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Research paper

Satellite DVB-RCS VSAT standards for fixed and mobile applications

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Abstract

The growing demand for communications bandwidth over all wireless media has motivated the introduction of compact satellite communications solutions that provide bi-directional services at greater than 90 Mb/s known as Digital Video Broadcasting-Return Channel via Satellite (DVB-RCS). Current applications may demand rapid installation at fixed locations as well as mobile platforms, such as stationary and moving vehicles, manned and unmanned aircraft, and ships on the oceans. More than a basic introduction, this course presents the specific approaches for designing a broadband satellite network using L/C, Ku, and Ka-bands, and should allow participants to configure major space and ground architecture, evaluate sources of antennas technology, RF electronics, and select the most appropri-ate satellite architecture, spot or regional coverage, bandwidth and services. Applications to commercial and government users are de-scribed as well as compliance with international radio regulations. This paper will provide a case study of the implementation of DVB-RCS scenario for Military Applications for Navy, Land and Aeronautical military platforms. The design and implementation DVB-RCS satellite constellation, development ground infrastructure of the Hub or Gateway as Ground Earth Station (GES) with antenna system and users network, the return link demodulation method, resource management scheme, fixed and mobile terminal structure including antenna configurations are described. The paper also addresses DVB-RCS applications that provide both IPTV and IPPC high-speed Internet base on DVB-S/DVB-RCS standards to the commercial and military passengers and crews for land, maritime and air vehicles, including E-education, E-medicine, E-banking (ATM), Defense Information Management (DIM), Voice over IP and Voice, Data and Video over IP (VDVoIP) and so on.

Keywords: *DVB-RCS; L/C-Band; Ku-Band; Ka-Band; DVB-S; DVB-S2; VDVoIP; Space Segment; Hub; Ground Segment; SIT; FIT; MIT; Fixed VSAT; Mobile VSAT; Constant Coding Modulation; Adaptive Coding Modulation; MPEG.*

1. Introduction

The first generation of satellite standard of DVB-S known as an DVB-RCS about 10 years ago quickly became around the globe one of the key solution in new satellite communication projects for broadcast and broadband interactive applications including high-speed Internet, IPPC and IPTV. The second generation of DVB-S2 CCM (Constant Coding Modulation) standard few years ago was presented as a more cost effective, efficient, reliable, secure and functional solution. The DVB-S2 CCM can be upgraded by the most effective latest and less cost third generation of DVB-S2 ACM (Adaptive Coded Modulation) platform, forward and reverse compatible, implementing the DVB-S2 Space and Ground segments of VoIP/VDVoIP for military solutions. The Ground Segment will be represented by Hub as GES (Ground Earth Station) and VSAT equipment known as Satellite Interactive Terminal (SIT) or Fixed Interactive Terminals (FIT) and Mobile Interactive terminals (MIT) or Remotes, compliant to all DVB-RCS standards for fixed and mobile solutions [1].

Today exist many manufacturers of modern fourth generation of the DVB-RCS standards such as ViaSat, Hughes, Advantech AMT Hughes and other leaders in broadcasting, broadband and multimedia satellite communications. The DVB-RCS Hub, and in particular its Return Link Sub-System (RLSS), is at the heart of the broadband access system for fixed and mobile civilian and military applications. The DVB-RCS Hubs are turnkey cost effective systems, which can be installed in days to enable a wide range of service. The system can be used by government, public and private network topologies including defense and tactical military applications [2].

The RLSS configurations are modular Hub sub-systems, which can be integrated with new or installed IP/DVB, broadcast platforms and IP switch/routing equipment to provide two-way satellite broadband access services. The RLSS is designed to receive upstream traffic, handle upstream and downstream signaling, and schedule and control networks of satellite interactive terminals (available from multiple suppliers). The RLSS can support networks ranging from just a few hundred to hundreds of thousands of simultaneously logged-on fixed or mobile terminals for civilian and military installations.

Many military systems and satellites are similar to commercial ones, but they send encrypted data that only a special receiver can decipher. Military surveillance satellites take pictures just as other earth-imaging satellites do, but cameras on military satellites usually have a higher resolution.

