IxLoad Access: LTE Access Testing

Ixia's IxLoad Access test solution provides complex, realistic user equipment (UE) modeling and emulation against LTE eNodeBs. It can overload an eNodeB with LTE UEs in capacity and rate of operation, sustaining runs for over 72 hours. It is a full-featured layer 4-7 test application that provides real-world traffic emulation of voice, video, and data services to test wireless networks and components. IxLoad simultaneously emulates multiple layer 7 protocol activities, making it perfect for testing new rich-media services, quality of service (QoS), policy control mechanisms, and voice over long-term evolution (VoLTE) systems.

The powerful and flexible VoLTE test solution is used by top LTE operators around the world to validate their VoLTE deployments. It offers realistic and easily-configured real-world subscriber modeling. IxLoad Access is one part of an extensive testing environment that includes eNodeB simulation, evolved packet core (EPC) emulation for eNodeB wrap-around and more, allowing end-to-end and individual LTE element isolation testing from the same hardware.

IxLoad Access is a powerful but easy-to-use solution for comprehensive performance testing of all aspects of LTE base stations. Using IxLoad's real-world subscriber modeling, testers do not need to be protocol experts to develop test realism. From a single application; testers can perform capacity tests, detail a devices throughput, measure voice and video quality, model a wide variety of mobility scenarios, and much more. Ixia's IxLoad Access has a modular system design that provides best-in-industry scalability for high-capacity testing.

IxLoad offers the industry's most comprehensive LTE access test solution, measuring all aspects of eNodeB base station capacity and performance. The test architecture is designed to scale to thousands of simulated UEs (smartphones and tablets). It has the flexibility to perform application layer testing, and supports complex LTE handover scenarios. To test policy management and QoS mechanisms, Ixia's LTE access test solution includes Ixia's leading service quality validation that uses both mobile subscriber modeling and advanced QoE measurements.

Ixia's LTE access solution allows users to:

- Verify there is reliable radio link between mobile subscribers and the network

- Maximize total cell/sector throughput

- Maximize the number of subscribers within a cell/sector

- Test the control (signaling) plane performance of eNodeBs

- Test complex handover scenarios

- Perform service quality validation with subscriber modeling, multiplay voice, video, and data traffic generation, and QoE measurement.
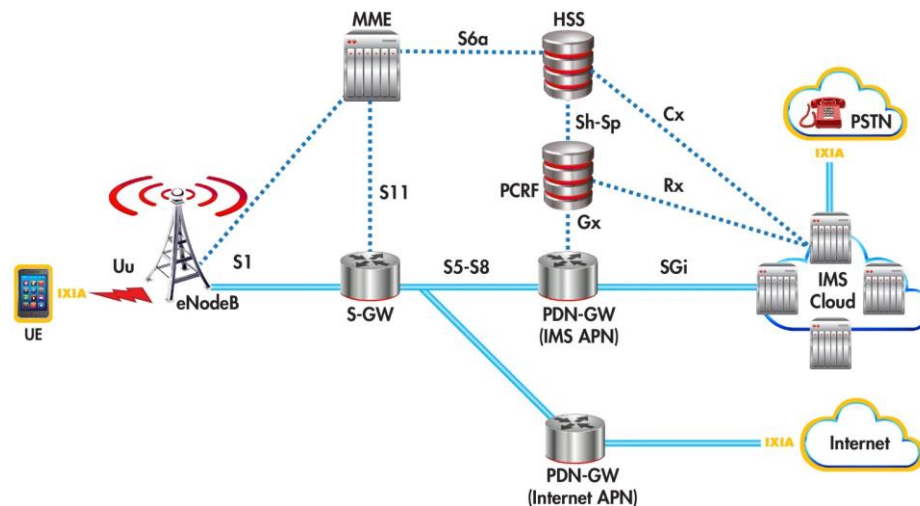
Figure 1: IxLoad Access VoLTE End to End Test Configuration

The eNodeB is the new radio base station for LTE access networks. It is the lynch pin in delivering the 3GPP's objective of improved radio spectrum efficiency to provide increased capacity and enhanced data rates. The eNodeB plays a fundamental role in managing traffic on the network and fulfilling the quality of experience (QoE) requirements of mobile subscribers. To meet QoE expectations, the eNodeB performs radio resource scheduling and uplink/downlink rate limiting to enforce policy decisions and QoS characteristics associated to different service and subscriber types on the network.

