

ADS-B In-Trail Procedures

Update for ISPACG-28

March 5 - March 7, 2014

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Federal Aviation
Administration

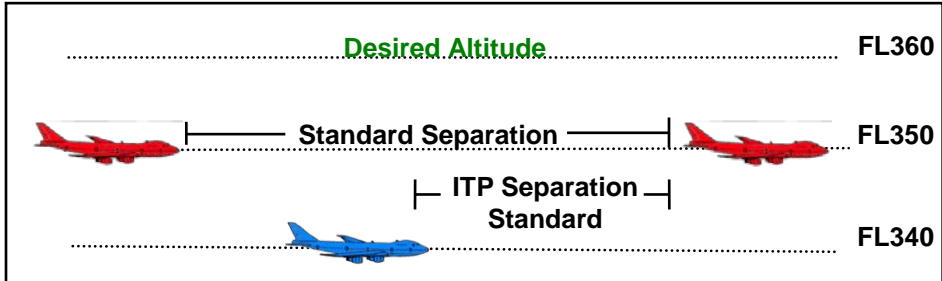
ITP Application Overview

Purpose: Provide operational benefits in non-surveillance airspace by enabling “in-trail” climbs/descents at reduced separation distances

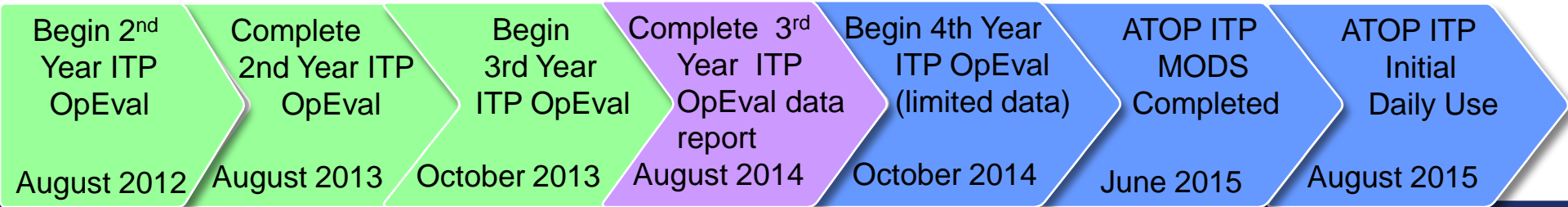
Goal: Employ ITP in oceanic air carrier operations (revenue service)

Objectives: Validate operational performance and economic benefits of ITP
Develop and validate ADS-B ITP MOPS material

Partners: United Airlines,
Honeywell, Goodrich,
Airports Fiji Limited,
Airways Corp NZ

