WiMAX Semiconductor Companies Ponder the Future of 4G Mobile Networks

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Abstract:
Four leading WiMAX semiconductor companies - Sequans, Beceem, GCT and Wavesat- presented their outlook for 4G networks and related silicon at the May 13th IEEE ComSoc panel session entitled, "**Semiconductor Evolution to 4G: Mobile WiMAX, LTE, and other 4G technologies**." This article will summarize that session and include additional comments from other experts on the journey to 4G mobile networks.

Before we dive deeper, let's consider what 4G actually means and network operator challenges that are driving them to deploy 4G networks.

Backgrounder: 4G definitions and challenges ahead

- To the standards purist (like this author) 4G networks will be based on ITU-R IMT Advanced recommendations, which are not yet completed. It is expected that LTE Advanced (3GPP version 10?) and the 4G version of WiMAX (IEEE 802.16m) will meet the LTE Advanced requirements and will be accepted as 4G standards. For more on the purist's view of 4G, please see reference 3. below.

- Many others believe that the initial version of LTE (3GPP release 8) and Mobile WiMAX (IEEE 802.16e) are 4G network technologies, because they already have the key building blocks required by 4G: OFDMA, flat- all IP- network, fixed or mobile operation, MIMO, hybrid ARQ (Automatic Repeat reQuest- for repeat transmission of mis-received packets) at the PHY layer, multi-megabit speeds delivered to users, etc. Those folks say that only incremental advancements will be made in future ("official 4G") versions of the respective standard.

- China may have its own 4G standards as well, making for a very confused 4G world. For example, China Mobile is said to be planning for a TDD version of LTE that will be backward compatible with TD-SCDMA and GSM.

- Whatever you think 4G really is, the wireless network operators will be forced to move forward with their 4G deployments in the next two to four years. Why? The amount of mobile data and video traffic continues to explode and 3G networks (which are packet over TDM overlays) will not be able to handle the speed requirements of many simultaneous mobile data/video users. Data caps (e.g. bandwidth metering) will have to be instituted which will frustrate and annoy users.

Let's take a look at some of the challenges mobile network operators face on their evolution from 3G to 4G networks. We have previously written that smart phones and "all-in-one" gadgets are driving the need for more bandwidth and QOS. This past week, AT&T CEO Randall Stephenson stated that networks were becoming choked by increased smart phone data traffic. This dynamic is already accelerating the movement to 3.5G mobile data networks and will eventually push operators to 4G. Reason: 4G networks offer more bandwidth per user, are more bandwidth efficient (e.g. OFDMA and MIMO), and are "all IP" packet based (vs. TDM overlays). For more on how network operators might deal with the mobile data explosion, please see reference 4. below.

Notebooks and netbooks will be heavy user 4G clients, because they are capable of much higher sustained throughput when uploading or downloading large (multimedia, video or zip) files. Multiple concurrent PC users will likely stress test a 4G network's performance guarantees. In particular, 4G networks will need to provide large amounts of bandwidth to multiple simultaneous users along with QOS for differentiated services and applications.

But what are those new services and applications? A huge problem for wireless operators is that their revenues are not keeping pace with the great increase in network bandwidth consumed and the need for QOS to support multimedia and "rich media" applications. Hence, revenue producing services must be developed and come to market quickly for operators to get a decent ROI on their investments in next generation mobile broadband networks.

Mobile video, gaming, music streaming, smart grid sensors, location based services/ advertising, and other applications have been hyped for years, but no sustainable business model(s) has yet been developed for them. Eventually, the market will determine the apps and revenue models (charging vs. advertising) that succeed or fail.

Session Presentation Highlights:

Lars Johnsson of Beceem expressed what seemed to be a consensus view of the four semiconductor company panelists: "Wireless is the hard part, silicon is the easy part." The basic premise is that the algorithms needed to achieve good performance on an OFDMA based wireless broadband link is more difficult then designing the silicon for that same link- especially when the end point is in motion. The broadband wireless design challenge starts with constantly changing signal strength and it gets more difficult once the terminal starts moving. Some of the wireless design issues Lars identified were: signal tracking (to improve performance under all conditions), channel estimation (allows for better decoding), high-speed mobility, hand-off (from one base station to another), maximum likelihood receiver (improves receiver sensitivity), interference detection, and noise cancellation.

