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Simply Better Wireless.

white paper

Smarter Wi-Fi for Mobile Operator Infrastructures

OPTIMIZING FOR COVERAGE AND CAPACITY WHILE OFFLOADING DATA FROM 3G/4G NETWORKS WITH SMARTER 802.11 TECHNOLOGY

Executive Summary

With the well-publicized tsunami of data traffic hitting mobile infrastructures around the world, operators are actively seeking any and every available tool to ease the strain on mobile networks.

Operators are under pressure to offer faster data speeds to keep up with their customers' insatiable demand for bandwidth-intensive applications. But the implications are dire: the cost of transporting data is rising faster than revenue, and poor user experiences resulting from network congestion are raising churn, one of the largest costs operators incur. Consequently, operators are planning to use every option available to them including:

- accelerating LTE,
- higher capacity backhaul,
- traffic management,
- tiered pricing plans,
- femtocells and
- advanced Wi-Fi technology.

Given the enormous installed-base of 802.11 silicon embedded in virtually every conceivable device, Wi-Fi is one of the most expedient and cost-effective ways to increase both capacity and coverage with a tight focus on where traffic is heaviest.

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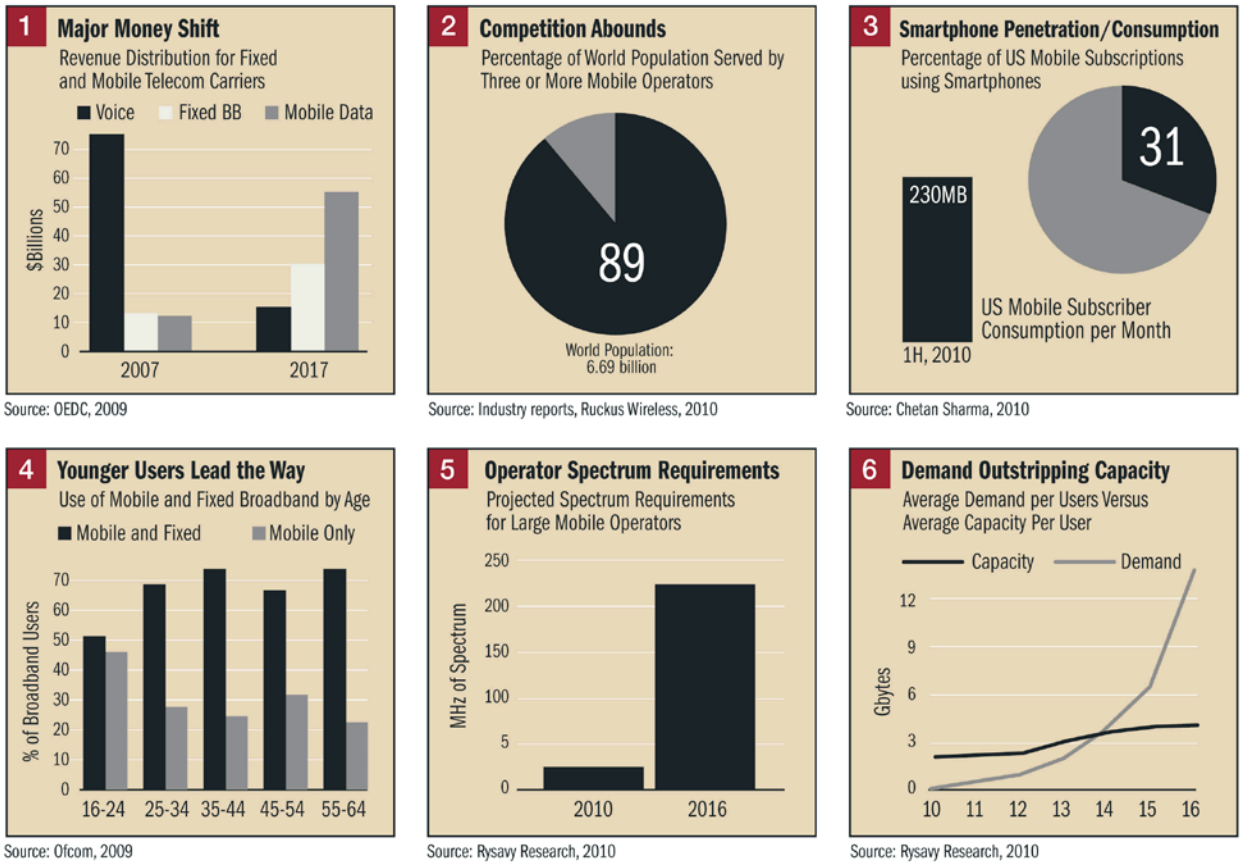
FIGURE 1: Pressure on mobile operators driving fundamental infrastructure changes