- eNodeB testing involves validating multiple levels, including:
- Physical, protocol, and application layer functionality
- User and control plane capacity and throughput
- Handover functionality and performance
- Policy management and QoS mechanisms for converged voice, video, and data traffic
- Security vulnerability assessment

LTE Compliance

- UE Category 1 – 4
- UE Category 5 under 2x2 MIMO
- FDD and TDD
- All 3GPP R8 2009 specifications
- 3GPP R9 June and December 2010 specifications
- All LTE FDD and TDD frequency bands
- All TDD configurations and SSF configurations
- Transmission modes; SISO, Tx Diversity, 2x2 MIMO and Beamforming
- 5, 10, 15, 20 MHz channel bandwidth support
- QPSK, 16QAM and 64QAM modulation schemes
- NAS/PDCP compression and ciphering
- Full DL/UL HARQ capability

- Semi-persistent scheduling
- UE power control, group hopping
- Frequency hopping modes 0, 2, 4
- Automatic configuration of MIB/SIB parameters

Capacity/Performance

- 1000 simultaneous connected UEs per sector with traffic
- Uses Ixia's new XAir module
- With additional idle UEs
- Attach Rate of 100 attach attempts per second
- Up to 6 sectors in one XG12 chassis
- Full capacity throughput per sector (up to 150Mbps DL, 75Mbps UL)
- Maximum single UE performance at 75/50 Mbps DL/UL
- 20/14 DL/UL UEs/TTI

Control plane

- 3GPP TS 24.301 Non-Access-Stratum (NAS) protocol for Evolved Packet System (EPS)
- 3GPP TS 36.331 Radio Resource Control (RRC) protocol specification
- 3GPP TS 36.323 Packet Data Convergence Protocol (PDCP) specification
- 3GPP TS 36.322 Radio Link Control (RLC) protocol specification
- 3GPP TS 36.321 Medium Access Control (MAC) protocol specification
- 3GPP TS 36.211 Physical Channels and Modulation
- 3GPP TS 36.212 Multiplexing and channel coding
- 3GPP TS 36.213 Physical layer procedures

User Plane

- VoLTE Voice & Video
- VoIP
- Video on Demand [VoD]
- HTTP Streaming
- HTTP
- FTP
- UDP

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

Real World Subscriber Modeling

Ixia provides real-world subscriber modeling that subjects an eNodeB to a challenging array of real-world scenarios. These leverage Ixia's global experience on eNodeB performance testing to target key performance metrics. Ixia achieves this through:

- UE high capacity, rate, and multiple UE ranges each with UE-specific properties
- Full-featured LTE UE emulation with FDD, TDD, DRX, etc.
- Mobile application modeling with voice, video, and data traffic, including QoE (MOS, PESQ) and QoS measurements
- Complex signaling operation, including Attach, Detach, Handover, TAU, and Idle Mode operation
- All LTE Inter and Intra-eNodeB HO supported across all connected sectors
- Channel modeling allowing UE cell center/edge simulation with LTE DL Fast Fading emulations including Pedestrian, Vehicle, Urban, and High-Speed Train

