Commercial Requirements for the use of DVB-RCS2 in Geostationary and Non-Geostationary Systems

DVB Bluebook C107

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Foreword

DVB is an industry-led consortium of broadcasters, manufacturers, network operators, software developers, regulators and others from around the world committed to designing open, interoperable technical specifications for the global delivery of digital media and broadcast services. DVB specifications cover all aspects of digital television from transmission through interfacing, conditional access and interactivity for digital video, audio and data. DVB dominates the digital broadcasting environment with thousands of broadcast services around the world using DVB specifications. There are hundreds of manufacturers offering DVB-compliant equipment. To date, there are over 1 billion DVB receivers shipped worldwide.

Executive summary

The DVB-RCS2 Standard is aimed at providing a variety of interactive services to consumers as well as professional and governmental users.

Existing systems typically provide shared capacity from GEO satellites, with throughputs of up to 100 Mbps per user in the downstream. DVB-RCS2 has been serving multiple customers across all market segments for more than a decade with this type of service, building on the features available from DVB-RCS for almost 25 years.

Recently the launch of constellations of satellites into other orbits (so-called NGSO) using proprietary access schemes has reawakened interest in extending the features of DVB standards to enable their use in such a system. Commercial and governmental entities have expressed an interest in adding the necessary signalling and beam handover features needed for a DVB system to operate in a LEO or MEO constellation and hence the original DVB-RCS2 commercial requirements have been extended here to incorporate the necessary features.

Contents

1. Introduction

DVB-RCS was the standard conceived to provide a standardised broadband interactivity connection as an extension of the Digital Video Broadcasting Satellite systems. It defines the MAC and physical layer protocols of the air interface used between the satellite operator hub and the interactive user terminal.

Large multi-spot beam satellite networks, using Ku and Ka-band and in many types of orbit, have recently been deployed or are being developed and will be operational over the coming years:

- Viasat-3 providing over 1 Tbps from each of 3 spacecraft worldwide from GEO
- Jupiter-3 providing over 500 Gbps from GEO
- Oneweb providing global coverage in Ku-band from LEO
- Starlink providing global coverage in Ku-band from LEO
- O3b mPower providing equatorial coverage from MEO
- Telesat Lightspeed providing global coverage from LEO
- IRIS2 European constellation
- Inmarsat (Viasat) in Ka band

(List not exhaustive)

In addition to many civilian systems, VSAT systems in general and the existing DVB-S2X/RCS2-based terminals in particular have been incorporated into governmental and institutional systems and NATO standards. This is expected to be an important potential market – for example in the context of upcoming institutional constellations.

Increasingly onboard processing is in important aspect of these systems – for example in the case of multi-satellite constellations, onboard routing and inter-satellite links are more important than has been the case with traditional GEO networks.

1.1. Market Projections

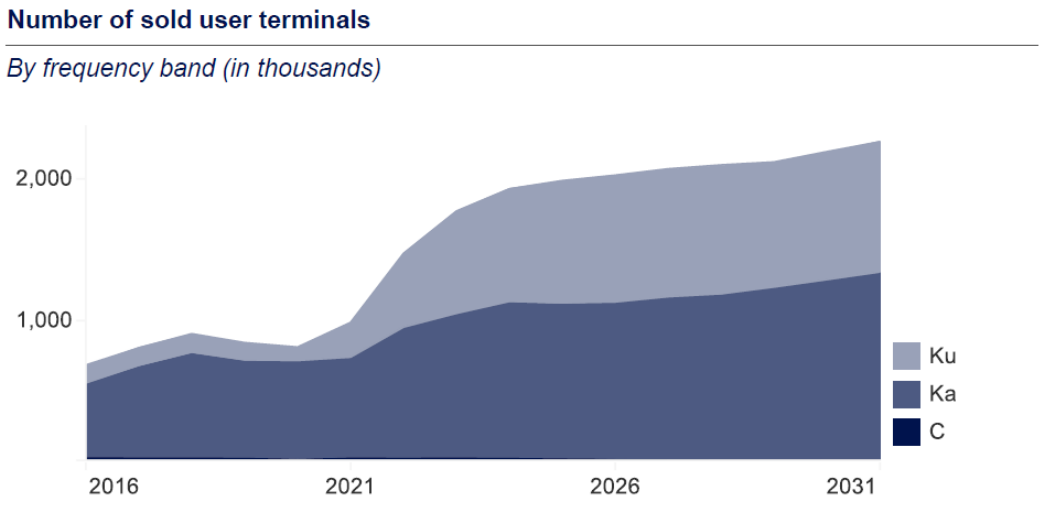

Figure 1 - Annual user terminal sales by frequency band [Euroconsult – Ground Segment Market Prospects 2022]

Terminal shipments passed 1 million per annum in 2022 and are estimated to reach 2 million by 2026 [Euroconsult], with new constellations such as OneWeb and Telesat joining Starlink in the NGSO market and Terabit-class satellites launching into GSO. The cumulative level of shipments over the decade will be approximately 20 million units. The majority of the growth (57%) is expected to come from Ka-band terminals, with the market split evenly between Ku and Ka terminals by 2031.

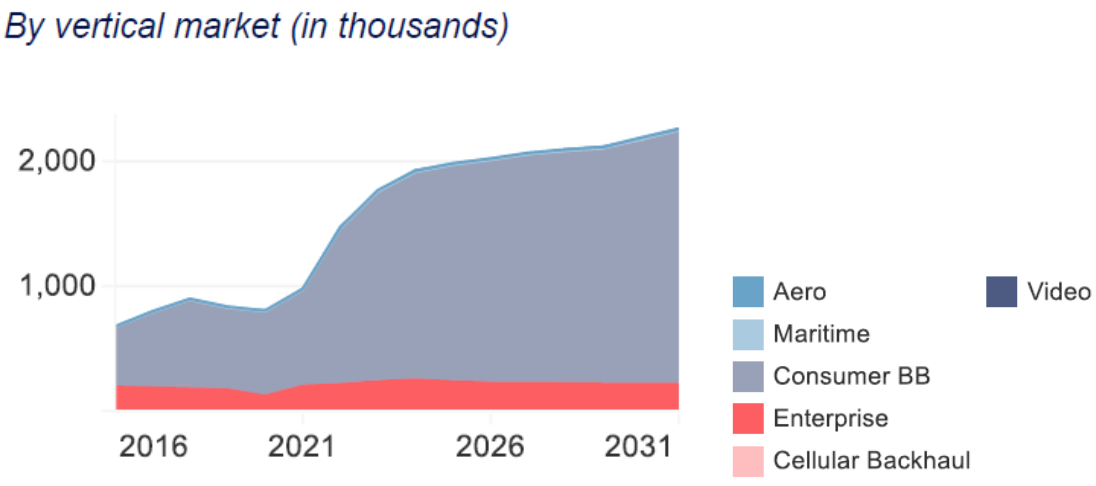

Figure 2 – Terminal volumes by market [Euroconsult – Ground Segment Market Prospects 2022]

The main growth driver remains consumer broadband and this will continue during the next decade, with this segment alone increasing to more than 2 million by 2031, a CAGR of 10%. Aero, however, is expected to have the high growth, with 12% CAGR over ten years, but overall volumes are small compared to consumer and enterprise. Likewise maritime is expected to grow at 6% CAGR over ten years, however volumes are still relatively small at 10,500 terminals installed per year by 2031.

