DVB-RCS New Generation towards NGN Convergence

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Abstract. The convergence between fixed and mobile networks is the new paradigm in the world-wide telecommunications network. Satellites are striving to become an important actor in the Next Generation Networks (NGN) by offering seamless integration with the terrestrial networks. This provides an opportunity to the Satellite industry to advance and adapt this framework to the new DVB-RCS (Digital Video Broadcast - Return Channel Satellite) standard.

Keywords: DVB-RCS NG, convergence, NGN, standardization.

1 Introduction

The network of the future is founded on the development of a converged all-IP communications and services infrastructure that will gradually replace the current Internet, mobile, fixed and broadcasting networks. These next generation network infrastructures [1] must support the convergence and interoperability of heterogeneous mobile and broadband network technologies, in order to support seamless services that are accessible everywhere and to support mobile usage. There is a need for a shared network solution, based on the convergence of fixed, mobile and broadcasting environments, capable of exploiting legacy, evolved and new infrastructure components. NGN promise to be multiservice, multiprotocol, multi-access and IP based infrastructure. The evolution of existing broadband satellite systems towards an NGN infrastructure will be crucial for the successful integration of the satellite systems in the new converged framework.

The DVB-RCS New Generation (DVB-RCS NG) comprises a series of draft documents produced by the DVB TM-RCS group in response to requirements delivered by the analogous DVB Commercial Module [2]. First time, DVB specifies a complete interactive system through a system document which is composed of two main documents, one referring to the Lower Layers (LL), and a second one focussing on the Higher Layers of the Satellite (HLS) interactive system. The current version of these documents will be available by the first quarter of 2011. The objective of the DVB-RCS New Generation is to elaborate a new version of the standard mainly suitable for the consumer market. With respect to the previous version of DVB-RCS standard [3], the new standard will not only define aspects from physical and MAC/link layers but will cover IP and Upper layers

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aspects. It is in this frame where a contribution based on the identification of functionalities, protocols and mechanisms necessary to be compliant with NGN framework will ensure the merge of new generation DVB-RCS into the NGN.

This paper provides an overview of the Next Generation Network architecture and how this concept is introduced in the new DVB-RCS NG standard. The paper starts with a brief introduction to the DVB-RCS NG standard and continues with the implications of the NGN convergence in the standard.

2 DVB-RCS NG Standard

The next generation of DVB-RCS standard is compound by layered specifications (Lower and Higher Layers). Both specifications are closely related, the MAC mechanisms in the LL specification must follow the requirements from the higher layer functions, while the signalling and resources must flow to the higher layers to be used appropriately in the network.

- The Higher Layers Satellite (HLS) specification covers the control, management and traffic areas.
- The Low Layers Satellite (LLS) specification covers the physical layer (definition of transmission parameters and frame constructions) and data link layer (definition of the logical link control and the medium access control protocols).

It is also foreseen that these main documents will be accompanied by an Implementation Guidelines and a System document.

2.1 Reference Architecture

The Reference DVB-RCS NG architecture is an overall Satellite Interactive Network with a large number of Return Channel Satellite Terminals (RCST) that comprises the following functional blocks:

- The Network Control Centre (NCC) which provides Control and Monitoring Functions (CMF). It generates control and timing signals for the operation of the Satellite Interactive Network to be transmitted by one or several Feeder Stations.
- The Network Management Centre (NMC) which provides management capabilities. It is responsible for the management functions (FCAPS) of Fault, Configuration, Accounting, Performance, Security management.
- RCSTs which provides star or mesh connectivity to end users

Two reference architectures will be considered: transparent and regenerative. The actors in both interactive systems are the same:

- Satellite Operator (SO), who manages the whole satellite, and sells capacity at the transponder level to one or several SNOs.

