T MU AM 06008 GU

Guide

Operational Concept Definition

Version 1.0

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Standard governance

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Document history

Version	Summary of Changes
1.0	First issue.

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Preface

The Asset Standards Authority (ASA) is an independent unit within Transport for NSW (TfNSW) and is the network design and standards authority for defined NSW transport assets.

The ASA is responsible for developing engineering governance frameworks to support industry delivery in the assurance of design, safety, integrity, construction, and commissioning of transport assets for the whole asset life cycle. In order to achieve this, the ASA effectively discharges obligations as the authority for various technical, process, and planning matters across the asset life cycle.

The ASA collaborates with industry using stakeholder engagement activities to assist in achieving its mission. These activities help align the ASA to broader government expectations of making it clearer, simpler, and more attractive to do business within the NSW transport industry, allowing the supply chain to deliver safe, efficient, and competent transport services.

The ASA develops, maintains, controls, and publishes a suite of standards and other documentation for transport assets of TfNSW. Further, the ASA ensures that these standards are performance-based to create opportunities for innovation and improve access to a broader competitive supply chain.

This document provides supporting guidance to T MU AM 06008 ST *Operational Concept Definition* for the development of operations concept definitions for heavy rail transport projects, programs and portfolios.

This operational concept definition (OCD) development guide is placed within the context of systems engineering as an integrated methodology to support the TfNSW asset management framework. Requirements for systems engineering are defined in T MU AM 06006 ST *Systems Engineering Standard* and supported by T MU AM 06006 GU *Systems Engineering Guide*.

This OCD development guide forms part of the systems engineering document hierarchy in development by the ASA.

This document is a first issue.

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1. Introduction

Development of operational concepts, as articulated in an operations concept definition (OCD) is a key activity that is performed in the concept stage of the TfNSW system life cycle.

An OCD is required to understand the operations of the new or altered system, and therefore the cost involved to operate over the expected system life time until retirement.

The OCD is an interim informing document that forms the link between the desired service and the business case and requirements to meet that service. It also provides additional assurance that the system solution is more likely to meet those objectives.

The *Operation Concept Definition* development guide provides guidance for the development of OCDs on heavy rail transport projects ranging from simple to highly complex following a structured approach.

This guide may be updated as improved best practice emerges in the development of OCDs.

2. Purpose

The purpose of this *OCD* development guide is to provide guidance in complying with the requirements stated in T MU AM 06008 ST *Operations Concept Definition*.

The initial objective is to align this guide to rail planning projects, and then extend it to application across the wider transport cluster in other transport modes.

2.1. Scope

This guide refers directly to the mandatory operational concept requirements stated in T MU AM 06008 ST *Operational Concept Definition Development*, which are quoted in the relevant sections of this document.

This document is neither an OCD nor a mandated template for an OCD. It provides guidance to ensure all key operational aspects of a transport investment project are considered and defined to support the development of a robust business case and business requirements.

Definition of business requirements that may be derived from an OCD is described in T MU AM 06007 GU *Guide to Requirements Definition and Analysis*.

While this guide describes how to define the whole-of-life operational concept for new or altered systems, it does not describe how life cycle costs are derived. For information on deriving life cycle costs, refer to T MU AM 01001 ST *Life Cycle Costing*.

2.2. Application

This guide applies to organisations involved in the planning, investment and specification of transport assets, collaboratively developing an OCD, including the following:

- The transport services contract manager - owner of the Rail Services Contract with the operator and maintainer, demand analysis and service design
- The passenger transport service customer engagement entity - passenger service customer inputs and demand identification
- The transport network investment capability and capacity planning entity - sponsor and owner of the OCD and BRS, and developer of the business case and business requirements
- The freight transport service customer engagement entity - freight demand identification through freight customer inputs
- Transport capital program delivery entities - project development including BRS and SRS, and review and agreement on CapEx costs
- Transport operators and maintainers (O&M) - operating the new or altered system, and review of expected OpEx costs
- AEOs providing technical advisor support to TfNSW in preparing an OCD

Application of this guide is constrained to passenger and freight rail transport systems initially, with planned future extension of application to other TfNSW transport modes.

This guide should be applied at a scalable level for the following operational scenarios:

- transport (integrated) network level - including all transport modes
- transport mode level (with initial focus on heavy rail transport)
- transport corridor level - initially rail corridors, eventually ferry and bus routes
- local sites and multimodal sites, for example, interchanges, stations, yards, depots, control centres and junctions

This guide is applied in the 'concept' and 'specify' phases of the asset life cycle, before finalising the business case and request for full funding from the NSW Treasury. The concept and specify phases are identified in the TfNSW asset life cycle model in T MU AM 06006 ST *Systems Engineering*.

The elements described in this guide should be tailored and scaled to suit the particular needs of each transport investment project, program or portfolio. Not every element of this guide applies to every project, and the user should select only those elements that apply.

The physical solution may not be defined at the early stages of the system life cycle. An operational concept is developed around an assumed range of asset types, which may change as user needs are synthesised into a physical solution.

3. Reference documents

The following standards and documents are either directly referred to in this guide or may provide further information and guidance. For dated references, only the cited edition applies. For undated references, the latest edition of the referenced document applies.

International standards

ANSI/AIAA G-043A-2012e Guide to the Preparation of Operational Concept Documents

IEEE 1362: 1998 IEEE Guide for Information Technology – System Definition – Concept of Operations (ConOps) Document

ISO/IEC/IEEE 29148: 2011 Systems and software engineering – Life cycle processes – Requirements engineering

Australian standards

AS/ISO 15288 System Life Cycle Processes

AS/NZS ISO/IEC/IEEE 42010 Systems and Software engineering - Architecture description

Transport for NSW standards

T MU AM 01001 ST Life Cycle Costing

T MU AM 06006 ST Systems Engineering

T MU AM 06007 GU Guide to Requirements Definition and Analysis

T MU AM 06008 ST Operations Concept Definition

T MU HF 00001 GU AEO Guide to Human Factors Integration

TS 20001:2013 System Safety Standard for New or Altered Assets

Legislation

Rail Safety (Adoption of National Law) Act 2012

Protection of the Environment Operations Act 1997

Disability Discrimination Act (DDA) 1992

Other reference documents

INCOSE Systems Engineering Handbook

UIP1973-DTP-OMC-0001-A1, Iss1.2 Deep Tube Railway – Generic Operations and Maintenance Concept – 2020 (London Underground)

TfNSW Long Term Transport Master Plan (LTTMP)

Sydney's Rail Future Plan

4. Terms and definitions

The following terms and definitions apply in this document:

AEO Authorised Engineering Organisation

ARTC Australian Rail Track Corporation

ATCS advanced train control system

BRS business requirements specification

ConOps concept of operations

DITLO day in the life of

DTRS digital train radio system

ETCS European train control system

INCOSE International Council on Systems Engineering

LTTMP long term transport master plan

MCD maintenance concept definition

non-traffic hours is the time when passenger services are stopped for planned maintenance

O&M operator and maintainer

OCD operations concept definition

ONRSR Office of the National Rail Safety Regulator

RAM reliability, availability, maintainability

SE systems engineering

SEMP systems engineering management plan

SRF Sydney's rail future

SRS system requirements specification

TfNSW Transport for New South Wales

5. Operations concept definition

Section 5.1 through Section 5.7 provides background information on OCD development and offers guidance on complying with the requirements around roles, responsibilities, and resources for OCD development for TfNSW transport projects as stipulated in T MU AM 06008 ST *Operations Concept Definition.*

For purposes of clarity the transport network investment capability and capacity planning entity (hereafter referred to as the 'transport planner') was previously known as the Planning and Programs Division (PPD) when T MU AM 06008 ST was published.

5.1. Need for operations concept definition

OCD development is a key activity that is performed during the concept stage early in the TfNSW systems life cycle.

An OCD is required in order to understand the operations of new or altered system and therefore the cost involved to operate over the expected system lifetime until retirement.

The OCD is the means to translate the initial service demand or need into a credible set of operational and business requirements, based on which a robust system design is developed.

The OCD as an artefact of the systems engineering (SE) methodology is intended to provide cohesion between operations, timetable, human factors and assets.

The operational concepts articulated in the OCD should align with the maintenance concept definition (MCD), in order to assure that both operation and maintenance of the new or altered system is considered in an integrated way over its lifetime. The MCD may be merged with the OCD to form a single integrated document.

The OCD is a mandatory predecessor to a system concept design, business case (and the funding request), and the final business requirements specification (BRS).

A well-developed OCD saves time, money, and rework and improve customer satisfaction early in the system life cycle, and therefore makes good business sense.

5.2. OCD development responsibility

T MU AM 06008 ST states the following requirement:

> *"Planning and Programs Division (PPD) of TfNSW shall be responsible for producing the OCD and business requirements that support it"*

The transport planner is responsible for producing the OCD and retains accountability for the business case and the supporting business requirements.

However, there may be certain cases where the transport planner does not have the capability at the time to produce the OCD, in which case this responsibility should be agreed and delegated to the appropriate alternative entity within TfNSW who can produce the OCD.

For example, there may be situations where the O&M is considering making relatively minor changes. That is changes that are not of a significant capital value, to the way in which it will carry out rail operations or maintenance, in order to more effectively deliver against its contractual commitments.

However, the default responsibility lies with the transport planner for the purposes of compliance to the OCD standard multiple stakeholder engagement.

T MU AM 06008 ST states the following requirement:

> *"Authorised and relevant stakeholders shall be consulted during development of an OCD"*

Key stakeholders should be engaged in defining and agreeing the operations and maintenance of new or altered system over its lifetime due to the multi-stakeholder nature of a railway operational concept change.

Stakeholders involved in the development of OCD should be authorised and relevant to the proposed change. In order to avoid the problem of excessive stakeholders, each relevant organisation should authorise a representative for their interests in the development of the OCD, and that representative should engage in the development of the OCD during the concept and specify stages.

Lack of engagement at the appropriate time, followed by late objections to operational concepts during the later phases of the project can have adverse effects on time, cost, quality, risk and system acceptance.

Stakeholders involved should be relevant to the OCD under development. For example, it would be inappropriate to involve station operators in developing the operational concept for a stabling yard or fleet maintenance depot, and vice versa.

The following authorised stakeholders may be consulted in developing and agreeing an OCD, depending on the scope and type of the proposed new or altered system:

- The transport services contract manager
- The passenger transport service customer engagement entity
- The transport network investment capability and capacity planning entity
- The freight transport service customer engagement entity
- Transport capital program delivery entities
- Transport Operators and Maintainers (O&M)

- Asset Standards Authority (ASA), TfNSW
- Roads and Maritime Services (RMS), TfNSW
- TfNSW Security
- Other transport operators (including rail operators, multi-modal facility operators and network owners, such as ARTC)
- Local Councils

Authorised representatives of the key stakeholders (as applicable to the proposed new or altered system) should review and approve the OCD.

T MU AM 06008 ST states the following requirement:

> *"The OCD shall be reviewed and approved by the authorised and relevant stakeholders"*

These stakeholders and their authorised representatives should actively engage and consult in development of the operational concepts associated with the proposed new or altered system, in order to minimise risk associated with timely approval of the OCD.

5.3. Preparation of OCD

T MU AM 06008 ST states the following requirement:

> *"PPD shall refer to T MU AM 06008 GU Operations Concept Definition Development Guide for guidance in preparing the OCD"*

This guide is intended to elaborate on and provide guidance to comply with the OCD standard, but does not mandate the approach to be followed.

The following suggested (non-mandated) process may be followed for preparing an OCD:

- identify source documents that set out high level demand and transport goals, for example the Long Term Transport Master Plan (LTTMP), Freight and Ports Strategy, or Sydney's Rail Future, and supporting operational performance capabilities, including draft service timetable
- develop a plan, resources, and schedule for developing the OCD, identifying and engaging with key stakeholders, and reviewing and approving the OCD
- develop models of the service required to support the draft timetable, to be used as a basis for developing operational concepts
- develop the OCD via a consultative process led by a core group and supported by advisors who represent a range of disciplines and functional areas (operations, maintenance, engineering, business, asset management, customers, project development and delivery)

- core group review of this material and decide on an appropriate approach, including development of draft operational processes, assumptions, dependencies and constraints, life-cycle considerations and future proofing
- schedule and hold multiple specialist workshops involving specialists from the following areas:
  - operations and maintenance
  - major upgrade programs
  - transport strategy (the transport contract manager/the transport planner)
  - asset performance
  - safety, quality, environment and risk (SQER)
  - security
- prepare a draft OCD from the workshop outputs
- validate the draft OCD by a series of workshops involving specialists, where 'day in the life of' (DITLO) scenarios are used to validate proposed operational concepts
- conduct key stakeholders' final review and approve the final OCD as a basis for the business case and associated business requirements

5.4. Coordination with other OCDs

In the complex and interrelated world of rail transport, and within the wider multi-modal public and freight transport network, a project introducing new or altered systems should consider the operational concepts and needs of other projects and modes.

T MU AM 06008 ST states the following requirement:

> *"Development of individual project and program OCDs shall be coordinated with other OCDs that are in development or may already exist, to ensure that optimisation of one element of the rail network does not adversely affect other elements of the network."*

The team responsible for leading the development of the OCD should ensure that it is aware of, and that it makes other parties aware of changes to operational concepts that affect different parts of the wider transport network. If the team is not within the transport planner, it should consult with the transport planner to ensure that there are no inconsistencies between different parties working on OCDs.

Examples of changes to operational concepts affecting other projects or modes can include the following:

- changes to passenger service operations on a line, junction or interchange may have impacts on concurrent changes in freight services and associated operational concepts

- increased services arriving at a particular transport interchange, without consideration of the need for additional bus services, taxi ranks or private motor vehicle parking
- introduction of driverless trains on a line that previously had driver-based operations may impact on stabling yard operations, network management and line control operations
- freight-related operational changes, for example, introduction of digital train radio on freight trains, or freight corridor projects

The transport planner, in consultation with stakeholders across the transport cluster, should ensure that OCDs are in coordination.

T MU AM 06008 ST states the following requirement:

> *"OCD information for all rail projects and programs shall be coordinated and managed by PPD"*

The OCD should be developed in conjunction with the MCD, to ensure that they align. In some cases it may be practical to merge maintenance concepts with operations concepts into a single integrated OCD, as the two elements are often interdependent on one another.

