APPENDIX 27

Telecommunications strategic plan 2015-20

Energex

Telecommunications Strategic Plan 2015-20

Asset Management Division

energex

positive energy

Version control

Version	Date	Description
1.2	22/10/2014	Final for Submission

Energex Limited (Energex) is a Queensland Government Owned Corporation that builds, owns, operates and maintains the electricity distribution network in the fast growing region of South East Queensland. Energex provides distribution services to almost 1.4 million connections, delivering electricity to 2.8 million residents and businesses across the region.

Energex's key focus is distributing safe, reliable and affordable electricity in a commercially balanced way that provides value for its customers, manages risk and builds a sustainable future.

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1 Introduction

Telecommunications systems are used to provide the information exchange services essential for the efficient and effective management of Energex's electrical network assets.

Energex Telecommunications systems:

- Improve safety through effective person-to-person remote communication in real-time;
- Make possible the centralised monitoring & management of the power distribution network and coordination of protection between sites;
- Extend the reach of corporate information systems for improved productivity across the organisation;
- Support the efficient operation and adaptation of the electrical distribution network through a common infrastructure.

Energex embarked on a substantial telecommunications infrastructure modernisation programme in 2009 with investment in an IP/MPLS core network and the roll-out of a mesh radio edge network as described in the 2008 Energex Telecommunications Strategy [8].

Energex considers that, as part of the Telecommunications Strategy 2015-20 (the Strategy), it is prudent to continue the core network deployment, scale back the planned mesh radio edge network deployments and continue the work needed for capitalising on the improved core network infrastructure, to deliver better long term outcomes for both Energex and its customers.

For this reason, this Strategy sets out the strategic objectives and operational requirements of Energex with respect to Telecommunications services and undertakes an evaluation to determine the most appropriate model to deliver these services over the 2015-20 regulatory period.

While this Strategy establishes the future program of work, the Network Asset Management Policy (RED 00807 / BMS 03595) provides the processes and practises that form the key inputs into this decision making process.

This Strategy is to be read with the following associated documents:

[1] Joint Network Vision (Outlook to 2030) (Energex Form 8093, Appendix 9 of RED 00775)

[2] Joint Network Technology Strategy (Energex RED 00776 / Energex BMS 03551)

Other supporting documents which may assist with deeper understanding are:

[3] Business and Information Blueprinting Program - 2015 Future State Blueprint – (14 November 2011 Version 1.5 – Endorsed)

[4] Office of the CIO 2020 Architecture Vision Network Asset Management and Operations

[5] Refurbishment / replacement Refurbishment and Replacement plan - Telecommunications Equipment (Energex STD 00945 / Energex BMS04173)

[6] CSIRO report "Enabling Australia's Digital Future: Cyber Security Threats and Implications" (http://www.csiro.au/Organisation-Structure/Flagships/Digital-Productivity-and-Services-Flagship/Smart-secure-infrastructure/Enabling-Australias-digital-future.aspx)

[7] SCADA & Automation Strategy 2015-2020

[8] Energex Telecommunications Strategy (2008)

[9] Energex Distribution Annual Planning Report 2014/15 – 2018/19

[10] An Architecture Vision for the Smart Grid enabled Enterprise in 2030 (JFSA 2030)

2 Purpose and Structure

2.1 Purpose

The purpose of this Strategic Plan is to identify:

- The strategic objectives and operational requirements of the business over the next regulatory period;
- The existing and ongoing capability of Energex Telecommunication assets;
- Any shortfalls between current capability and future operational requirements; and
- The most cost effective way of delivering telecommunications services to meet future operational requirements.

This Strategy is prepared in compliance with Energex's Corporate Strategy.

2.2 Structure

To achieve its purpose, the Strategy is structured according to the following sections:

1) Strategic Objectives – provides an overview of the strategic planning process and explains how the corporate strategic objectives are translated into operational initiatives and outcomes to be delivered by this Strategy;
2) Existing Capability – details the current operational capability of current Telecommunications services;
3) Operational Requirements – specifies Energex's future operational and service requirements;
4) Options Assessment – describes the assessment process to determine what is the most appropriate service delivery model going forward;
5) Costed Solution – provides detailed costs of the preferred service delivery model;
6) Governance – sets out the governance arrangements associated with this Strategy.

3 Strategic Objectives

This Strategy is part of an overall strategic planning process that ensures that the corporate strategic objectives are operationalised within the business. This framework is characterised by the inter-linkages detailed in Figure 3.1.

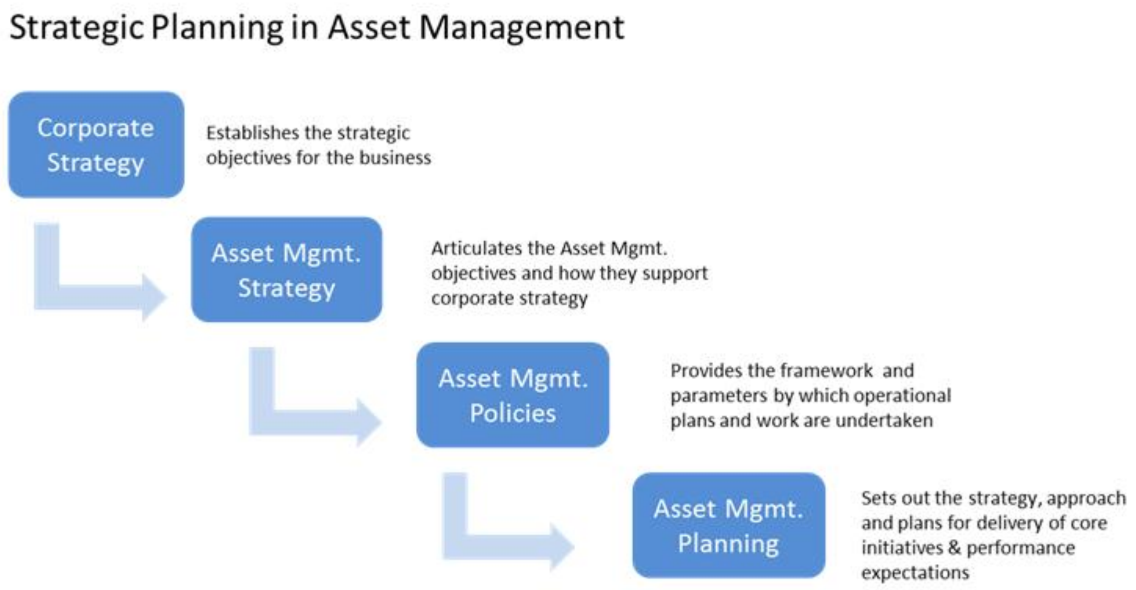


Figure 3.1: Energex's Strategic Planning Process

3.1 Network Asset Management Strategy

Energex's network asset management strategy aims to achieve the following objectives:

- Compliance with statutory obligations including safety, environment, and regulation and Energex Distribution Authority policies and standards
- Business outcomes achieved and customer and stakeholder expectations met including acceptable levels of network reliability
- Investment principles and optimised asset investment plans that balance network risk, cost and performance (service) outcomes
- A focus on asset life-cycle management including asset data and information and communication technology (ICT) initiatives (data adequacy and quality)
- Modernisation of the network to meet required business and customer outcomes
- Further development of Energex's asset management system (practice).

The asset management strategy is supported by a suite of policies, plans and guidelines. The delivery and application of the overall strategy will ensure that Energex continues to meet network challenges, deliver its asset management objectives and provide balanced results to customers and shareholders. How Energex Telecommunications directly contributes to these outcomes is detailed in section 3.2.

3.2 Telecommunications Strategy

The role of telecommunications systems is to optimise power system performance and minimise operating costs.

Consequently, Telecommunications is directly relevant in the delivery of operational excellence as part of the Business Performance operational strategy and achieving a Network delivering customer value and choice as part of Transformation Performance operational strategy.

The Telecommunications activities necessary to ensure these outcomes are achieved are detailed in sections 3.2.1 and 3.2.2 respectively.

3.2.1 Business performance

Telecommunication systems target improved business performance in the following areas:

- safety;
- compliance;
- reliability;
- productivity; and
- efficiency.

3.2.1.1 Safety

Energex Telecommunication systems:

- Enable teleprotection systems: without reliable, low latency communications between substations, would not be able to employ teleprotection.
- Enable real-time direct communication between workers: timely, direct person-to-person communication reduces risk.
- Enable remote monitoring & control: without the communications links, remote control (such as quickly & safely isolating power in a “wires-down” event) is not possible.
- Enable improved site access security: communications links enable central monitoring & control of substation access control systems.

3.2.1.2 Compliance

Energex Telecommunications systems mitigate the risk of non-compliance through:

- Enabling inter-site protection communications with low latency links
- Enabling remote monitoring & control of the primary plant via SCADA (Supervisory Control and Data Acquisition) system and DMS (Distribution Management System)
- Enable data provision to Powerlink
- Continued mesh radio network deployment & use to maintain the improved levels of SADI resulting from the DSS (Distributed SCADA System) deployment.
- Remote engineering access to enable faster identification of faults on primary network through remote analysis of protection relay oscillography and event capture.
- High availability of key data services such as inter-site protection links to minimise impact on electrical network state from any telecommunications plant failures (e.g. diversity in paths and direct signalling where feasible).
- Active monitoring of telecommunications plant with network management / element management tools to minimise time needed to locate and isolate telecommunication network faults on protection services and other important services.

3.2.1.3 Reliability, Availability, and Power Quality

Through various means, the Energex telecommunications system enhances the reliability, availability and power quality of the power system network:

- Enabling improved protection schemes, reducing the risk to primary plant from faults
- Enabling the remote visibility and control of the power system via DMS, Substation SCADA & DSS
- Enabling rapid fault isolation & outage restoration.
- Enabling measurement and operational adjustments to voltage at Substations and on long rural feeders.

3.2.1.4 Productivity

Energex Telecommunications systems improve productivity through:

- Communication between distributed workforce (e.g. mobile radios, telephones in substations)
- Enabling efficient network switching operations via DMS, Substation SCADA, and DSS

- Access to current information from worksites (e.g. secure access to corporate information systems from substations)
- Remote access to information sources within substations for condition monitoring/assessment of primary plant
- STPIS targets through mesh radio system supporting DSS deployment

3.2.2 Transformation performance

Creating a network delivering customer value and choice requires the business to respond effectively to changing technology to allow for the efficient integration of new energy generation and delivery technologies and customer end-use technologies.

The technological changes that are expected to have the most significant impact to improving Telecommunications capability and cost are:

- Embedded processing;
- Ethernet, Internet Protocol (IP), and MPLS
- Wireless technology advancements;
- OT/IT Technology convergence; and
- OT/IT integration.

3.2.2.1 Embedded processing

The expression of equipment functions through software not hardware enables rapid improvements in the number, type and sophistication of functions. It allows design errors to be fixed and new and improved functions to be added during the lifetime of the equipment.

The effects of “Mores law” (the doubling of transistor density every two years) and low power computing (driven by mobile phones and tablets) also enable the adoption of IT technologies requiring higher levels of processing power (originally impractical to deploy in harsh environments).

3.2.2.2 Ethernet, Internet Protocol (IP), and MPLS

Data networks based on packet switched technologies incorporating Ethernet interfaces and Internet Protocols have driven the expanding availability of the internet and associated growth in cost effective consumer products, applications, and services. This technology is mature, ubiquitous, and mainstream. ‘Intelligent’ power network measurement, monitoring & control devices are rapidly incorporating this technology.

Systems and products based on older circuit switched technologies are being obsoleted. Data, voice and video services are all now carried over packet switched networks.

Enhanced data network based on Multi-Protocol Label Switching (MPLS) can carry both older technology (serial data, 2Mbps trunks) and new technology (Ethernet/IP) services.

3.2.2.3 Wireless technology advancements

Consumer demand for faster mobile internet access (lower latency, higher bandwidth) is constantly driving developments in wireless data transfer.

3.2.2.4 OT/IT technology convergence

SCADA and Automation, Protection and Telecommunication systems (Operational Technologies or OT) benefit from the adoption of international standards originally developed for IT and telecommunications equipment and systems.

3.2.2.5 OT/IT integration

Data which was previously stranded on the OT side of the OT/IT divide can now be channelled efficiently into enterprise application systems, to improve both understanding and management of the power system and its associated secondary systems.

3.3 Strategic Challenges

The ongoing successful delivery of Telecommunication services in the 2015-2020 period is subject to both externally and internally derived challenges.

3.3.1 External challenges

3.3.1.1 Discontinuance of external service provider furnished networks

The services which rely upon external service provider furnished networks always carry the risk of discontinuance of the service by the provider.

In the case of the leased-line services (aka Voice Grade Dedicated Links (VGDL) or Permitted Access Private Line (PAPL) which Energex used extensively to provide data links for SCADA services, the public carrier discontinued their use, forcing a migration of services to an alternate network.

Similarly, the planned shutdown of the Fleetcoms network used for Energex Trunk Mobile Radio by the provider is driving the need for a significant project to migrate those services.

