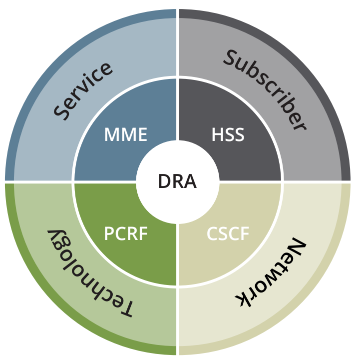
DIAMETER NETWORK TESTING

New Perspective

Testing Diameter Network for Better ROI

Subscriber services are the #1 cause of the skyrocketing signaling load in the operator diameter network. Some of these services introduce additional interactions among the diameter nodes that can be more complicated than any vendor can envision. Operators need to have a clear perception about their diameter network and critical factors that influence its performance. By discussing the four dimensions of the Diameter Network – Service, Subscriber, Technology and Network – and presenting a conceptual linkage among them, this paper outlines how an operators' Diameter Network can be built with ever-growing business demand for capacity and stability.

Subscriber growth and smart device evolution are driving both signaling and data traffic in the operator network. Smart devices are introducing new challenges to operator networks every day with the proliferation of chatty applications, battery saving cycles and multi-purpose device synchronizations. A recent industry report pointed out that signaling traffic has gone up 18 fold in the last 5 years. In a Diameter Signaling Control Market Forecast, Infonetics Research pointed out that current consolidated operator TPS (Transactions per Second) requirement of just under 1million TPS is expected to grow to more than 30million TPS by 2016.



Service

Services take the center stage in an operator's business model. Primary telco services like voice, data, messaging and roaming should continue to be the dominant categories for operators with LTE infrastructure. Competitive pricing conditions in primary services and substitutes are forcing operators to look for new services to bridge the revenue gap. RCSe, fleet management, tiered service plans based on dynamic policy and revenue sharing with content providers are some of the services that operators are considering in order to increase their revenue per subscriber. These service implementations impose additional load on the diameter network - threatening subscriber dissatisfaction and leading to churn. Hence, every service implementation decision needs to test the additional capacity requirement in the diameter network.

Subscriber

This dimension of the diameter network is about the subscriber level concepts that need to be implemented to enable the aforementioned services. These concepts consider subscriber level activity as a unit of work, irrespective of the technologies and networks it uses to enable a service. Some of these concepts are common among multiple services. Authentication is one such concept that is essential to pretty much all services. Fleet Management service requires subscriber location and mobility management to be implemented. Tiered service plans are enabled by policy management. Subscriber data handling and fault recovery are other examples of the subscriber dimension in diameter network implementation. Ability to plan, test and monitor by subscriber is critical to the stability of the diameter network.

Technology

This is the dimension that most of the industry is cognizant of and relates to when talking about the diameter network. This dimension involves Diameter Nodes, Diameter Interfaces and Interface Messages.

Indutry Predictions

Analyst firm Exact Ventures projects a figure of 235,000 TPS per 1 million subscribers.

Smart Phone Application "Draw Something" grew to 50 million users in 50 days after launch.

Chatty applications that are always-on and perform periodic background polling are expected to increase the traffic exponentially over the next 5 years.

Revenue per Subscriber

According to an Analysys Mason 2012 report, revenue/subscriber values by world region are $800, $220, $180 and $156 in NA, EMEA, CALA and APAC respectively.

Cost per Subscriber

Typical vendor pricing for the diameter network capacity (irrespective of type of Node) is in TPS units.

Average cost of a fully-redundant DRA install with 50K TPS capacity is $1.2 million (50K TPS per $1.2Mil)

Are you testing your diameter network enough to maximize the investment?

