Master Specification
Part RD-ITS-D1

Design of Intelligent Transport Systems (ITS)

September 2024

Government of South Australia
Department for Infrastructure and Transport

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Document Management

Contents

RD-ITS-D1 Design of Intelligent Transport Systems (ITS)

1 General

a) This Master Specification Part sets out the requirements for minimum functional, architectural and technical requirements for the design and documentation of the Intelligent Transport Systems (ITS), including:

i) the documentation requirements, as set out in section 2;

ii) the ITS general design requirements, as set out in section 3;

iii) the requirements for ITS equipment, as set out in section 4;

iv) the requirements for ITS infrastructure, as set out in section 5;

v) the requirements for the ITS communication network, as set out in section 6;

vi) the site layout requirements, as set out in section 7;

vii) the support structure design requirements, as set out in section 8;

viii) the testing, commissioning, and handover requirements, as set out in section 9;

ix) the requirements for warranties and spares, as set out in section 10; and

x) the Hold Point requirements, as set out in section 11.

b) This Master Specification Part does not apply to the design and functional specification development of any Tunnel plant management and control system (PMCS) where such a system also forms an integral part of the Works (refer TUN-PMCS-DC1 “Tunnel Plant Monitoring and Control Systems”).

c) Where the Contract Documents require the provision of a PMCS (as defined in TUN-PMCS-DC1 “Tunnel Plant Monitoring and Control Systems”) in addition to an ITS system as governed by this Master Specification Part and an ambiguity or conflict arises between the 2 Master Specification Parts:

i) for projects using an alliance form of contract, the ambiguity or conflict must be resolved in accordance with the Contract Documents; or

ii) for projects not using an alliance form of contract, the Contractor must request clarification from the Principal.

d) The design and documentation of the ITS must comply with the Reference Documents, including:

i) Austroads Guide to Smart Motorways;

ii) Austroads Guide to Road Tunnels (AGRT);

iii) ARPANSA RPS S-1 Radiation Protection Standard for Maximum Exposure Levels to Radiofrequency Fields - 3 kHz to 300 GHz (2021);

iv) AS/NZS 1170.2 Structural design actions, Part 2: Wind actions;

v) AS/NZS 1664 Aluminium structures;

vi) AS 1670 Fire detection, warning, control and intercom systems - System design, installation and commissioning;

vii) AS 1742.2 Manual of uniform traffic control devices, Part 2: Traffic control devices for general use;

viii) AS 1742.15 Manual of uniform traffic control devices, Part 15: Direction signs, information signs and route numbering;

ix) AS/NZS 1768 Lightning protection;

x) AS 2144 Traffic signal lanterns;

xi) AS/NZS 3000 Electrical installations (known as the Australian/New Zealand Wiring Rules);

xii) AS/NZS 3008 Electrical installations - Selection of cables;

xiii) AS 3011 Electrical installations - Secondary batteries installed in buildings;

xiv) AS/NZS 3085.1 Telecommunications installations - Administration of communications cabling systems, Part 1: Basic requirements;

xv) AS/NZS 3100 Approval and test specification - General requirements for electrical equipment;

xvi) AS 3990 Mechanical equipment - Steelwork;

xvii) AS 4055 Wind loads for housing;

xviii) AS 4070 Recommended practices for protection of low-voltage electrical installations and equipment in MEN systems from transient overvoltages;

xix) AS 4852 Variable message signs;

xx) AS 5156 Electronic speed limit signs;

xxi) AS IEC 60038 Standard voltages;

xxii) AS 60529 Degrees of protection provided by enclosures (IP Code);

xxiii) AS 61508 Functional safety of electrical/electronic/programmable electronic safety-related systems;

xxiv) AS 62040 Uninterruptible power systems (UPS);

xxv) AS/CA S008 Requirements for customer cabling products;

xxvi) AS/CA S009 Installation requirements for customer cabling (Wiring Rules);

xxvii) AS ISO/IEC 27001 Information technology - Security techniques - Information security management systems - Requirements;

xxviii) Austroads AP-R341/09 Freeway Design Parameters for Fully Managed Operations;

xxix) AP-R344/09 Austroads Best Practice for Variable Speed Limits: Best Practice Recommendations;

xxx) Department Road Design Presentation Standards (available from: https://dit.sa.gov.au/standards/standards_and_guidelines);

xxxi) IEEE 802.3 Ethernet;

xxxii) IEEE 802.3u Fast Ethernet;

xxxiii) IEEE 802.3z Gig Ethernet;

xxxiv) IEEE 802.3ae/an 10 Gigabit Ethernet over fibre/copper twisted pair;

xxxv) IEC 60268 Sound system equipment - Part 16: Objective rating of speech intelligibility by speech transmission index;

xxxvi) Ministerial Building Standard MBS 008 - Designated bushfire prone areas - additional requirements;

xxxvii) New South Wales Transport, Roads & Maritime Services Specification No.TSI-SP-069: Control Equipment for Road Traffic Signals (TS 06156);

xxxviii) South Australian Cyber Security Framework (SACSF) guidelines;

xxxix) TIA-232 Interface Between Data Terminal Equipment and Data Circuit- Terminating Equipment Employing Serial Binary Data Interchange;

xl) TIA-422 - Electrical Characteristics of Balanced Voltage Digital Interface Circuits;

xli) TIA-485 - Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems;

xlii) VicRoads Managed Motorway Design Guide, Volume 2, Parts 2 and 3;

xliii) VicRoads TCS 003 Ramp Control/Metering Signs; and

xliv) TrafficNet policy documents TP014 and TOP022.

e) In addition to the glossary of terms included in PC-IN2 “Glossary of Terms”, the term ‘equipment’ when used in this Master Specification Part:

i) means all electronic and electrical components, devices, hardware, associated systems and associated infrastructure (structures, conduits, pits and the like) that together form the ITS, spanning telecommunications network, communications, and control systems; and

ii) applies to all equipment (whether expressly identified or not) required to provide a fully functional system in compliance with the requirements of this Master Specification Part, whether the equipment is located within the Site, on approach roads or any area immediately outside of the Site, within the TMC, local computer equipment room (CER) or any other secondary CER location.

2 Documentation

2.1 Design Documentation

2.1.1 General

In addition to the requirements of PC-EDM1 “Design Management”, with respect to the ITS design, the Design Documentation must include:

a) a fully detailed (constructible) ITS design package capturing all milestones and hold points as listed in PC-EDM1 “Design Management” as required by section 3.1c);

b) a list of ITS equipment which the Contractor proposes to adopt for the ITS design, as required by:

i) section 3.1d), section 4.1c) and section 5.1b)i);

ii) PC-EDM5 “Digital Engineering”; and

iii) PC-CN2 “Asset Handover”;

c) evidence of:

i) compliance of each ITS equipment with the requirements of this Master Specification Part, as required by section 3.1e); and

ii) STREAMS interoperability and compatibility of nominated ITS equipment, including a list of currently supported devices and their protocols, as required by section 3.2.2b);

d) a list of all proposed required software forming part of the ITS design, including embedded software and device drivers, as required by section 4.3a);

e) details of proposed alternate incident detection systems, as required by section 4.5.1c);

f) details of proposed alternative vehicle detection systems, as required by section 4.5.4b);

g) individual Design Drawings (physical layout and single line power schematics) for each power distribution cabinet, as required by section 5.3.2c);

h) details of proposed unmanaged media devices, including evidence that such unmanaged media devices support link fault pass through, as required by section 5.4c)iv);

i) evidence that any proposed wireless link design will operate correctly and reliably over the expected wireless path and otherwise meets all requirements of ACMA, as required by section 5.4i);

j) communication link design (where the Contractor proposes to use a technology other than optical fibre or twisted pair copper), including details of security features applied, as required by section 5.4j);

k) details of the designed network availability, including the mean time between failure (MTBF) calculations, as required by section 6.2c);

l) details of the communications network load calculations, including proposed network equipment list, as required by section 6.3a)vii);

m) details of the ITS network power load calculations, including:

  i) UPS power requirements; and

  ii) calculated loads for permanently connected equipment (i.e. excluding power requirements for normally unused power outlets such as GPOs) and spare capacity at each power distribution cabinet and ITS cabinet;

n) evidence that the ITS equipment required by the ITS design meets the highest industry standards for reliability and performance, as required by section 6.3b);

o) ITS communications network concept design, as required by section 6.5.1a);

p) details of level of provision of network access points, to be included in the Contractor's Preliminary Design Documentation, as required by section 6.5.5k);

q) details of proposed wireless communication incorporated in the ITS design, as required by section 6.6.4;

r) details of licences of network-connected devices, as required by section 6.6.6d)iii); and

s) site layout details as required by section 7b).

2.1.2 ITS Design Report

a) In addition to the requirements of PC-EDM1 "Design Management", the ITS Design Report must address all aspects of the ITS design, including:

  i) with respect to the ITS Design Report to be provided as part of the Preliminary Design Documentation (with updates provided for all subsequent Design Report submissions):

    A. traffic operations;

    B. ITS communications network, including network drawings;

    C. location and details of all ITS equipment, including drawings demonstrating sightline analysis (with sightline time calculations) for driver information and regulatory signage;

    D. provision for future ITS network expansion;

    E. details of integration with the TMC, STREAMS and Principal's existing communications networks;

    F. risk management and Safety in Design considerations;

    G. physical asset security; and

    H. details of conduit systems provided (including conduits, pits and road crossings) for power and communications;

ii) without limiting the requirements of section 2.1.2a)i), the ITS Design Report to be provided as part of the Detailed Design Documentation (with updates provided for all subsequent Design Report submissions):

A. safety integrity level (SIL) requirements;

B. incident detection and management, including drawings demonstrating compliance with required incident detection and CCTV coverage;

C. technical details or specifications of all proposed equipment forming part of the ITS design;

D. details of hardware and software forming part of the ITS design;

E. copper cable and termination schedules;

F. fibre optic cable schedules including link budgets;

G. any specific calculations to demonstrate the ITS equipment and associated system meets the performance requirements specified and as required by the ITS design;

H. network performance monitoring, security and evaluation tools as required by section 6;

I. maintenance requirements (including access methods, preventive maintenance schedules, site or equipment specific safe working procedures);

J. without limiting section 2.1.2a)ii)I, a maintenance strategy report, detailing safe maintenance access and requirements for all ITS equipment, as required by section 3.6b); and

K. comprehensive, detailed description of the ITS communications network and associated design calculations; and

iii) demonstration of cross checks with other discipline designs including:

A. road layout and geometry;

B. road cross section;

C. road surface finish level;

D. roadside furnishing and barriers;

E. roadside signage and lines;

F. safety design;

G. power reticulation design;

H. PMCS and PLC system design; and

I. design review comment register demonstrating that all comments have been resolved.

b) The Contractor may include the information required by sections 2.1.2a)ii) and 2.1.2a)iii) as part of the ITS Design Report forming part of the Preliminary Design Documentation where relevant to that design stage of the ITS design.

c) The ITS Design Report must be separated into multiple sections to cover each aspect succinctly.

