SCOPE OF WORKS FOR THE DIGITAL MIGRATION PROJECT- PHASE 1

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List of Abbreviations

3GPP	Third Generation Partnership Project
CCTV	Closed-Circuit Television
CTC	Centralized Traffic Control
DMR	Digital Mobile Radio
EIA	Environmental Impact Assessment
eNB	Evolved Node B
EPC	Evolved Packet Core
EPS	Evolved Packet System
ETSI	European Telecommunications Standards Institute
E-UTRAN	Evolved Universal Terrestrial Access Network
GSM-R	Global System for Mobile Communications-Railway
ICASA	Independent Communications Authority South Africa
IMT	International Mobile Telecommunications
IP	Internet Protocol
kHz	Kilo Hertz
LTE	Long Term Evolution
LTE-R	Long Term Evolution Railway
Mbps	Megabits Per Second
MCPTT	Mission Critical Push-To-Talk
MHz	Mega Hertz
MPT	Ministry of Posts and Telegraph
NOC	National Operation Center
OBS	Outcome-Based Security
POC	Proof of concept
QA	Quality Assurance
RAN	Radio Access Networks
RDP	Radio Distribution Power
RFI	Request for Information
RTO	Radio Train Order

RTW	Radio Track Warrant
SCM	Supply Chain Management
SKA	Square Kilometer Array
TCO	Train control officer
TRIM	Transnet Rail Infrastructure Manager
UHF	Ultra High Frequency
UPS	Uninterruptible Power Supply
VDU	Video Display Unit
VHF	Very High Frequency
WAN	Wireless Access Network

1. INTRODUCTION

To facilitate voice-based communication between the train driver and the Train Control Officers (TCO), Transnet leverages two wireless radio communication methods. The first network is an open-channel radio communication network. This network is utilised when the train authorization is based on the Radio Train Order (RTO), Radio Track Warrant (RTW), and Video Display Unit (VDU). The second network is the Trunk Radio network, which is used in locations where authorization is based on the colour light signalling. Both networks have reached end of life and are no longer supported by their original equipment manufacturers (OEM).

Moreover, in March 2015, the regulator (ICASA) issued a government gazette (38640) declaring that incumbents in the 450-470MHz band must vacate the band for IMT technologies to be deployed. The gazette affects the 450-470 MHz frequency range, where Transnet currently operates. The business impact of non-compliance would be the unavailability of all voice communication for the train driver and TCOs, shunting of wagons, ports communication etc., which would lead to business disruption. The absence of radio network will also cause the unavailability of some electrical substation remote switching and condition assessment systems. To ensure operations continuity , compliance to the legislation and addressing obsolescence, Transnet must transition from an analogue network to a digital network within the prescription of the gazette.

In October 2015, Transnet issued a Request for Information (RFI) to assess the technologies that might be employed to assure compliance while simultaneously sustaining the current network infrastructure for operations. Long-term Evolution (LTE) and Digital Mobile Radio (DMR) were the two technologies approved for implementation in the railway environment with the capabilities to address both the present and future railway communication demands. The LTE technology is broadband, and the DMR technology is narrowband, both being the component of the International Mobile Telecommunications (IMT) technology and designated by ICASA for the frequency band (450MHz).

The 300km section on the Iron Ore line between loop 7 and loop 15 will have the DMR technology implemented as broadband radiation is strictly due to the Astronomical Geographic Advantage Act (Act 21 of 2007) protecting the area. This document seeks to detail the scope of works for the deployment of the LTE and DMR technologies across the Transnet network environment.

2. PURPOSE / OBJECTIVE

The purpose of this project is as follows:

- Upgrade the outdated radio network to enhance critical communications between Train Drivers, Train Control Officers, Marshalling Yards, Ports, and other essential operations.
- Ensure compliance with ICASA regulations and Government standards.
- Upgrade the UHF radio network nationwide to LTE digital technology, excluding the Northern Cape where the SKA footprint is located.
- Ensure that the LTE digital technology operates within the 450-470 MHz IMT frequency band.
- Deploy DMR Tier 3 narrowband technology in the SKA region of the Northern Cape, on the Frequency Band that will be permitted by the AMA and ICASA.
- Provide necessary data capacity: Currently, the network lacks data capabilities due to its analogue nature. The new radio network must support Transnet digital requirements.
- Support Outcome-Based Security (OBS) digital communication needs, including CCTV and drone usage
- Enable network expansions to meet new business radio coverage needs.
- Fulfil RSR-mandated safety requirements for train operations, including support for signalling, axle counters.
- Support rail reform 3rd party Train operating Company's communication requirements.
- Be scalable and flexible to provision for future expansions.

