Program of Works

2017 – 2022

Communication Network Bearers
(PUBLIC VERSION)

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1 Summary

PROGRAM	Replace Degraded Communications Bearer Network
SERVICE DATE	On-going throughout period 2018 – 2022
LOCATION	Various areas of Victorian Network
VALUE	$15.77M

FY17/18	FY18/19	FY19/20	FY20/21	FY 21/22	Total
$435	$1,774k	$8,107k	$5,457k	-	$15,773k

This works program document should be read in conjunction with the Communication Asset Management Strategy[1] which provides details of the service offerings, asset age, asset condition, key issues, and strategies.

2 Program Scope

Transmission medium systems are made up of optical fibre cable (OFC), electromagnetic waves (EM), and metallic systems. The share of each type of transmission system on the AusNet Services communication network is as shown in the figure below.

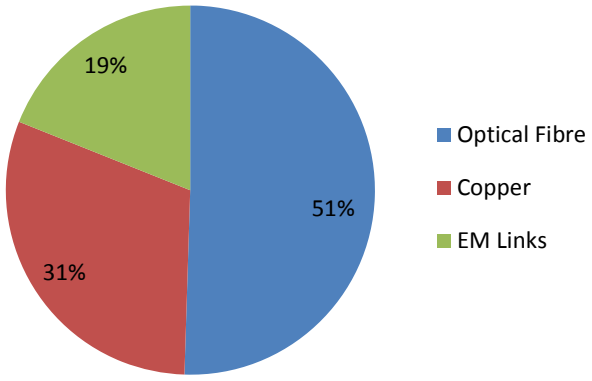

Figure 1 – Transmission Medium

Optical fibre is the predominant transmission medium. The metallic systems include copper cables and phase conductors (used for Power Line Carriers). Electromagnetic systems cover microwave radio antennas and waveguides.

[1] AMS 10-56 Communication Systems.

The majority of assets providing the communication transmission function have a "Remaining Life" greater than 45% (condition C1, C2, C3). However, some assets fall in the C4 and C5 condition category and therefore necessitate a programmed replacement in the next five to seven years if the availability of the network is to be maintained.

In addition to considerations of "Remaining life" of the assets, the configuration of some PLC links does not adequately satisfy the NER requirements which require independent communication routes for redundancy. The PLC links in question, though duplicated, use the same towers to support all the communication channels.

C4 condition rated assets have a "Remaining Life" of 25% which implies that the assets are in worse than average condition. The manufacturers no longer support maintenance of the equipment and spares sales have stopped. The only spares available are those in the AusNet Services storage facilities.

The C5 assets have a "Remaining life" of 5% meaning the assets have reached end-of-economic life. The manufacturers no longer support maintenance and development of the equipment and spares are only obtained by salvaging parts from retired equipment. There is increasing lack of experience and skill to maintain the asset both within AusNet Services and externally.

Coupled with replacement of C4 and C5 assets, this program will address the independent route requirement by introducing OPGW and/or Point to Point radio for PLC links in condition C4 and C5.

The general view of the assets to be considered is as follows:

Power Line Carrier Terminals (PLC)

- Despite the limited bandwidth available, 94 PLC links run the communication network, predominantly in the North West of the state;
- 15% have condition C4 and 6% are rated C5.

Optical Fibre

- About 85% of OFC build is Optical fibre in Ground Wire (OPGW), 13% All Dielectric Self Supporting (ADSS), and the rest underground optical fibre;
- 8% of the optical fibre assets have condition C5.

Point to Point (PTP) Radio Terminals

- There are 90 Radio schemes (Point to Point) that support the communication network;
- 25% of the radio terminals have a C4 rating.

2.1 Replacements

2.1.1 Lines and Links

2.1.1.1. Metallic (PLC)

- Horsham Terminal Station (HOTS) to Ararat Terminal Station (ARTS);
- Redcliff's Terminal Station (RCTS) to Burronga Station (BSS) in NSW.

