

# Hybrid Modeling and Simulation Platform for Rapid Prototyping and Testing of Ad-hoc Wireless Networks

Presented to:



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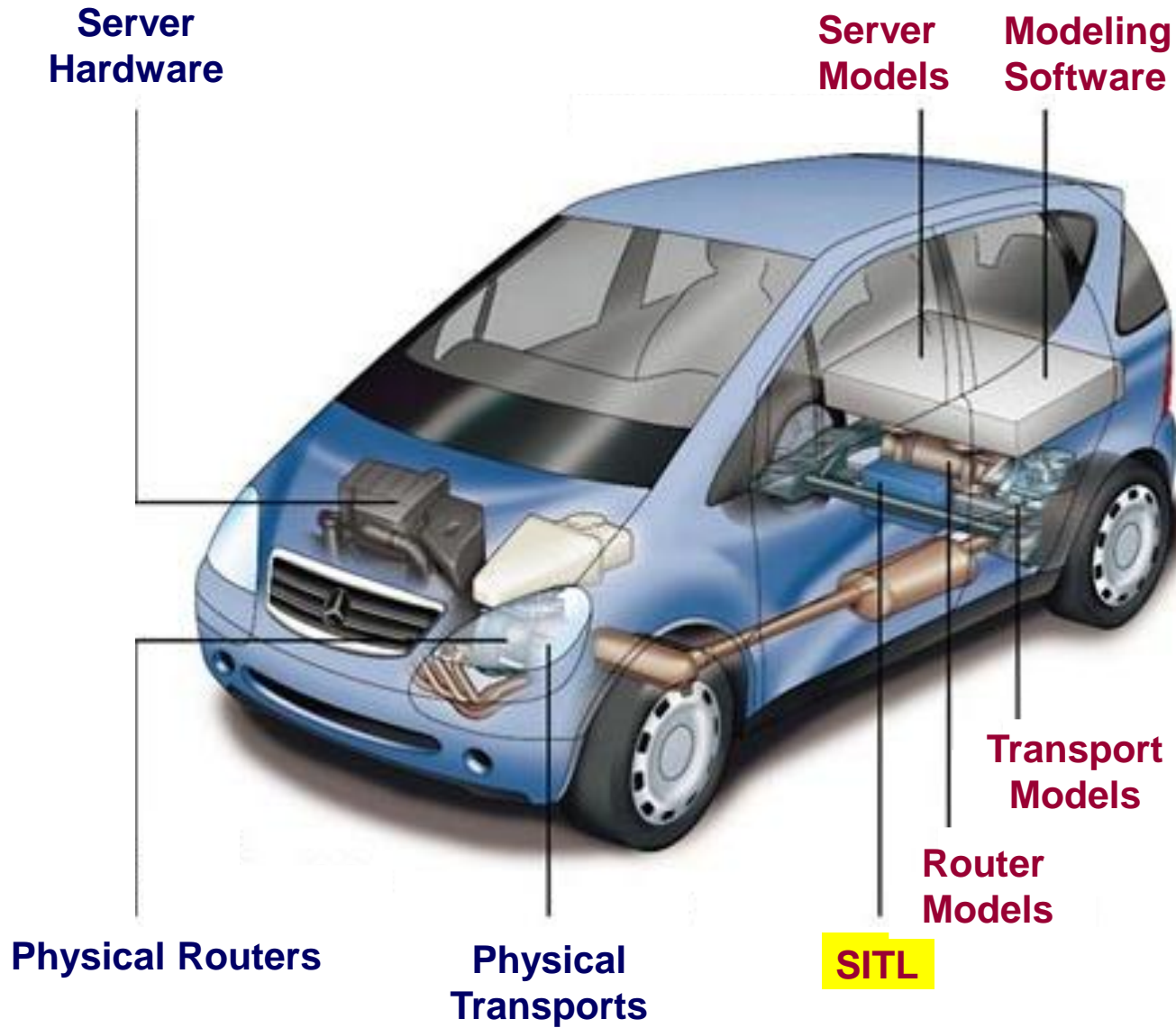
October 27, 2011