3. SCOPE OF WORKS

3.1 Geographical Scope

The successful services provider(s) will be required to supply and install the Radio Equipment at Transnet radio or communication sites for the deployment of LTE/DMR technologies to replace the obsolete technology in Transnet areas and will be categorised according to the priority phases as listed below.

1. Ore Line Corridor
2. Central / Concor Corridors
3. Cape Corridor
4. Natal Corridor
5. Northeast Corridor
6. North Corridor
7. Othe Transnet network areas e.g., Ports, eSwatini, etc

3.2 Business scope

The appointed service provider(s) shall supply, install, configure, commission, test and integrate the offered into the Transnet network. The digital radio communication solution offered to Transnet will include the following:

3.2.1 A Mission critical LTE system based on Third Generation Partnership project (3GPP) standards from Release 13 onwards.

3.2.2 A DMR Tier III system for the 300km section on the Iron Ore line between loop 7 and loop 15.

3.2.3 Supply of hardware and software supporting accessories for the offered digital technology systems.

3.2.4 Test and handover of this system to Transnet after successful completion of the project including As Build diagrams, training and associated manuals and any other materials of intellectual property to Transnet.

3.3 Inclusions and Exclusions

3.3.1 Inclusions

The scope of work includes the following:

- Radio simulations for individual high sites and development of engineering designs for radio networks.
- The design for locomotive communication systems that will function with the Radio communication system. All locomotive interfaces to be considered in the solution design.
- The detailed plan for the implementation of the dual illumination (radiating Analogue & Digital at the same site) strategy.
- Accurate capital costing for the project, including direct and indirect costs, contingency, forex and escalation.
- Project schedules in agreed format (to be decided in kick off meetings)
- Detailed Risk register including mitigation strategies.
- Project Execution Plan and recommendations for the way forward.

3.3.2 Exclusions

Due to the wide area of deployment the following is excluded from the scope of work.

- The environmental impact analysis (EIA) will be specific to a given site. Due to the phased approach of the project deployment, these studies will be carried out prior to the implementation of the individual site in a corridor.
- The land acquisition that would be required for the project is not included in the study. Rail Network has made a principal decision that any new Greenfield telecommunication high site will be in the Transnet servitude.

4. TECHNICAL SCOPE

The appointed service provider(s) shall supply, install, configures, commission, test and integrate the offered into the Transnet network. The digital radio communication solution offered to Transnet will include the following:

4.1.1 Supply and Installation of LTE eNodeB radio equipment

4.1.2 Supply and Installation of LTE Core equipment

4.1.3 Supply a Network Management System for the MCPTT LTE and DMR systems

4.1.4 Supply and Installation of DMR radio equipment in the SKA region

4.1.5 Supply and Installation of DMR Node equipment

4.1.6 Supply and install and configure an Interworking Function between LTE and DMR

4.1.7 Supply and installation of dispatchers in all Transnet CTC buildings

4.1.8 Supply of 19-inch cabinets in selected sites as and when required

4.1.9 Supply of LTE test equipment

4.1.10 Supply of DMR test equipment

4.1.11 Software/\for Geofencing application (Location based addressing)

4.1.12 Supply of LTE & DMR network peripheral equipment (Data and Voice) as and when required

4.1.13 Supply installation and programming of RDP modules

4.1.14 Supply of dual train radio modules

4.1.15 Configuration, commissioning, testing and handover of the solution

4.2 Functional requirements

4.2.1 The service provider shall declare any additional and speciality software that is to be procured for the lifespan of the equipment.

4.2.2 The service provider shall list all spare components for the supplied LTE and DMR equipment, plus list vendors that provide component and spares for the lifespan of provided equipment.

4.3 Training requirements

Adequate and appropriate training requirements for all systems, procedures and processes are to be provided to the relevant staff. Trainers from Transnet Faculty of Rail (FOR) will also attend the Digital Technology Technician course as well as Digital Technology Network Design and Configuration Training. They must be provided with full course documentation so that they may use this to train Transnet technicians in the future. All persons that are trained either by Faculty of rail or the manufacturer must be certified to do module, software changes, installations and commissioning without the warranties becoming void. A list of trainees will be provided as and when training is required. Provision must be made for at least 15 trainees per corridor and additional 15 for national FOR trainers.

