Information Needs in Flight Monitoring:

A Tool in Aviation Security

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Abstract

The Next Generation Air Transportation System security concept introduced flight monitoring as a part of risk management and shared situational awareness. Information on the aircraft performance, its flight trajectory, and the onboard situation with people and cargo are all part of the flight monitoring. This information is required to manage both an Air Traffic Management (ATM) emergency and a security event. That information today is distributed among many operators in the system: air carriers, air traffic and air security and defense operators, and the aircraft. Sharing this information is currently dependent on manual interactions of various organizations that have data on a flight and usually occurs during the event. Avionics could provide a more meaningful picture through automatic updates or in response to interrogation. For better risk management and more complete situational awareness, the aircraft could share status that goes well beyond what is required for air traffic management alone. For example automated emergency declarations could include the type of emergency such as 'cabin depressurization.' These indications may help explain erratic behavior by a flight and might quickly separate routine ATM events from security events. This paper is intended to initiate a dialogue within the community on the potential role of avionics to be used as a tool in aviation security.

Background

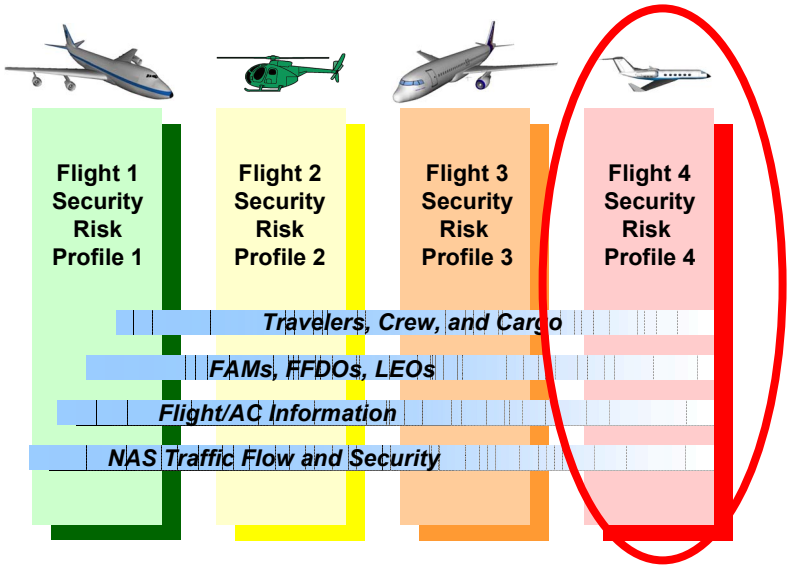
A concept of "flight monitoring" was introduced in the Next Generation Air Transportation System (NGATS) as part of risk management and shared situational awareness. Because events unfold real-time, it is not possible to quickly distinguish aircraft emergencies or air traffic management (ATM) situations involving the safety of a flight from security incidents involving a possible attack. With heightened concern for aviation security, decision making for security and air transportation management are now inextricably linked.

Situational awareness developments in the air traffic management community are focused on providing the flight crew information on surrounding flights, terrain, and weather that matches the picture held by ATM. The beginning of situational awareness according to the Department of Defense Joint Vision 2020 is each pilot being able to see on his digital cockpit display information captured by his own radar and those of his cohorts. Flight monitoring assumes a broader understanding of why information is to be shared and raises questions of what types of information should be available through avionics. John Stenbit observed shared situational awareness requires "each command post be able to tap the web for information particular to its needs as opposed to having someone else

decide which information to send it, as is now the case in broadcast systems." Broadcast capabilities and cockpit displays are entering service in some airspace. Now is the time for aviation community to start the dialogue on the future roles of aircraft systems and avionics in the flight monitoring concept in order to better aviation risk management and to enhance shared situational awareness.

Flight Monitoring Approach

The premise of flight monitoring is a "profile" of the risk posed by a flight is assessed and updated. Much of the information comes from sources and sensors external to the aircraft used to infer the flight's intent. When a flight deviates from its profile held by command centers on the ground, adjustments reflect not only the current situation but any uncertainties. Concerns about these gaps or contradictory information create a "flight of interest." As events surrounding a flight of interest unfold finer understanding of the flight path and circumstances on board are needed for informed decisions.



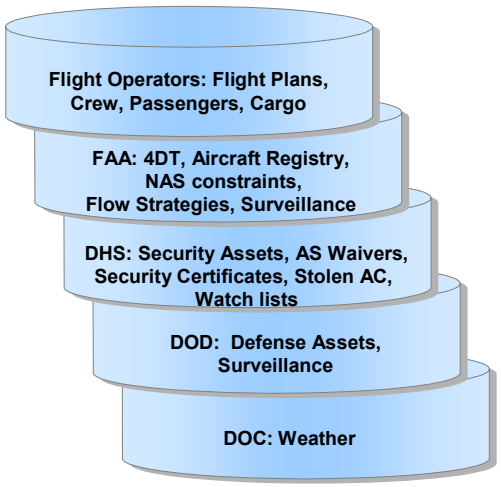
Data sources external to the aircraft can only be used to infer what is happening on board. More meaningful data may be collected on multiple channels originating on board the aircraft including avionics reports to ATM, air carrier flight communications, or air marshal reports. The next section explores the information aircraft could broadcast or send in response to interrogation to provide a truer picture for a flight of interest.

