



Session: Standards for Building Large QKD Networks

1st AIT Workshop on
Standardisation and certification
of QKD systems and QKD
networks

On-line, Sept. 28th 2021



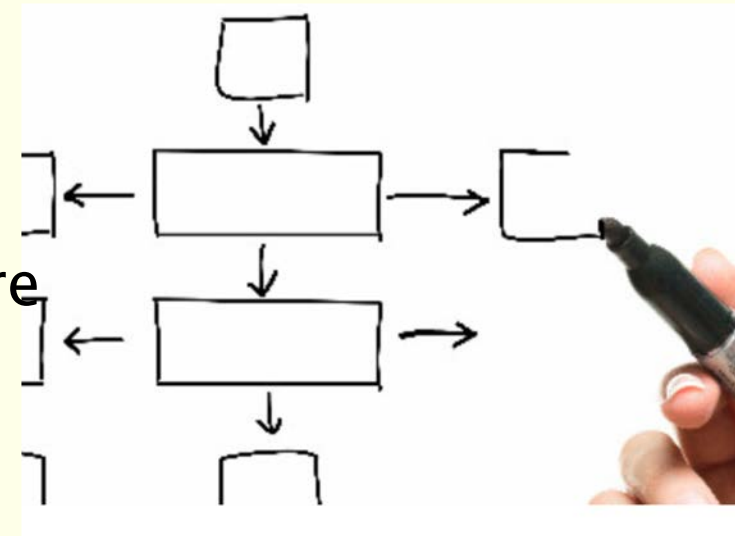
POLITÉCNICA

"Ingeniamos el futuro"

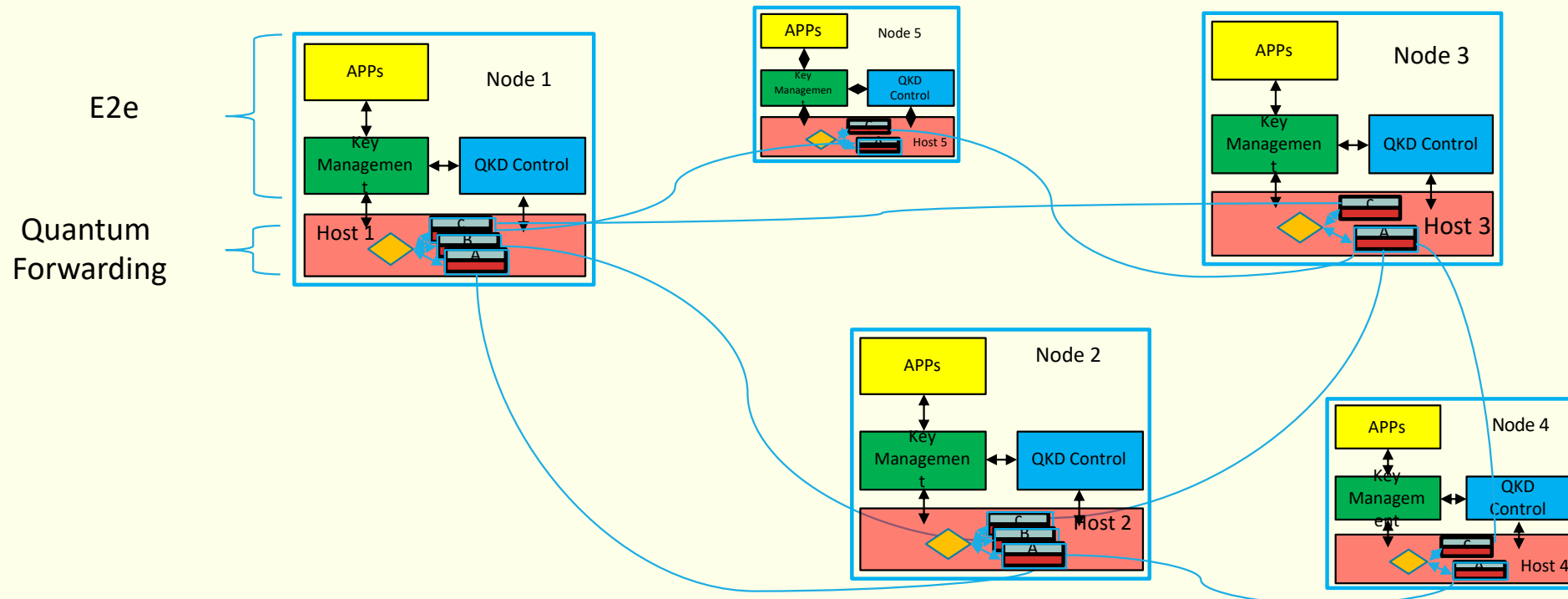
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- ▶ General Structure. What is new?
 - Decouple & Reuse : A network with two planes
 - An E2E overlay
 - The Quantum Forwarding Plane
 - Favor a large ecosystem
 - Integration in security ecosystem
 - Integration in networking ecosystem
- ▶ A generic model
- ▶ Settling for a Specific model : SDN
 - What has been done / what is missing

