SCADA and Communications Obsolete Asset Replacement (NMSC1)

Regulatory Business Case (RBC) 2024-29

PowerWater

Contents

1. Summary

This business case has been prepared to support the 2024-29 Regulatory Proposal. The business case demonstrates that Power and Water has undertaken appropriate analysis of the need for the expenditure and identified credible options that will resolve the need and ensure that Power and Water continues to meet the National Electricity Objectives and maintain the quality, reliability, and security of supply of standard control services and maintain the safety of the distribution system.

The proposed investment identified in this business case will undergo further assessment and scrutiny through Power and Water's normal governance processes prior to implementation and delivery.

This business case addresses the compliance and obsolescence risks of PDH and SDH technologies for the communications network

1.1 Business need

The electricity network is comprised of thousands of devices that need to communicate with other devices and the control room. These devices can be connected in a ring or on radial lines. To enable these devices to communicate efficiently, the signals are passed through concentrators known in the industry as multiplexors (or multiplexers), which combine or split out the signals.

PDH[1] and SDH[2] Multiplexors are two types of multiplexors currently in use on the Power and Water electricity network that are old technology and have been superseded by Multiprotocol Label Switching (MPLS) devices. MPLS is designed to operate in a virtual environment and therefore provides more flexibility as the switching and throughput can be easily changed virtually to meet changing requirements, without the need to make physical changes to the network. MPLS is also the stepping-stone for the next generation of communications technologies called the Software Defined Networks (SDN), therefore creating real options for future development of the network.

The Networks Technical Code and Planning Criteria (Technical Code) require that Power and Water maintain a communications network for monitoring and control of the electricity network. Power and Water is also required by the Technical Code to provide a communications network between any Users connected to the network and System Control. To achieve this, Power and Water must ensure the SCADA and Communications assets are fit for purpose and address any issues that could put the network at risk such as technological obsolescence, lack of vendor support or deteriorated condition.

Vendor support is critical to having equipment repaired, resolving software/firmware bugs, updating security patches to guard against cyber threats, and general overall support in programming and maintaining this equipment. When equipment is at End of Support (EoS), the vendor support is no longer available and vendors do not sell spares or undertake repairs of faulty equipment. Power and Water has limited capacity and capability to address difficult technical issues related to programming and maintaining complex telecommunications systems where the issues that need to be resolved are more complex than the normal day to day activities experienced with a telecommunications network.

[1] Plesiochronous Digital Hierarchy
[2] Synchronous Digital Hierarchy

This business case is focussed on addressing the risk presented by obsolescence of the PDH and SDH technologies and the need for Power and Water to maintain a modern functioning communications system to be compatible with MPLS technology:

- PDH and SDH technologies are obsolete and are being phased out by vendors as evidenced by End of Life and End of Support notices. There are 151 PDH and 62 SDH devices on the network.
- Vendors are transitioning to MPLS technology.
- Critical components of the Digital Mobile Radio network have been identified to be at end of life or are expected to reach end of life in 3 to 5 years and existing components are not compatible with MPLS technology. There are 22 devices on the network that are impacted.
- Existing Substation LAN implementations have been superseded by new technologies and are no longer compatible with many modern devices. There are currently 5 out of 38 zone substations with a modern LAN, the remaining 33 zone substations are impacted by the changing technology.

The Communications network is critical to ensure the safe and reliable operation of the electrical network. The Network Licence, enforced by the Electricity Reform Act 2000, requires the communications network to remain compliant with legislative requirements, including:

- System Control Technical Code
- Networks Technical Code and Planning Criteria
- ICT requirements of Power and Water and the NT government
- The 2022 amendments to the Security of Critical Infrastructure Act 2018

To meet these obligations, it is necessary for Power Services to manage assets that are obsolete, no longer supported by the vendor, or at the end of their design life.

1.2 Options analysis

There are limited viable options to resolve this need outside the replacement of the current technology. Hence, the option analysis focusses on the cost, risk and prudence of options considered in Table 1.

Retaining the existing technology (SDH and PDH) is not a credible option as the technology types are no longer being produced by vendors, and is inconsistent with the transition strategy commenced in the current regulatory period.

Table 1 Summary of credible options

Option No.	Option name	Description	Recommended
1	Continue to replace end of life assets with MPLS-IP technology	Continue the planned migration to MPLS-IP commenced in the current regulatory period to take advantage of the improved functionality and improved vendor support and availability of assets.	Yes
2	Continue to replace end of life assets with	Continue the planned migration to MPLS commenced in the current regulatory	No

	alternative MPLS-TP technology	period, using MPLS-TP, to take advantage of the improved functionality and improved vendor support and availability of assets.	

Both options were found to have a similar cost to implement, however, the technical functionality, flexibility and benefits of Option 1 were found to be superior and provide real options and value for Power Services to be able to meet future changes to technology or communications and cyber security requirements.

The analysis of the identified options to form the basis to identify the best possible option is in Section 3 of this document.

1.3 Recommendation

The recommended option is Option 1 – Transition to MPLS-IP technology to efficiently manage the removal of the SDH and PDH technology from the network over time. Continuing with the existing mix of SDH and PDH technologies is no longer feasible as they are out of production and support by vendors and therefore pose an increasing and unacceptable risk to the network.

Table 2 shows a summary of the expenditure requirements for 2024-29 regulatory period.

Table 2 Annual capital and operational expenditure ($'000, real 2021/22)

Item	FY25	FY26	FY27	FY28	FY29	Total
Capex	880	1,290	850	900	977	4,897
Opex	-	-	-	-	-	-
Total	**880**	**1,290**	**850**	**900**	**977**	**4,897**

2. Identified need

This section describes the fleet of assets being addressed by this business case and sets out the need to invest based on asset condition, the operating environment, deterioration modes and changes to vendor support. Section 3 assesses different options to address the identified need and assess them on an economic basis.

2.1 Background

Power and Water has historically implemented a program of works to replace communications assets due to condition, functionality and obsolescence of technology. Historically, the assets were replaced with a modern equivalent and typically the PDH or SDH technology was retained. The program described in this business case is the continuation of the historical program but with a revised focus due to changes in technology availability.

In 2018 manufacturers started issuing end of life and end of support notifications for PDH and SDH, this included the Ericsson SDH multiplexer which was the foundation of Power and Water's communications network. Since the announcements, Power and Water has largely continued with like for like replacement of SDH and PDH while spare are available and support still provided.

However, the notifications established that the SDH and PDH assets were not a viable technology in the long term so Power and Water undertook an in-depth analysis of available technologies, testing and assessment of which technology would meet the network needs. This involved learning from a southern energy utility and specific forums such as CIGRE D2. The outcome was that MPLS-IP was the most suited for Power and Water needs.

Based on the analysis, the historical condition, functionality and obsolescence program was refocused to start transiting to MPLS-IP technology as assets required replacement and has been renamed to "MPLS Transition" to more clearly articulate what it is achieving.

The transition started in 2020 with assets that have reached end of life and where insufficient spares were available. Core nodes were also deployed at Hudson Creek, the Disaster Recover Control Centre and Ben Hammond, as well as some other key locations to establish the foundation of the new technology.

The following sections provide detail regarding the specific issues with the PDH and SDH technology, compliance requirements, and the historical program.

2.2 Technical code requirements

The Networks Technical Code and Planning Criteria (Technical Code) requires Power and Water to maintain a communications network for monitoring and control of the electricity network. The communications network is managed by Power Services.

