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Leveraging Diameter to control the 'signalling storm' and maximise LTE monetisation

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SYNOPSIS

The rate of global LTE deployments is ramping up dramatically across the globe. In fact new research from Informa Telecoms & Media in conjunction with industry knowledge, reveals that – in terms of perceptions on LTE maturity - the majority of global operators see a "clear need" to launch LTE networks now. Some two-thirds of survey respondents - which was based on in-depth and extensive interviews with LTE operators as well as a full assessment of the launch strategies of 52 live LTE network operators globally - said the time is right to launch LTE in their markets immediately.

However, while the commercial imperative of 4G deployment is clearly understood, the fundamental packet-switched nature of LTE networks means that the new infrastructures are in many respects architecturally challenging compared to their circuit-switched predecessors and nowhere is this more apparent than in the area of dealing with sudden spikes in signalling traffic. Unfortunately for operators the nature of 4G traffic is characterised by such unpredictable bursts in network signalling traffic, making it imperative that measures are taken in the core network to address and control the effects on end users of these peaks and troughs in demand.

The headline culprit for this surge in LTE traffic is obviously the wireless broadband data traffic created by data-hungry smartphones accessing high bandwidth services. However, there is another equally – or by some estimates -even more severe problem - in the form of congestion on the signalling channels as handsets and network components exchange a massive number of Diameter messages to establish and maintain a communications channel or service and allow for real-time policy management and charging.

Recent evidence suggests that so-called "signalling storms" have been created by severe spikes in traffic leading to at least one global LTE operator experiencing and outage. And, according to market analysts this already difficult problem is set to get very much worse. Failure to address these issues will inevitably compromise quality of services, and ultimately revenues will be negatively impacted.

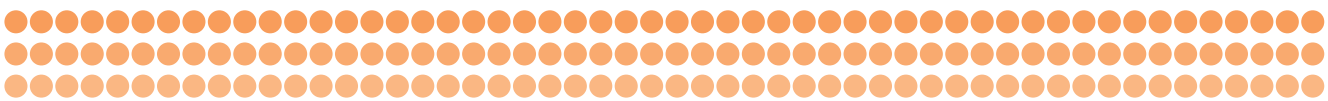
INTRODUCTION

LTE launches are accelerating rapidly, with Informa Telecoms & Media predicting that, by the end of 2013 onwards, Asia Pacific will be the territory with the highest concentration of new LTE subscriptions. Looking at the global picture total subscriber number are expected to approach 609.1 million by the end of 2016. The same report predicts that LTE subscriptions will see the biggest annual percentage increases between 2012 and 2013, as global operators deploy LTE.

Unlike their predecessors it is important to consider the fact that LTE networks will be accessed by 100 per cent of customers using smartphones from launch. And with the arrival of mainstream LTE-enabled handsets such as the latest iPhone which launched in Q3 12, the total number of subscribers relying on DSL-like mobile broadband services to deliver bandwidth-hungry content is growing rapidly. There has been much focus on the high bandwidth requirements of video, but operators' networks are set to be more severely impacted by other services including LTE gaming - which typically hosts large volumes of advertisements - and social networking in which users typically remain connected to multiple platforms for extended periods. And it should be noted that popular social networking sites including Facebook are increasingly featuring on-line games, all of which have the potential to hike up the Diameter signalling overhead dramatically.

And the fashion in which smartphone users access and use these fast-increasing volumes of mobile data on LTE networks will engender an even steeper rise in signalling traffic, according to telecoms experts. Diameter signalling traffic could "easily exceed" 100,000 messages per second per million users with personalised service offers, according to new estimates from Tolaga Research.

With signalling traffic growth outstripping mobile data traffic by 30 per cent to 50 per cent, according to 4G Americas, the concept of signalling storms that threaten the stability of mobile networks and creates congestion is a real and present danger.



THE PERFECT SIGNALLING STORM

LTE is acknowledged as being the fastest-growing cellular network technology ever, when measured in terms of overall subscription growth, but is still very much a new technology when viewed in terms of maintaining service levels. And this relative immaturity is apparent in areas including the management of signalling traffic.

