IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 1 Issue 4, June 2014.

www.ijiset.com

ISSN 2348 - 7968

Session Aware and Control Signal Routing For 3GPP Domain

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Abstract

In the smartphones era, mobile data traffic is skyrocketing. More and more people use their phones not only for voice but also for data. Laptop dongles, flat-rate plans, free social networking and network videos are only a part of what mobile operators are offering their clients. And this only increases data traffic. Operators have already realized that their 3G networks are not equipped to sustain this high level of traffic growth. They are thus looking at all-Internet Protocol (IP) networks such as Long Term Evolution (LTE) and IP Multimedia Subsystem (IMS) for a solution. They have to find a way to provide higher and higher bandwidth required to support devices and applications. They are also interested in cost effectively addressing the growing gap between traffic and revenue growth.That is why Diameter came into the game. Within the IMS control and service planes, Diameter plays a central role in policy, charging, authentication and mobility management. We can easily say that Diameter becomes the signaling protocol of the future.

Keywords: *DRA(Diameter Routing Agent), DSC(Diameter Signaling Controller), LTE(Long Term Evolution), AVPs(Attribute value pairs), PCRF-Policy Charging and Control Function,SDC(Signaling Delivery Controller).*

1. Introduction

Diameter is a critical protocol in modern telecom networks.It has evolved from being a successor to the RADIUS[2] protocol,to one that is central to advanced telecommunication networks.Besides authentication,authorization and accounting(AAA),it is widely used for policy updates and charging applications. Diameter serves as the base protocol that allows peer to exchange a great variety of messages and can be extended to provide services to new access technologies. It is the primary signaling protocol for AAA and mobility management in IMS,finds extensive application for policy and charging in LTE.The surge of the data hungry smart devices has further increased the importance of Diameter signaling in LTE and IMS networks.

The Diameter Routing Agent (DRA), the DRA is a functional element that ensures that all Diameter sessions established over the Gx, S9, Gxx and Rx reference points for a certain IP-CAN session[6][7] reach the same PCRF when multiple and separately addressable PCRFs have been deployed in a Diameter-realm.Routing of Diameter messages from a network element towards the right Diameter realm is based on standard Diameter realm-based routing, as specified in IETF[1] RFC 3588[3]. The DRA keeps status of the assigned PCRF for a certain UE and IP-CAN session across all reference points (e.g. Gx, Gxx, S9 and Rx interfaces).

The DRA[5] supports the functionality of a proxy agent and a redirect agent as defined in RFC 3588[3] . The mode in which it operates (i.e. proxy or redirect) shall be based on the operator's requirements. Diameter clients of the DRA (i.e. AF, PCEF, BBERF and PCRF) in roaming scenarios shall support all procedures required to properly interoperate with the DRA in both the proxy and redirect modes.

The main importance of DRA from Diameter perspective is that it's the first time that the 3GPP standard body is supporting and backing an "in between" Diameter component. Those components known as agents are part of Diameter in its IETF base, but were never used and adopted by the telecom standard bodies that adopted Diameter and headed by 3GPP[8] , it was always a client server game.

A DRA is really a Diameter Redirect Agent or a Diameter Proxy Agent as defined by the IETF[1]. The final stamp of approval to the IETF Diameter work and to the embracement of Diameter as the main signaling protocol for telecommunication networks.

2. DIAMETER

Diameter is an authentication, authorization, and accounting protocol for computer networks and an alternative to RADIUS[2].The fact is that, compared to RADIUS, Diameter introduced many improvements in different aspects (while still being backward-compatible) and came as a result of developments to eliminate RADIUS[2] limitations.The Diameter protocol is much more reliable, has network and transport layer security,

ISSN 2348 - 7968

and includes the addition of attribute value pairs (AVPs) and error notifications.

The Diameter base protocol specifies the delivery mechanisms, error handling and accounting. It is also more easily extendable via Diameter Applications which extend the base protocol by adding new commands and attributes. Applications using the Diameter protocol are able to support interfaces such as Cx, Dh, Dx, Rf, Ro, Sh. Diameter Applications specify service-specific functions and AVPs. Diameter fills the gap between the old world and the new world by being designed as a peer-to-peer architecture, while at the same time keeping the client/server concept in place. This is achieved by referring to the AAA elements as Diameter nodes.

A Diameter node can act as a client, server, or agent.The Diameter protocol is designed as a peer-to-peer-based architecture in a more generic sense. Besides, a special Diameter node called Diameter agent is clearly defined in Diameter. Nowadays the mobile data traffic has rapidly increased. Inorder to address the growing gap between traffic and revenue growth, Diameter came into existence. Cisco, for example, predicts that global mobile traffic will double in 2013 and triple in 2014 as shown in Fig.1.

