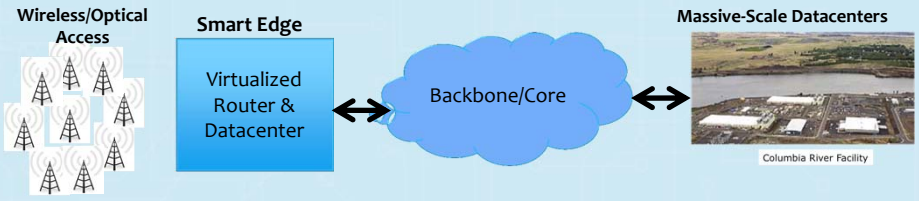
Integrated Wireless/Optical Access

Leslie A. Rusch
Université Laval

Core Team

- Leslie A. Rusch
  - Université Laval, Optical Communications, extensive laboratory facilities for radio over fiber testbeds
- Tho LeNgoc
  - McGill University, Wireless Communications, extensive laboratory facilities for software radio
- Majid Ghaderi
  - University of Calgary, Resource Allocation for Wireless Networks and Network Modeling
- Carey Williamson
  - University of Calgary, Broadband Wireless Networks, Protocols, Applications, and Performance
- Assembling new SAVI recruits
  - 1 post-doc, 5 graduate students, 2 undergraduates

SAVI Scope



Scope: Aspects that are central to future application platforms and that address key challenges to network and service providers

- **Wireless access in the 2015-2020 timeframe;**
- **Novel optical backhaul including radio-based methods in the optical domain;**
- Extension of cloud computing to infrastructure in a service provider smart edge;
- Control & management systems to enable experimentation with application platforms and Future Internet alternatives
- Clean and low-energy infrastructure;
- Application enablement **leveraging very-high bandwidth access** and services in the smart edge.

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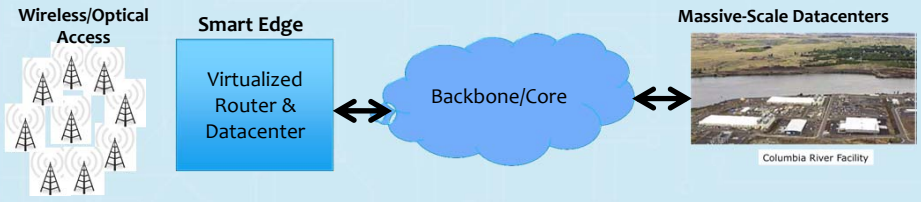
Future Application Platforms



- **High-bandwidth mobile apps**
- Sensors and data collection
- **Dense small cells inside and out**
- **Agile long reach optical backhaul**
- **Energy-proportional access**
- Media rich and intelligent enabling services
- Balance between smart edge and remote cloud
- Virtualized routing/datacenters
- Adaptive management for on-demand capacity, energy efficiency and sustainability

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Theme 4. Integrated Wireless/Optical Access

Team: *Rusch (lead), Ghaderi, LeNgoc, Williamson*, Boutaba, Ganjali, Leon-Garcia, 1 post-doc, 5 grad, 4 interns, 2 undergrads

Design of Virtualized Wireless/Optical Access Testbed	Virtualizing Digital Optical/Wireless i/f	Radio over Fiber	Spectrally Efficient Virtualization
Very-High BW Dense Small-Cell Access Testbed	Virtualized Broadband Wireless Access	Dense Small-Cell Access Networks	
Energy Proportional Adaptive Capacity Resource Mgmt	Inter-VN Resource Manager	Intra-VN Resource Manager	

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Wireless/Optical Access

Design of Virtualized Wireless/Optical Access Testbed

SDR DSP

digital

optical

backhaul

Very-High BW Dense Small-Cell Access Testbed

SDR DSP

Energy Proportional Adaptive Capacity Resource Mgmt

Smart Edge

… enabling Theme 3 resource management

Virtualized Router & Datacenter

- Capacity increases via cognition and coordination (interference mgt and spectral efficiency)
- Energy efficiency increases via all-optical backhaul and centralized virtualization & resource mgt
- SDR and optical architectures that enable virtualization

