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**Network Measurement & Analysis for E2E Performance  
A DOE Perspective**

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**Why Network Measurements**

**Pushing the limits of cyber-infrastructures for eScience**

- Distributed tera-scale computing
- Peta-scale data engineering

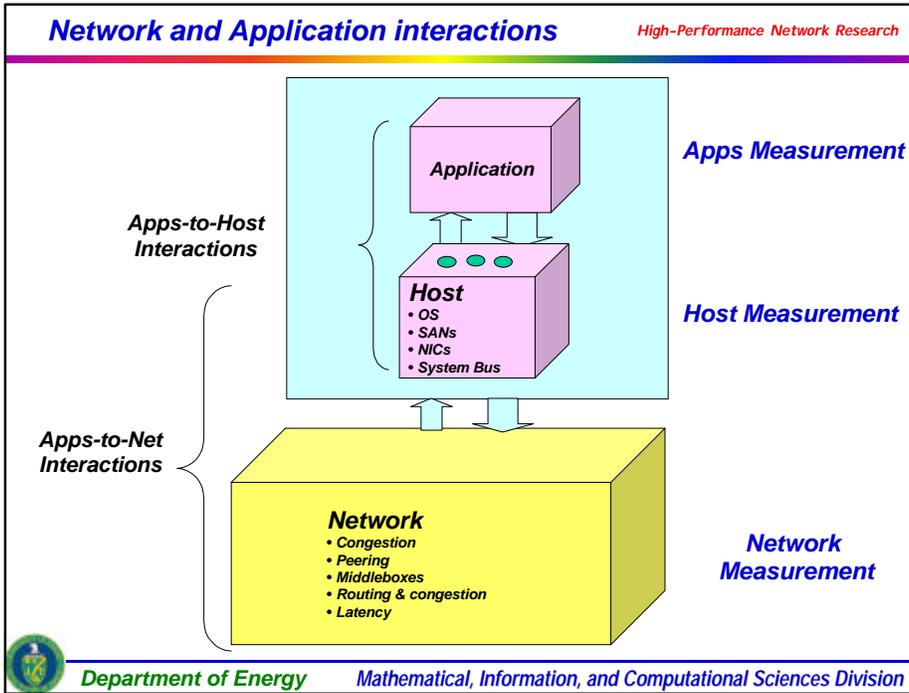
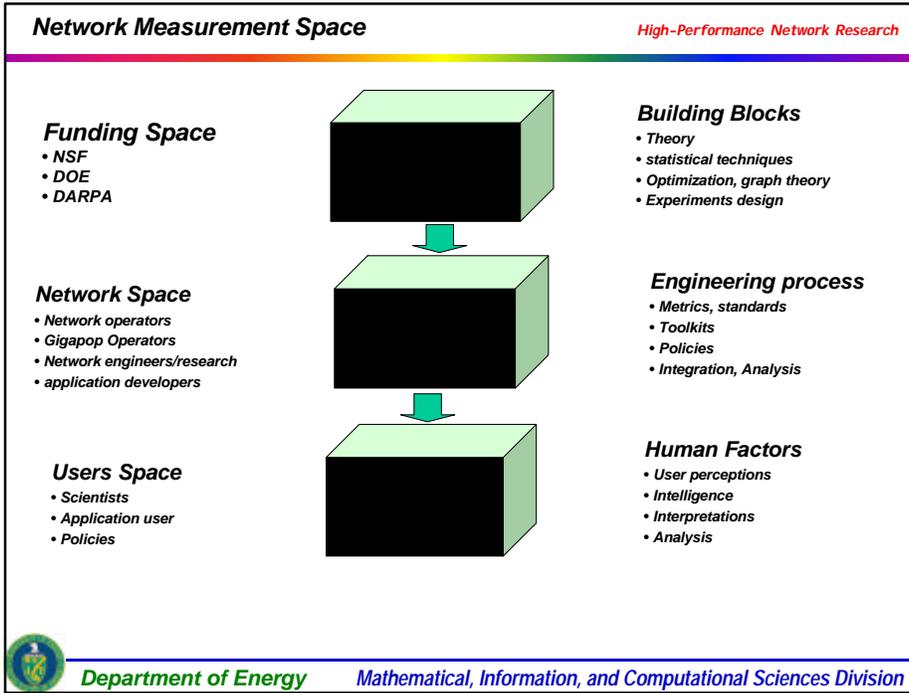
**The network performance challenge**

