

WHAT'S DIFFERENT THIS TIME AROUND?

Standards

802.11n provides 5x capacity over previous Wi-Fi standards

Technology

Advances in dynamic beamforming, adaptive meshing and interference avoidance enable unprecedented reliability

Devices

Millions of Wi-Fi-enabled mobile devices have flooded the market

Price

Cost per bit of Wi-Fi broadband access continues to drop faster than the alternatives

Applications

Focused on high-density areas where many users require access

Business Model

"Build as you grow" instead of blanket coverage

Compelling Economics for Wi-Fi Broadband Access

ADVANCES IN TECHNOLOGY, STANDARDS AND MARKET DYNAMICS MAKE SMART WI-FI A VIABLE OPTION TO PROVIDING RELIABLE, BROADBAND ACCESS. LEARN WHY.

Wi-Fi Broadband Gains Newfound Respect

802.11n-based wireless broadband access (WBA) is the new Metro Wi-Fi. Only this time, the business drives the network build out, not the other way around.

Early metro Wi-Fi networks suffered from a top-down deployment model. Wireless ISPs attempted to build Wi-Fi WANs across entire cities or counties to offer fixed wireless service, often with just a promise of funding from public-works projects.

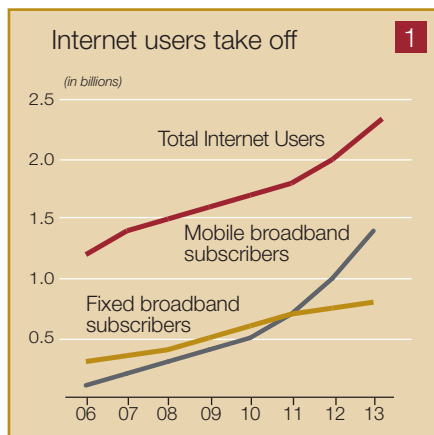
Meanwhile, the relatively low throughput and range of earlier 802.11a/g technology meant that the networks required a lot of equipment to achieve the coverage and capacity necessary for citywide scale, yet the delivered performance was but a fraction of what most subscribers could get from DSL and cable. Eventually, the business model broke down and the promise of the Metro Wi-Fi market was never realized. So, what is different this time around?

First, recent technological advances have made Wi-Fi much "smarter" and more attractive for building inexpensive wireless broadband access networks. The high-bandwidth IEEE 802.11n standard is one. New, sophisticated smart antenna, RF management, and interference avoidance technologies have also significantly bolstered the overall throughput and reliability of wide-area Wi-Fi networks.

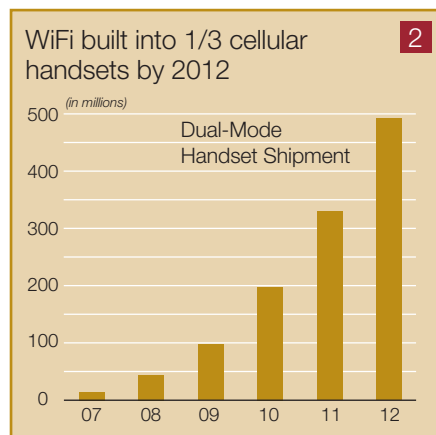
Compelling Economics for Wi-Fi Broadband Access

ADVANCES IN TECHNOLOGY, STANDARDS AND MARKET DYNAMICS MAKE SMART WI-FI A VIABLE OPTION TO PROVIDING RELIABLE, BROADBAND ACCESS. LEARN WHY.

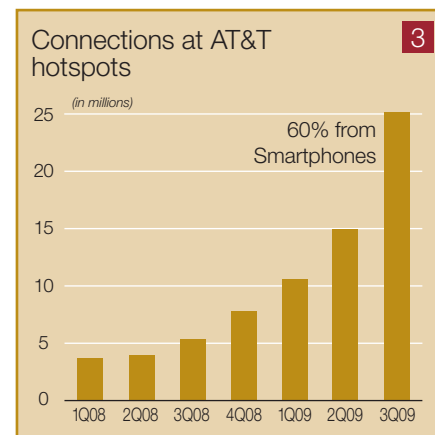
FIGURE 1: Mobile phone access will soon be universal. The next task is to do the same for broadband Internet access.