2.1.3 Drawings

a) Without limiting the requirements of PC-EDM1 “Design Management”, the Design Drawings relevant to the ITS design must comply with the requirements of the Department Road Design Presentation Standards, including:

i) DP001 General Requirements;

ii) DP002 Title and Index; and

iii) DP018 Intelligent Transport Systems (ITS).

b) The Design Drawings must update any existing infrastructure drawings.

3 ITS general design requirements

3.1 General

a) The ITS design must fulfil the operational and functional requirements defined in the Contract Documents.

b) The field equipment and systems forming part of the ITS design form a wholly integrated part of those similar systems installed elsewhere within South Australia generally, ensuring commonality in operational management capability, a homogenous driver experience and continuity in ITS service level provision.

c) The Contractor must submit to the Principal (as part of the Design Documentation) a fully detailed ITS design package capturing all requirements of PC-EDM1 “Design Management”.

d) The Design Documentation must include a list of all proposed or specified ITS equipment forming part of the ITS design, including as required by section 4.1c).

e) All ITS equipment proposed as part of the ITS design must satisfy the requirements of the Master Specification, with evidence of such compliance submitted as part of the Design Documentation.

f) Where the list of ITS equipment required by section 3.1d) includes equipment which performs a similar or identical function to devices listed on the Department Approved Products List but the proposed or specified equipment is not actually included in the Department Approved Products List, the Contractor must demonstrate that the alternative equipment which is proposed or specified meets the requirements of this Master Specification Part. The evidence of the alternative equipment complying with the requirements of this Master Specification Part must be submitted as part of the Design Documentation for approval by the Principal.

g) All ITS equipment and networking equipment must be allocated ITS equipment prefixes and numbering in accordance with RD-ITS-C1 “Installation and Integration of ITS Equipment”. Completed prefixes and numbering of ITS equipment and networking equipment must be submitted for approval by the Principal as part of the Design Documentation at the Detailed Design stage.

h) Where changes occur to ITS equipment prefixes or numbers, or locations between the Detailed Design stage and the IFC Design Documentation stage, and this affects the prefixes and numbering of the ITS equipment, the Contractor must:

i) update all drawings and documents accordingly; and

ii) create and update a register of changes to the ITS equipment prefixes and numbering, including references to all affected documentation and drawings.

3.2 STREAMS integration

3.2.1 General

The Contractor must ensure that the ITS design and all equipment proposed as part of the ITS design satisfies all STREAMS integration requirements as set out in:

a) this section 3.2; and

b) RD-ITS-C1 “Installation and Integration of ITS Equipment”.

3.2.2 Integration with ITS equipment design

a) All ITS equipment proposed in the ITS design must be interoperable and compatible with STREAMS.

b) The Contractor must provide evidence of STREAMS interoperability and compatibility of all ITS equipment proposed in the ITS design (including a list of currently supported devices and their protocols) as part of the Design Documentation.

c) The Contractor must submit the scope and the program of STREAMS integration works to be undertaken by Transmax Pty Ltd as required by the ITS design, to the TMC for review, endorsement and approval prior to submission of the Detailed Design Documentation.

d) Evidence of TMC's written approval and endorsement of the STREAMS integration works proposal must be included as part of the Detailed Design Documentation and at all subsequent Design Documentation submissions. The provision of TMC's written approval and endorsement at the specified design stages constitutes a **Hold Point** and further ITS design submissions must not occur until this Hold Point is released.

e) As a clarification, the Principal will arrange with Transmax Pty Ltd the delivery of:

   i) project discovery;

   ii) design review for STREAMS requirements; and

   iii) LUMS permissible frame combination report.

f) Note that a list of STREAMS supported devices is available from the Transmax Pty Ltd website.

3.2.3 Integration with PMCS/PLC systems

a) Where the ITS design includes a PMCS, the ITS design must include a joint system design and joint interface specification for any integration between PLC or PMCS and STREAMS.

b) For the purposes of section 3.2.3a), the ITS design must include:

   i) bi-directional status and alarm transmission and acknowledgment; and

   ii) remote monitoring, incident response plan initiation, and fault reporting of any PMCS and control system equipment via a dedicated PLC interface to dedicated field processors.

3.2.4 Traffic management centre computer systems

a) The Contractor must ensure that the ITS solution required by the ITS design is fully integrated with, and interoperable by, the Principal's existing TMC and BTMC computer systems in managing the road network utilising the expanded STREAMS motorway management system application and also any PMCS systems, where PMCS is included as a component of the ITS design.

b) The Contractor must coordinate and integrate the ITS design with the TMC with specific reference to STREAMS compatibility and integration and ITS telecommunications network requirements.

3.3 Design Life

a) The Contractor must ensure that all elements of ITS equipment required by the ITS design meets or exceeds the minimum Design Life set out in Table RD-ITS-D1 3-1.

b) The Contractor must ensure that the ITS design appropriately considers the specified ITS equipment element Design Life and the nature and location of the relevant element of ITS equipment, including the potential for heavy saline presence, high humidity, airborne pollutants, temperature extremes, vibration, humidity and other environmental factors.

Table RD-ITS-D1 3-1 ITS equipment element Design Life

Element	Design Life (years)
Network fibre	30 years
Cables (fibre and copper)	25 years
Enclosures and cabinets	20 years
Electronics	15 years
Display elements	15 years
Uninterruptible power supplies (UPS)	15 years
UPS batteries	5 years
UPS generator	30 years
Other electronic power supplies	15 years
Vehicle detector loops	15 years
Field processors	15 years
ITS telecommunications network devices	10 years
CCTV cameras	10 years
Video incident detection devices	10 years
All other ITS equipment	15 years

3.4 Vandalism

a) The Contractor must ensure that the ITS equipment and wide area telecommunications network forming part of the ITS design (including pits and conduits) is designed, monitored and located so as to protect such equipment and infrastructure from unauthorised access and vandalism.

b) For the purposes of section 3.4a), the Contractor must ensure that the ITS design includes protection treatments including:

   i) field device locations being fully visible from CCTV cameras included in the ITS design;

   ii) equipment cabinet doors being monitored as required in the Contract Documents; and

   iii) pits being identified in the ITS design as lockable or secured in accordance with the requirements of RD-EL-D3 “Conduit Design for Road Lighting, Traffic Signals and ITS”.

3.5 Traveller information systems

The Contractor must ensure that where required by the Contract Documents, the ITS design provides traveller information systems including:

a) variable message signs (VMS) in accordance with the requirements of:

   i) RD-ITS-S4 “Supply of Electronic Signs”; and

   ii) Austroads AP-R341/09 Freeway Design Parameters for Fully Managed Operations;

b) expansion of the “AddInsight” traveller information platform; and

c) wayfinding and positioning enhancement systems (i.e. GPS navigation augmentation).

3.6 Maintenance access

The Contractor must ensure that the ITS design satisfies the following maintenance requirements:

a) safe maintenance access must be designed and provided in the ITS design (as specified in RD-ITS-C1 “Installation and Integration of ITS Equipment”), including:

   i) location specific drawings and access descriptions;

   ii) provision of safe sight distances; and

   iii) deceleration and acceleration zones for entry and exit from maintenance bays; and

b) the Contractor must produce a maintenance access strategy report, detailing safe maintenance access and access requirements for all ITS devices which is compliant with section 4.1b) and submitted to the Principal for approval with the ITS Design Report.

3.7 System engineering and system safety

The Contractor must ensure that all system engineering and system safety methods relevant to the ITS design are applied in accordance with the requirements of PC-EDM6 “Systems Engineering Management”.

4 ITS equipment

4.1 General

a) The Contractor must ensure that the ITS design and all ITS equipment nominated in the ITS design complies with:

   i) RD-ITS-S1 “General Requirements for the Supply of ITS Equipment”;

   ii) RD-ITS-C1 “Installation and Integration of ITS Equipment”; and

   iii) the Contract Documents.

b) The Contractor must ensure that all ITS equipment proposed by the ITS design uses a ‘Plug n Play’ modular design that permits equipment failures to be easily repaired via module replacement in the field without the need of lane or full closure of the carriageway or affecting the operation of other devices wherever possible, including all electronic signs, sensors, cameras, signals, and field processors.

c) The Contractor must submit details to the Principal of all proposed ITS equipment included in the ITS design as part of the Design Documentation, including:

   i) manufacturer, model number and equipment technical details;

   ii) rated ambient operating temperature capability;

   iii) compatibility with STREAMS (where relevant);

   iv) details of maintenance requirements;

   v) details of software licensing;

   vi) details of Design Life;

   vii) details of equipment MTBF for each replaceable module of the equipment;

   viii) details of warranties;

   ix) manufacturer specified inrush, peak and average power consumptions (watts) and electrical loads (amps);

   x) IP rating (as calculated in accordance with AS 60529 Degrees of protection provided by enclosures (IP Code));

   xi) fixing, fastening or bracketry arrangements; and

   xii) any ongoing additional operational costs including licensing, and service agreement costs.

4.2 Removal of existing ITS equipment

The Contractor must detail in the ITS design the requirement for removal of any existing ITS equipment, including:

a) proposed staging of when the existing ITS equipment will be decommissioned and removed in the construction process; and

b) whether the ITS equipment is to be:

i) permanently removed;

ii) permanently or temporarily relocated; or

iii) modified.

4.3 ITS device drivers and firmware

a) The Contractor must submit a list of all proposed required software forming part of the ITS design, including embedded software and device drivers to the Principal as part of the Design Documentation.

b) Where a proprietary software solution is proposed as part of the ITS design, the Contractor must ensure that the information submitted to the Principal pursuant to section 4.3a) includes information justifying the selection. The acceptance of the use of the proprietary software is at the Principal's discretion.

4.4 CCTV

a) If not already specified in Contract Documents supplied by the Principal, the Contractor must clarify with the Principal whether CCTV is required to be included in the ITS design.

b) The Contractor must ensure that the ITS design, as relevant to CCTV systems, complies with the requirements of:

i) the Contract Documents; and

ii) RD-ITS-S5 "Imaging Equipment".

4.5 Automatic incident detection

4.5.1 General

a) The Contractor must ensure that all video incident detection systems forming part of the ITS design comply with the requirements of:

i) the Contract Documents; and

ii) RD-ITS-S5 "Imaging Equipment".

b) The Contractor must ensure that, where forms of incident detection other than those required by RD-ITS-S5 "Imaging Equipment" are proposed in the ITS design, those incident detection systems are fully STREAMS compliant in accordance with the requirements of:

i) this Master Specification Part; and

ii) RD-ITS-C1 "Installation and Integration of ITS Equipment".

c) Where the Contractor proposes to adopt alternative incident detection technologies pursuant to section 4.5.1b), the Contractor must include details of such proposed alternative incident detection technologies in the Design Documentation and acceptance of alternate detection technologies in any application is subject to approval by the Principal as a Design Departure.