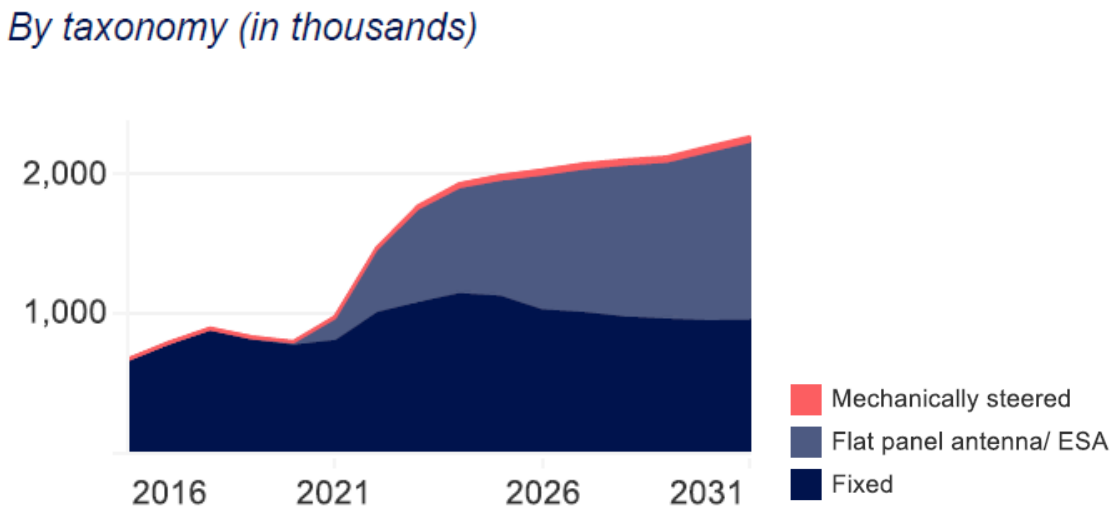

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Figure 3 – Terminal volumes by antenna type [Euroconsult – Ground Segment Market Prospects 2022]

The market for steerable terminals is expected to grow to 1.3 million units in 2031. Of these, flat panel antennas are expected to make up 97% of shipments. However, a significant number of fixed antennas remain – driven by applications where cost and efficiency take precedence over ease of use or aesthetics, such as professional or backhaul applications.

All the above markets are relevant for DVB-RCS2 over GSO and NGSO systems.

1.2. Scope of the document

This document addresses commercial requirements for interface standards applicable to systems based on DVB-RCS2, DVB-S2X and from this update, non-GSO systems.

1.3. Timing for the Introduction of RCS2

The introduction of RCS2 has taken a phased approach, first in the consumer and corporate market, followed by later introduction to the transparent mesh, regenerative mesh, mobile and military markets. Subsquently updates for DVB-S2X, beam hopping and more lately NGSO constellations have been introduced.

- Finalisation of standard for fixed star terminals within DVB - 2011
- Publication of fixed star standard by ETSI - end 2011
- Incorporation of hooks for govt/military terminals - 2011
- Finalisation of standard for mesh and mobile - mid 2012
- Publication of mesh standard by ETSI - end 2012
- Publication of mobile standard by ETSI - end 2012
- Publication of update to include new profiles and DVB-S2X - mid 2018
- Publication of update to include DVB-RCS2 over NGSO - end 2023

2. References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, DVB cannot guarantee their long term validity.

[1]	CM-S0050	"Proposed Commercial Requirements for Beam Hopping"
[2]	3GPP TR38.821	Technical Specification Group Radio Access Network; Study on Narrow-Band Internet of Things (NB-IoT) / enhanced Machine Type Communication (eMTC) support for Non-Terrestrial Networks (NTN) (Release 17) https://www.3gpp.org/ftp/Specs/archive/38_series/38.821/

3. Definitions and conventions

3.1. Terms

For the purposes of the present document, the following terms apply:

Beam Hopping	Rapid reassignment of power across a system's coverage pattern with capacity provided pro-rata to demand.
Constellation	Two or more satellites operating in unison to provide a service.
(x) Orbit	Various altitudes of orbit from very low to Geostationary, the latter where a satellite appears to fly over the same point on the Earth. Highly elliptic orbits vary in altitude such that the satellite is high in the sky over the target area for a large part of its orbital period.
Roll Off	Percentage of a carrier's bandwidth at the lower and higher frequencies that is not used for carrying modulated data symbols.
Superframe	Physical layer container in DVB-S2X allowing more resilience to interference, low SNR operation and beam hopping.

3.2. Abbreviations

For the purposes of the present document, the following abbreviations apply:

3GPP	3rd Generation Partnership Project
CMF	Control and Monitoring Function
COMSEC	Communication Security
COTS	Commercial Off The Shelf
CPM	Continuous Phase Modulation
DVB CM	DVB Commercial Module
DVB TM	DVB Technical Module
DVB-RCS2	DVB Return Channel via Satellite 2nd Generation
DVB-S2X	DVB 2nd Generation Satellite standard eXtensions
ESA	Electronically Steerable Antenna
GEO	Geostationary Earth Orbit
GNSS	Global Navigation Satellite Systems
HEO	Highly Elliptical Orbit
IDU	Indoor Unit
IOT	Internet of Things
IP	Internet Protocol
ISL	Inter-Satellite Links
LEO	Low Earth Orbit

LTE	(4G) Long Term Evolution
M2M	Machine to Machine
MEO	Medium Earth Orbit
MSym/s	Mega-Symbols per Second
NCC	Network Control Centre
NCR	Network Clock Reference
NMC	Network Monitoring Centre
NGSO	Non-Geosynchronous Orbit
ODU	Outdoor Unit
PEP	Performance Enhancing Proxy
QoS	Quality of Service
RCST/RCS2T	DVB-RCS2 (user) Terminal
SCADA	Supervisory Control and Data Acquisition
TRANSEC	Transmission Security
VLEO	Very Low Earth Orbit

3.3. Conventions

For the purpose of this document, the following normative conventions are used in the Commercial Requirements text:

Convention	Meaning
shall enable	The functionality shall be specified but its support is optional.
shall support	The functionality shall be specified and its support is mandatory.
should enable	The functionality is recommended to be specified and its support is optional.
should support	The functionality is recommended to be specified and supported.
may enable	The functionality may be specified and if it is then its support is optional, and it shall not have any weight in the selection or exclusion of any particular solution.
may support	The functionality may be specified and if it is then its support is recommended but it shall not have any weight in the selection or exclusion of any particular solution.
shall not preclude	The functionality shall not be prevented.
should not preclude	It is recommended not to prevent the functionality.

