Translink

Re-Signalling Coleraine - Derry

Telecommunications Project Design Specification

A013730-SN-SG-RP-0005 Rev 04
February 2010

Revision Schedule

Telecommunications Project Design Specification
February 2010

Rev	Date	Details	Prepared by	Reviewed by	Approved by
01	20/08/09	First Issue	**Jeremy Phelps** Telecoms Project Engineer	**Alick McLeod** Associate Telecoms Engineer	**Mark Betteley** Telecoms Engineering Manager
02	08/10/09	Second Issue	**Jeremy Phelps** Telecoms Project Engineer	**Alick McLeod** Telecoms Engineering Manager	**Alick McLeod** Telecoms Engineering Manager
03	19/02/10	Third Issue	**Jeremy Phelps** Telecoms Project Engineer	**Shane Rankin** Principal Engineer	**Kevin Goode** Principal Engineer
04	23/02/10	Fourth Issue	**Jeremy Phelps** Telecoms Project Engineer	**Shane Rankin** Principal Engineer	**Kevin Goode** Principal Engineer

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Figures and Tables

1 Acronyms

ADM	Add-Drop Multiplexer
AHB	Automatic Half-Barrier
CCTV	Closed Circuit Television
DSL	Digital Subscriber Line
DVR	Digital Video Recorder
ELR	Engineer's Line Reference
FTN	Fixed Telecommunications Network
GRIP	Guide to Railway Investment Projects
GSM-R	Global System for Mobile communications-Railway
GUI	Graphical User Interface
HMI	Human Machine Interface
IP	Internet Protocol
LC	Level Crossing
LOC	Location Case
MCB	Manually Controlled Barrier
MEI	Modern Electronic Interlocking
MSL	Miniature Stop Lights
NIR	Northern Ireland Railways
NR	Network Rail
NRN	National Radio Network
NTP	Network Termination Point
PLC	Programmable Logic Controller
P-MUX	Primary Multiplexer
PRC	Primary Reference Clock
PSB	Power Signal Box
PZT	Points Zone Telephone
RDM	Renewals Development Manual
REB	Relocateable Equipment Building
RR	Relay Room
RSD	Reference System Design
S&T	Signalling and Telecoms
SB	Signal Box
SDH	Synchronous Digital Hierarchy
SPT	Signal Post Telephone
SSP	Signalling Scheme Plan
SSU	Synchronisation Supply Unit
STM	Synchronous Transport Module
TDM	Time Division Multiplexing
TEH	Telecoms Equipment Housing
UPS	Uninterruptible Power Supply
UTX	Under Track Crossing
UWC	User-Worked Crossings

2 Standards & Specifications

The Contractor, and where required the Designer, shall undertake all works associated with this project in accordance with European and UK legislation including the requirements of:

- Health Safety and Environment guidelines
- Health and Safety at Work Act 1974
- The Management of Health and Safety at Work Regulations 1999
- The Railways (Safety Critical Work) Regulations 1994
- Her Majesty's Railway Inspectorate guidelines
- The Telecommunications Act 1984
- Construction (Design and Management) Regulations 2003
- Railway Safety Principles and Guidance Part 2 Section A – Guidance on Infrastructure
- Guide to the approval of railway works, plant and equipment

The above documents are available to the Contractor and shall not therefore be issued by Translink. Works undertaken as part of this project shall be in accordance with Network Rail Company and Railway Group Standards. Network Rail FTN and Northern Ireland Railways specifications shall also be consulted and complied with.

There are no anticipated non-compliance issues with the telecommunication elements of this project. Should however, any non-compliance issues become identified, as the project evolves, an application for a technical non-compliance or derogation shall be made to Translink. Where conflicts in standards are identified, Translink shall be informed, who will advise on the appropriate standard to be used, accordingly.

2.1 Railway Group Standards

Detailed in Table 1 is a non-exhaustive list of Railway Group Standards that have been consulted, and complied with, during the production of this Telecoms Project Design specification.

Standard	Issue	Date	Title
GK/RT0206	02	Apr 02	Signalling and operational telecommunications systems: safety requirements
GK/RT0209	01	Dec 00	Testing and commissioning of signalling and operational telecommunications Systems
GE/RT/8048	01	Feb 02	Positioning and labelling of Lineside Telephones

Table 1: *Railway Group Standards*

2.2 Network Rail Company Standards

Detailed in Table 2 is a non-exhaustive list of the Network Rail Company Standards that have been consulted, and complied with, during the production of this Telecoms Project Design specification.

Standard	Issue	Date	Title
NR/GN/SIG/11821	01	Aug 00	Sighting Requirements of Line-side Apparatus Housing
NR/GN/TEL/10117	02	Feb 06	Competence Management Systems for Work on Control and Communications Systems
NR/PS/TEL/00013	02	Jun 05	Cable Troughing
NR/PS/TEL/00015	03	Apr 06	Unit Twin Copper Telecommunications Cable
NR/SP/CIV/044	02	Aug 04	Design and Construction of Under Track Crossings
NR/SP/TEL/30028	02	Oct 05	Installation of Operational Telecoms Equipment
NR/L2/TEL/30022	05	Aug 08	Technical Requirements for Communications Engineering Schemes and Services
NR/SP/TEL/30031	02	April 06	Signal Box Telephone Design and Application Requirements
NR/SP/TEL/30032	03	April 06	Positioning and Labelling of Lineside Telephones
NR/SP/TEL/30035	02	Dec 05	Telecommunications Network Terminating Points
NR/L2/MTC/088	03	Aug 08	Responsibility for Maintenance of Changed Assets
NR/L2/TEL/30098	02	Aug 08	Testing and Commissioning of Telecommunications Equipment and Systems
NR/CS/TEL/30101	01	Feb 06	Telecommunications Assurance and Compliance
NR/L1/TEL/30100	02	Aug 08	Telecommunications Design
NR/L3/TEL/30106	02	Aug 08	Installation of Lineside Telephones

Standard	Issue	Date	Title
NR/SP/TEL/30002	04	Apr 06	SPT Concentrator Systems
NR/WI/TEL/00113	01	Apr 05	Wiring of Copper Telecoms Terminations
NR/L2/INI/02009	04	Dec 09	Engineering Management for Projects
NR/SP/SIG/19812	01	Feb 07	Cross Track Cable Management
NR/L3/SIG/30018	01	Sep 09	Signalling Design: Technical Details: Level Crossings

Table 2: *Network Rail Company Standards*

2.3 FTN Specifications

Detailed in Table 3 is a non-exhaustive list of the FTN Specifications that have been consulted, and complied with, during the production of this Telecoms Project Design specification.

Specification	Issue	Date	Title
SP/FTN(SU)/001	10.2	Feb 09	Survey of cables and cable routes
SP/FTN/(D&D)/004	9.2	Feb 09	Specification for the Renovation and Construction of New Cable Routes
SP/FTN/(D&D)/005	4.6	Feb 09	Joint, Termination & Test of fibre optic and copper telecoms cables
SP/FTN/(D&D)/008	4.2	Feb 09	Network design manual for Optical Fibre
SP/FTN/(D&D)/009	4.5	Feb 09	Network design manual for copper cables
SP/FTN/(D&D)/013	01	Aug 02	Specification for lineside cabinets without climate control

Table 3: *Network Rail FTN Specifications*

2.4 NIR Specifications

Table 4 details the NIR Specifications that have been consulted, and complied with, during the production of this Telecoms Project Design specification.