4.5.2 Video incident detection system

a) The Contractor must ensure that the video incident detection system forming part of the ITS design complies with the requirements of RD-ITS-S5 "Imaging Equipment".

b) For Tunnels, the Contractor must ensure that the ITS design includes primary incident detection systems for Tunnel environments that utilise integrated visible and infra-red spectrum based technology.

c) The Contractor must ensure that the video incident detection system design complies with the following:

i) all video feeds from the video incident detection system must also be available on the network as multicast video streams that can be viewed using the Principal's current video management system;

ii) real time alarms and associated video images must be relayed to the TMC automatically upon annunciation by the video incident detection system; and

iii) the video incident detection system must be designed to minimise false alarms in accordance with RD-ITS-S5 "Imaging Equipment".

4.5.3 In-pavement loop detectors

a) The Contractor must ensure that the ITS design provides for loop detectors at regular intervals on the main carriageway in both directions as specified in:

i) Austroads AP-R341/09 Freeway Design Parameters for Fully Managed Operations; and

ii) VicRoads Managed Motorway Design Guide, Volume 2, Parts 2 and 3.

b) The Contractor must ensure that the ITS design includes the provision of loop detectors which as a minimum are installed at the following locations:

i) locations of potential incidents and bottlenecks;

ii) downstream of merge points and areas of heavy weaving or lane changing;

iii) to detect excessive queue extension on off-ramps (minimum mid-points and toes) preventing impingement into through carriageway and end of the motorway prior to the queue extending back onto the main carriageway;

iv) at a maximum spacing interval of 500 m on the main carriageway;

v) on all entrances (on-ramps) to the motorway; and

vi) along all parallel lowered arterial roads.

c) The Contractor must ensure that the ITS design provides for vehicle detector loops on the carriageway to be installed in the following configuration:

i) 2 m loops; and

ii) pairs of loops 6 m head-to-head distance apart.

d) The ITS design must provide for the use of:

i) preformed loops on new carriageways, including entry and exit points, installed below the wearing course; and

ii) for rehabilitated or resurfaced roads, preformed or cut-in loops to be installed below the wearing course.

e) The Contractor's conduit design for the in-pavement loops must be in accordance with Department Standard Drawing S-4500, sheet 4.

f) Where the ITS design includes loops to be installed within continuously reinforced concrete pavements, the Contractor must ensure that the loop technology and installation requirements are detailed in the ITS design to meet the loop manufacturer's requirements for sensitivity and accuracy for use in this type of pavement design.

4.5.4 Alternative vehicle detection technologies

a) The Contractor must ensure that battery powered pavement embedded vehicle detection systems are not included in the ITS design.

b) Where the Contractor proposes any alternative vehicle detection technology than that required by section 4.5.3 as part of the ITS design, the Contractor must provide supporting documentation and evidence with the ITS design that the alternative vehicle detection

technology provides an overall whole of life benefit to the Principal as part of the Design Documentation, including:

i) sponsoring or submitting details of a previously conducted comparative trial of the alternative vehicle detection technology;

ii) generating a thoroughly researched trial report for the Principal's consideration; and

iii) ensuring that all requirements of Transmax Pty Ltd with respect to STREAMS integration will be satisfied.

c) The Contractor must obtain the Principal's approval to include the alternative vehicle detection technology in the ITS design as a Design Departure prior to the submission of the Detailed Design Documentation.

4.6 Electronic signs

4.6.1 General

Where the Contract Documents require the supply, installation and integration of electronic signs, the Contractor must ensure that the ITS design:

a) complies with the requirements of RD-ITS-S4 "Supply of Electronic Signs", including with respect to sign mounting arrangements and mounting structure protection; and

b) is integrated with the design of the directional sign plan.

4.6.2 CCTV coverage of sign displays

Where CCTV is being installed as a part of the Project, CCTV coverage must include coverage of all electronic sign displays which allows sign display messages to be verified.

4.6.3 Advance warning/real time information signs

The Contractor must ensure that the ITS design provides for advance warning VMS on all service road access ramps to the main carriageway, at all approach locations prior to the point of no return for entering the main carriageway.

4.6.4 Traveller information signs

a) The Contractor must ensure that the ITS design provides for traveller information signs, including VMS and CMS, to be provided in accordance with the requirements of Austroads AP-R341/09 Freeway Design Parameters for Fully Managed Operations, as a minimum.

b) The location and orientation of each VMS must be such that the message or symbols displayed on the VMS are legible and unobstructed for a minimum of 6.2 seconds by an approaching motorist travelling at the design speed of the road.

4.6.5 Variable speed limit signs and lane use management signs

a) The Contractor must ensure that the ITS design includes variable speed limit signs (VSLS) and lane use management system (LUMS) signs along the full length of the main carriageways as well as on at-grade roads upstream of any merge onto the main carriageway in accordance with the requirements of AP-R344/09 Austroads Best Practice for Variable Speed Limits: Best Practice Recommendations.

b) Spacing of VSLS and LUMS signs along the main carriageway must be no greater than 600 m.

c) Where interlocking of signs is required, the Contractor must ensure that the ITS design provides such interlocking via a common sign group controller with reference made to any specific SIL requirements.

d) For LUMS only, where;

i) an on-ramp meets the main carriageway and the on-ramp lane or lanes are managed by LUMS, or

ii) any geometric layout where merging or lane changes are not allowed (via line marking or solid barrier) and the lanes are managed by LUMS,

the LUMS for the on-ramp or merging lanes must be on separate group controllers to the main line LUMS, with permissible frames across all LUMS interlocked using STREAMS software.

e) The group controller required by section 4.6.5c) must ensure that only permissible frame sets are sent to the sign group.

4.6.6 Tunnels signs

The Contractor must ensure that the ITS design provides for Single Line VMS, for use as the Tunnel information signs system, in accordance with the requirements of AGRT Part 2: Planning, Design and Commissioning.

4.6.7 Ramp control signs

Where specified in the Contract Documents, the Contractor's ITS design must provide Ramp Control Signs in accordance with RD-ITS-D3 "Ramp Metering Systems".

4.7 Traffic signals

The Contractor must ensure that the ITS design includes a compliant traffic signal design (including any interfaces between ITS and traffic signal systems) in accordance with the requirements of:

a) RD-EL-D2 "Traffic Signal Design"; and

b) RD-GM-D4 "Traffic Analysis and Modelling".

4.8 Vehicle count and classification devices

a) The Contractor must ensure that the ITS design includes vehicle count and classification devices and associated infrastructure capable of Austroads 12-bin classification on all traffic lanes at the locations as defined in the Contract Documents.

b) The vehicle count and classification devices required by section 4.8a) must be Infra-Red Traffic Logger (TIRTL) devices manufactured by CEOS Industrial Pty Ltd.

4.9 Bluetooth capture stations

The Contractor's ITS design must:

a) include Bluetooth capture stations within all ITS cabinets (including traffic signal controller cabinets) or as nominated in the Contract Documents;

b) ensure that the nominated Bluetooth capture stations comprise an industrial DIN-mount programmable communications platform capable of Bluetooth (classic and low energy) and Wi-Fi MAC media access control address capture from passing vehicles, which must be connected into a port at the nearest network (TrafficNet) access point (Layer 2 switch);

c) include an external antenna configured to provide coverage only of the targeted road corridor and be capable of excluding other nearby roads to minimise the data collection of non-targeted road corridors;

d) ensure that Bluetooth capture stations are located along the primary road alignment with a spacing of no greater than 1000 m and at every interchange, signalised intersection and pedestrian crossing along the Project corridor;

e) ensure that for roads with grade separation, Bluetooth capture stations are located and configured to target traffic separately on surface roads and Tunnel roads;

f) ensure that Bluetooth capture stations are compatible with the AddInsight - Traffic Intelligence System 2023 protocol v3 and backwards compatible with v1/v2, including beacon and broadcast functionality; and

g) ensure that the Bluetooth capture station hardware is compatible with:

i) “Classic” Bluetooth (v2.1);

ii) Bluetooth low energy (v4.x);

iii) undiscoverable Bluetooth Classic (Bluetooth Lower Address Part only); and

iv) Wi-Fi (2.4 GHz and 5 GHz) technology.

4.10 Ramp metering

Where specified in the Contract Documents, the Contractor’s ITS design must include ramp metering in accordance with the requirements of:

a) RD-ITS-D3 “Ramp Metering Systems”;

b) RD-EL-D3 “Conduit Design for Road Lighting, Traffic Signals and ITS”; and

c) RD-GM-D4 “Traffic Analysis and Modelling”.

4.11 ITS cabinets

a) The Contractor must ensure that the ITS design includes ITS cabinets in accordance with the requirements of:

i) RD-ITS-S3 “ITS Enclosures”; and

ii) TUN-ME-DC4 “Tunnel Equipment Cabinets”.

b) The Contractor must ensure that the ITS design, with respect to ITS cabinets, complies with following:

i) individual Design Drawings must be provided for each ITS cabinet;

ii) if an item of ITS equipment cannot be seen from the ITS cabinet that controls the relevant ITS equipment, the Contractor must implement a method in the design to enable maintenance technicians to see the status and function of the relevant ITS equipment whilst undertaking maintenance activities within the ITS cabinet;

iii) ITS cabinets must not be located in the centre median;

iv) a minimum 1 m clearance must be maintained around ITS cabinets, including:

A. with cabinet doors in the open position; and

B. where ITS cabinet locations require safety or retaining structures in close proximity to the ITS cabinet;

v) the opening of ITS cabinet doors (other than traffic signal controller cabinet doors) must result in an alarm being generated at the TMC via STREAMS which identifies the ITS cabinet location and the door status (i.e. open/closed);

vi) where any other equipment cabinets such as power distribution, UPS or CCTV cabinets are located adjacent to or near (within 15 m) the ITS cabinet (e.g. in the same maintenance location), the door alarm circuit must be extended from the ITS cabinet out to the adjacent equipment cabinets monitoring all cabinet doors within any particular location. In this case, the Contractor must ensure that the alarm generated in STREAMS at a minimum identifies the equipment location and door status, but not necessarily which cabinet door is open; and

vii) wherever feasible, cabinets must be co-located in the ITS design to maximise the efficiency of safe maintenance access in the design and also the number of doors which are monitored.

4.12 STREAMS field processors

The Contractor must ensure that the ITS design provides all STREAMS field processors required in accordance with RD-ITS-S6 “Field Processors”.

