



ICAO

International Civil Aviation Organization

Eleventh Meeting of the FANS Interoperability Team – Asia (FIT-Asia/11)
Video Teleconference, 23 – 27 August 2021

Agenda Item 4: Review of ADS-C/CPDLC Operations and Performance

**Performance-based
Communication and
Surveillance (PBCS) -
Non-compliance Investigation
(Presented by the United States)**



**Federal Aviation
Administration**

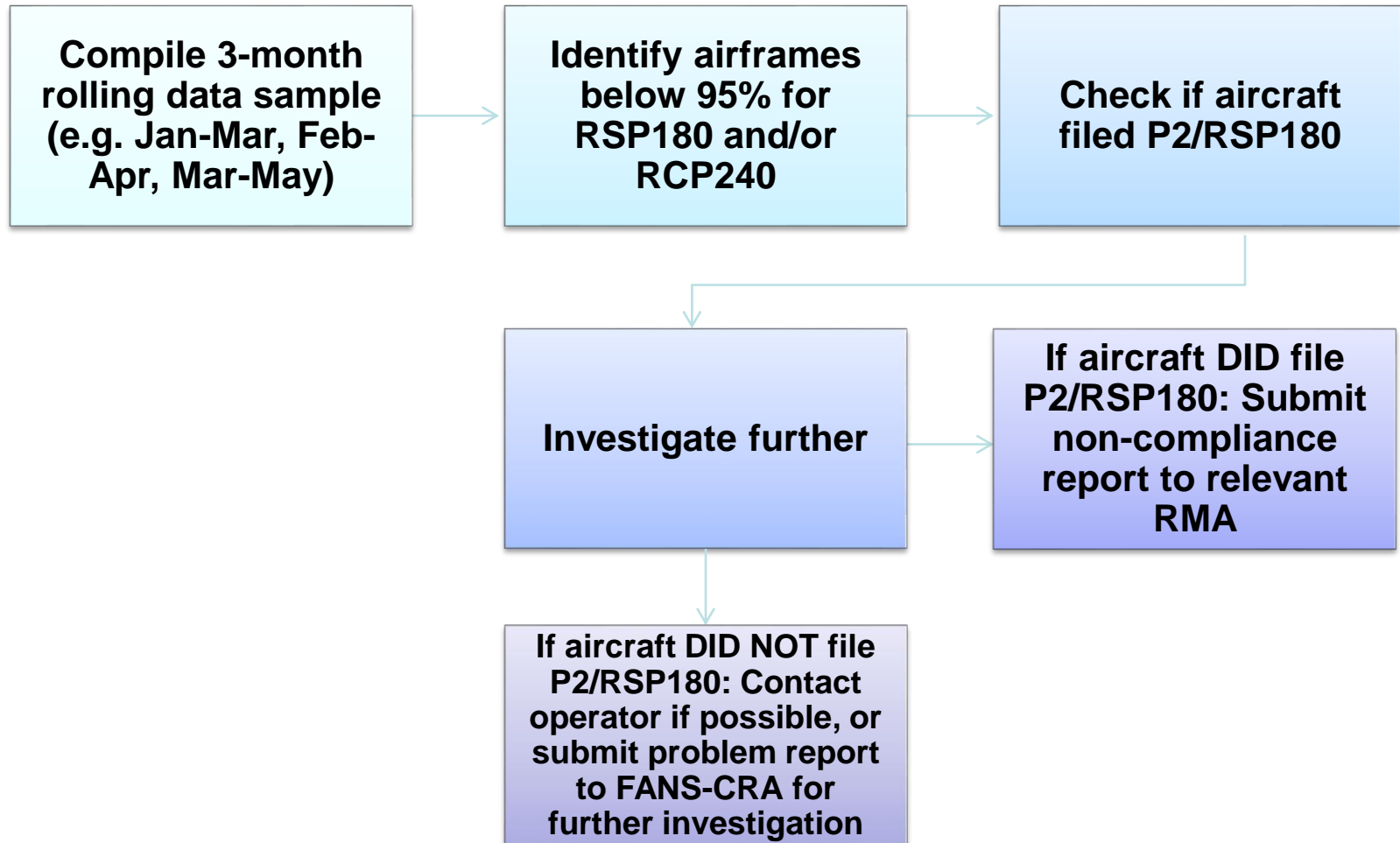


Overview

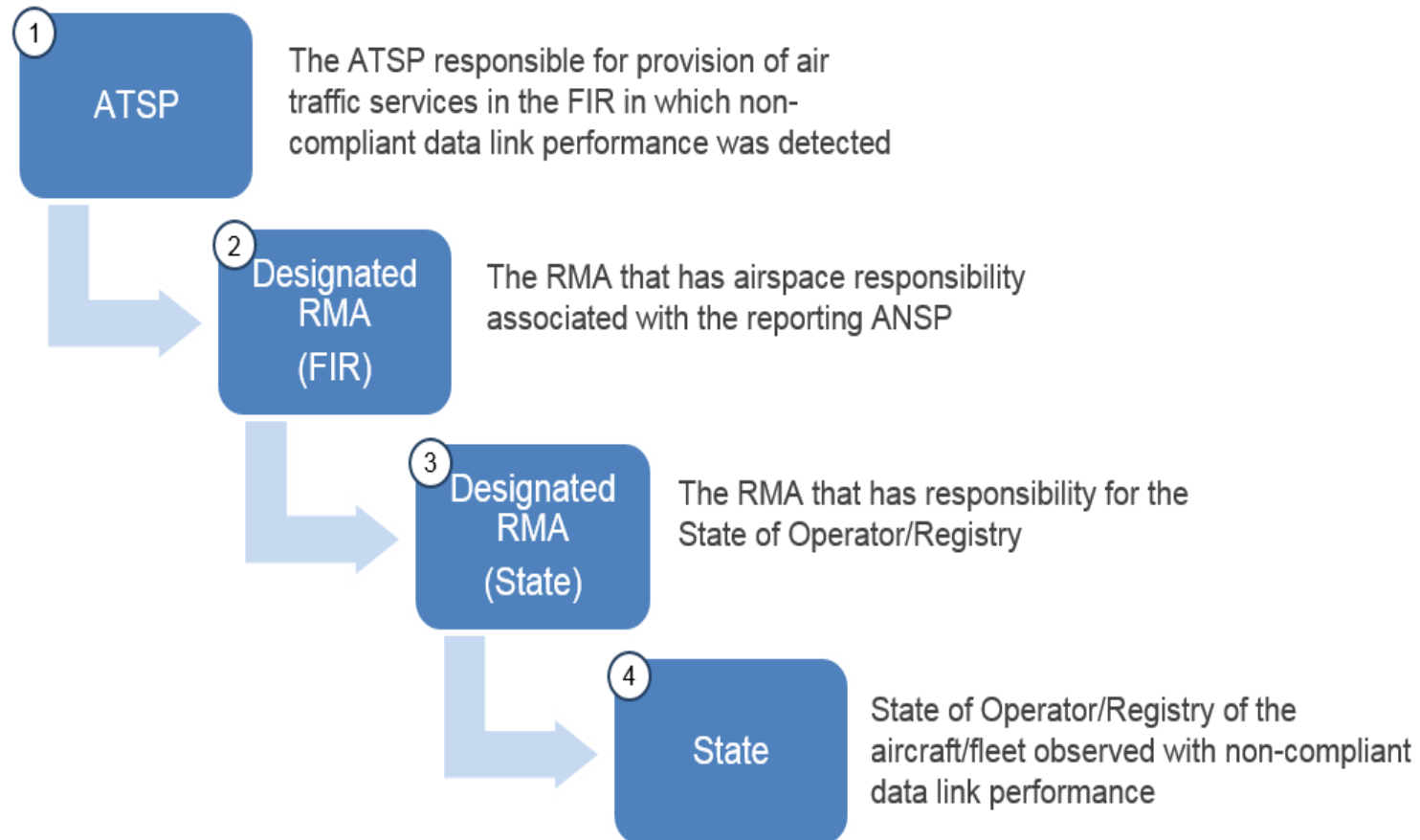
- **Monthly non-compliance monitoring for individual aircraft**
 - Review of the reporting and investigation processes
 - Summary of recent results for Oakland FIR
- **Analysis of performance issues observed by media delivery path**
- **Summary**



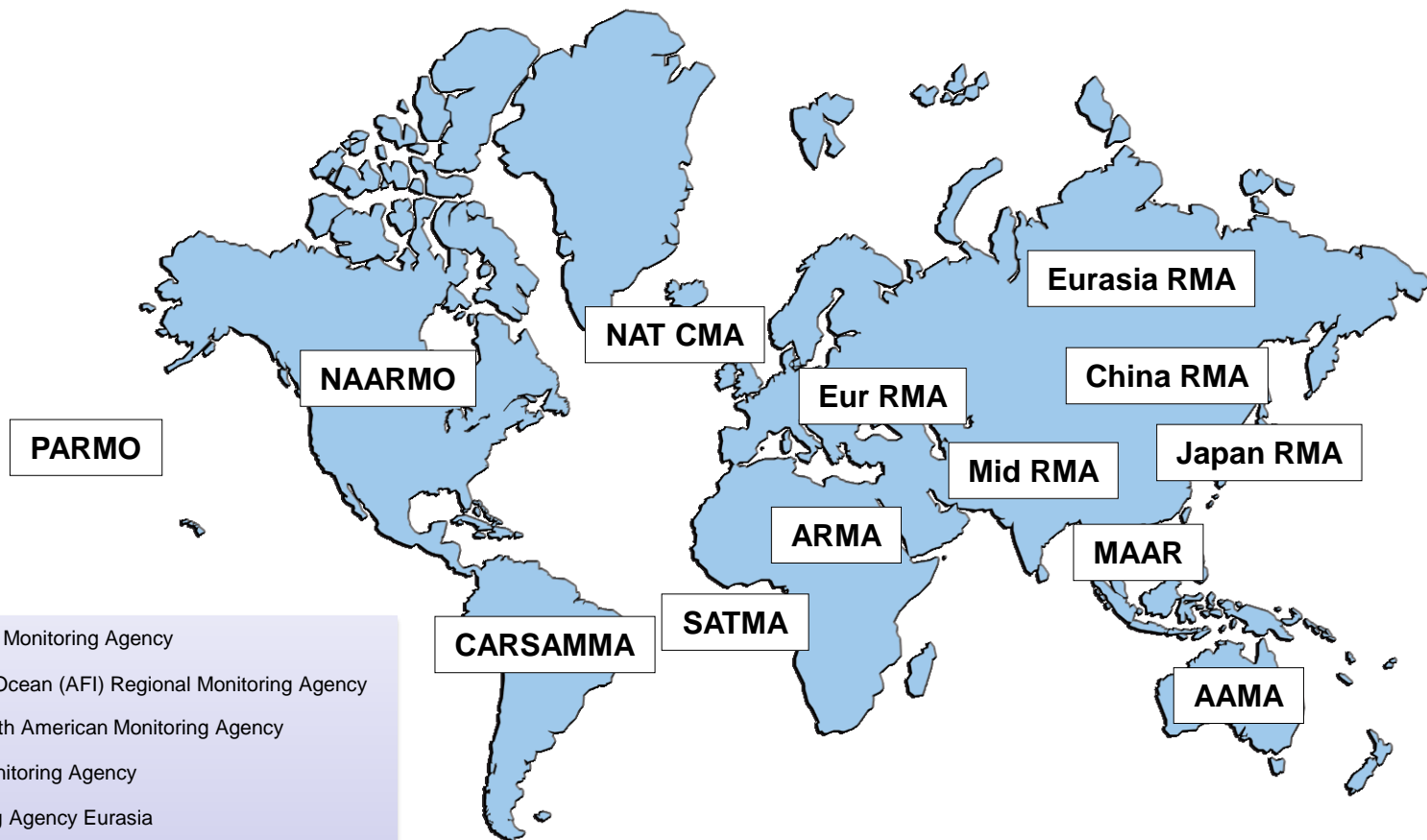
Monthly non-compliance monitoring



Non-compliance reporting



ICAO Endorsed Regional Monitoring Agencies (RMAs)



| | |
|-------------|---|
| AAMA | Australian Airspace Monitoring Agency |
| ARMA | African and Indian Ocean (AFI) Regional Monitoring Agency |
| CARSAMMA | Caribbean and South American Monitoring Agency |
| China RMA | China Regional Monitoring Agency |
| EurAsia RMA | Regional Monitoring Agency Eurasia |
| Eur RMA | European Regional Monitoring Agency |
| Japan RMA | Japan Regional Monitoring Agency |
| MAAR | Monitoring Agency for Asia Region |
| Mid RMA | Middle East Regional Monitoring Agency |
| NAARMO | North American Approvals Registry and Monitoring Org |
| NAT CMA | North Atlantic Central Monitoring Agency |
| PARMO | Pacific Approvals Registry and Monitoring Organization |
| SATMA | South Atlantic Monitoring Agency |

