Infrastructure Development and Renewal, Strategy and Objectives - Telecommunications

Summary

This strategy guides the management of TransGrid's existing Communications assets.

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Contents

1. Purpose

TransGrid's communications network is a fundamental enabler for TransGrid's systems supporting the delivery of transmission network services at world-class levels of safety, reliability and cost effectiveness.

TransGrid's central purpose is summarised in its mission 'To provide safe, reliable and efficient transmission services to NSW, the ACT and the National Electricity Market'. In order to maintain TransGrid's position as a world-class transmission entity the company needs to ensure the achievement of optimal network efficiencies and deliver increasing levels of asset performance by leveraging the technologies being deployed in management of remote assets.

A core focus in the development of the strategy and objectives are TransGrid's Business Strategic Objectives that have been developed to provide the guiding principles in order for TransGrid to achieve the organisations mission. The development and renewal plans defined within this document underpin TransGrid's business goals for transferring large amounts of key information from TransGrid's geographically diverse sites (and customers) reliably and securely.

The strategy and objectives detail the analysis of the internal and external drivers and how these impact the development of the communications network. Contained within this document is the assessment and classification of the risks associated with the function of the communications network and the plans to accommodate the various business drivers and manage business risks.

The intent of this document is to:

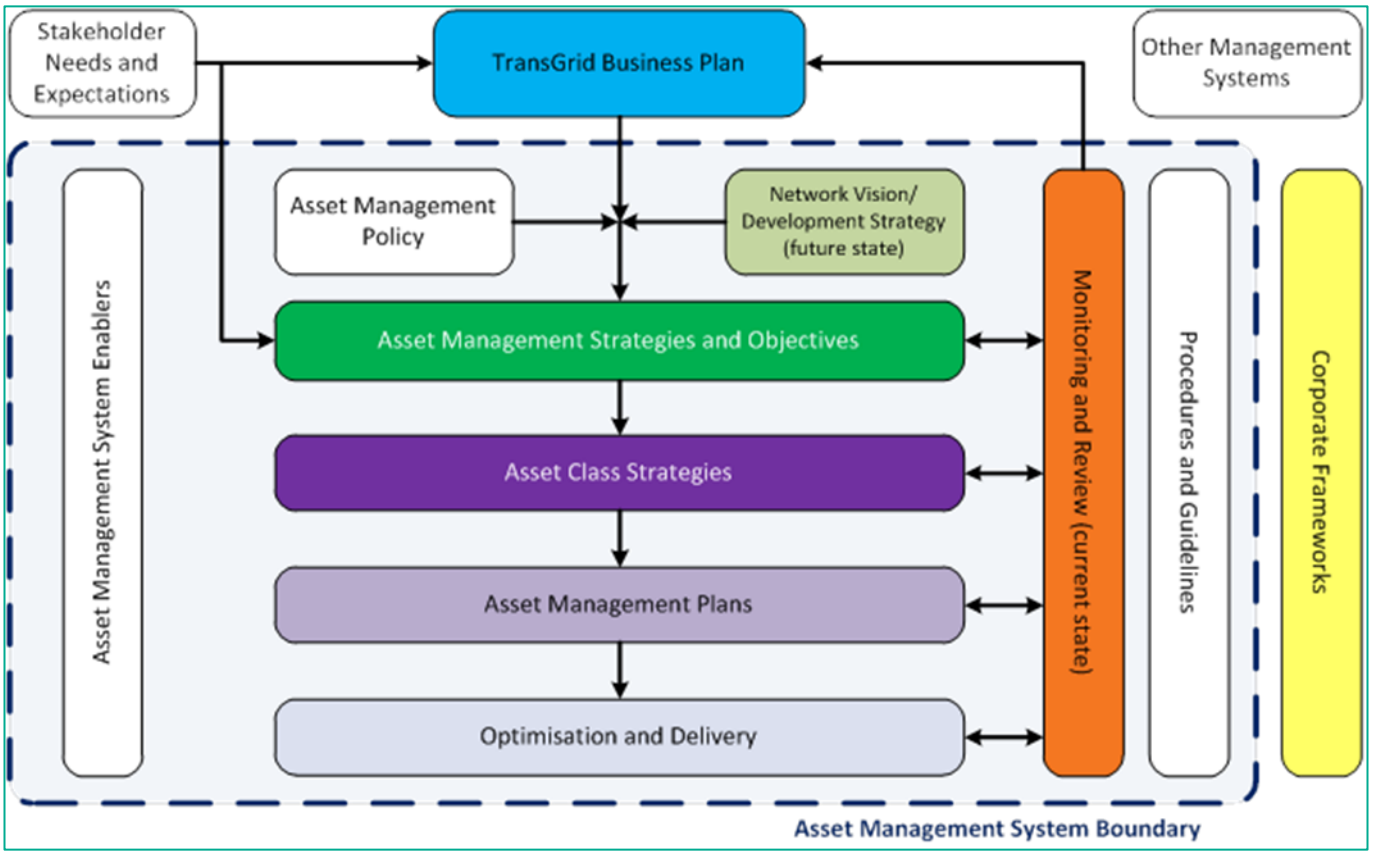
- Analyse the various external and internal drivers on TransGrid, and how these impact the development of the communications network;
- Assess and classify the safety, environmental, reliability, operational, financial and reputational risks associated with the function of the communications network;
- Define communications network goals to accommodate the various business drivers and manage significant risks; and
- Define major architectural guidelines to be adhered to when developing the communications network.

The primary purpose of this document is to provide the direction for the future development and renewal of TransGrid's communications network over the next 5 to 15 years to achieve TransGrid's mission and business goals.

2. Positioning within the Asset Management Framework

The *Secondary Systems Site Installation Renewal and Maintenance Strategy* document is one of several that comprise the Asset Management Strategies within TransGrid's Asset Management Framework. This document sits below the Asset Management Strategy and Objectives document as shown in Figure 2-1.

Figure 2-1: Asset Management System Document Hierarchy



3. TransGrid's Communications Network

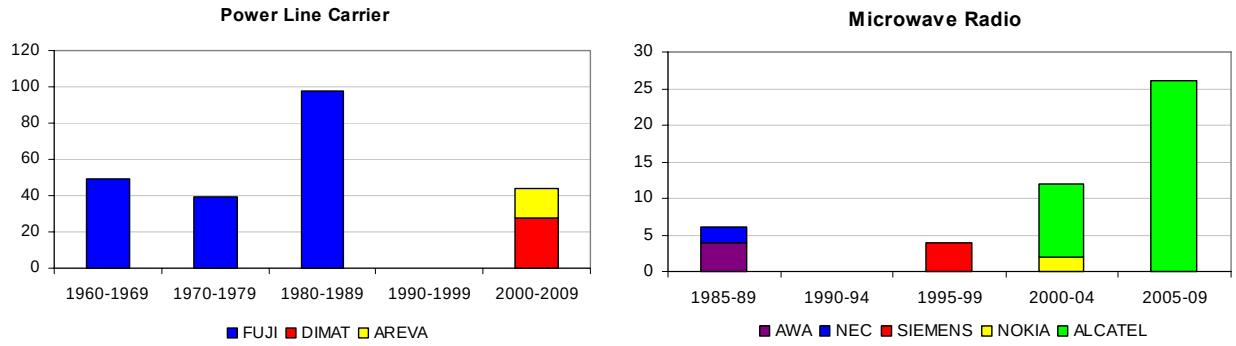
TransGrid communications network is composed of a range of equipment utilised for the provision of the communications services throughout the high voltage transmission network. The primary function is to provide communications to ensure that regulatory and statutory obligations under the current operating environment are achieved in an economically sustainable fashion.

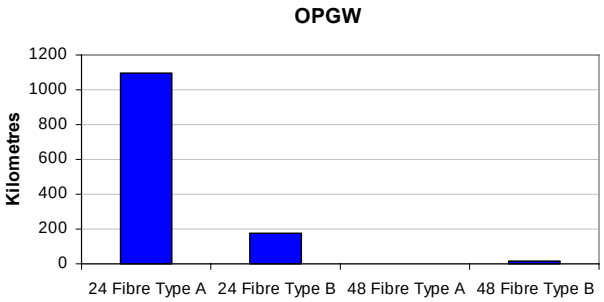
Power line carrier, microwave radio equipment and optical fibre ground wire (OPGW) are all utilised to deliver the communications bearers across the TransGrid network. Until now, optical fibre has been deployed opportunistically where synergies could be achieved with transmission line refurbishment or capital augmentation works. Whilst such a strategy has achieved the deployment of OPGW throughout the network, sections of OPGW have been stranded from the Optical Fibre Backbone, with TransGrid unable to take advantage of the investments made.

TransGrid is then dependent on microwave radio to provide communications bearer connectivity with stranded sections of OPGW. TransGrid's recent upgrade of the Western Radio Network was completed to provide a high capacity bearer between the Central and West Region to take advantage of the optical fibre installed in the West. Four years since its installation, the microwave radio equipment is now the constraining link with service capacity requests exceeding the capability of the radio equipment.

Microwave radio equipment and power line carrier technologies are ideally suited for the delivery of communications to remote sites or substations located off the main bearer network. The upgraded Western Radio Network highlighted the need for TransGrid to remove reliance on microwave radio equipment as a main bearer solution. Communications bearer technologies must be scalable so in the event that capacity requests exceed equipment capabilities, upgrades can be completed at minimal cost.

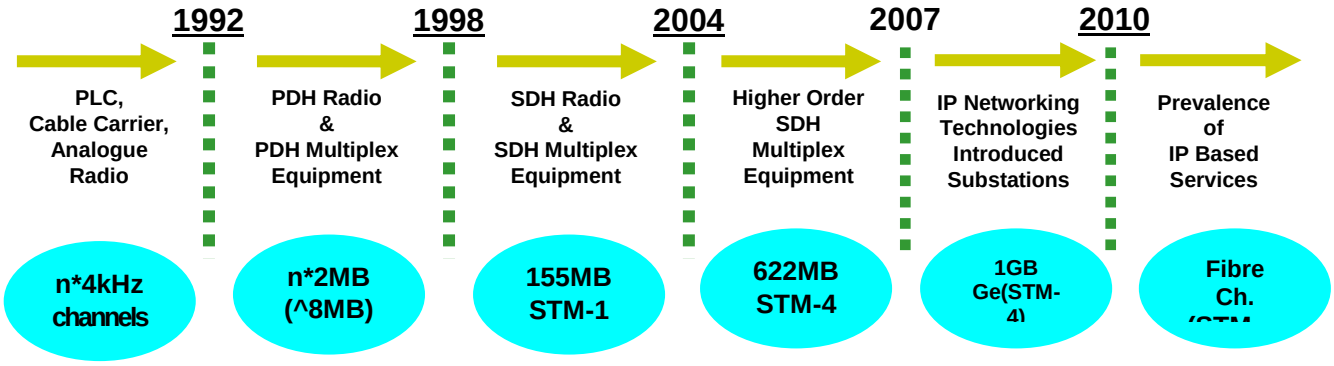
The following equipment profiles provide a representation of the current communications bearer technologies located within the TransGrid transmission network.





