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Australian Energy Regulator

Review of WiMAX for Smart Metering and other applications

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1 Background

Impaq Consulting has been engaged by the Australian Energy Regulator (AER) to provide advice in relation to smart metering with particular reference to the budget and charges applications lodged by the Victorian DNSPs for the rollout of Advanced Metering Infrastructure (AMI) in the years 2012 to 2015.

In this context the AER has requested Impaq Consulting to provide an update on the use of WiMAX technology for smart metering (and AMI) together with other applications.

2 WiMAX technology

2.1 Technology Overview

WiMAX is an open standard broadband wireless digital communications system designed to provide fixed and mobile internet access. The name WiMAX (acronym for “Worldwide Interoperability for Microwave Access”) was created by the WiMAX Forum (www.wimaxforum.org), which is the non-profit industry trade group formed in 2001 to promote conformity and interoperability of WiMAX equipment. The WiMAX Forum certification allows vendors to sell their equipment as WiMAX (Fixed or Mobile) certified, thus ensuring a level of interoperability with other certified products, as long as they fit the same profile.

The standards which define WiMAX are the Institute of Electrical and Electronics Engineers (IEEE) 802.16-2004 and 802.16e-2005 (mobile wireless). WiMAX is intended for wireless "metropolitan area networks” and it can provide broadband wireless access (BWA) up to 50 km for fixed stations, and 5 - 15 km for mobile stations. In contrast, Wi-Fi which is the IEEE 802.11 wireless local area network standard is limited in most cases to only 30 - 100m.

The WiMAX Forum has defined WiMAX as a "last mile" BWA alternative to cable modem service, telephone company Digital Subscriber Line (DSL) or T1/E1 service.

The original version of the standard on which WiMAX is based (IEEE 802.16) specified a physical layer operating in the 10 to 66 GHz range. 802.16a updated in 2004 to 802.16-2004, added specifications for the 2 to 11GHz range. There is no uniform global licensed spectrum for WiMAX; however the WiMAX Forum has published three licensed spectrum profiles: 2.3 GHz, 2.5 GHz and 3.5 GHz, in an effort to drive standardisation and decrease cost.

Like all wireless technologies, WiMAX can operate at higher bitrates, or over longer distances, but not both. Operating at the maximum range of 50 km increases bit error rate and thus results in a much lower throughput bitrate. Conversely, reducing the range (to less than 1 km) allows a device to operate at higher bitrates.

Vividwireless, in a recent city-wide deployment of WiMAX in Perth (discussed later), demonstrated that customers at the cell-edge with an indoor Customer Premise Equipment (CPE) typically obtain speeds of around 1–4Mbit/s, with users closer to the cell tower obtaining speeds of up to 30Mbit/s.

2.2 Wimax vendor support

Since the release of WiMAX there has been a number of semiconductor vendors develop chipsets to implement the technology. The most notable of these is Intel, which is renowned as the market leader for microprocessors for computers. Arguably, Intel has been the driver of WiMAX adoption. At one point, Intel proposed that all lap top computers which used Intel processors should have WiMAX functionality. However, the actual outcome has been widespread use of WiFi with alternative BWA implementations being offered as either internal or external interfaces for lap tops.

Since WiMAX was standardised, the range of mobile broadband services has expanded and, in Australia, the 3GPP standard known as high speed packet access (HSPA) has been adopted by each of Telstra, Optus and VHA.

The evolution of both the WiMAX and HSPA standards is known as long term evolution (LTE) and is standardised by 3GPP

With the emergence of LTE in the last two years, most WiMAX vendors are now also offering LTE solutions, including at the chipset level.

3 WiMAX for Smart Metering (or AMI)

WiMAX has been promoted by GE Energy and a smaller company, GridNet as a technology that is suited for smart metering and smart grid. Apart from the implementation of WiMAX at SP AusNet there appears to be three other implementations of WiMAX for AMI that have been of pilot scale.

3.1 Consumers Energy (Michigan)

Consumers Energy announced in 2009 that it would be implementing a pilot WiMAX smart metering system along with pilots of Mesh Radio technologies. This was the first WiMAX smart metering trial[1]. The pilot was conducted in conjunction with GE Energy and Grid Net. GE Energy provided the smart meters and Grid Net provided the WiMAX communications.