Real World Model	Key Details
Airbus A380 landing at Heathrow: passengers turning on cell phones	1000 UE attach signaling only, 100/second
Airbus A380 landing at Heathrow: passengers turning on cell phones with data roaming getting updates	1000 UE attach with 10 Mbps throughput objective
City regional power outage restored: attach storm	Max attach rates: 500 UE attach signaling only, single sector UE attempt attach rate 100/second
Bad coverage residential building	10 UE attach/detach cycle
High density financial district: extensive smart phones	1000 UE max DL/UL throughput
Large university smart phone activity	300 UE triple play
Rush hour highway commuter traffic	100 UE Intra-eNodeB X2, Intra-frequency HO
Rush hour highway commuter traffic	100 UE Inter-eNodeB S1, Intra-frequency HO
eNodeB serving an interstate highway with multi-lane north/south traffic	200 UE Intra-eNodeB, Intra-frequency HO
Medium density LTE voice call load	100MO/100MT voice VoLTE calls
Medium density LTE voice and video call load	100MO/100MT voice + video VoLTE calls

Functional Testing

In addition to subscriber modeling capability, Ixia's LTE Access solution also provides the ability to perform an extensive range of functional testing and validation, 354 key test scenarios are listed below.

Test Cases	Description
27	LTE Bands I..XIV, XVII..XXI, 33.41
8	LTE Attach under FDD or TDD with Bandwidths 5,10,15,20
3	PUSCH Data with Frequency Hopping Modes 0,2,4
6	PUCCH UCI Format Validation (1, 1a,1b, 2, 2a,2b)
3	Preamble Formats 0, 1, 4
32	PRACH configurations 0..31
9	PDCCH DCI Format Validation (0, 1, 1a, 1c, 2, 2a, 3, 3a)
64	TDD Configuration Formats 0..7, Special Subframe 1..8
5	Transmission Modes (1, 2, 3, 4) incl. SISO, MIMO
5	CQI reporting Aperiodic (1-2, 2-0, 2-2, 3-0, 3-1)
4	CQI reporting Periodic (1-0, 1-1, 2-0, 2-1)
2	RA PDCCH & MAC initiated
2	RA Selection from eNB & UE MAC
2	DL-SCH Assignment C-RNTI, Temporary C-RNTI
2	UL HARQ Adaptive/Non-adaptive
1	BSR operation
1	BCH Reception
2	DRX Long/Short
4	UM/AM Transmit Receive operation
2	AM Retransmission
4	Encryption AS/UP with SNOW3G/AES
2	Integrity AS with SNOW3G/AES

Test Cases	Description
2	Paging Reception, Single & Multiple UE
1	Service Request UE Initiated
2	Attach Default and Predefined APN
1	Attach Retry
1	RRC Connection Re-establishment
1	RRC Connection Re-tries
1	Security Key Refresh
1	Re-authentication NAS
8	PDCP Connection/Disconnection (Up to 4 Connections)
2	Dedicated Bearer UE or Network Initiated
2	Encryption NAS with SNOW3G/AES
2	Integrity NAS with SNOW3G/AES
1	GUTI Reallocation
1	USIM authentication algorithm
2	ACB & CSG
2	Connected & Idle Transitions
2	TAU, Idle Reselection
2	Detach, UE & Network Initiated
2	IP Address IPv4 & IPv6
2	Intra eNB HO FDD or TDD
2	Inter eNB HO Same Band Same Frequency
2	Inter eNB HO Same Band Different Frequency
2	Inter eNB HO Different Bands
1	Inter eNB HO FDD to/from TDD
1	Cell Reselection

Test Cases	Description
36	Throughput Load - UL Only, DL Only, UL & DL, TCP Vs UDP Vs Mixed & BW 5, 10, 15, 20
4	VoLTE Load - Max. VoLTE calls on an eNodeB (BW - 5, 10, 15, 20)
1	Default Bearer Load to Max. Bearers with unique APNs
2	Dedicated Bearers to Max with QCI (9), GBR and non-GBR
3	Triple Play L4-7 Traffic with QoE analysis
16	RRC Load
5	Attach Load (Attach, RACH with and without ACB, with and without traffic)
15	Scheduler Load (BW - 5, 10, 15, 20, UL Traffic, DL Traffic, UL & DL Traffic, UE Categories 1..5) to Peak Throughput
24	UE Paging Load (BW - 5, 10, 15, 20, with UL Traffic, With DL Traffic, with UL+DL Traffic, with and without eNodeB simulation)
4	UE Handover Load (BW - 5, 10, 15, 20)
4	UE Service Request Load (BW - 5, 10, 15, 20)
4	UE Signaling Load - Constant Attach/Detach cycle every sec. with a bit of traffic (BW - 5, 10, 15, 20)