WHY

HOW

WHEN

# .....➔ The Hybrid Concept



# → Desired Prototyping/Testing Characteristics

## → Realism

- Physical - High
- Modeling - Low
- Hybrid - Medium

## → Performance

- Physical - High
- Modeling - Low
- Hybrid - Medium

## → Scalability

- Physical - Low
- Modeling - High
- Hybrid - Medium

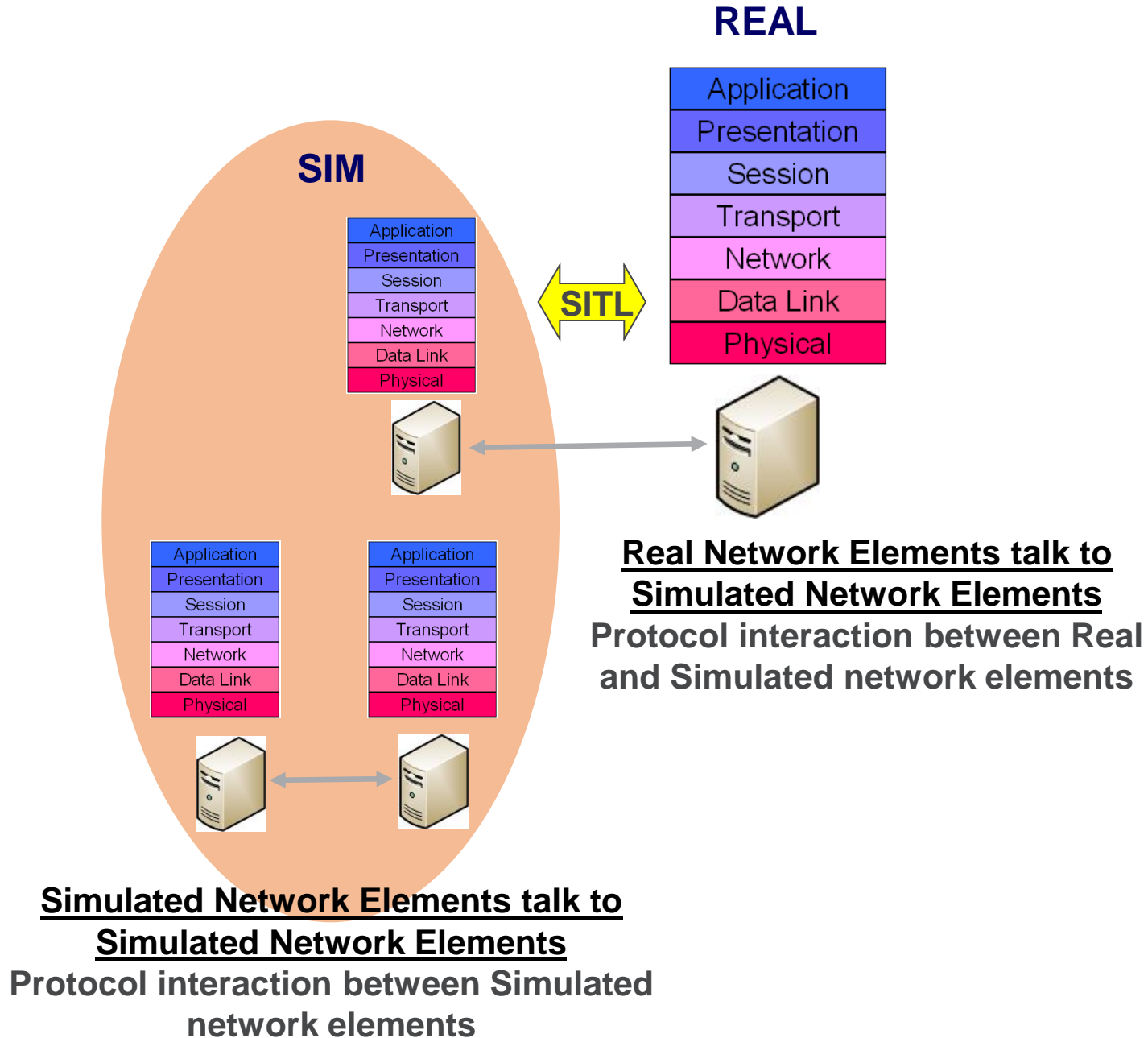
## → Cost

- Physical - High
- Modeling - Low
- Hybrid - Medium

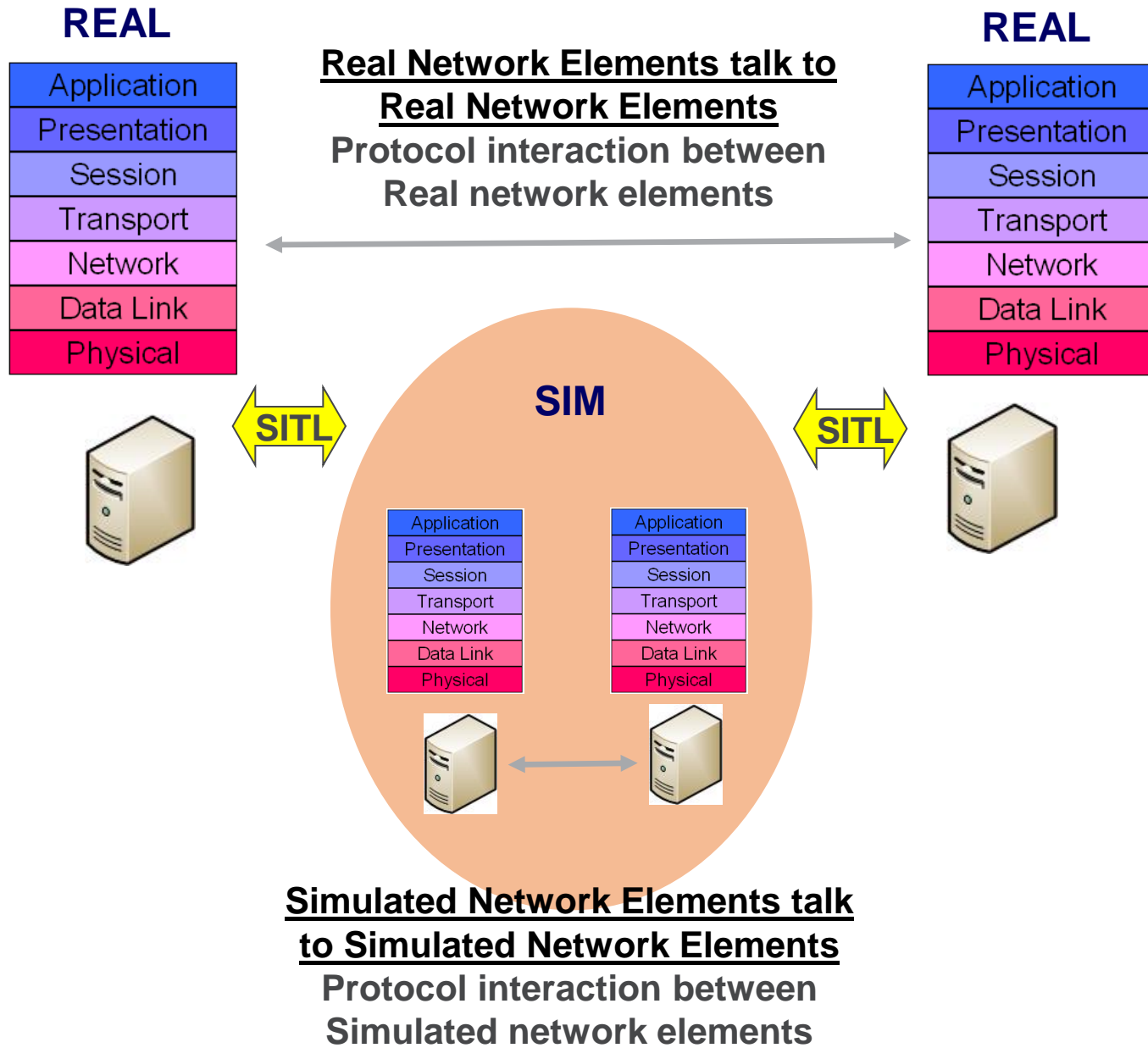
## → SITL (System-In-The-Loop)

