e-Aircraft™
Nose-to-Tail Solutions

ADS-C/CPDLC Workshop

ICAO ESAF

November 2015

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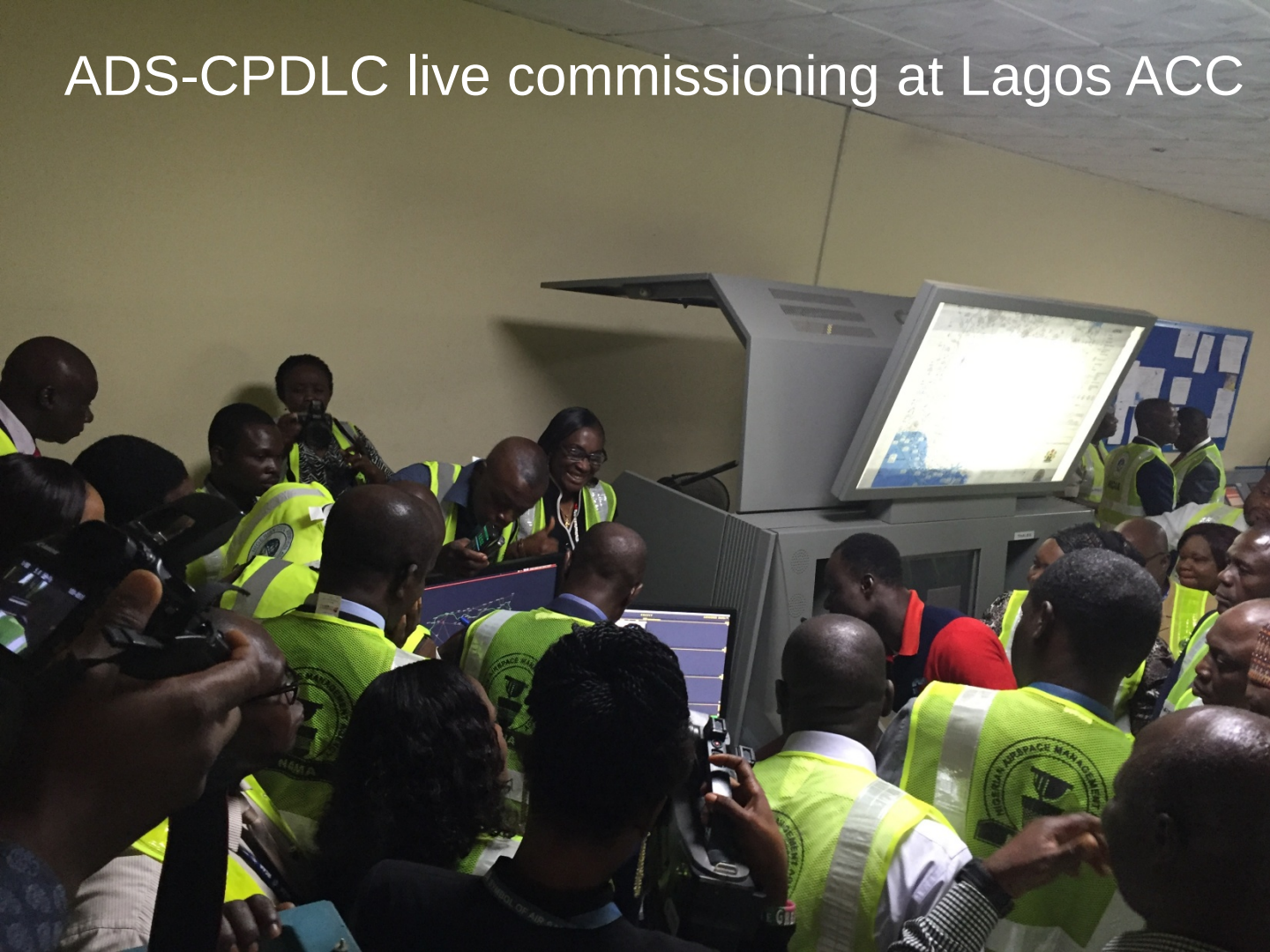
ADS-CPDLC live commissioning at Lagos ACC



Agenda

- Overview of SITA Air/Ground datalink
- ATC Datalink Infrastructure Technologies
- ATM Datalink Services and Solutions
- FANS 1/A Datalink ATM Solutions
- SITA Global datalink service footprint
- Datalink Regional context - AFI
- Datalink performance reports
- Wrap up

1 Overview of Air/Ground Datalink Services

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AIRCOM overview

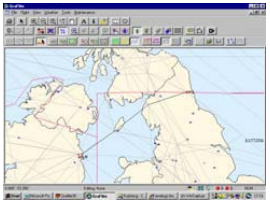
- VHF AIRCOM was launched more than 25 years ago as SITA's first step beyond ground network services into radio communications.
- AIRCOM also provides data and voice service via the Inmarsat satellites with coverage around the world between 80 deg N/S (since 2009, using I4 constellation) and benefits from the Japanese MTSAT satellite as well.
- In 2008 AIRCOM service has extended to provide data and voices services to cover polar areas via the Iridium constellation.
- Finally in 2008 SITA embarked on the new generation VDLm2 stations by becoming Eurocontrol's CSP of choice

A/G Data Link for AOC Purpose

Airline Operations depend on ACARS

Aircraft Maintenance
Engine reports via ACARS enable preventive maintenance avoiding costly in-flight breakdowns

Operations Control
Aircraft movement reports via ACARS key to synchronize operations through airports



Flight Planning
Flight plans & weather transmission to cockpit enable efficient operation of modern aircraft

Airline Operations have already made the transition to Data Link

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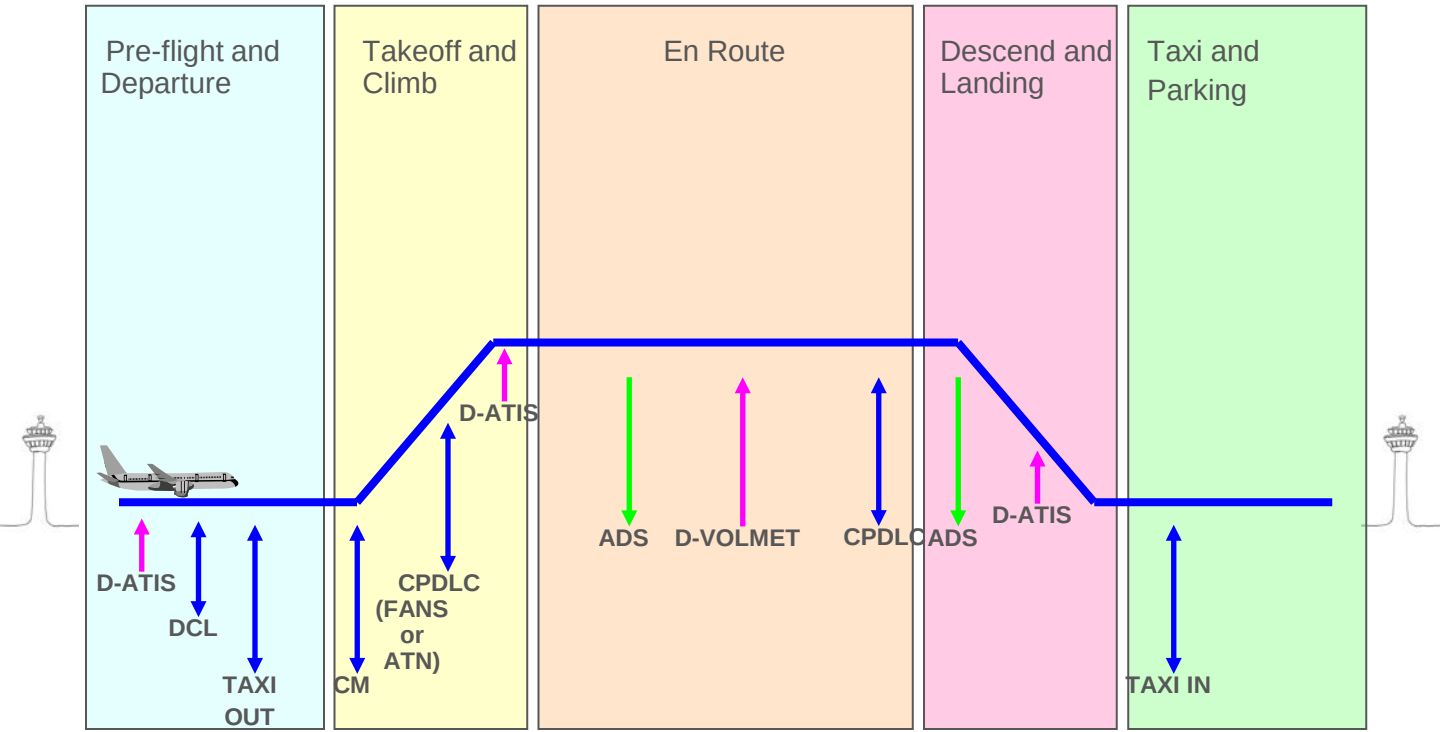
A/G Data Link for ATC Purpose



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ADS-C/CPDLC Data Link for ATC Purpose

1991: original ICAO FANS Committee definition of CPDLC & ADS

Long Haul : ATC in oceanic & remote airspace previously used only HF voice so data link equipage revolutionized operations

1992: Boeing use RTCA & AEEC work to define FANS-1 ADS & CPDLC package using ACARS

Today:
Boeing FANS-1, AIRBUS FANS-A avionics installed on over 2000 aircraft (mostly long haul)

Short Haul: Continental airspace has reliable VHF voice & radar so data link target is to off load the routine communications

1996:ICAO adopts VHF Digital Link Mode 2 standard
1998: ICAO adopts standard covering ATN & CPDLC

Today:
SES regulation calls for system validated by Eurocontrol Link 2000+ program

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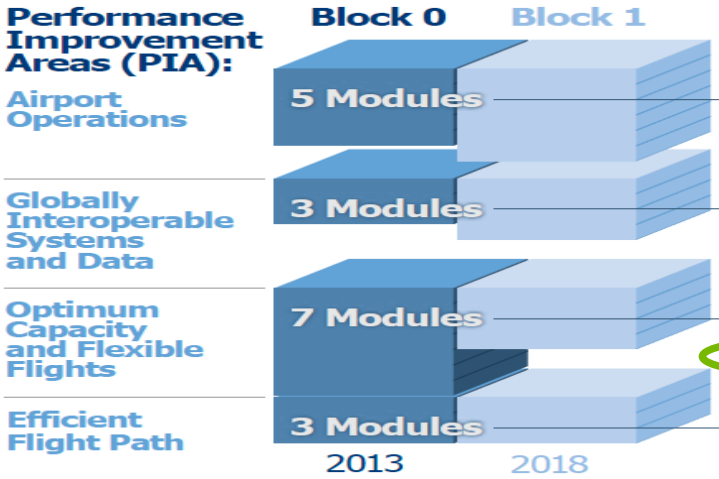
Block 0 Modules (18)



Source: ICAO

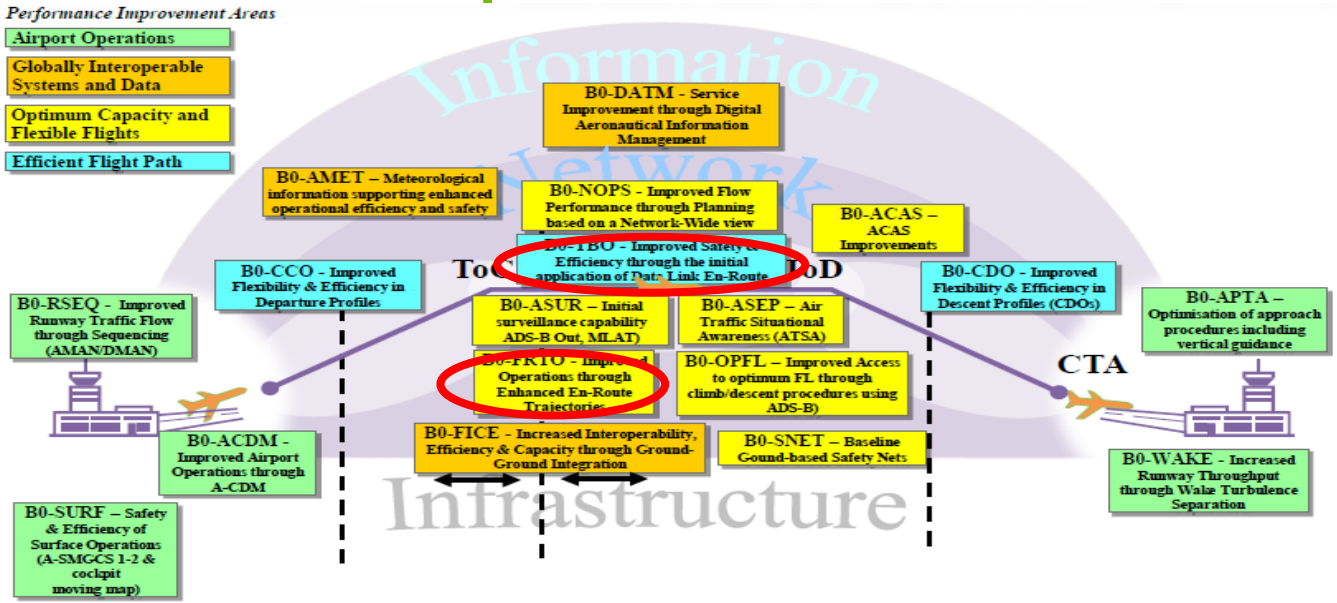
1. Optimised Approach Procedures including Vertical Guidance
2. Increased Runway Throughput through Optimised Wake Turbulence Separation
3. Safety and Efficiency of Surface Operations (A-SMGCS level 1-2)
4. Improved Airport Operations through Airport-CDM
5. Improve Traffic Flow through Sequencing (AMAN/DMAN)

1. Increased Interoperability, Efficiency and Capacity through Ground-Ground Integration
2. Service Improvement through Digital Aeronautical Information Management
3. Meteorological Information Supporting Enhanced Operational Efficiency and Safety

1. Improved Operations through Enhanced En-route Trajectories
2. Improved Flow Performance through Planning based on a Network-wide view
3. Initial Capability for Ground Surveillance
4. Air Traffic Situational Awareness (ATSA)
5. Improved Access to Optimum Flight Levels through Climb/Descent Procedures using ADS-B
6. Airborne Collision Avoidance Systems (ACAS) Improvements
7. Increased Effectiveness of Ground-Based Safety Nets

1. Improved Flexibility and Efficiency in Descent Profiles using Continuous Descent Operations (CDO)
2. Improved Safety and Efficiency through the Initial Application of Data Link En-route
3. Improved Flexibility and Efficiency Departure Profiles — Continuous Climb Operations (CCO)

Block 0 in Perspective



Performance Improvement Area (PIA)	Block No.	Module	Elements	ANSP datalink technology requirements
Optimum capacity and flexible flights	0	B0-FRTO: Improved Operations through Enhanced En-Route Trajectories	1. Airspace planning 2. Flexible Use of airspace 3. Flexible Routing	**CPDLC**
Efficient flight path	0	B0-TBO: Improved Safety and Efficiency through the initial application of Data Link En-Route	1. ADS-C over oceanic and remote areas 2. Continental CPDLC	**ADS-C** **VDL mode2** **Continental CPDLC**

