

IxLoad LTE Evolved Packet Core Network Testing: eNodeB simulation on the S1-MME and S1-U interfaces



In conjunction with its eNodeB emulation, IxLoad can simulate the behavior of hundreds of thousands of subscribers using assorted services.

For example, an emulated subscriber could be surfing the web, downloading files using FTP, checking and sending e-mail, exchanging data with peer-to-peer applications and watching video on demand.

All layer 7 protocol emulations are fully stateful implementations that can interact with real servers and peers.

IxLoad is a full-featured layer 4-7 test application that provides real-world traffic emulation testing of voice, video, and data networks and components. IxLoad simultaneously emulates multiple layer 7 protocols statefully, making it perfect for testing application delivery systems and components that use deep packet inspection (DPI).

IxLoad supports the 3GPP S1-AP and NAS protocols (Release 9 and Release 10) as well as the GTP-u protocol, enabling testing of the wireless evolved packet core (EPC). This is accomplished through the emulation of the eNodeB on the S1-MME and S1-U interfaces.

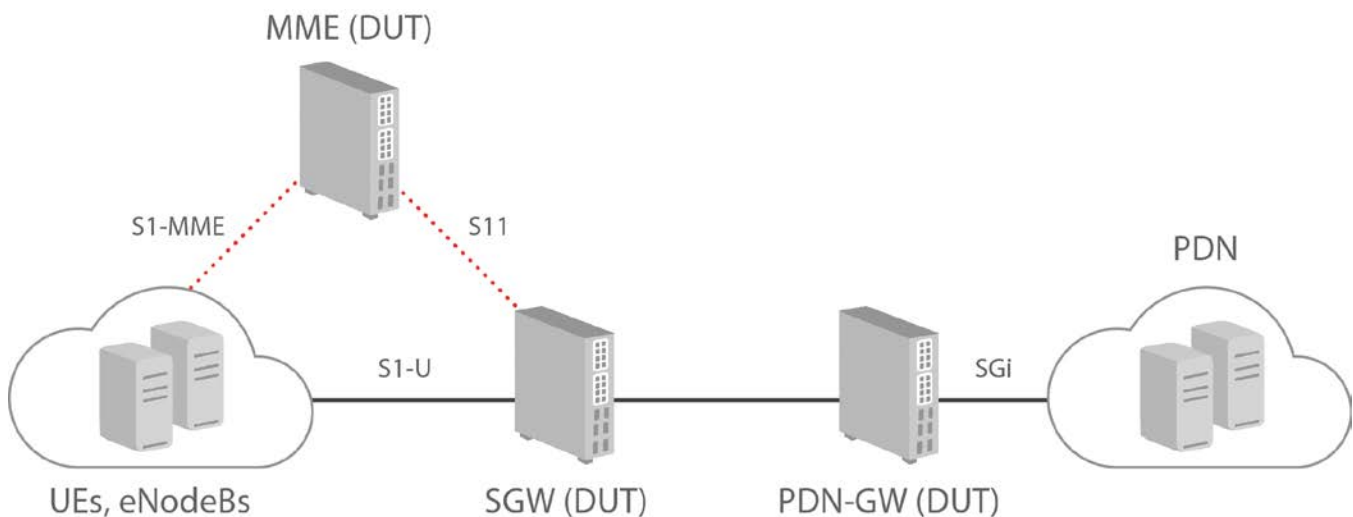


Figure 1: EPC testing topology

IxLoad's intuitive GUI greatly simplifies test construction by removing the requirement for building or modifying the control plane signalling procedures. IxLoad's implementation is a complete state machine that exposes many options for configuration and flexibility. This implementation makes it unnecessary to build complex and error prone message exchange sequences in order to construct a test case. With IxLoad, subscribers are simply configured and assigned to specific real-world activities, such as VoIP calls and web browsing. The test is then ready to start; the process is fast and time-efficient.

IxLoad's emulation includes all the procedures required for full testing: default and dedicated bearers, network and UE initiation, deletion and modification of the bearers, as well as full control over the traffic mix and intensity.

IxLoad also supports a clever handover mechanism in which a mobility path from one eNode B to another is defined as a list, along with a variable handover interval. IxLoad performs the handovers transparently, without any user intervention. Even the type of handover (X2 or S1 based, MME and SGW relocation or not) will be automatically detected and executed, based on the user configuration.