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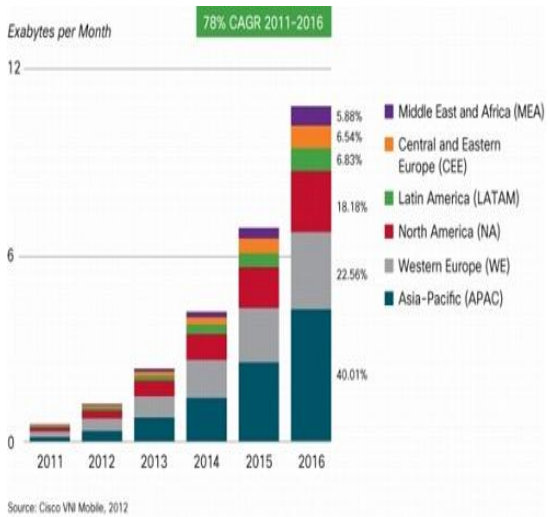

Fig.1 Global mobile traffic predicted by Cisco systems

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3. Diameter Signaling Controller

While data traffic continues to grow at an unprecedented rate, the emergence of Long Term Evolution (LTE) networks is causing a fundamental shift in the core network from SS7-based signaling to Diameter signaling. This has given rise to a new class of products referred to as Diameter Signaling Controllers (DSCs) that address the growth and expected congestion in signaling traffic by efficiently routing signaling information.

There are many network elements that need to interconnect using Diameter in Evolved Packet Core (EPC) and IP Multimedia Subsystem (IMS) networks as well as interconnection to legacy networks. With the growth in the number of LTE devices, the increased number of interfaces in the EPC and the migration of signaling from SS7 to Diameter.

The volume of Diameter messages in the EPC has exploded. This explosion illustrates the need for a carrier-grade infrastructure to support scalability and reliability for Diameter in the EPC. For SS7 the Signaling Transfer Point (STP) was used to facilitate a carrier-grade infrastructure. For Diameter the Diameter Signaling Controller (DSC)(Fig.2) is used for providing the same carrier-grade infrastructure in the EPC.

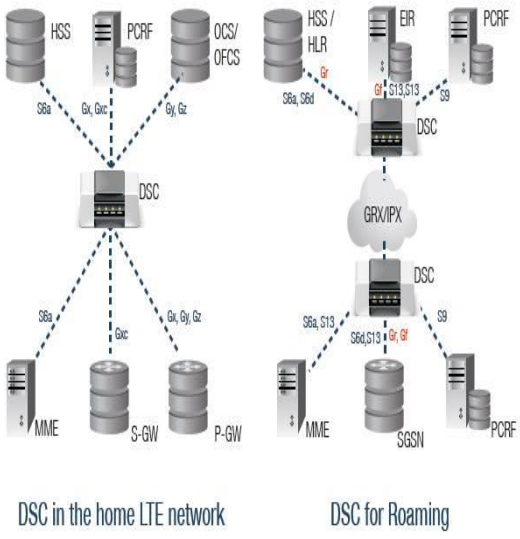

Fig.2 Diameter Signalling Controller

ISSN 2348 - 7968

The DRA is part of F5's[9] comprehensive Diameter signaling offering, which also includes an interworking function (IWF) for SS7/Diameter connectivity, a Diameter load balancer, and a Diameter Edge Agent (DEA). These components provide unlimited scalability and extend the capabilities of the SDC in network signaling for tighter security and normalized functionality in roaming, billing, and third-party content scenarios.

Diametriq, an innovator in Diameter signaling control technologies, offers an exceptional suite of DSC solutions, the Diameter Solution Suite™ (DSS)(Fig.3). Diametriq's application enabled platform includes a Diameter Routing Agent(DRA), a Diameter Load Balancer (DLB), Diameter Edge Agent.(DEA), and a Diameter Interworking Function (IWF). These functions can be configured to meet your specific network requirements as well as serve as a host for critical applications that utilize the information contained in Diameter messages.

4. Diameter Routing Agent

The introduction of the Diameter protocol has solved many issues, but there are still challenges that mobile operators have to face. These include: Complex routing and provisioning, Multi-vendor interoperability,Load balancing and overload control,Transport protocols interworking Network stability and security, Unmanageable mesh of peer-to-peer connections.

