IP over Satellite (IPoS) – The Standard for Broadband over Satellite

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1.0 Introduction

The Internet Protocol over Satellite (IPoS) standard was ratified as a U.S. Telecommunications Industry Association standard (TIA-1008) in November 2003. The standard fully specifies the layered architecture and protocols for the transmission of IP packets between a central hub station and remote satellite terminals using standard Ku-band bent-pipe geosynchronous satellites.

The IPoS system delivers “always on” IP services and is targeted at residential, SOHO and enterprise markets. The primary services offered to these segments are broadband Internet access (for enabling applications such as e-mail, Web browsing, and file transfer) and Wide Area Networking. Additionally IP Multicast services such as audio/video streaming and distance learning can be offered through the IPoS system.

Based upon Hughes Network Systems’ HughesNet®, the world’s leading two-way satellite system, IPoS is the only standard that incorporates elements critical for successfully addressing the mass market:

- Extensively field proven
- Proven scalability to large numbers of users
- Achieves the lowest terminal costs by virtue of design and volumes

Standards have historically been catalysts for dramatic growth in a multitude of industry segments directly and indirectly impacted by the standard. This increase in volume has led to decreases in costs, which stimulates further growth in a virtuous cycle. Within the satellite industry itself, the impact of the MPEG and DVB standards is a testament to this phenomenon. By providing its leading edge technology in the form of the IPoS standard, HNS intends to invigorate the ecosystem of terminal, hub, and ancillary equipment vendors, application developers, service providers, and end users.

1.1 Markets

In non-metropolitan areas worldwide, the availability of high-speed terrestrial broadband services (i.e., those delivered over cable or DSL) is often spotty. Satellite delivered networking is therefore a fundamental piece of the broadband mosaic. In the U.S., the HughesNet broadband-over-satellite service has shown strong subscriber growth to nearly 200,000 subscribers by year end 2003 while worldwide shipments of HughesNet-based terminals exceeded 400,000 in the same time frame. In 2002-03 alone, more than a dozen service providers outside the U.S. standardized on the HughesNet IPoS system as the means of delivering broadband services.

IPoS by virtue of its scalability helps participants in addressing this market. Its architecture reduces the cost of the terminal which is a major component of the startup costs of a satellite-based service. This in turn increases the penetration of the standard and the number of users of “broadband aware” applications and appliances. Broadband stakeholders potentially impacted by the standard include:
1.1.1 Residential and Corporate End-Users

End-users benefit from the lower cost and extensible nature of the IPoS standard. While the benefits of lower cost are quite obvious, the clean separation between satellite-dependent and satellite-independent layers in the terminal greatly eases the introduction of enhancements such as Performance Enhancement Proxies (PEP). These proxies counteract the effects of satellite delay and significantly improve the user experience. Support for secure multicast as embodied in IPoS facilitates applications such as audio-video streaming for entertainment, distance learning, and corporate communications with minimal impact on throughputs for the other data-centric applications.

1.1.2 Application Developers

Developers of multimedia and/or broadband application software and appliances will find a greater addressable market with the introduction of IPoS. A few categories of applications are discussed further below.

1.1.2.1 VPN Application and Appliance Vendors

VPN connections are extensively used by remote workers and branch offices to connect to corporate Intranets. By offering ubiquitous broadband connectivity, IPoS becomes an important platform for the widespread deployment of VPNs. Ensuring interoperability of the VPN application/appliance with IPoS expands the market for VPN vendors and allows them to propose universally available VPN solutions to enterprises. Users benefit from higher throughputs, support calls to enterprise IT staff decrease and the vendors have more satisfied customers. It is therefore expected that low cost IPoS based satellite services will open up new branch office and remote access markets for VPN vendors.

1.1.2.2 A/V Streaming and Other Multimedia Application Vendors

Many users are drawn to broadband to be able to receive high-quality audio/video streams and download large audio/video files. With their high downstream bit rates, IPoS-based systems can easily meet such needs. IPoS as a broadband access mechanism is unique in that it can support high rate multicast audio/video streams with no impact on throughput for data applications. HughesNet, for example, offers a multi-channel audio service free of charge to its subscribers, which has no impact on access throughputs.

1.1.3 PC Hardware, Operating System, 802.11 Appliance Vendor

A primary reason for consumers to buy a new PC or upgrade the operating system is to use broadband enabled multimedia applications like audio/video streaming and file sharing. Broadband invariably implies an “always on” connection, which frees up a telephone line and facilitates the connection of multiple home computers to the Internet. The availability of lower cost IPoS-based broadband over satellite services opens up new markets for vendors in this category.

1.1.4 Satellite Operators

As satellite-based broadband networks become more widespread, the demand for satellite capacity will increase significantly – linearly with the number of users. This is due to the unicast nature of
such connections, rather than the one-to-many nature of typical broadcast networks. IPoS is the best option for expanding the customer base since it is highly scalable and enables lower cost terminals, compared to other current alternatives.

1.1.5 Service Providers/Carriers

Reasons that service providers can benefit from IPoS include:

- IPoS is standards-based
- IPoS enables lower cost terminals
- IPoS is the only standard with demonstrated scalability to large number of users
- IPoS has demonstrated more applications and application developers support than any other standard.
- IPoS is designed to seamlessly interface and interoperate with terrestrial wide-area networks

1.1.6 Satellite Terminal and Appliance Developers

There is a proven market globally for Internet access services over satellite and the HughesNet system is the market leader globally. Terminal and appliance vendors developing equipment conforming to this standard will find a number of service providers who will be deploying systems based on the standard due to the many reasons mentioned above. The standard also facilitates product differentiation in a number of areas such as IP routing features, performance enhancing proxies, network management, etc.