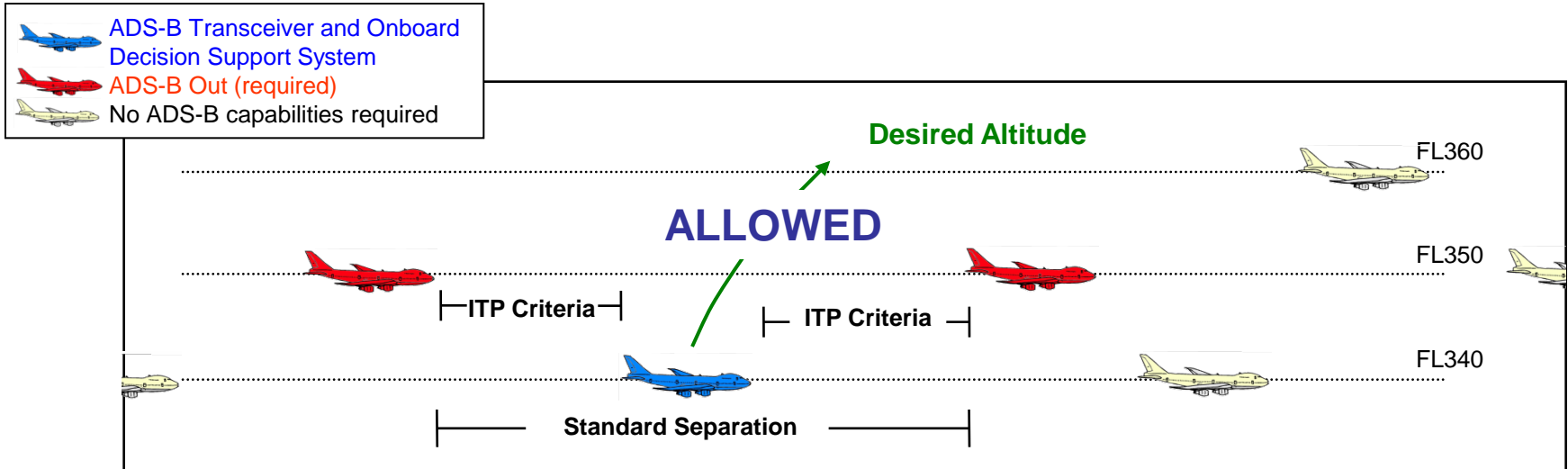


Complete (Green) Not Yet Started (Blue)
In Progress (Purple)



ADS-B In-Trail Procedures

ADS-B ITP Climb: Sequence of Events



Pilot Responsibility

Controller Responsibility

Step 1: Pilot verifies ITP criteria

- ITP distance is greater than 18NM
- Ground speed difference < 20Kts if 15NM-20NM from reference aircraft or <30kts if greater than 20NM

Step 3: Controller verifies:

- Altitude requested is available
- Closing Mach number difference between aircraft requesting ITP and reference aircraft ≤ 0.06

Step 2: Pilot requests ITP climb from ATC

Step 4: Controller grants ITP climb

Step 5: Pilot revalidates ITP criteria

Step 6: Executes maneuver

ADS-B ITP

- **Concept Summary**

- Maximum of two reference aircraft, \pm 2000 feet altitude of ownship
- Aircraft can be any combination of ahead of or behind
- Can climb or descend; no less than 300 fpm in maneuver
- Initiate no closer than 15 NM with no more than 20 knots of closure or 20 NM with no more than 30 knots of closure
 - Note: current operational trial limited to no closer than 18 nm
- Must maintain Mach number in climb
- Increased traffic situation awareness (can see traffic ~180 NM away)

- **ITP Aircraft High Level Requirements**

- ADS-B In with on board ITP decision support system CPDLC

- **Reference or Target Aircraft High Level Requirements**

- Valid ADS-B-Out signal (generally met with any GPS-equipped ADS-B out aircraft)

Operational Evaluation

- **Goals**

- Employ ADS-B ITP in oceanic air carrier operations

- **Objectives**

- Validate operational performance of ADS-B ITP
- Validate economic benefits of ADS-B ITP

- **Partnership**

- FAA and United Airlines agreement signed in April 2009
 - Additional partners include Honeywell and Goodrich

- **Scope**

- Retrofit 12 UAL 747-400 aircraft with certified ITP systems
- Gather data on use of ITP in the Pacific starting in 2011

