INTERNATIONAL TELECOMMUNICATION UNION

RADIOCOMMUNICATION
STUDY GROUPS

Document 4/88(Rev.1)-E
9 October 2006
English only

Source: Document 4B/TEMP/67(Rev.1)

Subject: Question ITU-R 269/4

Working Party 4B

DRAFT REVISION OF RECOMMENDATION ITU-R S.1709

Technical characteristics of air interfaces
of global broadband satellite systems

Summary

This revision of Recommendation ITU-R S.1709 relates to Annex 2 which contains the TIA Standard, TIA-1008, IP over Satellite. The revision to the Recommendation reflects the recent upgrade of this TIA Standard, referred to as TIA-1008-A, to include return carriers operating at higher data rates.

Annex 1

Changes to Recommendation ITU-R S.1709

Change 1

In the "Scope" section of the Recommendation, replace "TIA-1008" by "TIA-1008-A".

Change 2

Amend "Table 1" as shown below.

TABLE 1

Comparison Table between ETSI EN 301 790 V.1.3.1, TIA-1008-A and ETSI RSM-A

Item	ETSI EN 301 790	TIA-1008-A	ETSI RSM-A
Network topology	Star or mesh	Star	Star or mesh
Modulation	QPSK	CE-OQPSK	CE-OQPSK
Outbound traffic access method	DVB-S	DVB-S	High rate TDMA
Outbound traffic data rate (Mbit/s)	1 to 45	1 to 45	100, 133.33, 400
Inbound traffic access format	MF-TDMA	MF-TDMA	FDMA-TDMA
Inbound traffic data rate	No restriction	64 kbit/s, 128 kbit/s, 256 kbit/s, 512 kbit/s, 1 024 kbit/s, 2 048 kbit/s	128 kbit/s, 512 kbit/s, 2 Mbit/s, 16 Mbit/s
Protocols	DVB/MPEG2 TS outbound, AP/AAL5/ATM inbound	Multilayered protocol	IETF IP Network Protocols

Change 3

Amend Appendix 1 to Annex 1 of this Recommendation so that the title and URL correctly refer to TIA-1008-A.

Change 4

Amend Annex 2 to the Recommendation-as shown.

Annex 2

Air Interface Standard TIA-1008-<u>A</u> (IPoS)

CONTENTS

Page

1   Introduction

The solution provided in this section is an introduction to the Internet Protocol over Satellite (IPoS) standard that has been developed by the U.S. based Telecommunications Industry Association (TIA). IPoS outroute carriers (i.e. the broadcast carriers from a hub or broadcast terminal to many remotes) use a statistical multiplexing scheme compliant with the DVB data format and the distribution of IP traffic to the remote terminals which is based on the DVB multiprotocol encapsulation. The multiplexing sublayer on the outroute carrier permits the hub to transmit several traffic types, programmes, or services within the same outroute carrier and controls the transmission of each individual programme. The IPoS multiplexing sub_layer is based on the Digital Video Broadcast/Motion Pictures Expert Group (DVB/MPEG) statistical multiplexing format.

This Annex gives a technical overview of the IPoS specification. Section 2 describes the network architecture for the IPoS system and Section 3 describes the protocol architecture adopted for the satellite air interface between remote terminals and the hub.

