B-AMC

Final Achievements

Prepared by Frequentis and DLR

Presented by C. Rihacek

Contents

- Introduction – Specific B-AMC Context
  - Project Scope
  - Project Deliverables
  - From B-VHF to B-AMC
- B-AMC Operations
  - A/G and A/A Mode of Operation
  - Functional Scope
- Required Adjustments for L-Band Use
- B-AMC System Deployment
- Architectures
- Recommendations

Introduction

- Project Scope
  - Design a B-VHF like system for L-band use

- Project Results described in
  - D1: DME Spectrum Characterization and L-band System Availability for an OFDM-like System
  - D2.1: B-AMC System High Level Description
  - D2.2: Technology Operating Concept & Deployment Scenarios
  - D3: System Specification & Standardization & Certification Considerations
  - D4: Interference Analysis and Spectrum Requirements
  - D5: Expected System Performance
  - D6: Aircraft Integration & Ground Infrastructure Considerations

Introduction – From B-VHF to B-AMC

- What is B-AMC?
  - B-AMC: Broadband Aeronautical Multi-carrier Communications
  - B-AMC is B-VHF adjusted to L-band use
    - B-VHF is an overlay system for the VHF-band
    - B-VHF has been developed, investigated, and demonstrated within the EC co-funded project B-VHF
    - B-VHF is promising candidate technology on FAA/ECTL shortlist
  - Preferable B-AMC deployment between L-band DME channels
    - B-AMC is more an “inlay” than a real overlay system
    - B-AMC deployment options:
      - Option 1: Deployment between DME channels without any frequency planning
      - Option 2: Deployment between DME channels with frequency planning for B-AMC
      - Option 3: Deployment in “green” spectrum

Introduction – From B-VHF to B-AMC

- Why B-AMC?
  - New data link system for 2020 shall be implemented in L-band
  - B-VHF design can be re-used for B-AMC to a large extend
    - For A/G communications B-AMC inherits functional scope of B-VHF and is based on B-VHF physical layer and protocol concepts
    - For A/A communications B-AMC extends B-VHF capabilities
  - B-AMC offers a large co-existence potential in L-band
    - B-VHF side-lobe suppression concepts are re-used for B-AMC
    - Coding and interleaving tailored to combat L-band interference
  - B-AMC allows systematic adjustments to L-band use
    - Optimized link efficiency and robustness
    - Minimized interference to legacy systems

B-AMC Operations

- B-AMC Modes of Operation
  - One airborne radio covers two modes of operation
    - A/G mode
      - Data link communication
      - Voice communication (foreseen, optionally configurable)
      - Frequency-Division Duplex (FDD)
      - FL access-scheme: OFDMA and OFDM (packet-switched)
      - RL access-scheme: OFDMA
    - A/A mode
      - Data link communication and surveillance
      - Access-scheme: self-organized TDMA
      - “OFDM/TDMA” on a globally available Common Communication Channel (CCC)

B-AMC Operations

- Functional Scope of B-AMC Operations
  - A/G communications – B-AMC inherits B-VHF capabilities
    - Centralized communication controlled by GS
    - Cellular communications concept with B-AMC cell coverage decoupled from service operational coverage (high flexibility)
    - Seamless service area and cell handover
    - Data link communications
      - GS to AC: broadcast/multicast, unicast (point-to-point)
      - AC to GS: unicast point-to-point
    - Voice communications (foreseen, optionally configurable)
      - GS to AC: party-line (ATS, AOC), selective (AOC)
      - AC to GS: party-line (via GS re-transmission), selective
    - B-AMC covers all A/G ATS and AOC services
    - B-AMC supports A/G multi-link and multi-service communications

