The Evolution of the BTS Market: Towards 4G Technology

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Abstract

The base station infrastructure market is undergoing rapid evolution and experiencing unprecedented changes in market share, technology and business models. This paper focuses on the near term (2-3 year) outlook for the infrastructure equipment market focusing on next generation BTS architecture and high capacity microwave radio backhaul.

Introduction

While the industry remains under enormous pressure due to the current financial market upheavals, actual base station radio shipments have increased by roughly 25% over 2008 levels and are projected to continue to increase as 3G shipments overtake 2G shipments and as 4G technologies ramp up in 2010 and 2011.

Historical Background

2G GSM/EDGE technology continues to be the bulk of radio transceiver and base station shipments but the market already saw the peak for this technology in 2008 and the outlook is for this market segment to continue to decline. There are some new opportunities within GSM as the industry shifts from single carrier to multi-carrier technology over the next five years.

For the past five, the wireless infrastructure market has gradually shifted towards 3G technologies (W-CDMA/HSPA, CDMA2000 EVDO Rev. A) globally as consumer demand for more data intensive software applications has increased, driven by a new generation of smart phones like Apple's iPhone. As mobile networks are trying to understand the implications of consumer mobile data usage, networks have buckled under the strains as more and more smart phones continue to access the network.

Current Trends

China single handedly saved the wireless equipment industry in 2009 as the country began deployments for 3G technology. Billions of dollars were handed down in contracts for network equipment for W-CDMA, CDMA2000 EVDO Rev. A and TD-SCDMA base stations for China Unicom, China Telecom and China Mobile, respectively.

In 2009 the wireless industry began to write its latest chapter as Long Term Evolution (LTE) technology saw its first deployment with TeliaSonera in Oslo, Norway.

Large scale deployment will begin in 2010 across the world with initial focus on the US and Japanese markets, driven by Verizon Wireless and MetroPCS in the US and NTT DoCoMo in Japan.

According to the Global mobile Suppliers Association, there are already 64 network operator commitments across 31 countries for LTE technology. We expect that this number will increase dramatically between now and 2013. As for the "other" 4G technology WiMAX, we believe that it will be relegated to a lower level of importance for the ecosystem as global demand, while incrementally increasing, will be overshadowed by the emergence of LTE.

Near Term Opportunities

There are multiple opportunities near term and within the next decade as the wireless industry transitions to new technologies. We highlight some of the issues that are key enablers and drivers for the market in 2010 and 2011.

New Air Interface
- LTE (FDD/TDD)
- HSPA+

New Spectrum
- 2600MHz Auctions
- Digital Dividend Spectrum-European and Asian Analog/ Digital TV Transition 790-862MHz
- 900MHz W-CDMA
- 700MHz in US
- 2300MHz in China

New BTS Technology
- Integrated Radio Antennas (IRA)
- Remote Radio Units (RRU)
- Multi-Standard Radios (MSR)

New Millimeter wave Radio Technology
- E-Band Gb PTP Radios

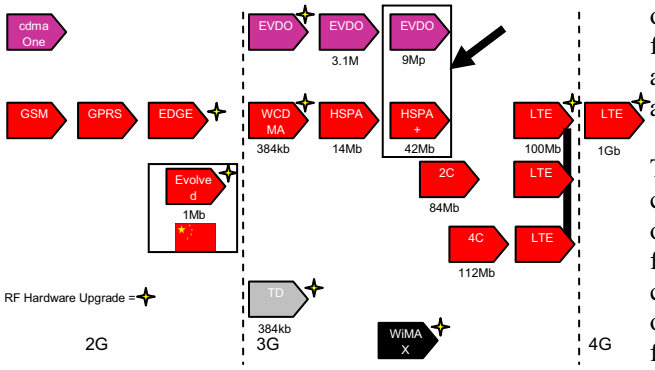
However, the single largest event that will impact the wireless infrastructure equipment market is the auction

for 3G spectrum across India which began on April 9th, 2010.

For the entire wireless ecosystem, India represents the growth of the industry in 2010 as each OEM is vying for billion dollar contracts with the spectrum winners to deploy W-CDMA.

New Air Interface
Exhibit 2 shows the evolution of the wireless air interface technologies from 2G to 4G.

