



# Internet Architecture Track

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# Context

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- What's New About GENI Grand Challenges?
  - Many attempts to create the "conclusive" list
  - Generally a technology view
- Instead: take a stakeholder's view
  - Governments
  - IP providers
  - Access providers
  - Facility providers
  - Consumers
  - The rest of the industry?



# Grand Challenge #1

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*How do we factor the Internet architecture? Where are the boundaries when we consider economic concerns?*

- Costs and Incentives
  - Race to the bottom (incentive)
  - Enable user choice (cost)
  - Protect & manage organization resources (cost)
  - Create an environment that fosters 3<sup>rd</sup> party services (incentive)
    - Distribution without resource ownership
    - Nested services with flexible composition
- How we define these boundaries will create/change industries



# Grand Challenge #2

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*How do we identify a good architecture? What makes an architecture good?*



# Pre-Work Grand Challenges

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# Participation Template

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- Grand Challenge:
  - *An distributed infrastructure for fine-grain pay-per-use services*
- Experiments Required:
  - *Claim: current service model requires either full carriers that own everything they need, or ads seen by humans. We need competitive nested services that are financially viable with low switching cost.*
  - *Demonstrate composable services: routing, storage, slices, management, backup, logging, multicast, billing, etc.*
  - *Demonstrate secure contract/payment system for services*
  - *Demonstrate that service provider can both buy resources and services, and can sell new value-added service.*
- Industry/Academic Relationship:
  - *Deployment in carrier (or CDN)?*



# Participation Template

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## ■ Grand Challenge:

- *How do we reconcile the discrepancy between the needs for open application development (via the end to end principle) and the needs for better security (that would benefit from more "circuits" style infrastructure, tighter control, etc)*

## ■ Experiments Required:

- *Articulate and quantify the tradeoffs. What is the cost of an open system when having to deal with security?*
- *Does the security architecture have to be a hodge-podge of IDS, IPS, virus scanner, firewalls, proxies, authentication protocols, crypto, etc?*
- *Don't really know ???*

## ■ Industry/Academic Relationship:

- *Sharing data from industry with academia would enable better evaluation of proposals and requirement for security solutions*



# Internet Addressing & Routing

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- Grand Challenge:
  - *Replace the addressing and routing architecture of the Internet with one that supports mobility, provider independence, and better scalability.*
- Experiments Required:
  - *Pilot deployments of candidate solutions.*
- Industry/Academic Relationship:
  - *Close collaboration to formulate pragmatic solutions and deploy them.*



# Participation Template

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- Grand Challenge:

- *Cleanly separate policy and trust relationships from mechanism in the design of the network layer. Although the current Internet was designed to be independent of end-to-end services, certain aspects are nevertheless entangled in IP – such as routing, forwarding, and addressing. Tussles must be allowed to play out in tussle space, outside the network mechanisms.*

- Experiments Required:

- *Implement a new network architecture and “live in it” to evaluate its ability to support multiple (competing) policies.*

- Industry/Academic Relationship:

- *Help building high-performance forwarding nodes that adhere to the new architecture. Commercial experiences with real-world policies and trust relationships would help evaluate the design.*



# Participation Template

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## ■ Grand Challenge:

- *Define a proper network architecture for each different network environment and ensure that these heterogeneous architectures interoperate each other smoothly.*

## ■ Experiments Required:

- *1. Define a network architecture for a current cellular network with strong performance requirement and test whether the architecture can perform as good as current cellular network.*
- *2. Define a different network architecture for a campus network with weak performance requirement and test whether the architecture can perform up to the current performance.*
- *3. Test whether the above two different architectures can interoperate smoothly.*

## ■ Industry/Academic Relationship:

- *Academia designs the architecture and implements prototypes in close collaboration with Industry. Industry participates in Academia activities to gain understanding and expertise to speedily deploy the developed technologies in real world.*



# Participation Template

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- **Grand Challenges:**

- Accept, formalize and standardize Middle Boxes: Overtime, several middle-boxes (Proxy, NAT, Firewall, Application gateways, VPN etc.) have filled in functionality which breaks several original premise and architectural principles. We need to acknowledge the reasons why market/industry have driven for these middle-boxes and what we can do to make them more holistically part of the Internet Architecture vs. the ad-hoc approach today which makes the network feel broken