5.5. Resources and tools for developing OCD

T MU AM 06008 ST states the following requirement:

> *"The OCD shall be prepared by authorised staff with appropriate competencies"*

Appropriate competencies required to support the OCD (and related MCD) development includes the following:

- transport strategy and planning
- portfolio development and management
- stakeholder engagement and communication
- transport economics
- transport statistical analysis
- transport service modelling (for example flow models, timetable modelling)
- transport operations analysis, design and development
- options analysis and cost benefit analysis
- asset management and systems engineering
- reliability and availability prediction and analysis
- maintenance analysis and planning
- requirements definition and analysis

- human factors integration
- integration of services into the network or freight operators with the current network and main line accessibility due to land acquisition and council developments

A single individual may not have all of the above competencies at a sufficient proficiency level, and therefore a core team may be formed with the required blend of competencies, and to engage with authorised stakeholders to develop a robust OCD.

T MU AM 06008 ST states the following requirement:

> *"Operational concepts and associated operational performance capabilities defined in the OCD shall be developed and verified using suitable transport performance modelling tools"*

Modelling and simulation is a virtual approximate representation of the real world that allows investigation and, in some cases, prediction of future outcomes. Usually a specialised computer based application is needed to facilitate the modelling and simulation.

Many tools are available to support the analysis and validation of a proposed change to service and associated operational concept. Following are some modelling and simulation tools used to develop and verify and validate operational concepts:

- RailSys: simulates rail operations using information about infrastructure, timetable, rolling stock and delays
- MTRAIN: models the train paths associated with the timetable
- FABEL: operational simulation of electrical traction systems
- TRAIL: model performance of train services (timetable) over a prescribed period of time addressing infrastructure and train reliability, maintenance and logistics strategy and operation strategy

5.6. Applicable standards and guides

The following standards and guides should be referred to in addition to this guide:

- T MU AM 06008 ST Operational Concept Definition
- ISO/IEC/IEEE 29148: 2011 Systems and software engineering - Life cycle processes - Requirements engineering
- IEEE1362: 1998 IEEE Guide for Information Technology - System Definition - Concept of Operations (ConOps) Document
- ANSI/AIAA G-043A-2012e Guide to the Preparation of Operational Concept Documents

5.7. Scheduling of OCD production

T MU AM 06008 ST states the following requirement:

> *"This standard shall be applied in the plan (concept and specify) phase of the system life cycle, prior to finalising the business case and the requesting of funding from NSW Treasury"*

The OCD should be prepared during the 'Plan' phase of the TfNSW asset lifecycle, following demand analysis, transport modelling, and analysis of different service and timetable options, in order to select and define the operational concept for the preferred option.

The concept stage (when the OCD is produced) of the Plan phase is identified in the TfNSW asset life cycle model in T MU AM 06006 ST *Systems Engineering*.

The OCD should be produced in conjunction with the MCD document, to ensure that the two documents align. The MCD may follow the OCD slightly due to the primary need to define the operations to support the service demand, and maintenance of assets (that is the MCD) in order to support the operational capability.

The OCD provides input to the development of the preferred concept design, business case (and funding request to NSW Treasury), and final business requirements specification.

An indicative process for developing the OCD and MCD is shown in Figure 1.

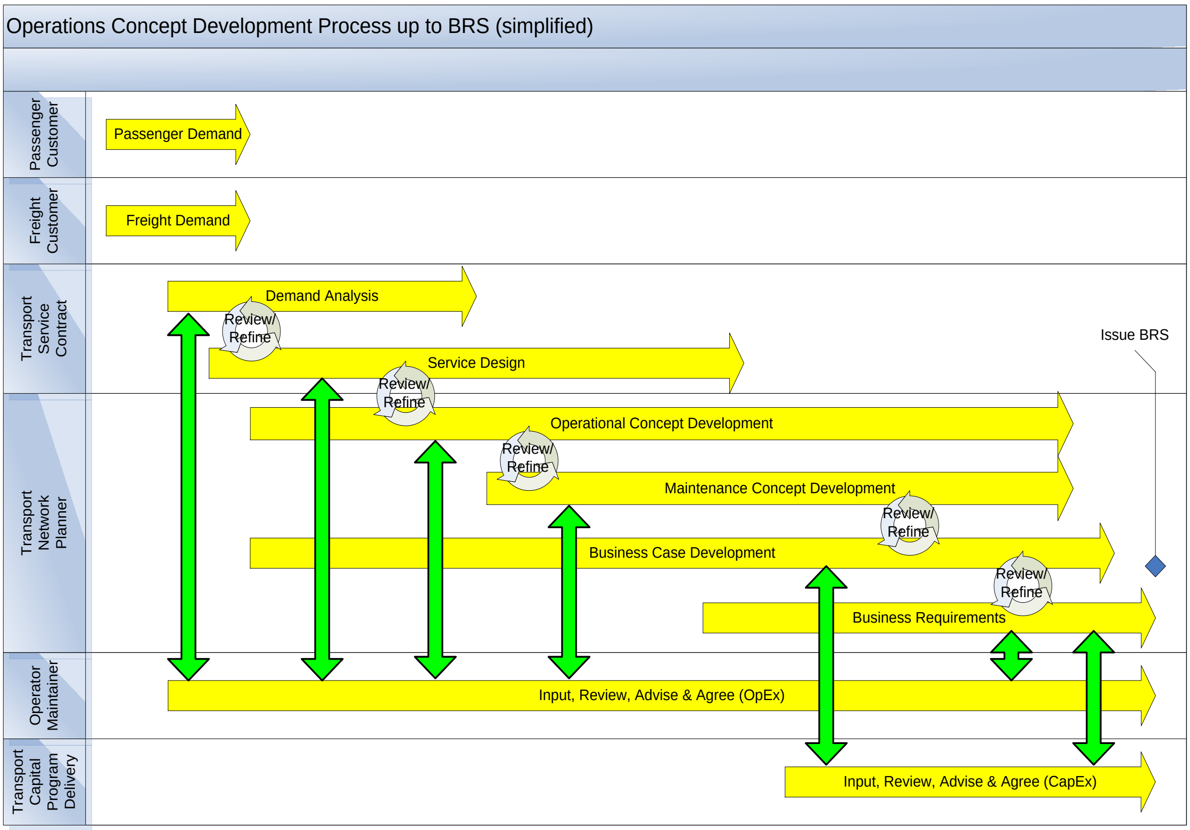

Figure 1 - OCD and MCD development process

6. Operational performance capability

T MU AM 06008 ST requires the OCD to identify operational performance capabilities and agreed performance measures. These capabilities should address transport enterprise objectives, future operational capabilities, and rationale for operational change.

6.1. Transport objectives

T MU AM 06008 ST states the following requirement:

> *"The OCD shall ensure that TfNSW enterprise level goals and objectives are identified and traced to the required operational capabilities, operational concept activities, organisation and assets"*

In order to develop an operational concept (and associated maintenance concept), TfNSW enterprise level goals and objectives should be identified, understood and traced to the required supporting operational capabilities, supporting concept activities, organisation and assets.

Transport objectives should be supported by a clear vision and strategy that clearly articulates the transport service of the future, in broad terms of achieving this service.

At the highest level, TfNSW Long Term Transport Master Plan (LTTMP) goals are identified to ensure that an integrated transport service is provided across all modes and geographic areas.

The LTTMP is supported and elaborated at the transport mode level in the following strategies:

- Sydney's Rail Future
- Sydney's Light Rail Future
- Sydney's Ferry Future
- Sydney's Bus Future
- Sydney's Cycling Future
- Sydney's Walking Future
- Freight and Ports Strategy

These objectives are achieved by identifying the future transport operational capability.

The systematic identification and synthesis of operational activities and functions to support the TfNSW objectives and capabilities, is supported by using an architectural framework and model that applies a consistent set of specification rules.

The architectural framework is based on the TRAK metamodel developed by the Rail Safety Standards Board (RSSB) in the UK. This was also used to develop the Deep Tube Railway - Generic Operations and Maintenance Concept - 2020 for London Underground.

The TRAK metamodel is shown in Appendix C of this guide. The key elements used in the definition of the OCD (and MCD) are as follows:

- organisation (TfNSW)
- enterprise (the business of planning, managing, procuring, assuring, testing and providing passenger and freight transport services in NSW)
- enterprise goal (the LTTMP and supporting 'Sydney's future' objectives restated below):
    - improve quality of service
    - improve liveability
    - support economic growth and productivity
    - support regional development
    - improve safety and security
    - reduce social disadvantage
    - improve sustainability
    - strengthen transport planning processes
    - Freight & Ports Strategy objectives
- capability (the capabilities needed to support the enterprise goals), such as follows:
    - service frequency capability of 20 trains per hour
    - average journey time capability on a line of 15 minutes
    - passenger transport interchange capacity of 1000 passengers per hour
    - stabling yard storage capability of 10 eight-car train sets
    - operational headway capability of 90 seconds
    - fleet capability in terms of size, availability and performance
- concept activity (operational processes needed to support the capabilities), such as follows:
    - managing the rail network and line operation
    - managing stations or interchange operations
    - stabling trains
    - maintaining and operating trains (on main line and in stabling yard)
    - managing (switching) electrical traction power
- metrics (performance measures for goals, capabilities and concept activities)

6.2. Future operational capability

Operational capability metrics associated with an operational concept are necessary in order to provide a basis for validating achievement of higher level enterprise goals.

T MU AM 06008 ST states the following requirement:

> *"Operational capability metrics shall be defined to support the operational concepts in the OCD"*

Metrics may include, but are not necessarily limited to the following operational capabilities:

- network-level capability metrics (for example, timetable capacity, degraded capacity)
- fleet capability metrics (for example, passenger capacity, maximum speed, comfort levels)
- station and transport interchange capability metrics (for example, total capacity, passenger flow rates)
- infrastructure capability metrics (for example, axle loading, gauging, traction power capacity)
- control and communications capability metrics (for example, trains per hour, signalling headway)
- stabling yard capability metrics (for example, number of trains, train type, length)
- fleet maintenance depot capability metrics (for example, number of trains at a time)
- environmental, congestion, noise and emission metrics

The OCD should support the introduction and use of new, novel systems and technologies.

Examples of new technologies associated with new operational concepts include Barangaroo Hub (semi floating pontoons), Light Rail (wireless traction), NWRL (driverless trains), Digital Train Radio System (DTRS) and Advanced Train Control System (ATCS).

6.2.1. System-level capability

When defining an OCD, a top-down analysis of system-level performance capabilities should be done, to ensure that long term strategic transportation objectives are achieved.

Rail system capability metrics include, but may not be limited to, the following:

- morning peak train plan (origin, destination, via interchange or junction)
- afternoon peak train plan (origin, destination, via interchange or junction)
- off peak train plan (origin, destination, via interchange or junction)
- journey time capability (minutes)
- network, line, and junction capacity (trains per hour)

- round-trip time (per line or corridor, in minutes)
- maximum service recovery time (minutes)
- station/terminal platform dwell time (minutes)
- on-time running (%)
- service availability (%)
- maximum permissible deviation from timetable (minutes)
- passenger access to, and between, transport modes
- passenger flow rates (end-to-end)
- ambience (comfort level, travel environment, aesthetics)
- passenger information (timeliness, accuracy, clarity)
- ton-kilometres (freight capability)

6.2.2. Fleet capability

The primary consideration for passenger and freight rail transport begins with the rolling stock fleet capability, as this is the means for transporting passengers and freight across the network.

The rolling stock fleet capability metrics include, but may not be limited to the following:

- fleet size (in service) - number of trains and consist configuration (4/8/12 car)
- fleet size (in reserve) - number of operationally-ready trains held available in reserve
- fleet size (in repair) - maximum permissible number of unserviceable trains
- train type (for example, rapid transit, light rail, commuter, outer suburban, intercity, freight)
- train length - number of cars or wagons per train, and total length vs. platform lengths
- train capacity or loading:
    - seated capacity (people / m^2, total seated passengers)
    - standing capacity (people / m^2, total standing passengers)
    - *Disability Discrimination Act 1992* (DDA) capacity requirements (for example, people per m^2 and total number of wheelchair passengers)
    - seating, standing, DDA configuration arrangement
    - load factor (%)
    - weight - loaded or empty (tons)
    - axle loading (tons)

- load type (freight)

- train dynamic performance (freight or passenger trains)
  - acceleration (m/s^2 or g)
  - full service braking rate (m/s^2 or g)
  - emergency braking rate (m/s^2 or g)
  - maximum safe speed (m/s)
  - traction power/effort (starting/maximum/continuous - MW, kN)
  - maximum permissible grade (%)
  - longitudinal jerk rate (m/s^2 or g)
  - lateral acceleration (m/s^2 or g)
  - vertical acceleration (m/s^2 or g)
  - collision impact withstand (m/s^2 or g)
- train ambience
  - climatic (temperature, humidity, dust level)
  - lighting levels - luminance (lux), luminous intensity (candela)
  - colour scheme - external and internal car body, seats, livery
  - seating comfort and pitch
  - ablution facilities (outer suburban and intercity trains)
  - catering facilities (intercity trains only)
- interoperability
  - axle gauge (standard gauge, narrow gauge, broad gauge, or variable gauge)
  - wheel profile (heavy rail, light rail, passenger, freight)
  - kinematic envelope (including station platform compatibility, tilting trains)
  - traction power (1500 V dc, 25 kV ac, diesel-electric)
  - train control and signalling - automatic train protection (ATP), European train control system (ETCS), communications-based train control (CBTC), train stops
  - train communications (new digital and legacy analogue, call handling, routing)

6.2.3. Station and interchange capability

As the primary means of accessing public rail transport, the station or multi-mode transport interchange is an essential element in defining the operational capability of the rail and wider multi-mode transport system.

Typical station and interchange capability metrics include, but may not be limited to the following:

- connectivity to other lines or transport modes
- passenger flow (mode to mode, concourse to platform, platform to platform, platform to train)
- concourse capacity
- number of platforms
- platform capacity (standing, seated, walking, DDA requirements)
- platform length

6.2.4. Infrastructure capability

When developing a new or altered service, and associated new or altered systems to support that service, the infrastructure capability before and after the change should be defined and understood.

