INTELLINET TECHNOLOGIES
Accelerating Convergence

Mobile Data Offload for 3G Networks

A Whitepaper

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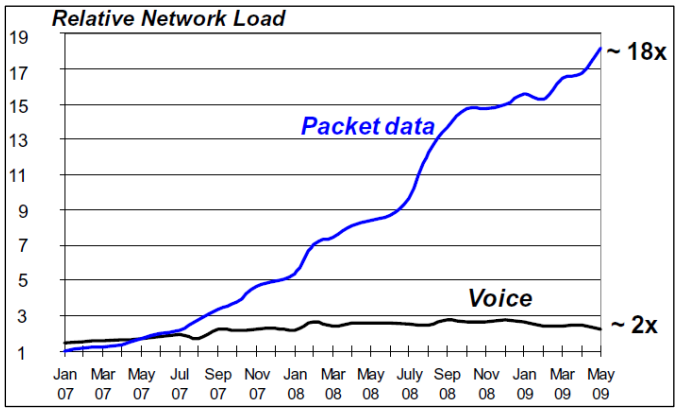
The growth and the overload

Data made its foray in cellular networks around 2002 with 2.5G networks. The initial uptake of these GPRS and CDMA-1xRTT networks was slow. There was little that could be done with clunky voice-centric handsets and lack of data services. It took a Blackberry to change that. Ubiquitous email had begun to whet the consumer's appetite for a service beyond voice. Four years later data growth was on its way to hit an inflection point. But the data deluge was just beginning. The iPhone exposed consumers to mobile internet and rich data services such as mobile video. Within a quick span of a couple of years, the operators scrambled to roll out 3G networks to support this infrastructure.

The rate of data consumption will continue to outpace technology upgrades

Engineering cellular networks is no trivial task. It requires years of planning for spectrum use, radio and infrastructure. Mobile Network Operators (MNOs) design their networks judiciously. These networks are engineered to deliver not only for current needs but with anticipated growth projections as well. For several years voice and SMS were the cutting edge services and scaling the network to subscriber growth was a well-understood task. Mobile data has been a recent phenomenon. The growth projections anticipated limited data services over conventional mobile devices. Smart-phones radically changed that. The nature of data transformed from text in emails, chat and photo exchange. Subscribers now had an easy access to streaming media for video and audio. Subscriber growth coupled with ownership of smart-phones compounds this further. The networks which could easily withstand a garden-hose flow of data are now being subjected to a pressure from a fireman's hose.

The following figure compares the growth of data relative to voice services in the North American networks. Packet data has put nine times more load than voice services. Interestingly the two inflection points for data can be traced to the release of the iPhone (July 07) and iPhone 3G (July 08).

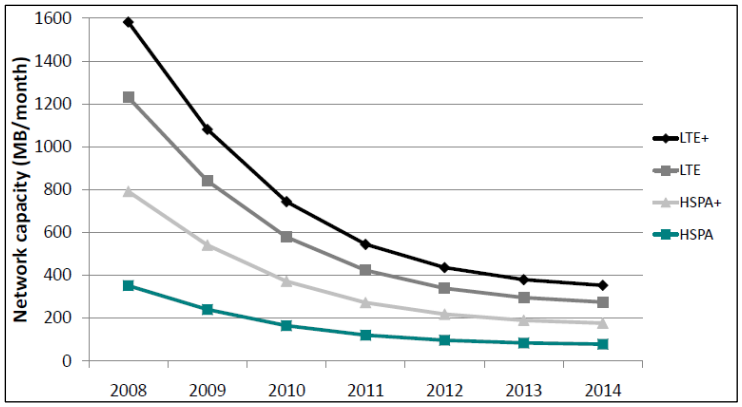


Source: Rysavy Research

Does 4G/LTE not solve the problem?

