

## Technical Specifications

The Applicant shall supply at least 96-core optical fibre duct cable in the Mid-hill highway and at least 48/24-core optical fibre duct cable for connecting district headquarters from Mid-hill Highway. The proposed fibre shall be any combination of underground and ADSS/OPGW. The proposed ADSS/OPGW can use existing pole/mast/tower or new poles/tower as specified in this RFA. Applicant can propose their own existing fibre network with similar specification and capacity. They shall be fully agreed to meet all the conditions of this RFA on sharing their existing fibre network.

The purpose of fibre network is to provide high speed backbone transmission network to all telecom service providers, internet service providers, network service providers, banks, schools, government agencies, private parties, broadcast agencies, etc. Dark fibres are also provided to the requesting service providers and all IP based bandwidths are also provided as per the market requirements.

### 9.1 Underground Optical Fiber Cables

Clause No.	Particulars of Technical Requirements
9.1.1	<p><b><u>General</u></b>            This specification deals with 96, 72, 48, 36 and 24 Single Mode Optical Fibre (duct cable), 24 fibre Single Mode Optical Fibre (Aerial) cables, enclosures, ODF and OTB to be used in various areas of Nepal. The offered fibre cables shall comply with ITU-T rec. G.652D (latest) and other relevant ITU-T recommendations. The Applicant shall supply 96 core optical fibre duct cable in the highway and 48 core optical fibre duct cable for connecting district headquarters.            The optical network shall be used for connecting 2G-4G cellular mobile network, NGN based access Network, IP Backbone (at the rate of 1, 10, 100 Gbps at present and 400 Gbps in the future), SDH Optical line equipment etc.            Full compatibility between offered cable and the equipment is mandatory.</p>
9.1.2	<p><b><u>Cable Life</u></b>            The fibre and cable shall be designed for a life expectancy of at least thirty (30) years without serious degradation of the performance or reliability when maintained in accordance with the manufacturer's recommendations and when operated in the environmental condition of Nepal.</p>
9.1.3	<p><b><u>Cable Construction</u></b>            a) <b><u>Fibre</u></b></p>

Clause No.	Particulars of Technical Requirements	
	The fibres shall be made from high-grade silica or compound glass.	
	The geometric and optical properties of the fiber shall be in accordance with table below.	
	Mode field diameter ( $\mu\text{m}$ ) at 1310 nm	8.6-9.5 $\pm$ 0.6 (ITU-T rec.G652D)
	Cladding diameter ( $\mu\text{m}$ )	125 $\pm$ 1
	Maximum mode field /core concentricity error ( $\mu\text{m}$ )	0.8
	Coating diameter ( $\mu\text{m}$ )	245 $\pm$ 10
	Maximum Cladding non-circularity	2%
	Maximum cut-off wavelength (nm)	1260
	Chromatic dispersion co-efficient	$\lambda_{0\text{min}}$ 1300 nm
		$\lambda_{0\text{min}}$ 1324 nm
		$S_{0\text{max}}$ 0.093 ps/nm <sup>2</sup> x km
	Maximum attenuation range at 1310 nm/1550 nm	0.38/0.2 dB/km
	<b>Cable Attributes</b>	
	Attenuation coefficient maximum at 1310 and 1550 nm	0.4 dB/km and 0.35 dB/km
	PMD Coefficient	<b>M</b> 20 Cables
		<b>Q</b> 0.01%
		Maximum PMD <sub>Q</sub> 0.20 ps/ $\sqrt{\text{km}}$
	b)	The loss increase of 100 turns of fibre, loosely wound with a 300 mm radius shall be less than 0.5 dB at wavelengths of 1310/1550 nm.
	c)	A PMD link design value, PMD <sub>Q</sub> , which serves as a statistical upper bound for the PMD coefficient of the concatenated optical fibre cables shall be supplied.
	d)	The nominal operating wavelength of the systems in this project shall be 1310 nm, (within the region of 1280-1330 nm). The fibres shall be able to support future systems in the 1550 nm region.
e)	<b>Coating:</b> A dual protective Ultra Violet (UV) curable primary coating or similar quality alternative materials shall be applied to the fiber. Removal of the primary coating for the jointing shall be achieved without the use of chemicals. A simple mechanical operation shall be sufficient to prepare the fiber for jointing.	
9.1.4	<p><b><u>Loose Tube</u></b> Loose buffer tube shall be made from Polypropylene (PP), colored distinguished between loose buffer tubes and filled by filling compound or water swellable materials.</p> <p>The filling compound shall be dermatologically safe. The viscosity of the filling compound must be low enough to allow free movement of the fibre. It shall be easily removable from the fibre by wiping.</p> <p>The swellable material shall contain super absorbent polymer (SAP) which rapidly swell upon contact with water.</p>	

Clause No.	Particulars of Technical Requirements		
	The Maximum no. of fibres that shall be put in a loose plastic tube of different size of Optical Fibre Cable is as followed:		
	Size of OFC	Type of OFC	Maximum no. of Fibre that shall be put inside loose tube of OFC
	96 Fibre	Duct	12
	72 Fibre	Duct	12
	48 Fibre	Duct	12
	36 Fibre	Duct	6
	24 Fibre	Duct	6
	24 Fibre	Aerial	6
9.1.5	<p><b><u>The Water Swellable Materials for Water Blocking</u></b></p> <p>The cable core shall use the dry core technology and shall be fully water blocked with the dry swellable materials or equivalents. The swellable material shall contain super absorbent polymer (SAP) which rapidly swell upon contact with water.</p>		
9.1.6	<p><b><u>Core Wrapping</u></b></p> <p>At least one close helical or longitudinal application of non-hygroscopic and non-wicking water blocking tape shall be applied over the cable core. The inside and outside of the core wrapping tape/ water-blocking tape (for a “dry core” cable design) shall be filled with the same compound.</p>		
9.1.7	<p><b><u>Moisture Barrier</u></b></p> <p style="text-align: center;"><b><u>Duct Cable</u></b></p> <p>Electrolytic chrome coated steel tape with a longitudinal overlap, coated with polyethylene / co-polymer on both sides shall be applied throughout the cable core. The thickness of steel tape shall be 0.15 mm and polyethylene / co-polymer coating on each side shall be 0.05 mm. This barrier shall be applied with sufficient overlay to ensure that it provides complete cover at the minimum bending radius of the cable as mentioned in mechanical characteristics.</p> <p>The corrugated steel tape shall be sealed and bonded to the inner surface of the polyethylene sheath extended over it. The tape shall be electrically continuous throughout the length.</p>		
9.1.8	<p><b><u>Sheath</u></b></p> <p>a) The cable shall be sheathed with polyethylene in accordance with the requirements of BS 6234-1987.</p> <p>b) The sheath shall be free of pinholes, joints and other defects. It shall be circular in shape. Thermoplastic cylinder may be used as filler for circular core formation.</p>		
9.1.9	<p><b><u>Strength Members</u></b></p> <p>a) <b><u>Central Strength Member</u></b></p> <p>All types of cables shall have one solid galvanized steel wire as central strength member. The loose tubes shall be placed around the central strength member.</p>		

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	<p>b) <b><u>Messenger wire for Aerial Cable</u></b>  Aerial cable shall contain a messenger wire of high tensile galvanised steel strand wires. The messenger wire must have seven wires, six of them stranded around central wire.</p>																						
9.1.10	<b><u>Cable Constructional Requirements</u></b>																						
	<p>a) <b><u>Duct Cables</u></b>  Construction and mechanical requirements of the duct cable shall be as per the table below.</p> <table border="1" data-bbox="329 600 1437 1052"> <tbody> <tr> <td>Maximum external diameter (mm)</td> <td>16.5</td> </tr> <tr> <td>Nominal outer sheath thickness (mm)</td> <td>2</td> </tr> <tr> <td>Nominal thickness of corrugated steel tape (mm)</td> <td>0.15</td> </tr> <tr> <td>Minimum central strengthening FRP diameter (mm) (depending on Fiber count)</td> <td>1.5–2.0</td> </tr> <tr> <td>Maximum weight (kg/km)</td> <td>300</td> </tr> <tr> <td>Maximum core diameter (mm)</td> <td>9.5</td> </tr> <tr> <td>Maximum number of fiber per loose tube</td> <td>12</td> </tr> <tr> <td>Maximum loose tube diameter (mm)</td> <td>3</td> </tr> <tr> <td>Bending radius under load (mm)</td> <td>&lt;300</td> </tr> <tr> <td>Minimum tensile load (N)</td> <td>2000</td> </tr> <tr> <td>Minimum crush resistance (N/ 10 cm)</td> <td>3000</td> </tr> </tbody> </table>	Maximum external diameter (mm)	16.5	Nominal outer sheath thickness (mm)	2	Nominal thickness of corrugated steel tape (mm)	0.15	Minimum central strengthening FRP diameter (mm) (depending on Fiber count)	1.5–2.0	Maximum weight (kg/km)	300	Maximum core diameter (mm)	9.5	Maximum number of fiber per loose tube	12	Maximum loose tube diameter (mm)	3	Bending radius under load (mm)	<300	Minimum tensile load (N)	2000	Minimum crush resistance (N/ 10 cm)	3000
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	<p>b) <b><u>Identification</u></b>  Following information shall be embossed or printed or indented on the cable sheath at intervals of 1m throughout the whole length of the cable to enable the identification of cable. The embossed or printed or indented marking shall be distinct to naked eye from a distance of not less than 50 cm.</p> <p>(i) Type and size of cable  (ii) Progressive length marking  (iii) Year of manufacturing  (iv) Manufacturer's name  (v) NEPAL TELECOMMUNICATIONS AUTHORITY  (vi) Laser symbol or text identifying the cable as optical fibre cables.</p>																						
	<p>c) <b><u>Sealing and marking ends</u></b>  After testing, the ends of each length of cable shall be enclosed in securely attached, tightly fitting caps having wall thickness and overall length of not less than 2 mm and 50 mm respectively.</p>																						
	<p>d) <b><u>Color Code</u></b>  The color code for the identification of fibre &amp; loose tube shall be in the following order,</p>																						