2 Datalink Infrastructure Components and Technologies

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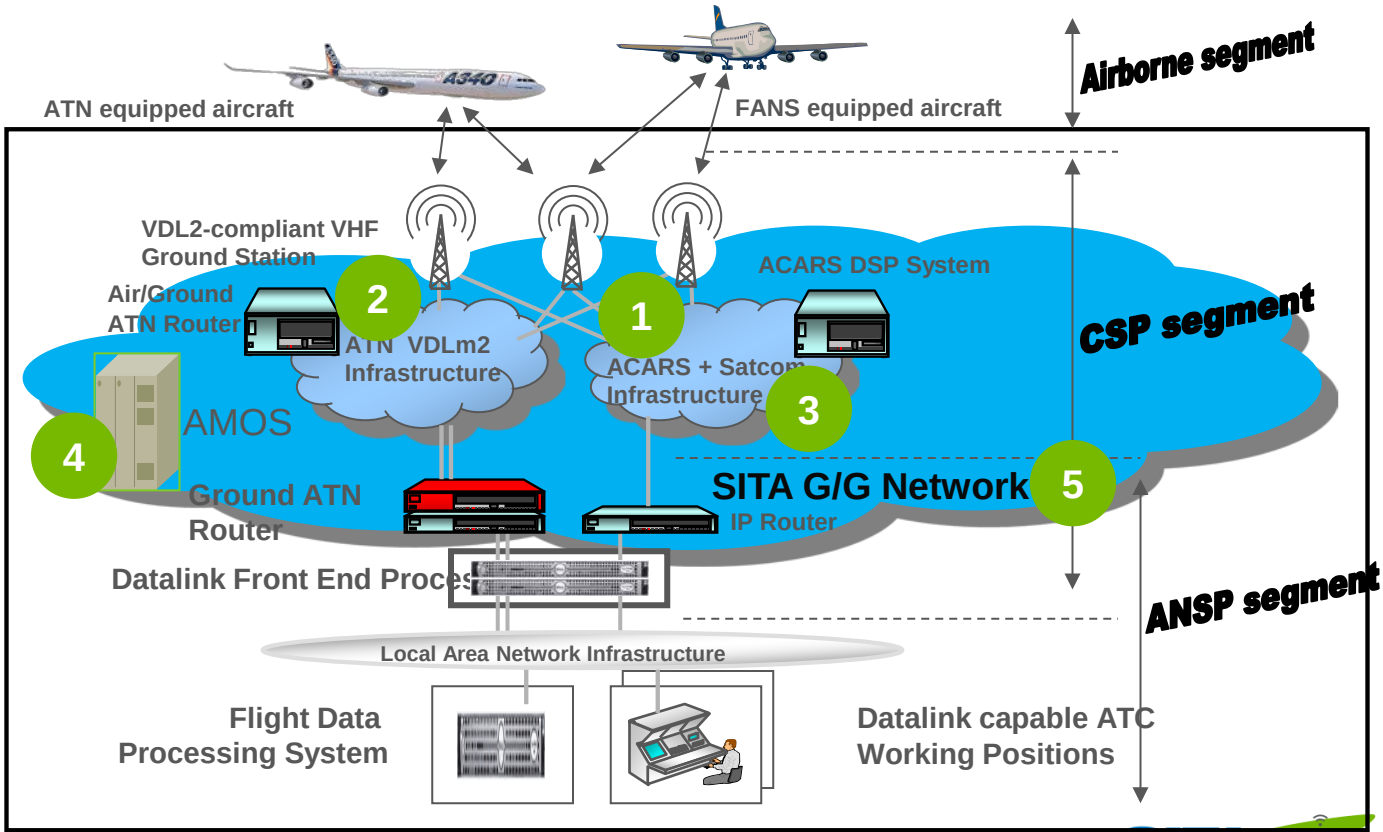
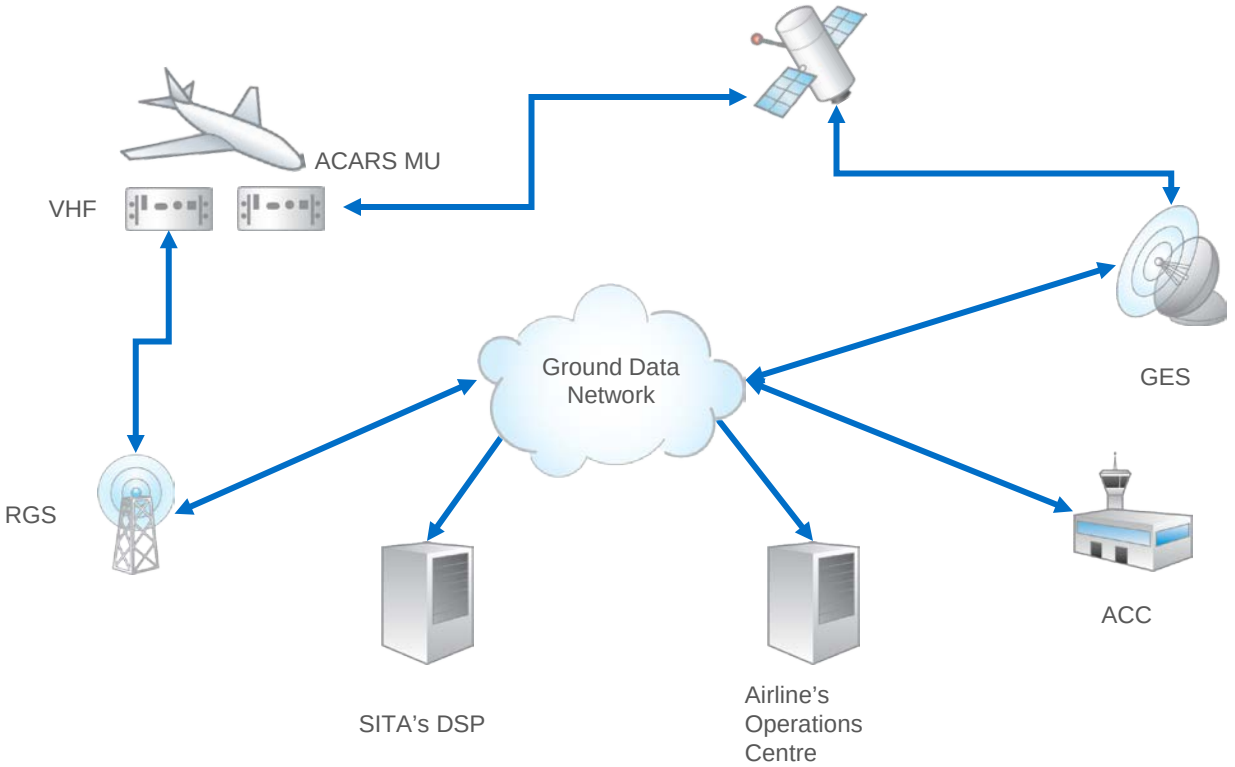
Overall Datalink Architecture: High-level schematics



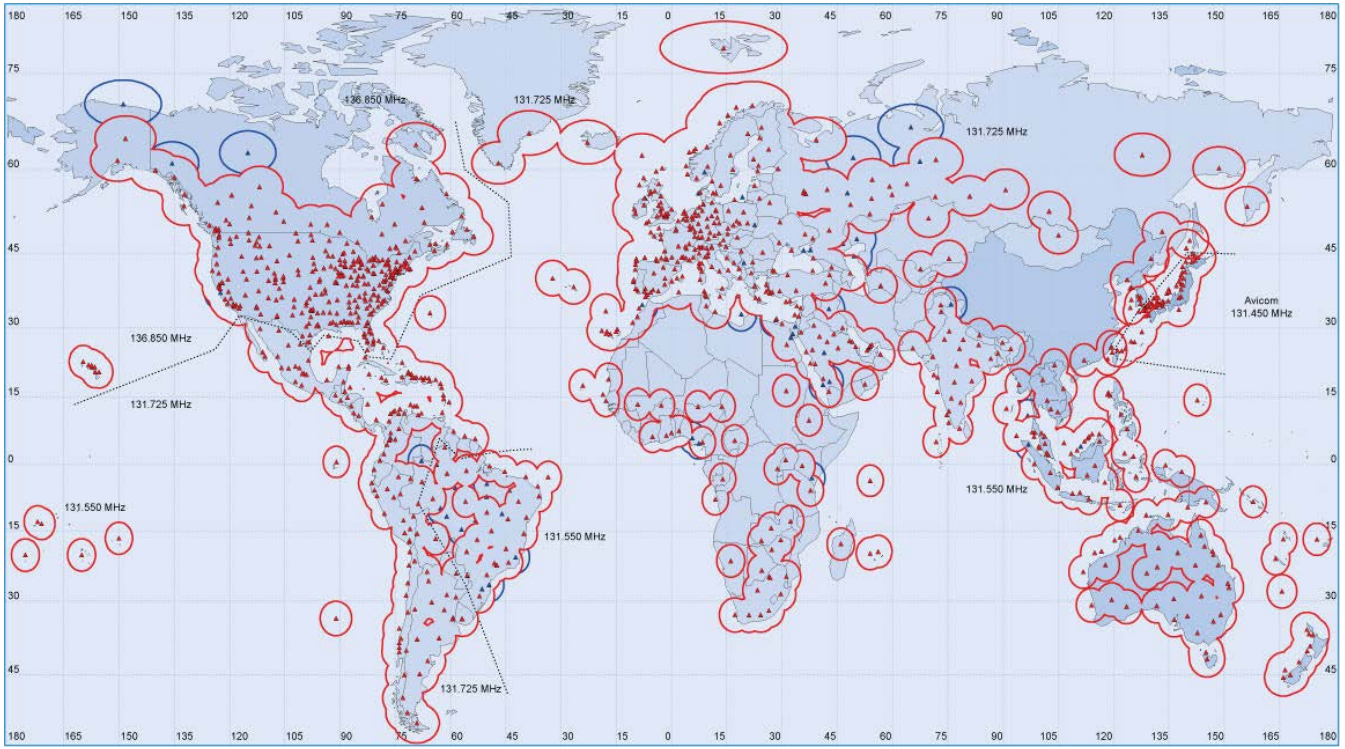
1. ACARS

- Uses Analogue VHF datalink radios
- Supports Air/Ground communication of FANS 1/A and Pre-FANS ATC application
- Strength
  - Globally available
  - Large fleet of equipped aircraft, standard equipage in new airframes
  - Strong support for AOC application
- Weaknesses
  - Low data rate: Max throughput is 300 bps
  - Near capacity saturation
  - Quality of Service less suitable for ATM applications
- New data link technology required for ATS: VDLm2

ACARS-based Data Link



VHF ACARS Coverage - worldwide



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VHF ACARS Coverage - Africa

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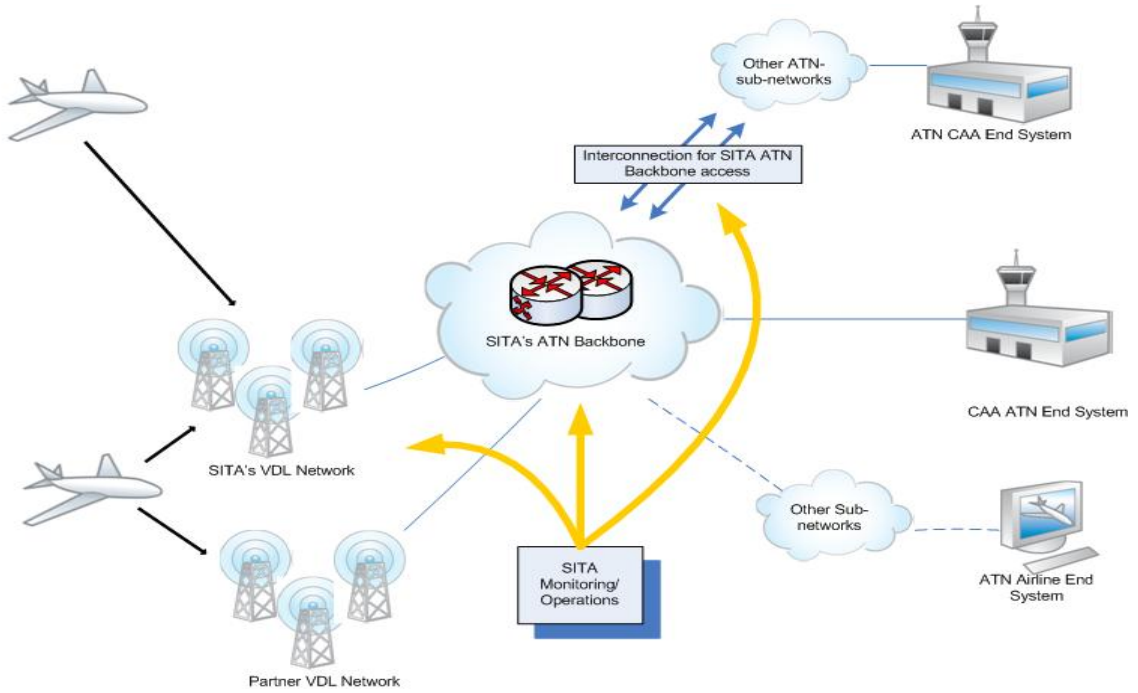
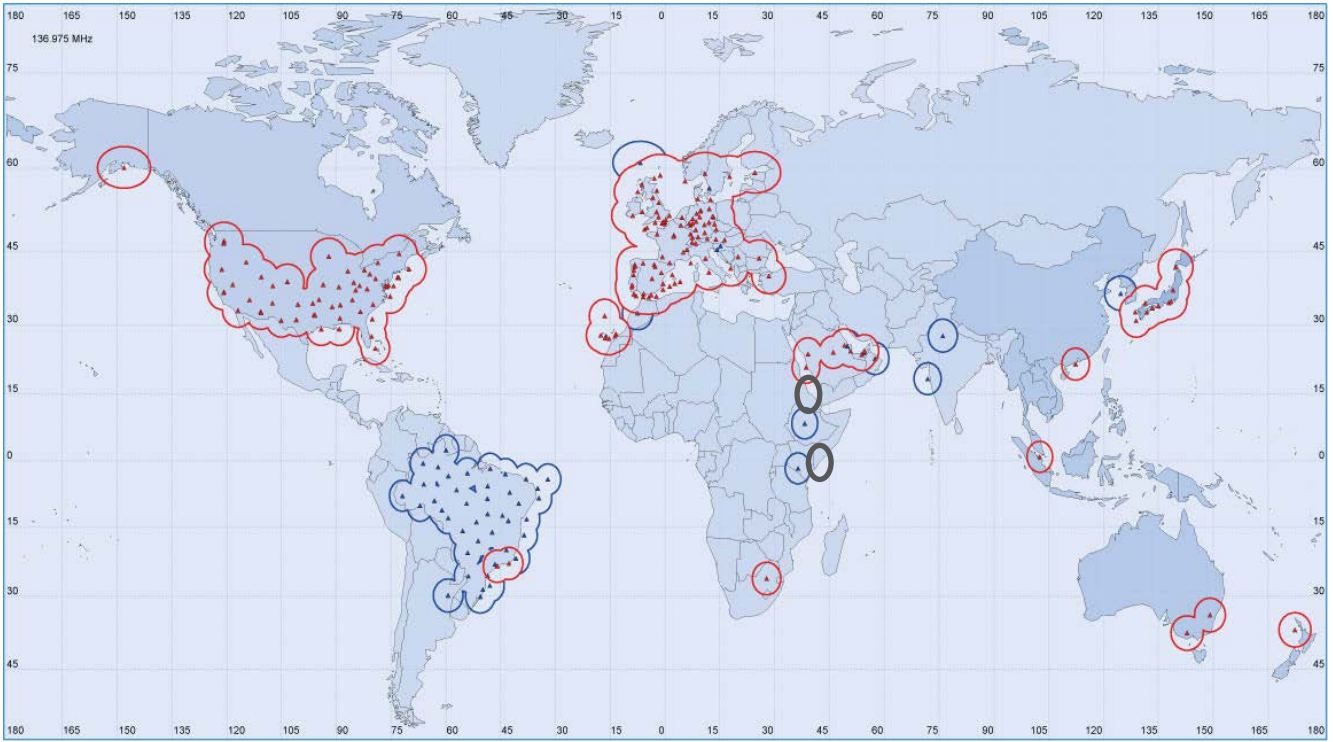
2. VDL Mode 2

- Standardised
  - ICAO SARPs
  - Originally proposed in May 1994
  - Adopted in March 1996
  - Published in Nov 1997
  - Supports FANS and Pre-FANS applications
- Provides 31.5 kbps data rate
  - Uses Differential 8-Phase Shift Keying
- **Mandatory requirement for ATN based ATC applications - e.g. Continental CPDLC**

