Network Operations

Operational Systems Strategy 2017 - 2025

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Tasmanian Networks Pty Ltd (ACN 167 357 299)

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Authorisation

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1. Introduction

1.1 Purpose

The purpose of the TasNetworks Network Operations – Operational Systems Strategy 2017-2025 (hereinafter called this Strategy) is to describe a robust framework to enable the effective utilisation of the NOCS platform to provide real-time operational support of TasNetworks' core business.

1.2 Scope

The scope includes the current capability and the systems to be delivered and supported by NOCS for the regulatory periods ending 2019 and 2024. These systems are required by Network Operations to manage the network within its technical envelope as well as wider TasNetworks to support the core business.

To achieve this there are four pillars that need to be integrated and aligned to take a strategic approach to real-time operational support systems. These pillars of people, processes, data and technology are necessary to support the provision of both transmission and distribution network services to TasNetworks' customers. Whilst the four pillars are required this strategy can only directly affect technology, with inputs to processes and data.

This strategy does not apply to SCADA systems located in remote substations as managed by TasNetworks' Secondary Asset Engineering Team.

1.3 Terms and Abbreviations

The table below lists the abbreviations and acronyms used throughout this standard.

Acronym	Description
ADMS	Advanced Distribution Management System
AEMO	Australian Energy Market Operator
AMI	Advanced Metering Infrastructure
AVS	Automatic Voltage Scheme
CAPEX	Capital Expenditure
DERMS	Distributed Energy Resource Management System
DMS	Distribution Management System
EMS	Energy Management System (Transmission)
GIS	Geographical Information System
HV	High Voltage
ICCP	Inter-control Centre Communication Protocol
LAN	Local Area Network
LV	Low Voltage
NOCS	Network Operation and Control System
OMS	Outage Management System

Acronym	Description
ORM	Outage and Restoration Management
PMU	Phasor Measurement Unit
RTU	Remote Terminal Unit
SAP	Systems, Applications and Products
SCADA	Supervisory Control and Data Acquisition
SOM	Switch Order Management
SPS	System Protection Scheme

1.4 Related Standards and Documentation

The following standards and documents are related.

Doc. Ref	Name
-	Enterprise Architecture, High-Level Strategy and Architecture Development Methodology, Version 0.5 Jan 2017