Other changes such as the requirement to accommodate NBN connections rather than regular PSTN at locations where the public network is migrated also impose additional work.

While in general there is reasonable notice given of intent to change, these services are always at risk of impact from changes driven by external entities, requiring investment, incurring opportunity cost through diversion of staff and deferral of other works to accommodate.

3.3.1.2 Technology driven obsolescence.

The enormous global market for internet enabled products and services have driven telecommunications network technologies and new network product developments. The effects of global markets, and the global financial crisis had a significant impact on the telecommunications network suppliers, with many product ranges being sold, rationalised, or discontinued. The major provider of PDH (time division multiplexed technology) multiplexer equipment that was the mainstay of Energex's operational telecommunications network through the 1980's,1990's and 2000's has stopped sale of that product line. This will be a market place trend.

3.3.1.3 Performance pressures

The essence of adoption of advanced technologies in pursuit of the benefits associated with the Smart Grid concept are heavily reliant on communications technologies. The high penetration of domestic PV makes this a priority for Energex.

3.3.1.4 Cost pressures

Energex will demand improvements in the lifecycle costs of Telecommunications services, in response to cost pressures on the business as a whole. Lifecycle costs reflect such factors as initial purchase/installation price, product lifetime and workforce productivity. Productivity pressures will increase due to a proliferation of "intelligent" devices, all of which will have to be monitored and managed.

3.3.1.5 Cybersecurity pressures

Threats to the availability of telecommunications services will increase due to the increased interconnectivity of systems, greater extent and higher exposure. The extent will increase in physical (e.g. geographical) and logical (e.g. number of subsystems) dimensions. The exposure will increase through connectivity with external (potentially hostile) systems and through the use of commercial telecommunications components having well publicised vulnerabilities.

3.3.2 Internal challenges

3.3.2.1 Accommodation of ongoing changes to business needs

As Energex responds to changes in customer needs, economic conditions and developments in the products available for improved Network performance, it can impact planned works. The consequential changes to telecommunications service requirements can require re-allocation of resources to enable cost-effective, architecturally compliant solutions. The migration/continued rollout of the IP/MPLS core network infrastructure with shift to a 'service deployment' processes will assist.

3.3.2.2 Establishing internal confidence in teleprotection over MPLS

While Energex is by no means at the leading edge with respect to MPLS adoption, the migration of critical teleprotection services to MPLS transport is still relatively new in the industry.

In the 2015-2020 period, Energex will actively identify the constraints and appropriate conservative engineering boundaries needed to be able to migrate these critical services to MPLS transport within the capability limits of our IP/MPLS network. Migration of teleprotection services will occur where feasible and prudent.

This will facilitate withdraw from service of the older/obsolete PDH based network products.

3.3.2.3 Legacy fleet

The telecommunications fleet includes unsupported and obsolescent equipment which requires upkeep in terms of both skills and spare parts.

3.3.2.4 Systems integration

The convergence of technologies across the whole Operational Technology & Telecommunication (OT&T) domain – telecommunication, protection, SCADA, automation and condition monitoring, and with IT, raises serious questions about how to organise equipment, systems, processes and skills for maximum business benefit.

3.3.2.5 Emergence of impacts from other business changes

Activities that alter the location of telecommunication facilities can have direct impact on the availability of key resources. Alterations to accommodate business decisions such as location/relocation of data centres, offices, depots, hubs, etc. have flow on effects to the supporting infrastructure and may displace planned telecommunication works.

3.3.2.6 Workforce capability

The increased deployment of ‘intelligent’ power network devices with Ethernet/IP interfaces, the increased deployment of modern IP/MPLS based telecommunications network products and associated advanced management toolsets will require continued skills training and development for our capable workforce. Modern networks and advanced toolsets will enable business efficiencies, and value.

Continued strong partnerships with our telecommunications network equipment providers will be required.

3.3.3 Summary

Energex is well under way with its transition from dependency on 1980s generation telecommunications core infrastructure to a modern core telecommunications network that will meet the current and future business needs of Energex. This IP/MPLS core network and the data centres Operational Technology Environment (OTE) has been designed with consideration of best practice cybersecurity principles. The core IP/MPLS network will continue to be rolled out over the next 5 year period. This, together with migration of existing services to Ethernet/IP based protocols will enable the decommissioning of obsolete older technology equipment. The mesh radio network upon which the DSS system depends provides a cost effective solution for DSS system and has achieved the targeted improvements in SADI and helped Energex to exceed its STPIS targets. This system will be expanded as needed over the next 5yr period. In the longer term, the DSS system is likely to migrate to some other wireless based technology.

Telco carrier based network services will continue to be used for some operational purposes where available, adequate, and cost effective. These may transition to Energex telecoms network based services as they become more widely available.

4 Existing Systems and Capability

A key input into the determination of resources necessary for the delivery of Telecommunications services for inclusion into Energex's Regulatory Proposal is an understanding of the capability of the existing system and whether enhancements are required to meet future operational needs.

This chapter details the current operational capabilities of the existing Telecommunications system.

4.1 Overview of the Current Telecommunications System

Energex's current Telecommunications system can be divided into main subsystems and key interfaces to related systems:

Physical Bearer networks (Copper Pilot, Optical Fibre, Microwave)

- Optical Fibre Bearer network
- Copper Pilot Bearer network
- Microwave Radio Transport network

Core & Intermediate networks (IP/MPLs, PDH)

- IP/MPLS (Matrix) Transport network
- PDH Transport network
- OPS-WAN ("Legacy-net") Transport network
- External Service Provider IP-WAN Edge Transport network

OT&T central applications & infrastructure

- Operational Technology & Telecommunications back-end infrastructure
- Substation Voice Services network (including OTN)
- Miscellaneous services systems.

Edge networks (fixed and mobile)

- Mesh Radio (Utilinet) Edge Transport network
- Trunk Mobile Radio (TMR) Primary Field Services network
- Substation Local Area networks

Key interfaces:

- Revenue Metering services interface
- Distribution network monitoring interface
- Corporate networks interface
- External Service Provider Public network interface
- Powerlink networks interface
- Ergon Energy networks interface

4.1.1 Optical Fibre Bearer network

The optical fibre bearer network is the physical cables and associated plant that is used to communicate between substation, depot and control/central sites.

Energex began the transition to fibre optic communications bearers from the older copper pilot cable bearers in 1985.

Since then a combination of organic growth, faulty copper pilot bearer replacements, the policy to deploy fibre with underground transmission feeders and strategic fibre-infill works has seen the network grow to more than 1,460 fibre optic bearers[1] across approximately 3,360 km.

4.1.2 Copper Pilot Bearer network

Prior to the introduction of fibre optic bearers, copper pilot cables were the preferred bearer used as the communications medium for telecommunications between substation sites. The Energex copper bearer network is aged, heavily committed, (little or no spare channels) and becoming unreliable. Copper networks are not current technology and suffer propagation and speed limitations and as such are limited in the services they can provide.

While Energex no longer actively deploys new copper cable bearers, a substantial installed base of copper pilot cable bearers is still in use for telecommunications. The majority of the copper bearer network is utilised for direct connection of protection circuits, though the use of PDH type technology from Nokia is being used to provide 2Mbps E1 (or fractional E1) capacity across suitable copper links to increase capacity of some parts of the copper network.

Energex currently manages 1146 copper pilot cable bearers across approximately 1,375km of network.

[1] At time of writing, the allocation of main bearer numbers has reached FO1464. This excludes the cables with special designations such as those interfacing to QR and other separately identified bearers (FOW, FOT, FOS etc.). Including the ancillary cables and current proposed cables there are currently 1593 optical fibre bearers across 3,568km in the CBMD database.

4.1.3 Trunk Mobile Radio (TMR) Primary Field Services network

The primary mission-critical mobile field communications network is currently the Fleetcomms TMR system. There is community and government expectation that Energex will be able to continue to operate and effectively control its network soon after any disaster. When all else fails, voice directed, manual operation is the fall-back approach.

Energex TMR equipment is capable of exclusive radio channel use, interconnection to PSTN/mobile phone services and PMR operation (similar to public CB radio). The Energex TMR fleet of radios includes 550 vehicle mounted radios, Office Triggers (base stations) in storm rooms, TACT units for PSTN connection and handheld radios.

Cellular telephony is also used (refer section 4.1.15), however the public carrier cellular networks are designed as a commercial offering and do not meet the coverage and availability requirements. This has been evidenced during all of the major storm events, with the cellular networking failing at crucial times during power restoration efforts, ironically often due to power outages.

The TMR network was originally scheduled for decommissioning in June 2012 but has been extended by Telstra out to at least 2017/18.

4.1.4 Digital multiplex (PDH) Transport network

Prior to the introduction of the IP/MPLS network, the PDH based digital multiplex network has been the primary mechanism for data transport between substation sites. In order to provide the Telecommunication requirements for Bulk and zone substations, depots and offices, Energex has been using PDH multiplexer equipment since 1996. This equipment provides the voice frequency, RS-232, Sub/Exchange, X.21, 10/100 Base-T and G.703 interfaces in order to provide for corporate data, operational data, protection, operational voice and SCADA circuits. The fibre cables have been utilised to provide 2-34Mbps links into substations and depots/offices by the use of fibre drivers. The copper cables have been utilised to provide 2Mbps digital links between sites with the installation of SHDSL drivers.

PDH nodes are installed across 284 sites, with 511 multiplexors, primarily providing services for Protection (311), SCADA (122), internal voice, site security (93) & remote engineering access (136).

4.1.5 IP/MPLS (Matrix) Transport network

The Energex IP/MPLS network is being deployed to reduce and eventually remove dependence on the now End-of-Life PDH equipment and transition to a higher capability, higher capacity core transport to better meet current and future needs.

At present there are 74 commissioned IP/MPLS nodes at sites across south-east Queensland.

4.1.6 Mesh Radio (Utilinet) Edge Transport network

A mesh radio network has been deployed primarily to service the needs of the Distribution SCADA system.

1,700 remotely controllable sites with an additional 334 installed with communications available but not yet commissioned for remote control.

This system is based on the best technology that was commercially viable for the intended purpose at the time of its deployment, however with its very limited data bandwidth, and relatively slow response times is seen as based on an interim / stepping-stone technology.

In addition to the mesh radios, there are a very small number of legacy DSA radios slated for replacement or decommissioning that are currently in service.

4.1.7 External Service Provider IP-WAN Edge Transport network

With the external withdrawal from service of leased lines (voice grade dedicated line) by the public carriers, a number of services were temporarily migrated to an interim external service provider's data network employing DSL and 3G public carrier services and appropriate data encryption. While not currently using 4G services, they can be deployed within this network if required.

This network is considered only an interim solution for most sites due to the very limited SLA and its dependency on external commercial infrastructure that typically becomes congested in times of major events such as flooding and unavailable shortly after power to the carrier's site is lost.

4.1.8 Microwave Radio Transport network

In a number of locations in SEQ, connection via a cable bearer network is impractical and a direct radio bearer link offers a more economically acceptable alternative.

Energex has 23 microwave radio sites with 60 microwave bearer links carrying services for protection, SCADA, engineering services etc.

4.1.9 Operational Technology & Telecommunications back-end infrastructure

With migration to an IP/MPLS network and the associated step change in cybersecurity has come the need for additional back-end services and segregated data communication networks for hosting and managing OT applications. An Operational Technology Environment (OTE) has been established at Energex's operational data centres. Shared infrastructure for IP-related services such as DHCP, DNS, etc. as well as tools for managing and maintaining the telecommunications system are hosted in a secure area in-line with recognised good practice.

The OTE now hosts the PowerOn Fusion DMS, and various Telecoms Network Management Systems (NMSs). Refer to Section 5.2 for a high level diagram showing OT applications deployed in the OTE.

A virtual network operational centre (NOC) has been established for monitoring & managing the SCADA & Telecommunications networks and systems. This is referred to as the SCADA & Telecommunications Operational Centre (STOC).

4.1.10 OPS-WAN (Legacy-net) Transport network

To provide access to corporate services from substation sites, an interim flat IP network was deployed using the digital multiplex (PDH) systems for carriage between sites.

Elements of this system are still in service in many substation sites, however the security posture of this older network has been significantly enhanced.

As services are migrated to the IP/MPLS network, the nodes of this interim network are decommissioned.

4.1.11 Substation Local Area networks

As secondary systems devices migrate to IP network based communications the needs of the local area networks within substations grow. At present these networks are typically quite limited, but the IP/MPLS infrastructure has been architected so it can expand to accommodate the anticipated service, traffic and interface growth. This will also improve what can be achieved with the potential transition to COTS RTUs for SCADA.

4.1.12 Substation Voice Services network (including OTN)

The Operational Telephone Network and Pilot Phone Network are 'in house' telephony platforms for voice communications between Control Centres, metropolitan substations, and regional remote radio sites.

Currently there are 510 PSTN lines in use for operational communications with substations via the public carrier network.

