Establishing Advanced AOC Systems for Single Pilot Operations

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ACARS - A Communications Breakthrough for Aviation Spurs Change in the 3-Man Crew

◦ The Aircraft Communications Addressing and Reporting System (ACARS) was developed by ARINC as a solution for saturated voice channels and to expand system capacity for ATC.

◦ Following test phases and trials in 1967, the FAA decided that "*general-purpose data link had no near-term ATC applications*". (1)

Thus, ACARS was shelved until…

ACARS and the 2-Man Crew

- Launch Customer – Piedmont Airlines 1978

- Piedmont known in the industry as forward-thinking and innovative with leading edge technology (e.g., first to use TCAS) , explored ideas on how to realize savings by operating the B737 with a two-man crew. (2)

- FAA would not certify Piedmont for two-man operations unless the airline demonstrated continuous "*reliable and rapid communications*" in FAR 121.99 so Piedmont asked ARINC for a designated network.

Communication Changes for AOC

- ARINC offered a solution to Piedmont in addition to a designated network – newly certified ACARS.

- In 1978 ARINC's ACARS and Piedmont's intention of a two-man crew had a revolutionary impact on aviation:

  Not just for the fact that ACARS was instrumental in solidifying a two-man crew but because it was inadvertently a precursor to the digital age of automation and communications. (3)

Then as Now – Requirements for Single Pilot Operations (SPO)

for Aeronautical Operational Control (AOC) leads one in the same direction – that in addition to integrated aircraft automation capabilities, it will be with the necessary communications and surveillance required to advance the standard crew size from two to one.

SPO and the Air Carrier

- There are many types of operations within the air carrier to examine concerning SPO:
  - Aircraft Automated Systems and Performance
  - Flight Operations and Pilot Requirements,
  - Maintenance Operations Control Center (MOCC)
  - System Operations Control Center (SOCC),
    - **Aeronautical Operational Control (AOC) and the dispatcher**
- This presentation will narrow approach to SPO and focus on AOC and the dispatcher, applying criteria already established today in ATM performance-based standards.

Required Total System Performance (RTSP)

- RTSP – Performance-based standards that pertain to Air Traffic Management (ATM) (4)

- Originally attributed to **Required Navigation Performance (RNP)**
  - Performance-based navigation (PBN) has been applied to oceanic separation criteria such as RNP10 or RNP4 (5)

- RTSP incorporates all functions of CNS/ATM: (Communications/Navigation/Surveillance in ATM)

  Required Communications Performance (RCP)
  Required Navigation Performance (RNP)
  Required Surveillance Performance (RSP)

Required SPO Systems & Performance (RSSP)

In order to standardize requirements for SPO the following might be considered:

RSSP – Required SPO Systems and Performance
Develop the criteria to establish the standards required for SPO operating within a whole system from the air carrier to air traffic control.

RSSP areas to be considered: Technology
                                        Procedures
                                        Organizational
                                        Human Factors
                                        Security

Two Possibilities for SPO Operations

1. Use of Unmanned Aircraft Systems (UAS) technology with remotely piloted operations to back-up SPO
2. Advanced AOC without a remotely piloted back-up UAS

SPO Supported by UAS Operations

Technology in place today that can enable a systems safety back-up to Single Pilot Operations with a UAS. Flights eventually can be fully autonomous and fly a programmed profile from A to B with the SPO as the primary monitor.

Definitions:

Unmanned Aircraft System (UAS) – FAA term that reflects all the complex systems associated with the UAV such as the ground stations involved in the process.   The UAS operations must be compliant with the same regulations and procedures of flights operated with a crew on board.

Optionally Piloted Aircraft (OPA) – FAA term for an aircraft that is being controlled from the ground even when there is a pilot on board.

However…

The future of SPO with an UAS in commercial aviation is foreseeable and would be the safest option but have the highest costs.

Are the inherent risks (with one highly trained pilot who must undergo additional physical and mental health screening plus computer proficiency in addition to airmanship proficiency) manageable to fly without a UAS?

Advanced AOC without UAS

SPO will require a highly integrated AOC with all automated systems.

- **3-way Comms**: Dispatch must be able to communicate with the pilot and controller in the same loop with RCP standards in use with ATC.

- **Surveillance**: Dispatch must have real-time aircraft situational display. Enable ADS-B so the dispatcher can receive the same signal as the controller. Or have ADSI approved for RSP.

