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A TMN eBOOK

LTE-A AND SMALL CELL DEPLOYMENT STRATEGIES.

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The Mobile Network

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INTRODUCTION

Todd Mersch, Senior Director, Software & Solutions, Radisys. Todd is responsible for strategic direction and product management for the Radisys solutions and Trillium software product line as well as its comprehensive services business.

LTE-ADVANCED AND SMALL CELLS:

TECHNIQUES FOR A TIERED DEPLOYMENT APPROACH

It's no secret; we've all become data hogs. As today's smartphone users consume ever-increasing network resources, mobile operators are rushing to deploy their LTE networks to meet subscriber demand.

Mobile operators have a tremendous opportunity to both serve and benefit from the development of new digital lifestyles across the world. To do that they must deploy networks that deliver the best experiences for end customers and for content and applications partners. The operators that do this most successfully will achieve market differentiation and access a broad range of value opportunities.

Two technology roadmaps stand out to help operators develop the capacities they need to take advantage of these opportunities: the development of heterogeneous networks and the introduction of LTE-Advanced (LTE-A) features. At Radisys, we see the two as symbiotic, as heterogenous networks take advantage of LTE-A to deliver increased bandwidths, reduced latencies and higher uplink and downlink throughputs to end users.

Most importantly, we see our role as enabling operators to deploy the advanced features in a phased manner,so they can control their network development in line with their business requirements whilst managing the increased complexity of 4G networks.

This eBook, with a feature article from Renuka Bhalerao of Radisys and market infographic from the team at The Mobile Network, explains the importance of that phased approach, and the relationship between the development of small cells and LTE-A.

Given this trend, operators are already planning their LTE-A deployments. Delivering true 4G speeds, LTE-A will boost data rates from 150 Mbps to 1Gbps. LTE-A will also provide enhanced cell edge performance, much improved radio interference mitigation and spectrum re-usage.

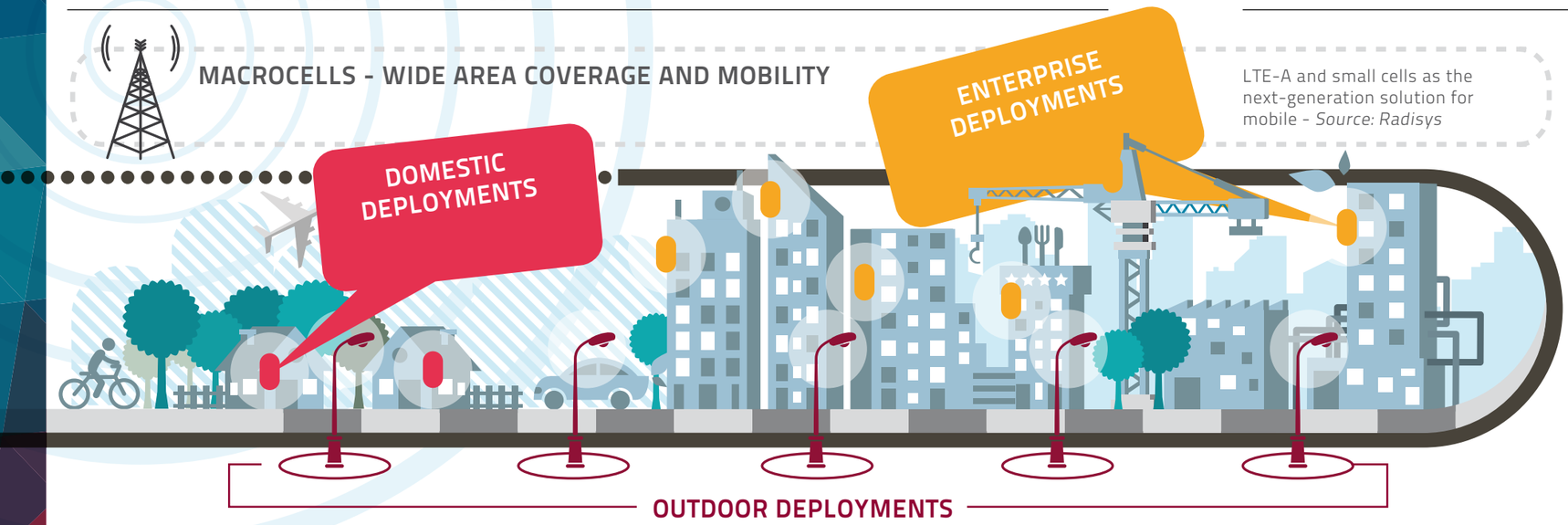
For subscribers, this translates to real-time HD voice and video services and fewer dropped calls. Operators implementing LTE-A can enjoy upsurges of network efficiency, monetised mobile broadband and increased network capacity. But what's the best approach for an LTE-A deployment?

