One of the most talked about ‘killer apps’ for GaAs is broadband wireless connectivity: 3G and Wireless Interoperability for Microwave Access (WiMax). It is upon cost-effective manufacture of RFICs that these businesses will depend. By no means can III-Vs be said to have cornered this market. In fact SiGe and even SiC are already making a play. When searching the Internet for WiMax, there is much conflicting opinion as to the full-scale viability of the technology. That is to be expected at this stage of its development and deployment.

GaAs and silicon contend the WiMax markets

In their eagerness to promote them there are always some who get a little ahead of the practicalities of any new technologies. If they were right, then there would be a Blu-ray DVD in every home and radar in every car by now. These technologies will likely succeed, but in their own time.

The market is filling in the gaps so to speak. Internet connections are going to get faster and at the same time broadband is going to be more widely available. With Wi-Fi, 3G and WiMax there will likely be nowhere on Earth that isn’t permanently connected to the net. Whether that is a good thing or not is down to individual opinion.

There could well be for some time a mix of semiconductor materials required for portable and base-station equipment. It is clear that LDMOS - barring some revolutionary development - is not the material of choice. For once it could be that III-Vs will hold sway. Yet various new silicon technologies already look promising too.

One of the pioneers of wide bandgap electronics, Cree Inc, chose the industry’s largest meeting, the IEEE/MTT-S to reveal that it is already shipping samples of a high power SiC MESFET optimised for broadband wireless access and WiMax.

As Cree said, SiC MESFETs offer nearly double the operating voltage and four times the achievable bandwidth compared to traditional technologies such as silicon LDMOS or GaAs. Because it can run hotter, reliability and lifetime are also promised. It is indeed surprising that SiC can be ready so soon.

Monolithic hybrid

However, SiC is even further behind than GaAs in one of the key areas, that of monolithic integration. Hybrid technology may be acceptable for base stations but not for LAN cards or handhelds. SiGe Semiconductor is using GaAs switches for the moment but in time the transceiver will be all-SiGe and the price will really come down with WiMax on a chip, so perhaps this is not going to be an area where SiGe technology can find a slot.

However SiGe may have some good efficiency figures at the requisite frequencies, but the power handling is not there yet, which indicates it may not yet be ready for WiMax PA applications (WiMax PAs require output powers of >$2W using OFDM modulation).

Even so, Fujitsu and SiGe Semiconductor are working together on WiMAX chips in SiGe. SiGe Semiconductor has been leveraging its RF experience to penetrate the WiMAX market. The company recently introduced four chips to cover the signal chain up to the WiMAX baseband, including the SE7351L, a 3.5 GHz RF transceiver chipset. Moreover it has a chipset which includes a GaAs switch.
Finally, another question arises as to what will have become the standard delivery method for multimedia in ten years time. Many are hopeful that fibre optics will still be there. Some operators may use fibre-free laser links. But the likelihood is that it will be completely RF-based wireless connections for computing and multimedia comms. Every home and office will use WiMax type technology at 100 Mbit/s. Much is at stake, but you can bet it will not be for want of trying should it fail. The troubling thought is that GaAs will not be there. Because of the lack of integration the transceiver costs will be too high for the price window needed to make the systems ubiquitous. The industry is in a cleft stick situation. Without the market, it cannot justify the expensive investment required to integrate all the components, and even if it does it will likely not be so readily matched to the downstream CMOS circuitry.

Seeing as SiGe has so much potential interest in this hot topic, readers will be wondering if the market might divide up into two areas only one of which will see III-Vs taking significant market share - power amplifiers in base stations and possibly for WiMax PAs for portable devices (and not portables which will be dominated by SiGe). So is GaAs doomed as far as these broadband apps are concerned, or is that too negative?

Some people disagree: GaAs has a place. However, for radio transceiver devices, they think that SiGe is a better option, in that it gives good performance with lower cost and better integration (especially RF + digital) capabilities.

“SiGe is the optimum technology for WiMax transceivers, but GaAs is certainly still going to be a strong contender for the PA devices due to the relatively high output power requirements. However, process modifications are possible that would enhance the output power of next generation SiGe technology offerings,” said Teddy O’Connell at IBM.

Readers will also be keen to understand how Cree thinks SiC can figure in WiMax etc, especially since SiGe Semiconductor, et al, stress the importance of monolithic integration. “One of the key properties of SiC is very high breakdown, eg 48V breakdown voltages. This may well find application for power amplifiers, particularly for the base station devices.