The Technical Code also requires Power and Water to provide a communications network between any Users[3] connected to the network and to System Control. The backbone communications network is required to provide highly available and reliable communications services for:

[3] A person, whether a Network User or a Generator User, who has been granted access to the electricity network by the Network Operator in order to transport electrical energy to or from a particular point.

- Protection schemes
- SCADA
- Operational voice communications system (UHF radio – DMR)
- Engineering Access Network also known as the Substation-LAN (for IEDs in the field)
- Corporate WAN (for remote substations)

To achieve this, Power Services must ensure its communications assets are fit for purpose and address any issues that could put the network at risk such as technological obsolescence, Cyber Security, lack of vendor support or deteriorated condition.

Vendor support is critical for maintaining highly specialised network equipment and ensuring it can be repaired, resolve software and firmware bugs, updating security patches to guard against cyber threats, and general overall support in configuring and maintaining the equipment.

The increasing threat to cyber security is also a core consideration that is closely linked to technological obsolescence and vendor support. The Security Legislation Amendment (Critical Infrastructure Protection) Bill, passed in federal parliament this year, also places new compliance obligations on Power and Water communications infrastructure.

This business case describes the communications assets that will reach the end of their serviceable life, use technology that will become obsolete, and will no longer be supported by the vendor during the next regulatory period (FY25 to FY29), establishing the need to invest to ensure network reliability and security.

The following sections describe the assets impacted by the changes to technology.

2.3 Overview of communications protocols and assets

The electricity network is comprised of thousands of devices that need to communicate with other devices and the control room. These devices can be connected in a ring or on radial lines. To enable these devices to communicate efficiently, the signals are passed through concentrators known in the industry as multiplexors (or multiplexers), which combine or split out the signals. This enables a single communications cable to carry the signals from multiple devices efficiently.

The technology used to achieve this has evolved over time. A detailed overview of the different technology types available is provided in Appendix B.

2.4 Vendor 'End of Support' notifications

There is a critical need for Power and Water to manage the communications network through a migration to MPLS technology as PDH and SDH multiplexors reach end of production and vendor end of support. Power and Water has already received several End of Life and End of Support notices for some PDH and SDH devices (see below). A wide range of critical communications components based on PDH and SDH technologies are expected to be at end of life in 3 to 5 years.

2.4.1 PDH multiplexors

There are 151 PDH units deployed on the Power and Water network. As an older technology, there are a significant number that are older than 8-10 years, which is a common expected serviceable life for operational technology assets. Figure 1 shows the age profile of the PDH assets. All of these assets are considered to be at end of life based on asset age and end of support notices from vendors.

SDH is a natural progression of PDH. Power and Water has historically deployed SDH nodes to work hand-in-hand with PDH. However, with the emergence of MPLS over the last 20 years and phasing out of SDH by vendors, this approach needs to be reassessed.

Power and Water holds limited spares for PDH for emergency fault restoration.

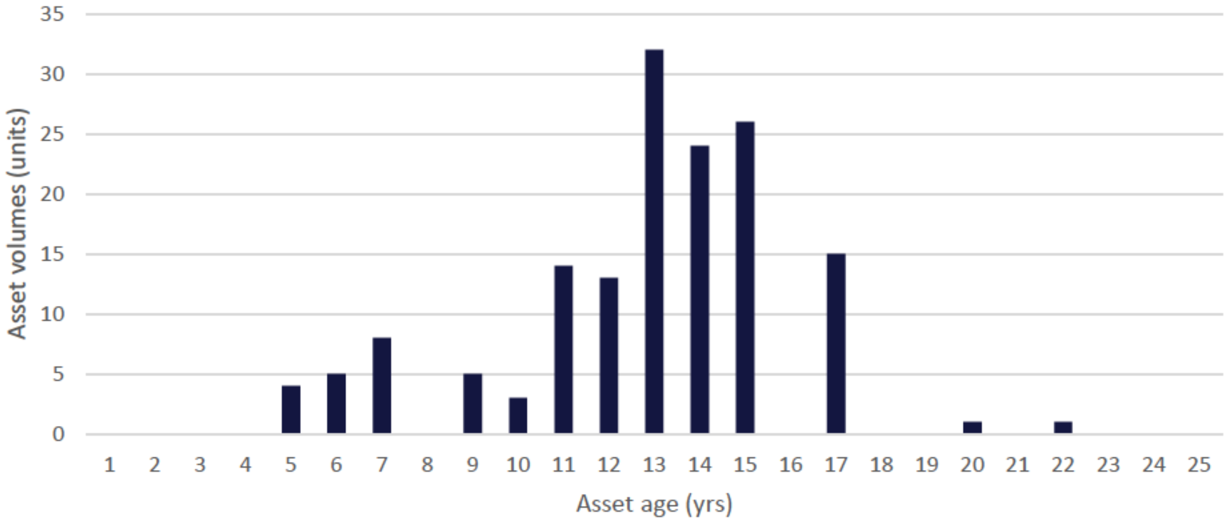

Figure 1 PDH age profile

2.4.2 SDH multiplexors

The SDH network is comprised of 62 units and wherever possible is built as a ring network to provide path redundancy. The equipment is duplicated so it is compliant with the Technical Code. This allows the equipment to be run to failure and hence maximises its life. A life extension strategy has been developed and is detailed in the SCADA & Communications Asset Class Management Plan. This strategy considers spares management, failure response and maintenance.

An End of Support notice was issued to Power and Water on the12th November 2013 for the following equipment used in the SDH network:

- Ericsson OMS800 series (11 units); and
- Ericsson OMS1200 series (39 units).

The End of Support date for these two asset types was 31 July 2019. This means there is no longer support for firmware bugs/upgrades or other technical issues provided from the vendor. This may expose Power Services to increased operational and cyber security risk. Failures must be managed through replacement with spares or alternative similar assets, which may be complex and time consuming to implement. At the time the end of support notice was issued, the vendors' recommendation was to migrate to the SPO14xx family of devices.

A Last Time Buy notice was issued to Power and Water on the 29th March 2018 for the following equipment used in the PWC SDH network:

- Ericsson SPO1410 (12 units)

The SPO1410 assets can no longer be purchased. However, the vendor will continue to provide technical support. An End of Support date has not been published. Based on other assets, End of Support typically occurs within a period of 3 to 5 years following the last time buy date, so is expected by 2023.