1.1.7 Hub Manufacturers

Hub vendors who develop equipment compliant with the IPoS standard and who demonstrate interoperability with remote terminals from other vendors will find service provider customers who want the flexibility to have alternate vendors for remote and hub systems. Service providers who select IPoS hubs which interoperate with different satellite terminals will be able to mix and match satellite terminals to meet different market requirements.

Now that we have discussed the potential benefits of the standard to different players in the satellite and broadband communities, we will take a brief look at the architecture and protocols specified by IPoS.

2.0 IPoS Overview

The IPoS standard applies to star satellite access networks wherein multiple remote terminals communicate bi-directionally with a hub as illustrated in Figure 2-1.
Three major segments are included in the access network:

- **Hub segment**: The hub segment consists of the gateway interconnecting the satellite access network with the external networks, e.g., Internet, corporate, or private packet networks. Typically, the gateway consists of a large earth station through which hundreds of thousands of satellite users communicate over a multiplicity of transponders over one or more satellites. The gateway is responsible for aggregating the traffic from remote users connecting to public and/or private data networks; converting traffic from one protocol to another; routing of the traffic across the satellite network; and the overall management, configuration, and provisioning of the satellite access network.

- **Space segment**: The space segment typically consists of commercial Ku-band, bent-pipe transponders on geosynchronous satellites, allowing transmission in both directions between the hub and remote terminals. The IPoS physical layer interface assumes Ku-band commercial satellites with spectrum that is designated for Fixed Satellite Services (FSSs). The gateway may access space segment resources from multiple satellites.

- **User segment**: The user segment is responsible for interfacing the user hosts or Personal Computers (PC) running the user applications at the customer premises. In general, the user segment consists of thousands to hundreds of thousands of remote terminals, each of them capable of providing broadband IP communications to a remote site through their IPoS satellite interface to the gateway.

### 2.1 IPoS Protocol Reference Model

The IPoS protocol is a multilayered peer-to-peer protocol providing the mechanisms to exchange IP traffic and signaling information between the entities in the central hub station and satellite remote terminals.
The IPoS protocol is structured according to the ETSI Broadband Satellite Multimedia (BSM) protocol architecture as defined in ETSI standard TR 101 984. This architecture provides a split between satellite-dependent and satellite-independent functions, through the Satellite-Independent Service Access Point (SI-SAP) interface as illustrated in Figure 2-2.

![Protocol Reference Model](image)

**Figure 2-2. Protocol Reference Model**

This standardized access point allows hardware and software that has been built to conform to the IPoS standard to operate with any satellite-independent hardware and software that also follows this interface specification. The SI-SAP interface provides the following benefits:

- The separation of the satellite-specific aspects from the satellite-independent higher layers facilitates future developments in IP-based networking features to be easily accommodated within an IPoS terminal. For example, new IP routing protocols can be supported with much less effort or redesign by virtue of the SI-SAP interface.
- Provides flexibility to add product differentiators (e.g., Performance Enhancement Proxies (PEPs)).
- Elements above the SI-SAP (the satellite independent functions) can be ported with greater ease to new satellite systems.

The SI-SAP interface used in IPoS is significant because it permits independent developments to occur in parallel, thereby improving terminals and systems as a whole to the benefit of all concerned parties. In an already proven systems environment, this has the potential to be a major step forward for the industry.
2.2 Characteristics of IPoS-based Remote Terminals

The remote terminal is the platform from which user hosts access the services of the IPoS system. IPoS supports a variety of remote terminals to allow maximum flexibility. Remote terminals are categorized by whether they require the support of a PC and type of return channel required. There are two categories for the former:

1. 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.

2. Self-hosted: Self-hosted terminals are aimed at all market segments. The self-hosted remote terminals do not require an external PC to support their operation in the IPoS system.

Categorizing remote terminals by return channel, data sent from terminal to hub, has terminals classified by:

1. Satellite Return Channel: transmits back to the hub directly via inroute satellite channels that are part of the IPoS system.

2. Receive-Only with Terrestrial Return: operates receive-only with respect to the remote terminal, using some form of terrestrial return capability (e.g., a dial-up connection).

Table 2-1 summarizes typical characteristics of the various types of remote terminals currently defined in the IPoS system.

<table>
<thead>
<tr>
<th>Terminal Name/Features</th>
<th>Hosting</th>
<th>Return Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-Cost, Two-Way, Broadband Satellite PC Peripheral</td>
<td>PC</td>
<td>Sat</td>
</tr>
<tr>
<td>Low-Cost, Two-Way, Broadband Self-Hosted Terminal</td>
<td>Self</td>
<td>Sat</td>
</tr>
<tr>
<td>Receive-Only Lowest-Cost Satellite Broadband, PC Peripheral</td>
<td>PC</td>
<td>Dial-up</td>
</tr>
</tbody>
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3.0 Further Reading

More details of the IPoS standard are provided in ETSI document BSM1503 which is available at request from Hughes Network Systems. The complete TIA-1008 standard is available for a fee from www.tiaonline.org.