Ground

Vehicle

Management System

Introduction

GVMS (Ground Vehicle Management System) is able to:

- Manage fleet of vehicles moving in airport, using a D- GPS and a UHF communication channel;
- show on the Surface Working Position (SWP) the vehicle positions identified by a label;
- allow the operator to set all the information relevant to the cooperative vehicles
- displays on board to the driver, the position of the vehicle;
- provide an aid for the maintenance through location, identification and presentation on board the vehicles and on dedicated GVMS position, of the airport area points that need maintenance (points of interest), signalled by the drivers.

Vehicle section

Each cooperative vehicle has to be equipped with a unit on board, called ACE / M (Argos Communication Equipment/Mobile) that allows:

- to calculate the GPS differential position of the vehicle according to the data received by the GPS system and to the data of differential correction transmitted on the communication channel by the TWR;
- to transmit on the communication channel a data report for the identification and location of the vehicle.

Figure 1: On board component

On each unit 4 functional buttons are available to allow the driver to use them for sending predetermined signals to the TWR. Such signals and those eventually sent by the TWR to the driver are displayed on an alpha-numerical panel too.

An acoustic alarm is installed inside the unit that sends acoustic signals when the following events occur:

- entrance/exit of the unit to/from the GVMS system;
- entrance/exit of the equipped vehicle to/from defined areas (i.e. for instance the manoeuvring area.

ACE has 4 diagnostic LED to inform the driver about the operative status of the unit itself.

If the equipped vehicle exits the airport area or does not receive information from the TWR, the system is set in "stand-by", and does not transmit any data on the communication channel. In this way transmissions on the UHF frequency out of the airport area are avoided.

The unit can be installed on board in three different configurations:

- "fixed", the UHF and GPS are installed on the roof of the vehicle while the on board unit is fixed inside the vehicle; the components are powered by the vehicle battery , after switching on the car dash board; such installation is recommended for vehicles that normally circulate in the airport area;

Figure 2: Fixed installation

- "configured", GPS and UHF are installed on the roof of the vehicle; in the vehicle a slide is foreseen for the unit installation; the components are powered by battery of the vehicle, after switching on the car dash board; such installation is recommended for vehicles that normally circulate in the airport area but that are seldom used;

Figure 3: Temporary installation

- "temporary", the GPS and UHF, fixed on magnetic mounting base, are installed on the roof of the vehicle and the unit is set temporarily inside the vehicle; the unit is powered through a lighter connector ; such installation allows vehicles that do not belong to the airport to perform activities work within the airport, to be easily equipped and thus controlled.

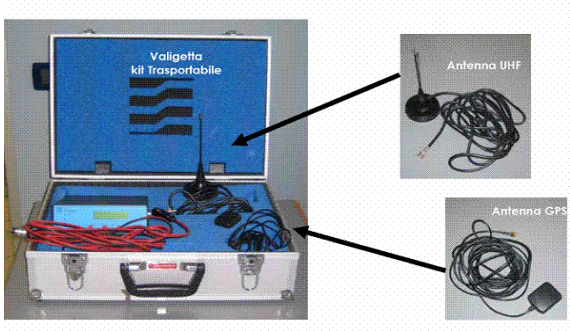

Figure 4: Temporary installation

To send to the Ground Controller the correct ID associated to a vehicle with a temporary installation, it is possible to activate the call sign assignment procedure using functional pushbuttons directly on board.

Figure 5: On board call sign

Besides the on board unit, the vehicle can be equipped with a touch- screen display, that shows the driver:

- the vehicle actual position;
- the missions position of interest depending on the vehicle category (i.e. for SAR category the points that need maintenance) in order to reach these locations as soon as possible;
- the messages to send to the TWR and the ones that the vehicle receives from the TWR.

