A Suggested Approach for Producing VAMS Air Transportation System Technology Roadmaps

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VAMS Project
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AMES Research

Overview

- VAMS Project Formulation Agreement Deliverable #3 requires the production of technology roadmaps to guide research
  - Producing this deliverable is the responsibility of the System Level Integrated Concepts (SLIC) sub-element lead by Rob Fong (rkfong@mail.arc.nasa.gov)

- Technical Approach
  - Use concept work to produce their own examples of technology roadmaps
  - Use system engineering work to produce an integrated catalogue of technology roadmaps along with technical discussions
  - The Top-level WBS steps are
    - 3.1 Top-level Technology and Operational Needs
    - 3.2 Top-level Technology Gaps
    - 3.3 Approach to Obtaining Transition Technologies
    - 3.4 Transitional Technologies - Round 2
    - 3.5 Integrated Roadmap: Top-down and bottom-up

VAMS Project Policy

- Every concept that is nurtured within the VAMS Project will need to develop an ATS Technology Roadmap for that concept
- Those concept specific roadmaps will be:
  - Updated annually
  - Discussed at all technical interchange meetings
  - Shared amongst all VAMS participants
  - Maintained by their producer
  - Available electronically in a widely used format (MAC and PC)
- Concepts should follow the format described herein, suggest modifications, or independently develop an equally descriptive approach with examples
- As they are completed the ATS Technology Roadmaps will be:
  - Collected into a catalogue,
  - Integrated with each other into different topical sets
  - Linked to AvSTAR, the OEP and NASA's long term ATS strategy
  - Accompanied by technical discussions and research recommendations
  - An integration point for the University efforts (Dr. Zellweger team and others)

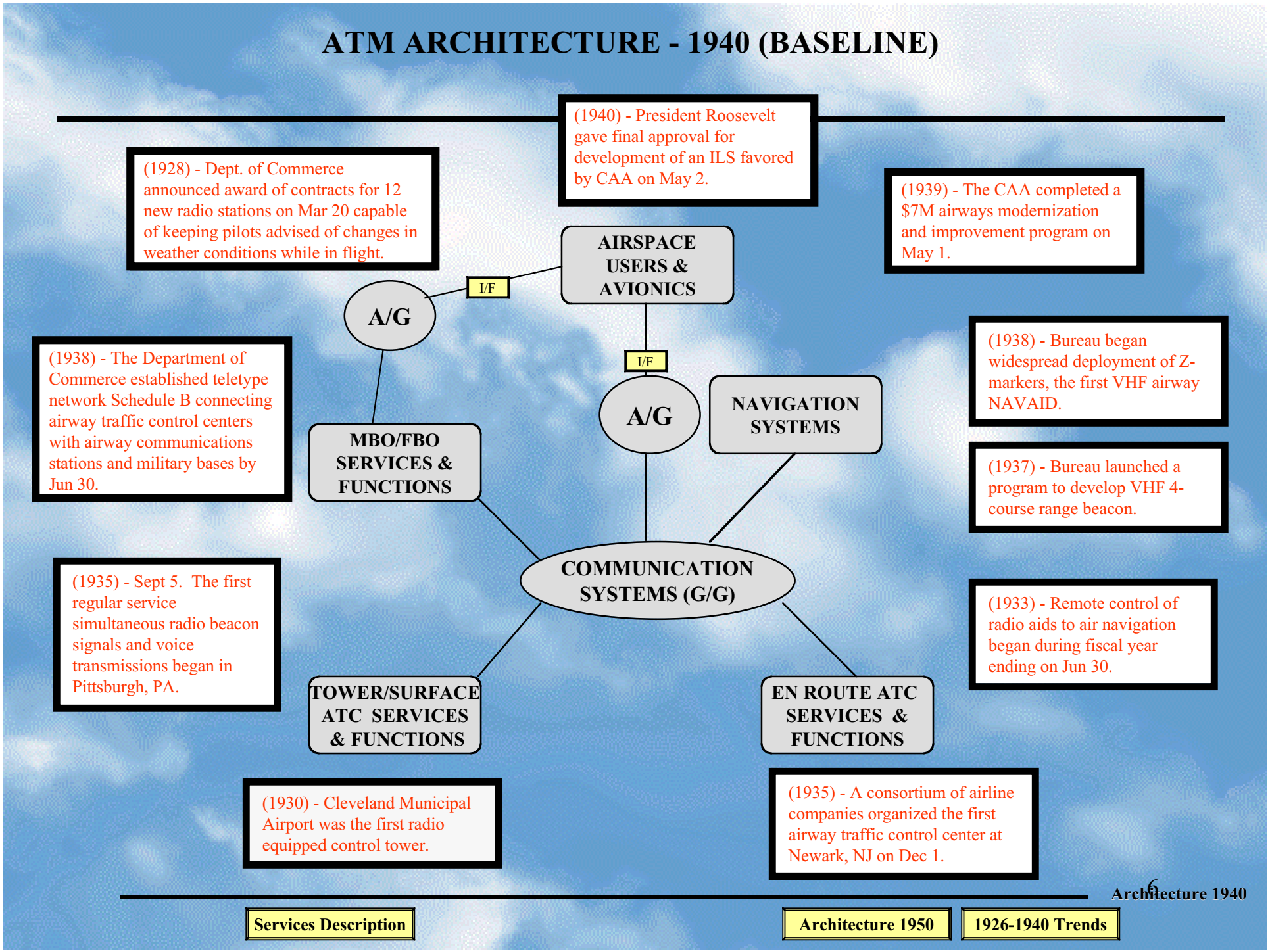
Technology Roadmap Framework

- Suggested Starting Framework (AATT's Task Order 40 - SAIC)
  - ATM model
    - Existing examples
      - 1940 (in backup)
      - 1950 (in backup)
      - 1960
      - 1970
      - 1980
      - 1990
      - 1999 (in backup)
    - Need to be created
      - 2002 (today)
      - 2006 (near-term)
      - 2010 (FAA OEP Horizon)
      - 2015 (Medium term Vision Horizon)
      - 2020 (Longer term NASA Vision Horizon)
      - 2025 (Longer term Stakeholder Vision Horizon)

