BelAir NETWORKS

Solution Brief

Alleviating Data Congestion in Mobile Networks

Targeted Wi-Fi offload delivers fast, cost-effective relief for overtaxed 3G networks and a clear path to LTE

The statistics sound so promising. Two billion mobile broadband users in 2014 – that's 1024% growth.[1] Of course, by now it has become clear that increasing competition for this high growth market is putting downward pressure on average revenue per user (ARPU), so mobile operators have to consider how to carry more data per user for less revenue per user. Meanwhile, some operators are already considering the issue of site acquisitions for the LTE pico-cells that will be needed to meet the capacity and coverage requirements in venues frequented by high concentrations of mobile data users.

Mobile Networks in High Traffic Areas Rocked by Mobile Data Explosion

The explosive growth in mobile data applications and resultant broadband traffic has placed mobile operators in a challenging position – especially in areas of high user concentration such as shopping districts, hotels, hospitals, university campuses, retail chains, mass transit vehicles and stations and at special events. Network capacity is being taxed to the limit, threatening to degrade the user experience, while revenues from these same applications reflect the realities of a competitive market requiring customer inducements such as flat rate pricing. We are now seeing the decoupling of data revenues from data traffic (see figure 1) that has been anticipated for years.

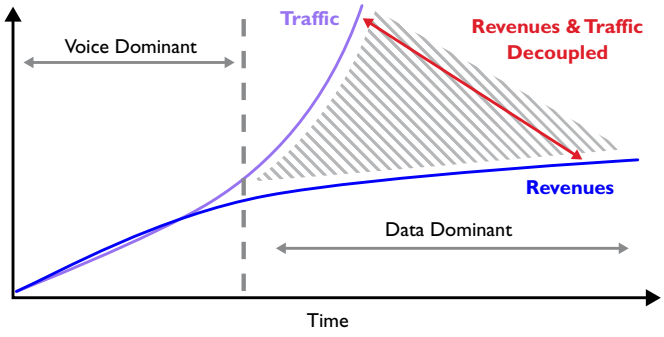

Figure 1. The decoupling of data traffic from revenues, foretold by this Unstrung Insider diagram back in 2007, is now a reality.

802.11g Wi-Fi pico-cells can provide 15 times the capacity of HSPA. 802.11n can deliver 20 times the capacity promised by LTE.

The diagram in figure 1 dates back to 2007, coinciding with some events which would eventually validate it including the launch of the iPhone in July of that year and the beginning of "all you can eat" mobile broadband offering by operator, 3, in September. A Q4 2009 study from Unwired Insight talks about 3G traffic volumes increasing by a factor of 20 by 2015, driven by many technology factors and also dramatic reductions in mobile data pricing. It points to the example of mobile broadband pricing that has fallen as low as $2 per gigabyte, "which is nearly half a million times smaller than the price per gigabyte of an SMS message."[2]

So, while network upgrades would seem imminent and unavoidable, there's no clear revenue growth justification for the required CapEx. Meanwhile, mobile operators must consider the high cost and huge risk associated with doing nothing. Of course, they are doing something. In addition to 3G upgrades, many operators have already announced 4G strategies, trials and launch dates. But while LTE (or even WiMAX) offers significant throughput advantages over current 3G technologies, the current rate of data demand promises to far outpace any increased supply enabled by tower or rooftop based 4G deployments.

"You can think of Wi-Fi as a giant offload point for wireless data traffic."

Greg Williams, VP, AT&T Wi-Fi Services

The iPhone™ is readily credited with kickstarting the long awaited mobile broadband market, delivering the mixed blessing of customer growth and reduced churn along with network outages and customer complaints to the operators lucky enough to secure early distribution rights. But the iPhone is no longer alone and, as the New York Times noted in September, 2009: "Other carriers will face similar problems as they sell more smartphones, laptop cards and tablets that encourage high data usage".

