SB510
Air-Ground Collaborative Applications

CPDLC

Controller-Pilot Data-Link Communication

January 2015

CPDLC?

- Controller
- Pilot
- Data
- Link
- Communications

Course plan

- Historical background
- What is CPDLC
- Use of CPDLC
- Implementations overview
- Future uses of CPDLC
  - D-TAXI example

Current Voice Communications Problems

- What are you thinking about???

HF Voice bandWidth : 118 - 123 MHz

Current situation with voice communication (1/3)

Voice duration is long

- Increasing **congestion** of voice radio communication
- Under time pressure standard **readbacks** (SOP) will be sacrificed frequently
- **Simplex and Serial**: „Only One at one time“
- Tendency to **hear what is expected** to hear
- **Misunderstandings** (e.g. similar call-signs, language, accent, etc.)

Current Voice Communications Problems (2/3)

- Critical Messages Vs. Non Critical Messages,
- Stuck Mike,
- No sequencing ,
- Use of Standard Phraseology,
- Misinterpretations and Garbling,
- Acknowledgement of messages,
- Addressing of Messages(pilot errors?),
- Message Composition
- No Automatic Exchange of Information,

climb 220
climb to 26
⇒ climb to and maintain 220

Wrong frequency

Current Voice Communications Problems (3/3)

But also:

- No Downstream Requests,
- Efficiency, Workload and Task Distribution,
- Bandwidth and Line of Sight…

Current Voice Communications Problems

The main risks:

no communication, follow FPL.

- PLOC: Prolonged loss of communication,
- Altitude deviation,
- Loss of separation,
- Wrong aircraft accepting clearance,
- Instructions issued to wrong aircraft,
- Heading deviation and runway transgression, including runway incursions,
- …

Current Voice Communications Problems

In wich cases?:

- Similar Call sign
- Frequency change
- Radio equipment malfunction (air),
- Radio interference,
- Content of message inaccurate or incomplete,
- Radio equipment malfunction (ground)
- Frequency congestion (11500 VHF atc services in Europe),
- Sleeping VHF receivers and pilot distractions
- …

Current Voice Communications Problems

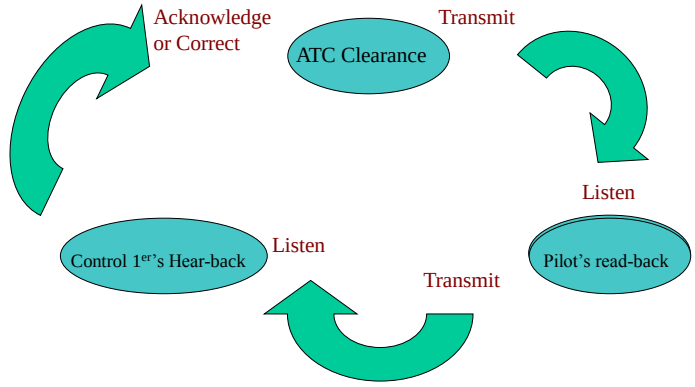
Some recommendations:

- Use of standard phraseology (NSP: Non Standard Phraseology is an obstacle to effective communication),
- Cross –checking process of the flight deck between the pilot flying (PF) and the pilot not flying (PNF) or pilot monitoring,
- Read-Back,

Current Voice Communications Problems

Some recommendations:

- The pilot-controller confirmation/correction is a « loop »…that ensures effective communication



need to close loop to make sure everybody understand.

Current Voice Communications Problems

Regulatory sources:

- ICAO Annex 10: Aeronautical Communications
- ICAO Annex 11: Air Traffic Services
- ICAO DOC 4444: Procedures for Air Navigation Services-Air Traffic Management (PANS-ATM)
- ICAO DOC 8168: Procedures for Air Navigation Services-Aircraft Operations (Pans-Ops)
- ICAO Doc 9432: Manual of Radiotelephony

Emergency communications:

- Eurocontrol- Guidelines for Controller Training in the Handling of Unusual/Emergency Situations

But…voice communication has also some advantages

- This is a way for pilots to being aware of traffic situation
- Data-link is not as efficient as voice in distress or stress situation
- It's a direct link between controllers and pilot
- It's friendly and « human »

13

What is CPDLC ?

- CPDLC is a technique that supports direct communications between air traffic controllers and pilots, using data link.

- CPDLC was designed to *overcome* problems experienced in voice communications (distortion, mispronunciation, misunderstandings, etc) as well as assisting with other limitations (e.g. frequency congestion, etc).

