

Category 2 Standard

S2501

(Formerly E7002)

Signalling control systems

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1 Purpose

- 1.1 This document is intended to indicate the underlying philosophy that must be adopted when preparing and introducing signalling control systems to London Underground.

2 Scope

- 2.1 This document covers the philosophy of automated control by computer systems or programme machines but does not consider manual based control systems such as the older signal boxes with levers or with push-buttons.
- 2.2 It is not the purpose of this document to describe in technology specific terms how the philosophy is to be met. Reference should be made to the signalling control systems codes of practice relating to computer systems and programme machines (G2521 and G2501) for this level of detail.
- 2.3 This standard replaces S2501 A4, E7002 A3, and TLL-ENG-7237-A1, which are withdrawn.

3 Requirements

3.1 User and system requirements specification

- 3.1.1 It is essential that the properties required of the signalling and control system are understood by all parties involved in its design, construction, use and maintenance. To this end, a User Requirements Specification and a System Requirements Specification shall be prepared.
- 3.1.2 The User Requirements Specification shall be a statement of the performance and operating functionality required of the system and shall be formally approved by the Users.
- 3.1.3 The System Requirements Specification shall incorporate the User Requirements Specification and must include a specification of all the system features, technical requirements and functionality of the control system. It shall be approved by the Business Client, Head of Signalling Engineering and the Project Manager.
- 3.1.4 All the features which are stated as requirements in the Systems Requirements Specification shall be capable of verification, by testing or other means, when the system has been constructed and installed.
- 3.1.5 The Systems Requirements Specification shall define any interim arrangements which may be necessary if a phased implementation of the system is proposed.
- 3.1.6 In order to allow the most cost effective control system meeting all the specified requirements to be chosen, the System Requirements Specification must not specify, in detail, the means by which the required functionality is to be achieved. This is to ensure that potential suppliers are not constrained by unnecessary restrictions from offering the most cost-effective solution.

3.2 System architecture

- 3.2.1 The signalling control system and the vital signalling system interface operationally but shall be separate and distinct having boundaries between them clearly defined, to:
- a) minimise the size and complexity of the vital signalling system;
 - b) facilitate high levels of functionality within the control system with minimal risk to safety;
 - c) facilitate validation, testing and fault finding.
- 3.2.2 The signalling control system architecture shall be such as to minimise the probability of a system failure and to aid rapid detection and disclosure of latent faults.
- 3.2.3 The chosen architecture may utilise either:
- a) local intelligent units, co-ordinated by a central computer; **or**
 - b) centralised intelligence, with highly redundant communications paths; **or**
 - c) some combination of the two, but must be supported by suitable analysis to demonstrate its ability to meet the specified targets and response time.
- 3.2.4 Signalling Control Systems shall, where required in the Systems Requirements Specification, provide an integrated common user interface to enable other systems to be controlled and monitored. Typically these systems could consist of CCTV, radio, power, train systems and E&M services.
- 3.2.5 Signalling Control Systems shall be designed to facilitate fall back modes of operation under failure conditions. The fall back modes of operation shall be defined in the Systems Requirements Specification, but shall include the ability for:
- a) local site to continue working in a specified degraded mode if communication to the centre is lost;
 - b) the ability for local control to be effected.
- 3.2.6 Where fault tolerant systems are provided, in the event of a single system hardware or software component failure, the system shall automatically restore full system functionality within the time specified in the performance criteria, indicate the failure to system users, and make available such information as is necessary to allow rapid and effective repairs to be made.
- 3.2.7 Only hardware purchased from established manufacturers or manufactured to proven designs using materials suitable for use in the London Underground railway environment and having published failure rates which allow the specified availability to be achieved, shall be used in the construction of a signalling control system.
- 3.2.8 Sufficient hardware redundancy shall be included to ensure that the specified system availability and fault tolerance can be achieved.