It does help to a large extent. But a catch-up game has started. The consumption of bandwidth from rich data services is not expected to slowdown. *Unwired Insight* anticipates a 20-fold growth in 3G traffic to 2014. Consumers today are using just about 10MB of bandwidth per month for audio, video, photos, software and email downloads. This will grow to an upwards of 2GB with five years. LTE delivers higher bandwidths over more spectral efficiency. The problem is however delivering to a traffic rate that is

growing as well. The consumer traffic demand shall continue to outstrip the network capacity in a similar pattern as the pressure on 3G networks.

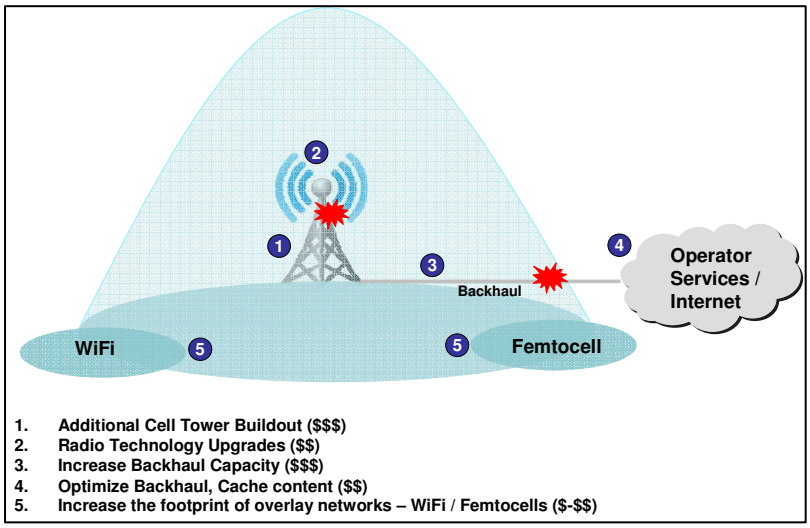


Source: Unwired Insight

Where's the problem really and how to solve it

The 3G infrastructure required to deliver data services to smartphones is creaking at two main points - radio and backhaul as shown in the figure. Radio refers to the technology used to deliver wirelessly to a terminal device. This is implemented at the cell-towers. The backhaul refers to the pipes that are connected from the core network to the cell-sites. Both radio and the backhaul go hand in hand. Wireless spectrum is a limited resource. Radio technology continues to evolve the efficiency of transmission and reception, but there are limits to how many bits can be packed into a radio stream. So how do we ameliorate the problem of an overload?

Radio and Backhaul are the main choke points in the overload phenomenon



Radio issues can be addressed by three methods: New build out, technology upgrades or innovation. Increasing capacity in underserved areas can be done by building new cell-sites. Addressing traffic demands can be offset by technology upgrade such as HSPA+. Innovation such as Software Defined Radio can further provide a newer method for rate adaptation. These options however bear high-costs.

Augmenting backhaul capacity and improvements is the next method to mitigate this offload. In several situations, more T1/OC3 lines need to be drawn to the cell-sites for carrying higher capacity. Improving the flow of traffic on the backhaul is gaining ground for innovation as well. The key is to control the flow of traffic on the pipe. This level of gating requires packet inspection. Selective packets can be throttled based on service level policy. Caching the overall content can also help to smooth the flow of traffic.

Overlay networks offer an orthogonal solution. These exploit an alternate path to deliver data wirelessly to the user at cost-effective price points. Overlay networks exploit the service provider's licensed spectrum with a femtocell solution or a ubiquitously available unlicensed spectrum for Wi-Fi networks. Both strategies extend the operator's network footprint.

The Case for Offload

We now have three methods to solve the overload: Scale, optimize or offload. The question now is which holds promise. While each method has its own merits. We need to understand an important fact of this overload. Network congestion is caused disproportionately by users.

According to the CTIA-IT Sep 2009 Keynote, AT&T acknowledged a 5000% growth in data in the last three years. It also shared an interesting fact. This growth has a disproportionate use by a few. Top 3% of smartphone users are consuming 40% of all smartphone data. They are consuming 13 times the data of an average smartphone user.