14

OJF9137, Maastricht 132.085, correction 132.635, by - by.
132,35 9137 by-by sir thank you.
132.635
132.635 by-by sir thank you.
welcome

CPDLC

- It is imperative to recognise that CPDLC is *not* simply a communications medium for exchanging textual information.

- Because CPDLC can interface directly with the aircraft avionics and permit the automatic transmission of reports (e.g. when the aircraft reached an assigned altitude), it is also expected that significant safety benefits and workload reduction could be realised.

- Automation includes the pilot's ability to load route clearances, cleared flight level, etc, from CPDLC messages automatically into the FMS.

CPDLC could help, because of…

- Performing of **routine** communication
- **Visualisation** of Information
- **Back up** for voice
- Enabling **recording**
- Enabling **sharing**
- **Precise** and **concise** exchange of information
- **Parallel** exchange of information
- Could **solve** the "**Stuck Mike**" Problem

17

But…

- More **inflexible** than voice
- **Slower** feedback than voice
- Suppression of **non-verbal** peripheral cues
- Mix of **equipped and non-equipped** aircraft
- Mix of **DL and voice** clearances
- Increased load of **visual perception**

18

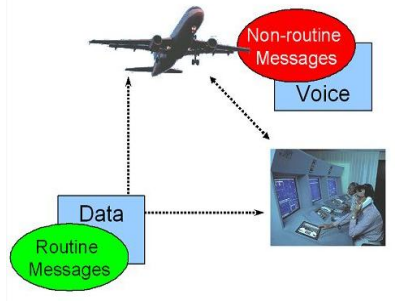
Anticipated Constraints
of the ATCOs and Pilots

Controller

- Increasing workload by increased **input requests** (mouse clicks)
- **Tactical & flexible control is endangered** (latency)
- Computed **taxi routes not flexible** enough to meet the users' needs
- Increased need for **internal crew communication**
- **Different procedures**, either brand specific or Airport specific, could lead to the flight crew's confusion
- **traffic context-dependent information** can hardly be transmitted

Use of CPDLC

The air law : Operating Principles
Compatibility with Voice Operations

Data versus Voice	Statement
	Controllers and Pilots will use CPDLC in conjunction with existing voice communications

Current use of CPDLC

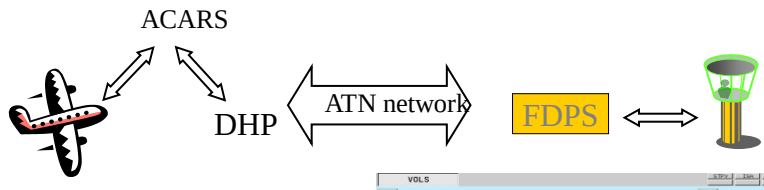
- Departure clearance
- En-route clearances
- Oceanic clearances
- D-ATIS

Automatic Terminal Information Service.

Datalink Services on ACARS

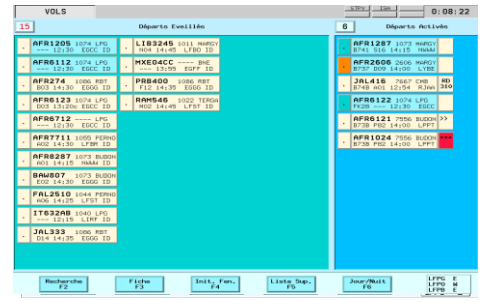
	Notification	Exchange of Messages	Information Services	Automatic Dependent Surveillance
Applications	**AFN** Context Management	**CPDLC** Controller Pilot Datalink Communication	**DFIS** Digital Flight Information Services	**ADS** Automatic Dependent Surveillance
Services	DLIC Datalink Initiation Capability	ACM : Freq. Transfer ACL : Clearances DCL : Dep. Clearances OCL : Oceanic Clearances D-TAXI : Start-up, Push back, Taxi clearances	D-OTIS (ATIS, VOLMET, NOTAM) : Tailored AIS/MET Information	ADS-C

