THE USE OF IP-BASED TECHNOLOGY OVER DARK FIBRE TO DELIVER S&T SOLUTIONS.

"JOCK WAN – FIBRE FIX"

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Testing Design Engineer (FTN Migration Project)

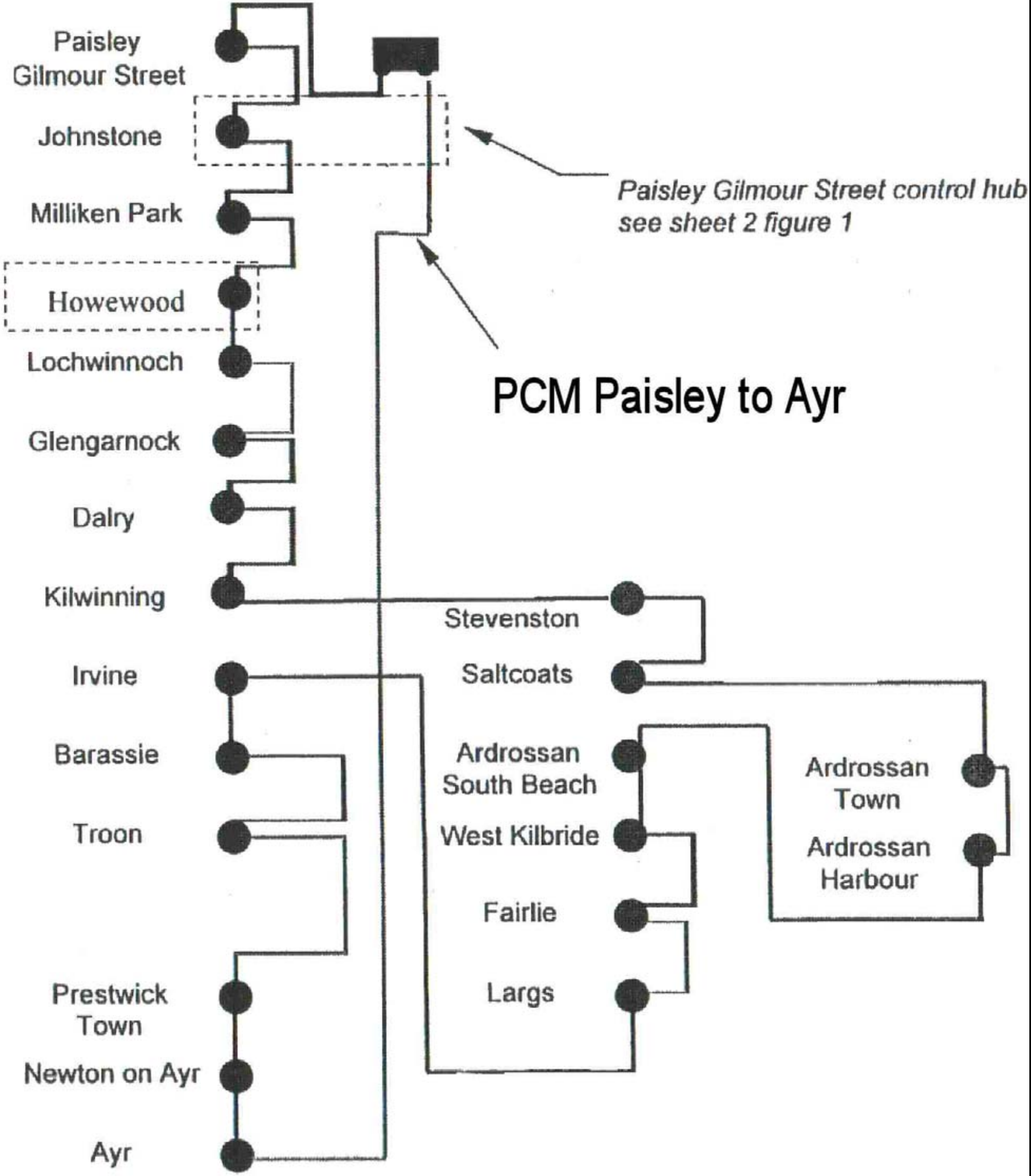
IN THE BEGINNING

Ayrshire LLPA System

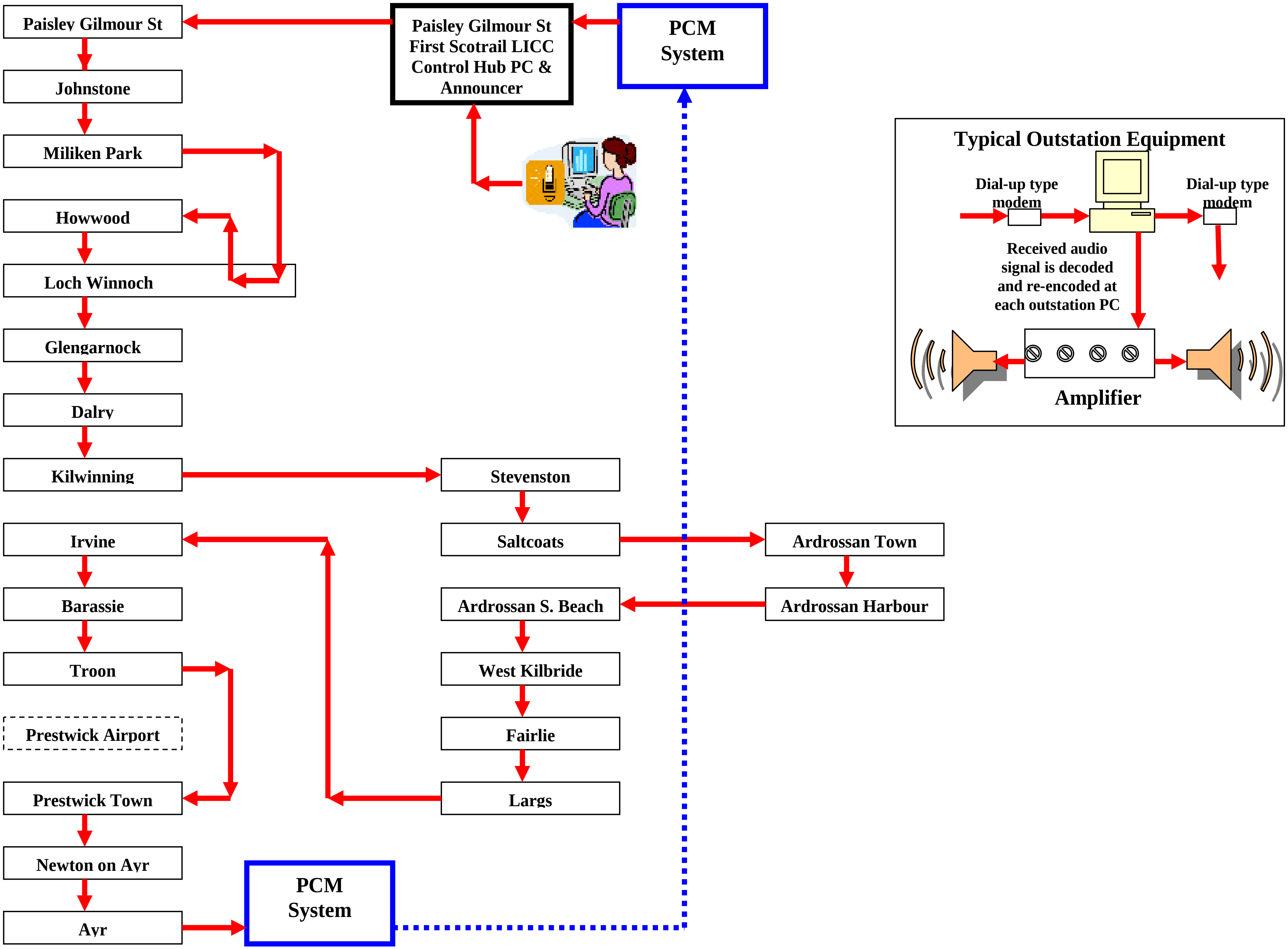
- No stored announcements for automatic broadcast.
- Poor speech quality
- Long time delay on “real time” announcements
- Early digital design which incorporated products designed for the “home” market


RFC
04/09/2008


04/09/2008


Paisley Gilmour Street
Johnstone
Milliken Park
Howewood
Lochwinnoch
Glengarnock
Dalry
Kilwinning
Irvine
Barassie
Troon
Prestwick Town
Newton on Ayr
Ayr
Stevenston
Saltcoats
Ardrossan South Beach
West Kilbride
Fairlie
Largs
Ardrossan Town
Ardrossan Harbour
Paisley Gilmour Street control hub see sheet 2 figure 1
PCM Paisley to Ayr

AYRSHIRE LLPA –EXISTING QSL SYSTEM



Need for Interim Solution

- First Scotrail and Route Director Pressure on RAM to get a working, real-time announcement solution
- Poor reliability of existing system
- Severe bandwidth limitations of 22kb modems and legacy PCM system
- Can’t wait for full FTN fibre solution in a year’s time

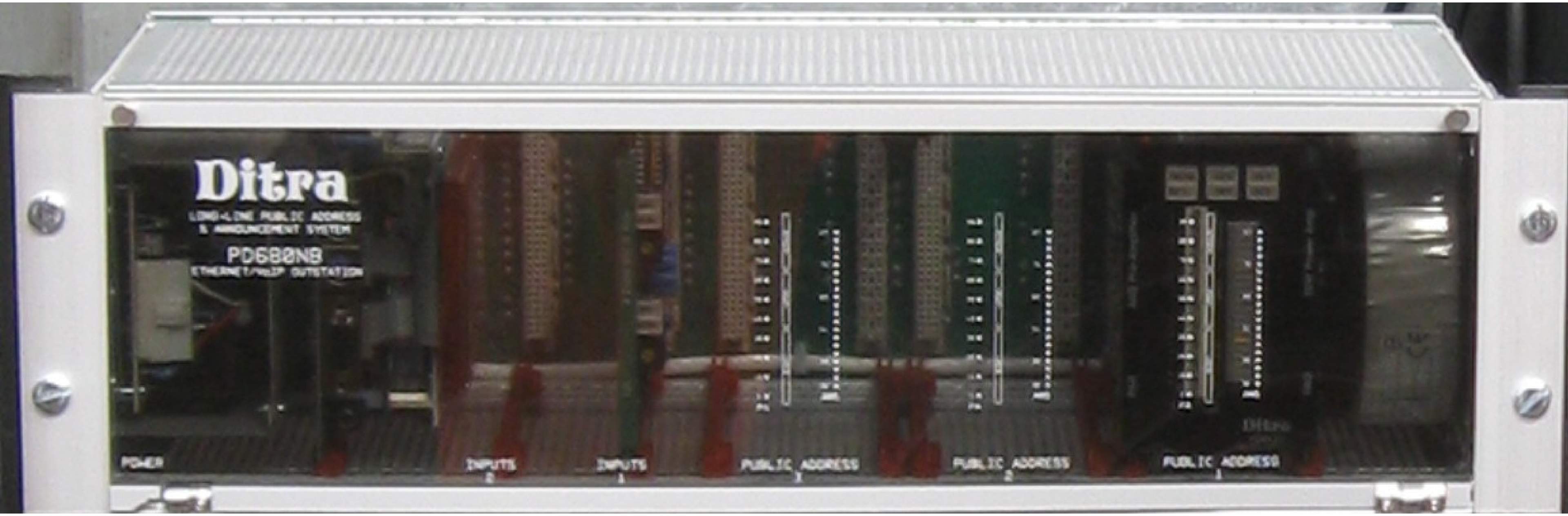
Constraints on Delivery

- Legacy copper was only viable solution
- First Scotrail refused to allow use of their WAN (bandwidth constraints)
- Head of Telecoms pushing for VOIP using FTN SDH as backbone
- Interim Solution concentrated on just Getting a Working System

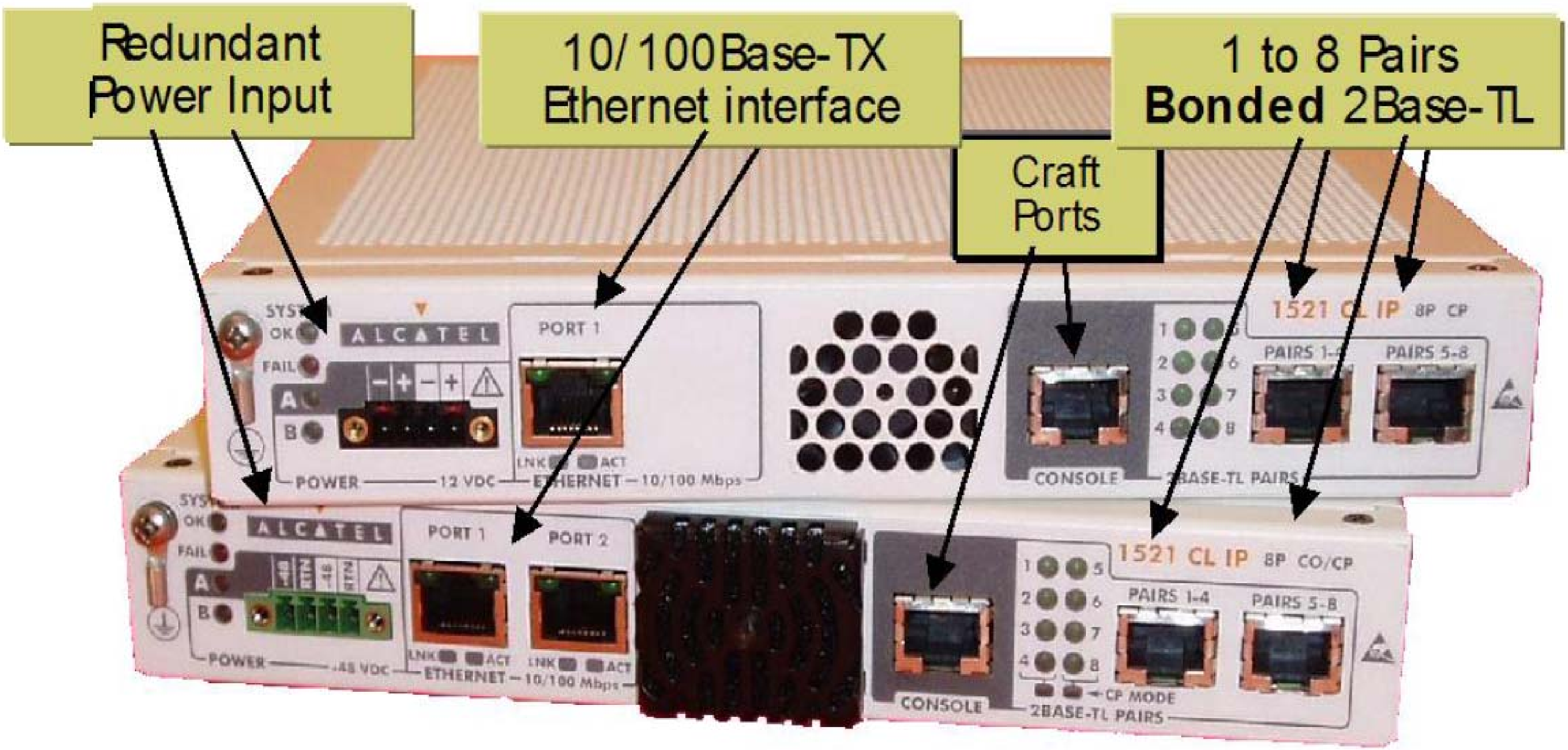
Technical Solution Adopted

- Use DITRA outstation/amplifier with IP addressing
- Use of a new Alcatel DSL product – 1521CLIP (basically an Ethernet extender)
- Use existing speakers and wiring
- Use existing location cabinets

