ENHANCED A-SMGCS

A combination of A-SMGCS and electronic flight strips to enhance safety nets far beyond A-SMGCS Level 2 Definitions

Konrad Köck, AviBit, Austria

Electronic Flight Strip System DIFLIS as installed at Vienna Tower. Photo: Austro Control, used with permission

Safety nets for ground operation are based on the knowledge obtained from a range of information that describes the current traffic situation at an airport. Therefore controllers use such tools as flight strips, approach radar, A-SMGCS, stop-bar switches, etc, which are operated independently more or less of one other. No single system can provide the complete picture regarding the traffic situation and specifically the state of each individual aircraft. Critical information such as clearances is either unavailable or isolated within individual systems. In particular during peak traffic hours there is a higher risk that the ATCO will not be able to react correctly in critical situations.

Enhanced safety nets can be implemented by integrating information from various systems, so A-SMGCS can further contribute to ensuring safer ground operations. This article describes an integrated solution through the combination of A-SMGCS and digital flight strips, which enables current A-SMGCS alerting mechanisms to go far beyond A-SMGCS Level 2 definitions.

State-of-the-art solution

In general a controller will work with various sources of information to achieve the required situational awareness. These sources are usually:

- Approach radar (ASR);
- Flight strips;
- A-SMGCS;
- Stop-bar control panel;
- Various others.

The controller will normally use surveillance tools to observe the present traffic situation while using paper flight strips as a redundant representation of the current situation and also for planning purposes. Moreover flight strips are used for conflict resolution and coordination.

These systems are usually not connected with one other, so the controller has to combine data from various sources in his mind to get an overall picture of the traffic situation. In situations where traffic is either light or medium, as well as during good weather conditions, this task can be adequately managed by the controller. However as soon as special cases occur, such as low visibility and high traffic peaks, the higher work load means that the controller is more likely to overlook potentially critical situations.

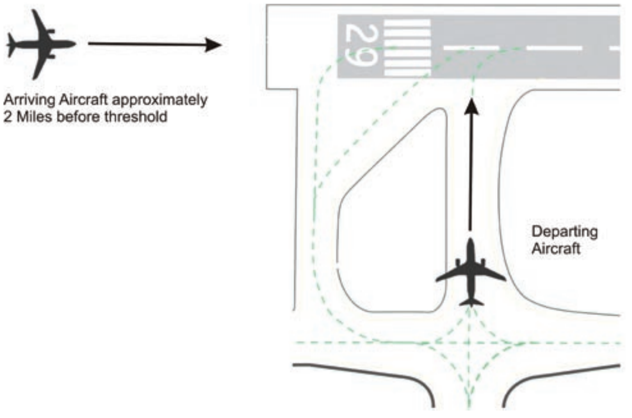

Figure 1: Runway Incursion. A typical alarm situation for an A-SMGCS

Naturally this risk can be greatly reduced through the safety nets built into the various systems. However these isolated safety nets are quite limited as regards the type of alarms they can trigger. This is due to the fact that they usually do not have the complete traffic data available. But by combining the traffic data from the various systems and implementing a common safety net, it is possible to extend and improve existing alarms, as well as implement new types of alarms.

This fact is well illustrated by an example for a typical A-SMGCS (Figure 1). As indicated, a departing aircraft will be detected by a conventional A-SMGCS as soon as it moves onto the runway if another arriving aircraft is approaching on the same runway. If the arriving aircraft is closer than two minutes (configurable), then an alert will be provided to the controller, who then has less than two minutes to resolve the problem.

When data from A-SMGCS and digital-flight strips are available, advanced alarm processing becomes possible. The A-SMGCS detects that the departing aircraft starts to line up – i.e. it starts moving from the holding point towards the runway. At this point, when the clearance status from the digital flight strip system is available, the safety net can immediately issue an

