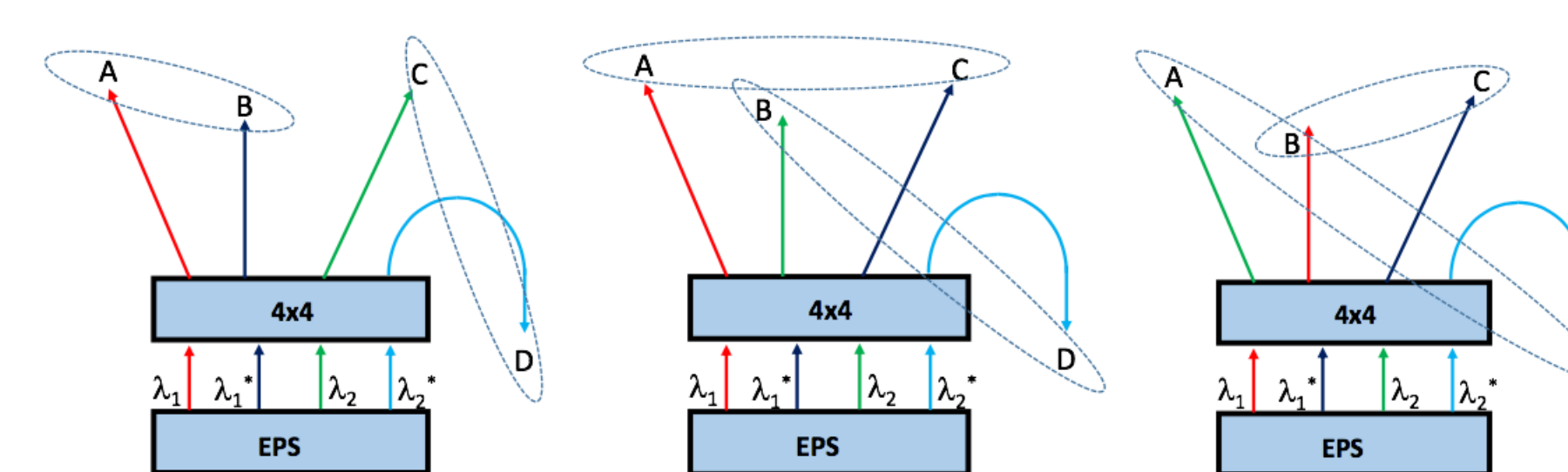


What is IEQNET?