4. Previous RCS2 Commercial Requirements Targetting GEO Systems – Still In Use

This section presents the commercial requirements for a DVB-RCS2 system as previously defined. These were targeting GEO systems and are still in force. Technical specifications need to be defined for the following commercial requirements which cover the interests of end users, service providers and network operators.

4.1. General Requirements

1 RCS2 must be designed for a lower cost of service (at least 30%) and better grade of service (in terms of higher provided rate level, lower delay, lower delay jitter and lower loss probability, as applicable for the service) than RCS, limiting as much as possible the gap in the user experience between RCS2 based access and typical terrestrial broadband access. It is suggested that TM-RCS analyse theoretical targets at the start of work in order to use as a later benchmark.

2 The specifications shall support cost effective installation, maintenance and use.

3 The specifications shall cover the different user segments and terminal types defined in Section 8.

4 Draft specifications shall be available by mid 2009 for the star transparent configuration with fixed terminal type for the consumer segment, the SOHO segment and the corporate segment. Draft specifications shall be available by mid 2010 for the mesh and mobile configuration.

5 RCS2 shall be available for fixed, mobile and mesh systems as per the timescales outlined in section 1.3.

6 Existing RCS terminals must not be affected by migration of a system from RCS to RCS2. The RCS2T could e.g. be able to run RCS as a migration solution.

7 When possible, terminal upgrades from RCS to RCS2 should be deployable as a remote controlled software/firmware update, with reference to the currently available products in the market in addition to future products. It is suggested current and planned product ranges are evaluated for potential hardware compatibility with proposed features of the new standard.

8 A forward link should support terminals of all implementation profiles of RCSTs and RCS2Ts simultaneously, ideally with fully integrated resource sharing but at least by sharing a single carrier.

9 It must be possible for terminals of all implementation profiles of RCSTs and RCS2Ts to co-exist in one Satellite Interactive Network (see Section 6), ideally by freely sharing the return link resources but at least by using partitioned resources.

10 The specifications shall provide commonality and interoperability between implementation profiles. Interoperable implementation profiles shall be provided to satisfy these requirements.

11 RCS2 shall be designed to support IP based application traffic. Common IP based applications used in the various user segments should be supported transparently. The specification will support native transport of IPv4 and IPv6, used separately or in combination.

12 The specifications should cover functions at different protocol layers as necessary to satisfy performance and efficiency requirements. This includes provisioning of features such as QoS, Performance Enhancement Proxies (to mitigate the impact of the high latency) as well as Management and Control functions (via air interface).

13 The specification shall not prevent multiple simultaneous subscriber connections per RCS2T towards multiple internet service providers, via multiple feeders and multiple hubs within the same network.

14 The specifications shall not prevent usage based accounting and billing.

15 The specifications must be transmission frequency independent.

16 RCS2 shall be designed to operate efficiently in low service cost frequency-reuse multi-spot-beam (forward and return) Ka-band satellite systems as well as conventional Ku-band (or lower) satellite systems and regenerative systems.

17 RCS2 must not prevent hubs from being able to synchronize sessions via IP over terrestrial backhaul in order to manage diversity sites.

18 RCS2 shall allow a RCS2T to operate on multiple transponders for transmission as well as reception.

19 RCS2 shall provide robust, scalable and access controlled means for common remote (via air interface) configuration, management and control of the RCST.

20 RCS2 shall provide means for upgrading remotely (via air interface) upgradeable SW/FW image of the user terminal through reliable IP-based downloading mechanisms, including means for efficiently multicasting upgrades to groups of user terminals and means for upgrading of individual user terminals. C.f. other work within DVB.

21 Essential subsystem interfaces should be recommended for RCS2 systems so that suppliers of subsystem technologies and test equipment can develop compatible products.

22 RCS2 should support efficient sharing of the full bandwidth of a wideband transponder (currently for example 250MHz bandwidth). RCS2 should be designed based on trade-off between cost and gain from increased hopping range compared to RCS in the return channel. These performance/costs points should be evaluated and reported by TM-RCS.

23 RCS2 must allow implementation of multi-feeder and multi-gateway networks. RCS2 must allow implementation of a single gateway or single feeder capable of supporting at least 100,000 terminals. The specifications must allow the network and the gateway design to be adapted in scale to the size of the network from thousands to millions of users.

24 Removed.

25 The specifications shall provision for interoperability between equipment from different vendors in order to provide economy-of-scale effects for users, service providers and network operators.

26 The specifications should apply existing technologies where sufficient and applicable. Where appropriate, existing international standards and relevant aspects of DVB and SatLabs specifications should be adopted in order to preserve investments and achieve interoperability, without compromising the effectiveness of the new standard.

27 An RCS2 based system shall be comparable to alternative access technologies to integrate into and interoperate with current broadband networks considering traffic, control and management (including accounting/billing) planes, as well as user premises and interconnected networks. The specifications should recommend application of network and service interfaces commonly used by the ISPs/Telcos for terrestrial broadband networks.

28 Removed.

29 RCS2 must allow COMSEC (e.g. IPsec) support to users and should provide the necessary "hooks" for extending the specifications with TRANSEC functionality.

30 The specifications be designed with protection of health and the safety of the user, any other person and inter-system or intra-system interference aspects in mind, in order to support operation of type-approved RCS2Ts under a common (blanket) licensing regime.

31 RCS2 shall not conflict with directives set forth by recognized regulatory bodies (ITU, CEPT, FCC, etc).

32 RCS2 should provide specifications to systems designed for mesh connectivity. This specification should be based on current specifications (e.g. complying with C2P, Connection Control Protocol, as specified by ETSI). It should support regenerative satellite mesh systems as well as transparent satellite mesh systems, and for transparent satellite mesh systems that support simultaneous mesh and hub-spoke traffic.

33 RCS2 should include specifications applicable to regenerative systems that most likely allows a terminal designed and manufactured for use in transparent star systems to be switched to regenerative system operation with a minimum of effort, preferably simply by changing to a specific SW image applicable to regenerative operation, or similar.