- Satellite Network Operators (SNO), who are assigned one or more satellite beams. The Master SNO owns the Hub/NCC of the interactive network and configures the frequency plan for the regenerative satellite or the Hub. Other SNOs only control their own capacity. SNOs distribute their own physical and logical resources to SVNOs.
- Satellite Virtual Network Operators (SVNO), who manage the Operator Virtual Networks (OVN). The OVN divides the capacity into several logical and independent networks. Each OVN is assigned a set of RCSTs in the management plane, is allocated physical resources in the control plane and is associated with Satellite Virtual Networks (SVN) in the traffic plane. They sell connectivity services to their subscribers. For the regenerative architecture, they may also manage one or several RSGWs.
- Subscribers (RCST), which are the set of user stations that receive service from the SVNOs. An RCST is assigned to one OVN, through whom the RCST is informed of the set of SVNs that it shall use.
- End-users, who are the final actors enjoying the satellite services and who are connected to the RCSTs LAN interfaces.

The two system architectures can be characterized as follows:

- Transparent system (see Figure 1)
  - Transparent satellite(s). One or more transparent satellites provide the link between terminals and the Hub, or among terminals for the transparent mesh system. DTP payloads can also give multi-beam connectivity.
  - Hub/NCC. Performs the control (NCC), management (NMC) and traffic plane (Traffic GW) functions.
  - Star or mesh terminals (RCSTs). Two types of terminals are considered: the star transparent terminal, that complies with the specifications of the DVB-RCS-NG standard, providing star connectivity, or mesh connectivity using a double satellite hop; the mesh transparent terminal is more complex, since it includes at least two demodulators (DVB-S2, DVB-RCS2) to provide single-hop mesh and star connectivity.
- Regenerative system (see Figure 2)
  - Regenerative satellite. Performs demodulation, demultiplexing, decoding (and probably decapsulation) functions at the receiver side, on-board switching (at different layers) for multi-beam systems, and the corresponding transmission functions after signal regeneration.
  - Management Station. It provides the management (NMC) and control (NCC) plane functions to the satellite network users.
  - RSGWs. The RSGW stations provide regenerative RCST users with access to terrestrial networks via the LAN interface. There may be one RSGW giving service to a small number of terminals, or to hundreds of terminals. Essentially, the gateway comprises one RCST, plus an SLA Enforcer and an Access Router, but may also include voice, traffic acceleration servers, or a backhauling module.
  - Regenerative terminals. These RCSTs are identical in terms of hardware to the star transparent terminals. Their software includes C2P functionalities to support dynamic mesh connectivity.

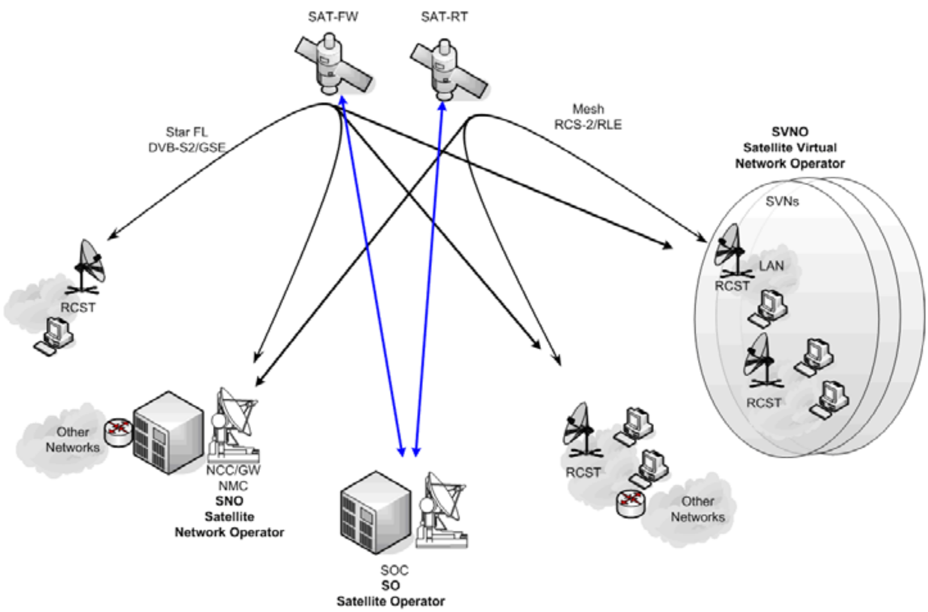

Fig. 1. Transparent network architecture

The reference architecture for the Higher Layers of DVB-RCS NG standard is divided into three different planes (User, Control and Management Plane). Each of the higher layers' functions can be mapped to one of the planes. Figure 3 represents this mapping of functions between planes and their different elements in a mesh regenerative system.

