must not be used and must be explicitly excluded from it in the agreement on background — unless otherwise agreed with the granting authority.

Ownership of results

Results are owned by the beneficiaries that generate them.

However, two or more beneficiaries own results jointly if:

- they have jointly generated them and
- it is not possible to:
    - establish the respective contribution of each beneficiary, or
    - separate them for the purpose of applying for, obtaining or maintaining their protection.

The joint owners must agree — in writing — on the allocation and terms of exercise of their joint ownership (‘**joint ownership agreement**’), to ensure compliance with their obligations under this Agreement.

Unless otherwise agreed in the joint ownership agreement or consortium agreement, each joint owner may grant non-exclusive licences to third parties to exploit the jointly-owned results (without any right to sub-license), if the other joint owners are given:

- at least 45 days advance notice and
- fair and reasonable compensation.

The joint owners may agree — in writing — to apply another regime than joint ownership.

If third parties (including employees and other personnel) may claim rights to the results, the beneficiary concerned must ensure that those rights can be exercised in a manner compatible with its obligations under the Agreement.

The beneficiaries must indicate the owner(s) of the results (results ownership list) in the final periodic report.

Protection of results

Beneficiaries which have received funding under the grant must adequately protect their results — for an appropriate period and with appropriate territorial coverage — if protection is possible and justified, taking into account all relevant considerations, including the prospects for commercial exploitation, the legitimate interests of the other beneficiaries and any other legitimate interests.

Exploitation of results

Beneficiaries which have received funding under the grant must — up to four years after the end of the action (see Data Sheet, Point 1) — use their best efforts to exploit their results directly or to have them exploited indirectly by another entity, in particular through transfer or licensing.

If, despite a beneficiary's best efforts, the results are not exploited within one year after the end of the action, the beneficiaries must (unless otherwise agreed in writing with the granting authority) use the Horizon Results Platform to find interested parties to exploit the results.

If results are incorporated in a standard, the beneficiaries must (unless otherwise agreed with the granting authority or unless it is impossible) ask the standardisation body to include the funding statement (see Article 17) in (information related to) the standard.

Additional exploitation obligations

Where the call conditions impose additional exploitation obligations (including obligations linked to the restriction of participation or control due to strategic assets, interests, autonomy or security reasons), the beneficiaries must comply with them — up to four years after the end of the action (see Data Sheet, Point 1).

Where the call conditions impose additional exploitation obligations in case of a public emergency, the beneficiaries must (if requested by the granting authority) grant for a limited period of time specified in the request, non-exclusive licences — under fair and reasonable conditions — to their results to legal entities that need the results to address the public emergency and commit to rapidly and broadly exploit the resulting products and services at

fair and reasonable conditions. This provision applies up to four years after the end of the action (see Data Sheet, Point 1).

Additional information obligation relating to standards

Where the call conditions impose additional information obligations relating to possible standardisation, the beneficiaries must — up to four years after the end of the action (see Data Sheet, Point 1) — inform the granting authority, if the results could reasonably be expected to contribute to European or international standards.

Transfer and licensing of results

Transfer of ownership

The beneficiaries may transfer ownership of their results, provided this does not affect compliance with their obligations under the Agreement.

The beneficiaries must ensure that their obligations under the Agreement regarding their results are passed on to the new owner and that this new owner has the obligation to pass them on in any subsequent transfer.

Moreover, they must inform the other beneficiaries with access rights of the transfer at least 45 days in advance (or less if agreed in writing), unless agreed otherwise in writing for specifically identified third parties including affiliated entities or unless impossible under the applicable law. This notification must include sufficient information on the new owner to enable the beneficiaries concerned to assess the effects on their access rights. The beneficiaries may object within 30 days of receiving notification (or less if agreed in writing), if they can show that the transfer would adversely affect their access rights. In this case, the transfer may not take place until agreement has been reached between the beneficiaries concerned.

Granting licences

The beneficiaries may grant licences to their results (or otherwise give the right to exploit them), including on an exclusive basis, provided this does not affect compliance with their obligations.

Exclusive licences for results may be granted only if all the other beneficiaries concerned have waived their access rights.

Granting authority right to object to transfers or licensing — Horizon Europe actions

Where the call conditions in Horizon Europe actions provide for the right to object to transfers or licensing, the granting authority may — up to four years after the end of the action (see Data Sheet, Point 1) — object to a transfer of ownership or the exclusive licensing of results, if:

- the beneficiaries which generated the results have received funding under the grant
- it is to a legal entity established in a non-EU country not associated with Horizon Europe, and

- the granting authority considers that the transfer or licence is not in line with EU interests.

