EXFO Diameter Testing

Kader Khan, Product Manager – EXFO Simulators Product Management

Today's mobile network operators are confronted with increasing complexity in mobile networks. One key challenge is to ensure the performance and availability of the signaling network, which is crucial for service delivery to customers. Core network signaling has been transformed from SS7-based protocols to session initiation protocol (SIP), Diameter and Megaco. While SIP and Megaco drive call control-plane traffic, bringing rich media services such as Voice over LTE (VoLTE), rich communication services (RCS) and web real-time communications (WebRTC), Diameter protocol is what truly enables critical functions in the IP multimedia subsystem (IMS), and 3G and 4G long-term evolution (LTE) networks.

WHAT IS DIAMETER PROTOCOL?

The specification for the Diameter protocol began in 1998, replacing the much-less-capable remote authentication dial-in user service (RADIUS) protocol for authentication, authorization and accounting (AAA) services in networks. The base protocol (RFC 3588) defines the commands (message format), and comprises a set of data elements defined as attribute-value pairs (AVPs). This protocol provides a base set of functions, such as peer discovery, capability exchange and error handling. Diameter supports the following two transport protocols: stream control transmission protocol (SCTP) and transmission control protocol (TCP)—and optionally, transport security is provided by transport layer security (TLS). The base set of functions can be extended by diameter applications through the addition of new commands and AVPs. As a result, today everything that is connected to or part of a network uses this protocol in some way. In addition to AAA, the Diameter protocol is used for policy and charging control (PCC), short message service (SMS), mobility management and subscriber management.

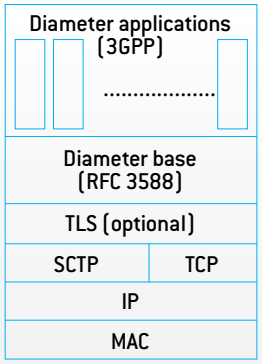

Figure 1. Diameter stack

WHY DIAMETER TESTING?

The Diameter protocol is the lifeblood of the signaling network. Network elements (NEs) such as call session control function (CSCF), mobility management entity (MME), home subscriber server (HSS) and application server (AS) use it to communicate with each other to get the data they need. Oracle's LTE Diameter Signaling Index (third edition) predicts that Diameter signaling messages will grow from 12 million messages per second in 2013 to 216 million messages per second by 2018. In fact, many different factors are contributing to the growth in Diameter traffic in the network, including evolving network complexity, subscriber roaming between different access networks, increasing smartphone subscriptions, exploding data traffic growth, and the introduction of new services, including both over-the-top (OTT) and telecom services such as machine to machine (M2M), LTE Broadcast and VoLTE. Most importantly, network failure scenarios can trigger a massive amount of Diameter signaling traffic (referred to as a **signaling storm**), which is caused by automatic reconnection requests from multiple devices. As a result, the number of signaling messages being sent and received is rising rapidly, and this is putting pressure on all parts of the network.

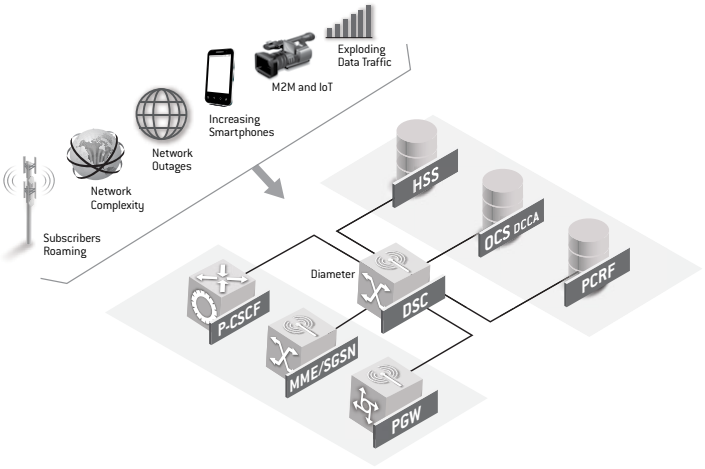

Figure 2. Diameter traffic growth

On a different note, the growth of Diameter signaling traffic is an indication of growth in revenue and monetization for operators. If not thoroughly tested, the result will be lost revenue, damaged reputation and dissatisfied customers.