While attempts to address this fast-increasing signalling overhead have been architectured into LTE, the full impact of unpredictable real-world bursts of data and signalling traffic remain unpredictable and problematic. The evidence of this is clear: over recent months several global operators have suffered significant outages in their newly rolled out LTE networks that have primarily been blamed on signalling storms bringing down various parts of their core networks.

There is a multiplicity of factors that have come together to create this perfect signalling storm. These include the fact that, in stark contrast to their 3G and 3.5G predecessors, LTE networks are accessed entirely by smartphones that produce a volume of signalling messaging that is very significantly higher than the devices that have mainly accessed legacy networks. This increase in signalling messaging impacts both the access network where the mobile device is polling the network) and the core network (where policy-driven messages are among the factors that create the increased overhead).

Informa Telecoms & Media analyst Peter Dykes warns that there are potentially multiple "pinch points" in both the RAN (Radio Access Network) and the core network, and signalling traffic management techniques addressing these areas will vary accordingly. However, he cautions that much of the increase in signalling traffic will be generated by applications which, though they may generate relatively low volumes of actual data traffic, are characterised by a very high signalling overhead.

"Indeed, some of these applications may the drop the connection by overloading the signalling channel long before the bearer network is threatened. This is known to be a problem on existing mobile networks, but dealing with it on LTE networks is still a relatively unexplored area," Informa's Dyke warns.

And the signalling problem is set to worsen quickly as mobile operators move to monetise their LTE networks to maximise Return on Investment through the launch of new services which will eventually include VoLTE, RCS and others. These new services will exacerbate signalling overhead still further on the core network compared with legacy systems which are relatively simple (e.g., driven by voice, SMS and data volumes).

Informa's data goes on to suggest that real-time, online charging and advanced offerings (e.g., family plans) will create new signalling traffic between operators' policy engines (PCRF) and various other parts (e.g., HSS, OCS). In many cases, this will be "several orders of magnitude" compared with current signalling traffic.

Without reliable signalling management, LTE networks are already showing themselves to be vulnerable to outages, but there is a potential solution to control the signalling storm that LTE operators can leverage in the form of the Diameter protocol.

Diameter is being increasingly recognised as a vital protocol for the smooth management and operation of an LTE network and the series of recent global outages have provided "adequate proof that dedicated elements for Diameter load balancing are necessary," according to Informa.

LTE subscription forecasts

Region	Dec 13	Dec 14	Dec 15	Dec 16	Dec 17
Africa	1,521,500	6,009,800	12,422,700	22,449,500	37,440,000
Americas	2,051,500	7,259,200	15,569,600	30,220,600	55,798,700
Asia Pacific	56,221,500	115,377,600	185,140,200	292,224,000	461,178,000
Europe: Eastern	2,682,200	7,199,800	15,304,500	28,979,900	45,588,000
Europe: Western	13,520,000	29,151,300	55,045,900	93,980,000	133,093,900
Middle East	268,400	727,700	1,669,300	3,647,000	7,204,000
USA/Canada	57,574,000	86,284,000	120,683,200	161,001,400	206,591,000
Total	**133,839,100**	**252,009,400**	**405,835,400**	**632,502,400**	**946,893,600**

Source Informa

SS7	Diameter
Primarily used for voice call/SMS services	Includes: Mobility management (e.g. handover, roaming), Database access (e.g., access to HLR/HSS records), Policy-driven messages (e.g., between PCR-OCS)
Contingency when a failure occurs	Each message routed over broken path must discover failure and reroute
More than 10 years of deployment	Immature, currently entering market

Source: Informa Telecoms & Media

DIAMETER – MORE THAN TWICE THE FUNCTIONALITY OF RADIUS

The Diameter protocol is an evolution of RADIUS (Remote Authentication Dial-In User Service) – the clue is evident in its name, as in geometry terms a diameter is twice the radius of a circle. This nomenclature has led to some confusion the market with some making the incorrect assumption that Diameter is just an simple update to RADIUS and had little additional functionality and utility to operators.