B-AMC Operations

- Functional Scope of B-AMC Operations (cont'd)
  - A/A communications – B-AMC extends B-VHF capabilities
    - Decentralized (self-organized) direct A/A communication
    - "Communication bubbles" defined by radio range around aircraft
    - All A/A communications are based on broadcast transmissions
      - Transmissions from any aircraft can be received by all other aircraft within communication bubble
    - Packet-switched communication (broadcast & header)
    - B-AMC supports A/A surveillance data link (ADS-B)
    - B-AMC supports other A/A data link communication
    - B-AMC covers all A/A ATS services
      (extendable to AOC, APC, and ad-hoc net communications)
  - Operation over landmass areas (GS available): A/G and A/A
  - Operation in OPR areas (no GS available): A/A

Required Adjustments for L-Band Use

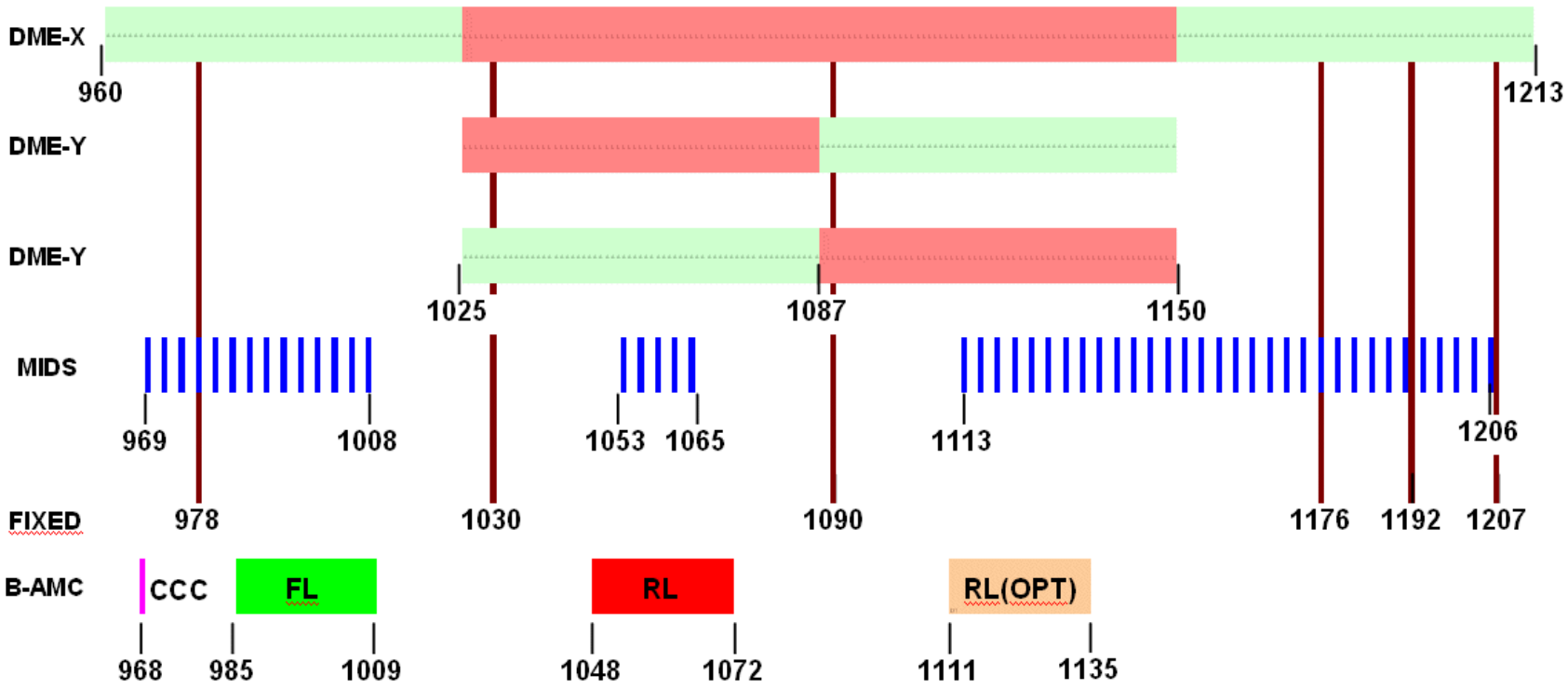
- Special L-Band Conditions
  - Interference situation and available spectrum blocks
    - B-AMC is more “inlay” than real overlay system
  - High carrier frequency (attenuation, Doppler, …)
  - L-band system shall mainly provide data link communications (voice may be configured for optional use)
- Required Adjustments (B-VHF to B-AMC)
  - Duplex scheme for A/G communication
    - FDD instead of TDD
    - Avoids large guard times as required for TDD
    - Effectively uses relatively small available channel bandwidth between DME channels (either for B-AMC FL or RL)
    - Relieves co-location interference situation at aircraft

