UIC CODE 753-3

2nd edition, April 2005

Original

OR

General procedures governing maintenance, operating and performance criteria for the UIC member railways telecommunication network

Procédures générales pour les critères de maintenance, d'exploitation et de performance des réseaux de télécommunications des membres de l'UIC

Instandhaltung, Betrieb und Leistungskriterien des UIC-Bahntelekommunikationsnetzes Allgemeine Verfahren

UNION INTERNATIONALE DES CHEMINS DE FER
INTERNATIONALER EISENBAHNVERBAND
INTERNATIONAL UNION OF RAILWAYS

Leaflet to be classified in Volume :

VII - Way and works

Application :

With effect from 1 January 1997
All members of the International Union of Railways

Record of updates

1st edition, January 1997	First edition
2nd edition, April 2005	Retyped in FrameMaker. Important: the articles (points) in this leaflet have been renumbered in the new edition. The first digit of each point has been increased by one (i.e. 0 becomes 1, 1 becomes 2, and so on). Please take account of this when using cross-reference from other leaflets.

The person responsible for this leaflet is named in the UIC Code

Contents

Summary

The Leaflet gives recommendations about test, verification and fault handling of the present international circuit switched telephone network between railways in Europe.

The Leaflet also gives some hints over questions that must be solved for a smooth migration to a digital telephone network for the railways.

Finally, the Leaflet gives a scenario over a future IRTN/international railway telephone network. This scenario takes into account organisation, operation, fault handling, maintenance, network management, accounting and Quality of service.

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1 - General

1.1 - Scope of document

This document describes the procedures to be adopted to maintain and operate the current telecommunications network of UIC member railways and to maintain, operate and upgrade the international railway telecommunications network (IRTN) together with the procurement specifications and the performance criteria for the grade of service available to users.

All references to the IRTN in this document identify with the new digital network.

This leaflet does not impose any requirement on railways' national networks procedures.

Most of the regulations in this leaflet are based in principle on those of the International Telecommunications Union (ITU-T) and ETSI and apply to the international circuit switched telecommunications services which will be provided to railway users in Europe in the digital era; matters relating to equipment and services are covered in *UIC Leaflet 753-1 and 753-2* (see Bibliography - page 16).

Terminology and definitions can be found in *ITU-T Volume I Fascicle I.3*.

1.2 - Service level agreements

This document requires all railways to come to agreement, bilaterally at a minimum initially, then internationally, via Euratel or its members and franchisees with the IMO (IRTN Management Organisation) as to service response times, covering:

- grade of service,
- capacity provision,
- fault response and rectification,
- traffic measurement,
- traffic and routing management,
- inter railway billing,
- settlement to national PTTs.

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2 - Existing network

2.1 - Maintenance

2.1.1 - General organisation

Theoretically maintenance is divided into "preventive maintenance", which is intended to avoid the appearance of faults as far as possible, and "corrective maintenance", which consists of eliminating faults.

The regulations laid down by each Railway are specific:

- to the equipment itself, which belongs to the Railway concerned;

- to maintenance of all the international circuits which form part of the national networks.

With regard to the operations to be carried out on the international circuits, the recommendations given in point 2.1.2 below and 2.1.3 - page 4 should be applied, also the directives in *UIC Leaflet 917-4* (see Bibliography - page 16) for the procedures for the exchange of service messages.

2.1.2 - Preventive maintenance of international circuits

2.1.2.1 - Consistence and frequency

This maintenance is limited to preventive tests, which comprise:

- "individual" tests, effected circuit by circuit, each day (this frequency is permissible as long as the number of circuits is small. Otherwise, it can be increased to a weekly frequency by agreement between the Railways concerned),

- "concentrated" tests, effected overall on each international connection annually.

2.1.2.2 - Preparation of test programmes

The working schedules of the tests are established bilaterally between the Railways concerned, for each international route. It will be advisable to provide for "concentration" tests in a time period near to that in which the peak traffic tendered is measured (see above), thus allowing for a complete exchange of information between the Railways at the same time.

2.1.2.3 - Working procedure

The "individual" tests shall be carried out in principle from a telephone or from a virtual automatic device provided for this purpose. The point called at the other end can be either a normal or simulated telephone.

The "concentration" tests are carried out, in principle, by means of:

- simultaneous call automatic transmitters, at the originating end;

- a concentration box of lines called, at the other end.

