

# **Toshiba's activities in Quantum Technology Area and QKDN R&D and use-cases in Japan**

1. Toshiba's activities in Quantum Technology Area
2. QKDN R&D and use-cases in Japan

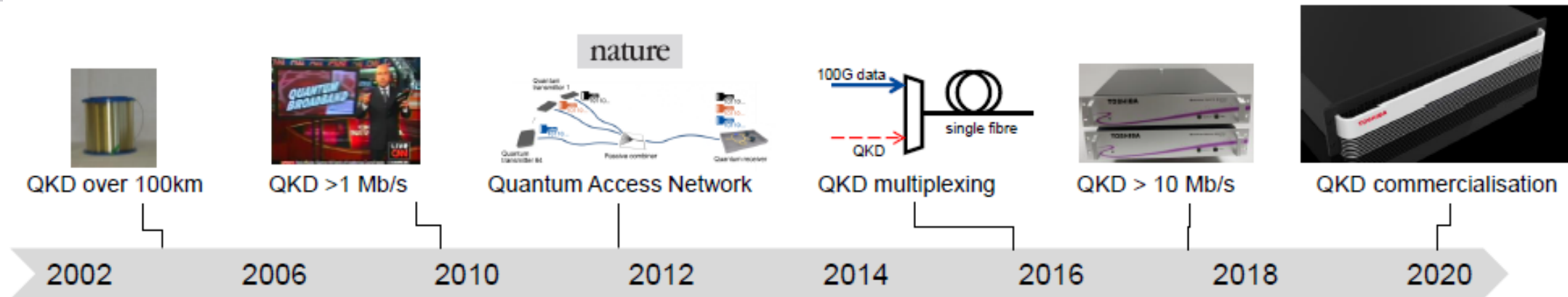
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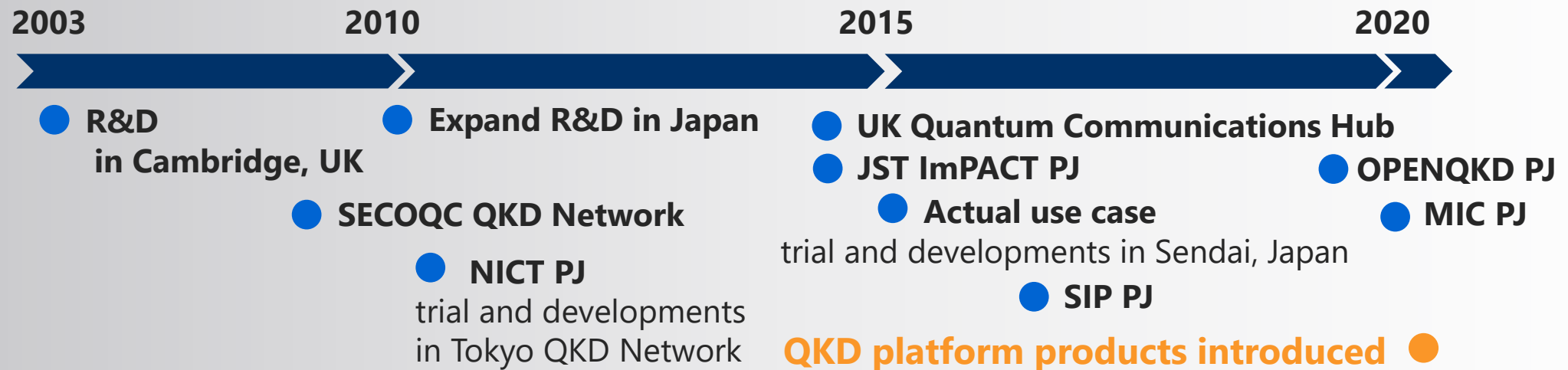
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# Toshiba at The Forefront of Quantum Technology R&D



## Toshiba QKD technologies on the courses of;



**Toshiba conducts Quantum Technology R&D, development, standardization, and trials.**

# QKD Platform Product Release (Oct., 2020)



Specifications	Long Distance (LD)	Multiplexed (MU)
Key Rate	300 kb/s @ 50 km	40 kb/s @ 50km
Range (ideal SM fibre)	120 km	70 km
Fibre Requirement	two fibres	one or two fibres
Multiplexing	-	multiplex data in C-band
Key Exchange Protocol	BB84 protocol with decoy states and phase encoding	
Security Parameter	key failure probability $< 10^{-10}$	
Detection Technology	proprietary self-differencing semiconductor detectors	
Dimensions	Standard 19" rack mount, 3U height	

