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Enabling the Mesh of Pervasive Connectivity

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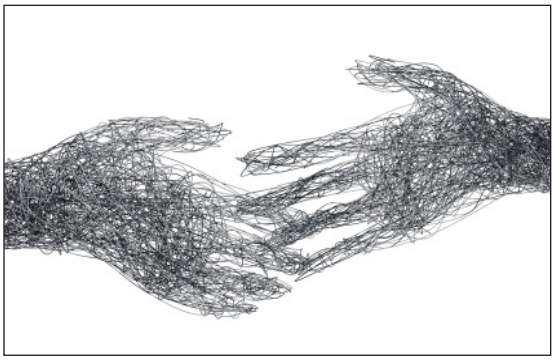


To say that life has changed significantly in the past decade would be a gross understatement.

In 2002, gas prices in the United States averaged around $1.47 per gallon, less than 60% of the population was online, and only about half of the population had a cellphone. The two leading manufacturers of alternative fueled and hybrid vehicles sold less than 30,000 units in 2002.

Fast forward ten years and gas prices have risen 260%, mobile device penetration is nearly 100%, everyone is online, and Toyota and Honda sold 660% more hybrid vehicles, legitimizing a new class of vehicle among the wheels on the road.

In the past, different classes of connectivity and access floated in separate silos, but today communications service providers are increasingly embracing a mesh of access technologies to deliver mobile connectivity; they simply have to. Mobile data will grow tenfold in the next five years, while operator revenues will only grow two-fold. Consumers want this data delivered in more and more places—in airplanes, cars, and the outback—and they expect a broadband-like experience.

What's more, the nature of traffic is changing as well. Most service providers engineered their data highways with five lanes heading south, and only one heading north, but click-to-cloud services (e.g. iCloud, Dropbox, Google Drive, etc.) and multi-megabyte user-generated content is increasingly filling upstream data pipes. As Don Bowman, CTO and founder of Sandvine explained, "mobile carriers aren't really planning on material upstream, and on mobile, it is 1000 more complex to get content upstream."

The solution and network innovation lies in weaving together and effectively utilizing multiple access technologies: 2G, 3G, LTE, WiMAX, Wi-Fi, small cell, wired back-haul, and even satellite. Increasingly, connectivity is becoming a mesh of access technologies, not just 3G or 4G. In this article, we'll explore how CSPs are knitting together these technologies, the underlying enabling software and hardware, and some of the challenges they face on

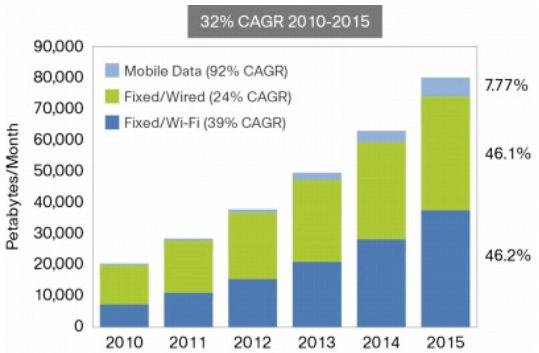
the road to pervasive connectivity.

Wi-Fi - It's not Just for Home Networks and Coffee Shops

As CSPs are faced with the need for ubiquitous connectivity (delivering mobile data anytime, anywhere), they must maintain access in planes, trains, and automobiles, leverage satellite resources for rural areas, utilize beam forming technologies to improve range and interference rejection, and team up with other operators to increase the breadth of coverage. A relatively new weapon CSPs are adding to their access arsenal is Wi-Fi . Unlike 2G, 3G, and 4G, it's inexpensive, it operates in white space (or unlicensed spectrum), and it's standardized on billions of devices. Today, to make a device Wi-Fi costs about 60 cents," said Ulik Broida, VP Marketing and Customer Service, Alvarion.

Wi-Fi is certainly a popular way to deliver internet traffic, and soon it will be the most popular, even surpassing wired connections. According to the Cisco Visual Networking Index (VNI), 46 percent of internet traffic will be delivered by WiFi by 2015, while less than 10 percent of this traffic will be delivered over cellular networks.

Wang Zhoujie, Huawei, recently wrote that Wi-Fi is, "a potential gold mine for operators. Wi-Fi is coming in from the cold, with many prominent operators using it or planning to use it to supplement their networks, including AT&T, Orange, PCCW, and China Mobile."