Nothing could be further from the truth as there is significant differentiation between Diameter and legacy technologies which do not enable operators and service providers to leverage their expertise and previous experience for new LTE networks. Diameter has the capacity to act as the base-level protocol that provides the communications "glue" to allow heterogeneous network equipment from best of breed manufacturers to function together in a coherent fashion.

Whereas legacy 3.5G, GSM and 3G networks are mainly defined by Signalling System No. 7 (SS7), LTE marks a radical departure as it is powered by the Session Initiation Protocol (SIP) and Diameter.

Informa notes that SS7 and Diameter have "fundamental differences" that can create headaches for operators when making initial deployments. These fundamental differences, in conjunction with the experience of recent network-wide failures experienced across some of the first to market LTE networks have focused the attention of operators on Diameter – and LTE signalling –especially when considering nationwide deployments.

DIAMETER: CREATING A MORE ROBUST AND MANAGEABLE SIGNALLING INFRASTRUCTURE

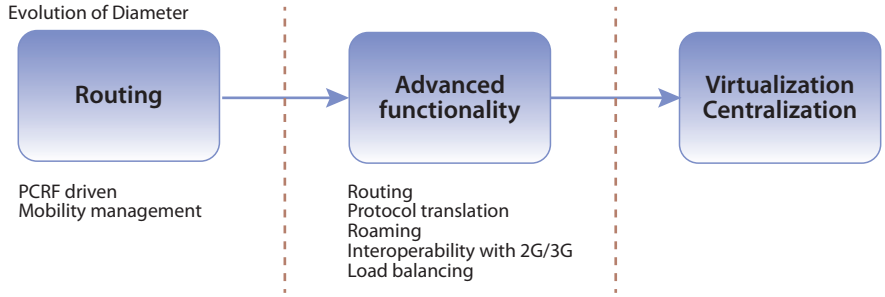
Diameter vendors currently dominate the signalling market meeting the demands of operators for more robust and manageable signalling infrastructures. And this market is evolving rapidly as LTE build outs accelerate beyond the initial deployments that typically relied on simple gateways to fulfil the role of Diameter routers in network cores.

Moving on for this starting position, operators and vendors rapidly woke up to the fact that Diameter signalling lies at the heart of LTE networks and impacts multiple areas and as such must be addressed holistically.

Informa Telecoms & Media identifies Diameter as one of the "vital" elements for LTE deployments, listing it as prerequisite in the following list of core components which are installed in combination:

- **Diameter Edge Router (DEA):** Placed at the edge of the mobile network to secure a network when interfacing with external networks. This can enable 3G and LTE roaming with third-party networks. It is defined by the GSMA.
- **Load balancer:** To maximise resiliency Diameter load balancers can be coupled with network-critical components such as subscriber registers (HSS) or billing-related components (PCRF, OCS) to make sure that unexpected incidents do not affect the operation of the network.
- **Diameter Routing Agent (DRA):** Rolled out between multiple key mobile core network components (e.g., PCRF, OCS, MME, HSS) and routes, manages and simplifies the operation of the network. If a DRA is not deployed, individual links between each network element have to be installed which is not an efficient or cost-effective solution.

- **Protocol translation:** This function can be included in any of the above components and allows for a centralised element which translates between legacy and non-mobile protocols to Diameter.
- **Diameter Signalling Controller (DSC):** A component that can perform any and all of the above functions. The DSC acts as a centralised multifunction node in the mobile core network.



Source: Informa Telecoms & Media

DEVELOPING AN INTELLIGENT DIAMETER DEPLOYMENT STRATEGY

In terms of deployments operators should remain open minded about Diameter, Informa recommends. It advises operators to be flexible when discussing Diameter technology roll outs with existing and/or new technology vendors. Operators and service providers should also seek expert advice from Diameter specialists concerning dedicated signalling equipment rather than building in an extra layer of functionality provided with other network elements (e.g., PCRF, HSS).

