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LTE Diameter Signaling Index

3rd Edition

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Executive Summary

Oracle forecasts global Long Term Evolution (LTE) Diameter traffic to reach 12 million messages per second (MPS) in 2013. Oracle also predicts global LTE Diameter MPS to reach 216 million by 2018. This is a compound annual growth rate (CAGR) of 78%.

This report outlines the global trends in LTE Diameter signaling growth through 2018¹. Serving as a barometer of demand for overall network capacity, the forecast includes regional traffic breakdowns and associated growth rates. Likewise, we analyze the key applications of Diameter and chart their impact on traffic and growth rates through the same forecast period.

The Oracle Communications LTE Diameter Signaling Index provides some guidelines for engineers and network planners. By focusing on some of the newest trends in applications, we provide some high-level guidance as to what the impact will be should a particular application or service be implemented in the network. The calculations are based on subscribers, devices and behaviors. These are fundamental to understanding the dynamics of Diameter signaling.

As LTE matures and Diameter is implemented in more networks globally, we see the introduction of new use cases dependent on Diameter signaling. These use cases are trending in various regions and address the vivacious appetites of smart device users.

Other findings in this year's report:

- Video services using LTE Broadcast will have a significant impact on the volume of signaling messages in Diameter networks. As subscribers broaden their use of mobile video, LTE Broadcast will grow beyond 26 million MPS. LTE Broadcast will also take the lead as the fastest growing application for Diameter, at a CAGR of 88%.
- Japan and Asia Pacific (JAPAC) represents the largest region in terms of Diameter MPS at the end of the forecast period, reaching nearly 105 million MPS by 2018.
- North America follows JAPAC with a total MPS of 59 million MPS by 2018.

¹ We limit the scope of this report to LTE connections only, as this is the only accurate data available for Diameter use.

- While Latin America and the Caribbean (LATAM) lags other regions in total MPS at 5.1 million, it has the highest growth rate with a CAGR of 161%.
- Europe, Middle East and Africa (EMEA) show strong growth potential but are only the third largest region in terms of signaling volume at just over 46.8 million MPS

<i>GLOBAL</i>	2013	2014	2015	2016	2017	2018	CAGR
North America	8,139,574	12,986,363	20,132,259	33,117,586	41,576,914	59,147,611	49%
EMEA	1,001,783	2,370,577	6,204,012	13,239,253	24,394,730	46,829,832	116%
CALA	42,093	102,448	328,495	1,088,405	2,491,334	5,138,699	161%
JAPAC	2,828,750	8,859,960	17,618,316	33,232,404	52,115,363	104,687,940	106%
TOTAL MPS	12,012,200	24,319,348	44,283,081	80,677,648	120,578,340	215,804,082	78%

The subscriber, the device type, and the behaviors of both continue to impact Diameter signaling growth, and we will continue to see these as determining factors in years to come. That is what makes Diameter traffic so much more difficult to size and dimension. There simply are no Diameter traffic models equivalent to erlang used in legacy networks.

In last year’s edition, we forecasted the impact of online and offline charging (OCS and OFCS). In this report, we have left out charging predictions and included those transactions in the four focus areas. In place of OCS and OFCS, we have added two new applications that are adding a significant amount of signaling traffic to LTE network this year and will for years to come: LTE Broadcast and Voice over LTE (VoLTE).

These applications are two reasons that the global numbers of LTE Diameter MPS are much higher than in last year’s report. LTE subscriber forecasts also rose for the next five years, significantly increasing the expected traffic.

Diameter was introduced as the signaling protocol replacement for Remote Access Dial-in User Services (RADIUS), and quickly grew to replacing Signaling System #7 (SS7) protocols, the Mobile Application Part (MAP) and Customized Applications for Mobile networks Enhanced Logic (or CAMEL for short). The role of Diameter signaling continues to grow and evolve as 3G interfaces are defined for this extensible protocol, and new applications evolve to the all-IP infrastructure of communications networks.

