Q*bird
quantum connectivity

Towards real application of quantum networking in operational logistic infrastructure environments

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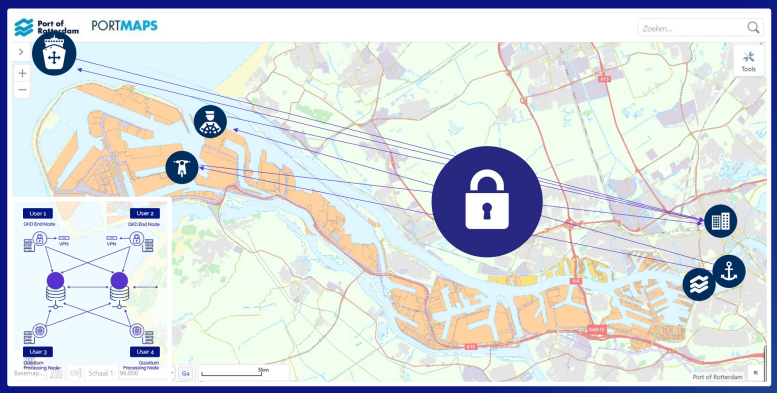
Q*Bird B.V.

Abstract

It is expected that in due time, quantum networks will enhance digital security by connecting critical logistic infrastructure locations. Towards this end, Q*Bird b.v. (a company based in Delft, South Holland), has been developing quantum networking and quantum key distribution systems that allow for multipoint-to-multipoint connectivity, multi-user access and multi-tenancy.

Q*Bird has worked towards quantum key distribution and systems integration with the Port of Rotterdam – a major logistics hub for a variety of goods entering NATO-member-state the Netherlands and the European sphere at large. The Port of Rotterdam's security vision is to keep the risk of security incidents within the Port area to a minimum and strict security rules are applied throughout the Port. Together, Q*Bird and the Port, have been examining potential security risks as well as how and where quantum key distribution and quantum networks can best decrease those risks. As a major first customer for Q*Bird, these Research Questions are shaping its technology development and creating real application in the Port infrastructure.

Q*Bird is preparing for integration between QKD equipment and operational port infrastructure. This includes experimentation on the coexistence of quantum networking qubit signals and control signals with conventional communication channels provided by secure communication providers. We present our analysis of the performance of a QKD network under various operational parameters. These field-tests further demonstrate that QKD and quantum network technologies can be made robust and integrable into conventional communication – especially critical infrastructure locations.



Quantum Inside Critical Infrastructure

Critical infrastructure, such as the Port of Rotterdam, has unique challenges making it well-suited for early deployments of quantum internet and QKD. Critical Infrastructure assets can be numerous, geographically widespread, with mission critical data moving between many different locations, and a low-density of active personal between infrastructure locations.

In our joint analysis we found a requirement for multi-user and thus multi-point-to-multi-point QKD connectivity between the Port Authority in the Port of Rotterdam, and several Port of Rotterdam users: e.g. Pilots, Vessel Traffic Management, Portbase's Digital Logistical Portal., etc.

To facilitate this, Q*Bird designed a centralized Hub to provide secure QKD connectivity to *all pairs of* users. Users' locations require only a simple module to have QKD connectivity to all other users connected to the Hub.

Typical messages include both small-packet high-frequency messaging and infrequent large datasets. To meet these demands, the *quantum bandwidth* of the network can be adjusted overtime to meet the demands of users.

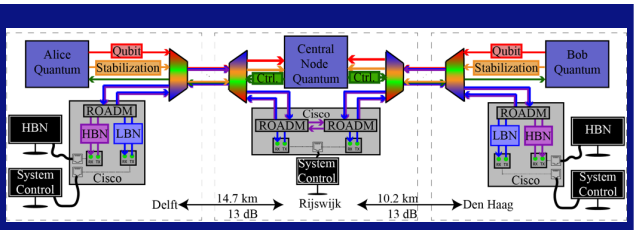
Integration with Conventional Networking Equipment

Full Integration involves considerations of the optical systems, the data connections, and the physical infrastructure environment itself.

Optical Integration: To demonstrate optical integration Q*Bird integrated its optical systems with systems from Port of Rotterdam partner Cisco [1]: namely, the optical platform NCS2000 series. All three network locations employed an NCS2006 system with modern ROADM linecards to multiplex conventional WDM optical traffic. Cisco routers were configured to provide multiple 10 Gb/s IP networks and their optical signals were multiplexed on the same optical fiber as the qubits from Q*Bird QKD devices, using different WDM channels. We designed the optical networks such that they operated over a fiber-pair between each network location. The performance of the QKD system during optical integration is shown on the right.

Physical Environment: Q*Bird devices are enclosures of standard 19" rack sizes. The devices are designed to be datacenter compatible, which includes standard power supplies, no strong magnetic fields, and no ultra-cold helium systems (as is often used in other quantum tech). By working closely with datacenter providers of the Port of Rotterdam, Q*Bird was able to engineer enclosures to meet the stringent environmental requirements of modern telecommunication datacenter and telecom environments.

Data Integration: This primarily entails transferring QKD key from QKD devices to other network equipment that will then use the key. Q*Bird implements an API according to an ETSI QKD Standard. This Key Management System operated continuously without fault for 3 months, while other devices (i.e. layer-2/3 encryptors) fetched QKD key up to every 30 s.



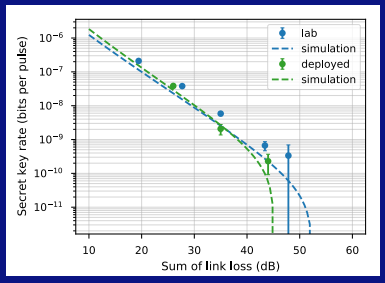


Figure (above): Schematic drawing of the optical network and WDM scheme used to demonstrate the integration of Q*Bird QKD systems with Cisco optical systems, on the same optical fiber. Qubits are co-propagating with the optical fields of the IP data channels.

Figure (left): Secret key rate as a function of the total link loss. All data was collected with >10 Gb/s IP data channels present on the same fiber as the qubits. Circles are System Performance. Dashed lines are simulated results.

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REFERENCES

[1] Berrevoets et al., "Deployed measurement-device independent quantum key distribution and Bell-state measurements coexisting with standard internet data and networking equipment", Commun Phys 5, 186 (2022).