NSERC Strategic Network on Smart Applications on Virtual Infrastructure

Alberto Leon-Garcia
University of Toronto
SAVI Scientific Director

September 15, 2011

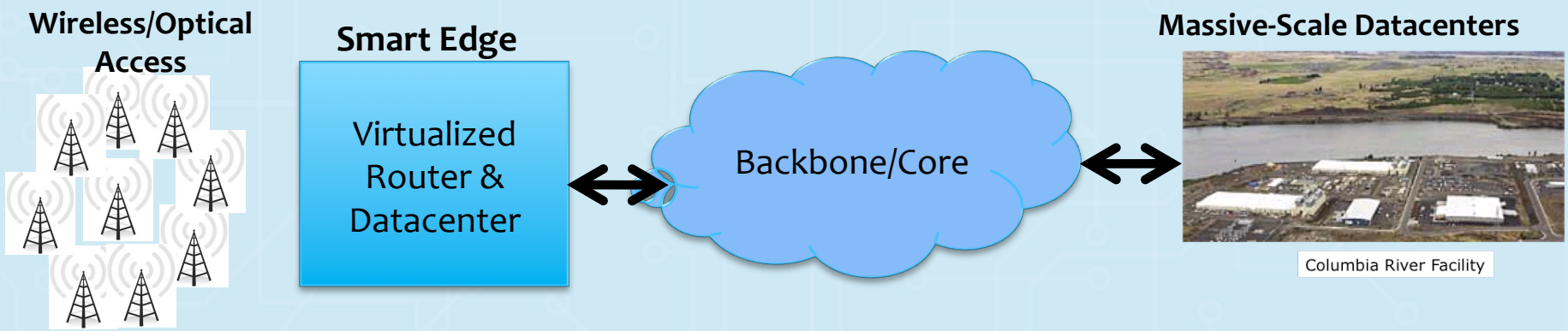
SAVI Challenge

- Vision of Application Platforms
  - Support open applications & content marketplace
  - Vast number of vendors buy/sell services to each other and to consumers
  - Extremely large scale, very high churn

- Fundamental requirements
  - Agile resource management in infrastructure
  - Scalability, reliability, accountability, and security
  - Multiple ownership: interconnection & federation
  - Rapid introduction of applications

Challenge: Design of infrastructure for application platforms that can achieve these requirements

SAVI Scope



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

- Extension of cloud computing to infrastructure in a ***service provider smart edge;***
- ***Application enablement*** leveraging very-high bandwidth access and services in the smart edge and the extended cloud;
- Control & management systems to enable ***experimentation*** with application platforms and Future Internet alternatives
- Integrated wireless/optical ***access controlled by the smart edge.***

Example App: Kaleidoscope

- Social Video Sharing
  - 10000 people in a stadium/main square/emergency
  - 1000 people streaming video from mobiles **(the video streaming app is location/ time aware)**
  - **Context**: tweet feeds (**identity**, **timestamp**), most from the **location** but from around the world
- Autonomic network provisioning through recognition of event
- Integration of the data streams from the different applications
  - Transcription **(adaptively on the core and/or smart edge)**
  - Tagging video with **(on the smart edge)**
    - tweets
    - links to other videos
- Searching the record
  - For a video from a special perspective (**location content and context**)
  - For video segments around specific tweeted events (through **time context**)
  - For videos from my friends (on the smart edge)

SAVI Innovation & Outcomes

Key Innovations

- Virtualization everywhere
- Two-tier Cloud
- Fine-grained adaptation
- Heterogeneous virtual operators
- Application-driven provisioning of infrastructure
- Open market services

Research Testbed Outcomes

- SAVI cluster prototype for programmable network node
- Adaptive edge-aware services platform
- SAVI application platform

SAVI Research Needs a Network Approach

- Computing & communications industries are converging
  - IBM, HP, Cisco, Juniper, …
- Applications, content & service delivery are converging
  - Telecom, Cable, Google/Android/YouTube, Apple, Amazon,…
- *A Converged Infrastructure is Inevitable*
- *But computing & communications research still separate!*

