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Hungary's First Multi-Link Quantum Key Distribution Network

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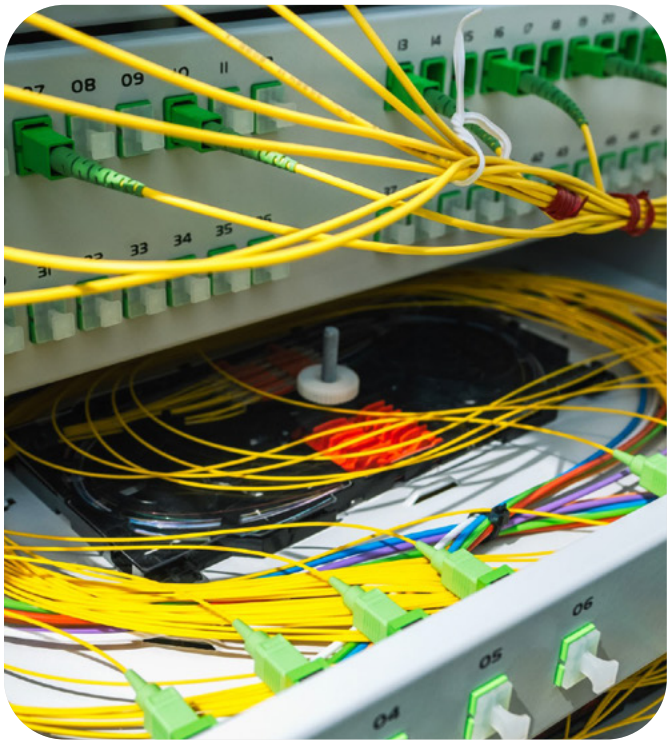
A Proof-of-Concept Milestone in Europe's Quantum-Safe Future

The global telecoms industry faces a transformative security challenge. With the rapid progress of **quantum computing,** today's widely used encryption methods are expected to become vulnerable within the coming decade.



For operators, this raises a critical question: how can we **future-proof communications infrastructure** against tomorrow's cyber threats, making it 'quantum-safe' – that is, immune to attack from quantum computing threats?

While large-scale quantum computers may still be a few years away, the threat is already here today in the form of so-called "Harvest Now, Decrypt Later" (HNDL) attacks. Malicious actors can intercept and store encrypted data now, with the intention of decrypting it once quantum computers become powerful enough. This means that data transmitted today – especially sensitive information with a long shelf life, such as corporate, governmental, or financial information – could be compromised in the future unless it is protected with quantum-safe methods now.

One of the most promising answers is **Quantum Key Distribution (QKD)** – a technology that uses the laws of physics to secure the exchange of cryptographic keys. Unlike classical key exchange, QKD is immune to computational advances, offering long-term protection for sensitive data.

At Toshiba, we've put this into practice, helping to launch Hungary's first **multi-node Quantum Key Distribution (QKD) network,** a collaborative project powered by **our QKD technology.** It demonstrates the real-world viability of quantum-safe communications across heterogeneous operator infrastructure, offering telecoms providers a clear blueprint for integrating **quantum security into telecoms networks.**

The results mark a turning point not just for Hungary, but for the wider European telecoms industry. For telecoms operators, this is proof that **quantum-safe networking can be commercially deployed today,** protecting customers and infrastructure while aligning with Europe's long-term **EuroQCI initiative.**

Hungary's First Operational Multi-Node QKD Network

This collaborative project marks Hungary's first successful demonstration of a multi-node Quantum Key Distribution (QKD) network.

Built using Toshiba's advanced QKD technology, the trial connected 3 locations: MVMNet's site in Székesfehérvár, Magyar Telekom's site in Budapest Kelenföld, and the Mobile Communications and Quantum TechLab of Budapest University of Technology and Economics, proving the feasibility of quantum-secure communications across multiple operator infrastructures.

The project represents a major step forward for Hungary and for Europe's broader quantum-safe networking ambitions.

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Why Quantum Security Matters for Telecoms Operators

Future-Proofing Security:

- Quantum computers will eventually break widely used public-key cryptography. QKD provides **information-theoretic security,** immune to advances in computing power.