The last media information on the WiMAX project was in March 2010 and this did not indicate any results. The Consumers Energy website has no information about WiMAX; instead the information about this trial, called Smart Street[2] is that it is powered by Silver Spring Networks mesh radio technology.

Consumers Energy is to rollout smart metering starting 2012[3]:

> *Our Smart Grid Program has involved several years of testing and assessing equipment, followed by small-scale meter and customer pilots. In 2011, we will demonstrate smart grid technology and our existing energy efficiency programs with our SmartStreet™ program in Grand Rapids. Michigan. In 2012, we will begin deployment of smart electric meters in the greater Grand Rapids area. Meter deployment across the state will continue over several years.*

3.2 American Electric Power (AEP)

AEP is an investor owned conglomerate of Electric Utilities that has subsidiaries in several states of the USA. One of AEP's subsidiaries, The Indiana Michigan Power Company launched an initiative called gridSMART in 2007[4].

In its submission[5] to the Michigan Public Service Commission (the regulator) AEP stated that:

> *I&M proposes that the first large scale deployment in AEP's system wide GridSMART initiative occur in its Michigan service territory involving all of its approximately 130,000 customers and 123 distribution circuits. An AMI network would be installed, serving as the platform for smart metering and*

[1] http://smartgrid.testing-blog.com/tag/wimax/

[2] http://www.consumersenergy.com/content.aspx?id=3776

[3] http://www.consumersenergy.com/content.aspx?id=1503

[4] Refer http://www.aepsustainability.com/ourissues/energy/gridsmart.aspx

[5] www.dleg.state.mi.us/mpsc/electric/.../oct11_07im_sm-da_proposal.pdf

distribution automation as well as enabling consumer conservation efforts and increased participation in demand response programs. I&M will use this deployment to evaluate the costs and potential benefits of smart metering and distribution automation, as well as the effectiveness of demand response initiatives in producing consumer conservation.

In relation to WiMAX technology, the submission notes that AEP has tested WiMAX (and other technologies) at their laboratory

"AEP has established a technology testing facility at its Dolan Laboratory in Groveport, Ohio, where various AMI technologies are installed and their performance validated. AEP is currently evaluating:

- *Communications technologies, including RF Mesh and WiMAX systems. AEP/I&M believe there are significant advances forthcoming in the near term.*
- *Distribution automation devices and systems that will leverage AEP's communications investments.*
- *Home area networks (HAN) to test functionality and features of emerging technologies in this market.*
- *The potential of having both advanced metering and distribution automation share a common communication network.*

Network testing should be complete by the end of the first quarter in 2008 with a final technology selection following.

In 2008 it would appear that the project was reduced in scope from an original 130,000 customers to 10,000 customers due to the pressures of the financial crisis. Details of the trial are provided on the Indiana Michigan Power website at https://www.indianamichiganpower.com/save/SmartMeters/Default.aspx. The purpose of the trial was to test the technology and to see how customers responded to the benefits of smart meter technology.

Later in 2008 the gridSMART pilot began and it covered 10,000 homes in the South Bend area of Indiana[6] as shown in the map in Figure 1 below.

[6] Refer http://tdworld.com/customer_service/aep-smart-metering-0908/

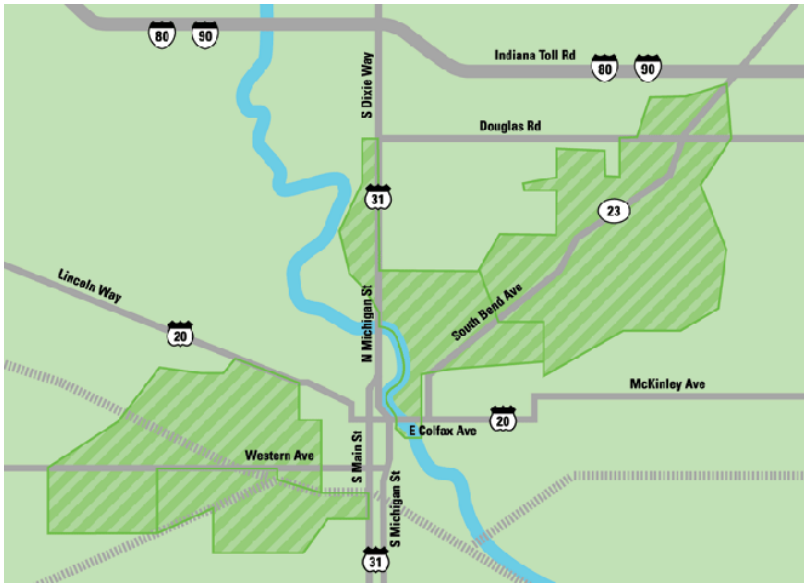

Figure 1 Trial area in South Bend, Michigan

The WiMAX component of the trial was to be run for 1 year in conjunction with GE Energy[7]. The trial was to end after the 2009 cooling season, but it was extended to include the 2010 cooling season because of some early technical problems. However it is noted that I&M trial information now only refers to Silver Spring mesh radio being used as the communications technology.

