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| **TSAG** |
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| **TD** |
| **Source:** | FG QIT4N Co-chairmen |
| **Title:** | Final report of the Focus Group on Quantum Information Technology for Networks (FG QIT4N) to TSAG |
| **Purpose:** | Information and action |
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| **Keywords:** | Report; FG QIT4N; TSAG; focus group; quantum information technology; |
| **Abstract:** | This document contains the final report of FG QIT4N to TSAG with proposals on the transfer of its deliverables to ITU-T SGs. |

**Action for TSAG:** TSAG is invited to review the outcomes of FG QIT4N, discuss further steps for QIT-related standardization in ITU-T and to decide on the transfer of the FG-QIT4N deliverables to ITU-T SGs, with consideration for FG-QIT4N’s proposal on their distribution below.

| **Deliverable** | **Text** | **Proposed SG(s)** |
| --- | --- | --- |
| D1.1 | QIT4N terminology: Network aspects of quantum information technologies  | ​[PDF](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Documents/D1.1.pdf)  | **13, 17** |
| D1.2 | QIT4N use cases: Network aspects of quantum information technologies | ​[PDF](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Documents/D1.2.pdf) | **11, 13, 15, 17**  |
| D1.4 | Standardization outlook and technology maturity: Network aspects of quantum information technologies | [PDF](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Documents/D1.4.pdf) | **ALL** |
| D2.1 | QIT4N terminology: Quantum key distribution network | [PDF](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Documents/D2.1.pdf)​ | **13, 17, 11** |
| D2.2 | QIT4N use cases: Quantum key distribution network | [PDF](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Documents/D2.2.pdf) | **13**, 17, 15, 11 |
| D2.3  | Quantum key distribution network protocols: Quantum layer | ​[PDF](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Documents/D2.3%20part%201.pdf) | **17**, 13, 11, 15 |
| D2.3 | Quantum key distribution network protocols: Key management layer, QKDN control layer and QKDN management layer  | ​[PDF](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Documents/D2.3%20part%202.pdf)​ | **11**, 13, 17, 2 |
| D2.4 | Quantum key distribution network transport technologies | ​[PDF](file:///C%3A/Users/makamara/Desktop/itu.int/en/ITU-T/focusgroups/qit4n/Documents/D2.4.pdf)  | **15** |
| D2.5 | Standardization outlook and technology maturity​​​: Quantum key distribution network​ | [PDF](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Documents/D2.5.pdf) | **ALL** |

# Introduction

The ITU-T Focus Group on quantum information technology for networks (FG QIT4N) was established by TSAG in September 2019 with an initial lifetime of 12 months from its first meeting (December 2019 - December 2020). The lifetime was extended by one additional year to December 2021 at TSAG’s September 2020 meeting (see [TSAG-R10](https://www.itu.int/md/T17-TSAG-R-0010/en)).

The objectives of FG QIT4N, as per the Terms of Reference (ToR, ref. TSAG-[TD632R3](https://www.itu.int/md/T17-TSAG-190923-TD-GEN-0632/en)), are:

– Considering evolution and applications of QIT for networks.

– The topics of study include:

* + telecom/network aspects of QKD networks that are identified in close coordination with ITU-T SG13 and SG17 as not within the scope of SG13 (QKD network architecture aspects) and SG17 (security aspects of QKD network and applications of QRNG for security).
	+ QIN technology and network evolution.

– The FG outputs will focus on terminology and use cases. The FG will reference relevant terminology defined in the pertinent ITU-T SGs. When necessary, the FG will liaise with the relevant SGs if terminology needs to evolve to take into account technology evolution.

– To provide necessary technical background information and collaborative conditions in order to effectively support QIN-related standardization work in ITU-T study groups.

– To provide an open cooperation platform with ITU-T study groups and other SDOs, including collaborative standardization work, co-located meetings, and workshop on quantum topic.

# Focus Group leadership and structure

The FG QIT4N management team was composed of three co-chairmen appointed by TSAG:

– Mr Alexey Borodin (PJSC “Rostelecom”, Russian Federation)

– Mr James Nagel (L3Harris Technologies, United States of America)

– Mr Qiang Zhang (University of Science and Technology of China (USTC), China)

and eight vice chairmen appointed by FG Membership at the first FG-QIT4N meeting:

– Mr Fahad Alduraibi (Communications and Information Technology Commission (CITC), Saudi Arabia)

– Mr Helmut Griesser (ADVA Optical Networking, Germany)

– Mr Kaoru Kenyoshi (National Institute of Information & Communications Technology (NICT), Japan)

– Mr Hyungsoo (Hans) Kim (KT Corporation, Korea (Rep. of))

– Mr Junsen Lai (China Academy of Information & Communications Technology (CAICT), China)

– Mr Jiajun Ma (QuantumCTek Co. Ltd., China)

– Mr Momtchil Peev (Huawei Technologies Duesseldorf GmbH (HWDU), Germany)

– Mr Dong-Hi Sim (SK Telecom (SKT), Korea (Rep. of))

FG QIT4N established **three** **working groups** with chairmanship as follows:

– Working Group 0 (WG0): Coordination committee under the co-chairmanship of the FG QIT4N co-chairmen

– Working Group 1 (WG1): Network aspects of QIT under the chairmanship of Mr Helmut Griesser (ADVA Optical Networking, Germany)

– Working Group 2 (WG2): Quantum key distribution networks (QKDN) under the chairmanship of Mr Zhangchao Ma (CAS Quantum Network, China)

# Summary of meetings and participation

FG QIT4N held one face-to-face meeting and ten virtual meetings since its establishment to progress the work on its deliverables, as summarized in Table 1.

To facilitate preparations for the FG QIT4N webinars, 10 joint WG0 and FG management team interim meetings were held. WG1 and WG2 each held 1 interim meeting to advance work on their deliverables.

As of 24 November 2021, the FG QIT4N list for general announcements (fgqit4n@lists.itu.int) had 222 subscribers (including 106 without TIES accounts). WG2 had 106 subscribers; followed by WG1 with 97 and WG0 with 75. By 24 November 2021, 203 messages were posted on the general announcements list; and the figures for the working groups were: WG0 (25); WG1 (51); WG2 (161).

