Chorus UFB Services Agreement

Fibre Backhaul Service:

Service Description for Chorus Exchange Connect (CXC)

Reference Offer

May 2025

Document Version History

Version	Date	Author	Description of Change
1.0	September 2023	Sergiy Kozakevych	Initial version
2.0	September 2024	Alexandru Tudor	Addition of Auto-Switching Diversity
3.0	May 2025	Sergiy Kozakevych	Addition of LOS and 400Gbps variant

1. Interpretation

1.1 References to clauses or sections are references to clauses or sections in this Service Description unless expressly provided otherwise. The definitions set out in the General Terms and the Operations Manual apply to this Service Description unless expressly provided otherwise. Capitalised terms not defined in this Service Description are as defined in the General Terms or the Operations Manual.

1.2 References to Operations Manual are references to the Operations Manual for Direct Fibre Access Services (layer 1) and references to the Service Level Terms are references to the Service Level Terms for Fibre Access Services (layer 1). Except as varied by this Service Description any references to Direct Fibre Access Service in the Operations Manual or to the Fibre Access Services in the Service Level Terms shall include the Chorus Exchange Connect Service. References to Chorus in this Service Description should be read as references to the LFC in the General Terms, Operations Manual or Service Level Terms.

1.3 This Service Description covers the provision of the Chorus Exchange Connect Service ("CXC" or "the Service").

1.4 The General Terms in the Chorus UFB Services Agreement/Reference Offer apply to provision of the CXC Service subject to any modifications, exclusions, and clarifications as set out in clause 1.5 below.

1.5 The CXC Service:

1.5.1 may be withdrawn by Chorus on 12 months' notice and individual links may be terminated by Chorus in accordance with clause 2.10 of this Service Description. Clause 5.2 (a) and 5.2 (b) of the General Terms do not apply to the withdrawal of the CXC Service. Any instance of the CXC Service that is subject to a Minimum Service Term that expires after the 12-month notice of withdrawal, shall continue to be provided by Chorus on the terms of the relevant Service Order until the expiry of that Minimum Service Term, and

1.5.2 may be subject to a Core Price Change, or an Ancillary Price Change in accordance with clauses 24.4(a) and 24.5(a) of the General Terms.

1.6 This Service Description may be changed by Chorus using the process for Agreement Changes set out in the General Terms except that:

1.6.1 the Change Management Forum's prior approval of any such proposed Agreement Change under clauses 24.1 and 25 of the General Terms is not required;

1.6.2 the Service Provider may not propose any Agreement Change in relation to this Service Description in accordance with clause 24.1(b) of the General Terms.

1.7 For the purposes of this Service Description:

1.7.1 "Available Connector" means one of the connectors set out in the list in the section titled "Optical Connector Type" within the "Technical Specification" at Appendix B;

1.7.2 "Network OFDF" means one of a range of connection types in the relevant Central Office as defined within the "Technical Specification" at Appendix B;

1.7.3 "UFB Area" means an area listed as an individual UFB Area in a table at the URL: https://sp.chorus.co.nz/product/ufb-handover/resources of the Chorus Service Provider website which aligns to the "UFB geographic area (POI Area)" in the Commerce Commission's Notice of points of interconnection available at: https://comcom.govt.nz/regulated-industries/fibre/projects/specified-points-of-interconnection[1].

2. The CXC Service

2.1 The CXC Service provides transparent layer 1 connectivity between two Chorus Central Offices or POIs, where both POIs are located within the same UFB Area. This will usually be delivered over a DWDM (Dense Wavelength Division Multiplex) system. The CXC Lit Service described below provides dedicated, uncontended bandwidth at either 10Gbps, 100Gbps or 400Gbps (additional bandwidth options may be added in the future as notified to Service Providers).

2.2 The CXC Service may be routed either between two Central Offices, between a POI and a Central Office, or between two POIs if those POIs are within the same UFB Area. For a backhaul service between two POIs which are in different UFB Areas, Service Providers should take the CRC Service.

2.3 To determine whether DWDM is installed at a specific Central Office, please contact the Chorus **Commercial Consulting team**.

