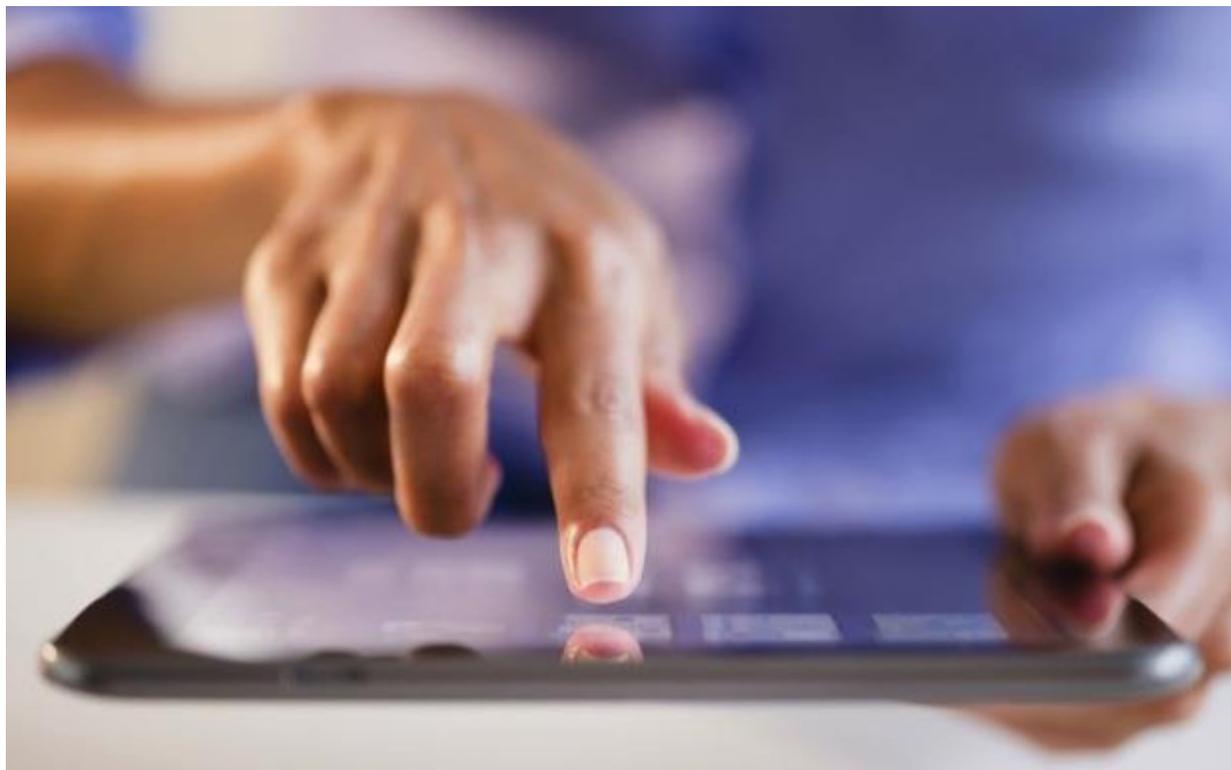
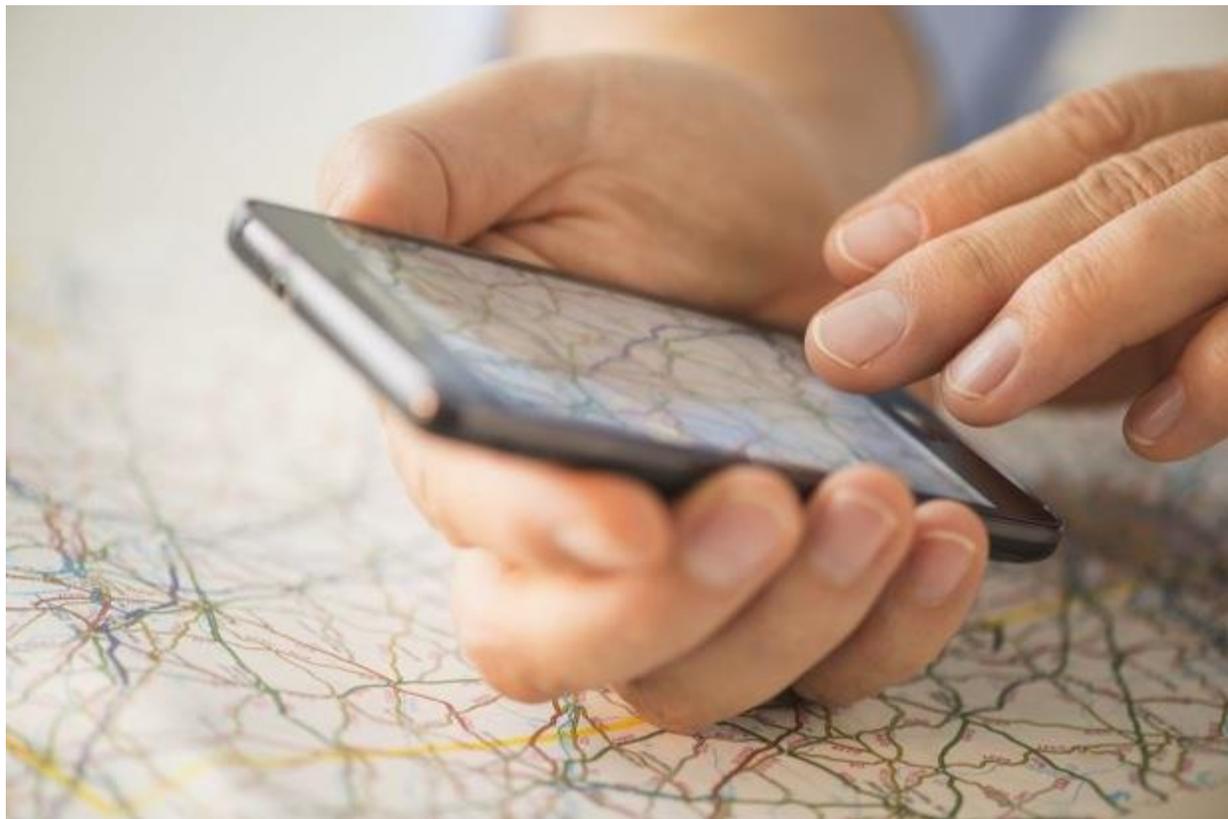


