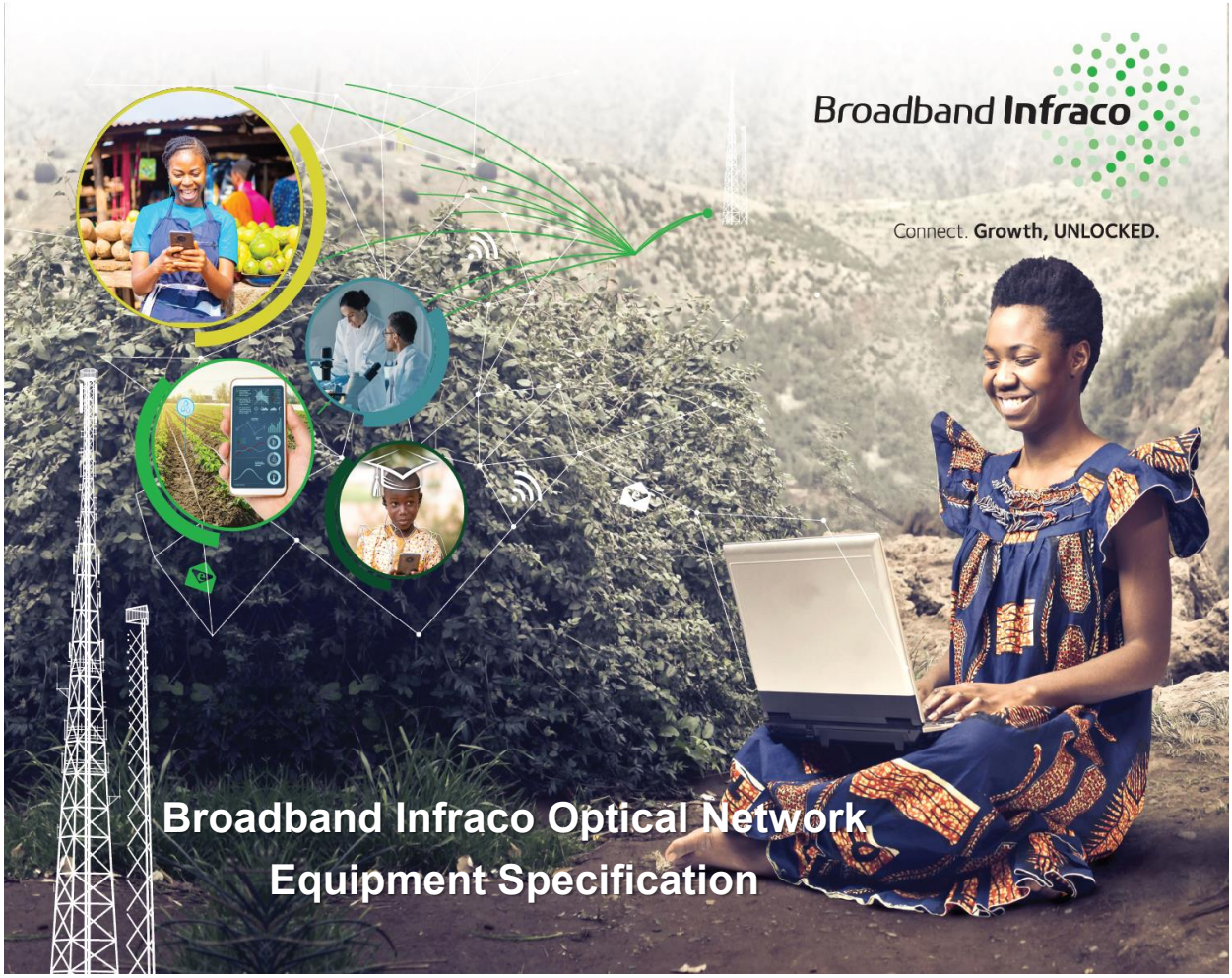

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Submission/Title: **Second Transmission OEM specification**

Submitted by: **Network planning team** Date: 29/11/2023 Submission Date
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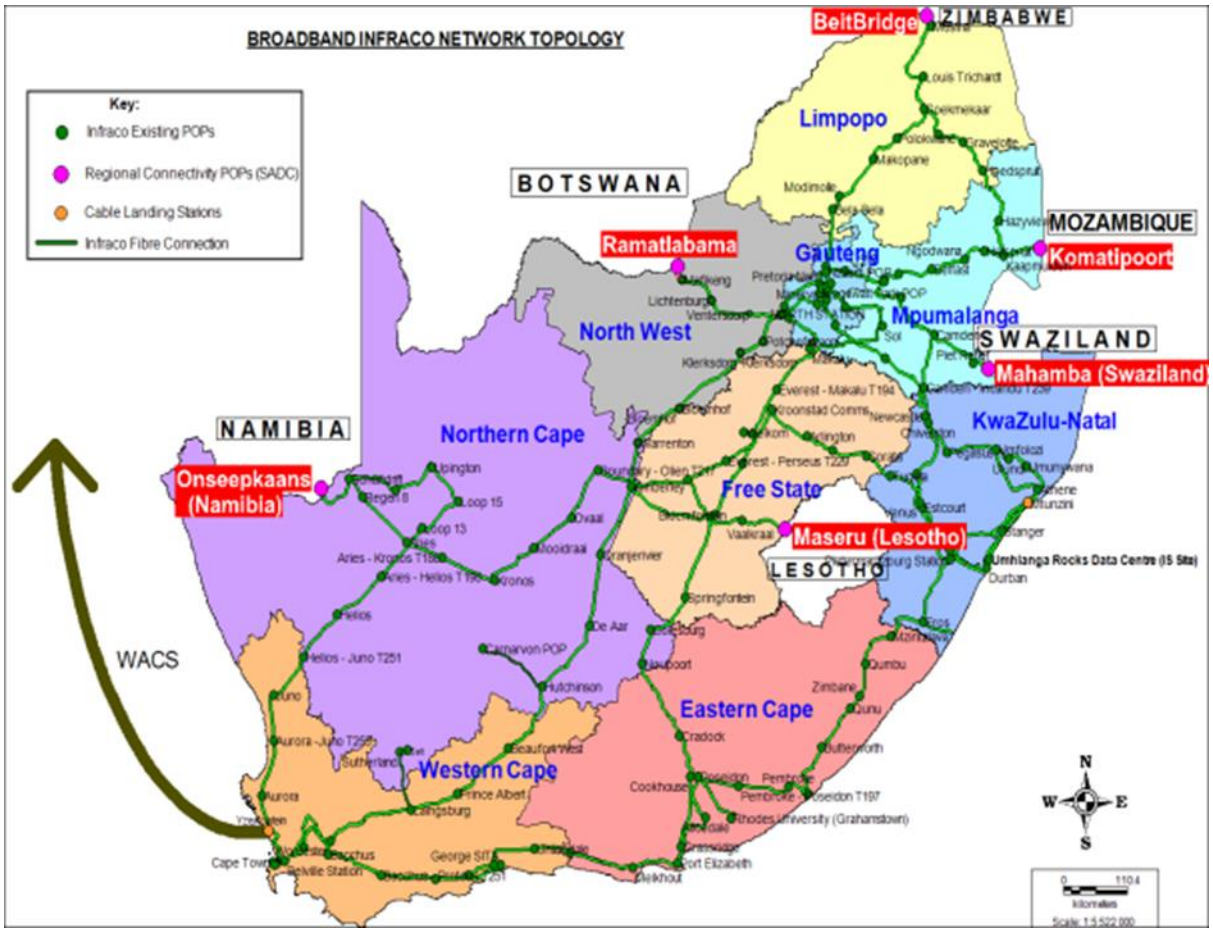

Figure 1: Broadband Infraco Long Distance Network

Broadband Infraco operates a national long distance fibre network using Dense Wave Division Multiplexing (DWDM) technology. The services that are provided over the DWDM network range from Synchronous Digital Hierarchy (SDH), Optical Transport Network (OTN), Ethernet and Internet Protocol (IP).

The current Broadband Infraco Transmission Network relies on traditional coherent and non-coherent Fixed Optical Add/Drop Multiplexer (FOADM), Reconfigurable Optical Add/Drop Multiplexer (ROADM), and Photonic Cross-connect (PXC) Dense Wavelength Division Multiplexing (DWDM) structures. These structures have limitations and cannot adequately accommodate the dynamic and unpredictable network traffic demand. Traditional Optical Add/Drop Multiplexing (OADM) architectures, which switch traffic at the wavelength level, require many ports as traffic volume increases.

Therefore, Broadband Infraco envisions a long-term solution to reduce the number of required ports, resulting in cost savings and simplified control complexity. The proposed solution is to adopt the coherent DWDM transport architecture known as Colourless, Directionless, Contentionless and Gridless (CG/CDG/CDCG) ROADM nodes. In (CG/CDG/CDCG)-ROADMs, ports are not dedicated to specific wavelengths or node degrees, allowing multiple

ports to simultaneously add/drop different channels at the same wavelength. Moreover, the (CG/CDC/CDCG) capabilities eliminate the need for manual field technician intervention, a significant improvement compared to the earlier generations of ROADMs.

The current DWDM network is based on a single vendor equipment and Broadband Infraco wants to expand the network and add a second transmission vendor to the network as part of its multi-vendor strategy.

Broadband Infraco intends to source high capacity optical transmission network systems that will provide carrier class services over the existing infrastructure, and contribute to the expansion of the Broadband Infraco transmission network and in support of projects of National interest.

This specification defines the Broadband Infraco requirement for OTN/DWDM equipment that can be used to expand the existing network. The specification covers requirements relating to ITU-T recommendations, Network Management System and the network planning tool.

2 Objective

The primary objective is to select the bidder that provides the most cost effective and technically compliant turnkey solutions utilising the latest transmission technology that would be sustainable for at least 7 years from contract signature for the required solutions as outlined below.

