GROUND SURVEILLANCE

A means to support separation of aircraft and vehicles during low-visibility conditions and in areas obstructed from the tower view has always been rated high in the air traffic controller's wish list

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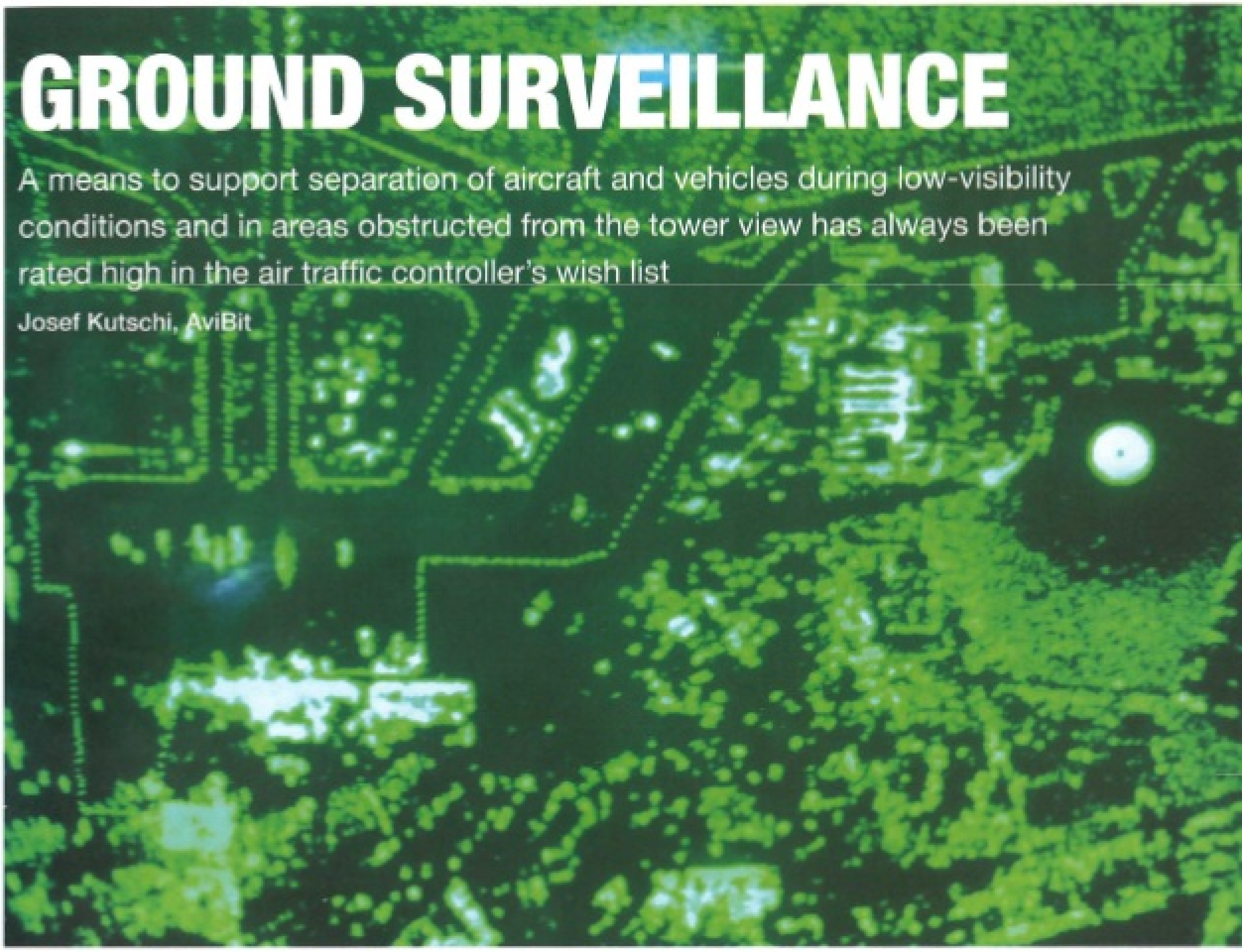


Recently the growing air traffic level at some airports has reached the limit of what can reasonably be handled in a safe and efficient way. A common way to handle the saturated traffic flow at high-density airports is to build new runways and add taxiways to support the busiest movement areas. But then the airport becomes more complex and difficult to overview. The challenge to operate a complex and growing airport becomes very evident during disrupted operations and adverse conditions.

To overcome some of above challenges airports around the world have relied on surveillance technologies, which use a diverse set of sensor types with various system algorithms to extract readable and usable information to the air traffic controller's benefit.