Hence, there are 62 SDH assets for which there are no new spares available, of which 50 SDH assets are out of vendor support and the remaining 12 which are likely to be out of support within the next 1 to 3 years. The age profile of these assets is shown in Figure 2

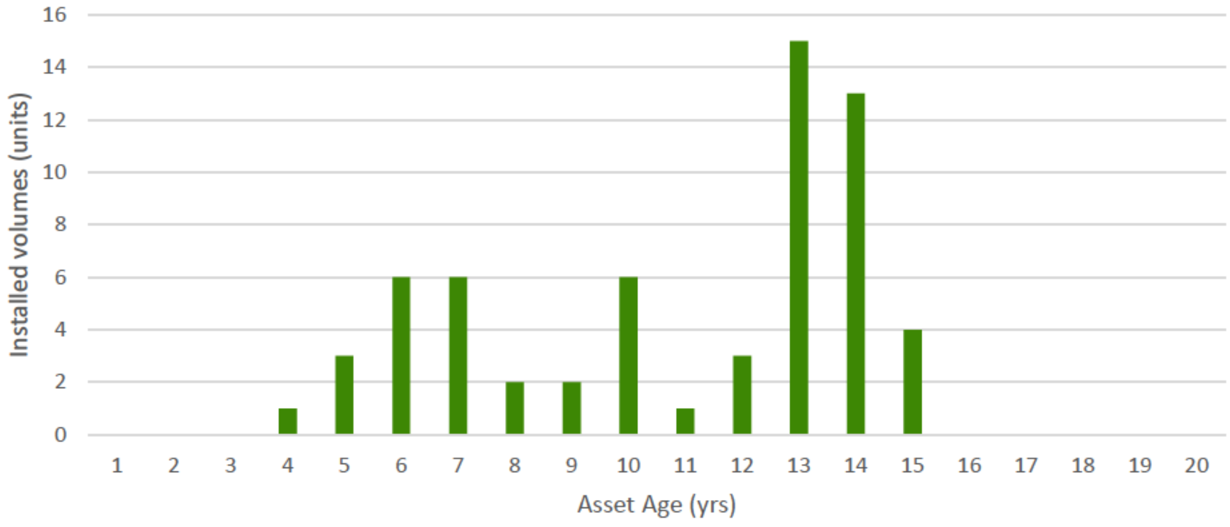

Figure 2 SDH age profile

2.4.3 Digital Mobile Radio assets

An Ultra High Frequency (UHF) Digital Mobile Radio (DMR) system was commissioned in June 2018. The DMR is used for voice communications and increasingly for data. The DMR is comprised of three predominant classes of assets:

- the transceivers (transmitters and receivers) that transmit and receive signals
- the network switches and routers that are located on site to provide the backbone connectivity to the transceivers,
- and the head end servers that operate the platform and provide console connections to the System Control operators.

Figure 3 shows the age profile of these assets.

Since commissioning, the vendor has released an End of Life notice for TB9300 base station (switches and routers asset class). The TB9300 has a published 'Last Time Buy' date of 30 June 2022 and will become out of support within the next regulatory period. The vendor has advised that this unit is superseded by the TB9400. The TB9400 is also compatible with MPLS.

A critical router (CGR2010) is expected to reach end of life in the next 3 to 5 years and is not compatible with the emerging MPLS technology.

An external consultant recommended preparing for the expected end of life of the CGR2010 routers and Dell servers by considering upgrading to MPLS compatible router equivalents like Nokia 7705 or Cisco IR8300 and virtual server environments.

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Additionally, as the PDH and SDH technology is removed due to EOL and obsolescence issues, the DMR will need to remain compatible with the modern replacement technology.

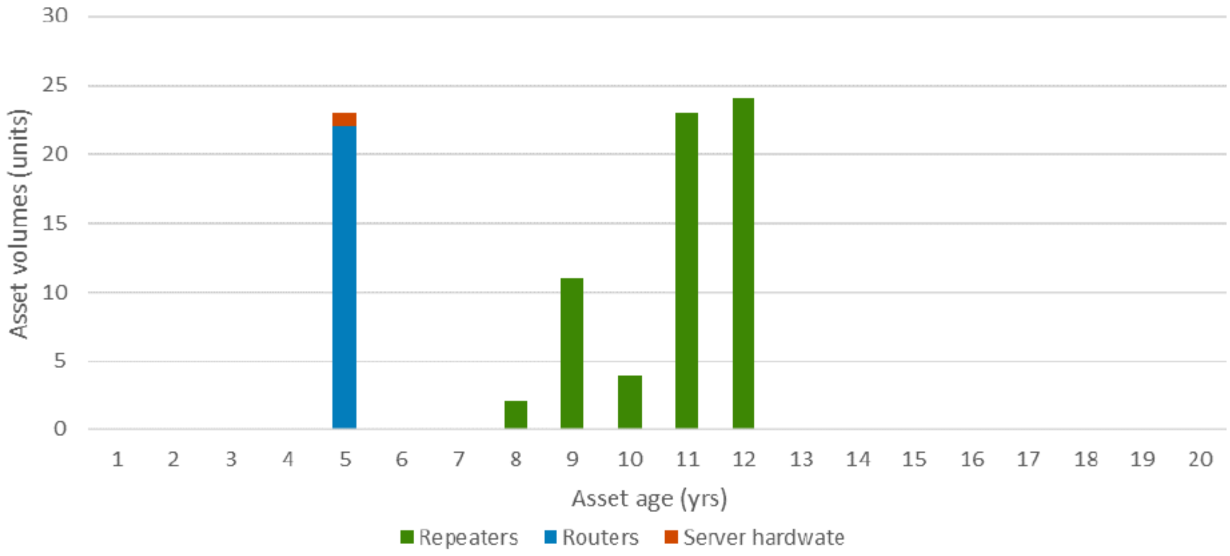

Figure 3 DMR age profile

2.4.4 Obsolete Engineering Access Network

Traditional SCADA requires specific outputs from devices located in a substation to be connected via serial connections (RS232) to the Remote Terminal Unit (RTU) which is then connected to the control room via the communication network. The connected devices could transmit data to the control room (and data storage). Different devices and technologies enable varying levels of access and control from the control room.

With increasing numbers of Intelligent Electronic Devices (IED) being deployed on the network, there are operational benefits to having the ability to remotely access these devices for fault analysis and configuration changes. The current Engineering Access Network implementations make the increased access difficult or limit the functionality.

The Engineering Access Network has two parts, the Engineering LAN (also known as Substation LAN) that provides local connectivity between IEDs and RTUs, and the Engineering WAN that provides the wide area network between sites and System Control.

Modern substation LAN deployments involve using newer generation RTU's so that all devices are connected via ethernet for the substation LAN and the communications protocols are upgraded to MPLS to enable improved cyber security and improved remote access and functionality via the WAN.

The improved functionality offered by modern replacement devices can include remote access for configuration management, post event data access and analysis and reducing system downtime. An additional benefit to Power and Water is the ability to reduce the need to travel long distances and to continue to service remote assets even when there may be physical site access issues during monsoons.

Older assets can be integrated into modern Substation LAN platforms. However, new assets often cannot be integrated into older LAN or traditional SCADA platforms. As devices need to be replaced, the ability to retain old SCADA networks will become increasingly difficult and they will be unlikely to comply with modern IT and OT requirements, such as the recent Critical Infrastructure Bill.

Currently, Power and Water has a modern Substation LAN implemented at 5 out of 38 zone substations.

2.5 Historical and current programs

Historically this program was implemented to replace end of life assets with a modern equivalent, but retaining the same SDH or PDH type where available. As described in section 2.1, the transition to MPLS-IP started in 2020 but has still been replacing assets with SDH and PDH technology while vendor support is still available and there are sufficient spares for a controlled management off the network. The focus to transition to MPLS will increase as it becomes the dominant technology and support from vendors cease for PDH and SDH.

The historical spend is shown in Figure 4. The decrease in expenditure during FY20 and FY21 was predominately driven by:

- the impacts of COVID on delivery or projects;
- time required to assess and plan the preferred approach for transitioning to MPLS technology; and
- delay in major projects resulting in expected and planned work not being implemented.

The increase in 2021/22 and the estimate (budget) for the remainder of the current regulatory period reflects the implementation of the transition program.