## World Leading Performance



Highest secure  
key rates



Longest range



Operation on data  
carrying fibre



Auto set-up  
and alignment



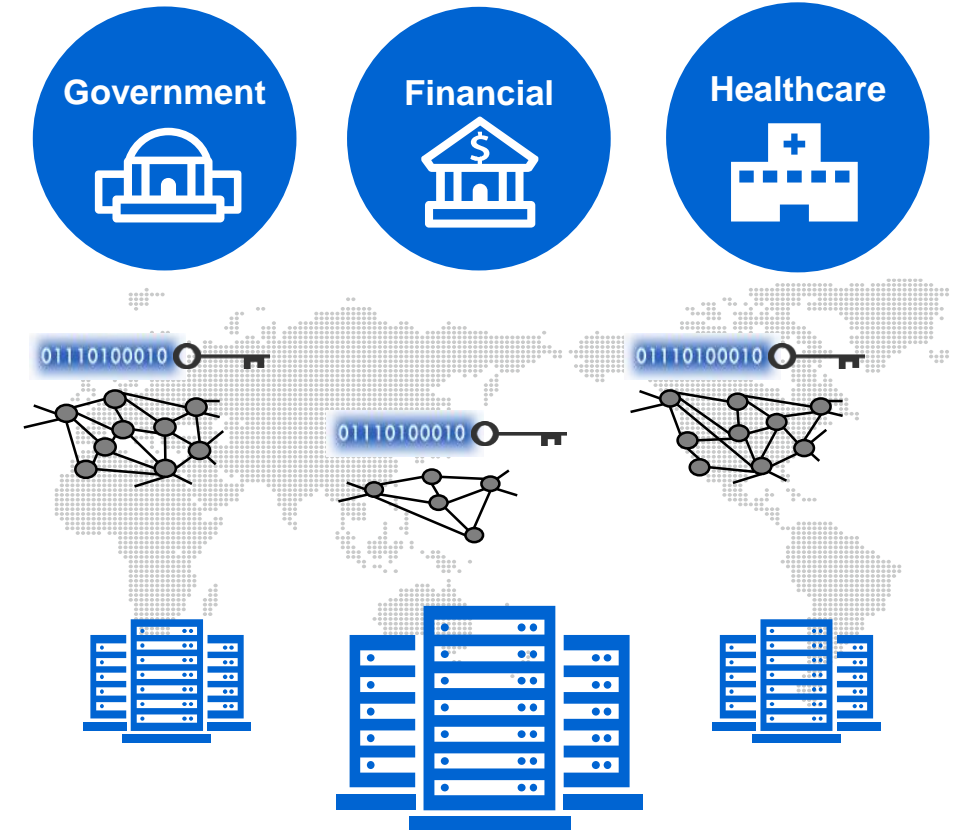
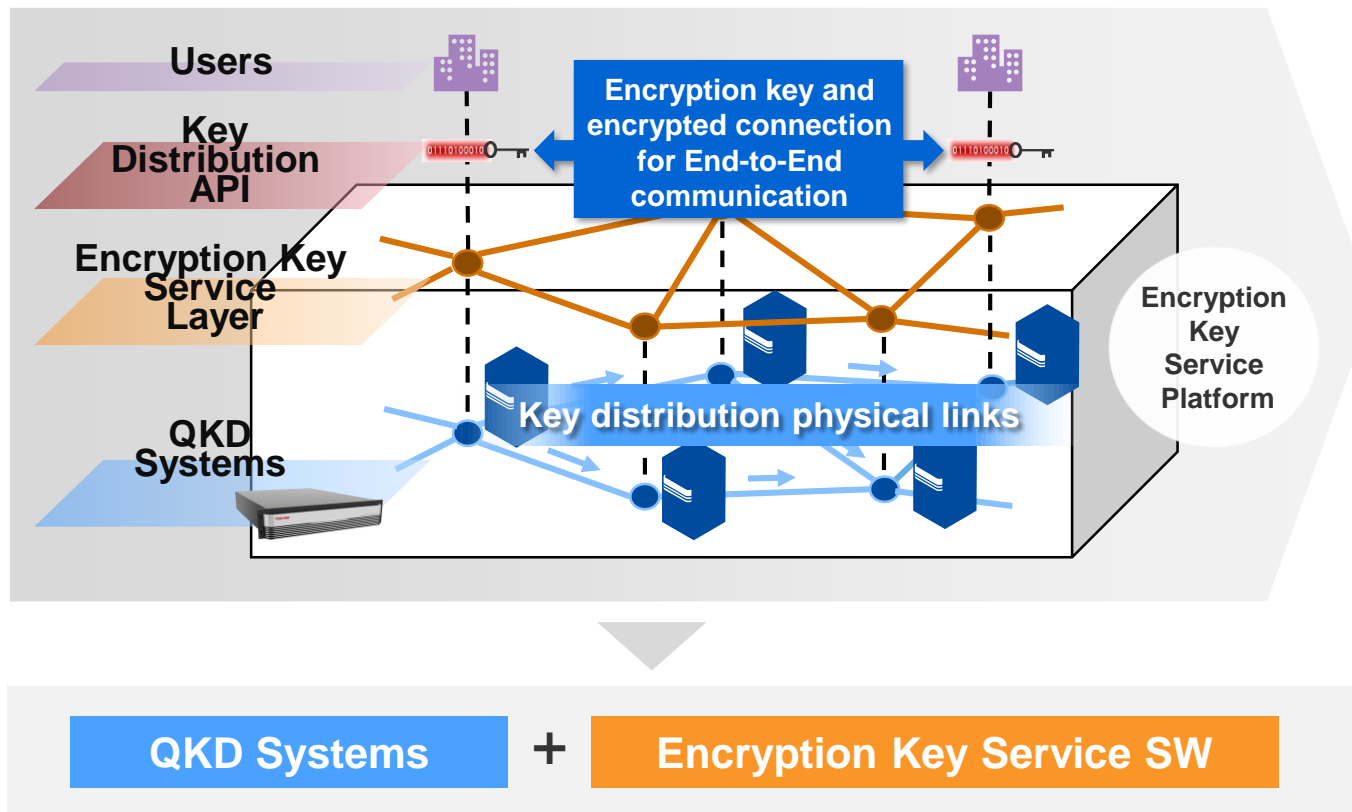
Integrated network  
key delivery



ETSI standardised  
interface

# QKD Service Platform – Future Release

## QKD service platform by Toshiba for regional QKD service providers



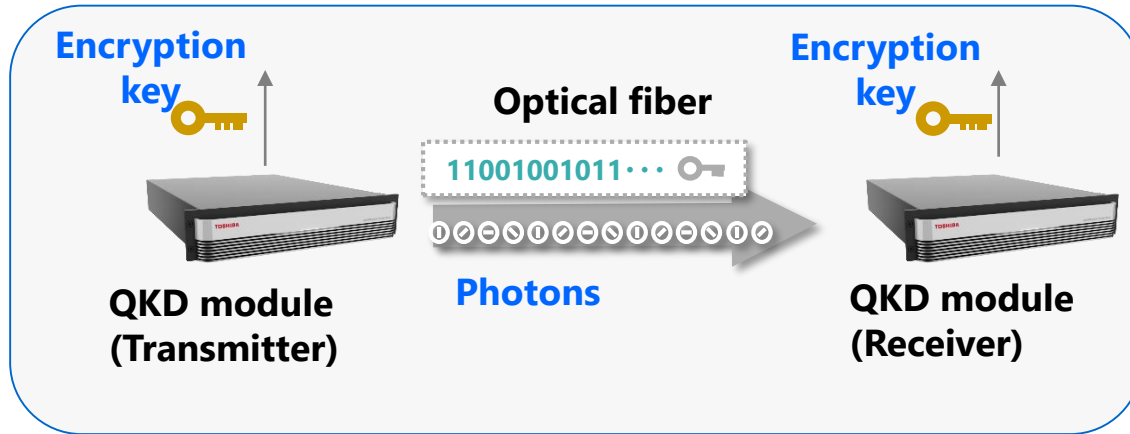
**Recruiting regional service partners**

