

A Multiplane Architecture Proposal for the Quantum Internet

draft-lopez-qirg-qi-multiplane-arch

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First Reminder

Why and How an Architecture Framework

- A reference to support further element and protocol definition
 - Working in the direction of an Internet with quantum capabilities
 - Not proposing a concrete choice of elements or protocols
 - But the foundations to describe and assess them coherently
- Leverage the operational experience gained with QKD infrastructures
 - Coexistence with classical networks
 - Service semantics
 - Operational best practices, including orchestration patterns
- Leverage SDN concepts
 - The CLAS architecture (RFC 8597)
 - Structured around strata, with a regular set of planes
 - Integration of the interplay with (shared) infrastructure
- Consider the impact of virtualization
 - Go cloud, young man...

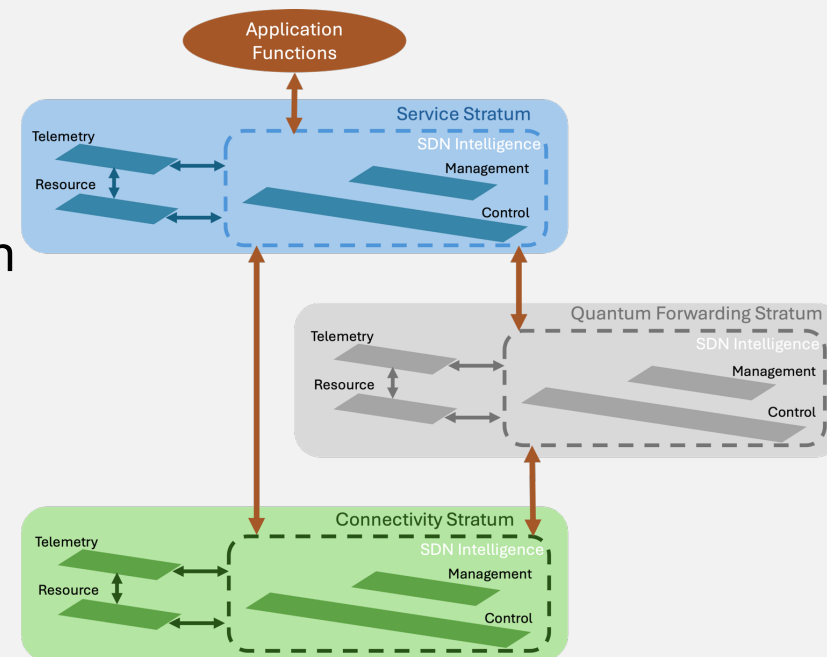
Enhanced Structure and Content

- Technology foundations
 - QKD experience
 - Interfacing with classical networks
 - *Applying network virtualization principles*
 - Introducing the CLAS architecture
- Framework architecture proposal
 - *CLAS strata for quantum networks*
(Extended discussion, including the *service unit* concept)
 - Identification of interfaces and protocols
 - *The role of network virtualization*
 - An introduction to synthetic environments
- Closing matters
 - Security considerations
 - . . .

Second Reminder

CLAS Strata for Quantum Networks

- A Service Stratum: functionality related to the purpose of the quantum network
 - Generation of management of keys in QKD
 - Others: time synchronization, identity assurance, sensing...
 - Entanglement distribution in a general quantum network
- A Quantum Forwarding Stratum: direct application of quantum protocols and algorithms
 - Between any two endpoints of a quantum link
 - Even when it is a multi-hop one, whatever the nature of *repeaters*
- A Connectivity Stratum: providing the paths to support the quantum links
 - Supported by OTN infrastructure, via fiber and/or open-space links
 - Follow a common connectivity paradigm
 - From current circuit-based approaches to any other potential *classical encapsulation*



Service Units

- The main concern of the Service Stratum
- The units for service provisioning to the application
 - Keys, shared states, identities...
- The base for essential network functionality
 - Addressing, routing, information structuring...
- Supported by equivalent units at Quantum Forwarding
 - Though a one-to-one mapping is not essential
- Enabled by physical (classical) links at the Connectivity Stratum
 - Including aggregated control and monitoring

Virtualization Matters: The QKD Experience

- Extending service models in QKD networks
 - AAA
 - Admission control
 - Mobility
 - Monitoring
- Decoupling quantum forwarding from service management
 - Service elements distribution and scale
 - Key forwarding and potential hybridization
 - Inter-domain communication
- Simplifying integration
 - Device diversity in quantum forwarding
 - Physical and emulated (QNDT) environments
 - *Trusted nodes* and (future) quantum repeaters

Virtualization Matters: Their Role in Quantum Internet

- Direct application at the Service Stratum
 - At the SDN intelligence plane: mapping of service units and quantum forwarding units
 - At the telemetry plane: dynamic monitoring and data aggregation
 - At the resource plane: support of the different nature at the Quantum Forwarding Stratum
- Leveraging orchestrated SDN and optical disaggregation at the Connectivity Stratum
 - Better integration with the Service Stratum
- Agent-oriented SDN principles in device management at the Quantum Forwarding Stratum
 - Structured integration with the other strata
 - Support of the mapping with service units
- And simplifying the integration issues
 - Device diversity in quantum forwarding
 - Physical and emulated (QNDDT) environments
 - *Service forwarders* and quantum repeaters

What We Expect to Come Next

- Enhance the discussion on virtualization
 - Extended QKD experience, including entanglement approaches
 - Identify patterns for the general Quantum Internet case
- Generalize and complete the service unit concept
 - Base for essential matters: addressing, routing, cross-domain interoperability...
- Demonstrate integration
 - Open-source implementation of the QNDT
 - Hybrid validation environment
 - Align software development and architecture framework
 - Evaluate and report how architectures and protocol proposals fit in the framework
- Evolve the draft in formal terms
 - Security considerations
 - Adoption request