



From Federated Software Defined Infrastructure to Future Internet

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for Next Generation Computing & Creativity



SwitchOn, Sao Paulo 10/14/2015



Clemson Next Generation Computing Research Overview

Global Industry

Cloud Platforms & Apps



Computing

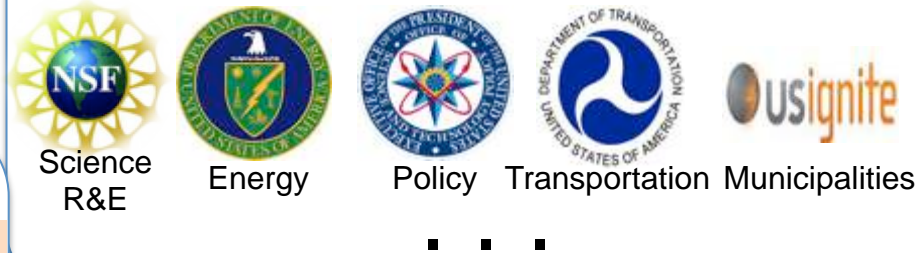


Networking & Storage



KC Wang, Clemson University

National Priorities



Global Networks



Major Computing Environment



Clemson Research



Convergence in Global Computing Focus

Convergence in

- Computing Needs
 - Big Data (> petabytes) analysis
 - Smart Edge
 - = Internet of Things
 - = Cyber Physical System
 - Visualization
 - Distributed, real time workflow
 - Virtual/hybrid reality
- Computing Infrastructure
 - HPC + Big Data + Cloud
 - Compute + storage + network
 - Convergence
 - Software orchestration
 - Software defined infrastructure

Research Investments

- US
 - NSF GENI → programmable testbed for future Internet
 - NSF Cloud → programmable testbed for future cloud
 - US Ignite → gigabit city “testbed” for future applications
 - NSF Data Infrastructure Building Blocks (DIBBS)
 - DoE Extreme Scale Science Storage System
 - ... White House “Smart City” programs
 - ... White House “National Strategic Computing Initiative”

- EU, South America, APAC, ...³

Convergence on Campus Center of Excellence for Next Generation Computing & Creativity

CLEMSON
CENTER OF EXCELLENCE
NEXT GENERATION COMPUTING and CREATIVITY

CREATING THE FUTURE

Our vision is to create a center that pushes the boundaries of discovery and innovation, transforming research, education and creative communication through cutting edge technologies and services. The Center for Next Generation Computing and Creativity provides an evolving hub for faculty, students, and IT staff to work in partnership, and will drive Clemson University towards its 2020Forward goal of offering an exceptional educational experience and raising up the leaders and innovators of tomorrow.

 *KC Wang, Clemson University*
DIGITAL CREATIVITY

 *SwitchOn, Sao Paulo 10/14/2015*
GEOSPATIAL TECHNOLOGIES


NEXT GENERATION COMPUTING

Tight IT integration to support university mission

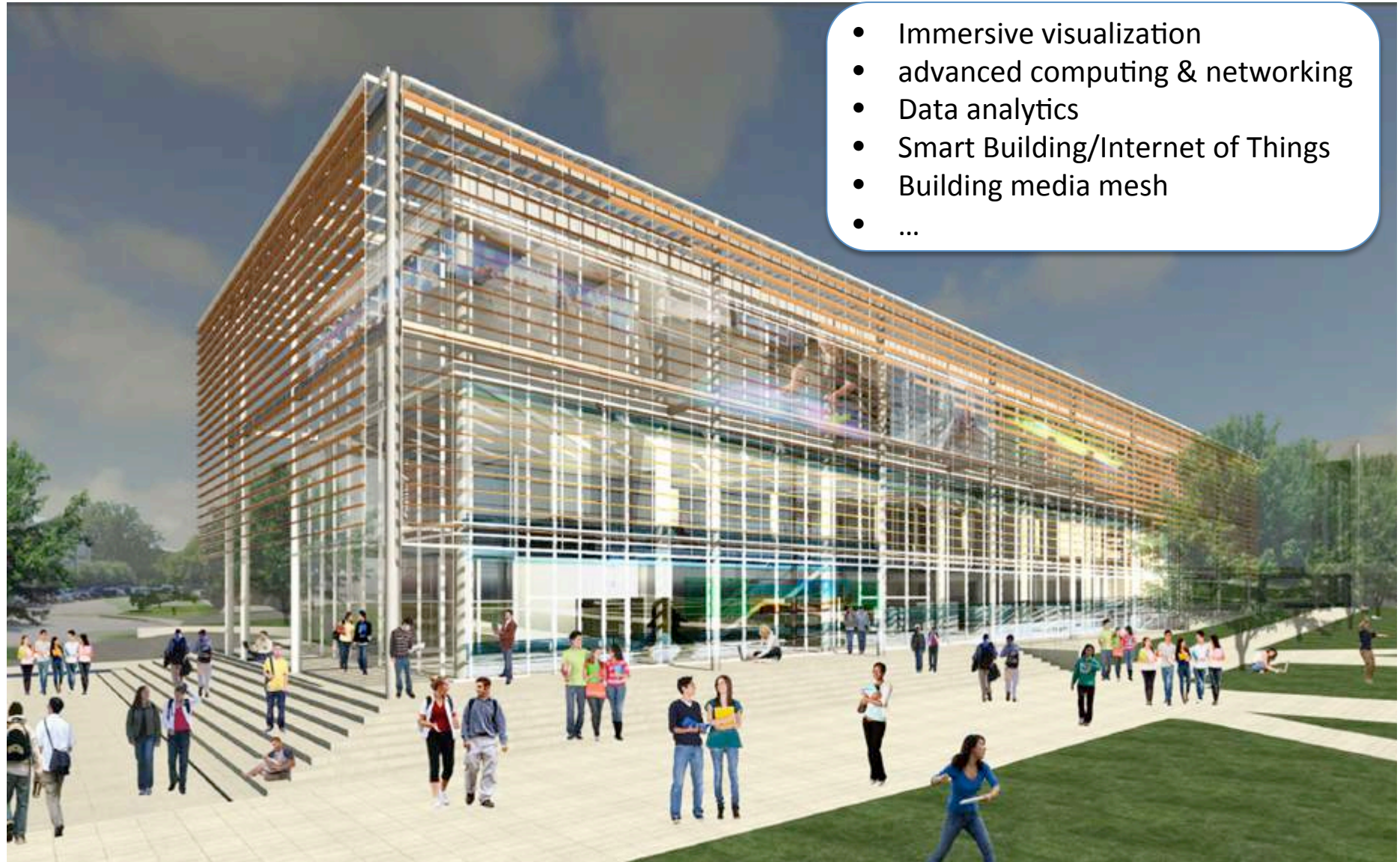
Three branches, Faculty led
KC/ECE, Jan/English, Stephen/Environmental