**Table 1: Summary of FG QIT4N meetings and their participation**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Jinan, 9-10 December 2019** | **E-meeting, 18-20 Feb 2020** | **E-meeting, 20-30 Apr 2020** | **E-meeting, 15-26 Jun 2020** | **E-meeting, 27 July-7 Aug 2020** | **E-meeting, 26 Oct-6 Nov 2020** | **E-meeting, 25 Jan-5 Feb 2021** | **E-meeting, 10-21 May 2021** | **E-meeting, 9-20 Aug 2021** | **E-meeting, 15-22 Nov 2021** |
| **Host** | Jinan Institute of Quantum Technology (JIQT) | - | - | - | - | - | - | - | - | - |
| **Input documents** | [54](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/input/Forms/01.aspx)(including [5 LSi](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/liaison/Forms/01.aspx?View=%7b4F977A2E-7FED-4B98-B1E4-2F9435D52A2D%7d&FilterField1=Type_x0020_of_x0020_Liaison&FilterValue1=Incoming)) | [41](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/input/Forms/02.aspx) (including [4 LSi](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/liaison/Forms/02.aspx?View=%7b4F977A2E-7FED-4B98-B1E4-2F9435D52A2D%7d&FilterField1=Type%5Fx0020%5Fof%5Fx0020%5FLiaison&FilterValue1=Incoming)) | [46](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/input/Forms/03.aspx) (including [1 LSi](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/liaison/QIT4N-LSi-010.zip)) | [34](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/input/Forms/04.aspx) (including [2 LSi](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/liaison/Forms/04.aspx?View=%7b4F7388C1-2657-48D7-A88B-D3C39E4E8708%7d&FilterField1=Type%5Fx0020%5Fof%5Fx0020%5FLiaison&FilterValue1=Incoming)) | [30](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/input/Forms/05.aspx) | [22](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/input/Forms/06.aspx) (including [4 LSi](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/liaison/Forms/06.aspx)) | [18](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/input/Forms/07.aspx) (including [1 LSi](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/liaison/Forms/07.aspx)) | [22](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/input/Forms/08.aspx) (including [5 LSi](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/liaison/Forms/06.aspx)) | [25](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/input/Forms/09.aspx) (including [3 LSi](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/liaison/Forms/09.aspx)) | [34](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/input/Forms/10.aspx) (including [6 LSi](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/liaison/Forms/10.aspx)) |
| **Output documents** | [6](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/input/Forms/01.aspx) | [14](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/output/Forms/02.aspx) | [13](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/output/Forms/03.aspx) | [14](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/output/Forms/04.aspx) | [16](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/output/Forms/05.aspx) | [10](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/output/Forms/06.aspx) | [13](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/output/Forms/07.aspx) | [13](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/output/Forms/08.aspx) | [14](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/output/Forms/09.aspx) | [14](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/output/Forms/10.aspx) |
| **Meeting report** | [O-006](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/output/QIT4N-O-006.docx?d=w1f11fb4e6b4442f9b2c93d810a6e7f98) | [O-020](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/_layouts/15/WopiFrame.aspx?sourcedoc=%7B6F2508E9-0AD7-4AD2-A2A1-E3C64089BE02%7D&file=QIT4N-O-020.docx&action=default) | [O-033](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/_layouts/15/WopiFrame.aspx?sourcedoc=%7B84AEC5A3-7FA4-4775-B87C-61ED12E711AF%7D&file=QIT4N-O-033.docx&action=default) | [O-047](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/_layouts/15/WopiFrame.aspx?sourcedoc=%7B4F49D60B-C8A1-42ED-BA5E-B8320AB0F749%7D&file=QIT4N-O-047.docx&action=default) | [O-063](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/output/QIT4N-O-063) | [O-073](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/_layouts/15/WopiFrame.aspx?sourcedoc=%7B19BD331B-65E7-43C5-8041-0BB2C0416726%7D&file=QIT4N-O-073.docx&action=default) | [O-086](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/_layouts/15/WopiFrame.aspx?sourcedoc=%7b4925CF13-497F-4EE6-99A5-122B0B0D0C0E%7d&file=QIT4N-O-086.docx&action=default) | [O-099](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/_layouts/15/WopiFrame.aspx?sourcedoc=%7b337147BB-9D82-4249-B625-F1B0F2DE6E5F%7d&file=QIT4N-O-099.docx&action=default) | [O-113](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/_layouts/15/WopiFrame.aspx?sourcedoc=%7B6A4E0BAA-29FD-4D0E-A400-65E80A2B8379%7D&file=QIT4N-O-113.docx&action=default) | [O-127](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/_layouts/15/WopiFrame.aspx?sourcedoc=%7B49049C64-8887-4FD0-A10C-FB9D8A62A9B9%7D&file=QIT4N-O-127.docx&action=default) |
| **Total participants** | [109](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/output/QIT4N-O-005.pdf?d=wb2b087760bb74bbc8a0c884734e56e78) (including 10 remote) | [95](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/output/QIT4N-O-019.pdf) | [82](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/output/QIT4N-O-031.pdf) | [80](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/output/QIT4N-O-044.pdf) | [62](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/_layouts/15/WopiFrame.aspx?sourcedoc=%7B046E7A4A-E426-4E52-B84F-428D12A5869F%7D&file=QIT4N-O-061.docx&action=default) | [49](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/output/QIT4N-O-072.pdf) | [69](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/_layouts/15/WopiFrame.aspx?sourcedoc=%7b384CCAB1-073B-40F9-8F51-DCE5BC474744%7d&file=QIT4N-O-085.pdf&action=default) | [83](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/_layouts/15/WopiFrame.aspx?sourcedoc=%7b3F113AA7-7BB1-4D4C-B74B-68CE6CE7A8B9%7d&file=QIT4N-O-098.pdf&action=default) | [73](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/_layouts/15/WopiFrame.aspx?sourcedoc=%7B441EAB0F-7E08-4623-88D0-1B4E296CADDB%7D&file=QIT4N-O-111.pdf&action=default) | [88](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/_layouts/15/WopiFrame.aspx?sourcedoc=%7B15B91D39-5135-4A7C-9AEF-38F17B68769B%7D&file=QIT4N-O-125.pdf&action=default) |

The global COVID-19 pandemic disrupted the planning of the FG activities after its first meeting. In consultation with the FG management team and the host organizations, all FG QIT4N meetings after the second meeting were all conducted as e-meetings. The comparison between the early planned activities and those conducted is summarized in Table 2.