- SAVI offers a common infrastructure virtualization & management approach and promises major OPEX & CAPEX benefits
- Multidisciplinary team spans research areas
- Multisector partners provide business & technology views
- Partnerships will yield new insights, especially across inter-discipline & inter-sector seams
- New HQP will emerge that does not recognize the old seams
- Isolated individual efforts cannot provide these benefits

SAVI Partners

- TELUS
- MTS Allstream

- IBM

- Cisco
- Juniper
- Ericsson
- Ciena

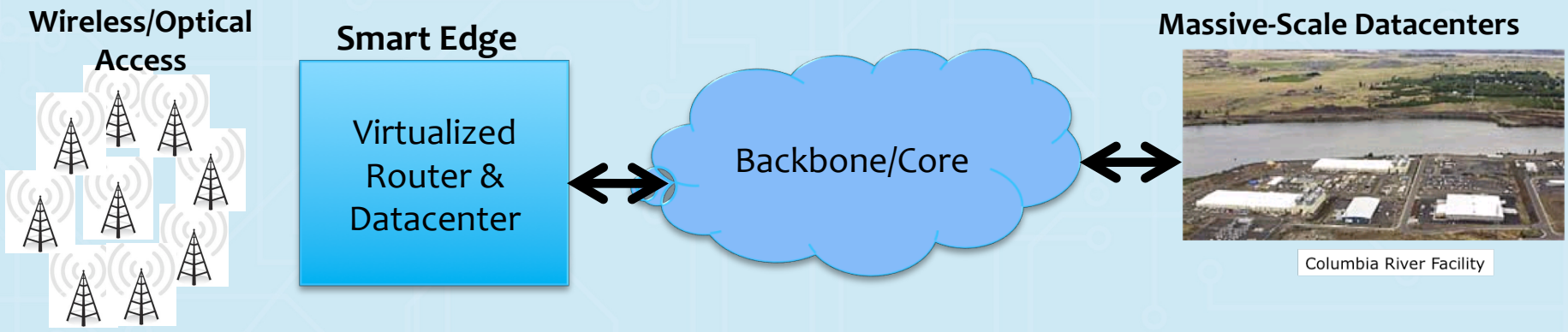
- Seawell Networks
- Nitido
- Dragonwave
- Belair Networks