4. Communications Network Planning

With the introduction of IP-based Secondary Systems technologies, remote monitoring and management capabilities and the expansion of business services to the substation, an exponential increase in capacity requirements has been experienced. The diagram below depicts the increasing capacity requirements.



Future demand for capacity and service functionality is difficult to determine, therefore TransGrid needs to establish a communications network flexible enough to allow significant capacity increases from the network's initial install base.

Capacity requirements for the main backbone of a communications bearer network are beyond the capabilities of microwave radio equipment, with Transmission Network Service Providers (TNSP) in other states installing high capacity, highly scalable technologies, modular in design and characterised with providing transparency to accommodate all communications protocols. Such technologies require the presence of optic fibre with the fibre bearer only limited in capacity by the terminal equipment.

Whilst microwave radio equipment is currently being utilised to achieve connectivity with the isolated fibre optical installs, TransGrid needs to relinquish its reliance on microwave radio as a main bearer, future proofing the TransGrid communications network with the installation of optical fibre in the critical links identified in this document.

Microwave technology has proven to be an economically justifiable solution for TransGrid. However, the technology is generally incompatible for permanent inclusion in the protected, high capacity communications rings set out in this document.

Therefore, microwave radio can only continue to be utilised in applications providing spur services to remote sites removed from the main protected rings. In instances where communications services to a single site not on a main protected ring are required, Microwave Radio should be assessed against other communications mediums for providing the optimal solution.

5. Definitions

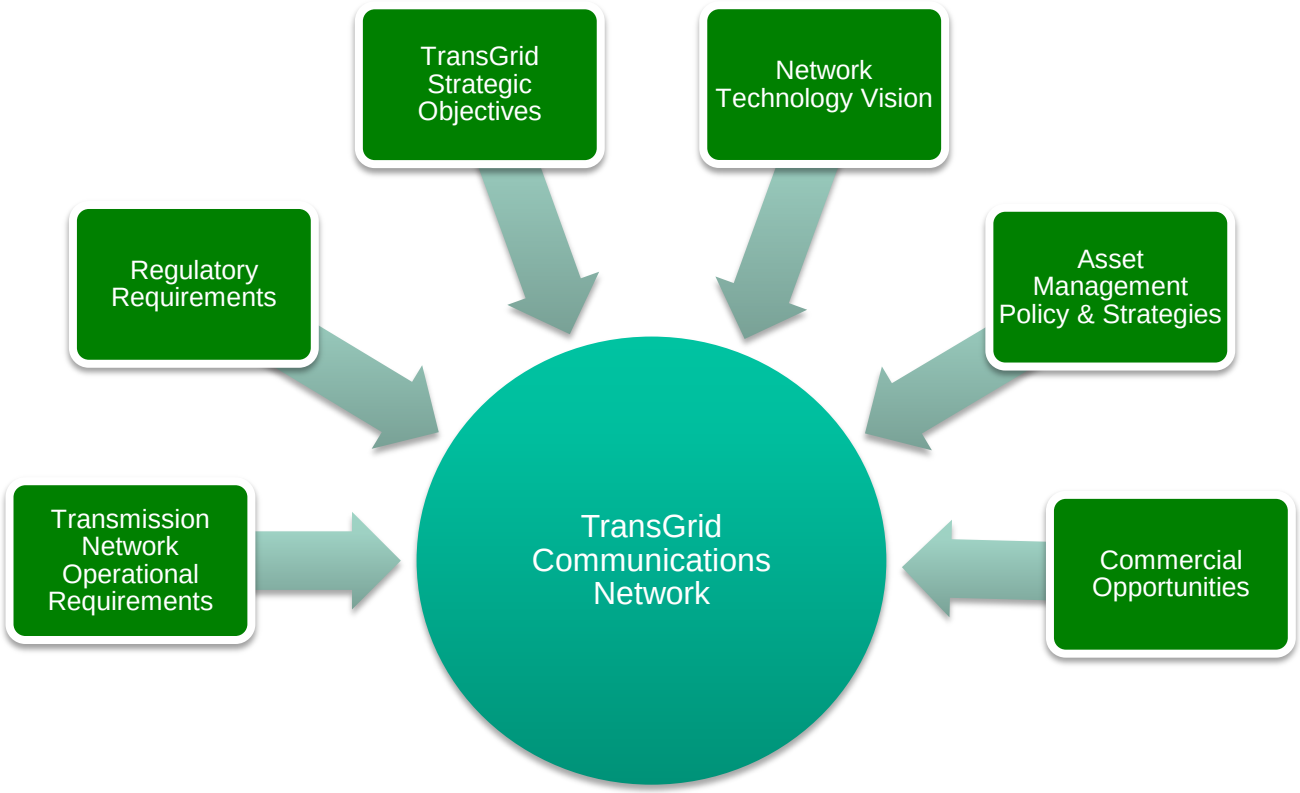
Term	*Definition*
AER	*Australian Energy Regulator.*
AEMO	*Australian Energy Market Operator*
AEMC	*Australian Energy Market Commission*
NER	*The National Energy Rules.*
RULES	*The National Energy Rules.*
NEM	*The National Electricity Market*
Licensed Carrier	Person or organisation holding a licence under the Communications Act to provide communications services to other parties for financial consideration and awarded the powers and responsibilities guaranteed by that Act to carry out their business.
ACMA	*Australian Communications and Media Authority*
Network	*The TransGrid Communications Network*
OPGW	*Optical Power Ground Wire*
PSDCS	*Standard for Power Systems Data Communications,* applicable under the *NER.*
Protection	High voltage protection systems; a part of the SAS that work to monitor and clear high voltage faults on the electrical network.
Protection signalling	The communications channels associated with a protection system that transmit signals to various protection system components to ensure that they can clear a fault within the required fault clearance time with any single protection element out of service.
SAS	*Substation Automation Systems* include assets relating to: • Control, Protection and Metering Systems • The connection of those systems to HV plant and LV power supply • Communications infrastructure, relating particularly to the operation of the Substation. The communication systems are covered by the *Network Renewal, Maintenance & Disposal Strategy – Communications.* • The interconnection of these systems
Control Assets (Control Systems)	As defined under the *National Electricity Rules*. Means of monitoring and controlling the operation of the *power system* or equipment including *generating units connected* to a *transmission* or *distribution network.*
Protection Assets	As defined under the *National Electricity Rules*.

Term	Definition
(Protection Systems)	A system which includes equipment, used to protect a *Registered Participant's* facilities from damage due to an electrical or mechanical fault or due to certain conditions of the *power system*.
Metering Assets (Metering Systems)	As defined under the *National Electricity Rules*. All *revenue, check* and *statistical metering* equipment, including current transformers (CT), voltage transformers (VT), interposing transformers, summation current transformers, meters, recorders, modems, transducers, panels, associated secondary wiring, circuit breakers, fuses, fuse relays, links and other wiring terminations.
SCADA	*Supervisory Control And Data Acquisition;*
Communications	Systems for transmittal of information across geographical locations.
VHF radio network	TransGrid's mobile radio network based on 70MHz mobile radios and base stations interconnected by a repeater network based on 40MHz repeater links and group relays. Some UHF systems may be required for special purposes and repeater links may be replaced by UHF digital radios in the future.
VHF	*"very high frequency" – radio systems generally operating 30MHz – 300MHz*
UHF	*"ultra high frequency" – radio systems generally operating 300MHz – 3000MHz*
SDH	*Synchronous Digital Hierarchy*
PDH	*Plesiosynchronous Digital Hierarchy*
OT	*Operational Technology*
IT	*Information Technology*
CCTV	*Closed Circuit Television*
CDN	*Corporate Data Network*
MIC	*Impacts of Constraints*
STPIS	*Service Target Performance Incentive Scheme*

6. Business Drivers

This section defines why the communications network exists, the services it provides, and the specific requirements to be achieved. The communications development strategy is impacted by six main input requirements shown in Figure 6-1 below. Each requirement is described in detail in this section.

Figure 6-1: Inputs to the Communications Strategic Plan



6.1 Transmission Network Operational Requirements

Communications services are an essential requirement for protection, control and operation of the electricity transmission network. This requirement has been the primary development driver for the TransGrid communications network.

The following services are supported by the TransGrid communications network for electricity transmission network operation:

- **Teleprotection:** Communications channels directly between substations, used by line protection systems for rapid identification and isolation of transmission line faults.
- **Metering:** Provision of infrastructure to enable Meter Data Reader to dial into metering IEDs, located within substations to acquire the metering data.
- **SCADA** (Supervisory Control and Data Acquisition): Data from substations and communications repeater sites to the TransGrid Control Centres for remote monitoring and control of all electricity transmission assets.
- **SSZ** (Substation Security Zone): Maintenance data from substations and communications repeater sites to the TransGrid Control Centres for remote monitoring and control of all electricity transmission assets.
- **Alarms**: Communication Alarm System (CAS), Backup Alarm System (BAS), Smart Alarm System, Remote Alarm System at Radio Repeater Sites to regional operation centres.
- **Operational Voice:** A speech network providing direct communications between substations, communications sites and Control Centre Network Operators.
- **VHF Network:** A mobile radio network providing communications between field based staff, works depots and Control Centre Network Operators, intended to assist in the operation of the HV network.
- **Non-Essential Services:** Various services not directly related to the operation of the electricity transmission network, such as Closed Circuit Television (CCTV) and access to the Corporate Data Network (CDN). Although non-essential the services provide critical data and information to enable informed decision making in the management of the Transmission Network.

The first seven services require very high levels of security and reliability, which are far higher than the levels, which could be provided on a public communications network. Teleprotection services must operate typically within 20 milliseconds regardless of network conditions and the very low communications network latency required to achieve this is unable to be verified through testing or ensured on public networks. For these reasons it is standard practice in electricity transmission utilities in Australia and throughout the world to operate their own communications networks to support essential services in the delivery of the Transmission services.

The requirements for capacity, reliability and security of these services have increased over time and continue to do so, as power system control technologies have developed and electricity network customer requirements have increased. Minimum standards for operational teleprotection and SCADA are now defined by regulation under the NER and the Power System Data Communications Standard (PSDCS).

6.2 Regulatory Requirements

The development of the TransGrid communications network has a number of regulatory requirements:

- The regulatory framework established by the Australian Electricity Regulator (AER, a division of the Australian Competition and Consumer Commission)
- Specific requirements under the National Electricity Rules (NER)
- Specific requirements of the Australian Electricity Market Operator (AEMO)
- Expectations of NSW Government Shareholders

6.2.1 AER Regulatory Environment

The development of the Communications network will progress in line with the regulatory framework established by the AER.