Hardware Configuration

Ixia's LTE UE emulation delivers the industry's highest UE performance in the densest platform. The new XAir module slots inside the Ixia XM platform for highest performance. Ixia uses a 1U Remote Radio Head for the LTE signal modulation. The r10 Wideband Radio head over a frequency range from 690 to 2690 MHz covers all major LTE Bands.
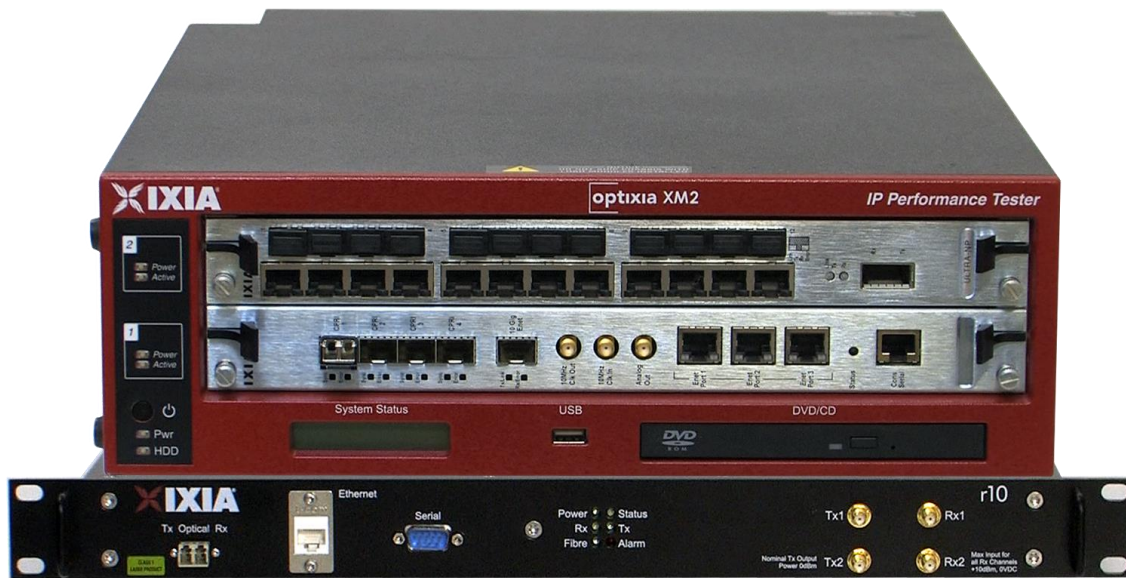

Figure 2: 1 sector, 1000 UEs, 4U, system configuration.

Figure 3: 6 sectors, 6000 UEs, system configuration.

