Overview of the National Airspace System

Al Secen
Agenda

• Introduction
• Course Objectives
• Early ATC
• Overview of ATC
  • Communications
  • Navigation
  • Surveillance
  • Air Traffic Management
• Airspace Structures and Management
• System Users
Archie League – the first controller

♦ The first US controller was a man by the name of Archie League

♦ Worked in St. Louis MO, during 1920’s where the airport operator employed him to prevent collisions between aircraft.

♦ His communication tools were simple: a red flag for "hold" and a checkered one for "go."

♦ In 1930’s when radios were installed, he became the first radio controller
Early ATC

Initially, pilot’s navigated via lighted routes
  - Predecessor of VOR navigation routes
  - Airlines hired people to keep track of their flights – the first en route controllers

♦ In 1929, Jimmy Doolittle first flew an entire flight using only instruments
  ♦ This necessitated someone else looking for obstacles and traffic

♦ WWII increased traffic in Terminal areas so Facilities to control air traffic were established

♦ Radar was soon introduced and an interconnected network of Air Traffic Control was created
Aviation Control Timeline

- Over the years, legislation has been enacted that, at first was meant to foster the aviation industry, and then to regulate and ensure safety.

1920 1930 1940 1950 1960 1970

Air Commerce Act of 1926

Civil Aeronautics Act of 1938 (Creation of CAA)

Congressional Action in 1940 (Creation of CAB)

Federal Aviation Act of 1958

DOT Act of 1966

Independent Safety Board Act of 1974
Creation of FAA

In the 1950’s, the commercial aviation industry in the U.S. was growing rapidly.

Control of that industry using pre-WWII methods was prevalent.
- Radar Control in Terminal Areas – procedural control en route

On June 30 1956 a TWA Lockheed Constellation and United Airlines DC-7 collided over the Grand Canyon.
- One of the contributing factors to the accident was listed as: “Insufficiency of en-route air traffic advisory information due to inadequacy of facilities and lack of personnel in air traffic control”

In 1958, the Federal Aviation Act was passed that established the FAA as an enforcement and rule-making organization.
Overview/Review of ATC
FAA Mission

• FAA Mission: Our continuing mission is to provide the safest, most efficient aerospace system in the world.

• FAA VISION: We strive to reach the next level of safety, efficiency, environmental responsibility and global leadership. We are accountable to the American public and our stakeholders.

• In order to achieve this goal, control must be exercised over the flying population

• From the FAA’s data website (for FY 2013):
  • 39,988,000 Aircraft handled at ARTCC
  • 38,983,000 Operations at TRACONS
  • 49,940,000 Airport Ops at ATCT
FAA Services and Facilities

Direct FAA air traffic services:
- Flight Service Stations (AFSS and FSS)
- Air Traffic Control Towers (ATCT)
- Terminal Radar Approach Control (TRACON)
- Air Route Traffic Control Center (ARTCC)
- Radar Approach Control (RAPCON)
- Terminal Radar Service Areas (TRSA)
- Combined En Route Approach Control (CERAP)
FAA Services and Facilities

Indirect support services provided by

- William J Hughes Technical Center (WJHTC)
- ATC System Command Center (ATCSCC)
- Mike Monroney Aeronautical Center (ARCTR)
- Traffic Management Unit (TMU)
- Center Weather Service Unit (CWSU)
- Volpe National Transportation System Center (VNTSC)
FAA Services and Facilities

• Administrative functions performed by
  – Flight Standards District Office (FSDO)
  – Regional Offices
  – National Headquarters (HDQ)
  – Numerous other maintenance field office, military facilities and administrative offices

♦ As of April 2015, there were 43,626 NAS facilities in the US (excludes foreign and non-federal facilities)

* Latest available as of August 2014
The National Airspace System

- Air Traffic Control Tower (ATCT)
- Terminal Radar Approach Control (TRACON)
- Air Route Traffic Control Center (ARTCC)
- Flight Services (AFSS)
- Air Traffic Control System Command Center (ATCSCC)
Air Traffic Control is often viewed as four major functions:

- **Communications** - ground to ground, air-to-ground
- **Navigation** - space-based, terrestrial
- **Surveillance** - radar, beacon, position reporting
- **Air Traffic Management** - Automation of intra-facility and inter-facility
Communication
FAA Communications Roadmap
FTI Scope

FTI provides

- point-to-point and multipoint Voice Grade (VG) analog services,
- point-to-point digital services,
- IP network services,
- switched circuit services.