Clause No.	Particulars of Technical Requirements			
	<b>Fibre No.</b>	<b>Color</b>	<b>Fibre No.</b>	<b>Color</b>
	1	Blue	7	Orange
	2	White	8	Black
	3	Yellow	9	Pink
	4	Green	10	Violet
	5	Grey	11	Brown
	6	Red	12	Aqua
	e) <b><u>Loose Tube Colour</u></b> The same colour coding system shall be followed for loose tube.			
9.1.11	<b><u>Tests</u></b> Tests on the finished cables shall be made to prove compliance with all requirements of this specification. There shall be a guarantee that the materials used for production of the fibers and coating shall be of the same origin for all cables. Combination of fibres and coating from different suppliers is not acceptable.			
9.1.12	<b><u>Tests For Geometrical, Optical &amp; Transmission Characteristics</u></b>			
	a) <b>Geometric tests shall include the following :</b> <ul style="list-style-type: none"> <li>– Mode field diameter</li> <li>– Cladding diameter</li> <li>– Mode field concentricity</li> <li>– Cladding non-circularity</li> <li>– Primary coating diameter</li> </ul>			
	b) <b>Optical properties test of the fibre shall include the following :</b> <ul style="list-style-type: none"> <li>– Refractive index profile</li> <li>– Maximum theoretical numerical aperture.</li> <li>– Cut off wavelength</li> <li>– Backscattering</li> </ul>			
	c) For each production length, to be delivered in Nepal, the following measurements shall be performed and random sampling shall be provided:  <ul style="list-style-type: none"> <li>– Attenuation at 1310 nm and 1550 nm.</li> <li>– Chromatic dispersion at 1310 nm and 1550 nm.</li> </ul>			
9.1.13	<b><u>Mechanical Test</u></b>			
	a) The following mechanical tests shall be carried out on the cables as per ITU (T) 652.D <ul style="list-style-type: none"> <li>– Tensile performance</li> <li>– Crush</li> <li>– Impact</li> <li>– Repeated bending</li> <li>– Torsion</li> <li>– Flexibility</li> <li>– Kink</li> <li>– Cable bend</li> </ul>			

Clause No.	Particulars of Technical Requirements				
	<p><b>b) The construction of protective cover of the cable shall be of good engineering practices with respect to:</b></p> <ul style="list-style-type: none"> <li>– Air tightness</li> <li>– Resistance to water penetration</li> <li>– Flexibility within a temperature range of <math>-5^{\circ}\text{C}</math> to <math>+50^{\circ}\text{C}</math></li> <li>– Mechanical stability</li> <li>– Chemical resistance</li> <li>– Small diameter, light weight</li> </ul>				
	<p><b><u>c) Conditions of measurement and test</u></b> All the measurements shall be carried out at a temperature of <math>20 \pm 5^{\circ}\text{C}</math>.</p>				
9.1.14	<b><u>Cable Drum Information</u></b>				
	a) <u>The cable shall be coiled on metallic or synthetic drum, the size of which shall conform to those given in table below.</u>				
		<b>Flange Diameter (mm)</b>	<b>Barrel Diameter (mm)</b>	<b>Overall Width Of Drum (mm)</b>	<b>Internal spindle hole dia. (mm)</b>
	Minimum	900	385	500	75
	Maximum	2200	1400	1200	-
	b) Strong battens shall be fixed on to the circumference of the flanges of the drum so as to protect cable from damage during transportation and storage.				
9.1.15	<b><u>Drum Length</u></b>				
	The bidder shall supply the cable in fixed length in each cable drum for every size of the cable. The length of cable drum for 24 and 36 fibres cables shall be at least four (4) km each and for 48, 72 and 96 fibre cables shall be at least three (3) km each. It is also suggested that the gross weight of the drum including the single length of cable wound on it, shall not exceed 3 Metric ton.				
9.1.16	<b><u>Closures</u></b>				
	<p>a) Re-enterable four-way water-proof and air-tight (at least up to 1m depth of water) closure shall be supplied for different sizes of optical fibre Cables.</p> <p>b) The closure shall be made of materials that are fire and chemical resistant and are mechanically strong (shall not break or deform when falling from a height of at-least 5m on hard cement surface).</p> <p>c) The closure shall be installed underground or in manholes or on the poles. Suitable clamping accessories shall be provided.</p> <p>d) Underground enclosure shall be in-line (Horizontal) type and Aerial enclosures shall be of Dome type.</p> <p>e) The enclosure shall allow for the tap-off splices and shall have enough space and facility to organize the loose tubes containing fibres that doesn't need to be cut and spliced at any pickup point.</p> <p>f) Grounding arrangements with grounding materials shall be provided to connect metallic part of cable &amp; closure to the earth.</p> <p>g) All the accessories and materials like clamping and ground continuity wires forming a set shall be provided.</p>				
9.1.17	<b><u>Optical Distribution Frame (ODF)/Termination Box</u></b>				

Clause No.	Particulars of Technical Requirements
	All the new fibre ends shall be terminated in ODF/Termination Box.
	<p><b>Optical Distribution Frame (ODF)</b>  ODF to be installed shall of rack system possessing with following characteristics :</p> <ul style="list-style-type: none"> <li>a) Standard 19 inch installation: fully enclosed rodent proof structure.</li> <li>b) Keyway type.</li> <li>c) Full front operation: capable of installation against wall, side by side or back to back.</li> <li>d) Complete cable routing design with fiber bend radius over 40 mm.</li> <li>e) Modular design with easy installation.</li> <li>f) Splice and Distribution Module with capacity of sufficient ports with FC adaptors.</li> <li>g) Optimal arrangement for patch cords with fiber storage units.</li> <li>h) Reliable holding, protection and grounding of optical cables.</li> </ul>
9.1.18	<p><b>Termination Box</b></p> <ul style="list-style-type: none"> <li>a) Termination boxes are to be installed in remote sites.</li> <li>b) Termination boxes shall be wall mountable with keyway entry access.</li> <li>c) The termination boxes shall have at-least two inlets for two cables and inlets for patch cords shall be separate.</li> <li>d) Necessary accessories for fixing the termination box shall be supplied.</li> <li>e) Grounding arrangements with grounding materials shall be provided to ground metallic parts of OFC and termination box to the existing station earth.</li> </ul>
9.1.19	<p><b>Environmental Conditions:</b> The Optical Fiber cable and Accessories shall be capable of maintaining its performance for 24 hours daily throughout the year under the following climatological conditions.</p> <ul style="list-style-type: none"> <li>(a) Temperature : -10 degree C to +55 degree C</li> <li>(b) Humidity : RH up to 100% @ 0 - 35°C &amp; up to 75% @ above 40°C.</li> <li>(c) Altitude : At any altitude up to 5000 m above sea level.</li> <li>(d) Ultraviolet Ray :OFC shall not be affected by ultraviolet ray exposure.</li> </ul>
9.1.20	<p><b><u>Option:1 Laying of PL-HDPE and Underground Optical Fiber Cable (UG Cable)</u></b></p> <p><b>Laying of PL-HDPE:</b></p> <ul style="list-style-type: none"> <li>i. The HDPE Duct shall be lubricated by co-extrusion technique with an inner layer of Solid Permanent Lubricant/ preferably spiral ribbed to reduce the Internal Co-efficient of Friction. The Internal Co-efficient of Friction shall not exceed 0.08, when measured with respect to Optic Fiber Cable.</li> <li>ii. In finished duct, the co-extruded Inner Layer of Solid Permanent Lubricant/ preferably spiral ribbed shall be integral with HDPE Layer and shall be white</li> </ul>