Primary radar

In the beginning of the era of airport ground control surveillance, systems were predominantly based on primary radar input (non-cooperative sensor technology). Surface movement radar (SMR) systems displayed a rudimentary raw radar output picture on a single screen placed in the ATC tower cab. The radar output processing included filtering to reduce radar signal clutter and noise and remove reflections from stationary objects such as buildings and signs. This gave controllers a fairly clear picture of all moving objects in the radar coverage area.

A trained and experienced controller could in many cases distinguish vehicles from aircraft in the raw radar display based on displayed radar echo size and movement trajectory and velocity. To verify the identity of a specific mobile (aircraft or vehicle) the controller had to verify the position by communicating with cockpit crew or driver over radio and match the given position information with actual raw radar echoes displayed in the controller working position. Sometimes the radar detected grass moving in the wind or other non-wanted information as dynamic data and the movement was not possible to filter out and was subsequently displayed as one or several moving objects.

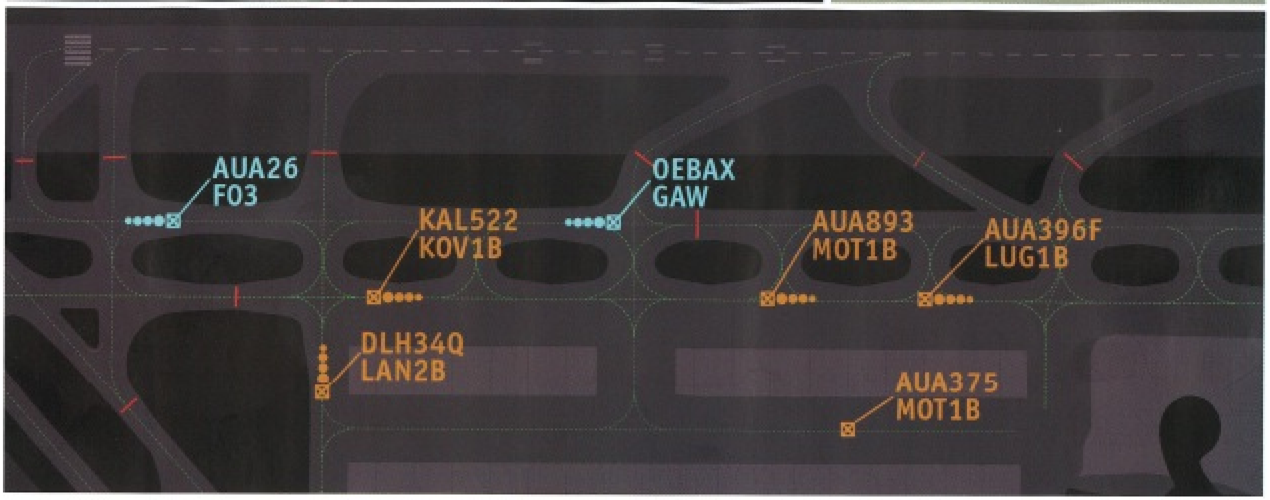
These shortcomings were not acceptable for separation of ground traffic that was often clustered in groups and operated close together. At this time SMR systems were not safety approved as a standalone tool for separation of ground vehicles and aircraft, but merely used operationally as a support tool for an overview of the traffic.

Today the raw radar data is further processed and used as one channel of many to detect the positions of mobiles (aircraft and

Opposite: Old raw radar

Left: Modern A-SMGCS

Below: Track symbol and label



vehicles), which are displayed as synthetic and tracked positions in the form of a symbol over a map of the airport. Sometimes controllers prefer to see the raw radar presentation of the mobiles in the background of the synthetic position symbols. The raw radar presentation in modern systems is also synthesised and emulates the look and feel of the old radar output display.

Supplemental sensors

In the late 1990s and early 2000s a new ground surveillance sensor array became popular for use in conjunction with and to augment the primary ground radar sensor. While the primary radar technology sent a radio pulse that was reflected off objects in its line of sight and displayed as an echo, the new ground sensor array used a new way of locating an aircraft, vehicle or stationary emitter by measuring the 'time difference of arrival' (TDOA) of a signal from an emitter at three or more receiver sites. This system is now commonly known as multilateration and is used both for local coverage of ground traffic at the airport and for airborne traffic in the close vicinity of the airport – known as local area management (LAM).When configured for surveillance of airborne traffic over large areas it is known as wide area management (WAM).

Multilateration is a cooperative sensor system, which communicates with emitters such as aircraft or vehicle mode A/C/S transponders. As a consequence of the use of transponders, the multilateration system is not only capable of calculating a high-resolution position of the emitter but is also able to receive mobile identification information from the transponder.