Exhibit 2: Wireless Air Interface Evolution



Source: EJL Wireless Research LLC

LTE actually is considered pre-4G as LTE-Advanced (LTE-A) is the official designated 4G technology by the International Telecommunications Union (ITU) which handles all standards definitions. Current LTE is capable of downlink speeds of 100Mbps using channel bandwidths of up to 20MHz while LTE-A technology will support 1Gbps downlink speeds using channel bandwidths up to 100MHz.

The market is not expected to see LTE-A technology emerge until 2014-2015. Since LTE needs a minimum of 10MHz and optimally 20MHz of channel bandwidth, currently designated spectrum is unable to effectively handle this.

There are also two versions of LTE technology: frequency division duplex (FDD) and time division duplex (TDD). The TDD-LTE version is what China Mobile is expected to migrated its current TD-SCDMA technology to. The current users of WiMAX technology such as Clearwire in the US market have also expressed interest in using TDD-LTE to replace WiMAX.

High Speed Packet Access Evolved (HSPA+) increases current High Speed Downlink Packet Access (HSDPA) from peak data rates of 14.4Mbps to 21Mbps by increasing the modulation index within the 5MHz channels. There is also a 2x2 MIMO version of HSPA+ that can increase the downlink to 42Mbps. In addition, there are two new versions that are being released in the future, dual carrier HSPA+ (2C-HSPA+) and quad –carrier HSPA+ (4C-HSPA+) that will increase downlink speeds to 42Mbps and 84Mbps by combining multiple 5MHz channels together and using 64QAM modulation without MIMO technology. Both the dual and quad-carrier HSPA+ have non-MIMO and MIMO versions.

New Spectrum
As new technologies such as HSPA+, 2C-HSPA+, 4C-HSPA+, LTE and LTE-A are introduced, they all have one thing in common, an ever increasing requirement for more channel bandwidth. As such, the regulatory agencies and industry has looked to new spectrum to accommodate this.

The 2600MHz bandwidth is currently un-occupied and can offer 20MHz channels to mobile operators for LTE operation. This is a new frequency band of operation for the industry and as it is higher in frequency than current 3G spectrum at 2100MHz, it offers more opportunity for the industry as all deployments in this frequency band are greenfield. The majority of LTE networks will be deployed in this frequency band.

The other major frequency band of focus is what is now being called the "Digital Dividend" spectrum. This spectrum in the ultra high frequency (UHF) band is created by the analog to digital television transition for the broadcast industry across the world. The US was the first market to transition and this has freed up spectrum in the 698-728MHz frequency bands that were auctioned by the FCC in Auction 73 that was held in 2008.

The same type of spectrum will be made available across Europe, the Middle East, Africa and across Asia Pacific in the 790-862MHz frequency band or commonly called the "800MHz" band. This spectrum will be auctioned off like it was in the US market. We expect that auctions in Europe may occur by 2012.

The other major frequency band is the 2300MHz band which will be focused for China. China Mobile will deploy current TD-SCDMA technology in this band and upgrade to TDD-LTE in the future.

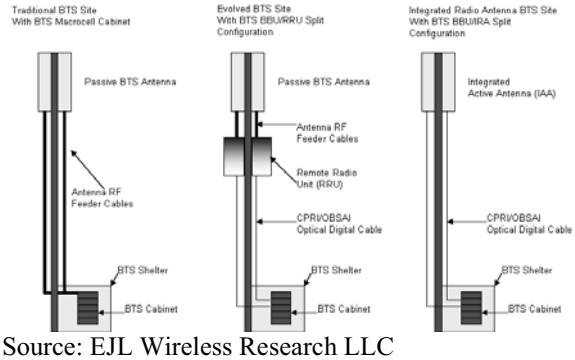
New BTS Technology
The base station has essentially stayed the same without any major changes for the past 20 years. However, the industry has recently begun migration towards a split architecture utilizing a baseband unit (BBU) and remote radio unit (RRU). Essentially, all of the RF functionality of the base station (transceiver,

power amplifier, and duplexer filter) has been removed from the cabinet and into a separate unit called the remote radio. The remaining digital, timing and network functionality of the base station is now housed in the BBT. The interface between the RF unit and the digital baseband unit has changed from a coaxial cable to fiber optic cable. The inherent 2-3dB loss of the coaxial feed cable has essentially been eliminated. The RRU is now deployed at the top of the tower mast near the RF antenna while the BBU sits within the BTS shelter or BTS cabinet at the bottom of the tower.