Maximizing spectrum with carrier aggregation and interference mitigation

As with any new technology that brings vastly different features than its predecessors, the roll-out of LTE-A is best taken in steps, weighing on the tactical advantage of each feature. This phased approach will begin with the achievement of higher throughput through carrier aggregation and enhanced MIMO, and improved interference mitigation through the implementation of Enhanced Inter-cell Interference Coordination (eICIC) techniques. Using LTE-A, mobile operators can implement carrier aggregation both practically and efficiently, by leveraging the use of their existing spectrum to help achieve a higher bandwidth and heightened speeds.

Carrier aggregation - a chief benefit of LTE-A - allows operators to consolidate their non-contiguous 3G spectrum and LTE frequency bands to enable more data throughput at one time. In effect, portions of existing spectrum can be combined to attain higher speeds, enabling up to 100 MHz of usable bandwidth. Increased spectrum capacity delivers the 1Gbps data rates required for high-demand services, such as HD voice and video. It is worth nothing that the ability to aggregate small amounts of spectrum from across diverse bands will enable carriers with less optimal spectrum allocations to compete with operators that have much larger contiguous spectrum assets.

A TMN eBOOK: LTE-A AND SMALL CELL DEPLOYMENT STRATEGIES



LTE-A and small cells as the next-generation solution for mobile – *Source: Radisys*

So as well as providing a technical edge, Carrier Aggregation promises to boost competitiveness and enable new business models for some carriers.

As most of the traffic load will still be seen indoors, small cells will play a crucial role in global LTE-A deployments and will underpin the key features of LTE-A technology such as carrier aggregation, key interference management features including Enhanced Inter-Cell Interference Coordination (eICIC) and range extension – all part of the LTE-A body of standards.

In many Asian countries, the dense deployment of small cells makes it particularly prone to more interference and thus imperative to extend beyond traditional LTE with frequency reuse to provide the carrier aggregation and interference mitigation capabilities delivered by LTE-A. Because traditional LTE networks do not supply the necessary capacity and coverage to utilise eICIC techniques, LTE-A networks provide an improved solution for organising small cells and macro cells. This ties back to carrier aggregation as it provides an effective means for mobile operators to use the available spectrum in chunks rather for increased capacity and coverage, rather than relying on the rare availability of a large section of contiguous spectrum.

LTE deployments in Japan are already very mature, and mobile operators are ready to leverage LTE-A technology to solve these issues. In addition, small cells deployments in Asia often exist on a different frequency and there is more available spectrum, making LTE-A a natural fit. NTT DoCoMo, in Japan, and SK Telecom, in South Korea, have both outlined plans to introduce Carrier Aggregation. SKT has said that it will have commercial Carrier Aggregation enabled in its network by September 2013, combining spectrum from 850MHz and 1800MHz bands to achieve a theoretical maximum of 150Mphs. NTT DoCoMo has outlined plans to deploy small cells that can enable Carrier Aggregation in 2015, as part of an advanced Cloud RAN architecture that envisions up to 48 low power cells operating as add-ons to a high powered "Master Base Station"

While Asia is leading the rate of LTE-A implementation, North American and European markets will soon follow, once their LTE architectures are sufficiently in place. In the USA, AT&T and Verizon have both stated they will reported to be looking at expanding capacity by using CA to combine their respective 700 MHz and AWS spectrum holdings. In Europe, the UK's EE has said it will trial Carrier Aggregation during 2013, with the operator expected to look at combinations between holdings in its 1800MHz and 2.6GHz bands.