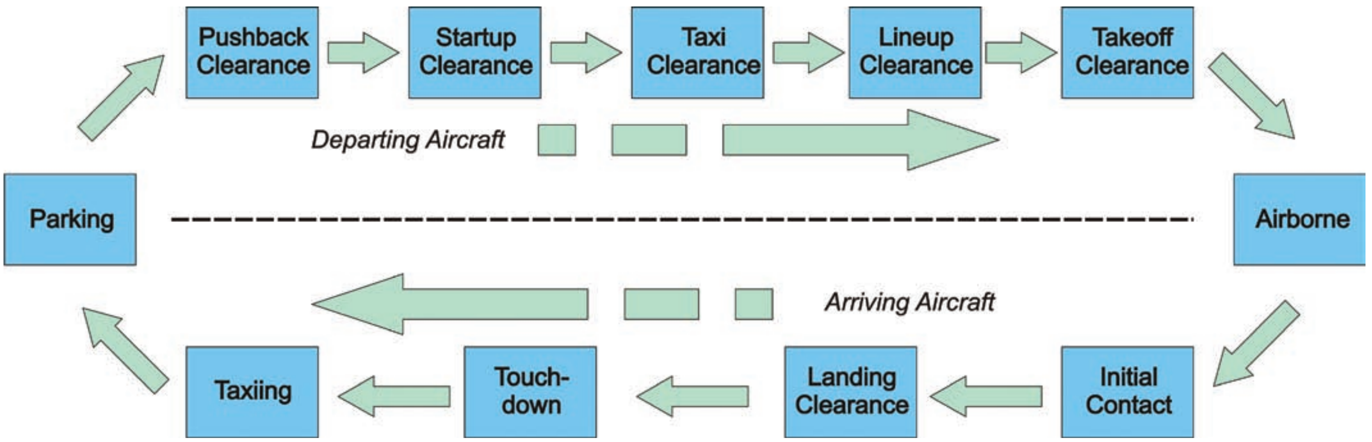

Figure 2: Various states of departing and arriving aircraft

alert (and not just if an arriving aircraft is already very close to the threshold). This provides the controller with considerably more time to react and to solve such a critical situation.

The state of an aircraft

In 95 percent of all cases aircraft handling on the ground follows the workflow illustrated in Figure 2. Starting at the parking position, an aircraft performs the following steps (simplified):

- Parking – the aircraft is at its parking position and no action is required by the controller.
- Pushback clearance – the pilot calls the controller and requests pushback. The controller approves pushback.
- Start-up – the controller approves start-up.
- Taxi – the controller approves taxiing.
- Line-up – the controller approves line-up.
- Take-off – the controller approves take-off.

Finally the aircraft is airborne and further controlled by approach or en-route units. As soon as it approaches the next airport, the workflow in the lower part of Figure 2 will apply:

- Initial contact by the pilot;
- Landing clearance issued;
- Touch down;
- Taxiing, controller provides taxi clearance;
- Parking.

Naturally numerous exceptions and shortcuts apply to the workflow shown and it will also differ from airport to airport. However the basic principle stays the same and AviBit's considerable experience confirms that in normal cases approximately 95 percent of all flights follow the defined workflow.

Digital flight strip system

To support such a work-flow as that described above, controllers need an instrument that will allow them to enter clearances, as well as move a flight (or flight strip) through a given workflow. One instrument that will enable this is DIFLIS – the Digital Flight Strip System by AviBit.

To support controllers in their daily tasks, DIFLIS includes a configurable predefined workflow (similar to the one described in Figure 2) that empowers the controller to move a flight strip from its current state to the next state as defined in the workflow. For example, picture a situation where a flight has performed its pushback and is now waiting for taxi clearance. In such a situation the controller simply needs to press an 'action button' and the system will update the internal state of the flight. The action button is on the right-hand side of each strip (See Figure 3, Buttons labelled LUP (lineup), TCL (taxi clearance), PARK, etc).

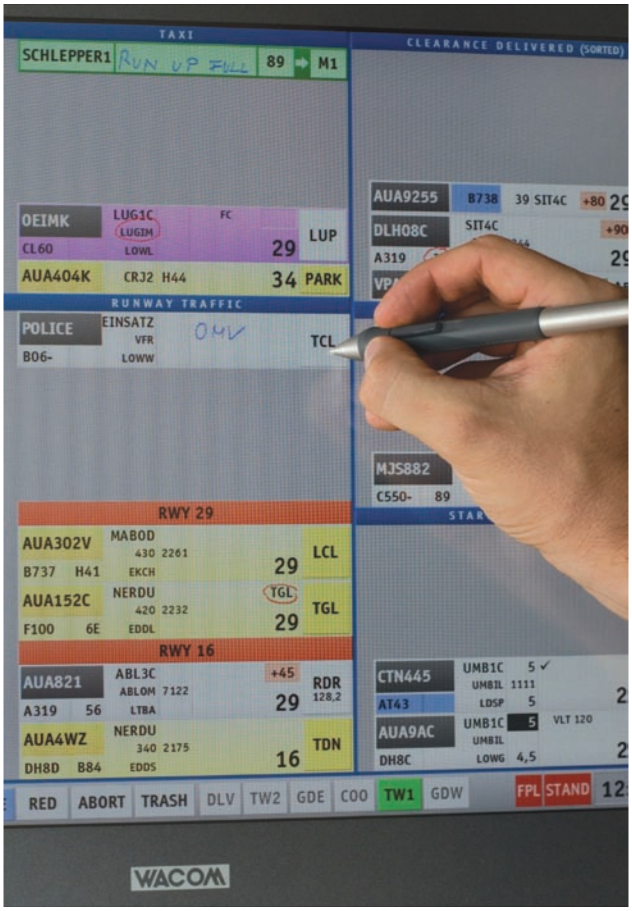

Figure 3: Digital Flight Strips System DIFLIS operated with pen input

DIFLIS is a standalone system that already includes safety features designed to assist the controller in both seeing and avoiding critical situations. These features only consider the state of a flight in the workflow and the bay where the strip is currently located – they do not consider data from any other source.