DCL Service
Departure clearance by datalink



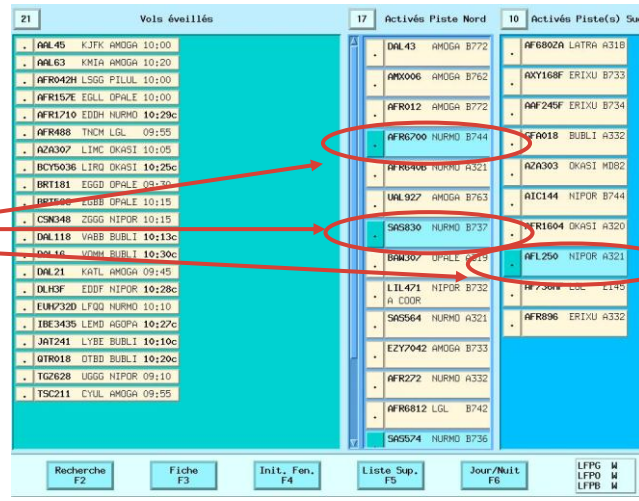
DCL Function

TWR EFSS

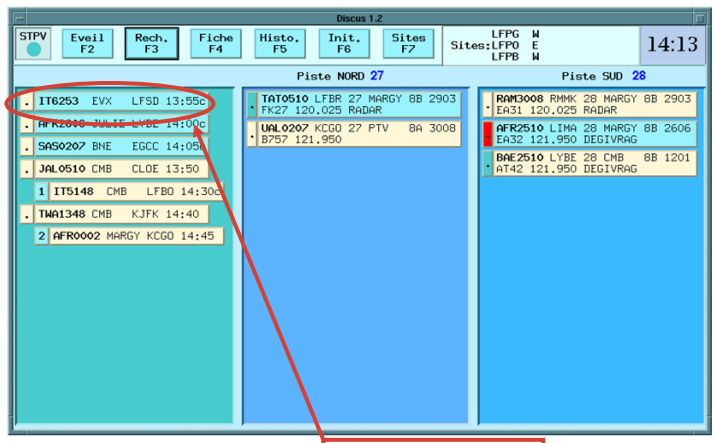


DISCUS SYSTEM IN PARIS CDG

Departure Clairance **Using Datalink: « In blue »**

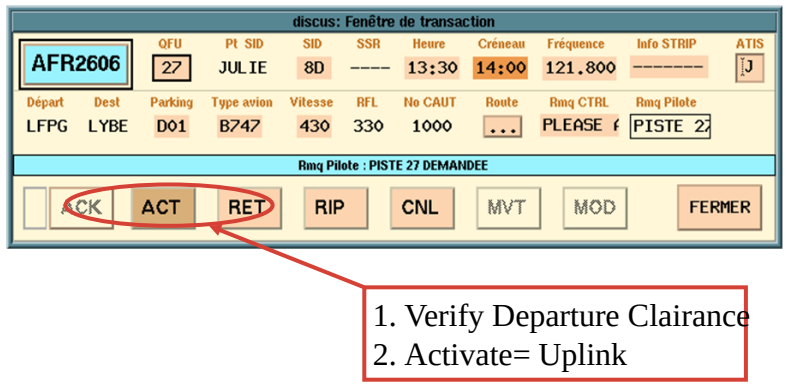


DISCUS SYSTEM IN PARIS CDG



Click on call sign

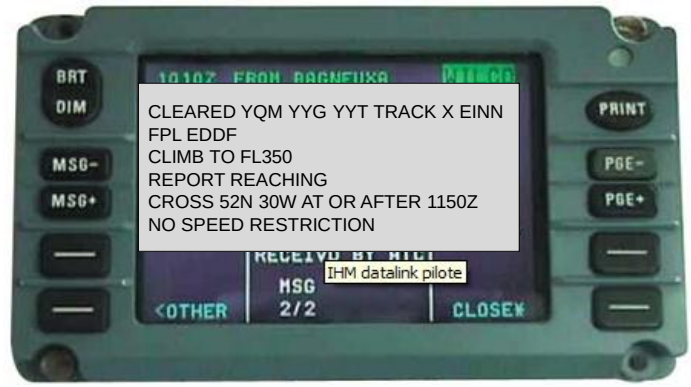
DISCUS SYSTEM IN PARIS CDG



1. Verify Departure Clairance
2. Activate= Uplink

PILOT SCREEN ON BOARD (MCDU)