Clause No.	Particulars of Technical Requirements
	<p>and clearly visible in cross section of Duct. The Inner Layer of Solid Permanent Lubricant shall be continuous all through and shall not come out during storage, usage and throughout the life of Telecom Duct.</p> <p>iii. The Applicant shall be responsible to trench and install two (2) numbers of PL-HDPE 40/33 mm direct buried type (Outside dia: 40mm, wall thickness:3.5mm) size ducts.</p> <p>iv. 96/48 cores of optical fiber cable is to be blown into one of the PL-HDPE ducts.</p> <p>v. The duct supplied shall have the properties for installation of optic fiber cable by internationally proven blowing technology, up to a minimum distance of 1000m under normal terrain conditions.</p> <p>vi. Usage of such ducts shall permit the installation of cable into ducts by Blowing Technology.</p> <p>vii. All the detailed drawing of the networks elements (Optical terminal boxes, manholes, hand holes, outdoor, splice boxes) with GPS co-ordinates, altitude etc. shall be prepared in AutoCAD and presented to NTA for approval.</p> <p>viii. The duct shall be supplied in continuous length of One (1) Km in a coil with both end sealed. Colour of the PL-HDPE Duct can be Black or Blue, Green, Yellow with 4 stripes/bands for identification.</p> <p>ix. The ducts shall be marked with each meter span and Inkjet printing as the Nepal Telecommunication Authority on outer surface of the duct with distinct, permanent, non-washable, non-fading color.</p> <p>x. The duct shall be joined by means of suitable Push-Fit Couplers to ensure durable water and airtight joints, using 'O' ring.</p> <p>xi. PL- HDPE Duct should have co-extruded copper wire. This duct would be a tracer duct with copper wire and extended along the entire length. The copper wire shall be co-extruded or embedded within the outer layer meeting all the criteria defined below. The copper wire shall be highly conductive and shall be used for radiating a signal along a duct line such that the cable duct can be easily traced with a signal tracing equipment (transmitter &amp; receiver with inbuilt GPS system). The co-extruded copper wire should have :-</p> <p>a) Diameter : 1.22 mm +/- 0.02</p> <p>b) Resistance : &lt; 15.0 Ohms/Km. at 27 deg. C.</p> <p>xii. Expanding washer and Threaded cover over the couplers and shall withstand 10Kg/cm<sup>2</sup> air pressure for at least 2 hours.</p> <p>xiii. The material specifications of ducts shall follow BS: 3412, Class N HDPE.</p> <p>xiv. The specific base density shall be within 940 to 958Kg/m<sup>3</sup>, when tested at 27°C.</p> <p>xv. The melt flow rate of the material shall be between 0.20 and 0.4 gm/10minutes when tested at 190°C with nominal load of 2.16 kgf.</p> <p>xvi. The design, workmanship, material and finish of all the Permanently lubricated high density polyethylene duct pipe (PL-HDPE) shall be free from</p>



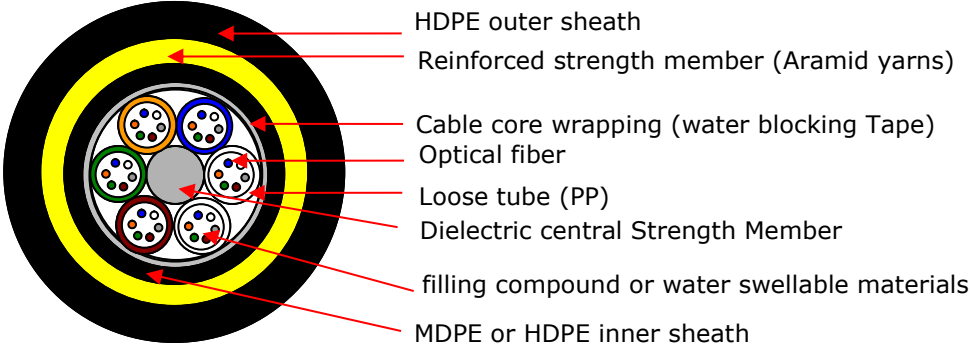
Clause No.	Particulars of Technical Requirements
	<p>defect and shall be capable of functioning perfectly and be able to withstand the rigours of long service in any type of area that may encountered in Nepal.</p> <p>xvii. The operating environment condition shall be -10°C to +50°C temperature range, up to 100% relative humidity, up to 5000m of altitude from sea level, Nepalese environment. Other accessories like Plastic coupler, End plug, Simple plug, Warning tape, Cable booster etc shall be used.</p> <p>xviii. In places like bridges, culverts, under rivers, inside pits, canals, rain washable areas, heavy vehicle traffic passing areas etc., the duct shall be made up of GI (Galvanized Iron) pipe.</p>
	<p><b><u>Option-2: Laying of Microduct and Underground Optical Fiber Cable (UG Cable)</u></b></p> <p><b>Laying of Microduct :</b></p> <ol style="list-style-type: none"> <li>i. The Microduct shall be made up of HDPE (High Density Polyethylene).</li> <li>ii. The recycled HDPE shall be not allowed for the Microduct.</li> <li>iii. The TWD Microduct for direct bury shall be bundled with the outer sheath (wall thickness : min. 1mm) and four(4) ways of 14/10mm thick walled duct (Outside dia : 14mm, wall thickness : 2mm).</li> <li>iv. The inner surface of the Microduct shall be pre-lubricated by silicone coating and may be straight ribbed for the better blowing performance.</li> <li>v. The Applicant shall be responsible to trench and install the Microduct.</li> <li>vi. 96/48 cores of optical fiber cable is to be blown into one of the Microduct.</li> <li>vii. The Microduct supplied shall have the properties for installation of optic fiber cable by internationally proven blowing technology, up to a minimum distance of 1000m under normal terrain conditions.</li> <li>viii. Usage of such Microducts shall permit the installation of cable into ducts by Blowing Technology.</li> <li>ix. All the detailed drawing of the networks elements (Optical terminal boxes, manholes, hand holes, outdoor, splice boxes) with GPS co-ordinates, altitude etc. shall be prepared in AutoCAD and presented to NTA for approval.</li> <li>x. The Microduct shall be supplied in continuous length of One (1) Km ~ Two (2) Km in a drum (White, Red, Green and Blue in colors).</li> <li>xi. The Microducts shall be marked with each meter span and embossed as the Nepal Telecommunication Authority on outer surface of the duct with distinct, permanent, non-washable, non-fading color.</li> <li>xii. The Microduct shall be joined by means of suitable push-pull connector using connector cover to ensure durable water and dusts.</li> <li>xiii. The Microduct shall withstand 15 bar air pressure for at least 2 hours.</li> <li>xiv. The specifications of Microduct shall follow International standard IEC 60794-5-10 Annex E, IEC 60794-5-10&amp;20.</li> <li>xv. The maximum Tensile load shall be 9.8 times of weight of the Microduct..</li> <li>xvi. The Microduct shall show no damage under maximum Crush load of 2,000N and Impact 5J.</li> <li>xix. The design, workmanship, material and finish of all the Microduct shall be</li> </ol>

Clause No.	Particulars of Technical Requirements
	<p>free from defect and shall be capable of functioning perfectly and be able to withstand the rigours of long service in any type of area that may encountered in Nepal.</p> <p>xx. The operating environment condition shall be -10°C to +50°C temperature range, up to 100% relative humidity, up to 5000m of altitude from sea level, Nepalese environment. Other accessories like Connector, End Cap, Warning tape etc shall be used.</p> <p>xxi. In places like bridges, culverts, under rivers, inside pits, canals, rain washable areas, heavy vehicle traffic passing areas etc., the Microduct shall be made up of GI (Galvanized Iron) pipe.</p>
9.1.21	<b>Construction Standards</b>
	<ul style="list-style-type: none"> <li>a) The trench shall be excavated to a depth of 130 cm in general in plain area and it shall be graded to enable the cable to be laid on an even plain. The depth reference for the trench shall be taken from the road surface.</li> <li>b) A bed of sand of 10 cm deep shall be laid along the bottom of the trench and duct shall be placed at the centre of the trench.</li> <li>c) A sand bed of 10 cm deep shall be provided above the duct.</li> <li>d) Warning tape shall be placed 20 cm above the sand bed.</li> <li>e) In rocky area, the trench shall be excavated to a depth of at least 100 cm.</li> <li>f) Sharp edges of rocks in the trench shall be removed. Sand cushion of 10 cm thick above and below the duct shall be provided. The bottom of the trenches shall be uniform level without any abrupt ups and downs.</li> <li>g) The optical fiber enclosures shall be used in each splice.</li> <li>h) Cable pulling machines, air blowing machines shall be used at a distance of 1 km apart in tandem in order to avoid fibre damage.</li> <li>i) Sharp cable radii shall be minimized as recommended by manufacturer or ITU-T recommendation G.652.</li> <li>j) Air conditioned splicing vehicle shall be used to provide dust and moisture free environment for fusion splicing. The average splice loss shall not be more than 0.05dB/splice.</li> <li>k) Tree routes shall be cut completely in the trench, which could grow and crush the duct pipe.</li> <li>l) To reduce the friction between the cables and duct, suitable lubricant shall be continuously applied.</li> <li>m) All manholes shall be covered properly.</li> <li>n) After completion of the termination and splicing in each section, the cable shall be tested for loss and recorded.</li> </ul>