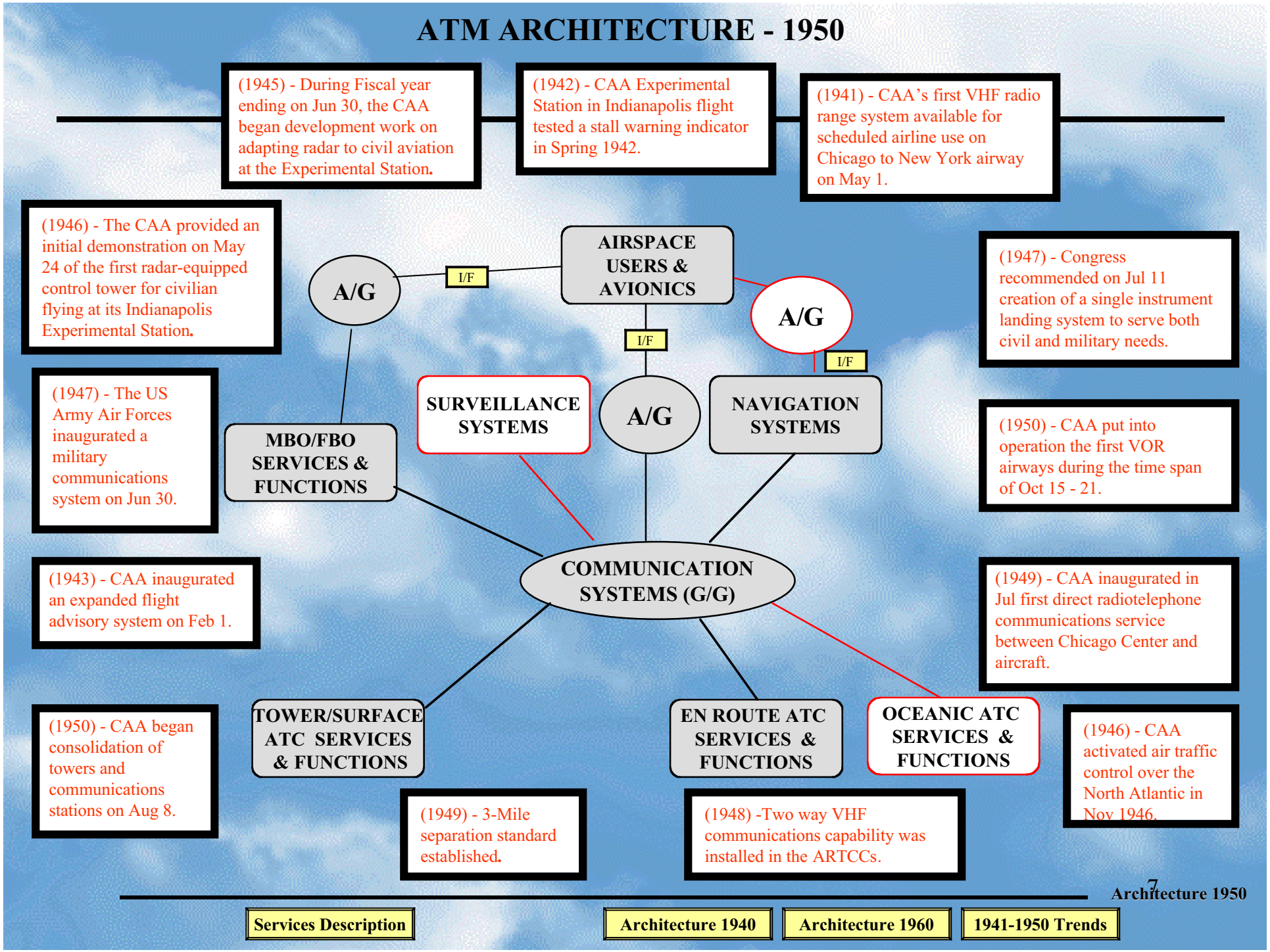
Technology Roadmap Characteristics

- Characteristics
  - Using the ATS model show a specific technologies time (from concept to market availability)
  - Discuss the science understanding
  - Discuss the performance needs/requirements
  - Indicate if any alternative approaches exist
    - Identify Technology pathways
    - Identify Gaps
    - Tradeoff pathway groupings
  - Risks
    - Technical
    - Political
    - Legal/Certification
  - Critical challenges for which solutions are needed and must be accomplished
  - Costs (by Phase)
  - Scenarios to demonstrate features or aspects
  - Supporting documentation