The Defense Satellite Communications (DSC) constellation can be configured of several spacecraft in Geostationary Earth Orbit (GEO) that transmit voice, data, and video or television signals between military sites. The Defense Support Program (DSP) uses satellites that are intended to give early warning of missile launches. Some military satellites provide data that is available to the public, such as weather and navigation data (the USGPS or Russian GLONASS) [3].

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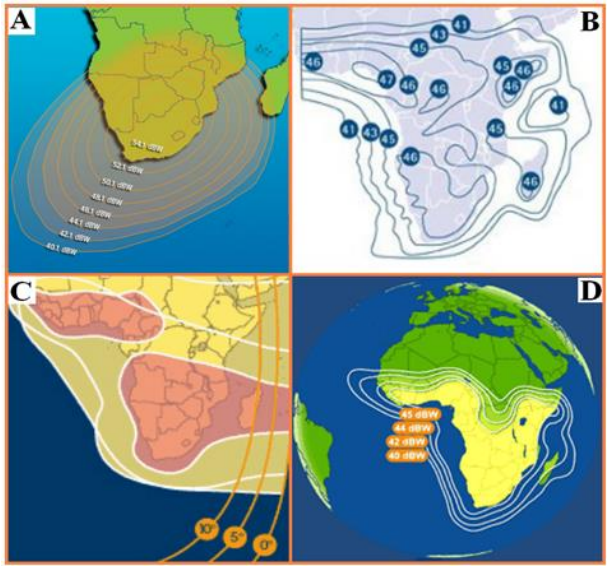


Fig. 1: DVB-RCS Satellite Constellations over Africa [4].

2. Basic current and future space segment

The following satellite operators are providing the current C/L, Ku and Ka-band Geostationary Earth Orbits (GEO) satellite constellations suitable for DVB-RCS S and S2 interactive scenario and covering South and Sub-Saharan Africa are illustrated in Figure 1: such as Intelsat (A), PanAmSat (B), SES-NewSkies (C) and Eutelsat (D). Those Operators are providing regional or global and spot beam coverage via GEO satellites. The future potential Space Constellation, Infrastructure and Ground Network are illustrated in Figure 2.

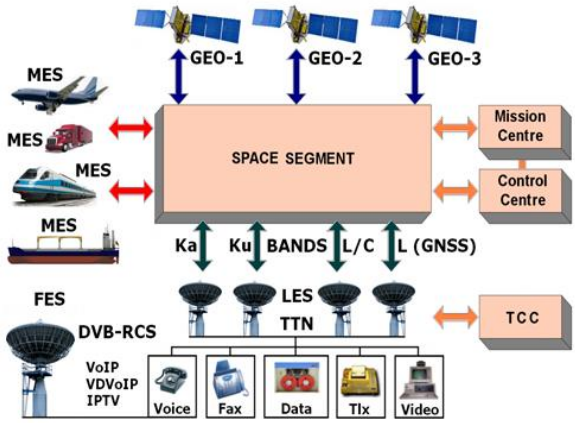


Fig. 2: Proposal for African DVB-RCS Network [5].

The Space Segment configuration may consist minimum three multipurpose GEO satellites with Communication and Navigation (GNSS) payloads, while the Ground Segment infrastructure may have Mission Centre to control the Network; Control Centre to manage Spacecraft and four Land Earth Stations (LES).
This network can use Ka, Ku, L/C and L-band (GNSS) respectively. The User Segment terminals are represented by Fixed Earth Stations (FES) and Mobile Earth Stations (MES) both interfaced to the Terrestrial Telecommunication Network (TTN) or to the Military Control Centre (MCC). The TTN or MCC infrastructures are connecting civilian or military subscribers via digital Voice, Data and Video facilities locally or worldwide [4].

