

## **TITLE: THE RACE FOR THE 802.16 CHIPSET MARKETS**

The first 802.16-2004 Red d compliant chip is finally being shipped to BWA equipment manufacturers by Montreal-based Wavesat Inc. The DM256 is a baseband IC developed by Wavesat and manufactured in France by Atmel. It is being shipped only to current Wavesat customers which issued POs varying from a few samples to several thousands of units. The chip is said to meet all WiMAX and 802.16-2004 specifications for both the base station and subscribers systems.

The Wavesat strategy from the time it decided to focus its energies exclusively on 802.16 baseband chips was to be the first to market, one way to differentiate itself from its rivals and especially the giants Intel and Fujitsu. Wavesat has done just that.

### **Context**

Wavesat has been working on OFDM technologies for more than 7 years to create its 6<sup>th</sup> generation product, the DM256. . Founded in 1993, it started developing amplifiers for the satellite and cellular industries . Much of its customer base was in the early stages of the broadband wireless industry, albeit in the pre-standard days. However, in 2003, the company changed directions and sold all of its primary technology in those areas to Mitec Telecom. The portion that remained with Wavesat was its Broadband Wireless Access business unit established in 1997.

“We lost the bulk of our revenue and employee base at that time,” Guay, CEO of Wavesat said. The new version of Wavesat had 25 employees and revenue in 2003 of less than \$100,000. The number of employees has jumped to 52, with revenue increasing to \$1.5M by year-end 2004. He expects the head count to double in 2005 and revenue to increase 10 times.

Selling the bulk of the company and refocusing on an emerging market put Wavesat back into a startup mode, and it went to the venture market for funding to go with the income it gained from the sale. Its latest round was for \$10.5M and included Pac-Link Management., Skypoint Capital, BDC Venture Capital, Monet Capital and Sunsino Ventures Group.

### **Strategy**

In the past year, Wavesat had been selling development kits to more than 30 companies around the world with a special focus on Chinese companies. Development kits included: digital cards, source code, FPGAs, and engineering support.

It is developing chipsets for both base station and customer-premise equipments. At the same time, it is feverishly working to develop an 802.16e offering, the mobile version of the WiMAX technology. This is the sector that looks to be the largest portion of the

WiMAX market, so it is even more important that the company has an established record to show customers when that emerges. A company can miss in its first efforts in the fixed broadband wireless market and still recover, but if the mobile version develops as predicted, the margin for error will be much smaller.

The next logical step for Wavesat will be to sell reference kits with added features such as RF cards and MACs from partners. Reference kits will go for \$50K each. It has already sold Development Kits to more than 30 customers.

**What does it mean for the overall 802.16 chipset roadmap?** A subscriber station or CPE is composed of three main elements: The PHY which includes a base band, the MAC (Medium Access Controller) and an analog RF front-end that serves as the means to place signals into a specific frequency band.

Equipment vendors look to chip makers to provide complete reference designs, bill of materials, components, software/firmware to manufacture WiMAX- certifiable equipment.

Wavesat is shipping the base band or PHY layer for subscriber and base stations and wants to remain a PHY only manufacturer. The price point of the current base band is \$35 for 10,000 units and lowers for larger volumes. Wavesat is partnering with Agere Systems to integrate RF front-ends for the 5.8GHz band and with RF Magic for the widely international 3.5 GHz band. The final development to an Integrated circuit will be completed in the next 6 months with partner Atmel.

As far as the MAC, Wavesat is still developing partnerships with other companies due to limited resources and time to develop, “to develop a MAC requires 50 full time software engineers” says Frank Draper, VP Marketing & Sales at Wavesat.

With a total of 40 engineers ( See Table 1) focusing on the development of the next generation in-door chipset which will be called “Shark”, and later the mobile version 802.16 e, Wavesat believes it has enough on its plate for now and will thus integrate and “distribute” MACs into its system on chip. The next generation chipset due at the end of 2005 will include subchannelisation on both the uplink and downlink to allow a gain of 12dB and thus better link budgets for true Plug & Play indoor installations.

To summarize, Wavesat is shipping basebands for subscriber and base stations to a limited number of customers and claims general availability at the end of January 2005. RF reference kit will include first the unlicensed 5.8GHz band.

**So what about base stations?**

Wavesat claims a low cost base station at \$2,000 per sector can be produced by integrating their base band DM256 along with a 1GHz processor and the RF front-end, with API interfaces and drivers.

While silicon is available, equipment vendors have still to go through the WiMAX plug fest and certification with at least 3 other vendors to be considered WiMAX certified.