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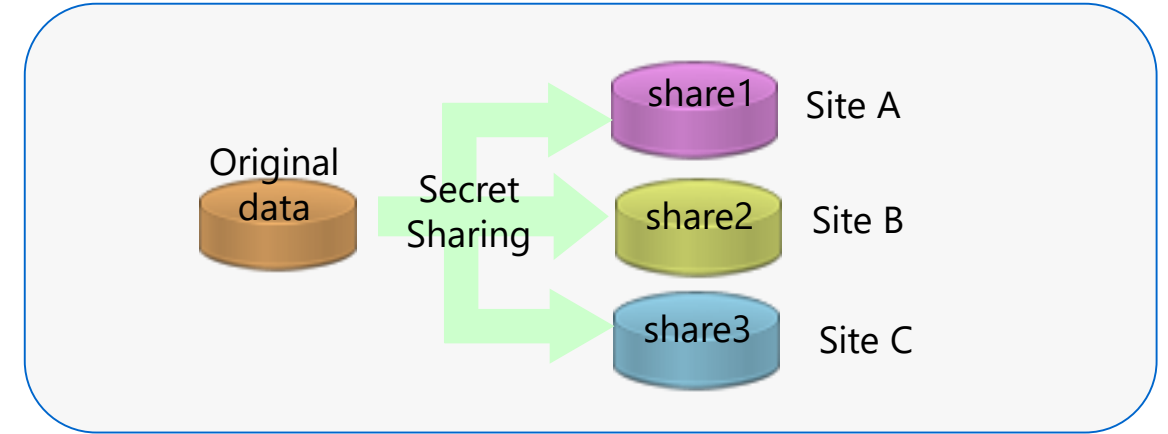
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# Quantum Secure Cloud



## Quantum Key Distribution

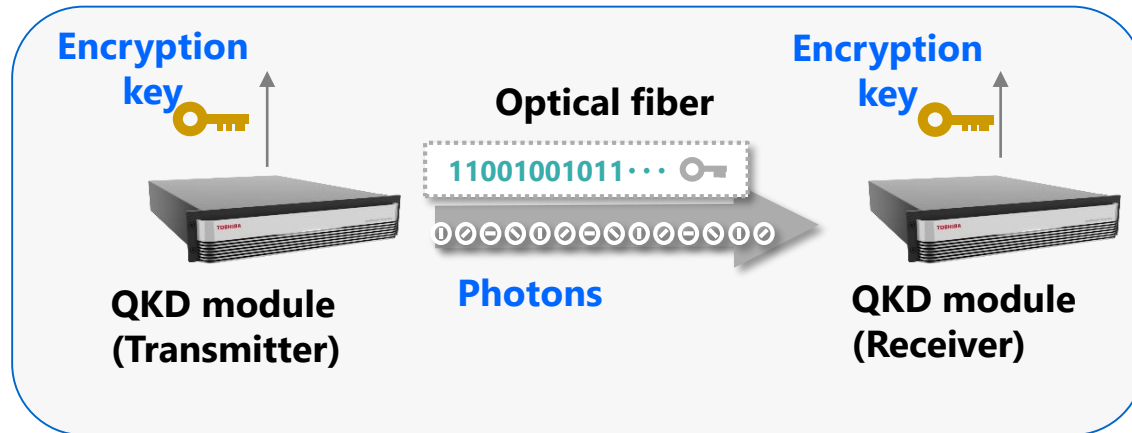
Information theoretic security  
for data transmission



