Broadband on Trains

ESA ARTES-1 Project
“Broadband on Trains”

Current BoT Trials and Commercial Systems

21/05/2007, ESA-ESTEC, Noordwijk (NL)

The info contained in this presentation has been gathered through different public presentations, including the BoT seminar held in London on Feb. 20th.
Current (or recently finalised) BoT Trials

21Net

- **Functional Trials in Spain (RENFE) with bidirectional satellite access (FWD DVB-S, RTN proprietary SCPC) in 2004**
  - Demonstrated multi-megabit data rates in both directions at 320 km/h (4 MBps down and 2 Mbps up)
  - Maritime tracking antenna adapted

- **Pre-Commercial Trials in France/Belgium (Thalys) in 2005**
  - Satellite access complemented with? 2.5G / 3G?
  - Most requested application(s)?

- **Enhanced Trials in France (SNCF?) with DVB-S/RCS, using a “tweaked” version of an existing DVB-RCS hub**
  - Demonstrate feasibility of DVB-S/RCS with MF-TDMA in railway environment
  - Identified challenges / required modifications?

- **Status / Further developments / Additional trials?**
Current (or recently finalised) BoT Trials

**Indra Espacio**

- Functional Trials in Spain (RENFE) with bidirectional satellite access (FWD DVB-S, RTN proprietary CDMA or SCPC based)
  - Low profile stabilized mobile antenna with automatic satellite locking and tracking
  - Multi-waveform software-radio modem platform
    - Spread-spectrum CDMA, plain QPSK and configurable spread-QPSK, for optimum – any insight about pros and cons of the different solutions?
    - Spectrum efficiency in all scenarios and regulations compliance
  - On-board gateway
    - To overcome satellite loss-of-visibility situations by automatically switching between wireless terrestrial networks and satellite – which wireless terrestrial technologies?
    - Quality of Service management

- Status / Further developments / Additional trials?
Current (or recently finalised) BoT Trials
Telespazio / Thales Alenia Space Italy

- Pre-commercial Trials in Italy (Trenitalia) with bidirectional satellite access (FWD DVB-S, RTN proprietary) in the new high-speed line Rome-Naples
  - Elliptical antenna with automatic satellite locking and tracking?
  - Packet-level time diversity in the FWD link to counteract channel erasures?
  - Investigation about gaf fillers for railway tunnels. Baseline solution?
- On-board Train Inter-Working Unit
  - To overcome satellite loss-of-visibility situations by automatically switching between wireless terrestrial networks and satellite – which wireless terrestrial technologies?
  - Quality of Service management?
  - Passenger response?
  - Supported applications and services?

- Status / Further developments / Additional trials?
Current (or recently finalised) BoT Trials

QinetiQ Rail / Nomad Digital

- Functional Trials in the UK (Virgin Trains) with hybrid access (satellite bidirectional + WiFi + WiMAX + 4 cellular connections) along the a west coast route
  - Dedicated trackside WiMAX network along 10 km stretch
  - Currently ongoing technical trials

- Status / Further developments / Additional trials?
Current (or recently finalised) BoT Trials

T-Mobile (Railnet)

- Functional and Pre-Commercial Trials in Germany (DB) with fully terrestrial access based on Flash-OFDM technology on-board 7 trains. Target 1 Mbps downlink and 0.5 Mbps uplink per train.
  - Coverage between Siegburg and Montabaur.
  - Distance of ca. 60 km with 12 tunnels (total 15 km, longest 3 km)
  - Average regular travel velocity 280 km/h
  - 9 Radio Routers in Multi/Simulcast configuration
  - Backhaul 2 Mbps
  - Measurement train with 450 MHz antenna
  - Train modem is modified PCMCIA card
  - Average track range of 8 km per site (track ranges of up to 15 km are possible)
  - Average round trip time 45 ms
  - Average mobile throughput 1180 kbps DL / 530 kbps UL
  - Average active DL SNR 14dB
  - Throughput is nearly independent from velocity
  - Max. allowable Doppler shift determines maximum velocity

- Status / Further developments / Additional trials
  - Finalisation of pilot – evaluate and review results
  - Joint rollout decision of Deutsche Bahn and T-Mobile
  - Final selection of Train-to-Land Backhaul Technology
  - Definition of possible rollout phases
  - Redesign of in-train installation (where required)
  - Adaptation of design to other ICE types
  - Review of business model
Existing (or upcoming) BoT Commercial Systems

**Icomera**

- Commercial system with hybrid access (satellite FWD link only + up to 4 3G cellular connections)
  - Typical commercial configuration
    - 4 x UMTS → 4x384 ~ 1.5 Mbps
    - 4 x EDGE → 4 x112 ~ 400 kbps
    - DVB-S 2 Mbps (capacity up to 40 Mbps)
    - WLAN 802.11 b/g 11/54 Mbps on board
    - 2 Cellular Network Operators (additional can be added)
  - Data volumes
    - Ratio of 1:4 (UL:DL)
    - Size of Mbytes
**Existing (or upcoming) BoT Commercial Systems**

**Icomera**

- **GNER (UK)**
  - Commercial service started in October 2004 with 10 trains
  - Service available on full fleet (41 trains)
  - 8,000 average number of weekly users
  - Average usage time has increased from 45 min (2004) to 80 min (2006)
  - 100s of first class upgrades recorded monthly
  - Big differentiator from car and budget airlines

- **SJ (Sweden)**
  - Commercial service started in September 2005 with 20 trains
  - Service available on full fleet (66 trains)
  - 7,000 average number of weekly users
  - Substantial number of upgrades to first class
  - Passenger growth linked to WiFi
  - Average usage time 90 min (2006)

- **Status / Further developments / Additional trials?**
  - HSDPA (up to 3.6 Mbps)
  - EV-DO (Rev 0; 2.4 Mbps – Rev A; 3.1 Mbps)
Existing (or upcoming) BoT Commercial Systems

Eutelsat and Orange

• Upcoming commercial system with hybrid access (satellite bidirectional + WiFi terrestrial connectivity)
  - About to start in 2008 with 5 trains
  - Proprietary satellite technology (ViaSat)

• Status / Last news?
Broadband on Trains

Existing (or upcoming) BoT Commercial Systems
Smart Connection (NS and KPN)

- Connectivity for passengers, employees and contractors in
  - Stations
  - On-board Trains
  - Along the Tracks
- As for today:
  - 50+ Cisco WLAN enabled stations
  - > 75% of passenger traffic
  - 10,000 Appear IQ enabled PDAs (55% of workforce)
- Future developments:
  - 80 Connected Stations:
    - 10,000 Internal Users
    - Public internet use
  - 1500 Connected Trains:
    - Narrow-casting with 6000+ screens installed
    - Internet connectivity
    - On-line realtime trip info
    - Performance & diagnostic from the trains

- Status / Last news?
Existing (or upcoming) BoT Commercial Systems

PointShot Wireless

• Commercial system with hybrid access (satellite + wireless terrestrial) available in Canada

• Status / Last news?
  – Still existing?

  – Extension to the USA?