2   Network architecture
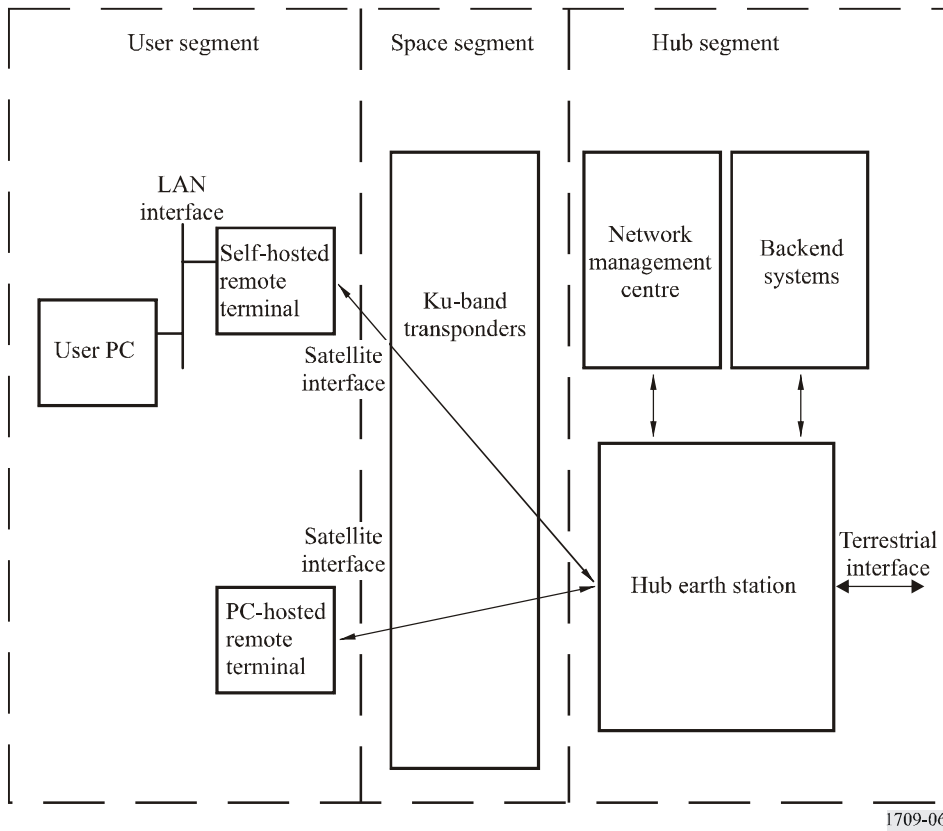
2.1   Network segments

IPoS is designed for use in a star satellite network that encompasses three major segments:

1.   *Hub segment*: The hub segment supports Internet access of a large number of remote terminals via satellite. It is composed of large hub earth stations and related equipment through which all traffic flows.

2.   *Space segment*: The space segment consists of bent-pipe transponders on geosynchronous satellites that allow transmission in both directions between the hub and remote terminals. IPoS parameters and procedures are somewhat independent of the underlying spectrum whether 6/4 GHz, 14/10-11 GHz, 30/20 GHz frequency bands, or even the 8/7 GHz frequency band used by the satellite transponders; however, there are physical requirements involving radio-frequency parameters that are specific for each particular frequency band. The present version of the IPoS physical (PHY) layer interface assumes IPoS services using 14/10-11 GHz satellites with spectrum that is designated for fixed-satellite service (FSS).

3.   *User segment*: In general, the IPoS user segment consists of thousands of user terminals, each of them capable of providing broadband, IP communications to a remote site. User terminals are also referred to in this standard as remote terminals. The remote terminals support the user hosts, or personal computers (PCs), running the applications. This support of user PCs could be broadly categorized as:

   –   *Single access point*: where the host and the remote terminal are connected, e.g. through a universal serial bus (USB) interface.

   –   *Customer premises LAN*: where the remote terminals provide access to a multiplicity of PCs. Customer LANs are considered external to the IPoS system.

Figure 6 illustrates the highest-level components in the IPoS architecture and identifies the major internal and external interfaces in the IPoS system.

FIGURE 6

IPoS system architecture


```
| User segment        | Space segment  | Hub segment              |

      LAN
      interface
                                          Network        Backend
         Self-hosted                      management     systems
         remote            Ku-band        centre
         terminal          transponders
 User PC
            Satellite
            interface

            Satellite                     Hub earth station    Terrestrial
            interface                                          interface

         PC-hosted
         remote
         terminal
```

1709-06

2.2   Network interfaces

The main interfaces in the IPoS system are:

–   *Terminal LAN interface*: This is the interface between the user hosts' computers, or PCs, and the remote terminals. The terminal LAN interface uses an Ethernet protocol that is not part of this standard.

–   *IPoS satellite interface*: This is the interface where remote terminals and the hub exchange user, control, and management information. The IPoS satellite interface, or air interface, is the main focus of this standard.

–   *Hub terrestrial interface*: This is the interface between the hub and the backbone connecting the hub to the external packet data networks, public Internet, or private data networks. The hub terrestrial interface uses IP protocols that are not part of this standard.

The IPoS satellite interface distinguishes between the two transmissions' directions:

–   The outroute direction from the IPoS hub to the user terminals is broadcast over the entire bandwidth allocated to the outroute carrier. Because the IPoS outroute can multiplex a multiplicity of transmissions, it streams to many remote terminals.