2.1.1.2. ADSS

- Hazelwood Terminal Station (HWTS) to Test Hut 5 (TH5);
- Morwell Terminal Station (MWTS) to Test Hut 5 (TH5);
- Yallourn Power Station (YPS) to Test Hut 5 (TH5).

2.1.2 Terminals

2.1.2.1. Radios

The links earmarked for replacement:

OTHB–MTBB

TATA–MTMJ

MTMJ–TAMK

BIGH–MBTS

MTBB–TATA

MTBW–COCK

COCK–TBTS

MLTS–PTH

SYTS–SMTS

2.1.2.2. PLC

The associated links for replacement are:

MBTS-DPS

HOTS-RCTS

2.2 Scope

Depending on transmission medium type, the works will include:

- Electricity transmission tower inspections for OPGW;
- Microwave radio line-of-sight analysis for Point to Point links;
- Site acquisitions, tower design, and tower erection for point to point radio;
- Design, installation and commissioning of bearer;
- Design, installation and commissioning of digital nodes;
- Commissioning of communications circuits;
- Update of relevant asset management systems with new asset data as part of completion of works.

2.2.1 PLC Link Replacements

2.2.1.1. HOTS - ARTS

- Install OPGW HOTS to ARTS;
- Install digital communication equipment;
- Remove existing PLC links.

2.2.1.2. RCTS – BSS in NSW

- Install new PLC links RCTS to BSS;
- Install new line traps;
- Install radio link RCTS to BSS;
- Install digital communication equipment
- Remove old equipment.

2.2.2 ADSS Link Replacements

2.2.2.1. HWPS – TH5

- Install new ADSS cable;
- Decommission and remove old cable.

2.2.2.2. MWTS – TH5

- Install new ADSS cable;
- Decommission and remove old cable.

2.2.2.3. YPS – TH5

- Install new ADSS cable;
- Decommission and remove old cable.

2.2.3 PLC Terminal Replacements

- Four sites as shown in 0;
- Install new PLC terminal equipment;
- Decommission and remove old equipment.

2.2.4 Radio Terminal Replacements

- 14 sites as shown in 0;
- Install new radio terminals;
- Decommission and remove old equipment.

2.3 Project Budget

	Amount $
HOTS – ARTS	C-I-C
RCTS – BSS (both PLC and radio link)	C-I-C
ADSS Replacements	C-I-C
Point to Point radio terminal replacement	C-I-C
PLC Replacement	C-I-C
Total	**15,773,000**

3 Project Drivers

Implementation of this program of work will enable AusNet Services to economically address the following business drivers:

3.1 Safety

- Industry leadership in safety performance;
  - Minimise electricity transmission network associated risks to employees, contractors and the general public by enabling safe remote monitoring and control of network assets during maintenance and business as usual operations.

3.2 People

- High performing leadership, capability and culture;
  - N/A.

3.3 Financial

- Sustainable earnings and security holder value growth:
  - Reduce the risk of widespread power outages caused by failure of protection and signalling systems.
- Expansive and accretive growth:
  - N/A.

3.4 Business and Asset

- Safe, resilient and reliable networks.
  - Comply with the National Electricity Rules (NER) by ensuring:
    - Stipulated fault clearance times are achieved so that the electricity system remains stable during fault conditions and equipment damage is minimised;
    - Power transfers are not constrained because of the unavailability of the communication network;
    - The operation of independent systems such as protection operation is achieved during contingency events;
    - The system is available at all times except for short periods (up to 8 hours) of time for maintenance;

- ❖ Data transfer from power stations and terminal stations meets Australian Energy Market Operator (AEMO) requirements;
- ❖ Availability of a telephone system even during the most adverse of times.

– An efficient business model supported by intelligent, automated and integrated processes and systems:
  - Provide services that incorporate existing requirements while accommodating new technological evolution.

– Industry leadership and advocacy role in regulatory development:
  - N/A.