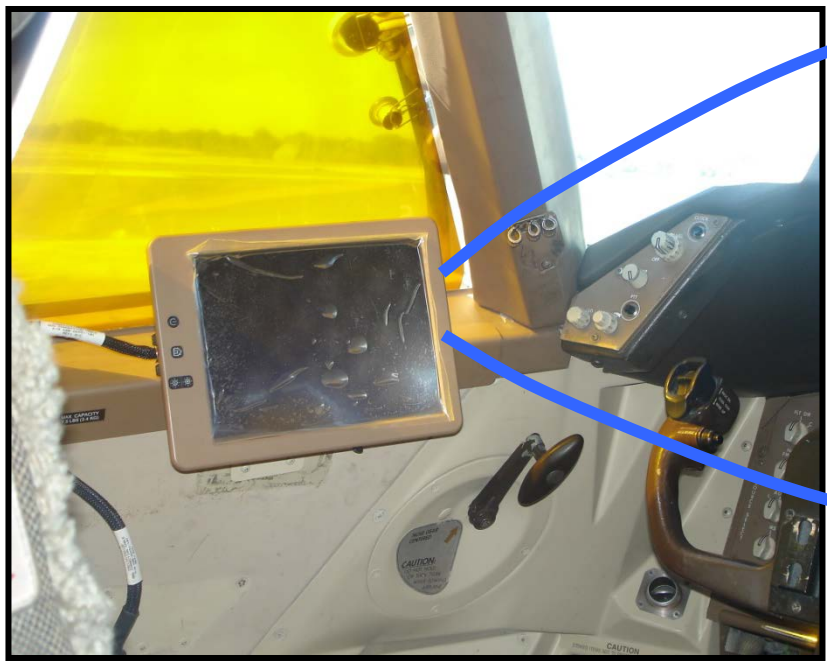


Honeywell

GOODRICH

Flight Crew Interface

- ADS-B-In requires hardware, software and crew interface
- EFB (side mounted display) solution chosen as a retrofit option
- Based on NASA's ITP Prototype



Side mounted display installed in a B747



Plan View



ITP Data View

ATOP ITP Checklist

¹ADS-B ITP CONTROLLER PROCEDURE

This procedure must be initiated by an ITP request

If any of the following steps are not true, advise the aircraft UNABLE

Validate ITP Request

The pilot-reported distance between the ITP aircraft and any referenced aircraft is at least 18nm.

Initiate probe on ITP aircraft

- 1 or 2 conflicts exist
- All call signs in conflict report(s) are included in the ITP request
- All conflict aircraft are same direction traffic as ITP aircraft until vertical separation is reestablished
- Closing mach difference of ITP aircraft and any referenced aircraft is $\leq .06$.
- All conflict aircraft are within 2000' of the ITP aircraft
- All conflict aircraft are at a single-assigned altitude
- No conflict exists at the requested altitude.
- No aircraft involved are cleared for a route deviation
- ITP aircraft and Reference are not part of another ITP operation at the same time

2nd PROF CONFLICTS FOR AIR02

Intruder	Dir	Alt	Uprd	Type	Stat
AIR02	C	AIR04	-	>>	1651

CLEARAN

AIR02 01S165M 1608/ 05S171M 1700/ 08S175M 1735

Urgent	Rpt	Negot	Rspn	Misc	Vert	Route	Speed	X-ing	Conn	Pre-Fnt				
RP	RR	CLIMB	@Time	@Fix	%Fix	DESCND	@Time	@Fix	%Fix	CROSS	A0A	A0L	NDA	MOOD
20		CLIMB TO AND MAINTAIN (alt)	F350			EOS								
26		CLIMB TO REACH (alt)	F350			BY (time)								EOS
27		CLIMB TO REACH (alt)	F350			BY (pos)								EOS
(20)		CLIMB TO AND MAINTAIN (alt)	F350											
(169)		(free text)	ITP BEHIND AIR04											

Probing : CLIMB TO AND MAINTAIN F350, ITP BEHIND AIR04
[AIR02]: Conflict with 1 aircraft, 0 airspace, IMMINENT