Source: Informa Telecoms, ITU, Forrester



Source: ABI Research



Source: AT&T

Likewise, much has happened on the mobile computing front. Just a few years ago, the laptop computer was virtually the only portable device that could take advantage of a public Wi-Fi service. Now nearly a billion Wi-Fi capable, mobile devices like smartphones, netbooks and electronic gadgets of all sorts are in the hands of consumers that desire access anywhere, anytime (see Figure 1).

Another major difference is the application of Wi-Fi broadband access networks. Unlike the first attempts at Metro Wi-Fi which assumed a “build it and they will come” business proposition, the new Smart Wi-Fi WAN is deployed for specific use cases where the compelling economics, high performance and convenience of Wi-Fi prevail over other wireless broadband alternatives. These use cases include last mile access in under served regions, cost effective public access service to offload overburdened 3G networks, as well as delivery infrastructures for managed business services such as corporate WLAN extension, telemedicine and wholesale hotspot services.

Ultimately, it is these economic realities that are drawing operators to consider Wi-Fi as a viable alternative, or, at the very least, a complimentary extension to established wireless broadband technologies: 1) no spectrum costs, 2) remarkably lower CAPEX, and 3) much shorter time to market and revenue.

No Spectrum Licensing Costs

3G and WiMAX generally use licensed spectrum which only deep-pocket operators can afford to acquire. Conversely, Wi-Fi, uses unlicensed spectrum, with no associated licensing fees.

Admittedly, Wi-Fi does not have the range for widespread coverage of sparsely populated markets — areas where traditional macro-cellular technologies such as HSDPA or WiMAX offer a more natural fit. But given that 60 percent of cellular usage is fixed or nomadic, many mobile broadband users can be served more cost effectively by Wi-Fi without consuming scarce licensed-spectrum resources.

Lower CAPEX

Wi-Fi technology has matured significantly over the past decade. The low equipment costs reflect economies of production scale driven by mass-market adoption in residential and enterprise markets.

Meanwhile the capacity of 802.11n Wi-Fi networks now matches or exceeds that of 3G and WiMAX. In most enterprise-class APs, each 802.11n radio offers 300 Mbps (for 2 streams) peak data rate and aggregate throughput of 150 Mbps or more.

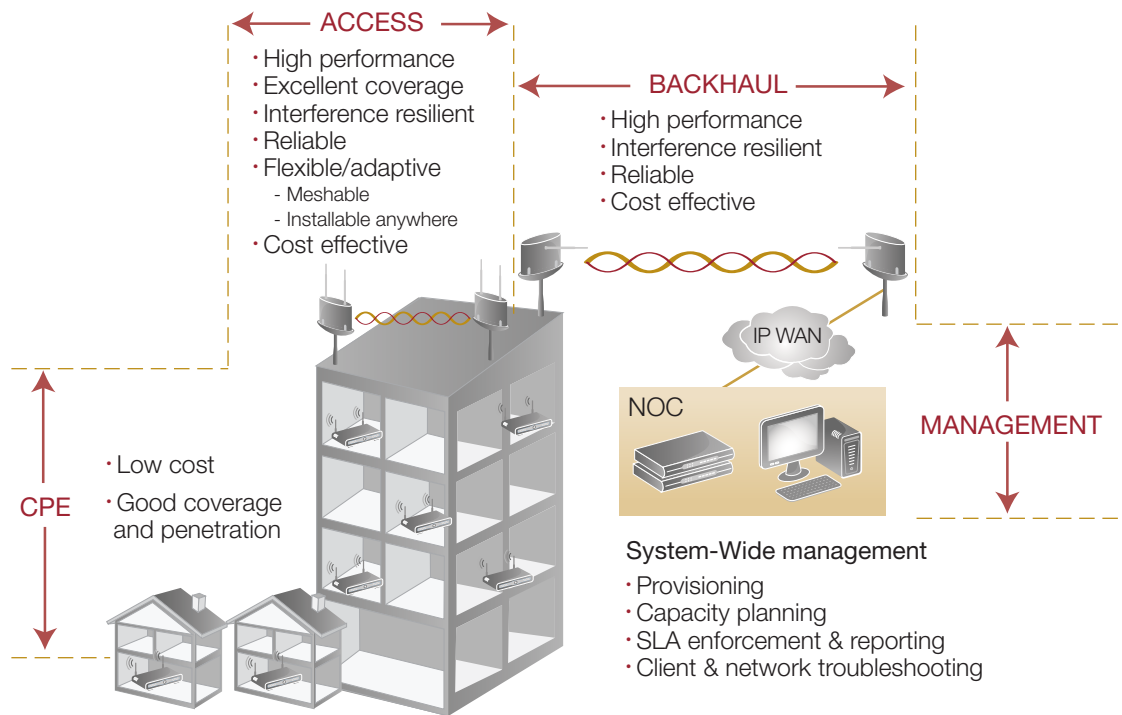
When it comes to CAPEX, Wi-Fi has a distinct advantage over 3G and WiMAX. For example, conservative estimates for delivering 2 Mbps of broadband access to users over one square kilometer using conventional WiMAX equipment would call for five WiMAX base stations. With associated antennas, backhaul, site acquisition, and installation expenses, the upfront cost could amount to nearly \$500,000, exclusive of spectrum fees.