Fortunately, much of this increased data traffic is directly attributable to dual-mode smart phones many of which now feature Wi-Fi. While the iPhone represents the vanguard of this movement, Android-based devices have made huge strides in terms of market momentum. After bucking the downward trend of other mobile devices in 2009, smart phones are expected to maintain a 20% compound annual growth rate through 2014[3], by which time it's estimated that 90% will have Wi-Fi[4]. Using Wi-Fi pico-cells to offload data from 3G networks in areas of high user concentration effectively forestalls the requirement for expensive, time-consuming mobile network upgrades while delivering a positive user experience. Wi-Fi pico-cells also offer an architecture and deployment model critical to the success of future LTE networks.

3G Macro-cells and Wi-Fi Pico-cells

By now, the characteristics of the traditional macro-cellular deployment approach common in today's mobile wireless networks are understood. However, it's worth summarizing these to better understand the supporting role that Wi-Fi can play. Macro-cells were quite suitable for deploying services that were primarily voice orientated but, as data use and demand grow, these characteristics present coverage and capacity challenges that threaten the user experience:

- Macro-cell coverage is prone to obstructions by terrain and buildings resulting in cold spots in coverage and dead zones in building "shadows"
- Signal levels are constrained at distance by diffraction losses over buildings and into streets resulting in lower signal strengths and, therefore, lower throughputs
- Frequency and spectrum re-use limits capacity at central point

Macro-cells are a very effective architecture for overlay coverage. The size of the cells also results in fewer mobility handoff events while the locations of the base stations can result in good in-building coverage for tall buildings.

By comparison, Wi-Fi pico-cell coverage offers the following characteristics, enabling it to be effectively used to complement macro-cell coverage in areas of high user concentration:

- Many times the capacity of macro-cells
- Provides coverage around terrain and building obstructions reducing risk of cold/dead spots
- Signal levels are higher due to small cell sizes resulting in higher throughputs
- Frequency re-use is optimized as channels can be reused frequently

Tri-sectored 3G FDD macro-cell

- 30MHz licensed band
- 5MHz/sector
  - reuse =1 by 3
  - All 15MHz in use at each cellsame spectrum used at the next cell
- Coverage area
  - 2sqkm
  - Range to cell edge = 800m

Omni Wi-Fi pico-cell

- 60MHz un-licensed band
- 20MHz/cell
  - reuse = 3
  - 20MHz used at each cell in a attern of 3 channel
- Coverage area
  - 2sqkm
  - 30-40 cells / km^2

Resultant Capacity
802.11g ≅ 15 x HSPA
802.11n ≅ 20 x LTE

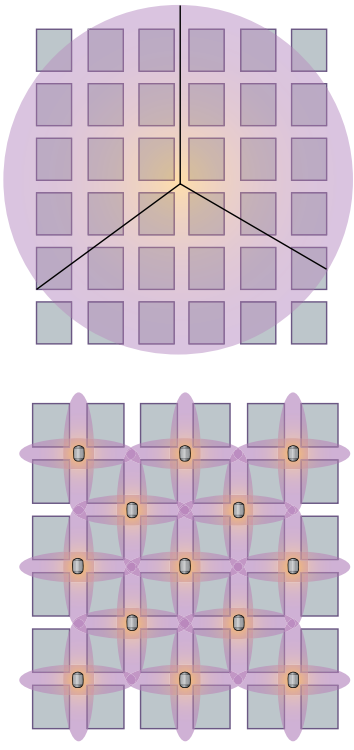

Figure 2. Comparison of 3G macro-cells vs Wi-Fi pico-cells.

With these characteristics, the benefits that Wi-Fi pico-cells can deliver in terms of capacity and user experience are clear. A detailed example is provided in figure 2. In fact, using 802.11g, Wi-Fi pico-cells can provide 15 times the capacity of HSPA and using 802.11n can result in 20 times the capacity promised by LTE.

Wi-Fi Evolution Leads to Carrier Adoption

It's fair to say the mobile carriers have not always been positive in their regard for Wi-Fi. Because it is an unlicensed band, some operators have QoS concerns. But when Wi-Fi pico-cells are focused on alleviating data congestion rather than delivering voice services, QoS is not an issue. And, in the indoor environments targeted for offload, it can be much easier to avoid the interference challenges of unlicensed spectrum.

