Session 3 – Performance-based Communication and Surveillance (PBCS)

Prepare for PBCS – ANSP and Operator

Presented to: Operational Data Link Seminar
(Bangkok, Thailand)

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Federal Aviation Administration

Why PBCS?

Operators have choices for their "data link"

Technology

- **FANS 1/A**
- **ATN B1**
- **B2**
- **POA (VDL M0/A)**
- **AOA (VDL M2)**
- **HFDL**
- **SATCOM**
  - Classic Aero on I3/I4
  - Data 2/Data 3
  - SwiftBroadBand (SBB)
  - Short Burst Data (SBD)
  - Certus

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Implementation

- **AOC**
- **Cabin Services**
- **Configurable Avionics**
- **Procedures**
- **CSP/SSP**
  - SITA
  - ARINC
  - Inmarsat
  - Iridium
  - MTSAT

→ Different capability and performance

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System changes and corrective actions

… and ATM operations, such as applying performance-based separation minima, are predicated on that capability and performance

Current Situation – Problem

The “system” can potentially apply separation minima to non-compliant operator/aircraft

Overview

- **The ICAO PBCS Provision**
  - Framework
  - Required Communication Performance (RCP)
  - Required Surveillance Performance (RSP)
- **Applications of the ICAO PBCS Provision to ATM Operations**
- **The ICAO PBCS Manual (Doc 9869)**
- **ANSP and Operator PBCS Planning and Implementation**

The ICAO PBCS Provision References

Adopted/Approved March 2016 → Applicable November 2016

ICAO Doc	Description	Amdt
Annex 6	Operation of Aircraft	
Part I	Commercial Air Transport — Aeroplanes	40
Part II	General Aviation — Aeroplanes	34
Part III	Operations — Helicopters	20
Annex 11	Air Traffic Services	50
Annex 15	Aeronautical Information Services	39
Doc 4444	PANS–ATM	7
Doc 8400	PANS–ABC	

My 1-Slide Summary of ICAO PBCS Provision

PBCS is a shared responsibility

In accordance with the ICAO PBCS Provision, State	In accordance with State policies	
	ANSP	Operator
❑ Establishes PBCS policies for ANSP, operator, airworthiness, etc. ❑ Prescribes RCP/RSP specifications in the applicable airspace for the relevant operations ❑ Publishes PBCS requirements in aeronautical information publication (AIP)	❑ Provides RCP/RSP-compliant services ❑ Recognizes RCP/RSP capabilities in air traffic control (ATC) automation ❑ Establishes PBCS monitoring program	❑ Prepares to file RCP/RSP capabilities in flight plan ❑ Participates in ANSP PBCS monitoring programs

Is PBCS Mandatory?

NO, BUT … it is beneficial and the following horizontal separation minima require PBCS, in accordance with PANS-ATM

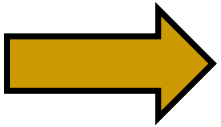
- **Lateral Separation Criteria And Minima (para 5.4.1.2.1.6.b))**
  - 42.6 km (23 NM)
- **Performance-based Longitudinal Separation Minima (para 5.4.2.9.2)**
  - 5 minutes
  - 55.5 km (30 NM)
  - 93 km (50 NM)

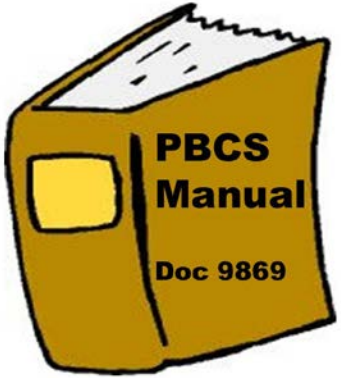
PBCS is Beneficial – even when not required

- **Establishes confidence that ATM operations that require PBCS are provided only to eligible aircraft**
- **Provides early detection of problems for cost-effective resolutions**
- **Provides for global exchange of analysis tools and information**
- **Ensures actual system performance is maintained**
- **Provides effective way to improve system performance**
- **Allows transition to more advanced ATM operations requiring more capabilities with more stringent performance characteristics**

PBCS Concept Overview

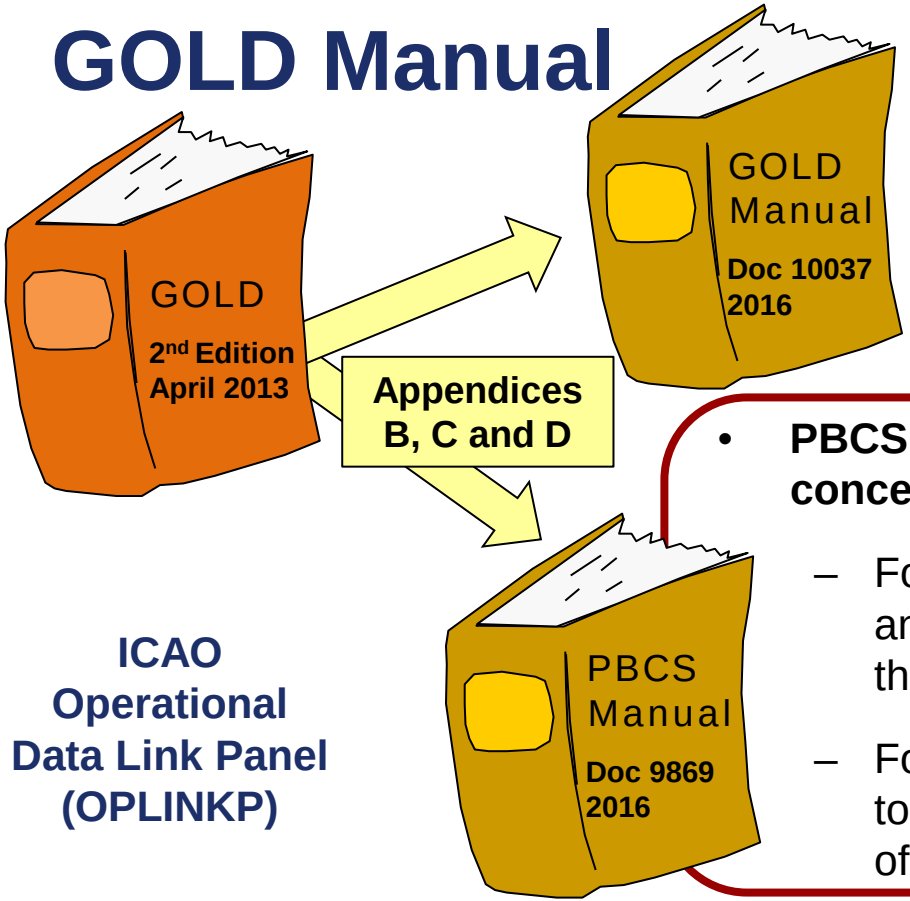
- **PBCS provides a framework for**
  - Prescribing criteria for communication and surveillance systems
  - Showing that these systems comply with the prescribed criteria
- **The ICAO PBCS Provision**
  - Supported by guidance material





