

# Managing Signaling Growth Challenges in LTE and IMS Networks

How to Build a Future-Proof Robust Signaling Core

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## Introduction

It is of no surprise to anyone that mobile telecommunications networks are rapidly modernizing and adopting IP as the transport of choice. IP Multimedia Subsystem (IMS) is now the accepted standard architecture underlying these new networks. Two IP based protocols have been standardized for signaling and session establishment in IMS networks. These protocols are Diameter (defined in IETF RFC 6733) and Session Initiation Protocol (SIP, defined in IETF RFC 3261). Whereas Diameter is concerned with subscriber services such as mobility, authentication, authorization, accounting, policy, charging, and others, SIP is used to establish voice, video, and messaging sessions between participants. Thus Diameter and SIP complement each other in providing the complete signaling needs for all aspects of a wireless service.

With the worldwide rollout of 4G/LTE networks and of data and real-time communications services defined over them, coupled with the rapid penetration of LTE enabled smartphones, both Diameter and SIP traffic volumes are rising at a furious pace. In this paper we shall explore this rise, the challenges this brings to service providers, and what they can do to position their networks to effectively deal with this onslaught.

## Rise in Diameter and SIP Signaling

According to the latest Oracle Communications LTE Diameter Signaling Index report released in October 2015<sup>1</sup>, Diameter traffic will increase from 30 million messages per second (MPS) in 2014 to more than 395 MPS in 2019 representing a compound annual growth rate (CAGR) of 68%. The report also predicts that by 2018, policy will account for over 70% of the signaling and that LTE broadcast, generally used for mobile video, will see the fastest growth of 75% over the next few years. While all regions of the world will see high double-digit or better growth rates, CALA and EMEA will triple digit CAGR.

In a research report, GSMA<sup>2</sup> has estimated that 352 mobile operators have launched 4G-LTE networks across 124 countries as of the end of

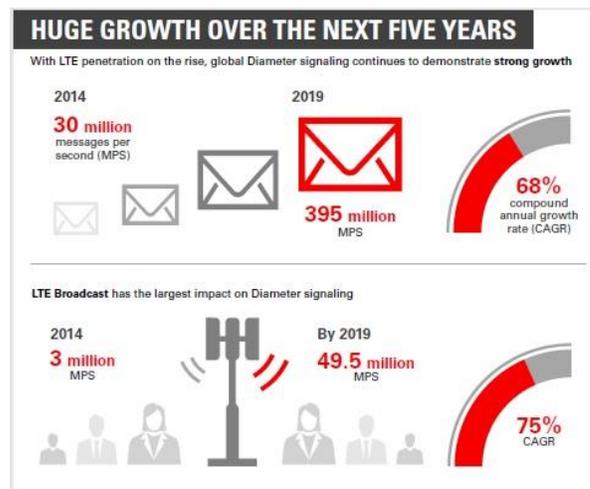


Figure 1: Growth in Diameter Signaling

<sup>1</sup> LTE Diameter Signaling Index Report: [www.oracle.com/goto/diametersignaling\\_report](http://www.oracle.com/goto/diametersignaling_report)

<sup>2</sup> GSMA 4G-LTE forecast 2010-2020, published March, 2015: <https://gsmainelligence.com/research/2015/03/infographic-global-4g-lte-forecasts-2010-2020/483/>

January 2015, that this number will double by 2020, and over 2.5 billion 4G-LTE connections (excluding M2M) will exist by 2020. Further growth is expected as LTE penetration rises even more, and as 3G operators introduce policy functions in their networks in order to be able to offer more innovative and attractive plans to their customers.

Diameter signaling is driven by the number of LTE subscribers on the network as well as the applications running on those subscribers' smartphones. Each time these applications access the network, download data, and every time the subscriber roams between service providers, Diameter messages are exchanged. Considering the number of data exchanging applications on each smartphone and number of smartphones, it is clear that Diameter signaling will continue on a growth path for a long time to come.