Diameter is not as “cut and dry” as SS7, and differs from one interface to another. It depends on what application is being supported and what interfaces in the network are being used as to what Diameter command is required. Each interface demands a different set of commands and parameters, and a different number of Diameter signaling commands.

This is why the use cases and applications being supported have such a great impact on Diameter signaling volume. It is also the reason that Diameter networks are harder to engineer and dimension. The Oracle Communications Diameter Signaling Calculator², upon which the forecast is based, is helping operator technology executives more accurately plan their network’s architecture. At the same time, a use-case specific understanding of customer behaviors and experiences is assisting operator business executives as they plan market-facing offers, evaluate opportunities and incorporate third-party capabilities into their services.

Industry Trends and Indicators

For this year’s report, we see four areas that will contribute significantly to Diameter signaling. We looked at how these services would be implemented and the number of subscribers most likely to use these services, and calculated the impact to Diameter signaling using our advanced traffic models.

- Mobility
- Policy with Quota Management
- LTE Broadcast (mobile video)
- VoLTE

These four use cases apply to all the regions, although some regions will have more implementations than others. For example, LTE Broadcast applies globally, but some of the regions will have more implementations of LTE broadcast than others. We took this into consideration in our assumptions.

A number of factors contribute to the overall growth of Diameter signaling traffic:

- LTE penetration rates
- Smart device penetration rates
- Video and voice services
- Machine-to-machine (M2M) applications entering the main stream

² Operators are encouraged to contact their Oracle Sales Team to learn how they can get their own customized Diameter forecasts.

- Sophistication in policy management use cases with more interactions with charging

LTE penetration rates continue to increase, but by 2018 we will only see a 22% penetration rate for LTE globally.³ This means there is still room for significant long-term growth. North America will lead the world with a penetration rate of 70% by 2018. Western Europe is the closest behind at 43% but all of Europe, Middle East, and Africa only shows a penetration rate of 14%. JAPAC is projected to have a total penetration rate for LTE of 24% by 2018, albeit only a handful of countries will contribute meaningfully to this number.

This means that SS7 networks will continue to be relevant well through 2018 with a subscriber penetration rate of 87% by 2018. Diameter and SS7 will co-exist for many years after, and interworking between the two technologies will be paramount to any implementations.

Devices also play a critical role in subscriber behaviors. Smart devices are predicted to be in the hands of 61% of the population by 2018.⁴ According to the GSMA, there will be 25.7 billion connected devices by the year 2020. According to Cisco⁵, tablets and laptops account for most of these devices, with tablets being the largest area of growth for devices.

Smart cars, health and fitness monitoring, and smart homes are already impacting Diameter networks through increased data sessions. The actual number of connected devices will exceed the number of subscribers as many subscribers own more than one device.

Another challenge for operators is the concept of a busy hour. This has been a traditional metric for dimensioning networks, but the busy hour in data applications varies by application. For video, the busy hour tends to be in the evening hours, while for data sessions, there really is no one busy hour. All of these factor into how we forecast Diameter signaling traffic, and all were taken into consideration for this report.

Oracle Communications LTE Diameter Signaling Index Forecast

Global LTE Diameter signaling will continue to show aggressive growth as LTE penetration rates increase. In this report, we examine four applications that represent the most opportunity for signaling growth. With CAGR of 88%, LTE Broadcast will have the biggest growth on Diameter signaling networks.

Policy remains as the major influence on Diameter signaling volumes. Use cases for policy continue to increase in sophistication and complexity, adding more signaling traffic to the network. We project 155 million MPS globally for policy traffic for a CAGR of 87%.

³ Ovum World Cellular Information Service

⁴ Global mobile Suppliers Association (GSA) "Evolution to LTE Report," July 16, 2013

⁵ "Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2013–2018," February 5, 2014

We see mobility trends shifting somewhat within the European Union due to the abolishment of roaming fees. At the same time, in North America we see roaming between 3G and 4G diminishing as 3G networks become obsolete and 4G penetration consumes the region.