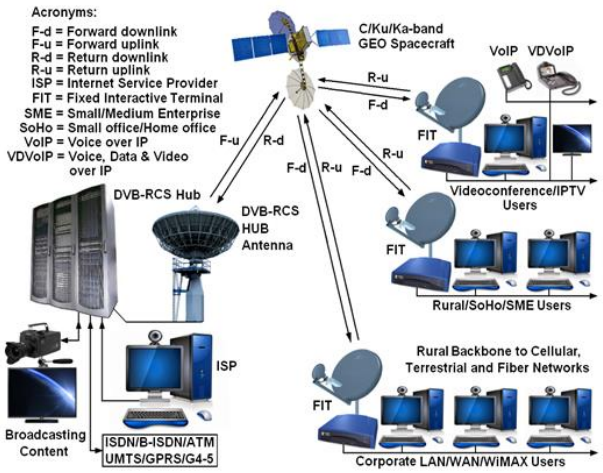


Fig. 3: Fixed DVB-RCS Space and Ground Networks [5].

3. Ground segment

The DVB-RCS VSAT network has been designed to minimize the cost of scaling a broadcast, broadband and multimedia access via few Hub solutions from terminal populations as small as several hundred SIT units to tens or even hundreds of thousands of simultaneously logged-on SIT units in urban and rural or remote areas, illustrated in Figure 3. The DVB-RCS network for mobile maritime, land (road and railway) applications is presented in Figure 4. Satellite interactive DVB-RCS via VSAT Hub with C (4-8 GHz), Ku (12-18 GHz) or Ka-band (27-40 GHz) antenna system interfaces and extends the Terrestrial Broadband, Broadcasting, UMTS/GPRS (Universal Mobile Telecommunications System /General Packet Radio Service), Asynchronous Transfer Mode (ATM), TTN, Internet Service Providers (ISP), Cellular, Private and Public Networks, Virtual Private Networks (VPT), Fiber Optical Networks (FON) and any other networks with corresponding satellite connection to SIT units or Remote terminals and enables the following major satellite services:

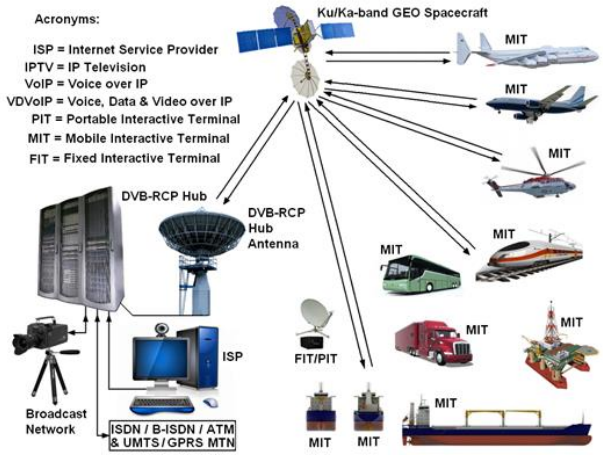


Fig. 4: Mobile DVB-RCS Space and Ground Networks [5].

1) Service Provider Platforms – The DVB-RCS Max Hub standard provides large fully integrated (Network Management System (NMS) with accounting interfaces network for one or multiple and multipurpose service providers, via one or hybrid satellites, on one or additional satellite transponders:

a) Regenerate Rural and Remote Communications: Internet Access and E-mail; Telecentres; Rural telephony; VoIP, Videoconference over IP (VCoIP); IPTV and two-way Broadcasting (Telephony, Broadband);

b) Electric and Distribution Networks; Community Centers; Back up to terrestrial networks; GSM backhaul, Transport control Stations (Tolls); Enterprise services to remote offices;

VPN with acceleration, Village Wi-Fi services to entire communities; SCADA or Machine to Machine (M2M) monitoring and control, etc.

c) Remote Teleservice E-medicine, E-education and E-solutions: VCoIP; Audio, Data and Video (ADV), VDV/Image transfer; IPTV, Interactive distance learning and training; Remote contribution for live events, Emergency management platform, Distance health diagnostics and medicine, etc.

2) Enterprises and Private Networks - The DVB-RCS Hub provides small flexible network with lower cost for up to 20 sites for wide geographic coverage: Asymmetric Digital Subscriber Line (ADSL) anywhere and anytime; Internet access and E-mail; VCoIP, VoIP and Fax transmissions; Consumer/SoHo/SME Corporate LAN/WAN, Intranet/Extranet/VPN, Data transfer/multicasting, Banking, Digital signage, Business TV; Enterprise Resource Planning (ERP), Inhouse E-training and education; File Transfer Protocol (FTP) and Hyper-Text Transfer Protocol (HTTP). The FTP scheme is service for moving and copying an electronic file of any type from one PC to another downloads and uploads over the Internet [5], [7], [8].

