Aeronautical Communications – An Important Enabler for Risk Mitigation

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Overview

- Developments in Air-Traffic Management (ATM)
  - European air-traffic is expected to double by 2025/2030
  - New ATM concepts for more efficiency, greenness, and safety are developed (SESAR, NextGen)
- Consequences for aeronautical communications
  - Increased capacity for communications required
  - Paradigm shift from voice to data link communications, e.g. 4D trajectories cannot be handled by voice
  - State-of-the-art communications have to be supplemented by future communications concepts
  - Aeronautical communications has the potential to enable risk mitigation in the near future

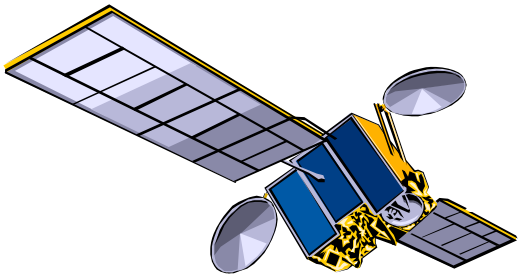
State-of-the-Art Communications

- Main pillar in communication between pilot and controller is still analog voice
- Recently first digital data links introduced
- Analog voice communications
  - Voice communication in VHF-band (118-137 MHz)
    - “Double Sideband Amplitude Modulation” (DSB-AM) technology introduced more than 50 years ago
    - Channel bandwidth 25 kHz (8,33 kHz introduced since 1999 for FL 245+ and since 2007 for FL 195+)
  - Voice communication in HF-band (2,8-22,0 MHz)
    - “Single Sideband (SSB) Modulation”
    - Channel bandwidth 4 kHz, bad voice quality
    - Used for remote areas without VHF voice coverage

State-of-the-Art Communications

ACARS: Aircraft Communications Addressing and Reporting System
VDL: VHF (Very High Frequency) Digital Link
HFDL: High Frequency (HF) Data Link

- Digital (data link) communications
  - ACARS: VHF, MSK with 2,4 kbit/s, for AOC only
  - VDL Mode 2: VHF, D8PSK with 31,5 kbit/s, CSMA, currently introduced in Europe
  - VDL Mode 3: Standardized but not introduced
  - VDL Mode 4: Standardized but not introduced
  - HFDL: HF, M-PSK with up to 1,8 kbit/s
- Satellite communications
  - Inmarsat: GEO (4), up to 432 kbit/s for SwiftBroadband, less for Swift 64 and classic services
  - Iridium: LEO (66), up to 9,6 kbit/s
  - Globalstar: LEO (48), up to 9,6 kbit/s



State-of-the-Art Communications

State-of-the-art communications
might not be sufficient
for enabling efficient risk mitigation

- Available data link capacity and data rates
- Missing connectivity between data links

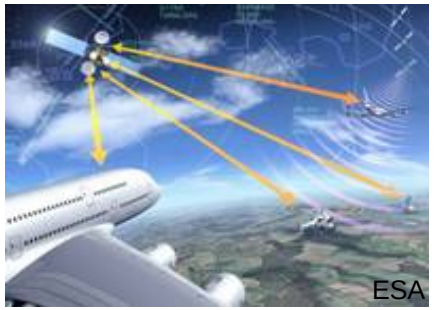
Future Communication Concepts

- Current data link developments
  - Aeronautical Mobile Airport Commun. System – AeroMACS
    - Airport data link based on WiMAX (IEEE 802.16e)
    - Very high data-rate, broadband data link (5/10 MHz)
    - Mobile (aircraft) and portable (sensors) applications
  - L-Band Digital Aeronautical Commun. System – L-DACS
    - L-DACS1: Broadband FDD system based on OFDM multi-carrier technology like WiFi, WiMAX, and LTE
    - L-DACS2: Narrowband TDD single-carrier system
    - Decision after prototyping and compatibility measurements, both performed within SESAR Joint Undertaking

DLR L-DACS1 Prototype

Future Communication Concepts

- Current data link developments
  - Satellite-based ATM communications system – ESA Iris Project
    - Dedicated European satellite system for ATM for oceanic and remote areas and as supplement for continental airspace
    - Envisaged final deployment: around 2020
    - Phase 1 (finalized): System definition
    - Phase 2 (running): System development, including standardization and validation
    - Phase 3 (planned): In-orbit verification and certification of pre-operational system, technical support to full system deployment