- More bandwidth -> more \$
- Advanced network capabilities

**Efficient utilization of networks**

- Measurements and analysis
- Traffic engineering

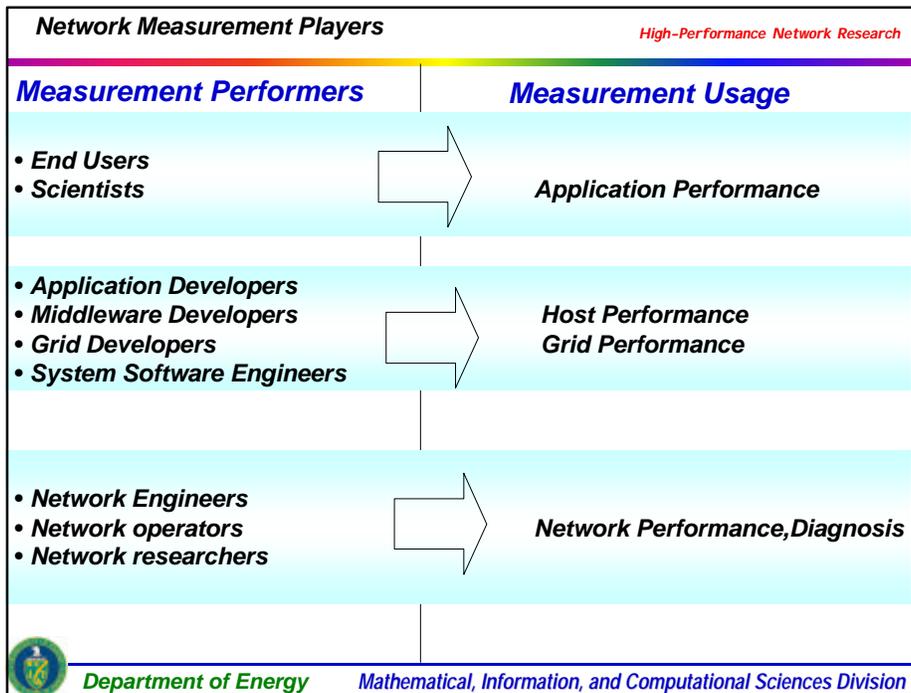




**Approaches** High-Performance Network Research

Measurement Points	Passive measurement	Active Measurement	Scheduled Measurement
✓ Application		✓	✓
✓ Host-based	✓	✓	✓
✓ Edge-based	✓	✓	✓
X Core Network	✓	✓	✓

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## Goals of Network Measurement and Analysis High-Performance Network Research

### Improve end-to-end performance

- Dynamic tuning of transport protocols
- Network-aware OS, NICs, I/O, etc.
- Network diagnosis

### Network-Aware Scientific Applications

- Export network performance parameters to applications
- Export application requirements to networks
- Network/application dynamic interactions

### Bridge the wizard Gap

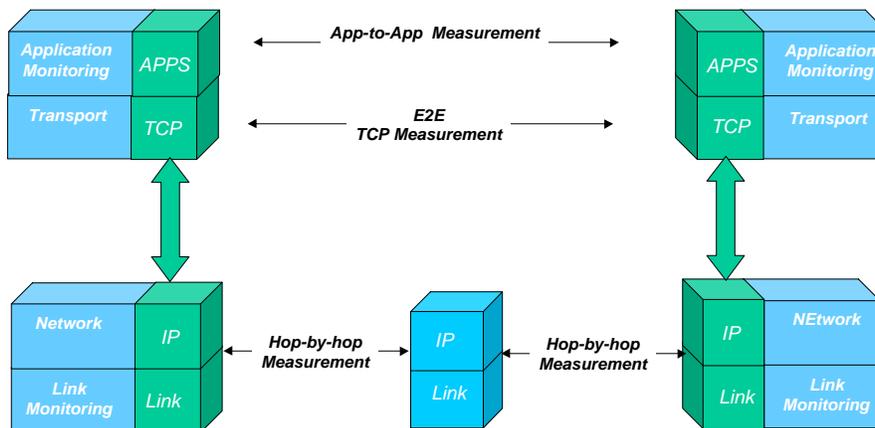
- Network performance portal
- Transparent and on-demand network and apps tuning
- Intelligent network usage