In contrast to Diameter, SIP handles establishment of multimedia real-time sessions. But like Diameter, SIP signaling is growing rapidly arising not only from growth in mobile networks but also the pace at which circuit switched access and interconnects are modernizing to packet switched. Another component of SIP signaling rise is due to SIP trunks which are on track to grow at the rate

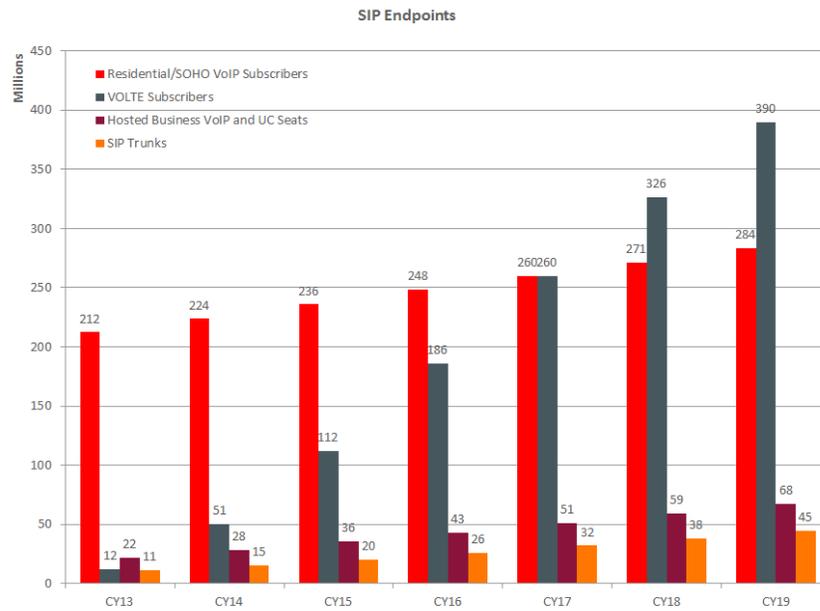


Figure 2: Growth in SIP Signaling

of about 35% a year.

Moreover, at the end of 2014, it was estimated that only about 20% of the business trunks had moved to SIP<sup>3</sup> which means that the growth is likely to continue for many years. Businesses and residences are also converting to hosted communications services that rely on SIP.

The LTE Diameter Signaling Index report also breaks out signaling rise due to the advent of VoLTE. Signaling due to VoLTE alone is expected to rise at 49% annual growth rate through 2019. This statistic shows the rapid expansion of VoLTE worldwide and implies further growth in SIP signaling.

## CSP Challenges and Requirements

This report should come as an eye-opener for CSP network planners and architects. This growth represents both an opportunity and a threat for their networks. Clearly the CSP benefits from increasing number of subscribers and their usage of the CSP network. On the other hand, if the network does not handle this increase properly, users may experience degraded performance and are likely to defect to other providers.

<sup>3</sup> Infonetics Research SIP Trunking Service Market Highlights: <http://www.infonetics.com/pr/2014/SIP-Trunking-Services-Market-Highlights.asp>



CSPs also need to understand the drivers of this growth at a more micro level. The traffic growth is as a result of a multitude of new services and personalization of existing services. Therefore, the number of communicating elements and interfaces as increased, with messages needed to be transmitted between several elements before being resolved.

While Diameter and SIP signaling will continue to rise, it should be remembered that even in the next several years, circuit switched networks and legacy protocols such as SS7 and associated applications such as Local Number Portability (LNP) will still be widely in use underscoring the need for CSPs to continue to support all three in their networks and maintain interoperability between them.

Therefore, to protect their network and services, CSPs need to carefully design their networks so that this anticipated increase in traffic can be processed effectively. The following requirements apply:

- » **Availability:** Planners need to ensure that failure of a single device does not compromise the service as a whole and that traffic can be re-routed to other available devices
- » **Load Balancing:** To effectively utilize available capacity it is imperative that each element handles its fair share and no single element gets overloaded which might result in processing delays or even device failure
- » **Interoperability:** In a network that has many signaling elements of its own and especially those that interconnect with other networks, there are bound to be differences in signaling that need to be normalized. Each element cannot be expected to change its messaging based on who it is sending it to
- » **Monitoring and Manageability:** Centralizing intelligence in the core makes for a simpler and a more efficient network. Configuration, that has proven to be where most errors are made, needs to be centralized and not spread across each element. A central point that can be monitored for troubleshooting is also required
- » **Centralized Routing:** To satisfy availability, load balancing, interoperability, manageability, security, and other requirements, network planners need to abandon element to element links which although simple to implement rapidly become unmanageable as the number of signaling elements increase. Instead, a centralized routing element that has the intelligence to mediate traffic is required
- » **Elasticity:** Even though the average traffic is forecasted to right at a steady clip, this growth could be uneven and there could be periods of peak demand followed by lulls. To handle this variability, designers should include ways in which available capacity can track the traffic requirements and avoid designing for the high mark which might result in wasted capacity in lean periods
- » **Security:** A fully meshed network could be a security nightmare, especially for interconnection, since it may expose the operator's network topology leading to potential security compromises. The network designer to consider a single central interconnect point, the connection to which can be properly secured

