

# Digital Flight Rules Enabled by GPS

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# Digital Flight definition

- **Digital Flight (DF)** is proposed as a new flight operations capability designed to complement existing Visual Flight Rules (VFR) and Instrument Flight Rules (IFR). Enabled by its own set of rules and procedures, DF would employ advanced automation for self-separation and flight path management, shared situation awareness through information sharing and data connectivity, and cooperative behaviors in lieu of visual procedures and ATC separation services.

# Origins of Digital Flight

- NASA Paper “New Flight Rules to Enable the Era of Aerial Mobility in the National Airspace System” NASA TM-20205008308
- Prior similar proposals were not supported by existing technology
  - Autonomous Flight Rules – NASA, 2011
  - Free Flight – FAA, 1995
  - Electronic Flight Rules – Lincoln Labs, 1973
  - Airborne Traffic Situation Display – MIT, 1965 – 1970
- GPS, ADS-B, DataComm and computing power have enabled an environment of technologies that can realistically support automation of the separation function in new flight operations, integrated with existing VFR and IFR flights.

# Who Benefits? Everyone!

- Scalable operations of new entrants, thousands where now there are tens



# Benefits Continued

- Access to Airspace
  - Many new operations do not fit into either VFR or IFR
  - VFR is severely limited by weather
  - IFR is restricted by system capacity and flexibility and human interaction limitations
  - DFR permits automated separation in IMC by giving right of way to VFR and IFR flights, enabling access by both new and legacy flight operators
- Flexibility in Trajectory Planning and Alteration
  - Necessary for many operations – Infrastructure inspection, surveillance, emergency response, on demand transportation
  - Permits flight optimization, response to anomalies, and re-optimization of legacy flight operations, providing cost savings and environmental benefits

# Key Attributes of Digital Flight Rules

- On demand access to all classes of airspace
- Flexibility to plan optimum flight trajectory and alter it with changing conditions when enroute
- Benefits accrue to first equipped user
- Responsibility to detect and resolve all safety hazards
- Give way to VFR and IFR aircraft for non-interference
- Participate in TFM when using traffic constrained facilities

# Reliance on GPS

- Navigation assumes reliable GPS signal coverage



- Airborne Surveillance begins with position, velocity and time
- DF safety dependent on system reliability

# GPS Vulnerabilities

## GNSS RFI threat monitoring - Active and evolving threat

- GNSS **jamming** conditions happen on a daily basis on large areas:
  - Over a total of 149965 flights monitored, mainly on Europe-Middle East routes, jamming has been detected on 27864 flights from 2017 to 2020 (included): 19% of flights



- GNSS **spoofing** is very likely the root cause of erroneous UTC time (erroneous hour) information observed in service



# GPS Backups and Alternatives

- Safety of life services require high reliability plus backup capability
  - Inertial systems
  - Electro-optical systems
  - On board radar
  - Cellular systems
  - GNSS Augmentations
  - Dual DME
  - eLORAN
  - Others?
- Alternative PNT should not require everyone to equip with multiple new systems

# Barriers to DFR Implementation

- Cost to users, for airborne equipment and training
- No, or inadequate, budget for service providers
- **Immature technology or competing alternatives**
- Solutions that require “critical mass” of users before benefits accrue
- FAA System for Safety Assurance
  - **Certification process (especially if new system doesn’t fit existing process)**
  - **Operational Approval process**
- Compatibility with the existing ATC paradigm
- Industrial resistance

# Success Factors

- Strong Business Case
- Strong Advocacy by Industry or Government Champion
- **Clear, proven technical solution**
- International cooperation and commitment
- FAA Mandate
- Congressional Action – passing a law
- Investment commitment by proponents

# Bottom Line

- Digital Flight Rules represents the most important new concept in support of aviation growth and mission expansion in decades
- Digital Flight will have a strong dependence on robust GPS service
- PNT alternatives make for costly DF implementation especially if requiring multiple technologies to achieve required safety level