## 9.2 ALL DIELECTRIC SELF-SUPPORTING CABLE (ADSS) AND ACCESSORIES

S.N.	Particulars of Technical Requirements	
9.2.1	<b>FIBER CHARACTERISTICS</b>	
	The fibers shall be made from high-grade germanium doped silica glass or compound glass. It shall have a primary coating made of silicon or similar material. The fiber shall be dual-window single mode type. The geometric and optical properties of the fiber shall be in accordance with table below.	
	Mode field diameter ( $\mu\text{m}$ ) at 1310 nm	9~10 $\pm$ 10 % (ITU-T rec.G652D)
	Cladding diameter ( $\mu\text{m}$ )	125 $\pm$ 1
	Maximum Core concentricity error ( $\mu\text{m}$ )	0.6
	Coating diameter ( $\mu\text{m}$ )	245 $\pm$ 5
	Maximum Cladding Non-circularity	1%
	Maximum cut-off wavelength (nm)	1260
	Maximum chromatic dispersion at 1310 nm	3.5 ps/nm.km
	Maximum attenuation range dB/km at 1310/1550 nm	0.35/0.2
	Macro bend Loss	@ 1310 nm (75 $\pm$ 2 mm dia Mandrel), 100 turns; Attenuation Rise $\leq$ 0.05 dB @ 1550 nm (30 $\pm$ 1 mm radius Mandrel), 100 turns; Attenuation Rise $\leq$ 0.05 dB
	Proof Test Level	$\geq$ 0.69 Gpa
	Chromatic Dispersion;	18 ps/(nm x km) @ 1550 nm 3.5 ps/(nm x km) 1288-1339nm 5.3 ps/(nm x km) 1271-1360nm
	Zero Dispersion Wavelength:	1300 to 1324nm
	Zero Dispersion Slope:	0.092 ps/nm <sup>2</sup> $\times$ km
	Polarization mode dispersion coefficient	$\leq$ 0.2 ps/km <sup>1/2</sup>
	Temperature Dependence:	Induced attenuation $\leq$ 0.05 dB (-60°C-+85°C)
9.2.2	The loss increase of 100 turns of fiber, loosely wound with a 37.5 mm radius shall be less than 0.05 dB at wavelengths of 1310 nm.	
9.2.3	The offered cables shall be used for SDH, IP L2/L3 switches and routers operating up to a bit rate of 100 Gbps and DWDM systems supporting up to 100 lambdas. The network shall be capable to provide services to 2-4G cellular mobile services, NGN, MPLS etc.	
9.2.4	The nominal operating wavelength of the systems in this project shall be 1310 nm, (within the region of 1280-1330 nm). The fibers shall be able to support in the 1550 nm and DWDM wavelength region. The Bidder shall supply full details of the fiber performance at the wavelengths.	
9.2.5	A dual protective Ultra Violet (UV) curable primary coating shall be applied to the fiber. An alternate offer with similar materials with details regarding its performance	

S.N.	Particulars of Technical Requirements																																				
	may be proposed.																																				
9.2.6	Fibers inside the cable must not contain any factory splices. Further, Fibers of different manufacturers must not be used in the same cable. The fiber coating shall be strippable for splicing and termination.																																				
9.2.7	The fiber and loose tube color coding shall be as follows:																																				
	<table border="1" data-bbox="321 409 1437 756"> <thead> <tr> <th data-bbox="321 409 548 445">Fiber No.</th> <th data-bbox="548 409 846 445">Color</th> <th data-bbox="846 409 1109 445">Loose Tube No.</th> <th data-bbox="1109 409 1437 445">Color</th> </tr> </thead> <tbody> <tr> <td data-bbox="321 445 548 483">1</td> <td data-bbox="548 445 846 483">Blue</td> <td data-bbox="846 445 1109 483">1</td> <td data-bbox="1109 445 1437 483">Blue</td> </tr> <tr> <td data-bbox="321 483 548 520">2</td> <td data-bbox="548 483 846 520">White</td> <td data-bbox="846 483 1109 520">2</td> <td data-bbox="1109 483 1437 520">White</td> </tr> <tr> <td data-bbox="321 520 548 558">3</td> <td data-bbox="548 520 846 558">Yellow</td> <td data-bbox="846 520 1109 558">3</td> <td data-bbox="1109 520 1437 558">Yellow</td> </tr> <tr> <td data-bbox="321 558 548 596">4</td> <td data-bbox="548 558 846 596">Green</td> <td data-bbox="846 558 1109 596">4</td> <td data-bbox="1109 558 1437 596">Green</td> </tr> <tr> <td data-bbox="321 596 548 634">5</td> <td data-bbox="548 596 846 634">Grey</td> <td data-bbox="846 596 1109 634">5</td> <td data-bbox="1109 596 1437 634">Grey</td> </tr> <tr> <td data-bbox="321 634 548 672">6</td> <td data-bbox="548 634 846 672">Red</td> <td data-bbox="846 634 1109 672">6</td> <td data-bbox="1109 634 1437 672">Red</td> </tr> <tr> <td data-bbox="321 672 548 709"></td> <td data-bbox="548 672 846 709"></td> <td data-bbox="846 672 1109 709">7</td> <td data-bbox="1109 672 1437 709">Orange</td> </tr> <tr> <td data-bbox="321 709 548 747"></td> <td data-bbox="548 709 846 747"></td> <td data-bbox="846 709 1109 747">8</td> <td data-bbox="1109 709 1437 747">Black</td> </tr> </tbody> </table>	Fiber No.	Color	Loose Tube No.	Color	1	Blue	1	Blue	2	White	2	White	3	Yellow	3	Yellow	4	Green	4	Green	5	Grey	5	Grey	6	Red	6	Red			7	Orange			8	Black
	Fiber No.	Color	Loose Tube No.	Color																																	
	1	Blue	1	Blue																																	
	2	White	2	White																																	
	3	Yellow	3	Yellow																																	
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	5	Grey	5	Grey																																	
	6	Red	6	Red																																	
		7	Orange																																		
		8	Black																																		
9.2.8	<p><b>Tests for Geometrical, Optical &amp; Transmission Characteristics</b></p> <p>Tests on the finished cables shall be made to prove compliance with all requirements of this specification. All the measurements shall be carried out at a temperature of <math>20 \pm 5</math> °C. If measurement is done at different temperature, the result shall be corrected to 20°C.</p>																																				
9.2.9	ADSS optical fiber cable supplied shall be used for hanging on 132KV, 66KV, 33KV, 11KV existing power towers/poles and new poles as per requirements found during detail survey and design.																																				
9.2.10	<p>Optical cable shall be designed, manufactured and packed to ensure to be able to stand Nepalese environment during process of storage, transportation, installation and operation such as air temperature variation from <math>-5^{\circ}\text{C} \sim +55^{\circ}\text{C}</math>, direct sun radiation may increase the outside temperature to <math>55^{\circ}\text{C}</math> and in flooded environment or place where insect and rodent may injure the cable, wind pressure of 47 m/s for area below 3000 m altitude and 55 m/s for area above 3000 m altitude as per Nepal National Building Code (NBC)104:1994.</p> <p>Study of the local environmental condition of the respective areas is recommended.</p>																																				
9.2.11	<b>All Dielectric Self-Supporting Cable, (ADSS) Construction</b>																																				
	<p>Design of cable from core to skin shall be as follows:</p> <ol style="list-style-type: none"> <li>Center strength member (CSM) shall be made from non-metallic materials.</li> <li>Loose buffer tube filling compound to protect the fibers in the loose tube against water ingress and vibration, this compound must enable optical fibers move easily in the tube.</li> <li>Loose buffer tube shall be made from Polypropylene (PP), colored distinguished between loose buffer tubes and filled by filling compound or water swellable materials.</li> <li>Fillers and Loose tubes shall be arranged round CSM according to the reverse lay method (SZ). Fillers with neuter color shall be used to distinguish with loose buffer tubes.</li> </ol>																																				

S.N.	Particulars of Technical Requirements	
	<p>e) After application of fillers, at least one helical or longitudinal application of non-hygroscopic and non-wicking water blocking tape shall be applied over the cable core.</p> <p>f) The inner jacket shall be of MDPE or HDPE as per the latest relevant BS standards.</p> <p>g) Peripheral strength member shall be made from aramide yarns with high straining intensity and low stretching capacity.</p> <p>h) HDPE outer jacket shall be able to sustain high electric field.</p>	
9.2.12	<p>The Cable structure shall be as follows:</p> 	
9.2.13	<b>Cable Types</b>	
	<b>a) ADSS cable for 11/33KV 100m span 12/24/48 core</b>	
	<b>Description</b>	<b>Technical Requirement</b>
	<b>ADSS cable</b>	
	Span length	100m
	Lifetime	≥ 30 years
	Dielectric central strength member diameter	≥ 2.0 mm
	<b>Minimum Quantity (or Amount) of Aramid Yarn</b>	> 34,000 den
	Rated Tensile Strength	≥ 9 kN
	Maximum allowable Tension	≥ 3.6 kN
	Every day Stress	≥ 2.25 kN
	Applied Load Crush Resistance	≥ 2 kN/100mm

