IRSE SEMINAR: Railway Telecommunications

16th November 2010, 1 Birdcage Walk, London, SW1H 9JJ, UK

Programme

	Subject	**Speaker** (Affiliation)
09.30	Welcome and Introduction	Paul Jenkins, IRSE President
	SESSION 1	
09.35	**Keynote Address**	Steve Hailes, Professional Head, Signals & Telecoms Engineering, Network Rail
09.55	**Future Bandwidth Demand in the Railways**	**Richard Wormersley**, Executive Consultant, Helios Technology Ltd
10.30	**IP Teach-in – What is IP & How Does it Work**	**Paul Darlington**, S&T Route Asset Manager, Network Rail
11.05	Coffee	
	SESSION 2	
11.20	**IP Services on Trains for Passengers and Operators** (includes live demonstration)	**Nigel Wallbridge**, Executive Chairman, Nomad Digital
12.00	**Telecomms & the Future Railway – IP-Based Signalling – Technology Risks**	**Tim Whitcher**, Solutions Architect, Invensys Rail
12.30	Lunch & Networking	
	SESSION 3	
13.30	**SISS & New Technologies**	**Pete McNamara**, Project Director, Application Solutions (Safety & Security) Ltd
14.10	**In-Cab Platform CCTV**	**Paul Dobbins**, Head of Engineering, Telent Technology Services Ltd
14.50	Coffee	
	SESSION 4	
15.05	**Railway and the Use of Spectrum**	**Farha Sheikh**, Technical Manager - Control and Communications, Department for Transport
15.45	**Panel Session and Debate**	Paul Jenkins, IRSE President
16.20	Closing Remarks	Steve Hailes, Professional Head, Signals & Telecoms Engineering, Network Rail
16.30	Close	

Dealing with Future Bandwidth Demand on the Railways

Richard Womersley, Helios

IRSE Conference, 16 November 2010

Who is driving bandwidth demand?

- Across the railway the largest demand for mobile data services comes from passengers!
  - Dealing with this is a commercial issue between the passengers and mobile companies
  - Some TOCs do provide WiFi on board trains
  - Coverage is patchy and service levels are not guaranteed

- Rail users also require mobile data services
  - What are the needs of the railway?
  - What is bandwidth is currently available?
  - How is it currently provided?
  - What gaps exist?
  - What solutions might there be?

Applications which drive future bandwidth requirements

- These applications are drawn from TSAG work on achieving the DfT's vision for the railway over the next 10 to 20 years

  - **Passenger experience:** Personal journey assistants, integrated transport ticketing and passenger information
  - **Train maintenance:** Train condition monitoring
  - **Network maintenance:** Track condition monitoring
  - **Traffic management:** Control of train operations, disruption management and real-time demand-driven capacity
  - **Automation:** ATO and driverless trains
  - **Performance measurement:** Measurement and management of service quality and delay attribution
  - **Retail:** Onboard catering and retailing, ticketing and revenue collection
  - **Safety:** CCTV on level crossings, passenger flow management

Bandwidth requirement characteristics

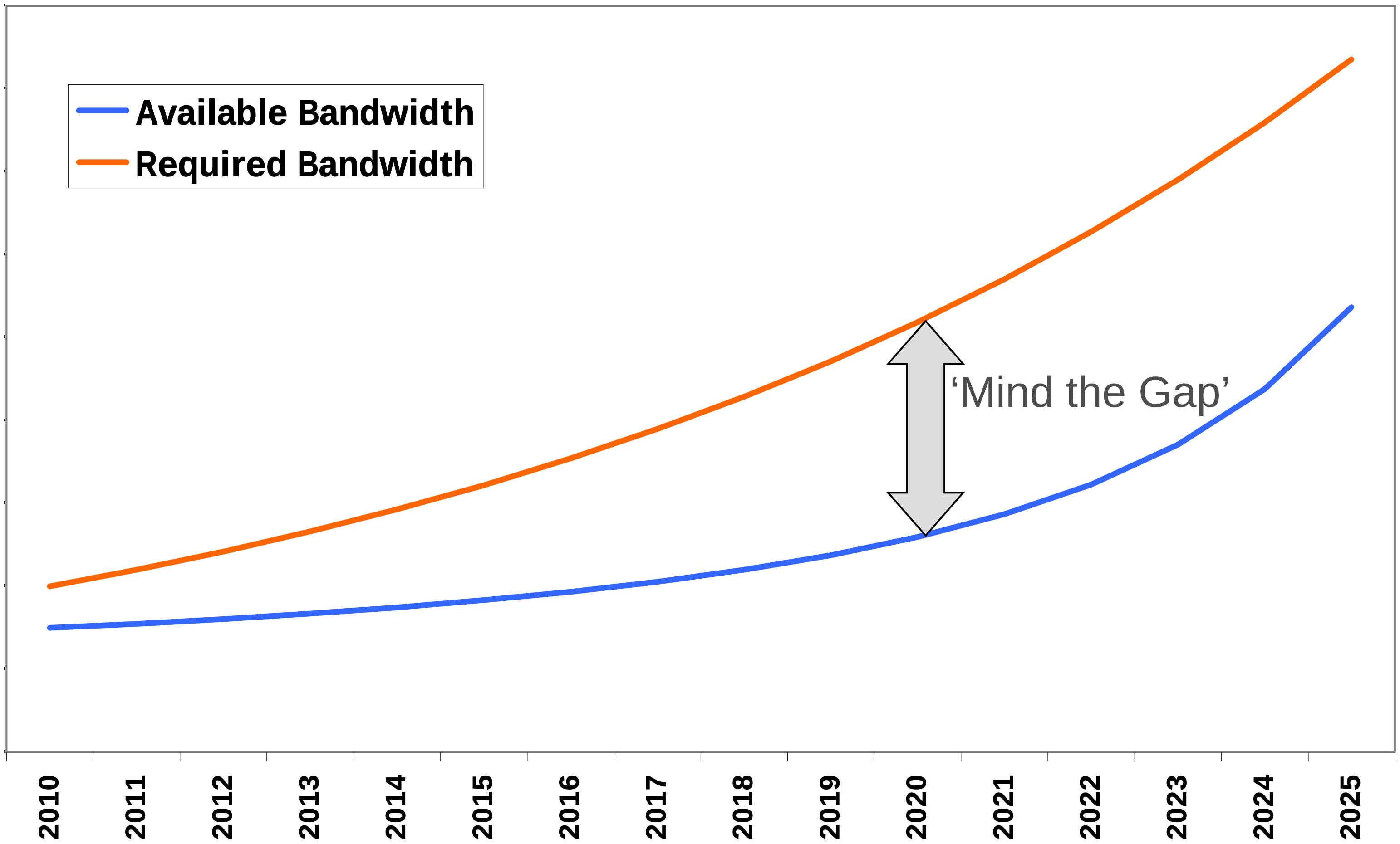
- Many of these applications have relatively low bandwidth requirements (tens of kilobits/second)
    - however, added together they represent a combined requirement of hundreds of kbps
    - some applications (such as CCTV) require much greater connectivity, of order Megabits/second but their use will be relatively infrequent
- In many cases, the data connection could be necessary at any point within a train’s journey
- In others, however, it is sufficient to up- and down-load data when connectivity becomes available.

Today’s available bandwidth

- In terms of rail-specific mobile data connections, there is virtually nothing available
    - The old, analogue, NRN and CSR radio networks provide precious little data capacity.
    - Even GSM-R, when rolled-out, will only support connection speeds of up to 9.6 kbps if sufficient network capacity available.
    - The GSM-R network is primarily intended (to support the running of the railway. Even if on-train applications could gain access to its data capacity, they would not be permitted to.

- Commercial data (and voice) networks such as 2G (GSM) and 3G (UMTS) could be used
    - these offer much greater data capacity (up to tens of Mbps) but coverage is limited
    - This is especially true for 3G services whose coverage outside urban and suburban areas is very small –these are often the locations where rail users require capacity the most!
- There have been attempts to boost data capacity on the railways by, for example, installing WiFi hotspots in railway stations and depots
    - however these highly localised and thus not a holistic, network-wide, solution

Demand will continue to exceed supply unless action is taken



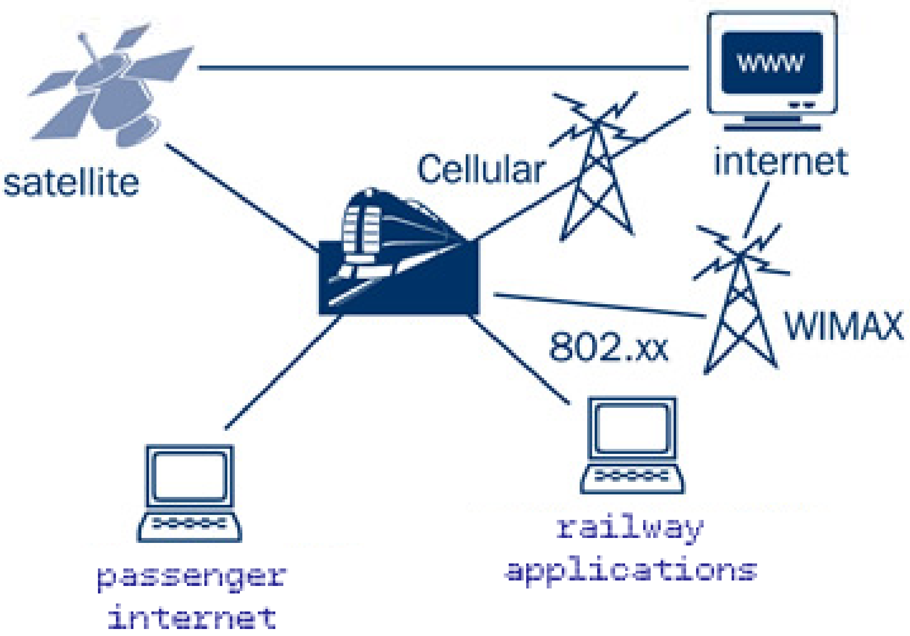
('Bandwidth' includes a consideration of coverage)

‘Mind the Gap’

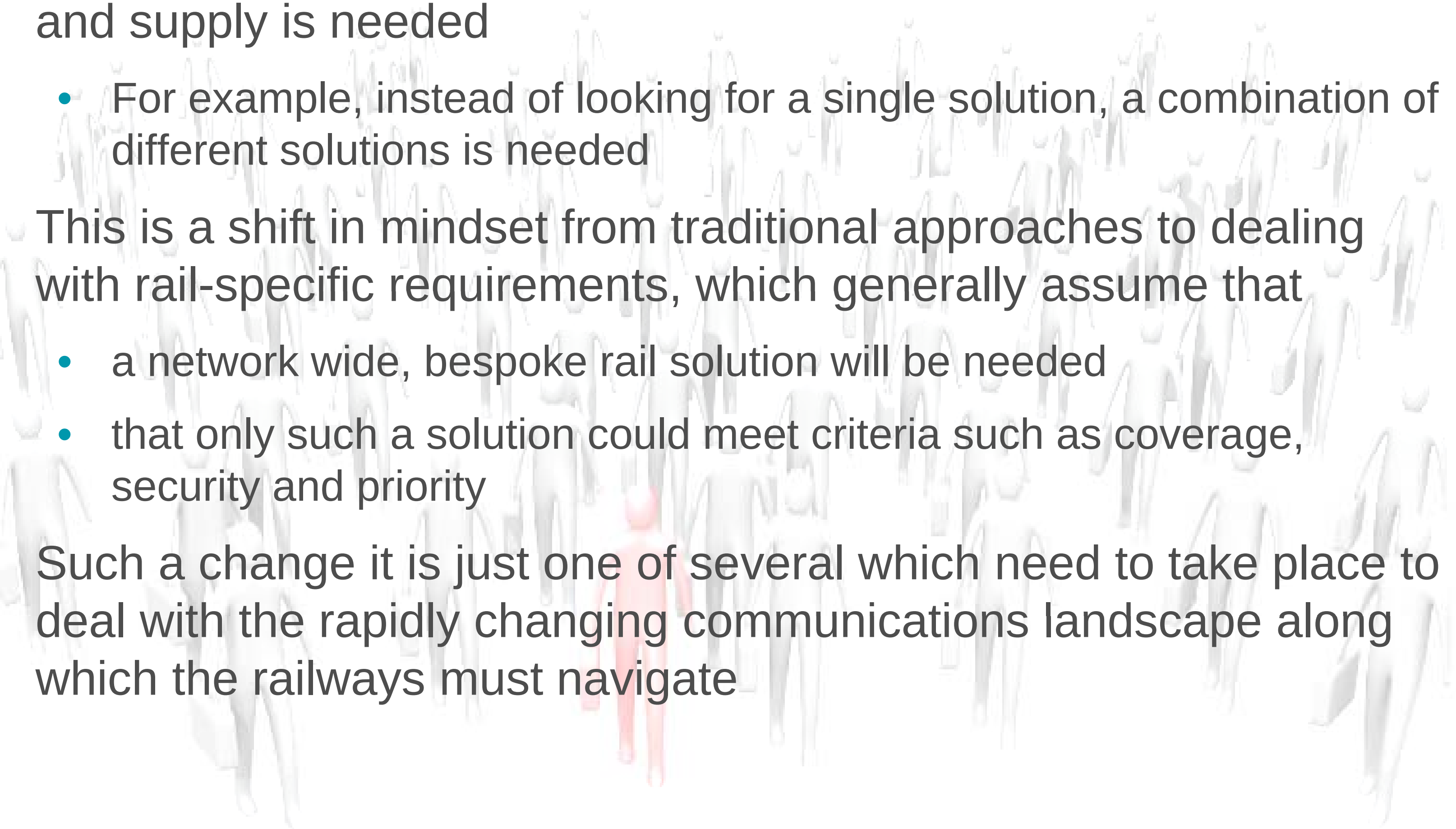
- There is a large gap between the current and future demand for bandwidth on the railways, and its availability!
- Some organisations have already been forced to address this and are using technology in a novel way
  - they have combined the complementary features of a number of different technologies to provide a holistic solution
- Whilst this is a step forward, it will not solve the railway’s wider data capacity requirements
- There is no single solution which will deliver all of the railways’ data requirements across the whole network

One example of a ‘Best of Breed’ solution

- WiMAX / WiFI
  - In stations, depots and in other limited areas
  - First choice if available as costs low
- Commercial cellular (3G) networks
  - Where coverage is available
  - Second choice
- Satellite
  - Only in remote areas where no other service is available



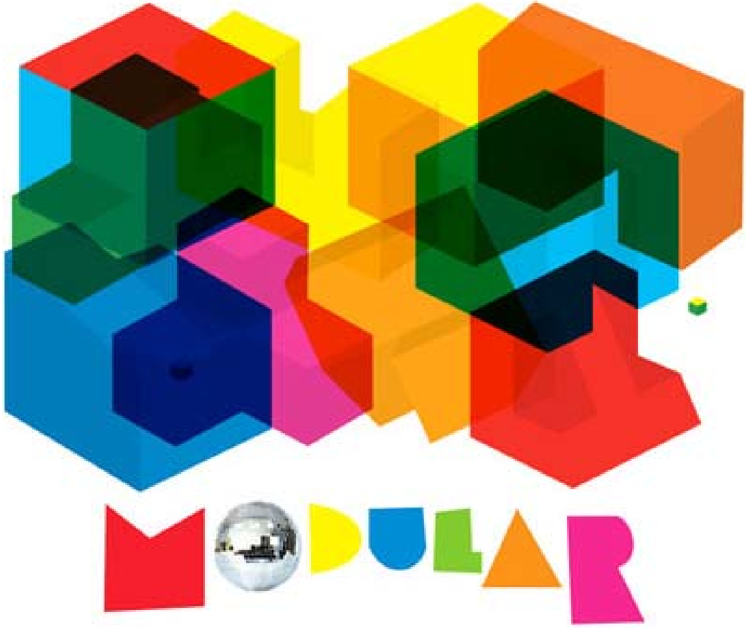
The answer is not technical, but a change in mindset



- A different approach to solving the capability gap between demand and supply is needed
  - For example, instead of looking for a single solution, a combination of different solutions is needed
- This is a shift in mindset from traditional approaches to dealing with rail-specific requirements, which generally assume that
  - a network wide, bespoke rail solution will be needed
  - that only such a solution could meet criteria such as coverage, security and priority
- Such a change it is just one of several which need to take place to deal with the rapidly changing communications landscape along which the railways must navigate

‘Plug and Play’

- There is a need for a ‘plug and play’ approach to the use of communication systems. This would
  - allow new technologies to be replaced, updated or adopted as and when it becomes appropriate to do so
  - require the definition of standard interfaces
  - need a modular approach to defining applications and services
  - stop the expense associated with ‘-R’ solutions in the future



Bandwidth as an input rather than an output

- There is a need to consider how, when and where data capacity can be supplied
  - as an input to considerations and definitions of new rail applications
  - rather than as an output from them!
- Rather than assuming that a solution will become available, designers need to recognise the limitations of available systems as part of the design process

A national rail data strategy

- There is a need for a defined rail data strategy
- This will ensure that data can be stored, transferred and exchanged between stakeholders in a consistent and repeatable way

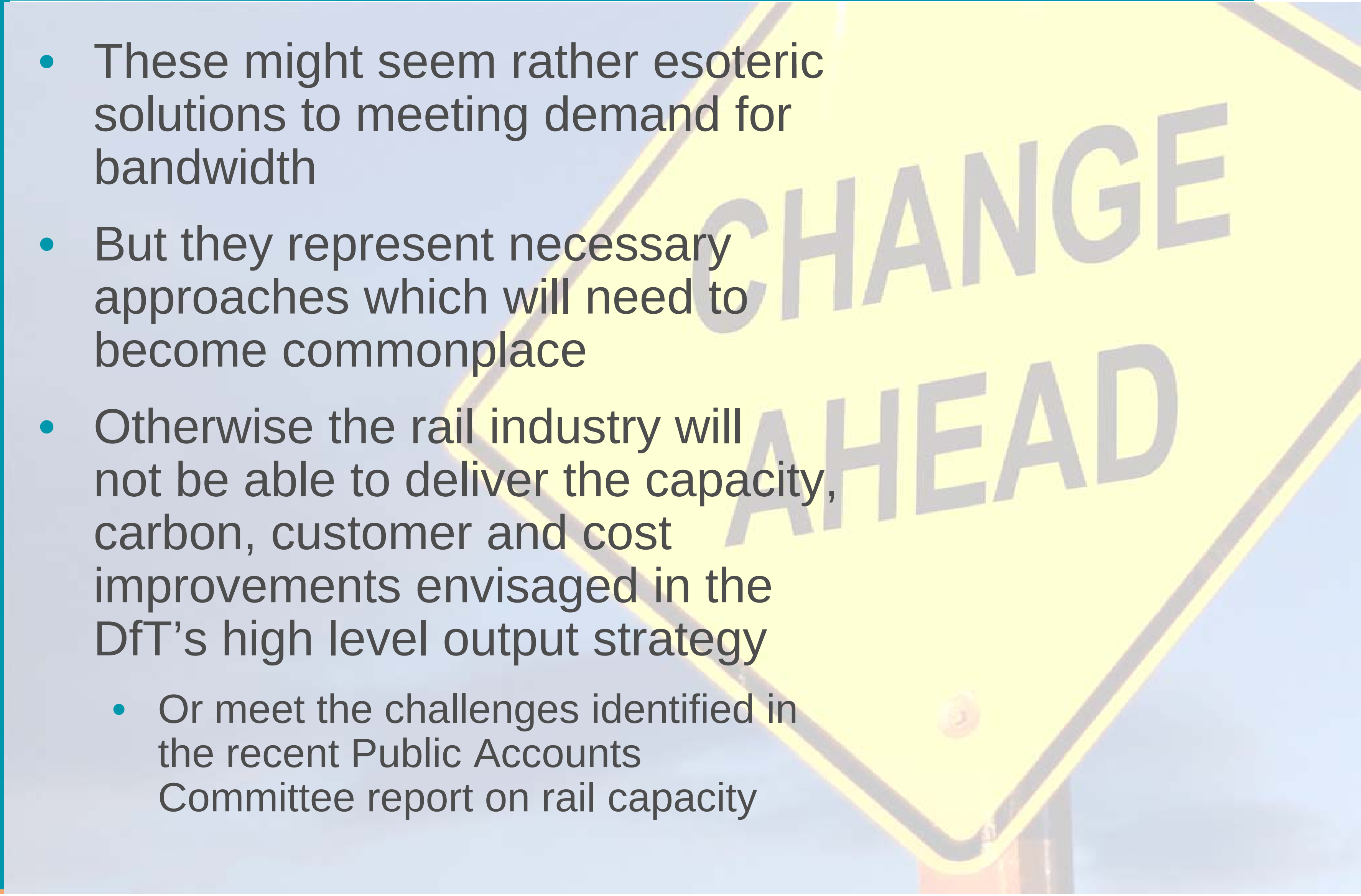
Casting the net wider

- There is a need to work with other (non-rail) stakeholders such as, for example, the emergency services to
    - identify areas where service requirements are similar
    - specify and procure communications together
- so that there are sufficient economies of scale to enable a tailored solution to be realised

Act as a single entity

- There is a need to pull together as an industry
  - to procure new services with better economies of scale
  - to share information with potential suppliers such that account can be taken of the whole industry
  - to follow common technical and commercial strategies
- To maximise the industry’s leverage!

Change is coming



- These might seem rather esoteric solutions to meeting demand for bandwidth
- But they represent necessary approaches which will need to become commonplace
- Otherwise the rail industry will not be able to deliver the capacity, carbon, customer and cost improvements envisaged in the DfT's high level output strategy
  - Or meet the challenges identified in the recent Public Accounts Committee report on rail capacity

Any questions?

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richard.womersley@askhelios.com

About the author

Richard Womersley is an executive with transport and telecommunications consultancy Helios. He has 20 years commercial and technical experience working with suppliers and end-users of telecoms services, as well as regulators and manufacturers. His work has been global in nature, covering the UK and Europe as well as Asia, Africa, the Caribbean and the Americas.

What is IP &

how does it work

Internet Protocol

Paul Darlington
CEng MIET MIRSE
Network Rail

Content

- What is IP?
- What does it mean?
- What will it do for us?
- What does an IP network look like?
- What will it do for signal engineering?

Internet protocol for novices

So what's data communications?

What is the role?

- To transmit across a small or large distance, many different forms of data, using agreed protocols

What is a Protocol?

- A set of rules which govern the way things operate
- An agreed standard by which all parties operate
- e.g. social protocols, highway code etc

Circuit & Packet switched

Circuit switched

A permanent connection between two applications; all data is sent directly from one to the other. Locks up the communication resource but simplifies the data exchange. No resilience unless standby path provided.

e.g. Signalling TDM systems

Packet Switched

Multiple paths available and are used only when data needs to be sent, requiring routing to be established for each data exchange. Data split into small packets to share capacity. Resilience built in and enables communications resources to be shared but requires extra data to control flow and routing.

e.g. the Internet

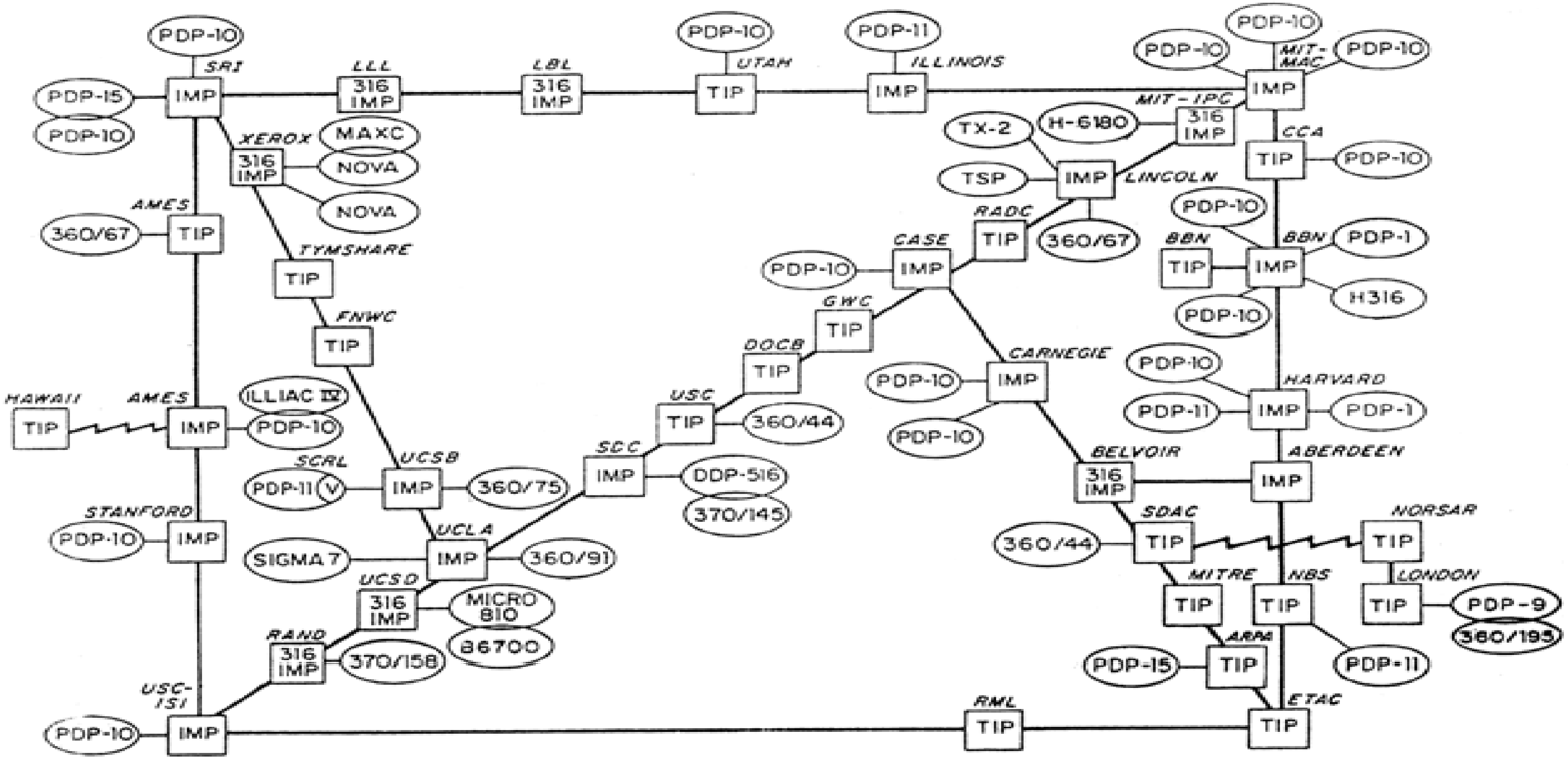
Network Rail

History of IP

- The ARPANET, developed by Advanced Research Projects Agency (ARPA), of the US Departmemnt of Defence, was the world's first operational packet switching network, and the predecessor of the global Internet.

