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Issue	Issue 2
Date	May 2004

Company Specification

Message Handling & Data Transmission Requirements Between Processor Based Systems

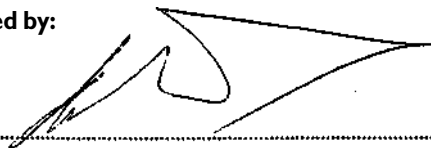
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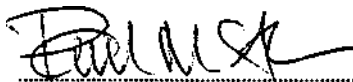
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Issue record

Issue	Date	Comments
1	August 2001	Original Issue
2	May 2004	Change to initialisation / Area Recall. S Class message section revised and miscellaneous corrections.

Implementation

The requirements specified in this documents shall be enforced from 15th May 2004.

Compliance

This specification builds on current practices and incorporates recent enhancements. Compliance shall be from 15th May 2004. Alternative practices may be accepted where they can be demonstrated to be as good or better than the contents of this document.

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I Purpose

To ensure that Network Rail's electronic Signalling and Telecommunications Systems can be expected to communicate and interact with each other, a common protocol and message classification needs to be specified. This document builds on past experience and best practice to ensure future compatibility.

2 Scope

2.1 General

2.1.1

This specification describes the methods to be used to link a Host processor based system with any other similar system or compatible device, in those applications where protocol overheads are to be kept to a minimum.

2.1.2

Experience has shown that the following methods give satisfactory results, although it shall be understood that the protocol does not cover all possible error situations.

3 Reference documentation

3.1 Basic references

3.1.1

British Standard BS4505; 1971 – 1990, Digital Data Transmission

3.1.2

Network Rail Company Product Specification RT/E/PS/00012
Specification for the Preparation and Implementation of Train Descriptor System
Parameter Tables

4 Glossary of Terms

ACK	Acknowledge message to confirm correct receipt
ACI	Automatic Code Insertion - used at locations where train journeys start.
Alternative Link	When the possibility exists for data to be transferred from systems X to Y via Z, under normal operating conditions, data would transfer between X and Y direct, then the path X-Z-Y shall be referred to as an alternative link.
ASCII	American Standard Code for Information Interchange
BCC	Block Check Character
Berth	The location of a Train Description normally associated with a given signal.
CCITT	Consultative Committee for International Telephone and Telegraph

Data Channel	A two way communication path between two (or more) points.
Data Link	A number of channels between the same two (or more) points.
EFA	Equipment Fault Alarm
ETX	End Of Text
FSK	Frequency Shift Key
Hot Standby	The standby system's transient data is up to date and is able to takeover from the online system.
N	Message Repeat Number
NAK	Return message to confirm message received with incorrect parity.
NDSD	Not Described Special Description represented by *** or *X*.
N/R	No Response - this refers to the non-return of an ACK or NAK by the receiving system within the specified timeout period.
OCU	Operators Control Unit
PS9 Link	A communications link complying with this specification (formerly an I810 Link).
STEP	Transfer of a TID from one berth to the next, usually initiated by a train when a route is set.
SOH	Start Of Header
STX	Start Of Text
TDN	Train Description - usually a 4 character alpha numeric code of the form NANN.
Transmission	An attempt to convey data between two points using a message protocol as defined in this specification.
TID	Train Identity
TRTS	Train Ready To Start
VDU	Visual Display Unit
XON	Handshake On
XOFF	Handshake Off

4.1 Example of System Abbreviations

All terms and abbreviations used in this specification are detailed below.

ARS	Automatic Routesetting Subsystem
CIS	Customer Information System
CSR	Cab Secure Radio
NCP	Network Control Processor – an interface unit between systems.
PMUX	Panel Multiplexer
PP	Panel Processor
SIVS	Station Information VDU System
SMART	Signal Monitoring and Reporting to TRUST
SNP	SIVS Network Processor
TD	Train Descriptor
TDM	Time Division Multiplex transmission system
TOPS	Total Operations Processing System
TRUST	Train Running System on TOPS

5 Interface

5.1

Asynchronous data transmission in the range of 110-19200 bits per second (bps) shall be permitted for all links as detailed in the Project Requirements Specification.