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## Layer Monitoring Architecture High-Performance Network Research

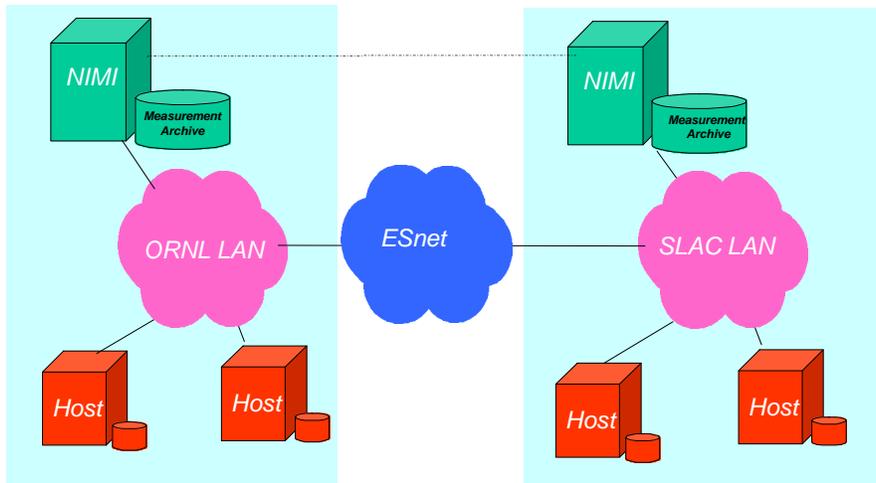


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# DOE Networking Environment

High-Performance Network Research



- NIMI capable platform per campus/site
- Host-based network measurement/analysis

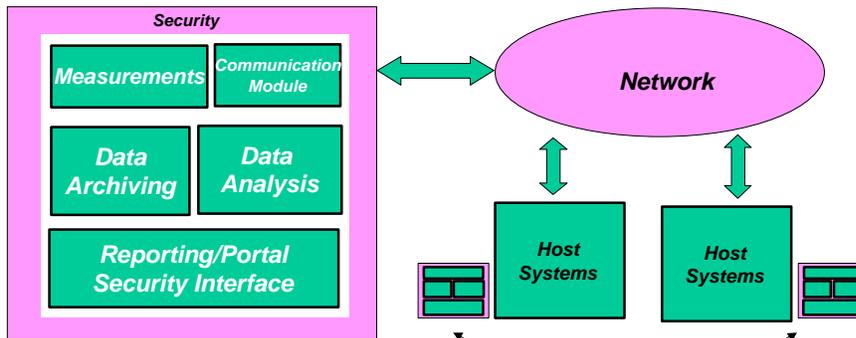


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# Measurement & Analysis Platforms

High-Performance Network Research



- Portable across different OS
- Dynamic Probing
- Self-configurable
- Secure Measurement
  - Data collection and archiving
  - Data analysis, Analysis,
- On-demand measurement



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## Challenges - I

High-Performance Network Research

### Measurement Methodology and Process

- Lack of standardized measurement metrics
- Lack of measurement and tools taxonomies
- Measurement intervals (sec, minutes, hrs, days)
- Inter-domain measurement and analysis
  
- Security and privacy in network monitoring
- Access to core network and middleboxes
- Statistical analysis of measured data
  
- Lack of experiment design
- Simulation augmented network measurement and analysis
  
- Network performance prediction based on measurements
- Proliferation of measurement non-scalable tools



