

# Quantum Key Distribution Network (QKDN)

Accelerating the world's transition to a connected, quantum-secure future through software-defined orchestration of QKD nodes and controllers.

## Introduction

Traditional QKD systems were limited to point-to-point communication: typically, between two nodes known as Alice and Bob.

- **Need for a scalable way:** As networks grow and span across geographical locations, all enterprises must find a scalable way to extend QKD's power across multiple links, nodes, and applications.
- **Need for better control:** All QKD nodes, links and applications must be controlled centrally with better visibility.

## Product Overview

QNu Labs' Quantum Key Distribution Network (QKDN) is a networked, software-defined architecture that connects multiple QKD systems. QKDN orchestrates quantum key distribution at a network scale using Software Defined Networking (SDN) principles.

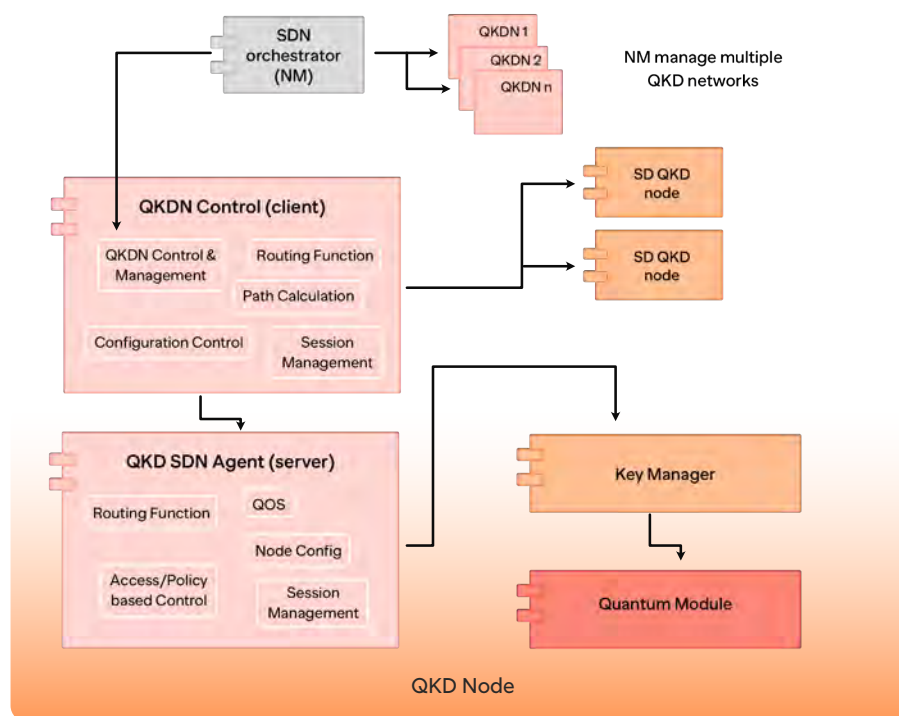
- Offering a unified, secure and manageable infrastructure
- Quantum-secure communication networks of Terrestrial QKD, Free space QKD and Digital QKD.
- Scalable foundation for the future of quantum
- Fully compliant with international ETSI GS QKD 014, 015, 018, and IETF NETCONF/YANG standards

## Key Benefits of QKDN

- **End-to-End Orchestration:** Manage the entire quantum key network — from nodes to controllers — through a central orchestrator.
- **Scalable Quantum Security:** Supports hundreds of QKD nodes and controllers, connecting multiple cities or data centres.
- **Flexible:** It is compatible with all three formats of QKD systems: physical, digital, and hybrid.
- **Automated & Built-in Fault Handling:** Self-evolving, re-routing, and diagnostic intelligence.
- **Cost-effective:** Compared to the current point-to-point systems, QKDN has better cost-effectiveness.

## How QKDN Works?

- Quantum Key Distribution Network extends QKD from a single link to a full network by interconnecting multiple QKD nodes through a Software Defined Network (SDN).
- A Network Manager (NM) centrally orchestrates the system and it interacts with QKD Network Controllers (QKDNCs) managing each domain of nodes.
- Each layer is built on standard interfaces and protocols (NETCONF, YANG models). It will ensure vendor independence.



