“Preparation for Internet to Trains Initiative: Broadband on Trains, Analysis of the Opportunity and Development Roadmap” – Phase 2

STATUS of ETSI and DVB-RCS standards

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• ESA Support to standard
• DVB-RCS + Mobile (M) overview
• DVB-RCS+M in railway environment
• ETSI regulatory in railway environment
• Conclusions
• ESA strongly supports standard solutions in different application and service domains: DVB-RCS, DVB-S2, DVB-SH, DVB-GBS, S-UMTS, ETSI-BSM, Satmode, etc.

• ESA support is provided for
  – the creation of a solid standard with internal technical contributions and inputs from ARTES 1 activities
  – development of related products and systems (ARTES 3/4/5)
  – piloting of applications (ARTES 3/4)
  – consolidation and validation of the standard through standard revisions and test bed (ARTES 5)
  – certification and interoperability programs (e.g. Satlabs)

• ESA supports the innovations that implicitly favour the success of the European/Canadian standard solutions (e.g. Amheris payload, Hylas satellite, …)
Background on DVB-RCS+ Mobility (M)

- **Annex L to the guidelines adopted in March 2005**
  - Reflects when DVB-RCS as it is can be used for mobile applications and outlines some technical issues

- **Study mission report finalized in March 2006**
  - Highlights the technical issues for defining a modified DVB-RCS suited for mobile applications

- **Commercial requirements**
  - Were presented a first time in June 2006 and a modified version in September 2006
  - Were accepted with minor modifications and submitted to the SB.

- **Satlabs working group on mobility**
  - Was created when the RCS AHG was in sleeping mode to progress with the work in case the AHG was re-activated. Only 1 meeting took place in September 2006 as the group was re-activated just before the Satlabs meeting of November.

- **Activation of the DVB-RCS working group**: November 2006
  - 6 meetings held in Nov.06, Jan.07, Feb.07, March 07, Apr. 07 and May 07
DVB-RCS + M is not an enhanced RCS version for fixed terminals.

• MAIN GOAL: The current WG mandate is to update the standard to include mobility in different scenarios and applications
  – Proposes a 2 steps approach with a first document addressing only the LOS cases and a revised document 6 months later including the non-LOS cases. A single and independent specification is to be written.

• Other items:
  – To include Connection Control Protocol (C2P) for mesh connectivity
  – To introduce minor updates and clarification

• Mobility section will be mandatory for mobile terminals
• Options will be minimized to facilitate interoperability
• Application environments
  – Maritime, Aeronautical, Railway and Land Vehicular

• Scenarios
  – Line of Sight (LOS) (Maritime, Aeronautical)
  – Non line of Sight (NLOS) (Railway, Land Vehicular)

• It will be issued as DVB-RCS v 1.5.1

• Deadline: to be approved by end of 2007
  (Line of Sight scenario will be finalized by June 2007)
Key Technical Features (still under investigation by the group)

- Spread spectrum techniques to meet regulatory constraints with small antenna sizes (mostly applicable to the aeronautical and vehicular scenarios)
  - DS-spectrum spreading in the FL and Burst repetition in the RL
- Beam, gateway and satellite handover
- Return link: DVB-S2-based SCPC mode as an option
  - Joint management of SCPC and MF-TDMA resources
- Ability to cope with large log-on timing uncertainties
- Shadow/fading resilient techniques
  - Proactive retransmission in RL, Upper Layer FEC in FL, may need more for the land vehicular case
- ACM applicability to mobility
- Additional signaling to handle Logon, Handover Management (HOM), Control and Management Functions (CMF) and management of continuous carrier operation in DVB-RCS networks that support mobility
DVB-RCS 1.5.1

- DVB-RCS Baseline V 1.4.1
- Minor updates & clarifications
- C2P
- All Mobile Extensions
- FL & RL Spreading
Railway environment is considered a NLOS scenario with a high percentage of LOS situations

The standardization group is focusing on solutions which will make RCS + M a viable solution for railway applications addressing the following ISSUES:

• Technical:
  • Short link interruptions resilient techniques
  • ACM/VCM support
  • Beam handover (mainly for multi-spot beam systems)
  • DVB-S2-based SCPC support in the return link

• Commercial:
  OPEX reduction:
  • spectral efficiency
  • system efficiency,
  • bandwidth management,
  • installation and maintenance
  CAPEX reduction:
  • Modem and HUB costs
• **Short link interruptions (electrical trellises and short tunnels) resilient techniques**
  
  – DVB-S2 demodulator synchronization analysis
    
    • Good demodulator design guidelines to keep lock
    • Fast re-synchronization analysis
  
  – **Proactive re-transmissions**
    
    • Assign contingency capacity for lost burst re-transmission. Losses detected through FL signal loss indications
      
      – Higher achieved throughput and lower latency than PEP-based TCP re-transmissions
  
  – **Upper Layer FEC protection schemes**
    
    • May be needed to guarantee integrity with some applications (TBC)

• **Doppler impacts**
  
  – GW demodulator may handle the carrier frequency shift provided a good carrier synchronization algorithm is used
  
  – No issue for the DVB-S2 terminal receiver
  
  – Large uncertainty logon
• **Fade mitigation techniques**
  - Multipath fading
    • About 3 dB FL signal loss due to multipath at 50 km/hr
      - A PHY layer interleaver of a some tens of ms may recover most of this loss
  - Weather-induced signal fading
    • ACM applicability to mobile
      - Higher margin required due to mobility but still provide important benefits