## Building a Robust Signaling Core

Mobile voice and data applications increasingly use Diameter signaling to manage communications between the various elements that make up the network, such as the IMS core, application servers, charging systems, policy management, and Home Subscriber Server (HSS) databases. Evolved Packet Core (EPC) components also use Diameter for policy control and to access user and charging information. Diameter traffic volume is heavily influenced by the type of data sessions that subscribers and their devices create. For example, a simple data session for connecting to the Internet does not create a lot of Diameter traffic. But in comparison, a Voice over LTE (VoLTE) session creates more than twice the amount of Diameter traffic, and is a major influence in Diameter traffic growth. In addition to Diameter, VoLTE also uses SIP protocol for signaling and controlling multimedia communication sessions.

Figure 3 shows the different signaling interfaces and routing control that are implemented within a service provider network today.

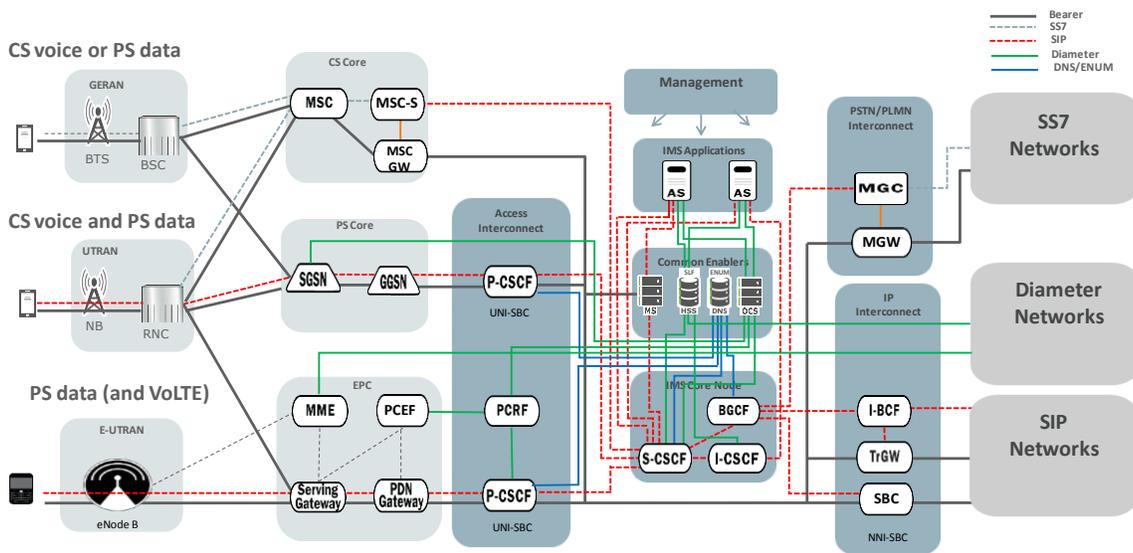


Figure 3: Traditional Signaling in LTE and IMS Networks

Service provider's network architecture, routing plans, and design tend to change frequently because of changes customer expectations and rapid evolution in technology. Figure 3 shows a routing and signaling architecture based on fully meshed interconnections. This network topology is not conducive to rapid changes because of the number of elements that would need to be touched in order to make even simple alterations.