The next evolution of this architecture further integrates the RRU with the antenna to create an active smart antenna system called an integrated radio antenna (IRA).

We show this evolution in Exhibit 2.

Exhibit 2: BTS Architecture Evolution



Source: EJL Wireless Research LLC

We believe that the BBU/RRU technology is mainstream today and will represent a larger and larger portion of the overall BTS market as time goes by.

We also anticipate initial deployments of IRA technology and other smart antenna technologies in 2010.

Multi Standard Radio Drives Software Business Model

The multi-standard radio represents the migration from a hardware centric model for the base station industry to a more software centric model. While every generation of wireless base stations required new hardware for each upgrade cycle, HSDPA is actually a software only upgrade fro W-CDMA base stations. This also applies to non-MIMO HSPA+ as well.

In addition, with the separation of the digital functionality of the base station within the BBU, base station equipment suppliers are now able to create a software upgradeable BBU that can support multiple air interface technologies such as GSM/EDGE, W-CDMA/HSPA and LTE within the same unit. This is a change from the past platforms that required new hardware for the upgrades. However, a multi-standard base station is typically only for the BBU unless the same RF frequency bands are used for multiple air interface technologies such as for GSM900 and W-CDMA900. All other technologies that require a different RF frequency band for the air interface technology will continue to require a separate RRU for each frequency band (i.e. GSM900/W-CDMA2100).

We believe that over time, margins will continue to decline for base stations but the opportunity for margin rich software upgrades will be a key focus for wireless OEM equipment suppliers.

OEM Analysis

Within the past five years, the market share distribution within the wireless equipment market has dramatically shifted towards the Chinese OEMs. Last year, Huawei Technologies finally surpassed Ericsson as the leading supplier of radio transceivers for the BTS equipment market. ZTE has moved up fourth position, surpassing Alcatel-Lucent.

OEM consolidation has been discussed for a number of years and Nortel Networks finally succumbed to market conditions and filed for bankruptcy protection and was broken apart and sold in 2009. Ericsson was able to purchase the North American CDMA and GSM assets of Nortel to consolidate its market share in the United States. We clearly expect that Motorola is the next OEM to be broken apart within the BTS equipment market. The question remains who is a potential suitor for the assets.

High Capacity Microwave PTP Backhaul

As more and more data demand is thrust upon the mobile networks, one area within the network has is beginning to see more and more attention is the mobile backhaul equipment market, in particular, the microwave/millimeter wave point to point (PTP) radio market. The requirement for LTE base stations to need hundreds of Mb of capacity to even Gb of capacity has prompted the industry to explore where potential bottlenecks may lie within the overall network. Even through the deployments of 3G networks, the primary technology for backhauling traffic from the base stations have been PTP radios.

Typical capacities for these radios were 4xE1 (8Mbps) up to 16xE1 (32Mb) capacity. Current technology will allow a single radio link within the 7-38GHz market to support 380Mbps capacities before aggregation of radio links is needed. There is currently no solution below 38GHz that can support a full Gb of transport

capacity. The emergence of the E Band (71-77GHz, 81-86GHz) in both the US and international markets allows for relatively low modulation modems to support gigabit capacity.

We believe that LTE networks will require some amount of gigabit capacity links within the network architecture, either at the tail node or aggregation node. With Ericsson recently announcing a 2.5Gbps radio link for E Band, the market has seen validation of the business case for this technology.

Besides, E Band, the traditional microwave radio PTP market from 7-38GHz continues to be an area of long term growth as overall mobile networks will require higher and higher capacity radio links.

CONCLUSIONS

With new technologies, new spectrum and new networks planned for the next decade, the wireless base station equipment market is poised for growth with more opportunities for compound semiconductors. The push towards higher frequency bands of operation, wider channel bandwidths, and more efficient systems will create opportunities for both GaAs and GaN semiconductor products for RF switches, LNAs, power transistors and mmwave MMICs.

We expect that the base station equipment market will continue to see unit growth in 2010 and 2011 as next generation networks begin deployments.

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