2.4 The expected termination point is within the Service Provider's Central Office Footprint in the POI or the Central Office, however the CXC Service may be connected to other services beyond the POI or Central Office as follows (as well as a Jumpering Service if required):

2.4.1 Chorus Data Centre Connect to a data centre within the UFB Area where available;

2.4.2 Chorus Relay Connect to a POI in a different UFB Area where available;

2.4.3 Direct Fibre Access Services to a site within the Central Office service area where available;

2.4.4 CXC Dark Fibre Extension (as defined in 2.7 below);

2.4.5 Handover Connection Service;

2.4.6 Third party backhaul, either directly or via TPAD (Third Party Access Distribution);

2.4.7 Intra-Candidate Area Backhaul Service; or

2.4.8 Any other available Chorus backhaul service.

The inter-operability of the CXC Service with a particular Chorus service and optic will need to be confirmed by Chorus before a Service Request becomes a Service Order. Service Provider will be responsible for confirming the inter-operability of the CXC Service with any third party service.

2.5 A diagram of the configuration for the CXC Service is set out in Appendix A.

[1] Note that UFB Areas as defined in this Service Description do not align with the UFB candidate areas or UFB coverage areas as specified in the government's UFB programme.

2.6 The CXC Service is generally available as a DWDM based variant (the “CXC Lit Service”) as follows or, if DWDM capacity is not available, may be provided as a dark fibre extension of the CXC Lit Service (described further in 2.8 and 2.9 below):

2.6.1 The DWDM based variant is fibre with the addition of electronics to provide a 10Gbps, 100Gbps or 400Gbps lit fibre service from an Available Connector on the Network OFDF at the originating Central Office to an Available Connector on the Network OFDF at the destination Central Office; and

2.6.2 The 10Gbps CXC Lit Service can be delivered as either dual fibre working (DFW) or single fibre working (SFW) while the 100Gbps and 400Gbps service can only be delivered as DFW.

2.7 The CXC Lit Service has an optional add-on feature, LOS (Loss of Signal) Laser OFF that notifies Service Provider equipment when a DWDM (Dense Wavelength Division Multiplexing) service pathway is disrupted. This function;

2.7.1 also provides a notification when a service traverses 'back-to-back' transponders, such as transitioning from the LFC Core DWDM network to an LFC Regional DWDM network and one of these DWDM sections is down;

2.7.2 It enables Service Provider equipment to switch to a secondary pathway or alerts the Service Provider that the service pathway is down; and

2.7.3 can either ordered with a new circuit or added later.

2.8 Where the CXC Lit Service is not available due to a lack of DWDM equipment or has not yet been fully extended to a route, a dark fibre extension (the “CXC Dark Fibre Extension”) may be taken, being a dark fibre from one of the following:

2.8.1 an Available Connector on the OFDF at the Service Provider’s Footprint in the originating Central Office; or

2.8.2 the Jumpering Service on the Network OFDF at the originating Central Office connected to the Service Demarcation Point of an associated Direct Fibre Access Service on that Network OFDF; or

2.8.3 the Jumpering Service on the Network OFDF at the originating Chorus Central Office connected to the Service Demarcation Point of a UFB Handover Connection on that Network OFDF;

to:

2.8.4 an Available Connector on the OFDF at the Service Provider’s Footprint at the destination Chorus Central Office; or

2.8.5 an Available Connector on the Network OFDF (where the Jumpering Service is utilised) at the destination Chorus Central Office connected to the Service Demarcation Point of an associated Direct Fibre Access Service on that Network OFDF.

2.9 The CXC Dark Fibre Extension is only available outside of the Chorus DWDM existing footprint either:

2.9.1 as an extension of CXC Lit Service; or

2.9.2 where the Service Provider wishes to take CXC from a POI or Central Office to a second Central Office but there is no DWDM footprint in the proposed route.

2.10 The CXC Dark Fibre Extension Service is limited to distances of up to 40km with stepped pricing as set out in the Price List. Pricing for circuits with distances above 40km will be calculated by adding additional steps using the same stepped pricing from 40km and will need input from Chorus Customer Solutions (CCS) team.

2.11 As the DWDM footprint expands, CXC Dark Fibre Extension instances of CXC will be migrated to the CXC Lit Service and the CXC Dark Fibre Extension will no longer be available in those areas. The Service Provider will do all things reasonably necessary to facilitate the migration of instances of CXC Dark Fibre Extension to the CXC Lit Service where it becomes available, including removing any incompatible equipment as necessary. If the Service Provider does not wish to migrate to the CXC Lit Service, the Service Provider can terminate those instances of the CXC Dark Fibre Extension and Chorus may terminate any instances of the CXC Dark Fibre Extension that have not been migrated to the CXC Lit Service within 12 months of the CXC Lit Service becoming available on the relevant route.