FTI ALSO provides interface types that include

- VG, DDC, DDS, T1, T3, ETHERNET, FDDI, and ISDN.

FTI services can be ordered across a range of availability requirements from 0.997 to 0.9999971 and across a range of latency limits from 50 ms to 1000 ms.

For Security, FTI provides a range of Security Services that includes Basic security, VPNs, Gateways to non-NAS users, and Dedicated Services for critical NAS operational communications traffic.

At this point, Harris says it has transitioned more than 90 percent of the FAA’s legacy networks to the FTI network.
Navigation
Civil airways are either low or high, L/MF (MQI), VHF, UHF or RNAV-GPS based.
Global Positioning System (GPS)

- Satellite-based radio navigation, positioning, and time transfer system operated by the DoD
- For 3-dimensional position, the system is required to have at least four satellites in view
- At least five satellites in view are required for RAIM checking, and six to do RAIM isolation and corrupt signal removal
- IFR Certified receivers are expensive and must be panel mounted
Augmentation Systems

- GPS guidance is hindered by technology, atmospherics and design
- The basic GPS signal is only accurate enough to allow en route navigation
- In order to provide accurate landing guidance, the GPS signal must be augmented (LPV, LNAV/VNAV)
- Two systems will provide the accuracy, availability, and integrity needed to use GPS as a primary means of navigation in the NAS
  - Wide Area Augmentation System (WAAS) improves GPS signals from 100 to 7 meters
  - Ground Based Augmentation System (GBAS) improves the signal to allow CAT I, II, and III landings
PBN: Performance Based Navigation

- PBN specifies that aircraft RNP and RNAV systems performance requirements be defined in terms of:
  - Accuracy
  - Integrity
  - Availability
  - Continuity
  - Functionality

required for the proposed operations in the context of a particular airspace, when supported by the appropriate navigation infrastructure

- PBN allows:
  a. Fixed radius paths
  b. Fly-by turns
  c. Easier holding pattern flight
  d. Offset flight paths

Rather than specifying which navigation system to use, PBN requires that your system (whatever it is) meet certain performance requirements
Surveillance
Surveillance

- In order to efficiently control air traffic, some knowledge of aircraft location is required

- This knowledge is currently provided over the continental US by
  - **Radar**
    - Primary - is the echo of directed energy reflected off of an object
    - Secondary – transponder system replying to interrogations
  - **Automatic Dependent Surveillance - Broadcast**
    - ADS-B – A near continuous broadcast of position and intent data
    - Experiments with satellite-based ADS-B via Iridium are being discussed
  - **Automatic Dependent Surveillance – Contract**
    - ADS-C – A negotiated communication link (contract) providing *periodic contract*, *event contract*, or *demand contract* position reporting
  - **Multilateration** is a technique to derive position based upon the arrival of signals from multiple, accurately positioned receivers
Surveillance Systems

- Surveillance systems types:
  - Primary (search) - ARSR, ASR, ASDE-X, PAR, etc.
  - Secondary - ATCBI, ATCRB, Mode-S (4-digit octal code)
  - ADS-B – Aircraft must equip; receivers in-place over CONUS, Alaska, GOMEX (may soon move to satellite)
- ADS-C – Oceanic
- MLAT – usually surface but is used airborne in some locations (Aspen CO)
- Most en route and terminal radar are collocated with the ATCRB.
- There are still some stand-alone ATCBI systems deployed. Beacon data relies on transponder replies
- ADS-B relays GPS (or other) derived position data in the form of a state vector
Automatic Dependent Surveillance

- ADS-A/C is based on a negotiated one-to-one peer relationship between an aircraft providing ADS information and a ground facility requiring receipt of ADS messages
- ADS-B is a surveillance system designed for active participants
  - Security personnel worry about that aspect
- UPS-AT first used ADS-B to allow company pilots to self-monitor their position relative to company traffic through their internally developed CDTI
  - Overnight ATC services reduced
- ADS-B sends aircraft information and intent data to controllers and other aircraft – allowing TIS-B and CDTI for cockpit self-separation if necessary
Surveillance Antennae

- ARSR (200-250 mi)
- ASR with ATCBI (40-60 mi)
- ASDE (1-5 mi)
- ADS Ground Station
- MLAT Receiver

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Automation
Automation

- There are many automation systems used by the FAA to aid controllers
  - There are 90 separate Systems/Services listed in the FAA Automation Roadmap
  - They are either decommissioned, in service, or planned

