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Mobile Applications and Networks

Key Operator Considerations as the Industry
Rapidly Innovates

Inside:

[Carrier Priorities for 2012 and 2013](#)

[OTT and Apps: What's Next for Operator Business Models](#)

[Leveraging OTT Drives Innovation](#)

[Small Cells and HetNets: Lessons Learned](#)

[Making the Decision on Mobile Backhaul Strategy](#)

[The Role of Back-Office Transformation](#)

B/OSS
Business & Ops World

[Image Gallery--Special CTIA Wrap-Up](#)

CONTENTS

No. 5, May 2012

www.vision2mobile.com



OPINION

[3 Editor's Letter: Carrier Priorities for 2012, 2013 Show Little Consensus](#)

[12 Guest Column: Carrier Innovation Required](#)

FEATURES

[6 What's Next for Mobile Broadband: Apps, LTE and Spectrum](#)

By Tara Seals

Verizon Wireless is focused on spectrum availability. Sprint is concerned about privacy and security issues, and the industry's reputation among consumers. T-Mobile is looking to make a fresh start with its LTE network after the AT&T merger fell through. And last but certainly not least, AT&T is thinking about what's next to compete on after all players have LTE and similar networks.

[15 It's a Small \(Cell\) World After All](#)

By Nick Johnson

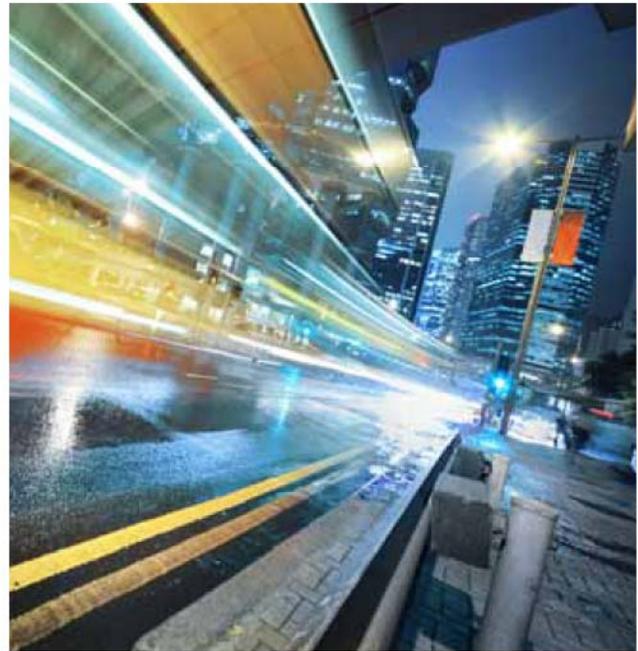
For mobile networks to get bigger – in terms of both capacity and coverage – they will first have to get smaller and more intelligent.

With one million small cells already in use in homes and offices, there are six key lessons from the first deployments that can apply to the large scale public roll-out of small cell carrier networks.

[22 Predicting When 10GigE is Right For Mobile Backhaul](#)

By Prayson Pate

While the number and range of random events coming to bear on the future cannot be over-estimated, one CTO outlines how it is still possible to highlight the four most important dimensions of variability for consideration and guidance.



[28 Mobile Operators Can Lead Their Market Through the Revenue Crunch](#)

By Cyril Doussau de Bazignan

The Telstra BSS/OSS consolidation project outlines key next-gen service management challenges in today's mobile broadband networks.

[32 Image Gallery: CTIA Shines a Light on Carrier Priorities](#)

By Danica Cullins and Tara Seals

CTIA was invaluable in advancing the industry conversation around a few key themes, including spectrum policy; small cells and heterogeneous networks (HetNets); the value of wireless to economic development; and T-Mobile's future plans.

Predicting When 10GigE is Right For Mobile Backhaul

By Prayson Pate



In a
Hard-to-Predict
Future, Four
Guiding Principles
Dominate

So, 10GigE is coming to mobile backhaul, first in aggregation and then in access. The problem is that it is hard to predict what that demand will be, and when. While the number and range of random events coming to bear on the future cannot be over-estimated, it is still possible to highlight the four most important dimensions of variability to the top for consideration and guidance.