Typical infrastructure capability metrics include, but may not be limited to the following:

- maximum permissible line speeds, including differential line speeds for different services
- interoperability (for example, traction power systems)
- clearances and envelopes (for example, structure gauge, electrical and EMI clearances)
- energy supply (for example, 1500 V dc, 25 kV ac, 750 V dc, other)
- weight and load limits (for example, viaduct and bridge loads, track axle load)

6.2.5. Control and communications capability

Typical control and communications capability metrics may include, but are not limited to the following:

- signalling capability
    - signalling headways
    - available signalled routes

    - signalling availability
    - safety

- signalling system interoperability, including ATP and automatic train operation (ATO), with different rolling stock
- telecommunications capability
    - number of subscribers per node
    - types of services, such as video, data, voice, operational, and retail
    - number of channels
    - telecommunications service availability
    - telecommunications security
- telecommunications system interoperability, including new and legacy systems, call handling, and routing

6.2.6. Stabling yard capability

When determining fleet size to meet a particular operational capability, how and where to stable the fleet during non-traffic hours should be considered.

Typical stabling yard capability metrics include, but may not be limited to the following:

- rate of acceptance - the capacity to receive maximum number of trains per hour into the stabling yard
- rate of despatch - the capacity to despatch maximum number of trains per hour from the stabling yard
- number of trains - total stabling capacity (for 4 car, 8 car, and 12 car trains)
- number of stabling roads
- stabling road length - relates to length and number of trains

6.2.7. Maintenance depot capability

While maintenance depot capability should be considered in detail in the MCD, the operations associated with withdrawing rolling stock, infrastructure and systems from operational use in order to repair and maintain them may be included in the OCD.

Typical maintenance depot capability metrics include, but are not limited to the following:

- rolling stock fleet maintenance depot capability
    - number of trains that can be serviced simultaneously

  - maintenance turnaround times for different activities
  - frequency of utilisation
- infrastructure maintenance depot capability
  - track and civil - service types, levels, staff numbers, response times
  - electrical - service types, levels, staff numbers, response times
  - signals and control - service types, levels, staff numbers, response times
  - telecommunications - service types, levels, staff numbers, response times

6.2.8. Freight terminal capability

Where a freight service should be supported within the TfNSW rail network, the operational concept may need to consider the capability of the freight terminal.

Freight terminal operational capability metrics may include, but are not limited to the following:

- type (bulk, containerised) and commodity (for example, coal, mineral, general freight)
- loading/unloading rates of trains
- number and length of sidings
- terminal equipment
- storage capacity of the site
- annual throughput (for containerised facilities)
- auxiliary services such as warehousing, refrigerated storage, maintenance and fuelling facilities, fumigation, quarantine areas
- train paths (number of trains)

6.2.9. Security operations capability

Security operational capability metrics include, but may not be limited to the following:

- surveillance coverage (for example, number of cameras per station or yard)
- security staffing levels at key points
- incident response times (for example, worst case response to vandalism or trespass)

6.3. Rationale for operational change

Changes in rail transport operational capability should be based on sound business decisions in order to ensure that NSW taxpayer's money is responsibly allocated to new or altered systems that provide real benefit to the people of NSW.

T MU AM 06008 ST states the following requirement:

> *"The OCD shall justify the rationale and expected performance capability benefits of a proposed operational change to the transport network"*

The OCD provides justification for any change in operational capability and should identify clear, measurable expected benefits to support the business case for the change. These benefits should be defined in terms of capital expenditure (CapEx) and operational expenditure (OpEx).

6.3.1. Recording of assumptions

T MU AM 06008 ST states the following requirement:

> *"The assumptions that underpin the rationale and expected performance capabilities shall be identified"*

Since the OCD is developed very early in the system life cycle during the concept and specify phases, unknown factors may only be clarified later, when a particular system solution has been selected.

All assumptions should be recorded and continued to be tested as the solution becomes apparent later in the 'procurement' and 'design' phases of the life cycle.

For example, the OCD may assume that the operational change will be based on continued use of the 1500 V dc traction power supply option, but later option development during the reference design and system requirements development may determine that longer term operational life cycle cost savings can only be achieved by changing to 25 kV ac traction power.

7. Operational constraints

Operational constraints are any limitations of a physical, geographic, policy, industrial relations or security nature, that place limits on the range of options to be considered when developing an operational concept.

T MU AM 06008 ST states the following requirement:

> *"The OCD shall describe any constraints applicable to a proposed operational change"*

Operational constraints may include, but are not necessarily limited to the following:

- service operating hours, such as 24/7 operation, night time shutdown, weekday, weekend, and holiday hours
- operating staff constraints, for example, staff numbers, capabilities, and competencies
- operating staff facilities, such as mess facilities, ablutions, rest areas, and proximity to services

- easy access constraints, for example, mobility constraints and constraints due to hearing and vision impairment
- transport interchange access constraints, such as pedestrian, cycle, car, bus, taxi, light rail, ferry
- industrial relations, such as industry collective bargaining agreements
- safety constraints, for example, *Rail Safety (Adoption of National Law) Act 2012* and the Office of the National Rail Safety Regulator (ONRSR) requirements
- technology, system design and asset performance constraints
- security issues, for example, issues related to being on or near high crime areas, vandalism, and trespass
- geographic limits, for example, locations on or near hills, mountains, waterways, cuttings, embankments, and tunnels
- flood and drainage constraints, for example, constraints as a result of being on or near low lying flood plains, marshes, catchments, and run-offs
- environmental constraints, for example, constraints due to being on or near protected flora and fauna sites, noise and other emissions
- heritage constraints, for example, constraints due to being on or near historical and Aboriginal sites

There may be additional operational constraints unique to a specific project.

8. Operational service levels

T MU AM 06008 ST states the following requirement:

> *"The OCD shall adopt a layered approach to transport operational service levels for planning and decision-making"*

This may be achieved by categorising operational services into the following levels:

- Level 1 - strategic
- Level 2 - tactical
- Level 3 - operational

8.1. Level 1 - Strategic

This level is policy-based and applicable to high complexity systems, with a transport network or mode-wide scope, and network or mode-wide implications.

It deals with long-term change, and is non-routine.

At this level, the pattern of service is determined for the working timetable in effect.

Examples of strategic level operational concepts are decisions to introduce a rapid transit metro service, or driverless trains, or change the traction electrification to 25 kV ac across the network.

8.2. Level 2 - Tactical

This level is plan, process and procedure-based, dealing with how to achieve policy and strategy, and focuses on medium complexity systems.

It deals with medium-term operational arrangements for achieving service and timetables, routing and regulation.

At this level, parameters are set for service regulation and intervention decisions.

Examples of tactical operational concepts may be an existing corridor or junction performance upgrade, additional traction substations to provide additional capacity, or signalling upgrades.

8.3. Level 3 - Operational

This level deals with routine operations and decisions in each operational area of the transport mode, including degraded and emergency operations, short-term changes, and is routine.

At this level, day-to-day decisions are made on routing and regulating train services under abnormal conditions, excluding incident management. Decisions on what regulation and intervention is required are based on parameters set at level 2.

This level involves activities from operating trains and granting movement authorities, including routing, through to implementing decisions made at level 2 on regulation and intervention.

9. Operational assets and facilities

All rail transport operations require some form of physical assets or support facilities. The assets and facilities required to support the operational concept and its associated services should be described.

T MU AM 06008 ST states the following requirement:

> *"The OCD shall describe operational assets and facilities affected by the proposed operational change"*

Operational assets and facilities may include, but are not necessarily limited to the following:

- fleet stabling facilities, for example, rolling stock stabling yards
- fleet assets, for example, passenger and freight rolling stock and maintenance vehicles
- maintenance depot facilities, for example, fleet, civil, track, electrical, signals, telecommunications

- civil infrastructure assets, for example, track, bridges, viaducts, drainage, structures
- station and transport interchange assets
- control and communications assets, for example, signalling and optical fibre network
- electrification assets, for example, feeders, substations and overhead wiring (OHW)
- freight terminal facilities, for example, freight marshalling yards, loading and off-loading facilities
- security control and monitoring facilities

9.1. Existing asset and facility description

The OCD should describe existing operational assets and facilities, including but not necessarily limited to the following:

- rolling stock fleet
- stations and interchanges
- control and communications, such as signals, communications and control systems
- traction electrification facilities
- fleet stabling facilities, for example, stabling yards, sidings, terminal platforms
- maintenance facilities, such as fleet, infrastructure, and control and communications

Where the change involves introduction of a completely new facility, the detail should be provided in the future asset and facility description.

9.1.1. Rolling stock fleet

The OCD should describe the rolling stock fleet, in terms of form, fit and function.

Rolling stock fleet description includes, but may not be limited to the following:

- traction type, such as electrical direct current, alternating current, or diesel
- load type, such as passenger, freight, or bulk mineral
- train and vehicle type, such as heavy rail commuter, light rail commuter, high speed intercity, and freight
- train consist configuration, such as mixed electric multiple unit (EMU) and diesel multiple unit (DMU) trailer cars, and locomotive hauled types
- driver training simulator facilities
- train maintenance, test and diagnostic facilities (this may be in the MCD)
- incident recording, storage and playback systems

9.1.2. Stations and interchanges

The OCD should describe station assets and facilities to support services.

Station and interchange asset description includes, but are not limited to the following:

- station staff accommodation facilities
- station control facilities
- vertical transportation systems, for example, stairs, ramps, lifts, and escalators
- passenger information and public address services
- Wi-Fi, mobile phone and other wireless communication services
- heating, ventilation and air conditioning services
- lighting, signage and way finding facilities
- easy access and DDA facilities
- passenger help points and other emergency facilities
- CCTV surveillance systems, including platform gap and security

9.1.3. Control and communications

The OCD should describe control and communications facilities to support the service.

Control and communications asset description includes, but may not be limited to the following:

- signalling control, interlocking and trackside protection systems
- fixed communications systems, including type, functions, performance systems
- mobile communications systems, including type, functions, performance systems
- passenger information displays and public address systems
- closed circuit television (CCTV) systems for passenger safety and security
- backup control and communication facilities and systems
- voice and incident recording and playback systems
- data archiving and warehousing systems
- web-based information facilities
- general ICT systems for operational and non-operational use
- changes to fleet on-board communications and control assets

9.1.4. Traction electrification

The OCD should describe traction electrification facilities to support the service.

Traction electrification asset descriptions include, but are not limited to the following:

- traction control systems, such as supervisory control and data acquisition (SCADA) system
- high voltage (HV) bulk supply, metering, feeder and switching facilities
- traction substations and sectioning huts
- traction protection facilities, such as high voltage and direct current traction facilities
- OHW arrangements, including types and configuration
- electrical switching staff accommodation
- full back up and local traction power control facilities and systems
- changes to fleet on-board traction power systems

9.1.5. Fleet stabling facilities

The OCD should describe the following fleet stabling facilities:

- staff accommodation facilities, such as yard and train crew, mess, ablutions, and rest areas
- train washing, cleaning, vacuuming, litter and graffiti-removal facilities
- yard lighting arrangements, including perimeter, stabling roads, and walkways arrangements
- yard security arrangements, including manned, unmanned, remote, access, and incident response arrangements
- yard drainage and water treatment arrangements
- provisioning facilities
- interfaces with main line access
- land acquisitions
- ferry mooring facilities (when out of service)
- light rail stabling facilities
- bus stabling depots

9.1.6. Maintenance facilities

The OCD should describe maintenance facilities to support the following services:

- fleet maintenance facilities, including but not necessarily limited to the following:
  - depot shore supplies
  - inspection pits
  - lifting jacks
  - test and diagnostics equipment
  - wheel lathes
  - depot signalling and communications
- infrastructure and systems maintenance depots, such as the following:
  - civil structures and track
  - electrical and OHW
  - signals and telecommunications
- maintenance staff accommodation, including ablutions, mess and rest facilities
- material and spares storage facilities
- provisioning and refuelling facilities

9.1.7. Freight terminal facilities

The OCD should briefly describe freight terminal facilities, including but not limited to the following:

- freight terminal access by rail and other transport modes, such as other rail, road or ship
- freight sorting facilities
- freight terminal control facilities
- stacker and reclaimer equipment, and bulk commodity storage facilities
- container stacking facilities
- wagon tippler facilities
- loading and unloading facilities
- rail sidings

9.1.8. Security control and monitoring facilities

The OCD should briefly describe security facilities, including the following:

- security operations centres
- security depots
- surveillance systems
- local security control points

9.2. Future asset and facility description

The OCD should briefly describe the new or altered operational assets and facilities. However, at the concept phase of the system life cycle, the nature of future assets may not be fully defined. This may be reviewed as the system progresses to the ’procure‘ and ’design‘ phases.

Depending on the nature of the operational change, the following future assets should be described:

- rolling stock fleet, for example, new driverless automatic train operation (ATO) and dual-voltage trains
- stations and interchanges, for example, from manned to unmanned, automated stations
- control and communications
  - signalling changes, for example, from mechanical train stops to European train control system - Level 1 (ETCS-L1)
  - telecommunications changes, for example, from Metronet train radio to digital train radio system (DTRS)
  - control system changes, for example, from push-button panel to advanced train running and information control systems (ATRICS)
- infrastructure
  - track changes, for example, from ballasted to slab track
  - civil and structures changes, for example, from 2 lane to 4 lane overbridge widening
  - OHW changes, for example, from single to double contact wire
  - traction power changes, for example, from 1500 V dc to 25 kV ac
- service and utility interfaces

10. Operational process scenarios

The identification of operational process scenarios is the core of the OCD, and these are often written in a style that brings together operational assets, operational roles, operational service levels, and operational modes in the process description.

T MU AM 06008 ST states the following requirement:

> *"The OCD shall identify and describe relevant operational process scenarios"*

The OCD should describe how the transport system operators interact with each other, with customers, with external parties, and with the operational assets and facilities, in order to carry out services under various operational scenarios.

Depending on a particular project, an OCD selects only those operational process scenarios that are relevant to the scope. For example, an OCD for a new fleet stabling yard project may select only stabling yard scenarios and some elements of train operations scenarios that are applicable to operating trains into, within, and out of the stabling yard.