In addition to this there are 76 PBX/OTN direct lines providing control room console voice services to substation locations and hotlines to other key sites provided via the Energex internal operational voice services network. These are independent of the regular corporate telephone infrastructure and not reliant on the public carrier networks so critical services remain available during times of natural disaster.

4.1.13 Revenue Metering services interface

The revenue metering infrastructure is mostly independent of the operational telecommunications network, and utilises public Telco mobile data services where coverage is available.

4.1.14 Distribution network monitoring services interface

The data communications network for distribution network monitoring services currently leverages the meter reading infrastructure.

A trial of European power line carrier technology (PRIME) for data communications with meters / network monitoring units has demonstrated some promise.

4.1.15 Corporate networks interface

A number of services are provided and managed through Energex's IT provider arrangements. This is typically the case for services where there is no need for physical access to electrical substation sites in order to maintain the services.

The corporate telecommunications includes: mobile voice & data via pubic carrier, voice & data fixed point in office locations.

In addition to the services entirely managed within the IT services framework, a number of administrative functions such as billing of PSTN and IP-WAN Edge Transport are handled with corporate billing for improved operating efficiency.

4.1.16 External Service Provider Public network interface

Energex makes use of public network infrastructure where feasible.

General corporate telecommunications (internal PBX and interface to public telephone services and mobile phone) are managed by SPARQ Solutions on behalf of Energex, with various interfaces between groups.

Where practical the internal networks are used to reduce the number of services required from public network interfaces to decrease operational costs.

4.1.17 Powerlink networks interface

Energex has a number of interfaces with Powerlink for various telecommunications services.

- Tele-protection services associated with power network interconnections.
- Carriage of Energex services over Powerlink infrastructure where Energex does not have plant but requires a telecommunications service
- Carriage of Powerlink services over Energex infrastructure where Powerlink does not have plant but requires a telecommunications service
- Power network control and monitoring data between Powerlink EMS and Energex DMS.

These services are co-operatively managed to provide clear delineation of responsibility and lower costs to customers through sharing of infrastructure.

4.1.18 Ergon Energy networks interface

Energex has a number of interfaces with Ergon Energy for various telecommunications services.

- Carriage of Energex services over Ergon Energy infrastructure where Energex does not have plant but requires a telecommunications service

- Carriage of Ergon Energy (non-carrier) services over Energex infrastructure where Ergon Energy does not have plant but requires a telecommunications service

These services are co-operatively managed to provide clear delineation of responsibility and lower costs to customers through sharing of infrastructure.

4.2 Existing Capability and Performance

The current core capability of Energex's telecommunications system is sufficient to operate the network now, but it is evident that additional capability and performance will be required as the industry develops and Energex evolves to respond to the needs of its customers and the community. Energex has maintained its capability to deliver telecommunications services in a manner that is largely transparent to the business functions that are heavily dependent upon them.

5 Future Requirements

To establish the most appropriate level of operational telecommunications capability it is necessary to identify future business requirements.

Once these requirements are established then an objective assessment of the ability of the existing system to meet these obligations can be made and, where there are service gaps, an appropriate response can be developed.

This chapter sets out the operational requirements of the business.

5.1 **Operational Requirements**

Energex's basic operational requirement of telecommunications systems is that they provide the following capabilities:

- Data services to enable teleprotection
- Voice communication services to enable centralised Network Operations control
- Data services to enable the remote control & monitoring of primary plant (SCADA, Statistical metering, transformer monitoring, power quality monitoring etc)
- Data services to enable status and control information exchange with key external parties (Powerlink, Ergon Energy)
- Data services to enable protection, status and control information exchange with embedded generation
- Revenue metering data services
- Data services for remote monitoring and management of secondary systems
- Data services for the collection of key *Network* performance figures (voltage regulation, power quality etc.) to support effective *Network* planning
- Data services for collection of asset condition monitoring for support of condition based maintenance rather than time-scheduled maintenance.
- Data services for the geographically dispersed distribution network (DSS) sites
- AFLC replacement service(s) for demand management (timeframe unclear).
- Services for site physical security such as access control, alarm systems and video surveillance
- Corporate telecommunications services (standard phone, mobile phone, corporate LAN etc.)

5.1.1 Enumeration of services

Service type	Communications and description	Potential number of Devices 2025
Digital protection services	TDM services	400 – 500 Subs
SCADA services	DSA/DSS and Substations Including condition monitoring and reporting of critical plant, and the ability to forecast asset deterioration prior to failure and enable preventative actions.	400 – 500 Subs 7,000 – 10,000 of the30,000 – 40,000 installed switches
Operational Voice and operational data services	In vehicle and mobile communications devices	1000 – 5000
Lower level SCADA type services	Distribution transformer monitoring (43,000 now unmonitored)	20,000 - 40,000 Transformers
	Loss of service alarms	20,000 to 2 Million
	Equipment monitoring and alarms	10,000 to 100,000
	Distributed generation monitoring	10,000 – 1,000,000
Asset Condition monitoring & remote engineering access	Asset condition monitoring data for support of condition based asset management in line with ISO 55000. Remote engineering access for detailed incident analysis, configuration management validation, secondary systems fault analysis etc. Remote monitoring of high risk plant to mitigate risks to staff and network.	100-600 10-100 devices per substation 10-100
AMI or customer premises based services	Metering at one per premises	1-2 million
	At 5 controllable loads per premises (e.g. Air, pool, fridges, electric car charge)	5 million + load controlled devices
Corporate	PC's, servers, systems, phones, video conferencing.	2000 - 5000

Service type	Communications and description	Potential number of Devices 2025
Safety/site security	Site access control. Video in substations and where benefit is identified. RFID technology.	400 – 500 Subs 1000+

5.1.2 Data services to enable teleprotection

Energex telecommunications currently carries 424 protection data services at or above 110kV, and 536 at 33kV level. Any extended outage (>8 hours) of these protection data services can require the associated feeder(s) be de-energised.

The need for these services is ongoing. Growth due to additional power network growth is expected to be slow based on forecasts[2], however migration of existing services off old copper bearers is required to maintain network reliability.

5.1.3 Voice communication services to enable centralised Network Operations control

The current requirement for both fixed and mobile voice services which can be relied upon at locations where the general public telephony networks are unavailable remains unaltered.

The replacement of the TMR system is focused on the same basic business needs.

5.1.4 Data services to enable the remote control & monitoring of primary plant

SCADA (Transmission & Sub transmission) requires real time access with medium sensitivity to latency. When the transition is made to IEC61850/CIM centric data communications for SCADA between substations and the central systems (DMS), much higher bandwidth, native IP data links will be needed. For further detail refer to the SCADA & Automation Strategy [7].

5.1.5 Data services for remote monitoring and management of secondary systems

As the remote monitoring and management features available in secondary systems devices increase, carriage of the associated data services between power network sites and the central management systems is needed.

[2] Refer forecasting section of Energex Distribution Annual Planning Report 2013/14 to 2017/18.

5.1.6 Revenue metering data services

With the current tariff and regulatory arrangements, telecommunications for revenue metering data services in the main is best served through the current arrangements with public carrier networks.

If the landscape of the power distribution network changes with the arrival of pending disruptive technologies (e.g. high penetration of electric cars, high penetration of residential and commercial local energy storage), the performance requirements of the telecommunications services for electricity customers may alter.

While not presently carried over Energex Operational Telecommunications infrastructure, the IP/MPLS network architecture includes provision to accommodate carriage of metering services (e.g. wireless or power line carrier backhaul) in the future if required.

5.1.7 Distribution network monitoring services interface

The data communications network for distribution network monitoring services will continue to utilise public Telco mobile data services and leverage the meter reading infrastructure in the short term. The power line carrier technology (PRIME) and other wireless technology alternates may provide cost effective options in the longer term.

5.1.8 Data services for the collection of key electrical Network performance figures to support effective network planning

Effective network planning requires understanding of the current network performance and behaviour in addition to trends in alteration of customer usage patterns.

The need to support further increases in monitoring and measurement devices is anticipated given the relatively low visibility of the LV network.

5.1.9 Data services for collection of asset condition monitoring for support of condition based maintenance rather than time-scheduled maintenance.

Information on primary plant is available through the SCADA system via the DMS and other associated tools. The number of parameters that can be obtained this way is generally limited to those that are also required for network control operational reasons.

As plant condition monitoring devices become more commonplace, the opportunity to remotely gather far more information to support the analysis of plant condition increases.

Where higher bandwidth, securely segregated IP communication services can be provided (such as where the IP/MPLS network is deployed), the available data can be linked back to a central gathering mechanism independent of the SCADA system and the associated stringent data quality validation & system assurance constraints which impact on the speed and cost of change deployment.

5.1.10 Data services for the geographically dispersed distribution network (DSS) sites

While the existing mesh radio network is sufficient to handle the basic remote monitoring and control of plant such as the pole mounted reclosers, its limited data capacity and significant latency constrain its application value for other functions.

When products with sufficient capability, suitable for a progressive deployment are available, it is expected that migration of these services to a native IP system with higher bandwidth and lower latency.

5.1.11 Data services for field staff at substations

Enable staff to access greater information in the field using high-security data network access points deployed at substations.

5.1.12 Corporate services

Energex will continue to require a range of corporate enterprise grade telecommunication services for efficient day to day operations.

- Corporate mobile voice
- Corporate voice fixed point
- Corporate data fixed point
- Corporate Mobile data

These services are primarily provided by external service providers managed by Energex & Ergon Energy's ICT services entity SPARQ Solutions.

Where there are overall (whole-of-lifecycle) operational cost reduction opportunities to reduce monthly charges for services by carriage over Energex's own telecommunications infrastructure, these will be pursued.

5.1.13 Data services to enable status and control information exchange with key external parties (Powerlink)

As noted with the primary mission-critical mobile field communications network, there is community and government expectation that Queensland's power network management organisations will be able to continue to operate and effectively control its network soon after any disaster.

Key data links such as the Inter Control Centre communications between Energex and Powerlink need to be provided independent of the public carrier commercial telecommunications networks.

5.1.14 Data services to enable status and control information exchange with embedded / distributed generation

The need for economical data links capable of providing all of the necessary protection, monitoring and control is already emerging in connections with various projects and the need for this class of data link is anticipated to grow.

5.2 **Elements**

Future Telecommunication systems will comprise the following elements:

- Physical bearers (optical fibre cable, radio bearers)
- Core network;
- Intermediate network;
- Edge network;
- Operational Technology & Telecommunications computing environment;
- External service provider interfaces;
- Engineering and asset management toolsets.

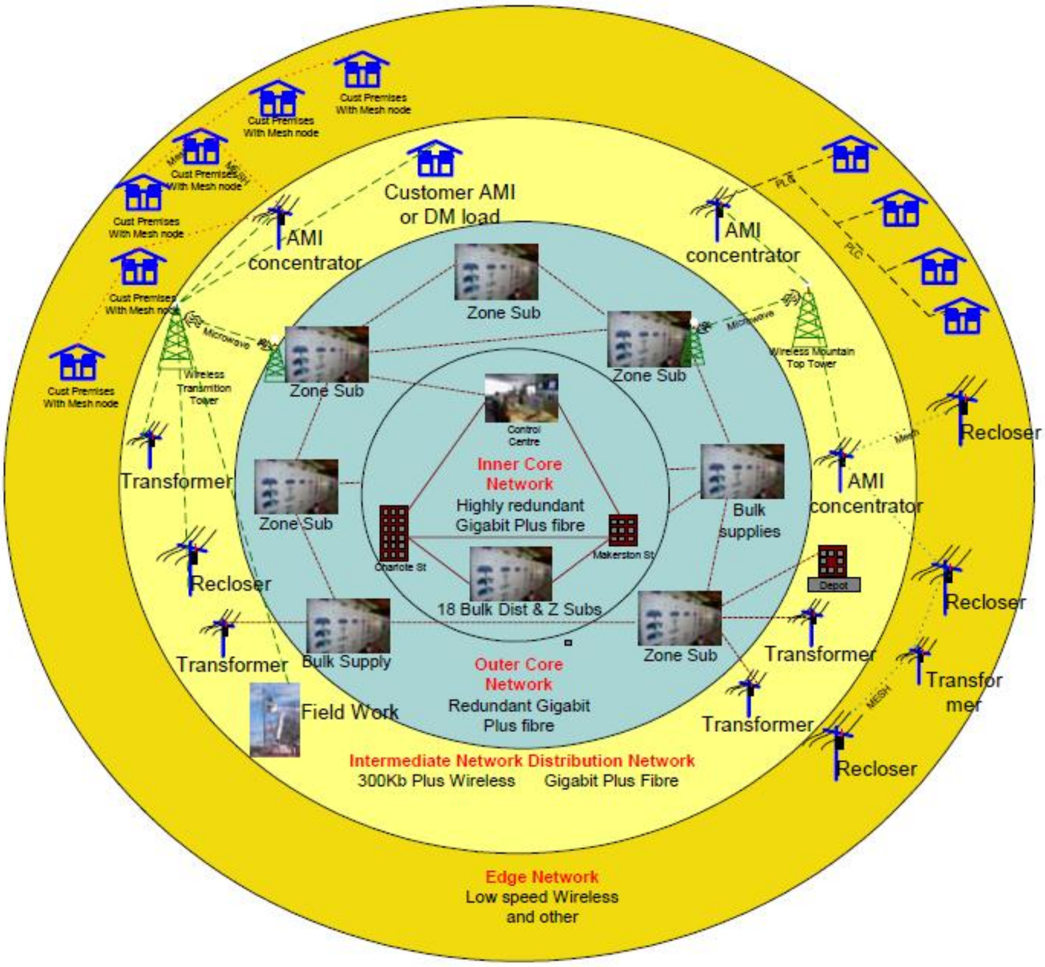


Figure 5.1 - Strategic view of the common infrastructure telecommunication network

