3G UMTS Wireless Lab Simulation
COMMUNICATIONS NETWORKS LAB (CNL)

- Each LAB test system emulates 3G network elements and traffic types within the Wireless infrastructure.

- Provides a base network environment that enables the researchers to test applications, devices, and services prior to deployment on real-time networks.
GSM, TDM and TDMA, Core interfaces T1 E1 but now migrating to IP

WCDMA, Same Core network as 2G

LTE, OFDMA, SC-FDMA, All IP
MAPS™ (Message Automation & Protocol Simulation)

- **Multi-protocol, Multi-technology** Platform.
- Simulate any node, and any interface in network with MAPS™ (except Air interface).
- Supports **Emulation, Conformance**, and **Load** testing of a variety of protocols over IP, TDM, and Wireless networks.
3G CNL - EMULATION OPTIONS

- Mobile to Mobile Call Emulation
- Mobile to Mobile SMS Emulation in CS Network
- Mobile to Landline Call Emulation
- Mobile Traffic and Web Access Emulation in PS Network
Complete 3G CNL System w/Real NodeB

**Mobile-Mobile**
- Real NodeB
  - IP Access NodeB
  - Mobile Phones
  - SIMs
- Iuh
  - PKS160 MAPS™ IuCS IuH
- IuCS
  - PKS160 MAPS™ IuCS IuH
  - PKS102 RTP Core (only @ MSC)
- C, D
  - PKS132 MAPS™ MAP IP
- High density Bulk Calling
  - MAPS™ High Density RTP Generator

**Mobile-SMS CS**
- Real NodeB
  - IP Access NodeB
  - Mobile Phones
  - SIMs
- Iuh
  - PKS160 MAPS™ IuCS IuH
- IuCS
  - PKS160 MAPS™ IuCS IuH
- C, D, and E
  - PKS132 MAPS™ MAP IP
- High density Bulk Calling
  - MAPS™ High Density RTP Generator

**Mobile-SMS PS**
- Real NodeB
  - IP Access NodeB
  - 2 Mobile Phones
  - 2 SIMs
- Iuh
  - PKS160 MAPS™ IuCS IuH
- IuPS
  - PKS164 MAPS™ UMTS IuPS
- Gr, Gd
  - PKS132 MAPS™ MAP IP

**Mobile-Landline**
- Real NodeB
  - IP Access NodeB
  - Mobile Phones
  - SIMs
- Iuh
  - PKS160 MAPS™ IuCS IuH
- IuPS
  - PKS164 MAPS™ UMTS IuPS
  - ETH102 MobileTrafficCore GW
- Gn Gp
  - PKS166 MAPS™ Gn Gp
  - ETH102 MobileTrafficCore GW
- Gr
  - PKS132 MAPS™ MAP IP
- High density Bulk Calling
  - MAPS™ High Density RTP Generator

**Mobile-Web Browsing**
- Real NodeB
  - IP Access NodeB
  - Mobile Phones
  - SIMs
- Iuh
  - PKS160 MAPS™ IuCS IuH
- IuPS
  - PKS164 MAPS™ UMTS IuPS
  - ETH102 MobileTrafficCore GW
- Gn Gp
  - PKS166 MAPS™ Gn Gp
  - ETH102 MobileTrafficCore GW
- Gr
  - PKS132 MAPS™ MAP IP
- High density Bulk Calling
  - MAPS™ High Density RTP Generator
Complete 3G CNL System w/ Real NodeB
Complete 3G CNL System w/ Simulated NodeB

- Complete 3G CNL System with Simulated Home NodeB
- Mobile-Mobile
  - Iu-CS
  - PKS160 MAPS™ IuCS IuH
  - PKS182 RTP Core (only @ MSC)
  - C, D
  - PKS132 MAPS™ MAP IP
  - High Density Bulk Calling
  - MAPS™ High Density RTP Generator
- Mobile-SMS CS
  - Iu-CS
  - PKS160 MAPS™ IuCS IuH
  - C, D, and E
  - PKS132 MAPS™ MAP IP
  - High Density Bulk Calling
  - MAPS™ High Density RTP Generator
- Mobile-Landline
  - Iu-CS
  - PKS160 MAPS™ IuCS IuH
  - C, D
  - PKS132 MAPS™ MAP IP
  - ISUP
  - XX649 MAPS™ SS7 TDM with T1 E1 Hardware
  - PKS145 Media Gateway Conversion
  - Analog Simulation
    - XX624 MAPS™ PKO FXS iProbe™ T1 E1 Hardware Qr
    - XX551 MAPS™ CAS with T1 E1 Hardware and APS
- Mobile-Web Browsing
  - IuPS
  - PKS164 MAPS™ UMTS IuPS
  - ETH101 MobileTrafficCore GTP
  - Gn Gp
  - PKS156 MAPS™ Gn Gp
  - ETH101 MobileTrafficCore GTP
  - Gr
  - PKS132 MAPS™ MAP IP
  - High Density Bulk Calling
    - PacketLoad 4x10G Data Traffic Generator
- Mobile-SMS PS
  - IuPS
  - PKS164 MAPS™ UMTS IuPS
  - Gr, Gd
  - PKS132 MAPS™ MAP IP
  - High Density Bulk Calling
    - PacketLoad 4x10G Data Traffic Generator
## Supported Protocols