Beneficiaries that intend to transfer ownership or grant an exclusive licence must formally notify the granting authority before the intended transfer or licensing takes place and:

- identify the specific results concerned
- describe in detail the new owner or licensee and the planned or potential exploitation of the results, and
- include a reasoned assessment of the likely impact of the transfer or licence on EU interests, in particular regarding competitiveness as well as consistency with ethical principles and security considerations.

The granting authority may request additional information.

If the granting authority decides to object to a transfer or exclusive licence, it must formally notify the beneficiary concerned within 60 days of receiving notification (or any additional information it has requested).

No transfer or licensing may take place in the following cases:

- pending the granting authority decision, within the period set out above
- if the granting authority objects
- until the conditions are complied with, if the granting authority objection comes with conditions.

A beneficiary may formally notify a request to waive the right to object regarding intended transfers or grants to a specifically identified third party, if measures safeguarding EU interests are in place. If the granting authority agrees, it will formally notify the beneficiary concerned within 60 days of receiving notification (or any additional information requested).

Limitations to transfers and licensing due to strategic assets, interests, autonomy or security reasons of the EU and its Member States

Where the call conditions restrict participation or control due to strategic assets, interests, autonomy or security reasons, the beneficiaries may not transfer ownership of their results or grant licences to third parties which are established in countries which are not eligible countries or target countries set out in the call conditions (or, if applicable, are controlled by such countries or entities from such countries) — unless they have requested and received prior approval by the granting authority.

The request must:

- identify the specific results concerned
- describe in detail the new owner and the planned or potential exploitation of the results, and
- include a reasoned assessment of the likely impact of the transfer or license on the strategic assets, interests, autonomy or security of the EU and its Member States.

The granting authority may request additional information.

Access rights to results and background

Exercise of access rights — Waiving of access rights — No sub-licensing

Requests to exercise access rights and the waiver of access rights must be in writing.

Unless agreed otherwise in writing with the beneficiary granting access, access rights do not include the right to sub-license.

If a beneficiary is no longer involved in the action, this does not affect its obligations to grant access.

If a beneficiary defaults on its obligations, the beneficiaries may agree that that beneficiary no longer has access rights.

Access rights for implementing the action

The beneficiaries must grant each other access — on a royalty-free basis — to background needed to implement their own tasks under the action, unless the beneficiary that holds the background has — before acceding to the Agreement —:

- informed the other beneficiaries that access to its background is subject to restrictions, or
- agreed with the other beneficiaries that access would not be on a royalty-free basis.

The beneficiaries must grant each other access — on a royalty-free basis — to results needed for implementing their own tasks under the action.

Access rights for exploiting the results

The beneficiaries must grant each other access — under fair and reasonable conditions — to results needed for exploiting their results.

The beneficiaries must grant each other access — under fair and reasonable conditions — to background needed for exploiting their results, unless the beneficiary that holds the background has — before acceding to the Agreement — informed the other beneficiaries that access to its background is subject to restrictions.

Requests for access must be made — unless agreed otherwise in writing — up to one year after the end of the action (see Data Sheet, Point 1).

Access rights for entities under the same control

Unless agreed otherwise in writing by the beneficiaries, access to results and, subject to the restrictions referred to above (if any), background must also be granted — under fair and reasonable conditions — to entities that:

- are established in an EU Member State or Horizon Europe associated country
- are under the direct or indirect control of another beneficiary, or under the same direct or indirect control as that beneficiary, or directly or indirectly controlling that beneficiary and

- need the access to exploit the results of that beneficiary.

Unless agreed otherwise in writing, such requests for access must be made by the entity directly to the beneficiary concerned.

Requests for access must be made — unless agreed otherwise in writing — up to one year after the end of the action (see Data Sheet, Point 1).

Access rights for the granting authority, EU institutions, bodies, offices or agencies and national authorities to results for policy purposes — Horizon Europe actions

In Horizon Europe actions, the beneficiaries which have received funding under the grant must grant access to their results — on a royalty-free basis — to the granting authority, EU institutions, bodies, offices or agencies for developing, implementing and monitoring EU policies or programmes. Such access rights do not extend to beneficiaries' background.

Such access rights are limited to non-commercial and non-competitive use.

For actions under the cluster 'Civil Security for Society', such access rights also extend to national authorities of EU Member States for developing, implementing and monitoring their policies or programmes in this area. In this case, access is subject to a bilateral agreement to define specific conditions ensuring that:

- the access rights will be used only for the intended purpose and

- appropriate confidentiality obligations are in place.

