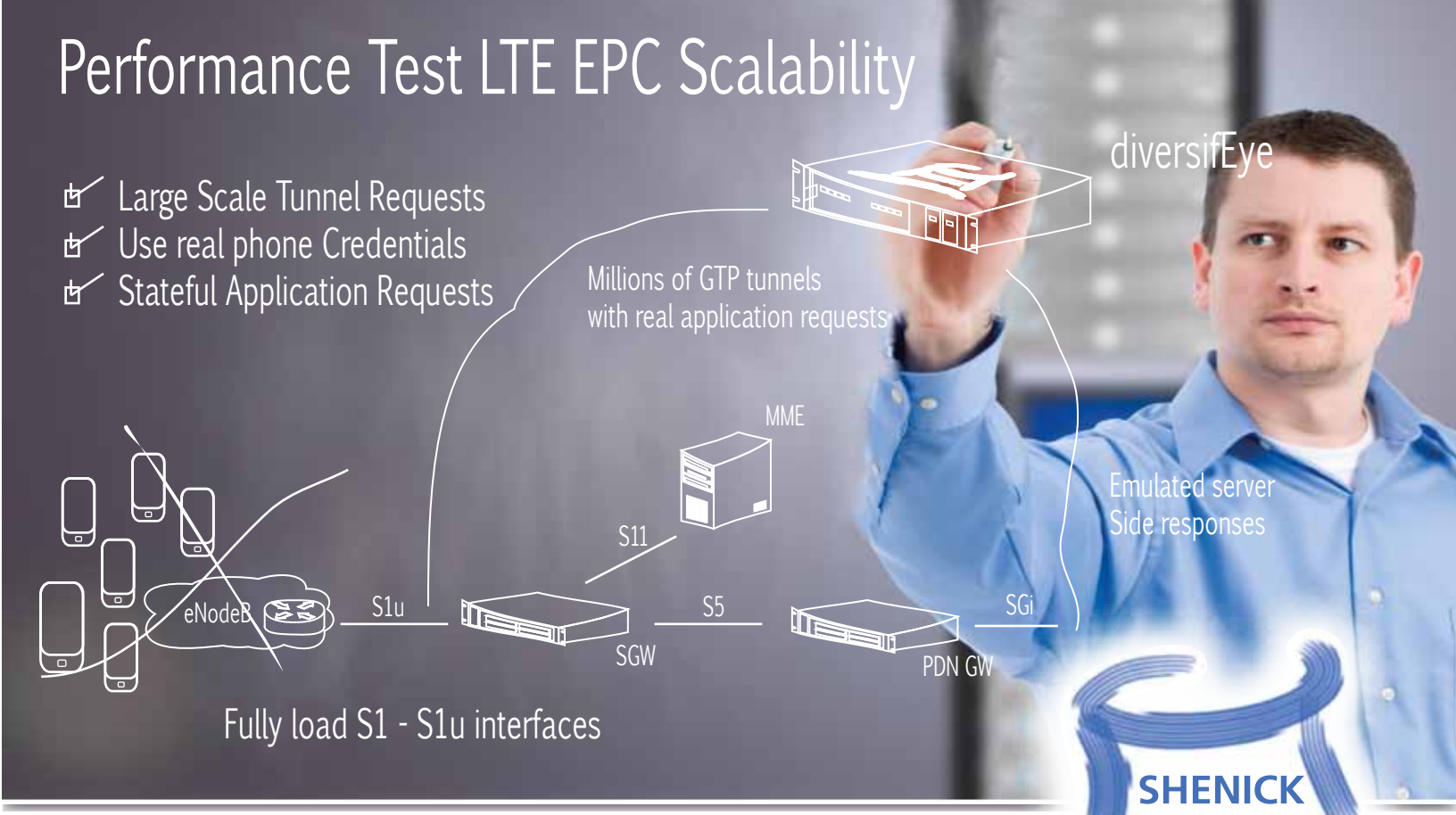

Enhancing 4G Networks - What's in it for the Service Provider?

Introduction

With the exponential growth in smart phones and the increasing number of applications, service providers are under pressure to be cost effective, yet still provide a high quality of service (QoS) to customers.

Customers have a wide choice when it comes to choosing a carrier and an even greater choice in applications and new service offerings such as video-on-demand. But the problem for service providers is that the potential gain for additional revenue is small, yet they must continue to meet customer QoS or face customer churn.