The SITA ATN Service – Architecture



VDL World-Wide Coverage



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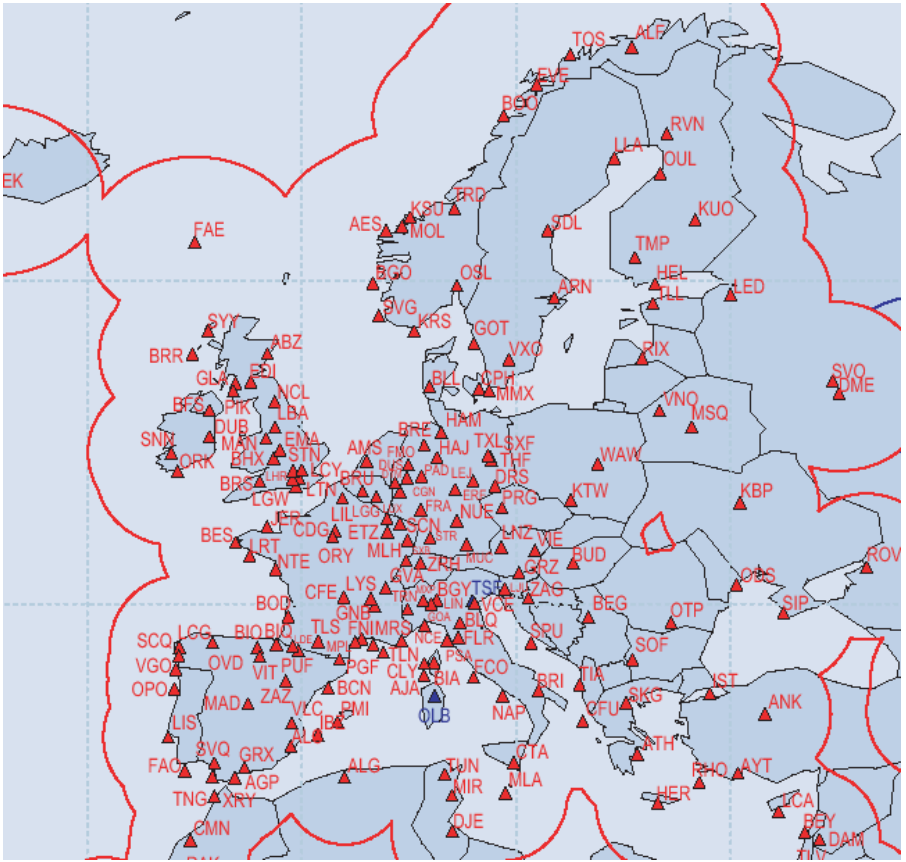
VDL Coverage – Europe (85% done by SITA)



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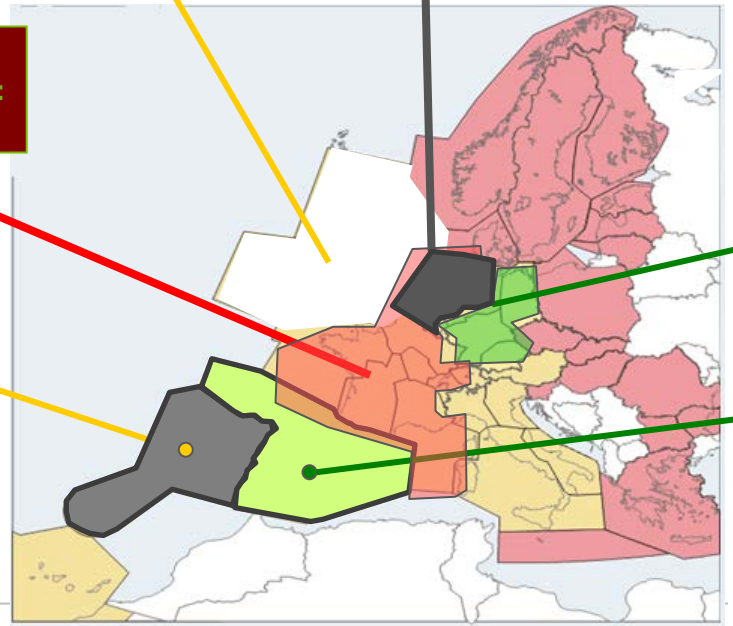
SITA's Current ATN/VDLm2 Provision in Europe



NATS/IAA FAB: ATN/VDLm2 Service

Maastricht UAC: ATN/VDLm2 Service

FABEC (France, Benelux, Switzerland): VHF Partnership

DFS (Germany): VHF Partnership

NAV Portugal: VHF Partnership

AENA (Spain): VHF Partnership

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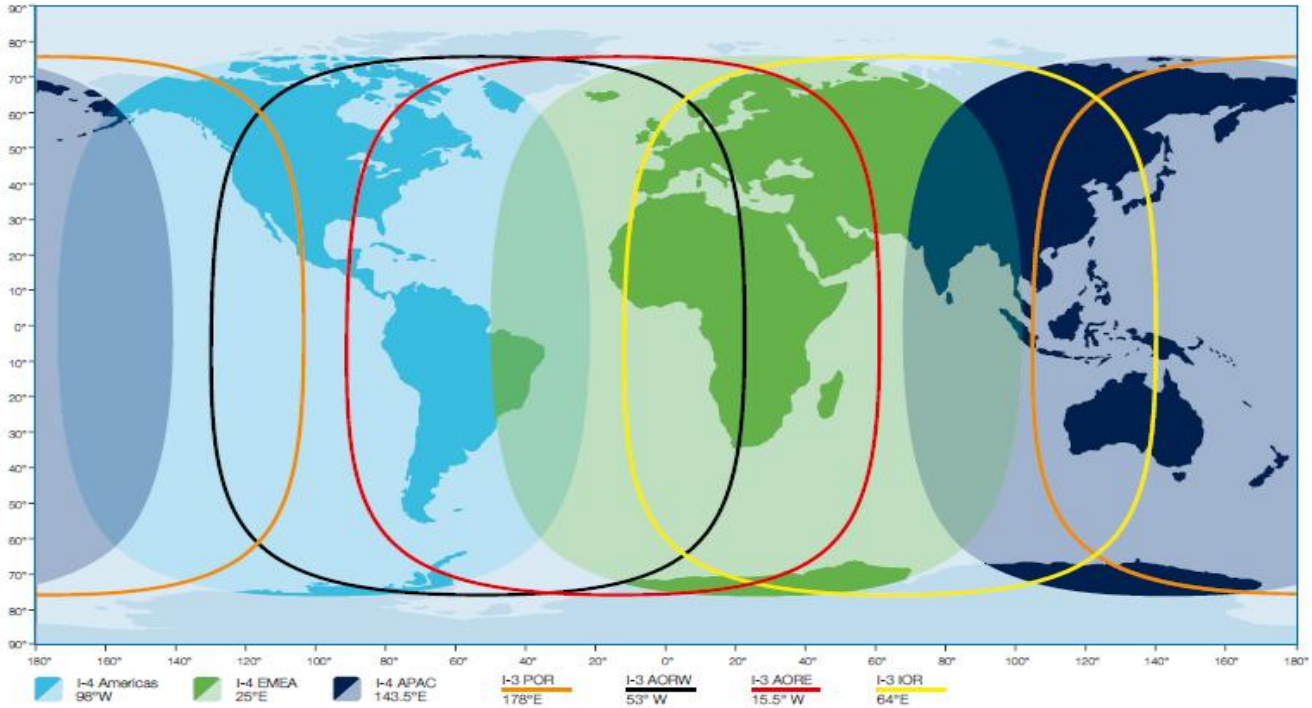
3. Satcom Services

- Inmarsat
  - Classic Aero services (*high-quality voice, low-speed data and safety communications*)
  - Swift64 (*64kbps-per-channel*)
  - SwiftBroadband (*Simultaneous voice and broadband data, Contended IP data at up to 432kbps)*
- Iridium (*for customers with lower cost/weight avionics*)
  - Voice
  - Data – (Datalink)

Inmarsat Classic Aero coverage

AIRCOM Satellite Classic Aero Inmarsat coverage



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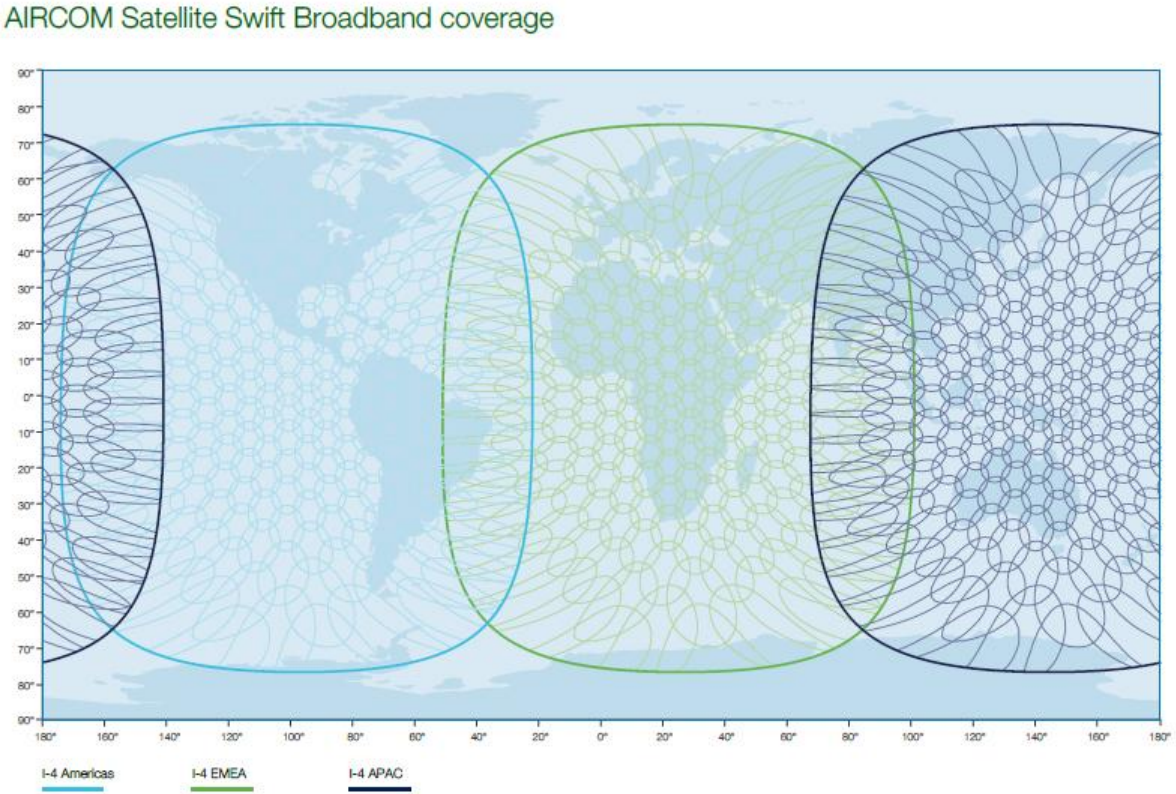
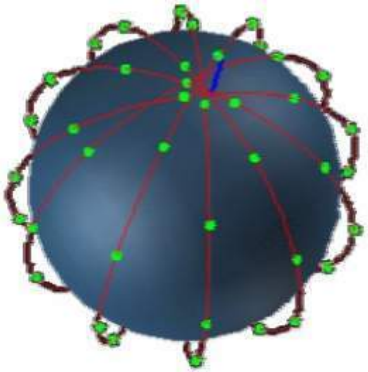
Inmarsat Swiftbroadband Coverage