DL : REQUEST F350
ITP BEHIND AIR04/22
AHEAD OF AIR06/37

Process Route

CONFLICT

same direction

0.0 degrees LOS NOW ACTU

PASSING POINT

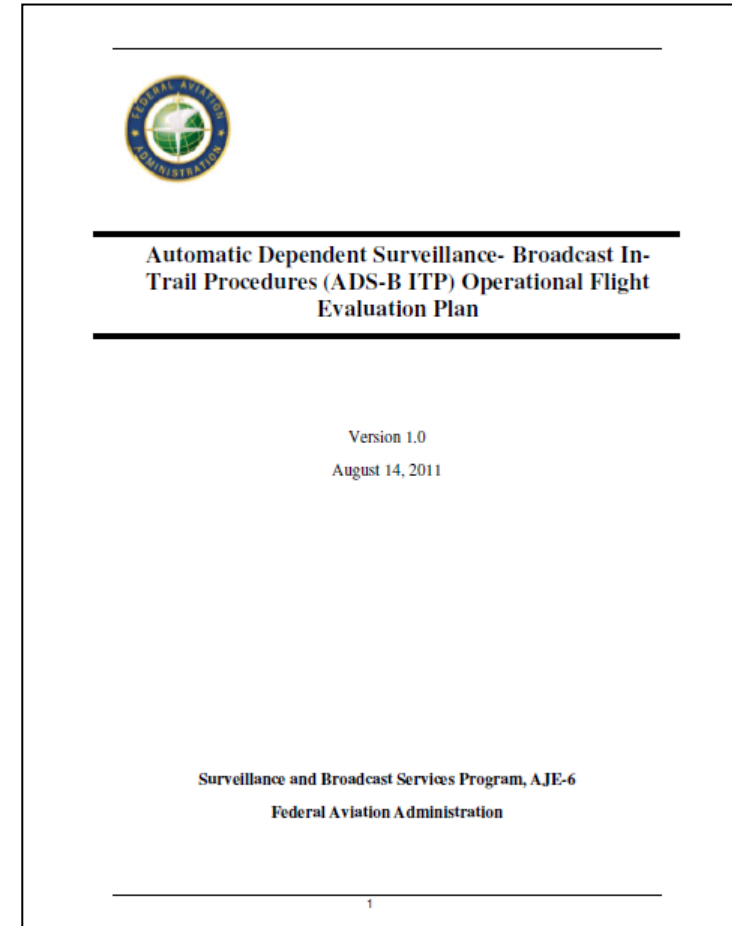
B744	F330	↑
*AIR02	F350	
N0502		
B744	F340	
AIR04	F340	
N084		

PRB	CAN	TPRB	SND	UNABL	VHF	SAVE	EALT	DYRB	COORD	RCPT	REJ	HLP
AIR02	*	MR	3H	330	01S 165M 1608	05S 171M 1700	08S 175M 1735			PHNL	AU	
01										YSSY	F 2A	ND
										.	R	
AIR04	*	MR	3H	340	01S 165M 1605	05S 171M 1658	08S 175M 1735			PHNL	AU	
01										YSSY	F A	ND
										.	R	



Operational Evaluation

- **Data is being collected from the following sources**
 - Dispatch
 - United Airlines computer data
 - Dispatch Comment Sheet
 - Controller/Oceanic Center
 - CPDLC messages
 - ADS-C position reports
 - Controller Comment Sheet
 - Cockpit
 - Pilot Comment Sheet
 - Pilot Data Sheet
 - Data cards from the traffic computer
- **Data from all sources is correlated and de-identified**
 - Data associated with a given flight assigned a random identifier and all identifying information is removed from the data