3.5 Customer

– A highly developed customer service capability;
  - N/A.

4 Overview

The communications network is installed, operated and maintained to facilitate the operation of the Victorian electricity transmission network. The Australian Energy Regulator (AER) and the Australian Energy Market Operator (AEMO) have setup rules and regulations that govern power system data, voice traffic, remote control, and protection operation signalling.

In addition to meeting the requirements stipulated in the National Electricity Rules (NER), the communication network supports other applications in AusNet Services which contribute to the company meeting its agreement obligations.

The current composition of bearers includes optical fibre, electromagnetic waves, power lines, and copper cables. Power Line Carrier (PLC) and Copper Supervisory are becoming increasingly uneconomical in supporting the requirements of the electricity transmission network. Applications demanding higher bandwidth and better performance requirements are consigning legacy bearers to obsolescence.

Whereas Optical Ground Wire (OPGW) is the preferred bearer for the AusNet Services communication network, All Dielectric Self Supporting (ADSS), Underground Optical cable, and Point to Point Microwave links are acceptable alternatives. The cost of OPGW is significantly reduced when included in projects earmarked for earth wire replacement.

5 Risk Analysis

5.1 External Risks

5.1.1 Political, Regulatory and Statutory

- Breach of power system protection operational requirements;
- Failure to provide data for the energy market operations.

5.1.2 Technology

- Inability to get spares for maintenance because vendor has ceased manufacture of the products.

5.2 Internal Risks

5.2.1 Process and Services

- Ageing bearers are prone to failure and require increased resources for maintenance.

5.2.2 Strategy

- Failure to align with corporate asset replacement strategy leading to increased operational costs (repair on failure).

5.2.3 Stakeholder Management

- Not providing and meeting customer needs adequately.

5.2.4 Data / Information

- Communication network not meeting availability targets and affecting power systems protection and control.

5.3 Summary Risk Assessment

The risks identified with the current bearer network may be summarised as follows:

- Failure to operate the power system protection devices;
- Lack of spares to maintain failed bearers;
- Increase in resource requirements for maintenance;
- Missing service availability targets.

The risk evaluation, using AusNet Services' Risk Matrix[2] (Corporate Risk Management Framework V3.0 RM 001-2006), is shown in Table 2 – Appendix B.

[2] AusNet Services Risk Management Framework – RM 001-2006.

The figure below shows the current risk level and risk level after completion of the program of works.

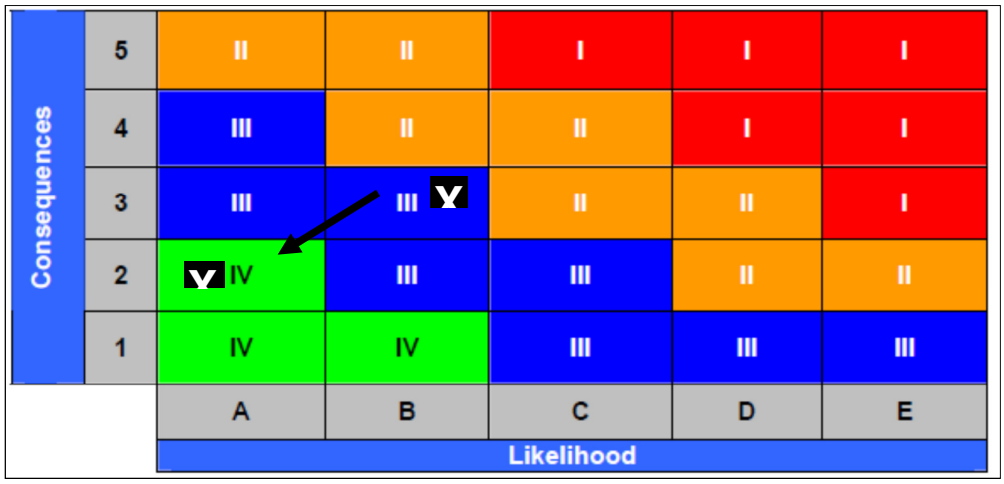

Figure 2 – Risk level before and after Program of Works

6 Options

Option 1 Business as Usual

Option 2 Replace Bearer on Failure

Option 3 Planned Replacements with Combination of Bearer Types

Option 4 Planned Replacements with OPGW and Underground Fibre

Option 5 Third Party Leasing

6.1 Option 1 – Business as Usual

The "Business as Usual" option operates and maintains existing equipment until repairs are not possible and the assets are abandoned:

- Run assets and abandon when repairs are not possible;
- Engage rare resources to maintain assets.

6.2 Option 2 – Replace Bearer on Failure

Operate and maintain existing assets to a point where repairs are not possible and then replace the asset with a similar type:

- Run assets and replace when repairs are not possible;
- Replace failed asset with like asset;
- Engage rare resources to maintain assets.

6.3 Option 3 – Planned Replacement with Combination of Bearer Types

Plan replacement program on an economic timetable:

- Replace assets when maintenance costs become uneconomical;
- Consider current and future requirements;
- Increase capacity and functionality of the communication network as required;
- Select most appropriate technology.

6.4 Option 4 – Planned Replacement with OPGW and Underground Fibre

Plan replacement program on an economic timetable:

- Replace assets when maintenance costs become uneconomical;
- Consider current and future requirements;
- Increase capacity and functionality of the communication network as required;
- Use optical fibre as the only transmission medium.

6.5 Option 5 –Third Party Leasing

- Negotiate with 3rd Parties to extend the communication network to terminal stations;
- Determine Service Level Agreements commensurate with the electricity transmission network.

7 Options Analysis

7.1 Option 1 – Business as Usual

This option fails to address any of the key business drivers in section 3. The 'Business as Usual' approach exposes the company to significant financial and regulatory risk arising from:

- Unavailable communication channels which immobilises protection schemes from clearing faults in a specific location leading to extensive power supply outages;
- Failed bearers not being replaced leading go the eventually collapses of the communication network and failure to support the energy market;
- Progressive step change in maintenance costs;
- Repeated services interruptions attract increased scrutiny from the regulator which could lead to withdrawal of operator licence;
- Reputation of the company as a capable asset manager is questioned.

7.2 Option 2 – Replace Bearer on Failure

This option maintains the operation of the communication network but at a high price:

- Unplanned failures attract high mobilisation and replacement costs because there is no opportunity to negotiate for the best price;
- Repeated untimely interruption of services attract increased regulatory oversight;
- Initial increase in operational and maintenance costs, however as degraded bearers are replaced maintenance costs reduce for the new bearers;
- Bearer capacity and functionality remains the same.

7.3 Option 3 – Planned Replacement with Combination of Bearer Types

This option addresses the key business drivers in section 3:

- Bearer availability and network operating safety is maintained;
- No step change to operational and maintenance costs;
- Network capacity and functionality is improved;
- Good corporate image.

7.4 Option 4 – Planned Replacement with OPGW and Underground Fibre

This option addresses the key business drivers in section 3 with the bearer that provides the highest bandwidth and availability:

- Bearer availability and safety is maintained;
- No step change to operational and maintenance costs;
- Network capacity is increased;
- No consideration for alternative bearers.

7.5 Option 5 – Lease from Third Party

- Bearer availability and safety is limited;
- Step change in operational costs associated with leasing arrangement;
- Network capacity is increased;
- Not all services at terminal stations can be provided. For example protection signalling to be provided by alternative methods.

8 Financial Analysis

The options have been analysed using the corporate NPV model. The benefits and costs of each option are based on an estimate from the corporate risk model. Option 3: "Planned Replacement with Combination of Bearer Types" achieves the greatest benefit for the lowest capital cost compared to option 2 and 4. Option 5 does not adequately satisfy the requirements of protection signalling and will require a significant step change in operational costs.