5.2

The interface shall conform to one of the following standards:

- a) 20mA Current Loop
- b) RS232C
- c) RS422
- d) RS485

5.2.1

Alternative standards may be proposed, subject to the prior written approval of the Infrastructure Controller.

5.2.2

The specification to be adopted shall be adhered to in full, particularly with reference to connectors, pin assignments and polarity of 4 wire (non-FSK) interfaces. Hardware handshaking shall normally be implemented.

5.3

One of the following CCITT recommendations shall normally be used although other speeds defined in 5.1 may also apply:

- a) V24 (1200 bits/sec per channel)
- b) V24 (2400 bits/sec per channel)
- c) V24 (9600 bits/sec per channel)

5.4

Modems shall be used where the system-to-system distance is in excess of the standards of the interface specification used, or for purposes of equipment isolation.

5.4.1

Connection between modems and the equipment shall be made via RS232 interface as specified above.

5.4.2

Modems and channels shall be capable of full duplex operation, subject to the requirements of the relevant CCITT recommendation.

5.5

Channels shall have their transmitter/receiver sections designed such that links with other equipment that conforms to this specification shall be electrically isolated. The Project Requirements Specification shall provide instructions for any exceptions to this requirement.

5.6

A link should consist of multiple channels to maximise availability. However, the Project Requirements Specification shall specify whether a link is to be single or multiple channel.

5.6.1

If the link consists of multiple channels, then the link shall operate under normal conditions should only one channel be operational.

5.6.2

Where an alternative link is to be provided via another suitable device, the details of how this is to work shall be given in the Project Requirements Specification.

5.6.3

A direct link which may additionally operate as an alternative link as given in 5.6.2 shall have sufficient capacity to provide both functions simultaneously.

5.6.4

Where an alternative link has been specified via another suitable device, it shall only be used when the direct link is declared faulty. It shall remain in operation until it has been established that the direct link is operating correctly, whereupon transmission over the direct link shall be resumed.

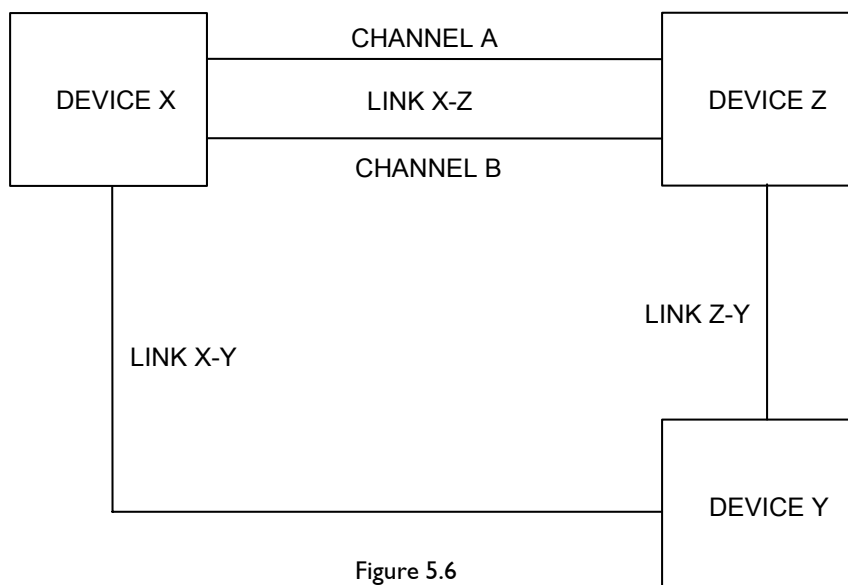


Figure 5.6

The diagram in Figure 5.6 shows the following:

Single Channel Links (X-Y and Z-Y);

Multiple Channel Link (X-Z);

The philosophy behind alternative link routing where Device Y is "...another suitable device..." is as referred to in 5.6.2.