Required Adjustments for L-Band Use

- Required Adjustments (cont'd)
  - FL access-scheme
    - OFDM and OFDMA instead of MC-CDMA
    - OFDM is special case of OFDMA and enables packet-switched instead of circuit-switched communications
    - Packet-switched communication is preferable where data link is the primary concern
  - OFDM parameters
    - Different frequency band and different interference situation
    - RF bandwidth and sub-carrier spacing (together with other OFDM parameters) have to be adjusted
  - Framing structure
    - Framing structure has to be adjusted due to choice of FDD and adjusted OFDM parameters

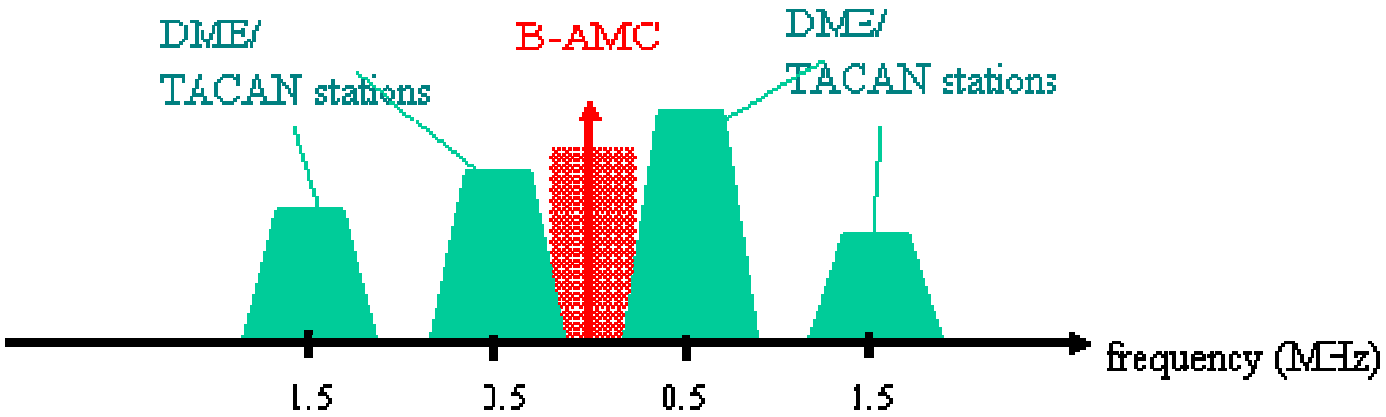
B-AMC System Deployment

- L-band Usage by B-AMC



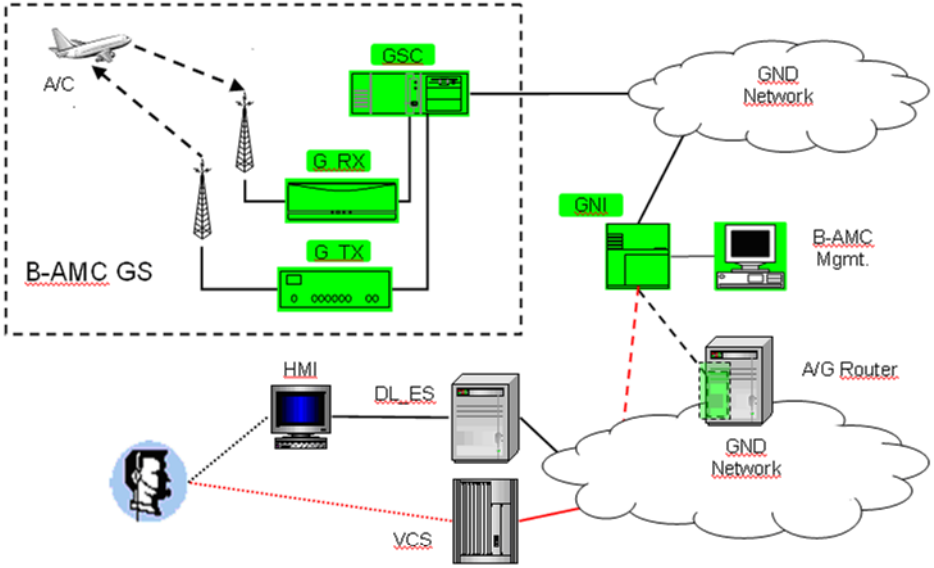
B-AMC System Deployment

- Option 1: Deployment between DME channels without any frequency planning
- Option 2: Deployment between DME channels with frequency planning for B-AMC
- Option 3: Deployment in “green” spectrum



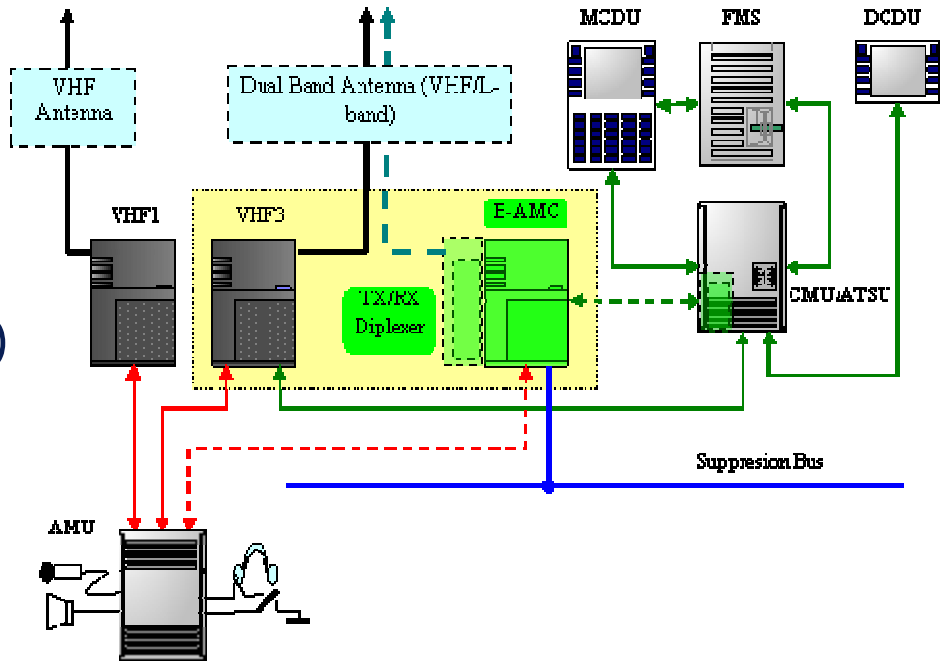
B-AMC Ground Architecture – A/G Mode

- GNI provides network access (ATN or IP A/G router) and handles wide-area coverage
- GSC implements parts of the protocol stack, basically the DLL
- Physical radios (G_RX & G_TX) implement physical layer and MAC



B-AMC Airborne Architecture – A/G Mode

- Physical B-AMC radio comprises TX, RX and duplexer
  - Connected to CMU
  - Optionally connected to the audio system (AMU)
  - TX part connected to suppression bus
- CMU implements DLL and the sub-network layer of the protocol stack



Recommendations

- Detailed commonly agreed interference scenarios based on the common inputs should be prepared and used in the next phases of the FCS investigations in order to enable a fair comparison of the candidate L band technologies.

- Detailed commonly agreed data traffic scenarios, based on the EUROCONTROL / FAA Communications Operating Concept and Requirements document, should be prepared for different flight phases in different domains (APT Surface, APT Zone, TMA, ENR, ORP, and AOA).