AUV System Description

Railway usage authorization system (called AUV, by its abbreviation in Spanish) is a Safe Train Control (STC) system provided by Alta Rail Technology (ART). AUV system's structure is based in multiple computers distributed software, connected to a local network, which allows the system to accomplish real-time centralized control, monitoring and train dispatch objectives.

AUV system architecture schematic is shown in figure 1.

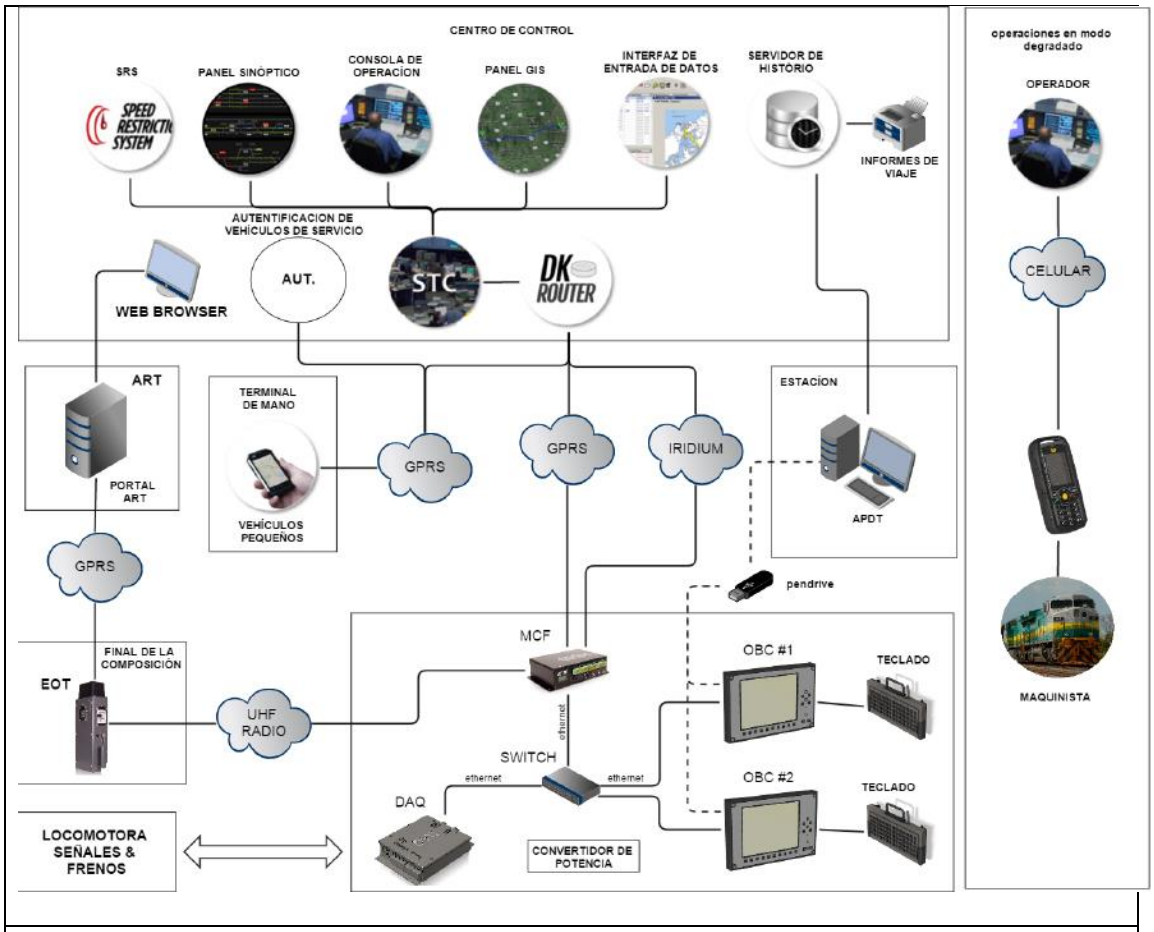

Fig 1 System architecture

As shown in Figure 1, AUV system could be separated in 3 main blocks:

- On-board cabin equipment
- Operational Control Center (OCC) components
- Degraded mode of operation and support vehicles equipment.

Detailed specifications about those main blocks are shown next.

1. On-board cabin equipment.

On-board equipment block is, essentially, a group of hardware components which implements communication between train Driver and the OCC. Those components are installed in order to sense and report some physical parameters to the OCC, where sensed values are stored in a database.

Main On-board equipment on the train are:

- 2 OBC terminals (On Board Computer) with keyboard.
- MCF (Communication Module).
- DAQ (Data Acquisition Module).
- EOT device (End Of Train).