- **SITL** is an add-on module for OPNET's modeling and simulation products
- **SITL** provides a simple "plug and play" interface that connects live applications or network devices, such as servers and routers, to OPNET<sup>®</sup> simulations
- **Real ↔ Sim Scenario**: provides a communication path between a simulated network element and a real network element
- **Real ↔ Sim ↔ Real Scenario**: provides transparent transport of traffic between real network elements

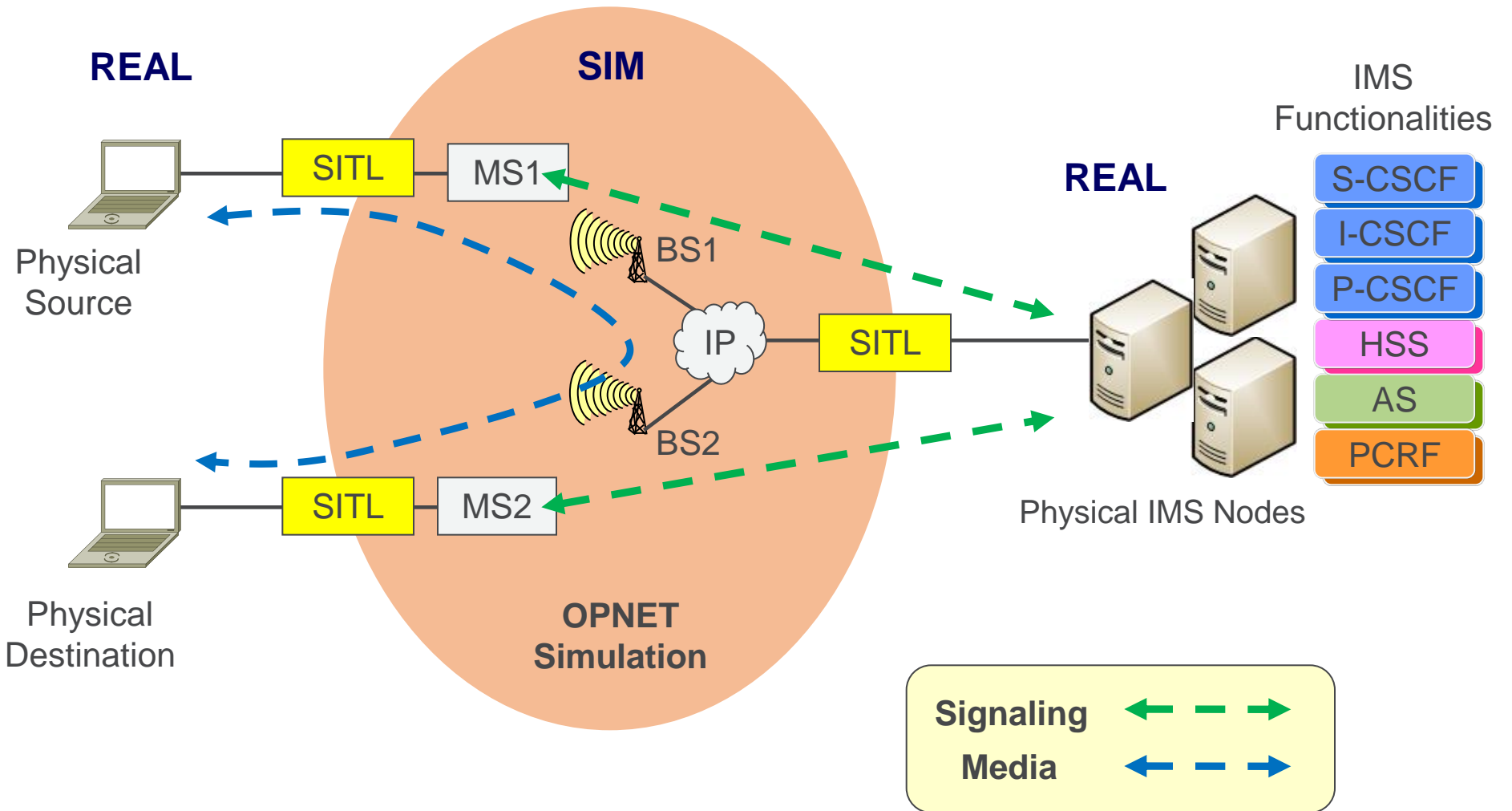
# REAL to SIM Scenario



# REAL to SIM to REAL Scenario

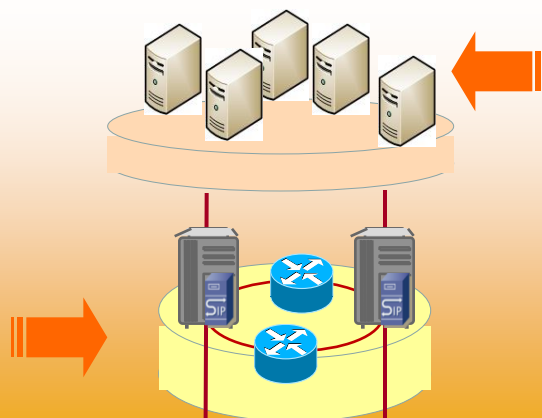


# Hybrid Modeling and Simulation Platform





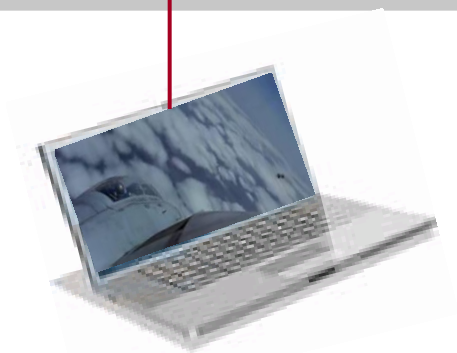
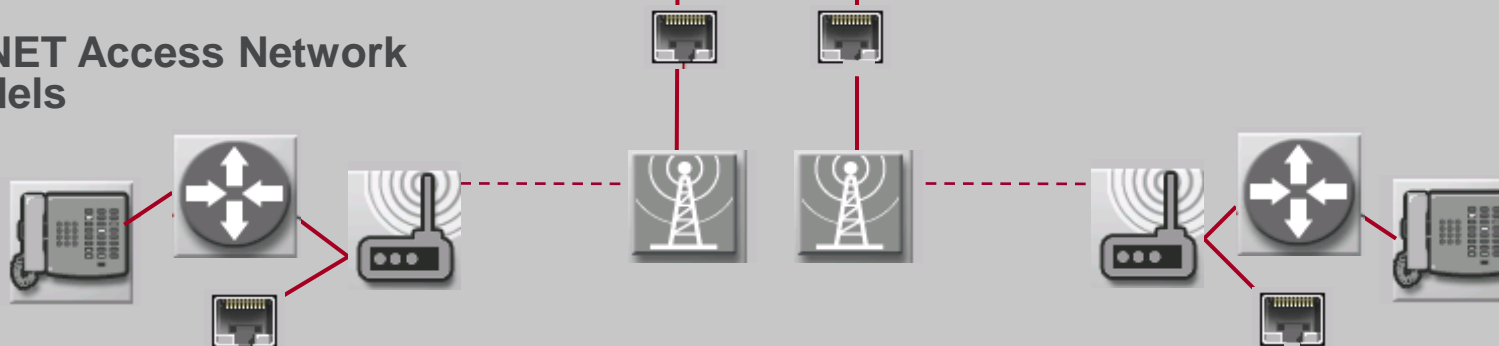
# End-to-End Prototyping Framework



IMS Stack

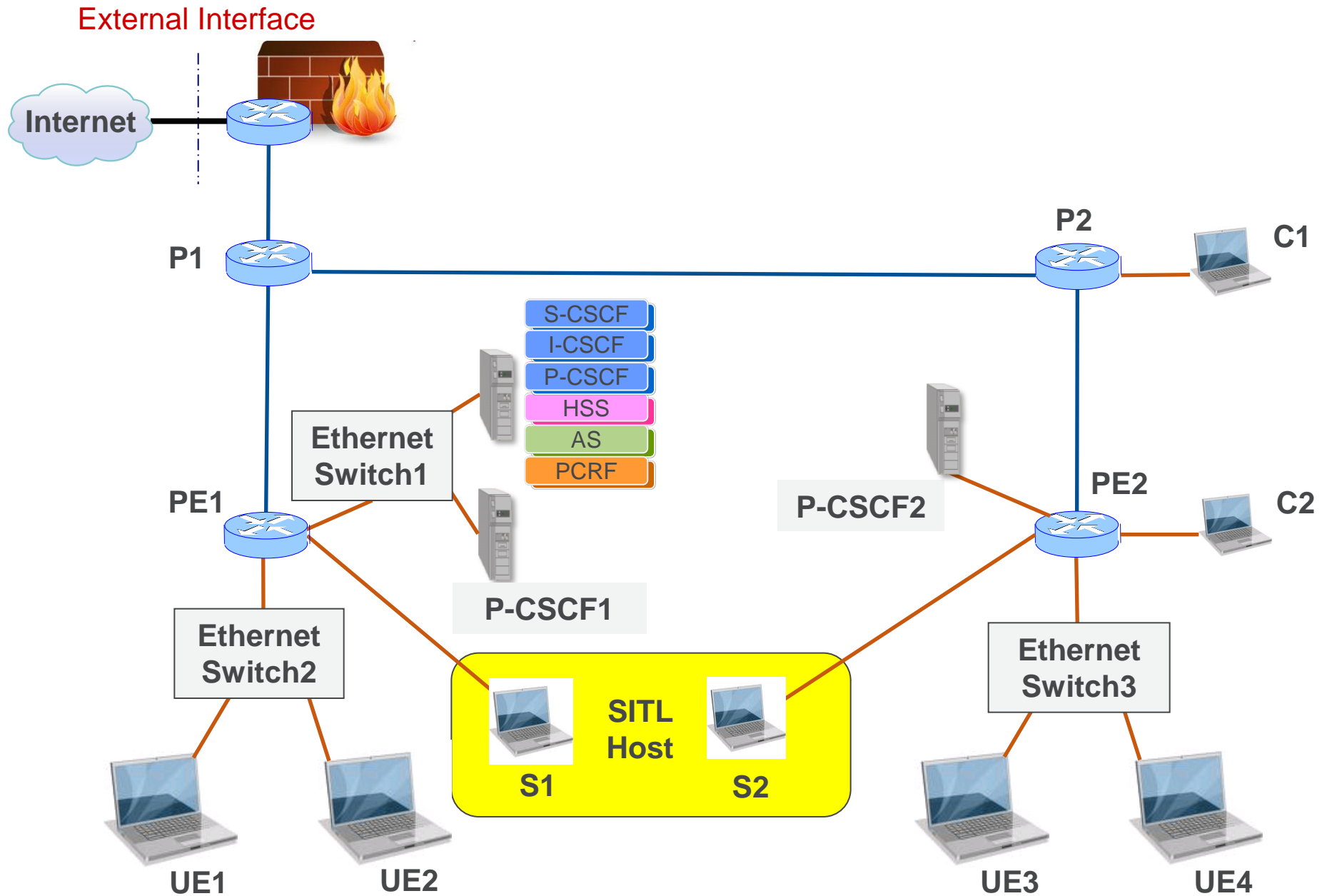
- S-CSCF
- I-CSCF
- P-CSCF
- HSS
- AS
- PCRF