Sample non-compliance report form

| PBCS ATSP Non-compliance Report Form | | | | | | | |
|--|-----------------------------|--|-------------------------------|-----------------------|--------------------------|-----------------------|------------|
| Report Date: | | 7/27/2020 | | | | | |
| Period of observed non-compliance: | | January-March 2020 | | | | | |
| Reporting Air Traffic Service Provider (ATSP): | | FAA - Oakland | | | | | |
| Contact email address(es) at Reporting ATSP: | | FAAPBCSmonitoring@faa.gov | | | | | |
| Reporting to Regional Monitoring Agency (RMA): | | PARMO | | | | | |
| ICAO CODE: | | XXX | | | | | |
| Airline Operator: | | XXX Inc. | | | | | |
| State of Operator/Registry: | | United States | | | | | |
| PBCS Data | | | | | | | |
| FIR | 4-letter ICAO Aircraft Type | Registration | ADS-C downlink Message Counts | 95% RSP 180 Benchmark | CPDLC Transaction Counts | 95% RCP 240 benchmark | Issue code |
| | | | | ASP | | ACP | |
| | | | | <=90 sec | | <=180 sec | |
| KZAK | B772 | Reg 1 | 410 | 93.41% | 25 | 96.00% | (*1)(*3) |
| KZAK | B772 | Reg 2 | 290 | 94.48% | 21 | 95.24% | (*1) |



Considerations for determining whether or not to put on the non-compliance report

- **If using a 3-month rolling data sample, was the aircraft observed in the most recent month? If so, was the performance different in the most recent month?**
- **Was the underperformance has been observed or reported in a previous monitoring period or in another flight information region (FIR)?**
- **How many messages were observed and from how many flights?**
- **Was the issue observed intermittently or were there multiple periods of consecutive delayed messages?**
- **Does the issue appear to have affected only one flight?**
- **Does the issue appear to have resolved within the monitoring period?**



PBCS monitoring – aircraft report

Oakland

| Monitoring period | Jan 2021 | Feb 2021 | Mar 2021 | Apr 2021 | May 2021 | Jun 2021 |
|---|----------|----------|----------|----------|----------|----------|
| Total aircraft observed using data link | 2,378 | 2,329 | 2,384 | 2,411 | 2,487 | 2,565 |
| Have 100 or more ADS-C downlink reports and/or CPDLC transactions | 1,782 | 1,743 | 1,745 | 1,781 | 1,813 | 1,861 |
| Observed below 95% for RSP180 and/or RCP240 | 40 | 30 | 33 | 47 | 50 | 52 |
| Filed P2/RSP180 | 17 | 13 | 16 | 22 | 20 | 25 |
| # Aircraft reported to PARMO | 1 | 3 | 2 | 0 | 1 | 6 |



Most commonly observed problems

| Notes by numbers | Explanation | Recommendation(s) |
|--|--|--|
| <p>(*1) Delayed reports around VHF/SAT transitions.</p> | <p>This note is used when ADS-C or CPDLC reports are observed with delays when there is mixed media usage in the sequence of reports before, at or after the delayed reports (ex.: VHF/VHF/SAT/VHF/SAT).</p> | <p>- Review "NAT OPS Bulletin 2019_003: Data Link Performance Improvement Options" and recommended solutions/actions (Problem/Issue #2).</p> |
| <p>(*2) Delayed reports via HF media.</p> | <p>This note is used when delayed ADS-C or CPDLC reports are observed to be delivered via HF data link (HF DL) or near reports delivered via HF DL. Check whether this appears to be a SATCOM failure with one flight or a period during the flight, or more continuous, intermittent use of HF DL. Potential issue with aircraft media priority settings.</p> | <p>- Review "NAT OPS Bulletin 2019_003: Data Link Performance Improvement Options" and recommended solutions/actions (Problem/Issue #1, #4, #9). - Review all Service Information Letters (SILs) and Software Bulletins (SBs) released from Satcom avionics manufacturers, particularly advice on Operator Requirement Table (ORT) set-up. - Operator should be aware that HF DL DOES NOT meet the RCP/RSP criteria for PBCS operations.</p> |
| <p>(*3) Delayed reports due to Inmarsat satellite to satellite transition (aircraft) or satellite problems (network).</p> | <p>This note is used when ADS-C or CPDLC reports are observed with delays and its noticed that there is a switch sequence between different or same Inmarsat satellite paths (Ex.: XXF/XXH/XXF/XXH). One known area where this occurs in the NAT is at 30W longitude. If multiple aircraft observed with same issue around same time, may be a network-related issue and ATSP may want to report to FANS-CRA/DLMA.</p> | <p>- Review all Service Information Letters (SILs) and Software Bulletins (SBs) released from Satcom avionics manufacturers, particularly advice on Operator Requirement Table (ORT) set-up. - Check with contracted Data Link Service Provider and Satellite Service Provider for possible coverage problems.</p> |
| <p>(*4) Delayed reports due to Iridium avionics (aircraft) or satellite problems (network).</p> | <p>This note is used when ADS-C or CPDLC reports are observed with delays via Iridium satellite paths (IG1, IGW1). If multiple aircraft observed with same issue around same time, may be a network-related issue and ATSP may want to report to FANS-CRA/DLMA.</p> | <p>- Check for SATCOM radio/unit problems.</p> |