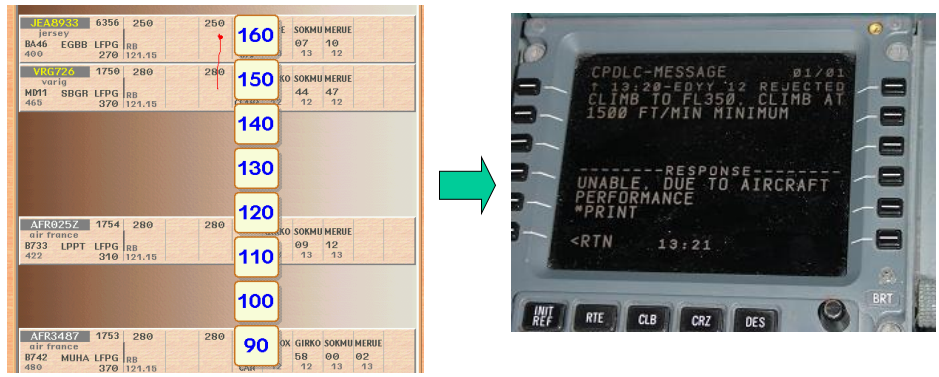
REQUEST CLEARANCE YQM YYG YYT
TRACK X EINN FPL EDDF
REQUEST CLIMB FL350
WE CAN ACCEPT FL390 AT 1139Z
REQUEST MACH .84



Some CPDLC messages

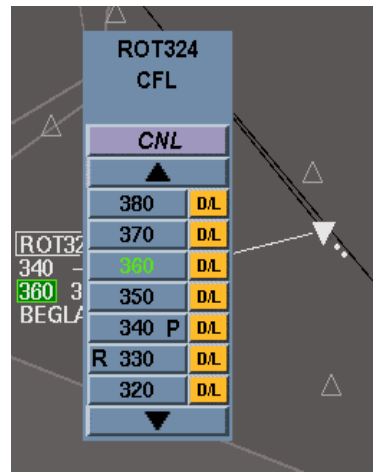
- **Pre-formatted messages replacing voice communication ICAO phraseology**
- Altitude, speed, route clearances
  - (ex : CLIMB TO AND MAINT FL350)
- Transfert ATC
  - (ex : CONTACT BRISBANE 130.9MHz)
- Reports
  - (ex : PRESENT SPEED M0.83)
- Emergency
  - (ex : MAYDAY)
- Free Text

Data link message



Automatic sending of a CPDLC « climb to » message

Another controller Menu



CPDLC VARIOUS APPLICATIONS

•DCL (Departure Clearance) Service

•Automatic system of transmission of departure clearance settled on several airports and in development on others.

•3 types op operational messages :

- RCD (DCL request)
- CLD (Departure clearance)
- CDA (Departure clearance acknowledgement)

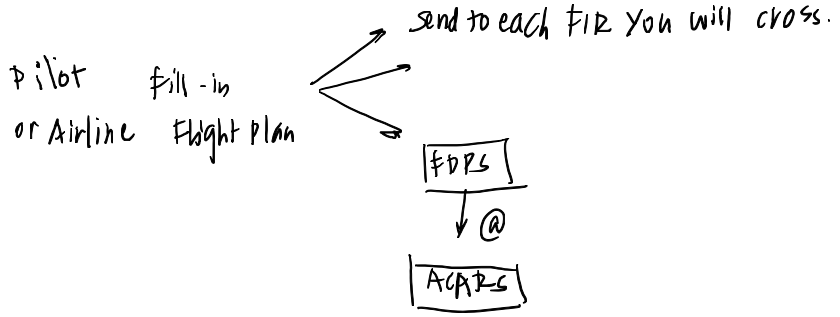
A) DATALINK services
CPDLC identity and flight plan

All aircrafts have an their own ICAO address, and it must be mentioned in the flight plan :

Field 10 : **J**

Field 18 :

DAT/V CODE/AF24FB5 COM/CPDLC



THE ATIS MESSAGE
Automatic Terminal Information Service

- **Under classical voice form on a published VHF frequency :**
  - Provided for all listening aircrafts,
  - giving parameters concerning meteorological conditions, state of radio aids, and potential dangers for flights.
  - Composition normalized to avoid any confusion.
    - Must be recorded with discipline with a regular rhythm but moderate, with a particular care for articulation.
    - Or voice synthesis
- **Digital ATIS (D-ATIS)** ⇒ CPDLC.
  - Via CPDLC and FANS 1/A (ACARS)

ATIS ⇒ voice

THE ATIS MESSAGE

- **Name of airport and time of recording**
- **Activities of zones**
- **Information on air trafic areas**
- **Runway in use and type of approach**
- **Transition level**
- **Wind direction and strength** → reference pressure level
- **Visibility**
- **State of clouds**
- **Temperature**
- **Dew point** 凝结点
- **Pressures : QNH, QFE**
- **Significiant phenomenas**
- **Time of sunset**