Integrating the Flight Profile

Increased sensitivity to potential threats may create greater disruption to the ATM operation, unless decision makers can quickly acquire the data needed to properly assess the situation and capture a true profile of the threat. The distinction between responding to an ATM event and a security event is not always clear a priori. Currently the information required to manage either type of event is distributed among many operators in the system: air carriers, air traffic and air defense and security operators, and the aircraft. The use of ATM bandwidth should be reserved to the task of safely separating and landing aircraft. The line between information to manage a flight in crisis and data to manage the security implications of that flight is blurred. A shared understanding of what

data is to be requested through the different available channels is needed as part of a unified command structure for assembling and managing flight profiles and flights of interest. For example, the flight course and flight management system status including mechanical details may become part of the ATM communications, while cargo hold and cabin sensors for explosives, radiation, biological, chemical and nuclear weapons would report through a different communications channel. Once all the data needed for security is reported, the results must be reassembled for use in managing both the ATM and security consequences of a flight of interest. The next section explores what might be the ATM avionics role in delivering not only 4-dimensional trajectories, but other aircraft status, surveillance and constraint data.

Information Sources Examples Supporting The Aviation Security Mission



Avionics Role in Completing the Picture

Today's broadcast service baseline provides basic flight path and simple emergency declarations. Surrounding aircraft and ground command centers can collect this data on the flight's status and infer near-term intent. This broadcast data does not explain rapidly changing intent or emerging threats on board the aircraft. To broaden the understanding of possible roles for aircraft and avionics consider two examples where unfolding events may warrant additional information be shared by a flight. The first is a flight with no pilot response to ATM instructions and the second is a flight which begins to significantly deviate from course.

In the first case, ATM must provide separation assurance along both the original and cleared flight paths. As the flight continues on the original course, it becomes a flight of interest for security purposes as well. If no communications is received from anyone on board an intercept mission is likely. However, intercepts would not be necessary in cases where the flight automatically broadcasts identifying the specific nature of the emergency. This may include the pilot's health/responsiveness, cabin pressurization, mechanical failures and other key factors.

If the flight has an incapacitated pilot even more detail is needed to manage the event. Currently manual calculations are made on the ground with extrapolated trajectories to calculate where a flight which has lost its pilot is likely to go down. In one such recent event ground personnel were contacted to determine the fuel on board and calculated the expected point where the flight would run out as a stretch from West Virginia to Washington DC. Knowing the programmed course and fuel on board directly from the aircraft will reduce the uncertainty significantly. Such knowledge is the difference between clearing huge airspace for the eventual crash of the un-controlled aircraft and the decision to intentionally destroy the aircraft.

There are other cases where a flight is non-responsive to commands and an emergency was not broadcast. For commercial flights knowing on-board events preceding the loss of communications would weigh heavily in the response. With the proper sensors the aircraft could respond to interrogations about the cockpit door status, if the autopilot engaged or disabled, and if there is a biometric match for the assigned pilot.

Consider the case where a flight suddenly deviates significantly from its flight plan. The most likely cause, a gross navigation error, could be detected by interrogating the flight management system to determine differences between the filed flight plan and what was programmed. If the flight begins deviating from its plan in more radical ways or the flight management system is disengaged then the situation becomes both an ATM emergency and a security event. In this case, the avionics ability to offer a play by play description of what is happening would be a great tool in managing the event. As an extreme example if intent and navigation status (angle of attack, bank, flaps, landing gear, and fuel) was available in a special requested broadcast mode then automation can determine the trajectory of the flight in real-time instead of inferring it from the past flight trajectory. And the detail knowledge to maneuver other aircraft would be available with the necessary precision to manage the airspace. In essence this would provide an air combat maneuvering capability to manage both collision avoidance and determine where the flight of interest is heading.

Conclusions

These two examples are only possibilities not answers. Our purpose is not to recommend a specific set of messages and reports, but to consider the types of information and application that may go beyond the current generation of broadcast services. The questions that remain are what types of information should be broadcast all the time, what could be broadcast in special modes requested by the ground, and what specific data should be sent in response to direct interrogation? The answers must consider bandwidth, ATM needs and security needs. A hybrid of broadcast and contracted services appears to be a starting point for consideration from this initial concept experiment. As we move forward the ATM and air security communities will have to work closely on those arrangements, as well as the specific communications purposes to allocate information across the different channels available to the aircraft. Now is the time to broaden the dialogue on avionics and view them as a tool for security as well as ATM.