IxLoad's complete automation facilities allow regression tests to run unattended. A fully-featured TCL interface provides access to all IxLoad functions. In addition, a test configuration created with the IxLoad GUI can be turned into an automation TCL script with a single click of the mouse. In this way IxLoad tests can be run without GUI interaction, and without any required programming.

Protocols

Control plane

- 3GPP TS 36413 v9.3.0 (R9 June 2010) Evolved Universal Terrestrial Radio Access Network (E-UTRAN); S1 Application Protocol (S1AP)
- 3GPP TS 24301 v9.3.0 (R9 June 2010) Non-Access-Stratum (NAS) protocol for Evolved Packet System (EPS); Stage 3
- IPv4 and IPv6 transport

User Plane

- 3GPP TS 29.281 GPRS Tunneling Protocol User Plane (GTPv1-U)
- HTTP v1.0 and v1.1
- HTTPS
- FTP
- POP3
- SMTP
- IMAP
- SIP/TCP + RTP
- Peer-to-peer protocols
- Video on demand with RTSP
- Application replay – stateful replay of packet captures
- Stateless Peer (stateless packet generator)
- IPv4 and IPv6 support for all applications

All layer 7 protocols listed above are true stateful emulations that can interact with real network devices.

Control Plane Features

- Support for default and dedicated bearers, with a maximum of 11 per user equipment (UE)

- UE initiated dedicated bearer creation and deletion
- Network initiated dedicated bearer creation and deletion
- Support for IDLE state (S1 Release), Paging and TAU procedures
- Echo request and response
- Dynamic IP address allocation during session establishment
- Ability to configure the number of simulated eNodeBs
- Supports X2 handovers with configurable event intervals and mobility paths between eNodeBs
- Supports S1-based handovers with indirect data forwarding
- Supports MME and/or SGW relocation for all handover types
- Configuration of IMSI, MSISDN, IMEISV, RAC/LAC/TAC, MCC/MNC and many more parameters
- Configuration of QoS parameters (QCI included) and TFT per layer 7 activity
- Prebuilt TFTs are supplied, with the ability to manually override with user TFT definition.
- Configurable APNs per subscriber range, with support for multi-APN per subscriber
- Support for IPv4, IPv6 and IPv4v6 (dual stack) PDN connections, in any combination for multi-APN configurations
- Support for authentication, integrity protection and ciphering
- Support for MME pooling and network sharing

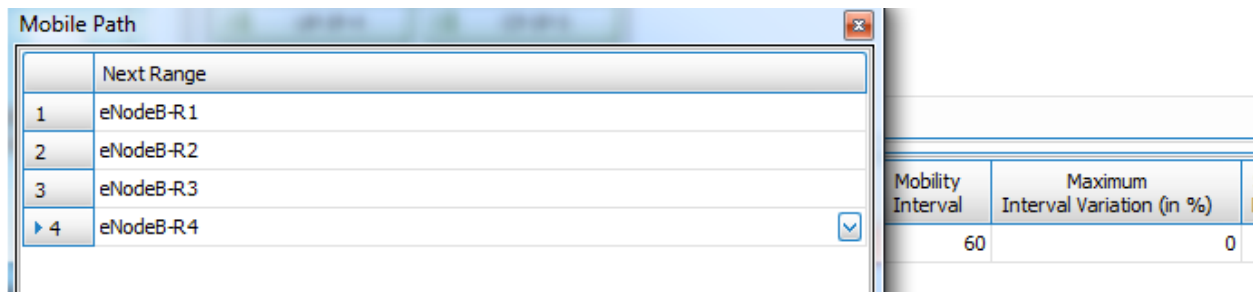


Figure 2: Handover configuration

L7 (User Plane) Features

- Leverages Xcellon-Ultra™ NP TCP acceleration technology to achieve very high throughput rates for http and Application Replay activities
- Multiple activities can be configured per UE, each having a distinct layer 7 protocol and data rate profile
- Each layer 7 activity can be configured with a distinct objective consisting of
 - Simulated users
 - Throughput
 - Connections/sec
 - Connection attempts/sec
 - Layer 7 transactions/sec
 - Concurrent connections/sessions
- Support for IPv4 and IPv6 traffic activities
- Multiple L7 activities can be mapped to distinct UE ranges, in any combination, giving each range an individual traffic profile and mix

- Multiple activities mapped to a single UE range can be configured to request a dedicated bearer or can use the existing default bearer
- Running activities can be remapped from the default bearer to a dedicated bearer dynamically
- Supports L7 protocol servers and peers on the Gi interface