- CANARIE
- ORION
- WestGrid

- SciNet
- Cybera

- Wesley Clover

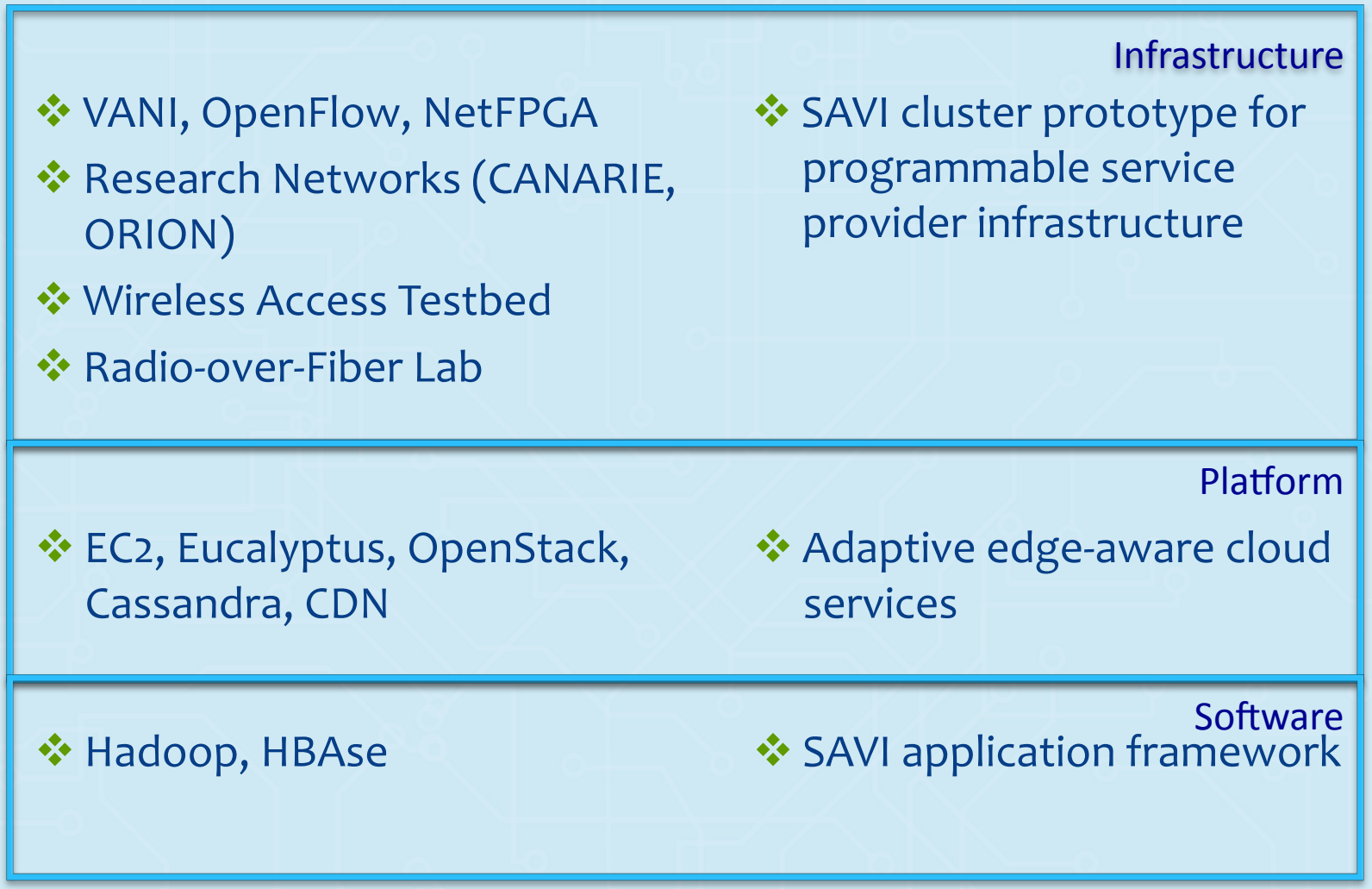
SAVI Research Program



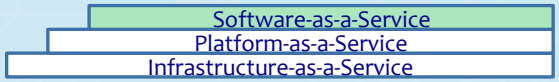
- Theme 1: Smart Applications
- Theme 2: Extended Cloud Computing
- Theme 3: Smart Converged Edge
- Theme 4: Integrated Wireless/Optical Access
- Theme 5: SAVI Application Platform Testbed

Software-as-a-Service	SaaS Mgmt
Platform-as-a-Service	PaaS Mgmt
Infrastructure-as-a-Service	IaaS Mgmt

SAVI Builds on Existing Base



Theme 1. Smart Applications



- **Team:** *Li (lead), Müller, Stroulia*; 1 postdoc, 5 grads, 6 interns, 2 undergrads

Future-Oriented Application Classes

- Large-Scale Data-Intensive Apps
- User-Centric Apps for Smart Mobile Devices
- Real-Time Collaborative Virtual Reality Apps

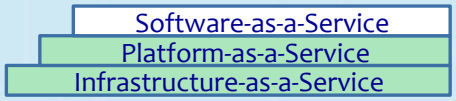
Reusable Application Frameworks for Rapid Development

- Massively-Parallel Computation & Distributed Petascale Storage
- Mobile Online Presence & Collaboration
- System-wide Event Generation & Notification