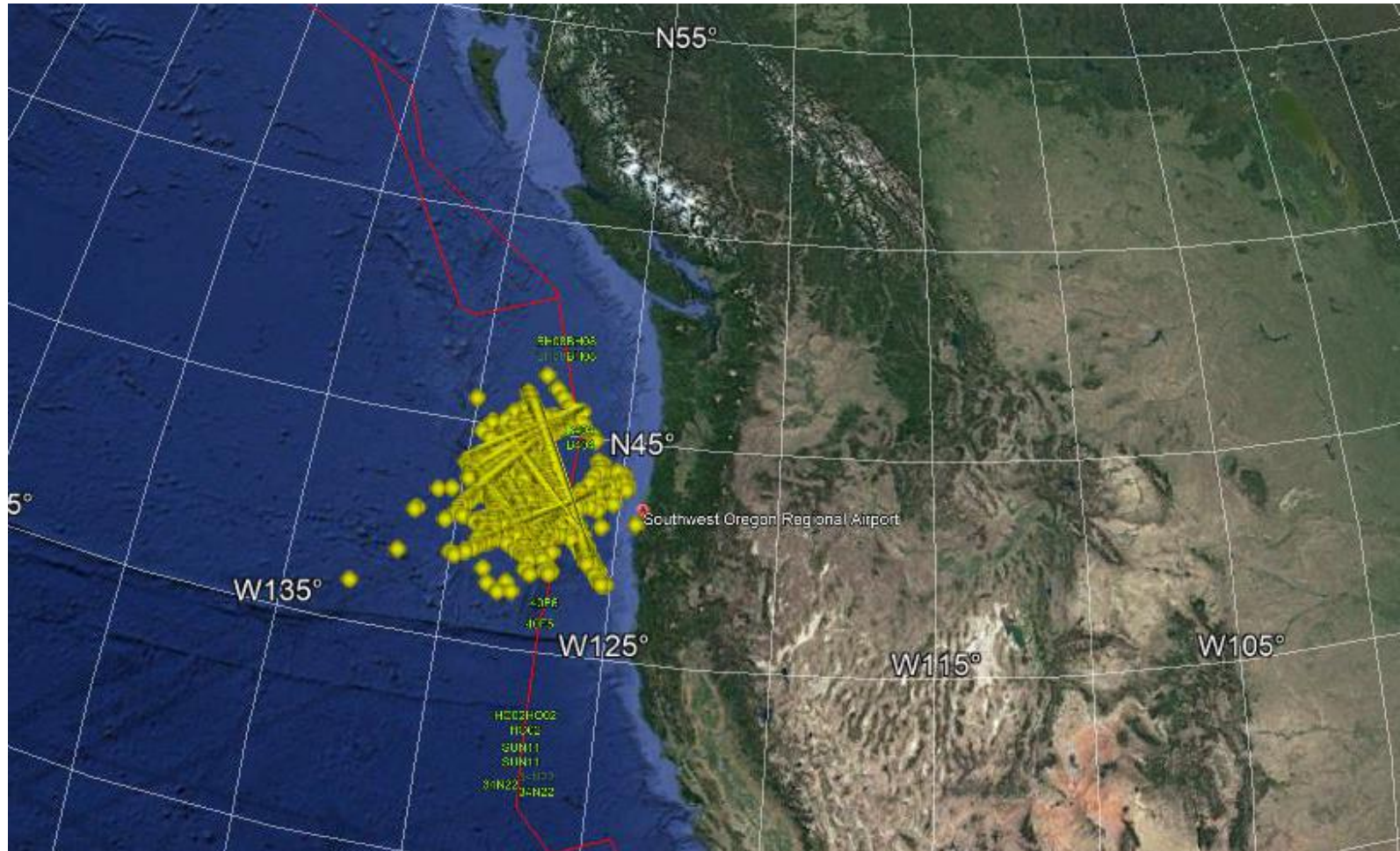


Performance by media delivery path – observed below 95%

| FAA-Oakland Reporting on ADS-C Actual Surveillance Performance (ASP) Period: Jan 01, 2021 to Jun 31, 2021 (6 months) | | | | | |
|---|-----|--|----------------|--------------------------|----------------------------|
| Color key: Meets criteria 99.0%-99.9% Under criteria | | | Message Counts | 95% RSP 180 Benchmark | 99.9% RSP 180 Benchmark |
| | | | | RSP <=90 sec | RSP <=180 sec |
| Path ID | | | | | |
| OTH | VHF | | 5,440 | 89.43% | 95.11% |
| H02 | HF | | 3,115 | 68.64% | 81.54% |
| OTHV | VHF | | 2,447 | 94.32% | 97.92% |
| STS7 | VHF | | 1,857 | 90.85% | 94.72% |
| H01 | HF | | 1,092 | 67.40% | 78.57% |
| SAN9 | VHF | | 889 | 93.14% | 96.51% |
| STS8 | VHF | | 786 | 88.80% | 93.38% |
| CRQ | VHF | | 768 | 92.06% | 95.83% |
| H16 | HF | | 741 | 60.73% | 73.01% |
| XXN | SAT | | 711 | 89.31% | 95.08% |
| SBA1 | VHF | | 629 | 93.48% | 99.84% |
| UIL8 | VHF | | 291 | 91.75% | 98.63% |
| EUG8 | VHF | | 212 | 92.92% | 100.00% |
| H09 | HF | | 116 | 76.72% | 87.93% |



Locations of ADS-C message delivered via OTH/OTHV (Jan-Jun 2021)



