

Schedule 5(b)

Digital Communications Network

California High-Speed Rail Authority



Standard Specifications

TSCC Specifications

SPEC-0006 – Digital Communication Network (DCN)

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1 INTRODUCTION

1.1 Scope of the Technical Specification

- 1.1.1 The scope of this Technical Specification is to define the Authority's Requirements for the Digital Communication Network (DCN) system, hereinafter: DCN.
- 1.1.2 This Technical Specification is based on the Authority's Design Criteria Manual (DCM) Chapter 12: Communication Systems and Train Control.
- 1.1.3 The functional architecture of the DCN is presented in Appendix A.
- 1.1.4 The requirements are formulated using the following words and their meanings:
- "Shall": Indicates a mandatory requirement that must be strictly implemented; a waiver from a mandatory requirement is permissible only with approval of a design variance.
 - "Should": Indicates a preferred course of action; a design variance is not required if it is not exercised.
 - "Must": Indicates an obligation or a mandatory requirement.
 - "May": Indicates a permissible course of action within the limits of the standards; a design variance is not required if it is not exercised.



2 REFERENCE STANDARDS AND DOCUMENTS

2.1 General

- 2.1.1 The TSCC Contractor shall apply the in-force standards, guidelines, and specifications provided in this chapter for all stages of the design, test, manufacture, supply, delivery, assembly, installation, testing, commissioning, and training, operations and maintenance.

2.2 Design Guidelines

- 2.2.1 The latest version of the following Design Guidelines shall be applied:

ID	Code	Title
[R1]	Design Criteria Manual	Chapter 12 – Communication Systems and Train Control
[R2]	AREMA Standards	Chapter 17 – High-Speed Rail Systems

TABLE 5 - DESIGN GUIDELINES

2.3 Standards

- 2.3.1 The TSCC Contractor shall fully consider and apply the following standards, the in-force standards shall be applied.

ID	Standard	Title
[R3]	ANSI/TIA-568-B.1-5	Telecommunications Cabling Standard Part 1: General Requirements Addendum 5 - Telecommunications Cabling for Telecommunications Enclosures
[R4]	ANSI/TIA-568-B.2-6	Telecommunications Cabling Standard Part 2: Balanced Twisted-Pair Cabling Components – Addendum 6: Category 6 Related Component Test Procedures
[R5]	ANSI/TIA-758-A	Customer-Owned Outside Plant Telecommunications Standard
[R6]	EIA-TIA-455	Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components
[R7]	EN 300 386	Telecommunication network equipment; Electromagnetic Compatibility (EMC) requirements; Harmonized Standard covering the essential requirements of the Directive 2014/30/EU
[R8]	EN 50121	Railway Applications – Electromagnetic compatibility (All Parts)
[R9]	EN 50121-3-2	Railway applications - Electromagnetic compatibility - Part 3-2: Rolling stock – Apparatus
[R10]	EN 50121-4	Railway applications - Electromagnetic compatibility - Part 4: Emission and immunity of the signaling and telecommunications apparatus
[R11]	EN 50121-5	Railway applications - Electromagnetic compatibility Emission and immunity of fixed power supply installations and apparatus
[R12]	EN 50122	Railway Applications – Fixed Installations, Electrical Safety (All Parts)
[R13]	EN 50122-1	Railway applications - Fixed installations - Electrical safety, earthing and the return circuit - Part 1: Protective provisions against electric shock
[R14]	EN 50124	Railway applications - Insulation coordination



ID	Standard	Title
[R15]	EN 50125	Railway applications - Environmental conditions for equipment (All parts)
[R16]	EN 50125-2	Railway applications - Environmental conditions for equipment - Part 2: Fixed electrical installations
[R17]	EN 50125-3	Railway applications - Environmental conditions for equipment - Part 3: Equipment for signaling and telecommunications
[R18]	EN 50126	Railway Applications – The specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS) (All parts)
[R19]	EN 50126-1	Railway applications - The Specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS) - Part 1: Generic RAMS Process
[R20]	EN 50126-2	Railway applications - The Specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS) - Part 2: Systems Approach to Safety
[R21]	EN 50128	Railway Applications – Communications, signaling and processing systems – Software for railway control and protection systems
[R22]	EN 50129	Railway Applications – Communication, signaling and processing systems – Safety-related electronic systems for signaling
[R23]	EN 50155	Railway Applications – Electronic equipment used on rolling stock
[R24]	EN 50159	Railway applications - Communication, signaling and processing systems - Safety-related communication in transmission systems
[R25]	EN 50164	Lightning Protection Components
[R26]	EN 50164-3	Lightning Protection Components (LPC) -- Part 3: Requirements for isolating spark gaps
[R27]	EN 50173	Information technology - Generic cabling systems
[R28]	EN 50174	Information technology - Cabling installation
[R29]	EN 50289-1-6	Communication cables - Specifications for test methods - Part 1-6: electrical test methods - Electromagnetic performance
[R30]	EN 50310	Application of equipotential bonding and earthing in buildings with information technology equipment
[R31]	EN 50600-2-4	Information technology - Data center facilities and infrastructures - Part 2-4: telecommunications cabling infrastructure
[R32]	EN 55024	Information technology equipment. Immunity characteristics. Limits and methods of measurement
[R33]	EN 60297-3	Mechanical structures for electronic equipment - Dimensions of mechanical structures of the 482,6 mm (19 in) series - Part 3-100: basic dimensions of front panels, sub racks, chassis, racks and cabinets
[R34]	EN 60332-1	Tests on electric and optical fiber cables under fire conditions
[R35]	EN 60529	Degrees of protection provided by enclosures (IP Code)



