

Electricity Distribution Metering Asset Management Strategy 2018 – 2025

Part 2

WiMAX AMI Solution

PUBLIC

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EDM AMS - Part 3 - WiMAX AMI Solution

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Supporting Documentation

The following document suite comprises the AusNet Services asset management strategy for managing and maintaining equipment assets for advanced metering technologies. These documents shall be annually updated with reviewer feedback incorporated and support the respective FMECA management recommendation approaches.

Document	Version	Review Dates	Owner(s)	Approver
AMI Asset Management Strategy Overview	0.1	30 June 2019	Alan Crockett	Brendan Buckland
Part 1 - Electricity Meters & Metering Equipment	---	30 June 2019	Srikanth Sridhar	Brendan Buckland
Part 2 - WiMAX Asset Management Strategy	3.0	7 Aug 2020	Alan Crockett	Brendan Buckland
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Acknowledgments

1. Recommendation's from this strategy will be summarised and managed through the AMI Asset Management Strategy Overview.
2. Figures, volumes and costings referenced to within this document are subject to change. Where a statistic is required, the document owner should be contacted for latest information.

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1 Executive Summary

The Electricity Distribution Metering Asset Management Strategy (EDM AMS) provides the framework for AusNet Services' management of its metering assets for the period CY 2018 – 2025. This period includes the subsequent EDPR period 2021 to 2025 as well as the remainder of the current 2016-2020 period.

Within the context of the current and forecast status of the assets, it identifies the strategies to operate and support a safe, compliant and efficient metering system.

The EDM AMS consists of a Strategy Overview document, together with the following three attachments describing the specific asset states and strategies for each EDM AMS component:

- Part 1 – Electricity Meters and Metering Equipment: the physical meter, meter firmware, meter program, low voltage current transformers, and associated meter test equipment.
- Part 2 – WiMAX AMI Solution.
- Part 3 – Mesh AMI Solution.

AusNet Services currently manages a fleet of WiMAX and Mesh operated communications modules, configured with the PolicyNet and UIQ firmware, respectively.

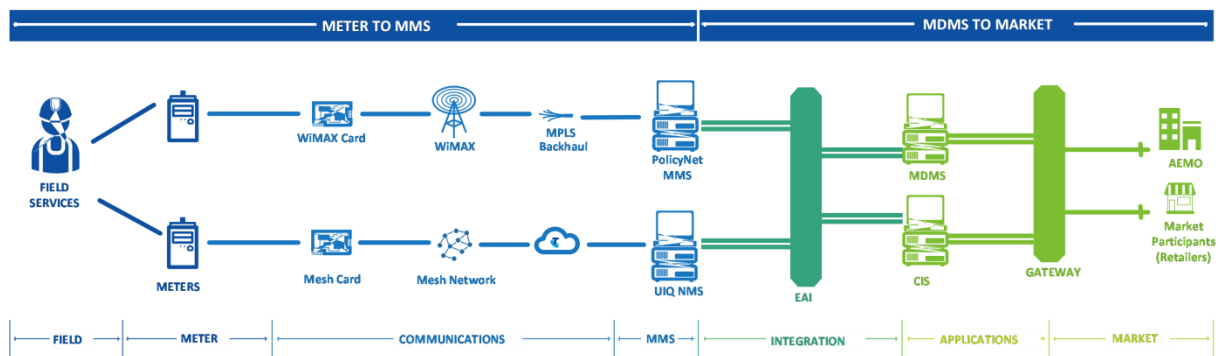


Figure 1: AusNet Service's high level End-to-End AMI solution (Meter to MMS and MDMS to Market).

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1.1 High Level Recommendations

The following high-level recommendations are proposed from the WiMAX asset management strategy.

No:	Recommendation	Section
1	Bi-annually maintain the FMECA risks set out within this strategy	4.1
2	Monitor WiMAX failure rates	4.2
3	Deliver against Uneconomical WiMAX tower removal	4.32
4	Support Bi-annual WiMAX executive briefing strategy	
5	[C-I-C]	[C-I-C]
6	Monitor and manage WiMAX component risks and spares	5
7	[C-I-C]	[C-I-C]

2 Overview

This document, the EDM AMS for the WiMAX AMI Solution, defines AusNet Services' asset management strategy for the end-to-end WiMAX metering solution including communications modules, WiMAX base stations, backhaul network, WiMAX head end, software applications and backend servers and services.