OBC device is a heavy-duty Human Machine Interface (HMI) installed in driver's cabin for crew-OCC interaction purposes. In order to reach higher safety levels through redundancy, it is recommended to have two OBC units per locomotive. A screenshot of OBC interface is shown in Figure 2. Through this device the driver can take the following actions:

- Request for railway usage authorization
- Upload trip data
- Check self-positioning through GPS
- Communicate with the OCC
- Receive notifications in case of unauthorized railway section occupancy
- Inform stop action cause
- Check EOT device status.

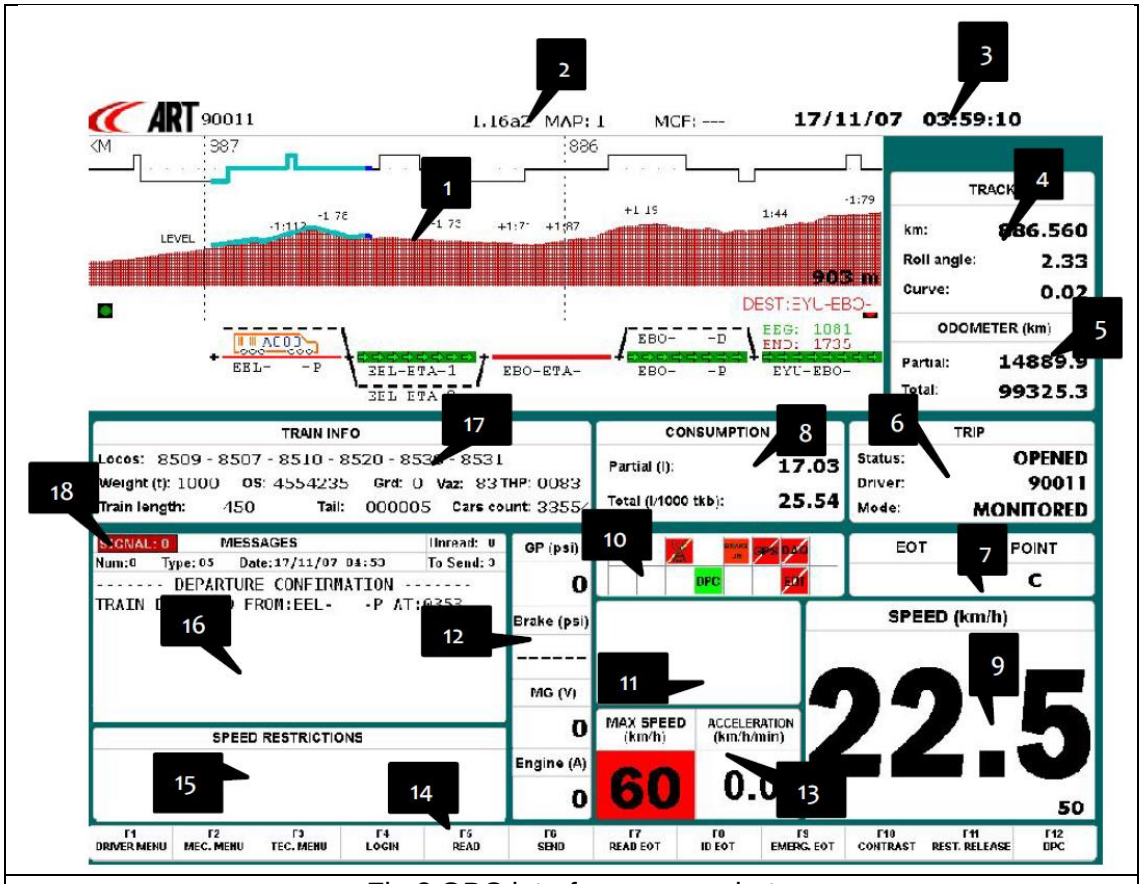

Fig 2 OBC interface screenshot

In Figure 2 some icons and relevant information are remarked:

- (1) Navigation screen
- (2) OBC version and map
- (3) Current date and time
- (4) Track information
- (5) Odometer
- (6) Trip information
- (7) Acceleration notch and EOT
- (8) Consumption
- (9) Current speed
- (10) Icons
- (11) Switch
- (12) Sensors readings
- (13) Acceleration and maximum speed
- (14) Keyboard shortcuts
- (15) Restrictions
- (16) Messages and menu
- (17) Train summary
- (18) Iridium signal Level
- (19) DPC counter.

Besides, OBC device stores the system's safety algorithms, which takes parameters such as GPS positioning, OCC authorization and calculates electronic fences and braking curves.