3 SCOPE and Technical Requirements

Broadband Infraco intends to install Optical Transport Network and DWDM equipment as part of its network optimisation and expansion projects. The Scope of Work shall be as follows:

- Supply of OTN and DWDM equipment;
- Installation and commissioning of OTN equipment including Network Management System, Network Planning Tool; and
- Commissioning of Network.

The Bidder shall implement the Broadband Infraco requirement as a turnkey solution.

3.1 Network Design

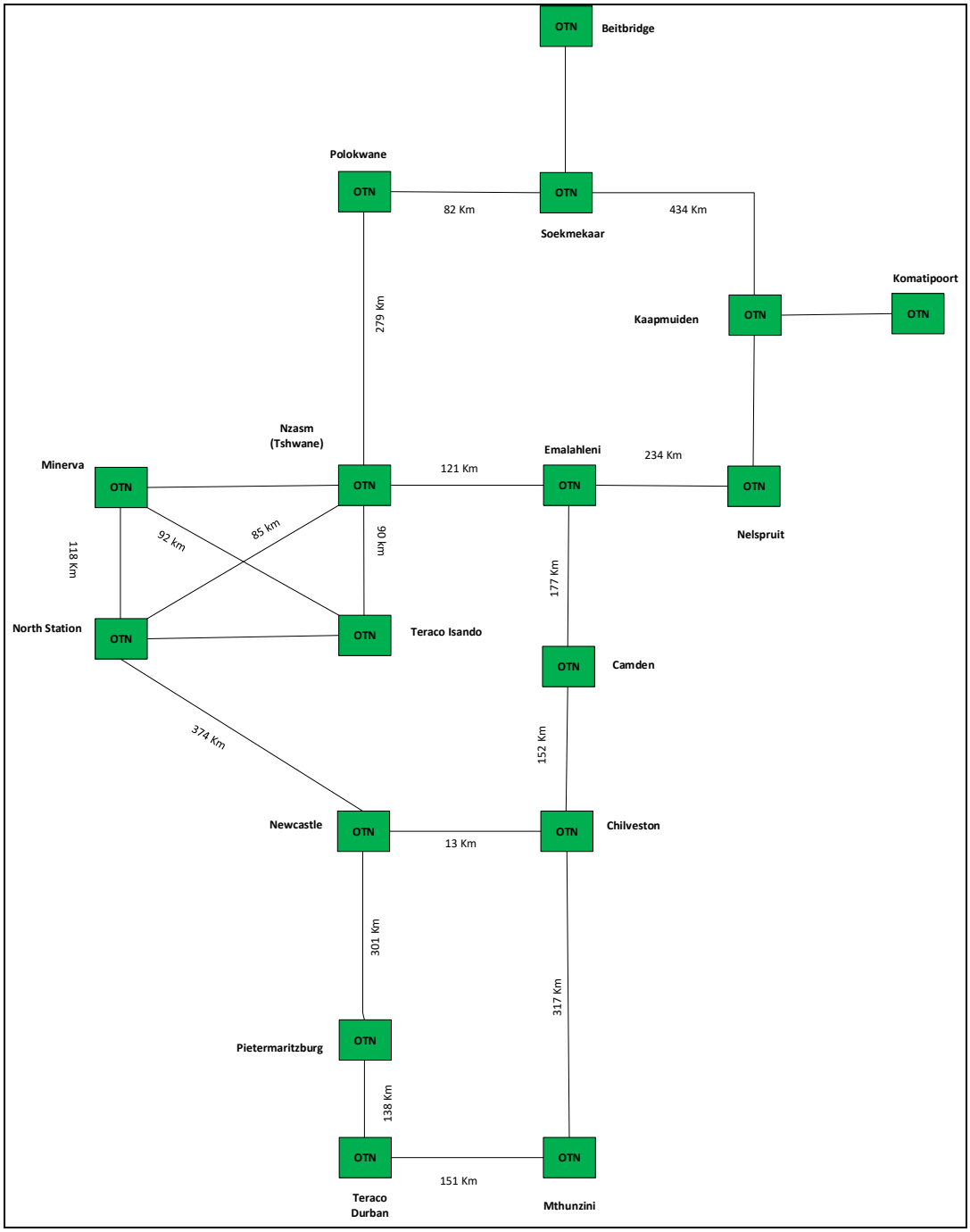

Figure 2: Broadband Infraco OTN Requirement

The figure above illustrates the Broadband Infraco OTN network design requirements. This network shall be implemented over the existing Broadband Infraco fibre network. The OTN network shall be implemented on the following Broadband Infraco network routes:

- Teraco Isando -Teraco Durban via Emalahleni and Empangeni;
- Teraco Isando -Teraco Durban via Newcastle;
- Gauteng Metro; and
- Northern Ring network.

The proposal must include the technical design and related bill of material, and services, as per the diagrams below, illustrating the Broadband Infraco initial network and capacity requirements. The proposal shall include a network management system and a Project Implementation Plan.

Note: Broadband Infraco reserves the right to amend the required scope prior to implementation based on the Broadband Infraco network needs at the time of implementation.

3.1.1 Teraco Isando – Teraco Durban

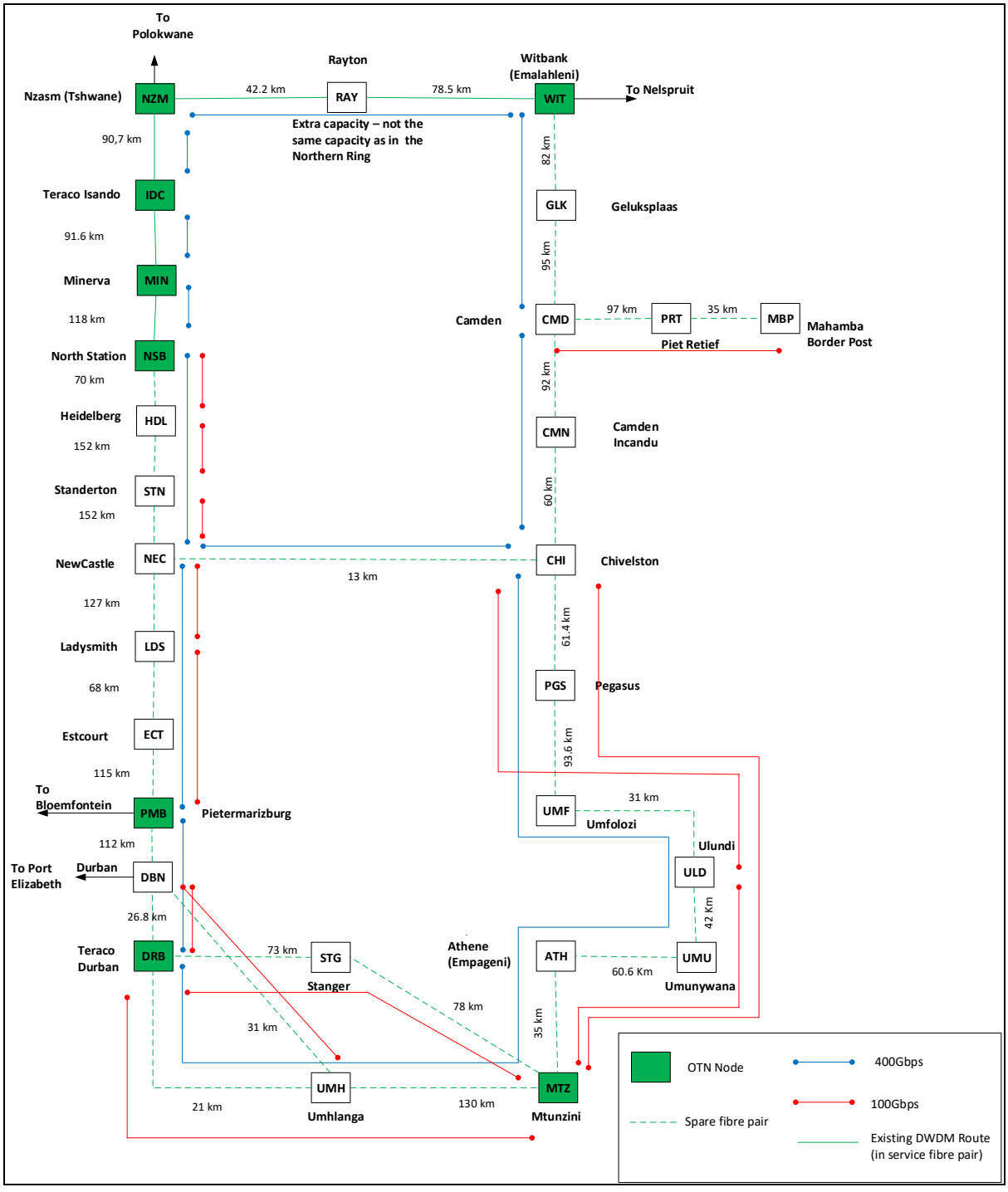

Figure 3: Teraco Isando - Teraco Durban

The figure above illustrates the Broadband Infraco OTN requirements over the highlighted sections of the Broadband Infraco network. The table below provides further details.