This guide is focused on heavy rail operations, but the high-level structure and principles of the standard and this guide can facilitate expansion and application to other transport modes.

Operational process scenarios that are defined in the OCD may include, but are not limited to the following, which are explored in detail in Section 10.1 through to Section 10.10:

- network-level management, that is the network level operations of NSW rail assets owned by TfNSW, and managed and operated by NSW rail transport agencies
- line (or corridor) management, that is specific lines and their unique and interconnected operations
- signal or area control, that is the division of a line into multiple signal control areas
- electrical switching, that is switching of traction power on the supply and load side
- stabling yard, that is yard entry and exit, and internal yard operations
- fleet depot, that is depot entry and exit, and internal depot operations
- train, that is driver, guard and revenue protection operations on the train
- station and interchange
- freight terminal
- security, incident management and response

Figure 2 describes a layered view of operations within the TfNSW transport network. The outer layer identifies all modes of transport.

The second layer indicates the rail network operations and operational interfaces with other transport modes.

The third layer identifies all rail services in terms of lines or rail corridors that comprise the rail network collection of operations.

The core layer identifies the main operational process areas that apply to all rail service corridors, including station operations, fleet depot operations, stabling yard operations, traction power switching operations, and finally all these operations coordinated by train operations.

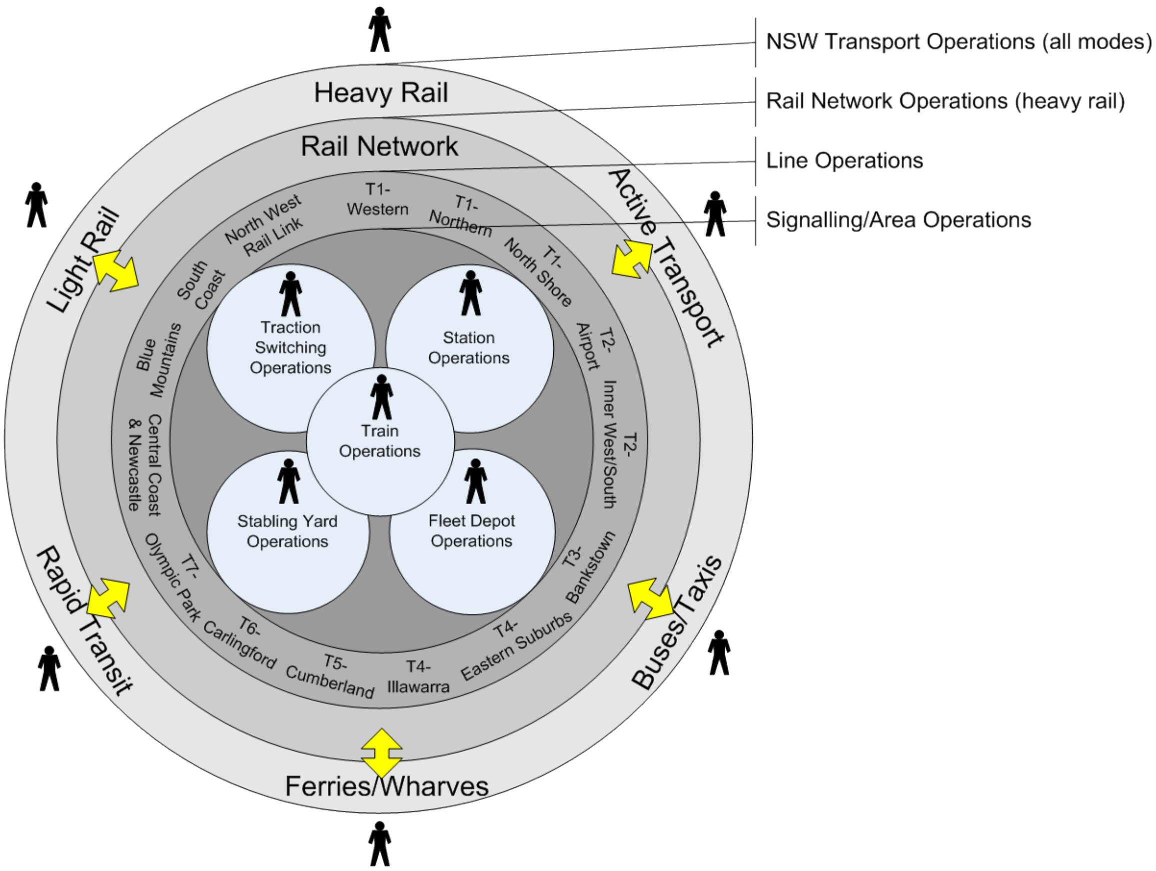

Figure 2 - Passenger rail operational layers and context

10.1. Network management operations

The OCD should describe line management operations, including but not necessarily limited to the following:

- early warning of network service perturbations
- manage service prediction
- manage service regulation
- manage service recovery (for example, how service is recovered following power outages)

Key operational functions of network management include line management, electrical control and infrastructure control, as well as operational interfaces. These are summarised in Figure 3, which shows some of the possible operational communications links between the network management function and other operational activity nodes within the network. For example, there may be an operational communications and coordination link between the network manager and the electrical bulk supplier to manage a significant bulk supply power outage to the railway.

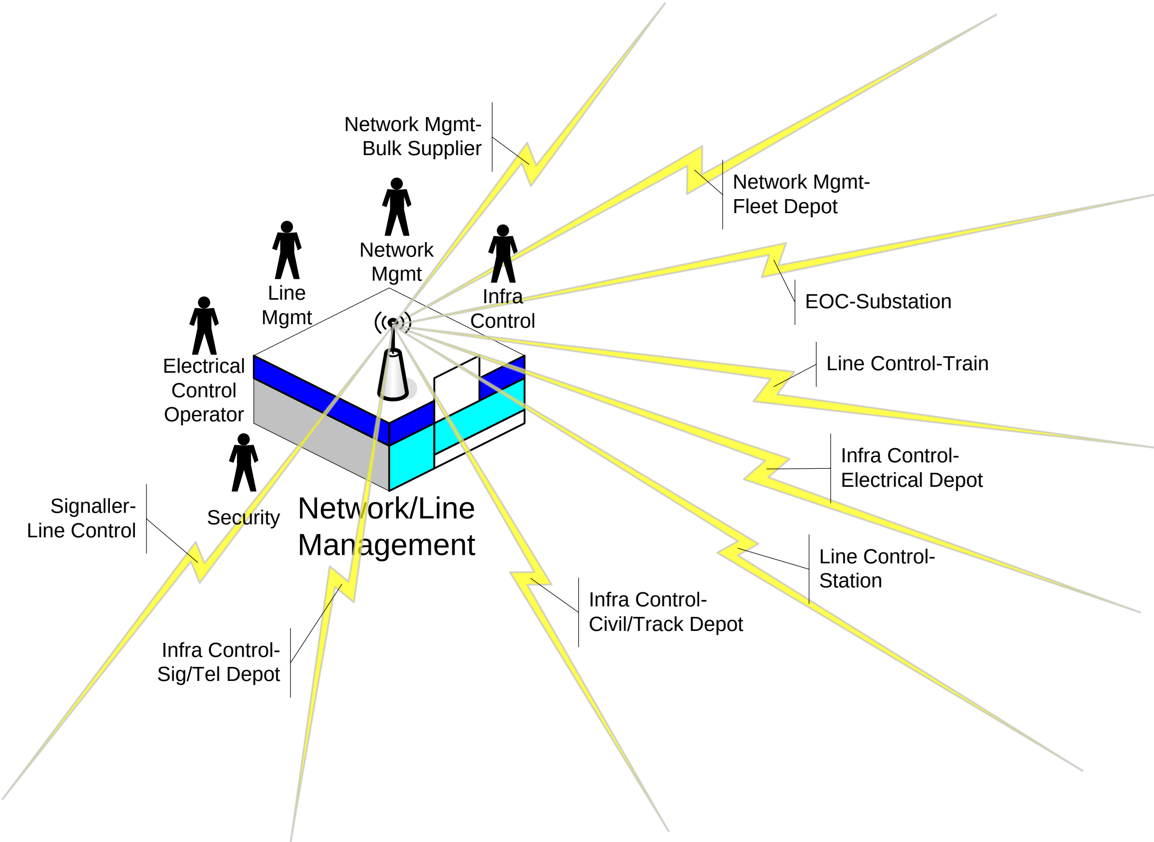

Figure 3 - Network management operational concept diagram

10.2. Line management operations

The OCD should describe line management operations, including but not necessarily limited to the following:

- planning the train service for the line and connections with other lines or services
- directing and supervising the train service on the line (in normal conditions)
- responding to a track access request by inspectors, maintainers, other parties
- optimising the number of trains in service on the line (in normal conditions)
- modifying the current train service plan as required
- modifying train working arrangements in response to the situation
- managing line incidents; examples are as follows:
    - providing assistance following an incident or perturbation on the line
    - responding to a train protection request following an incident or breakdown

    - reporting line incident details to appropriate authorised persons
    - implementing service recovery following an incident on the line
    - adapting the train service following an incident or perturbation on the line
    - notifying affected third parties following an incident on the line
    - managing evacuation from trapped trains (in tunnels, viaducts, cuttings)
    - arranging for a train to re-enter service following incident or repair
    - keeping customers informed of incident status and resolution progress
- planning and communicating line service modifications, for example, alternate platform arrangements and terminating services
- planning and managing emergency train stabling arrangements
- adapting service to line blockage, for example, single line bi-directional working
- managing infrastructure possessions, for example, during construction, testing and maintenance
- planning the route for a diverted train, due to abnormal or degraded operations
- routing trains to the stabling facility (as per schedule)
- routing trains from the stabling facility (as per schedule)
- managing timetable perturbation and recovery
- backup control operations in the event of loss of primary line control facilities

10.3. Signal and area control operations

The OCD should describe signalling and area control operations, including but not necessarily limited to the following:

- controlling the signal area (in normal conditions)
- controlling signalling manually, for example, on loss of automatic routing facilities
- managing route blocking, for example, during possessions or trackside staff protection
- managing imposition and lifting of temporary speed restrictions
- managing trackside staff protection requests, for example, during inspection, maintenance, or survey activities
- managing train identification and routing in signalling control area
- managing junction movements in signalling control area
- managing station movements in signalling control area

- managing movements onto and off the running line, for example, from stabling, maintenance, and sidings
- managing headways
- managing energy efficiency, for example, not stopping train on an upward grade

Figure 4 provides an example of signal and area control operational users and the associated operational communication and control interfaces.

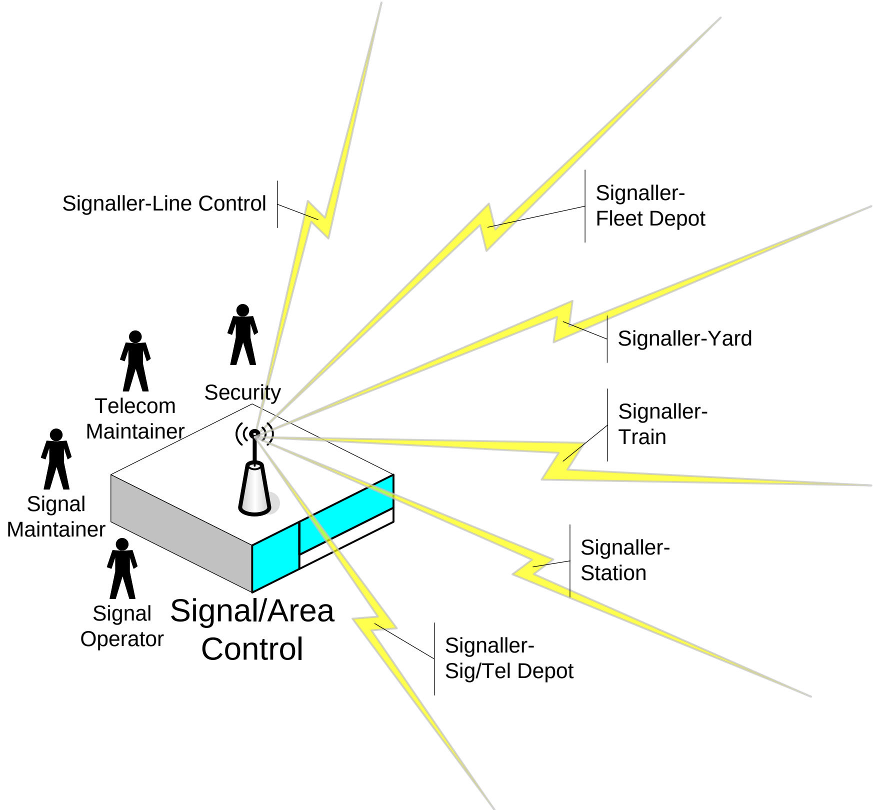

Figure 4 - Signal and area control operational concept diagram

10.4. Electrical switching operations

The OCD should describe electrical traction power switching operations, including but not necessarily limited to the following:

- manage (HV) bulk supply point and HV feeder switching (11 kV, 33 kV and 66 kV)
- manage electrical traction switching (1500 V dc / 25 kV ac)
- manage HV feeder and electrical traction protection
- manage electrical traction switching permits (maintenance, possessions)
- manage maximum demand, power factor, harmonics and general power quality
- respond to OHW dewirements and livened structure incidents
- respond to traction current discharge request (incident)

- respond to traction current recharge request (incident)
- communicate with line management
- communicate with signal and area controllers
- Figure 5 provides an example of some typical electrical switching operations, including users, assets and operational communications and control interfaces.