Source: Cisco Visual Networking Index (VNI) Global IP Traffic Forecast, 2010-2015

The promise of Wi-Fi is three fold. First, it economically reduces strain on Radio Access Networks (RANs), especially in shorter-range or high-density situations. Second, by rolling out a network of company-branded and -managed hotspots, carriers can move up the value chain. (Just look at AT&T's extensive network of Wi-Fi hotspots in McDonald's and Starbucks.) Third, by managing the Wi-Fi handover and keeping the customer within a controlled network, carriers can ensure session integrity, consolidate identity management and policy control, and better monitor and guarantee Quality of Service (QoS).

"It also heavily interferes. We don't believe that carrier Wi-Fi in the open space is going to offer significant material value."

Carrier Wi-Fi is already being effectively deployed in large arenas and indoor networks. Universities and colleges around the world are deploying Wi-Fi networks, and Alvarion recently provided wireless coverage for an entire soccer stadium with just a handful of access nodes. Wi-Fi will also be the predominant wireless connectivity technology for most M2M connections in the future.

On the downside, "Wi-Fi has a very poor range compared to 3G," commented Don Bowman. "It also heavily interferes. We don't believe that carrier Wi-Fi in the open space is going to offer significant material value."

However, Johan Terve, Aptilo Networks, responded to these concerns by explaining that it boils down to how each access technology is used, and that no single technology is superior in all situations. It's more important to understand "when and where it should be used," implored Terve. "If you have a range issue, you should use the macro network. It's not as if you should build a complete Wi-Fi network (similar to the 3G network). Most customers we have do it in a more pragmatic way. It's very easy for them to identify the very few, most congested base stations. Eighty percent of the data traffic goes through 20 percent of the base stations, so at those stations, build out the Wi-Fi ."

In addition, like all access technologies, Wi-Fi specifications are constantly evolving. The latest standard, 802.11ac, enables very high bandwidth in the 5Ghz spectrum, leverages baked in interference management and rejection advancements, and can simultaneously stream HD video to multiple clients in a single home, office, restaurant, or similar location. For these reasons, "Wi-Fi is totally embraced by operators," says Terve.

It's no wonder, then, that we see major telecommunications equipment manufacturers jumping on the Wi-Fi opportunity. At Mobile World Congress this year, there was significant buzz around Wi-Fi . Alcatel-Lucent made headlines by integrating Wi-Fi into base stations and small cells, some of which have already been deployed by Telefonica. Wim Sweldens, President of Alcatel-

Lucent's Wireless division, said in a statement that by adding Wi-Fi to their lightRadio modules, "service providers will be able to build closer relationships with their customers by delivering seamless high-speed broadband connections, wherever they are, using LTE and Wi-Fi networks. For subscribers, this approach provides the peace of mind they want when accessing the Internet wherever they go."

Adding their stamp of approval, Ericsson, the largest mobile infrastructure maker in the world, purchased BelAir networks and added Wi-Fi into it's integrated network offering. Similarly, Cisco maintains a robust Carrier-Grade Wi-Fi solution with numerous deployments.

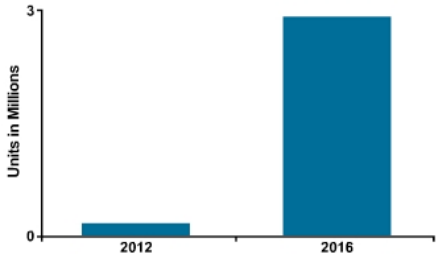
Small Cells

As mobile operators race to meet skyrocketing demands in densely populated and hard-to-service areas, small cells have risen to the challenge and provide another crucial piece of the connectivity mesh. Small cells are just diminutive macro cells, pint-sized radio access nodes that can be installed, positioned, and operated in less time and for less cost than their bigger brothers. The inherent self-organizing and self-management capabilities of small cells grant them distinction from femtocells and picocells.

Lower-power access nodes with a shrunken profile aren't new, but the way they are being used has changed. "While small cells, including microcells and picocells, have been used for the past two decades to improve voice coverage, now mobile broadband is shifting the game to capacity upgrades," wrote Stéphane Téral, Principal Analyst for mobile infrastructure and carrier economics at Infonetics Research.

"Service providers will be able to build closer relationships with their customers by delivering seamless high-speed broadband connections, wherever they are, using LTE and Wi-Fi networks."

Infonetics expects about 3 million small cells to ship worldwide in 2016



© Infonetics Research, *Small Cell Equipment Biannual Worldwide and Regional Market Size and Forecasts*, March 2012

Small cells are a critical component in the mesh of wireless connectivity. "…the chief objective is to complement and enhance the macro-cell layer from a capacity standpoint with a new breed of low-power nodes like public space femtocells and Wi-Fi," explained Téral in a statement.