- Quantum Networks as composed of **two planes**
- An **E2E, overlay plane**, where the “product of quantum resources” becomes available
 - With a structure suited to the specific service
 - Key distribution in a QKD network, where the keys are stored and delivered by a KMS
 - Qubit transmission in teleportation
- A **Quantum Forwarding Plane (QFP)**, to encapsulate the “transport” of quantum signals
 - Direct qubit exchange
 - Entanglement distribution



- A Quantum Network is just a collection of nodes
 - E2E (overlay) plane components combined with QFP components
- E2E components as complex (KMS for QKD) or simple (quantum buffer for teleportation) as required
- E2E and QF planes interact through a control module
 - Applying SDN principles for network operation and management



Favor a Large Ecosystem: Disaggregation

Why consider disaggregation?

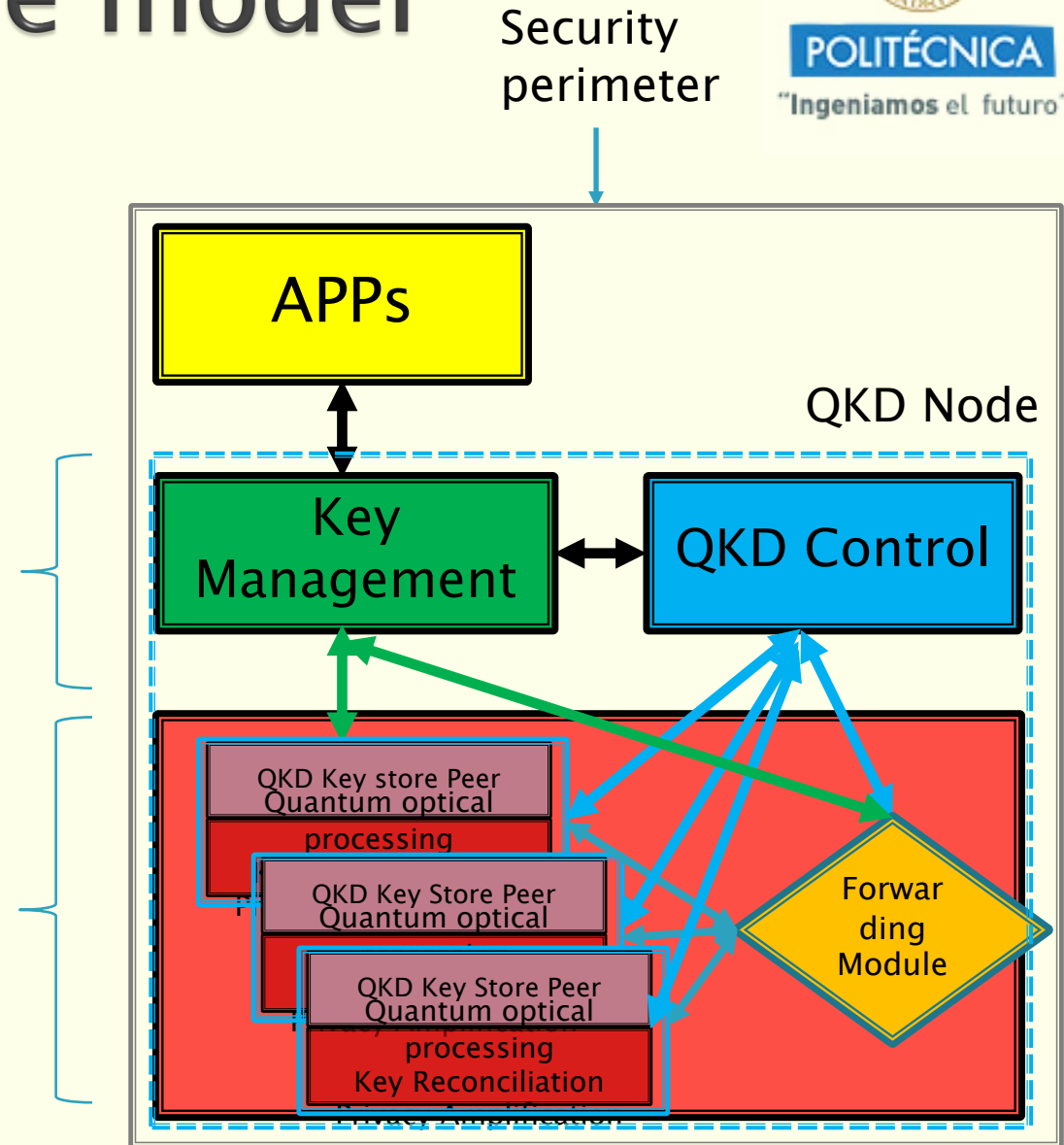
- We want to help QKD to become a mainstream technology.
- Parts of a QKD network are actually **extensions of classical technology**
 - e.g.: The Key management systems (needs adapted symmetric key mgmt.)
 - e.g.: The controller in a SDN network (needs how to control QKD systems)
- If the **components/interfaces are clearly specified** (and large enough):
 - The key mgmt. company could put an add-on module to support fast renewal of symmetric keys and have a "QKD-ready" product.
 - The SDN SW company could include a control module in e.g. OpenDaylight to integrate QKD in networks.
- **Opens the door to other industries to become part of a QKD ecosystem.**