**Table 2: Comparison between planned FG QIT4N activities and activities conducted**

|  |  |  |
| --- | --- | --- |
|  | **ACTIVITIES PLANNED** | **ACTIVITIES CONDUCTED** |
|  | **Meeting dates** | **Host organization** | **Co-located events** | **Meeting dates** | **Co-located events** |
| **2** | **Riyadh,** **18-20 February 2020** | CITC, Saudi Arabia | Thematic workshop on QIT, 17 February 2020 | **E-meeting,** **13, 17-20 February; 28 and 31 March 2020** | - |
| **3** | **St. Petersburg, 20-23 April 2020** | PJSC “Rostelecom”, Russian Federation | Thematic workshop on QIT, 20 April 2020Joint meeting with ISO/IEC JTC 1 SC 27 | **E-meeting, 20-30 April 2020** | Joint meeting with ISO/IEC JTC 1 SC 27, 21 April 2020 |
| **4** | **London, 10-12 June 2020** | ETSI ISG QKD | Joint meeting with ETSI ISG QKD, 10 June 2020 | **E-meeting, 15-26 June and 3 July 2020** | Joint meeting with ETSI ISG QKD, 10 June 2020 |
| **5** | **Washington DC, 3-7 August 2020** | L3Harris Technologies, USA  | Thematic workshop on QITCo-location with IEEE (Not confirmed) | **E-meeting, 27 July - 7 August 2020** | - |
| **6** | **Japan, October 2020** | IRTF QIRG | Co-location with IRTF QIRG | **E-meeting, 26 October - 6 November 2020** | - |

To facilitate participation in the e-meetings, the following was considered in the organization of the e-meetings:

1) The FG QIT4N e-meetings were organized as a series of e-meeting sessions spanning several weeks in the case of the 2nd FG QIT4N meeting (13, 17-20 February; 28 and 31 March 2020) and spanning 2 weeks in the case of all subsequent meetings.

2) In the 2nd FG QIT4N meeting, a rotating time plan was adopted in attempt to strike a balance between late nights and early mornings amongst the meeting’s participants from the various regions represented. However, after the 2nd FG QIT4N meeting, all e-meetings were conducted between **15:00-17:30 CEST** (and **14:00-16:30 CET**) as this was deemed the most favourable in accommodating the time difference.

3) Priority was given to advancing the work on the FG QIT4N deliverables and on facilitating collaboration activities on QIT. In addition, a series of thematic webinars were organized in 2021 instead.

Meetings were announced via TSB Circular, the Focus Group website and email reflectors. Remote participation was offered for all meetings.

# Summary of webinars

To promote the ongoing work of FG QIT4N, a series of webinars covering various topics related to its work on quantum information technologies for networks were organized successfully since March 2021. These webinars collectively attracted over 1000 unique participants from 90 countries and brought great attention on the work of FG QIT4N amongst the QIT community. The respective links to the reports summarizing the webinar discussions and each webinar’s webpage (containing the recording, Q&A transcript, and presentation slides) can be found in Table 3.

**Table 3: Summary of FG QIT4N webinars and their participation**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Date** | **Title** | **Co-organizers** | **Viewership** | **Report** |
| 23 March  | [Joint Sy](https://www.itu.int/en/ITU-T/Workshops-and-Seminars/2021/0323/Pages/default.aspx)[mposium on Standards for Quantum Technologies](https://www.itu.int/en/ITU-T/Workshops-and-Seminars/2021/0323/Pages/default.aspx) | IEC and IEEE UK & Ireland Photonics Chapter | 438 unique viewers from 45 countries | [I-246](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/_layouts/15/WopiFrame.aspx?sourcedoc=%7B24E3766B-C6CD-4495-A177-110810B23A4B%7D&file=QIT4N-I-246.docx&action=default) |
| 8 April  | [Cybersecurity in the quantum era](https://www.itu.int/net4/wsis/forum/2021/Agenda/Session/266) (Held at the WSIS Forum 2021) | ETSI | 392 unique viewers from 57 countries  | [I-251](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/_layouts/15/WopiFrame.aspx?sourcedoc=%7BADBA6F61-859C-48DB-8ADA-1B9E006934F4%7D&file=QIT4N-I-251.docx&action=default) |
| 28 April  | [Joint Symposium on Quantum Transport Technology](https://www.itu.int/en/ITU-T/webinars/20210428/Pages/default.aspx) | IEC and IEEE UK & Ireland Photonics Chapter | 226 unique viewers from 49 countries  | [I-247](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/_layouts/15/WopiFrame.aspx?sourcedoc=%7BCCDB9BF0-AC42-4571-9875-58CE285796D5%7D&file=QIT4N-I-247.docx&action=default) |
| 26 May  | [Quantum Information Technologies (QIT) for networks – Use cases](https://www.itu.int/en/ITU-T/webinars/20210526/Pages/default.aspx) | - | 175 unique viewers from 31 countries | [I-264](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/_layouts/15/WopiFrame.aspx?sourcedoc=%7BB1E39025-570E-4540-8C36-DA3598182793%7D&file=QIT4N-I-264.docx&action=default) |
| 23 June  | [Harmonisation of Terminology in Standards for Quantum Technology](https://www.itu.int/en/ITU-T/webinars/20210623/Pages/default.aspx) | ETSI, IEC and IEEE UK & Ireland Photonics Chapter | 115 unique viewers from 37 countries | [I-265](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/_layouts/15/WopiFrame.aspx?sourcedoc=%7B960BD8FC-0EFC-431B-9D84-690630DBE3E2%7D&file=QIT4N-I-265.docx&action=default) |
| 2 November | [Joint Symposium on Quantum Photonic Integrated Circuits (QPICS)](http://itu.int/go/QIT-06) | IEC and IEEE UK & Ireland Quantum group & Photonics Chapter  | 124 unique viewers from 34 countries | [I-290](https://extranet.itu.int/sites/itu-t/focusgroups/qit4n/_layouts/15/WopiFrame.aspx?sourcedoc=%7BE2D5626C-6382-44FB-B964-BAFBFEF35773%7D&file=QIT4N-I-290.docx&action=default) |

The FG QIT4N management team appreciate the moderators, panellists, viewers, and all involved in the successful organization of the FG-QIT4N webinars, particularly the co-organizers from ETSI, IEC and the IEEE UK & Ireland Chapter for their valuable partnership.