- **Experiments Required:**

- Develop frameworks, Build prototypes and approach for any standards

- **Industry/Academic Relationship:**

- Approaches like GENI can help develop the experiments which will drive the Internet architectures and innovations as proof-points, followed by adoption into network/Internet and industry to resolve some of the long standing issues we have been facing today



# Network Architecture Life Cycle

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- Grand Challenge:

- *The capability to dynamically create and change on-the-fly network architectures in response to user needs and requirements based on a unified analytical framework for evaluating the cost and performance of architectures and a flexible programming system capable of spawning architectures as easily as processes are spawned in end-systems*

- Experiments Required:

- **Analytical research:** *Determine the minimum cost network architecture that can be deployed on top of an infrastructure of programmable routers and switches. Determine how the collection of protocols and algorithms deployed impact the cost and performance of an architecture –* **Systems Research:** *Build a wide area network programming system capable of capturing the description of network architecture as a profiling script and deploying/modifying the architecture by executing the script and performing bindings between independent data path and control plane software components*

- Industry/Academic Relationship:

- **Broad vision:** *Several schools/labs have worked/are working in different seemingly independent areas: network architecture analysis/programmable networking/overlays/network virtualization. This vision brings all these independent research efforts together*



# Participation Template

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## ■ Grand Challenge:

- *The scalability of the current Internet is due in part to its adoption of a federated architecture that scales through bilateral contracts between infrastructure providers. If the future GENI-based Internet is to retain this scalability, should designing for federation be a top-priority goal in GENI? If so, what does this imply?*

## ■ Experiments Required:

- *Not sure. Maybe...*
  - *partner with euro-GENI, china-GENI, etc. early on?*
  - *model "administrative boundaries" in experiments?*

## ■ Industry/Academic Relationship:

- *involve ISPs and industry experts on policy and peering (Ed Norton, Akamai, etc.) in designing the GENI architecture?*



# Session Minutes

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# Larry's Session Notes

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## Stakeholders

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Users/Consumers - choice

Governments - policy, public interest, regulatory issues

Carriage / Access Providers - commodity bit service

Service Providers -- give users high-level services they want

Facility/Content Providers (how to make money)

Enterprise (how manage and protect resources)

Grand Challenges

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Stakeholder perspective...

(1) How do we (re)factor the space; where do we put the boundaries?

Economic Concerns -- costs, incentives

- race to the bottom (commodity) \*incentive\*
- enable user choice \*cost\*
- protect & manage organizational resources \*cost\*
- federation & peering relations \*cost/incentive\*
- can we create environment that fosters "third party" service providers \*incentive\*
  - o don't own their own infrastructure (embed in someone else's infrastructure)

nested services; flexible composition (mashup)

Others?

- complexity
- security, robustness
- societal priorities

MIC: how we define these boundaries \*will\* create/affect industries

(2) What makes an architecture good, and how do you know?



# Hong Li's Session Notes

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# Stakeholders

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- Governments
- IP providers
- Access providers
- Facility providers
- Consumers
- The rest of the industry?



# Participation Template

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- Grand Challenge:
  - Commoditized IP providers
  - How to broker IP services
  - Unenforceable services in the case of multiple providers
  - Distributed service providers without owning the infrastructure, create players can bet on new services
  - A model for “people in the middle”
- Experiments Required:
  - ...
- Industry/Academic Relationship:
  - ...



# Participation Template

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- Grand Challenge:
  - Another grand challenge: Changing the underlying basis for architecture design, in a more formalized way?
- Experiments Required:
  - ...
- Industry/Academic Relationship:
  - ...



# Participation Template

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- Grand Challenge:
  - Legal aspects enterprises have to face
  - Policy enforcements, security, QoS, service differentiation, ...
  - Enterprise as identity providers
  - Formal definition edge points? How do we deal with visibility and control?
- Experiments Required:
  - ...
- Industry/Academic Relationship:
  - ...



# Participation Template

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- Grand Challenge:
  - Don't have a good understand what the clear boundaries are for enterprises
- Experiments Required:
  - ...
- Industry/Academic Relationship:
  - ...