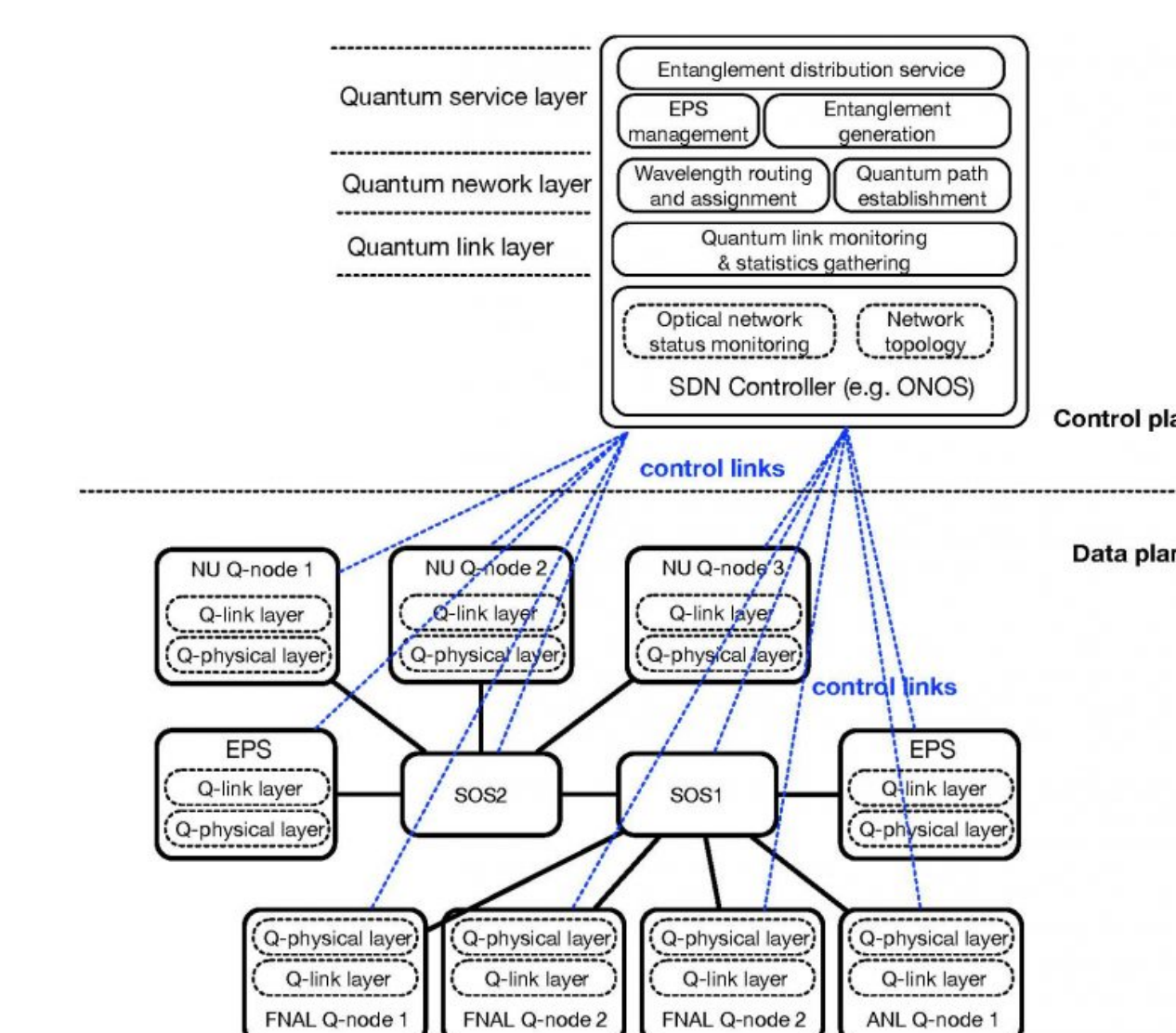
- A metropolitan-scale quantum network testbed that demonstrates important quantum networks capabilities
 - ❖ Support multi-node, flexible, and resilient network configurations
 - ❖ Support multi-users
 - ❖ Coexist with traditional networks in the same optical fiber transmission systems and share the same DWDM network component.
 - ❖ Adopt a layered architecture and a centralized control.
- A joint research project among FNAL, ANL, Northwestern University, Caltech, NuCrypt, and HYPERLIGHT
- Project web site: <https://ieqnet.fnal.gov>