A generic node model

- **Full QKD Node**
 - with a Classical and Quantum part
 - It needs to have a **control module**
 - Centralised or distributed. Could be more than one.
 - It needs to have a **Key Manager**
 - Centralised or distributed. Only one per node: just one entry point for the **APPLications**.
 - **Interfaces** appear naturally between well defined components (with clear functionality)
 - **Intra-node** (local) and **Inter-node** ifcs.
 - Possible **standardization points**.

C. Part
e2e

Q. Part:
QFP
"QKD
Host"



► Once the components are fixed this determines the **INTERFACES**.

■ **Intra-node (local) interfaces:**

- App – Key manager interface.
- Key manager – QKD Forwarding module .
- Key manager – QKD module
- Key manager – Control interface.
- Control – QKD module interface:
- QKD Module – Forwarding Module interface
- Control – Forwarding Module Interface

■ **Inter-node interfaces:**

■ Key management related node interfaces:

- Node KM to node KM interface
- Node KM to Central KM interface

■ Control Node interfaces:

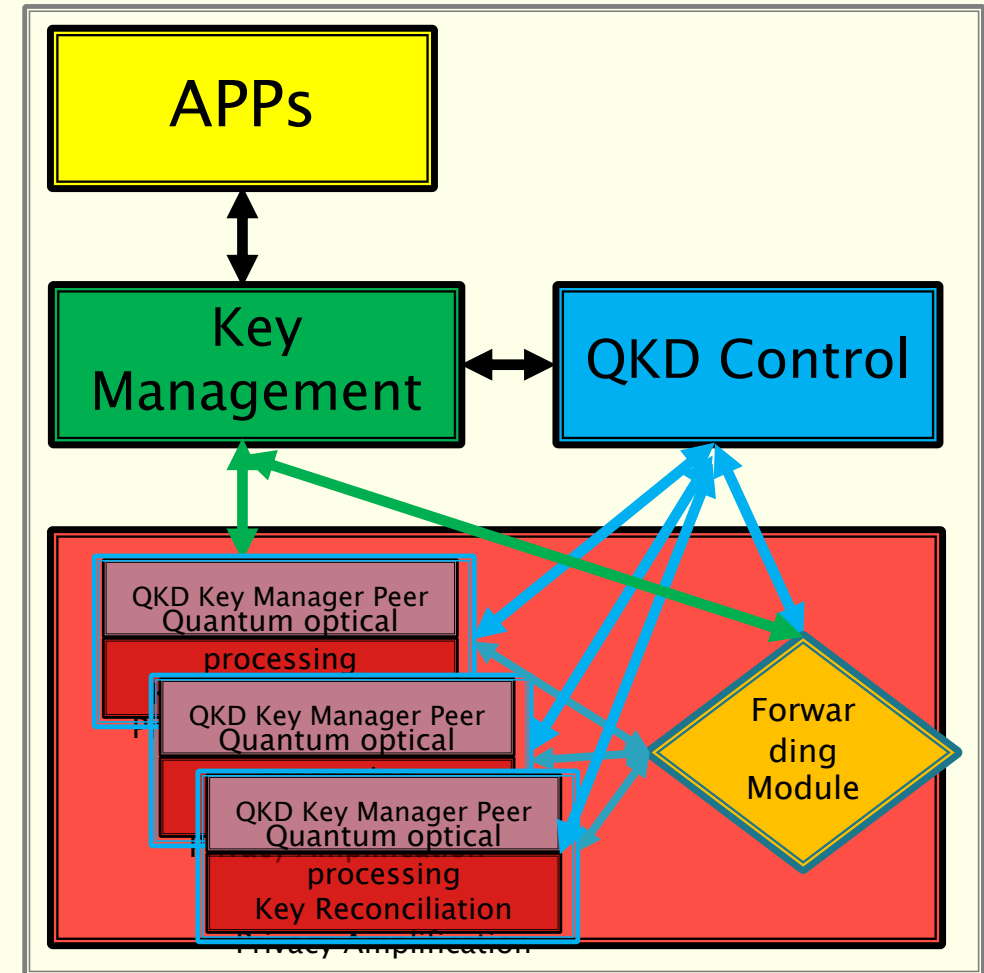
- Node KM to Network Control Interface
- Node Control to network Control Interface
- QKD Network Control peer interface

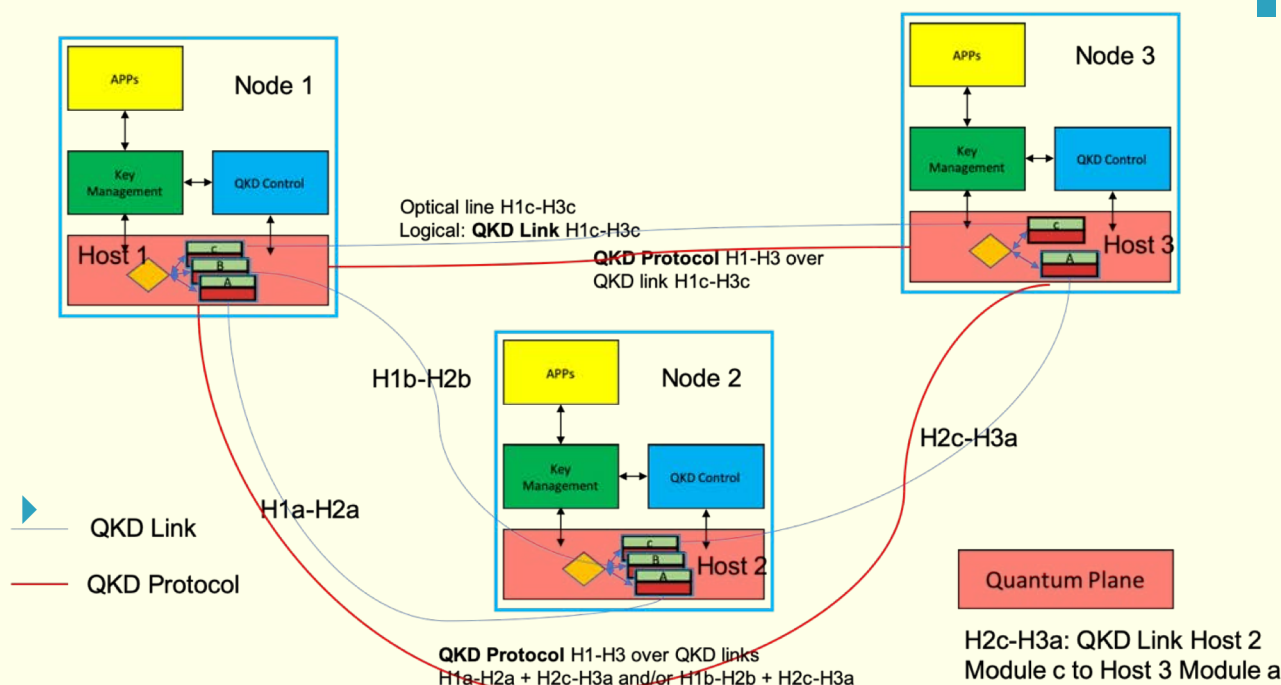
NOTE: not all interfaces have to be present always.

