D5.1 Dissemination and exploitation

Revision: v.0.4

Work package	5
Task	5.1
Due date	31 May 2023
Submission date	02 June 2023
Deliverable lead	UNILU
Version	4
Authors	Zaira Ambu
Reviewers	Wallace ALVES MARTINS
Abstract	The main purpose of this deliverable is the provision of strategies for the dissemination, communication, and exploitation of the project results. Key aspects described in this deliverable are the communication of the project achievements to society, dissemination to targeted groups such as potential customers, industry players, and end-users, exploitation of project results to other peers and exchange of results with other Horizon Europe/DEP/CEF and national QCI initiatives such as LUQCIA. This is the first version of the document, as it has been planned that the interim and final versions of this report will be respectively produced by M15 and M30. This strategy is aligned with the project development as well as with the aim to further develop and improve the communication and dissemination of the project results.
Keywords	Dissemination & Communication, engagement strategies, exploitation of project results

Document Revision History

Version	Date	Description of change	List of contributor(s)
V0.1	24/05/2023	Description of the participation to international events added to the document	Wallace Alves Martins (UNILU)
V0.2	26/05/2023	- Table 2, Section 1.2, page 11: updated message/benefit column for first 3 entries: public authorities, large industry and SMEs;	Arash Atashpendar (ALab: itrust Abstractions Lab)
V0.3	31/05/2023	- Updated Table 3 Added exploitation description in section 1.4 for ITR, ALab items listed in Table 3	Heinrich Fries (ITR: itrust consulting)
V0.4	31/05/2023	- Revised Table 3 Revised exploitation description in Sect. 1.4	Arash Atashpendar (ALab)

DISCLAIMER

Co-funded by the European Union

LUX4QCI Luxembourg Experimental Network for Quantum Communication Infrastructure project has been co-funded by the Digital Programme under the Grant Agreement No. 101091508.

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

COPYRIGHT NOTICE

Project co-funded by the European Commission in the Horizon Europe Programme		
Nature of the deliverable:	**R**	
Dissemination Level		
PU	*Public, fully open, e.g. web (Deliverables flagged as public will be*	✓

	automatically published in CORDIS project's page)	
SEN	*Sensitive, limited under the conditions of the Grant Agreement*	
Classified R-UE/ EU-R	*EU RESTRICTED under the Commission Decision No2015/ 444*	
Classified C-UE/ EU-C	*EU CONFIDENTIAL under the Commission Decision No2015/ 444*	
Classified S-UE/ EU-S	*EU SECRET under the Commission Decision No2015/ 444*	

* R: Document, report (excluding the periodic and final reports)

DEM: Demonstrator, pilot, prototype, plan designs

DEC: Websites, patents filing, press & media actions, videos, etc.

DATA: Data sets, microdata, etc.

DMP: Data management plan

ETHICS: Deliverables related to ethics issues.

SECURITY: Deliverables related to security issues

OTHER: Software, technical diagram, algorithms, models, etc.

EXECUTIVE SUMMARY

The deliverable D5.1 Dissemination and exploitation describes the dissemination, communication and exploitation strategies of the project LUX4QCI aiming to increase awareness of the project results and engage stakeholders from public and private sectors towards maximised impact, business exploitation and expanded synergies, at national and EU levels. This includes the identification of communication and dissemination tools such as websites, posters, fliers, and channels such as conferences, industrial events, etc. Moreover, this deliverable will set the path for content creation in a common workflow with the partners as well as the collaboration plan with other national projects such as LUQCIA and at the international level with other Horizon Europe/DEP/CEF national QCI initiatives, as well as the promotion of activities in the context of EuroQCI events.

The communication and dissemination activities will be carried out taking into consideration national and European regulations on EU-RESTRICTED and SENSITIVE information, as the project has been classified as EU RESTRICTED, considering that, at proposal stage, it was mentioned that at least one project partner had already participated in a project that used or generated EU-classified information. Moreover, within the project framework, the deliverable "D6.1 Gap analysis and roadmap for alignment with the security baseline" has been classified as EU-RESTRICTED, while most of the deliverables have been classified as SENSITIVE information with security recommendation.

A list of target groups for communication and dissemination measures and channels has been already identified during the proposal preparation. This list has been further updated in this document. Additionally, during the project duration, possible new activities will be identified and added to the table in a continuous monitoring approach.

Moreover, the project will also be measured against its performance indicators some of which are strictly related to communication, dissemination, and exploitation activities. The relative indicators for the D5.1 activities have also been reported in this document and will be monitored. This document is a preliminary version, and during the project duration a further enhanced interim reporting version will be produced by M15 (D5.2, Impact creation report and initial exploitation plan), and a final version by M30 (D5.3, Final impact report, roadmap and exploitation plan).

