FANS in the North Atlantic

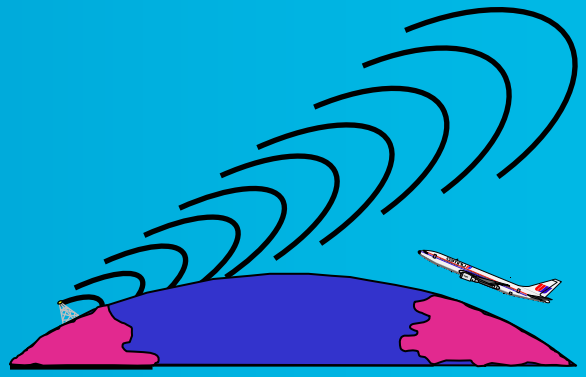
An introduction to the development of FANS in the NAT

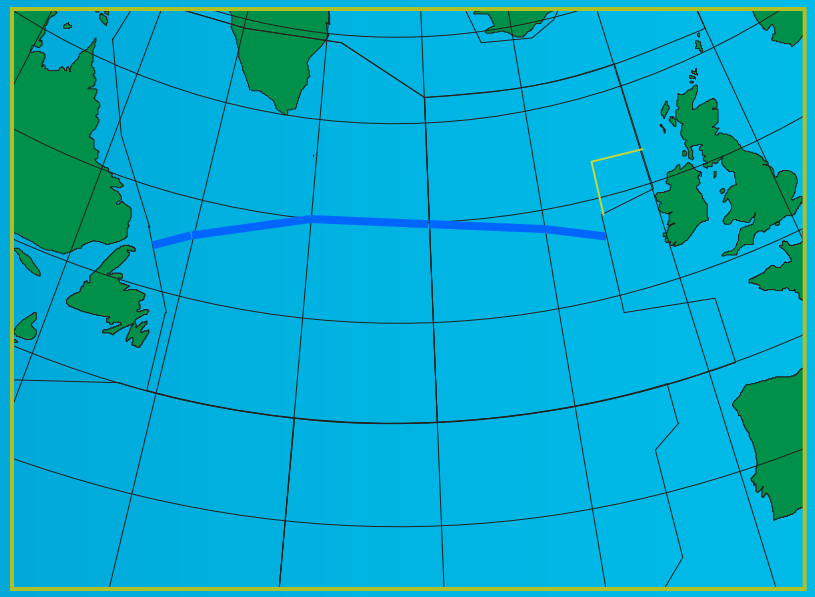
Session-2

Use of Data link for operational improvements

Oceanic Communications

- No ground-based VHF R/T or radar cover over most of NAT
- Voice communications mostly provided by HF R/T
- HF subject to weather effects
  - Audibility can be limited
  - Sometimes communication is impossible
- ATC issue strategic clearances that are separated to exit point, which is the reason that RCP/RSP is not predicated on standard separations





FANS History in the NAT

- FANS introduced in the PAC region in the 1990s
- Offered reliable communications and safety benefits through reduced likelihood of ATC instructions being misheard
- ADS-C position reporting introduced in the NAT in 1999
- CPDLC introduced in 2002
- In 2005, NAT SPG made a strategic decision to mandate the use of FANS in the NAT from 2015

NATS

NAT Data Link

The two main elements are;

ADS-C (Automatic Dependent Surveillance - Contracts)

Essentially the ATSU can set up contracts which require the aircraft avionics to provide surveillance information, such as waypoint reports etc.

CPDLC (Controller Pilot Data Link Communications)

ATSU can establish a connection to be able to send and receive messages from the cockpit as an alternative to voice.

NATS

NAT Data Link

All new aircraft are delivered with the FANS capability, although not all airlines choose to use the option, and a number have been retro-fitted. Currently figures recorded monthly show approx 65% of flights in Shanwick are using FANS. Noting that current predictions of equipage for 2015 indicate an equipage rate of 87%.

INITIAL LOGON

The first step is for the pilot to logon to the ATSU. It provides the ATSU with the type of applications supported by the avionics (CPDLC/ADS) and the ACARS addresses of those applications. The logon, is the trigger for the ground system to provide datalink services to the aircraft.

NATS

INITIAL LOGON

In FANS-1/A terminology, the logon is known as the Facilities Notification Contact Message **(FN_CON)**

The pilot enters the 4 letter ICAO code of the ATS unit, via a template on the Flight Management System (FMS,) and the ATSU acknowledges receipt.

INITIAL LOGON

ATSU

EGGX

COA61

1. AFN Contact (FN_CON)

2. AFN Acknow' (FN_AK)

45min BEFORE BOUNDARY PILOT LOGS ONTO AFN (EGGX)

FDP CHECKS REGISTRATION AND CALLSIGN THEN RESPONDS WITH ACKNOWLEDGE ACCEPT OR REJECT

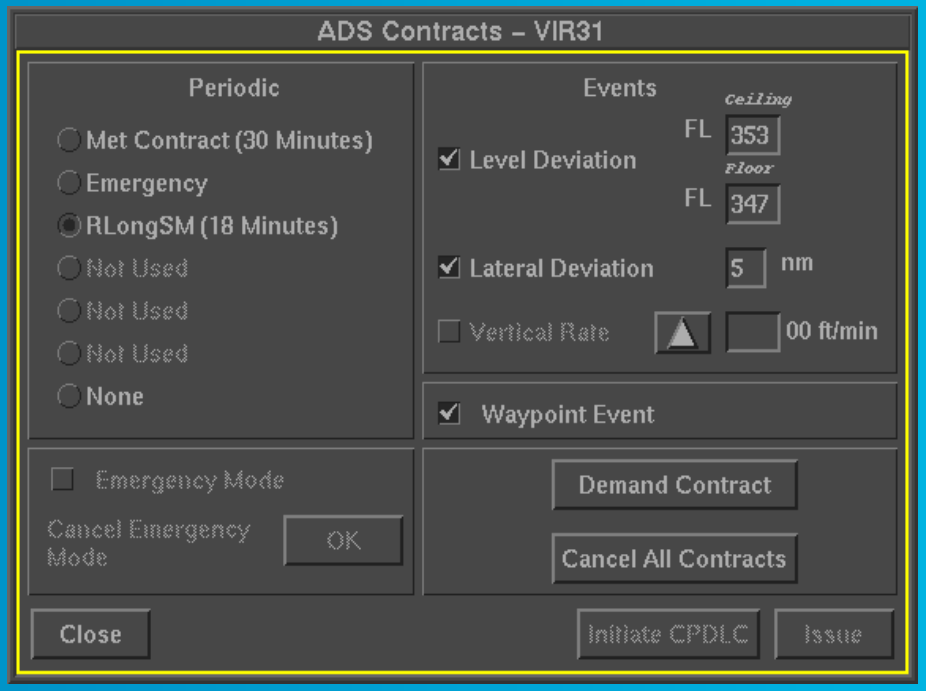

```
1000 FANS   AFN CONTACT WITH FLIGHT COA61   HAS BEEN ESTABLISHED
1000 FANS   AFN CONTACT RECEIVED FROM FLIGHT COA61
```

ADS

ISSUING OF CONTRACTS

Following a successful Logon, at defined times, all NAT ANSPs will issue contract requests to the avionics.

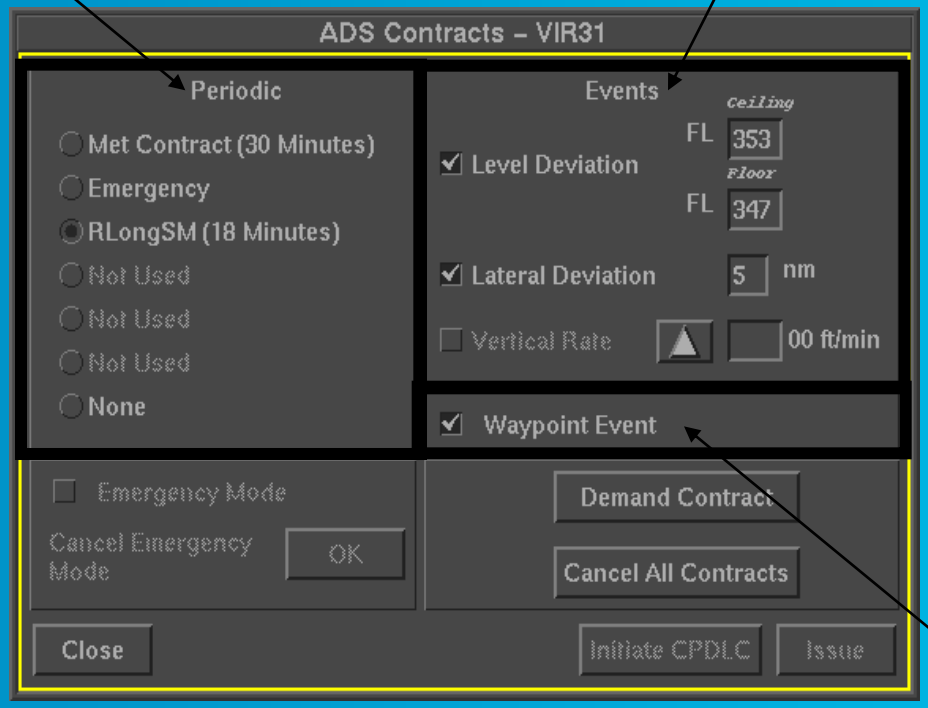
Contracts can be set manually by the Controller should it be required. This is done via the ADS Contracts Management Window.



ISSUING OF CONTRACTS

PERIODIC CONTRACT

EVENT CONTRACT



WAYPOINT CONTRACT

NATS

ISSUING OF CONTRACTS

WAYPOINT EVENT CONTRACT

Aircraft contracted to report passing waypoints entered in to FMS, and when any waypoint is changed by pilot. Issued 70mins prior to boundary from a domestic ACC, and 20mins from an oceanic centre.

WAYPOINT REPORT CONTENTS

Basic ADS Group. This consists of ACID, position (latitude, longitude, and altitude) and time stamp (minutes and seconds).

NEXT POS [estimate] – NEXT +1

Conformance Checked to the second by SAATS on receipt.

ISSUING OF CONTRACTS

PERIODIC CONTRACT

Aircraft contracted to make a position report at an agreed interval, this is set to 18 minutes in SAATS. (RLong) Issued 5 mins after entering Shanwick westbound and 5 mins before entering Shanwick eastbound.

PERIODIC REPORT CONTENTS

Basic ADS Group
MET Information
FOM (Figure of Merit = aircraft navigational status.)
If the FOM is below 4, a periodic report (or contract acknowledgment) will be sent directly to the controller and will not be applied.
Conformance checked by SAATS.

ISSUING OF CONTRACTS

SAATS will automatically issue a default periodic contract of 18 minutes. The controller can manually select the MET only contract if required, via the ADS Contract Window. This can be used to continue to provide MET information, but at a rate that prevents the flight from being eligible for RLong. (Default 18 minute periodic contract contains MET)

Note MET reporting is an ICAO requirement.

MET CONTRACT

Aircraft contracted to make a report at an interval of 30mins. Issued only after manual selection by controller.

PERIODIC REPORT CONTENTS

- Basic ADS Group
- MET Information

ISSUING OF CONTRACTS

The controller can send up a DEMAND contract. A DEMAND contract is basically a periodic contract of one which, each time is sent, will instruct the avionics to send an instantaneous report.