5 ITS infrastructure

5.1 General

a) A detailed list of all required ITS equipment and ITS related infrastructure equipment must be included in the ITS design.

b) The ITS infrastructure design must:

i) only propose or specify ITS infrastructure, products and equipment which form part of the Department Approved Products List or which are submitted for Approval as part of the Design Documentation submission;

ii) only propose or specify standard non-proprietary “open” interfaces to facilitate ease of maintenance and the future expansion or extension of the system by others;

iii) provide redundancy (as detailed elsewhere in this Master Specification Part);

iv) be suitable for future expansion;

v) consider the Design Life of all electronic and telecommunications components;

vi) be able to use network time protocol setup on the ITS network where involved with time stamping of events;

vii) use mature technologies, and commercially available equipment; and

viii) ensure that each device has its own individual power circuit (unless dual redundant power circuits are specified elsewhere in the Contract Documents for specific equipment, in which case 2 diverse power circuits are required).

5.2 Protective treatment for roadside equipment

a) The Contractor must ensure that roadside equipment proposed by the ITS design features protective treatment in accordance with the requirements of RD-ITS-C1 “Installation and Integration of ITS Equipment”.

b) The ITS design must ensure that, all roadside ITS equipment, including field cabinets, is appropriately positioned and located outside of a crash risk zone or otherwise protected by the installation of roadside safety barriers.

c) Where the ITS design assumes the installation of road-side safety barriers pursuant to section 5.2b), the roadside barriers must extend to protect the working area around the relevant ITS roadside equipment.

d) The Contractor’s ITS design must ensure that all roadside ITS equipment, including field cabinets, is appropriately positioned and located outside of flood-prone areas.

e) Where the Project is within a designated bushfire prone area as defined in “Ministerial Building Standard MBS 008 - Designated bushfire prone areas - additional requirements”, the ITS design must identify critical asset components and define how these critical assets are protected by the ITS design, including:

i) protection within a fire-resistant structure;

ii) adequate clearance from vegetation in the vicinity of the asset; or

iii) any other means which will as-far-as-reasonable protect the critical asset from fire damage.

5.3 Power

a) The Contractor must determine the location of all power connection points required for the ITS system in conjunction with SAPN and on the basis of the Contract Documents and detail the power connection points in the ITS design. Where applicable, the connection point location must be designed in conjunction with the SAPN service relocation designs.

b) The Contractor must ensure that all ITS equipment power usage is to be metered.

c) Where the power distribution design incorporates provision for power supply to traffic signals or road lighting, the Contractor must ensure that they are fed from an unmetered supply, with the exception of Tunnel lighting and smart (controllable) lighting systems, which must be connected to a metered supply.

d) The Contractor must ensure that the ITS design satisfies the following requirements:

i) mains power must be provided for all equipment installed according to the requirements specified in RD-ITS-C2 “Mains Power Supplies for Roadside Traffic Management Equipment”;

ii) electrical switchboards (excluding those located within Tunnels) must be provided in accordance with RD-ITS-S2 “Roadside Electrical Switchboards”;

iii) electrical switchboards located within Tunnels must be provided in accordance with TUN-ME-DC4 “Tunnel Equipment Cabinets”;

iv) all equipment must support an input voltage of 230 V AC as specified in AS IEC 60038 Standard voltages, unless the equipment is specified to be or designed to be operated on ELV;

v) each ITS device must be supplied by a separate power cable individually protected by its own circuit breaker;

vi) where field devices are located more than 50 m from a cabinet supplying them with power, each field device must be capable of being easily isolated at its location, including via a local circuit breaker or fuse which is accessible from ground level;

vii) equipment power supply and communications must be derived from a common field cabinet;

viii) power supply to all equipment must incorporate protection against electrical transients and overvoltage in accordance with the requirements of:

A. AS 1768 Lightning protection; and

B. AS 4070 Recommended practices for protection of low-voltage electrical installations and equipment in MEN systems from transient overvoltages;

ix) power and signal earthing and grounding to all equipment sites which incorporate electrical equipment must be designed to minimise any incidence of equipment damage or unreliability due to electrical surges, transients and stray currents;

x) the use of a multiple earthed neutral supply configuration must be included where required in accordance with the requirements of AS/NZS 3000 Electrical installations;

xi) dedicated DIN-rail mountable electronic power supply must be provided and hard-wired to each ITS device;

xii) plug-pack type power supplies must not be included in the ITS design. Where equipment has an integral power cable which plugs directly into a GPO or an IEC socket, the plug and socket design must incorporate a method of locking or holding the plug into place, to prevent it moving or loosening over time;

xiii) where equipment incorporates the facility for dual power supplies to be connected to provide redundancy (including ethernet switches and media converter racks), dual supplies must be included in the ITS design;

xiv) power for ITS equipment located within CERs and within or powered from ITS cabinets must be supplied and controlled via a network-managed power distribution system, to allow remote power control and monitoring of connected equipment;

xv) each piece of ITS equipment must have its own controlled outlet feeding its power supply. Where multiple power supplies are provided for a single piece of ITS equipment (including redundant or power-over-ethernet supplies for network switches), each power supply must be on a dedicated output;

xvi) managed power distribution units must provide for both individual and grouped control of power outlets including:

A. power off;

B. power on;

C. automated power-cycle functions; and

D. the ability to define power-up sequences of individual outlets or groups of outlets, such that equipment can be powered up in a defined, controlled sequence after a planned or unplanned total power loss;

xvii) managed power distribution units must provide the ability to define groups of outlets to be controlled together on the same PDU or across PDU's on the same network segment;

xviii) managed power distribution units must be capable of monitoring via a secure web-based interface using SNMP v3;

xix) managed power distribution units must provide the ability to monitor at least the following:

A. power usage on a per-port basis;

B. total power usage per power rail;

C. temperature; and

D. humidity; and

xx) equipment that supports power over ethernet (PoE) (including CCTV cameras) may only be proposed or specified in the ITS design if they satisfy the following:

A. PoE equipment must be compatible with IEEE 802.3af, IEEE 802.3at or IEEE 802.3bt;

B. where PoE equipment is proposed or specified in the ITS design, the ethernet cabling chosen must be capable of handling the maximum voltage and current required by the PoE equipment at the calculated required cable length, and as specified in the relevant standard; and

C. for IEEE 802.3af and IEEE 802.3at compliant PoE equipment, the ITS design must incorporate compatible PoE switches and not incorporate mid-span power over ethernet injectors. Regardless of the power source, the ITS design must ensure that all PoE sources are capable of being remotely controlled via a network interface to allow for remote isolation or power cycling of power over ethernet-powered devices.

e) The Contractor must ensure that all ITS equipment and related communications network infrastructure forming part of the ITS system features UPS support, transient protection and appropriately designed earthing arrangements.

f) Where a generator is specified as a requirement in the Contract Documents to provide backup power to critical infrastructure (including for Tunnel infrastructure), the Contractor must ensure that the ITS design includes a list of critical infrastructure to be supported by the generator, including calculations of critical infrastructure power loads to support the sizing of the UPS and generator systems.

5.3.2 Power distribution cabinets

a) The Contractor must ensure that the ITS design complies with the requirements of:

   i) RD-ITS-S2 “Roadside Electrical Switchboards”; and

   ii) TUN-ME-DC4 “Tunnel Equipment Cabinets”.

b) The Contractor must ensure that the ITS design adopts a standard design, including the layout of equipment within the power distribution board cabinet, for all power distribution cabinets.

c) The Contractor must provide individual Design Drawings (physical layout and single line power schematics) for each power distribution cabinet, as part of the Design Documentation.

d) The Contractor must ensure that the ITS design does not locate power distribution cabinets in the centre median.

5.3.3 Backup power - TrafficNet equipment

a) The Contractor must ensure that the ITS design for backup power to TrafficNet equipment complies with the requirements of RD-ITS-D2 “TrafficNet Infrastructure Buildings”.

b) Unless otherwise specified in Contract Documents:

   i) the Contractor must ensure that the ITS design determines and identifies essential ITS equipment which requires uninterruptible power supply to be able to operate continuously without interruption; and

   ii) where a TrafficNet Infrastructure Building forms a part of a larger infrastructure installation, the Contractor must ensure that the backup power system required by section 5.3.3a) is designed to be capable of supporting all essential ITS and communications equipment required for the safe operation of the infrastructure.

5.3.4 UPS systems

a) The ITS design must include UPS as required for the Project, supporting all field equipment (nominally via UPS located in cabinets in the field).

b) The ITS design must integrate all UPS with STREAMS via:

   i) a Modbus/transmission control protocol; or

   ii) SNMP v3 interface.

c) Subject to section 5.3.4e) and section 5.3.4f), the following equipment and subsystems must be designed with an appropriately rated UPS such that they continue to function on full load for a minimum of 4 hours (or such other period nominated in the Contract Documents) during a power outage:

   i) all traffic signals containing a network access point;

   ii) all traffic signals nominated in the Contract Documents;

   iii) all field cabinets;

   iv) all ITS equipment;

   v) all communications devices which provide communications to ITS equipment; and

   vi) all racks and essential equipment within the CER (noting the requirement in clause 5.3.3 for essential equipment to also be provided with generator backup).

d) The ITS design must ensure that an appropriately sized UPS is nominated or specified which is capable of supporting the start-up loads and run modes of all devices connected, plus an additional capacity of 20%.

e) The UPS requirements of section 5.3.4c) do not apply where the relevant equipment or subsystem is also supported by a generator system which is capable of providing

uninterrupted power, in which case the relevant equipment or subsystem must be supported for the duration nominated for the generator system.

f) The UPS design must ensure that all devices are still controllable at all times from the TMC for the at least 4 hours (or such other duration nominated in the Contract Documents) via STREAMS during a power outage.

g) UPS must be designed to allow maintenance and battery replacement to be undertaken without any power interruption to the load. Batteries must be hot swap replaceable.

h) UPS systems must be designed to incorporate an automatic bypass switch to automatically switch the load to mains supply in the case of an UPS output fault to ensure continuous power to equipment and eliminating operation downtime.

