AEEC General Session
Atlanta 2016

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AEEC Meeting Report
April 25-28, 2016
Atlanta, Georgia

Official Report of the Airlines Electronic Engineering Committee

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AEEC | AMC

DELTA

AEEC EXECUTIVE COMMITTEE

Atlanta 2016

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AIRFRANCE KLM	Piet van den Berg
Alaska	John Melvin
American Airlines	Dennis Zvacek
myAustrian	Wolfgang Hornbacher
BRITISH AIRWAYS	Mike Nebylowitsch (not present)
DELTA	Jim Lord
Lufthansa	Jürgen Lauterbach

BOEING	Kathleen O'Brien Chairwoman-Elect
AIRBUS AN EADS COMPANY	Thierry Harquin
Southwest	Brian Gleason
TAP PORTUGAL	Mário Araújo
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ups	James McLeroy
U.S. AIR FORCE	John Morris (for David Setser)
ARINC INDUSTRY ACTIVITIES An SAE ITC Program	Paul Prisaznuk

Meeting Report
Executive Summary

AEEC | AMC Opening Session

Robert Swanson, FedEx, welcomed participants to the AEEC | AMC in Atlanta. He summarized AEEC's accomplishments in the past year. His welcoming remarks are reproduced as Attachment 1a to this report.

Robert introduced Jim Lord, Delta Air Lines, the *host airline*. Jim welcomed meeting participants to Atlanta and introduced the keynote speaker, Captain Steve Dickson, Delta Air Lines.

Keynote Address

Captain Steve Dickson delivered the keynote address. He described the Delta operation, its global presence, the focus on customer satisfaction, and its rich history in aviation. Since its humble beginnings as the first aerial crop dusting company, Delta has become one the largest airlines in the world. On behalf of the employees of Delta, Steve welcomed participants to the AEEC | AMC. His keynote address is reproduced as Attachment 1b to this report.

AEEC Action Summary

The AEEC Executive Committee voted to adopt four ARINC Project Papers and ten Supplements to existing ARINC Standards at the AEEC General Session in Atlanta. A summary of the 14 adoption items is provided on Page 4 of this report.

The AEEC Executive Committee voted to approve ten APIMs that will initiate ARINC Standard development activities in 2016 and 2017. The APIM summary is provided on Page 4 of this report.

The Awards Program

Trumbull Award

Kathleen O'Brien, Boeing, introduced the AEEC Trumbull Award provided to the outstanding airline individual. She emphasized the importance of recognizing those airline representatives who have made outstanding contributions to aviation.

Mark Sorensen, Delta, received the Trumbull Award for his outstanding contribution to the development of ARINC Standards over several decades. This includes data communication standards, VHF and satcom, as well as cabin In-Flight Entertainment Systems. The Trumbull award citation and Mark's remarks are included as Attachment 2 to this report.

Volare Awards

Ray Frelk, President of Airline Avionics Institute (AAI) provided a Volare Award to the following recipients:

- Mike Rennick, Delta Air Lines
- Yves Saint-Upery, Airbus

Congratulations to the Volare Award recipients. The award citations are reproduced as Attachment 3 to this report.

Meeting Report
Executive Summary

AEEC Member Transitions

The AEEC Executive Committee elected three new voting members as follows:

- José Almeida, TAP Portugal
- Wolfgang Hornbacher, Austrian Airlines
- Jean-Francois Saint-Etienne, Airbus

Five AEEC Executive Committee members were recognized for their contribution to the AEEC as they plan to step-down at the close of the 2016 AEEC General Session:

- Mário Araújo, TAP Portugal
- Thomas Laxar, Austrian Airlines
- Martin Maller, Austrian Airlines (alternate)
- Thierry Harquin, Airbus
- Yves Saint-Upery, Airbus (alternate)

A certificate of appreciation was presented to each in recognition of their service on the AEEC Executive Committee. An example is reproduced as Attachment 4 to this report.

Hospitality at the AEEC | AMC

The Airline Avionics Institute (AAI) organized lunch and coffee for meeting attendees in Atlanta. This created an excellent networking opportunity for everyone. Additionally, the AAI hosted an evening reception on Tuesday, April 26, 2016. A special thanks to AAI and the entire supplier community for supporting the AEEC | AMC.

Atlanta Charity

AEEC | AMC participants gave generously in Atlanta to support Children's Healthcare of Atlanta, the largest hospital of its kind in the Southeast United States. AEEC | AMC participants donated $1200. Thanks to all who contributed to this worthy cause.

Delta B-747-400 Model Airplane Drawing

Delta Air Lines provided a 1:100 scale model of a beautiful B-747-400 in Delta livery. The drawing is open to all Members and Corporate Sponsors of ARINC Industry Activities. The lucky recipient was Sam Mallos, Business Development Manager, Teledyne Controls.

Attendance Summary

725 people attended the AEEC General Session and Avionics Maintenance Conference. This included 155 airline people representing 32 airlines. 570 supplier and service provider representatives were also in attendance. The list of attendees is included as Attachment 5 to this report.

Meeting Report
Executive Summary

AEEC Leadership Transition

In accordance with the AEEC Organization and Procedures Guide, Robert Swanson, FedEx stepped down as AEEC Chairman at the close of the AEEC Advisory Session meeting held on April 28, 2016.

Kathleen O'Brien, Boeing, became the AEEC Chairwoman. James McLeroy, UPS, became the AEEC Chairman-elect.

Future AEEC Events

AEEC Mid-Term Session - 2016

October 13-14, 2016

Toulouse, France

All interested parties are invited to attend.

AEEC General Session - 2017

May 1-4, 2017

Milwaukee Convention Center and nearby Hilton Hotel

All interested parties are invited to attend.

The AEEC Event Calendar is provided at *www.aviation-ia.com/aeec*.

Presentation Materials

Presentation materials are circulated independent of this report. They are available with Reference Letter 16-070/AGS-183.

AEEC Members and Corporate Sponsors are invited to access their copy of AEEC General Session presentations from the AEEC website *http://www.aviation-ia.com/aeec/general_session/gs_reports/index.html*.

Others may access these documents at the AEEC General Session Reports website for a nominal fee. For more information, please visit: *http://www.aviation-ia.com/MembershipAndSponsor/index.html.*

Comments and Inquiries

Questions and comments concerning the AEEC and the ARINC Standards development process may be directed to:

Paul J. Prisaznuk
Executive Secretary & Program Director
ARINC Industry Activities
1-240-334-2579
pjp@sae-itc.org
www.aviation-ia.com/aeec

AEEC Adoption Action Summary

The AEEC Executive Committee adopted 14 documents in Atlanta that will be published as ARINC Standards:

ARINC Specification 424-21: *Navigation System Database*

ARINC Characteristic 535B-1: *Lightweight Headset and Boom Microphone*

ARINC Specification 618-8: *Air/Ground Character-Oriented Protocol Specification*

ARINC Specification 661-6: *Cockpit Display System Interface to User Systems, Part 1, Avionics Interfaces, Basic Symbology, and Behavior*

ARINC Report 665-4: *Loadable Software Standards*

ARINC Characteristic 771: *Low-Earth Orbiting Aviation Satellite Communication System*

ARINC Specification 816-2 Change 1: *Embedded Interchange Format for Airport Mapping Database*

ARINC Specification 816-3: *Embedded Interchange Format for Airport Mapping Database*

ARINC Specification 822A: *On-Ground Aircraft Wireless Communication*

ARINC Specification 832-1: *Cabin Equipment Interfaces, 4GCN Cabin Management and Entertainment System, Cabin Distribution System*

ARINC Specification 834-6: *Aircraft Data Interface Function (ADIF)*

ARINC Specification 841-3: *Media Independent Aircraft Messaging (MIAM)*

ARINC Specification 844: *Guidance for Target Hardware Design, Part 1, Airborne Computer High Speed Data Loader (ARINC 615-3)*

ARINC Specification 844: *Guidance for Target Hardware Design, Part 2, Airborne Computer High Speed Data Loader (ARINC 615-4)*

New AEEC Projects

The AEEC Executive Committee initiated ten projects in Atlanta as follows:

APIM 16-002 – ARINC Project Paper 6xx: *Common Standards for Software Data Loading and Data Management*

APIM 16-003 – Supplement 7 to ARINC Characteristic 781: *Mark 3 Aviation Satellite Communication System*

APIM 16-004 – Supplement 2 to ARINC Report 842: *Guidance for Usage of Digital Certificates*

APIM 16-005 – ARINC Specification 628: *Cabin Equipment Interfaces (multi-part update)*

New AEEC Projects (continued)

APIM 16-006 – Supplements to ARINC Characteristic 791 Part 1 and Part 2: *Ku-Band and Ka-Band Satellite Communications System*

APIM 16-007 – Supplement 5 to ARINC Specification 622: *ATS Data Link Applications over ACARS Air-Ground Network*

APIM 16-008 – Data Link Users Forum *(3-year project extension)*

APIM 13-011A – Supplement 1 to ARINC Characteristic 771: *Low-Earth Orbiting Aviation Satellite Communication System*

APIM 11-005B – Supplement 22 to ARINC Specification 424: *Navigation System Database*

APIM 08-004C – Supplement 7 to ARINC Specification 661: *Cockpit Display System Interfaces to User Systems, Part 1, Avionics Interfaces, Basic Symbology, and Behavior*

– ARINC Project Paper 661: *Cockpit Display System Interfaces to User Systems, Part 2, User Interface Markup Language (UIML) for Graphical User Interfaces*

2. Symposium – Aircraft Health Management (AHM)

Moderators: Jim Lord, Delta and Ted McFann, FedEx
Speaker: Nicolas Andre, Airbus
Speaker: Mike Hurd, Boeing
Speaker: Dean Gibson, FedEx
Speaker: James Jackson, Delta Air Lines

Jim Lord, Delta and Ted McFann, FedEx, led a symposium on Aircraft Health Management (AHM). The symposium highlighted the technologies, the applications, and the benefits of integrating AHM into the airline operation. Featured speakers in this symposium represented Airbus, Boeing, FedEx and Delta Air Lines.

Aircraft Health Management (AHM) Speaker: Nicolas Andre, Airbus

Nicolas Andre described the role that Airbus provides to assist airlines with predictive and reactive maintenance scheduling. Airbus has teamed with IBM to provide a unique data analysis platform using “big data” techniques. Maintenance data is collected before an aircraft dispatches, as well as during flight. The airline can utilize the Airbus “Airman” service, along with dedicated fleet technical specialists, or the airline may use their own organic data management solution.

Using prognostics, diagnostics, and troubleshooting data, airlines can better plan for resources required including personnel scheduling and fleet spares levels. Using data analytics and complex algorithms, an engineer can discover that two or more seeming related minor issues could potentially indicate that a larger component or system could be expected to fail sometime in the future. The ultimate goal is to predict and prevent maintenance failures by anticipating problems that may affect aircraft dispatches.

Nicolas concluded his briefing by noting that Airbus was evaluating and implementing solutions across their fleet types in a phased schedule. The “Airman” tool is presently available to Airbus A330 operators. It will be deployed fleet wide by the end of 2017.

The audience thanked Nicolas for his presentation.

Aircraft Health Management (AHM) Speaker: Mike Hurd, Boeing

Mike Hurd described Boeing’s commitment to lifecycle support of aircraft in service. Using real-time data available from an aircraft in flight, an airline can diagnose and plan a maintenance action before an affected aircraft has even landed at its destination. This moves maintenance from reactive to proactive, and most importantly predictive. Through this progression, both cost and scheduling reliability is favorably affected.

As aircraft have been equipped with increasingly powerful Central Maintenance Computer (CMC) systems, the available parameters monitored have climbed to nearly 200,000 data points per aircraft type. This adds

opportunity for data evaluation to legacy maintenance discrepancy reporting such as crew alerts and fault messages.

Boeing has a comprehensive approach to AHM, with each improvement building on the success of the AHM system. The steps include:

- Connecting the airplane – ACARS, operations, secure communications
- Enhancing the ground system – Variety of platforms in real-time, secure, data management
- Optimizing the operation – Fleet wide, deep domain knowledge using aerospace analytics

Mike concluded his briefing by summarizing the overall benefits of using analytic data, aircraft design data and operational data, for AHM. Airlines will see increased reliability, improved operations, and lower maintenance costs.

The audience thanked Mike for his presentation.

Aircraft Health Management (AHM) Speaker: Dean Gibson, FedEx

Dean Gibson focused on the paradigm shift needed to move an airline towards a robust AHM program. FedEx has developed a proactive and predictive maintenance philosophy. They have implemented an AHM program to avoid the high cost of delayed and cancelled flights. Dean pointed out that a traditional airline carrying passengers can have a flight delayed or cancelled, and the revenue may be only marginally affected. However, when a cargo airline delays packages, the customer gets a full refund. On a single cargo flight, there are tens of thousands of customers represented by packages.

Dean outlined a typical FedEx's response to an alert provided by their AHM program. When a fault is noted, the potential outcomes are explored such as cancellations, delays, restrictions to operations, etc. At the same time, repair information is being researched including the expected parts to be replaced, the consumables, and notification of personnel on station. The proper action is taken.

FedEx uses data and prognostics to troubleshoot a fault from the ground, even as the aircraft is still in the air. For example, FedEx monitors bleed air pressures and temperatures while the airplane is in flight to monitor system health and assess any system degradation. Action is taken before an unscheduled maintenance event takes place.

Dean also noted that as AHM prognostics improve over time, the events will become "quiet events" and go unnoticed by airlines executives and management. A quiet event is a proactive way to avoid an unscheduled maintenance action, delay, AOG, or aircraft rescheduling.

Dean said that data parameter monitoring and continuous communication to the ground should be basic to every airplane. Event-driven communication is desirable using adjustable event triggers and notifications. In addition to CMC equipment, additional capabilities should be provided such as access to Digital Flight Data Acquisition Units with the throughput and connectivity needed to provide the content to ground systems.

In summary, Dean said that a successful AHM program depends on the airlines ability to quantify the value of AHM. This is accomplished by actively quantifying the results of each preventative action before it disrupts the operation. This reinforces the paradigm shift and ensures a robust AHM program.

The audience thanked Dean for his presentation.

Aircraft Health Management (AHM) Speaker: James Jackson, Delta Air Lines

James Jackson described how AHM and prognostics can be successfully applied at the fleet type level. By spreading the data analytics across a wide sampling of aircraft, common failures and trends come into clear focus.

James explained that Delta Air Lines has moved to a prognostic-centered maintenance philosophy. Communication was key across several organizations to keep the collective focus on the AHM program. Training classes, weekly AHM meetings, station visits were used to move personnel towards modernizing maintenance prediction and repairs.

Airline leadership support is necessary. Monthly updates to senior leadership in Delta TechOps, as well as the airline side were key to showing the value of AHM and the paradigm shift.

James highlighting some best practices that Delta has found beneficial throughout the process. Integrated teams using Subject Matter Experts (SME) across several disciplines come together to solve trending issues before they reach a critical mass and negatively affect operations.

Data management and information systems linkage is important for data visibility and data mining. Innovative improvements to legacy aircraft to improve their instrumentation and data transfer capabilities added to the overall AHM efforts.

James emphasized the value of AHM to Delta and recommended that other airlines consider implementing an AHM program.

The audience thanked James for his presentation. Presentation materials are circulated with Reference Letter 16-070/AGS-183. The materials are available at the AEEC website *http://www.aviation-ia.com/aeec*.

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3. Cabin Systems

3a. Ku/Ka Band Satellite Communications

ARINC 791, ARINC Project Paper 792, ARINC Project Paper 848
Chairman: Peter Lemme, Totaport
Secretary: Tom Munns – *thomas.munns@sae-itc.org*
APIM 14-007: Small Form Factor Ku/Ka-Band Satellite System
APIM 14-008: Satcom Functional Interface Standard

Goal: The goal of the Ku/Ka Satellite Communications (KSAT) Subcommittee is to develop standards for broadband satellite equipment hardware and electrical/electronic installation interfaces onto all types of commercial transport aircraft.

AEEC General Session Results:

Peter Lemme, Totaport, provided a status report of the activities of the Ku/Ka Satcom Subcommittee as follows:

ARINC Project Paper 792: *Second Generation Aviation Ku-Band and Ka-Band Satellite Communication System* is being prepared. The key goal of ARINC Project Paper 792 is to define Ku-band and Ka-band satcom embracing the latest technologies that improve weight, volume, and complexity while enhancing performance of connectivity systems. Peter identified the features and trade-offs that the Subcommittee is considering, including accommodation of a range of antenna options, location of components versus performance and accessibility, and compatibility with the provisions of ARINC Characteristic 791.

Peter reported that the Subcommittee has prepared strawman material intended for inclusion in **ARINC Project Paper 848:** *Broadband Satellite System Functional Interface Standard*. The goal is to define common network protocols and interfaces between non-safety broadband systems and aircraft IP networks. Peter described the challenges and identified the key tasks that the Subcommittee is focusing on, including domain separation, Quality of Service definition, and network security considerations. Peter reported that the KSAT Subcommittee has been working with the NIS and the SAI Subcommittees to clarify the objectives of this activity. The next step is to work with the NIS Subcommittee to prepare a new APIM 16-xxx, replacing APIM 14-008. Details are provided in Agenda Item 8c provided later in this report.

APIM Approval:

- **AEEC approved APIM 16-006.** This APIM calls for **Supplement 3 to ARINC Characteristic 791 Part 1** to include several changes viewed to be necessary as a result of the installation and operation of Ku-band and Ka-band satcom systems. The APIM also calls for **Supplement 2 to ARINC Characteristic 791 Part 2** to provide proper references to network interface definitions, revisit antenna installation issues, and update the Management Information Base (MIB) definition.

Future Work Program:

- **Supplement 3 to ARINC Characteristic 791 Part 1:** *Ku-Band and Ka-Band Satcom System Definition* is expected to be mature in October 2017.
- **Supplement 2 to ARINC 791 Characteristic Part 2:** *Ku-Band and Ka-Band Satcom System Definition* is expected to be mature in October 2017.
- **ARINC Project Paper 792:** *Second Generation Aviation Ku-Band and Ka-Band Satellite Communication System* is expected to be mature in October 2017.

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3b. Cabin Systems Subcommittee

ARINC 628, ARINC 664, ARINC 800, ARINC 832
ARINC Project Paper 648, ARINC Project Paper 820, ARINC Project Paper 836A
Chairman: Dale Freeman, Delta Air Lines
Secretary: Tom Munns – *thomas.munns@sae-itc.org*
APIM 08-011A: Cabin Enclosures, Mini-Modules for Modular Rack Concept
APIM 12-004B: Cabin Network 10 GbE
APIM 13-010: 4th Generation Cabling Network (4GCN)
APIM 13-014A: Cabin Cables and Connectors
APIM 14-001: Cabin Architecture for Wireless Distribution System
APIM 15-001: Cabin Passenger Seat Production Testing
APIM 15-006: Cabin Wireless Access Point (CWAP) Operational Management

Goal: The CSS is developing cabin network interface standards that enable the development of systems that exceed passenger expectations. This effort includes cabin communication, broadband connectivity, wireless distribution, cabin interface protocols and connector standardization.

AEEC General Session Results:

Dale Freeman summarized the Cabin System Subcommittee (CSS) activities as follows:

- **Supplement 8 to ARINC Specification 628, Part 1:** *Cabin Management and Entertainment System Peripherals*, to evaluate and standardize technical solutions for Global CWAP Operational Management (GCOM) for use on domestic or international flights.
- **ARINC Project Paper 648:** *Cabin Architecture for Wireless Distribution System* will provide guidance for production testing of seats electronics.
- **Supplement 3 to ARINC Specification 664, Part 2:** *Aircraft Data Network, Ethernet Physical and Data Link Layer Specification* will include the physical and data layer for 10 Gbps Ethernet interface for commercial aircraft.

- **Supplement 1 to ARINC Specification 800, Part 2:** *Cabin Connectors and Cables – Specification of Connectors, Contacts, and Backshells* will define a hybrid (i.e., fiber optic-copper) connector insert for use in cabin equipment retrofit and line-fit installations.
- **Supplement 1 to ARINC Specification 800, Part 3:** *Cabin Connectors and Cables – Specification of Cables* will define a hybrid (i.e., fiber optic-copper) cable for use in cabin equipment retrofit and line-fit installations.
- **ARINC Project Paper 820:** *Cabin Architecture for Wireless Distribution System* will define cabin network architectures for wireless distribution.
- **A mature Supplement 1 to ARINC Specification 832:** *4GCN Cabin Distribution System*, defines a hybrid (i.e., fiber optic-copper) connector, seat-to-seat cable, and hybrid floor disconnect box.
- **ARINC Project Paper 836A:** *Cabin Standard Enclosures* will standardize miniature modules for equipment being installed into a modular rack concept.

AEEC Adoption Action:

- **AEEC adopted Supplement 1 to ARINC Specification 832***: 4GCN Cabin Distribution System.* APIM 13-010 was closed as a result of this action.

APIM Approval:

- **AEEC approved APIM 16-005.** This APIM calls for several cabin systems standards to be updated to include:
  - High-Definition Landscape Camera and 4K Ultra High Definition Video standards
  - USB 3.1 Interface
    Update of Network System Components

Future Work Program:

The Cabin System Subcommittee work program includes the following:

- **Supplement 8 to ARINC Specification 628, Part 1** is expected to be mature in October 2017.
- **Supplement 9 to ARINC Specification 628, Part 2** is expected to be mature in April 2017.
- **Supplement 4 to ARINC Specification 628, Part 9** is expected to be mature in October 2017.
- **ARINC Project Paper 648** is expected to be mature in October 2017.
- **Supplement 3 to ARINC Specification 664, Part 2** is expected to be mature in by the end of 2016.
- **Supplement 2 to ARINC Specification 800, Part 2** is expected to be mature by the end of 2016.
- **Supplement 2 to ARINC Specification 800, Part 3** is expected to be mature by the end of 2016.

- **Supplement 4 to ARINC Specification 809** is expected to be mature in April 2017.
- **ARINC Project Paper 820** is expected to be mature in April 2017.
- **Supplement 2 to ARINC Specification 832** is expected to be mature in April 2017.
- **ARINC Project Paper 836A** is expected to be mature in 2017.

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3c. Galley Insert (GAIN) Subcommittee

ARINC 810 and ARINC 812A
Co-Chairman: Ralph Schnabel, Airbus
Co-Chairman: Scott Coburn, Boeing
Secretary: Tom Munns – *thomas.munns@sae-itc.org*

Goal: The goal of the GAIN Subcommittee is to standardize the physical dimensions, electrical interfaces, communication protocol, qualification test guidelines, and maintenance provisions for Galley Inserts to support standard installations.