Specification	Issue	Date	Title
I/SG/IMP/SPEC/001	2.0	Apr 08	Specification for Cable Routes
I/SG/IMP/SPEC/002	1.0	Oct 07	Specification for Signalling & Telecoms Cables

Table 4: *NIR Specifications*

3 Project Background/Scope

Under the Coleraine to Londonderry re-signalling project several options are being considered to help modernise the route, reduce journey times and increase line capacity.

These options centre around a number of sites; particularly Londonderry, Eglinton, Castlerock and Coleraine. Each site is being developed as a separate site to aid option selection.

The main changes that are proposed under this scheme are:

- To transfer control from Castlerock and Londonderry to a new PC based VDU system at Coleraine. Making Londonderry and Castlerock signal boxes redundant.
- To provide train detection between Coleraine and Londonderry.
- To remove the passing loop at Castlerock.
- To provide a new passing loop at Eglinton.

The Signalling Outline Project Specification (Document Number: A013730-SN-SG-RP-0004) describes the signalling works necessary for the re-signalling of Coleraine to Londonderry. This is a feasibility report and is dependant on the options taken forward and there may be sections and comments that will no longer be applicable.

The indicative commissioning timescale is intended to be 2012/2013.

4 Purpose of Document

The purpose of this document is to specify the detailed technical scope and post construction requirements for the chosen single option to meet and sustain the project requirements.

It will follow the guidelines as laid down in Network Rail's Guide to Railway Investment Projects Manual ref RDM06 (V7.01).

This document should be read in conjunction with the documentation detailed in Table 5:

Document Number	Document Name	Document Owner
C0363-LY-CE-DG-0001 to C0363-LY-CE-DG-0010 Rev 01	Londonderry – Coleraine Relay / Resignalling Project with UWC Safety Improvements Signalling Sketch	Translink
A013730-SN-SG-RP-0002	Asset Condition Report	Scott Wilson Ltd
A013730-SN-SG-RP-0003	Train Detection in Coastal Areas	Scott Wilson Ltd
A013730-SN-SG-RP-0004	Signalling Outline Project Specification	Scott Wilson Ltd
I-SG-WPI-C0362-01	WPI for Signalling Feasibility & Scheme Development Services on the Coleraine to Londonderry Track Relay Project	Translink

Table 5: *Reference Documentation*

5 Description of the Telecoms Technical Scope

The arrangements for the project are depicted on a series of Translink Signalling Scheme Sketches C0363-LY-CE-DG-0001 to C0363-LY-CE-DG-0010 Rev 01. These may be subject to change and final agreement.

As a result of the Coleraine to Londonderry re-signalling works, it shall be necessary to make a number of alterations to the incumbent telecoms infrastructure in this area.

Based on the signalling design / development thus far, listed below are key telecoms systems requirements judged necessary to provide operational circuit connectivity:

- Relocation of the signalling/telecoms function at Londonderry and Castlerock to a new control facility at the existing Coleraine SB
- Provision of a new optical fibre cable 'backbone' to support the revised signalling layout and level crossing arrangements
- Provision of new copper cable infrastructure where required, to support the revised signalling layout, level crossings and associated operational telephones
- Rationalisation of existing STS Concept 32 telephone concentrators located at Coleraine, Castlerock and Londonderry. It is proposed to retain the concentrator at Coleraine SB.
- Provision of new SDH transmission equipment to support the revised signalling layout and level crossing arrangements
- The option of integrating existing transmission equipment with the proposed new SDH infrastructure
- The option of installing new P-MUX and recovering existing SELTA P-MUX equipment
- Provision of facilities for remote Network Management of transmission equipment from a new control facility at Coleraine
- Provision of new lineside telephones to support the revised signalling layout and level crossing arrangements
- Provision of new CCTV cameras, control and DVR equipment to support the revised level crossing arrangements

6 Geographical Area

The project is located along the railway corridor between Coleraine Station (61.75MP) and Londonderry Station (95.25MP). The site is mainly contained within trackside perimeter fencing and sea defences.

The line from Coleraine to Londonderry is approximately 34 miles in length. There are two tunnel sections at Castlerock and a significant portion of the line is alongside water. From Coleraine the railway runs along the bank of the river Bann before meeting the coast again at Castlerock. The railway travels inland before rejoining the coast shortly after Ballykelly AHB. The line runs inland again to the Castle River crossing where it then runs alongside Lough Foyle to Londonderry.

The diagram in Figure 1 shows the geographical location of the scheme. It is indicative only and indicates some of the key features including the River Bann Bridge opening and the location of City of Derry Airport.

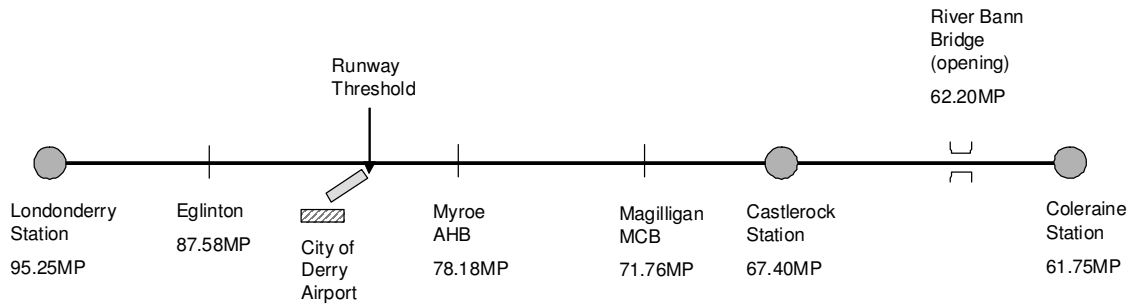

Figure 1: *Geographical Area*

7 Detailed Project Requirements – Operational

7.1 Existing Operational Buildings & Telecoms Assets

Relocation of the telecoms/signalling function at Londonderry and Castlerock to a new control facility at Coleraine SB will impact on the existing operational buildings and telecoms assets. The existing main telecoms (and signalling) operational buildings are located at the following sites:

- Coleraine SB and RR
- Castlerock SB and REB
- Magilligan REB
- Londonderry SB and RR
- Bann River Bridge control box

A separate Asset Condition Report (Document Number: A013730-SN-SG-RP-0002) has been produced describing the signalling assets at the above locations.

Table 6 summarises the existing telecoms assets at the aforementioned locations.

Building	Construction	Telecoms Asset
Coleraine SB	Brick & Wood	STS Concept 32 telephone concentrator & keyboard. Artillery Road MCB CCTV control panel/monitor.
Coleraine RR	Brick	SELTA P-MUX transmission equipment. ADC DSL line drivers. BT NTP, Circuit Number: MXBT233749 – leased line to Belfast Central Station.
Castlerock SB	Brick & Wood	Wall mounted colour CCTV monitor for blind spot on crossing. Direct line to Coleraine SB. DVR. Magilligan MCB CCTV control panel/monitor. Telephone concentrator keyboard.
Castlerock REB	3-Compartment*	STS Concept 32 telephone concentrator. BT Kilostream circuit to Belfast Central station (train radio) – Circuit Number: AXUK567072 to Belfast Central Station. Kenwood VHF FM repeater. GEC RR3000 FDM Transmitter (now redundant). Philips repeaters (4&6) associated with the CCTV transmission of Magilligan & Castlerock MCB back to Coleraine – this system is not operational.
Magilligan REB	3-Compartment*	SELTA P-MUX transmission equipment. ADC DSL line drivers. REB phone. Magilligan MCB CCTV control rack; controlled from Castlerock SB. GEC RR3000 FDM Receiver (now redundant).
Londonderry SB	Brick	Telephone concentrator keyboard.
Londonderry RR	Brick	STS Concept 32 telephone concentrator & keyboard. SELTA P-MUX transmission equipment. ADC DSL line drivers. A Siemens PLC operates in association with a TDM link from the REB located on the perimeter of the City of Derry Airport.
Bann River Bridge control box	Brick	Direct line to Coleraine SB.