TABLE OF CONTENTS

Table of Contents

LIST OF TABLES

ABBREVIATIONS

BE	Belgium
CEF	Connecting Europe Facility
C&D&E	Communication, Dissemination, and Exploitation plan
CY	Cyprus
DE	Germany
DEP	Digital Europe Programme
ESA	European Space Agency
EU	European Commission
EuroQCI	European Quantum Communication Infrastructure Infrastructure
GR	Greece
GRNET	NATIONAL INFRASTRUCTURES FOR RESEARCH AND TECHNOLOGY
HEU	Horizon Europe
IE	Ireland
INC	InCert G.I.E
ISM	Interdisciplinary Space Master
ITR	ITRUST CONSULTING SARL
LHoFT	Luxembourg's Fintech Innovation Hub
LCON	LuxConnect SA
LUQCIA	Luxembourg Qauntum Communication Infrastructure Laboratory)
LUX4QCI	Luxembourg Experimental Network for Quantum Communication Infrastructure European Space Agency
NL	the Netherlands
PSO	Project Security Officer
QCI	Quantum Communication infrastructure
QKD	Quantum Key Distribution
UNILU	University of Luxembourg

RES	FONDATION RESTENA
SAB	Security Advisory Board
SES	SES TECHCOM SA
SMC	MINISTERE D'ETAT

1 COMMUNICATION, DISSEMINATION AND EXPLOITATION AND TRAINING

Within the framework of the project LUX4QCI, the WP5 'Communication, dissemination, exploitation and training' aims to define and implement a comprehensive and effective set of dissemination and communication activities, to create awareness about project results and to stimulate engagement of private and public stakeholders; to create a community in order to foster interactions with other EU-funded projects and particularly other DEP (Digital Europe Programme), national QCI (Quantum Communication infrastructure) initiatives and for project development, scaling up, best-practice exchange and experience sharing; to monitor relevant certification/standardisation initiatives linked to the project; to create a roadmap for further development of the national QCI in the context of EuroQCI (European Quantum Communication Infrastructure); to facilitate exploitation of the project outcome and to promote the development of innovative solutions based on the project outputs both for partners and other EU (European Commission) players; to create and deliver a training curriculum for prospective QCI professional. In order to achieve these goals, the following tasks and related deliverables have been identified (Table 1).

Table 1: WP5 List of deliverables

Task No. & name	Deliverable No & name	Responsible partner	Type	Dissemination Level	Due Date (month number)	Description (including format and language)
T5.1 Dissemination and communication	D5.1 Dissemination and exploitation	UNILU	R	PU	M5	Planning the LuxQCI strategy for WP5 activities, including dissemination, liaison, community building, exploitation and training.(electronic /en/50)
T5.2 Liaison with other National, International and EuroQCI initiatives	D5.2 Impact creation report and initial exploitation plan	UNILU	R	PU	M15	Reporting existing achievements for WP5 activities and describing the exploitation plan, particularly the modalities of the third-party access framework for the LUX4QCI infrastructure. (electronic/en/70)
T5.3 Clustering and Exploitation Framework	D5.3 Final impact report, roadmap and exploitation plan	UNILU	R	PU	M30	Final report on the project achievements and future exploitation plan particularly in the context of follow-up EuroQCI

						activities (electronic/en/70)

1.1 COMMUNICATION, DISSEMINATION AND EXPLOITATION (C&D&E) PLAN OVERVIEW

As part of the WP5 deliverables, in this document the communication, dissemination, and exploitation plan (C&D&E) for the project LUX4QCI has been elaborated. The plan aims to ensure the proper dissemination of the project results taking into consideration the dissemination level (related to classified EU RESTRICTED and SENSITIVE information) and to guarantee that the activities carried out within this framework are reported and timely planned to ensure the full engagement of all the consortium members and the complete use of the potentials of the project to reach both scientific and non-scientific audiences.

In particular, the project consortium will play specific attention to the security issues and restriction on dissemination and communication of the EU RESTRICTED deliverable D6.1 Gap analysis and roadmap for alignment with the security baseline, and on the SENSITIVE classified deliverables:

- D1.1 Project management handbook
- D1.2 Data management plan
- D1.3 Report on participation to the EuroQCI initiative and on the collaboration with the other DIGITAL projects
- D2.1 Technical report on national use case and scenario selection,
- D2.2 Technical report on the consolidated set of requirements for the selected use cases
- D2.3 Technical report on the requirement definition for the system certification and accreditation
- D2.4 Technical Report on the specification of the physical security for certified and accredited trusted nodes
- D3.1 Technical report on System Architecture
- D3.2 Technical report on Network Topology
- D3.3 SDN/NFV-based network-level and system level simulator
- D3.4 Technical Report on the EAGLE-1 Emulator
- D3.5 Design Document of the Secure KMS
- D3.6 Software Design Document of Secure KMS
- D3.7 Secure KMS Design Validation Report

- D3.8 Technical Report on Security Analysis of Selected Architectural Elements
- D4.1 Market vendor analysis for suppliers of Quantum-Enabled Secure Networking Components
- D4.2 Report on site survey results and field deployment plan for trusted nodes and dark fibre,
- D4.3 Characterization of deployed dark fibre between selected trusted nodes
- D4.4 QKD Measurement Campaign and Demonstration
- D4.5 Final Lux4QCI Physical Infrastructure: Description, Characterization, Roadmap).