S.N.	Particulars of Technical Requirements	
	Allowed Bending Radius	20 times of diameter of cable
	Inner jacket thickness Outer jacket thickness	$\geq 1.0$ mm $\geq 1.5$ mm
	Cable weight	120 -160 kg/km
	Fiber length in the cable compared to the cable length	$\geq 1\%$
	<b>b) ADSS cable for 11/33KV 200m span 12/24/48core</b>	
	<b>Description</b>	<b>Technical Requirement</b>
	<b>ADSS cable</b>	
	Span length	200m
	Lifetime	$\geq 30$ years
	Dielectric central strength member diameter	$\geq 2.0$ mm
	<b>Minimum Quantity (or Amount) of Aramid Yarn</b>	$> 79,600$ den
	Rated Tensile Strength	$\geq 15$ kN
	Maximum allowable Tension	$\geq 6$ kN
	Every day Stress	$\geq 3.5$ kN
	Applied Load Crush Resistance	$\geq 2$ kN/100mm
	Allowed Bending Radius	20 times of cable diameter
	Inner jacket thickness Outer jacket thickness	$\geq 1.0$ mm $\geq 1.5$ mm
	Cable weight	140 -180 kg/km
	Fiber length in the cable compare with the cable length	$\geq 1\%$
	<b>c) ADSS cable for 11/33KV 300m span 12/24/48core</b>	
	<b>Description</b>	<b>Technical Requirement</b>
	<b>ADSS cable</b>	
	Span length	300m
	Lifetime	$\geq 30$ years
	Dielectric central strength member diameter	$\geq 2.0$ mm

S.N.	Particulars of Technical Requirements	
	<b>Minimum Quantity (or Amount) of Aramid Yarn</b>	> 137,600 den
	Rated Tensile Strength	$\geq 18$ kN
	Maximum allowable Tension	$\geq 7$ kN
	Every day Stress	$\geq 4.5$ kN
	Applied Load Crush Resistance	$\geq 2$ kN/100mm
	Allowed Bending Radius	20 times of cable diameter
	Inner jacket thickness	$\geq 1.0$ mm
	Outer jacket thickness	$\geq 1.5$ mm
	Cable weight	150 -190 kg/km
	Fiber length in the cable compare with the cable length	$\geq 1\%$
	<b>d) ADSS cable for 11/33KV 500m span 24/48core</b>	
	<b>Description</b>	<b>Technical Requirement</b>
	<b>ADSS cable</b>	
	Span length	500m
	Lifetime	$\geq 30$ years
	Dielectric central strength member diameter	$\geq 2.0$ mm
	<b>Minimum Quantity (or Amount) of Aramid Yarn</b>	> 201,600 den
	Rated Tensile Strength	$\geq 27$ kN
	Maximum allowable Tension	$\geq 10.5$ kN
	Every day Stress	$\geq 6.5$ kN
	Applied Load Crush Resistance	$\geq 2$ kN/100mm
	Allowed Bending Radius	20 times of diameter
	Inner jacket thickness	$\geq 1.0$ mm
	Outer jacket thickness	$\geq 1.5$ mm
	Cable weight	180 -230 kg/km
	Fiber length in the cable compare with the cable length	$\geq 1\%$
	<b>e) ADSS cable for 11/33KV 1000m span 24core</b>	

S.N.	Particulars of Technical Requirements	
	Description	Technical Requirement
	<b>ADSS cable</b>	
	Span length	1000m
	Lifetime	≥ 30 years
	Dielectric central strength member diameter	≥ 2.0 mm
	<b>Minimum Quantity (or Amount) of Aramid Yarn</b>	
	Rated Tensile Strength	≥ 62 kN
	Maximum allowable Tension	≥ 25 kN
	Every day Stress	≥ 16 kN
	Applied Load Crush Resistance	≥ 2 kN/100mm
	Allowed Bending Radius	20 times of diameter
	Inner jacket thickness	≥ 1.0 mm
	Outer jacket thickness	≥ 1.5 mm
	Cable weight	230 -260 kg/km
	Fiber length in the cable compare with the cable length	≥ 1%
9.2.13	<b>ADSS Accessories</b>	
	<p><b>a) Tension Assembly (Clamp)</b></p> <ul style="list-style-type: none"> <li>• The offered tension clamp shall be suitable for the offered cable.</li> <li>• The offered tension clamp shall have a lifetime of at least 30 years.</li> <li>• The maximum tensile force of the offered tension clamp shall be as per the design of the network.</li> </ul>	
	<p><b>b) Suspension Assembly (Clamp)</b></p> <ul style="list-style-type: none"> <li>• The offered suspension clamp shall be suitable for the offered cable.</li> <li>• The offered suspension clamp shall have a lifetime of at least 30 years.</li> <li>• The maximum tensile force of the offered suspension clamp shall be as per the design of the network.</li> </ul>	
9.2.14	<b>Optical Distribution Frame (ODF)/ Optical Termination Box(OTB)</b>	
	<p><b>a) <u>Optical Distribution Frame (ODF)</u></b></p> <p>All the fiber ends shall be terminated in ODF/OTB. ODF to be installed in each district head quarter shall be of rack system with following characteristics :</p> <ul style="list-style-type: none"> <li>• Standard 19 inch installation: fully enclosed rodent proof structure.</li> <li>• Keyway type.</li> <li>• Full front operation: capable of installation against wall, side by side or back to back.</li> </ul>	



S.N.	Particulars of Technical Requirements
	<ul style="list-style-type: none"> <li>• Complete cable routing design with fiber bend radius over 40 mm.</li> <li>• Modular design with easy installation.</li> <li>• ODF shall have a modular design for 19 inches standard frame.</li> <li>• Reliable holding, protection and grounding of optical cables.</li> <li>• The size of rack shall be as per the port capacity requirement as per design</li> <li>• Necessary accessories for fixing the ODF shall be supplied.</li> </ul> <p style="margin-left: 40px;"><b>b) <u>Termination Box</u></b></p> <ul style="list-style-type: none"> <li>• Termination boxes are to be installed in each district head quarters.</li> <li>• Termination boxes shall be wall mountable with keyway entry access.</li> <li>• Shall be able to accommodate with FC adapter.</li> <li>• The termination boxes shall have at-least two inlets for two cables and inlets for patch cords shall be separate.</li> <li>• Optical Termination box shall have provision to accommodate in standard 19 inches frame.</li> <li>• Necessary accessories for fixing the termination box shall be supplied.</li> <li>• Grounding arrangements with grounding materials shall be provided to ground metallic parts of OFC and termination box to the existing station earth.</li> </ul>
9.2.15	<p><b><u>Outdoor Splicing Box (Closure)</u></b></p> <ul style="list-style-type: none"> <li>• Re-enterable four-way water-proof and air-tight (at least up to 1 m depth of water) closure shall be supplied for different sizes of optical fiber cables.</li> <li>• Outdoor splicing box shall be dome type.</li> <li>• The closure shall be made of materials that are fire and chemical resistant and are mechanically strong (shall not break or deform when falling from a height of at-least 5m on hard cement surface).</li> </ul>
9.2.16	Any other required accessories shall need to be supplied.
9.2.17	<p><b><u>Poles and Tower</u></b></p> <p>Specification of 7.5m, 9m and 12m poles are listed below for a reference. However, required pole size and strength shall be finalized by the SLO after detailed survey and design wherever necessary. They are welcome to use existing poles, mast/towers of any utilities services wherever available. However, Applicant shall be responsible to arrange such available facilities and bear all expenses. Applicant may also propose 7.5 or 9 or 12 m of poles wherever underground cable is not technically viable and poles/towers of other utilities are not available.</p>
9.2.18	<p><b><u>Galvanized Steel Pole (7.5m)</u></b></p>
	<p>a)Scope: The steel poles, single piece telescopic type, are used in conjunction with pole accessories for supporting ADSS/Aerial cable</p> <p><b><u>b) Reference</u></b></p> <p>The pole shall meet the following standard specification:  -Steel tube and base plate for pole : ISO/630</p>

S.N.	Particulars of Technical Requirements
	<p>- Hot dip galvanizing : BS-729</p> <p><b>c) Detailed requirements for steel poles, base plate and top cap</b></p> <ul style="list-style-type: none"> <li>• The telescopic pole shall be made of only one single length tapered steel tube.</li> <li>• All the tubes and base plate shall be made of steel as per ISO 630 grade Fe 430 B or nearest equivalent grade in other standard.</li> <li>• The outer and inner surface of the pole including with base plate shall be hot dip galvanized as per BS 729 with minimum layer thickness of galvanization being 450 gm/sq-m.</li> <li>• The thickness of the section of steel tubes shall range between 2 mm and 3 mm.</li> <li>• The jointing process in the pole for seam welding shall be performed by either high frequency welding method or arc welding (preferably submerged arc welding) method. The joint thus formed by arc welding shall be uniform and smooth. The mechanical characteristic in the welded part shall be at least equivalent to those of the base metal.</li> </ul> <p>d) The poles shall be supplied with following properties:</p> <ul style="list-style-type: none"> <li>• Pole size of 7.5 meters shall have the total length of 7500 mm +2%. The pole shall withstand minimum horizontal load of 365 Kg applied at 50 cm from the top of the pole and a wind pressure of 110 Kg/sq m applied on the pole without permanent deformation and without the application of stay. The minimum breaking load of this pole shall be 520 KgF when applied at 50 cm from the top.</li> <li>• The top end diameter of the pole shall be between 100 mm and 125 mm and the bottom end diameter shall be between 185 mm and 250 mm. Any additional tolerance on diameters shall not be acceptable and shall be rejected.</li> <li>• The outer surface of the steel tube between 1000 mm and 1900 mm for pole size 7.5 meters, from the bottom shall be coated all around with anti corrosive paint, which shall be tar epoxy type or equivalent.</li> </ul> <p>A non-metallic or metallic cap with material thickness of 2 mm to 3 mm shall be provided to fix on the top of pole. The cap shall be of press fitted type.</p>
9.2.19	<b>Galvanized Steel Pole ( 9 m and 12 m)</b>
	<b>a) Scope</b>
	The pole shall be of the tubular type.
	<b>b) Reference</b>
	This shall meet the following standard specification:
	<ul style="list-style-type: none"> <li>• Steel tube and base plate for pole : ISO/630</li> <li>• Hot dip galvanizing : BS-729</li> </ul>
	<b>c) Technical Specification of Galvanized Steel Pole</b>
	All the tubes and base plate shall be made of steel as per ISO 630 grade Fe 430 B or nearest equivalent grade in other standard.
	The outer and inner surface of the pole including with base plate shall be hot dip galvanized as per BS 729 with minimum layer thickness of galvanization being 450