Operational Evaluation Metrics

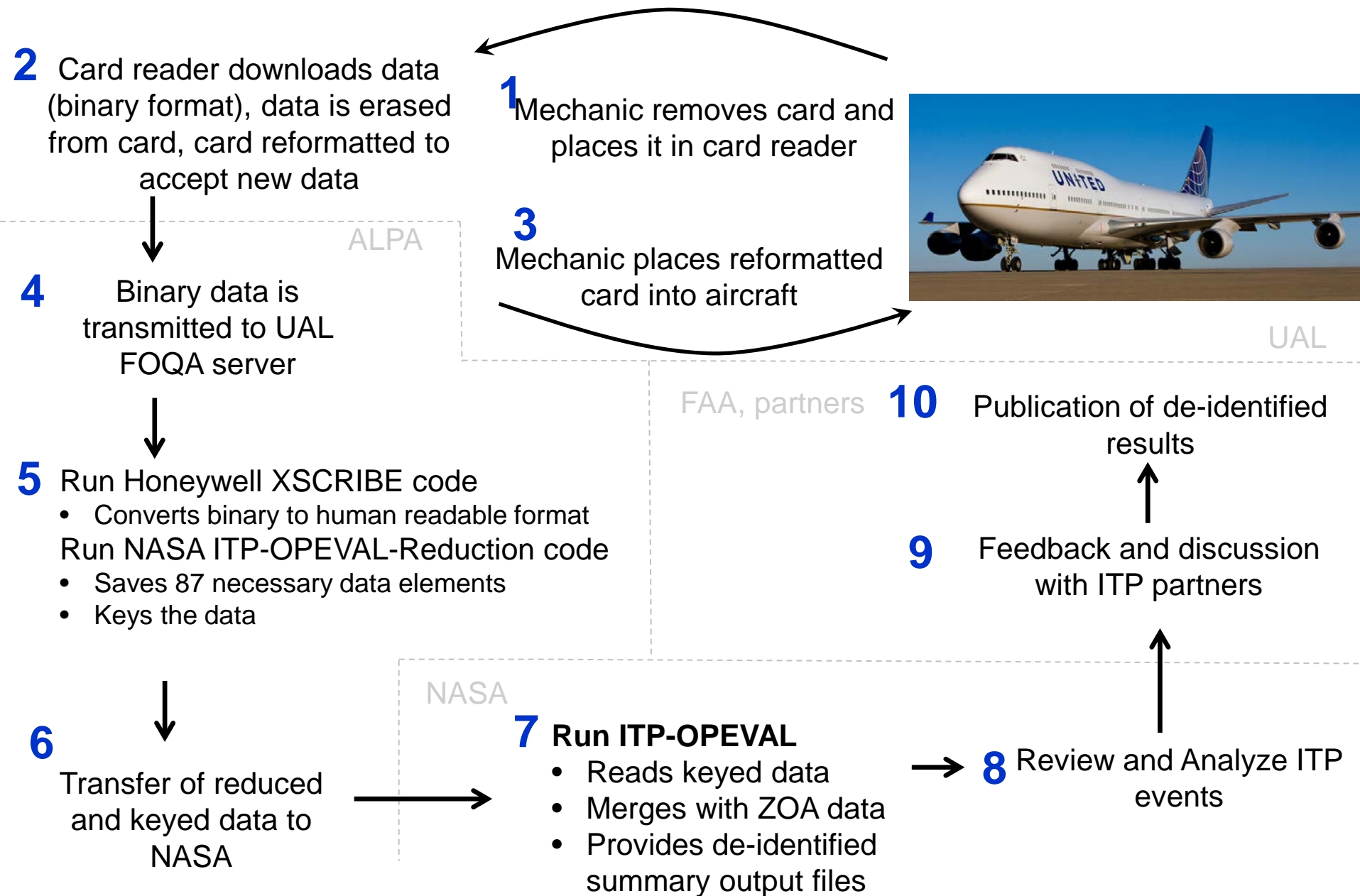
January 2014

Application Validation Metric	Southern Pacific		Northern Pacific		Totals	
	Expected	Actual	Expected	Actual	8/2013 - 1/2014	8/2011 - 1/2014
Number of ITP capable flights per month	60	66	180	191	1420	2786
Number of ITP requests	2	1	12	8	57	160
Number of ITP maneuvers performed	1	0	2	4	9	31
Number of "standard" flight level changes (from an ITP request)	1	1	7	2	21	59
Number of denied flight level changes (from an ITP request)	0	0	3	2	16	45
Number of immediate limited standard climbs	0	0	0	0	5	9
Number of climbs after moving reference aircraft	0	0	0	0	5	10
Number of standard climbs after period of time	0	0	0	0	1	6