All communications projects will be based on business justifications, identifying the need for the development of the communications network, which are required for compliance with the National Electricity Rules and other regulatory requirements. In addressing this need, project justifications shall incorporate a series of technical solutions accompanied by economic analysis (lowest life cycle cost to the consumer), the timing of implementation and risk assessment

6.2.2 National Electricity Rules

The Australian National Electricity Market (NEM) operates under statutory rules – the National Electricity Rules (NER) – that are set by the Australian Energy Market Commission (AEMC) and enforced by the Australian Energy Regulator (AER). The day-to-day operational and financial running of the electricity market is performed by the Australian Electricity Market Operator (AEMO), a company owned by the Australian Government.

Some sections of the National Electricity Rules define requirements for the performance of TransGrid's communications network:

- Chapter 4 of the NER requires TransGrid, as a Network Service Provider, to provide the necessary communications facilities for the transmission of control, indication and operational metering signals (SCADA data) from all substations and connected power stations to nominated AEMO termination sites. This chapter also requires AEMO to develop performance standards for these communication facilities.
- Chapter 4 of the NER also places obligations on TransGrid to provide facilities for voice traffic between the control centres of AEMO, TransGrid, and connected power stations.
- Chapter 5 and Schedule 5.1 of the NER sets standards for network operation and protection designed to ensure a stable and reliable network. These standards indirectly set performance requirements for communications systems, because meeting the protection performance standards for lines above 100kV normally requires use of teleprotection systems, and meeting the protection reliability standards requires fully duplicated communications systems.

Section 5.1.2.1(d) identifies that TransGrid is required to maintain protection and associated communications systems in a manner that ensures outages of a single protection system are not greater than eight hours. This defines minimum operational requirements for response times and rectifying faults.

6.2.3 AEMO Power Systems Data Communications Standard

To implement the requirements in Chapter 4 of the NER, AEMO produced the Power System Data Communications Standard (PSDCS), which came into effect on 1 January 2004. This standard defines performance requirements for SCADA data provided to AEMO. Section 3 defines the reliability and diversity criteria, which must be met by communications networks operated by the Australian electricity market participants (i.e. Queensland, New South Wales, Victoria, ACT, South Australia, and Tasmania).

The PSDCS requires that TransGrid comply with certain standards when providing communications facilities for control, metering and indication. TransGrid's performance with respect to the standard is measured via the accumulated time of critical outages in the data communications system.

Section 3.2 of the Power Systems Data Communication Standard requires TransGrid to arrange the communications infrastructure to provide sufficient redundancy to network elements in order to satisfy the reliability standards set out in Clause 3.1.

6.3 TransGrid Strategic Objectives

The TransGrid Board has approved the following Business Strategic Objectives by Strategic Theme to guide the performance of the company through the current changing business environment.

The objectives are network management-specific applications defined in TransGrid's Corporate Plan 2014-2019, including:

- **Ensuring an effective safety culture -** improve safety outcomes by strengthening the safety culture of our employees and contractors and maintaining employee safety engagement.
- **Developing new business –** deliver at least $100 million revenue by 2018/2019 in lines of business where TransGrid has a competitive advantage.
- **Preparing for a competitive future** – improve out competitiveness for new business, drive costs down and promote strong customer service.
- **Delivering best practice stakeholder engagement** – be an open and consultative organisation that values input from stakeholders and encourages them to be a part of decision making.

With the associated enablers:

- **Enhancing leadership performance** – supporting leaders to be role models, driving accountability and personal responsibility
- **Managing strategic change** – improve how we deliver strategic change to achieve our objectives.

6.3.1 Business Unit Plan

TransGrid's investments in its assets and the subsequent work undertaken are driven by its corporate strategy, as detailed within the Corporate Plan. The corporate strategic themes, objectives and performance targets are translated into holistic asset management strategies, objectives and key performance indicators (KPI) as detailed in the Asset Management Business Unit Plan. These asset management strategies are aimed at mitigating the key network related risks and establishing a range of optimised interventions across the complete asset lifecycle. These asset strategies are then applied to the specific risks for each asset group to form individual asset strategies, objectives and KPIs.

6.3.2 Asset Management Strategy 'Line of Sight'

The renewal and maintenance strategic initiatives set out in this document support the achievement of the strategies set out in the Asset Management Strategy and Objectives document. The strategic alignment of the initiatives in this document to the Asset Management Strategy and Objectives document is shown in the tables below.

Table 6.3-1: Communications Asset Contributions to Asset Outcomes

Strategic Theme	Business Plan Objectives	Asset Management Objectives	Asset Management Performance Indicators	Asset Management Strategies
Operational Excellence	Health and Safety	▪ Manage communications related public and staff safety risks to As Low As Reasonably Practicable (ALARP)/So Far As Is Reasonably Practicable (SFAIRP) ▪ Manage communications related bushfire risks (people safety) to ALARP/SFAIRP	▪ Zero communications related LTIs ▪ Zero communications related fire starts ▪ Key Hazardous Events at 5 year average levels: a. catastrophic communications system failure b. communications structure failure c. uncontrolled discharge/contact with electricity d. unauthorised entry	▪ Asset Class Strategies
	Environment	Minimise environmental harm and property damage	▪ Maintain 5 year average level of communication related environmental incidents ▪ Maintain 5 year average level of environment related Key Hazardous Events (Electromagnetic Radiation)	▪ Asset Class Strategies
	Reliability	Maintain network reliability	▪ Maintain current 5 year average number loss of supply events due to communications asset faults ▪ Maintain current level of unplanned outage Key Hazardous Event	▪ Asset Class Strategies

Table 6.3-2: Communications Asset Contribution to Financial Outcomes

Strategic Theme	Business Plan Objectives	Asset Management Objectives	Asset Management Performance Indicators	Asset Management Strategies
Operational Excellence/Customer Oriented Growth	Efficiency and Productivity/Core Prescribed Revenue Growth	Improve CAPEX performance	▪ Improve capital project performance	▪ Asset Class Strategies
		Improve OPEX performance	▪ Perform within 1% of the Asset Management Program of Works budget	▪ Asset Class Strategies
		Pursue STPIS revenue where cost effective	▪ Better than average performance of the STPIS measures: a. fault and forced outage rates b. average outage duration due to communications faults c. protection system failures due to communications faults	▪ Asset Class Strategies

6.3.3 Key Performance Indicators (KPI)

The renewal and maintenance strategies set out in this document are aimed at supporting the achievement of the corporate target to maintain the assets to better the AER OPEX allowance.

6.3.4 Review of Renewal and Maintenance Strategies

As part of TransGrid's five yearly Revenue Determination process, the Renewal and Maintenance Strategies set out in this document are completely reviewed, reassessed and reset to align them to changes in:

- Actual condition and performance of the assets.
- TransGrid's asset base.
- Corporate objectives.
- Required asset outcomes to be achieved over the upcoming regulatory period.
- Stakeholder requirements.
- Regulatory requirements for the upcoming regulatory period.
- Strategic and business context of the organisation, such as changes to the risk tolerance for the assets.
- Financial constraints on the organisation.

Also, significant changes to the asset management system, as and when they occur, are used as a "trigger" for the Asset Manager to review the Renewal and Maintenance Strategies. Details of significant changes to the asset management system are set out in the Change Register.

Additionally, the Asset Manager reviews the:

- Results of the actual interventions undertaken to confirm that the Renewal and Maintenance strategies remain aligned and fit for purpose to achieve the Corporate Plan.
- Alignment of the Renewal and Maintenance Strategies to the annual Corporate Plan. This analysis is undertaken as part of the annual corporate planning and budgeting cycle.

The outcomes arising from these reviews/analysis are used to update the Renewal and Maintenance Strategies.

6.3.5 Renewal Plan and Maintenance Plan

After the Renewal and Maintenance strategy has been reviewed and approved, the Asset Managers prepare the relevant Renewal Plan and Maintenance Plans. These plans set out the scope of the actual renewal and maintenance interventions to be undertaken by the service providers.

The Renewal Plan and the Maintenance Plan for the communications infrastructure assets are available on TransGrid's intranet, called The Wire.

The Corporate Targets that have been established for the delivery of planned work are:

- 95% of planned maintenance schedule to be achieved on time and on budget.
- 70% of critical capital projects delivered on time and on budget.

The Service Providers report, on a monthly basis, their actual performance in achieving the plans to the TransGrid Executive. The results of the service provider's actual performance are published via Executive Dashboard reporting on TransGrid's intranet, called *The Wire.*

Asset Managers review the actual performance of the service providers to deliver the Renewal Plan and the Maintenance Plan. Significant variances between planned performance and actual performance are analysed and discussed by the Asset Manager with the service provider. The outcomes of these discussions may result in the:

- Service provider undertaking additional work to address backlogs in order to comply with the plan.
- Asset Manager modifying the plans.

6.4 Network Vision

The Network Vision supports the development of the communications through identifying a number of scenarios and factors that may significantly influence the future of the network. In order to address the factors with significant influence, TransGrid has identified key objectives for its network of the future:

1. Deliver safe, secure, environmentally responsible and cost effective electricity transmission services.
2. Engage stakeholders and the community to align expectations and maintain our social licence to operate critical infrastructure.
3. Maintain flexibility and responsiveness of the network in an uncertain future to ensure value is being delivered.
4. Optimise the network to match future demand requirement and the changing mix of generation sources.
5. Leverage technology and innovation to optimise the capability and capacity of the network.
6. Develop and grow a profitable non-regulated business.

The communications network is the underlying delivery platform to be developed with sufficient capacity (bandwidth) and redundancy (availability) to support the deployment of the network technologies and decision support systems to achieve TransGrid business objectives.

Elements of the Network Vision that are directly relevant to the communications network are:

- Improved flexibility of the transmission network to meet changing requirements whilst maintaining compliance with Regulatory and Stakeholder Needs;
- Improved Network Reliability and Resilience against failures of critical network assets;
- To achieve low barrier entry and minimised constraints for the connection of new generation sources;
- Leverage technology and innovation to improve the utilisation of individual network assets and reduce overall service costs;
- Early adoption of new technology where quantifiable service improvements and cost efficiencies can be achieved; and

Enhanced monitoring, control and automated system technologies for the collection of dynamic data and more efficient use of TransGrid's Network Assets.

6.5 Asset Management Policy and Strategies

The asset management policy and supporting strategy documents provide the binding documentation between TransGrid's Strategic Objectives and the high-level asset management principles guiding the development and management of the communications assets and supporting infrastructure.

The asset management strategies drive TransGrid's communications to ensure the delivery of secure, resilient and highly reliable services, facilities and infrastructure achieved through transparency of equipment and the establishment of a delivery platform scalable to meet increasing business requirements. The delivery platform must be agile in design allowing the expansion or replacement of equipment with minimal impacts on the services being delivered.