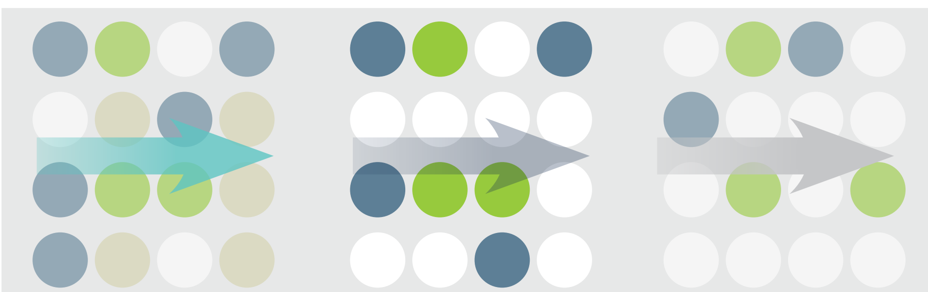
Each diameter node, such as DRA/DRF/DSC, MME, HSS, CSCF, and PCRF plays a significant role in the diameter network managing one or more subscriber concepts and services. Each node supports numerous deployment models and one or more diameter interfaces. Multiple vendor solutions exist for each diameter node. Each piece of vendor equipment performs well to the published specification when tested stand-alone, but the same results don't hold up in a multi-vendor diameter network.

Network

This is the most crucial dimension in the implementation of the diameter network. The factors that influence this dimension are the likes of Diameter Message Transport (SCTP/TCP), Encryption, Connectivity (IPv4/IPv6), Network Configuration and Redundancy. Underlying network characteristics can dramatically alter the functionality as well as performance of the diameter network nodes, in turn affecting operator services.

Vendor Selection Criteria – Best Practices

In the previous section, we reviewed four dimensions of the diameter network and how they affect the performance. In this section, we discuss best practices for vendor selection in the diameter network buildout.



Performance Filter

First, filter out all the vendors that don't deliver expected diameter network performance.

Standard Compliance

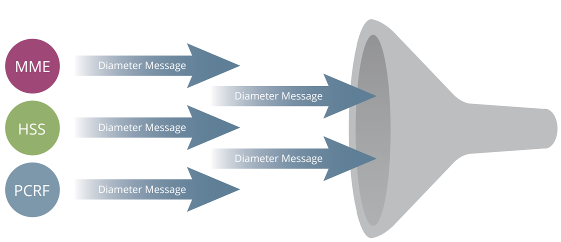
Second, test vendor implementations for standard compliance. If a vendor is not standard compliant, chances are very high for an unbalanced diameter network. Also check the IMS connectivity equation.

Operator Unique Qualifier

Vendors might have the best possible solution that stands out in the market place, but they may still not be suitable for an operator's unique diameter network. At this point, you should have a waiting list of vendors if the first choice falters.

Performance

As we have outlined in the four dimensions, performance is key for diameter network stability. The first step in this process is to identify the elasticity of diameter network performance. The performance is expected to decrease proportionally up to a stress level. But the elasticity of the diameter network performance is defined by the amount of stress it can take before the performance drops rapidly as a result of delay.



Stand-Alone Node Performance

The performance of a single diameter network node like an HSS or PCRF in a typical configuration needs to be tested to benchmark its performance elasticity. Some of the specifics of the testing include average response times and resistance to packet loss.

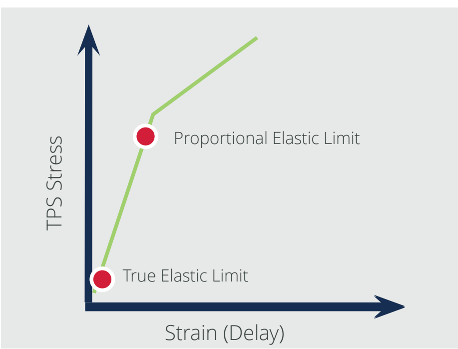
Networked Node Performance

The next step in the performance benchmarking of a vendor node is the networked environment. This can be a fully or partially simulated diameter network to measure the performance for different combinations/configurations of the vendor nodes.

What is the Desired Capacity in My Network?

This is a question on every operator's mind during network design phase. Max TPS is looked at as the peak volume capacity - max capacity an operator needs to have to tackle the "peak hour" traffic volumes. Typical TPS/Subs is anywhere from 3 to 8 depending on subscriber types.

Max TPS = # of Subs X TPS/Sub



With the introduction of Diameter Routing Agent (DRA), average networked node performance can be improved significantly. At the same time, DRA itself needs to be tested for higher performance numbers. Typically it is common to test a DRA for 4x of the desired networked node performance on each port.