# Summary of deliverables and their transfer to ITU-T Study Groups

FG QIT4N produced nine deliverables as summarized in Table 4 below.

**Table 4: Summary of FG QIT4N deliverables**

| **Ref.** | **Title** | **Description** | **Text** |
| --- | --- | --- | --- |
| D1.1 | Quantum information technology for networks terminology: Network aspects of quantum information technologies | Based on existing work of various Standards Development Organizations (SDOs) and academic literature, it surveys terminology on network aspects of quantum information technology, studies their overlap and divergence and provides a list of terms that are required but are yet to be standardized. Future efforts to standardize terminology on network aspects of quantum information technology could be informed by this technical report. | ​[PDF](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Documents/D1.1.pdf) |
| D1.2 | Quantum information technology for networks use cases: Network aspects of quantum information technologies | This Technical Report sorts and analyses QIT for network use cases gathered during the lifetime of the ITU-T FG QIT4N. The uses cases which are only applied by QITs are collected, investigated and summarized; all use cases are analysed by current bottlenecks, application scenarios, technical requirements and solutions. This Technical Report also provides analyses and suggestions for future applications and potential standardization requirements. | ​[PDF](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Documents/D1.2.pdf) |
| D1.4 | Standardization outlook and technology maturity: Network aspects of quantum information technologies | This Technical Report provides a snapshot of the standardization landscape of QIT for networks; prospects and barriers to the development and adoption of standards for QIT for networks; a review of methodologies for assessing technology maturity and standardization readiness of QIT for networks.This document studies the standardization outlook and technology maturity of quantum information technologies which either comprise or impact the requirements for a quantum information network (QIN), at the period of performance of the ITU-T FG QIT4N. | [PDF](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Documents/D1.4.pdf) |
| D2.1 | Quantum information technology for networks terminology: Quantum key distribution network | This technical report provides a survey of terminology relevant to QKDN currently published or under development by SDOs including ETSI ISG QKD, ISO/IEC JTC1 SC27 WG3 and ITU-T SG13/17. Based on the survey, the terms are categorized according to the specific technical directions they fall under. | [PDF](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Documents/D2.1.pdf)​ |
| D2.2 | Quantum information technology for networks use cases: Quantum key distribution network | This Technical Report consolidates the QKDN use cases gathered during the lifetime of the ITU-T FG QIT4N. The QKDN uses cases are classified into 6 classes and the report highlights the competitive advantage of the use cases brought by QKDN and provides suggestions for future standardization efforts. | [PDF](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Documents/D2.2.pdf) |
| D2.3  | Quantum key distribution network protocols: Quantum layer | This Technical Report studies and reviews protocols in the quantum layer of a QKDN. It mainly focuses on QKD protocols in the quantum layer, where QKD is an essential part of the QKDN and is an emerging technology expected to strengthen the security of the current communication network.This technical report endeavours to give an overall review of the QKD protocols, including different types of QKD protocols, their workflows, protocol features, parameters, commercialization status. For this reason, it briefly discusses the security of QKD, specifically the security of protocols in their relation to real world QKD systems. More generally, this technical report discusses the potential of integration of QKD in future networks and provides an overview of considerations and suggestions for future work on QKDN protocols. | ​[PDF](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Documents/D2.3%20part%201.pdf) |
| D2.3 | Quantum key distribution network protocols: Key management layer, QKDN control layer, and QKDN management layer | This Technical Report studies classical communication protocols in the QKDN which include protocols with respect to the key management layer, QKDN control layer, and QKDN management layer.The QKDN protocols are classified into different layers according to main functions of each layer. Representative operational procedures and corresponding message parameters are given for some protocols. | ​[PDF](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Documents/D2.3%20part%202.pdf) |
| D2.4 | Quantum key distribution network transport technologies | This Technical Report discusses QKDN transport technologies such as transport system components, technical solutions, the typical scenarios of the co-existence of quantum and classical signals in a common fibre (CEQC). Analysis about the impact of the classic optical light on the quantum signals is given. Furthermore, some CEQC schemes are shown in the document, both for DV-QKD system and CV-QKD. | ​[PDF](file:///C%3A/Users/makamara/Desktop/itu.int/en/ITU-T/focusgroups/qit4n/Documents/D2.4.pdf) |
| D2.5 | Standardization outlook and technology maturity​​​: Quantum key distribution network​ | This Technical Report provides an overview of quantum key distribution (QKD) technology, including frontier research, system experiment, field trial, and commercialized product. It conducts a summary of QKD industry status, including market players such as system vendor, network provider, and end user, project and opinions from different country and region, and other aspects. It also contains the QKD network standardization landscape, conducts gap analysis, and provides future standardization suggestions. | [PDF](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Documents/D2.5.pdf) |

At the time of this report’s submission, their pre-published versions were available in PDF format at: <https://www.itu.int/en/ITU-T/focusgroups/qit4n/Pages/default.aspx>.

FG QIT4N has taken note of the QIT-related standardization activities initiated by ITU-T Study Groups: especially, ITU-T Study Groups 13 and 17 which have established Questions dedicated to QIT within their respective mandates:

– Question 16/13, *Future Networks: Trustworthy and Quantum Enhanced Networking and Services*. Its terms of reference are available at: <https://www.itu.int/en/ITU-T/studygroups/2017-2020/13/Pages/q16.aspx>.

– Question 15/17, *Security for/by emerging technologies including quantum-based security*. Its terms of reference are available at: <https://www.itu.int/en/ITU-T/studygroups/2017-2020/17/Pages/q15.aspx>.

FG QIT4N has also taken note of the approved Recommendations by ITU-T Study Groups 13 and 17 and the various initiated work items in SGs 11, 13, 17 on QIT-related topics.

FG QIT4N deliverables have the potential to inform future work across multiple Study Groups i.e., deliverables D0.1, D1.4 and D2.5 are relevant to all Study Groups and all other deliverables except D2.4 are relevant to two or more Study Groups, see Table 5 which contains the distribution proposal of its deliverables for consideration by TSAG.