Beyond the Fourth
Generation of Mobile
The next wave of mobile
services and technologies



Contents

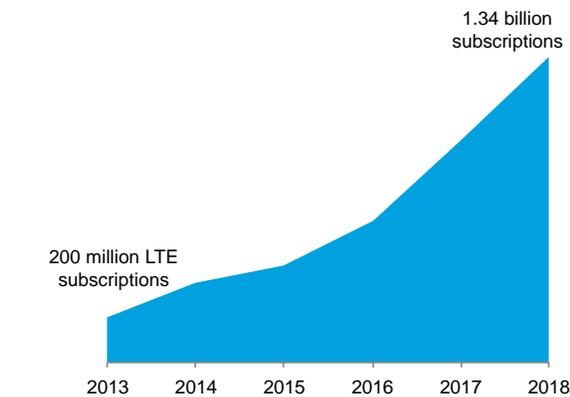
Introduction	1
Levers for growth and profitability	2
Conclusion	9
References	10
Contacts	11



Introduction

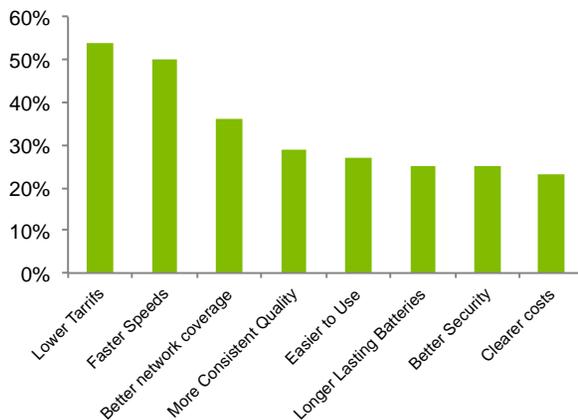
The proliferation and adoption of fourth generation Long Term Evolution (LTE) mobile broadband services has steadily grown. Moreover, the adoption of new applications and services coupled with smartphone advancements has presented profound problems for a Communication Service Provider (CSP):

- What are the levers to offset the staggering costs of deploying LTE networks?
- What technology and operations advances can deliver superior customer experience?



Global Mobile Subscription Forecasts (LTE-only)¹

LTE market today with around 56% of all LTE subscribers, the percentage of population covered by LTE globally is expected to grow from 6% to 50% in 6 years².