6 Protocol

6.1

The protocol is based on Part I of BS4505 1981; Specification for basic mode control procedures.

6.2

The characters and mnemonics shall be as defined in BS4505. Each character shall be in ASCII code and consist of ten bits transmitted in the following order (Refer also to Section 11):

One	Start bit	
Seven	Data bits	
One	Parity bit	(Even)
One	Stop bit	

6.3

The characters ACK, NAK, SOH, STX, ETX shall only be used as defined in this specification except when they follow immediately after an ETX when they shall be assumed to be the BCC. XON and XOFF characters shall have no effect on the operation of the link on which they are used.

6.4

The message format shall be either:

6.4.1

SOH (Heading)	=	Start of Header
STX	=	Start of Text (Control Character)
N (Text)	=	Message Repeat Number (0, 1, 2). Includes message classification
ETX	=	End of Text (Control Character)
BCC	=	Block Check Character

OR

6.4.2

STX	=	Start of Text (Control Character)
N (Text)	=	Message Repeat Number (0, 1, 2). Includes message classification
ETX	=	End of Text (Control Character)
BCC	=	Block Check Character

6.4.3

The inclusion of the message repeat number shall be assumed unless otherwise detailed in the Project Requirements Specification.

6.5

With reference to 6.4, the BCC shall be calculated to give longitudinal parity using modulo 2 summation for all characters up to and including the ETX, but excluding in 6.4.1, SOH and in 6.4.2, STX. Examples of this calculation are given in Section 11.

6.6

The total message length shall not exceed 128 characters.

6.7

By reference to the flow chart in Appendix A, a message as defined in 6.4 and detailed in Appendix B shall be sent by the transmitter.

6.7.1

The receiving system shall reply to the transmitter in one of the following three ways:

6.7.1.1

ACK To signify that the message has been received correctly as defined by format, character parity and the BCC.

6.7.1.2

NAK To signify that the message has been received correctly as defined by format, but incorrectly as defined by character parity or the BCC.

6.7.1.3

N/R Signifies that the message was incorrectly formatted with no STX or ETX or BCC or excessive message length or for any reason other than 6.7.1.1 or 6.7.1.2. where "N/R" signifies No Response to be given.

6.7.1.4

The receiving system response shall be within 50ms of receipt of BCC, or immediately following sending of BCC for a message in the process of being transmitted.

A to B: <..Message 1..>BCC <..Message 2..>BCC
B to A: <50ms>ACK <..Message 3..>BCC ACK

Diagram to explain 6.7.1.4

6.7.1.5

Should a second SOH or STX character be received before an ETX is detected, then they shall be assumed to be the start of a new message and all characters received previously shall be discarded.

6.8

Where messages are required to be repeated as in 6.7.2.2, transmission shall be attempted a further two times.

6.8.1

A message shall start with the message repeat number (where required) at zero and be incremented for each time it is repeated.

6.8.2

The repeat number (where required) for Test message sub-classification Q shall be kept at zero.

6.8.3

Should a NAK be received or N/R each time, then on the third attempt that channel shall be declared failed. The message shall be sent via the alternative channel/link where this is applicable (see Section 5.6 or 7.3). The Project Requirements Specification shall detail any alternative link where this is via another suitable device.

6.9

From the time of transmission of the BCC of a message, an acknowledgement shall have been received within 2 seconds, otherwise a No Response (N/R) shall be assumed.

6.10

The retransmission timeout figures detailed in 6.9 shall in no way diminish the performance requirement given in 6.7.1.

6.11

The protocol specified in this section may be used to transmit messages in either direction simultaneously.

6.11.1

Response characters shall be transmitted only when messages currently being sent have been completed, i.e. following the appropriate BCC.