Logical Systems View for Network Systems - 2020

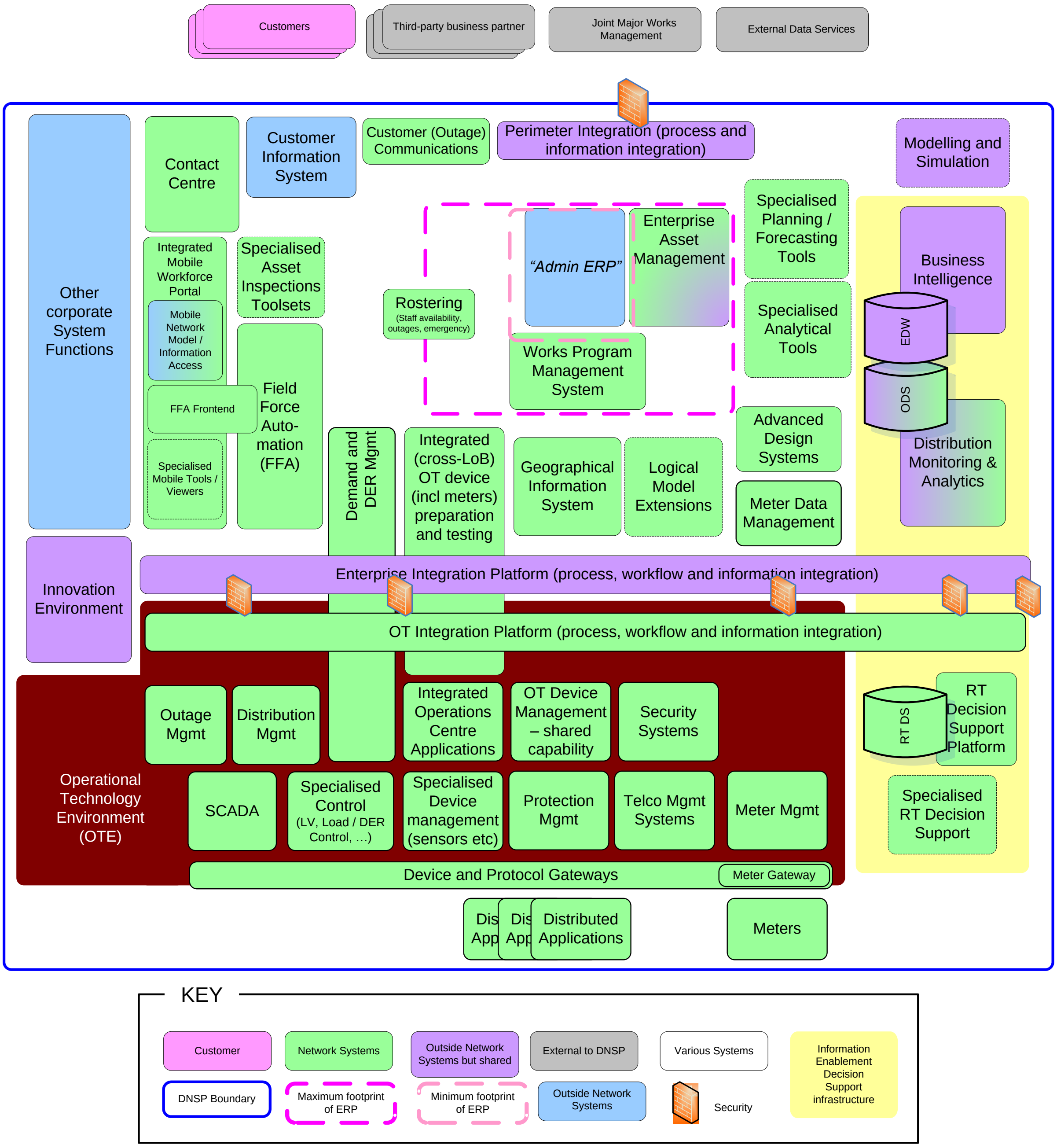


Figure 5.2 - Logical systems view for network systems 2020

5.3 **Non-Functional Attributes**

Future Telecommunication systems will have to possess the following attributes:

- sufficiently reliable and available;
- sufficiently cyber-secure;
- flexible and adaptable to accommodate future needs;
- economically maintainable.

5.3.1 Sufficiently reliable and available

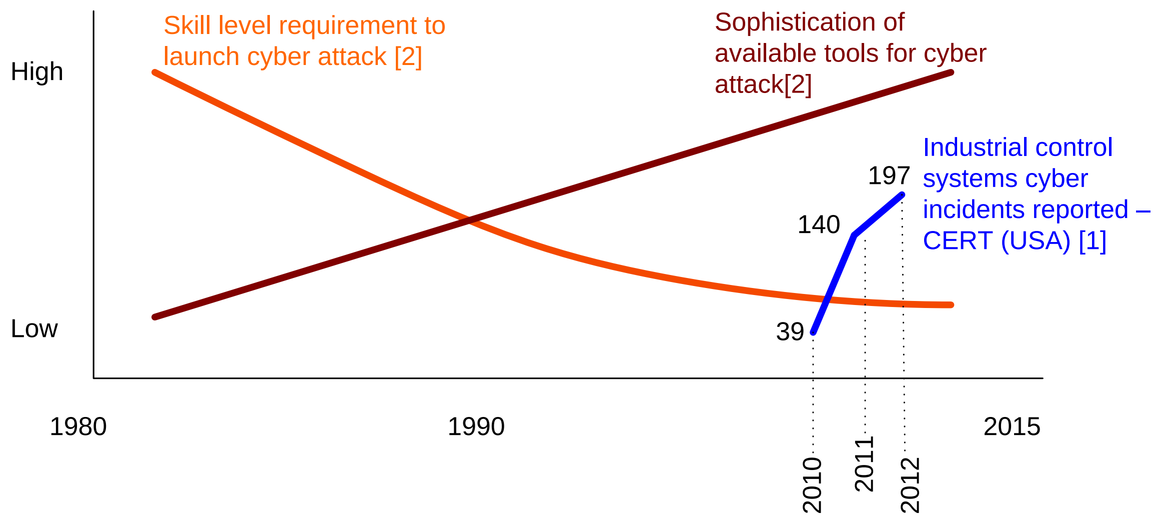
As Energex's reliance on Telecommunication systems increases, due attention will have to be given to architectural features (e.g. redundancy/duplication) and component attributes (e.g. MTBF and maintainability) that contribute to reliability and availability.

5.3.2 Sufficiently cyber-secure

A subset of the overall system distribution network security, but worthy of specific attention given international events, risk mitigation against cybersecurity threats is essential.

Figure 5.3 below shows a rise in industrial cybersecurity incidents consequent on the increasing availability of sophisticated hacking tools. Securing systems against cyber-attack requires the design, implementation, ongoing enhancement and testing of defences in compliance with a cybersecurity architecture. For more background refer to the CSIRO report [7].

Figure 5.3: Cybersecurity trends



[1] http://ics-cert.us-cert.gov/sites/default/files/documents/Year_in_Review_FY2012_Final.pdf; Table 2, pg 13
[2] Barbara Laswell, Ph.D. September 2003 CERT / Carnegie Mellon University

5.3.3 Flexible and adaptable to accommodate future needs

Energex's smart grid directions will develop in response to as-yet-unseen developments in technology and energy policy. Energex's future telecommunications systems should be capable of enhancement beyond their initial capability levels through the ability to accept new software, upgrade capability/performance and exchange data with other systems.

5.3.4 Economically maintainable

The massive rates of change and obsolescence typical of consumer electronics can have negative effects on industrial equipment, e.g. unavailability of spare parts due to "early" component obsolescence. This is countered through attention to architectural features (e.g. Standards compliance) and component attributes (compliance with a product line architecture and roadmap) that contribute to long-term maintainability. It also requires the availability of means to maintain sufficient technical support and application engineering expertise with the products.

6 Options Assessment

Having established the current capability and future operational requirements, the purpose of this chapter is to identify gaps between current capability and future requirements and to identify an appropriate solution.

6.1 Assessment of Current System

Goal: To provide cost-effective telecommunication services meeting business requirements

Operational Requirement	Current State	Key Gaps
Best practice enterprise integration	Limited integration.	• Data integration between functional silos (Refer to [3] and [4])
Best practice secondary system asset management. Functions to be coordinated include asset tracking, condition assessment, operation and maintenance	Low maturity for telecoms asset management. In-flight between older system and new. Some tactical deployments of toolsets provide partial/interim solution for some legacy equipment. Advanced toolset for IP/MPLS network	• Limited data, • Limited toolsets for legacy networks • Limited capability of tactical solutions • DM&A
Ability to produce and maintain accurate, consistent design artefacts for secondary systems pursuant to provisioning requests	Diverse systems (some obsolescent, some proprietary) with little or no data sharing or cross referencing, e.g. Ellipse, NFM, Bentley, IPS, SCADAbase, CBMD, AutoCAD, Alcatel Element Manager	• Secondary systems design integration • CBMD replacement & GIS integration • Inventory & configuration management • Optic Fibre cable asset management & GIS integration

Operational Requirement	Current State	Key Gaps
Systems deployed in accordance with Matrix architecture to optimise capacity, reliability, security and economic efficiency	Systems in various states of transition from legacy infrastructure	• Migrate systems to new infrastructure
Hosted core OT services operating on a common IP/MPLS network to optimise reliability, security, economic efficiency and functional integration	Systems in various states of transition from legacy infrastructure	• Migrate substations and field equipment to IP/MPLS network • Transition to IP-based wireless platform
Optimal fleet taking into account spare parts and support costs	Fleet in transition between obsolete products and new standard building block elements.	• Migration of services from PDH to IP/MPLS (including teleprotection)
Network elements designed, deployed, configured, secured, managed and maintained.	Mostly manual processes and toolsets for legacy networks. More advanced toolsets for newer networks and equipment IP/MPLS.	• Improve service design & service activation processes. • OT Device Management & Security
Best practice cyber security management	New networks incorporate cyber security principles. Legacy networks - risks assessed & managed	• As identified through internal audits • Phase out legacy network equipment • Continuous improvements as BAU
Bugs, limitations and usability problems systematically managed; continuous improvement has predictable funding and resourcing	Management and funding of continuous improvement is ad hoc and limits speed of response	• Continuous improvement policy and budget • Issue management process and toolset
Building blocks available as required	Number of significant element obsolescence issues being managed (e.g. PDH multiplexers).	• Continuous development of alternate/new building blocks as BAU.

Operational Requirement	Current State	Key Gaps
Resilience & disaster recovery	Considered for priority services and core network. Partial consideration for edge networks and associated services.	• Optical Fibre bearers (OF In-fill programme) • Alternate OF bearer paths (OF In-fill programme) • Alternate path via Telco Carrier where OF and radio links not available

The number, nature and magnitude of the gaps to be addressed requires a progressive approach, targeting areas of highest risk and expected benefits.

6.2 **Summary of Required Changes in Capability and Performance**

6.2.1 System core operational capability enhancements needed

- Continued rollout of the Core IP/MPLS network.

- Continued rollout of Optical Fibre cable bearers for;
    - Core IP/MPLS network deployment
    - Core IP/MPLS network alternate paths
    - Replacement of obsolete Copper Pilot cables.

- Migration of services from external service providers to internal networks for reduction of ongoing monthly carrier charges.

- Radio Spectrum Management: Migration of services from telecom carrier networks facing radio spectrum changes to either internal network services, or to alternate/replacement telecom carrier networks (e.g. 900MHz 2G / 3G -> 700MHz LTE).

- Enhanced cyber security toolsets and facilities.

- Improved configuration management toolsets and procedures.

- Asset management toolsets for planning & managing the operational telecommunications networks. Integration with GIS and with DM&A.

- The increased deployment of ‘intelligent’ power network devices with Ethernet/IP interfaces, the increased deployment of modern IP/MPLS based telecommunications network products and associated advanced management toolsets will require continued skills training and development for our capable workforce. Modern networks and advanced toolsets will enable business efficiencies, and value.

- Teleprotection over MPLS.