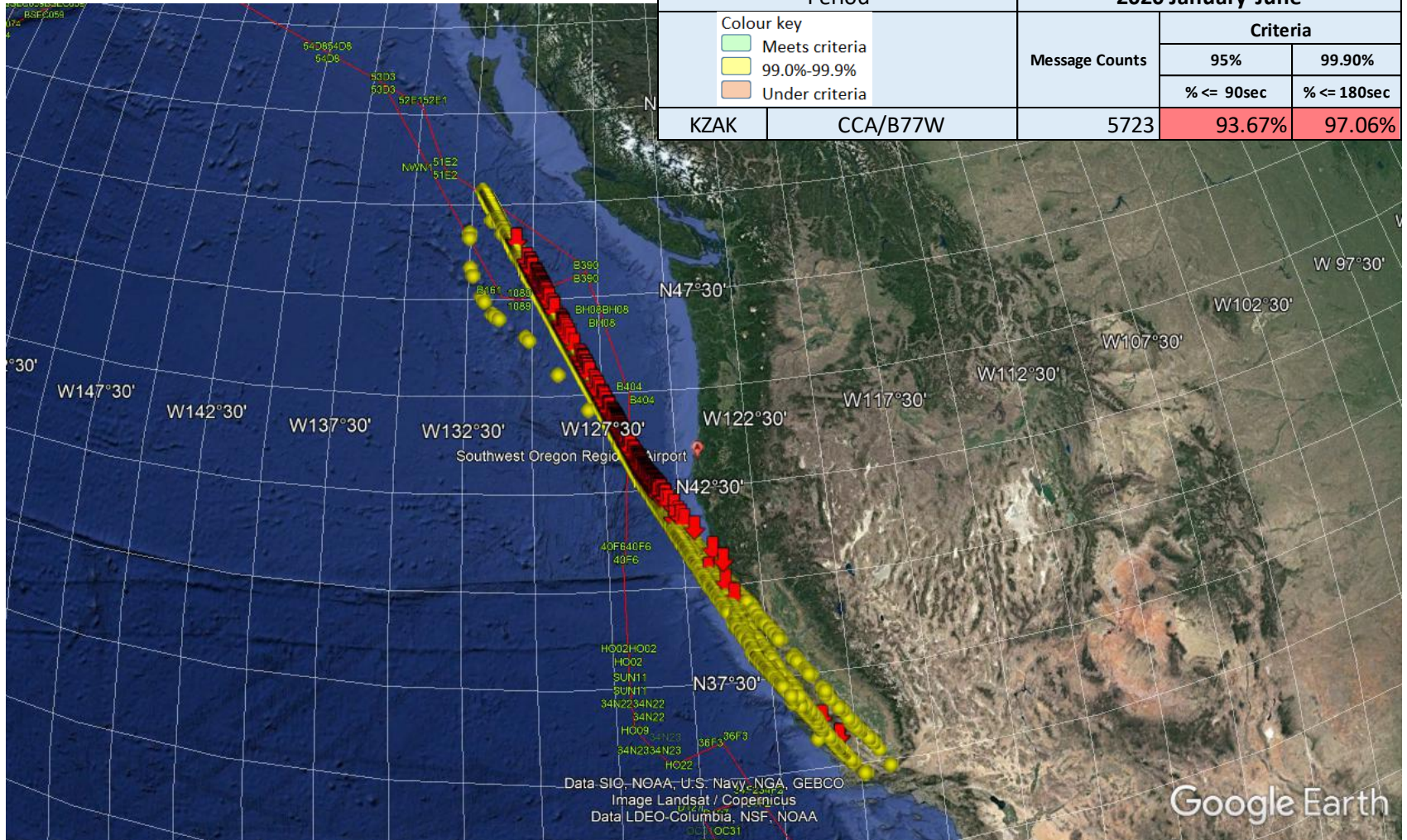
Drill down by aircraft type and operator for OTH/OTHV

| Aircraft Type | Operator | Total ADS-C via OTH | Total > 90 sec | % of all ADS-C via OTH | % of all ADS-C via OTH and > 90 sec | Aircraft Type | Operator | Total ADS-C via OTH | Total > 90 sec | % of all ADS-C via OTH | % of all ADS-C via OTH and > 90 sec |
|---------------|----------|---------------------|----------------|------------------------|-------------------------------------|---------------|----------|---------------------|----------------|------------------------|-------------------------------------|
| B77L | CSN | 802 | 102 | 10% | 14% | B789 | CXA | 366 | 4 | 5% | 1% |
| | KAL | 276 | 58 | 3% | 8% | | UAL | 227 | 18 | 3% | 3% |
| | CAO | 267 | 24 | 3% | 3% | | AAL | 226 | 7 | 3% | 1% |
| | FDX | 196 | 33 | 2% | 5% | | CSN | 183 | 1 | 2% | 0% |
| | CKK | 160 | 36 | 2% | 5% | | KAL | 168 | 5 | 2% | 1% |
| | SOO | 9 | | 0% | 0% | | CCA | 83 | | 1% | 0% |
| | CKS | 1 | | 0% | 0% | | ANA | 30 | 1 | 0% | 0% |
| B77W | CCA | 692 | 125 | 9% | 17% | | AMX | 16 | | 0% | 0% |
| | KAL | 507 | 144 | 6% | 20% | | ACA | 7 | | 0% | 0% |
| | UAL | 123 | 37 | 2% | 5% | | B738 | ASA | 821 | 50 | 10% |
| | AAL | 38 | 11 | 0% | 2% | | | | | | |
| | CES | 12 | 3 | 0% | 0% | | | | | | |
| | CPA | 12 | 2 | 0% | 0% | | | | | | |
| | ANA | 7 | 3 | 0% | 0% | | | | | | |
| | PAL | 6 | 3 | 0% | 0% | | | | | | |
| | SIA | 2 | | 0% | 0% | | | | | | |
| | ACA | 1 | | 0% | 0% | | | | | | |
| UAE | 1 | 1 | 0% | 0% | | | | | | | |