OPNET Access Network Models

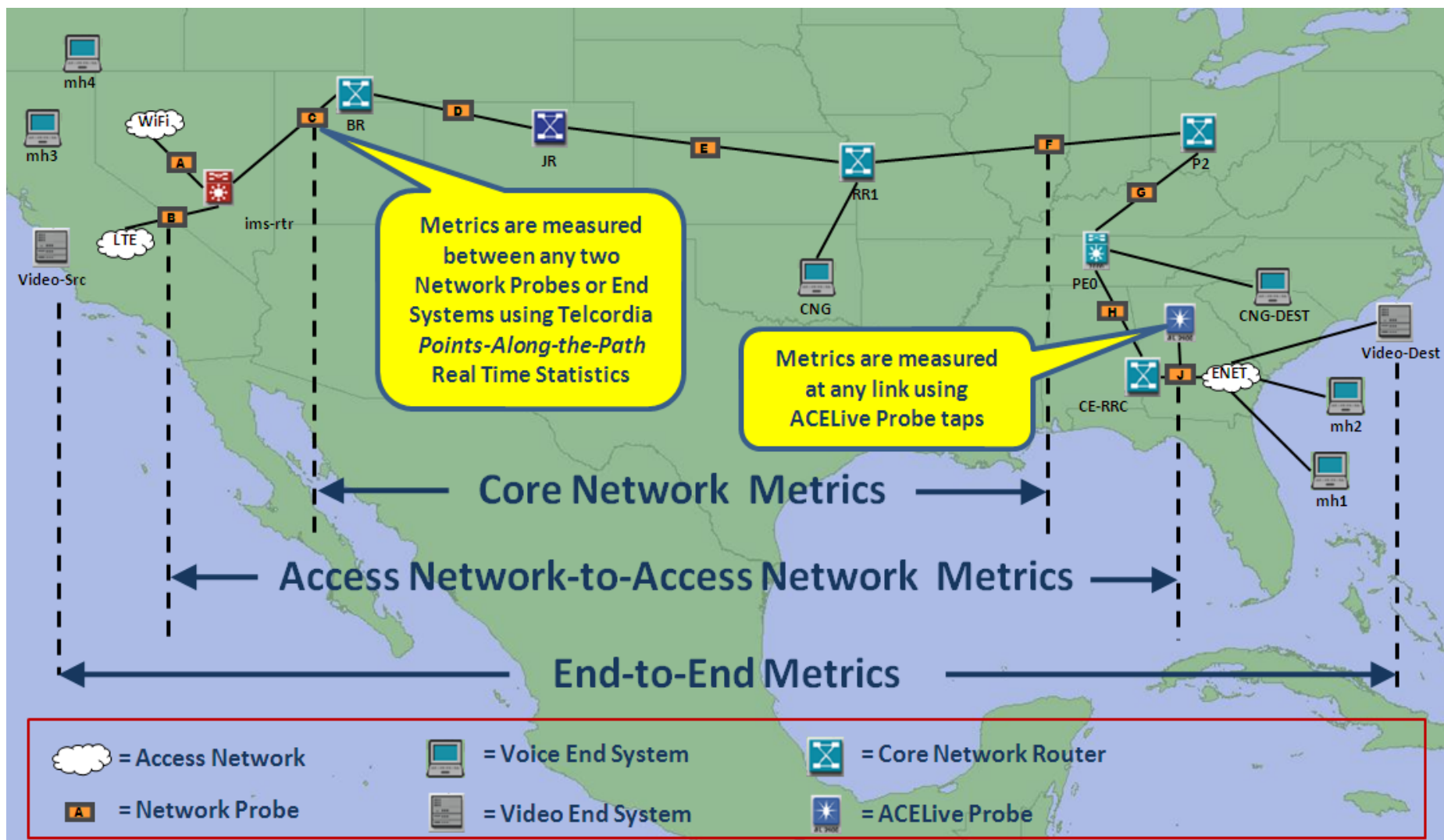




# Example Testbed Hardware Configuration



# End-to-End Network Prototyping



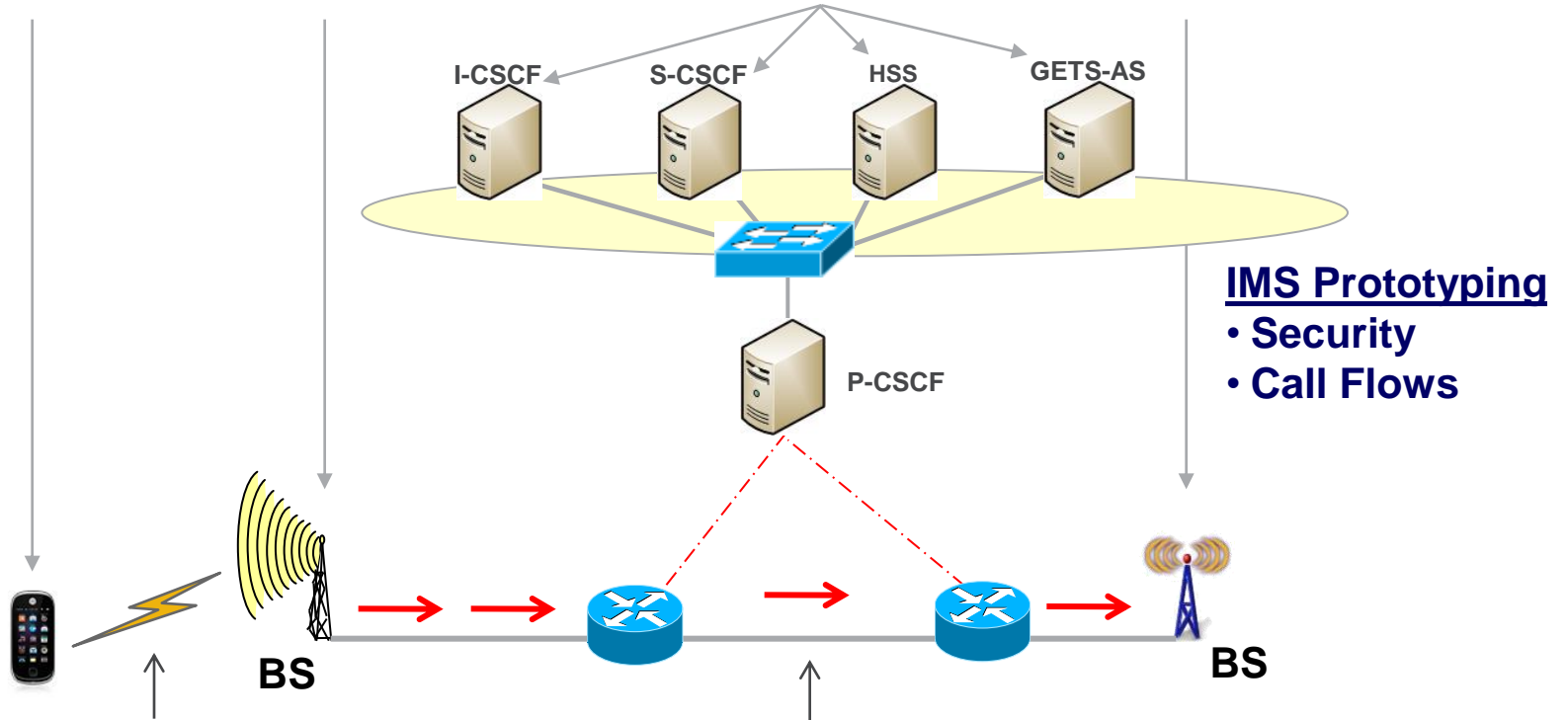
# End-to-End Performance Features

**Access Control Algorithm**

**Transport Queueing**

**Server Processing**

**Management Queueing**



**IMS Prototyping**

- Security
- Call Flows

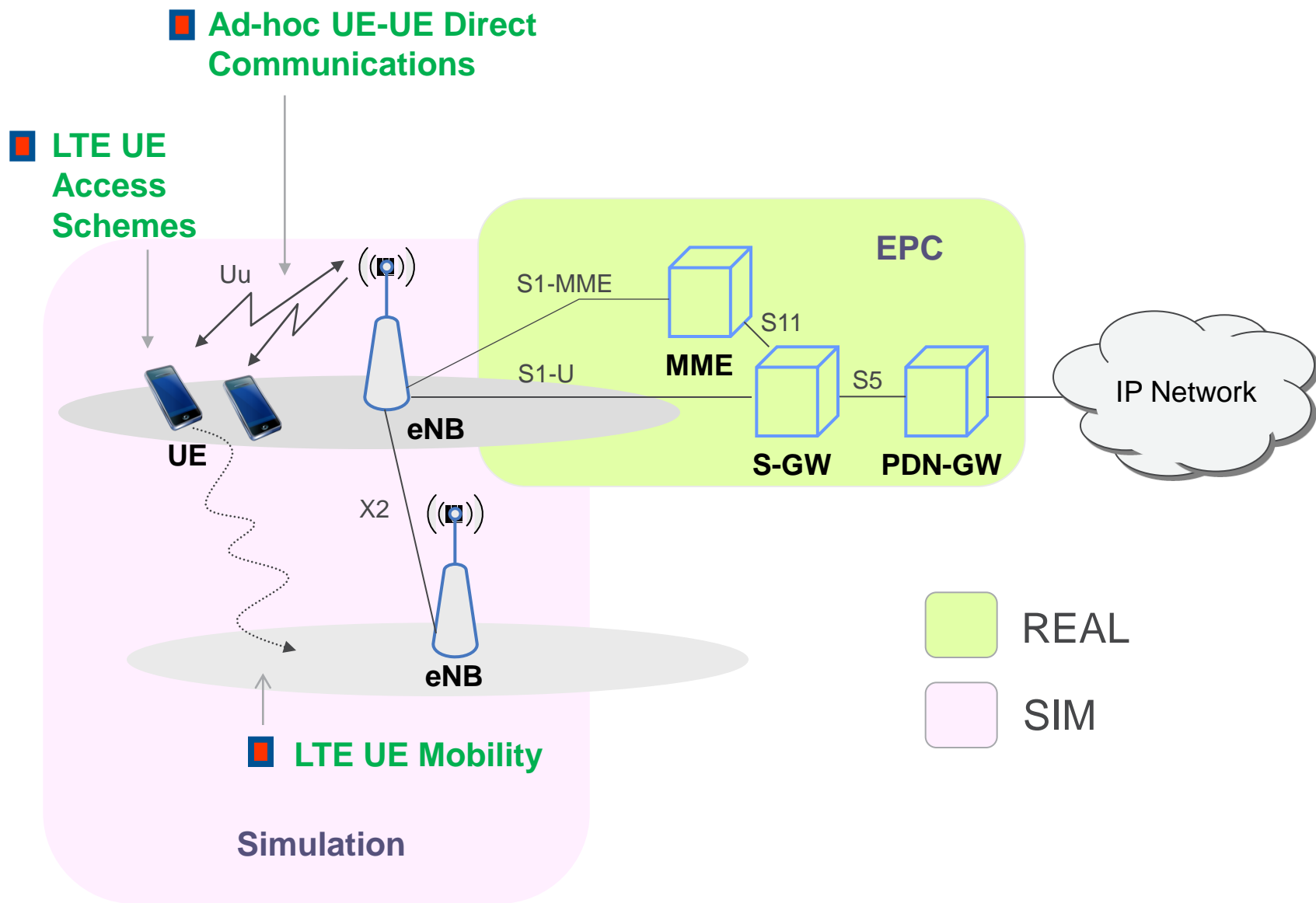
**Access Modeling**

- EvDO
- WiMAX
- LTE
- Ad-hoc Mobile

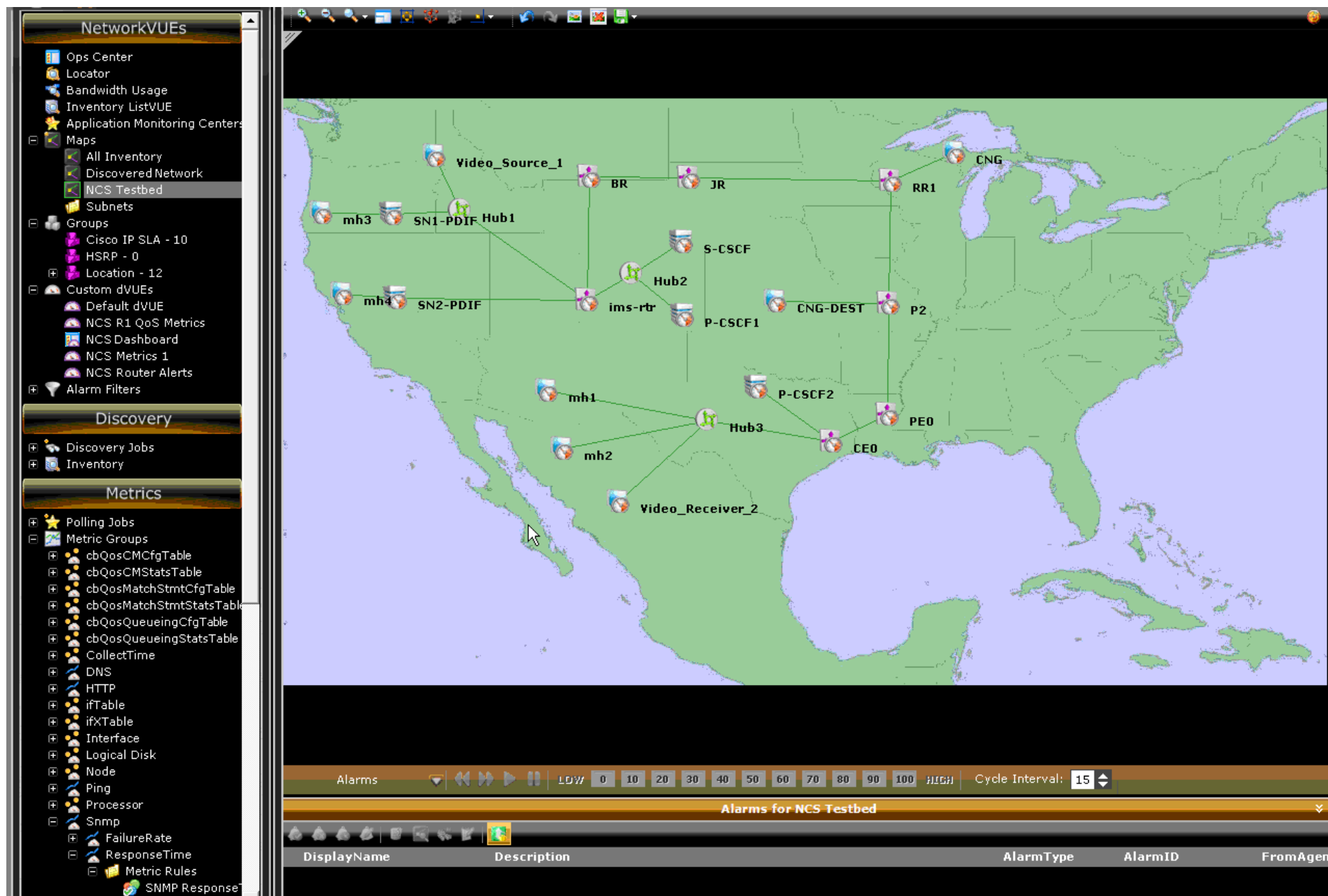
**IP v4/v6 Prototyping**

- Multi-Domain Transport
- Quality of Service (DiffServ)

# LTE Access Performance Features



# Visualization of Prototyped Network



# Network Performance Dashboard

Video

- NCS Dashboard
- NCS Metrics 1
- NCS Router Alerts
- Alarm Filters

Discovery

- Discovery Jobs
- Inventory

Metrics