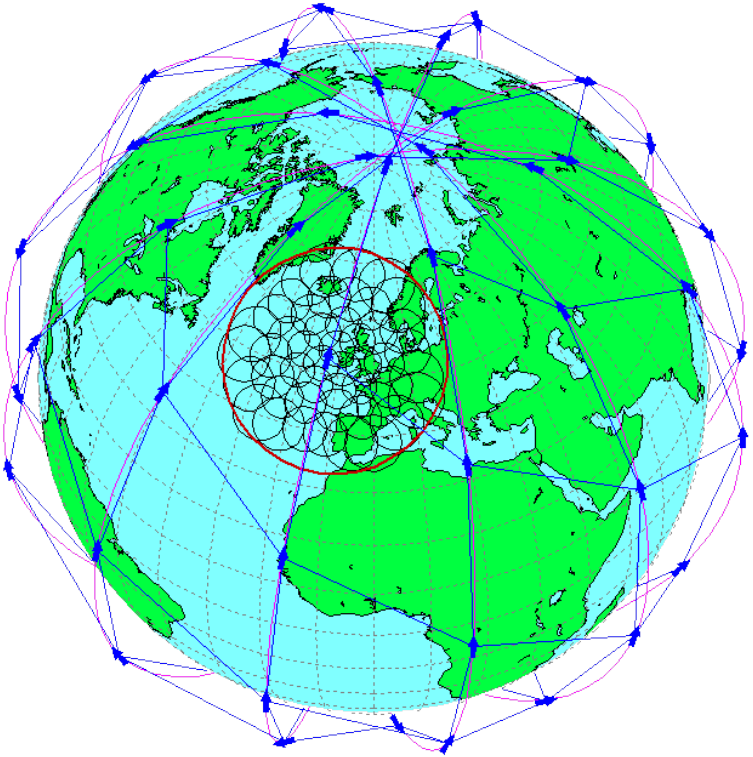


Iridium Coverage

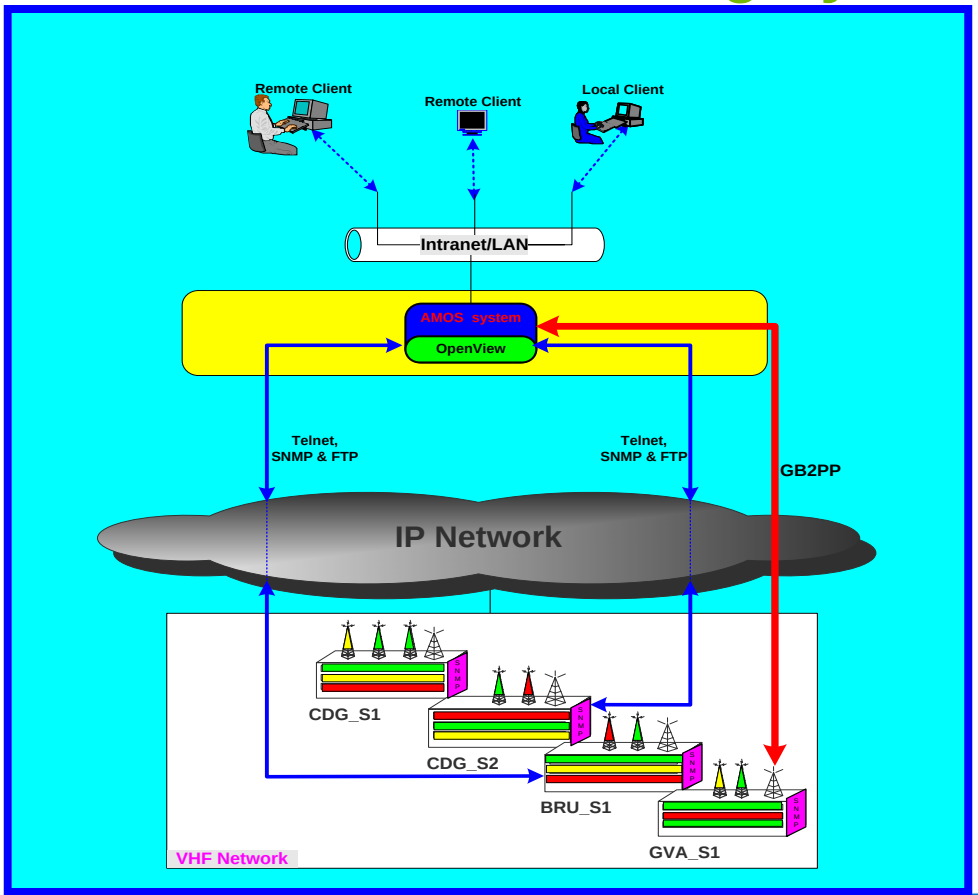


Polar-type constellation of low earth-orbiting (LEO) satellites

- 6 orbital planes with 11 satellites (+1 spare) per plane



4. AMOS Network Monitoring System



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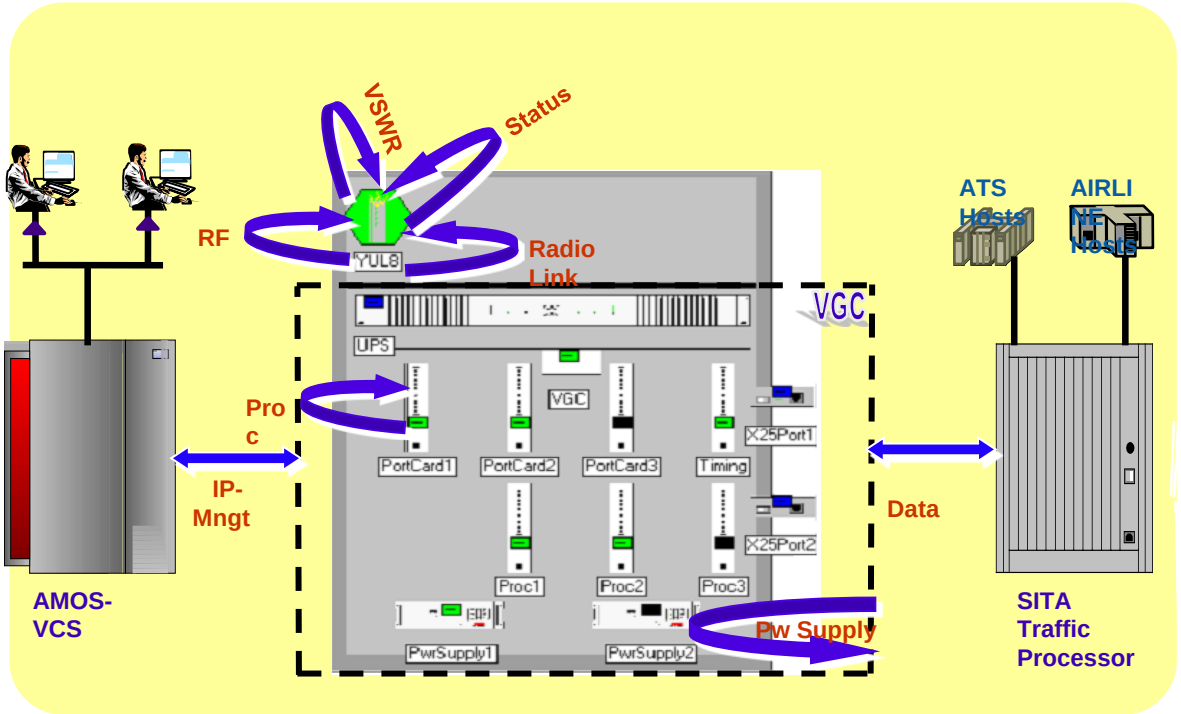
VHF Network Faults Monitoring



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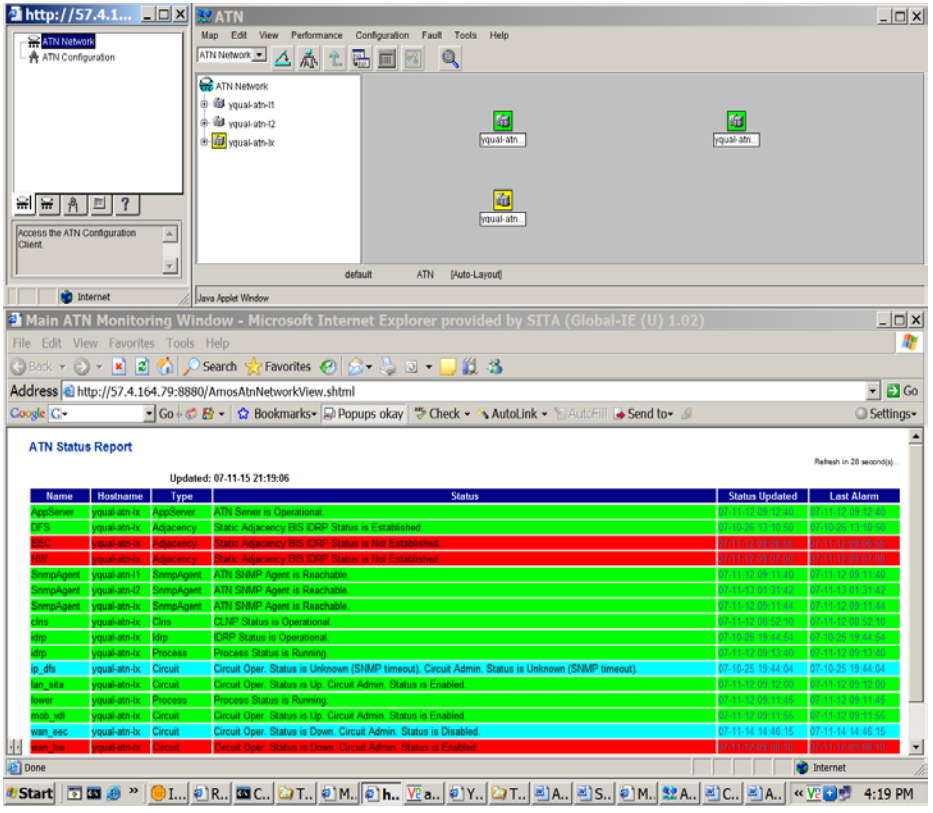
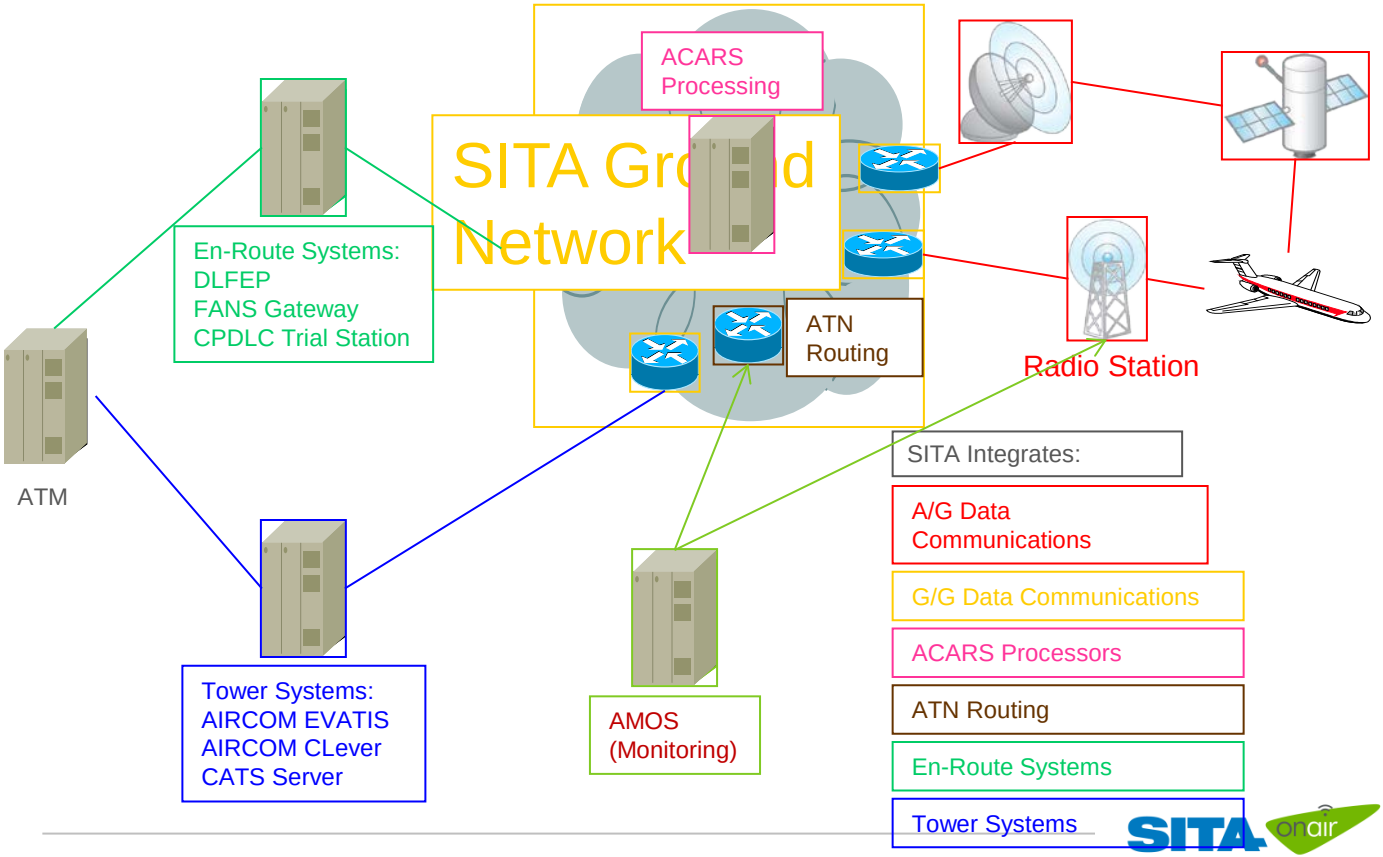
ATN Routers Monitoring

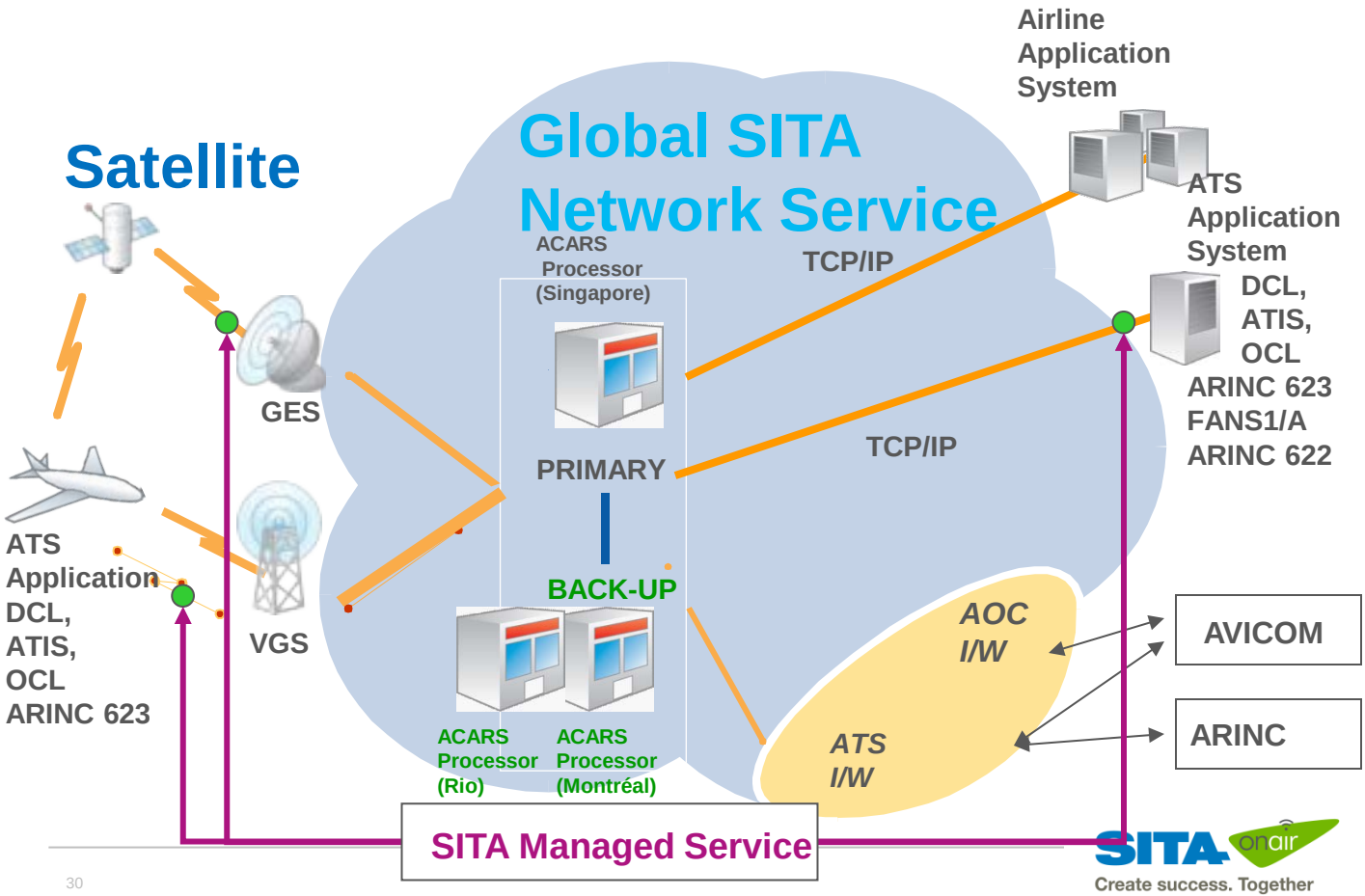


- Maps animation
- ProATN Processes status monitoring
- ProATN Alarms browsing & filtering

5. SITA as A/G Data Link Integrator



HOW DOES IT WORK IN SITA?



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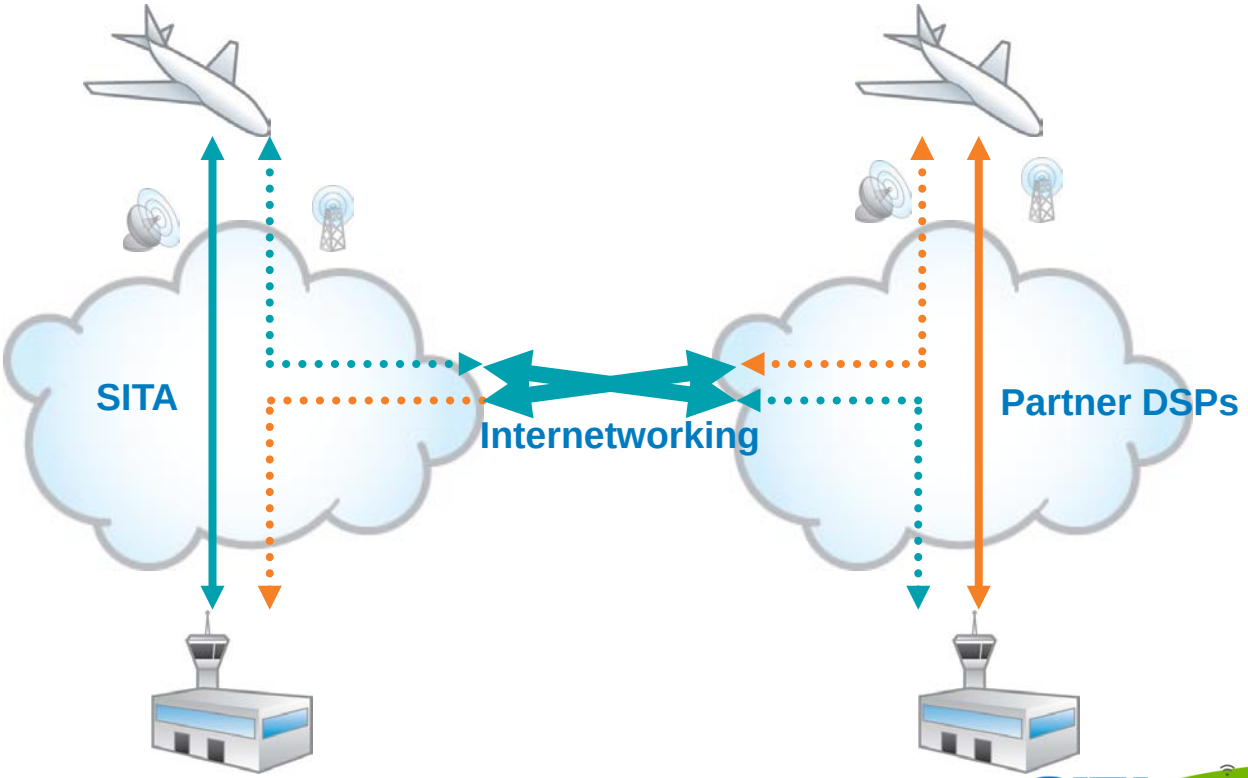
ATS Internetworking