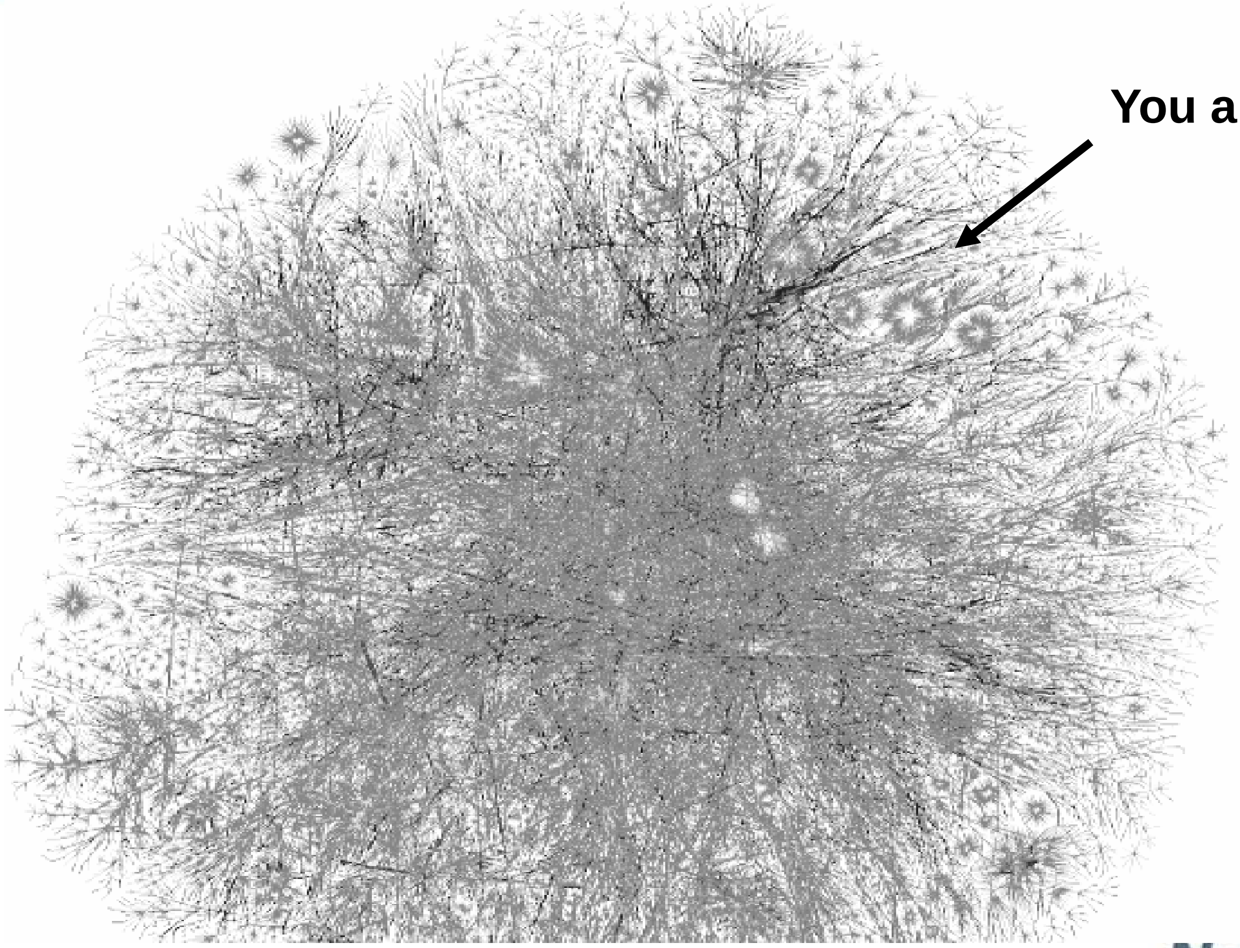
- The first message ever to be sent over the ARPANET occurred at 10:30 PM on October 29, 1969. The message itself was simply the word "login“. The "l" and the "o" transmitted without problem but then the system crashed. Hence, the first message on the ARPANET was “lo." They were able to do the full login about an hour later.

History of IP



ARPA NETWORK, LOGICAL MAP, SEPTEMBER 1973

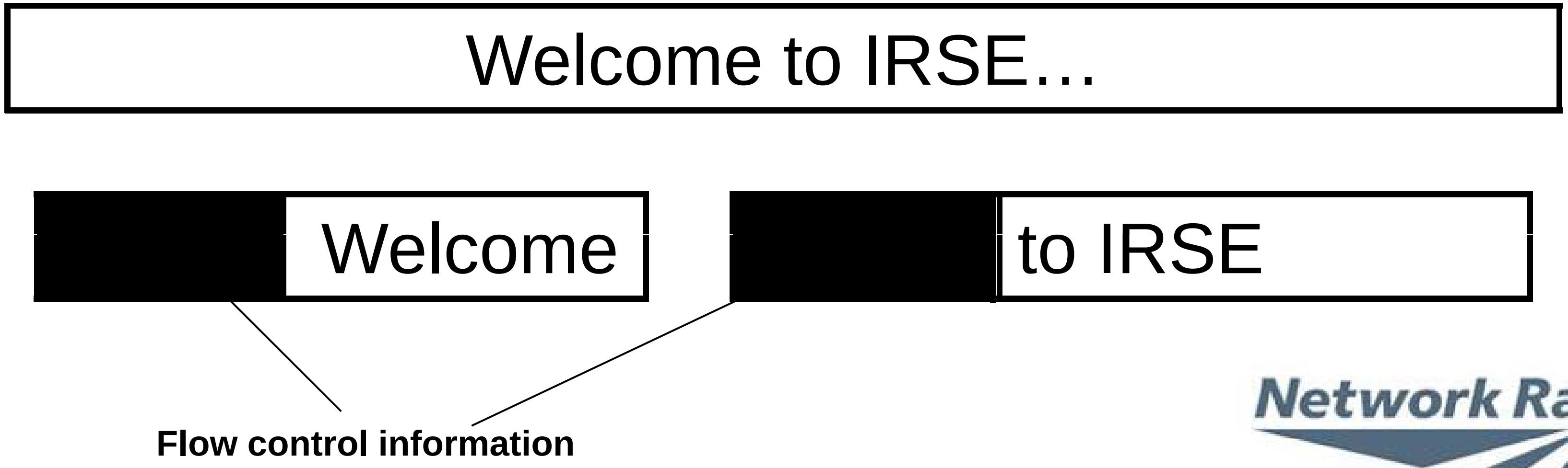
Internet today



You are here !

Packet data

- A small block of data needs to be transmitted
- Each element of information is split into a packet and then transmitted
- Data from a different source can be interleaved, sharing the transmission path
- Each packet has flow control information
- This additional information is an “overhead”



Welcome to IRSE…

Welcome

to IRSE

Flow control information

Packet switched data

- Each packet needs to be given information about the destination (and normally its origin and other information)
- This adds further overhead, increasing the amount of data to be sent
- But now the data can be routed round a meshed network

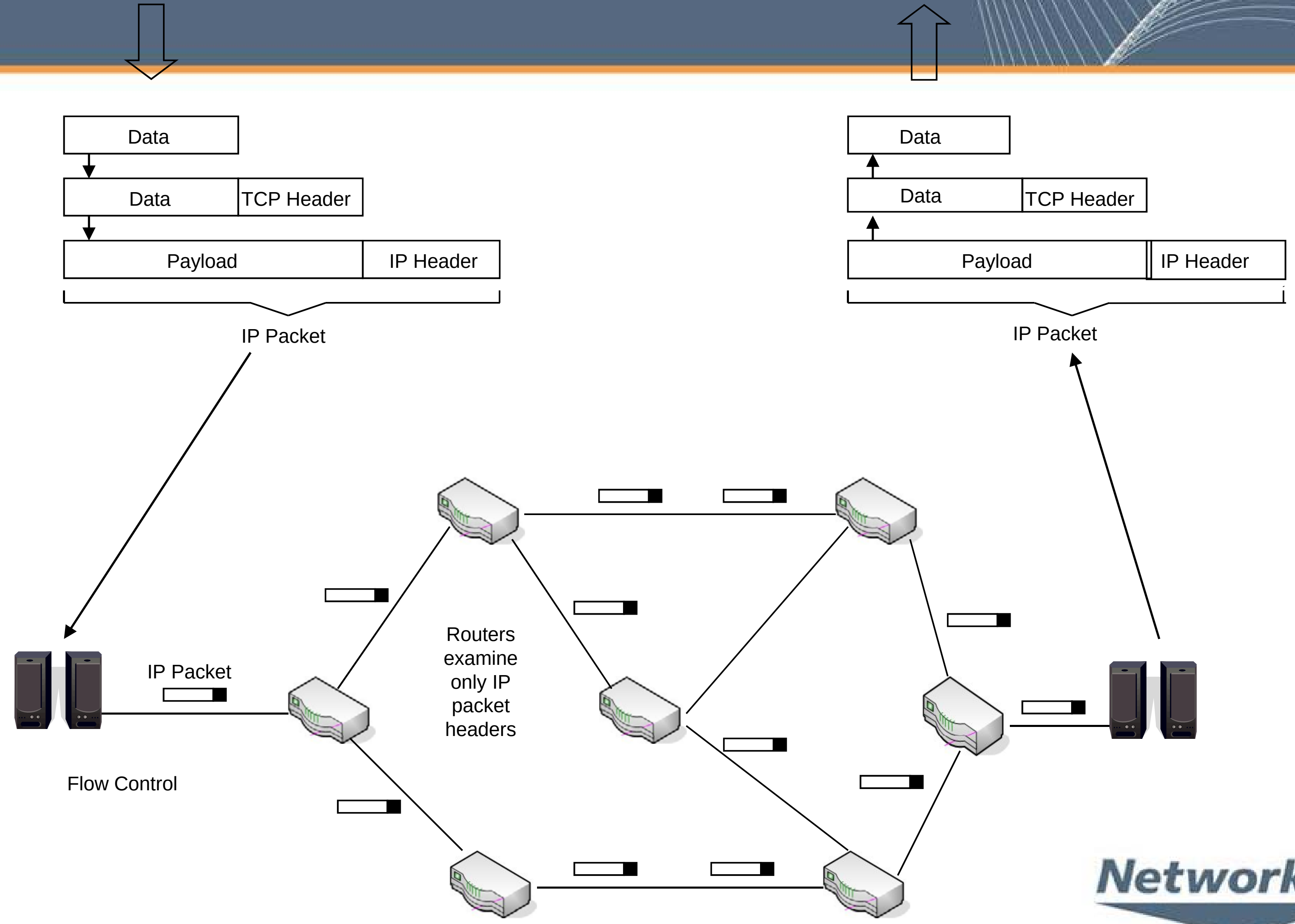
Welcome

Routing information

TCP

- The Transmission Control Protocol (TCP) sits above the IP layer.
- TCP is a reliable protocol that specifies the format of data and acknowledgments used in the transfer of data.
- TCP also specifies the procedures that the computers use to ensure that the data arrives correctly.
- TCP allows multiple applications on a system to communicate concurrently because it handles all demultiplexing of the incoming traffic among the application programs.

IP Network



Data

Data | TCP Header

Payload | IP Header

IP Packet

Data

Data | TCP Header

Payload | IP Header

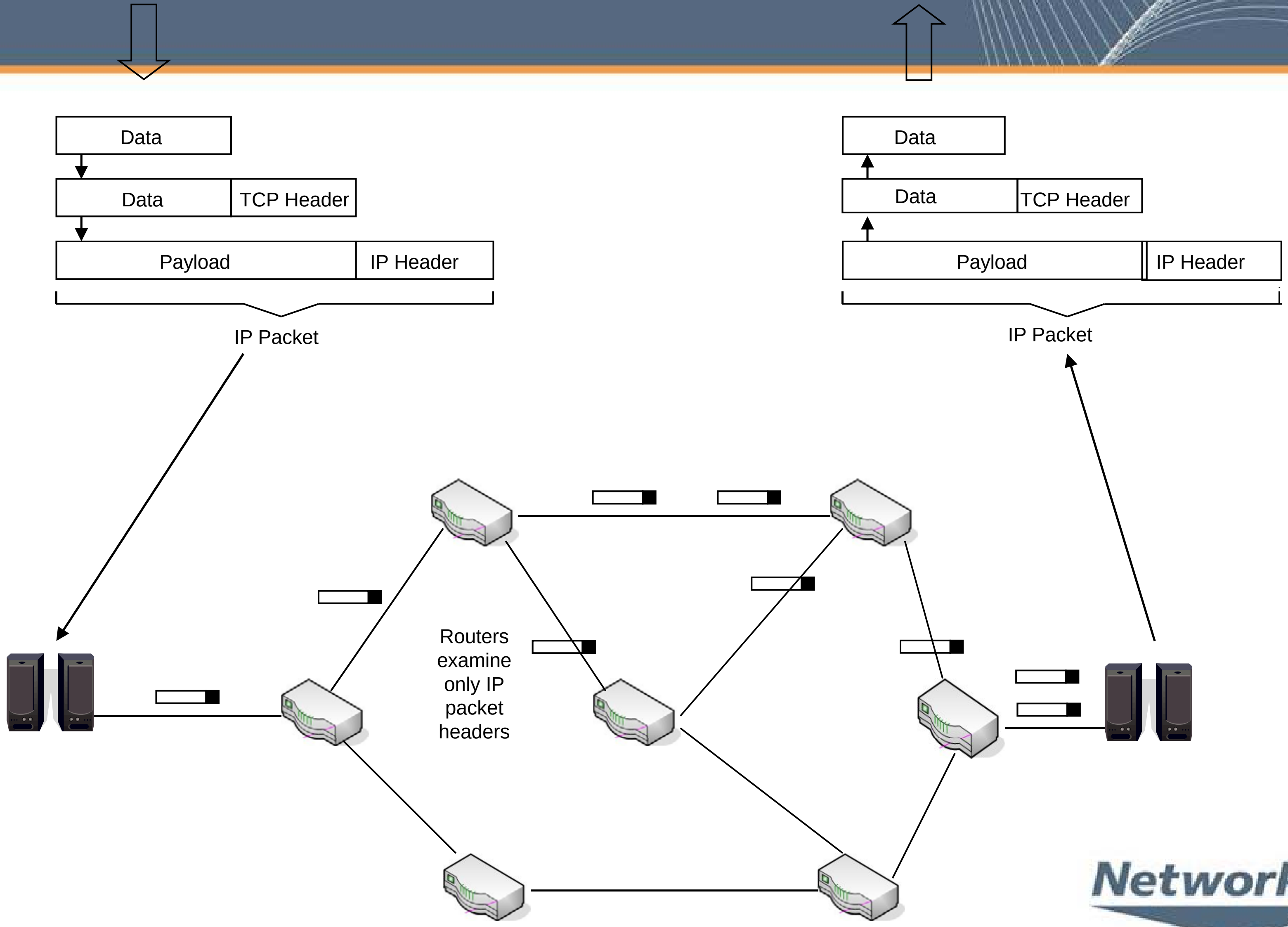
IP Packet

IP Packet

Routers examine only IP packet headers

Flow Control

IP Network



Routers examine only IP packet headers

Internet Protocol

- Addressing- IP headers contain 32-bit addresses (IPV6 has 128-bit) which identify the sending and receiving hosts. These addresses are used by intermediate routers to select a path through the network for the packet;

- Packet timeouts- Each IP packet contains a Time To Live (TTL) field, which is decremented every time a router handles the packet. If TTL reaches zero, the packet is discarded, preventing packets from running in circles forever and flooding a network;

- Type of Service- IP supports traffic prioritisation by allowing packets to be labelled.

- IP provides several optional features, allowing a packet's sender to set requirements on the path it takes through the network (source routing), trace the route a packet takes (record route), and label packets with security features.

Challenging requirements

Not every application has the same requirements!

Transmitting a Word document

Critical that you get all the document – no holes. Time sensitive but not critical.

TCP – request re-transmit of missing or corrupt packages

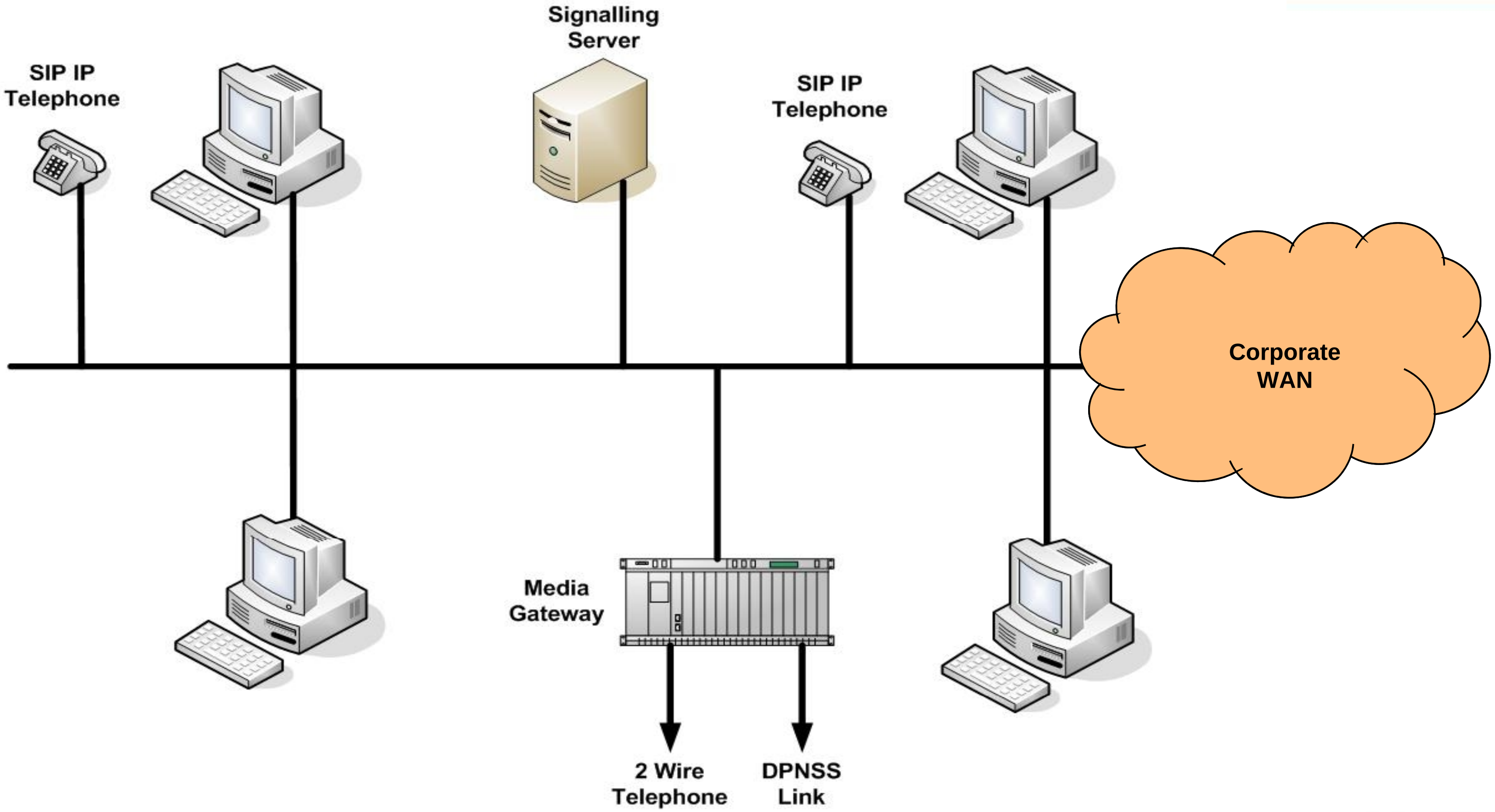
Transmitting Voice or Video images

Time critical, but gaps in the image or voice can be tolerated – may not even be noticed.

UDP – assemble in order but no re-transmit;
but high QoS (Quality of Service) requirement

What do we mean by “Convergence” ?

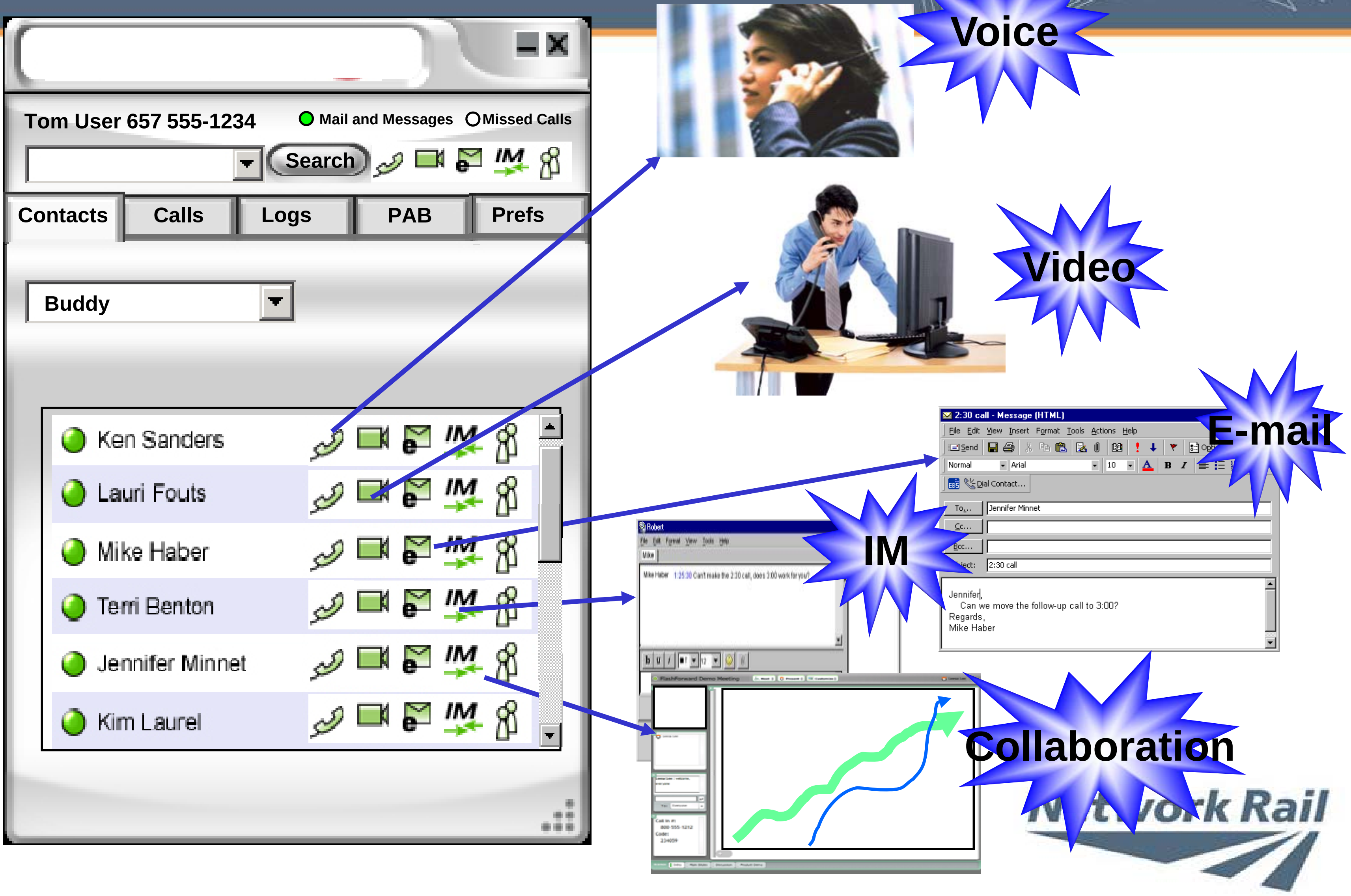
Voice over IP (VoIP) telephony



Benefits of VoIP

- Voice is just another data application
- Telephony can be integrated into other computer systems
- A single computer package can manage all forms of communications

Convergence: Business Environment – One Interface



Tom User 657 555-1234

Mike Haber 1:25:30 Can't make the 2:30 call, does 3:00 work for you?