Given these assumptions, we anticipate mobility will contribute up to 9.2 million MPS for a CAGR of 43% globally.

GLOBAL	2013	2014	2015	2016	2017	2018	CAGR
Mobility	1,517,730	2,450,523	3,398,224	4,216,032	5,879,928	9,154,828	43%
Policy	6,796,308	13,762,119	26,361,514	53,283,667	82,862,142	154,990,511	87%
LTE Broadcast	1,104,323	3,499,451	5,058,157	10,049,913	13,658,341	26,102,513	88%
VoLTE	2,593,839	4,607,256	9,465,186	13,128,036	18,177,929	25,556,229	58%
TOTAL MPS	12,012,200	24,319,348	44,283,081	80,677,648	120,578,340	215,804,082	78%

Forty-one service providers are deploying VoLTE services this year, with several already deployed.⁶ VoLTE introduces another growth opportunity for Diameter signaling, as well as SIP signaling in the IMS. Both technologies are needed to support voice services in LTE, replacing SS7 ISUP services. Policy management will also play a role in supporting these services, so we can count on additional signaling between the policy server and enforcement points.

We forecast a CAGR of 58% for VoLTE related signaling globally, based on LTE subscribers and a conservative call model. With the combined Evolved Packet Core (EPC) and IMS transactions, VoLTE is projected to add another 25.6 million MPS. The relatively low number in 2013 and 2014 reflects early adopters of VoLTE, but the numbers quickly grow as more deployments are completed in other parts of the world.

LTE Broadcast has a similar impact. Fifteen operators have announced LTE Broadcast trials, while KT in South Korea has already launched.⁷ The major service providers in the U.S. have also undergone trials and are in the process of deploying LTE Broadcast. In countries with high smart phone penetration rates, LTE Broadcast promises to be a major influence for at least the next 10 years.

⁶ Global mobile Suppliers Association (GSA), “Global Mobile Broadband Market Update,” May 16, 2014,

⁷ Global mobile Suppliers Association (GSA), “LTE Broadcast (LTE Multicast) market status report,” August 26, 2014

While LTE Broadcast introduces twice as much signaling per session into the network than VoLTE, there are likely more voice sessions per subscriber than there will be video sessions. Video sessions are most likely during the evening hours, and will present some challenges in network dimensioning.

We forecast the compound annual growth rate of LTE Broadcast to be 88% based on current deployment schedules globally. We do not anticipate all subscribers to embrace video on their mobile devices, so the overall signaling growth attributed to LTE Broadcast has been considered in our modeling.

Trend #1 – North America represents the largest LTE market in the world

<i>North America</i>	2013	2014	2015	2016	2017	2018	CAGR
Mobility	775,886	958,649	1,246,145	1,563,461	2,279,593	3,147,148	32%
Policy	5,314,848	7,881,816	11,153,719	19,755,155	25,361,678	33,304,509	44%
LTE Broadcast	424,760	1,888,540	2,302,163	5,372,367	6,208,977	13,914,563	101%
VoLTE	1,624,081	2,257,357	5,430,231	6,426,603	7,726,666	8,781,391	40%
TOTAL MPS	8,139,574	12,986,363	20,132,259	33,117,586	41,576,914	59,147,611	49%

North America, especially the U.S., has been very aggressive in its LTE deployments, and remains the largest LTE market in the world. Almost all devices will be LTE enabled by 2015 according to industry reports. Aiding in this acceleration is the continued growth in wireless broadband services replacing fixed line service.

Subscriber growth continues to be strong, which is a major contributor to Diameter signaling growth. As more subscribers embrace smart devices and become more engaged in a digital lifestyle, we will continue to see major growth in Diameter signaling in this region.

We are forecasting Diameter signaling to reach 59 million MPS by 2018, at a 49% CAGR. LTE Broadcast is a major contributor to this growth, as is VoLTE. We see LTE Broadcast contributing 14 million MPS in 2018, a five-year CAGR of 101%. North American consumers will continue to embrace mobile video quickly, as demonstrated by digital video services such as Netflix.