Command Properties for 'APN'

Access Point Name (APN):

☒ Use Dedicated Bearer

☐ Network Initiated Bearer
☒ UE Requested Bearer

☒ Default Bearer Fallback

Traffic Flow Template:

☒ Use Default TFT

MBRU (kbps) MBRD (kbps)
 GBRU (kbps) GBRD (kbps)
 QCI ☒ Use Default QCI

Figure 3: APN, QoS and TFT configuration when using a dedicated bearer

Performance

Metric	Per Port CPU Xcellon-Ultra NP	Per Load Module Xcellon-Ultra NP
Max session activation rate	300 activations/second	3600 activations/second
Max amount of bearers	60 K	720 K
Max amount of eNodeBs	100	1200
Max handover rate – X2 handover	430	5160
Max handover rate – S1 handover	230	2760
Max throughput – http (60K UEs with 1 Default Bearer per port, 620K per Load Module)	83 x 959 Mbps (ULxDL)	1 x 9.6 Gbps (ULxDL)
Max throughput (L2/L3)– Application Replay (60K UEs with 1 Default Bearer per port, 620K per Load Module)	850 x 850 Mbps (UL x DL)	9.4 x 9.4 Gbps (UL x DL)

Notes:

- UL: Uplink
- DL: Downlink
- Throughput values expressed with UL x DL means that the values are achieved simultaneously

Statistics and Measurements

All statistics and measurements listed below are available in real time, as well as in comma separated value (CSV) format at the end of a test.

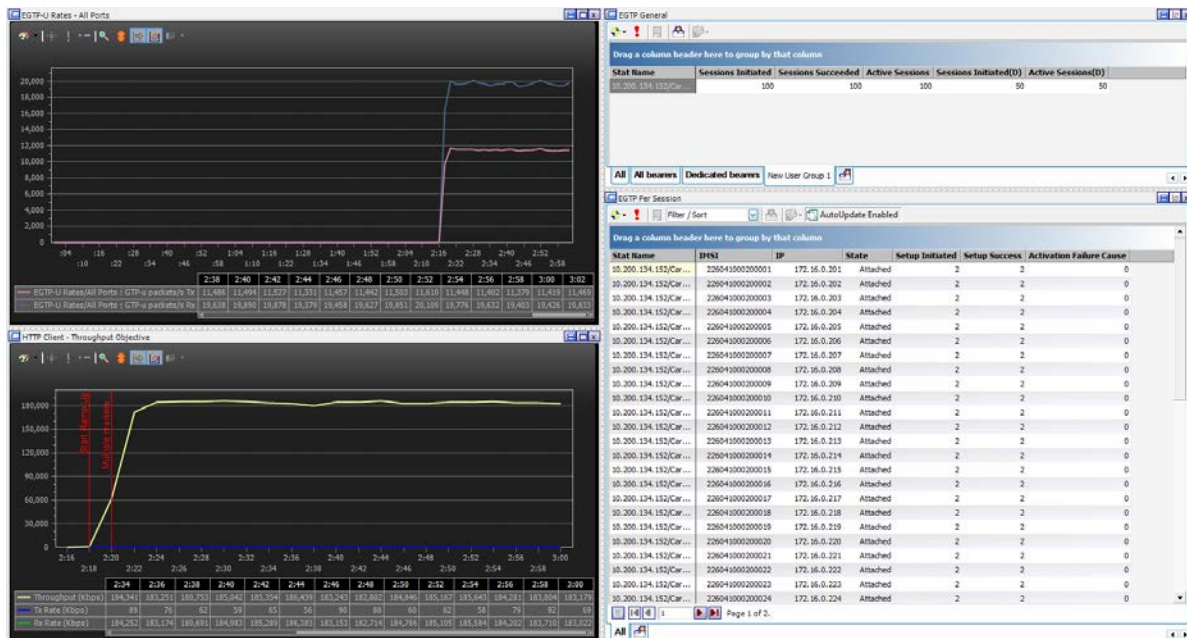


Figure 4: Statistics displayed in real time during a test.

Global statistics

Sessions

Statistic	Description
Sessions Initiated	The aggregate number of default and dedicated bearer sessions initiated during the test.
Sessions Succeeded	The aggregate number of default and dedicated bearer sessions that were successfully initiated during the test.
Sessions Failed	The aggregate number of default and dedicated bearer sessions for which initiation failed during the test.