3) Broadcasting and Content Distribution - The DVB-RCS enables the following broadcastings: An overlay to existing broadcast networks; Fast and secure distribution of digital content anywhere, ADV content origination from both fixed and mobile or transportable sites; Satellite News Gathering (SNG) over IP (SNGoIP); Software distribution to remote site servers, Film distribution to movie theaters; Secure Intranet VDV transfer; Pay TV services; Near Video on demand; IPTV delivery and Interactive/enhanced TV; Different onscreen games, Programme guides and so on.

4) Satellite News Gathering (SNG) - The DVB-RCS standard provides SNGoIP as one of the tools now becoming available to the Broadcasting industry. SNG can reduce the cost of gathering content and bandwidth from the field. For instance Traditional analog SNG platform cost 100,000 US$, IP Mesh platform costs about 50,000 US$ and the price of DVB-RCS platform is 30,000 US$. It provides the following services: Corporate Data and Disaster Recovery; Video streaming; Multicasting integrated DVD; Web casting; Push/Pull data delivery; In-field Military Data Communications; Accident and Emergency response; Video monitoring of remote sites etc.

5) Satellite Emergency, Distress and Security Management - The DVB-RCS standards can provide remote broadband interactive satellite VDV and Internet backbone communications for the following Homeland Security System (HSS) applications: National Emergency management and Distress solutions; Search and Rescue (SAR) and on-scene communications at sea and on the ground; Disaster Management; Police operations; Drug Enforcement; Anti-terrorism and pirates actions; Border security and control; Environmental green monitoring; Interim gateways pending permanent installation; Firefighting actions; Fire Training and Drills; Telemedicine, Teleeducation and Trainings (mining, fisheries, oil, exploration, surveying etc); Government and Military actions and utilities (Natural Resources Management, Military Defense and Tactical, National Security) [5, 9].

6) Defense Information Management - The special DVB-RCS network is unique qualified to supply unparalleled satellite solutions for Military tactical and defense applications. This advanced satellite broadband network significantly enhances the performance of any existing military service and enable a hosts of new applications, with bi-directional transmissions in excess of a T1 (1.544 MH/s) speed line.

The Network enables rapidly deployable fixed and mobile terminals with latest in content-driven applications for the benefit of today's tactical warfighter. For instance, one DVB-RCS Hub is able to cover all applications for Navy, Ground and Air forces on the soil of South Africa including entire African Continent and to connect up to 200,000 fixed and mobile terminals with Central and other Command posts, for the following services:

a) Rebuilding efforts:
- Mesh, Star, SCPS-like (Single Channel Per Carrier) or Hybrid Network build on open standards;
- Frequency L, C, Ku, extend-Ku, extend-C, K and other frequency bands;
- Interface with multiple satellites, beams and/or transponders from a single Hub;
- Optional different kind and capacity of Hubs with flexible and scalable design;
- Bandwidth configurable to 80 MB/s outbound, and from 64 Kb/s to 4 MB/s inbound; and
- Tens to tens of thousand of sites on a single infrastructure.

b) Secure (encrypted) communication:
- SIPRNet (Secret-secure IP Router Network);
- GCCS/JC2 (Global Command & Control System/Joint Control & Command); and
- Defence Messaging, High Resolution Data and VCoIP.

c) Troop communications:
- NIPRNet (Non Secret-secure IP Router Network); and
- E-mail, V-mail (Video mail) and VoIP.

d) Logistics Management:
- GCSS (Global Combat Support System); and
- RCSS (Regional Combat Support System).

e) E-Training and Education:
- Hazardous materials and Bio-chemicals;
- New technologies and equipment;
- Simulations and operations; and
- Socio-cultural training [8], [9].

