CGSIC

GPS for ICAO Global Tracking

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Need

- Loss of AF447 and MH370 highlighted need for tracking of aircraft
- Socially not acceptable to not know aircraft location at all times

- ICAO Global Tracking Conference (May 2014):
  - Position report every 10 minutes (ops normal)
  - Position report every 1 minutes (ops non-normal)

- ICAO High Level Safety Conference (Feb 2015):
  - Position report every 15 mins (ops normal)
  - Locate wreckage within 6 NM
  - Take advantage of existing surveillance systems

- ICAO Performance Standard for Global Tracking being developed
Operational Context (Australia)

- **Controlled Airspace - ATC Services**
  - Continental airspace
    - Surveillance (tracking) by ATC radar / ADS-B (since 2005)
  - Oceanic airspace
    - implies Automatic Position Reporting, messages by Satcom
- 90+% of wide-body aircraft equipped with FANS-1/A ADS-C
- Airservices ATC Automation System supports FANS-1/A ADS-C
- ADS-C already in routine service in Australian FIRs (20 yrs)
- Non normal aircraft operation can be detected by monitoring of lateral & vertical conformance to ATC Clearance
  - Clearance is known to ATC & Pilot but not to the Airline base
- Use of one system to provide ATC Surveillance and aircraft Global Tracking allows cost to be offset by improved ATC service (smaller separation standard increases probability of optimum route & altitude)
FANS-1/A ADS-C

ATC Display System

GPS

GES

Comm

ADS-C Message Processor

ABC 123
FL 280

XYZ 456
FL 300

connecting australian aviation
ADS-C Contracts

Contracts – Aircraft FMC to ATC Automation System

- Periodic Position Report
  - Aircraft position

- Waypoint Change Event
  - Occurs when Next or (Next + 1) waypoint changes
  - ADS-C Route Conformance Warning (ARCW)

- Event – Lateral Deviation Event - route conformance

- Event – Level Range Deviation Event - flight level conformance

- Demand - also known as one shot
  - can be initiated by controller at any time
Concept

- Adapt existing FANS-1/A ADS-C surveillance
  - Less than comprehensive solution but available today

- Automatic Position Reporting
  - **GPS** provides aircraft position and time tag
  - Reporting rate (aircraft operations normal) = 1 per 14 min
    - ATC System check Position & Altitude against Clearance

- ATC System checks for missed messages
- Controller can set higher reporting rate as required
Automatic, timely detect of (serious) non normal operations
  - Aircraft off path - Lateral or Vertical deviation
    - if on route & altitude will reach intended destination
  - Check route consistency – aircraft FMC to ATC automation (ARCW)
    - FMC Reports Level (altitude) Range Deviation (LRDE)
    - FMC Reports Lateral Deviation Event (LDE)

Non-normal events reported / displayed to the Controller
  - Missed message; failure to pass waypoint on time (ETO)
  - Inconsistent route (ARCW), Route Adherence Monitor (RAM)
  - Cleared Level Adherence Monitor (CLAM), Pilot declared Emergency

Automatic New Contract - reporting rate ops non-normal (1 per 5 min)
  - ATC Procedures define response to non normal operation
    - Lost Comms Procedure → SAR Procedure
Proof of Concept

- **Partners**
  - **Airlines**
    - Virgin Australia: B777 x5 & A330 x5
    - Qantas: A380 x12, B744 x12 & A330 x26
  - **ANSP/ATC**
    - Airservices
  - **Communications Providers**
    - Inmarsat (sitcom), SITA & ARINC (datacom)

- **Location**
  - Oceanic east of Australia (OTS East) plus Nauru & Honiara FIRs
  - 10 min reporting (ICAO recommendation May 2014)

- **Operations commenced on 30 Jan 2015**
Proof of Concept …

ADS-C Global Tracking:
- Nauru
- Honiara
- Blue area
Phased Implementation

- **Prime Consideration:**
  - Care to ensure not overload:
    - **Satcom** – **Biggest Concern** – limited bandwidth, cost
    - Data Comm networks (SITA & ARINC)
    - ATC Automation System FANS-1/A processing

- **Satellite Communications Modelling:**
  - Increase in Periodic Reports; Decrease in Rate Change messages
  - 4% increase in downlink; 17% decrease in uplink
  - Messages recorded; message rate and latency analysed
    - Negligible increase in total message count
      - Increase in periodic message count as expected
      - Decrease in rate change message count as expected
  - No loss of performance, no increase in latency
  - No signs of distress
Phased Implementation …