Table 1:Teraco Isando - Teraco Durban Site Type

					Client interface			
Site Name	**Site Type**	**OTN Switching Capacity (Tbps) (Minimum)**	**Nodal Degrees**	**Line Capacity (per direction)**	**100G**	**10G**	**1G**	**Comments**
Geluksplaas	OLA		2	As per diagram				
Camden	Optical Cross connect	6	3	As per diagram	5	10	10	
Piet Retief	OLA		2	As per diagram				
Mahamba	ROADM		1	As per diagram		6	6	Border site to eSwatini
Camden Incandu	OLA		2	As per diagram				
Chilveston	Optical Cross connect	6	3	As per diagram	5	10	10	
Pegasus	OLA		2	As per diagram				
Umfolozi	OLA		2	As per diagram				
Athene	OLA		2	As per diagram				
Ulundi	ROADM		2	As per diagram		6	6	
Umunywana	OLA		2	As per diagram				
Stanger	OLA		2	As per diagram				
Mtunzini	CD ROADM		3	As per diagram	5	10	10	
Umhlanga	ROADM		3	As per diagram		6	6	
Durban	ROADM		3	As per diagram		6	6	
Teraco Durban	Optical Cross connect	12	3	As per diagram	5	20	20	
Pietermaritzburg	Optical Cross connect	6	2	As per diagram	5	10	10	
Estcourt	OLA		2	As per diagram				
Ladysmith	ROADM		2	As per diagram		6	6	

					Client interface			
Site Name	**Site Type**	**OTN Switching Capacity (Tbps) (Minimum)**	**Nodal Degrees**	**Line Capacity (per direction)**	**100G**	**10G**	**1G**	**Comments**
Newcastle	Optical Cross connect	6	3	As per diagram	5	10	10	
Standerton	ROADM		2	As per diagram		6	6	
Heidelberg	ROADM		2	As per diagram		6	6	

3.1.2 Northern Ring Network

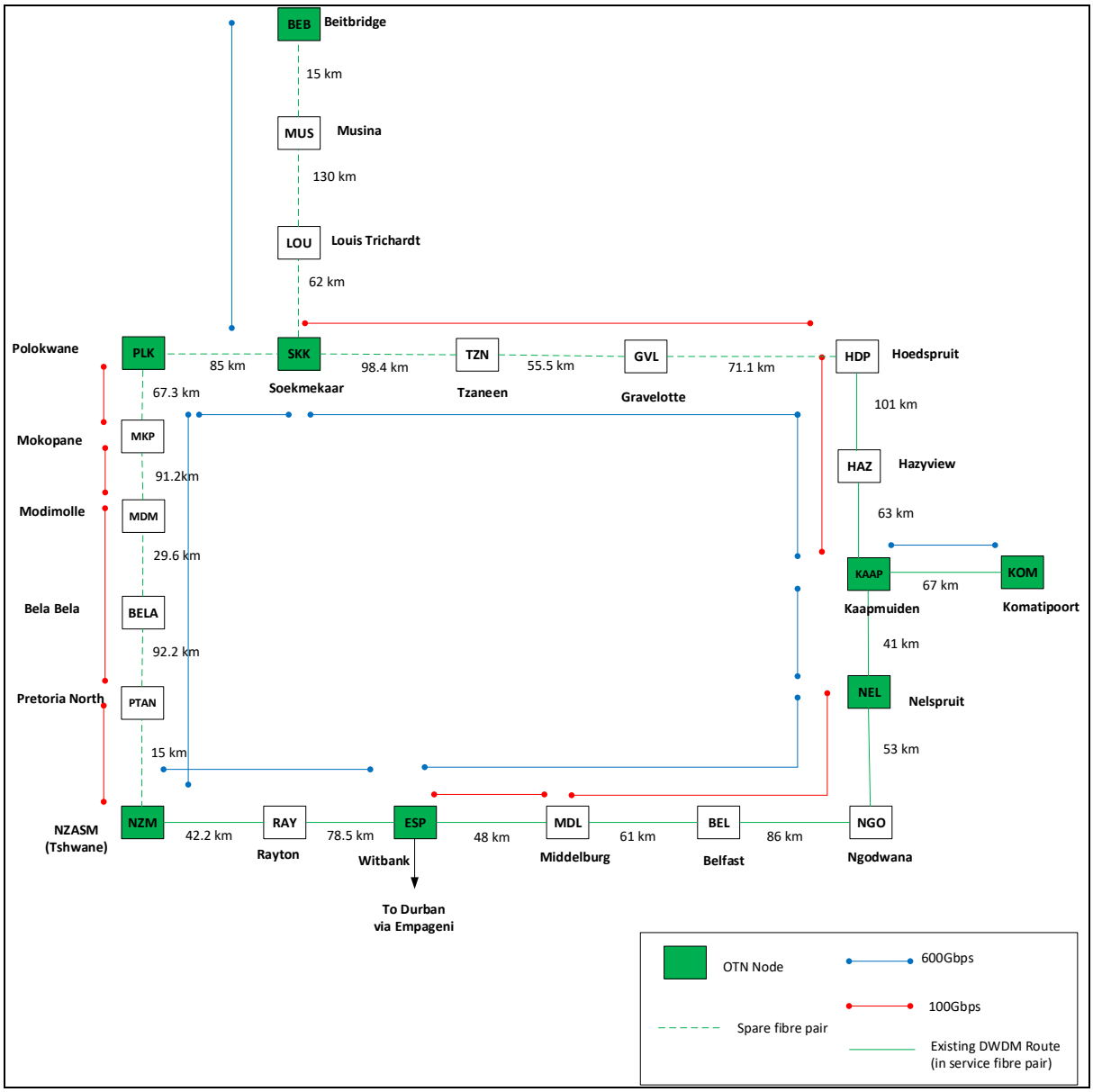

Figure 4: Northern Ring Network

The figure above illustrates the Broadband Infraco OTN requirements over the highlighted sections of the Broadband Infraco network. The table below provides further details.

Table 2: Northern Ring Network Site type

			Nodal Degrees			Client interface			
Site Name	**Site Type**	**OTN Switching Capacity (Tbps) (Minimum)**	**Current scenario**	**Future direction**	**Line Capacity (per direction)**	**100G**	**10G**	**1G**	**Comments**
Pretoria North	CD ROADM		2	1	As per diagram		6	6	
Bela Bela	Patching site		2		As per diagram				Pass through/patching site - no equipment required
Modimolle	ROADM		2		As per diagram		6	6	
Makopane	ROADM		2		As per diagram		6	6	
Polokwane	Optical Cross Connect	6	2		As per diagram	3	10	10	
Soekmekaar	Optical Cross Connect	12	3		As per diagram				
Louis Trichardt	OLA		2		As per diagram				
Musina	Patching site		2		As per diagram				Pass through/patching site - no equipment required
Beitbridge	Optical Cross Connect	6	1		As per diagram	4	20	20	Border site to Zimbabwe
Tzaneen	OLA		2		As per diagram				
Gravellote	OLA		2		As per diagram				
Hoedspruit	ROADM		2	1	As per diagram		6	6	
Hazyview	OLA		2		As per diagram				
Kaapmuiden	Optical Cross Connect	6	3		As per diagram		10	10	
Komatipoort	Optical Cross Connect	6	1		As per diagram	2	10	10	Border site to Mozambique
Nelspruit	Optical Cross Connect	6	2		As per diagram	3	10	10	

			Nodal Degrees			Client interface			
Site Name	**Site Type**	**OTN Switching Capacity (Tbps) (Minimum)**	**Current scenario**	**Future direction**	**Line Capacity (per direction)**	**100G**	**10G**	**1G**	**Comments**
Ngodwana	OLA		2		As per diagram				
Belfast	OLA		2		As per diagram				
Middelburg	ROADM		2		As per diagram		6	6	
Emalahleni	Optical Cross Connect	12	3		As per diagram	3	10	10	
Rayton	OLA		2		As per diagram				

3.1.3 Gauteng Metro

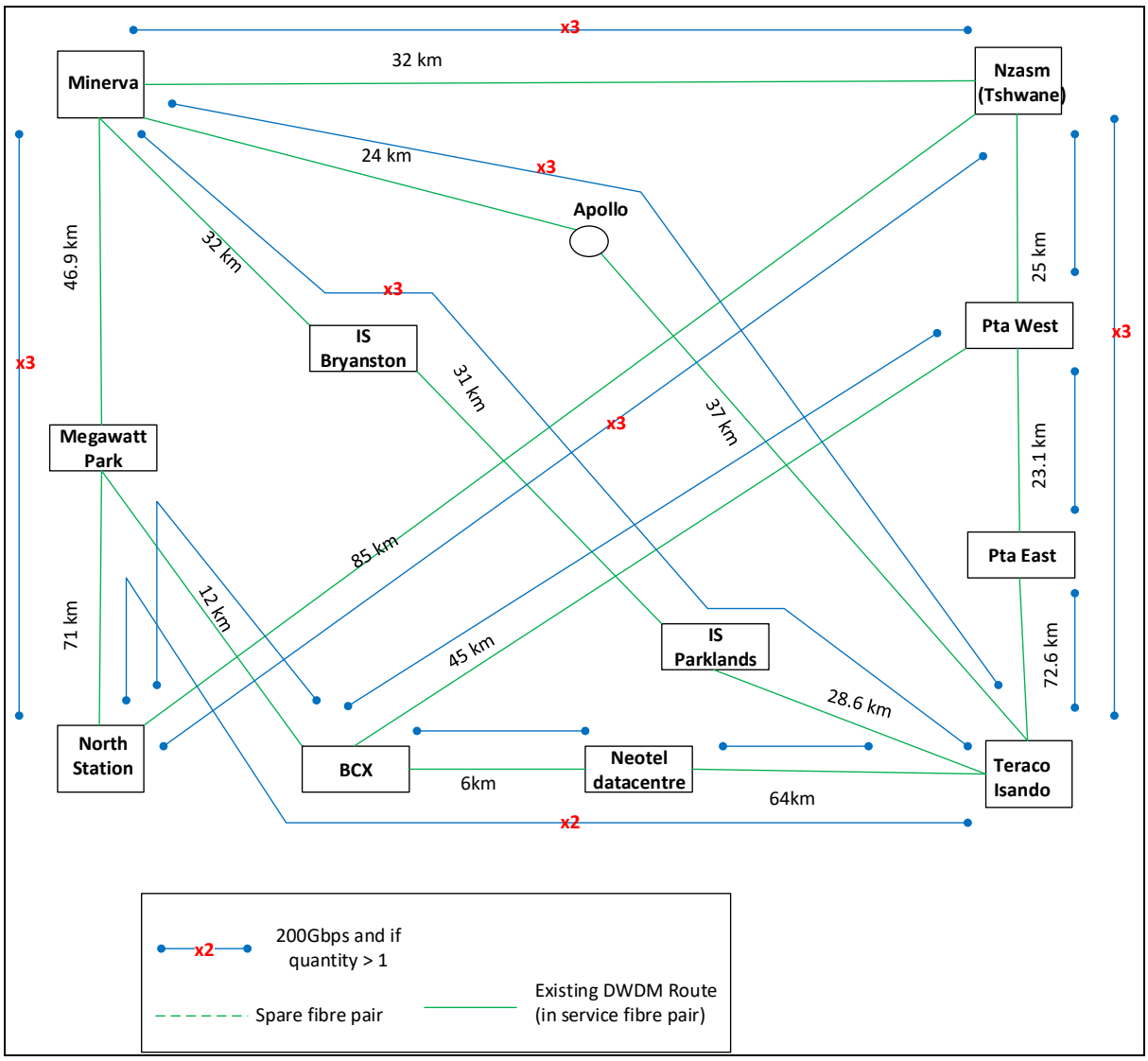

Figure 5: Gauteng Metro Network

The figure above illustrates the Broadband Infraco OTN requirements over the highlighted sections of the Broadband Infraco network. The table below provides further details.