6.3 **Options Assessment**

In the Energex secondary systems ecosystem, there many inter-related aspects that could be altered in a various ways, and many different permutations of timing, but from a fundamental approach, the basic business asset investment choices for Telecommunications for each of the primary areas are:

6.3.1 Physical Bearer networks (Copper Pilot, Optical Fibre)

a. Break-fix only – cut spending to a minimum and accept an accelerating decline in current capability and performance relative to requirements.

b. "BAU" – no significant platform changes; no investment beyond maintaining current capability and resolving any significant issues

c. Invest in active increased deployment of fibre network to replace the copper pilot networks.

6.3.2 Core & Intermediate Data Transport network

a. Break-fix only – cut spending to a minimum and accept an accelerating decline in current capability and performance relative to requirements.

b. "BAU" – no significant platform changes; no investment beyond maintaining current capability and resolving any significant issues

c. Continue investment in the deployment of the Common Infrastructure for Telecommunications in accordance with the 2008 telecommunications strategy.

6.3.3 Edge networks

a. Break-fix only – cut spending to a minimum and accept an accelerating decline in current capability and performance relative to requirements.

b. "BAU" – no significant platform changes; no investment beyond maintaining current capability and resolving any significant issues; slow growth of DSS network.

c. Invest in continued high rate active deployment of mesh radio nodes.

6.3.4 OT&T central applications & infrastructure

a. Break-fix only – cut spending to a minimum and accept an accelerating decline in current capability and performance relative to requirements as business dependency on this infrastructure increases.

b. "BAU" – no significant platform changes; no investment beyond maintaining current capability and resolving any significant issues

c. Invest in further consolidation and migration of Operational Technology services to the new high security central infrastructure.

6.3.5 Field services networks (TMR discontinuance)

a. Divest (not replace) and accept a significant step change reduction in current capability relative to requirements with reliance on commercial cellular network services.

b. Invest in integration of essentially a like-for-like replacement system to maintain current capability for mission-critical mobile voice communications.

   i. Install a TMR network as an extension of the network that Ergon Energy are deploying.

   ii. Request another party to implement and operate TMR network compatible to and integrated with the Ergon Energy network for Energex's use

   iii. Request another party to implement and operate a network that will meet Energex's requirements

c. Invest substantially more in an Energex owned and operated network as replacement for the current TMR system.

Tabular summary:

Core Capability Area	Planned Strategic Direction	
	2015-20	**2020-25**
Physical Bearer networks (Copper Pilot, Optical Fibre, Microwave)	c. Invest in active deployment: • Active deployment of bearers to enable IP/MPLS network (optical fibre infill) • Proactive replacement of copper bearers on basis of load at risk • Continue lowering long term costs by including fibre bearers with transmission feeder installations	c. Invest in deployment: • Proactive replacement of copper bearers on basis of load at risk • Continue lowering long term costs by including fibre bearers with transmission feeder installations
Core & Intermediate networks(IP/MPLS, PDH)	c. Invest in active deployment: • Continued deployment of IP/MPLS network as basis of core and intermediate network • Progressive migration of services off the aging PDH based network	c. -> b. Transition to BAU • Progressive migration of services off the aging PDH based network • BAU
Edge networks	c. -> b. Transition to BAU • Slowed growth of DSS mesh radio network	b. -> c. BAU with possible technology refresh investment • BAU (Maintain) DSS; • Possible introduction of migration technology for mesh network replacement if suitable products available. • Possible introduction of alternative load control communications system if suitable products available.

OT&T central applications & infrastructure	c. Consolidation and migration • Migration of services and applications to OTE	b. Transition to BAU • BAU
Field services networks (TMR discontinuance)	b. like-for-like replacement system • Migration to alternative service/network.	• BAU with new system

6.4 **Conclusion**

Based on the analysis undertaken, Energex considers that the most efficient operation and economic efficient solution is to continue with the migration of the telecommunication services to optical fibre and the IP/MPLS network, continue the necessary establishment of foundation systems for economical service deployment and continue risk-based replacement or renewal of existing assets.

7 Proposed Solution

This chapter identifies the financial requirements to deliver the proposed telecommunications services for each year of the next regulatory period.

7.1 Proposed Solution

A number of projects have been identified as part of the preferred solution model. These projects are provided in detail at Attachment 1.

The long-term implementation of this solution will extend beyond the 2015-20 regulatory period. Figure 7.1 provides a road map for the implementation of this program of work.

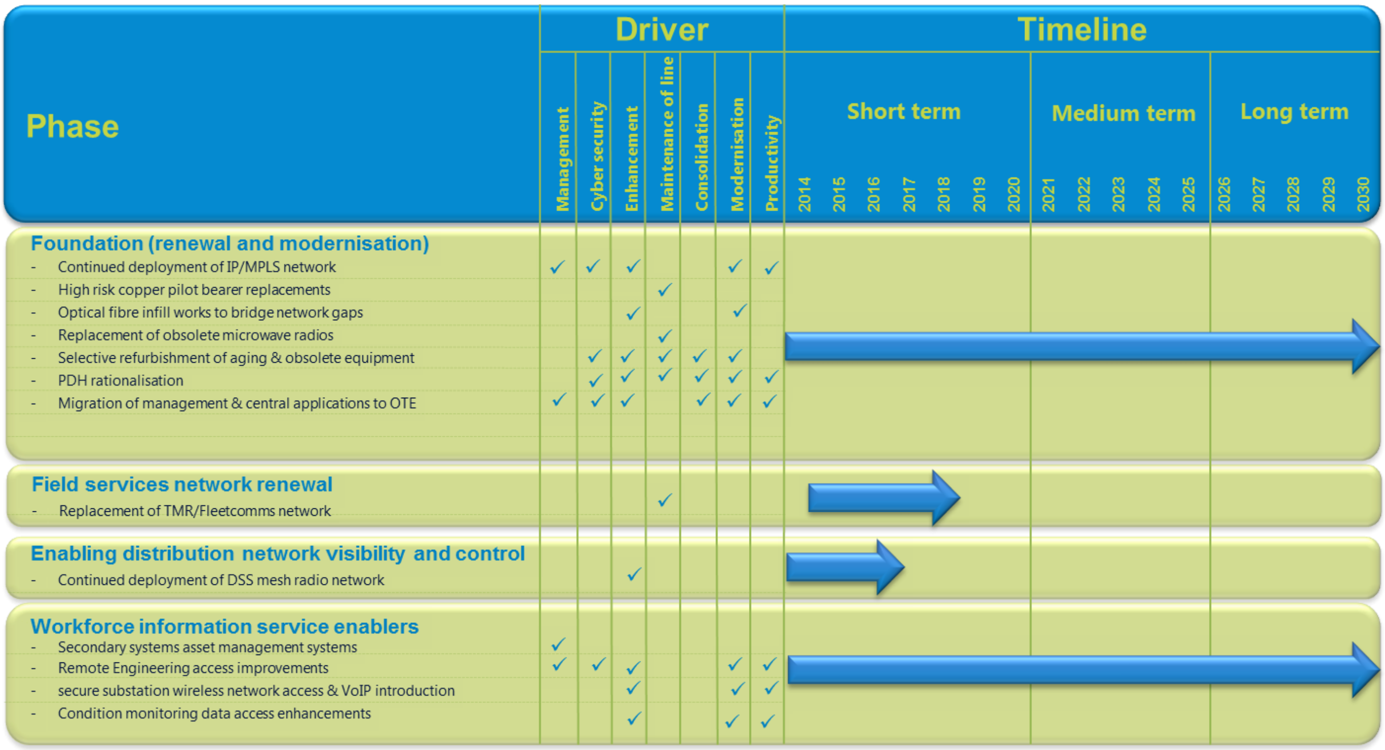


Figure 7.1 – Programme Roadmap

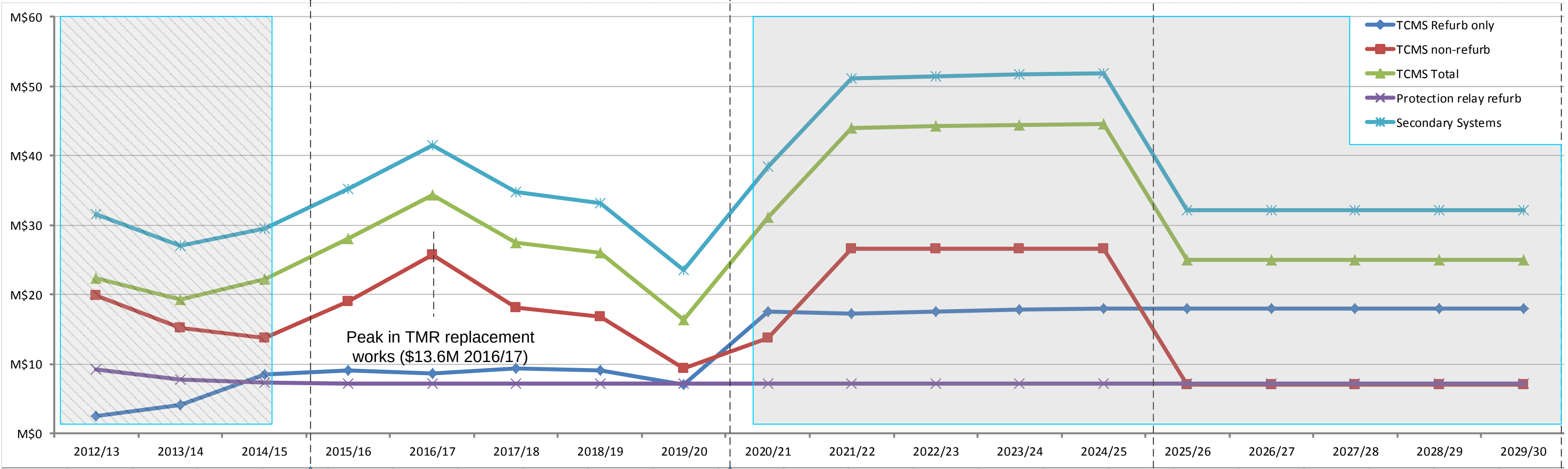
ROAD MAP – Secondary Systems Directs (Protection/SCADA& Automation/Telecommunications)

Safety:
Improvements with removal of at risk relays
Network Performance:
STIPIS risk minimisation - Deployment of Distribution System SCADA
Obsolete technology risk reduction
Foundations for next 20+ years for telecomms
Cyber security improved

Capital Expenditure deferral -
Substation protection schemes will withstand increased loading under N-1 outage condition (no Secondary Systems constraint).
Resource Demand reduced - Relay setting standardisation , less need for Protection Permits, simpler circuitry, lower dependency on internal development, faster project implementation.
Cyber security improved
Maintenance Cost reduced

Network Management improved - Capability to implement Smart Grid function
Longer term resource demands reduced - SCADA/ COMMS/Protection - Sustainable deployment, operation and maintenance costs.

TCMS= Telecommunications, SCADA and Automation works



Telecommunications Core Rebuild
DSS system development & deployment
Enabling DMS
Operational Data Centre environment rebuild
Critical obsolescence works (VGDL, Microcontrollers, SICM1 etc)
Smart Grid Trials
Critical Relay replacements
Protection Engineering tool-suite

Capitalising on existing assets & integration of Secondary Systems
Transition to new standards:
- Use protection relays in place of SICM
- More asset management data from comms enabled field devices
- Commercial RTU
- Migration to new telecom core

Continued Telecom infrastructure deployment
Strategic obsolete plant replacements
Preparation for IEC-61850 introduction

Adopt IEC-61850 Station Bus for substation secondary systems standard
- Massive organisational change impact
- Complete change to way primary & secondary circuitry design is performed
- Need to support existing and new processes & tools until existing systems migrated
- Assumes main project spend of ~$80M over 3 years + ongoing $17M/yr for remainder of systems works
- Timing subject to suitable product availability

Preparation for Processes Bus (IEC-61850)

IEC-61850 based communications for substation to DMS communication
Process Bus (IEC-61850) introduction
DMS Network model based wide-area automation
Ongoing deployment of IEC-61850 Station bus as sites are refurbished

7.2 **Transition Risks and Issues**

Considering the telecommunications strategic programme overall, the main risks to delivery are:

- Disruptive technology impact
- Government policy impacts
- Strategic direction changes by external service providers
- Further deferral of Trunk Mobile Radio network decommissioning by Telstra
- Conflicting resource demands
- Typical development project risks

Each of these is briefly discussed in the following sections.

7.2.1 Disruptive technology impact

Probability of occurrence assessment: Moderate

Impact on strategy assessment: Moderate impact

The rapid development of disruptive new power network related technologies may have an impact on this strategy. Widespread uptake of technologies such as electric vehicles, low cost battery storage, etc. could result in the need to re-allocate resources to respond to altered distribution network needs.

7.2.2 Strategic direction changes by external service providers

Probability of occurrence assessment: High

Impact on strategy assessment: Low - Moderate

There is a risk that an external service provider may alter the services they provide or the terms under which they are prepared to offer their services. Examples are changes around the Telstra TMR services, new mobile data services etc. Such changes may impact timing (for example further deferral of the TMR replacement) or even require reconsideration of basic direction for certain areas of this strategy.