2.12 The CXC Service is an input service which the Service Provider can use as a building block to combine with other Chorus services (or with the Service Provider's own network or wholesale services provided by other providers) to provide fibre telecommunications services to End Users.

3. Exchange Service and Implementation Activities

Disapplication of the Operations Manual

3.1 Part 5 of the Operations Manual shall not apply to the CXC Service and clauses 3.2 to 3.4 below shall apply.

Installation Services

Standard and Non-Standard Installation

3.2 The CXC Service includes a Standard Installation as set out below (in each case to the extent that the relevant provisioning works are not already complete for the relevant Service Order). Chorus will provide Non-Standard Installation for the CXC Service as an Ancillary Service. A Standard Installation includes connection of the CXC Service to an Available Connector, on the OFDF installed in the Service Provider's Footprint, or an Available Connector on the Network OFDF at the POI or Central Office as listed on website sp.chorus.co.nz.

Provisioning at POIs and Central Offices – Network OFDF

Chorus will provide the following as part of a Standard Installation:

3.2.1 Termination on an Available Connector on the Network OFDF; and

3.2.2 Connection of the CXC Service to either:

(a) a Tie Cable from the Network OFDF to the Service Provider's Footprint at the POI or Central Office. The Tie Cable will be supplied pursuant to the terms of the appropriate co-location service; or

(b) an extension service listed in 2.4, as well as a Jumpering Service if required.

Service Demarcation Points

Termination Point at Originating POI or Central Office

3.3 At the originating POI or Central Office, the termination point for the purposes of the CXC Service and the "Service Demarcation Point" for the purposes of this Service Description is a splice or Available Connector on the Network OFDF.

Termination Point at Destination POI or Central Office

3.4 At the destination POI or Central Office, the termination point for the purposes of the CXC Service and “Service Demarcation Point” for the purposes of this Service Description is a splice or Available Connector on the OFDF within the Service Provider’s Footprint.

Testing

3.5 Chorus will test the CXC Service from end-to-end to ensure the CXC Service is within the technical specification set out at Appendix B.

3.6 Chorus testing is performed at 1310 and 1550nm in accordance with ITU standard G.650.

Additional Services

3.7 If the Service Provider requires additional services such as:

3.7.1 provision of diversity between POIs or Central Offices (when the second or subsequent instance of the CXC Service is purchased); and

3.7.2 installation and testing of the Service Provider’s Equipment,

Chorus may be able to provide these on request on terms and conditions to be agreed with the Service Provider.

Interconnection Requirements

3.8 To use the CXC Service the Service Provider must have the capability to access and interconnect with the CXC Service, either by co-locating Service Provider Equipment in a Service Provider Footprint at the originating or destination POI or Central Office, or by purchasing the additional services set out in 2.4.

Additional Service Characteristics

3.9 The technical specification of the CXC Service is set out in Appendix B.

3.10 Chorus will provide certain support and other assistance as part of the CXC Service including:

3.10.1 an electronic facility for Service Requests;

3.10.2 an electronic facility for fault notifications; and

3.10.3 a tool to assist the Service Provider in determining the location and availability of the CXC Service.

3.11 The CXC Service specifically excludes:

3.11.1 provision or maintenance of any cabling or connection or active device beyond the Service Demarcation Points;

3.11.2 configuration, monitoring, operation, on-going support or maintenance of Service Providers' or End Users’ applications, equipment, or networks; and

3.11.3 supply of mains and backup power, accommodation space, heating, ventilating, air conditioning and facilities at the Central Office.

4. Chorus Service Demarcation Point

4.1 The Service Demarcation point for the CXC Service at the POI or Central Office is the termination and service demarcation point described in (as applicable) clauses 3.3 and 3.4.

5. Tie Cable Connection

5.1 Where required, Chorus will provide a Tie Cable between the Network OFDF and the Service Provider's Available Connector on the Service Provider's OFDF in its co-located Footprint at the POI or Central Office. More detail on the Tie Cable service is provided in the Central Office and POI Co-Location Service Description and Operations Manual. The Tie Cable may consist of a MPO pre-connectorised cable directly into the Service Provider's Footprint and presented on an OFDF panel as individual 12F MPO connectors or broken out as LCUPC Connectors.