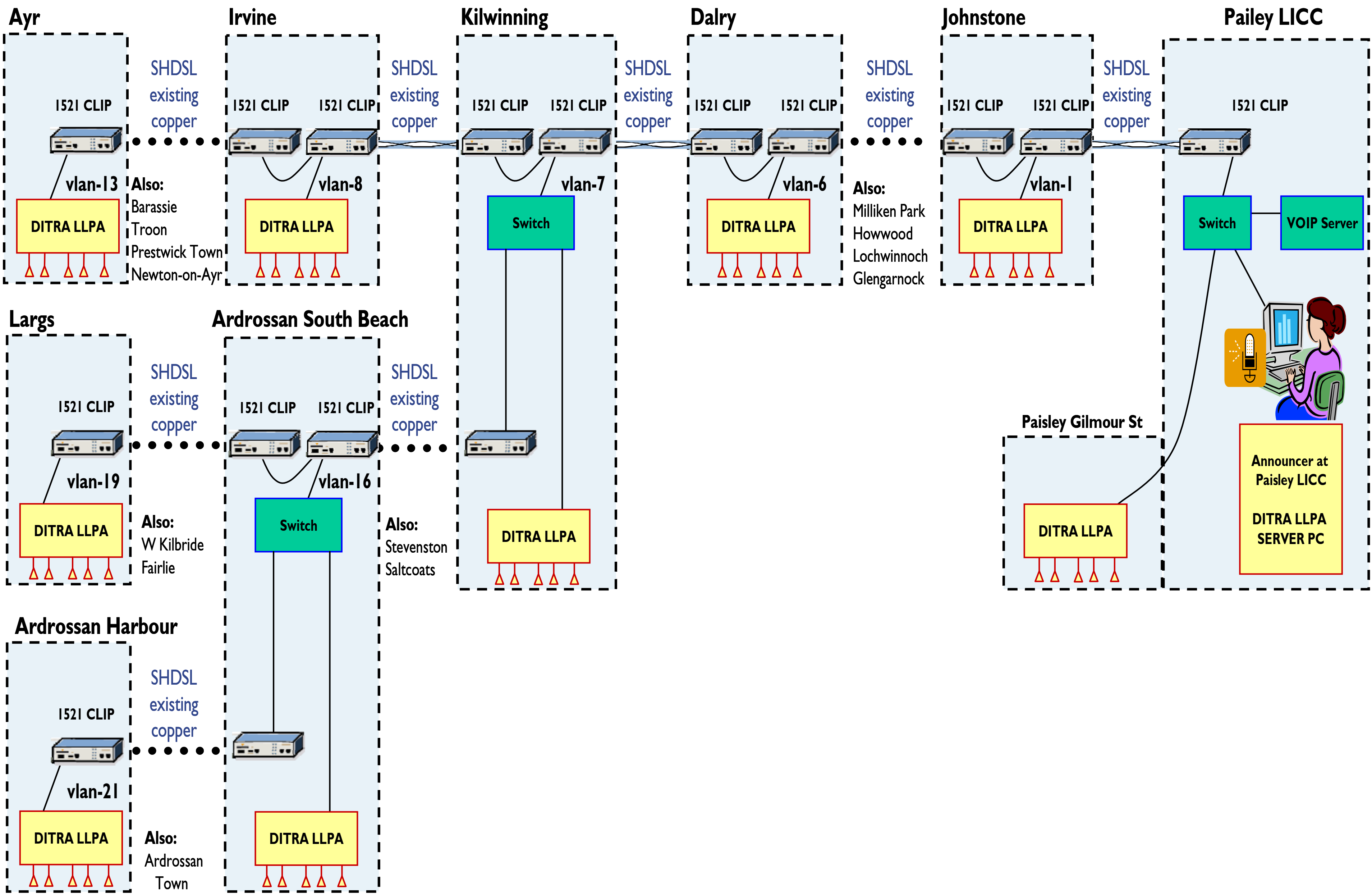
DITRA Outstation Amplifier



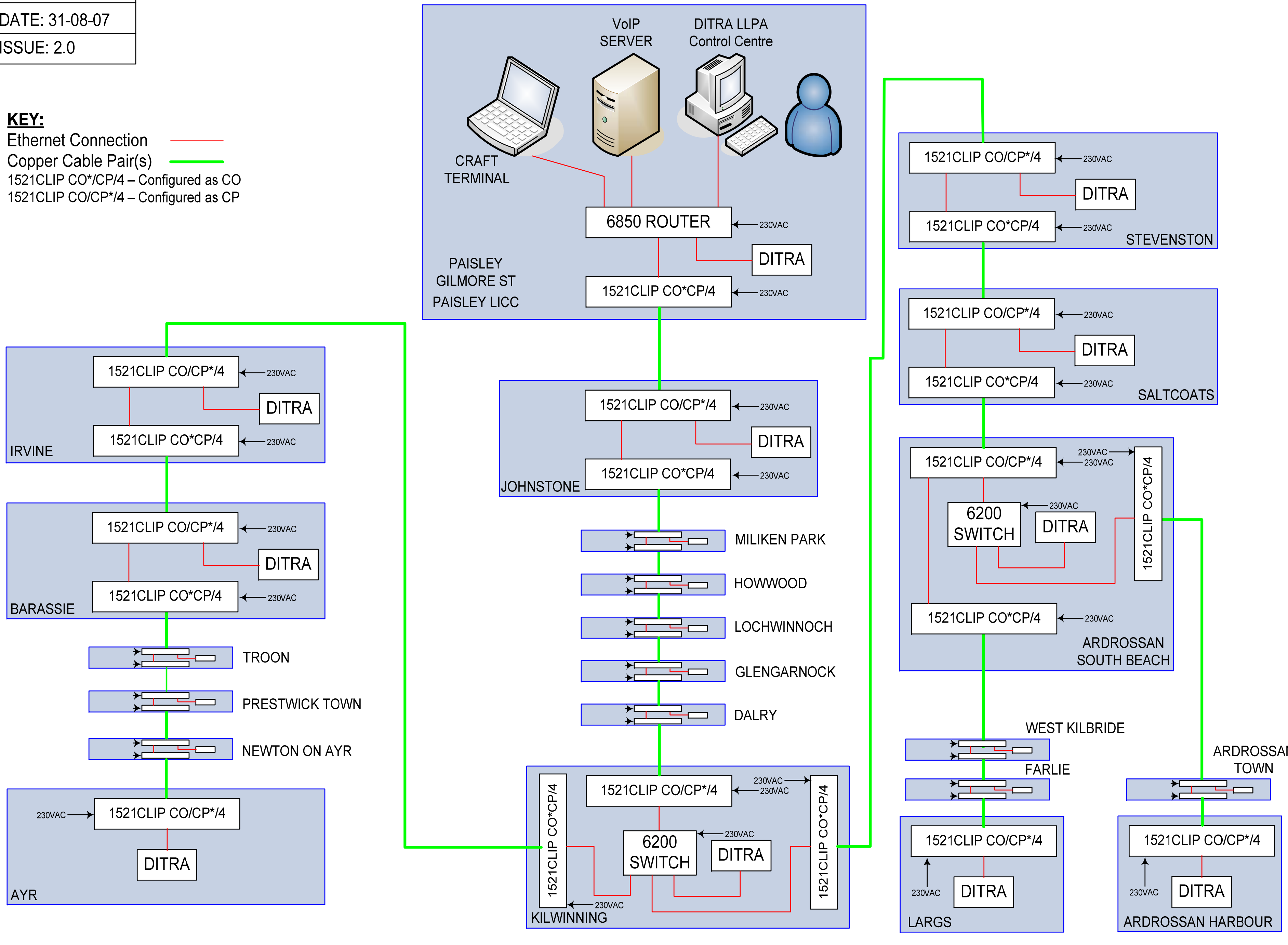
Alcatel 1521CLIP

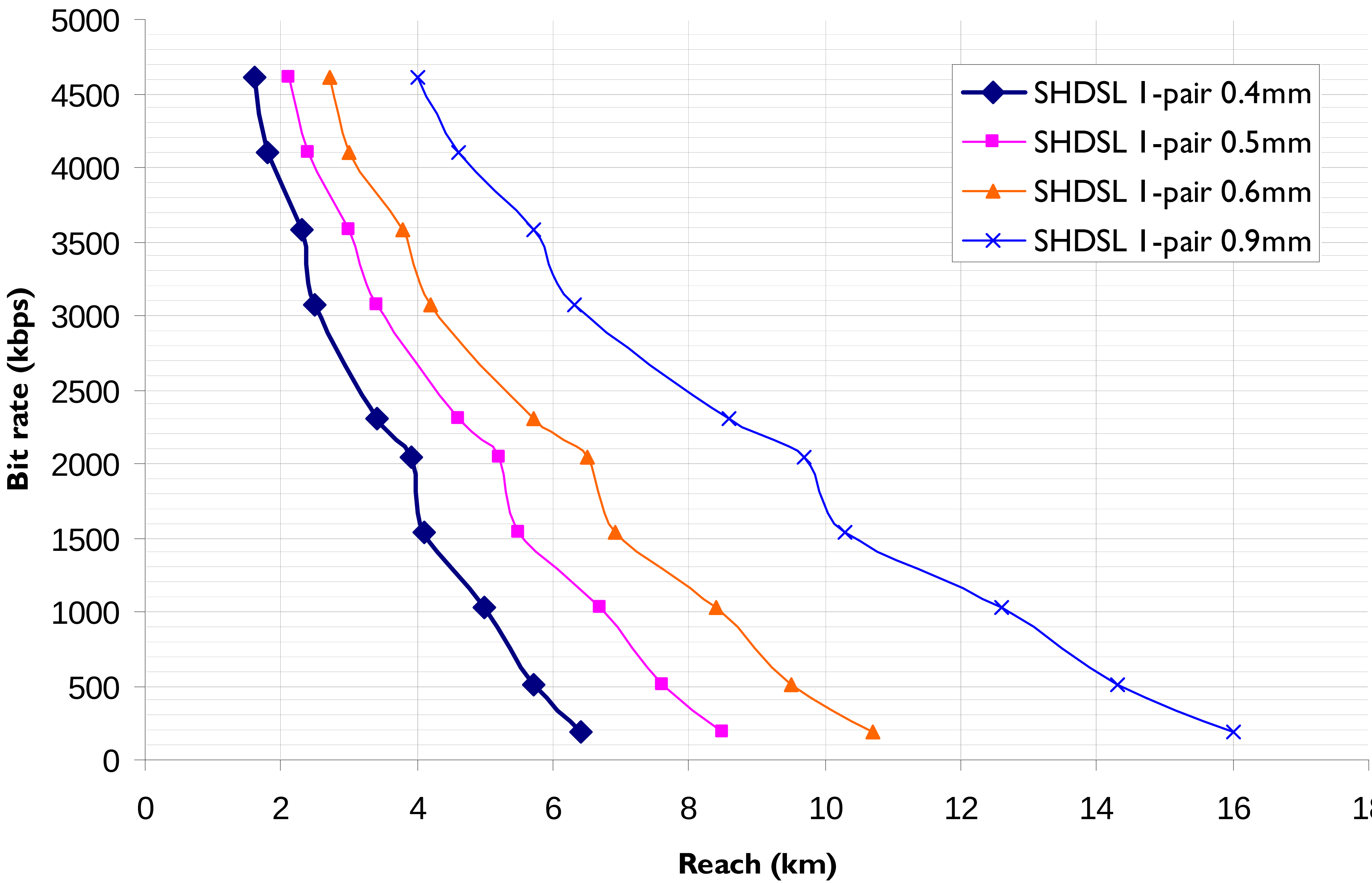


AYRSHIRE LLPA – PROPOSED USE OF 1521 CLIP WITH VLAN CONFIGURATION



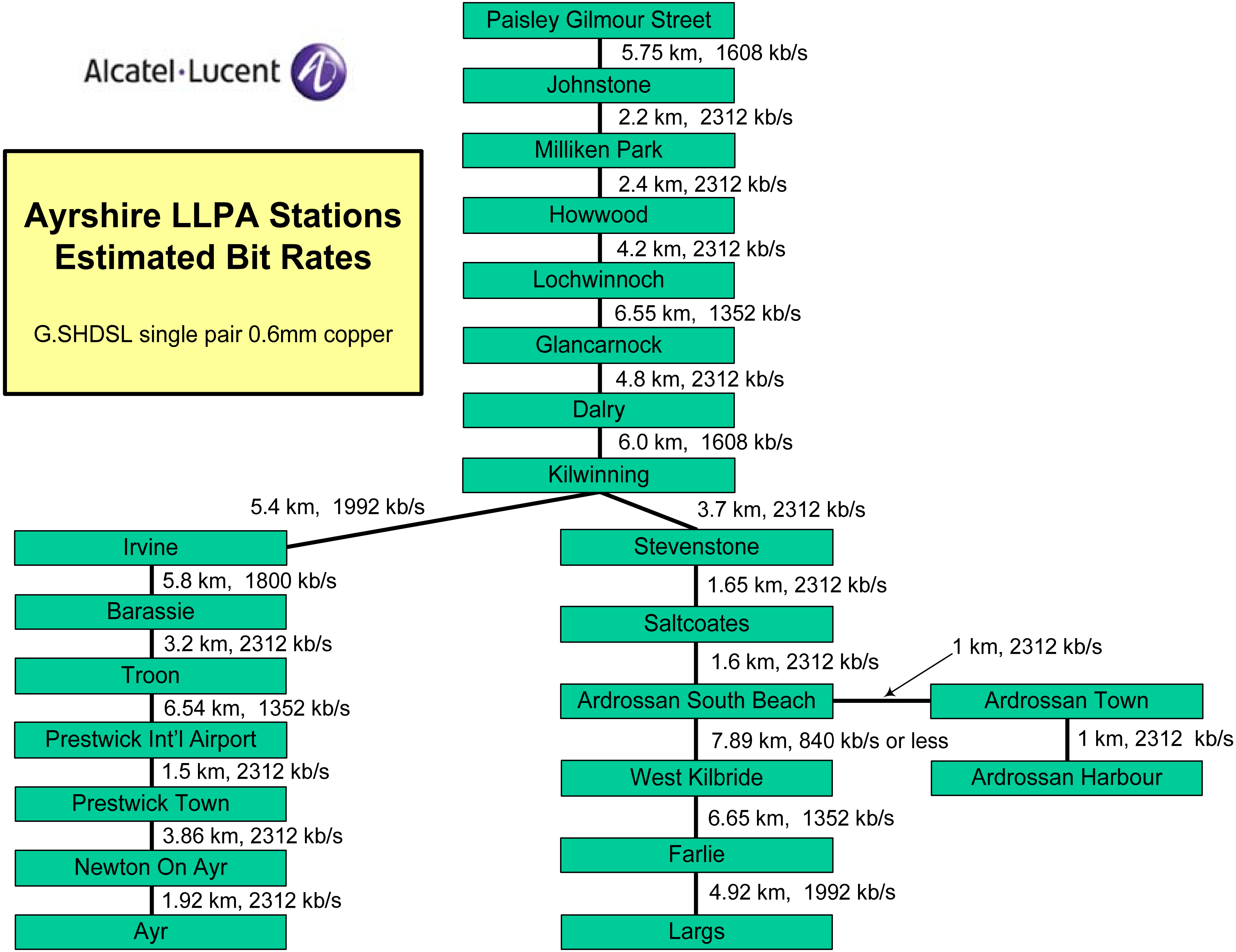
DRAWN: Rob Hall
DATE: 31-08-07
ISSUE: 2.0



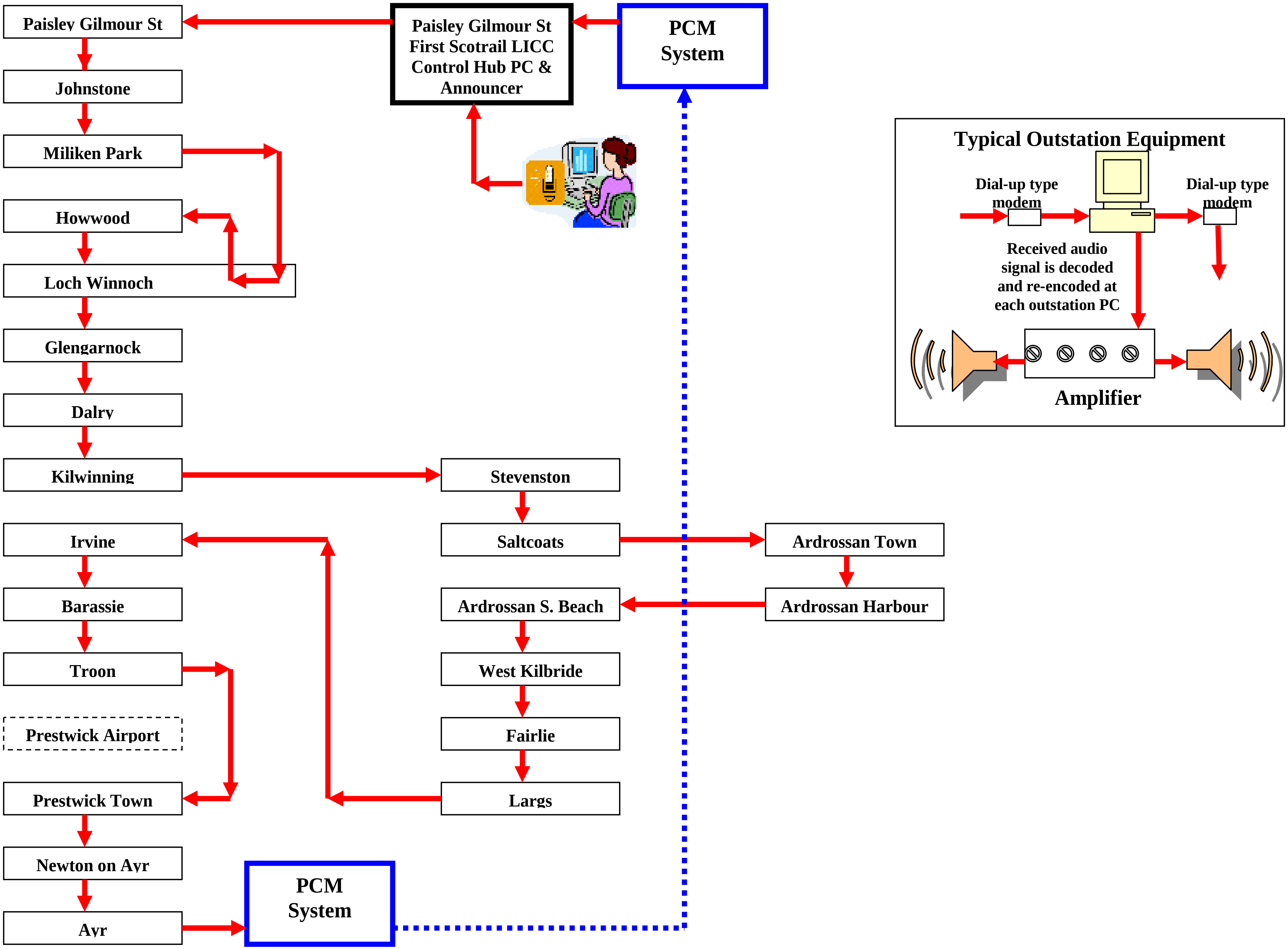

5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Bit rate (kbps)
0
2
4
6
8
10
12
14
16
18
Reach (km)
SHDSL 1-pair 0.4mm
SHDSL 1-pair 0.5mm
SHDSL 1-pair 0.6mm
SHDSL 1-pair 0.9mm

Ayrshire LLPA Stations Estimated Bit Rates

G.SHDSL single pair 0.6mm copper



AYRSHIRE LLPA –EXISTING QSL SYSTEM



Long Term Solution:-

Let’s Use the FTN SDH Network!

Proposed Design Using FTN SDH

- Use existing Alcatel 1640FOX as main fibre bearer with 1642EMC and ISA card as interface to get to Ethernet connectivity
- Use Alcatel 1521CLIP to extend Ethernet over copper to Stations
- Provide 1521Clip “receiver”, router and IP based LLPA at Stations (plus new speakers)
- Would have some resilience in the event of a cable cut
- Remit for final solution includes additional locations on the G&SW as far as Gretna

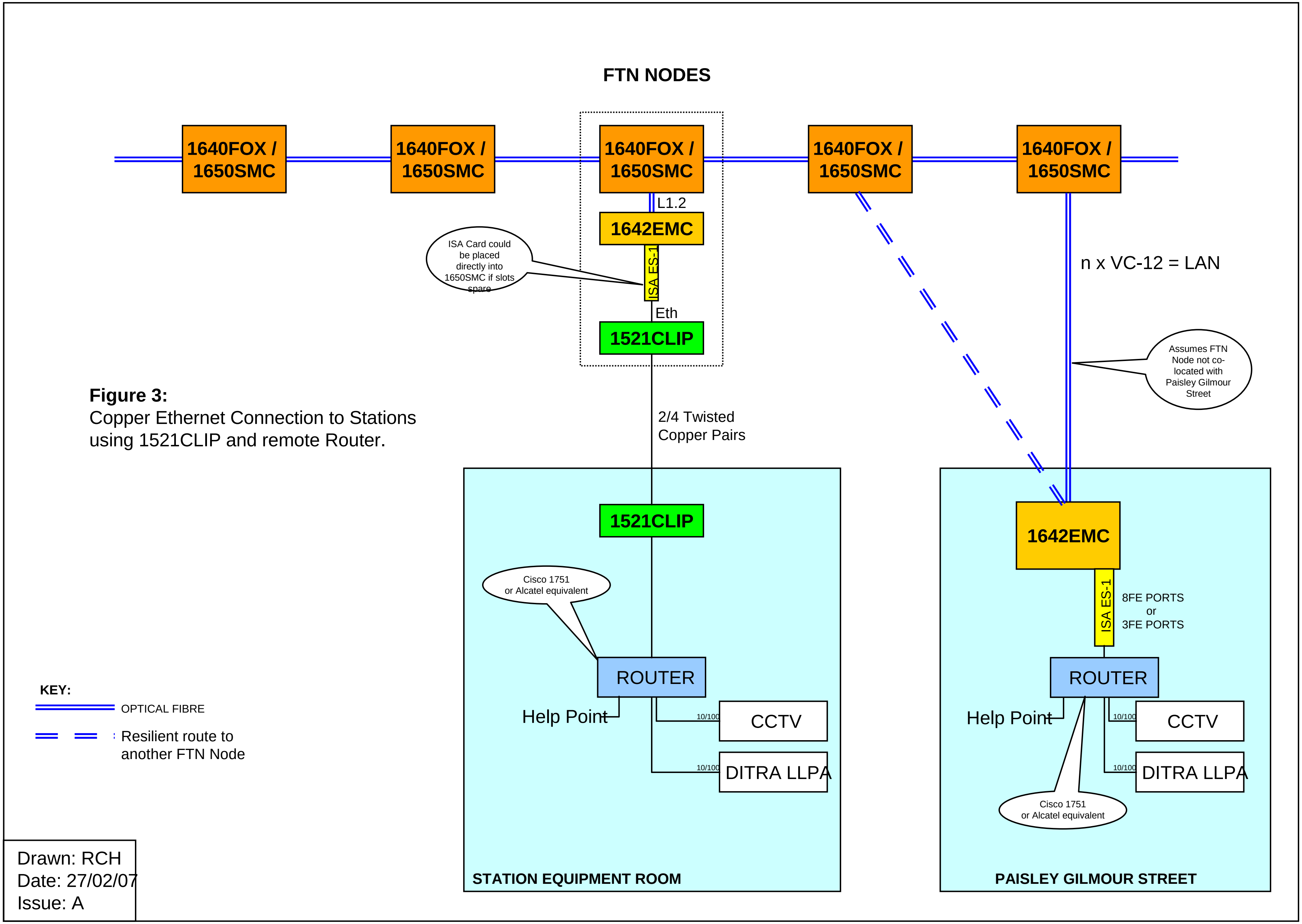


Figure 3:
Copper Ethernet Connection to Stations using 1521CLIP and remote Router.

Drawn: RCH
Date: 27/02/07
Issue: A


BARRY A MORGAN
Topline
BARRY A MORGAN
SCANIA
124L
420

Difficulties Adopting FTN Design

- No FTN design resource available (2012 top of agenda)
- Bandwidth not available in some sections
- Relatively expensive and complicated solution for a project that was not safety-critical
- Design not flexible for non-fibre areas
- FTN nodes not located at Stations
- Some SDH products were nearing the end of their life spans

Let’s Look at a Low Cost Alternative that we can Design and Manage Ourselves!