Elements of the Asset Management Strategies that are directly relevant to communications are:

- Standardisation and alignment of technologies to achieve operational efficiencies through applying a consistent standardised approach to the deployment and management of digital technologies;
- Convergence and interoperability of digital technologies to achieve economies of scale and realise the benefits of technology integration;
- Efficient implementation of technology solutions with a scalable and flexible architecture that supports the dynamic business environment and increasing capacity needs;
- High availability platform for digital systems supporting critical national infrastructure;
- Security of our information and physical assets, complemented by disaster recovery and business continuity strategies; and
- Ensuring secure and reliable access to the business tools and corporate systems.

6.6 Commercial Opportunities

TransGrid will capitalise on non-regulated communications opportunities as presented through the delivery of their core operational services across the transmission network.

TransGrid has acquired a communications carrier licence, enabling TransGrid to draw on the Communications Act (Cth) for the installation of equipment outside that permissible under TransGrid's Transmission Authority Licence.

Communications network planning takes into account the life expectancy of the equipment being installed. Communications equipment is depreciated over a fifteen-year financial life with the technical life of the equipment hopefully in close alignment. Inevitably surplus capacity becomes available when the equipment is initially installed due to the capacity planning for the life of the equipment.

TransGrid can capitalise on this opportunity on-selling the future spare capacity and access to infrastructure to third parties, where commercial opportunities are available at low marginal cost. The provisioning of commercial services is opportunistic and should only be pursued where spare capacity is available that has not been identified for use within the next 4 to 6 year window.

7. Primary Development and Renewal Plans

This section outlines the primary development and renewal plans for the TransGrid communications network.

Three primary development plans are presented that are fundamental to ensuring the communications network holds the capability and capacity to support the changing business services.

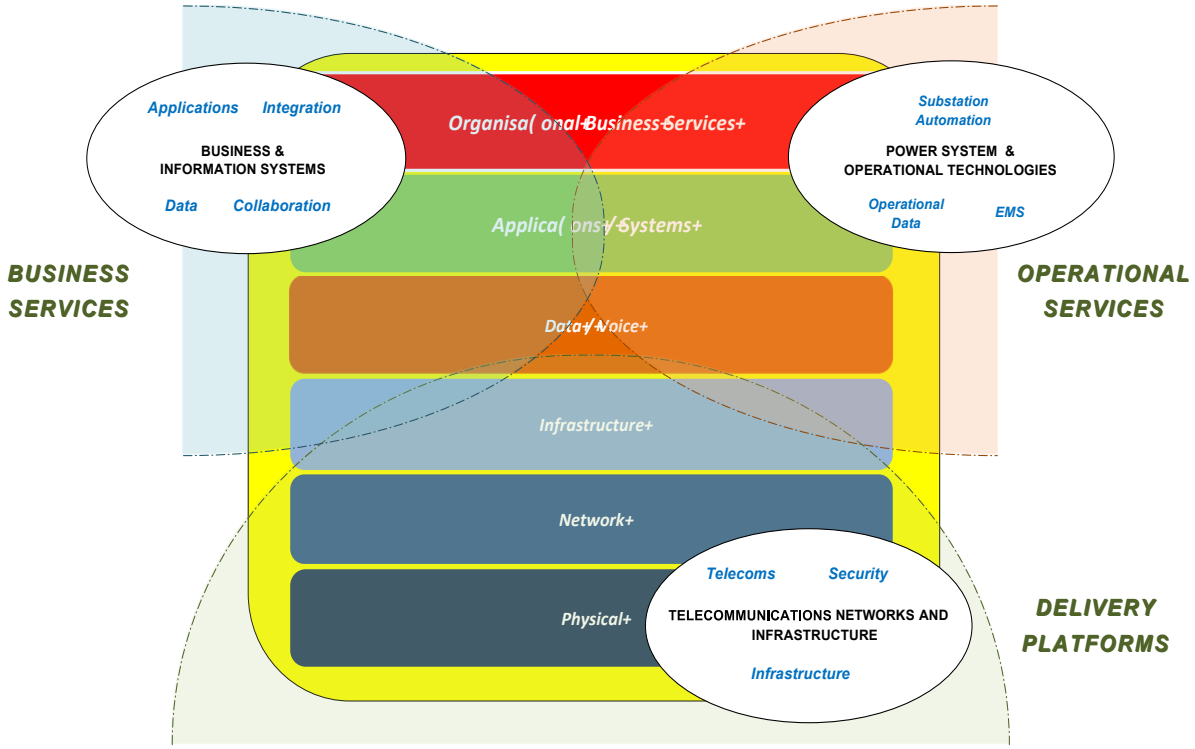
These include:

1. Preparedness for Increasing Capacity Demands;
2. Establish Network Protected Rings; and
3. Establish IP-Based Service Delivery Platforms.

As shown in the following diagram the communications network and supporting infrastructure are critical in the delivery of both business and operational services supporting the high voltage transmission network.

The communications network is the supporting delivery platform and is the fundamental enabler from which both information technology (IT) and Operational Technology (OT) services are delivered.

Failure to advance the development of the communications network in alignment with IT and OT business service requirements will result in the business benefits not being realised from the services being deployed.



OSI Hierarchy of Services

7.1 Preparedness for Increasing Capacity Demands

TransGrid will extend the reach of its fibre optic network to provide a secure and reliable high capacity, high availability bearer network capable of supporting the business and operational services being deployed.

Development Plan

Extend the Fibre Optic Network to reach all 500kV, 330kV, 220kV and 132kV TransGrid substations

Activity

Installation of fibre optic cable to the transmission network.

Justification

TransGrid is deploying the following services that have high capacity requirements:

- IP networking for SCADA, Telephony, Metering, Corporate and IEC 61850 substation control systems;
- Operational and corporate information systems, such as inter-control centre data, inter-office communications, remote data access and disaster recovery networks;
- Substation security to retrieve data and information from remote sites; enabling the use of CCTV and remote site management systems; and
- Mobility solutions to achieve operational efficiencies in the deployment of field works activities and improve data quality and collection practices.

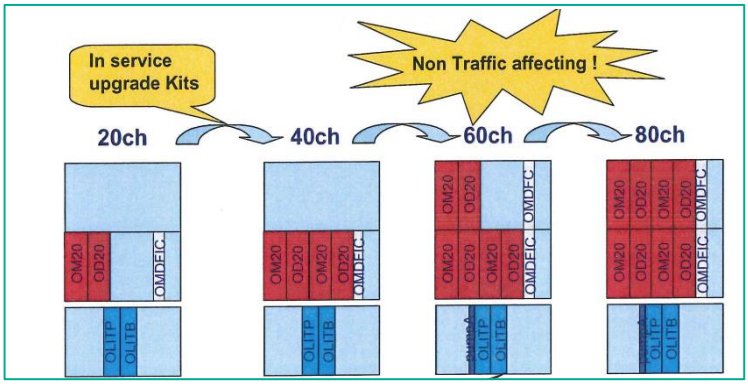
Strategic Alignment

Financial / Cost

Key hazards = Exceed AER Opex allowance

TransGrid's secondary system design standards feature digital technologies equipped with remote monitoring and interrogation capabilities that necessitate high capacity communications between substation sites and the Network Operations Centre. Operational efficiencies can be realised through utilising the capabilities of the digital technologies being deployed; with remote configuration, condition and performance monitoring tools available.

TransGrid is actively pursuing remote asset monitoring and the remote operation of high voltage plant. The expansion of the communications network, allows for real-time control and monitoring of network assets, ensuring significant operational and cost efficiencies are being achieved. Once this strategy is delivered TransGrid will be able to deploy bearer technologies that are highly scalable and modular in design allowing non-traffic affecting capacity upgrades as depicted in the below diagram.



Fibre based terminal equipment capable of in-service capacity expansion without impacting the communications bearer.

7.2 Establish Network Protected Rings

TransGrid will advance the communications network architecture to include protected rings to provide a more secure and resilient delivery platform for business and operational services supporting the HV Network.

Development Plan

Establish a protected ring topology across the communications network

Activity

Install high capacity communications bearers to close network rings

Justification

The benefits received through establishing a protected ring topology including:

- Improved communications service availability;
- Improved network resiliency and fault recovery;
- Reduced after hours maintenance call outs;
- Simplifies network outage planning;
- Allows easy access to network infrastructure; and
- Aligns with industry standards

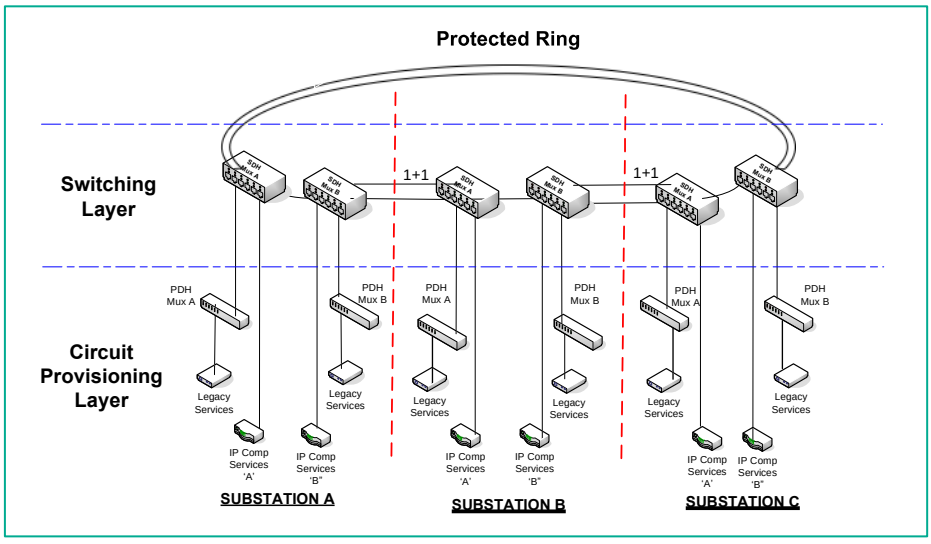
Strategic Alignment

Financial / Cost

Key hazards = Exceed AER Opex allowance

Establishing a protected ring topology will further enhance the resiliency of the existing network architecture.

Protected ring topology is the industry standard across transmission utilities with the prevalence of IP based technologies supporting the transmission network. As high capacity communications bearers extend into regional areas, protected rings will be progressively established. The diagram below presents the existing switching and circuit provisioning layers with the protected ring topology overarching the existing network.



7.3 Establish IP-Based Service Delivery Platforms

TransGrid's adoption of IP-based technologies requires the communications network to accommodate IP based services; with this plan specifically targeting the deployment of IP enabled delivery platforms.

Development Plan

Establish a communications network capable of supporting IP based services

Activity

Installation of multi-service, IP enabled service delivery platforms

Justification

TransGrid are deploying the following services that are IP based:

- The Corporate Data Network (CDN), which is increasing in functionality, with TransGrid's dependency on the available business and operational data increasing;
- Substation SCADA and Control technologies will be based on conventional wide area network protocols such as TCP/IP, as opposed to the current protocols which are designed for point-to-point communications;
- The establishment of a Metering WAN will be based on TCP/IP protocols that will need to be designed to achieve high availability requirements; and
- The deployment of improved security across the TransGrid substations will involve the deployment of CCTV and additional site management and monitoring systems based on IP protocols.