5.2 More details of the Chorus Tie Cable services are provided in the Service Description and Operations Manual for the appropriate Co-location service, examples are:

5.2.1 Chorus UFB Services Agreement Central Office and POI Co-Location Service; and

5.2.2 Chorus Services Agreement Appendices for the Exchange Space Service.

6. Capacity and geographic availability

6.1 Chorus will supply the CXC Service between Central Offices where Chorus has available capacity. Routes where CXC Lit Service is available, CXC Dark Fibre Extension will not be available. Both CXC Lit Service and CXC Dark Fibre Extension are subject to feasibility test via CCS – please contact CCS team at Chorus.Solutions@chorus.co.nz.

7. Service Provider Responsibilities

7.1 The Service Provider's responsibilities are detailed in the General Terms and Operations Manual.

7.2 The Service Provider will be responsible for all of the design, specification and commissioning of its equipment and plant (both active and passive) connected to the CXC Service. This includes additional fibre and connections at either end of the CXC Service.

8. Fibre Diversity

8.1 The CXC Service provides a single circuit between the originating and destination POIs and/or or Central Offices.

8.2 The Service Provider can request a second instance of the CXC Service to provide a level of diversity. There may be practical limitations to providing full physical diversity to some sites. The provision of a separate instance of the CXC Service to and between POIs and Central Offices will have unique site specific engineering considerations and will attract additional costs on terms and conditions to be agreed with Chorus. Standard Installation Charges and Service Levels do not apply to the provision of diversity products.

8.3 If the diverse path is not ordered in the same order as the primary path, the Service Provider is responsible for providing the primary path details for Chorus to create a linkage between these two instances in the relevant Chorus systems. Each instance of the CXC Service, primary and diverse, will be treated as an individual line for the purpose of availability Service Levels.

8.4 Diverse paths will be in separate fibre cable sheaths, and if requested in separate cable routes. The diverse cable routes will be a minimum of the width of a street apart and should not share any manholes or access points. Separate entries into the Central Office will be used where requested.

9. Auto-Switching Diversity

9.1 Auto-Switching Diversity is an optional add-on feature that provides simple geographically diverse path redundancy for a Layer 1 lit fibre service between the service end points, as further set out in this section.

9.2 Auto-Switching Diversity provides dedicated protection to each optical channel, reducing service interruptions, and enhancing network reliability.

9.3 Auto-Switching Diversity is only available on the 100Gbps product variant.

9.4 Auto-Switching Diversity has the following key features:

9.4.1 Uses Optical Channel ("OCH") protection, which provides redundancy of an individual optical channel. Each optical channel, carrying specific wavelengths of light, provides the transparent lit fibre service.

9.4.2 The diverse path is fully geographically diverse, i.e. different physical fibre paths, between the optical line board at the source end point and the optical line board at the destination end point.

9.5 Path redundancy is between the optical line board at one service end point and the optical line board at a second service end point. This provides a level of protection against fibre cuts and certain hardware failures, but not against a line board failure.

9.6 A diagram of Auto-Switching Diversity OCH protection is set out in Appendix C.

9.7 In the event of a primary path failure or disruption scenario, the LFC Network will automatically switch between the primary (or working) path and the diverse path.

9.7.1 The optical channel switching latency is expected to be under 50ms. Note that this may mean a higher observed latency at Layer 2.

9.7.2 The LFC will notify the RSP of any incident causing auto-switching to occur within 2 hours of the incident, via the Service Events channel.

9.7.3 The LFC will provide a planned work notification via the Service Events channel to inform the Service Provider of the manual switch back to the primary path.

9.7.4 As the diverse path is most likely to be longer than the primary path, the Service Provider may observe a slight increase in latency while the service is running on the diverse path.

10. Service Levels

10.1 The Service Level Terms for Fibre Access Service in the Chorus Reference Offer (as updated from time to time) shall apply to the provision of the CXC Service subject to any modifications, exclusions, and clarifications as set out in this clause 10.

10.2 Clauses 1.1 to 1.3 of Appendix 1 to the Fibre Access Service Level Terms do not apply and the following new clauses 1.1 and 1.2 will apply to the CXC Service instead:

1.1 Chorus must complete each installation of a CXC Service connection on the date accepted by the Service Provider via Chorus' ordering and booking system.