As a growing trend, operators are considering off-the-shelf hardware to host some of the critical diameter network nodes including DRA. Such deployments would definitely need a thorough performance test cycle to weed out any impending issues as a result of the OTS factor.

Following are the allowed delay and packet loss rates allowed as per 3GPP TR 23.401 for different LTE services.

Priority	Delay Budget	Error Loss Rate	Services
1	100ms	10^{-6}	IMS Signaling
2	100ms	10^{-2}	Conversational Voice
3	50ms	10^{-3}	Real Time Gaming
4	150ms	10^{-3}	Conversational Video (Live Streaming)
5	300ms	10^{-6}	Non-Conversational Video (Buffered Streaming)

Standard Compliance

Most of the diameter network interface standards are updated to 3GPP release 10.x. Although it is desirable, it is not practical to expect that all the diameter network nodes will support the latest and greatest release of 3GPP standards. Hence, operators need to be prepared to deal with multiple 3GPP releases. Apart from multiple releases, due to the flexibility provided by the diameter protocol, vendors can be quite unique in their node implementations. To normalize the differences and increase interoperability, IETF, IMS Forum and ETSI have taken initiatives to define conformance test suites for critical Diameter Interfaces like – Base Protocol, Cx, Sh, Rx, Gx and Ro.

Performance Trivia

Networked Node Performance, of all the nodes, helps you find the lowest common denominator of the diameter network performance.

Operators can save time and money by simulating the adjacent nodes to figure out Networked Node Performance.

Depending on the operator configuration, DRAs might need to be tested for up to 1 million TPS for optimal performance.

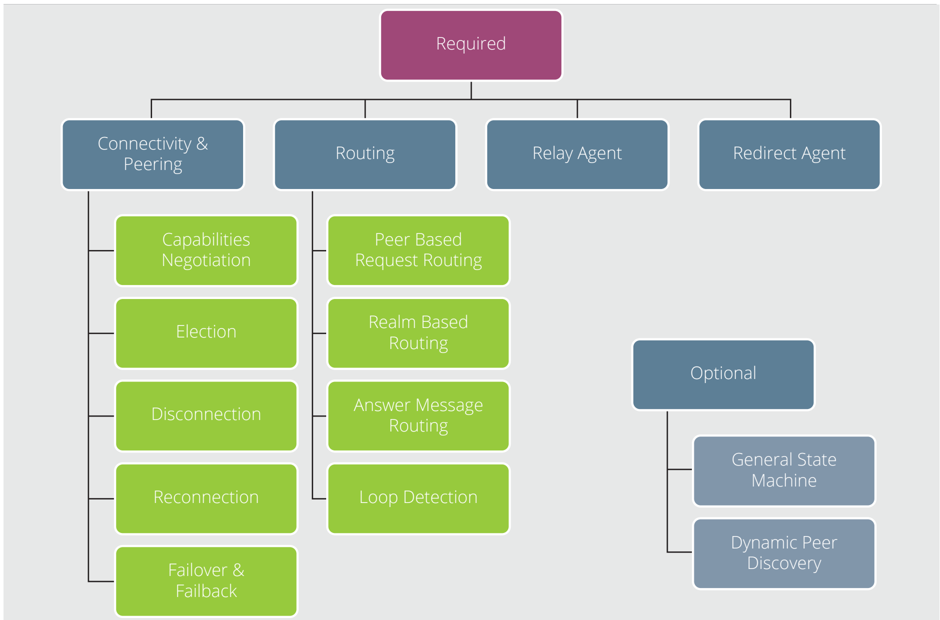
It is a common practice to operate a particular Diameter Node much lower than its advertised capacity to maintain the sanctity of the network.

Processing delays at MME (on S6a) and PGW (on Gx, Ro/Gy) cannot exceed 100ms as per the standard.

Most of the DRAs in the market claim processing delays between 15ms to 25ms.