- Examples are
  - Advanced Technologies and Oceanic Procedures
  - DOTS – Dynamic Ocean Tracking System
  - DSP – Departure Space Program
  - DUATS – Direct User Access Terminal Service
  - OFDPS – Oceanic Flight Data Processing System
  - STARS – Standard Terminal Automation Replacement System
  - CARTS – Common Automated Radar Terminal System
  - MEARTS – Micro Processor En Route Automated Radar Tracking System
  - TBFM – Time Based Flow Management
  - SMA – Surface Management Advisor
  - ERAM – En Route Automation Modernization
  - ERIDS – En Route Information Display System
  - FDIO – Flight Data Input/Output

What about SWIM? DataComm?
ATOP

- Anchorage, Oakland, and New York ARTCC provide air traffic control services to nearly 23 million square miles of airspace in the Arctic, Pacific, and Atlantic Oceans.

- Currently, transoceanic flights are limited as to what routes and altitudes they can fly due to:
  - third party communications between pilots and controllers via High Frequency radio operators;
  - pilot position reporting for surveillance due to a lack of radar coverage over most of the oceanic airspace;
  - highly manual processes used by FAA air traffic controllers to ensure coordination and safe separation of air traffic.

- Advanced Technologies and Oceanic Procedures provides
  - integrated capabilities such as flight data processing (FDP)
  - radar data processing (RDP)
  - automatic dependent surveillance (ADS)
  - controller–pilot datalink communications (CPDLC)
  - ATC interfacility data communications (AIDC)
  - conflict probe
  - graphical controller situation display
ERAM

• En Route Automation Modernization (ERAM) will replace the current NAS software and add the capabilities needed to support the NAS Architecture 4.0, Free Flight, ATS needs, and information security requirements.

• In concert with other En Route programs, ERAM will modernize the En Route infrastructure to provide an open-standards based system that will be the basis for future capabilities and enhancements

• ERAM capabilities will include
  • Native URET capabilities
  • Airline Operation Center (AOC) support
  • collaborative decision making (CDM) support
  • better NAS status
  • improved surveillance products
TBFM

- Time Based Flow Management (TBFM)
  - computes flight arrival sequencing, scheduled time of arrival (STA), and estimated time of arrival (ETA) at various points along the aircraft flight path to an airport
  - Responds to changing events and controller inputs by providing en route sector team information to maintain optimum flow rates to runways
  - expand the rule and scope of time-based metering operations more widely throughout the NAS,
    - Addition of Extended Metering and Coupled Scheduling
  - close the performance gap in transition of the retired Traffic Management Advisor (TMA) system to the follow-on system called Integrated Enterprise Solution (IES).
    - Three-Dimensional Path Arrival Management (3D PAM) will test Optimum Profile Descent (OPD) procedures that deliver aircraft from the top of descent to a metering fix with greater predictability
Airspace and System Users
Airspace

Airspace is defined by ICAO rules to fall into one of six classes: A, B, C, D, E, G
- Starting from G and working toward A, the requirements to operate in the airspace become more stringent
System Users

• The FAA has defined rules that govern operation of aircraft based upon the job being performed: These are Title 14 (Aeronautics and Space) Code of Federal Regulations

♦ The Code of Federal Regulations have parts that have specific rules for operations:
  – Part 91 - General Operating and Flight Rules augmented by:
    – Part 121 - Air Carriers and Commercial Operators
    – Part 135 - Commuter and On-Demand Operations
    – Part 137 - Agricultural Aircraft Operations

♦ Users are defined by which part of the Federal Regulations they operate under
Name the Operation!
Name the Operation!

BBJ

F4 Skyhawk PJ

SouthernJet

USAF T3A Firefly

Jet Ranger Ag Sprayer

SeaPort Airlines
Well known CFR (FAR’s)

- CFR 91.3 - The pilot in command of an aircraft ... is the final authority as to the operation of that aircraft

  ♦ CFR 91.11 - No person may assault, threaten, intimidate, or interfere with a crewmember in the performance of the crewmember’s duties...
  ♦ CFR 91.21 - ...no person may operate ...any portable electronic device on ... any aircraft while it is operated under IFR

  ♦ CFR 91.107(2) - No pilot may cause to be moved on the surface, take off, or land ...[an] aircraft ... unless ... each person on board has been notified to fasten their safety belt.

  ♦ CFR 91.519 - Before each takeoff, the pilot in command ... shall insure that all passengers have been orally briefed on ...1) smoking ... 2) use of safety belts ... 3) location [of] ... emergency exits ... 4) location of survival equipment ... 5) ditching procedures ... 6) ...use of oxygen equipment
• Thank you!