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.
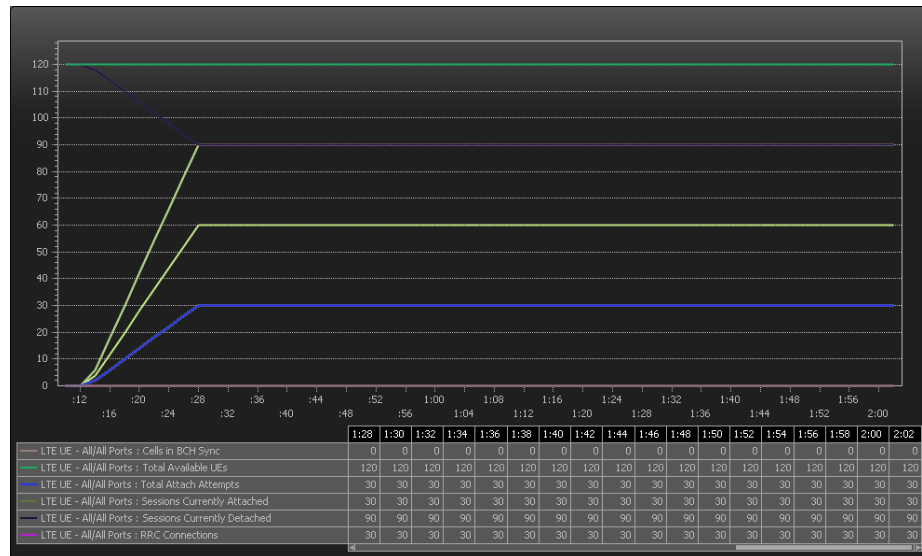

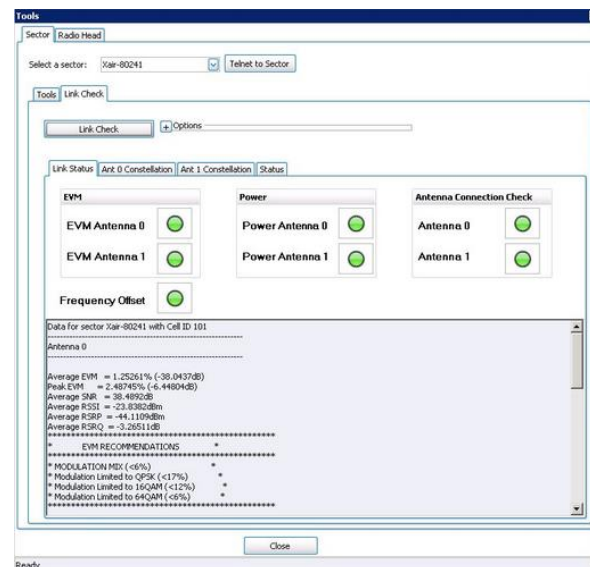**Figure 4: Statistics displayed in real time during a test.**

Figure 5: Link Check – Frequency Error, Noise (EVM), DL Attenuation

Network Overview Statistics

Statistic	Description
Sessions Initiated	Number of UE sessions started over the whole test
Sessions Succeeded	Number of UE sessions succeeded over the whole test
Sessions Failed	Number of UE sessions failed over the whole test

Per-Sector and Per-UE Statistics

Statistic	Description
Current Dedicated Bearer Count	The current number of dedicated bearers
Sessions Initiated Count	The total number of UE sessions started
Sessions Succeeded Count	The total number of UE sessions succeeded
Sessions Rejected Count	The total number of UE sessions failed
Total Attach Attempts	The total number of Attach attempts
Total Attach Succeeded	The total number of Attach successes
Total Attach Failed	The total number of Attach failures
Total Detach Attempts	The total number of Detach attempts
Total Detach Succeeded	The total number of Detach successes
Total Detach Failed	The total number of Detach failures
Total Handovers Attempted	The total number of HO attempts
Total Handovers Succeeded	The total number of HO successes
Total Handovers Failed	The total number of HO failures
Total Modeling Attempts	The total number of Modeling attempts
Total Modeling Succeeded	The total number of Modeling successes
Total Modeling Failed	The total number of Modeling failures

Per-Sector Cell Statistics

Statistic	Description
DL Received bps	Total DL data rate (bps)
UL Granted bps	eNB Granted UL data rate
DLSCH PDSCH Count	Incremented for each separate valid downlink DCI received. This currently includes those containing RARs
ULSCH PUSCH Count	Incremented for each separate valid uplink DCI received for which the MAC provides data in response to the grant
PDCCH Count	Incremented once per frame, when the received PDCCH is decoded
PUCCH Count	Incremented for each type 1, type 1A, type 2 or type 2A PUCCH allocated
PCFICH Count	Incremented once per frame, then the PDFICH is decoded
PRACH Count	Incremented for each PRACH that is sent. One PRACH opportunity could thus result in multiple PRACHs, each recorded individually
PHICH Count	Incremented for every valid PHICH response received, and includes both ACKs and NAKs