The next generation chipsets for base stations will include four separate FPGAs that are programmable with a basic MAC processor.

### **Overall Cost**

Wavesat also announced a strategic partnership with EDOM Technology Co, for the distribution of its chips in Taiwan and the rest of the region.

With basebands at \$35 or lower at greater volumes, RF front-ends including filters, BPFs, in the \$35-\$40 range and MAC processors at \$20-25 with ARM 9, the total cost of chipsets to manufacturers will initially vary around a base price point of \$100. Therefore the goal of providing subscriber stations at \$250 or less is within reach, all depending on when the mass volumes materialize. The market for fixed WiMAX will not necessarily bring those volumes but it is a required step towards integration and lower equipment cost for the future mobile standard which will require integrated ICs' into laptops, handsets and PDAs at much lower costs to compete against broadband mobile contenders such as 802.20 or 3G.

### **Mobility**

The mobile version of 802.16 (e) will be ratified somewhere in the middle or end of 2005. Meanwhile chipset makers are busy tuning up their development boards. While OFDM is the modulation of choice for fixed applications, various modulations are being pushed by various technology players for 802.16e with OFDMA being the leading contender. This will not be good news for Wavesat who is pushing hard to promote OFDM 256 FFT for mobile applications to guarantee backward compatibility.

“This will allow manufacturers and operators to easily evolve from fixed to full mobility networks over the many generations of systems to come” adds Frank Draper.

How important is it to operators, to be able to use is whether the equipment purchased in 2005 will still be useable in future years. Will the carriers be able to amortize their purchases over multiple years? Technologically this means: will base stations in the future support the fixed applications and provide migration towards nomadic, portable and even mobile applications?

“One box cannot do it all” says in substance Rupert Baines, VP Marketing with Picochip, a UK-based chipset and software developer. The mobile version of WiMAX will be four times more complex than the fixed version with different power and coverage requirements. You need the capabilities of OFDMA to provide true mobility and portability. Sai Subramanian, VP Marketing with Navini Networks agrees “successful portable and mobile deployments will require higher link budgets and the use of smart antennas. Scalable OFDMA will be the required modulation for mobility”.

Wavesat believes that it can use OFDM 256FFT as the PHYSICAL layer, in both fixed and mobile systems to provide a natural evolution towards future systems. “Future base stations will be able to recognize and operate both fixed and mobile applications, but to do so the PHY must minimally have the same number of sub-carriers (256) or FFT (Fast Fourier Transforms)” says Frank Draper, VP Marketing with Wavesat.

“This has always been the premise on which the IEEE 802.16 committees have been working, that is, to provide backward compatibility between mobile (802.16e) and fixed (802.16-2004) systems” Frank added.

### **Competitive Landscape**

So what about the other players? The table 1 below shows in more details the respective product offering of the various companies involved in the development of 802.16 chipsets. In general most players will provide a system on chip to the equipment vendors whether they decide to develop both MAC and PHY internally differ. All have to partner with outside suppliers for the RF-front ends. On the mobility side, the battle will be between OFDM and its cousin OFDMA modulation. The case of Motorola is unique as it is the only equipment manufacturer developing its own chipset internally.