ISSUING OF CONTRACTS

Only a pilot can initiate the ADS-C Emergency Mode either by sending a MAYDAY via CPDLC or selection of the emergency Mode on the flight deck. This not only causes SAATS to issue a EMERGENCY Periodic Contract, but also sets the flight status to emergency.

EMERGENCY CONTRACT
Periodic rate of 10 minutes

EMERGENCY REPORT CONTENTS
Basic ADS Group
Predicted Route
Earth Reference

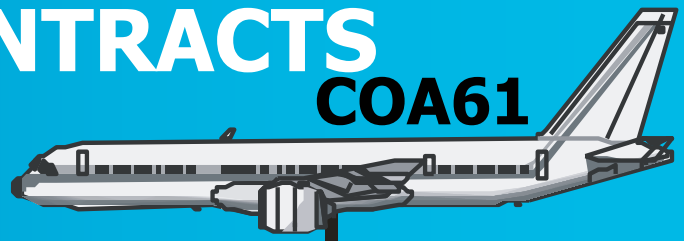
NATS

ISSUING OF CONTRACTS

ATSU

EGGX

COA61



EVENT CONTRACT ISSUED (waypoint)

FDP ISSUES EVENT CONTRACT (WAYPOINT)

AVIONICS RESPONDS WITH ACKNOWLEGMENT

EVENT CONTRACT ACKNOWLEDGED

1412 FANS FLIGHT SWR84T ACCEPTS THE EVENT ADS CONTRACT. CONTRACT NUMBER: 1
1412 FANS AUTO ADS WAYPOINT EVENT CONTRACT ISSUED FOR SWR84T.

VATS

ISSUING OF CONTRACTS

DEVIATION EVENT CONTRACT

Aircraft is contracted to output a position report whenever the flight drifts from its active flight plan stored in the FMC by either more than 5nm laterally from cleared route plus SLOP (up to 7nm), or more than 300ft vertically. Issued 5 mins after entering Shanwick.

DEVIATION EVENT REPORT CONTENTS

Basic ADS Group
Earth Reference

Deviation Contract (more detail)

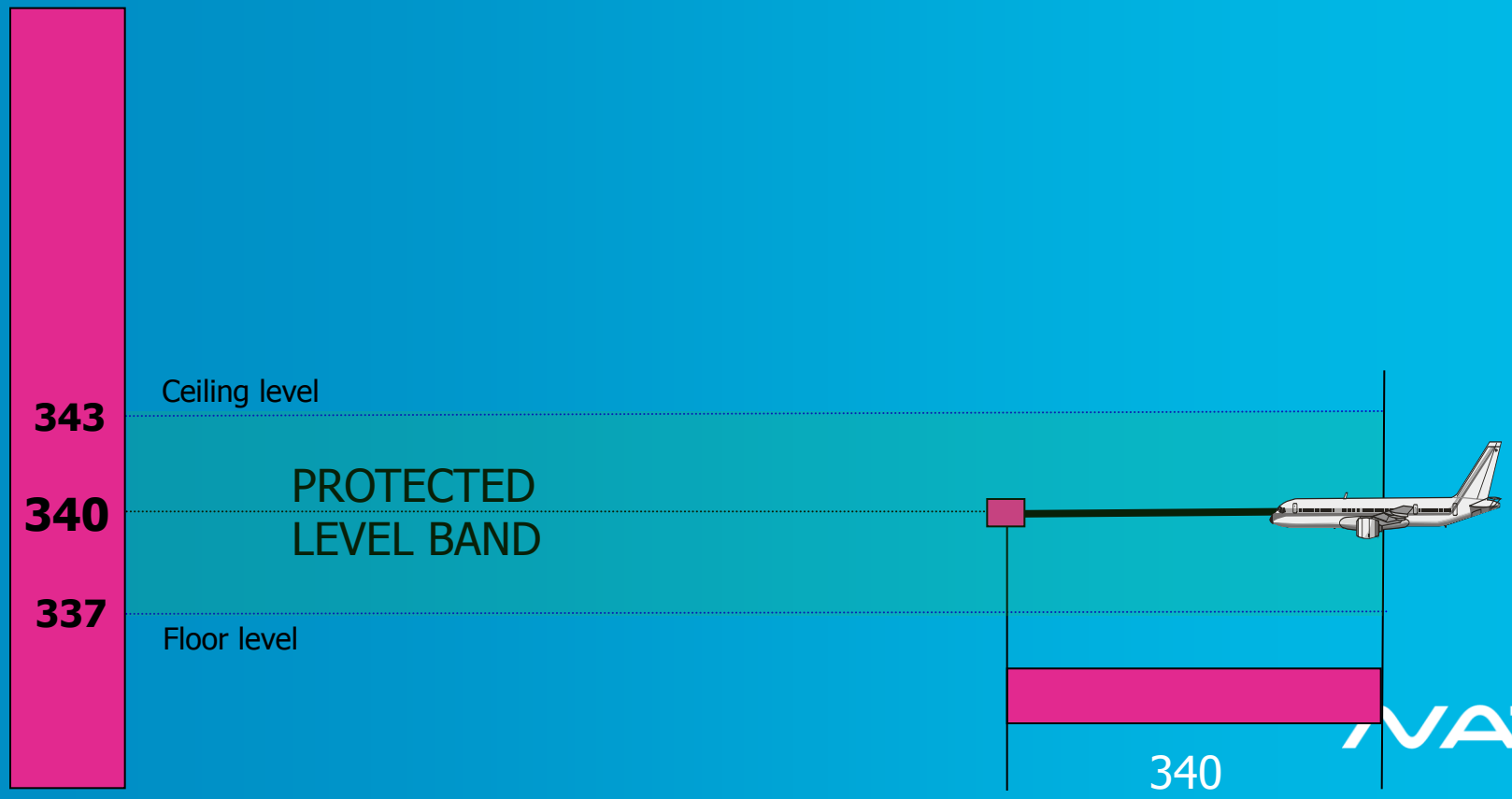
- A Lateral Deviation report triggered by the avionics is straightforward, and should rarely result in a non conforming position report, as flight has to either drift from its active flight plan route, or be manually taken off the route by 5nm.
- Following successful logon, SAATS automatically issues a vertical deviation event contract 300 ft above and below the cleared level in the flight plan in SAATS.
- Vertical Deviation reports will be more common, as it will be triggered either due to an unauthorised climb, or a level bust.
- The next few slides cover this datalink functionality in more detail.

NATS

Vertical Deviation Contract

INFO BOX

With the cleared flight plan in SAATS cleared at FL340, the EVENT contract parameter will set the avionics to output a position report if the aircraft drifts below FL337 or above FL343.

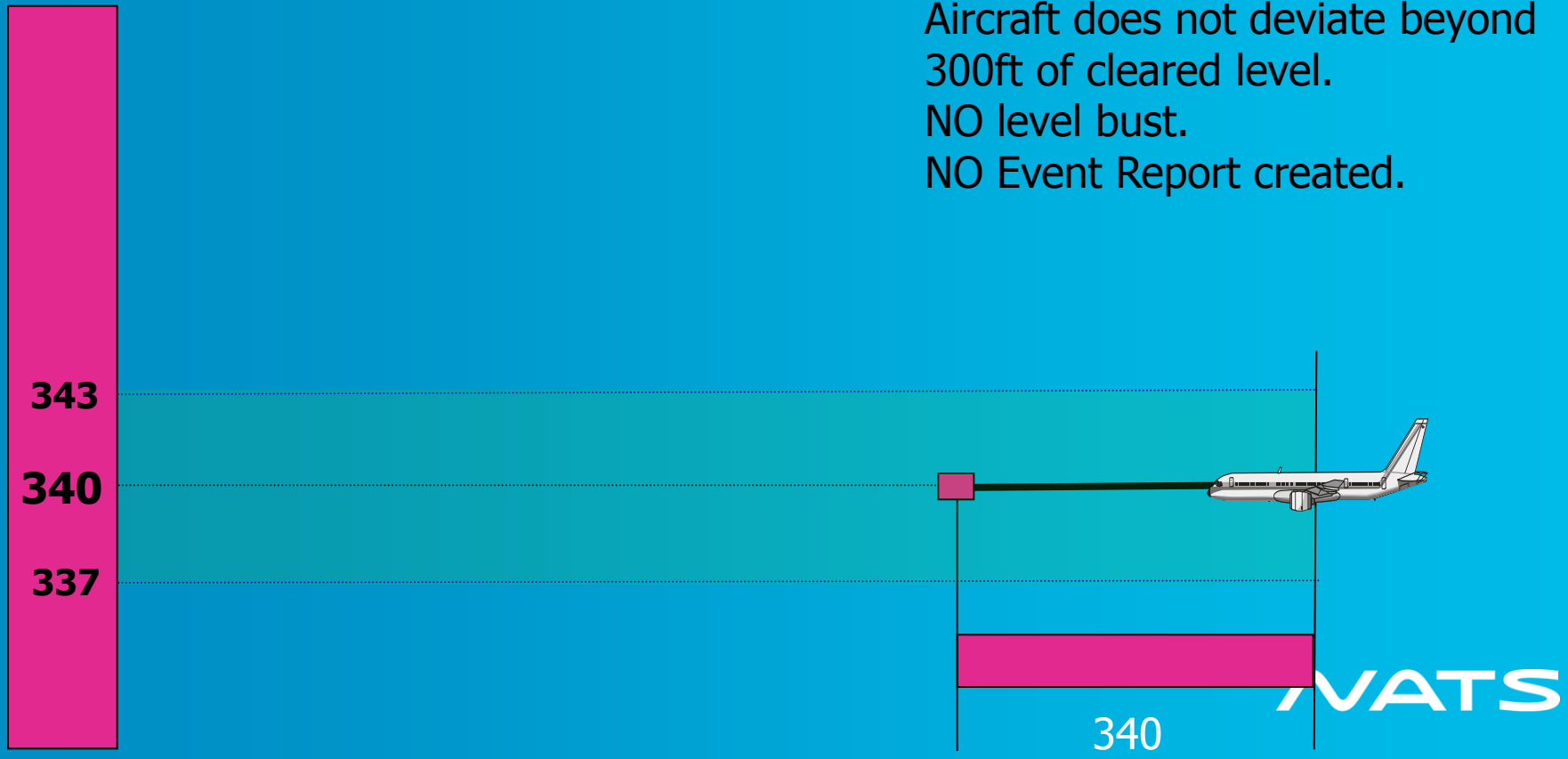


Vertical Deviation Contract

INFO BOX

The cleared Flight Plan in SAATS will be at FL340, therefore should the flight drift by more than 300ft, up or down, the controller will be alerted with an Event Report.

Aircraft does not deviate beyond 300ft of cleared level.
NO level bust.
NO Event Report created.