5.4 ITS equipment connections

a) The Contractor must ensure that the ITS design satisfies the following ITS equipment connection requirements:

i) all ITS equipment forming part of the ITS design that integrates with or is controlled by STREAMS must communicate with STREAMS via a STREAMS compatible field processor;

ii) more than one item of ITS equipment may be connected to a single field processor;

iii) each field processor must have at least 2 spare (unused) ports, to allow for future expansion;

iv) where multiple field processors are located within the same cabinet, provision must be made for at least 2 spare (unused) ports between the field processors;

v) where a single communications cable drives more than one device, multidrop communications must not be used between field processors and ITS equipment;

vi) for rotating prism styles of CMS which have more than one CMS element in a sign face, each CMS element within such a sign must be controlled via a separate port from a common field processor; and

vii) all TIA/EIA232, TIA/EIA422 or TIA/EIA485 connections between the field processor serial port and the device serial port must comply with the specifications detailed in, and otherwise be designed according to the recommendations in, the relevant TIA/EIA standards documents and telecommunications systems bulletins, including:

A. TIA-232 Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange;

B. TIA-422 - Electrical Characteristics of Balanced Voltage Digital Interface Circuits; and

C. TIA-485 - Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems.

b) The Contractor must ensure that the ITS design colour codes twisted pair cores as follows:

i) white/blue - (field processor) command positive;

ii) blue - (field processor) command negative;

iii) orange - (field processor) return positive; and

iv) white/orange - (field processor) return negative.

c) The Contractor must ensure that the ITS design satisfies the following:

i) standards based IEEE 802.3 ethernet technology must be used for ethernet connections;

ii) the minimum data rate for ethernet connections required by section 5.4c)i) must be no less than 100 Mbps cabling;

iii) all IP equipment must connect to the network via a L2 network access switch; and

iv) where media converters are used (including to extend an ethernet connection to a single device over optical fibre), managed media converters must be used. If the Contractor proposes to use unmanaged media devices, details must be included in the Design Documentation, including evidence that such unmanaged media devices support link fault pass through.

d) Where ITS equipment is located remotely from a field processor, control or communications device, the Contractor must ensure that the ITS design includes communications links which provide full galvanic isolation between the field processor and the remote equipment. The selection of the technology for the communication links must be in accordance with the following order of precedence:

i) fibre optic cable, regardless of distance;

ii) twisted pair copper wire with appropriate surge suppression, optical isolation and grounding design at the location of both devices (notwithstanding the use of surge suppression and optical isolation devices, the field equipment must be powered from the outstation (field cabinet) which controls it). Such links must be designed in accordance with the recommendations contained in the relevant TIA/EIA serial interface standard; and

iii) wireless (4G/5G, radio or microwave), requiring approval as a Design Departure.

e) Where fibre optic cable is used to connect an ITS field device to an ITS cabinet, the ITS design must ensure that, at a minimum, there is an equal number of terminated spare fibre cores to the number of used fibre cores within the cable.

f) For fibre optic cable connection between an ITS cabinet and the backbone fibre, the ITS design must ensure that, at a minimum, there is an equal number of terminated spare fibre cores to the number of used fibre cores within the cable.

g) Directional wireless links over private property to provide communication to ITS equipment must not be used in the ITS design.

h) The Contractor must ensure that no communications related equipment (including microwave) is proposed to be installed on a hinged type or moveable pole in the ITS design.

i) As part of the Design Documentation and subject to section 5.4d)iii), the Contractor must provide evidence that any proposed wireless link design:

i) will operate correctly and reliably over the expected wireless path; and

ii) meets all ACMA requirements, and specifically for radiated power.

j) Where the ITS design proposes to use a technology other than optical fibre or twisted pair copper, the Design Documentation must include the communication link design, including details of security features applied.

k) The Contractor must ensure that the ITS design states that spare power and communications cables installed on-site are to be tested, terminated, labelled and documented in the As-Built Records.

5.5 Computer equipment room or TrafficNet Infrastructure Building

5.5.1 General

a) Where the Contract Documents include requirements for CERs or TrafficNet Infrastructure Building, the Contractor must design CERs or TrafficNet Infrastructure Building in accordance with this section 5.5.

b) The Contractor must ensure that the design of the network within the CER or TrafficNet Infrastructure Building is based on a full structured-cabling design allowing for cross-

connection of equipment without the need to run patch leads from rack to rack (whether fibre or copper).

c) The Contractor must ensure that CERs and TrafficNet Infrastructure Buildings are designed in accordance with the requirements of:

i) RD-ITS-D2 “TrafficNet Infrastructure Buildings”;

ii) Ministerial Building Standard MBS 008 - Designated bushfire prone areas - additional requirements; and

iii) the National Construction Code (NCC).

d) The Contractor must ensure that all racks to be provided within the TrafficNet Infrastructure Building comply with the requirements of this section 5.5.

e) All computer and networking equipment that is to be installed in the CERs must be rack mountable.

5.5.2 Equipment racks

a) CER equipment racks must:

i) be MFB S2005 or Rittal DK 5514.110 network server cabinets;

ii) be 45RU, 800 mm width and 1200 mm depth; and

iii) have integral vertical cable ducts (MFB P/N 03311-01) down both sides of the cabinet, front and rear.

b) The front mounting rails of equipment racks must be recessed into the cabinet to provide at least 150 mm clearance between the door and the front of the mounted equipment.

c) Equipment racks must be fitted with double vented doors front and rear.

d) Each equipment rack must be fitted with a telescopic shelf which satisfies the following:

i) the shelf must be 450 mm deep;

ii) rated to at least 45 kg (evenly distributed); and

iii) installed at a height of between 1,000 mm and 1,100 mm above floor level.

e) Equipment racks must be fitted with a manually switchable internal light mounted in the rear of the rack at the top.

f) Equipment installed in equipment racks must take account of:

i) ventilation requirements and heat load dissipation of each equipment; and

ii) maintenance access requirements.

g) Horizontal cable management facilities must be provided above and below each piece of equipment where cables are connected (front and rear).

h) Appropriate front-to-rear horizontal cable management between the vertical cable management ducts must be installed in at least 2 locations on both sides of each rack.

i) All cabling within the racks must be routed via the internal cable management systems.

j) Equipment rack cable management systems must not be filled to more than 50% capacity when all cables and equipment have been installed.

5.5.3 Equipment rack power provision

a) Each equipment rack must have power supplied from at least 2 separate dedicated circuits and be labelled accordingly.

b) Each circuit must not exceed 80% of its rated capacity in total when at peak design load.

c) Power load must be balanced across phases.

d) Equipment rack power circuits supplied form 2 redundantly configured UPS units must be configured such that a single UPS failure will not cause a total loss of power to rack-mounted equipment and:

  i) have one PDU supplied:

    A. from each UPS; or

    B. from one UPS and the other PDU directly from the generator-backed essential power feed (bypassing the UPS); and

  ii) be labelled accordingly as to being fed via 2 independent sources of supply.

e) All PDUs must be clearly labelled:

  i) with the circuit ID to which they are connected; and

  ii) which unit is backed up by UPS.

f) All power cables must be adjusted to fit without needing to be coiled up or cable tied to parts of the rack to accommodate slack.

g) Power cables carrying power to the racks must be mounted in cable trays suspended from the ceiling.

h) Power connection must be via captive power cords to prevent unintentional dislodging.

i) Power cables running between equipment and the rack mounted power rails must be at appropriate lengths so as to allow for their adequate functioning without necessitating the sequestering of the excess length inside the rack.

j) Each rack must have left side and right side mounted vertical power rails at the rear.

k) Rack-mounted equipment with dual redundant power supply units (PSUs) must:

  i) have each PSU connected to alternative PDUs; and

  ii) be provided with warning labelling indicating that it is fed via 2 independent sources.

l) Rack-mounted equipment without redundant power supplies must be connected to the UPS-fed PDU.

m) All power leads must be labelled at both ends in a manner that clearly identifies which device they are connected to.

5.5.4 CER telecommunications cabling

a) The telecommunications cabling requirements of this section 5.5.4 must apply only to CERs and equipment connected within CERs.

b) All ethernet cables within CERs must comply with the following colour coding scheme:

  i) green: generic TrafficNet ethernet segment;

  ii) purple: iSCSI network connections;

  iii) yellow: router to router (or firewall) connections that do not pass a TrafficNet boundary;

  iv) orange: serial connections (RS232/RS422/RS485) over Cat 5/6;

  v) pink: video applications (including digital video);

  vi) black: crossover cables;

  vii) blue / grey: not to be used for TrafficNet;

  viii) red: fire alarm systems and equipment only; and

ix) other colours: only by arrangement with the Principal's authorised TrafficNet representative.

c) All ethernet cables within CERs must be made to length whenever possible.

d) Connectors must be fitted with suitable strain relief to prevent stressing of the terminations within the connectors.

e) All interconnectivity between racks must be achieved using a structured cabling arrangement based on:

i) a minimum category 6 cabling designed, installed and tested in accordance with the requirements AS/NZS 11801 Information technology - Generic cabling for customer premises general requirements to Class EA (10Gbps Ethernet / 500MHz);

ii) the requirements of AS/CA S009 Installation requirements for customer cabling (Wiring Rules); and

iii) the structured cabling system having at least 100% extra capacity.

f) One equipment rack must be dedicated as a "distribution frame" or "patch bay" rack for ethernet cabling.

g) All structured cabling entering or exiting the CER or interconnecting racks must terminate in the ethernet cabling rack required by section 5.5.4f).

h) One equipment rack must be dedicated as a "distribution frame" or "patch bay" for optical fibre.

i) All optical fibre structured cabling entering or exiting the CER or interconnecting racks must terminate in the optical fibre rack required by section 5.5.4h).

j) Telecommunications cables must be labelled in accordance with the requirements of RD-ITS-C3 "Telecommunications Cabling".

5.5.5 CER cable routing

a) The cable routing requirements of this section 5.5.5 must apply only to CERs and equipment connected within CERs.

b) All cabling entering or leaving racks must be via an overhead cable ladder.

c) Cable ladders must be provided at 450 mm above the cabinets along the axis of the cabinet bay or row.

d) Transverse cable ladders (perpendicular to the cabinet row) must be provided 900 mm above the cabinets.

e) Separate cable ladders must be provided for:

i) copper data (Ethernet) cables;

ii) fibre optic cables; and

iii) electrical or power cables.

f) Cable ladders must not be filled to more than 50% capacity.

g) Vertical cable ladder extensions must be provided between:

i) longitudinal and transverse ladders; and

ii) longitudinal sections and each rack.

h) Cable management and cable ladder bend radii must be designed and supplied to ensure cable manufacturer's specified minimum bend radius is not violated.

i) Where cables are retrospectively installed within an existing CER and separate ladders required by section 5.5.5e) cannot be provided, the cables must be segregated as follows:

i) power and data cables must be kept sufficiently far apart that they do not interfere with each other either physically or electrically (direct or induced);

ii) copper and optical fibre cables must be segregated; and

iii) the segregation must be accommodated for and enforced by the nature of the cable tray carrying the cables and must not rely on cable ties or similar mechanisms.

5.5.6 Server console access

The Contractor must ensure CER servers are provided with the following console access requirements:

a) provision must be made for console access to all servers;

b) server hardware that incorporates a separate “lights-out management” facility such as Dell’s iDrac Enterprise (or equivalent) must be adopted;

c) where Dell servers with iDrac Enterprise facilities are supplied pursuant to section 5.5.6b), the iDrac port must be configured and connected to the network to provide remote console access;

d) the network configuration required by section 5.5.6c) must be agreed with the Principal’s authorised TrafficNet representative; and

e) if the Contractor supplies servers pursuant to section 5.5.6b) which do not provide the iDrac Enterprise facility, a rack-mounted internet protocol-based keyboard-video-mouse shelf must be supplied and installed to provide local console access to all such servers.