NOTE – In the ‘Proposed SG(s)’ column in Table 5, **bold** font indicates the SG(s) deemed as most relevant to a deliverable e.g., both SG13 and 17 of equal relevance to D1.1, SG13 of most relevance to D2.2 etc. SGs not indicated in bold font are listed in descending order of relevance.

**Table 5: Distribution proposal for the FG QIT4N deliverables**

| **Deliverable** | **Proposed SG(s)** |
| --- | --- |
| D0.1 | The journey and evolution of FG-QIT4N | **ALL** |
| D1.1 | Quantum information technology for networks terminology: Network aspects of quantum information technologies | **13, 17** |
| D1.2 | Quantum information technology for networks use cases: Network aspects of quantum information technologies | **11, 13, 15, 17** |
| D1.4 | Standardization outlook and technology maturity: Network aspects of quantum information technologies | **ALL** |
| D2.1 | Quantum information technology for networks terminology: Quantum key distribution network | **13, 17, 11** |
| D2.2 | Quantum information technology for networks use cases: Quantum key distribution network | **13**, 17, 15, 11 |
| D2.3  | Quantum key distribution network protocols: Quantum layer | **17**, 13, 11, 15 |
| D2.3 | Quantum key distribution network protocols: Key management layer, QKDN control layer, and QKDN management layer | **11**, 13, 17, 2 |
| D2.4 | Quantum key distribution network transport technologies | **15** |
| D2.5 | Standardization outlook and technology maturity: Quantum key distribution network | **ALL** |

With a view to maximize the benefit of the deliverables to ITU-T SGs, FG QIT4N organized a briefing session open to any/all (interested Study Groups) on 6 December 2021, upon interests expressed initially from SGs 11 and 13 and later also from Q15/17.

All FG-QIT4N deliverables were presented during the session and the suggested way forward for QIT-related standardization was discussed. Participants highly praised the presentations which summarized the key points of the deliverables as especially useful. The recording of this briefing session, all presentation material, and links to the deliverables are publicly available at: [https://www.itu.int/en/ITU-T/focusgroups/qit4n/Pages/SG11&13.aspx](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Pages/SG11%2613.aspx).

FG QIT4N welcomes any other ITU-T Study Groups to express their interest in having a similar briefing session or a dedicated session on any particular deliverable and requests them to kindly contact the FG Secretariat: tsbfgqit4n@itu.int with detailed proposals for such sessions, including potential dates/times, whether it should be held at SG level or Question level or on a specific deliverable(s), etc.

# Summary of relationships and interaction with other groups

As an open and collaborative platform on the pre-standardization aspects of QIT for networks, FG QIT4N established liaison relationships with relevant groups i.e., ITU-T Study Groups SG2, SG11, SG13, SG15 and SG17; ETSI ISG QKD, IEEE, ISO/IEC JTC 1/SC 27/WG3, ISO/IEC JTC 1/WG14, IETF/IRTF, CEN-CENELEC FG QT and IEC TC 86.

ETSI ISG QKD, ISO/IEC JTC1 SC27, ITU-T SG13 and SG17 presented their work on quantum information technology to the first meeting of the Focus Group. IEC TC86 and ISO/IEC JTC 1/WG14 also presented their work in the fifth and seventh FG QIT4N meetings respectively, outlining clear directions on potential topics of cooperation. The BSI UK BSI Quantum Technology Panel also presented their work during the ninth FG QIT4N meeting.

All FG QIT4N meetings have reviewed incoming liaison statements from the Collaboration on ITS Communication Standards (CITS), ITU-T Study Groups (2, 11, 13 and 17), ITU-T Focus Groups (FG AI4EE and FG ML5G) and external groups (ISO/IEC JTC 1/SC 27 WG3 & WG4 and ETSI ISG QKD).

FG QIT4N has taken note of the ongoing QIT-related standardization activities and work items across ITU-T Study Groups (11, 13 and 17) and has regularly reported its progress on its draft deliverables to all its liaison groups (ITU-T SG2, SG11, SG13, SG15 and SG17; ETSI ISG QKD, IEEE, ISO/IEC JTC 1/SC 27/WG3, ISO/IEC JTC 1/WG14, IEEE, IETF/IRTF, CEN-CENELEC FG QT, IEC TC 86).

To facilitate these liaison relationships, the following FG QIT4N representatives were appointed to act as liaison officers and represent FG QIT4N in their respective groups, summarized in Table 6.

**Table 6: List of FG QIT4N liaison officers**

| **Group** | **Representative** |
| --- | --- |
| ETSI ISG QKD | Mr. Momtchil PEEV (Huawei Technologies Duesseldorf GmbH (HWDU), Germany) |
| IEEE | Mr. James NAGEL (L3Harris Technologies, United States of America) |
| IEC TC 86 | Mr. Bernard LEE (Senko Advanced Components, Malaysia) |
| IETF/IRTF | Mr. Fred BAKER (Internet Systems Consortium (ISC), United States of America) |
| ISO/IEC JTC 1/SC 27 | Mr. Hao QIN (National University of Singapore (NUS), Singapore) |
| ITU-T SG11 | Mr. Kaoru KENYOSHI (NICT, Japan) |
| ITU-T SG13  | Mr. Zhangchao MA (CAS Quantum Network, China​​​) |
| ITU-T SG17  | Mr. Dong-Hi SIM​ (SK Telecom, Korea (Rep. of)) |

To foster cooperation on the development of topics related to QIT, FG QIT4N has leveraged its liaison relationships and successfully held two joint meetings with liaison groups as follows:

– **E-meeting, 21 April 2020:** Joint ITU-T FG QIT4N and ISO/IEC JTC1/SC27/WG3 meeting

– **E-meeting, 10 June 2020:** Joint ITU-T FG QIT4N/ETSI ISG QKD meeting on quantum information technology

As follow-up activities to the 21 April 2020 joint session with ISO/IEC JTC1 SC27/WG3, FG QIT4N has received three invitations to contribute to the development of the work item ISO/IEC 23837 (Security requirements, test and evaluation methods for quantum key distribution - Part 1: Requirements and Part 2: Test and evaluation methods) and has submitted comments to their draft standard for their consideration.