Delivering the same coverage and capacity using next generation Smart Wi-Fi technology would reduce the cost by a factor of five, to less than \$100,000. This would include 41 outdoor 802.11n mesh APs, point-to-point 802.11n backhaul systems and nominal site acquisition and installation fees (see the Ruckus paper: “The Business Case for Wireless Broadband Access”).

Compelling Economics for Wi-Fi Broadband Access

ADVANCES IN TECHNOLOGY, STANDARDS AND MARKET DYNAMICS MAKE SMART WI-FI A VIABLE OPTION TO PROVIDING RELIABLE, BROADBAND ACCESS. LEARN WHY.

FIGURE 2: Essential components needed to build an end-to-end Wi-Fi broadband access network



Build As You Go; Shorter Time to Revenue

3G and WiMAX infrastructures tend to be built from top down, sweeping many cities and markets before going live. Building out wide-reaching 3G and WiMAX infrastructures takes time and funds, so the time to revenue and return on investment (ROI) is slow in coming. In contrast, Wi-Fi broadband access can be deployed on a much more granular “build-as-you-go” model, letting operators serve pockets of users as needed and where needed, incrementally.

Unique Advantages for Wireless Broadband Access with Ruckus Wireless

The components of a wireless broadband network includes:

- Customer premises equipment (CPE), typically in-home repeaters/bridges/APs, to aid signal penetration where necessary;
- High-performance outdoor mesh APs for access;
- High capacity wireless backhaul systems when wired backhaul is unavailable, and
- Remote management of all the network elements, including end-to-end provisioning, fault and performance management across the network, to the CPE.

No longer must operators cobble these network elements together from a mishmash of equipment suppliers; rather, they are now available in a coherent, end-to-end managed wireless broadband access solution from Ruckus Wireless.

Furthermore, unique, patented Ruckus technologies such as dynamic beamforming, intelligent antenna arrays and adaptive meshing greatly simplify Wi-Fi broadband access network deployment – delivering the best possible user experience through reliable, extensive signal coverage and consistent network performance.

Better Indoor Signal Penetration

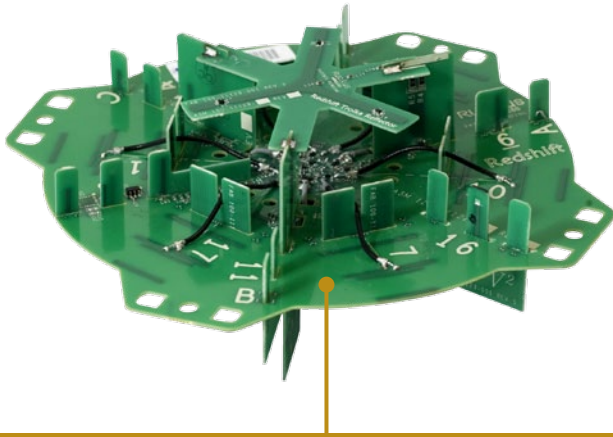
While in many cases the laptops can reach the access network, a successful deployment requires purpose-built CPE in difficult locations where indoor penetration and coverage is limited.