Vertical Deviation Contract

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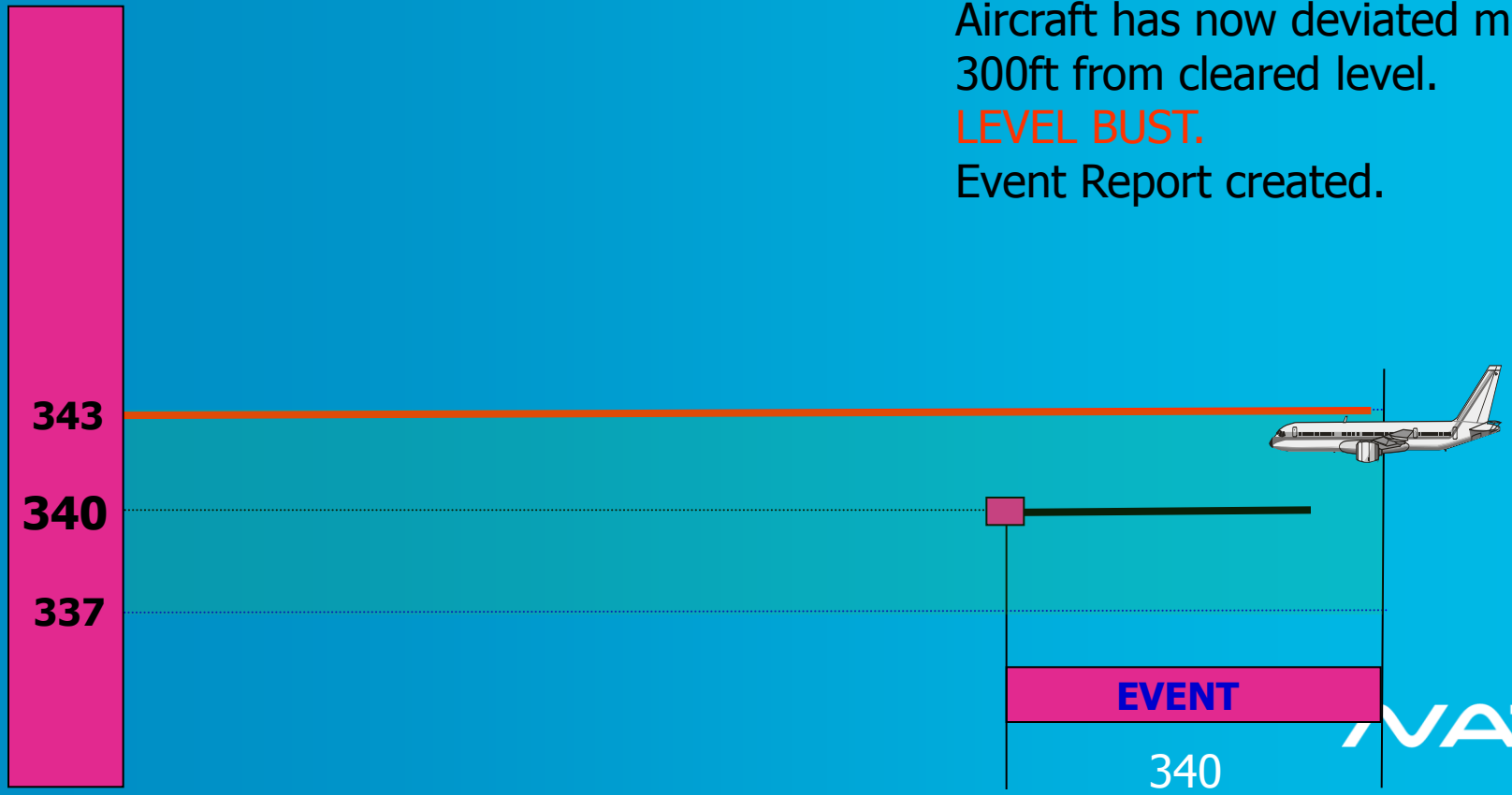
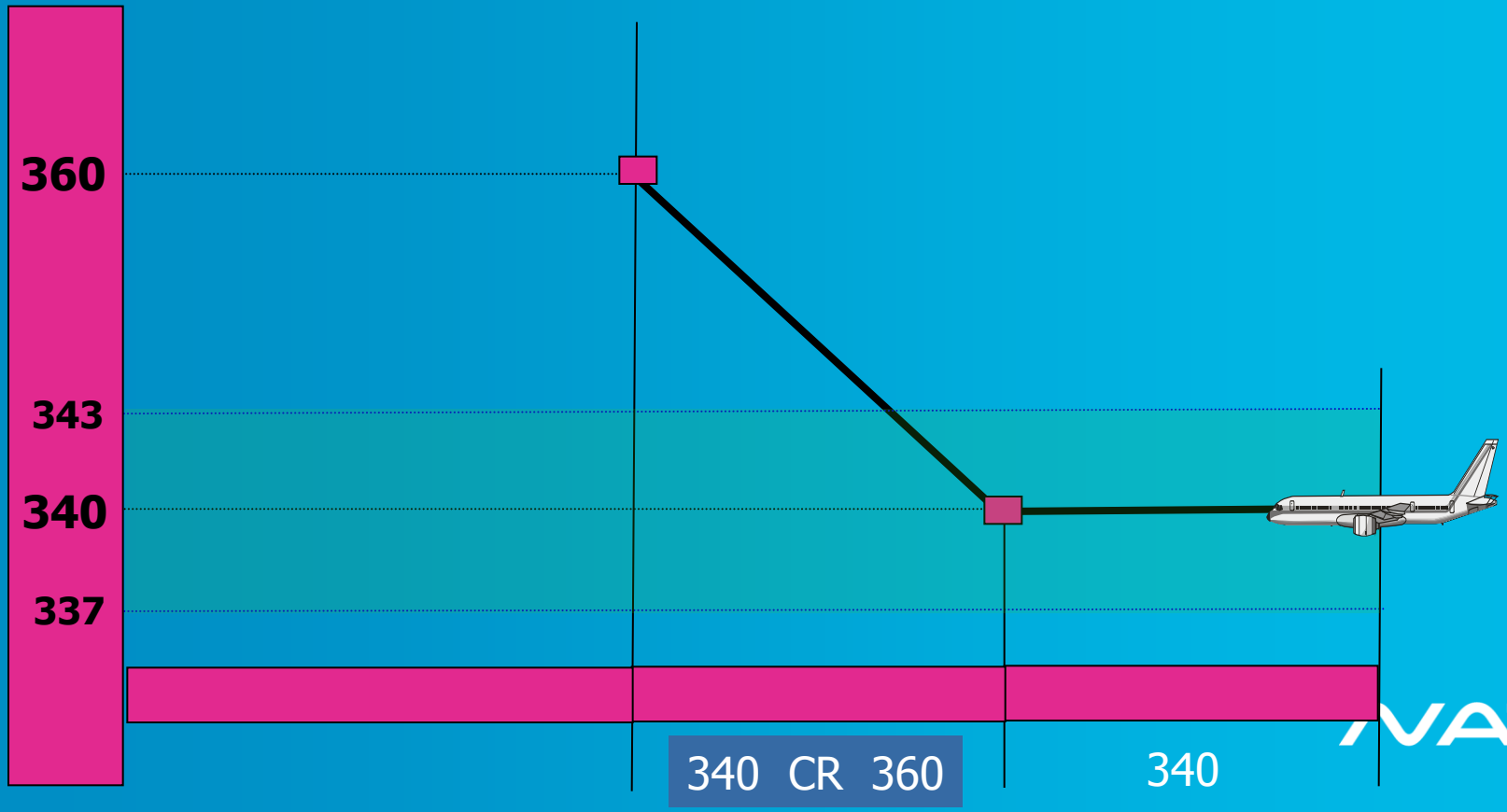


Aircraft has now deviated more than 300ft from cleared level.
LEVEL BUST.
Event Report created.

Vertical Deviation Contract

INFO BOX

Clearance from SAATS to climb from FL340 to FL360 is issued to the flight. Note that this does not cause SAATS to send up another vertical deviation contract.