5.5.7 Network equipment console server

a) The Contractor must provide a TCP/IP connected terminal console server that will provide “out of band” console access to all network equipment installed in a computer equipment room.

b) The terminal console server required by section 5.5.7a) must:

i) have sufficient ports to connect to the console port of each network switch or router, plus at least 6 spare ports for future expansions or additions;

ii) provide redundant network connections via at least 2 different methods (e.g. ethernet, 4G/5G). Note that the Contractor is not required to provide the SIM card for any such connection;

iii) be capable of strong encryption of any traffic passing over a third-party network (e.g. a cellular mobile telephone network); and

iv) be cabled to the console port of each networking device (router, firewall, or switch) via the CER’s structured inter-rack cabling.

c) The Contractor must ensure that all such connections are documented as part of the patching records to be completed and supplied by the Contractor as part of the As-Built Records.

5.6 Communication cable and cable support

a) The Contractor must ensure that enclosures and cabinets that incorporate conduits for entry of telecommunication cables comply with the requirements of AS/CA S009 Installation requirements for customer cabling (Wiring Rules).

b) The Contractor must ensure that the ITS design includes the following elements relevant to the ITS communications network:

i) new conduit and pit systems for ITS communications network fibre-optic cable must be installed along the full length of the Project, including for ITS devices on approach roads;

ii) where the ITS communications network adjoins or is in reasonable proximity (i.e. within 150 metres) to an existing Principal ITS network, the new conduit and pit systems must be integrated to the existing ITS network; and

iii) ITS cabinets must be provided in accordance with section 4.11.

c) The Contractor must ensure that the ITS design includes spare conduits in accordance with the requirements of RD-EL-D3 “Conduit Design for Road Lighting, Traffic Signals and ITS”.

d) Where trenches are required for purposes other than ITS communication network cabling (including to ITS equipment located off the backbone or for road lighting which does not use the backbone trench), one spare communications conduit, with a minimum diameter of 100 mm, must be installed in the trench and connected to the ITS backbone conduit system. The conduit must terminate in a pit no smaller than P4 at the end of the trench.

e) In addition to this section 5.6, the Contractor must also ensure that the communication cables and cable support in the ITS design comply with the requirements of:

i) RD-ITS-C3 “Telecommunications Cabling”; and

ii) RD-EL-D3 “Conduit Design for Road Lighting, Traffic Signals and ITS”.

6 ITS communications network

6.1 General requirements

a) The ITS communications network forming part of the ITS design must be compatible with, and connect to, the Principal’s existing ITS infrastructure.

b) All data streams, including digital video and audio streams, must be transmitted with correct levels of services between the field and the relevant destination.

c) The ITS design must state that specified spare fibre cores are terminated and tested to the same specification as utilised fibre cores, so that they are immediately useable.

d) The ITS communications network must be designed in accordance with:

i) RD-ITS-C1 “Installation and Integration of ITS Equipment”;

ii) RD-ITS-C3 “Telecommunications Cabling”; and

iii) RD-ITS-S5 “Imaging Equipment”.

e) The design of the ITS communication network must be aligned with a 3-tiered redundant connection “Core Metropolitan Area Broadband Network, Distribution and Access/Field Network” design, as further detailed in Appendix 1: ITS Network Reference Design.

f) Connectivity between the field and the core must be firewalled.

g) The ITS telecommunication network:

i) must provide full-duplex connectivity between the TMC and an ethernet port at the network access point;

ii) must be of modular design to facilitate future network expansion at minimal cost; and

iii) must allow the connection of network equipment from multiple suppliers.

h) All network-connected equipment must support both dynamic host configuration protocol and static IPv4 and IPv6 addresses.

i) “Uplink” (backbone) ports between field switches and from field networks to the CER must be configured as 802.1q trunk ports.

j) All VLANs must be tagged.

k) The trunk “native” VLAN must not be used.

6.2 Functional requirements

a) The ITS communications network must be capable of transmitting all data between ITS equipment in the field and both:

i) the TMC; and

ii) the BTMC.

b) The ITS communications network must provide a high level of availability with a MTBF that exceeds required lifetimes.

c) The Contractor must fully document the designed network availability in the ITS design and submit the MTBF calculations as part of the Design Documentation.

d) The following dynamic routing requirements must be satisfied:

i) dynamic routing protocols must be used on Layer 3 links to manage routing within the Project and to the backhaul network;

ii) the dynamic routing protocols required by section 6.2d)i) must integrate with or extend those already used on TrafficNet;

iii) neither Routing Information Protocol (RIP) nor Routing Information Protocol Next Generation (RIP-NG) may be used;

iv) the routing protocol used must support, and be configured for, sub-second failover or convergence in the case of a network link failure;

v) Layer 3 network links must be configured to detect a failure of Bidirectional Forwarding Detection. This must be integrated with the dynamic routing protocol to facilitate the fastest possible routing protocol reconvergence after a network link failure;

vi) IP addresses must be allocated to maximise the opportunity for route summarisation;

vii) route summarisation must be used as far as is practicable to minimise routing table size; and

viii) route redistribution must be avoided unless absolutely necessary. Wherever possible, routes should be advertised natively rather than as redistributed routes.

6.3 Performance requirements

a) The Contractor must ensure that the ITS design satisfies the following network bandwidth and throughput requirements:

i) the operation of ITS equipment forming part of the ITS design must not be compromised by bandwidth or latency limitations of the ITS communications network under full utilisation conditions, including projected future data traffic;

ii) “end to end” network latency for the ITS network designed by the Contractor must not exceed 10 ms with the ITS network loaded to its full, expected worst-case load (network latency must be tested using a “ping” test to end devices from a workstation or laptop connected to an access layer switch in the CER);

iii) overall latency from an end device to the TMC or BTMC must not exceed 30 ms (to be tested from a workstation at the TMC and BTMC);

iv) CCTV video and control data must use IP (internet protocol) and be transmitted over the same communications channel as all other data. Quality of service mechanisms must be used to give priority as required for the data packets;

v) network load calculations must be performed by the Contractor, and the Contractor must select network equipment models and licensing in accordance with the above requirements;

vi) the Contractor must perform network load calculations for each field network ring, the CER network, and the expected worst-case inter-site traffic;

vii) the network load calculations must be incorporated in the Design Documentation, along with the proposed network equipment list;

viii) firewalls must be capable of processing the full expected network load (plus at least 50% headroom for future growth and expansion) in real time;

ix) where a firewall cluster is used, each member of the cluster must be capable of handling the full bandwidth (plus the specified headroom) if other cluster members fail (e.g. if the calculated worst-case network bandwidth crossing the firewall cluster is 800 Mbps, all cluster members must be capable of passing and processing the full 800 Mbps bandwidth); and

x) the bandwidth of each connection to the firewall (from the field Layer 3 switch and the distribution switch) must be sized to carry the full, worst-case network load in the case that it is the only active port (e.g. if the overall field network bandwidth exceeds 1 Gbps, this will necessitate 10 Gbps links between the firewall and the Layer 3 switches); and the ITS communications network forming part of the ITS design must be capable of carrying all projected (worst-case) data generated or consumed by ITS equipment forming part of the Project (including CCTV, incident detection, PMCS/PLC systems, and other required data streams) with at least 100% headroom capacity for future expansion without exceeding jitter of 30 ms or the specified latency).

b) Unless specified otherwise in Contract Documents, the Contractor must ensure that the ITS communications network forming part of the ITS design (including any PMCS/PLC network) provides a high level of availability of a minimum 99.995%. The Contractor must provide evidence that the ITS equipment specified in the ITS design meets the highest industry standards for reliability and performance as part of the Design Documentation.

6.4 Security requirements

a) TrafficNet is gazetted as State Government critical ICT infrastructure and as such, falls within the scope of The South Australian Cyber Security Framework (SACSF). The Contractor must ensure that the design of any ITS which includes or interfaces with TrafficNet complies with:

i) SACSF Guidelines; and

ii) South Australian Government Department of Premier and Cabinet (DPC) requirements for connection.

b) The Contractor must ensure that the network equipment proposed in the ITS design complies with the Principal's requirements for authentication, authorisation, accountability and data integrity (TrafficNet Procedures TP007 and TP016 will be provided by the Principal during the design).

c) The Contractor must ensure that the ITS design satisfies the following security requirements for the network equipment and data transfer:

i) any data that is to travel over third-party links must be encrypted (whole payload encryption not just header) with an IPSec tunnel between the sites. For the purposes of this requirement, a third-party link is defined as one where the Principal does not have control over all active devices in the end-to-end data transmission path;

ii) all equipment attached to the network that is managed remotely must support secure protocols including SSH (v2 or later) and HTTPS with the ability to disable any insecure protocols that it might support;

iii) all equipment that is part of the network operation must support remote management;

iv) all equipment must support the ability to take offline or disable any portion or segment of the equipment that is not required to be in use at any time (including the ability to remotely disable and enable ports on switches, routers and firewalls);

v) access to any equipment must be via an authorised username and password exchange authentication mechanism, and at no time is this exchange to be carried "in the clear" or via "clear text" forms of exchange;

vi) any equipment that requires authorisation to access must support the ability to remotely verify the appropriate credentials (including via a RADIUS (server authentication mechanism));

vii) all network communications must be IEEE 802.3 ethernet and the protocols IP based;

viii) all cabinets, racks and other housings in which equipment is to be stored must have intrusion detection systems present that alarm when physical access is obtained (these systems must be compatible with the TMC's STREAMS system);

ix) all equipment and CERs are to be kept under 24x7 video surveillance with 100% coverage at all times, without the need to pan or tilt the CCTV systems in order to obtain this 100% coverage;

x) any location on the network where equipment is installed that will allow for network access to occur must be able to be monitored via CCTV from the TMC; and

xi) the ITS design must allow for remote access to devices connected to TrafficNet only via a secure VPN connection using 2 factor authentication, in accordance with TrafficNet policy documents TP014 and TP022.