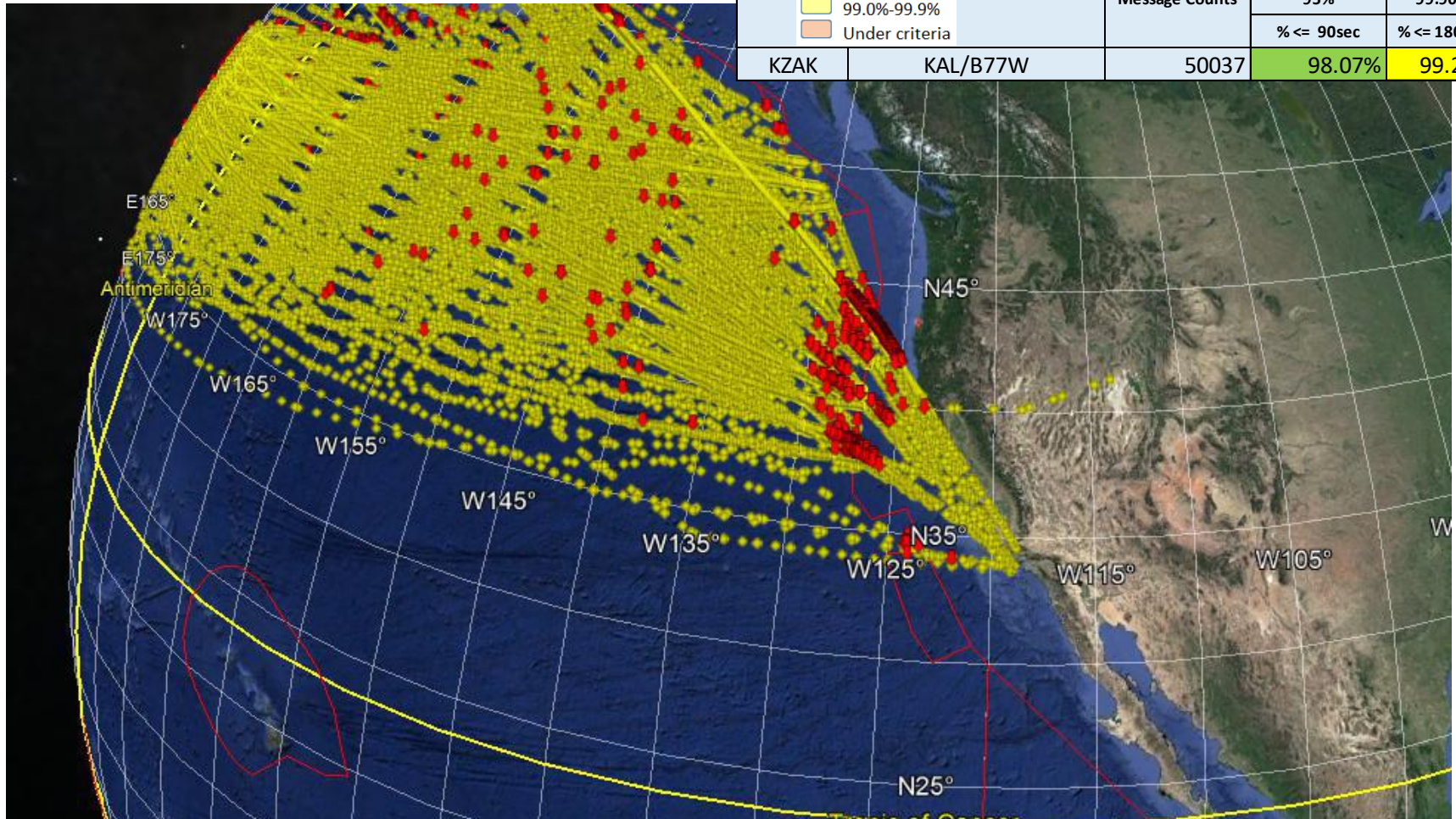
Locations of ADS-C messages – CCA B77W (Jan-Jun 2021)

| Performance Criteria | | RSP180 | | |
|---------------------------------------|----------------|-------------------|------------|-------------|
| Period | | 2020 January-June | | |
| Colour key | | Message Counts | Criteria | |
| ■ | Meets criteria | | 95% | 99.90% |
| ■ | 99.0%-99.9% | | % <= 90sec | % <= 180sec |
| ■ | Under criteria | | | |
| KZAK | CCA/B77W | 5723 | 93.67% | 97.06% |