Affordable CPE that acts as a high-gain receiver, then repeating the signal into the home is an ideal solution. However most low-cost wireless bridges have poor RF performance and cannot address the coverage and penetration problem adequately. This has led to the commercial and technical failure of many Wi-Fi based broadband wireless networks.

Compelling Economics for Wi-Fi Broadband Access

ADVANCES IN TECHNOLOGY, STANDARDS AND MARKET DYNAMICS MAKE SMART WI-FI A VIABLE OPTION TO PROVIDING RELIABLE, BROADBAND ACCESS. LEARN WHY.

FIGURE 3



Dynamic Beamforming with Smart Antenna Arrays

Adaptable to any standard 802.11a/b/g/n chipset, this Ruckus patented technology comprises a compact antenna array with multiple, dual-polarized antenna elements capable of forming 2^N (N being the number of antenna elements) unique antenna patterns, and expert system software that continuously learns and selects the optimum antenna pattern for each packet transmission. By steering each transmission over the highest quality signal path, dynamic beamforming enables Ruckus devices to avoid interference, maximize transmit speeds and minimize transmit errors. This results in better signal range, higher performance and more reliable coverage.

Unlike omni-directional antennas that radiate signals in all directions all the time, the Ruckus dynamic beamforming antenna array directs all transmit energy toward the receiving device, maximizing reach while minimizing noise to neighbor Wi-Fi devices that are not on the signal path.

And unlike fixed-position directional antennas, the expert antenna control software forms “beams” on a per destination, per packet basis by combining one or more antenna elements. With literally thousands of unique “beams” covering all directions and all signal polarities, beamforming antenna arrays are flexible, adaptive and omnifarious.

Ruckus CPE provide a low-cost solution with superior RF design, reducing significantly the overall cost of the network and improving the end-user experience.

Simplified Deployment

All Ruckus outdoor access point and backhaul systems are designed to be unobtrusive, equipped with internal antenna arrays in light weight, compact packages. This simplifies acquisition of radio sites as many real estate facility managers are concerned about the aesthetics of large, unsightly radiating objects on their properties.

Small and integrated, Ruckus intelligent antenna arrays are flexible and adaptive. The smart antenna arrays contain both horizontally and vertically polarized antenna elements to maximize performance against dispersed client devices with varying antenna designs and orientations (see Figure 3).

More importantly, the Ruckus antenna arrays self-optimize, controlled by dynamic beamforming software that resides in each Ruckus bridge, AP and backhaul product.

The intelligent software continuously learns and, for each packet, selects a combination of antenna elements that directs transmissions to the destination over the best performing air path. This automatic adaptation relieves the burden on wireless installers to precisely position outdoor Wi-Fi radios and tune the antennas.

The same degree of auto-optimization extends from an individual Ruckus AP to a mesh AP network. Smart Mesh networking, a native feature on all indoor and outdoor Ruckus APs, automatically forms and reforms mesh topologies based on real time performance of the APs and their mesh connections without human intervention.

Hence a Ruckus outdoor mesh deployment may simply start with a drawing of the intended AP placement points on the Google Map within the Ruckus FlexMaster remote management system. The configuration for each AP and its designation (“Root” vs. “Mesh”) can be pre-provisioned on FlexMaster. At each site, the installer can simply mount the AP to face the general direction of subscribers and power it up. From there, the AP contacts the FlexMaster over the air and is auto-configured.