AEEC General Session Results:

Tom Munns reported that the GAIN Subcommittee is responsible for three standards that define galley equipment interfaces. The documents are viewed to be stable at this time:

- **ARINC Specification 810:** *Definition of Standard Data Interfaces for Galley Insert (GAIN) Equipment, Physical Interfaces*, specifies physical attachments, envelopes, system connections, system performance attributes, and design guidance for galley equipment. The latest version, ARINC 810-5, provides a definition of a new Size 6 galley insert to accommodate the installation of microwave ovens.
- **ARINC Specification 812A, Part 1:** *Standard Data Interfaces for Galley Insert (GAIN) Equipment, CAN Communications*, defines digital galley equipment and data protocols.
- **ARINC Specification 812A, Part 2:** *Standard Interfaces for Galley Insert (GAIN) Equipment, CAN Communications Verification and System Test Guidance*, defines functional test requirements and procedures to verify ARINC 812A Part 1 bus protocol implementation.

Future Work Program:

- Quarterly web conferences will monitor galley development activities and to determine the need for additional ARINC Standards.

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4. Symposium – Trending in Aviation

Moderator: Kathleen O'Brien, Boeing
Speaker: Dan Johnson, Honeywell, Cyber Security
Speaker: Mark Petzinger, FedEx, Carriage of Lithium-Ion Batteries
Speaker: Joe Cramer, Boeing, Spectrum/Frequency Management
Speaker: John Melvin, Alaska, Going Mobile

Kathleen O'Brien led a symposium on a variety of topics that are emerging as important trends in commercial aviation. Featured speakers in this symposium represented Honeywell, FedEx, Boeing, and Alaska Airlines. Honeywell presented Cyber Security considerations, FedEx presented issues associated with Carriage of Lithium-Ion Batteries, Boeing presented Spectrum and Frequency Management, and Alaska Airlines described their EFB Maintenance Toolbox.

Cyber Security Speaker: Dan Johnson, Honeywell

Dan Johnson presented "Future Trends in Aviation Cybersecurity." The current trends in aviation are toward increasing connectivity, more attention due to criminal and terrorist threats, and progression in attack approaches from casual to organized.

New external connections that could be exploited for potential cyber-attack include wireless and cellular systems, broadband satcom (serving cabin and cockpit), tablets (e.g., EFB, maintenance tools, and cabin controls), IP-based cockpit services and Air Traffic Management (ATM) services. In addition, new concerns are arising relating to exploitation of older non-secure connections, including ACARS, software data loading, aeronautical data distribution, and In-Flight Entertainment (IFE).

Dan pointed out that attacks have become "systematized, utilized, and monetized" Threatening groups will take system vulnerabilities and use them to achieve the group's goals, including criminal gangs perpetuating fraud and scams, quasi-political groups using disruption and vandalism, nationalistic groups conducting corporate espionage and perhaps sabotage, paparazzi using privacy violations and exposure, and individuals and insiders carrying out vendettas, corporate espionage, and sabotage.

Regulatory trends in response to these cyber-security factors include the following:

- **Type Certification for Airworthiness Security.** Transition of FAA Special Conditions into regulations is anticipated shortly. Special conditions currently apply to commercial transports and business jets, but will likely soon be applicable to General Aviation, helicopters, and engines.
- **ATM Systems** are under scrutiny. This scrutiny may result in European regulation for these applications.
- **Continuing Airworthiness Security.** Aircraft Network Security Program (ANSP) for operators are currently applicable to operators that have aircraft with special conditions. It is anticipated that security management for EFBs and other PEDS will be scrutinized.

- There is a proposed amendment to a U.S. Congressional FAA bill with a clause to examine security risks of **IFE systems.**

Dan reported that an Aviation Information Security Analysis Group (ISAG) has been formed to assist government and industry respond to cyber security concerns and provide guidance.

Dan described the layered security approach, including eight layers of security – link protection, connection protection, network protection, application input protection, OS protection, software/firmware update protection, support equipment protection, and organizational protection. He listed a range of standards addressing cyber-security, including ARINC Standards. Industry standards must be able to adapt to emerging threat scenarios.

The audience thanked Dan for his presentation.

Lithium-Ion Batteries Speaker: Mark Petzinger, FedEx

Mark Petzinger presented "Transportation of Lithium Batteries on Aircraft." He started by asserting that Lithium Metal and Lithium-Ion Batteries are Safe--for the most part. Although it is true that, under certain conditions, lithium batteries will experience thermal runaway, these cases are usually attributed to some form of abuse, such as electrical abuse (e.g., over-charging), physical abuse (e.g., dropping or denting), or thermal abuse (e.g., heating above ambient temperatures).

Bulk transport of lithium batteries are of particular concern for cargo carriers. Lithium batteries are banned from shipment on a passenger aircraft.

Mark reported that FAA test results have shown that the heat generated in a thermal runaway event and the fire that sometimes is a result, makes containment very challenging. Testing has shown that extinguishing the flames and controlling the heat will not keep the aircraft safe when a bulk shipment of lithium batteries is experiencing thermal runaway. In these cases, explosive gases must also be controlled.

Mark described a multi-layer approach to safely transport lithium batteries. This approach includes the following:

- The existing aircraft Halon fire suppression systems in the lower deck Class C cargo compartments
- Supplemental fire suppression systems for the main deck cargo compartment
- Specially designed battery packaging to prevent thermal runaway events
- Reducing state of charge for stand-alone (bulk) shipments of batteries to 30%
- Fire containment covers (FCCs) and fire-resistant containers (FRCs)
- New, safer, battery configurations

Supplement fire suppression systems, beyond what is supplied by the OEMs, have been developed. In full scale fire tests, supplemental systems have proven to be effective at suppressing and/or extinguishing class A fires, fires involving equipment containing lithium-ion batteries, and on limited quantities of shipped alone lithium cells.

Testing by industry has shown that FCCs can suppress a fire involving equipment containing lithium-ion batteries. However, FAA testing has shown that FCCs do not contain the effects of large quantities of bulk lithium batteries.

The FAA Tech Center has demonstrated that a composite fire-resistant container could contain a Class A fire for four hours. However once damaged, only 60 seconds was required for it to be fully engulfed in flames.

Several companies have started work on developing performance based packaging that will contain the detrimental effects of a thermal runaway in a shipment of lithium and/or lithium-ion batteries.

In closing, Mark recommended a multi-layer approach to the safe transportation of lithium batteries.

The audience thanked Mark for his presentation.

RF Spectrum Issues Speaker: Joe Cramer, Boeing

Joe Cramer, Boeing, presented “Radio Frequency Spectrum: Importance to and Issues Impacting Aviation.” He pointed out that radio-frequency spectrum is essential to civil aviation. It is a limited resource that is highly sought after and tightly regulated. The aerospace industry is constantly at risk of losing this resource.

International regulatory procedures as well as procedures of each country determine the rules to access to and use of radio spectrum. Spectrum is allocated to services through international treaty, with the International Telecommunication Union (ITU) and International Civil Aviation Organization (ICAO) defining operating restrictions and parameters, standards, and recommended practices. National regulatory authorities also allocate and regulate spectrum usage based upon national goals and assign licenses for specific frequencies within these allocations. To protect aviation’s requirements and interests, the aviation industry must participate in all of the regulatory processes.

International Radio Regulations were revised at the November 2015 World Radio-communication Conference (WRC). Issues specifically impacting the aerospace/aviation communities included (1) allocation of globally harmonized radio frequency spectrum in the band 4200 to 4400 MHz for wireless avionics intra-communications system (WAIC), (2) allocation of the frequency band 1087.7 to 1092.3 MHz for satellites and space stations to receive Automatic Dependent Surveillance-Broadcast (ADS-B) emissions from aircraft transmitters, and (3) allowance for the use of satellites (Fixed Satellite Service) to provide command and control for UAVs in a number of frequency bands.

The main civil aviation and aerospace issues at the ITU WRC-19 included the following:

- Spectrum and regulatory provisions for the introduction and use of the Global Aeronautical Distress and Safety System (GADSS)
- High Altitude Platform Stations (HAPS)
- Consideration whether wireless access systems, including radio local area networks (WAS/RLAN), should be allowed to operate in areas

of the 5 GHz band (5,150 and 5,925 MHz) not already allocated to these purposes

The top priority was to identify additional radio-frequency spectrum for International Mobile Telecommunications (IMT). ICAO has established a new Frequency Spectrum Management Panel to address international pressure to find spectrum for IMT, which could force aviation to reduce spectrum use.

The audience thanked Joe for his presentation.

Going Mobile Speaker: John Melvin, Alaska Airlines

John Melvin presentation called “Going Mobile” describes the equipment and applications that have been provided for their front line operations.

Mobile devices provided to customer service agents come preloaded with the Alaska Airlines app, a bag scan app, flight info, Google translator app, and Outlook for email. The bag scan app and flight info app were both developed internally.

Flight attendant mobile devices include check-in, flight information, and translator apps. The Check-In app allows flight attendants to check in at the beginning of their trip, using GPS to pinpoint their location. Block2Block is a flight information app that pulls the flight attendant’s schedule for the next 24 hours and provides relevant flight information. The app provides an electronic version of preliminary and final flight paperwork which includes gate information, check-in information, inflight crew details and customer information. They are informed of seating location of VIP customers, their preferences, special services, meal selections, customer connections, and so forth. The translator app allows flight attendants to communicate with customers who may speak a language other than English.

Alaska Airlines flight crew EFBs (iPads tablets) use Jeppeson Flight Deck-Pro for flight planning. The EFBs contain all of the flight manuals that the flight crews used to carry in their large and heavy suitcases.

Maintenance technicians have their choice or Apple iPad Mini or iPad2 Air, both equipped with cellular and WiFi connectivity. The home screen is the Boeing Toolbox Mobile Library (TML). TML provides the correct and current manual reference for all aircraft, including AMM, IPC, FIM, SRM, CMM, and WDM. The manuals have graphics and hyperlinks to aid in research and troubleshooting. Alaska is developing maintenance task cards, effectively converting from a paper form to electronic form, in the next two years.

Alaska is evaluating the functionality of Boeing Maintenance Turn Time app for maintenance technicians. The purpose of this app is to enable complete planeside troubleshooting of aircraft, including electronic organization and creation of rich-media artifacts (e.g., photo, audio, diagrams) for investigating and documenting maintenance actions and to enable two-way electronic collaboration with the rest of maintenance organization from technician’s location.

Alaska developed the Tow Plan app to improved efficiency by reducing pain points for towing aircraft to the gate. Tow Plan provides real-time information regarding aircraft position, timeline, and tow status. The goal is to alleviate ramp congestion and delays in getting aircraft to their gates. Tow Plan has

led to significant improvements in on-time performance, especially for the very important first flight of the day.

In the future, Alaska sees an opportunity to further improve operational efficiency by connecting employee mobile devices to the airline network.

The audience thanked John for his presentation. Presentation materials are circulated with Reference Letter 16-070/AGS-183. The materials are available at the AEEC website *http://www.aviation-ia.com/aeec*.

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5. Data Communications

5a. Data Link Users Forum

Co-Chairman: Colin Gallant, British Airways
Co-Chairman: Brian Gleason, Southwest Airlines
Secretary: Vic Nagowski – *vnagowski@sae-itc.org*

Goal: The goal of the Data Link Users Forum is to provide continuous improvements to data link system performance in a way that maximizes the operational benefit to the user community.

AEEC General Session Results:

Colin Gallant, British Airways, highlighted the benefits gained by the airline community as a result of the DLK Users Forum, a coordinating activity among airlines and cargo carriers, aircraft manufacturers, avionics manufacturers, and data link service providers. Economic benefits are obtained through the exchange of technical information and through the resolution of common problems. The activity also provides an opportunity for airlines to provide input to Civil Aviation Authorities (CAA) and Air Traffic Service (ATS) providers on the direction and schedule of new ATS data link programs.

Recent achievements include investigating the progress of the Controller Pilot Data Link Communications (CPDLC) in Europe. The European Laboratory for Structural Assessment (ELSA) consortium was formed to investigate the performance issues associated with the CPDLC Operations in Europe. The European Commission (EC) announced a schedule modification to the Data Link Services Implementing Rule (DLS IR) regulation due to system performance issues. The status of the FAA CPDLC program is also being monitored.

Some key concerns expressed included:

- Performance issues associated with the European CPDLC network
- The ELSA consortium is expected to release results of their investigation of the root cause of the ATN performance issues and develop recommendations for system improvements in 2Q16
- The new EC DLS IR implementation date for Air Navigation Service Providers (ANSPs) is 2018 and the implementation date of 2020 for forward fit and retrofit aircraft

- The FAA Data Communications program is continuing with the implementation of Departure Clearance service at 57 towers and preparations are underway to support enroute services
- The Harris Corporation is managing the ground system implementation in the US being provided by data link service providers

APIM Approval:

- **AEEC approved APIM 16-008**. The APIM will extend the work of the Data Link Users Forum for three more years (2019).

Future Work Program:

The DLK Users Forum will continue to monitor emerging data link programs as follows:

- Monitor the results and assess the impact of the ELSA Consortium investigation of performance issues associated with the CPDLC Operations in Europe program and the EC aircraft exemptions
- Monitor the implementation status of the FAA CPDLC program
- Track mandatory data link equipage requirements
- Monitor system performance and operational trial results
- Monitor new air-ground data link opportunities

The next DLK Users Forum meeting is scheduled for September 12-15, 2016, in Dublin, Ireland. The meeting will be hosted by Airtel ATN. Colin thanked Brian Gleason for agreeing to co-chair the DLK Users Forum and thanked all the organizations that host the DLK Users Forum meetings.

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5b. Data Link Systems Subcommittee, MIAM and AOC

ARINC 618, ARINC 631, ARINC 633, ARINC 841
Data Link (DLK) Systems Chairman: Bob Slaughter, American Airlines
AOC Chairman: Dirk Zschunke, Lufthansa German Airlines
Secretary: José Godoy – *jose.godoy@sae-itc.org*
APIM 09-001A: ARINC 841: Media Independent Aircraft Messaging (MIAM)
APIM 10-013: ARINC 631: VDL Mode 2 Implementation Provisions
APIM 11-011A: ARINC 633: AOC Air/Ground Data and Message Exchange
APIM 13-013: ARINC 618: Air/Ground Character-Oriented Protocol

Goal: Develop and maintain datalink standards that promote reliable transfer of data between the aircraft and the ground. These standards include existing Aircraft Communications Addressing and Reporting System (ACARS), the emerging Aeronautical Telecommunications Network (ATN) as defined by the ICAO SARPs, and supports FAA NextGen/Data Comm and European SESAR programs.

AEEC General Session Results:

Bob Slaughter, American Airlines, provided the DLK Systems Subcommittees summary. He also presented the AOC Subcommittee activities on behalf of Dirk Zschunke, Lufthansa German Airlines.

The DLK Systems Subcommittee has developed a mature Draft 3 of **Supplement 8 to ARINC Specification 618:** *Air-Ground Character-Oriented Protocol Specification* as authorized by APIM 13-013. The standard defines ACARS datalink protocols. Supplement 8 supports the ACARS improvement program with the goal of continuously achieving 180 seconds data delivery for Required Surveillance Performance (RSP 180) required to obtain preferred airspace operation (30 NM lateral and longitudinal separation). Supplement 8 specifies a new VHF-to-satcom routing timer (RAT1) and optimizes the value of the existing Airborne NO ACK Timer (SAT7). Detection of duplicate Uplink Block Identifiers (UFI) is also defined.

The DLK Systems Subcommittee has developed a mature Draft 2 of **Supplement 3 to ARINC Specification 841:** *Media Independent Aircraft Messaging* as authorized by APIM 09-001A. MIAM facilitates the exchange of large volume of data (5 Mbytes) over VHF (traditional ACARS and VDLM2) or broadband subnetworks (Internet Protocol (IP) and satcom). MIAM improves the utilization of the RF spectrum and provides ACARS access to new datalink users (e.g., EFB applications). Supplement 3 updates the protocol version negotiation between the aircraft and the MIAM ground entity. New On-Ground and In-Flight MIAM Segment Temporization timers are defined. Protocol Implementation Conformance Statements (PICS) are updated.

The DLK Systems Subcommittee is developing **Supplement 7 to ARINC Specification 631:** *VHF Digital link (VDL) Mode 2 Implementation Provisions* as authorized by APIM 10-013A. Supplement 7 will improve VDLM2 frequency management (i.e., multi-frequency, autotune procedures, ground station handoff selection, etc.). It will also provide guidance on the allocation of VDLM2 ground station addresses, define avionics perceived channel utilization, add ground station requirements, and deduce Provider Aborts (PA).

The maturity of Supplement 7 depends upon VDLM2 multi-frequency deployment and recommendations expected from the ELSA Consortium. The ELSA Consortium, created by the SESAR Joint Undertaking (SJU), is investigating the unusually high nuisance ATN delays and disconnects plaguing the European Data Link Services (DLS) operation.

Bob reported on the activities of the AOC Subcommittee and their role to standardize Aeronautical Operational Control (AOC) applications provided by different suppliers on different aircraft types. AOC messaging is expected to provide complimentary information to these applications that can be hosted in the Communications Management Unit (CMU) and/or an Electronic Flight Bag (EFB).

The AOC Subcommittee is developing **Supplement 3 to ARINC Specification 633:** *AOC Data and Message Exchange Format* as authorized by APIM 11-011A. Supplement 3 will add several new Data Structures (i.e., Oceanic Tracks, Load Trim Data) and expands existing XML schemas, including Flight Plan, eFF, NOTAM, Weight & Balance, Drift Down, and others. A new section providing examples and lessons learned will be included. Supplement 3 will also correct issues discovered during Supplement 2 validation.

AEEC Adoption Actions:

- **AEEC adopted Supplement 8 to ARINC Specification 618:** *Air/Ground Character-Oriented Protocol Specification*. Paul Prisaznuk reported that JSC Infocomavia (Russian DSP) advised they are transmitting VDL Mode 0/A on 136.775 MHz. Paul suggested this could be provided as information to the operators in the table of Global Standard Frequencies. José Godoy added that this is not an ideal operating frequency. The AEEC Executive Committee supported the inclusion of this information in ARINC 618 with a note stating Russian operation is contrary to the ICAO global frequency plan. APIM 13-013 was closed as a result of this action.
- **AEEC adopted Supplement 3 to ARINC Specification 841**: *Media Independent Aircraft Messaging (MIAM).* APIM 09-001A was closed as result of this action.

APIM Approval:

- **AEEC approved APIM 16-007.** This APIM calls for **Supplement 5 to ARINC Specification 622:** *ATS Data Link Applications Over ACARS Air-Ground Network.* The document is expected to add Air Traffic Services (ATS) Wind Uplink Service for Advanced Interval Management**.**

Future Work Program:

- **Supplement 5 to ARINC Specification 622:** *ATS Datalink Applications Over ACARS Air-Ground Network* is expected to be mature in April 2017.
- **Supplement 7 to ARINC Specification 631:** *VHF Digital Link (VDL) Mode 2 Implementation Provisions* is expected to be mature in 2017.
- **Supplement 3 to ARINC Specification 633:** *AOC Air-Ground Data and Message Exchange Format* is expected to be mature in October 2016.

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5c. Air Ground Communications Systems (AGCS) Subcommittee

ARINC Project Paper 771
Chairman: Kenny Blankenship and Robert Holcomb, American Airlines
Secretary: José Godoy – *jose.godoy@sae-itc.org*
APIM 13-011: Low-Earth Orbiting Satellite Communications System

Goal: The goal of the AGCS Subcommittee is to develop and maintain satellite communication (satcom) standards to meet airline operational requirements.

AEEC General Session Results:

José Godoy presented a summary of the AGCS Subcommittee activities on behalf of Robert Holcomb, American Airlines.

The AGCS Subcommittee has prepared a mature draft of **ARINC Project Paper 771:** *Low-Earth Orbiting Satellite Communications System* as authorized by APIM 13-011.

The Iridium NEXT satellite network will replace the Iridium Legacy (Block 1) satellite network. Iridium Certus services and faster rates will be available with the deployment of the Iridium NEXT constellation in 2017. Block 1 worldwide mobile communications services (Voice and Data Link Communications) will be enhanced and existing handsets, devices and applications will be sustained.

Form, fit, function and interface of the satcom system components (i.e., Satellite data Unit (SDU) and Antennas) are specified in two configurations:

- Size 2 MCU with an SDU that contains the RF Block and a passive Low Gain Antenna (LGA)
- Size 2 MCU and an Active Low Gain Antenna (ALGA) which contains the RF Block

Safety and non-safety services will be supported. The standard includes Data Security considerations, isolating the Aircraft Control Domain from the Airline Information Services (AIS) domain.

Satcom systems allow air-ground communication in areas with no VHF coverage.

AEEC Adoption Action:

- **AEEC adopted ARINC Project Paper 771:** *Low-Earth Orbiting Satellite Communications System*. APIM 13-011 was closed as a result of this action.

APIM Approvals:

- **AEEC approved APIM 13-011A.** This APIM calls for Supplement 1 to ARINC Characteristic 771 to include:
  - High gain antennas to satisfy Iridium Certus higher rates and services
  - SDU Cross Talk Switching
  - Expand Data Security Analysis in Section 4
- **AEEC approved APIM 16-003.** This APIM calls for Supplement 5 to ARINC Characteristic 781 describing Inmarsat SwiftBroadband satcom equipment, installation and new services, for example:
  - Add Security Overlay option (e.g., VPN) in support of ACARS over SwiftBroadband (SBB) Safety Services
  - Define SBB Ethernet Ports (Align with ARINC 771 – Iridium Certus)
  - Expand Data Security Analysis in Attachment 8

Future Work Program:

- **Supplement 1 to ARINC Characteristic 771:** *Low-Earth Orbiting Satellite Communications System* is expected to be mature in April 2017.
- **Supplement 5 to ARINC Characteristic 781:** *Mark 3 Satellite Communications System* is expected to be mature in April 2017.

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5d. Internet Protocol Suite (IPS) for Aeronautical Safety Services

ARINC Project Paper 658
Co-Chairman: Luc Emberger, Airbus
Co-Chairman: Greg Saccone, Boeing
Secretary: Paul Prisaznuk – *pjp@sae-itc.org*
APIM 15-004: Internet Protocol Suite (IPS) for Aeronautical Safety Services

Goal: Develop a roadmap for the introduction of an Internet Protocol Suite (IPS) in air/ground communication systems considering the current air/ground infrastructure and the need for information security.

AEEC General Session Results:

Paul Prisaznuk provided a progress report on behalf of Luc Emberger and Greg Saccone. He reported that the AEEC Executive Committee had formed the IPS Subcommittee to prepare standards for Internet Protocol Suite (IPS) services. APIM 15-004 calls for Roadmap Document leading to the development of IPS standards. ICAO Doc 9896 provides a preliminary IPS definition and leverages commercial IPS network technology.

This project is a large infrastructure definition that has the potential to improve data communication technologies used for NextGen and SESAR. In turn it is expected to provide a number of benefits to airlines, airframe manufacturers, and avionics suppliers. Airline benefits are expected to accrue in the form of improved data communication performance compared to ACARS and ATN.

The first IPS Subcommittee meeting took place at RTCA in February 2016. The purpose of the meeting was to work toward a better understanding of IPS concepts and timeframe for developing IPS standards. At that meeting several organizations reported on their activities to study the potential for IPS implementation, to analyze how IPS can be applied to existing aircraft architectures, and to present the results of IPS prototyping. At that meeting Boeing reported that trials have been conducted sending and receiving messages to an IPS ground system. Boeing predicts that IPS capability will be needed in 2025.