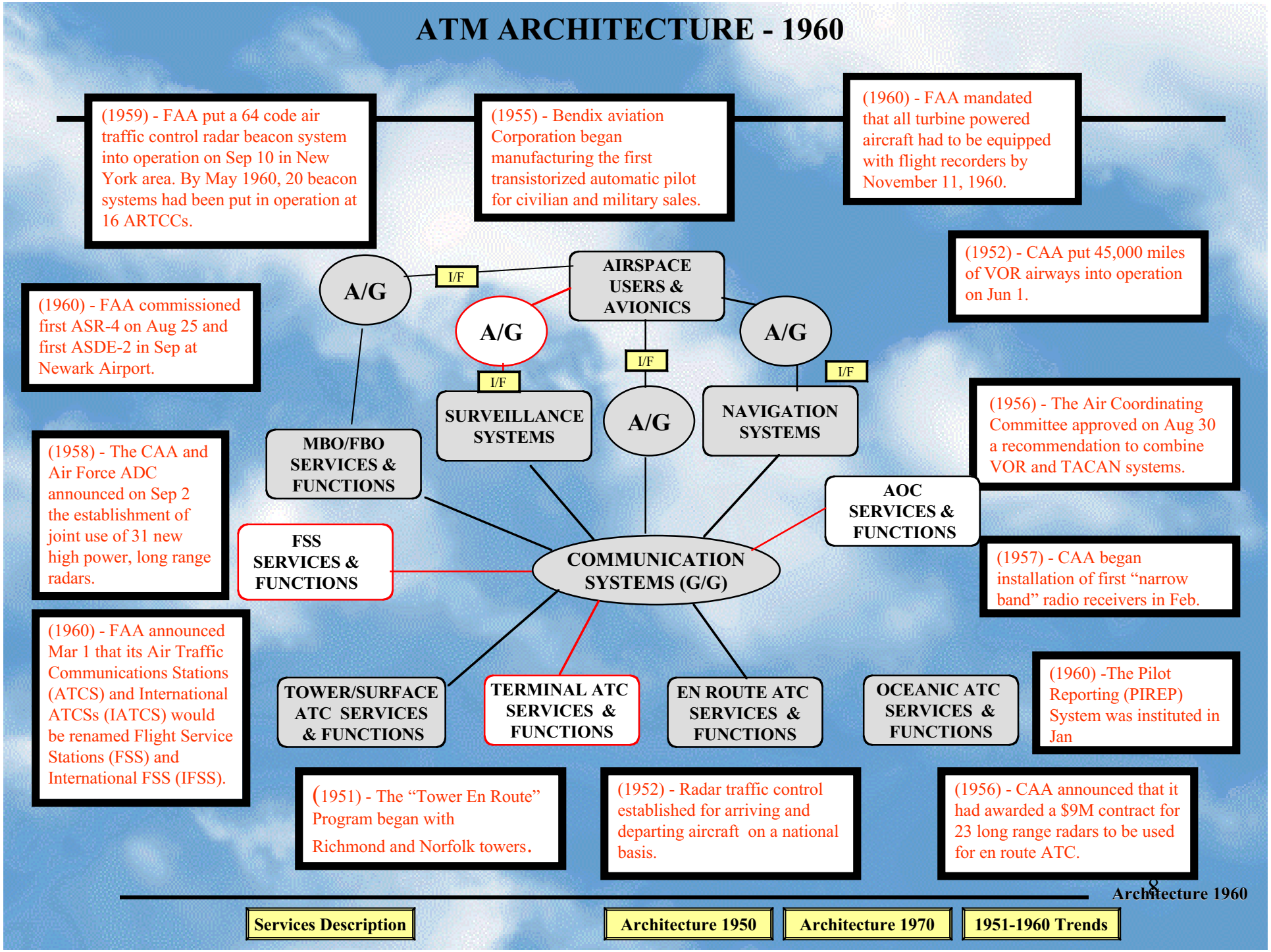
ATM ARCHITECTURE - 1940 (BASELINE)



ATM ARCHITECTURE - 1950



ATM ARCHITECTURE - 1960



ATM ARCHITECTURE - 1970

(1970) - FAA established on Jun 19 two-way ATC satellite communications between ATC facilities in San Francisco and Honolulu.

(1970) - FAA commissioned the International Aeronautical Telecommunications Switching Center at Kansas City on Apr 30.

(1964) - Pan Am announced on Jul 21 that Inertial Navigation Systems would be installed on most of its jet aircraft.

(1963) - FAA issued rule on Jul 1 requiring DME equipment on all airline turbojets and all other civil aircraft flying IFR above 24,500 0 ft in the US.

(1964) - FAA commissioned first DME combined with ILS at Kennedy International Airport in Nov.

(1961) - Beacon Committee recommended FAA use secondary Surveillance radar (SSR) has primary part of air traffic surveillance. Also recommended MODE-C be used for aircraft height reporting.

(1961) - FAA commissioned the first Doppler VOR at Marquette, Michigan on Jun 29.

(1963) - The FAA and DoD agreed on Feb 1 the joint use of operational point-to-point communications networks on a worldwide basis.

(1970) - FAA established the ATC Systems Command Center on Jul 29 to integrate functions of Central Flow Control Facility, Airport Reservation Office, Air Traffic Service Contingency Command Post, and Central Altitude Reservation Facility (CARF).

(1964) - FAA announced on Feb 4 the first phase of a long range plan to gradually reduce the number of FSSs in the US from 297 to 150.

(1967) - Pan Am jet flying the North Atlantic on Nov 21 used NASA ATS III satellite for air-ground-air radio voice relay.