Table 3: Gauteng Metro Site type

					Client interface		
Site	**Site Type**	**OTN Switching Capacity (Tbps) (Minimum)**	**Nodal Degrees**	**Line Capacity (per direction)**	**100G**	**10G**	**1G**
Nzasm	Optical Cross Connect	12	5	As per diagram	4	20	40
Minerva	Optical Cross Connect	12	4	As per diagram	4	20	40
North Station	Optical Cross Connect	12	3	As per diagram	4	20	40
Teraco Isando	Optical Cross Connect	12	4	As per diagram	10	40	40
Pretoria West	Optical Cross Connect	1	3	As Per Diagram		10	10
Pretoria East	Optical Cross Connect	1	2	As per Diagram		10	10
BCX	Optical Cross Connect	1	3	As Per Diagram		10	10
Neotel Data Centre	Optical Cross Connect	1	2	As per Diagram		10	10

3.1.4 Planning and Design Assumptions

The Bidder can apply the following assumptions to its network design:

- Loss or attenuation coefficient of 0.225 dB/Km in line with the G.652D optical fibre ITU-T optical fibre recommendations;
- The proposal must be based on a Coherent DWDM/OTN network;
- Only a pair of fibre is available for implementation:
    - There are sections of the proposed network implementation where spare fibre is not readily available for use by the bidder. The only available pair of fibre is in use by the incumbent DWDM system. The Bidder will have to develop a detailed Method of Procedure to replace the incumbent DWDM system;
- The proposed equipment must be DC powered;
- Optical equipment should be able to cater for the required link Budget (total loss of cable for each span) along with 3 dB End of Life (EOL) margin for each span;
- The services from different directions shall be provisioned on different line boards to ensure high network reliability and service routing resilience;
- The tributary and line boards shall not be configured in the same board to ensure high network reliability and services availability; and
- It is preferred that the proposed equipment is 19 inch mountable and must fit in a cabinet with the following dimensions; 2200mm*600mm*300mm.

3.2 Broadband Infraco Responsibilities

Broadband Infraco shall ensure the following during implementation of the proposed network:

- Broadband Infraco shall assign a Project Manager serving as a single point of contact for any access or other issues related to performing the mutually agreed scope of work;
- Broadband Infraco to ensure that space and power are available for NMS servers (main and DR);
- Broadband Infraco to ensure that all required HW and SW requirements for Client workstations and Local Craft Terminals are in compliance with the Bidder's requirement;
- Broadband Infraco to ensure spare fibres are available end to end for those sections of the network where spare fibre is available;
- Broadband Infraco shall ensure that it's sites are ready for the deployment of all equipment. The successful Bidder must provide to Broadband Infraco its RFO requirement prior to implementation of the required network. The site readiness shall include the following:
    - Space, Power and cooling of all sites where transmission equipment will be deployed.

3.3 Requirements from Bidder

The proposal from the bidder shall include the following:

- Detailed Technical Design Document based on the Broadband Infraco technical requirement;
- Detailed Bill of Material and Services;
- Project implementation Plan;
- Method of Procedure (MoP):
    - There are some segments of the proposed network implementation where there is no spare pair of fibre available for use by the Bidder. In these cases, the bidder may be required to re-use the in service optical pair of fibres. This will require the Bidder to develop a detailed Method of Procedure (MOP) to place the DWDM network into service while minimising service outages. The Bidder shall include in their budget provided with this proposal the necessary resources to develop and implement this MOP. The Bidder shall be responsible for implementing this MOP in a manner that will minimise service outages. Broadband Infraco will provide personnel to work directly with onsite Bidder personnel during implementation and cutover of existing services to the proposed OTN/DWDM network.

3.3.1 Installation, Testing and Handover of Transmission Equipment

3.3.1.1 Installation

The Bidder shall engineer, furnish, deliver, install all associated installation materials and auxiliary equipment for a OTN/DWDM network that is fully functional, properly installed, turned up, and tested as per these specifications. The Bidder shall be responsible for engineering the full bill of materials necessary to provide Broadband Infraco a complete functional installation of the project, including all minor hardware, brackets, covers, and wiring for the OTN/DWDM network equipment. The equipment, all interconnecting fibres and cables and the rack shall be labelled as per Broadband Infraco Labelling Standard.

The list of materials below is not meant to be comprehensive, but are items preferred or recommended by Broadband Infraco, however if the Bidder has other options, they shall request approval from Broadband Infraco's representative for the change.

3.3.1.2 Equipment

The Bidder shall list the physical dimensions of all equipment proposed.

3.3.1.3 Equipment racks

The Bidder shall furnish and install appropriate equipment racks for the proposed DWDM or cross-connect equipment.

The Bidder shall supply the footprint (width, depth, height) of such equipment racks that form part of the proposed solution. The internal frame of the equipment rack should have a width of 19''.

Equipment racks (and associated equipment shelves) proposed by the Bidder as part of the solution shall be in compliance with ETSI 300-119-1, and/or ETSI 300-119-2, and/or ETSI 300-119-3 and/or ETSI 300-119-4.

3.3.1.4 Fibre patch cords

The Bidder shall provide all fibre patch cords for the network interfaces (line side) of the DWDM equipment from the proposed DWDM equipment to Broadband Infraco's fibre patch panel. Jumpers shall be duplex, single mode, 3mm, yellow in colour.

The Bidder shall provide all fibre patch cords for the service drop interfaces (customer side) of the DWDM equipment from the proposed DWDM equipment to Broadband Infraco's (or facilities provider's Meet Me Rack) equipment. Patch cords shall be duplex, single mode, 3mm, yellow in colour.

The Bidder shall assume E2000/APC connectors at the fibre patch panel and a length of twenty (20) meters for the network interfaces (line side) of the DWDM equipment.
The Bidder shall assume E2000/APC connectors at the fibre patch panel and a length of ten (10) meters for the service drop interfaces (customer side) of the DWDM/OTN equipment.

The Bidder shall furnish and install appropriate fibre patch cord slack management for each equipment rack provided by the Bidder. Excess fibre patch cord length shall not be coiled and left on top of equipment or on top of the cable racking, but shall be stored in the slack management panel.

3.3.1.5 Alarm and Management cabling

The Bidder shall furnish and install alarm and management cabling from the DWDM network equipment to Broadband Infraco's management interface device. The alarm and management cabling shall be properly routed, secured and terminated at both the DWDM equipment end and the management device end.

The Bidder shall assume RJ-45 connectors at the management device and a length of fifteen (15) meters. The Bidder shall verify the connector type and length at the management device at each site prior to the installation.

3.3.1.6 Installation Documentation

The Bidder shall provide schematics showing equipment layout for installation purposes.

The Bidder shall provide detailed instructions indicating all necessary procedures and information required to complete installation of all items proposed and to turn up the system.

The Bidder shall provide a functional block diagram and a wiring diagram of the complete system.

3.3.1.7 Testing and Acceptance

Broadband Infraco personnel shall be fully involved in the testing and acceptance process by the Bidder to become familiar with, and observe, the testing methods and results. Such involvement shall however not relieve the Bidder of its responsibility of achieving satisfactory performance, and thereafter, to honour the warranty requirements.

Broadband Infraco's agent shall inspect the installation of all equipment provided as a part of the Bidder's solution to determine the quality of the installation. Attention will be paid to the connections, cabling, labelling, configuration, and overall functionality of the equipment.

The Bidder is responsible for determining the tests required and having qualified personnel perform the tests. The following tests are to be performed on the equipment as a minimum:

- Check all proposed line units features and operation;
- Check vacant slot operation;
- Check connectivity to EMS system software;
- Verify connectivity on all SFP ports; and
- Verify that provisioned services between nodes are working correctly and are within the manufacturer's recommended error thresholds.

All measurements shall be bi-directional. All test procedures and measurements recommended by the equipment manufacturers shall be performed. These results shall be supplied by the Bidder on the manufacturer's standard test and alignment sheets and shall be delivered to Broadband Infraco to review during the inspection.

The Bidder shall provide all equipment necessary to perform system testing throughout installation and acceptance testing.

All installed equipment shall be fully operational for a minimum of fourteen (14) days (burn-in time) before the final acceptance testing is to be performed.

Testing and acceptance will not occur until after all discrepancies identified during the system burn-in period have been cleared.

Factory Test (FT)

The Bidder shall be prepared to conduct factory test of the equipment with Broadband Infraco personnel seeking approval of that equipment. Broadband Infraco personnel will test the equipment to check conformity with this specification.

The Bidder shall include in its offer such factory tests costs that will be incurred.

Provisional Acceptance Tests (PAT)

Broadband Infraco personnel will conduct the PAT before acceptance of the installed system.