S.N.	Particulars of Technical Requirements		
	gm/sq.m.		
	<b>Dimension of the Poles</b>	<b>Pole (9 m)</b>	<b>Pole (12 m)</b>
	Overall Length	9 m	12 m
	Planting Depth	1.5 m	2.0 m
	Sections Length (m)		
	Top (h1)	2	3
	Middle (h2)	2	3
	Bottom (h3)	5	6
	Outside Diameter (mm)		
	Top (h1)	114.3	114.3
	Middle (h2)	139.7	139.7
	Bottom (h3)	165.1	165.1
	Thickness (mm)		
	Top (h1)	3.65	3.65
	Middle (h2)	4.5	4.5
	Bottom (h3)	4.5	4.5
	Approximate Weight (Kg)	147	195
	Crippling Load Kgf	367	367
	Application Load from Top of the Pole (m)	0.3	0.6
9.2.20	<b><u>Marking</u></b>		
	<p>All poles shall be painted or printed with the word “<b>Nepal Telecommunications Authority</b>” on external surface with distinct unwashable yellow color. The size of the letter should be (Thickness x Width x Height) 8mm x 30mm x 50mm.</p> <p>For erection of any pole/tower, the SLO shall follow the guidelines of ICAO and applicable laws of Nepal.</p>		
9.2.21	<b><u>Life expectancy</u></b>		
	<p>All poles shall be designed for a life expectancy of at least 30 years without any serious degradation of the performance or reliability maintained and when installed at the temperature range of <math>-10^{\circ}\text{C}</math> to <math>+55^{\circ}\text{C}</math> in Nepal.</p>		
9.2.21	<b><u>Construction</u></b>		
	<p>a) Pole Clearance: All types of ADSS shall have minimum of 7 m clearance from the point of lowest sag for 9 m and 12 m poles.</p> <p>b) Pole Material: Suitable Poles/Mast/Tower shall be of galvanized steel and/or concrete with adequate strength and Installation Practice as well as other Pole/Mast/Tower quality features shall be of applicable well known International Standard such as BS (British Standard), IS (Indian Standard), ITU, etc.</p> <p>c) Any structures of NEA for the Optical on Ground Wire (OPGW) are also acceptable standard, wherever OPGW route is proposed.</p>		

### 9.3 Dense Wavelength Division Multiplexing (DWDM)

9.3.1	<p><b>Introduction</b></p> <p>The Applicant shall design optical fiber based 80 Channel/Lambda with 100 Gbps capacity DWDM network to carry router/switch/SDH traffic as well as DWDM lambda traffic from other DWDM equipment. It shall support NGN (C4/C5) VoIP services and TDM voice services, support all types of data and voice services available in Nepal. All DWDM equipment shall be connected with routers on the customer ends.</p>
9.3.3	<p>The DWDM equipment shall be able to carry the traffic from the supplied routers as well as carry the existing SDH and Ethernet traffic for the rates 1 Gbps, 10 Gbps and 100 Gbps at present and 400 Gbps in the future.</p> <p>The Applicant shall dimension and provide the DWDM equipment with minimum capacity of 100Gbps.</p>
9.3.5	<p>The network shall be based on DWDM equipment supporting minimum of 80 channels/wavelengths than can carry 100 Gbps of traffic in each lambda.</p>
9.3.6	<p><b>Optical source protection</b></p> <p>Laser optical source if used should be automatically switched off (ALS) in case of load is disconnected from transmitter. This option should be guaranteed by system software as per ITU-T Recommendation G.958.</p>
9.3.7	<p>The equipment shall provide necessary air circulation inside itself (air-cooled type).</p>
9.3.8	<p>All the equipment shall be treated to resist corrosion and growth of fungus.</p>
9.3.9	<p>The offered equipment shall have carrier-grade resilience features including, but not limited to, the following:</p> <ul style="list-style-type: none"> <li>▪ Modular, chassis-based, rack-mountable system with no single point of failure</li> <li>▪ Resilient architecture with 1+1 sparing for all system modules</li> <li>▪ Link aggregation for link resilience and load balancing</li> </ul>
9.3.10	<p>The backplane architecture of the equipment shall be modular and scalable in nature.</p>
9.3.11	<p>The equipment shall have consistent performance on “Round the Clock – Round the Year” basis under the following operating environmental conditions:</p> <ul style="list-style-type: none"> <li>▪ Temperature: -5°C to 40° C nominal and -20°C to +50° C short term (temperature hardened preferred)</li> <li>▪ Humidity: Up to 95%</li> <li>▪ Dusty: Dusty environment during dry season</li> <li>▪ Altitude: Up to 4000 meter above sea level</li> </ul>
9.3.12	<p><b>Architecture</b></p>

	<ul style="list-style-type: none"> <li>▪ Network Processor based: The offered equipment shall have network processor (with memory) based architecture.</li> <li>▪ Distributed Architecture: The offered equipment shall have distributed architecture for high processing capability and failover redundancy of processing and packet forwarding. The details shall be provided by the supplier.</li> <li>▪ Backplane: The offered equipment shall have proven backplane architecture for high degree of redundancy.</li> <li>▪ Processor Redundancy Feature: The offered equipment shall be equipped with processor in 1+1 hot standby mode to ensure high-availability of the system. The equipment, in the event of failure of any one processor, should automatically switchover to the redundant processor without dropping any traffic. There should not be any impact on the performance in the event of active processing engine failure.</li> <li>▪ Hot Swapability: All the equipment shall support on line hot insertion and removal of cards. Any insertion or removal of line card in active/operational mode should not call for router rebooting nor should disrupt the remaining traffic flowing in any way.</li> </ul>
9.3.13	<p><b>Power supply</b></p> <ul style="list-style-type: none"> <li>▪ All the offered equipment shall work on -48V DC dual-power supply systems.</li> <li>▪ All the offered equipment shall have 1+1 power supply redundancy protection mechanism.</li> <li>▪ Adequate protective devices and alarms shall be provided to protect the system from any damage caused due to surge, high voltage, and high current or overheating.</li> </ul>
9.3.7	<p><b>Interfaces:</b></p> <p>Ethernet Interfaces:</p> <ul style="list-style-type: none"> <li>▪ The equipment shall support following SFP/XFP interfaces in the equipment side:</li> <li>▪ LAN/WAN Gigabit Ethernet (GE) Interface</li> <li>▪ LAN/WAN 10 Gigabit Ethernet (10 GE) Interface</li> <li>▪ LAN/WAN 100 Gigabit Ethernet (100 GE) Interface</li> </ul> <p>TDM/SDH Interfaces:</p> <ul style="list-style-type: none"> <li>▪ STM-1</li> <li>▪ STM-4</li> <li>▪ STM-16</li> <li>▪ STM-64</li> </ul>

	<p><b>Capacity and Interfaces:</b></p> <p><b>Type: 1</b></p> <ul style="list-style-type: none"> <li>• 100G line and 100G client with optics : 3</li> <li>• 100G line and 10x10g client with optics: 1</li> <li>• ROADM per degree : 1</li> </ul> <p><b>Type: 2</b></p> <ul style="list-style-type: none"> <li>• 100G line and 10 x 10g client with optics: 2</li> <li>• 10G line and 10 x 10g client with optics: 1</li> <li>• ROADM per degree: 1</li> </ul> <p><b>Type: 3</b></p> <ul style="list-style-type: none"> <li>• 100G line and 10 x 10g client with optics: 1</li> <li>• 10G line and 10 x 10g client with optics: 1</li> <li>• ROADM per degree: 1</li> </ul> <p><b>Type: 4</b></p> <ul style="list-style-type: none"> <li>• 10G line and 10 x 10g client with optics: 1</li> <li>• ROADM per degree: 1</li> </ul> <p>The applicants shall propose the repeater sites for 3R in between two DWDM sites if deemed necessary.</p>
9.3.14	<p><b>References and Protection</b></p> <ol style="list-style-type: none"> <li>a) It shall fully comply with ITU-T Rec. G.692 / G.694.1 / G.694.2.</li> <li>b) It shall support G.652 fiber type.</li> <li>c) The conversion between equipment side (client-side) signal wavelengths and ITU-T G.692 compliant standard wavelengths shall be possible.</li> <li>d) It shall support at least 80 wavelengths/channels.</li> <li>e) It shall support point-to-point, ring, mesh and add-drop topology with Protocol Transparent transmission.</li> <li>f) It shall have in-built capability to support standard CWDM/DWDM client interfaces.</li> <li>g) It shall have ROPA system or equivalent proven technology to pre Amplify and Boost signals for long haul transmission.</li> <li>h) It shall have in-built Intelligent Power Adjustment (IPA) function.</li> <li>i) It shall support STM-16, 64 NG-SDH, GE, 10G and 100G data rate interfaces of SDH and Routers/Switches, in addition to FC, ESCON, FICON and POS</li> <li>j) It shall have built-in transponders to support the mentioned data rate</li> <li>k) Optical Add/Drop modules (OADM) shall support an extended port in order to add further wavelengths without interrupting traffic.</li> </ol>