### **Table 1: Product Offering**

	PHY	MAC	RF	IF AND IO	PROCESSOR	OPTIONS	FOUNDRY
BEECEM	OFDMA	OFDMA	Confidential	Confidential	Confidential	NA	Confidential
CYGNUS MULTIMEDIA	PHY & MAC in the chipset . OFDM/OFDMA	PHY & MAC in the chipset	NA	Both	0.13 micron transitioning to 0.09	64 QAM, Subchannelisation, Alamouti, FEC: required variants at a minimum, Encryption: DES,3DES,AES	Confidential
FUJITSU	PHY & MAC in the chipset by fujitsu.	PHY & MAC in the chipset by fujitsu.	Partner	Both	ARM 9 AND ANOTHER UNDISCLOSED	64QAM, Subchannelisation, FEC (RS, Turbo, TPC,...) ,Encryption (DES, 3DES, AES,...)	FUJITSU FOUNDRY IN JAPAN
INTEL	PHY & MAC in the chipset .	PHY & MAC in the chipset	Partner	Both	NA	• 64QAM, Subchannelisation, • Alamouti (stc) NOT DISCLOSED, • FEC (RS, Turbo, TPC,...) NOT DISCLOSED, Encryption SAME AS 802.11	NA
PICOCHIP	OFDM256 (16d), OFDMA1024(WiBRo), sOFDMA(16e)	Lower MAC integrated. Partners (Airspan and others) for upper MAC.	Partner	Both	Upper MACX Supported on ARM, PowerPC and Intel IXP2800.	64QAM, Diversity, Alamouti, subchannelization, RS+CC, advanced FEC options, scope for AAS, lower MAC integrated.	0.13 (moving to 0.09). TSMC.
RUNCOM	PHY MAC mainly ( RF as a service) 2KOFDMA solution	PHY MAC mainly ( RF as a service) 2KOFDMA solution	Partner	Both	MIPS-0.18micron	• 64QAM - • Subchannelisation • Alamouti (stc) Optional • FEC (RS, Turbo, TPC,...) • Encryption DES	UMC(Taiwan)
SEQUANS	Fixed: 802.16-2004 OFDM Mobile: S-OFDMA	Fixed: 802.16-2004 OFDM Mobile: S-OFDMA		Both	ARM 9	64QAM, Subchannelisation,Alamouti, RS-CC, DES+AES	Under NDA
SI-WAVE	PHY right now.	MAC later in 2005.	NA	NA	Confidential	NA	Confidential
TELECIS	SOC ASICs and reference designs, Fixed: 802.16-2004 OFDM-TCW1620	SOC ASICs and reference designs, Fixed: 802.16-2004 OFDM	NA	Both	Confidential	64QAM, Subchannelisation,Alamouti, FEC, AES, Smart Antennas built-in	Confidential
WAVESAT	802.16-2004 OFDM 256FFT- Mobile: OFDM or OFDMA	Partners	Agere (5.8Ghz)/RF Magic(3.5GHz)	Both	ARM9	64QAM, Subchannelisation,Alamouti, FEC, AES, Smart Antennas built-in	Atmel

One notable company that has silicon available is Pico Chip Designs, with its PC102 Pico Array chip that has just started shipping. The company is providing reference designs for customers seeking to build base stations around the technology. It announced a strategic partnership with Airspan Network in October 2004 to deliver upgradeable WiMAX base station reference designs called SoftMax. Airspan developed the MAC and higher layer software while Pico chip is responsible for the PHY, the base band processor and customer support.

Picochip also signed more recently a key agreement with the Chinese Institute of Computing Technology (ICT) of the Chinese Academy of Sciences (CAS) to collaborate on the acceleration of WiMAX in China. ICT will use picoChip's industry- WiMAX reference designs and PC102 processors.

In fact Picochip is believed to have a dozen licensing agreements already in place at the time this article is going to press. Among them are believed to be at least 2 of the top traditional FBWA market share holders. Picochip is clearly aiming at building a strong position for the upcoming mobile version of WiMAX “ We have established strong relationship with Korean partners for the upcoming WiBRO testing and deployments but we cannot disclose who they are at this time” says Rupert Baines, Vice President of Marketing with Picochip.

Sequans is another fabless semi-conductor company who recently reported major wins. the availability of its FPGA platform and two strategic partnerships. The company has signed agreements with Airspan Networks and Cambridge Broadband to deliver an integrated WiMAX System-on-Chip (SoC), addressing both base station and subscriber station with a comprehensive PHY and MAC offering. In reality Picochip and Sequans are not competing each to serve Airspan needs :”The Sequans technology allows us to complete a full range of WiMAX infrastructure products, including now a micro base station offering with a similar architecture to successful WipLL product line”. said Jonathan Paget, Chief Operating Officer of Airspan Networks. Sequans is believed to charge substantial amount of money to partners they work with in order to insure they are serious about their commitments. The company is expected to announce further agreements in the weeks to come.