- Phase 2
  - 14 min ops normal reporting
    - Meets ICAO HLSC (Jan 2015) 15 min requirement AND
    - ATC 30/30 NM Procedural Aircraft Separation Standard
  - Extend service all ADS-C A/C in Brisbane/Honiara/Nauru FIRs
  - Commenced 1 May 2015

- Phase 3
  - Extended service to include all ADS-C Aircraft in Melbourne FIR
  - Commenced 29 May 2015

- New Zealand – commenced 29 May 2015
- USA (Anchorage & Oakland FIRs) commenced 25 June 2015
- Malaysia has increased their tracking rate
- Discussions with Indonesia, Fiji & South Africa
Benefit Achieved
Benefit Achieved …

- **Wide Body Aircraft** - ADS-C equipped
  - A330 / A340 / A380 / B744 / B777 / B787
  - 7,370 operations / month = 65%

- **Narrow Body Aircraft** - not ADS-C equipped
  - A320 / B737
  - 3,990 operations / month = 35%

- Passenger exposure (passenger hours)
  - Passengers carried (average)
    - Wide Body 300 to 550 – average 400 passengers
    - Narrow Body – average 180 passengers

- Flight duration (av) – Narrow Body: 4 hours; Wide Body: 11 hours
  - Wide Body = 91.9%    Narrow Body 8.1%

- Benefit achieved for 91.9% of passenger hours
User Preferred Route

- 2.4 < 29 mins * 8 flights = 0.3 < 3.8 ft hours/day
- 0.3 < 3.8 hr @ 11 tonne/hr = 3.3 < 41.8 tonne/day
- 3.3 < 41.8t * 10.8 * 59 * 1.48 = $ 3,112 < 39,420 AUD/day
- 3.3 < 41.8t * 3.3 = 10.9 < 138 tonne CO₂/day

30/30 NM – small separation standard greater probability of optimal altitude
Next Steps …

- Explore solutions for non ADS-C equipped aircraft
  - Significant numbers of A320 & B738 oceanic flights to/from Aust
  - Across the Tasman to New Zealand
  - Northern Australia to holiday destinations in Asia

- Need a sitcom link of some sort
  - driven by customers wanting internet / wifi
Complimentary Developments

- SITA & ARINC Developing Display Systems for Airlines
  - Uses ADS-C messages
    - ATC initiated messages (when available)
    - else Initiate ADS-C messages themselves
  
- Fuse ADS-C data with (any) other aircraft positional data
  - ADS-B
  - Radar
Summary

- GPS / ADS-C meets the intent of HLSC recommendation on Global Tracking today

- GPS / ADS-C fitted to most wide body aircraft operating oceanic

- GPS / ADS-C Global Tracking to 92% of passengers flying oceanic
  - in/out of Australia (will be different for other countries / routes)

- Display to ATC and / or Airline

- Cost is a modest (~4%) increase in ADS-C messaging

- Cost can be more than offset by more efficient aircraft operations
  - greater use of lateral separation (50/50 or 30/30 NM)
  - greater probability of optimum altitude (operating efficiency)
GPS & ADS-B

- Aircraft Position
  - GPS

- Broadcast
  - Ground
  - Aircraft
  - (direct) Satellite reception
Satellite ADS-B data gathered by ProbaV confirms feasibility!
GPS & Space ADS-B …

- multiple Proposals
- multiple Architectures
- multiple Comms Constellations

- Aircraft Position – **GPS**
- LEO satellite(s) receives aircraft’s ADS-B signal
  - Pass ADS-B message satellite to satellite to ground station
  - Pass ADS-B message LEO satellite to GEO satellite to ground station

- LEO satellite constellation
  - 60 to 100 satellites
  - Satellites
    - Large, long life, expensive
    - small, short life, cheap

- Aircraft position information sold as a service – how much? when?
Thanks

- GPS has continually improved:
  - Robustness - 27 Satellite geometry
  - Accuracy – SA off and Equivalent User Range error decreased
  - Availability – aviation practical purposes 100%
  - Reliable

- Women and Men who pioneered / developed / operate GPS:
  - You have our Sincere thanks for the truly exceptional Service

- Politicians & Administrators:
  - GPS gives immense Safety, Environment and Economic benefit
  - Ubiquitous in all aspects of life; value under recognised
  - Easy to take for granted
  - GPS needs to be protected, fostered, replenished, grown
Any Thoughts