Customer Trust & Differentiation:

- Early adopters of quantum-safe services will set themselves apart in high-value markets such as finance, healthcare, and government.

Regulatory Alignment:

- European programs like **EuroQCI** are accelerating the adoption of quantum-safe communication. Early deployments prepare operators for regulatory and competitive shifts.

Revenue Opportunities:

- QKD-protected services, such as quantum-safe networking and ultra-secure data centre interconnects, represent new monetisable offerings.

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The Hungarian Multi-Link QKD Project

This project brought together **Toshiba Europe Limited, Magyar Telekom, Budapest University of Technology and Economics (BME), Netvisor Ltd.,** and **Advanet Hungary Ltd.** to deploy Hungary's first QKD test network.

Objectives:

- Demonstrate a multi-link QKD network on the operator's infrastructure.
- Validate the technical feasibility of QKD over real telecoms fibre.
- Evaluate key performance metrics such as secret bit key rate and Quantum Bit Error Rate (QBER).
- Showcase live traffic encryption secured by quantum-safe encryption keys.

Network Topology

Nodes:

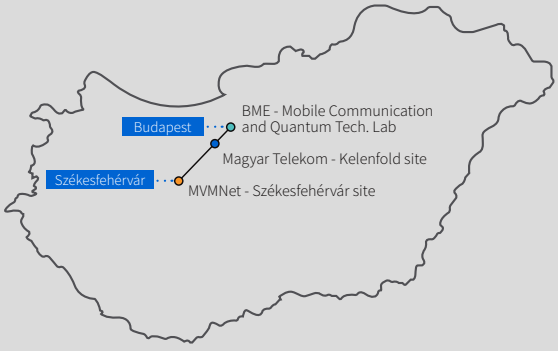
MVMNet Székesfehérvár → **Magyar Telekom** Kelenföld, Budapest → **BME** (Budapest).

Distances:

76 km with 26.8dB optical loss (Székesfehérvár ↔ **Magyar Telekom** Kelenföld) and 2.5 km with 2.35dB optical loss (**Magyar Telekom** Kelenföld, Budapest ↔ **BME**, Budapest).

Infrastructure Providers:

Magyar Telekom, MVMNet

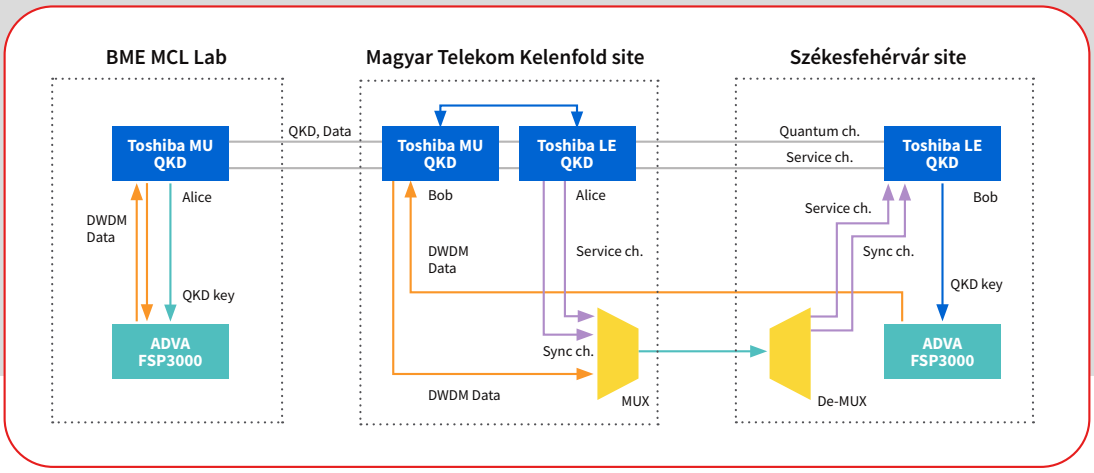


Network Architecture

1. QKD Layer:
Toshiba QKD devices (Alice & Bob) generating quantum-safe keys.

2. Key Management Layer:
Secure distribution of quantum-safe keys across the network using Toshiba's Key delivery system.