2 Datalink ATM Solutions

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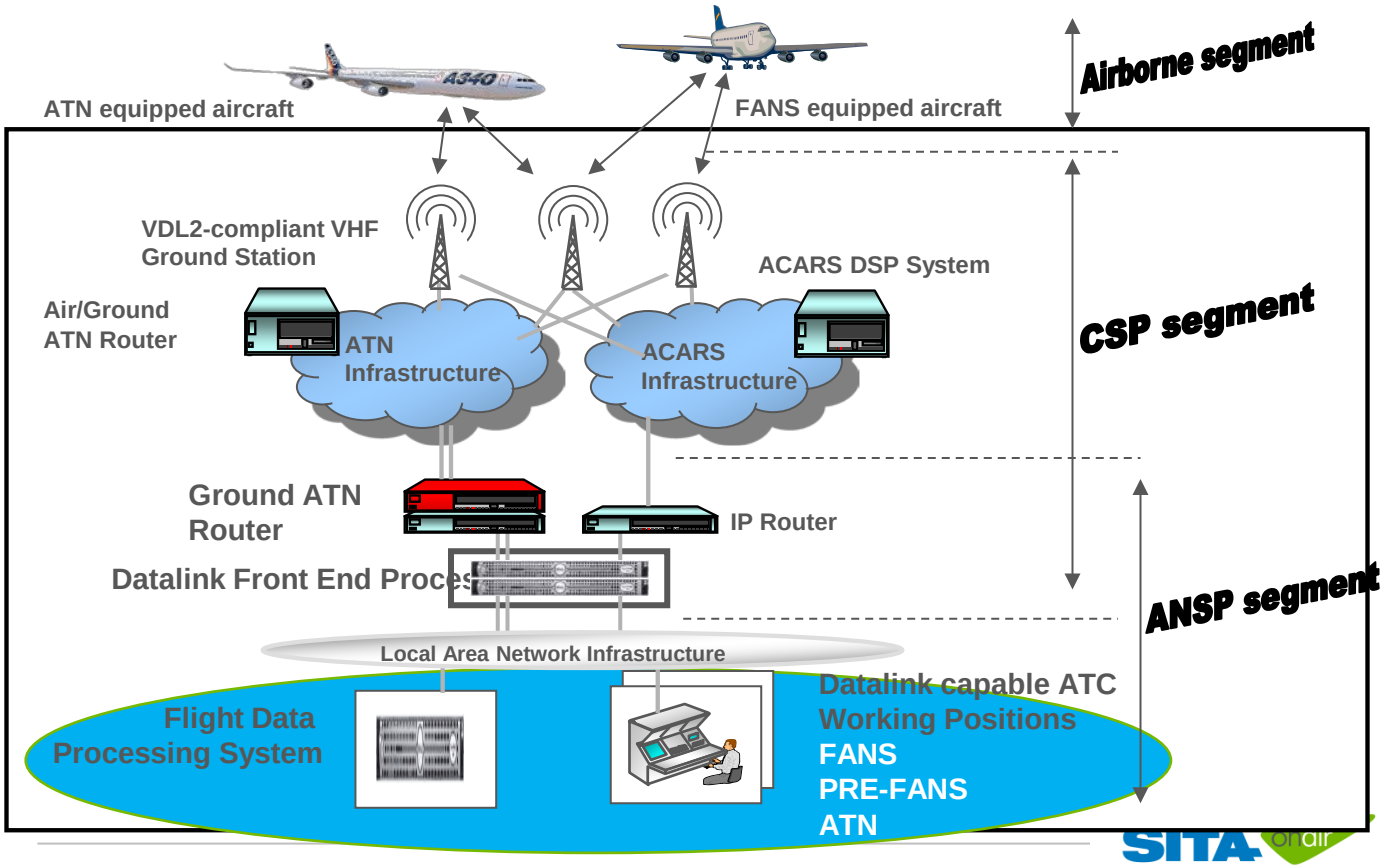
Overall Datalink Architecture: High-level schematics



ATS AIRCOM portfolio – Classic services and Solutions

Pre-FANS services	Description
• Departure Clearance • Digital ATIS • Oceanic Clearance • Digital VOLMET	➢ *Mainly at Airport Towers* ➢ *Includes AIRCOM connectivity to End System, SLA, Helpdesk 24/7 access and Customer Support* ➢ *Can be bundled with turn-key solutions*

FANS services	Description
• ADS-C • CPDLC • Context Management (AFN)	➢ *Mainly at Oceanic ACCs* ➢ *Includes AIRCOM connectivity to End System, SLA, Helpdesk 24/7 access and Customer Support*

ATN services	Description
• ATN Continental CPDLC • ATN Backbone Service • ATN Test Service	➢ *Currently in Europe area only* ➢ *Includes AIRCOM connectivity to End System, SLA, Helpdesk 24/7 access and Customer Support* ➢ *Test service to airlines , airframers, avionic vendors*

3 FANS 1/A Datalink ATM Solutions

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FANS 1/A applications

- AFN (ATS Facilities Notification)
  - Allows aircraft to logon to ATC facility & the transfer of control
- CPDLC (Controller Pilot Data Link Communications)
  - Replaces verbal ATC instructions and pilots read-backs
  - Automates ATC processes
- ADS (Automatic Dependent Surveillance)
  - Gives accurate position reporting
  - Allows additional data reporting (wind, temperature etc)
  - Provides reporting in regions out of radar coverage
  - Significantly increases traffic that can be handled in remote areas

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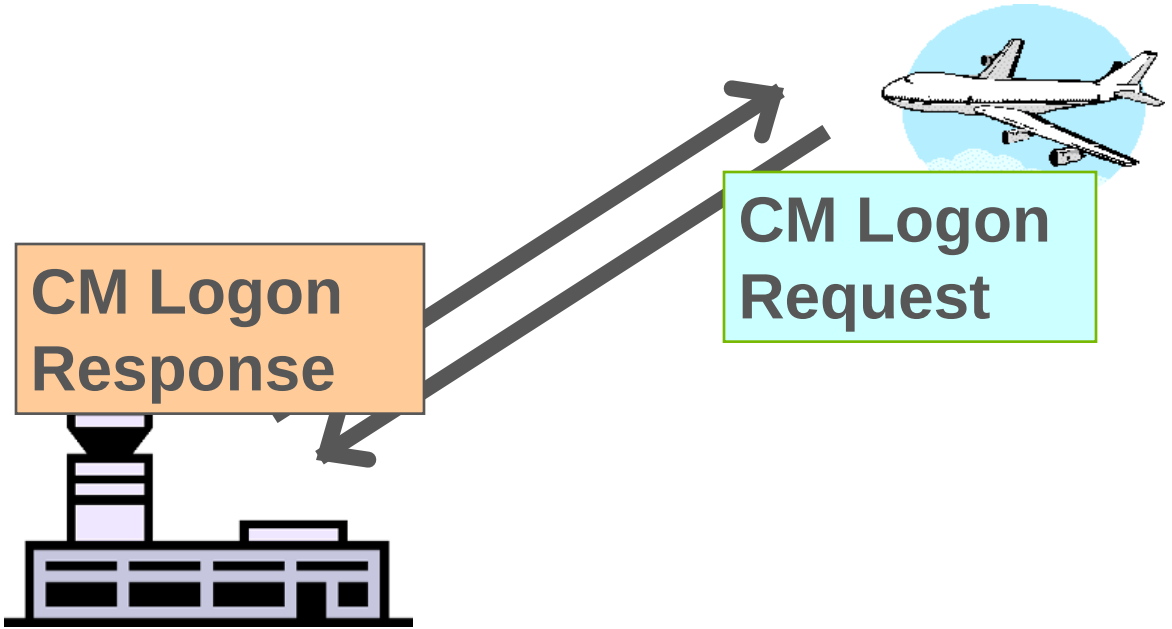
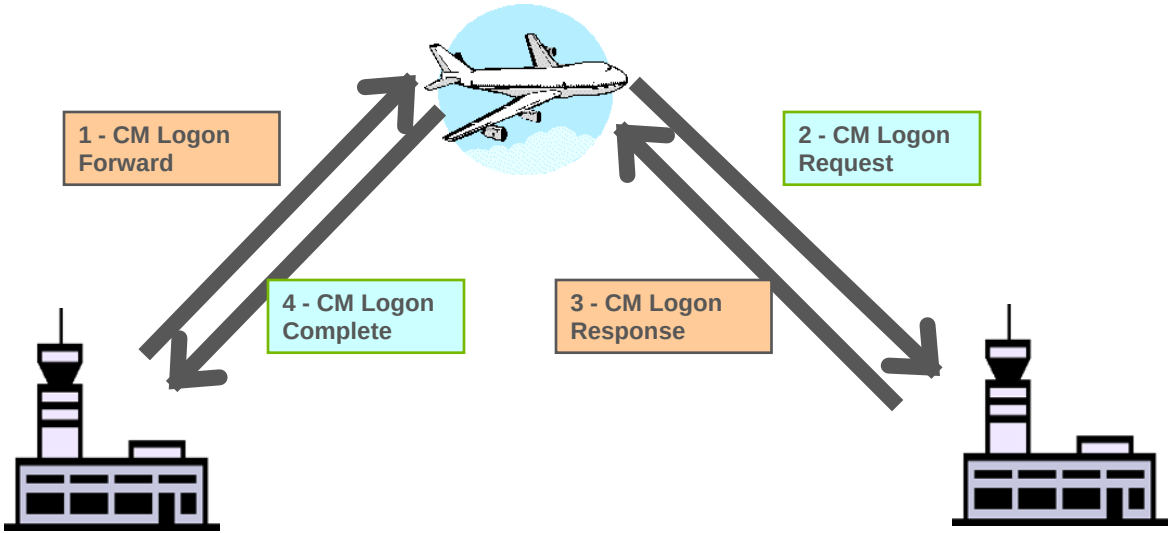
The AFN application

- AFN stands for ATS Facility Notification.
- AFN is the FANS equivalent service for what ICAO defines as Context Management (CM).
- Referred to as Data link Initiation Capability (DLIC) Service in Link2000+ terminology.
- AFN process is made of several steps.
  - The aircraft “logs on” to a Facility (CM logon request)
  - The Facility Ground System checks if the aircraft is entitled to logon, and responds either positively or negatively.
  - When necessary, the Facility Ground System will request the aircraft to logon to the next sector.
  - The aircraft will notify when the next logon is completed.

FANS applications – Context Management



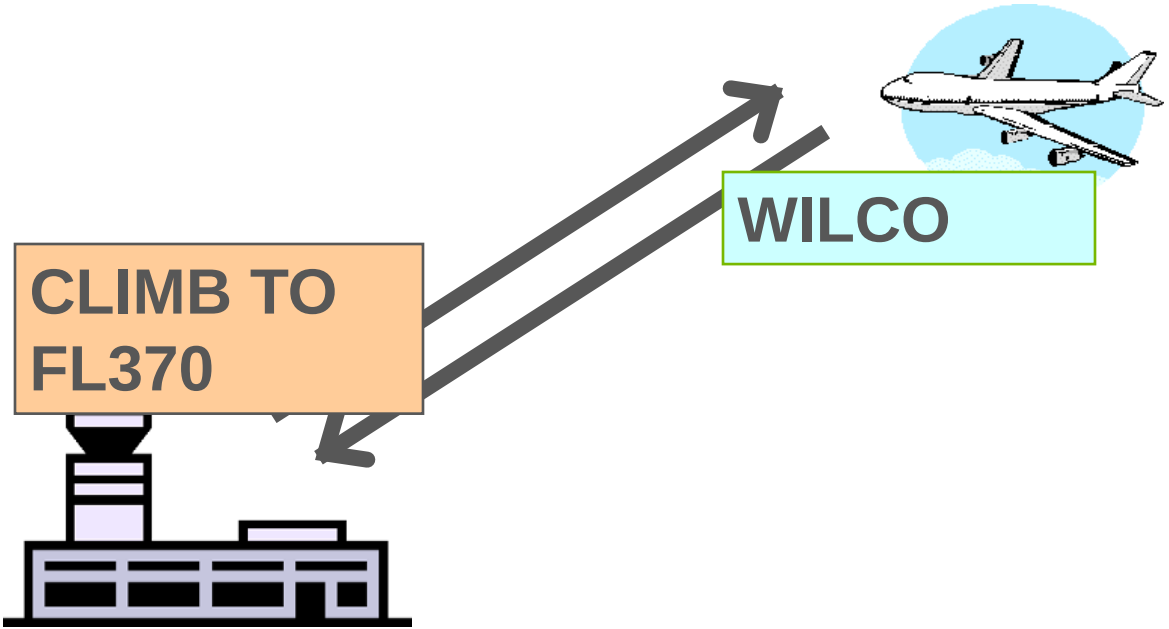
FANS applications - CM forward



The CPDLC application

- CPDLC stands for Controller Pilot Data Link Communication.
- Referred to as Air Traffic Clearance (ACL) Service in the Link2000+ terminology
- CPDLC application enables the controller and the pilot the exchange ATC requests and instructions over datalink rather than the VHF or HF radio.
- CPDLC enables the automation of routine communication (e.g transfer of control).
- CPLDC programs on going in the NAT and SoPAC (FANS), as well as USA and Europe (ATN).

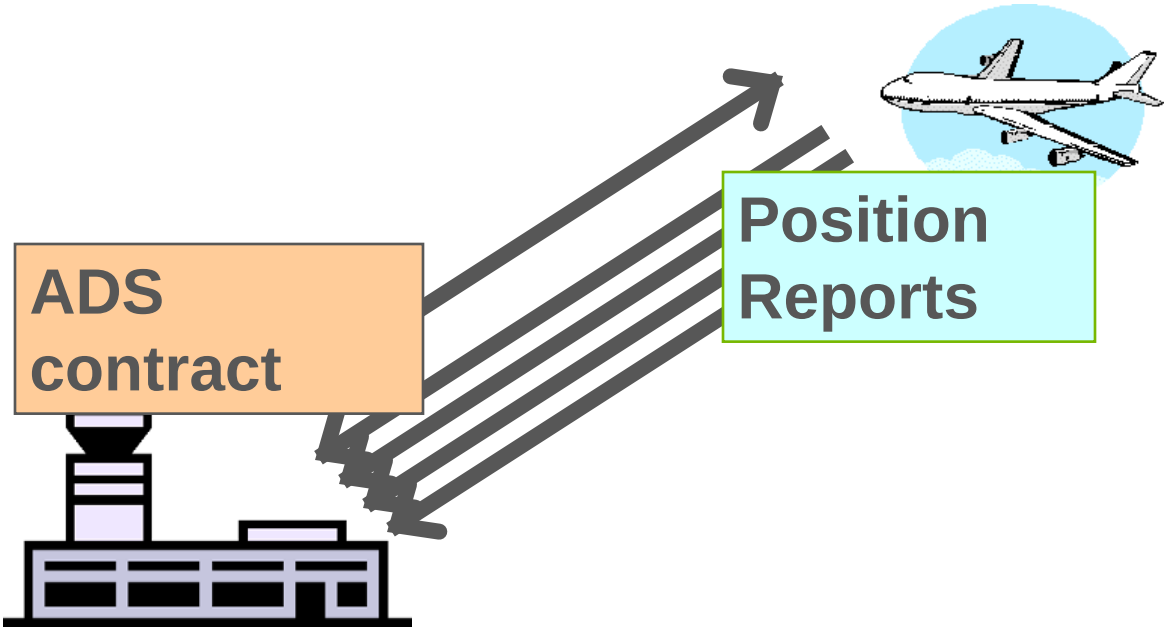
FANS applications - CPDLC



The ADS application

- ADS stands for Automatic Dependant Surveillance.
- ADS application enables the aircraft to transmit its GPS position (and other data) via datalink
- ADS enables aircraft situation awareness were radar is not available (e.g oceanic and remote regions).
- ADS enables “periodic” contracts, “demand” contract, “event” contract
- ADS situation display usually reproduces radar display