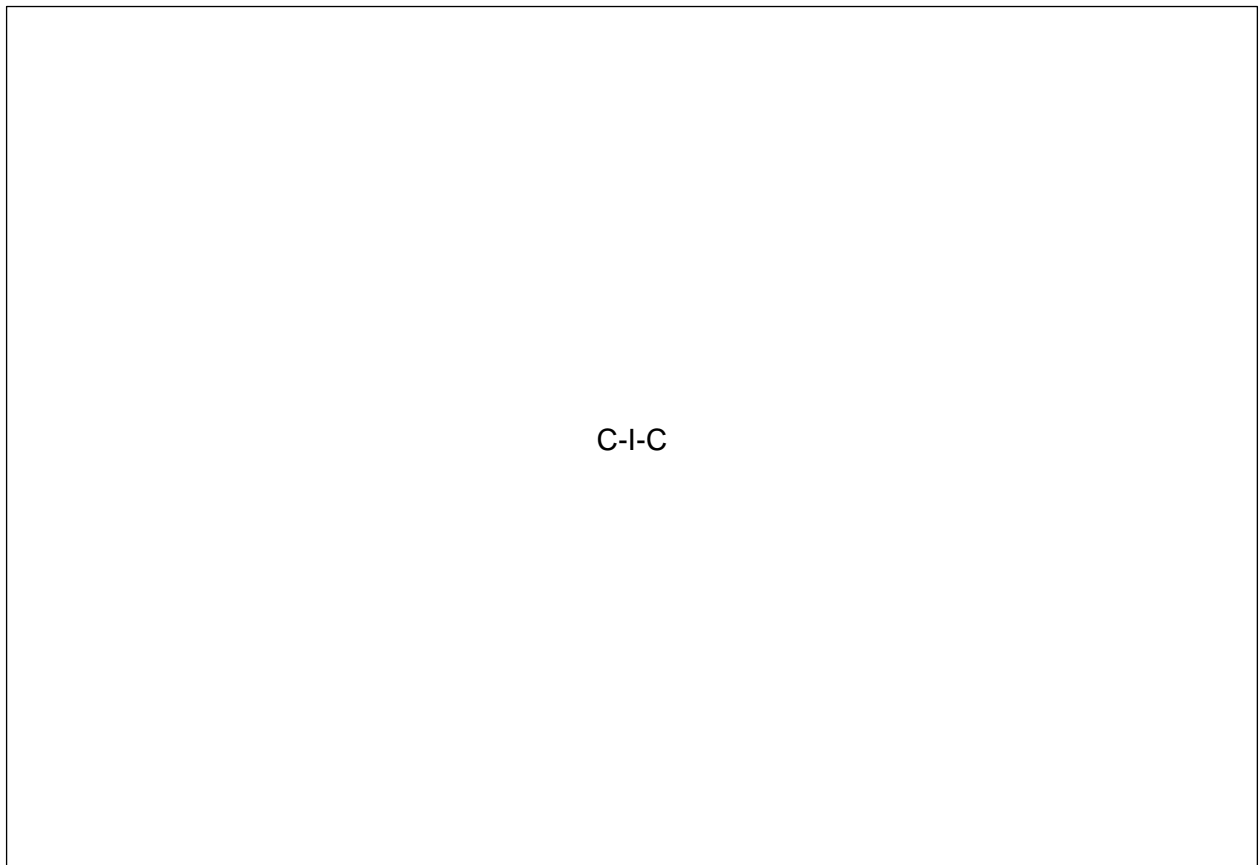
The EDM AMS in general aims to:

1. Ensure the continued safe operation of the metering asset;
2. Lift the capability of the AusNet Services metering and communications solution to be compliant with regulatory obligations;
3. Maintain the asset so that it continues to meet regulatory compliance and business needs in the most efficient manner possible (for optimal total life cycle cost);
4. Enhance and apply the meter capabilities to better manage the AusNet Services' electricity distribution network and position AusNet Services for the future operating and regulatory environment, in alignment with the AusNet Services business plan.

The specific aim of this Part 2 of the EDM AMS is to present the optimum support strategies for the WiMAX AMI solution, so that the meter communications are effective in supporting the achievement of all regulatory and business requirements.

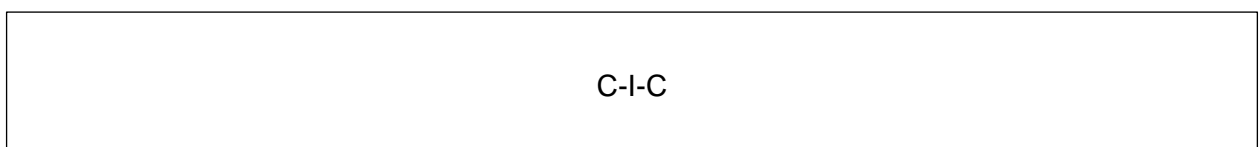
2.1 Background

After the decommissioning of the 3G AMI technology, AusNet Services' end-to-end AMI solution is comprised both the WiMAX and Mesh technologies. Both technologies utilise different network infrastructures and software applications for the data traffic flowing between meters and data centres, but share business services for MDMS to Market as shown in Figure 3.