3.3 Energy Australia (now AusGrid)

As the AER would be aware, AusGrid was awarded the Commonwealth Government grant for the development of the Smartgrid Smartcity project. In mid-2010 AusGrid announced they would be using WiMAX based smart metering as part of the project. However in subsequent discussion with the leaders of the project they advised that although WiMAX would be used for the project, their view was that AusGrid would not use WiMAX for a rollout of smart metering, preferring instead to give consideration to LTE.

3.4 SP AusNet

The SP AusNet WiMAX based rollout of AMI is the first large scale implementation of WiMAX for AMI or smart metering. Furthermore a global review suggests that no other utilities are planning on implementing WiMAX for an AMI rollout.

[7] Refer “Smart Metering and Distribution Automation Project proposal” presented by the Indiana Michigan Power Company to Michigan Public Service Commission (Regulator) dated 8 Oct 2007

4 WiMAX as a backhaul technology for Smart Metering

WiMAX as a wireless broadband technology that can cover many kilometres of distance is potentially a useful technology for backhaul communications from AMI data concentrators. There are two implementations of WiMAX for backhauling data from mesh radio data concentrators (sometimes called Access Points).

4.1 CenterPoint Energy

CenterPoint Energy is a large investor owned Houston Texas based electricity utility with about 2 million customers spread across a 5000 square mile territory. CenterPoint are well advanced in the rollout of their Itron Openway mesh radio smart metering solution and will have all 2 million meters rolled out by mid-2012.

The Itron Openway mesh radio meters communicate using the 900MHz ISM frequency band back to data concentrators (also called access points). Originally CenterPoint had planned on using Broadband over Powerline (BPL) to take the data from data concentrators back to their offices. However a range of technical problems caused them to review this decision. Instead they have installed a WiMAX backhaul system supplied by GE Digital Energy Communications (MDS Mercury 3650) that operates at 3.65GHz with a speed of 13Mbps. This is illustrated in Figure 2 below.

Figure 2 – MDS Mercury architecture

The MDS Mercury radios take data from about 7000 Itron OpenWay data concentrators (each concentrator communicates with about 300 customer meters) and brings the data back to about 100 CenterPoint substations. From the substations the data is carried by their fibre network through to their offices.

4.2 Hydro One

Hydro One is a major electricity utility in the state of Ontario in Canada that services 1.3 million customers mostly in rural areas. They have almost completed the rollout of smart meters to all their customers. Hydro One uses the 2.4GHz Trilliant mesh radio system for the last mile communications from meters to access points. The architecture of the smart metering communications systems is given in Figure 3.