<table>
<thead>
<tr>
<th>Supported Protocols</th>
<th>Specification Used</th>
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<tr>
<td>SCCP</td>
<td>Q.713, CCITT (ITU-T) Blue Book</td>
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<td>M3UA</td>
<td>RFC 3332</td>
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<td>RANAP</td>
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<td>GMM / SM</td>
<td>3GPP TS 24.008 V5.16.0 (2006-06)</td>
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<td>SMS</td>
<td>3GPP TS 03.40 V7.5.0 &amp; 3GPP TS 04.11 V7.1.0 GSM 03.38 version 7.2.0 Release 1998</td>
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## PROTOCOL STACK SPECIFICATION

<table>
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<th>Supported Protocols</th>
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<tr>
<td>SCCP</td>
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<td>Q.703, ITU-T Blue Book</td>
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<td>3GPP TS 03.40 V7.5.0 &amp; 3GPP TS 04.11 V7.1.0 GSM 03.38 version 7.2.0 Release 1998</td>
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</tbody>
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UE-TO-UE (UMTS) PROCEDURES

- Mobile Originated Call (MOC)
  - CHANNEL REQUEST
  - AUTHENTICATION, CIPHERING, VALIDATION
  - CALL SETUP REQUEST
  - ALLOCATING DEDICATED VOICE CHANNEL OVER AIR INTERFACE

- Mobile Terminated Call (MTC)
  - PAGING
  - IDENTITY & AUTHENTICATION, CIPHERING
  - LOCATION UPDATE
  - CALL SETUP REQUEST
  - ALLOCATING DEDICATED VOICE CHANNEL OVER AIR INTERFACE

- Location Update Call (LUC)
UE-TO-UE (UMTS) PROCEDURES (MOBILE ORIGINATING CALL - MOC)
UE-TO-UE (UMTS) PROCEDURES
(MOBILE TERMINATING CALL - MTC)
UE-TO-UE (UMTS) PROCEDURES (LOCATION UPDATE CALL - LUC)

- Location Update Request
- CC Connection Confirm
- Location Updating Accept
- Iu-Release Command
- Iu-Release Complete
- RLS Release
- RLS Release Complete

SCCP connection establishment
Authentication, Security Mode Control, Identification and TMSI Reallocation procedures
(includes new TMSI)
All the associated resources released
SCCP connection is released
UMTS IuPS PROCEDURES

- ATTACH PROCEDURES
- IDENTITY PROCEDURES
- ROUTING AREA PROCEDURES
- PDP CONTEXT CREATE, ACTIVATE, DEACTIVATE, AND DELETE PROCEDURES
- WEB BROWSING SESSION
- DETACH PROCEDURES
UMTS-GPRS MOBILITY MANAGEMENT PROCEDURE
HD RTP and Packet Data Traffic Generation Appliances
RTP HD System

- The RTP HD Server network appliance supports generation of high volume of calls with traffic for load testing 2G/3G networks.
- Specialized 1U rackmount appliance, achieve up to 20,000 endpoints per appliance (5000 simultaneous calls with duplex traffic per port).
Remote RTP HD System

- The load (high density real-time traffic and signaling) simulated in the above lab setup across 2G/3G/4G networks can be evenly distributed in round-robin fashion over the 4x HD ports on the RTP HD system, so that incoming requests may be evenly distributed among all of them.

- Each HD port is capable of 5000 simultaneous calls with duplex traffic.

- Once the port limit is reached the load is distributed across the remaining HD ports available in the system.
PacketLoad 10G

- PacketLoad 4 x 10Gbps (PKS174) is a Data Traffic Generator 2U Rack Appliance with 4 x 10Gbps NIC interfaces: total capacity of up to 40 Gbits/sec Stateful TCP/HTTP Traffic.

- It supports massive simulation of UEs (up to 500,000) with high density (up to 4 Gbps or 40 Gbps) mobile data traffic simulation for both UMTS, and LTE networks.
TEST LAB CONFIGURATIONS
### Testbed Setup: 3G SGSN

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<th>Value</th>
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<td>MTP Parameters</td>
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<td>Network Indicator</td>
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<td>Source SCP Mode</td>
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<td>Location Area Identifiers</td>
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<td>Location Area Identifier</td>
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</tbody>
</table>

**Diagram:**
- **HLR 10.10.1.22 8.8.8**
- **MME 10.10.1.20 1.1.1**
- **SGSN 10.10.1.26 6.6.6**
- **SGSN 10.10.1.28**
- **GGSN 10.10.1.28**
- **UMTS Core Network PLMN 90170**
- **GSM Core Network**

**Connections:**
- HLR to MME (Gr)
- MME to SGSN 1 (Gn)
- SGSN 1 to SGSN 2 (Gn)
- SGSN 2 to SGSN 3 (Gn)
- SGSN 3 to UMTS Core Network (Gp)
- MME to UMTS Core Network (Gp)

**Networks:**
- HLR
- MME
- SGSN 1
- SGSN 2
- SGSN 3
- UMTS Core Network
- GSM Core Network
Testbed Setup: 3G MSC
Testbed Setup: 3G HLR
Testbed Setup: 3G GGSN
The MAPS™ Listener is configured to run on start-up. While running an icon should be displayed in Windows notification area. If the icon is missing, invoke MAPSListener_x64 from the Desktop.

