

A Multiplane Architecture Proposal for the Quantum Internet

draft-lopez-qirg-qi-multiplane-arch

D. López, L.M. Contreras (Telefónica),
V. Martín (UPM),
B. López (IMDEA Networks)

A First Reminder: Why an Architecture Framework

- Provide a reference for further protocol and interface definition
- Application of architecture principles and operational experience
- Support convergence: Applications and technologies at scale
- Address three essential Quantum Internet goals
 - *Universality*, accommodating any application
 - *Transparency*, sharing physical media with classical networks
 - *Scalability*, supporting the growth of the network
- Acknowledging *an exclusively Quantum Internet is neither feasible nor desirable*
 - Working in the direction of an Internet with quantum capabilities
- Not a set of protocols or interfaces per se
 - But a way to describe and evaluate them in a consistent manner

A Second Reminder: The Foundations

- Three essential properties of the framework architecture
 - *Agility*, with general enough abstractions
 - Avoiding a tight coupling with specific (physical) technologies
 - *Sustainability*, at all levels and in full scale
 - Open availability in technological and economical terms
 - *Pliability*, seamless integration with classical
 - (Adapted) best practices in use by the Internet community
- Apply the operational experience with (reasonably large) QKD infraststructures
 - Interfacing applications, service semantics, and the interaction with classical networks
- Leverage SDN concepts: the CLAS architecture (RFC 8597),
 - Structured around strata, with a regular set of planes
 - Integration of control mechanisms, and the interplay with (shared) infrastructure
 - General trends: Cloud-nativeness, zero-touch management, intent...

How the Draft Is Evolving

- Addressing received comments
 - We eagerly expect more to come
- Restructure
 - Clear differentiation of base technologies and the framework proposal
 - A more thorough discussion of strata and their functions
- Initial discussion on synthetic environments
 - As a an essential means to validate the proposal
 - And more
- TBP so far
 - A better term for “quantum forwarding”?
 - Mapping existing interface/protocol proposals onto the framework
 - Security considerations

New (Current) Structure

- Technology foundations
 - QKD experience
 - Interfacing with classical networks
 - Introducing the CLAS architecture
- Framework architecture proposal
 - CLAS strata for quantum networks
 - Principles for the identification of interfaces and protocols
 - An introduction to synthetic environments
- Closing matters
 - Security considerations
 - . . .

The Role of Synthetic Environments

- The essential means
 - Given the issues with devices, scale...
 - Not strictly an NDT
- Validate the framework
 - Roles of strata and planes
 - Evidence on interfaces
- Assess its applicability
 - Using current proposals on architecture and protocols as touchstone
- Assess the integration with
 - Classical networks
 - Meshes of synthetic and real elements
- First experiments
 - Collaboration welcome

And What Comes Next

- Keep working on interfaces and protocols
 - Current proposals as tocuhstone
 - Identify potential gaps
 - Aligned with describing the role of planes within the different strata
- Report initial experiments with synthetic environments
 - Experiment descriptors and environment components
 - Applicability of OAM practices (automation, cloud-nativenes...)
 - Integration with similar approaches for classical networks
- Provide a supporting framework for further experimentation

And a Back-Up Slide on CLAS Itself

CLAS Strata for Quantum Networks

- A Service Stratum, dealing with the 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, in charge of the 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, taking care of 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*

Evolved CLAS Architecture
(simple representation)