Active Sessions	The total number of default and dedicated bearers that are currently active. This is a real-time statistic, rather than a cumulative total.
Max Active Sessions	The maximum number of default and dedicated bearers that were active at any one time during test execution.
Detach Initiated	The number of Detach Requests initiated by the UE.
Detach Succeeded	The number of Detach procedures that were successfully completed.
Detach Failed	The number of Detach procedures that failed to complete successfully.

Dedicated bearers

Statistic	Description
UE Initiated	The total number of UE-initiated dedicated bearer request that were initiated
UE Succeeded	The total number of UE-initiated dedicated bearer requests that were successfully completed.
UE Failed	The total number of UE-initiated dedicated bearer requests that were rejected.
NW Initiated	The total number of network-initiated dedicated bearer requests that were initiated.
NW Succeeded	The total number of network-initiated dedicated bearer requests that were successfully completed
NW Failed	The total number of network-initiated dedicated bearer requests that were rejected
Active Bearers	The total number of dedicated bearers that are currently active. This is a real-time statistic, rather than a cumulative total.
Max Bearers	The maximum number of dedicated bearers that have been active at any one time during execution of the test
Terminated	The total number of dedicated bearers that were terminated.

Handovers

Statistic	Description
Total Initiated	The total number of handovers (both X2-based and S1-based) that have been initiated.
Total Succeeded	The total number of handovers (both X2-based and S1-based) that were successfully completed.
Total Failed	The total number of handovers (both X2-based and S1-based) that failed.
X2 Initiated	The total number of X2-based handovers that have been initiated.
X2 Succeeded	The total number of X2-based handovers that have been successfully completed.
X2 Failed	The total number of X2-based handovers that failed.
S1 Initiated	The total number of S1-based handovers that have been initiated.
S1 Succeeded	The total number of S1-based handovers that have been successfully completed.
S1 Failed	The total number of S1-based handovers that failed.
eNB Initiated	The cumulative number of eNodeB-initiated inter-RAT handovers that were initiated. These are handovers destined for an R7-based UMTS network.
eNB Succeeded	The cumulative number of eNodeB-initiated inter-RAT handovers that were successfully completed. These are handovers destined for an R7-based UMTS network.
eNB Failed	The cumulative number of eNodeB-initiated inter-RAT handovers that failed. These are handovers destined for an R7-based UMTS network.
RNC Initiated	The cumulative number of inter-RAT handovers initiated from an RNC. These are handovers destined for an R8-based eNodeB.
RNC Succeeded	The cumulative number of inter-RAT handovers initiated from an RNC that were successfully completed. These are handovers destined for an R8-based eNodeB.
RNC Failed	The cumulative number of RNC-initiated inter-RAT handovers that failed. These are handovers destined for an R8-based eNodeB.

Messages

All individual messages, transmitted and received, are counted. All retries for transmitted messages, and timeouts for received messages, are also counted individually per message.

Per session statistics

Statistic	Description
Interface Identifier	The identifier that IxLoad assigns to this eGTP interface.
UE ID	The International Mobile Subscriber Identity (IMSI) associated with the mobile device configured for this session
Sessions Initiated	The number of default and dedicated bearer sessions initiated for this UE.
Sessions Succeeded	The number of default and dedicated bearer sessions that were successfully initiated for this UE.
Sessions Failed	The number of default and dedicated bearer sessions for which initiation failed for this UE.
Active Sessions	The total number of default and dedicated bearers that are currently active for this UE. This is a real-time statistic, rather than a cumulative total.
Max Active Sessions	The maximum number of default and dedicated bearers that were active at any one time during test execution.
Detach Initiated	The number of Detach Requests initiated by the UE.
Detach Succeeded	The number of Detach procedures that were successfully completed.
Detach Failed	The number of Detach procedures that failed to complete successfully.
Active Dedicated Bearers	The total number of dedicated bearers that are currently active. This is a real-time statistic, rather than a cumulative total.
Dedicated Bearers Terminated	The total number of dedicated bearers that were terminated.
UE Dedicated Bearers Initiated	The total number of UE-initiated dedicated bearer Attach Requests that were initiated.
UE Dedicated Bearers Succeeded	The total number of UE-initiated dedicated bearer Attach Requests that were successfully completed.
UE Dedicated Bearers Failed	The total number of UE-initiated dedicated bearer Attach Requests that were rejected.
NW Dedicated Bearers	The total number of network-initiated dedicated bearer Attach Requests that