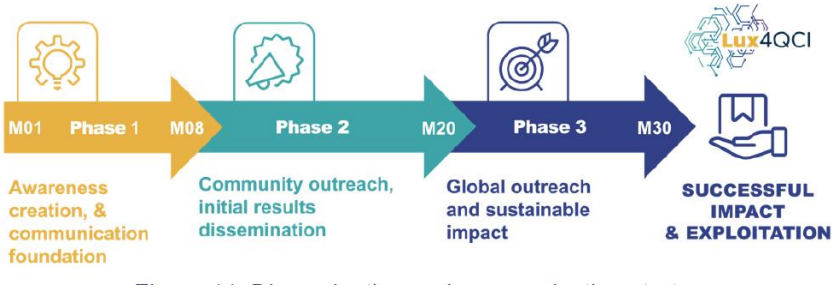
The main objectives of the plan are:

- Ensure broad visibility and raise awareness about LUX4QCI, spreading knowledge about the project and its results
- Reach, stimulate and engage a critical mass of stakeholders from the various domains of intervention to ensure that LUX4QCI results are effectively showcased, leading to validation, expansion, and improvement
- Facilitate the exploitation of the project's outputs and their further adoption
- Foster impactful contribution to relevant scientific domains and standardisation bodies, as appropriate and relevant to the planned exploitation plans
- Ensure close coordination with relevant initiatives, research, standardisation working groups and bodies
- Ensure and promote contribution to policies as planned

The plan will be used as a tool to inform all relevant stakeholders about the project's scope and objectives; to define the liaisons and interaction mechanisms with relevant entities and players, including further actions supported by DEP, Horizon Europe, Connecting Europe Facility, ESA (European Space Agency), and other funding schemes and instruments. In order to achieve these results, the plan has been divided into the following phases (Fig.1):

- **Phase 1 Awareness creation and communication foundation:** this will take place from M01 until M08 and it will concern the design of the C&D&E strategy and plan, including detailed definitions and lists of target groups and selection of dedicated tools and community-building activities; to inform all relevant stakeholders about the project's scope and objectives; to define the liaisons and interaction mechanisms with relevant entities and players, including further actions supported by DEP, Horizon Europe, Connecting Europe Facility, ESA (European Space Agency), and other funding schemes and instruments
- **Phase 2 Community outreach, initial results dissemination:** This phase will last from M09 until M20 and it will aim to reach out to the main target stakeholders, generate interest in LUX4QCI and increase awareness of the target groups regarding the first project results, development and deployment activities, as well as to foster active collaboration with other outbound national initiatives

- **Phase 3 Global outreach and sustainable impact:** from M21 until M30, the aim is to actively engage and support the adoption and deployment of the network, technologies, know-how and research concepts and achievements of the project through dedicated promotional activities



1.2TARGETED AUDIENCE AND CHANNELS

Already at the proposal stage a detailed definition and list of target groups and selection of dedicated tools and community-building activities have been created (Table 2). This list, within the framework of the C&D&E strategy phase 1, will be updated by the consortium and a new list will be provided by the end of M08.

Table 2 List of targets groups, measures and channels

Target groups	Message / benefit	Measures / Channels
Public authorities / policy makers	Government and institutional entities are among the main targeted end-users of the intended QCI network. They will directly benefit from the expected enhanced cybersecurity delivered by LUX4QCI. Such benefits include the use of novel solutions for quantum-secure communication and the possibility to get acquainted with quantum communication technology in preparation for future, more sophisticated, developments.	Specific regular meetings / Workshops with public authorities concerned by LUXQCI initiative (including SMC involved in the Consortium and ANS in the Advisory Board) in order to evaluate, adjust project activities, involve strategic stakeholders and beneficiaries, etc. Development of specific communication actions (policy briefs, factsheets, etc) towards industrial community (social media, website, specific press, etc)
Large Industry	Data-centres (e.g. LuxConnect), health industry, communications industry (e.g. SES, POST), and banking industry (e.g. FinTech UNILU partners) are examples of large industries that are also targeted as end-users of the intended QCI network. Therefore, they will benefit from the	Involvement in the experimentation phase, engagement in project meetings, events, workshops; development of specific communication actions towards industrial community (social media, website, specific press targeting industry); professional training

	innovation results brought by LUX4QCI in the cybersecurity domain, e.g., for securing direct data-exchange communication lines between data centres having specific security requirements that could be satisfied via solutions envisioned within LUX4QCI.	
Start-ups / SMEs	Start-ups / SMEs within the Luxembourg cybersecurity ecosystem will benefit from an open testbed to validate their innovation within the quantum technology domain. Those actors will have access to expensive high-end equipment/infrastructure without the burden to build their own e.g., thereby, allowing them to experiment with and test prototypes that can interface with LUX4QCI key provision services.	Involvement in the experimentation phase through the third-party access framework, engagement in project meetings, events, workshops; development of specific communication actions towards the industrial community. Support on national business intermediaries such as incubators and clusters (e.g., Luxinnovation, LHoFT - Luxembourg's Fintech Innovation Hub, etc.) for communication actions; professional training
Academy / public research	Academia and research centres will leverage the lessons learned and results developed within LUX4QCI to produce innovative research in QKD networks and train the next generation of QCI engineers	Participation and presentation at technology/industrial events, publications in scientific journals/magazines, targeted communications, online and offline presence and materials, project website, project workshops, presentations, newsletters, QCI training in postgraduate courses e.g. ISM (interdisciplinary space master).
Infrastructure providers	Providers of fibre-optics links will benefit from expected follow-ups of LUX4QCI to establish new PoPs throughout the country and enable an efficient multiplexing of QKD (Quantum Key Distribution) and conventional carriers over a common fibre medium	Engagement in project activities, events, workshops; development of specific communication actions towards infrastructure providers (social media, website, specific press targeting industry); professional training
National representatives of EuroQCI / National	They will benefit by knowledge exchange and collection of important information about best practices and approaches, increasing their awareness on the European and global challenges	Participation and presentation at technology/industrial events, publications in scientific journals/magazines, targeted communications, online and offline presence and materials, project website,