3 Convergence towards NGN

The evolution of DVB-RCS standard towards NGN will allow service providers to reach all their potential customers by creating a single telecommunications network environment. In this context, broadband multimedia satellite systems, working as the access network technology, should play a key role in NGN definition. Satellite systems, due to their characteristics, can be the most suitable technology to assure the independence between theservice provisioning and location.

The convergence requires interoperability between DVB-RCS NG satellite system and terrestrial systems at user, control and management planes, in order to allow network operators to deliver to end users the same experience as terrestrial access networks.

Network interoperability requires: the use of IP-based methods; interfaces for standard network-layer protocols; and enhancements when required to support the unique features of satellite. Operator interoperability demands the

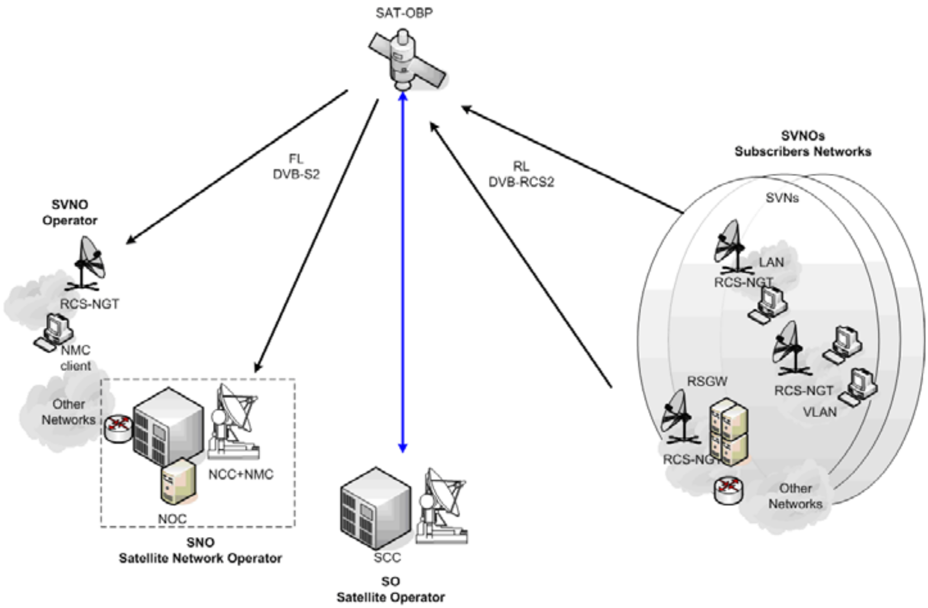

Fig. 2. Regenerative network architecture

specification of an OSS interface, for compatibility with ISP/Telcos, allowing the integration of several access networks in a common management platform.

The interoperability among different manufacturers, alongside the seamless integration with terrestrial networks, help to achieve a user experience close to those terrestrial access networks ones, whilst reducing costs reduction to make satellite services affordable for consumers. The features will be appropriate for a range of satellite systems (not only DVB-RCS) and will be made available to the wider community.

According to the CM-RCS, the DVB-RCS NG system shall be compatible with access technologies to allow it to be integrated into and interoperate with current broadband networks.

The proposed technologies in the Higher Layer Satellite specifications for the DVB-RCS NG will define a new framework for satellite networks capable of interoperate and converge with the new terrestrial networks and Service Providers. It is crucial to ensure satellite systems become an integral part of the all-IP wave.

The integration of NGN and DVB-RCS NG implies the definition of interfaces, protocols and procedures in the transport, control and management plane.