ID	Standard	Title
[R36]	EN 60664-1	Insulation coordination for equipment within low-voltage systems -- Part 1: Principles, requirements and tests
[R37]	EN 60754-2	Test on gases evolved during combustion of materials from cables – Part 2: Determination of acidity (by pH measurement) and conductivity
[R38]	EN 61000-6	Electromagnetic compatibility (EMC) - generic standards (All parts)
[R39]	EN 61000-6-2	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity standard for industrial environments
[R40]	EN 61000-6-4	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments
[R41]	EN 61034	Measurement of smoke density of cables burning under defined conditions
[R42]	EN 61508	Functional safety of electrical/electronic/programmable electronic safety-related systems
[R43]	EN 61643-11	Low-voltage surge protective devices - Part 11: Surge protective devices connected to low-voltage power systems - Requirements and tests methods
[R44]	EN 61643-21	Low voltage surge protective devices - Part 21: Surge protective devices connected to telecommunications and signaling networks – Performance requirements and test methods
[R45]	EN 62305	Protection against lightning (All parts)
[R46]	EN 62305-1	Protection against lightning - Part 1: General principles
[R47]	EN 62305-2	Protection against lightning - Part 2: Risk management
[R48]	EN 62305-3	Protection against lightning - Part 3: Physical damage to structures and life hazard
[R49]	IEC 60068	Environmental testing
[R50]	IEC 60304	Standard colors for insulation for low-frequency cables and wires
[R51]	IEC 60331	Tests for electric cables under fire conditions
[R52]	IEC 60364	Low-voltage electrical installations (equivalent to HD 384 series)
[R53]	IEC 60794-1-21	Optical fiber cables - Part 1-21: Generic specification - Basic optical cable test procedures
[R54]	IEC 60794-3	Optical fiber cables - Part 3: Outdoor cables - Sectional specification
[R55]	IEC 61000-3-6	Electromagnetic compatibility (EMC) - Part 3: Limits - Section 6: Assessment of emission limits for distorting loads in MV and HV power systems - Basic EMC publication
[R56]	IEC 61000-3-7	Electromagnetic compatibility (EMC) - Part 3-7: Limits - Assessment of emission limits for the connection of fluctuating installations to MV, HV and EHV power systems
[R57]	IEC 61000-5-2	Electromagnetic compatibility (EMC) - Part 5: Installation and mitigation guidelines - Section 2: Earthing and cabling



ID	Standard	Title
[R58]	IEC 61156-5	Multicore and symmetrical pair/quad cables for digital communications – Part 5: Symmetrical pair/quad cables with transmission characteristics up to 1 000 MHz – Horizontal floor wiring – Sectional specification
[R59]	IEC 61643	Low-voltage surge protective devices
[R60]	IEC 61850	Communication networks and systems for power utility automation - ALL PARTS
[R61]	IEC 62305-4	Protection against lightning - Part 4: Electrical and electronic systems within structures
[R62]	IEC/EN 60793-1-1	Optical fibers - Part 1-1: Measurement methods and test procedures - General and guidance
[R63]	IEC/EN 60793-1-20	Optical fibers - Part 1-20: Measurement methods and test procedures - Fiber geometry
[R64]	IEC/EN 60793-1-21	Optical fibers - Part 1-21: Measurement methods and test procedures - Coating geometry
[R65]	IEC/EN 60793-1-22	Optical fibers - Part 1-22: Measurement methods and test procedures - Length measurement
[R66]	IEC/EN 60793-1-30	Optical fibers -- Part 1-30: Measurement methods and test procedures - Fibre proof test
[R67]	IEC/EN 60793-1-32	Optical fibers - Part 1-32: Measurement methods and test procedures - Coating strippability
[R68]	IEC/EN 60793-1-33	Optical fibers - Part 1-33: Measurement methods and test procedures - Stress corrosion susceptibility
[R69]	IEC/EN 60793-1-40	Optical fibers - Part 1-40: Attenuation measurement methods
[R70]	IEC/EN 60793-1-45	Optical fibers - Part 1-45: Measurement methods and test procedures - Mode field diameter
[R71]	IEC/EN 60793-1-47	Optical fibers - Part 1-47: Measurement methods and test procedures - Macrobending loss
[R72]	IEC/EN 60793-1-48	Optical fibers - Part 1-48: Measurement methods and test procedures - Polarization mode dispersion
[R73]	IEC/EN 60793-2-50	Optical fibers - Part 2-50: Product specifications - Sectional specification for class B single-mode fibers
[R74]	IEC/ISA 62443 (ISA/99)	Security for industrial automation and control systems.
[R75]	IEEE 1220	IEEE Standard for Application and Management of the Systems Engineering Process
[R76]	IEEE 802.1AE	IEEE Standard for Local and metropolitan area networks–Media Access Control (MAC) Security
[R77]	IEEE 802.1p	CoS Prioritization



ID	Standard	Title
[R78]	IEEE 802.1Q	IEEE Standard For Local and Metropolitan Area Networks--Bridges And Bridged Networks
[R79]	IEEE 802.1q	VLAN
[R80]	IEEE 802.3ae	10 Gb Ethernet over Fiber; 10GBASE-SR, 10GBASE-LR, 10GBASE-ER, 10GBASE-SW, 10GBASE-LW, 10GBASE-EW
[R81]	IEEE 802.3af	Power over Ethernet (PoE)
[R82]	IEEE 802.3an	10GBASE-T 10 Gb Ethernet over Unshielded Twisted Pair (UTP)
[R83]	IEEE 802.3at	Power over Ethernet Plus
[R84]	IEEE 802.3u	100BASE-TX specification
[R85]	IEEE 802.3x	Ethernet flow control
[R86]	IEEE 802.3z	1000BASE-X specification
[R87]	IEEE 802.ax	Local and Metropolitan Area Networks Link Aggregation
[R88]	ISO 11064	Ergonomic design of control centers
[R89]	ISO 7240-16:2007	Fire detection and alarm systems — Part 16: Sound system control and indicating equipment
[R90]	ISO/CEI 15288	Systems engineering - Systems life cycle processes
[R91]	ISO/IEC 11801	Information technology — Generic cabling for customer premises
[R92]	ITU-T E. 408	Telecommunication Networks Security Requirements
[R93]	ITU-T E. 409	Incident Organization and Security Incident Handling
[R94]	ITU-T G.652/G.655/G.656	Fiber Optic Cable Specification
[R95]	ITU-T G.8010	Architecture of Ethernet layer networks
[R96]	ITU-T G.8110	MPLS layer network architecture
[R97]	ITU-T G.8262	Timing characteristics of a synchronous equipment slave clock
[R98]	ITU-T G.8271/Y.1366	Time and phase synchronization aspects of telecommunication networks
[R99]	ITU-T G.8273.2/Y.1368.2	Timing characteristics of telecom boundary clocks and telecom time slave clocks for use with full timing support from the network
[R100]	ITU-T G.8275/Y.1369.2	Architecture and requirements for packet-based time and phase distribution
[R101]	ITU-T X. 805	Security Architecture for Systems Providing End-to-End Communications
[R102]	ITU-T Y.1540	Internet protocol data communication service - IP packet transfer and availability performance parameters
[R103]	ITU-T Y.1541	Network performance objectives for IP-based services



ID	Standard	Title
[R104]	NFPA 780	Standard for the Installation of Lightning Protection Systems
[R105]	RFC 2030	Simple Network Time Protocol (SNTP) Version 4
[R106]	TIA/EIA-568-B/C	Telecommunications Cabling Standards
[R107]	TIA/EIA-606-A	Administration Standard for Commercial Telecommunications Infrastructure
[R108]	TIA/EIA-607-A	Grounding and Bonding Requirements for Telecommunications
[R109]	TIA-526-7 (OFSTP-7)	Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
[R110]	TIA-569-B	Standards for Telecommunications Pathways and Spaces

TABLE 6 – STANDARDS

2.4 Other Documents

2.4.1 The following documents shall be referred:

ID	Document	Title
[R111]	Schedule 1	Safety, Security and RAM Requirements
[R113]	Schedule 16	Scope of Work
[R114]	Schedule 5a SPEC-0005	Cyber Security Technical Specification

TABLE 3 - OTHER DOCUMENTS

3 TERMS, DEFINITIONS, AND ABBREVIATIONS

- 3.1.1 All the terms, definitions, and abbreviations are provided in the Glossary of Terms, Abbreviations and Definitions.