Don Bowman of Sandvine agrees that this is the era

of the small cell. “There is no question in my mind that small cells are here,” Bowman said. “Small cells are [also] going to be heavily used in indoor technologies,” he added.

Same Network, Different Flavors of 4G

Small or large, the access nodes of the future are being built to support multi-mode operation. Alcatel-Lucent’s lightRadio, for instance, comes in micro and macro sizes, and supports 3G, 4G, and Wi-Fi. Similar offerings are available from Huawei, Ericsson, and Nokia Siemens Networks. But what’s interesting is that some operators are using multiple flavors of 4G simultaneously in order to leverage legacy assets and widen their nets.

Sprint announced a hotspot last month that operates on 3G, LTE, and WiMAX. This was Sprint’s answer to the question posed by many reporters: What are you going to do with WiMAX as you move to LTE?

Even though LTE has emerged as the 4G champ, it is important that we don’t neglect the capabilities of WiMAX. WiMAX is more than just Wi-Fi on steroids. It offers wide coverage, can be effectively used for municipal and large enterprise networks, offers high bandwidth, and can be less expensive than LTE deployments. It’s also the predominant form of 4G in many developing areas of the world. Adding the WiMAX piece to the connectivity puzzle greatly enhances the capabilities and reach of tomorrow’s networks.

It’s a Bird, It’s a Plane—No, It’s a Satellite

Small cells, multi-mode macro cells, and next-gen Wi-Fi hotspots are impressive, but there’s one problem: their signals cannot always reach us at sea or in the air. In order for the connectivity mesh to extend to these often-traveled areas, satellite technology must be employed. Luckily, like most other technologies, satellite telecommunication has dramatically improved over the past decade. Costs have fallen and capabilities have risen due to miniaturization, reduced power consumption, near-earth-orbit arrays, advanced interference management, and Ka band spectrum. Today, satellite isn’t just providing maritime phone service; it’s adding capacity and coverage for global CSPs.

Intelsat CEO Dave McGlade commented on the significance of the launch of a new satellite at the end of March, “…its customized beams will further progress our global mobility broadband fabric, allowing always-on broadband for ships and planes traversing the world’s busiest transport routes,” McGlade said in a statement. “Intelsat delivers broadband infrastructure everywhere, and the successful launch of Intelsat 22 delivers enhanced satellite capacity for telecommunications leaders in Asia, the Middle East, Africa and Europe, such as the UAE’s Etisalat and Ethio Telecom of Ethiopia.”

What are you going to do with WiMAX as you move to LTE?

The Gateway and Policy Controller

So now that we have multiple access technologies and hardware elements, how do we connect them functionally as a wholly unified entity?

“It’s all about how we stick these varying access technologies together, seamlessly--right now it’s a little clumsy,” said Ian Miller, director of new access network, Telefonica, at Mobile World Congress.

The challenge isn’t so much connecting different transports as it is seamless managing their interoperability, authentication, and enforcing policy as users bounce between different components in the network. In fact, none of the possibilities we’ve outlined are possible without this critical piece of software. It must function at light speed, offer unprecedented scale and elasticity, and be both vendor and platform agnostic. In fact, it could be argued that the sudden rise in policy controllers is a result of the evolution of the connectivity mesh.

In order to spread the traffic load evenly, ensure QoS, the gateway and controller must select between the “best” access node dynamically, and in real-time. It must provide single log-on authentication, and ensure that user policies are maintained no matter whether the session is delivered over 3G, 4G, Wi-Fi, or satellite. What’s more, the “best” access node is highly dependent on a number of network and user scenarios.

“It makes no sense offloading to an almost congested Wi-Fi node,” noted Johan Terve. The best policy control and rules function server can send policies to another ANDSF node, which in turn can set policies; that is the next step in offloading,” he said.

Different Words, Same Mesh

Network equipment manufacturers and CSPs use different terms to describe the mesh of connectivity that is evolving today. Huawei calls it Network Synergy; Verizon and Sprint call it the Het Net, or Heterogeneous Network. Whichever term is used,

they all define the method by which carriers deliver ubiquitous connectivity.

In a recent white paper, Huawei argued that, "synergy between different networks is necessary if they hope to deliver comprehensive services." This simple truth underlines the innovation occurring in today's communication networks. Just as companies are embracing coopetition in order to link disparate service ecosystems, so too are multiple access technologies coming together to form the connectivity mesh that will deliver anywhere, anytime access.