Network Design & Architecture II



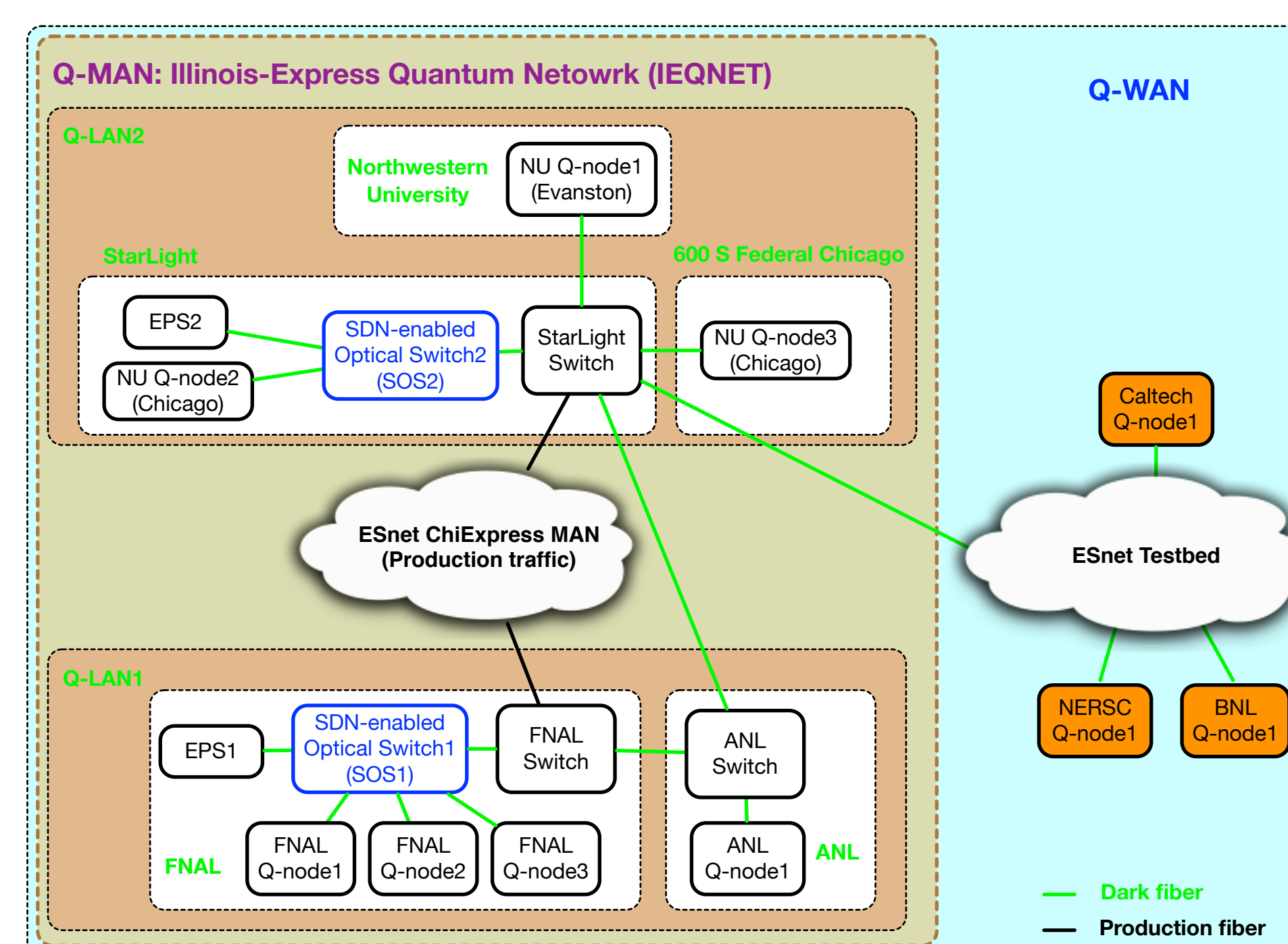
Support multi-users, flexible, and resilient network configurations

Depiction of entanglement distribution using a 4-wavelength EPS connected to a 4×4 spatial switch.