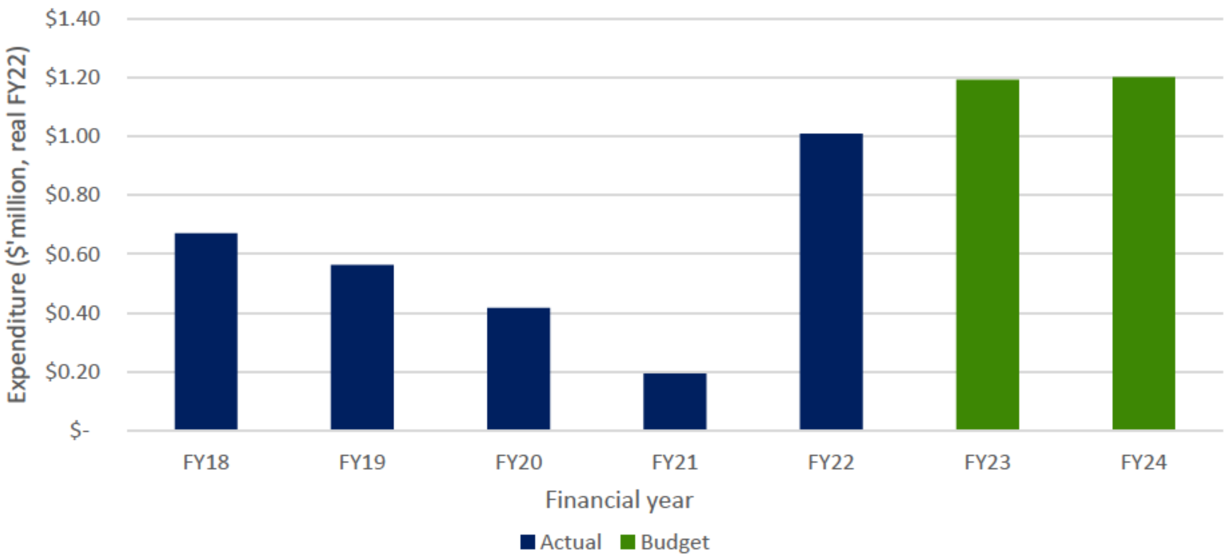

Figure 4 Historical actual expenditure and budget for the rest of the current regulatory period

2.6 Risk assessment

Power and Water has developed the Risk Quantification Procedure to enable consistent quantification of risk from their assets into dollar terms.

The procedure is applicable to most assets where there is a direct link between an asset failure and the impact of that failure on the defined consequence categories. Sufficient network data also needs to be available to derive the required inputs.

The communications assets are difficult to analyse using the risk quantification procedure:

- The communications system has inbuilt redundancy, so a second contingency event is required to possibly result in a disruption of supply or a safety incident.
- The network can continue to operate without the communications network, although with a reduced level of control and monitoring. Hence, a loss of the communications network does not necessarily lead directly to an outage or safety incident but may increase the likelihood or consequence of an incident should it occur.
- There isn't sufficient outage data for communications assets recorded to develop appropriate inputs to the risk model. Hence, application of the risk model would require a lot of assumptions with the outcome not likely to be meaningful.

As a result of the above issues, it is not possible to identify the probability of an outage, the likelihood of consequences that may result from an outage, nor the cost impact of any regulatory compliance issues. Hence, Power and Water has undertaken a qualitative assessment of the risks posed by the identified issues.

The communications system is critical for control of the network for protection systems, to undertake network switching operations and to have visibility of the network status. Without adequate reliability there is a high risk of loss of communications, contributing to issues in Alice Springs including:

- **Health and Safety:** The communications network enables protection systems to operate correctly and for the status of the network to be displayed in the control room so operators can take appropriate actions. Failure of the communications network is likely to result in increased risk to Power and Water's field crews and the public through failure to manage the network configuration to isolate faults, incorrect operation of protection systems, or through operation of switches that could energise faulted sections of the network.
- **Compliance:** Power and Water has compliance obligations established by the network licence and the Power Networks Network Technical Code and Network Planning Criteria as described in Appendix D. Failure to address the identified need will significantly impact Power and Waters ability to maintain compliance.
- **Service delivery:** Loss of visibility of the network could result in delayed response times, extending outages and therefore result in poor service to our customers

The qualitative risk assessment of the inherent risk and targeted risk is shown in Figure 5 using the matrix approach set out in the Enterprise Risk Management Standard.

	Insignficiant	Minor	Moderate	Major	Severe
Almost certain	Medium	High	Very High	Extreme	Extreme
Likely	Low	Medium	High	Very High	Extreme
Possible	Low	Low	Medium	High	Very High
Unlikely	Low	Low	Medium	High	High
Rare	Low	Low	Low	Medium	Medium

Figure 5 Qualitative risk assessment

2.7 Summary

This section has set out the risks posed to Power and Water to meet their obligations:

- PDH and SDH technologies are obsolete and are being phased out by vendors in favour of MPLS. A number of End of Life and End of Support notices have been issued to Power and Water, identifying an increasing risk to maintaining safe and reliable operations of the communications networks by those assets.
- Critical components of the Digital Mobile Radio network have been identified to be at end of life or are expected to reach end of life in 3 to 5 years. In addition, existing components are not compatible with MPLS technology. Accordingly, the management and requirements of the DMR must be considered concurrently with the management of the PDH and SDH assets.
- Existing Substation LAN implementations have been superseded by new technologies and are no longer compatible with many modern devices. Further, the existing implementations do not enable Power and Water to fully benefit from the functionality afforded by modern devices and communications networks.

The Communications network is critical to ensure the safe and reliable operation of the electrical network. The Network Licence, enforced by the Electricity Reform Act 2000, requires the communications network to remain compliant with legislative requirements, including:

- System Control Technical Code
- Power Networks Technical Code and Planning Criteria
- ICT requirements of Power and Water and the NT government
- The 2022 amendments to the Security of Critical Infrastructure Act 2018

To meet these obligations, it is necessary for Power and Water to manage assets that are obsolete, no longer supported by the vendor, or at the end of their design life, through replacement or spares management as set out in the option analysis section.

3. Options analysis

This section describes the various options that were analysed to address the increasing risk to identify the recommended option. The options are analysed based on ability to address the identified needs, prudency and efficiency, commercial and technical feasibility, deliverability, benefits and an optimal balance between long term asset risk and short-term asset performance.

3.1 Comparison of credible options

A comparison of the two identified credible options and the issues they address in the identified need is depicted in the table below. A detailed discussion of each option is provided in the following sections. The two options recognise that continuing with existing technologies is not feasible and the decision for future technology deployment is between the types of technology to use:

- Option 1 – Continue to replace end of life assets with MPLS-IP technology. This option involves continuing the planned migration to MPLS-IP commenced in the current regulatory period to take advantage of the improved functionality and improved vendor support and availability of assets.
- Option 2 – Continue to replace end of life assets with alternative MPLS-TP technology. This option involves continuing the planned migration to MPLS commenced in the current regulatory period, but changing to MPLS-TP technology, to take advantage of the improved functionality and improved vendor support and availability of assets.

Both options assume a managed transition to maximise the use of existing assets and spares, hence, the option for a deferred transition is implicit in both options and is not a separable/stand-alone option.

As summarised in Table 3, Option 1 provides greater benefits when compared with Option 2 for the same estimated cost and is therefore the preferred option.