To... Jennifer Minnet

Subject: 2:30 call

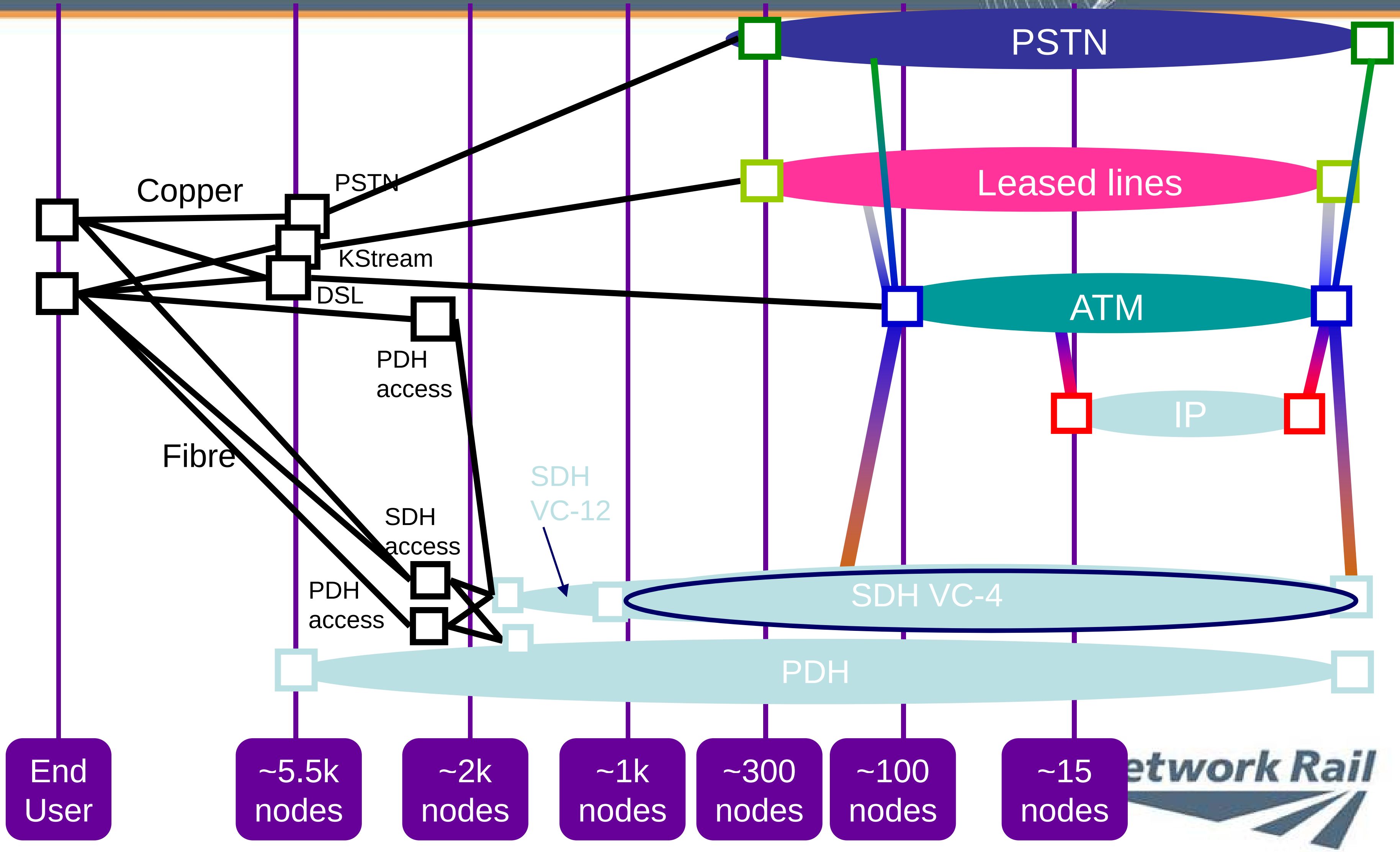
Jennifer,
Can we move the follow-up call to 3:00?
Regards,
Mike Haber

Converged Carrier Network

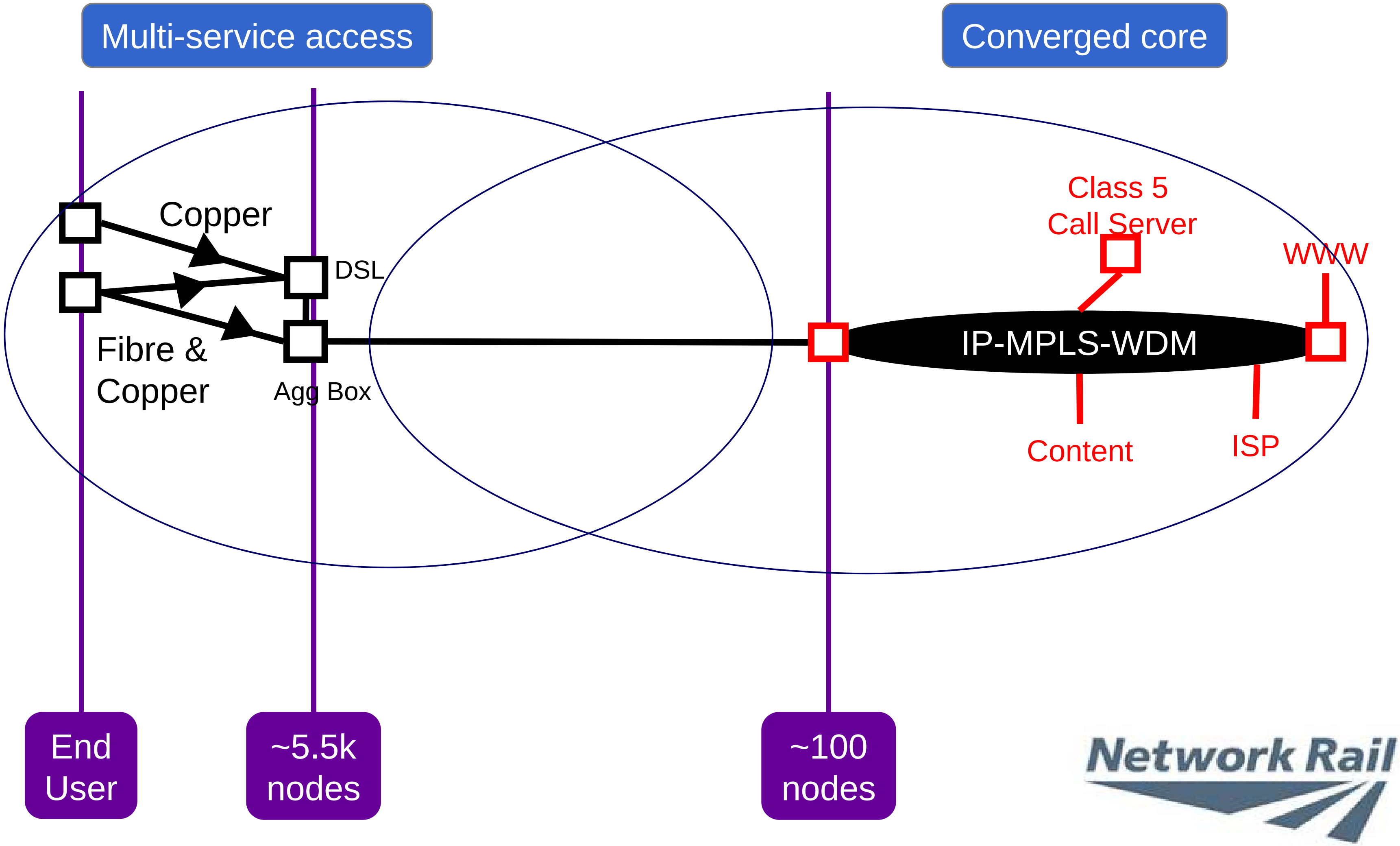
- Many carriers have already deployed either converged IP networks, or IP overlay on top of legacy networks.

- One of the largest examples is the BT network supporting the PSTN and various data networks.

BT’s legacy network



BT's 21^{st} Century Network



Network Rail

Railway IP vision – how we do business

Wireless access for trackside workers

Remote condition monitoring

Bridge bash detectors

Wind speed monitors

Rail temperature

Trackside CCTV

Intruder alarms, access control

Trespass & Vandalism monitoring

Real Time Asset tracking

Level Crossing monitoring

Depot Connectivity

Signal box connectivity

Stations CIS & LLPA

Smart ticketing

Security CCTV remote access

Many more…..

Network Rail

IP private networks

- **Railway Administrations include;**

  SBB (Switzerland), PKP (Poland), OBB (Austria), ZSR (Slovak Rep.), ADIF (Spain), REFER (Portugal) RailTel (India), Bankferket (Sweden), NMBS (Belgium) Network Rail (GB)

- **Power Utilities include;**

  ENEL (Italy), Transelectrica (Romania)
  NEK (Bulgaria), EDF/RTE (France)
  Elia (Belgium), Tennet (Nederland)
  SEPS (Slovak), Furnas (Brasil),

- **Roads**

  Highways Agency (GB) Motorway CCTV, help point and road sign control

Signal Engineering - Applications

- Condition monitoring – points, axle counters, etc
- Non-vital controls – Signal Box to Interlocking.
- CCTV for level crossing monitoring (CCTV is a standard IP application)
- …….. and surely more.

Network Rail

Signal Engineering - Issues

Latency (delay) – could be 50mS for IP

(SSI latency must not exceed 4.49mS end to end and 3.6mS difference in the diverse paths)

- FTN design will provide circuit switching to comply with SSI standard
- Good design can reduce the network delay
- Applications need to take into account the possibility of data transmission delays

Security (open networks)

- MPLS VPN control drives through the IP network
- Managed by rail professionals reduces the risk – need to specify competence and procedural control measures

Network Rail

Signal Engineering - benefits

- Cost – standardise on off-the-shelf data communications products
- Resilience – reduction in risk of loss of data communications path (99.99%)
- Flexibility – easier to transfer control to an alternative location
- Inevitability – IP will dominate,
- so don't ignore it!

Network Rail

Thank you for listening

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Nomad Digital

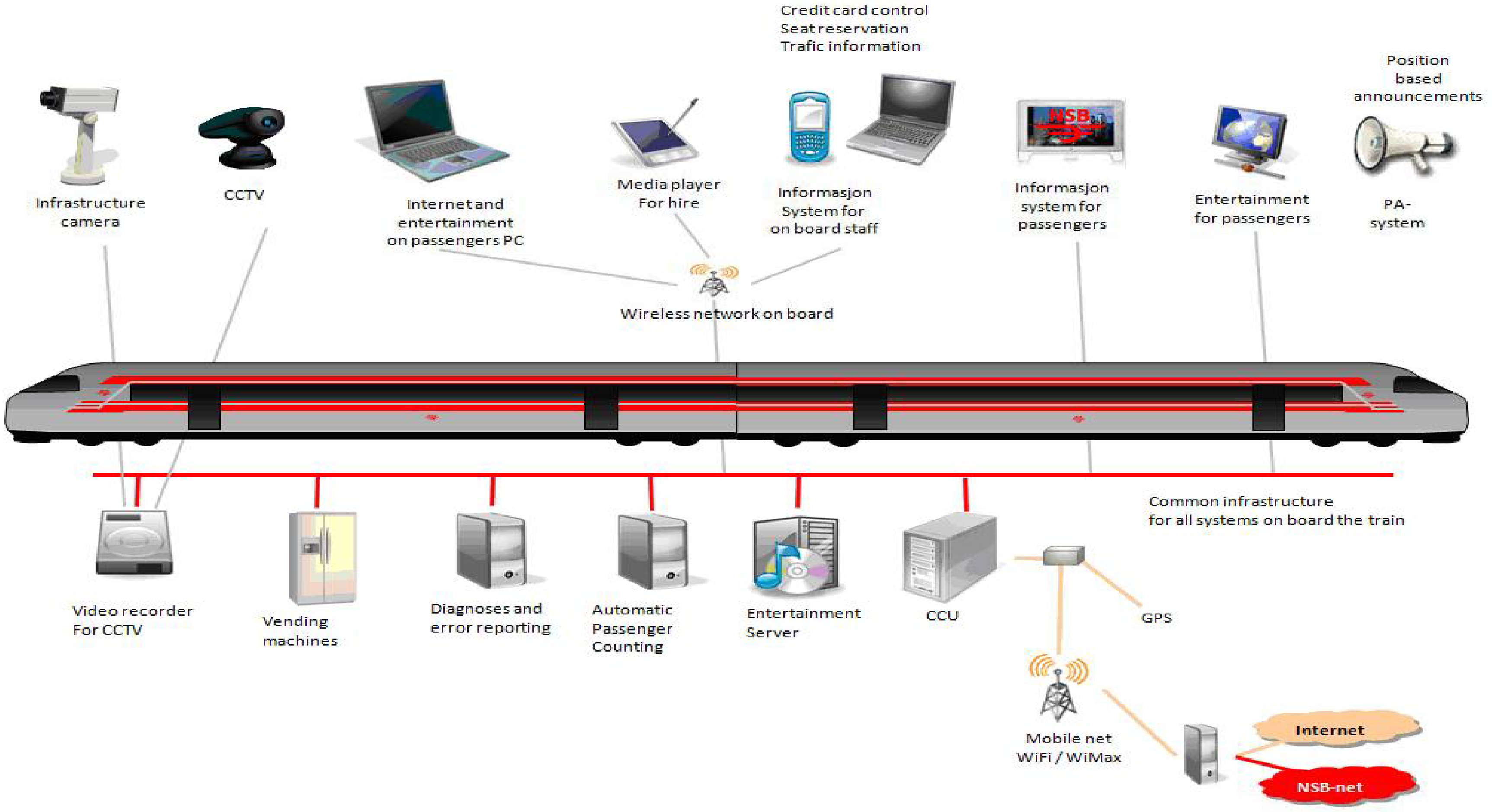
IP Services on trains for Passengers & Operators

Executive Chairman: Nigel Wallbridge Ph.D, MIMechE, MBA

IRSE Technical Seminar

London, Tuesday 16th November 2010

Nomad Digital



Credit card control
Seat reservation
Trafic information

Position based announcements

Infrastructure camera

CCTV

Internet and entertainment on passengers PC

Media player For hire

Informasjon System for on board staff

Informasjon system for passengers

Entertainment for passengers

PA-system

Wireless network on board

Common infrastructure for all systems on board the train

Video recorder For CCTV

Vending machines

Diagnoses and error reporting

Automatic Passenger Counting

Entertainment Server

CCU

GPS

Mobile net WiFi / WiMax

Internet

NSB-net

Nomad Digital

Examples of connected-train applications:

Passenger Applications:

- **WiFi**
- **Live view** - moving map
- **Passenger information** - Informative, comprehensive, live and personal. For tourists as well as regular passengers.
- **Entertainment** (Music, movies, games, kids)

Business Intelligence:

- Mining a wealth of data

Security:

CCTV Live - remote monitoring
CCTV Playback – file download for review

System tools:

- **IP Health** – real time status of IP devices
- **IP Health History**
- **Screen Manager** – management of on-board screens

Train Operations:

- **Consist Mapping** – train orientation
- **Passenger Comfort**
- **Vehicle Tracker**
- **Energy monitoring / driver performance**
- **Schedule Adherence**
- **Driver Advisory System**
- **Automatic Passenger Counting**
- **e-ticketing**
- **OTMR**
- **Retail Stock**
- **Vandalism detection**
- **Remote starting**
- **Condition Based Maintenance**
  - Door Monitor
  - HVAC Monitor
  - Coolant Monitor

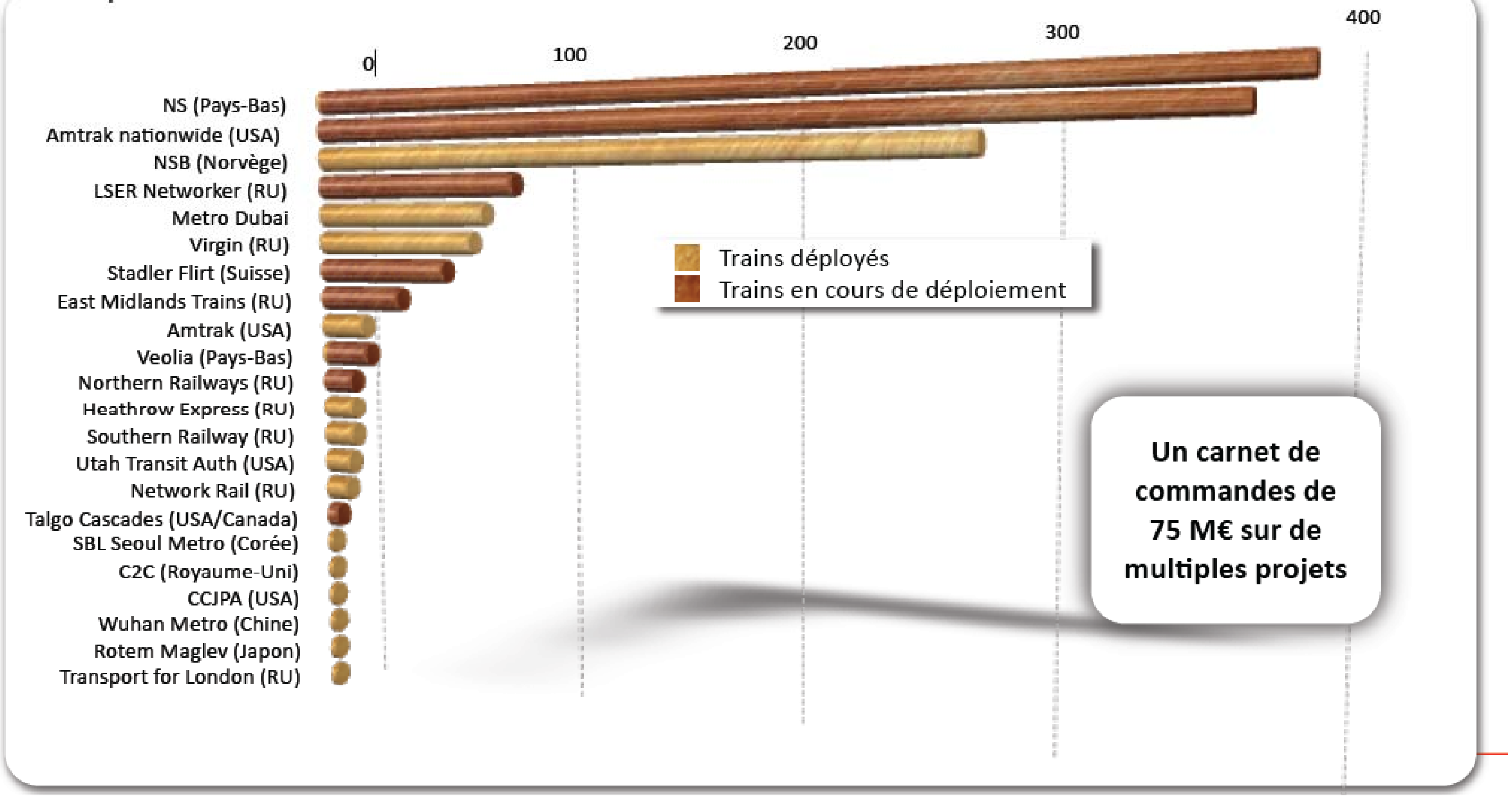
The past……

- ❑ Trains and telecoms share an interwoven history from telegraphy to Sprint
- ❑ However since 1991 (the introduction of the ICE for example), we have had mobile phones (1992), laptops (1993), dial-up Internet and email (1994), world-wide web (1996), ISDN (1998), Google (1999), ADSL (2000), WiFi (2002), 3G (2004), iphone (2008), ipad (2009).
- ❑ **Are the changes likely to be less in the next 20 years?**
- ❑ Trains – an ideal environment for connected services - became ‘the land that IP forgot’ . Its not much help to say that new trains are IP devices – the vast majority of the fleet isn’t.
- ❑ **Why? Perhaps because the industry is too self-referential?**
- ❑ GSM-R specifications were finalized in 2000. According to the National Implementation Plans, 50% of the GSM-R planned network in Europe is expected to be in operation end 2010.
- ❑ **Will the next signalling system be IP based?**

Nomad Digital

Nomad est devenu le fournisseur de référence

Le premier fournisseur mondial en nombre de trains



Un carnet de commandes de 75 M€ sur de multiples projets

The goal....

- **Creating a B2B app store for continuously connected IP trains**
- Why?
  - 10% fewer trains bought.
  - 10% less energy used.
  - 10% more passengers carried
- How?
  - A ‘Vodafone’ for the rail industry
  - Enabling creativity

In the next few years?

The connected train is not isolated from fast rising technical and commercial tides:

- The ‘Internet of things’
    - Particularly mobile things
    - Particularly transportation
- The battle for the 3rd screen – the next generation of devices won’t need a table and will pay the rail fare.
- Is LTE really going to solve everything?
- The rail industry and spectrum

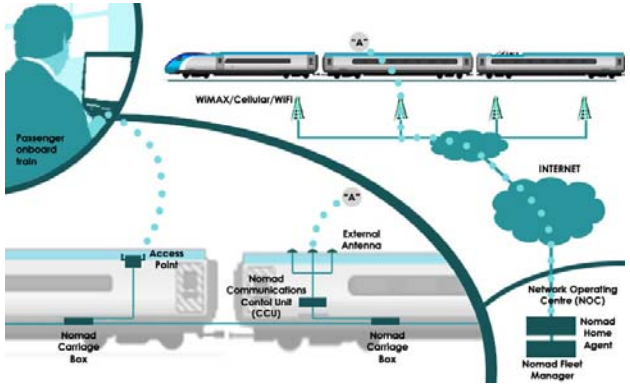
UTA

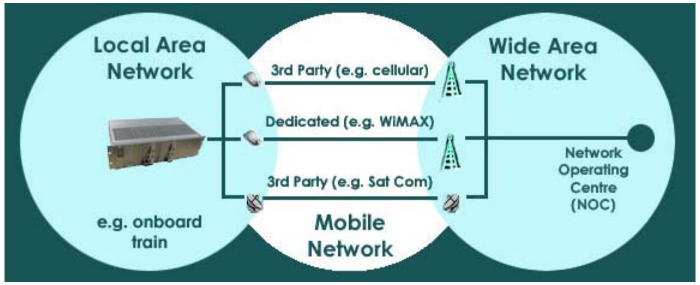
Rotem Maglev

HEx

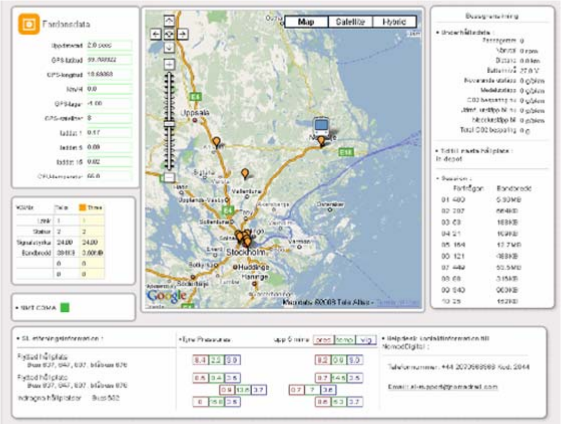
Technical solution overview (1)

1. Complete network schematic →
   Nomad provides a complete end-to end open standards IP solution from the on-board LAN to the NOC and beyond.

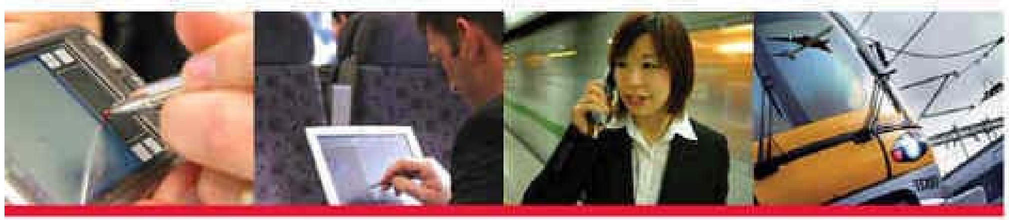




← 2. Train-to-shore switching and aggregation
   Flexibility and best-in-class performance from Nomad's world beating multi-carrier approach.



3. Network operating centre (NOC) →
   Nomad provides full-back office functionality with both hardware and software for network management, enterprise security, fleet configuration etc.



Technical solution (2)

4. Key on-board hardware →

Nomad uses compact
train-approved equipment
which is easily and quickly
Installed and has a small footprint

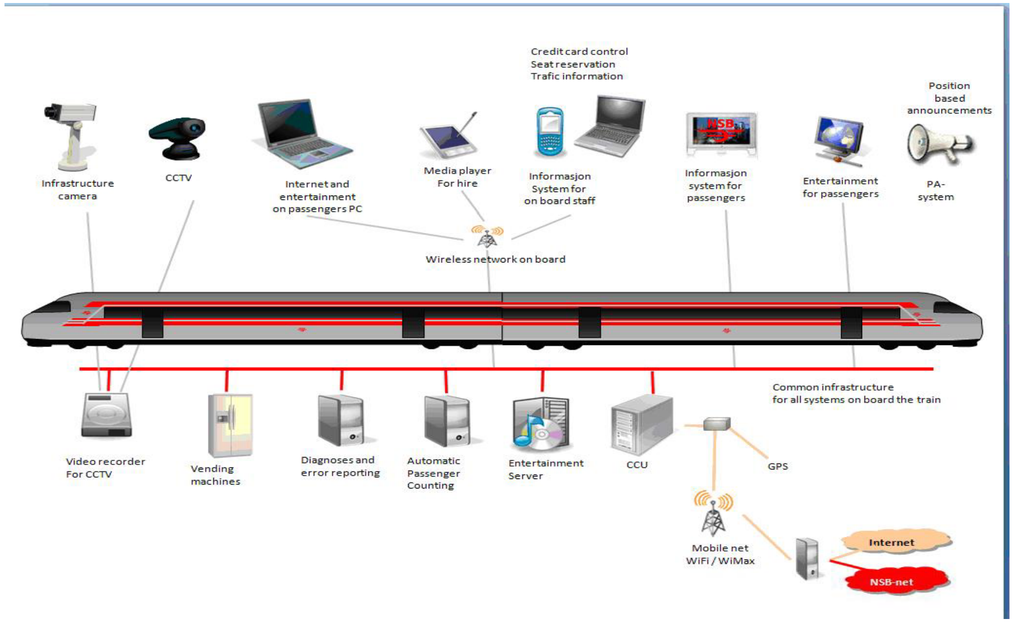
Nomad CCU R3200
280mm (W) x 178mm (D) x 50mm (H)
A compact CCU

Nomad CCU R3500
3U High 19” Rack Mount
Expands for all applications

Roof-top antenna

5. Applications →

The value in ‘IoB’ lies in using ‘apps’ to benefit the TOC by reducing whole-life cost and improving passenger experience. Apps are provided by Nomad, increasingly its customers and third parties. As Nomad has the largest installed base of IP connected trains – it also has most apps for its customers to share.



invensys

Telecoms and the Future Railway - IP based Signalling Technology Opportunities

Tim Whitcher

Engineering Graduate, Invensys Rail Ltd.