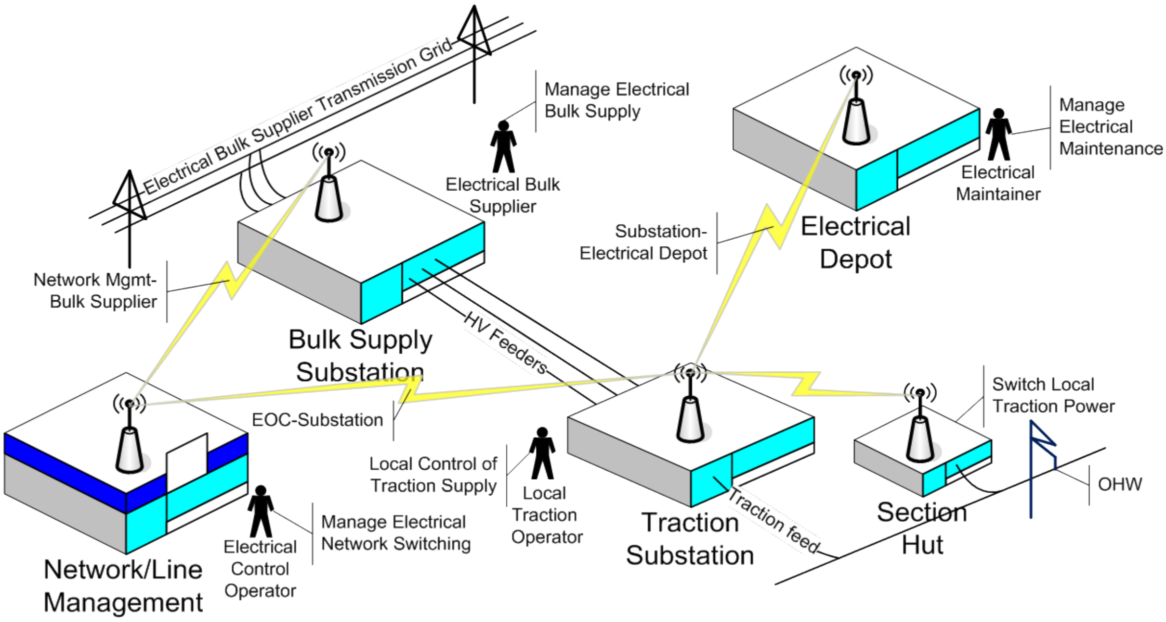

Figure 5 - Electrical switching operational concept diagram

10.5. Stabling yard operations

The OCD should describe operations for stabling yards, including but not necessarily limited to the following:

- manage train acceptance operations (into yard from running lines)
- manage train despatch operations (out of yard onto running lines)
- manage train stabling movements (within the yard)
- manage train inspection and condition monitoring operations
- manage train washing, vacuuming, presentation, and graffiti removal operations
- manage stabling yard security operations
- communicate with line management

  Describe the process, protocols and systems used by stabling yard staff when communicating with line management during service.
- communicate with signal and area controllers regarding movements to and from running line

Describe the process, protocols and systems used by stabling yard staff when communicating with signal and area controllers during service.

- communicate with fleet depot regarding inspection, maintenance, and repair issues

  Describe the process, protocols and systems used by stabling yard staff when communicating with depot staff during service.

Figure 6 provides an example of stabling yard operations, with users, assets and operational communications and control interfaces.

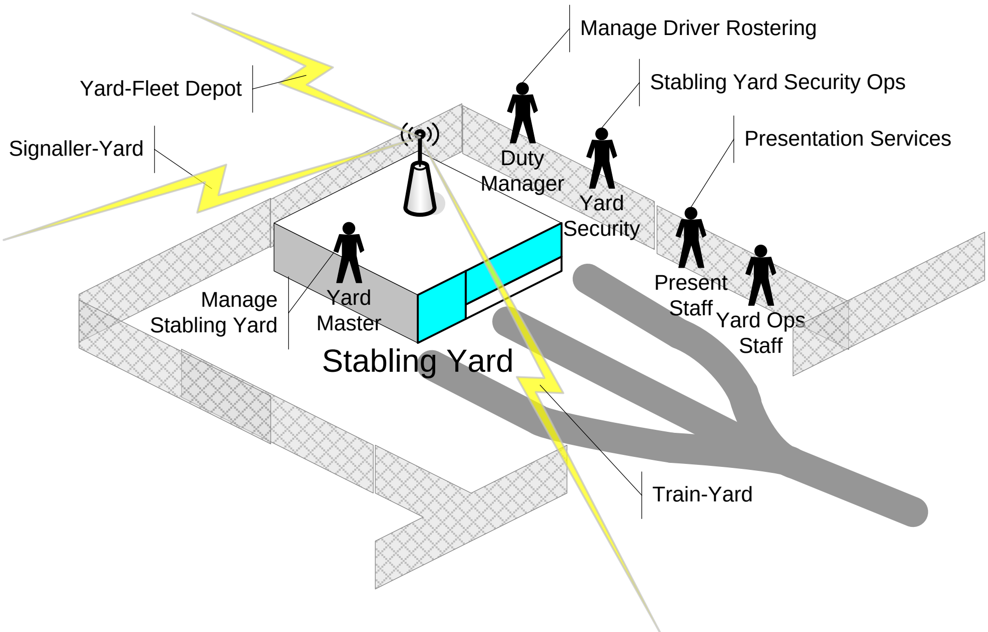

Figure 6 - Stabling yard operational concept diagram

10.6. Fleet depot operations

The OCD should describe operations for fleet depots, including but not necessarily limited to the following:

- manage train acceptance operations (into depot from the running lines)
- manage train despatch operations (out of depot onto running lines)
- manage train movements (within the depot)
- manage train inspection and condition monitoring operations
- train vacuuming, presentation, and graffiti removal operations
- manage fleet depot security operations
- communicate with line management

  Describe the process, protocols and systems used by depot staff when communicating with line management during service.

- communicate with signal and area controllers (movements to and from running line)

  Describe the process, protocols and systems used by depot staff when communicating with signallers during service.

Figure 7 provides an example of some fleet maintenance depot operations, with users, assets and operational communications and control interfaces.

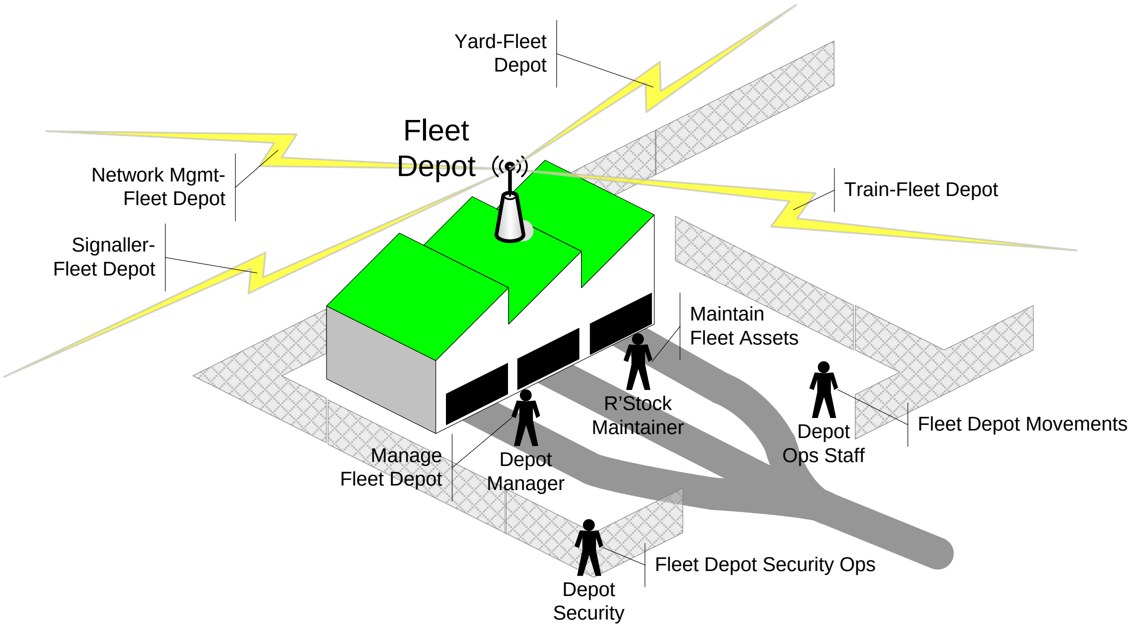

Figure 7 - Fleet maintenance depot operational concept diagram

10.7. Train operations

The OCD should describe operations for train operating staff, including but not necessarily limited to the following:

- book on with the duty manager at the start of a service shift
- book off with the duty manager at the end of a service shift
- enter train and safely starting up services on a train at a stabling yard at start of shift
- leave train after safely shutting down services on a train at a stabling yard at end of shift

  Describe the process followed by train staff, including drivers and guards, to shut down services on the train and leave the train at the stabling yard at the end of a service shift.

- pick up, enter and safely start up services on a train at a depot
- drop off and leave a train after safely shutting down services on a train at a depot
- pick up and enter a train and safely starting up services on a train at a siding
- drop off and leave a train after safely shutting down services on a train at a siding
- plan next service assignment

- pick up and enter an abandoned train and safely starting up services on a train
- identify, communicate and resolve train defects (for maintainer, depot, operations, and station staff)
- accept a mobile technician on-board (rolling stock, signalling, communications) for repairs
- arrange for a replacement for a defective train taken out of operational service
- relieve train control from other train driver (shift change, turnback operations, unwell driver)
- transfer train control to relief driver
- drive train in yard or depot
- drive train in service (on running line)
- manage energy efficiency during journey, including coasting and regeneration
- manage driving modes if provided (full ATO, supervised ATO, restricted manual)
- manage arrival and stopping at station and interchange platforms
- manage departure from station, interchange, and terminus platforms
- manage turn-back operations and terminal station operations
- manage setting back operations after platform overrun (planned and unplanned)
- manage post signal passed at danger (SPAD) signal overrun operations
- manage train authorised SPADs (under signaller authorisation)
- manage pantograph operations, for example, raising and lowering pantographs
- manage dual traction voltage changeover operations (between 1500 V dc and 25 kV ac)
- manage push out a stalled or defective train operations (during emergency and degraded conditions)
- manage dividing and joining train operations
- manage unattended station and platform operations
- manage short platform operations, for example, locking rear carriage doors
- manage correct side door operations
- manage person stuck in door incident
- manage train operations in tunnels and on bridges and viaducts
- manage curved platform operations ('mind the gap' warning, signal and indicator sighting, platform clear message)

- manage DDA access operations, including coordination between train guards and station staff
- manage fire and smoke emergency on trains (in tunnels, bridges and viaducts, platforms)
- manage emergency train evacuation (in tunnels, bridges and viaducts, platforms)
- manage person under train event
- communicate with and inform passengers
- communicate with train crew, for example, from driver to guard
- communicate with station staff, for example, from train driver or guard to station platform staff
- communicate with stabling yard staff

  Describe the process and protocols and systems used by train staff when communicating with stabling yard staff during service.

- communicate with fleet depot staff

  Describe the process and protocols and systems used by train staff when communicating with fleet depot staff during service.

- communicate with signaller

  Describe the process and protocols and systems used by train staff when communicating with the signaller at the control centre or signal box during service.

- communicate with line control staff

  Describe the process and protocols and systems used by train staff when communicating with line control staff at the line control/network management centre during service.

- communicate with network management staff

  Describe the process and protocols followed and systems used by train staff when communicating with the line control staff at the network management centre during service.

- communicate with emergency services staff

  Describe the process and protocols followed and systems used by train staff when communicating with emergency services during and after an incident.

- operational processes when a third party, such as freight, is operating on the network

The introduction of driverless trains and platform screen doors onto the NSW rail network requires re-allocation of driver and guard operations to other actors (human or automated). These initiatives require planning and assessment of current operational scenarios to ensure that function, performance and risk are not adversely affected.

Figure 8 provides an example of key train operational users, process scenarios and operational communications and control interfaces.

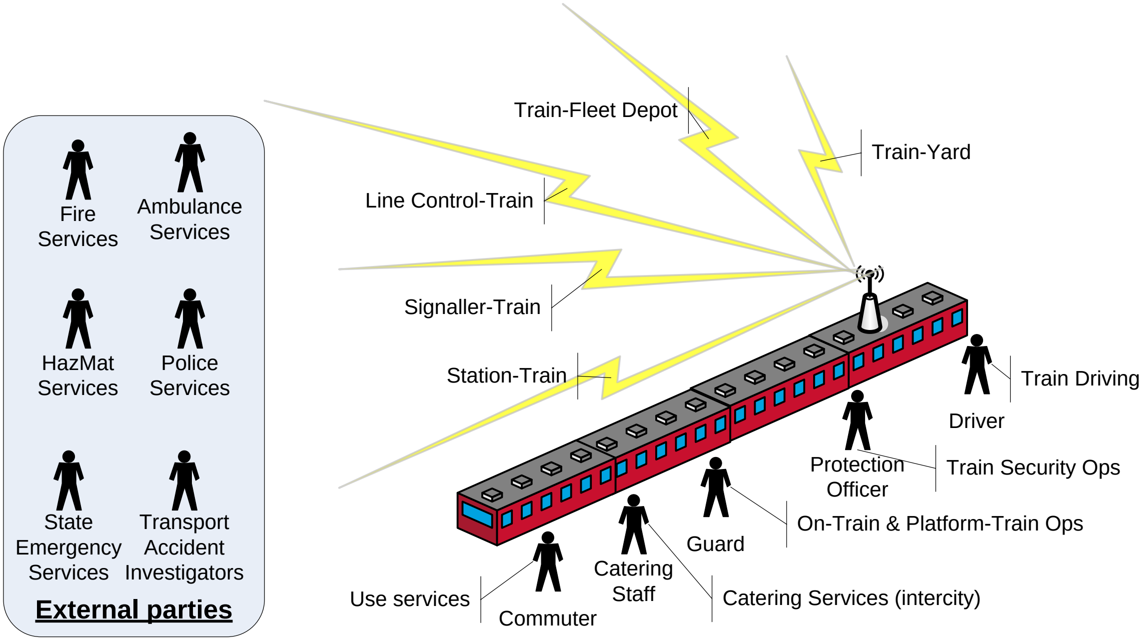

Figure 8 - Train operator's process scenario concept diagram

10.8. Station operations

For the purposes of the OCD, station operations include those for transport interchanges, terminus stations, through to stations and stops.