Factors that drive customer selection of a CSP for mobile data services⁴

To stay ahead of users' insatiable appetite for mobile data, CSPs have invested heavily in the deployment of LTE networks globally. LTE networks are expected to be the fastest deployed networks in the history of mobile communications, with 175 commercial networks launched in 70 countries in less than 2 years¹. Furthermore, there are 248 new networks in 87 countries proposed to be launched by the end of 2013¹. While North America leads the

Deloitte's analysis highlights the need for CSPs to evolve customer engagement to differentiate LTE from legacy mobile services. In addition to the ability to launch a data session anytime and anywhere, every mobile broadband user now expects consistently high data rates, improved service quality, and better security⁴. Different profiles of a mobile broadband consumer exist — from the high value/high volume business user, to the average user with modest data needs (basic email, and texting services). CSPs must prepare their networks to leverage LTE's unique capabilities to address subscriber types, while offering a cost competitive and attractive portfolio of services.

Telecom Spending by Sector in 2013³:

Services: 75%
Equipment: 25%

Mobile Data Services as a share of Telecom Services Revenue³:

41% → 59%
(2013) (2018)

Number of Mobile Subscription⁷:

6.5 B → 8.2 B
(2013) (2018)

Number of Smartphone Subscriptions⁷:

2.1 B → 4.5 B
(2013) (2018)

Avg. Mobile Connection Speed (Smartphones)⁷:

3.9 Mbps → 7.04 Mbps
(2013) (2018)

Note: 2013 numbers are actuals, 2018 numbers are forecasts

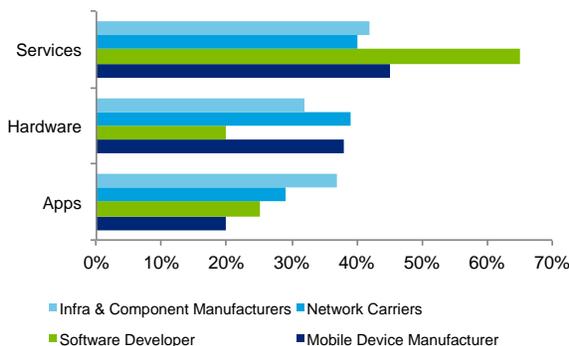
As used in this document, "Deloitte" means Deloitte Consulting LLP, a subsidiary of Deloitte LLP. Please see www.deloitte.com/us/about for a detailed description of the legal structure of Deloitte LLP and its subsidiaries. Certain services may not be available to attest clients under the rules and regulations of public accounting.

Levers for growth and profitability

Simultaneous to 4G LTE deployments, CSPs need to assess additional growth and profitability levers

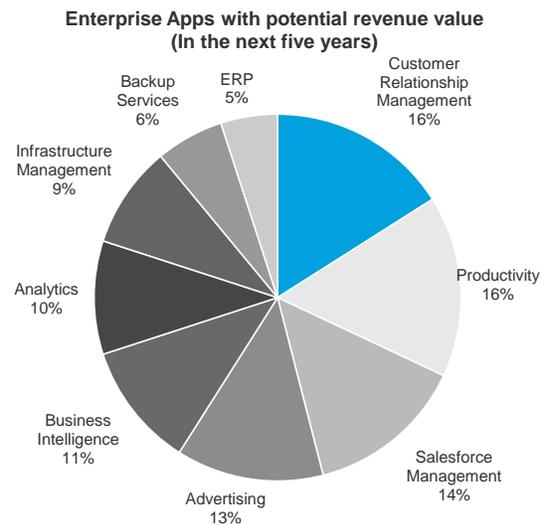
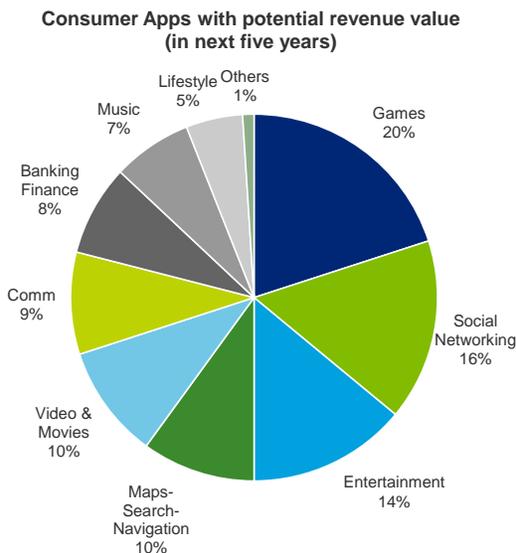
- How can CSPs maximize the return on investment (ROI) for LTE?
- What are the considerations to improve operational efficiency?
- What are the optimization strategies available to maintain network performance and improve quality?
- What are the challenges with upcoming technology innovations that require planning and preparedness?