Contents

Introduction

and the Future Railway - IP based
Technology Opportunities

Deliberate re-title – because IP-based technology presents many more opportunities than risks...

Risk is opportunity in disguise

Part 1

Present State Analysis

Present State Analysis

- Historical Uses

- Traditional uses of telecommunications in the railway have been limited and progressed slowly...
    - Telephony

Telecoms Dispatching

Telegraph-enabled Block Instruments

Present State Analysis

- Historical Uses

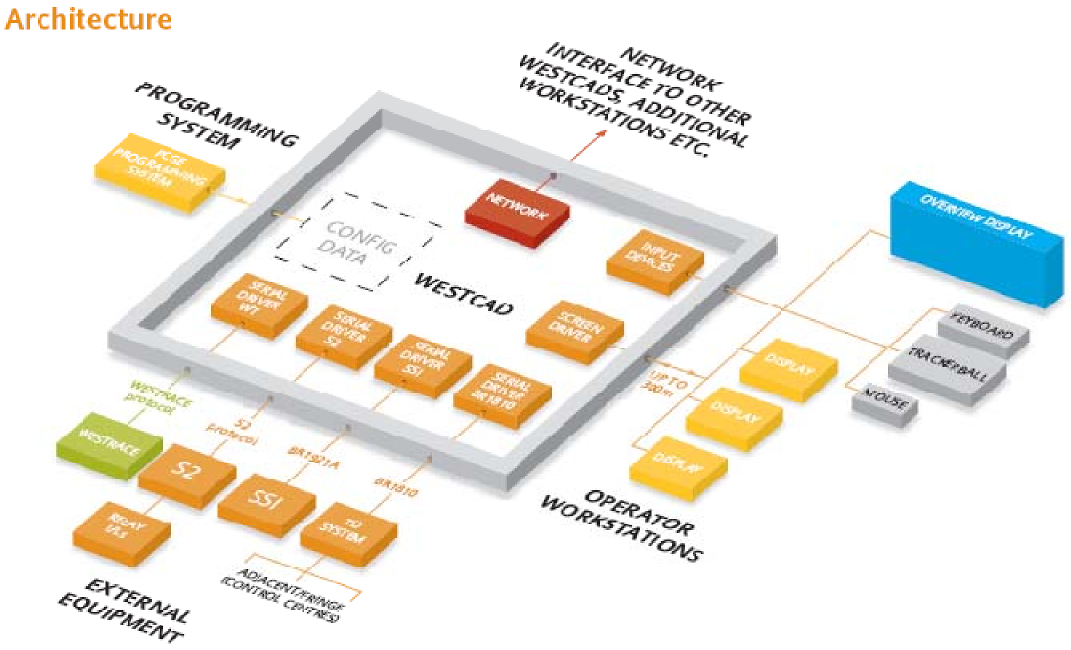
- Centralised Traffic Control

RETB Traffic Management (1970s and 80s)

CTC Demonstration (1930s)

Present State Analysis
- Existing Practice

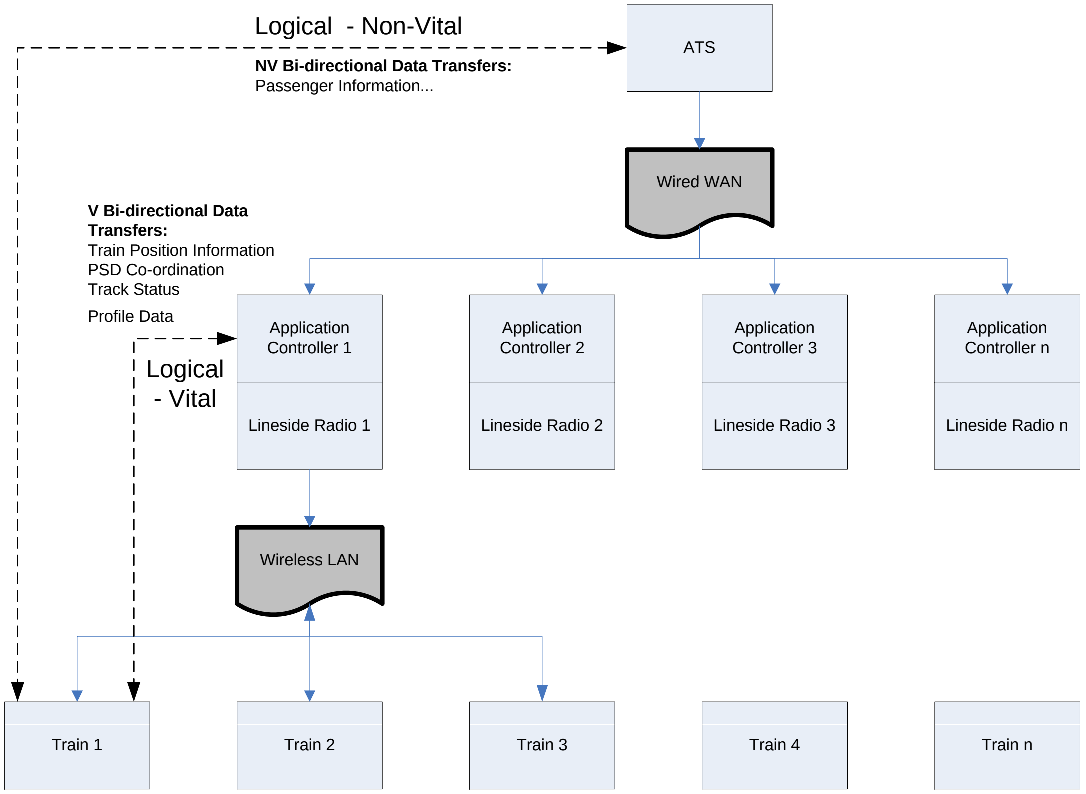
- Control Centres
  - SystematICS
  - WESTCAD
- Interlockings
  - SSI (sort of...)
  - WESTLOCK
  - WESTRACE



Present State Analysis

- Existing Practice

- CBTC
  - All trains are considered as nodes on a network
  - System enabled by IP technologies



Logical - Non-Vital

NV Bi-directional Data Transfers:
Passenger Information...

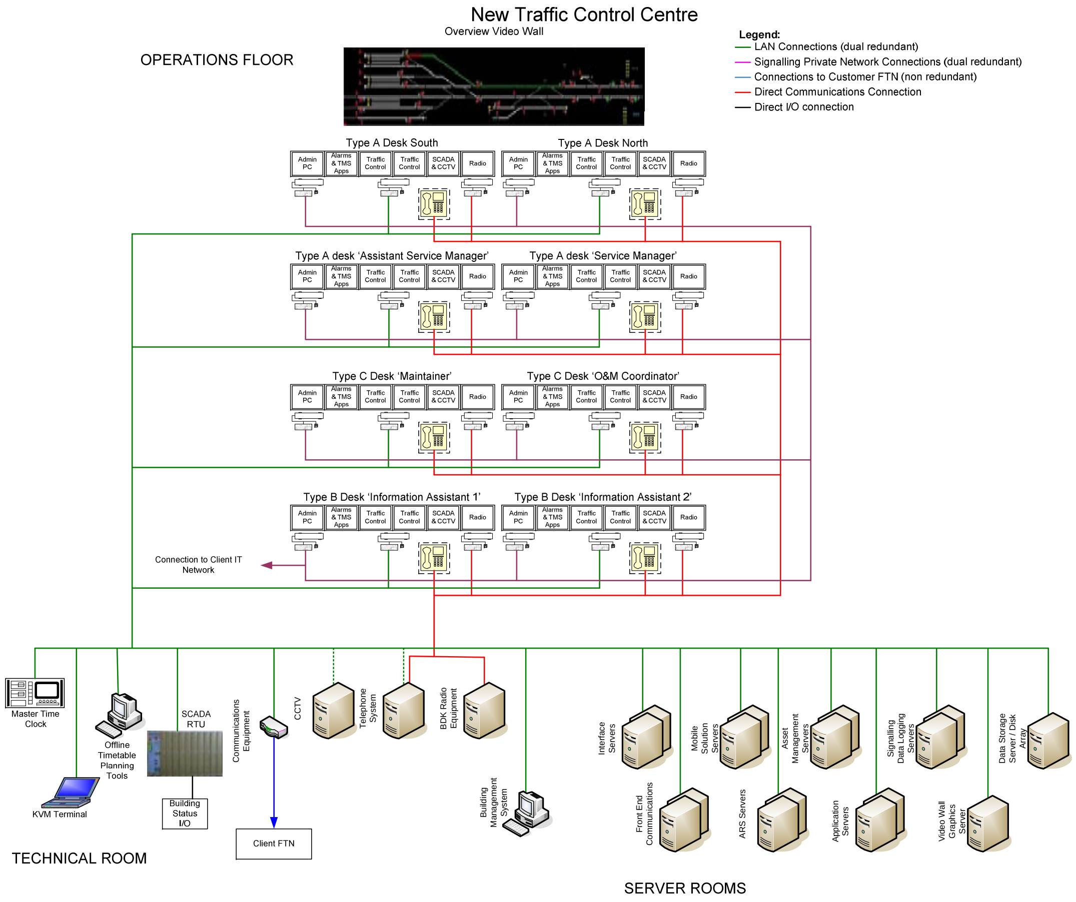
V Bi-directional Data Transfers:
Train Position Information
PSD Co-ordination
Track Status
Profile Data

Logical - Vital

Present State Analysis

- Existing Practice: Control Centres

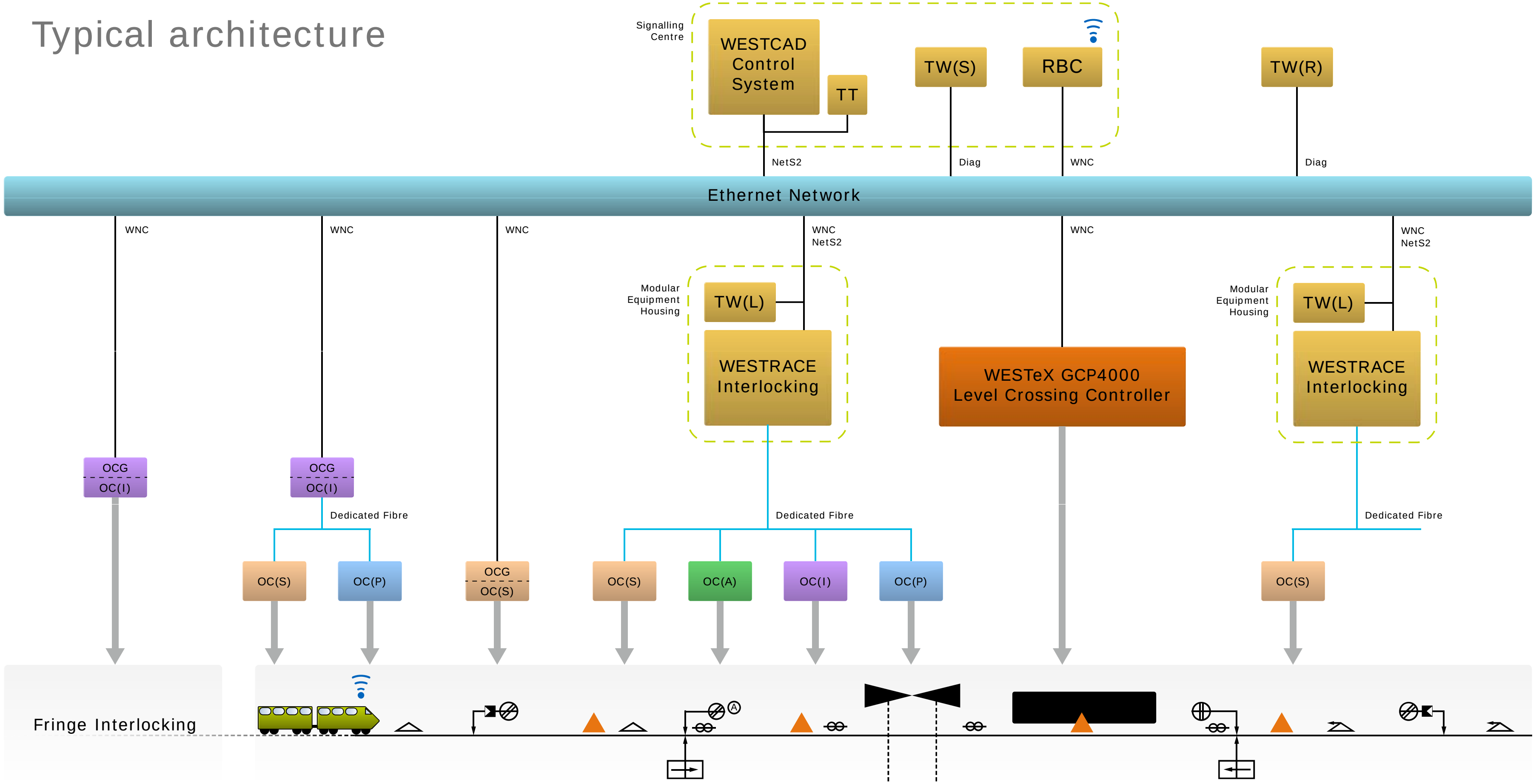
An example TMS



Present State Analysis

- Emerging Practice: Modular Signalling

Typical architecture



Present State Analysis

- Summary

IP-based systems are here!

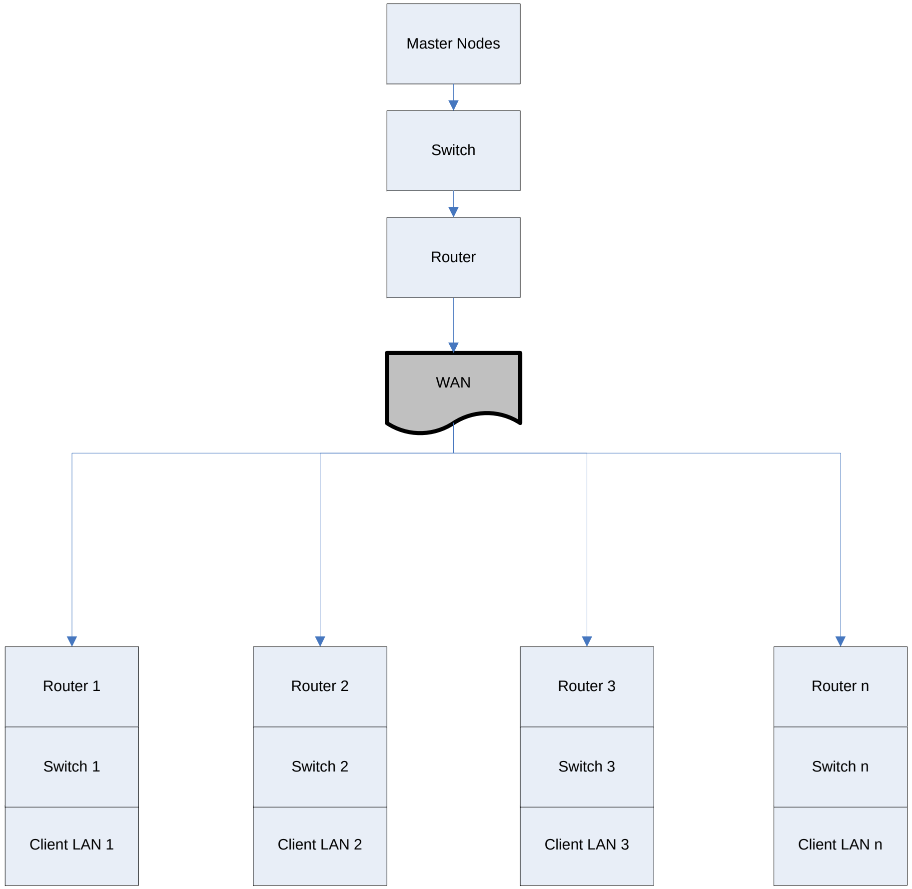
Part 2

Pros and Cons of IP-based Signalling

Pros and Cons of IP-based Signalling

- Traditional Network Model

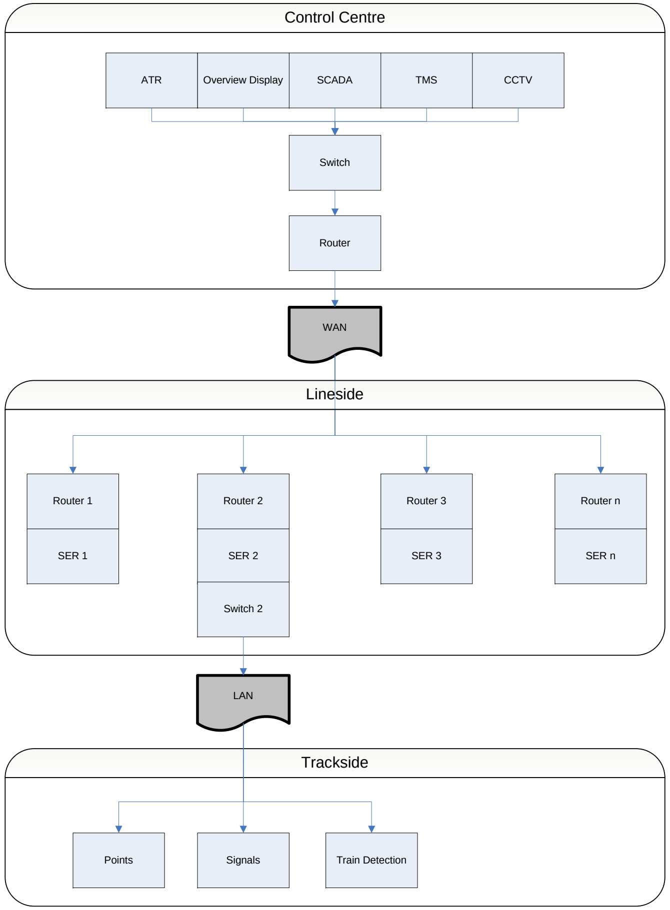
- Traditional models include Nodes, involves Switches, Routers and some (as yet) undefined transmission medium such as the internet
- Operation is carried out using the TCP/IP model
- This capability is available using commercial off-the-shelf equipment
- This is how almost everything works: Internet, most company networks and telecommunications works.



Pros and Cons of IP-based Signalling

- Future Signalling Model

- Utilises TCP/IP
- Assigns an IP based network address to all elements in the network
- IP addresses can assigned either statically or dynamically but most probably utilising unique static IDs
- Network can be provided by either wired or wireless communications



Pros and Cons of IP-based Signalling

- Pros

- Price
  - Commercial, off-the-shelf equipment readily available
  - Optical fibre and/or copper wire
  - Less communications cable if go wireless
- Capacity and Flexibility
  - Potentially supports diverse application developments such as improved intelligent infrastructure and predictive maintenance
  - The generic nature of IP networks allows greater flexibility of configuration and design
  - Fibre mitigates EMC issues
- Power
  - Lower power consumption than traditional methods thus reducing power requirements for design and end-user costs
- Robustness
  - More available routes and wider range of connections

Pros and Cons of IP-based Signalling
- Cons

- Reliability
  - IP is a ‘best effort’ system and needs to be combined with TCP and other protocols to ensure messages arrive in order, via optimal routes etc.
- Power
  - Still required to power devices
  - If using the commercial wireless band then have to contend with interference from other users
- Obsolescence
  - Moore's Law – technology is upgrading fast and far out-stripping the rate of change in the rail industry meaning potentially higher life-cycle costs or reduced service life
  - Drive for flexible system designs that allow for frequent technology refreshes.

Part 3

Potential Technical Issues and Risks

Potential Technical Issues and Risks

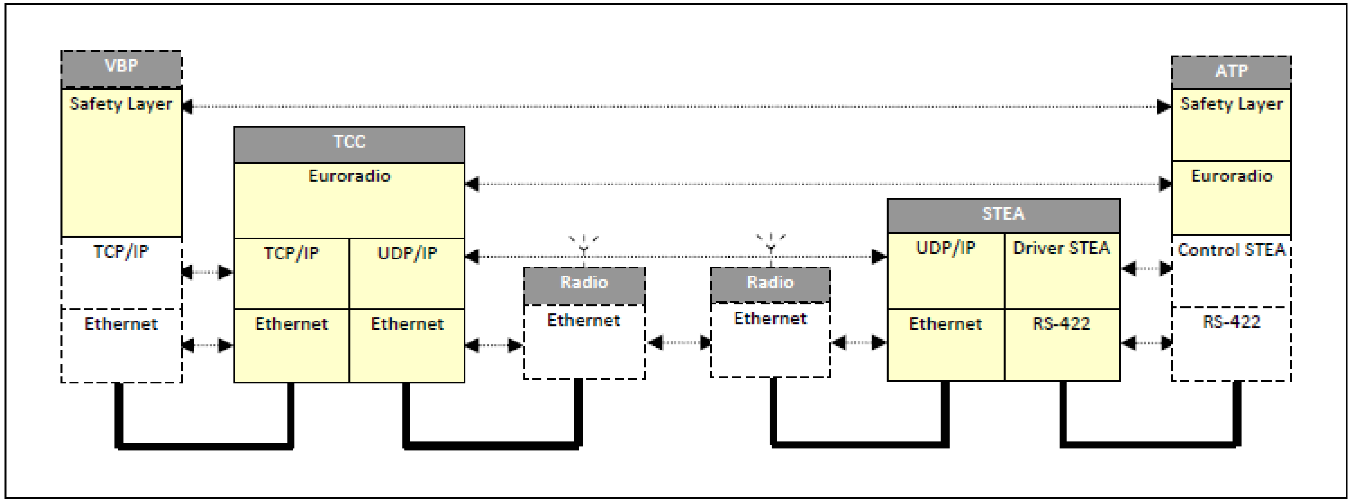
- Security

  - Data transfers taking place via uncontrolled internet or unlicensed wireless bands
  - How to share the same space as commercial and public traffic
  - Need to cope with potential for attacks from beyond controlled boundaries
- Mitigation
  - Encryption and firewall software are commercially available and in many designs, types and formats to suite application
  - Quantum cryptography
  - Use of Private IP networks to isolate sections of signalling network, e.g. control centre, lineside, trackside; and the use of Router/NAT devices provides integral functional firewall
  - There is a whole world of industry with as big or even greater need for security

Potential Technical Issues and Risks

- Safety

- System design to embody
  - Un-assured communications
  - Fast changing technologies
- Put safety at the application layer



Potential Technical Issues and Risks

- Connection Performance

  - Still have to deal with
    - Delays, data corruption….
- Quantity of data overwhelming the network
- Speed of transfer
- The sorts of challenges that are managed through a robust Systems Engineering approach.
  - Interface management, performance specification and modelling

Part 4

Future Opportunities

Future Opportunities

- Globally Distributed Networks

- Utilise extensive wireless networks to provide low cost signalling over widely distributed areas
    - May be need for ‘suck it and see’ to build confidence using unlicensed bands
- Wireless trackside equipment combined with renewable power generation to create remote signalling assets with no trackside connections – potentially useful in geographically remote locations and developing nations where VSAT is often more accessible than traditional cabling
    - Cost and delays
- Potentially reduce the number of control centres as data becomes accessible from any location with the appropriate access rights

Future Opportunities

- Urban Railways

- Extensive urban Wi-Fi/WiMax coverage can be utilised to minimise trackside equipment in congested areas and provide low cost control and interface systems for tram and light rail networks

Future Opportunities

- Inter-train Communications

- What’s the next step from CBTC and ERTMS?
- Trains talk to trains to manage movements
    - Exchange position, speed etc
    - Dispense with the trackside vital systems
- A line-wide wireless network allows trains to talk to the other trains in their vicinity
- Train systems manage all vital actions
- Wireless network allows trains to manage trackside operations such as points machine operations

A pessimist is one who makes difficulties of his opportunities and an optimist is one who makes opportunities of his difficulties.

-Harry Truman

Any questions?

SISS and Future Technologies

Pete McNamara

Director of Projects

Contents

- Overview of SISS Systems
- SISS Systems – Ensuring Successful Delivery
- Future Technologies
- Conclusion
- Questions

Introduction

Peter McNamara

- Director of Projects at ASL
- B Eng (Hons) in Aeronautical Engineering
- 5 Years experience in delivery of mission and safety critical systems within the aerospace industry
- 10 years experience of delivering Signalling and Telecommunications Systems within the Rail Industry
  - Network Rail
  - London Underground
  - Other
    - Canada
    - South Africa

Overview of SISS Systems

Overview of SISS

What is an SISS?