–   The inroute direction from the remote terminals to the IPoS hub is point-to-pointP-P, either using a bandwidth assigned by the hub for individual remote terminals or using a bandwidth shared by all terminals on a contention basis.

2.3   Remote terminal characteristics

The remote terminal is the access platform from which the user hosts access the services of the IPoS system. Whether or not a terminal requires the support of a PC is one of the critical methods used to categorize IPoS terminals. According to these criteria, there are two remote terminal categories:

–   *PC-hosted*: This type of terminal is primarily oriented toward consumer applications. PC-hosted remote terminals operate as a PC peripheral, typically a USB peripheral, and significant support from the PC is required for operation. This support includes:

  –   Downloading the peripheral's software.

  –   Enabling performance enhancement function.

  –   Commissioning and management functions.

–   *Self-hosted*: Self-hosted terminals are aimed at all classes of customers, i.e. consumer, ~~and~~ small office, home office (SOHO) and enterprise market segments. The self-hosted remote terminals do not require an external PC to support their operation in the IPoS system. Self-hosted terminals ~~could~~can be fully managed by the hub, e.g. self-hosted remote terminals can have their software downloaded, and their configuration parameters set by the hub.

Another criterion for categorizing remote terminals is the type of return channel that a terminal uses to send data to the hub. Accordingly, remote terminals can be classified into:

–   *Satellite-return channel*: transmits back to the hub directly via the inroute satellite channels part of the IPoS system.

–   *Receive-only with terrestrial return*: operates receive-only with respect to the satellite, using some form of terrestrial return capability (e.g. a dial-up connection).

Table 2 summarizes typical characteristics of the various types of remote terminals currently defined in the IPoS system.

TABLE 2

IPoS terminals typical characteristics

Terminal name/features	Hosting	Return channel
Low-cost, two-way, broadband satellite PC peripheral	PC	Satellite
Low-cost, two-way, broadband self-hosted terminal	Self	Satellite
Receive-only lowest-cost satellite broadband, PC peripheral	PC	Dial-up

3   IPoS satellite interface

3.1   IPoS protocol reference model

The IPoS protocol is a multilayered peer-to-peer protocol providing the mechanisms to exchange IP traffic and signalling information between the entities in the hub and remote terminals.

The IPoS protocol is structured according to the broadband satellite multimedia (BSM) protocol architecture as defined in TR 101 984. This architecture provides a split between satellite-dependent functions and satellite-independent functions, as illustrated in Fig. 7.

FIGURE 7

Protocol reference model
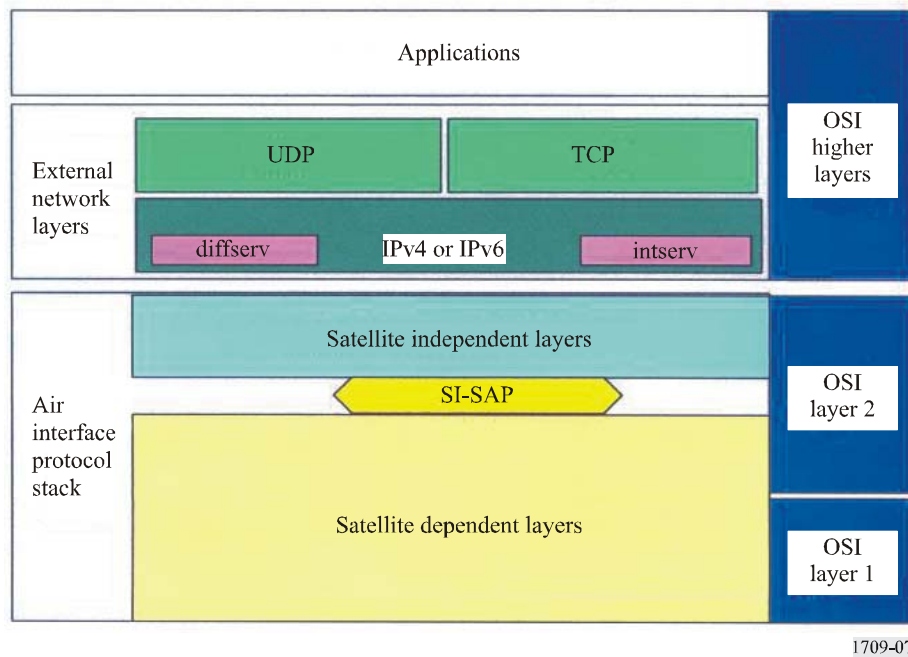
The protocol architecture separates satellite-dependent functions and satellite-independent functions via an interface designated for the SI-SAP. The purpose of this split is as follows:

– Separate the satellite-specific aspects from the satellite-independent higher layer. This separation is designed to permit future market developments, in particular IP enhancements.