7.2.3 Conflicting resource demands

Probability of occurrence assessment: High

Impact on strategy assessment: High

Unplanned events such as key suppliers going into liquidation, product end-of-life announcements, internal department restructuring/downsizing and the need for support from other areas of the business to resolve high priority concerns currently have direct impacts on availability of staff to work on strategic projects. With reduced staff levels and significant disruptive events likely, risk to delay of strategic works is considered to be high.

7.2.4 Typical development project risks

Probability of occurrence assessment: High

Impact on strategy assessment: Low-Moderate

Since much of the work involves substantial change to established process, tools and techniques as well as significant technology integration works, it carries with it the project risks typical of development projects.

8 Governance

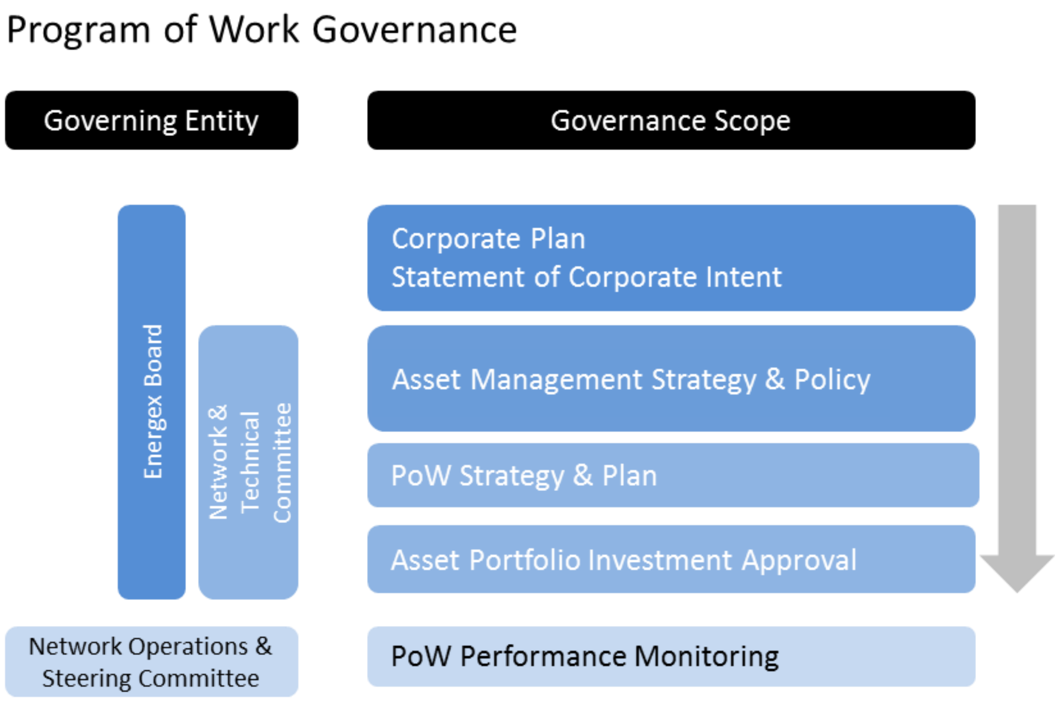
This chapter sets out the governance arrangements that will apply to Energex Telecommunications strategic works.

8.1 Ownership

This strategy is owned by Group Manager Engineering Standards and Technology within the Asset Management Division.

8.2 Governance

Energex Program of Work Governance ensures strategy & policy development and resulting portfolio investment approvals align to achieve the strategic objectives of the business. Monitoring and review of the program of work performance against annual targets and performance standards is undertaken by the Network Operations & Steering Committee.



8.2.1 Performance Monitoring and Reporting

Monitoring of performance achieved compared to the approved program investment is to be presented on a quarterly basis to the Network Operations and Steering Committee or earlier if as requested.

Reporting about this strategy/program is facilitated through the following form/methods:

- Telecommunications Strategy Progress Report

Reporting occurs at quarterly intervals and is produced by Engineering Standards and Technology Group.

8.3 Review

This Strategy is to be reviewed annually as part of Energex's annual business planning process. Review details can be referenced in the Version Control section at the start of this document.

8.4 Publication

The current version of this Strategy is available on the Energex document management system. All other electronic and printed versions of this document are to be deemed as non-current and uncontrolled unless specifically authorised by the owning Group Manager.

9 Glossary

Term	Definition
3G (IMT2000)	International Mobile Telecommunications-2000 (IMT-2000) is the global standard for third generation (3G) wireless communications as defined by the International Telecommunication Union. In 1999 ITU approved five radio interfaces for IMT-2000 as a part of the ITU-R M.1457 Recommendation: • IMT-DS Direct-Sequence o also known as W-CDMA or UTRA-FDD, used in UMTS • IMT-MC Multi-Carrier o also known as CDMA2000, the successor to 2G CDMA (IS-95) • IMT-TD Time-Division o This comprises: TD-CDMA (Time Division - Code Division Multiple Access) and TD-SCDMA (Time Division - Synchronous Code Division Multiple Access). Both are standardised by 3GPP in UMTS like UTRA TDD-HCR (3.84 Mcps, 5 MHz bandwidth, TD-CDMA air interface) and UTRA TDD-LCR (1.28 Mcps, 1.6 MHz bandwidth, TD-SCDMA air interface). • IMT-SC Single Carrier o also known as EDGE[1] • IMT-FT Frequency Time o also known as DECT On 18 October 2007 The ITU Radiocommunication Assembly took a decision to include WiMAX-derived technology in the framework of the IMT-2000 set of standards as the sixth element: • IP-OFDMA TDD WMAN o IP-OFDMA TDD WMAN is a specific variant of IEEE 802.16 with specific WiMax profiles.
ACMA	Australian Communications & Media Authority
AER	Australian Energy Regulator
AFLC	Audio Frequency Load Control
APRS	Advanced Power Restoration System DMS-hosted application for distribution automation
Automation	Autonomous control of power system functions, closely associated with (typically embedded in) the SCADA system and/or the DMS
CIM	Common Information Model The UCAIug CIM is a standard information model for power systems and related secondary systems and computer applications

Term	Definition
COS	Customer Outcome Standard – The power supply security standard adopted in place of the previous more conservative "N-1" based standard (Schedule 3 of the Energex Distribution Authority No. D07/98, amended 30th June 2014).
COTS	Commercial-Off-The-Shelf A product that is designed to meet the requirements of a market segment, not an individual customer, is manufactured to a common specification and is sold/purchased "as-is" off the shelf
CT	Current Transformer A type of instrument transformer.
DAPR	Distribution Asset Planning Report
DER	Distributed Energy Resources
DM	Demand Management
DM&A	Distribution Monitoring & Analytics – a programme to provide improved analytical tools for leveraging information about the Distribution Network to improve operations, planning & engineering.
DMS	Distribution Management System
DNP3	Distributed Network Protocol version 3 Industry standard SCADA data communication protocol used by SACS, SICM2B and many other products. Has been adopted as a key "smart grid interoperability" protocol by NIST through its codification as IEEE standard 1815
DSS	Distribution System SCADA SCADA for the power system outside bulk supply and zone substations, especially the 11kV primary distribution network
GPRS	General Packet Radio Service (GPRS) is a packet oriented Mobile Data Service available to users of Global System for Mobile Communications (GSM) and IS-136 mobile phones. It provides data rates from 56 to114 kbit/s. GPRS can be used for services such as Wireless Application Protocol (WAP) access, Short Message Service (SMS), Multimedia Messaging Service (MMS), and for Internet communication services such as email and World Wide Web access. GPRS data transfer is typically charged per megabyte of traffic transferred, while data communication via traditional circuit switching is billed per minute of connection time, independent of whether the user actually is using the capacity or is in an idle state. GPRS is a best-effort packet switched service, as opposed to circuit switching, where a certain Quality of Service (QoS) is guaranteed during the connection for non-mobile users.

Term	Definition
	2G cellular systems combined with GPRS are often described as "2.5G", that is, a technology between the second (2G) and third (3G) generations of mobile telephony. It provides moderate speed data transfer, by using unused Time division multiple access (TDMA) channels in, for example, the GSM system. Originally there was some thought to extend GPRS to cover other standards, but instead those networks are being converted to use the GSM standard, so that GSM is the only kind of network where GPRS is in use. GPRS is integrated into GSM Release 97 and newer releases. It was originally standardized by European Telecommunications Standards Institute (ETSI), but now by the 3rd Generation Partnership Project (3GPP).
GPS	Global Positioning System Global system for precise determination of position and time.
GSM	Global System for Mobile communications: originally from Groupe Spécial Mobile) is the most popular standard for mobile phones in the world. Its promoter, the GSM Association, estimates that 82% of the global mobile market uses the standard. GSM is used by over 3 billion people across more than 212 countries and territories. Its ubiquity makes international roaming very common between mobile phone operators, enabling subscribers to use their phones in many parts of the world. GSM differs from its predecessors in that both signalling and speech channels are digital, and thus is considered a second generation (2G) mobile phone system. This has also meant that data communication was easy to build into the system. The ubiquity of the GSM standard has been an advantage to both consumers (who benefit from the ability to roam and switch carriers without switching phones) and also to network operators (who can choose equipment from any of the many vendors implementing GSM). GSM also pioneered a low-cost, to the network carrier, alternative to voice calls, the Short message service (SMS, also called "text messaging"), which is now supported on other mobile standards as well. Another advantage is that the standard includes one worldwide Emergency telephone number, 112. This makes it easier for international travellers to connect to emergency services without knowing the local emergency number. Newer versions of the standard were backward-compatible with the original GSM phones. For example, Release '97 of the standard added packet data capabilities, by means of General Packet Radio Service (GPRS). Release '99 introduced higher speed data transmission using Enhanced Data Rates for GSM Evolution (EDGE).
HMI	Human-Machine Interface Operator console.
IEC 61850	A suite of international standards published by the International Electrotechnical Commission (http://www.iec.ch/) for secondary systems which has the potential to improve capability and reduce labour costs
(IEC 61850) Process Bus	Means the use of data (not electrical signals) to convey primary system measurements. Highly challenging transition from existing systems

Term	Definition
(IEC 61850) Station Bus	Means the use of data (not electrical signals) to convey control and automation quantities. Moderately challenging transition from existing systems
IED	Intelligent Electronic Device A multi-function electronic device suitable for integration into a wider system via one or more communication ports. An IED can serve any or all of the following needs – protection; automation; SCADA; condition monitoring; event recording; oscillography; HMI
IEEE C37.94	An IEEE standard developed for protection applications that defines a generic standard content-agnostic logical and physical interface to carry data over digital multiplex equipment (e.g. PDH,SDH, other G.704 frame/G.703 interface) with specific requirements on how loss of communications signals are handled to make it suitable for protection use.
IP	The Internet Protocol Suite (commonly TCP/IP) is the set of communications protocols used for the Internet and other similar networks. It is named from two of the most important protocols in it: the Transmission Control Protocol (TCP) and the Internet Protocol (IP), which were the first two networking protocols defined in this standard. Today's IP networking represents a synthesis of several developments that began to evolve in the 1960s and 1970s, namely the Internet and LANs (Local Area Networks), which, together with the invention of the World Wide Web by Sir Tim Berners-Lee in 1989, have revolutionized computing. The Internet Protocol Suite, like many protocol suites, may be viewed as a set of layers. Each layer solves a set of problems involving the transmission of data, and provides a well-defined service to the upper layer protocols based on using services from some lower layers. Upper layers are logically closer to the user and deal with more abstract data, relying on lower layer protocols to translate data into forms that can eventually be physically transmitted. The TCP/IP model consists of four layers (RFC 1122). From lowest to highest, these are the Link Layer, the Internet Layer, the Transport Layer, and the Application Layer.
IP/MPLS	Internet Protocol/Multi-Protocol Label Switching Technologies for high performance data networking
ISCS	Interim Secondary Control System An adjunct to Energex’s DMS, which provides ancillary control and support services
ISM (band)	An allocation of radio frequency spectrum principally for Industrial Scientific and/or Medical use covered by a “class” licence (eg: 915 – 928 MHz, 2.4GHz WiFi spectrum etc). This is “shared” spectrum, and does not have the same level of spectrum management as individually licensed bands.