- **Station Information and Surveillance System**

- **Provides Control and Monitoring of various services for operation of facility such as Station or Railway from single common GUI**
  - Situational Awareness
  - Incident Management
  - Maximised Operational Throughput
  - Centralised Maintenance

Security

- Situational Awareness
- Fast Response
- Easy Access to Security Personnel

Customer Service

- Access to Current Information
- Choice of Entertainment, Shopping, Dining
- Competitive Travel Experience

Operations

- New Business Models
- Control of HVAC, Lighting, Lifts
- Support for Mobile Service Staff

IT Efficiency

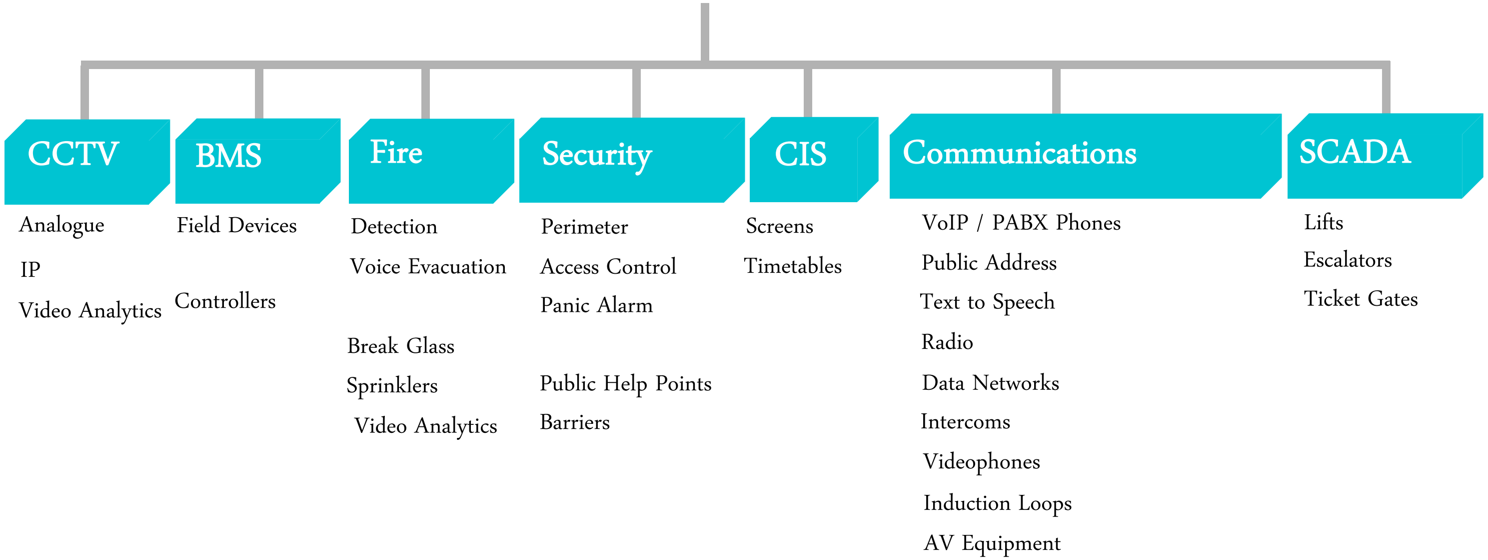
- Scalability
- Ease of Management
- Interoperability

Overview of SISS

What is an SISS?

- **Services**
  - Integrated Data Networks
  - Voice Communications (Telephony and Radio)
  - CCTV
  - Public Address
  - Voice Alarm
  - Passenger Information Systems
  - Access Control
  - Security Systems
  - Equipment Monitoring
  - SCADA

SISS



CCTV
- Analogue
- IP
- Video Analytics

BMS
- Field Devices
- Controllers

Fire
- Detection
- Voice Evacuation
- Break Glass
- Sprinklers
- Video Analytics

Security
- Perimeter
- Access Control
- Panic Alarm
- Public Help Points
- Barriers

CIS
- Screens
- Timetables

Communications
- VoIP / PABX Phones
- Public Address
- Text to Speech
- Radio
- Data Networks
- Intercoms
- Videophones
- Induction Loops
- AV Equipment

SCADA
- Lifts
- Escalators
- Ticket Gates

Ensuring Successful Delivery

ASL

Ensuring Successful Delivery

Requirements Capture

- Consideration of Operational Concept and End User Requirements
- Consideration of system use during major incident
- Early Identification of Safety Requirements
- Aspirations for improvements translated into Requirements
- Filtering of standards

Integration

- Consistent Specification of Subsystems Suppliers
- Management of Legacy Interfaces
- Specifying Industry Standards as part of Requirements
- Independent reference equipment for testing/de-risking

Ensuring Successful Delivery

Migration

- Staged Migration
- Strategy for Retention of operator services through migration
- Consideration of available Space

Assurance/Acceptance

- Ensure Assurance process suitable for application
- Managing process to consider new technologies
- Understand and Manage multi-tiered acceptance process
- Understand and Manage multi-tiered access process

Ensuring Successful Delivery

Consequences

- **Unnecessarily High Costs and risks to deliver systems**
  - Disproportionate for smaller stations
  - Publically funded projects – Tax Payer!
- **Poorly delivered systems**
  - Old Technology
  - No Progress – Stuck in the current
  - Ineffective Station/Railway Management
  - Safety and Security Risks
- **Reluctance to upgrade**
  - Life expired systems retained
  - High maintenance and poor reliability
- **Unsatisfied general public**
  - Poor Perception in Press
  - Unwillingness to use public transport.

Future Technologies

Future Technologies

Key Drivers

- **Cost Reduction**

  Capital equipment 25% and implementation up to 75%

  Whole life cost!

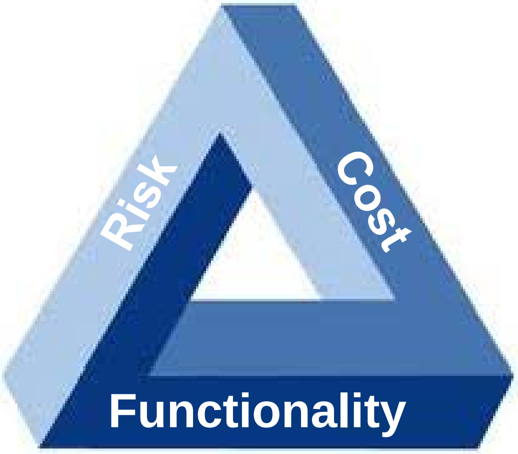
- **Risk Reduction**

  Integration complexity, configuration issues and project overrun

- **Increased Functionality**

  For control room operators, end user and stakeholders

Achieve the "Impossible Triangle"?



Future Technologies

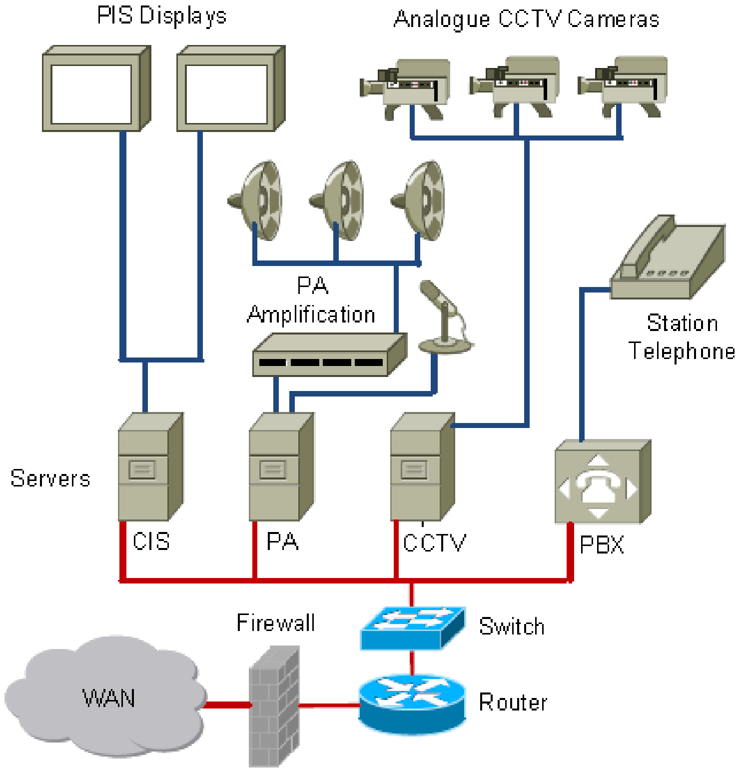
- **Utilisation of Emerging Technologies**
  - Virtualisation and server consolidation
  - Analytics (audio, video and data)
  - Converged Networks
  - Energy Management
- **Event driven control rooms**
  - Sensor fusion
  - Situational Awareness
  - Right message, right person, right time...
- **Mobile and New Media technologies**
  - Peer based. Not dependent on location
  - Publish and Subscribe
  - User orientated
  - Open Standards based

Emerging Technologies

Traditional Station Implementation

Individual Servers for each Subsystem

- High Implementation Cost
- Requires significant space to house
- Requires significant cabling
- High Operational Costs
- High Energy Usage
- Reduced reliability across hardware
- More Complex Maintenance

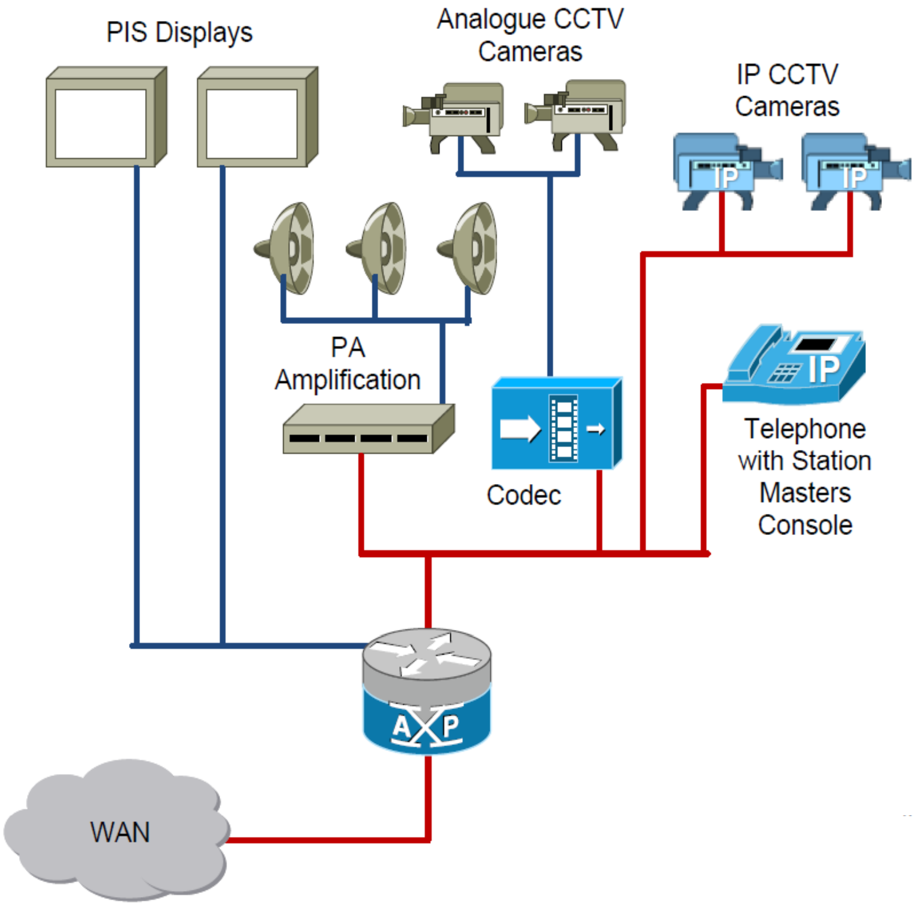


Emerging Technologies

Virtualisation

Station Control "in a box"

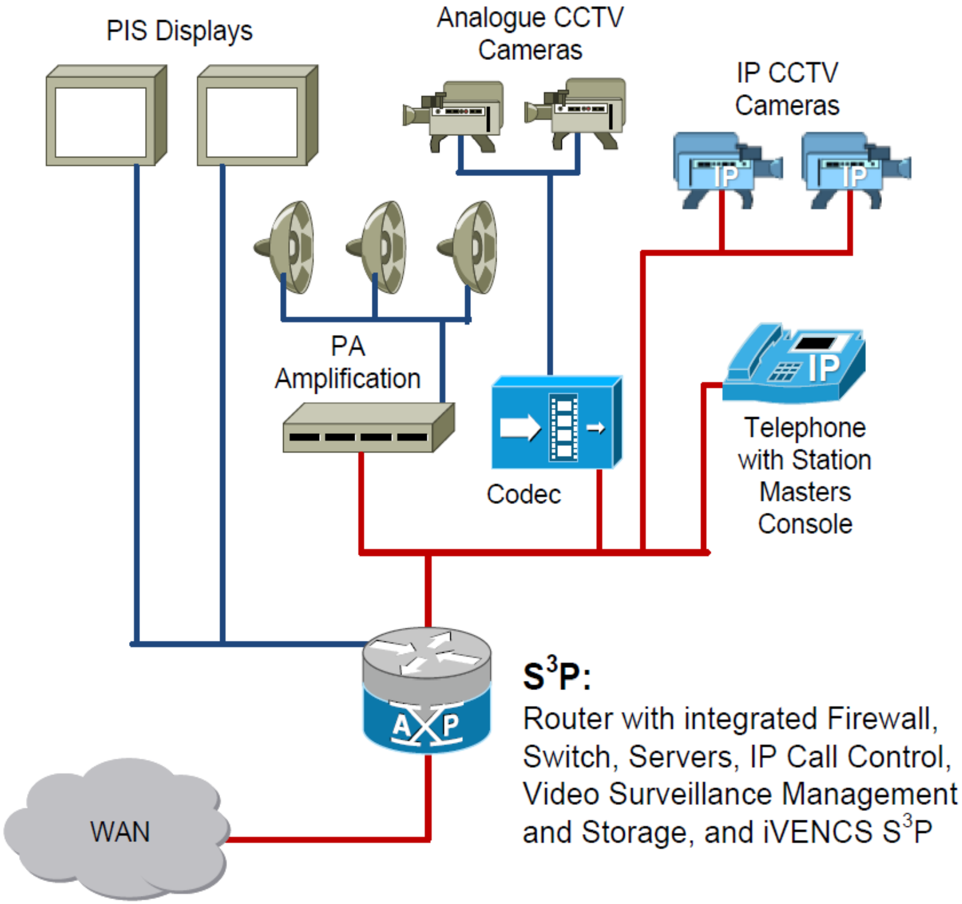
- Consolidated blade server platform
  - "Put the functions you want in the hardware you need"
- Virtual processes can share resources but remain protected
- Cost effective redundancy with better MTTR



Emerging Technologies

Virtualisation using S^3P

- Cheaper to Implement
  - Just one box
  - Single FAT / SAT
- Cheaper to Operate
  - Reduced Energy usage – Greener
  - Simplified Remote maintenance
- Approved & Tested Common Hardware
  - EMC, Environmental etc
  - Higher availability
- Supports Network Convergence
  - Ties the QoS to the subsystem events
  - Subsystem cause and effect happens at the station



S^3P:
Router with integrated Firewall, Switch, Servers, IP Call Control, Video Surveillance Management and Storage, and iVENCS S^3P

Emerging Technologies

Sensor Fusion & Analytics

- **Combining multiple sensor feeds**
  - e.g. video and audio analytics
- **Behaviour recognition**
  - Loitering and overcrowding
  - Trackside intrusion
- **Reactive deterrent announcements**
  - ‘Talking CCTV’ e.g. Middlesbrough
  - Smoking on platforms
  - Move down the carriage
  - Aggression / panic detection
- **Revenue protection / generation**
  - Tailgating at turnstiles
  - Passenger counting

Emerging Technologies

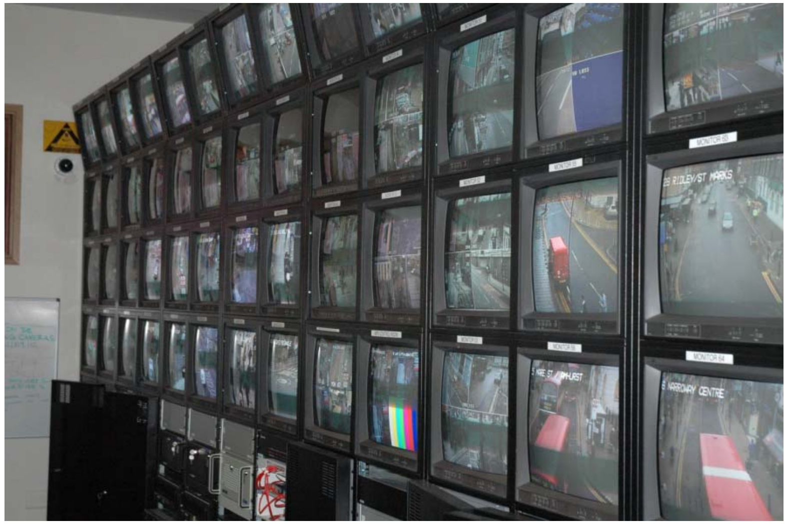
The Converged Network has arrived

- VoIP for Public Address, Telephony, Voice Recording
    - Simplifying Implementation
    - LLPA from any network IP Telephone
- Video over IP
    - Video Recording
    - Flexibility of viewing through browsers
- Integrated Incident Analysis

Event Driven Control Rooms

Existing Control Systems – monolithic architecture

- Limited Integration
  - Multiple GUIs on Desk
  - Inefficient control surfaces
- Often based on previous implementations
  - Limited progression and advancement
- Limited or no Automation
  - Manual responses
  - Increased operator workloads
- Limited representation of controlled area
  - Reliant on operator familiarity
  - Reduces operator effectiveness – especially in crisis
- Redundancy as an expensive option
  - Based on 'warm' stand-by within same site



Event Driven Control Rooms

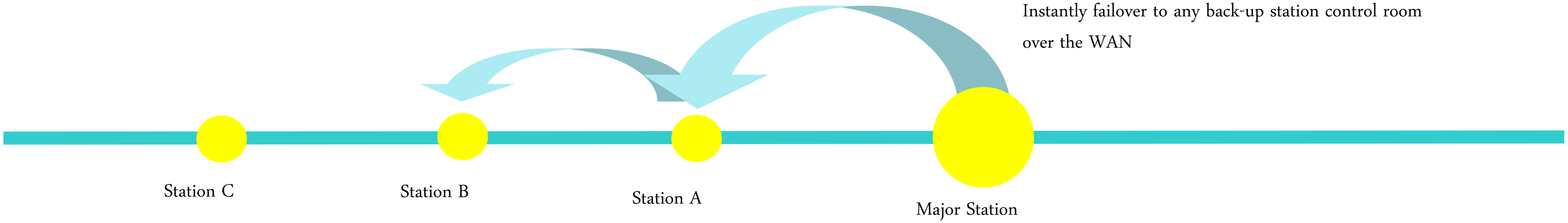
Improved Situational Awareness

- 3D GUI gives real world view
- 1 or 2 screens show combined status for dozens of subsystems
- Context driven navigation around tasks and station operation
- Overlay of non-equipment data such as fire-zones, passenger density, staff locations, or security incidents

Event Driven Control Rooms

Global Control

- Tiered Command Structure
- Back-up Control
- Distributed architecture



Instantly failover to any back-up station control room over the WAN

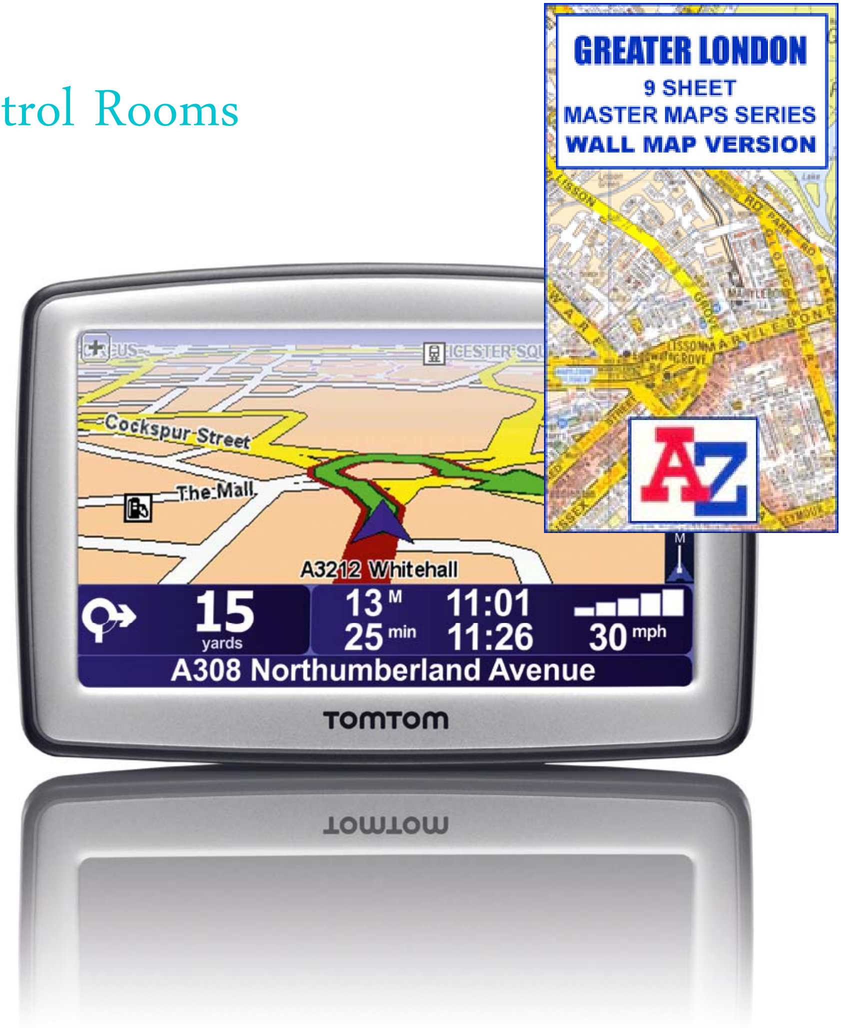
Event Driven Control Rooms

Automated Operator Assistance

- Camera on Help Points
- Video Analytics based alarms
- Situation-aware scripts for incidents

Traditional control room was like an atlas.

New technologies enable “turn-by-turn” guidance.



Environmental Management

- **Energy management designed in**
  - Energy Star Ratings for equipment
  - Supports Multiple Management Polices
- **Power over Ethernet**
  - Reduced Cabling
  - Centralised power back-up
  - Device wake-up
- **Adaptive Power Management**
  - Monitoring and adapting to site usage patterns
  - Intuitively Presented Carbon Map
  - Reporting of usage

- **Noise Abatement Technology**
  - Consideration of Railway Neighbours
  - Integration with Video to “target” announcements
  - Intelligibility of announcements through Dynamic Ambient Noise
  - Central and local Policies through distributed Architecture..

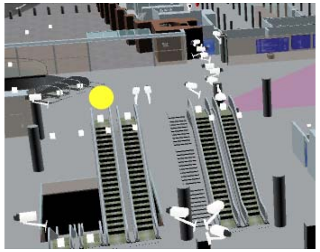
Mobile and New Media

Portable Media

- Control and Monitoring of system services for front line staff
  - Selection/Viewing CCTV
  - Public Address Announcements
  - Access to CIS data for Customer Service.

- Maintenance
  - Job sheets
  - Visual assist
  - Mobile commissioning
  - Barcode reader

- Location based
  - Staff location on 3D map
  - Lone worker panic alarms
  - Closest available responder
  - Proximity based alerting



Mobile and New Media

Multimedia Displays – Not just Train Times!

- Advertisements - Additional Revenue
- Video Streaming
- Live News
- Integrated Transport Information

Conclusions

Conclusions

Future Technologies – The Challenge!

- Deliver Improvements whilst Reducing Costs and Risk
  - The Triangle!!
  - Stay close to the **actual** operational requirements to understand how they can be safely met by new concepts from gaming, social media and military etc.
  - Stay focussed on the bigger picture. Railways vs. Stations and Processes vs. Kit items

Questions

IRSE Seminar
Railway Telecommunications

In Cab Platform CCTV

Paul Dobbins
Engineering Manager – telent Rail

telent
service • commitment • value

There must be some 3 letter acronyms…..

London Underground:

OPO – One person operation

Mainline Rail:

DOO – Driver only operation

A system that assists the train operator to safely depart the platform.

Today this is via providing a clear view of the train to platform interface.

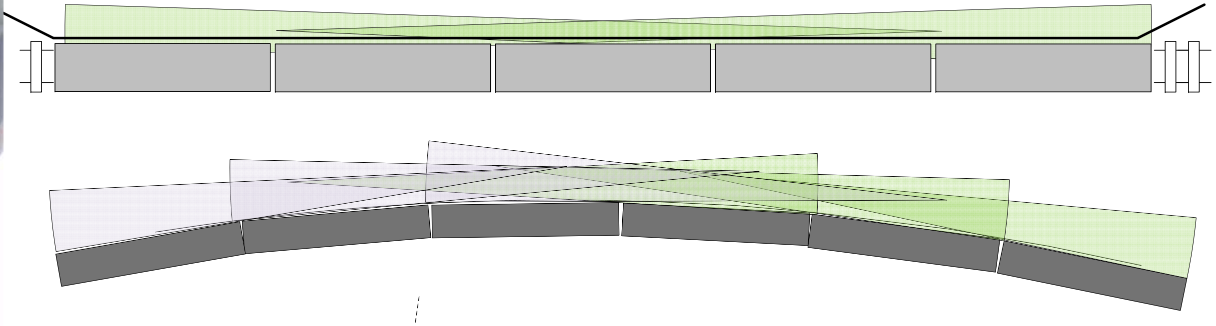
A brief history – full manual control

A brief history – no smoke, just mirrors

Manual systems have some limitations

And when the dispatcher is lost in the crowd?