4.4 Deliverables

The project must deliver a Digital broadband technology using the long-term evolution (LTE) with emphasis in railways. The following systems will be delivered:

4.4.1 Installation of eNodeB that comply with Release 13 and onwards of the LTE technology. The equipment must be configurable to 5G technology. Additionally, new sites will be built for the Coal line which currently uses the GSM standard which is delivered by MTN.

4.4.2 The installation of new Train Cab radio systems to ensure voice and data communication from the Train. This radio system shall have the capability of being programmed over the air to ensure flexibility of operations.

4.4.3 A network management system that will have the capability of configuring the Telecoms network. The system shall ensure that all activation and deactivation of all unit will be possible from a centralised area.

4.4.4 A core network that ensures management of all the eNodeB's that are in the system. The core will also have the configuration of outside stations to enable Open Channel radio communication that is required for RTO/RTW/VDU authorisation. The solution will also include a mapping functionality.

4.4.5 A strategy for cross border communication to ensure communication with neighbouring countries. The design for interfacing with Eswatini will be documented to ensure seamless communication between Komatipoort and Richards Bay.

4.4.6 The project must also deliver a Digital narrowband technology using the Digital Mobile Radio (DMR) for the SKA region in the Northern Cape to ensure compliance to the Astronomy geographic advantage act.

4.4.7 Supply and deliver tunnel communication system for the Ore line.

4.5 Project Assumptions

It is assumed that by this stage, PRASA will have implemented its GSM-R network across all metropolitan areas. Once Transnet's MCPTT network is deployed, integration with the GSM-R network will follow. This will allow a Transnet TCO to authorize trains within PRASA sections using their dispatch unit and enable a PRASA TCO to communicate with Transnet trains passing through PRASA sections. Service provider should consider this integration requirements in their final proposal.

4.6 Project Constraints

The following constraints are applicable to this Project:

- Land acquisition.
- Environmental Impact Assessments (EIA).
- Long lead times with item procurement.
- Optimal stakeholder engagement.
- All work including procurement of materials shall be done according to Transnet Rail Infrastructure Manager Standards and Specification.
- Transnet shall arrange all occupations.
- Compliance to all applicable standards governing railway environment.

4.7 Critical success factors

***Stakeholder management**:* Actively involving and managing project stakeholders throughout the project lifecycle, this will help in understanding their needs, managing expectations, and gaining their support, which is crucial for project success.

Clear scope: Well-defined and agreed-upon project objectives, providing a clear direction for the project team and stakeholders, ensuring everyone is aligned on what needs to be achieved.

***Effective Communication**:* Open, transparent, and timely communication among project team members, stakeholders, and relevant parties to facilitate collaboration, problem-solving, and decision-making, reducing misunderstandings and conflicts.

Risk Management: Identifying, assessing, and managing risks throughout the project lifecycle and mitigating potential threats and seizing opportunities, ensuring project success despite uncertainties.

Quality Management: Implementing robust quality management processes and standards that ensures project deliverables meet specified requirements and stakeholders' expectations, enhancing satisfaction and reducing rework.

Resource Management: Efficiently managing project resources, including human resources, finances, materials, and equipment, ensures optimal utilization and allocation, preventing resource constraints that could impede project progress.

5. CORRIDOR SCOPE OF WORK

5.1 Phase 1A: The Ore line (OREX)

The successful services provider will be required to supply and install the Digital Radio Equipment for the 300km section on the Iron Ore line between loop 7 and loop 15 which house approximately 35 sites. The site names and depots are indicated in Tables 1 below. The 10 sites marked in red are located within the SKA area and will implement DMR technology. A mandatory requirement is that the Loop 15 site must deploy both technologies.

High Site Name	Depot	High Site Name	Depot	High Site Name	Depot
Saldanha /Ready Mix	Saldanha	Loop 7A	Saldanha	Loop 18	Upington
Salkor	Saldanha	Repeater C2	Saldanha	Repeater F	Upington
Loop 1	Saldanha	Loop 8	Saldanha	Olifantshoek	Upington
Repeater A	Saldanha	Loop 9	Saldanha	Loop 19	Upington
Loop 2	Saldanha	Loop 10	Saldanha	Sishen (ERTS)	Upington
Loop 3A (New Site)	Saldanha	Loop 11	Upington		
Loop 3	Saldanha	Loop 12	Upington		
Repeater B	Saldanha	Loop 13	Upington		
Loop 4	Saldanha	Loop 14	Upington		
Lutzville	Saldanha	Loop 15	Upington		
Loop 5	Saldanha	Repeater D	Upington		
Loop 6A (New Site)	Saldanha	Loop 16	Upington		
Loop 6	Saldanha	Repeater E1	Upington		
Lientjie se Kop	Saldanha	Loop 17	Upington		
Repeater C1	Saldanha	Repeater E2	Upington		