The Bidder shall provide a procedure document detailing such steps that need to be followed during PAT. During these tests, the Bidder will have to demonstrate to Broadband Infraco that their system in fully inter-operable with the existing Broadband Infraco transmission system.

The Bidder shall be responsible for all test equipment.

Final Acceptance Test (FAT)

The Bidder shall prove through testing, the reliability and performance of the proposed system.

The Bidder shall provide written notification to Broadband Infraco that the system is ready for inspection and tests. All preliminary testing and clean-up must be completed prior to the Bidder's notification.

The Bidder shall absorb costs incurred due to the Bidder's delays in inspection and tests.

Broadband Infraco and the Bidder must jointly accept and approve all test results before the project is considered complete.

3.3.1.8 Test Equipment

The Bidder shall provide all test equipment necessary to perform the Bidder's standard installation test and acceptance procedures.

3.3.1.9 Handover

The Bidder shall complete an electronic "As Built" document for handover. Results of tests shall be presented as traces and / or tables that will be included in the As Built document.

3.3.1.10 Training

The Bidder shall provide training to the Broadband Infraco staff. The training shall be as follows:

- Presented by suitable qualified and experienced presenters;
- Include hands-on on demonstration on proposed or installed equipment so that all students are sufficiently exposed;
- Include all course material;

- Include all demonstration equipment; and
- Included in the Bidder costs.

Configuring and operating training

- On-site training sessions, given that Broadband Infraco has 13 Service Centres located nationally, with approximately 40 Field engineers, maintaining the Broadband Infraco Network. This training shall be aimed at operational support staff. It shall be:
    - Presented twice, first directly after equipment installation and second at end of guaranty period;
- For 15 persons each time.

Network Planning and Design courses

- Classroom training aimed at Network Engineering, for approximately 15 Network Planning Engineers;
- Training on Network Planning Tool; and
- Cover all aspects of Optical Network transmission system planning.

Technical support training

This training shall be aimed at technical support staff. It shall be:

- Presented twice, first directly after equipment installation and second at end of guaranty period;
- For 15 persons each time;
- Cover all aspects of equipment comprehensively to allow Broadband Infraco to configure, operate and maintain the equipment independently;

The Bidder shall provide information and costs for additional training courses not included as part of this base proposal.

4 EQUIPMENT SPECIFICATION

The purpose of this specification is to outline the technical requirements for OTN and DWDM equipment and forms part of Broadband Infraco's request for proposal/quotation for the supply, installation and commissioning of OTN/DWDM equipment, Network Management System (NMS) and network planning tool.

4.1 NORMATIVE REFERECES

The OTN/DWDM equipment/system shall conform to the following ITU-T and IEEE Recommendations. The latest version of ITU-T and IEEE Recommendations at date of tender award will also be considered:

4.1.1 Normative

I. ITU-T Rec. G.709 Interfaces for the Optical Transport Network.
II. Recommendation ITU-T G.694.1: Spectral grids for WDM applications: DWDM frequency grid.
III. ITU-T G.8112/Y.1371 Interfaces for the MPLS transport profile layer network.
IV. ITU-T G.698.2 Amplified multichannel dense wavelength division multiplexing applications with single channel optical interfaces.
V. G.671 'Transmission characteristics of optical components and subsystems'.
VI. G.672 'Characteristics of multi-degree reconfigurable optical add/drop multiplexers'.
VII. G.798 'Characteristics of optical transport network hierarchy equipment functional blocks'.
VIII. G.806 'Characteristics of transport equipment - Description methodology and generic functionality'.
IX. G.8251 'The control of jitter and wander within the optical transport network (OTN).
X. IEEE 802.3ba 'Media Access Control Parameters, Physical Layers and Management. Parameters for 40 Gb/s and 100 Gb/s Operation.'
XI. G.8080/Y.1304 'Architecture for the automatically switched optical network'.
XII. RFC 3945 'Generalized Multi-Protocol Label Switching (GMPLS) Architecture'.

4.2 DEFINITIONS

The requirement in this document that do not have any of the definition or letter description are general by default. The Bidder is required to state compliance or non-compliance to all requirements.

Table 4: Response indicators

Definition	Description
[D]: Description	Give a description of the function or the feature as requested.
[G] General	General information to be noted by Bidders and accepted or rejected. Non-compliance may be accepted or tolerated.
[I]: Information	Bidders to give actual values, quantities or other specific details called for. It is mandatory for Bidders to provide the requested information, failure to provide the information may lead to disqualification.
[M]: Mandatory	Compliance required.

4.3 GENERIC REQUIRMENTS

The following requirements apply to all equipment called for in this specification. The information requested must be provided for all equipment.

a) Only equipment manufactured to recognised relevant international standards, and complying with the relevant ITU-T, IEEE, ETSI performance recommendations and reports, shall be accepted. [M]
b) The MTBF figures (in years) of all offered equipment shall be stated. For modular systems the Bidder shall specify the MTBF figures for each replaceable component. The assumed environmental conditions in the given MTBF figures shall also be specified. [I]
c) The metric system shall be used in all technical documentation. [M]
d) ITU-T, ETSI and IEEE terminology shall be adhered to where applicable. [M]
e) For all equipment offered, the Bidder shall state their support and maintenance contract options, terms, costs and durations thereof. [M]
f) The Bidder shall state the launch date and the planned manufacture discontinuation date for each piece of equipment offered. [M]
g) The duration of continuing support (repairs and supply of spares) for the equipment beyond the manufacture discontinuation date must be stated. [M]
h) The Bidder shall state the frequency and budgetary costs for network element software upgrades, if any, over the next 7 years. Actual planned dates should be stated if available. [I]
i) Technical handbooks giving detailed information about the systems on offer shall be provided for all equipment offered. [I]
j) Bidder to provide a detailed project implementation plan as part of the submission. [M]

k) Bidder to indicate whether they subscribe to Open Line Systems and disaggregated networks. Is the Bidder a member of the Open Interface Forum (OIF)? [D]

4.4 SYSTEM REQUIRMENTS

The system for which the requirements are specified in this specification are for OTN and DWDM equipment that can transport SDH, OTN, Ethernet, MPLS-TP, FC, and IP services.

4.4.1 Client Interface Requirements

The following client interfaces shall be available:

SDH/MPLS-TP

a) STM-16 [M]
b) STM-64 [M]

OTH/MPLS-TP

c) OTU-1 [M]
d) OTU-2 [M]
e) OTU-4 [M]

Fast Ethernet/MPLS-TP/IP/FC

f) 100BASE-TX [M]
g) 100BASE-FX [M]
h) 100BASE-SX [M]

Gigabit Ethernet/MPLS-TP/IP/FC

i) 1000BASE-SX [M]
j) 1000BASE-EX [M]
k) 1000BASE-ZX [M]

10 Gigabit Ethernet/MPLS-TP/IP/FC

l) 10GBASE-SR [M]
m) 10GBASE-LR [M]
n) 10GBASE-ER [M]

100Gigabit Ethernet/MPLS-TP/IP/FC

o) 100GBASE – SR [M]
p) 100GBASE – LR [M]
q) 100GBASE – ER [M]

NOTE: For bidding 100Gbps service boards, pluggable coherent CFP/CFP2/CFP4 optical modules shall be used to facilitate subsequent maintenance, improve device integration, and reduce power consumption.

Additionally:

a) The bidder shall describe their solution for mapping 10GE LAN PHY/10GE WAN PHY. to ODU-2. [M]
b) The bidder's solution shall support 10 x STM-64 / 10GBE LAN PHY / 10GE WAN PHY signals mapped into ODU4. [M]

4.4.2 Traffic cross connection requirements

a) The system shall have a fully meshed backplane to support soft cross connection between all cards. [M]
b) The system shall support all traffic interfaces stated in section 4.4.1. [M]
c) The system shall support the minimum traffic switching capacity required by Broadband Infraco. [M]
d) The system configuration to support the requirement in (c) shall be provided. [M]
e) The maximum traffic switching shall be provided, and the upgrade path and process stated. [I]
f) The system shall support automatic switching for all services described in (4.4) with use of Automatically Switched Optical Network (ASON) and traditional schemes. [M]
g) The Bidder shall state additional automatic switching protocol supported by their system. [I]
h) The equipment shall be able to support point-to-point, ring, star, and mesh topologies. [M]
i) The Bidder shall provide the protection schemes for the line side and client side, with details of each. [I]

4.4.3 Optical Line Requirements

a) Support of ITU-T G.652d single-mode optical fibre. [M]
b) The Bidder shall state modulation schemes used to achieve the OTU-k line rates described in ITU-T G.709 recommendations. [I]
c) The Bidder shall state highest line rate that their system can achieve. Details on how the line rate is achieved shall be provided. [I]
d) The Bidder shall state the type of modulation formats supported (e.g. QPSK, BPSK, QAM) and whether the modulation schemes are user-configurable, i.e. adaptable modulation. [I]
e) The Bidder shall state whether the modulation schemes are software selectable per wavelength. [I]
f) Compliance to ITU-T G.694.1 Spectral grids for WDM applications: DWDM Frequency Grid. Any advancement from the standard ITU-T grid shall be stated and explained in detail. [I]
g) Reconfigurable Optical Add-Drop Multiplexing (ROADM) capability information to be provided. [M]
h) The Bidder shall provide information of the architecture and capabilities of the ROADM, including capabilities of remote re-configurability, and colourless, directionless and contention-less multiplexing. [M]
i) The Bidder shall state the maximum number of wavelengths that the equipment supports. A minimum of 40 channels at Beginning of Life (BoL) shall be supported. [M]
j) The DWDM system shall be based on a coherent technology with a minimum of 100Gbps line per channel with Flexible wavelength grid. The equipment shall be able to add or drop any wavelength at any access nodes. [M]
k) The solution shall support automatic optical power management, auto levelling, and monitoring. [M]
l) The DWDM system shall support in built OTDR functionality and be able to measure fibre parameters without impacting traffic while DWDM system is in service. [M]
m) The Bidder shall describe the Forward Error Correction (FEC) used and its associated coding gain and overheads. [I]
n) The Bidder shall describe the maximum system reach without regeneration (3R), with details of how the reach is achieved. [I]
o) The details required under (n) are: rate per channel, number of channels used (maximum), channels spacing, placement of repeaters, OSNR values for each span, type and description of signal amplification used for each span, the hop lengths, and the modulation scheme used per channel. [I]
p) The Bidder shall state if the system can support the insertion of wavelengths from foreign transponders, with details of how the insertion will be achieved. [I]
q) The system shall support automatic switching for all provisioned wavelengths with use of Wavelength Switched Optical Networks (WSON) technology. [M]
r) The Bidder shall state additional automatic switching protocol supported by their system on the line side. [I]