Moreover, the requesting national authority or EU institution, body, office or agency (including the granting authority) must inform all other national authorities of such a request.

Additional access rights

Where the call conditions impose additional access rights, the beneficiaries must comply with them.

COMMUNICATION, DISSEMINATION, OPEN SCIENCE AND VISIBILITY (— ARTICLE 17)

Dissemination

Dissemination of results

The beneficiaries must disseminate their results as soon as feasible, in a publicly available format, subject to any restrictions due to the protection of intellectual property, security rules or legitimate interests.

A beneficiary that intends to disseminate its results must give at least 15 days advance notice to the other beneficiaries (unless agreed otherwise), together with sufficient information on the results it will disseminate.

Any other beneficiary may object within (unless agreed otherwise) 15 days of receiving notification, if it can show that its legitimate interests in relation to the results or background would be significantly harmed. In such cases, the results may not be disseminated unless appropriate steps are taken to safeguard those interests.

Additional dissemination obligations

Where the call conditions impose additional dissemination obligations, the beneficiaries must also comply with those.

Open Science

Open science: open access to scientific publications

The beneficiaries must ensure open access to peer-reviewed scientific publications relating to their results. In particular, they must ensure that:

- at the latest at the time of publication, a machine-readable electronic copy of the published version or the final peer-reviewed manuscript accepted for publication, is deposited in a trusted repository for scientific publications

- immediate open access is provided to the deposited publication via the repository, under the latest available version of the Creative Commons Attribution International Public Licence (CC BY) or a licence with equivalent rights; for monographs and other long-text formats, the licence may exclude commercial uses and derivative works (e.g. CC BY-NC, CC BY-ND) and

- information is given via the repository about any research output or any other tools and instruments needed to validate the conclusions of the scientific publication.

Beneficiaries (or authors) must retain sufficient intellectual property rights to comply with the open access requirements.

Metadata of deposited publications must be open under a Creative Common Public Domain Dedication (CC 0) or equivalent, in line with the FAIR principles (in particular machine-actionable) and provide information at least about the following: publication (author(s), title, date of publication, publication venue); Horizon Europe or Euratom funding; grant project name, acronym and number; licensing terms; persistent identifiers for the publication, the authors involved in the action and, if possible, for their organisations and the grant. Where applicable, the metadata must include persistent identifiers for any research output or any other tools and instruments needed to validate the conclusions of the publication.

Open science: research data management

The beneficiaries must manage the digital research data generated in the action ('data') responsibly, in line with the FAIR principles and by taking all of the following actions:

- establish a data management plan ('DMP') (and regularly update it)

- as soon as possible and within the deadlines set out in the DMP, deposit the data in a trusted repository; if required in the call conditions, this repository must be federated in the EOSC in compliance with EOSC requirements

- as soon as possible and within the deadlines set out in the DMP, ensure open access — via the repository — to the deposited data, under the latest available version of the Creative Commons Attribution International Public License (CC BY) or Creative Commons Public Domain Dedication (CC 0) or a licence with equivalent rights,

following the principle 'as open as possible as closed as necessary', unless providing open access would in particular:

- be against the beneficiary's legitimate interests, including regarding commercial exploitation, or
- be contrary to any other constraints, in particular the EU competitive interests or the beneficiary's obligations under this Agreement; if open access is not provided (to some or all data), this must be justified in the DMP

- provide information via the repository about any research output or any other tools and instruments needed to re-use or validate the data.

Metadata of deposited data must be open under a Creative Common Public Domain Dedication (CC 0) or equivalent (to the extent legitimate interests or constraints are safeguarded), in line with the FAIR principles (in particular machine-actionable) and provide information at least about the following: datasets (description, date of deposit, author(s), venue and embargo); Horizon Europe or Euratom funding; grant project name, acronym and number; licensing terms; persistent identifiers for the dataset, the authors involved in the action, and, if possible, for their organisations and the grant. Where applicable, the metadata must include persistent identifiers for related publications and other research outputs.

Open science: additional practices

Where the call conditions impose additional obligations regarding open science practices, the beneficiaries must also comply with those.

Where the call conditions impose additional obligations regarding the validation of scientific publications, the beneficiaries must provide (digital or physical) access to data or other results needed for validation of the conclusions of scientific publications, to the extent that their legitimate interests or constraints are safeguarded (and unless they already provided the (open) access at publication).