4.2. Consumer and SOHO segment

34 RCS2 must be designed for low-cost terminal equipment, less than 250 Euros (whole sale price to network operator or service provider in 10,000’s quantities), including IDU+ODU;

35 RCS2 shall support use of small antennas, comparable in size to competing systems.

36 RCS2 shall allow system designs that support different levels of logon load. RCS2 shall provide means that facilitates dynamic adjustment of the resources reserved for log on and increase the capacity for simultaneous logon of RCS2Ts.

37 RCS2 shall support IP QoS differentiation of traffic into at least 5 service classes at link level, comparable to those supported by other common IP transport technologies (like the ubiquitous wired access technology Ethernet).

Table 1 – Consumer QoS classes

Example of use	**# service classes {with an example of distinguishing traffic types – c.f. IEEE802.1D}**
Home, simple	1 {BE}
Home, standard	3 {BE, VO, VI}
Home, premium	5 {BK, BE, VO, VI, NC}

Abbreviations used for the distinguishing traffic types:

BK – Background

BE – Best Effort

VI – Video

VO – Voice

NC – Network control

38 The specifications shall facilitate the ease of equipment set up, maintenance and use. Standardised support for plug and play installation shall be specified. The terminal shall include required supporting tools to allow terminal installation without the need of specialised personnel. RCS2 shall provide means for the installation of the terminal to be carried out by the user (plug&play concept)

39 The RCS2 specification shall allow implementation of a service availability ratio of at least 99.7% (the network is accessible with the specified grade of service).

40 RCS2 shall allow any IP based application that can tolerate the satellite propagation delay to be supported.

41 RCS2 shall allow system design supporting downlink data rate of at least 20 Mbit/sec and uplink data rate of at least 2 Mbit/sec of TCP traffic through the PEP.

4.3. Multi-dwelling segment

4.3.1. General multi-dwelling segment requirements

Aggregated requirements for one or more of the other user segments apply, depending on the targeted utilization.

42 The RCS2 specification shall be useful for a multi-dwelling implementation, where the traffic for one terminal is an aggregate for several subscribers, possibly belonging to different user segments. A subscriber is in this context the legal entity that holds the SLA e.g. a private individual, a company subscriber or an organizational unit of some other type.

43 The capabilities of a multi-dwelling terminal must at least comply with an implementation profile merged from the specified implementation profiles applicable for the users utilizing the same terminal. The service specification applied for the multi-dwelling terminal is assumed to reflect the individual subscriber service specifications and a relevant multi-dwelling traffic model.

44 The specifications should recommend an interface for remote configuration, management and control of multi-user access.

4.3.2. Fixed multi-dwelling terminal type

Requirements for one or more of the other user segments apply, depending on the targeted utilization.

45 The specifications shall facilitate the use of a single terminal for shared access in a domestic environment. They shall also support connection of such a terminal with in-house communication networks.

46 RCS2 should provide means for transport of metadata (e.g. MPLS tags, VLAN tags, user priority) associated to the IP packet, to facilitate the use of RCS2 for implementing virtual satellite access networks capable of extending multi-network packet switched transport technologies commonly used to transport IP.

4.3.3. Fixed-mesh multi-dwelling terminal type

47 RCS2 shall be a useful specification for extension to simultaneous transparent mesh communication from any given multi-dwelling mesh terminal to up to 2000 other multi-dwelling mesh terminals.

4.4. Corporate segment

4.4.1. General corporate segment requirements

48 As per requirement 46.

49 See requirement 40.

50 RCS2 shall support IP QoS differentiation of traffic into at least 7 service classes at link level, comparable to those supported by other common IP transport technologies (like the ubiquitous wired access technology Ethernet).

Table 2 - Corporate QoS classes

Example of use	**# service classes {with an example of distinguishing traffic types – c.f. IEEE802.1D}**
Corporate backbone	7 {BK, BE, EE, CL, VI, VO, NC}

Abbreviations used for the distinguishing traffic types:

BK – Background

BE – Best Effort

EE – Excellent Effort

CL – Controlled Load

VI – Video

VO – Voice

NC – Network control

51 The specifications must allow vendors to guarantee a mean time between equipment failures as high as 10 years (TBC).

52 RCS2 must allow operators and vendors to guarantee a maximum time to repair of 1 day (TBC).

53 RCS2 shall allow implementations to support automatic hot and cold standby terminal redundancy in critical applications.

4.4.2. Fixed corporate terminal type

54 It shall be possible to configure an RCS2 system to target a service availability of at least 99.9% (the network is accessible with the specified grade of service).

55 RCS2 shall allow system design supporting max peak downlink data rate of 256 Mbit/sec and max peak uplink data rate of 20 Mbit/sec of TCP traffic through the PEP..

4.4.3. Fixed-mesh corporate terminal type

56 Removed

57 RCS2 shall be a useful specification for extension to simultaneous transparent mesh communication from any given corporate mesh terminal to up to 2000 other corporate mesh terminals.

4.5. SCADA/transaction (IOT/M2M) segment

58 RCS2 shall support extension for use in SCADA networks and transaction oriented networks.

59 RCS2 must allow sharing of at least forward link resources between SCADA/transaction terminals and consumer terminals.

60 As per requirement 51.

61 As per requirement 52.

62 As per requirement 53.

4.6. Backhaul segment

4.6.1. General backhaul segment requirements

63 As per requirement 46.

64 The following applications shall be possible to support: Backhauling, WiMax backhauling, 5G backhauling, LTE backhauling, etc.

65 RCS2 shall support IP QoS differentiation of traffic into at least 4 service classes at link level, comparable to those supported by other common IP transport technologies (like the ubiquitous wired access technology Ethernet).

Table 3 - Backhaul QoS classes

Example of use	# service classes {with an example of distinguishing traffic types – c.f. IEEE802.1D}
GSM backhaul	4 {BE, EE, VO, NC}

Abbreviations used for the distinguishing traffic types:

BK – Background

BE – Best Effort

EE – Excellent Effort

CL – Controlled Load

VI – Video

VO – Voice

NC – Network control

66 As per requirement 51.

67 As per requirement 52.

68 As per requirement 53.

4.6.2. Fixed backhaul terminal type

69 It shall be possible to configure an RCS2 system to target a service availability of at least 99.99% (the network is accessible with the specified grade of service).

70 As per requirement 55.

4.6.3. Fixed mesh backhaul terminal type

71 Removed.

72 RCS2 shall be a useful specification for extension to simultaneous transparent mesh communication from one backhaul mesh terminal to up to 2000 other backhaul mesh terminals.

4.7. Military (Governmental) segment

4.7.1. General military segment requirements

73 As per requirement 46.

74 It shall be possible to support all aspects of TRANSEC .

75 RCS2 shall support IP QoS differentiation of traffic into at least 7 service classes at link level, comparable to those supported by other common IP transport technologies (like the ubiquitous wired access technology Ethernet).