Influence and co-develop IT infrastructure

Diverse & Sustained Funding

Industry partnerships

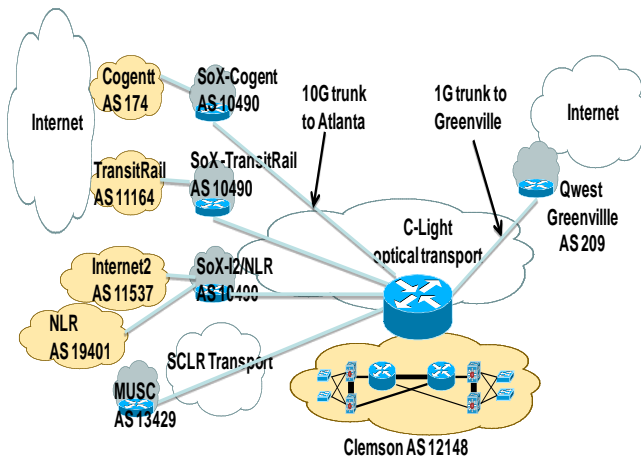
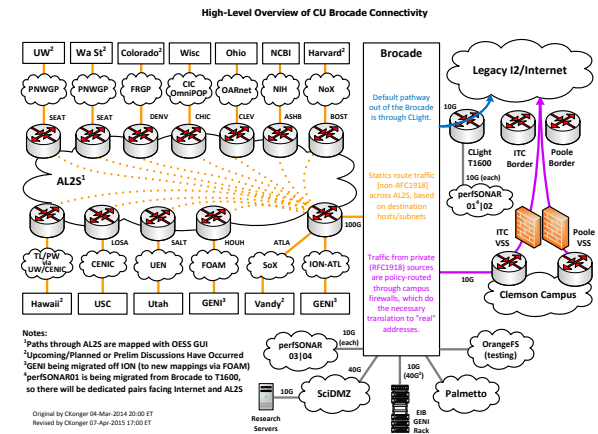
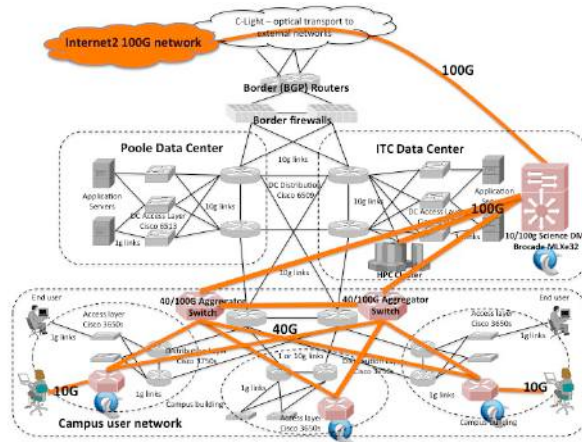
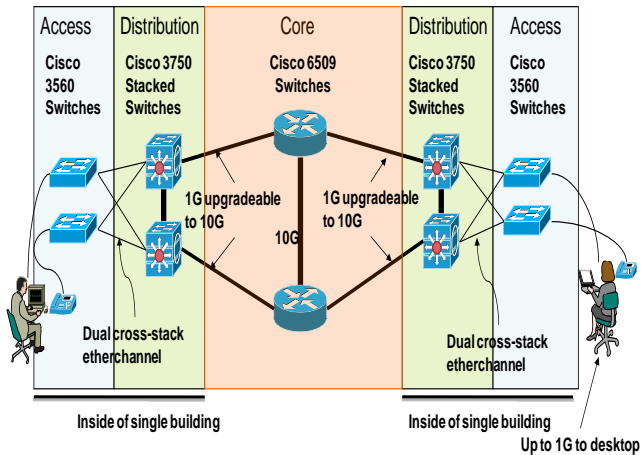
Watt Family Innovation Center



- Immersive visualization
- advanced computing & networking
- Data analytics
- Smart Building/Internet of Things
- Building media mesh
- ...

2009 ... 2012 ... 2015

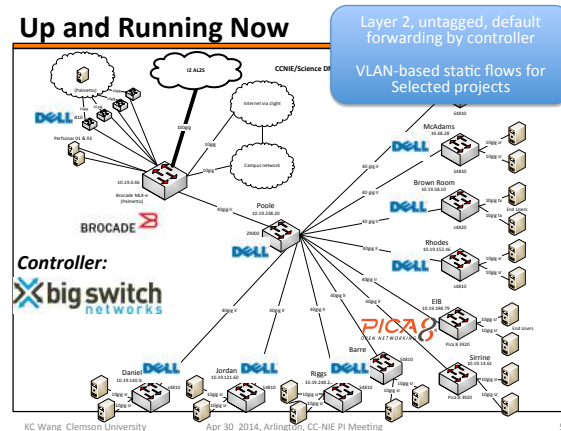
Convergence in Research & Production Infrastructure