QCI networks	in QKD networks, and promote the research challenges, best practices and research topics for better design for the future. Promoting Luxembourg as a key member state for the satellite-QKD segment.	project workshops, presentations, newsletters
Similar / complementary actions (EUROQCI-QKD, Horizon Europe / DEP / CEF / ESA, etc.)	Lux4QCI will ultimately enhance the capabilities developed in the projects (e.g. LUQCIA Luxembourg Qauntum Communication Infrastructure Laboratory) funded by similar/complementary actions in terms of research, technical capabilities, and infrastructure	Dissemination via EuroQCI network with the support of SMC which is the national Sherpa representative at European level. Active participation in relevant events at national and European levels, cooperation with similar Consortiums funded by DEP HEU (Horizon Europe), CEF (Connecting Europe Facility) and ESA, etc.
Certification, standardisation, accreditation bodies	LUX4QCI partners and liaisons will look for participating actively to the relevant ongoing standardisation/accreditation efforts	Publications, participation and presentation in targeted events, newsletter, project website, social media, showcase events
Civil society	Citizens will benefit from the outcomes of the project in terms of innovation and consequent preparation for a more secure digital transformation of society	Press and media communications, publications in dedicated press, organisation of and participation at domain-focused events, newsletter campaigns, social media, project website, partners' communication channels, project presentation and flyer

1.3 COMMUNICATION AND DISSEMINATION MEANS

The project has established a set of communication and promotional tools. These tools will be used only to disseminate and communicate project results that have been classified as Public and/or have been approved by the SAB (Security Advisory Board) and PSO (Project Security Officer) after security evaluation. In particular, in relation to the envisioned tools to disseminate and communicate, the project will utilise:

- **LUX4QCI visual identity and promo kit**, comprising brand guidelines needed for all applicable online or offline channels and collaterals

- **LUX4QCI website** (www.lux4qci.eu): currently engaging in the procurement or the setup and management of the website. This tool will be used only to disseminate general information on the project, partners' participation, aims, and all the information and results

produced that have been classified as Public and have been allowed to be communicated widely after SAB and PSO security evaluation

- **PETRUS website:** within the framework of the EuroQCI networks, the project will be disseminated on the PETRUS website improving the visibility and allowing to connect to similar projects exchanging knowledge and knowhow

- **PETRUS network events:** within the framework of joint participation, LUX4QCI consortium will also take part in events organized by the PETRUS network on EuroQCI and QKD. In particular, the first event was held on the 11th of April 2023 for the NatQCIs representative to introduce the projects and the activities that will be carried out in each EuroQCI project creating a network. Within this framework further upcoming events are also foreseen such as on Education and communication for NatQCIs powered by PETRUS: PETRUS, as Coordination & Support Action, will offer a series of webinars for the NatQCIs projects. The objectives of these seminars are to:

    - Create and strengthen the EuroQCI community including Introduction to EuroQC, QKD Basics, Basic QKD network architecture, Standardization &Testing and validation.

    - Provide answers to urgent questions (Q&A session)

    - Prepare a common ground of vocabulary and basic understanding of EuroQCI

    - Continue the dialogue amongst the NatQCIs projects

- **Social media:** The project will communicate the established security safe information via the coordinator's Twitter and LinkedIn accounts. This will permit to build of a community around the project's work and activities that are not EU-RESTRICTED classified

- **Newsletter/newsflashes:** regular updates about the project's activities and work not related to EU-RESTRICTED information will be pushed out via a dedicated news channel hosted on the LUX4QCI website, and a dedicated newsletter will be issued every four months

- **Dedicated events (workshops, exhibitions, webinars):** to help increase the visibility of the developed technologies and trials, unrelated to EU-RESTRICTED information, showcasing achievements and promoting the increased deployment of LUX4QCI results. In particular, the following activities will be carried out:

    - In the framework of engagement of potential users, customers, and stakeholders, there will be three specific workshops where the consortium will be meeting with a selected group of organisations/entities to present the LUX4QCI project and to gather closer information on user needs and requirements. The workshops are expected to be organized to target specific sectors or industries

- **Press releases** in the project's and partners' communication channels and channels of liaised initiatives. In all the content, online and offline channels, and promotional material the EC communication and visibility rules will be followed

- **Online tools for educational purposes**: the use of novel tools (e.g., web applications) towards raising awareness and providing tool support for pedagogical efforts aimed at introducing a larger audience to quantum technology

- **Dedicated simulation software**: release of dedicated simulation software created by consortium partners, and corresponding press releases, aimed at potential end users who may benefit from such tools to better prepare for their migration to quantum-secure solutions by being able to map out, among other things, technological and integration requirements as well as expected performance.