VoLTE is expected to contribute 9 million MPS by 2018, a CAGR of 40%.

The key factors influencing trends in North America include:

- **Mobility between 3G and LTE networks:** We predict mobility in North America to generate 3.1 million MPS for a CAGR of 32%. This is 34% of global mobility, which we project to be 9.2 million MPS by 2018.

- Policy management-driven services: Service providers in this region have fully embraced the use of policy management, creating new services for their subscribers beyond traffic management. Our projection of 33.3 million MPS by 2018 for policy only considers several simple use cases. We anticipate policy to contribute much more to the overall Diameter signaling traffic in this region from more complex use cases that have yet to be developed.
- LTE Broadcast implementation: The major service providers have already begun trialing and deploying LTE Broadcast. As discussed, given consumers' taste for this flavor of broadcast television, we project LTE Broadcast to be a major force in Diameter signaling growth.

Trend #2 – EMEA proves to be diverse in LTE successes

<i>EMEA</i>	2013	2014	2015	2016	2017	2018	CAGR
Mobility	176,299	301,849	474,704	600,719	815,250	1,382,361	51%
Policy	451,990	1,263,673	4,229,806	9,871,392	18,880,420	37,355,124	142%
LTE Broadcast	163,998	335,545	619,064	1,200,854	2,119,231	3,761,616	87%
VoLTE	209,496	469,510	880,438	1,566,287	2,579,828	4,330,731	83%
TOTAL MPS	1,001,783	2,370,577	6,204,012	13,239,253	24,394,730	46,829,832	116%

While Africa represents the largest mobile market in Europe, Western Europe has the largest number of LTE subscriptions. Smartphones are not widespread in Africa, and economics do not favor widespread adaption of smart devices and broadband services. As economics change and we see cheaper smart devices in the region, this market will be a dominant driver of Diameter signaling growth.

Russia and Ukraine make up the largest mobile markets for Eastern Europe, representing 52% of that market. Russia is expanding its LTE coverage and is already seeing a 48% penetration for smart devices. The Middle East LTE market is dominated by Iran and UAE, representing the top 20 markets in the world for new subscriptions.

Western Europe is the most mature market for LTE services, with 4G enabled devices making their way into the largest markets in the region. New services continue to expand the market and LTE devices will continue to drive signaling.

We project a total of 47 million MPS for this region for a CAGR of 116%.

The key factors influencing trends in Europe, the Middle East and Africa include:

- Mobility tariffs abolished: As the EU continues to push towards the removal of roaming fees, we predict subscribers will increase their roaming activity, no longer worried about roaming fees. We are projecting mobility transactions to add 1.4 million MPS in 2018 for a CAGR of 51%.

- Policy use cases begin maturing: We believe that there will be additional maturity in the types of services offered in LTE networks throughout the region, driving the need for increased signaling between policy servers and enforcement points. Western European operators were among the first to offer bundled streaming content as part of mobile data plans, and more complex offers will emerge throughout all of EMEA in the forecast period. This will add another 37.4 million MPS of Diameter signaling for a CAGR of 142%.
- LTE Broadcast is here: Germany is already looking into using LTE Broadcast as a replacement to their traditional broadcast television system. Continued adaptation of this technology throughout the region will add another 3.8 million MPS for a CAGR of 87%.
- VoLTE will be key: VoLTE will have the largest impact on Diameter signaling in the region, adding another 4.3 million MPS of signaling. Operators will be deploying VoLTE throughout the region, for a CAGR of 83%.