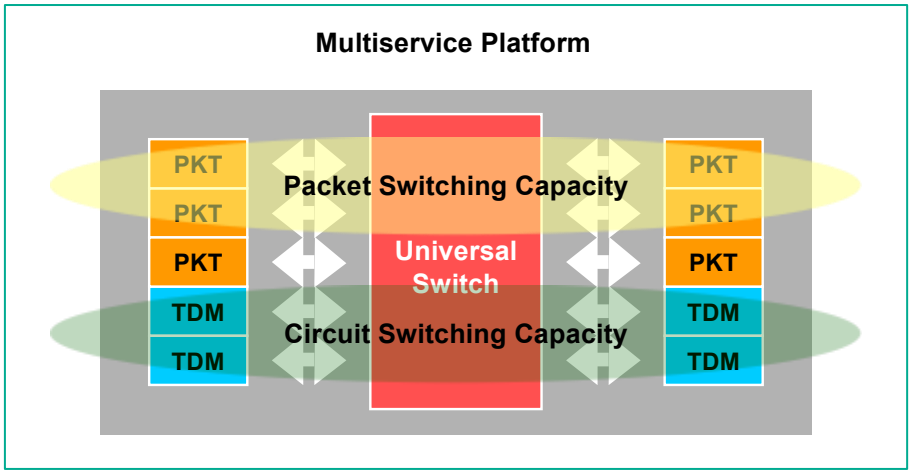
Strategic Alignment

Financial / Cost

Key hazards = Exceed AER OPEX allowance

TransGrid must deliver equipment strategies in alignment with the major communications providers with technology capable of provisioning circuit and packet services. Through aligning with the major communications providers this will ensure that the longest term of manufacturer support will be achieved for the network equipment.

A multiservice platform will optimise network efficiency and eliminate the need to map traffic into another technology. Ideally the service platform should be flexible enough to allow any combination of service provisioning.



8. Supporting Development and Renewal Plans

In addition to the primary development and renewal plans presented under Section 4, the following three supporting plans are required for the development of the communications network.

These include:

1. Establish a Digital Technology Centre;
2. Developing 'One Network'; and
3. Establishing a 'Centralised Management Platform'.

8.1 Establish a Digital Technology Centre

There has been a significant change in the communications technologies being deployed. The introduction of IP enabled digital technologies has changed maintenance practices with a move away from performing routine maintenance tasks. This ability to self-monitor and provide remote interrogation capabilities has removed the opportunity for field staff to maintain equipment familiarisation.

Development Plan

Establish a Digital Technology Centre

Activity

Install a test, development and training environment representing in-service technologies

Justification

TransGrid's deployment of evolving IP based technologies requires a technology centre to:

- Test updates or modifications to operational in-service equipment, to verify that no undue side effects will be encountered;
- To streamline and prepare for in-service changes, minimise any impacts, optimise project delivery cycles and significantly reduce the possibility of error;
- To manage business risks associated with design modifications, new system integration, firmware changes and interoperability issues across different technologies;
- To replicate field fault scenarios and accelerate the rectification of equipment faults while minimising the risks imposed by avoiding fault testing on in-service network;
- To provide a training environment allowing Design, Operations and Field Staff to maintain their familiarity and competency with the technologies deployed; and
- To establish the infrastructure to support the technologies and facilitate the delivery of good industry practice in the management of digital technologies.

Strategic Alignment

Financial / Cost

Key hazards = Exceed AER Opex allowance

8.2 Developing 'One Network'

This plan is to develop the TransGrid communications network as a single network. Making investment decisions that take into account network wide opportunities presented outside any single project.

Development Plan

Develop the 'One Network' to achieve all of TransGrid's business requirements

Activity

Establish a central business focus on developing the network to meet all requirements

Justification

A number of different business units across TransGrid are developing siloed networks and sub-nets with different business drivers and priorities. These are currently being developed to achieve immediate requirements without the presence of a common goal in the development of the communications network.

This strategy is required to:

- Achieve organisation endorsement and awareness of the methodology taken for the development of the communications network;
- Achieve the requirements of the communications network customers (internal to the business) through focusing their efforts on developing a single common network;
- Take a network-wide approach to the development of the communications network to ensure that opportunities to advance the develop the network are capitalised;
- Select and acquire technology that results in a more manageable, stable, secure and effective architecture by minimizing the diversity of technologies deployed across the business;
- Reduce the risk of technology failure by maintaining a standardised suite of technologies, managed with planned upgrades maintaining technology at vendor supportable releases;
- Achieve the standardisation of equipment, systems and protocols in order to minimise lifecycle costs, acquiring commercially available technologies, rather than building technologies in-house; and
- Achieve alignment across the different business units, bringing them together to agree on the development of the communications network.

Strategic Alignment

Financial / Cost

Key hazards = Exceed AER Opex allowance

8.3 Establishing a 'Centralised Management Platform'

This plan is to establish a Centralised Management Platform capable of providing effective centralised management of all communications and IP based digital technologies.

Development Plan

Establish a Central Management Platform to seamlessly manage the converging digital technologies

Activity

Establish an Operational Support System to manage the digital technologies

Justification

TransGrid's deployment of evolving IP based technologies requires an Operational Support System to:

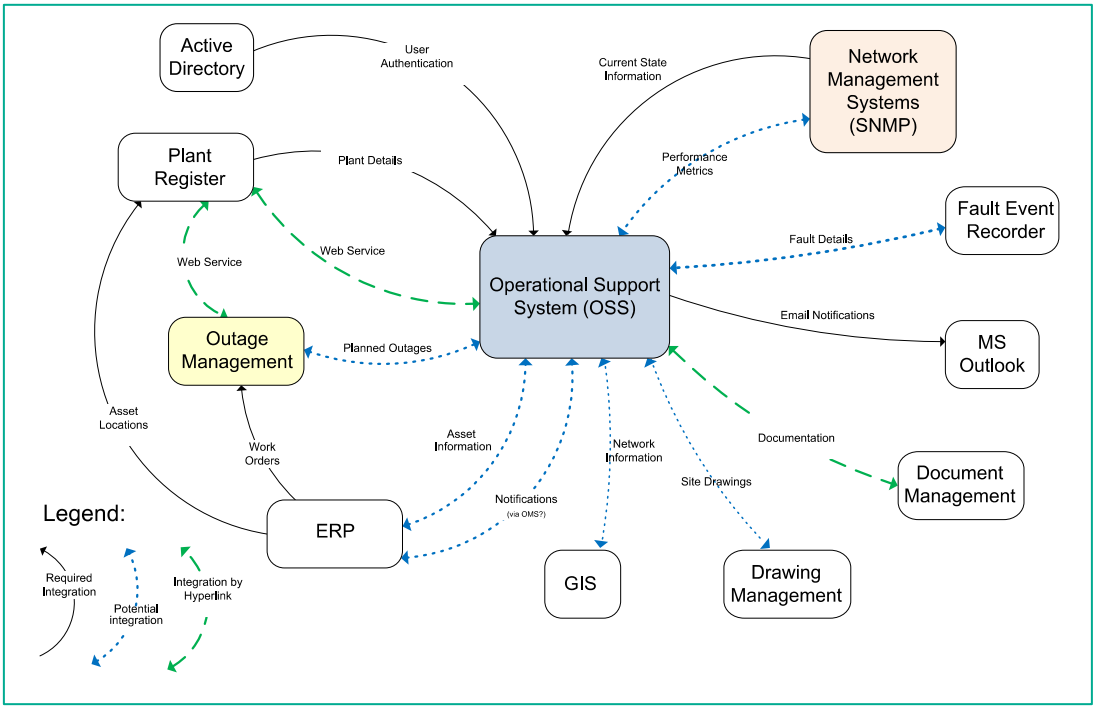
- Provide a seamless management solution capable of providing effective centralised management of all IP based digital technologies;
- Provide the capability to monitor, control, analyse and manage the IP based digital technologies providing a more sophisticated centralised management platform;
- Standardise on corporate and operational tooling sets used for the management of like model technologies and the same equipment;
- Provide real time, accurate, and reliable information representing the network and supported technologies;
- Provide a graphical representation of the entire communications network and services being supported;
- Increase the collaboration between business units to deliver improved management services for all digital technologies present through the high voltage network.

Strategic Alignment

Financial / Cost

Key hazards = Exceed AER Opex allowance

The following diagram is a graphical representation of the integration achievable across different tool sets to achieve a centralised operational support system.



9. Development and Renewal Principles

In order to guide the Regional Development and Renewal Plans, guiding principles on how the work is to proceed are required. The following principles will help shape how and when the development will take place.

9.1 Supersede Microwave Radio as a Trunk Bearer Service

TransGrid's experience with the Western Microwave Radio Network has shown that Microwave Radio cannot be relied upon for providing trunk bearer communications services on its network. The requirements for high capacity communications at each TransGrid site is expanding rapidly and can currently be met only with those sites connected to the existing Optical Fibre Backbone. Utilising Microwave Radio for Trunk services, particularly when in radial configuration, should be targeted for replacement.

9.2 Selecting Routes to Connect the Greatest Number of Sites

The development of the Optical Fibre Backbone on TransGrid's network has focussed on connecting the most critical sites on the network with high capacity communications. This has resulted in the bulk of the OPGW rollout to date occurring on 330kV Transmission Lines.

In many instances, lower voltage transmission lines run in parallel with the main 330kV lines, supplying intermediary substations along the way. These sites are essentially bypassed when the OPGW is installed on the 330kV Transmission Lines.

In order to establish high capacity communications to more sites on TransGrid's network and create a protected ring system, lower voltage transmission lines, specifically the 132kV network, should be utilised for installing OPGW in order to connect the greatest number of sites possible.

9.3 Establish Interim Protected Rings First

Establishing protected rings in interim configurations will still provide many benefits while allowing for capital expenditure for the ultimate configurations to be spread over a greater period. Examples of interim protected rings may include:

- A microwave hop is used to complete the ring, such that high capacity communications is available to every site on the ring; however the final hop in the ring is made via Microwave Radio.
- Large protected rings (10 or more sites) are established that can possibly introduce latency issues when diverse paths for services are required.

9.4 Retirement of PLC communications

Once protected rings are established, there is no requirement to maintain PLC communications system. The PLC system can then be retired as part of the development and renewal plan. This will improve the operational cost due to the removal of communication service duplication which will now be exclusively via high capacity protected fibre optic paths.