To continue to deliver lower prices with increased benefits, service providers need to extract much more from their networks. One way to do this is by optimizing key network elements to yield greater utilization. This paper will outline the challenges service providers face and discuss the use of emulation solutions to enable cost-effective ways of scaling to meet the demands of tomorrow's customers.

The Challenge

The Evolved Packet Core (EPC) in LTE is experiencing an unprecedented increase in the levels of subscriber traffic flows. However, one of the key architectural benefits of LTE is the separation of the control and signalling planes. The two key components on the separated planes are the Mobility Management Entity (MME) and the Serving Gateway (SGW).

Utilization improvements are the result of optimizing these devices. It's success is dependent on how the optimization impacts a subscriber. In the case of MME optimization, it's critical that there is no impact to a service by adding un-necessary latency to the authentication and authorization mechanisms.

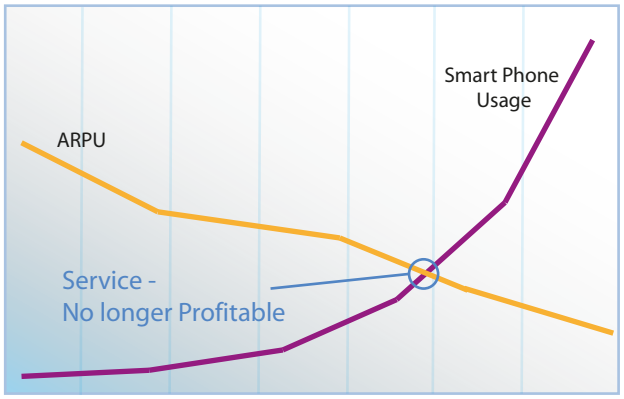

Figure 1: Service providers face a difficult challenge of maintaining profit with increased smart phone usage.

Any optimization of the SGW / PDN must have no impact to the various application flows passing through them. A potential SGW / PDN optimization relates to the buffer sizes. It's important to note that an incorrect setting of the buffer may have a negative impact on service quality in the core by increasing the levels of retransmission of packets due to loss or latency.

Scalability

The level of scalability that's achievable in the EPC is dependent on the number of sessions the MME will establish, closely linked with the volume of traffic flows the SGW can cope with.

Testing the performance of utilization or optimizing either the control or signalling plane in LTE would require millions of subscriber handsets. An unrealistic approach to this type of testing would be to expect millions of handset users to simultaneously access and run applications connecting to global web services. Another issue with attempting such a test is the variation in specification of the User Equipment (UE) or mobile device types.

In addition, performance testing in any network must be reliable, repeatable and easily transferable between network node locations. An important aspect to reporting utilization performance is the standardization of the report for the multiple devices deployed in the EPC.

One of the simplest solutions to measuring utilization or to optimizing the EPC's performance is to emulate the millions of subscriber UEs and activities.

Why Emulate and not Simulate?

Simulation tends to produce static packets of a certain size to represent a subscriber and UE usage, which maybe suffice for utilization testing. However, in real live networks, subscribers will have dynamic behavior with unique usage patterns, subscribers will utilize different services with varying levels of proficiency.

Network Optimization will impact subscriber flows in a number of different ways. To test the impact of optimization requires the presence of stateful traffic flows, one in which the dynamic nature of a subscriber and the device is represented. Using per flow emulation it's possible to represent unique subscriber activity and measure performance of quality on a granular basis for each and every emulated subscriber activity.

Emulation is critical to testing application flow quality especially in times of congestion. One way in which a network deals with congestion is through Transmission Control Protocol (TCP) window resizing. Simulated UEs will not respond to these requests.

The ability of the UE to adjust the TCP window size and manage flow requests will have an impact on the level of traffic flowing over the S1-u, S5 and SGi interfaces of the EPC.