s) The equipment shall support Optical Supervisory Channel monitoring. The Optical Supervisory Channel (OSC) channel and service channel must be separated and OSC channel shall not be amplified. [M]
t) The equipment must support the Wavelength Selective Switch WSS architecture and implementation of Generalized Multiprotocol Label Switching (GMPLS) (RFC 3945) and/or Automatic Switching Optical Networks (ASON) (ITU-T G.8080) for restoration requirement in the offered model and sub-rack. The GMPLS/ASON control plan is adopted in Optical Channel (Och) scenarios. [M]
u) The DWDM equipment shall support non-blocking CDCG ROADM architecture. Any client port of source node must be able to configure in any client port of destination network through any path between two nodes through all available direction. [M]
v) DWDM system shall support Remote NMS Reconfiguration having at least 80 Och reconfiguration with access to all channels and capable of switching between common port and switched ports. [M]
w) The DWDM system shall support a modular and flexible architecture, to allow scaling, the equipment in accordance with the network requirements. [M]
x) The proposed DWDM system should be able to ensure hitless in-service insertion of new channels or removal of channels, with the ability to automatically adjust/tune. [M]
y) The DWDM system shall support Automatic Power Equalization (APE). The system shall be capable of automatically adjusting power per channel to its optimum value, if and when channels are added or removed without the need for manual adjustment. [M]
z) The DWDM system shall support all types of architecture i.e., Optical Terminal Multiplexers (OTM), Reconfigurable Optical Add and Drop Multiplexers (ROADM), sharing the common modules, to minimize the number of spares. [M]
aa) The life cycle of the equipment shall not be less than 10 years. [M]
bb) The DWDM system shall be 400Gbps and 800Gbps per channel ready for future traffic capacity upgrade or expansion requirements. [M]

4.4.3.1 Amplification

a) The Bidder shall state the preferred optical amplifier technology:
   I. Semi-Conductor Amplifiers (SOA); [I]
   II. Erbium Doped Fibre Amplifiers (EDFA); [I]
   III. Raman Amplifiers; [I]
   IV. Hybrid Amplifiers. [I]
b) The equipment shall support automatic amplifier gain adjustment. [M]
c) The equipment shall support a hop distance of 200km without a repeater. Parameters for ITU-T G652D shall be used. [M]
d) The Bidder shall state the maximum hop distance, with and without amplification that is supported by the equipment as well as, the amplification technology used. **[I]**

4.4.3.2 Optical Receiver Requirements

a) The Bidder shall state the worst case minimum required OSNR for each transponder or muxponder provided. [I]
b) The equipment shall support electronic dispersion compensation. [M]
c) The Bidder shall state the maximum tolerable chromatic dispersion (pm/nm) [I]
d) The Bidder shall state the maximum tolerable mean Differential Group delay measured in picoseconds (as related to polarisation mode dispersion (PMD)) [M]

4.4.4 Power Requirements

a) All transmission equipment shall operate a nominal voltage of 48 V DC positive earthed supply (Range: 40V to 57V). [M]
b) The equipment shall have reverse polarity protection. [M]
c) Power feed to sub-racks shall be arranged using DC circuit breakers so as to permit disconnection of any sub-rack without affecting supply to other connected sub-racks within the rack. [M]
d) The Bidder shall state the DC power consumption of all offered equipment. This information shall include the total power consumption per site based on the proposed Bill of Material, the typical power consumption per shelf and power consumption per shelf when fully populated. [M]

4.4.5 Environmental Requirements

a) All equipment shall operate as specified under the following environmental conditions:
b) Altitude: 0 - 2500 metres above sea level. [M]
c) Temperature: -5° C to +50° C. [M]

4.4.6 Reliability, Availability, Scalability and Security

a) The equipment shall have dual, redundant power inputs. [M]
b) The equipment shall have dual, redundant control modules/processors. [M]
c) The Bidder shall provide information on compliance to CIP and related cyber security standards, inclusive of supported encryption algorithms (particularly type III encryption). [I]
d) The power supply, control, clock, and cross-connect/switching fabric boards of the bidding equipment shall be configured with 1+1 protection. [M]

5 NETWORK MANAGEMENT SYSTEM

The Network Management System (NMS) solution for the monitoring and management of the devices and network is required. The NMS shall be fully centralized for management of all network elements (NE), offering the possibility to perform network management tasks from a single site or several sites. The NMS shall be of Server and clients-based architecture.

a) Bidders shall provide details of the Network Management System for managing the equipment, including its Fault, Configuration Accounting, Performance and Security (FCAPS) management of capabilities. [I]
b) Bidders shall provide hardware, software and third-party software requirements for the network management system. [M]
c) Bidders shall provide management system requirements pertaining to the design of the Data Communications Network (DCN). [M]
d) A support and philosophy of hot standby configuration NMS that automatically assumes control of the network elements in the event of failure of the main NMS, shall be provided. [I]
e) Bidders shall provide information on support of hardware virtualisation and the requirements thereof. [I]
f) Bidders shall provide information on the north-bound interfaces supported by the management system (for example SNMP, CORBA, NetConf). [I]
g) Bidders shall provide information on the south-bound interfaces supported by the management system. [I]
h) The technical documents for all equipment offered shall be supplied with the response documentation to the enquiry. [M]
i) Software upload/download capability [M]
j) Backup and Restoration Management of all NE [M]
k) The devices are capable of being configured to any type of DWDM systems i.e., OTU, OADM, OLA etc. and associated with Elements Management System (EMS) and Network Management System (NMS). [M]

5.1 Requirements of Online System Performance Monitoring

a) The DWDM equipment system shall have the capability to monitor system performance online without circuit interruption. [M]
b) The DWDM equipment system shall support monitoring and estimating OSNR, measuring optical power of each channel. Operator shall be able to view the related data in NMS. [M]
c) The DWDM system shall support OTDR functionality. Operator shall be able to view the related data in NMS. [M]
d) The NMS must support optical impairment awareness of the user during trail creation and beyond. This means the user can see the actual measurements from the network and judge whether the optical trail's OSNR meets Och signal performance requirements. [M]

e) The NMS shall support latency detection and map function. [M]
f) The NMS must support Graphical network (visualization) usage chart – graphically show used/free resources over the whole network or drill-down into a link (lambda and sub-lambda levels). For links, it should be possible to display availability in case of network growth. [M]
    i. NMS shall provide end-to-end visualization of wavelength paths.
    ii. NMS shall provide end-to-end display of optical power measurements.
    iii. NMS shall provide details for end-to-end wavelength channel provisioning and automated wavelength channel restoration.

5.2 NMS Hardware requirements

g) There will be provision to use Laptop/Notebook as Local Craft terminal (LCT) with appropriate software to connect DWDM and OTN equipment directly so that configuration and monitoring can be done from the Laptop. The LCT shall be able to connect all network elements on the same network (autonomous system) from a locally connected device. [M]
h) The bidder to indicate the Required HW and SW requirements for Server, Client workstations, Local Craft Terminal i.e.
    iv. CPU (type and number of cores, speed)
    v. RAM (Capacity)
    vi. Disk (Capacity + required partitioning)
    vii. Number of network interfaces
    viii. Platform power consumption, power protection

Note: HW should be chosen for each management entity according to the total size of the network and no. of node / NE to be managed and monitored by the NMS.

6 NETWORK PLANNING TOOL

Design and Planning Tools:

a) The Bidder shall provide an optical link design tool, with the following minimum capabilities: [M]

I. Optical link budget calculation [M]
II. Chromatic Dispersion calculation [M]
Polarisation Mode Dispersion calculation [M]
III. Optical Signal to Noise determination [M]
IV. Production of a Bill of Material (BOM) [M]
V. A detailed report of the planned channel [M]
VI. A network inventories [M]
VII. What if analysis [M]
VIII. Capacity utilization report [M]

b) The planning tool shall be able to interchange data with the Network Management System as shown in figure 1 below. [M]

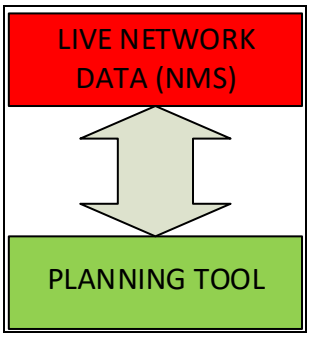

Figure 6: Planning tool data flow.

c) The Bidder shall provide information on software and hardware requirements of the optical link design planning tool. [M]

7 MISCELLANEOUS REQUIREMENTS

a) Spares

I. The Bidder shall provide a spares breakdown for each item of equipment offered. [I]

b) Tools and Test Equipment

I. The Bidder shall provide a list of test equipment considered necessary to perform on-site maintenance and fault-finding on all offered equipment. Test sets that are proprietary to the manufacturer shall only be recommended where commercial general-purpose test equipment cannot be employed, or where its use would be grossly uneconomic. [I]

II. The Bidder shall supply a list of special tools, connector cords, card extenders, etc. that are considered necessary to perform on-site maintenance and fault finding on the on all offered equipment. [I]

c) Documentation

I. Handbooks (Instruction Manuals) are required for each piece of equipment. They must be comprehensive enough to enable a competent Technician to identify each component, test point and terminal and to check supply voltages and signal voltages/signal conditions throughout the module/unit/equipment. [M]