At the same meeting Airbus stated that it supports IPS in the long-term and believes that IPS will not be needed before 2028. Airbus said that it supports a schedule for developing standard necessary for 2025.

The current focus is Step 1: Roadmap for Standardization and Main Architecture Impacts of IPS. **ARINC Project Paper 658:** *Internet Protocol Suite (IPS) for Aeronautical Safety Services - Roadmap Document* is under development. The document will describe the roadmap for the standardization of IPS and the timeline for elements to be standardized. It will also discuss with other Standards Development Organization (SDO), the need to develop and/or update industry standards e.g., ARINC, RTCA, EUROCAE, ICAO. This will include an identification of IPS requirements, in terms of performance, information security, and provide a description of the avionics architecture impacts.

Future Work Program:

- **ARINC Project Paper 658:** *Internet Protocol Suite (IPS) for Aeronautical Safety Services Roadmap Document* is expected to be mature at the end of 2017.
- **Step 2:** Development of an ARINC Standard to define the avionics architecture, functions, and an IPS profile is anticipated as a follow-on activity.

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6. Symposium – Enhanced Vision System (EVS) and Synthetic Vision System (SVS)

Moderator: Robert Swanson, FedEx
Speaker: Stedman Stevens, Jetcraft
Speaker: Gerald Avella, FAA
Speaker: Lee Bormuth, Elbit Systems
Speaker: Josh Kendrick, FedEx

Robert Swanson organized a symposium on EVS and SVS. He invited industry experts to describe the latest advancements in these technologies to the aviation community.

EVS/SVS Speaker: Stedman Stevens, Jetcraft

Stedman Stevens presentation topic was “Changing the Conversation: The Economics of Flight Vision Systems.” He stated that an Enhanced Flight Vision Systems (EFVS) can add value in specific operations, namely extreme low-visibility conditions, with Head Up Displays (HUD) and Category III ILS system monitoring. The business case is frequently compared to autoland capability.

Stedman outlined the benefits that EFVS offer various stakeholders:

- Passenger: On-time arrivals
- Airline: Maintain schedule reliability and revenue
- OEM: Market differentiation and improved aircraft performance
- Airport and Air Traffic Control (ATC): maintained capacity and potential growth at airports without large infrastructure

Delays and cancellations are the passengers’ biggest concern. He observed that 50% of US delays are due to low ceilings and low visibility. Air traffic operations are slowed considerably even in moderate weather due to slowed arrival and approach speeds and increased separation requirements set by ATC. These affects are compounded on Performance Based Navigation (PBN), Area Navigation (RNAV) and Required Navigational Performance (RNP) approaches.

Stedman illustrated the effects of weather on operations at San Francisco International Airport. He noted that in clear weather, the airport can accept 60 aircraft per hour. In marginal visibility, this declines to 38 aircraft per hour, and in instrument weather, it declines still further to 30 aircraft per hour. This is one half of that possible in clear weather.

Stedman said that airlines often build some buffer time into their block times to account for small delays. He emphasized that these buffers may mask

operational inefficiencies, but they do not eliminate the true cost of the delay. The cost of these delays in the USA, in terms of fuel, crew, maintenance aircraft ownership and other items totaled $9.2 billion in 2014.

Stedman commented that the current airspace procedures do not encourage EFVS equipage. As a result, airlines are missing out on operational benefits and significant economic value. If EFVS were more broadly used it would:

- Enable the use of all instrument approach procedures
- Eliminate delays due to low visibility, fog, ceilings, cloud, snow, etc.
- Improve airport capacity
- Improve schedule reliability with minimal increase to infrastructure

The audience thanked Stedman for his presentation.

EVS/SVS Speaker: Gerald Avella, FAA

Gerald Avella presented Enhanced/Synthetic Vision Certification Considerations. He began by describing commonly the various types of equipment as follows.

- Head-Up Display (HUD): Projects primary flight information on a transparent screen in the pilot's forward field of vision.
- Enhanced Vision System (EVS): Provides a display of the actual external scene topography using imaging sensors.
- Synthetic Vision System (SVS): Provides a computer generated image of the external topography.
- Enhanced Flight Vision System (EFVS): Provides enhanced vision system displayed on a head-up display.

Gerald summarized the certification requirements and described the roles of Advisory Circulars (AC), Issue Papers (IP) and Transport Aircraft Issues List related to HUD, EVS, SVS and EFVS. Some of the general considerations include:

- How the software is developed
- Use of programmed electronic hardware devices
- Displays must include brightness controls
- System cannot degrade or obscure flight information or external view
- The display cannot possess undesirable characteristics

Gerald then detailed the certification considerations for each type of system.

For HUD:

- The display must be conformal. The altitude and flight path must be aligned and scaled with the outside view.
- In the event of loss of all but one primary display, the HUD is not sufficient.
- The equipment must not interfere with emergency equipment or egress.
- Content, arrangement, symbology and format must be consistent with other displays.

- Installation needs to prevent possibility of head injury.
- The display must be adjustable without removing hands from primary flight controls.

For EVS:

- Requires real-time imaging sensor
- If provided on primary display, it should easily de-clutter or remove sensor image

For SVS:

- Requires terrain and obstacle databases, precision navigation position, and must display height, altitude and heading
- Must identify prominent topographical features including bodies of water

For EFVS:

- All HUD requirements apply
- All EVS requirements apply
- EFVS images must consider the pilot view requirements

Gerald recommended that airlines refer to the Transport Airplane Issues List for additional information. He also suggests contacting the responsible FAA Aircraft Certification Office (ACO). Notice of Proposed Rulemaking (NPR) are in process to update CFR 25.773 to address vision systems located in the pilot's view, and CFR 91.176 consolidating all EFVS requirements and to include a requirement for an EFVS repeater.

Gerald concluded with some observations about anticipated future developments including the possibility of introducing Head Worn Displays (HWDs).

The audience thanked Gerald for his presentation.

EVS/SVS Speaker: Lee Bormuth, Elbit Systems

Lee Bormuth presented a historical view of the progress made in the development of EVS systems. He began with a split-screen image of a runway on short final. The non-enhanced image shows heavy fog, runway centerline lights and little else. In contrast, the EVS image clearly shows the runway lights, the runway environment and the surrounding terrain. He also provided an EVS image in mountainous terrain as compared to a non-enhanced image and the improvement is dramatic. He emphasized that nothing is safer than seeing the outside environment.

Lee explained that the first generation of EVS equipment was certified in 2001 but is no longer in production. Elbit certified a second generation EVS in 2007. Over 1,000 of these units are in operation. The next generation of EVS is expected to be certified in 2016. This will offer improved reliability, higher resolution, lighter weight, and fewer LRUs than previous versions.

These capabilities will be expanded to combine SVS, Infrared, day camera, and volcanic ash detection. Many improvements have evolved through the various EVS generations:

- Natural vision – complete cloud, no discernable visible objects
- First generation – approach lighting is visible with some runway visible
- Second generation – the runway with aiming point and distance markers are visible
- Next generation – the runway, aiming point, precision approach path indicator (papi) and piano bars are clearly visible
- The addition of SVS and infrared will enable the complete runway environment and distant terrain to be visible

Lee summarized EFVS equipage on the FedEx fleet and its benefits. With EFVS, new rules state that if the runway environment is in sight using the EFVS, the pilot may continue the approach all the way to touchdown and rollout, avoiding potentially costly diversions.

Lee presented a HUD image view, an SVS approach, and head-wearable displays. He also described a special blending technique wherein images from two different sources can be combined. Additional improvements are possible from merging mid-wavelength infrared (MWIR) and short-wavelength infrared (SWIR) images into a single image.

Lee reported that advancements continue to be made in packaging EFVS equipment. Multiple sensors can be integrated into a single unit. This will ease installation and reduce the overall cost of EFVS.

The audience thanked Lee for his presentation.

EVS/SVS Speaker: Josh Kendrick, FedEx

Josh Kendrick, FedEx, provided an update on the HUD/EFVS program at FedEx. He said that safety was the primary motivation for FedEx to equip its aircraft with HUD/EFVS. The safety benefits are as follows:

- Increased situational awareness
- Better energy management
- Improved aircraft control
- Monitoring benefits
- Improved global 24/7 operations

The operational improvements are:

- All weather operations
- Reduced service failure and disruptions
- FedEx brand benefits

Josh provided an equipage summary. He said that all McDonnell Douglas MD-11/MD-10s, and Boeing B757, B767, and B777 are presently equipped. Operational specifications allowing use of EFVS are in place for the MD-11/MD-10 fleet, with the Boeing fleet expected this year.

Josh then summarized current FAA regulations regarding EFVS which state:

"The pilot determines that the enhanced flight visibility observed by use of a certified enhanced flight vision system is not less than the visibility

prescribed in the standard instrument approach procedure being used…and may continue to 100' above TDZE using enhanced flight visibility…".

Josh reported that FedEx received an exemption which allows them to initiate an approach with the following requirements:

- At least 1000 feet runway visual range (RVR) or ¼ mile visibility
- Applies to approaches with vertical and lateral guidance
- Specific pilot, training, and recording requirements

Josh commented that EFVS capabilities are often compared to Category III ILS approach capabilities in which an airplane can descend to the runway in zero visibility. However, this is an unreasonable comparison because there are very few Category III runways in existence. He added that FedEx is a global operation, and that EFVS can approximate Category II capability on any runway. He showed a short video of a FedEx B757 approach into Austin, Texas utilizing the HUD/EFVS juxtaposed to the natural vision out of windshield.

Josh supported the need for international harmonization efforts leading to:

- Minima credits in various flight phases (taxi, takeoff, and landing)
- Equipment requirements
- Training requirements
- Supporting regulations and inspector guidance

Josh reported that FedEx is presently seeking taxi credit for EFVS that is equivalent to visual operations. He believes that future capabilities will continue to develop, eventually allowing EFVS to touchdown. Josh expressed concern with LED lighting at airports not being visible to EVS systems due to the low heat signature.

The audience thanked Josh for his presentation. Presentation materials are circulated with Reference Letter 16-070/AGS-183. The materials are available at the AEEC website *http://www.aviation-ia.com/aeec*.

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7. Flight Deck and Aeronautical Data Bases

7a. Flight Management Systems (FMS)

ARINC 702A
Chairman: Mike Bakker, GE Aviation
Secretary: Paul Prisaznuk – *pjp@sae-itc.org*
APIM 15-005: ARINC 702A Advanced Flight Management Computer System

Goal: Flight Management Computer Standards for emerging airspace requirements are being developed to take advantage of advancements in Communication, Navigation and Surveillance (CNS), all with the collective goal to increase the capacity and efficiency of the airspace.

AEEC General Session Results:

Paul Prisaznuk provided a status report on behalf of Mike Bakker, GE Aviation. Paul reported that one in-person meeting has been held since APIM 15-005 was approved in September 2015. The results were summarized as follows:

Supplement 5 to ARINC Characteristic 702A: *Advanced Flight Management Computer System*, is being updated to support NextGen and SESAR airspace initiatives. It is expected that Supplement 5 will be aligned to the applicable RTCA/EUROCAE standards in support of Performance-Based Navigation (PBN) and Trajectory Based Operations (TBO).

The objectives of Supplement 5 include:

- Align with and refer to the corresponding RTCA DO-236C RNP MASPS and RTCA DO-283 MOPS – and go a step further
- Standardize interfaces for FMS Landing System (FLS) and Final Approach Segment (FAS) data block
- Align with evolutions since the last major ARINC 702A update (e.g., ATS datalink)

Future Work Program:

- The next FMS Subcommittee meeting is scheduled for July 6-8, 2016 in Annapolis, Maryland.
- **Supplement 5 to ARINC Characteristic 702A** is expected to be mature at the end of 2017.

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7b. Navigation Database (NDB) Subcommittee

ARINC 424
Chairman: Chuong Phung, FedEx
Secretary: Sam Buckwalter – *sam.buckwalter@sae-itc.org*
APIM 11-005A: Navigation Data Base (NDB)

Goal: The goal is to develop and maintain Navigation Database (NDB) standards used with Flight Management Systems.

AEEC General Session Results:

Sam Buckwalter reported the NDB Subcommittee has prepared a mature Supplement 21 to **ARINC Specification 424:** *Navigation System Database*. One of the many benefits of this update is to ensure continued interoperability of ATS procedures and FMS implementations. Additional benefits are expected from the reduced separation standards and the increased availability of user-preferred routing that will result from the development of RNP RNAV procedures.

The activity is in the process of modeling the ARINC 424 content using the Unified Modeling Language (UML), enabling an object-oriented definition of ARINC 424 and the creation of a standard XML Schema Definition (XSD) file for inclusion in ARINC 424 Supplement 22. In doing so, the current ARINC 424 interchange format of 132 characters will be expanded to include an XML format that is easy to extend and has no size constraints.

Sam Buckwalter reported on the numerous updates to Draft 6 of Supplement 21. Additionally, he advised that Draft 6 was circulated to industry and received no comments.

AEEC Adoption Action:

- **AEEC adopted Supplement 21 to ARINC Specification 424:** *Navigation System Database.* APIM 11-005A was closed as a result of this action.

APIM Approval:

- **AEEC approved APIM 11-005B.** This APIM calls for **Supplement 22 to ARINC Specification 424:** *Navigation System Database*, defining a navigation database standard the will include both ASCII and XML encoding of data.

Future Work Program:

- The next NDB Subcommittee meeting is scheduled for March 2017 in Florida.
- The schedule for Supplement 22 is TBD.

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7c. Aeronautical Databases (Airport Mapping, Terrain, and Obstacle)

ARINC 814 and ARINC 816
ARINC Project Paper 813, ARINC Project Paper 815
Chairman: Brian Gilbert, Boeing
Secretary: Peter Grau – *peter.grau@sae-itc.org*
APIM 09-008A: Airport Mapping Data Base
APIM 12-006: Terrain Database and Obstacle Database
APIM 12-007: XML Encoding and Compression

Goal: The goal of the ADB Subcommittee is to define open encoding formats for the Airport Mapping Database (AMDB), Terrain Database, and Obstacle Database. The AMDB will utilize features and attributes specified by RTCA DO-272, DO-291, EUROCAE ED-99, ED-119 and maintain alignment with them. Similarly, the Terrain Database and Obstacle Database

will maintain alignment with RTCA DO-276, DO-291, EUROCAE ED-76 and ED-119.

AEEC General Session Results:

Brian Gilbert, Boeing, provided a summary of ADB Subcommittee activities. During the past year, the subcommittee prepared a mature draft of **Supplement 3 to ARINC Specification 816:** *Embedded Interchange Format for Airport Mapping Data Base.* Supplement 3 introduces new features including:

- Preferred and Low Visibility Taxi Routes
- Extending the Aerodrome Surface Routing Network
- Container Improvements
- Runway Slope Definition
- Airport Lighting

Errors in the electronic support files for ARINC Specification 816-2 were identified in September 2015 as compliant datasets were being constructed and validated. The ADB Subcommittee participants made an appeal for ARINC to maintain this version of the standard alongside of the latest version prepared as Supplement 3. The ADB Subcommittee has since corrected the errors in Supplement 2 and has prepared the modifications as **Change 1 to ARINC Specification 816-2:** *Embedded Interchange Format for Airport Mapping Data Base.* The document and the electronic files are viewed to be mature.

ARINC Project Paper 813: *Embedded Interchange Format for Terrain Databases* is being developed to support a variety of applications such as Terrain Avoidance and Warning Systems (TAWS), Vertical Situation Displays (VSD), and Synthetic Vision Systems (SVS).

ARINC Project Paper 815: *Embedded Interchange Format for Obstacle Databases* is being developed to support a variety of applications such as Terrain Avoidance and Warning Systems (TAWS), Vertical Situation Displays (VSD), and Synthetic Vision Systems (SVS).

ARINC Specification Paper 814: *XML Encoding and Compression Standard* was adopted and published in 2015. The document is expected to be applicable to all types of aeronautical databases. Supplement 1 to ARINC 814 is being prepared as a result of changes found necessary in the development of ARINC Project Paper 813 and ARINC Project Paper 815.

AEEC Adoption Actions:

- **AEEC adopted Change 1 to ARINC Specification 816-2:** Embedded Interchange Format for Airport Mapping Data Base.
- **AEEC adopted Supplement 3 to ARINC Specification 816:** *Embedded Interchange Format for Airport Mapping Data Base.* APIM 09-008A was closed as a result of this action.

Future Work Program:

- **ARINC Project Paper 813:** *Embedded Interchange Format for Terrain Databases* is expected to be mature in October 2017.

- **Supplement 1 to ARINC Project Paper 814:** *XML Encoding and Compression Standard* is expected in October 2017.
- **ARINC Project Paper 815:** *Embedded Interchange Format for Obstacle Databases* is expected to be mature in October 2017.

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7d. Cockpit Display Systems (CDS) Subcommittee

ARINC 661
Chairman: Chad Weldon, Rockwell Collins
Secretary: Peter Grau – *peter.grau@sae-itc.org*
APIM 08-004B: Cockpit Display System

Goal: The goal is to prepare flight deck display interface standards for new aircraft development programs including air transport, business, regional, general aviation and military aircraft.

AEEC General Session Results:

Chad Weldon summarized the activities of the CDS Subcommittee. During the past year, a mature **Supplement 6 to ARINC Specification 661:** *Cockpit Display System Interfaces to User Systems: Avionics Interfaces, Part 1, Basic Symbology, and Behavior* emerged. This has the potential to expand CDS capability and includes:

- Additional new widgets and widget extensions
- Multi-touch and touchscreen technology
- Synthetic vision capability
- Widget structure meta definition
- Parameter synchronization
- Post Windows Icons, Menu and Pointing (WIMP) devices

The CDS Subcommittee enjoys strong participation of major airframe manufacturers, avionics suppliers, and specialty software providers.

AEEC Adoption Actions:

- **AEEC adopted Supplement 6 to ARINC Specification 661**: Cockpit Display System Interfaces to User Systems, Part 1, Avionics Interfaces, Basic Symbology, and Behavior. APIM 08-004B was closed as a result of this action.

APIM Approvals:

- **AEEC approved APIM 08-004C.** This APIM calls for **Supplement 7 to ARINC Specification 661:** *Cockpit Display System Interfaces to User Systems, Part 1, Avionics Interfaces, Basic Symbology*, and Behavior and **ARINC Project Paper 661:** *Cockpit Display System Interfaces to User Systems, Part 2, User Interface Markup Language (UIML) for Graphical User Interfaces.*

Future Work Program:

- The next CDS Subcommittee meeting is scheduled for June 6-10, 2016 in Grand Rapids, Michigan.

- Supplement 7 to ARINC Specification 661 Part 1 is expected to be mature in April 2018.
- **ARINC Project Paper 661 Part 2** is expected to be mature in April 2018.

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8. Data Networks

8a. EFB Users Forum

Co-Chairman: Phillip Haller, Austrian Airlines
Co-Chairman: Will Ware, Southwest Airlines
Secretary: Peter Grau – *peter.grau@sae-itc.org*
APIM 09-009B: Electronic Flight Bag Users Forum

Goal: The Electronic Flight Bag (EFB) Users Forum coordinates the development of EFB operational concepts among airlines, aircraft manufacturers, EFB suppliers, system integrators, and regulators. This will help achieve the goal of developing a wide range of EFB products, expanded capabilities, and lower cost.

AEEC General Session Results:

Peter Grau described the EFB Users Forum activities jointly organized with IATA. The topics under discussion include:

- Operator Experiences
- Emerging EFB Technology
- Applications
- Human Factors
- Security and Connectivity
- Regulatory Changes

Benefits of the EFB Users Forum are in the form of operational improvements to the EFB hardware and software. These improvements are expected to reduce direct operating costs, clarify in-service issues and support the development of EFB applications. The EFB Users Forum uses a four-session format, with presentations from subject matter experts describing current EFB experiences and future developments. It is the world's largest EFB Conference, attracting over 300 participants from a wide range of backgrounds including airline flight operations, engineering, maintenance, information technology, and regulatory authorities.

Two EFB Users Forum meetings took place in 2015, one in Denver, Colorado hosted by Jeppesen, and one in Dubai, UAE hosted by Microsoft. The AEEC Executive Committee recognized the success of this activity.

Future Work Program:

The next EFB Users Forum meeting will be held May 24-26 in Munich, Germany. The meeting will be hosted by Lufthansa Systems.

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8b. Electronic Flight Bag (EFB) Subcommittee

ARINC 834
Co-Chairman: Maurice Ingle, American Airlines
Co-Chairman: Sonja Schellenberg, Lufthansa Airlines
Secretary: Peter Grau – *peter.grau@sae-itc.org*
APIM 11-012C: Aircraft Data Interface Function (ADIF)

Goal: The goal of the EFB Subcommittee is to develop hardware and software interface standards for EFBs. This is a rapidly evolving technology with wide-ranging applications.

AEEC General Session Results:

Peter Grau provided a summary of EFB Subcommittee activities. During the past year, ARINC published **ARINC Specification 828-4:** *Electronic Flight Bag (EFB) Standard Interface*.

The EFB Subcommittee has prepared a mature draft of **Supplement 6 to ARINC Specification 834:** *Aircraft Data Interface Function (ADIF).* This document specifies how ACARS messages can be prepared using the EFB.

The next step is to define a printer protocol that will enable the EFB to create print files for transmittal to the cockpit printer. This task is included in APIM 11-012C but has been delayed beyond Supplement 6. Airbus was invited to provide an input at the next meeting.

AEEC Adoption Action:

- **AEEC adopted Supplement 6 to ARINC Specification 834:** *Aircraft Data Interface Function (ADIF).* APIM 11-012C was kept open to define the printer protocol in Supplement 7.

Future Work Program:

- The next meeting will take place May 23-24, 2016 in Munich, Germany.
- **Supplement 7 to ARINC Specification 834** is expected to be mature in April 2017.

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8c. Network Infrastructure and Security (NIS) Subcommittee

ARINC Project Paper 822A, ARINC Project Paper 852
Chairman: Steve Arentz, United Airlines
Secretary: Vanessa Mastros – *vanessa.mastros@sae-itc.org*
APIM 13-003A: On-Ground Aircraft Wireless Communication
APIM 13-005: IP Security Data Logging

Goal: The NIS Subcommittee prepares standards for aircraft network connectivity using Internet Protocols (IP) and associated information security.

AEEC General Session Results:

Steve Arentz provided a status report highlighting the focus, progress, accomplishments, and future work plan for the NIS Subcommittee. The role of the NIS Subcommittee is to develop standards for aircraft network and connectivity solutions. The focus is on network interfaces and not necessarily the hardware or software interfaces. Operational assessments of network solutions and analysis of security issues is also included.

