# LoadCore™ 5G Core Testing

## Problem: Scaling New Services and Preparing for 5G

5G deployments will enable enhanced mobile broadband services with higher data rates, increased capacity, and lower latencies. New business opportunities and increased revenue sources can be found in fixed wireless access (FWA) and massive and critical IoT services in sectors like automotive, manufacturing, energy and utilities.

But to ensure the carrier-grade quality required to carry this wireless traffic, service providers need to characterize and continuously validate their 5G Core (5GC) network in the lab and pre-production deployments. This requires extensive testing of 5G SA (Standalone) elements in the Core network. Challenges include:

- Implementing virtualization technologies and cloud-optimized network functions
- Validating emerging architecture and standards: handling simultaneous protocol requests for tunneling-, session-, or HTTP2-based signaling

## Solution: Pre-Deployment Validation Using Real-World Subscriber Simulation

Keysight's 5G LoadCore™ test solution addresses critical validation requirements for improved reliability and performance of 5G emerging architectures. With comprehensive performance testing of all nodes and interfaces, this powerful yet easy-to-use solution helps network operators deliver higher-performing services, greater scale, and lower-latency communications.

### Highlights

- Simulate UE behavior in multiple 5G use cases: Network slicing, multi-access edge computing (MEC) low latency and offloading, video optimization
- Scale up to millions of subscribers using stateful application traffic mixes that can interact with real servers and peers
- Perform service quality validation with subscriber modeling, multiplay traffic generation, and quality of experience (QoE) measurements
- Validate complex scenarios for service-based architecture (SBA)
- Control test traffic mix and intensity using network objectives to independently manage control and user planes

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TECHNOLOGIES

Using real-world subscriber modeling, testers do not need to be protocol experts to develop realistic test scenarios. From a single application, perform capacity tests, detail a device's throughput, measure voice and video quality, and model a wide variety of mobility scenarios.

Full automation via REST API and Python allows users to create regressions for continuous validation of product quality and to adapt their environments to the CI/CD lifecycle demands.

With 5G development and adoption progressing rapidly, *cloud native* is central to the 5GC architecture. With its microservice architecture and options to be deployed either as a virtual machine (VM) or Container, LoadCore is fully aligned to this new paradigm.

## 5G Core Validation

LoadCore is the one-stop-shop for testing 5G Core. From end-to-end to node isolation, the tool simultaneously simulates multiple nodes and interfaces, perfect for recreating entire networks in your lab by using a topology-based user interface (web UI).
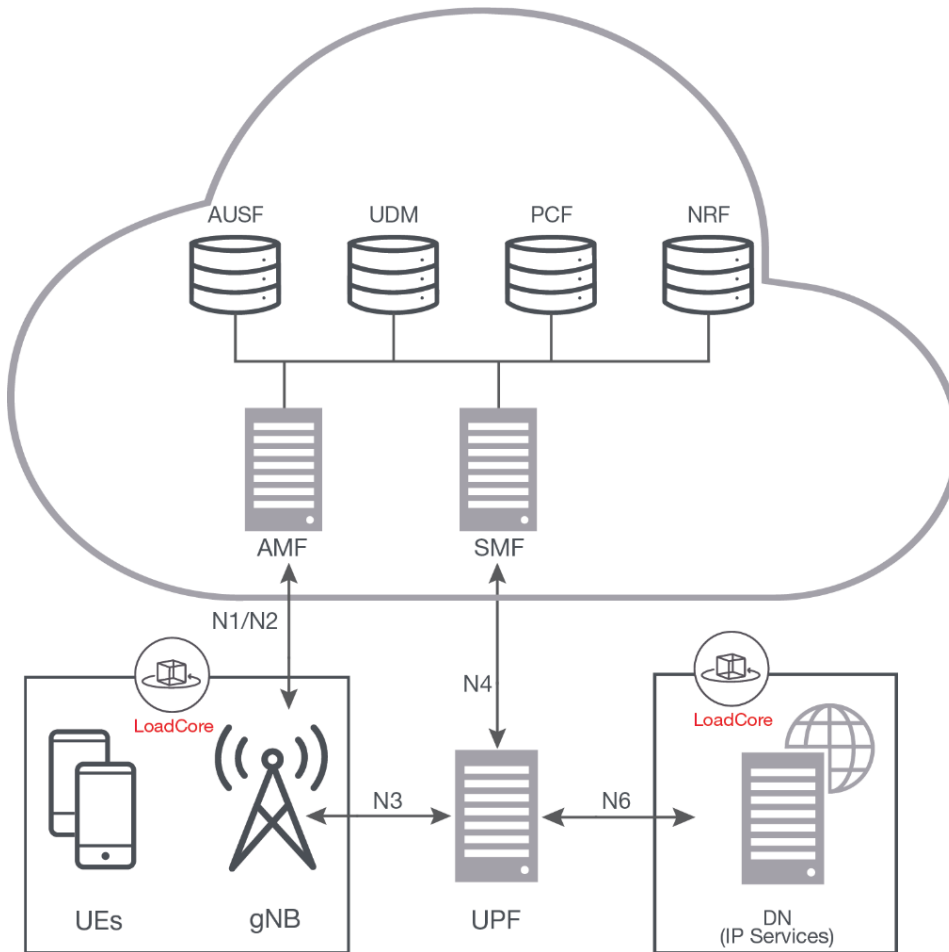
Currently available topologies are depicted below, with more to follow.