Table 6: *Existing Operational Buildings & Telecoms Assets*

Note: * The REB is divided into three separate areas; the S&T equipment room, the battery and generator area. The battery area also houses the power transformers. The generator room contains the standby generator and an UPS.

The photograph in Figure 2 shows the three compartment REB at Castlerock. Note that the entrance to the S&T equipment room is at the far end of the REB and is not visible on this photograph.

Figure 2: *Castlerock REB*

7.1.1 Equipment Housing

New lineside telecoms equipment shall be housed in new standard location cases or REBs. A site survey is required for positioning, siting and access arrangements. Enabling works may be necessary prior to work starting.

New location cases shall be installed in accordance with the requirements of NR/GN/SIG/11821, 'Sighting Requirements of Lineside Apparatus Housings'. Where possible, location cases shall be sited at least 3 metres from the nearest running rail, to provide safe access for maintenance.

New REBs shall be provided wherever new electronic interlocking is required; namely, Londonderry, Castlerock and Coleraine. Telecoms infrastructure shall be provided to support the revised signalling layout and level crossing arrangements. It is recommended that active telecoms equipment (i.e. transmission equipment) is located in REBs as opposed to lineside TEHs wherever possible.

7.2 Optical Fibre Cabling

There is no existing optical fibre cabling running alongside the line between Coleraine and Londonderry, a distance of approximately 34 miles.

The existing operational telecoms cabling infrastructure is provided via copper cabling only. Copper cabling has its limitations and it is understood that the existing copper DSL line systems in some instances, have been unreliable and prone to faults.

The project aspiration is to migrate to a new optical fibre cable 'backbone' to support the revised signalling layout and level crossing arrangements. An optical fibre cable 'backbone' will provide a unified optical network for transmitting voice, data and signalling information. It is understood that initially, the purpose of the optical fibre cable 'backbone' will be to support operational telecoms requirements only.

In summary, the optical fibre cable 'backbone' will provide the following:

- Support all railway operational telecoms circuits
- Facilitate circuit migration from the legacy copper transmission systems
- Will offer improved reliability over copper DSL line systems
- Facilitate network management of transmission equipment from Coleraine Signal Box
- Will support the possible future introduction of GSM-R - compatibility with a future GSM-R system is a project objective
- Will support the possible future introduction of retail, business and IT circuits

Consideration should be given to Table 7 with respect to migration towards an optical fibre cable 'backbone' or retention of copper based infrastructure.

Item	Fibre	Copper
Bandwidth	10Gbit/s & beyond	Up to 10Gbit/s over 100m
Future-proof	Evolving towards the desktop	CAT7 under development
Noise	Immune	Susceptible to EMI/RFI interference crosstalk & voltage surges
Handling	Lightweight, thin diameter, strong pulling strength (pulling specification is up to 10 times greater than copper)	Heavy, thicker diameter. Strict pulling specifications
Security	Almost impossible to tap	Can be tapped
Attenuation	Very low attenuation	Comparatively high attenuation
Temperature	Less susceptible to temperature fluctuations	Performance degrades with increasing temperature
Space	Takes up less space in cable ducts	Takes up more space in cable ducts
Termination	More difficult to terminate than copper	Easier to terminate than fibre
Testing	Easier to test than copper	Harder to test than fibre
Costs	More expensive than copper in short term, but over long term; can be less costly	Cheaper than fibre in the short term but maybe more expensive in the long term
Maintenance	Less costly to maintain and less 'downtime'. Requires less hardware.	Less reliable than fibre based systems therefore maintenance costs higher

Table 7: *Fibre versus Copper – Considerations*

Clearly, a fibre solution offers huge advantages over a copper based solution utilising DSL systems. The main advantage is that fibre is a 'Future-proof' solution in that it can support >10Gbit/s of Bandwidth. Moreover, over the long term, it can be more cost-effective than copper based systems.

It is recommended that a fibre cable network survey is carried out to make sure that all existing and proposed route and copper cable network elements are taken into consideration in the design produced. Note that the survey requirements shall be defined at subsequent GRIP stages.

Consideration should be given to the following survey requirements:

- Centre to centre optical cable length – will be required to minimise cable wastage between adjacent joints
- The proposed locations for joints – ideally should be positioned in a permanent green zone to provide safe access for maintenance
- The proposed positions of sheath gaps – the metallic sheath of fibre cables should be gapped at strategic points to keep continuous lengths short to prevent the build up of hazardous voltages

- The proposed positions of spur cables – a spur cable will connect an Access Node to the main cables
- The proposed positions of terminations – optical terminations shall be located within trackside TEHs, or in a wall mounted box/termination rack within an REB, RR or existing building
- Core Node Sites – located at Coleraine and Londonderry
- Access Node Sites – located at intermediate sites between Coleraine and Londonderry, (e.g. Castlerock & Magilligan).
- Choice of cable type – duct cables contain minimal physical protection and are designed to be small and light for installation into underground duct routes where the surrounding duct will provide suitable physical protection.
- Entries to buildings - availability and capacity of existing duct entries.

In addition to the above, consideration should be given to the optical fibre splicing arrangements at:

- Through joints
- Spur joints
- Terminations at Core Nodes
- Terminations at Access Nodes

The optical fibre cable design shall be developed at subsequent GRIP stages. Reference should be made to NR's FTN Project Specification SP/FTN(D&D)/008 for optical fibre design principles and considerations. Reference should be made to NIR specification I/SG/IMP/SPEC/002 regarding the optical fibre cable specification. Note that the required cable specification and 'fibre count' will be determined at the detailed design phase.

7.3 Copper Cabling

7.3.1 Existing & New Copper Cabling Infrastructure

There will be a requirement to interface with the existing copper cable infrastructure between Coleraine and Londonderry.

However, consideration should be given to the new proposed copper cable network architecture for the following three scenarios as detailed within Section 7.6.2.

- Copper connectivity through the section – facilitates successive and adjacent feeding of SPTs
- Copper Islands with no Mid-Section Services – does not facilitate successive and adjacent feeding of SPTs
- Copper Islands with Mid-Section Services fed by a TEH– does not facilitate successive and adjacent feeding of SPTs

Note that a 'Copper Island' solution would normally only be deployed where there is no requirement for successive and adjacent feeding of SPTs.

Reference should be made to NR Company Standard NR/PS/TEL/00015 and FTN Specification SP/FTN(D&D)/009 with respect to copper cabling design requirements.

Copper cabling shall be in accordance with NIR specification I/SG/IMP/SPEC/002.

7.3.2 Tail Cabling

There shall be a requirement for new tail cables to be installed from distribution cabinets to new lineside telephones installed as part of this project.