The Railways concerned should agree together on the actual procedures, depending on the effective existence of all or part of the apparatus mentioned above at the exchanges in question.

2.1.2.4 - Nature of the tests to be carried out

1. "Individual" tests

   - Test E 1 : calling an available telephone, conversation, replacing.
   - Test E 2 : calling an available telephone, conversation, replacing of the receiver by the person receiving the call.
   - Test E 3 : calling an engaged telephone.
   - Test E 4 : replacing of the receiver by the calling party during dialling.

2. "Concentration" tests

   To be carried out simultaneously on all "outgoing" or "both-way" circuits of the line concerned (namely **n** circuits).

   - Test E 5 : Calls, in repetitive cycles (about one hundred cycles), to **n** available telephones, conversation on each connection, but with hanging-up of the receiver by the calling party.
   - Test E 6 : Calls, in repetitive cycles (about one hundred cycles), to **n** available telephones, conversation on each connection, but with hanging-up of the receiver by the parties called.

For both-way circuits the tests are obviously to be carried out in each direction.

The various phases of functioning are followed by observance of indicator lights or other means of display, and listening to supervisory tones.

2.1.2.5 - Faults detected during the tests

Any person detecting a fault during the tests must, in conjunction with the other Exchange, take all necessary measures to determine its cause, before cancelling the current cycle and beginning the following cycle.

Generally speaking, repair must be carried out immediately. However, if the incident seems difficult to deal with quickly, the defective part should be disconnected, with a view to repair later, and the tests continued.

2.1.3 - Corrective maintenance of international circuits

Faults should be rectified in accordance with the directives for the equipment concerned, in conjunction with the other international main exchanges, if necessary. In any case, individual operating tests in accordance with "individual" test above, should be carried out after repair.

2.2 - Intervention of operators

2.2.1 - Function and equipment of operators

For connections operated in semi-automatic mode:

- The caller's operator at the originating exchange of the international circuit, sets-up the connection. If the national circuits between the calling receiver and the calling exchange are of the 4-wire type, the calling operator will effect the connection, by means of 4-wire connections throughout.

For connections effected in semi-automatic mode and for those effected in automatic mode but passing through a manual exchange:

- the insertion loss of the operators' equipment should not exceed 1dB. It is recommended that a 4-wire connection should be used for this equipment;

- any intervention by an operator in a conversation already taking place should be indicated to the users concerned in the form of a rhythmic presence signal. The exact composition of this signal is left to the discretion of the Railways, in relation to their national regulations.

2.2.2 - Operators at the destination exchange

When information is required, it should be possible to call the operator at the destination exchange. The relevant call numbers can be found in the maps shown in *UIC Leaflet 753-2, Appendix 1*.

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3 - Transient phase

3.1 - Testing and maintenance of mixed sections with digital and analogue exchanges

Maintenance involves the whole operation required for setting-up and maintaining, within prescribed limits, any element entering into the setting up of a connection. The basic philosophy is valid in principle, for analogue, mixed and digital networks. However, many digital network elements are more suited to the implementation of controlled maintenance than are elements in analogue networks.

Due to new technological developments maintenance functions can be incorporated into the digital equipment. Analogue equipment often requires additional external maintenance systems in order to permit controlled maintenance. The introduction of digital telecommunications equipment with enhanced maintenance functions, including the facility for remote reporting and control, provides new opportunities for centralisation and new possibilities for low cost maintenance. This opportunity applies not only for individual exchanges, but for the whole network, e.g. using the same technology for both transmission and switching.

The maintenance organisation and maintenance facilities, including test equipment, must be provided so as to be available when the new transit exchange is introduced.

The strategy should include the following maintenance considerations:

- it should consider the evolution of the network from the present analogue environment to the future wholly-digital environment. In doing this, it must consider the services and functions offered by networks (e.g. ITU-T Signalling System n.7 and ISDN) and the tools and capabilities then available (e.g. Telecommunication Management Network - TMN),

- it should employ an overall maintenance philosophy that uses the maintenance entity concept, failure classification and network supervision process,

- it should provide for the maintenance for the IRTN during the following activities:

  - installation and acceptance testing,
  - bringing into service,
  - keeping the network operational,

- it should support other maintenance activities associated with the administration of maintenance operations (e.g. data bases, spare parts, failure statistics, etc.) along with a detailed plan for preventive maintenance on the telecommunication equipment,

- it should have the major aim of minimising both the occurrence and the impact of failures.