- Polling Jobs
- Metric Groups
  - cbQosCMCfgTable
  - cbQosCMStatsTable
  - cbQosMatchStmntCfgTable
  - cbQosMatchStmntStatsTable
  - cbQosQueueingCfgTable
  - cbQosQueueingStatsTable
  - CollectTime
  - DNS
  - HTTP
  - ifTable
  - ifXTable
  - Interface
  - Logical Disk
  - Node
  - Ping
  - Processor
  - Snmp
    - FailureRate
    - ResponseTime
    - Metric Rules
    - SNMP Response
- NetFlow

NetOps

- Events
- Rules
- Actions
  - Clear Alarm
  - Create Alarm
  - Custom DLL
  - Templates

Reports

- Inventory
- Alarm
- Top N Alarmed
- Performance

No alarms found.

**Non-Priority Call Congestio**  
Grouped By Severity

No alarms found.

**Priority Call Congestion Ale**  
Grouped By Severity

**Top 5 Bandwidth Transmit Utilization**

RR1 - Ethernet3/2{ifIndex[8]}	
P2 - Ethernet1/4{ifIndex[7]}	
PE0 - FastEthernet4/0{ifIndex[14]}	
BR - FastEthernet0/1{ifIndex[2]}	
PE0 - Ethernet3/0{ifIndex[6]}	

**NCS Testbed**

**doppleVUE**

Interface:Utilization Out  
RR1 - Ethernet3/2{ifIndex[8]}

Interface:Discards Out  
RR1 - Ethernet3/2{ifIndex[8]}

Pkt Discards - EF  
RR1

Q Depth - EF (VoIP, SIP)  
RR1

Pkt Discards - AF4  
RR1

Q Depth - AF4 (Video)  
RR1

Pkt Discards - Best Effort  
RR1

Q Depth - Best Effort  
RR1



# End-to-End Performance Measurement

Version d20100915-h0912/3.54  
Expires Fri Dec 2 00:00:00 2011  
Active channels 4  
11:04:32

logout

- VolP Data
  - Call Lookup
  - Alert Lookup
- VolP Data Settings
  - Call Quality Thresholds
  - VolP Call Metrics
  - Time Zone
- Administration Tools
  - Status
  - License
  - Capture Settings
  - Protocol Settings
  - UI Settings
  - Backup
  - Data Purge
  - Diagnostics
  - Documentation