– Provide flexibility for the addition of more complex market segment-based solutions (e.g. performance enhancing proxy (PEP)).

– Elements above the SI-SAP can be ported with greater ease to new satellite systems.

– Extensibility to support new higher-layer functionalities without major re-engineering of existing designs.

As shown in Fig. 7, the SI-SAP is positioned between the data link (layer 2) and network layers in the International Organization for Standardization (ISO) layering model. Elements above the SI-SAP can be, and indeed should be, designed without specific knowledge of the supporting satellite link layer. The satellite-independent layers in Fig. 7 are generic, including services not currently specified by IPoS such as IntServ, DiffServ, and IPv6.

The IPoS interface is organized into planes, layers, and directions of transmission over the satellite. There are three protocol planes:

Plane 1:   *User-plane (U-Plane)*: provides the protocols needed for reliable transport of IP traffic containing user information across the satellite interface.

Plane 2:   *Control-plane (C-Plane)*: contains the signalling protocols needed to support and control the satellite access connections and resources needed in the transport of user traffic.

Plane 3:   *Management-plane (M-Plane)*: concerned with the administration and messaging related to the commissioning of remote terminals, the billing of the users, performance, and alarm reporting. The management-plane is outside the scope of this standard.

Each of the IPoS planes is logically divided into three protocol sublayers. The protocol sublayers are used to decompose the overall system functionality into groupings of functions at the same abstraction level.

– *PHY layer*: provides the lower-level functionality related to modulation, error control of the information, and signalling streams transported across the interface.

– *Data link-control (DLC) layer*: provides the multiplexing of the various streams as well as reliable and efficient transport services.

– *Network-adaptation layer*: controls user access to the satellite and controls radio resources needed for this access.

3.2 Layer-wise functional partitioning

This subsection gives the functional responsibilities for the layers in the satellite-dependent part of the IPoS interface.

3.3 PHY layer

The physical-layer function provides the transmission and reception of the modulated waveforms used to transport the data provided by the data link and higher layers over the satellite. At the PHY, there is no distinction between the transport methods provided for U-Plane and C-Plane or M-Plane information. This distinction is made at higher layers.

The services provided by the PHY layer are grouped into the following categories:

– The initial acquisition, synchronization, and ranging procedures with the hub, including the timing alignment of the transmissions with the frame structure of the inroute carriers and the adjustment of the power transmitted by the remote terminals.

– The modulation, coding, error correction, scrambling, timing, and frequency synchronization of information flows, provided by the DLC's U-Plane and C-Plane to the outroute and inroute carriers.

– The performance of local measurements such as received E_{b}/N_0, recovered clock, and status and supervision of the physical parameters (such as timing) and their reporting to higher layers.

3.4 Outroute satellite transmission

IPoS outroute carriers use a statistical multiplexing scheme compliant with the DVB data format and the distribution of IP traffic to the remote terminals is based on the DVB multiprotocol encapsulation. Symbol rates from 1 MSymbol/s to 45 MSymbol/s are supported, at ~~forward error correction (FEC) R~~rates 1/2, 2/3, 3/4, 5/6 and 7/8 with DVB-S modulation and coding, and at FEC rates ranging from 1/4 to 9/10 with DVB-S2 modulation and coding.

3.5 Inroute satellite transmission

An IPoS inroute uses offset quadrature phase shift keying (OQPSK) modulation at transmission rates of 64, 128, or 256 kSymbol/s when using ~~R~~rate 1/2 convolutional ~~en~~coding, or at transmission rates of ~~128 or~~ 256, 512, 1 024 and 2 048 kSymbol /s when using Turbo ~~FEC~~and BCH ~~en~~coding.