DFIS: ATIS Vs D-OTIS

- D-OTIS=D-ATIS+NOTAM
- D-ATIS=ATIS(Arr/Dep)+VOLMET

CPDLC
two implementations :

- FANS 1/A
  - (ACARS and SATCOM networks)
- FANS B or ATN
  - (VDL2)

Controller Pilot Data Link Communications (CPDLC)

2 implementations :

FANS 1/A (Boing, Airbus) (1999)

- based onto ACARS
- Pacific and north Atlantic

ICAO Doc9705 compliant ATN/CPDLC system, (or FANS 2/B)

- Based on VDL mode 2 (so, much faster)
- Operational in Maastricht
- In test in several European Countries
- Supported by Eurocontrol LINK2000+ program
- Safety proved by EUROCAE ED-120 (RTCA DO-290)
- Best candidate for HF replacement

VDL 2 ≃ TCP/IP

ATS messages are Displayed onto A standard DCDU unit on board

CPDLC UPLINK MESSAGES

UL #	RESPONSES/ACKNOWLEDGMENTS
0	UNABLE
1	STANDBY
2	REQUEST DEFERRED
3	ROGER
4	AFFIRM
5	NEGATIVE

41

CPDLC UPLINK MESSAGES

UL#	VERTICAL CLEARANCES
6	EXPECT **[altitude]**
7	EXPECT CLIMB AT **[time]**
8	EXPECT CLIMB AT **[position]**
9	EXPECT DESCENT AT **[time]**
10	EXPECT DESCENT AT **[position]**
11	EXPECT CRUISE CLIMB AT **[time]**
12	EXPECT CRUISE CLIMB AT **[position]**
13	AT **[time]** EXPECT CLIMB TO **[altitude]**
14	AT **[position]** EXPECT CLIMB TO **[altitude]**
15	AT **[time]** EXPECT DESCENT TO **[altitude]**
16	AT **[position]** EXPECT DESCENT TO **[altitude]**
17	AT **[time]** EXPECT CRUISE CLIMB TO **[altitude]**
18	AT **[position]** EXPECT CRUISE CLIMB TO **[altitude]**

42

CPDLC UPLINK MESSAGES

UL#	VERTICAL CLEARANCES
19	MAINTAIN **[altitude]**
20	CLIMB TO AND MAINTAIN **[altitude]**
21	AT **[time]** CLIMB TO AND MAINTAIN **[altitude]**
22	AT **[position]** CLIMB TO AND MAINTAIN **[altitude]**
23	DESCEND TO AND MAINTAIN **[altitude]**
24	AT **[time]** DESCEND TO AND MAINTAIN **[altitude]**
25	AT **[position]** DESCEND TO AND MAINTAIN **[altitude]**
26	CLIMB TO REACH **[altitude]** BY **[time]**
27	CLIMB TO REACH **[altitude]** BY **[position]**
28	DESCEND TO REACH **[altitude]** BY **[time]**
29	DESCEND TO REACH **[altitude]** BY **[position]**
30	MAINTAIN BLOCK **[altitude]** TO **[altitude]**
31	CLIMB TO AND MAINTAIN BLOCK **[altitude]** TO **[altitude]**

CPDLC UPLINK MESSAGES

UL#	ADDITIONAL MESSAGES
164	WHEN READY
165	THEN
166	DUE TO TRAFFIC
167	DUE TO AIRSPACE RESTRICTION
168	DISREGARD
169	**[free text]**
170	**[free text]**
176	MAINTAIN OWN SEPARATION AND VMC
177	AT PILOTS DISCRETION

CPDLC DOWNLINK MESSAGES

DL#	RESPONSES
0	WILCO
1	UNABLE
2	STANDBY
3	ROGER
4	AFFIRM
5	NEGATIVE

45

CPDLC DOWNLINK MESSAGES

DL#	VERTICAL REQUESTS
6	REQUEST **[altitude]**
7	REQUEST BLOCK **[altitude]** TO **[altitude]**
8	REQUEST CRUISE CLIMB TO **[altitude]**
9	REQUEST CLIMB TO **[altitude]**
10	REQUEST DESCENT TO **[altitude]**
11	AT **[position]** REQUEST CLIMB TO **[altitude]**
12	AT **[position]** REQUEST DESCENT TO **[altitude]**
13	AT **[time]** REQUEST CLIMB TO **[altitude]**
14	AT **[time]**REQUEST DESCENT TO **[altitude]**
69	(message not supported)

