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

Presented to:

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The Hybrid Concept

- Server Hardware
- Physical Routers
- Physical Transports
- Server Models
- Modeling Software
- Router Models
- Transport Models
- SITL
### Desired Prototyping/Testing Characteristics

<table>
<thead>
<tr>
<th>Realism</th>
<th>Physical - High</th>
<th>Modeling - Low</th>
<th>Hybrid - Medium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance</td>
<td>Physical - High</td>
<td>Modeling - Low</td>
<td>Hybrid - Medium</td>
</tr>
<tr>
<td>Scalability</td>
<td>Physical - Low</td>
<td>Modeling - High</td>
<td>Hybrid - Medium</td>
</tr>
<tr>
<td>Cost</td>
<td>Physical - High</td>
<td>Modeling - Low</td>
<td>Hybrid - Medium</td>
</tr>
</tbody>
</table>
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 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.

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REAL to SIM Scenario

Real Network Elements talk to Simulated Network Elements
Protocol interaction between Real and Simulated network elements

Simulated Network Elements talk to Simulated Network Elements
Protocol interaction between Simulated network elements
REAL to SIM to REAL Scenario

Real Network Elements talk to Real Network Elements
Protocol interaction between Real network elements

Simulated Network Elements talk to Simulated Network Elements
Protocol interaction between Simulated network elements
Hybrid Modeling and Simulation Platform
End-to-End Prototyping Framework

OPNET Access Network Models

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

IMS Lab

IP Lab

Telcordia
Example Testbed Hardware Configuration

External Interface

Internet

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

P1

PE1

Ethernet Switch1

P-SCSF1

P-CSCF2

Ethernet Switch2

S1
S2

Ethernet Switch3

P2

PE2

UE1

UE2

UE3

UE4

C1

C2

SITL Host

Ethernet

Switch

Internet

PCRF

AS

HSS

I-CSCF

S-CSCF

External Interface
End-to-End Network Prototyping

Metrics are measured between any two Network Probes or End Systems using Telcordia Points-Along-the-Path Real Time Statistics

Metrics are measured at any link using ACELive Probe taps

Core Network Metrics

Access Network-to-Access Network Metrics

End-to-End Metrics

- = Access Network
- = Voice End System
- = Core Network Router
- = Network Probe
- = Video End System
- = ACELive Probe
End-to-End Performance Features

Access Control
Algorithm

Transport
Queueing

Server
Processing

Management
Queueing

Access Modeling
• EvDO
• WiMAX
• LTE
• Ad-hoc Mobile

IP v4/v6 Prototyping
• Multi-Domain Transport
• Quality of Service (DiffServ)

IMS Prototyping
• Security
• Call Flows
Visualization of Prototyped Network
Network Performance Dashboard
End-to-End Performance Measurement
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

Systems Engineering Stages

- Definition
- Design
- Development
- Deployment

- Modeling
- Prototyping
- Testing
Q & A