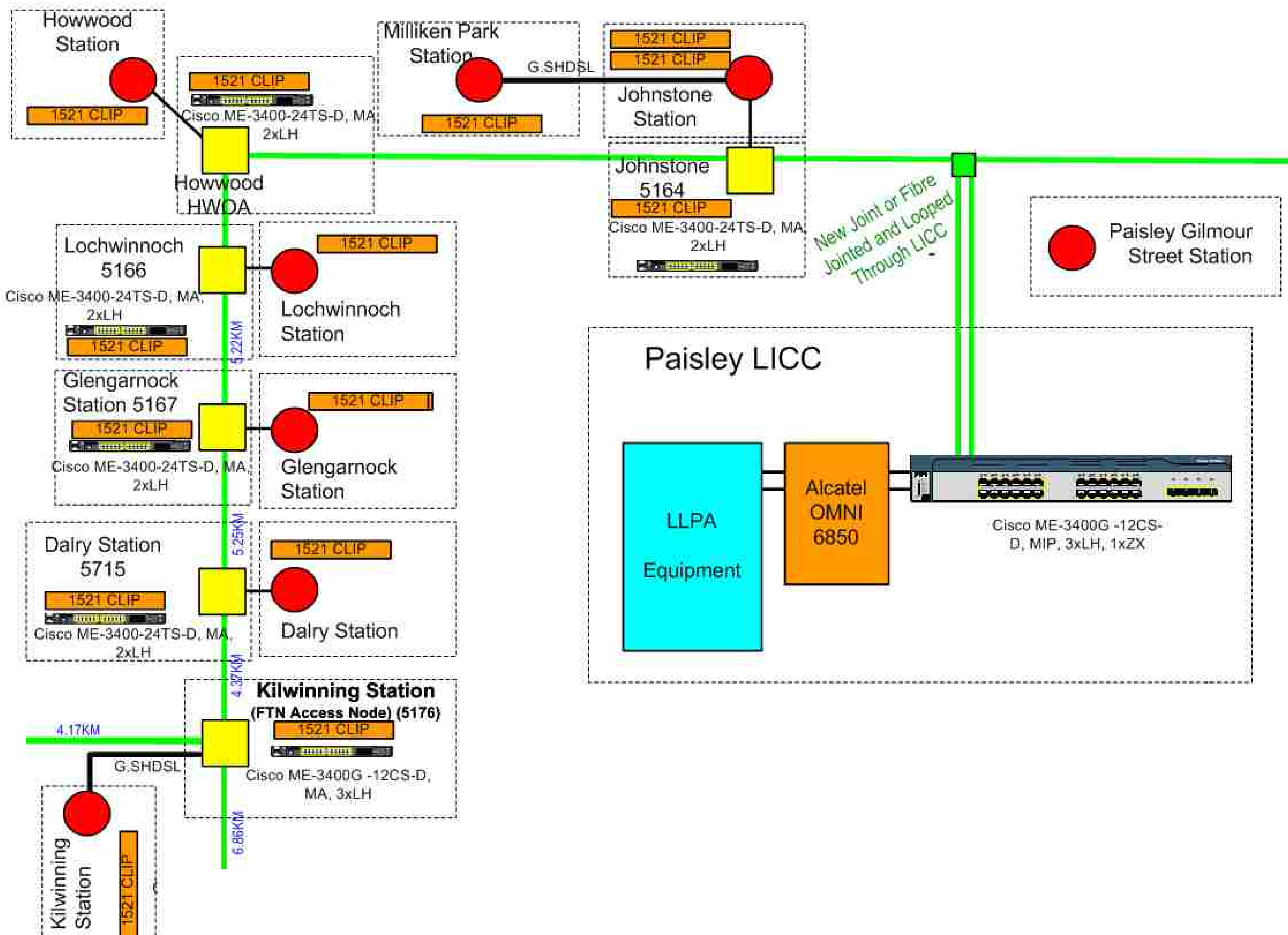
The Birth of

"JOCK WAN"

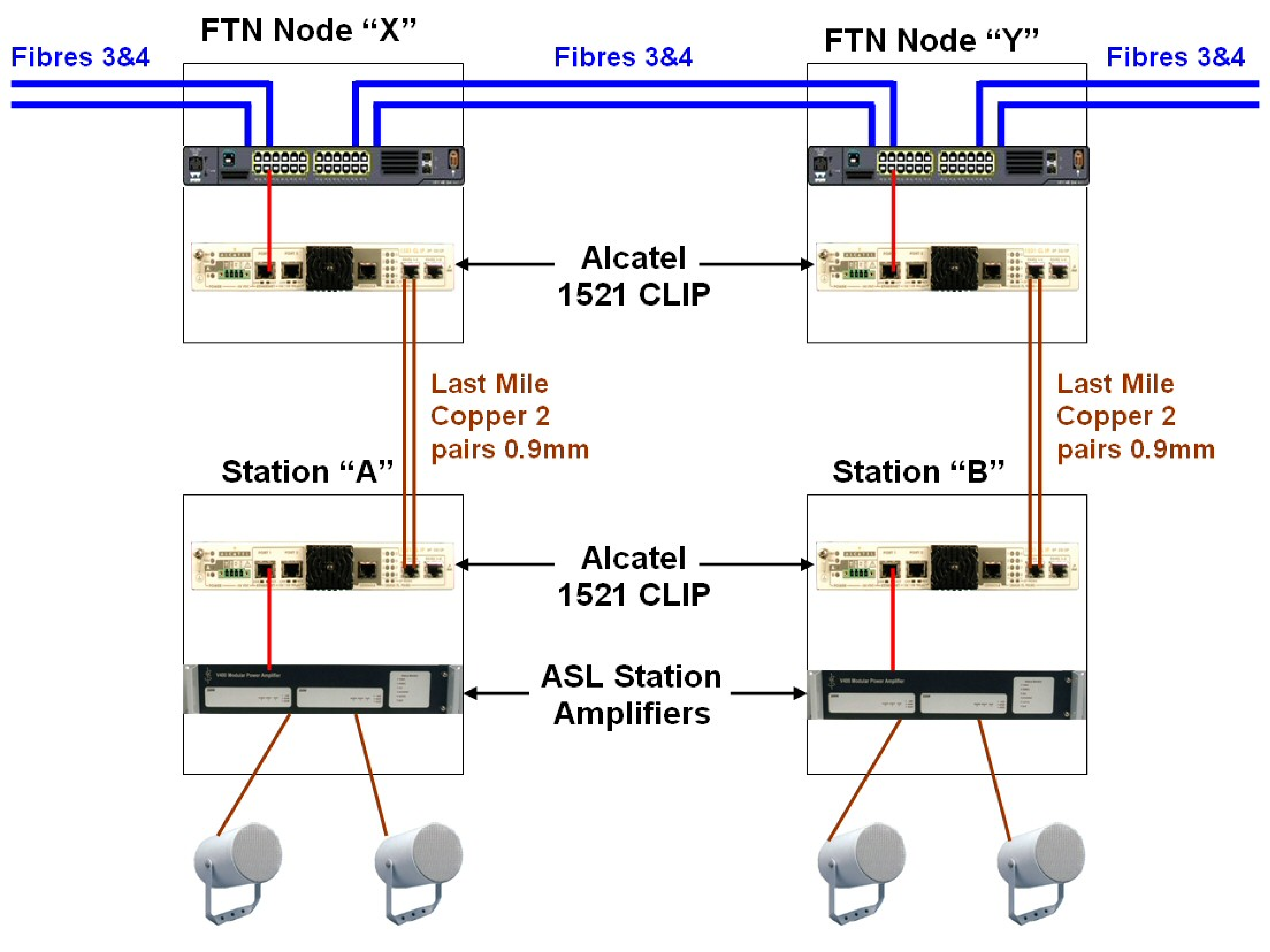

gok

Where the Idea Came from…

- RCM Pilot Project was already using IP based technology
- FTN had kindly provided plenty of spare fibres along most of the route
- FTN had provided secure, climate-controlled accommodation with battery back-up along route
- Low cost CISCO fibre switches/routers could form a simple but resilient network backbone
- No longer reliant on FTN design availability
- Expertise in network design was available and willing
- Bandwidth – no longer a problem with 1Gb routers



Howwood Station
1521 CLIP
1521 CLIP
Cisco ME-3400-24TS-D, MA, 2xLH
Howwood HWOA
Milliken Park Station
1521 CLIP
G.SHDSL
1521 CLIP
1521 CLIP
Johnstone Station
Johnstone 5164
1521 CLIP
Cisco ME-3400-24TS-D, MA, 2xLH
New Joint or Fibre Jointed and Looped Through LICC
Paisley Gilmour Street Station
Lochwinnoch 5166
Cisco ME-3400-24TS-D, MA, 2xLH
1521 CLIP
1521 CLIP
Lochwinnoch Station
5.22KM
Glengarnock Station 5167
1521 CLIP
Cisco ME-3400-24TS-D, MA, 2xLH
1521 CLIP
Glengarnock Station
Paisley LICC
LLPA Equipment
Alcatel OMNI 6850
Cisco ME-3400G -12CS-D, MIP, 3xLH, 1xZX
5.25KM
Dalry Station 5715
1521 CLIP
Cisco ME-3400-24TS-D, MA, 2xLH
1521 CLIP
Dalry Station
4.37KM
Kilwinning Station (FTN Access Node) (5176)
1521 CLIP
Cisco ME-3400G -12CS-D, MA, 3xLH
4.17KM
G.SHDSL
6.86KM
Kilwinning Station
1521 CLIP


FTN Node "X"
FTN Node "Y"
Fibres 3&4
Fibres 3&4
Fibres 3&4
Alcatel 1521 CLIP
Last Mile Copper 2 pairs 0.9mm
Last Mile Copper 2 pairs 0.9mm
Station "A"
Station "B"
Alcatel 1521 CLIP
ASL Station Amplifiers


MSC DON GIOVANNI

What other Improvements can we make?

- Look for a Cabinet which is fit for purpose and minimises manual handling and avoids track possessions


Danger
240V.AC
Modular Power Amplifier
240V.AC
07/06/2010

What other Improvements can we make?

- Look for a Cabinet which is fit for purpose and minimises manual handling and track possessions
- Why don’t we record our own announcements?

What other Improvements can we make?

- Look for a Cabinet which is fit for purpose and minimises manual handling and track possessions
- Why don’t we record our own announcements?
- Provide 10Mb bandwidth at each Station making the system future proof by connecting the Stations with a “last mile” new 0.9 mm copper cable using 2 pairs for the Ethernet extenders


Cisco ME 3400 SERIES
CONSOLE

What other Improvements can we make?

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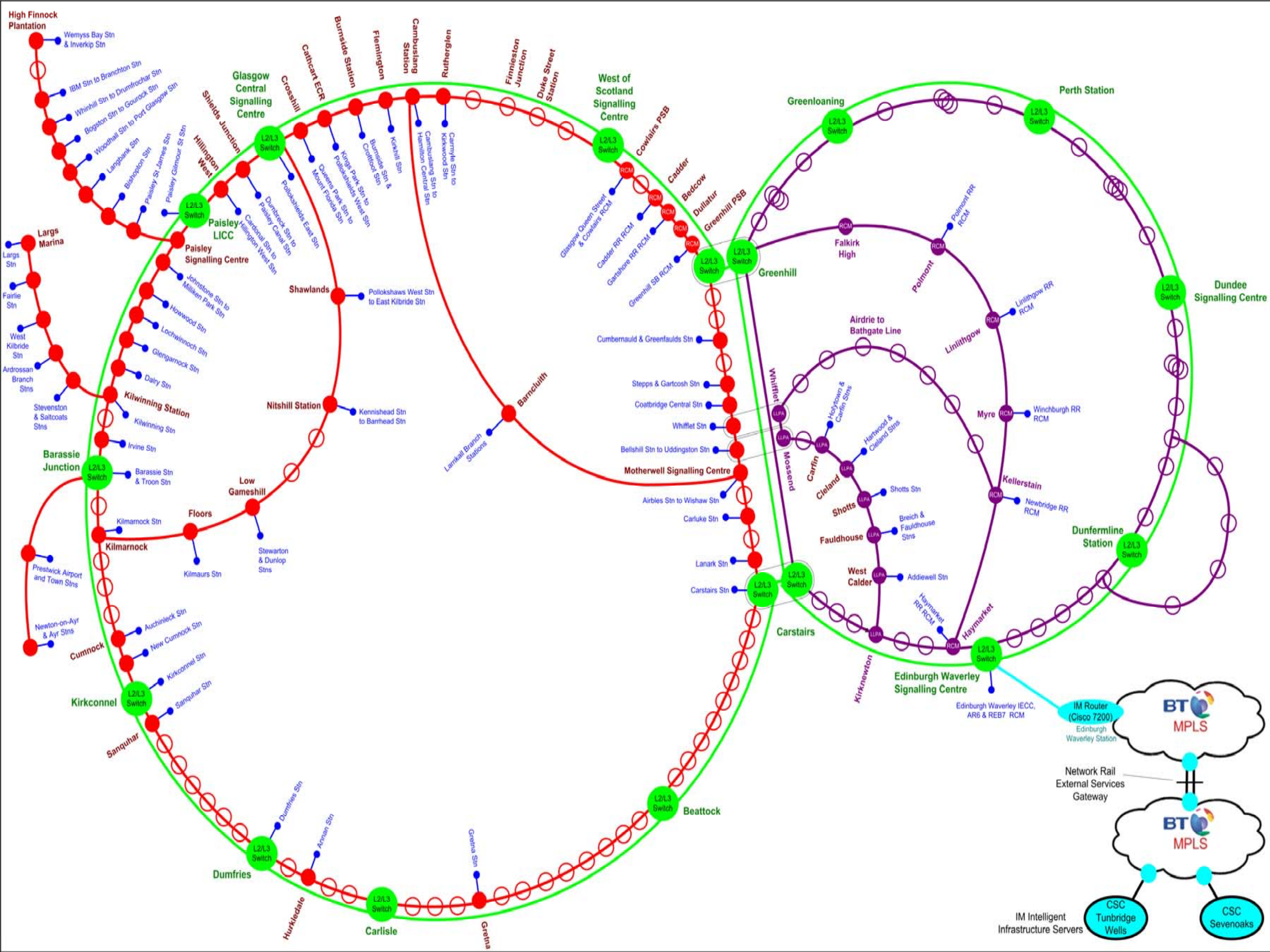
- Design using closed rings wherever possible
- Design the system to incorporate (and minimise the cost to) the 4 subsequent projects


High Finnock Plantation
Wemyss Bay Stn & Inverkip Stn
IBM Stn to Branchton Stn
Whinhill Stn to Drumfrochar Stn
Bogston Stn to Gourock Stn
Woodhall Stn to Port Glasgow Stn
Langbank Stn
Bishopton Stn
Paisley St James Stn
Paisley Gilmour St Stn
Hillington West
Shields Junction
Glasgow Central Signalling Centre
Crosshill
Cathcart ECR
Burnside Station
Flemington
Cambuslang Station
Rutherglen
Finnieston Junction
Duke Street Station
West of Scotland Signalling Centre
Cowlairs PSB
Cadder
Bedcow
Dullatur
Greenhill PSB
L2/L3 Switch
Paisley LICC
Paisley Signalling Centre
Cardonald Stn to Hillington West Stn
Dumbreck Stn to Paisley Canal Stn
Pollokshields East Stn
Queens Park Stn to Mount Florida Stn
Kings Park Stn to Pollokshields West Stn
Burnside Stn & Croftfoot Stn
Kirkhill Stn
Cambuslang Stn to Hamilton Central Stn
Carmyle Stn to Kirkwood Stn
Glasgow Queen Street & Cowlairs RCM
Cadder RR RCM
Gartshore RR RCM
Greenhill SB RCM
RCM
Largs Marina
Largs Stn
Fairlie Stn
West Kilbride Stn
Ardrossan Branch Stns
Stevenston & Saltcoats Stns
Johnstone Stn to Milliken Park Stn
Howwood Stn
Lochwinnoch Stn
Glengarnock Stn
Dalry Stn
Kilwinning Station
Kilwinning Stn
Irvine Stn
Barassie Junction
Barassie Stn & Troon Stn
Shawlands
Pollokshaws West Stn to East Kilbride Stn
Nitshill Station
Kennishead Stn to Barrhead Stn
Barncluith
Larnkall Branch Stations
Low Gameshill
Floors
Kilmarnock Stn
Kilmarnock
Kilmaurs Stn
Stewarton & Dunlop Stns
Prestwick Airport and Town Stns
Newton-on-Ayr & Ayr Stns
Cumbernauld & Greenfaulds Stn
Stepps & Gartcosh Stn
Coatbridge Central Stn
Whifflet Stn
Bellshill Stn to Uddingston Stn
Motherwell Signalling Centre
Airbles Stn to Wishaw Stn
Carluke Stn
Lanark Stn
Carstairs Stn
Carstairs
Greenloaning
Perth Station
Greenhill
Falkirk High
Polmont
Polmont RR RCM
Linlithgow
Linlithgow RR RCM
Dundee Signalling Centre
Airdrie to Bathgate Line
Whifflet
Mossend
LLPA
Holytown & Carfin Stns
Hartwood & Cleland Stns
Carfin
Cleland
Shotts
Shotts Stn
Breich & Fauldhouse Stns
Fauldhouse
West Calder
Addiewell Stn
Myre
Winchburgh RR RCM
Kellerstain
Newbridge RR RCM
Dunfermline Station
Haymarket RR RCM
Haymarket
Kirknewton
Edinburgh Waverley Signalling Centre
Edinburgh Waverley IECC, AR6 & REB7 RCM
IM Router (Cisco 7200)
Edinburgh Waverley Station
BT MPLS
Network Rail External Services Gateway
BT MPLS
IM Intelligent Infrastructure Servers
CSC Tunbridge Wells
CSC Sevenoaks
Auchinleck Stn
New Cumnock Stn
Cumnock
Kirkconnel Stn
Kirkconnel
Sanquhar Stn
Sanquhar
Dumfries Stn
Dumfries
Annan Stn
Hurkledale
Carlisle
Gretna Stn
Gretna
Beattock

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- Design using closed rings wherever possible
- Design the system to incorporate (and minimise the cost to) the 4 subsequent projects
- Prove that design on the bench and at the factory to minimise risk
- Consider all other uses the Network could deliver

Next Steps

- Maximise the potential of the network
- Work with IM to reduce BT private wire charges
- Extend the RCM data collection since the larger network is now established
- Take first steps to provide Signalling bearer circuits over IP
- Consider initially LC CCTV with a local camera identification
- Contract negotiations are in final stages for FTNe roll out
- Long term replacement of SDH with IP – even talk of SDH over IP as an interim step

Ethernet Transport Networks for the railways

Robert Gardner

09 Feb 2011

Transmission Systems

Should we just stick to what we know?

Section One

Transmission Systems

Should we just stick to what we know?

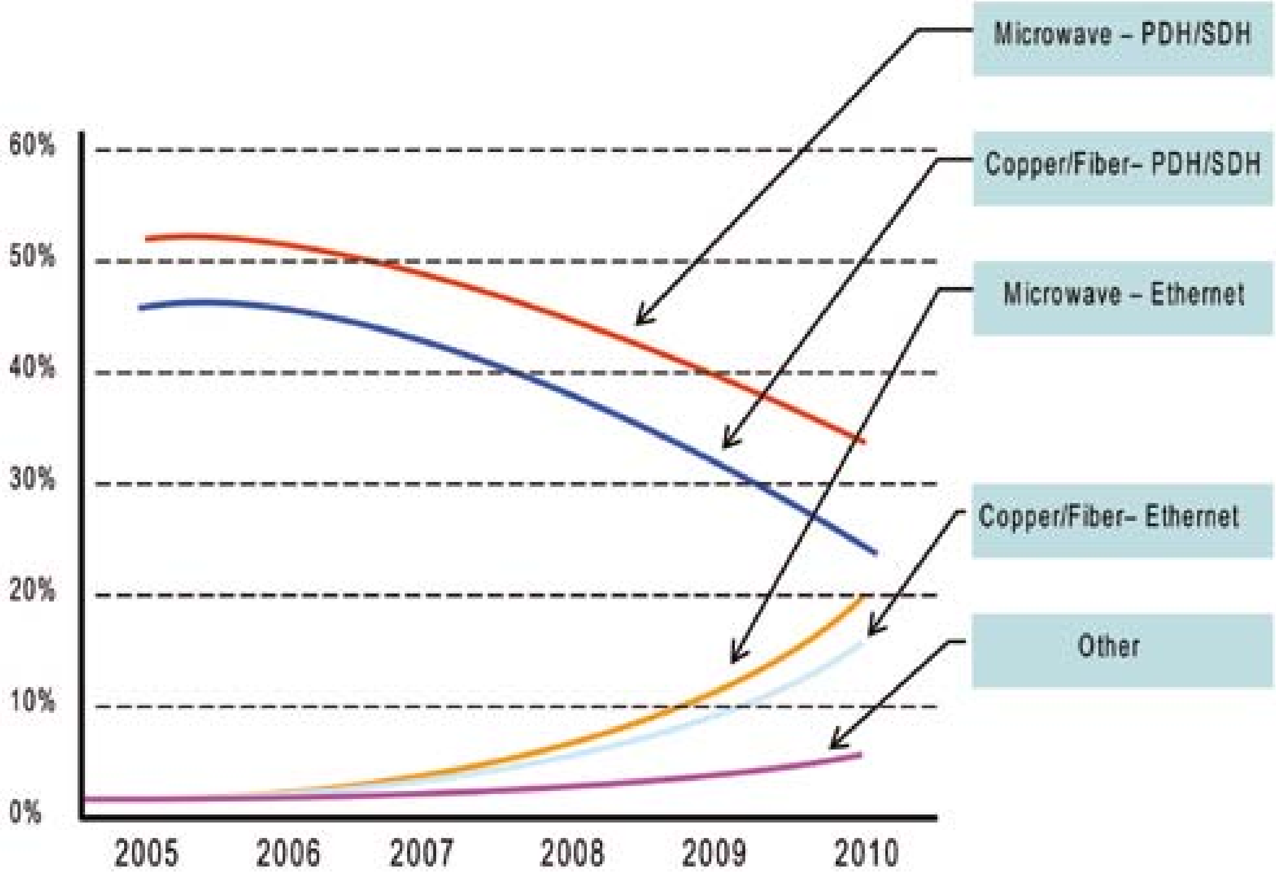
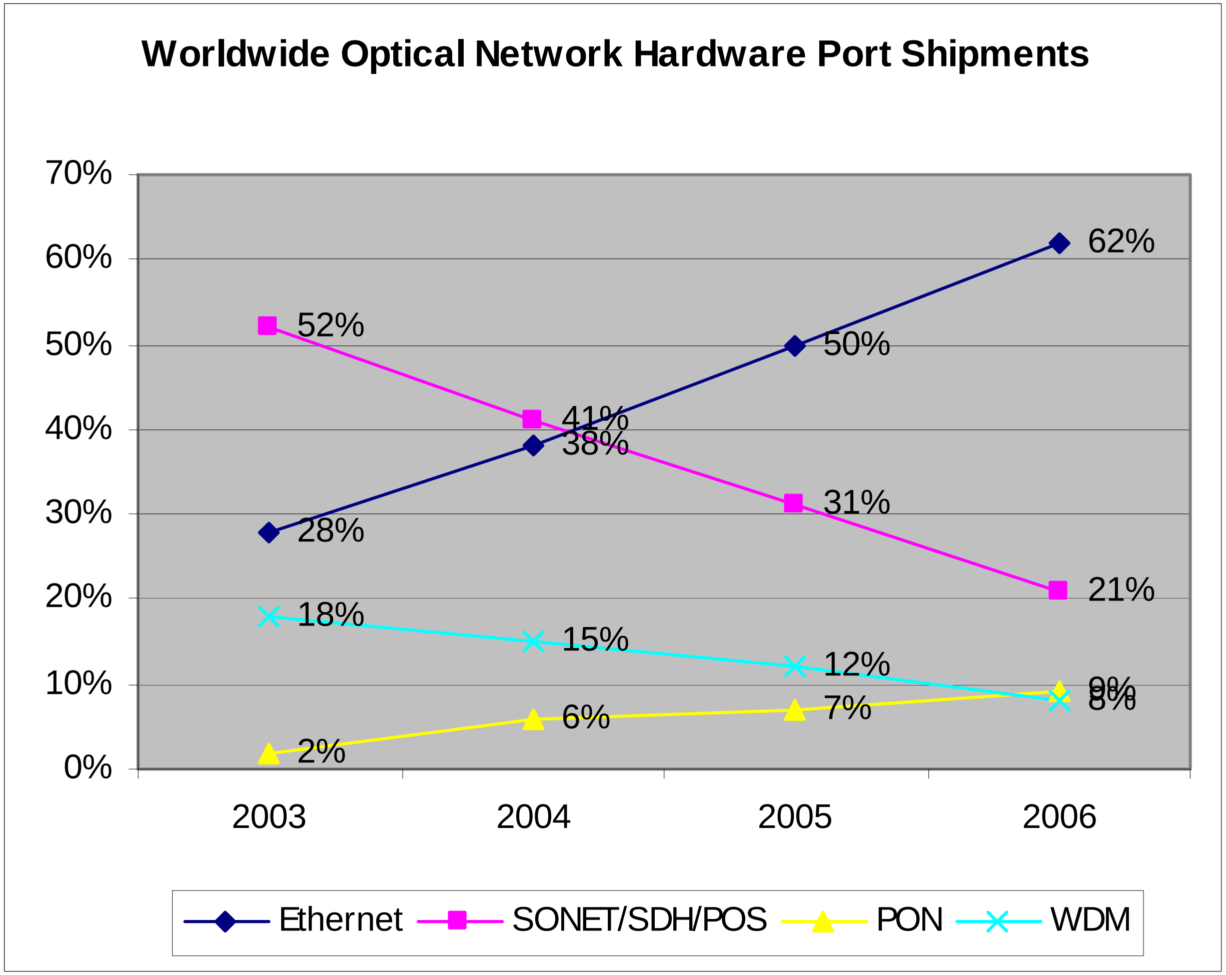