Table 3 Summary of options analysis outcomes

Assessment metrics	Option 1 Replace with MPLS-IP	Option 2 Replace with MPLS-TP
NPC ($'000, real FY22)[4]	$4,300	$4,300
BCR	N/A	N/A
Capex ($'000, real FY22)[5]	$4,900	$4,900
Meets customer expectations	●	●
Aligns with Asset Objectives	●	●
Resolved identified need	●	◑
Technical Viability	●	◑

[4] Values have been rounded to nearest $100,000
[5] Values have been rounded to nearest $100,000

Deliverability	●	●
Preferred	✓	✗

● Fully addressed the issue ◕ Adequately addressed the issue ◑ Partially addressed the issue ○ Did not address the issue

3.1.1 Option 1 – Replace end of life assets with MPLS-IP technology

This option proposes to continue the transition of the communications network from PDH and SDH to MPLS as vendor support is withdrawn for the obsolete assets. This option will enable Power and Water to remain aligned to the progression in technology indicated by the vendors and therefore have ongoing access to support, compatibility with new devices, and provide real option value to make changes at low incremental cost, such as to achieve compliance with any new cyber security requirements.

To completely transition to the new technology, the following assets must be replaced:

- Replacement of 151 PDH mux
- Replacement of 62 SDH mux
- Replacement of 22 Digital Radio switches and routers
- Replacement of the LAN at 10 zone substations. The substations identified are in remote locations and represent the highest risk, and therefore priority for replacement as they provide the greatest benefit for maintaining access, maintenance and control of the network.
- Establish a testing facility to enable configuration testing, testing of patches and assessment of other network parameters. It will also enable pre-configuration of devices to facilitate installation in the field – the devices only need to be connected without configuration so installation is quicker and doesn't require specialised skills.
- Purchase of critical spares for assets that have a Last Time Buy notice issued so Power and Water can purchase sufficient spares for a controlled and managed transition away from the asset type by the time they reach End of Support.

Given the current ICT environment and the recent critical infrastructure bill, Power and Water plans to fully transition to MPLS-IP within approximately 10 years. The assets identified for replacement have been adjusted to remove the major projects and customer connection projects which will likely include the upgrade of necessary zone substation assets and connection assets, respectively.

The cost estimates shown in Table 4Table 4 Forecast cost of Option 1 ($'million, real 2021/22) are based on recent similar projects and historical prices, in accordance with Appendix A.

Table 4 Forecast cost of Option 1 ($'million, real 2021/22)

Program	FY25	FY26	FY27	FY28	FY29	Total
PDH and SDH replacement	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
DMR asset replacement			[redacted]		[redacted]	[redacted]

Substation LAN	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Testing and configuration facility		[redacted]				[redacted]
Critical Spares					[redacted]	[redacted]
Total	**0.88**	**1.29**	**0.85**	**0.90**	**0.98**	**4.90**

The key benefit of this program is that it will ensure that Power and Water remains compliant with its Network Licence. Additional benefits it will achieve in addressing the network need are:

- It will manage the risk and maintain existing levels of reliability and network safety enabling us to meet customer expectations for a safe and reliable network
- It will be efficient as it will only replace devices as vendor support expires and the spares management approach requires devices to be changed, or as major projects or new connections are undertaken.
- The rate of replacement can be ramped up easily to meet any new requirements that are created, such as through the Critical Infrastructure Bill.
- It will assist Power Services improve their ranking against the AESCSF.
- This option will enable us to remain in compliance with our obligations, including for safety, reliability and with the technical codes.
- This option aligns with our corporate and asset management objectives related to network safety, reliability and prudent and efficient management of network risk.

Our analysis found that whilst MPLS-IP (Option 1) has superior functionality compared with MPLS-TP (Option 2), there is no material difference in the capex and opex between the two technologies. The CBA demonstrated that these two options had a materially equivalent NPV and BCR so the selection was based on functionality.

Detailed analysis of the technologies in Appendix B. This covers both the need for fixed diversity of communications paths for some services such as protection, as well as the need for flexible and dynamic re-routing of communications paths for other services such as safety related voice communications.

MPLS-IP has evolved over time and is now the more common version of MPLS due to its flexibility to provide a wider range of services and features. It uses Internet Protocol (IP) and is fully implemented in a virtual environment. With a virtual implementation, this system is much more flexible than MPLS-TP and can re-route traffic in a dynamic manner, accounting for volume, route capacity and priority of different services.

This option is recommended.

3.1.2 Option 2 – Replace end of life assets with alternative MPLS-TP technology

This option proposes to continue the transition of the communications network from PDH and SDH to MPLS technology for the identified assets in Option 1 as vendor support is withdrawn for the obsolete assets. Instead of MPLS-IP technology, this option considered MPLS-TP.

Accordingly, this option has the same scope and shares many of the same benefits as Option 1. There are no forecast cost implications of the different technology selection for Option 2 versus Option 1, with the total estimated cost being the same.

Detailed analysis of the two technologies in Appendix B. This covers both the need for fixed diversity of communications paths for some services such as protection, as well as the need for flexible and dynamic re-routing of communications paths for other services such as safety related voice communications.

As discussed in Option 1, the MPLS-IP technology is preferred over Option 2. Accordingly, this option is not recommended.

3.2 Non-credible options

Our analysis also identified a number of options found to be non-credible. These options are described below and were not taken through to detail analysis for the reasons provided.

3.2.1 Retain SDH and PDH technologies – does not address the need and is not possible due to vendor transition to MPLS

Retaining SDH and PDH technology is not considered a credible option. Major vendors have notified Power and Water that they are transitioning to MPLS and no devices will be developed or produced based on SDH and PDH technology. Some smaller vendors have indicated they will continue production of SDH and PDH assets, but there is uncertainty for how long and the smaller vendors do not provide sufficient support. Further, these smaller vendors are not proven on DNSP networks and there are software and firmware compatibility issues between the devices and the existing management platforms, without the existing vendors being available to help integrate the new assets etc. The current management platforms are no longer supported and also present an increasing risk to cyber security.

Therefore, Power and Water do not consider this a technically viable option. Power and Water must continue to transition to a new technology to enable provision of a communications network, maintain compliance with the legislative requirements and to ensure safety and reliability of the electricity network.

3.2.2 Retire or de-rate assets to extend life – does not address the need

Total retirement of the assets is not a credible option as the communications network is required for safe and reliable operation of the electricity network. However, each option will assess where an asset type can be retired or the topology can be changed to ensure prudency and efficiency of the option.

3.2.3 Non-Network alternatives – does not address the need

Due to the type and function of the assets in the SCADA and Communications network, there are no non-network alternatives or solutions that can be implemented in place of direct asset replacement with like for like or modern equivalent assets.

3.2.4 Capex/Opex Substitution – does not address the need

Power and Water's communications network is primarily used for the provision of protection and network control services. The protection services are critical to ensure safety of the public and personnel and to minimise damage to assets. Protection systems require high reliability and availability of communications systems. Third party communications providers do not guarantee availability or reliability to the levels required for a protection system.

Due to the criticality of the protection and network control services, opex substitution is not available, leaving replacement capex as the only option to ensure the communications network remains functional.

4. Recommendation

The recommended option is Option 1 – Transition to MPLS-IP technology to efficiently manage the removal of the SDH and PDH technology from the network over time. Continuing with the existing mix of SDH and PDH technologies is no longer feasible as they are out of production and support by vendors and therefore pose an increasing and unacceptable risk to the network.

Option 1 has an estimated cost of $4.9 million (real 2021/22) for the 2024-29 regulatory period being the most prudent and cost effective option to meet the identified needs.