Over the course of the year, the NIS Subcommittee has primarily focused efforts on developing two documents as described below:

- **ARINC Project Paper 822A:** *On-Ground Aircraft Wireless Communication* was prepared per APIM 13-003A. provides guidance on wireless communication services utilizing technological advances (4G Cellular, IEEE 802.11n & ac) and current best practices for on-ground, wireless communication between an aircraft with weight-on-wheels and a ground-based network. Draft 4 of ARINC Project Paper 822A was viewed to be mature.
- **ARINC Project Paper 852:** *Guidance for Security Data Logging in an IP Network Environment* is being developed per APIM 13-005. The scope of this document includes security monitoring, data logging and reporting of onboard networks with external connectivity. Guidance for data logging in the Airline Information Services (AIS) and Passenger Information and Entertainment Services (PIES) domains is being prepared. This will establish a common set of security related data elements and formats that can be used by airline IT departments in the analysis of aircraft security log file data.

AEEC Adoption Actions:

- **AEEC adopted Draft 4 of ARINC Project Paper 822A**: *On-Ground Aircraft Wireless Communication* as modified by pink pages:
  - Honeywell provided comments on Appendix B. The syntax reflects “openssl” encoding. This could be interpreted as “openssl” is the only solution. New wording was provided.
  - Airbus suggested that IP address ranges should be included in ARINC 822A. A reference to ARINC 664 will be included in the published version of ARINC Specification 822A.
- APIM 13-003A was closed as a result of this action.

APIM Approval:

- **AEEC approved APIM 16-004 calling for Supplement 2 to ARINC Report 842:** *Digital Certificate Guidance.*

Future Work Program:

- **Supplement 2 to ARINC Report 842:** *Digital Certificate Guidance* is expected to be mature in April 2018.
- **ARINC Project Paper 852:** *Guidance for Security Data Logging in an IP Network Environment* is expected to be mature in October 2016.
- **Standardization of a Broadband Network Interface** to support non-safety services was discussed at length. Steve reported that the NIS Subcommittee is familiar with this topic as a result of joint meetings with KSAT/NIS. APIM 14-008 had called for the definition of a broadband network interface in **ARINC Project Paper 848.** For example, broadband services may be shared with both passenger and non-passenger devices, such as tablet device functioning as an Electronic Flight Bag (EFB). The generic network interface could be Ku-band, Ka-band, Gatelink, or other non-safety service. Common network protocols and interfaces between non-safety broadband systems and aircraft IP networks need to be defined. The key tasks include AIS/PIES domain separation, Quality of Service definition, and network security considerations. Steve suggested that the NIS Subcommittee is the proper forum for preparing such a standard. The AEEC Executive Committee agreed with this recommendation. As a result, the NIS Subcommittee was invited to prepare APIM 16-xxx to describe the scope, schedule, and deliverables for this activity, and submit it to the AEEC Mid-Term Session in October 2016.

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8d. CANbus

ARINC 825
Chairman: Tom Joseph, GE Aviation
Secretary: Tom Munns – *thomas.munns@sae-itc.org*
APIM 13-004C: On-Ground Aircraft Wireless Communication

Goal: The goal of the CAN Working Group is to prepare **Supplement 4 to ARINC Specification 825:** *General Standardization of Controller Area Network (CAN) for Airborne Use* as outlined in APIM 13-004C.

AEEC General Session Results:

Tom Munns provided a summary of the CAN Working Group focused on **Supplement 4 to ARINC Specification 825:** *General Standardization of CAN (Controller Area Network) Bus Protocol for Airborne Use.* The CAN Working Group will define a version of the CAN FD (Flexible Data Rate) protocol for aviation use. In addition, the CAN Working Group is considering the following issues in Supplement 4:

- Timing, bandwidth management, latency, and jitter

- Wire-level protocols
- Safety and reliability
- Protocol and service implementation conformance
- CAN security
- System and network interoperability

Future Work Program:

- **Supplement 4 to ARINC Specification 825** is expected to be mature in December 2017.

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9. Avionics Systems & Architectures

9a. Systems Architecture and Interfaces (SAI) Subcommittee

Co-Chairman: Bob Semar, United Airlines
Co-Chairman: Reinhard Andreae, Lufthansa
Secretary: Paul Prisaznuk – *pjp@sae-itc.org*

Goal: The SAI Subcommittee prepares avionics architecture recommendations for new equipment as well as next generation airspace initiatives, in particular NextGen and SESAR. This includes modification to existing aircraft as necessary to meet the needs of emerging airspace requirements.

AEEC General Session Results:

Bob Semar, United, reported that the SAI Subcommittee is working with FAA, Eurocontrol and other industry stakeholders to further identify equipment requirements for NextGen and SESAR. This includes those standards necessary to satisfy CNS/ATM requirements using data link communications, GNSS navigation and ADS-B for traffic surveillance. Avionic architectures, data network interfaces, and those functions necessary to assure cost-effective support over the life of the aircraft are topics of discussion.

SAI Subcommittee activities include:

- Plan the evolutionary path for aviation data communications, including the application of the Internet Protocol Suite (IPS) for Aeronautical Safety Services
- Prepare recommendations for Global Aircraft Tracking
- Consider the need for avionics software quality and reliability standards
- Explore ARINC Standards opportunities, i.e., APIM Review

The SAI Subcommittee is building upon the recommendations of **ARINC Report 660B:** *CNS/ATM Avionics Architectures Supporting NextGen/SESAR Concepts*.

Supplement 5 to ARINC Characteristic 702A: *Advanced Flight Management Computer System*, is being prepared to support emerging airspace requirements.

Aeronautical Mobile Airport Communications System (AeroMACS) standards are being developed in the AeroMACS working group preparing **ARINC Project Paper 766:** *Aeronautical Mobile Airport Communication System (AeroMACS) Transceiver and Aircraft Installation Standard*.

The SAI Subcommittee has been the AEEC focal point for Global Aircraft Tracking and for reviewing ICAO Aeronautical Distress & Safety System (GADSS) recommendations. ICAO will require GADSS on new production aircraft starting in 2021

- Normal Tracking – all flight phases – 15-minute interval
- Abnormal Tracking – 1 Minute intervals
- Autonomous Distress Tracking – high data rates

Technologies under consideration include Mode S Transponder, ADS-B, Space-based ADS-B, and ADS-C. Datalink technologies include VHF and satcom. Airlines prefer a simple, low-cost solution that meets the emerging requirements.

APIM Discussions:

The SAI Subcommittee has been the focal point for discussing new project proposals and building industry consensus leading to the development of new ARINC Standards. Ten project proposals have been reviewed in the first quarter of 2016

Bob reported that Lufthansa has prepared APIM 16-001: Software Quality and Reliability. The main themes are as follows:

- Improve software quality by defining and standardizing software quality parameters, availability of function and reliability.
- A second element is to provide guidelines on how to prepare product support agreements in a way that uses the quality parameters to improve software quality and reliability.
- Lufthansa recommended the aviation industry develop a set of measurable parameters to define a level of reliability and quality of software parts.

This topic will be discussed in detail at the next SAI Subcommittee meeting.

A list of APIMs approved and the new AEEC Projects is provided in the Executive Summary, Pages 4 and 5 of this report.

Future Work Program:

The next SAI Subcommittee meeting will be held June 14-16, 2016 at the Boeing UK offices in central London. Topics include:

- Standardization of Avionics Software Performance and Reliability
- Systems Approach to Aircraft Data Networks
- Global Aircraft Tracking
- ARINC Report 660B and NextGen/SESAR Avionics

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9b. Traffic Surveillance and ADS-B

Chairman: Jessie Turner, Boeing
Secretary: José Godoy – *jose.godoy@sae-itc.org*

Goal: Develop and maintain traffic surveillance standards to enhance flight crew situational awareness and to ensure safety. These include traffic surveillance and ADS-B standards appropriate for FAA NextGen, Single European Sky ATM Research (SESAR) and other present and future Air Traffic Management (ATM) operations.

AEEC General Session Results:

José Godoy provided the status report on behalf of the Working Group's Chairman, Jessie Turner, Boeing.

ADS-B Out: Enables precise airspace (and airport surface) surveillance by the periodical squitter of your position, altitude, airspeed, intent (Selected Heading, Alt, Selected Speed), etc.

ADS-B In: Enhances own situational awareness when used with a Cockpit Display of Traffic Information (CDTI). ADS-B In applications allow cost efficient maneuvers resulting in reduced fuel consumption, operation at optimum flight paths and altitudes.

ADS-B Mandates:

USA Airspace (ADS-B Out - Version 2 per RTCA DO-260B)

- Forward Fit: January 2020
- Retrofit: January 2020

EU Airspace (ADS-B Out - Version 2 per RTCA DO-260B)

- Forward Fit: June 2016
- Retrofit: June 2020

The Traffic Surveillance Working Group is monitoring ACAS X and Hybrid Surveillance activity within RTCA SC-147, Traffic Alert & Collision Avoidance System and their deliverables:

- **RTCA DO-300A Change 1:** Minimum Operational Performance Standards (MOPS) for Traffic Alert and Collision Avoidance System II (TCAS II) Hybrid Surveillance
- **RTCA DO-185B Change 2:** MOPS for Traffic Alert and Collision Avoidance System II (TCAS II)
- **RTCA DO-337:** Recommendations for Future Collision Avoidance Systems

The Working Group is monitoring Mode S and ADS-B functionality activity by the RTCA SC-209: ATCRBS/Mode S Transponder Special Committee and their deliverable:

- **RTCA DO-181F**: *MOPS for Traffic Alert and Control Radar Beacon System/Mode Select (ATCRBS/Mode S) Airborne Equipment*

The Working Group is monitoring ADS-B activity within RTCA SC-186, Automatic Dependent Surveillance - Broadcast (ADS-B) and their deliverables:

- **RTCA DO-317B:** MOPS for the Aircraft Surveillance Application (ASA) System
- **RTCA DO-260C:** MOPS for 1090 MHz Extended Squitter for ADS-B and TIS-B (Joint Document with EUROCAE)

Future Work Program:

- The Traffic Surveillance Working Group is monitoring Mode S Transponder, ADS-B activities, and the role of satellite based ADS-B technology in Global Aircraft Tracking initiatives.
- The Working Group will continue to monitor ACAS X development, the changes to RTCA DO-181F and DO-260C, and advise when updates to ARINC Characteristics 718A, 735B and 768 are needed.

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9c. GNSS Evolution

Speaker: Rex Hygate, CMC Electronics

Rex Hygate summarized Global Navigation Satellite Systems (GNSS) development activities on behalf of John Studenny, CMC and RTCA SC-159 Global Positioning System Special Committee. GNSS positioning data is used in navigation and surveillance, including global aircraft tracking. The presentation focused on the efforts to standardize Multi-Constellation Multi-Frequency (MCMF) GNSS.

Rex pointed out that GNSS is comprised of multiple satellite constellations. These include:

- United States – Global Positioning System (GPS)
- Russia – GLObal Navigation System (GLONASS)
- Europe – Galileo – scheduled to be completely operational in 2020
- China – Beidou – expected to be fully operational in 2020.

RTCA SC-159 WG2 is developing new Minimum Operation Performance Standards (MOPS) for Aviation GNSS. It is determining what constellations and frequencies will be included in the standard. The new document will be based upon the existing L1 GPS Standard, **RTCA DO-229D:** *MOPS for GPS/SBAS Airborne Equipment*.

All candidate signals must be in the Aeronautical Radio Navigation Service (ARNS) bands. ARNS signals include:

- GPS: L1 coarse/acquisition code (C/A), L5
- GLONASS: G1
- Galileo: E1, E5a
- Future GLONASS signals
- Future Beidou signals

Due to antenna location limitations and practicalities, the potential GNSS frequency list has been reduced to the following:

- 1575.42 MHz: L1 (Code Division Multiple Access (CDMA) protocol)
- 1176.45 MHz: L5 (CDMA protocol)

- 1602 MHz + n: G1, where n is a GLONASS satellite's frequency channel number between minus 7 and 6.

CMC has recommended that the new RTCA Standards identify clear benefits to end users. It should outline benefits to MCMF users beyond those offered by GPS, SBAS and GBAS L1:

- New airspace capabilities such as RNP
- New precision approach capabilities
- Satisfy new mandates
- Guidance on how MCMF equipment can be effectively used

Signal filtering standards for sensitivity and noise are expected to be included in MCMF standards. Adjacent Band Compatibility (ABC) requirements are evolving and should also be in the new standards (i.e., new RF interference masks and filter requirements, specific noise/interference margins for frequencies L1, L5, and G1.

Because GLONASS G1 is next to Mobile Satellite Services (MSS) frequency band, there is a potential for Radio Frequency Interference (RFI) in the G1 band. Therefore, signal separation requirements will be necessary for GNSS antennas, including filter masks, sensitivity, noise tolerance, receiver susceptibility, and signal immunity requirements.

Rex noted that a key benefit to SBAS expansion and standardization will be CAT-II Lateral Precision with Vertical (LPV) guidance. New systems need to transmit continuous navigational signals, as well as, or better than today's proven GPS L1 C/A signal. Constellation and satellite availability is required, justifying the need for GNSS augmentation. In short, SBAS is needed and should be included in new GNSS MOPS.

Current GBAS standards development efforts focus on CAT-II/III GBAS Approach Service Type D (GAST-D) using the legacy GPS L1 C/A signal. Future items for discussion include the "most evil waveform" and its impact on creating hazardously misleading information to the GBAS receiver. These are among the many issues being discussed by RTCA SC-159.

Rex concluded by saying that the next phase of GNSS work has just started. The RTCA MOPS development activities will present some challenges in the areas of receiver design. MCMF has the potential to improve the accuracy, integrity and availability of positioning data.

The audience thanked Rex for his presentation. Presentation materials are circulated with Reference Letter 16-070/AGS-183.

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10. Symposium – Aircraft Tracking and Space-Based ADS-B

Moderator: Mário Araújo, TAP Portugal
Speaker: Kathleen O'Brien, Boeing
Speaker: Thierry Harquin, Airbus
Speaker: Arnold Oldach, ACSS
Speaker: Michael Garcia, Aireon

Mário Araújo moderated the Aircraft Tracking and Space-Based ADS-B symposium. He introduced the speakers and provided background on the need for global aircraft tracking. Mário said that aircraft tracking has become a dominant topic since Malaysian Airlines MH370 tragically vanished two years ago. Multi-national search teams have surveyed 120 square miles of the Indian Ocean sea bed, an area greater than Portugal and Brussels combined. The most expensive search in aviation history has yielded only small debris, including a flaperon that washed ashore at Reunion Island. The location of the bulk of the aircraft has not been found. The cause of the event is unknown and the aircraft's voice and data recorder have not been recovered. Since that time, the need for global aircraft tracking has become quite visible.

Aircraft Tracking Speaker: Kathleen O'Brien, Boeing

Kathleen O'Brien, noted that Boeing recognizes the importance or global aircraft tracking, as MH370 was a B777 aircraft. Boeing is working with customers, regulators and industry evaluating tracking methods that will provide a satisfactory solution. The final solution should add value to the operator, be affordable and effective. Boeing wants to provide the same solution for different aircraft types, both production and retrofit.

Kathleen presented the ICAO Global Aeronautical Distress Safety System (GADSS) concept diagram depicting the tracking levels being considered as follows:

- Normal Tracking.
- Abnormal Tracking
- Autonomous Distress Tracking

Normal Tracking

Normal Tracking requires aircraft position reporting every fifteen minutes. It can be accomplished with existing equipment and technology. Aircraft with satcom systems and/or an ADS-B system can meet the Normal Tracking requirement. ICAO recommendation is for operators to comply with Normal Tracking by 2018.

Boeing recommends that operators investigate their State requirements and plan on installing satcom or an ADS-B system depending on where the airplane flies.

Abnormal Tracking

Abnormal Tracking requires aircraft position reporting based on certain triggers. These triggers are still to be defined. Once triggered, the aircraft reports its position every minute. Abnormal Tracking is described in the

ICAO document but there are no recommendations on when it is actually required. Autonomous Distress Tracking includes Abnormal Tracking.

Kathleen reported that the B787 has an emergency reporting capability that satisfies Abnormal Tracking requirements. Boeing will also offer an emergency reporting capability on the B777.

Autonomous Distress Tracking (ADT)

The goal of Autonomous Distress Tracking is to provide enough information to locate the aircraft within 6 NM, reporting about once every minute. Boeing's is concentrating its efforts on Autonomous Distress Tracking. However, this requirement cannot be satisfied using existing equipment. New technologies are being defined and developed.

Autonomous Distress Tracking triggers are being defined by RTCA SC-229, 406 MHz Emergency Locator Transmitters (ELT) Special Committee. Once activated, a formal distress signal will be transmitted for the search and rescue teams.

To satisfy this requirement, Boeing feels that the Mode S transponder cannot be turned off. It may need to be powered independently from a back-up power supply. This can be a challenging requirement.

Boeing supports the GADSS concept and plans to support the major elements of the document. The GADSS document scopes the subject well but it contains a few items that Boeing does not favor, such as provisions for an Automatically Deployable Flight Recorder (ADFR). Boeing does not favor the use of an ADFR because the requirement cannot be met by the use of available technologies. The cost of development would be high and Boeing does not feel this is in the airlines' interest. The intent can be satisfied by data streaming, when available in a few years.

Boeing successfully lobbied ICAO to have the requirements specified in terms of a performance-based standard rather than promoting a specific technology. The ICAO Standards and Recommended Practices (SARPs) became effective on March 20, 2016 and Normal Tracking will be applicable on November 8, 2018.

Kathleen said that the ICAO Air Navigation Commission had approved the SARPs in March 2016 and noted that the European Commission recommendations are slightly different.

Kathleen expressed the following concerns with the development of Autonomous Distress Tracking solutions:

- Cost and schedule make it prohibitive to redesign ACARS, satcom, Communications Management, or the ADS-B transponder function to provide tamper proof independent capability.
- The FAA requires the ability to deactivate the aircraft transponder, if directed by ATC. This complicates an integrated solution and may require new rulemaking.
- Space-Based ADS-B: Performance criteria for satellite reception of ADS-B signals will need to be addressed by ICAO.
- Boeing believes Space-Based ADS-B cannot affordably meet Autonomous Distress Tracking requirements

- ADS-B does not provide abnormal event triggering.
- ADS-B is not tamper proof, per FAR Part 91.217.
- A major redesign/replacement of ATC transponders might be required to address these deficiencies.
- Space-Based ADS-B implementation issues include:
  - Space-Based ADS-B ground infrastructure does not yet exist
  - It is not clear how position reporting will be made available to airlines and who would pay for communication costs
  - How would regional communication costs be determined
  - Would it be a world-wide solution?

Kathleen emphasized that there is work to be done particularly in the ADS-B area. Modifying existing ACARS and other data communication systems to satisfy global aircraft tracking objectives would be costly, there is no time available to retrofit aircraft, and is therefore not recommended.

The audience thanked Kathleen for her presentation.

Aircraft Tracking Speaker: Thierry Harquin, Airbus

Thierry Harquin provided the Airbus perspective on Global Aircraft Tracking. He said that Airbus has been deeply involved with ICAO GADSS, and numerous aircraft tracking, reporting and related studies.

Thierry presented the GADSS concept slide with defined Aircraft Tracking levels. He pointed out that there are existing solutions that can be used to satisfy the need for Normal Tracking and Abnormal Tracking.

However, Autonomous Distress Tracking and data recovery requirements will require new equipment. Thierry underscored the ICAO point of view that aircraft tracking is the airline responsibility. The national authorities will determine if the ICAO SARPs recommendations are enforced in their jurisdiction.

The goals are as follows:

- Track aircraft
- Alert problem with flight
- Locate wreckage and recorders
- Retrieve data

Track Aircraft Goals:

Normal Tracking and Abnormal Tracking goals are based on aircraft position reports. There are several feasible solutions:

- Use or modify existing systems (i.e., ACARS, AOC messages, Aircraft Condition Monitoring System (ACMS), ADS-C) with the associated communication means in the aircraft.
- Install a local dedicated, standalone system
- Use Space-Based ADS-B

Thierry provided an aircraft datalink communications overview. All Airbus aircraft have VHF capability. This a good solution when operating over land. However, when operating over the ocean, and in areas where VHF is not accessible or reliable, satcom (both Inmarsat and Iridium) and HF

communications are available on most Airbus aircraft. Iridium with its availability over polar regions is presently not offered on the A350 and A380. Airbus is waiting for the Iridium NEXT constellation deployment to make a decision.

Using the ACARS network, there are three aircraft tracking solutions that do not require additional flight crew workload:

- Airline Operational Control (AOC)
- Aircraft Condition Monitoring System (ACMS)
- Automatic Dependent Surveillance – Contract (ADS-C)

Aircraft Tracking Solution using AOC Application

Airbus is working with AOC suppliers, to offer Normal Tracking and Abnormal Tracking through an AOC customized database. It is a software only modification that is currently being utilized by several airlines.

Activation of Abnormal Tracking is automatic through a process that monitors specific parameters. When triggered, it transmits aircraft information every minute, and it is seamless to the flight crew.

Aircraft Tracking Solution using ACMS

Airbus is developing an Aircraft Tracking solution that provides Normal Tracking through a customized ACMS database. The Abnormal Tracking solution also requires the custom database. it has access to many avionics parameters that can trigger an event. Tracking using datalink will require a contract with a DSP using the applicable communication medium, e.g., VHF, HF, satcom.

Aircraft Tracking Solution using ADS-C

- Normal Tracking: ADS-C reporting every 1 to 15 minutes per contract.
- Abnormal Tracking: ADS-C reporting every minute.

This is only available to aircraft that are FANS A, FANS A +, FANS A+B equipped.

Locate Recorder Goals

Thierry elaborated on the recent data recorder requirements which have been influenced by various incident investigations and recommendations (i.e., AF 447 and MH 370). Thierry elaborated on some of the new requirements. In order to locate the aircraft, a new 8.8 kHz low-frequency underwater locator beacon frequency was defined. This frequency can be received underwater from a range of several kilometers. This underwater beacon must have of battery duration of at least 90-days.

Airbus Readiness

Thierry reported that many Airbus aircraft are capable of being tracked today. AOC messaging is the recommended solution. Aircraft tracking ground tools are presently available (i.e., Airbus' AirFlight Tool: a web based application that provides situation awareness for the airline's entire fleet.

Future tracking alternatives include Space-based ADS-B using the Iridium NEXT satellites with ADS-B capability expected in late 2017 to early 2018.

Airbus does not believe that aircraft or avionics changes will be required for aircraft already equipped with ADS-B Out.

The audience thanked Thierry for his presentation.

Aircraft Tracking Speaker: Arnold Oldach, ACSS

Arnold Oldach, presented the ACSS perspective on Global Aircraft Tracking System (GATS). The presentation concentrated on ADS-B Out and the use of the Mode S transponder and ADS-B.

Aircraft tracking can be supported using the existing ADS-B Out capabilities of the Mode S transponder. The Mode S parameters are broadcast approximately every four seconds. These include all the information necessary for aircraft tracking (e.g., Alt Reporting, Flt ID, intent parameters, ICAO 24-bit address, etc.).

Arnold discussed FAA FAR Part 91.217 on the topic of Altitude Reporting. He clarified the FAA requirement to turn-off altitude reporting capability when asked to do so. This is often misunderstood as a requirement to turn-off the transponder.