4 SYSTEM DESCRIPTION

4.1 Purpose of the DCN

- 4.1.1 The purpose of the Digital Communication Network (DCN) system is to provide a robust, reliable, redundant, and high-capacity communication infrastructure to support all the requirements of the California High-Speed-Rail system.
- 4.1.2 The purpose of the DCN shall be the primary telecommunications infrastructure for California High-Speed-Rail. It shall provide connectivity between different locations and facilities.

4.2 DCN System Definition

- 4.2.1 The DCN system is a distributed network designed to manage communication between various facilities, trackside equipment, and the control center.
- 4.2.2 The DCN system shall be provided by the TSCC Contractor, including both active and passive components of the system.

4.3 DCN System Operational Context

- 4.3.1 The mission of the DCN system is to facilitate clear and reliable communication between the various stakeholders involved in CHSR operations in compliance with the operational needs.

4.4 Design Life

- 4.4.1 The design life shall be 15 years.
- 4.4.2 The design life requirements for the DCN system shall allow for the pertinent evolution and technological change of the DCN system throughout its life.
- 4.4.3 The TSCC Contractor shall ensure that the DCN components with shorter design lifespans shall be managed by scheduled technology refresh strategies and spares management plans.
- 4.4.4 The TSCC Contractor shall ensure that the manufacturers will be able to produce DCN system components (with equal or compatible technical specifications) for the entire design life required.



5 SYSTEM REQUIREMENTS

5.1 General Requirements

- 5.1.1 The DCN shall be designed in accordance with the requirements described in this specification.
- 5.1.2 The TSCC Contractor's scope shall include all phases, including design, supply, deployment, installation, configuration, testing, and commissioning for the DCN system.
- 5.1.3 The TSCC Contractor shall provide all necessary DCN equipment, cabling, software, and licenses required to design, supply, deploy, install, configure, test, and commission the system at all locations.
- 5.1.4 The DCN shall transport all required video, voice, and data between OCC, Stations, Facilities, Traction power substations, solar sites, and wayside facilities along the California high-speed line.
- 5.1.5 The DCN shall include advanced network management features, which will provide control, monitoring, and configuration of the network system, maintain configuration database for all network elements, gather and log alarm events from these elements, and generate performance statistics reports, including availability and performance. With the proposed network management system, it shall be possible to completely reconfigure the transmission network in case of a failure.
- 5.1.6 DCN equipment shall be backed up with Uninterruptible Power Supplies that provide localized battery backup for at least 12 hours in the event of mains power failure at DCN sites.
- 5.1.7 Buildings containing DCN equipment shall be provided with an external connection point for a backup generator.
- 5.1.8 The DCN equipment shall have a service life of not less than 15 years.

5.2 Environmental Conditions Requirements

- 5.2.1 The TSCC Contractor's DCN system design shall respect local climatic conditions.
- 5.2.2 All equipment shall be protected from damage or degradation in performance due to shock or vibration as experienced in the railway environment.
- 5.2.3 The TSCC Contractor's design for the DCN system shall comply with the following telecom-related environmental requirements (list non-exhaustive):
 - 5.2.3.1 The equipment provided and installation-related material shall be adapted to the special local environmental conditions, e.g., stainless-steel fixations, housing, etc.
 - 5.2.3.2 Based on the different installation sites, the different ingress protection (IP) requirements shall be specified.
 - 5.2.3.3 Air conditioning calculation and air conditioning systems shall be provided for the different required technical rooms in and outside of technical buildings provided by the TSCC Contractor.
 - 5.2.3.4 The equipment provided shall be protected from damage or degradation in performance due to shock or vibration as experienced in the railway environment.

5.3 Operational Requirements for DCN

- 5.3.1 The TSCC Contractor's DCN design shall ensure compliance with the California HSR planned operations and shall allow the operation and maintenance of the main line and related local facilities.



5.4 Functional Requirements for DCN

5.4.1 General requirements

- 5.4.1.1 The DCN shall be a digital transmission network that provides the following functions:
- Transmit data, voice, and video from the various subsystems.
 - Continuously monitor the network status and inform operator(s) in real time.
 - Automatically reconfigure the network in case of failure.
- 5.4.1.2 For the CHSR railway, the DCN shall be based in a fully redundant self-healing backbone transmission network. MPLS (Multi-Protocol Label Switching) or other options may be proposed with appropriate justification.
- 5.4.1.3 The DCN data-link layer (layer-2) shall be preferably based on IP-MPLS technology and properly justified. If GMPLS, MPLS-TP, or any other technologies are considered by the TSCC Contractor as an alternative to the IP-MPLS preferred solution, it shall be properly justified. Only solutions based on technologies successfully deployed in high-speed railway infrastructures shall be proposed by the TSCC Contractor and subject to Authority approval.
- 5.4.1.4 As a minimum, the DCN system shall consist of the following components:
- Access: consisting of switches and different interfaces to manage all field and end equipment.
 - Backbone and Distribution: to supply redundant connectivity to switches located in the stations and sites.
 - Connectivity through the optical fiber cable network connecting stations, depot, OCC, distributed sites, and maintenance facilities.
 - Compliance with Cybersecurity Project requirements to avoid malicious intrusions.
 - Network Management System for the DCN.
 - A state-of-the-art architecture and connectivity solution shall be provided to the OCC data center infrastructure.
- 5.4.1.5 The TSCC Contractor's design shall consider at least two redundant DCNs, one for carrying the critical operational services and another for the non-critical operational services, aligned with the cybersecurity policies designed for this project, with redundancy regarding to:
- nodes within the network.
 - redundant DCN power supply equipment.
 - interconnection topology considering the optical fiber cable network.
 - and any other requirement within this specification.
- 5.4.1.6 The allocation of operational services into critical and non-critical should be as follows (non-exhaustive, to be refined during the design phase):
- 5.4.1.7 Critical operational services:
- ETCS
 - Interlocking
 - Traffic Management System
 - Wireless Communication Systems.
 - Network Timing System.



- Telephony System.
- Integrated Control and Supervision System.
- Power SCADA
- Intrusion Detection

5.4.1.8 Non-critical operational services:

- Public Address and Customer Information System.
- CCTV System.
- Automated Fare Collection System.
- Fire Protection System
- Electronic Access Control Systems.
- Asset Management.
- Hazard Detection and Early Warning System
- Stations equipment's (as per 6.3)
- Facilities equipment's (as per 6.4)
- Asset Management System.