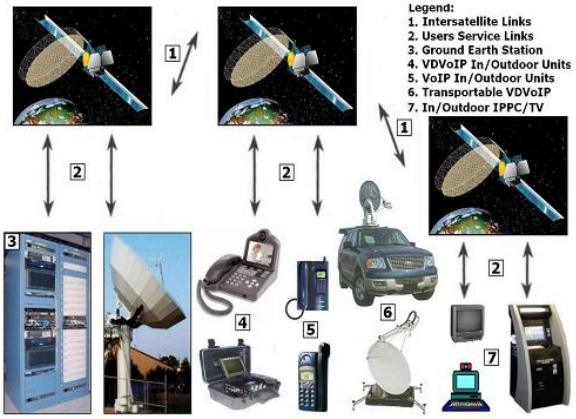


Fig. 5: Mobile DVB-RCS Infrastructure [3].

4. DVB-RCS Hub or GES

The Satellite Hub or Gateway supports existing DVB-RCS VSAT compliant Forward Link System (FLS), but optionally can be provided full FLS, illustrated in Figure 4. The DVB-RCS Hub provides all the required interfaces and management functions necessary to set up a DVB-RCS service for fixed and mobile users presented in Figure 5.



Fig. 6: Three Configurations of DVB-RCS Hub [2].

The Hub Main operator can interface SIT DVB-RCS terminals to a terrestrial network or telecommunication service provider, and manage all the operational aspects of the system. It can be delivered in a number of different configurations to suit customer precise applications. The customer has choice of C, Ku or Ka antennas and CIT RF equipment, what is depending on available satellite transponder RF band.

EMS has tow additional models:

1) The DVB-RCS Mini Hub consists of a Mini RLSS and is also providing low-cost forward-link, network management, including has possibility to provide solution of the MPEG/DVB-S or DVB-S2 mode. Sufficient capacity for small networks is from 10 to 100 Interactive VSAT units, and each VSAT can connect up to 100 IPPC or IPTV.
2) The DVB-RCS Ka-band only Hub satellite terminal is similar to VSAT Hub, but for the moment cannot be upgraded to offer MPEG/DVB-S mode [6, 10].

The main components of the Hub illustrated in Figure 6 are as follows:

a) Network Control Centre (NCC) – The NCC ground configuration assures traffic management, system supervision and protocol handling, and offers sophisticated bandwidth management of the return link through four different bandwidth allocation algorithms based on the DVB-RCS standard. The Network Management Subsystem is the interface between the Operator and the Hub, using a customer friendly Web-interface. Call and management data is stored in system memory and made available towards other operational tools through standard interfaces, e.g. for the billing purposes.
b) Forward Link Subsystem (FLS) – This link consists and offers typically (but not necessarily) of an IP-encapsulation, and in this point, provides the encapsulation of IP transfer of data packets into MPEG frames, an MPEG Multiplexer and a modulator according to the DVB-S transmitting specification. The Hub can be delivered with manufacturers providing the new or integrated towards an existing FLS.
c) Return Link Subsystem (RLS) – This link is the powerful bank of receivers (Rx), which collect the Turbo-coded MF-TDMA bursts transmitted by all the terminals in the network. Each of RLS receivers can be individually configured to operate at any frequency, bit-rate or coding rate. In this way the Hub offers unrivalled flexibility for the operator to maximize the use of air-interface resources. The modular design of the RLS enables the system to scale from small to very large networks.
d) Reference and Synchronization Subsystem (RSS) – This special equipment delivers the synchronization and timing information in the gateway for synchronization of the entire satellite network [6], [9].

4.1. Characteristics of DVB-RCS hub

The three types of HUB terminals are shown in Figure 6. They can extend the boundaries of terrestrial and satellite networks by converging PC in LAN with VDVoIP and IPTV solutions over shared networks with the following characteristics:

- Up to 100 Mb/s downstream using QPSK or 8PSK modulation and RS/Convolutional (RS/C) or LDPC coding and up to 4 Mb/s or even 15 Mb/s upstream per carrier using QPSK modulation, MF-TDMA Multiple Access Method and Concatenated RS/C or Turbo coding.
- Downstream interface is MPEG/DVB-S (Moving Picture Expert Group/DVB-Satellite) or DVB-S2.
- Upstream interface is DVB-RCS supporting IP, ATM or MPEG protocols.
- Optimized for IP (Internet Protocol) and multi-media content.
- Open standard design (DVB-RCS) qualified with multiple IP/DVB broadcast platform vendors and also interoperable with 3rd party terminal vendors.
- Qualified with multiple IP/DVB satellite broadcast platform vendors.
- The DVB-RCS terminal is designed to support up to 80,000 SIT units.
- Every Remote Terminal is able to support many PC or IPTV in LAN, depending on used bandwidth.
- DVB-S can be upgraded by the most effective and cost less 2nd generation DVB-S2 CCM and 3rd generation DVB-S2 ACM platform, forward and reverse compatible.
- The modularity of the DVB-RCS network, scalability and flexibility of the RLSS system architecture allow systems operators to add capacity and features as their businesses grow, and enable DVB-RCS operators to enjoy compelling economics, particularly for growing networks of terminals [6], [11].