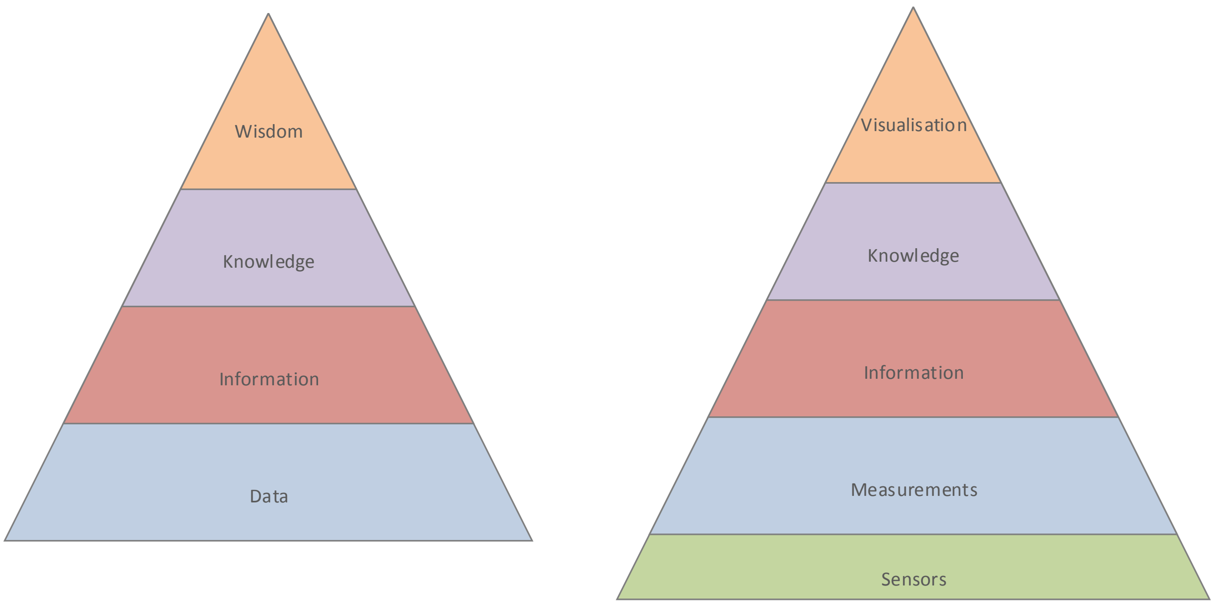
2. Current State

NOCS monitors the entire Tasmanian power system from Generation through transmission to distribution. There is a vast difference in capability between transmission and distribution, reflecting the heritage of the NOCS and the different requirements of the transmission and distribution networks.

The transmission coordinators have advanced network modelling and prediction functionality whereas the distribution operators have a functional SCADA platform with HV electronic schematics.

The traditional knowledge pyramid and a SCADA interpretation of this pyramid is shown in Figure 1. There is an additional layer to split data into sensors and measurements, to emphasise the need for deployed sensors to provide observation of the network.

Figure 1 Knowledge Pyramid



Traditional Knowledge Pyramid

SCADA Knowledge Pyramid

The current capability of NOCS is shown in Figure 2. The distribution functionality stops between the measurement and information layers, whereas transmission is functioning within the knowledge layer. A more detailed view of the components to be implemented within the various systems is shown in Figure 4.