In the wake of any successful initial Diameter deployments it is crucial that operators undertake a detailed and proactive signalling monitoring programme. Such a course of action focussing on existing patterns of traffic and signalling which can then be extrapolated to predict likely trends is essential if the operator is to be able to plan for traffic growth in the future. These programmes will also prove useful to operators as they scale up Diameter deployments going forwards to address the challenges associated with the arrival of new innovations such as online charging and VoLTE services.

DIAMETER: ALIGNED TO REVENUE GENERATION

An additional factor that is focussing operators' attention on Diameter is the fact that it is typically tied up with revenue generation due to its central role with policies and charging, and other new services and packages offered for the first time in LTE networks. This means that Diameter has been rapidly pushed towards the top of the agenda in a way which was not the case with more limited legacy signalling, which was primarily to network basic networking functions such as call setup.

In contrast to this legacy approach to signalling operators should move to deploy Diameter components to address multiple issues. Diameter routers should be used to optimise network efficiency, while Diameter edge agents can safely deliver roaming and load balancing to ensure critical network elements do not fail.

Informa analyst Dimitris Mavrakis notes that operator CTOs are currently deploying Diameter primarily for routing policy messages, but this is evolving rapidly as it is realised that Diameter can offer far greater functionality. DEAs are not yet a prime focus, and recent outages have led operators to deploy additional Diameter equipment for load balancing in front of critical components, namely HSSs and/or HLRs, he noted.

"Diameter is a critical element for the operation of LTE networks which require several "touch points" for Diameter infrastructure. Diameter deployments have now evolved to offer advanced functionality, including routing, load balancing, protocol translation and interoperability with legacy elements. This functionality manifests itself as several of the components listed above which are expected to evolve with time," Mavrakis pointed out.

He added that Diameter should not be considered as a less-critical network component as an inappropriate deployment could lead to network-wide failures.

Looking to the future the centralised nature of Diameter has the potential to create enhanced business models, whereby a substantial volume of data and control traffic are routed via the centralised Diameter component. Such data and traffic could be internal (e.g., mobility management, policy messages) and external (e.g., roaming requests, Wi-Fi authentication requests). It plays a critical role in the security of a wireless network made more vulnerable by its IP-based architecture, and in connecting to legacy systems to preserve operators' investments.

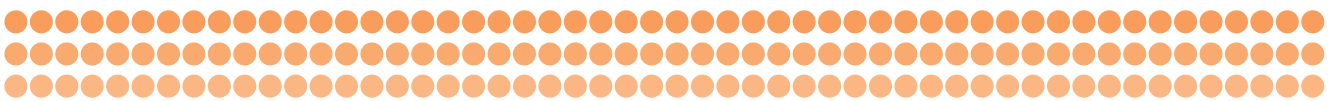
CONCLUSIONS

Going forwards the importance of Diameter is set to increase substantially as LTE network deployments increase and existing LTE infrastructure are configured to maximise resiliency, scalability and availability. Informa predicts that – as LTE matures - Diameter deployments will both increase in terms of numbers, while simultaneously evolving in terms of technological and deployment sophistication. This will take the form of enhanced functionality from Diameter equipment, including roaming (DEA), protocol translation and the ability to interoperate more seamlessly with legacy 2G/3G networks. Indeed, the centralised nature of Diameter means it is expected to play an ever more central role in facilitating interoperability.

This will be, at least initially, more apparent at the edge of the network where Diameter will play an increasingly important role in the secure interface with non-LTE infrastructures. And as many operators have the requirement to interface with several networks across different physical media platforms Diameter gateways are expected to emerge as the preferred solution when it comes to interfacing signalling networks.

Security is of paramount importance and the GSA has defined that for interconnection a secure (IPsec) communication must be used and that topology hiding should be implemented. Other security risks are in the area of DDoS and unwanted signalling entering the operator's network or revealing information that needs to be protected by the operator.

The move to relative maturity of Diameter in the global market is expected to become apparent during 2013. The fact that operators are also moving to implement online and real-time charging will further push Diameter signalling up the agenda of operators during this year. More strategically the deployment of advanced LTE services – notably VoLTE – is predicted to push up signalling volumes by a significant margin, and the issues associated with this hike in signalling will drive demand for Diameter infrastructure components still further.



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