Formerly the Manual on RCP

GOLD Manual



ICAO Operational Data Link Panel (OPLINKP)

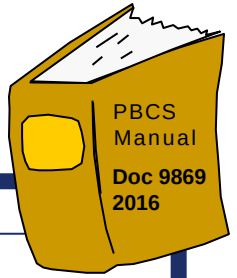
GOLD Manual (Doc 10037), CPDLC / ADS-C

- Preparation and readiness
- Procedures – Controller and flight crew

Subject of this presentation from ANSP and Operator perspective

- **PBCS Manual (Doc 9869), performance-based concept that provides global framework**
  - For ANSP to prescribe criteria for communication and surveillance capabilities that are applicable to the air traffic operations in relevant airspace
  - For appropriate parties (e.g. operator) to show that the different components of the system comply with prescribed criteria

PBCS Manual (Doc 9869) Contents

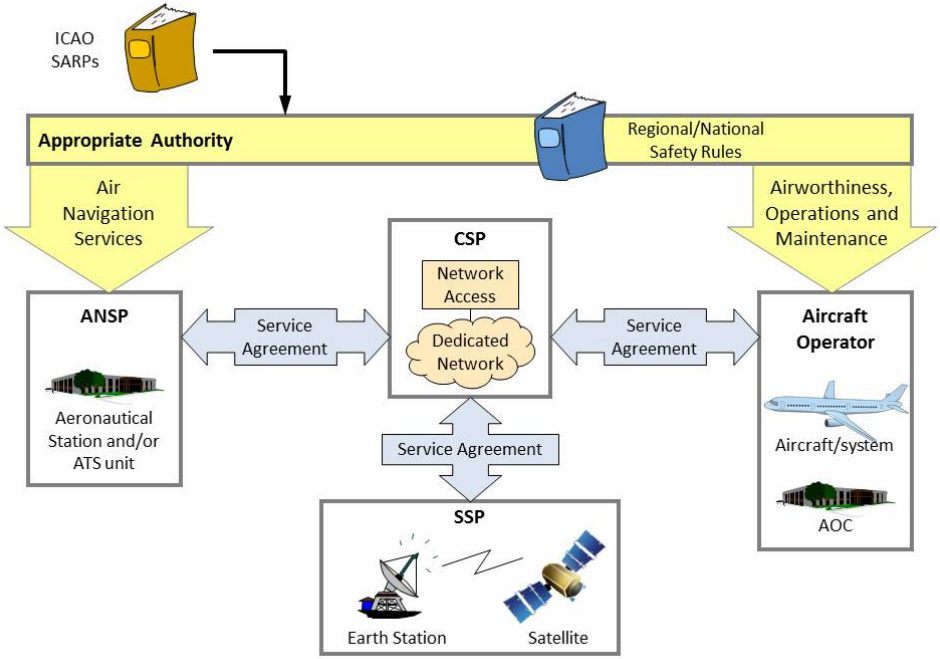


Information	Background	All
	Publications, Acronyms, Glossary	All
	PBCS concept	All
Guidelines	Developing an RCP/RSP specification	Standards bodies
	Applying an RCP/RSP specification	State
	Complying with an RCP/RSP specification	All
	Establishing State policies	State
	Initial compliance	ANSP and Operator
	Continued operational compliance	ANSP and Operator
Supporting Guidelines	PBCS Implementation Plan – Checklist	Appendix A
	RCP specifications	Appendix B
	RSP specifications	Appendix C
	PBCS monitoring (CPDLC and ADS C)	Appendix D
	PBCS monitoring (SATVOICE)	Appendix E

State Safety Oversight Framework

Means of compliance guidance → Doc 9869

- **Initial compliance**
  - ANSP
  - Operator, aircraft and system
  - ANSP and Operator oversee CSP/SSP via service agreements
- **Post-implementation monitoring**
  - Component and sub-component analysis
  - Change management
  - Continuous improvement – corrective action