The joint meetings were well attended and areas of future coordination and cooperation with ISO/IEC JTC1 SC27 and ETSI ISG QKD were identified. Following the joint activities, active participation by experts from both groups was noted in FG QIT4N’s activities through their attendance in meetings and submission of inputs for discussion in FG QIT4N meetings.

FG-QIT4N has also effectively collaborated with external groups in the organization of the following joint webinars:

– **23 March 2021,** joint webinar with IEC and IEEE UK & Ireland Photonics Chapter

– **8 April 2021,** joint webinar with ETSI

– **28 April 2021,** joint webinar with IEC and IEEE UK & Ireland Photonics Chapter

– **23 June 2021,** joint webinar with ETSI, IEC and IEEE UK & Ireland Photonics Chapter

– **2 November 2021,** joint webinar with IEC, IEEE UK & Ireland Photonics Chapter and Quantum Group

Going forward, continued cooperation will be essential at the current stage of QIT-related standardization:

– From an “ITU-internal perspective”, further development of its deliverables and future QIT-related standardization in ITU-T will require a continued collaborative approach between the Study Groups after the termination of FG QIT4N.

– Externally, FG-QIT4N has established relationships with several SDOs and external groups working on QIT-related standardization and benefitted from the fruitful exchange of information and cross participation of delegates (in meetings and webinars) from CEN CENELEC FG QT, ETSI ISG QKD, IEC TC 86, IEEE, IRTF QIRG, ISO/IEC JTC/1 SC27 and ISO/IEC JTC 1/WG14. It is proposed to maintain and build on these existing relationships moving forward.

# Acknowledgements

The ITU-T FG QIT4N management team acknowledges the Working Group chairs, editors, contributors, liaison officers, the Jinan Institute of Quantum Information Technology for hosting the December 2019 meeting, all participants, and ITU-TSB staff Ms. Xiaoya Yang and Ms. Gillian Makamara for the Secretariat service they provided to this group. The work of the Focus Group would not have been possible without their contributions and commitment. See Appendix I for a list of all participants in the ten FG QIT4N meetings.

Despite the inability to hold physical meetings after December 2019, the FG QIT4N management team would also like to acknowledge the following institutions for their willingness to host FG QIT4N meetings: Communications and Information Technology Commission (CITC) in Riyadh, Saudi Arabia; PJSC “Rostelecom” in St. Petersburg, Russian Federation; ETSI ISG QKD in London, United Kingdom; L3Harris Technologies in Washington DC, United States and the IRTF QIRG in Japan.

# Action for TSAG

TSAG is invited to review the outcomes of FG QIT4N and discuss the efficient transfer of the deliverables and the further steps for QIT-related standardization in ITU-T.