Operating a fully meshed signaling & routing network becomes increasingly cumbersome and complex as components are added or removed. A centralized routing & signaling layer that can manage traffic congestion and help scale networks more efficiently for next generation communication session delivery is required. Introducing such central elements will result in a dramatically simplified network signaling architecture and in ongoing CapEx and OpEx savings, which include:

- » licensing costs: eliminate additional licensing costs associated with upgrade of each network component to handle increase subscribers and traffic growth
- » systems integration cost: eliminate additional system integration costs associated with a fully meshed interconnections
- » network monitoring cost: centralized point to monitor, control and manage traffic congestions leading to improved operational efficiency

A detailed mapping of Oracle Communications Diameter Signaling Router (OCDSR) and Session Router (OCSR) to simplify signal routing and control complexity is depicted in Figure 4. It shows Oracle's Next Generation Routing Reference Architecture based on a multi-protocol signaling control platform with a layered view on the linkage to different signaling nodes. The centralized, overlay routing control and signaling elements ensure efficient scaling and management of the Diameter and SIP signaling traffic for next generation communications session delivery.

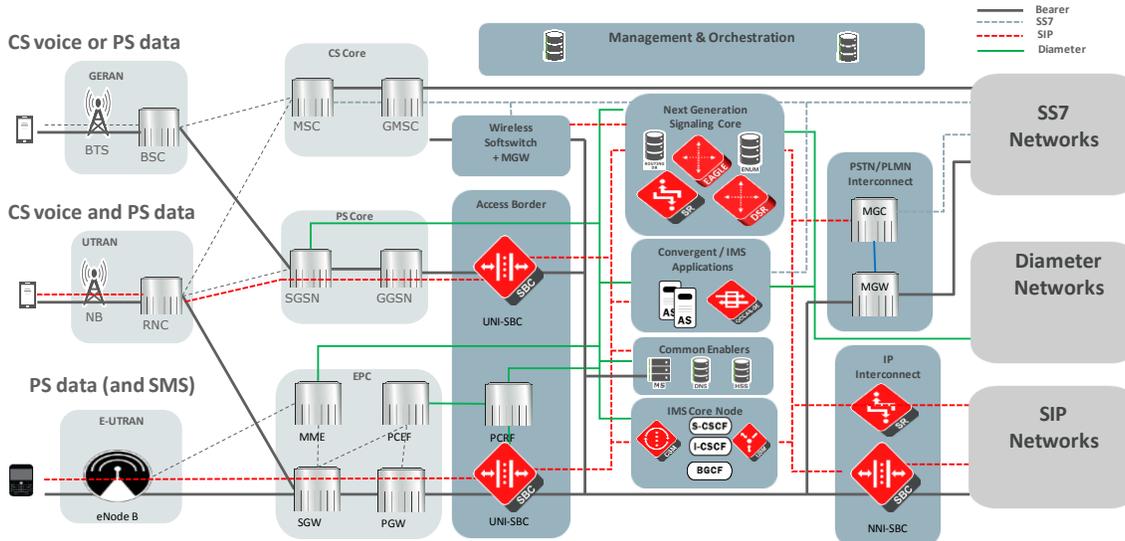


Figure 4: Next Generation Robust Signaling Infrastructure

## Oracle Communications Signaling Solution Components

The following components provide the centralized routing and signaling solution greatly simplifying the design of a robust signaling core for a communications service provider.

### Oracle Communications Session Router

Oracle Communications Session Router helps scale the next-generation signaling infrastructure. It delivers scalable, high performance SIP session routing that reduces the cost and complexity of multimedia services, and enables service providers to increase network capacity. It allows for extensive and flexible routing policies, implements IMS Breakout Gateway Control Function (BGCF), supports IMS Transit Routing Function (TRF) for VoLTE roaming, includes local and external routing databases along with Electronic Number Mapping System (ENUM) based routing support, programmability for interworking and mediation, and sports carrier-class high-availability. Oracle Communications Session Router:

- » Simplifies and scales core session routing infrastructure
- » Reduces cost and complexity of next-generation SIP interconnect
- » Enables cost-effective network scalability
- » Mitigates risk and protects uptime
- » Provides rapid interoperability and faster time to market

### Oracle Communications Diameter Signaling Router

Oracle Communications Diameter Signaling Router centralizes Diameter routing helping create a secure signaling architecture that reduces the cost and complexity of the core network and enables elastic growth, interoperability, and rapid introduction of new services. It has robust traffic and congestion management capabilities with GUI driven provisioning, extremely flexible address resolution routing, topology hiding capabilities, multivendor interoperability, SS7-to-Diameter interworking, integrated troubleshooting, load-balancing, and multiple integrated proxy solutions such as for HSS, policy, charging, and roaming. It helps create an architecture that enables IMS and LTE networks



to be truly elastic and adapt to increasing service and traffic demands while optimizing the network resources. Some of the most common use-cases for Oracle Communications Diameter Signaling Router include:

- » Scaling and maintaining a centralized signaling architecture with GUI driven flexible routing and load balancing for mobility management as well as policy and charging
- » Protecting the network from signaling storms and preventing network degradation and outages with the most flexible and robust congestion management
- » Securing the network at interconnect points against Denial of Service (DoS) attacks through GSMA IR-88 compliant encryption and topology hiding
- » Alleviating interworking and interoperability issues in a multi-vendor and multi-protocol environment with the most flexible GUI-driven mediation rules engine
- » Enhancing the network visibility by providing context and targeted reporting and with integrated troubleshooting capabilities

### Oracle Communications Session Monitor product family

Oracle Communications Session Monitor allows operators to monitor their end-to-end service to gain visibility into signaling and media interactions, and leverage key indicators to identify, troubleshoot, and resolve issues for enhanced IP network service assurance. Oracle Communications Session Monitor:

- » Reduces operational cost and increases service quality
- » Provides insight and analysis of signaling and media messages
- » Offers comprehensive views of customer experiences
- » Improves operational efficiency
- » Enables low configuration; quick turn-up and use

### Oracle Communications Session Delivery Manager

Oracle Communications Session Delivery Manager manages and optimizes network infrastructure elements and their functions with comprehensive tools and applications for provisioning and fault, performance, security, and route management. It:

- » Centralizes and simplifies Session Border Controller (SBC) and Session Router (SR) management
- » Scales from small to very large network element deployments
- » Enables capacity planning and performance and fault monitoring
- » Facilitates provisioning, OSS integration, and network management
- » Provides an extensible platform for advanced applications and services

## Oracle Communications Robust Signaling Value Proposition

### Use Cases

Oracle Communications Diameter Signaling Router and Oracle Communications Session Router help build a robust core in service provider networks in Diameter and SIP signaling respectively. Some of their most common use-cases are described below.

- » **Core Centralized Routing:** In a mesh type logical network, the addition of new nodes is costly and doesn't scale over time. Ineffectively managed traffic can result in network degradation or outage. Oracle Communications Diameter Signaling Router and Oracle Communications Session Router optimize the utilization of network resources with centralized intelligent routing and robust congestion control and traffic prioritization

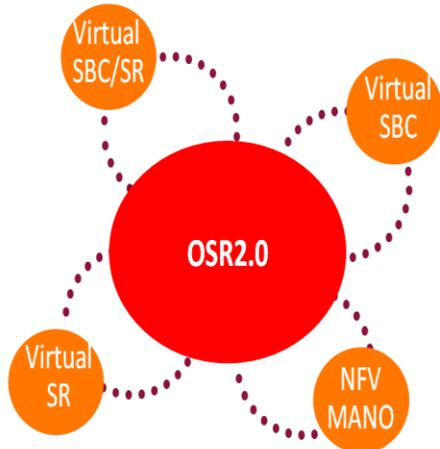
- » **2G/3G-to-LTE and LTE-to-LTE Roaming:** In a mesh-type network, operators do not have a way to effectively secure the network against malicious attacks. Oracle Communications Diameter Signaling Router provides a centralized vantage point to defend against potential attacks using topology hiding and encryption mechanisms. Additionally, it allows seamless LTE to 2G/3G roaming with Mobile Application Part (MAP) to Diameter interworking function
- » **HSS/PCRF/OCS Address Resolution:** Unlike IMS networks, there is no subscriber location function in the LTE architecture. Oracle Communications Diameter Signaling Router provides mapping between subscriber identities and destination servers and improves the utilization of the network resources by optimizing traffic distribution
- » **Policy and Charging Binding:** In networks with multiple PCRF/OCS elements, operators need to bind subscribers' sessions to the correct policy/charging server. Oracle Communications Diameter Signaling Router provides dynamic session binding and network-wide session correlation across sites to ensure correct billing and proper application of policy
- » **Interconnect and Peering:** Interconnection of two networks brings challenges in provisioning and uniting different routing algorithms and policy control. Oracle Communications Session Router simplifies interconnections by centralized route provisioning, utilizing standard ENUM and DNS route lookup protocols, providing interworking functions, and call admission control based on policies
- » **Transitioning to all-IP network:** Service providers may be moving towards an all-IP communications future, but they still need to interwork with legacy protocols. Oracle Communications Session Router allows integration of routing between Mobile Switching Centers (MSCs) and disparate protocols such as SIP and SIP with embedded ISDN (SIP-I). It also allows IP networks to use number portability techniques by dipping into translation databases
- » **Business Services:** Operators provide SIP trunking and hosted services to enterprises by using several SBCs, some of which are likely to be multi-tenanted. This leads to complex routing, configuration, and scalability issues. Introduction of Oracle Communications Session Router provides a clean solution to all of these
- » **Congestion Control:** The management of network overload is paramount in today's networks, where a signaling peak can propagate quickly and result in network degradations or even outages. Oracle Diameter Signaling Router and Oracle Communications Session Router's robust congestion control capabilities manage traffic congestion and fully protect the signaling core. The main building blocks allows for:
  - » Traffic prioritization allows for message prioritization so that traffic with highest priority (e.g. VoLTE calls) takes precedence over traffic with lowest priority during congested situations
  - » Ingress congestion control allows controlling the traffic from the clients per connection. Signaling storms are stopped and excessive traffic penalized based on configurable thresholds
  - » Overload control, guarantees the performance specifications
  - » Egress congestion control protects the most critical network element from overloading, with intelligent throttling that takes into account the traffic priority across groups of servers