A reasonable question arises as to how to backhaul the pico-cells. This is addressed by deploying Wi-Fi pico-cells in conjunction with existing mobile network points of presence (PoPs) or at targeted venues to take advantage of existing wiring, and expanding the coverage via pico-cells linked through high performance wireless mesh backhaul.

Many mobile operators have viewed Wi-Fi in terms of disparate unmanaged hotspots. But large-scale deployments have now proven that Wi-Fi networks consisting of more than 10,000 Wi-Fi access points, can be effectively and centrally managed. These large Wi-Fi networks have also proven the viability of both transparent authentication and mobility for Wi-Fi, enabled by medium access control (MAC) or Extensible Authentication Protocol Method for GSM Subscriber Identity Modules (EAP-SIM) authentication and advanced tunneling protocols.

Wi-Fi has also benefited from continued innovation, including lower battery consumption and better integration of connection management through auto-connectivity features.

As Greg Williams, VP, AT&T Wi-Fi Services explains: "You can think of Wi-Fi as a giant offload point for wireless data traffic. Look at the growth in smartphones and data traffic, and it's pretty clear that Wi-Fi can be a real plus to AT&T."

BelAir Network: Carrier-Grade Data Offload for Mobile Networks

BelAir Networks offers a comprehensive portfolio of indoor and outdoor Wi-Fi access points (see figure 3) that can be deployed to offload data traffic from macro-cell networks wherever mobile operators face high user concentration. BelAir Networks enables mobile operators to change the economics associated with providing wireless capacity through carrier-grade solutions that integrate with their back