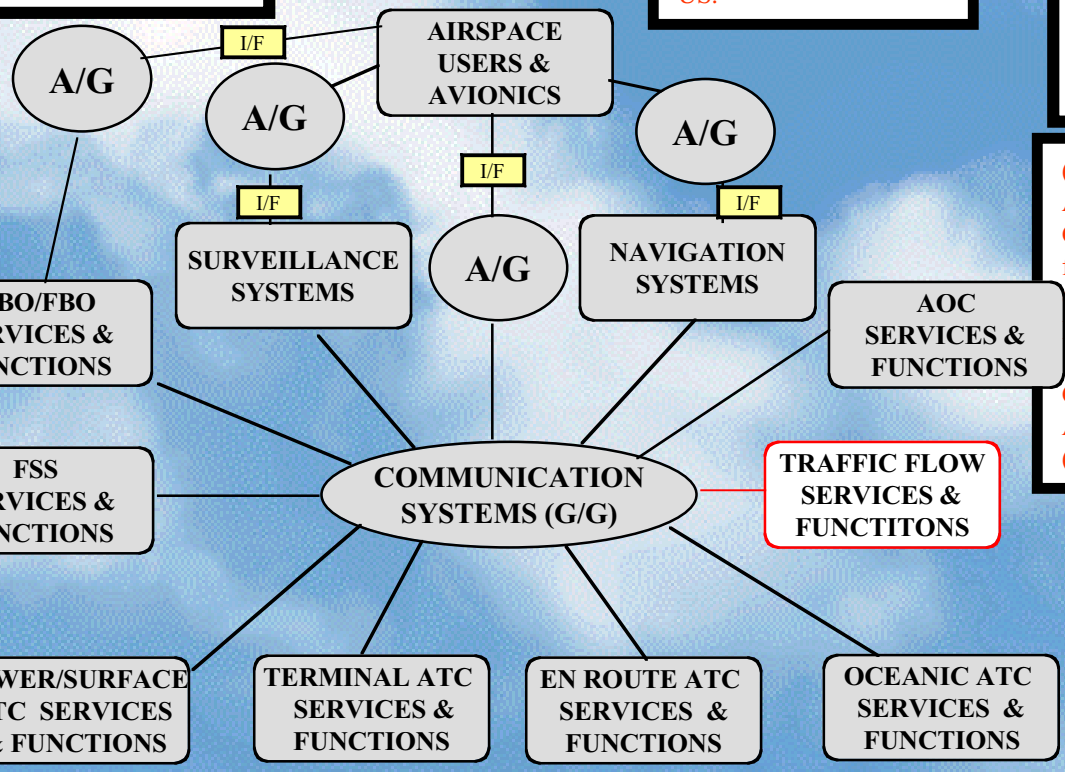
(1968) - By Jul 15, FAA had commissioned first Bright Radar Indicator Tower Equipment (BRITE-1) at Newark, Dallas (Love), and Birmingham towers.

(1961) - On Dec 26, Air Traffic rules became effective for conducting flight operations around all controlled airports in the US.

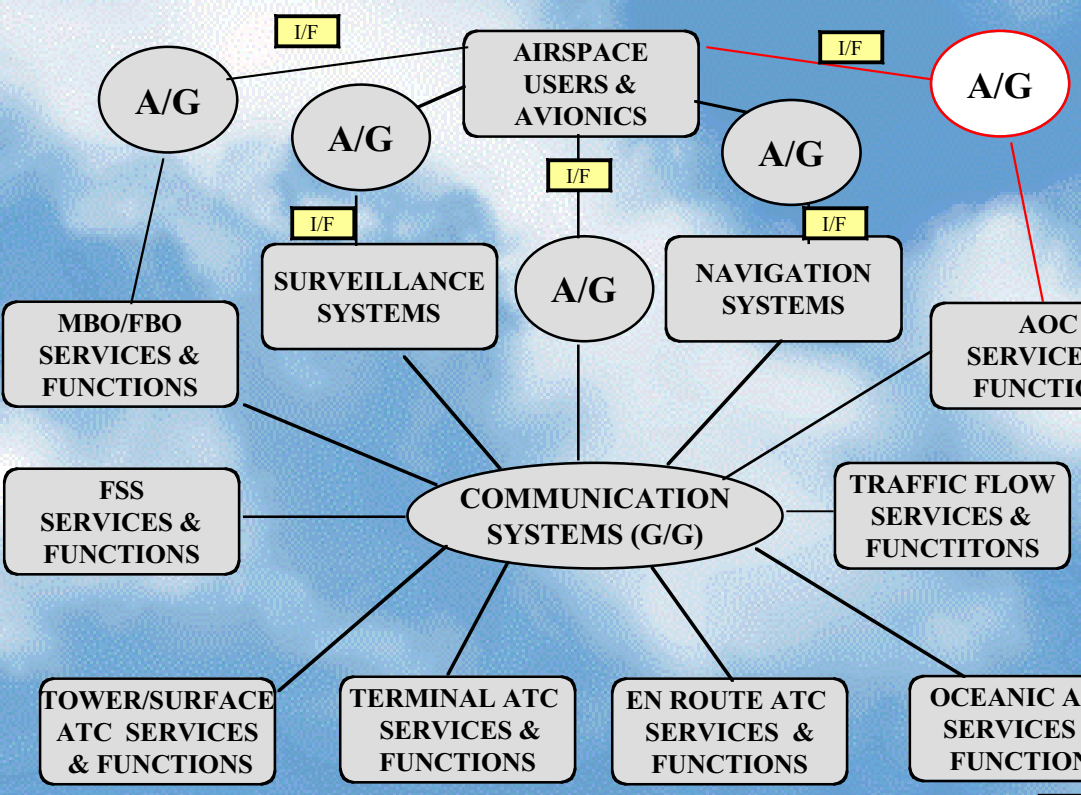
(1969) - New York Common IFR Room shifted form a manual radar system to a computerized radar system on Jun 1.

(1968) - The data processing part of NAS Stage A went into part time operation on Dec 30 at Jacksonville ARTCC.