Initial rollouts of LTE-A in Asia have provided opportunities for many lessons learned, including the realisation that, when it comes to capacity management, redirection alone is not sufficient. Instead, sophisticated algorithms must be utilised to ensure adequate coverage during peak usage times, such as emergencies and rush hour. While imperative for the future of mobile, the robust functionalities of LTE-A add to the complexity of the roll-out process. The implementation of Self-Organizing Networks (SON) has served as a useful player in LTE-A deployment, in terms of solving the practical issues that come along with a mass rollout and architectural changes, as well as effectively aiding in interference mitigation.

TAKING A TIERED APPROACH TO LTE-A ROLL-OUT.

Because the roll-out of LTE-A requires numerous architectural changes, operators are wise to deploy this technology in a tiered approach, beginning with carrier aggregation and interference mitigation. This is aided by eICIC techniques that enable better coordination in time domain between small cells and between small cells and macro cells, boosting cell edge performance. Small cells will continue to form a critical role in next-generation deployments. Using sophisticated techniques, eICIC mitigates interference on traffic and control channels. Because they have many of the same features as LTE-A networks themselves, small cells can be uniquely coordinated by LTE-A to provide enhanced cell edge performance.

The second phase of an LTE-A roll-out will include Coordinated Multi-point (CoMP) techniques to ensure even greater performance is achieved at the edge. This complex technology is currently being tested in the lab, and will be deployed at a later date. Relay nodes are another feature to be considered for phase two or three in this tiered deployment approach, as they represent a substantial change in network architecture.

With its powerful combination of capacity and coverage, LTE-A supports the growing relevance of small cells. Radisys recently announced the world's first LTE-A small cell solution, which has been enhanced to include key LTE-A features that enable operators' phased LTE-A deployments. As part of a Heterogeneous Network, or HetNet, the LTE-A small cell solution brings enhanced capacity and coverage.

LTE-A addresses the growing needs of mobile by bringing increased capacity and coverage, delivering true 4G speeds by boosting data rates from 150 Mbps to 1 Gbps. In order to meet rising subscriber demands, boost network efficiency, monetize mobile broadband and increase capacity, a phased approach to deployment of LTE-A is most effective for operators. The tiered approach - beginning with carrier aggregation and interference mitigation -will offer operators the best opportunities to maximise efficiency, enhance cell edge performance and improve spectrum reuse for an optimal user experience.

GLOSSARY

Carrier Aggregation (CA) - With Carrier Aggregation multiple component carriers are used to increase bandwidth in the network. LTE-A definitions support the aggregation of up to 100MHz.

Range Extension - Balances the load between small cells and the macro layer, resulting in a more even distribution of radio resources between users. This effectively expands the range of small cells deployed within a macrocell.

Coordinated multipoint (CoMP) transmission - CoMP refers to a set of technololgies designed to increase coordination between small cells, and between small cells and macro cells.

Enhanced Inter-Cell Interference Coordination (eICIC) - Inter-cell interference becomes a challenging issue in heterogenous network scenarios. eICIC uses advanced time domain scheduling techniques to mitigate interference between cells.

SMALL CELLS AND LTE-A:

WHY A SMALL CELL STRATEGY MUST TAKE NOTE OF LTE-A

1 SMALL CELLS

TODAY:
11.5M SMALL CELLS

56% OF ALL BASE STATIONS GLOBALLY (INFORMATM)

2016:
8X **92M** SMALL CELLS

Installed base of small cells is set to grow from 11 million units in February 2013 to 92 million units in 2016 - an 8x increase - with a total market value of over US$22 billion

A MASS MARKET?

Sprint: 1 million deployments, by end 2012. (1m)

at&t: 1 million+ by early 2013 (1m >)

SoftBank: 100k+ (100K >)

SFR: 100k+ (100K >)

vodafone (100K) Several hundreds of thousands in the UK.

98 PERCENT MOBILE OPERATORS SAY *"Small cells are essential for future networks"*

55% SAY public access most important

Public access will account for only 4% of small cells sold, but 73% of the market value

4% V 73%

2 LTE SMALL CELLS

NTT DoCoMo launched a dual mode 3GT/LTE femtocell during December 2012.