Vertical Deviation Contract

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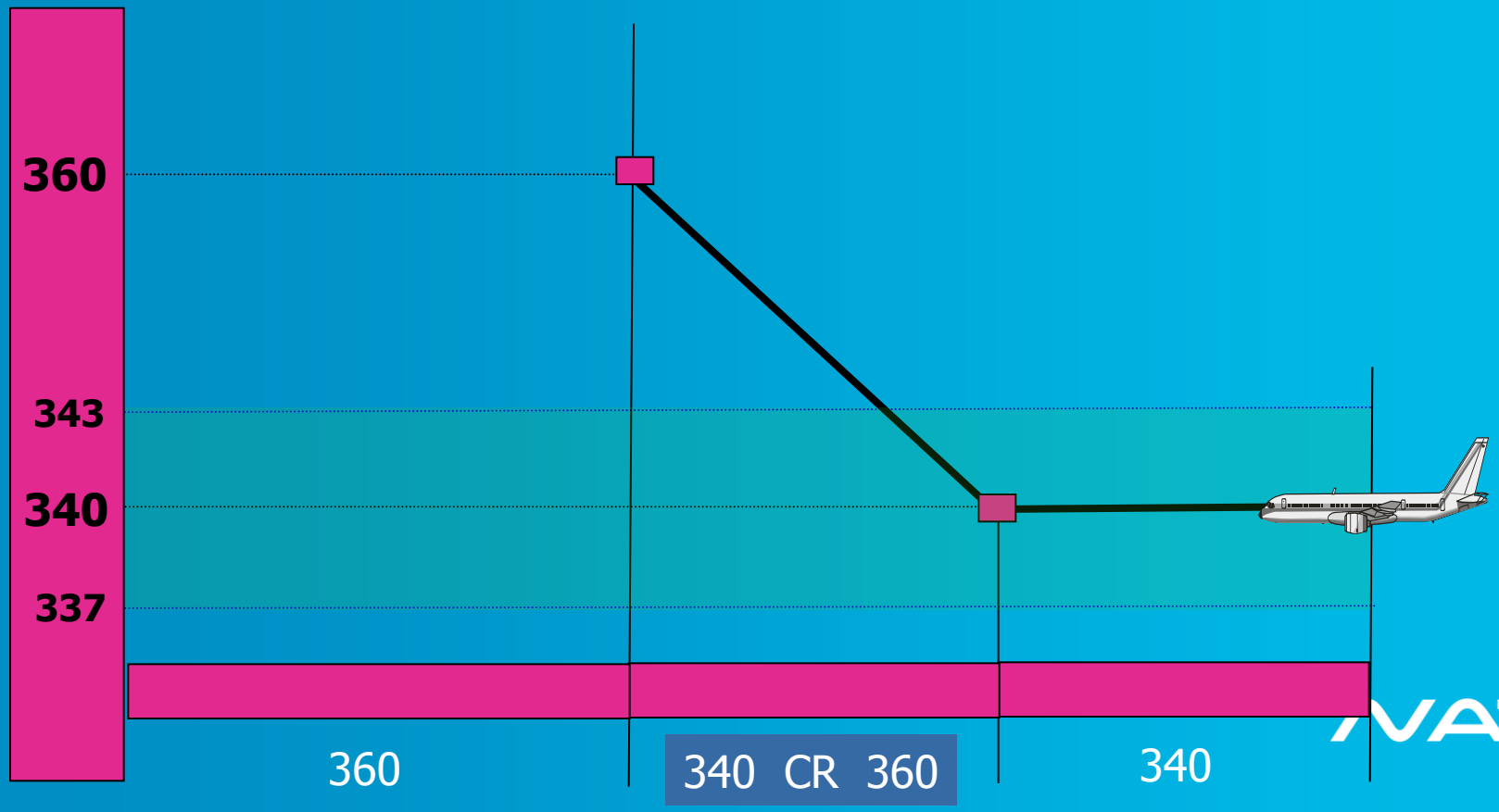
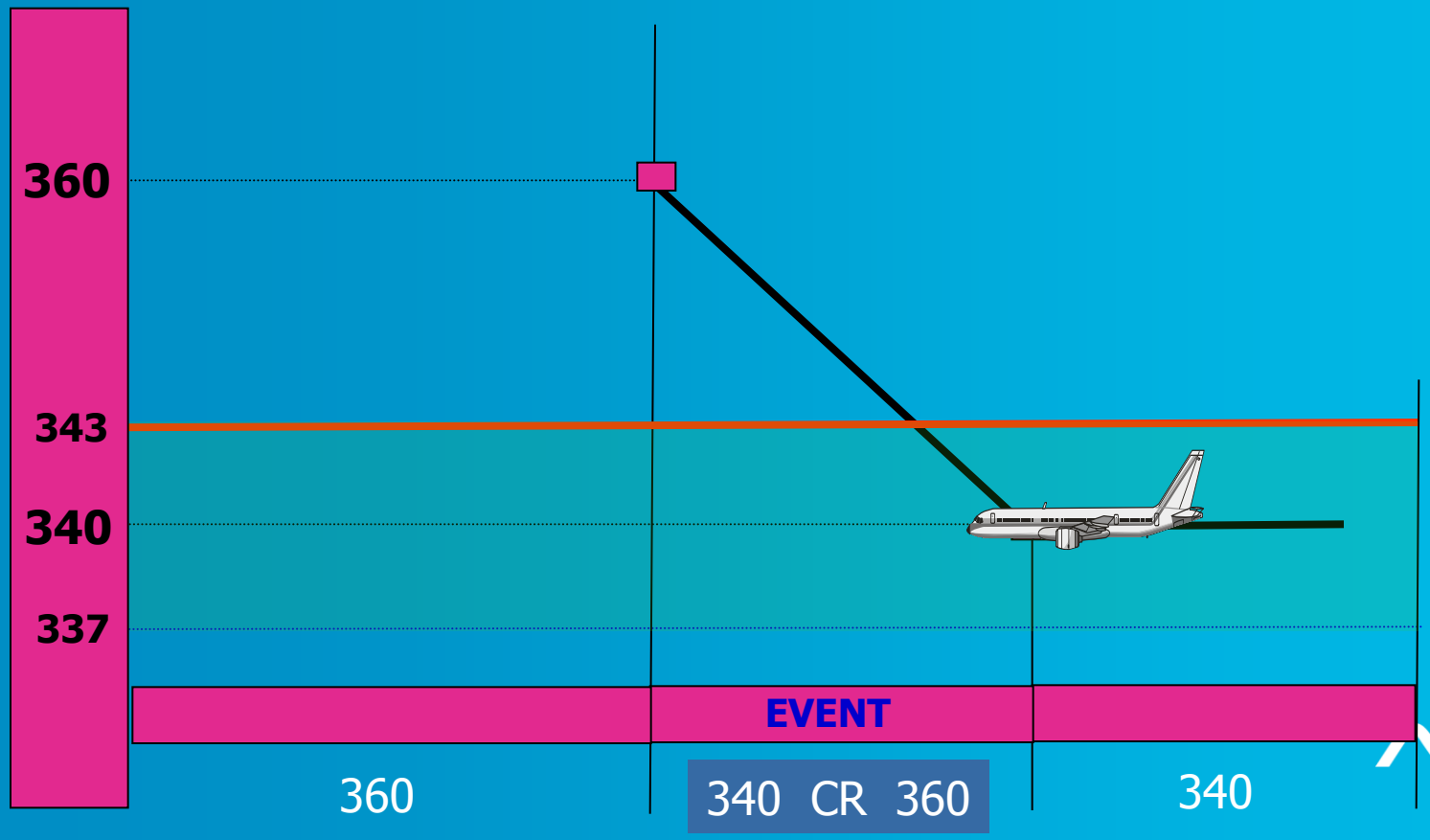


Vertical Deviation Contract

INFO BOX

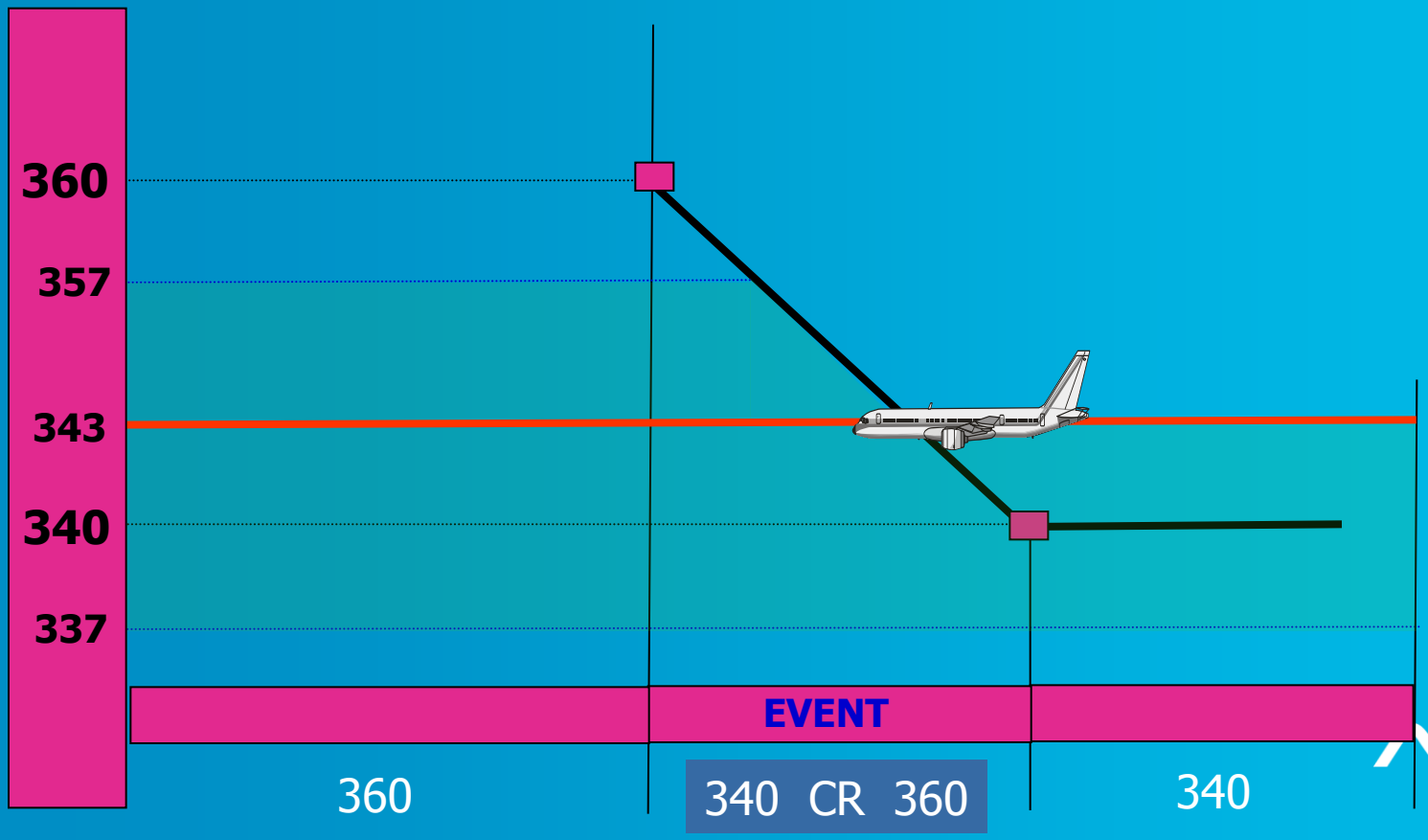
However, when the flight goes through FL343 as per the clearance, it will trigger an EVENT report. SAATS will cross check this against the cleared flight plan, and see that a clearance to FL360 has been issued, and therefore only go into the flight history, not forwarded to message queue as a warning.



Vertical Deviation Contract

INFO BOX

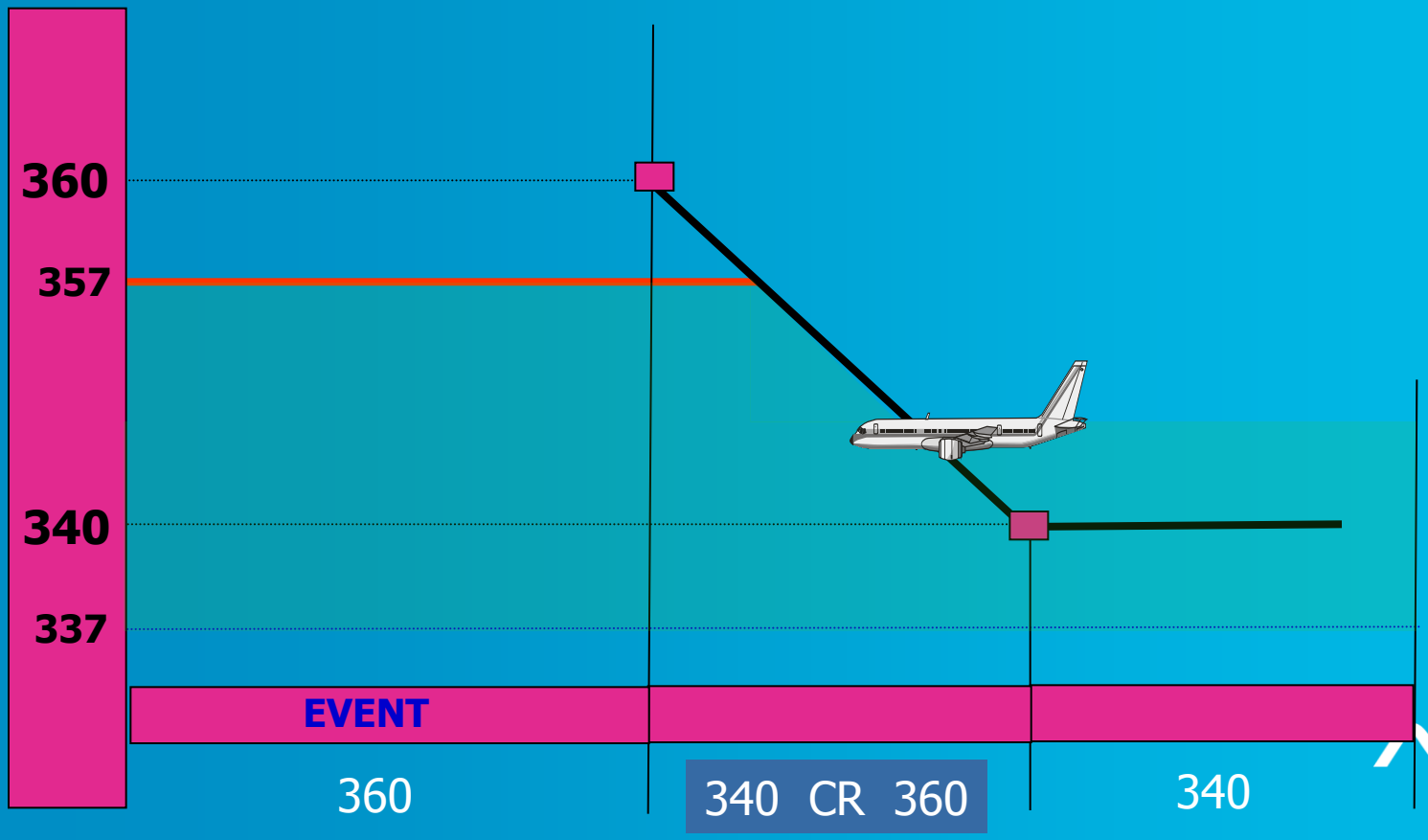
This then causes SAATS to automatically issue another EVENT contract, with a new upper level. This new level will be 300ft below the final cleared level, which in this case is FL357.