**Table 2: Competitive Landscape & Roadmap**

	TARGET MARKETS	STRATEGY	ROADMAP	WIMAX EMPLOYEES	INVESTORS	FINANCES
<b>BEECEM</b>	Mobile devices	NA	2006	50 employees	Sequoia Capital, Wallden International	1 round - undisclosed amount
<b>CYGNUS MULTIMEDIA</b>	WIMAX Fixed and mobile CPEs and Base Stations manufacturers	NA	2006- both fixed and mobile chipsets	17 employees	Network Operators and ODMs	Last round \$20M, July 2004
<b>FUJITSU</b>	WIMAX Fixed and mobile CPEs and Base Stations manufacturers	STRATEGY IS TO PROVIDE 5 BITS/HZ USING 64qam	First chipset 802.16-2004 in Q2 2005	ABOUT 150 EMPLOYEES IN MULTIPLE SITES WITH CROSS COMPETENCIES, EX: IP ELEMENTS CUSTOMIZED MARKETING & R&D FOR 802.16 MAINLY IN CALIFORNIA	Public Company	Public Company
<b>INTEL</b>	WIMAX Fixed and mobile CPEs and Base Stations manufacturers	An integrated SOC at \$25 integrated into laptops and mobile devices	First chipset 802.16-2004 in Q2 2005	NA	Public Company	Public Company
<b>PICOCHIP</b>	802.16 d Base Stations manufacturers-	upgradeable to WiBro and e	802.16 e Base Stations & CPEs manufacturers	50-40 engineers	Private	Total US\$24M
<b>RUNCOM</b>	mobile CPEs and Base Stations manufacturers	Korea WiBro and mobile integrators	Initially Chip set . PHY and Low MAC in one ASIC and upper MAC with external processor	40 engineers	Vertex and Concord + other confidential	Under NDA
<b>SEQUANS</b>	WIMAX Fixed and mobile CPEs and Base Stations manufacturers	End-to-end solution with a full PHY&MAC solution for both the BS and SS. Implement extended features with an optimized implementation, delivering added performance (indoor coverage, spectral efficiency) and services (VoIP, video).	first FPGA platform is available. Our SoC will be available end Q2'05.	24 engineers, 3 sales	ISOURCE, Cap Decisif	Last Round: 1.5ME, June 04 Next Round : Confidential, Dec 04
<b>SI-WAVE</b>	WIMAX mobile ONLY CPEs and Base Stations manufacturers	sell development boards only to key customers.	Proto available right now in FPGA. Integrated PHY + MAC later in 2005. Silicon samples will be ready by middle of 2005. Large volumes by End of 2005.	The company was founded by a core team and employs a number of system and ASIC engineers with extensive experience in the wireless industry. 90% of the team is engineering.	are self funded. will seek VC funding once we are ready to mass market chip.	Confidential
<b>TELECIS</b>	WIMAX Fixed and mobile CPEs and Pico Base Stations manufacturers	Provide better performance at better price with objective to allow \$100 CPEs. Taiwanese ODMs- Ultimately combining 802.11 and 802.16 on a single ASIC- Strategic alliances with Samsung and Korea Telecom-Provide multi-protocol chipsets supporting Wi-Fi, WiMAX and Wi-Bro	Reference Design Kits will be available providing a complete solution from antenna port to Ethernet. Kit contents include: - Reference Design Board, With or Without Diversity, MAC and APIs, Software Development Kit-	32 engineers	Samsung Ventures, ATA	has raised \$8.7M in venture funding + licensing revenues from 802.11
<b>WAVESAT</b>	WIMAX Fixed and mobile CPEs and Base Stations manufacturers	First to market - Focus on PHY development and partners to provide SOC's- Special focus on China market	DM256 PHY available Now- Indoor version IC "shark" end 2005- New BS FPGAs and MAC end 2005	40 engineers	Solidarity Fund GFL, Pac-Link Management Corp., Skypoint Capital Corporation, BDC Venture Capital, Innovatech Montréal, Monet Capital and SunSino Ventures Group.	\$10M in new funding this year

As shown in the table 2, different chipset vendors have different strategies and solutions. While many are planning to provide a system on chip with PHY and MAC, some tend to specialize on CPEs and less power devices like Sequans and Intel. Others such as Wavesat are building “one does it all” SOC for both CPEs and Base stations with little variants. Some like Becem and Runcom will leapfrog the fixed version of Wimax and concentrate on 802.16e.

The Holy Grail is the mobile market of end-user devices. Surprisingly, start-ups entering late in the game were able to secure significant funding from venture capital firms. I say surprising since they will be competing against Intel and Fujitsu without the head start that Wavesat enjoys.

In such an emerging market with leading figures such as Intel, to be the first to market can be a powerful differentiation strategy but it will not be enough to survive. 2005 will be critical to all chipset vendors as the deals they land now will decide their faith tomorrow. Some may become attractive acquisition targets while others won't even enjoy this easy exit...

**About the Author:**

Adlane Fellah, MBA, is CEO and founder of Maravedis In a world-leader in market research and analysis, specializing in BWA and VoIP markets . He is the author of the landmark report "WiMAX, NLOS and Broadband Wireless Access (Sub-11Ghz) Worldwide Market Analysis 2004-2008" which has been updated in February 2005. He is a leading industry analyst on wireless broadband technologies and recently conducted an extensive survey of regulators worldwide to build a unique BWA/WiMAX license holders database.