## Architecture Overview

| Component                                      | Function                                | Standards Interface                         |
|------------------------------------------------|-----------------------------------------|---------------------------------------------|
| <b>Network Manager / SDN Orchestrator</b>      | Orchestrates the entire QKD network     | ETSI GS QKD 018 (Southbound: NETCONF/ YANG) |
| <b>QKD Network Controller (QKDNC)</b>          | Controls QKD nodes and manages sessions | ETSI GS QKD 015                             |
| <b>Key Management Module</b>                   | Key session creation and delivery       | ETSI GS QKD 014, SKIP                       |
| <b>QKD Nodes (Physical / Digital / Hybrid)</b> | Quantum key generation                  |                                             |

Key Features of QKDN

| Feature                   | Description                                                                               |
|---------------------------|-------------------------------------------------------------------------------------------|
| User & Access Management  | User registration, role-based access, and MFA authentication                              |
| Inventory Management      | Manages Digital, Free-Space, and Hybrid QKD, and QRNG devices                             |
| Network Configuration     | End-to-end orchestration, including node creation, topology setup, and path configuration |
| Monitoring & Reporting    | Tracks alarms, QBER, temperature, SKR via WebSocket, RabbitMQ, NETCONF                    |
| Automated Reports         | Schedule and email detailed QKD node reports for audit and analysis                       |
| Key Management            | Dynamic session control and key distribution via ETSI GS QKD 014                          |
| Fault & Incident Handling | Multi-level fault recovery, path re-routing, and BITE/POST diagnostics                    |
| Security Management       | PQC-secured links, TLS 1.3, data encryption at rest and in transit                        |
| QoS Policies              | Application-based bandwidth and TTL management                                            |
| Visualisation             | Network maps and topology rendering                                                       |

Architecture Intelligence

| Functionality     | Description                                     |
|-------------------|-------------------------------------------------|
| Path Management   | Intelligent cost-based routing                  |
| QoS Control       | Application-level quality of service management |
| Routing Protocols | OSPF-based routing and optimisation             |
| Diagnostics       | Real-time data analysis and performance metrics |

|              |                                                |
|--------------|------------------------------------------------|
| Audit & Logs | Syslog, audit trails, and compliance reporting |
|--------------|------------------------------------------------|

Technical Specifications

| Parameter             | Specification                                                                             |
|-----------------------|-------------------------------------------------------------------------------------------|
| Network Scale         | Hundreds of QKD nodes                                                                     |
| QKD Controllers       | Up to 100 controllers                                                                     |
| High Availability     | Active-Standby and horizontal load balancing                                              |
| Supported QKD Types   | Physical, Digital, and Free space QKD                                                     |
| Controller Hardware   | Intel Xeon (8 cores, 32 GB RAM)                                                           |
| Orchestrator Hardware | Intel Xeon (32 cores, 64 GB RAM)                                                          |
| Network Interface     | 1 Gbps between controllers and nodes, 10 Gbps between the controller and the orchestrator |
| Applications per Node | 25+ applications per node, 1000+ key paths per network                                    |

Standards & Compliance

| Standard                    | Description                               |
|-----------------------------|-------------------------------------------|
| ETSI GS QKD 014             | Key delivery API                          |
| ETSI GS QKD 015             | Control interface for SDN                 |
| ETSI GS QKD 018             | Orchestration interface for SDN           |
| IETF RFC 6020 / 7950 / 6241 | NETCONF and YANG data modelling standards |





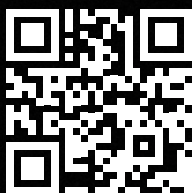
QNu Labs is revolutionizing cybersecurity with cutting-edge quantum-safe solutions, making India a leader in quantum cryptography. Through its patent-protected products - Armos and Tropos, QNu Labs is at the forefront to enable quantum secure key generation & distribution for secure data transmission.

With its innovative QShield platform, which is based on NIST compliant PQC algorithms, QNu offers quantum-secure services such as VPN, messaging, file sharing & key management (QHSM).

QNu Labs is at the forefront of quantum security, shaping the future of secure communications & protecting critical infrastructures like finance, defence, and telecom from future quantum threats.

Have a trusted advisor get in touch with you to explore how QHSM can protect your operations from quantum cyber threats.

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