(1970) - FAAs first IBM 9020 system became operational on Feb 18 at Los Angeles ARTCC.



ATM ARCHITECTURE - 1980



(1979) - On Jun 25, the first new generation air route surveillance radar, ARSR-3, went into operation.

(1974) - FAA published a rule on Dec 24 requiring installation of Ground Proximity Warning System (GPWS) on large turbojet and turboprop aircraft.

(1978) - The Aircraft Communications and Addressing and Reporting System (ACARS) achieved IOC at 155 airports

(1976) - FAA effected a national Beacon code allocation plan on Jul 12.

(1972) - FAA commissioned first operational CAT IIIA landing system at Dulles International Airport on Jan 21.

(1974) - On Oct 1, FAA reduced minimum separation distance for simultaneous ILS approaches on parallel runways.

(1980) - DOT announced the award of competitive contracts to three companies on Jan 25 to design computer systems for automating the FAA's network of Flight Service Centers (FSSs).

(1973) - FAA awarded a contract on Jan 6 for an electronic voice switching system to replace ARTCC communications and radio control and signaling equipment at remote sites.

(1978) - FAA's LLWAS became operational at seven airports in Sep.

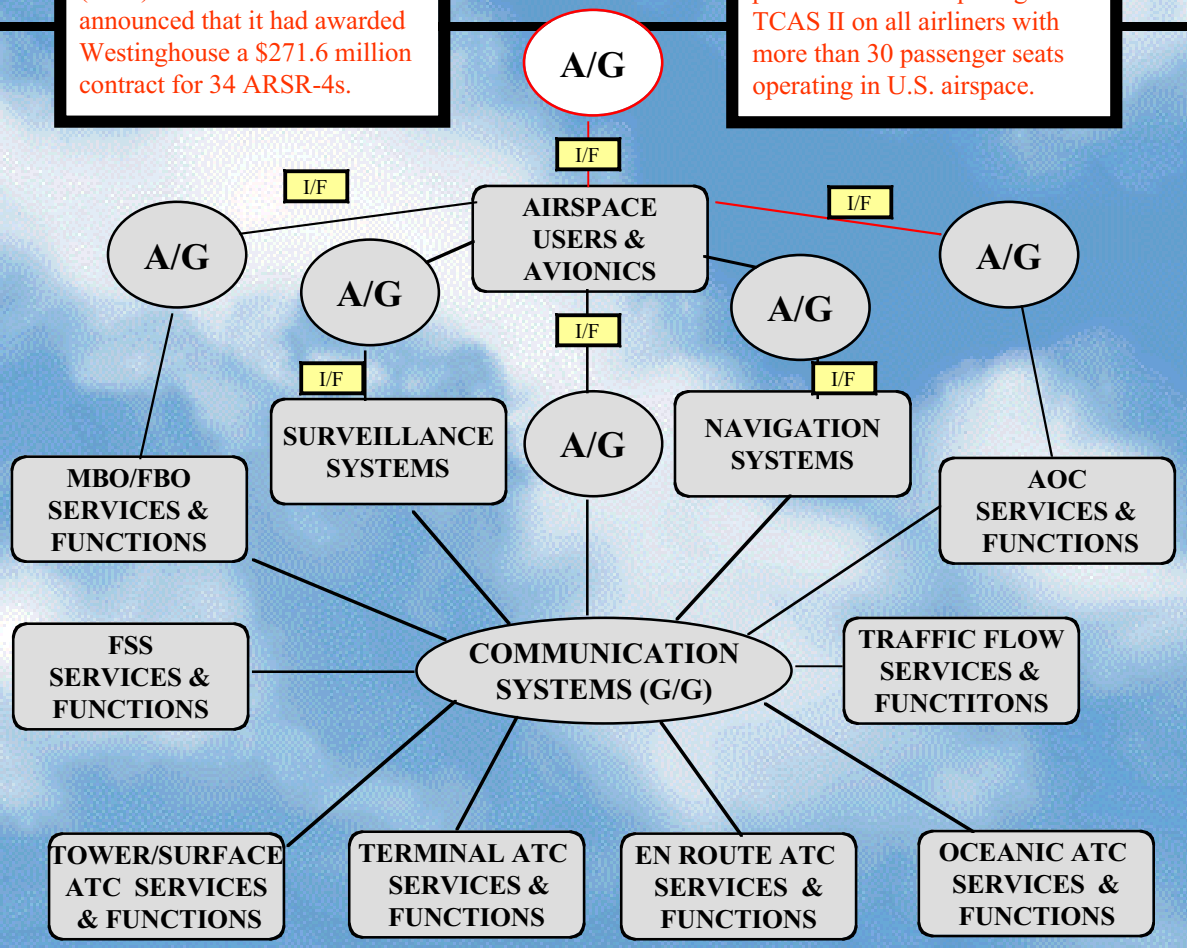
(1971) - FAA commissioned first ARTS III at O'Hare TRACON on Oct 4.

(1978) - On Dec 12, first ARTS-II began operations at Toledo TRACON.

(1975) - Phase II of NAS Stage A was completed on Aug 26 with commissioning of the 20th RDP system at Miami ARTCC.

(1979) - The first two Direct Access Radar Channel (DARC) systems were delivered to the FAA Academy and NAFEC.

ATM ARCHITECTURE - 1990



(1988) - On Jul 25 FAA announced that it had awarded Westinghouse a $271.6 million contract for 34 ARSR-4s.

(1989) -On Jan 10 FAA published a rule requiring the TCAS II on all airliners with more than 30 passenger seats operating in U.S. airspace.

(1989) - On May 2 FAA commissioned the first operational ASR-9 airport surveillance radar 30, 1983).