**Entire core is simulated**, with each node independently deployed. User equipment (UE) actions (Registration/PDU Session Establishment/Modification, Handovers, etc.) are simulated across all 5G Core nodes and interfaces, offering a complete end-to-end view.
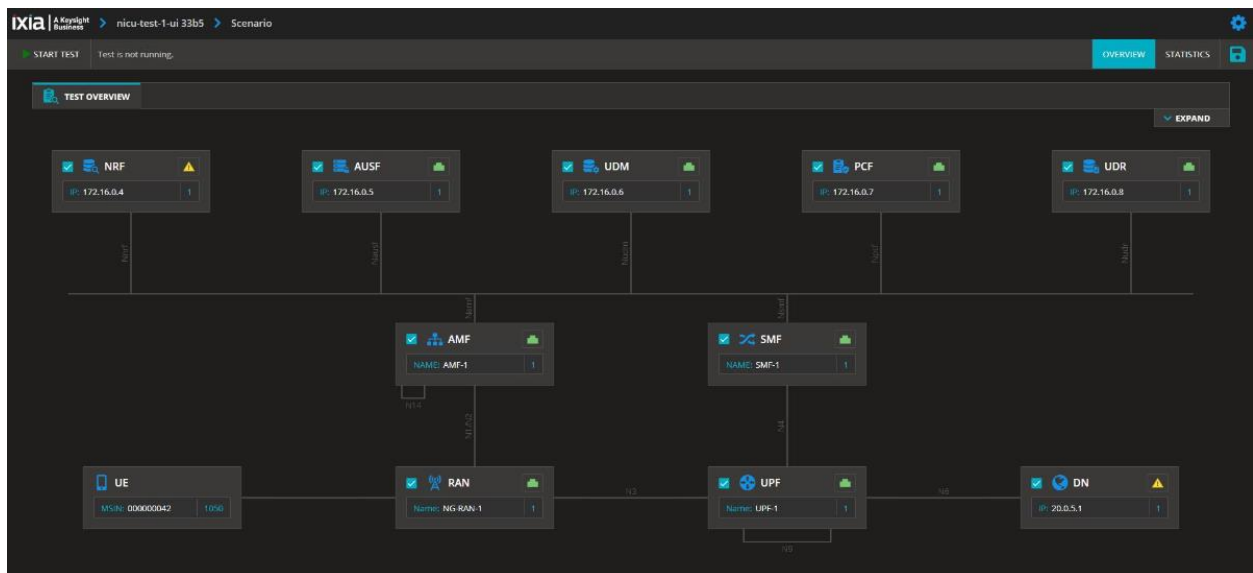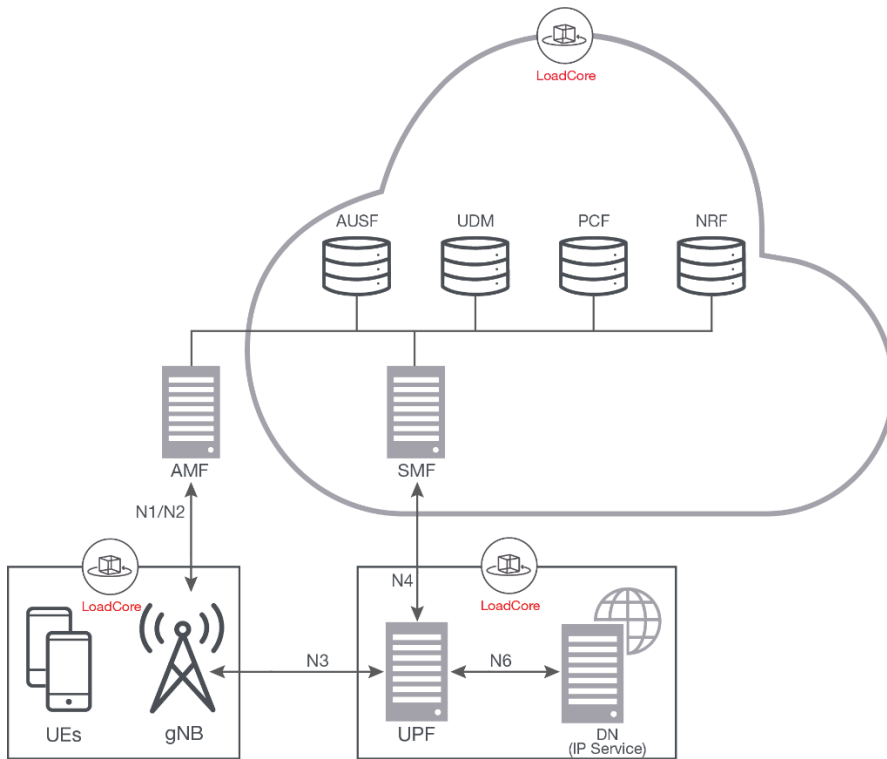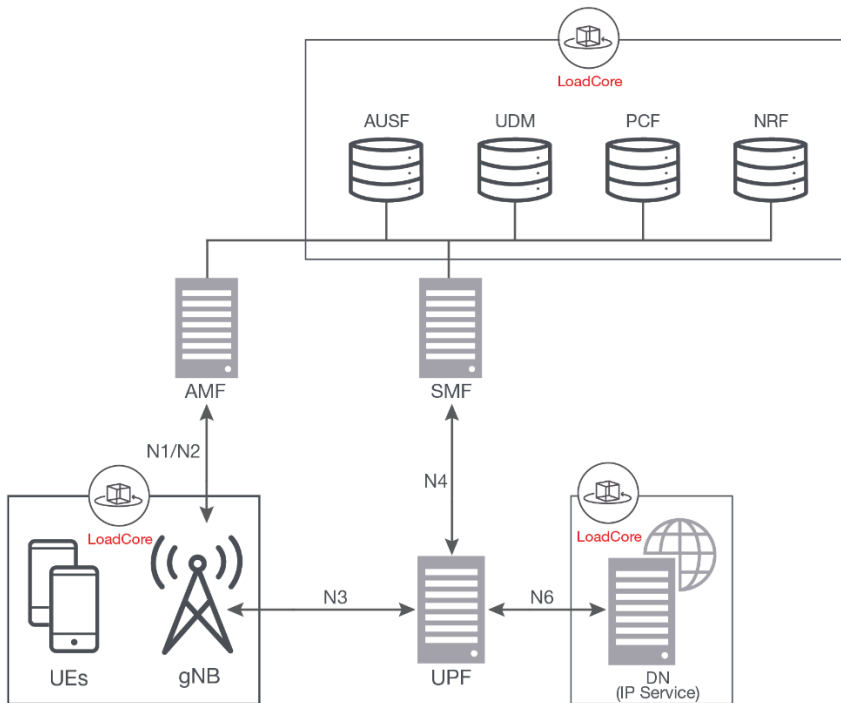