Figure 2 - Global Trends in Backhaul Implementation/Transport

(source: Infonetics Research – Mobile Backhaul Equipment 2007)

Transmission Systems

Should we just stick to what we know?



Transmission Systems

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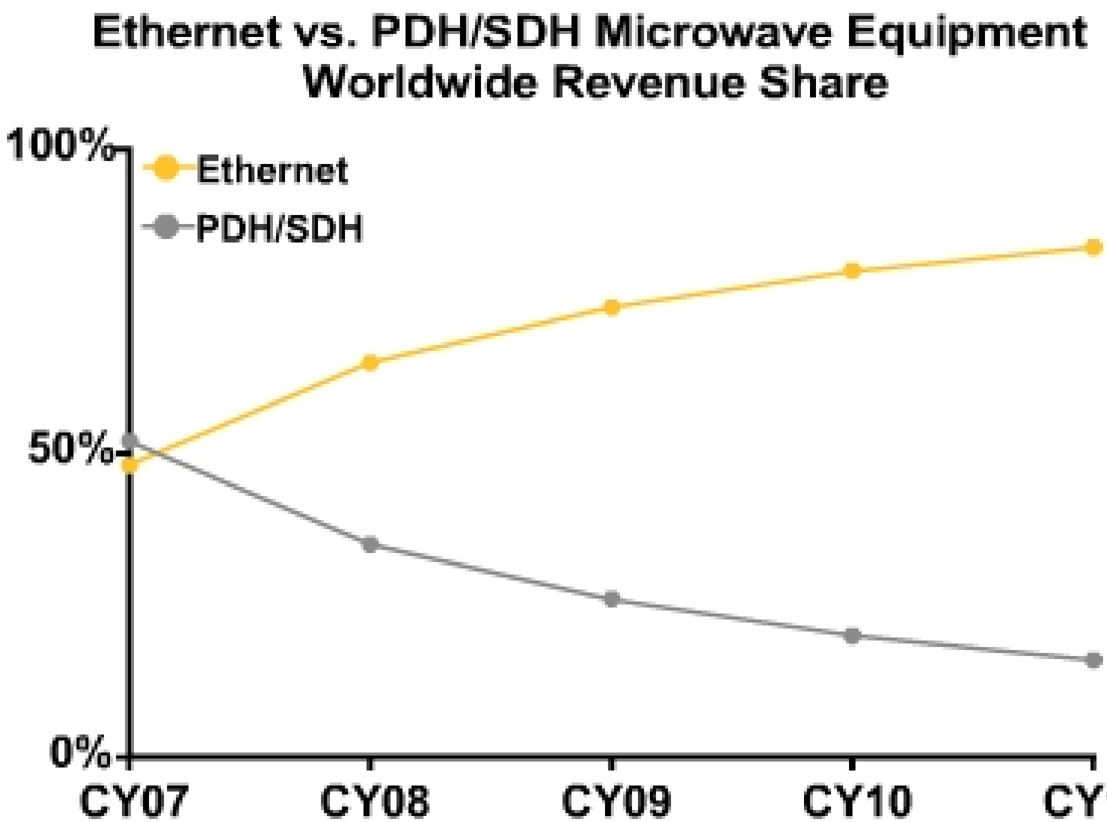


© Infonetics Research, *Microwave Equipment Market Outlook* December 2008

Transmission Systems

Should we just stick to what we know?

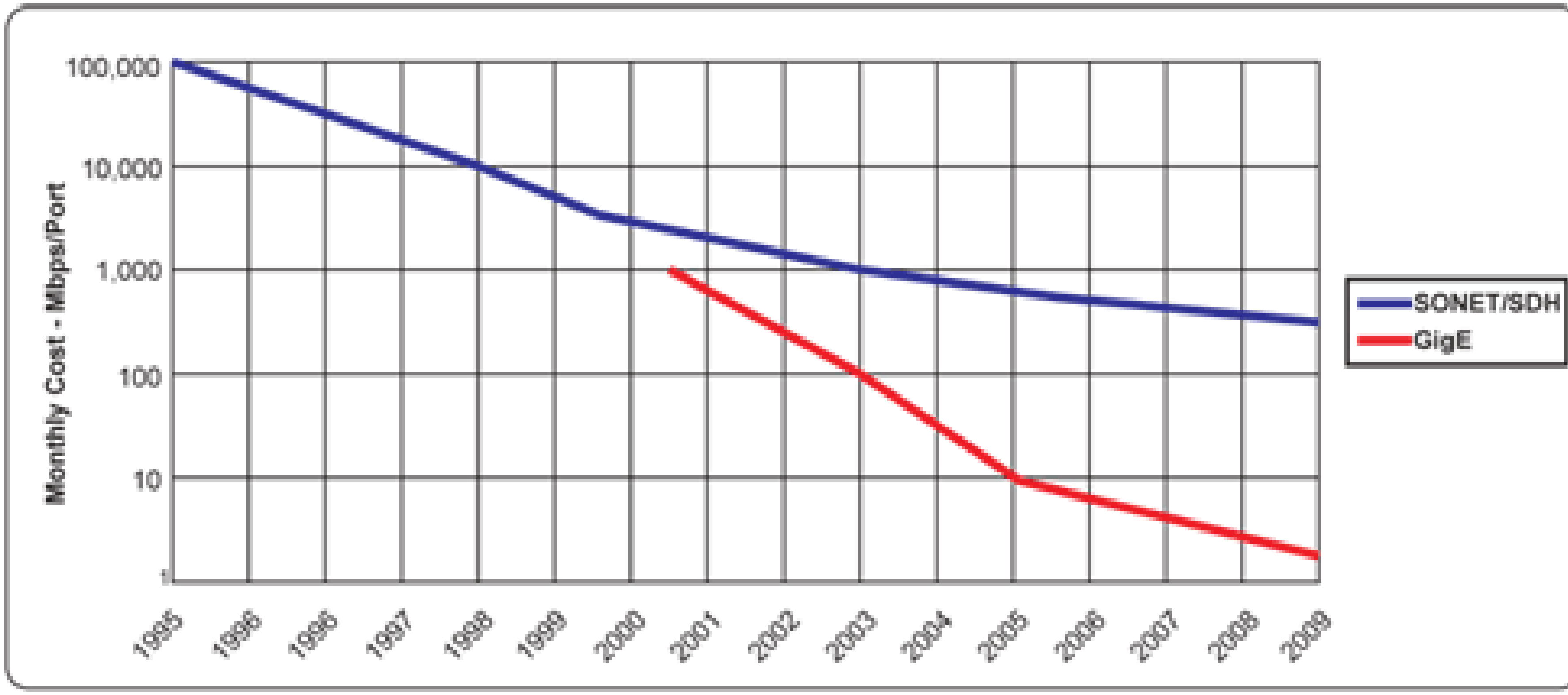


Fig. 5: SONET/SDH vs. Ethernet Monthly Cost

This is the only graph I could find where Gigabit Ethernet is falling (and faster than SDH)

Transmission Systems

Should we just stick to what we know?

2003 Metro Ethernet

- CAPEX savings of **39%** vs. legacy SONET/SDH network
- OPEX savings of **49%** vs. legacy SONET/SDH

2010 Metro Ethernet

- CAPEX savings of **~60%** vs. legacy SONET/SDH network
- OPEX savings of **~60%** vs. legacy SONET/SDH

TRANSMISSION

- Does the job, most of the time, albeit a bit slowly… but comfortable and familiar

TRANSMISSION

- Quite large and clunky, and very energy-hungry…

TRANSMISSION

- Well understood, safe option… but expensive to maintain
- And doesn't interface easily with newer stock

- In 1972, the APT-E, a gas turbine-powered experimental test-bed, was constructed. It was experimental, pioneering, futuristic.
- Ethernet was developed at Xerox PARC between 1973 & 1975;
- In 2010 we have Pendolinos and MPLS / IP / Ethernet, both technologies having matured decidedly.


…Like the French
TGV…and similarly,
Ethernet just keeps
getting faster!
F

Transmission Systems

Should we just stick to what we know?

- The communications world is moving at a faster pace than ever before
- The railways need extremely high performance communications at an affordable price and therefore we MUST investigate and adopt new technologies.
- If not
  - Old, maintainable equipment ➔ higher cost
  - Interfacing problems ➔ higher cost
  - Lack of trained staff ➔ higher cost
  - Inability to deploy new services ➔ higher cost
  - Poorer network availability ➔ higher cost

Ethernet Transport Vision

What is this?

Section One

Ethernet Transport Vision

What is this?

- The ability to continuously adapt has made Ethernet a significant innovation in facilitating **unified communications**. Since the invention of Ethernet in the 1970s, Ethernet has proven itself to be a technology that can **adapt to evolving market needs**.

- Ethernet was initially developed as a LAN standard for connecting at 10 Mbps speeds but has subsequently been upgraded to offer 100 Mbps, 1 Gbps, and now 10, 40 and 100 Gbps speeds over both copper and fibre media.

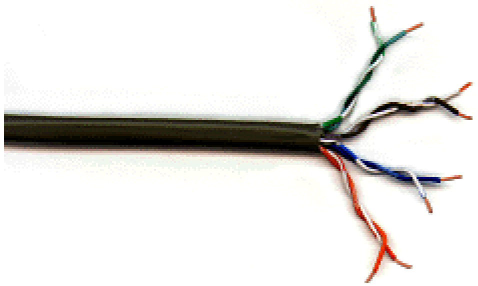
- Ethernet is one of the most **significant disruptive innovations** of this generation—and has now evolved from Local Area Networks (LANs) to the Metro and Wide Area Network (MAN/WAN). The **implications of these capabilities are immense**.

from Whitepaper: What is Carrier Grade Ethernet? - Brocade

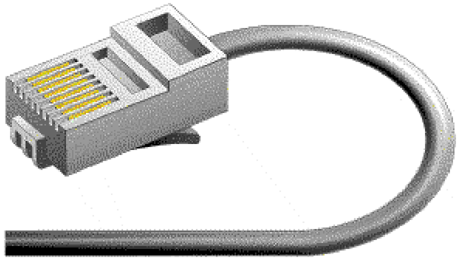
Ethernet Transport Vision

What is this?

- **Ethernet** and the **Internet Protocol** (IP) have emerged as the dominant data communications technology.
- Reasons:
  - – high performance vs. relatively low cost
  - – flexible yet simple (at the point of use)



- Now widespread in the MAN/WAN with **MPLS** enabling Carrier-Grade enhancements - Carrier (Grade) Ethernet

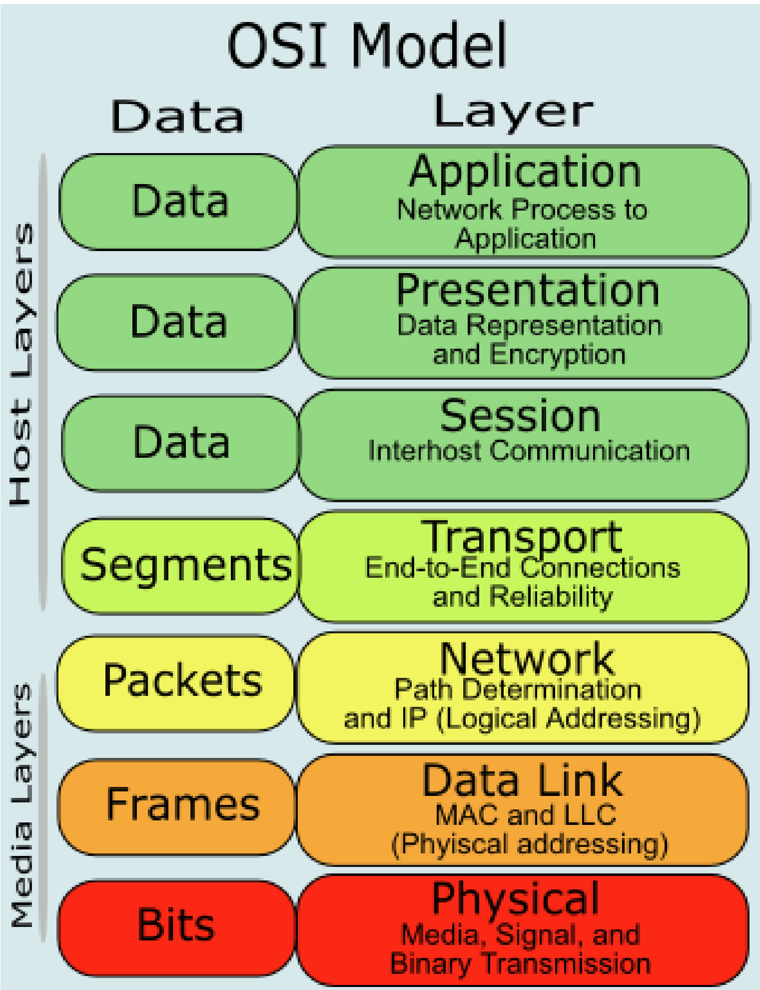


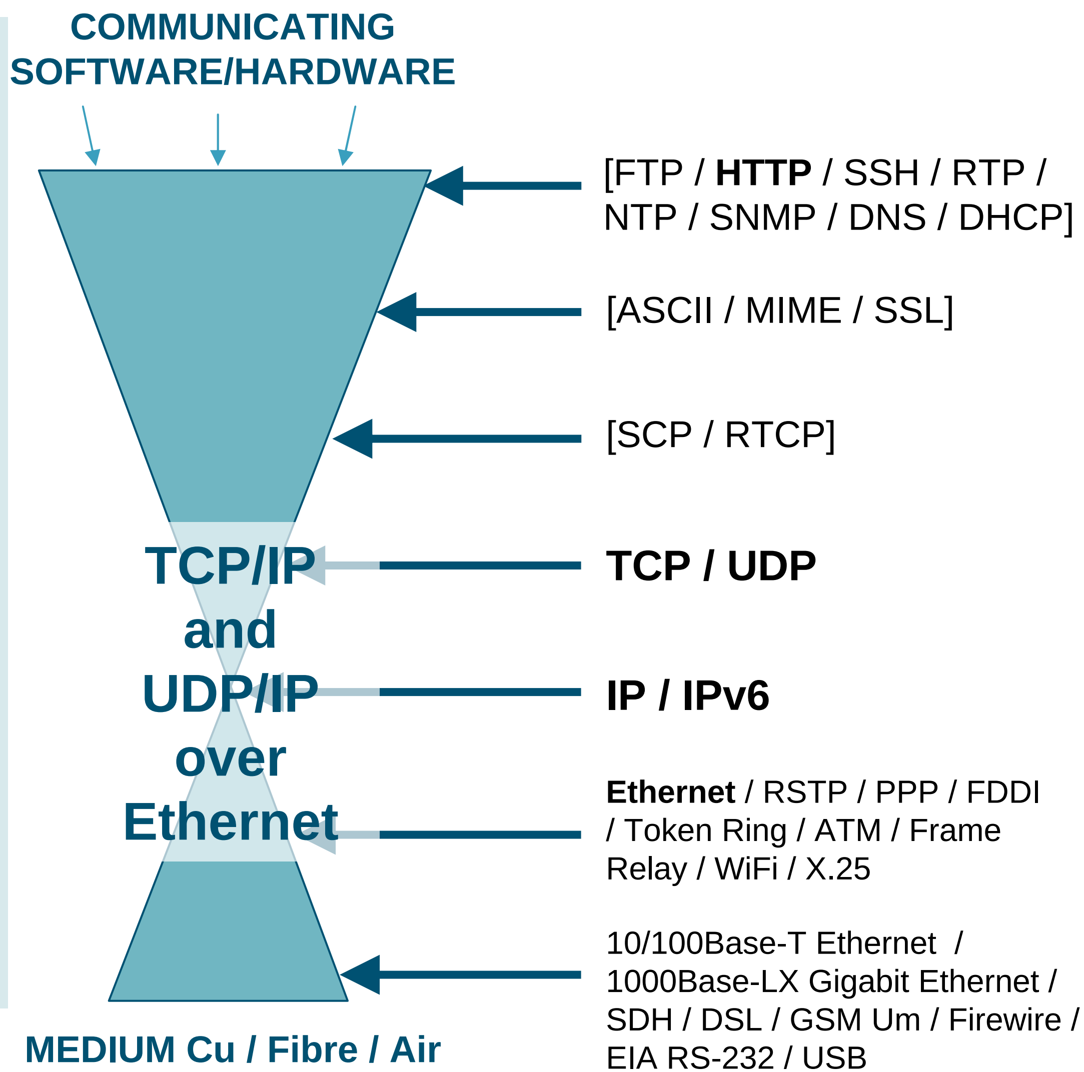
Universal standard 8P8C connector with TIA/EIA-568-B wiring typically used with Cat5e cabling for all non-optical Ethernet speed versions.

(informally and incorrectly known as RJ45)

Ethernet Transport Vision

What is this?





Ethernet Transport Vision

What is this?

Standards Body	Ethernet Services	Architecture/Control	Ethernet OAM	Ethernet Interfaces
IEEE	-	• 802.3 – MAC • 802.1D/Q – Bridges/VLAN • 802.17 - RPR • 802.1ad – Provider Bridges • .1ah – Provider Backbone Bridges • .1ak – Multiple Registration Protocol • .1aj – Two Port MAC Relay • .1AE/af – MAC / Key Security • .1aq – Shortest Path Bridging • .1Qay – PBB-Traffic Engineering	• 802.3ah – EFM OAM • 802.1ag – CFM • 802.1AB - Discovery • 802.1ap – VLAN MIB	• 802.3 – PHYs • 802.3as - Frame Expansion
MEF METRO ETHERNET FORUM	• MEF 10 – Service Attributes • MEF 3 – Circuit Emulation • MEF 6 – Service Definition • MEF 8 – PDH Emulation • MEF 9 – Test Suites • MEF 14 – Test Suites • Services Phase 2	• MEF 4 – Generic Architecture • MEF 2 – Protection Req & Framework • MEF 11 – UNI Req & Framework • MEF 12 - Layer Architecture	• MEF 7– EMS-NMS Info Model • MEF 15– NE Management Req • OAM Req & Framework • OAM Protocol – Phase 1 • Performance Monitoring	• MEF 13 - UNI Type 1 • MEF 16 – ELMI • E-NNI
ITU	• G.8011 – Services Framewrk • G.8011.1 – EPL Service • G.8011.2 – EVPL Service • G.8601 – Service Mgmt Arch • G.smc – Service Mgmt Chnl	• G.8010 – Layer Architecture • G.8021 – Equipment model • G.8010v2 – Layer Architecture • G.8021v2 – Equipment model • G.8261 – Ethernet Sync Architecture	• Y.1730 – Ethernet OAM Req • Y.1731 – OAM Mechanisms • G.8031 – Protection • Y.17ethqos – QoS • Y.ethperf - Performance	• G.8012 – UNI/NNI • G.8012v2 – UNI/NNI
- TeleManagement FORUM	-	-	•TMF814 – EMS to NMS Model	-

Ethernet Transport Vision

What is this?