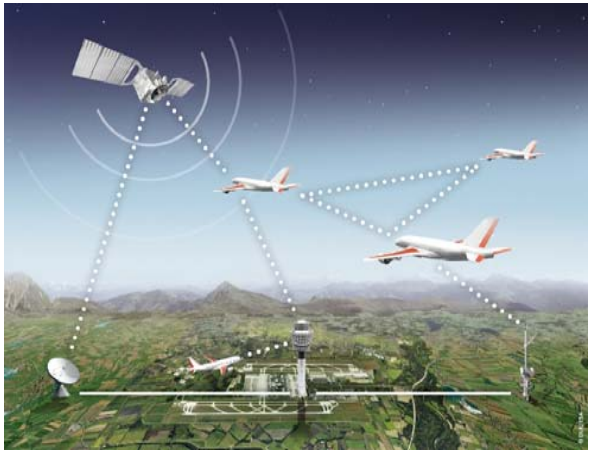


  - Direct air-to-air communications
    - Recently started research activity, e.g. by DLR
    - Goal: Air-to-air connectivity beyond ADS-B as provided by SSR Mode S or UAT

Future Communication Concepts

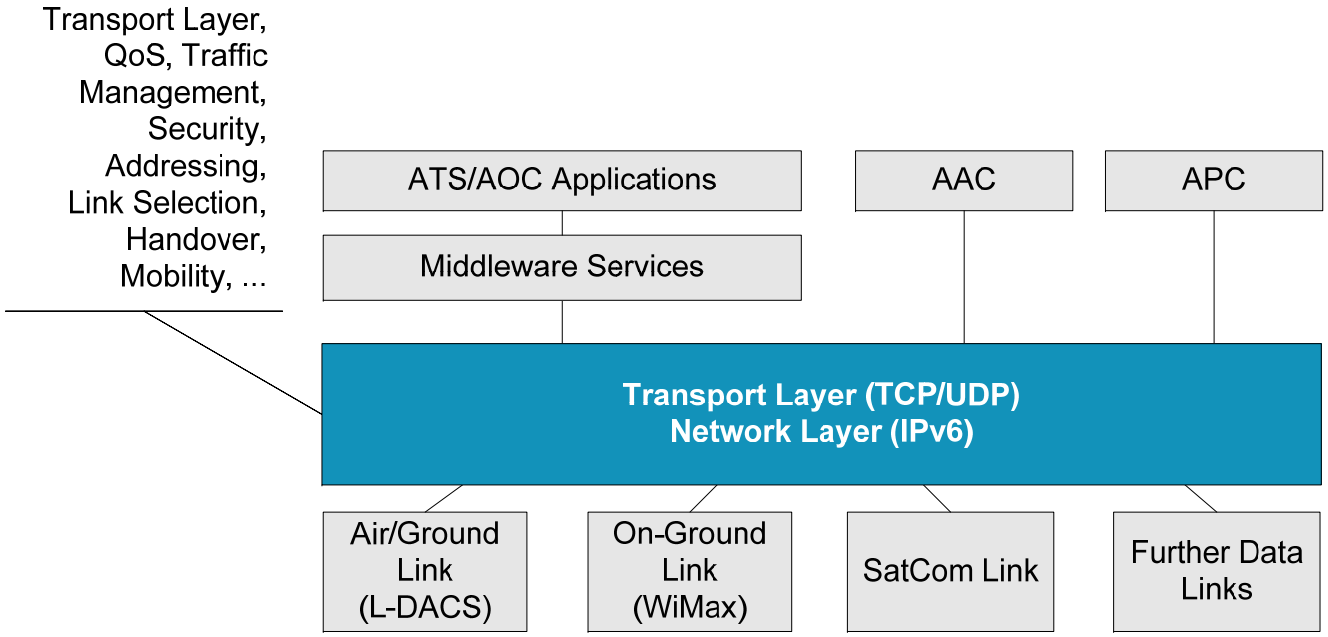
NEWSKY: Networking the Sky
SANDRA: Seamless Aeronautical Networking through int. of Data links, Radios, and Antennas

- Aeronautical networking – “Networking the Sky”
  - Several data links are available or in development:
    VDL Mode 2, HFDL, AeroMACS, L-DACS, SatCom
  - Disparate commununication systems are expensive and inefficient
  - DLR vision “Networking the Sky”
    Development of solutions for an aeronautical communication network based on IPv6 for the integration and interoperability of different services and different data links
    - EU project NEWSKY
      initiated and led by DLR proved feasibility and developed networking concept
    - EU project SANDRA
      is aiming – as NEWSKY follow-up –
      at demonstrator implementation
      of networking concept