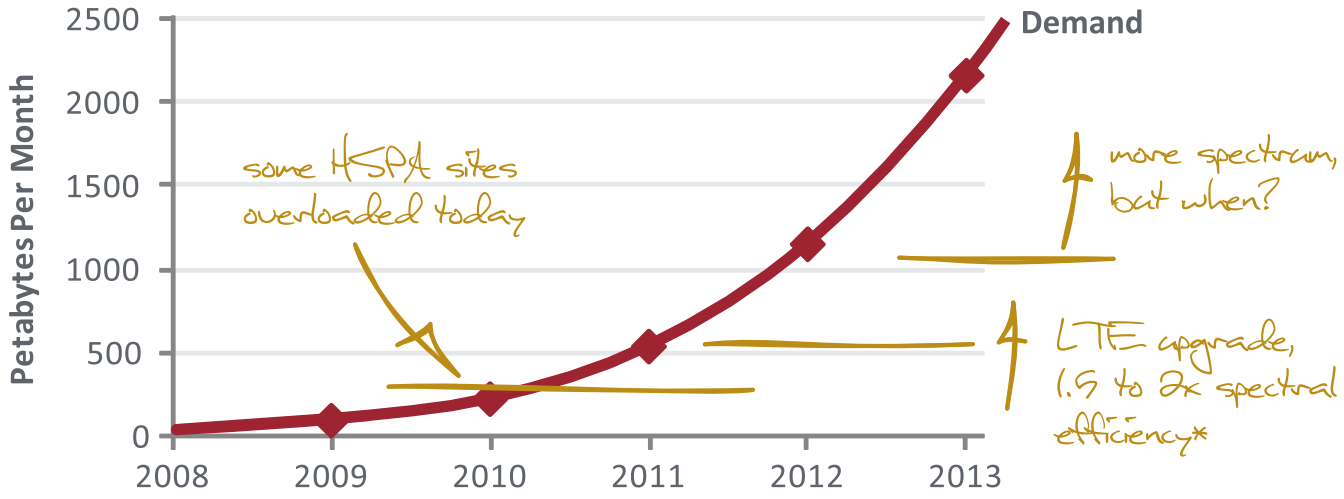
However a smarter, more robust approach to Wi-Fi that employs advanced interference rejection techniques and adaptive signal controls is required to provide the range and predictable performance expected by mobile operators. In addition, a seamless subscriber roaming experience, clean integration into the 3GPP network and a complete range of Wi-Fi form factors (from customer premise equipment to mesh access nodes, point-to-point backhaul to comprehensive network management) are all essential elements of a next generation Wi-Fi solution for mobile operators.

Ruckus Wireless has developed a reference architecture for providers that addresses many of their concerns about the integration of Wi-Fi into the mobile operator infrastructure. This next generation reference architectures addresses areas such as: increasing the reliability of the unlicensed spectrum through the use of advanced radio technology and interference rejection techniques, comprehensive end-to-end management, higher speed and lower cost long-range 802.11n backhaul links and much more.

Recent advances in RF technology through the use of intelligent beamforming, such as those patented by Ruckus Wireless, when combined with new 802.11n standards have proven to increase both the range and reliability of Wi-Fi connectivity. This enables, for the first time, a complementary carrier-class Wi-Fi infrastructure capable of delivering consistent performance, adaptable interference mitigation and more reliable Wi-Fi services for latency-sensitive multimedia applications.

These “smarter” Wi-Fi networks not only take the pressure off increasingly congested mobile infrastructure but let operators offer more reliable and higher capacity wireless access at a lower cost per bit.