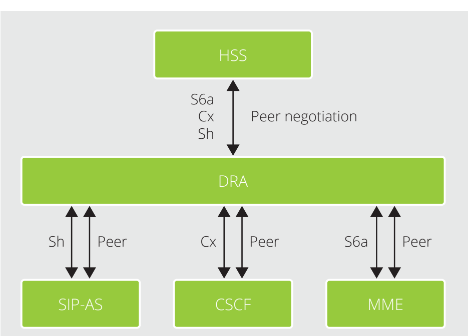
Base Protocol Conformance Suite

Diameter base protocol conformance suite, also referred to as the diameter interoperability test suite, defines the required and optional functionality expected in all diameter products. This test suite verifies the RFC3588 standard compliance. The required functionality is the baseline capability that an implementation must support to allow basic interoperability. Optional functionality covers features that not all implementations support or may wish to test. i.e. Dynamic Peer Discovery, General State Machine.



Shared Diameter Peer

Diameter protocol allows multiple diameter application interfaces to share a base peer. This reduces the number of diameter connections that a diameter node needs to establish with connecting nodes, simplifying the configuration. In case of DRA based Diameter Network deployments shared Diameter Peer is a defacto configuration method. On the other hand, you would also need the ability to negotiate multiple peers with different attributes, each going to a separate diameter node for interoperability testing.



Subscriber Profiles

A majority of the diameter interfaces are defined around subscriber activities. To test these interfaces you need to be able to simulate subscribers up to a few million. This can get complicated if you are emulating the UEs and eNodeBs, as you will not be able to achieve higher subscriber counts. As an example, to generate traffic volume in the range of 100K TPS, you would need to simulate at least 300K to 400K subscribers for optimum results.

Conformance Test Specifications

Base Protocol – IETF Diameter Base Protocol Interoperability Test Suite (30 test cases)

Diameter Cx – IMS Forum Cx Compliance Test Specification (40 test cases)

Diameter Sh – IMS Forum Sh Compliance Test Specification (35 test cases)

Diameter Ro – IMS Forum Ro Compliance Test Specification (20 test cases)

Diameter Rx – ETSI TS 101 580-1,2,3 (12 test cases)

Diameter Gx – ETSI TS 101 606-1,2,3 (12 test cases)

Protocol Message Contents

So far we talked about subscribers, capacity and network connectivity. But the content in the diameter interface messages plays a big role from an interoperability aspect. Message Length, Attribute Value Pair (AVP) Data Type, Standard vs. Custom AVPs, and AVP Security are some of the key content areas that need to be addressed in a multi-vendor environment.

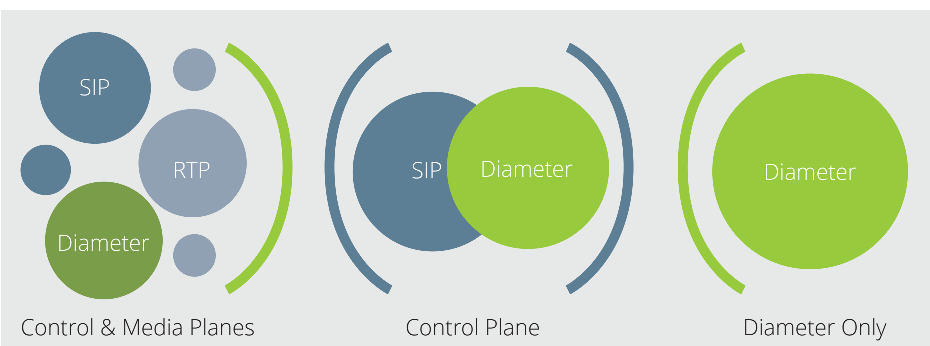
Operator Unique Qualifier

Every operator's goal is to serve their subscribers with many high quality services. These services try to differentiate from competitors with claims like faster response times, no dropped calls and superior quality of experience. To fulfill these claims, operators need to build network architectures and aspire for goals such as - less than 100msec packet delay, 99.999% reliability, 0.01% packet loss and no packet corruption. The combination of these goals creates a unique qualifier for the operator. All the vendors that make up the operator's diameter network need to be tested against this qualifier. Sometimes vendor solutions modify a qualifier that operators decide to adopt as a result of other limitations. Modified qualifier needs to be tested against all other vendor solutions in the network.