The DVB-RCS network has successfully responded to market demands capable of meeting many functional and scalability requirements of variety of the following HUB configurations:

1) Micro DVB-SCPS HUB with DVB-S/S2 outbound and Single Channel per Carrier (SCPC) inbound, upgradeable to RCS and economic for networks of 10's of SIT units.
2) Micro and Mini DVB-RCS HUB satellite terminals with DVB-S/S2 outbound and DVB-RCS inbound, full performed and economic for networks of 100's and 100's to 1,000's SIT units, respectively.
3) Mini DVB-RCS satellite HUB unit with DVB-S/S2 outbound and DVB-RCS inbound, offering maximum capacity and hitless hot redundancy for economic specialized networks over 1,000's VSAT (SIT) units [6, 10].
4) Maxi DVB-RCS redundant HUB with DVB-S/S2 outbound and DVB-RCS inbound managed by Network Control Centre (NCC). The NCC can manage up to 1 Regional Network Control Centre (RNCC), each supporting up to 8,000 SIT units, for a total of up 80,000 SIT or Remote units in one HUB Network.

Thus, the DVB-RCS HUB terminals are turn-key systems, including the its Return Link Sub-System (RLSS), and the heart of the broadband access system, which can be installed in days to enable a wide range of public commercial and military network topologies with SIT or Remote terminals. The RLSS configuration is a modular HUB terminal sub-system, which can be integrated with new or installed IP/DVB platform, broadcast platforms and IP switch/routing equipment to provide two-way satellite broadband access services.

The RLSS is designed to receive upstream traffic, handle upstream and downstream signaling, and schedule and control networks of satellite interactive terminals (available from multiple suppliers). The RLSS can support networks ranging from just a few hundred to hundreds of thousands of simultaneously logged-on Remote terminals [5].

4.2. Characteristics of satellite interactive terminal (SIT) or VSAT remotes

The SIT equipment or Mobile Interactive Terminal (MIT) is two-way transmission satellite terminal composed by Receiver and Transmitter, namely Transceiver, which consists of two main units, the Indoor Unit (IDU) and the Outdoor Unit (ODU).

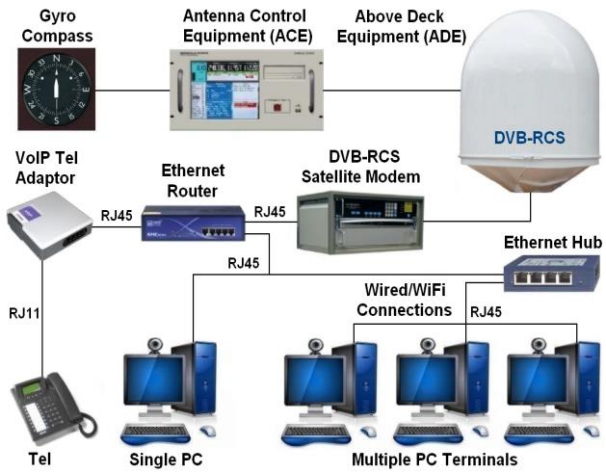


Fig. 8: Shipborne DVB/RCS with Antennas [7].

4.2.1. Outdoors unit (ODU) or transceiver antenna

The ODU is transceiver antenna unit shown in Figure 7 (Above), which can be installed on the roof or mast and may provide to SIT or Indoor Unit (IDU) the following features:

- Full DVB-RCS compliance and very easy to install.
- Range of C, Ku or Ka-band antenna sizes possible for optimizing system throughput from 0.75 - 2.4 m.
- Standard ODU/IDU interfaces ensure full compatibility with any DVB-RCS or VSAT modem.
- Two-way enhanced DiSeqC control capability, which interfaces between IDU and transmitter supports automatic line-up function at installation.