A layer architecture and a centralized control

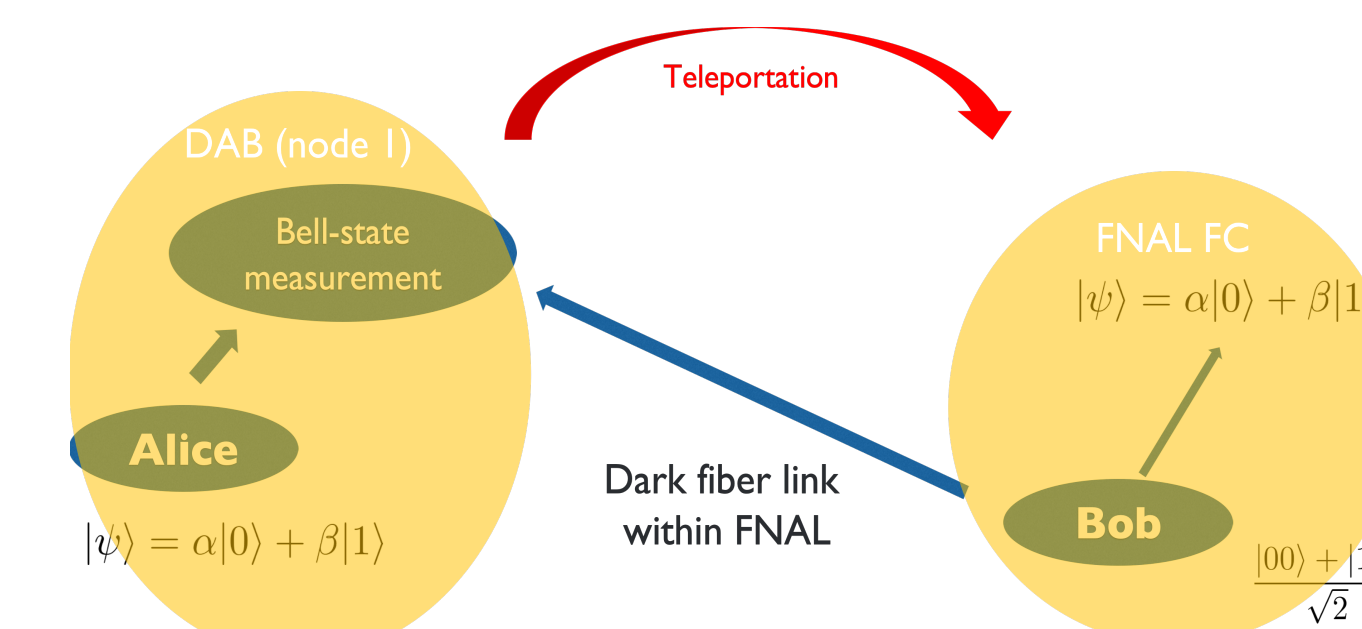
IEQNET Topology



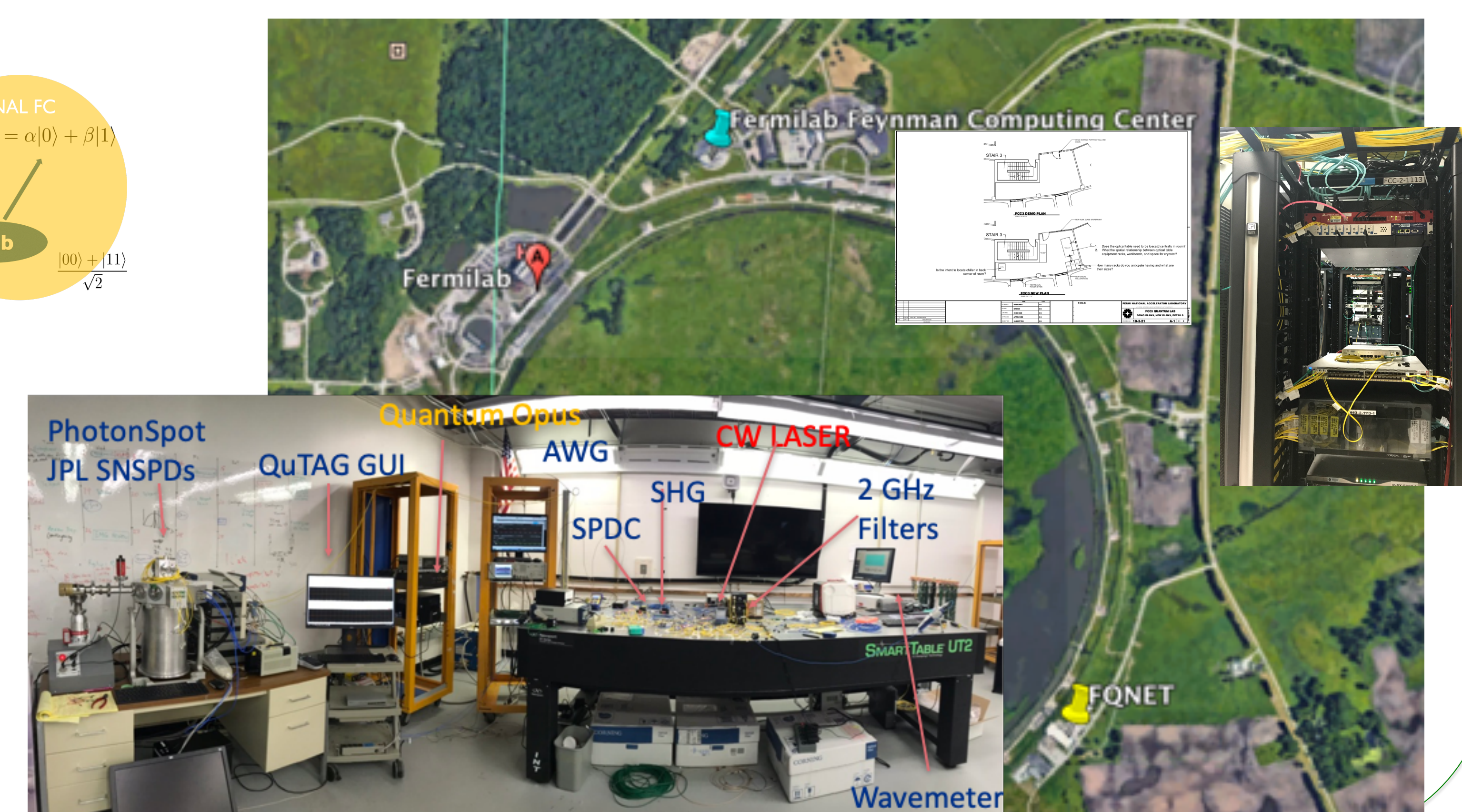
- Q-LAN1 (based on existing FQNET)
 - EPS1 (Entangled photon source)
 - SOS1 (SDN-enabled Optical switch)
 - Q-nodes
- Q-LAN2
 - EPS2 (Entangled photon source)
 - SOS2 (Optical switch)
 - Q-nodes