Adaptive Deployment of Future-Oriented Applications

- Run-Time Binding Between Applications and Reusable Services
- Run-Time Adaptation of Application Deployment to Varying Resource Availability

Theme 2. Extended Cloud Computing



Team: *Litoiu (lead), Chinneck, Salem, Woodside*; 1 post-doc, 5 grads, 4 interns, 2 undergrads

- Supply chain life cycle: Design➔Deploy➔Manage➔Undeploy

Adaptive Mgmt Framework for Extended Cloud	Framework for Design & Analysis of Adaptive Cloud Mgmt	Goal Mgmt in Hierarchical Adaptive Systems	Runtime Supply Chain Mgmt
Optimization for Resource Adaptation	Partitioning Computing & Storage Between Edge & Core	Strategies & Layer Coordination in Cloud Computing	
Storage & Data Services in Core/Edge of Extended Cloud	Two-Tier Storage Services	Support for Bi-Directional Data Streams	Mgmt of Limited Edge Resources

Theme 3. Smart Converged Edge

Team: *Leon-Garcia (lead), Boutaba, Chow, Ganjali*, 1 post-doc, 5 grads, 5 interns, 2 undergrads

Virtualized Smart Edge Architecture

- Integrated Network/ Computing Resource Mgmt
- Support for Future Internet Protocols
- Supporting Services & Apps in Smart Edge

Virtual Resource Mgmt in the Smart Edge

- Adaptive Scaling & Migration of VNs
- VN Reliability & Fault Tolerance
- Inter-domain VN Mgmt

Theme 4. Integrated Wireless/Optical Access

Team: *Rusch (lead), Ghaderi, LeNgoc, Williamson*; 1 post-doc, 5 grad, 4 interns, 2 undergrads, ¼ technician

Wireless/Optical Access

Design of Virtualized Wireless/Optical Access Testbed

Very-High BW Dense Small-Cell Access Testbed

Energy Proportional Adaptive Capacity Resource Mgmt

SDR DSP

digital

optical

backhaul

SDR DSP

Smart Edge

… enabling Theme 3 resource management

Virtualized Router & Datacenter

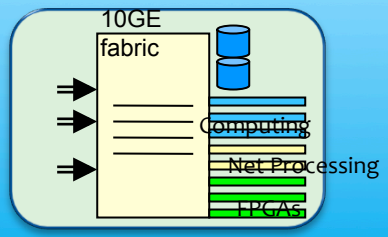
- Capacity increases via cognition and coordination (interference mgt and spectral efficiency)
- Energy efficiency increases via all-optical backhaul and centralized virtualization & resource mgt
- SDR and optical architectures that enable virtualization

Theme 5. SAVI Application Platform Testbed

Software-as-a-Service
Platform-as-a-Service
Infrastructure-as-a-Service

Team: *Leon-Garcia (lead), Boutaba, Chow, Ganjali, Li, Litoiu, Rusch, Steffan,,* 1 engineer, 1 + 4 x ¼ post-docs, 5 grads, 2 interns, 2 undergrads