- Because they are exclusive, e.g. A interface for a centralized component in a distributed implementation
- Because the implementation coalesces two components into one, then their (explicit) interface disappears.

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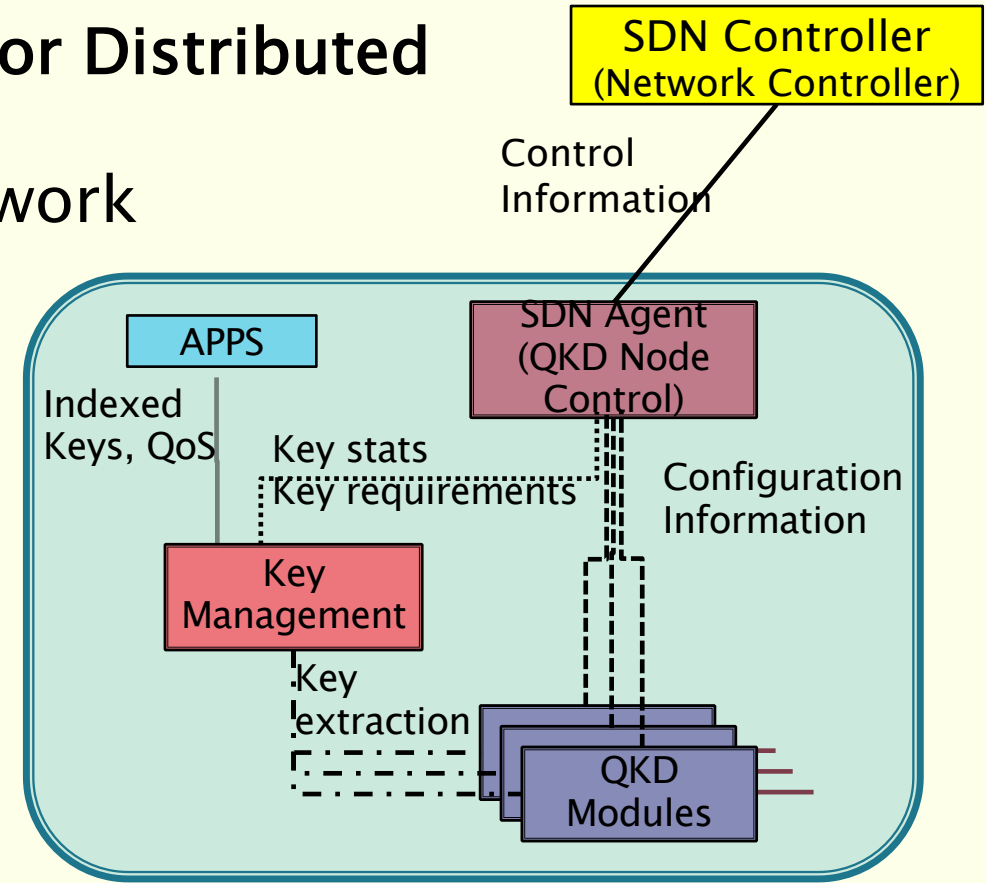
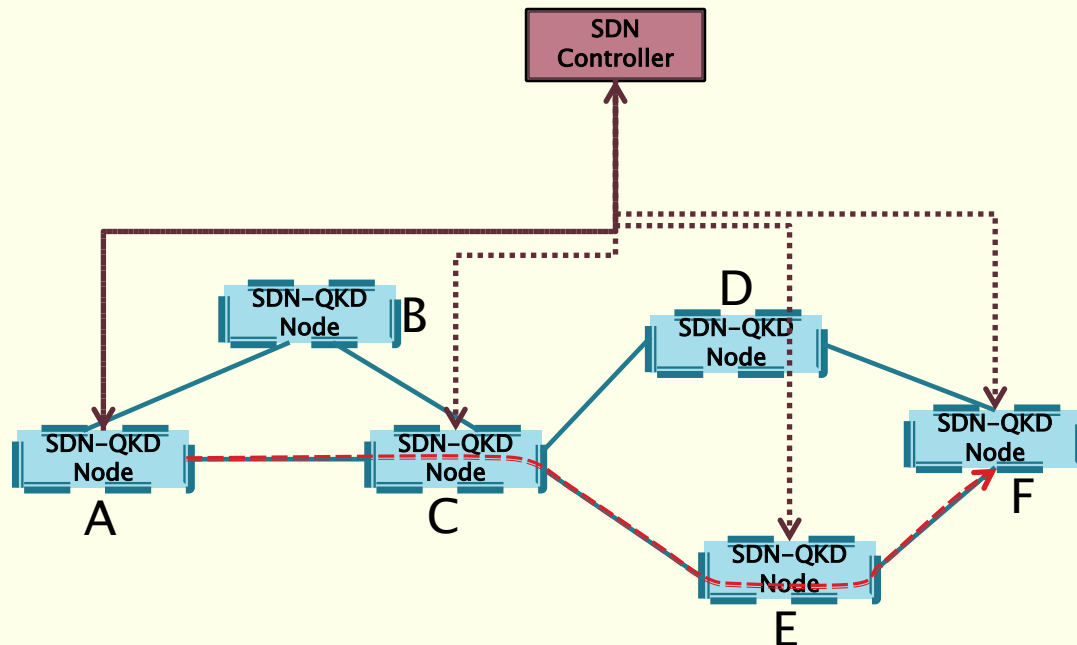
- Node KM to Node Control Interface
- Node KM to Network Control Interface
- Node Control to network Control Interface
- QKD Network Control peer interface (e.g. between domains or networks or between classical and quantum sections of the network if classical/quantum control is separated)

