# Deploying and Stress-Testing a Quantum-Resilient Communications Infrastructure Across an Urban Area

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The advent of cryptographically relevant quantum computers poses an existential threat to classical public-key infrastructure. Quantum Key Distribution (QKD) addresses this challenge by providing information-theoretic security for key establishment, independently of any computational hardness assumption [1]. However, moving from controlled laboratory demonstrations to city-scale operational infrastructures remains a major challenge for the field. Real networks introduce fiber heterogeneity, environmental variations, integration with existing IT ecosystems, and the need for continuous automated operation.

This work reports the deployment and experimental validation of a metropolitan-scale quantum-secure network connecting four nodes located in data centers across Milan. The network operates over installed fiber infrastructure and implements a layered architecture integrating QKD hardware, standards-compliant Key Management (KM), and centralized Software-Defined Networking (SDN) orchestration. Dynamic path reconfiguration via active optical switching and trusted-node routing allow automated fail-over solutions. Application-layer validation across diverse protocols and workloads confirms the seamless interoperability of all system components.

As a figure of merit, Figure 1 shows the Secure Key Rate (SKR) of the QKD network during the tests. These results demonstrate the technical and operational readiness of metropolitan QKD networks for production deployment, and provide a replicable blueprint for building quantum-secure communication infrastructure at metropolitan scale.

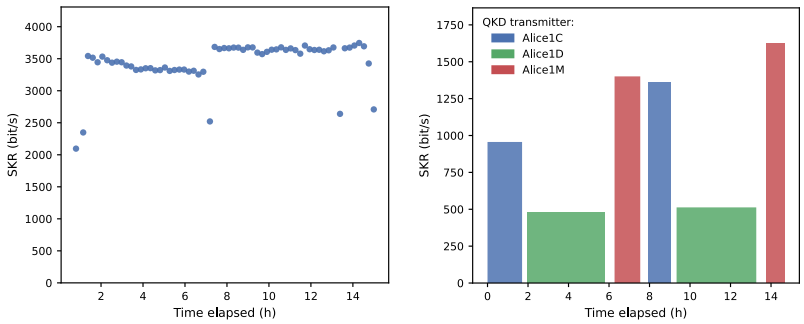


**Fig. 1:** *Secure Key Rate (SKR) of the QKD network during the deployment. The left plot shows the performance of a point-to-point link, whereas the right plot refers to links managed via an optical switch.*

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**References**

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