5.4.1.9 The DCN must be based on packet switching and routing as a major evolution of backbone technologies.

5.4.1.10 Each DCN node shall be fully redundant, and single points of failure shall be avoided.

5.4.1.11 The TSCC Contractor's DCN design shall provide routing between the nodes based on an optimal configuration within the optical fiber cables.

5.4.1.12 The optical fiber cables shall be connected to the stations (and other facilities) along the high-speed line. The topologies may be proposed and properly justified by the TSCC Contractor upon approval by the Authority.

5.4.1.13 The network shall be dimensioned to interface and interconnect the critical and non-critical sub-systems for operational purposes.

5.4.1.14 QoS assurance shall be supported by the network nodes.

5.4.1.15 QoS management shall utilize (not limited to):

- Classification and marking tools shall be used for DCN Core, Distribution, and Access nodes to differentiate between applications and sort packets into different traffic types.
- Congestion management tools to determine which queue to place the packets into include priority queuing, first-in, first-out, and low-latency queuing.
- Congestion avoidance tools to drop low-priority packets when congestion occurs.
- Shaping and load balancing tools to manipulate DCN traffic prioritization and policies for real-time applications over less time-sensitive applications.
- The TSCC Contractor's solution for the DCN shall support the following features (not limited to):
 - Network segmentation functionalities.
 - Layer 2-4 switching capabilities.
 - Multicast and Unicast transport with IPv4 and IPv6 packets.



- Multicast through IGMP.
- Loop prevention technology.

- 5.4.1.16 The TSCC Contractor shall describe the configuration, operation, interoperability, and synchronization of the network, including its operation during different possible fault scenarios.
- 5.4.1.17 The TSCC Contractor's design for DCN shall respect special country-related requirements and regulations (e.g., local governmental laws concerning subscriber information and database sharing, etc.).
- 5.4.1.18 The DCN shall be equipped with facilities for high security of data and protection from external sources via suitable firewalls to ensure the security and integrity of the rail systems.
- 5.4.1.19 Firewall/proxy server appliances shall be provided at the point of interconnection with the Internet and as a gateway to the DCN network.
- 5.4.1.20 Access to the operating system software for maintenance purposes shall be segregated on an administration and management network through a dedicated MPLS VPN connectivity.
- 5.4.1.21 Access to the operating system software for maintenance purposes shall be password protected to allow access by appropriately qualified levels of personnel for maintenance.

5.4.2 Network Management System (NMS)

- 5.4.2.1 The NMS solution designed by the TSCC Contractor shall include a comprehensive network management system (NMS) for the entire DCN's components and devices.
- 5.4.2.2 All DCN shall be managed and monitored by NMS to be located at the OCC.
- 5.4.2.3 The NMS shall include system monitoring tools, configuration tools, traffic controlling, service planning, and activation tools that shall be used by operation and maintenance personnel.
- 5.4.2.4 The NMS shall incorporate a real-time optical fiber monitoring and assurance system that can, at least, identify degradations, localize failures, and provide root-cause analysis. These monitoring features shall be carried out by the network equipment itself or by means of external dedicated devices.

5.4.3 Optical Fiber

- 5.4.3.1 The TSCC Contractor shall install a single-mode fiber optic cable in a duct, on one side of the track, for the entire length of the Right-of-Way. The Optical fiber cables shall consist of a minimum of 192 fibers each distributed in multiple tubes.
- 5.4.3.2 The TSCC Contractor's design shall ensure, for the optical fiber cable, protection against impact, crush, and rodent damage at any point of the optical networks. This protection against impact, crush, and rodents shall be provided by the multi-ducts, micro-ducts, and any other solutions.
- 5.4.3.3 The TSCC Contractor's design shall ensure external additional protection against rodents, especially in the manholes, extract points, and where micro-ducts do not provide enough protection or are not recommended. Those specific solutions regarding rodent protection shall be properly described and justified by the TSCC Contractor and approved by the Authority.
- 5.4.3.4 In general, the TSCC Contractor's design shall ensure and provide the proper continuity of enough multi-ducts/micro-ducts all along the cableways both in open line and in stations or any other facility even for undertrack crossings to maintain the protection when fiber cross from the opposite side of the track to the equipment location, station building or any trackside equipment. The main reason is that the multi-ducts/micro-ducts shall provide protection against impact, crush, and rodents to the fibers to avoid the fiber being unprotected in any section of the cableways.



- 5.4.3.5 Optical fiber cable shall be deployed to support routing between the nodes.
- 5.4.3.6 The Optical Fiber system shall be duly documented, using a software tool, allowing the identification of every FO in use for each service and for every section of the fiber path, as well as the reserve FO, allowing potential changes to be made graphically.

5.5 Performance Requirements for DCN

5.5.1 General requirements

- 5.5.1.1 The DCN's design shall be based on state-of-the-art technology for high-speed railways.
- 5.5.1.2 DCN's design shall be compliant with the norms and standards listed in 2.3 (not limited to), but especially to:
 - EN 50128 Railway Applications – Communications, signaling and processing systems – Software for railway control and protection systems.
 - EN 50129 Railway Applications – Communication, signaling and processing systems – Safety related electronic systems for signaling.
 - EN 50159 Railway applications - Communication, signaling and processing systems - Safety-related communication in transmission systems.
 - EN 61508 Functional safety of electrical/electronic/programmable electronic safety-related systems (SIL)(certification).
- 5.5.1.3 The TSCC Contractor shall provide expected data traffic analysis as part of the Design to include overhead management and expandability.
- 5.5.1.4 The DCN shall use optical fibers as the physical transmission layer (high bandwidth, not sensitive to electromagnetic interference, extendibility, etc.).
- 5.5.1.5 The TSCC Contractor shall dimension the provided DCN according to the required network services and the number of different network users.
- 5.5.1.6 The TSCC Contractor shall be responsible for providing a solution with adequate requirements, in terms of throughput and latency, to fulfil the most demanding needs for all the operational applications to be served (to ensure non-blocking service provision and avoid bottlenecks in data throughput).
- 5.5.1.7 For the network topology design, the number of rings and the number of nodes per ring shall be dimensioned considering aspects such as the latency, time synchronization, delivery, and others to ensure the redundancy and optimal performance of the whole DCN.
- 5.5.1.8 The DCN shall enable the convergence of multiple applications/subsystems within the same infrastructure, considering that each of these applications/subsystems has unique network requirements, priorities, security restrictions, bandwidth capacity, latency, QoS, etc.
- 5.5.1.9 To ensure a high level of security for transmission and to offer efficient traffic management, the DCN shall support application segment routing, resource reservation, encryption, traffic differentiation, and isolation (for example, based on VLANs, VXLAN, VPNs, IPVPN, EVPNs, wavelength separation, and DWDM / CWDM, or other similar approaches).
- 5.5.1.10 The DCN shall be able to allocate bandwidth as per request from any of the sub-systems and shall provide the ability to reserve bandwidth for some of the sub-systems and applications that require guaranteed bandwidth.