FIGURE 2: Exponential increase in demand but linear increase in capacity challenges operators



Source: Cisco, "Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update," February 10, 2010.

* Rysavy Research

Ultimately, directing network traffic from mobile devices across a carrier-class Wi-Fi network that is fully integrated with the existing mobile infrastructure enables operators to maximize revenue, meet subscriber expectations and ensure sustainable growth in mobile data for years to come.

Mobile broadband growth goes up and away

Mobile operators around the globe have been caught off guard by the popularity of mobile data services and are facing an unprecedented amount of data traffic flooding their 3G networks. This is thanks to a combination of predictable flat-rate mobile data pricing, smartphones and other data-friendly devices, and new, compelling user interfaces that provide unhindered access to the same Internet subscribers know and love from their wired broadband experience. Apple's introduction of the iPhone in 2007 exclusively with AT&T Mobility kicked off this data revolution. iPhone owners consistently use more data--more than 500 MB per month — and offer higher average revenue user (ARPU) than other smartphone users. Operators expect Android-based devices to prompt the same fundamental changes in subscriber behavior as their popularity grows.

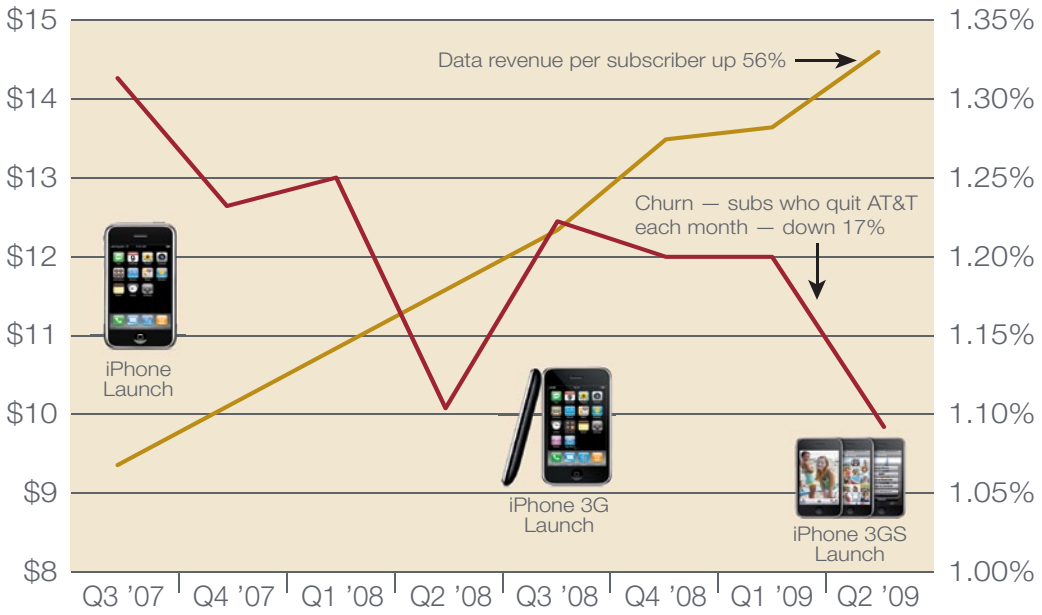
Smartphones now account for 20 percent of global handset sales, according to Informa Telecoms & Media, and sales of smartphones in the U.S. now represent more than 30 percent. By the end of 2011, RBC estimates that worldwide smartphone sales will surpass worldwide PC sales, approaching 400 million annual shipments of each.[1]

Laptop users, as expected, also consume a significant amount of data — an average of 13 GB per month.[2] Add non-traditional devices to the mix, such as the Apple iPad plus its many imitators being rushed to market now and data usage will continue to surge.

A rapidly growing portion of data traffic is data-intensive video. Industry reports project that video content running over mobile networks will make up the majority — 66 percent — of mobile data traffic by 2014. AT&T, for instance, recently announced that it will make IPTV content available on mobile handheld devices to its U-Verse subscribers, a move major European and Asian carriers are making as well.

1 "Smartphone sales to beat PC sales by 2011," Aug. 21, 2009, Silicon Alley Insider
2 "Mobile Broadband: When is it profitable?", Jan. 27, 2010, FierceWireless

FIGURE 3: Key wireless metrics since iPhone launch



Source: Company reports. Churn refers to postpaid subscribers.