AusNet Services has a total fleet of ~760,000 electricity meters which is comprised of ~12,000 Non-AMI and ~748,000 AMI type meters (as of August 2017). WiMAX communication modules are currently installed in 48% of the installed AMI metering fleet operate off the WiMAX network with the remaining 52% of AMI meters operating on the Mesh operating system. (see Table 1 for more details).

Commencing in 2010, the WiMAX network was built within AusNet's electricity distribution network. The WiMAX Network was constructed of 87 WiMAX Base stations and a further 8 repeater stations. The network operates over AusNet's existing MPLS network, which are on AusNet owned locations and connected over microwave links which are typically on third party or privately owned locations. Since the network build three WiMAX towers have been removed, bringing the tower totals for WIMAX and Repeater sites to 84 and 8 respectively.



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The WiMAX technology itself is obsolete with no indication of any further technological development or usage worldwide. Key risks due to the WiMAX obsolescence have been analysed in the WiMAX Asset Obsolescence Risk Assessment and provide a key input into the EDM AMS.

2.2 Scope

This Strategy encompasses all aspects of assets related to the WiMAX AMI end-to-end solution including:

- WiMAX communication modules and external antennas;
- WiMAX Base Stations including tower structures, equipment and spectrum;
- Radio Communication Links (Microwave and Fibre Links) and the MPLS network of the WiMAX Backhaul;
- The WiMAX Head End;
- Applications and Monitoring systems
- Maintenance and support services; and
- Proposed Recommendations Endorsed under this Strategy.

2.3 Out of Scope

This Strategy excludes assets related to:

- Actual AMI specified Meters and meter related maintenance and operations (subject to Part 1); and
- Mesh AMI end-to-end solution (subject to Part 3).

2.4 Structure

EDM AMS Document:

0. Overview
1. Metering Equipment
2. WiMAX AMI Solution
3. Mesh AMI Solution

2.5 References

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3 Asset Description

The scope of the assets covered in this section include all WiMAX assets from the meter communications module to MMS (Meter Management System) and shared applications and services that form part of the MDMS (Meter Data Management System) to Market function. Within the WiMAX solution, a meter connects via the communication module to the WiMAX access network. The WiMAX network makes use of the AusNet Services' AMI Multi-Protocol Label Switching (MPLS) backhaul network to deliver AMI traffic to the WiMAX core and MMS PolicyNet. The overall physical configuration of the WiMAX network is shown in Figure 5.

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] The following section will provide a description of the individual asset classes and components.

3.1 Meter Communication Modules

The AMI meter communications module is an essential component in the end-to-end AMI solution, providing the connectivity between the meter and the communications infrastructure. The communication modules are the interface to the meters for the collection of meter and distribution network data. They are also the interface for the remote delivery of meter programs, firmware upgrades and messaging.

The AusNet AMI meter solution requires specific communication modules for the respective WiMAX and Mesh AMI technologies. The communication modules are physically interchangeable on the meter enabling an easy and virtually seamless transition between both technologies. Both communication modules types consist of the following core components:

1. The physical assembly including meter data processor, and transmit and receive communications circuit boards;
2. ZIGBEE component;
3. Embedded firmware (and software) to control meter data and communications between the meter and the Meter Management System (MMS); and
4. Separate, externally mounted and connected RF antenna.

3.1.1 WiMAX Module Population

To date, WiMAX communication modules have been supplied by General Electrics (GE) and Landis + Gyr (L+G) and are typically installed in medium-to-high meter density areas. GE manufactured cards (~55% of WiMAX modules) were first installed in 2010 and L+G cards (~45%) in 2012. The volumes of AMI meters and installed communication modules as of end of August 2017 are as follows:

Meter/Module Vendor	Quantity of Meters	LC'd	% LC'd	% Modules	% AMI Meters
AMI Meter/GE WiMAX	227,032	226,590	99.8%	31.0%	31.0%
AMI Meter/L+G WiMAX	188,057	186,295	99.1%	25.7%	25.6%
AMI Meter/Mesh NIC	293,982	287,459	97.8%	40.2%	40.1%
AMI Meter/Mesh uAP	22,270	21,750	97.7%	3.0%	3.0%
AMI Meter/No Module	1,393	0	0.0%	0.0%	0.2%
Total AMI Meters	733,249	722,094	98.5%		
Non-AMI Meter	11,970				
Total Meters	745,219				

Table 1: Volumes of Installed Communication Module Types as of August 2017

WiMAX modules are deployed to approximately 48% (i.e. ~367,000 meters) of all AMI meters. The geographical distribution of AMI communications modules across AusNet's 9 divisions is shown in the following table.