3.2 - Infrastructure phasing

The migration plan towards the new IRTN operation will strongly depend on:

- the lead time for development and agreement of a tender process and ITT, manufacturers to bid, a contractor to be selected, switch development, installation and commissioning;

- the availability of a suitable transmission infrastructure;

- the time required to set up and operate the IMO, including any joint venture and other commercial agreements involved;

- the readiness of individual national railways to link into the SS7 IRTN infrastructure;

- potentially, commercial judgements about the viability of any third party or public services offered;

- regulatory processes, such as the agreement of NNIs with PSTNs (if appropriate) or application for PTO status (if and where allowed).

It is expected that the "baseline" IRTN for west-central Europe will be phased in over a period of at least five years, with the possibility of further extension (e.g. eastward or to provide fill-in nodes) over another five to ten years.

The processes of:

- installing and commissioning transmission links,

- installing and commissioning IRTN nodes,

would be planned and undertaken substantially in parallel. Changeover to a new system, and decommissioning of old infrastructure, would follow when both aspects were finalised.

4 - Digital era

4.1 - Network management

R **4.1.1 -** The functions that are required to manage the international network are:

- fault management;
- performance management;
- configuration and name management;
- security management;
- accounting (see point 4.5 - page 10).

O **4.1.2 -** Initially each node will be managed by the local national railway network management organisation. The nodes must have management capabilities integrated within the exchange hardware. Where railways already possess a suitable network management platform, this will be used for management of the international node.

R **4.1.3 -** Where a suitable system does not exist, workstations must be installed providing a graphical human interface to the exchange/node providing the above functions.

R **4.1.4 -** Management of the network will migrate to single or dual operations and management centre and the use of open management standards will be supported for both the centralised and any national management systems.

R **4.1.5 -** In the first instance IRTN switching nodes will be monitored and managed by their host national railway, e.g. a node in Paris would be managed by SNCF. The ATM service will follow the same regime, i.e. each ATM hub will be managed by the host nation.

R **4.1.6 -** IRTN-node host nations will also be responsible for end-to-end management of the transmission channels, in SDH terminology, both between IRTN nodes and from an IRTN node to connected national switches.

R **4.1.7 -** In the longer term it is planned to centralise the IRTN management functions, and to combine them with the central accounting function.

O **4.1.8 -** Management of transmission services at a lower level (e.g. individual SDH "hops", SDH add/drop multiplexes (ADMs), fibre physical integrity) is the responsibility of the nation in which the equipment is located. Bilateral agreements will be required at national boundaries.

R 4.2 - Maintenance

Maintenance of nodes and transmission infrastructure will usually be devolved locally. Thus each national railway will maintain the fibre installed by its trackside, to an agreed service level.

Certain aspects of maintenance will need to be referred back to the equipment suppliers. The IMO will set up the operating arrangements for this, but responsibility for calling-in suppliers will rest with local operators.

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4.3 - Fault handling

A fault handling and escalation process will be set up for the IRTN.

It is expected that national railways will co-ordinate national and international fault reports from their users, as now. International fault reports would be referred to a branch of the IMO, which will co-ordinate the fault tracking within the IRTN.

Where faults are identified, the IMO will contact the local maintenance organisation to effect repairs. It will notify the fault report centres of all railways affected by the problem, and of progress in repair.

The next level of fault escalation are:

- National Manager for day-to-day operating telecom networks,

- National Managing Experts for transit exchanges and upgrades to digital operations.

A list of the telephone and fax numbers plus job title and name of person nominated as Local Manager and Managing Expert together with a list of national fault desk numbers to be advised to all railways.

4.4 - Test and approval process and commissioning of international transit exchanges and connections

O **4.4.1 -** As soon as any Railway has decided to install a new International transit exchange over the IRTN and/or to bring a new international transmission system and/or circuit into service, the necessary contacts, for the exchange of information, are made between its Headquarters Technical Service Group (TSG)[1] and UIC, or any other Body responsible for operation of the IRTN. The TSG has to make sure the necessary tests and adjustments have been performed to ensure the new system meets required specifications and supports the existing connection to established networks before its installation and bringing into use.

O **4.4.2 -** All countries connected to the IRTN have to be advised by the Railway introducing the new node on the IRTN, at least 3 months in advance of digital transit exchanges/connections being added into the network.