The project has also envisioned a series of dissemination measures, which are:

- **Participation and organization of events and training activities:** LUX4QCI consortium will participate as well as organise different events and training activities in the form of webinars, workshops, demos, expert panels' discussions, and training will play a crucial role. The Consortium envisages organizing/participating in at least 20 workshops/sessions/ webinars pursuing co-location with related national and EU initiatives, including actions from DEP/Horizon Europe/CEF/ESA, etc. Planned activities include at least 2 events per year jointly organised with other liaised initiatives and the CSA funded under the same Call, 2 showcasing events presenting and demonstrating the project validation activities and achievements, 5 international collaboration workshops with the liaised national representatives of EuroQCI, 3 yearly training webinars/sessions, at least 2 requirement workshops (and interviews). In particular, the following concrete activities have been currently envisioned to be carried out to support the application of quantum technologies and to provide a better understanding of their value for different kinds of stakeholders:

    - **Training activities:** A beginner training course for specialists in the sector of communication engineering looking to build expertise in the quantum area will be offered via the Luxembourgish Digital Learning Hub. The training aims to explain the basic motivation of quantum communications and quantum computing, the basic working of quantum information systems as well as to identify the potential use-cases of these technologies and explain the current status of these technologies (more information on the training is available at the following link: Introduction to Quantum Computing and Communications - Digital Learning Hub (dlh.lu))

    - **Courses:** Quantum Communications and Quantum Key Distribution, this is a winter semester (2023/2024) course for university students as part of the Erasmus Mundus Joint Master in Cybersecurity (CYBERUS) that will be held by Prof. Symeon CHATZINOTAS together with Dr. Junaid UR REHMAN. The course is designed to familiarize the attendees with the framework of quantum communication systems, and it covers the following topics:

        - Review of linear algebra
        - Quantum states and their properties
        - Fundamental protocols of quantum communications, tools of quantum information theory, and basic treatment of noise in quantum systems
        - Quantum cryptography techniques, including quantum key distribution protocols, their implementations, and their analyses

- **International events:** the Consortium has already participated in two international events, namely:
    - The kick-off meeting of the Greek DEP project, called HellasQCI, took place on 19-20 January 2023. The meeting took place in Athens (hybrid mode of participation), at GRNET's headquarters. LUX4QCI was invited to present Luxembourg's plan for the DEP call, and after the presentations of Greece's and Ireland's plans, synergies were discussed. LUX4QCI was represented by Dr. Wallace ALVES MARTINS, who attended the meeting remotely
    - The DEP Call kick-off meeting, which took place on 24 January 2023, in Brussels (hybrid mode of participation). Each one of the granted DEP projects were allocated to a group, a total of 6 groups, and each group presented their national projects. Prof. Symeon CHATZINOTAS and Dr. Wallace ALVES MARTINS represented LUX4QCI and presented an overview of the project
- **Scientific/technology/industrial events:** Towards efficient dissemination and promotion of the project results the Consortium will have at least 5 participations/presentations in relevant events, such as OpenQKD Quantum Industry Board (QIB), EuroQCI Coordination and Support Action, ESA Workshops on Secure Satcom for Safety and Security ("4S"), GOVSATCOM, ISO JTC1 SC27 meetings, ICT Spring, LIST TechDay, ARCH Summit, Luxembourg Internet Days, Cybersecurity Week, IQT conference (https://iqtevent.com/). The Netherlands is also very active in organising Quantum events (https://quantumdelta.nl/events) which could be attended by the LUX4QCI partners. Additionally, the partner SMC can reach out to the other Sherpas in order to check whether they are organising national / international events. Another possibility to be further analysed is a closer collaboration with the LU DoD within this framework
- **Journals/magazines/press:** Publication in IEEE Transactions on Quantum Engineering (TQE), IEEE Quantum Education Summit, Progress of Theoretical and Experimental Physics, Quantum Information Processing, Quantum Science and Technology, GEANT Connect Magazine, OpenSpace magazine, press releases in SMC and other partners and liaised initiatives and national networks websites, and more
- **Online simulation tools**: inclusion of LUX4QCI specific features into the consortium members' existing simulation software allowing targeted end users to simulate various scenarios in an attempt to provide potential users with a better understanding of the foreseen results. Such simulation software could also facilitate the testing and integration of LUX4QCI prototypes.

1.4EXPLOITATION PLAN

In relation to the exploitation of the project results, close coordination, collaboration, synergies and liaisons with the EC, the various ongoing relevant initiatives under CEF/Horizon Europe/ESA/DEP, will be initiated taking also advantage of the already extended network of the partners participating actively in several relevant initiatives such as Quantum Technologies Flagship, OpenQKD, QTEDU, ISO, JTC1 SC27 WG3, ETSI QKD and more.

LUX4QCI contributes in a very concrete manner to the digital transformation primarily of Luxembourgish society but also of European society as a whole. Digital transformation is the key expression that summarises much of the efforts that public and private players have been putting into policies, strategic activities, and innovations to interconnect people, devices/machines, and things in general via communication networks. Through this, the society can greatly benefit from the existing computational power and the integration of artificial intelligence into virtually all processes where reasoning is demanded. We are all witnesses of how strong digital transformation can affect our daily lives. A case in point is the invention, followed by their widespread adoption, of smartphones; just think of the way people interact with them today, and all the applications and broadband mobile services that appeared (and continue to appear) sparked by such invention; and it is rather likely that this was just a minor transformation considering all the potential of what is to come: a real digital transformation. Of course, all of these efforts are made for the better of the society and for economic reasons, but along with great and powerful tools usually come on par threats. The clear trend is that almost all aspects of our lives will be highly virtualized (in a way that we can only have a glimpse today) and, therefore, extremely susceptible to cyber-attacks. Those societies that embrace digital transformation while accounting for all the associated threats will be clearly in the vanguard in terms of economic competitiveness and efficiency, as well as with respect to welfare. The EU wants to play a pivotal role in this regard and has set forth several policies and concrete initiatives to implement a reliable digital transformation. Luxembourg stands out as a country running several initiatives to play a central part in the EU's digital transformation.