## Virtualization

Just as the cloud has transformed the IT industry, Network Functions Virtualization (NFV) is transforming the communications industry by enabling CSPs to move beyond the limitations of proprietary hardware. NFV has the potential to revolutionize service agility and speed to market. Figure 5 shows how NFV technology aids agility, elasticity, and scalability of the network while retaining simplicity. However, virtualizing networks is not enough; CSPs must consider how to transform the network to meet customer needs and grow the bottom line, while best leveraging existing assets in the new hybrid network reality.

## Agility

High level of agility is achieved by detaching the physical resources from the applications.  
New applications & services are virtualized and instantiated on-demand in the cloud



## Elasticity

High degree of workload adaptability to provision and de-provision resources in an automatic manner.  
Able to dynamically adjust to the changing needs of users, applications and services over resources in a shared infrastructure

## Simplicity

Simplifies operations of a cloud networking environment.  
Presents an integrated network and service management view binding both physical and virtual resources to a particular service for advanced optimization, monitoring and troubleshooting

## Scalability

Ease of scalability as SW & HW are virtualized.  
Virtualized SW can be instantiated on what the needs are and where physically the capacity is needed.  
Virtualized HW can easily scale by adding more capacity in areas where it is needed

Figure 5: Oracle's NFV Based Signaling Solution

Realizing the importance of Network Function Virtualization (NFV), Oracle Communications has developed a comprehensive NFV architecture and strategy to deliver open, cloud networking benefits for interconnect solutions.