Vertical Deviation Contract

INFO BOX

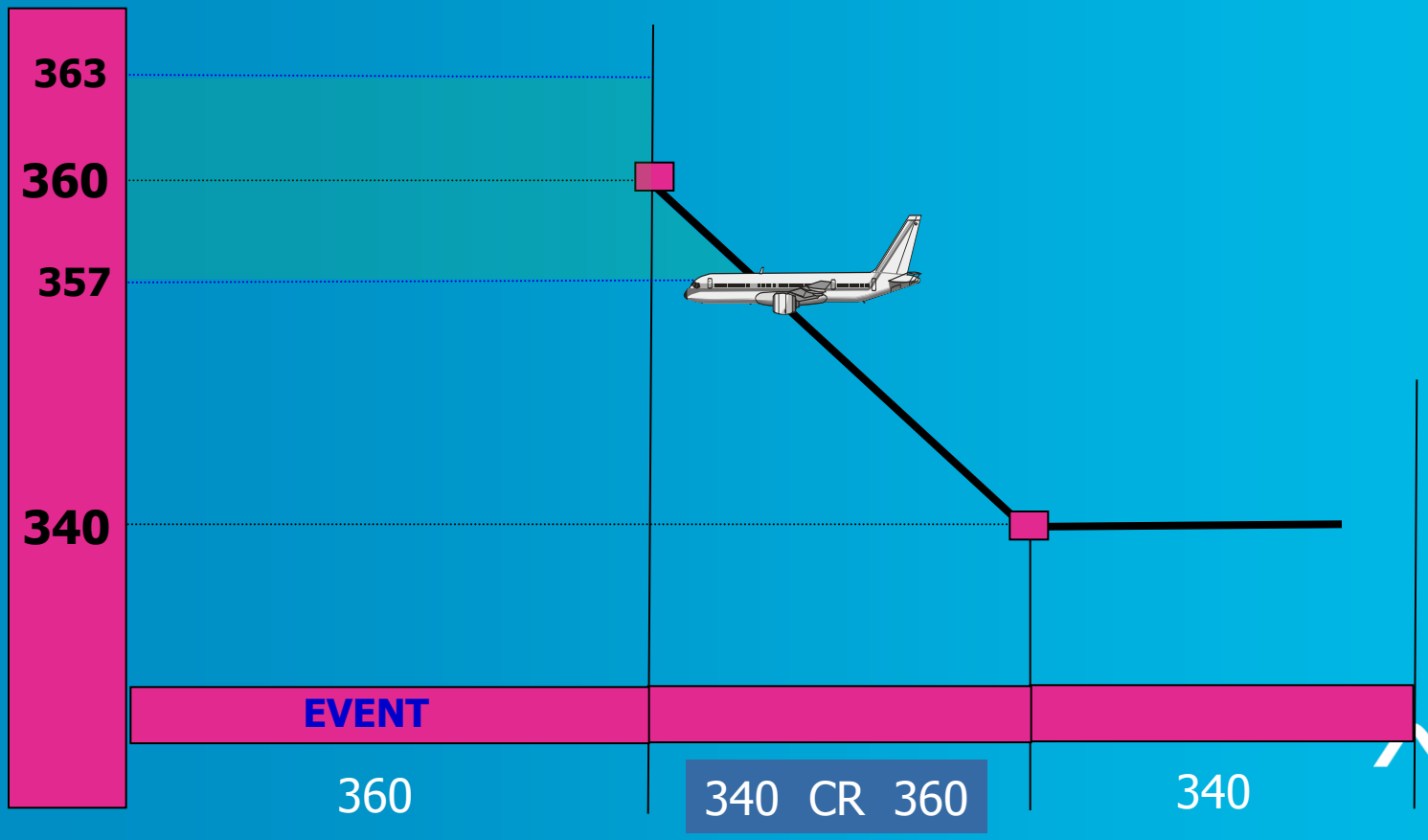
When the flight passes through FL357, it again causes the avionics to send an EVENT report. SAATS checks this again, inserts the details in the history, and sets up another EVENT contract which protects the final cleared level FL360, by setting the vertical parameter to FL363 and FL357.



Vertical Deviation Contract

INFO BOX

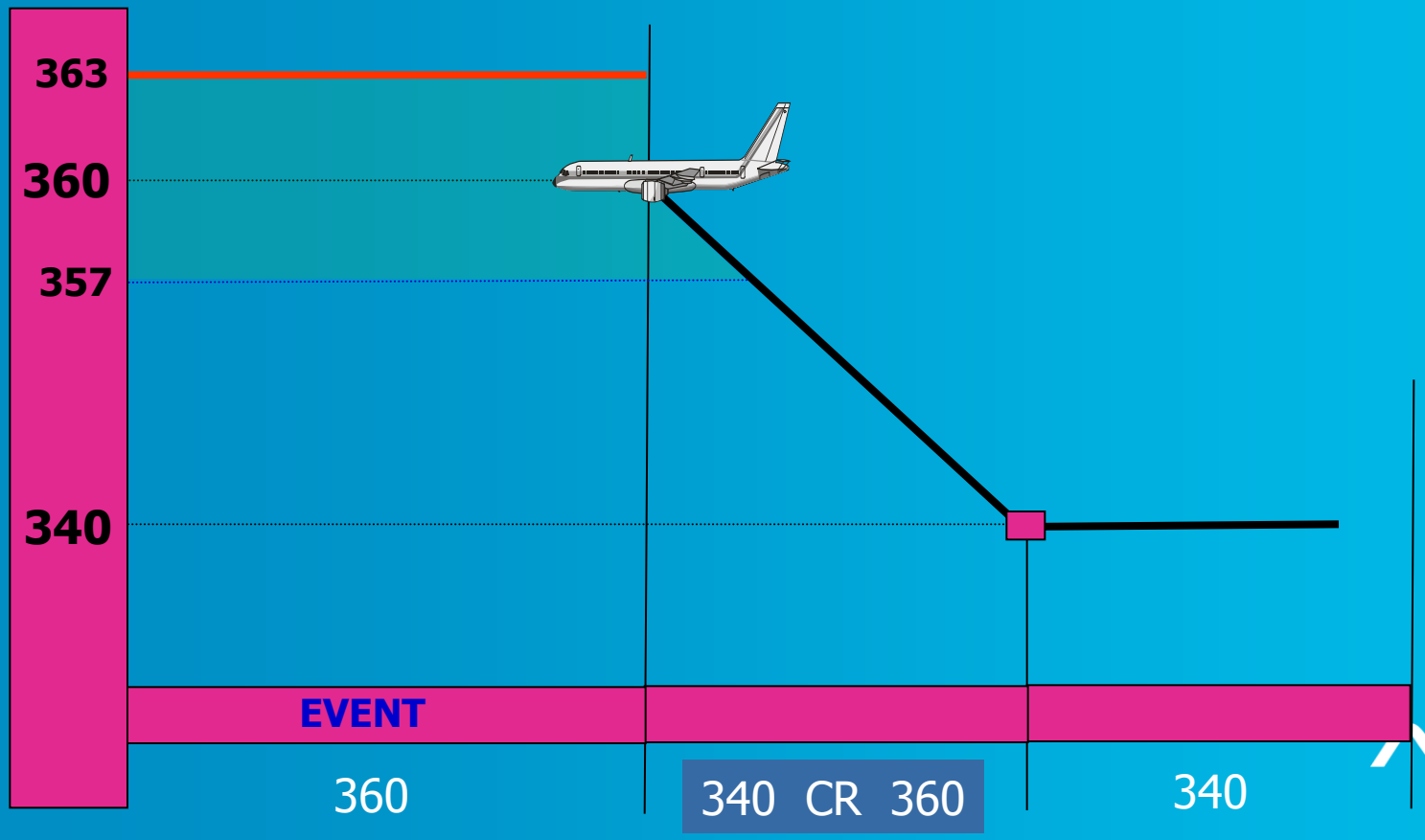
When the flight passes through FL357, it again causes the avionics to send an EVENT report. SAATS checks this again, inserts the details in the history, and sets up another EVENT contract which protects the final cleared level FL360, by setting the vertical parameter to FL363 and FL357.



Vertical Deviation Contract

INFO BOX

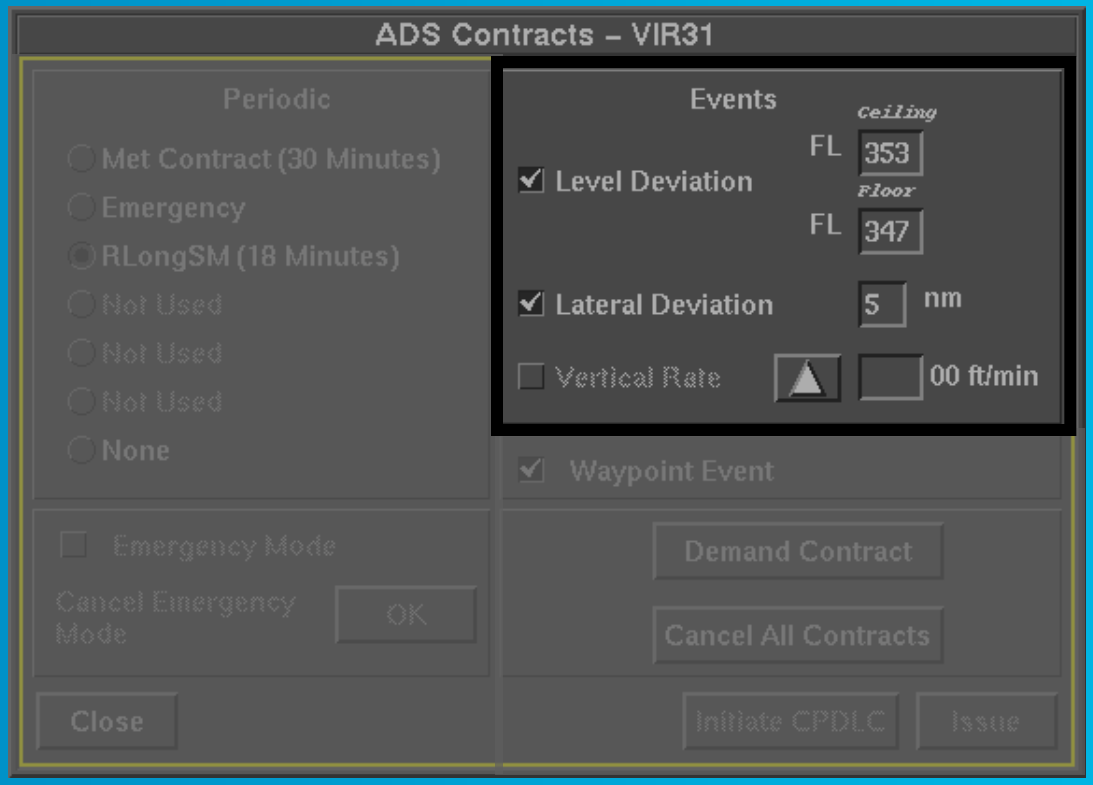
Should the flight continue his climb incorrectly (LEVEL BUST), then the avionics will be triggered again. This time the EVENT report does not conform with the cleared flight plan in SAATS which is FL360, and sends the report as a Conformance Alert to the controller.