Trend #3 – Latin America and the Caribbean shows the strongest growth

<i>CALA</i>	2013	2014	2015	2016	2017	2018	CAGR
Mobility	8,923	25,218	59,747	197,622	376,852	661,832	137%
Policy	2,890	17,873	142,933	643,961	1,639,976	3,518,292	314%
LTE Broadcast	12,228	23,972	50,810	99,645	191,582	387,019	100%
VoLTE	18,053	35,385	75,005	147,177	282,924	571,555	100%
TOTAL MPS	42,093	102,448	328,495	1,088,405	2,491,334	5,138,699	161%

This region consists of Central and South America, and the Caribbean. Brazil leads South America in LTE penetration, with Chile and Argentina also ahead of most countries in the region. A total of 17 countries in the region have deployed LTE to date, although those deployments are limited in scope. Six of those countries are located in the Caribbean, with very small markets.

An additional 19 countries have announced plans to deploy LTE in the next few years, so we will see some growth but it will be small in comparison to other regions.

The key factors influencing trends in Central and South America, and the Caribbean include:

- Mobility between 3G and 4G: Given the relatively small size of the LTE deployments, we anticipate higher mobility trends in the region. This will only increase as more deployments are made, but given the slower implementation rate in the region, we are only projecting 662,000 MPS, a CAGR of 137% by 2018.
- Policy is already key in the region: Those that have already deployed LTE (such as in Brazil) have already recognized the value of policy management, and we are seeing more sophisticated use cases

involving policy and charging coming from this region. We anticipate a baseline of 3.5 million MPS by 2018 for a CAGR of 314%.

- Video will be key: Sporting events will certainly help drive the adaptation of mobile video services in the region, and we expect to see 387,000 MPS by 2018. This represents a CAGR of 100% by 2018.
- Voice services migrating: It is likely many subscribers will embrace VoLTE services given the poor penetration rate of fixed line throughout the region. Still, LTE penetration is lagging here so we are only projecting 572,000 MPS for a CAGR of 100%.

Trend #4 – China will be a big factor in Japan and Asia Pacific Diameter growth

<i>APAC</i>	2013	2014	2015	2016	2017	2018	CAGR
Mobility	556,623	1,164,807	1,617,627	1,854,229	2,408,234	3,963,487	48%
Policy	1,026,581	4,598,756	10,835,056	23,013,159	36,980,068	80,812,586	139%
LTE Broadcast	503,337	1,251,393	2,086,121	3,377,047	5,138,551	8,039,314	74%
VoLTE	742,209	1,845,003	3,079,512	4,987,968	7,588,510	11,872,553	74%
TOTAL MPS	2,828,750	8,859,960	17,618,316	33,232,404	52,115,363	104,687,940	106%

China, India, and Indonesia are the largest mobile networks in the region, accounting for 71% of subscriptions. However, a developing economy in India will prevent subscribers here from making a big impact on Diameter signaling. China will be the biggest contributor as it continues expanding its implementations of LTE.

Likewise, Singapore, Australia, South Korea, and Japan represent the largest broadband markets with South Korea representing the second largest LTE market in the world. Smartphone penetration is also very high in these countries, driving Diameter signaling throughout the region. The region contributes 105 million MPS to the global traffic in 2018, comprising nearly half of global Diameter traffic then.

The key factors influencing trends in Asia Pacific:

- Mobility continues to be a factor: We are projecting mobility traffic to contribute 4 million MPS by 2018, the largest of any of the regions.
- Services via policy: Policy also plays a key role and will continue to be a factor going forward. We project policy sessions in the region to contribute another 80 million MPS by 2018 for a CAGR of 139%.
- Mobile video is in demand: This region has an appetite for all things mobile, including mobile video. With the high percentage of smart devices in key markets, mobile video has already proven to be popular with subscribers. We anticipate LTE Broadcast will add another 8 million MPS by 2018.

- Voice will be migrating to VoLTE throughout the region: We expect VoLTE to add another 12 million MPS by 2018.

The Future of Signaling

Diameter signaling growth is highly dependent on the number of subscribers in an LTE network using smartphones. This is what drives their behaviors and their appetites for more applications, and more data sessions. LTE penetration rates vary by region, and in some regions may be more aggressive in a few countries and lagging in others.