Where the call conditions impose additional open science obligations in case of a public emergency, the beneficiaries must (if requested by the granting authority) immediately deposit any research output in a repository and provide open access to it under a CC BY licence, a Public Domain Dedication (CC 0) or equivalent. As an exception, if the access would be against the beneficiaries' legitimate interests, the beneficiaries must grant non-exclusive licenses — under fair and reasonable conditions — to legal entities that need the research output to address the public emergency and commit to rapidly and broadly exploit the resulting products and services at fair and reasonable conditions. This provision applies up to four years after the end of the action (see Data Sheet, Point 1).

Plan for the exploitation and dissemination of results including communication activities

Unless excluded by the call conditions, the beneficiaries must provide and regularly update a plan for the exploitation and dissemination of results including communication activities.

SPECIFIC RULES FOR CARRYING OUT THE ACTION (— ARTICLE 18)

Implementation in case of restrictions due to strategic assets, interests, autonomy or security of the EU and its Member States

Where the call conditions restrict participation or control due to strategic assets, interests, autonomy or security, the beneficiaries must ensure that none of the entities that participate as affiliated entities, associated partners, subcontractors or recipients of financial support to third parties are established in countries which are not eligible countries or target countries set out in the call conditions (or, if applicable, are controlled by such countries or entities from such countries) — unless otherwise agreed with the granting authority.

The beneficiaries must moreover ensure that any cooperation with entities established in countries which are not eligible countries or target countries set out in the call conditions (or, if applicable, are controlled by such countries or entities from such countries) does not affect the strategic assets, interests, autonomy or security of the EU and its Member States.

Specific rules for MSCA actions

When implementing MSCA Doctoral Networks (DN), Postdoctoral Fellowships (PF) and COFUND actions, the beneficiaries must respect the following conditions:

- take all measures to implement the principles set out in the Commission Recommendation on the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers[3] and ensure that the researchers and all participants involved in the action are aware of them

- ensure that the researchers enjoy at the place of the implementation at least the same standards and working conditions as those applicable to local researchers holding a similar position

- ensure that the employment contract, other direct contract or fixed-amount-fellowship agreement (see Article 6) specifies:

    - the name of the supervisor(s) for the research training activities

    - the starting date and duration of the research training activities

    - the monthly support for the researcher under this Agreement (in euro and, if relevant, in the currency in which the remuneration is paid)

    - the obligation of the researcher to work exclusively for the action, unless part-time for professional reasons is allowed and has been approved (and for MSCA-DN and MSCA-PF: not to receive, for activities carried out in the frame of the action, other incomes than those received from the beneficiary or other entities mentioned in Annex 1)

    - the working pattern of the researcher

    - the arrangements related to the intellectual property rights (during implementation of the action and afterwards), in particular full access — on

[3] Commission Recommendation 2005/251/EC of 11 March 2005 on the European Charter for Researchers and on a Code of Conduct for the Recruitment of Researchers (OJ L 75, 22.3.2005, p. 67).

a royalty-free basis — for the researcher to background and results needed for their activities under the action

- the obligation of the researcher to inform as soon as possible about events or circumstances likely to affect the implementation of the action or the compliance with requirements under the Agreement (see Article 19)
- the obligation of the researcher to maintain confidentiality (see Article 13)
- the obligation of the researcher to ensure the visibility of EU funding in communications or publications and in applications for the protection of results (see Articles 17)
- where set out in the call conditions, the obligation of the researcher to carry out a mandatory return period of 12 months

- assist the researchers in the administrative procedures related to the recruitment
- inform the researchers about:
  - the description, conditions, location and timetable for the implementation of the research training activities
  - the rights and obligations toward the researchers under this Agreement
  - the obligation of the researchers to complete and submit — at the end of the research training activities — the evaluation questionnaire and — two years later — follow-up questionnaire provided by the granting authority
- ensure full access — on a royalty-free basis — for the researchers to background and results needed for their activities under the action
- ensure that the researchers do not have to bear any costs for the implementation of the action as described in Annex 1
- provide training and the necessary means for implementing the action (or ensure that such training and means are provided by other participants in the action)
- ensure that the researchers are adequately supervised and receive appropriate career guidance
- ensure that personalised career development plans are established, support their implementation and update in view of the needs of the researchers
- ensure an appropriate exposure to the non-academic sector (if applicable)
- respect the maximum limit for secondments set out in the call conditions
- respect the conditions for the outgoing and return phases set out in the call conditions (if any)
- ensure that the researchers are informed that they are 'Marie Skłodowska-Curie fellows'
- for MSCA-DN and MSCA-COFUND:

- advertise and publish vacancies internationally, including on the web-sites requested by the granting authority, indicating the gross salary (not including employer's social contributions) to be offered to the researcher
- recruit the researchers, following an open, transparent, merit-based, impartial and equitable recruitment procedure (for postdoctoral programmes in MSCA-COFUND: with regular selection rounds and international peer review), on the basis of:
  - their scientific skills and the relevance of their research experience
  - the impact of the proposed training on the researcher's career
  - a fair gender representation (by promoting genuine equal access opportunities throughout the recruitment process)

  The selection committees must bring together diverse expertise, have an adequate gender balance and include members from different countries and with relevant experience to assess the candidates.
- ensure that no conflict of interest exists in or arises from the recruitment

- for MSCA-DN and MSCA-PF:
  - ensure that the researchers do not receive, for activities carried out in the frame of the action, other incomes than those received from the beneficiaries (or other entities mentioned in Annex 1)
  - host the researchers at their premises (or at the premises of other participants in the action)
- for MSCA-COFUND where doctoral or post-doctoral programmes are implemented as financial support to third parties through implementing partners:
  - ensure that the implementing partners comply with the same standards and procedures for implementing the research training activities, including the recruitment and working conditions for researchers, the specific rules for MSCA-COFUND actions and the specific rules on ethics and research integrity set out in Annex 5
  - implement effective monitoring and oversight arrangements towards the implementing partners, covering all aspects relating to the action
  - ensure effective and reliable reporting by the implementing partners, covering the activities implemented, information on indicators, as well as the legality and regularity of the expenditure claimed
  - ensure that the implementing partners provide that the bodies mentioned in Article 25 (e.g. granting authority, OLAF, Court of Auditors (ECA), etc.) can exercise their rights also towards the final recipients.

When implementing Horizon Europe MSCA Staff Exchanges (MSCA-SE), the beneficiaries must respect the following conditions:

- take all measures to implement the principles set out in the Commission Recommendation on the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers[4] and ensure that the seconded staff and all participants involved in the action are aware of them
- ensure that the seconded staff enjoys at the place of the implementation at least the same standards and working conditions as those applicable to local staff holding a similar position
- assist the seconded staff with the administrative procedures related to their secondment
- inform the seconded staff about:
  - the description, conditions, location and timetable for the implementation of the secondment
  - the rights and obligations of the beneficiary toward the seconded staff under this Agreement
  - the obligation of the seconded staff to complete and submit — at the end of the secondment — the evaluation questionnaire and — two years later — the follow-up questionnaire provided by the granting authority
  - the arrangements related to the intellectual property rights between the beneficiary and the seconded staff (during the secondment and afterwards), in particular full access — on a royalty-free basis — for the staff to background and results needed for their activities under the action
  - the obligation of the seconded staff to maintain confidentiality (see Article 13)
  - the obligation of the seconded staff to ensure the visibility of EU funding in communications or publications and in applications for the protection of results (see Article 17)
- ensure that the seconded staff do not have to bear any costs for the implementation of the action as described in Annex 1
- provide training and the necessary means for implementing the action (or ensure that such training and means are provided by other participants in the action)
- ensure that the seconded staff are adequately mentored
- ensure that the rights and obligations of the seconded staff remain unchanged during the secondment
- ensure full access — on a royalty-free basis — for the staff to background and results needed for their activities under the action

[4] Commission Recommendation 2005/251/EC of 11 March 2005 on the European Charter for Researchers and on a Code of Conduct for the Recruitment of Researchers (OJ L 75, 22.3.2005, p. 67).

- if appropriate, ensure that seconded staff are reintegrated after the secondment
- ensure that the seconded staff are covered by an adequate medical insurance scheme
- ensure that the seconded staff have the relevant expertise for the action
- use the top-up allowance (see Article 6) to contribute to the subsistence, accommodation and travel of the seconded staff.