		Economic Least Cost Analysis				Financial Return		
	Analysis of Investment Options ($'000s)	PV Capital Cost	PV Opex Costs	PV Community Costs & Benefits	Total PV Cost	NPV including Reg Return (post tax)	PV Cost Ratio	PV of Incentive / (Penalty)
1	Business As Usual	-	(372)	(28,078)	**(28,450)**	-	1.00	-
2	Replace on Failure	(18,531)	-	(6,928)	**(25,459)**	693	49.78	-
3	**Planned Replacement with Combination of Bearer Types**	**(14,363)**	**(30)**	**-**	**(14,393)**	**546**	**38.66**	**-**
4	Planned Replacement with OPGW only	(23,164)	(30)	-	**(23,194)**	867	62.30	-
5	Leasing	(298)	(6,463)	(51,498)	**(58,259)**	11	18.16	-

All figures are in $000's unless otherwise stated.

8.1 Option 1 – Business as Usual

"Business as Usual" option will lead to complete loss of the communication network and failure to operate the electricity network.

PV of Capex and Opex	• No CAPEX however substantial level of OPEX to maintain the assets until complete failure.
PV of Community Costs & Benefits	• Loss of communications could lead to loss of supply or delays in restoration of an outage. Such an incident will lead to increased scrutiny from the regulator, undue press coverage and loss of confidence in the company by the Stakeholders.

8.2 Option 2 – Replace Bearer on Failure

Replace on fail option will eventually lead to the replacement of the degraded bearers however; the costs are high because rates for mobilisation of unplanned works are high. The communication network will have long outages which in some cases will impact the supply of electricity.

PV of Capex and Opex	• Opex Cost are high for in-service bearers but will reduce as the obsolete assets are gradually phased out.
PV of Community Costs & Benefits	• Loss of communications could lead to loss of supply or delays in restoration of an outage. Undue press coverage and loss of confidence in the company by the stakeholders.

8.3 Option 3 – Planned Replacement with Combination of Bearer Types

The planned replacement ensures resources are reserved and the best prices can be negotiated.

PV of Capex and Opex	• No step change in OPEX.
PV of Community Costs & Benefits	• This option will avoid the costs associated with the "Business as Usual" option.

8.4 Option 4 – Planned Replacement with OPGW and Underground Fibre

The planned replacement with optical fibre ensures resources are reserved and the best prices can be negotiated. However, this option considers only optical fibre as a bearer.

PV of Capex and Opex	• No step change in OPEX.
PV of Community Costs & Benefits	• This option will avoid the costs associated with the "Business as Usual" option. • Capital cost is much higher for this option compared to Option 3 for no increase in benefits.

8.5 Option 5 – Lease from Third Party

The planned replacement with leased services ensures resources are reserved and the best prices can be negotiated. However, this option is not suitable for protection signalling and therefore other bearers will have to be considered to provide services which cannot be catered for.

PV of Capex and Opex	• Significant step change in OPEX.
PV of Community Costs & Benefits	• This option will avoid some of the costs associated with the "Business as Usual" option because not all services can be provided.

9 Recommended Action

Option 3 “Planned Replacement with Combination of Bearer Types” is recommended.

10 Reference Documents

- Electricity Safety Act.
- Occupational Health & Safety Act – provision of safe work environment.
- AEMC National Electricity Rules (version 71).
- Asset Health Report (AHR 10-56).
- AMS for Victorian Electricity Transmission Network - Communications Systems (AMS 10-56).
- AMS – Victorian Electricity Transmission Network – Asset Life Evaluation (AMS 10-101).
- Asset Management Strategy for the Victorian Electricity Transmission Network (AMS 10-01).

