SDN Enabled Optical Networks

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Overview

- Issues:
  - Exponential growth of data
    - Scientific simulations, experimental data, collaborative data analyses for high energy physics, climate change, genomics, fusion, etc.
  - Wide range of communication patterns
    - Diverse research teams lead to new and fluctuating communications traffic patterns
  - Multiple Networks
    - End user communication may require multiple national networks
- Approach: Combine SDN and FlexGrid

# Transitioning to Elastic Optical (Flex Grid) Networking

UCDAVIS UNIVERSITY OF CALIFORNIA

Raytheon BBN Technologies

Conventional DWDM Network
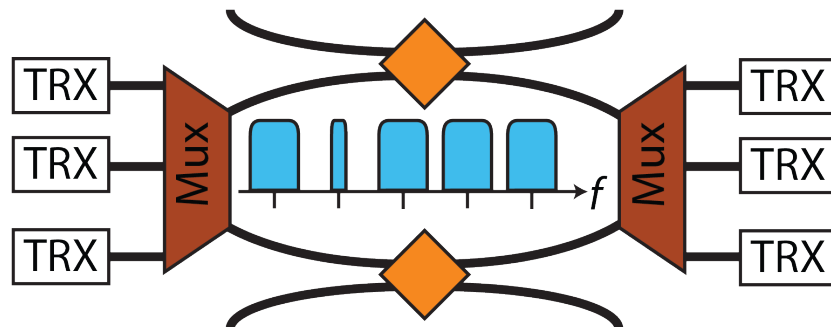
TRX = Transmitter and Receiver

- **Limited achievable spectral efficiency due to spectral guard bands**
- **Single channel bandwidths limited by frequency grid spacing**
- **Sub-wavelength and super- wavelength channels difficult**
- **Stranded bandwidth problem**

Flexible Bandwidth Network
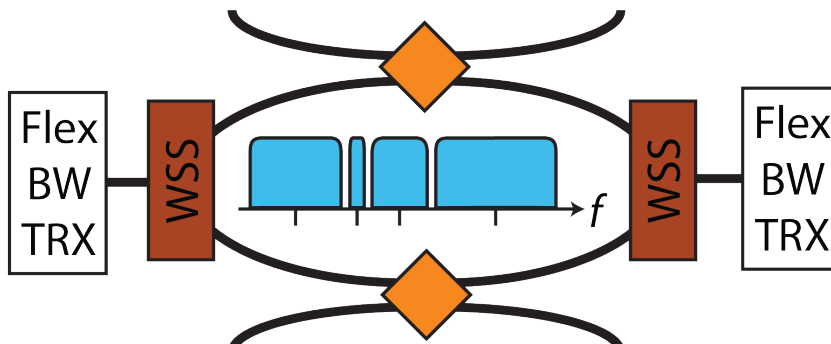
Flex BW TRX = Flexible Bandwidth Transmitter and Receiver

- **Spectral efficiency no longer limited by network architecture**
- **Arbitrary channel bandwidth capable**
- **Arbitrary modulation format capable**
- **Capable of sub-wavelength and super-wavelength channels**

Routing and Spectrum Assignment (RSA)

- The setup and release of connections in a dynamic elastic optical network (EON) scenario can fragment the optical spectrum into non-continuous small pieces