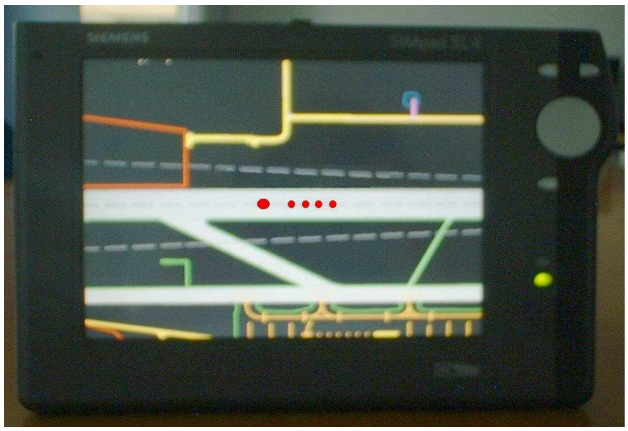

Figure 6: On board display

The display powered by the vehicle battery is connected to the ACE/M through a serial line . It can be switched ON manually but there are two possible procedures for switching OFF :

- manually, by pushing the ON button again;
- automatically, few minutes after switching the car off.

Communication channel

The communication channel used by the cooperating vehicles and the TWR is a 430 ÷ 470 MHz radio channel with 12,5 KHz, including eventual guard bands .

The management of the communication channel uses a half-duplex mode through the TDMA (Time Division Multiple Access) access technique in order to:

- transmit from the TWR service/alert messages and differential correction data;
- transmit from each vehicle the GPS reports with D-GPS position, vehicle ID and possible points of interest identified by the driver.

TDMA technique with static allocation guarantees the vehicle to use the channel without conflicts.

It is possible to guarantee the availability of the communication to a fleet of more than 100

vehicles, through a "super-frame" management of the channel, setting the refresh time according to the vehicle category and speed and the actual zone in which the vehicle is moving.

Data processing section

The processing section is dedicated mainly to:

- calculate periodically the differential correction data;
- receive GPS report sent by cooperative vehicles actually in operation;
- transmit commands, service messages and differential data correction to on board units.

Such functions are performed by the GSE (Ground Station Equipment) that it is composed by a GPS_BS differential station, called GPS Base Station, and by ACE/T, that is totally identical to the ACE/M installed on vehicles.
GPS_BS and ACE / T can eventually be in redundant configuration.

Figure 7: Ground Station Equipment

The GPS reports received are processed by the GVP server (Ground Vehicles Processor) where the SW GVT (Ground Vehicles Tracker) module runs. The processing consists in:

- label correlation that allows to associate to the received report the vehicle identification stored in the system database called DBVM (Data Base Vehicles Management);
- position correlation that increases the precision of the position.

The processed reports are transmitted according to a specific protocol:

- in case of stand-alone configuration, to the Display Section, to visualize GPS tracks;
- in case of system integrated in A-SMGCS, to the Multi Sensor Fusion (MSF) for the fusion of the tracks coming from SMR radar and from other systems.

Anyway, if a report is not received (for instance due to temporary fading on the radio channel), the GVT is able to determine the position of the vehicle through an extrapolation algorithm based on the last kinematic data and the last positions of the vehicle itself.

If the report contains the activation state of an ACE/M functional button, the GVT has moreover the following tasks:

- to notify the driver, by a message transmitted on the radio channel, that the signal has been received correctly;
- to determine which signal corresponds to the functional button pushed, according to the information of DBVM;
- to store the message received.

Display section

The Display section HMI (Human Machine Interface) through which the operator can interact with the GVMS system. The HMI is organized in 2 menus :

- “DBVM” menu, used by the operator to define all the information referring to the cooperative vehicles;
- “operative” menu that shows to the operator the airport vehicle traffic and in case of system integrated in A-SMGCS the vehicle tracks will be displayed also on the SWP enabled.