Division	AMI Meters	WiMAX cards	NICs	uAPs	Non-AMI Meters
Bairnsdale	52,236	24,404	24,267	3,359	1,023
Beaconsfield	130,340	77,111	51,587	1,525	1,325
Benalla	36,707	15,987	16,119	4,318	571
Leongatha	51,213	20,086	27,699	3,321	933
Lilydale	189,767	127,481	60,896	1,136	3,693
Seymour	21,181	6,339	12,781	1,959	472
South Morang	134,054	89,200	44,137	522	1,482

Division	AMI Meters	WiMAX cards	NICs	uAPs	Non-AMI Meters
Traralgon	73,601	36,371	33,441	3,496	1,915
Wodonga	44,150	18,110	23,055	2,634	556
TOTAL	733,249	415,089	293,982	22,270	11,970

Table 2: Installed Communication Modules by Division (as of August 2017).

GE supplied the first generation WiMAX communications modules. A subsequent supply agreement with Landis + Gyr Australia was established in late 2011 for ongoing supply of WiMAX communications modules. There are multiple types of WiMAX antennas that are supplied by Panorama Antennas.

The annual installations volumes of currently installed WiMAX communication modules are shown in Table 3. The oldest cards are now ~ 8.5 years in age, with the majority of modules being 4-5 years old.

With an expected design life of the communications modules of 7 years an increase in the failure rate of communications modules could be experienced from 2017 onwards but this has not been observed to date.

Year of installation	Communications Module Type	
	GE WiMAX	L+G WiMAX
2010 Actuals	53,469	0
2011 Actuals	60,232	1
2012 Actuals	95,237	52,160
2013 Actuals	16,016	84,874
2014 Actuals	577	23,615
2015 Actuals	1,245	20,442
2016 Actuals	235	6,386
2017 Actuals	21	579
2018 Actuals	0	0
2019 Actuals	0	0
Total	415089	

Table 3: Currently installed WiMAX communication modules by year of installation (as of Aug 2017).

3.1.2 WiMAX Communication Module Firmware Versions

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3.2 WiMAX Base Stations

The WiMAX base stations serve as access points to AusNet's MPLS backhaul network. The base stations with WiMAX radios are deployed in medium to high meter density areas in AusNet's electricity distribution network (see Figure 6). [C-I-C]

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All WiMAX base stations are equipped with a WiMAX radio for the direct communication with the AMI meters. Additionally microwave equipment is installed on some base stations for communication between base stations and repeater towers. All base stations are connected with the MPLS backhaul network, as shown in Figure 7 and Figure 19, either via fibre or microwave links (refer Section 3.3).

3.2.1 WiMAX Base Station Components

The WiMAX radio access network is comprised of the RF heads (wireless transceivers and antenna) and the BCU (controller unit). The following WiMAX equipment is deployed to all 86 base stations:

- RF heads and antennas (2 RF heads required per WiMAX signal sector and 4 sectors per base station)
- Power supplies
- Firmware
- Environmental controls:
 - Batteries
 - Rectifiers
 - Air conditioner
- Chassis
- Site controller
- Modem (1 modem per 2 signal sectors, i.e. 2 modems per base station)
- Cables
- GPS assembly for site synchronisation
- MSO (GPS Backup 24h Controller)

All WiMAX sites designed with 4 signal sectors for which 8 RF heads are required (two RF heads per signal sector), except for base stations at Ringwood TS that were designed with 3 sectors only, i.e. 6 RF heads. Additionally, the WiMAX cell range capability is extended over 15 km.

Asset Type	Quantity
WiMAX Base Stations (Radios)	84
WiMAX RF Heads and Antennas (Avg. 6 ~ 8 Heads per Base Station)	660

Table 4: Wireless Communication Infrastructure Asset Summary

3.2.2 WiMAX Spectrum

The communication facilities that provision the wide area connections from the field back to aggregation points use reserved spectrum that has license costs with the two providers Optus and NBN co. The spectrum leases established with both providers extend to 2035. The NBN spectrum is up for renewal in 2025, a 12 months' notice period is required prior to termination, which will be available to AusNet in 2024. There are additional options to relinquish spectrum, which could be sought as an opportunity to downsize the network.

