Clean Slate Design vs. Darwinism
Service Provider Perspective on GENI

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GENI Success Scenarios

- Change the research process
  - Sound foundation for future network architectures
  - Experimental evaluation, rather than paper designs
- Create new services
  - Demonstrate new services at scale
  - Attract real users
- Aid the evolution of the Internet
  - Demonstrate ideas that ultimately see real deployment
  - Provide architectural clarity for evolutionary path
- Lead to a future global network
  - Purist: converge on a single new architecture
  - Pluralist: virtualization supporting many architectures

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Challenges that GENI Will Face

- The Means Becomes the End
  - Huge investment of intellectual energy in mechanism design
- Focusing on What We Know
  - Yet another forwarding engine…
  - Are we "conceiving the future by letting go of the present" or not?
- Demonstrating new services at scale
  - If it's experimental*, it may not work
  - If it doesn't work, no-one will use it

* The GENI infrastructure is not supposed to be experimental, but it's research uses should be.

- Clean Slate vs. Darwinism
  - It's hard to predict what will be valuable
  - Network externalities suggest that valuable ideas will morph so they can be incrementally deployed

- Service provider need
  - ***Make it possible to quickly and safely deploy new services***
  - Key GENI concepts, Programmability and Virtualization, do apply.

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Example network services?

- Network wide protocol stacks:
  - MPLS, MPLS VPNs, IPv6, VPLS, etc.
- Manipulate existing protocols:
  - RFC 1998: customers signal preference using BGP community values
  - RCP/IRSCP: route selection performed outside routers (e.g., using external information)
- Localized protocols
  - MIRO multipath extends BGP bilaterally
- Cross-layer-aware services
  - Network-aware content distribution
  - Service-aware network monitoring
  - Network-aware server migration

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How can Programmability Help?

- Platform that allows third party code to be executed on routers
  - Both control and data planes
  - Support changes to network or higher layer functionality
  - Support co-location of other functions (application services, monitoring, etc.)
- Why should we care?
  - Minimizes vendor dependence
  - Allows differentiation / customization
  - Reduces deployment and operations costs
- Impact on existing services?
  - Networks are shared
  - Protocol and resource dependencies
  - Virtualization…

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What Do We Mean by Virtualization?

- Slices and slivers
  - Subset of network resources (links/nodes/subnets)
  - Software management framework
- Commercial network virtualization solutions already exist…
  - MPLS
  - Dynamic bandwidth services
  - Router virtualization
- New Ideas???
  - Robust framework for hitless upgrades and incremental deployment
  - Meta-management plane
  - Specific ideas for application/customer specific control planes

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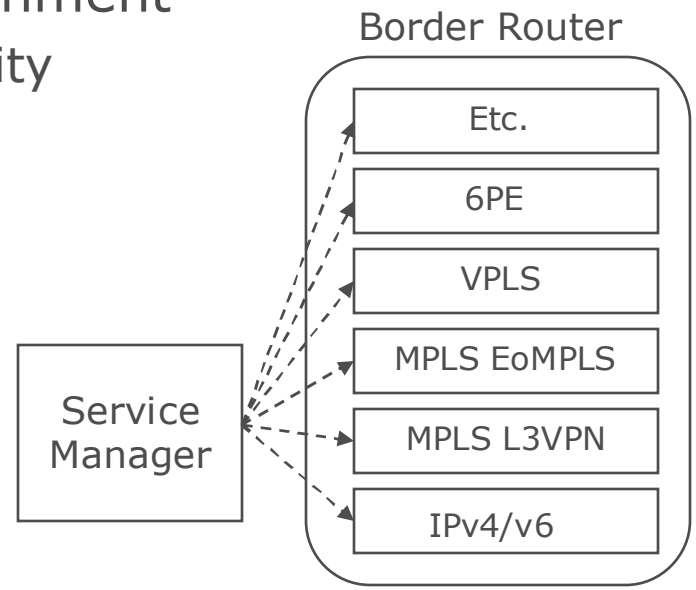
What Do We Mean by Virtualization? …contd.

- Commercial example:
  - Logical Routers (Juniper Networks feature)
  - Fairly "complete" virtualization of router functions
    - Each logical router performs independent routing tasks
    - Separation of administrative control
  - Can create a flexible testbed environment
    - Still constrained by vendor functionality



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Router programmability

- What does router programmability mean?
  - Ability to add control plane **and** data plane functions to a routing platform
- Commercial example:
  - SoftRouter (Planned Alcatel-Lucent product)
  - Leveraging commodity packet processing and general purpose processor chips, and open source software
  - Add functionality through well defined interfaces
  - Support customization of router functions as well as third party applications