## Secret Sharing

Information theoretic security  
for data storage

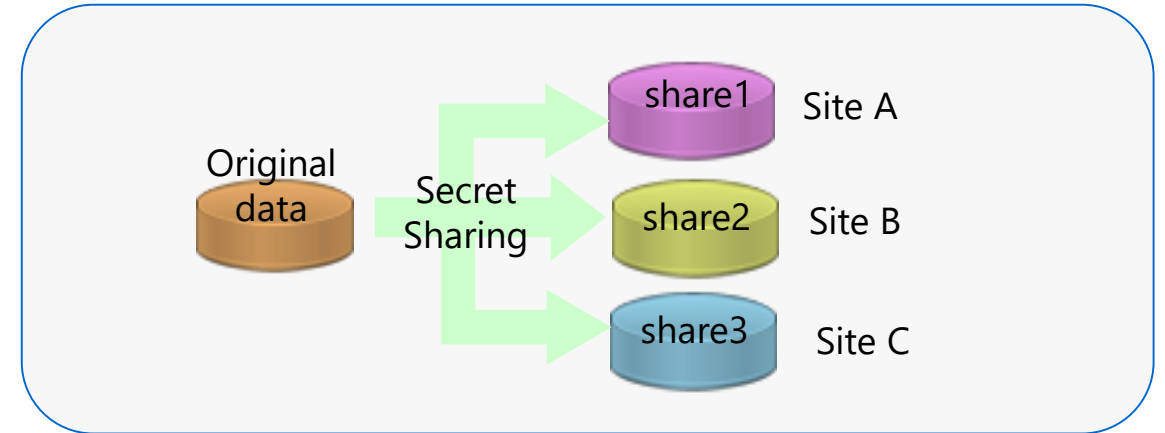
# Quantum Secure Cloud



## Quantum Key Distribution

Information theoretic security  
for data transmission

+



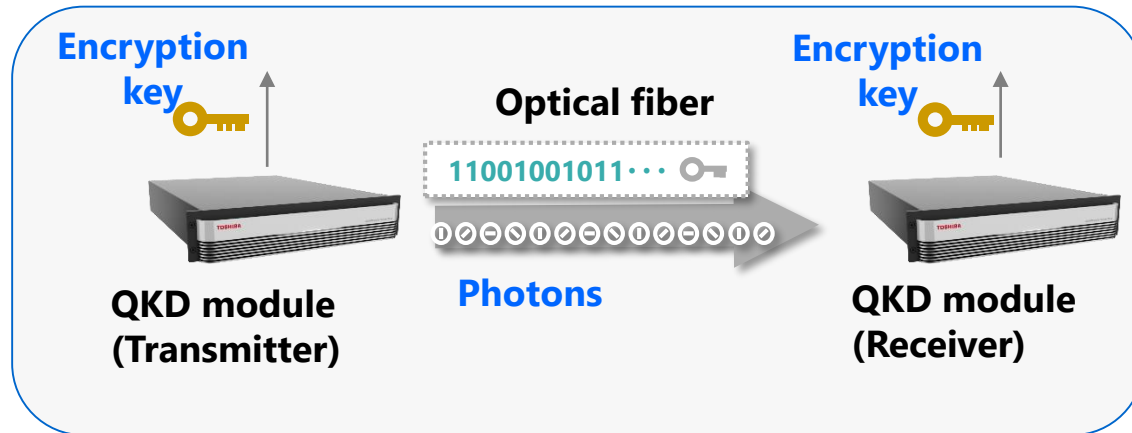
## Secret Sharing

Information theoretic security  
for data storage

- A technology for distributing data amongst a group of participants, each of whom is allocated a share of the data.
- The data can be reconstructed only when a sufficient number of shares are combined together.
- Individual shares are of no use on their own.
- It provides confidentiality and availability (redundant back up) of data