Table 1:OREX sites

5.1.1 Technical scope

Each eNode B will be equipped with one to four sectored antennas, each paired with a remote radio unit (RRU) positioned behind the antenna. The RRU will connect to the Baseband Unit (BBU) via a CPRI cable. The eNode B equipment will be supported by a stable power supply system, including backup batteries to maintain connectivity during power outages. Connection to the EPC will occur over a high-speed backhaul network using either optical fibre or microwave links. Existing analogue microwave links will be upgraded (Transnet) to support the digital network. Additionally, local IP network must be available to link the eNode B to the core network nodes. The LTE core equipment will be installed in the Bellville test room.

The 10 DMR high sites are required to operate at Tier 3 level and will be backhauled via either optical fibre or microwave links. The DMR node will be installed in the Bellville test room alongside the LTE core equipment. To ensure seamless communication between the two technologies, they must be interconnected using the IWF DMR-LTE Server. The Network

Gateway for Legacy Systems must also be in place to allow analogue communication during the dual illumination stage. It must be ensured that all voice communications are recorded.

Along the Iron Ore Corridor, various radio-based and in-cab systems are currently in use, including Radio Distributed Power, Ultrasonic Broken Rail Detectors, Wayside Intelligent Long Stress Management, and Dragging Equipment Detection. These legacy systems must be migrated and integrated into Transnet's newly upgraded digital network. Additionally, geofencing software and hardware must be implemented to create virtual geographic boundaries that trigger specific actions when the train enters or exit these areas.

5.1.2 CTC scope

The Ore Line CTC operates three on-track sections, south, middle and north board, including 3 additional radio systems for off-track communication. These workstations must install dispatcher systems essential for managing and coordinating communications across the network. The number of dispatchers to be installed can be seen in Table 2 below.

5.1.3 Tunnel Communication

The communication system currently deployed in some tunnels is analogue in nature. To enable its operation on the LTE network, modifications are required, including a hardware adjustment (swapping the Tx and Rx ports) and software configurations to update the operating frequencies. The Bobbejaansberg (Oreline), Cedara (Container) tunnels are prioritised as part of Phase 1 of the project.

5.2 Phase 1B: The Container Corridor

The Container Corridor connects the Port of Durban to Gauteng's economic hub via a 688 km rail network. This corridor transports a variety of commodities, including containers, automotive goods, grain, fuel, chemicals, coal, manganese, chrome, and general freight cargo like FMCG products. Passenger services also utilize this rail infrastructure but are managed by operators other than Transnet. The Natcor radio network, supporting this corridor, is maintained by radio depots in Ladysmith, Heidelberg, and Durban. As part of the digital migration, only an LTE network will be implemented along this corridor. Table 3 below denotes the list of sites to be migrated.

5.2.1 LTE Technical scope

The technical scope for implementing an LTE network along the Container Corridor would involve the following key aspects:

Radio Access Network (RAN) Design:

- Detailed coverage planning along the 688 km rail route to ensure uninterrupted LTE service.
- Strategic placement and design of eNodeB's (LTE base stations) at key intervals to provide coverage across the entire corridor, including tunnels and remote areas. The use of Transnet existing sites would be preferred.
- Optimization of signal strength and handovers to maintain high-quality service

Core Network Integration:

- Installation of the LTE core network infrastructure, including the Evolved Packet Core (EPC), to enable data routing and mobility management, with deployment taking place at the Durban station.
- Integration with Transnet's existing network to enable seamless communication and centralized monitoring.

5.2.2 CTC scope

The Container Corridor comprises of four CTC's: the Newcastle, Durban, Standerton and Danskraal. The Danskraal CTC contains four (4) workstations, Standerton, three (3), Newcastle, three (3), and Durban has 13 workstations. Each of these workstations requires the installation of dispatcher systems that are essential for managing and coordinating network communications. The quantity of dispatchers needed for each CTC is shown in Table 4 below.

5.2.3 NOC scope

A Network Monitoring System (NMS) must be installed in all Transnet Network Operations Center (NOC) facilities such as Johannesburg, Essellen park and Durban.

In the Ladysmith section, two 30-meter masts are needed at the Van Reenen and Escourt sites.

Furthermore, two sites in the Heidelberg section, Vergenoeg and Danhauser, were vandalized and need to be restored to standard condition.