The tail cables shall comply with the requirements of FTN specification SP/FTN/(D&D)/009: Network Design Manual for Copper Cable, with specific regard to the 100m maximum length rule. Any non-compliance will be listed in the GRIP stage 4 Telecoms Reference System Design.

All new tail cables will be 2pr in accordance with NIR specification I/SG/IMP/SPEC/002 and shall be terminated on Tyco Mondragon VX IDC type connectors, within lineside distribution cabinets to specification SP/FTN(D&D)/013.

Where tail cables are required to cross the track, the preferred method is the use of UTXs. Alternatively, tail cables can be clipped to the sleeper. Note that hollow sleepers do not exist for NIR track gauge. Translink to confirm the protocol for 'orange pipes'. Cable routes shall be designed in accordance with NIR specification I/SG/IMP/SPEC/001.

7.4 Telephone Concentrators & Voice Recording

Existing STS Concept 32 telephone concentrators are located at:

- Coleraine SB
- Castlerock REB
- Londonderry RR

Since the existing signalling/telecoms function at Londonderry and Castlerock is being relocated to a new control facility at Coleraine SB, there is an opportunity to rationalise the existing telephone concentrators into a single telephone concentrator at Coleraine SB. This will make the existing telephone concentrators located at Castlerock REB and Londonderry RR redundant at these locations. However, concentrator equipment could be reutilised at Coleraine or used as spares. Furthermore, the existing telephone concentrator keyboards will also need to be rationalised.

With a single telephone concentrator located at Coleraine, all lineside circuits (e.g. SPTs) will be carried over the fibre based SDH transmission network back to Coleraine and circuits will be presented within the equipment room MDF/IDF and jumpered to the respective telephone concentrator line cards. Reference should be made to NR Company Standard NR/SP/TEL/30002 with respect to SPT Concentrator Systems requirements.

Note that the existing voice recording arrangements will also need to be rationalised. Details of this will be provided at subsequent GRIP stages.

7.5 Lineside Telephones & Signalling Control Circuits

The following new lineside telephones shall be provided hosted of the telephone concentrator in Coleraine SB:

- New SPTs shall be provided for all new signals with a red aspect.
- PZTs
- Platform and Level crossing telephones

All new operational telephone instruments (e.g. SPTs & PZTs) shall be post-mounted, CB type, weatherproof and vandal resistant with an armoured handset cord. Such a telephone is the GAI –Tronics 'Titan' (NRS Part No. 0087/037914) which has product approval for installation on Network Rail owned infrastructure. The SPTs will be connected to the nearest distribution cabinet (LOC), by means of a tail cable.

The Signal Sighting Committee shall determine the final position of the SPTs and PZTs. This committee will also determine if telephones are required for areas of 'limited clearance', and, if required the geographic locations.

Positioning and labelling of all lineside telephones shall be in accordance with specifications GE/RT8048 and NR/SP/TEL/30032.

The following Signalling Control Circuits will be required:

- MEI
- Train Describer
- Emergency Alarm
- Remote Condition Monitoring

7.6 Transmission Systems & Network Management

7.6.1 SDH versus PDH - Considerations

The proposal is to provide a new SDH transmission system as detailed in Section 7.6.2. Consideration should be given to the advantages of SDH over a PDH network architecture as shown in Table 8 below.

Item	SDH	PDH
Network Architecture	Typically used in Ring networks.	Generally limited to point-to-point networks.
Survivability	Enables automatic reconfiguration & traffic rerouting when a link is damaged.	Primitive protection mechanisms. Requires more hardware than SDH to provide certain levels of protection.
Software Control	High flexibility. Network Management Platforms often provide a GUI for easy configuration of cross-connects etc.	Software control not as advanced as SDH. Relies on 'field cabling' to ensure equipments/circuits are managed.
Efficient Drop & Insert	Simple & efficient cross-connect without full hierarchical multiplexing or de-multiplexing.	Non-efficient Drop & Insert. Full hierarchical multiplexing or de-multiplexing required.
Robustness & resilience	SDH has inherent robustness/resilience built-in to the hardware; e.g. Switch/Power card protection.	PDH less robust/resilient than SDH hardware.
Equipment size/operating costs	SDH uses less hardware than PDH & therefore maintenance costs should be less.	PDH uses more hardware than SDH & therefore maintenance costs should be greater.

Table 8: *SDH versus PDH - Considerations*

7.6.2 Transmission System Architecture

The existing lineside transmission systems consist of DSL copper line systems and SELTA primary multiplexer (P-MUX) equipment.

It is understood the existing P-MUX network architecture is a 'hub and spoke' arrangement and there is dialogue with SELTA to investigate possible migration to a 'ring' P-MUX architecture (as an interim measure) to provide increased levels of resilience.

A typical SELTA P-MUX is shown in Figure 3:

Figure 3: *SELTA P-MUX*

As previously discussed, the project aspiration is for a new optical fibre cable 'backbone' to support the revised signalling layout and level crossing arrangements.

The proposed new network architecture consists of four layers as follows:

- Copper Layer – the purpose of the copper layer is to provide circuit connectivity
- Primary Layer – the purpose of the primary layer is to multiplex circuits to 2Mbit/s prior to delivery to the bearer layer
- Bearer Layer – the bearer layer is the SDH transmission network. The bearer layer also includes PTO bearers. PTO bearers are used to provide diversity in the transmission network.
- Switch Layer – the switch layer consists of telephone concentrator equipment.

The proposed SDH transmission network architecture is shown in Figure 4:

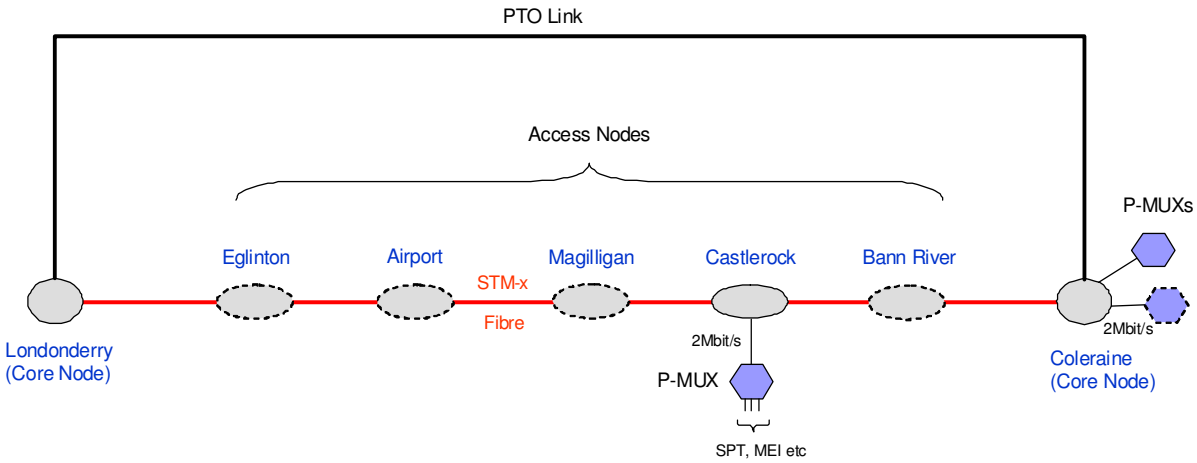

Figure 4: *Proposed SDH Transmission Network Architecture*

The network architecture is based on SDH transmission over optical fibre using a ring topology. The ring topology is facilitated by the PTO link. The design consists of discrete transmission nodes connected by optical fibre cable.