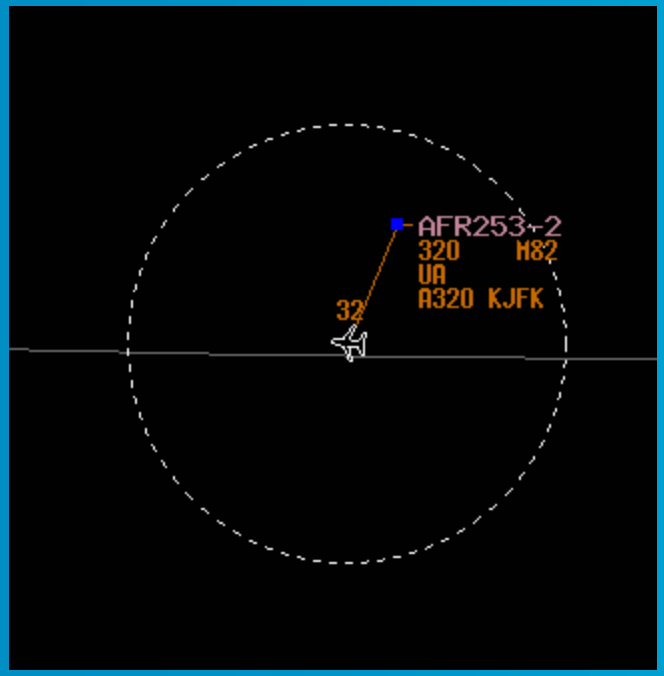
Vertical Deviation Contract

INFO BOX

Both Lateral and Vertical deviation EVENT contracts are normally handled automatically by SAATS, however these can be adjusted manually in the ADS Management Window. Note that they cannot be set to a value less than 5nm lateral, and 300ft vertical.



Non Conformant Report



- A non conformant ADS-C report will create a Copy version of the flight plan in our system.
- The non conformant position will be entered into the flight plan route as a waypoint for separation probe purposes and an alert placed in controller's message queue
- A graphical symbol is highlighted to show last reported position that was out of conformance.

CPDLC

CPDLC CONNECTIONS

CDA Current Data Authority

An aircraft can only have one current data authority, that is the ATSU that the flight logged onto, and who sent a connection request (CR1) up, as long as the avionics did not already have a CDA at the time.

It is the only authority that the aircraft can communicate with via CPDLC

NATS

CPDLC CONNECTIONS

NDA Next Data Authority

This is the authority that the aircraft will be told, via the NDA process, will be the next data authority that it will communicate with (the next CDA).

When that new authority (NDA) sends up the connection request (CR1), it will be accepted and the avionics sets a technical flag accordingly, which will only allow comms to take place when the current authority sends an end service message.

NATS

CPDLC CONNECTIONS

NDA Next Data Authority

If the flight logs onto another ATSU (FN_CON) but which has not been told will be the NDA, and it has a CDA in place, then the connection request sent up by that unit (CR1) will be rejected.

ATSU

CZQX

COA61

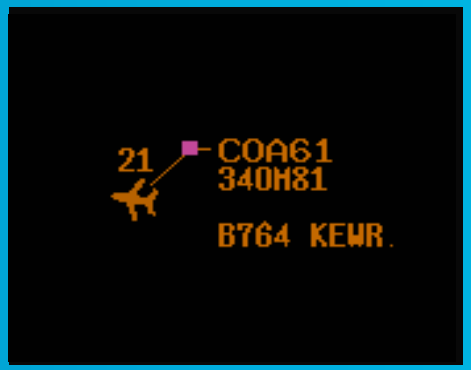
CDA=EGGX
NDA=none

CPDLC CONNECTION REQUEST CR-1

CONNECTION REQUEST SENT UP BY CZQX WHO ARE **NOT** THE NDA

AVIONICS WILL REJECT THE CONNECTION REQUEST

CPDLC CONNECTION CONFIRM CC-1



NATS

ATSU

CZQX

COA61

CDA=EGGX
NDA=CZQX

CPDLC CONNECTION REQUEST
CR-1

CONNECTION REQUEST SENT UP BY CZQX WHO **ARE** DESIGNATED THE NDA

AVIONICS RESPONDS WITH CONFIRM

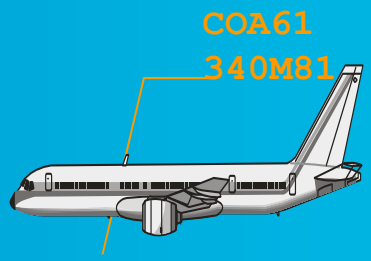
CPDLC CONNECTION CONFIRM
CC-1

1423 FANS CPDLC CONNECT CONFIRM RECEIVED FROM FLIGHT SWR84T
1423 SAATS CPDLC - SWR84T - [EGPK] [labelA]

VATS

GANDER

SHANWICK



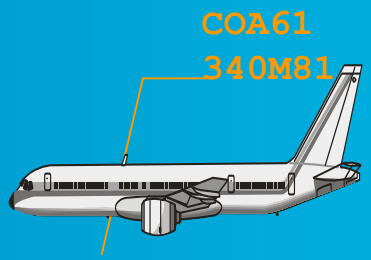
CPDLC

CDA – EGGX

GANDER

SHANWICK

NDA = CZQX



CPDLC

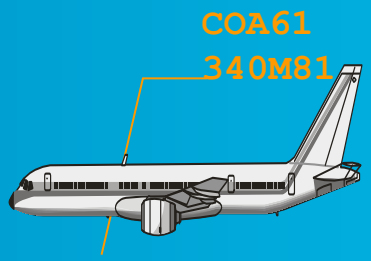
CDA – EGGX
NDA - CZQX

NATS

GANDER

SHANWICK

CZQX CR1

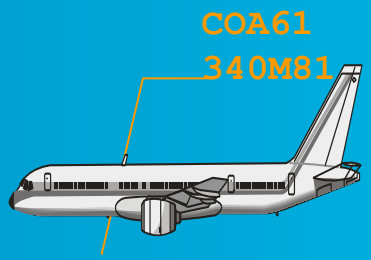


CPDLC

CDA – EGGX
NDA - CZQX

GANDER

SHANWICK



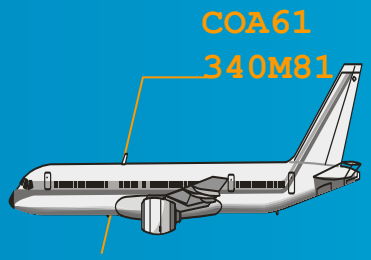
CPDLC

CDA – EGGX
NDA - CZQX

GANDER

SHANWICK

END SERVICE



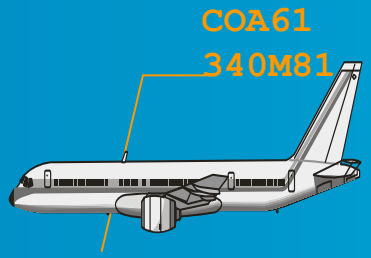
CPDLC

CDA – EGGX
NDA - CZQX

NATS

GANDER

SHANWICK



CPDLC

CDA – CZQX

DATA LINK TRANSFER PROCESS

NATS

ADDRESS FORWARDING

Address forwarding is used to instruct the avionics to forward the aircraft's application addresses to a particular ATS unit. This consists of sending an FN Contact Advisory **(FN_CAD)** which contains the address of the ATSU. This process is completely invisible to the flight crew.

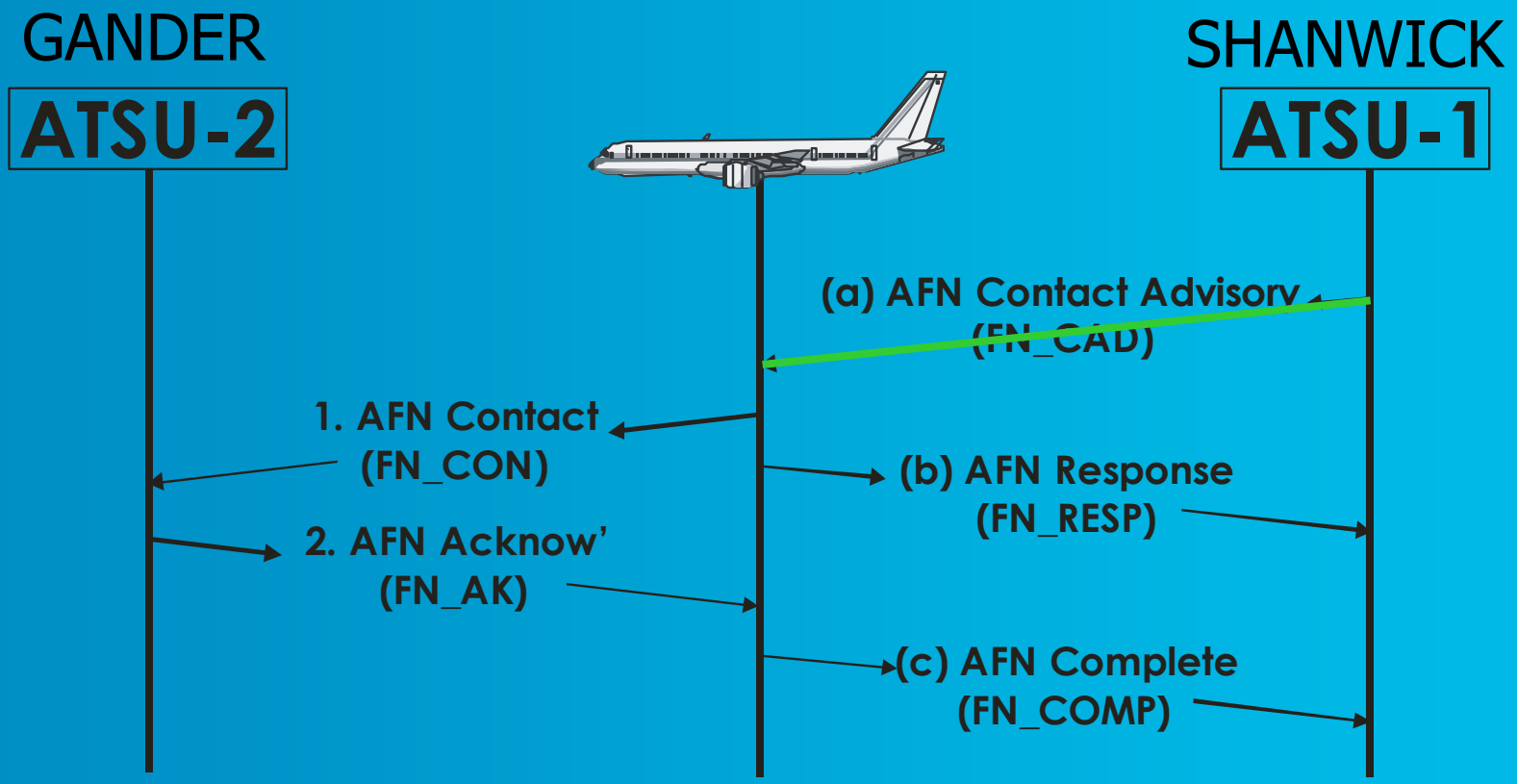
On receipt of this address, the avionics will automatically trigger the FN_CON with that unit.