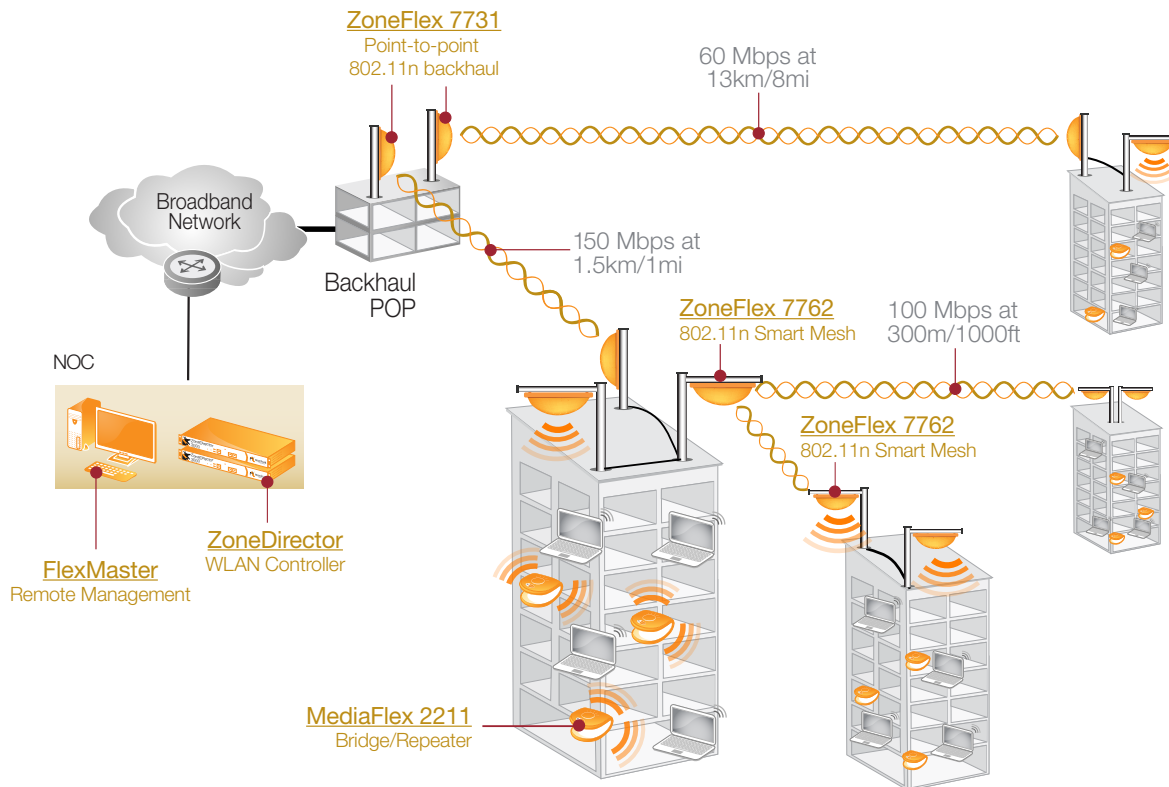
Better Backhaul

WBA networks are often constrained by the backhaul links connecting an apartment complex to the nearest POP. Many times a wired alternative is not available (or too expensive). Wireless backhaul has been available for a while but has failed to combine high performance, interference resiliency, reliability, and cost-effectiveness. Ruckus provides an 802.11n long-range Point-to-Point (PtP) and Point-to-MultiPoint (PtMP) bridges meeting all of these requirements.

Compelling Economics for Wi-Fi Broadband Access

ADVANCES IN TECHNOLOGY, STANDARDS AND MARKET DYNAMICS MAKE SMART WI-FI A VIABLE OPTION TO PROVIDING RELIABLE, BROADBAND ACCESS. LEARN WHY.

FIGURE 4: End-to-end Ruckus Wireless Smart Wi-Fi System Enables Reliable and Cost-Effective Last Mile Broadband Access



Reliable Coverage, Consistent Performance

Operating in open spectrum, outdoor Wi-Fi networks face constant interference from nearby radios sharing the same spectrum space, as well as incessant signal fades created by foliage and other moving objects. When interference is experienced, conventional APs mitigate by lowering the transmission speeds. If the interference is severe and persistent, packets could be lost and the ensuing retransmissions could trigger system-wide performance degradation and dropped connections.

Designed to combat interference and physical obstructions, the Ruckus antenna arrays are designed with a large number of antenna elements, (12 to 19 in the Ruckus outdoor APs) for maximum diversity. For example, the Ruckus ZoneFlex 7762 AP offers thousands of unique antenna combinations from which the dynamic beamforming software can select for transmitting a packet to a particular destination (a client device or an adjacent mesh AP).

Massive antenna diversity, coupled with intelligent learning and antenna selection algorithm, enables a Ruckus device to adapt

its signal path so that high transmit rates can be maintained and packet errors can be avoided.