- 5.5.1.11 To get the best optimization of network resources, the DCN shall support QoS (Quality of Service) and Traffic Engineering. Additionally, it is recommended that the DCN be capable of supporting wavelength multiplexing to increase traffic capacity as needed for future extensions.
- 5.5.1.12 The TSCC Contractor shall define and deploy the specific Traffic Engineering configuration compliant with DCN operational, functional, and performance specifications and Cybersecurity project requirements.
- 5.5.1.13 The TSCC Contractor's design for DCN shall specify target convergence times after a disconnection within the DCN WAN for critical services, non-critical services, and end-to-end services.
- 5.5.1.14 The network equipment carrying synchronization information shall be compliant with IEEE 1588v2 Precision Time Protocol (PTP), G.8271, G.8275.1&2, G.8273.1&2 (not limited to) to provide time accuracy expressed in terms of time error with respect to a common reference, that allows the synchronization of the most demanding systems like FRMCS.
- 5.5.1.15 The network equipment carrying synchronization information shall be compliant with Network Time Protocol to provide time synchronization for systems.
- 5.5.1.16 The TSCC Contractor's design for the DCN shall comply with ITU-T G.8010, ITU-T G.8110, RFC 3031, RFC 3032, and any other relevant standards applicable.
- 5.5.1.17 The access strategy of the different subsystem and field equipment (CCTV cameras, PACIS end devices, etc.) to the DCN shall be assessed by the TSCC Contractor to provide the most optimal solution in terms of performance, use of network devices, and cybersecurity considerations.
- 5.5.1.18 DCN network devices shall support MACsec (IEEE 802.1AE) encryption. Vendor's proprietary encryption features (layer 2 or layer 3) may be proposed subject to Authority approval.
- 5.5.1.19 Prior to the detailed design and manufacturing of the DCN, the TSCC Contractor shall:
- Assess the data rates, bandwidth requirements, and usage level of each individual system that the DCN is required to support and shall estimate total loading and submit such details for the approval of the Authority.
 - Compile and submit an expected performance report to the Authority that includes details of the required DCN capabilities, network throughput, worst-case transmission delay times, availability, including MTTR.

5.5.2 Network Management System

- 5.5.2.1 The NMS for DCN main components shall include (not limited to):
- Managing entities.
 - Managed devices.
 - Agents.
 - Standard network management protocols.
 - Monitoring, configuration, and setup tools.
 - Network traffic engineering, monitoring & control.
 - Resource utilization (CPU, RAM memory, IOPS, etc.).
 - HMI, GUI, and dashboards.
- 5.5.2.2 The Network Management System (NMS) for DCN main functions shall include (not limited to):
- Automatic network discovery tools for all equipment types and services.



- Automatic network mapping tool.
- Element management for each networking sub-system, including web interface.
- Asset inventory monitoring and reporting.
- Creation, configuration and deletion of users and roles.
- IP address management.
- Performance alarms triggered by thresholds parameters defined by the operators.
- Troubleshooting capabilities.
- Reporting tools.

5.5.2.3 The NMS for DCN shall be (not limited to):

- Scalable to manage all networking and information systems elements within a single system.
- Virtualized solution capability.
- Capable of managing network elements from different vendors within a single system, with the monitoring of alarms and performance.
- Based on the latest version of network management protocol and shall support the latest versions of SNMP.
- Support the addition of new and specific Management Information Base(s) (MIBs) easily and with a user-friendly procedure.
- Aligned with cybersecurity policies to implement security features to prevent unauthorized users from gaining access to critical network resources.
- Provided with an embedded performance tool to manage the overall performance of all network and information systems components.
- Able to perform network planning, traffic engineering, remote configuration, installation, maintenance, expansion, restoration, and disaster recovery.
- Provided with features for security and accountability and shall generate a log file for any user access to configuration or platform changes.

5.5.2.4 All analyzed Quality of Service (QoS) performance parameters shall be monitored by the NMS for DCN:

- Bandwidth: Core, Distribution, and Access switches/routers and port allocation.
- Latency: Video, Voice (to include Mean Opinion Score (MOS)), Data, Metadata, including Firewalls.
- Jitter: variation in packet delays, including Firewalls.
- Packet Loss: Packet delivery percentage of packets that are dropped within the DCN Network as per a predefined period.
- Throughput and IOPS: for all systems interfacing the DCN.
- Bit Error Rate (BER).
- Connected link optical fiber loss profile monitoring (attenuation levels and location of events and failures).
- Disaster Recovery response times.
- All performance levels shall be end-to-end.



- 5.5.2.5 The NMS's graphical user interface (GUI) shall be well-designed, agile, easy to use, and intuitive and shall include (not limited to):
- Access control and profiling functionalities aligned with the project's cybersecurity policies.
 - Network admission control.
 - Dashboard Human-Machine Interface (HMI) and GUI to the OCC operators.
 - Network map and topology view for each network layer.
 - Services map view for each service type.
 - Drill-down capabilities from network map to specific device or specific service.
 - Configuration wizard tools.
 - Automatic discovery and configuration of new components.
 - Capability of configuring multiple devices at a same time.
 - Capability of Command Line Interface (CLI) support.
 - Outstanding alarms.
 - Troubleshooting features.
- 5.5.2.6 The NMS shall forward the selected events to the ICSS system.
- 5.5.2.7 The NMS system shall support (not limited to):
- 802.1Q VLAN, IEEE 802.1P, IEEE 802.1w, IEEE 802.3x Ethernet Flow Control, RMON, TFTP/FTP, CLI MAC, etc.
 - Load balancing, QoS, bandwidth, latency, response time, and errors, real-time and ad-hoc monitoring.
 - Monitoring, management, and allocation of bandwidth.
 - Automated and/or manual scripts setup.
 - Monitoring and reporting of all equipment.
- 5.5.2.8 Monitoring capabilities shall support Management Information Base (MIB), Simple Network Management Protocol (SNMP v3 and associated security features), traps reporting, and Internet Control Message Protocol (ICMP), including packets containing error, control, and informational messages.
- 5.5.3 Optical Fiber**
- 5.5.3.1 The TSCC Contractor shall specify and justify the number of fiber optic cables and the number of fibers inside those cables to ensure the provision of adequate fiber optic cores to service the designed DCN (spare and dark fibers shall be considered in the dimensioning).
- 5.5.3.2 The TSCC Contractor shall design for the minimum requirements for fiber optic materials:
- Fibre optic cables shall be, at least, compliant with the following standards: ITU-T Recommendation G.652D, G.655, G.657, IEC/EN 60793-1-20/21/22/30/32/33/40/42/45/47/48, IEC/EN 60793-2-50 Category B-652.D, EIA/TIA 455, IEC 60794-1-2, IEC 60794-3, EIA/TIA 568-C, EN 50173-1, ISO/IEC 11801.
 - Single-mode fiber optic cable shall be compatible with CWDM, DWDM, and non-DWDM technologies.
 - Fiber optic color coding shall be as per IEC 60304.