FANS applications - ADS



4 Implementation and operational challenges of ADS-C/CPDLC service

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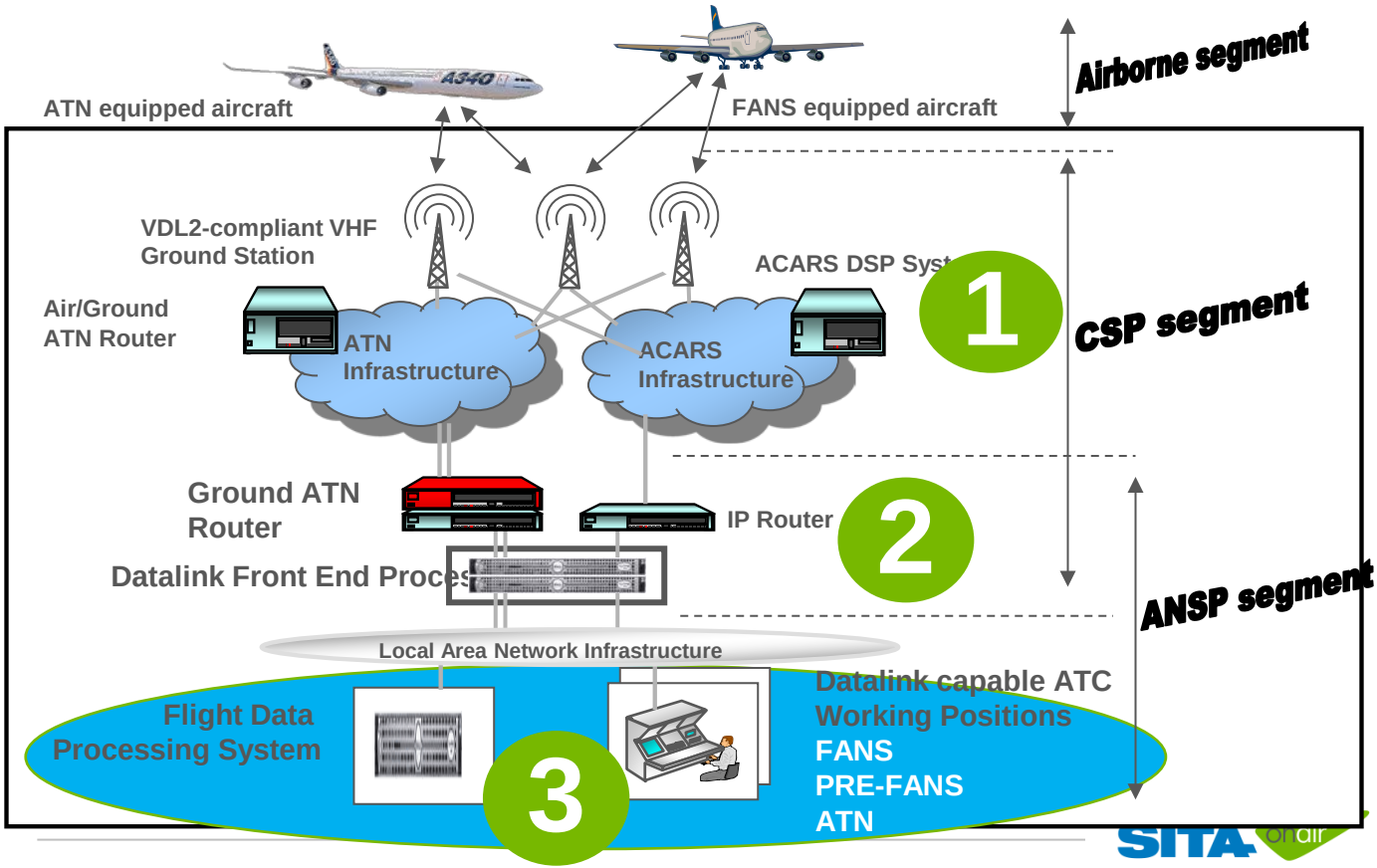
Overall Datalink Architecture: High-level schematics



Components of operational ADS-C/CPDLC datalink ATC service

1. Air/Ground datalink infrastructure (ACARS or VDLm2)
   - Through Service Provider
   - Through VGS Partnership
2. Access to Air/Ground datalink service provider
   - IP link to the equipment room
3. ATM Automation System
   - Existing FDPS capable of FANS 1/A (ADS-C/CPDLC) or
   - Stand-alone ADS-C/CPDLC Workposition

1. Air/Ground Datalink Infrastructure

- Deploying VHF datalink system by ANSPs would not be cost effective and interoperable globally
- SITA and ARINC are global providers of A/G datalink infrastructure
- SITA has unparalleled VHF ACARS coverage globally as well as in the AFI region
- SITA provides A/G datalink support for ADS-CPDLC through FANS 1/A Managed Services offering at a reasonable monthly fee

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2. Access to A/G datalink infrastructure

- SITA provides an IP network connection between the ACC and nearest SITA node to access the SITA AIRCOM network
- SITA provides single or dual redundant local IP leased lines through local Telecom network providers
- The biggest implementation and later on operational challenge comes from this component
- Delivery of local leased lines take very long lead time and has totally unpredictable lead time

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Current efforts to overcome connectivity problems

- SITA migrated all ANSPs to IP from legacy connections
- SITA engaged in discussions with both ATNS and ASECNA for possible integration of AFISNET and NAFISAT with SITA AIRCOM Network
- ASECNA is planning to implement gateways at Dakar and France to connect to SITA
- ATNS has already implemented gateways at JNB and CPT to connect to SITA AIRCOM network (2 FANS and 3 pre-FANS sites already connected)
- Further in-depth discussions needs to take place in terms of the capability of the networks to carry FANS traffic

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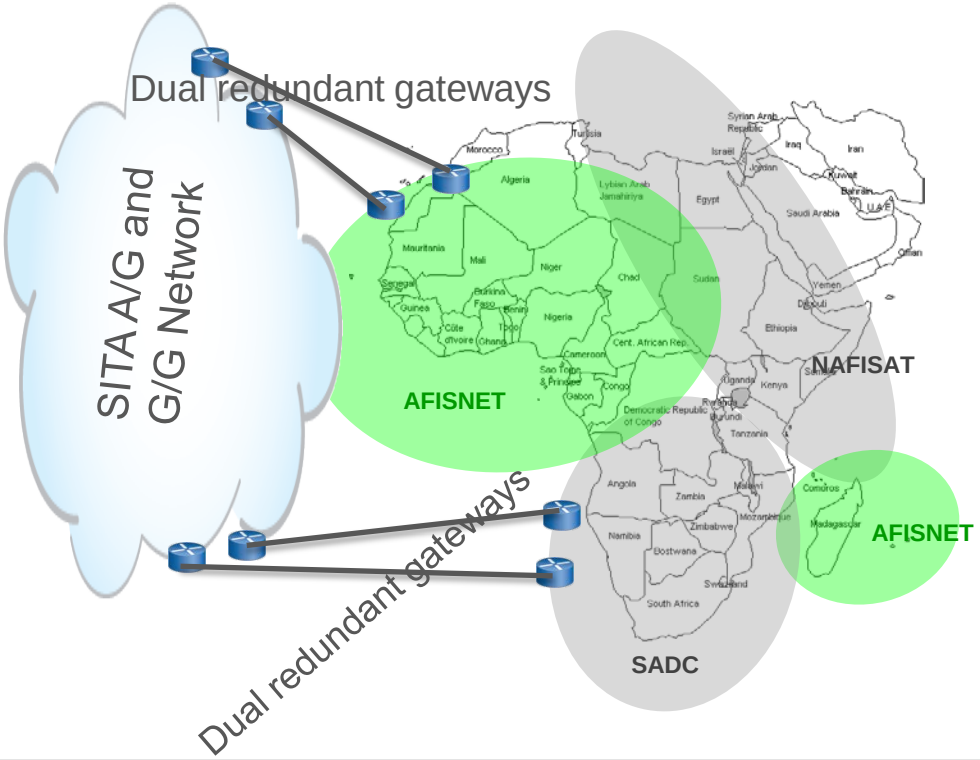
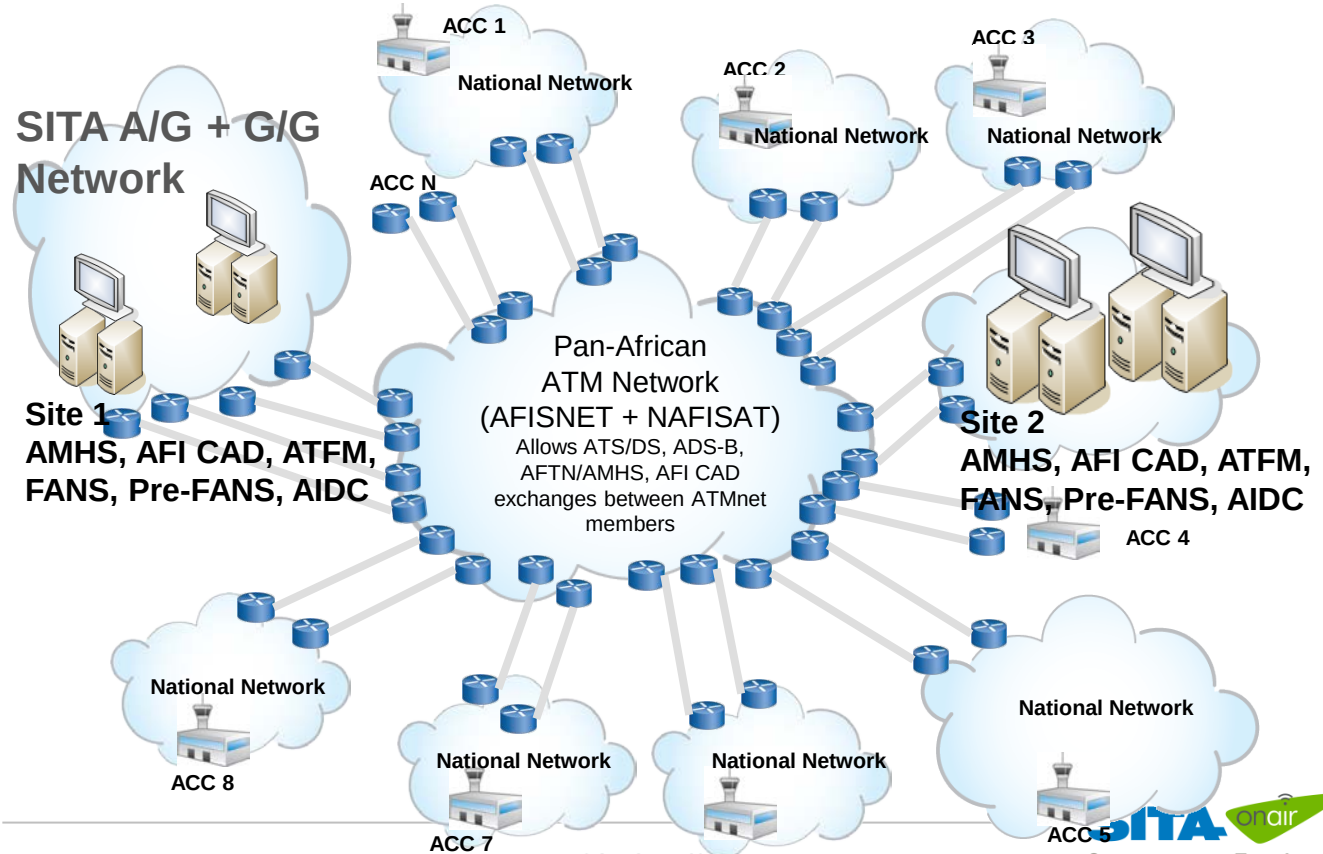
Current VSAT based Networks in AFI region



SITA's vision for AFI future ATM environment



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3. ATM Automation System

- If ANSP's current ATM system supports FANS 1/A ADS-C/CPDLC then SITA will only implement the IPVPN network, interface with the ATM system and configure for operation
- If ANSP current ATM system does not support FANS 1/A then they have two choices
  I. Request an upgrade from current supplier to enable FANS 1/A services
  II. SITA can provide stand-alone FANS 1/A workstation at reasonable price

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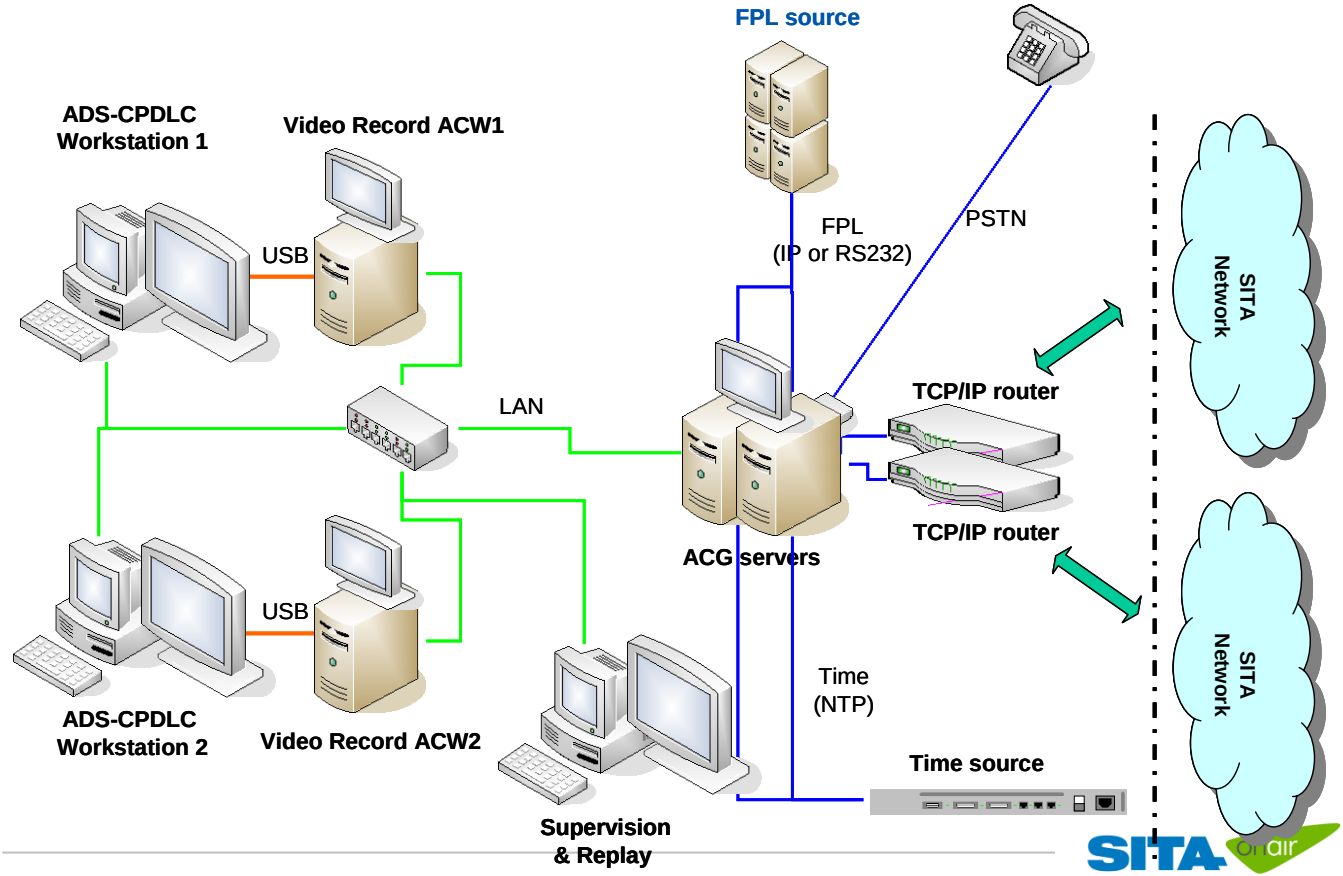
SITA ADS-C/CPDLC stand-alone solution



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ADS-CPDLC Workstation

ICAO ASBU B0 - FRTO

ICAO ASBU B0 - TBO

- **Huge Safety and efficiency benefits by replacing the unreliable HF communication by CPDLC and non-existent surveillance by ADS-C**