3. Encryption Layer:
Classical telecoms equipment encrypting traffic with QKD-generated keys.



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Toshiba QKD Systems Deployed

Two Toshiba QKD systems were used:

QKD-LE (Long Distance Flexible Model)

Presents dedicated optical output ports for quantum and service channels, giving operators flexibility in deployment.

QKD-MU (Multiplexed Model)

Efficiently multiplexes quantum and classical DWDM data channels over two fibres, providing easy overlay of QKD over deployed 'lit' fibres.

Business Impact:

The multiplexed model demonstrates that QKD can coexist with standard telecoms traffic on existing operator infrastructure — a key requirement for rapid and cost-effective deployment, significantly reducing OPEX costs deployment.

Performance Results:

Measured over real-world fibre infrastructure

Link	Average secret bit rate	Average QBER
Székesfehérvár ↔ Kelenföld	53.3 kbit/s	3.36 %
Kelenföld ↔ BME (University)	1146.5 kbit/s	3.82 %

Interpretation for Operators:

- Stable secret bit rates confirm feasibility for both long-haul and metro networks.
- QBER within operational thresholds (typically less than 5%) ensures robust error correction and security.
- Results confirm that commercial-grade QKD systems can perform reliably in an operator's network.

Testing with Real Traffic:

Beyond quantum-safe key distribution, the project demonstrated **live traffic encryption** across the QKD-secured links.

Demonstrations:

- **1 Gbit/s Traffic Injection:** Traffic analyzer injected 1 Gbit/s streams through the QKD channel with no significant delays.
- **Internet Traffic Test:** University LAN traffic, including laptop users, was routed through the QKD-secured link and connected seamlessly to the public internet.

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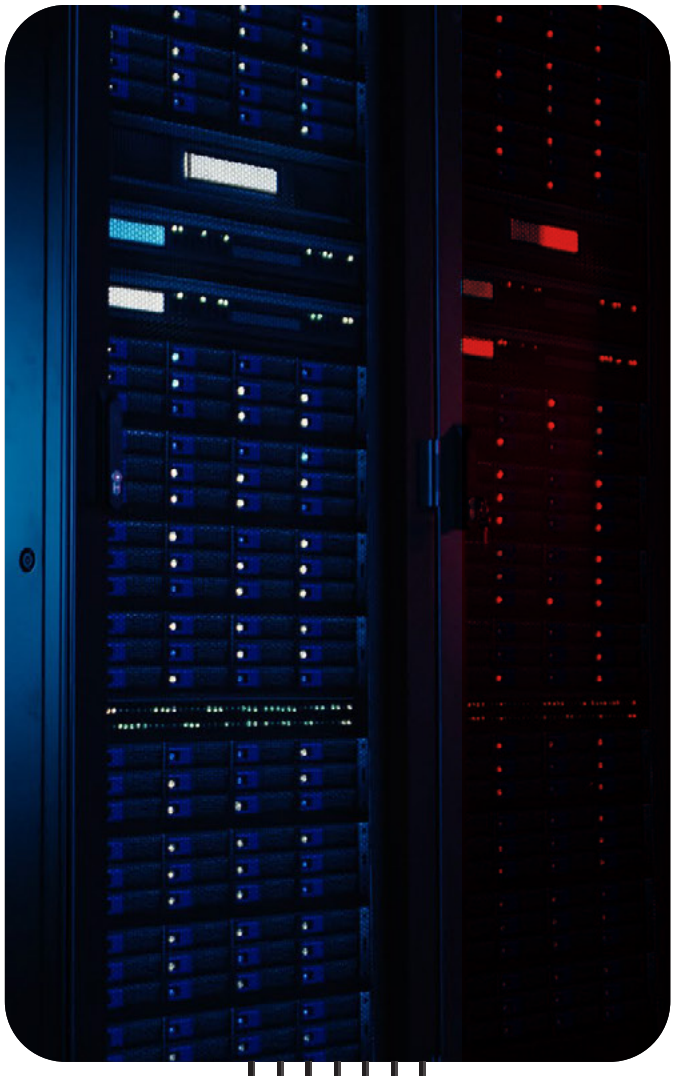
Lessons for Telecoms Operators

