From PIS to Multimedia Services: Standards and Market Trends

Davide AMATO[1], Victoria CALLEJA DURO[2], Laurent LLERENA[3], Eric LAVILLONNIERE[4], Tom LANE[5]

[1]Sadel S.p.A., Castel Maggiore (BO), Italy
[2]International Union of Railways, Paris, France
[3]SNCF Rolling Stock Engineering Center, Le Mans, France
[4]Mitsubishi Electric R&D Centre Europe, Rennes, France
[5]Ampetronic Ltd, Newark, United Kingdom
Corresponding Author: Davide AMATO (davide.amato@sadel.it)

Abstract

In the design of modern trains, there are strong requirements from railway operators to enable the passenger to be highly connected: fully informed about their train journey, entertained with songs, movies and internet surfing. They want to have also the whole knowledge about their door-to-door travel with details about other means of transport and real-time update about connections at their train destinations. Also the train staff (train driver and train conductor) requires advanced and complete interaction with the passengers. Equipment must provide the monitoring of the whole train and enable fast response to customers' requests (i.e. Passenger Alarm System). The train operator has to comply also with regulations for Persons with Reduced Mobility and further additional national requirements for blind and hearing impaired people.
The needed solutions already moved the border from an obsolete Passenger Information System (PIS) to a comprehensive MULTIMEDIA System with several services. Special attention must be considered for Safety and Security aspects for some of their functionalities.
The established UIC-IEC SLG (Strategic Liaison Group) MULTIMEDIA Subgroup collects expertise of train operators, train builders, system integrator and product manufacturers. The subgroup collected several Use Cases from the most important players of the railway market. The analysis of the acquired information and identification of common solutions is allowing the subgroup to provide inputs for both organizations, UIC and IEC, to update existing standards or create new ones.

Keywords: Rolling Stock, PIS, MULTIMEDIA, IEC Standards, UIC Leaflets.

1. Introduction

In the developing process of new PIS solutions, it is important to consider and analyze regional and international requirements. The UIC-IEC SLG MULTIMEDIA Subgroup counts around 20 participants collecting the expertise of railway operators, train builders and system integrators in state-of-the-art solutions and current railway operators and passenger's expectation. In our current activities we collected twenty-one Use Cases from active members. These show PIS implementation in eleven target countries of two different continents (Europe and Asia) for rolling stock projects from metro to high-sped trains. With this comprehensive approach we identified market trends and new standardization needing to support UIC and IEC organizations in the preparation of new railway standards fulfilling requirements coming from the market.

2. MULTIMEDIA Services

The overall MULTIMEDIA passenger services could be grouped in four main categories:

- Visual plus Audio PA Information and Intercom Calls
- Personal Infotainment (Information and Entertainment)
- Video Surveillance/CCTV
- Others

Each service is briefly described in the following paragraphs.

2.1 Visual plus Audio PA Information and Intercom Calls

It is possible to identify six services related to visual information, audio information and Intercom Calls.
The first one is "**Visual PA Information outside the train**". It covers information for passengers waiting the train at the platform and allow them to enter the correct train and coach. This service could be implemented with external front and/or side LED panels. These panels could display text and graphical information. The main information could be train number, train coach, departure station, intermediate stops and final destination with scheduled time.
The second one is "**Visual PA Information inside the train**" able to broadcast journey details to the entire train or in some specific coaches with LED panels or TFT-LCD screens. The main information could be train number, departure and arrive stations, actual time, stops with scheduled time, next stop actual arrival time, next stop timetable connections, position of the train on a linear and/or on a map. If TFT-LCD screens are used, as secondary functionality it is possible to provide to passengers also entertainment and/or advertisement contents.
The third one is "**Audio PA Information outside the train**". This service is not common on trains. It is implemented with external loudspeakers adjacent to each entry door.
The fourth service is "**Audio PA Information inside the train**". These audible messages could be broadcasted to the entire train or in some specific coaches with loudspeakers, audio amplifiers, intelligent automatic players and handsets. The broadcast could be: automatic scheduled based on the train journey, on-demand prerecorded started by the train driver or conductor, manual with the direct voice of the train driver or train conductor.
The fifth service is "**Passenger Intercom Call**". This could be available to passengers by the adoption of a Passenger Alarm Device with audio intercom call capability. This equipment allows the passengers to speak with the train conductor, driver or the ground operator. This bidirectional audio call could be supported by images from the CCTV subsystem to increase the situational awareness of the staff.
The last of this category is "**Train Staff Intercom Call**". This service is not directly related to passengers, but it refers to train staff intercom calls between train driver, train conductor, train staff and Ground Operator. It is grouped in this section, because it is often implemented with the same equipment of Audio PA Information and Passenger Intercom Call services.