9.5 Manage Frequency Spectrum Re-allocation Risk

Microwave Radio requires a spectrum allocation from the Federal Government in order to operate. This spectrum remains the property of the Federal Government and a risk exists that this spectrum can be re-allocated with no recourse for TransGrid. This occurred to the 2GHz spectrum around 2000, which was one of the primary drivers for the initial roll-out of OPGW on the TransGrid network.

This risk still exists and is increased in high population areas where the frequency spectrum is more congested, such as the Sydney Metropolitan Area and the North Coast of NSW. Unlike Microwave Radio, Optical Fibre does not require an allocated frequency spectrum to operate and is therefore free of this risk.

10. Regional Development and Renewal Plans Update

TranGrid's existing primary communications networks comprises of Optical Ground Wire (OPGW) on high voltage transmission lines, Underground Fibre Optic (UGFO), Microwave Radio (MWR), Microwave Radio Sites and Power Line Carriers (PLC). The above primary communications networks coupled with secondary communications equipment formed an integrated communications system delivering services to various customers (internal and external).

As of late, TransGrid's primary communications network interconnects to all of the business' 101 x High Voltage substations/switchyards/switching stations via approximately 41 x OPGW, 109 x MWR Links, 48 x Radio Repeater Sites and 113 x PLC Links. External service providers such as the distributors (AusGrid, Endeavour Energy, Essential Energy) and other commercial network providers such as AARNET, NextGen/Vocus, Luminet etc are also called upon to provide the communication links where it is economically justifiable to do so.

The purpose of this document is to provide:

(1) an updated listing of various projects that have been raised to address the fibre optic rollouts (Need 699 and Need 1355). Please refer to Figure 10-1 and Table 10-1.

(2) the high level scope of the eventual primary communications network which interconnects to all of the 101 x High Voltage sites using primarily optical fibres to achieve a fully protected digital network in-line with the business' communications network vision. Please refer to Figure 11-1.

(3) A description of the methodology by which the eventual primary communications network presented is determined

Listed below are some of the benefits of the optical fibre rollouts:

- Future proof of all 101 x High Voltage sites
- It provides for the obsolescence of MWR SDH technology which is being phased out in the next decade
- It provides for the obsolescence of PLC technology which is limited in capacity with the current hardware no longer being supported in the next decade
- It provides for the rationalisation and simplification of TransGrid's communication network with flow on benefits in designing, procuring, maintaining, operating and the eventual replacement of the assets
- It provides for the eventual route diverse ie. Protected communications to each of TransGrid's 101 x High Voltage sites to ensure reliability of critical services such as Protection Intertrips, SCADA, Runback/Transfer Trip Schemes, AEMO Main Dispatch Data
- It provides the foundation to support the business across the information technology and operational technology functions and services rationalisation
- It positions the business as a credible major telecommunication service provider within Australia and in particular New South Wales
- It provides the foundation to support the business in growing non-regulated telecommunication business
- It provides for the foundation to support the business in providing a one stop shop for High Voltage connection points and Telecommunications connection points of prescribed and contestable customers

Note:

Communications Primary Equipment (Optical Fibres) needs to be coupled with Communication Secondary Equipment (OLTE, Lower order Muxes, etc) to form a Communication System.

Communication Secondary Equipment rationalisation will be covered in a separate Asset Strategy document.

A summary of the above strategy and associated Project Document Governance System (PDGS) Need 699 and Need 1355 is as below:

(1) Northern Region Development Goals

Timeframe	Description	Status
2014 – 2018	1. Move the majority of the North Coast TransGrid substations off microwave radio equipment and transfer the services onto the optical fibre.	Due for completion June 2018 under Need 699.
	2. Complete the North Coast protected ring with Microwave Radio until fibre becomes available	Completed April 2016 under Need DCN312
2019 - 2023	1. Reduce the size of the North Coast Ring with Fibre between Coffs Harbour and Armidale forming an Upper and Lower North Coast Ring	OPGW proposed to be installed on Line 87 for completion by June 2023 under Need 1355
	2. Close the New England protected ring with the installation of optical fibre between Moree and Inverell	OPGW proposed to be installed on Line 9U2 for completion by June 2023 under Need 1355
2024 - 2029	1. Close the Upper North Coast Ring with Fibre, replacing the microwave link	No active planning. Business Case to be reviewed for period 2024-2029.

(2) Central and West Region Development Goals

Timeframe	Description	Status
2014 – 2018	1. Installation of Optical fibre between Mt Piper and Wellington for the Western Loop to be established, connecting Wellington and Wollar substations to the Optical Fibre Backbone	Due for completion June 2018 under Need 699.
	2. Installation of Optical fibre between Parkes and Cowra to establish a reliable telecommunications service supporting the Far West Substations (Cowra, Parkes, Forbes, Manildra and Molong).	Due for completion June 2018 under Need 699.
2019 - 2023	1. Mt Piper to Bayswater fibre installation to establish a protected fibre ring for Western and Generator Loops.	Scope reduced to Wollar to Bayswater. OPGW proposed to be installed on Line 5A4 for completion by June 2023 under Need 1355
	2. Fibre installation to from Marulan to Bannaby, Gullen Range and Yass.	OPGW proposed to be installed on Line 36/36, 3J and 61 with completion scheduled by June 2023 under Need 1355
2024 - 2029	1. Establishing high capacity fibre optic connections to other substations within the Central and West region	No active planning. Business Case to be reviewed for period 2024-2029.

(3) Southern Region Development Goals

Timeframe	Description	Status
2014 – 2018	1. Installation of Optical fibre for the Wagga to Yass Loop to be established, connecting Burrinjuck, Tumut Gadara substations to the Optical Fibre Backbone.	Due for completion June 2018 under Need 699, DCN129, DCN130
	2. Installation of Optical fibre between Williamsdale and Cooma to establish a reliable telecommunications service supporting the Snowy Foot Hills Area.	Due for completion June 2018 under Need 699.
	3. Installation of Optical fibre for the Riverina Loop connecting Yanco, Griffith, Darlington Pont with OPGW on TL99F to be installed first.	Due for completion June 2018 under Need 699.
2019 - 2023	1. Installation of OPGW on TL63 to progressively establish the Riverina Loop	Due for completion by June 2023 under Need 1355
2024 - 2029	1. Installation of OPGW on TL99J, TL99K to eventually establish the Riverina Loop	Due for completion by June 2029
	2. Establishing high capacity fibre optic connections to other substations within the Snowy Foot Hills and South West Area.	No active planning. Business Case to be reviewed for period 2024-2029.

In addition, other related project transmission lines project such as OPGW replacement or rebuilt of transmission lines with OPGW due to condition assessment are also presented: TL970, TL96H, TL99F, TL992, UGFC.

An overall depiction of the strategy with the associated the afore mentioned projects is as per Figure 10-1 and associated Table 10-1

Figure 10-1: Updated Progress

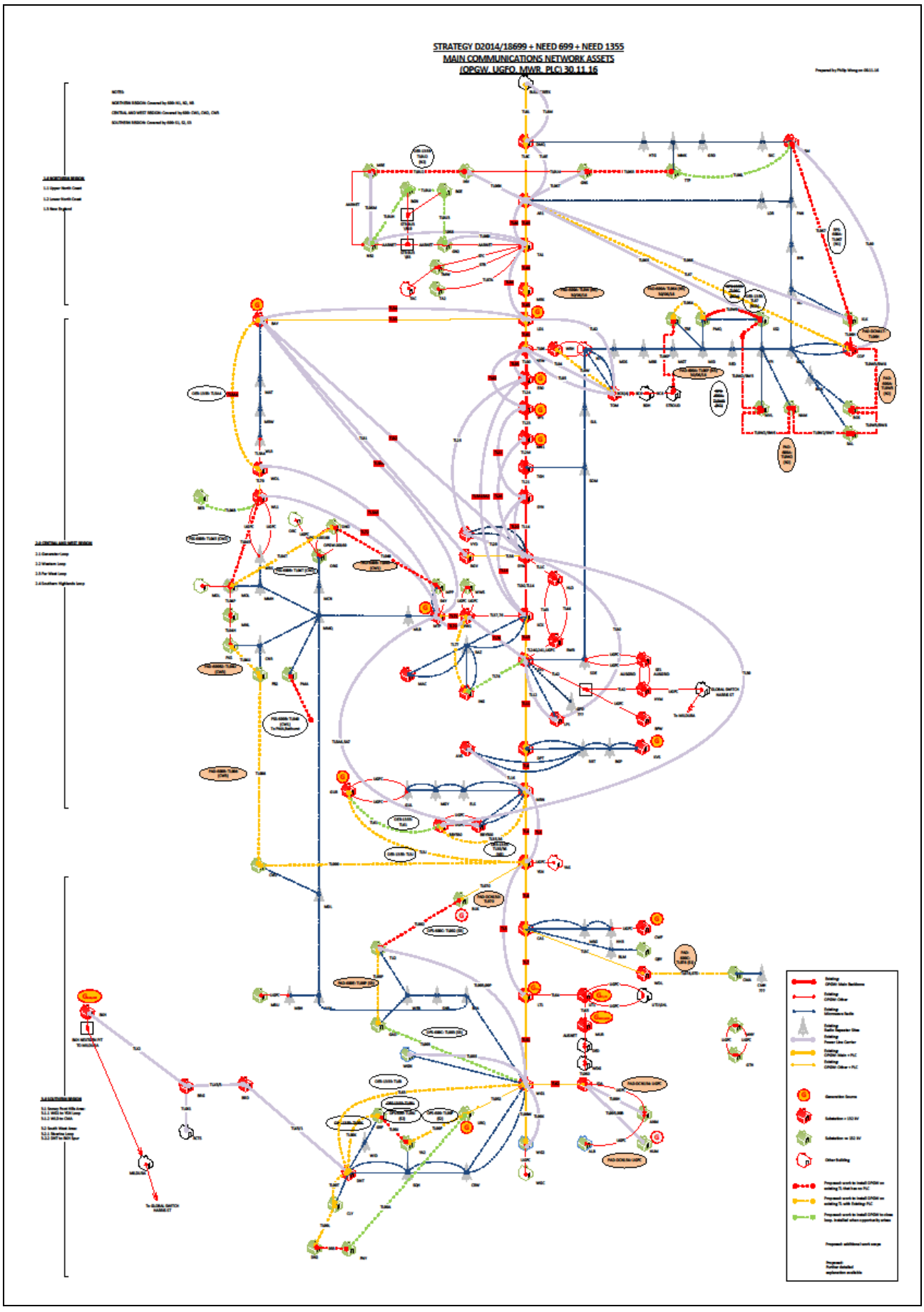


Table 10-1: Updated Progress

TL/UGFC	NEED ID	PROJ ID	GOVERNANCE STAGE	PAD DELIVERY	RP	KM	TOTAL KM
UGFC	PAD-DCN154		PAD	15/16	RP1	40	
TL970	PAD-DCN130		PAD	16/17	RP1	37	
TL96H	PAD-DCN417		PAD	17/18	RP1	80	
TL967	699	N1	RPS		RP1	90	
TL9W2	699	N2	PAD	17/18	RP1	65	
TL9W3	699	N2	PAD	17/18	RP1	45	
TL964	699	N3	PAD	17/18	RP1	66	
TL96P	699	N3	PAD	17/18	RP1	87	
TL9W	699	N3	PAD	17/18	RP1	9	
TL949	699	CW1	PAD	17/18	RP1	110	
TL945	699	CW2	PSS		RP1	67	
TL94T	699	CW2	PSS		RP1	30	
TL94U	699	CW3	PAD	16/17	RP1	31	
TL998	699	CW3	PAD	17/18	RP1	89	
TL978	699	S1	PAD	16/17	RP1	80	
TL99F	699/PAD-DCN143	S2	PAD	17/18	RP1	109	
TL99J	699	S2	OFS		RP1	46	
TL993	699	S3	OFS		RP1	80	
TL99P	699	S3	PAD	17/18	RP1	8	
TL992	699/PAD-DCN129	S3	PAD	17/18	RP1	53	RP1 = 1222 KM
TL87	1355	N1b	OER		RP2	136.1	
TL9U2	1355	N2	OER		RP2	143.2	
TL35/36	1355	N3	OER		RP2	20	
TL63	1355		OER		RP2	151.6	
TL61	1355		OER		RP2	59.1	
TL3J	1355		OER		RP2	65.6	
TL5A4	1355		OER		RP2	114.7	RP2 = 690.3 KM

11. Strategy Evolution

Figure 11-1 sets out the possible OPGW rings and the evolution of strategy. It shows a simplified, rationalised and protected fibre optic network interconnecting all of the business' high voltage sites.