Note that at no point will an aircraft be disconnected from an ATSU without having established contact with the next ATSU.

Following diagram explains.

NATS

1521 SAATS AFN CONTACT ADVISORY YQXE2YA



20 minutes prior to boundary exit estimate, SAATS sends an FN_CAD (Facilities Notification Contact Advisory Message)

This contains the address of who the aircraft is to contact

```
1521 FANS   AFN RESPONSE RECEIVED FOR AUTO AFN CONTACT ADVISORY FOR ACA875
            GOING TO CZQX
1521 SAATS  AFN CONTACT ADVISORY YQXE2YA
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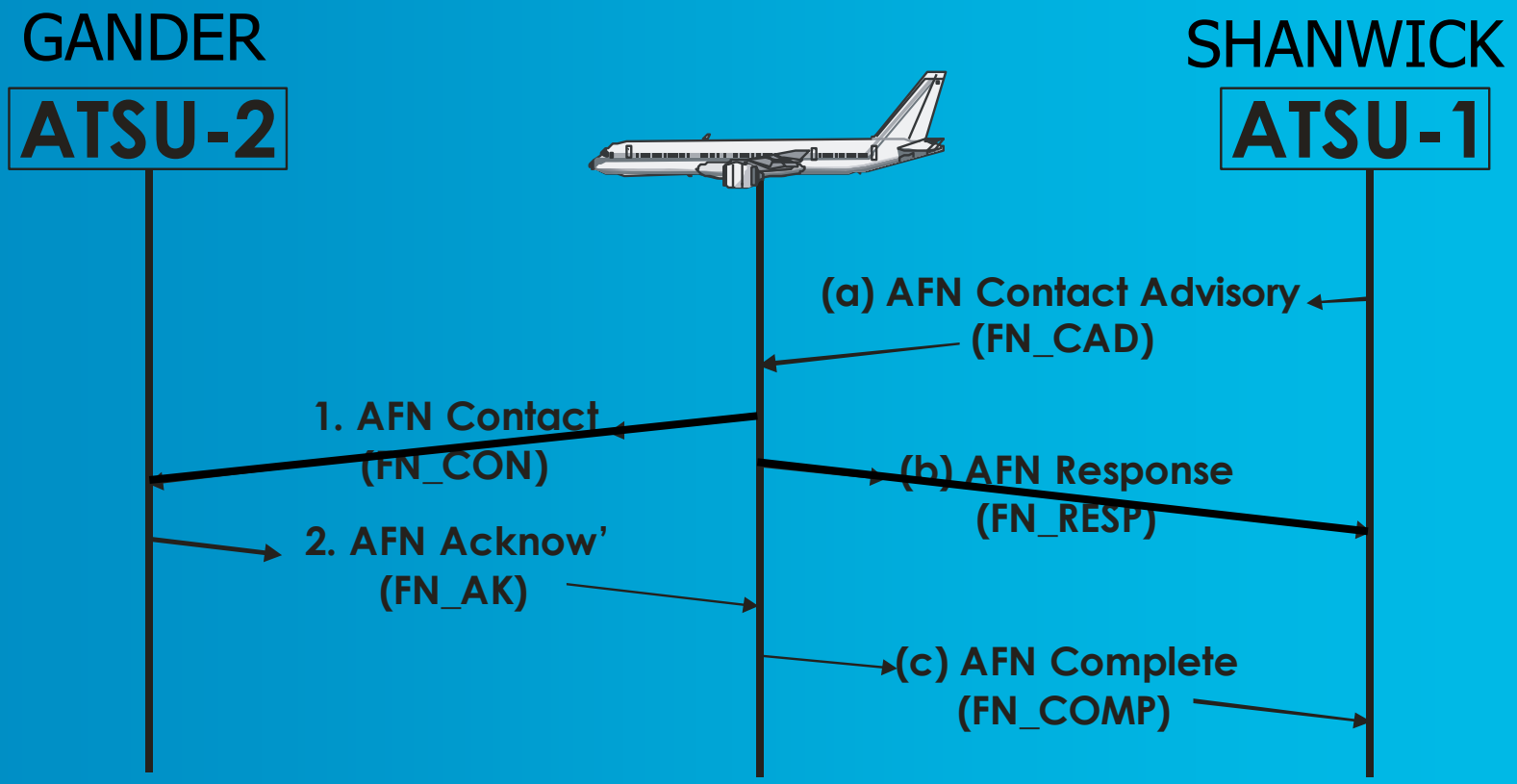
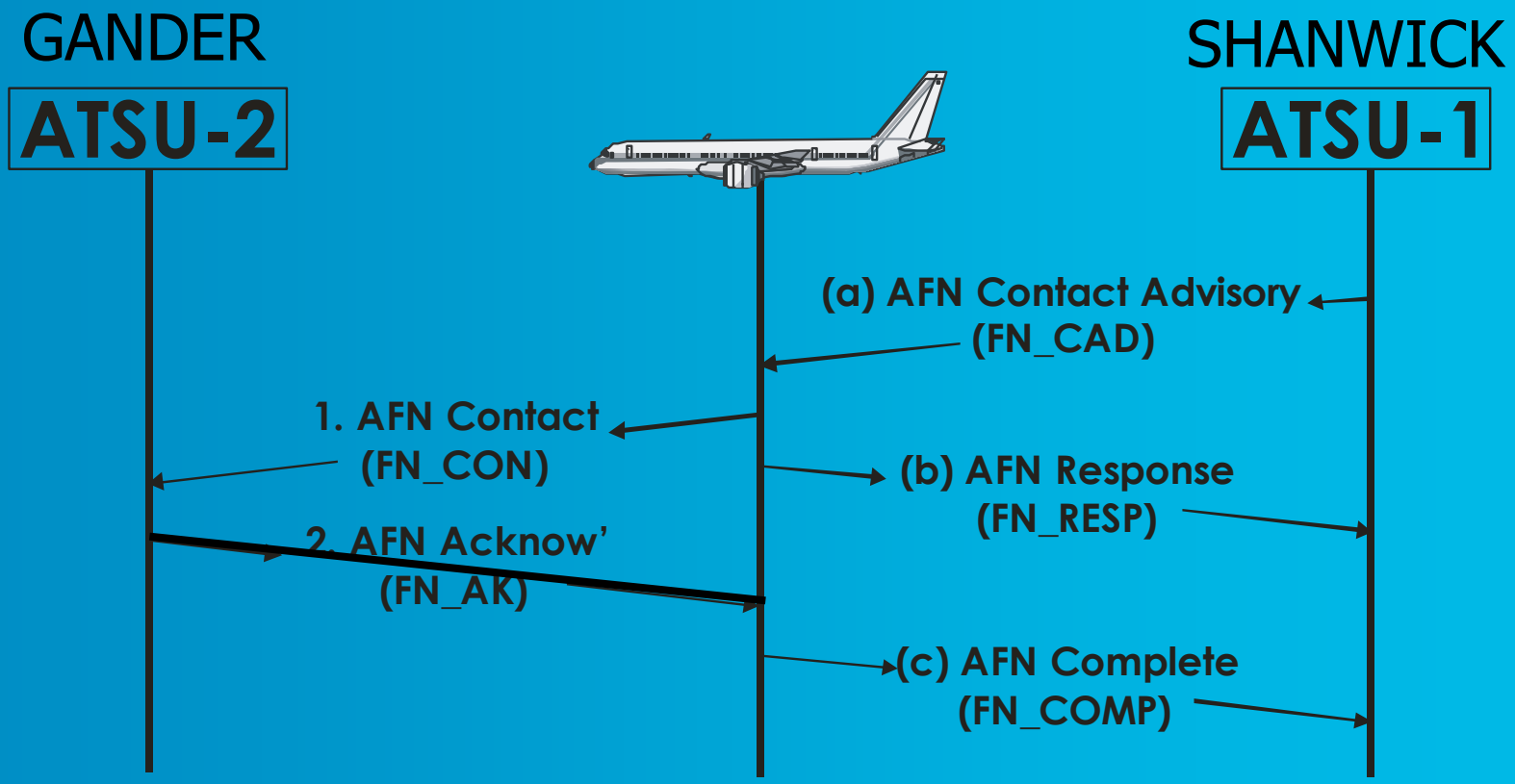


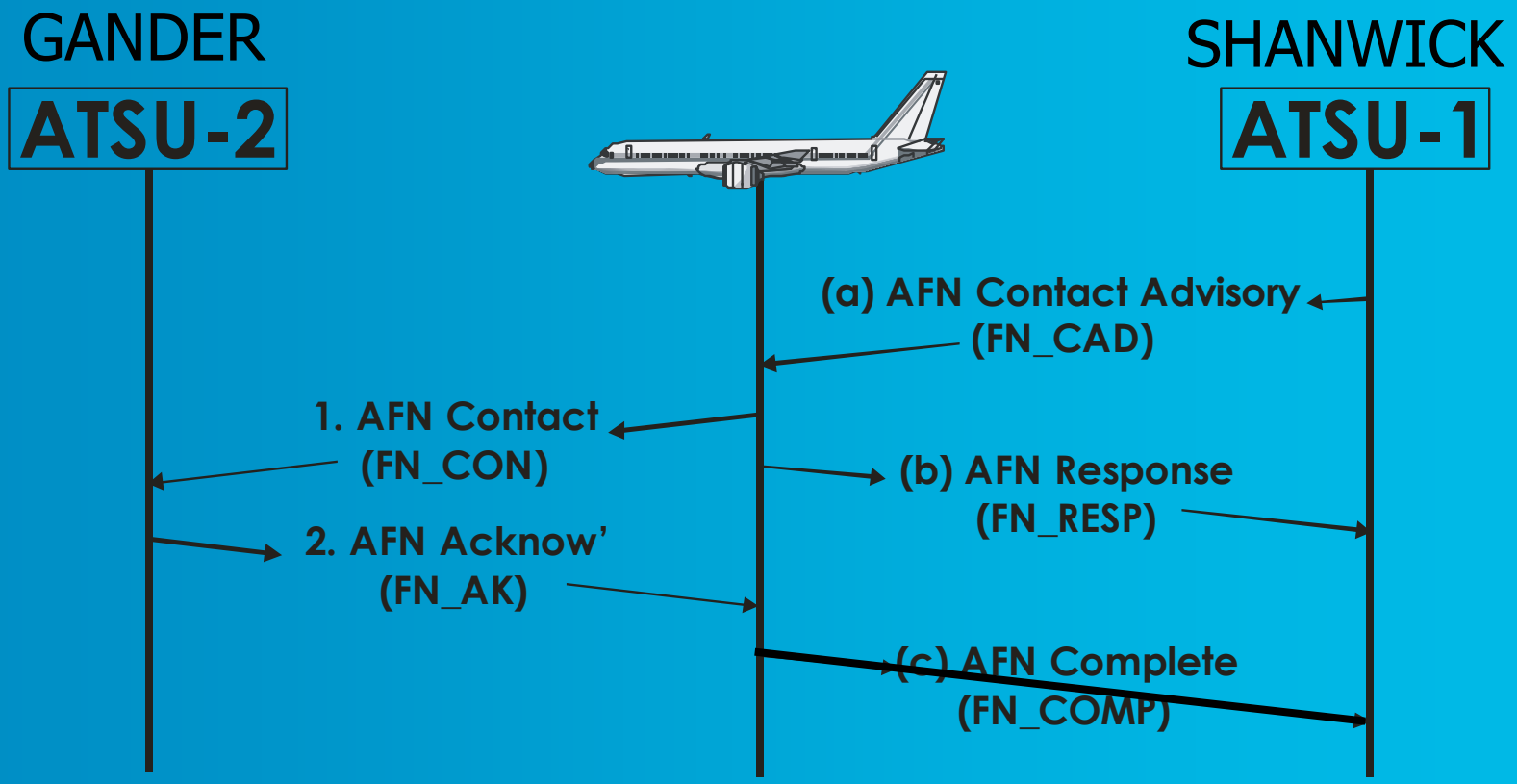
When received the aircraft sends a response to SAATS to tell it that it is sending an FN_CON to (Gander)



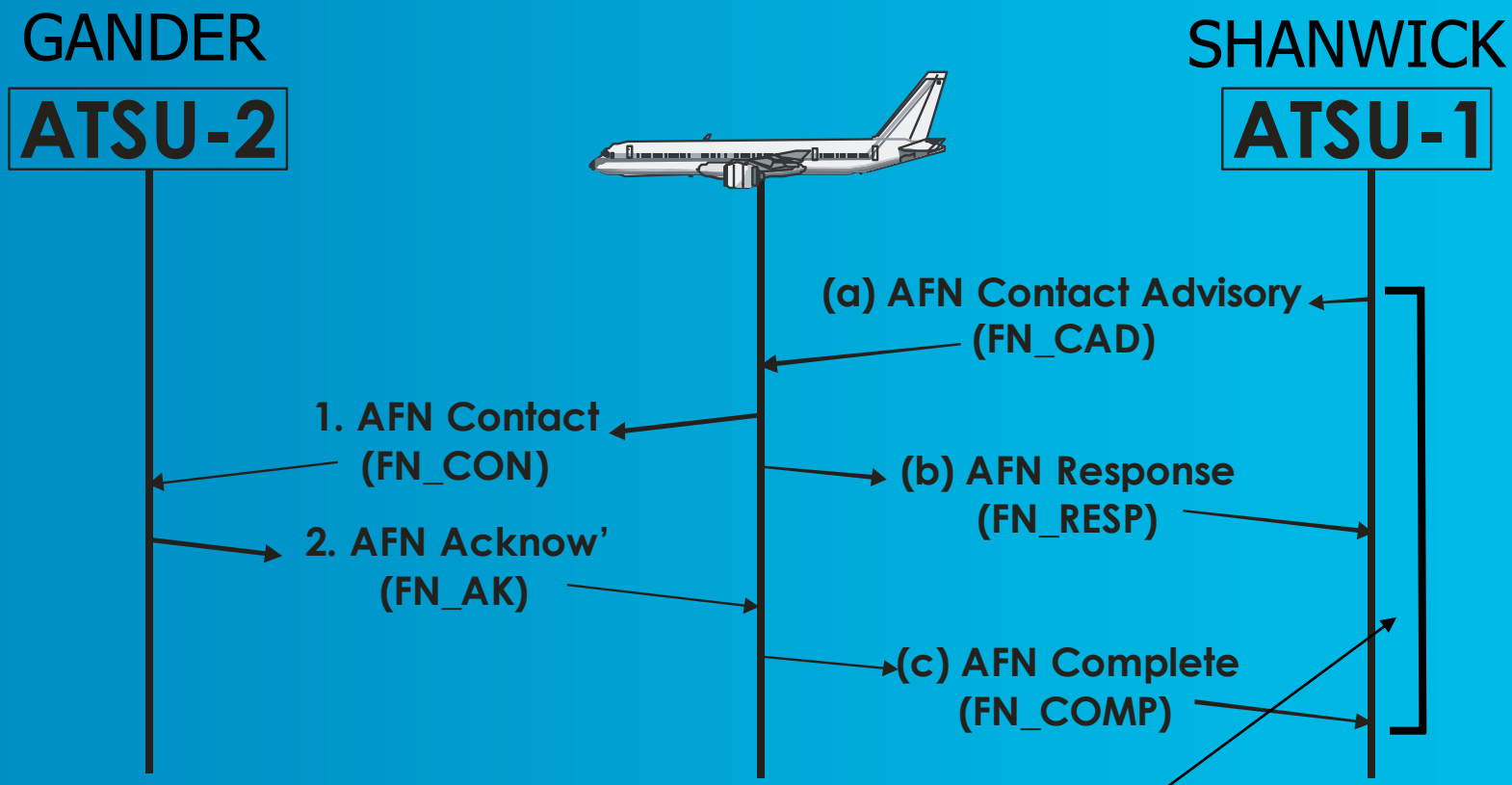
Upon receiving the FN_CON, GAATS will do the same checks against callsign and registration SAATS did.

And when successful, GAATS will send an ACK message to the aircraft.

1522 FANS AFN COMPLETE RECEIVED FOR FLIGHT ACA875 GOING TO CZQX



This will in turn cause the aircraft avionics to send a FN_COMP message (Facilities Notification Complete), which tells SAATS that the FN_CAD has been successful.



The receipt of an FN_COMP message is monitored by SAATS, and if nothing is received within an adaptable time, a warning indicating that the address forwarding has failed will be output, requiring controller to send the "AT BDY SELECT ATC COMM OFF……" message, ensuring flight makes datalink contact with the ATSU upon passing the boundary.

NATS

RLongSM Issue Criteria

- Flights are MNPS Certified
- Periodic (18 mins) contracts suitable for RLongSM are in place
- Flights have an active CPDLC connection

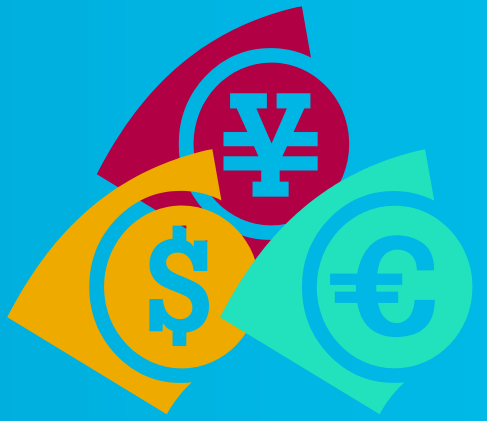
- When RLongSM becomes standard and has associated RCP/RSP then our systems will use this to determine whether or not flight meets the criteria to be separated by RLongSM.

NAT Region Datalink Mandate

- In 2005, NAT SPG made a strategic decision to mandate the use of FANS in the NAT from 2015 to coincide with dates for the ICAO EUR Datalink Implementation Rule
- Agreed to introduce DLM Airspace in two phases
- IMG agreed that introduction will be done with more than two phases
- Phase 1 (one OTS track, FL360-390) introduced February 2013
- Discussion underway on phase 2 staging and scope

Influencing Factors for Phase 2 Planning

Safety



Profitability

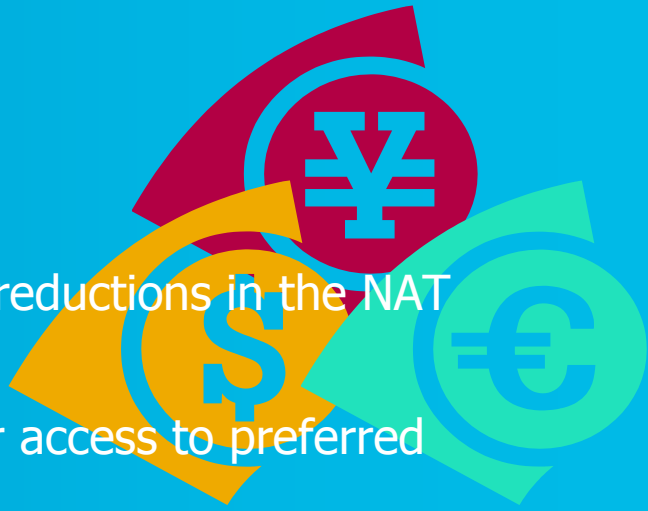
Future Development

NATS

Impact on Safety Performance

- FAA Report to SARSIG 16 identified FANS as offering major reductions to time spent at wrong level