O **4.4.3 -** Testing procedures have to be agreed between countries where the interface is to change at least 6 months before the change is scheduled to be implemented into service.

R **4.4.4 -** These proposals and procedures have to be passed on to the National Managing Experts.

R **4.4.5 -** The TSG of each Railway, or the Telecommunications group providing such service, is responsible for the installation of new systems, for the establishing and lining-up of the circuit section in its territory, and for ensuring that the adjustment and tests required are made by the engineering staff concerned.

O **4.4.6 -** A "reference point" has to be defined, in each international transit exchange centre, to be connected to in order to activate the above procedures in a standardised way and in "reference configuration", which has to be the same all over the IRTN.

1. TSG: the appropriate authorities (national managing expert) responsible for making international agreements on technical and engineering aspects of provision and maintenance.

R 4.5 - Accounting

The IRTN will be a single accounting zone. Logging equipment will measure the traffic delivered into and out of the IRTN.

Calls will be charged according to an agreed tariff structure (to be devised). Settlements will be made between the IMO and national railways (and third party users, if connected) at an appropriate frequency.

If the IRTN is fully used, there should be no requirement for bilateral settlements between railways for telecommunications. Because of the structure of the IRTN, no country will be charged for (or receive payment for) transit traffic. Accurate call accounting is thus possible.

R 4.6 - Procurement

The UIC will provide a mode specification and a framework contract with suppliers for nodes and expansion modules. Individual railways shall procure against that contract.

The process of specifying the transmission network is not yet developed. However it would be IMO would be expected to specify a transmission infrastructure to some extent, for implementation by individual railways. Procurement and ownership of SDH equipment, and possibly also ATM equipment, would be the responsibility of railways, although compliance with the IMO transmission framework specification would be mandatory.

R 4.7 - Call accounting

The IMO will provide accounting services for the traffic carried by the IRTN. Depending on the accounting mechanism selected, the IMO may provide statements of bulk traffic exchanged with the national railway network, or per call records for all calls sent to and received from the IRTN.

The specific mechanisms used nationally for recording international traffic sent and received are left to the national railway network management organisation and will be dependent on the method used for internal charging within the railway.

An accounting rate will be agreed with each railway which will define the value of the traffic exchanged with the IRTN. This accounting rate will be used to determine billing to each railway for use of the IRTN. It is likely that a standard accounting rate will be used throughout the IRTN.

4.8 - Performances

R 4.8.1 - Introduction

The performance of the network can be considered in terms of:

4.8.1.1 - Availability

Probability of the network functioning correctly and being capable of supporting the required service level.

The criteria are:

- mean time between failures (MTBF);
- mean time to repair (MTTR).

4.8.1.2 - Service level

Quality of service provided to users, e.g. maximum delay for connection.

The criteria are:

- service access availability;
- call set-up time;
- average transfer duration;
- number of successful/failed calls;
- connection quality.

These criteria will be dependent upon:

- *The network configuration* : the number of alternate routes and number of nodes that a call must pass through;
- *Switch reliability* : the degree of duplication of equipment and reliability (MTBF) of switch components;
- *Dimensioning of the network* : the maximum switch load and the transmission link capacity.

The performance levels must be similar to those provided by the existing public network.

4.8.2 - Network Availability

R **4.8.2.1 - Mean time between failures (MTBF in h)**

The suggested limits for equipment failures are provided in table 1 and 2. They are based on statistical data from German Telecoms. These failures rates must be below the values identified for at least the past 20 years.

Table 1: Switch node failure rates

	MTBF (h)	
	Hardware	**Software**
2 Mbit/s port	1 460 000	88 000
8 analogue subscribers	438 000	175 000

Table 2: Transmission failure rates - ISDN primary rate connection

	MTBF (h)
PCM 30, length about 214 km	1125
S2m connection, length about 130 km	885

R **4.8.2.2 - Mean Time to Repair (MTTR)**

Repair time should be defined according to three levels of failure and their effect on the level of service, see table 3.

Table 3: Limits to repair times

Urgent intervention	< 3,5 hours
Deferred intervention	< 12 hours
No imperative need for intervention	< 72 hours

R **4.8.2.3 - Service level criteria/Service access availability**

Service access availability defines the ability of a user to obtain a service.

Table 4 below proposes acceptable levels.