IN THIS ISSUE

Small Cells p. 15 ■ BOSS p. 28 ■ Table of Contents p. 2

The Future is Hard to Quantify

“Prediction is very difficult, especially if it’s about the future.” - Niels Bohr

Figure 1 shows a sample network with GigE access and 10GigE aggregation. Many networks today are not yet at these speeds. Table 1 shows that access and aggregations speeds will go up as demand increases and as fiber and equipment costs come down. In the long run, only Ethernet-over-fiber will provide the needed capacity to meet this growing demand. The question is, when will this happen?

Figure 1: A sample network with GigE access and 10GigE aggregation. Many networks today are not yet at these speeds.

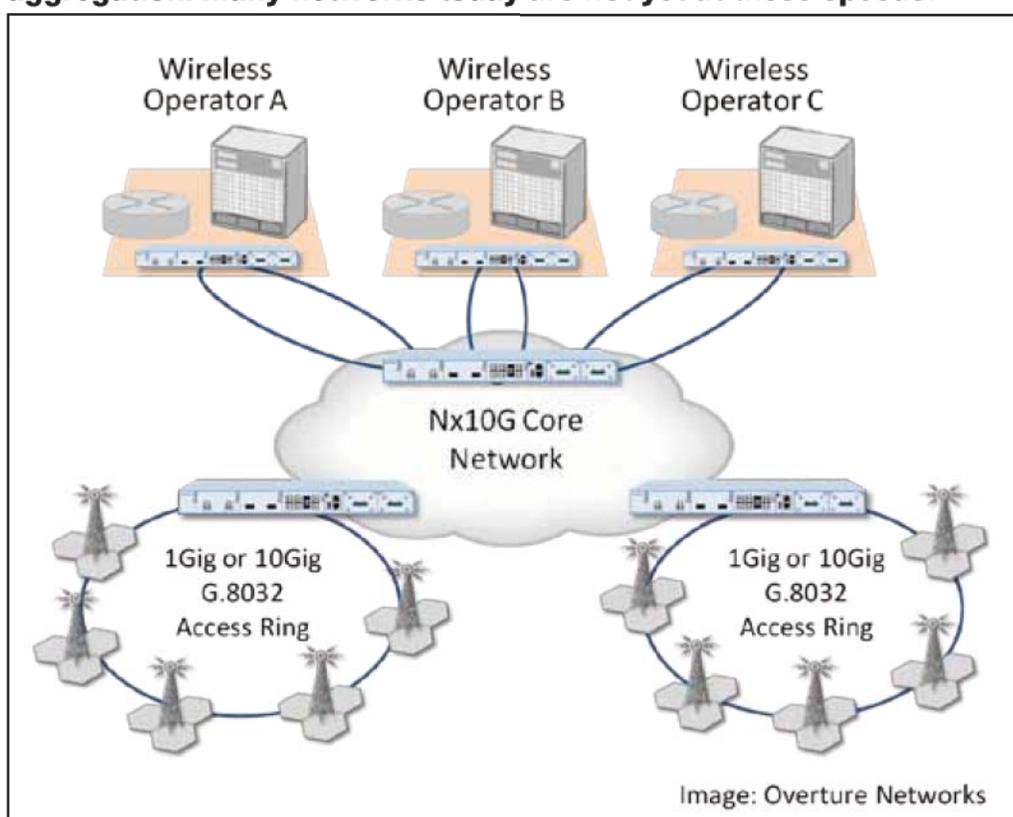


Table 1

| Access Interface | Aggregated Interface |
|--|----------------------|
| EoC, TDM/PDH, SONET/SDH, radio, 100FX, 1G fractional and PON | GigE |
| GigE Ethernet and GPON | 10GigE |
| 10GigE Ethernet | 100GigE |
| 10GigE Ethernet over WDM | 100GigE WDM |

IN THIS ISSUE

Small Cells p. 15 ■ BOSS p. 28 ■ Table of Contents p. 2

Notice that there are no dates for the rows in Table 1. This omission is in recognition of the difficulty of making quantifiable predictions about the future. The book *Thinking Fast and Slow* by Daniel Kahneman describes the failure of experts to be able to accurately predict outcomes for future events in their field, such as stock prices, elections and sporting events. The experts consistently underestimated the range of variation of outcomes, largely because of over-confidence in their understanding of the field, and underestimation of the number of random events affecting the outcomes.

This unpredictability applies to mobile backhaul as well, due to rapid changes in technology, regulation and demand.