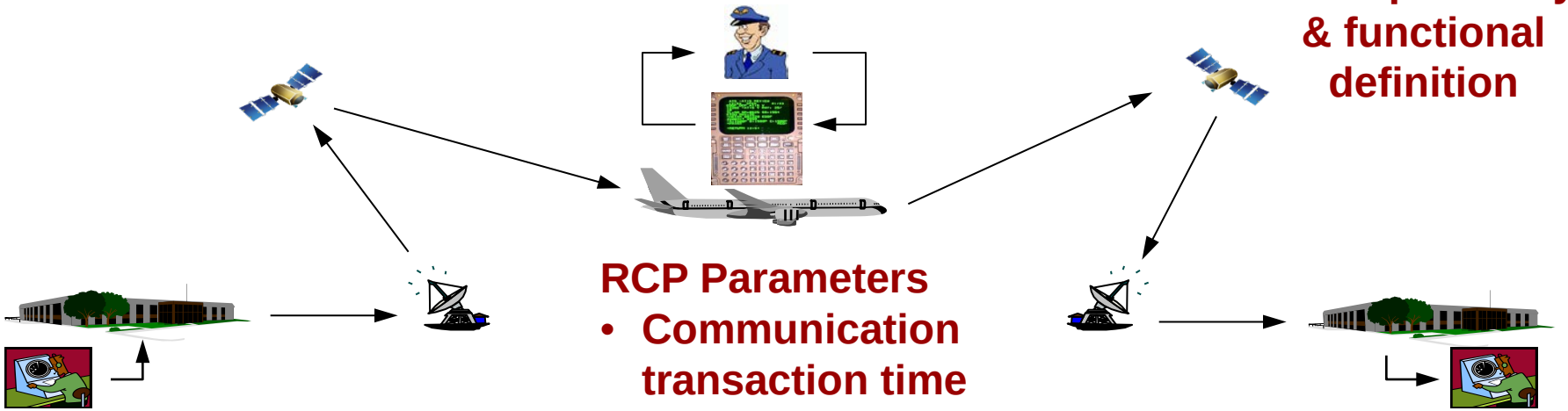
RCP-RSP Specifications

- **RCP-RSP specifications are applied to capability and provide functional, safety and performance criteria that are allocated to system components**
  - ANSP system (includes CSP)
  - Aircraft system
  - CSP (includes SSP)
  - Operator (includes CSP)
- **Current specifications – RCP240, RCP400, RSP180, RSP400**

RCP 240 Specification

Applies to controller's intervention capability

Interoperability & functional definition



RCP Parameters

- **Communication transaction time**
- **RCP continuity**
- **RCP availability**
- **RCP integrity**

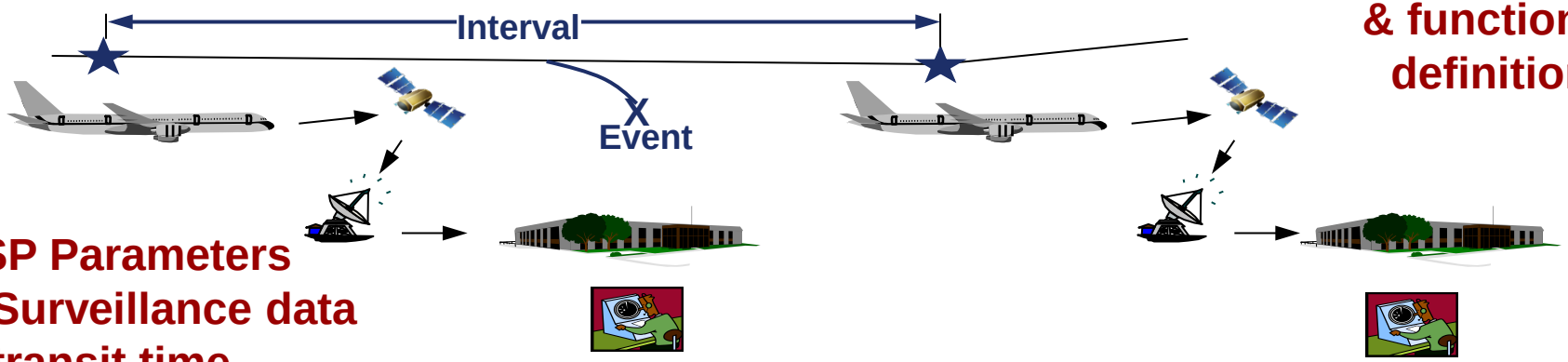
Controller issues ATC instruction

Controller receives response

RSP 180 Specification

Applies to surveillance data

Time at position



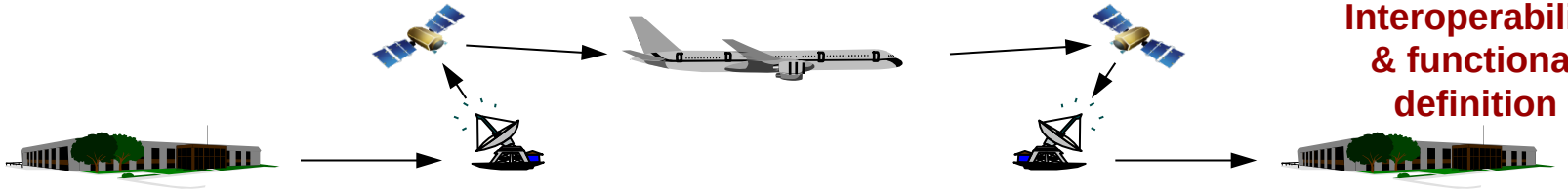
Interoperability & functional definition

RSP Parameters

- Surveillance data transit time
- RSP continuity
- RSP availability
- RSP integrity