Source: ATT Keynote CTIA-IT

Offload offers a greater value to solve the overload problem over solutions of scale or optimization

Scaling the network capacity is only masking the problem. With a high cost/MB, this approach provides a broader delivery pipe. The main user segment gets a fractional benefit as the major consumers will continue to hog the increased bandwidth.
Optimization is a promising solution as it helps in flow-control. The challenge is that optimization techniques pose three challenges. The techniques to isolate heavy data users require intensive packet inspection and correlation. This has performance and cost overhead. Plus there are privacy issues and users don't like to be policed.
Offload on the other hand provides an alternate path of wireless delivery with a best performance capability. In either situation offload works effectively. If traffic for a bandwidth-hogging user is offloaded to an alternate overlay network it will relinquish bandwidth for other consumers on the macro network. Alternately, a user competing for bandwidth from a loaded macro site can be offloaded to an alternate network.
Offload can therefore be done to an alternate network. These networks can function with the macro-cellular network as an adjunct network either operating independently or as an overlay network. Both femtocells and Wi-Fi networks have their merits as candidates for offloading networks.
Femtocells leverage the licensed spectrum, offer better indoor coverage at lower power and work with common single-radio handsets. The challenge is that they have yet not reached widespread availability. This will take a few more years to reach pervasiveness.
Having been around longer, Wi-Fi offers an advantage of using the unlicensed spectrum, which means there are less of spectrum planning and refactoring issues. Access-points and

hotspots are ubiquitous, with MNOs such as AT&T, T-Mobile, Orange and Vodafone owning a large footprint. Formerly seen as a challenge of dual-mode handsets, smartphones have made Wi-Fi availability and ease-of-use an attractive feature to consumers.

Offloading Data on the Wi-Fi path

A growing number of smartphone users are already using their Wi-Fi channel to access Internet services. Is that not a data offload? On the contrary, it is a network bypass from the mobile network. Service providers need to use this to their advantage or risk losing all. The important point to understand is that Wi-Fi simply provides an access transport. The alternate path the service provider uses to deliver data must conform closely to service standards which have been set to the cellular networks.

The short answer is no. The difference lies in providing Wi-Fi as an integrated and managed service. This is possible only if the service provider can exercise control over this service. Providing this as an integrated and managed service enable the operator control the alternate path of data services through the unlicensed spectrum and help monetize this effectively on operator owned hotspots. This delivers the following value.

- Enable seamless authentication by network methods and apply service provider level security
- Deliver operator hosted/delivered content
- Leverage operator charging methods and provide better integration with BSS.
- Summarize Consumer Behavior for improving QoS and reducing churn

Operators can either leverage Wi-Fi to their advantage or make it a liability for network bypass

The minimal model of providing Wi-Fi as a managed service is to provide an access network. This is what most operators offer as a public WLAN or hotspot service. This service is typically inherited from a WISP and is therefore managed but not well integrated. Integration refers to interworking with the cellular network. A wireless service provider offers service through a cellular network. The interworking therefore must apply to the following facets

- Common authentication methods – this implies a common identity which can be authenticated from the subscriber provisioning done in the core network
- Charging – support for postpaid and prepaid charging that conform to the charging entities in the cellular network
- Mobility – seamless movement between a Wi-Fi and cellular network
- Service Integration -

The objective is to provide the consumer with the following value proposition

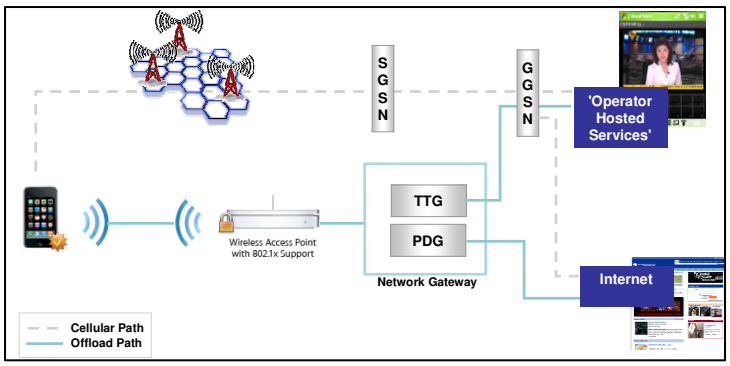
- Enable seamless and transparent access without the need to know of the underlying radio network.
- Easy or zero touch authentication while moving between cellular and Wi-Fi