3.2.3 Tower Environment

The WiMAX system is further supported by assets to support the tower environment that are essential to the AMI solution but do not actively carry or transport communications traffic themselves:

- HVAC to regulate the temperature in enclosures containing electronic equipment and batteries;
- Rectifier to convert AC to DC and re-charge backup batteries;
- Outdoor Unit (ODU) Cabinets to house various wireline and wireless communications equipment at remote sites;
- Power supply;
- Tower:
 - Structure (Table 5 provides volumes of all tower structures and the supported communication technology):
 - Monopole (30, 35, 40, 45 and 50m);
 - Lattice Tower (40 and 50m);
 - High Voltage (HV) Tower;
 - Transmission (TX) Tower (Communications Tower);
 - 3rd Party Tower;
 - A list of all towers, incl. the 8 Repeater towers, can be found in Table 33;
 - 46 WiMAX towers are network endpoints;
- Lighting;
- Aircraft warning lights;
- Environment servicing for vegetation and pest control; and
- Supporting Vendors;

Categories	Monopole					Lattice		HV	TX	3rd Party	Tot
	30m	35m	40m	45m	50m	40m	50m				
WiMAX	1	1	4	4	0	0	0	1	0	0	11
WiMAX and Microwave	3	0	25	17	8	1	1	12	4	5	76
Microwave (Repeater)	0	0	0	0	0	0	0	0	8	0	8

Total	4	1	29	21	8	1	1	13	12	5	95
AusNet Property	2	0	8	4	2	0	0	3	12	0	32
Lease Agreement	2	1	21	17	6	1	1	10	0	5	63

Table 5: Overview of various tower types, installed communication technology (WiMAX, microwave) and lease agreements including decommissioned Yarra Glen site.

3.2.4 Tower Lease Agreements

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3.3 Backhaul

The WIMAX backhaul network is comprised of the communication bearer links and the Multi-Protocol Label Switching (MPLS) Wire line Network to deliver AMI traffic to the PolicyNet Meter Management System (MMS).

3.3.1 Communication Bearer Links

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3.3.2 MPLS Wireline Network

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3.4 WiMAX Head End

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3.4.1 Gateway Decision Point Hardware - CAPC

The CAPC facility consists of a separate, specialist hardware stack as well as specifically configured software and forms a critical, singular infrastructure component of the WiMAX head end. The hardware facility consists of three principal components:

- The CAPC Chassis – the ‘box’ that forms the bulk of the installation and containing power supply, cooling and physical connection points for the other network infrastructure;
- The CAPC Controller cards that direct configured data traffic to the appropriate processing facility contained on payload cards;
- The Payload cards themselves that are responsible for ‘understanding’ the meter communication data that is being transmitted via the base stations across the WiMAX microwave connections.

The Brocade router is a specific appliance that has been configured into the solution to supply network data transmission across the internal AusNet infrastructure. The core router is comprised of:

- Chassis;
- Line Cards;
- Fabric Controller Card;
- Management Module; and
- Fan Module.

The CISCO ASR 9010 data centre routers, comprised of chassis, line card and RSP (Route Switch Processor), are vital for the continued operation of the WiMAX solution.

3.5 IT Applications

The WiMAX AMI application suite contains 3 key applications that are dedicated to the AusNet Services service offering around smart metering.

These are:

1. The Meter Management System called PolicyNet,
2. The Meter Data Management System called Energy IP and
3. The Enterprise Application Integration EAI.

There are other applications supporting these core applications which provide key functions. These include the Customer Information System (SAP CIS), Grid-Director/ADW for reporting and dash boarding, Enhanced system -monitoring via the Tivoli suite of product and the Business to Business / Enterprise Application Interface being Web Methods.

This section covers the Operational Support Systems and AMI dedicated applications.

A high level view of the AMI applications can be seen below in Figure 8.

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3.5.1 Operational Support Systems (OSS)

To support and ensure reliable and efficient operation of numerous communication elements various Operational Support Systems (OSS) are used within the AMI Network. These systems provide the monitoring, configuration and maintenance capabilities for the Wireless, Bearer and Wireline assets. Some of these systems are shared while others are dedicated to specific functions.

Typical examples of these OSS systems and use cases include:

- Configuration and monitoring of various Cisco Routers & switches using the Cisco Prime OSS
- Configuration and monitoring of various Checkpoint firewalls
- Configuration and monitoring of the Ceragon Microwave Radio systems (Ceragon PolyView)
- Configuration and monitoring of NewNet (Motorola) WiMAX infrastructure components (WiMAX EMS)
- Monitoring of the Out Door cabinets (ODUs), ~9 customer defined alarms are configured including air-conditioning mains failure, HVAC failure, smoke alarm etc.

In all of the above and many other cases, the ability to remotely configure and monitor equipment provides the operational staff with the capability to effectively manage the network.

Table 5 below shows the summary of various OSS assets.