The OCD should describe operational concepts for station, interchange, and terminus staff including, but not limited to the following:

- open station to passengers (initial conditions, process, communications, facilities, actions)
- close station to passengers (initial conditions, process, communications, facilities, actions)
- respond to a major station incident, including but not necessarily limited to the following:
  - respond to general security alert
  - respond to person(s) threatening harm to others, including staff and passengers
  - respond to person self-threatening (self-harm)
  - respond to general criminal activity, for example, fare evasion, vandalism, and theft
  - respond to person under train incident
  - respond to unauthorised person on track incident (trespass)
  - respond to ill person at stations or on trains
  - respond to station fire, smoke, and gas incidents
  - respond to health alert including air quality, vermin, noise and vibration levels

  - respond to incident and assistance request
  - assist incident manager
  - assist emergency services
  - evacuate platform following an incident
  - evacuate entire station and interchange following an incident

- manage station for scheduled special events, for example, events at Olympic Park, and steam train rides events
- manage station platform dwell time, including use of platform screen doors
- manage station overcrowding, including overall crowding of entrance, concourse, and platforms
- manage platform overcrowding, for example, stopping escalators to the platform
- communicate with other station operations staff on the platform or concourse
- communicate with line management
- communicate with train operator staff including drivers and guards
- communicate with passengers (on the platform or concourse)
- communicate with emergency services

Figure 9 provides an example of typical station or interchange operations, with users, assets and operational communications and control interfaces.

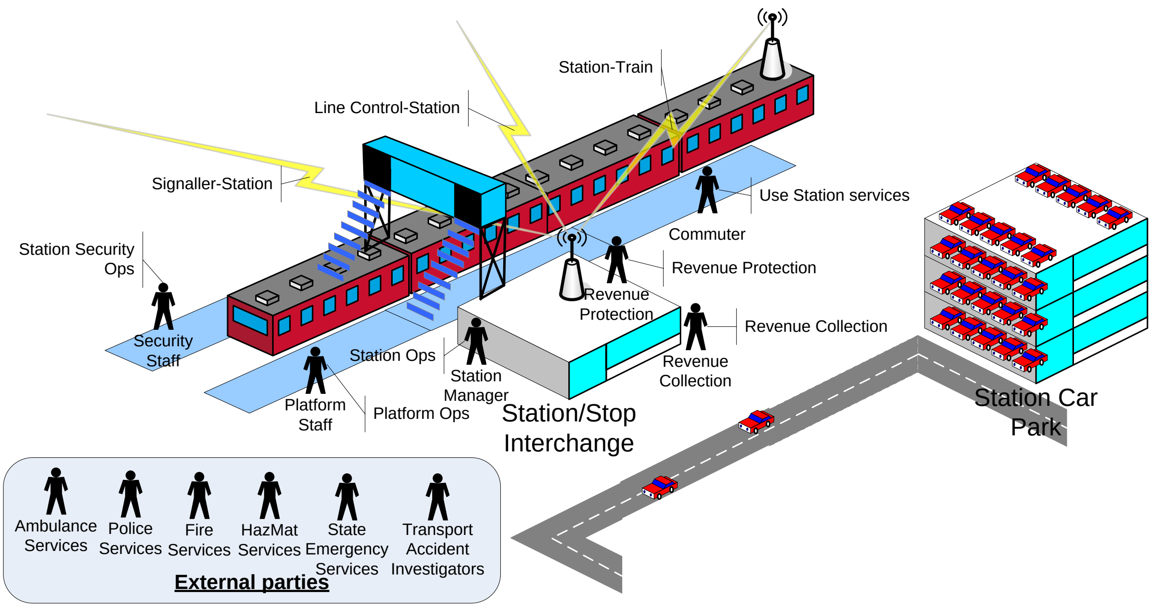

Figure 9 - Stations operation concept diagram

10.9. Freight terminal operations

The OCD should describe freight terminal operations, including but not necessarily limited to the following:

- management of freight or bulk material trains into and out of the terminal
- management of road freight or bulk material transport into and out of the terminal
- management of maritime freight vessels into and out of the port terminal
- handling and transfer of freight or bulk material from one transport mode to another

Third party operators and private sidings need to identify principles of site operations and network interfaces.

TfNSW yards should have more detailed operational concepts specific to the new or altered system considered.

10.10. Security operations

The OCD should describe security operations, including but not necessarily limited to the following:

- security monitoring of stations, interchanges and facilities
- security monitoring of the rail corridor
- security monitoring of trains
- planning and carrying out security patrols
- managing response to security incidents
- protection of staff and passengers

11. Geographic operations

Due to the extensive area covered by the metropolitan and inter-city heavy rail network, the network is subdivided into geographically defined line operations. The OCD should describe these specific geographic transport routes, services and operations, as applicable to the project scope. The OCD should describe passenger and freight services on these routes. The line operations for the Sydney greater metropolitan rail network are as follows:

- Western Line
- Northern Line
- North Shore Line
- Airport Line

- Inner West and South Line
- Bankstown Line
- Eastern Suburbs Line
- Illawarra Line
- Cumberland Line
- Carlingford Line
- Olympic Park Line
- Central Coast and Newcastle Line
- Blue Mountains Line
- South Coast Line
- North West Rail Link (SRT Stage 1, 2 and 3)
- Freight corridors such as North Sydney Freight Line and South Sydney Freight Line, Port Botany Branch Line
- All regional NSW lines maintained by CRN and carrying NSW Trains services or private freight operators.

12. Operational users

In developing the OCD, the roles and associated responsibilities of operational users, including operators, maintainers, passengers, and the public and external parties such as emergency services should be identified.

T MU AM 06008 ST states the following requirement:

> *"The OCD shall identify and describe roles and responsibilities of operational users, as applicable in their interactions with the proposed new or altered system"*

Operational users to be identified in an OCD may include, but are not necessarily limited to the following:

- network management operators
- line management operators (as applicable to the line)
- signal or area control operators
- electrical switching and control operators (HV feeder and traction power switching)
- fleet maintenance operators

- stabling yard operators, including yard master, yard operations staff, yard security staff and presentation staff
- fleet depot operators, including fleet depot manager, fleet depot operations staff and fleet depot security staff
- freight terminal operators
- train operators, including third party operators and rolling stock owners, including duty manager, drivers, guards and catering staff (for intercity trains)
- station operators such as station manager, platform staff, revenue collection staff, revenue protection staff and security staff
- maintainers for the following disciplines:
  - civil and structures
  - track
  - electrical (including OHW)
  - signalling
  - communications
  - stations and buildings
  - rolling stock
- infrastructure delivery projects including possession managers and protection staff
- customers like fare-paying passengers, non-fare customers using facilities in and around the station and interchange and freight customers
- emergency services such as fire brigade, ambulance and police
- security control, monitoring and contract guard operators
- utility owners and operators, for example, electricity, water and gas

T MU AM 06008 ST states the following requirement:

> *"The OCD shall relate responsibilities, accountabilities and informing of operational users to the operational process scenarios"*

The OCD may use a RACI matrix to summarise responsibilities, accountabilities, consulting and informing of operational users against the operational process scenarios in Section 10.

T MU AM 06008 ST states the following requirement:

> *"The OCD shall consider the implications on operational staff skills and any training or retraining needed due to the operational changes resulting from the introduction of new or altered assets"*

Changes in operations from existing operational arrangements may require a skills assessment or reassessment, in order to determine if current operational staff competencies match the tasks to be performed under new operational arrangements. For example, removal of guards and introduction of driver only operation may place additional tasks on the driver in terms of managing the platform-train interface.

Closure of a mechanical signal box and relocation to a central signalling control centre with computerised traffic control systems, require re-skilling of operations staff on new systems and operational procedures.

Conversion of a stabling yard to fully signalled operation and removal of traditional yard staff places additional skills demands on drivers and guards.

Identification of operational users and their interaction with operational assets and processes should consider human factors as explained in T MU HF 00001 GU *AEO Guide to Human Factors Integration.*

13. Operations migration

T MU AM 06008 ST states the following requirement:

> *"The OCD shall describe how operations will be safely migrated from existing operations to the future operations, including possible interim operations so far as is reasonably practical at this stage of knowledge of the technology related to the new or altered assets"*

Due to the complex nature of integrated railway operations, and the need to safely maintain services while introducing new or altered systems to meet a new operational need, making a full change in a single step is impractical.

The normal approach is to plan and execute the migration from existing to future operations as a series of intermediate configurations, while supporting interim timetables and services.

13.1. Existing operations

The OCD should describe the baseline existing operations against which the introduction of the new or altered assets and associated operations, will take place.

13.2. Future operations - Interim

The implementation of a highly complex new or altered system onto the transport network is unlikely to occur in a single stage of work.

New or altered systems may be introduced in a series of interim stages. The OCD should describe the operational migration arrangements associated with these interim stages.

13.3. Future operations - Final

Once all interim stages are completed, the OCD should describe the future final proposed change for new or altered systems and the associated operations involved.

13.4. Migration arrangements

T MU AM 06008 ST states the following requirement:

> *"The OCD shall describe arrangements to preserve acceptable levels of safety, timetabled services, efficiency, asset integrity, and service availability during operations migration"*

The operational migration arrangements associated with introducing new or altered transport systems should be clearly identified, in order to ensure that the integrity of existing transport network assets and associated operational availability and safety is maintained, so far as is reasonably practicable.

Migration arrangements include, but are not necessarily limited to the following:

- safety - how existing operational safety will be maintained
- efficiency - how operational efficiency will be maintained
- contingency - fall-back and business continuity arrangements during the migration
- rules - any minor or major changes to operational rules to accommodate the migration
- processes - interim changes to operational processes to accommodate the migration
- assets - interim changes to existing operational assets to accommodate the migration.

  In software-based systems, this could involve hardware or software changes.
- people - interim organisational changes, including changes in responsibility and accountability, as well as interim skills changes

14. Operational interfaces

T MU AM 06008 ST states the following requirements:

> *"The OCD shall identify and describe operational interfaces",* and
>
> *"Interfaces with internal or external organisations associated with assets across the interface shall be identified"*

Careful consideration should be given while identifying and defining operational interfaces when developing an OCD.

An OCD should include operational interfaces that involve changes in technology or operational philosophy or responsibility. This may include the following:

- internal or external operational interfaces
- operational roles (identification of communicating parties)
- means of communication (voice, data, video, visual/audio)
- what is communicated (decisions, information sharing, actions)
- communications protocol and process (direction, acknowledgement, allocation of responsibility)

All operational interfaces should be recorded centrally so that they can be independently reviewed by multiple operational stakeholders, in line with agreed performance measures, timetable and other operational measures.

Changes to operational interfaces should be under configuration control.

14.1. Internal operational interfaces

The heavy rail network has many internal operational interfaces, and the OCD should describe the way these operational interfaces work. These internal operational interfaces may include, but are not necessarily limited to the following:

- network management, including line control and infrastructure control, to others
- signal and area control to others
- stations and interchanges to others
- train to others
- maintenance depots, including signals, telecommunications, civil, track, and electrical to others
- fleet depot to others
- stabling yard to others

14.2. External operational interfaces

The heavy rail passenger and freight network has operational interfaces with other transport modes. The OCD should describe the way these operational interfaces work. These external operational interfaces to other transport modes may include the following:

- light rail, including CBD and South East Light Rail, Newcastle, Parramatta light rail
- rapid transit, including North West Rail Link and future rapid transit route extensions
- ferries and wharves

- bus and taxi services
- private motor vehicles, including parking arrangements at transport interchanges
- active transport, including walking and cycling

The heavy rail passenger and freight network has operational interfaces with external parties. The OCD should describe the way these operational interfaces work. These external operations interfaces to other parties outside TfNSW may include, but are not necessarily limited to the following:

- ambulance and paramedic services
- police services
- fire services
- hazardous material services
- state emergency services
- transport accident investigators
- ONRSR
- ARTC operations and maintenance
- freight rail and private passenger operators
- utilities, such as electricity, gas, and water
- Country Rail Network (CRN)
- bridge owners

15. Operating modes

T MU AM 06008 ST states the following requirement:

> *"The OCD shall describe how the system will operate under different operating modes so far as is reasonably practical at this stage of knowledge of the technology related to the new or altered assets"*

The nature of complex systems such as the transport system, and in particular the rail transport system, is that they can fail to a greater or lesser extent. In order to address this issue, the following should be identified:

- how the system may fail
- to what extent it may fail
- the arrangements needed to be in place to ensure some suitable level of business continuity until full functionality and performance is restored

Operating modes may include the following:

- normal mode
- interim or abnormal mode, for example, special sporting events
- degraded mode (includes fault mode where failure has occurred and operation is limited)
- emergency mode, for example, incident recovery, security, backup control
- maintenance or possession mode

15.1. Normal mode

Normal operations are the default and should be described in 'operational process scenarios'.

Figure 10 shows an example of normal mode operation for operational communications between various rail operational staff (station staff, train staff, line controllers and passengers).