The rising demand for mobile applications and services provides significant opportunities for CSPs to improve ROI



Mobile industry players believe that Services and Applications will drive revenues growth in the coming 3 years⁶

CSPs view commercial LTE networks as a driver to meet the growing demand for high speed data services. Data usage continues to grow due to an evolving mobile ecosystem that now includes a plethora of connected devices powered by advanced hardware, software, and applications. While global mobile data traffic is forecasted to increase at a phenomenal CAGR of 78%, corresponding data revenue is increasing at a much lower CAGR of 13%^{3,5}. The average mobile data ARPU for the top four U.S. CSPs was 35% of the total ARPU in 2012¹. With compressed asset lifetimes and growing competition, there is pressure to drive more revenue from the network in a shorter time frame. Deloitte's Open Mobile Survey 2012 found 60% of the mobile industry players believe that Services and Applications will be



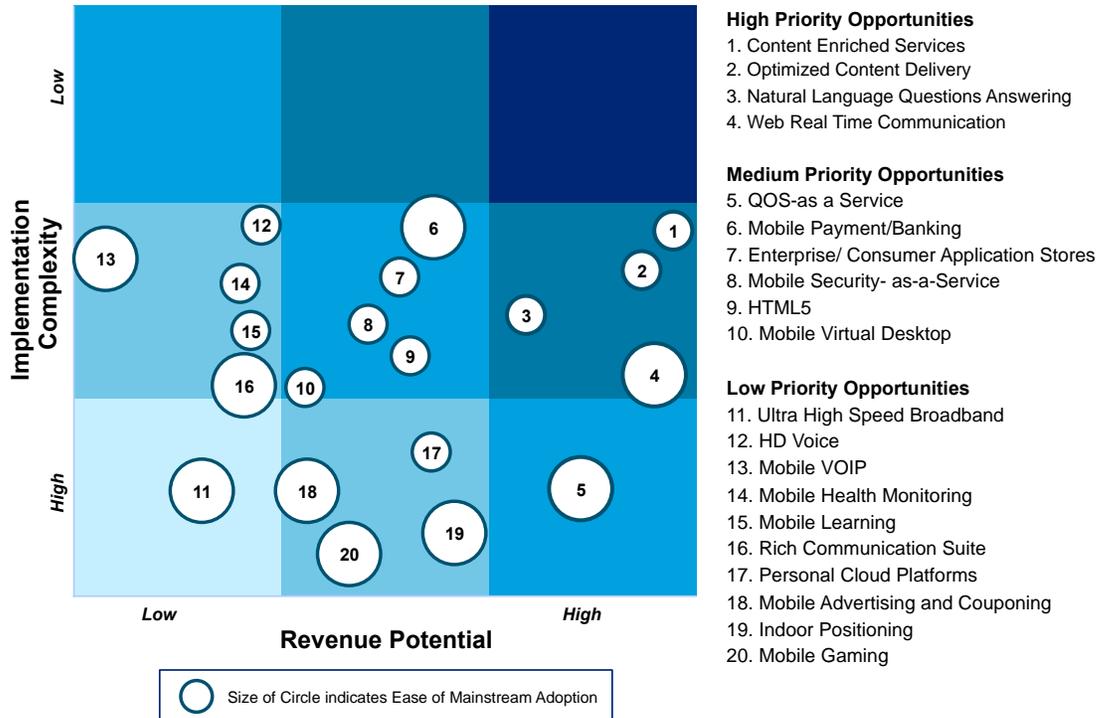
Potential Revenue value for Consumer and Enterprise services⁶

significant contributors to revenue growth in the coming years⁶.

To capture a share of this opportunity, CSPs need to pay careful consideration to the level of customization, shortened development and launch cycles, and support models for each service. Likewise, tighter integration of network platforms and interfaces with vertical industries can help CSPs offer compelling solutions that foster more lasting partnerships and recurring revenue opportunities. Looking at the growth potential of mobile applications and services across different industries shows Health care, Consumer products, Financial Services, and Automotive as leading candidates for such targeted product development.

The matrix below shows the potential applications and services that CSPs can target to offer using core LTE features, such as UICC, MIMO, and Quality of Service (QoS) on its all-IP and low-latency LTE network.

Keeping the focus on enterprise and consumer services related to CRM, Productivity, Advertising, Gaming, and Social Media & Entertainment, it is important to prioritize the realization of each service across several aspects. Every service opportunity for the areas highlighted above has been mapped across the parameters of Revenue Potential, Implementation Complexity, and Market Appetite.