The updated vision ensures a protected path to 96 of 101 high voltage sites with DMQ and TA2 being connected to a single fibre optic cable; BRD, BRG and BKH being connected via single PLC links in addition to non-TransGrid links back to Haymarket.

The main fibre backbone can be traced from the northern tip of NSW at Dumaresq 330 kV Substation (DMQ) to the southern tip of NSW at Wagga 132 kV Substation (WG2), encompassing 21 high voltage sites.

As can be seen from Figure 11-1, fibre rings can be classified in accordance to its location relative to the main fibre backbone.

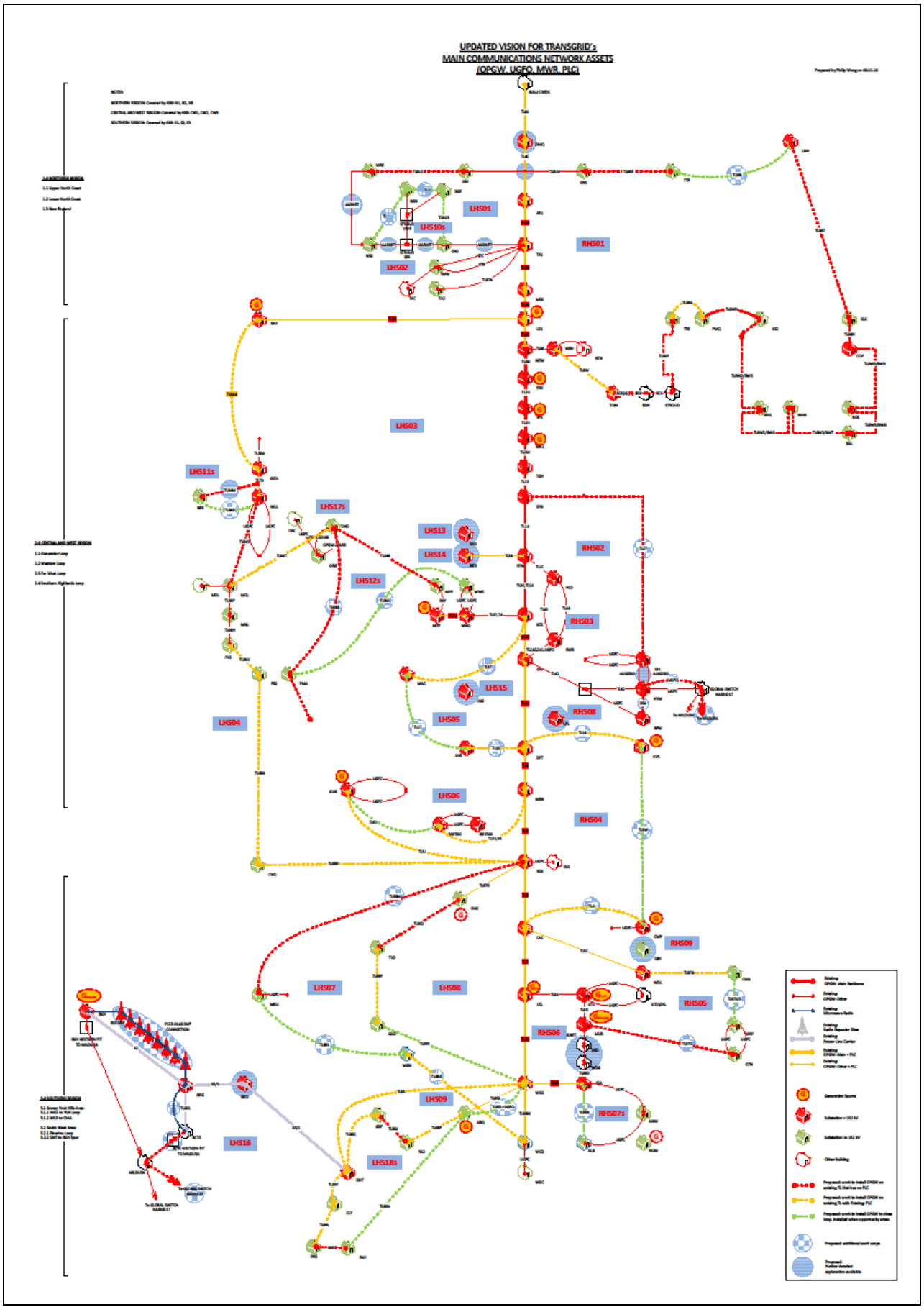
There are 9 distinct fibre rings to the right hand side of the main fibre back bone, identified as:

Updated Ring	Related Ring	Substation to be Connected
RHS01: DMQ(TL8C) to NEW Ring	Upper North Coast Ring Lower North Coast Ring	DMQ(TL8C), GNS, TTF, LSM, KLK, COF, BOS, RAL, NAM, MVL, KS2, PMQ, TRE, STROUD (NON-TG), BDH (NON-TG), TOM, WRH, NEW
RHS02: SYN to SYS Ring		SYN, SE1, HYM, BFW, SYS
RHS03: SYW to SYS Ring		SYW, HLD, RWR, SYS
RHS04: DPT to CA1 Ring		DPT, KVS, CWF, CA1
RHS05: CA1 to LT1 Ring	Williamsdale to Cooma	CA1, WDL, CMA, MNY, GTH, MUR, UT1, LT1
RHS06: LT1 to WG1 Ring		LT1, UT1, MUR, DED (NON-TG), WDG (NON-TG), JDA, WG1
RHS07s: JDA-ANM-ALB-HUM Sub-Ring		JDA, ANM, ALB, HUM
RHS08: LP1 Ring		LP1
RHS09: QBY Ring		QBY

There are 18 distinct fibre rings including the DNT-BKH Spur, to the left hand side of the main fibre back bone, identified as:

Updated Ring	Related Ring	Substation to be Connected
LHS01: DMQ(TL8C) to TA1 Ring	New England Ring	DMQ (TL8C), INV, MRE, NB2, GN2, TA1
LHS02: TA1(TL97C) to TA1(97B) Ring		TA1, TMW
LHS03: LD1 to KCK Ring	Generator Ring Western Ring	LD1, BAY, WOL, WL1, MOL, ONO, MPP, MTP, WW1, KCK
LHS04: KCK to YSN Ring	Far West Ring	KCK, WW1, MTP, MPP, ONO, MOL, MNL, PKS, FB2, CW2, YSN
LHS05: KCK to DPT Ring	Southern Highlands Ring	KCK, MAC, AVS, DPT
LHS06: MRN to YSN Ring		MRN, BBY, GUR, YSN
LHS07: YSN to WG2 Ring		YSN, MRU, WGN, WG2
LHS08: YSN to WG1 Ring	Wagga to Yass Loop	YSN, BUK, TU2, GAD, WG1
LHS09: WG1(TL9R1) to WG1(TL63) Ring		WG1(TL9R1), URQ, YA2, GRF, DNT, WG1(TL63)
LHS10s: GN2-BGE-BGN-NB2 Sub-Ring		GN2-BGE-BGN-NB2
LHS11s: WL1-BER-WOL(TL79) Sub-Ring		WL1, BER, WOL(TL79)
LHS12s: ONO-PMA-WWS-WW1 Sub-Ring		ONO-PMA-WWS-WW1
LHS13: VYD Ring		ER0, VYD, SYW
LHS14: RGV Ring		RGV
LHS15: ING Ring		ING
LHS16: DNT to BKH Spur		DNT, BRD, BRG, BKH
LHS17s: ONO(TL97G)-ORG-ONO(TL94T) Sub-Ring		ONO, ORG
LHS18s: URQ(TL99F)-YA2-GRF-DNT-CLY-DN2-FNY-URQ(TL99A) Sub-Ring		URQ, YA2, GRF, DNT, CLY, DN2, FNY

Figure 11-1: Updated Vision of TransGrid's Main Communications Network



In line with the maturity and evolution of the communications strategy, Table 11-1 provides for a listing of possible 2024-2029 OPGW rollout.

Table 11-1: Strategy Evolution: Possible 2024-2029 OPGW rollout

Timeframe	Description	Status
2024 - 2029	1. Establish LHS05 fibre ring: Kemps Creek, Macarthur, Avon, Marulan	In accordance to PDGS
	2. Establish LHS15 fibre ring: WW1, Ingleburn, Sydney South	In accordance to PDGS
	3. Completing RHS02 fibre ring: Sydney North, Sydney East, Haymarket, Beaconsfield, Sydney South	In accordance to PDGS
	4. Establish RHS08 fibre ring: Sydney West, Liverpool, Sydney South	In accordance to PDGS
	5. Establish LHS07 fibre ring: Yass, Murrumburrah, Wagga North, Wagga 330	In accordance to PDGS
	6. Establish LHS13 fibre ring: Eraring, Vineyard, Sydney West	In accordance to PDGS
	7. Establish RHS04 fibre ring: Dapto, Kangaroo Valley, Capital Wind Farm, Canberra	In accordance to PDGS
	8. Establishing RHS09 fibre ring: Canberra, Queanbeyan	In accordance to PDGS

12. Benefits of RHS Rings: Retirement of Poles/Towers, RRS, PLC Links

12.1 RHS01: DMQ(TL8C) to NEW Ring

RHS01 connects the following 17 x substations:

DMQ(TL8C), GNS, TTF, LSM, KLK, COF, BOS, RAL, NAM, MVL, KS2, PMQ, TRE, STROUD (NON-TG), BDH (NON-TG), TOM, WRH, NEW.