Enable AOC Communications & Surveillance to be same as ATC/Pilot
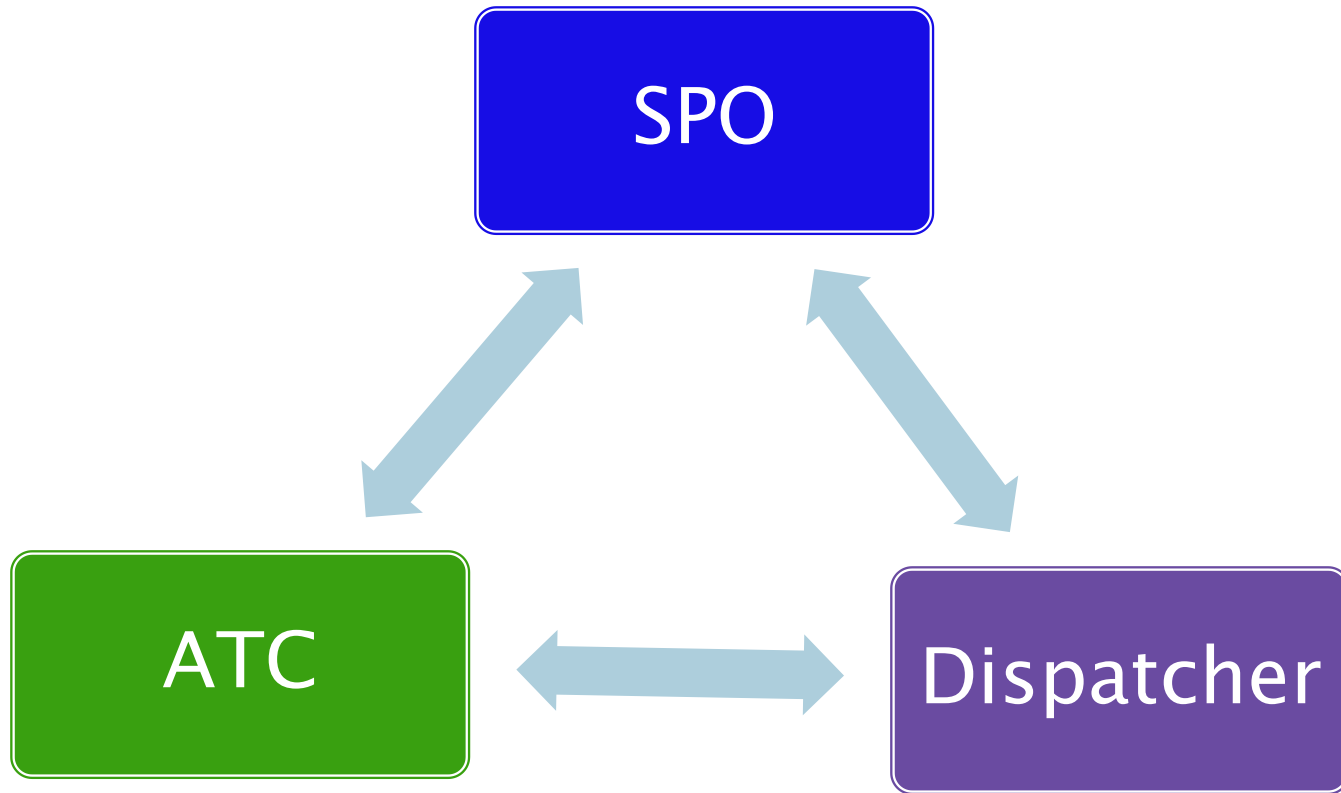
Dispatcher as <u>Controller</u> and <u>Copilot</u>

Situational Awareness

- Dispatcher must have direct communications and surveillance with SPO and ATC.
- System such as Ocean21- or other prototypes that use FAA's Aircraft Situational Display to Industry (ASDI) needed to develop a "big picture" with each SPO aircraft in his control.
- Possible direct link to position of aircraft with ADS-B and the EFB.

Support & Monitor

- Dispatcher must support the pilot in decision making as a Copilot would.
- Dispatch must monitor SPO flight for anything that is non-standard or marginal weather at any destination or alternates. Must cut down on information overload and brief pilot on pertinent issues only.
- Know when to call for back-up pilot.

Dispatcher as Controller

Dispatcher as Copilot

How? Establish AOC Performance-Based Communications & Surveillance

COMMUNICATIONS:

Controller Dispatcher Data Link Communications

Dispatcher Pilot Data Link Communications

- Performance-based communications are based on the ICAO material on RCP, which considers communication **process time**, **continuity, availability**, and **integrity** among other criteria. (6)

- SPO should have the same standards already established by Performance-Based Communications & Surveillance as used by ATC for controlling traffic.