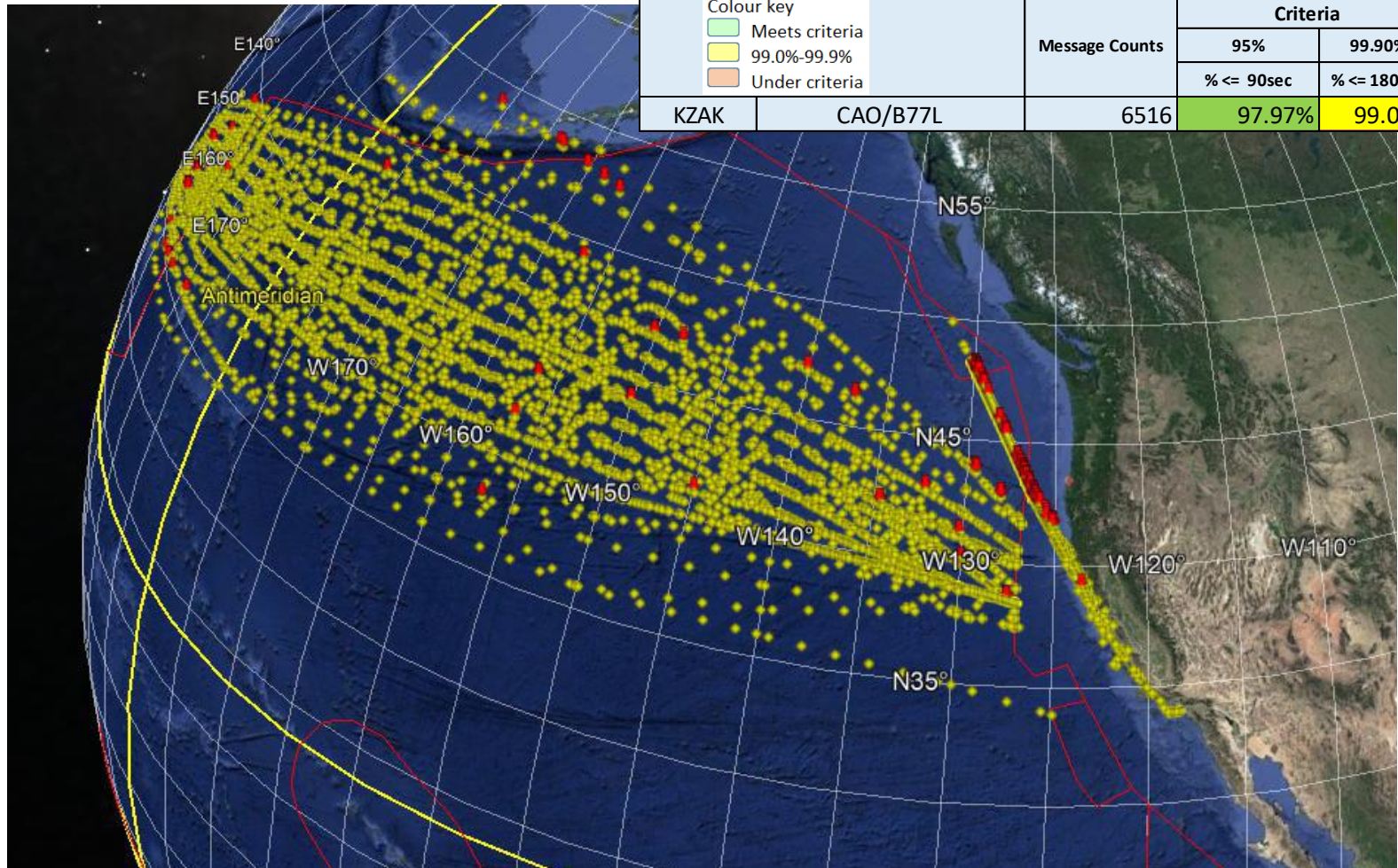


Locations of ADS-C messages – KAL B77W (Jan-Jun 2021)

| Performance Criteria | | RSP180 | | |
|--|----------|-------------------|-------------|--------|
| Period | | 2020 January-June | | |
| Colour key ■ Meets criteria ■ 99.0%-99.9% ■ Under criteria | | Message Counts | Criteria | |
| | | | 95% | 99.90% |
| | | % <= 90sec | % <= 180sec | |
| KZAK | KAL/B77W | 50037 | 98.07% | 99.20% |



Locations of ADS-C messages – CAO B77L (Jan-Jun 2021)



| Performance Criteria | | RSP180 | | |
|---------------------------------------|----------------|-------------------|------------|-------------|
| Period | | 2020 January-June | | |
| Colour key | | Message Counts | Criteria | |
| ■ | Meets criteria | | 95% | 99.90% |
| ■ | 99.0%-99.9% | | % <= 90sec | % <= 180sec |
| ■ | Under criteria | | | |
| KZAK | CAO/B77L | 6516 | 97.97% | 99.03% |

Analysis conclusions

- **The underperformance observed for the OTH/OTHV paths appears to be due to the distance from oceanic routes that parallel the coast**
 - Certain routes keep aircraft in proximity to the VHF/SAT transition area longer and the aircraft keeps trying to use VHF
- **Drilling down to aircraft/operator, it had appeared certain fleets were causing the problem**
- **Then plotting the routes for fleets with high and low failure rates over OTH/OTHV, it was observed that aircraft flying on the routes where they are in proximity to OTH/OTHV longer are observed with a higher percentage of delays, versus those that fly on routes where they more quickly transition to SATCOM**



VHF to SATCOM Transitions - Transitions from using VHF to using SATCOM, especially when they occur repeatedly in a short period of time, reduce datalink performance because the ACARS protocols are generally not designed to maximize performance but rather to minimize cost by persistently attempting to use less costly VHF.

Solution a): Disable VHF datalink just prior to entering oceanic airspace

- Implement flight crew procedures to disable VHF datalink (usually by placing the VHF radio used for VHF datalink into voice mode) just prior to entering oceanic airspace or prior to leaving contiguous VHF coverage in order to proactively force SATCOM use. Conversely, enable VHF datalink when exiting oceanic airspace or entering contiguous VHF coverage.

Solution b): Implement more precise VHF region definitions

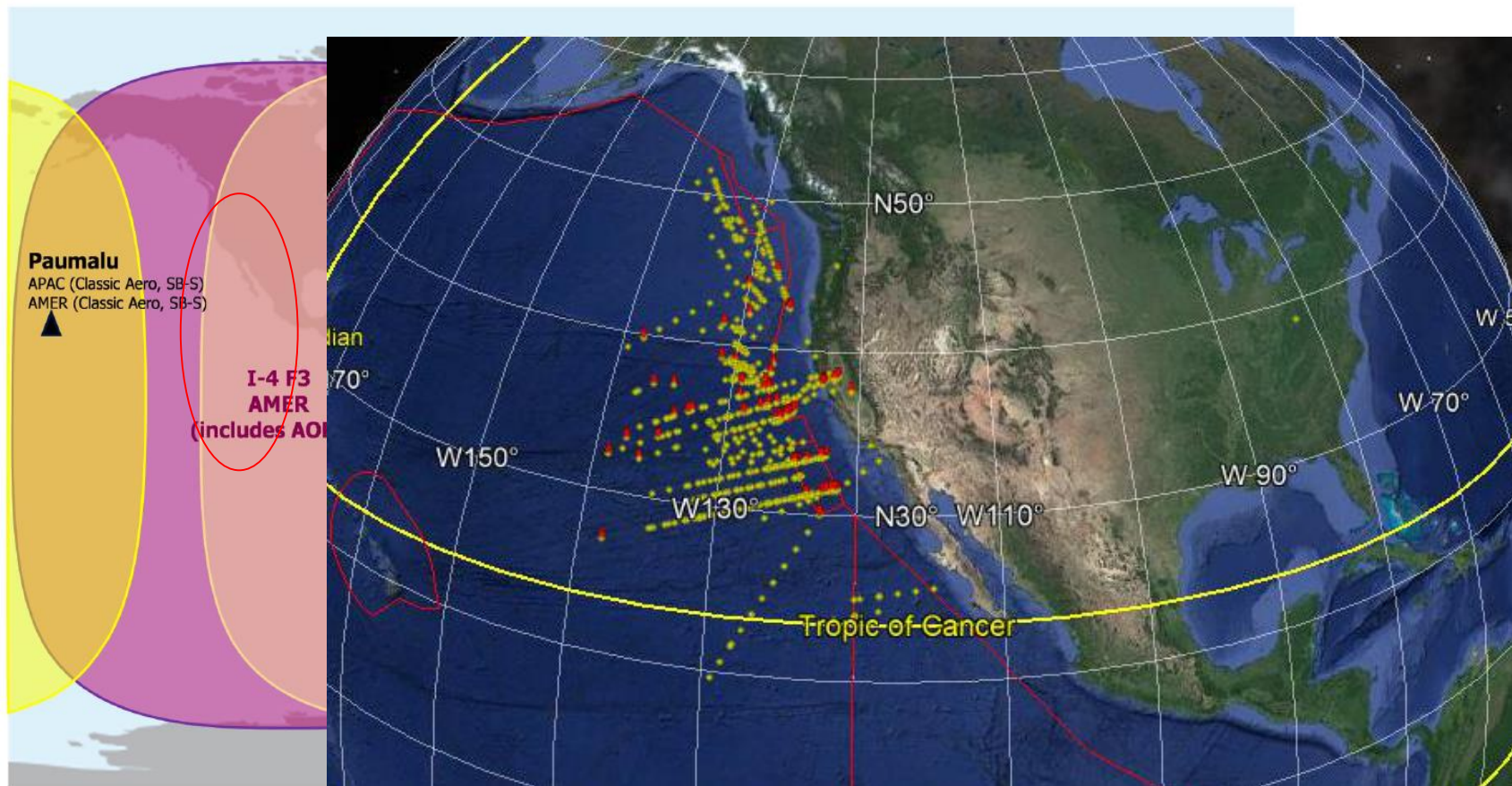
- In avionics that offer the capability to prefer specified subnetworks in defined geographic regions (including 777 DCMF and 787 CMF), implement more precise VHF region definitions that exclude areas of the world with only intermittent VHF subnetwork coverage in order to force SATCOM use in those areas. Such areas, in which the DLMA has observed consistent performance problems, include the North Pacific near the Aleutian Islands and the Kamchatka Peninsula, the South Pacific near New Caledonia and Vanuatu, and the North Atlantic near Bermuda and the Azores.