Table 4 - Military QoS classes

Example of use	**# service classes {with an example of distinguishing traffic types – c.f. IEEE802.1D}**
Military comms	7 {BK, BE, EE, CL, VI, VO, NC}

Abbreviations used for the distinguishing traffic types:

BK – Background

BE – Best Effort

EE – Excellent Effort

CL – Controlled Load

VI – Video

VO – Voice

NC – Network control

76 As per requirement 51.

77 As per requirement 52.

78 As per requirement 53.

4.7.2. Fixed military terminal type

79 It shall be possible to configure an RCS2 system to target a service availability of at least 99.99% (the network is accessible with the specified grade of service).

80 As per requirement 55.

4.7.3. Fixed mesh military terminal type

81 Removed

82 RCS2 shall be a useful specification for extension to simultaneous transparent mesh communication from a military mesh terminal to up to 2000 other military mesh terminals.

4.8. Additional Mesh Requirements Added August 2011

The following commercial requirements have been added in August 2011, following a re-opening and re-confirmation of the need for a mesh profile in RCS2.

83 The specifications shall support concurrent operation of a mix of transparent mesh RCSTs where each mesh RCST support concurrent reception of any number between 1-32 burst carriers.

84 The specifications shall support concurrent operation of a mix of transparent mesh RCSTs and transparent star RCSTs.

85 The specifications shall allow cross-link QoS optimization by allowing the mesh transmitter to determine the specific use of assigned resources, assuming the transmission resources made available are physically usable for several links and QoS classes.

86 The specifications shall allow mesh connectivity optimisation by allowing the mesh connectivity controller to determine the resource utilization per mesh link.

87 The specifications shall allow two-hop routing via transparent star to be implemented as a last resort back-up for traffic between mesh link peers.

88 The specifications shall support mesh unicast services as well as mesh multicast services.

89 The specifications shall support systems using cross-strapping between beams, with different beams for return link signal uplink and downlink, as well as systems sharing one beam for return link signal uplink and downlink.

90 The specifications shall not prevent systems being used in a regenerative mesh network.

91 The specifications should support harmonized hybrid star/mesh operation with integrated star/mesh control and management framework.

92 The specification shall have a harmonized RCST QoS model for star and mesh.

93 The specification should have a light connectivity control signalling protocol (meaning light in signalling BW consumption and number of messages to be supported)

94 The specification should support dynamic integration between the satellite network’s mesh signalling protocols and IP networks’ routing and multicast protocols.

4.9. Requirements for New Profiles Added June 2017

The following commercial requirements have been added in June 2017, following an evaluation of the existing profiles. ETSI TS 101 545-1 V1.2.1 (2014-04) has the following profiles defined:

- Consumer
- Multi-dwelling
- Corporate
- SCADA
- Backhaul
- Institutional

Two new profiles shall be created:

- CPM Consumer
- CPM SCADA

“CPM Consumer” and “CPM SCADA” which will be based on “Consumer” and “SCADA” respectively but only mandate CPM modulation. The existing profiles “Consumer” and “SCADA” will be modified to make CPM modulation optional. These requirements should be read in conjunction with Chapter 5.

95 The specification shall add the new profile “CPM Consumer” based on “Consumer” but that only mandates CPM modulation.

96 The specification shall add the new profile “CPM SCADA” based on “SCADA” but that only mandates CPM modulation.

97 The specification shall modify the “Consumer” and “SCADA” profiles to make CPM modulation optional for these profiles.

98 The specification shall update the transmitted terminal capabilities according to the new and modified profiles.

4.10. Requirements Update For DVB-S2X Added June 2017

The following commercial requirements have been added in June 2017 to include the support of DVB-S2X in the forward link of RCS2.

99 Update to DVB-RCS2 to harmonise operation with systems utilising DVB-S2X forward links.

5. New Requirements for Non-GSO Systems - June 2023

5.1.1. Commercial Requirements

The following commercial requirements have been added in June 2023 to include the support of Non-GSO constellations and other additions to the original standard.

100 The specification shall enable DVB-S2X/RCS2 systems to operate in a non-geostationary satellite constellation (VLEO, LEO, MEO, HEO), e.g., support for higher Doppler shifts generated in lower orbits.

101 The specification shall allow for high dynamic range operations, e.g., support operation with electronically steerable antennas at low elevation angles.

102 The specification shall be compatible with transparent and regenerative payloads.

103 The specification shall support mesh and hub-based constellation operations.

104 The specification shall support constellations operating with ISL (Inter Satellite Link) routing, e.g., to cope with the effect of increased latency and jitter on higher layer protocols and minimise their impact on user traffic.

105 The specification shall support a beam-hopping system as referred to in CR5 of CM-S0050.

106 The specification shall support make before break handovers and break-before-make handovers.

107 The specification should be able to operate without GNSS support.

108 The specification shall not disrupt existing standards and not break backwards-compatibility.

109 The specification shall include provision for DVB-S2X-based return link carriers in constant carrier mode.

110 The specification shall support jumbo frames in the return link.

111 The specification shall support symbol rates up to 500 Msym/s.

112 The specification shall support the placement of NCR data within superframes to enable the highest efficiency in processing payloads.

113 The specification shall support at least 5% roll-off or better (in line with DVB-S2X) in the return link with linear modulation.

114 The specification should enable efficient beam pointing and acquisition.

115 The standard should support alternative satellite positioning formats, allowing for higher-precision orbital description for NGSO constellations.

5.1.2. Timing Requirement

116 The specification shall be available no later than Q2 2024.

5.1.3. V&V requirements

117 A system based on the specification shall be simulated to ensure compliance with the above commercial requirements.

118 Interoperability should be demonstrated between prototype hardware emulating functionality of user terminals, hubs and spacecraft onboard processors.

6. Expected technical work

6.1. Impact on existing specifications or need for new ones

In the implementation of beam hopping, following the previous update of commercial requirements, numerous modifications were identified that will be required for the support of NGSO systems. Furthermore, there were requests for the standardisation of the use of DVB-S2X in the return link for constant-carrier mode applications. The original DVB-RCS2 CC mode used a unique specification (it was created several years before S2X) and some equipment providers have replaced this with proprietary implementations using S2X. There is a clear desire to harmonise this.

7. Reference System Scenarios

An overall Satellite Interactive Network, within which a large number of Return Channel Satellite Terminals, second generation (RCS2T) will operate, will comprise the following functional blocks, as shown in the figure below:

- Network Control Centre: a NCC 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.