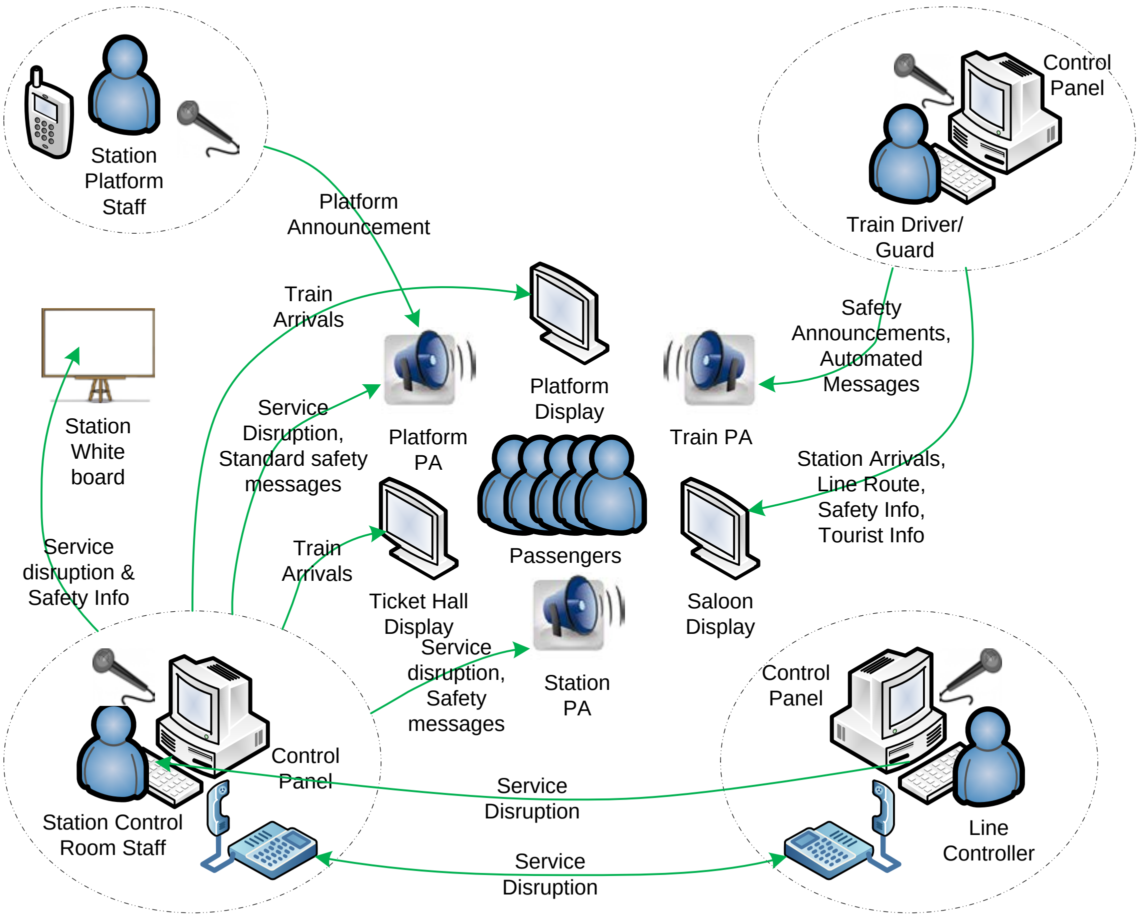

Figure 10 - Normal mode operational communications (suggested sample)

Note: This example is intended to be used for illustrative purposes only. It does not necessarily represent a deployed operational system.

15.2. Interim or abnormal mode

The OCD should identify and describe how interim or abnormal operations are conducted.

Interim or abnormal modes do not necessarily imply degraded operations, but relate to special events where deviations from normal operations may be required, including, but not necessarily limited to the following:

- longer trains, for example joining of 4 car sets to make up an 8 car set for larger groups
- sporting and entertainment events, for example, events at Sydney Olympic Park
- shorter trains (provision of special short trains as required)
- closed or skipped stations (occurring during late night and weekend operations for rural or remote stations)

Figure 11 shows an example of abnormal mode operation for operational communications between various rail operational staff (station staff, train staff, line controllers and passengers).

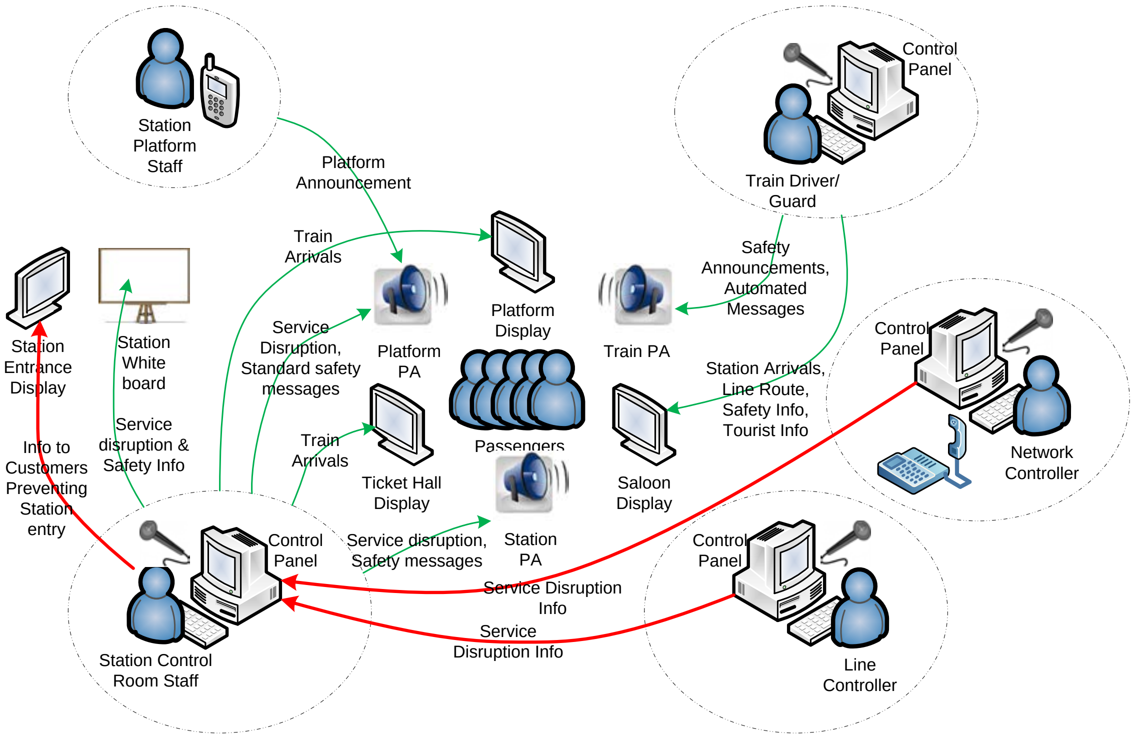

Figure 11 - Abnormal mode operational communications (suggested sample)

Note: This example is intended to be used for illustrative purposes only. It does not necessarily represent a deployed operational system.

15.3. Degraded mode

Degraded operations cover situations where full operational capability, including functionality or performance is not achievable due to degraded physical asset or human performance.

The OCD should identify degraded operations and how they are managed including, but not necessarily limited to the following:

- service recovery modes
- service recovery modifications
- speed restriction management
- signalling control system (SCS) failure fall-back
- route flexibility
- secure points and crossings
- electrical traction current control

Figure 12 shows an example of degraded mode operation for operational communications between various rail operational staff (station staff, train staff, line controllers and passengers).

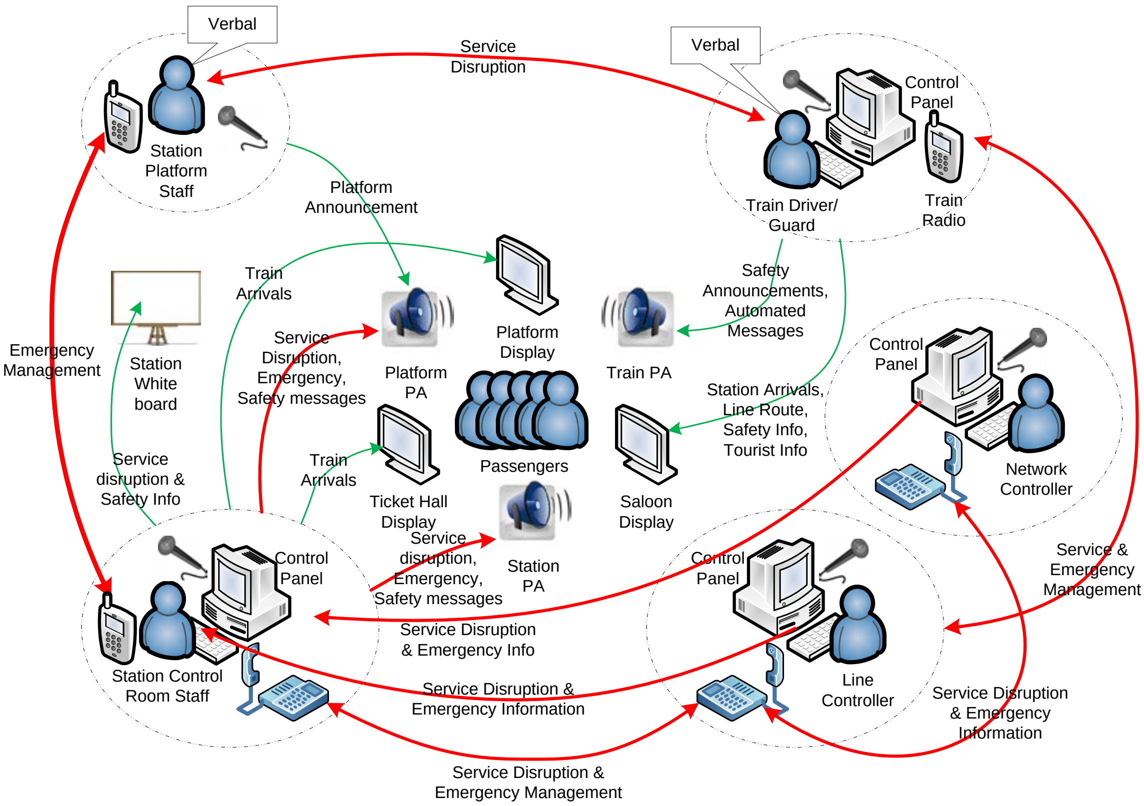

Figure 12 - Degraded mode operational communications (suggested sample)

Note: This example is intended to be used for illustrative purposes only. It does not necessarily represent a deployed operational system.

15.4. Emergency mode

Emergency mode covers situations where full operational capability, including functional and performance capability, is severely degraded or completely lost due to a catastrophic system event, including physical asset or human failure.

The OCD should identify emergency operations and how they should be managed, including but not necessarily limited to the following:

- security alerts and alarms (types, priority, when and how raised, who actions)
- terrorist attack (procedure, communication, responsibilities)
- line fatality management (procedure, communication, responsibilities)
- interim emergency operations (procedure, communication, responsibilities)
- joint security operations (procedure, communication, responsibilities, other parties)
- backup control facilities (where located, staffing arrangements, when and how used)
- recovery plan/process (procedure, communication, responsibilities)

Figure 13 shows an example of emergency mode operation for operational communications between various rail operational staff (station staff, train staff, line controllers and passengers).

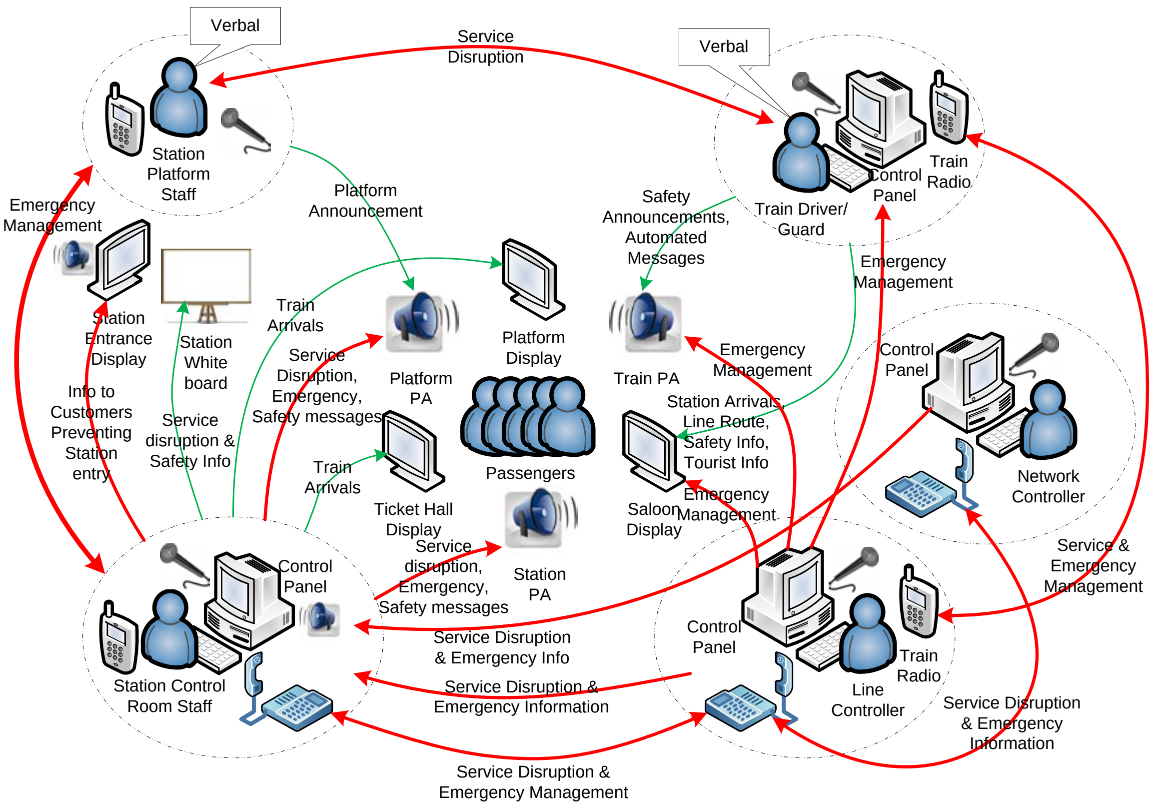

Figure 13 - Emergency mode operational communications (suggested sample)

Note: This example is intended to be used for illustrative purposes only. It does not necessarily represent a deployed operational system.

15.5. Maintenance or possession mode

The OCD should identify maintenance or possession mode operations, for example, service arrangements around weekend or night time track work. The management of maintenance or possession mode operations should also be identified and may include, but are not necessarily limited to the following:

- service preparation before to possession or maintenance
- service management during possession or maintenance
- service recovery after possession or maintenance
- access arrangements for maintenance / possession regime

15.6. Response and recovery to normal mode

T MU AM 06008 ST states the following requirements:

"The OCD shall describe arrangements that will be implemented following an incident or when the service deviates from normal to abnormal, degraded or emergency levels", and

"The OCD shall describe the incident management organisation required to implement special command and control processes"

The aim of the incident management and control organisation and processes is to safeguard customers, employees and assets during incidents, and to facilitate return of services to normal.

The key to effective management of any incident is the rapid implementation of command and control management arrangements, including people and processes. This begins with the first responder on site, usually a manager or supervisor, who should act promptly to control the incident and contain the loss.

The OCD should describe the incident organisation and operating modes other than normal mode, where the organisation is required to implement special command and control processes.

Appendix A Compliance to ISO 29148

Table 1 shows the alignment of information contained in this guide with ISO/IEC/IEEE 29148.