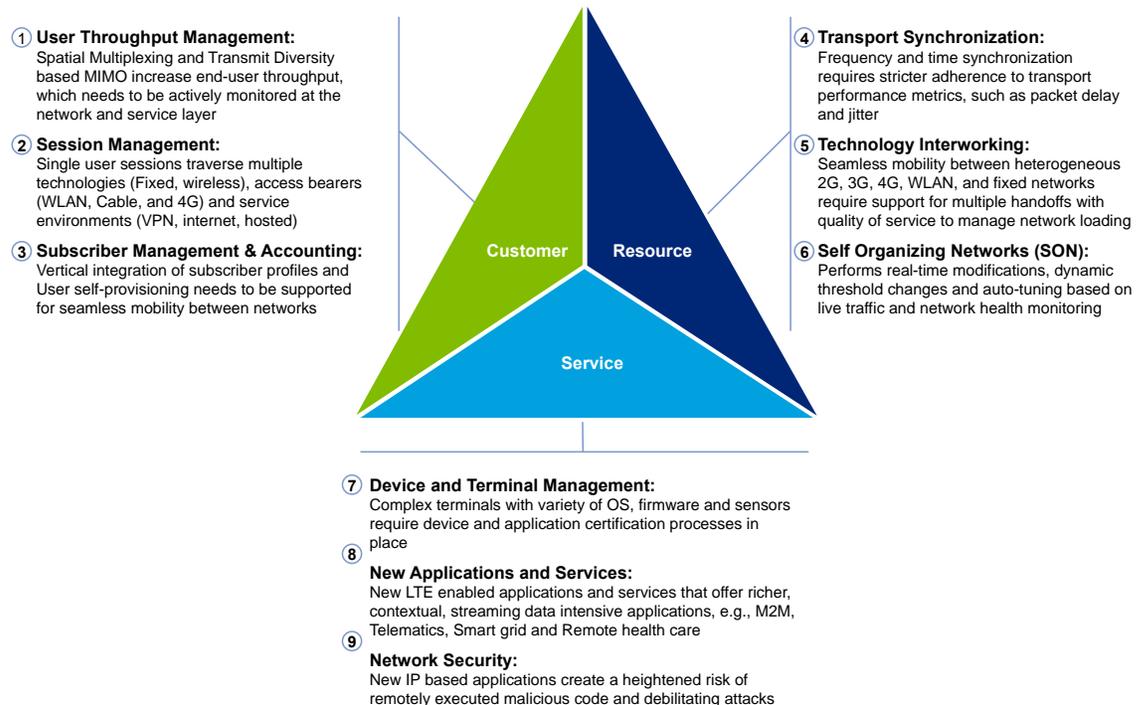


CSPs are currently evaluating the value proposition of each of these opportunities based on analysis of individual network/platform capabilities and markets. It should also be noted that monetization considerations extend beyond technology. Application storefronts, OS selection, HTML5 adoption, developer outreach, and service-specific business models all contribute to the value proposition.

CSP's considerations for LTE operational efficiency are distributed across all aspects of network and service operations with several key operational challenges that need to be addressed

The impact of adding new features and services brings new operational challenges, as well as enhancements to existing tools and platforms, which need to be addressed while defining support requirements. These considerations can be organized into three inter-related groups:

- **Customer:** User Throughput Management, Session Management, and Subscriber Management
- **Resource:** Technology Inter-working, Transport Synchronization, and Self-Organizing Networks (SON)
- **Service:** Device and Terminal Management, New Applications and Services, and Network Security



The operational challenges for these three groups affect all facets of network, IT, operations and marketing:

Customer

- **User Throughput Management:** Highly-mobile users with multiple applications require optimization and tuning of the Radio Access Network' parameters, capacity, and configurations.
- **Session Management:** Contextual data from subscriber profiles and unified service assurance platforms are vital to ensure service continuity with low impact to the end-user experience. Business intelligence and analytics with solid policy enforcement integrated across the service delivery path is required.
- **Subscriber Management and Accounting:** Comprehensive Subscriber Data Management with policy and identity enforcement is needed to bind subscriber usage and profile data from disparate network, IT, and marketing repositories.