Interworking WLAN for Data Offload

3GPP standards introduced the specifications for interworking WLAN with cellular networks. These standards continue the progression to enabling WLAN connectivity to the evolved packet core for LTE-4G networks. The standards-based infrastructure makes a compelling case to support the infrastructure for the data offload path. Unlike UMA, IWLAN was carefully designed to support rich data services such as streaming audio and video over the unlicensed spectrum.

The fundamental bridge that IWLAN provides is to build a trusted relation between a non-cellular entity with the core network. This is critical since the Wi-Fi path is not secure.

IWLAN utilizes the SIM based identity of the user device to provide a common authentication scheme as deployed in a GSM/UMTS network. Having authenticated the user, the next step is to setup a secure transport on which signaling and traffic can be encrypted.



IWLAN is therefore able to provide two modes of interworking. Using a Tunnel Terminating Gateway (TTG), it can expose operator hosted services typically behind a GGSN and accessible through an APN. The TTG terminates the Wi-Fi transport tunnel and extends it to GGSN connectivity. In the second mode, utilizing a Packet Data Gateway (PDG), it can provide an access to the packet data network or the internet services itself. The advantage is that this mode can offload GGSN traffic as well. Both modes are capable of applying service based local policy for enforcing QoS. Finally utilizing underlying IP-mobility based methods; it can provide seamless handoff between the cellular and Wi-Fi networks.

Putting it all together

So how does this work. As we noted most smartphones support both a 3G and a Wi-Fi channel. Devices such as the iPhone are smart enough to switch between 3G and Wi-Fi using the network preferences. An interworking WLAN client application on the handset offers the ability for two functions. First it detects the optimal radio path and has the capability to direct a switchover. This is seamless to the application and presents a transparent view to the user. Second, it establishes connectivity to an IWLAN network gateway which provides operator level control and management of the traffic flow be it to the internet or an operator hosted service. So in this situation, a user streaming video can be offloaded to a Wi-Fi channel from the 3G network.

IntelliNet Solutions for Data Offload
IntelliNet Technologies offers a portfolio of interworking WLAN products. These include the IWLAN server which can support the 3GPP modes of a TTG and PDG. IntelliNet provides the interworking elements for supporting authentication with its AAA server. The IWLAN set also includes a Voice Call Continuity Server for supporting voice applications. IntelliNet also enables offload through femtocells with its Femtocell Gateway. Both solutions are available on an Advanced TCA platform and can also be hosted on an OEM platform.

About IntelliNet Technologies
Headquartered in Melbourne, Florida with offices in Bangalore, India, IntelliNet Technologies is a leading provider of next-generation network convergence and application development solutions for PSTN, cellular, wireless and IP Multimedia Subsystem (IMS) networks. Major equipment vendors, application developers and global operators currently use IntelliNet's products for prepaid, location services, messaging and fixed mobile convergence. Additional solutions include: mobility, fraud management, and network bridging applications including SS7/IN, SIGTRAN, DIAMETER, SUPL, SIP and other emerging signaling protocols. For more information please visit: http://www.intellinet-tech.com

3G/UMTS	3rd Generation Universal Mobile Telecommunication System
APN	Access Point Name
GGSN	Gateway GPRS Service Node
GPRS	GSM Packet Radio Service
GSM	2nd Generation Groupe System for Mobile Communications
IWLAN	Interworking Wireless Local Area Network
LTE	Long Term Evolution
PDG	Packet Data Gateway
TTG	Tunnel Terminating Gateway
UMA	Unlicensed Mobile Access