2.2 Personal Infotainment

These are information and entertainment services addressed to a single passenger and could be available at its own seat or in common use areas.
The first of this category is "**Passenger Infotainment on passenger own device**" (smartphone, tablet, and laptop) with local (train or coach) Wireless connectivity. Thanks to their own multimedia devices the passengers could choose the preferred information, entertainment or advertisement content among the possible ones. The mains, but not only, are: train journey information, other trains connections, audio entertainment (song, radio, etc.), video entertainment (movies), advertisement, internet connectivity. This service could be split in three subservices: Information, Entertainment and Internet.
For Information subservice the passenger could receive on its own device the basic information related to e.g. train journey, next stop connections, news and weather forecasts. For Entertainment, audio and video contents are available for passenger as e.g. songs, radios and movies. The Internet subservice allows passengers to surf on internet with web browsers, to receive and send emails with email client software or webmail and to establish VPN connectivity.
The second service is "**Seat Infotainment**". Audio or audio plus visual personal infotainment are available at the passenger seat with a device installed locally (audio player or multimedia equipment). The service is for each person of the train or for a specified level of class. With this communication channel, several multimedia contents could be addressed to the passenger on its own request. As the previous service it could be split in three subservices: Information, Entertainment and Internet.
The third one is "**Interactive Infotainment Kiosk**". These devices could be placed in the aisle near the external doors of the coach of the train or for coaches of a specified category. They provide audio information, visual information, entertainment and advertisement to passengers.

2.3 Video Surveillance/CCTV

These services gather interaction with Video Surveillance and CCTV functionalities.
The first is "**Internal Passenger Video Surveillance/CCTV**". The CCTV subsystem has the capability to capture images from the different passenger areas of the train, display these images in driver cabs and in train staff cabs if present. Optionally the images could be displayed in passenger areas e.g. on TFT-LCD screens. Additionally the images are recorded, retrieved, exported, play backed and analyzed. The images are stored in the train, but could be transmitted on-line or off-line to the ground system, with the capability for the operator in the OCC to view a specific camera in the train.
The second service is "**External Side View Video Surveillance/CCTV**". This allows the train driver to see the passengers entering and exiting the train from the side doors in the station at each train stop. It is achieved with side view external cameras and monitors in the driver desks.
The third is "**External Front and Rear View Video Surveillance/CCTV**". It permits to continuous monitor the front and the rear of the train with the capability to detect external information as traffic management signage and intrusions on the railway line.
The fourth is "**Internal Video Surveillance/CCTV for train staff areas**". This service enable the guard of the driver cabs, train conductor cab and train staff cabs if present.
The fifth is "**Pantograph Video Surveillance/CCTV**". This service allows the continuous monitoring of the contact between power line and pantograph with an external roof top camera and a recorder. This functionalities can help to solve issues between railway undertaker and infrastructure owner.
These five services could even be integrated in a comprehensive Video Surveillance/CCTV subsystem.
A latter service is "**External Platform Video Surveillance/CCTV**". This allows the train driver to receive images from cameras placed on the platform of the station. These images could be displayed on monitors in the driver desks when the train is stopped in the station. It is achieved with platform cameras and wireless connectivity between the station and the train. It is often present in metro trains.

2.4 Other Services

Some additional MULTIMEDIA passenger services couldn't be grouped in a specific category. For this reason they are inserted in this paragraph.
The "**Passenger Counting**" service is the capability to know the number of passengers inside the train. This service could provide real time and/or off-line information about passenger entering and exiting the train for a specific train, journey and stop.
The "**Seat Reservation**" service informs passengers if a seat is reserved or not for the current journey or a part of it. The device could simply display if the seat is reserved or free, or it could show starting and ending stops of the reservation in respect of the current position.
The "**Improvement of Audio and Data Mobile Communication**" service improves the wireless mobile communication based on 2G, 3G and 4G technology for voice calls and data exchange inside the train for passenger devices (mobile phones, tablets and USB mobile keys). An example of implementation is a repeater capable of amplifying in a bidirectional way one or more RF mobile bands inside the vehicles to compensate the attenuation effect due to the Faraday cage effect of the carriage. This service could improve voice quality of audio mobile calls and communication speed of data packets.