It is precisely in this context that LUX4QCI finds its way to support Luxembourg's initiatives towards its digital transformation, which is in line with the EU's. More specifically, LUX4QCI will provide a real network testbed for quantum-enhanced secure communications, with demonstrated integration with operational communications networks, eventually strengthening the security and resilience of digital infrastructures in Luxembourg. In fact, at least two use cases and two test scenarios will be selected based on technical/business value and national relevance. This has the great potential of making an unprecedented impact on the current Luxembourg cybersecurity ecosystem, which counts over 300 organisations (private, public and civil sectors) that may directly benefit from an open testbed to validate their innovation within the quantum technology domain. Such a rich innovation-oriented environment may provide many products and services for a secure digital transformation for the betterment of society. In addition, LUX4QCI will work through bilateral cooperation with other national QCIs and multilaterally with EuroQCI to plan future concrete actions towards a European QCI. LUX4QCI will exchange design directions and lessons learned from the intended QCI deployment with a number of similar initiatives currently running in other EU Member States. In this context, LUX4QCI emulation of international connectivity via OGS (Optical Ground Station) interfaces towards already planned satellite assets, such as SES' EAGLE-1, will empower the society with the possibility to distribute quantum keys to farther remote regions. Another impact of paramount importance on society will come from Lux4QCI's intended educational support for Luxembourg professionals. More specifically, society will have access to theoretical and practical training on quantum communications. Thus, LUX4QCI will contribute to building trust in the digital world by making people aware of the benefits of this technology for the development of highly secure communication and data networks, by

introducing selected topics from this area in the related postgraduate and undergraduate courses in Luxembourg. A third-party access framework will be set up for national stakeholders outside the project consortium to engage in both training and joint experimentation activities. In fact, the project aims to use the testbed as demonstration pilot during the training activities, therefore creating a bridge between dissemination and exploitation of the project results.

A selection of the project results that will be exploited has been made (Table 3) and grouped based on expected overall project results, mechanisms, and targeted groups:

Table 3 Exploitation Table

Exploitable result	Description	TRL (beginning)	TRL (end)	Responsible partner	Exploitation mechanism	Target groups
Updated simulation SW	Simulation software developed and updated by ALab for educational purposes	3	4	ITR,ALab	Online web application that can be made available to the general public if deemed appropriate	All considered targeted groups
HSM-enhanced key storage and cryptographic processing	Deployment and testing of HSM interfacing with the LUX4QCI key provision service	3	4	ITR,ALab	HW+SW connected to LUX4QCI UEP	SMEs, public authorities, large industry, academia, infrastructure providers
Implementation of novel hybrid key exchange solution	A prototype implementation of hybrid key exchange developed within LUX4QCI	2	3-4	ITR,ALab	SW	All partners
Key Exchange on fibre with production payload	Setup and Proof that a single fibre can be used for QKD in parallel with	3	6	RESTENA	News Article/Publication	All considered target groups

	unrelated internet traffic					
EAGLE-1 emulator	The EAGLE-1 emulator can also be exploited as a tool to anticipate compatibility between EAGLE-1 and any other national QCI domain	N/A	N/A	SES	Generation of licenses to grant access to the emulator.	Member States can connect and test their national QCI with the EAGLE-1 emulator, a virtual EAGLE-1 QKD system, before they have establishe d their OGS
Secure KMS	The design of the Secure KMS, including the draft specification for one, and the result of the interaction between the Secure KMS and the terrestrial QKD infrastructur e will be exploited for the subsequent developmen t of LuxQCI	N/A	N/A	SES	Use of the generated information	Consortiu m
LUX4QCI network	The complete QCI network	N/A	N/A	UNILU	Complete or partial rental	Any stakeholde r entity,

	deployed is envisaged to be at disposal for testing and additional developmen t				of the infrastructure	potential users and customers
Test reports	The different test reports generated can also be exploited as evidence of the performance of the network in order to engage potential customers	N/A	N/A	SES - UNILU	Use of the generated information	Potential users and customers

Simulation software (ALab+ITR)

Depending on resource availability, the goal would be to design and develop a piece of QKD simulation software that would combine a customizable point-to-point full-stack QKD protocol simulator (based on the BB84 protocol), with Lux4QCI-specific features, e.g., the simulation of network-based QKD by incorporating network simulators such as Ns.

The intended exploitation of the QKD simulation software can be summarized as follows:

- In terms of dissemination, the developed QKD simulation software will be released as an online web-application to provide tool support for pedagogical efforts aimed at introducing a larger audience to quantum technology;
- In terms of user acquisition, the simulation software will be made available for potential end-users to prepare for the migration to quantum-secure solutions by being able to simulate various scenarios and using the results to map out, among other things, technological and integration requirements as well as expected performance;
- In terms of development, the simulation software could be used during the development of Lux4QCI systems to facilitate the testing and integration of prototypes.