SURVEILLANCE: OCEAN21 (7)

Advanced AOC Dispatcher Certifications

- **Special Dispatcher Certification** for SPO Operations such as a type-rating. This would involve in depth knowledge of the aircraft and IT systems.

- FAR121. 533 Joint responsibility with the Captain is taken to new levels.

- FAR 121.465 – Amend duty regulations to limit SPO dispatcher to maximum of 8 hrs on duty within a 24 hr period with no more than 5 consecutive days. Most likely would be similar regulations as the SPO.

Required Performance Applications with Data Link (8)

Enroute Separation: 5NM DL

Navigation: RNAV/RNP1

Surveillance: Radar or

   ADS–B with Mode S

   (60 times a second)

Communication:

   VDL Mode 2 support
   ACARS/CPDLC/ATN2
      RCP10/V
   RCP/120D

- 50/50 or 30/30 w/ATOP
- RNP10 or RNP4
- ADS–C RSP180
   periodic rate 27mins
   periodic rate 14mins

- RCP400/V + RCP240D

| Future Domestic Airspace | Oceanic Airspace w/ATOP |

Automatic Dependent Surveillance – Broadcast (ADS-B) with Mode S (9)

▸ Automatically transmits position & velocity vector from GPS or FMS on the aircraft to other ADS-B equipped stations.

▸ Implementation in Domestic Airspace will update position once every second – 60 times per minutes vs. radar once every 5-7 seconds
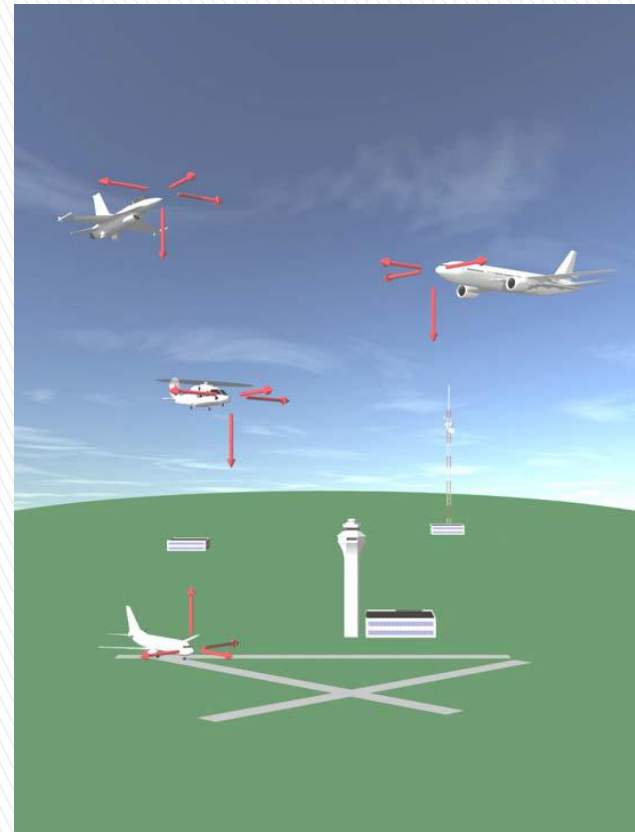
Final Thoughts

- Advanced AOC Systems would significantly save in crew costs by enabling a SPO and require the dispatcher to assume a higher degree of responsibility as a controller and co-pilot.

- Advanced AOC Systems will enhance operational efficiency while reducing human error.

- Implement Required SPO Systems and Performance (RSSP) to establish SPO framework and coordinate world-wide into a seamless global system .

- Performanced-Based criteria in Communications & Surveillance will be the guidelines for approving SPO with such mediums as CDDLC, DPDLC and similar systems to Ocean21.

Establishing Advanced AOC Systems for Single Pilot Operations

Questions?

Notes from slides

- **Slide 2**: One of the notable ARINC innovations was ACARS – originally named the *ARINC Communications Addressing and Reporting System*. It was renamed in the 1990s to *Aircraft Communications Addressing and Reporting System.* The ACARS test phases and trials coincided interestingly enough, with the B737 two-man certification process that was also conducted in 1967.

- **Slide 3**: Therefore, it would not be ATC to launch data link but the commercial airline industry. Piedmont had been exploring ideas on how to realize savings by operating a two-man crew. The FAA would approve this request only if the airline could demonstrate AOC, requiring them to have continuous reliable communications (FAR 121.99) with their aircraft. Piedmont inquired from ARINC whether they could have a designated network that would enable them to monitor specific VHF frequencies in which their aircraft could receive calls from dispatch.