Term	Definition
ISO Layers	The Open Systems Interconnection Basic Reference Model (OSI Reference Model or OSI Model) is an abstract description for layered communications and computer network protocol design. It was developed as part of the Open Systems Interconnection (OSI) initiative[1]. In its most basic form, it divides network architecture into seven layers which, from top to bottom, are the Application, Presentation, Session, Transport, Network, Data-Link, and Physical Layers. It is therefore often referred to as the OSI Seven Layer Model. A layer is a collection of conceptually similar functions that provide services to the layer above it and receives service from the layer below it. For example, a layer that provides error-free communications across a network provides the path needed by applications above it, while it calls the next lower layer to send and receive packets that make up the contents of the path. Even though it has been largely superseded by newer IETF, IEEE, and indeed OSI protocol developments (subsequent to the publication of the original architectural standards), the basic OSI model is considered an excellent place to begin the study of network architecture. Not understanding that the pure seven-layer model is more historic than current, many beginners make the mistake of trying to fit every protocol under study into one of the seven basic layers. Especially the attempts of cross-layer optimization break the boundaries of the original layer scheme. Describing the actual layer concept with implemented systems is not always easy to do as most of the protocols in use on the Internet were designed as part of the TCP/IP model, and may not fit cleanly into the OSI Model.
IT	Information Technologies
Latency	The time taken for a packet of data to get from one location to another.
Matrix	The project under which Energex is rolling out its IP/MPLS-based data network
MDC	Master Data Concentrator A high-level node in Energex's SCADA data communication hierarchy.
MPLS	Multi Protocol Label Switching (MPLS) is a data-carrying mechanism that belongs to the family of packet-switched networks. MPLS operates at an OSI Model layer that is generally considered to lie between traditional definitions of Layer 2 (Data Link Layer) and Layer 3 (Network Layer), and thus is often referred to as a "Layer 2.5" protocol. It was designed to provide a unified data-carrying service for both circuit-based clients and packet-switching clients which provide a datagram service model. It can be used to carry many different kinds of traffic, including IP packets, as well as native ATM, SONET, and Ethernet frames. A number of different technologies were previously deployed with essentially identical goals, such as frame relay and ATM. MPLS is now replacing these technologies in the marketplace, mostly because it is better aligned with current and future technology needs. While the traffic management benefits of migrating to MPLS are quite valuable

Term	Definition
	(better reliability, increased performance), there is a significant loss of visibility and access into the MPLS cloud for IT departments
NPV	Net Present Value
NTC	Network Technical Committee
OPGW	Optical Power Ground Wire (Earth or ground wire with fibre wound into the core)
OPS-WAN	OPerationS Wide Area Network A pastiche of legacy technologies which currently provides data communication services to Energex's SCADA and Automation system.
Oscillography	The capture and display of pre- and post- fault voltage and current waveforms
OT	Operational Technologies
OTE	Operational Technology Environment A secure network environment at Energex's operational data centres for deploying operational related application and systems. The OTE is separated from, but connected with the Corporate IT network environment. Applications hosted within the OTE communicate with field devices via the core IP/MPLS network, substation legacy network, or carrier fringe networks.
PAPL	Permitted Access Private Line - Copper bearer running as a pair from point to point. (Telstra)
PC-SACS	The current incarnation of SACS. PC-SACS versions 2 and 3 are obsolescent; PC-SACS version 5 is current (there was no version 4).
PDH	Plesio-synchronous Digital Hierarchy – PDH is the generic shorthand term for equipment based on a suite of telecommunications standards (ITU-T recommendations) that use a deterministic transport mechanism for multiple channels of varied pre-defined capacity. Refer http://www.itu.int; G.701-G.705 This is a legacy communications protocol mostly for 2Mbps point to point clocked data links. SDH (Synchronous Digital Hierarchy) has largely replaced PDH as a clocked or synchronous technology.
Platform	Loosely, the infrastructure supporting an IT-based system, e.g. the hardware is a platform for the operating system; the hardware and operating system together form a platform for applications.
PLC	Power Line Carrier – communication signalling over power lines.
POPS	Plant Overload Protection Software SACS-based substation automation software
PoW	Program of Work

Term	Definition
QNX	The real-time software operating system used by SACS (a commercial product)
RDC	Remote Data Concentrator A mid-level node in Energex's SCADA data communication hierarchy.
RTU	Remote Terminal Unit Historically, a (dumb) remote endpoint of a SCADA system. More recently, a (smart) remote platform for SCADA and Automation functions
ROSS	Radio Operational Support System – a software system that enables faster deployment and improved management of the Mesh Radio network.
SAS	Substation Automation System Loosely, a system comprising an RTU, IEDs and support (monitoring and management) subsystems. An SAS can serve any or all of the following needs – protection; automation; SCADA; condition monitoring; event recording; oscillography; HMI
SCADA	Supervisory Control and Data Acquisition Remote eyes and hands for power system operators.
SCADA HMI	The HMI component of SACS
SCADAbase	A proprietary tool used to design and build configuration data for Energex's SCADA and Automation systems. The decision to develop SCADAbase was taken after a market scan failed to find any suitable COTS offering
SCID	SCADA Common Information Display application – a software utility used to provide access to historical data and trends from the Substation SCADA and DSS system.
SDH	Synchronous Digital Hierarchy - A circuit mode digital transmission network standard defined in G.707 and G.708 that supersedes PDH technology. Uses a base transmission rate of 155Mbps to transmit data over fibre. The base rate (known as STM-1) can be multiplexed together to create higher order rates such as 2.5Gbps (STM-16) and 10Gbps (STM-64). Can carry PDH streams such as 2Mbps or 34 Mbps by encapsulating them in a larger SDH frame.
SICM2B	Serial Interface Control Module, model 2B An Energex proprietary IED used for interfacing with substation plant
SNMP	Simple Network Management Protocol Standard protocol widely used in mainstream IT systems for remote monitoring of platforms and infrastructure
teleprotection	Use of telecommunications to improve the ability of the protection system to achieve faster or more sensitive electrical protection schemes.

Term	Definition
UCAIug	The UCA International Users Group The UCAIug is a not-for-profit corporation consisting of utility user and supplier companies that is dedicated to promoting the integration and interoperability of electric/gas/water utility systems
UtiliNet	Wireless data communications network used by Energex for DSS
VoIP	Voice-over-Internet protocol (VoIP) is a protocol optimized for the transmission of voice through the Internet or other packet-switched networks. VoIP is often used abstractly to refer to the actual transmission of voice (rather than the protocol implementing it). This latter concept is also referred to as IP telephony, Internet telephony, voice over broadband, broadband telephony, and broadband phone.
VT	Voltage Transformer A type of instrument transformer.
VVR	Volt-Var Regulation A SACS-based substation automation application
WAN	Wide Area Network
WiFi (IEEE 802.11)	IEEE 802.11 is a set of standards for wireless local area network (WLAN) computer communication, developed by the IEEE LAN/MAN Standards Committee (IEEE 802) in the 5 GHz and 2.4 GHz public spectrum bands. Although the terms 802.11 and Wi-Fi are often used interchangeably, the Wi-Fi Alliance uses the term "Wi-Fi" to define a slightly different set of overlapping standards. In some cases, market demand has led the Wi-Fi Alliance to begin certifying products before amendments to the 802.11 standard are completed.
WiMAX (IEEE 802.16)	The IEEE 802.16 Working Group on Broadband Wireless Access Standards, which was established by IEEE Standards Board in 1999, aims to prepare formal specifications for the global deployment of broadband Wireless Metropolitan Area Networks. The Workgroup is a unit of the IEEE 802 LAN/MAN (Metropolitan Area Network) Standards Committee. A related future technology Mobile Broadband Wireless Access (MBWA) is under development in IEEE 802.20. Although the 802.16 family of standards is officially called Wireless MAN, it has been dubbed “WiMAX” (from "Worldwide Interoperability for Microwave Access") by an industry group called the WiMAX Forum. The mission of the Forum is to promote and certify compatibility and interoperability of broadband wireless products.

Appendix A – Explanatory notes

Mesh Radio Network deployment

From the beginning of the rollout in 2008 to June 2014, Energex has deployed a very significant population of mesh radios with DSS to enable reductions of SADI and meet STPIS targets. The value of the network has been demonstrated during the recent Brisbane floods, enabling the restoration of power to areas not directly impacted rather than them needing to remain without power while affected feeders were restored. *Figure 9.1* below demonstrates the breadth of the deployment across the Energex service area.

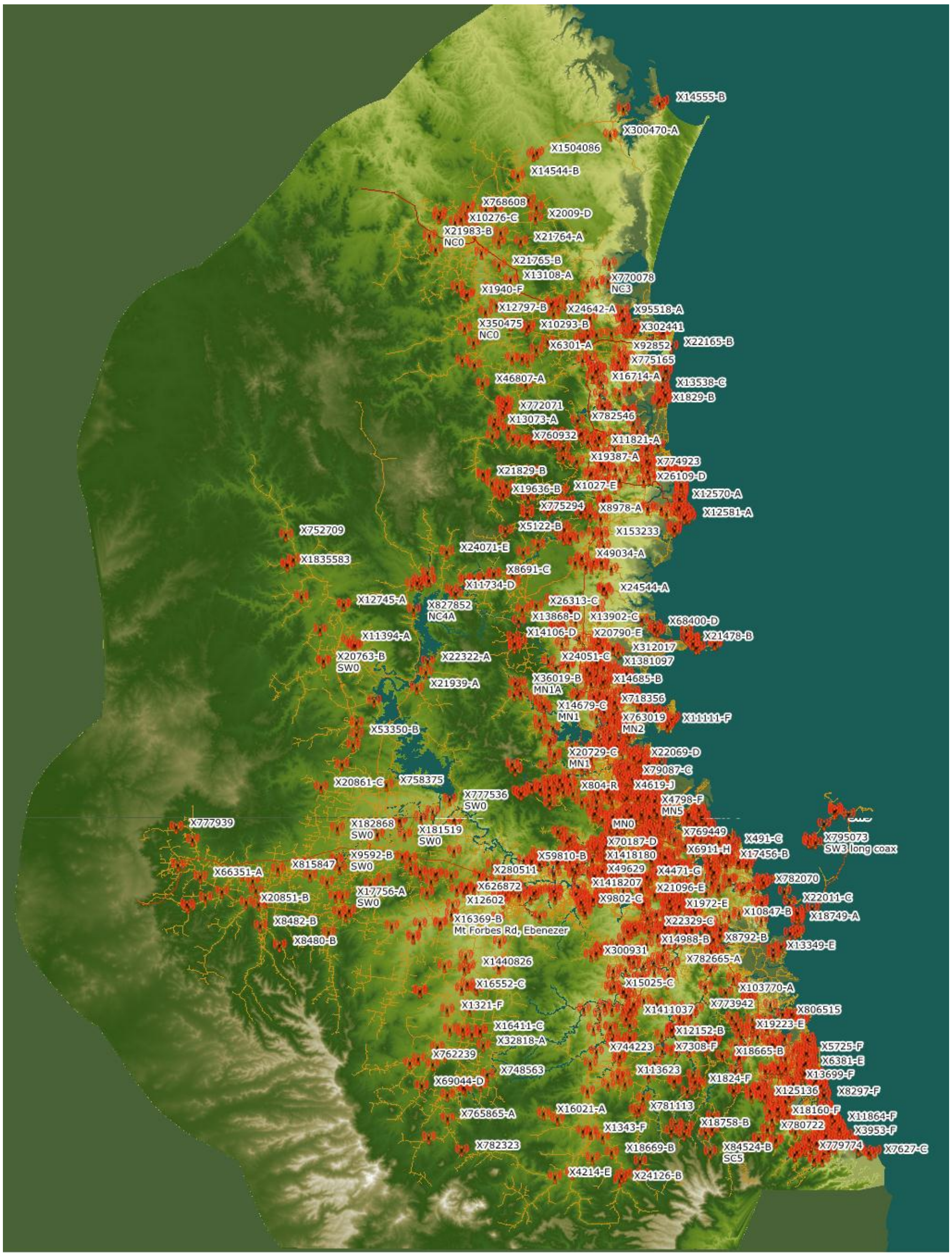


Figure 9.1 Energex Mesh Radio (DSS) network – nodes in active service as at June 2014.