The proposed program is consistent with the National Electricity Rules Capital Expenditure Objectives as the expenditure is required to maintain the quality, reliability and security of supply of standard control services and maintain the safety of the distribution system.

In the guidance notes for the Regulatory Investment Test for Distribution, the AER recognises that under certain circumstances, particularly for compliance, the preferred option may have a negative NPV[6]. In these cases, the least negative option is preferred.

4.1 Strategic alignment

The "Power and Water Corporation Strategic Direction" is to meet the changing needs of the business and our customers. The proposed program is aligned with the market and future economic conditions of the Northern Territory projected out to 2030.

This proposal aligns with Asset Management System Policies, Strategies and Plans that contribute to the D2021/260606 "PWC Strategic Direction" as indicated in the table below.

Table 5 Summary of strategic direction focus areas

	Strategic direction focus area	Strategic direction priority
1	Always Safe	Improve Public Health and Safety
2	Sustainable solutions for the future	Enhance Customer Experience and Engagement
3	Customer and the community at the centre	Cost Prudency

4.2 Dependent projects

Due to the type of asset, some of the assets will be replaced as part of other major projects (such as during the replacement of Berrimah ZSS). These projects have been considered in the development of this business case to ensure replacements are not double counted. This is set out in the high-level scope of work in Appendix C.

The assets proposed to be replaced in this project are not included in the cyber security enhancement project, focussed on IT requirements to meet the SOCI Act.

[6] Regulatory Investment Test for Distribution, Application Guidelines, December 2018, Australian Energy Regulator, Section 3.3 Example 6

4.3 Deliverability

Power and Water has already gained some experience in deploying MPLS compatible products on the electricity network. This existing experience combined with additional familiarity with MPLS products that will be gained in the transition program during this regulatory period will mean that any issues in migrating to MPLS technology will be understood before the next regulatory period. Additionally, a range of Australian and international vendors already have extensive experience in implementing MPLS technology on Australian electricity and other telecommunications networks.

Power and Water consider that this program to be deliverable.

4.4 Customer considerations

As required by the AER's Better Resets Handbook, in developing this program Power Services has taken into consideration feedback from its customers.

Feedback received through customer consultation undertaken at the time of writing this RBC, has demonstrated strong support amongst the community for appropriate expenditure to enable long term maintenance of the network to ensure continued reliability, maintainability and safety of supply.

4.5 Expenditure profile

Power and Water has deployed some MPLS compatible assets on the network as PDH and SDH assets have become unavailable. So far there has not been any expenditure on a planned transition to MPLS technology other than what is deployed to meet the NT government solar connection commitments, and expenditure committed for during the current regulatory period.

Table 6**Error! Reference source not found.** below shows a summary of the expenditure requirements for the 2024-29 regulatory period for the proposed program, corresponding with Option 1.

Table 6 Annual capital and operational expenditure ($'000, real 2021/22)

Item	FY25	FY26	FY27	FY28	FY29	Total
Capex	880	1,290	850	900	977	4,897
Opex	-	-	-	-	-	-
Total	**880**	**1,290**	**850**	**900**	**977**	**4,897**

The total cost to transition from the obsolete assets to MPLS (including the expenditure requested for the 2024-29 regulatory period and assets replaced by major projects) is estimated to be $10 million (real 2021/22).

As this program of works is required for compliance, the benefits have not been quantified and hence the NPV is negative (the cost of the capital works).

The program is estimated to incur $4.0 million (real 2021/22) in the current regulatory period, being for the historical actual replacements of communications assets during 2019/20 to 2021/22 and the estimated transition to MPLS technology program in 2022/23 and 2023/24 (see Figure 4). The forecast level of expenditure of $4.9 million in the next regulatory period is comparable to the historical expenditure.

4.6 High-level scope

There are four key components to the scope of the transition to MPLS that will occur during different timeframes. This is provided in detail in Appendix C.

The planned schedule for replacement of PDH and SDH assets during the 2024-29 regulatory control period is summarised in Table 7 below. Due to increased functionality provided by the replacement MLPS devices compared to SDH and PDH, in some locations multiple SDH or PDH devices are replaced by a single MPLS device.

Table 7 Replacement schedule summary

Location	2025	2026	2027	2028	2029	Total
MPLS Transition	10	16	11	17	14	104

Appendix A. Cost estimation

The forecast expenditure for this program is based on analysis at a program and sub-program level. It takes into account the costs for replacement of obsolete PDH and SDH assets by migration to MPLS, with costs estimated for replacement of assets by minor projects at specific locations by year (see Table 10). It includes installing LANs in ZSS and replacing obsolete SCADA assets.

Capex has been forecast based on historical unit rates for 6 different types of MPLS assets (SAR-8, SAR-18, SAR-SM, SAS-T, CNMS-NG and NFMP).

Table 8 shows the unit costs applied for forecasting purposes. More recent experience is indicating that these unit costs are increasing as a result of impacts of COVID19 on supply chains and the current inflationary environment.

Table 8 indicative asset costs

Asset type	[redacted]
SAR-8	[redacted]
SAR-18	[redacted]
SAR-HM	[redacted]
SAS-T	[redacted]

Appendix B. Description of technology type

B.1 PDH and SDH multiplexors

The original protocol used was called Plesiochronous Digital Hierarchy (PDH). This combines signals from multiple devices based on the clock of each individual device which do not need to be synchronised. The speed of this system is typically limited to 140 Mbps per channel. PDH is not compatible with modern communications protocols.

The next development was Synchronous Digital Hierarchy (SDH). This protocol also combines signals from multiple devices, but they are all synchronised to a master reference clock that simplifies the system and makes it much quicker and more stable than PDH, with a maximum speed typically of 156 Mbps per channel.

The PDH and SDH Multiplexors provide a number of critical features that are advantageous for a utility operational telecommunications system, including:

- Provision of down to 64 Kbps tributaries;
- Multiple fibre optic interfaces at capacities of STM1, STM4 and STM16; and
- Protected SDH ring and terminal options.

The PDH and SDH network is used for:

- Tele-protection;
- SCADA
- UHF private mobile radio site interconnections
- Communications Network Management System
- Corporate IT connections
- Engineering Access Network

Both PDH and SDH are designed for application in a physical circuit switched network. This means they need point-to-point dedicated connections and a multiplexor at each end.

B.2 Multiprotocol Label Switching (MPLS)

The most recent development is Multiprotocol Label Switching (MPLS) which is designed to operate in a virtual environment and therefore provide more flexibility as the switching and throughput can be easily changed to meet changing requirements. Being a multiprotocol design mean MPLS can accommodate many other protocols, including PDH and SDH.

With the advent of MPLS, vendors have commenced phasing out PDH and SDH assets. Power Services has received a number of End of Support notices and must assess alternative options to ensure the communications system can be maintained. There are two type of MPLS available – MPLS-TP and MPLS – IP.

MPLS-TP was the original technology that superseded PDH and SDH hardwired switch networks. MPLS-TP applied similar design principles as the networks it was replacing and has limited flexibility.

MPLS-IP has evolved over time and is now the more common version of MPLS due to its flexibility to provide a wider range of services and features. It uses Internet Protocol (IP) and is fully implemented in a virtual environment. With a virtual implementation, this system is much more flexible than MPLS-TP and can re-route traffic in a dynamic manner, accounting for volume, route capacity and priority of different services.