Start Time	Duration	Call Status	Originator	Terminator	Caller Number	Callee Number	Signal
2011-01-31 10:21:25	0m 12s (Active)	200 OK	172.16.6.111	92.1.18.1	"2138883333" <sip:2138883333@172.16.6	<sip:2138881111@ncs.testbed>	1
channels							
Start	Duration	Source -> Destination	MoS CO	Packet Loss (%)			
2011-01-31 10:21:38	N/A	92.1.18.1 : 22224 -> 172.16.6.111 : 22224	4.2	0			
2011-01-31 10:21:38	N/A	172.16.6.111 : 22224 -> 92.1.18.1 : 22224	4.2	0			
2011-01-31 10:21:29	0m 06s (Active)	200 OK	172.16.8.222	92.1.18.2	"2138884444" <sip:2138884444@172.16.8	<sip:2138882222@ncs.testbed>	
channels							
Start	Duration	Source -> Destination	MoS CO	Packet Loss (%)			
2011-01-31 10:21:35	N/A	92.1.18.2 : 22224 -> 172.16.8.222 : 22224	4.2	0			
2011-01-31 10:21:35	N/A	172.16.8.222 : 22224 -> 92.1.18.2 : 22224	4.2	0			

Quality
Degradation
Packet loss
Delay/jitter
Codec
QoS
Channel Details
Channel Charts

**MOS**

time

— MOS LQ — MOS CQ for Local Probe

**Jitter**

time

— PPDV for Local Probe — MAPDV — Packet Interval  
— Packet Loss Rate for Local Probe

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# Experience the Performance

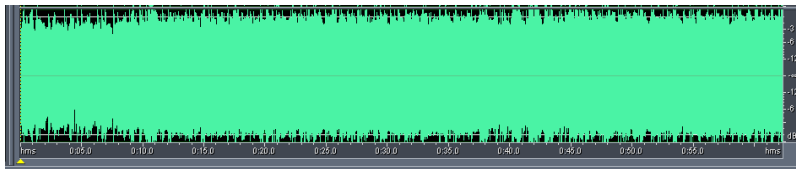
- Transmitted Video under Normal Load



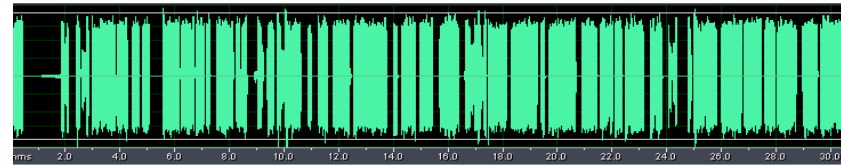
- Transmitted Video under Congestion



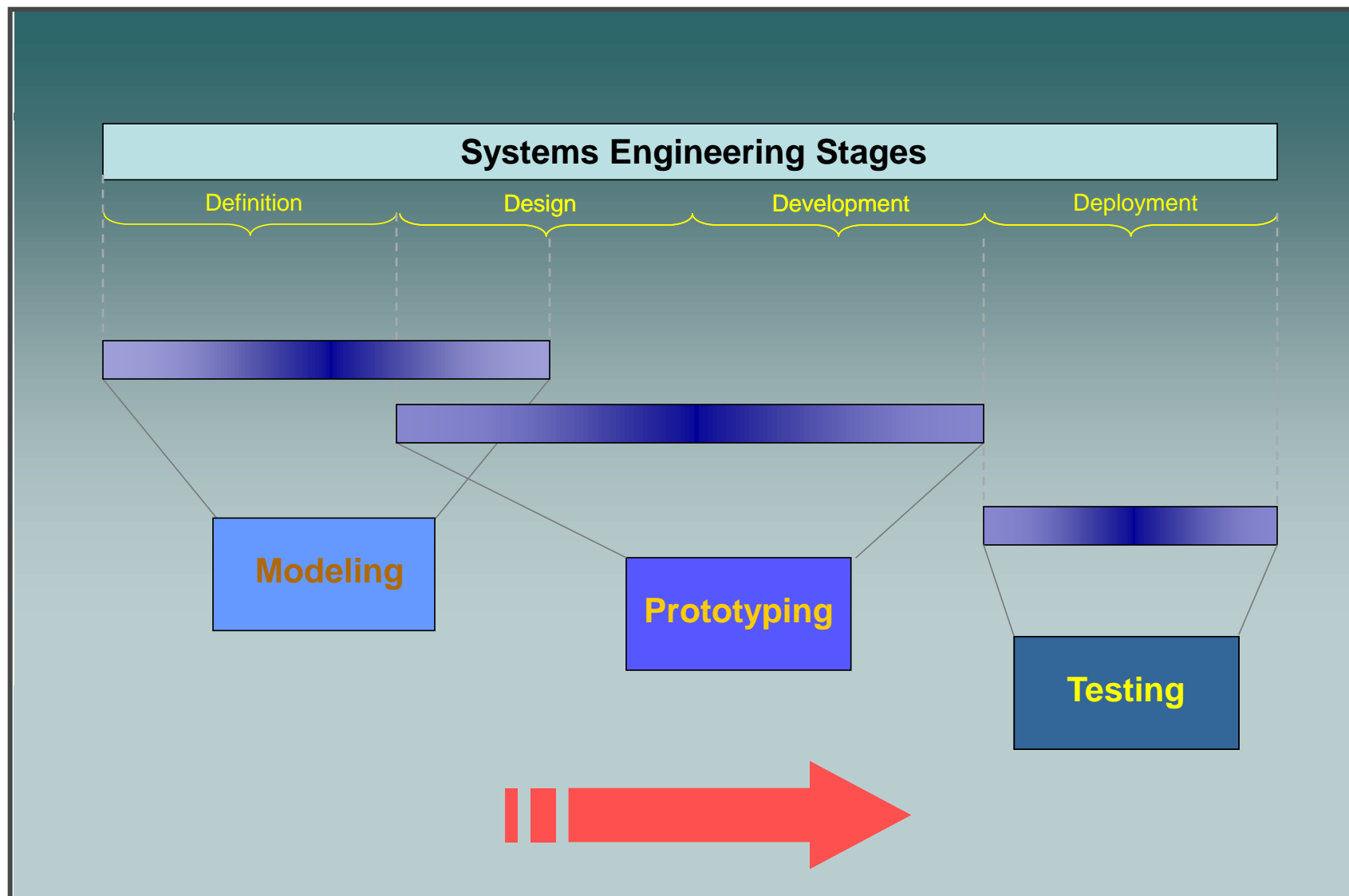
- Transmitted Audio under Normal Load



- Transmitted Audio under Congestion



# Continuously Evolving Hybrid Platform





Q & A