Core Nodes are located at Coleraine and Londonderry, this is where the transmission system interfaces with the PTO network. It is anticipated that Access Nodes are required at the following intermediate sites:

- Bann River
- Castlerock
- Magilligan
- Airport
- Eglinton

The precise locations for both Core and Access Nodes will be developed at GRIP Stage 4. The locations identified within this document are based on the Signalling MEI requirements, i.e. an Access Node is required to provide MEI circuit connectivity back to Coleraine SB.

The diagram in Figure 4 also illustrates the requirement for P-MUXs at Core and Access Node sites. The P-MUXs will allow connectivity for any sub 2Mbit/s circuits. These will include for example SPT, PZT, level crossing phones and MEI circuits. Note that for simplification and illustration within Figure 4, just one 'remote' P-MUX has been shown at Castlerock.

Coleraine SB will contain the largest number of P-MUXs (and circuits) due to the fact that it is the controlling site.

Allowance has also been made in the design for providing LC CCTV connectivity back to Coleraine, should this be required. This is facilitated by the proposed new optical fibre cable 'backbone'. The SDH bandwidth requirement will be determined at GRIP Stage 4. Note that SDH is based on an STM-1 (155Mbit/s) rate and is equivalent to 63 x 2Mbit/s.

With respect to the Access Node network architecture, there are three scenarios that will need to be considered at subsequent GRIP stages. These include:

- Copper connectivity through the section
- Copper Islands with no Mid-Section Services
- Copper Islands with Mid-Section Services fed by a TEH

These are defined within NR FTN Project Specification SP/FTN(D&D)/009.

The diagram in Figure 5 shows 'Copper connectivity through the section'.

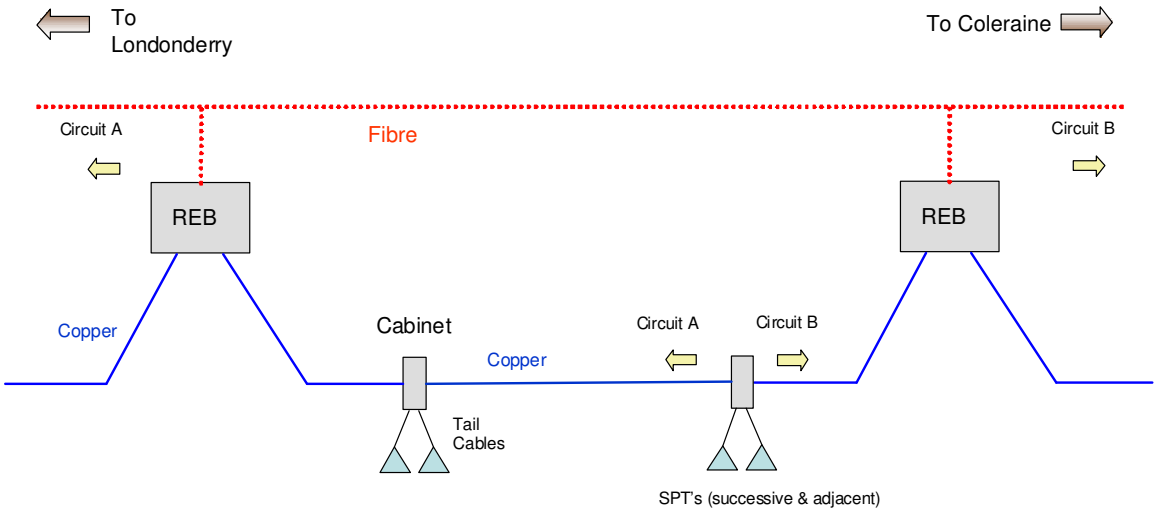

Figure 5: *Copper Connectivity through the section*

Lineside transmission circuits are carried over the fibre cable via transmission Access Nodes located in the REB. Here, the presence of mid-section copper connectivity through the section facilitates successive and adjacent feeding of SPTs. Circuit A is routed 'Westwards' towards Londonderry whilst Circuit B is routes 'Eastwards' towards Coleraine. Note that Circuit A will ultimately be presented at Coleraine via the diverse route (i.e. a PTO link). The requirement for successive and adjacent feeding of SPTs will need to be confirmed at subsequent GRIP stages.

The diagram in Figure 6 shows 'Copper Islands with no Mid-Section Services':

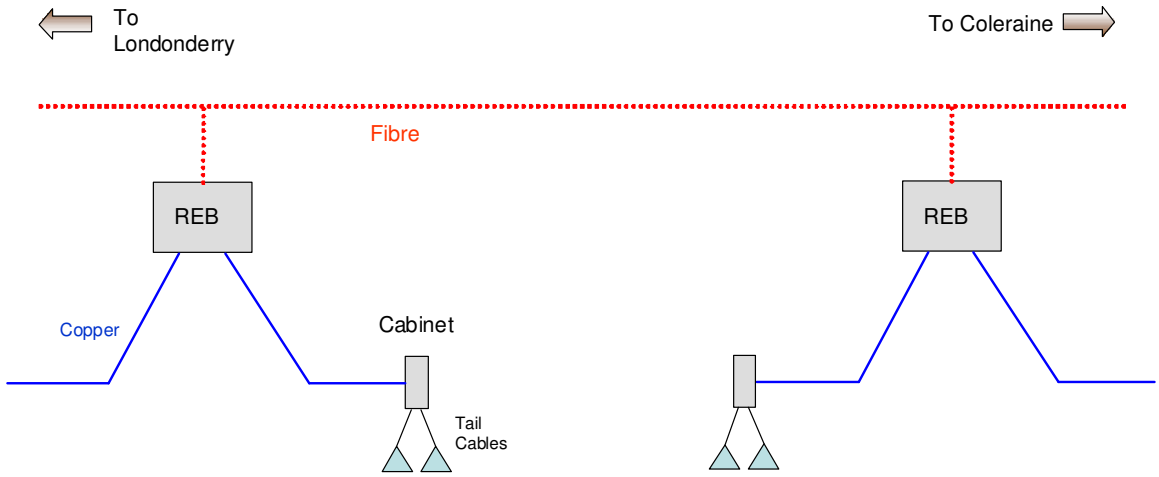

Figure 6: *Copper Islands with no Mid-Section Services*

Here, lineside transmission circuits are carried over the fibre cable via transmission Access Nodes located in the REB. This architecture removes the requirement for DSL links.

The absence of any mid-section services through the section removes the need for a continuous copper cable.