HSM-enhanced key storage and cryptographic processing (ALab+ITR)

Hardware security modules (HSM) are hardware computing appliances aimed at protecting and managing cryptographic keys as well as performing various cryptographic operations. As part of the envisaged security concept for Lux4QCI, an integration of HSMs in the form of COTS into the architecture is foreseen. This would be to provide more sophisticated key storage and transfer mechanism.

Depending on resource availability and assuming that adequate HSMs are procured during the project lifetime in a timely manner, once the technical details of the security concept including an interfacing of Lux4QCI's key provisioning services with HSMs are fleshed out, various use case scenarios will be formulated that will revolve around the use of HSMs. Taking this concept into account, corresponding software will be developed by ALab and ITR that supports the deployment of HSMs within Lux4QCI.

itrust and ALab intend to exploit this for the acquisition of an HSM that can be integrated into Lux4QCI user endpoints. Furthermore, the developed hardware and software package can be installed at every user endpoint allowing potential end-users to use it.

Implementation of novel hybrid key exchange solutions (ALab+ITR)

Hybrid authenticated key exchange protocols combine keying material from different sources (post-quantum, classical, and QKD) to build protocols that are resilient to various types of failure which may be due to advances in quantum computing, implementation vulnerabilities, or our evolving understanding of the security of supposedly quantum-secure primitives. Such constructions represent viable candidates for initial deployment of post-quantum-secure cryptographic primitives as they hedge against undiscovered weaknesses.

As far as exploitation by ALab and ITR is concerned, the developed hybrid scheme will be disseminated via publications in relevant journals and conference and the developed software made available to consortium members and potentially released as open source.

Key exchange on fibre with production payload (RESTENA)

One of the cornerstones of the project is the proof that it is not required to provision dedicated fibre for the QKD links; but that instead existing fibre infrastructure can accommodate QKD traffic so long as several channels on the fibre are available. With this proof, the required investment for QKD becomes much smaller because existing infrastructure can be re-used. Restena Foundation will exploit the corresponding finding by communicating on all appropriate channels that this has been proven to work under relevant conditions, and that the option to encrypt payload traffic becomes available for its connected institutions using their existing fibre uplink.

EAGLE-1 emulator (SES)

The EAGLE-1 initiative is comprised of the following segments:

- Space Segment: The EAGLE-1 spacecraft and its payload
- Ground Segment: The ground infrastructure that is necessary to operate the EAGLE-1 satellite
- User Segment: Elements related to EAGLE-1 users
- Launch Segment: The launch vehicle and related elements

Since the national OGS will not be available during LUX4QCI project duration, SES will develop an EAGLE-1 emulator, whose main objective is to prepare for the deployment of QKD Ground Terminals by allowing to implement and test all ground Terminal interfaces. Furthermore, the EAGLE-1 emulator facilitates preparing the integration of the Ground Terminal in the User's infrastructure allowing to test the interaction with key management and to assess the expected

performance of the Eagle-1 service. This will be achieved by emulating the Eagle-1 specific QKD-Chain and Space Segment.

Therefore, the EAGLE-1 emulator has the potential to be exploited as an enabling technology for testing cross-border links to other national QCIs via OGS towards EAGLE-1 to be operated by SES. This will enable preliminary validation of space interfaces for the integration of terrestrial networks with satellite QKD.

Secure KMS (SES)

Deploying the physical infrastructure of QKD transceivers is just a first step towards an operational QCI. An important challenge also lies with the development and integration of the higher layers (e.g. SDN controllers, VNFs and KMS), which will enable the interconnection with operational networks and cryptographic applications. More specifically, this challenge includes the development of secure SDN signalling and intra-domain routing of key streams as well as the development of a secure KMS that offers all required QKD-specific and control & management functionalities to enable both intra-domain and inter-domain routing at a later point in time. SES will develop a secure KMS enabling the key generation and distribution over the integrated satellite and terrestrial segments using inter-domain key routing and mixed crypto-primitives. The resulting secure KMS will then be exploited by the Consortium for deploying and testing the networking aspects of QKD in LUX4QCI.

LUX4QCI network (UNILU)

As detailed in the initial paragraphs of this section, the resulting LUX4QCI network will provide a real network testbed for quantum-enhanced secure communications, with demonstrated integration with operational communications networks, eventually strengthening the security and resilience of digital infrastructures in Luxembourg. So, the deployed QCI infrastructure is expected to be exploited by the current Luxembourg cybersecurity ecosystem, which counts over 300 organisations (private, public and civil sectors) that may directly benefit from an open testbed to validate their innovation within the quantum technology domain.

Test reports (SES-UNILU)

All test reports and security analysis resulting from the project have the potential to be further exploited by potential users and costumers. Indeed, as QKD puts many operational constraints on the underlying network, it is not a straightforward task to go from laboratory or “clean”, i.e., single uninterrupted fibres, to a deployment in real life networks with multiplexers, spliced interruptions and other real-life operational hurdles; or with the need to establish links across administrative domains spanning over multiple trusted nodes. In this context, the test reports with the details of the studied QKD solutions in a production-grade telecommunications network, alongside existing traditional network operations, can also be exploited as evidence of the performance of the network in order to engage potential customers.