Resource

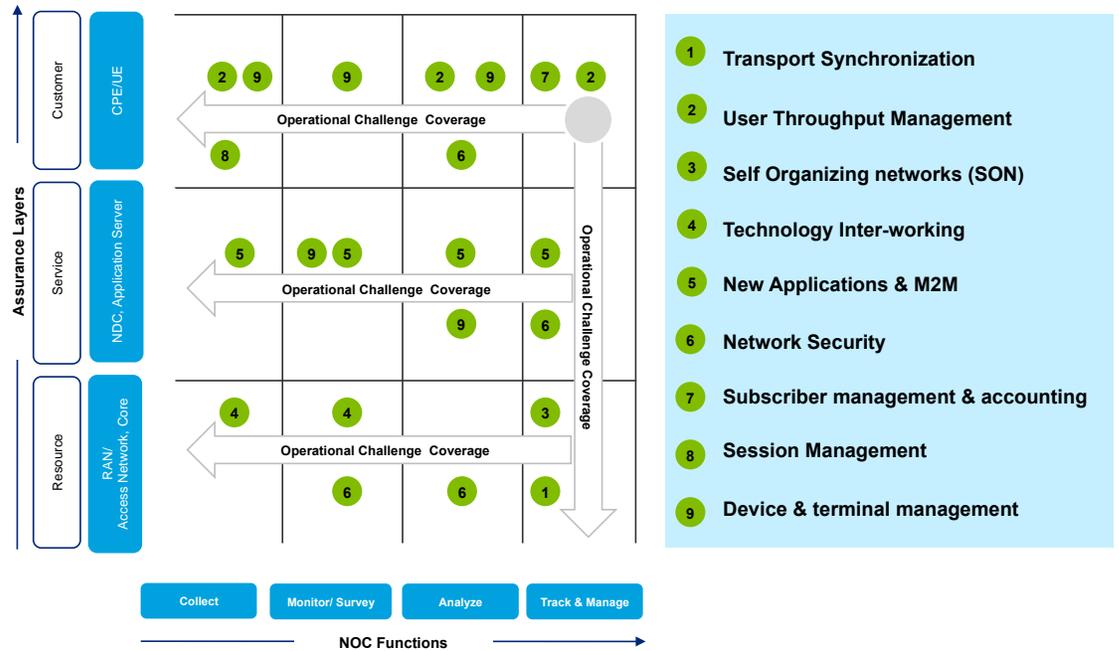
- **Transport Synchronization:** Routine definition and management of relevant sync requirements up-front, including impacts to QoS, frequency of timing packets, and boundary constraints is needed.
- **Technology Interworking:** Fault management and performance management tools need to evolve to account for session continuity across multiple networks and the impact on end-user experience.
- **Self-Organizing Networks (SON):** Federated modeling practices must be defined to support real-time configuration and topology mapping of the network components. End-to-end application troubleshooting and event correlation with defined policies and configuration management systems are required.

Service

- **Device and Terminal Management:** Over the air terminal diagnostics, remote firmware audit and upgrades, as well as user agent based service quality management methods need to be adopted.
- **New Applications and Services:** Monitoring of shared network/spectrum resources and workload management across data centers, network clusters, resource pools, and devices to better support applications are critical needs.
- **Network Security:** Audits for disaster and Distributed Denial of Service attack vulnerability with readiness assessments to include policies for privacy and data protection must be conducted; user security management and compliance requirements across multi-jurisdictions must be defined.

To effectively manage the operational challenges, CSPs will need a detailed service assurance framework developed using leading industry practices and inputs from standards bodies to drive service quality requirements.

Service Quality Management (SQM) refers to the aspect of overall network operations that monitors, analyzes, and maintains the overall quality of service of the different applications and services offered by the CSP. SQM requires the ability to take network/device specific metrics and correlate or model them into customer specific metrics using existing systems for Fault Management, Network Probes, and Performance Management systems. In addition to these data sources, newer “unstructured” data sources, such as Social Media, Machines and Sensors, and Audio/Video devices can also be considered to capture and improve the end-user service experience.



The service assurance framework maps each of the new LTE driven operational considerations against the Customer (device profile, location, and vendor), Service (application performance) and Resource (Network metrics) layers of service assurance. To drive detailed functional, application and tooling requirements, the framework aligns the requirements against day-to-day NOC functions of Collection, Monitoring, Analysis, and Tracking and Resolution.

The implementation of such a framework involves a thorough analysis of the existing operating model to support new services. This covers the network capabilities, operations tooling, Tier 1–4 organization and operations planning requirements. The service assurance framework allows incorporation of best practices across distinct operational functions, while also identifying tangible next steps that form the basis of a transition plan.