ATSU/controller receives the surveillance data

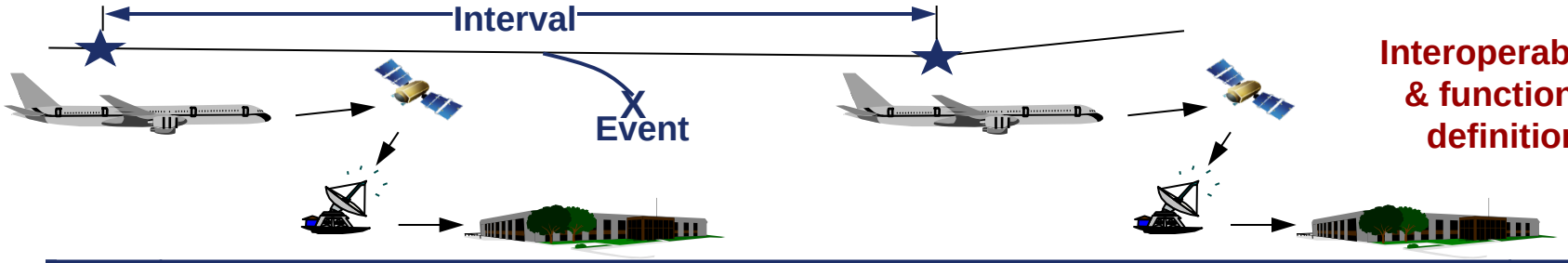
RCP 240 Time and Continuity



Interoperability & functional definition

	RCP specification (communication transaction time)									
RCP	**240**									**RCP**
	Controller composes and sends message	←	**Operational Performance (Monitored)**						→	Controller receives indication and confirms response
		Communication transaction time								
99.9%	Part of 30	**210**								Part of 30 **ET**
95%	Part of 30	**180**								Part of 30 **TT**
		RCTP (Ground to Air)			PORT	RCTP (Air to Ground)				
99.9%		P(150)			60	P(150)				**99.9%**
95%		P(120)			60	P(120)				**95%**
		ATSU system	CSP	Aircraft system		Aircraft system	CSP	ATSU system		
99.9%		P(15)	P(120)	P(15)		P(15)	P(120)	P(15)		**99.9%**
95%		P(10)	P(100)	P(10)		P(10)	P(100)	P(10)		**95%**

RSP 180 Time and Continuity



Interoperability & functional definition

	RSP specification (surveillance data transit time)				
RSP	**180**				**RSP**
	Time at position (RNP at +/-1 sec UTC)	← **Operational Performance (Monitored)** →		ATSU receives surveillance data	
		Surveillance data transit time			
99.9%		**180**			**OD**
95%		**90**			**DT**
		Aircraft system	CSP	ATSU system	
99.9%		5	170	5	**99.9%**
95%		3	84	3	**95%**

RCP 240 – RSP 180 Availability

- **RCP 240 – RSP 180 aircraft availability requirement**
  - 0.999 availability – a single system can meet requirement
  - Carriage requirements for multiple communication radios are typically specified only for voice communications
- **RCP 240 – RSP 180 communication services availability requirements are as follows**

RCP 240 – RSP 180 availability requirements			
Availability parameter	**Efficiency**	**Safety**	**Compliance means**
Service availability (A_{CSP})	0.9999	0.999	Contract/service agreement terms
Unplanned outage duration limit (min)	10	10	
Maximum number of unplanned outages	4	48	
Maximum accumulated unplanned outage time (min/yr)	52	520	
Unplanned outage notification delay (min)	5	5	

Note.— DO 306/ED 122 specifies a requirement to indicate loss of the service. Unplanned outage notification delay is an additional time value associated with the requirement to indicate the loss to the ATS provider per the RCP/RSP related safety requirement (SR) 4 for the ANSP.

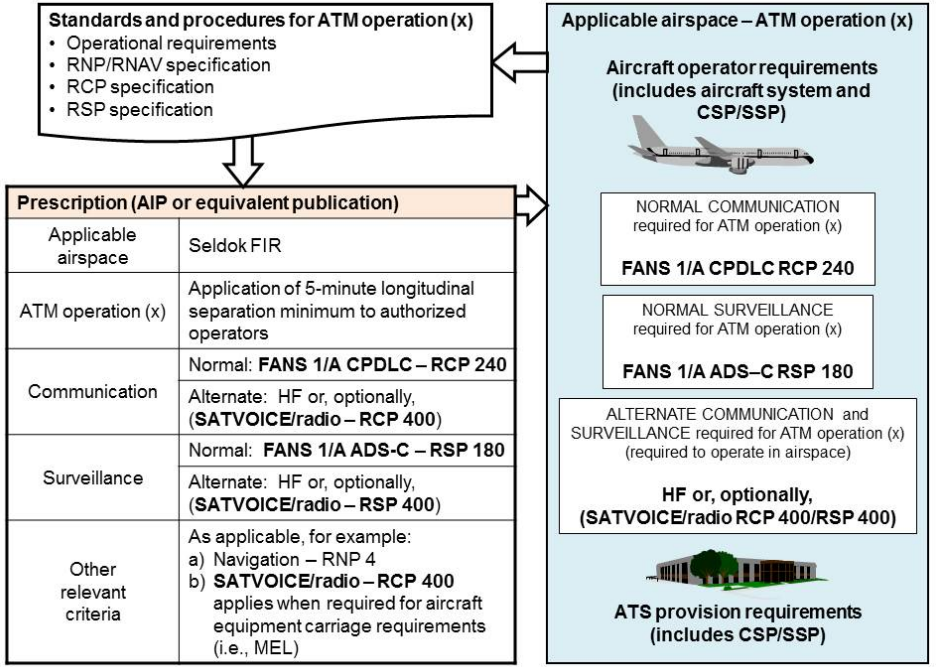
RCP 240 – RSP 180 Integrity

- **RCP 240 – RSP 180 provide safety requirements for the components of the operational system**
  - Integrity issues discovered post-implementation are reported to the appropriate Regional/State monitoring agency and/or authorities for appropriate action
- **For RSP 180, the integrity criteria include accuracy of navigation position data and time at the position provided in the surveillance data (e.g., RNP 4 at +/- 1 sec UTC)**

RCP 240 – RSP 180 availability requirements		
Integrity parameter	**Integrity value**	**Compliance means**
Integrity (I)	Malfunction = 10^{-5} (per flight hour)	Analysis, safety requirements, development assurance level commensurate with integrity level, (compliance shown prior to operational implementation). See also RCP related safety requirement SR-26 for the ATSP. CSP contract/service agreement. See also RCP integrity criteria for CSP, paragraph B.2.1.2.