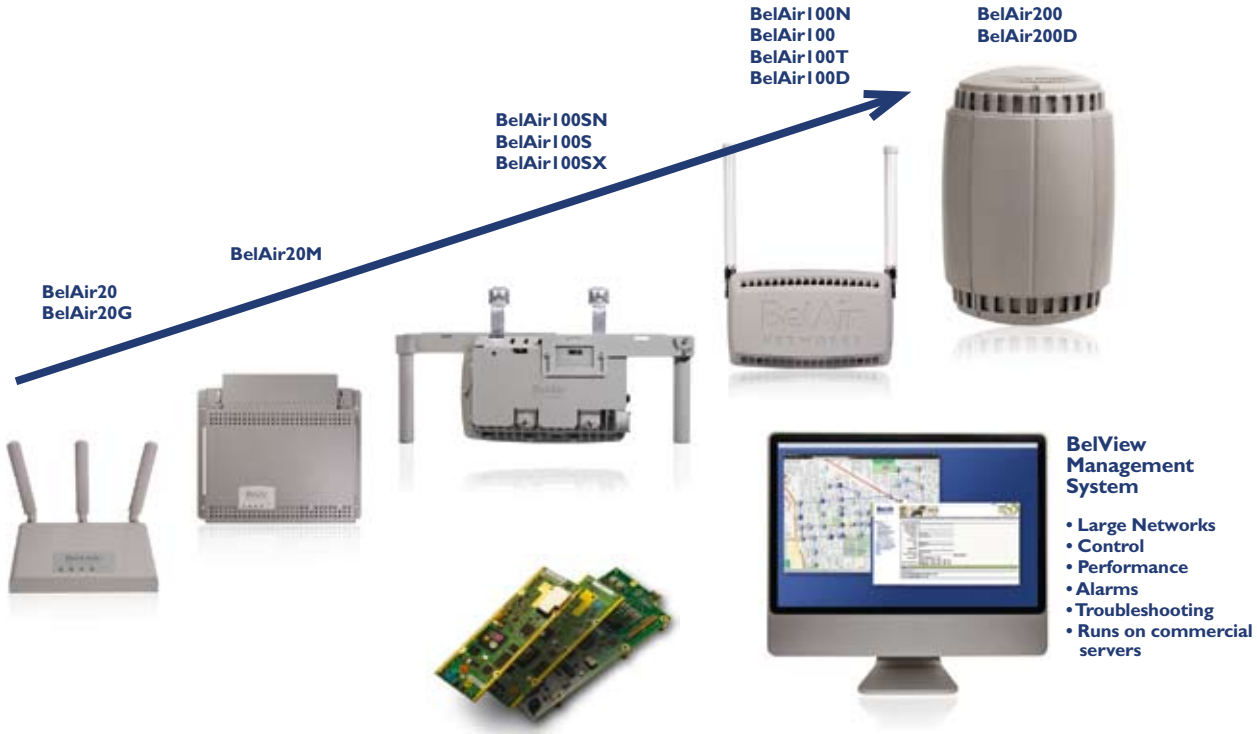

Figure 3. BelAir Networks carrier grade product portfolio addresses any data offload deployment configuration.

office infrastructure while delivering the lowest cost/bit/area. These solutions offer the fastest time-to-capacity while leveraging license-free spectrum and exploiting the availability of Wi-Fi enabled devices.

In high traffic venues, the deployment of Wi-Fi picocells also provides the opportunity for pre-emptive LTE pico-cell site acquisition. Today's Wi-Fi AP can be swapped or upgraded for LTE pico-cells, once the availability of LTE devices warrants the switch. BelAir Networks is unique in its ability and track record for supporting both licensed and unlicensed frequencies, offering products that integrate combinations of licensed and unlicensed radio mobules into single, compact and easily deployed nodes.

Whether alleviating data congestion indoors or outside, the Wi-Fi networking equipment is just one part of the offload equation. Critical to the implementation is the integration of the Wi-Fi network into the mobile operator's existing back office infrastructure to enable faster and easier deployment and reduced network commissioning. The BelAirOS operating system (see figure 4) common to all BelAir Networks products enables auto-configuration as well as remote configuration and management. BelAir Networks products can also be integrated with the mobile operator's management system to enhance subscriber and device management, authentication and location-based services.

Mobile operators can also take advantage of BelAir Networks support for multiple BSSIDs, both broadcast and private (ie hidden or suppressed). Separate encryption and authentication is supported for each SSID, as well as separate VLANs and QoS levels enabling mobile operators to support separate and distinct service offerings in a single venue. For example, in a public venue such as a stadium or conference center, an operator could offload data from subscribers while also supporting managed Wi-Fi services for the venue's enterprise networking requirements and extending branded Wi-Fi access to other operators or retail customers, all on separate SSIDs.

BelAirOS Operating System

Carrier Focused Functionality

- Downloadable dual bank flash
- Auto configuration
- Remote configuration / management
- Interfaces
  - SNMP
  - SSH / SSL
  - CLI / Web GUI
- AP features
  - Virtual AP – MBSSID
  - Advanced interference mitigation
  - RF Survey mode
- Backhaul capabilities
  - P2P
  - Mesh
  - Multi radio
- Peer-peer blocking capabilities
- Mobility features
  - Wide scale hot zone Wi-Fi device mobility
  - High speed make before break for transportation applications

Figure 4. BelAir OS Operating System features support easy integration to carrier networks.

Determining where to focus Wi-Fi coverage to target high concentrations of users can be accomplished through mapping software that enables filtering by Standard Industrial Classification (SIC) Code, identifying the locations of appropriate types of businesses and points of interest such as schools. BelAir Networks leverages these mapping tools to support mobile operators in their business and coverage planning. Of course, mobile operators can also determine where Wi-Fi coverage will best address their immediate needs by simply identifying which base stations experience the highest amounts of traffic.

BelAir Network offers mobile operators ideal high performance solutions for data offload. From carrier-grade hardware offering flexible mounting, interface and power options and plug & play auto-configuration to industry leading wide area mobility, scalability, centralized management and authentication, BelAir Network addresses mobile operators immediate need for increased data capacity while clearing the way for LTE success.

1. Ovum, Mobile Broadband Growth Forecast, April, 2009
2. http://www.unwiredinsight.com/press_rel_will3Gnetworkscope4.aspx
3. Ovum, Mobile Broadband Growth Forecast, April, 2009
4. ABI, Analyst Insider, August 2009

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