The diagram in Figure 7 shows 'Copper Islands with Mid-Section Services fed by a TEH':

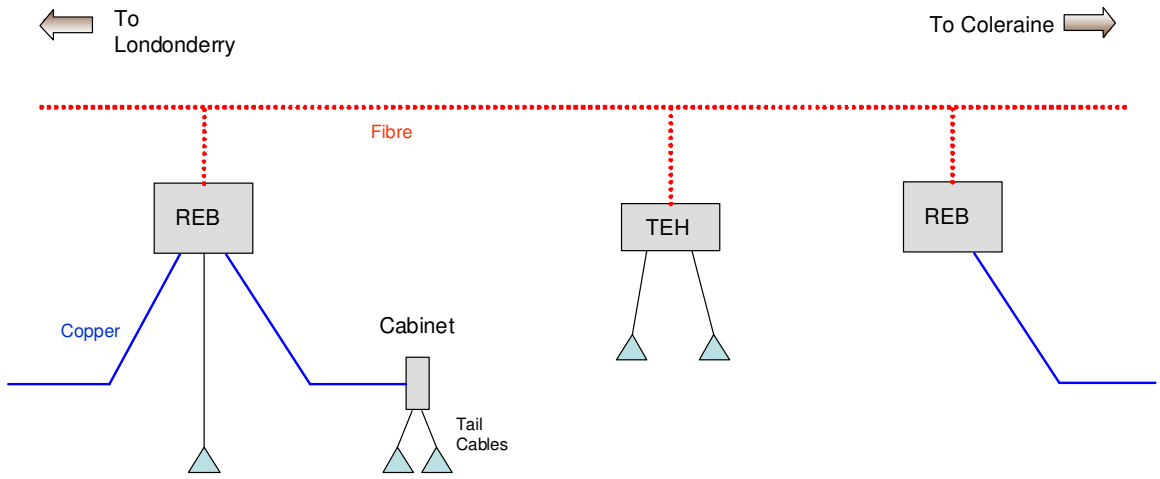

Figure 7: *Copper Islands with Mid-Section Services fed by a TEH*

Here, a TEH is introduced to interface the mid-section services with the fibre cable. This maybe more cost-effective than a continuous copper cable through the section.

The decision whether to deploy 'Through Copper Connectivity' versus 'Copper Islands' is both a technical and a commercial one.

Note that the following conditions must be satisfied before a copper island solution can be considered:

- The cable section includes fibre cable
- There is no requirement for successive and adjacent feeding of SPTs
- There is no intermediate signal box within the cable section
- There are no other circuits that require node to node copper connectivity, for example MEI circuits
- Any mid-section services occur in 'clumps' rather than being spread through the section

Note that copper islands occur when there is a proliferation of services near to a transmission node.

7.6.3 Diversity

In order to satisfy the requirement for MEI data link diversity to achieve the required availability, and to facilitate successive and adjacent routing of lineside circuits, it is proposed that the transmission network shall have a diverse route back to Coleraine via a PTO link.

7.6.4 Synchronisation

Transmission synchronisation will be required to prevent any transmission errors in the SDH network. The synchronisation source would normally be via a PRC and SSU located at Coleraine SB. The synchronisation design will be developed at subsequent GRIP stages.

7.6.5 Circuit / Bandwidth Requirements

The following sub 2Mbit/s circuits are required:

- SPT
- PZT
- Platform phones
- Level Crossing phones
- MEI
- Train Describer
- Emergency Alarm
- Remote Condition Monitoring

In addition to the Sub 2Mbit/s circuit requirements, allowance has also been made in the design for providing LC CCTV connectivity back to Coleraine SB, should this be required. This is facilitated by the proposed new optical fibre cable 'backbone'. CCTV bandwidth is dependant upon the type and number of CCTV cameras installed.

The 'Day 1' bandwidth will be confirmed at subsequent GRIP stages. Note that the design is flexible in that the bandwidth can be increased as required via the installation of higher capacity optical interface line cards (dependant on SDH shelf type). For example, STM-1 (155Mbit/s), STM-4 (622Mbit/s), STM-16 (2.5Gbit/s). The SDH architecture is therefore extremely flexible and allows for future growth in bandwidth.

7.6.6 Network Management

It is understood that Network Management (which includes circuit provisioning) of the transmission equipment will be required from a new control facility at Coleraine SB.

This will be relatively easy to achieve since the SDH ADM management bandwidth data is contained within the optical overhead on the SDH frame. This management bandwidth data for all the ADMs will be available via a management interface on the ADM equipment at Coleraine SB. Note that the management interface, when activated on the ADM allows for connection to the Network Management Platform. The Network Management platform is essentially a PC/Monitor normally providing a Graphical User Interface.

Local Network Management will be possible at each location via a Local Craft Terminal which can either be a laptop computer, or a hand-held service terminal dependant upon the manufacturer.

It is suggested that provision is always made for Local Craft Terminal access. This will ensure that there is still management capability in the event that the 'Gateway' management interface is lost.

Figure 8 shows Network Management from Coleraine SB.

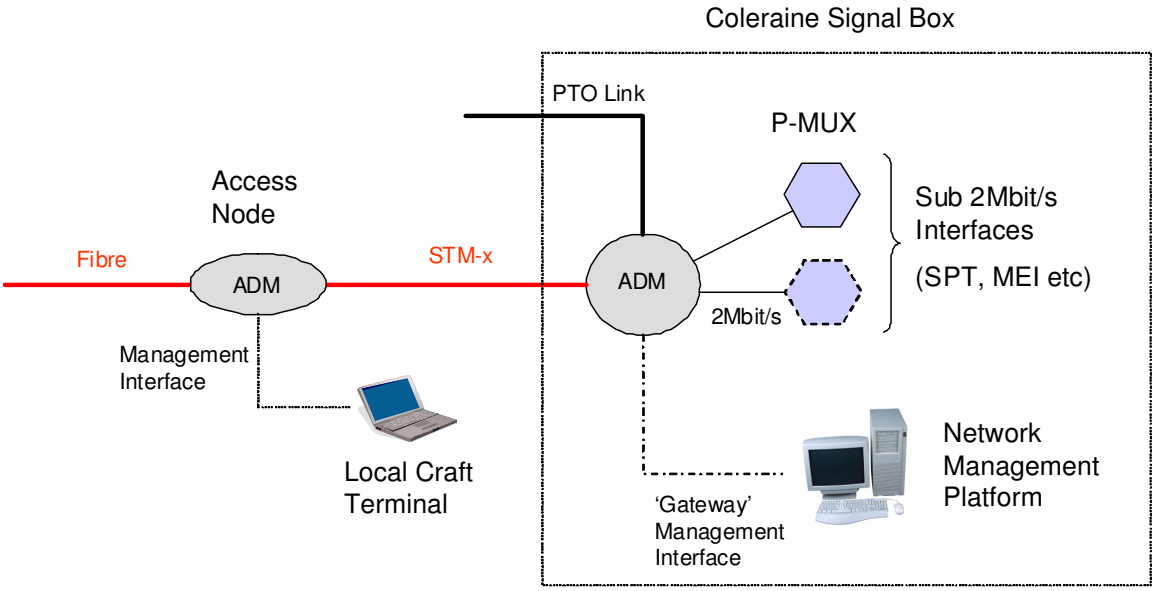

Figure 8: *Network Management from Coleraine SB*

Note that where new ADMs are being installed, hosted from a physical location, which does not already have ADMs present, then a DCN, connection (e.g. typically 2Mbit/s) will be required along with a router to provide a LAN segment for connection of the new ADMs. This would allow Network Management from any location, e.g. Belfast Central Station.

Figure 9 shows Network Management from a location with no ADMs present.