- 3.2.9 Only software designed, produced and tested according to published specifications and methodologies approved by London Underground shall be used in signalling control systems.
- 3.2.10 A fault in any major sub-system shall not inhibit the operation of the remainder of the system.
- 3.2.11 A signalling control system shall be specified to have at least 25% expansion capability for both inputs and outputs beyond delivery of the initial system functionality.
- 3.2.12 A signalling control system shall be specified to utilise no more than 60 per cent of the processing capacity under peak load conditions.
- 3.2.13 It must be recognised that a signalling control system contains data which is of potential benefit in a wider engineering context. A means shall be provided to allow external systems to access signalling control system data in a standardised secure manner and to provide integrated control at the Human Machine Interface. Precautions shall be taken to ensure that, whatever external demands are imposed, the performance of the signalling control system is not degraded beyond any of the specified limits.
- 3.2.14 A means shall be provided to monitor the operation of equipment which is under control, for example the response time of mechanical equipment, in order to generate an alarm when the response time exceeds a predefined limit.

3.3 Networking

- 3.3.1 If the signalling control system makes use of networks, sufficient information transfer capability and redundancy shall be incorporated into the network to ensure that the specified performance criteria will be met under all circumstances and to include 25% spare capacity.
- 3.3.2 The protocols in use on a network shall be approved by the Head of Signalling Engineering and preference shall be given to protocols which follow the general principles of ISO/IEC 7498-1 Information technology; Open systems interconnection; Basic reference model, unless the requirement for a more efficient form of information transfer is overwhelming.
- 3.3.3 The protocol which is used for each layer of the Reference Model shall be published. Preference shall be given to the use of protocols which are published by a recognised standards body. ISO standard protocols shall be used for the Physical, Datalink, Network and Transport layers. The protocols shall be implemented in such a way that access points are provided for the possible enhancement of the system to include standard higher layer protocols, where these are not provided initially.
- 3.3.4 In normal use, the signalling control Information shall be transmitted via a dedicated circuit. The chosen protocols shall be used in such a way that essential information captured by the signalling control system is never lost. Information transmitted via the network shall not be deleted or overwritten until acknowledgement of its receipt is obtained from the recipient, or until a defined time-out has expired as detailed in the System Requirements Specification.

- 3.3.5 The integrity of all communications paths which are not currently carrying continuous traffic shall be confirmed at regular intervals. The required maximum interval shall be stated in the System Requirements Specification.
- 3.3.6 Provision shall be made for future associated systems to obtain access to train service data via the network.

3.4 Display of information

- 3.4.1 It shall be possible for a user of a signalling control system to obtain any information which is necessary for him to perform his function at any time. It is also necessary that occurrences which may require the intervention of a traffic controller are brought to his attention immediately, regardless of the use being made of the system at that time.
- 3.4.2 Information shall be presented so as to minimise the probability of its mis-interpretation by a user.
- 3.4.3 The system shall be capable of displaying all train position information both as large scale diagram displaying an overview and on visual display units. The capability to display all train position information is of prime importance particularly when failure conditions occur in either the vital signalling system or the signal control system.
- 3.4.4 A user of the system shall have the choice of how much detail to display on visual display track diagrams. The user shall be able to change the level of detail at any time.
- 3.4.5 Information which is known to be erroneous or out of date, shall be clearly and unambiguously indicated as such when displayed.
- 3.4.6 Facilities shall be available to allow a traffic controller to insert information manually where fault conditions prevent the signalling control computer from providing the information automatically. Any such manually inserted information shall be clearly distinguished from automatically gathered information, when displayed.
- 3.4.7 When changing between different views of related data, the first view shall continue to be displayed and shall not be obscured, until the system is ready to refresh the screen with the replacement data, to minimise the period when no data is shown.

3.5 Input of information or commands

- 3.5.1 All information or commands which are input into the signalling control system shall be verified for consistency before being accepted by the system. Detectable errors shall be clearly and concisely indicated to the user.
- 3.5.2 Menu selection and short cut techniques shall be utilised to minimise the number of user actions necessary for the most frequently used functions.
- 3.5.3 Protection shall be provided to prevent unauthorised users from inputting system commands or accessing system information. A means to declare the operators identity and level of authority shall be specified in the System Requirement Specification.