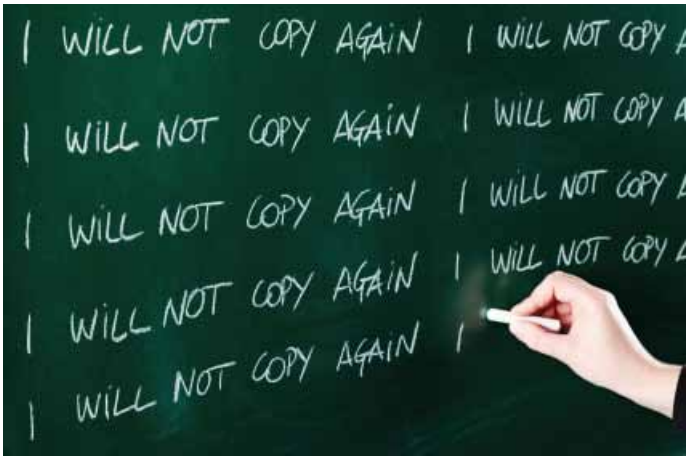

Figure 2 : Simulation is the repeat of the same packet over and over to load a network path, it offers no dynamic behavior, or deviation even when the network is requesting change from the end user device.

Emulation Solutions

diversifEye provides large scale emulation of stateful application flows, by accurately representing UEs and parameters such as IMSI and user authentication details.

diversifEye's emulated traffic flows are used to load the S1 interface providing the necessary performance details on MME scalability. The result of loading the S1 interface is the presentation of large volumes of traffic on the SGW S11 interface, enabling analysis of how this gateway impacts service quality.

diversifEye is not limited to just loading the MME S1 interface but also enables the delivery of real user activity on a per UE basis. diversifEye's per flow architecture means multiple application flow requests per registered UE, representing a real subscriber's smart phone activity.

After loading the S1-u interface of the SGW it's possible to test utilization performance of the LTE EPC. diversifEye's per flow architecture provides performance measurements on each and every emulated application flow associated with each and every emulated UE, enabling users to quantify how optimization changes impact a subscriber's service.

diversifEye per flow architecture and large scale test capabilities are not only used to test the scalability of the LTE EPC, but provide vital details on a per subscriber Quality of Experience basis.

