CANopen panel-PC controls Italian trams

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Figure 1: 6000 series tram operating in Turin

The 6000 series tram is a modern vehicle operating in the city of Turin and Catania in Italy. It has security systems on-board, including an interactive diagnostic monitor installed in the driver's cabin. This monitor is a vital component of the tram and its malfunction causes the tram to become non-operative and requires the vehicle to be returned to the depot for maintenance. This monitor is not just a display as its name suggests, but an embedded computer with display capability that works as a HMI (human machine interface) for the driver.

The monitor previously developed by the tram manufacturer was afflicted by severe design issues. It had problems related to the environment (extended temperature range and humidity). Turin is a city with cold winters and hot summers while Catania is very hot in summertime.

In fall 2008, LVD Systems, the local representative of Janz Tec in Italy, proposed to the local transportation company (GTT) a monitor solution based on the EmView series from Janz Tec (Germany). The chosen 8-inch Panel-PC is based on ARM architecture running embedded Linux.

The diagnostic monitor was a one-to-one replacement of the previous device, requiring no modification to others sub-systems on-board to avoid complex qualification procedures. The former monitor communicated with the main supervisor computer through an EIA-485 line with a proprietary protocol, which encapsulates VT100-like graphical commands plus custom extensions and other tram status information. It also used physical push buttons to receive commands from the driver.

In order to make the EmView to become a replacement component, Linux with QT Embedded from Nokia was chosen as operating system. Real-time patches were applied to the Linux kernel in order to comply with the strict timing requirements of the protocol. Every incoming packet must be acknowledged after 2 µs from reception and not later than 5 µs. A missing acknowledge would cause the tram to stop for security.

After a complex work of reverse engineering LVD Systems completed the software and the first prototype was delivered to the customer. Physical push buttons were replaced by touch-screen buttons reducing the cost of integration and maintenance.

First units were sold to Turin City public transport company (GTT), later also Catania public transport company bought some units to replace former malfunctioning diagnostic monitors.

CAN-based solution

The CAN network has been selected to connect all the devices for the command-and-control system of the Torino city train. The software implementation is a ▷

Figure 2: The EmView panel-PC installed in driver's cabin

Figure 3: Tram diagnostic screen

custom protocol compatible with the CANopen specification (CiA 301). This allows the use of standard COTS (commercial off-the-shelf) CANopen devices as well as special custom devices for the specific needs of the city train. In order to reach this result a special SDO (service data object) has been implemented with a COB-ID (communication object identifier) compatible to the CANopen specification. Standard frame format (11-bit CAN-IDs) is used to communicate among devices. The supervisor/master of the system used the CAN interfaces (Vmod-FCAN) by Janz to interface all the nodes.

The used protocol is based on two communication services: Write PDO (process data object) and Read PDO. In order to keep under control all the devices and activate them, a loop query was generated by the CANopen NMT master periodically. Depending on the CAN bit-rate, this guarantees to detect occurred failures and satisfy the system requirements. Via the Em-View-8T/A400 monitor the operator may read the alarm status of each device in the system. ◀

Company background
LVD Systems offers embedded solutions targeted on transportation, industrial, avionic, telecom and scientific market. With more than 20 years of experience, the company develops hardware and software solutions based on customer necessities. The system integration solutions make use of COTS (commercial off-the-shelf) products.