Appendix 1: Sites and Replacement Equipment

Sites	Radio	PLC	Optical Fibre	Copper
ATS				
BATS				
BETS				
BIGH	yes			
BLTS				
BTS				
C-452				
CAMH				
CBTS				
C-EPS				
C-FVTS				
C-JLGA				
C-LYGS				
C-MOPS				
C-MPS				
C-NPSD				
COCK	yes			
C-PTH	yes			
C-YTS				
DDTS				
EPSY				
ERTS				
FBTS				
GNTS				

Communication Network Bearers

Sites	Radio	PLC	Optical Fibre	Copper
GTS				
HOTS		yes		
HTS				
HWPS				
HWTS			yes	
HYTS				
JERH				
KCC				
KGTS				
KTS				
LY				
LYPS				
MAC				
MBTS	yes	yes		
MLTS	yes			
MTBB	yes			
MTBD				
MTBL				
MTBN				
MTBW	yes			
MTCL				
MTMD				
MTMJ	yes			
MTS				
MTSD				
MTST				

Communication Network Bearers

Sites	Radio	PLC	Optical Fibre	Copper
MTTA				
MTWH				
MWTS			yes	
OTHB	yes			
RCTS		yes		
ROCC				
ROTS				
RTS				
RTTS				
RWTS				
SHTS				
SMTS	yes			
SVTS				
SYTS	yes			
TAMK	yes			
TATA	yes			
TBTS	yes			
TGTS				
TSTS				
TTS				
VINE				
VNSC				
WBTS				
WETS				
WMTS				
WOTS				

Sites	Radio	PLC	Optical Fibre	Copper
YPS			yes	

Table 1 – Sites and Replacement Equipment

Appendix 2: Risk Register Template

Entity/Project: _____ **Facilitator:** Aloysius Nainhabo **Date:** _____

RISK IDENTIFICATION			RISK TREATMENT			RISK ANALYSIS						
						Residual Risk				Target Risk		
Risk	Causes	Impacts	Controls (Current)	RCE	Treatment Actions (Future)	Conseq Rating	Like. Rating	Residual Risk Rating	Project Financial Exposure (Residual)	Conseq Rating	Like. Rating	Target Risk Rating
Power system protection operational requirements fail during a fault condition	Failure of communication network resulting in failure to transfer Protection signaling between stations	Regulation/Compliance: • Breach of regulatory requirement resulting in investigation and directive issued Reputation • adverse national press reporting over several days Customer: • Loss of supply	Regular Maintenance	Partially Effective	Develop and implement replacement program for C5 condition assets	3	B	Level II		1	B	Level IV
Inability to get spares when equipment fails	Manufacturer stopped production of parts. Equipment classified as obsolete	Regulation/Compliance: • Breach of regulatory requirement resulting in investigation and directive issued Reputation • adverse national press reporting over several days Customer: • Loss of supply	Regular contact with manufacturers	Partially Effective	Develop and implement replacement program for C5 condition assets	3	B	Level II		1	B	Level IV
Increase in resource requirements	• Increasing equipment failure rate • Costs of repair on failure is comparatively higher than planned repair	Financial • Increase in OPEX cost	Monitoring equipment failure rates and maintenance frequency	Partially Effective	Alignment with corporate Asset Replacement Strategy	2	C	Level III		1	B	Level IV
Missing service availability targets	• Frequent failures • Capacity constraints	Regulation/Compliance: • Breach of regulatory requirement resulting in investigation and directive issued Customer:	Monitoring equipment failure rates and maintenance frequency	Partially Effective	Develop and implement replacement program for C5 condition assets taking into consideration future requirements	3	B	Level II		1	B	Level IV

RISK IDENTIFICATION			RISK TREATMENT			RISK ANALYSIS						
						Residual Risk				Target Risk		
Risk	Causes	Impacts	Controls (Current)	RCE	Treatment Actions (Future)	Conseq Rating	Like. Rating	Residual Risk Rating	Project Financial Exposure (Residual)	Conseq Rating	Like. Rating	Target Risk Rating
		• Insufficient data for the energy market People • Reduced efficiency of corporate applications										

Table 2 – Risk Evaluation