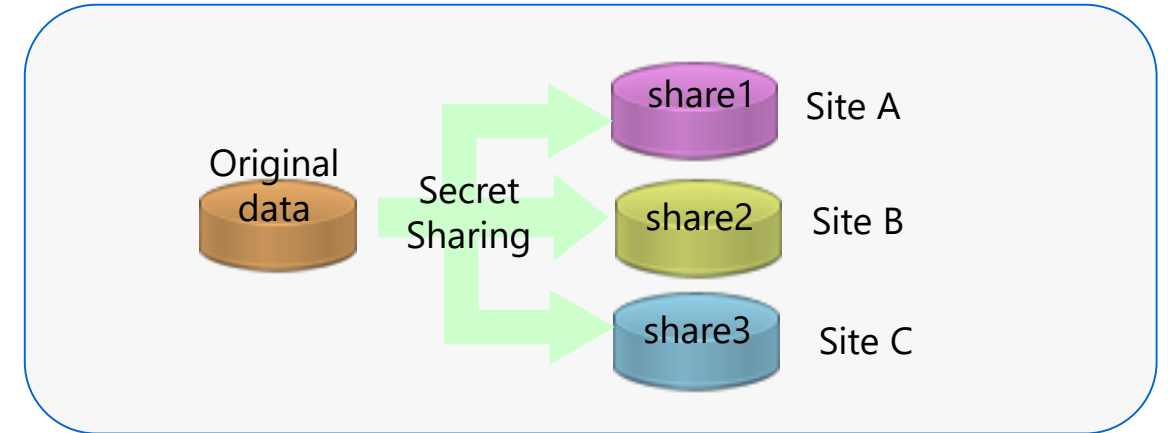


# Quantum Secure Cloud



## Quantum Key Distribution

Information theoretic security  
for data transmission



## Secret Sharing

Information theoretic security  
for data storage



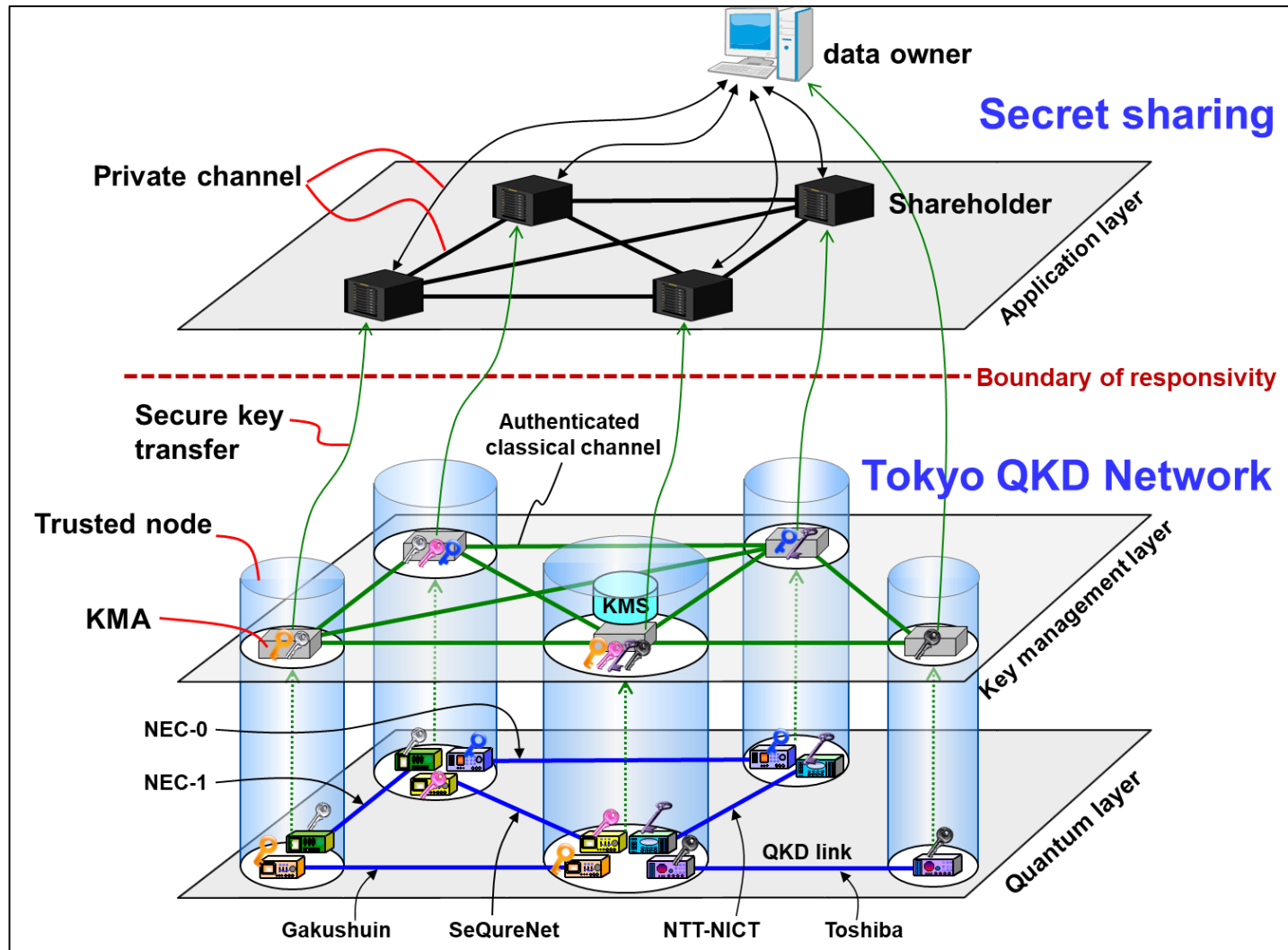
Integration with networking technology

# Quantum Secure Cloud

Platform for information theoretic security for data transmission and data storage

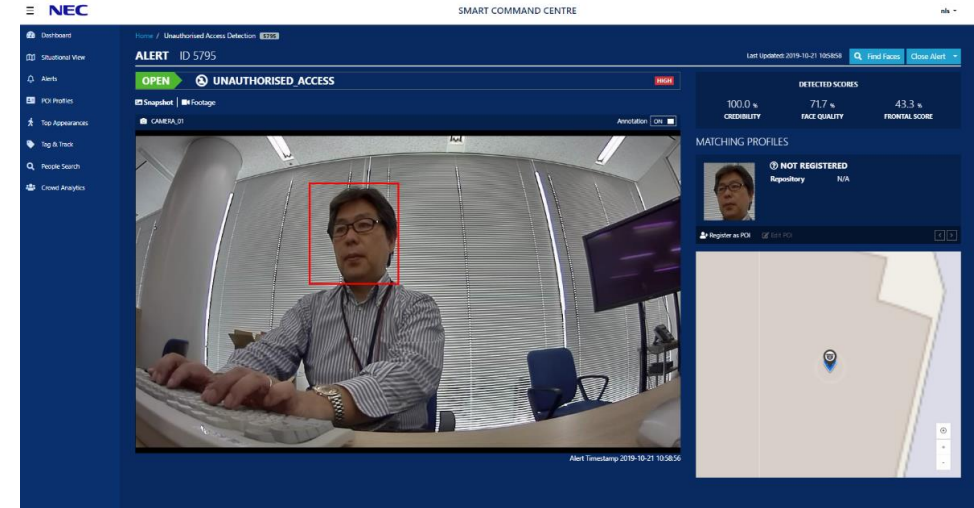
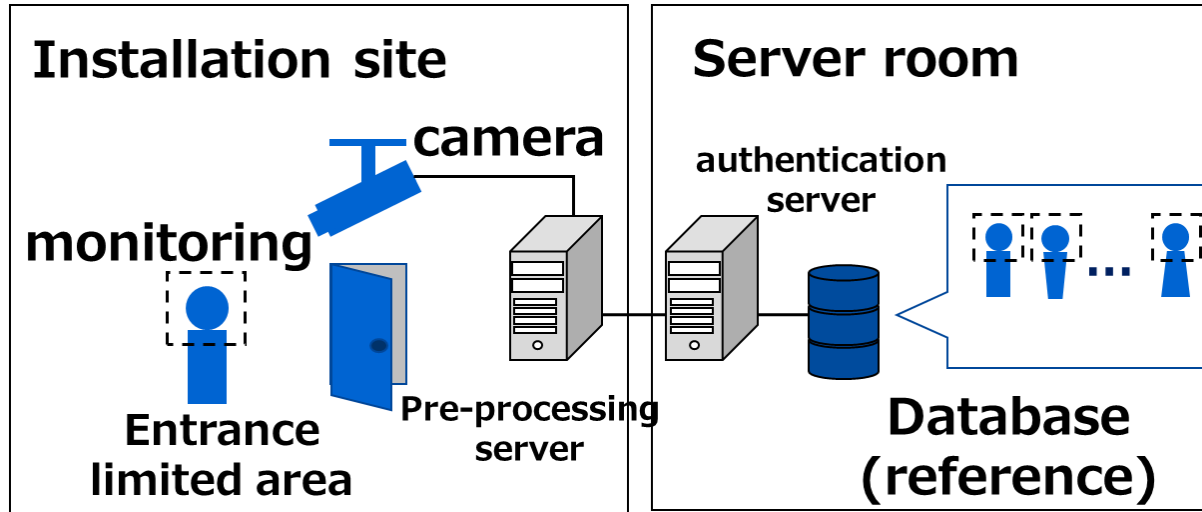
# Quantum Secure Cloud