IEQNET can be extended in the future to build up the quantum Internet

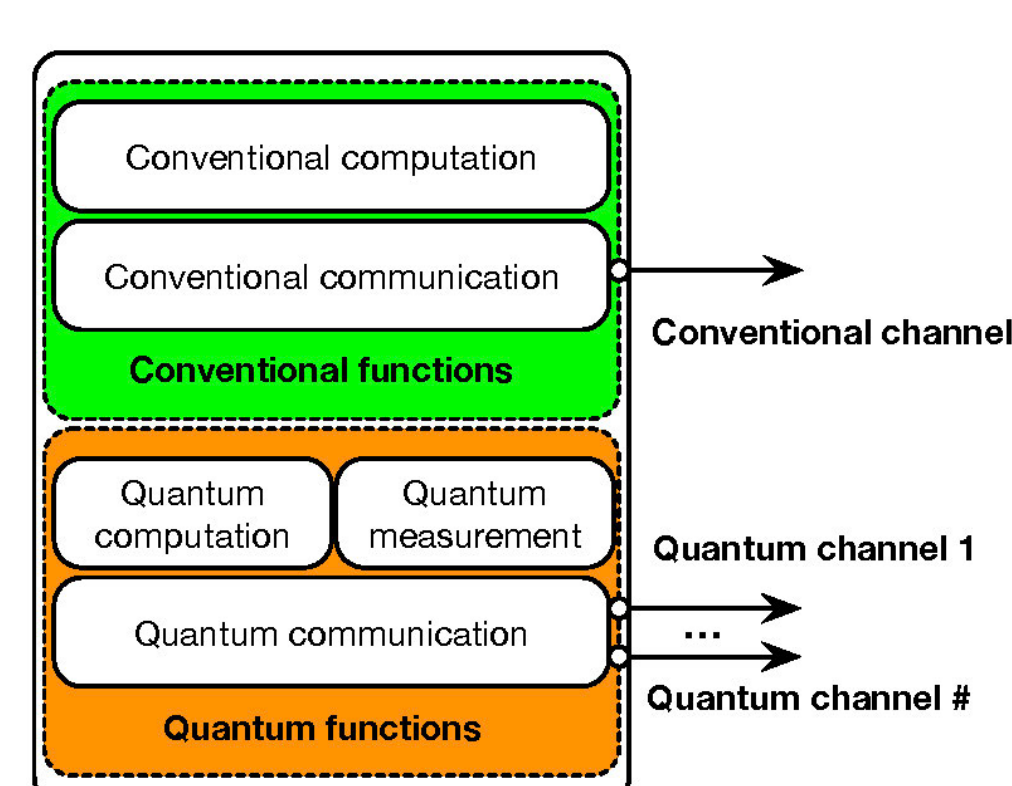
IEQNET Status I



- 5 km separation
- Exploring routing options
- First switch installed at FCC, ready for first test involving existing FQNET nodes