Table 4: Service access availability

Unavailability of a subscriber	$< 5 \times 10^{-5}$ (excluding line and handset)
Unavailability of a circuit	$< 1 \times 10^{-4}$ hours
Unavailability of a signalling group	$< 1,9 \times 10^{-5}$
Total stoppage of service	< 2 hours in 40 years

R **4.8.2.4 - Call set up time**

The requirements for call set up times are shown in table 5 (pre-dialling delay: time between lifting of the subscriber handset or circuit seizure signal and the invitation to transmit, (P > x) = Probability for the invitation to transmit time to be greater than x seconds).

Table 5: Call set-up time

	Normal load	Overload +40% number of calls
Pre-dialling delay for subscriber	$(P > 1) < 5 \times 10^{-3}$ $(P > 3) < \times 10^{-3}$	$(P > 3) < 10^{-2}$
Pre-dialling delay for circuit	$(P > 1) < \times 10^{-3}$	$(P > 1) < \times 10^{-2}$
Selection duration	$(P > 2) < 5 \times 10^{-3}$	$(P > 2) < 5 \times 10^{-2}$
Probability to a call to be rejected	$Pr < 10^{-4}$ Pr	$< 2 \times 10^{-4}$

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4.8.2.5 - Call failure rate

The performance objectives as regards security of operation must comply with ITU recommendations Q541 and Q543. Probability of premature clear-down in a one minute period: < 2 x 10^{-5}. Probability of other failures in a one minute period: < 10^{-4}.

The failure rate of computers and peripheral equipment that are indispensable for traffic flow, must be below 9 immediate interventions per year, and below 25 x 10^{-4}/hour for all types of interventions, i.e. fewer than 22 interventions per year.

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4.8.2.6 - Average transfer duration

The SS7 signalling standard adopted on the international network must correspond to a transfer duration of 1,5 s/transit exchange.

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4.8.2.7 - Number of successful/failed calls

Table 6 provides a guide to a typical profile of the number of calls successfully switched that should be supported at various points in the network.

Table 6: Number of successful calls

Type of call	Local	Outgoing	Incoming	Transit
Successful	90%	85%	85%	80%
No reply	8%	10%	10%	12%
Busy	2%	5%	5%	6%
False manoeuvre	0%	0,1%	0%	1,5%
Unsuccessful calls due to network failure	0%	0%	0%	0,5%

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4.8.2.8 - Connection quality

Excessive errors in the frame alignment signal must trigger a failure indication. For an error rate <10^{-4}, the probability of triggering a failure indication in a few seconds must be below 10^{-6}. For an error rate >10^{-3} this probability must be above 0,95.

The transmission error rate must be <10^{-9}.

The quality of speech is related to compliance with a national and international transmission plan. For the international system, the nominal relative levels at the reference of 800Hz (1020 Hz) must be, for digital circuits:

- 3,5 dB at transmission;
- 3,5 dB at reception.

National digital switches on four conversation wires have the following attenuation:

- 0 dB from 4 wires junction to 4 wires junction;
- 3,5 dB from 4 wires junction to subscriber.

List of abbreviations

ATM	Asynchronous Transfer Mode
CCITT	International Telephone and Telegraph Consultative Committee
EIRENE	European Integrated Railway Radio Enhanced Network
ETSI	European Telecommunications Standard Institute
GSM	Global Standard for Mobile telecommunications
IMO	IRTN Management Organisation
IRTN	International Railway Telecommunications Network
ISDN	Integrated Standard for Digital Networks
ITT	Invitation To Tender
ITU-T	International Telecommunication Union - Telecommunication sector
MTBF	Mean Time Between Failures
MTTR	Mean Time To Repair
NNI	Network-Network Interface
PABX	Private Automatic Branch EXchange
PSTN	Public Switched Telecom Network
PTO	Public Telecommunications Operator
Q.Sig	Signalling at Q reference point (for private telecom network)
SS 7 CCITT	Signalling System No. 7
SDH	Synchronous Digital Hierarchy
TMN	Telecommunication Management Network
TSG	Technical Service Group
UIC	International Union of Railways

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Warning

Printed by the International Union of Railways (UIC)
16, rue Jean Rey 75015 Paris - France, April 2005
Dépôt Légal April 2005

ISBN 2-7461-0593-4 (French version)
ISBN 2-7461-0594-2 (German version)
ISBN 2-7461-0595-0 (English version)