99.999%
Reliability

Diameter Testing – IMS to EPC

IMS Integration is one of the critical milestones in the deployment of the diameter network. All critical domains of the service enablement where Diameter is used are tightly integrated and very much interdependent. Some of the nodes that use Diameter to query/update other nodes also support other signaling protocols like SIP, TCAP and ISUP. For example, CSCF needs interact with HSS and PCRF while processing a new call session request. Some nodes that use Diameter are also responsible for media path (RTP) management. For example, PCEF function interacts with PCRF to regulate a user call bandwidth. As 3GPP has strict guidelines around processing delays, testing Diameter implementations in the midst of other control and media plane protocols is highly recommended.



Summary

The explosive growth in data-enabled devices and applications is the greatest revenue opportunity that operators have ever seen. However, that opportunity will not translate into revenue unless the new services are marketed on time with differentiable stability and resilience of the network. Success on those fronts will largely be dictated by fast and accurate vendor evaluations as well as continuous regression based test methodology. By selecting an intuitive and powerful test tool to address the most challenging functional and load test scenarios, you will have a great start towards achieving your goals.

Spectra2 Solution Specification

Solution Highlights

Test Domains	LTE EPC Testing, Core Network Testing, Policy Testing, IMS/VoIP Testing, TDM Testing
Form Factors	High Capacity IP Server, TDM/IP Mixed Server, Software Only
Line Speeds	1G and 10G Ethernet
User Interface	Intuitive Point and Click GUI to simplify the scripting of complex scenarios
Traffic Generation	Traffic Mix/Shaping w/ Multiple Protocols, Call-legs, Scripts and Scenarios
Built-In Features	Subscriber Profiles and Protocol Message Libraries w/ options to edit, save and reuse
Troubleshooting	Visual Display, Multi-protocol Ladder Display, Complete Protocol Decodes, Automated Test Generation from Wireshark Import
Test Automation	API for Test Harness, Batch Execution, Scheduler
Programmability	Procedures, If/Then/Else Programming, Run-time Parameter Get/Put Management
Protocol Interworking	Diameter Interfaces, SIP, TCAP
Conformance Test Suites	Diameter, SIP, H.323, MGCP, Megaco

Diameter Protocol Functionality

Policy Interfaces	Gx/Rx, Gq/Rq, S9, Sp, Ud
HSS/MME Interfaces	Cx/Dx, Sh/Dh, SLh/SLg, S6a/S6d, Zh/Dz
Charging Interfaces	Ro/Gy/Sy, Rf/Gz
EIR Interfaces	S13
AAA Interfaces	S6b, STa, SWa/SWd/SWm/SWx
NGN Interfaces	Rq, Gq/Gq', E2/E4
Node Interfaces	PCRF, HSS/HLR, AAA, CSCF, IMS-AS, MSS, OCS, PCEF, SLF, CTF, CGF, UE

Other Protocol Functionality

VoIP Signaling Protocols	SIP, SIP I/T, SIP TLS, H.323
Application Protocols	WebRTC, HTTP, XCAP, RTSP
CODECs	Voice: G.711, G.722, G.723, G.726, G.729, AMR WB/NB, EVRC Tones: RFC 2833, RFC 4733, DTMF, SF Video: H.263, H.263+, H.264, MPEG4 Fax : T.38
Media Transport	RTP, RTCP, SRTP
QoS Testing	Audio/Video, Active/Passive, POLQA, PESQ, MoS, R-Factor
PSTN Protocols	ISUP, TCAP, BICC, ISDN
TCAP	AIN, MAP, CAMEL, GSM, INAP, IS-41, IS-634A, IS-826, INCS2
Node Simulations	CSCF, SBC, MGC, SGW, MGW, IMS-AS, MSS, SSP, STP
IP Versions	IPv4, IPv6
IP Transports	TCP, UDP, SCTP and SIGTRAN (M2PA, M3UA)
PSTN Transports	TDM (T1/E1, OC3)

For More Information

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