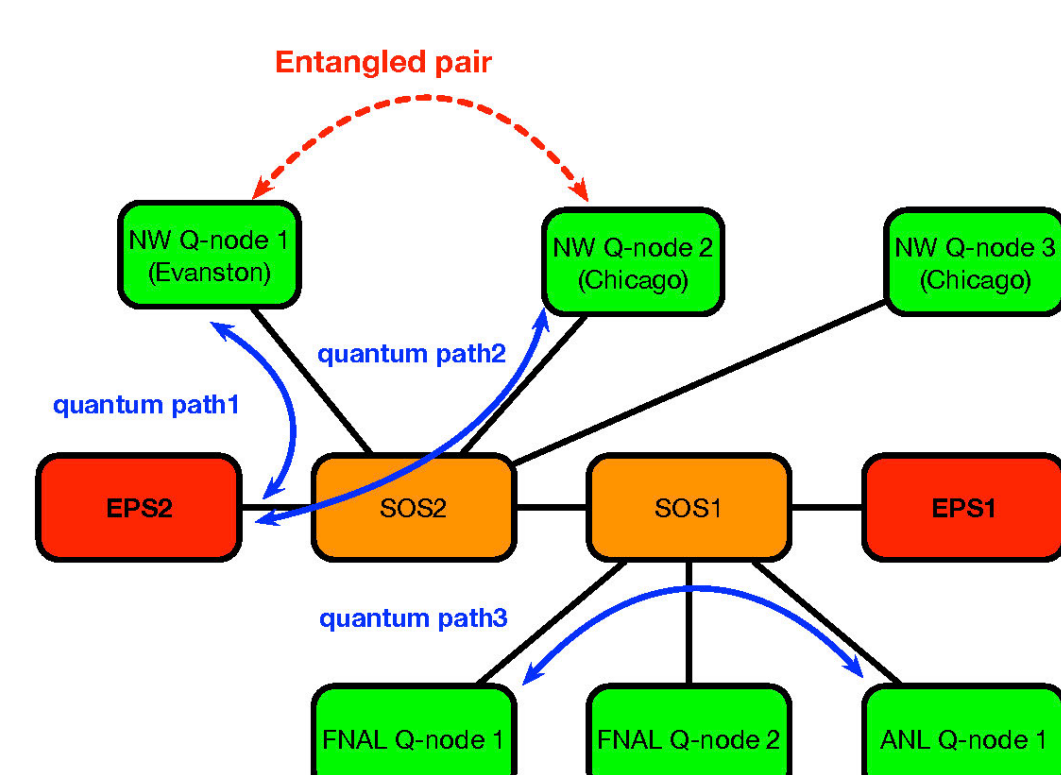


Network Design & Architecture I



IEQNET Q-node model

Q-nodes represent the communication parties in quantum network



Quantum path and routing

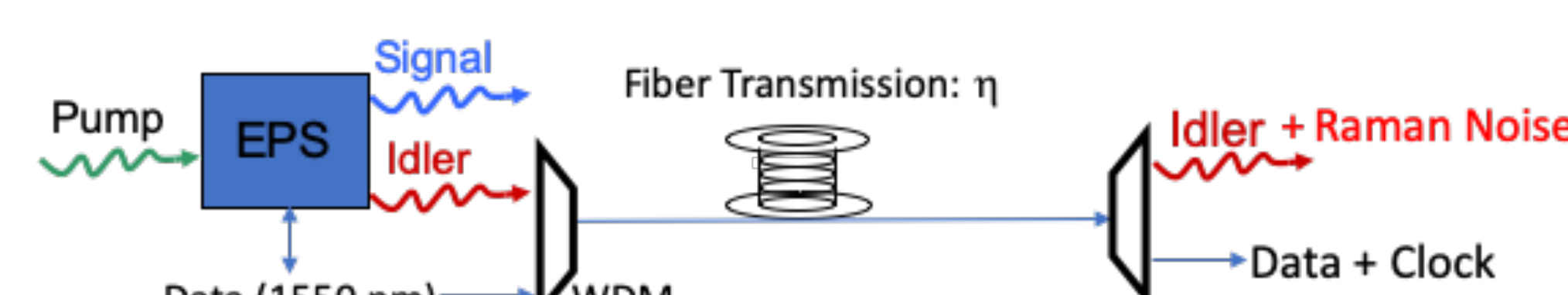
Use SDN to perform wavelength routing and assignment to establish quantum paths