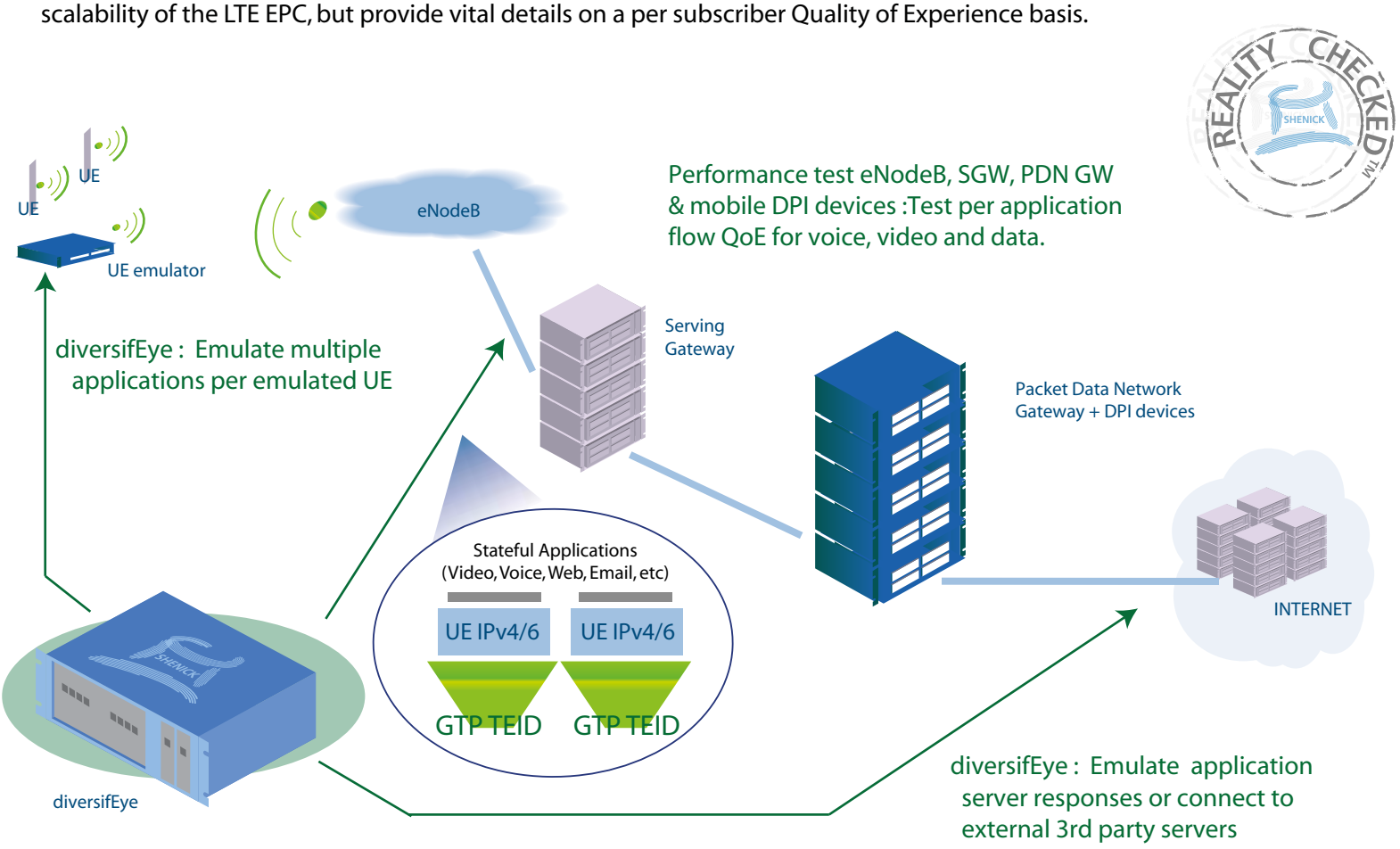

Figure 3: diversifEye offers stateful testing and application performance analysis for PDN gateways, furthermore diversifEye's per flow test capabilities provides effective testing of DPI devices in mobile networking. DPI devices are important part of the EPC deployment and are expected to identify and classify traffic correctly.

Per flow ensures diversity of application types and activity flows, key to successful DPI testing in mobile networks.

LTE performance Tests

A list of the common test strategies that can be deployed using emulation and performance measurement tools :

Subscriber Activity

- Per flow / per client emulation and measurement: Emulate millions of UEs, with the ability to measure the performance of individual applications such as data, voice and video.
- Dynamic Behavior: Create UE activity - in and out of service, emulate and analyze in real time the effect of 'waves' of UE data traffic in the network.
- Random Traffic: Emulate use profiles to create randomness - add randomness to voice, video and TCP / UDP based applications.
- Emulate multiple application flows per UE: Measure the performance on stateful TCP and UDP based data applications. The TCP based application clients back off just as real clients do with network congestion. This impossible with a simulation tool.

Optimization

- Traffic Altering: Emulate and determine where traffic types can be altered in an attempt to improve timing issues and reduce traffic volumes.
- Traffic Prioritization: Ensure in real-time, traffic shaping mechanisms or load balancing have no impact on delay sensitive applications. Determine if applications are being granted the allocated bandwidth during peak or busy hours.
- Quality of Experience: Determine on a per client application basis individual quality of experience, define performance requirements from one to several thousand UEs.
- Emulate and Measure: Voice, video and TCP / UDP based application flows, measure packet and application statistics on a per flow / per UE basis.
- False Positive/False Negative Identification: Ensure that all emulated flows are classified correctly, with minimum errors in terms of handling. Test that no flow is mis-classified e.g. SIP enabled RTSP flow versus SIP RTP flow, and that no illegal flow is passing unchecked.

Scalability

- PDN Scalability: Test the performance of the PDN gateway to deliver large volumes of connections. Test GTP tunnel handling with a large volume of requests for IP packets.
- UE application performance: Examine performance on low latency dependent applications such as video and audio.
- Quality of Experience: Ensure in real-time, on a per emulated UE per application flow basis the application performance under varying load conditions.
- Security: The PDN gateway is a concentrator of many nodeB traffic flows, it must maintain operation throughout extreme conditions. Emulate a mix of legal and illegal traffic flows, ensure no performance loss with associated PDN packet inspection devices.

Conclusion

Optimizing 4G networks to save costs has been greatly simplified by Shenick's per-flow emulation and test approach. With per-flow emulation and real time analysis it's possible to limit the impact to customer QoS. Using Shenick's solutions, service providers are given the necessary granular view of end-user quality in real time. Any subtle changes in quality are picked up by Shenick's thresholding facility, enabling service providers to quickly judge, in real time, if a decision to change or optimize a device setting is the correct one. This win-win situation ensures service providers continue to deliver services at the right price!

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