3.1 Transport and Control Plane

In the integration of the DVB-RCS NG system with NGN, the following interfaces need to be defined:

- TNI (Transport Networks Interface).
- RCI (Resource Control Interface).

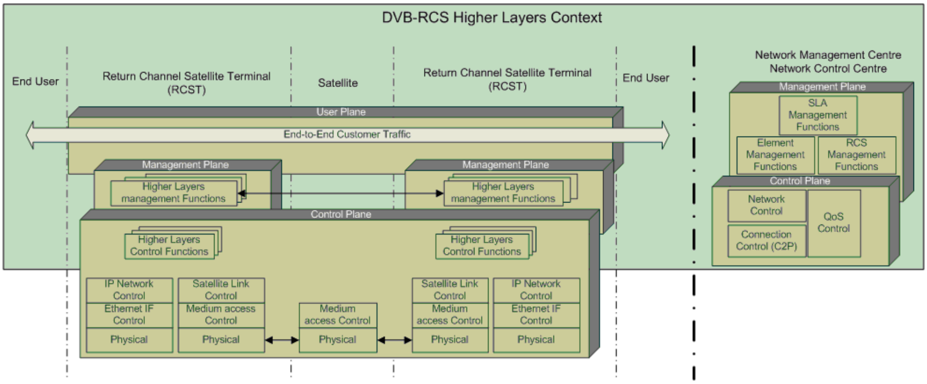

Fig. 3. Elements Functional Architecture

The Resource Control Interface (RCI) is used to allow resource requests from external actors (Other networks/ Telcos) into the RCS-NG systems. The main purpose of this interface is related to the provisioning of end-to-end Quality of Service; optionally it could include functionalities related to the SLA management. The specification of RCI should include:

- Method for registration and authentication of requesters.
- Protocol for resource allocation.

The Transport Network Interface (TNI) is defined to help the implementation of data services over a DVB-RCS transport network. It should recommend requirements from other protocols in order to communicate with the DVB-RCS NG system in a consistent way. For example, if the DVB-RCS system is connecting two HFC networks, the interface should specify the basic parameters for a seamless communication.

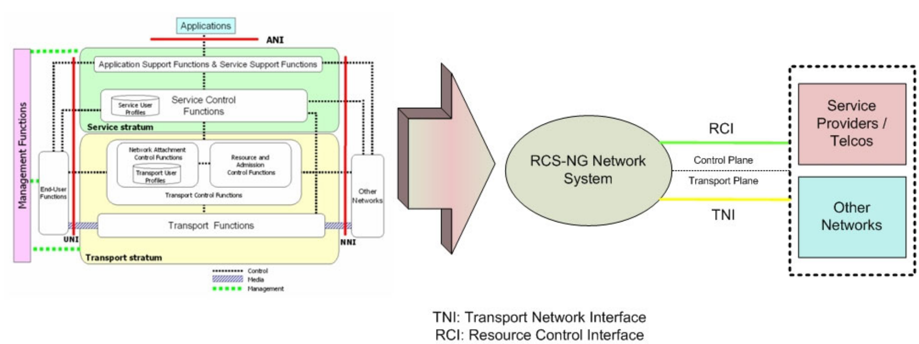

Fig. 4. Integration of NGN paradigm [4] into DVB-RCS NG system

3.2 Management Plane

The management functionality of the RCS NG network shall be envisaged in two environments (see Figure 5):

– Internal management: it shall be based on a central manager capable of interacting with network elements through common protocols and management information bases. The central manager is the NMC, which shall manage the following Network Elements: RCSTs, GWs, NCC, NMC, network devices and OBP for regenerative systems.
– OSS-NMC management (external): it compounds the functionalities related to the relationships with other networks and service providers.

The basic functionality of the NMC is the management of the elements of the network (RCST , GW , NCC). For this purpose, SNMPv3 [5] protocol and MIB [6] data bases (in the communication between NMC and network elements - Internal interface shall be supported). The NMC shall be interpreted as the SNMP manager, and the RCST , NCC or GW as SNMP agent. The activity of the NMC should be extended to include Service and Network related management functions and the interaction with external networks and Service Providers.