First demonstration of Quantum Secure Cloud was made on Tokyo QKD Network



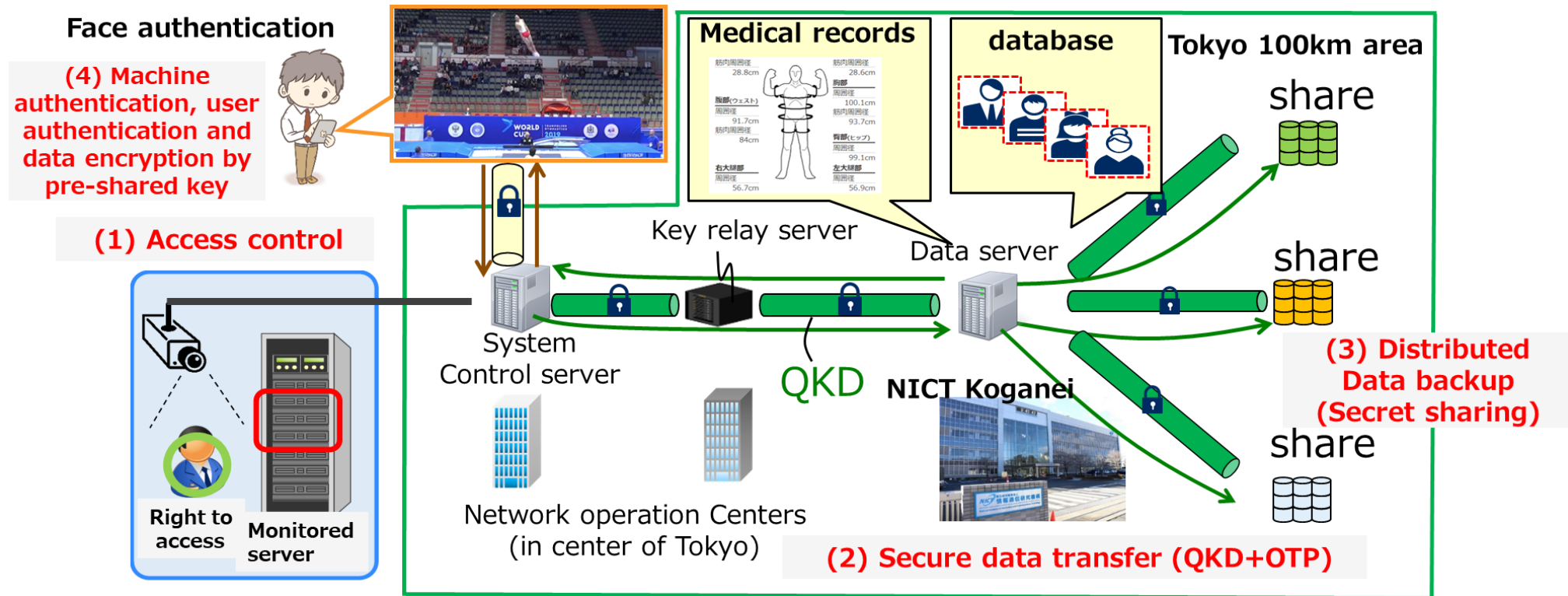
Fujiwara, et al., Scientific Reports, 6:28988 (2016).

# Use-case 1: Biometrics authentication system (1/2)



- Biometrics authentication (face authentication) needs reference database.
- Biometrics data cannot be changed even stolen.  
⇒ So the reference data needs to be stored securely in quantum secure cloud.

# Use-case 1: Biometrics authentication system (2/2)



Biometrics reference data and medical record data are securely transported using QKD+OTP and stored using secret sharing in a distribute manner.

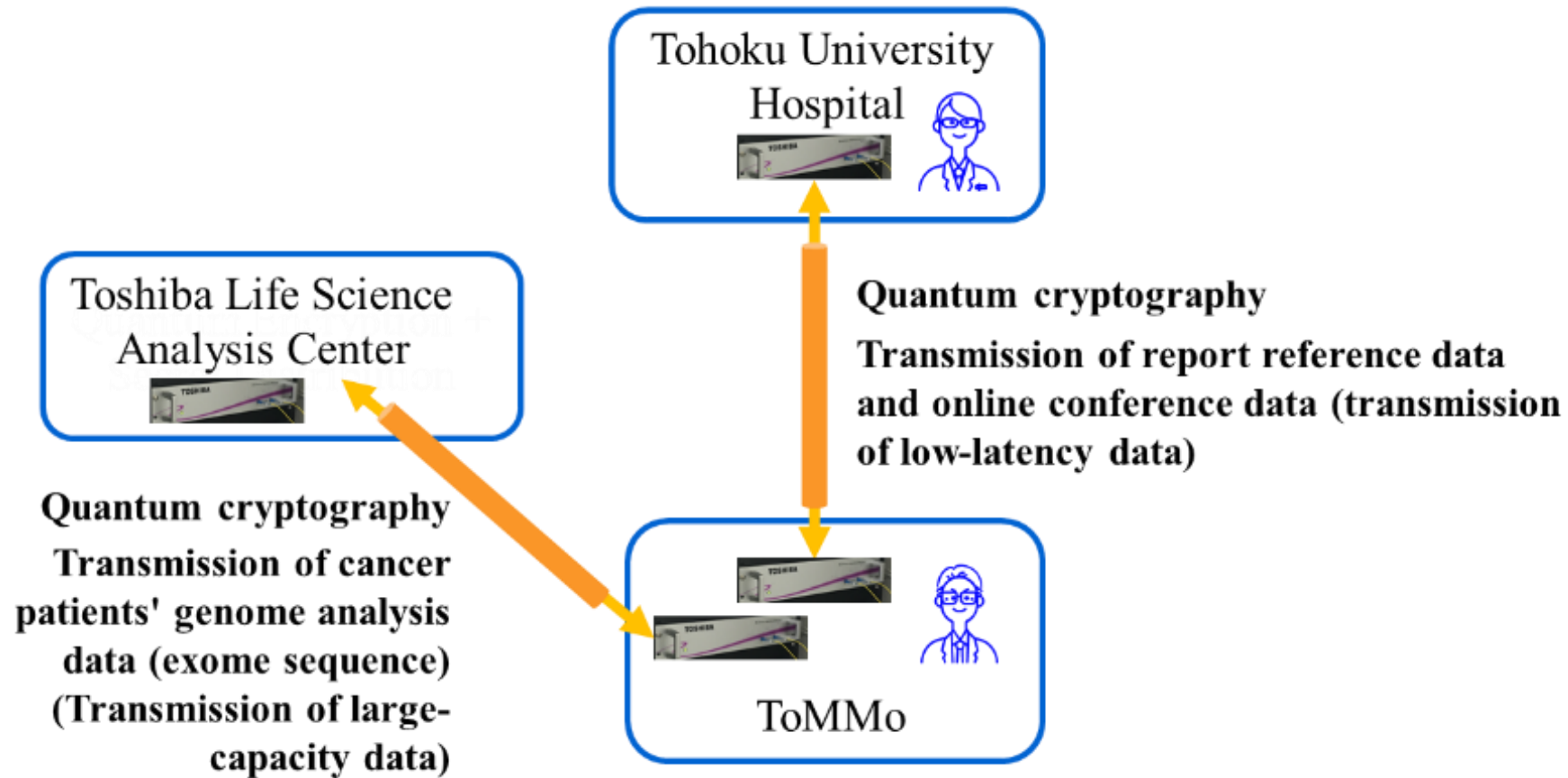
## Use-case 2: Genome / Medical data system (1/5)