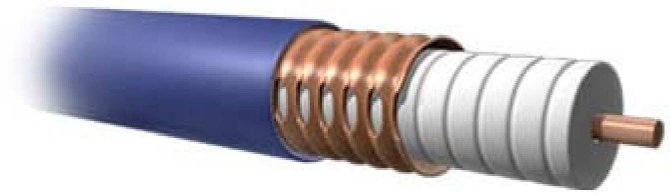
CCTV Technology introduced to improve performance



Cab Platform Video introduced through the 1990s

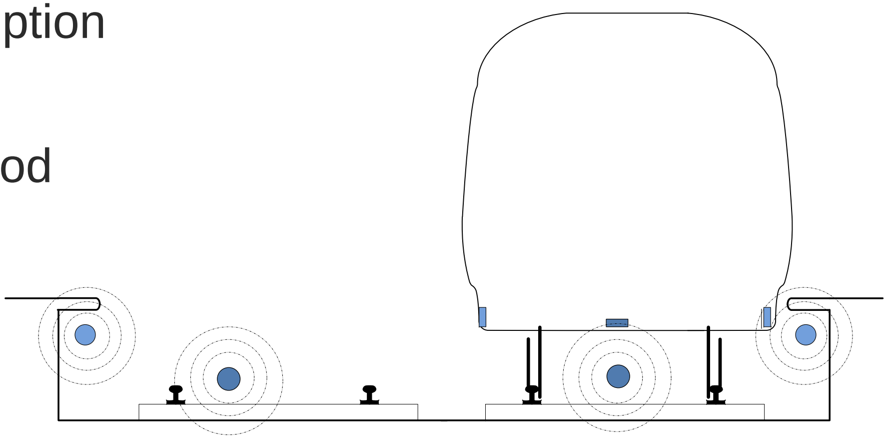
- New rolling stock and technology advances
- Removed reliance on platform displays
- Improved driver Human Factors
- Supports continued view on departure

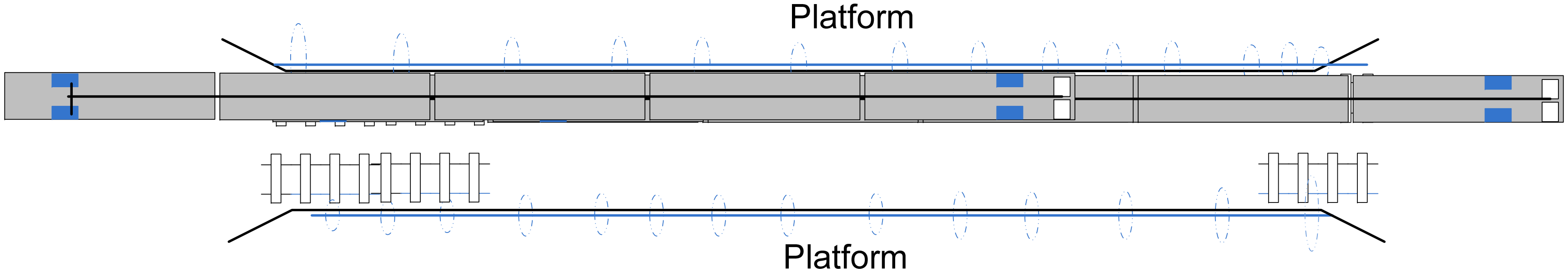
Transmitting CCTV images to Train



- Video must be real time and high quality
- This is a demanding requirement for radio
- Originally close proximity radio was main option

- Leaky Feeder has been the standard method





Examples of Leaky Feeder Installations

Central Line:

Leaky feeder in track bed

Jubilee/Victoria/Northern Line:

Leaky feeder /tube antenna under nosing

telent

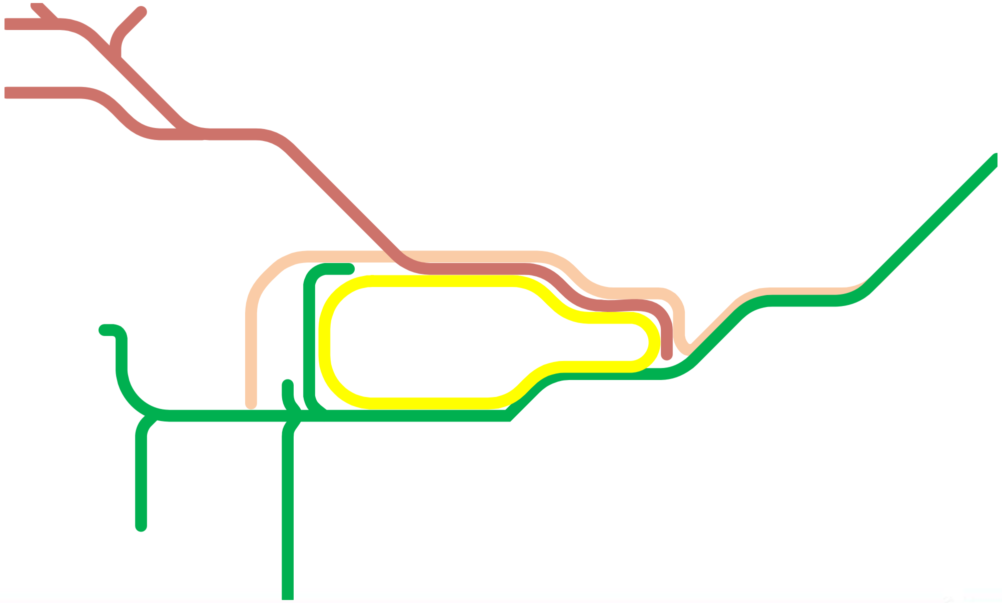
service • commitment • value

A new way –

telent In Cab System for new S Stock trains

S Stock for London Underground Sub Surface Railway

- Hammersmith and City, District, Circle and Metropolitan Lines
  - 105 stations
  - 240 Platforms
- In cab platform CCTV required for 190 new S Stock trains
- Some of the most complex track configurations across LU



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Project Background

- ITT issued in 2007

- Various transmission systems considered by telent
  - Leaky Feeder
    - We had implemented this system on Jubilee Line (and still maintain)
  - Radiating Tube Antenna
    - We had implemented this system on Northern Line (and still maintain)
  - Infra red
    - Dismissed based on our experience on Hong Kong MTRC system
  - Microwave solution
    - New to telent and the UK, however;
      - Track record of high performance in Hong Kong
      - LU had previously tested concept

- telent chose to offer a Microwave solution working at 31GHz

Why 31GHz Microwave ?

- Considered low risk to achieve the required performance
  - High Performance - broadcast quality video, Interference free
  - LU had already undertaken some limited trials
  - Licensed Spectrum Available

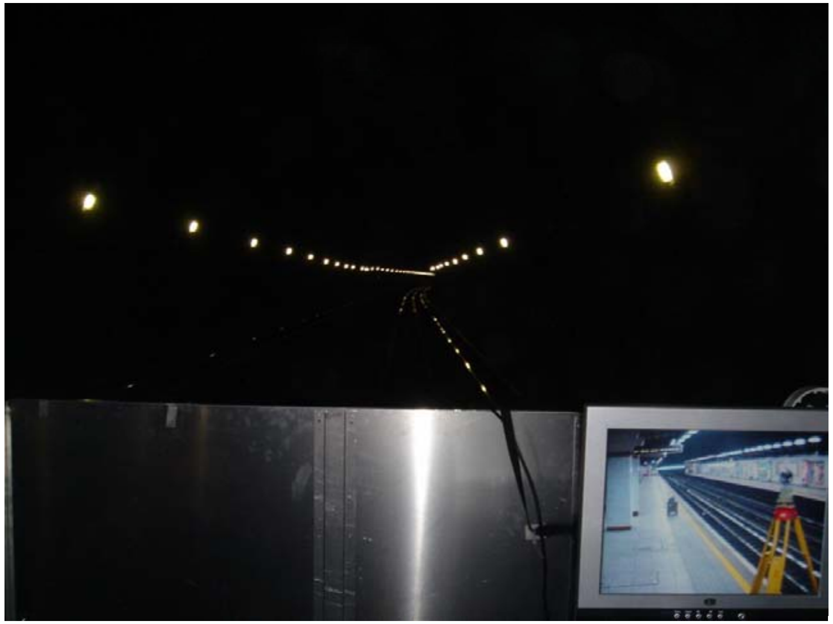
- Greatest Advantages
  - Not susceptible to environmental contamination
  - Flexibility in selecting video switch on and off points
  - Extra channel capacity (40 channels)
    - Frequency planning at complex areas easily accommodated
    - Elimination of incorrect platform picture risk
    - Growth potential – two way data or video

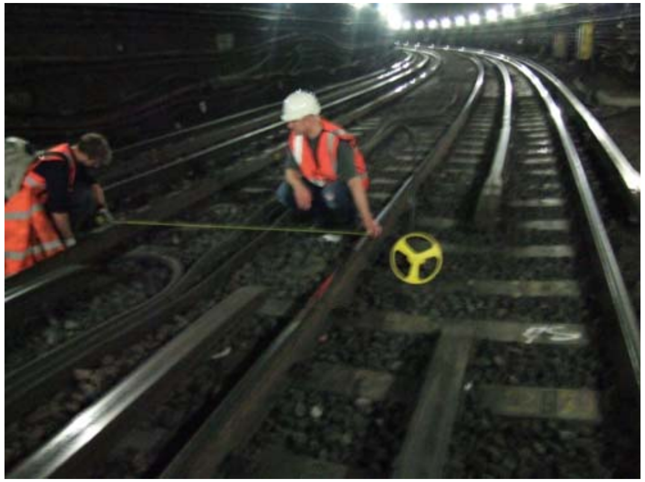
- telent embarked on a joint trial of Microwave technology in 2008

Transmission System trials

Complex Track Sections Chosen for trial

- Great Portland Street toward Kings Cross
  - ‘Cut and cover’ typical of SSR, with large curvature
- Chiswick Park
  - Very open 4 track station with tight curve
- Aldwych
  - Example of deep tube
- Analogue, Digital and IP trialled



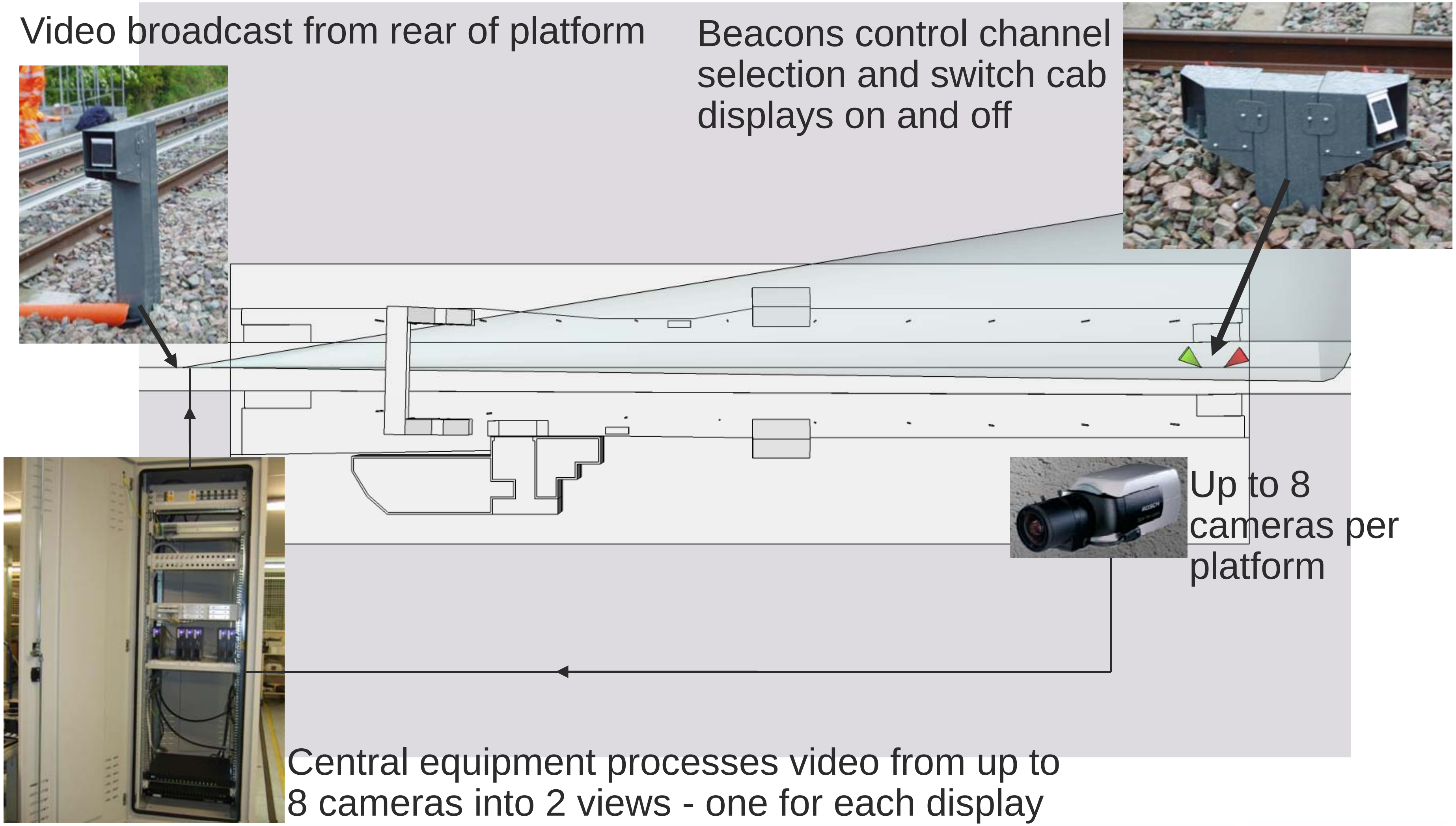


Trial Results

- True ‘broadcast quality’ images achieved in all scenarios
- Achieved stable pictures over 450m from platform, well beyond line of sight
- Trial results
  - IP Transmission (not part of CCTV trial)
    - High data rates and long distances achieved
  - Digital Video (DVB-T)
    - High quality image with delays within tolerance
    - Retained connection for greatest distance > 500m
    - Frozen image on loss of signal
    - Concerns of risk of distortion due to doppler at full train speed
  - Analogue Video
    - Real time high quality image
    - Subjectively better picture
    - Gradual break up of picture on signal loss
- Analogue chosen over digital to minimise programme risk

The new SSR In Cab System

Trackside System



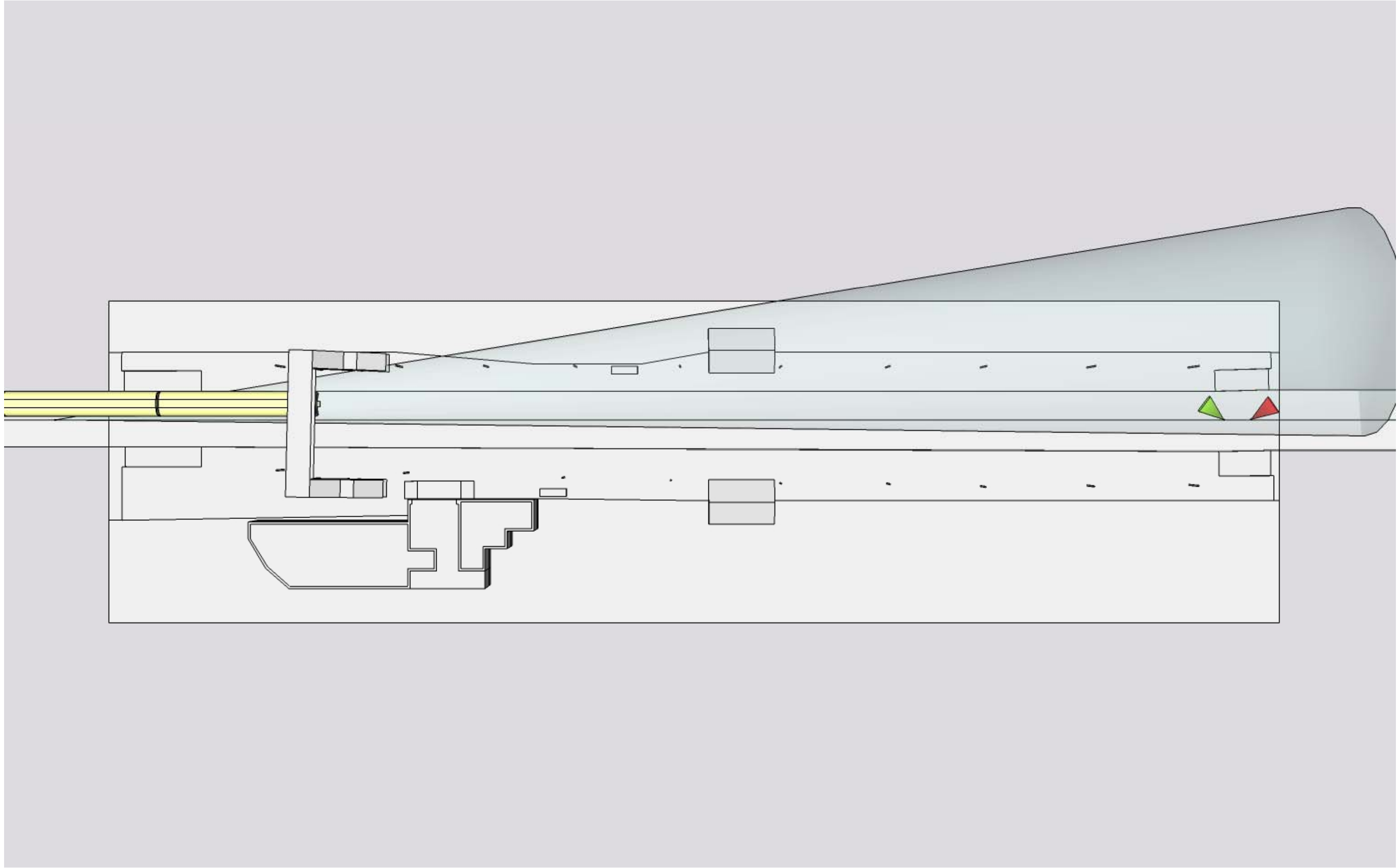
Video broadcast from rear of platform

Beacons control channel selection and switch cab displays on and off

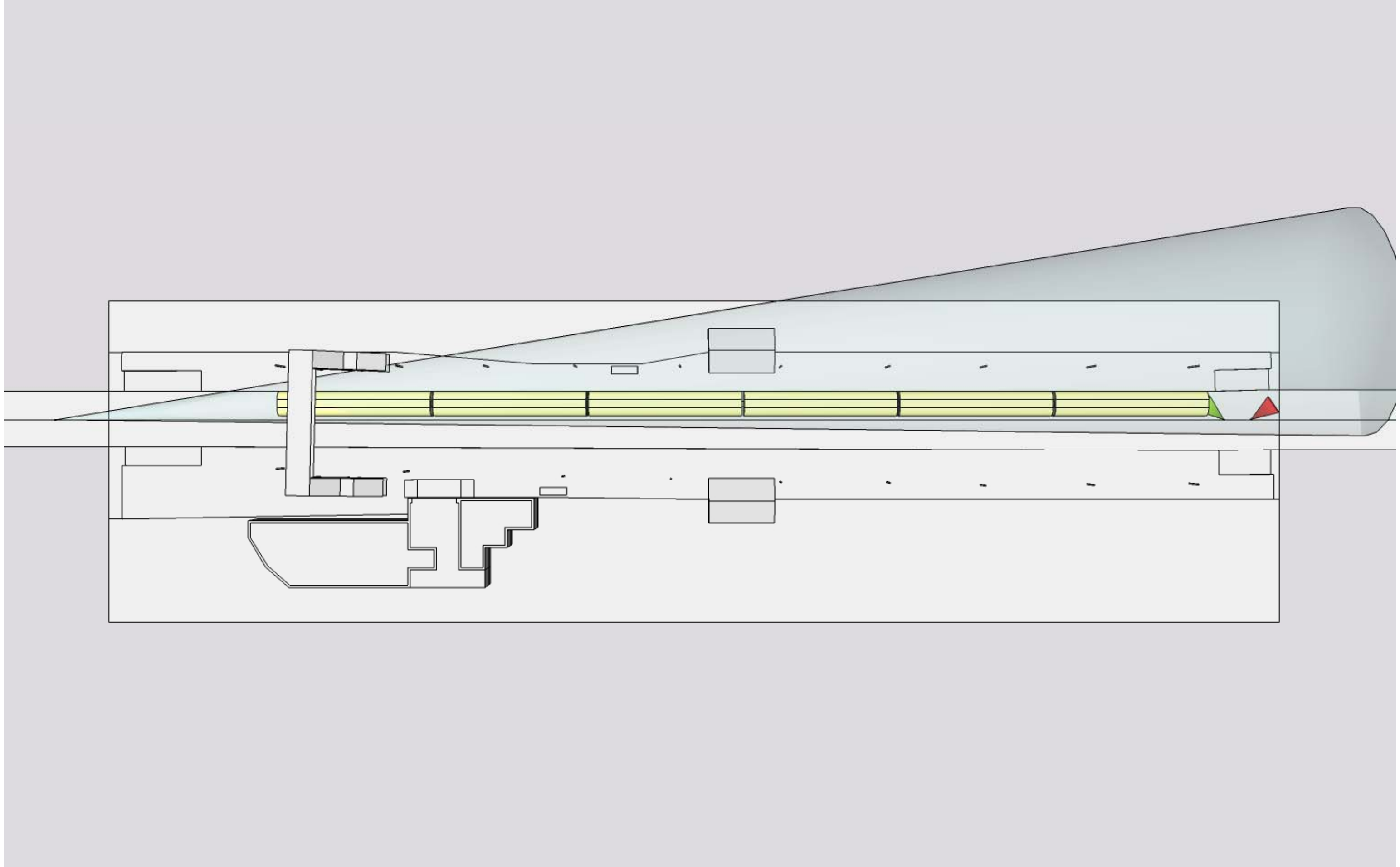
Up to 8 cameras per platform

Central equipment processes video from up to 8 cameras into 2 views - one for each display