SDN invisible to IT

- GENI VLANs to lab
- Data analysis network

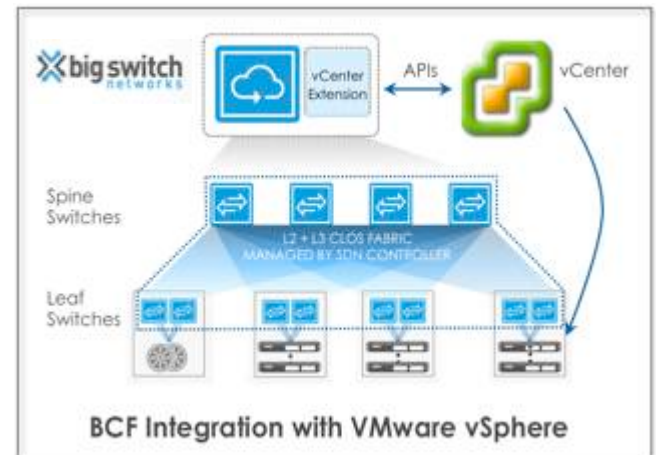
KC Wang Clemson University



SDN trial by IT

- 20 buildings science DMZ, lots of issues, sparse p2p research traffic, production grade service

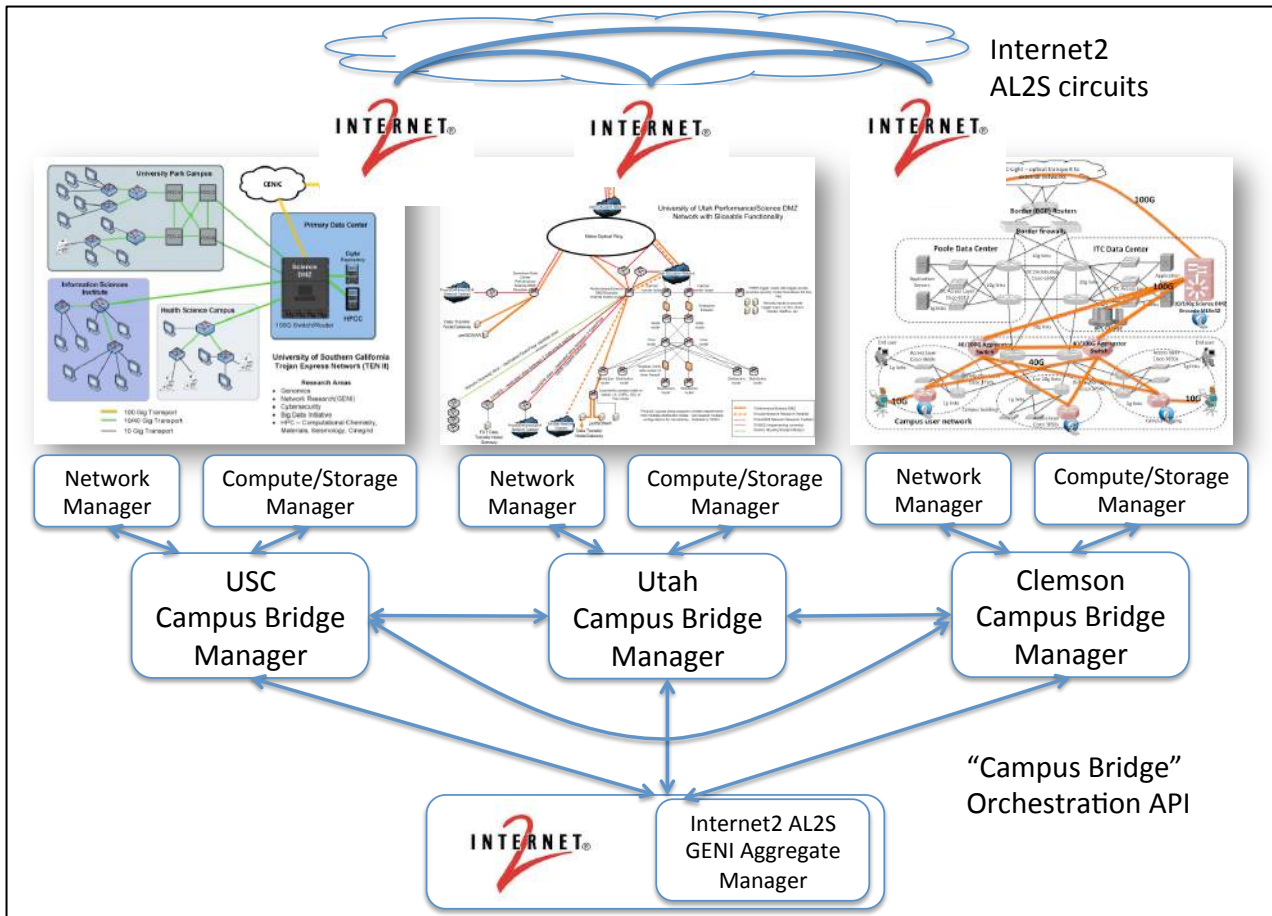
SwitchOn, Sao Paolo 10/14/2015



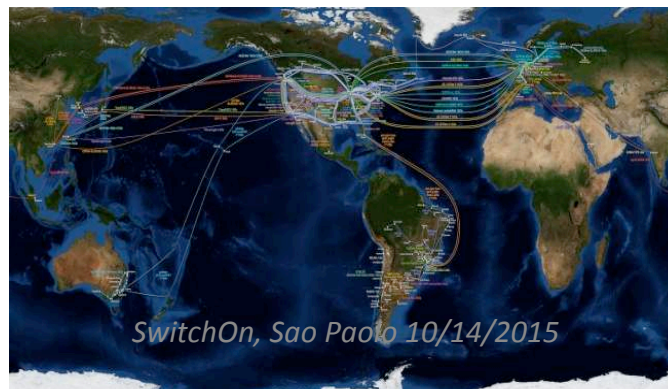
SDN in production by IT

- New data center fabric pods
- New strategies for networking, security, disaster recovery