The following list of configurable digital-flight strip safety net features is just provided as an example:

- Moving a strip into the Taxiing Bay is only possible after giving a taxi-clearance.
- Taxi-clearance is only possible after push-back clearance.
- No landing clearance is possible without initial contact.
- Trying to issue a landing clearance will provide a warning when there is a vehicle strip in the runway bay.

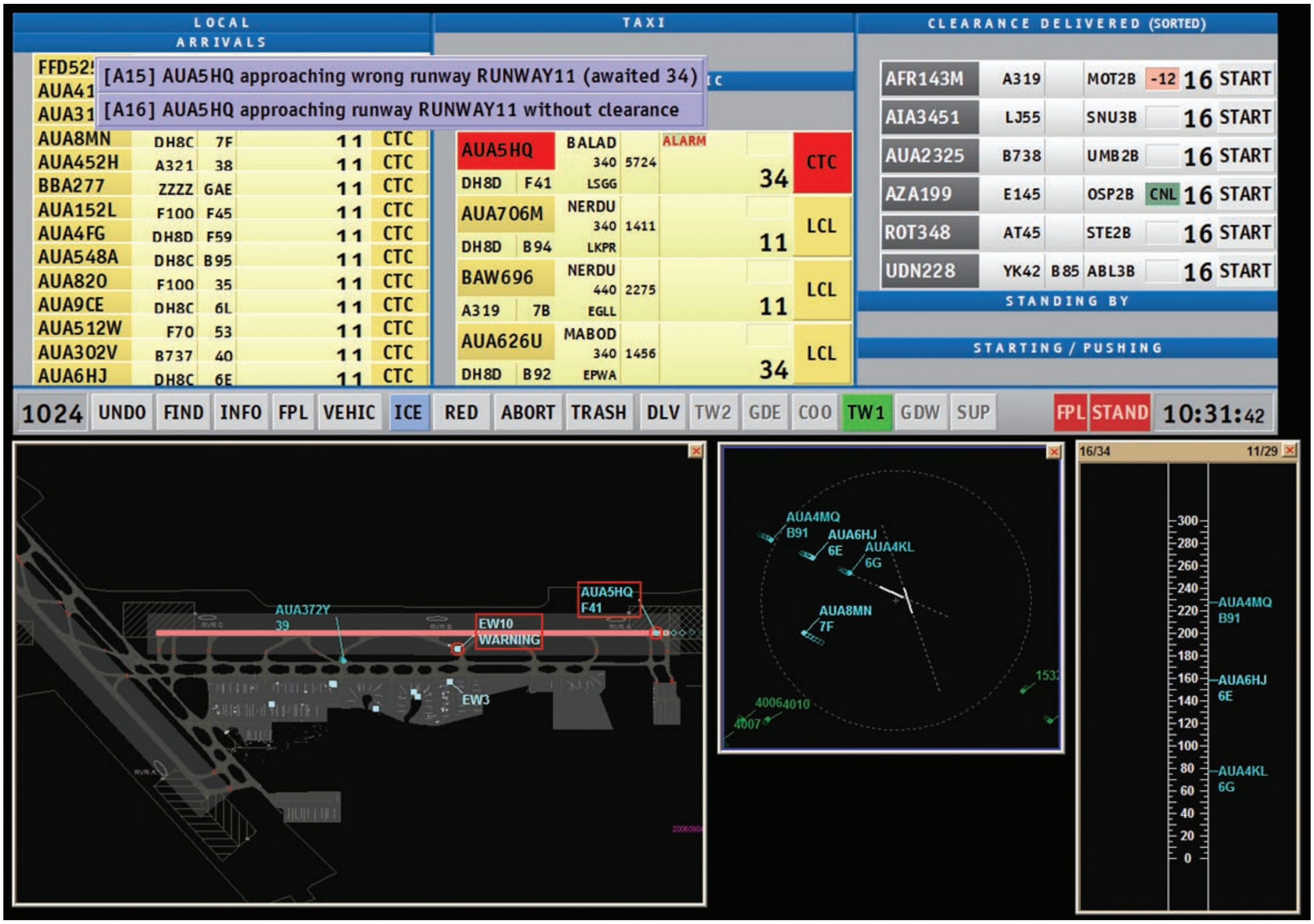

Figure 4: Combined EStrips and A-SMGCS Alarm indicated by a highlighted label on the A-SMGCS and highlighted call sign on the flight strip