Domain / Area	Assets Monitored	OSS Applications	Quantity	
			Prod	Non-Prod
Wireless Network Infrastructure	WiMAX Base Stations	[C-I-C]	2	2
	WiMAX Head End	[C-I-C]	1	

Domain / Area	Assets Monitored	OSS Applications	Quantity	
			Prod	Non-Prod
Bearer Network Infrastructure	Microwave	[C-I-C]	2	1
Wireline Network Infrastructure	Cisco Routers & Switches	[C-I-C]	2	2
	Checkpoint Firewalls		13	9
	Cisco Router & Switches, Checkpoint Firewalls	[C-I-C]	6 blade servers supporting 27 instances each	

Table 6: AMI Operational Support Systems.

3.5.2 Meter Management System (MMS) - PolicyNet

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3.5.3 Meter Data Management System (MDMS) – Energy IP

The EnergyIP application processes meter data provided by the MMS application and applies the relevant regulatory validation obligations to the data which is then supplied to the AEMO and the retailers. Several components of Energy-IP are the;

- Adaptor – Accepts Data from the MMS
- Cleaner – validates the format of the data
- Archiver - publishes the data to the Energy IP data base
- Billing Cycle Module - Generates billing requests for AEMO, Retailers and Network Billing (Kinetiq)
- Billing Reads processor and dispatcher – fulfils the billing requests and provides estimations and or substitutions where required (Regulatory obligation rules)
- Billing exporters - sends the above transactions to AEMO, Retailers and Network Billing

3.5.4 Enterprise Application Interface – EAI

The EAI applications facilitate integration of many different applications across the business as well as between AusNet Services and other participants in the energy market. In particular, EAI is the interface for AMI data between the Meter Management Systems (PolicyNet (WiMAX) and UIQ (Mesh)) and the Meter Data Management System, (Energy IP).

3.5.5 Monitoring and Reporting

The supporting applications that provide monitoring and reporting for the smart metering solution consists of the AMI Data Warehouse (ADW) which stores information including interval data and Grid-Director that displays the data to which regulatory and business rules/logic have been applied.

The operational monitoring of the end to end AMI solution is done using the IBM Tivoli monitoring suite.

- Grid Director:
 - Displays ADW data in various formats;
 - Used for reporting and referral purposes;
 - Dashboards of end-to-end solution health trends range from high level reporting to detailed technical metrics;
- Tivoli Suite:
 - Live dynamic tool used to provide monitoring, alerting and alarming of the end to end components of the smart metering solution;
 - Purposed to keep AMI network and applications up and running;
 - ITNM – Discovery of network topology and root cause analysis of network devices based on topology and network components;
 - TNPM – Performance of network devices;
 - SCAPM – Health and performance of applications and their underlying infrastructure and databases;
 - OMNIBUS – Fault and event management;
 - DASH – Network and Application live management dashboards (consolidates the above information);
- ADW - DataStage and Cognos
 - Consolidated reporting solution;
 - Combines data from disparate source operational systems; and
 - Provides a consistent view of AusNet Services' AMI data through a number of Regulatory and Compliance reports.

3.5.6 AMI Compute Platforms and Shared Network Assets

AusNet Services operates and maintains the IT infrastructure and technologies to support the end-to-end AMI systems to provide the full suite of AMI services and capabilities. The IT Infrastructure broadly leverages both of AusNet Services data centres to house all of the backend systems needed to receive the meter data, perform all necessary computations and then presentation/delivery to market.

Shared Infrastructure Assets are defined as systems established by non-AMI initiatives and used by both AMI specific systems as well as corporate systems. These shared infrastructures are deemed to be the base building blocks of an ICT network.

Shared systems that fall into this category are:

- Storage Area Network (SAN) Fabric and Storage
- Data centre facilities (power, cooling and protection)
- Network Security
- Network communications
- Monitoring systems

- Backup system
- Directory Services

AMI on Demand (AOD) Platform – All data centre assets were designed to enter end-of-life in 2016. AMI and WiMAX related applications were moved to the AMI on Demand (AoD) platform. Asset details including vendor support information for this platform are yet to be confirmed by ICT.

3.5.7 Other Monitoring and RF Software Tools

The following table lists additional WiMAX software tools that are used for monitoring and RF planning/optimisation.