“For the transceiver devices SiC is not really an option and SiGe is a better technology (cost, power consumption, integration).”

The question is: are we talking about two distinct things here? Is Cree after base stations and the SiGe chips are for cards and phones? “Yes, I think so.”

**Power issues**

Power is a key issue too. Will SiGe single chip transceivers for WiMax get too hot? LDMOS is obviously not a contender for this reason and others. “For the cards and cell phones it is possible that SiGe will be sufficient to handle the power requirements, depending on the power requirements, but for output powers up to say 2 W, SiGe may be sufficient.”

Another key player in the field is of course Canada’s SiGe Semiconductor. III-Vs Review spoke to Andrew Parolin to find out more about their view. The company launched a key, new chipset for WiMax in March. This SiGe chipset has two chips but he says that in due course it will be an all-monolithic solution. “It is broken down according to presently reliable and high performance technologies meaning that you have the 3.5 GHz RF chip plus the IF chip. All you need is a few external filters etc., for a complete radio transceiver solution eminently suitable for WiMax and related wireless applications.”

The forthcoming total integration of these chips will be a confirmation of how the market is expected to progress and the applicability of SiGe. “Noise, power, efficiency etc., are all key factors for wire- less broadband and so on. SiGe can fulfill all of these but goes one better thanks to integration. This is especially true when you include other semiconductors like GaAs and SiC. For the short-to-medium term I can see SiGe BiCMOS as a preferred solution. Maybe later RFCMOS will also become important but it is relatively immature for WiMax at the moment.”

The WiMax market is proceeding in two stages. “The consensus is that first application opportunities will be the boxes outside the home or office. Later it will be smaller form-factor single-ship WiMax transceivers for portables. A third generation some years off will exploit ultra-small applications.”

**Geography dictates**

Geographically, SiGe Semiconductor is seeing wide interest. “But deployment of WiMax will likely appear first in Asia and Africa - where broadband needs to be delivered wirelessly due to lack of infrastructure. The advantage of the 3.5GHz spectrum is that it is available worldwide. In the USA, we are addressing the..."
The 2.5GHz and 3.5GHz markets. The 2.5GHz is allocated spectrum that has been purchased, where the 3.5GHz is available to many ISPs.

What other factors will likely come into play and how does WiMax measure up to other wireless datacoms? “SiGe is well matched to most of these such as Bluetooth and Wi-Fi etc. We have been on reference designs with market leaders such as CSR and Broadcom so as to maintain our leadership position.”

Meanwhile, it certainly doesn’t look as if the merchant GaAs RFIC players are intending to give up on WiMax. Several key new products for this market were launched at MTT-S. TriQuint has added a pair of new amplifiers for applications including WiMAX. “TriQuint is committed to providing a full line of RF components for BWA and WiMAX applications. These markets are cost sensitive, and TriQuint is ready with high performance products that are easy to use and cost effective for the manufacture. The new components further expand our existing line-up of discrete HPA products for the 2.5, 3.5- and 5.8-GHz frequency bands, and soon-to-be-released MMIC PA/Drivers,” said TriQuint’s Broadband Products marketing director, Dan Green.

Toshiba is offering new high gain, high linearity internally matched GaAs FETs for use in amplifiers and microwave digital radios for 3.5 GHz and 5 GHz fixed wireless access systems including WiMAX etc.

“Recent progress in standardisation of broadband wireless is expected to spur significant interest and growth in this market,” said Toshi Nakamura, business development manager, Microwave Devices, for Toshiba America Electronic Components, Inc. “Although proprietary terrestrial microwave networks have been in existence for many years, recent support for WiMAX and U-NII FWA systems in leading personal computer and network chipset solutions, combined with other industry efforts to standardise FWA networks, is likely to help expand the market, particularly in geographic regions without widespread availability of DSL or cable.”

“Our new devices provide a powerful combination of high gain, high linearity and output power up 48dBm,” he continued. “This high output power level is sufficient to support advanced features including orthogonal frequency division multiplexing (OFDM), a modulation scheme that enables broadband wireless systems to support non-line-of-site service.”

Traditional microwave communication systems have been point-to-point, with a requirement for line-of-site connectivity. OFDM eliminates the line-of-sight requirement, but requires a much higher peak output power to operate.