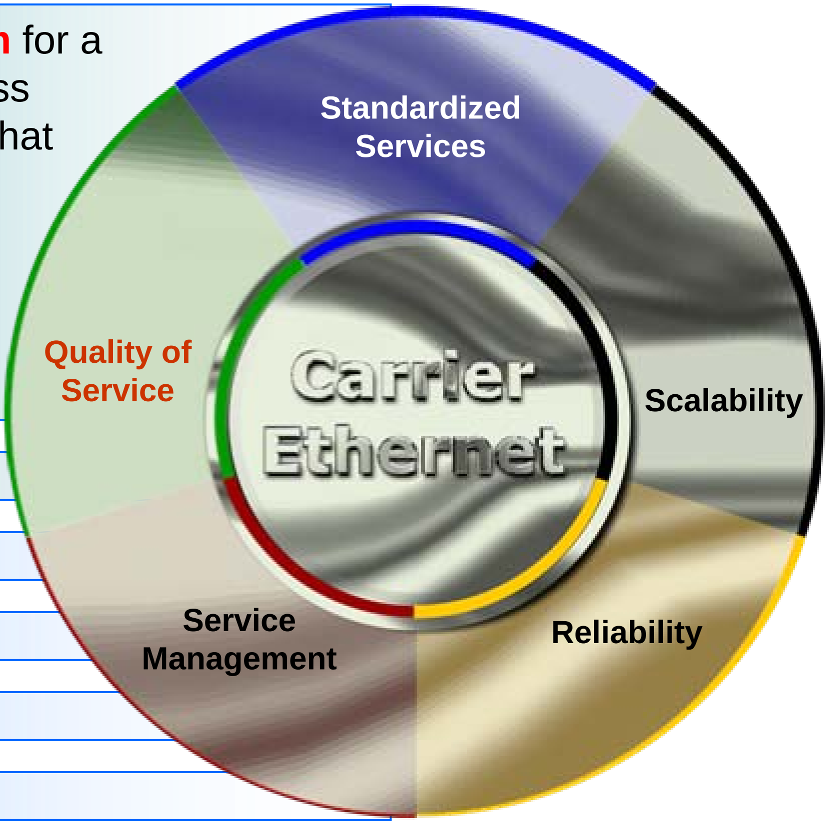
Metro Ethernet Forum

Carrier Ethernet

- Carrier Ethernet is an **umbrella term** for a ubiquitous, standardized, carrier-class **SERVICE** defined by five attributes that distinguish Carrier Ethernet from familiar LAN based Ethernet
- It brings the compelling business benefit of the Ethernet cost model to achieve significant savings

Carrier Ethernet Attributes

- **Standardized Services**
- **Scalability**
- **Service Management**
- **Reliability**
- **Quality of Service**



IP/Ethernet Equipment

Comparison with SDH/PDH transmission

Section One

IP/Ethernet Equipment

Comparison with SDH/PDH transmission

- Transmission
  - Born out of telecommunications
  - Medium: electrical / optical / radio
  - Synchronous (SDH) or Plesiochronous (PDH) operation
  - Data is Time Division Multiplexed into Timeslots (plesio-/syn-chronous)
  - Data separation via timeslot
  - 64kbit/s, 2, 8, 34, 155, 625Mbit/s, 2.5Gbit/s etc. at fixed granularity
  - Relatively high cost / larger size
- Ethernet
  - Born out of data communications
  - Medium: electrical / optical / radio
  - Asynchronous operation but with Synchronous capability
  - Data is Time Division Multiplexed into Frames/Packets (asychronous)
  - Data separation via frame labelling
  - 10Mbit/s, 100Mbit/s, 1Gbit/s, 10Gbit/s, 40Gbit/s, etc. at any granularity
  - Relatively low cost / smaller size

IP/Ethernet Equipment

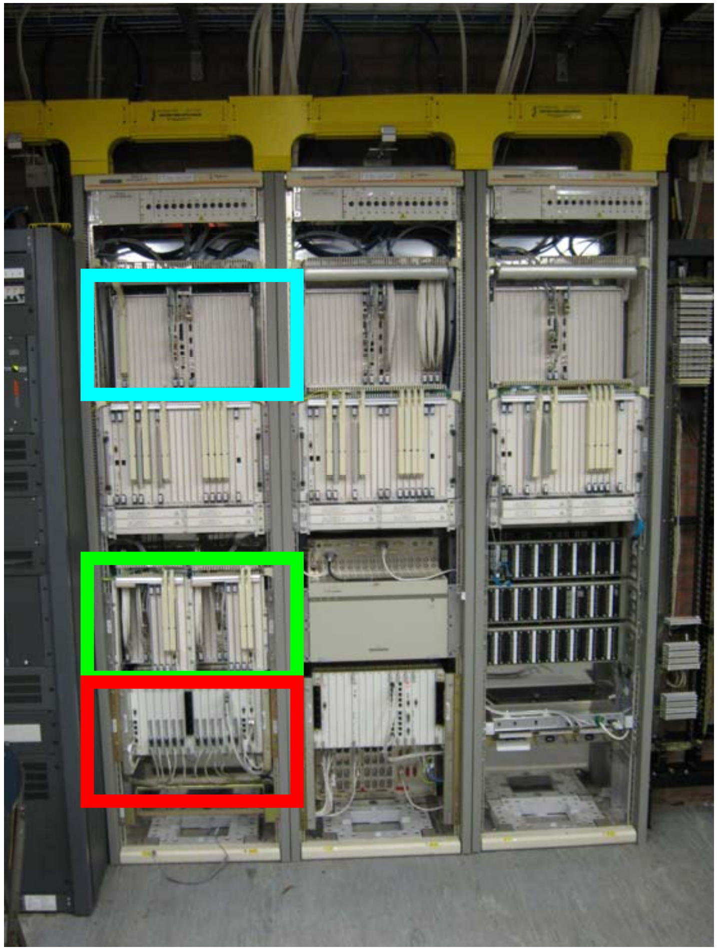
Comparison with SDH/PDH transmission

- Transmission
  - Protection < 50ms (SNCP)
  - Traffic Engineering: Virtual Concaten
  - Transport network is not involved in addressing data security threats since it's just a basic point to point pipe
  - Deterministic performance because all traffic channelised and routes fixed

- Ethernet
  - Redundancy < 50ms (MPLS, REP)
  - Traffic Engineering: MPLS
  - Packetisation of data provides inherent BS EN 50159 threat mitigation abilities and network can enhance security
  - Predictable Performance (SLAs) using QoS. Routes can be fixed or non-fixed

IP/Ethernet Equipment

Comparison with SDH/PDH transmission: SIZE



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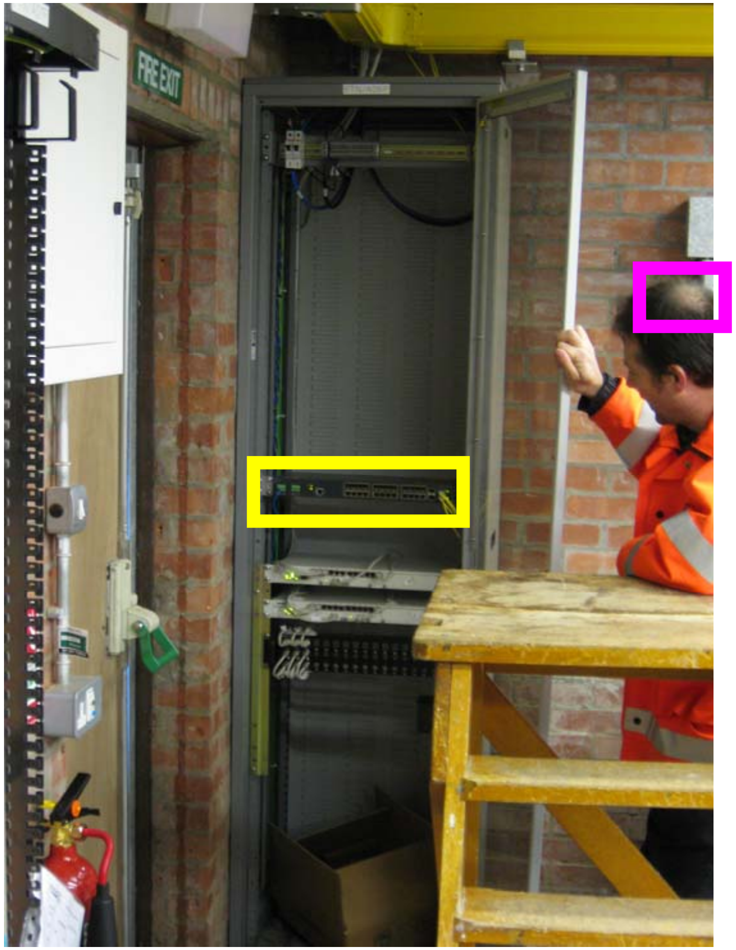
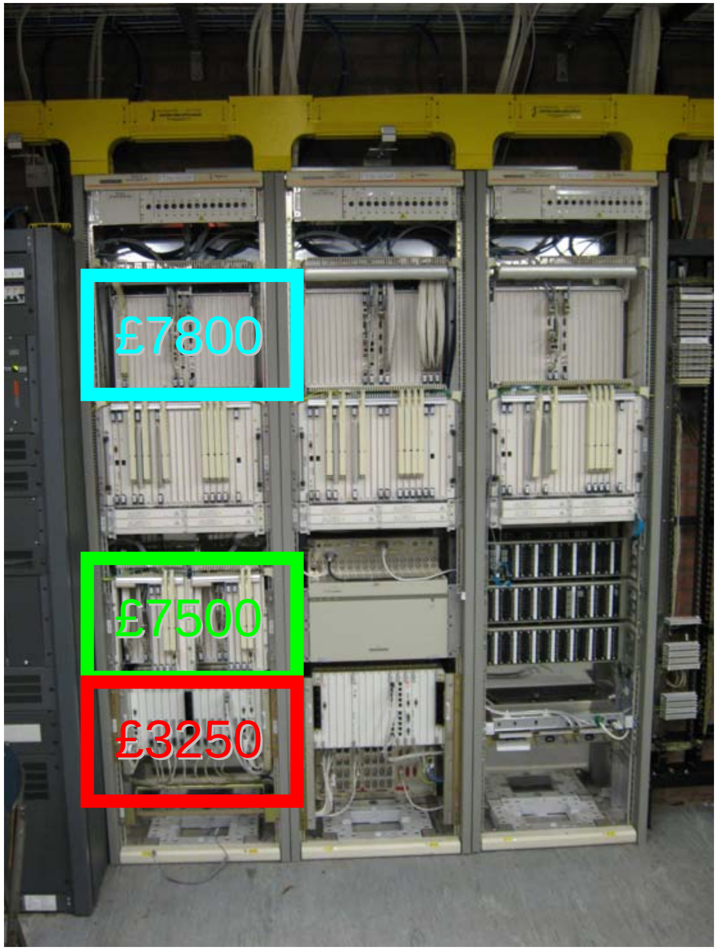


IP/Ethernet Equipment

Comparison with SDH/PDH transmission: COST



Ethernet Transport Vision

What is this?

8P8C plug/socket

Network

8P8C patch panel

Network Provides

Communications with right level of:

Reliability / Availability

Quality of Service

Additional Security Features

Scalability

Manageability

Good value for money

Encoder

Decoder

Codecs provides necessary SIL

Ethernet Transport Vision

What is this?

Network

Network Provides

Communications with right level of:

Reliability / Availability

Quality of Service

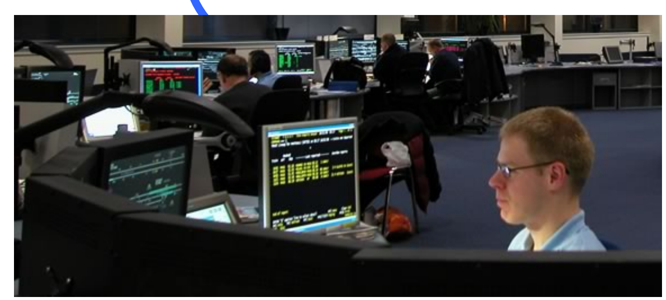
Additional Security Features

Scalability

Manageability

Good value for money

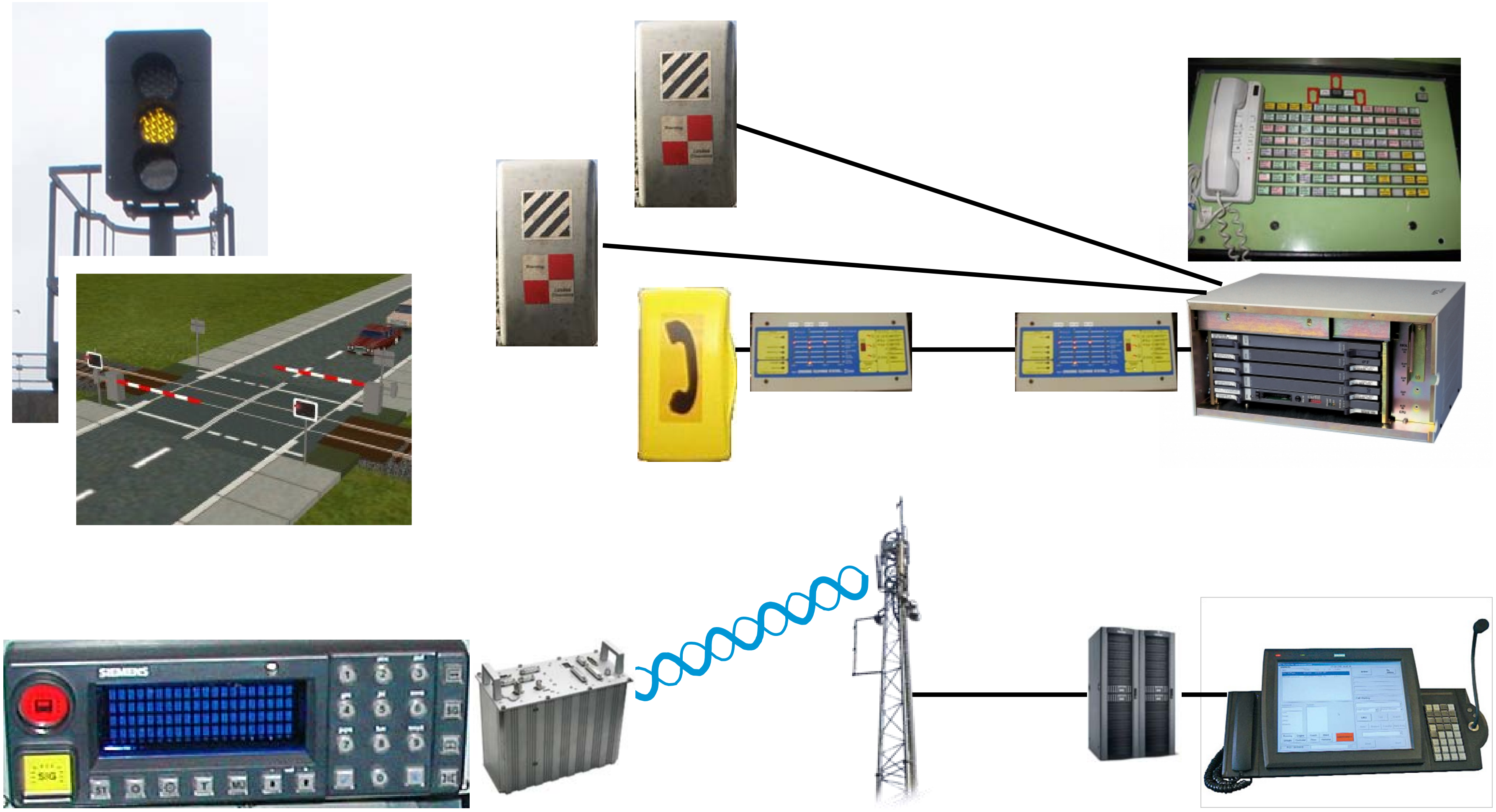
IECC with SSI



Interlocking and LDT comms provides necessary SIL

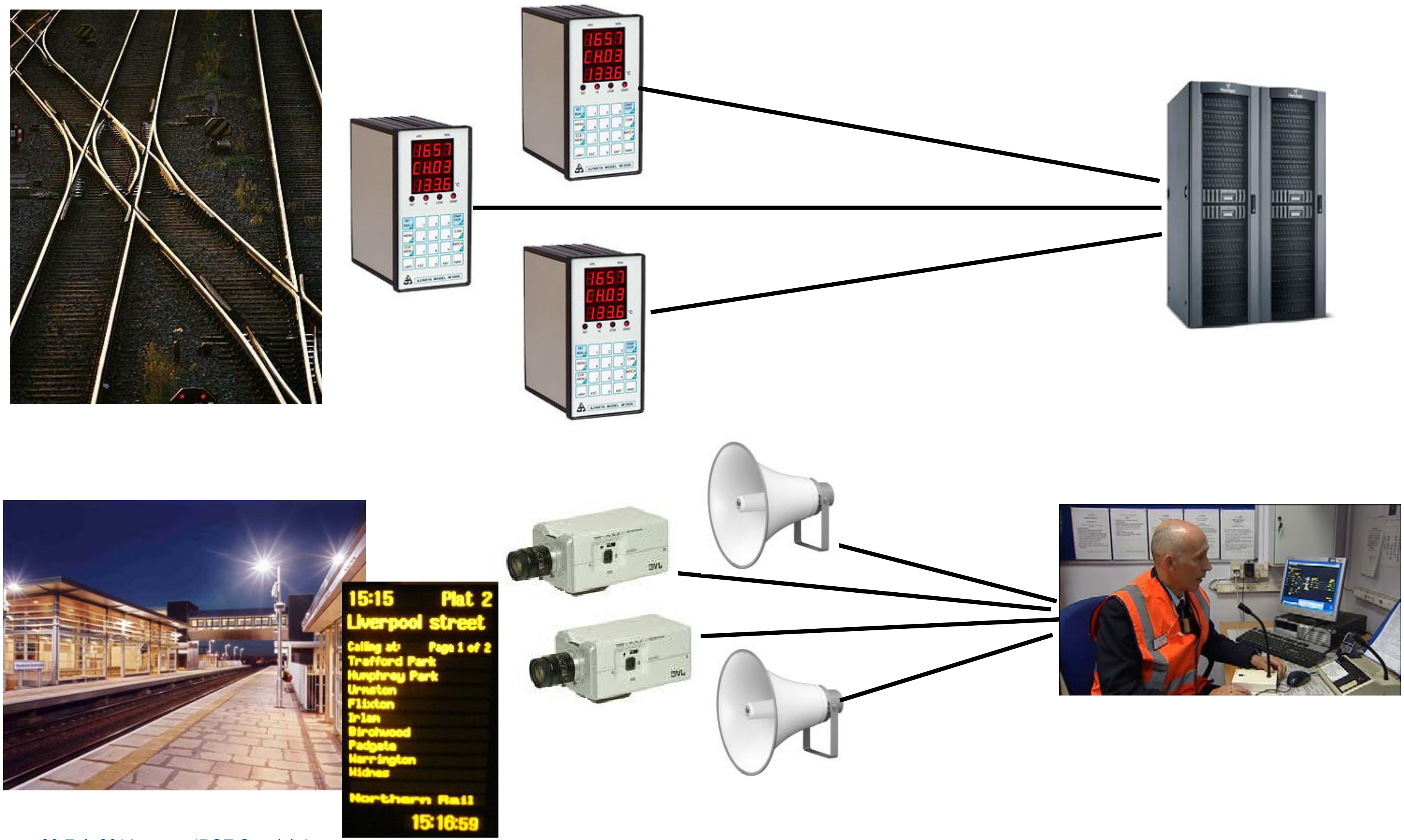
Ethernet Transport Vision

What is this?



Ethernet Transport Vision

What is this?



