WirelessCabin: *Development and Demonstrator of Wireless Access for Multimedia Services in Aircraft Cabins*
Wireless Cabin: The Motivation

Broadband satellite services for aircraft become reality

Demand for Internet access and telephony during flight

Airline passengers want to use their normal communications equipment and personal profile

Typical equipment:
- mobile phone (GSM, UMTS)
- laptop (modem, RJ-45, WLAN)
- PDA

Wireless is the preferred access for business people on the move

People want to be reachable during flight

Wireless access will soon dominate the office and home environment, too

Airlines must cope with this technology development
Mobile In-Flight

Business environment

In-flight entertainment

Personal communications
Benefits

- mobility
- ease of connection
- easy of cabin network re-configurability
- security aspects for airlines
- benefits for cabin crew communications
- flexible adaptation to different aircraft types

- Passengers can use their own equipment without software installation / setup

Business case:
- for satellite operators
- for network operators
- for aircom service providers
- for airlines
Objectives

**Specification and dimensioning of the system**
- UMTS, W-LAN, Bluetooth access
  - RF dimensioning, topology, antenna placement
  - Protocol and signaling aspects
- Wave propagation in aircraft (channel, interference)
- Identification of methods to certify the EMC with aircraft equipment
- IP aircom architecture issues: VPN, IP-Mobility, AAA, QoS-Support
- Ground segment architecture: Aircom service provider, access to backbones

**Development and integration of key components**

**Implementation of a demonstrator (in-flight)**
- A380 cabin for measurements
- A340 (Airbus #1) for in-flight demo (sat equipment from ESA Aboard)
- Second campaign with smaller aircraft

**Market analysis, passenger acceptance interview, service demand estimates**
Research Issues

Wireless propagation in cabin

Interference to aircraft equipment

System dimensioning of cabin cellular network
- capacity
- antenna locations, topology
- coverage

Connection of the cabin cellular network to terrestrial telecom networks
- service integration, dynamic bandwidth sharing, QoS support
- satellite link (limited bandwidth, asymmetric up-/down-link)
- network architecture (access nodes in cabin, IP mobility, VPN, AAA)
- terrestrial infrastructure for service provisioning
- protocol aspects (effect of propagation delay on signaling)
Consortium

*Complementary companies from research, network manufacturers, aircraft manufacturers, satellite service providers, and satellite and aeronautics consultancy*

DLR  
research, aerospace and space communications and networks

Airbus  
aircraft manufacturer, cabin equipment

Ericsson  
telecom equipment manufacturer, satellite service provider

ESYS  
consultancy, satellite market and business models, technology evaluation

Inmarsat  
satellite service provider, mobile including aeronautical

KID-Systeme  
cabin integrator (manufacturer), cabin entertainment

Siemens Austria  
telecom equipment manufacturer

TriaGnoSys  
consultancy, aircom and satellite services

University of Bradford  
research, satellite and mobile communications

No airline in the consortium ñ integrated by interviews

More service provider will be integrated by interviews
CMHN: Collectively Mobile Heterogeneous Network

- Integration of several access segments and protocols
- Limited satellite bandwidth
- Dynamic bandwidth management and QoS support for different services
- Encapsulation of protocols
- Support of asymmetrical satellite links and handover
- Loose vs. tight integration of satellite MAC
System Architecture

Cabin Segment
- Satellite dish
- Sat-Modem
- Service Integrator
- W-LAN
- UMTS
- Bluetooth

Space Segment
- Aircraft Protocol Functions
- IP mobility Server
- AAA
- VPN
- DHCP
- QoS

Ground Segment
- Terrestrial telecom router
- Service Integrator
- Passenger Company Intranet
- IP Backbone
- IP
- PSTN
- UMTS
- GSM

Aircom Provider Segment
- Bluetooth
- UMTS IF
- RNC
- SGSN
- GGSN
- MSC
- GMSC
- UMTS Core
- AAA, Billing
- Mobility ISP server
- VPN, mobility support, QoS support

Service Integrator
- AAA, Billing
- Mobility ISP server
- VPN, mobility support, QoS support
Cabin Channel Model

$f = 900 \text{ MHz}$
$v = 0.7 \text{ m/s}$

Channel knowledge drives:
- Antenna placement
- Coverage planning
- Impact on capacity by coverage
- Link budget considerations at base station
- Interference to avionics

Typical example of an indoor propagation channel
Airbus A340-300

Seats (typical): 284
Overall length: 63.69 m.
Cruise speed: 869 km/h
Range (full passengers): 12,493 km
Cruise altitude (typical): 10,670 m.

Coverage and network topology
- no coverage gaps
- cell size based on expected traffic
- coverage overlaps minimised
- layout based on simulations and measurements
UMTS Aircraft-Satellite-Earth Interface

- Aircraft
  - Service integrator / modem
  - Node B / RNC
  - UMTS terminals

- Ground station
- UMTS core network
- UTRAN network

Ku or K/Ka or L/Ku-band
Bluetooth Access

- Access home base station (HBS) - as with DECT
- UMTS signaling and data is routed over PSTN to UMTS core network
- Can cope with low or asymmetrical bit rates over satellite link
- IP support:
  - HBS as UMTS access point over Bluetooth, handheld works as modem
  - HBS as IP access point for laptops with Bluetooth interface
Demonstration and Trials

Channel measurement campaigns:
- A380 body
- A340
- business jet

Field Trials to show the end-to-end concept
- UMTS, W-LAN, Bluetooth access in aircraft
- Integration with terrestrial Internet, aircom provider
- Integration with terrestrial UMTS testbed (core network)

Space segment: Inmarsat III or IV satellite, combination of L-Band Ku-Band transponder

Aircraft: A340-600, short haul or business jet (A319 or Falcon)

Equipment: Flight test license only

Participation to Air Shows, Trade Shows, Conference with demonstrator
Business Development

Business Survey:
- Derive the potential of the market
- Interviews will yield acceptance by Airlines, Passengers, Network Providers, Service Providers
- Derive estimates for service usage and expected traffic

Satellite Roadmap:
- WirelessCabin multimedia regional traffic, satellite capacity prediction with combined L-band Ku, K/Ka-band payloads
- Consideration of other aeronautical traffic (e.g., ATM)

Licensing and Certification Possibilities for Equipment

Business Model:
- New relation between actors due to dedicated aircom service providers
- Interaction model and accounting methods
Dissemination Plans

Conferences (AIAA ICSSC, AIAA IAF, DGLR, EMPS, Ka-Band Utilization, IEEE Globecom, etc.)


Air Shows (Farnborough, Paris, ILA)

Cabin Equipment Trade Shows (WAEA, IPEC, Aircraft Interiors Expo)

IST Cluster (Beyond 3G) and Concertation Meetings

ASMS Task Force

COST 279 (Analysis and design of advanced multiservice networks supporting mobility, multimedia and internetworking)

Other Dissemination Methods:

- Website
- Press Releases
- etc.
Standardisation & Licensing

Following major areas for standardisation are foreseen:
- ITU-R: radio frequency coordination for aeronautical services
- ETSI: interaction and definition of regulation rules for aeronautical use of UMTS bands
- ICAO / ARINC / EUORCAE / RTCA: certification of wireless handhelds for in-cabin usage