Arnold reported that **RTCA DO-181E:** *ATCRBS/MODE S MOPS* and **RTCA DO-260B:** *ADS-B and TIS-B MOPS* are in the process of being updated. The proposed modifications include:

- 1090 MHz spectrum mitigation
- Phase modulation
- Weather/MET data
- Advanced Flight Deck Interval Management (FIM) support
- Improvement of the Mode S reply rate

Phase Modulation technique is an overlay on the existing pulse position modulation that add the ability to add around 150 extra characters of data on every pulse. The overlay of eight phase shift keying is similar to differential eight phase shift modulation presently used by VDL Mode 2.

The reason that the ATC Transponder is being proposed as the best medium for Global Aircraft Tracking is because redundant transponders are installed on most aircraft today, ADS-B Out mandates are in place around the world, and there are no complex operations on board the aircraft. Aireon has announced a space-based ADS-B Tracking Service using a transponder receiver in the Iridium NEXT satellite constellation. The ITU has protected the 1090 MHz spectrum for global aircraft tracking.

No new logic needs to be added to today's transponder for Abnormal Aircraft Tracking, indication or alerting. The extended squitter specified by RTCA DO-260B provides sufficient data. Indication of Abnormal Aircraft operation can be quickly determined and reported to the ground.

Arnold reported that ATC implements conformance monitoring today using the flight plan. Abnormal operations could be detected quickly. No extensive calculations of what is normal is required on-board the aircraft.

Mode S transponder issues to be addressed include:

- Preventing crews from turning off, or placing in standby mode, a normally operating transponder
- Activity within RTCA, EUROCAE and AEEC to develop necessary standards and operating procedures for maintaining ADS-B Out capability during flight

Global Tracking: ACSS Position

L-3 and ACSS are fully supportive of the global tracking initiative, endorsing a coordinated, international approach to achieve harmonization of global aviation safety regulations. Global standards must be performance-based evolving away from prescribing technology to performance-based Communications, Navigation, and Surveillance.

Global tracking should use existing system capabilities on the aircraft. There are suitable alternatives which do not require new aircraft equipment. There are suitable means today including ACARS and FANS 1/A. Long-term solution can be based on ADS-B Out capability.

In terms of recommendations, Arnold proposed that the SAI Subcommittee evaluate issues associated with Mode S transponder modification, including associated systems to determine how transponders can be used for global aircraft tracking.

Arnold volunteered to prepare a set of recommendations in the form of a white paper with suggestions:

- Re-locating circuit breakers outside the flight deck
- Allowing pilot to switch transponders. For example, when both transponders are placed in standby mode, one transponder continues to broadcast at a low rate ADS-B Out squitter interval.
- Allow use of alternate position source (IRS, FMS) to the transponder in case of GPS failure

The AEEC Executive Committee expressed support for the SAI Subcommittee role in global aircraft tracking. The audience thanked Arnold for his presentation.

Speaker: Dr. Michael Garcia, Aireon

Mike Garcia provided an update on the Aireon's Space-Based ADS-B program. The Iridium NEXT constellation will replace the existing Iridium Block 1 satellites that have been operational for approximately 15 years. The NEXT satellites will provide uninterrupted Iridium voice and data services. An ADS-B receiver is being added to NEXT satellites' payload operating with all aircraft equipped with Mode S transponders.

The space-based ADS-B receiver will gather aircraft state, position and intent data. It sends the ADS-B data through a teleport network which in turn downlinks the information to the Aireon Processing and Distribution Center. The information is then distributed to the ANSPs.

The fully deployed NEXT constellation will consist of 66 satellites in a Low Earth Orbit providing worldwide coverage. There are 11 satellites per plane. Six in-orbit spare satellites bring the total airborne satellites to 72. Availability is expected to be 99.9 percent or better. The typical satellite lifecycle is 14

years. ADS-B surveillance and global aircraft tracking will be available without the need for additional aircraft equipage.

Mike emphasized that the space-based ADS-B network performs per RTCA DO-260, just like the ADS-B ground system. Reports are sent within 8 seconds (average is every 1.5 seconds). This compares well with the 15, 3 and 1 minutes, supported by other aircraft tracking systems.

Canada and the UK hope to reduce separation from 30 NM to 15 NM minimums by 2018. Aireon believes their solution is robust and that it can satisfy the requirements of Autonomous Distress Tracking.

Mike reported that ALERT is an Aireon service for emergency situation as compared to the regular space-based ADS-B service which is for ANSPs. ALERT is available 24/7. The alerting system will be made available as a public service free of charge. Any airline, State and Rescue Coordination Center can pre-register.

In the event of a distress or alert phase where there is no known aircraft position, Aireon will make the last known position or track available.

Aireon ALERT will globally satisfy the ICAO 15 minutes' flight tracking recommendation at 8 seconds or less without any additional avionics or related costs.

In summary, Mike said:

- The Aireon solution is "just ADS-B". Benefits expected will include optimized flight altitudes and reduced separation.
- No new boxes or antennas on the aircraft beyond what is already required for ADS-B 2020 mandates.
- Substantial benefits are anticipated for aircraft that fly in oceanic and/or remote areas.
- NavCanada and NATS plan to begin Reduced Oceanic Separation (ROS) services with 15 NM or better separation over North Atlantic Tracks beginning in 2018.
- Going beyond ANSPs, Aireon plans to sell the data to airlines and other users.
- Launch of 10 Iridium satellites with Aireon ADS-B payload is planned for later this year.

The audience thanked Michael for his presentation. Presentation materials are circulated with Reference Letter 16-070/AGS-183. The materials are available at the AEEC website *http://www.aviation-ia.com/aeec*.

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11. Special Topics

11a. Software Data Loading

ARINC 665
ARINC Project Paper 844, ARINC Project Paper 849
Co-Chairman: Ted Patmore, Delta Air Lines
Co-Chairman: Rod Gates, American Airlines
Secretary: Scott Smith – *scott.smith@sae-itc.org*
APIM 10-016B: Considerations for ARINC 615 Hardware Targets
APIM 13-007: Avionics Shop Loading of Line Replaceable Units
APIM 15-003: Supplement 4 to ARINC 665, Loadable Software Standards

Goal: The SDL Subcommittee is responsible for standardizing software data loading. ARINC Standards produced and maintained by the SDL are concerned with standardizing file formats, media types, media and part numbering schemes, and data loading protocols.

AEEC General Session Results:

Ted Patmore, Delta Air Lines, summarized the work of the SDL Subcommittee as follows:

- **Supplement 4 to ARINC Report 665:** *Loadable Software Standards* updates reference material, incorporate errata, and to include technical material pertinent to the document. The work includes:
  - Adding integrity check methods – SHA256, SHA512, CRC64
  - Incorporating industry technical inputs
  - Incorporating received editorial comments and errata
  - Updating the MMM code application process

  Supplement 4 to ARINC Report 665 was viewed to be mature.
- **ARINC Project Paper 844:** *Guidance for Target Hardware Design, Part 1, Airborne Computer High Speed Data Loader (ARINC 615-3).* This guidance intended for aircraft equipment manufacturers designing and implementing hardware targets that will utilize ARINC 615-3 data loading methods. The document will also provide software developers the background required to build ARINC 615 loadable targets using efficient, standardized processes. Also addressed are methods and procedures to utilize directory structures on mass storage devices for ARINC 615 data files as compared to floppy disk media. ARINC Project Paper 844, Part 1 was viewed to be mature.
- **ARINC Project Paper 844:** *Guidance for Target Hardware Design, Part 2, Airborne Computer High Speed Data Loader (ARINC 615-4).* This guidance intended for aircraft equipment manufacturers designing and implementing hardware targets that will utilize ARINC 615-4 data loading methods. The document will also provide software developers the background required to build ARINC 615-4 loadable targets using efficient, standardized processes. Also addressed are methods and procedures to utilize directory structures on mass storage devices for ARINC 615 data files as compared to

floppy disk media. ARINC Project Paper 844, Part 2 was viewed to be mature.

- **ARINC Project Paper 849:** *Avionics Shop Loading of Line Replaceable Units (working title).* This project intends to define off-wing data loading specifications and develop guidance for requirements and processes to allow shop loading of aircraft software parts. Modern avionics may require stimulus from other systems to allow operational or database loading, and must be emulated in an avionics repair facility environment.

AEEC Adoption Actions:

- **AEEC adopted Draft 5 of Supplement 4 to ARINC Report 665**: *Loadable Software Standards.* APIM 15-003 was closed as a result of this action.
- **AEEC adopted Draft 2 of ARINC Project Paper 844:** *Guidance for Target Hardware Design, Part 1, Airborne High Speed Data Loader (ARINC Report 615-3)*
- **AEEC adopted Draft 3 of ARINC Project Paper 844:** *Guidance for Target Hardware Design, Part 2, Airborne High Speed Data Loader (ARINC Report 615-4).* APIM 10-016B was closed as a result of this action.

APIM Approval:

- **AEEC approved APIM 16-002.** This APIM calls for the development of common standards for aircraft software loading, security, and management. It will document reference information common to airborne data loading and software standards. Examples of expected guidance include:
  - Common terminology to avoid different definitions across multiple standards
  - Software security standard references
  - Standardized file nomenclature, numbering, and header descriptions
  - Hard cover labeling guidance

  Airbus requested that APIM 16-002 be modified to stipulate that no changes to **ARINC Report 835:** *Guidance for Security of Loadable Software Parts Using Digital Signatures* would be made as a result of this APIM or the new ARINC Standard. The AEEC Executive Committee concurred.

Future Work Program:

- The next SDL Subcommittee meeting will be held August 25-26, 2016, in Toulouse, France.
- **ARINC Project Paper 6xx:** *Common Standards for Software Data Loading, Security and Data Management* is expected to be mature in April 2018
- **ARINC Project Paper 849:** *Avionics Shop Loading of Line Replaceable Units (working title) i*s expected to be mature in April 2017.

- Maurice Ingle reported that American Airlines is preparing an APIM with other operators that would propose standardization of eEnabled ground systems used for electronic management and distribution of Field Loadable Software (FLS). The idea is to define a common ground tool that could handle multiple processes including downloading data from aircraft, for example:
  - Maintenance Data
  - Log Data
  - Software configuration data

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11b. Fiber Optics Subcommittee

ARINC 803, ARINC 804, ARINC 805, ARINC 806, ARINC 807
ARINC Project Paper 845 and ARINC Project Paper 846
FOS Chairman: Robert Nye, Boeing
Secretary: Scott Smith – *scott.smith@sae-itc.org*
APIM 13-008: Fiber Optic Expanded Beam Termini
APIM 13-009: Fiber Optic Mechanical Transfer Termini

Goal: The goal of this activity is to develop and maintain a set of fiber optic interface standards that specify physical characteristics, design guidelines, component criteria, testing, and maintenance procedures. The objective is to promote a high level of performance while minimizing the cost of procurement, installation and maintenance.

AEEC General Session Results:

Scott Smith reported that the Fiber Optics Subcommittee is updating physical standards, design guidelines, component criteria, and testing and maintenance procedures for fiber optic components and systems for use on air transport aircraft.

The Fiber Optic set of documents in work includes:

- **ARINC Report 803:** *Fiber Optic Design Guidelines*
- **ARINC Report 804:** *Fiber Optic Active Device Specification*
- **ARINC Report 805:** *Fiber Optic Test Procedures*
- **ARINC Report 806:** *Fiber Optic Installation and Maintenance Procedures*
- **ARINC Report 807:** *Fiber Optic Training Requirements*

Scott reported that the FOS Subcommittee is focusing on the definition of two new fiber optic termini and resulting connectors for use in air transport aircraft. Two new project papers are being drafted:

- **ARINC Project Paper 845:** *Fiber Optic Expanded Beam Termini*. This project, chartered by APIM 13-008, intends to define a new fiber optic Expanded Beam (EB) contact for use in connectors with frequent disconnect/connect operations and/or in harsh environments. This work may require modifications to one or more of the existing ARINC Fiber Optic Standards.

In April 2015, TE Connectivity signed a Commitment to License the applicable Intellectual Property enabling interested parties to define a compatible fiber optic expanded beam termini.

At the January 2016 meeting, the FOS Subcommittee reached consensus that was contingent on TE Connectivity providing several technical items for inclusion in the document. TE Connectivity provided the material as requested, with the exception of three specific parameters:

- Rayleigh range
- Beam waist radius
- Beam waist location

The ARINC staff prepared Draft 3 of ARINC Project Paper 845 for industry review as an adoption candidate as requested by the FOS Subcommittee. Airbus and Boeing provided technical comments shortly before the AEEC General Session.

At the AEEC General Session, Boeing reported that, given the lack of technical material provided by TE Connectivity, Boeing could not support a vote on adoption at this time. Airbus agreed with the Boeing position, and expressed concern about the interoperability, as well as the ease-of-maintenance of the expanded beam termini proposed.

In the course of discussion in Atlanta, TE Connectivity responded by saying that the three data parameters requested by industry is considered to be TE intellectual property and that TE is reluctant to provide this information at this time. Furthermore, the three missing parameters can be calculated using the methods provided by TE.

The AEEC Executive Committee determined that Draft 3 of ARINC Project Paper 845 was not mature. The vote was deferred until after the data is made available. The FOS Subcommittee was asked to resume discussion, resolve the differences and provide the data parameters necessary to ensure physical and optical interoperability among multiple suppliers.

Scott Smith took the action to coordinate with the FOS Subcommittee and to provide a status report at the AEEC Mid-Term Session in October 2016.

- **ARINC Project Paper 846:** *Fiber Optic Mechanical Transfer Termini.* This project, chartered by APIM 13-009, intends to define a new fiber optic Mechanical Transfer contact for use in connectors with frequent disconnect/connect operations and/or in harsh environments. This work may require modifications to one or more of the existing ARINC Fiber Optic Standards. An initial draft is expected in 2016.

Future Work Program:

- The next FOS Subcommittee meeting will be held June 21-23, 2016, in Mukilteo, Washington.
- **ARINC Project Paper 845** is awaiting a response from TE Connectivity. When the TE material arrives, the FOS Subcommittee

will review the material, update the document, and forward the results to the AEEC Executive Committee for consideration.

- **ARINC Project Paper 846** is expected to be mature in April 2018.
- **Updates to ARINC Standards 803 through 807** are in work.

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11c. Application/Executive (APEX) Software Interface

ARINC 653, Part 0 through Part 5
Co-Chairman: Frederic Aspro, Airbus
Co-Chairman: Gordon Putsche, Boeing
Secretary: Scott Smith – *scott.smith@sae-itc.org*
APIM 08-003B: Avionics Application Software Standard Interface

Goal: The goal is to develop and maintain **ARINC Specification 653:** *Avionics Application Software Standard Interface*, defining a standard interface between avionics application software and Real Time Operating System (RTOS).

AEEC General Session Results:

Scott Smith presented the status of ARINC 653 activities for Frederic Aspro, Airbus, and Gordon Putsche, Boeing. ARINC 653 is used extensively on new civil and military aircraft produced by Airbus, Boeing and others. Avionics suppliers have expressed the desire to use ARINC 653 RTOS on regional, business and private aircraft. ARINC 653 enables application software to be developed concurrently and independent of the RTOS. This will enable avionics functional updates to be made with minimal impact on the underlying computing platform.

ARINC Specification 653: *Avionics Application Software Standard Interface* consists of seven parts as follows:

- **Part 0:** *Overview of ARINC 653*, introduces the seven-part set and explains the purpose and role of each document.
- **Part 1:** *Required Services*, was recently updated to defined services capable of supporting multi-core processors, and is presently considered stable.
- **Part 2:** *Extended Services*, was recently update to define multi-core services that are considered to be optional, and is presently considered stable.
- **Part 3A:** *Conformity Test Specification for Required Services* is viewed to be stable.
- **Part 3B:** *Conformity Test Specification for Extended Services*, is in development. A mature draft is expected in 2016.
- **Part 4:** *Subset Services*, defines a strict subset of Part 1. It defines RTOS services for small-scale platforms and it is viewed to be stable.
- **Part 5:** *Core Software Required Capabilities*, provides guidelines to facilitate software operating system integration on highly integrated platforms.

Scott Smith summarized the subcommittee's activities over the past 12 months. ARINC Specification 653, all parts, have remained stable. APEX Subcommittee web conferences have discussed the evolution of the ARINC Specification 653.

Work continues on defining requirements for multicore processors including health monitoring, partition management, and core affinities. The next meeting will determine the scope of work needed over the next 36 months and draft a new APIM 16-xxx. The APIM will be delivered to the SAI Subcommittee for review at their next meeting.

Future Work Program:

- The APEX Subcommittee will meet May 10-12, 2016 in Poznan, Poland.
- A new APIM 16-xxx is expected to emerge from that meeting.

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12. Special Topics

12a. AeroMACS

ARINC Project Paper 766
Chairman: Tom McGuffin, Honeywell
Secretary: José Godoy – *jose.godoy@sae-itc.org*
APIM 11-013A: AeroMACS

Goal: Develop the installation characteristics for an airborne Aeronautical Mobile Airport Communications System (AeroMACS) radio transceiver meant for operation in the protected C-band frequency of 5091 MHz to 5150 MHz, using the IEEE 802.16e WiMAX protocol.

AEEC General Session Results:

José Godoy provided the AeroMACS Working Group summary on behalf of Tom McGuffin, Honeywell. The AeroMACS Working Group is developing **ARINC Project Paper 766:** *Aeronautical Mobile Airport Communication System (AeroMACS) Transceiver and Aircraft Installation Standards* as authorized by APIM 11-013A.

The AeroMACS Radio Unit (ARU) and antenna form, fit, function and interfaces are described. Two ARU configurations are defined, a size 2 MCU per ARINC Specification 600, and a flange mount unit. Onboard routers, switches, IP applications are outside the scope of this characteristic. ARU Interfaces will include ARINC 664 Ethernet supporting multiple domains and ARINC 429 using Williamsburg file transfer protocols to the CMU.

AeroMACS services at the airports have not yet been identified. It is expected that AeroMACS will serve both ATS and AOC datalink services deployed on the airport surface. The Working Group is monitoring AeroMACS activities in the WiMAX Forum, FAA, Eurocontrol, ICAO's Aeronautical Communication Panel (CP) Surface Datalink Working Group (WGS), and RTCA SC-223: AeroMACS. The documents include:

- RTCA DO-345: Aeronautical Mobile Airport Communication System (AeroMACS) Profile

- RTCA DO-346: Minimum Operational Performance Standards (MOPS) for Aeronautical Mobile Airport Communication System (AeroMACS) summarized the accomplishments of the AeroMACS Working Group.

Future Work Program:

- **ARINC Project Paper 766** is expected to be mature in April 2017.

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12b. Flight Deck Audio

ARINC Characteristic 535B
Secretary: Peter Grau – *peter.grau@sae-itc.org*
APIM 12-003: Headset and Boom Microphone

Goal: The goal is to update audio system interface standards.

AEEC General Session Results:

Supplement 1 to ARINC Specification 535B: *Lightweight Headset and Boom Microphone* proposes changes to the pin assignments on the new XLR-7 connector to align them with the first five pins of the legacy XLR-5 connector.

AEEC Adoption Item:

- AEEC adopted **Supplement 1 to ARINC Characteristic 535B**: *Lightweight Headset and Boom Microphone*

Future Work Program:

- No future activity is planned.

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13. Announcements and Adjournment – AEEC Leadership Transition

The AEEC Mid-Term Session will be held October 13-14, 2016 in Toulouse, France. The meeting is open to all interested parties.

The next AEEC General Session will be held May 1-4, 2017 at the Milwaukee Convention Center and nearby Hilton Hotel in Milwaukee, Wisconsin.

The AEEC Event Calendar is located at *www.aviation-ia.com/aeec.*

In accordance with the AEEC Organization and Procedures Guide, Robert Swanson, FedEx, stepped down as AEEC Chairman at the close of the AEEC Advisory Session meeting held on April 28, 2016.

Kathleen O'Brien, Boeing, became the AEEC Chairwoman. James McLeroy, UPS, became the AEEC Chairman-elect.

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14. Presentation Materials, Memberships and Sponsorships

AEEC Members and Corporate Sponsors are invited to access the presentation materials from the ARINC Store free of charge per their membership and/or sponsorship agreement. Others may purchase the presentation materials from the ARINC Store for a nominal fee.

Presentation materials are circulated independent of this report. They are available with Reference Letter 16-070/AGS-183 and available at:

http://www.aviation-ia.com/aeec/general_session/gs_reports/index.html

For information on ARINC Industry Activities Membership and Corporate Sponsorship, please visit:

http://www.aviation-ia.com/MembershipAndSponsor/index.html

Attachment 1a

Attachment 1a

AEEC | AMC Opening Session 2016
Welcoming Remarks

Robert Swanson
AEEC Chairman
FedEx

Good morning! My name is Robert Swanson with FedEx Express, and on behalf of the AEEC Executive Committee, welcome to the AEEC General Session and Avionics Maintenance Conference!

AEEC was very busy this past year with on-going Subcommittee work, the AEEC General Session in Prague, and the AEEC Mid-Term Session in Seattle. Thanks to all of you for your participation in making 2015 a very productive year.

During 2015, AEEC Subcommittees and Working Groups held 49 face-to-face meetings, involving nearly 2700 experts from the industry. We started the year with 55 documents in work. During the course of the year, 22 ARINC Standards were completed by the subcommittees and then adopted by the AEEC Executive Committee. It was a daunting task that could only have been accomplished with the support of people who are willing to do this work, in addition to their day job and with the support of their companies, who continue to perceive AEEC as a worthwhile industry activity that adds value to each participating organization through industry collaboration and equipment standard development.

This week, the AEEC will be meeting next door, considering 15 new ARINC Standards up for adoption here in Atlanta, and 12 new project requests, or “APIMs”. I invite you to join the discussion. As ARINC Industry Activities has been acclimating to its new home with SAE, the Industry Activities Advisory Group spent some time this year in reflection and self-assessment, pondering the question, “What is our value to the industry?”

In a nutshell, the outcome of that assessment was:

First, the recognition that the commercial aviation industry and its regulatory environment are very competitive, complex, and dynamic, with operators sharing the same supplier base and similar challenges.

Second, ARINC Industry Activities provides the forum to engage the entire aviation community and shape the outcomes, which improves airline performance, safety, and reliability, all adding up to cost-effective operations and life cycle management.

Supplier participation in the AEEC is a great way to show support and appreciation for the airline customers. Through your involvement, you are an integral part of this mission.

This year marks my 19th year of involvement with the AEEC. My world back in 1997 was deeply immersed in the then-recent regulations of additional parameters for the flight recorder system, so I attended several industry meetings, including the AEEC DFDR Subcommittee, to keep up on industry developments. I never could have imagined the impact that AEEC Subcommittee attendance would have

on my life and my career. There are many, past and present, who have become my dear friends and have helped me to grow in the industry.

As mentioned previously, this is the 67th AEEC General Session. It is likely that there are none in attendance this week who were at the very first meeting. If there are, I would invite you to stand, if you can.