IPoS uses demand-assigned multifrequency time division multiple access (MF-TDMA) on its inroutes to allow terminals to transmit to the hub. The IPoS inroute has a 45 ms TDMA frame length divided into a variable number of slots. Transmissions from a terminal to the hub are referred to as a "burst." A burst requires an integral number of slots for overhead and then carries an integral number of slots of data. These overhead slots are used to provide the burst preamble and to allow adequate time between bursts to ensure that consecutive bursts do not overlap in time.

3.6 Data link layer (DLL)

The DLL provides the actual transport service over the IPoS network. It is divided into the following sublayers:

– satellite link control (SLC);

– media access control (MAC);

– outroute multiplexing sublayer.

3.7 Satellite link control (SLC) sublayer

The SLC layer is the sublayer of the DLC that is responsible for transmission of packets between remote terminals and the hub.

IPoS supports different delivery methods over the outroute and inroute directions.

A reliable error-free delivery method is used in the inroute direction using selective retransmissions. In this reliable delivery method, the receiving SLC entities deliver only error-free data packets to the higher layers.

Over the outroute where the transmission errors are very low (typical BER = 10^{-10}), the transmit SLC delivers each data packet only once without retransmission of erroneous or missing packets.

The functional responsibilities of the SLC are:

– Generation of session Ids and mapping incoming packets into the corresponding session.

– Encryption of specific IP PDUs for user-to-user data privacy.

– Segmentation and reassembly, which performs segmentation/reassembly of variable-length higher layer data packets into smaller PDUs.

– Delivery of data in sequence to the peer using the reliable/unreliable mode of delivery.

3.8 Media access control (MAC) sublayer

The services or functions provided by the MAC layer can be grouped into the following categories:

– *Data transfer*: This service provides transfer of MAC interactions between peer MAC entities. This service does not provide any data segmentation; therefore, the upper layers provide the segmentation/reassembly function.

– *Reallocation of radio resources and MAC parameters*: This service performs control procedures for identifiers that are allocated to a particular DLC layer by the network layer for an interval of time or on a permanent basis. It also performs procedures for the establishment and termination of transfer modes over the DLC layer.

– *Error detection*: Procedures for the detection of procedural errors or errors occurring during the transmission of frames.

3.9 Outroute multiplexing sublayer

In the outroute direction, the multiplexing sublayer permits the hub to transmit several traffic types, programmes, or services within the same outroute carrier and controls the transmission of each individual programme. The IPoS-multiplexing sublayer is based on the digital video broadcast/motion pictures expert group (DVB/MPEG) statistical multiplexing format.

In this DVB/MPEG format, all the frames or packets associated with one of the traffic types have the same programme identifier PID. At the remote terminals, a demultiplexer breaks the outroute multiplex into specific transport streams with the remote terminal filtering only those that match the PID addresses configured in the terminal.

IPoS remote terminals are configured to filter two types of PID associated with the following types of transport streams, which are relevant to the IPoS system:

Type 1: PSI tables, which provide both IPoS and non-IPoS terminals with configuration of services. The IPoS terminals receive the PSI tables to determine the specific configuration of the IPoS system.

Type 2: IPoS user and control information, which is transported in the IPoS logical channels. The information contained in the IPoS logical channels can be targeted to all, a group, or individual IPoS terminals.

Outroute DVB/MPEG packets are broadcast over the entire outroute carrier bandwidth with IPoS terminals filtering those packets that do not match their own addresses. The addressing scheme is included as part of the transport packet header and MAC header.

3.10 Network adaptation layer

The network adaptation layer function provides the following major subfunctions:

– *IP packet transport*: This function performs the functions necessary to determine the class of service of the IP packet based on packet type, application type, destination, and internal configuration.

– *Traffic management*: This function performs the traffic shedding and policing functions on IP packets before they are offered to the IPoS transport services.

– *PEP*: This function improves the performance of certain applications for improving service over a satellite link. PEP are often used to reduce the degradations in throughput experienced by transmission control protocol (TCP) applications because of the delays and losses in satellite links.

– *Multicast proxy*: This proxy adapts IP-multicast protocols (e.g. PIM-SM) to the appropriate IPoS transport services to provide the multicast.

The network adaptation layer is not part of the IPoS air interface specification.

––––––––––––––––