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It's estimated that global mobile data traffic is now growing 2.4 times faster than global fixed broadband data traffic. The average mobile broad-band connection today consumes about 1.3GB of capacity per month. By 2014, the average connection is expected to see 7GB per month.[3]

The consequences of mobile data growth

While mobile broadband growth has been a boon for operators around the world as they face a maturing market characterized by falling voice revenues, this swift and massive growth comes with consequences.

Network usage threatens to outstrip capacity — and has already done so in select dense urban markets. This results in churning subscribers and creates a new situation where the costs associated with transmitting mobile data exceed incoming revenues.

When a 3G cell reaches its data load, the size of the cell shrinks. This slows network speeds and increases dropped sessions.

3 Cisco

AT&T Mobility is perhaps the most well-known operator struggling with a mobile data capacity crunch, thanks to its introduction of the iPhone. Company executives have openly admitted that AT&T's network has not been operating up to par in densely populated cities such as New York and San Francisco. AT&T has indicated that about 3 percent of its smartphone users are generating approximately 40 percent of the operator's data traffic, and the company is looking at ways to encourage these customers to modify their usage.[4]

Meanwhile UK operator O2, then the exclusive provider of the iPhone, recently apologized to customers after iPhone users complained of dropped calls and other reception problems.[5]

Analysts and other mobile industry operator executives are beginning to sound the alarm. Research firm Informa forecasts a 50 percent increase in mobile data traffic in 2010, but only a 13 percent rise in data revenues.

4 "AT&T chief addresses network problems in NYC, San Fran," Dec. 9, 2009, FierceWireless
5 "UK's O2 apologizes to iPhone customers over quality problems," Dec. 30, 2009, *FierceBroadbandWireless*

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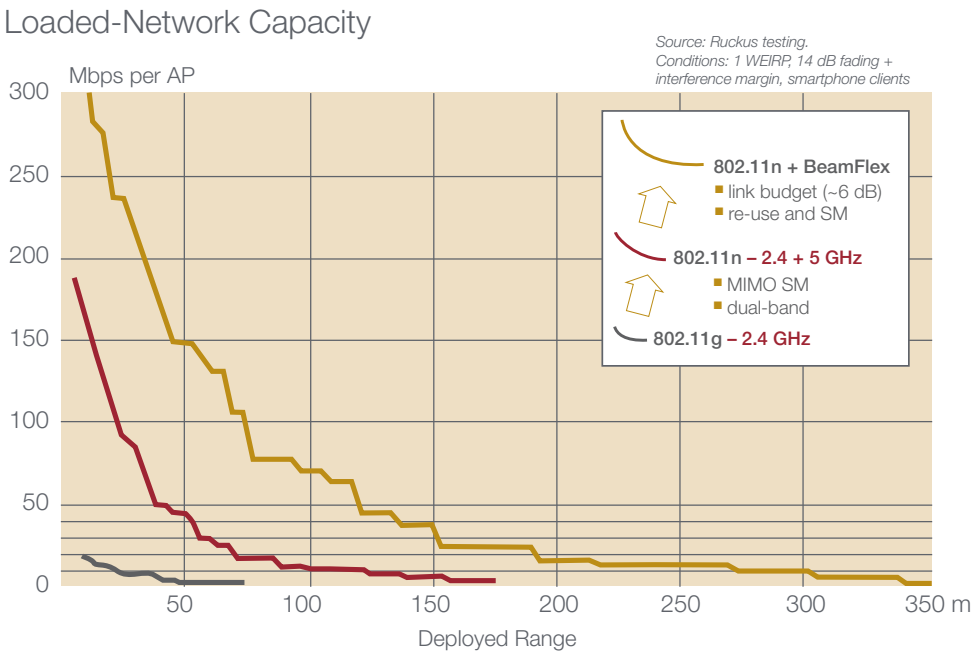
FIGURE 4: 802.11n Technology Advances



The need is evident. Operators must find ways to bring the growth of their network costs associated with delivering mobile broadband services in line with and even lower than the growth in mobile data revenues.