(1983) - On May 23 the first aircraft to navigate across the Atlantic entirely by use of the GPS landed at Paris.

(1990) - On Mar 6 FAA issued a rule requiring private aircraft flying into or out of the country through an Air Defense Identification Zone (ADIZ) to be equipped with altitude-reporting (Mode C) transponders by Dec 30..

(1988) - In Dec the Federal Radio navigation Plan (FRP) was issued as a replacement and update to the 1986 FRP.

(1987) - On May 17 FAA began using the Aircraft Situation Display (ASD) at its Central Flow Control Facility at Washington Headquarters.

(1986) - On Feb 12 FAA commissioned the first "family" group of automated flight service stations (AFSSs), at airports in Cleveland, Ohio, Dayton, Ohio, and Bridgeport, Conn.

(1983) - On Dec 31 operational use of an IBM 4341 computer began at the Central Flow Control facility at FAA's Washington headquarters.

(1989) - On May 5 FAA's National Data Interchange Network 1A (NADIN 1A) became fully operational, supplanting several independent communications networks with a single, effective means of transmitting weather and flight plan data.

(1989) - On Dec 14 FAA authorized use of the Oceanic Display and Planning System (ODAPS) at the Oakland Air Route Traffic Control Center.

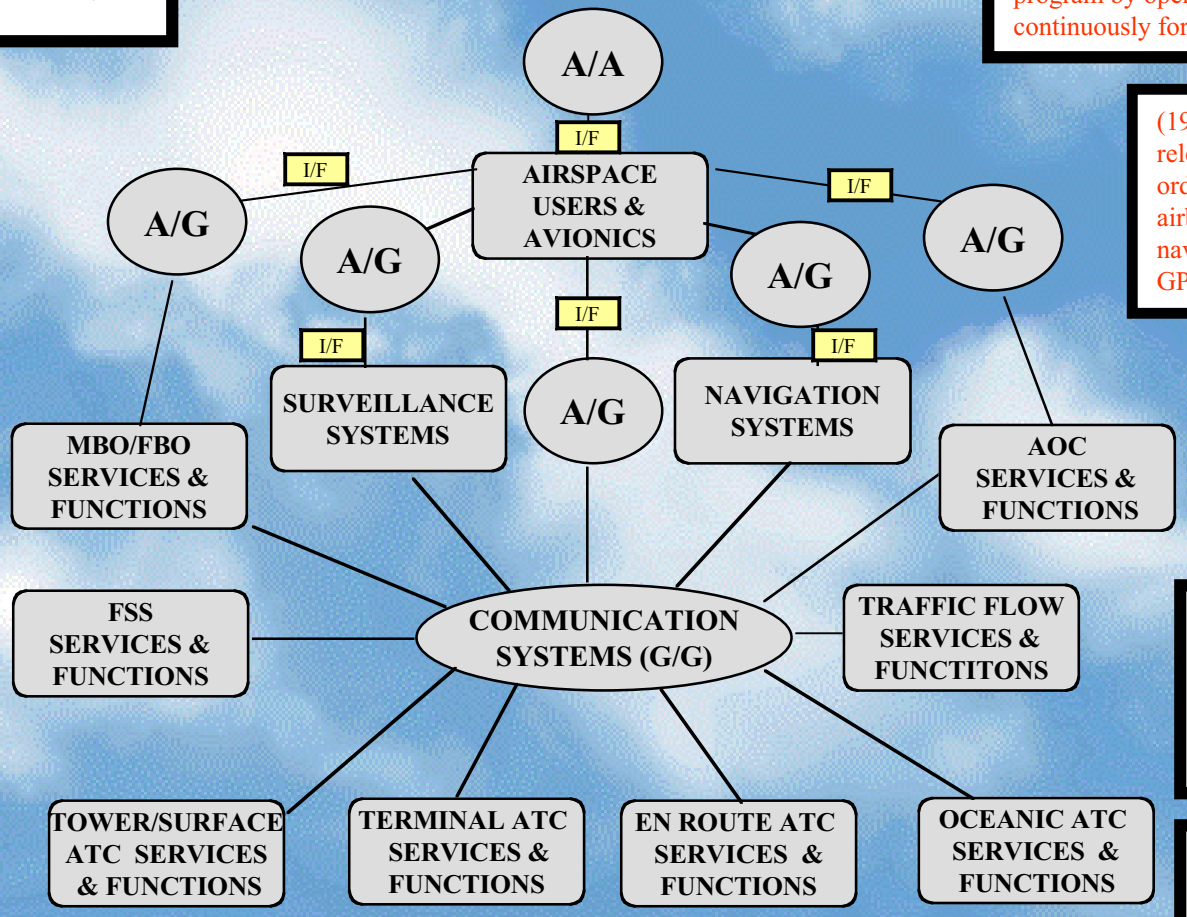
(1988) - In Aug FAA began a test and demonstration of the Precision Runway Monitor (PRM) at the Memphis airport, followed in May 1989 by a year-long test at the Raleigh-Durham airport.

(1981) - The New York TRACON became operational on Jan 10 at Hempstead, Long Island.

(1987) - On May 29 FAA commissioned the first of its Host Computer Systems at the Seattle air route traffic control center (ARTCC).

(1981) - FAA commissioned first Direct Access radar Channel (DARC) at the Salt Lake City ARTCC on Feb 2.

ATM ARCHITECTURE - 1999



(1997) - The FAA made an investment decision on Aug 12 to procure ATC Beacon Interrogator Replacements, ATCBI-R(6).