1.2 Further to clause 4.4. of the Fibre Access Service Level Terms, any time period:

a. during which any Force Majeure Event prevents installation of a CXC instance or prevents restoration of CXC instance which is subject to Downtime; or

b. during which Chorus is, due to a Force Majeure Event, unable to safely access any location or premises where physical access is required to install a CXC instance or restore a CXC instance which is subject to Downtime; or

c. which reflects any minimum notice requirements or access constraints contained in any existing arrangements referred to in clause 12.2(b) of the General Terms and which contain the permissions or consents that are relied upon,

will be added to the periods specified in clause 1.1 as applicable.

10.3 Clauses 2.1.to 2.4 of Appendix 1 to the Fibre Access Service Level Terms do not apply to the CXC Service and the following new clauses 2.1, 2.2 and 2.3 will apply to the CXC Service instead:

2.1 Subject to clauses 2.2 and 2.3 the LFC must ensure that CXC Services for which Downtime is reported to the LFC are restored within the following timeframes from the time that Downtime is reported in the OSS/BSS reporting system:
(i) Before midday are restored by 7 p.m. on that day;

(ii) After midday are restored by midday on the following day.

2.2 Prior to reporting Downtime to Chorus, Service Provider must reasonably ascertain that that the fault lies within Chorus Network, If the Service Provider fails to do so and the fault is not found within Chorus Network, the Service Provider will be liable for a no fault found fee specified in the Price List.

2.3 For the purposes of clause 2.1:

(i) Downtime has the meaning set out at Appendix A to the Direct Fibre Access Service Operations Manual, except that Downtime in in relation to availability of a CXC Service connection will not be measured in relation to End Users but rather in relation to the length of time that the Service Provider is without service at any Service Provider site or sites connected to the Services;

(ii) Service at a CXC Service connection is restored when the service at the connection meets the service specification set out at Appendix B of the CXC Service Description, either by way of a workaround or resolution of the fault.

10.4 Appendix 2 to the Fibre Access Service Level Terms does not apply and the following Appendix 2 will apply to the CXC Service instead:

Appendix 2

The following table specifies the Service Rebates payable by Chorus in relation to the CXC Service.

Service Level (references are to clauses in Appendix 1)	***Core Service Rebate***
CXC Provisioning Core Service Levels	
1.1 – installation of CXC Service connections	*A fixed fee of $500.00 for each time that the Service Level is not achieved.*
CXC Restoration Core Service Levels	
2.1 CXC Service fault restoration	*A fixed fee of $500.00 for each time the Service Level is not achieved*

11. Operations Manual

11.1 The Operations Manual in the Chorus Reference Offer applies to provision of the CXC Service subject to any modifications, exclusions, and clarifications:

11.1.1 set out in this section 11; and

11.1.2 set out in clause 3.1.

11.2 Forecasts for the CXC Service are to be included in the forecast figures provided in accordance with Part 2 – FORECASTING of the Direct Fibre Access Service Operations Manual.

11.3 Section 8.1 and 8.3 of the Operations Manual do not apply, and the following new section 8.1 and 8.3 applies to the CXC Service instead:

Pre-qualification

8.1 Pre-qualification is a service that enables the Service Provider to:

8.1.1 confirm if a given Central Office is within the area of geographical coverage

8.1.2 determine if the CXC Service is available between the requested Central Offices and/or POIs

8.1.3 confirm primary and diversity path information

8.3 Automated Pre-qualification is available in OSS/BSS or by sending an email to Chorus Customer Solutions team. If pre-qualification request is sent through by email channel, all responses will be provided by emails. The same applies to Special Manual Pre-qualification if required.

11.4 Clause 9.21 of the Operations Manual does not apply and the following replacement clause 9.21 applies to the CXC Service instead:

Testing

9.21 At the completion of a CXC Service installation Chorus will perform an end-to-end test of the circuit between the originating and terminating POI Central Office and/or Central Office locations, to ensure it is within specification (Appendix B).

11.5 Clauses 17.1 and 17.2 of the Operations Manual do not apply and the following new clauses 17.1 and 17.2 apply to the CXC Service instead:

Diversity

17.1 The CXC Service provides a single connection between the relevant POIs and/or Central Offices. Diversity (a second or subsequent instance of the CXC Service between the relevant POIs as a separate instance of the CXC Service. Service Level Terms do not apply to the provision of diversity products and each instance is treated as an individual Connection for the purpose of availability Service Levels.

17.2 Where practical Chorus will provide diversity on request if available for POI Central Offices as a Non-Standard Install.

11.6 The following definitions apply to the CXC Service in addition to those set out in the Operations Manual, Appendix A – Glossary.