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5 SITA Global Datalink ATC Services Footprint

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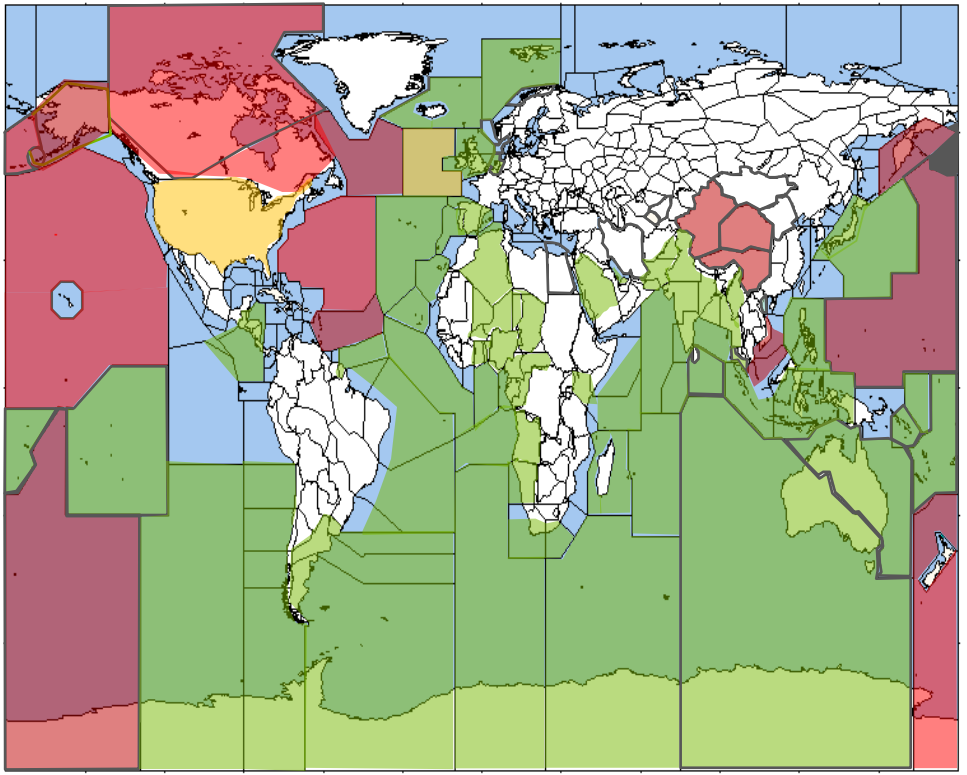
ATS - FANS Services footprint



- SITA Customer FIRs
- Rockwell Collins-ARINC Customer FIRs
- Both SITA and Rockwell Collins-ARINC Customer FIRs

NOTE: Date Aug 2015 Flight Information Region (FIR) boundaries are approximate. Shaded FIRs are FIRs for which we are contracted or aware that Rockwell Collins-ARINC is contracted, but, not all are operational and it is possible not all will implement in the end. However, most shown are operational.

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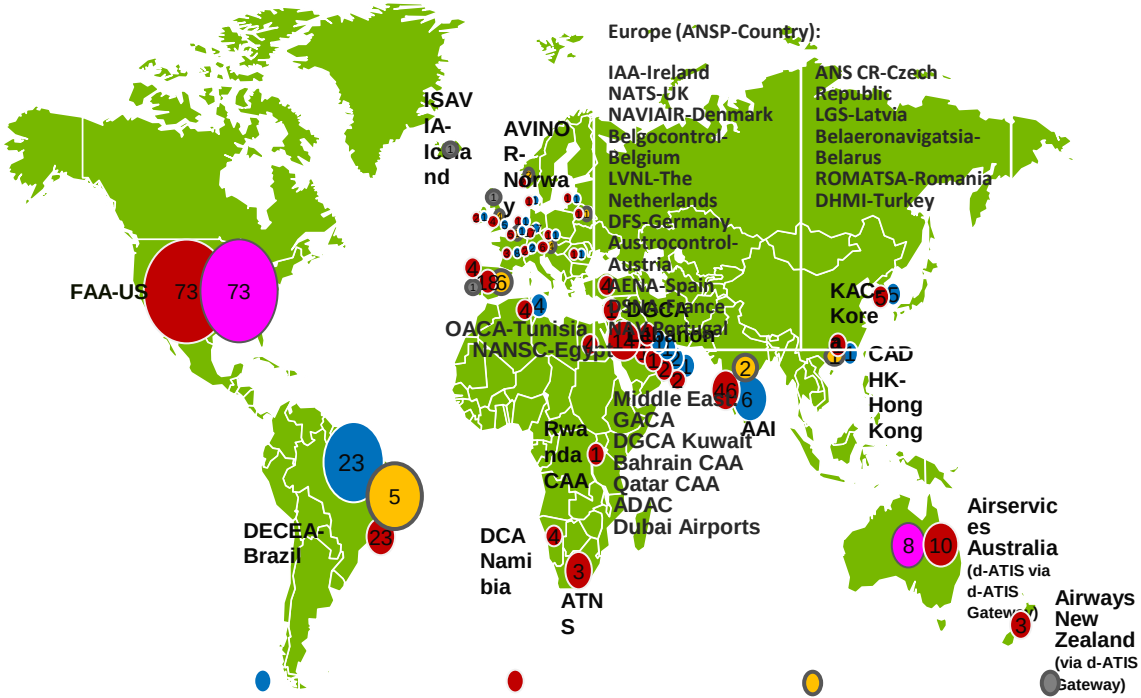
ATS – Pre-FANS Services footprint – Oct 2015



SITA pre-FANS PDC
- Seeking airline customers
- 81 airports

SITA pre-FANS DCL
- 19 Customers
- 82 airports

SITA pre-FANS ATIS
- 35 Customers
- 273 airports

SITA pre-FANS VOLMET
- 9 Customers
- 26 airports and 5 FIRs

SITA pre-FANS OCL
- 3 Customers
- 3 FIRS

Note: Map show SITA Contracted pre-FANS Services (not all are operational yet)

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6 Regional context - Africa

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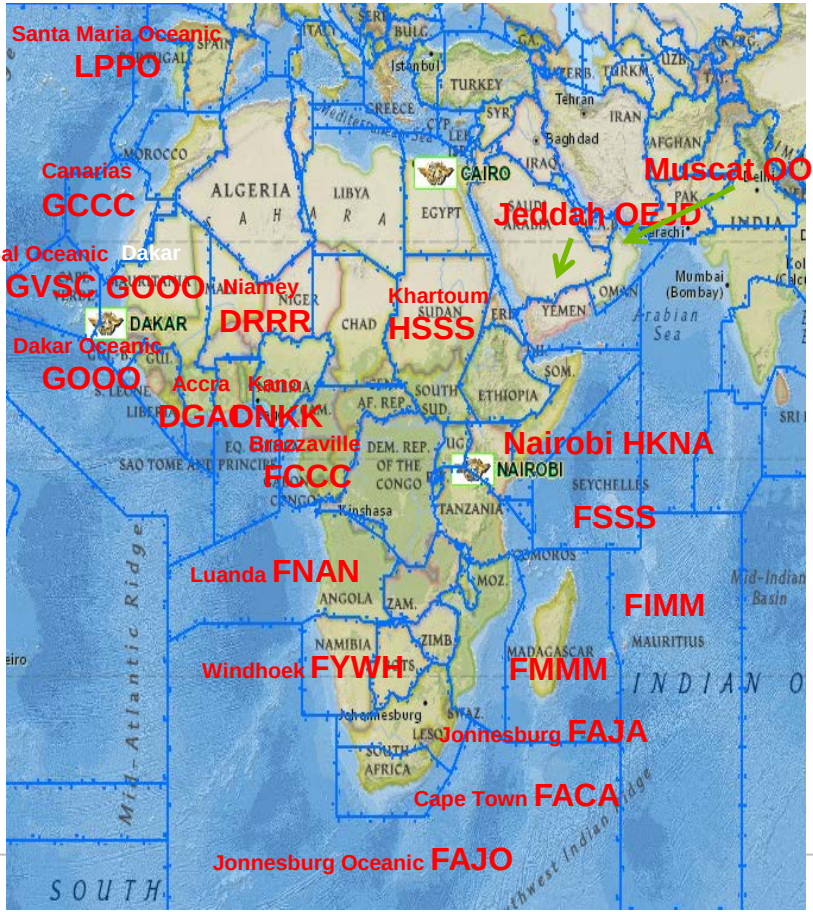
AFI Region – SITA contracted FIRs for FANS



Source ICAO

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AFI - Status of ADS/CPDLC implementation (1/2)

Country	FIR	ANSP	Status	Service Provider	Ground System Provider
Angola	Luanda	ENANA	Pre-operational	SITA	SITA
Benin	Cotonou	ASECNA	Implementation	SITA	Thales
Burkina-Faso	Ouagadougou	ASECNA	Implementation	SITA	Thales
Cabo Verde	Sal	ASA CV	Operational	SITA	Indra
Cameroun	Douala	ASECNA	Implementation	SITA	Thales
Chad	Ndjamena	ASECNA	Operational	SITA	Thales
Comores	Moroni	ASECNA	Implementation	SITA	Thales
Congo (Republic of the)	Brazzaville	ASECNA	Operational	SITA	Thales
Equatorial Guinea	Malabo	ASECNA	Implementation	SITA	Thales
Gabon	Libreville	ASECNA	Implementation	SITA	Thales
Ghana	Accra	GCAA	Operational	SITA	SITA
Ivory Coast	Abidjan	ASECNA	Operational	SITA	Thales

AFI - Status of ADS/CPDLC implementation (2)

Country	FIR	ANSP	Status	Service Provider	Ground System Provider
Madagascar	Antananarivo	ASECNA	Operational	SITA	Thales
Mauritania	Nouakchott	ASECNA	Implementation	SITA	Thales
Mauritius	Mauritius	CAA Mauritius	Operational	SITA	Thales
Namibia	Windhoek	DCA Namibia	Operational	SITA	Thales
Niger	Niamey	ASECNA	Operational	SITA	Thales
Nigeria	Lagos	NAMA	Implementation	SITA	SITA
Nigeria	Kano	NAMA	Implementation	SITA	SITA
Senegal	Dakar	ASECNA	Operational	SITA	Thales
Seychelles	Seychelles	SCAA	Operational	SITA	Selex
South Africa	Johannesburg	ATNS	Operational	SITA	Thales
Sudan	Khartoum	SCAA	Implementation	SITA	Thales
Togo	Lomé	ASECNA	Implementation	SITA	Thales

7 Datalink Traffic & Performance

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AIRCOM ATS-622 Traffic & Performance report

- 1. FANS Service Executive Summary
  - 1.1 Global FANS Datalink Traffic
  - 1.2 FANS Systems Performances
  - 1.3 FANS Reliability Performance
  - 1.4 FANS Service Performances
- 2. FANS Traffic Statistics
  - 2.1 FANS Global Datalink Traffic
  - 2.2 FANS Traffic by Media and Airlines
- 3. FANS Service Performance
  - 3.1 AIRCOM FANS Service Availability
  - 3.2 FANS RGS Availability
  - 3.3 FANS GES Availability
  - 3.4 Uplink Success Rate
  - 3.5 Uplink Reject Rate per FANS Service
  - 3.6 Uplink Reject Rate per Airline

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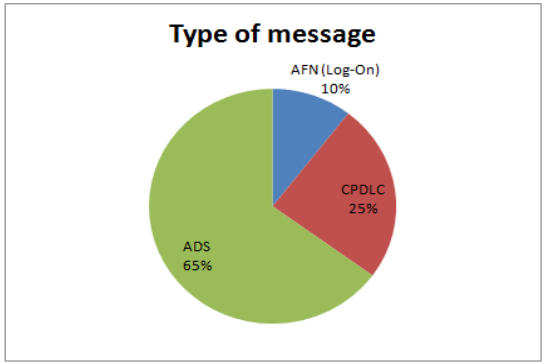
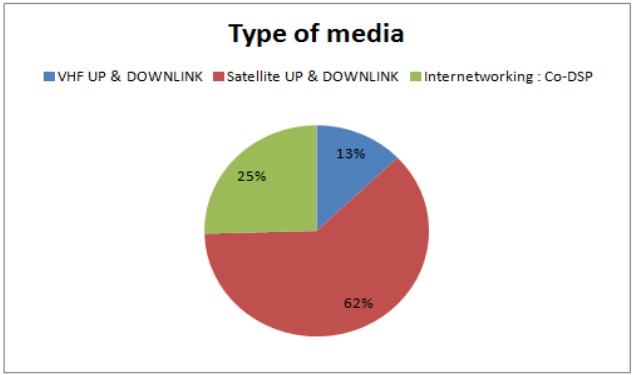
FANS Traffic in AFI region (1)

Ground Traffic in Messages (Uplink + Downlink)		%
ATS Provider	12-month average	
ATS Provider	925,682.42	
AFN (Log-On)	96,707.58	10%
CPDLC	227,766.83	25%
ADS	601,208.00	65%



	FANS BY MEDIA	%
ATS Provider	12-month average	
VHF UP & DOWNLINK	118,891	13%
Satellite UP & DOWNLINK	571,580	62%
Internetworking : Co-DSP	235,211	25%
Total FANS Traffic	925,682	



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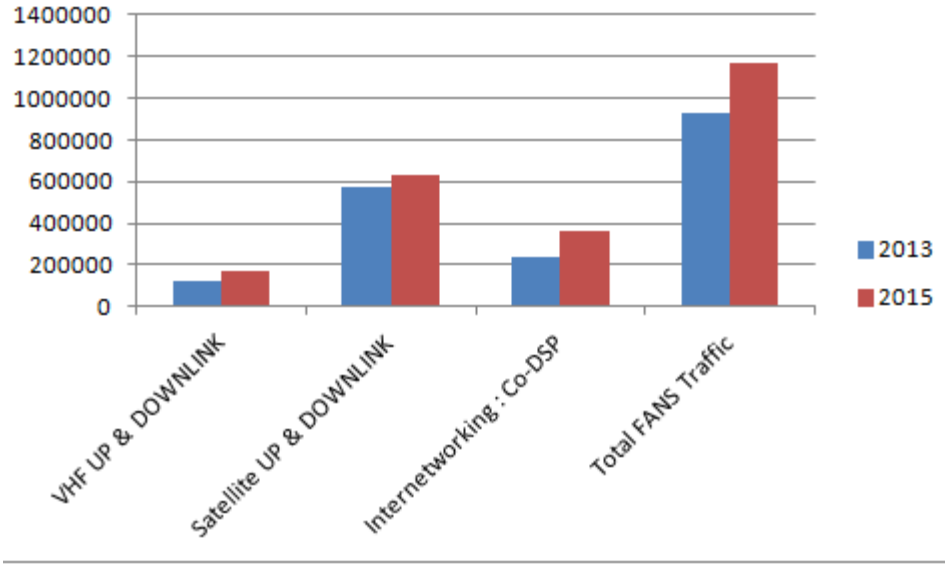
FANS Traffic in AFI region (2)

Evolution of Ground Traffic Messages (Uplink + Downlink) – 12 month average



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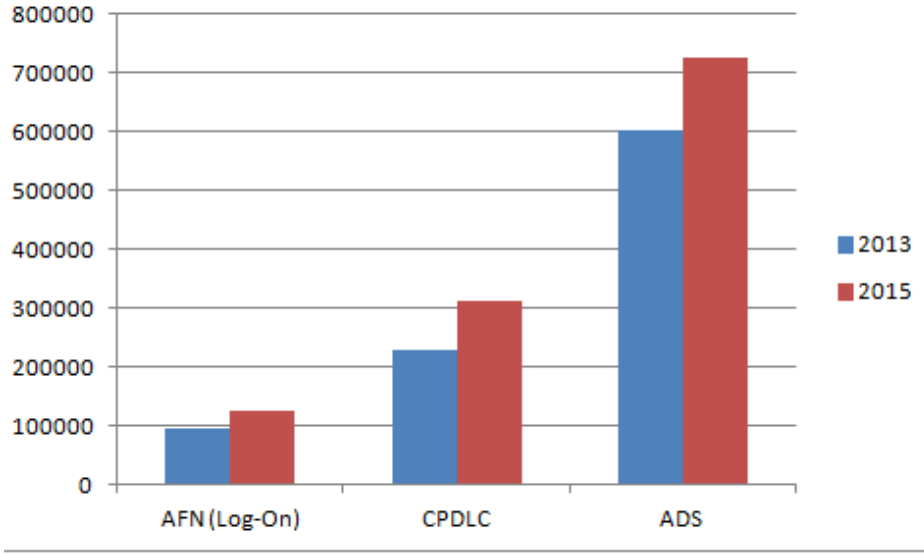
FANS Traffic in AFI region (3)