Offloading data traffic onto Wi-Fi networks drives down mobile data costs

As the cost of transporting data climbs, and providers begin to experience network capacity challenges, operators everywhere are looking at a number of options to ease costs and congestion such as:

- Adding more carriers to high-traffic sites;
- Implementing traffic management tools in the core;
- Accelerating plans for Long Term Evolution (LTE) deployments;
- Increasing the bandwidth of backhaul links;
- Acquiring new or re-purposed spectrum;
- Adding femtocells in force, and
- Embracing Wi-Fi networks

The unprecedented growth of data traffic means that no single tool — not even LTE networks — will solve the problem, as each solution has its limitations, including cost and time-to-market realities.

In the new “data” era, while operators still need to engineer their networks for “peak busy hours” to cope with subscribers tuning into their favorite football match on their iPhone, they need to understand that mobile architectures must support consistently higher capacity and user behavior changes. In a marked change from past models based on passive Internet content consumption, consumers are now using their always-on everywhere connectivity in a more symmetrical manner as user-generated content (particularly video) explodes.

Solving this capacity problem is not as straightforward as many think. The most natural inclination is to add more base stations. But this approach is impractical, costly and time-consuming. In many cities, there are legal limits or explicit customer pushback on installing new macro base stations. Microcell approaches with smaller-footprint radio gear can help, but in addition to hitting the same siting constraints, self-interference issues in these networks limit their density as well.

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Carriers are now considering new technologies and complementary architectures for deploying mobile networks such as multi-beam antennas and beam steering. Operators are also actively trying to offload traffic onto other networks using Wi-Fi and femotocells, for example, both in consumer and enterprise settings.

Offloading 3G/4G data traffic onto smarter Wi-Fi networks in high data use areas makes sense as a cornerstone solution of this data growth conundrum given its cost and speed-to-market advantages. Moving data off a congested mobile network onto Wi-Fi changes the economics of transporting those bits.

Telekom Austria's CEO, Hannes Amestsreiter, recently declared that the company was looking to use Wi-Fi as an offload tool to keep its High Speed Packet Access (HSPA) network from struggling under the data load. He indicated that offloading data traffic onto Wi-Fi networks could reduce traffic over mobile infrastructure by about 30 percent.[6]

AT&T is another prime example. With some 20,000 hotspots across the U.S. AT&T saw Wi-Fi usage in 2009 reach a record 85.5 million connections to the Internet — four times the number of connections made in 2008.[7] With the release of the iPhone 3.0 version software, user connections can now be transparently directed to AT&T Wi-Fi hotspots.

The case for carrier-class Wi-Fi networks

The advantages of using Wi-Fi can be delivered in either self-build or partnered models.

For tier 2 and 3 operators, partnering with a third-party wholesaler, building out standard Wi-Fi hotspots or acquiring hotspots from another provider offers the benefits of lower data transport costs by shifting traffic onto Wi-Fi networks.

Tier 1 operators can benefit today, and in the long-term, through operator-built carrier-class Wi-Fi networks.

This allows carriers to address the two essential priorities related to network operation and expansion: control and cost. However this requires a comprehensive and well-thought through architectural approach that spans the radio access network, backhaul and core infrastructure — addressing issues such as:

- provisioning,
- traffic flow,
- seamless authentication,
- lawful intercept,
- IP mobility and
- policy control and management.

Any truly carrier-class Wi-Fi data offload solution must offer the ability to seamlessly and transparently move subscribers between 3G networks and Wi-Fi hotspots — without requiring the client or subscriber to do the heavy lifting — and offer subscribers the same services and features they receive on the operator's 3G network.

With a controlled and cooperative Wi-Fi/cellular infrastructure, operators can both deliver service capacity in Wi-Fi mode as well as monetize applications enabled by higher-bandwidth connections. This allows them to reduce the costs associated with offloading data and signaling traffic onto Wi-Fi while simultaneously generating revenues.

Ruckus Wireless has made significant advances in the areas of Wi-Fi radio performance, smart meshing, quality of service, and back-end internetworking capabilities that enable both of these approaches with a complete, end-to-end Wi-Fi solution that includes true-broadband access network and backhaul elements — all of which can be deployed at a fraction of the cost of classic macro-cellular 3G/4G technologies.