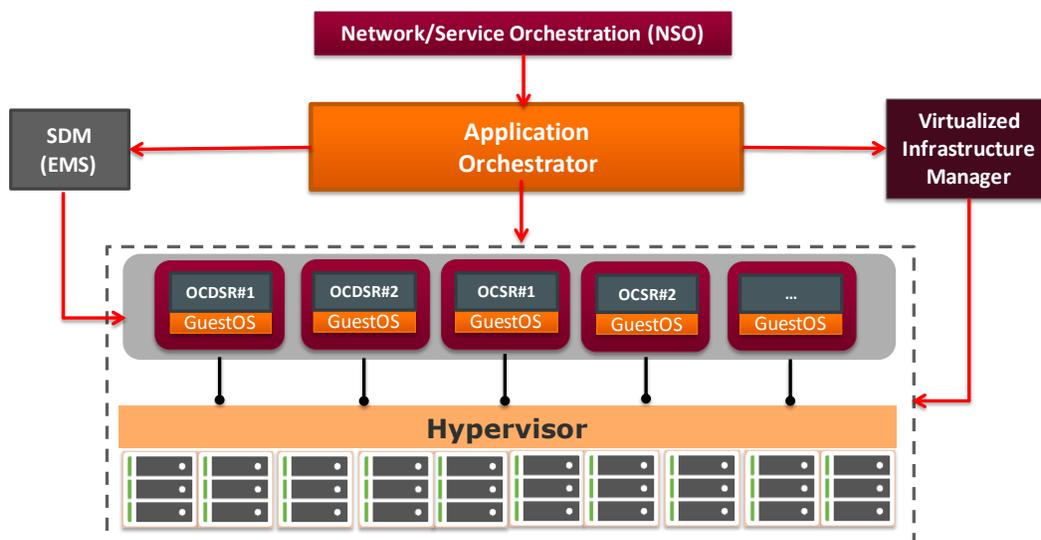


Figure 6: Oracle Communications Virtualization of Signaling Core



Oracle Communications solution for a virtualized signaling core is comprised of three layers of orchestration for enhanced service agility, and includes the following functions:

- » **Management & Orchestration (MANO):** Oracle Communications Network Service Orchestration (OCNSO) solution supports the full scope of cloud and WAN networks orchestration and control in a converged cloud networking architecture for full NFV service lifecycle creation, activation and assurance. The OCNSO provides onboarding of NFV services, global resource management, authorization of VNF resource requests and policy management of NFV service instance. OCNSO comes with a domain / data model that translates a service graph which can include both physical and logical VNF components and the associated network connectivity between them (inter-VNF links)
- » **VNF Manager:** Oracle Communications Application Orchestrator (OCAO) is a highly available, open and flexible VNF manager for orchestrating the entire service lifecycle of VNF instances including instantiation, scale-out/in, performance measurements and termination. OCAO comes with a domain / data model that translates a service graph which can include both VNFs and group of VNF components (composite VNF) and the associated network connectivity between them (intra-VNF links)
- » **Element Management System (EMS):** Oracle Communications Session Delivery Manager (OCSDM) provides the FCAPS functions for operation management of the VNFs. The OCSDM coordinates and adapt the role for configuration and event reporting between VNF and the VNF Manager
- » **Virtualized Infrastructure Manager (VIM):** Oracle OpenStack is the primary focus for cloud control, with the ability to support other open standard cloud controllers as needed including APIs integration with Oracle Virtual Machine (OVM), Kernel-based Virtual Machine (KVM) and VMware

An agile virtualized signaling core enables dynamic setup of virtual machines for different types of call flows. Since call flows may be different with regards to their protocol headers, interfaces, policy and rules that must be applied to them, their mode of operations, etc., an orchestrated interconnection infrastructure can support the logical separation of call flows on a per VM instance.

Oracle is committed to provide communications service providers (CSPs) with a fully virtualized, NFV-ready solution portfolio. Our signaling solution components are necessary to orchestrate connections of virtualized LTE/IMS network elements and provide a foundation for virtualization, where reliability, flexibility, scalability, automation, and maintainability become even more critical. With the new releases of NFV-enabled signaling products, Oracle helps CSPs conquer the layers of complexity inherent in bridging physical and virtual environments as they continue on their journey toward NFV.

## Summary

The overall benefits of Oracle Communications' next generation signaling core may be summarized as follows:

- » **Simplify:** Remove mesh connections and centralize routing for both SIP & Diameter
- » **Interoperate:** Ensure interworking between devices from different vendors without software changes
- » **Secure:** Hide topologies and addresses to keep privacy where necessary
- » **Provision:** Decrease the number of interfaces, ports, and routes that need to be provisioned per network element and eliminate potential errors
- » **Load balance:** Increase capacity of your network granularly by load balancing between available devices
- » **Make the network agile:** Grow by virtualization and automate through intelligent orchestration
- » **Segregate traffic patterns:** Collect statistics for the different call flows or categories of networks on a global level statistics, isolate problems for trouble shooting, simplify operations for fault management
- » **Make network efficient :** Increase granularity of control and policy based on each call flow, simplify scaling based on traffic requirements for each call flow
- » **Increase flexibility:** Enable different mode of SIP operations such as stateless, transaction and dialog stateful

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- » **Increase reliability and availability:** Eliminate single points of failure, avoid multiple call flows, interfaces and policies on a single system, and avoid single IP address becoming a network bottleneck

### For More Information

Oracle Communications Products: <http://www.oracle.com/communications>

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