A-SMGCS

The AviBit A-SMGCS as a standalone system already includes safety nets that go far beyond the definitions of Eurocontrol A-SMGCS Level 2 specifications. The following list provides an example of the safety net features of the standalone A-SMGCS:

- Aircraft on a restricted area: The A-SMGCS enables the ATCOs to define arbitrary restricted areas (for example construction sites). When an aircraft taxies into such an area, an alarm is triggered.
- Vehicle on a closed-area: Same as above, except for vehicles.
- Vehicle on an arrival protection area: The arrival protection area comprises the runway safety-strip, including the ILS protection areas. When a vehicle is located within this area while an aircraft is approaching, an alarm is triggered.
- Arriving aircraft and another aircraft on the arrival protection area of the landing runway: An aircraft is in the arrival protection area while another aircraft is approaching.
- Multiple line-up: Two aircraft are lining up for the same runway.
- Arriving aircraft and another aircraft on an intersecting runway: This case is for intersection runway configurations. Checks take place to ensure a departing aircraft on one runway has a certain separation from an aircraft arriving on the intersecting runway.
- Departing aircraft and another aircraft on an intersecting runway: Two departing aircraft on intersecting runways are checked.
- Stop-bar crossing: This alarm is triggered when an aircraft crosses a red stop bar.

The AviBit A-SMGCS distinguishes between 'hints' and 'alerts'. A hint is an indication on the HMI that a special condition has occurred and is also known as a Stage 1 Alert in common A-SMGCS literature. The hint display on the A-SMGCS HMI is designed to be visible but not disturb controllers during their work and it is down to the controller to deal with the hint. Unobtrusive colours are used on the HMI to indicate hints. An alert is a strong indication (red colour) on the HMI that confirms that a special condition has occurred. It requires immediate attention on the part of the controller.

Safety nets using combined information

The following list describes some of the extended safety net features that have been implemented in the integrated A-SMGCS/ Digital Flight Strip System:

For outbound flights

- Aircraft pushes back without clearance: The A-SMGCS detects a pushing (moving) aircraft and if no clearance has been provided, the system warns the controller. No standard A-

SMGCS can do this if it is unaware whether or not a clearance has been provided to the pilot.
• Line-up without clearance: The A-SMGCS recognises whether an aircraft starts to line up. If no clearance has been provided, the system triggers an alert.
• Take-off without clearance: Again the A-SMGCS detects when an aircraft starts its take-off run. If no take-off clearance has been provided, the system will warn the controller accordingly.
• Aircraft taxis to the wrong take-off runway: As one of the most important items, the electronic strip holds the planned take-off runway. If the A-SMGCS detects that an aircraft has been moved to the wrong runway, an alert will be generated.

For inbound flights

• Aircraft approaching without landing clearance: The system detects arriving aircraft by the application of radar (ASR) data. When the aircraft is ILS-aligned, the system checks from the flight strip if a landing clearance has been provided, and if this is not the case the controller will be warned accordingly.
• Wrong landing runway: From ASR data the A-SMGCS detects the runway on which an aircraft is approaching. If this runway does not match the runway for which it has been cleared, an alert will then be generated.

Vehicles

• If a vehicle enters the runway and the controller has no vehicle strip or no clearance has been provided, an alert is generated.

Whenever an alert occurs, the system highlights both the label on the A-SMGCS and the strip on the Digital Flight Strip System. This ensures that the controller will be able to react properly and quickly make the right decision. Finally this reduces the controller's work load and increases safety (see Figure 4).

Implementation

AviBit has integrated appropriate interfaces for its A-SMGCS (ACEMAX) and Digital Flight Strip (DIFLIS) products to integrate them into a common system. Nevertheless both remain independent and this means they do not necessarily rely on one other. Since all systems need to use data that describes the state of aircraft, both of them share a common flight database (FD).

The AviBit Alarm Checker is the heart of the safety-net logic. It receives all flight plan updates from the FD, containing the basic flight plan data as well as all relevant flight events and the current flight status. In addition the Alarm Checker can be configured online for various operational modes that will change the behaviour of the safety net to account for all different weather conditions (e.g. low visibility procedures (LVP), NON-LVP), etc. All HMIs use these alarm messages to highlight the associated aircraft accordingly.

Open FD interfaces

Third-party products can be accommodated in this scheme by providing them access to the FD. For this purpose an open FD interface is defined, enabling a standardised access to all FD data. Therefore third-party products can either be used to import events into the system or to use the alarms created by the safety-net. This allows the basic concept to be extended to A-SMGCS and digital flight strip products from other vendors. ❖