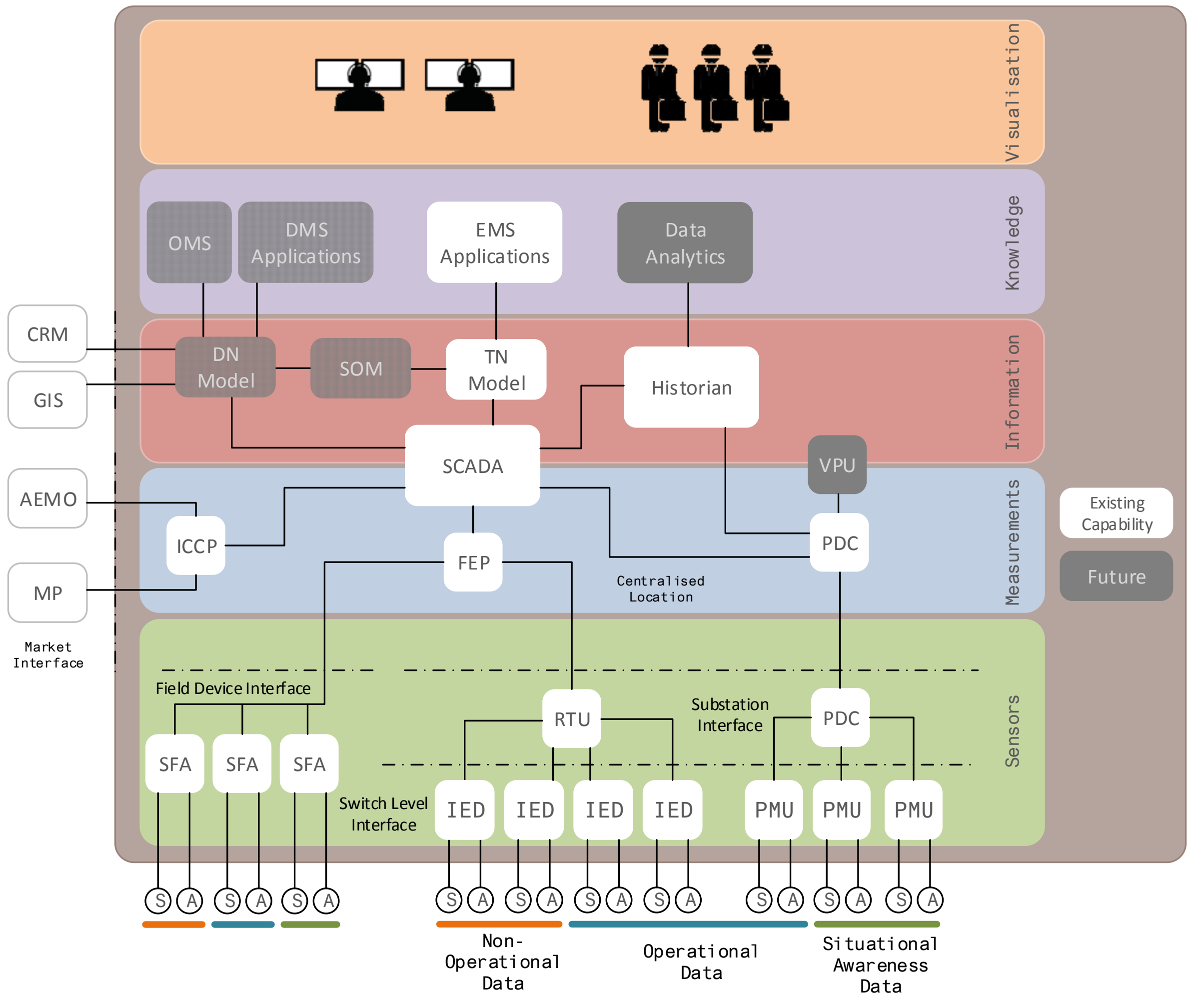
2.1 Architecture

The existing NOCS architecture is a traditional ICS design with a segmented SCADA network utilising a DMZ for historian and corporate visibility. The SCADA network utilises dual Ethernet LAN for servers and workstations, with a separate redundant LAN for serial and IP remote communications, including Basslink and additional System Protection Scheme (SPS) control. In addition, there is a DMZ for ICCP connection to other market participants, namely the Australian Energy Market Operator (AEMO) and Hydro Tasmania.

The hardware architecture for the current SCADA system, commissioned in 2003, utilised individual physical servers. Recent hardware upgrades have seen a move towards virtualisation for all but the production SCADA servers. Future upgrades will have the NOCS completely virtualised.

The NOCS environment consists of production, testing and development components, with future upgrades to enhance the testing suite to be more representative of the production environment.

Figure 2 Application Landscape



2.2 SCADA

After the 2014 merger, the Aurora Energy SCADA system was decommissioned and the substations and field devices it monitored were moved to NOCS, the Transend SCADA system. This validated that the NOCS SCADA system could be readily scaled to meet the needs of the distribution business whilst still providing the necessary functionality and performance for the transmission system.

2.3 Historian

Since the July 2014 merger of the Aurora Energy electric distribution business and the Transend Networks transmission system, TasNetworks has operated multiple historical data collectors. These include OpenHIS, OpenHRS, eDNA and Pi.

Currently all the time series data stores are aimed at the enterprise. The key differences in requirements for production versus enterprise historians relates to the length of time data is maintained. Retentions for historians in the production environment are typically 13 months or less. On the other hand, a retention period of 7 years or greater may be required for the enterprise historian. There can also be differences in the data refinement, some data such as non-operational data may not ever be used in the real-time production domain but is important for enterprise storage.

2.4 EMS

The current state of the Energy Management System (EMS) is mature and robust. TasNetworks has a transmission network model, to the feeder circuit breaker, with:

- Topology processor;
- Power flow;
- State estimation;
- Short circuit analysis;
- Contingency analyser; and
- Voltage stability analysis.

This allows TasNetworks to confidently manage the transmission network within its technical envelope.

In addition the solid SCADA platform has allowed for a number of Special Protection Schemes (SPS) and Automated Voltage Schemes (AVS) to be developed to help manage the special requirements of the Tasmanian power system.

2.5 DMS/ADMS

TasNetworks does not currently have a Distribution Management System (DMS). The current state contains parts of a DMS, however they are not complete or integrated. The points of interest for the current state are:

- Currently the operators have electronic schematics which they use to review connectivity and component characteristics. Temporary conditions are currently managed by placing manually created notes into the electronic schematic.
- There is no comprehensive distribution model. The network is heavily meshed in the urban environments however portions of the distribution network categorised as remote and low density rural, are primarily fed radially and are still highly unobservable.
- There is a HV connectivity model in the GIS, however the suitability of the data for use in a DMS is low, with key information including phasing and sub-station modelling currently missing.
- In addition to the shortfalls in the HV connectivity model, there is no LV connectivity model in the GIS.
- TasNetworks has an OMS, however it currently is not integrated with SCADA and GIS. There are projects underway, including SAP and ORM, which may provide limited integration.