Solution c): Implement the ARINC 618 RAT1 timer

- Upgrade ACARS router avionics (CMU or equivalent) software to include the new ARINC 618 RAT1 timer when it becomes available. This timer is intended to improve performance for FANS downlink messages during VHF-to-SATCOM transitions by additionally attempting to send a message via SATCOM when attempts to send it via VHF have not been successful for 60 seconds (such as when exiting land-based VHF coverage). This feature is available on some new aircraft types and will gradually become available for retrofit via software updates on existing aircraft.

Locations of ADS-C positions delivered via XXN

Inmarsat Operational Coverage Map (Classic Aero and SB-Safety)



BUILT TO FLY

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inmarsat
AVIATION

Drill down by aircraft and operator

| Aircraft Type | Operator | Total ADS-C via XXN | Total > 90 sec | % of all ADS-C via XXN | % of all ADS-C via XXN and > 90 sec |
|---------------|----------|---------------------|----------------|------------------------|-------------------------------------|
| B77W | EVA | 155 | 3 | 22% | 4% |
| B788 | AAL | 141 | 3 | 20% | 4% |
| B772 | AAL | 80 | 13 | 11% | 16% |
| | UAL | 12 | 2 | 2% | 3% |
| B763 | UAL | 71 | 20 | 10% | 25% |
| | UNK | 1 | | 0% | 0% |
| B744 | GTI | 42 | | 6% | 0% |
| | AAR | 10 | 2 | 1% | 3% |
| | PAC | 9 | 2 | 1% | 3% |
| C5M | RCH | 34 | 11 | 5% | 14% |
| | MIL | 11 | 2 | 2% | 3% |
| | UNK | 4 | 2 | 1% | 3% |
| K35R | MIL | 33 | 4 | 5% | 5% |
| | RCH | 7 | 2 | 1% | 3% |
| GL5T | PVT | 20 | | 3% | 0% |
| B737 | MIL | 18 | | 3% | 0% |
| GLEX | PVT | 16 | 4 | 2% | 5% |
| B748 | KAL | 7 | | 1% | 0% |
| | PAC | 5 | | 1% | 0% |
| C17 | RCH | 10 | 2 | 1% | 3% |
| | MIL | 2 | | 0% | 0% |
| CL35 | XOJ | 11 | 1 | 2% | 1% |
| B764 | UAL | 9 | 5 | 1% | 6% |
| GLF4 | PVT | 4 | | 1% | 0% |
| B789 | AMX | 3 | 2 | 0% | 3% |
| | AAL | 1 | | 0% | 0% |
| GLF6 | PVT | 1 | | 0% | 0% |

Maximising access to the Classic Aero Ground Earth Station (GES) services:

- In the Inmarsat SATCOM system, there are a multitude of transmission paths available via the different ground stations and satellites. If one path fails, the aircraft may be able to switch to an alternate path provided the Operator Requirement Table (ORT) in the SATCOM terminal is correctly configured.
- Proper configuration of the ORT table is therefore vital for maximizing availability of SATCOM services.
- Below are some links to the SATCOM manufacturers' information portals:
 - Cobham: <https://sync.cobham.com/satcom/>
 - Honeywell: <https://myaerospace.com/>
 - Thales: <https://www.thalesgroup.com/en/customer-online>
 - Rockwell Collins: <https://www.shopcollins.com>

NAT OPS Bulletin 2019_003 Rev 1 Data Link Performance Improvement Options

Summary

- **The monthly non-compliance reporting process is underway for FAA oceanic airspace – Oakland, Anchorage, New York**
- **After further investigation there are a negligible number of aircraft with performance issues found to be significant enough to report**
 - Some repeat offenders are being observed making it unclear if reports are getting to the State and/or Operator
 - Most common problems are delays in VHF/SAT transition areas, HF data link, Inmarsat satellite to satellite transition (aircraft) or satellite problems (network), and Iridium avionics (aircraft) or satellite problems (network)
- **Observed issues by media delivery path generally traced to specific aircraft/avionics or design of routes in relation to VHF/SAT transition areas**
- **Because there is little VHF coverage in the Oakland airspace, depending on the routes flown, VHF/SAT transition issues for a fleet or aircraft can be masked due to the aggregate nature of the PBCS monitoring**