The interoperability among different vendors of DVB-RCS NG sub-systems is achieved through the harmonization of their management interfaces between higher layer OSS and individual Network Elements (the RCSTs). Thus, a more consistent management architecture is accomplished closer to the TMN framework of six-logical layers model (Business management, Service management, Network management, Element management, Network elements).

The Operation Support System combines the management functions that enable a Provider to monitor, control, analyze and manage systems, resources and services. The OSS should provide the development of a flexible service integration framework, which eases the introduction of new technologies and reduces the cost base. The OSS can be envisaged according to the functional areas FCAPS (Fault, Configuration, Accounting, Performance and Security). The functions of each area are summarized:

– Fault Management: The goals of fault management are to provide failure detection, diagnosis, and perform or indicate necessary fault correction. Fault identification relies on the ability to monitor and detect problems, such as error-detection events. Fault resolution relies on the ability to diagnose and correct problems, such as executing a sequence of diagnostic test scripts, and correcting equipment or configuration faults.
– Configuration Management:: it is concerned with adding, initializing, maintaining and updating network elements. The operation consists on modifying operating parameters associated to physical resources or logical objects (for example QoS).
– Accounting Management: it includes collection of usage data and permits billing the customer based on the subscriber's use of network resources.

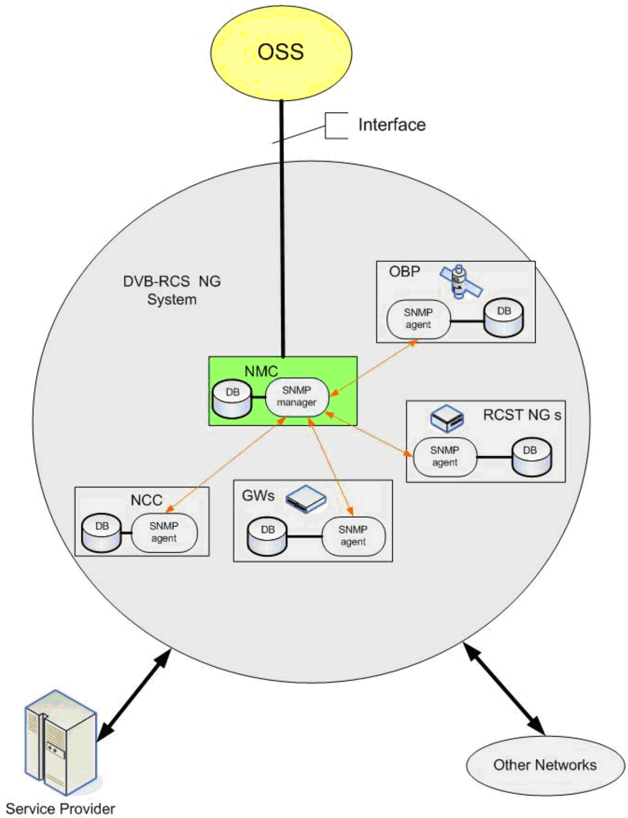

Fig. 5. Management Reference Framework

- Performance Management: Performance management functions include collecting statistics of parameters. These monitoring functions are used to determine the health of the network and whether the offered Quality of Service (QoS) to the subscriber is met.
- Security Management: It is concerned with both security of management information to protect the operations systems as well as managing the security information.

4 Conclusions

A correct definition of the Higher Layer Satellite specification for interactive satellite broadband satellite networks is crucial to ensure satellite systems become an integral part of the all-IP wave. DVB-RCS New Generation has already performed a "Call for Technologies" stage. The main objective of this new standard is to elaborate a new version of the standard mainly suitable for the consumer market, and it will include protocols and mechanisms to be compliant with NGN framework.

The key point and interest of NGN is to really find the solution for an easy integration and interworking of satellite networks with the rest of terrestrial networks. The DVB-RCS NG will define the main functional modules related to NGN principles in the management, control and traffic planes.

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