IQNET Status II

Co-existence:

Case 1: 1310 nm entangled photon source (EPS)

- Bidirectional fiber connections: EPS-to-Receiver carries quantum and classical channels
- Use 1550 nm band to transmit classical data and clock recovery
- Can embed clock recovery in binned data channel (for control of quantum link);
- Control Raman using matched filtering and ~30 THz wavelength separation
- Goal for 100's of mW co-propagating total power in data channels (DWDM compatible)



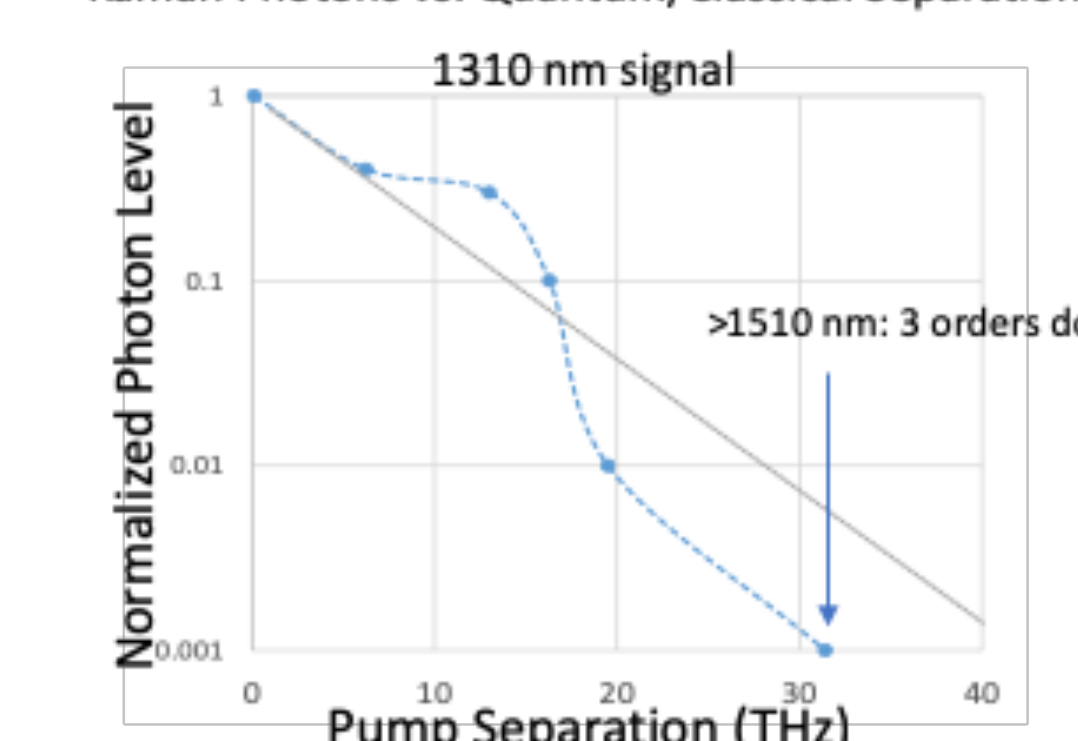
Case 2: 1550 nm quantum photons

Option 1: - Use CWDM bands: 1270, 1290 ± 13 nm for data/clock channels

- perform "frame" synchronization to allow long distance timing information)
- timing accounts for group velocity dispersion
- Control Raman using matched filtering
- Goal for 10's of mW net power in co-propagating data channels

Other options include: DWDM (C-band) or CWDM (1610 nm) lower-power clock/data channels

Raman Photons vs. Quantum/Classical Separation



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