There are likely hundreds who have come and gone over the years to whom we owe a great deal for all that they did to get us to this point in our history. We all now have a duty to develop the next generation of aviation experts who will take the industry forward on paths that we cannot even now imagine. As we walk the foggy (CAT III) path, seeing only a few years ahead with any clarity, we now need to train those who are not bound by our traditions, whose imaginations will help the aviation industry to continue to fly safer, more reliably, and at a profit, while maintaining legal fitness.

Once again, welcome to Atlanta! We look forward to a productive week of meetings, discussions, approvals, resolutions, and, of course, the camaraderie that comes with this annual event.

Thank you.

Leadership: Prisaznuk/AEEC, O'Brien/Boeing, McFann/FedEx, Jozic/KLM, Dickson/Delta, Swanson/FedEx, Frelk/AAI, Rockwell/ARINC IA, Buckwalter/AMC, Lord/Delta

Attachment 1b

Attachment 1b

AEEC | AMC Opening Session 2016
Keynote Speech

Captain Steve Dickson
Senior Vice President of Flight Operations
Delta Air Lines

Jim Lord, Delta Air Lines, introduced the keynote speaker, Captain Steve Dixon, Senior Vice President of Flight Operations at Delta Air Lines.

Thanks, Jim. Good morning, everyone. It is a privilege to be with you this morning at this coveted Monday morning timeslot. I hope you had enough coffee to get through all the talking heads this morning at the opening plenary session, but I would also like to offer a warm welcome to Atlanta.

This building actually holds some personal significance and memories for me. If you are not familiar with it, Atlanta's history does not go back by comparison with other parts of the world for very long, but the Hyatt Regency was actually the first large atrium hotel that was built anywhere in the world, and now that has become the design standard that we are all very familiar with. I remember my grandfather brought me down here when I was 10 years old in 1967 right after it opened and we went to Sunday brunch and looked with awe up at all these indoor balconies and the very spectacular atrium at the time, and little to know that was really one of the first big steps Atlanta took to becoming what is now a very major city and certainly the home of Delta Air Lines.

I would also like to remember my Delta colleagues this morning. I would like to thank them for their leadership and all of their hard work in helping to set up this event as well as Jim for his welcome this morning.

I would like to start with a story. Just a recent little story about some of our leadership at Delta Air Lines. Really, a lot of what we are talking about this morning and your work throughout the week focuses so much on leading the industry forward and on the importance of collaboration.

Last week, thinking about some of the topics that you will be covering this week, Delta CEO Richard Anderson, Don Mitacek, the Senior Vice President of our Technical Operations organization, and David Garrison, our Senior Vice President for Maintenance Engineering, were on their way to lunch. They were talking about the coming week, and as they were walking along, David saw a brass object off to the side, and he took the time to divert from their walk and picked it up, and it was this brass urn, and he took his handkerchief out and he started to polish it up a little bit, and a genie popped out.

This genie was so happy to be released from his brass confinement that he told the three Delta leaders that he would grant them three wishes. David was very anxious and so he was the first. David said, "Well, I would like a 60-foot yacht on a Caribbean island, with a private beach and enough money to keep myself and my family happy for the rest of our lives." So the genie nodded his head, and then POOF! David was gone.

Don was next. Don said, “For my wish, I would like to be married to a supermodel, and I would like to have a penthouse condo in London, New York, and Hong Kong.” POOF! Don was gone.

So then the genie turned to Richard Anderson, and asked Richard what his wish was. Richard responded, “I want those two idiots back at their desks by 2 pm working for our customers.”

The moral of the story is, as we all know: Always let your boss go first.

I want to take just a few minutes now, on a little more serious note, to walk you through the history of how your industry, avionics in particular, has touched Delta Air Lines from the days when IFR literally meant “I Follow Roads” as a pilot, through today’s marvels of GPS navigation and all of the possibilities which we are now just beginning to unlock.

Let’s start with a short scenario to put to you in a Delta frame of mind, which means that ultimately, our focus is on our customers. We will take a look at industry trends, how Delta is currently integrating some of the tools into which you have poured your hearts and your minds. In the end, I want you to know that we appreciate the work that you do, certainly the leadership and the collaboration that you portray, and the role that it plays in Delta advancing into the future, always keeping our passengers safe and happy on our aircraft. Really, a lot of this discussion, although it focuses on technology, one of the big things that we always need to be thinking about is the human machine interface and what that technology enables in terms of improved operational capability.

To that end, when you think about it, the pilot role has really changed quite a bit over the last century. Delta is almost a 90-year-old company now. We started off and actually owe our existence to an insect, believe it or not. I think we are the only airline in the world that can make that claim, because Delta started out as a crop dusting company. Over the years, although the laws of aerodynamics have not changed, certainly the way that we are flying the airplanes has evolved a lot. We started out with celestial navigation, which we incorporated from sailors, navigating our way with references to the sun, the moon, a few planets and stars guiding our way through the sky. The old airways system within the US with bonfires and then later beacons to guide pilots on to their destinations. Not so long ago we had to tune to identify NDB stations, correct for crosswinds, and accept large margins of error while navigating from station to station. You gave us ILS, first developed in 1929, and VOR, which was first used in the late 1950s, which was a step well above NDB, that came with a higher margin of safety. Then we saw Loran, Omega, and Inertial Navigation greatly changing the way that we operate, allowing up to travel more effectively to further destinations.

These new technologies decreased track errors, improved bad weather capabilities, all while getting us closer and closer to the intended landing runway. These new capabilities gave us the ability to operate across the oceans in a shorter time frame, delivering our customers in more efficient manner, saving time, fuel, and money along the way.

Since the introduction of GPS in the early 1980s, its evolution among the commercial aviation sector has given us some of the amazing possibilities that you are designing, selling, operating, and repairing this very day.

I don’t know about you, but it is sort of like AM radio. Nobody really listens to AM radio anymore, I listen to my favorite Atlanta sports talk station on my way to work in the mornings, but that is about the only time people use AM radio anymore because we can actually stream radio onto our smart devices. So the way that we are interacting with our environment on the ground and in the air is changing at a very rapid pace. Ultimately, that is a big challenge for all of us as managing through all of this change.

AEEC | AMC Opening Session 2016
Keynote Speech

All of you have travelled on aircraft to business meetings, many of you coming to this conference this week. Imagine yourself as a passenger on the Delta red-eye flight from LAX to ATL, trying to arrive early on a Monday morning for a 9am meeting downtown. 15 minutes before your scheduled arrival time, the captain comes over the public address announcement system and announces that you are holding for weather. He lets you know that the aircraft may need to divert to Memphis if the weather does not clear, and he tells you that the ILS approaches on two of the five runways are not functioning properly at Hartsfield-Jackson, and ATC is restricting traffic flows into the airport. I imagine that some of you, if not most of you, are sitting on the edge of your seats now, saying “Well, what about the RNAV approach? Why haven’t they implemented GBAS? Will I miss my meeting because the airport and the airline have not caught up to and invested in the latest technology?”

These are all great questions, and part of the reason that we are all here today. These are the questions that drive us forward, using your expertise to create the tools that we need to put the needs of our customers first.

At the end of the day, our operating performance is how we measure how we are doing. It is our report card, and how we compare ourselves to our competition. When we put a new piece of equipment on our airplane, a lot of times we are looking at it through the lens of what kinds of operational reliability improvements this will allow us to achieve within our operation, because we at Delta believe that a big part of our success, a big part of our product is the performance of our daily operation. At the end of the day, that makes our customers trust us and want to come back to fly with us.

If you look at Delta’s recent operating performance, in 2015, we operated for the first time more than 1 million flights and flew more than 180 million customers in our system. Over this time period, those 1 million flights, we had 2237 flights that diverted or landed at an airport other than the one they were originally scheduled for. Now, these happened for all kinds of reasons, some of which are not related to weather: medical diverts, air turn backs, things like that. This is for the entire year. That is a diversion rate of 0.22%. Another metric that we use is completion factor. This is the percentage of flights that do not cancel. On a typical day at Delta, more often than not, we are actually completing 100% of our flights with a perfect completion factor day. In 2015, we had 214 days with no cancellations, and for the entire year, a completion factor of 99.56%. We typically operate with good on-time performance, and we are running this rate this year of about 86%, and if we have a day when there is no significant weather in the system, like big frontal activity or a lot of deicing activity in the winter time, we will typically run about 92% on time. We would not be able to achieve that kind of performance without the hard work that your industry does and the equipment that we have on our aircraft that will allow us to operate in all of these different conditions that we are faced with.

This kind of performance gives our customers tremendous confidence when they book flights that they will arrive at their destination safely and as scheduled. Again, we are able to achieve these impressive operational stats by using the advanced technologies that all of you have had a hand in developing.

At Delta, we are a little different than some carriers. You have carriers like Southwest Airlines that, although they are acquiring some new aircraft like the B737 MAX, essentially focus on operational efficiency and simplicity with one fleet type. At Delta, we are challenged with 11 fleet types, which is extremely challenging for our maintenance and engineering organization. It is certainly challenging for flight operations to make sure that we are appropriately staffed and trained for all of those different fleet types. It also creates some tremendous opportunities for us commercially. Our average age of our fleet is currently 15 years old, and as technology advances, we continually are evaluating the cost/benefit of modifying aircraft to take advantage of new operational capabilities, or whether we can operate with the suite that we currently have on the aircraft today.

We need to start at the beginning, working side by side with the regulators and the manufacturers, to maximize efficiencies that are afforded to us in today's world. All of these efficiencies can be achieved by collaboration: through performance based resolutions that may not always fit perfectly into prescriptive-based regulations. With the hard work, leadership, and vision found in this room, and the technology afforded to us in today's marketplace, Delta is able to operate our newest and oldest aircraft in an ever-evolving technologically advanced environment.

Stated most simply, one of our primary goals in today's aerospace system is to operate essentially with VFR arrival throughput rates at our airports in all types of weather. In the US, we schedule to the best weather conditions, and we manage the exceptions. When we have Air Traffic Control delay control programs or ground stops around the system, we have to manage around that. Delta participates in numerous aviation industry organizations, including the NextGen Advisory Committee, or NAC. Our CEO, Richard Anderson, is currently the chairman of the NAC. This is a Federal Advisory Committee, and many of you are familiar with it, that was formed to provide the FAA with advice on policy-level issues facing the aviation community in the process of modernizing the aviation system. Delta has committed significant resources into making our fleet NextGen capable. Many modifications are already underway, and many are planned for the future. These equipage initiatives can be challenging, to say the least. We have to make a business case to justify the modifications, and we are competing with other priorities around the business that may deliver immediate and concrete benefits in terms of operational performance. Often the issue is compounded by a constrained supply chain trying to supply the entire industry with the same equipment as solutions to some of these issues.

Let me move now to Delta's Communications, Navigation, and Surveillance, or CNS, philosophy. Our CNS philosophy addresses these major initiatives, leveraging existing equipment to the maximum extent possible, to deliver the needed operational benefits. We call this NextGen. The CNS philosophy is: Communication through CPDLC and FANS; Navigation through Performance-Based Navigation, which has several flavors to it (RNP, RNP AR, and even basic RNAV); and then surveillance, which currently is ADS-B Out. We expect these NextGen benefits to improve safety, reliability, and customer service, all while reducing emissions and lowering fuel burn. With respect to safety, our CNS strategy reduces operational variability and increases predictability for the pilots on the flight deck and the Air Traffic Controllers, and it also provides consistent lateral and vertical paths to the end of the runway. With respect to reliability, our CNS philosophy provides more consistent and repeatable operations, and also allows us to attain those VFR-like arrival rates in most weather conditions. With respect to customer service, our network schedules are more reliable for customers, and we also see reduced delays, especially in irregular operations. And finally, with respect to environmental benefit, we see reduced noise emissions, and less fuel burn and carbon emissions. This plan helps us adapt our current fleet while selecting the appropriate equipment for future aircraft orders, all while complying with current and future regulations.

Moving on to navigation for a moment. I know that many of you are familiar with the Ground-Based Augmentation System technology, or GBAS. Last week, I attended the International Ground-Based Augmentation System Working Group, the IGWG, in Oslo, exploring the applications of this technology. It will provide the capability for airports to operate up to 40 approaches from one ground-based station transmitting directly with receivers onboard the aircraft, enabling operations essentially down to ILS-like minima. The possibilities of additional approaches help our goals of a more consistent lateral and vertical path from takeoff all the way to touchdown, all while helping to alleviate multiple vectors, speed reductions, and delays in the arrival terminal airspace. Delta is currently ordering our newest aircraft, the B737-900, the A321, and the A350, with the avionics installed for GBAS ready to operate in this environment as it becomes available. In fact, our representative at the conference learned that the

Frankfurt Airport has introduced a landing fee rebate of up to 10,000 Euros per aircraft for all operators who are equipped and certified for GBAS operations. Seattle is implementing the technology, and Atlanta has given the green light to study the benefits of GBAS. We see it at other hubs, certainly in the study phase, around the country. At its operational peak, Delta operates nearly 1000 flights a day into the airspace, and we see GBAS as a positive initiative for our customers and our hometown Atlanta.

From a communications perspective, FANS is the datalink communication between pilot and controller that makes communication safer and more efficient. Just think of it as text messaging instead of talking over VHF/HF voice communications. FANS helps alleviate one more step where a mistake can happen, where the pilot or controller can misinterpret what is said, causing additional radio chatter deviations and delays. We are currently using CPDLC and departure clearance, or DCL, in daily operations. All carriers across the ocean have used CPDLC on the majority of their transoceanic operations for years. Delta will have more than 250 aircraft equipped by year's end, including a number of B737s, which operate mostly in the domestic airspace, as this capability to expand to transcontinental airspace. As part of an overall industry initiative, the US government recently provided funding to help equip domestic aircraft and expedite the use of CPDLC in the domestic system. DCL, the departure clearance capability, is currently being used and is scaled rapidly by the FAA on our B767-400 and B777 fleets on flights that operate out of JFK and Los Angeles. It will be implemented in Atlanta later this year. The controller sends the pilots the clearance and departure routing directly to the FMS on the flight deck. This gives the crew the opportunity to again eliminate the middle man by saving time and mistakes from a voice clearance, using a normal clearance delivery method. The FAA plans to leverage this new technology in the airborne and route environment in the domestic US airspace by 2018 and 2019. Delta plans to use existing equipage during this long-term transition by utilizing current ACARS or plain old ACARS. This gives us the ability to configure over 500 CPDLC-capable aircraft as participants for the FAA program, although it will leave several fleet types out of the mix in the short term due to the high implementation cost.

Now that we have talked about communication, let's go back to navigation for a moment. We have done a lot of recent work in advanced RNP operations. RNP approaches are used in bad weather to guide our aircraft into mountainous airports like Missoula, Montana; Jackson Hole; Juno, Alaska; and the like. But RNAV approaches also give us operational flexibility on VFR days. Our pilots can start a descent from the enroute environment, link to an RNAV arrival with predetermined speeds and altitudes, connect to a visual RNAV approach, including a safe landing, all while saving time and fuel, minimizing our carbon footprint as well as noise pollution. Think about it: the airplane, using the computers on board, can determine the most economic path for its entire route because it knows what to expect from start to finish. When the flight crew is given different speeds, altitudes, and flight vectors in the terminal environment, it can elongate the flight path, costing us time, fuel, and in the end, affecting our customers with delays and missed connections. RNP navigation will reduce pilot and controller workload and give us consistent throughput in most weather conditions, allowing more reliable flight schedules. This is yet another addition and enhancement to safety and customer satisfaction: a win/win in our book.

Now that we have discussed improved common navigation initiatives, let's talk about how ATC will interface with aircraft operations in the near future. Of course, the most prominent aspect is ADS-B with the mandate associated with it. ADS-B is a surveillance technology in which an aircraft determines its position via satellite GPS and periodically broadcasts it, enabling it to be tracked much more accurately than we can through ground-based radar. To this effort, US regulations will require that aircraft operating in most US-controlled airspace be equipped with ADS-B by January 1, 2020. Currently, Delta has 179 of its 800+ aircraft equipped with a new transponder, and this number is increasing every day. Delta plans to be compliant by the implementation date; however, some of the major hurdles we will need to overcome consists of supplier constraints, late availability of MMRs, and recently delivered aircraft that

require GPS modifications, all of which have made the process longer than it really needs to be. All of these changes cost Delta well over $100 million, including man-hours and equipment out of service time. You can see how just one aspect of the NextGen program affects Delta as one operator in the national air space system in terms of time and money. The good news is all of our new A321 and A350 aircraft will be equipped with new compliant ATC transponders as soon as they arrive on Delta property.

Our latest piece of equipment that everyone is very excited about is our ACARS software upgrade, ACARS 6.02. This gets back into measuring and managing our daily operational performance. We find that our leaders get really thrilled over data and spreadsheets sometimes when we get into this area. It may seem a little funny to you that I would talk about something like an ACARS technology when we are talking about ADS-B and other advanced technologies. But we are getting a lot better at not only harvesting all the data off of our aircraft, but also analyzing it and determining what it really means for our daily operations. This software upgrade will give us access to data that was not available to us before, certainly in terms of how granular it is. That in turn will help us more precisely measure our daily operations and make appropriate decisions to manage them going forward. The upgrade allows us to measure door open and close times, including cargo doors, cabin, galley, and cockpit doors. It measures when the aircraft starts to move during pushback, when it moves under its own power, and how long it sits before the cabin doors open at arrival. Some of you might be wondering why we are so excited about this, but it is an amazing way to monitor the operation and trend our data to improve our operational performance metrics, because what we find is, at choke points in the daily operation, we can change our policies and procedures and perhaps even the schedule of the airline to account for where those choke points are, and improve the way that we are using our equipment every day. At current fuel prices, every minute increase to system average taxi time costs us an additional $19 million on an annual basis. This means that every minute we can save in taxi time not only saves us $19 million, it also gets our passengers to their gate without delay, and gives us more time for maintenance to complete their operational checks and make any necessary repairs so we can keep the fleet healthy. One of the biggest benefits of reducing taxi time is to create more time that the aircraft is in the air transporting our passengers without having to add additional aircraft or headcount to our bottom line. Simply put, this allows us to add additional flying to our daily schedule with our existing asset base. We can monitor our deicing operations, watching how long the aircraft dwells in the deice pad, or in the line waiting to deice. This helps make the process more efficient by allowing us to simplify and perhaps shorten the procedure on the deicing pad and add additional resources during peak times, when needed.

Remember your earlier diversion into Memphis, when you missed your meeting? Think, if we could have saved a few minutes during pushback on the ground in Los Angeles, in the originating station, maybe that would have allowed your flight a little longer hold time with enough fuel to land in Atlanta as planned. In the end, it all comes back, as I said at the beginning, to customer satisfaction. Getting our passengers home to their loved ones, to their business meetings, and even Thanksgiving dinner safely and efficiently, keeps them coming back to Delta, again and again.

As you can see, we are driven by safety and ensuring that our customers are not only satisfied, but that we exceed their expectations and earn their loyalty for repeat business. The technology that this group is joining forces on to implement today and on into the future its essential to our business model. Your hard work and determination allows Delta to be an industry leader not only in operational performance, but also in innovation. Our key to success, as I said at the beginning, is leadership, collaboration, and putting ourselves in a position so we can plan for what is yet to come. We live in a rapidly changing world of rapidly evolving requirements and regulations. Working together by ensuring our ability to adapt without constraints is essential to our business model. It is essential to our customers. Just as I cannot imagine anyone still searching for a ballgame on an AM receiver when they can stream it live on their iPhone,

I cannot imagine navigating in and out of the busiest airport in the world without GPS and RNAV guidance. Please keep up the great work.

Again, it has been humbling and a great privilege to be with you this morning, and I wish you a great conference this week. Welcome to Atlanta.

Captain Dickson is the Senior Vice President of Flight Operations of Delta Air Lines. His responsibilities include overseeing Delta's day-to-day operations on six continents, as well as Delta's pilot training, pilot standards, technical support, pilot staffing and scheduling, quality operations assurance, and regulatory compliance.

He also provides leadership to 2700 Delta pilots and growing. He currently qualified to fly and flies in the A320 as Captain, and has also flown (you can tell how long he has been with Delta by this list of aircraft) the B727, B737, B757, and B767. He has been in his role as Senior Vice President since 2006.

He currently serves in the industry and is the chairman of the international Air Transport Association's Operations Committee, recently returning from Copenhagen. He also is past chairman of two Federal Advisory Committees: The Air Traffic Management Advisory Committee known as ATMAC, and the NextGen Implementation Taskforce, commonly known in industry circles as Task Force Five.

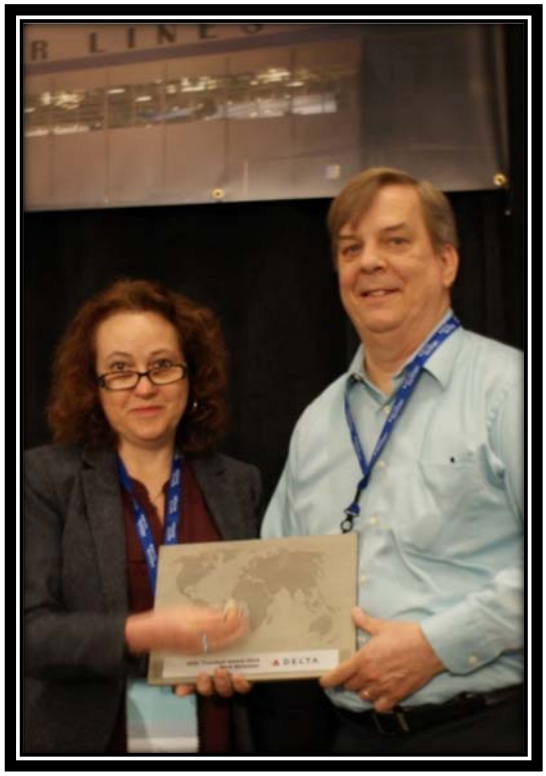
In these and other roles, he has continued to be a strong advocate for safety management systems and improvements to national air space systems, specifically NextGen. to improve manufacturing process and product quality by adding value, reducing total cost, and promoting collaboration between global stakeholders in the mobility and other interested industries.

Attachment 2

Attachment 2

The Austin Trumbull Award
Awarded to the Outstanding Airline Representative

The AEEC Executive Committee Chairwoman-Elect, Kathleen O'Brien, Boeing, introduced the Trumbull Award recipient



Good morning ladies and gentlemen. My name is Kathleen O'Brien; I'm a Technical Fellow at Boeing and am the AEEC Chairwoman-elect. I have the honor today of presenting the **AEEC Trumbull Award** which is given every year to an airline employee who has made an outstanding contribution to the work of the AEEC through leadership in the development of ARINC Standards.

As most of you know, the AEEC develops technical standards for airborne avionics and cabin systems. Traditional specs are Form, Fit and Function, but the AEEC is being challenged to keep up with rapidly changing technologies. We're addressing issues such as on-board and off-board networking, cyber security, air traffic management modernization, and mobile devices. It's an exciting time, and this year's Trumbull award winner is leading the pack in moving the industry forward.

Before I announce the winner, just a little bit about Austin Trumbull. Over the years, when I was sitting in the audience, I wondered, who was this Austin Trumbull? We know the story that he developed the ARINC 404 Air Transport Rack, which was renamed in 1967 to the Austin Trumbull Rack. But I always wanted to know more, who was Austin Trumbull, what was he like? So, I Googled Austin Trumbull.