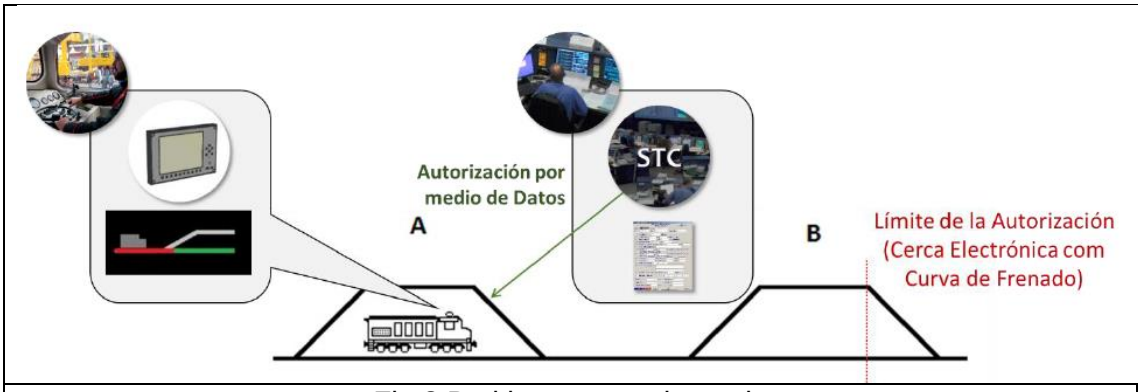

Fig 3 Braking curve schematic

DAQ device is developed as an interface with the locomotive signals and its tasks comprehend signal sensing and working as an actuator over some control parameters.

Particularly, DAQ device senses the following signals activation:

- Brake pressure
- Excitation current
- Generator voltage
- Engine temperature
- Horn
- Acceleration notch

This DAQ device, working as an actuator, also receives instructions from the OBC in order to activate locomotive brakes in case of breach of circulation authorization..

MCF module is a heavy-duty modem, suitable for hard railway environment usage. This module implements a redundant communication channel with the OCC over 2 GPRS (or 1 GPRS and 1 Iridium) links. Besides, MCF device receives signals sent by the EOT device, in order to prove train integrity.

EOT device is intended to be installed in the last convoy wagon for train integrity verifying purposes. In order to test convoy integrity status this device senses wagons pressure tube status. In case of out-of-range pressure sensing, or distance to last wagon larger than expected, this device sends warning signals to the OBC triggering alarms (sent to OCC) and activating emergency train brakes.

2. CCO components.

OCC components are, most of all, software components which implement dispatched trains management and tracking. This OCC software is composed by the following modules:

- Synoptic panel
- Speed Restrictions System
- GIS panel
- Data inquiry interface.

The Synoptic panel (Fig 4) is a real-time train location tool for tracking each convoy in all of the virtual circuits in which the railway system is divided. This tool is used by OCC staff for railway usage authorization assigning.

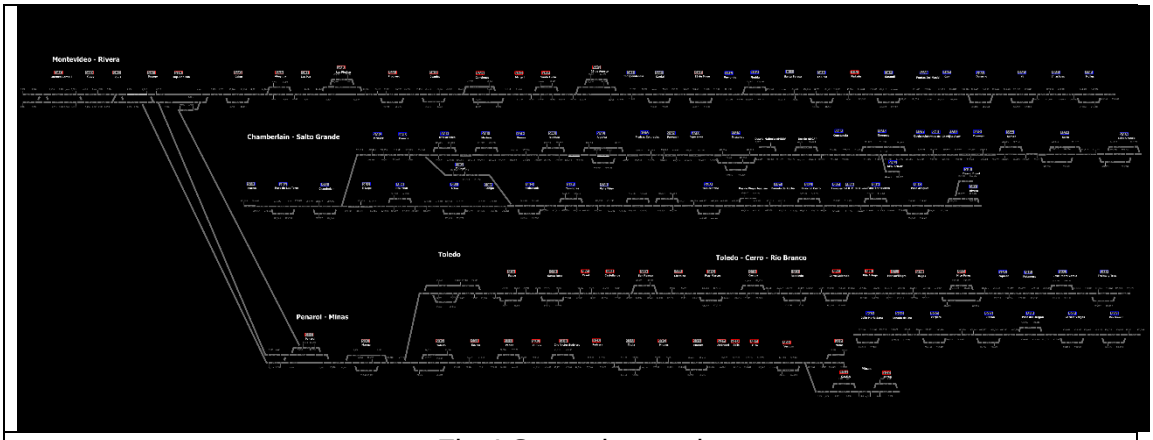

Fig 4 Synoptic panel

Speed Restriction System allows managing speed limits in real time for each section of the railway system considering the integration of track equipment.

The GIS panel shows real-time geo-referenced location of those locomotives which are logged in the system.

Data Inquiry Interface allows historical data searching in order to get past trains runs information.

3. Degraded mode of operation and support vehicles equipment.

This block is composed by the equipment needed in case of an emergency due to OBC or locomotive-OCC communication failures. For this mode of operation, there is a voice channel (cell-phone or radio) provided in order for OCC to communicate locomotives the relevant railway section usage authorization. Support vehicles usage, such as Road-rail vehicles, inspection or maintenance vehicles, is covered by this block as well, and it is mandatory for those vehicles to use a smartphone APP to receive railway section usage authorizations from the OCC.