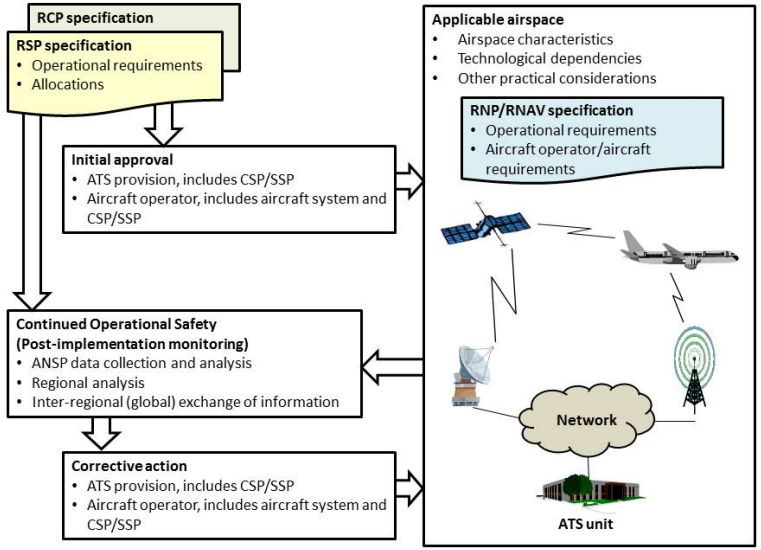
Prescribing RCP/RSP Specifications

- **When prescribing the RCP/RSP specification, the State specifies**
  - Applicable airspace or specific routes
  - Specific ATM operations
  - Interoperability designators for the relevant systems
- **Interoperability designators for CPDLC and ADS-C can be found in the GOLD Manual (Doc 10037)**



Complying with RCP/RSP Specifications

- **Initial compliance**
  - ANSP (CSP, SSP)
  - Aircraft type/system
  - Operator (aircraft, CSP, SSP)
- **Post-implementation monitoring**
  - ANSP data collection and analysis
  - Regional analysis
  - Inter-regional exchange of information
- **Performance improvement**
  - ANSP (CSP, SSP)
  - Operator (aircraft, CSP, SSP)



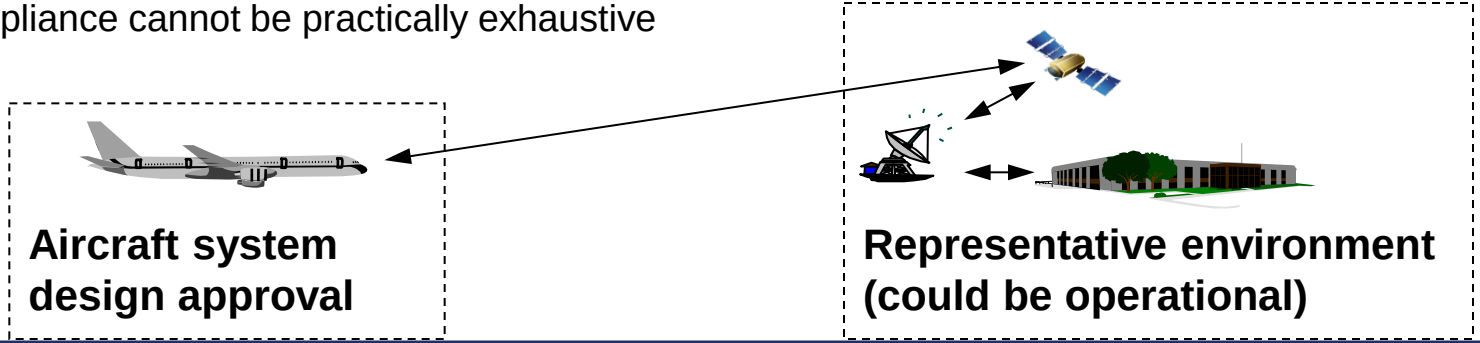
Associated with complying with interoperability standards

Initial Compliance – ANSP

- **Consistent with State Safety Program, ANSP provides services in accordance with State policies → ensures ATS system meets allocated interoperability and RCP–RSP criteria → specifies operator requirements in AIP**
  - ATC system design and procedures
  - Controller and other ATS staff training, as appropriate
  - Service agreements with CSP(s)
  - Operational trials
  - Notification of data link services, operator requirements, including aircraft equipage and flight plan requirements (e.g. P[n] codes)
  - Contingency and restoration of service procedures

Initial Compliance – Aircraft/Avionics

- **Aircraft/avionics manufacturer obtains design approval in accordance with State policies (State of Design and State of Manufacture); ensures avionics meet allocated interoperability and RCP – RSP criteria**
  - Aircraft/avionics manufacturer shows operational performance with a representative ATS system
  - Flight manual and master minimum equipment list (MMEL)
  - Compliance cannot be practically exhaustive



Initial Compliance – Operator (1 of 2)

- **Operator determines eligibility in accordance with State policies (State of the Operator or State of Registry); ensures operations and maintenance meet allocated interoperability and RCP – RSP criteria**
  - Aircraft system approval for the intended use
  - Flight crew training and qualification
  - Minimum equipment list (MEL)
  - Maintenance, such as user modifiable software used to establish airline policies for the management of communication media
  - Service agreements with the CSP(s)/SSP(s)
  - Procedures for submitting problem reports and data to the PBCS monitoring programme

Initial Compliance – Operator (2 of 2)

- **Aircraft types/systems in an operator's fleet normally perform acceptably in accordance with maintenance and operations specifications (e.g. configured avionics, CSP/SSP, area(s) of operation), BUT…**
- **If non-compliant, the** State of the Operator **or** State of Registry
  - Provides operator with a notice to improve performance
  - If non-compliance is not corrected, removes the RCP [X] and/or RSP [Y] eligibility status
  - The operator may still use CPDLC and ADS-C, but specified aircraft types within its fleet or individual airframe would not be eligible for any ATM operation predicated on RCP [X] and/or RSP [Y]