Software Defined Network and Exchange



- Clemson deeply engages in US SDN in multiple fronts
 - Campus (NSF CC-NIE)
 - Regional (NSF CC-IIE)
 - International (GEANT, PRP)
- Clemson drives multiple NSF compute bridging efforts
 - Palmetto + EXEDE + OSG
 - CloudLab
- Clemson leads identity access management federation
 - NSF FeduShare

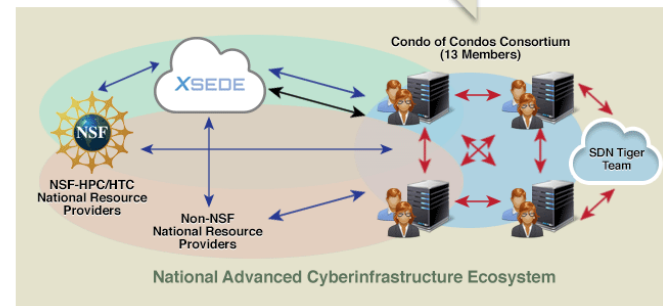
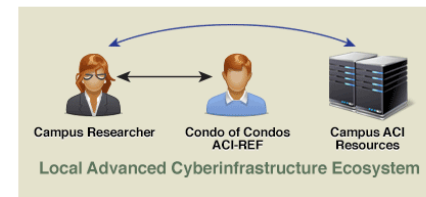
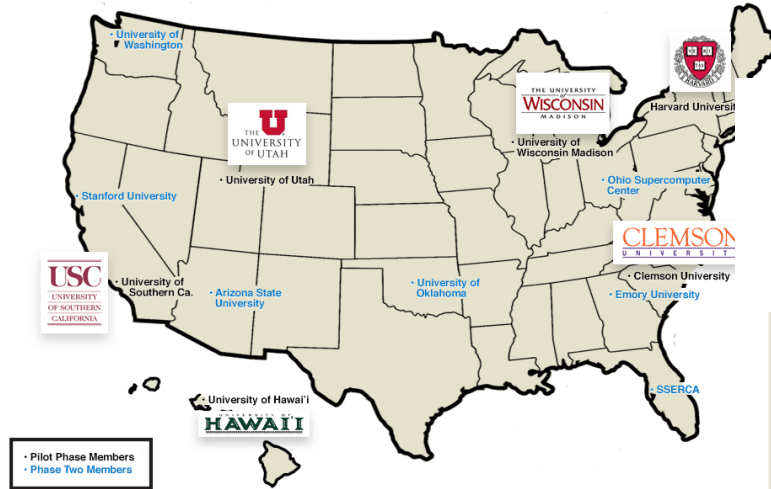


Convergence in IT Operation NSF ACI-REF

Advanced Cyberinfrastructure Research & Education Facilitator

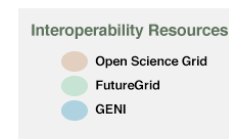
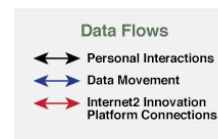
ACI-REF project: Condo of Condos

NSF #CNS-1338155 – PI: Jim Bottum, Clemson



ACI-REF campus research computing centers are federating to share resources – both human and computational

Also all connect to the Internet2 Layer 2/3 Network at 100G



CloudLab – a NSF Future Cloud

CloudLab

NSF Reverse Site Visit
March 29, 2014

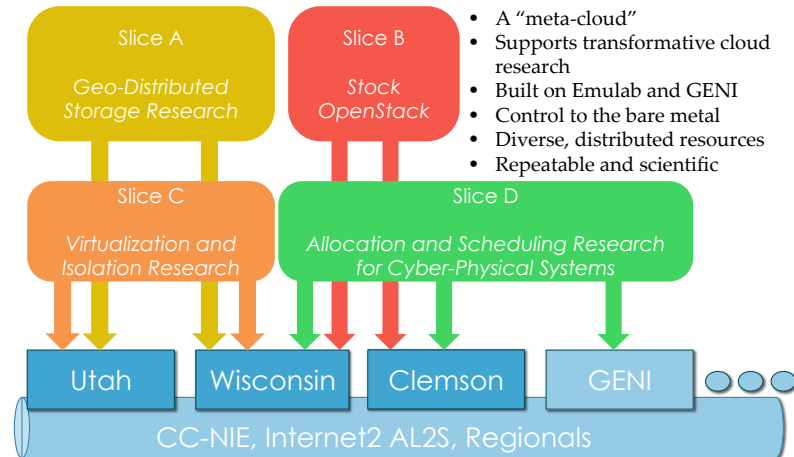


5/29/14

CloudLab RSV

3

What Is CloudLab?



- A “meta-cloud”
- Supports transformative cloud research
- Built on Emulab and GENI
- Control to the bare metal
- Diverse, distributed resources
- Repeatable and scientific

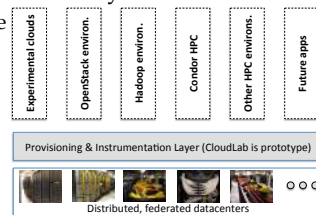
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CloudLab RSV

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A Vision For Running Infrastructure

- Just the start: “Meta-Infrastructure”
 - Infrastructure for running infrastructure
 - Already: OpenCloud, other popular software stacks
 - In progress: HPC clusters
 - Future: Enterprise services
- Different kinds of infrastructure side-by-side
 - Slide boundaries as needs change
 - More flexible, agile, efficient



5/29/14

CloudLab RSV

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New Hardware



Common

- About 5,000 cores -> 15,000 total
- 8-16 cores per node
- Baseline: 4GB RAM / node
- Latest virtualization hardware
- TOR / Core switching design
- 10 GB to nodes, SDN
- Connections to I2 via CC-NIE
- Partnership with vendors

Wisconsin

- **Storage and networking**
- Balanced nodes
- Local storage
- Some SSDs
- Clos fat-tree
- Cisco

Clemson

- **High-memory**
- 16 GB RAM / core
- 16 cores / node
- Bulk block store
- Net. up to 56Gb
- High capacity
- Dell

Utah

- **Power-efficient**
- ARM64 / x86
- Power monitors
- Flash on ARMs
- Disk on x86
- Very dense
- HP