Entire Core simulation
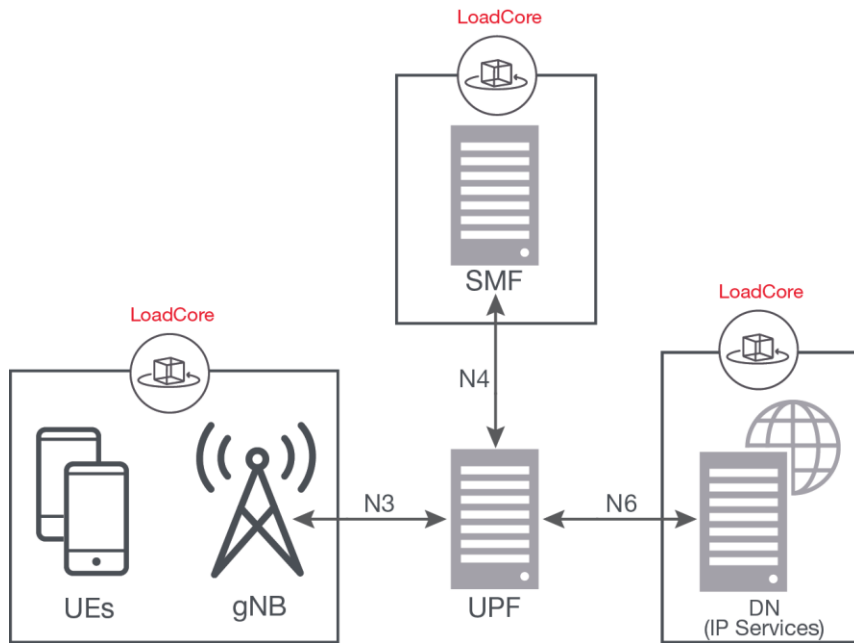
gNB (NGRAN) simulation via coordinated N1/N2/N3
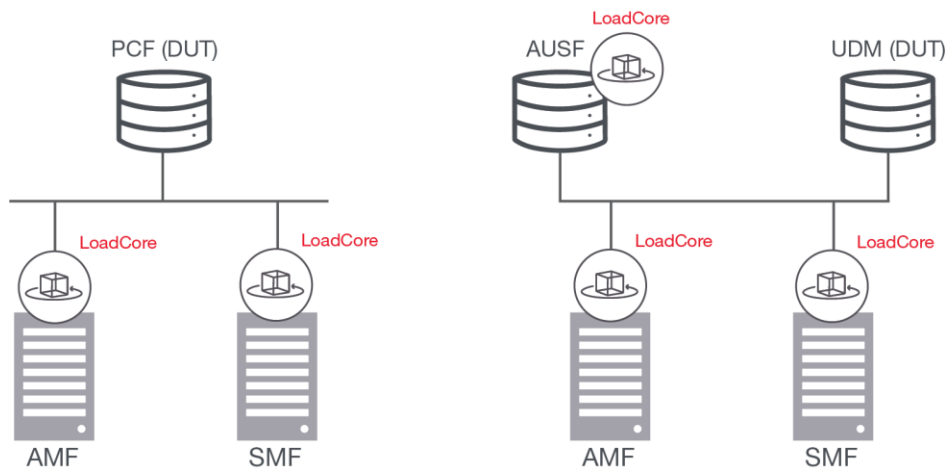
# Node(s) Isolation Topologies