- Time spent at wrong level is the greatest safety risk in NAT operations (currently, vertical risk exceeds target by around a factor of 10 or more)
- So FANS is seen as critical to managing NAT safety performance
- Overly flexible exemptions from FANS equipage reduce the scope for improving safety performance

Impact on Airline Profitability



- FANS is fundamental to the provision of separation reductions in the NAT (RLongSM, RLatSM)
  - Provides benefits to airlines in the form of better access to preferred levels and routes
- So, for FANS-equipped flights, benefits are improved safety plus reduced fuel burn
- Certain aircraft cannot be economically fitted with FANS (near end of life, rarely operate on the NAT, etc.)
- Challenge for phase 2 is to strike the balance between providing benefit to equipped flights while mitigating impact on non-equipped flights
  - If too much of the NAT area or too many flights are exempted, safety benefits and fuel benefits for equipped flights will be reduced
  - If too little mitigation is provided for non-equipped flights, they may become uneconomical to operate

NATS

Impact on Future Developments

- Future NAT service improvements are dependent on use of ADS and CPDLC
- Maximised use of FANS creates the opportunity for a substantial contraction in HF provision, with consequent savings to airlines
- A long-duration, extensive exemption limits the scope for achieving benefits
- An overly-flexible exemption could disincentivise airlines from equipping and further delay the full realisation of potential benefits

Phase 2 Mandate Options

- Options Phase 2+:
  - Level bands
  - Geographical areas or routes

  - Note that there is no exemption cell for the NAT therefore accommodation can only be achieved by leaving areas available for non equipped aircraft to operate.

Phase 2 Mandate Options

- Level Bands
  - Introduce a level band over most of the MNPS area at (say) FL360-390
  - Subsequent stages would extend the level band to (say) FL340-390, then FL280-410
- Geographical Area
  - 340-390 levels on the OTS, and subsequent stages may expand in the vertical and horizontal planes
  - Areas where ATS Surveillance is available or where datalink coverage is not available (North of 80N) will be exempt.

Balancing Issues

- Achievement of mandate objectives:
  - Safety benefits
  - Fuel benefits
  - HF regression
- Airline costs
  - Nugatory expenditure on end-of-life aircraft
  - Inadequate ROI on flights which don't normally operate on the NAT
- Fairness to airlines who have invested
  - Many airlines have heavily invested in FANS as a result of the mandate
  - They expect to see the FANS-enabled developments rolled out so they can achieve a return on their investment

NATS