# Appendix I – List of all participants in the ten FG QIT4N meetings[[1]](#footnote-2)

| **Name**  | **Entity**  | **Country**  |
| --- | --- | --- |
| ABO SEIDA Hassan | National Authority for Remote Sensing and Space Sciences | Egypt |
| AHMADZAI Gulshah | Ministry of Communication and Information Technology  | Afghanistan |
| AIHONG Tan | China Jiliang University | China |
| AL-ALI Jassim | Telecommunications Regulatory Authority (TRA) | United Arab Emirates |
| ALDURAIBI Fahad | Communications and Information Technology Commission (CITC) | Saudi Arabia  |
| ALJUNID Syed Abdullah | S-Fifteen Instruments Pte. Ltd. | Singapore |
| ALONSO Agustin | Autoridad Federal de Tecnologías de la Información y las Comunicaciones | Argentina |
| ALRUMAYH Muath | Communications and Information Technology Commission (CITC) | Saudi Arabia |
| ANWAR Khoirul | Ministry of Communications and Informatics | Indonesia |
| ARABI Junid | Afghanistan Telecom Regulatory Authority (ATRA) | Afghanistan |
| ARAVINDAKSHAN Jishnu | Telecommunications Standards Development Society, India (TSDSI) | India |
| ARLUNA Gustavo | Instituto Argention de Normalizac (IRAM) | Argentina |
| ARRIBAS Ismael | KUNFUD | Spain |
| AVELLANEDA Oscar | Innovation, Science and Economic Development Canada  | Canada |
| AVILA Domingo | NYCE SC | Mexico |
| AZIZ Muhammad Reza Kahar | Institut Teknologi Sumatera | Indonesia |
| AZUMA Mitsuhiro | Fujitsu Limited | Japan |
| BÄDER Uwe | Rohde & Schwarz GmbH & Co. KG | Germany |
| BADIMO Anna | SIGMATEQ | South Africa |
| BAKER Fred | Internet Society | United States |
| BAO Elisa Wensi | Deloitte | China |
| BEDINGTON Robert | SpeQtral | Singapore |
| BEI Bei | Beijing University of Posts and Telecommunications (BUPT) | China |
| BHANDARI Sundeep | National Physical Laboratory (NPL) | United Kingdom  |
| BORODIN Alexey | PJSC «Rostelecom» | Russian Federation |
| BRATT Emelie | British Standards Institution (BSI) | United Kingdom  |
| BRAY James | General Electric Company | United States |
| BRENNA Wilson | SED Systems | Canada |
| BRITO Juan | Universidad Politécnica de Madrid (UPM) | Spain |
| BUSH Stephen F | GE Research | United States |
| CANNIZZARO Giovanni | Telespazio S.p.A. | Italy |
| CARUGI Marco | KT Corporation | Korea (Rep. of) |
| CARVALHO Daniel | Florida Atlantic University | United States |
| CHA Daejoon | SK Telecom | Korea (Rep. of) |
| CHAIWONGKHOT Poompong | Mahidol University | Thailand |
| CHAKARI Aimal | Afghanistan Telecom Regulatory Authority (ATRA) | Afghanistan |
| CHALLENER Bill | GE Research | United States |
| CHEN Kai | University of Science and Technology of China (USTC) | China |
| CHEN Yu | China ​Academy of Information and Communications Technology (CAICT) | China |
| CHENG Ming | China Telecommunications Corporation | China |
| CHENGBIN Wu | ZTE Corporation | China |
| CHNG Brenda  | S-Fifteen Instruments Pte. Ltd. | Singapore |
| CHOE Howard | WSN Technologies | United States |
| CHOI Taesang | Electronics and Telecommunications Research Institute (ETRI) | Korea (Rep. of) |
| CHUGH Prashant | Centre for Development of Telematics | India |
| COHEN Ruben | VeriQloud | France |
| COLBECK Roger | University of York | United Kingdom |
| COULTER Marco | Inside Quantum Technology | United States |
| DANOU Liu | Jinan Institute of Quantum Technology (JIQT) | China |
| DARAHUGE Maria Elena | Universidad Kennedy | Argentina |
| DEEPA Deepa | Ministry of Communications | India |
| DHAVAMANI Vigneshwar | R. V. College of Engineering | India |
| DILMAHOMOD Waziim | Ministry of Information Technology, Communication and Innovation | Mauritius |
| DOOLAN Paul | Infinera Corporation | United States |
| DUBUISSON Olivier | Orange | France |
| DUTTA Indranil | Teledyne e2v | United Kingdom  |
| EDEAGU Samuel | University of Nigeria | Nigeria |
| EHLERS Désirée  | Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology | Austria |
| ELIASON Dale | Zenaciti Corporation | United States |
| FANG Fang | Beijing University of Posts and Telecommunications (BUPT) | China |
| FELDMAN Peter | Novum Industria LLC | United States |
| FERRARI Marco | Telespazio S.p.A.  | Italy |
| FRANCK Akobé | Autorité de Régulation des Télécommunications/TIC de Côte d'Ivoire (ARTCI) | Côte d'Ivoire |
| FRANTZ Terrill | Harrisburg University of Science and Technology | United States |
| FU Yuexia | China Mobile Communications Corporation | China |
| FUNG Fred | Huawei Technologies Co., Ltd. | China |
| GAO Yansong  | Independent expert | China |
| GARAY Maribel | Escuela de Postgrado Neumann | Peru |
| GARCES Maria Gragera | Cisco Systems, Inc. | United States |
| GAUTAM Suryash | Ministry of Communications | India |
| GAYFUTDINOV Eldar | PJSC «Rostelecom» | Russian Federation |
| GEESEY Abdulaziz | Independent expert |  |
| GENG Wei | Huawei Technologies Co., Ltd. | China |
| GIGRICH Jim | Keysight Technologies | United States |
| GODFREY James | evolutionQ | Canada |
| GOLDSTEIN Barbara | National Institute of Standards and Technology (NIST)  | United States |
| GONZÁLEZ Arellano | Universidad Kennedy | Argentina |
| González CARDOSO Juan  | Seguridata Privada, S. A. de C. V. | Mexico |
| GRAGERA GARCES Maria | Cisco Systems, Inc. | United States |
| GRAMMEL Gert | Juniper Networks | United States |
| GRIESSER Helmut | ADVA Optical Networking  | Germany |
| GRIFFIN Phillip | International Organization for Standardization (ISO) | Switzerland |
| GU Yuan | ZTE Corporation | China |
| GUBERMAN Andres  | Virgil Systems | Canada |
| HAMAD Heba | Ministry of Telecommunications & Information Technology | Palestine |
| HASEKIOĞLU Atilla | TUBITAK BİLGEM | Turkey |
| HAW Jing Yan | National University of Singapore (NUS) | Singapore |
| HE Wei | China Information Communication Technologies Group (CICT) | China |
| HE Zhixue | China Information Communication Technologies Group (CICT) | China |
| HONDA Mariko | Nippon Telegraph and Telephone Corporation (NTT) | Japan |
| HONG Tan Joo | ST Engineering | Singapore |
| HU Mengjun | Huawei Technologies Co., Ltd. | China |
| HU Xiao-long | Jinan Institute of Quantum Technology (JIQT) | China |
| HUANG Albert | National University of Singapore (NUS) | Singapore |
| HUANG Luyu | Beijing University of Posts and Telecommunications (BUPT) | China |
| HUANG Peng | Shanghai Jiao Tong University  | China |
| HUANG Qiang | Shenzhou Guoxin (Beijing) Quantum  | China |
| HUDOBIVNIK Alojz | Slovenian Institute for Standardization | Slovenia |
| IMANAKA Hideo | National Institute of Information and Communications Technology (NICT)  | Japan |
| INNE Anne-Rachel | American Registry for Internet Numbers (ARIN) | United States |
| JAMOUSSI Bilel | International Telecommunication Union (ITU) | - |
| JAUPI Orjola | Ministry of Infrastructure and Energy | Albania (Republic of) |
| JEE Eun Kyeong | International Telecommunication Union (ITU) | - |
| JIANG Cong | Jinan Institute of Quantum Technology (JIQT) | China |
| JIANG Haifeng | Computer Network Information Center of the Chinese Academy of Sciences | China |
| JIANG Yan | QuantumCTek Co., Ltd.  | China |