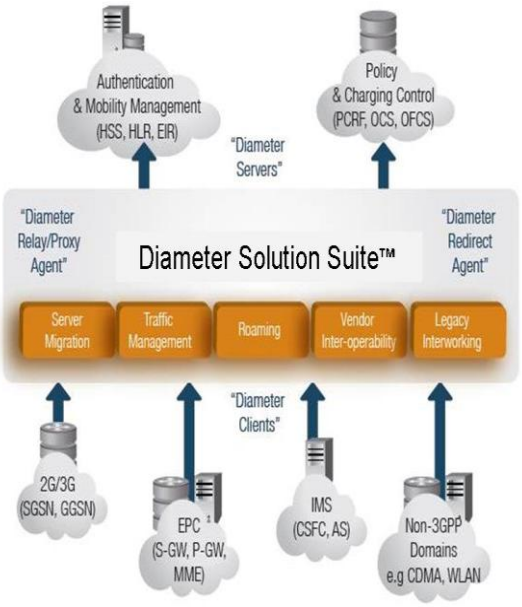

Fig.3 Diametriq's Diameter solution suite

Considering the Diameter mesh(Fig.4) in the LTE environment, the Diameter Router Agent (DRA) will have the role of a centrally managed device, thereby simplifying provisioning and reducing this mesh of Diameter connections(Fig.4). DRA enables operators to increase the resiliency and reliability necessary to support new, complex services to their customers and to scale and grow IMS, LTE and 2G/3G networks.

There are also other benefits that DRA can provide:Central maintenance and management point,Routing based on any AVP content (e.g. host, realm, Q&S, location),Routing based on external systems (LDAP, DB) or services (WS, SOAP),Reduced time of change implementation, Topology hiding.

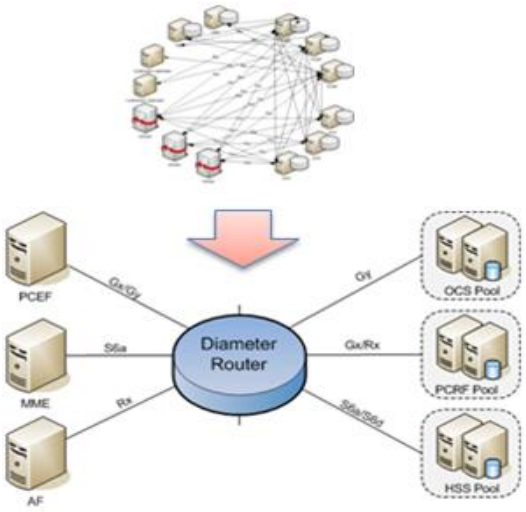

Fig 4: Diameter Router use case – Core Diameter routing

In addition to client and servers, the Diameter protocol introduces relay, proxy, redirect, and translation agents[5]. They are useful for several reasons:

They can distribute the administration of systems to a configurable grouping, including the maintenance of security associations. They can be used for concentration of requests from a number of co-located or distributed NAS equipment sets to a set of like user groups.They can perform value-added processing to requests or responses.They can be used for load balancing.A complex network will have multiple authentication sources; agents can sort requests and forward them towards the correct target.

4.1 Traffic-Management:

Diameter interfaces are peer-peer with no central management resulting in a mesh with no scalability or reliability in the network. The DSS functioning

ISSN 2348 - 7968

as a Diameter Routing Agent (DRA) provides:Flexible load balancing to enable maximum usage of servers with failover and failback. Enhanced routing to enable flexible configuration of the network and independent scalability of the clients/servers.Session binding and congestion management with Diameter throttling.

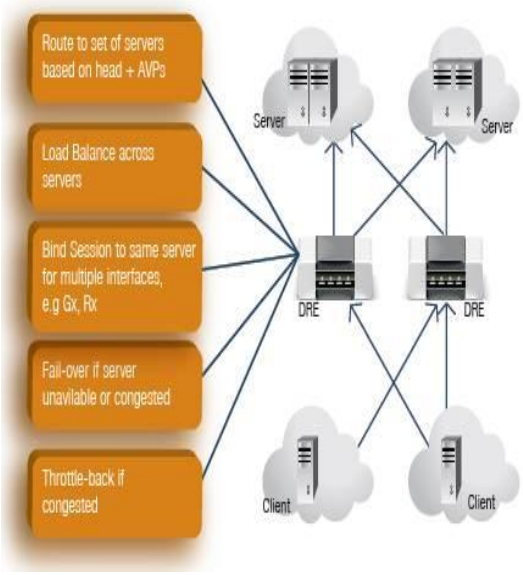

Fig.5 Traffic Management

Features are:Support for all interfaces (s6a, S9, S13, Sy, Rx, Gx, Gy, Gz, Rf, Ro, etc..).Flexible rules-based routing using configurable AVPs with AVP modification.High availability (HA) solution on a single site giving at least 99.999% reliability.Geographic redundant (GR) solution across multiple sites for disaster recovery (DR).Capacity of up to 100K messages/sec per server/blade.Scalable to 1M messages/sec per cluster.