II. All critical voltages and voltage limits shall be indicated on circuit diagrams or included in the text. All signal levels or signal conditions shall be similarly detailed, together with permissible limits for satisfactory operation of the equipment. [M]

d) Warranty

I. Bidders shall state the warranty period on all offered equipment after installation and the terms thereof. [I]

e) Repairs

I. The Bidder shall provide a repair service for faulty units, sub-units and modules removed from site by Broadband Infraco's technicians. This service shall form part of the support service to be negotiated with the Bidder post awarding. [M]

f) System

I. The system shall support Intelligent Network Control Plane (e.g. GMPLS). [M]

APPENDIX A: ACRONYMS

	Acronym	Description
1	ADM	Add/Drop Multiplexer
2	APS	Application Program System
3	BBI	Broadband Infraco
4	BoM	Bill of Materials
5	BOM	Bill of Material
6	C/DWDM	Coarse/Dense Wavelength Division Multiplexing
7	CD	chromatic dispersion
8	CIP	Critical Infrastructure Protection
9	CORBA	Common Object Request Broker Architecture
10	DC	Direct Current
11	DCN	Data Communication Network
12	DCN	Data Communications Network
13	DWDM	Dense wavelength division multiplexing
14	EDFA	Erbium Doped Fibre Amplifiers
15	ER	Extended Reach
16	ETSI	European Telecommunications Standards Institute
17	EVC	Ethernet Virtual Connection
18	FC	Fibre Channel
19	FCAPS	Fault, Configuration Accounting, Performance and Security
20	FEC	Forward Error Correction
21	GE	Gigabit Ethernet
22	IEEE	Institute of Electrical and Electronics Engineers
23	IP	Internet Protocol
24	ITU	International Telecommunication Union
25	LR	Long Reach
26	MEF	Metro Ethernet Forum
27	MPLS-TP	Multiprotocol Label Switching - Transport Profile
28	MTBF	Mean time between failures
29	NMS	Network Management System
30	NE	Network Element
31	ODU	Optical channel Data Unit
32	OSNR	Optical Signal to Noise Ratio
33	OTN	Optical Transport Network
34	OTU	Optical channel Transport Unit

	Acronym	Description
35	PMD	Polarisation Mode Dispersion
36	ROADM	Reconfigurable Optical Add-Drop Multiplexing
37	CD-ROADM	Colourless Directionless Reconfigurable Optical Add-Drop Multiplexing
38	OLA	Optical Line Amplifier
39	SDH	Synchronous Digital Hierarchy
40	SNMP	Simple Network Management Protocol
41	SOA	Semi-Conductor Amplifiers
42	SR	Short Reach
43	STM	Synchronous Transfer Mode
44	Tbps	Terabit per second
45	WDM	Wavelength Division Multiplexing

APPENDIX B: COMPLIANCE SCHEDULE

Bidders must submit a compliance statement as part of their response. The tenders should respond to the requirements as follows:

1. **Full Compliance (FC)** - This means that the Bidder's proposal meets the technical requirement as required by Broadband Infraco.
2. **Non-Compliance (NC) –** This means that the Bidder's proposal does not meet the technical requirements as required by Broadband Infraco. The reasons for non-compliance must be included in the compliance statement.
3. Partial Compliance (PC) - This means that the bidder's proposal does not fully meet the technical requirments without a workaround or an alternative proposal. A description of the workaround or an alternative proposal must be included in the compliance schedule.

Require-ment	Description	Bidder Compliance	Bidder Statement of Compliance
4.3	**Generic Requirements**		
a)	Only equipment manufactured to recognised relevant international standards, and complying with the relevant ITU-T, IEEE, ETSI performance recommendations and reports, shall be accepted.		
b)	The MTBF figures (in years) of all offered equipment shall be stated. For modular systems the Bidder shall specify the MTBF figures for each replaceable component. The assumed environmental conditions in the given MTBF figures shall also be specified.		
c)	The metric system shall be used in all technical documentation.		
d)	ITU-T, ETSI and IEEE terminology shall be adhered to where applicable.		
e)	For all equipment offered, the Bidder shall state their support and maintenance contract options, terms, costs and durations thereof.		
f)	The Bidder shall state the launch date and the planned manufacture discontinuation date for each piece of equipment offered		
g)	The duration of continuing support (repairs and supply of spares) for the equipment beyond the manufacture discontinuation date must be stated.		
h)	The Bidder shall state the frequency and budgetary costs for network element software upgrades, if any, over the next 7 years. Actual planned dates should be stated if available.		

Require-ment	Description	Bidder Compliance	Bidder Statement of Compliance
i)	Technical handbooks giving detailed information about the systems on offer shall be provided for all equipment offered.		
j)	Bidder to provide a detailed project implementation plan as part of the submission		
k)	Bidder to indicate whether they subscribe to Open Line Systems and disaggregated networks. Is the Bidder a member of the Open Interface Forum		
4.4	**System Requirements**		
4.4.1	**Client Interface Requirements**		
	SDH/MPLS-TP		
a)	STM-16		
b)	STM-64		
	OTH/MPLS-TP		
c)	OTU-1		
d)	OTU-2		
e)	OTU-4		
	Fast Ethernet/MPLS-TP/IP/FC		
f)	100BASE-TX		
g)	100BASE-FX		
h)	100BASE-SX		
	Gigabit Ethernet/MPLS-TP/IP/FC		
i)	1000BASE-SX		

Require-ment	Description	Bidder Compliance	Bidder Statement of Compliance
j)	1000BASE-EX		
k)	1000BASE-ZX		
	10 Gigabit Ethernet/MPLS-TP/IP/FC		
l)	10GBASE-SR		
m)	10GBASE-LR		
n)	10GBASE-ER		
	100Gigabit		
o)	100GbE - SR		
p)	100GbE - LR		
t)	100GbE - ER		
q)	The bidder shall describe their solution for mapping 10GE LAN PHY/10GE WAN PHY. to ODU-2.		
r)	The bidder's solution shall support 10 x STM-64 / 10GBE LAN PHY / 10GE WAN PHY signals mapped into ODU4.		
4.4.2	**Traffic cross connection requirements**		
a)	The system shall have a fully meshed backplane to support soft cross connection between all cards.		
b)	The system shall support all traffic interfaces stated in section 4.4.1.		
c)	The system shall support the minimum traffic switching capacity required by Broadband Infraco.		
d)	The system configuration to support the requirement above shall be provided		

Require-ment	Description	Bidder Compliance	Bidder Statement of Compliance
e)	The maximum traffic switching shall be provided, and the upgrade path and process stated.		
f)	The system shall support automatic switching for all services described in (4.4) with use of Automatically Switched Optical Network (ASON) and traditional schemes.		
g)	The Bidder shall state additional automatic switching protocol supported by their system.		
h)	The equipment shall be able to support point-to-point, ring, star, and mesh topologies.		
i)	The Bidder shall provide the protection schemes for the line side and client side, with details of each.		
4.4.3	**Optical Line Interface Requirements**		
a)	Support of ITU-T G.652d single-mode optical fibre.		
b)	The Bidder shall state modulation schemes used to achieve the OTU-k line rates described in ITU-T G.709 recommendations.		
c)	The Bidder shall state highest line rate that their system can achieve. Details on how the line rate is achieved shall be provided.		
d)	The Bidder shall state the type of modulation formats supported (e.g. QPSK, BPSK, QAM) and whether the modulation schemes are user-configurable, i.e. adaptable modulation.		
e)	The Bidder shall state whether the modulation schemes are software selectable per wavelength.		
f)	Compliance to ITU-T G.694.1 Spectral grids for WDM applications: DWDM Frequency Grid. Any advancement from the standard ITU-T grid shall be stated and explained in detail.		
g)	Reconfigurable Optical Add-Drop Multiplexing (ROADM) capability to information to be provided.		

Require-ment	Description	Bidder Compliance	Bidder Statement of Compliance
h)	The Bidder shall provide information of the architecture and capabilities of the ROADM, including capabilities of remote re-configurability, and colourless, directionless and contention-less multiplexing.		
i)	The Bidder shall state the maximum number of wavelengths that the equipment supports. A minimum of 40 channels at Beginning of Life (BoL) shall be supported.		
j)	The DWDM system shall be based on a coherent technology with a minimum of 100Gbps line per channel with Flexible wavelength grid. The equipment shall be able to add or drop any wavelength at any access nodes.		
k)	The solution shall support automatic optical power management, auto levelling, and monitoring.		
l)	The DWDM system shall support in built OTDR functionality and be able to measure fibre parameters without impacting traffic while DWDM system is in service.		
m)	The Bidder shall describe the Forward Error Correction (FEC) used and its associated coding gain and overheads.		
n)	The Bidder shall describe the maximum system reach without regeneration (3R), with details of how the reach is achieved.		
0)	The details required above are: rate per channel, number of channels used (maximum), channels spacing, placement of repeaters, OSNR values for each span, type and description of signal amplification used for each span, the hop lengths, and the modulation scheme used per channel		
p)	The Bidder shall state if the system can support the insertion of wavelengths from foreign transponders, with details of how the insertion will be achieved.		
q)	The system shall support automatic switching for all provisioned wavelengths with use of Wavelength Switched Optical Networks (WSON) technology.		
r)	The Bidder shall state additional automatic switching protocol supported by their system on the line side.		