6.5 Network architecture

6.5.1 General

a) The Contractor must submit the proposed ITS communications network concept design as part of the Design Documentation. Appendix 1: ITS Network Reference Design is provided for information in this regard, noting that while the concept diagram shows only 4 Layer 2 field rings, the Contractor's proposed ITS communications network architecture must comprise sufficient rings to ensure reliability and redundancy.

b) The Contractor must ensure that the ITS design satisfies the following network architecture requirements:

i) all connections from CERs to the field and between field cabinets (including to devices that are not co-located with their associated field cabinet) must be made using single mode optical fibre;

ii) wireless links must not be used, except in cases where a fibre connection is not reasonably practicable as agreed to by the Principal (the distance or the need to trench or bore outside a project boundary is not to be used as a determinant of what is "reasonably practicable");

iii) microwave backhaul links must not be used, except in cases where a fibre connection is not reasonably practicable as agreed to by the Principal based on the following:

A. a suitable redundant path fibreoptic link in the Principal's existing network is not available;

B. they are allowed for in the Contract Documents; and

C. the Contractor's ITS design includes detailed calculations to support the capacity and reliability of the microwave link;

iv) the ITS communications network must comprise the following:

A. ITS backbone fibre-optic cable along each side of the Project's main alignment for its full length;

B. network access switches providing multi-port ethernet connectivity to allow connection of ITS field equipment;

C. network access switches incorporated in a Layer 2 expanded ring topology;

D. ITS cabinets used to house network access switches and associated equipment communications cable equipment; and

E. a backhaul link between the CER and the TMC (the ITS design must extend the Metropolitan Area Broadband Network (MABN) to CER via diverse connectivity);

v) the field network must provide full redundancy and high-availability to each field cabinet using rapid spanning tree protocol (redundant ethernet protocol may be used if supported);

vi) individual spanning-tree instances per VLAN must be supported;

vii) the primary (backbone) network rings must be constructed as expanded rings with geographic diversity for the redundant path; and

viii) unless explicitly allowed for in the Contract Documents "collapsed rings" must not be used with the exception of spurs from the mainline network to field cabinets.

c) The ITS design must make a distinction between:

i) spare fibre cores (those that will be terminated and available for immediate use);

ii) unused fibre cores (those that are not allocated once used and spare fibre cores have been allocated); and

iii) dark fibre cores (those that will be left unterminated e.g. fibre cores that are not contiguous due to being used for device-to-cabinet connections along part of their length).

6.5.2 Core network (MABN)

The Contractor must ensure that the ITS design satisfies the following core network (MABN) requirements:

a) the core network must provide Layer 3 connectivity to the rest of TrafficNet (via the MABN and inter-site routing (including route summarisation));

b) the telecommunications network proposed by the ITS design must utilise the MABN for back haul communications purposes between the site located CER and both the TMC and BTMC;

c) TrafficNet (MABN) backhaul links must provide high availability and redundancy using multiple geographically diverse links to the nearest or most logical existing MABN-connected site or sites;

d) the location of interconnections to the existing MABN must be:

i) as stipulated in the Contract Documents; or

ii) proposed by the Contractor and submitted as part of the Design Documentation;

e) the ITS design must ensure integration with the existing MABN systems including:

i) 2 x 10 GB MABN ring core connectivity, including:

A. redundant core switches at the CER;

B. redundant CER routers and distribution switches;

C. redundant firewalls; and

D. redundant field connection switches;

ii) network monitoring and management;

iii) network time protocol;

iv) dynamic name system; and

v) the deployment of an optical fibre expanded self-healing ring network topology utilising both fibre trenches located at each side of the main carriageway alignment for its entire extent to carry the primary backbone between the CER and the field equipment;

f) MABN switches must be individual switches, not stacked;

g) inter-site routing must be provided by 2 site routers separate from the MABN switches; and

h) each site router must be capable of routing in real time the full expected worst-case network load if the other fails or is taken offline.

6.5.3 Distribution network

The Contractor must ensure that the distribution network forming part of the ITS design, satisfies the following requirements:

a) the distribution network must provide intra-site routing between VLANs;

b) the distribution network must utilise Layer 3 switches in a geographically diverse redundant arrangement, utilising virtual stack arrangement;

c) Layer 3 switches in the distribution network must support zero-downtime upgrade and hot-standby redundancy with stateful switchover, either by use of:

   i) a Layer 3 switch incorporating redundant route processors; or

   ii) a Layer 3 switch stack;

d) each member of the distribution switch stack must be capable of switching and routing the full expected worst-case network load should the other member fail or be taken offline;

e) where the Layer 3 switches are located within the same structure, the Layer 3 switches must be 2 hour fire separated;

f) the fibre cable used for the distribution network between Layer 3 switches must:

   i) contain not less than 48 fibre cores with a minimum of 50% of the installed cores being retained as spare cores; or

   ii) where the Layer 3 switches for distribution network are geographically separated along the motorway, the field network requirements for fibre cabling in section 6.5.5 must apply to the distribution network fibre cabling; and

g) the connection between Layer 3 switches for the distribution network must be in a self-healing expanded ring arrangement.

6.5.4 Access network

The Contractor must ensure that the access network forming part of the ITS design, satisfies the following requirements:

a) the access network must utilise Layer 2 switches;

b) the access network must provide connections to devices located within or around TrafficNet Infrastructure Buildings (including, servers, workstations, CCTV cameras, UPS and generators), with traffic being functionally separated using VLANs;

c) access switches are connected to the Layer 3 switches in distribution network with port aggregation (ether channel/port channel) controlled using link aggregation control protocol;

d) redundant access network switches are used to connect servers to the distribution network;

e) each device group has a separate access network switch; and

f) a single access network switch is provided for connection to lights-out device management services and managed rack power rails.

6.5.5 Field networks

The Contractor must ensure that the field network forming part of the ITS design, satisfies the following requirements:

a) the field network must utilise Layer 2 switches;

b) the field network must provide network access points for the connection of field devices located along the motorway;

c) the ITS design must ensure that connectivity between the field network and the distribution network is firewalled;

d) the fibre cable used for the field network backbone must contain not less than 144 fibre cores with a minimum of 50% of the installed cores being retained as spare cores. This fibre cable must run through the full geographical length of the Project;

e) the ITS design must ensure that:

   i) the ITS field network backbone consists of a fibre-optic cable and associated network equipment, and must extend along both sides of the road corridor for the entire extents of the Project;

   ii) the ITS field network backbone is configured as a self-healing expanded ring arrangement;

   iii) there is a maximum number of 7 Layer 2 switches in any field network ring;

   iv) the network rings must be “interleaved” (e.g. odd numbered cabinets on one ring and even numbered cabinets on the alternate) to avoid loss of control or visibility of an entire section of road with the loss of an entire ring; and

   v) each field network terminates at 2 Layer 3 switches;

f) a stateful firewall must be provided to isolate the field network from the CER network. Firewall redundancy must be provided through clustering. Clustering must be configured in accordance with the manufacturer’s best-practice recommendations;

g) the firewalls required by section 6.5.5f) must be configured to:

   i) allow all outgoing connections from TrafficNet to the field networks; and

   ii) block all connections from the field network into TrafficNet except those required for normal equipment operation;

h) at least one network switch is provided in every ITS field cabinet;

i) the network switches have sufficient ports for each device in the field cabinet, plus:

   i) 2 uplink ports; and

   ii) at least 3 spare ports once all devices are connected (for future expansion or additions and technician maintenance access);

j) for remote cabinets associated with network connected devices not co-located with an ITS cabinet (including pole-mounted CCTV cabinets or VMS cabinets), a managed network switch must be provided to allow for technician maintenance access as well as device connection. The requirements for port count specified in section 6.6.1f) apply equally to this section 6.5.5j);

k) the level of provision of network access points must be included in the Preliminary Design Documentation;

l) the connection between ITS field equipment and the ITS communication field network must satisfy the following requirements:

   i) CCTV cameras must connect to the network via a Layer 2 network access switch;

   ii) IP equipment (other than CCTV cameras addressed in section 6.5.5l)i)) must:

      A. connect to the network via a Layer 2 network access switch; and

      B. communicate via the same switch as the field processor; and

   iii) industry standard patch leads must be used to connect all equipment in accordance with the requirements of RD-ITS-C3 “Telecommunications Cabling”;

m) electrically isolated communication links must be used where fibre optic cable is to be used to connect an ITS field device to a network access point either by direct connection or via a media converter, a fibre optic cable with minimum 12 cores must be included in the ITS design; and

n) the field network must be designed to separate traffic using VLANs based on role, purpose, or function (e.g. separate VLANs for network switch management, CCTV, incident detection devices, STREAMS, ramp metering, SCATS and Bluetooth).

6.6 Network equipment

6.6.1 General requirement

The Contractor must ensure that network equipment selected as part of the ITS design satisfies the following requirements:

a) the network equipment must be capable of achieving the functional, performance and security requirements specified in this Master Specification Part;

b) the network equipment must be selected to ensure that the ITS communication network can be configured in accordance with the requirements of RD-ITS-C1 “Installation and Integration of ITS Equipment”;

c) the proposed or specified network equipment must use non-proprietary communication protocols;

d) hot-swappable equipment and redundant power supplies must be specified for network equipment;

e) all networking equipment must support the internet protocol (IP) suite of protocols including:

   i) IPsec;

   ii) IPv4;

   iii) IPv6;

   iv) Internet Control Message Protocol;

   v) Simple Network Management Protocol version 3; and

   vi) Internet Group Management Protocol (multicast) versions 2 and 3;

f) the following requirements regarding network device management must be satisfied:

   i) all active network devices in ITS communication network must be managed devices;

   ii) all network-connected devices must support monitoring via SNMP version 3 with authorisation and privacy enabled;

   iii) all network-connected devices must support remote logging using the “Syslog” protocol. Details of the Principal’s syslog servers will be provided by the Principal on request from the Contractor together with the IP address assignments required by section 6.6.1f)i); and

   iv) Layer 2 network links must provide a means of detecting and raising alarms for unidirectional network links (Unidirectional Link Detection);

g) physical interfaces provided at the point of access on network equipment must utilise industry-standard connections. Physical interconnections must be captive (in the following order of preference):

   i) automatic “click” type (such as RJ-45);

   ii) manual “click” type; and

   iii) screw-type;

h) the network equipment must provide indication for following network parameters or status information at the physical interfaces (e.g. by light emitting diodes at physical port):

   i) link integrity;

   ii) disabled;

iii) activity;

iv) full-duplex indicators for each port; and

v) system power;

i) all network equipment must adhere to the requirements of:

i) Institute of Electrical and Electronics Engineers, Internet Engineering Task Force (IETF); and

ii) International Organization for Standardization (ISO) standards,

without the use of proprietary technologies;

j) all networking equipment must include programmable “Application Specific Integrated Circuits” which must be compatible with Cisco’s “Dynamic Network Architecture Software-Defined Networking” fabric, and support network automation using open standards including network configuration protocol (NetConf) and representational state transfer configuration protocol (RESTConf) application programming interfaces; and

k) all stacked switch arrangements must support, and be configured for, zero-downtime software upgrades (also known as in service software update or ISSU), as well as hot-standby redundancy with stateful switchover (SSO).