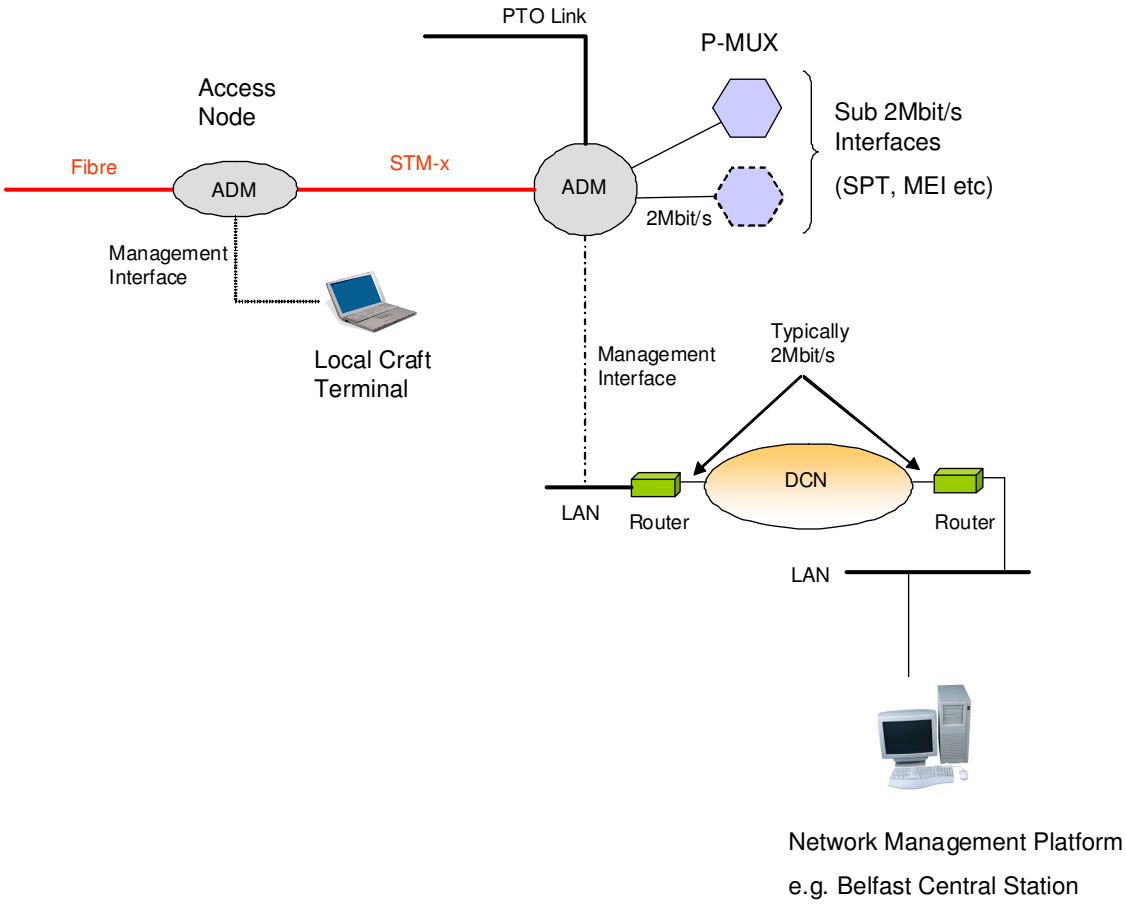

Figure 9: *Network Management from a location with no ADMs present*

The Network Management design will be developed further at subsequent GRIP stages.

7.7 Radio Systems

Train radio is in operation along the length of single line track between Coleraine and Londonderry providing a vital form of communication, particularly during emergency situations. The existing train radio system is an analogue VHF FM repeater-based radio network.

During a non-intrusive site survey carried out between 08/06/09 to 11/06/09, a number of sites were visited and the following radio equipment was identified:

- Castlerock REB
    - Kenwood VHF FM Repeater TKR-751 (Trigger Radio)
    - BT NTP – 'Kilostream' circuit to Belfast Central station, Circuit Number: AXUK567072 (Train Radio)
    - VHF Radio Antenna (Trigger Site)
- Londonderry Station - VHF Radio Antenna (Trigger Site)

Figures 10 and 11 show the rack mounted Kenwood Trigger Radio equipment located in Castlerock REB and the VHF Radio Antenna outside Castlerock REB.

Figure 10: *Kenwood VHF FM Repeater TKR-751 (Trigger Radio) - Castlerock*

Figure 11: *VHF Radio Antenna (Trigger Site) - Castlerock*

The above equipment is indicative of the installed radio infrastructure between Coleraine and Londonderry. A complete inventory of radio equipment was not captured during the site survey.

Furthermore, following the site visit at Belfast Central station on 08/06/09, it is also understood that Kenwood VHF FM Trigger Radio equipment is due to be commissioned at Belfast Central station, approximately July/August 2009.

With reference to the Signalling Outline Project Specification A013730-SN-SG-RP-0004, the option of using DC track circuit train detection has been proposed between Coleraine and Londonderry. Continuous communication between train crew and signal operators will be necessary. The most practical method of communication between train crew and signal operators is via radio.

Due to the proposed alterations to the route, it is recommended that radio coverage testing is carried out to assess the availability of radio communications. The proposed alterations to the route and infrastructure are as follows:

- Eglinton – New passing loop to be provided and signalled
- The construction of two new platforms at Eglinton with the proposal to demolish the existing but unused platforms
- Castlerock – Existing loop to be recovered

It is understood there are no plans to introduce GSM-R yet, however, an optical fibre 'backbone' as previously discussed will support the future introduction of GSM-R. Note that compatibility with a future GSM-R system is a project objective.

7.8 Level Crossings - CCTV

A total of 9 User Worked Crossings (UWCs) are to be upgraded to include MSLs mainly due to the proposed increase in line speed as detailed within Translink signalling sketches C0363-LY-CE-DG-0001 to C0363-LY-CE-DG-0010 Revision 01. The precise number of UWCs to be upgraded will be confirmed at subsequent stages of the design development. The Signalling Outline Project Specification document A013730-SN-SG-RP-0004 details the level crossing arrangements.

Due to the cost of installing transmission nodes at such a large number of sites, it is proposed that CCTV at MSL sites will be recorded locally using a DVR (with hard drive). The CCTV data can be copied from the DVR onto a laptop if needed for further investigation.

Allowance has also been made in the design for providing LC CCTV connectivity back to Coleraine SB should this be required. This is facilitated by the proposed new optical fibre cable 'backbone'. The option to provide LC CCTV connectivity back to Coleraine SB will be developed at subsequent GRIP stages. This includes a cost-effective option of networking the DVRs so that they can be interrogated remotely. Note also that 2 phones per MSL site will be required.

Figure 12 shows a typical example of a User Worked Crossing with MSL and shows Menarys UWC XP245 which is located on the Coleraine to Portrush line.

Figure 12: *CCTV at Menarys UWC XP245 on Coleraine to Portrush line*

The MCB level crossing at Castlerock is currently controlled from the signal box and relay interlocking. A new electronic interlocking will take on the interlocking for the crossing and this will be controlled from Coleraine SB. The crossing will require a CCTV system to Coleraine SB. Note at Castlerock REB, there are two Philips repeaters (4&6) associated with the CCTV transmission of Magilligan and Castlerock MCB back to Coleraine. This system is not operational.

At Bann River Bridge, CCTV may be required, controlled from Coleraine SB.

8 Detailed Project Requirements – Retail Systems

Alterations to existing retail systems may be necessary to cater for new stations, new platforms and changes to services.

For example, the construction of two new platforms at Eglinton has been proposed due to the proposal for a new passing loop at Eglinton. The existing but unused platforms at Eglinton would therefore need to be demolished.

9 Detailed Project Requirements – Infrastructure

9.1 Cable Route & UTX

Cable routes shall be designed in accordance with NIR specification I/SG/IMP/SPEC/001 and cabling shall be in accordance with NIR specification I/SG/IMP/SPEC/002.