Depending on the mode the transponder is operating in, and the capability of the multilateration system, it is also possible for the system to receive other data such as GPS position data together with identification data. The multilateration system gives the much needed information to get a positive identification of an equipped vehicle or aircraft together with a high-accuracy position of the mobiles for processing in the ATC surveillance system.

Modern surveillance systems such as Advanced Surface Movement Control and Monitoring Systems (A-SMGCS) use both primary radar and multilateration arrays to cover the complete airport movement area to control and monitor mobiles. The cooperative and non-cooperative sensors provide position data, which in the A-SMGCS is tracked and fused to provide a unified picture with position and ID of all equipped airside traffic.

Safegate docking guidance system

Correlation

With automatic positive identification of aircraft and vehicles the A-SMGCS is able to connect the real time surveillance positions with flight-plan information. The flight-plan data provides information such as aircraft ID, flight number, aircraft type, weight turbulence category, inbound/outbound way points and parking position. Since the positive identification is now available in the received position data, the synthetic position can be correlated with the correct flight plan by a simple process of matching the flight plan ID with the correct surveillance position ID. When the surveillance position track is correlated with a flight plan, the relevant flight plan information is shown in a label attached to the track symbol in the A-SMGCS display.

Blind spots

Even with modern technology there are still areas of the airport where the primary radar and the multilateration sensors struggle to provide a high-quality representation. Such area may be close to passenger boarding bridges and in narrow passages between buildings, where the primary radar line of sight is in a radar shadow or the multilateration communication and/or primary radar signal is reflected several times before it is received, often referred to as multipath effects and ghosting. Normally the areas with questionable quality are masked out in the A-SMGCS display and will not give any position data to the air traffic controller.

These blind spots, especially close to the gates, create a challenge to the A-SMGCS in providing automatic correlation of flight plans with outbound traffic. In many cases the correlation is made after push back, when the aircraft is clear of the blind spot, or by manually dragging and dropping the flight-plan information to the track in the A-SMGCS. This is a shortcoming that controllers eventually become used to.

In the era of A-SMGCS advanced routeing and guidance, where mobiles are given a representation of their cleared route by automatically controlling the airfield lights from the A-SMGCS and guiding the mobiles with green centreline lights, the blind spots are no longer acceptable. A fully automatic routeing and guidance system demands high-resolution coverage from gate to runway and runway to gate.

It is in this respect that a new sensor capable of providing the needed coverage at the gate area is most welcome.

Gap filler sensor

In late 1990 Safegate Group started delivering its new laser-based Docking Guidance System (DGS), which provides information to pilots for parking at the passenger boarding bridge. The DGS is positioned in clear view of the pilots, either on a pole or directly at the terminal building at each gate. It consists of a large display showing the remaining distance to the stopbar and if any steering correction is needed to keep the aircraft centred on the lead-in line. The distance measurement is made by the inbuilt DGS laser that continuously scans the incoming aircraft during the docking procedure.

Internally the laser sensor system provides a three-dimensional picture for processing that can identify the aircraft type and stop the docking sequence if it does not match the setting of the boarding bridge. This safety feature is essential to avoid aircraft hitting the bridge during docking. Before and during docking the DGS is able to scan for debris such as tow bars, bags and baggage carts, which are not allowed in the safety zone. If any debris is found the DGS will immediately stop the docking and alert gate/ramp personnel.

The laser scans the ramp area in front of the gate in a wide enough angle to support the docking 80-100m out from the stopbar. This is normally the distance from the terminal building within which primary radar and multilateration sensor data is filtered out from display in the A-SMGCS to avoid unwanted tracking of false targets. The laser does not suffer from multipath effects and ghosting and is a perfect complement to support tracking of inbound and outbound aircraft in the gate area.

At the gate area the laser sensor can be used in parallel with the docking guidance process and provide ASTERIX data that is fed into the A-SMGCS tracker and fusion processor. Most Safegate DGSs are connected to the airport FIDS or the AODB, where the DGS automatically provides real-time off-block and on-block times. The DGS also receives information from the FIDS or AODB about the aircraft type, aircraft ID and expected time of arrival or departure. With this information in the system, Safegate is able to provide not only the position track data but also correlation of flight-plan data directly to the AviBit A-SMGCS (AviGROUND) in the form of ASTERIX data for further processing in the tracker and fusion part of the AviBit system.

With the Safegate DGS used in parallel to the docking function as a gap filler, with none of the shortcoming of present surveillance technologies at the gate area, plus the features of the advanced AviBit tracker and fusion unit, we now have a system capable of providing full surveillance coverage at the airport ready to support advanced features such as fully automated airfield lighting routeing and guidance. ❖