Eventually, when the ring is complete, the following quantity of links and communications medium can be retired:

- 14 x Radio Poles/Towers within TransGrid's high voltage sites (including backbone sites)
- 18 x Radio Repeater Sites (RRS) including associated Radio Poles/Towers
- 11 x PLC Links

12.2 RHS02: SYN to SYS Ring

RHS02 connects the following 5 x substations:

SYN, SE1, HYM, BFW, SYS

Eventually, when the ring is complete, the following quantity of links and communications medium can be retired:

- 2 x Radio Repeater Sites (RRS) including associated Radio Poles/Towers
- 2 x UGFC
- 1 x AusGrid UGFO linkEs

12.3 RHS03: SYW to SYS Ring

RHS03 connects the following 4 x substations:

SYW, HLD, RWR, SYS

This ring is currently complete by utilising sections of AusGrid's UGFC.

12.4 RHS04: DPT to CA1 Ring

RHS04 connects the following 4 x substations:

DPT, KVS, CWF, CA1

Eventually, when the ring is complete, the following quantities of links and communication medium can be retired:

- 3 x Radio Poles/Towers within TransGrid's high voltage sites (including backbone sites)
- 4 x Radio Repeater Sites (RRS) including associated Radio Poles/Towers
- 3 x PLC Links
- 1 x UGFC

12.5 RHS05: CA1 to LT1 Ring

RHS05 connects the following 8 x substations:

CA1, WDL, CMA, MNY, GTH, MUR, UT1, LT1

Eventually, when the ring is complete, the following quantities of links and communication medium can be retired:

- 2 x PLC Links
- 1 x UGFC

12.6 RHS06: LT1 to WG1 Ring

RHS06 connects the following 7 x substations:

LT1, UT1, MUR, DED (NON-TG), WDG (NON-TG), JDA, WG1

This ring is currently complete by utilising sections of Ausnet Services network in Victoria.

12.7 RHS07s: JDA-ANM-ALB Sub-Ring

RHS07s connects the following 4 x substations:

JDA, ANM, ALB, HUM

Eventually, when the ring is complete, the following quantities of links and communication medium can be retired:

- 3 x PLC Links

12.8 RHS08: LP1 Ring

RHS08 connects the following 3 x substations:

SYW, LP1, SYS

Eventually, when the ring is complete, the following quantities of links and communication medium can be retired:

- 2 x Radio Poles/Towers within TransGrid's high voltage sites (including backbone sites)
- 2 x PLC Links

12.9 RHS09: QBY Ring

RHS09 connects the following 2 x substations:

CA1 to QBY

Eventually, when the ring is complete, the following quantities of links and communication medium can be retired:

- 2 x Radio Poles/Towers within TransGrid's high voltage sites (including backbone sites)
- 1 x Radio Repeater Sites (RRS) including associated Radio Poles/Towers

13. Benefits of LHS Rings: Retirement of Poles/Towers, RRS, PLC Links

13.1 LHS01: DMQ(TL8C) to TA1 Ring

LHS01 connects the following 5 x substations:

DMQ (TL8C), INV, MRE, NB2, GN2, TA1

Eventually, when the ring is complete, the following quantities of links and communication medium can be retired:

- 4 x PLC Links

13.2 LHS02: TA1(TL97C) to TA1(TL97B) Ring

LHS02 connects the following 2 x substations:

TA1, TMW

This ring is currently complete.

13.3 LHS03: LD1 to KCK Ring

LHS03 connects the following 10 x substations:

LD1, BAY, WOL, WL1, MOL, ONO, MPP, MTP, WW1, KCK

Eventually, when the ring is complete, the following quantities of links and communication medium can be retired:

- 3 x Radio Poles/Towers within TransGrid's high voltage sites (including backbone sites)
- 4 x Radio Repeater Sites (RRS) including associated Radio Poles/Towers
- 2 x PLC Links
- 3 x UGFC

13.4 LHS04: KCK to YSN Ring

LHS04 connects the following 11 x substations:

KCK, WW1, MTP, MPP, ONO, MOL, MNL, PKS, FB2, CW2, YSN

Eventually, when the ring is complete, the following quantities of links and communication medium can be retired:

- 8 x Radio Poles/Towers within TransGrid's high voltage sites (including backbone sites)
- 6 x Radio Repeater Sites (RRS) including associated Radio Poles/Towers
- 4 x PLC Links

13.5 LHS05: KCK to DPT Ring

LHS05 connects the following 4 x substations:

KCK, MAC, AVS, DPT

Eventually, when the ring is complete, the following quantities of links and communication medium can be retired:

- 4 x Radio Poles/Towers within TransGrid's high voltage sites (including backbone sites)
- 1 x Radio Repeater Sites (RRS) including associated Radio Poles/Towers
- 5 x PLC Links

13.6 LHS06: MRN to YSN Ring

LHS06 connects the following 4 x substations:

MRN, BBY, GUR, YSN

Eventually, when the ring is complete, the following quantities of links and communication medium can be retired:

- 2 x Radio Poles/Towers within TransGrid's high voltage sites (including backbone sites)
- 3 x Radio Repeater Sites (RRS) including associated Radio Poles/Towers
- 7 x PLC Links
- 2 x UGFC

13.7 LHS07: YSN to WG2 Ring

LHS07 connects the following 4 x substations:

YSN, MRU, WGN, WG2

Eventually, when the ring is complete, the following quantities of links and communication medium can be retired:

- 2 x Radio Poles/Towers within TransGrid's high voltage sites (including backbone sites)
- 3 x Radio Repeater Sites (RRS) including associated Radio Poles/Towers
- 5 x PLC Links
- 1 x UGFC

13.8 LHS08: YSN to WG1 Ring

LHS08 connects the following 5 x substations:

YSN, BUK, TU2, GAD, WG1

Eventually, when the ring is complete, the following quantities of links and communication medium can be retired:

- 3 x Radio Poles/Towers within TransGrid's high voltage sites (including backbone sites)
- 3 x Radio Repeater Sites (RRS) including associated Radio Poles/Towers
- 4 x PLC Links

13.9 LHS09: WG1(TL9R1) to WG1(TL9R2) Ring

LHS09 connects the following 5 x substations:

WG1(TL9R1), URQ, YA2, GRF, DNT, WG1(TL63)

Eventually, when the ring is complete, the following quantities of links and communication medium can be retired:

- 5 x Radio Poles/Towers within TransGrid's high voltage sites (including backbone sites)
- 3 x Radio Repeater Sites (RRS) including associated Radio Poles/Towers
- 8 x PLC Links

13.10 LHS10s: GN2-BGE-BGN-NB2 Sub-Ring

LHS10s connects the following 4 x substations:

GN2-BGE-BGN-NB2

Eventually, when the ring is complete, the following quantities of links and communication medium can be retired:

- 3 x PLC Links

13.11 LHS011s: WL1-BER-WOL(TL79) Sub-Ring

LHS11s connects the following 3 x substations:

WL1, BER, WOL(TL79)

Eventually, when the ring is complete, the following quantities of links and communication medium can be retired:

- 1 x PLC Links

13.12 LHS12s: ONO-PMA-WWS-WW1 Sub-Ring

LHS12s connects the following 4 x substations:

ONO-PMA-WWS-WW1

Eventually, when the ring is complete, the following quantities of links and communication medium can be retired:

- 2 x Radio Poles/Towers within TransGrid's high voltage sites (including backbone sites)
- 3 x Radio Repeater Sites (RRS) including associated Radio Poles/Towers
- 1 x PLC Links

13.13 LHS013: VYD Ring

LHS13 is required to connect VYD to the OPGW Back-bone.

Eventually, when the ring is complete, the following quantities of links and communication medium can be retired:

- 2 x Radio Poles/Towers within TransGrid's high voltage sites (including backbone sites)
- 2 x Radio Repeater Sites (RRS) including associated Radio Poles/Towers

13.14 LHS014: RGV Ring

LHS14 is required to connect RGV to the OPGW Back-bone.

Eventually, when the ring is complete, the following quantities of links and communication medium can be retired:

- 2 x PLC Links

13.15 LHS015: ING Ring

LHS15 is required to connect ING to the OPGW Back-bone.

Eventually, when the ring is complete, the following quantities of links and communication medium can be retired:

- 2 x Radio Poles/Towers within TransGrid's high voltage sites (including backbone sites)
- 1 x Radio Repeater Sites (RRS) including associated Radio Poles/Towers
- 2 x PLC Links

13.16 LHS16: Darlington Point Spur

LHS16 is required to connect DNT, BRD, BRG, BKH to the OPGW Back-bone.

Eventually, when the ring is complete, the following quantities of links and communication medium can be retired:

- 3 x PLC Links

13.17 LHS17s: ONO(TL94G)-ORG-ONO(TL94T) Sub-Ring

LHS17s is required to connect ONO to OPGW Back-bone via ONO.

LHS17s Ring is essentially complete without further need for fibre optic augmentations.

13.18 LHS18s: URQ(TL99F)-YA2-GRF-DNT-CLY-DN2-FNY-URQ(TL99A) Sub-Ring

LHS18s is required to connect to 7 x substations:

URQ, YA2, GRF, DNT, CLY, DN2, FNY

Eventually, when the ring is complete, the following quantities of links and communication medium can be retired:

- 2 x Radio Poles/Towers within TransGrid's high voltage sites (including backbone sites)
- 5 x PLC Links

14. Implementing the Strategies

To implement the strategic renewal and maintenance initiatives stemming from this document, actions are to be established via the:

- Capital Works Program: The capital works program outlines the approved asset renewal and disposal projects.
- Secondary Systems Smart Network Vision: This vision details the roadmap of technological initiatives requiring to be implemented and within what timeframes.

The Secondary Systems and Communications Asset Manager is responsible for the preparation of maintenance plans and referring the renewal and disposal initiative to the network investment process. Field Services is responsible for delivering the maintenance plans as per the Service Level Agreements, and Portfolio Management group/Project Services are responsible for delivering the renewal and disposal initiatives detailed in the approved capital works program.

15. Monitoring and review

Implementation of the “SSA Strategy - Infrastructure Development and Renewal, Strategy and Objectives – Communications” is monitored and reviewed by the Secondary Systems and Communications Asset Manager, Manager/Asset Strategy and Executive Asset Strategy Committee annually.

16. Roles and Responsibilities to Develop this Asset Strategy

The roles and responsibilities of those responsible for the development of this asset strategy are as follows:

- The Asset Strategy Manager is responsible for the approval of this strategy.
- Secondary Systems and Communications Asset Manager is responsible for the development and regular review of this strategy. The document will be reviewed biannually and as significant changes to investment needs become apparent.

17. Change history

Revision no	Approved by	Amendment