(1999) - Apr 9. Raytheon completed the Stability Build milestone in the WAAS program by operating continuously for 72 hours.

(1992) - On Jul 30 FAA excluded general aviation aircraft from the rule that all transponders installed after Jul 1, 1992, be Mode S transponders.

(1992) - On Dec 10 FAA released a technical standard order prescribing standards for airborne supplemental navigation equipment using GPS.

(1994) On Mar 8 FAA commissioned its first monopulse beacon radar by upgrading the Mode S sensor at the same airport.

(1998) - The FAA, DOT and Coast Guard announced in Jul that they would continue LORAN-C to 2008 rather than 2000.

(1997) - The FAA awarded a contract in Sep to the Harris corporation to replace the present FSS Automation System.

(1994) - On Apr 15 FAA's Air Traffic Control System Command Center (ATCSCC) officially began operations in its new facility at Herndon, VA.

(1993) - On Nov 2 FAA dedicated the new Leased Interfacility National Airspace Communications (LINCS) telecommunications system following an initial installation that took about nine months.

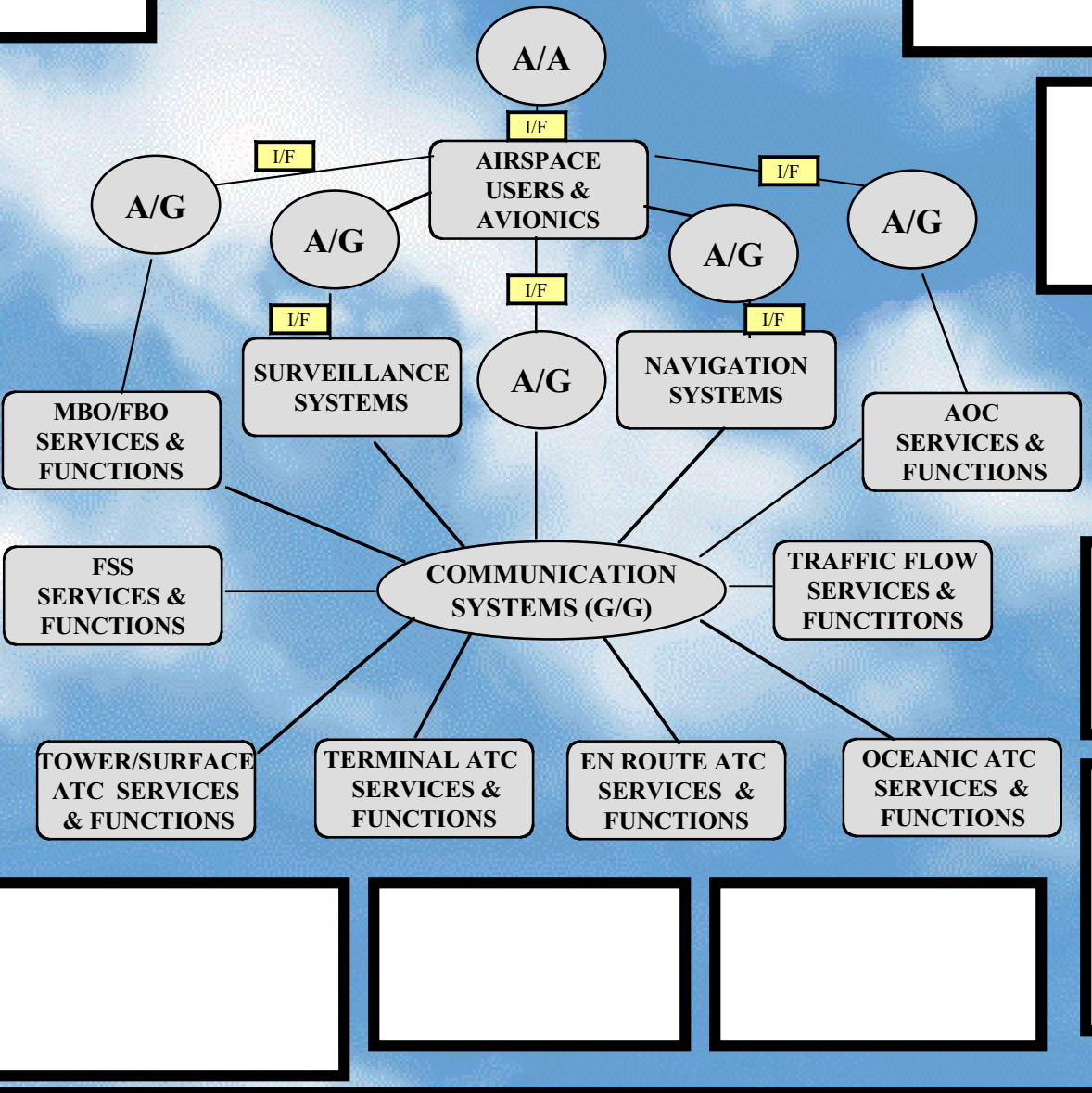
(1998) - The FAA announced in Nov that it was investigating an approach to provide Oceanic Automation Systems from existing systems deployed Internationally.

(1996) - On Jun 27 FAA signed a contract with Northrup Grumman Systems for three full-scale development versions of the Airport Movement Area Safety System (AMASS).