- Traffic Gateway: a TG receives the RCS2T return signals, provides accounting functions, interactive services and/or connections to external public, proprietary and private service providers (data bases, pay-per-view TV or video sources, software download, tele-shopping, tele-banking, financial services, stock market access, interactive games etc.) and networks (Internet, ISDN, PSTN, etc.).

- Feeder: a Feeder transmits the forward link signal, which is a standard satellite digital video broadcast (DVB-S or DVB-S2) uplink, onto which are multiplexed the user data and/or the control and timing signals needed for the operation of the Satellite Interactive Network.

Typically, the network will consist of multi or single beam coverage. In most networks the satellite carrying the FW link signal may be the same as the one responsible for the return link.

The forward link carries signalling from the NCC and user traffic to RCS2Ts. The signalling from the NCC to RCS2Ts that is necessary to operate the return link system is called "Forward Link Signalling" in the following. Both the user traffic and forward link signalling can be carried over different forward link signals. Several RCS2T configurations are possible depending on the number of forward link receivers present on the RCS2T.

The Satellite Interactive Network for the mobile scenario comprises the same functional blocks (e.g NCC, NMC, Gateway, Interactive Network Adapter) and signalling mechanisms (forward and return link) as described for the fixed scenario.

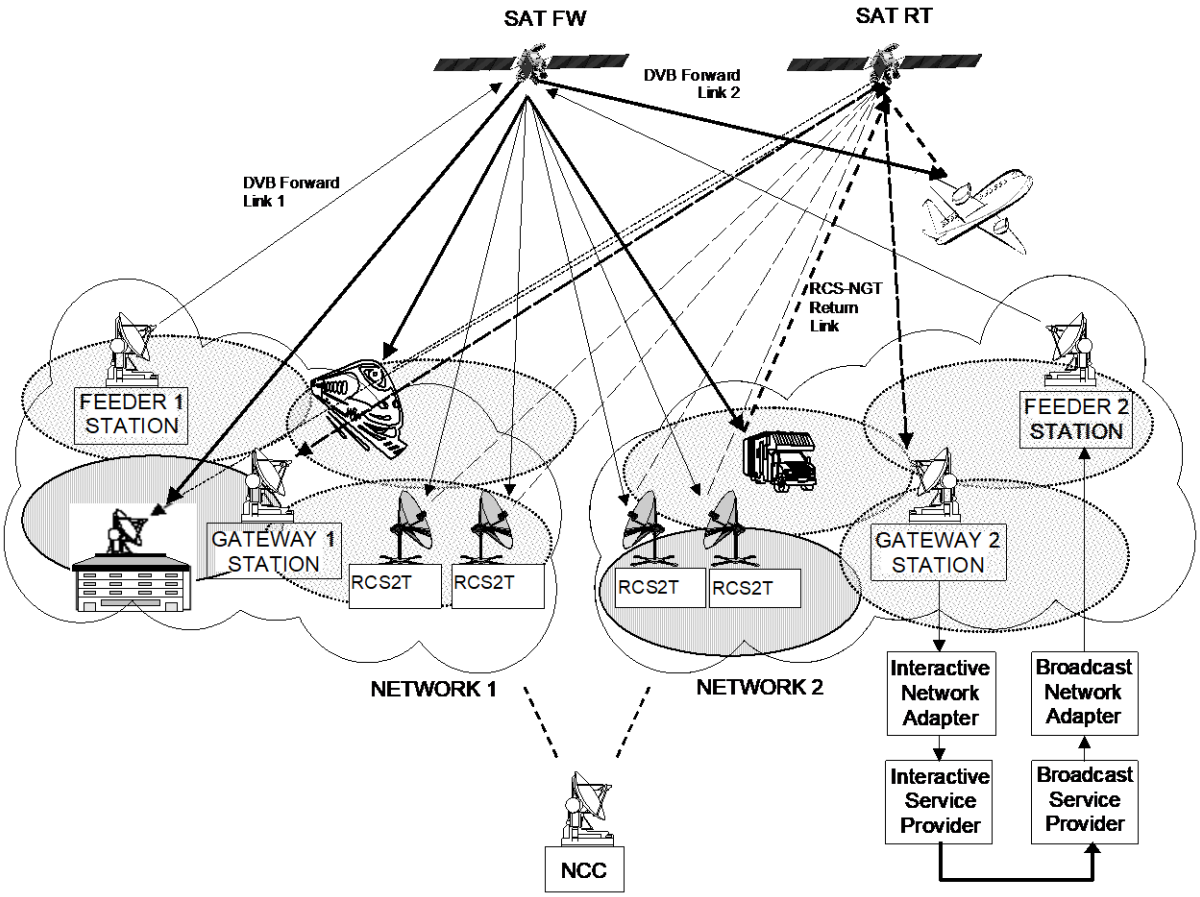

Figure 5 - Star reference scenario

RCS2 can also allow the development of mesh satellite systems, i.e. systems in which the communications between NCC, Gateways, Feeders and terminals transit in a single hop through the satellite, either with regenerative satellite functions (as opposed to a conventional, bent pipe, satellite) or in a transparent mode (using mesh links demodulators at the RCS2T). This allows mesh connectivity to be established in the most efficient way. This is depicted in Figure 6.