The DBVM menu allows the operator to define also:

- the vehicle Category , where category stands for a class of vehicles dedicated to a specific airport service. (i.e.. Follow Me, SAR, etc);
- the Airport Functions, where airport function stand for a signal concerning one or more categories that can be transmitted by the

driver (for example: an “alert” signal is valid for all categories, but the “hole” signal is typical for SAR service);

- the on board units (ACE), where the characteristics of the available units are described.

Using commands from menu it is possible to:

- define the vehicles that belong to a specific category, showing ID and type;
- indicate each category with a specific colour to represent the vehicles belonging to it on the HMI;
- define a symbol for each airport function to be displayed on the HMI of point of interest signalling by the driver;
- associate the vehicle belonging to a category, to the on board units.

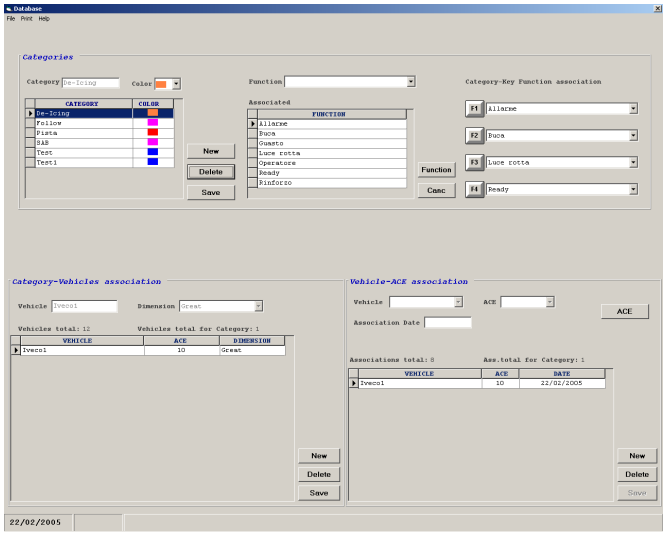

Figure 8: “DBVM” menu

In the operative menu, such informations are used to show on the airport map the moving vehicles and the points of interest signalled by the drivers.

In particular the vehicle positions are represented by coloured icons according to the category they belong to and are labelled by ID stored in the DBVM. Through manual commands, the operator can:

- enable/disable the presentation of one or more vehicle categories;
- set the number of points history to show, where point history stands for the last positions of the vehicle.

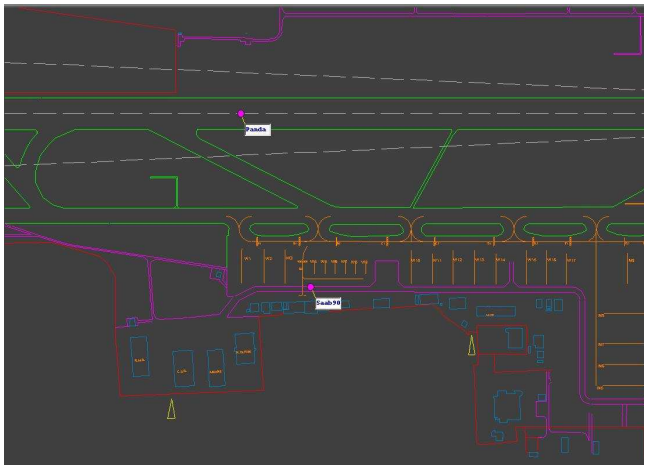

Figure 9: Operative menu (I)

Also the signals are represented by symbols defined in the DBVM and by elementary commands it is possible to:

- provide filters for subsystem presentation of detected signals;
- delete signals no longer useful.

For every point of interest, through a colour code, the degree of accuracy of the position can also be shown, that depends on the vehicle speed at the moment in which the driver has sent the signal.

Figure 10: Operative menu (II)

In case of integration with A-SMGCS systems, the GVMS system contributes to the localization of the vehicles that will be integrated together with the aircraft tracks detected by the surface radar .

GVMS has been integrated with the ASMGCS developed by Selex S.I., Thales and Transtech.