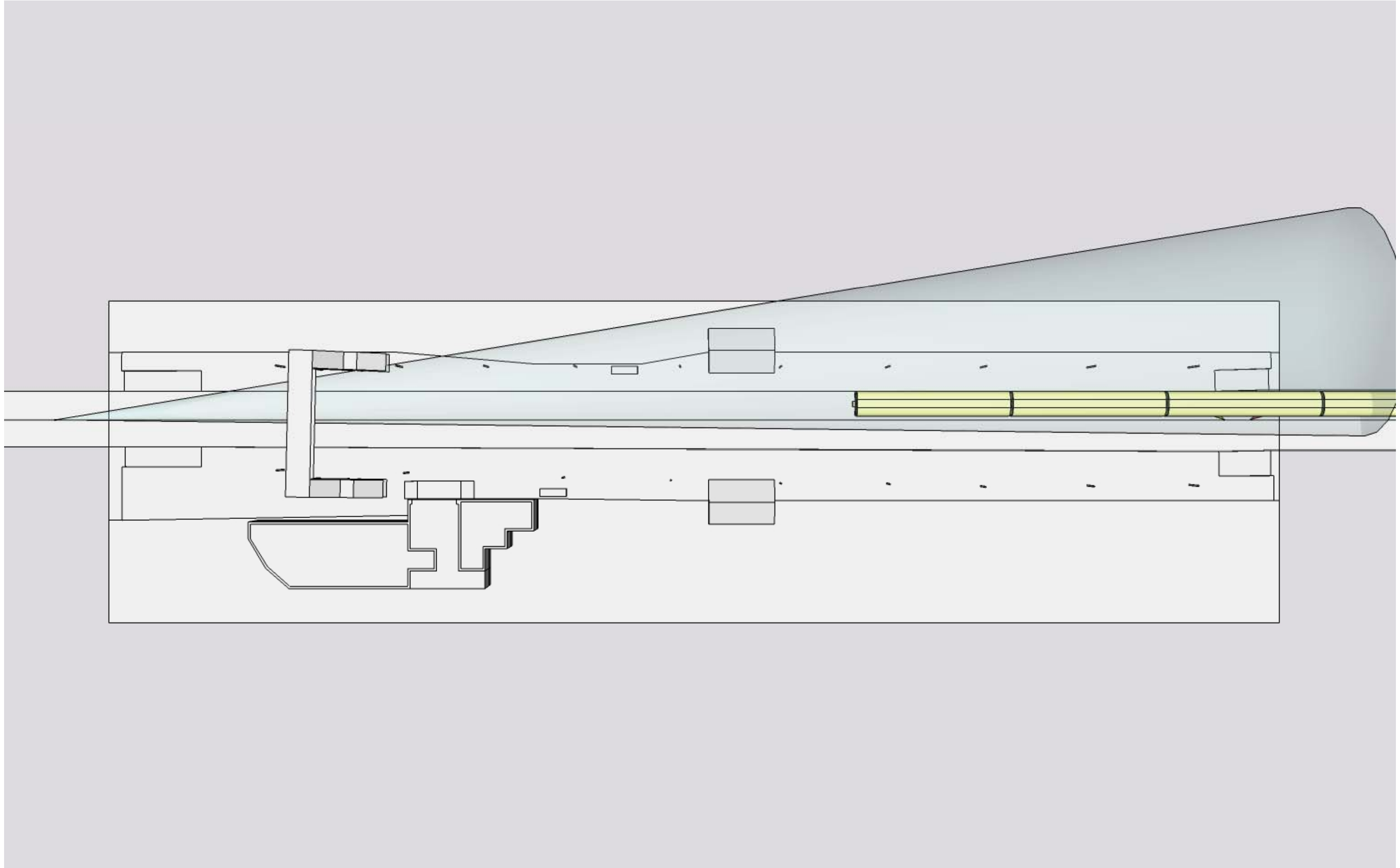
Train Approach – blank display



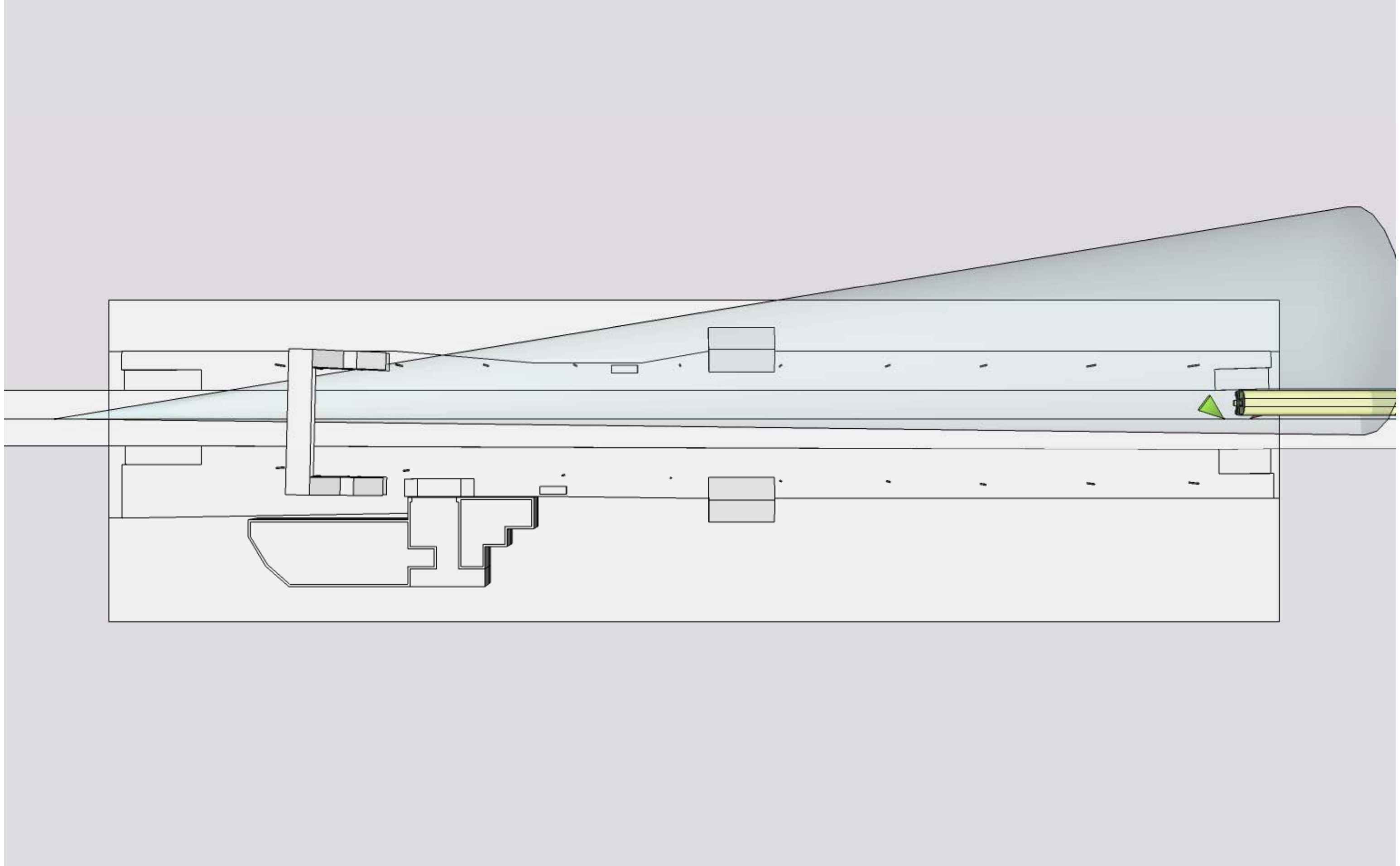
Display on – at point before stop mark



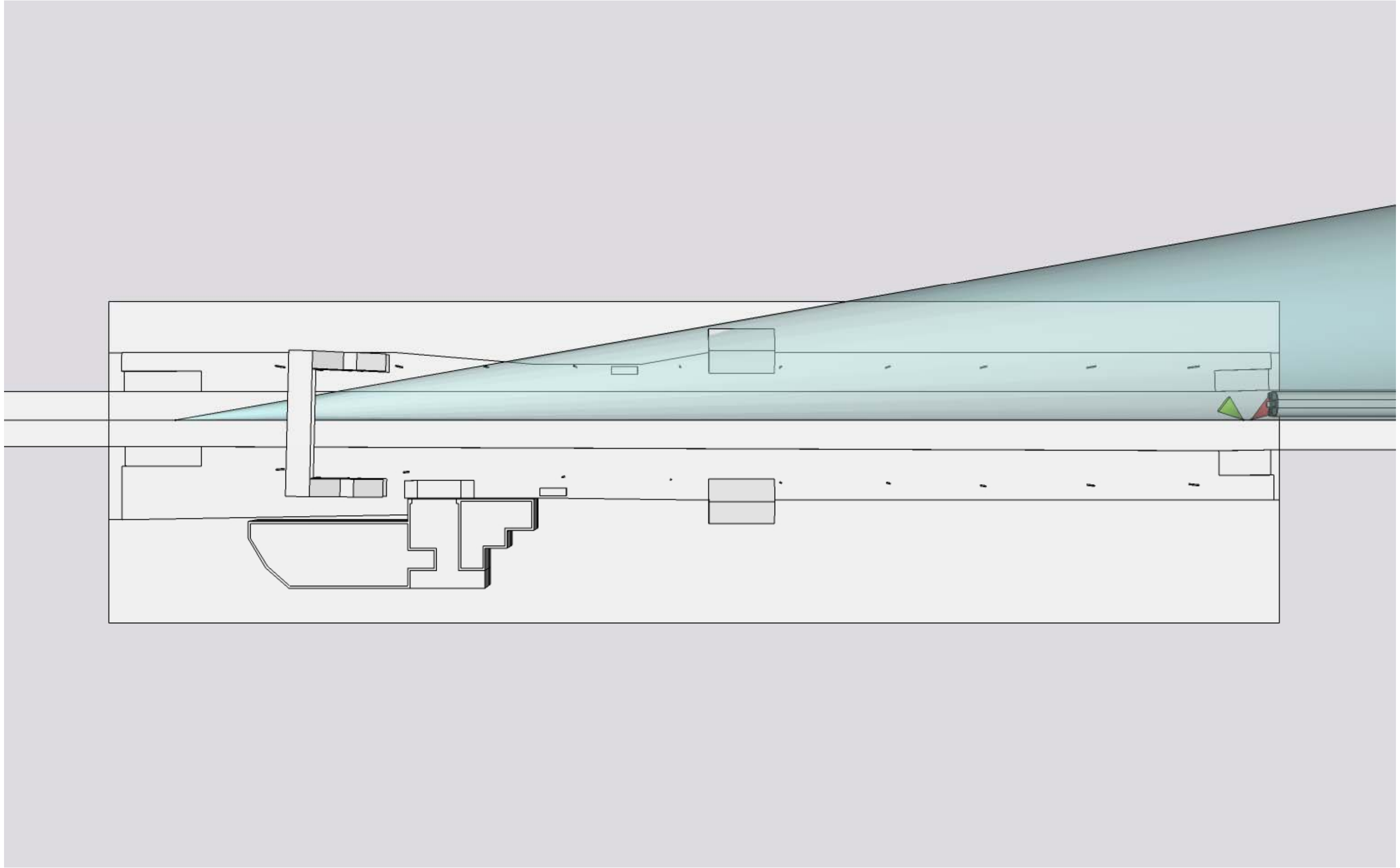
Train Departure – constant display



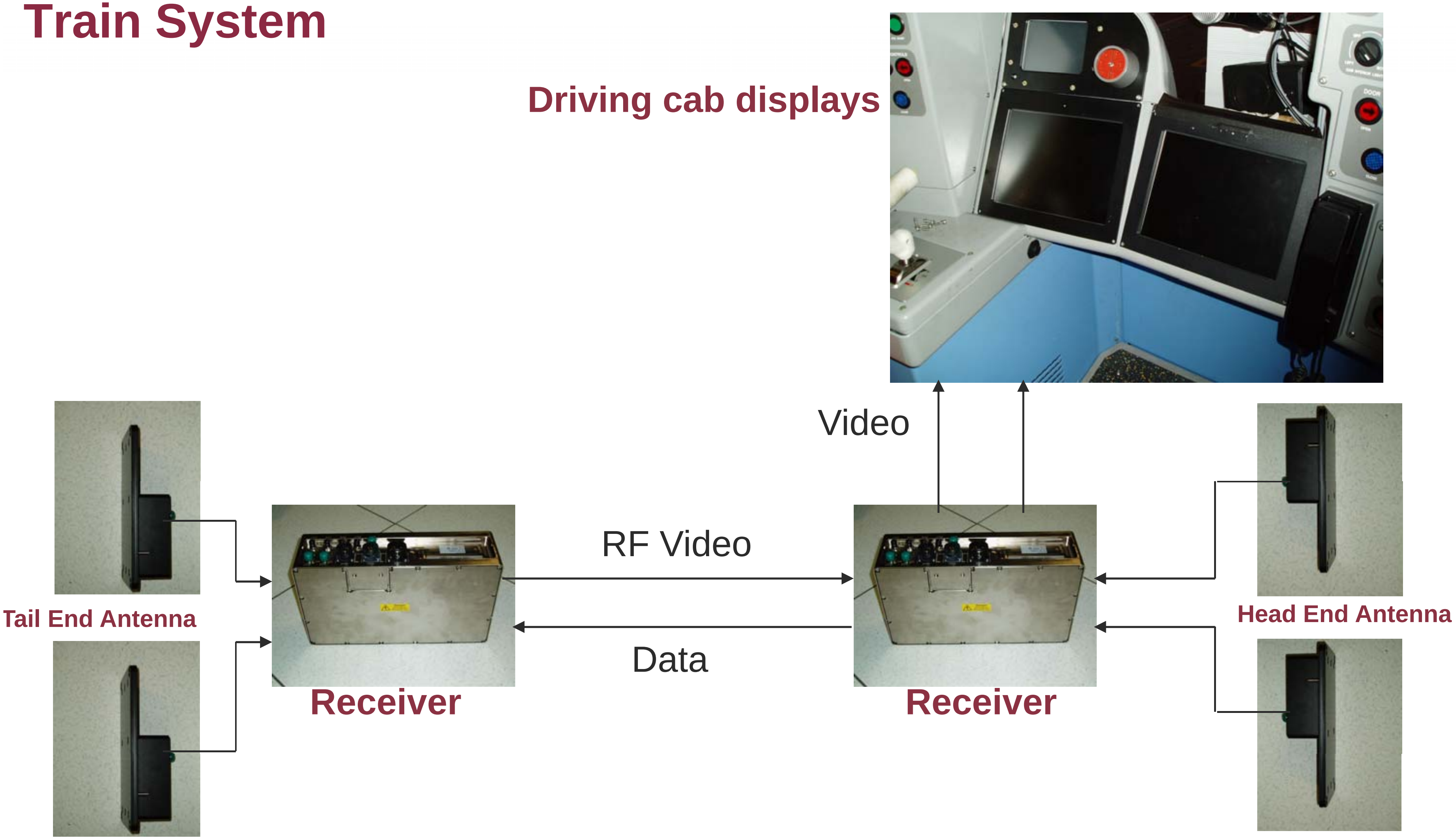
Display present even approaching end of platform



Departing End of Platform – display blanks



Train System



Driving cab displays

Video

RF Video

Data

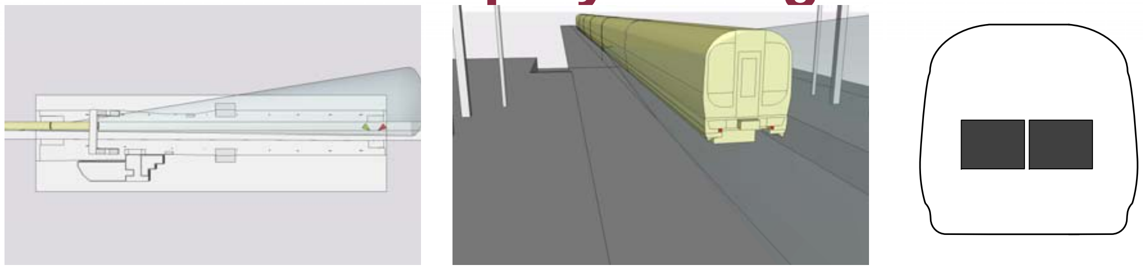
Tail End Antenna

Receiver

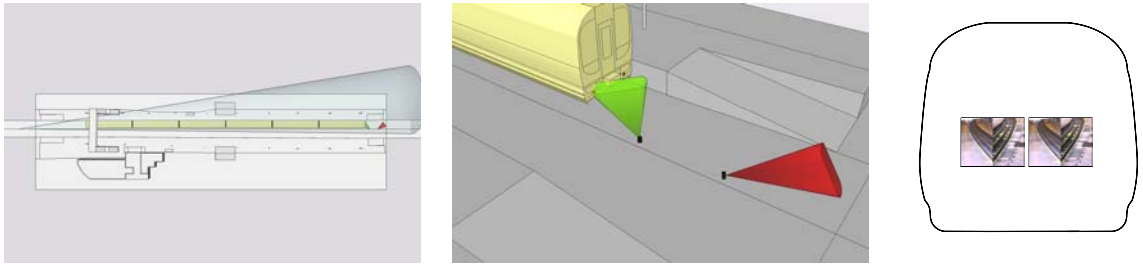
Receiver

Head End Antenna

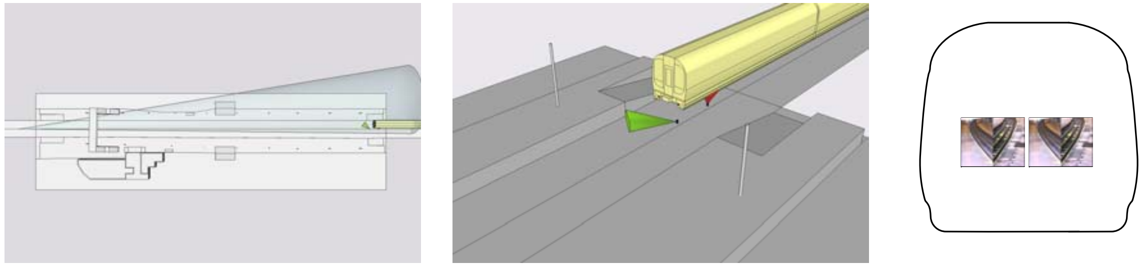
In cab CCTV display timing



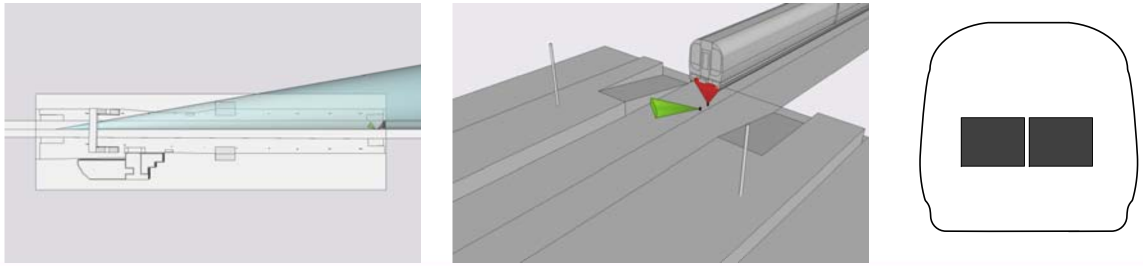
Train Approach



At designated on position



As trailing cab nears end of platform

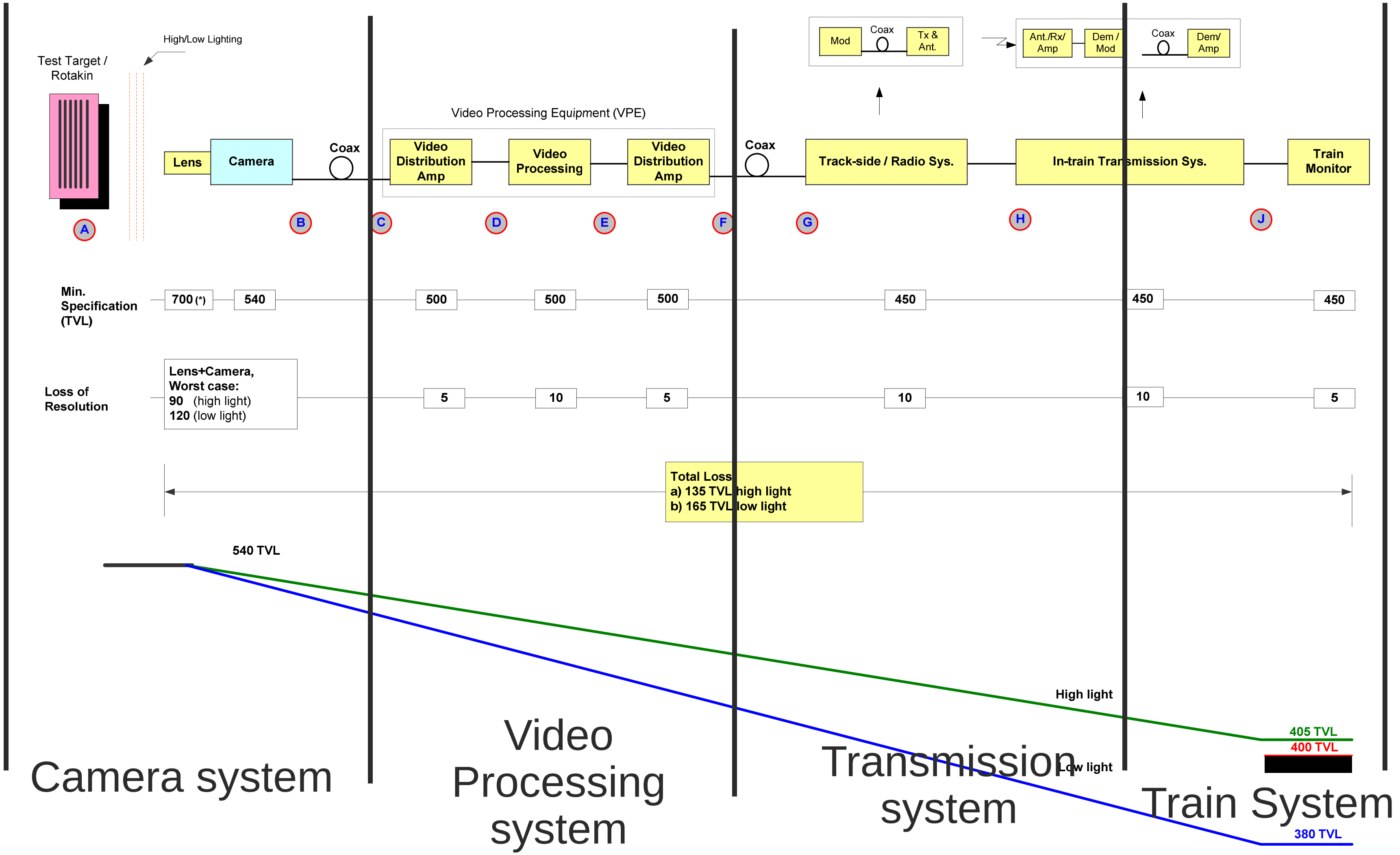


As trailing cab clears end of platform

System Performance and Current Progress

End to end Performance is Critical

OPO - RESOLUTION BUDGET CALCULATIONS



Test Target / Rotakin

High/Low Lighting

Lens | Camera | Coax

Video Processing Equipment (VPE): Video Distribution Amp | Video Processing | Video Distribution Amp

Coax | Track-side / Radio Sys. | In-train Transmission Sys. | Train Monitor

Mod | Coax | Tx & Ant.

Ant./Rx/ Amp | Dem / Mod | Coax | Dem/ Amp

A B C D E F G H J

Min. Specification (TVL): 700 (*) | 540 | 500 | 500 | 500 | 450 | 450 | 450

Loss of Resolution: Lens+Camera, Worst case: **90** (high light) **120** (low light) | 5 | 10 | 5 | 10 | 10 | 5

Total Loss
a) 135 TVL high light
b) 165 TVL low light

540 TVL

High light

Low light

405 TVL

400 TVL

380 TVL

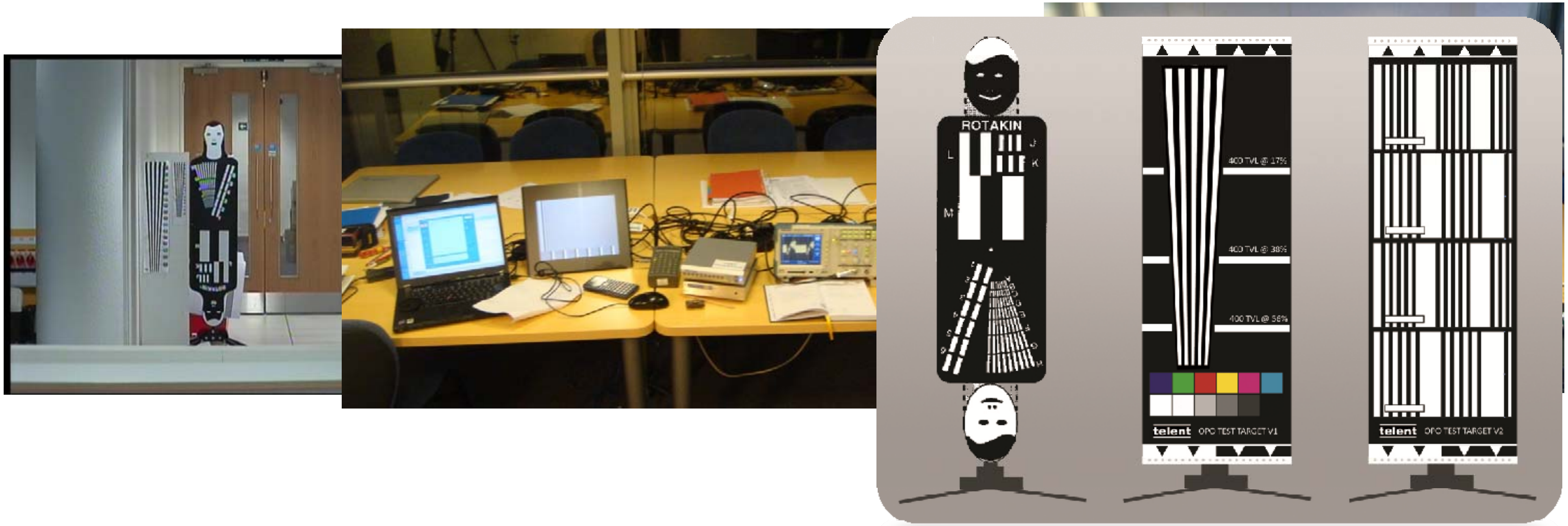
Camera system

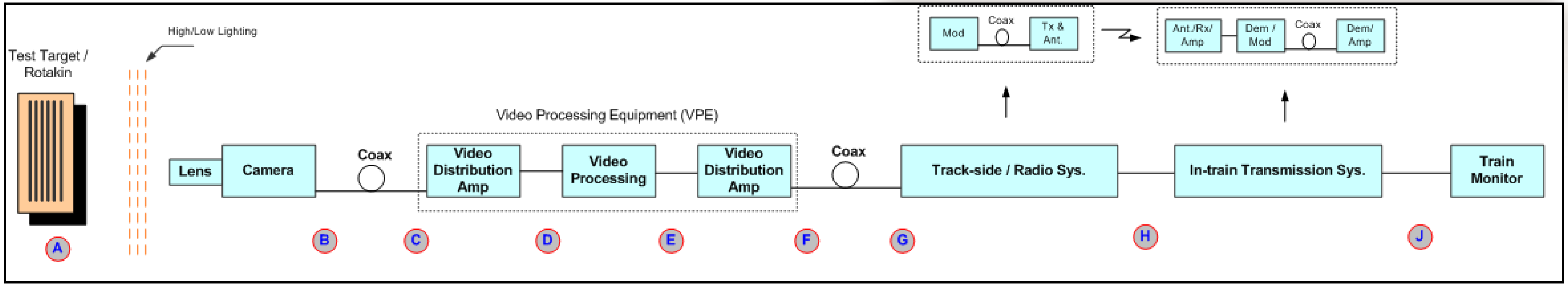
Video Processing system

Transmission system

Train System

New levels of performance measurement required

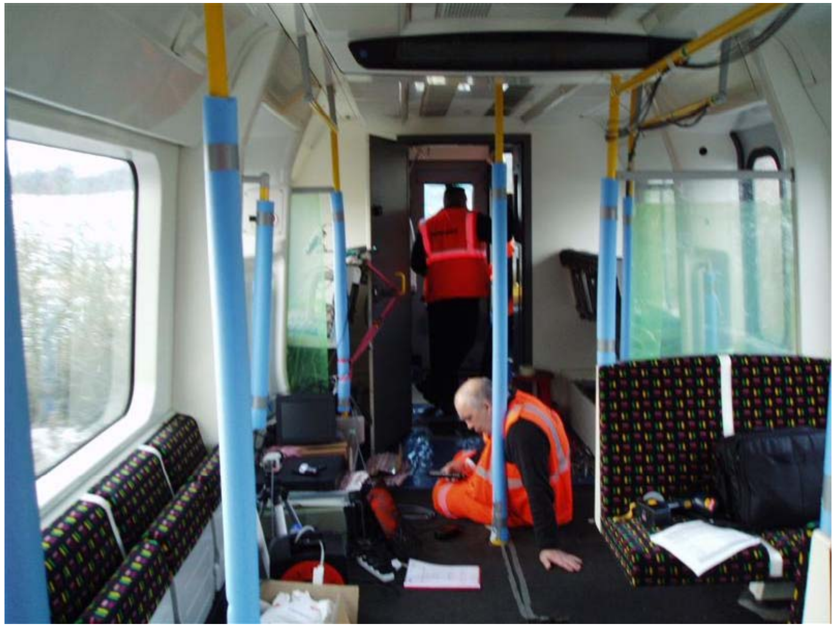




New Site Commissioning Techniques Developed

Current progress

- Extensive train tests at Old Dalby and on running Line – all successful
- Phases 1 to 4 (110 platforms) operational and ready for passenger service
- Train Operators have even been heard saying…. ‘ the best system we’ve ever had ‘