6.6.2 Layer 2 switches

The Contractor must ensure that the ITS design satisfies the following Layer 2 switch requirements:

a) field network rings must utilise 802.1 w rapid spanning tree protocol to prevent switching loops;

b) per-VLAN RSTP or multiple spanning tree protocol extensions may be used;

c) the selected protocol must be configured for the minimum possible convergence time; and

d) where Layer 2 switches are stacked, each member of the switch stack must be capable of switching the full, worst-case network load in the case of the other stack member failing or being taken offline (including for maintenance).

6.6.3 Routers and Layer 3 switches

The Contractor must ensure that the ITS design satisfies the following router and Layer 3 switch requirements:

a) Layer 3 network switches terminating Layer 2 networks that carry video streaming traffic must support “Protocol Independent Multicast Snooping” on a global or per-VLAN basis;

b) all Layer 3 network switches and routers must support;

i) multicast routing using Protocol Independent Multicast Sparse Mode (PIM-SIM);

ii) PIM bootstrap router protocol (PIM-BSR); and

iii) must be able to dynamically learn of (and advertise) multicast “Rendezvous Points” using the PIM-BSR protocol;

c) Layer 3 switches and routers must support, and be licensed for, the following dynamic routing protocols as a minimum:

i) enhanced Interior Gateway Protocol (EIGRP - full implementation - not “stub only”) for IPv4 and IPv6;

ii) Open Shortest Path First (OSPF) for IPv4 and IPv6; and

iii) Intermediate System to Intermediate System (IS-IS);

d) field network rings must be terminated on a Layer 3 switch stack in a CER and the Layer 3 switch stack used must satisfy the following requirements:

i) it must provide inter-VLAN routing for the field network and be the default gateway for the field networks;

ii) it must support dynamic routing protocols compatible with those already in use on TrafficNet; and

iii) it must support and be configured for zero-downtime software upgrades (also known as in-service software update or ISSU), as well as hot-standby redundancy with stateful switchover (SSO);

e) where Layer 3 switches are stacked, each member of the switch stack must be capable of switching the full, worst-case network load in the case of the other stack member failing or being taken offline (including for maintenance); and

f) all network edge devices intended to connect to foreign networks must support “Border Gateway Protocol” (BGP) for both IPv4 and IPv6.

6.6.4 Wireless network devices

If the Contractor’s ITS design includes any proposal for wireless communications, the following must be addressed in detail in the ITS design and submitted as part of the Design Documentation:

a) antennas are positioned so that ongoing line of sight to the opposite communication partner is guaranteed at all times;

b) the installation of antennas does not impact traffic or pedestrians;

c) antennas must be placed on structures that protect the equipment from unauthorised access and vandalism;

d) easy and safe access for maintenance staff must be allowed for in the design and documented in the maintenance access strategy report required by section 3.6;

e) antennas must be connected to the related equipment via industry standard connectors;

f) antenna gains must be within the legal limits as specified in the relevant legislation. For Class-Licensed Equipment in the 900 MHz, 2.4 GHz, 5.4 GHz, and 5.8 GHz bands, the relevant legislation is the Radiocommunications (Low Interference Potential Devices) Class Licence 2000;

g) the maximum wind loading of antenna equipment must be appropriate for the specific wind speed and terrain categories of the proposed equipment location, as specified in AS 4055 Wind loads for housing;

h) antennas must be fitted with suitable surge protection to protect connected network and ITS equipment in the event of surges or lightning strikes;

i) the antenna site must be designed to minimise the risk of occupational or public exposure to radiation, in accordance with the principles outlined in ARPANSA RPS S-1 Radiation Protection Standard for Maximum Exposure Levels to Radiofrequency Fields - 3 kHz to 300 GHz (2021); and

j) evidence of compliance with section 6.6.4i) must be verified and compliance records provided as part of the Design Documentation in accordance with the requirements of Standard for Limiting Exposure to Radiofrequency Fields - 100 KHz to 300 GHz (Rev 1), Australian Radiation Protection and Nuclear Safety Agency (ARPANSA).

6.6.5 Firewall devices

a) Firewall devices for the field network must support dynamic routing protocols compatible with those already in use on TrafficNet, including:

i) Enhanced Interior Gateway Protocol for IPv4 and IPv6;

ii) Open Shortest Path First (OSPF) for IPv4 and IPv6; and

iii) IS-IS.

b) All firewall devices must support multicast routing using “Protocol-Independent Multicast Sparse Mode” and must be able to dynamically learn of (and advertise) multicast “Rendezvous Points” using the “Protocol-Independent Multicast Bootstrap Router” protocol.

6.6.6 Licensing and support for proposed network equipment

a) All proposed or specified ITS network equipment included in the ITS design must be capable of being covered by a manufacturer support agreement as required by PC-CN3 “Construction Management”, RD-ITS-S1 “General Requirements for the Supply of ITS Equipment” and RD-ITS-C1 “Installation and Integration of ITS Equipment”.

b) All ITS network equipment proposed or specified in the ITS design must:

i) have a published product life cycle (e.g. a published on sale, end of sale notice, end of sale, and end of support cycle) and be on sale or be current equipment at the time of the inclusion in the ITS design;

ii) not have a published end of sale or end of support notice at the time of proposal in the ITS design; and

iii) be supported by the supplier for the entire specified Design Life at the time of inclusion in the ITS design.

c) The Contractor must supply licences for each network-connected device to connect to:

i) the Principal’s automated security monitoring systems; and

ii) the Principal’s automated network performance monitoring systems.

d) The licences required by section 6.6.6c) must:

i) be in the form of network flow licensing or device licensing;

ii) support 5 years of operation;

iii) be quantified and the type and quantities submitted with Design Documentation for approval; and

iv) include, but is not limited to, the following device types:

A. routers;

B. switches;

C. firewalls; and

D. as required by the Contract Documents.

e) The Contractor must liaise with the Principal to determine currently used systems including:

i) the automated security monitoring systems; and

ii) the automated network performance monitoring systems.

6.7 Server equipment

The Contractor must ensure that all network servers included in ITS design satisfy following requirements:

a) the network servers must provide “lights-out” management capability via an integrated management card with a dedicated network interface that is separately configured from the main server network interfaces;

b) the “lights-out” management card required by section 6.7a) must:

i) remain operational when the network server is powered off, as long as there is power available at the network server’s power supplies; and

ii) provide full control and monitoring of the network server hardware, including a “virtual console” that allows remote access to the network server as if connected via a local monitor; and

c) each network server must include dual power supplies.

7 Site layout

a) Further to the requirements of RD-ITS-C1 “Installation and Integration of ITS Equipment”, the Contractor must ensure that the ITS design, as applicable to site layout, facilitates the achievement of the following objectives:

i) provides safe access to the site, and protection while on site, for personnel undertaking maintenance;

ii) minimises the requirement for traffic restrictions (including speed and lane restrictions);

iii) minimises the requirement for specialist access equipment;

iv) enables maintenance and inspection to be undertaken efficiently and safely;

v) minimises unauthorised access and damage from vandalism; and

vi) minimises the probability of damage or injury to maintenance staff from out of control vehicles.

b) The Design Documentation must include plans showing the physical layout at each site where ITS equipment will be installed. The Design Documentation must show:

i) general layout;

ii) reduced levels and inclines;

iii) equipment position;

iv) coordinates or offsets;

v) speed zones;

vi) conduit and pit sizes, usage (e.g. communications, power etc) and locations;

vii) mounting structure positions and foundation details;

viii) any protective barriers; and

ix) details of site access as required by RD-ITS-C1 “Installation and Integration of ITS Equipment”.

c) The Contractor must ensure that verge treatments for barriers and conduits in the ITS design are in accordance with the requirements of RD-ITS-C1 “Installation and Integration of ITS Equipment” to provide effective solutions to meet ITS equipment needs and ensure safe maintenance access.

8 Design of support structures

8.1 General

The Contractor’s ITS design of support structures associated with ITS equipment and infrastructure must ensure that:

a) support structures are designed in accordance with the requirements of this section 8;

b) mounting brackets or holes for attachment of equipment (including any brackets, ducts or holes for cables) are incorporated into the support structure design to minimise the need for subsequent drilling or welding;

c) mounting arrangements for equipment to be mounted on structures are designed to allow for any necessary aiming and orientation of the equipment during or post installation;

d) the mounting structures are easily and safely accessible for inspection and maintenance purposes;

e) the access system prohibits access by unauthorised personnel;

f) the access system and platform provide for secure mounting points for effective rescue of incapacitated personnel from the platform;

g) the support structures must generally be of the same form and be aesthetically compatible with any other similar structures on the adjoining road network;

h) the design of the support structures and footings is undertaken by a chartered Professional Engineer who is suitably experienced in the design of such structures; and

i) the design of the support structures is verified in accordance with AS 9001: Clause 7.3.5 “Design and Development Verification”.

8.2 Design requirements

a) The Contractor must ensure that all support structure design and documentation forming part of the ITS design is undertaken in accordance with the structural requirements of the Contract Documents, including ST-SD-D1 “Design of Structures”.

b) The Contractor must ensure that all support structures are designed for the Design Life specified in ST-SD-S1 “Design of Structures”.

c) The Contractor must ensure that gantries and major support structures required for ITS equipment satisfy the following requirements:

   i) large signs supported on tubular single posts, tubular cantilever supports or gantries must comply with the requirements of:

      A. AS 1742.2 Manual of uniform traffic control devices, Part 2: Traffic control devices for general use; and

      B. AS 1742.15 Manual of uniform traffic control devices, Part 15: Direction signs, information signs and route numbering; and

   ii) VMS mounted on major support structures must have a ladder and service access platform in accordance with part RD-ITS-S4 “Supply of Electronic Signs”.

9 Testing and commissioning, handover

The Contractor must ensure that the ITS design incorporates all elements necessary to meet the requirements of:

a) testing and commissioning and handover as detailed in:

   i) RD-ITS-C1 “Installation and Integration of ITS Equipment”; and

   ii) PC-CN1 “Testing and Commissioning”;

b) software licensing and software and hardware service and support agreements; and

c) digital engineering and asset management requirements as required by PC-EDM5 “Digital Engineering” and PC-CN2 “Asset Handover”.

10 Warranty and spares

The Contractor must ensure that the ITS design incorporates all elements and information necessary to meet the requirements of warranty and spare parts as specified in RD-ITS-S1 “General Requirements for the Supply of ITS Equipment”.

11 Hold Points

Table RD-ITS-D1 11-1 details the review period or notification period, and type (documentation or construction quality) for each Hold Point referred to in this Master Specification Part.

Table RD-ITS-D1 11-1 Hold Points

Section reference	Hold Point	Documentation or construction quality	Review period or notification period
3.2.2d)	Evidence of TMC written approval and endorsement of proposed Transmax Pty Ltd STREAMS integration works	Documentation	10 Business Days review

12 Appendix 1: ITS Network Reference Design