This is why under one-third of the world will be connected to 4G by 2018⁸. Developed markets will fully embrace 4G technologies, while developing countries will struggle to justify the cost to upgrade. The driver for LTE is clearly support of smartphones and the applications developed for smartphones.

While North America represents the largest LTE market in the world, there are countries with much larger populations. However, their economics simply do not support the move to LTE services. India is a good example of this where LTE is deployed in some choice markets, but the rest of the country remains on 2G and 3G networks. Unless operators in India can figure out a way to make devices cheaper for their subscribers, it is unlikely we will see widespread deployment.

China represents a huge market for LTE and we could see China penetration rates increase very quickly in the next few years. Devices are available and affordable, and the Chinese are already demonstrating an appetite for faster connections.

Yet, 73% of devices will be simple devices without smart capabilities in 2018.⁹ This means 2G and 3G services will continue to reign, supported by SS7 signaling. Even M2M and the Internet of Things (IoT) could have a minimal impact on Diameter, because it is believed that most M2M traffic will be offloaded to 2G and 3G networks. Only 14% of M2M traffic is forecast to be sent over LTE according to Cisco's VNI report.

The future of signaling is not all futuristic. Diameter is not taking over the world's signaling networks in 10 years. We will see a consistent rate of growth as shown in this report, but SS7 will continue to dominate the world's networks for some time.

What this means to network operators is they will need to support SS7, SIP (for voice and video), and Diameter traffic, many times in the same network. Interworking is key to supporting services of the future, which is a better way of looking at this challenge.

⁸ Ovum

⁹ Cisco VNI report 2014

Rather than focus on the latest technology, operators need to be focused on the latest services and applications, and how they can best support those services in their networks using either existing technologies, new technologies such as Diameter, and and bridges between them.

The future of signaling will be one of evolution and bridging between old and new. Co-existence will be the key to successful network implementations of 4G. While services based on Diameter are being introduced, many services can still run on both Diameter and SS7, but may continue in the SS7 domain for many years to come.

Annex A – Assumptions and Methodology

The methodology for crafting this forecast continues to evolve. This version of the Index is based on updated current and forecasted LTE subscriptions as well as new traffic models that take advantage of Oracle's experience in global service provider LTE networks. We have fine-tuned our models to accurately reflect evolving subscriber behaviors.

The forecast period shifted, as this Index considers growth beginning in 2013 rather than 2012, and extending through 2018. Because 2013 saw higher penetration rates than 2012, the overall CAGR for Diameter changed accordingly.

The Index is an LTE Diameter traffic demand model rather than an engineered network model. It is a baseline model that serves as a starting point from which service providers can layer on additional factors such as network architecture, topology, capacity requirements, geo-redundancy and others needed to design a robust, reliable and scalable Diameter network. Readers are cautioned not to rely solely on this macro-level analysis to predict their unique needs.

The Index focuses solely on LTE networks and does not account for Diameter traffic on 3G networks, other than 3G to 4G mobility. The Index also excludes IMS applications with the exception of VoLTE.

The Oracle Communications LTE Diameter Signaling Index relies on a number of industry resources such as LTE subscriber data from Ovum, SIP information from Heavy Reading and the Cisco Visual Networking Index for general market context. 3GPP and GSM Association specifications are used for determining traffic flows for each unique service. The flows are then used to determine the number of Diameter messages that are created for individual session types. These are then applied to complex traffic models based on a number of different factors.

Traffic flows are also validated in Oracle's Diameter Traffic Laboratory, which is a dedicated facility that uses our Diameter Signaling Router, Policy Server, and Home Subscriber Server network elements.

A key input to the forecast is our proprietary Oracle Communications Diameter Traffic Calculator. Operators who wish to have their own customized traffic study can contact Oracle Communications and inquire about our new Diameter Traffic Study service provided by our professional services experts.

In this report and forecast, we use the industry standard metric of Messages per Second (MPS) for the volume of signaling traffic in a network. The 3GPP standards refer to Diameter transactions as two messages (request/answer). In this Index the total number of Diameter messages are counted in the MPS.



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