3. Vision

TasNetworks is evolving in an industry that is in transformation. There is increased pressure to deliver:

- Cost effective and reliable energy; and
- Improved choice and outcomes for customers.

This creates a set of challenges through the convergence and integration of people, processes, data and technology. In recognition of this, TasNetworks has adopted a vision of being “trusted by our customers to deliver today and create a better tomorrow”.

This strategy will support TasNetworks to achieve the following outcomes:

- **Our Customers:** Improve customer outcomes by supporting the reliable delivery of energy, the optimisation of the network and improved customer choice, by:
    - Improving the visibility and modelling of the network to identify areas for improvement;
    - Providing automation to support the network; and
    - Continued compliance with regulatory requirements.
- **Our Business:** Manage operational systems to:
    - Leverage the convergence of technology to deliver operational systems efficiently, securely (manage cyber risk) and reliably;
    - Remove system duplication and provide one operational platform for the management of both transmission and distribution networks; and
    - Improve visibility and awareness of the NOCS throughout the business.

Leveraging a baseline with quality data and models will provide TasNetworks with the foundation for a much improved integrated technology environment.

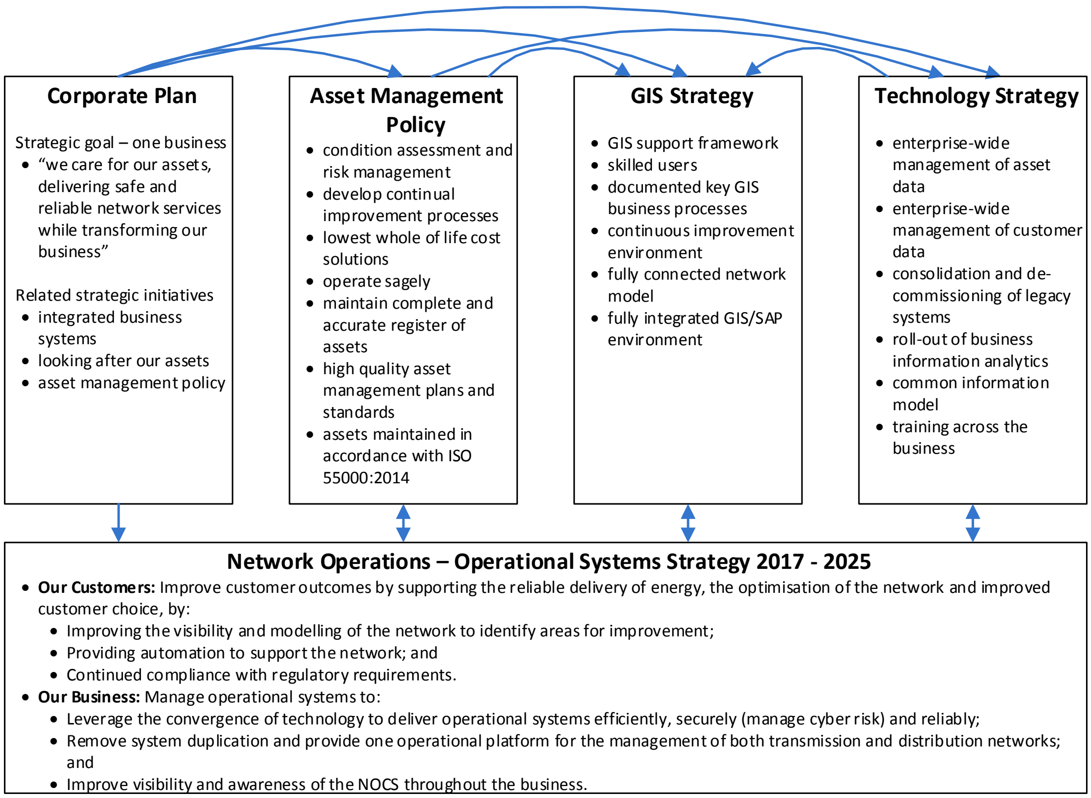
3.1 Drivers

NOCS is managed within an environment that is influenced by key TasNetworks’ strategies and plans as shown in Figure 3.