	<ul style="list-style-type: none"> <li>l) Within each wavelength all the constituent tributaries shall be cross-connectable.</li> <li>m) Wavelengths of added &amp; dropped modules shall be able to be queried on the management system.</li> <li>n) The equipment shall have 1:1 redundancy for the major cards (control cards) and 1+1 Line and Client Side protection</li> <li>o) The equipment shall have a high PMD tolerance.</li> </ul>
9.3.15	<p><b>High availability features:</b></p> <ul style="list-style-type: none"> <li>a) All the equipment shall have 1+1 redundancy in control card.</li> <li>b) Any disruption in the control plane (for connection management), which will cause a switch-over to the standby control module, shall not affect forwarding of data in the line card, hence no performance implications shall be present on the failure of any individual component.</li> <li>c) All the equipment shall have redundancy in power modules, fans, clock and bus. There shall be provision of redundant and load-sharing power-supply modules even under maximum load operation.</li> <li>d) All the equipment shall have mechanism for over-current and overvoltage protection in Interface modules and power modules.</li> <li>e) All the equipment shall have protection against polarity mismatch in power supply connections.</li> <li>f) All the equipment shall have hot-swappable power modules and fans.</li> <li>g) All the equipment shall have support for online insertion &amp; removal of cards.</li> <li>h) All the equipment shall have protection against mis-insertion of cards/modules into the chassis.</li> <li>i) DWDM for the network shall carry STM-16/64 NG-SDH/GE/10G/100 G traffic and shall have built-in transponder.</li> <li>j) The DWDM shall be of Dynamic ROADM type.</li> <li>k) The equipment shall have software-based wavelength tuning facility to be accessed from NMS.</li> <li>l) It shall support full n-degree (minimum 4 degree or higher directions in future) operation for multiple ring, subtended ring, star and full-mesh topologies.</li> <li>m) It shall support end-to-end monitoring.</li> <li>n) The equipment shall have provision for link protection. The supplier shall describe the types of protection and their deployment in details.</li> <li>o) It shall be possible to plan, build and maintain any architecture for capacity growth, with wavelength management and service provisioning.</li> <li>p) The equipment shall also perform automatic power budgeting in case a different fiber pair needs to be used or a fiber pair with different span length needs to be used.</li> <li>q) The equipment shall be equipped automatic gain equalization and line attenuation Compensation.</li> <li>r) It shall support remote lambda service and node configuration upgrades, thereby reducing the need for wavelength pre-planning and allowing an optimum node configuration with high traffic availability.</li> </ul>

	<p>s) It shall have Intelligent GMPLS-aware/ASON/WSO<sub>N</sub> or equivalent control plane features to support third party Tx/Rx.</p>
9.3.16	<p><b>Network management System</b></p> <p>The Network Management System (NMS) – client/server based – shall provide full featured management and control of all the offered network elements. The NMS shall include the functionality of system configuration, network monitoring, alarm management, data acquisition for analog monitoring, performance monitoring, reporting, housekeeping etc.</p> <ul style="list-style-type: none"> <li>a) The offered NMS server shall have UNIX/Linux operating platform.</li> <li>b) The offered NMS system shall support management at least 100 DWDM nodes, as the network grows and expands in the future.</li> <li>c) The proposed NMS system shall provide a central management platform to provision, manage and control the whole network.</li> <li>d) The proposed NMS system shall view the whole network topology to show real-time running status.</li> <li>e) The proposed NMS shall monitor, in real-time, the network performance indices and customized performance monitor indices.</li> <li>f) The proposed NMS system shall employ a Graphical User Interface that allows users to manage the network through a multilevel window. (i.e. Network and Sub networks Maps window).</li> <li>g) The proposed NMS system shall have the functionality of standard-based methods of management access including Local Craft Terminal (LCT), CLI, Telnet, console, SNMP v1/v2/v3/RMON1/2/3/9, web-based management features, system logging and alarms, in addition to providing a GUI-interface with drag-drop functionality.</li> <li>h) The proposed NMS system shall have the functionality of standard-based methods of management access including Local Craft Terminal (LCT), CLI, Telnet, console, SNMP v1/v2/v3/RMON1/2/3/9, web-based management features, system logging and alarms, in addition to providing a GUI-interface with drag-drop functionality.</li> <li>i) The proposed NMS shall have the ability to perform remote inventory</li> </ul>
9.3.17	<p><b>Hardware features in addition to the ones mentioned in the other clauses:</b></p> <ul style="list-style-type: none"> <li>a) The Product shall be of standard Server Family based on proven technologies, design and compatibility to high-end and low-end future technologies.</li> <li>b) Two core processor of at least 3.06 GHZ with at least 1066 MHz Front Side Bus.</li> <li>c) It Shall have at least 8 MB L2 cache</li> <li>d) It shall be equipped with minimum 4 GB of DDR2 RAM</li> <li>e) Capability to upgrade the memory capacity up to 16 GB RAM by adding memory modules (the slots should be present).</li> <li>f) It shall have at least 4x146GB HD storage capacity of at least 15K rpm.</li> <li>g) The server shall be supplied with RAID 5 configured HDD (SATA Drives).</li> <li>h) The hardware RAID Controller (at least 2 sets) shall be able to do automatic controller fail-over in case of controller failure in order to continue the</li> </ul>



	<p>operation.</p> <ul style="list-style-type: none"> <li>i) The server shall be provided with the standard DVD R/W drive and a tape drive.</li> <li>j) The server shall be with at least 17” LCD display for managing and monitoring.</li> <li>k) The server shall be equipped with at least two 10/100/1000 Mbps Ethernet Network Interface cards.</li> </ul>
9.3.18	<p><b><u>Software:</u></b></p> <ul style="list-style-type: none"> <li>a) The application software of the proposed NMS shall be GUI-based. There shall be textual display as well as graphical report displays. The operator shall be able to select a segment and zoom-in to obtain details of the segment. The status of items of equipment (standby or active) shall be represented by color.</li> <li>b) The application software shall also support Command Line Interface (CLI).</li> <li>c) Software commands shall be user-friendly &amp; menu-driven.</li> <li>d) The NMS shall support point-to-point, chain, mesh, ring, multi-ring, and complex topologies.</li> <li>e) If new upgraded software version for the offered system is released prior to the expiry of the warranty period, the supplier shall implement the new version software.</li> </ul>

## 9.4 Routers

9.4.1	<p>The SLO shall deploy IP/MPLS Backbone and associated equipment with high capacity router with GE / 10GbE / 100GbE interfaces with the following major specifications:</p> <ul style="list-style-type: none"> <li>a) <b>Processor Redundancy Feature:</b> Router shall be equipped with processor in 1+1 hot-standby mode to ensure high-availability of the system. The equipment, in the event of failure of any one processor, should automatically switchover to the redundant processor without dropping any traffic. There should not be any impact on the performance in the event of active processing engine failure.</li> <li>b) <b>Firmware Up-gradation Feature:</b> The router shall have firmware up-gradation and down-gradation feature. Up-gradation and down-gradation of software in the standby processor should not affect traffic switching in the main processor. If not currently available, the bidder shall clearly show the roadmap with timeline.</li> <li>c) <b>Hot Swapability:</b> All the equipment shall support on line hot insertion and removal of cards. Any insertion or removal of line card in active/operational mode should not call for router rebooting nor should disrupt the remaining unicast and multicast traffic flowing in any way.</li> </ul>
9.4.2	<p><b><u>Power Supply</u></b></p>