- Single-mode Fiber optic insertion loss shall be $\leq 0.35\text{dB/km}$.
- Fiber optic splice fusions insertion loss shall be $\leq 0.05\text{dB}$.
- Testing shall be in accordance with TIA/EIA-455, IEC/EN 60793-1 and IEC/EN 60794-1-2x.
- Drop-off fiber optic cables shall be halogen-free (HFFR), flame retardant, and shall comply with IEC-60332-1.
- Multimode Fiber optic (if additionally provided) shall be at least OM3 50/125 μm .

- 5.5.3.3 At least one meter of fiber shall be stored without twists or kinks within optical fiber splice organizers at joints and terminations.
- 5.5.3.4 Optical fiber splice organizers shall accommodate individual strain relief for each splice and allow for future maintenance or modification without damage to the cable or splices.
- 5.5.3.5 The number of fibers shall be calculated considering all the sub-systems to interface with (in conjunction with the TSCC Contractor), plus a 50% excess, and another percentage reserved for dark fiber to be confirmed by the Authority.
- 5.5.3.6 The estimation of the number of cables and fibers per cable shall be the most efficient possible to avoid unnecessary/in excess splices and intermediate points of failure. This estimation shall be done in conjunction with the Authority, who may involve third-party users.
- 5.5.3.7 The TSCC Contractor shall reserve a dedicated fiber optic pair (dark fiber) for the Power Supply & MV/LV Distribution Systems along the CHSR alignment.

5.6 Safety Requirements

- 5.6.1 DCN shall comply with the safety requirements defined in Schedule 1.

5.7 RAM Requirements

- 5.7.1 The TSCC Contractor shall be responsible for performing all the activities as specified in Schedule 1.
- 5.7.2 The availability of DCN at circuit level shall be defined as the availability of the circuit between both end points of the DCN where the required bandwidth is available for access.
- 5.7.3 Any circuit of the DCN shall be considered unavailable when:
- There is a loss of communication between the end points of the circuit, or
 - The quality of signal transmission within the circuit is below the performance standards.

5.8 Cybersecurity and Security Requirements

- 5.8.1 The TSCC Contractor's design for DCN shall be in full compliance with the CHSR Cybersecurity Technical Specification.
- 5.8.2 The DCN network shall be designed in compliance with the network security and network segmentation requirements defined in the cybersecurity specification and enable the implementation of the zone and conduit model.
- 5.8.3 The DCN shall have a System Owner who shall be accountable for cybersecurity risk ownership and mitigation.
- 5.8.4 The DCN team shall work closely with the Cybersecurity Lead and Cybersecurity Services Lead to procure and configure network devices in compliance with the cybersecurity technical specification, specifically,



switches, routers, firewalls, and other devices that are configured to allow/disallow communications across the network.

- 5.8.5 The DCN network shall be designed to facilitate the logging information required to be transmitted from devices to the SIEM, also considering future log sources being on-boarded during later phases of the CHSR works.
- 5.8.6 The DCN team shall facilitate cybersecurity requirements and objectives by attending risk assessments, attending threat modelling exercises, designing network layer controls such as tunnel mode VPNs to facilitate encryption between devices that may not support encryption, configuring the NMS in compliance with the cybersecurity technical specification to maintain the integrity of network configurations and security, and other activities as requested by cybersecurity teams.
- 5.8.7 DCN boundaries must be protected by a deny-by-default firewall with intrusion prevention capabilities, boundaries include all locations where the DCN interfaces with another network.
- 5.8.8 DCN boundary devices must have an appropriate vulnerability and patch management plan.
- 5.8.9 Firewalls shall be placed appropriately across the DCN to enable east-west traffic filtering; a firewall shall be located at each equipment room or other room containing computing equipment at a minimum.



6 INTERFACES REQUIREMENTS

6.1 General Requirements

6.1.1 Interfaces are classified as below:

- Third Party interfaces: interfaces between TSCC systems and systems provided by Third Party (excluding CHSR contractors);
- External interfaces: interface between TSCC systems and systems provided by CHSR contractors (Civils Packages, Stations contractor, Facilities contractor, Solar PV and BESS contractors);
- Internal interfaces between systems within the TSCC scope.

6.1.2 The TSCC Contractor shall develop design considering the identified Third Parties, External and Internal interfaces to ensure the required functionalities and performance described in this specification.

6.1.3 The TSCC Contractor shall, if necessary, propose any additional interfaces required to ensure the functionalities and performance described in this specification. Third Partys Interfaces

6.2 Third Party Interfaces

6.2.1 The DCN shall provide interfaces with external networks such as Internet Service Provider (ISP) networks, Transit Agency networks, First Responder Networks, and Utility Company networks as necessary to meet the Contract Requirements.

6.2.2 The TSCC Contractor shall coordinate with the Supplier for the optical fiber cable. The TSCC Contractor shall provide the design inputs related to optical fiber cable to the Supplier.

6.3 External Interfaces – stations contractor

6.3.1 Stations DCN connectivity

6.3.1.1 The stations contractor shall supply, install, terminate, label, and test all data infrastructure cabling throughout the stations, excluding :

- Telecommunications equipment rooms
- Wayside in stations areas

6.3.1.2 The stations contractor shall provide all associated containment, patch panels, outlets, and related passive components required to deliver a fully functional structured cabling system up to the designated DCN switch connection points.

6.3.1.3 The stations contract shall coordinate with the TSCC Contractor to ensure compatibility of cable terminations and interface points with the DCN switching equipment.

6.3.1.4 The TSCC Contractor shall supply, install, configure, and commission all the DCN network switches to which the data infrastructure cabling provided by the stations contractor shall connect.

6.3.1.5 The TSCC Contractor shall supply, install, terminate, and test all data infrastructure cabling located within telecommunication equipment room and wayside areas, including connections between switches, servers, storage, and other active equipment.

6.3.1.6 The TSCC Contractor shall ensure all DCN switch ports are appropriately configured and operational for the services and systems requiring connectivity.

6.3.1.7 The TSCC Contractor shall provide integration testing of switches with the stations contractor's cabling infrastructure to confirm end-to-end performance and compliance.