- Genome data/Genome analysis data are:
  - treated as personal information identifying specific individuals
  - huge volume (for example, hundred gigabyte data)
  - Essential for genomic medicine
- Storing and transporting such large amounts of secure data requires very high level security.
- Genome researchers sometimes physically transport hard disks in locked security boxes, which is problematic in terms of cost and time.  
⇒ So the QKD technology is introduced to transfer Genome analysis data and related data securely.

Collaboration research of Toshiba, Tohoku University Tohoku Medical Megabank Organization (ToMMo) and Tohoku University Hospital

A part of this work was performed for Council for Science, Technology and Innovation (CSTI), Cross-ministerial Strategic Innovation Promotion Program (SIP), "Photonics and Quantum Technology for Society 5.0"(Funding agency : QST).

# Use-case 2: Genome / Medical data system (2/5)



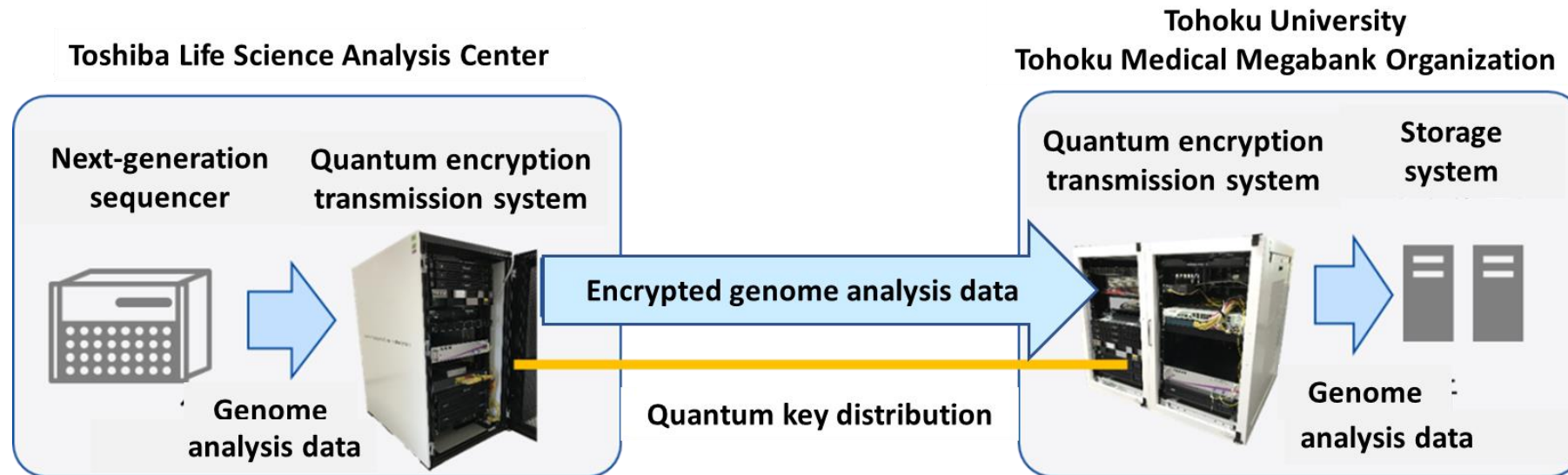
**Overview of Sendai site**

Collaboration research of Toshiba, Tohoku University Tohoku Medical Megabank Organization (ToMMo) and Tohoku University Hospital

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## Use-case 2: Genome / Medical data system (3/5)

We have developed a genome data transfer system: real-time transmission of genome sequence data with data volumes exceeding several hundred gigabytes.



**Overview of the development transmission system for genomic sequence data**

Collaboration research of Toshiba, Tohoku University Tohoku Medical Megabank Organization (ToMMo) and Tohoku University Hospital

[https://www.toshiba.co.jp/rdc/rd/detail\\_e/e2008\\_01.html](https://www.toshiba.co.jp/rdc/rd/detail_e/e2008_01.html)  
Murakami, et al., Qcrypt 2020 poster 117 (2020)

A part of this work was performed for Council for Science, Technology and Innovation (CSTI), Cross-ministerial Strategic Innovation Promotion Program (SIP), "Photonics and Quantum Technology for Society 5.0" (Funding agency : QST).



## Use-case 2: Genome / Medical data system (4/5)

We have developed a genome data transfer system: real-time transmission of genome sequence data with data volumes exceeding several hundred gigabytes.