In Conclusion

- In cab systems are now established in busy rail environments
- Ever increasing passenger numbers demand high performance systems
- Transmission to train is critical, but only a part of an end to end system

- the telent ‘In Cab CCTV System’ has set a new level of performance
- ….and will be assisting the public have a safe departure very shortly

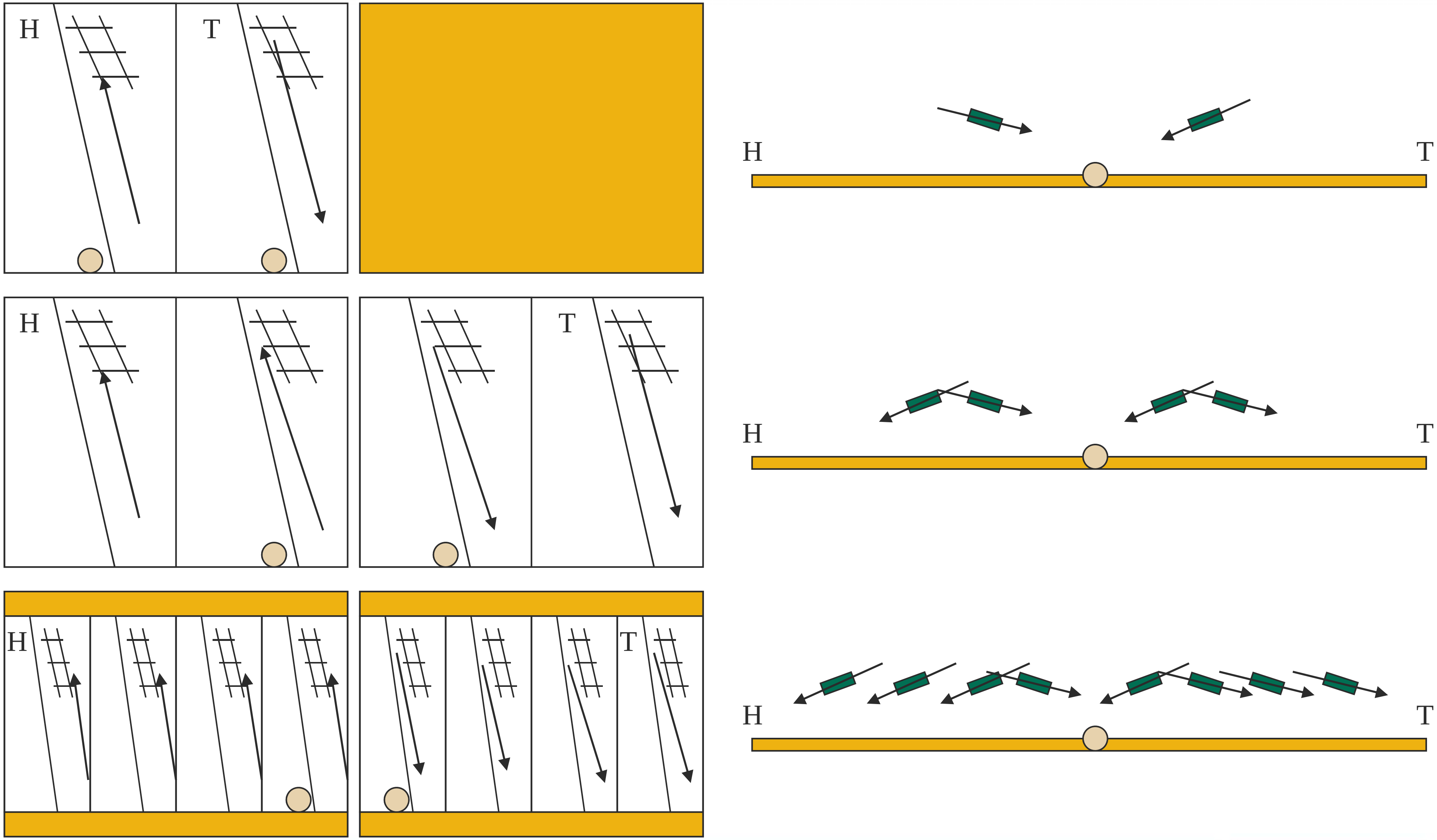
telent
OPO DVR 2
Date 05/11/10
Time 02:23:20

Thank You

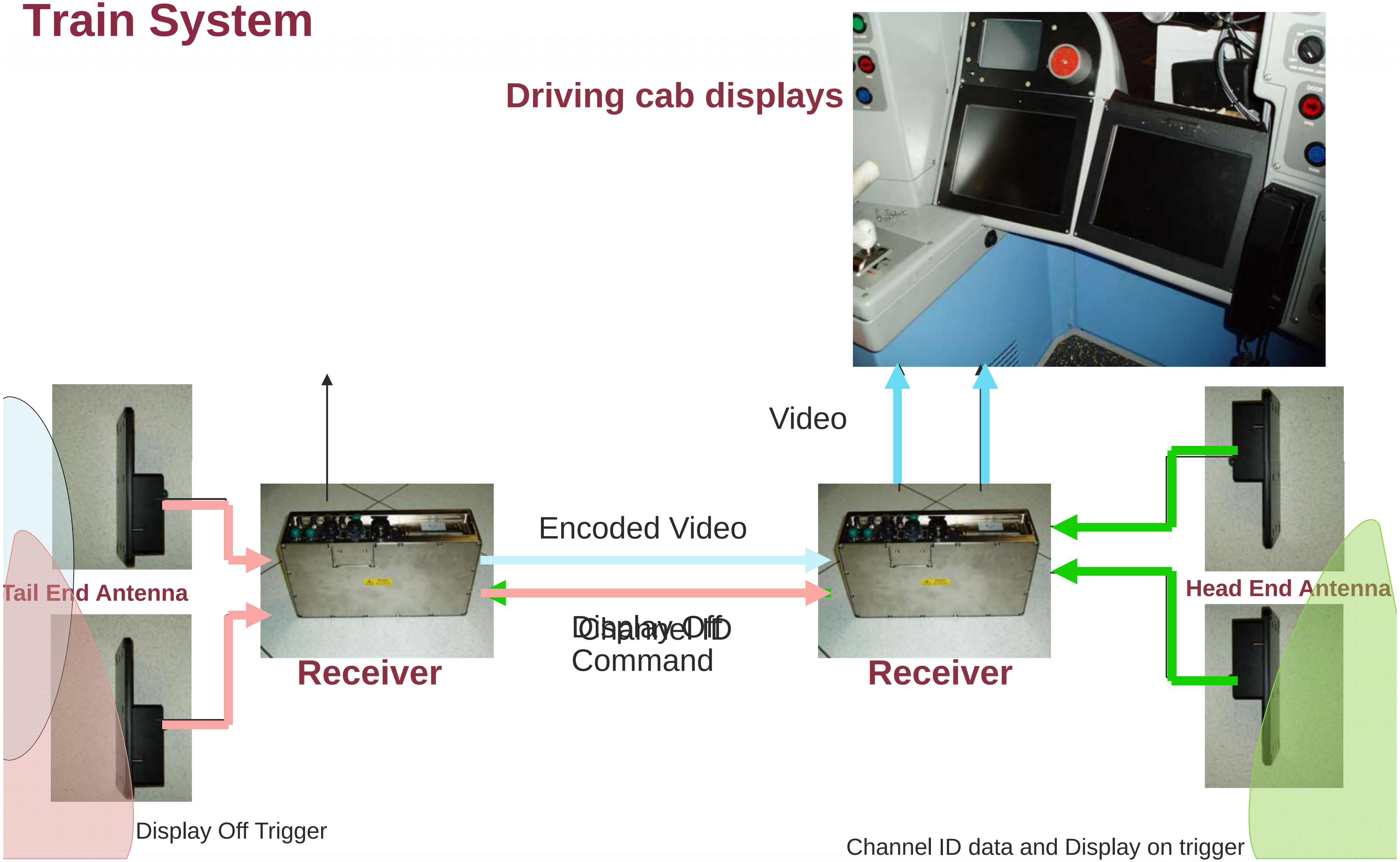
Thank You

telent
service • commitment • value

Video Processing



Train System



Driving cab displays

Video

Encoded Video

Display Off

Channel ID

Command

Tail End Antenna

Receiver

Receiver

Head End Antenna

Display Off Trigger

Channel ID data and Display on trigger

IRSE Seminar 2010
Railway Telecommunications
“Railways and the Use of Spectrum”

Farha Sheikh

Technical Manager Control and Communications,
DfT - Rail Technical and Professional

Introduction

Department for Transport

- Introduction (Summary)
- Historical use of spectrum on railways
- Current railway spectrum use
- Changing world:
  - Legislative impacts – National and European
  - Growth in demand for spectrum (societal and across industry, specifically rail)
- Use of wireless services within rail
  - Demand forecasting
  - Predicted growth
  - Un-met demand
  - Future access to spectrum
  - Available spectrum, sharing with other industries
- Conclusions: the future

Historical use of spectrum

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- Railways rely on telecomms to provide vital operational services.
- Railways have adopted various technologies as comms have developed.
- Railways are generally very conservative about the adoption of new comms technologies and state of the art.
- Approach to spectrum different between transport modes: aviation heavily regulated (international requirements), road transport uses various local applications to improve efficiency / safety

Current Use of UK spectrum on railways

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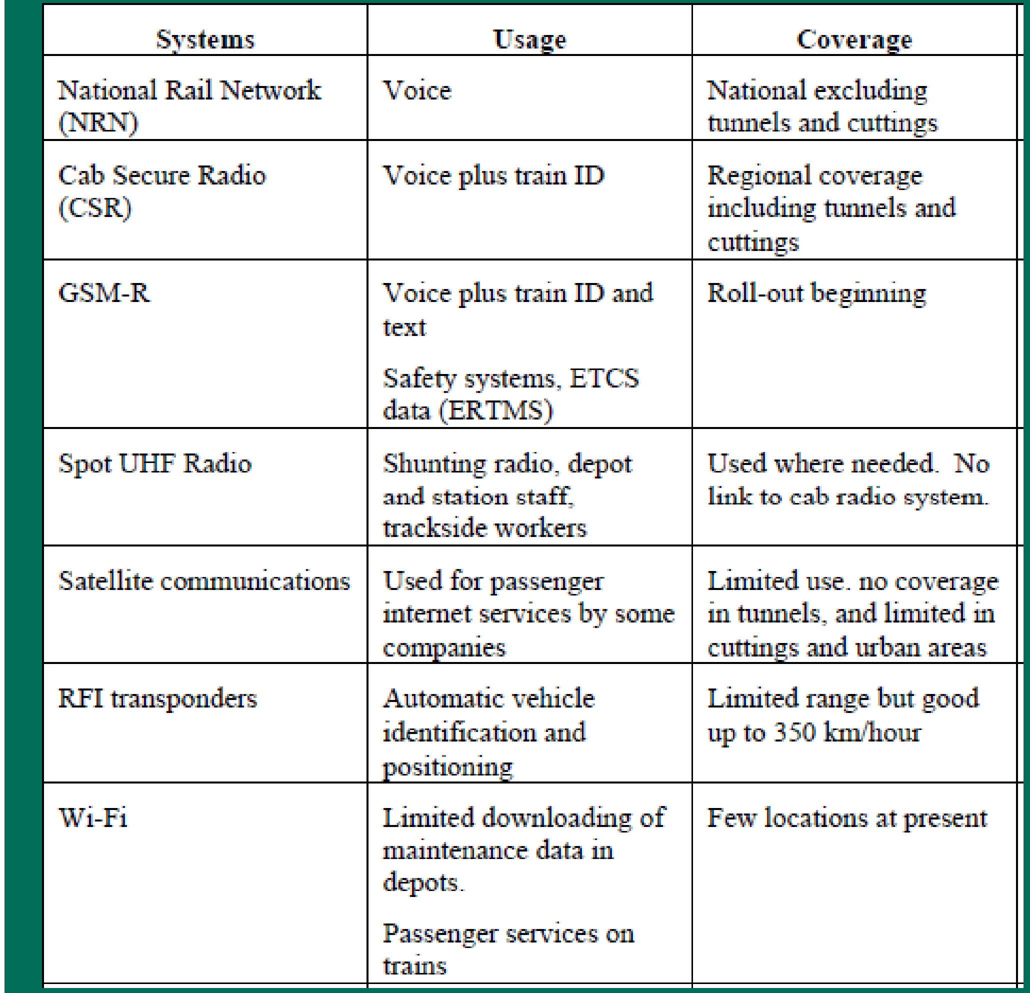

Systems	Usage	Coverage
National Rail Network (NRN)	Voice	National excluding tunnels and cuttings
Cab Secure Radio (CSR)	Voice plus train ID	Regional coverage including tunnels and cuttings
GSM-R	Voice plus train ID and text Safety systems, ETCS data (ERTMS)	Roll-out beginning
Spot UHF Radio	Shunting radio, depot and station staff, trackside workers	Used where needed. No link to cab radio system.
Satellite communications	Used for passenger internet services by some companies	Limited use. no coverage in tunnels, and limited in cuttings and urban areas
RFI transponders	Automatic vehicle identification and positioning	Limited range but good up to 350 km/hour
Wi-Fi	Limited downloading of maintenance data in depots. Passenger services on trains	Few locations at present

Spectrum is becoming a limited resource!

Spectrum use moving towards allocation at an EU level (676/2002/EC – sets out role of the EC and arrangements for voluntary coordination)

Radio Spectrum Decision – coordination of Community position on spectrum for representation at an international level.

Establishment of National Regulatory Authorities (UK = Ofcom) to maintain national Frequency Allocation Tables (FAT)

Changing World (1)

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- Increased use of short range devices (RFID) for SDO and other applications needing positioning information
- NRN spectrum withdrawal (expected end 2012)
- Forecast for increased demand for wireless services for operational uses and applications (RSSB Research report T817 on "Assessing Bandwidth Demand for Future Communication Needs on GB Railways" by BWCS, 2010)
- Increased public demand for access to broadband services – need to match this whilst "on the move" ("Digital Britain" published 2009 by the Dept for BIS and OFCOM research into Mobile Not-Spots, published Nov 2010)
- Spectrum is now a valuable "asset" (UK Government Spending Review 2010)

Changing World (2)

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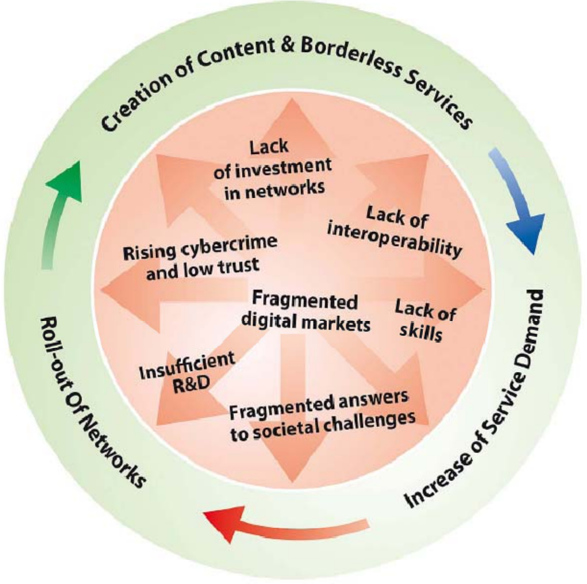
Changing European scene:

- INSPIRE Directive and UK Regulations 2010 (on **IN**frastructure for **SP**atial **I**nformation in the **E**uropean Community)
- EU Intelligent Transport System ITS Action Plan
- Increasing focus on ERTMS deployment
- Widespread GSM-R deployment – use of GPRS to provide value added services

Figure 1: **Virtuous cycle of the digital economy**



EC communication on Digital Agenda (2010) : emphasises the importance of smart use of technology to deliver improved transport services (energy efficient, real time travel information, retail services, intelligent systems), facing challenges such as climate changes and ageing population – <u>a proposal for a single market for spectrum</u>

Use of wireless services within rail

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- DfT’s Rail Technical Strategy – published 2007 and the work of Technical Strategy Advisory Group (TSAG) has identified the need for broadband services to achieve their aims (the Four C’s)
- Access to mobile services “on the move”: see recent Ofcom publication on “Mobile Not-Spots” and UIC study “Broadband Communication with Moving Trains”
- Strong independent business cases for the delivery of passenger broadband services, and broadband network for operational applications. Is there an opportunity for a reduced payback period if the business cases are merged?
- Growth in telecomms technologies across all sectors- however development and application of novel telecomms technologies not a core railway competence

Increasing demand for mobile services ⇨ **what does this mean for spectrum ?**

Any demand forecasting needs to consider:

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Political	Governmental investment in rail, level of priority given to passenger focussed service (incl. within franchises), need to increase network capacity
Economic	Greater economic growth = greater demand for services, rate of direct / indirect taxation, affordability of telecomms
Socio cultural	Willingness to travel by train, demand for services/capacity, expectations for mobile services whilst “on the move”, overall growth in demand for services
Technological	Rate of network rollout, willingness for rail to adopt, willingness for rail to invest

Growth in demand difficult to predict

(the massive increase in bandwidth demand as a consequence of the iPhone not foreseen)

Predicted growth in demand for mobile comms from:

- Non-safety critical operational, business and retail applications such as
    - Real time drivers advisory system data (low demand, high QoS)
    - Real time remote diagnostic (low demand, high QoS)
    - Passenger information (rich, real time, media-content)
    - “Info-tainment”
    - Real time CCTV
    - Passenger services – mobile voice and data
    - Growth in remote diagnostics (both train and infra) but bandwidth demand is modest
- ERTMS, level 2 and possibly level 3 which will need increased level of security, quality of service, coverage – dedicated spectrum?
- Backhaul services need to have sufficient bandwidth to transport data demanded by mobile services

There are several options for securing the mobile bandwidth needed to deliver these services: additional spectrum is only one option

Un-met Demand

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- Train based communications – applications slow or stop where coverage is not available
- Demand from passengers for mobile voice and data services : they’re used to receiving constantly improving levels of services and applications
- Consequences of not meeting demand : Services and equipment that offer poor Value for Money
- Today rail prefers to meet its demand from the use of externally sourced networks – can these provide sufficient capacity, security, resilience and reliability for tomorrow’s applications?

Future access to spectrum

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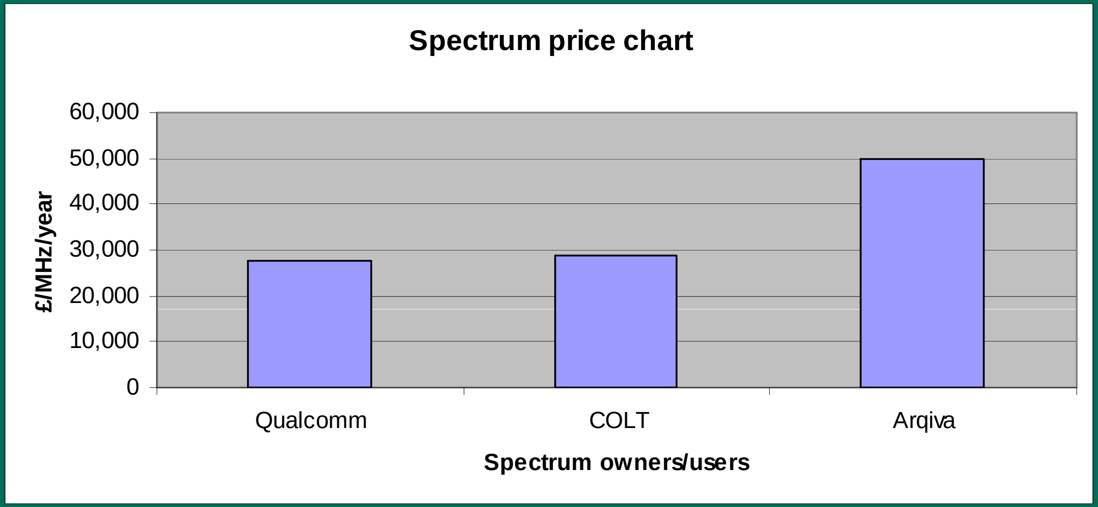
- Spectrum now has an economic value (Government Spending Review 2010) – market based approach to spectrum award is expected to drive efficient use of spectrum
- Spectrum auctions resulted in large variance in spectrum price
- Government has announced intention to auction 800MHz and 2.6GHz in 2011
- EC Decision to liberalise the 900 MHz spectrum



Note: the spectrum awarded was in the sweetspot range >300 MHz to <3GHz. The auctions were not like for like in terms of spectrum - this chart is used for illustrative purposes only.

Efficient use of spectrum: Sharing Services with other sectors or transport modes…..

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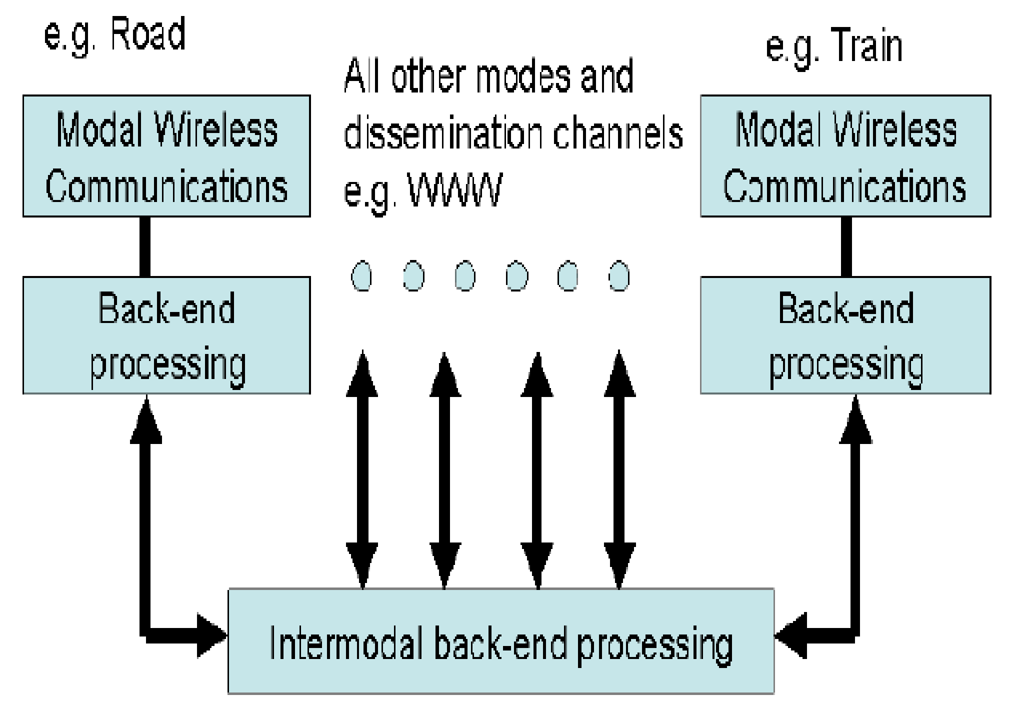

…….a “Vision” only…

- Shared bandwidth and back haul services
- Spectrum procured through the market
- Use of COTs technology, reducing cost to each sector

A single broadband facility for rail?

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- Technology neutral, obsolescence managed
- Capable of delivering voice and data services for passengers, as well as operational, retail and business services for rail
- A separate business case for both could be made – merging them strengthens the case
- Sharing spectrum / services with other users and operators

Conclusions

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- How can rail act to make the best of a scarce provision?
- What are the benefits / disbenefits of an integrated approach?
- What can we learn / gain from working with our European colleagues and from other transport modes?
- Government spending review impact: fewer resources, less effort
- Government looks to industry to find solutions that can deliver the forecasted demand……

References

Department for Transport

- RSSB research projects T809 (“Development of a Technology Road Map and Action plan for GB Railways”), T817 (“Assessing Bandwidth Demands for Future Communication Needs on GB Railways”) http://www.rssb.co.uk/RESEARCH/Pages/default.aspx
- DfT commissioned research “ERTMS Level 3 Risks and Benefits to UK Railways” by TRL / Parsons http://www.trl.co.uk/consultancy/rail/what_we_can_offer/european_railway_traffic_management_system_ertms.htm
- OFCOM research on Mobile Not Spots http://stakeholders.ofcom.org.uk/market-data-research/telecoms-research/mobile-not-spots/
- UIC study on “E-Train Broadband Communication with Moving Trains” http://www.uic.org/etf/publication/publication-detail.php?code_pub=190_14

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Thank you for your attention

Any questions?

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