Ambroise Popper of Sequans stated that many core silicon functional blocks, now used in WiMAX (IEEE 802.16e-2005) can be leveraged for 4G: the OFDM modulator/demodulator, FEC, Channel estimation, and MIMO processing. Sequans plans to facilitate a smooth evolution to 4G for WiMAX network operators. They plan to develop and offer converged dual-mode IC's for backwards compatibility with Mobile WiMAX devices. Those components will fully support the existing 802.16e and either 802.16m or LTE (dependent on market demand). They see efficient low-power implementation and radio performance as key differentiators between 4G and Mobile WiMAX/802.16e.

Sequans CEO Georges Karam believes WiMAX/802.16e is providing economies of scale to network operators that plan to offer both fixed broadband wireless and mobile services. Of course, the big semiconductor growth opportunity is in the mobile space, since all the smart terminal devices and gadgets would contain 4G chips and radios. Georges believes that LTE is the future, but the issue is when will it be commercially realizable to large number of customers? He predicts that LTE won't happen till 2012. Nonetheless, Sequans plans to sample an LTE chip set (baseband and RF)

sometime next year. It will evolve over the next three to five years to meet network operator requirements and have backward compatibility via dual modes.

Alex Sum of GCT presented a very pragmatic assessment of the WiMAX vs LTE debates. He first highlighted the cellular, WiMAX, and Wireless LAN paths, which all converge to 4G.

-Please refer to GCT Slide 2 here-

Alex believes that most WiMAX operators are 'green field' operators, while legacy cellcos are generally looking to LTE. The Greenfield WiMAX carriers are characterized by the following attributes:

- They do NOT own existing cellular networks (with a few exceptions[1]), but in large #s
- They provide low cost alternatives to higher cost DSL, and high cost 3G services
- They provide data speed much better than current 3G, and even 3.5G cellular
- They are serving developed, as well as under-developed countries
- They are meeting the 'market hunger' for high, uninterrupted data speed
- With mobile dual mode devices available, it levels the wireless playing field
- IEEE 802.16m, if it is released in time, will match those higher performances of LTE

Alex correctly observes that most 3G cellular operators are committed to LTE deployments. The LTE line-up includes an awesome bunch of cellco's: Verizon and Verizon Wireless, Vodafone, KDDI, DoCoMo, CMCC (China Mobile is planning TDD-LTE). Here are some of Alex's observations and expectations for LTE:

- LTE FDD development is ahead of TDD by at least six months (FDD needs two transmit/receive chains and is hence more expensive to implement than a TDD component)
- Just like UMTS and WiMAX, initial LTE device introduction will follow a maturation trend, but of course there will be some surprises
- LTE will be data-centric with PC data cards, USB dongles, and smart phones
- Femto APs will be developed and installed within homes and buildings (for better indoor penetration and to take traffic off cellular networks)
- Finally, embedded devices and handsets will become available

From GCT's perspective, WiMAX is and continues to be a very viable market. It is a growing into a very large world market, certainly not a niche. It will pay off handsomely for all those who have invested and persisted. The strong eco-system being built-up by WiMAX will enable IEEE 802.16m to prove itself to be a strong competitor for LTE. WiMAX and LTE are both OFDMA based, so they could be complimentary offerings, and could even converge. GCT is keeping a close eye on the industrial trend and commercial developments.

- Please refer to GCT Slide 5 here-

Editors Note: GCT's Mobile WiMAX Wave 2 single-chip GDM7205, which supports both 2.3GHz and 2.5GHz, has been integrated into LG Innotek's new M-WiMAX SIP module. This module is said to be the smallest Mobile WiMAX module available today.

[1] Sprint's WiMAX service was spun off to the new Clearwire. They are now only a MVNO for the Clear WiMAX service.