Safety Related Parameter	Expected Avg.	Measurements (current month)			Measurements (8/2013 - 11/2014)			Measurements (8/2011 - 1/2014)		
		Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
ITP Initiation Distance	20 nm	20.8	29.9	47.2	20.8	33.2	67.7	19.1	29.8	88.4
ITP Distance at Co-altitude	18 nm	21.5	30.5	46.6	21.5	33.7	67.9	20.2	30.4	88.5
Time From ITP Initiation to Level Off at New Altitude	7 min	3	4.5	7	2.0	4.5	7.0	2.0	4.8	8.0
Percentage of ITPs where a wake encounter occurred and a wake incident was reported	2%					0.0			0.0	
Wake Turbulence Incident Severity (5-1) (5 is minimal, 1 is catastrophic)	5		N/A			N/A			N/A	



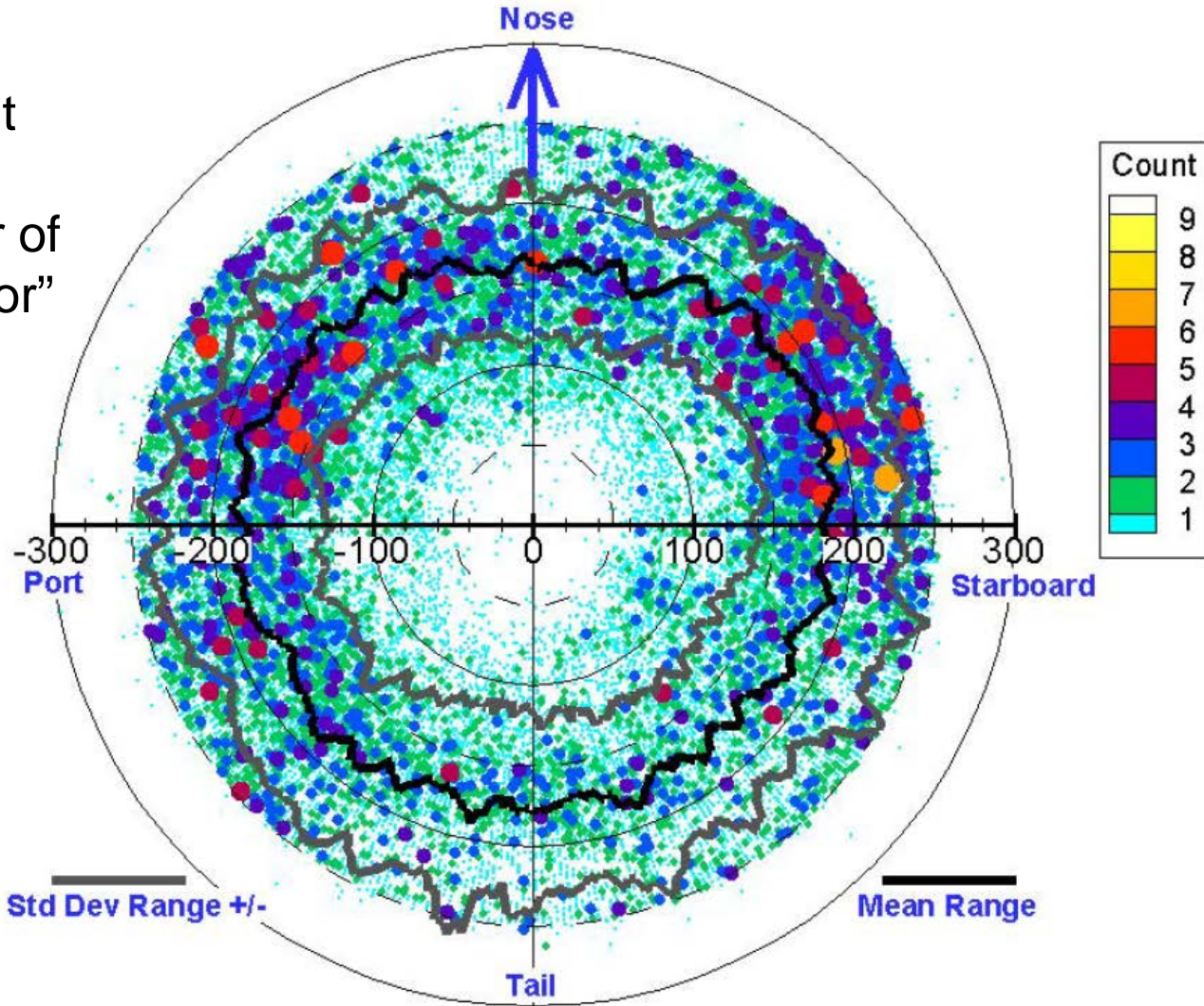
Electronic data card collection process



Electronic Data Card Results

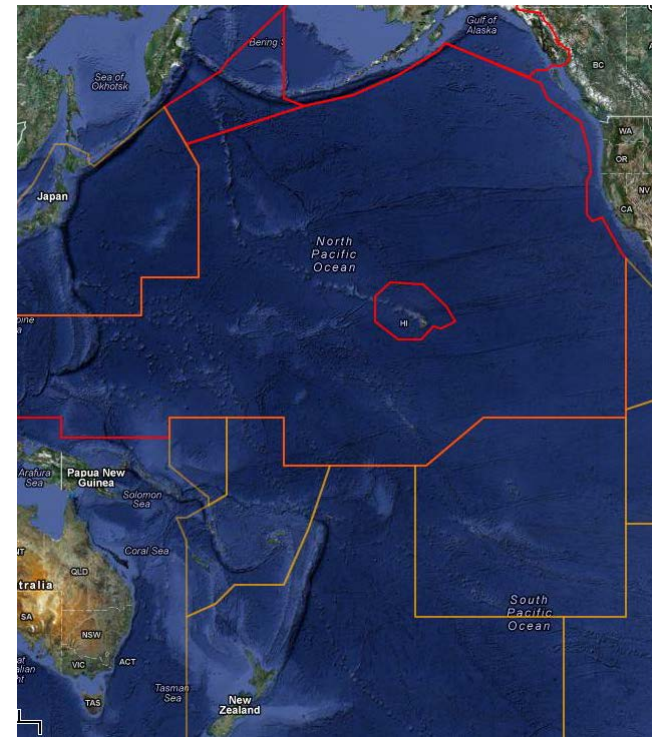
Maximum observed range

- Data represents about 400 flights
- “Count” is the number of data points in a “sector”