Session Statistics

Statistic	Description
Sessions Initiated	Number of UE sessions started over the whole test
Sessions Succeeded	Number of UE sessions succeeded over the whole test
Sessions Failed	Number of UE sessions failed over the whole test

Global Statistics

Statistic	Description
Cells in BCH Sync	The number of EMM Security Mode Commands received
Available UEs	The number of EMM Security Mode Completes transmitted
Current Attached UEs	EMM_Registered
Current Detached UEs	EMM_Deregistered
Current RRC Connected UEs	The current number of connected UEs
Current RRC Idle UEs	The current number of idle UEs
Current APN Connections (Default)	The total number of default APN connections
Current Dedicated Bearers	The total number of dedicated bearers
Throughput UL	The total UL throughput
Throughput DL	The total DL throughput
Total Attach Attempts	The total number of Attach attempts
Total Attach Succeeded	The total number of Attach successes
Total Attach Retries	The total number of Attach retries
Total Attach Failed	The total number of Attach failures
Total Detach Attempts	The total number of Detach attempts
Total Detach Succeeded	The total number of Detach successes
Total Detach Failed	The total number of Detach failures
UEs that attempted HO	The number of configured UEs that have attempted HO
Total HO Attempts	The total number of HO attempts
Total HO Succeeded	The total number of HO successes
Total HO Failed	The total number of HO failures
Total Modeling Attempts	The total number of Channel Modeling attempts
Total Modeling Succeeded	The total number of Channel Modeling successes

Statistic	Description
Total Modeling Failed	The total number of Channel Modeling failures
Subscribers/s	Subscriber Attach attempt rate
Handovers/s	Handover attempt rate

Current Attach-Detach Statistics

Statistic	Description
Current Attached UEs	EMM_Registered
Current Detached UEs	EMM_Deregistered
Current RRC Connected UEs	The total number of Attach failures
Current RRC Idle UEs	The total number of Detach attempts
Current APN Connections (Default)	The total number of Detach successes
Current Dedicated Bearers	The total number of Detach failures

Cumulative Attach-Detach statistics

Statistic	Description
Total Attach Attempts	The total number of Attach attempts
Total Attach Succeeded	The total number of Attach successes
Total Attach Retries	The total number of Attach retries
Total Attach Failed	The total number of Attach failures
Total Detach Attempts	The total number of Detach attempts
Total Detach Succeeded	The total number of Detach successes
Total Detach Failed	The total number of Detach failures

Channel Modeling Statistics

Statistic	Description
Total Modeling Attempts	The total number of Modeling attempts
Total Modeling Succeeded	The total number of Modeling successes
Total Modeling Failed	The total number of Modeling failures

Handover Statistics

Statistic	Description
UEs that attempted HO	The number of configured UEs that have attempted HO
Total HO Attempts	The total number of HO attempts
Total HO Succeeded	The total number of HO successes
Total HO Failed	The total number of HO failures

Ordering Information

925-3174

IXLOAD ADVNET-LTE-ACCESS-R8FDD Multi-UE simulation on the Uu interface, 3GPP Release 8. REQUIRES previous purchase of 925-3001 (IXLOAD), 925-3002 (IXLOAD-BASIC), OR 925-3300 (IXLOAD-PLUS)

925-3175

IXLOAD ADVNET-LTE-ACCESS-R9FDD Multi-UE simulation on the Uu interface, 3GPP Release 9. REQUIRES previous purchase of 925-3001 (IXLOAD), 925-3002 (IXLOAD-BASIC), OR 925-3300 (IXLOAD-PLUS)

925-3176

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925-3177

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925-3355

IxLoad Multi Play-2012, Software Bundle, Layer 4-7 Performance Test Application