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3.6 Maintenance and Support Services

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4 Asset Assessment and Risk Mitigation Strategy

4.1 Asset Lifecycle Approach

The evaluation of asset “conditions” is largely based on 3 major criteria:

- **Commercial availability, warranty and support.** The ability for a manufacturer to continue selling and supporting an asset in a non-superseded form is a key replacement consideration. This is known as the “product shelf-life” which lasts until the product is eventually removed from the market, as announced by the supplier. The “asset life” goes beyond this, but is contingent upon the supplier’s warranty and support arrangements. It is to be noted that if adequate maintenance procedures are in place the “asset life” can be potentially extended beyond the supplier’s commercial support period, as long as the consequently operational risk of service disruption is managed.
- **Technical capability.** The ability for an asset or technology to continue to deliver the required functions and acceptable performance to meet business requirements is another key replacement consideration. Each part of the end-to-end solution needs to deliver the required function. For example, if the communications RF Head is functional, but does not the Carrier Access Point is not functional then the business requirements cannot be met.
- **Asset integrity.** The ability for an asset to continue to perform its function based on mechanical/material condition and integrity of the asset.

These assessment criteria vary over the age of the assets in terms of:

- Reaching the product shelf-life;
- Obtaining adequate support agreements;
- Likelihood of change affecting an asset’s ability to meet business requirements; and
- Physical asset deterioration causing assets to fail.

The following asset condition summaries are an assessment based on one or more of the above criteria. A [Failure Mode, Effects and Criticality Analysis](#) (FMECA) was performed on WiMAX assets with high risk profile. This also includes key risk assets that were previously identified in the WiMAX Asset Obsolescence Risk Assessment

4.2 WiMAX Communication Modules

WiMAX communication modules experienced high failure rates in the first half of 2015 due to defects in their firmware’s NANO flash memory issues. The failure rate stabilised at ~ 0.44% (annualised) in the first half of 2016 after the deployment of an updated firmware version 2.9.16 in late 2015. The communication module failure rate has remained at consistent levels since. Currently, ~99.8% of communication cards have been updated to version 2.10.5 firmware.

All currently deployed firmware versions and their quantities are summarised in the following table.

Version	Count	%
2.10.5	410008	99.83%
2.10.4	5	0.00%
2.9.16	406	0.10%
2.9.6	3	0.00%
2.9.3	265	0.06%
2.7.2	37	0.01%
2.6.3	1	0.00%
2.4.2	1	0.00%

Table 7: Currently Deployed WiMAX communication module firmware versions.

Based on their manufacturing date, the oldest deployed WiMAX communication modules are now 7.5 years old with the majority of modules being an average 4-5 years of age. The WiMAX modules were forecast to enter end-of-life after the required service life of 7 years. To date, no

increase of the module failure rate has been observed indicating that the deployed WiMAX communication modules have not yet entered end-of-life.

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4.3 Base Stations

Equipment currently installed at the WiMAX base stations is summarised in the following table:

Asset Type	Quantity
Towers	92
ODU Cabinets	83
GPS Back Up 24hrs Controller	83
GPS antenna	83
[C-I-C]	[C-I-C]
Power Cable Kit Fibre/DC	660
Y Cable Kit Sector Fibre/DC 1.5m	660
BCU Chassis	83
Modems	160
System Controllers	83
Rectifiers	281
Air conditioners	83
Batteries	660
Aviation Warning Lights	7

Table 8: Supporting Infrastructure Asset Summary

Some base station environment controls had displayed some reliability problems and required maintenance. In particular, 33 of all 83 air-conditioning units installed at WiMAX base stations have failed to date and required replacement. All air-conditioning units are subject to an annual maintenance schedule that is carried out by AusNet's INS Team.

Due to the high failure rate of air-conditioning units, it is recommended that annual maintenance activities are scheduled to be undertaken in collaboration with the vendor Vertiv (Emmerson). This is due to commence in the last quarter of 2017.

Due to inadequate air-conditioning and ventilation, the battery enclosures can reach extreme temperatures during summer carrying the increased risk of premature battery failure and reduced load bearing capacity of the batteries. Battery failure poses risk of loss of power to base station equipment in case of power outage resulting in potentially manual recovery of equipment upon power restoration. Consequently, all meters supported by the affected base station that cannot register with alternative base stations would go offline until power is restored and equipment restarted leading to breach of our performance.

Base station batteries are subject to an annual maintenance schedule by the INS Stations Delivery/Comms group under the scheduled maintenance program and are replaced when found defective. With a life expectancy of 7 years, batteries are expected to reach end-of-life commencing in 2018. One of the immediate treatment plan is to replace base station battery fleet with new batteries within 2018. Procure additional batteries for new and replacement (fault) remediation work (scheduled and unscheduled maintenance). Replacement of batteries that are end-of-life is covered under the metering budget.

Any WiMAX that enters an uneconomical status will have all battery replacements put into a hold status with all future battery replacements deferred until the tower is removed.