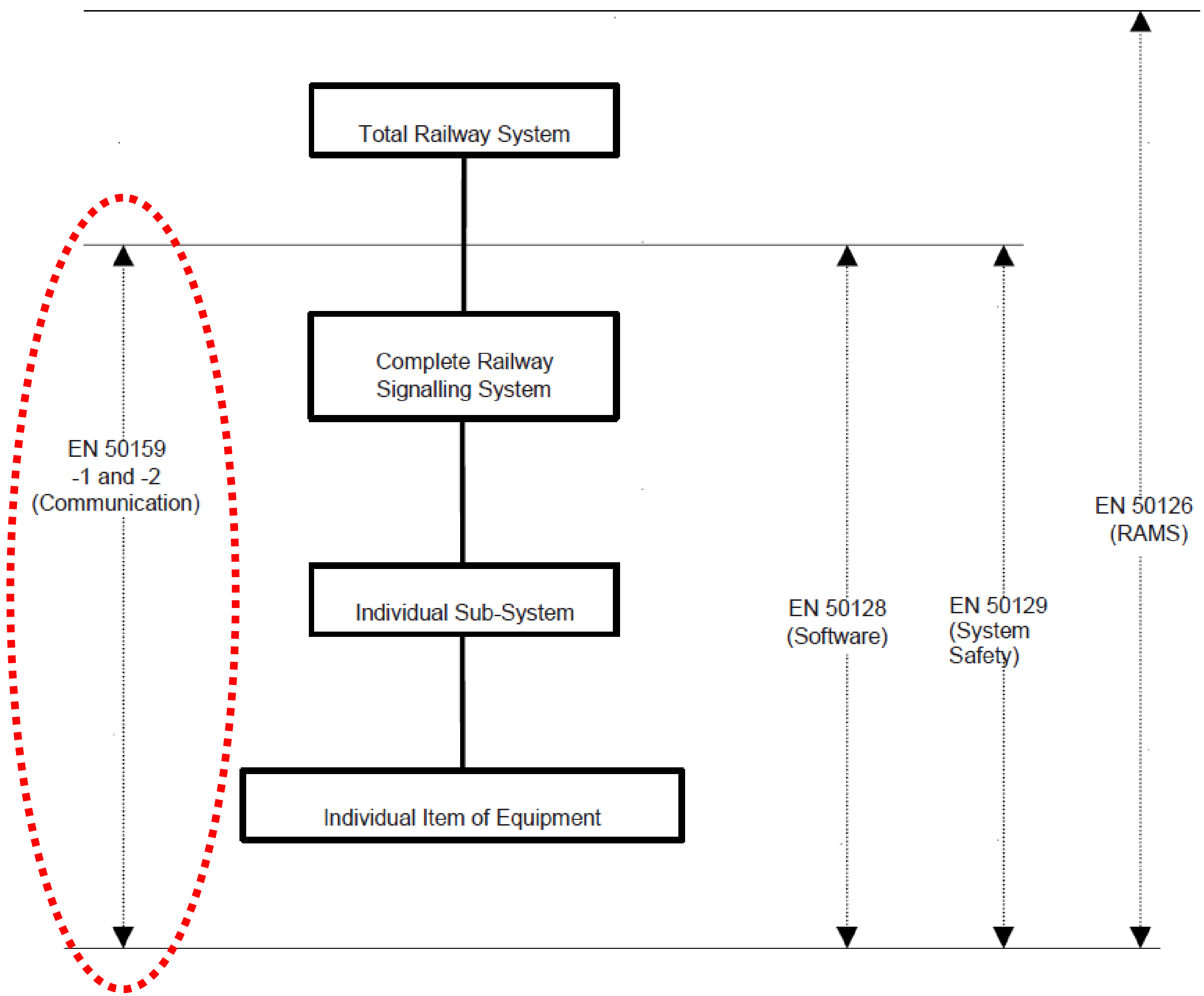
Safety & Performance Standards Compliance

Section Three

Safety Integrity and Security

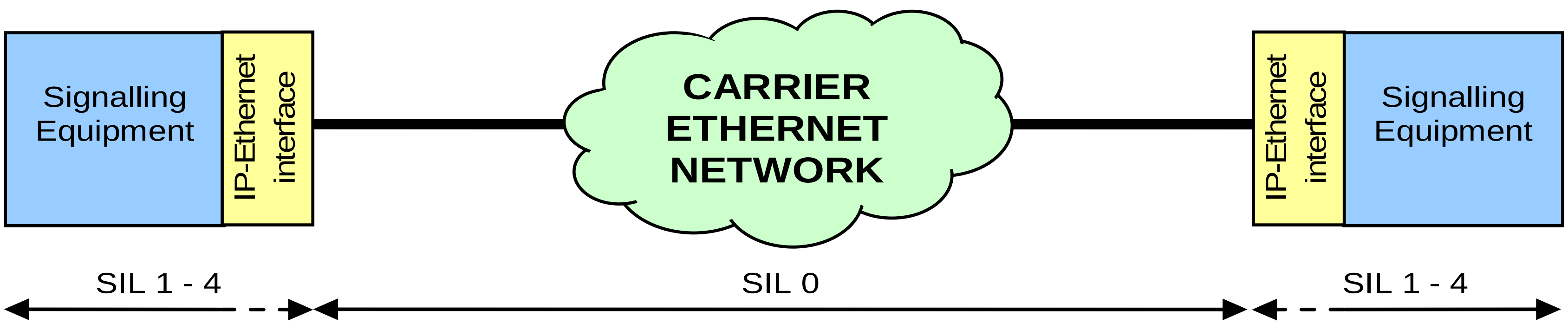
- Important standards associated with Railway Communication, Signalling and Processing Systems are:
  - BS IEC 61508:2003, Functional safety of electrical/electronic/programmable electronic safety-related systems. (Over-arching document)
  - BS EN 50126-1:1999 – Provides a process for implementing a consistent approach to management of reliability, maintainability and safety (RAMS).
  - BS EN 50129:2003 – Defines requirements for the acceptance and approval of safety-related electronic systems in the railway signalling field. Deals with the Safety Case and Safety Integrity Levels.
  - BS EN 50128:2001 – Specifies procedures and requirements for development of programmable electronic systems for use in railway control and protection applications where there are safety implications.
  - BS EN 50159:2010 – Gives the basic requirements needed to achieve safety-related communication between safety-related equipment connected to a transmission system (open or closed).

Safety Integrity and Security



Safety Integrity and Security

- The network is generally regarded as a SIL Level "0" entity
  - i.e. network normally plays no safety role in the movement of trains.
  - all SIL functionality is normally provided by safety-related signalling equipment, designed according to EN 50129.
  - However, BS EN 50159:2010 permits safety requirements to be implemented in by transmission system equipment, as long as there is control by safety measures to meet the allocated SIL.



Safety Integrity and Security

- BS EN 50159 Threat/Category relationship

Category	Repetition	Deletion	Insertion	Re-sequence	Corruption	Delay	Masquerade
Cat. 1	+	+	+	+	++	+	-
Cat. 2	++	++	++	+	++	++	-
Cat. 3	++	++	++	++	++	++	++

Key

- Threat can be neglected.

+ Threat exists, but rare; weak countermeasures sufficient.

++ Threat exists; strong countermeasures required.

NOTE This matrix of threats is only a guide – analysis will always be necessary to determine whether countermeasures are required and to what degree. Each threat will be dependent on network type, application and configuration.

Category 1 (Closed) systems: under the control of the designer and fixed during their lifetime

Category 2 (Open) systems: partly unknown or not fixed; unauthorised access can be excluded

Category 3 (Open) systems: not under the control of the designer, where unauthorised access has to be considered → Cryptographic techniques applicable to counter the threat of masquerade.

Safety Integrity and Security

- BS EN 50159 Threats vs. Defences

Reduced requirements for Category 1 (closed) network:
required   as required

Threats	Defences							
	Sequence number	Time stamp	Time-out	Source and destination identifiers	Feed-back message	Identification procedure	Safety code	Cryptographic techniques
Repetition	X	X						
Deletion	X							
Insertion	X			X [a]	X [b]	X [b]		
Re-sequence	X	X						
Corruption							X [c]	X
Delay		X	X					
Masquerade					X [b]	X [b]		X [c]

[a] Only applicable for source identifier.
Will only detect insertion from invalid source.
If unique identifiers cannot be determined because of unknown users, a cryptographic technique shall be used, see 7.3.8.

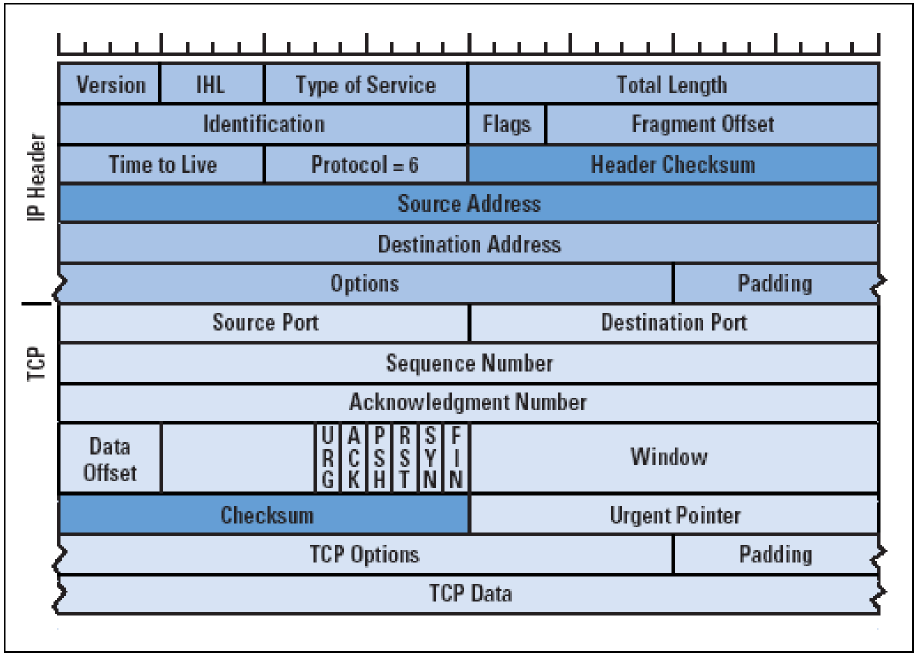
[b] Application dependent.

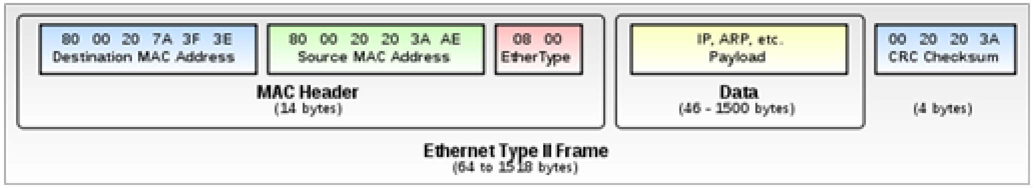
[c] See 7.4.3 and Clause C.2.

Safety Integrity and Security

- Defence for threats listed in BS EN 50159:2010 for Category 2 networks
  - Sequence number in TCP implemented in safety-related equipment protects against: Repetition, Deletion, Insertion, Re-sequence
  - TCP timestamps can be used, as required, by safety-related equipment to defend against Delay.
  - Safety code is mandatory but not necessarily a cryptographic one.

    Ethernet CRC (CRC-32-IEEE 802.3) is a safety code that protects against Corruption.





$$x^{32} + x^{26} + x^{23} + x^{22} + x^{16} + x^{12} + x^{11} + x^{10} + x^{8} + x^{7} + x^{5} + x^{4} + x^{2} + x + 1$$

Safety Integrity and Security

- Defence for threats listed in BS EN 50159:2010 for Category 3 networks
  - This appears to be a requirement for any SDH/PDH circuit transiting PTO link. e.g. BT Megastream
  - Must use cryptographic code. Either:
    - Cryptographic safety code
    - Non cryptographic safety code + enciphering
    - Non cryptographic safety code + cryptographic code
  - TCP/IPv6 with Authenticated Encapsulating Security Payload (ESP) based on HMAC-SHA-x and TCP or application-layer timestamps will provide defence against: all of the threats
    - IPsec is MANDATORY for IPv6 nodes

Performance

- However, the network must be designed according to RAMS principles to ensure suitable performance.
  - comms downtime → train delays → financial penalties

- Specifically, the communications network must be designed so that faults do not lead to errors and failures (EN 50126:1999)
  - use hardware redundancy, fault protection/isolation mechanisms, failure prediction, etc.

Performance

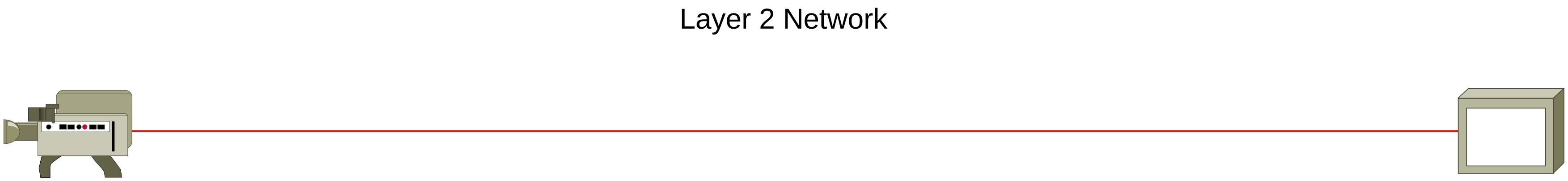
- Electromagnetic Compatibility (EMC)
  – various standards apply (e.g. EN 50121-4 & NR/L2/TEL/30003)
- Ability to handle the timing requirements of existing railway TDM systems.
- and many other standards and guide books…
  – NR/L2/TEL/30025 – Standby power
  – NR/PS/TEL/00014 and /15 – Optical fibre & UT copper specs
  – No Network Rail standards specifically dealing with Ethernet/IP, yet
  – GK/RT0206 – Signalling and Operational Telecommunications Systems: Safety Requirements
  – Engineering Safety Management (The Yellow Book)

Building the Network Architecture (The Pipework)

Section Three

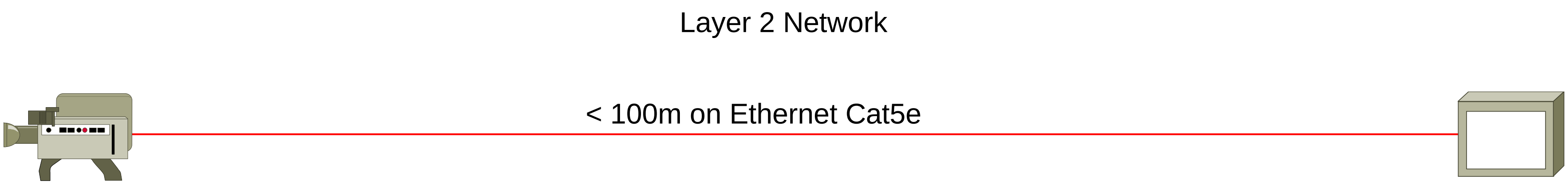
Building the Network Architecture

- Connect a camera and a screen (with codecs as necessary) forming a simple Layer 2 LAN network



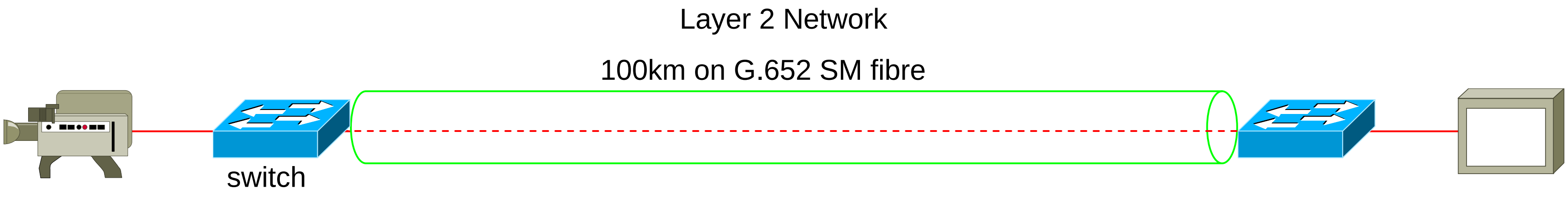
Building the Network Architecture

- But unless it's a fibre interface or extended using a pair of G.SHDSL modems (range up to 10miles) then the limitation is 100m.



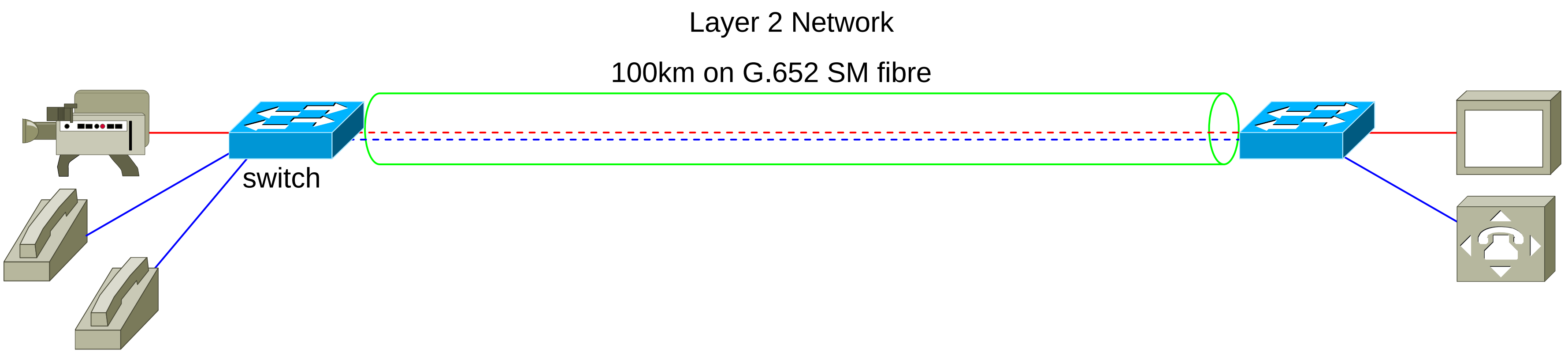
Building the Network Architecture

- Introducing a switch with an optical interface is a convenient way to extend the distance – up to 100km on a single optical hop.
- Still a single physical LAN albeit more or a WAN!



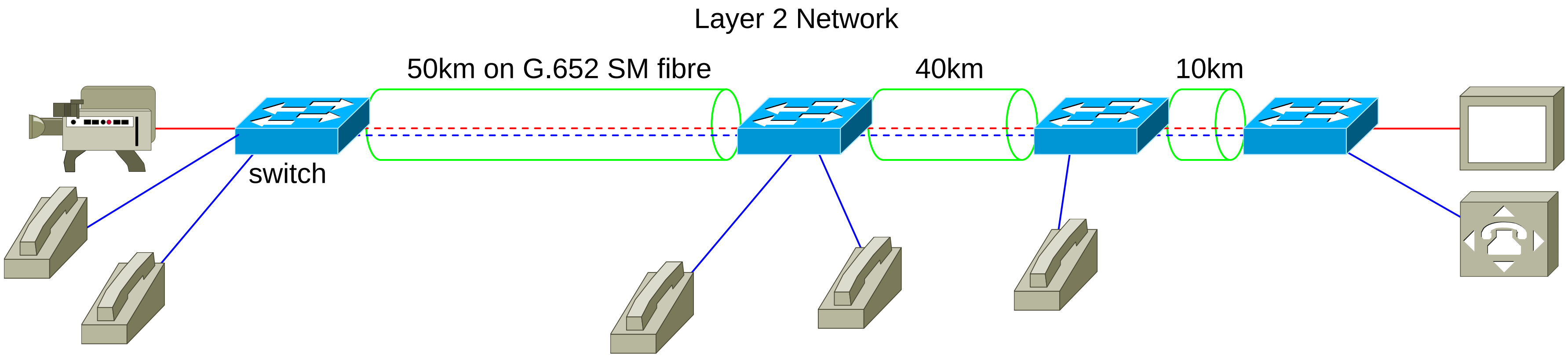
Building the Network Architecture

- It seems a shame not to make better use of the Gigabit link.
  - Add a couple of phones on a second subnet
  - Two separate pipes (VLANs) now used down the same fibre.
  - Data is logically separated by labelling as opposed to time shifting



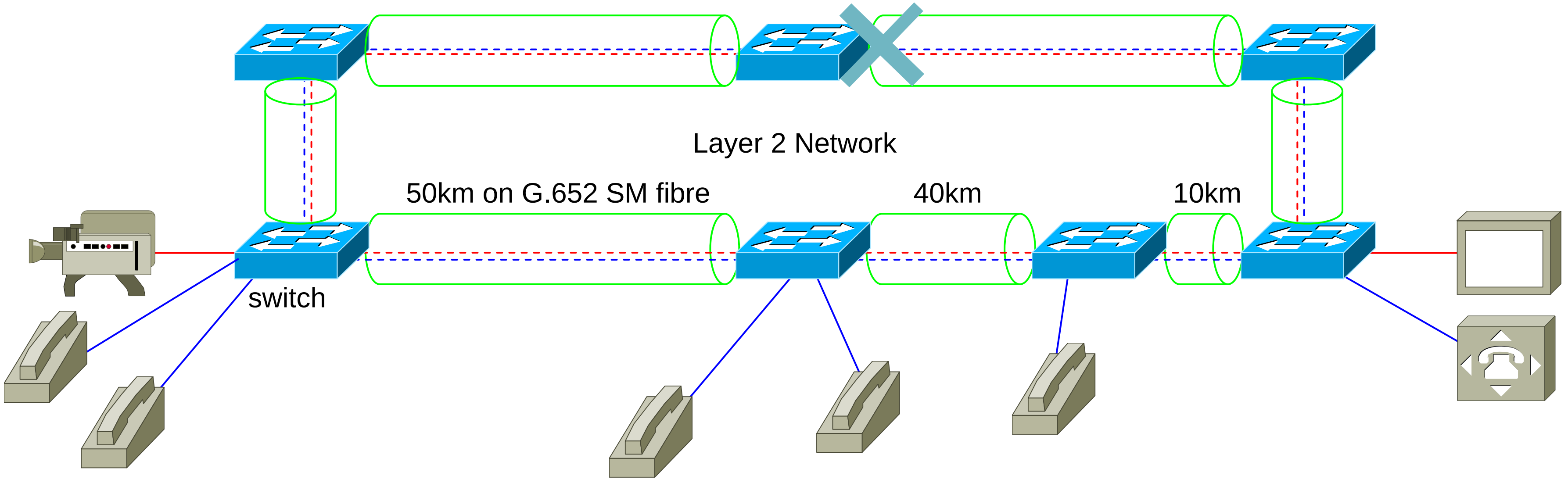
Building the Network Architecture

- All services aren't necessarily in two points
  - All some more phones connecting the same or different pipes
  - This exhibits a nice feature of Ethernetworking – you can easily provide point-to-point or point-to-multipoint.