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- Components can be mapped in Centralized or Distributed architectures.

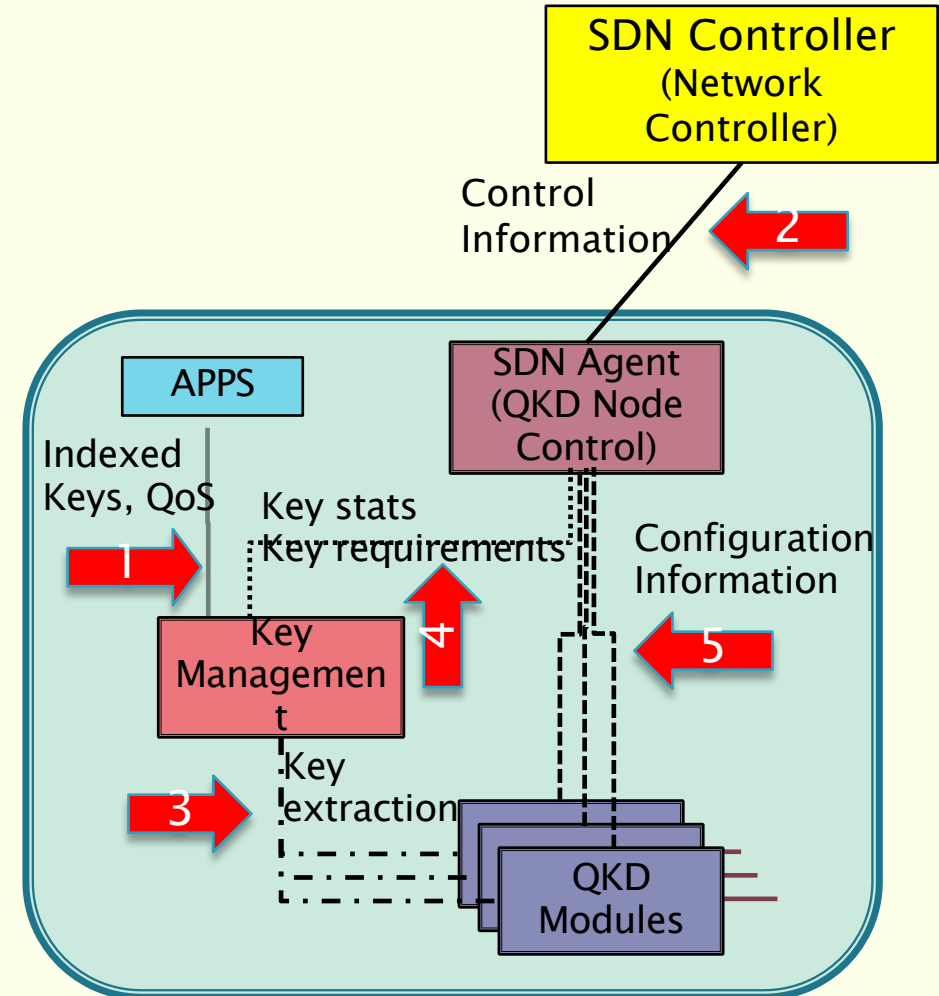
E.g.: Centralized Control SDN QKD Network



