FIT-Asia 15 Seminar Workshop

Boeing CRA

Agenda

- PBCS Overview

- PBCS Compliance Demonstration for Aircraft Systems

- PBCS Design Compliance Status – Boeing Aircraft

- Challenges to PBCS Operational Compliance

- Interoperability Testing

- PR Resolution Techniques Examples

PBCS Overview

Provides a framework for managing communication and surveillance performance in accordance with globally accepted Required Communication Performance (RCP) and Required Surveillance Performance (RSP) specifications.

The RCP/RSP specifications provide the means to:

1. Qualify different parts of the Datalink end-to-end system (aircraft system, ATSU system, network).
2. Manage continued operational end-to-end system performance

ICAO Performance-Based Separation Minima *

	Separation Minima	RCP	RSP	RNP
Lateral	23 nm/30 nm	240	180	4
Longitudinal	5 min	240	180	4 or 10
Longitudinal	30 nm	240	180	4
Longitudinal	50 nm	240	180	4 or 10

ICAO DOC 9689

PBCS Compliance Demonstration for Aircraft Systems

RCP240/RSP180 – Aircraft Allocations (for initial qualification)

Transaction Time – Nominal (95%) and Expiration (99.9%)	RCP240	95% within 10 sec
		99.9% within 15 sec
	RSP180	95% within 3 sec
		99.9% within 5 sec
Availability	RCP240 RSP180	0.999
Integrity	RCP240 RSP180	Probability of undetected error no greater than 10^{-5} per flight hour
Safety Requirements	RCP240 RSP180	25 Monitoring and Alerting Criteria

PBCS Compliance Demonstration for Aircraft Systems

- Integrated lab testing to collect the Transaction Time (Nominal and Expiration Times)

- Revise ATS Capabilities Document

  - Include Statement of Compliance

  - Document collected Transaction Time

  - Provide Availability and Integrity

  - Address Safety Requirements

- Revise AFM to include the statement of compliance (if the system is being certified)

PBCS Design Compliance Status – Boeing Avionics

- **PBCS Compliant Avionics:**
  - 737 GE FMC
  - 747-400 & 747-8 NG FMC
  - 757/767 Pegasus II
  - 777 AIMS-2
  - 787 CMF

- **PBCS Non-Compliant Avionics:**
 - 747-400 Legacy FMC
  - 777 AIMS-1

Challenges to PBCS Operational Compliance

- **VHF – SATCOM Link Transitions**

  - Avionics generally designed to minimize costs to operators where possible (preferring less expensive VHF links over SATCOM links)

  - Avionics attempt to deliver a downlink through a VHF link a certain number of defined times at a defined interval before considering the VHF link to be unavailable

  - This can cause delays when the aircraft is on the edge of VHF coverage – causing time performance to seem poor via SATCOM, when the avionics are actually attempting (but failing) to deliver the downlink via VHF

  - RAT1 timer (reference FIT-Asia/13 – IP/2) intended to address this issue, but implementation is not yet universal

Challenges to PBCS Operational Compliance

- VHF – SATCOM Link Transitions
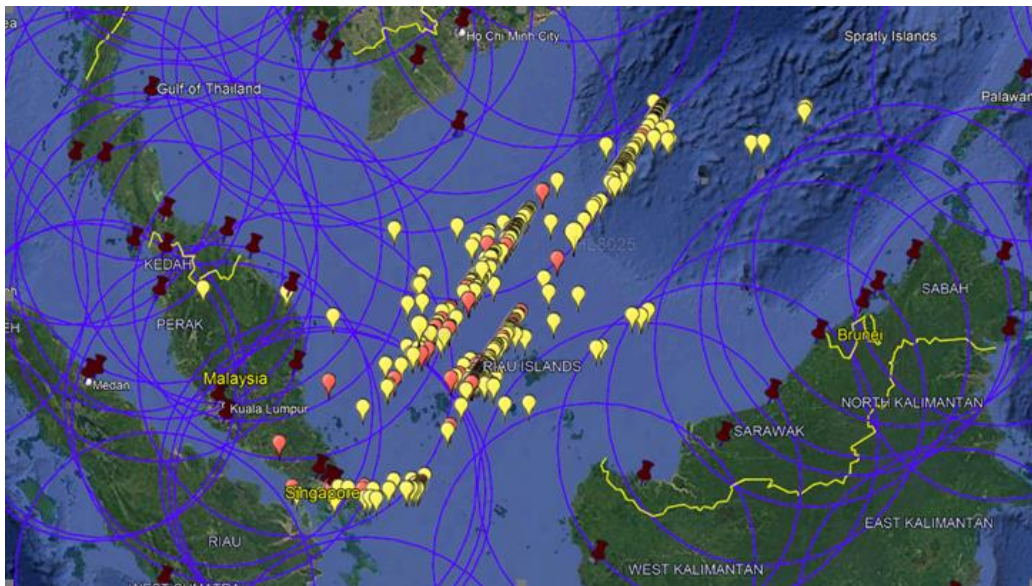
South China Sea
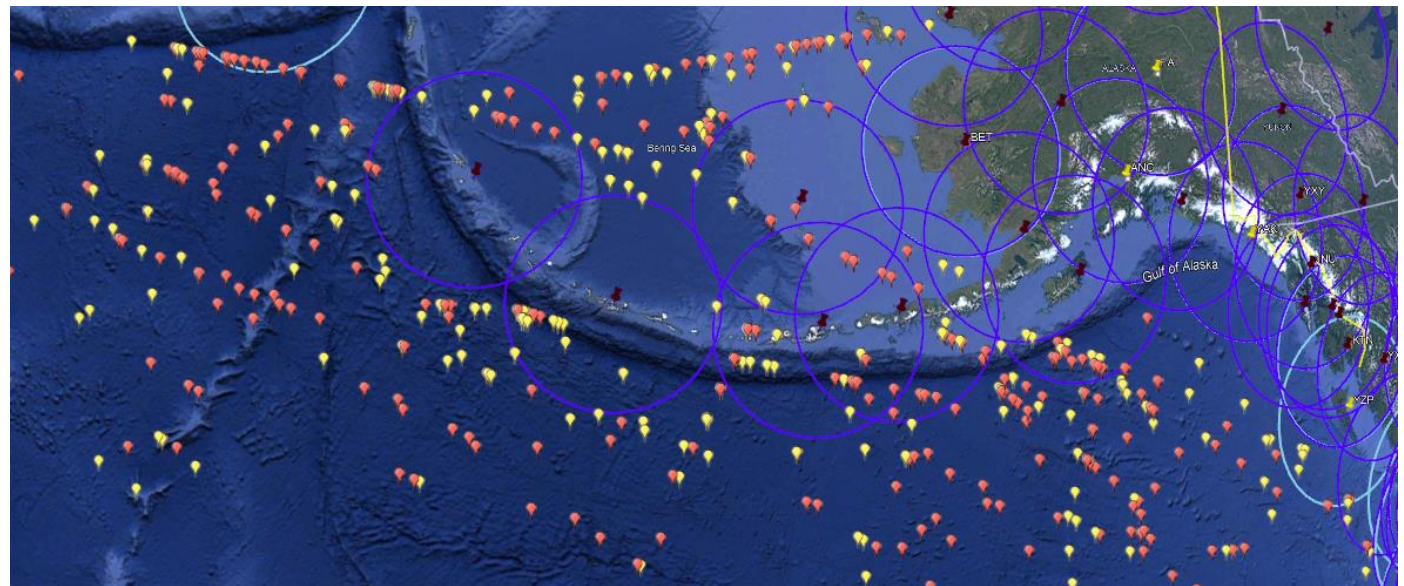
North Pacific