	<ul style="list-style-type: none"> <li>a) All the equipment shall work on -48V DC power supply.</li> <li>b) All the equipment shall have 1+1 power supply redundancy protection mechanism.</li> </ul>
9.4.3	The router shall have 1+1 redundancy in control card and switching fabrics.
9.4.4	<ul style="list-style-type: none"> <li>a) The router shall support inter-slot and intra-slot Ethernet Link Aggregation based on IEEE 802.3ad.</li> <li>b) The router shall have Non Stop Forwarding with GR (Graceful Restart) or Non-Stop Routing (Stateful Failover) for BGP, OSPF and LDP.</li> <li>c) The router shall support Bi-Direction Forwarding Detection (BFD).</li> <li>d) The router shall have support for Fast Reroute (FRR).</li> <li>e) The router shall have support SNMP v1, v2, v3</li> </ul>
9.4.5	<p>Router shall support full MPLS Services, MPLS CoS, MPLS VPN, MPLS TE</p> <ul style="list-style-type: none"> <li>▪ Layer 2 VPN (managed and unmanaged) Services</li> <li>▪ Layer 3 VPN (managed and unmanaged) Services</li> <li>▪ VPLS Services</li> <li>▪ Metro Ethernet Services</li> <li>▪ Remote Access to MPLS VPN- IPsec, Secure Socket Layer (SSL VPN), IP Tunneling, GRE</li> <li>▪ Inter AS VPN and Carriers Carrier Services</li> </ul>
9.4.6	<p>Full Bandwidth management features for various traffic of converged services including, but not limited to:-</p> <ul style="list-style-type: none"> <li>◆ MPLS Traffic engineering (TE-FRR, RSVP-TE, ISIS-TE, OSPF-TE)</li> <li>◆ Prioritization</li> <li>◆ Classification</li> <li>◆ QoS/CoS (DSCP-802.1p mapping, DSCP-EXP bit)</li> <li>◆ Security</li> <li>◆ Bandwidth Management Control (Policing, Shaping)</li> <li>◆ Bandwidth granularity (on the fly)</li> <li>◆ Secured Control Plane</li> <li>◆ Full IPv6 compliance</li> <li>◆ IP wholesale services to ISPs, ASPs and NSPs (Carrier Support Carrier)</li> <li>◆ Secured Internet Access with protection from DDoS</li> <li>◆ Multicast services (e.g IPTV)</li> <li>◆ Transparent LAN Services.</li> <li>◆ Video conferencing services – both residential and commercial</li> </ul>

9.4.7

## Slots, Capacity and Interfaces

### Router Type:1

- Minimum Number of Service Slots: 6 (each slot supporting minimum 100 Gbps, expandable to 400G per slot full-duplex).
- Switching Capacity: Minimum 3 Tbps
- Packet Forwarding Capacity per service slot (at least): 150 Mpps
- Packet Forwarding Performance for Chassis (at least): 2400 Mpps
- Routing Table Size for IPv4 (at least): 2M
- Routing Table Size for IPv6 (at least): 1M
- Number of 100GE ports at present (2Nos of optical 100G CFP for 10 Km): 3
- Number of 10GE ports at present (5 Nos of optical 10G SFP+ for 2km, 20km,40km and 80km respectively): 20
- Number of GE ports at present (5 nos of optical 1G SFP for 2km, 20km, 40km and 80km respectively):20

### Router Type:2

- Minimum Number of Service Slots: 6 (each slot supporting minimum 100 Gbps, expandable to 400G per slot full-duplex).
- Switching Capacity: Minimum 3 Tbps
- Packet Forwarding Capacity per service slot (at least): 150 Mpps
- Packet Forwarding Performance for Chassis (at least): 2400 Mpps
- Routing Table Size for IPv4 (at least): 2M
- Routing Table Size for IPv6 (at least): 1M
- Number of 100GE ports at present (2Nos of optical 100G CFP for 10 Km): 2
- Number of 10GE ports at present (2 Nos of optical 10G SFP+ for 2km, 10km, 20km, 40km and 80km respectively): 10
- Number of GE ports at present (5 nos of optical 1G SFP for 2km, 20km, 40km and 80km respectively):20

### Router Type:3

- Minimum Number of Service Slots: 2 (each slot supporting minimum 40 Gbps)
- Switching Capacity: Minimum 80 Gbps full duplex
- Forwarding Capacity per service slot (at least): 60 Mpps
- Packet Forwarding Performance for Chassis (at least): 512 Mpps
- Routing Table Size for IPv4 (at least): 500k
- Routing Table Size for IPv6 (at least): 60k
- Number of 10GE ports at present (2 Nos of optical 10G SFP+ for 2km, 20km,40km and 80km respectively): 8
- Number of GE ports at present (5 nos of optical 1G SFP for 2km, 20km, 40km and 80km respectively):20

<p>9.4.8</p>	<p><b><u>NMS</u></b>  The router shall support command line and NMS based configuration management.</p> <ul style="list-style-type: none"> <li>a) The Network Management System (NMS) shall provide full featured management and control of all the offered network elements (for the routers).</li> <li>b) The NMS shall include the functionality of system configuration, network monitoring, alarm management, data acquisition for analog monitoring, performance monitoring, reporting, housekeeping etc.</li> <li>c) The offered NMS system shall support management of up to at least 500 switches and 100 numbers of Routers, as the network grows and expands in the future.</li> <li>d) All other features shall be similar to the NMS of DWDM.</li> </ul>
<p><b>9.5 <u>Microwave Equipment</u></b></p>	
	<ul style="list-style-type: none"> <li>a) <b><u>Radio Equipment</u></b>  The radio equipment to be offered shall be based on above link engineering and shall conform to relevant ETSI, R&amp;TTE, ITU-T, ITU-R recommendations unless specified otherwise.   The radio relay system shall be based on the frequency of upper 6 GHz (6.4 GHz - 7.1 GHz) as per Link details sheet. The Tx-Rx separation (duplex spacing) and channel spacing shall be as per ITU-R recommendations <b>F.384.7</b>.</li> <li>b) <b><u>Network Management System</u></b>  The Applicant shall provide full featured Network Management System (NMS) with FCAPS functionality (Fault, Configuration, Accounting, Performance and Security) for both Radio equipment.   The proposed NMS system shall support Q3/CORBA/SNMP/XML management interface protocol as per ITU-T standard (ITU-T Rec. G.771, G.773 etc.)/TMF standard (TMF-513, TMF 608, TMF 814 etc.).</li> <li>c) <b><u>Antenna and Accessories</u></b>  The Applicant shall supply Superior High Performance, Dual Polarized Parabolic Antenna for all the links.   Nominal Frequency: 6.425- 7.125 GHz Band</li> </ul> <p><b>Transmission Line</b>  The Feeder cable (Coaxial Cable) to join IDU &amp; ODU shall have the following specification</p> <ul style="list-style-type: none"> <li>i. Frequency: as per the Tx IF and Rx IF used in the system (MHz)</li> </ul>

	<ul style="list-style-type: none"> <li>ii. Attenuation dB/100 meters: &lt; 6.7</li> <li>iii. Characteristic impedance: 50 +/- 2 ohms</li> <li>iv. DC resistance (both conductors): &lt; 6 ohms</li> <li>v. VSWR: &lt; 1.1</li> <li>vi. Group velocity (at center frequency): &gt; 80%.</li> </ul> <p>Capacitance(conductor to shield): &lt;100pF/m</p>
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### 9.6 Network Availability Criteria

The overall Network Availability Criteria shall be 99.99% and 99.97% of the time for accessible and none accessible areas by vehicle respectively.

9.6.1	<p><b><u>Mean Time to Restore</u></b></p> <p>Mean Time to Restore (MTTR) shall be different for Hilly/Mountainous area and Plain area as it depends on the efficiency of the transport facilities in those regions. The physical movement is much slower in hilly/mountainous area in comparison to plain area. MTTR shall be as mentioned below for mountainous, hilly and plain area.</p> <p>Mountainous Area -72 hours  Hilly Area -24 hours  Plain Area -12 hours  Accessible Area -6 hours (12 months accessed by vehicle with black top road)</p>
9.6.2	<p><b><u>Bit Error Rate (BER)</u></b></p> <p>BER shall not be greater than <math>10^{-11}</math></p>
9.6.3	<p><b><u>Operation and Maintenance (O&amp;M)</u></b></p> <p>Operation and Maintenance of the network shall be controlled and performed by an operating system. It is required that DWDM/Router network element is managed according to Telecommunication managing Network rules.</p>
9.6.4	<p><b><u>Power Supply</u></b></p> <p>All equipment racks shall be supplied with direct current source having indicating voltage at -48V with positive pole grounded.  All equipment parameters should be normal if voltage ranges varies within <math>\pm 10\%</math>.</p>
9.6.5	<p><b><u>Earthing System</u></b></p> <p>The earth resistance shall be &lt;2 ohm nominally however, in dry and rocky area up to 10 ohm may be acceptable.</p> <p>Grounding way shall be compliant with ETS 300 253 standard</p>

9.6.6	<p><b><u>Service Availability</u></b></p> <p>The SLO shall ensure that the optical fibre network is available 24hrs a day throughout a year to its customers.</p>
9.6.7	<p><b><u>Service Obligation</u></b></p> <p>The SLO shall ensure that the services are made available through the installation, activation and operation of optical access network lines through shared or dedicated leased optical cable to its customers that shall be retained and continued throughout the period of the authorization validity. The SLO must provide the 25% of the fibre installed or upgraded through subsidy to its customers at NTA's discretion.</p>
9.6.8	<p><b><u>Failure to meet service quality and availability obligations</u></b></p> <p>The failure of the SLO to meet the obligations specified in this section shall result in the imposition of penalties for breach of contract and Authorization conditions and other applicable penalties stipulated in the Act. However, the penalties shall not apply if the failure results solely from an event of force majeure.</p>