Table 1 - OCD development guide alignment with ISO/IEC/IEEE 29148

OCD development guide (this guide)		ISO/IEC/IEEE 29148:2011	
Section	**Heading**	**Section**	**Heading**
1	Introduction	A.1	Overview
B1/B2	OCD template (examples)	A.2	Operational concept document
2.1	Scope	A.2.1	Scope
	Foreword	A.2.1.1	Identification
2, 2.1	Purpose, Scope	A.2.1.2	Document overview
9	Operational assets and facilities	A.2.1.3	System overview
3	Reference documents	A.2.2	Referenced documents
9	Operational assets and facilities	A.2.3	Current system or situation
1,2,2.1	Introduction, Purpose, Scope	A.2.3.1	Background, objectives, and scope
7	Operational constraints	A.2.3.2	Operational policies and constraints
9	Operational assets and facilities	A.2.3.3	Description of current system or situation
15	Operating modes	A.2.3.4	Modes of operation for current system
12	Operational users	A.2.3.5	User classes and other involved personnel
12	Operational users	A.2.3.5.1	Organizational structure
12	Operational users	A.2.3.5.2	Profiles of user classes
13	Operational interfaces	A.2.3.5.3	Interactions among user classes
13.2	External operational interfaces	A.2.3.5.4	Other involved personnel
6.2.7	Maintenance depot capability	A.2.3.6	Support environment
6.3	Rationale for operational change	A.2.4	Justification for and nature of change
6.3	Rationale for operational change	A.2.4.1	Justification for changes
6.2	Future operational capability	A.2.4.2	Description of desired changes
6.3	Rationale for operational change	A.2.4.3	Priorities among changes
6.2	Future operational capability	A.2.4.4	Changes considered but not included
7	Operational constraints	A.2.4.5	Assumptions and constraints
6.2	Future operational capability	A.2.5	Concepts for the proposed system
2	Purpose	A.2.5.1	Background, objectives, and scope
7	Operational Constraints	A.2.5.2	Operational policies and constraints
9.2	Future asset/facility description	A.2.5.3	Description of the proposed system
15	Operating modes	A.2.5.4	Modes of operation
12	Operational users	A.2.5.5	User classes and other involved personnel

OCD development guide (this guide)		ISO/IEC/IEEE 29148:2011	
Section	**Heading**	**Section**	**Heading**
12	Operational users	A.2.5.5.1	Organizational structure
12	Operational users	A.2.5.5.2	Profiles of user classes
12/14	Operational users / Operational interfaces	A.2.5.5.3	Interactions among user classes
12	Operational users	A.2.5.5.4	Other involved personnel
9.2	Future asset/facility description	A.2.5.6	Support environment
10	Operational Process scenarios	A.2.6	Operational scenarios
13	Operations migration	A.2.7	Summary of impacts
13	Operations migration	A.2.7.1	Operational impacts
13	Operations migration	A.2.7.2	Organizational impacts
13	Operations migration	A.2.7.3	Impacts during development
6.2	Future operational capability	A.2.8	Analysis of the proposed system
6.3	Rationale for operational change	A.2.8.1	Benefits
6.3	Rationale for operational change	A.2.8.2	Disadvantages and limitations
6.3	Rationale for operational change	A.2.8.3	Alternatives considered
A/B/C/D	Appendices	A.2.9	Appendices
4	Terms and definitions	A.2.10	Glossary

Appendix B Generic OCD structure

Examples of templates for OCD structures are available in various standards. Two possible examples are provided in Section B.1 and Section B.2 as guidance.

B.1. OCD template – Example 1

The OCD template from IEEE 1362-1998 - *IEEE Guide for Information Technology – System Definition – Concept of Operations (ConOps) Document* is provided as follows:

- Title page
- Revision chart
- Preface
- Table of contents
- List of figures
- List of tables
- 1. Scope
- 1.1 Identification
- 1.2 Document overview
- 1.3 System overview
- 2. Referenced documents
- 3. Current system or situation
- 3.1 Background, objectives, and scope
- 3.2 Operational policies and constraints
- 3.3 Description of the current system or situation
- 3.4 Modes of operation for the current system or situation
- 3.5 User classes and other involved personnel
- 3.6 Support environment
- 4. Justification for and nature of changes
- 4.1 Justification of changes
- 4.2 Description of desired changes
- 4.3 Priorities among changes
- 4.4 Changes considered but not included

- 5. Concepts for the proposed system
- 5.1 Background, objectives, and scope
- 5.2 Operational policies and constraints
- 5.3 Description of the proposed system
- 5.4 Modes of operation
- 5.5 User classes and other involved personnel
- 5.6 Support environment
- 6. Operational scenarios
- 7. Summary of impacts
- 7.1 Operational impacts
- 7.2 Organisational impacts
- 7.3 Impacts during development
- 8. Analysis of the proposed system
- 8.1 Summary of improvements
- 8.2 Disadvantages and limitations
- 8.3 Alternatives and trade-offs considered
- 9. Notes
- Appendices
- Glossary

B.2. OCD template – Example 2

The OCD template from the ANSI/AIAA/INCOSE standard, G043A-2012e - *Guide to the Preparation of Operational Concept Documents* is provided as follows:

- 1. Scope
- Identification
- System purpose
- Document overview
- 2. Referenced documents
- 3. Background
- 4. Existing systems and operations
- 5. Proposed system operational overview
- Missions
- Operational policies and constraints
- Operational environment
- Personnel
- Support concept and environment
- Justification for and nature of changes
- Impact summary
- 6. System overview
- System scope
- System goals and objectives
- Users and operators
- System interfaces and boundaries
- System states and modes
- System capabilities
- System architecture
- 7. Operational processes
- 8. Other operational needs
- Mission needs

- Personnel needs
- Quality factors
- 9. Analysis of the proposed system
- Summary of advantages
- Summary of disadvantages/limitations
- Alternatives and tradeoffs considered
- Summary of impact by classes of users
- Regulatory impacts
- Other impacts
- 10. Appendix A: Acronyms, abbreviations and glossary
- 11. Appendix B: System operational scenarios
- Appendix B.1 Operational processes
- Appendix B.2 Common scenarios and conditions

Appendix C TRAK metamodel as a basis for developing an OCD

Figure 14 illustrates 'The Railway Architecture Framework' (TRAK) metamodel, and how it would be applied as a basis for developing an OCD. TRAK is an architecture framework that sets rules to develop rail architecture models. It was developed by the Rail Safety & Standards Board (RSSB). TRAK is based on AS/NZS ISO/IEC/IEEE 42010 *Systems and software engineering — Architecture description* and derived from the *UK Ministry of Defence Architecture Framework* (MODAF).

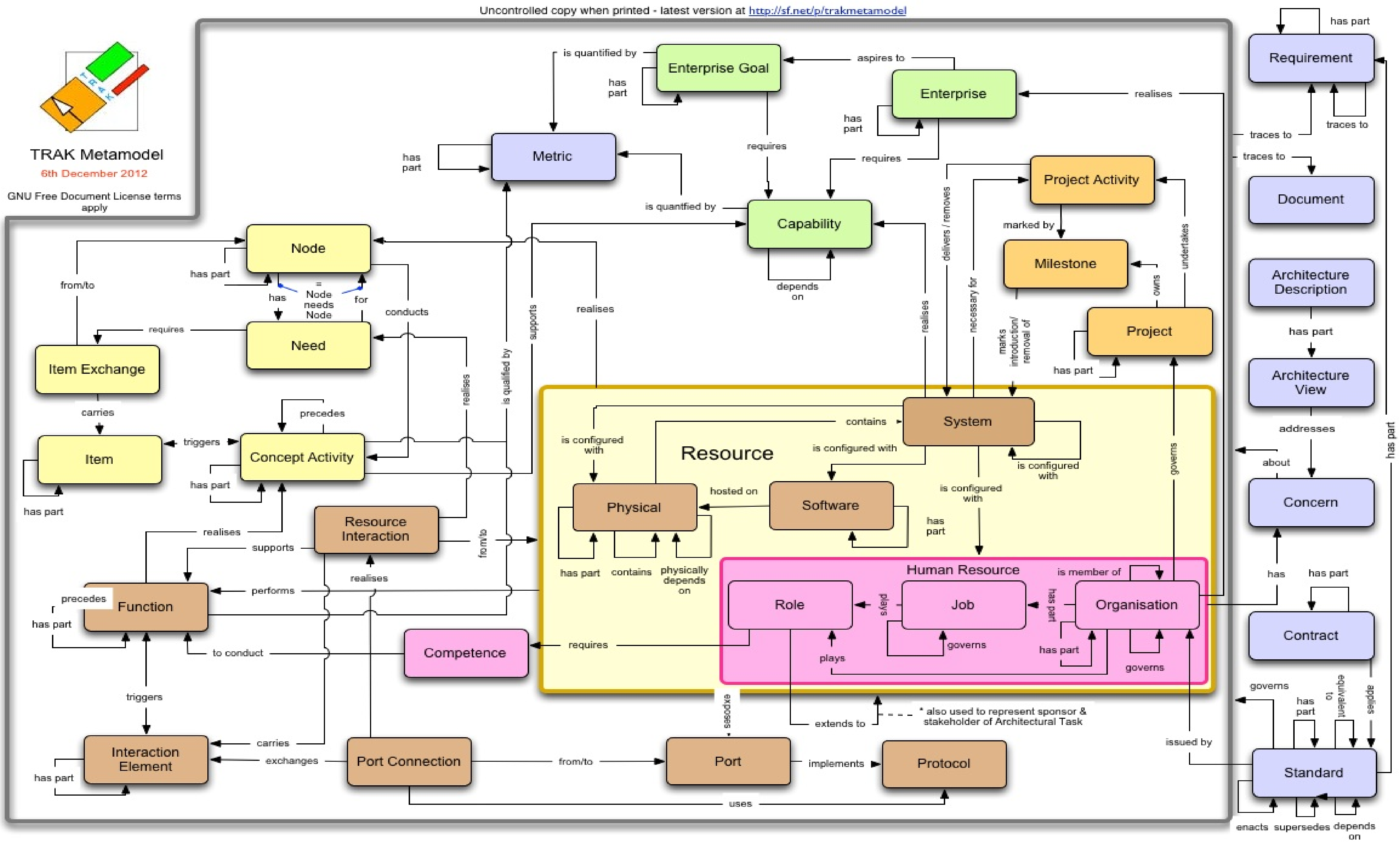

Figure 14 – TRAK metamodel

Appendix D Heavy rail operational concept graphic

Figure 15 illustrates how a heavy rail network system could be applied as an operational concept, showing the various operational assets, facilities, stakeholders, users and operational interfaces that can occur.

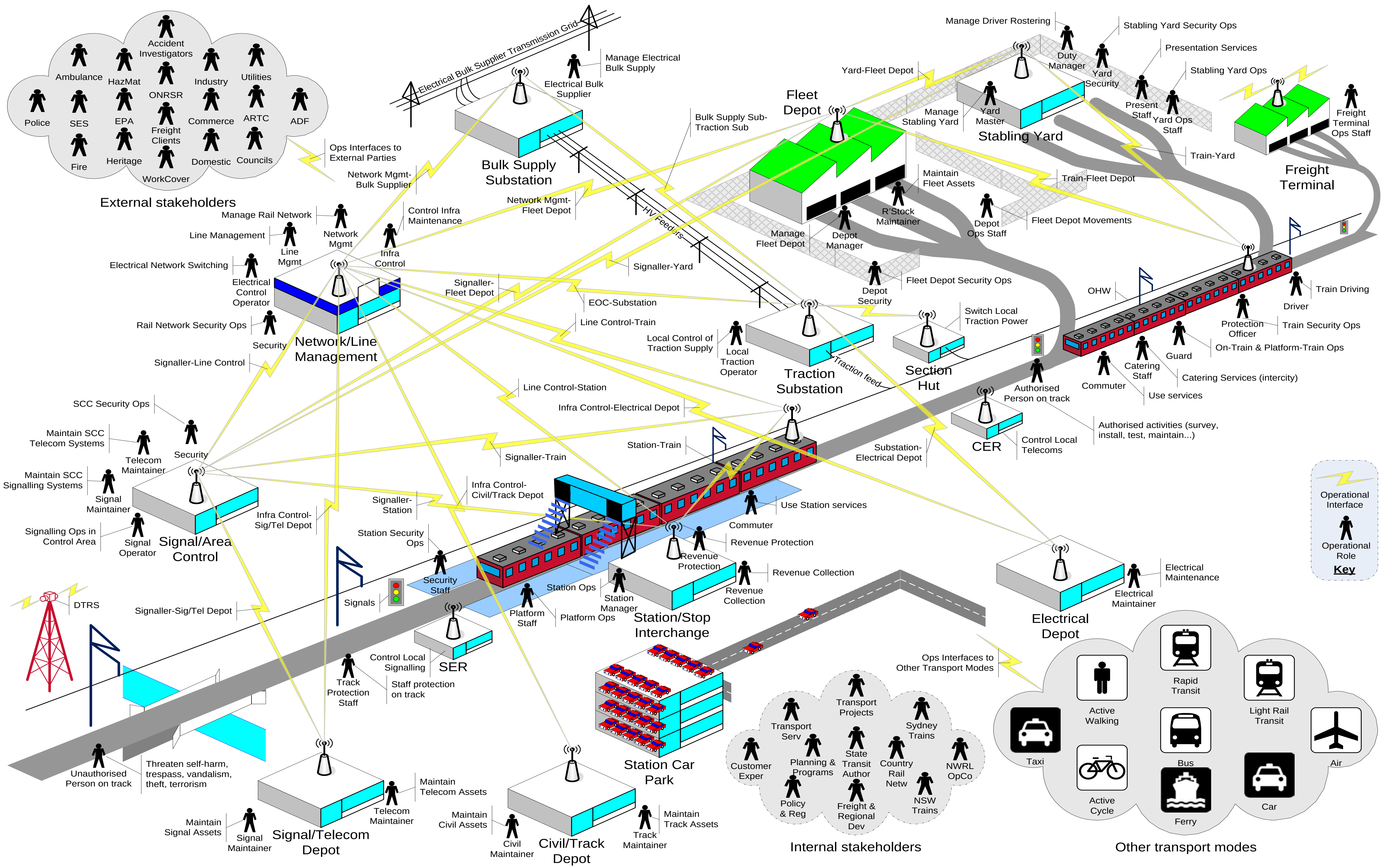

Figure 15 - Operation concept for a heavy rail network