Smart Grid Community

NSF I/UCRC: RISE

Real-time Intelligence for Smart Electric Grid



A partnership between Clemson University & Georgia Tech

<http://risewithus.org>

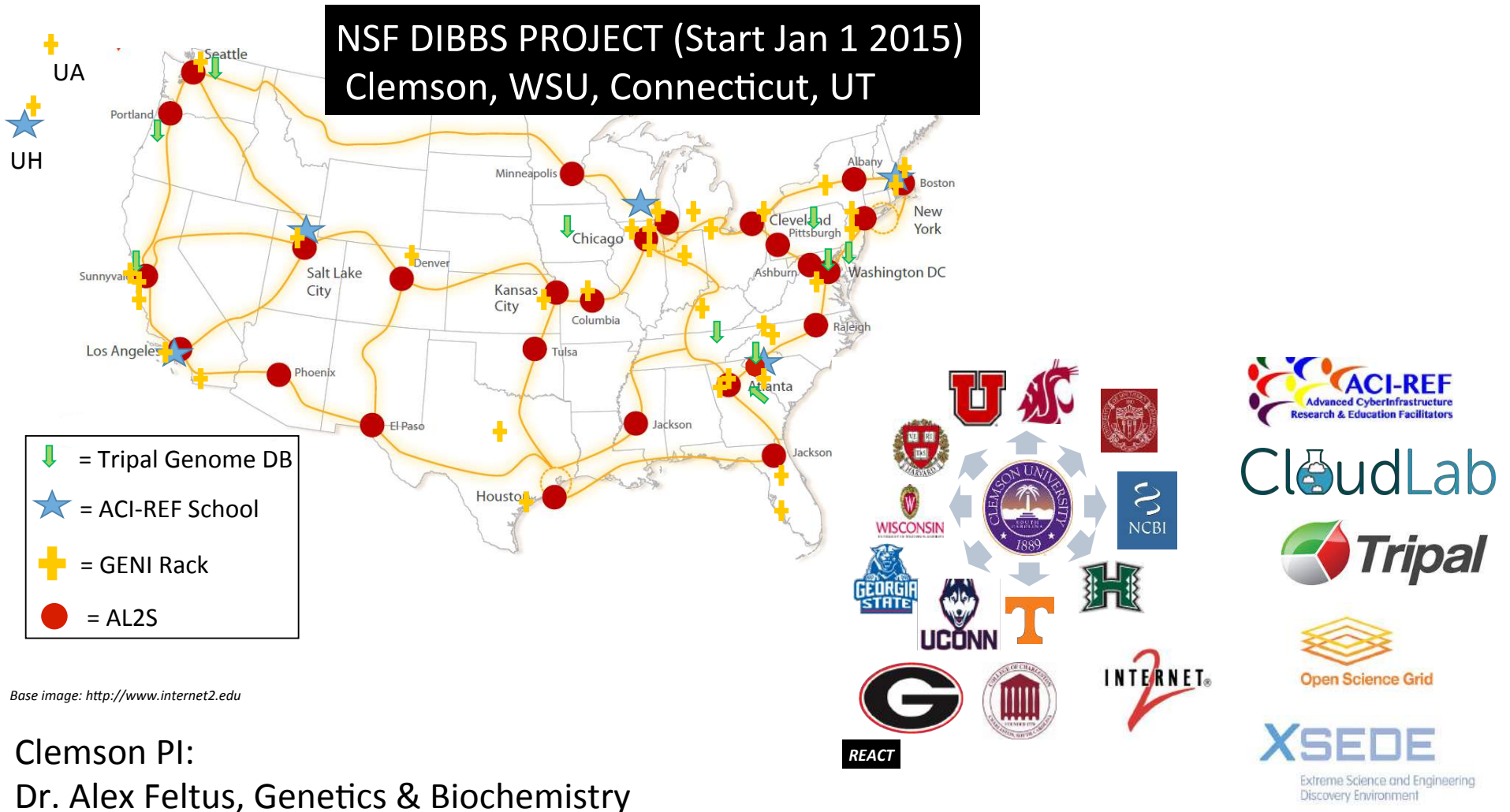
PI: Dr. G. Kumar Venayagamoorthy

Duke Energy Distinguished Professor of Power Engineering

Clemson University

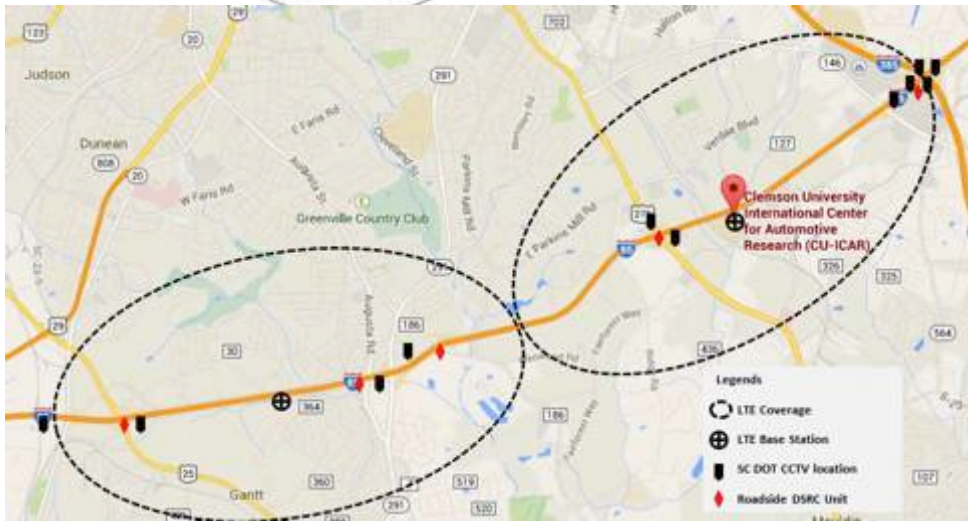
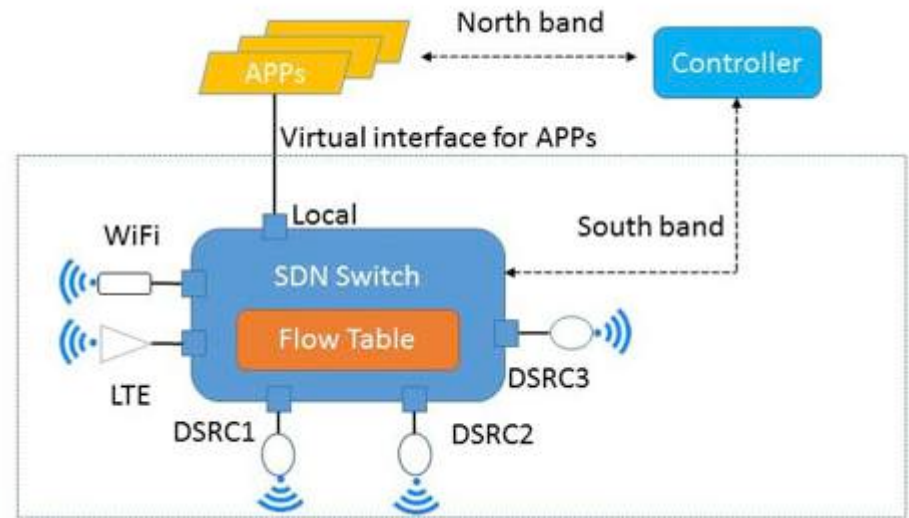