Require-ment	Description	Bidder Compliance	Bidder Statement of Compliance
s)	The equipment shall support Optical Supervisory Channel monitoring. The Optical Supervisory Channel (OSC) channel and service channel must be separated and OSC channel shall not be amplified.		
t)	The equipment must support the Wavelength Selective Switch WSS architecture and implementation of Generalized Multiprotocol Label Switching (GMPLS) (RFC 3945) and/or Automatic Switching Optical Networks (ASON) (ITU-T G.8080) for restoration requirement in the offered model and sub-rack. The GMPLS/ASON control plan is adopted in Optical Channel (Och) scenarios.		
u)	The DWDM equipment shall support non-blocking CDCG ROADM architecture. Any client port of source node must be able to configure in any client port of destination network through any path between two nodes through all available direction.		
v)	DWDM system shall support Remote NMS Reconfiguration having at least 80 Och reconfiguration with access to all channels and capable of switching between common port and switched ports.		
w)	The DWDM system shall support a modular and flexible architecture, to allow scaling, the equipment in accordance with the network requirements.		
x)	The proposed DWDM system should be able to ensure hitless in-service insertion of new channels or removal of channels, with the ability to automatically adjust/tune.		
y)	The DWDM system shall support Automatic Power Equalization (APE). The system shall be capable of automatically adjusting power per channel to its optimum value, if and when channels are added or removed without the need for manual adjustment.		
z)	The DWDM system shall support all types of architecture i.e., Optical Terminal Multiplexers (OTM), Reconfigurable Optical Add and Drop Multiplexers (ROADM), sharing the common modules, to minimize the number of spares.		
aa)	The life cycle of the equipment shall not be less than 10 years.		

Require-ment	Description	Bidder Compliance	Bidder Statement of Compliance
ab)	The DWDM system shall be 400Gbps and 800Gbps per channel ready for future traffic capacity upgrade or expansion requirements.		
4.4.3.1	**Amplification**		
a)	The Bidder shall state the preferred optical amplifier technology:		
	I. Semi-Conductor Amplifiers (SOA).		
	II. Erbium Doped Fibre Amplifiers (EDFA).		
	III. Raman Amplifiers.		
	IV. Hybrid Amplifiers.		
b)	The equipment shall support automatic amplifier gain adjustment.		
c)	The equipment shall support a hop distance of 200km without a repeater. Parameters for ITU-T G652D shall be used.		
d)	The Bidder shall state the maximum hop distance, with and without amplification that is supported by the equipment as well as, the amplification technology used.		
4.4.3.2	**Optical Receiver Requirements**		
a)	The Bidder shall state the worst-case minimum required Optical Signal to Noise Ratio (OSNR) for each transporter or muxponder provided.		
b)	The equipment shall support electronic dispersion compensation.		
c)	The Bidder shall state the maximum tolerable chromatic dispersion (pm/nm)		
d)	The Bidder shall state the maximum tolerable mean Differential Group delay measured in picoseconds (as related to polarisation mode dispersion (PMD))		
4.4.4	**Power Requirements**		
a)	All transmission equipment shall operate a nominal voltage of 48 V DC positive earthed supply (Range: 40.8 V to 57.6 V).		

Require-ment	Description	Bidder Compliance	Bidder Statement of Compliance
b)	The Network Management System computers and workstations shall operate a nominal voltage of 230 V AC (Range: 216.2 V to 243.8 V), and nominal frequency 50Hz (range 47.5 Hz to 52.5 Hz), mains power.		
c)	The equipment shall have reverse polarity protection.		
d)	Power feed to sub-racks shall be arranged using DC circuit breakers to permit disconnection of any sub-rack without affecting supply to other connected sub-racks within the rack.		
e)	The Bidder shall state the DC power consumption of all offered equipment. This information shall include the total power consumption per site based on the proposed Bill of Material, the typical power consumption per shelf and power consumption per shelf when fully populated.		
4.4.5	**Environmental Requirements**		
a)	All equipment shall operate as specified under the following environmental conditions:		
b)	Altitude: 0 - 2500 metres above sea level		
c)	Temperature: -5° C to +50° C		
4.4.6	**Reliability, Availability, Scalability and Security**		
a)	The equipment shall have dual, redundant power inputs.		
b)	The equipment shall have dual, redundant control modules/processors		
c)	The Bidder shall provide details on how highly available and dependable links (such as 99.95% of time) may be achieved. State the assumptions to be considered, as well at the calculation methodology used.		
d)	The Bidder shall provide information on compliance to CIP and related cyber security standards, inclusive of supported encryption algorithms (particularly type III encryption).		
5	**Network Management System**		

Require-ment	Description	Bidder Compliance	Bidder Statement of Compliance
a)	Bidders shall provide details of the Network Management System for managing the equipment, including its Fault, Configuration Accounting, Performance and Security (FCAPS) management of capabilities.		
b)	Bidders shall provide hardware, software and third-party software requirements for the network management system.		
c)	Bidders shall provide management system requirements pertaining to the design of the Data Communications Network (DCN).		
d)	A support and philosophy of hot standby configuration NMS that automatically assumes control of the network elements in the event of failure of the main NMS, shall be provided.		
e)	Bidders shall provide information on support of hardware virtualisation and the requirements thereof.		
f)	Bidders shall provide information on the north-bound interfaces supported by the management system (for example SNMP, CORBA, NetConf).		
g)	Bidders shall provide information on the south-bound interfaces supported by the management system.		
h)	The technical documents for all equipment offered shall be supplied with the response documentation to the enquiry.		
i)	Software upload/download capability		
j)	Backup and Restoration Management of all NE		
k)	The devices are capable of being configured to any type of DWDM systems i.e., OTU, OADM, OLA etc. and associated with Elements Management System (EMS) and Network Management System (NMS).		
5.1	**Requirements of Online System Performance Monitoring**		

Require-ment	Description	Bidder Compliance	Bidder Statement of Compliance
a)	The DWDM equipment system shall have the capability to monitor system performance online without circuit interruption.		
b)	The DWDM equipment system shall support monitoring and estimating OSNR, measuring optical power of each channel. Operator shall be able to view the related data in NMS.		
c)	The DWDM system shall support OTDR functionality. Operator shall be able to view the related data in NMS.		
d)	The NMS must support optical impairment awareness of the user during trail creation and beyond. This means the user can see the actual measurements from the network and judge whether the optical trail's OSNR meets Och signal performance requirements.		
e)	The NMS shall support latency detection and map function.		
f)	The NMS must support Graphical network (visualization) usage chart – graphically show used/free resources over the whole network or drill-down into a link (lambda and sub-lambda levels). For links, it should be possible to display availability in case of network growth.		
a)	The DWDM equipment system shall have the capability to monitor system performance online without circuit interruption.		
b)	The DWDM equipment system shall support monitoring and estimating OSNR, measuring optical power of each channel. Operator shall be able to view the related data in NMS.		
c)	The DWDM system shall support OTDR functionality. Operator shall be able to view the related data in NMS.		
d)	The NMS must support optical impairment awareness of the user during trail creation and beyond. This means the user can see the actual measurements from the network and judge whether the optical trail's OSNR meets Och signal performance requirements.		
e)	The NMS shall support latency detection and map function.		

Require-ment	Description	Bidder Compliance	Bidder Statement of Compliance
i.	NMS shall provide end-to-end visualization of wavelength paths.		
ii.	NMS shall provide end-to-end display of optical power measurements.		
iii.	NMS shall provide details for end-to-end wavelength channel provisioning and automated wavelength channel restoration.		
5.2	**NMS Hardware requirements**		
g)	There will be provision to use Laptop/Notebook as Local Craft terminal (LCT) with appropriate software to connect DWDM and OTN equipment directly so that configuration and monitoring can be done from the Laptop. The LCT shall be able to connect all network elements on the same network (autonomous system) from a locally connected device.		
h)	The bidder to indicate the Required HW and SW requirements for Server, Client workstations, Local Craft Terminal i.e.		
	iv. CPU (type and number of cores, speed)		
	v. RAM (Capacity)		
	vi. Disk (Capacity + required partitioning)		
	vii. Number of network interfaces		
	viii. Platform power consumption, power protection		
6	**Network Planning Tool**		
a)	The Bidder shall provide an optical link design tool, with the following minimum capabilities:		
	I. Optical link budget calculation.		
	II. Chromatic Dispersion calculation.		
	III. Optical Signal to Noise (OSNR) Determination.		
	IV. Production of a Bill of Material (BOM).		

Require-ment	Description	Bidder Compliance	Bidder Statement of Compliance
	V. A detailed report of the planned channel.		
	VI. A network inventories.		
	VII. What if analysis.		
	VIII. Capacity utilization report.		
b)	The planning tool shall be able to interchange data with the Network Management System as per below diagram.		
c)	The Bidder shall provide information on software and hardware requirements of the optical link design planning tool.		
7	**Miscellaneous Requirements**		
a)	**Spares**		
	I. The Bidder shall provide a spares breakdown for each item of equipment offered.		
b)	**Tools and Test Equipment**		
	I. The Bidder shall provide a list of test equipment considered necessary to perform on-site maintenance and fault-finding on all offered equipment. Test sets that are proprietary to the manufacturer shall only be recommended where commercial general-purpose test equipment cannot be employed, or where its use would be grossly uneconomic.		
	II. The Bidder shall supply a list of special tools, connector cords, card extenders, etc. that are considered necessary to perform on-site maintenance and fault finding on the on all offered equipment.		
c)	**Documentation**		
	I. Handbooks (Instruction Manuals) are required for each piece of equipment. They must be comprehensive enough to enable a competent Technician to identify each component, test point and terminal and to check supply voltages and signal voltages/signal conditions throughout the module/unit/equipment.		

Require-ment	Description	Bidder Compliance	Bidder Statement of Compliance
	II. All critical voltages and voltage limits shall be indicated on circuit diagrams or included in the text. All signal levels or signal conditions shall be similarly detailed, together with permissible limits for satisfactory operation of the equipment.		
d)	**Warranty**		
	I. Bidders shall state the warranty period on all offered equipment after installation and the terms thereof.		
e)	**Repairs**		
	I. The Bidder shall provide a repair service for faulty units, sub-units and modules removed from site Broadband Infraco's technicians. This service shall form part of the support service to be negotiated with the Bidder post awarding.		
f)	**System**		
	I. The system shall support Intelligent Network Control Plane (e.g. GMPLS).		