AMF isolation



AMF+SMF+UPF isolation

UPF-isolation topology via coordinated simulation of gNB/SMF (N3/N4)

## SBA Node(s) Isolation



PCF or UDM isolations

# Product Capabilities

## Control Plane Features

- Simulate millions of sessions across multiple coordinated interfaces; perform UE Register/Deregister/Authentication/Session Establishment and Release
- Ability to simulate or place under test any of the nodes and associated interfaces: gNB, AMF, SMF, UPF, AUSF, UDM, UDR, PCF, NSSF, CHF, NRF
- Topology-driven UI: start by defining your test topology by selecting your device(s) under test

- Validate PDU Sessions establishment, uplink and downlink flows, deletion and modification of the sessions
- Option to configure single or multiple PDU sessions per UE, with single or multiple DNNs
- Test any mix of IPv4 and IPv6 for control and user planes
- Impair control-plane IE (information elements) and define negative behavior
- Reconfigure default state machine and have multiple UE groups with different behaviors
- Ease of use and intuitive definition of call models and traffic patterns
- Perform isolation testing for SBA nodes: AUSF, UDM, PCF, IWF
- Perform network function (NF) Register/Deregister/Discovery vs simulated or real NRF
- Ability to simulate coordinated HTTP/2.0 (SBI) and Diameter (4G) flows for validating combo boxes such as PCF/PCRF or HSS/AUSF/UDM
- Ability to build complex call models and traffic patterns via Control Plane Primary and Secondary test objectives
- Ability to configure and execute control-plane-only traffic models
- Ability to perform Control Plane Impairment at IE or Message level on all protocols (SCTP, PFCP, HTTP2)

**gNB/AMF N1/N2 Procedures**

- UE Initial Registration
- Authentication
- Security Mode Control
- PDU Session Establishment/Release
- PDU Session Modification (QoS Flow establishment/modification/release)
- AN Release/UE initiated Service Request
- Paging
- Handovers
- UE Deregistration

**SMF/UPF N4 Procedures**

- PFCP Node Association Setup/Update/Release
- UE Initial Registration (known/unknown UEs)
- PDU Session Establishment/ Release
- PDU Session Modification (Create/Delete QoS Flows, Xn Handover, Modify QoS Flow, Enter/Exit Idle)
- AN Release/UE initiated Service Request
- Paging
- Session Report
- Handovers

**NRF Service Operations**

- Nnrf_NFDiscovery
- NF Heartbeat
- Nnrf_NFManagement_NFRegister

- Nnrf_NFManagement_NFDeregister
- NFStatusSubscribe
- NFStatusUnsubscribe
- NFStatusNotify

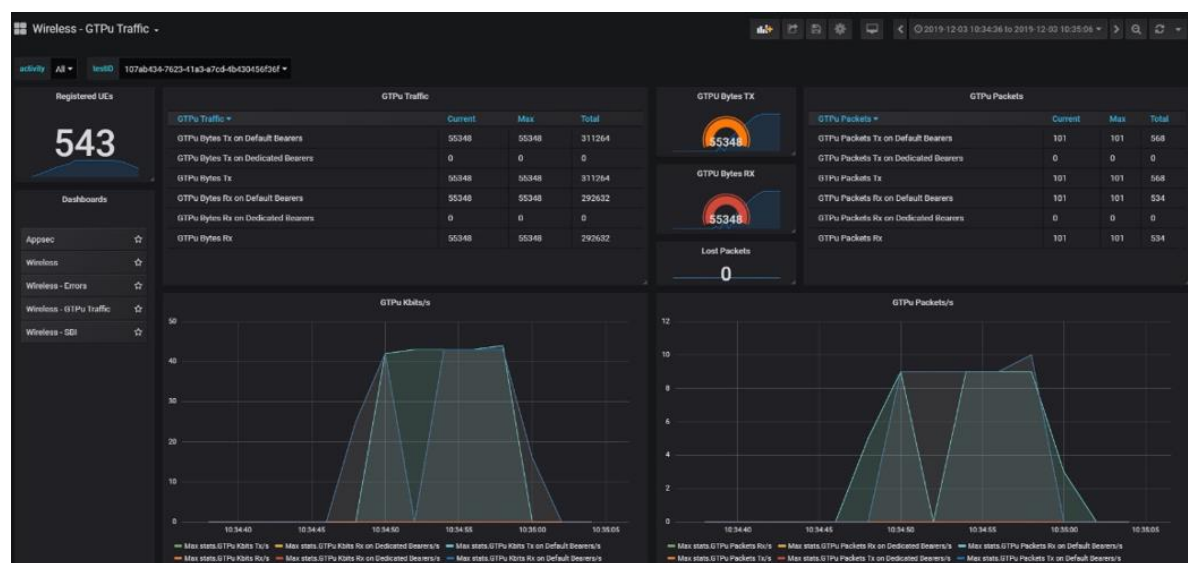**SBA tester serving the following topologies**