Higher Capacity with 802.11n

Because Wi-Fi is a shared medium, every hop on a Wi-Fi mesh reduces the bandwidth available to each mesh node. Wi-Fi mesh networks built on older 802.11a/g standards are inherently limited by the maximum speed of 54Mbps. Incremental capacity can be gained by employing dual- or even tri-radio APs such that one radio can be dedicated for access while the other is used exclusively for backbone links.

New, dual-band 802.11n mesh APs (such as the Ruckus ZoneFlex 7762) can boost network capacity by an order of magnitude, with up to 300Mbps of raw bandwidth dedicated for the mesh backbone and a separate 300Mbps radio for access traffic. Today, dual-band 802.11n outdoor APs are already available and can be had for the same price as their older 802.11a/g counterparts.

Compelling Economics for Wi-Fi Broadband Access

ADVANCES IN TECHNOLOGY, STANDARDS AND MARKET DYNAMICS MAKE SMART WI-FI A VIABLE OPTION TO PROVIDING RELIABLE, BROADBAND ACCESS. LEARN WHY.

Ruckus' dynamic beamforming antenna system further optimizes mesh capacity through spatial reuse. Because omni-directional antennas radiate signals in all directions, when a conventional mesh AP transmits, all other APs will sense that the medium is busy and wait.

With dynamic beamforming, the energy from each transmitting Ruckus AP is directed toward its receiver without spreading to neighbor APs that are located outside of the transmit beam. These APs are then free to transmit at the same time, on the same channel, thereby maximizing total mesh throughput.

On Demand Capacity

As the subscriber base grows, more access capacity can be injected to a particular site by deploying an additional Ruckus mesh AP and connecting it to the existing mesh AP over an Ethernet link. The Ruckus Smart Mesh software automatically updates the mesh topology by re-computing mesh paths based on the real-time performance of each AP and its upstream link. With the capacity of a gigabit Ethernet uplink, the new AP is brought into the mesh with virtually no mesh-hop penalty. The ability to mesh intelligently over wired and wireless backbone connections allows wireless broadband operators to minimize upfront cost by deploying for network coverage to start, then adding capacity incrementally as business dictates.

For instance, operators could have started by deploying Ruckus ZoneFlex 2741 802.11g smart mesh access points for pure coverage and then migrated to Ruckus ZoneFlex 7762, dual-band 802.11n for capacity - re-deploying 2741 assets to new areas. This ensures very high capital efficiency. Additionally, for hybrid mesh deployments on building tops, customers can use the ZoneFlex 7762 as a 5 GHz mesh access point and extend the mesh for subscriber access by connecting additional 2741s to the Ethernet port on the 7762. This eliminates mesh performance penalties and increases the cost efficiency for buildout options.

End-to-End Management

FlexMaster serves as the dashboard from which an entire distributed outdoor Wi-Fi network is managed. The network operator can test signal strength in specific locations, monitor mesh topology changes, provision subscriber equipment and run end-to-end performance tests, for example. Ruckus APs collect reams of statistics on subscriber connections and achieved data rates to provide granular information on subscribers' performance and to facilitate capacity planning.

Application

Last Mile Access Network for Under Served Areas

In developing regions of the world, fixed-line broadband access is often limited by the lack of data-quality cabling even in dense urban centers. More often than not, 3G or WiMAX service is also non-existent. Even in the developed countries, there are many out of the way places where telecom operators have not been able to cost justify building out the last mile networks. In both cases, Wi-Fi broadband access can be a viable option.

Take the case of a non-incumbent operator in India, where the average Internet access speed is 128Kbps to 256Kbps, DSL penetration is extremely low (about 20 million lines serving 1 billion people currently), and WiMAX spectrum auctions have only just begun. The operator has elected to roll out a nationwide Wi-Fi broadband network based on Ruckus' WBA solution to support fixed wireless broadband services at 0.5Mbps to 1+Mbps.

Given that the cellular ARPU in India is currently US\$2-US\$3 per month while monthly DSL service at 258kbps costs about US\$8, a key consideration for the operator is to control the total cost of ownership (TCO) in order to justify a business case that supports comparable monthly service plans.