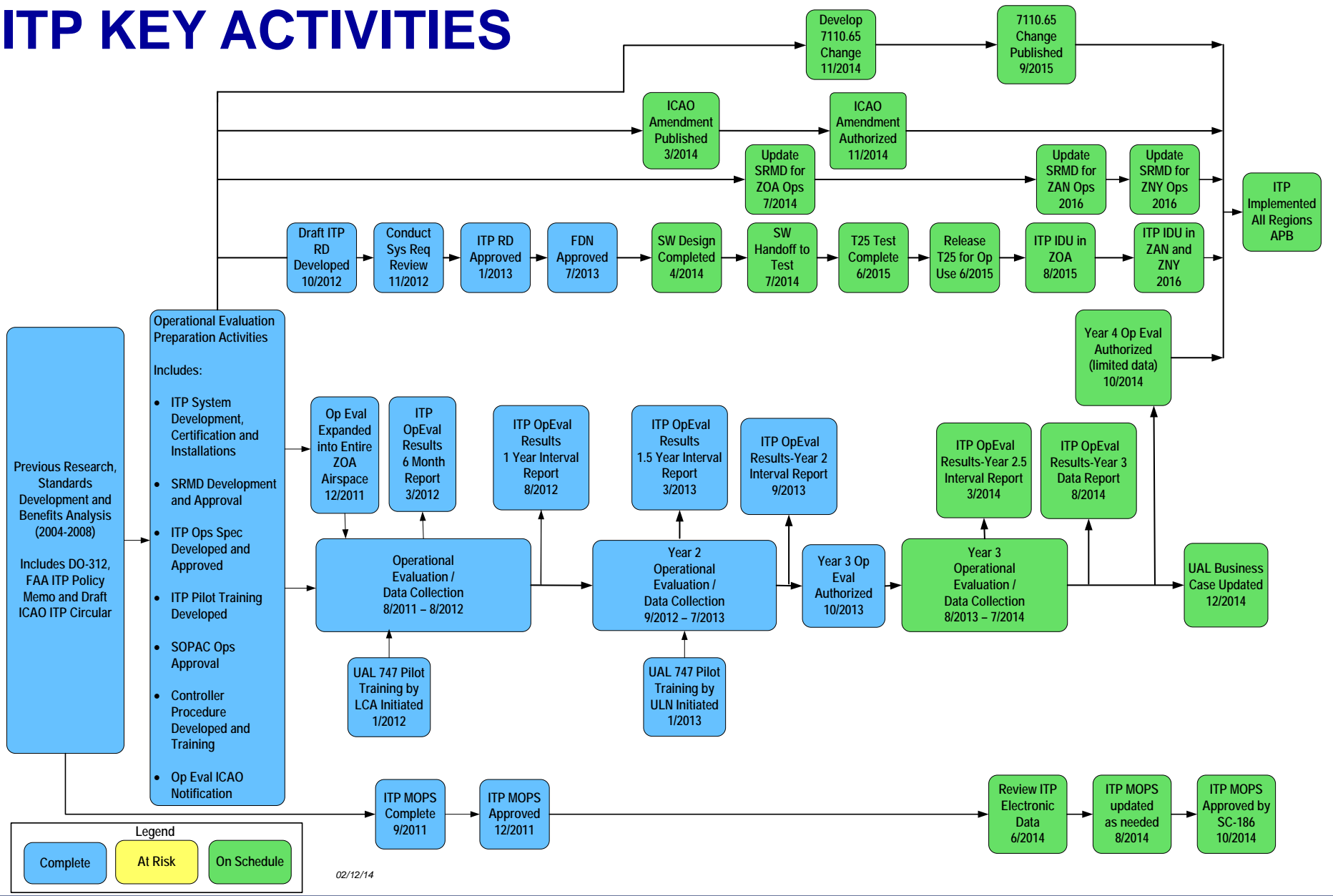


Activity Status

- **Typically receive 12-14 ITP requests per month**
 - Generally results in 3-4 ITP climbs, 6-8 standard climbs and 2-3 denials (operational reasons)
- **Pilot training**
 - United is updating their pilot training
- **ITP Expansion**
 - United Op Spec modified to reflect ops in Fiji, New Zealand, ZOA and Icelandic radar airspace
 - Working with United, New Zealand and Fiji to facilitate opportunities and get data
- **Benefits Analysis**
 - *Very preliminary results* show that on average the ITP requests have resulted in a savings of 800 lbs of fuel per climb (could go higher)
- **ATOP ITP Mods**
 - FAA is in the process of developing ITP mods for ATOP
 - Budget cuts could delay delivery of the mods



ITP KEY ACTIVITIES



02/12/14



Summary

- **First operational ITP flights conducted during the evening of August 15th in ZOA airspace; operational in the entire ZOA region December 2011**
- **Typically receive 12-14 ITP requests per month**
- **Working to increase operational evaluation participation**
 - United Op Spec modified to reflect ops in Fiji, New Zealand, ZOA and Icelandic radar airspace
 - Working with United, New Zealand and Fiji to facilitate opportunities and obtain data
- **ITP mods for ATOP are being developed**
 - Budget cuts could delay delivery of the mods