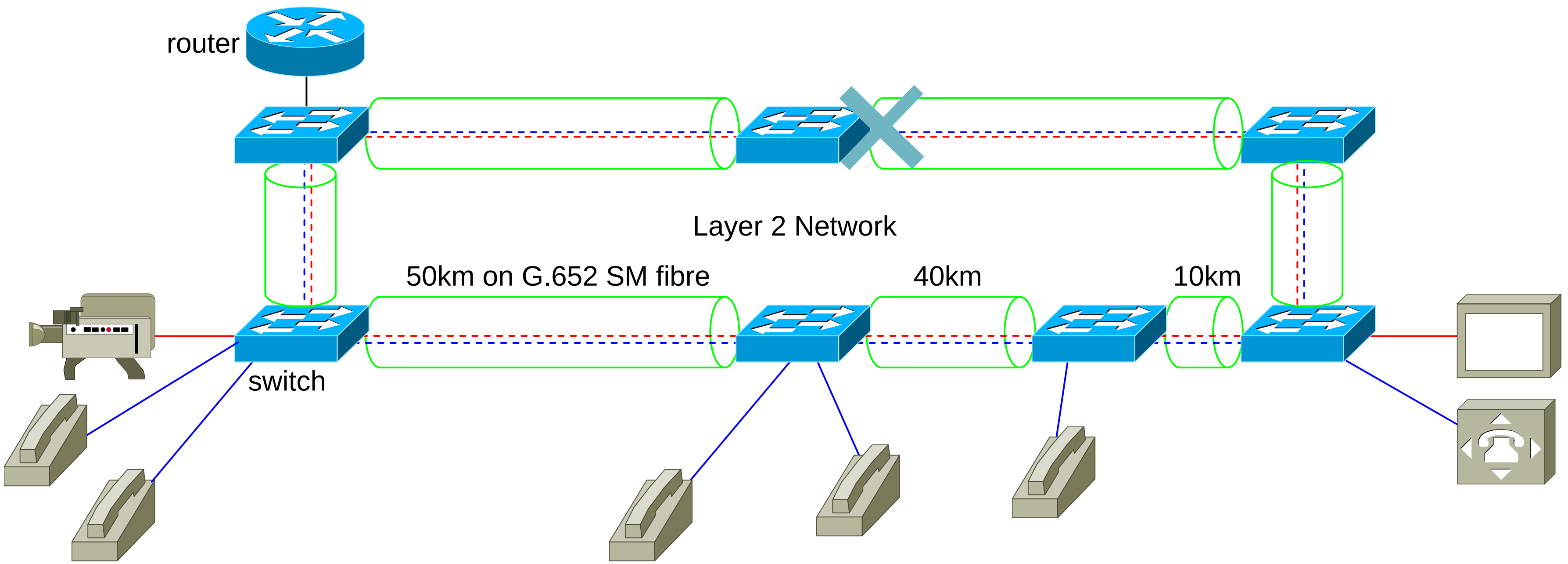
Building the Network Architecture

- What if there's a fibre break or a node failure?
  - Form a ring (or partial mesh) to provide resilience
  - Add a protocol to prevent traffic circulating – e.g. RSTP / REP



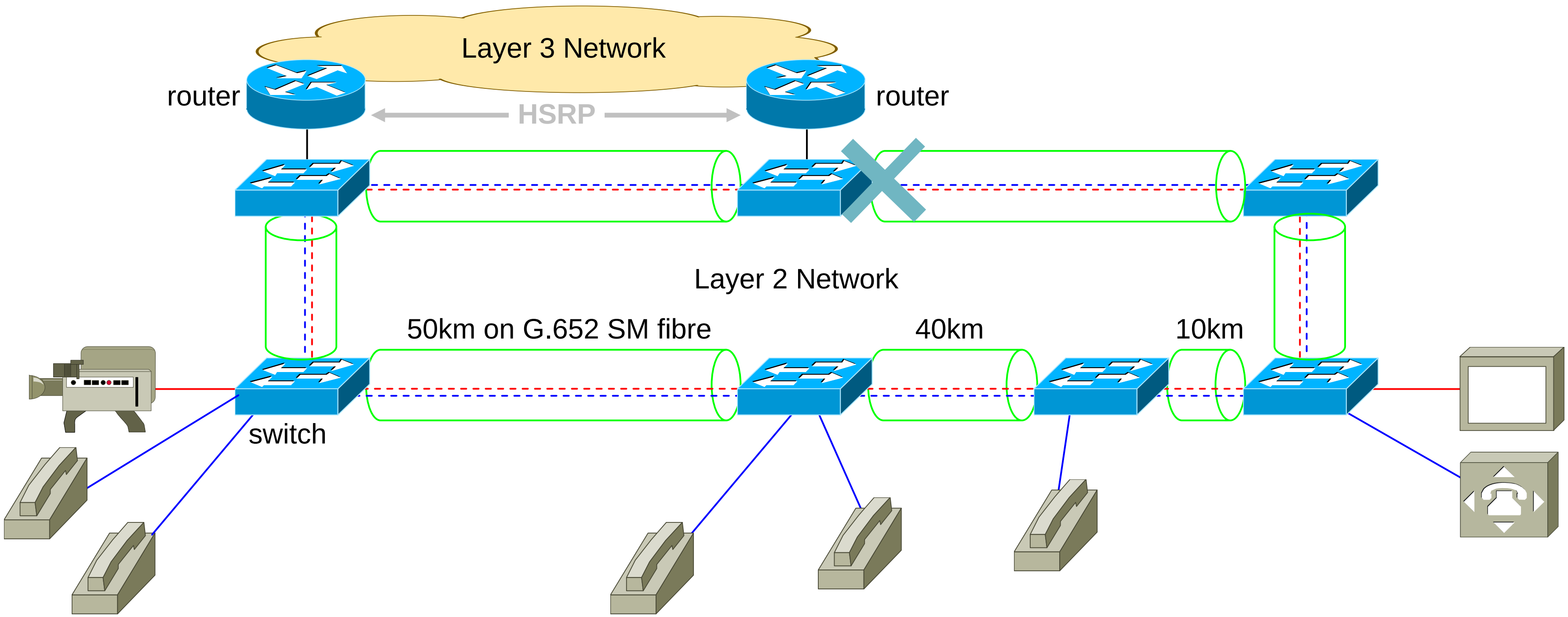
Building the Network Architecture

- We may wish to join with other LANs / subnets
  - Need to introduce a router



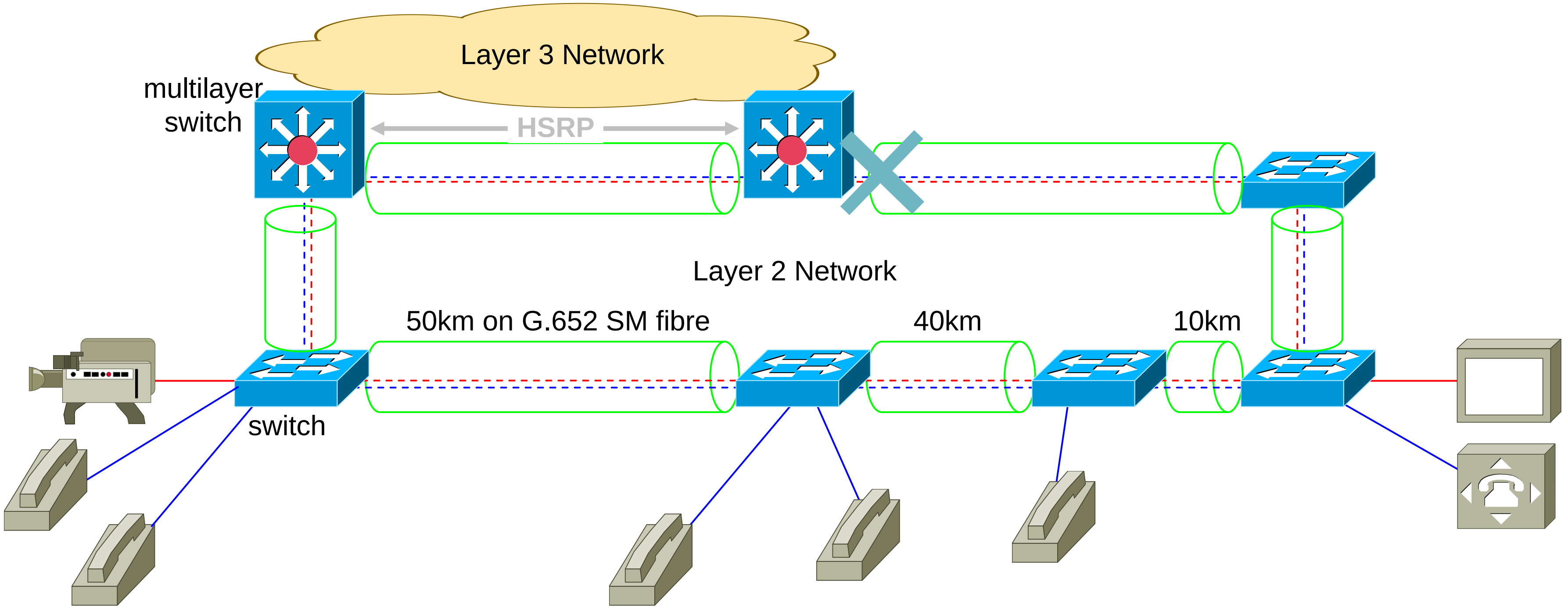
Building the Network Architecture

- But if that router fails….
  - Add more routers
  - Use HSRP protocol to provide virtual gateway



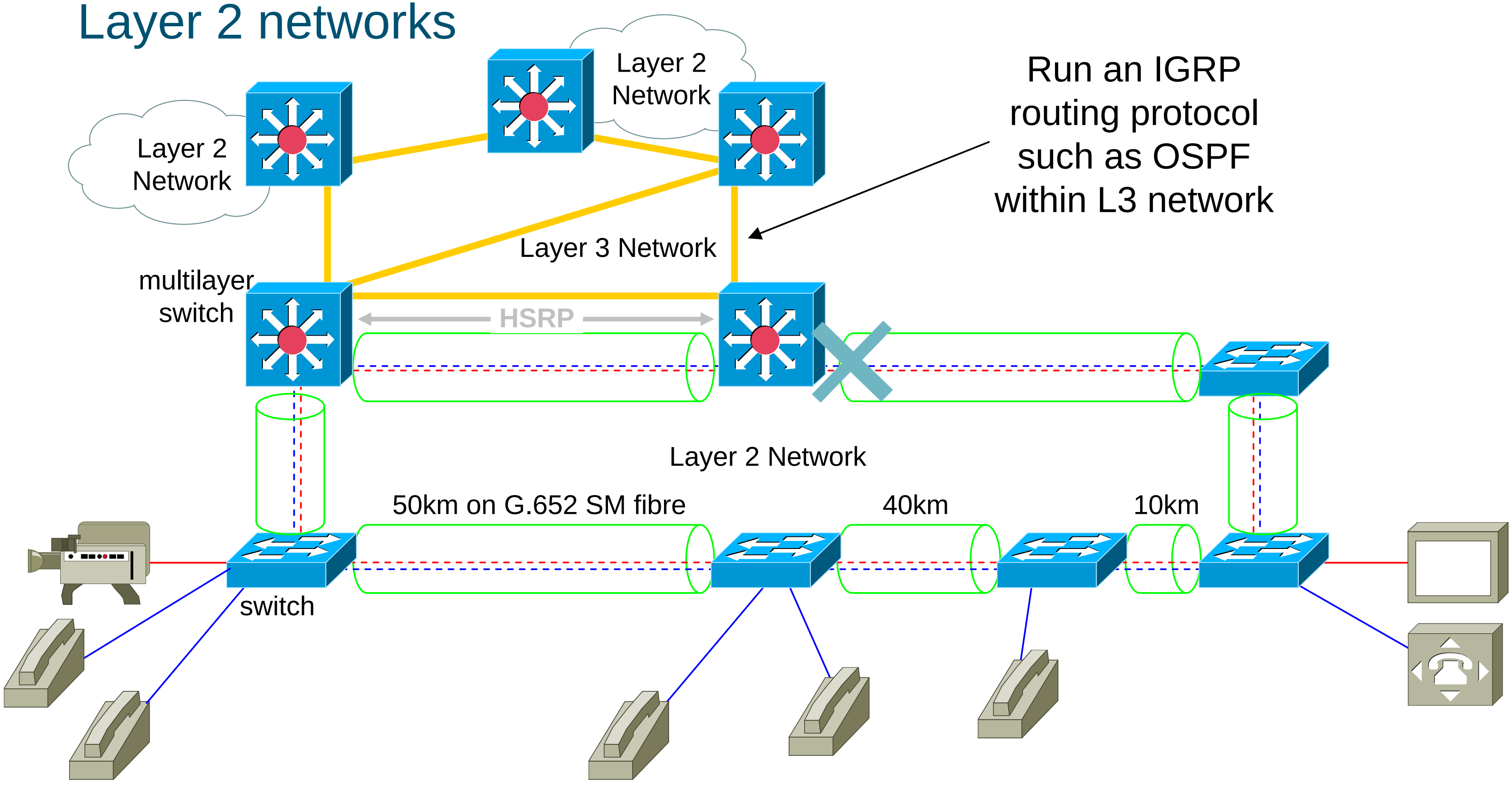
Building the Network Architecture

- No need for separate routers and switches
  - Use multilayer switch for router/switch combinations
  - In our network, this is just a software change on standard unit



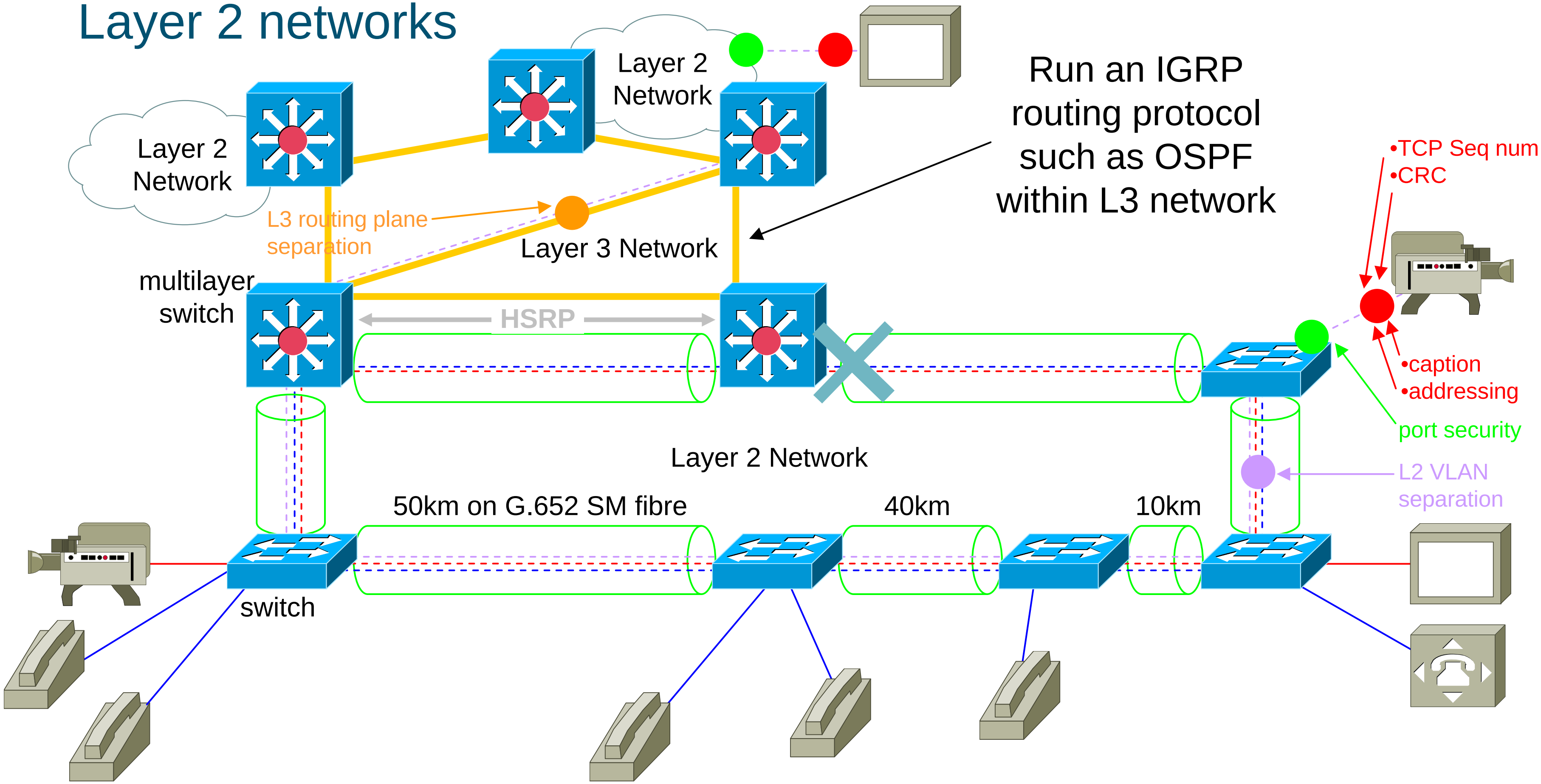
Building the Network Architecture

- Add extended Layer 3 network to provide connectivity with other Layer 2 networks

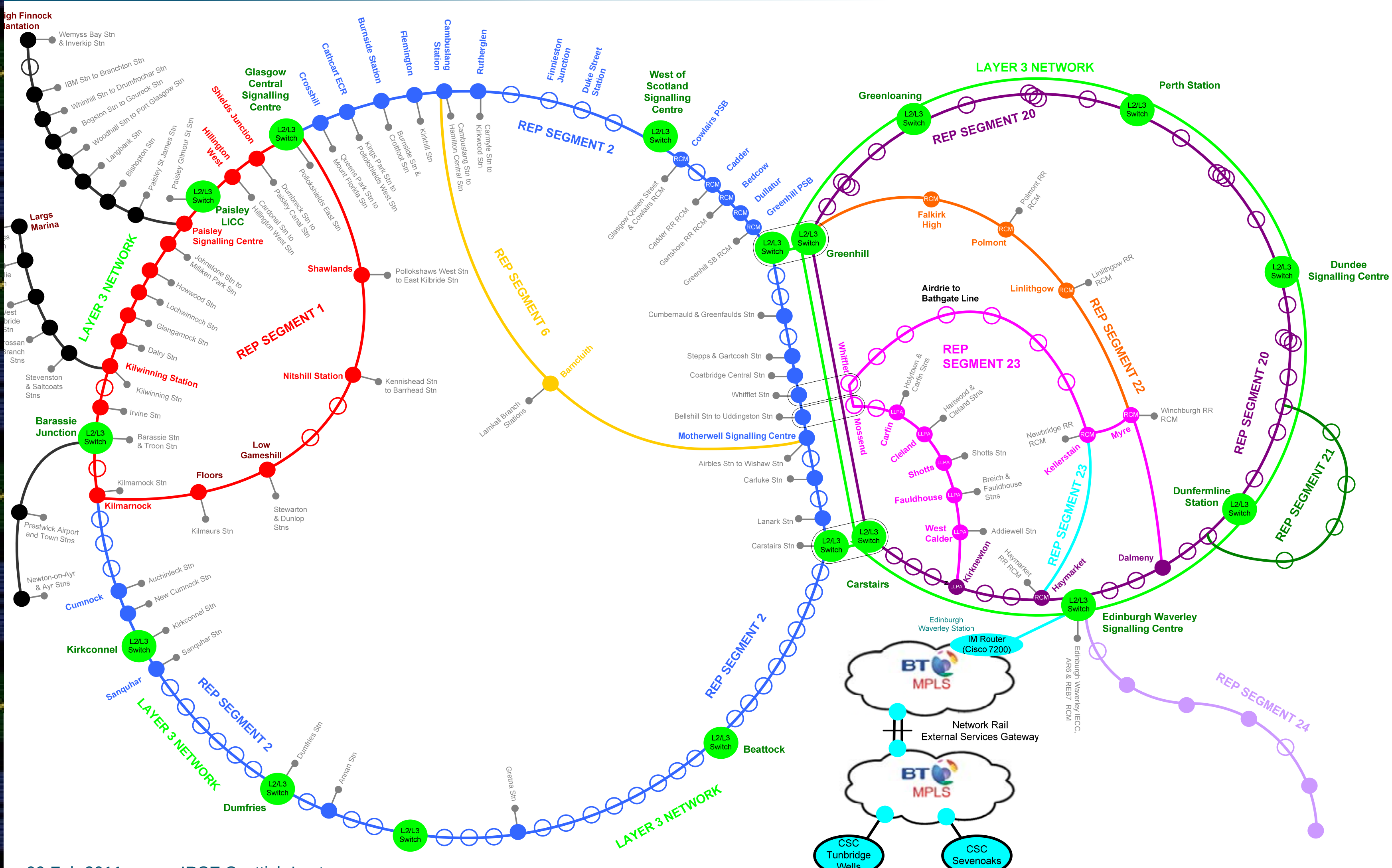


Building the Network Architecture

- Add extended Layer 3 network to provide connectivity with other Layer 2 networks