For some services, such as protection, define and fixed routes are required to ensure diversification of routes for redundancy, such as X Y protection schemes and strict control of asymmetry. However, for other services such as voice communications, SCADA and Engineering Access, the ability to change routing to ensure continued service is more important.

The skills required for each technology and the cost of the components and implementation are similar. Some DNSPs that were early adopters of MPLS-TP, find they require both MPLD-TP and MPLS-IP to be run in parallel to provide the functionality for the different services.

Modern implementations of MPLS-IP provide both functionalities. The figures below provide a high-level view of the differences between the technologies.

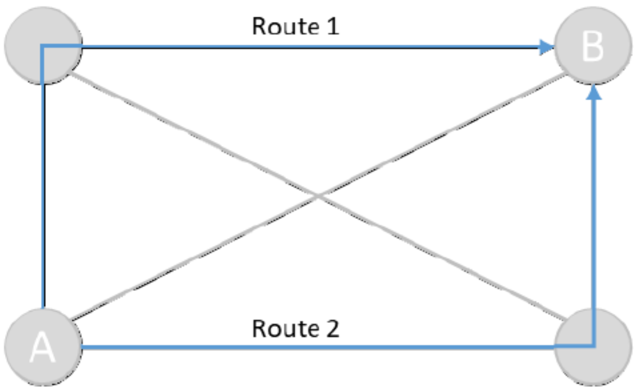

Figure 6 Normal state of the network

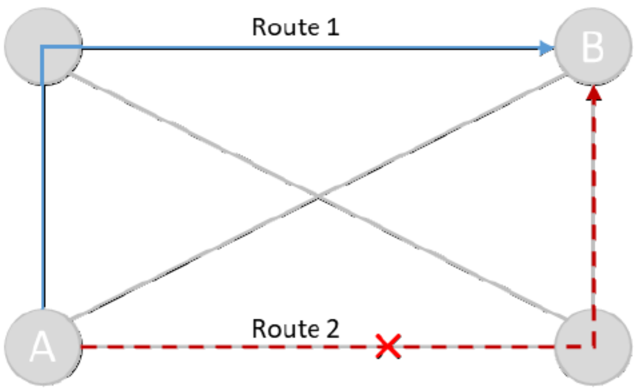

Figure 7 An outage on one of the routes

MPLS-TP requires predefined routing for each path needed from Point A to Point B. If there is an outage on that path, then capacity becomes limited and services are prioritised based on preconfigured Class of Service.

Therefore, for MPLS-TP, an outage on Route 2 means all relevant services must be transmitted via Route 1 and some services may have restricted capacity or no service for period of time to enable higher Class (higher priority) services.

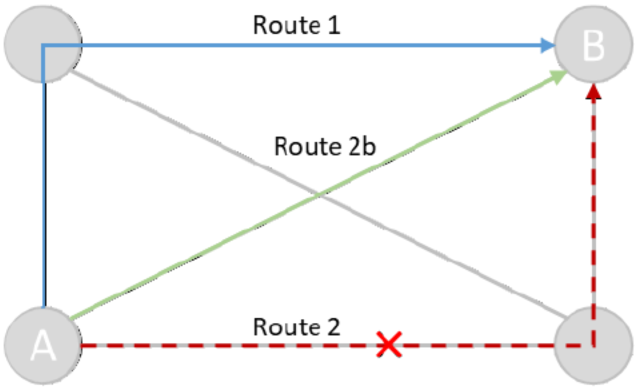

Figure 8 MPLS-IP can adapt to re-route traffic and maintain communications

MPLS-IP applies an IP (virtual) based system that enables traffic to be redirected through another path. This redirection is done dynamically to account for the capacity or other routes the Class of Services on those routes. This enables more traffic to be on the network as the allowance for spare capacity in case of an outage is optimised and reliability improved.

MPLS-IP can also be set up to mimic MPLS-TP for specific services such as protection, where there is already X-Y redundancy and the same route can't be used by both protection schemes. For example, the services on Route 2 can be dynamically sent via Route 2b.

Table 9 Comparison of MPLS-TP and MPLS-IP

Requirement	MPLS-TP	MPLS-IP
Flexible	Partly	Fully
Secure	Fully	Fully
Scalable	Partly	Fully
Training and competency	Minor	Moderate
Functionality required for OT (ICT)	Partly	Fully
Functionality required for Protection services	Fully	Fully
Technology availability	Yes	Yes
Technology longevity	Unsure	Yes
Meets Power Water requirements	**Partly**	**Fully**

Appendix C. High-level scope

There are four key components to the scope of the transition to MPLS that will occur during different timeframes.

C.1 Proposed replacement schedule

The PDH and SDH assets have been prioritised for replacement with MPLS-IP assets based on alignment with major projects, and where there are no known major projects, based on asset age as a proxy for reliability.

Where one site has multiple assets, they are all replaced at the same time based on the priority given to the oldest asset. This is required to ensure compatibility and simplicity of the replacement design and implementation.

The replacement schedule shown in Table 10 is based on addressing the oldest assets first, but also replacing all assets at that site at the same time. Due to the change in technology and functionality of the devices, the 143 SDH and PDH assets are expected to be replaced by 104 MPLS assets. However, the final number will be determined during the detailed design phase for each site.

Table 10 Replacement of assets by Minor Projects (this business case)

Location	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	Grand Total
HC	1											1
DRD	2											2
HCCC		17										17
Batchelor	3											3
CI			1									1
FH	1											1
Hughes	2											2
Karama			1									1
KAWT			1									1
Lake Bennett						2						2
McMinns			5									5
O'Shea			1									1
Pine				7								7

Robin			1									1
Weddell				9								9
CAWT						3						3
CIPS					11							11
CIRS						1						1
DWWTP						3						3
Francis						6						6
LMSB							2					2
NTGAS							2					2
BH						2						2
Casuarina							10					10
Marrara								2				2
Sadadeen								1				1
Manton								3				3
Mt Bundy								1				1
Parap								3				3
DRCC									11			11
KA									5			5
KAPS										2		2
Woolner										6		6
HCRS										1		1
Leanyer											6	6
Strangways											6	6
BHCW											2	2
Total	**9**	**17**	**10**	**16**	**11**	**17**	**14**	**10**	**16**	**9**	**14**	**143**

As new major projects or customer connections are identified, or operational issues identified at specific sites, the forecast for replacement will be revised. These replacements are not included in this business case and are provided for reference only.

Table 11 Replacement of assets by Major Projects

Location	2023	2024	2025	2026	2027	2028	2029	2030	Grand Total
Katherine					10				10
Palmerston							6		6
Berrimah		6							6
Lovegrove			8						8
Owen			11						11
Sadadeen								13	13
Archer				9					9
Darwin				6					6
Uterne			1						1
Total	**0**	**6**	**20**	**15**	**10**		**6**	**13**	**70**

C.2 Digital Radio asset replacements

There are 23 units planned for replacement that can be migrated to the MPLS platform bringing about cost savings in maintenance of devices/licencing, DC load on sites and also stream-lining the network architecture

Table 12 DMR replacement schedule summary

Location	Asset	Replacement	Quantity
Ali Curung	Legacy	MPLS	1
Casuarina	Legacy	MPLS	1
Brooks	Legacy	MPLS	1
Darwin River Dam	Legacy	MPLS	1

Fountain Head	Legacy	MPLS	1
Hughes	Legacy	MPLS	1
Jabiru	Legacy	MPLS	1
Katherine	Legacy	MPLS	1
Lake Bennet	Legacy	MPLS	1
Larrimah	Legacy	MPLS	1
Mount Bundy	Legacy	MPLS	1
Mc Minns	Legacy	MPLS	1
Mataranka	Legacy	MPLS	1
Oshea Hills	Legacy	MPLS	1
Pine Creek	Legacy	MPLS	1
Parap	Legacy	MPLS	1
Robin Falls	Legacy	MPLS	1
Tenant Creek	Legacy	MPLS	1
Venn	Legacy	MPLS	1
West Gap	Legacy	MPLS	1
Ben Hammond	Legacy	MPLS	2
Hudson Creek	Legacy	MPLS	1
	Total	**MPLS**	**23**

C.3 Zone substation LAN replacements

There are 10 sites planned for replacement of the LAN. The locations being target each year are shown in Table 13 Zone substation LAN schedule.