5.2.4 Container corridor sites

High site	Depot
Steynsrus Silo	Ladysmith
Arlington HS	Ladysmith
Kaallaagte Silo	Ladysmith
Afrikaskop	Ladysmith
Danielsrus Silo	Ladysmith
Birdcage Hill	Ladysmith
Congleton	Ladysmith
Kransfontein	Ladysmith
Retiefsnek	Ladysmith
Fouriesburg	Ladysmith
Ionia	Ladysmith
Ficksburg	Ladysmith
Hillcrest	Ladysmith
Modderpoort Silo	Ladysmith
Hartebeeskop	Ladysmith
Reits Water Tower	Ladysmith
Tweeling Silo	Ladysmith
Frankfort Silo	Ladysmith
Villiers	Ladysmith
Mpati Hill	Ladysmith
Dannhouser New	Ladysmith
Chivelstone	Ladysmith
Ceasers Camp	Ladysmith
Uithoek R-R	Ladysmith
Klipfontein	Ladysmith
Heidelbergkop	Heidelburg
Van kolderskop	Heidelburg
Vergenoeg	Heidelburg
Standerskop	Heidelburg
Perdekop	Heidelburg
Palmford	Heidelburg
Verkykerskop	Heidelburg
Platrand-Vodacom	Heidelburg
Inkwelo	Heidelburg
Signal Hill	Heidelburg
Country School	Heidelburg

High site	Depot
Chievely	Ladysmith
Escourt comms	Ladysmith
Hidcote	Ladysmith
Mooiriver Comms	Ladysmith
Nottinghamm Road	Ladysmith
Ladygate	Ladysmith
Van Reenen	Ladysmith
Pimple Hill	Ladysmith
Wembezi	Ladysmith
Bayhead Px Blg	Durban
Burlington	Durban
Mariannhill	Durban
Delville Wood	Durban
Alverstone (Transmission only)	Durban
Cliffdale	Durban
Hammersdale	Durban
Crookes Farm	Durban
Ashburton R - R	Durban
Napier Hill	Durban
Umbogintwini	Durban
Green Point	Durban
Katinka (Transmission only)	Durban
Woolwich	Durban
Hibberdene	Durban
Muckelbrae (Transmission only	Durban
Portshepstone	Durban
Echo Valley	Durban
Glenlyn	Durban
Blinkwater	Durban
Kranskop (KZN)	Durban
Durban Station	Durban
Brickfield	Durban
Trenance	Durban
Stanger	Durban
Umhlali	Durban

Table 2: Container corridor sites

5 QUALITY MANAGEMENT

The following quality management processes are essential and will be implemented throughout the project:

- **Quality Assurance**: This process will involve evaluating project performance to ensure that all specifications and requirements are met.
- **Quality Audits**: These audits are a key part of the quality assurance process and will be conducted to uphold project standards.
- **Quality Standardization**: This process will identify the required standards and specifications that must be followed when equipment or installations are tested for quality outcomes. Details on quality standardization will be provided in the FEL-4 documentation.
- **Quality Control**: This process will verify that specific project outcomes meet established quality standards and will include methods for addressing any areas of unsatisfactory performance.
- **Quality Management plan:** device and present a detailed quality management plan to Transnet for final sign off.

6 LEGAL REQUIREMENTS

6.1. All potential service providers must conduct a baseline risk assessment, which includes:

- Identifying risks and hazards that could impact individuals during the project execution phase.
- Analysing and evaluating these risks and any identified ergonomic factors using a documented method.
- Developing a documented plan with safe work procedures to mitigate, reduce, or control identified risks and hazards.
- Establishing a monitoring plan and a review process.

6.2. Written confirmation and approval must be obtained from the TRIM Corporate Safety Department for this procurement event, including sign-off on the evaluation criteria where required.

6.3. Health and Safety specifications should be based on the findings of the Baseline Risk Assessment.

6.4. As a tender requirement, the principal contractor must demonstrate that adequate funding is allocated for Health and Safety. The associated costs should be included in the Bill of Quantities.

6.5. Tenders must submit a complete pricing schedule and lead/delivery times for all services to be provided. These prices must include all licensing and fees.

7 APPENDIX 1: ESTIMATED BILL OF QUANTITIES

The attached appendix 1 shows estimated quantities per corridor. The quantities provided are for reference, allowing bidders to anticipate the potential volume of procurement. This approach ensures that bidders can factor in economies of scale when determining their unit rates, enabling Transnet to secure more favourable pricing for bulk quantities.