AEEC | AMC Opening Session 2016
Trumbull Award

The first thing I found is that the distance between Austin, Texas and Trumbull, Connecticut is 1813 miles! And since Mr. Trumbull worked at United, I discovered the "Trumbull United" Soccer Club.

I also found that in 1945 he authored an SAE Technical Paper: *"Future Aircraft Electrical Loads"* and published a related article in Popular Mechanics saying that he foresaw that electric planes would *"permit great savings in weight and power through reduced drag and more efficient propeller locations…"* He truly was ahead of his time – perhaps envisioning the fuel efficiency of the modern aircraft, like the 787, due to the efficient power generation, distribution, and use. He was truly ahead of his time, because he got to SAE before we did!

It is fitting, therefore, that this award should be given to a visionary engineer working on technologies that will bring our industry into the future.

This year's Trumbull award winner is recognized for his role in the development of standards for airline and passenger connectivity systems and as a leader in design, modification, and certification to support his airline's introduction of connectivity into passenger service. Starting with the formative meeting of the Ku/Ka Satcom Subcommittee in 2007, he has continuously supported nearly all of the over 100 sessions, including web conferences and face-to-face meetings. He has been a model contributor, a vocal proponent for consideration of airline maintenance and operations, a convincing advocate for participation from suppliers and service providers, and an expert and experienced sounding-board for knowledge, testing ideas and requirements. He is always willing to tackle the tough problems. His encyclopedic knowledge of onboard avionics and systems was invaluable in the development of ARINC 791.

He received a BS degree in Electrical Engineering from the University of Minnesota in 1974. After a stint with Aero Systems Engineering, he started with Northwest Airlines in 1984, literally following in the footsteps of his father, taking over the position of Senior Aircraft Engineer that his dad held for 40 years, as well as his Dad's assigned phone number. He stayed through the transition to Delta Air Lines and currently holds the position of Senior Principal Engineer, Avionics. Two sons continue the family legacy in aviation with Delta and United, respectively. Mark "the Young" Sorensen of Delta Air Lines is this year's Trumbull Award winner.

Mark received the Volare Award in 2009 in Minneapolis when Northwest was hosting. Now that Mark moved from Minneapolis to Atlanta, he gets the Trumbull Award.

Mark Sorensen's Remarks:

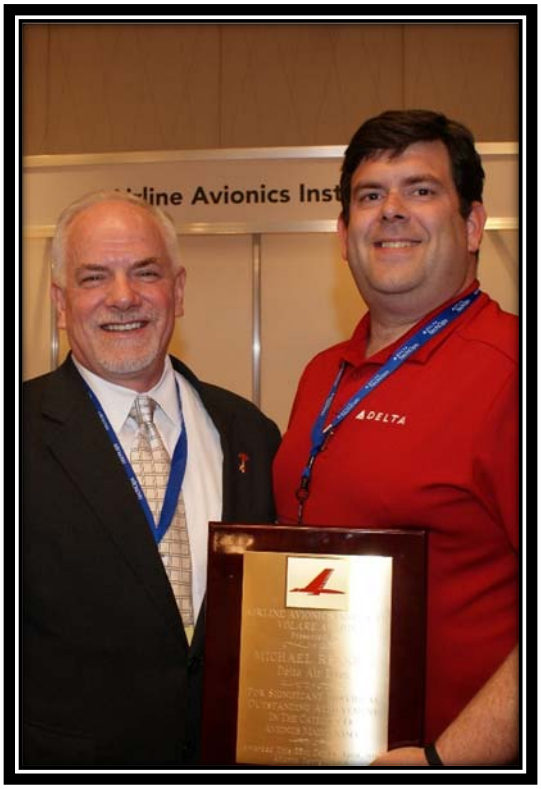
> *Thank you very much. When I got the Volare Award, I was completely stunned, and now I am 10 times over-stunned. I really appreciate those who elected me to get this award. I love this conference. I love the AMC. I love the AEEC. I'll do anything for this group if they need me. I don't think I've contributed as much as Trumbull, but I really do appreciate it. Thank you very much, and have a great conference.*

Attachment 3

Attachment 3

AIRLINE AVIONICS INSTITUTE
VOLARE AWARD

Michael Rennick
Delta Air Lines
Volare Award – Avionics Maintenance



Ray Frelk, President of the Airline Avionics Institute (AAI) introduced the AAI Volare Award recipients for 2016.

This candidate was formerly the manager of Component Engineering, developing repairs and reliability projects for components in all ATA chapters for all fleet types, in addition to having responsibility for nearly all PMA approvals except cabin interiors. He is now the Manager of the Engine Technology and Repair Development team. He is also the Modification and Replacement Parts Association (MARPA) Airline Committee Chairperson.

He has a degree in Aeronautical and Astronautical Engineering from Purdue University. He also had a pilot's license and has always loved airplanes.

He's married, has two children of 6 and 9 years old, is a wonderful dad, and even became a den leader so his son could enjoy Boy Scouts. He places high priority on attending his son's soccer games and daughter's swim meets. He likes trying new foods and loves spicy dishes.

He loves world travel with his family and recently took them to Japan for spring break. Just last year he traveled to 8 countries, over 40 cities, and 3 continents, more than 70,000 miles.

His hobbies include racing and learning to fix things. He loves watching Formula One and sports car racing, and is a driver for an endurance race team in the Lemons Series, no, not the Le Mans, that's right, Lemons! And of course, just like his aircraft, he likes to tinker and learn how to fix the Lemon race cars too.

He is very active and most cooperative during the AMC Conference and has been extremely supportive in various working groups.

On Behalf of the Airline Avionics Institute, is my great honor to present the Volare Award for Significant Individual Outstanding Achievement in the category of Avionics Maintenance to Michael Rennick of Delta Air Lines.

AIRLINE AVIONICS INSTITUTE
VOLARE AWARD

Mike Rennick's Remarks:

Wow. This is very unexpected and a huge honor. Frankly, I didn't even know if I was going to be here this year because of some recent career changes. I'm now an engine guy. I went from airframes to components to engines.

This organization, I tell everybody that I come across, this is the best technical conference I get to go to. It is a privilege to have the air carriers in one place, the OEMs, our PMA providers, our repair stations. It is unique. And to have productive, constructive conversations sometimes here, sometimes in the suites, is amazing.

It is such a great honor and a privilege. Thank you very much.

AEEC | AMC

AIRLINE AVIONICS INSTITUTE
VOLARE AWARD

Yves Sint-Upery
Airbus
Volare Award – Avionics Engineering

This candidate was born in Tarbes, France and currently resides in Colomiers near Toulouse. He graduated in 1984 from the ISAE, Aeronautics and Space Institute, the most famous engineering school in France, which is based in Toulouse.

He initiated his career in aviation as a cockpit research engineer performing research activities on cockpit functions. Then, he began working on prospective Flight Management System as a project leader, enabling the early foundations of Sextant, now Thales, as a key player in the FMS market.

He then took on project leader responsibility for the team in charge of preparing the Avionics choices and architectures for the future A380, in particular for Modular Avionics technologies. Additionally, as head of the Cockpit Operations Group, he led the team in charge of defining the A380 and A400M cockpits, enabling evolutions on A320, A330, and A340 and preparing research activities for future cockpits. He was nominated Expert in Cockpit Systems Design in 2004.

This candidate was also the head of the Avionics Systems Integration Tests department which was in charge of preparing and performing ground tests and analyzing ground and flight tests for Displays, Warning, Maintenance, Air Traffic, Communication, Navigation, Surveillance, and Modular Avionics systems.

He has also been very active in ARINC Industry Activity meetings, acting as expert for systems integration tests. He has been the Airbus focal point in AEEC's SAI Subcommittee for more than 10 years and has served as an alternate representative to Airbus' AEEC Executive Committee.

His great humility can't hide the brilliance of this industry-leading expert in cockpit design and integration testing.

On Behalf of the Airline Avionics Institute, is my great honor to present the Volare Award for Significant Individual Outstanding Achievement in the category of Avionics Engineering to Yves Saint-Upery of Airbus.

AIRLINE AVIONICS INSTITUTE
VOLARE AWARD

Yves Saint-Upery's Remarks:

I am a fully surprised and really honored by this award. I am happy to see that my contribution to the SAI activities has been recognized by my peers.

I would like to thank the people who proposed me for this award. Also, I thank Paul Prisaznuk, who has a very positive leadership of the SAI activities and also of the ARINC activities. I would like also to thank my very knowledgeable colleagues with whom I have been always very pleased to work with during these more than 15 years at the SAI Subcommittee level.

Thank you very much. I am really honored and happy for this award.

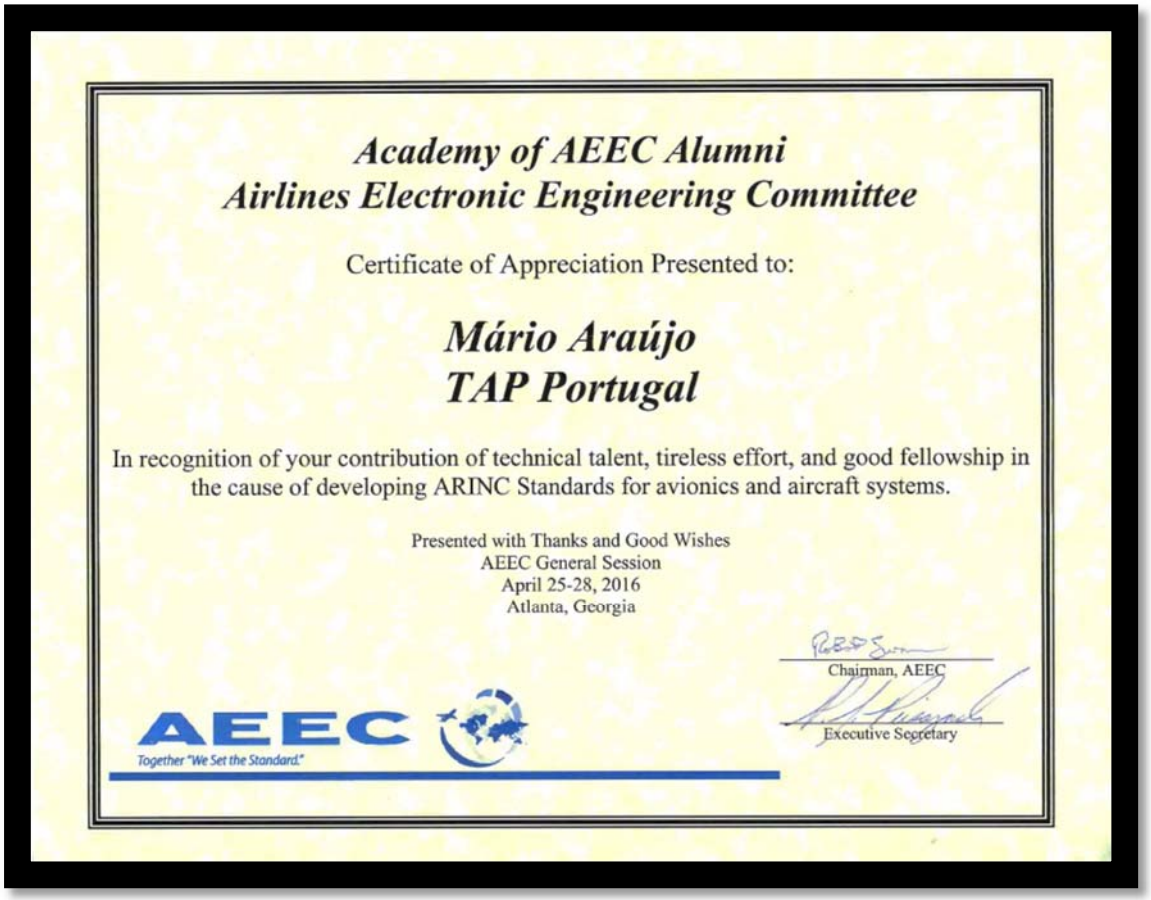
AEEC | AMC

Attachment 4

Attachment 4

AEEC | AMC Opening Session 2016
AEEC Alumni Award Recipients

Paul Prisaznuk with Mario Araujo, TAP Portugal, Yves Saint-Upery, Airbus and Thierry Harquin, Airbus. Not shown are Thomas Laxar and Martin Maller, both of Austrian Airlines



Academy of AEEC Alumni
Airlines Electronic Engineering Committee

Certificate of Appreciation Presented to:

Mário Araújo
TAP Portugal

In recognition of your contribution of technical talent, tireless effort, and good fellowship in the cause of developing ARINC Standards for avionics and aircraft systems.

Presented with Thanks and Good Wishes
AEEC General Session
April 25-28, 2016
Atlanta, Georgia

Chairman, AEEC

Executive Secretary

AEEC
Together "We Set the Standard."

Attachment 5

Attachment 5

AEEC | AMC Registration List 2016

1st Choice Aerospace	Cuaddra, David
1st Choice Aerospace	Potter, Dion
4M Sigma Corp	Pauli, John
AAI	Frelk, Raymond
Absolute Aviation Services	Slater, Timothy
ABX Air	Freese, Joe
Acme Aerospace	Cercone, Dan
Acme Aerospace	Lottes, Randy
ACS Aviation Component Solutions	Stummer, Guenter
Advanced Technical Group	Gonzalez, Carlos
Advanced Technical Group	Lopez, Juan
Aero Controls, Inc.	Fix, Richard
Aero Fluid Products	Dewalt, Lauren
Aero Fluid Products	Hahn, Erich
Aero Instruments & Avionics	Baldi, John
Aero Instruments & Avionics	Maniscalco, Mike
Aero Instruments & Avionics	Mitri, Nick
Aerosonic	Snyder, Rick
Aerosonic	Tellbuescher, Cory
Air Canada	Jodoin, Guy
Air Cost Control USA, LLC	Jones, Kevin
Air France	Boina, Oliver
Air France	Poulet, Philippe
Air France	Roueche, Xavier
Air France	Seys, Francois-Xavier
Air France	Teyssedou, Eric
Airborne Maintenance & Engineering	Siebenaler, Jeffery
Airborne Maintenance & Engineering	Smith, Greg
Airbus	Adolphe, Bertille
Airbus	Andre, Nicolas
Airbus	Cherkaoui, Ahmed
Airbus	Gatesman, William
Airbus	Goedecke, Rolf
Airbus	Harquin, Thierry
Airbus	Jansen, Ruediger
Airbus	Jaupitre, Arnaud
Airbus	Lavainne, Jerome
Airbus	Matthews, Justin
Airbus	Mouysset, Jean-Luc
Airbus	Saint-Etienne, Jean-Francois
Airbus	Saint-Upery, Yves
Airbus	Solier, Michel
Airbus	Soyer, Patrick
Aircraft Systems & Manufacturing	Schultz, Mark
Aircraft Systems & Manufacturing	Wilcox, Robert
Aireon	Garcia, Michael
Alaska Airlines	Melvin, John
All Nippon Airways	Fujita, Noriaki
All Nippon Airways	Mukai, Seiichiro
All Nippon Airways	Yamaguchi, Taihei
Aloft Aeroarchitects	Eichten, John
ALTYS Technologies	Gonzalez, Carlos
American Airlines	Gates, Rodney
American Airlines	Gilbertson, Marcus
American Airlines	Ingle, Maurice
American Airlines	Jaeger, Tom

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American Airlines	Kramer, Kevin
American Airlines	Kuhn, David
American Airlines	McDaniel, Darrell
American Airlines	Moorthy, Anand
American Airlines	Pasupathy, Ganesh
American Airlines	Pereira, Mel
American Airlines	Rempel, Travis
American Airlines	Rizvi, Zeeshan
American Airlines	Schweiger, Jamin
American Airlines	Slaughter, Bob
American Airlines	Stillo, Anthony
American Airlines	White, Allen
American Airlines	Yang, Qia
American Airlines	Zvacek, Dennis
Ametek MRO	Klink, Mitch
Ametek Muirhead Avionics	Wells, Steve
ANA Component Technics Co. Ltd.	Imano, Keisuke
ARINC (Retired)	Martinec, Daniel
ART, Inc.	Kerr, Deann
Astro-Med, Inc.	Paul, Mark
Astronautics Corp Of America	Koelling, Robert
Astronautics Corp Of America	Levine, Larry
Astronautics Corp Of America	Ruhl, Bill
Astronics Aerospace	Pattison, Michael
Astronics Aerospace	Rankins, Matt
Astronics Ballard Technology, Inc.	Christian, Kevin
Astronics Ballard Technology, Inc.	Solberg, Jeff
Astronics Test Systems	Kochel, Chuck
Astronics Test Systems	Price, Brian
Astronics Test Systems	Serate, Lester
Astronics Test Systems	Tilley, Gary
Astronova	Berthe, Xavier
Astronova	Carll, Tom
Astronova	Chester, David
Astronova	Kendrick, Bill
Astronova	Natalizia, Michael
Astronova	Schuh, Alexander
ATR	Fusina, Pascal
ATR	Sainte-Marie, Martine
Austrian Airlines	Hornbacher, Wolfgang
Austrian Airlines	Maller, Martin
Av-DEC	Baker, Andy
Av-DEC	Bogert, Will
Av-DEC	Hitchcock, Jay
Av-DEC	Kern, Becky
Av-DEC	Ryan, Brendan
Avia Radio	Egholm, Jens
Aviation Component Solutions	Kucera, Gregory
Aviation Data Communication Corp	Tan, Xijing
Aviation Data Communication Corp	Tang, Yeyang
Avicom Japan Co, Ltd	Ando, Tsutomu
Avionic Instruments LLC	Yassa, Michael
Avionica, Inc.	Alvarado, Jeffrey
Avionica, Inc.	Dickinson, Richard
Avionica, Inc.	Espinosa, Claudia
Avionica, Inc.	Kolich, Matthew

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Avionica, Inc.	Kong, Steve
Avionica, Inc.	Lott, Ron
Avionica, Inc.	McConnell, Michael
Avionica, Inc.	Neville, Richard
Avionica, Inc.	Reilly, Sean
Avionica, Inc.	Rios, Anthony
Avionica, Inc.	Segredo, Raul
Avionica, Inc.	Shewfelt, Derek
Avionica, Inc.	Wargacki, Darrin
Avionics Magazine	Bellamy, Woodrow
Avionics Magazine	Drake, Tish
Avionics Magazine	Joyce, Susan
Avionics Magazine	Van Wagenen, Juliet
Avionics Specialist, Inc.	Allbright, Mark
Avionics Specialist, Inc.	Dahler, Eric
Avionics Support Group	Fortes, Hugo
Avionics Support Group	Rodrigo Jr, Alex
Avionics Support Group	Rodrigo, Alex
Avtech Avionics & Instruments	Linares, Ricardo
AvtechTyee	Bias, J.B.
AvtechTyee	Vander Putten, Ken
Avtron Aerospace	Pesec, John
Avtron Aerospace	West, Steven
Avtron Aerospace	Winkler, Daniel
Azul Brazilian Airlines	Souza, Ricardo De Azevedo E
B/E Aerospace	Miller, Mark
B/E Aerospace	Rozewicz, Jeff
B/E Aerospace	Schlieske, Thomas
B/E Aerospace	Shah, Sanket
BAE Systems	Luybli, Richard
BAE Systems	Muniak, Thomas
BAE Systems	Polhamus, Richard
BAE Systems	Reeves, Marc
BAE Systems	Singletary, Kenny
BAE Systems	Wetzel, Jack
Barfield, Inc.	Allen, Stephen
Barfield, Inc.	Arnett, Robert
Barfield, Inc.	Bertot, Christophe
Barfield, Inc.	Bontorno, Victor
Barfield, Inc.	Floyd, Richard
Barfield, Inc.	Giacoman, Luis
Barfield, Inc.	Glenfeldt, Chris
Barfield, Inc.	Imparato, Anthony
Barfield, Inc.	Molano, Jose
Barfield, Inc.	Reynolds, Erika
Barfield, Inc.	Rogers, John
Barfield, Inc.	Stromberg, Mike
Barfield, Inc.	Troussard, Joanne
Barfield, Inc.	Wingate, Lew
Bombardier Aerospace	Sobey, Charles
British Airways	Gallant, Colin
CAA Denmark	Kjeldsen, Tom
Canard Aerospace	Denkmann, Paul
Canard Aerospace	Ferche, Bruce
Canard Aerospace	Harris, Cindy
Cargo Transit Inc.	Abu-Nameh, Moe

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Cargo Transit Inc.	Belland, Steve
Cargo Transit Inc.	Foust, Mike
Carlisle Interconnect Technologies	Allen, Tim
Carlisle Interconnect Technologies	Behlendorf, Jeff
Carlisle Interconnect Technologies	De Buhr, Merritte
Carlisle Interconnect Technologies	Docarmo, Peter
Carlisle Interconnect Technologies	Fahy, Kasha
Carlisle Interconnect Technologies	Hall, Jack
Carlisle Interconnect Technologies	Martin, Matthew
Carlisle Interconnect Technologies	Nunn, Kelly
Carlisle Interconnect Technologies	Schiefelbein, Avery
CAVOK	Forkin, Kevin
CAVOK	Sharpe, James
Children's Healthcare of Atlanta	Marrow, Melisa
Cobham	Anderson, Brian
Cobham	Lagarde, Stephane
Cobham	Lapasset, Marc
Cobham	Moussabih, Essam
Cobham Avcomm	Coltvet, Jeff
Cobham Avcomm	Hill, Guy
Cobham Avcomm	Riekena, Sarah
Cobham Avcomm	Smith, Russ
Cobham Satcom	Ter Hove, Mark
Cobra Systems Inc.	Radtke, Thomas
Cobra Systems Inc.	Wohlford, Mark
COMAC	Fandong, Meng
COMAC	Jinling, Cheng
COMAC	Linfang, Yan
COMAC	Yue, Zhang
Co-Operative Industries Aerospace	Wright, Dave
Crane Aerospace & Electronics	Bigcraft, Jared
Crane Aerospace & Electronics	Jones, Greg
Crane Aerospace & Electronics	Merrill, Nancy
D.E.R. Global	Baldus, Arne
DAC International	Sutphin, Brad
Dayton-Granger	Maholm, Christopher
Dayton-Granger	Pacheco, Javier
DCME Aerospace Inc	Jardee, Donald
Delta Air Lines	Amalfitano, Margaret
Delta Air Lines	Anvid, David
Delta Air Lines	Barrette, David
Delta Air Lines	Bolstridge, Loren
Delta Air Lines	Burkett, Bobby
Delta Air Lines	Cuccio Jr., Frank
Delta Air Lines	Dickson, Steve
Delta Air Lines	Falkenbach, Joe
Delta Air Lines	Freeman, Dale
Delta Air Lines	Gingrich, Darell
Delta Air Lines	Gregory, Michael
Delta Air Lines	Hardwick, Brad
Delta Air Lines	Harkey, Charles
Delta Air Lines	Harper, Joseph
Delta Air Lines	Hoare, Stephen
Delta Air Lines	Holstein, Eric
Delta Air Lines	Jackson, Jim
Delta Air Lines	Jorek, Olaf