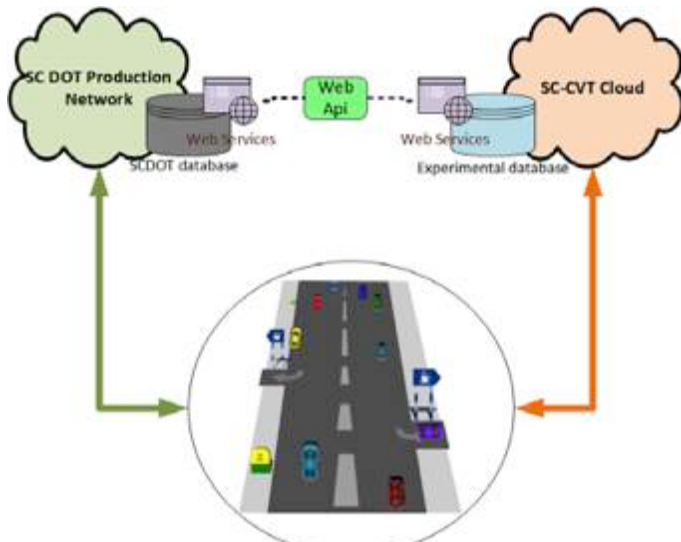
Genomics Community

NSF CIF21 DIBBS: Tripal Gateway, a Platform for Next-Generation Data Analysis and Sharing



Transportation/Automotive Community

NSF US-Ignite: Connected Vehicle Testbed



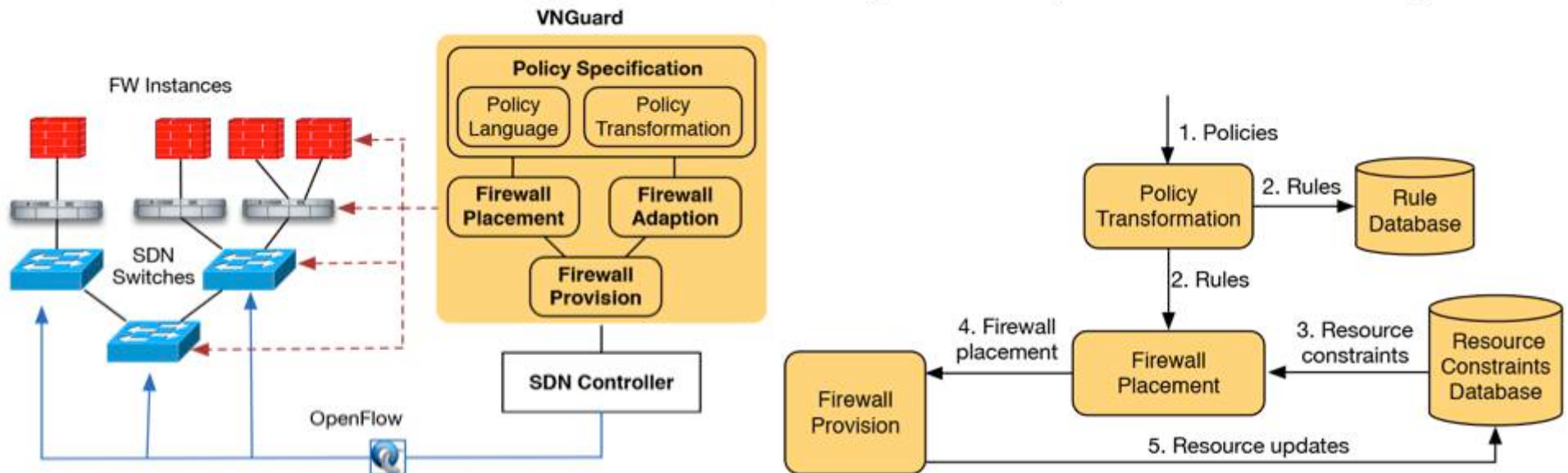
Clemson PI:
Dr. James Martin, School of Computing

Security Community

VNGuard: An NFV/SDN Combination Framework for Provisioning and Managing Virtual Firewalls