Initiated	were initiated.
NW Dedicated Bearers Succeeded	The total number of network-initiated dedicated bearer Attach Requests that were successfully completed.
NW Dedicated Bearers Failed	The total number of network-initiated dedicated bearer Attach Requests that were rejected.
Total Handovers Initiated	The total number of handovers (both X2-based and S1-based) that have been initiated.
Total Handovers Succeeded	The total number of handovers (both X2-based and S1-based) that were successfully completed.
Total Handovers Failed	The total number of handovers (both X2-based and S1-based) that failed.
Total X2 Handovers Initiated	The total number of X2-based handovers that have been initiated.
Total X2 Handovers Succeeded	The total number of X2-based handovers that have been successfully completed.
Total X2 Handovers Failed	The total number of X2-based handovers that failed.
Total S1 Handovers Initiated	The total number of S1-based handovers that have been initiated.
Total S1 Handovers Succeeded	The total number of S1-based handovers that have been successfully completed.
Total S1 Handovers Failed	The total number of S1-based handovers that failed.
eNB IRAT Handovers Initiated	The cumulative number of eNodeB-initiated inter-RAT handovers that were initiated. These are handovers destined for an R7-based UMTS network.
eNB IRAT Handovers Succeeded	The cumulative number of eNodeB-initiated inter-RAT handovers that were successfully completed. These are handovers destined for an R7-based UMTS network.
eNB IRAT Handovers Failed	The cumulative number of eNodeB-initiated inter-RAT handovers that failed. These are handovers destined for an R7-based UMTS network.
RNC IRAT Handovers Initiated	The cumulative number of inter-RAT handovers initiated from an RNC. These are handovers destined for an R8-based eNodeB.
RNC IRAT Handovers Succeeded	The cumulative number of inter-RAT handovers initiated from an RNC that were successfully completed. These are handovers destined for an R8-based eNodeB.
RNC IRAT Handovers Failed	The cumulative number of RNC-initiated inter-RAT handovers that failed. These are handovers destined for an R8-based eNodeB.
Tx Attach Request	The number of Attach Requests sent by the UE to the network as part of an

	attach procedure.
Rx Attach Accept	The number of Attach Accept messages that the UE received from the network. This message is sent to the UE to indicate that the corresponding attach request has been accepted.
Tx Attach Complete	The number of Attach Complete messages sent by the UE to the network. This message is sent by the UE in response to an Attach Accept message.
Rx Attach Reject	The number of Attach Reject messages that the UE received from the network. This message is sent to the UE to indicate that the corresponding attach request has been rejected.
Attach Retry	The number of Attach Request messages that the UE retransmitted because of the expiration of the retransmission timeout.
Attach Timeout	The number of Attach Request timeouts that occurred.
Tx UE Detach Request	The number of Attach Requests sent by the UE to the network as part of an attach procedure.
Rx Detach Accept	The number of Detach Accept messages that the UE received from the network. This message is sent to the UE to indicate that the UE-originating detach procedure has been completed.
Tx Detach Accept	The number of Detach Accept messages that the UE sent to the network, in response to a Detach Request. The UE sends this message to the network, as part of the MME-Initiated Detach Procedure, the SGSN-Initiated Detach Procedure, the HSS-Initiated Detach Procedure, and the PGW-Initiated Bearer Deactivation procedure.
Rx Paging	The number of Paging requests received from the network for this UE.
Tx UE Service Request	<p>The number of UE-triggered Service Requests sent by the UE to the network as part of a Service Request procedure.</p> <p>The purpose of the service request procedure is to transfer the EMM mode from EMM-IDLE to EMM-CONNECTED mode and establish the radio and S1 bearers when uplink user data or signaling is to be sent.</p> <p>Another purpose of this procedure is to invoke the MO/MT CS fallback procedure.</p>
Tx Resource Allocation Request	The number of Bearer Resource Allocation Requests sent by the UE to the network as part of Bearer Resource Allocation procedure.

Ordering Information

925-3167

IxLoad ADVNET-EGTPR8-S1ENB, Optional Software, Enables eNodeB simulation on the S1-MME and S1-U interfaces; REQUIRES previous purchase of 925-5001 (IXLOAD), 925-5002 (IXLOAD-BASIC), OR 925-5300 (IXLOAD-PLUS)