• **DVB-S2 SCPC in the return link**
  - Means to increase return link spectral and power efficiency for highly aggregation of user traffic
  - Resources dynamically managed together with MF-TDMA traffic
    • Switch to MF-TDMA during low traffic hours
  - Low baud rate DVB-S2 carrier compatible with the RCS-phase noise mask
    (no major performance degradation)

• **Beam Handover**
  - Specific signalling adaptation
Solutions for OPEX Reduction

- **Spectral efficiency**
  - DVB-S2 is mandatory
  - SCPC option in the return link
  - ACM/VCM support
  - PHY layer interleaver in the FL (?)
  - GSE support (low overhead)

- **Bandwidth management**
  - Dynamic allocation of resources in the return link (benefit from RCS)
  - Dynamic switch between MF-TDMA and SCPC in return link depending on traffic load and railway traffic circulation
  - Q.o.S implementation (benefit from RCS)

- **Network management**
  - Benefit from DVB-RCS management and control currently specified in Satlabs

**Conclusion:** with the above solutions a further reduction of 50% of capacity cost (wrt current solutions) can be achieved
• **Modem**
  – Benefit from DVB-RCS developments and extensive testing large reuse
  – more than 30,000 terminals deployed

• **Hub**
  – Benefit from DVB-RCS and DVB-S2 developments and extensive testing large reuse (more than 100 networks deployed worldwide)

• **Benefit from multi-vendors:**
  – Interoperability (has been achieved through Satlabs Qualification Program)
  – Competition
  – Second source (as back-up solution)
• ETSI EN 302 448 v1.1.1
  – Satellite Earth Stations and Systems (SES):
    Harmonised EN for satellite Earth Stations on Trains (ESTs) operating in the 11/12/14 GHz frequency bands allocated to the Fixed Satellite Service (FSS) covering essential requirements under article 3.2 of the R&TTE directive

• It is a draft which has been released for public enquiry
• Deadline for public enquiry is July 2007
• It includes conformance requirements
• Test methods are here specified
• Off-axis EIRP emissions within the band
• Carrier suppression
• Off-axis and on-axis spurious radiation
• Antenna pointing and alignment
  – Mechanical stability
  – Pointing error detection
  – Polarization angle alignment
• Cessation of emission
• Control and monitoring functions
Refine, consolidate, implement, test and fully validate (in lab) the adaptations proposed to make the DVB-S2/RCS standard applicable to mobile satellite applications.

Consolidate the DVB-S2/RCS standard adaptations investigated by former ESA ARTES study contracts (e.g. ARTES 1 project AO4867).

**Envisaged testbed:**
- Able to represent the mobile applications scenarios including:
  - Aeronautical, Railway, Vehicular, Maritime
  - Handover to terrestrial gap-fillers
- Contains:
  - A representative gateway
  - A channel simulator
    - Able to reproduce typical mobile channel conditions (fading, shadowing, intra/infra-system interference, Doppler, propagation delay, thermal noise) for all mobile scenarios on FL and RL
  - A user terminal
    - Not including the antenna
  - Ancillary monitoring, control and performance assessment facilities
    - Terminal could be detached for satellite live tests (with appropriate RF front end)

**Budget:** 1.5 M€

**ITT will be issued in Q4 2007**
Standard are not essential to trigger niche markets BUT ...

- Standard is key for operators in order to:
  - Mitigate development and validation risks
  - Meet regulatory requirements
  - Have multi-vendor solutions
  - Have interoperable terminals
  - Reduce OPEX and CAPEX
  - Move to emerging/advanced services and applications since standards attract more contributions/developments from whole Satcom community

- Standards such as DVB-RCS+M are open to operators interested into providing requirements and feedback to proposed solutions
Thank you for your attention

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Useful links:
http://telecom.esa.int
www.dvb.org
www.satlabs.org
www.etsi.org
Additional information material
- NLOS Railway link considerations,
- FMT Applicability to Mobile,
- Reverse Link Countermeasures Against Short Interruptions,
- FW link Acquisitions: Simulation parameters,
- SCPC-based return link: Impact of the DVB-RCS phase noise to the performance of a typical DVB-S2 demodulator,
- FL_CarrierCombiningScheme,
- Criteria for solution choice,
- DVB-SH presentation,
- SCPC Architecture,
- RL_RepetitionSpreading
- RL_ConventionalSpreadingSim
- Control and Monitoring functions
- Beam Handover Mechanisms
- Proposed Additional Signalling for Mobility
- Framework for FL assessment of mobile RCS
- DVB-RCS Mobile: ESA’s view on standardization effort
- Performance Assessment of a DVB-S2 FL with spreading achieved via two parallel carrier transmission
- Control and Monitoring functions
- Proposed Technique for Return Link Spreading
- SatNEx mobile DVB-RCS activities
- Presentation mobile RCS long bloc coding
- Mobile RCS Raptor code
- DVB-SSP_status
- The Need for Spectrum Spreading
- Railway_DVB-RCSimulator
- ESA_FMT_Applicability_Railwayscenario
- Mobile DVB-RCS for vehicular
- GSE benefits for the return link