Invoke MAPS™ Remote Controller from the 3G system Desktop.

The Controller is configured to control the following MAPS™ nodes: RNCs (IuCS and IuPS), HNBGW, HLR, SMSC, SGSN, GGSN

Start All to connect to all MAPS™ server nodes.
System Quick Start - Start Testbeds
Cycle through the nodes in Remote Controller and verify the Link Status of the following nodes:
System Quick Start - 3G Calls w/ Real Mobiles
System Quick Start - 3G SMS w/ Real Mobiles
System Quick Start - Simulated Mobile Traffic
Inter-Networking 3G with 2G and 4G Lab (Inter-Operability)
Inter-Network Calls

- Inter-Network Calls
  - 3G user calling 2G user
  - 3G user calling 4G user
  - 3G user sending SMS to 2G user
  - 3G user sending SMS to 4G user

- Roaming calls
  - 3G user calling 2G roaming user
  - 3G user calling 4G roaming user
When a voice call or SMS call is placed from UE1 to UE2, MSC on 3G network receives call from UE1 and checks for the received MSISDN registration using MAP table.

If MAP is found then call is routed within same network otherwise call is routed to 2G MSC. MSC in the 2G network routes the request to 2G user.
Inter-Network Calls - 3G calling 2G

- CM SERVICE REQUEST message is sent to 3G MSC
- Authentication procedure is initiated at the HLR Node
- When Setup Message (Voice Call) is received, MSC checks whether Called MSISDN is registered to 3G Network. If not, the Initial Address (BICC Call is initiated) towards GMSC.
Inter-Network Calls - 3G calling 4G
When a voice call is placed from UE1 to UE2, MSC on 3G network receives call from UE1 and checks for the received MSISDN registration using MAP table.

If MAP is not found then MSC checks 4G CSV. If MSISDN is available in 4G CSV then call is routed to MGC using Initial Address Message.
Inter-Network Calls - 3G SMS to 2G
Roaming Calls - 3G Calling 2G Roaming UE

- When 3G user calls 2G roaming user, MSC receives Call and checks Called MSISDN is registered into MSC.
- If registered, Paging is initiated to RNC within 3G network to call 2G user.
Roaming Calls - 3G Calling 2G Roaming UE
Roaming Calls - 3G Calling 4G Roaming UE

- 4G User when roaming into 3G Network registers to 3G MSC, i.e. Location update is performed and MSC has MSISDN vs IMSI MAP stored.

- When 3G user calls 4G roaming user, MSC receives Call and checks Called MSISDN is registered into MSC. If registered, Paging in initiated to RNC within 3G network to call 4G user.
PERFORMANCE...

- Load, Stress, and Performance, Testing to measure the capability of an entity for various traffic conditions.
- Load /Stress test with different statistical distribution patterns with capacity of 2000 simultaneous calls,
  @ 500 call per second rate
- Control and operate MAPS™ remotely, also gather statistics, logs and reports.
- Traffic Simulation to perform end-to-end testing of various traffic - mobile traffic simulation over GTP, transmit/record real time voice traffic, DTMF and MF digits, user defined single/dual tones over established channels
MAPSTM Remote Controller
MAPS™ Remote Controller

- Remotely control multiple MAPS™ Servers running on different PCs from a single remote client application
- Allows multiple users to use MAPS™ products installed on a single MAPS™ server
MAPS™ Remote Controller

- Communicates with the multiple MAPS™ Server via Listener over TCP/IP.
Flexible MAPS™ architecture to test emerging technologies including UMTS, LTE better known as 3G, 4G, IP networks (such as SIP, MGCP, MEGACO, SIGTRAN), and legacy networks (such as CAS, SS7 and ISDN)

Multi-Interface and Protocol Simulation over different transports layers - IP network (TCP, UDP, SCTP, IPv4 and IPv6), TDM network (MTP2, and LAPD) links

Multi-Homing feature is supported in SCTP for simulating multiple nodes

Automation Features –
- Execution of the multiple calls sequentially or randomly to handle incoming and outgoing calls
- Automation via CLI clients (TCL, Python, Java and C#)
- Scheduler to load pre-defined test bed setups and configuration files to automate test process at specified time.
- Control multiple nodes via Remote Access and run tests
THANK YOU