2 COMMUNICATION AND DISSEMINATION REPORTING & RELATED KPIS

The project will also keep track of the communication and dissemination activities. In particular in line with the continuous reporting of the EC portal. The following excel tables will be used to monitor the project progress on this regard (Table 4).

Table 4 Project continuous reporting dissemination activites

Project Continuous Reporting	
Dissemination activities	list the dissemination activities carried out in the context of the project including the one in the proposal and new ones

Name of the dissemination activity	when? date	what? tipe of dissemination activity (choose from drop-down menu)	who? Target audience (choose from drop-down menu)	How many? (number of participant/ n. audience reached)	why? Descripion of the objectives with refeence to a specific project output (maximum 200 characers)	additional comments

In relation to the dissemination activities (conferences, workshops, etc.) the monitoring will be focusing on the type of dissemination activities carried out or in which the consortium will participate, the number of addressed participants as well as the typology of audience that will be addressed.

Table 5 Project continuous reporting communication activities

Project continuous reporting	
Communication activities	Communication on projects is a strategically planned process that starts at the outset of the action and continues throughout its entire lifetime, aimed at promoting the action and its results. It requires strategic and targeted measures for communicating about (i) the action and (ii) its results to a multitude of audiences, including the media and the public and

	possibly engaging in a two-way exchange. List the communication activities carried out in the context of the project. Use the same labels used in your DEC plan.

Communication activitiy name	How? Communication channel (choose from drop-down menu)	who? Target audience (choose from drop-down menu)	How many? (n. audience reached)	outcome (specific key performance indicator)	Comments (add a short description of the communication activity carried out)

In relation to the communication activities, the monitoring will be therefore based on the typology of events that the consortium members will attend or organise, as well as the typology of communication channels (e.g publications, social media, etc.) the typology of the audience that will be a target and how many as well as the related KPIs. At the proposal stage, several KPIs have been identified to measure and monitor the impact of the project in relation to communication and dissemination of the project (Table 5).

Expected outcome	Relevant dissemination and communication KPIs
First deployed QKD experimental networks integrated and operating with existing communication networks in several Member States and addressing different advanced use cases, stimulating the emergence of a fully-fledged and technologically autonomous European quantum communication industry and contributing to preparations for the full deployment of the EuroQCI	**Number of national QCI networks (involved countries):** 6 (GR, CY, NL, IE, BE, DE) • This KPI reflects the fact that LUX4QCI has as Associated Partner one EU Member State, namely GR (through GRNET S.A.), which is also developing its own national QCI network. Besides it, LUX4QCI will liaise with the corresponding initiatives by CY, NL, IE, BE, and DE through a lighter mode of interaction, like bilateral coordination meetings, workshops, and discussion sessions aiming at cross-border

	connections. The Consortium has been already in touch with the relevant coordinators during the proposal preparation and agreed on the liaising modes, assuming the respective DEP proposals are successful.
	Number of organised liaison workshops: 2 • This KPI measures the minimum number of liaison workshops to be organised by LUX4QCI on top of any bilateral interactions with other EU Member States and national stakeholders. More specifically, LUX4QCI will organise one workshop for national stakeholders titled "QCI Capabilities and Services in Luxembourg" and one workshop with other EU Member States titled "The role of Luxembourg within EuroQCI".
A large number of trained users in quantum communication technologies and Member States ready for the design and deployment of next generation highly secure communication and data networks.	**Number of delivered QCI courses: 2** • This KPI reflects LUX4QCI intent to engage in a training curriculum under the UNILU leadership focusing on "Concepts of Quantum Physics", "Enabling Technologies", and "Quantum Communication" according to the structure of the European Competence Framework for Quantum Technologies (QTEdu). The curriculum will be available in two formats: Short (1 ECTS) and Long (3 ECTS). The short course will be more suitable for professionals who are just entering the quantum domain, while the long one would be addressed to graduates with some existing background on the topic. **Number of training demos: 2** • This KPI accompanies the QCI courses and aims at one demo for each type of course. The demos will be organised in sessions at UNILU premises (Luxembourg City and Belval), and visits will also be organised to other PoPs hosting the equipment to allow the audience to observe the specific demo.

	Number of trained users: 50 • This KPI also accompanies the QCI courses and reflects the expected demand for training in the quantum technology domain in Luxembourg in the coming years. It must be highlighted that this demand will tend to significantly increase once the planned quantum-related activities take off in the country.

These KPIs will be used to monitoring the project progress in relation to the communication and dissemination activities and will be adequately updated during the project duration.

3 CONCLUSIONS

The main output of Deliverable D5.1 is the LUX4QCI communication, dissemination, and exploitation plan (C&D&E).

Sections 2 and 3 describe the Communication and Dissemination strategy and preliminary plans also for the exploitation of the project results. This covers scientific/technical and industrial dissemination such as conference presentations and papers as well as broader communication mechanisms such as Branding/ logo, Website, social media, Newsletters. Also, conferences, workshops and dedicated trainings activities. This plan will be revised during the project duration, resulting in the development of an updated version by M15 and a final version by M30.

Co-funded by the European Union