#	Data Type	Data size	Encryption	Time
1	Whole-genome	581GB	QKD +OTP	Sequencing 58.65 hrs, Transmission 1 min 52 sec
2	Whole-genome	601GB	QKD +OTP	Sequencing 58.93 hrs, Transmission 1 min 37 sec
3	Whole-exome	87.7GB	QKD +OTP	Sequencing 29.25 hrs, Transmission 3 min 38 sec
4	Whole-exome	91.3GB	QKD +OTP	Sequencing 28.73 hrs, Transmission 38 min 32 sec

### Results of 4 trials of transmitting genome sequence data using the quantum cryptography

Period	Average QBER	Average secure key rate	Average sifted key rate	Amount of generated quantum keys
Trial 1&2	3.2 %	9.1 Mbps	35.7 Mbps	1.4 TB
Trial 3&4	3.2 %	7.8 Mbps	33.8Mbps	0.15 TB

### Operation summary of the QKD system during 4 trials on installed fibers (2.3 dB transmission loss)

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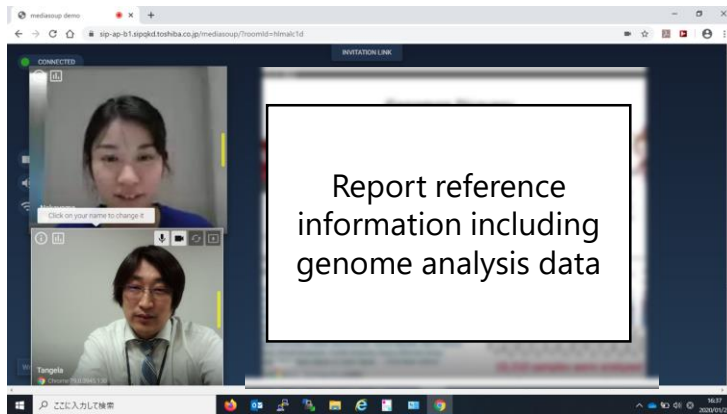
[https://www.toshiba.co.jp/rdc/rd/detail\\_e/e2008\\_01.html](https://www.toshiba.co.jp/rdc/rd/detail_e/e2008_01.html)  
Murakami, et al., Qcrypt 2020 poster 117 (2020)

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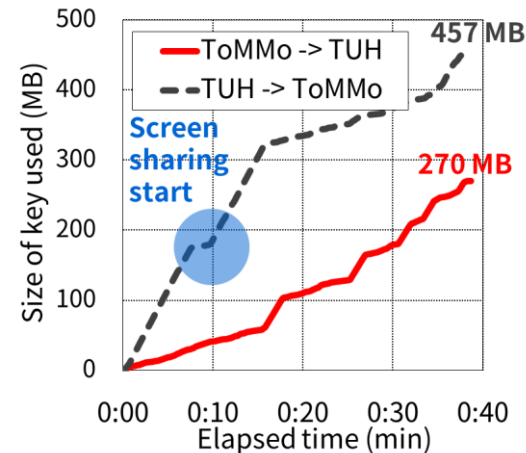


# Use-case 2: Genome / Medical data system (5/5)

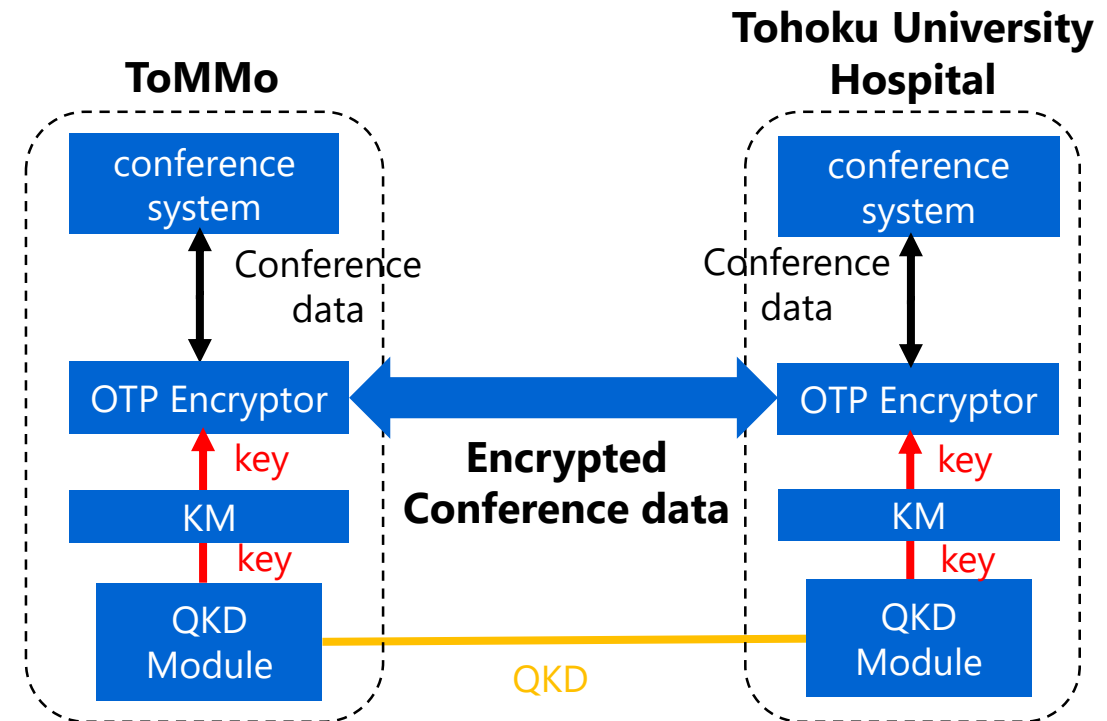
- We have demonstrate a TV conference system for clinical use for discussion and data reference of patient cases among medical experts.
- Average key consumption rate (1.56Mbps) can be supported our high speed QKD secure key rate (max 10Mbps).



**Example of the clinical conference screen**



**Key consumption during the demonstration**



Collaboration research of Toshiba, Tohoku University Tohoku Medical Megabank Organization (ToMMo) and Tohoku University Hospital

[https://www.toshiba.co.jp/rdc/rd/detail\\_e/e2008\\_01.html](https://www.toshiba.co.jp/rdc/rd/detail_e/e2008_01.html)  
Takahashi, et al., Qcrypt 2020 poster 141 (2020)

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## Thank you for your attention

ITU-T Webinar  
Quantum Information Technologies (QIT) for networks – Use cases  
26 May 2021

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