Term	Definition
Chorus Reference Offer	Means the UFB suite of documents posted on the Chorus website www.chorus.co.nz/ufbservices as updated from time to time.

12. Price List

12.1 The Price List sets out the installation pricing for the CXC Service which is based on a set price point for 10Gbps, 100Gbps and 400Gbps per instance at each POI and/or Central Office location that the service is available as listed on www.chorus.co.nz/ufbservices.

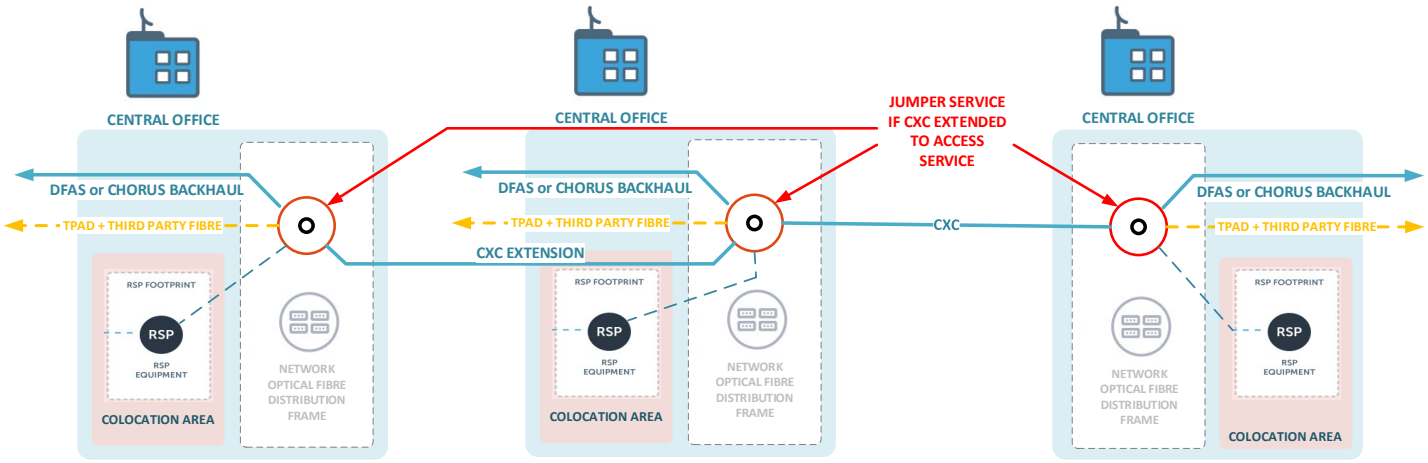
12.2 Ongoing monthly Charges for the CXC Service will priced as follows:

12.2.1 The CXC Lit Service has distance based pricing based on actual distance and should be discussed with the CCS team; and

12.2.2 The CXC Dark Extension where the CXC Lit Service is not yet available has distance based steps with stepped pricing, the pricing steps for which are set out in the Price List.

Appendix A

Chorus CXC Service Configuration



Appendix B – Technical Specification

Single Mode Fibre	External fibre must comply with ITU-T specification G.652D or alternately ITU-T G.657A2. Internal building fibres comply with ITU-T G.657A2, and meet appropriate fire regulations i.e. be Flame-Retardant, Non Corrosive, Low Smoke, Zero Halogen (FRNC/LSZH).
Copper Connector Type	RJ45 An 8-position 8-contact (8P8C) Ethernet interface complying with TIA568 wiring standard.
Network OFDF	The first Optical Fibre Distribution Frame (OFDF) within a Chorus Central Office, providing a cross-connection facility between external cables entering the site, and all internal tie cables. The Network OFDF can contain a range of connection types as listed below.
Optical Connector Type	Connector optical performance complies with the IEC61300-4 (Grade B) for Insertion Loss and IEC61300-6 (Grade 1) for Return Loss. Multi-Push-On (MPO) connectors are Method B wire map and are defined as Ultra Low Loss (ULL), complying with IEC 61754-7 and TIA-604-5-D for intermateability. Connector types (“Available Connectors”) and locations will be: • LCAPC or a splice at Network OFDF locations – for SFW • LCUPC or MPO 12F at Service Provider Footprints – for DFW More information on these connector types is provided in the technical resources on the Service Provider Site under the CXC Service.
Optic Path	Laser types and path characteristics expected to be designed to a minimum standard which are contained in the documents for 10G, Compliant with Telcordia GR-253/IEEE 802.3ae/G.959. Generally: MSA compliant pluggables are acceptable 10G variant is either 10G LAN PHY – 10GBase-R or 10G WAN PHY – 10Gbase- 10G LAN PHY is predominant, 10G WAN PHY is an exception The standard optic wave lengths are 1310nm and 1550nm for dual fibre working. Single fibre working pluggables use 1330nm client RX/ 1270nm client TX. More information on SFW pluggables made available under technical resources on Service Provider site under the CXC Service.
Tie cables	Tie cables between Network OFDF and SP Footprint can consist of the following connector types: LCAPC at Network OFDF and MPO and / or LCUPC at SP Footprint.