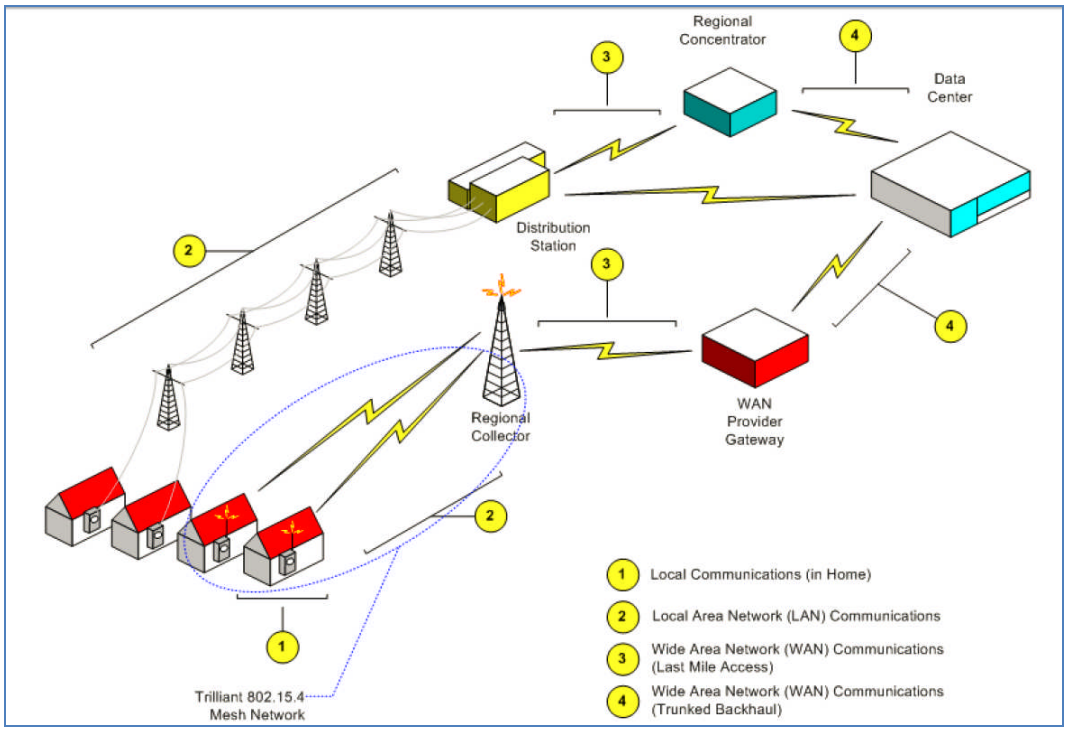

Figure 3 – Hydro One Smart Metering Architecture

The communications from regional collectors back to their data center is mainly provided by commercial wireless carriers (mobile networks). However for about 15% of their customers who are in more remote rural areas there is no mobile network coverage. For those areas Hydro One has chosen to use Wimax (running in the 1.8GHz band) provided by Canadian company Redline Communications.

5 Wimax for retail broadband services

5.1 WiMAX networks

As outlined in section 2.1 WiMAX is a broadband wireless technology. It offers higher bit rates than 2G technologies and as a result there was significant interest in the technology when it was launched in the early 2000's.

The WiMAX forum in their March 2011 status report list 582 WiMAX networks in 150 countries, which is illustrated in Figure 4.

Figure 4 – Map of WiMAX deployments

The WiMAX forum also states that there are now 13 million WiMAX subscribers. Of these the top 50 WiMAX operators account for 8.4 million subscribers.

However it would appear that WiMAX will not become the major mobile wireless technology as almost all major wireless carriers have decided against WiMAX instead favouring LTE. In developed countries, many of the carriers that adopted WiMAX are in financial difficulty.

5.2 WiMAX carriers

The following is a brief review of some of the WiMAX carriers.

5.2.1 Clearwire

The largest WiMAX carrier is Clearwire (Nasdaq CLWR) which is based in the USA but has WiMAX networks in several countries. As of the end of 2010 Clear had some 680,000 customers. The ownership of Clearwire is shown in Figure 5.

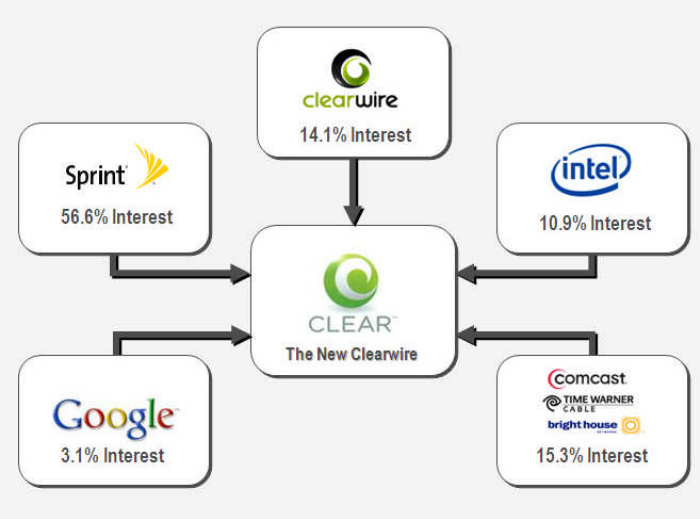

Figure 5 – Clearwire ownership

Clearwire has been successful in gaining significant numbers of customers on its WiMAX network. However this is coming at a large cost. In 2010 Clearwire's sales were US$556 million and its net loss was US$487 million. In September 2010 Clearwire advised the SEC (securities regulator) in their quarterly reporting statement (10-Q statement) that:

> *Based on our current projections, we do not expect our available cash and short-term investments as of September 30, 2010 to be sufficient to cover our estimated liquidity needs for the next 12 months. We also do not expect our operations to generate positive cash flows during the next 12 months. Without additional financing sources, we forecast that our cash and short-term investments would be depleted as early as the middle of 2011*.