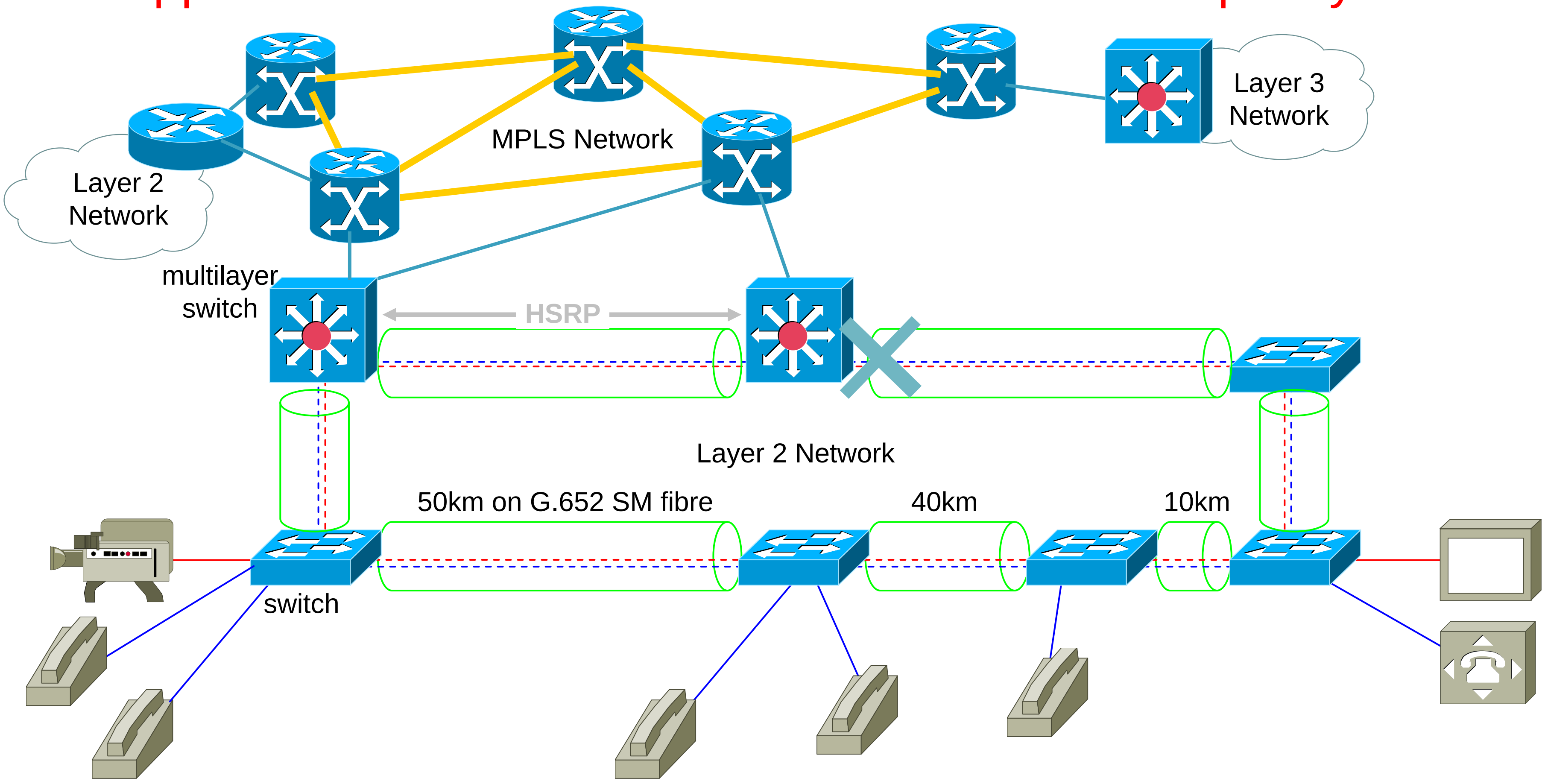
JockWAN



Wemyss Bay Stn & Inverkip Stn
IBM Stn to Branchton Stn
Whinhill Stn to Drumfrochar Stn
Bogston Stn to Gourock Stn
Woodhall Stn to Port Glasgow Stn
Langbank Stn
Bishopton Stn
Paisley St James Stn
Paisley Gilmour St Stn
Largs Marina
Glasgow Central Signalling Centre
Shields Junction
Hillington West
Crosshill
Cathcart ECR
Burnside Station
Flemington
Cambuslang Station
Rutherglen
Finnieston Junction
Duke Street Station
West of Scotland Signalling Centre
Cowlairs PSB
Cadder
Bedcow
Dullatur
Greenhill PSB
L2/L3 Switch
Paisley LICC
Paisley Signalling Centre
REP SEGMENT 2
REP SEGMENT 1
REP SEGMENT 6
LAYER 3 NETWORK
Shawlands
Pollokshaws West Stn to East Kilbride Stn
Johnstone Stn to Milliken Park Stn
Howwood Stn
Lochwinnoch Stn
Glengarnock Stn
Dalry Stn
Kilwinning Station
Kilwinning Stn
Irvine Stn
Stevenston & Saltcoats Stns
Barassie Junction
Barassie Stn & Troon Stn
Nitshill Station
Kennishead Stn to Barrhead Stn
Barrhead
Lanark Branch Stations
Low Gameshill
Floors
Kilmarnock
Kilmarnock Stn
Kilmaurs Stn
Stewarton & Dunlop Stns
Prestwick Airport and Town Stns
Newton-on-Ayr & Ayr Stns
Cumnock
Auchinleck Stn
New Cumnock Stn
Kirkconnel
Kirkconnel Stn
Sanquhar Stn
Sanquhar
Dumfries
Dumfries Stn
Annan Stn
Gretna Stn
Beattock
Carstairs
Carstairs Stn
Lanark Stn
Carluke Stn
Airbles Stn to Wishaw Stn
Motherwell Signalling Centre
Bellshill Stn to Uddingston Stn
Whifflet Stn
Coatbridge Central Stn
Stepps & Gartcosh Stn
Cumbernauld & Greenfaulds Stn
Glasgow Queen Street & Cowlairs RCM
Cadder RR RCM
Gartshore RR RCM
Greenhill SB RCM
Greenhill
Greenloaning
Perth Station
REP SEGMENT 20
Falkirk High
Polmont
Polmont RR RCM
Linlithgow
Linlithgow RR RCM
REP SEGMENT 22
Airdrie to Bathgate Line
REP SEGMENT 23
Whifflet
Mossend
Carfin
Cleland
Shotts
Fauldhouse
West Calder
Kirknewton
Holytown & Carfin Stns
Hartwood & Cleland Stns
Shotts Stn
Breich & Fauldhouse Stns
Addiewell Stn
Newbridge RR RCM
Kellerstain
Myre
Winchburgh RR RCM
Haymarket RR RCM
Haymarket
Dalmeny
Dundee Signalling Centre
Dunfermline Station
REP SEGMENT 21
Edinburgh Waverley Signalling Centre
Edinburgh Waverley Station
IM Router (Cisco 7200)
BT MPLS
Network Rail External Services Gateway
CSC Tunbridge Wells
CSC Sevenoaks
Edinburgh Waverley IECC, AR6 & REB7 RCM
REP SEGMENT 24

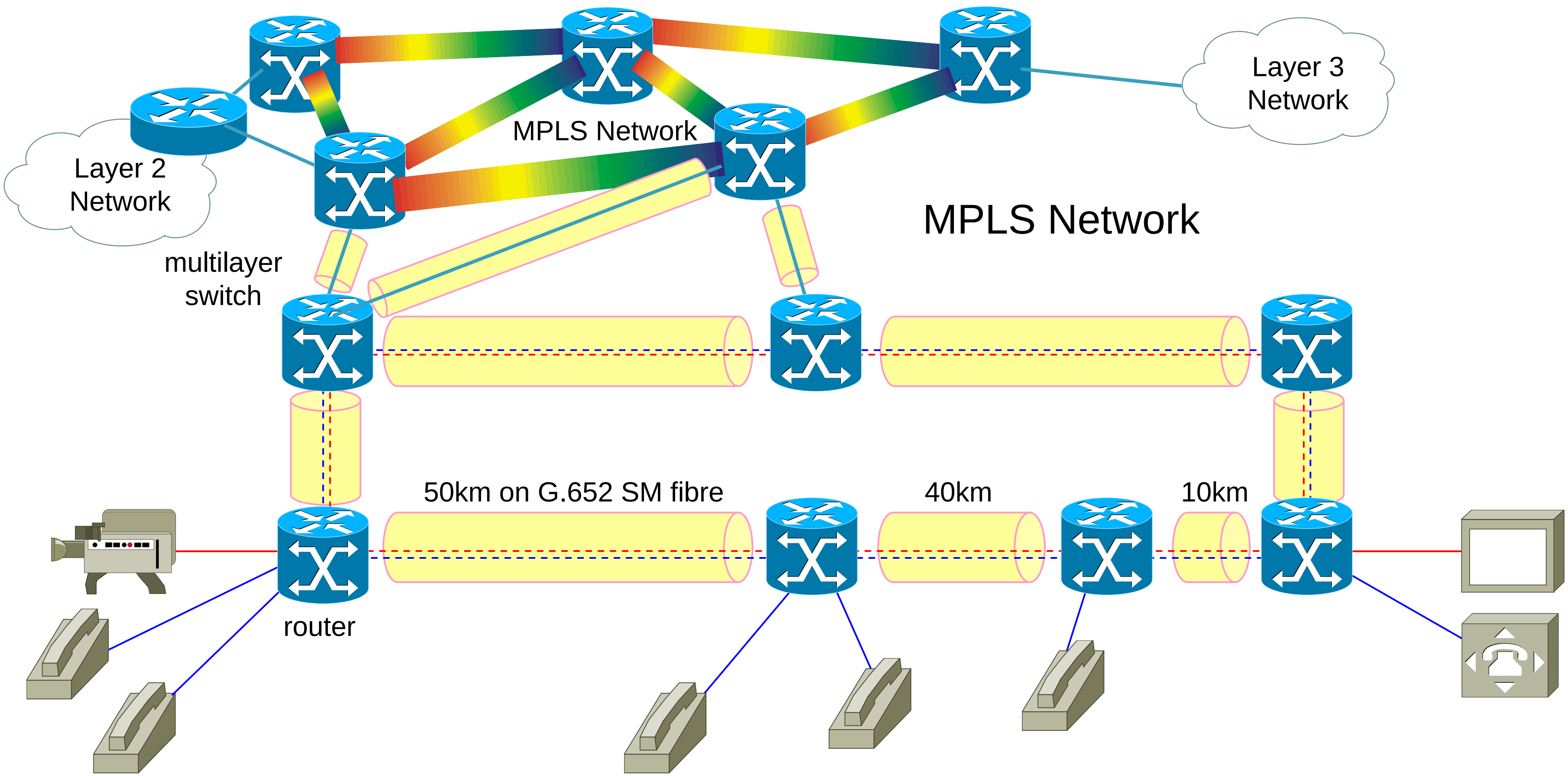
Building the Network Architecture

- Add MPLS / BGP VPN functionality and SyncE to properly support PDH data such as GSM-R and old VF telephony



Building the Network Architecture

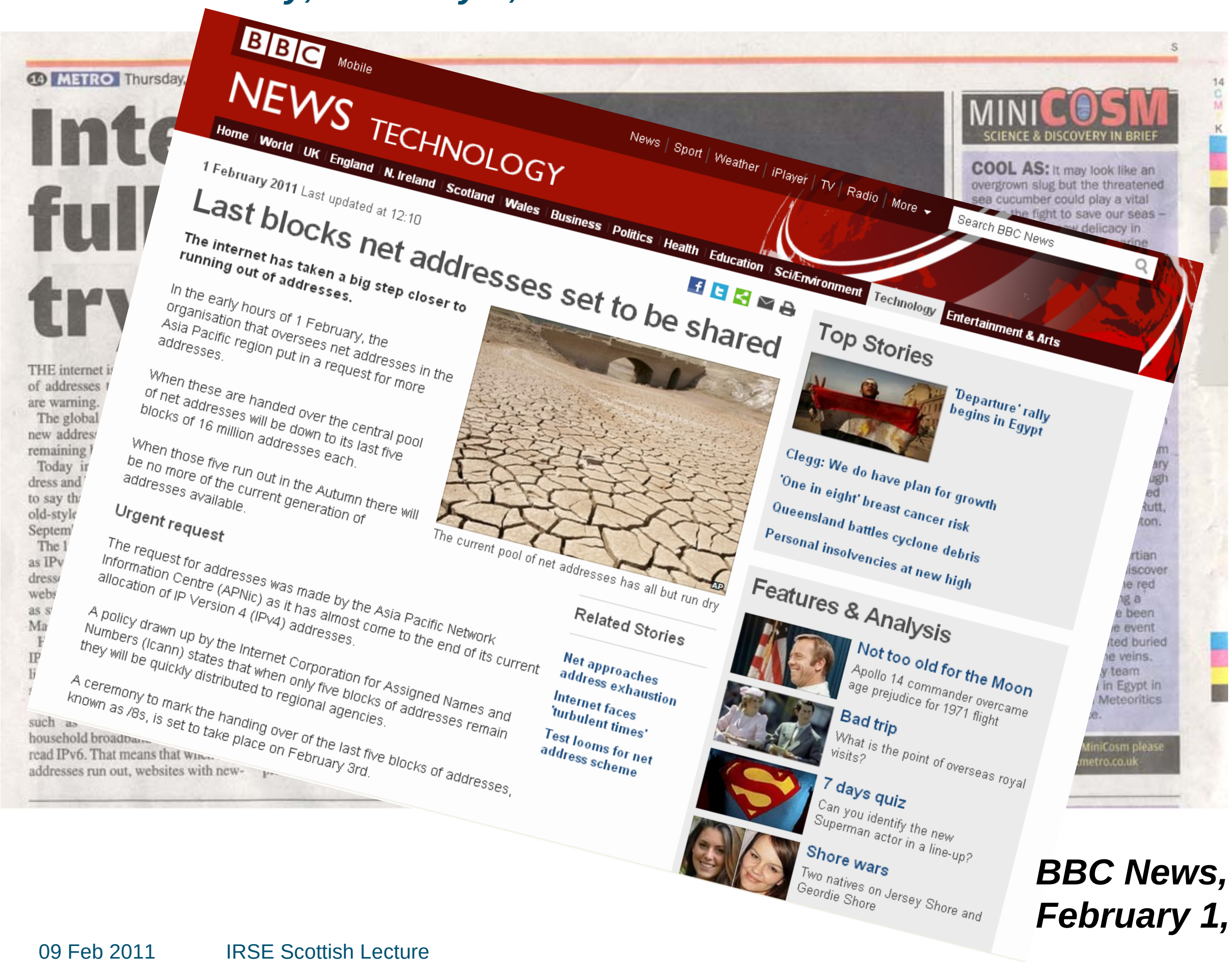
- Add WDM to core (and access if required)
- Replace L2 access with MPLS



Ethernet Transport Vision

What is this?

METRO Thursday, February 3, 2011



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1 February 2011 Last updated at 12:10

Last blocks net addresses set to be shared

The internet has taken a big step closer to running out of addresses.

In the early hours of 1 February, the organisation that oversees net addresses in the Asia Pacific region put in a request for more addresses.

When these are handed over the central pool of net addresses will be down to its last five blocks of 16 million addresses each.

When those five run out in the Autumn there will be no more of the current generation of addresses available.

The current pool of net addresses has all but run dry

Urgent request

The request for addresses was made by the Asia Pacific Network Information Centre (APNic) as it has almost come to the end of its current allocation of IP Version 4 (IPv4) addresses.

A policy drawn up by the Internet Corporation for Assigned Names and Numbers (Icann) states that when only five blocks of addresses remain they will be quickly distributed to regional agencies.

A ceremony to mark the handing over of the last five blocks of addresses, known as /8s, is set to take place on February 3rd.

Related Stories

Net approaches address exhaustion

Internet faces 'turbulent times'

Test looms for net address scheme

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Shore wars
Two natives on Jersey Shore and Geordie Shore

The railway network is not the "Internet"

It is a private network so all addresses available

We can even reuse addresses by layering

The network runs IPv4 and IPv6 alongside each other. Select based on end device capability.

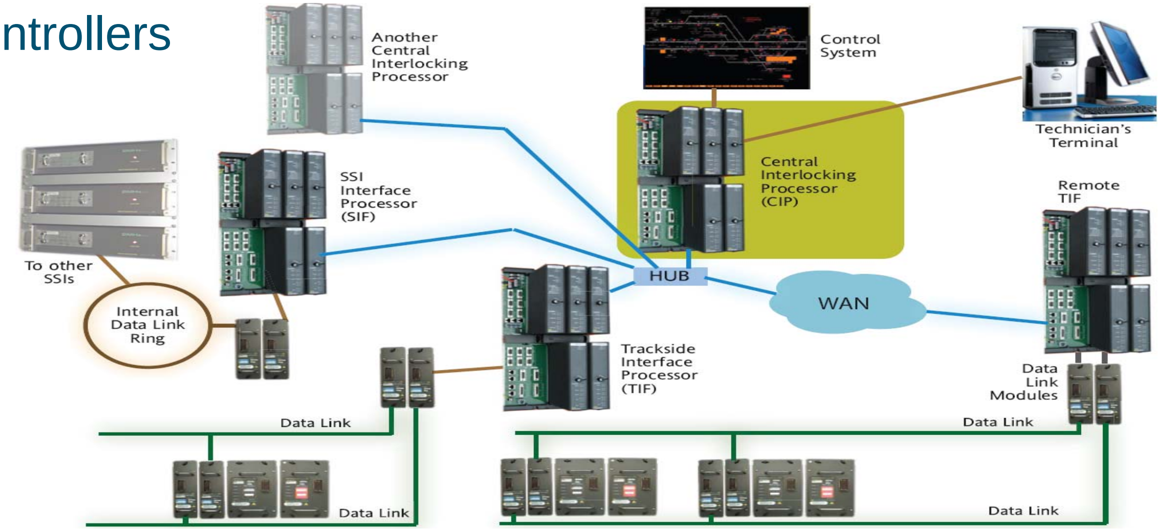
BBC News, Tuesday, February 1, 2011

The Telecoms Vision

Section Three

Applicability

- The most modern signalling and ECR SCADA equipment is already capable of (sometimes favours) communication over an IP-Ethernet network
  - e.g. ERTMS object controllers
  - Westlock Solid State Interlocking (SSI) comms links.
  - SCADA
  - Loggers



- We must encourage all new railway signalling and control systems to support IP/Ethernet connectivity.

Drivers and Motivators

- Should invididual applications/projects be driving network roll out or should there be national roll out? Carrot & stick compromise?
- Needs to be **direction** on what and how
- Technology development
  - Need to keep up with comms developments (like BR did)
  - Collaboration with equipment manufacturers to develop technology, appropriate interfaces and test new systems.
- Guidance on documentation, records, management systems
- Who will perform these **vital** functions?

That's the way to do it and here's a bit of help/assistance/consultancy…

Architectural Compatibility

Nobody at present

Asset Management

Where is the "Operational Datacoms Development" Function

Future Emphasis

- Network Nodes exactly where needed!!! **(VERY IMPORTANT)**
- Asset Management **(EXTREMELY IMPORTANT)**
  - – Guidance on what and how / Knowing what and where
  - – Sustainable record management (ccts, connectivity)
  - – Network management (OA&M)
- Integration with FTNe
  - – Interconnectivity needed? Yes for ECR SCADA, RCM, CCTV
- VoIP interface with traditional POTS telephony
- Support of FTN PDH Muxes & GSM-R via E1 interface (+SyncE)