Network installation started at the end of 2008 and the operator began signing up subscribers in the spring of 2009. The majority of Ruckus APs are mounted face down on the rooftops of high-rise apartment buildings (see **Figure 2**, previous page). Each AP provides coverage for the apartment units underneath. APs on the same rooftop are directly connected over gigabit Ethernet and meshed to other APs within a physical zone over Wi-Fi. A physical zone may span several buildings. Each mesh is connected via a pair of point-to-point, long range wireless bridge for backhauling to a fiber POP.

For residences that are at outer part of the rooftop AP's range, a repeater/bridge CPE is provided to aid signal penetration. The Ruckus CPE is also marketed to subscribers who want to connect multiple PCs located anywhere within the home. A Ruckus FlexMaster server is deployed in the central NOC for inventory management, provisioning, monitoring and trouble-shooting.

In one instance, 15 Ruckus mesh APs were able to cover all 3,000 residences in a four-building residential complex. The operator was able to market services to these residents immediately. When the traffic load increased, new APs were added at the rooftops to provide additional capacity.

Compelling Economics for Wi-Fi Broadband Access

ADVANCES IN TECHNOLOGY, STANDARDS AND MARKET DYNAMICS MAKE SMART WI-FI A VIABLE OPTION TO PROVIDING RELIABLE, BROADBAND ACCESS. LEARN WHY.

Even in the U.S. and many other developed markets, government broadband stimulus programs have been introduced to help fund broadband access for under served areas. To qualify for funding, wireless ISPs (WISPs) must demonstrate a plan that meets certain timetable milestones set by the lending body.

Many WISPs are finding that Wi-Fi-based broadband access architecture lets them meet the lender's criteria and accelerate time-to-market by offering the greatest economies per bit of traffic transported through a very straightforward implementation. Not only is the Ruckus Solution priced competitively against similar offerings from other suppliers, dynamic beamforming technology ensures that fewer Ruckus APs are need (60% on average) for any given coverage or capacity criteria.

Application

3G Data Traffic Offload

It is well recognized that mobile data traffic is growing at a faster rate than mobile data revenues. This imbalance will only get worse as more sophisticated mobile internet devices and more media-rich mobile applications come on the market. And while mobile operators are diligently testing and planning next generation LTE network rollouts, many are already forecasting that the increased spectral efficiency promise will not be enough to keep up with tomorrow's mobile internet usage.

Mobile operators are beginning to seek capacity relief through the use of Wi-Fi hotspots. Historically, Wi-Fi hotspot service had not been strategic to mobile network operators - revenue was miniscule compared to voice and SMS services; consumer usage of Wi-Fi hotspot was low and they wanted the service to be free of charge.

But the popularity of dual-mode mobile devices like smartphones and netbooks changed everything. A smartphone is capable of generating more than 30 times the traffic of a feature phone, and a netbook, 450 times. Given that Wi-Fi coverage can be offered at a fraction of the cost of a new cellular network site, Wi-Fi is becoming a strategic option for mobile operators to reduce the cost per bit of data traffic transported.

Increasingly, users have been turning to Wi-Fi hotspot services, in part, because there is no usage cap on Wi-Fi and it is often bundled with fixed line or 3G service plans. More importantly, Wi-Fi offers faster connection speeds and the hotspot user experience has been greatly improved with automatic sign-on capability built into dual-mode devices.

Ruckus Wireless offers a comprehensive product line for building hotspots of any size, in any setting. All commercial Ruckus APs can be deployed standalone for a small hotspot such as a restaurant, or coordinated by a WLAN controller for a large complex such as a hotel, airport or shopping mall.

Outdoor APs are available for public venues like stadiums, train stations, university campus grounds and entertainment districts. All APs can be meshed or wired. Ruckus even offers a residential "home-spot" AP for operators that want to quickly maximize their hotspot footprint.

Summary

With the highly efficient 802.11n networks, as well as performance- and range-enhancing features built into them by innovators such as Ruckus Wireless, Smart Wi-Fi now provides a simple and economical option to building wireless broadband access networks that can be incrementally, easily and affordably scaled as needed.

Fortunately for operators – whether they are servicing enterprises, consumers, or property owners – all the elements needed to provide broadband Wi-Fi services from multi-dwelling unit buildings to an entire city are now available in a coherent, end-to-end managed solution.