46

CPDLC DOWNLINK MESSAGES

DL#	ADDITIONAL MESSAGES
65	DUE TO WEATHER
66	DUE TO AIRCRAFT PERFORMANCE
67	**[free text]**
67b	WE CAN ACCEPT **[altitude]** AT **[time]**
67c	WE CAN ACCEPT **[speed]** AT **[time]**
67d	WE CAN ACCEPT **[direction]** **[distanceOffset]** AT **[time]**
67e	WE CANNOT ACCEPT **[altitude]**
67f	WE CANNOT ACCEPT SPEED **[speed]**
67g	WE CANNOT ACCEPT **[direction]** **[distanceOffset]**
67h	WHEN CAN WE EXPECT CLIMB TO **[altitude]**
67i	WHEN CAN WE EXPECT DESCENT TO **[altitude]**
68	**[free text]**
74	MAINTAIN OWN SEPARATION AND VMC
75	AT PILOTS DISCRETATION

47

AMC: ATC Micro CHECK

to all aircraft

The AMC service allows controllers to send an instruction to CPDLC capable aircraft on a given frequency, at the same time, in order to instruct flight crews to verify that their voice communication equipment is not blocking a given voice channel. This instruction will be issued only to those aircraft under his control. The AMC service will be available to controllers only after use of the ACM service.

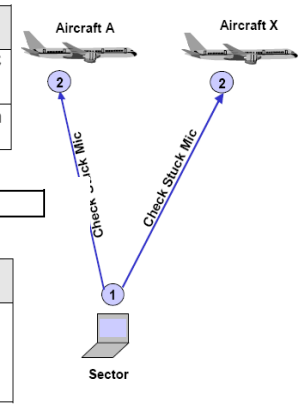
has to log on to receive the message

AMC: ATC Micro CHECK

Step	Operating Method
1	An instruction to check a blocked microphone is sent to all CPDLC capable aircraft under the responsibility of the controller
2	The flight crews are notified upon aircraft receipt of the AMC instruction

UM157 CHECK STUCK MICROPHONE [frequency]

Step	Operating Method
	The flight crews check their communication equipment to: - determine if they are responsible for the blockage, and - correct the problem, if applicable

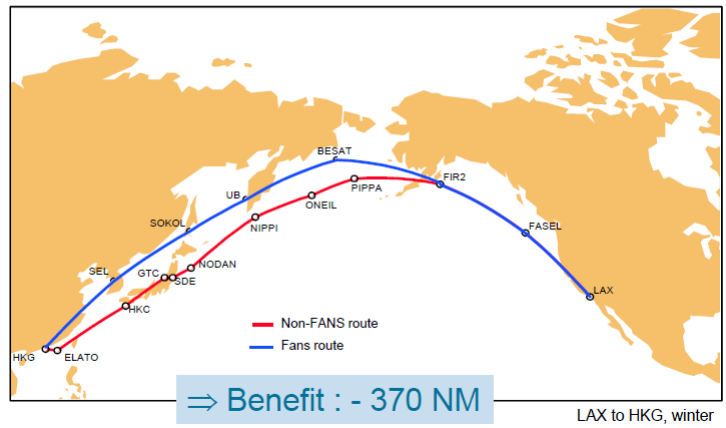


FREE TEXT

- Both pilot and controller have the ability to compose free text messages for transmission to each other.
- Free text should only be used for clarification, or for when an appropriate CPDLC message does not exist .

FANS 1/A benefits for airlines: shorter routes

Los Angeles - Hong Kong



⇒ Benefit : - 370 NM

LAX to HKG, winter

FANS 1/A benefits for airlines: separation reduction

- CPDLC and ADS-C allow to introduce new procedures reducing A/C separations in FANS controlled airspaces.
- 30NM / 30NM spacing implemented in Pacific areas (Tasmania sea, Oakland, Australia, Fiji and New Zealand,…)

	Separation Standard 30NM/30NM	Separation Standard 50NM/50NM
Communications	DCPC [CPDLC]	VHF or CPDLC or HF
Navigation	Both aircraft RNP 4	Both aircraft either RNP 4 or RNP 10
Surveillance	ADS-C reporting at least every 14 min	Position report at least every 30 min

52

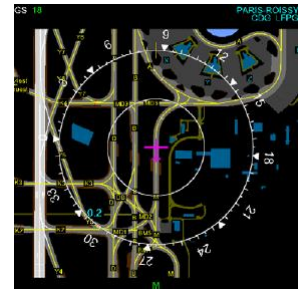
The future ?