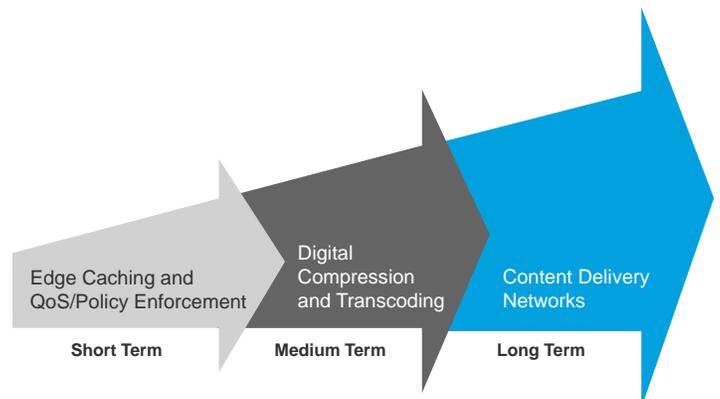
Optimized LTE networks can help improve reuse of mobility infrastructure and prepare for the surging demand for higher speeds, spectrum, and bandwidth

With the continuing uptake of smartphones and tablets, the growth in data traffic served over mobile networks is expected to grow exponentially. The chief contributor to this staggering rate of adoption is video. This forces the CSPs to optimize networks to offer a higher quality of experience for content delivery to the end users. The options for CSPs to optimize will vary on time and cost considerations.

Short-Term Strategies

As LTE networks proliferate, Edge Caching via deployment of Caches at the SAE Gateway can help CSPs to deliver content to data intensive applications with low latency and increased throughput.

QoS and Policy Enforcement can also increase network efficiency by managing network traffic based on application requirements. Content-



aware Bit Rate throttling techniques can deliver content consistent with the viewing rate, reducing wastage of data due to fewer session terminations and concurrent sharing of content sessions.

Medium-Term Strategies

CSPs can reformat and repurpose content for the multiplatform environment by employing different digital compression and complex transcoding techniques to provide multiple content streams.

Transrating techniques, such as Content-Aware Video Transrating⁹, Device-Aware Video Transrating, and Network-Aware Video Transrating can help service providers to lower the input video bit rate to effectively save bandwidth without compromising the Quality of Experience (QoE) for subscribers.

Long-Term Strategies

CSPs can also own and maintain Content Delivery Networks (CDN) to manage delivery of high-bandwidth content with a high QoE. But as more and more CDNs are required, the cost considerations are expected to drive these providers to optimize their CDN footprint by interconnecting with other CDN Federation partners¹⁰ to cross-deliver traffic.

By employing multiple upstream/multiple downstream structures or a cascaded CDN structure, CSPs can strategically pool resources in different CDN topologies to reduce their traffic and signalling overheads while managing delivery of a wider variety of content with a much higher QoE

The CSP owns the “last mile” of data services delivery to the end users. This is particularly emphasized in the mobile broadband domain, where the end user’ experience is heavily impacted by the availability of a high bandwidth and low latency service. While our focus here has been on optimizing user experience and lowering CSP costs for mobile content delivery, there are other challenges too that need to be mitigated. Some examples of these are the dynamic radio environment, a plethora of device types (operating systems, hardware, and software), screen resolutions, and radio technologies (LTE, WiMax, Wi-Fi, 3G, UMTS, etc.). To achieve scale and coverage, CSPs also bear the cost of implementing transit and peering connections, with aggregation and routing infrastructure to support the traffic. All of these are further areas to be investigated and addressed in the short, medium, and long-term strategy for mobile video and content optimization.

Technology innovations have helped achieve enhanced bandwidth¹³, increased spectral efficiency and increased coverage in LTE-Advanced; but challenges remain

Upcoming 3GPP Release 10 and 11 features and designs bring forth a host of advancements¹¹ that seek to address challenges in improving overall spectral efficiency and capacity of the 4G LTE network. The snapshot below highlights the most significant technology innovations¹² that are currently being developed and tested in the LTE and LTE-Advanced feature set, and the challenges that each of them present from a CSP perspective.