6.12

In circumstances where headers are required, messages shall be formed thus:

SOH
 (Destination code)
 (Source code)
 STX
 N
 (Text)
 ETX
 BCC

Where "N" is the message repeat number.

6.12.1

The inclusion of the message repeat number shall be assumed unless otherwise detailed in the Project Requirements Specification.

6.12.2

The Destination and Source codes shall be as defined in the Project Requirements Specification. Each code may be up to four characters in length.

6.13

If a message is received which obeys the protocol requirements defined in 6.7.1, the appropriate protocol response shall be given.

6.13.1

If the protocol response sent is NAK or N/R the message shall not be acted upon, but be discarded.

6.13.2

If the protocol response sent is ACK, but the contents of the message (including header) are not of a form recognised by the receiving system, the message shall not be acted upon, but be discarded.

6.13.3

If the protocol response sent is ACK, and the contents of the message (including header) are recognised by the receiving system, the message shall be acted upon, and then be discarded.

7 Link And Channel Usage

7.1

Where a link consists of multiple channels, one of the following methods for sending of messages shall be employed as detailed in the Project Requirements Specification:

7.1.1

Use of each useable channel in turn. i.e. 1, 2, 3..., 1, 2, 3..., etc.

7.1.2

Use of one channel only, until failure or other changeover criteria. i.e. 2, 2, 2..., (channel 2 fails) 1, 1, 1..., etc.

7.1.3

In 7.1.2 the requirements of 7.5 shall be met for the channel that is not being used for data transfer.

7.2

A connection between two systems where one (or both) are configured as independent processing units shall consist of separate single (or multiple) channel links.

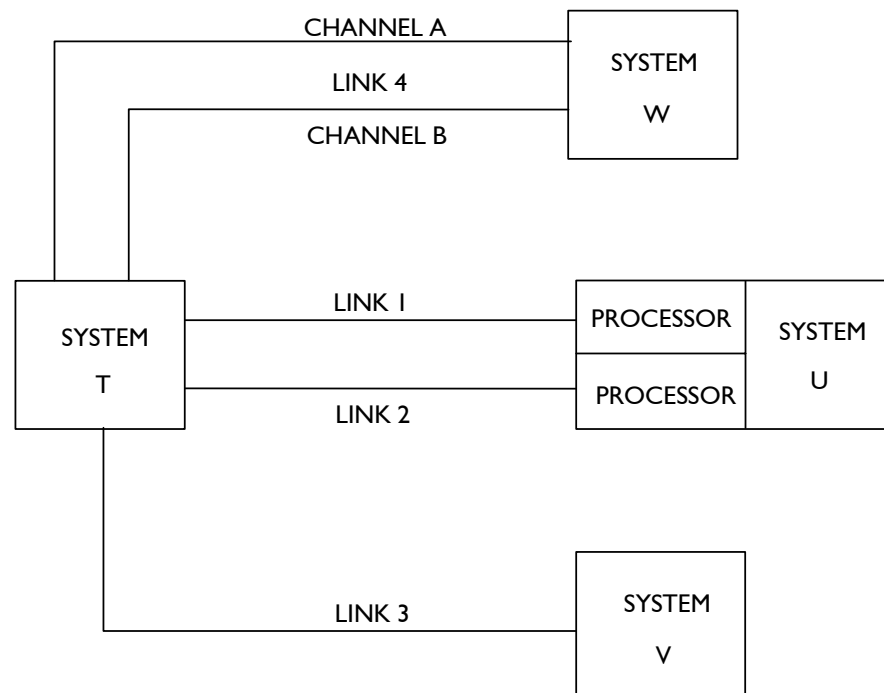


Figure 7.2 illustrates the possible Link and Channel Configurations where:

7.2.1

Link 1 consists of a single channel from System T to a self-contained processor within System U.

7.2.2

Link 2 consists of a single channel from System T to a self-contained processor within System U.