| JIANG Yangfan | University of Science and Technology of China (USTC) | China |
| JIANG Yu | China Telecommunications Corporation | China |
| JILLAVENKATESA Ajit | Cyber and International Communications and Information Policy (CIP) | United States |
| JIN Hua | HengTong Group | China |
| KAEWELL John | InterDigital | United States |
| KAI Naruki | Information Technology Promotion Agency | Japan |
| KAI Zhang | Independent expert | China |
| KALASUWAN Pruet | Prince of Songkla University | Thailand |
| KAPLAN Marc | VeriQloud | France |
| KARUNARATNE K | Qubitekk, Inc. | United States |
| KATOK Victor | State Service of Special Communications and Information Protection of Ukraine | Ukraine |
| KATSUBE Yasuhiro | Toshiba Corporation | Japan |
| KELLY Michael | Keysight Technologies | Germany |
| KENYOSHI Kaoru | National Institute of Information and Communications Technology (NICT)  | Japan |
| KHANENKOV Sergey | PJSC «Rostelecom» | Russian Federation |
| KHROMOVA Viktoriya | PJSC «Rostelecom» | Russian Federation |
| KIM Hans (Hyungsoo) | KT Corporation | Korea (Rep. of) |
| KIM JangMyun | SK Telecom | Korea (Rep. of) |
| KIM Sejin | Ministry of Science and ICT | Korea (Rep. of) |
| KLEINERT Moritz | Fraunhofer HHI & IIS | Germany |
| KLISH Cypryan | L3Harris Technologies | United States |
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| LAI Junsen | China Academy of Information and Communications Technology (CAICT) | China |
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| LEE Alex | Independent expert |  |
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| LEE Choon-Meng | Huawei Technologies Co. Ltd | China |
| LEE Gyu Myoung | Korea Advanced Institute of Science and Technology (KAIST) | Korea (Rep. of) |
| LEE Min Soo | KT Corporation | Korea (Rep. of) |
| LEWIS Adam Miles | European Commission | - |
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| LI Fang | Ministry of Industry and Information Technology (MIIT)  | China |
| LI Ming-Han | CAS Quantum Network Co. Ltd.  | China |
| LI Wuyi | QUDOOR | China |
| LI Xinyang | Beijing University of Posts and Telecommunications (BUPT) | China |
| LI Yalin | QuantumCTek Co., Ltd.  | China |
| LI Yongmin  | Shanxi University | China |
| LI Zhengyu | Huawei Technologies Co., Ltd. | China |
| LI Zhijie | International Telecommunication Union (ITU) | - |
| LICCHESI Victor | Radiall | France |
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| LIU Baojie | Independent expert | China |
| LIU Di | Huawei Technologies Co., Ltd. | China |
| LIU Fei | Huawei Technologies Co., Ltd. | China |
| LIU Hongwei | Beijing University of Posts and Telecommunications (BUPT) | China |
| LIU Jiang  | China Telecommunications Corporation | China |
| LIU Lu | China Institute of Information and Communication  | China |
| LIU Xing | Jinan Institute of Quantum Technology (JIQT) | China |
| LU Chuxian | Jinan Institute of Quantum Technology (JIQT) | China |
| LU Xiaoming  | Zhejiang Quantum Technologiies Co. Ltd. | China |
| LUNIN Anatoly | InfoTecs | Russian Federation |
| LUO Bin | ZTE Corporation | China |
| LV Bo | China Academy of Information and Communications Technology (CAICT) | China |
| LV Dingshun  | Huawei Technologies Co., Ltd. | China |
| MA Bingke  | China Mobile Communications Corporation  | China |
| MA Jiajun | QuantumCTek Co., Ltd | China |
| MA Shizhao | Jinan Institute of Quantum Technology (JIQT) | China |
| MA Xiongfeng  | Tsinghua University | China |
| MA Zhangchao | CAS Quantum Network Co. Ltd.  | China |
| MAKAMARA Gillian | International Telecommunication Union (ITU) | - |
| MANDICH Denis | Qrypt | United States |
| MARINELLI Veronica | Instituto Argention de Normalizac (IRAM) | Argentina |
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| MARYOPI Dick | Telkom University | Indonesia |
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| MCFADDEN Mark | Department for Digital, Culture, Media and Sport (DCMS) | United Kingdom  |
| MEERKHIL Ilyas | Afghanistan Telecom Regulatory Authority (ATRA) | Afghanistan |
| MEHROTRA Rakesh | ITU-APT Foundation of India  | India |
| MEKHTIEV El | Moscow Institute of Physics and Technology | Russian Federation |
| MENG Yao | Independent expert | China |
| MENON Mythili | International Telecommunication Union (ITU) | - |
| MONDE Judicael Vivien | Nokia Corporation | China |
| MONTESANTI Giuditta | European Commission | - |
| MURAKAMI Makoto | NTT Communications Corporation  | Japan |
| NAGEL James | L3Harris Technologies | United States |
| NAHAYO Jericho | Ministère de la Jeunesse, des Postes et des Technologies de l'Information | Burundi |
| NAJARIAN Paul | Cyber and International Communications and Information Policy (CIP)  | United States |
| NOORI Haroon Mohammad | Ministry of Communication and Information Technology (MCIT) | Afghanistan |
| OKAMURA Haruo | Global Plan Incorporated | Japan |
| ORTIZ Laura | Universidad Politécnica de Madrid (UPM) | Spain |
| OU Yanni | Nokia Bell Labs | Germany |
| PAGANELLI Rudi | CNR-IEIIT | Italy |
| PALLAN Madhavan | United Nations Research Institute for Social Development | - |
| PAPADOPOULOS Homer | National Center for Scientific Research Demokritos (NCSRD)  | Greece |
| PARK Joon-Shik | Korea Electronics Technology Institute | Korea (Rep. of) |
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| PEEV Momtchil | Huawei Technologies Duesseldorf GmbH (HWDU)  | Germany |
| PEREVALOV Alexey | PJSC «Rostelecom» | Russian Federation |
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| PITWON Richard | Resolute Photonics | United Kingdom  |
| PLATO Andrew | Zenaciti Corporation | United States |
| POPPE Andreas | Austrian Institute of Technology (AIT) | Austria |
| POULIN Luc | Cogentas  | Canada |
| PRABHAKAR Anil | IIT Madras | India |
| PRIIUTOV Aleksandr | QRate Limited Liability Company  | Russian Federation |
| PUMO Beth | Kaiser Permanente | United States |
| QI Wei | CAS Quantum Network Co. Ltd. | China |
| QI Xiaodong | Huawei Technologies Co., Ltd. | China |
| QIAN Heng  | International Organization for Standardization (ISO) | Switzerland |
| QIAN Yi | China Information Communication Technologies Group (CICT) | China |
| QIN Hao | National University of Singapore (NUS) | Singapore |
| QIN Jiqian | Independent expert | China |
| QUIST-APHETSI Kester | CRITAC | Ghana |
| RAM Vishnu OV | Independent consultant | India |
| RANNOW Randy | Silverdraft Supercomputing | United States |
| RAZGULYAEV Kirill | ITMO University | Russian Federation |
| RAZI Milad | Afghanistan Telecom Regulatory Authority (ATRA) | Afghanistan |
| REDWIN Paul | Department for Digital, Culture, Media and Sport (DCMS) | United Kingdom  |
| REZAZADA Nooria | Afghanistan Telecom Regulatory Authority (ATRA) | Afghanistan |
| ROOPCHAND Kaylin | Innovation, Science and Economic Development Canada | Canada |
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1. Includes remote and on-site participants of the FG QIT4N meetings and their affiliation at time of participation. [↑](#footnote-ref-2)