Otherwise, by using special Mobile satellite tracking antennas, SIT equipment can be installed as MIT onboard mobiles, such as ships, road and railway vehicles, and aircraft [6, 8].

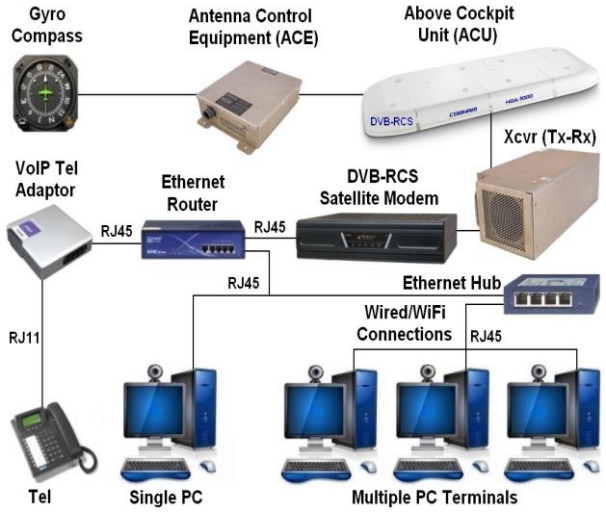


Fig. 9: Airborne DVB/RCS with Antenna [7].

4.2.2. Indoor unit (IDU) or satellite transceiver

The IDU terminals are the ideal satellite devices designed to connect remote end-user PC LAN and IPTV to a DVB-RCS Satellite Network, and can be installed in office or with some modification on onboard mobiles. It provides two-way Multimedia IP communications via adequate satellite at C, Ku or K-band frequencies, illustrated in Figure 7 (Below), 8 and 9, for Fixed, Maritime and Aeronautical applications respectively.



Fig. 7: Fixed DVB-RCS Antenna and VSAT Remote Terminals [1].

The IDU terminal can be supplied for either desktop or rack mounting onboard ships or aircraft and comes in a scalable choice of performance with a variety range of data IP throughputs from 4 to 15 Mb/s. The units can serve for government, (all military applications at sea, on the ground and in the air), state corporations, institutions, private companies or home offices offering an open-interface for high-capacity satellite broadband access that bypasses the "last mile" bottleneck associated with terrestrial infrastructure.

The DVB VSAT system offers satellite broadcast, broadband and multimedia access to core IP ground networks using standard technologies such as DVB-S (DVB-Satellite), DVB-RCS, IP interfacing DVB-T (DVB-Terrestrial) and MPEG/DVB-S or DVB-S2 with user terminals via corresponding C, Ku or Ka-band satellite transponder. The DVB-RCS IDU terminals are capable to provide RLSS service up to 100 PC in LAN customer sets simultaneously with Ethernet interface or, let's say PC and IPTV fixed units. The mobile satellite antenna for onboard installations is autotracking by using gyrocompass, while transportable or portable antenna is high-grade motorized satellite antenna.

Compared to alternative solutions this antenna can provide a data rate that reaches speeds of 4 Mb/s upload and 36 Mb/s download. Therefore it is an ideal for phone and data connectivity with the DVB-RCS platform or audio/video transmissions. With a simple push of a button, the transportable antenna will be locked onto predetermined satellites, transmitting or receiving the content in less than five minutes of deployment. The mobile autotracking antenna is focused onto the corresponding satellite almost in the real time [5], [6], [10].



Fig. 10: Satellite DVB-RCS Transportable and Portable Antennas [8].

4.3. Transportable and portable DVB-RCS terminals for commercial and military solutions

The DVB-RCS SIT can be mounted in cars or somewhere in remote locations by utilization transportable and portable antenna systems for civilian applications suitable for two-way or interactive SNG, VDVoIP and Audio, Data and Video (ADV) transmission, shown in Figure 10. The solutions of DVB-RCS Mobile and Portable Antenna systems are presented in Figure 11.