Challenges to PBCS Operational Compliance

- **Legacy Avionics**

  - Not all aircraft flying in PBCS airspace have fully compliant or modern avionics – older data link systems and software baselines generally do not perform as well

- **Inconsistent Performance Monitoring & Reporting**

  - Different ANSPs may use different tools or thresholds for compliance monitoring, leading to inconsistent enforcement or reporting

  - Operators may often lack internal processes to analyze and respond to PBCS non-compliance reports

- **Procedural Non-Compliance**

  - Even with compliant equipment, human factors may cause non-compliances (e.g., not responding to uplink messages in a timely manner)

Challenges to PBCS Operational Compliance

- **Sufficient Data Points in Non-Compliance Reports**

  - Several PBCS Non-Compliance reports have been submitted in the past with limited data (<50 data points), making it difficult to conduct detailed investigation

  - One small period of delayed reports can cause PBCS Non-Compliance, when there are limited data points in the overall set

  - Recommendation: ANSPs could implement data sharing between centers to produce high-quality data sets for PBCS Non-Compliance monitoring

Interoperability Testing

- Boeing is willing to support interoperability tests with FIT-Asia ANSPs who are interested in testing their ground system with avionics
  - Simulation of reduced separation operations using multiple Boeing lab test benches at once
  - Testing of new software updates before implementing in operation

- Past examples:

  - Testing PBCS operations with India

  - Testing RPHI's ground system before operational use and roll-out

  - Frequent tests with FAA Data Comm program across multiple models to test out new functionality

Example: PR Resolution Techniques

- **<u>FANS PR 3661</u>**

    1. FAA submitted PR reporting that an operator's B777s were underperforming in the North Atlantic region (while other operators' B777s did not experience the same underperformance)

    2. Detailed log investigation by the CRA found that the operator's B777 fleet experiences a high frequency of SATCOM satellite transitions over the North Atlantic (even when the switches do not make sense)

    3. Issue reported to operator, with recommendation to provide Boeing with SATCOM ORT files for investigation

    4. Feedback provided to operator to update SATCOM ORT files and implement on a select number of aircraft

    5. Changes were found to improve performance of those select aircraft, and changes were made to nearly all of the operator's B777 airframes to address underperformance

    Conclusion:

    - Resolution of PR required cooperation from FAA, Operator, Boeing, Rockwell Collins, and CRA

    - Issue identified due to ANSP implementing detailed compliance monitoring and reporting significant non-compliance

Example: PR Resolution Techniques

- **<u>FANS PR 3683</u>**

  1. B764 flight crew reported that multiple CPDLC downlink messages (sent in response to uplink messages) were responded to with a DOWNLINK ERROR uplink message from the ground

  2. Analysis of ACARS logs and lab testing found that the issue did not lie with the avionics, and ANSP was contacted for further investigation

  3. ANSP responded that their CPDLC system will close a CPDLC uplink after a set period of time without a response and send a DOWNLINK ERROR to any downlink responses at that point

  4. CRA investigation found that there was a Service Provider internetworking issue at the same time that this issue occurred, causing the Service Provider to deliver the uplinks to the aircraft after a delayed period of time

  5. Flight crew responded to the messages immediately – however, this was still after the ANSP's threshold for closing a CPDLC uplink, causing the DOWNLINK ERROR uplink messages. PR was Closed with full resolution

  Conclusion:

- Different ANSP system implementations can lead to issues not seen in other parts of the world

- Issues may often lie with multiple stakeholders (ground, service provider, avionics, flight crew), requiring multi-party investigation for PRs