NOCS is an enabling technology with the following drivers:

- To provide a unified, reliable and fit for purpose operational platform to enable users to visualise, interpret, plan and interact with the power system and assist in ensuring the power system is operating within its technical envelope.
- To provide a platform that has the flexibility and capability to support the changing requirements of the power system, its customers and regulatory bodies over the next 10 years. Flexibility is key to support the rapid introduction of technology.
- To support the reduced cost of communications and data leading to the increase in the availability and quantity of telemetry data.
- To support the shifting workforce, which is changing and becoming more mobile, NOCS needs to be able support this paradigm shift.

Figure 3 Links to Corporate Strategic Objectives



3.1.1 Grid Operations Strategy Drivers

The existing capability and 2025 goals have been identified in the grid operations strategy as follows:

- Having a grid operation based on real-time data;
- Having operational data from grid modernisation deployments used to optimise processes across the company;
- Having an increased level of automated decision making within protection schemes;
- Having grid operations planning based more on fact, using grid data made available through modern grid capabilities;
- Enhanced grid information being available across systems and organisational functions;
- The grid being the enabler for new services and dynamic markets; and
- The grid successfully integrating renewables, new technologies and optimising two-way energy flows.

3.2 Principles

The principles by which NOCS delivers operational systems capability are wide and varied.

The primary principle in the support of the operational systems capability is to maintain and support the in-service systems which have had significant time and effort invested in implementing them. This maintenance work includes:

- Supporting CAPEX projects from other areas of the business including the "program of work";
- Managing risk, including cyber risk;
- Supporting system security by maintaining SPS, AVS and other control schemes; and
- Ensuring the performance of existing capability is not compromised by the introduction of additional capability.

With the introduction of additional capability, TasNetworks has an "Enterprise Architecture, High-Level Strategy and Architecture Development Methodology" which identifies a number of operating principles that are relevant to NOCS, including:

- Reduce unnecessary diversity and complexity;
- Optimise for organisational benefit;
- Enterprise assets being managed through the entire life cycle;
- Risk-based security;
- Data is an asset; and
- Use, Buy and Build.

This encourages using a single platform that supports vertical integration of capability within NOCS, where practical. This in turn leads to a single data source (source of truth) for relevant data.

A key principle is to provide a flexible platform that can meet the changing needs of the business, industry and customers. To achieve this build a solid foundation of data, information and models that allow for additional capability to be plugged in as required. This will allow for:

- A just in time investment approach; and
- Potential deferment of CAPEX by supporting intelligent schemes like NCSPS.

Where practical, telemetered data should be made available to NOCS before being used elsewhere in the business. This will allow for this data to be included in real-time models and analysis, before being available in raw form, or preferably with value add, to the rest of the business. As with all NOCS data this should be made available to the wider business where appropriate in a meaningful way.

The NOCS support principle is to have a competent trained in-house support team with optional external support for specific project work.

4. Initiatives

The transition to the future state needs to recognise the parallel journeys required of both the data required by the future state and the deployment of field based technology to support TasNetworks' future goals. Additionally, this includes supporting customer deployed technology and changing regulated technology, such as smart meters. Managing the different speeds at which these technologies transform will be a significant challenge, leading to different parts of the grid having varied capabilities and requirements.

Figure 4 shows the proposed future state of the NOCS. As functionality moves up the pyramid (Figure 1) the requirement for accurate network and asset data increases. To achieve the proposed future state a gradual rollout of the functional blocks is recommended, following the pace of the required data, field devices and network requirements. This approach ensures a cost effective implementation of only required modules, thus reducing licencing and ongoing maintenance costs.

The following sections identify the major initiatives as part of the operational systems strategy.