EXFO DIAMETER TESTING

EXFO's QualityAssurer Series of high-performance and high-capacity simulators are used by equipment manufacturers and mobile operators to verify their wireless network, e.g., LTE, evolved packet core (EPC) and IMS, in their labs prior to deployment. Our tools are used to recreate and simulate the real-world network traffic patterns of millions of subscribers accessing VoLTE/SRVCC, WebRTC, small cells, and the Wi-Fi offload service. EXFO's dsTest™ Diameter test product powered by Developing Solutions® is a complementary solution to EXFO's QualityAssurer simulator product, and helps isolate and test NEs that support Diameter protocols and interfaces such as PCRF, HSS and diameter routing agent (DRA).

Figure 3. NE supporting Diameter

EXFO's Diameter simulator test solution is a software-only product that runs in commercial off-the-shelf (COTS) hardware. This solution delivers the best scalable high capacity and high performance in the industry, coupled with unmatched flexibility and user-friendliness. In addition, it enables Diameter network element testing during the various stages of IMS and LTE network development and deployment. The following two Diameter testing use cases explain how operators boost operational efficiency and increase the reliability of the Diameter signaling network.

PCRF TESTING

Policy and charging rules function (PCRF) acts as the decision point for policy and charging actions in the network by managing rules across subscribers, devices and networks that use Diameter messages. As such, it is one of the most critical components in IMS and LTE networks. In test labs, PCRF is normally tested with other real NEs, such as PDN GW. Such a test setup does not fully exercise the functionality, performance or capacity of PCRF, because PCRF not only communicates with single PDN GW, but also multiple PDN GWs. PCRF also communicates with policy control enforcement function (PCEF), such as deep-packet-inspection (DPI), online-charging-system (OCS), and offline-charging-system (OFCS) functions, as well as proxy-call session control function (P-CSCF) and other PCRFs (visited) and more.

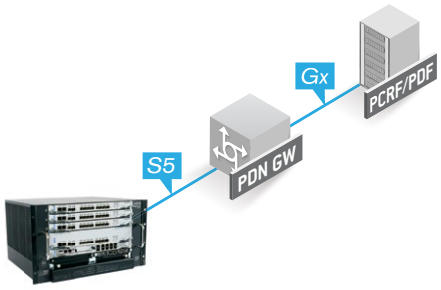

Figure 4. Indirect PCRF testing

As the demand for sophisticated policy implementations increases, PCRF testing becomes more difficult and more critical. As such, it must be surround tested for high capacity in terms of subscriber count and transactions per second (TPS), for flexibility in terms of support for vendor-specific information, and for coordination across multiple interfaces. EXFO's Diameter PCRF testing solution addresses these challenges by providing stateful, standards-based applications/interfaces that surround PCRF and react appropriately to both expected and unexpected events without the need for scripting. This solution surpasses all other tools in its ability to achieve PCRF testing goals thanks to its capacity, performance and ease of use. For example, it can help operators ensure that appropriate amounts of bandwidth are dynamically allocated to each service in real time, thus making the most efficient use of network resources delivering advanced services such as VoLTE and WebRTC. In addition, it can be used to validate the complete set of procedures as defined in 3GPP specifications, such as installation, modification and removal of PCC rules, binding and quality-of-service (QoS) parameter mapping, application detection and control, requesting and reporting usage, and failure and restoration.