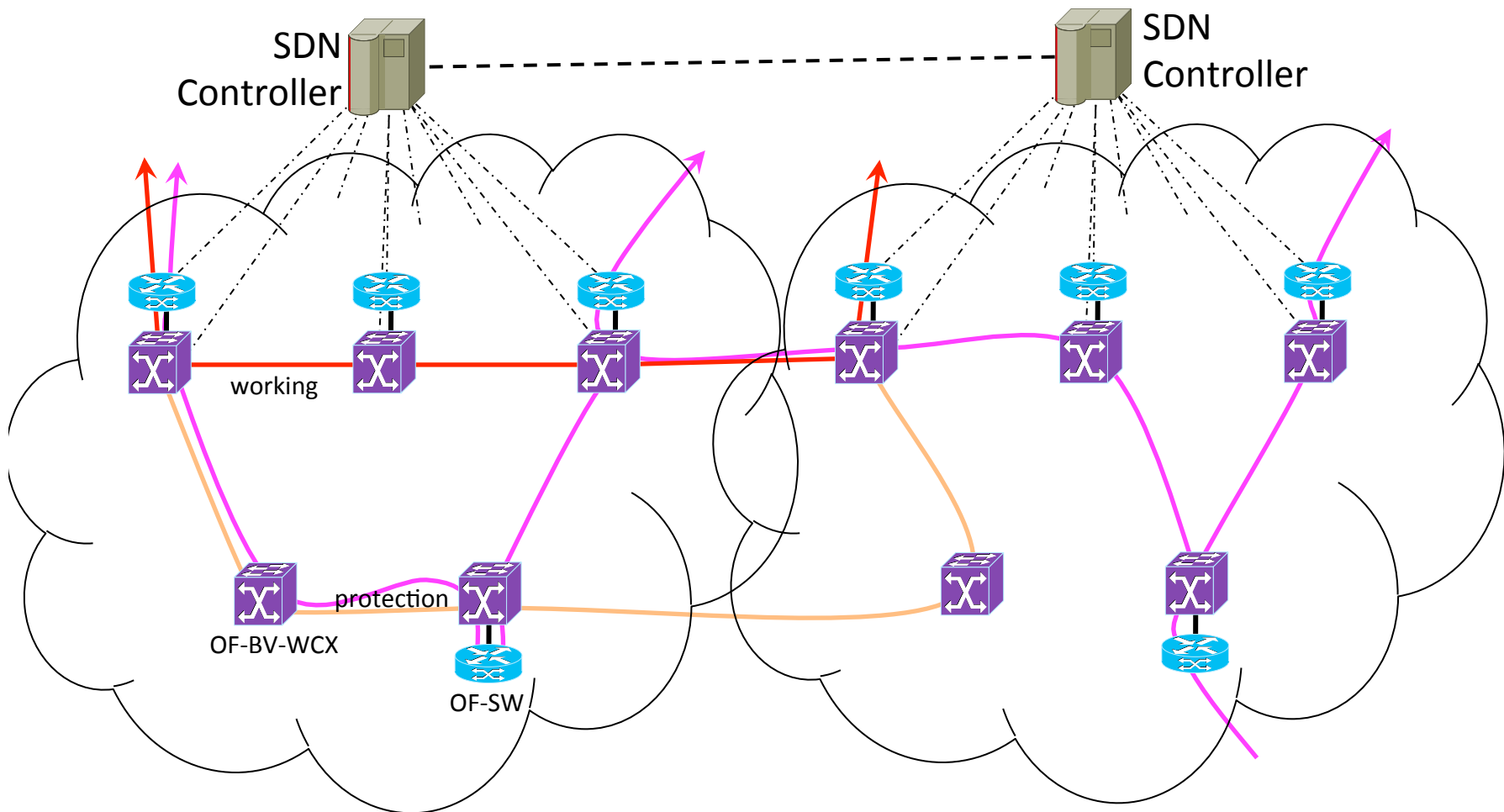- Two fragmentation-aware routing and spectrum assignment algorithms are implemented
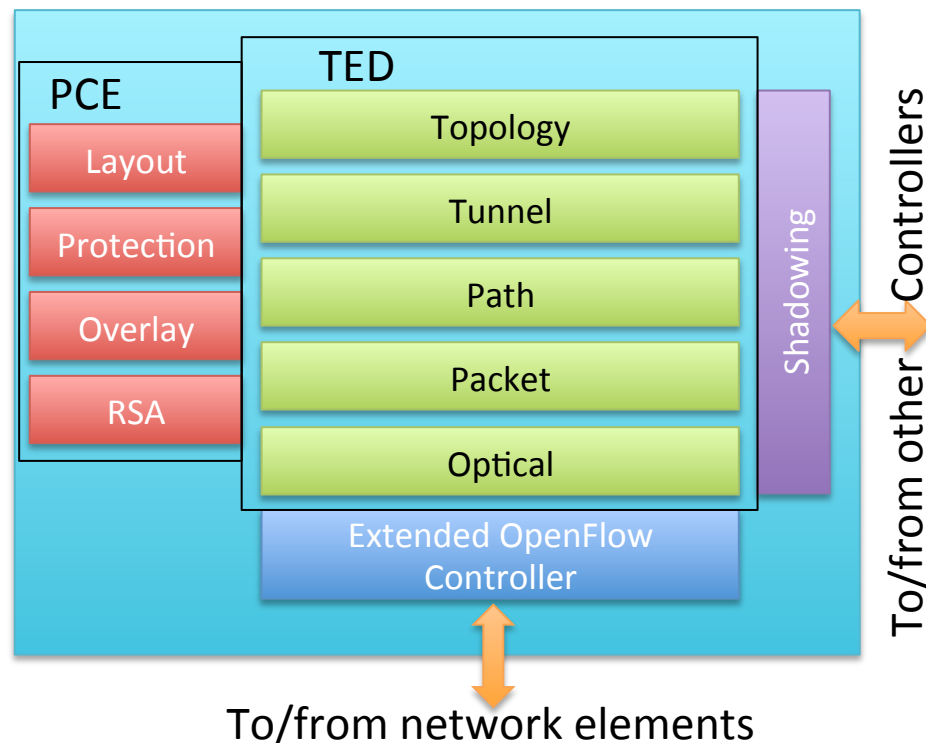
Our SDN-EON testbed
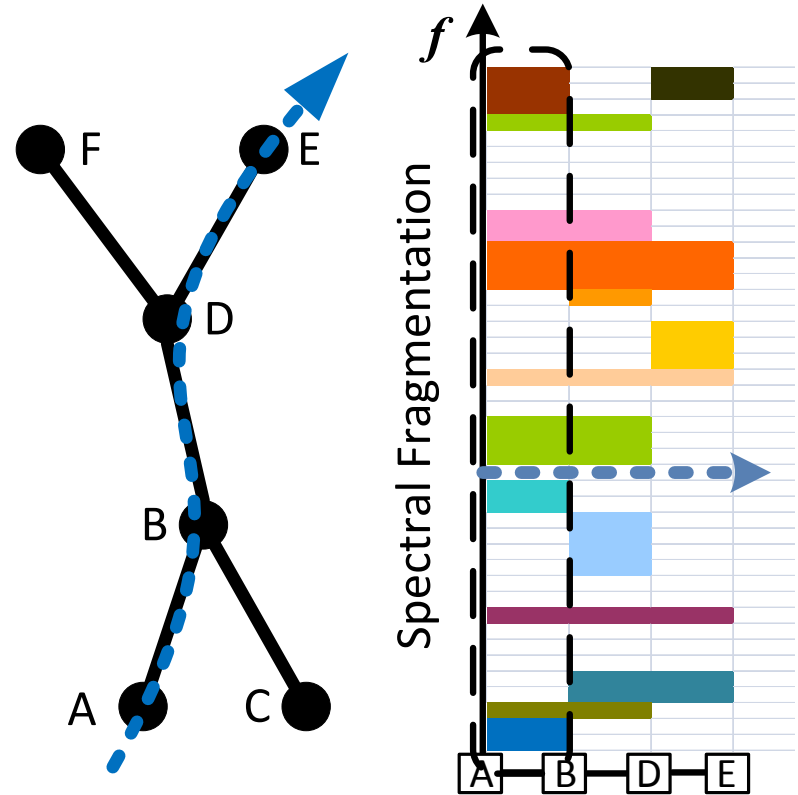
- **Real-time, dynamic waveform switching based on supervisory channel monitoring**
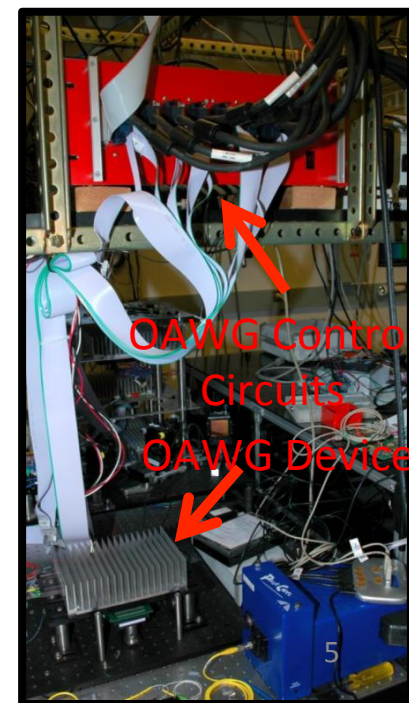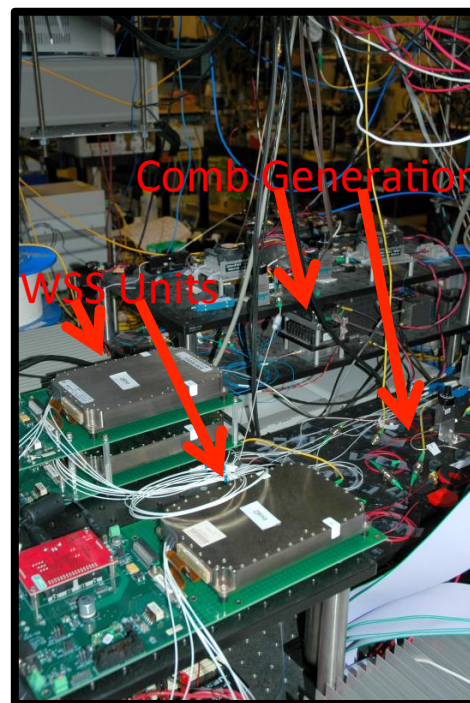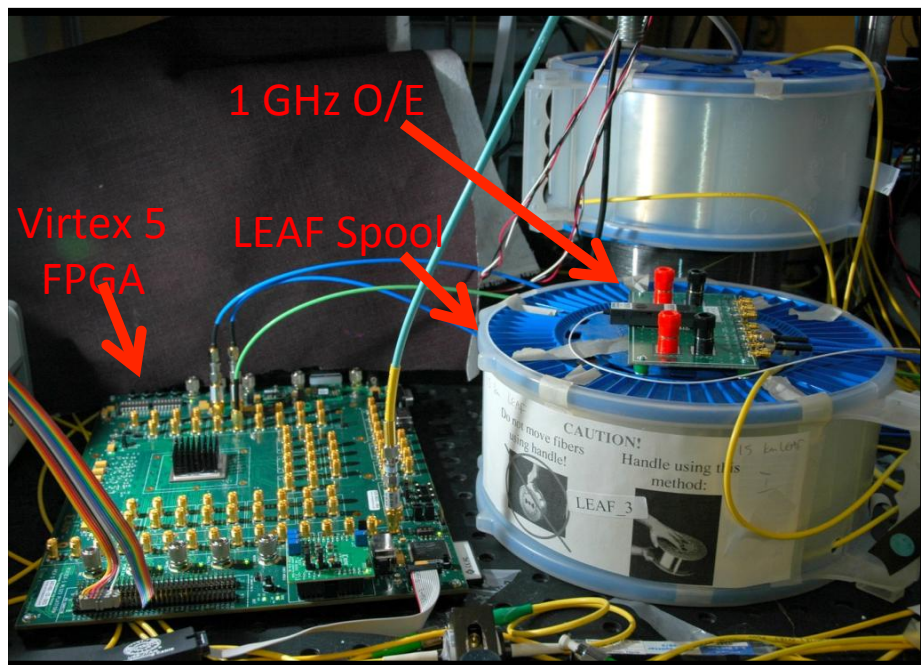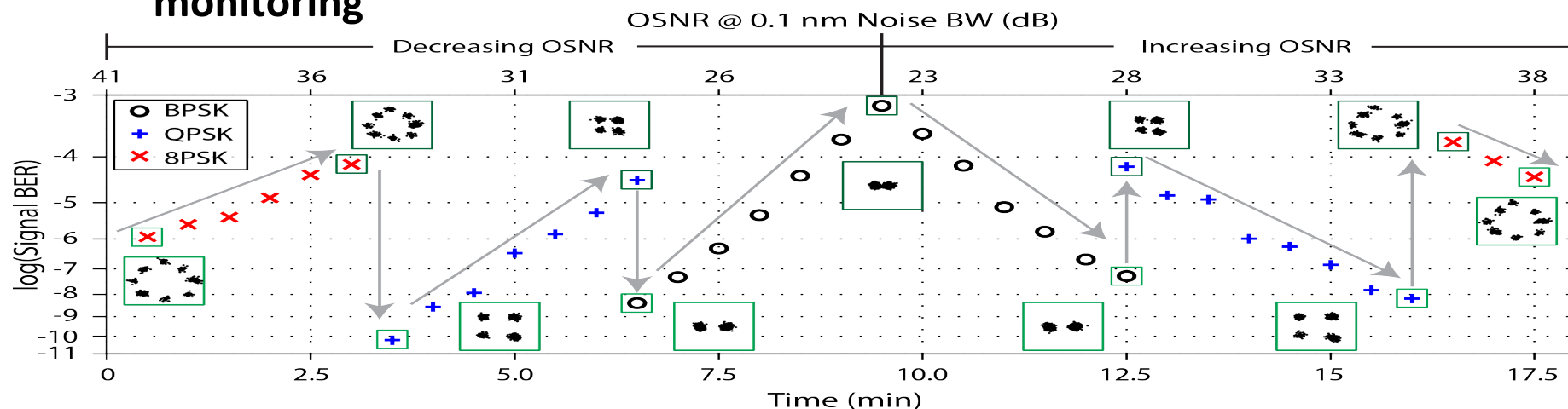
Objectives

- Cross-layer optimization
- Cross-domain decomposition

- Reliability
- Wide range of virtual topologies

SDN Controller Architecture

- Supports cross-layer optimization
- Supports sharing information with other controllers (shadowing)
- Event-based triggering in response to network changes or topology requests
- Implemented algorithms for:
  - Constrained Shortest Path, Maximum Flow, 1:1 protection, VPN layout, point-to-point RSA, Sharing TED info

Technical Challenges

- Cross-layer optimization
  - Topology layout (multicast)
  - Packet overlay
  - RSA

- Cross-domain decomposition
  - What information to share
  - Semi-distributed algorithms

- Reliability
  - Shared backup protection
    - Point-to-point, multicast, network
  - Failure detection, isolation, reconfiguration