RCP/RSP is Filed with Interoperability

FPL Item 10 – Equipment and Capability	
Ltr	**Equipment and capbility**
	Item 10A
J1	CPDLC ATN VDL Mode 2 (See Note 3)
J2	CPDLC FANS 1/A HFDL
J3	CPDLC FANS 1/A VDL Mode A
J4	CPDLC FANS 1/A VDL Mode 2
J5	CPDLC FANS 1/A SATCOM (INMARSAT)
J6	CPDLC FANS 1/A SATCOM (MTSAT)
J7	CPDLC FANS 1/A SATCOM (Iridium)
M1	SATVOICE ~~ATC RTF SATCOM~~ (INMARSAT)
M2	SATVOICE ~~ATC RTF~~ (MTSAT)
M3	SATVOICE ~~ATC RTF~~ (Iridium)
~~P1–P9~~	~~Reserved for RCP~~ CPDLC RCP 400 (See Note 7)
P2	CPDLC RCP 240 (See Note 7)
P3	SATVOICE RCP 400 (See Note 7)
~~P4–P9~~	Reserved for RCP
	Item 10B
D1	ADS-C with FANS 1/A capabilities

…

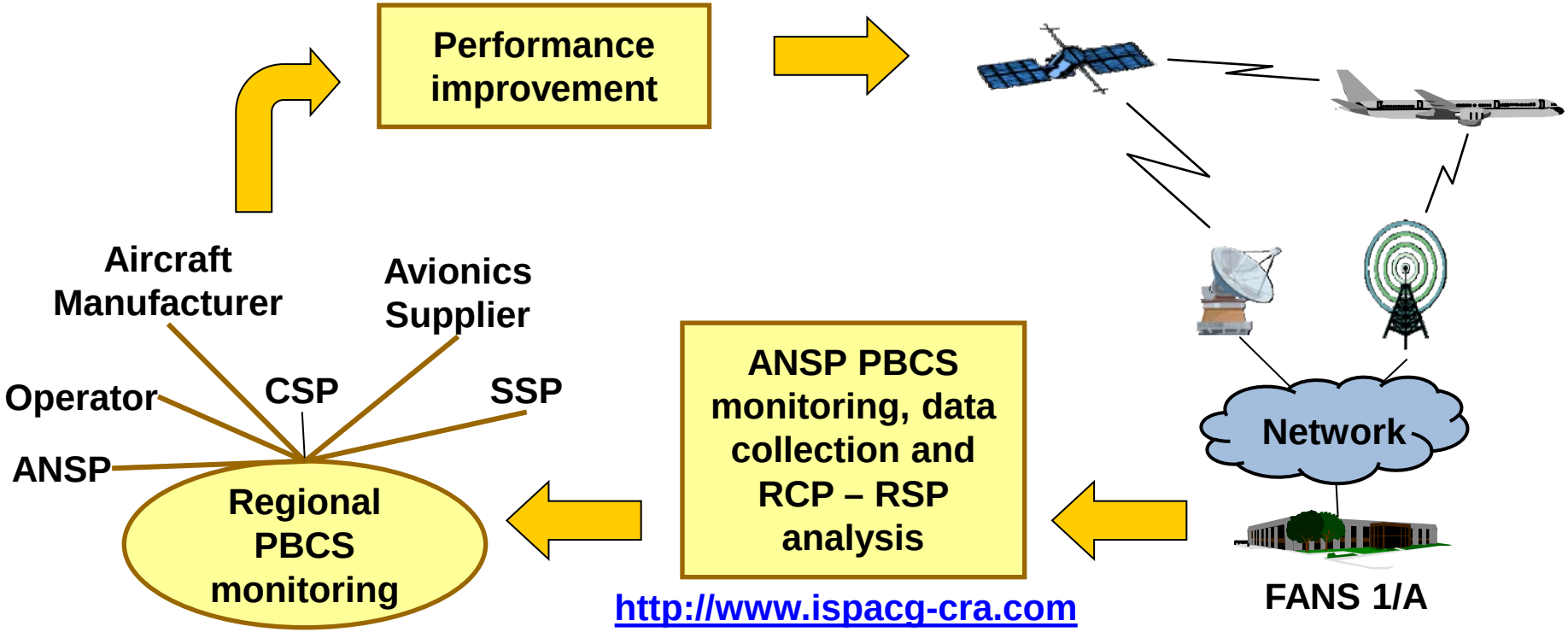
Note 1.— The RSP specification(s), if applicable, will be listed in Item 18 following the indicator SUR/. …

- **Eligible operator files RCP/RSP capabilities per State policies and relevant AIPs**
- **RCP/RSP descriptors are inserted only when interoperability descriptors are also inserted in item 10**
  - RCP/RSP capabilities denote performance
  - J2 through J7, M1 through M3 and D1 in item 10 denote the interoperability

Benefits of RCP/RSP Flight Plan Codes

- Paramount – **Ensure SAFE application of performance-based separation minima**
- **Allow ATS system to automatically determine eligibility of aircraft, similar to PBN codes (e.g. L1 for RNP4) → eliminate need for manual procedures**
- **Signify initial approval → eliminate the need for ANSPs to "police" for "noncompliant" operators/aircraft types**
- **Allow non-compliant operators to continue to use capabilities, such as CPDLC and ADS–C, for operations that do not require compliance to certain RCP–RSP specifications**
- **Allow transition to more stringent RCP–RSP specifications to accommodate advances in technology to further efficiency gains in ATM operations**