Network Challenges	Enabling Technologies	CSP Consideration
Coverage Expansion	<p>Relay Nodes: Extends coverage of traditional networks</p> <p>Enhanced ICIC: Manages interference in heterogeneous networks</p>	<ul style="list-style-type: none"> • Impacts to overall cell interface and its dependency on LTE features, such as SON, eICICI, and CoMP need to be factored by engineering and operations teams • Implementations on reference signals of femto cells may cause higher interference situations that need to be considered
Throughput Maximization	<p>Coordinated Multipoint: CoMP reduces interference at the network edge</p>	<ul style="list-style-type: none"> • Joint processing requires expensive high-speed optical fiber between nodes and complex design and processing by the radio network nodes
Spectral Efficiency	<p>Enhanced MIMO: Increases system capacity and spectral efficiency</p>	<ul style="list-style-type: none"> • Complete Channel State Information, which is a requirement also increases the overhead on the RAN and Transport network
Bandwidth Optimization	<p>Carrier Aggregation: Increases maximum download speed to 1 Gbps</p>	<ul style="list-style-type: none"> • Design constraints on the usage of guard bands and the inter/intra-band carrier allocation need to be carefully planned

CSPs are trialing and testing the features noted here in an effort to aggressively deploy and address their long-term coverage, capacity, and spectrum needs. However, the deployment and management of these features in conjunction with a multitenant and growing base of devices and applications poses significant challenges that must be addressed with diligent planning and upfront involvement of engineering and operations planning resources.

Conclusion

As CSPs look to maximize their investment in LTE, they will need to consider 'out-of-the-box' strategies to better monetize and efficiently operate their networks. Perhaps the biggest challenge in being able to monetize LTE services and drive incremental revenue is creating that service differentiation to cater to the subscriber's habits and their need for personalized services. Being at the forefront of addressing the end-user and enterprise customer's speed, coverage, and quality demands, CSPs are uniquely positioned to grow their revenue and reduce churn. However, doing so will depend on understanding what is happening in the network in real time, analyzing subscriber usage patterns, and quickly acting on those insights to offer personalized applications and services to the different customer segments.

While creative service offerings and personalized plans can attract customers, a deep understanding of the quality of services in an LTE network can help ensure optimal utilization of all network and data center infrastructure without compromising the end user's quality of experience. Mechanisms for proactive service quality management and policy definitions can help assure multiple services delivered over multivendor and multidomain networks. The exploding data traffic generated by smart phones and connected devices needs to be managed by leveraging next-gen content delivery network architectures, as well as the ongoing innovations in LTE-Advanced. With a surgical focus on both revenue generating and operational efficiency initiatives in LTE deployments, CSPs can lead from the front and deliver innovative services, while offering the best in class user experience.

References

1. Global Mobile Suppliers Association (GSA) website
2. LTE Market Trends by Digiworld
3. Gartner Forecast Overview: Telecommunications Market, Worldwide, 4Q13 Update
4. Deloitte Perspectives on the Global Mobile Consumer, 2011
5. Cisco VNI Traffic Forecast
6. Deloitte Open Mobile Survey, 2012
7. Ericsson Mobility Report 2013
8. Gartner Market Trends: Global Telecommunications Market, Worldwide, 3Q12
9. Network Aware Optimization: A unique approach to solving network congestion, November 2010, Mobixell
10. Established CDN players and telco rivals duke it out at CDN Asia 2012 by Tony Brown, Feb 8, 2012. Accessed online <http://blogs.informatandm.com/3984/established-cdn-players-and-telco-rivals-duke-it-out-at-cdn-asia-2012/>
11. Qualcomm Whitepaper: LTE Advanced: Heterogeneous Networks, January 2011
12. Nomor Research GmbH: Inter-Cell Interference Coordination for LTE-A, September 2011
13. Effective Carrier Aggregation on the LTE Advanced Systems: A. Z. Yonis, M. F. L. Abdullah, M. F. Ghanim, International Journal of Advanced Science and Technology, Vol 41, April 2012

Contacts

Craig Wigginton

U.S., Global and Americas Telecom Leader
Deloitte & Touche LLP
cwigginton@deloitte.com

Dan Littmann

U.S. Consulting Telecom Leader
Deloitte Consulting LLP
dlittman@deloitte.com

Rahul Bajpai

Director
Deloitte Consulting LLP
rbajpai@deloitte.com

Kaushik Iyengar

Senior Manager
Deloitte Consulting LLP
kiyengar@deloitte.com

Additional Contributors

Deepshikha Ganjoo

Senior Consultant
Deloitte Consulting LLP

Ketan Merchant

Senior Consultant
Deloitte Consulting LLP

**About Deloitte**

Deloitte refers to one or more of Deloitte Touche Tohmatsu Limited, a UK private company limited by guarantee, and its network of member firms, each of which is a legally separate and independent entity. Please see www.deloitte.com/about for a detailed description of the legal structure of Deloitte Touche Tohmatsu Limited and its member firms. Please see www.deloitte.com/us/about for a detailed description of the legal structure of Deloitte LLP and its subsidiaries. Certain services may not be available to attest clients under the rules and regulations of public accounting.