Evolution of Ground Traffic in Messages (Uplink + Downlink) – 12 month average



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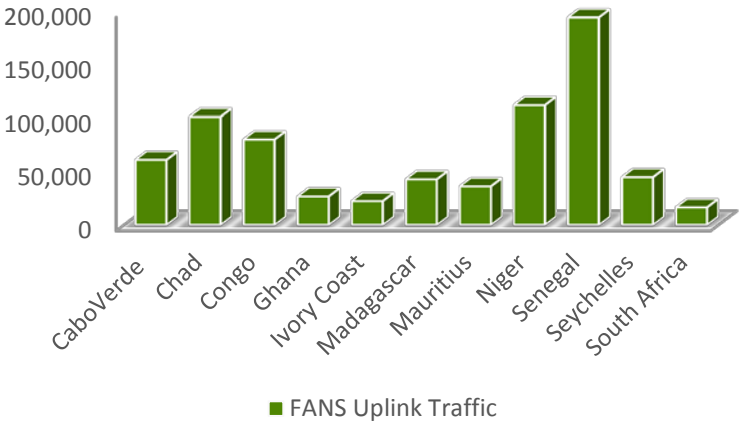
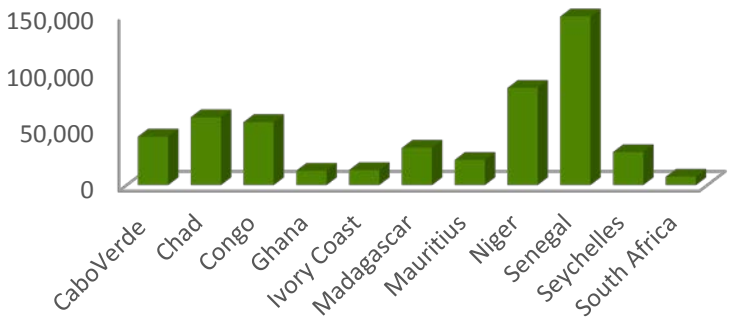
FANS Traffic in AFI Region (4)





Customer	Ground Traffic (Uplink + Downlink)	Air-Ground Traffic (Uplink + Downlink)
CaboVerde	60,927	42,696
Chad	101,018	59,680
Congo	79,998	55,330
Ghana	26,659	12,645
Ivory Coast	22,308	13,222
Madagascar	42,756	32,692
Mauritius	36,136	22,080
Niger	111,759	85,385
Senegal	194,003	148,233
Seychelles	44,724	28,996
South Africa	16,410	7,336

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AIRCOM Service Availability (1)

1. FANS Services Executive Summary for April 2015

1.1 GLOBAL FANS DATALINK TRAFFIC

Customer	Ground Traffic (Uplink + Downlink)	Percentage Total	Air-Ground Traffic (Uplink + Downlink)	Percentage Total
ATS Provider	155,229	100%	123,758	100%
FANS Services				
AFN (Log-on)	17,436	11.23%	13,369	10.80%
CPDLC	43,992	28.34%	35,170	28.42%
ADS	93,801	60.43%	75,219	60.78%

1.2 FANS SYSTEMS PERFORMANCE

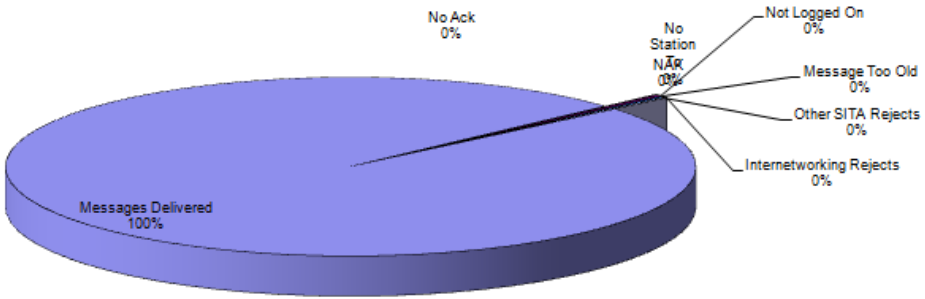
Availability	Apr-15	Last 3 Months	Last 12 Months
VHF FANS AIRCOM Processor Availability	100.00%	100.00%	100.00%
Satellite FANS AIRCOM Processor Availability	100.00%	100.00%	100.00%
VHF Access Network Availability	98.14%	98.59%	98.10%
Satellite Access Network Availability	100.00%	100.00%	100.00%
FANS Service Availability via VHF	**98.14%**	**98.59%**	**98.10%**
FANS Service Availability via Satellite	**100.00%**	**100.00%**	**100.00%**

⇒Major source of VHF service failure is associated with leased line break downs
⇒Most of the aircraft are Satellite equipped and the FANS messages are exchanged via Satellite when the VHF stations are not available.

AIRCOM Service Availability (2)

1.3 FANS RELIABILITY PERFORMANCE

FANS Services	AFN (Log-on)			CPDLC			ADS			TOTAL		
Success / Reject Rate	Apr-15	Last 3 Months	Last 12 Months	Apr-15	Last 3 Months	Last 12 Months	Apr-15	Last 3 Months	Last 12 Months	Apr-15	Last 3 Months	Last 12 Months
Messages Delivere	98.97%	99.21%	99.09%	99.41%	99.53%	99.37%	99.30%	99.38%	99.41%	99.30%	99.41%	99.35%
No Ack + NAK	0.09%	0.07%	0.08%	0.06%	0.05%	0.05%	0.06%	0.05%	0.04%	0.06%	0.05%	0.05%
No Ack	0.09%	0.07%	0.08%	0.06%	0.05%	0.05%	0.06%	0.05%	0.04%	0.06%	0.05%	0.05%
NAK	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
No Station To	0.10%	0.04%	0.01%	0.05%	0.02%	0.01%	0.02%	0.01%	0.00%	0.04%	0.01%	0.01%
Not Logged On	0.34%	0.26%	0.35%	0.21%	0.17%	0.27%	0.29%	0.23%	0.27%	0.26%	0.21%	0.28%
Message Too Old	0.13%	0.06%	0.06%	0.01%	0.01%	0.02%	0.04%	0.03%	0.05%	0.04%	0.03%	0.04%
Other SITA Rejects	0.23%	0.17%	0.22%	0.13%	0.10%	0.11%	0.15%	0.14%	0.10%	0.15%	0.13%	0.12%
Internetworking Rejects	0.14%	0.19%	0.20%	0.15%	0.12%	0.18%	0.15%	0.16%	0.13%	0.15%	0.15%	0.15%

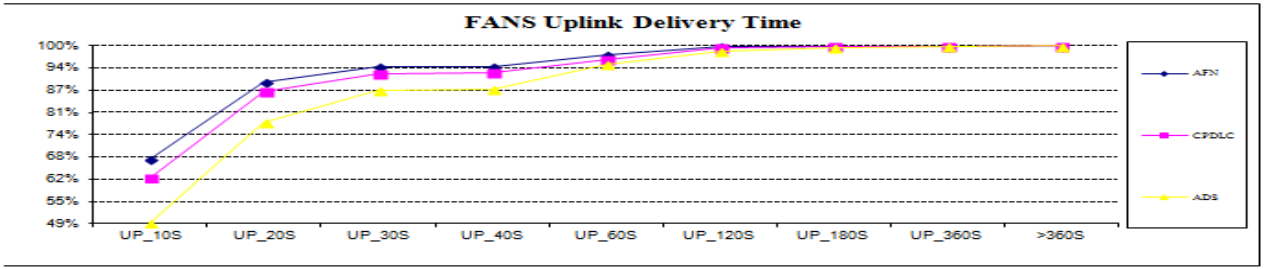


TOTAL TRAFFIC

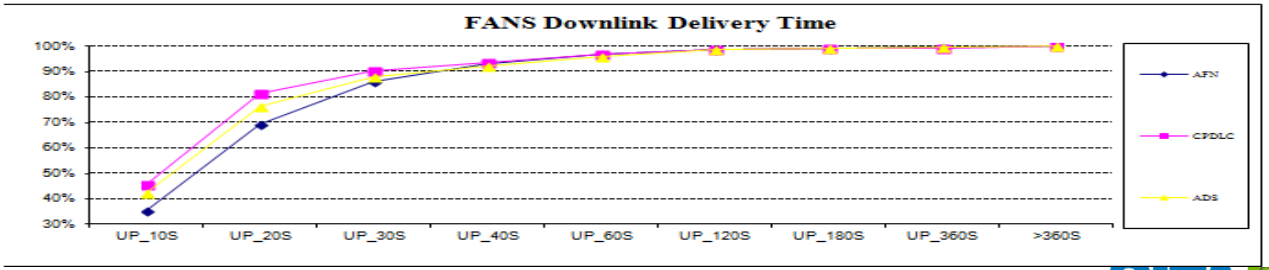
AIRCOM Service Availability (3)

1.4 FANS SERVICE PERFORMANCE (VHF+SAT)

Uplink Message Delivery Time	10 s	20 s	30 s	40 s	60 s	120 s	180 s	360 s	>360 s
ATS Provider	56.37%	82.95%	89.85%	90.24%	95.63%	99.09%	99.75%	99.99%	100.00%
AFN (Log-on)	67.36%	89.67%	93.98%	94.04%	97.42%	99.74%	99.83%	99.98%	100.00%
CPDLC	61.96%	86.98%	91.98%	92.21%	96.03%	99.51%	99.86%	99.99%	100.00%
ADS	49.14%	78.06%	87.11%	87.71%	94.84%	98.60%	99.64%	99.99%	100.00%



Downlink Message Delivery Time	10 s	20 s	30 s	40 s	60 s	120 s	180 s	360 s	>360 s
ATS Provider	42.23%	76.72%	88.51%	92.68%	96.44%	98.84%	99.23%	99.71%	100.00%
AFN (Log-on)	35.17%	69.36%	86.11%	93.34%	97.09%	98.80%	99.33%	99.65%	100.00%
CPDLC	45.62%	81.36%	90.23%	93.51%	97.05%	98.86%	99.17%	99.47%	100.00%
ADS	42.25%	76.23%	88.26%	92.15%	96.03%	98.83%	99.23%	99.82%	100.00%



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AIRCOM customer Support process

- 3 levels of support
  - Level 1 : Aircom support, H24/7
  - Level 2 : Regional aircom specialists
  - Level 3 : Expert teams on ATS and airline applications

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Level 1 : AIRCOM Support - Helpdesk H24/7

- AIRCOM Service Desk 24/7
  - Follow the sun operation
    - Staffed 12 hours from Montreal and then 12 hours from Singapore
    - Completely seamless transition for our customers
  - First level support
    - System operation and service supervision
    - Centralized problem reporting (Trillium)
    - Routine problem investigation and resolution

SITATEX : HDQASXS
E-mail : **aircom.support@sita.aero**
Tel : +65 65 48 28 28 or +1 514 282 7899
Toll Free (NA): 1 866 AIRCOM1 (247-2661)

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Level 2: AIRCOM Customer Support

- AIRCOM Specialists
  - Second level support
    - Problem analysis, investigation, testing
    - Provide assistance to AIRCOM Service Desk
    - Inform customer on new products and services that may be suitable
  - Performance reports
    - Monthly or quarterly reports
    - Performances review meeting
  - Adhoc Customer training
  - Reachable globally aircom.customer.support@sita.aero
    - Regionally at:
      - aircom.customer.support.europe@sita.aero
      - aircom.customer.support.americas@sita.aero
      - aircom.customer.support.asiapacific@sita.aero

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Level 3 - AIRCOM ATS Applications Support

- AIRCOM ATS systems Technical Specialists
  - Third level support
    - Engineers dedicated to the development, implementation, support, training of the FANS, Pre-FANS and ATN SITA ground applications
    - SW and HW Problem analysis, investigation, testing
    - Remote software correction/upgrade during warranty/maintenance period (tel/e-mail/remote access)
  - Adhoc Customer training eg on configuration/maintenance in Paris in SITA ATS Lab or at customer premises
  - Reachable globally **aircom.systems.support@sita.aero**

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Thank you

Questions?

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Emnet Meheret
ATM Business Development
Senior Manager
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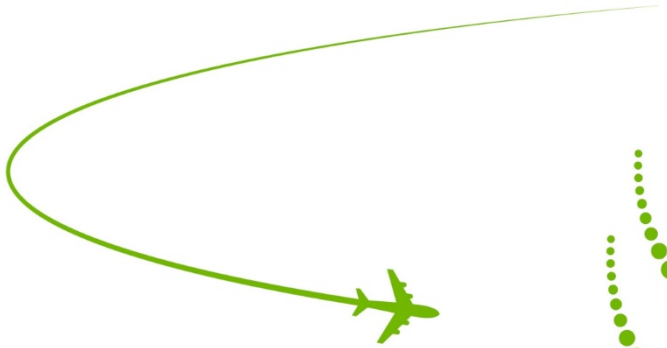
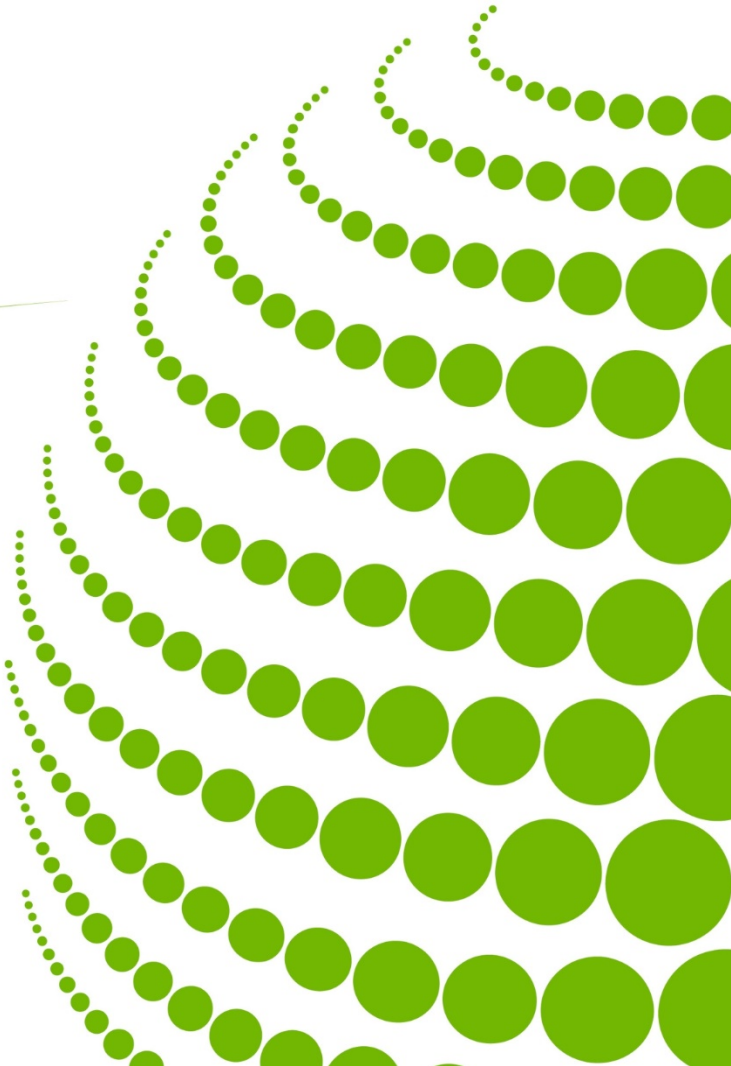
Johannesburg, South Africa





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