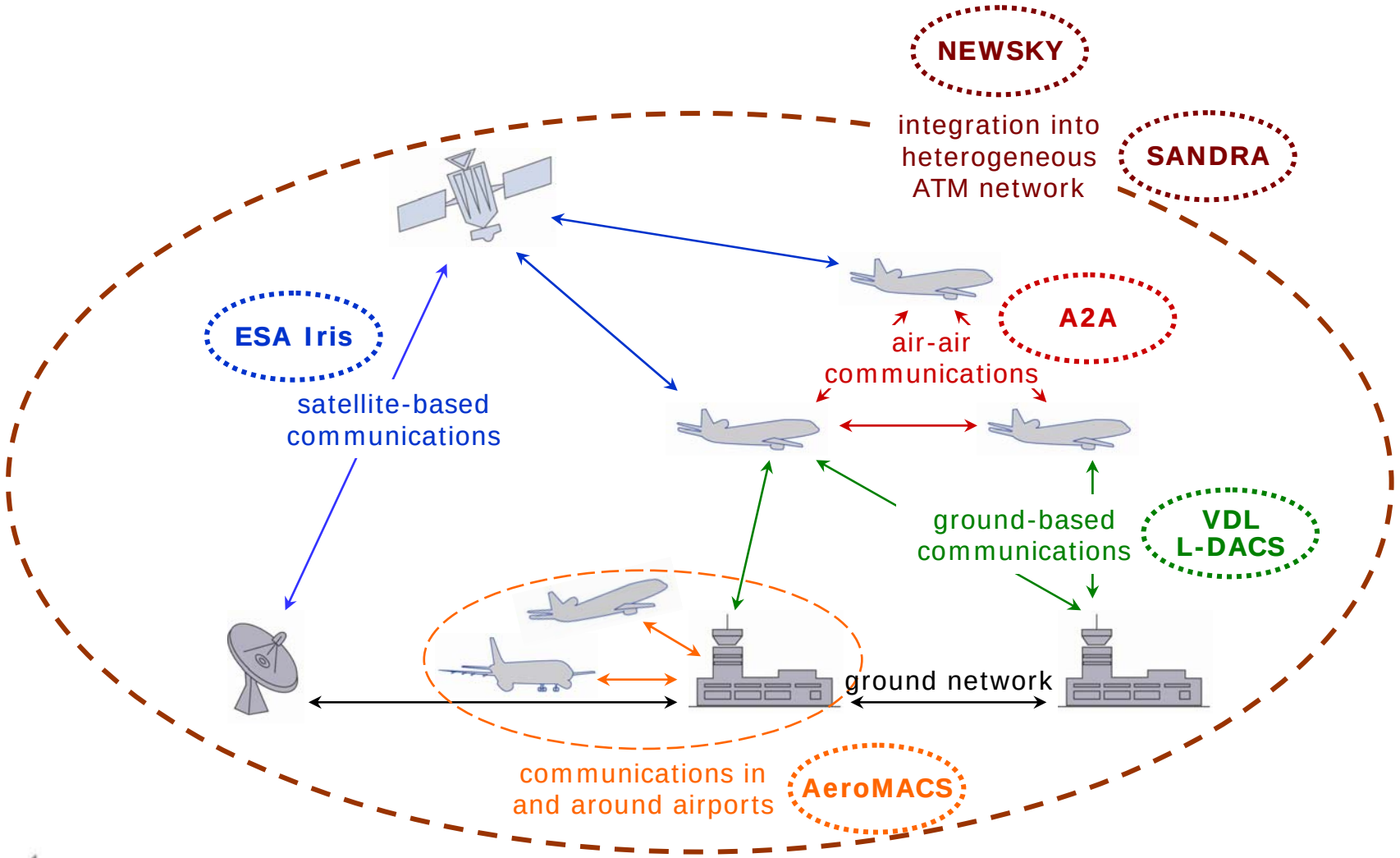


Future Communication Concepts

- Aeronautical networking – “Networking the Sky”
  - The IPv6 based networking solutions aim at cost savings, high reliability and an optimal alignment with the evolution of communication and security technologies



Future Communication Concepts – Summary



Potential for Risk Mitigation

- Information of aircraft crews about weather effects
  - Using dedicated links – ground-based data links (VDL, L-DACS) or satellite links in remote areas
  - Using aeronautical communications network
  - Countermeasures are taken, e.g. re-routing of flight route
- Airborne sensor network
  - Each aircraft acts as a sensor for meteorological data
  - Sensor data is centrally collected on ground and processed
  - Global weather map is produced on ground
  - Aircraft in areas with (severe) weather effects are informed
  - Prerequisite: Broadband aeronautical communications network

Potential for Risk Mitigation

- "Online" black-box
  - Black-box essential for avoiding future accidents
  - Sometimes data or black-box itself gets lost during accidents
  - Countermeasure:
    - Continuously transmit black-box data to ground
    - In case of accident, data is immediately available for inspection
  - Prerequisite: Broadband data link connection
    - Dedicated broadband satellite link
    - Broadband aeronautical communications network

Conclusions

COM: Communication
SURV: Surveillance
NAV: Navigation

- In the medium-term, an aeronautical communications network is envisaged with potential for risk mitigation
- In the short-term, dedicated satellite links may be used
- Applications for risk mitigation should be defined (asap!)
  - Including requirements on data rate, latency, etc.
  - Important for consideration within future link development
- Technology for broadband communication is available
  - Problem is spectrum resource
  - Aeronautical spectrum is quite large, but inefficiently used
    - Modernization of SURV and NAV systems required
    - Rearrangement between SURV, NAV and COM required

Conclusions

Future communication concepts have the potential for risk mitigation

- Demand and requirements must be clearly stated
- Resources (spectrum) must be made available

Questions?