- PCF isolation
- UDM isolation
- AUSF isolation
- UDM+AUSF isolation
- IWF isolation
- Diameter/HTTP2.0 correlation for combo boxes isolation (PCF/PCRF or
- Multiple TCP connections to DUT

**SBA Procedures**

- Initial Registration/Deregistration
- Authentication
- PDU Session Establishment/Teardown
- Notifications

## User Plane Features

- Configure multiple activities per UE, each having a distinct Layer 7 protocol and data rate profile; multiple L7 activities can be mapped to distinct UE ranges in any combination, giving each range an individual traffic profile and mix
- Validate QoS enforcement at UPF level by leveraging inbuild per-UE detection mechanism
- Configure each UE group with a distinct objective consisting of single or multiple flows with the ability to specify overall throughput and distribution per flow



LoadCore statistics dashboard

## Specifications

| Protocol | Feature |
|---|---|
| **3GPP Technical Specifications** | Supported 3GPP versions: Rel15 – September 2019<br><br>• TS 23.501: "System Architecture for the 5G System; Stage 2"<br>• TS 23.502: "Procedures for the 5G System; Stage 2"<br>• TS 23.503: "Policy and Charging Control Framework for the 5G System"<br>• TS 23.214: "Architecture enhancements for control and user plane separation of EPC nodes; Stage 2"<br>• TS 29.571 - 5G System; Common Data Types for Service Based Interfaces; Stage 3<br>• TS 23.003: "Numbering, Addressing and Identification"<br>• TS 24.501: "Non-Access-Stratum (NAS) protocol for 5G System (5GS); Stage 3"<br>• TS 24.502: "Access to the 5G System (5GS) via non-3GPP access networks; Stage 3"<br>• TS 29.281: "General Packet Radio System (GPRS) Tunnelling Protocol User Plane (GTPv1-U)"<br>• TS 29.244: "Interface between the Control Plane and the User Plane Nodes; Stage 3"<br>• TS 29.500: "5G System; Technical Realization of Service Based Architecture; Stage 3"<br>• TS 29.501: "5G System; Principles and Guidelines for Services Definition; Stage 3"<br>• TS 29.502: "5G System: Session Management Services: Stage 3"<br>• TS 29.503: "5G System; Unified Data Management Services; Stage 3"<br>• TS 29.504: "5G System; Unified Data Repository Services; Stage 3"<br>• TS 29.507: "5G System; Access and Mobility Policy Control Service; Stage 3"<br>• TS 29.509: "5G System; Authentication Server Services; Stage 3"<br>• TS 29.510: "5G System: Network function repository services; Stage 3"<br>• TS 29.512: "5G System; Session Management Policy Control Service; Stage 3"<br>• TS 29.513: "5G System; Policy and Charging Control signaling flows and QoS parameter mapping; Stage"<br>• TS 29.519: "5G System; Usage of the Unified Data Repository Service for Policy Data, Application Data and Structured Data for Exposure"<br>• TS 29.518: "5G System; Access and Mobility Management Services; Stage 3"<br>• TS 29.522: "5G System; Network Exposure Function Northbound APIs; Stage 3"<br>• TS 33.501: "Security architecture and procedures for 5G System"<br>• TS 33.220: "Generic Authentication Architecture (GAA); Generic Bootstrapping Architecture (GBA)"<br>• TS 33.501: "Security architecture and procedures for 5G system"<br>• TS 37.324: "Evolved Universal Terrestrial Radio Access (E-UTRA) and NR; Service Data Adaptation Protocol (SDAP) specification"<br>• TS 38.300: "NR; NR and NG-RAN Overall Description" |