Continued Compliance – ANSPs and All

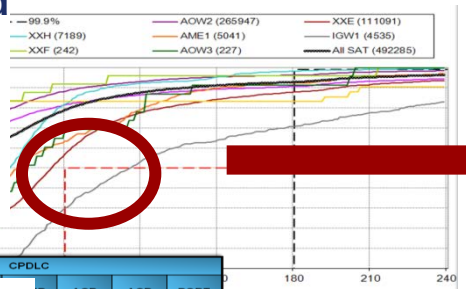


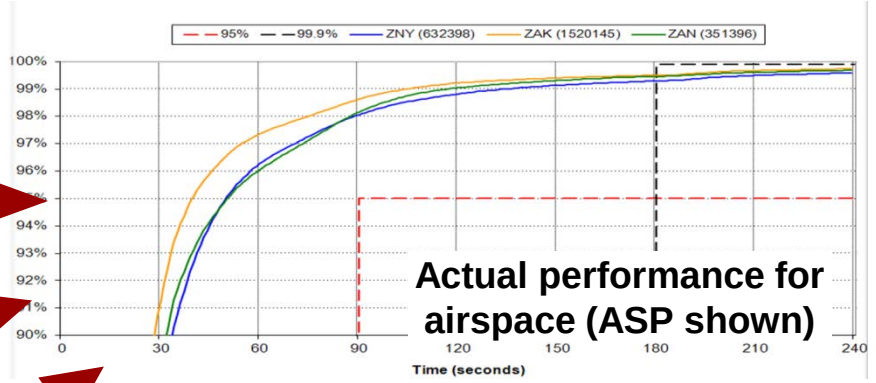
http://www.ispacg-cra.com

Managing Performance and Change

CSP agreements (shared by ANSP and Operator)

ASP for surveillance data delivery via different routing (ZNY)





Actual performance for airspace (ASP shown)

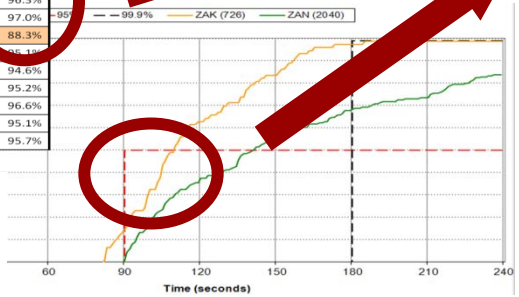
Operator approval

ASP, ACP, ACTP and PORT for different operators (ZNY)

	ADS-C				CPDLC					
Ope Code							ACP 95%	ACP 99.9%	PORT	
L							97.5%	98.2	91.8%	
AA							99.4%	99	96.6%	
BB							99.0%	99	96.3%	
FF							98.6%	99	97.0%	
DD							97.0%	97.8	88.3%	
A							98.0%	98.7%		
EE							99.0%	99.5%	94.6%	
GG							98.9%	99.1%	95.2%	
R							99.0%	99.3%	96.6%	
JJ	24,022	3.8%	99.6%	99.9%	862	2.1%	100%	100%	99.4%	99.4%	95.1%
HH	23,153	3.7%	99.0%	99.1%	1,136	2.8%	99.9%	99.9%	99.0%	99.2%	95.7%

Operator or aircraft system approval

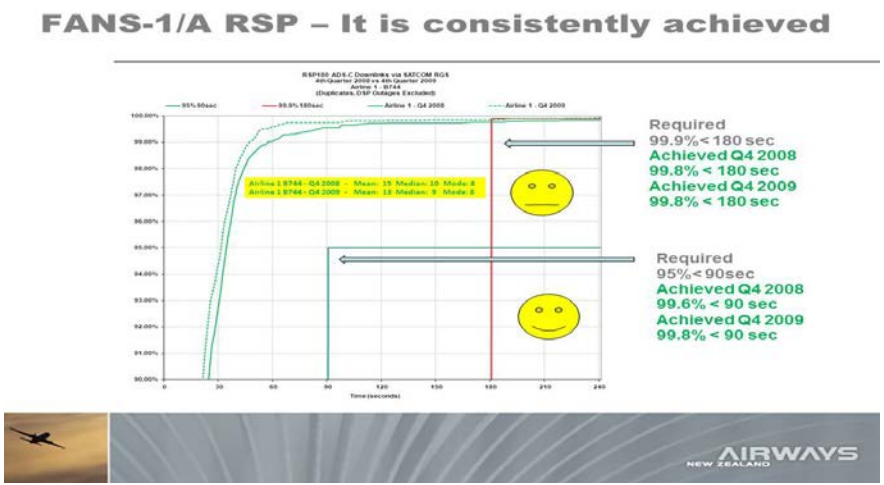
ASP for an aircraft type (ZAK and ZAN)