From this proof-of-concept, several important findings emerge:

- QKD can be deployed over existing fibre networks operated by different providers.
- Multiplexed QKD systems make deployment cost-effective by enabling operators to easily and quickly deploy QKD over existing fibres alongside existing data services.
- Live traffic validation shows QKD is compatible with standard telecoms services.
- Early participation in QKD pilots gives operators the skills and knowledge to prepare for emerging demand.



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Conclusion

The Hungarian multi-node QKD deployment, powered by **Toshiba's leading QKD technology,** demonstrates that quantum-safe security is no longer theoretical. It is **operational, scalable, and commercially relevant** today.

For telecoms operators, the message is clear:

- Quantum threats are real and approaching.
- Commercial QKD systems can easily be deployed into operator's networks.
- Early movers will lead in secure, differentiated services.

Toshiba Europe Limited is proud to partner with telecoms operators across Europe to accelerate the transition to quantum-safe networks.

Partner with Toshiba to secure your network

To find out more about Toshiba QKD, please visit **toshiba.eu/quantum** or contact us at **qt@toshiba.eu**

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About Magyar Telekom

Magyar Telekom, Hungary's largest telecommunication operator was established in 1991. It provides a full range of telecommunications and infocommunications (ICT) services, including fixed line and mobile telephony, data transmission, and non-voice as well as IT and systems integration services. Magyar Telekom is the majority owner of Makedonski Telekom, the leading fixed-line and mobile operator in the Republic of North Macedonia. Magyar Telekom's majority shareholder (65.78%) is Deutsche Telekom Europe B.V., fully owned by Deutsche Telekom AG.

More information on www.telekom.hu.

About Netvisor Ltd.:

Netvisor Ltd. was founded in 1998 by Hungarian experts.

Netvisor is a system integrator company specialized in development, implementation and support of **IT and communication infrastructures, value-added IT and IoT service systems,** as well as **systems for managing them.** Netvisor is also involved in equipment delivery.

Netvisor has significant references in eight industry sectors: government; financial sector; info communications and telecommunications providers; energy providers; utility providers; industry and trade; transport and shipping; healthcare and education.

Netvisor has developed a fully integrated family of operational support systems. Netvisor's systems allow proactively prevent operational errors in complex infrastructures and the applications and management systems based on the infrastructure helping operating departments in this complex tasks. Netvisor's softwares also enable professional detection of errors, sophisticated prediction of potential failures, and rapid identification of the root cause of errors.

About AdvaNet:

AdvaNet Hungary Ltd. committed to quality and secure data transmission and telecommunications infrastructure offers services and support as a system integrator for more than 10 years in the fields of optical data transmission, telecommunication, data center infrastructure, fiber optic sensing and monitoring systems. AdvaNet is the local partner of Toshiba Europe Limited on the Hungarian market and representing world's renowned manufacturers (ADVA/Adtran, Oscilloquartz, AFL, Fujikura, etc.) whose portfolio perfectly fit in their vision to serve not only the networks of the present, but also the networks of the future with solutions that can be flexibly adapted to needs, have the appropriate intelligent automation and monitoring functions, ensuring long-term stable, predictable, safe and economical operation.

About Budapest University of Technology and Economics (BME)

Founded in 1782, BME is Hungary's most prestigious technical university and one of the oldest institutes of technology in the world. Located in Budapest along the Danube River, BME offers a wide range of programs in engineering, architecture, economics, and natural sciences. The university comprises eight faculties and over 110 departments, and it issues approximately 70% of Hungary's engineering degrees. With a strong emphasis on research, innovation, and interdisciplinary collaboration, BME maintains partnerships with global industry leaders and research institutions.

To find out more about Toshiba QKD, please visit **toshiba.eu/quantum**

or contact us at **quantum@toshiba.eu**

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