DWDM 10Gbps Optic Interface

Either 10G LAN PHY – 10GBase-R or 10G WAN PHY – 10GBase-W.

Item	Unit	Value		
Supported optical interface type	-	10 Gbit/s Multi-rate -10 km	10 Gbit/s Multi-rate -40 km	10 Gbit/s Multi-rate -80 km
Optical line code	-	NRZ	NRZ	NRZ
Light source type	-	SLM	SLM	SLM
Target distance	km	10	40	80
Operating wavelength range	nm	1290 to 1330	1530 to 1565	1530 to 1565
Maximum mean launched optical power	dBm	0.5	2	4
Minimum mean launched optical power	dBm	-8.2	-1	0
Minimum extinction ratio	dB	6	8.2	10
Maximum -20 dB spectrum width	nm	NA	0.3	0.3
Minimum side-mode suppression ratio	dB	30	30	30
Eye pattern	Compliant with Telcordia GR-253/IEEE 802.3ae/G.959			
Receiver type	-	PIN	PIN	APD
Receiver sensitivity (multirate)	dBm	-11	-14	-24
Receiver sensitivity (10GE LAN)	dBm	-14.4	-15.8	-24
Minimum overload point (multirate)	dBm	-1	-1	-7
Minimum overload point (10GE LAN)	dBm	0.5	-1	-7
Maximum reflectance	dB	-27	-27	-27

DWDM 100Gbps Optic Interface

Either 100GBase-LR4 Single Rate or 100GBase-ER4 Single Rate

Item	Unit	Value	
Supported optical interface type	-	100GBASE-LR4	100GBASE-ER4
ITU-T Application Code	-	4I1-9D1F	
Light source type	-	SLM	SLM
Target distance	km	10	40
Operating wavelength range	nm	1294.53 to 1296.59 1299.02 to 1301.09 1303.54 to 1305.63 1308.09 to 1310.19	1294.53 to 1296.59 1299.02 to 1301.09 1303.54 to 1305.63 1308.09 to 1310.19
Maximum mean launched optical power	dBm	2.4	2.4
Minimum mean launched optical power	dBm	-1.5	-1.9
Minimum extinction ratio	dB	8	9
Minimum side-mode suppression ratio	dB	30	30
Eye pattern	Compliant with G.959.1		
Receiver type	-	PIN	PIN
Receiver sensitivity (per LANE) OTU4	dBm	-7	-19.9
Receiver sensitivity per channel (100GE LAN)	dBm	-7.8	-19.9
Maximum reflectance	dB	-26	-26

DWDM 400Gbps Optic Interface

QSFP56-DD 400GBASE

Item	Unit	Value	Value
IEEE application code	-	400GBASE-FR4	400GBASE-LR4-6
Modulation format	-	PAM-4	PAM-4
Symbol rate per lane	Gbaud	53.125 ± 100ppm	53.125 ±100ppm
Bit rate per lane	Gbit/s	106.25 ± 100ppm	106.25 ±100ppm
Target distance	km	0 to 2	0 to 10
Centre Wavelength	nm	1271 1291 1311 1331	1271 1291 1311 1331
Minimum side-mode suppression ratio	dB	30	30
Total maximum mean launched power	dBm	10.4	11.1
Maximum mean launched power / Lane	dBm	4.4	5.1
Minimum mean launched power / Lane	dBm	-3.2	-2.7
Minimum extinction ratio / Lane	dB	3.5	3.5
Maximum mean input power / Lane	dBm	4.4	5.1
Maximum input OMAouter / Lane	dBm	3.7	4.4
Maximum reflectance	dB	-26	-26

Appendix C – Auto-Switching Diversity