3. Existing Standards for MULTIMEDIA Applications

The standardization activity inside UIC-IEC SLG MULTIMEDIA Subgroup takes into consideration preexistent international and regional standards coming from several standardization organizations. Firstly, we analyze standards from IEC TC9 WG46 OMTS (On-Board Multimedia and Telematics Systems for railways). Then we verified UIC Leaflets related to this topic. These are around 20 years old and are often overcome by railway operator technical specifications. At the regional level, there are also specific laws. Inside EU, some TSI (Technical Specification for Interoperability) regulations issued by EURA (European Union Railway Agency) impose mandatory requirements for Passenger Information System (PIS). These are references inside PRM TSI, TAP TSI and LOC&PAS TSI. Additional local CEN/CENELEC standards as EN 16334 and EN 16683 identify further rules that could

be considered in the development of passenger services. Fig. 1 shows the Legislations and Standards pyramid.

Fig. 1: Legislation and Standards.

3.1 UIC Leaflets and IRS

The three main UIC leaflets related to PIS are Leaflet 176 [1], Leaflet 568 [2] and Leaflet 440 [3].
Leaflet 176 describes which information should be displayed outside and inside the train and how to display them. These range from final destinations and intermediate stops to seat reservations.
The other two leaflets refer to audio functionalities. Leaflet 568 explains the implementation of Public Address (PA), telephone link with the tractive unit and radio-telephone link with central control point. Leaflet 440 sets out guidelines so that information may be given over the public-address system on scheduled long-distance passenger trains in a standard and user-friendly way, and it defines the characteristics of public-address equipment in order to facilitate its use on international services

3.2 IEC Standards

IEC started to draft a set of multimedia standards around fifteen years ago. It was decided to divide the documents between an architecture standard referenced IEC 62580-1 [4], and several application standards. Besides IEC 62580-1 the technical specification IEC 62580-2 [5] concerning Video Surveillance is available. Following our common IEC/UIC work a new standard IEC 62580-4 dealing with Passenger Orientated services will be drafted. After all a standard concerning Train operator/maintainer orientated services could also be the subject of future works.
The purpose of these standards is to provide interoperability between multimedia services. Because of their bandwidth requirement they are based on Ethernet connection. One natural choice is to lay these services upon the IEC 61375 series Ethernet standard (Ethernet Train Backbone and Ethernet consist network). But some other type of Ethernet connection could be considered.

3.3 CEN/CENELEC Standards

Thanks to the Frankfurt agreement between IEC and CEN/CENELEC the two IEC 62580 series standards are available also as European standards.
Two additional only European Standards EN 16334 [6] and 16683 [7] deal with “Passenger Alarm System” and “Call for Aid” to identify interactions between passengers, train staff and train behavior.

3.4 EURA Technical Specifications for Interoperability (TSI)

EURA drafts TSIs which each member state must mandatorily apply (Rules and Directive part of the pyramid shown before). PIS is in the scope of Regulation 454/2011 “TAP TSI” [8], “Regulation 1302-2014 LOC&PAS TSI” [9] and Regulation 1300/2014 “PRM TSI” [10].
The content of the TSIs can be found elsewhere in the standards, but the element selected here should be mandatorily implemented in the member states of the European Union.

4. Safety and Security Requirements for MULTIMEDIA Services

Some of the multimedia services could have safety and/or security requirements on some trains, due to specific country regulations or some international circulation rules. The train operator, train builder or system integrator must identify if there are safety issues for some functionality and could require risk analysis to identify Safety Integrity Level (SIL) for specific functions or require specific analysis to preserve data integrity.

4.1 Safety Requirements

An example of a relevant hazard could be the loss of verbal communications from the train driver to passengers for manual PA announcements. In such situation an architecture based on a redundant system with the UIC558 train lines can ensure the level of safety required. Moreover, additional features such as permanent monitoring of the devices can be implemented if the reliability of the system in conveying the signal is insufficient. Another example could be the loss of intercom emergency communication between passengers and the driver. The failure of such functions/services could omit to evacuate the train in case of an emergency or to report a fire/smoke to the train staff. In such case, specific design architecture should be implemented to obtain the required level of failure rate target.

4.2 Security Requirements

As CCTV solutions become more sophisticated, and increasingly used in both private and public applications, it demands more rigorous data protection to ensure security requirements. Whether CCTV network data protection is regulated or not, there is a need to protect the integrity of the network's user interface, prevent disruption of service and mitigate the risk of data theft.
The security of the on-board video surveillance consists of system integrity and data integrity. System integrity includes physical security of all system components and control of access to the system. Data integrity includes prevention of loss and manipulation of data before clearance.
Strong recommendation from European security agencies as EDPS (European Data Protection Supervisor) have been established to ensure Confidentiality of data and intrusion into the system.
As a given recommendation, the video surveillance system transmission must be routed through secure communication channels and protected against interception and encryption of data must be considered.
Furthermore, the new EU privacy General Data protection Regulation (GDPR) is applicable since 25th May 2018 which details information security and privacy protection concerns of CCTV systems.