SAVI Converged Virtual Cluster & VNs



Secure SAVI Cluster

SAVI Virtual Networks

SAVI Control & Mgmt Planes

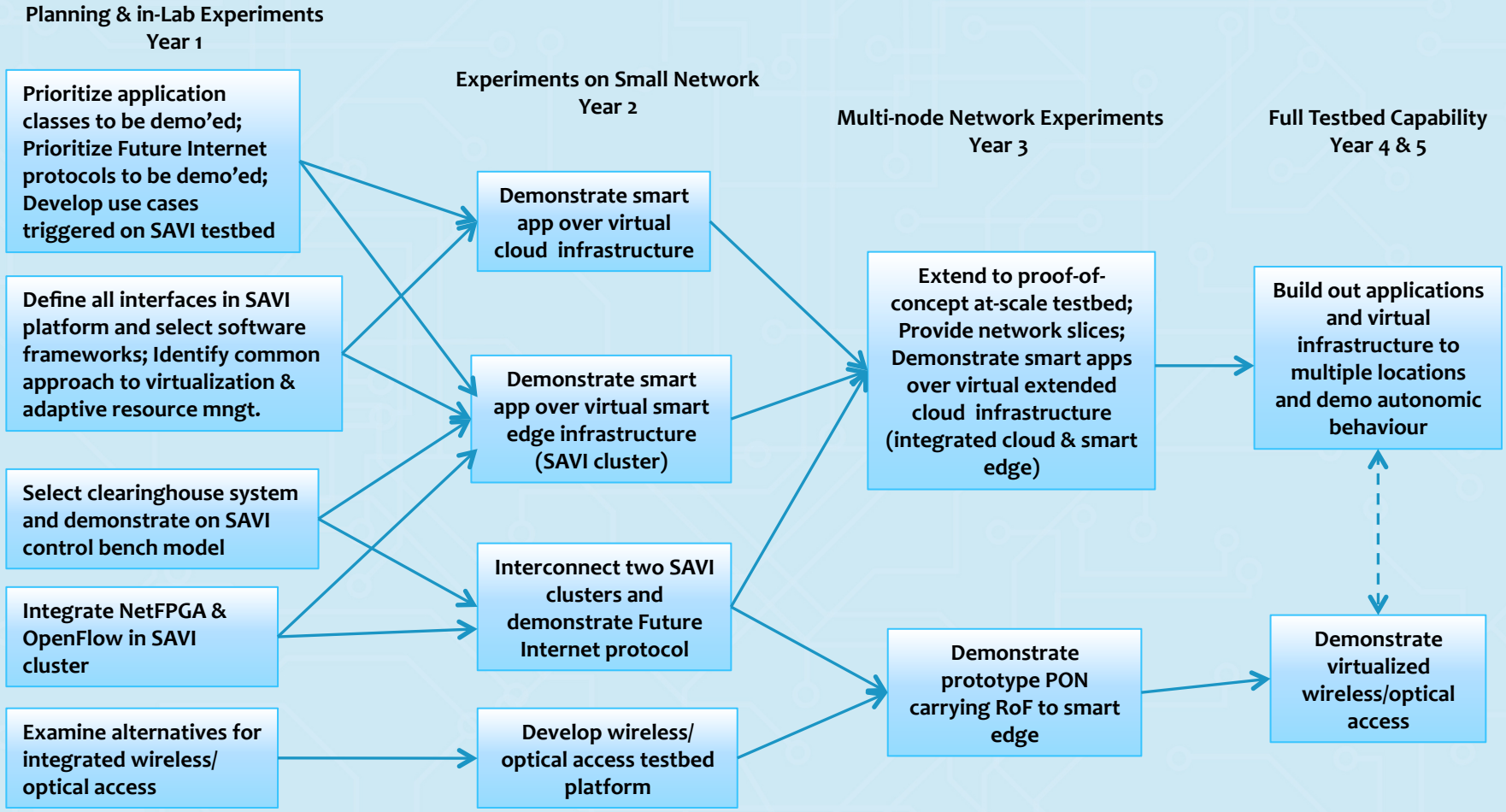
Service Provisioning & Resource Management Layer