SKT and KT have launched LTE small cells for public access.

More than two thirds of small cells deployed in 2017 devoted to LTE-FDD or TD-LTE (*Mobile Experts*)

PUBLIC ACCESS PLANS

AT&T 40k by 2015 | O2 London 2012 success | Verizon 2H 2013 | Vodafone Tri-mode tests | SKT 3G & LTE already | >

WHERE THE TRAFFIC IS HEADED

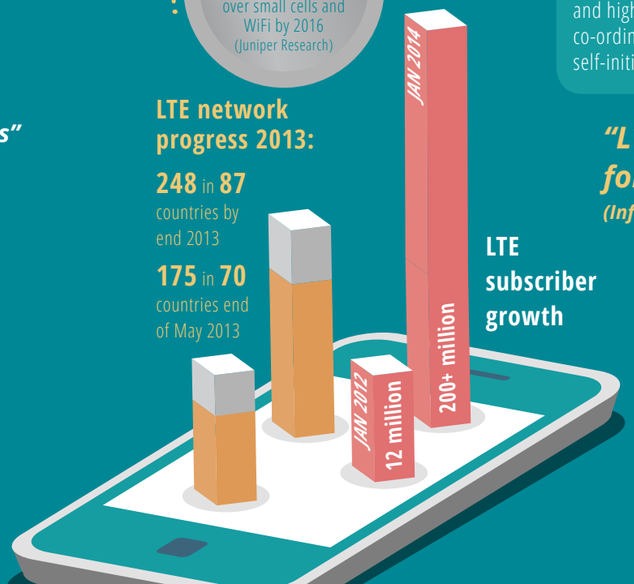
30% of mobile traffic over small cells and WiFi in 2013 (Infonetics Research)

60% of all mobile traffic over small cells and WiFi by 2016 (Juniper Research)

LTE network progress 2013:

248 in **87** countries by end 2013

175 in **70** countries end of May 2013



LTE subscriber growth

3 LTE-A

Public access small cells keep rolling...

Downlink peak data rates up to 3Gbps. Uplink data rates up to max 1.5Gbps .Support for up to 100Mhz bandwidth. Maximum 8x8 MIMO downlink, 4x4 uplink. Higher spectral efficiency, from a maximum of 16bps/Hz in R8 to 30 bps/Hz in R10. Carrier aggregation for better spectrum flexibility and higher bandwidth. CoMP and eICIC for improved co-ordination. Enhanced SON techniques going beyond self-initialisation. Relaying for outdoor range extension.

docomo | Korea Telecom | Sprint | Yota | SK telecom

LTE-A 2013 LAUNCHES PLANNED (JUST COOKING)

Small cell solutions with carrier aggregation early 2014.

"LTE-Advanced is gearing for true 4G prime time" *(Infonetics)*

LTE-A AND THE HETNET

In LTE advanced, the possibility for efficient heterogeneous network planning is increased by the introduction of eICIC and extensions to the X2 protocol that allow for better coordination between macro and small cell layers, for both interference mitigation and mobility.

WHAT'S NEXT FOR LTE-A AND SMALL CELLS?

3GPP Release 12 - completion expected September 2014.Small Cell enhancements focus on smooth integration in the macro network, address improved coordination between small cells and macro, introducing dual connectivity. Operators with diverse spectrum holdings to aggregate multiple smaller carriers. Carrier aggregation also key for improving TD-LTE throughput. Improved energy efficiency through development of the Cloud RAN.

CAN YOUR NETWORK BOOST THE BOTTOM-LINE?

MAXIMIZE
SPECTRUM UTILIZATION
with Radisys small cell solutions

The deployment of small cells, the emergence of HetNets (heterogeneous networks) and the leap towards LTE-Advanced's promise to maximize spectrum utilization—is making networks more efficient, increasing capacity and coverage, and enabling operators to monetize mobile broadband.

For small cells, Radisys offers complete software that supports the latest standards including LTE-Advanced, is deployment-proven for both 3G and LTE networks, and is integrated with leading specialized small cell silicon.

WORLD'S 1ST LTE-A Small Cell SOLUTION

radisys®

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