6.3.2 DCN equipment integration in stations



- 6.3.2.1 The TSCC Contractor shall install all DCN network equipment in the station communication rooms being provided by stations contractors.
- 6.3.2.2 The TSCC Contractor shall provide to stations contractors:
- Equipment dimensions
 - Equipment clearances requirements
 - Equipment mounting and fixings requirements
 - Cable routes/containment requirements
 - Equipment loadings
 - Installation and maintenance requirements
 - Equipment heating loads
 - Equipment cooling loads
 - Equipment hydraulic requirements
- 6.3.2.3 The TSCC Contractor shall provide the following information to stations contractors to accommodate DCN equipment installation and operations and maintenance:
- Room dimensions and layouts
 - Room facilities (Plumbing, HVAC, Lighting, Fire Protection Systems, Doors, electricity)
 - Room raised floor system
 - Delivery access routes.

6.4 External Interfaces – facilities contractor

6.4.1 Facilities DCN connectivity

- 6.4.1.1 The facilities contractor shall supply, install, terminate, label, and test all data infrastructure cabling throughout the stations, excluding :
- OCC equipment rooms and OCC desks in OCC control rooms
 - Wayside in facilities areas
- 6.4.1.2 The facilities contractor shall provide all associated containment, patch panels, outlets, and related passive components required to deliver a fully functional structured cabling system up to the designated DCN switch connection points.
- 6.4.1.3 The facilities contract coordinate with the TSCC Contractor to ensure compatibility of cable terminations and interface points with the DCN switching equipment.
- 6.4.1.4 The TSCC Contractor shall supply, install, configure, and commission all the DCN network switches to which the data infrastructure cabling provided by the facilities contractor shall connect.
- 6.4.1.5 The TSCC Contractor shall supply, install, terminate, and test all data infrastructure cabling located within OCC equipment's rooms and wayside areas, including connections between switches, servers, storage, and other active equipment.
- 6.4.1.6 The TSCC Contractor shall ensure all DCN switch ports are appropriately configured and operational for the services and systems requiring connectivity.
- 6.4.1.7 The TSCC Contractor shall provide integration testing of switches with the facilities contractor's cabling infrastructure to confirm end-to-end performance and compliance.



6.4.2 DCN equipment integration in Facilities

6.4.2.1 The TSCC Contractor shall install all DCN network equipment in the OCC and facility buildings being constructed by the facilities contractor.

6.4.2.2 The TSCC Contractor shall provide to the facilities contractor:

- Equipment dimensions
- Equipment clearances requirements
- Equipment mounting and fixings requirements
- Cable routes/containment requirements
- Equipment loadings
- Installation and maintenance requirements
- Equipment heating loads
- Equipment cooling loads
- Equipment hydraulic requirements

6.4.2.3 The TSCC Contractor shall provide the following information to the facility building contractor to facilitate the DCN equipment installation and operational/maintenance requirements:

- Room dimensions and layouts
- Room facilities (Plumbing, HVAC, Lighting, Fire Protection Systems, Doors, electricity)
- Room raised floor system
- Delivery access routes.

6.5 Internal Interface for DCN

6.5.1 Interfaces with TSCC Systems – data connectivity

6.5.1.1 The DCN shall have an interface with the following Critical services sub-systems to provide them with a robust, reliable, redundant, and high-capacity communication transport infrastructure.

- Telephony system
- Network Timing system
- ETCS
- Interlocking
- Traffic Management System
- Power SCADA
- Wireless Communication Systems
- Integrated Control and Supervision System

6.5.1.2 The DCN shall have an interface with the following non-critical services sub-systems to provide them with a robust, reliable, redundant, and high-capacity communication transport infrastructure.

- Hazard Detection and Early Warning System
- CCTV system.
- Automatic Fair Collection System.
- Public Address and Customer Information System.



- Fire Protection system.
- Electronic Access Control Systems.
- Asset Management System.
- Technical Buildings (Shelters/Containers) and related MEP system.

6.5.2 Interface with Integrated Control and Supervision Systems

6.5.2.1 The ICSS shall monitor status and operational alarms from DCN.

6.5.3 Interface with Asset Management System (EAMS)

6.5.3.1 The DCN System shall provide static Asset Information and dynamic Asset Information to the EAMS for maintenance activities and asset lifecycle management activities.



7 MATERIALS, PRODUCT AND COMPONENTS REQUIREMENTS

7.1 General Requirements

- 7.1.1 All materials supplied by the TSCC Contractor shall conform to the requirements and test methods of the relevant EN standards or other applicable recognized standards. Refer to 2.3.
- 7.1.2 All materials supplied shall be of sufficient grade and quality to meet the design life requirements.

7.2 Software and Hardware Requirements

- 7.2.1 Single-mode (SM) optical fiber cables shall be considered for the backbone transmission network in open line and network uplinks (preferably OS2 type).
- 7.2.2 Fibers shall comply with the instructions ITU-T G.652/G.655/G.656/G.657. However, the TSCC Contractor may propose any other optical fiber technology if there are objective and demonstrable improvements for the system.
- 7.2.3 For structured cabling inside buildings and data centers, Single Mode optical fiber shall be preferred, but Multimode fiber (preferably OM4) may be considered upon the TSCC Contractor's assurance of no impact on performance and the avoidance of potential bottlenecks and allowing for future developments.
- 7.2.4 In addition, all the elements required for an optimal optical connectivity shall be considered, such as connectors and ODF/patch panels for backbone, terminating and interconnecting equipment, including Termination Protection Devices, SM optical patch cords, MM optical patch cords (if needed), latching connectors, racks, shelves and trays, cabinets, termination, and distribution boxes.
- 7.2.5 All cables shall be fire and flame retardant, halogen-free, non-corrosive, etc., in accordance with local applicable Laws.
- 7.2.6 Fiber optic splice enclosures shall be installed with 50% spare capacity.
- 7.2.7 Detailed cable routing and labeling plans shall be delivered by the TSCC Contractor.
- 7.2.8 The TSCC Contractor's design for all central servers shall be on-premises, either physical, virtualized, or cloud-based, to facilitate system evolution and comply with cybersecurity requirements.
- 7.2.9 Network equipment for open-line trackside locations (Technical Buildings, Cabinets, TPS, Radio sites, etc.) shall preferably be fan-less. Fan cooling may be accepted upon the TSCC Contractor's evidence that reliability figures are equivalent to the fan-less solution.
- 7.2.10 The DCN components shall be fully redundant in hardware, power supply, cabling, and software so that the provided services survive during any one failure of hardware, cabling, and software.
- 7.2.11 The DCN and NMS components shall incorporate a hot-swappable power supply.
- 7.2.12 The DCN equipment provided shall be extendable without requiring the replacement of existing equipment.
- 7.2.13 Hot-swappable elements, such as fans and power supplies, should be swappable without tools.
- 7.2.14 Hardware, software, firmware, or data changes required to support future extensions or expansions on-line shall be accomplished without performance or functionality degradation or availability to the operational systems.
- 7.2.15 A 50% spare capacity for each subsystem shall be provided for the DCN design.
- 7.2.16 DCN shall be adapted for electric power systems using IEC-61850 protocols (GOOSE, SV messaging).