Table 13 Zone substation LAN schedule

Regulatory Year	Location 1	Location 2
FY25	Manton	Pine Creek
FY26	Katherine 132	Katherine 22
FY27	Lovegrove	Owen Springs
FY28	Sadadeen	Hudson Creek Control Centre
FY29	Chanel Island Power Station	Batchelor

C.4 Testing and configuration facility

A temporary test lab facility has been set up with two firewalls to accurately test the configurations, functions and traffic simulations prior to deployment. This prevents outages in the live network during commissioning and significantly reduce mistakes and time wasted in the field.

This facility needs to be expanded in a dedicated location and maintained to test and simulate MPLS and traffic engineering behaviours as the network size and the functionality increases. The assets required for this are:

- 2 x MPLS routers
- 2 x MPLS switches
- 2 x equipment racks
- Traffic and Cyber Security test equipment
- Additional storage capacity for test configurations and data
- Other miscellaneous materials such as cables, connectors, SFP and fasteners.

C.5 Critical spares acquisition

To ensure ongoing operations of the Communications network, it is prudent and common practice to hold spares for critical assets where the lead time for ordering replacements is too long, or spares become unavailable for purchase, to be able to ensure network reliability and security. As new asset types are installed on the network, Power Water assesses the need for critical spares.

This item is a small allocation for purchasing of spares that have a Last Time Buy notice issued so Power Services can purchase sufficient spares for a controlled and managed transition away from the asset type by the time they reach End of Support.

The budget for critical spares is $80,000 (real 2021/22).

Appendix D. Compliance requirements

Power and Water is required to maintain the communications network to ensure compliance with a number or legislative requirements. This is consistent with the principles of the Risk Quantification Procedure, and while there are legislated penalties for non-compliance, compliance has been considered in a qualitative manner.

The relevant Legislation, Regulation and Codes include:

- Electricity Reform Act 2000
- Network Licence (varied 15 May 2020)
- National Electricity (NT) Rules (NT NER)
- Network Technical Code and Network Planning Criteria (Network Technical Code)
- System Control Technical Code

The key clauses that relate to the provision of communications systems are:

- The System Control Technical Code Clause 6.18(a) requires System Participants (the definition includes Power and Water as the network operator) to provide control and monitoring, alarms and measurements to the Power System Controller's SCADA system via communication links.
- The Network Technical Code Clauses 3.2.6 and 3.3.6.2 define the communications links between a User (generator or load) and the control centre (System Control) to be the responsibility of the Network Operator (Power Services).
- The Network Licence Clause 10 requires Power and Water to comply with all applicable provisions of the System Control Technical Code and the Network Technical Code.
- The Electricity Reform Act 2000 Clause 31 provides a maximum penalty of 2,500 penalty units for contravening the licence conditions. A penalty unit is worth $157 in 2021/22[7], providing a maximum penalty of $392,500 per contravention.

There are clear legislative and government requirements for Power and Water to maintain a modern communications system and that the requirements are expected to become more stringent within the next few years with the introduction of the proposed Critical Infrastructure Bill. Decisions made on the technology and asset types installed now must provide real options8 for providing the cyber security capability and technology compatibility required in the near future.

Australian Energy Sector Cyber Security Framework (AESCSF).

Cyber security for operational technology deployed on energy sector networks has been under the spotlight in the recent years with the federal government bringing in legislative requirements to strengthen network security including product support systems, incident management and reporting based on prescribed frameworks.

Power and Water, like other network service providers, have adopted the Australian Energy Sector Cyber Security Framework (AESCSF). The framework guides businesses on how to assess and score their cyber security capability and identifies areas of strength and weakness to highlight where development is

[7] https://justice.nt.gov.au/attorney-general-and-justice/units-and-amounts/penalty-units

[8] Regulatory Investment Test for Distribution, Application Guidelines, December 2018, Australian Energy Regulator, Section 3.2.3

required. This framework has been developed through collaboration by industry and government stakeholders, including the Australian Energy Market Operator (AEMO), and is based on good industry practice and takes into account recent guidelines and determinations made by the AER and the Federal government.

There are two components to the framework:

- Maturity Indicator Levels (MILs) which assess the organisation to identify specific practices which should be undertaken and to confirm that specific bad practices are not present. There are three levels of MILs and to progress to the next MIL level, all preceding MILs much be achieved. As a Medium Energy Sector Participant, Power Services is recommended to achieve a MIL of 2.5.
- Security Profiles (SPs) identify if a specific set of MILs have been achieved. There are three levels of SPs that are based on the criticality of the organisation. As a Medium Energy Sector Participant, Power Services is recommended to achieve an SP of 2.0. An SP2 requires 200 MILs to be achieved across the three MIL levels.

An assessment was undertaken by EY in 2022 and found that the maturity level of the OT environment was lower than recommended, as shown in **Error! Reference source not found.**, demonstrating that development in cyber security is required.

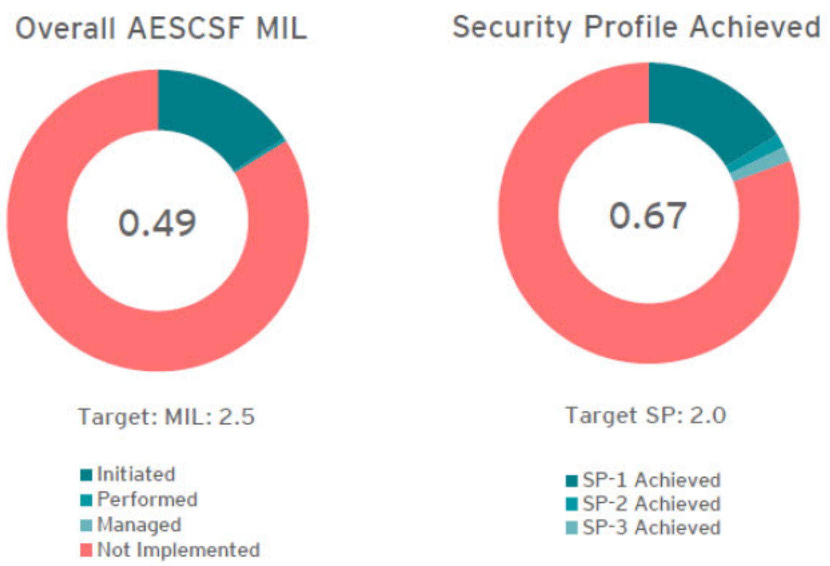

Figure 9 AESCSF assessment results[9]

[9] Power and Water Corporation, SCADA Cyber Security Review – Final, March 2022, EY

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