5.2.2 Sprint

Sprint is a US based carrier which has struggled for some years. It would appear that Sprint decided to embrace WiMAX as a means of getting a 4G technology ahead of their major competitors (eg: Verizon and AT&T). Although it has succeeded in this and signed up many customers to WiMAX their financial situation is not healthy as shown in Table 1.

	2010	2009	2008
Revenue (US$b)	32.6	32.3	35.6
Net Loss (US$b)	3.46	2.46	2.8

Table 1 – Sprint Revenues and Profits (Losses)

Sprint's Balance Sheet shows:

- Total Assets US$51.6b, including 22.3b of intangible assets
- Total Liabilities US$37.1b including US$22b debt
- Net Assets US$14.5b. However if intangible assets are excluded Net Assets is negative US$8b

Hence Sprint is far from healthy and although it is the majority shareholder of Clearwire it may not be in a position to provide Clearwire with extra capital to allow it to continue to operate.

5.2.3 Vivid Wireless (Australia)

Vivid Wireless is subsidiary of Channel 7 which has been established in 2009 to sell WiMAX services in Australia. Vivid includes the assets of Unwired which was a broadband wireless provider which was acquired by channel 7 in 2008. There is a connection between Vivid and SP AusNet. David Spence the first CEO of Vivid (previously in Unwired) reported to IT News Oct 23, 2009

"Under the agreement signed yesterday, once the power company (SP AusNet) builds its network using Unwired's 2.3 GHz spectrum it will share the infrastructure with Unwired. Unwired will then use the assets to augment the rollout of its Vividwireless network in Melbourne.

Vivid has initially targeted Perth with a significant network build out. It is offering WiMAX wireless broadband at prices which are competitive with the major HSPA carriers. Vivid also operates smaller networks in Sydney and Melbourne. Vivid is currently trialling LTE in Sydney and is likely to offer LTE services on a commercial basis in the future.

5.2.4 Yota

Yota is one of the most substantial WiMAX operators, with reportedly around 500,000 customers in Russia. Until recently overtaken by Clearwire it was the largest mobile WiMAX operator in the world. Outside Russia Yota has WiMAX networks in neighbouring Belarus and in Peru and Nicaragua. Despite this Yota has decided to switch to LTE.

5.3 Equipment providers

The WiMAX forum has certified 26 Vendors for base stations and 51 vendors for subscriber/mobile stations (eg: CPE equipment). However some of the larger companies are starting to pull out because the major carriers in all countries have decided to move to LTE rather than WiMAX. For example:

Cisco – one of the early supporters of WiMAX, advised on 5 Mar 2010 that it will stop developing and making WiMAX base stations and modems[8].

Alcatel Lucent – has advised that the company is "not putting a lot of effort into [WiMAX] any longer", adding that upcoming LTE launches by companies such as Verizon showed "a clear direction taken by the industry towards LTE"[9].

[8] Statement made by Jim Brady of Cisco to Computerworld

[9] Reported by ZDNet May 2010 – statement by Patrick Plas COO for Alcatel Lucent

6 Prospects for WiMAX for smart metering

From the foregoing it would appear that WiMAX is not likely to be a major BWA technology. All of the major carriers in Australia have adopted LTE, leaving WiMAX to the second tier carriers and other communications users. This does not mean that WiMAX is "dead"; however it does mean that it will be relegated to niche opportunities which have relatively low volumes of equipment.

In relation to smart metering it appears that the only actual or planned rollout is that being done by SP AusNet, although WiMAX may continue to be used for backhaul from data concentrators.

It is our view that this situation increases the risk profile for WiMAX for smart metering. Without major carrier uptake the volume of WiMAX chipsets is likely to be relatively small. This in turn increases the likelihood an increasing price path for these chipsets in outbound years. The lower volume also increases the risk of inadequate support (or at least expensive support) for the hardware and software required for WiMAX smart metering.