- 7.2.17 Copper cable shall be avoided whenever possible in favor of optical connections.
- 7.2.18 If copper cable is not avoidable, CAT6A/CAT7A cable compliant with IEC 11801, TIA/EIA-568-b-2, IEC60332-1, IEEE 802.3, 10GBASE-T, EN50288-5-1 and other relevant standards shall be used.
- 7.2.19 Structured cabling inside stations and other facilities for Telecom system operational purposes shall be provided by the TSCC Contractor as part of access to the DCN.
- 7.2.20 The structured cabling shall be certified according to the latest applicable standards in this regard.
- 7.2.21 The structured cabling cables shall be compliant with (not limited to):
- CAT6A cables shall comply with IEC 61156-5 CAT6A.
 - CAT7A cables shall comply with IEC 61156-5 CAT7A.
 - Cables' flame retardancy shall comply with IEC 60332-1. Indoor cables shall withstand 120 minutes.
 - Cables shall be halogen-free (HFFR) and shall comply with IEC 60754-2.
 - Cables evaporated smoke density under burning conditions shall comply with IEC 61034.
 - CAT6A/CAT7A patch cords shall be shielded.
 - CAT6A/CAT7A patch cords shall be earthed and bonded.
 - RJ45 molded connectors shall comply with IEC 11801.
- 7.2.22 Regarding the terminating and interconnecting equipment of the structured cabling, it shall include (not limited to):
- termination protection devices.
 - distribution cabinets.
 - cross-connects.
 - cable trays and hangers.
 - CAT6A/CAT7A patch cords.
- 7.2.23 The core routers/switches shall be delivered with extra 50% spare ports with respect to the final number of active ports and supported bandwidth and shall be scalable by 50% more without changing supervisors, CPU's, power supplies, chassis (if modular design considered by the TSCC Contractor), etc.
- 7.2.24 The distribution routers/switches shall be delivered with an extra 50% spare ports with respect to the final number of active ports and supported bandwidth.
- 7.2.25 The access switches shall be delivered with an extra 50% spare ports with respect to the final number of active ports and supported bandwidth.
- 7.2.26 Equipment Interfaces shall operate under IP with Ethernet RJ-45 and fiber connections.
- 7.2.27 The TSCC Contractor shall provide technical racks to allocate all the equipment. Standard EIA 483 mm or ETSI compatible 19" racks at least 42U of height shall be installed and shall support both EIA-310 and OCP racks.
- 7.2.28 The NMS shall be based on COTS software and hardware (cloud, on-premises, or virtualized).
- 7.2.29 Any upgrade or intervention made on the NMS shall not impact the operational functioning of the network.



7.3 EMC Requirements

- 7.3.1 The DCN shall be fully immune and protected from any Electromagnetic Interference (EMI) with traction power, multi-tubular cabling, and Radio Frequency Interference (RFI). The EMI emissions shall be mitigated in accordance with applicable standards (EN 50122 or equivalent).



8 TOLERANCES

Not applicable to DCN System.



9 SCOPE OF SUPPLY AND DELIVERY

9.1 General Requirements

- 9.1.1 The TSCC Contractor shall supply and deliver all components related to the DCN system scope of work, except where the Authority furnishes the main optical fiber cable to the TSCC Contractor.
- 9.1.2 The TSCC Contractor shall supply and deliver all passive components related to the optical fiber cable.

9.2 Specific Requirements

- 9.2.1 The DCN scope of supply and delivery shall include (not limited to):
- Network devices for backbone and LAN networks (routers, switches, etc.).
 - Cabling and connectors.
 - Racks.
 - Software architecture, including full definition of protocols used.
 - Network Management System for the DCN.
 - Central servers.
 - Workstations/HMIs.
 - All HW/SW licenses covering the duration of the Agreement.
 - Auxiliary elements and gear for DCN (connectors, patch panels, tools, etc.).
 - Spare parts.
 - Maintenance laptops.
- 9.2.2 The Optical fiber cable scope of supply and delivery shall include (not limited to):
- Optical Fiber cables (Except main FO furnished by the Authority).
 - Protection against impacts, crush, and rodents for FO, especially in the manholes and extract points.
 - FO management software solution.
 - FO measurements and testing equipment.
 - Auxiliary elements and gear for FO (including connectors, ODFs, patch panels, FO tools, FO blowing machines, etc.).
 - Optical fiber splice organizers.
 - Spare parts.



10 MANUFACTURING

10.1 General Requirements

10.1.1 General manufacturing requirements are defined in the Contract.



11 INSTALLATION AND INTEGRATION

11.1 General Requirements

11.1.1 General installation and integration requirements are defined in Schedule 16 Scope of Work and Schedule 3.



12 TESTING & ACCEPTANCE

12.1 General Requirements

12.1.1 General testing and acceptance requirements are defined in Schedule 16 Scope of Work and in Schedule 3.

12.2 Specific Requirements

12.2.1 Specifically, to check the condition of the optical fiber cables following splicing and connection, but before implementation of an optical link, optical tests and measurements shall be performed by the TSCC Contractor. Each fiber shall be fully tested (including spare ones) according to OTDR tests (Optical Time Domain Reflectometer). Testing shall comply with TIA/EIA-526-7 standard, and the following information (not limited to) shall be recorded and reported during the test procedure:

- Type of test equipment used (manufacturer, model, and serial number).
- Date of test.
- Date of last test equipment calibration.
- Optical source wavelength, spectral width, and for multi-mode, the coupled power ratio (CPR).
- Fiber identification.
- End point locations.
- Test direction.
- Reference power measurement (when not using a power meter with a Relative Power Measurement Mode).
- Measured attenuation of the link segment.
- The measurement curve shall be attached to the report.



13 SUBMITTALS

13.1 General Requirements

13.1.1 General submittal requirements are defined in Schedule 16 Scope of Work.



14 QUALITY MANAGEMENT

14.1 General Requirements

14.1.1 General quality management requirements are defined in the Agreement and associated Schedules.



15 ADDITIONAL INFORMATION REQUESTED

15.1 General Requirements

- 15.1.1 In addition to the mandatory requirements outlined in this specification, the Authority reserves the right to request from the TSCC Contractor and Supplier information pertaining to the performance of proposed or supplied elements under similar service conditions, with particular emphasis on railway management aspects which may influence DCN subsystem reliability, availability, and maintainability characteristics.



16 LOGISTICS

16.1 General Requirements

16.1.1 General logistics requirements are specified in the Agreement.