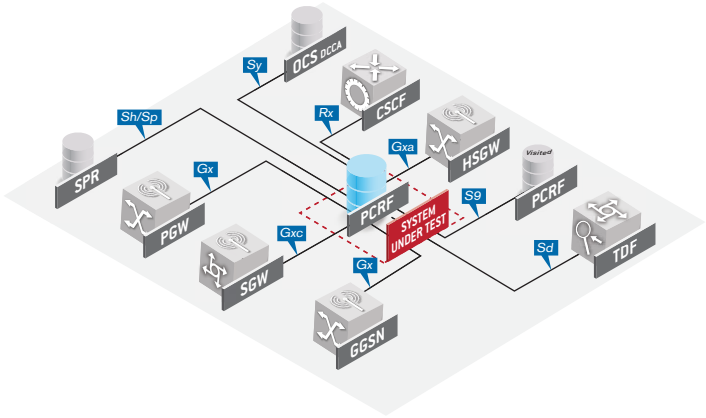

Figure 5. PCRF surround/isolation testing

DRA TESTING

The volume of Diameter signaling traffic in LTE and IMS networks is already sufficiently large; operators are proactively architecting signaling controllers to avoid mesh network architecture. Diameter signaling controllers (DSCs), DRAs, or diameter agents (DAs) are at the core of the Diameter network helping to alleviate Diameter traffic and considerably reduce configuration time. DRAs are deployed in a single mated pair (failover) for small- to medium-sized networks. In the case of large networks, signaling networks are divided across several interconnected DSCs, each serving a separate and independently administered domain. The DRA must be thoroughly tested, being the central node in the network for carrier-grade robustness, redundancy, scalability, overload protection, high performance and capacity. In addition, it must be characterized for a wide variety of Diameter interface support, such as S6a, Gx and Rx mimicking real-world conditions across multiple stateful nodes and interfaces.

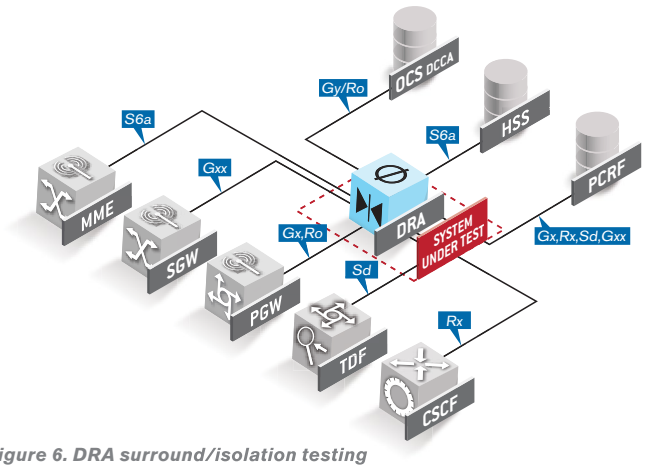

Figure 6. DRA surround/isolation testing

EXFO's Diameter DRA testing product is currently the only solution on the market that tests all of the DRA use cases, generating hundreds of thousands of stateful Diameter transactions with a large number of subscriber simulations. The major load-testing use cases that can be tested are as follows:

- **Centralized routing:** How well is the DRA able to aggregate and offload Diameter routing requirements from individual nodes for congestion control?
- **Roaming:** Is the DRA able to handle traffic from networks when users are roaming across from LTE to LTE, LTE to 2G/3G, and other access networks?
- **HSS address resolution:** Is the DRA able to map the subscriber identity with the home subscriber server (HSS) by implementing the subscriber location function?
- **PCRF binding:** Can the DRA dynamically load balance across multiple PCRFs and bind the subscriber session to ensure correct billing and tracking of service usage?
- **Interoperability:** Is the DRA able to translate Diameter messages to other protocols, such as mobile application part (MAP), customized applications for mobile networks enhanced logic (CAMEL), lightweight directory access protocol (LDAP), domain name system (DNS) and dynamic host configuration protocol (DHCP)?
- **Security protection:** The ability of the DRA to protect the Diameter nodes from distributed denial of service (DDoS) attacks.

CONCLUSION

While the Diameter protocol offers many critical functions in the network, it is not without considerable impact in the LTE and IMS networks. The Diameter NEs must be isolated and thoroughly tested in the labs to mitigate live network failures. A failure in the Diameter protocol or Diameter element will have a direct impact on operators' revenue and monetization. EXFO's Diameter test solution helps equipment manufacturers and mobile operators verify their Diameter elements in the lab prior to deployment. It can be used to recreate and simulate the real-world network traffic patterns of millions of subscribers and thousands of TPS in order to test complex features. This enables customers to deploy reliable networks and services with total confidence.

EXFO Headquarters > Tel.: +1 418 683-0211 | Toll-free: +1 800 663-3936 (USA and Canada) | Fax: +1 418 683-2170 | info@EXFO.com | www.EXFO.com

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