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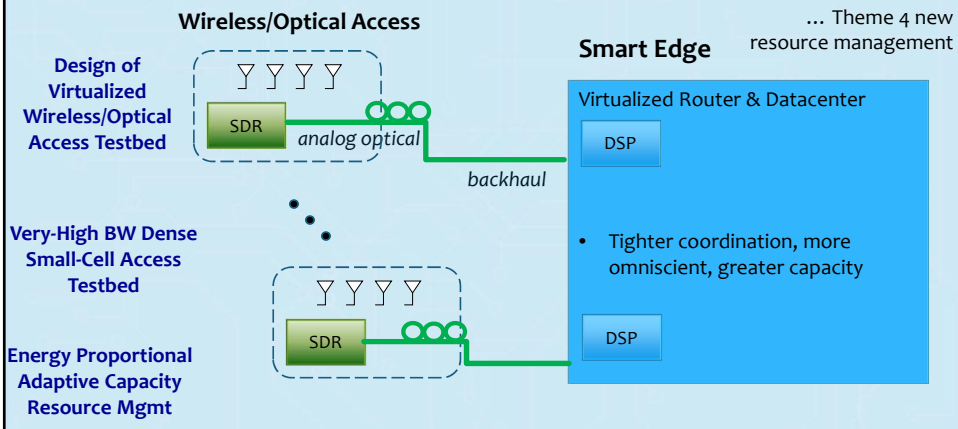
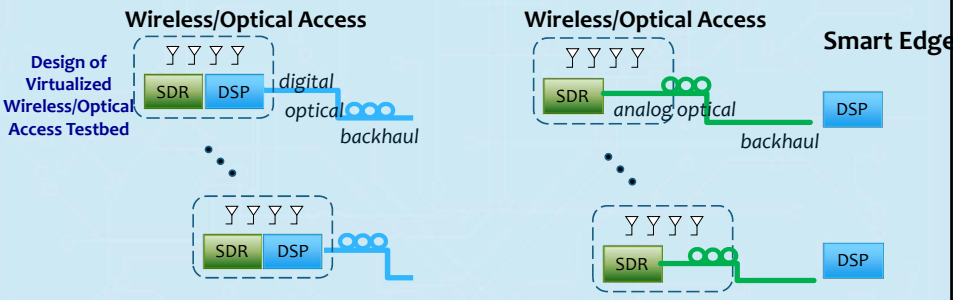
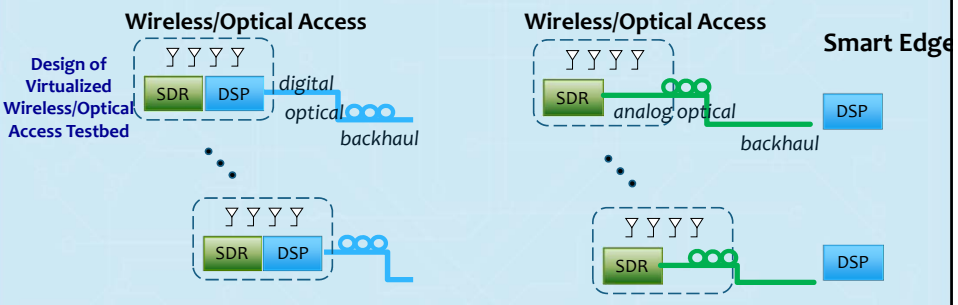


Radio over Fiber



- existing standards have high overhead and are tied to specific wireless interfaces; lots of "housekeeping" at access point
- RoF offers higher capacity by pushing housekeeping to smart edge where impact is smaller
- Challenges remain in multiplexing – multiple antennas per access points, various architectures for backhaul (PON, homerun, etc.)

Spectral Efficiency & Granularity



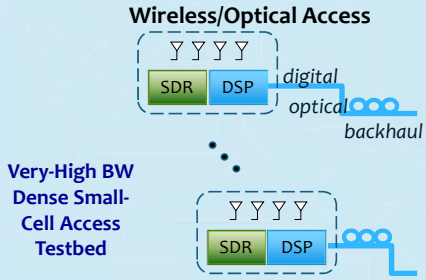
- Key challenge is granularity – very different sized pipes
- Trickle down of optical technologies from long haul (Cadillac) to backhaul (Volkswagen)
- Maintain spectral efficiency gains (vis-à-vis current standards) in analog transmissions as demand grows

Dense Cells

- Air-interface and network architecture design
- Cognitive radio
- Capacity and coverage optimization

smaller cells lead to denser networks, greater interference and greater gains from coordination

Exploiting Proximity



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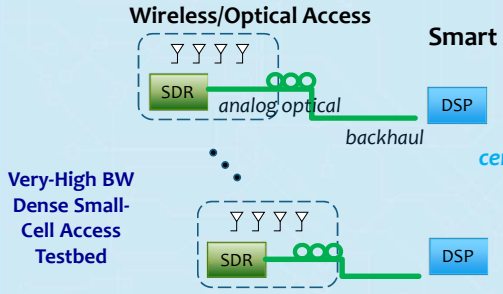
smaller cells lead to denser networks, greater interference and greater gains from coordination

distributed structures and various optimization criteria

- sum-rate maximization
- power minimization
- rate balancing under end-user QoS
- constraints in terms of minimum required rate and limited delay

Exploiting Coordination

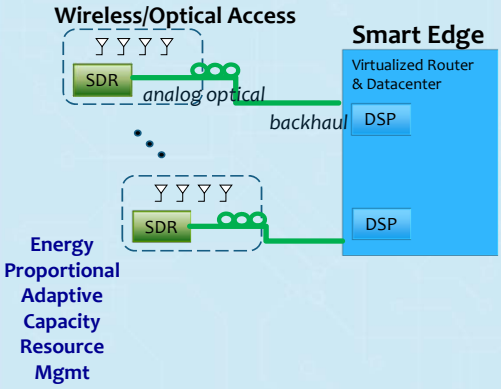


centralized structures

- cognitive radio with dynamic spectrum access
- power control and admission control mechanisms
- multicarrier signalling as an enabler

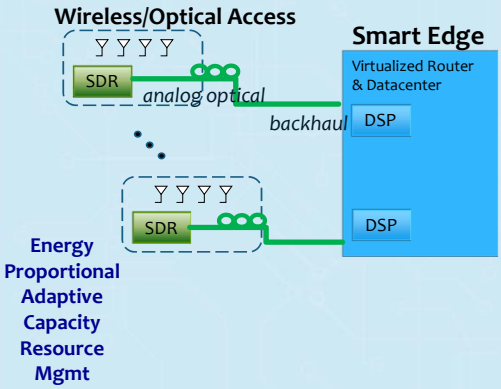
Limits of Control at a Distance

On-demand creation of VNs
- Resource isolation across different VNs
- Customization within individual VNs
- Efficient resource utilization



Energy Proportional Adaptive Capacity Resource Mgmt

Limits of Control at a Distance



Energy Proportional Adaptive Capacity Resource Mgmt

Inter Virtual Network Resource Manager

Inter-VRM is centralized and communicates with Intra-VRM modules

- Admission control of virtual networks
- Scheduling and interference management
- Energy proportional capacity management

Intra-VRM

Intra-VRMs are responsible for local resource management within individual VNs

- Flow admission control
- Flow scheduling
- QoS/QoE monitoring

SAVI Testbed & Theme Integration Activities