6 "Wi-Fi offload should be used, claims Telekom Austria CEO," Feb. 19, 2010, *FierceWirelessEurope*
7 "AT&T Wi-Fi handles more than 85 million total connections in 2009, more than four times 2008," Jan. 25, 2010, AT&T press release

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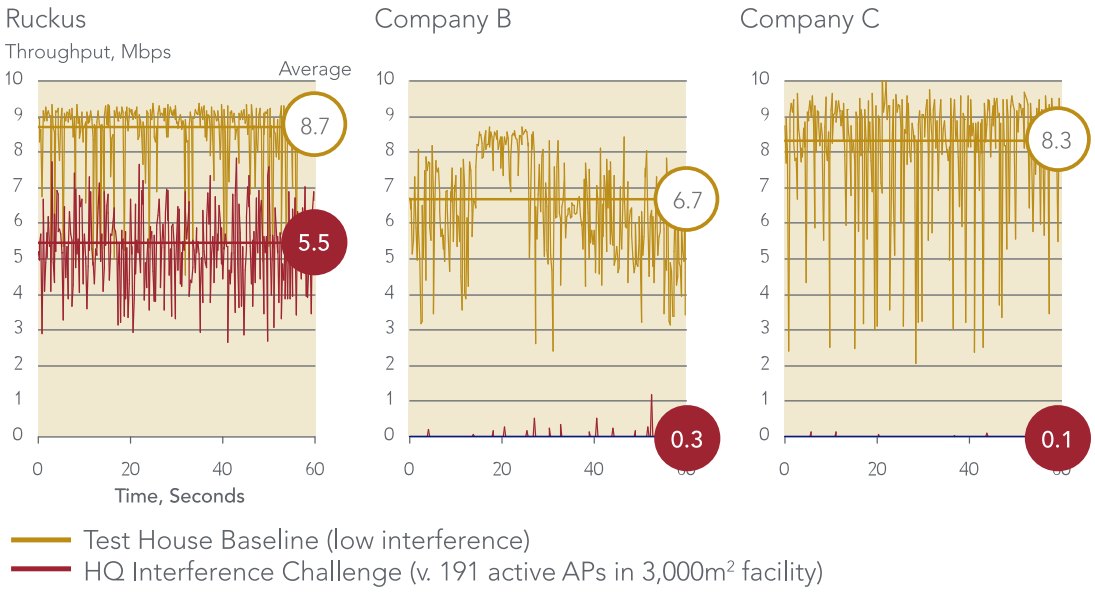
FIGURE 5: Interference management in practice: *iPhone 3G client results*



Competitive testing reveals that throughput and range is severely impacted by RF interference. The ability for Wi-Fi systems to actively avoid and mitigate interference is key to delivering predictable performance to subscribers.

Addressing cost and while providing a reliable Wi-Fi infrastructure

Operators are looking to drive down both capital costs and operating expenses in the midst of tremendous data traffic growth, while at the same time retaining customers and fighting for market share amid cut-throat competition.

Offloading 3G data traffic onto Wi-Fi networks effectively prevents operators from having to make expensive network upgrades while delivering a seamless user experience

Next-generation of Wi-Fi networks, known as 802.11n networks, have ushered in improved coverage, capacity, and interference handling of Wi-Fi, offering operators the scale they need to effectively offload 3G data traffic onto Wi-Fi infrastructure. 802.11n effectively bumps Wi-Fi's theoretical performance 10-fold and increases the range three times that of the 802.11g standard. At a distance of about 500 meters, an 802.11n Wi-Fi device can transmit data at 15.5 Mbps or higher.

While 802.11n significantly increases top line bandwidth, it remains just as susceptible to interference as 802.11b/g, and in some cases, even more so.

As a result, real-world throughput rates for typical 802.11n implementations are significantly lower than the data rates that are advertised by the standards bodies and some unscrupulous vendor marketeers. 802.11n uses "spatial multiplexing" to combine two beams of data at the receiving end, theoretically doubling throughput—but also doubling the chances of and sensitivity to interference. This forces operators to look for more reliable, carrier-purposed Wi-Fi infrastructure solutions that address these shortcomings.