New buried cable route ducting will be provided along the entire length of the Railway between Coleraine and Londonderry. This shall have at least 30% spare capacity. No surface concrete troughing shall be provided. This buried ducting will carry all new lineside cables required; this is likely to be a mixture of Power, Fibre Optics and Multicore cable.

It is proposed to use available spare conductors in existing telecoms multipair cables where a minimum of 10% spare conductors will remain. Prior to use, existing spare conductors will be tested to ensure compliance with relevant cable standards. Any cables that are found to fail the test shall be replaced.

Telecoms main cable track crossings will be made using UTXs where possible and shall be designed in accordance with Company Standard NR/SP/CIV/044. UTXs shall be sized to accommodate all the projects cable requirements, and shall adhere to NR/SP/SIG/19812, Cross Track Cable Management. The UTX access manholes will be accessible under Green Zone conditions.

Where cables are required to cross the track, the preferred method is the use of UTXs. Alternatively, cables can be clipped to the sleeper. Translink to confirm the protocol for 'orange pipes'. Note that hollow sleepers do not exist for NIR track gauge.

9.2 Platform Ducting

Where existing platform ducting infrastructure needs to be utilised (e.g. for the installation of telecoms tail cables for platform telephones), it is assumed that spare cable capacity exists. This will need to be verified at subsequent GRIP stages.

9.3 Driver's Walkways

Driver walkways will be required at the site of each lineside telephone. SPTs are to be located 5m from the signal on its own post with a 15m walkway leading up to it. Hand rails are to be provided as necessary. The Signalling Sighting Committee shall confirm the exact position and lengths of these walkways.

9.4 SPT Bases

There may be a requirement for a properly constructed concrete base at the site of each lineside telephone. This shall be evaluated in more detail at GRIP Stage 4.

10 Impact Assessment on Existing Network

There will be a significant impact on the existing telecoms network due to the new proposed infrastructure requirements.

It is envisaged the following areas will be impacted upon:

- Equipment room space
- Power requirements
- Operational requirements – possible rationalisation of transmission & switching equipment
- Support/Maintenance – due to new hardware / software
- Spares holding – due to new equipment
- Equipment recoveries
- Training

With reference to Translink document, I-SG-WPI-C0362-01, Signalling & Telecommunications Consultancy Services Contract, consideration should also be given to the following projects along the line section that are in progress and which will be completed in advance of, or in parallel to, the works namely:

- Bridge Replacements UBs 203, 204 and 215
- Sea Defence Strengthening Works
- City of Derry Runway Protection
- UWC MSL Upgrade Phase 1
- River Bann Bridge Refurbishment (may be included in project)

11 Option Selection Summary

A number of options have been considered based on a new optical fibre cable 'backbone' to support the revised signalling layout and level crossing arrangements. An optical fibre cable 'backbone' will provide a unified optical network for transmitting voice, data and signalling information.

The options that have been considered include the following:

- Optical Fibre cable 'backbone' utilising PDH technology
- Optical Fibre cable 'backbone' utilising SDH technology
- IP solution

Note that modifications to the existing copper cable 'backbone' utilising DSL technology was not considered to be a viable option moving forward since it does not give the required level of resilience, flexibility and 'future-proofing' required.

Having evaluated and technically appraised the various options available, the Optical Fibre cable 'backbone' utilising SDH technology Single Option has been selected for a number of reasons as summarised below:

- SDH is a proven technology in the railway environment offering advantages over PDH systems as described in Section 7.6.1. Note that Network Rails FTN Bearer Layer utilises SDH transmission technology and its use is well established throughout Network Rails infrastructure.
- SDH provides the reliability of circuit-switched pathways and resiliency should there be a fault.
- SDH will support a variety of transmission interfaces, including Ethernet (Ethernet over SDH).
- IP is not a proven or mature product in the railway environment. It is envisaged that an extensive testing / product acceptance phase would be required prior to the introduction of this technology within the Translink infrastructure.

12 System/Network Interfaces

The following telecoms related interfaces have been identified:

12.1 Signalling

- Signalling Scheme Plan
- Signalling Outline Project Specification
- SPT Sighting Committee

12.2 Civils

- Cable Routes
- Drivers Walkways
- Location case & REB bases
- Stations including Platform alterations

12.3 Third Party

- PTO – for provision of PTO link

13 Maintenance & Operational Requirements

CDM regulations are applicable to this project and designers shall consider the 'maintainability' & operational requirements in the event of failure of all systems/equipment installed.

Specific maintenance and operational aspects are to be considered in the design of the project in particular those relating to Staff Safety:

- Safe Cess Walkways.
- Provision of Driver's Walkways to SPTs.
- Safe Cess access routes to all operational equipment.
- Positioning of location cases to permit access without being "on or near the line".
- Taking "touch potential" into account.
- Provision of REBs such that foot and Vehicular access is available without being "on or near the line" wherever possible.

14 Scheme Development – Cost Estimates

Tables 9 and 10 show cost estimates for materials and contractor costs. These items are expected to be included within any subsequent GRIP Stage 4 Telecoms Reference System Design. These costs are indicative only and exclude costs for cable route since this will be covered in the civils cost estimates.

The cost estimates are based on installing 7 x STM-1 SDH transmission nodes and the installation of new optical fibre cable between Coleraine to Londonderry. In addition, the cost estimates include the installation of a Network Management platform at Coleraine SB and the installation of Telephone Concentrator equipment to facilitate the addition of relevant lineside circuits. Note that the line from Coleraine to Londonderry is approximately 34 miles (54.7km) in length.

Materials Costs (estimated):

Item	Cost (£k)
Copper Cable	100
Fibre Cable @ £3.60/metre	197
SDH Equipment Shelf/P-MUX/PSU/Ancillaries @ £20k per site (7 sites)	140
Network Management Platform & Licences	30
Local Craft Terminals (Laptops) & Software	6
Telephone Concentrator hardware/software	20
CCTV cameras/camera mounting & cables, DVR equipment, LOC for housing DVR – based on 9 UWCs to be upgraded with MSLs @ £5k per site (9 sites)	45
Total	**£538k**

Table 9: *Materials Costs - Estimated*

Contractor Costs (estimated):

Item	Cost (£k)
Installation of Copper Cable	300
Installation of Fibre Cable @ £11.50/metre	629
Site Surveys of transmission sites	2.5
Transmission Installation based on 7 x STM-1 nodes	21
Transmission In-station testing based on 7 x STM-1 nodes	7
System Test/Integration of transmission system	7
Telephone Concentrator installation	5
Telephone Concentrator testing	2
PTO interconnect at Coleraine & Londonderry (diverse route)	tbc
Installation & commissioning of CCTV/DVR/LOC equipment – based on 9 UWCs to be upgraded with MSLs @ £5k per site (9 sites)	45
Total	**£1,018.5k**

Table 10: *Contractor Costs - Estimated*

Table 11 shows the cost estimate for design documentation development.

Design Documentation Development (estimated):

Item	Cost (£k)
GRIP Stage 4 & 5 Design Documentation development	50
Total	**£50k**

Table 11: *Design Documentation – Estimated*

With reference to Tables 9, 10 and 11, the estimated total cost (Materials, Contractor & Design Documentation Development) is approximately £1.6 million + PTO interconnect costs