An example
Taxi CPDLC
(on ground, with FANS 2/B)

caution : not in service yet, still experimental !

D-TAXI

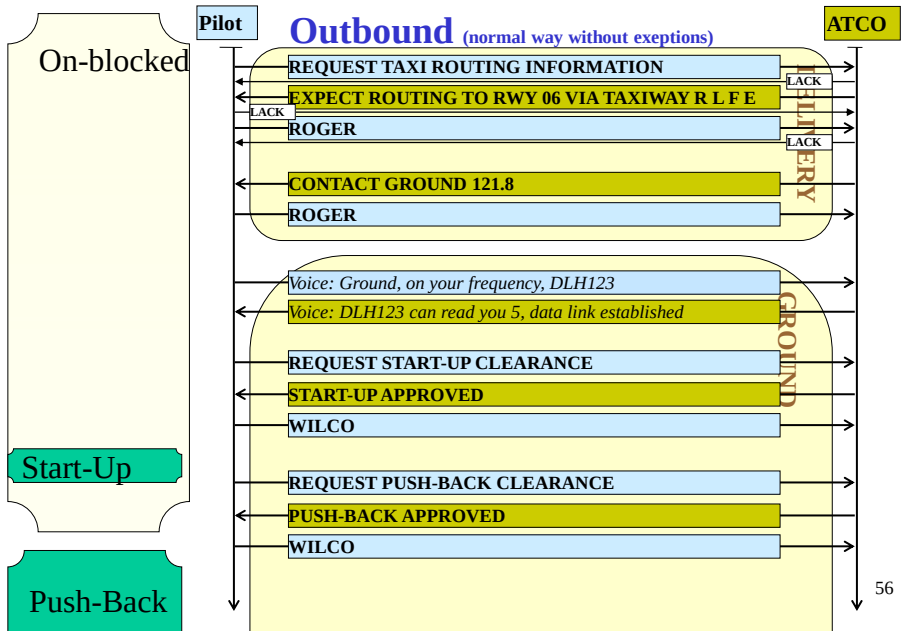
- OANS(On-board Airport Navigation System)is an Airbus system (Hardware / Software & Airport Database package) able to determine and display the a/c position on airport map
- ANF (Airport Navigation System on A350XWB)