For mobile operators trying to determine the best time to deploy 10GigE for mobile backhaul, four dimensions of variability are the most important to weigh and balance.

1. Access Media and Speed

“Too much of a good thing can be wonderful.” – Mae West

Mae West wasn't referring to the desire for more and more bandwidth by mobile subscribers of course, but the quotation is still very apt. In order to address demands in a cost-effective manner, the service provider must have the ability to exploit a range of access media, preferably using only a few devices.

- Copper – Copper is available at more than 90% of cell site locations, so it must be included in any comprehensive plan for backhaul, including G.SHDSL for resilient long-reach access and VDSL2 for shorter links.
- TDM/SONET – The traditional access for 2G sites includes T1/E1, DS3/E3, and SDH/SONET links.
- 100FX – This is a lower cost alternative where fiber is available but aggregator capacity is limited.
- 1 Gig – This is the current sweet spot for fiber-based access, thanks to high capacity and low cost.
- 10G – The emerging choice for aggregation of gigabit links, and the future choice for access.

Today, 3G and LTE cell sites require 50-100Mbps of uplink capacity. About half of these sites are reached by fiber today, and Gigabit Ethernet is the current sweet spot for capacity, optics and electronics. However, fiber is still expensive, so the other half of access is divided among technologies such as Ethernet over Copper (EoC), TDM (PDH/SONET/SDH) and microwave.

IN THIS ISSUE

[Small Cells p. 15](#) ■ [BOSS p. 28](#) ■ [Table of Contents p. 2](#)

Interface and aggregation speeds need to increase to support the growing demand for bandwidth, but there are other factors that must also be considered.

2. Resiliency

“The bamboo that bends is stronger than the oak that resists.” - Japanese Proverb

Mobile access networks use both adjacency and uplink protection to provide network resiliency. The reliance on adjacency (the ability of a neighboring cell to take over for a failed node) becomes more important with the emergence of small-cell sites. An alternative approach is to use a technology such as Wi-Fi to home a number of small cells onto a master. In this case, uplink resiliency becomes critical.

Protected or unprotected? Linear or rings? The prudent choice is to pick the best solution for today, but to be prepared to make a change as technology advances. This means selecting equipment with flexibility with respect to the types of resiliency supported.

3. Synchronization

“Time is at once the most valuable and the most perishable of all our possessions.” - John Randolph

The mobile backhaul network is undergoing a transition in its synchronization plan. 2G and 3G equipment relied on the availability of T1 links for timing, but packet-based LTE equipment uses a mix of GPS, SyncE and IEEE 1588.

- GPS imposes the least requirements on the access network and radio equipment, but adds the most incremental cost.
- SyncE adds minimal cost in modern equipment, but requires support in every part of the access network. Also, it does not provide phase or wall clock information.
- IEEE 1588 works across different access topologies, but imposes limits on latency and latency variation. It also adds cost and complexity to the radios for timing recovery.

To provide maximum future-proofing, backhaul equipment should support SyncE, but should also have low latency and latency variation to support 1588 if needed.

IN THIS ISSUE

[Small Cells p. 15](#) ■ [BOSS p. 28](#) ■ [Table of Contents p. 2](#)

4. Performance and SLAs

“High achievement always takes place in the framework of high expectation.” - Charles F. Kettering

Optimum performance of a mobile network requires predictable high performance from the backhaul network and equipment. Backhaul operators must be able to ensure that they can not only achieve the required Service Level Agreements (SLAs), but that they can also provide hard numbers to back up their claims to the wireless operator. Today, these numbers include measurements of delay, delay variation and packet loss. Other performance parameters or reporting methods may be required in the future. For example, the Metro Ethernet Forum is currently refining definitions for class-of-service and performance parameters for mobile backhaul. As this work progresses, the requirements for backhaul equipment and networks will change.

Any deployed equipment must be able to report the required SLA parameters today, and must also be flexible enough to support additional measurements in the future.

Plan and Adapt

“The art of life is a constant readjustment to our surroundings.” - Kakuzo Okakura

Mobile backhaul operators will most likely remain unable to see into the future, however, considering the four most important dimensions of variability for predicting when 10GigE is right for mobile backhaul, operators are more able to form network plans that fit what they know today, but which provide for adaptation as circumstances change. ▶

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IN THIS ISSUE

[Small Cells p. 15](#) ■ [BOSS p. 28](#) ■ [Table of Contents p. 2](#)