Ensure adequate spares readily available for breakdown/repair. Update spares register to include components. Review the service provision contract (SLA) includes for the regular inspection and maintenance of items

Access point static connections such as power and data cables have failure rates that can be attributed to cable breaks owing to vermin and pest invasion and although they are commonly available commodity stock require replacement resulting in increased operational costs. AusNet has procured spare cables in 2016. Given the current rate of cable breaks and the possibility of an increased failure rate in the upcoming years, there is a risk that the current stock levels of spares may be depleted before the end of the operational period. A bulk order spare cables to sure up stock reserves before current spares are depleted should be initiated. Cables can be ordered from suppliers other than NewNet without causing any warranty issues.

In general, the majority of base station equipment has end-of-life expectations between 2020 and 2024 depending on the base station installation date. Replacement units for environment controls, access point static connections, batteries and base station equipment are considered commodity stock and can easily be procured from a range of suppliers.

AusNet's ANS Team performs regularly scheduled preventative maintenance activities on all base station. Preventative maintenance is furthermore carried out by vendor Meridian for LadSafe certification and the bird-proofing of cables.

With the volume of spares that will be returned under the uneconomical WiMAX tower project there are sufficient spare equipment. All WiMAX towers that are deemed uneconomical will fall into a fix on failure maintenance regime where only minimal site inspection will be performed. Site batteries and equipment will continue to be monitored but will only be replaced on failure.

4.3.1 Base Station Leases

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4.3.2 Uneconomical Tower Approach

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4.3.3 Watsonia Tower removal

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4.4 WiMAX

4.4.1 Spectrum

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4.5 Backhaul

4.5.1 Microwave Assets

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4.5.2 Multi-Protocol Label Switching (MPLS)

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4.6 WiMAX Head End

4.6.1 CAPC

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4.6.2 Cisco Routers

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4.6.3 Brocade Appliance

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4.7 Meter Management Systems/ Backend Servers and Services

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4.7.1 PolicyNet Application

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4.7.2 PolicyNet Infrastructure

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4.8 Disaster Recovery Status

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4.9 WiMAX Security

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4.10 Internal and External Support

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4.11 WiMAX Operating Costs Summary

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5 Mitigation and Strategy Summary

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5.1 Required Mesh Network Upgrades

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5.2 Planned Transition to Alternative AMI Technology

Under the current business directive, only Mesh communication modules are installed in new connections and WiMAX communication modules are replaced with Mesh modules upon co-incident maintenance site visit. Assuming a network growth of ~15,000 new connections, ~2,900 abolishment's and ~17,000 site visits per year the evolution of the WiMAX and Mesh meter fleets can be estimated as shown in Figure 15. [C-I-C]

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5.3 Early Transition Scenarios

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5.4 Unrecoverable Failure of WiMAX Solution

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6 Glossary

3/4/5G	third/fourth/fifth generation of wireless telecommunication technology	ICT	Information and Communication technology
AC	alternate current	IDU	indoor unit
ACMA	Australian Communication and Media Authority	IP-10, IP-10G	Microwave units
ADSS	all-dielectric self-supporting	L+G	Landis and Gyr
ADW	AMI Data Warehouse	LC'd	Logically converted
AMI	Advanced Metering Infrastructure	MDMS	Meter Data Management System
ANS	access service network	MMS	Meter Management System
AoD	AMI on Demand	MPLS	multiprotocol label switching
AP	access point	MSO	GPS backup 24h controller
ASR-9010	Data Centre router	NBN	national broadband network
ASR-903	Base station router	NIC	network interface card
BCU	base station controller unit	ODU	outdoor cabinet
Brocade	Data Centre switch	OOS	Operational Support Systems
CAPC	carrier access point controller	OPEX	operational expenditure
CAPEX	capital expenditure	OPGW	optical ground wire
CPI	consumer price index	PTD	pole top device
CY	calendar year	RACI	Responsible, accountable, consulted, informed
DC	data centre	RF	radio frequency
DC	direct current	RFU	radio frequency unit
DR	disaster recovery	SSN	Silver Spring networks
EAI	enterprise application integration	TS	terminal station
EDM AMS	Electricity Distribution Metering Asset Management Strategy	TX	communication tower
EMS	Element Monitoring System	uAP	micro access point
FMECA	Failure mode, effects and criticality analysis	UIQ	Utility IQ
FOC	fibre optical cable	WDM	Wavelength Division Multiplexers
GE	General Electrics	WiMAX	Worldwide Interoperability for Microwave Access
GPS	global positioning system	ZIGBEE	wireless standard
HV	high voltage	ZSS	zone substation
HVAC	heating, venting, air conditioning		

7 Appendix

7.1 Tower Lease Summary

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7.2 Tower Summary

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7.3 Tower Colocation Sites

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7.4 MPLS Network

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7.5 Data Centre Wireline Network

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