5. PRM Services on Rolling Stock

Some passengers have additional needs to be able to access transport mobility services effectively and are sometimes described as "Persons with Reduced Mobility" (PRM). Their needs may not just be in physical movement, but also in other less visible ways such as visual, hearing, and cognitive difficulties. When considering Multimedia, one area that can benefit from assistance is audible communication for people with hearing difficulties, who often use a hearing aid, particularly if their hearing loss is significant.

5.1 Support for Hearing Aid Users

One method of assistance is the "Hearing Loop", also called "audio-frequency induction loops" (AFILs) or "induction loops". This widely used system consists of a physical loop of cable (or sometimes an array of multiple loops). These cables are placed around a designated assisted area, usually the passenger area of a train coach, and driven with an audio-frequency current. The current in the loop wire generates a magnetic field throughout the looped space, which can be picked up by a 'telecoil' provided in the majority of hearing aids. The system is also compatible with cochlear implant (CI) processors and hand-held hearing loop receivers which are available for individuals whose hearing aids are not telecoil equipped. There is a relevant standard for hearing loop system audio and magnetic performance, IEC/EN 60118-4, which should be met for best effectiveness. Hearing Loops are generally the only viable hearing assistance technology for use in transient situations such as public transport,

because all other current technologies require a receiver to be issued to the user. The advantage of a hearing loop is that a hearing aid user can access the facility discreetly and anonymously, provided the service is effective where they are in the train.

5.1.1 Hearing Loops for PA Announcements

For PRM passengers with hearing assistance needs, the biggest difficulty with PA announcements can be the other sounds in the train (other passengers, train motion, etc.) and the clarity of the PA system. By use of a hearing loop, hearing aid users can directly hear PA announcements from the same audio sources as the PA for other passengers. In general, it is far preferable and normally possible to provide assistance to whole vehicles or the whole train; if coverage is limited, it is important to identify the vehicles, and if relevant the part of the vehicle (e.g. PRM area), where this service is provided. Whether coverage is limited or of the whole vehicle, indication of hearing loop assistance is important, otherwise users do not know the assistance is available. This is usually achieved by displaying the standard symbol shown in Fig. 2 (as defined in both the IEC 60118-4 and European PRM standards) in the areas of effective hearing assistance.

Fig. 2: Hearing Loop signage.

5.1.2 Hearing Loops for Passenger Intercom Call

For passenger intercom, it is important that a PRM hearing aid user can hear the train staff or remote call center, in some cases, in what might be an urgent situation. This can be achieved by integration of a hearing loop into the intercom call point, often using a small loop coil and hearing loop amplifier in or adjacent to each equipped intercom terminal, providing assistance only immediately in front of the it.

6. Conclusions

The railway industry needs a common IT architecture for Multimedia services to offer a full interoperability of IT systems for public transportation. This initiative will promote new UIC and IEC standards and a possible future common platform with the deployment of new passenger services and practice for on board plug and play updates. This will allow costs reduction, security and maintainability.

Acknowledgment

We would like to thank all the other active contributors and experts from train operators and railway industries. They supported the UIC-IEC SLG MULTIMEDIA Subgroup with their Use Cases, expertise and deep knowledge on PIS and Multimedia services allowing the achievement of an excellent result.

References

[1] UIC Leaflet 176: Specifications for passenger information displayed electronically in trains, 1st edition, July 2001
[2] UIC Leaflet 568: Loudspeaker and telephone systems in RIC coaches – Standard technical characteristics, 3rd edition of 1.1.96
[3] UIC Leaflet 440: Public-address systems in coaches (RIC), 4th edition, December 2001
[4] IEC 62580-1:2015 Ed.1 Railway applications – On-board Multimedia Systems for Railway –Part 1 General Architecture
[5] IEC TS 62580-2:2016 Ed.1 Railway applications – On-board Multimedia Systems for Railway – Part 2 Video Surveillance/CCTV services
[6] EN 16334:2014 Railway Applications – Passenger Alarm System – System requirements
[7] EN 16683:2015 Railway Applications – Call for aid and communication device - Requirements
[8] EURA Regulation 454/2011 (1st TAP TSI) 13/05/2011
[9] EURA Regulation 1302/2014 (2nd LOC&PAS TSI) 01/01/2015
[10] EURA Regulation 1300/2014 (2nd PRM TSI) 01/01/2015