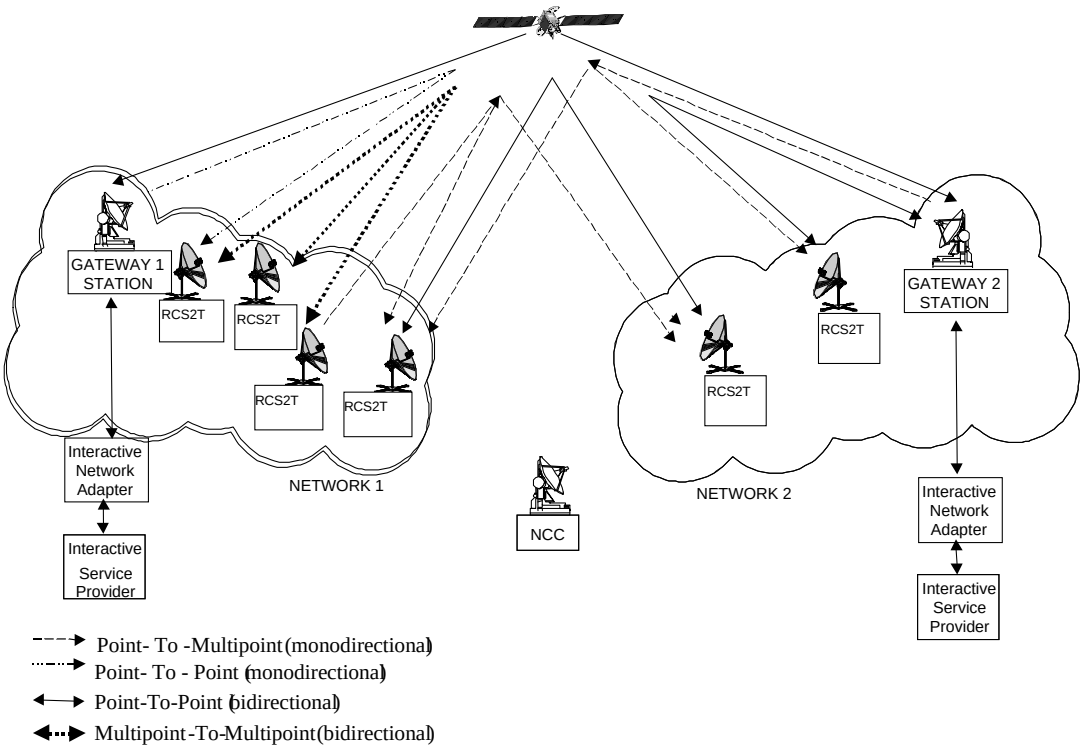

Figure 6 - Mesh reference scenario

RCS2 shall also allow deployment of NGSO (non-Geosynchronous Orbit) constellations of satellites with and without make-before-break capability on user terminals as handover is required from one satellite to the next in the constellation. These constellations typically have onboard processing and may additionally feature inter-satellite links. Figure 7 shows a reference scenario with a constellation represented by 3 satellites over a geographic area, but it may contain several thousand in reality. RCS2Ts may be static or mobile.

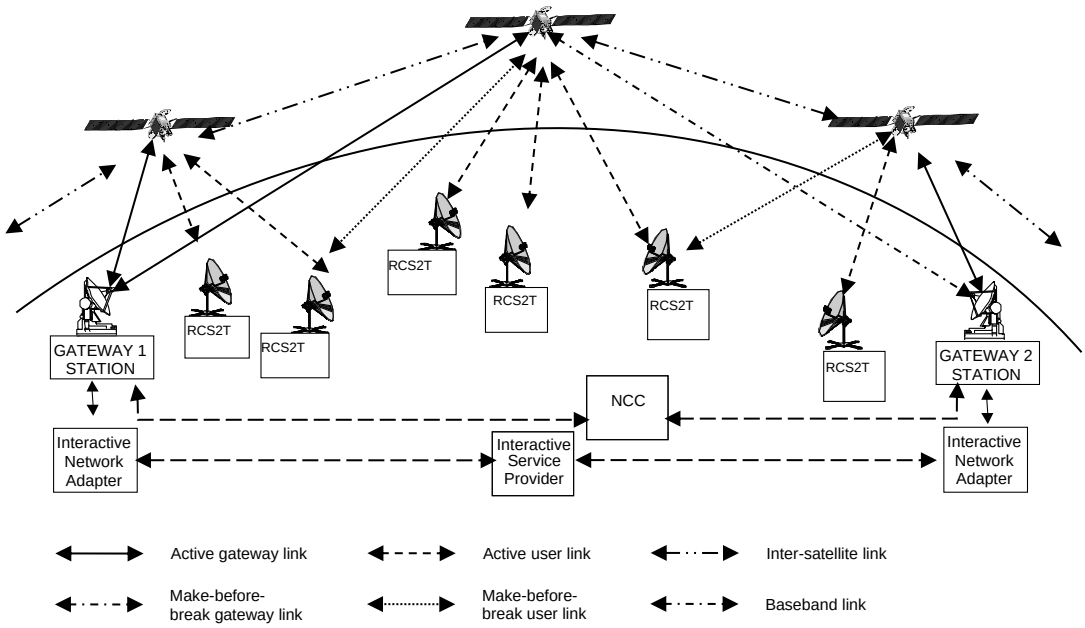

Figure 1 - NGSO reference scenario

8. Annex: Use cases (informative)

Mapping of commercial requirements to specific user segments and terminal types is applied as a way to differentiate between implementations, allowing cost/performance optimization. The following user segments and terminal types are identified:

- Consumer and SOHO: fixed and fixed-mesh
- Multi-dwelling: fixed and fixed-mesh
- Corporate: fixed, mobile and fixed-mesh
- Military: fixed, transportable, mobile and fixed-mesh
- Backhaul: fixed, transportable, mobile and fixed-mesh
- SCADA/transaction: fixed and fixed-mesh

A transportable terminal type is considered to be equal to a fixed terminal type as far as standardisation is concerned.

Specific mesh terminal types are considered for different mesh network architectures (transparent mesh and regenerative mesh) and user segments. These terminal types may be associated with supplemental specifications required for mesh management and control.

A specific implementation of an RCS2 terminal is assumed mandated to comply with one or several predefined implementation profiles which make the terminal suited for at least one of the terminal types in one or several of the user segments.

The main reason for the establishment of these commercial requirements is the recent evolution of large multi-beam satellite networks for consumer access and an ongoing evolution in regenerative systems. For the first version of a new standard, definition of implementation profiles are considered most essential for the following terminal types and user segments:

a) Consumer and SOHO segments

b) Shared access for multiple subscribers in the consumer/SOHO segment (i.e. multi-dwelling)

c) Corporate segment

d) Fixed terminal type

RCS2 must support coexistence of terminals of different implementation profiles within the same network to allow good statistical resource utilisation from mixing diverse user groups.

The first version of the RCS2 specification should concentrate on implementation profiles outlined above, with additional work extending the standard to mobile terminals, the military segment and mesh terminal

types. RCS2 should be prepared for adoption of specific technical elements concerning these areas as this will allow exploitation of economies of scale.

In section 4.1, a set of common commercial requirements for the different user segments and terminal types is provided. The other sections provide commercial requirements specific to terminal types and user segments.

8.1. Consumer and SOHO segment

The reference type of consumer terminal has fixed mounting, typically at the consumer home, in LOS visibility of the satellite providing the services. A single or a few users may be utilizing the same DVB-RCS2 terminal. The following characteristics apply to a consumer terminal:

a) Low-cost terminal equipment, lower than 250 Euros (whole sale price to network operator or service provider in quantities of 10,000+), including IDU+ODU;

b) Support of DIY (Do-It-Yourself) installation (including antenna pointing) – allowing standardised alignment and installation tools, for example;

c) No satellite tracking antenna required;

d) Antenna diameter is small enough for consumer acceptance – e.g. comparable to proprietary broadband or TVRO ODUs in the same market;

e) Size of the IDU comparable to ADSL modems;

f) The terminal will allow a service with sustained downlink IP data rates of at least 8-20 Mbit/s range;

g) The terminal will allow a service sustained uplink IP channel rates of at least 2 Mbit/s (and support lower rates);

h) Support for differentiated QoS support in both the forward and the return directions;

i) Consumer broadband internet access (e.g. easy configuration, routing, DHCP, NAT (static, dynamic, port forwarding), Firewall, Wi-Fi access point interoperability);

j) Performance Enhancement Proxy (TCP and HTTP) support, compatible with all common applications (e.g. VoIP and video);

k) Can operate well at high service contention ratios through graceful degradation at increasing congestion;

l) Significantly (30% or more) better return link BW efficiency than provided by RCSTs in RCS networks. Performance can be increased further at higher layers;

m) The terminal will allow an instantaneous return link rate at least in the range 128 ksps – 2 Msps;

n) The terminal will operate on forward links supported by COTS receiver chips;

o) A typical terminal will be capable of operating in a regenerative system if loaded with applicable SW;

p) Terminals shall support active flow-based queue management in order to improve QoS and achieve lowest possible latency.