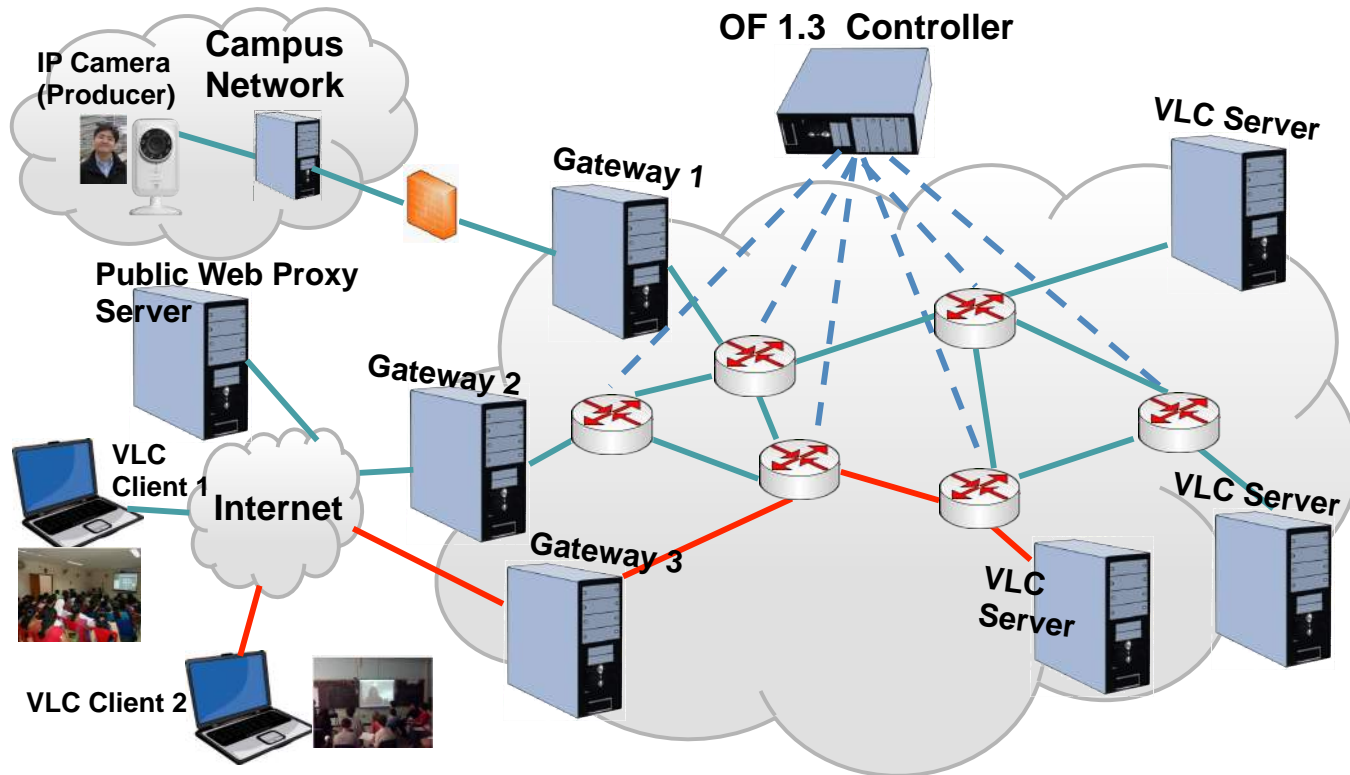
Juan Deng[†], Hongxin Hu[†], Hongda Li[†], Zhizhong Pan[†],
Kuang-Ching Wang[†], Gail-Joon Ahn[‡], Jun Bi[‡], Younghee Park[#]

[†]Clemson University [‡]Arizona State University [‡]Tsinghua University [#]San Jose State University

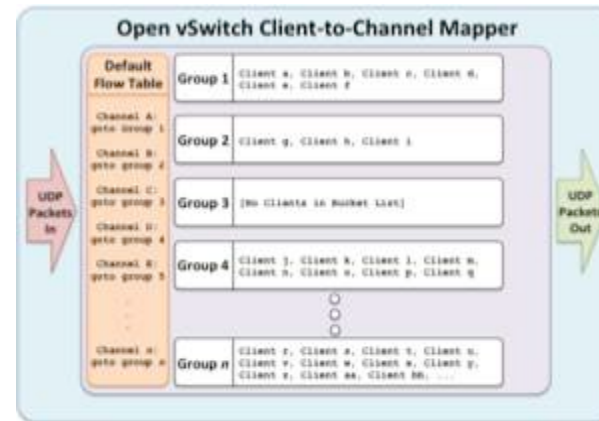
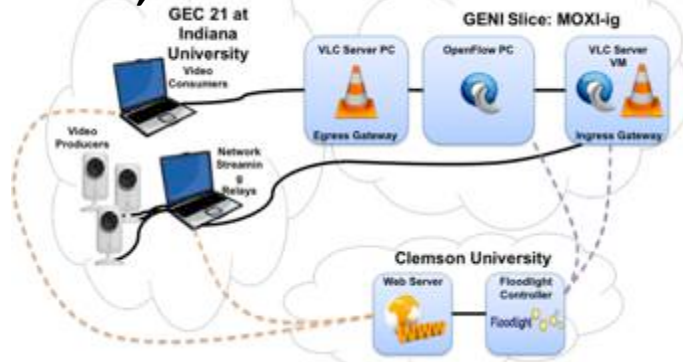


With *elastic NFV* services
instantiated via software in *highly interconnected, pervasive data centers*,
we can create *service fabrics across Internet & CPS's*