7.2.3

System U is configured with multiple processors that have no Inter-Processor link and therefore have no means of keeping one another up-to-date.

7.2.4

Link 3 consists of a single channel from System T to System V.

7.2.5

Link 4 is configured as dual channel (A/ B) from System T to System W.

7.2.6

Systems T, V, and W may consist of single or multiple processor-based units.

7.3

Any channel declared failed shall not be used for data transfer. However a test message, classification CQ as defined in Appendix B2, shall be transmitted via the failed channel every 30 seconds.

7.3.1

On receipt of an ACK response to the test message, the 30 second delay is suspended and further classification CQ messages are sent immediately after each ACK is received.

7.3.2

Provided that five successive ACK responses have been received in 7.3.1, then the channel shall be reinstated to normal operation.

7.3.3

If during channel failure, a message is received which obeys the protocol requirements in Section 6.7.1 the system shall respond as defined in Section 6.13, but the channel shall remain declared failed until 7.3.2 has been satisfied.

7.4

When the processor starts-up or becomes on-line, all channels shall be assumed to be operational. The actual status of these channels shall be determined by the sending of messages to adjacent systems.

7.5

A test message of classification CT shall be passed over all operational channels every 30 seconds and when a failed channel is restored to operational status. The test message is defined in Appendix B2.

8 Buffers

This section applies to systems making use of buffer control of the link, however modern systems tend to utilise inbuilt hardware control.

8.1

The following are minimum requirements for buffer lengths, any variation will be detailed in the Project Requirements Specification.

8.1.1

Output buffers shall be of sufficient length to avoid the possibility of overload under normal operation including the failure of one of the transmitting channels (Section 5.6). A buffer shall be capable of storing messages generated at the maximum rate for the link concerned, for a minimum period of ten seconds.

8.1.2

Input buffers shall be provided to minimise the effects of processing delays on the operation of the communications paths. The lengths depend on the worst case processing delays likely under normal operation.

8.1.2.1

In the event of an input buffer becoming saturated, all messages received during this period shall be given a N/R (Section 6.7.1.3).

8.1.2.2

Positive responses (Section 6.7.1.1 and 6.7.1.2) should not be given until spare capacity in the input buffer has returned.

8.1.3

For the purposes of calculation the average message shall be assumed to contain 30 characters.

8.2

Should an output buffer become overloaded then all messages in the buffer shall be discarded and replaced by the queue overload message classification CL (as defined in Appendix B2).

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8.2.1

No messages shall be added to the buffer until the queue overload message has been positively acknowledged.

8.2.2

Under total link failure conditions, the output buffer shall clear and cease to be loaded.

8.2.3

The occurrence of a buffer overload shall be logged together with details of the link affected.

8.3

On receipt of a buffer overload (CL) message, the receiving System shall respond as detailed in Appendix B2 unless otherwise detailed in the Project Requirements Specification.

9 Test Procedures And Monitoring

9.1

Monitoring facilities for data channels and links shall be provided to aid diagnostics and to log events.

9.1.1

The beginning of each file stored and displayed or printed shall bear the start time and date stamp.

9.1.2

At midnight, the time and new date shall be stored and displayed or printed, together with the current status of all channels.

9.1.3

Every new hour shall be stored and displayed or printed.

9.2

Access to each channel in a link shall be by commands entered from the fault logging device or equivalent. In this specification, the command is expressed in the form:

CMD LC

Where **CMD** is the command

L is the link identification

C is the channel number

The following commands are examples of useful diagnostic facilities that may be varied to suit individual systems:

9.2.1 **PLC L (Print Count)**

All current count values including date and time of last reset, and current date and time shall be displayed (printed). The command shall immediately reset all the counts to zero for the link specified, along with the date and time. This command shall be automatically cancelled.

Protocol character counts of: **ACK** **NAK** **N/R**

shall be kept for individual channels. Each count shall cycle around 2^{15} (32 x 1024).