| Protocol | Feature |
|---|---|
| | • TS 38.331: "NR; Radio Resource Control (RRC); Protocol Specification"<br>• TS 38.401: "NG-RAN Architecture description"<br>• TS 38.410: "NG-RAN; NG general aspects and principles"<br>• TS 38.412: "NG-RAN; NG signaling transport"<br>• TS 38.413: "NG-RAN; NG Application Protocol (NGAP)"<br>• TS 38.415: "NG-RAN; PDU Session User Plane protocol" |
| **RFC** | • RFC 768: User Datagram Protocol<br>• RFC 2131 Dynamic Host Configuration Protocol<br>• RFC 2616: Hypertext Transfer Protocol HTTP/1.1<br>• RFC 3736 Stateless Dynamic Host Configuration Protocol (DHCP) Service for IPv6<br>• RFC 2818: HTTP Over TLS<br>• RFC 4627: The application/json Media Type for JavaScript Object Notation (JSON)<br>• RFC 4861 Neighbor Discovery for IP Version 6 (IPv6)<br>• RFC 4862 IPv6 Stateless Address Autoconfiguration<br>• RFC 4960 Stream Control Transmission Protocol<br>• RFC 5246: The Transport Layer Security Protocol 1.2<br>• RFC 6101: The Secure Sockets Layer (SSL) Protocol Version 3.0<br>• RFC 7540: Hypertext Transfer Protocol HTTP/2.0 |

## Performance Metrics

| LoadCore | |
|---|---|
| **Performance per VM (*) for N4 (PFCP)**<br>• Max active Sessions: 5M<br>• Procedure Rate: 25k/sec | **Performance per VM (*) for NGRAN (N1/N2/N3)**<br>• Max active Sessions: 1.2M<br>• Procedure Rate: 4k/sec |
| (*) high performance COTS server, default image 4x vCPUs, 4GB RAM | |
| **Performance per VM (**) for N3/N6 (User Plane)**<br>• 8 x 8 Gbps UDP/TCP on 10G NIC<br>• 22 x 22 Gbps UDP/TCP on 25G NIC<br>• 36 x 36 Gbps UDP/TCP on 40G NIC<br>• 90 x 90 Gbps UDP/TCP on 100G NIC<br>Support for: 10/25/40G NIC Intel/Mellanox + 100G NIC Mellanox<br><br>(**) high performance COTS server, vCPUs and RAM requirements vary depending on NIC. DPDK = ON | |

## Ordering Information

### Part numbers

**939-9551**

LoadCore WRLS 5G Core, FLOATING Perpetual License, Single Interface emulation

**939-9552**

LoadCore WRLS 5G Core, FLOATING Perpetual Licenses, Performance enabler

**939-9557**

LoadCore WRLS 5G Core, FLOATING Perpetual Licenses, User Plane capability

**939-9563**

LoadCore WRLS 5G Core, FLOATING Perpetual Licenses, Control Plane Impairment

**939-9553**

LoadCore WRLS 5G Core, FLOATING Subscription License, Single Interface emulation

**939-9554**

LoadCore WRLS 5G Core, FLOATING Subscription Licenses, Performance enabler

**939-9558**

LoadCore WRLS 5G Core, FLOATING Subscription Licenses, User Plane capability

For more information, visit:

https://www.ixiacom.com/products/5g-core-testing

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