Fibre Network deployment progress

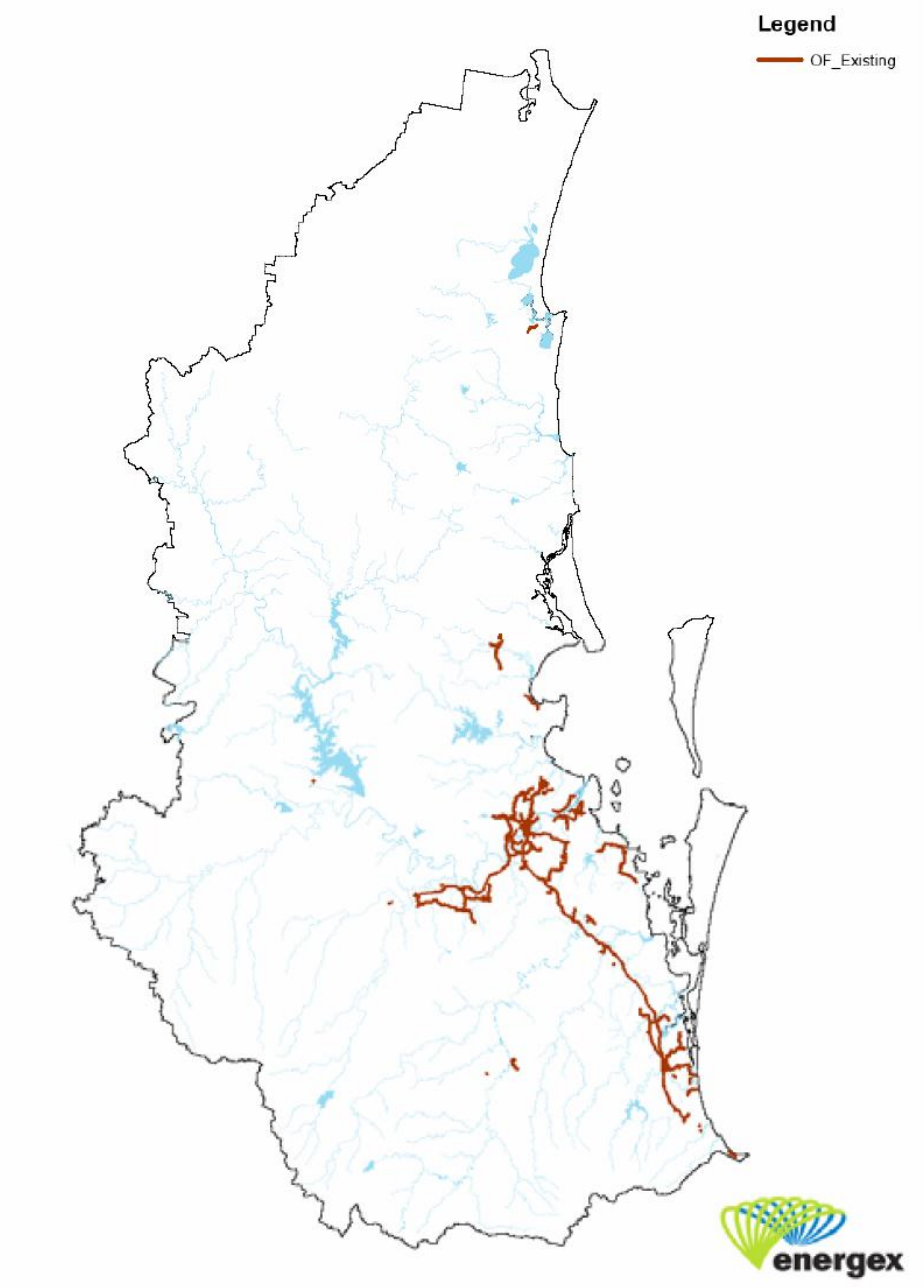


Figure 9.2 - 2008 Energex Optical Fibre network

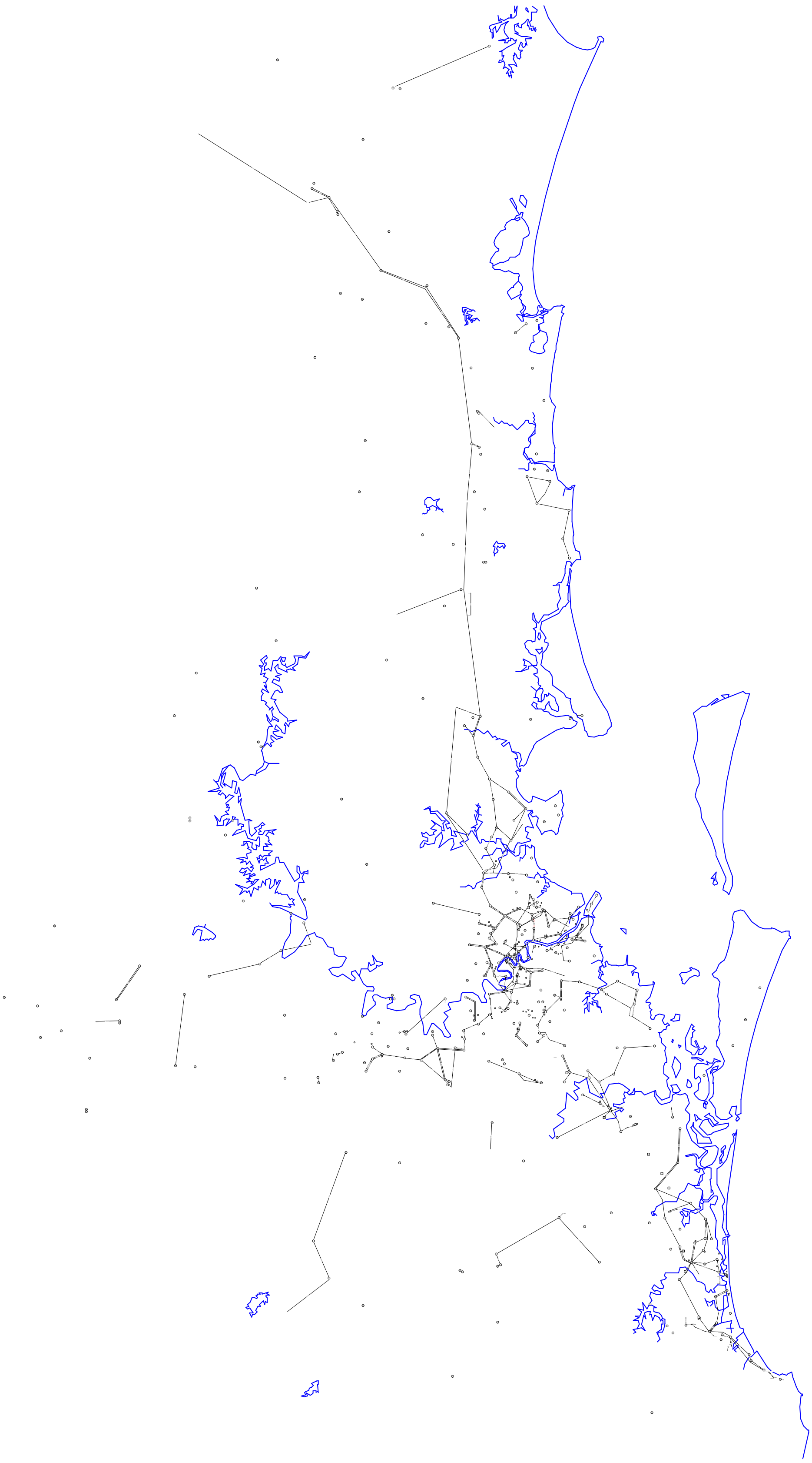


Figure 9.3 - 2014 Energex Optical Fibre network

Energex telecommunication service characteristics

The following table (reproduced from the 2008 Telecommunications Strategy) provides a basic summary of the key telecommunications characteristics of the various services for which Energex telecommunications provides carriage.

	Name	Description	Bandwidth	Criticality of service	Low Latency Sensitivity
1	Direct Protection	Dedicated physical link only. This service incorporates a direct physical link between substation switches for high speed no latency protection signalling.	Full fibre	Critical	Physical layer propagation
2	Multiplexed Protection	Dedicated slice on SDH or channel on PDH. Running on multiplexed equipment over shared physical medium. Could be over fibre or to some extent copper and microwave.	Full channel	Critical	Critical
3	Future Protection	Dedicated logical path (using IP) on MPLS. Latency control is critical. Could be over fibre, copper or microwave.	Low at edge	Critical	Critical
4	SCADA (Transmission & Sub transmission)	Real time access with medium sensitivity to latency Used for control – non protection. Could be over fibre, copper or microwave. IP based.	Low at edge	Very High	Moderate
5	Distributed Systems SCADA (DSS)	Real time access with low sensitivity to latency Could be over fibre, mesh radio, copper or microwave. Most typically this service would be used for control of reclosers and similar on 11kV feeders. Future IP based connection to centralised systems.	Low at edge	High	Low
6	Technical access to intelligent field devices (from within Zone substations)	Typically this service will be used by technical staff or systems to access smart substation devices such as protection relays, substation switches, transformers etc. This can be described as condition monitoring, configuration, firmware upgrades and historical data. IP based real time device access.	100MBs	Medium	Moderate

	Name	Description	Bandwidth	Criticality of service	Low Latency Sensitivity
6A	Technical access to intelligent field devices outside of zone substations	Typically this service will be used by technical staff or systems to access smart field devices such as reclosers or switches, distribution transformers etc. This can be described as condition monitoring, configuration, firmware upgrades and historical data. IP and legacy protocol based real time device access.	Moderate 100K +	Medium	Low
7	Corporate data fixed point	IP based service with very low sensitivity to latency.	High 10Mb/s+	Medium	Very low
8	Corporate voice fixed point	VoIP with medium/high sensitivity to latency.	Moderate	High	High
9	Corporate mobile voice	Mobile phone service for corporate use without external (other organisation) over subscription of capacity. E.g. ‘Can’t get a line’ due to flooding of system by external parties. priority service for field use)	N/A	Medium	N/A
13	Alternate Mobile Voice	Typically a commercial service. (Can be subject to call flooding) and subsequent denial of service.	N/A	Medium	N/A
10	Corporate Mobile data	Mobile data in the 100Kbps upward range (targeted 500K upward) most often expected in use as field access to corporate systems.	Moderate 200K+	High	Very Low
11	Field Force Automation	Central systems data to mobile field vehicles typically for dispatch, logging jobs, update jobs, GPS, Safety etc..	Low per vehicle	High	Low
12	Mission critical mobile voice	A voice service for delivery of trunked mobile radio. One to one, one to group or group to group. Could be IP based in the future. Not externally able to be oversubscribed. (Guaranteed number of circuits)	Moderate	Critical	N/A
14	AMI	Automated meter reading	Low at edge but high in core	Low	Very Low

	Name	Description	Bandwidth	Criticality of service	Low Latency Sensitivity
15	DLC	Direct load control of customer loads. (e.g. air con, pool pumps, hot water or commercial loads)	Low at edge	Medium /High	Very Low
16	Video	Security, conferencing and infield video	Moderate /High	Low	High
17	Interface to embedded / distributed generation	Larger scale embedded / distributed generation requires Protection & SCADA interfaces to enable management of the distribution network interface.	Low at Edge	Low to Medium	Low to Moderate

Attachment 1 – Project Benefits & Relative Size Summary

Telecommunications Strategy – Project benefits and relative size

Legend:

Scope A measure of business impact and the need for alignment with corporate policy and strategy		**Scale** A measure of the extent and nature of primary and/or secondary systems impacted	
5	Enterprise	5	Large
4	…	4	…
3	…	3	…
2	…	2	…
1	Department	1	Small

Note: Size = Scope x Scale is an indication of complexity and management effort (and to some extent cost), but not of precedence or ownership:

- Some relatively small initiatives are enablers for much larger initiatives. Precedence relationships are indicated in the high-level schedule
- The largest initiatives are imported from the Corporate IT strategy in order to emphasise the need for them at this level

An example of a recent 4 (scope) x 5 (scale) = 20 (size) project is the DMS upgrade from GenE to PowerOn Fusion, at a cost of approximately $70m.

Initiative	Benefits (How)	Scope	Scale	Size
IP/MPLS network & fibre deployment	Project Matrix will provide for the Common Infrastructure Telecommunications (CIT) network as detailed in the 2008 Telecommunications Strategy approved by the Board. On completion, the CIT will provide a high speed, highly secure environment for all Energex operational technology and will provide the basis for addressing the many security / obsolescence risks with the current systems and will provide new capability for deploying services to customers.	4	5	20
High risk copper pilot cable bearer replacements	Avoids significant, long duration unplanned outages of transmission feeders that could result from in-service failure of the remaining operating pairs in high-risk copper bearers used for protection.	2	2	4
Replacement of obsolete microwave radios & miscellaneous refurbishment works	Avoids significant, long duration unplanned outages of feeders that could result from in-service failure of unmaintainable plant.	2	2	4
PDH network rationalisation	Mitigate risk of extended telecommunication service outages with equipment no longer available for purchase.	2	2	4

Initiative	Benefits (How)	Scope	Scale	Size
Migration of management and central applications to Operational Technology Environment	Improved cybersecurity Improved visibility of OT infrastructure asset condition to enable better management	2	2	4
Replacement of TMR network	Avoid loss of capability to communicate between staff in outer/rural areas and during times of disruption of public carrier networks (e.g. floods)	4	4	16
Continued deployment of DSS network	Deliver more energy with the same infrastructure and use improved means to reduce fault impacts, avoid overloads and reduce contingency impacts through effective and fast load transfer operations.	3	3	9
Secondary systems asset management improvements	Improved visibility of secondary systems assets to enable better management	2	3	6
Remote management of secondary systems	Productivity and risk management (Enables remote configuration management of thousands of field devices)	4	3	12
Remote monitoring of secondary systems	Productivity and risk management (Enables remote supervision of thousands of field devices)	4	3	12

Initiative	Benefits (How)	Scope	Scale	Size
Secure substation wireless network & VoIP introduction	Improved access to corporate information sources (e.g. GIS, engineering drawings)	2	1	3
Condition monitoring data access enhancements	Central access to existing sources of condition monitoring information for improved planning and asset management of primary plant.	2	2	4
Remote access to event and oscillographic data	Productivity (Enables collection of event and oscillographic data without site visits – promotes systematic and complete auditing and investigation of power system incidents)	3	3	9