4.1 Infrastructure Architecture

The NOCS infrastructure is the core foundation component of NOCS capability. Future hardware upgrades will see the NOCS adopting:

- More virtualisation;
- Alignment with IT where practical; and
- Additional security in line with current best practice for ICS and SCADA systems.

This will allow the infrastructure to scale as required to meet future application demands.

4.2 Historian Consolidation

Exercising the single platform principle, NOCS needs to consolidate the enterprise historian to a single platform.

4.3 EMS

As discussed in Section 2.4, the EMS is robust and mature, and as such, the initiatives are only value adding in a few key areas.

4.3.1 System Security Enhancements

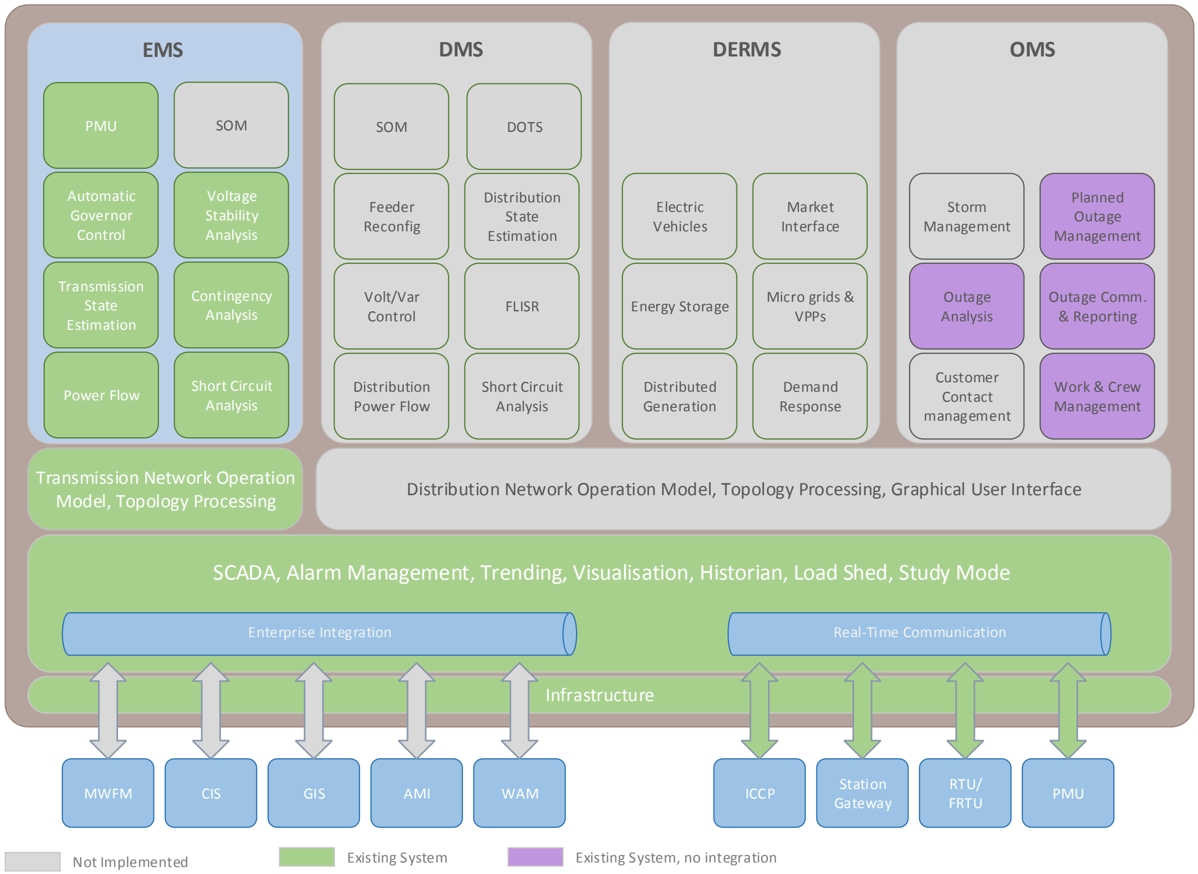
The state of the EMS has allowed for the development of SPS and AVS control schemes to assist in the management of the network. Looking to the future with additional renewable generation, additional reactive support and possible second interconnector, there may be additional control schemes required to support these changes.