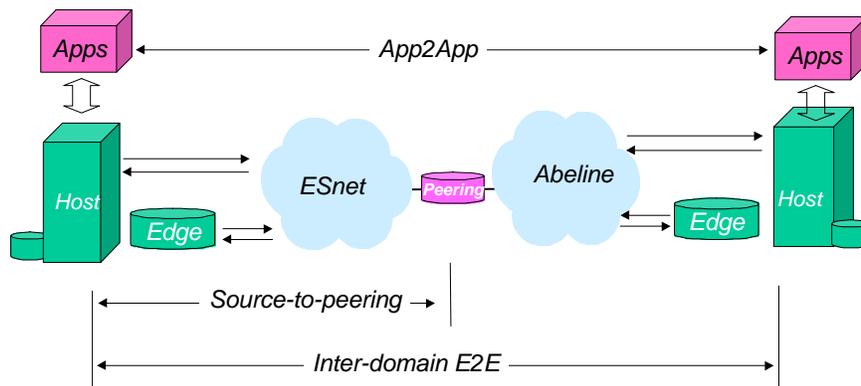
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## Challenges - II

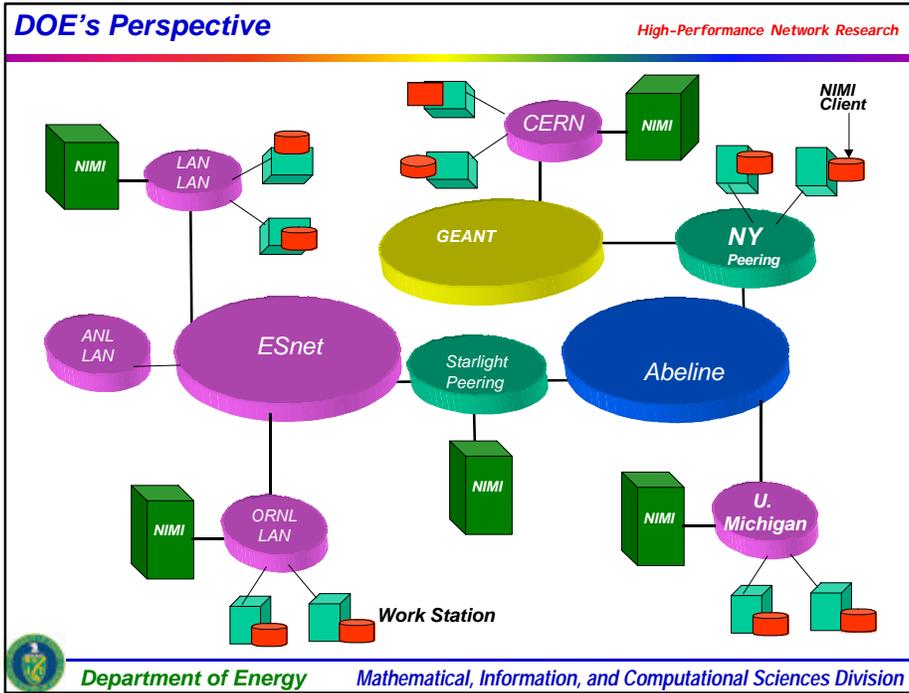
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### Inter-Domain Measurement & Analysis



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**Host-based tools**

- Host-based End-to-end tools
- Application-based end-to-end tools

- Net100 – Network-aware operating systems (UCSD, ORNL, PSC, LBL)
- 2. Netlogger

**Network & edge-based tools**

- Network tomography
- Network performance characterization
- Hop-by-hop

- INCITE – Edge-based measurement and inference Rice U., LANL, SLAC/LBL
- Self-configuring network monitoring, LBL
- Network Characterization Service, LBL
- Hop-by-hop bandwidth measurement and apps, UCSD, U. Delaware

**Data analysis tools**

- Statistical analysis
- Data clustering and data mining

- None

**Network-aware toolkit**

- APIs
- Tuning agent

- Net100 – Network-aware operating systems (UCSD, ORNL, PSC, LBL)
- Netlogger

**DOE R&D Activities for:**

- Network measurement toolkits development
- Network measurement data analysis techniques
- Network performance characterization service
- E2E network performance portals
- Network-aware OS

**DOE Initiatives**

- Joint E2E performance initiative
- Network measurement & performance portal
- Grid performance monitoring WG at GGF



**END**