Raj Singh, CEO of Wavesat- an innovator in multimode 4G baseband chipsets – touted the company's Odyssey architecture, where a single vendor programmable chipset can be used to support WiMAX/802.16e, LTE and XGP in different versions/ part numbers. A vendor programmable Air-Interface chip architecture was said to offer flexibility and "uncompromised" performance. The following Odyssey attributes were highlighted:

- Programmable 4G PHY layer
- WiMAX Wave 2 (MIMO Matrix A & B, beam-forming and Hybrid-ARQ), LTE[2] Cat 3, XG-P 1.0 (Japanese version of 4G)
- TDD & FDD with channelization of up to 20 MHz
- Adaptive modulation schemes (up to QAM-256 in DL and UL), up to 1K FFT, multi-zone support per frame and advanced FEC techniques
- Enhanced Security Protocol (EAP, AES and PKMv2)
- OTA In-field programmable

Raj suggested there were several 4G market segments, defined by category:

1. Fixed Data Access: Last Mile backhaul, DSL replacement, Femotcells
2. Data Mobility: Notebook, MID, UMPC, Handset
3. Embedded: Security Cameras, Game consoles, Wireless HDMI, Digital cameras
4. Voice: VoIP, GSM, CDMA

There might be several 4G Wireless Standards in different parts of the world, with some countries going with WiMAX, others with LTE, or their own home grown versions of 4G (e.g. Japan and China). [Author's Note: If there were too many 4G variants, the worldwide 4G market could be fractured, with insufficient volumes to drive prices down. Further, there would be serious interworking and roaming problems for users that traveled.]

Advances in semiconductor technology were seen as an enabler of 4G network and device capabilities. In particular:

•Very dense process geometry
•Very low power (needed for long battery life)
•Mixed signal availability on bulk CMOS
•CMOS volume drives pricing
•Dense geometries allow significant integration

4G Discussion Topics:

The consensus belief of the four participants was that WiMAX/ 802.16e is a very credible competitor to 3G networks and it will be a commercial success - even if true mobility doesn't happen on a large scale. The networking technology just "won't be as sexy." While all of the companies mentioned are offering WiMAX components, only Sequans and Wavesat stated they were also developing LTE chips/ chip sets.

[2] The commercial introduction of Wavesat's LTE baseband component was not disclosed.

During the panel session, Ambroise Popper of Sequans said it was not likely for a semiconductor company to combine 3G and Mobile WiMAX on the same chip/ chip set, because those two wireless networks would generally not be built out by the same network operator. (Again, the one exception we know of is SPRINT, which has its EVDO based 3G network and will be a MVNO for Clearwire's Mobile WiMAX service.),

Jose P. Puthenkulam- Intel's WiMAX Standards Director and 4G visionary- recently commented on the MVNO model and shared network approach to offering 4G services: "I feel the model where every operator goes out and builds a nationwide wireless network is broken. It creates an entire duplicate network infrastructure and results in more costs being passed on to the end user. With network sharing and MVNO models, there is more scale and also better capital efficiency and overall end users will get more affordable services."

Jose also has a strong opinion on mobile VoIP: "I see Mobile VoIP happening on WiMAX first even before LTE. The reason is that today 3G networks have been designed to also support Circuit Switched (CS) voice. So as 3G voice is primarily still going to be circuit switched, there will be a push to continue CS voice over LTE networks to maintain seamless behavior.

One huge advantage for WiMAX is that it has no legacy (backward compatible network) and therefore will be able to always use Mobile VoIP. That allows for rich augmentation of voice services. However LTE networks with CS voice will be the same old cellular voice (to be backward compatible with 2G and 3G) for some time to come."

References:

1. The May 13th ComSoc session presentations and speaker bios can be accessed from:
http://www.ewh.ieee.org/r6/scv/comsoc/ComSoc_2009_Presentations.php

2. At our March 25th meeting, Intel presented a Mobile WiMAX Update and IEEE 802.16m (the 4G version of WiMAX). Presentation is at:
http://www.ewh.ieee.org/r6/scv/comsoc/Talk_032509_WiMAXUpdate.pdf

3. Are LTE and mobile WiMAX really 4G networks? A look at ITU-R IMT Advanced Requirements
http://viodi.com/2008/12/30/itu-r-imt/

4. **How will wireless network operators cope with the coming bandwidth bottlenecks of the 'Zettabyte Era?'**
http://wimaxcommunity.ning.com/profiles/blogs/how-will-wireless-network