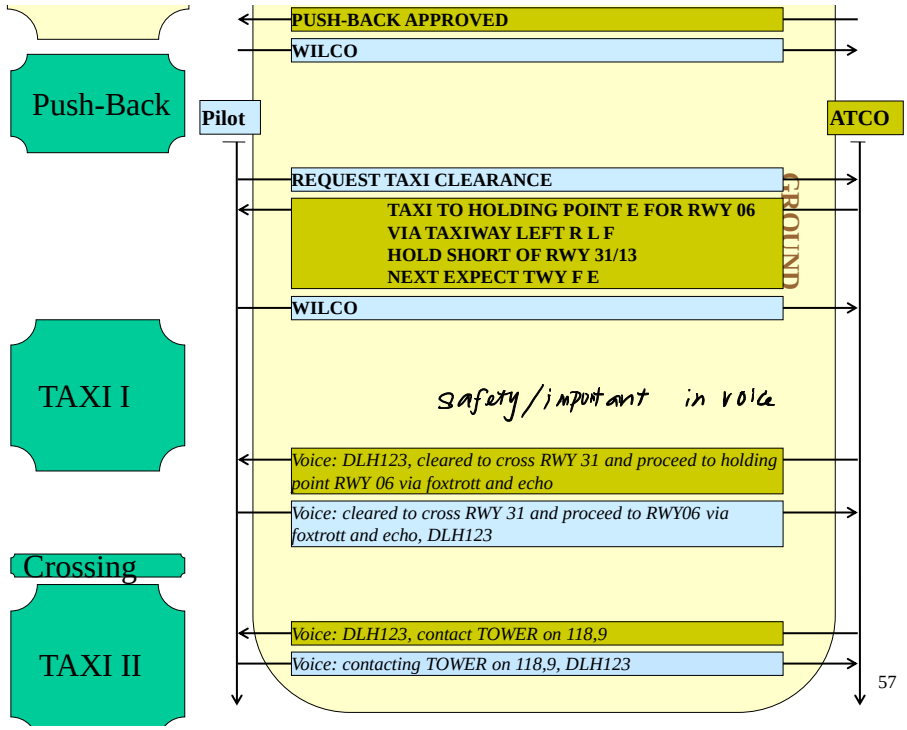


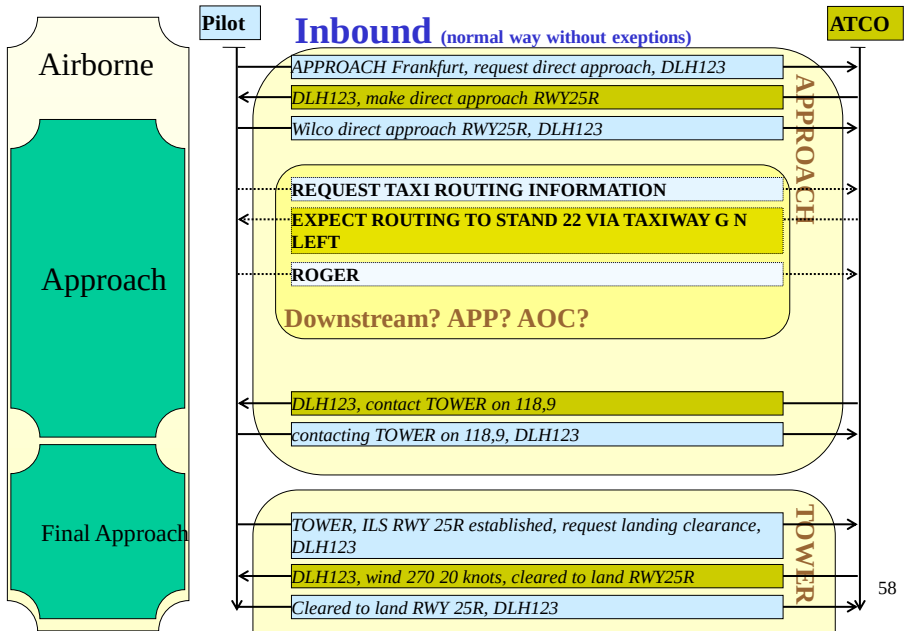
•Objectives :
- •Improve operational efficiency during taxi phases
- •Diminution of pilot workload, high during this phase
- •Less incidents (less misunderstanding)
- •Better organization, less delays during this phase

•Contribute to improve security on ground platforms, more and more complex and dense

•Help to prevent runway incursion, take-off from a wrong runway or a taxiway




Push-Back
TAXI I
Crossing
TAXI II
Pilot
ATCO
PUSH-BACK APPROVED
WILCO
REQUEST TAXI CLEARANCE
TAXI TO HOLDING POINT E FOR RWY 06
VIA TAXIWAY LEFT R L F
HOLD SHORT OF RWY 31/13
NEXT EXPECT TWY F E
GROUND
WILCO
safety / important in voice
Voice: DLH123, cleared to cross RWY 31 and proceed to holding point RWY 06 via foxtrott and echo
Voice: cleared to cross RWY 31 and proceed to RWY06 via foxtrott and echo, DLH123
Voice: DLH123, contact TOWER on 118,9
Voice: contacting TOWER on 118,9, DLH123
57


Airborne
Approach
Final Approach
Pilot
ATCO
Inbound (normal way without exeptions)
APPROACH Frankfurt, request direct approach, DLH123
DLH123, make direct approach RWY25R
Wilco direct approach RWY25R, DLH123
APPROACH
REQUEST TAXI ROUTING INFORMATION
EXPECT ROUTING TO STAND 22 VIA TAXIWAY G N LEFT
ROGER
Downstream? APP? AOC?
DLH123, contact TOWER on 118,9
contacting TOWER on 118,9, DLH123
TOWER, ILS RWY 25R established, request landing clearance, DLH123
DLH123, wind 270 20 knots, cleared to land RWY25R
Cleared to land RWY 25R, DLH123
TOWER
58

The great CPDLC projects in the world

ATN operational or to be settled in many places

In Asia as a ground infrastructure for AHMS communications (Aeronautical Message Handling System) FPL MOTAM F1

In the United States with the NEXTGEN Build 1A program

- Questions ?

THE END

Thank You !