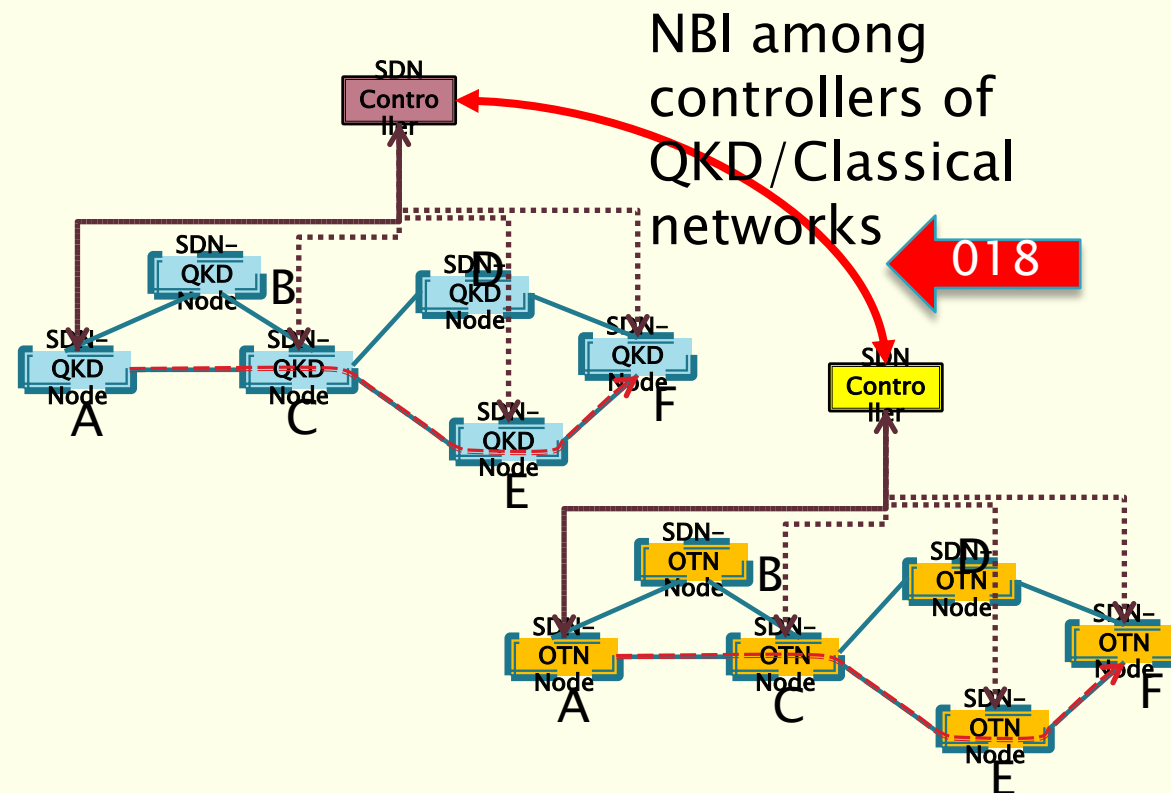
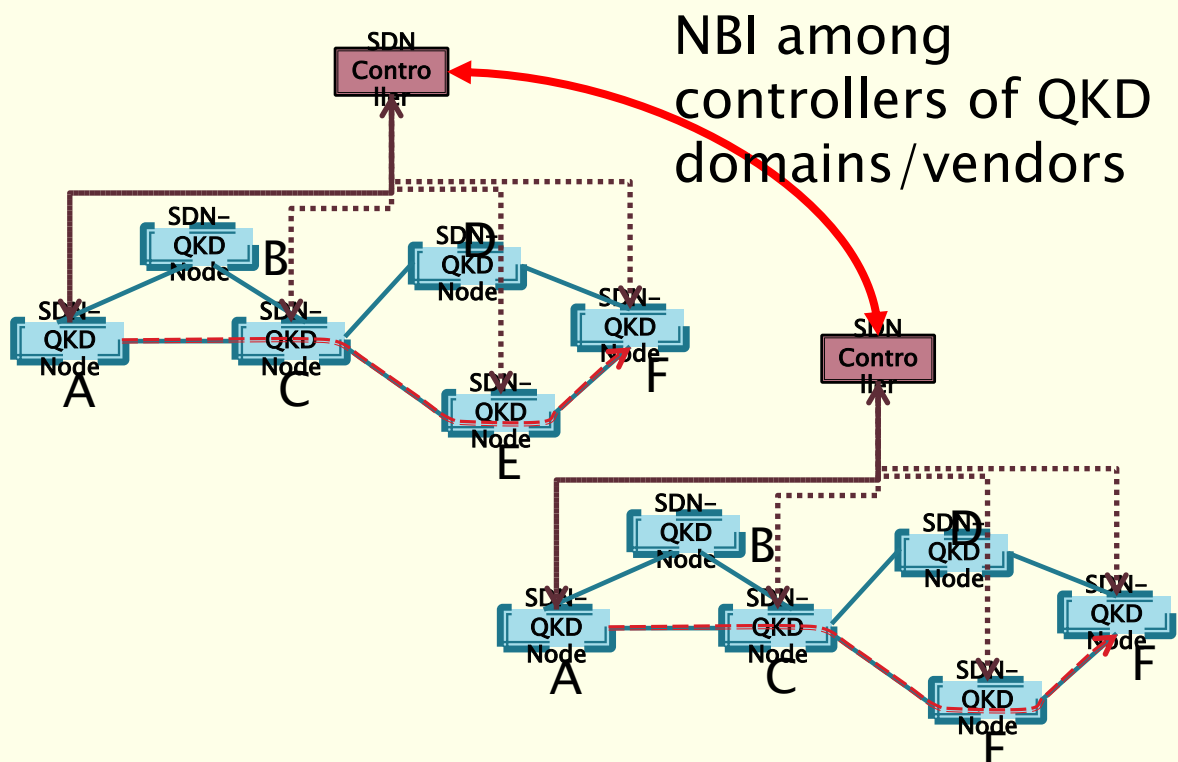
E.g.: SDN QKD Node

- Some of the Interfaces were already subject of standardization at ETSI.

-  and  ETSI ISG GS 004 and 014 Key API.
-  ETSI SDN QKD GS 015, SDN Control Interface



- But many are not ...



018

ETSI SDN QKD GS 018, Orchestration Interface for SDN Networks

- ▶ Importance of clearly defining “What is new”
 - E2E overlay plane for services/products of the
 - Quantum Forwarding Plane
- ▶ Keep an eye on the ecosystem
 - We are not alone: Interface with what exists, facilitate new players (dissaggregation)
- ▶ From a general model to a Specific one.
 - Flows of information –> Interfaces, standards
- ▶ Not discussed: setting up and managing the whole infrastructure
 - Operationalization