4.1.1 DSC policy Router

The DSC Policy Router feature fulfills the role identified as a Diameter Routing Agent (DRA). The DRA, as specified by 3GPP[8], allows MNOs to deploy multiple Policy and Charging Rules Function (PCRF) elements in their network. The DSC (operating as a DRA) correlates specific user equipment to IP-CAN sessions[6] and ensures subsequent messages for the session are sent to the same PCRF regardless of which interface (e.g. Gx, S9, Gxx, and Rx) they originate.

The DSC also addresses the need for very high performance and reliability requirements for policy systems. Coupling DRA functionality and advanced load balancing, PRCF systems can be dynamically managed, avoiding congestion, and allowing incremental dynamic growth of servers.

4.1.2 Challenges

As Diameter traffic volume rises and the number of Diameter server elements increase, MNOs are faced with the challenge of how to cost effectively operate and maintain policy (PCRF) in a scalable and resilient manner. There are considerations for traffic steering when multiple different PCRF systems are used, and for load distribution across multiple servers acting as a single PCRF. There will be challenges.

4.1.2.1 IP-CAN Session Routing

When a user establishes an IP-CAN session[7], for example when a tablet requests a video stream, all subsequent messages for this IP-CAN session (bandwidth policy/enforcement, charging, etc.) must be handled by the same PCRF that handled the initial session. Diameter messages to the PCRF can arrive on several different Diameter interfaces from different nodes and the IP-CAN session relationship is identified by Diameter parameters like IMSI and/or IP address. The challenge is that only the PCRF knows the IP-CAN session association making it impossible for the connected nodes to route the subsequent messages to the correct PCRF.

4.1.2.2 Interoperability

The number of vendors entering the Diameter signaling market is increasing, and despite Diameter being a standard, interpretations of the standard are numerous. When a new vendor enters the network an extensive amount of interoperability tests are required to minimize the number of incompatibilities and Diameter session failures. F5[9] Adds RFC 6733[4] Support to the Diameter Router; Better Security

5.DSC Solution

The solution to these challenges is to deploy the DSC as a Diameter Routing Agent (DRA). The Diameter Routing Agent is defined in 3GPP[8] specifications. In this configuration, the DSC “front-ends” a set of PCRF nodes, enabling an IT style server-farm deployment allowing IP-CAN session load sharing, very high service availability, topology hiding, and seamless back-end capacity upgrades. The DSC manages and routes traffic flow and optimizes application availability and performance.

3GPP defines an IP-CAN session as an association between the user equipment (phone, tablet, etc.) and an IP network. The DSC will load balance all IP-CAN establishment requests among the available PCRFs and store the corresponding IP-CAN session association information – IMSI, IP address, Access Point Name, etc. This enables the DSC to correctly route subsequent Diameter messages associated with an established IP-CAN session.

The DSC manages and routes traffic flow (IP-CAN sessions) between the available back-end servers. As traffic volume increases, new PCRF servers can be added without any impact to the Diameter network. This allows for a "start small" service deployment and the subsequent addition of capacity, in the form of new servers, as traffic volume increases.Using Service-Oriented Routing technology, the DSC maintains service availability during loss of any server without involving the Diameter network, by load sharing all traffic between the other available PCRF servers. The DSC is backed by over 30 years of experience in providing high-availability solutions for telecom networks and is architected with all the characteristics of a carrier-grade solution.

6. Conclusion

We present the implementation of the Diameter Routing Agent(DRA).The Diameter Routing Agent , the DRA is a functional element that ensures that all Diameter sessions established over the Gx, S9, Gxx and Rx reference points for a certain IP-CAN session reach the same PCRF when multiple and separately addressable PCRFs have been deployed in a Diameter realm.Routing of Diameter messages from a network element towards the right Diameter realm is based on standard Diameter realm-based routing.

The DRA keeps status of the assigned PCRF for a certain UE and IP-CAN session across all reference points (e.g. Gx, Gxx, S9 and Rx interfaces).The DRA supports the functionality of a proxy agent and a redirect agent .The mode in which it operates (i.e. proxy or redirect) shall be based on the operator's requirements.

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