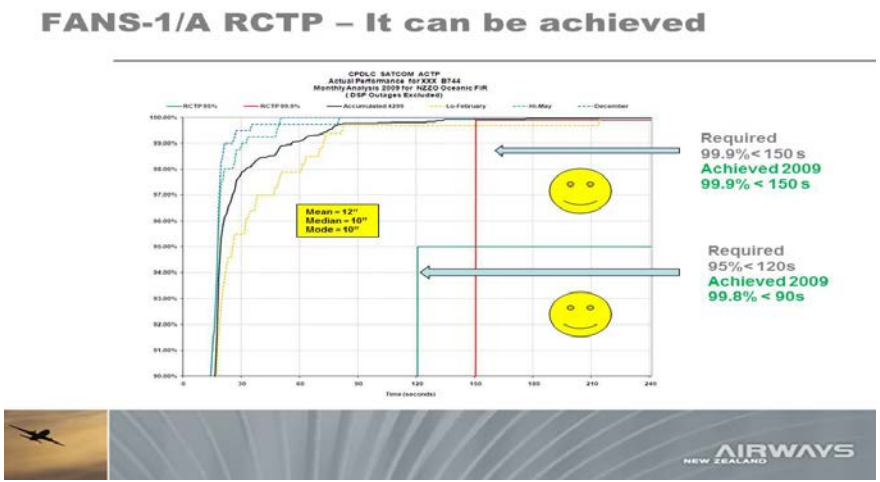


These problems do not help aggregate performance for airspace

RCP/RSP Criteria are Achievable

But you have to find the problems …

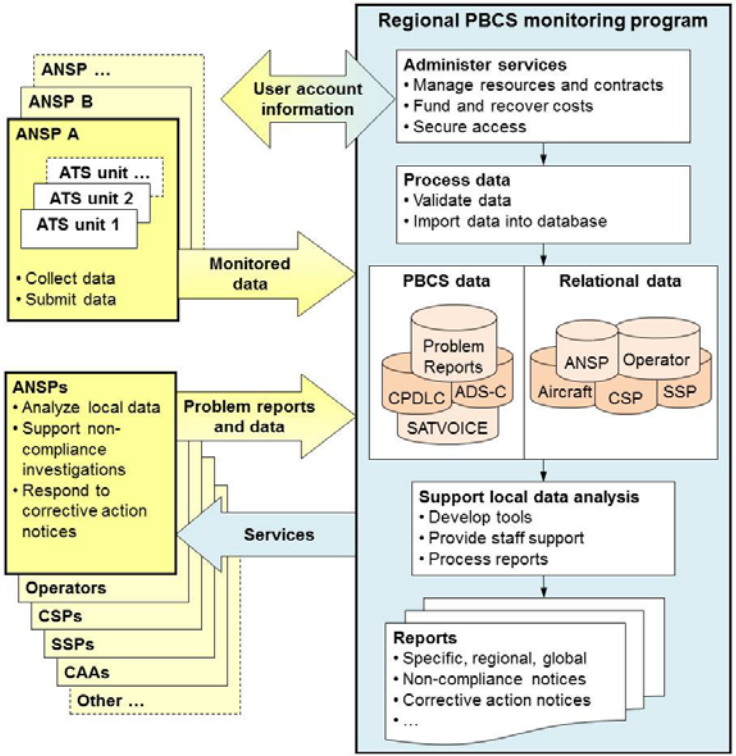




And fix them!

Regional PBCS Monitoring Program

- **Determine area of operation to which the information applies**
  - Such as one or more regions
- **You need**
  - Host
  - Information security policy
  - Cost recovery mechanism
- **Supports local analysis and global exchange of information**



Global Exchange of Information

Regional PBCS monitoring programs should exchange information at the global level and support State Safety Program

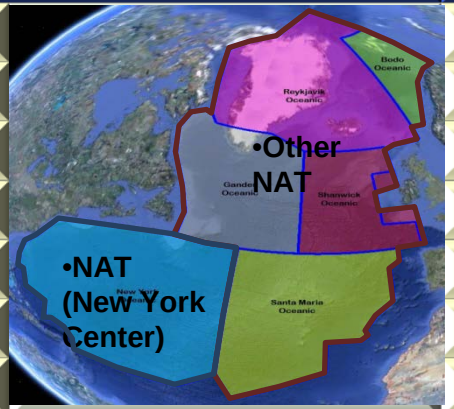
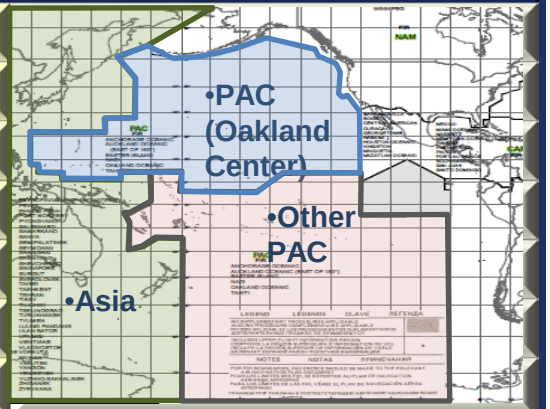
- **Lessons learned**
- **Analytical tools that can be shared**
- **A list of aircraft operators that are eligible for RCP240 / RSP180 operations**
  - file RCP/RSP designators in their flight plan
- **A list of known problems**
  - including those with particular networks, components of a network, aircraft types/systems, or aircraft operators, and associated resolutions

PBCS Implementation Plan – Checklist

Task ID	Task Descriptor
Group A tasks – State/Region preparation	
A-1	AIP – Prescription of an RCP/RSP specification
A-2	ANSP – PBCS policies, objectives supporting safety oversight
A-3	Operator and Aircraft System – PBCS policies, objectives supporting safety oversight
A-4	Regional Supplementary Procedures (Doc 7030) for PBCS operations, if applicable
Group B tasks – ANSP general project development and management	
B-1	PBCS Implementation Plan
B-2	Target dates for PBCS and relevant ATM operations
B-3	RCP/RSP specifications
B-4	PBCS awareness
Group C tasks – ANSP implementation activities – ATS service provision	
C-1	Operational concepts and procedures for PBCS operations
C-2	ATC automation changes to use flight plan RCP/RSP indicators
C-3	ATC automation changes for PBCS monitoring
C-4	Confirm initial ANSP compliance with RCP/RSP specifications
Group D tasks – Aircraft operator, Aircraft type/system (airworthiness) eligibility	
D-1	Aircraft operator readiness
D-2	Confirm initial operator and/or aircraft type/system compliance with RCP/RSP specifications
Group E tasks – All stakeholders – post-implementation monitoring	
E-1	PBCS monitoring – post-implementation

Planning and Implementation

- **(Formal) North Atlantic Systems Planning Group (NAT SPG), etc.**
- **Informal South Pacific ATS Coordinating Group (ISPACG)**
- **Informal Pacific ATC Coordinating Group (IPACG)**

North Atlantic (NAT) Region		Asia-Pacific (APAC) Regions	
Canada		Australia	
Iceland		Chile	
Ireland		Fiji	
Norway		French Polynesia	
Portugal		Japan	
United Kingdom		New Zealand	
United States		United States	

Summary

- **ATM operations are becoming more dependent on CPDLC and ADS–C**
- **CPDLC and ADS–C systems are very complex systems for use by pilots and controllers**
- **PBCS ensures these systems will provide reliable CPDLC and ADS–C service suitable for advanced ATM operations**
- **Plan for PBCS implementation at the same time when you plan for CPDLC and ADS–C implementation**
- **States will need to establish PBCS policies for its operators even if they are not implementing CPDLC, ADS–C or PBCS in its airspace**