- **Slide 4**: ARINC, having just certified ACARS, persuaded Piedmont that ACARS would be a communications solution in addition to the network. The initial application of ACARS automated the four phases of flight – OOOI times. ARINC estimated that 70% of air/ground communications were just for transmitting these flight times alone (Steel, 1997). As ACARS caught on, the airlines soon figured out that a host of other operational activities performed by VHF Voice communications could be digitally automated. Pre-departure information, the actual weight and balance calculations for take-off, fuel status, weather updates, new flight plans, engine performance parameters, and virtually any type of operational communication could now be sent to the small printer in the cockpit. By the end of 1979, Piedmont's original 13 ACARS sites quickly grew within that first year to 134 ground stations with 4 airline customers, 415 aircraft ACARS-equipped and 6 more airlines signed up (ARINC, 1987). Today ACARS is implemented world-wide and integrated not only into commercial aviation but a means of communication for ATC as well.

- **Slide 5**: The evolution of ACARS shows us the importance of communications for commercial, military, and ATC operations today. Air Traffic Control is defined by Communications, Navigation , and Surveillance in Air Traffic Management – CNS/ATM. Highly automated aircraft and future AOC systems most likely will have the same specifications of Communications & Surveillance in order to safely support a SPO.

- **Slide 6**: There are many types of operations that comprise an airline however this presentation will narrow the approach to SPO and focus on Aeronautical Operational Control in reference to the dispatcher's role, applying criteria already established today in ATM performance-based standards.

  Different airlines use different acronyms to designate their flight dispatch/crew scheduling/system operations centers – Systems Operations Control Center (SOCC) also synonymous with Airline Operations Control Center (AOCC) or Global Operations Control Center (GOCC).

- **Slide 7**: Performance-based operations, such as RTSP in ATM, provide a flexibility for new technologies to be implemented by using a structured analytical approach with methodology verses historically made regulations based on an evaluation of equipment and human limitations. ICAO uses RTSP as an operational concept for global ATM. Ultimately as performance-based standards are used as separation minimums to safely control air traffic**, it then follows that the same performance-based standards could be applied to AOC requirements in approval of a SPO.**

Notes from slides cont.

- **Slide 8**: RSSP is a solution for managing the capabilities and performance of a SPO and will establish operational, safety, and performance requirements world-wide.

- **Slide 10**: **Flights eventually can be fully autonomous and fly a programmed profile from A to B with the SPO as the primary monitor.** These advanced automated aircraft could be "*armed*" on departure to be operated remotely or from a pre-programmed profile in the event of pilot incapacitation. Basically already in use today with high altitude UAVs – the Global Hawk program with operations termed Mission Control Element (MCE) and Launch and Recovery Element (LRE). In the event of loss of communications the flight would respond as programmed to continue to destination, land at nearest airport, or return to departure point.

  UAS Issues:
  - How can one determine pilot incapacitation and know when to take command of a SPO?
  - How many flights would the remote pilot have in their control?
  - How many hours should a remote pilot be on duty?
  - Does the dispatcher monitor the flight and then alert an OPA on duty when needed?
  - And what are the Single Pilot Duty Requirements? Would they be something like a **2by2by8 rule**? SPO Restricted to 2 Engine Aircraft with 2 take-offs and landings and under 8 hours flight time with new duty-time regulations.

- **Slide 12**: This researcher believes it is possible to implement a SPO <u>without</u> an UAS in place but that it will require a highly automated AOC, integrated with the aircraft systems through advanced mediums such as the EFB Class 3 Type 2 or 3, and ATC Next Generation Air Transportation System (NextGen). The dispatcher's communication with the pilot will be direct links primarily with digital data messaging, voice, or streaming video through the EFB. Instead of separate data conduits, the Advanced AOC system would be a single source of information.

- **Slide 13**: The dispatcher must have direct communications with ATC via the same data link modes the aircraft uses in order to support a single pilot in the same way a Co-pilot would, enabling the pilot to focus on flying the plane. They must be able to interrogate the aircraft systems for real-time flight planning predictions with 4-D trajectory and receive enhanced weather from onboard avionics. The surveillance is necessary to establish a situational awareness with the aircraft in order for the dispatcher to have real-time knowledge of where the plane is and all performance factors associated with it. Although the dispatcher is not separating traffic as a controller, they have a new level of responsibility in supporting a single pilot. The job of dispatcher would become more of a combination of Dispatcher as Controller and Copilot.