Specific rules for ERA Fellowship actions

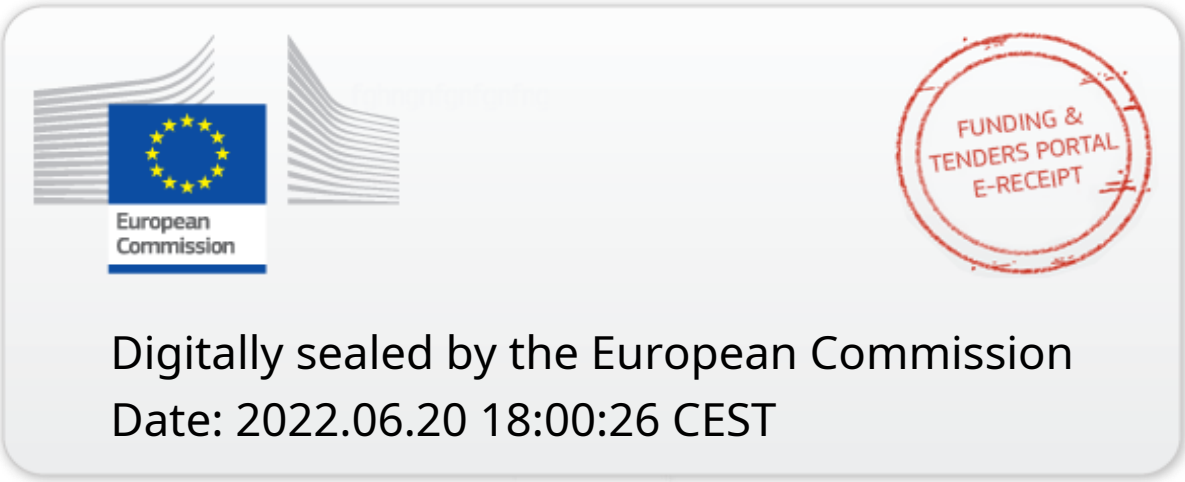
When implementing ERA Fellowships, the beneficiaries must respect the following conditions:

- take all measures to implement the principles set out in the Commission Recommendation on the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers[5] and ensure that the researchers and all participants involved in the action are aware of them
- ensure that the researchers enjoy at the place of the implementation at least the same standards and working conditions as those applicable to local researchers holding a similar position
- ensure that the employment contract, other direct contract or fixed-amount-fellowship agreement (see Article 6) specifies:
    - the name of the supervisor(s) for the research training activities
    - the starting date and duration of the research training activities
    - the monthly support for the researcher under this Agreement (in euro and, if relevant, in the currency in which the remuneration is paid)
    - the obligation of the researcher to work exclusively for the action, unless part-time for professional reasons is allowed and has been approved (and not to receive, for activities carried out in the frame of the action, other incomes than those received from the beneficiary or other entities mentioned in Annex 1)
    - the working pattern of the researcher
    - the arrangements related to the intellectual property rights (during implementation of the action and afterwards), in particular full access — on a royalty-free basis — for the researcher to background and results needed for their activities under the action

[5] Commission Recommendation 2005/251/EC of 11 March 2005 on the European Charter for Researchers and on a Code of Conduct for the Recruitment of Researchers (OJ L 75, 22.3.2005, p. 67).

  - the obligation of the researcher to inform as soon as possible about events or circumstances likely to affect the implementation of the action or the compliance with requirements under the Agreement (see Article 19)
  - the obligation of the researcher to maintain confidentiality (see Article 13)
  - the obligation of the researcher to ensure the visibility of EU funding in communications or publications and in applications for the protection of results (see Articles 17)
  - where set out in the call conditions, the obligation of the researcher to carry out a mandatory return period of 12 months
- assist the researchers in the administrative procedures related to the recruitment
- inform the researchers about:
  - the description, conditions, location and timetable for the implementation of the research training activities
  - the rights and obligations toward the researchers under this Agreement
  - the obligation of the researchers to complete and submit — at the end of the research training activities — the evaluation questionnaire and — two years later — follow-up questionnaire provided by the granting authority
- ensure full access — on a royalty-free basis — for the researchers to background and results needed for their activities under the action
- ensure that the researchers do not have to bear any costs for the implementation of the action as described in Annex 1
- provide training and the necessary means for implementing the action (or ensure that such training and means are provided by other participants in the action)
- ensure that the researchers are adequately supervised and receive appropriate career guidance
- ensure that personalised career development plans are established, support their implementation and update in view of the needs of the researchers
- ensure an appropriate exposure to the non-academic sector (if applicable)
- respect the maximum limit for secondments set out in the call conditions
- respect the conditions for the outgoing and return phases set out in the call conditions (if any)
- ensure that the researchers are informed that they are ‘ERA fellows’
- ensure that the researchers do not receive, for activities carried out in the frame of the action, other incomes than those received from the beneficiaries (or other entities mentioned in Annex 1)

- host the researchers at their premises (or at the premises of other participants in the action)



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