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Delta Air Lines	Karow, William
Delta Air Lines	Kozacek, Roger
Delta Air Lines	Landrum, Alvin
Delta Air Lines	Lewis, Natalie
Delta Air Lines	Lewis, Rick
Delta Air Lines	Linzbach, Mike
Delta Air Lines	Lord, Jim
Delta Air Lines	Matthew, Tash
Delta Air Lines	McBride, Mike
Delta Air Lines	McCormick, John
Delta Air Lines	Minarovic, Vido
Delta Air Lines	Odell, James
Delta Air Lines	Patmore, Ted
Delta Air Lines	Perry, Tristan
Delta Air Lines	Petro, Mark
Delta Air Lines	Pointek, Jay
Delta Air Lines	Portor, Randy
Delta Air Lines	Quist, Pete
Delta Air Lines	Rennick, Michael
Delta Air Lines	Schwah, James
Delta Air Lines	Segars, Ebb
Delta Air Lines	Shideler, Richard
Delta Air Lines	Simmons, Mike
Delta Air Lines	Sorensen, Mark
Delta Air Lines	Tharp, Ana
Delta Air Lines	Vikram, Aditya
Delta Air Lines	Wampler, Rick
Delta Air Lines	Webb, Linda
Delta Air Lines	Weigel, Michael
Delta Air Lines	Windless, Marquis
Delta Air Lines	Yigit, Selcuk
Delta Air Lines (Retired)	Story, Martin
Delta Air Lines (Retired)	Windham, Pat
Delta Techops	Barcenas, Fernando
Delta Techops	Duggan, Neil
Delta Techops	McCoy, Philip
Delta Techops	Stoltz, Jason
Delta Techops	Symons, Andy
Delta Techops	Voghell, Brian
Diehl Aerospace	Fenoy, William
Diehl Aerospace	Finkenberger, Michael
Diehl Aerospace	Hottel, Rob
Diehl Aerospace	Ide, Gerard
Diehl Aerospace	Knoedler, Torsten
Diehl Aerospace	Ludlum, Robert
Diehl Aerospace	Njengere, John
Diehl Aerospace	Rogers, Jacob
Diehl Aerospace	Weldon, Johnna
DMA Aero	Ciulla, Renato
DMA Aero	Comiskey, Michael
DMA Aero	Marchiori, Arrigo
Duncan Aviation	Kromberg, Russ
Duncan Aviation	Miesbach, Kevin
Dynamic Consulting Services	Santana, George
EDMO Distributors	Baker, Brad
EDN Aviation	Peri, Sam

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Eirtech Aviation Services	Kearns, Niall
Eirtech Aviation Services	O'Shea, Gerry
El Al Israel Airlines	Ganor, Dan
El Al Israel Airlines	Rubinstein, Mark
Elbit Systems	Bormuth, Lee
Elbit Systems	Jackson, Jeremie
ELTA	Boyer, Tiphaine
ELTA	Guissart, Julie
ELTA	Mathias, Phillippe
Embraer Aircraft Corporation	Bentim, Carlos
Embraer Aircraft Corporation	Carvalho, Adriano
Embraer Aircraft Corporation	Chappaz, Ivanir
Erie Aviation	Jakes, Tad
Esterline CMC Electronics	Babos, Cathy
Esterline CMC Electronics	Barker, John
Esterline CMC Electronics	Brown, Bill
Esterline CMC Electronics	Chalkiadakis, Nick
Esterline CMC Electronics	Huynh-Belanger, Alexandre
Esterline CMC Electronics	Hygate, Rex
Esterline CMC Electronics	Irizarr, Javier
Esterline CMC Electronics	Lawson, Josefa
Esterline CMC Electronics	Mamajek, Eugene (Smack)
Esterline CMC Electronics	O'Leary, Tim
Esterline CMC Electronics	Roy-Girard, David
Esterline CMC Electronics	Vanhaecke, Stefaan
Esterline CMC Electronics	Wong, Jimmy
Esterline Control Systems	Cochran, Mark
Esterline Control Systems	Howard, Tom
Esterline Control Systems	Jacques, Bob
Esterline Power Systems	Benson, Keith
Etihad Airways	Dosal Roiz, Borja
Federal Aviation Administration	Avella, Gerald
Federal Aviation Administration	Sprayberry, Robert
FedEx	Gibson, Dean
FedEx	Kendrick, Josh
FedEx	McFann, Ted
FedEx	Petzinger, Mark
FedEx	Sullivan, Ken
FedEx	Swanson, Robert
Finnair	Helenius, Pekka
Fokker Services	Wehnes, Frank
Gables Engineering	Bibb, Charlie
Gables Engineering	Finale, Rick
Gables Engineering	Franklin, Anna
Gables Engineering	Galimidi, Gary
Gables Engineering	Gutierrez, Albert
Gables Engineering	Jackson, Andrew
Gables Engineering	Male, Philip
Gables Engineering	Richardson, Lone
Gables Engineering	Sanchez, Jorge
Gables Engineering	Walrath, Tracy
GE Aviation	Beresford, Jean-Paul
GE Aviation	Edgar, Daniel
GE Aviation	Kondik, Bob
GE Aviation	Leach, Robert
GE Aviation	Mesny, Victor

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GE Aviation	Minors, Richard
GE Aviation	Moores, Peter
GE Aviation	Reed, Robert
GE Aviation	Reilly, Ed
GE Aviation	Sheller, David
GKN - Fokker Services	Bouwma, Kars
GPS Design Inc	Stutes, Gregg
Hawaiian Airlines	Smith, Dan
HEICO Aerospace	Armstrong, Hayley
HEICO Aerospace	Braselton, Greg
HEICO Aerospace	Comer, John
HEICO Aerospace	Depaoli, Joe
HEICO Aerospace	Dillon, James
HEICO Aerospace	Ferrell, Juston
HEICO Aerospace	Flosdorf, David
HEICO Aerospace	Forst, Mike
HEICO Aerospace	Gonzalez, Leon
HEICO Aerospace	Hansen, Lisa
HEICO Aerospace	Howard, Walter
HEICO Aerospace	Hunter, John
HEICO Aerospace	Laramee, Tom
HEICO Aerospace	Markham, Patrick
HEICO Aerospace	McGrath, Rachel
HEICO Aerospace	Paetznick, Michele
HEICO Aerospace	Schwieg, Bryan E.
HEICO Aerospace	Wright, Tony
Honeywell, Inc.	Allred, Chris
Honeywell, Inc.	Ballantyne, Maura
Honeywell, Inc.	Churchill, Abigail
Honeywell, Inc.	Eberth, Ed
Honeywell, Inc.	Folkert, Doug
Honeywell, Inc.	Garrison, Dean
Honeywell, Inc.	Henderson, Tom
Honeywell, Inc.	Ishoop, Raeid
Honeywell, Inc.	Johnson, Daniel
Honeywell, Inc.	Jongsma, Ken
Honeywell, Inc.	Kiani, Farrokh
IAI	Ran, Aharon
IAI	Sharvit, Yakov
Icelandair	Asgeirsson, Sigurdur
Icelandair	Baldursson, Bragi
Icelandair	Brynjolfsson, Theodor
Icelandair	Kristjansson, Julius
Icelandair	Stefansson, Gauti
IDD Aerospace	Sorenson, Jim
IFE Products, Inc.	Olstinske, Dan
IFE Products, Inc.	Shipley, Jim
Inflight Warning Systems	Barclay, Joseph
Inflight Warning Systems	Kirby, Brian
Inflight Warning Systems	Klein, Walt
Inmarsat	Bee, Lisa
Inmarsat	Matar, Sam
Inmarsat	Narey, Dan
Inmarsat	Paterson, Brett
Innovative Aerospace	Ardussi, John
Iridium Satellite	Hooper, Michael

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JANA Inc.	Chilsen, Peter
JANA Inc.	Montemayor, Ramon
JANA Inc.	Niland, Ean
Japan Airlines	Aso, Yuichiro
Japan Airlines	Ito, Satomi
Japan Airlines	Kato, Yoshito
Japan Airlines	Matsuoka, Toshihiko
Japan Airlines	Sasaki, Kazushi
Japan Airlines	Sekiguchi, Akihiro
Jeppesen	Pschierer, Christian
Jetcraft Corporation	Stevens, Stedman
Kapco Global	Kuwik, Jim
Kapco Global	Matthews, Guy
KETI	Park, Pusik
KITCO Fiber Optics	Stone, Donald
KLM Royal Dutch Airlines	Jozic, Marijan
KLM Royal Dutch Airlines	Manoch, Inge
KLM Royal Dutch Airlines	Van Den Berg, Piet
KLM Royal Dutch Airlines	Van Der Veek, Apm
KLM Royal Dutch Airlines	Van Soest, Maarten
Kuwait Airways	Alkhalid, Mohammad
Kuwait Airways	Alrahmani, Khalid
L2 Aviation	Bristow, Grant
L2 Aviation	Davis, Katie
L2 Aviation	Larkin, Raymond
L2 Aviation	Lebovitz, Mark
L2 Aviation	Paul, Kevin
L-3 Communications	Allen, Fred
L-3 Communications	Baumert, Eric
L-3 Communications	Blair, Dwight
L-3 Communications	Bontell, Mike
L-3 Communications	Brown, Sandra
L-3 Communications	Carpenter, David
L-3 Communications	Carter, Mike
L-3 Communications	Chartier, Stephane
L-3 Communications	Clairis-Gauthier, Jean-Michel
L-3 Communications	Dupuy, Stephan
L-3 Communications	Flaishans, Terry
L-3 Communications	George, Robert
L-3 Communications	Karapatnitski, Ruslan
L-3 Communications	Khawaja, Wasif
L-3 Communications	Laplante, Shane
L-3 Communications	Masella, Louis
L-3 Communications	Oldach, Arnold
L-3 Communications	Parker, Jim
L-3 Communications	Senen, Ed
L-3 Communications	Totti, Simone
L-3 Communications	Tremose, Michael
L-3 Communications	Wrye, Donald
Latitude Technologies Corporation	Monsalve, Carlos
Laversab Inc	De La Grandville, Thibault
Lockheed Martin	Kenward, Paul
Lufthansa	Lauterbach, Jurgen
Lufthansa Cargo	Goldhammer, Martin
Lufthansa Systems	Webster, George
Lufthansa Technik	Abraham, Thomas

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Lufthansa Technik	Biller, Sven
Lufthansa Technik	Harich, Joachim
Lufthansa Technik	Lehne, Jens
Lufthansa Technik	Mailat, Doug
Lufthansa Technik	Martens, Wolfgang
Lufthansa Technik	Schmidt, Enno
Lufthansa Technik	Schowalter, Joerg
Lufthansa Technik	Tilgner, Sebastian
Lufthansa Technik	Walling, Kenny
Luminator	Saunders, Larry
Luminator	Stark, Brian
MarathonNorco Aerospace	Brown, Brad
MarathonNorco Aerospace	Latham, Del
MarathonNorco Aerospace	McGee, Anthony
MBS Electronic Systems	Fliegner, Matthias
MBS Electronic Systems	Nicholls, Charles
MBS Electronic Systems	Nicholls, Karin
Meggitt	Herrmann, Ralf
Meggitt Aircraft Braking Systems	Kurko, Kevin
Meggitt Aircraft Braking Systems	Steiner, Richard
Meggitt Aircraft Braking Systems	Waddingham, Seth
Meggitt Control Systems	Conners, Don
Messier-Bugatti-Dowty	Da Costa, Didier
Millennium International	Creemer, Trafton
Millennium International	Durham, Simon
Millennium International	Rafferty, Dan
MITRE/USAF	Morris, John
NAASCO	Leslie, John
Nav-Aids Ltd	Galliker, Joseph
Nav-Aids Ltd	Gilday, Allison
Nav-Aids Ltd	Gilday, Brent
Nav-Aids Ltd	Hassani, Roderick
Navhouse Corporation	Jenkinson, Doug
Nexeya Canada	Plewinski, Jeff
Norwegian Air Shuttle	Geist, Aleksander
Norwegian Air Shuttle	Viken, Per
OFS	Bell, Leruth
Ontic Engineering & Manufacturing	Benjamin, Bill
OTTO Instrument Service	Farley, Chuck
OTTO Instrument Service	Finley, Jeff
OTTO Instrument Service	Lockwood, Keith
OTTO Instrument Service	McConaughey, Meagan
OTTO Instrument Service	Mckernon, Bob
OTTO Instrument Service	Rosenthal, Ben
OTTO Instrument Service	Villasenor, Theresa
Oxley Group	Cavan, Darren
Oxley Group	North, Steve
Pace	Spaeth, Oliver
Panasonic Avionics Corp	Anderson, Stuart
Panasonic Avionics Corp	Boucher, Phillip
Panasonic Avionics Corp	Dinsdale, Stewart
Panasonic Avionics Corp	Enock, Justin
Panasonic Avionics Corp	Falcinella, Rowena
Panasonic Avionics Corp	Flynn, Chris
Panasonic Avionics Corp	Germain, Priscilla
Panasonic Avionics Corp	Pamplona, Larry

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Panasonic Avionics Corp	Powell, Bill
Panasonic Avionics Corp	Rex, Jeffrey
Panasonic Avionics Corp	Saldana, Jamie
Panasonic Avionics Corp	Savage, Matt
Panasonic Avionics Corp	Simone, Joseph
Panasonic Avionics Corp	Smith, Scott
Panasonic Avionics Corp	Smith, Troy
Panasonic Avionics Corp	Strange, Richard
Panasonic Avionics Corp	Vanwie, Patrick
Panasonic Avionics Corp	Walther, Matthias
Paramount Panels, Inc.	Thorne, John
Performance Software Corp.	Gyde, Mike
Performance Software Corp.	Ziebarth, Scott
Philippine Airlines	Juan, Paul Michael
Powerjet Parts, Inc	Auh, Daniel
Powerjet Parts, Inc	Ferguson, Phil
Powerjet Parts, Inc	Knorr, William
R J Frelk & Associates	Frelk, Debbie
Republic Airways Holdings	Stevens, Frank
Rockwell Collins	Anderson, Orin
Rockwell Collins	Burke, Linda
Rockwell Collins	Burrowes, Mark
Rockwell Collins	Carkin, Kevin
Rockwell Collins	Carlton, Laurie
Rockwell Collins	Hansen, Jason
Rockwell Collins	Hubbard, Steve
Rockwell Collins	Jueckstock, Brian C.
Rockwell Collins	Kauffman, John
Rockwell Collins	Lagrange, Chad
Rockwell Collins	Lang, Andy
Rockwell Collins	McDowell, Michael
Rockwell Collins	Neurohr, Gary
Rockwell Collins	Pares, Jacques
Rockwell Collins	Parpart, Ron
Rockwell Collins	Quade, Bruce
Rockwell Collins	Renner, Chuck
Rockwell Collins	Sadowitz, Jeff
Rockwell Collins	Sullivan, Tracey
Rockwell Collins	Valdes, Luis
Rockwell Collins	Waterman, Jennifer
Rockwell Collins	Weldon, Chad
Rockwell Collins	Whitley, Mike
Rockwell Collins	Worrall, Andy
Rockwell Collins	Zeigler, David
Rotor & Wing	McKenna, James
Sabre Airline Solutions	Mitten, Anthony
SAE International	Feix, Laura
SAE ITC, ARINC IA	Buckwalter, Sam
SAE ITC, ARINC IA	Godoy, Jose
SAE ITC, ARINC IA	Grau, Peter
SAE ITC, ARINC IA	Hess, Lori
SAE ITC, ARINC IA	Mastros, Vanessa
SAE ITC, ARINC IA	Munns, Tom
SAE ITC, ARINC IA	Nagowski, Victor
SAE ITC, ARINC IA	Prisaznuk, Paul
SAE ITC, ARINC IA	Rockwell, Michael

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SAE ITC, ARINC IA	Smith, Scott (Smitty)
Safran	Rouxel, Cedric
Saft America	Brady, Mike
Saft America	Rappe, Valerie
Saft America	Schiavone, Dave
Satair	Concha, Ralph
SERMA	Bougere, Helene
SERMA	Poirier, Etienne
SiliconExpert Technologies	Holbrook, Bobby
SiliconExpert Technologies	Picken, Rob
Skywest Airlines	Ray, Allen
Skywest Airlines	Spindler, Todd
Solaseed Air Inc.	Asahi, Akinari
Southwest Airlines	Gleason, Brian
Southwest Airlines	Hall, Ryan
Southwest Airlines	Reaves, Prewitt
Spectralux Avionics	Elison, Eric
Spectralux Avionics	Gilbert, Ian
Spectralux Avionics	Hummel, Frank
Spectralux Avionics	Reynolds, Jim
Spectralux Avionics	Sammons, Bryan
Spherea Test & Services	Bihet, Valerie
Spherea Test & Services	Chiquillo, Loic
Spherea Test & Services	Dabasse, Christian
Spherea Test & Services	Delfour, Gerard
Spherea Test & Services	Foussereau, Loup
Spherea Test & Services	Freneuil, Patrick
STS Aviation Group	Antoon, Kim
STS Aviation Group	Covella, Tom
STS Aviation Group	Cunnane, Pat
STS Aviation Group	Obiala, Kerry
STS Aviation Group	Salisbury, Taylor
STS Aviation Group	Steele, Ethan
STS Aviation Group	Tyler, Patrick
STS Aviation Group	Watson, Scott
Summit Aerospace	Holder, Keith
Summit Aerospace	Kendrick, Kent
Talon Aerospace	Ballou, Mike
Talon Aerospace	Beyersbergen, Frank
Talon Aerospace	Martin, Ken
Talon Aerospace	Murdock, Randy
TAP Portugal	Almeida, Jose
TAP Portugal	Araujo, Mario
TAP Portugal	Carpinteiro, Goncalo
TAP Portugal	Duque, Paulo
TAP Portugal	Franzoi, Guilherme
TE Connectivity	Olson, Earle O.
Technologies Harness Scanner	Lussier, Alain
TechSAT GmbH	Eggert, Jasmine
TechSAT GmbH	McRae, William
TechSAT GmbH	Schlecht, Bruno
Teledyne Controls	Chambers, Scott
Teledyne Controls	Chan, Canice
Teledyne Controls	Dormire, Marshall
Teledyne Controls	Glen, Ian
Teledyne Controls	Hassan, Masood

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Teledyne Controls	Keating, Ken
Teledyne Controls	Kuske, Chris
Teledyne Controls	Lindgren, Chris
Teledyne Controls	Madden, Cindy
Teledyne Controls	Mallos, Sam
Teledyne Controls	Martinez, Reuben
Teledyne Controls	Neurfert, Hans-Juergen
Teledyne Controls	Nori, Ravi
Teledyne Controls	Radmehr, Mehrdad
Teledyne Controls	Reeves, Randy
Teledyne Controls	Sakho, Tacko
Teledyne Controls	Salvador, Edgar
Teledyne Controls	Skelton, Murray
Teledyne Controls	Solis, Elizabeth
Teledyne Controls	Sonnenberg, Wolf
Teledyne Controls	Sullivan, Crista
Teledyne Controls	Swarts, Ellen
Teledyne Controls	Valdez, Jorge
Teledyne Controls	Wing, Matt
Teledyne Controls	Zamba, Elaine
Tel-Instrument Electronics	Reed, Mike
Teradyne	Batson, Troy
Teradyne	Vennerholm, Mark
Testek, Inc.	Black, Alan
Testek, Inc.	Meredith, Todd
Thales	Atkinson, Brian
Thales	Bard, John
Thales	Bettoni, Marie-Pierre
Thales	Crostini, Mike
Thales	Gandon, Francois-Xavier
Thales	Kerihuel, Briac-Yves
Thales	Kumar, Shyam
Thales	Michal, Denis
Thales	Soquet, Eric
Thales Avionics	Bailly, Carine
Thales Avionics	Bauer, Matt
Thales Avionics	Courteville, Romain
Thales Avionics	Diore, Thierry
Thales Avionics	Margulescu, Sorin
Thales Avionics	Pesch, Tony
The Boeing Company	Brunson, Paul
The Boeing Company	Cramer, Joseph
The Boeing Company	Dankers, Robert
The Boeing Company	Fuller, James
The Boeing Company	Gilbert, Brian
The Boeing Company	Gish, Jeffery
The Boeing Company	Ho, Hai
The Boeing Company	Hurd, Mike
The Boeing Company	Johnstone, Randy
The Boeing Company	Kalata, Nellie
The Boeing Company	Katona, Thomas
The Boeing Company	Mueller, Anthony
The Boeing Company	Navarro, Raymond
The Boeing Company	O'Brien, Kathleen
The Boeing Company	Price, Jerry
The Boeing Company	Sandate, Richard

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The Boeing Company	Schmidt, Michael
The Boeing Company	Tjaden, Dan
The Boeing Company	Tran, Kha
The Boeing Company	Wolters, Nick
The Weather Company	Murry, Rich
Thomas Global Systems	Cooper, Lizzie
Thomas Global Systems	Hutchinson, Angus
Thomas Global Systems	Hutchinson, Stephanie
Thomas Global Systems	Hutchinson, William
Thomas Global Systems	Laird, Bruce
Thomas Global Systems	Meyboom, Kars
Thomas Global Systems	Meyboom, Kars
Thomas Global Systems	Pandis, Robert
Thomas Global Systems	Widlitzke, Markus
Totaport	Lemme, Peter
Traffic and Construction Authority	Kaas, Lars Ronnow
Turkish Airlines Technic Inc.	Arayici, Ozgur
Unicorp Systems Inc	Hall, Scott
Unicorp Systems Inc	Schonefeld, Jim
Unicorp Systems Inc	Whitman, Scott
United Airlines	Arentz, Steve
United Airlines	Conner, Dean
United Airlines	Fulton, Bill
United Airlines	Fulton, Laura
United Airlines	Gradwohl, Sharon
United Airlines	Johnson, Brian
United Airlines	Kochem, James
United Airlines	Moreland, Pamela
United Airlines	Petrick, Charles
United Airlines	Semar, Robert
United Airlines	Stillwell, Richard
United Airlines (Retired)	Allen, Chris
United Parcel Service	Christman, Joe
United Parcel Service	Gossman, James (Russ)
United Parcel Service	McLeroy, James
United Technologies Corporation	Collier, William
United Technologies Corporation	Krenz, Michael
United Technologies Corporation	McQueen, Steve
United Technologies Corporation	Newman, John
United Technologies Corporation	Orth, Jacqueline
United Technologies Corporation	Saul, Leon
Universal Avionics Systems Corp	Kline, Robert
Universal Avionics Systems Corp	Miller, Richard
Vicom Australia	Pearce, David
Virgin America	Devlin, Greg
VSATS	Meer, James K.
W.L. Gore & Associates, Inc.	McMullen, Tim
W.L. Gore & Associates, Inc.	Yates, Nick
Wencor MRO	Meade, Kevin
Westjet Airlines	Boivin, Paul
Zodiac Aerospace	Brooke, Jason
Zodiac Aerospace	Mallo, Jose
Zodiac Aerospace	Sericola, Didier