OpenFlow-Based Control Plane

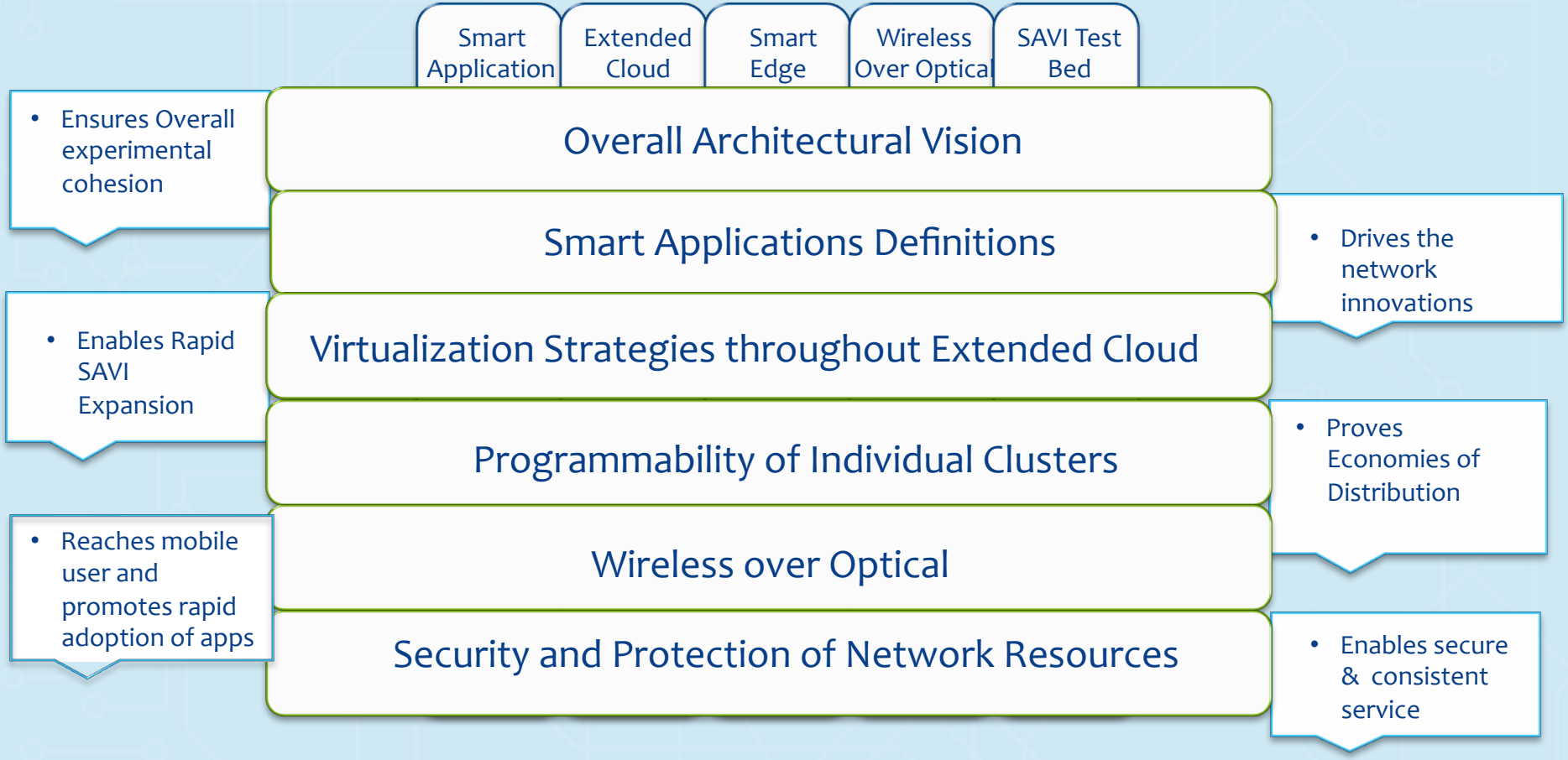
Testbed Activities & Integration of Research Themes

Activity Timeline (next slide)

SAVI Testbed & Theme Integration Activities



SAVI Cross-Theme Value Creation



International Partnerships

- Essential to keep up and stay at the forefront of international efforts
- EU Framework 7 & 8 Programs
  - Canada-EU Future Internet Workshop March 23-24, 2011
  - Potential collaboration with Future Internet Projects and Testbed Projects
- Korea Future Internet
  - Collaboration on Management Architecture for Future Internet
- GENI TBD
- GreenTouch
  - Green networking & cloud computing