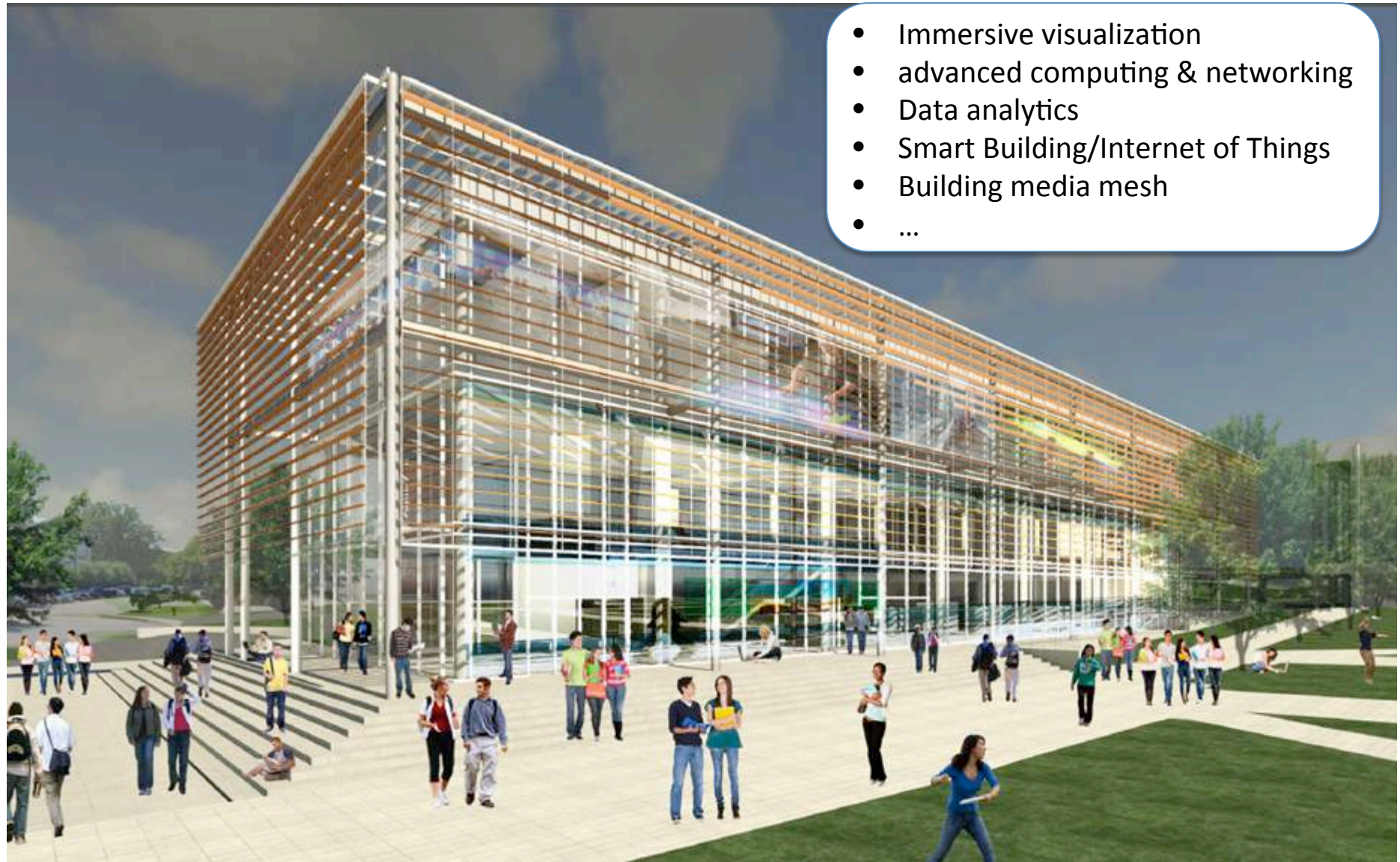
GENI Cinema – Seamless, Scalable Live Video Streaming From GENI to Germany, GEANT GTS



GEC21, CNERT best demo awards



Watt Family Innovation Center



- Immersive visualization
- advanced computing & networking
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Clemson Center for Geospatial Technologies



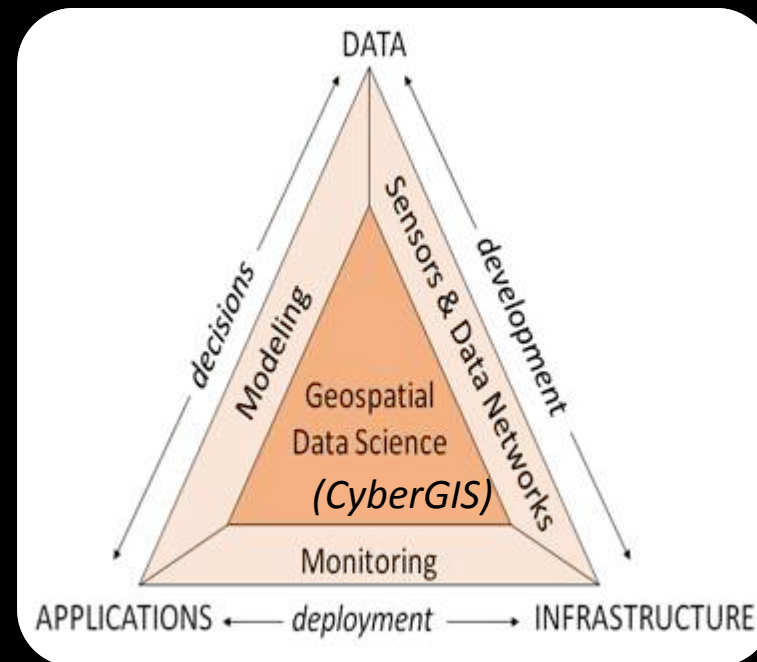
Co-directors:

Stephen Moysey, Environmental Engineering & Earth Science

Patricia Carbajales, CCIT

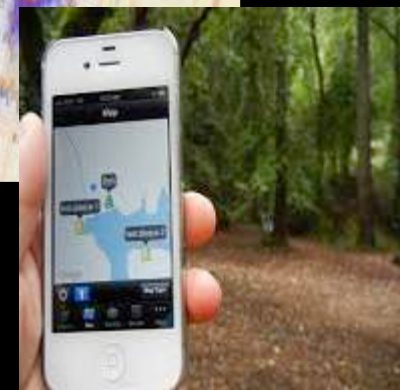


- Build a community of interdisciplinary practitioners
- Support of innovation in research, teaching, and outreach
- Enable next generation collection, analysis, and application of geospatial data



Research Focus

- Smart Cities and Environments
- Environmental Sensing & Decision Making
- Citizen Science
- Big Data for Geospatial Applications



Thanks!

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