- **Slide 14:** Dispatcher SSM/SPO: Situational Awareness, Support, Monitor in Single Pilot Operations. The dispatcher must have real-time communications with the flight and be able to see what the pilot sees onboard the aircraft through remote access to onboard systems in order to achieve SSM.

Notes from slides cont.

- **Slide 15**: **3-Way Communication.** Currently dispatcher does communicate through company data link systems to flight but not with RCP standards. CPDLC in the U.S. is routed by ARINC or SITA through the NADIN network. If a flight can send a message to a controller directly, there is no reason why a dispatcher should not be able to do the same. Currently performance groups, such as the Performanced-Based Aviation Rule-Making Committee – Communications Work Group (PARC CWG) are shaping communication standards with ICAO guidance material Global Operational Data Link (GOLD) and new documents such as Satellite Voice Guidance Material (SVGM). Some trials underway with new SATCOM using Iridium Data Link – FANS 1/A over Iridium (FOI) are with Cargo Lux, Continental (now United), Hawaiian, and UPS. The benefits of Iridium are a lower cost solution to Inmarsat, draws less power on the aircraft, lighter in weight, and has global coverage including the polar regions.

- **Slide 16**: **Surveillance.** Ocean21 here shows the ADS-C reports presented to a controller's situation display as flight data blocks to provide enhanced situational awareness and the potential for reduced separation. On the left are the electronic flight strips and other ATM functions such as Automatic conflict probe, Trajectory conformance monitoring, ADS-C, ADS-B, CPDLC, Micro-EARTS (Microprocessor-based enroute automated radar tracking system, and Traffic-load monitoring. Ocean21 by Lockheed is not the only design out there although it was the one that won the contract with the FAA for Oceanic ATM. Other companies have similar prototypes such as ARINC, SABRE, Boeing, Flight Explorer, Jeppessen, and more. And worth mentioning are the systems, some most likely by Raytheon, for the UAS operations that we don't know about.

- **Slide 17**: Issues: How many SPO flights are safely controlled by the dispatcher at one time?

  Are SPO flights mixed in with a dispatcher's other fights in the airline's system?

- **Slide 18**: ATOP – Advance Technologies and Oceanic Procedures, used with Ocean21 by Oakland, Anchorage and NYC Oceanic Centers. VHF Data Link (VDL) Mode 2 – digital data link for CPDLC. Single European Sky rule requires all new aircraft flying in Europe to be CPDLC compliant after Jan. 1, 2014 with Aeronautical Telecommunications Network (ATN) 2 standard.

  Oceanic RTSP: RNP10 – 50/50nm lateral separation criteria RCP 400 with ADS-C 27mins periodic rate. RNP4 – 30/30nm lateral separation criteria with RCP240 with ADS-C 14 mins periodic rate – CPDLC must be received within 210 seconds 95% of the time and 240 seconds 99.95 of the time. ADS -C RSP180 – position of aircraft must be received within 90 seconds 95% of the time and within 180 seconds 99.9% of the time.

- **Slide 19**: FAA deadline to have the U.S. ADS-B equipped by 2013 and all aircraft equipped with ADS-B OUT by 2020. However, in order for ADS-B to realize it's full potential, operators will need to equip sooner than 2020. Australia, the leader in ADS-B deployment, has continent-wide coverage of it's enroute airspace and in the process of determining how to proceed with ADS-B for lower altitudes.

  VDL Mode 4 – enables data link with ground stations and other aircraft. Trials in Europe with ADS-B and VDL Mode 4 underway.

Notes from slides cont.

- **Slide 20**: Single Pilot Operations (SPO) are not new – what is new is applying it to Commercial Aviation and large jet transport that will interface within the National Airspace. SPO may possibly be just a stepping-stone to a Commercial Unmanned Aerial Systems (UAS) – a topic that the FAA currently is requesting public input on selection for 6 UAS test sites to collect data for a safe civilian UAS integration into the NAS.

  And this integration is actually already happening as with the Global Hawk flights flying above the Pacific track system. One pilot recently enroute to Hawaii relayed that a voice came up on their VHF Guard 121.5 "Any Station, Any Station – this is Global Hawk123 (actual callsign omitted here) descending from above F600 down to F450 due operational necessity." The pilots were then simply amazed to see the contrails of the flight and the Global Hawk just above them – so close as a matter of fact that they took pictures. There was no loss of separation but they expressed how astounding it was to see this unmanned aircraft in their airspace and to hear a human voice on their radio from a pilot transmitting on the ground! It is this advanced technology in use today – the automation on the aircraft and on the ground - that will be the cornerstone for commercial aviation's advanced AOC systems in the future.

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