Fig. 11: Satellite DVB-RCS Mobile and Portable Antennas for Military Applications [8].

This equipment can be mounted in cars or somewhere in remote locations by utilization transportable and portable antenna systems for military applications suitable for ADV and VDVoIP.
The transportable or mobile and portable satellite antenna systems, for both civilian and military applications, are the best solutions for transmitting and receiving ADV and VDVoIP. Applications include rural and remote offices, mobiles such as ships, road and rail vehicles and airplanes, special road vehicles for SNG or Internet services (café), oil drilling onshore and offshore sites, agriculture, forestry service, mining, construction sites, explorations, safari, military command posts and multiple phone lines, law enforcement, temporary work environment, geographically challenged areas, disaster recovery, telecommunication and cellular network backup, and more.
Using DVB-S2 does not only cost less, it also allows professional users to do more. With the Variable Coding and Modulation (VCM) mode of DVB-S2, it is possible to transmit several signals on the same carriers, each with his own coding rate and modulation scheme (MODCOD). For instance, the high efficiency of DVB-S2 is therefore well needed to squeeze 5 to 8 HDTV channels in 36 MHz satellite transponders [5], [11].
Early results have also shown that using DVB-S2 in VCM mode for IP trunking network could improve the bandwidth efficiency by up to 70% compared to DVB-S. With VCM can be dynamically selected MODCOD for each IP packet in function of the instantaneous receive conditions at each site, effectively using the gain margin to increase the efficiency by up to 130% in average. For DVB-RCS systems, this gain will be a decisive factor in the tough competition against terrestrial Internet access services such as ADSL or cable.
The newest DVB-S2 with CCM (Constant Coding Modulation) and ACM (Adaptive Coding Modulation) are providing 30% and 50% more throughout than first generation DVB-S, respectively, shown in Figure 12 [5].

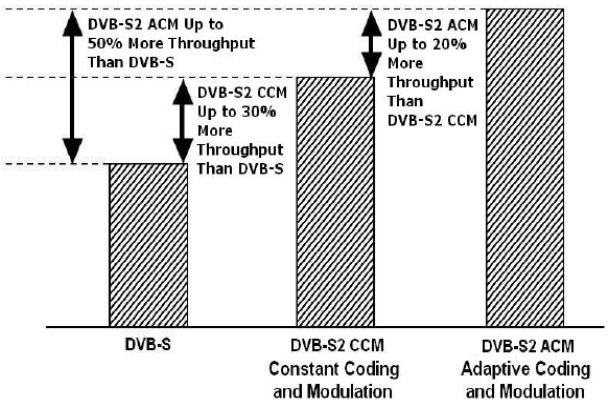


Fig. 12: Comparison of DVB-RCS Standard [8].

5. Conclusion

The satellite DVB-RCS network delivers two-way VDVoIP and IPTV multimedia connectivity both between user terminals in the satellite system and between user terminals and the terrestrial network. The RLSS is a modular sub-system, which can be combined with several new or installed IP/DVB broadcast platforms to provide two-way satellite interactive service. The MPEG2/DVB-S or DVB-S2 is last DVB-RCS technology allows transmission of several signals on the same carriers. With very low cost per bit, service prices become comparable to those offered by terrestrial networks and can be delivered where other technologies cannot reach.
The DVB-RCS network can provide solutions in vast variety of segments for civilian and military solutions in Southern Africa, better and cost-effective than any other existing wireless or terrestrial network.
In addition, this network provides better penetration of signals inside of building, greater Internet speed in excess of more than 90 Mb/s, and definitely in the future will substitute or integrate all wireless and terrestrial communication systems, mobile networks and also can spread range of telecommunication landline and optical networks.
The new DVB-S2 is designed to minimize overall system costs for service providers and system operators. This network offers the lowest system costs on the market today for multiple access systems managing VDVoIP and IPTV multimedia, broadcast and broadband contents. This top quality network is proven to support technologies providing up to 10x cost reduction, spot beams, 3 mentioned bands or Ka-band only, Turbo coding, CF-DAMA MAC Layer up to 25% more efficient than DAMA, MF-TDMA up to 30% effective than TDMA, more than 40% higher gain in bandwidth efficiency, and so on.

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