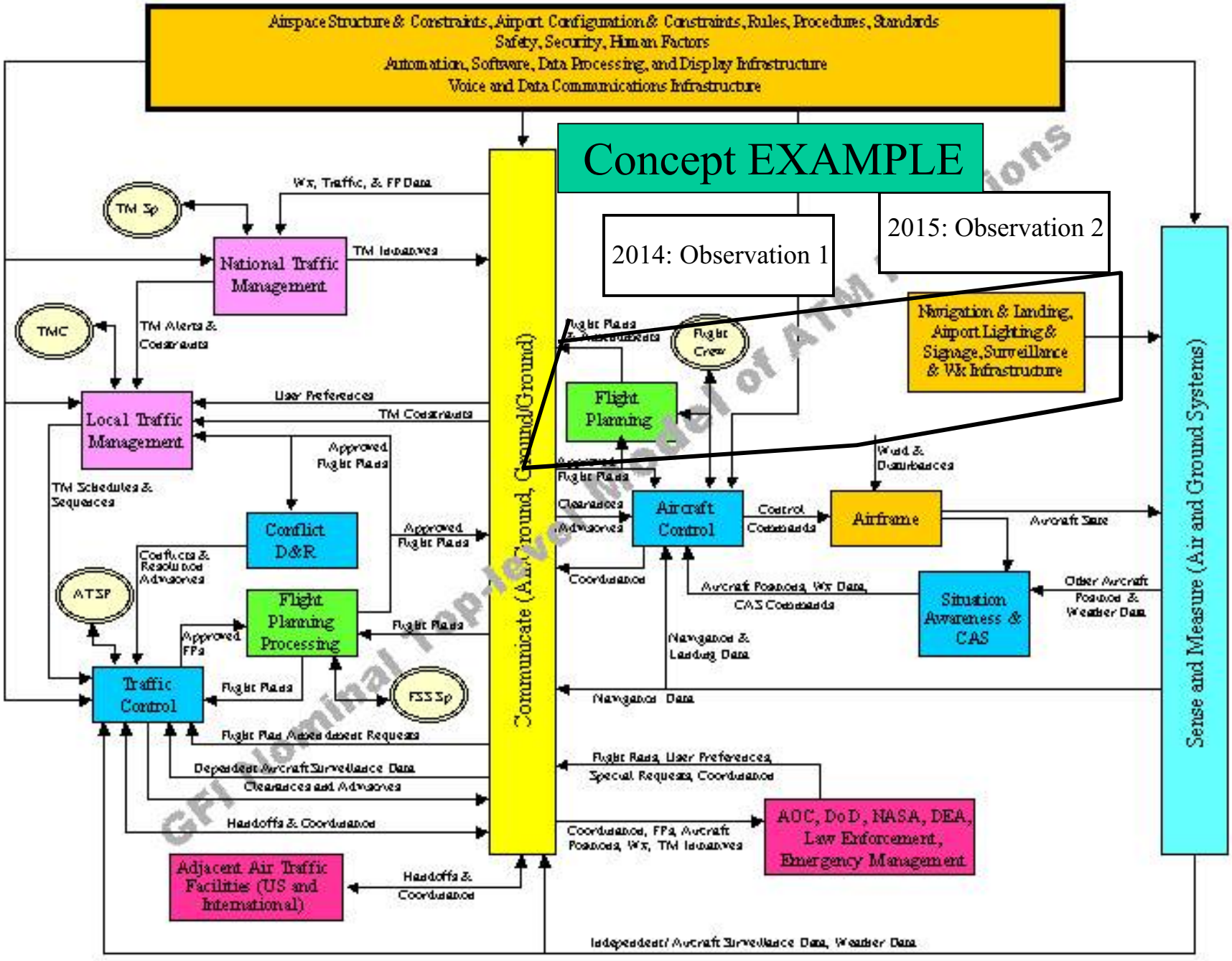
(1998) - The FAA Common ARTS system reached IOC at the Chicago Metroplex on Aug 28.

(1998) - The FAA on Dec 15 declared the Display System Replacement (DSR) fully operational at the Seattle ARTCC.

ATM ARCHITECTURE - 2010



Services Description | Architecture 2002 | 2002-2010 Trends


Airspace Structure & Constraints, Airport Configuration & Constraints, Rules, Procedures, Standards
Safety, Security, Human Factors
Automation, Software, Data Processing, and Display Infrastructure
Voice and Data Communications Infrastructure
Concept EXAMPLE
2014: Observation 1
2015: Observation 2
Communicate (Air/Ground, Ground/Ground)
Sense and Measure (Air and Ground Systems)
TM Sp
National Traffic Management
Wx, Traffic, & FP Data
TM Initiatives
TMC
TM Alerts & Constraints
Local Traffic Management
User Preferences
TM Constraints
TM Schedules & Sequences
Approved Flight Plans
Conflict D&R
Conflicts & Resolution Advisories
ATSP
Flight Planning Processing
Approved FPs
Flight Plans
Traffic Control
FSS Sp
Flight Plan Amendment Requests
Dependent Aircraft Surveillance Data
Clearances and Advisories
Handoffs & Coordination
Adjacent Air Traffic Facilities (US and International)
Handoffs & Coordination
Flight Plans & Amendments
Flight Crew
Flight Planning
Approved Flight Plans
Clearances / Advisories
Coordination
Aircraft Control
Control Commands
Airframe
Wind & Disturbances
Aircraft State
Aircraft Position, Wx Data, CAS Commands
Situation Awareness & CAS
Other Aircraft Position & Weather Data
Navigation & Landing Data
Navigation Data
Navigation & Landing, Airport Lighting & Signage, Surveillance & Wx Infrastructure
Flight Plans, User Preferences, Special Requests, Coordination
AOC, DoD, NASA, DEA, Law Enforcement, Emergency Management
Coordination, FPs, Aircraft Position, Wx, TM Initiatives
Independent Aircraft Surveillance Data, Weather Data
GPI Nominal Top-level Model of ATM Operations