4.3.2 Phasor Measurement Data

TasNetworks has developed a basic synchrophasor capability, initially to support the Musselroe windfarm. The benefits of this were such that all new windfarm projects will require a PMU at the connection point into the network.

Looking forward as TasNetworks drives the network harder the capability needs to mature to be capable of supporting faster acting control schemes, potentially replacing existing NOCS SCADA based control schemes.

Figure 4 Future EMS and ADMS Architecture



4.4 Switch Order Management

This involves the implementation of a Switch Order Management (SOM) system across both distribution and transmission. The implementation is reliant on a reasonable network model and as such SOM can be considered for transmission now, but distribution would have to wait until an adequate distribution network model is available.

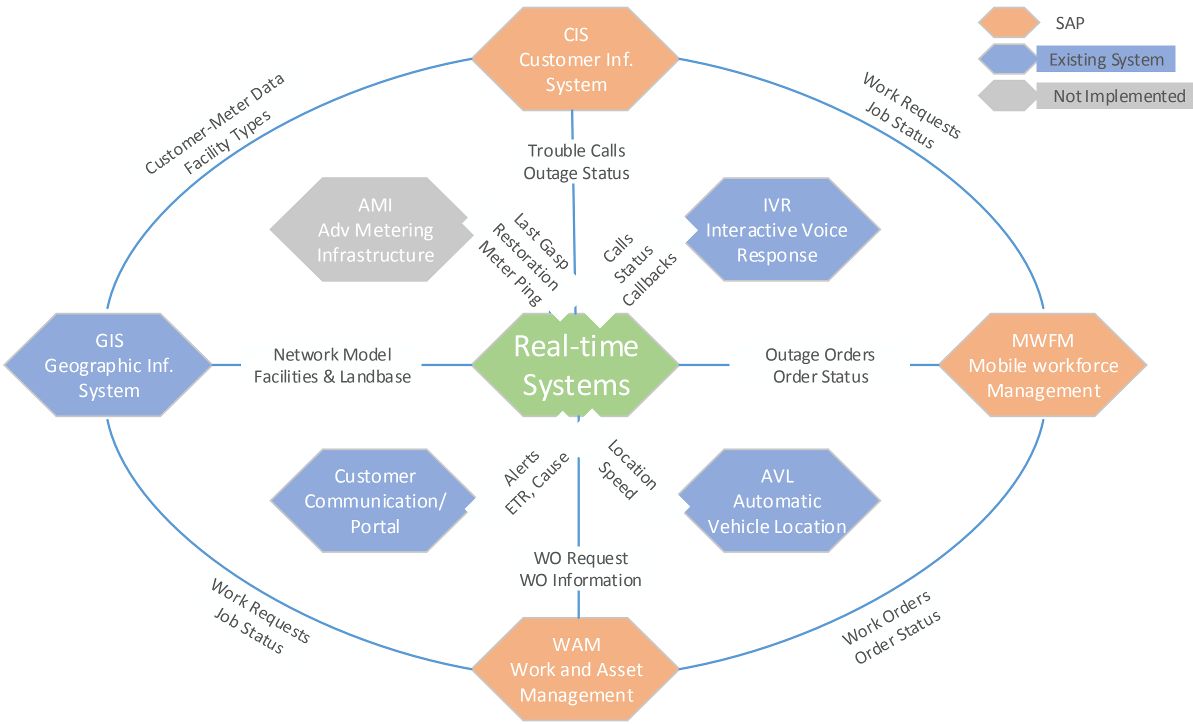
4.5 ADMS

An ADMS is a software platform that supports the full suite of distribution management and optimisation. It includes functions that automate outage restoration and optimise the performance of the distribution grid. ADMS functions available for electric utilities include fault location, isolation and restoration, Volt/Var ampere reactive optimisation, conservation through voltage reduction, peak demand management and support for microgrids and electric vehicles.

A fully functioning ADMS provides real-time information and situational awareness to locate exactly where a fault is and expedite deployment of a crew to fix the problem if required. This results in reduced outage times, more efficient use of resources, improved system reliability, improved asset life and reduced risk to public safety.