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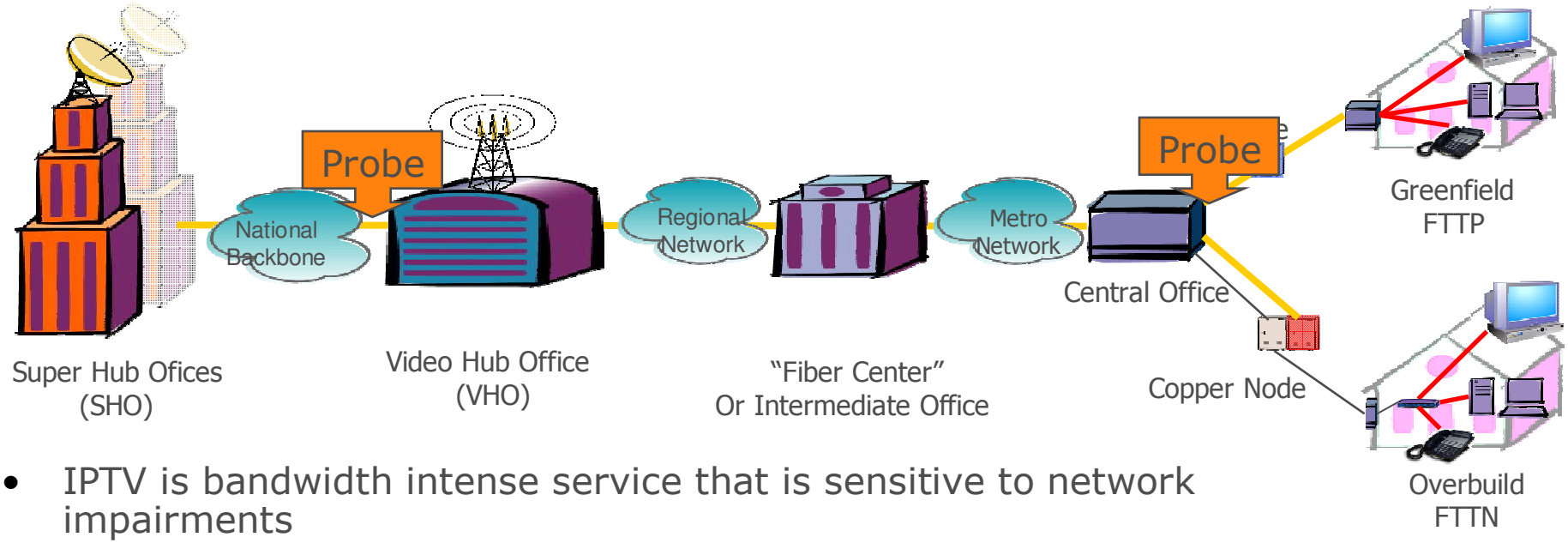
Service-aware network monitoring (e.g., IPTV)



- IPTV is bandwidth intense service that is sensitive to network impairments
- Commercial deployments involve "many moving parts"
- Ensure end-to-end service and/or root cause analysis, need flexible monitoring ***anywhere*** along the path
  - E.g., what is the video quality for a particular stream when it enters/leaves/traverses the north-east regional network?
- State of the art: statically deploy flexible (programmable) probes in network
  - Problems: slow (deployment), expensive, coverage (always in wrong place)

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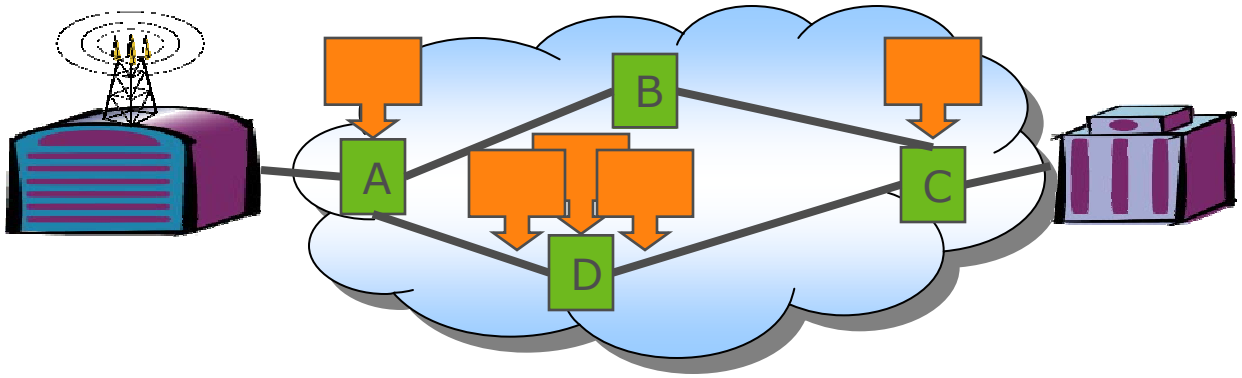
Service-aware network monitoring



- What is the video quality for a particular stream when it enters/leaves/traverses the north-east regional network?
  - Being able to deploy custom network monitoring code at *relevant* node(s)/interface(s) in the network
- E.g., suppose "flow of interest" traverse A-D-C
- Network monitoring application:
  - Determine appropriate nodes (A,D,C)
  - Instantiate appropriate monitoring software
  - Report video quality per probe point

Network Programmability:Need per-interface, programmable, network monitoring capabilities

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Summary

- Real challenge is how to quickly and safely deploy new services, in light of the Internet today
  - Theory of natural selection for network adaptations…
- There is a case for both programmability and virtualization
  - Opportunity may be less about reinventing than evolving
  - Research community has much to contribute
  - Must consider real operational issues (incremental deployment, upgrades, provisioning, monitoring) to be fully successful

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