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Smarter Wi-Fi developed with carriers in mind

With a heritage in innovating Wi-Fi products and technologies for telecom carriers and mobile operators, Ruckus Wireless is the only Wi-Fi company to have developed a complete, end-to-end Wi-Fi solution to help service providers address essential coverage and capacity concerns while lowering infrastructure costs and cutting deployment times. This solution uniquely provides:

- A complete portfolio of Wi-Fi products, from customer premise equipment to mesh APs to long-range backhaul systems;
- Comprehensive management of all devices as a uniform network;
- Advanced technologies, such as interference rejection, that minimizes packet efforts to deliver a wire-like predictability and a two- to four-fold increase in wireless signal propagation;
- Integrated support for multimedia applications such as IPTV and VoFi.

By moving intelligence to the edge of the access network where it can scale, limiting incremental requirements on client devices to simple “ze-ro-touch” configuration, and leveraging standard 3GPP control interfaces, Ruckus has developed a flexible, lightweight and scalable internetworking design. This new reference architecture give operators the power to quickly deploy a carrier-class Wi-Fi infrastructure that seamlessly integrates with the existing mobile infrastructure put forth in the short term while anticipating the forthcoming 3GPP standard in the longer term.

Interference rejection enables carrier-class reliability

Given the growth of Wi-Fi and Wi-Fi-enabled devices, urban environments where traffic is heaviest are usually already well populated with Wi-Fi signals. Ruckus BeamFlex technology was purpose-built for carriers looking to realize the predictability experienced in the licensed band within the unlicensed band. This patented technology uses a state-of-the-art multi-element phased array antenna system that is software controlled to form and direct wireless transmissions over the best performance signal paths and away from sources of interference — thereby minimizing packet loss,extending range, and increasing overall throughput.

This field-proven technology effectively ignores the majority of co-channel interference, even in extremely busy environments — delivering unprecedented reliability relative to conventional omni-directional antenna approaches used with newer 802.11n MIMO-based systems. This gives operators investment projection needed to leverage with confidence the attractive cost structure of Wi-Fi as a key part of their capacity strategy.

Ruckus BeamFlex smart antenna technology mitigates interference by sending Wi-Fi energy only in the intended direction, greatly increasing the range of successful spatial multiplexing. In addition, Ruckus improves 802.11n’s “channel bonding” techniques, which combine two 20Mhz channels into a single-wide 40Mhz channel, for increased throughput. With BeamFlex, channel bonding effectiveness is increased four-fold.

Ruckus technology helps guarantee that 802.11n parameters for beam forming and channel selection are dynamically tuned for optimal throughput. When enabled by Ruckus BeamFlex, an 802.11n Wi-Fi AP can reliably support up to six or more simultaneous, flicker-free, 10Mbps streams of high-definition MPEG4 video. And its inherent QoS controls allow it to provide capacity for Web browsing, email, and Wi-Fi VoIP phones, thus creating a true carrier-class Wi-Fi network data offload solution that is ideal in urban areas where interference is most problematic and where operators need to offload data traffic the most.

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Conclusion

The massive growth of data traffic is creating a strain on mobile network infrastructures. The implication is that the growth in cost of transporting data will soon outpace revenue, and a poor user experience will result from network congestion.

Offloading 3G data traffic onto Wi-Fi networks is quickly becoming one of the most attractive options for operators.

To achieve the full promise of Wi-Fi, operators need a well conceived carrier-built architectural approach that spans the radio access network, backhaul and core cellular infrastructure — addressing issues such as provisioning, seamless authentication and IP mobility. Such an approach allows operators to both offer a high quality service to subscribers and monetize services that travel over Wi-Fi.

Ruckus Wireless has uniquely developed a 3G/Wi-Fi reference architecture built on field-proven products and technologies that address seamless client provisioning and authentication, comprehensive, end-to-end network management, effortless integration with the existing 3GPP core and wire-like wireless performance and reliability.

This practical, field-tested approach provides immediate data congestion relief while offering a future-proof solution, delivering seamless subscriber experiences while eliminating any incremental software requirements on phones — a requirement critical to subscriber adoption and swift deployment — and connecting efficiently into the established 3GPP/LTE core.

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