The enterprise-wide capabilities that ADMS can leverage are shown in Figure 5.

Figure 5 Future State Enterprise Integration



TasNetworks needs to determine the platform to be used for the ADMS. Whilst using the current vendors product achieves the majority of principles for new capability, a due diligence exercise should be followed to identify whether it is the best platform to use. Similarly if an OMS replacement is to be considered, a due diligence exercise should also be followed there.

The following sections detail the larger units of work for achieving an ADMS once a platform has been identified.

4.5.1 Distribution Model

The foundation component of an ADMS is a functional distribution model. As discussed in Section DMS/ADMS2.5, TasNetworks does not have a full HV connectivity model in the GIS and there is no LV connectivity model in the GIS.

Before any other work on a DMS or ADMS is considered, the data and processes to achieve a suitable connectivity model in NOCS from GIS needs to be completed. The data improvements required to the GIS distribution model include:

- Full HV connectivity model, including switching stations, etc; and
- Ideally a full LV connectivity model, however a significant step towards this may be more realistic.

With the provision of this data, the objective of a distribution network topology processor may be achieved. The changes to the processes to maintain the data required for the model can include:

- Managing commissioning work; and
- Recording phase connective information, including the moving of transformers between phases.

These dependencies are outside the scope of NOCS and hence will be listed in Section 5.

4.5.2 DMS

Once the distribution network model is available and reasonably robust, some of the features of a DMS can be considered for implementation as business needs arise. Some of the components of a DMS that may be useful include:

- Distribution State Estimator;
- Distribution Power Flow;
- Short Circuit Analysis; and
- Distribution Training Simulator.

4.5.3 DERMS

This involves the implementation of software to manage and dispatch distributed energy resources on the distribution network. There will be a requirement for this, with the timing and functionality required driven by external factors such as uptake of renewable energy and storage of energy.

4.5.4 OMS

This involves further developing the OMS, whether by advancing the existing ORM functionality or implementing a replacement OMS solution that is part of the ADMS suite.

5. Dependencies

The scope identified four pillars of people, processes, data and technology that need to be integrated and aligned to take a strategic approach to real-time operational support systems. Whilst Operational Systems has an input into these four pillars, it can only really affect change in the technology space. Other dependencies that operational systems has are outlined in the following sections.

5.1 People

For NOCS to have the capacity to maintain the existing capability and support the introduction of new functionality it needs to be able to attract, develop and retain appropriate personnel. Personnel will be required to have, to a reasonable depth, an understanding of multiple knowledge domains. Specifically this includes Power Systems, Control Systems, Protection, software development as well as IT infrastructure. Additionally, field staff will need to have the capacity to handle rapid change and manage a broad range of intelligent technology in the field.

5.2 Processes

The implementation of the capability in this strategy is reliant on a number of existing processes, including risk management (including security) and change management.

In addition to relying on existing business processes, the implementation of additional functionality will also impact existing processes. In particular, an ADMS implementation will require changes to primary processes involved in data collection, maintenance and management.

5.3 Data

As mentioned previously, the foundation of an ADMS is the distribution network model. TasNetworks currently maintains this in the GIS, however it is not 'fit for purpose' for a DMS implementation. Known gaps in the model include:

- Sub-stations are not correctly modelled;
- Phasing information is missing and/or incomplete; and
- There is no LV connectivity.

There will need to be a data discovery exercise to determine the data gaps, how to collect the additional data, changes to processes to ensure future data is captured, etc. This may also impact asset data.

A crucial component of the data is its quality. The quality of telemetered data is nominally reported with the measurement. With other data collection, for example phasing, connected kVA, there needs to be consideration of the accuracy of the recordings.

5.4 Technology

The infrastructure of NOCS is aiming for alignment with IT, noting that this alignment needs to be as a fast-follower at most. The security, reliability and performance of the operational systems may be higher than that required for corporate IT. Ideally technology should be proven in IT before being deployed for operational systems.

Where IT alignment of a particular technology is not suitable for operational systems, then operational systems will not align with corporate IT.