8.2. Multi-dwelling segment

The most essential multi-dwelling (i.e. several subscribers sharing a terminal) segment is assumed to be multiple subscribers in the consumer and/or SOHO segments that are sharing a satellite terminal. The requirements are essentially the same as for a terminal in the consumer/SOHO segment, possibly except for support of a larger aggregate of traffic, addition of enforcement of necessary capacity sharing policies, per-subscriber accounting and billing mechanisms and support for alternative LAN access technologies.

8.3. Corporate segment

The reference type of fixed Corporate terminal has fixed mounting, typically at the Company/Institution location, in LOS visibility of the satellite providing the services. The ODU for the mobile corporate terminal type will be specific to each application. The following characteristics apply to a Corporate terminal:

a) *Proper installation may require a professional installer;*

b) *The terminal will allow a service with sustained downlink IP data rates within 8-256 Mbit/s (256Mbit/s rates could be achieved on wideband transponders, for example);*

c) *The terminal will allow a service with sustained maximum uplink IP data rates within 2-20 Mbit/s;*

d) *No satellite tracking antenna required (unless on a mobile terminal);*

e) *Interoperability with wireless terrestrial access (WiFi, WiMax, 5G;*

f) *Support for an extended set of traffic classes for differentiated QoS support, in both the forward and the return directions;*

g) *Support for MPLS (TBC) for support of multiple "Virtual Satellite Networks", one per terminal or several per terminal, as shown in* **Figure** *;*

h) *High reliability (as specified in section 5);*

i) *Performance Enhancement Proxy (TCP and HTTP) support, compatible with all common applications (e.g. VoIP and video);*

j) *Can operate well at high service contention ratios through graceful degradation at increasing congestion;*

k) *Significantly (30% or more) better BW efficiency than provided by RCSTs in known RCS networks;*

l) *The terminal will allow an instantaneous return link rate in the range 128 ksps – 2 Msps on a low datarate terminal (2Mbit/s class in requirement c);*

m) *The terminal should support the use of content compression and header compression at appropriate layers of the protocol stack (e.g. VOIP).*

n) *Terminals shall support active flow-based queue management in order to improve QoS and achieve lowest possible latency.*

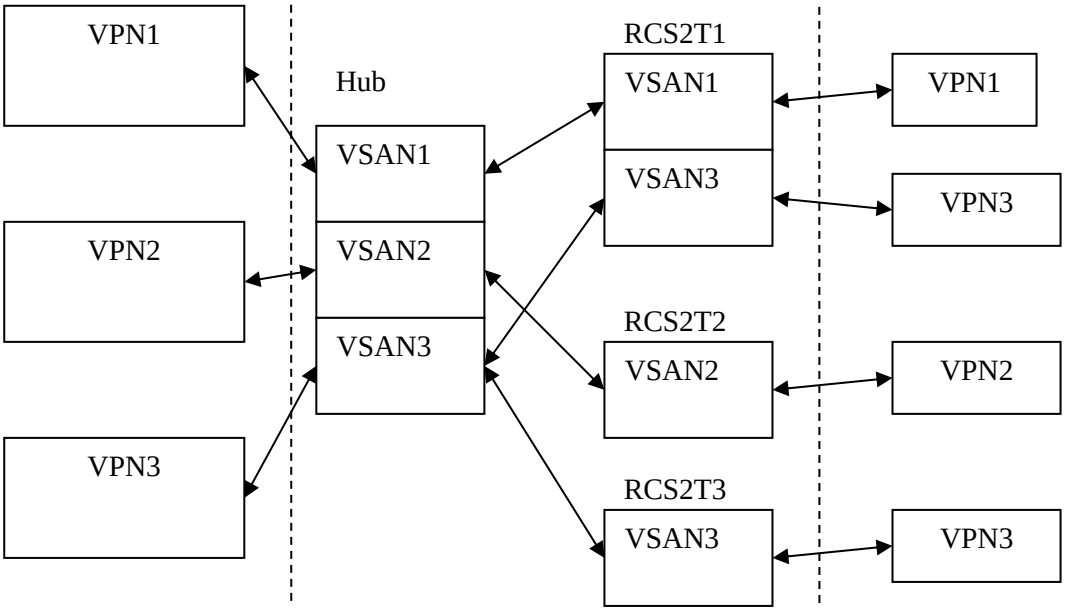

Figure 8 - Virtual Satellite Access Networks (VSAN) for interconnection of multiple IP VPNs via a shared satellite network.

8.4. Military segment

The reference type of fixed Military terminal has fixed transportable mounting, in a field location, in LOS visibility of the satellite providing the services. The ODU for the mobile Military terminal type will be specific to each application. The high-level characteristics of the military terminal are the same as the commercial terminal.

8.5. SCADA/transaction segment

The reference type of SCADA/transaction terminal has fixed mounting and has LOS visibility of the satellite providing the services. The following characteristics apply to a SCADA/transaction terminal:

a) Proper installation may require a professional installer;

b) No satellite tracking antenna required;

c) High reliability;

d) Adapted to the operational environments typically found in SCADA applications;

e) Efficient for transactional applications;

f) Efficient at data rates found in typical SCADA applications;

g) The terminal will allow an instantaneous return link rate in the range typically found in SCADA applications;

h) The terminal will operate on forward links supported by COTS receiver chips;

i) Support transport of X.25 protocol

9. History

Reference	Month Year	Milestone
---	Jan 2009	Initial commercial requirements (Internal document CM-RCS0010r1.0)
---	August 2011	Update with requirements for mesh systems (Internal document CM-RCS0010r1.1)
---	June 2017	Update with new profiles and support for DVB-S2X (Internal document CM-RCS0010r1.2)
C107	July 2023	First BlueBook publication Update with support for non-GSO systems (Internal document CM-S0039r1.8)