Digital Broadband Delivery System
Phase 1.0

System Overview

Revision 1.0

Scientific-Atlanta, Inc.

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1. Introduction

1.1 Purpose

This document describes a Digital Broadband Delivery System. Included is a description of the system architecture, components and subsystems, and interfaces. Also included is a synopsis of the operation of the system.

This document is intended for planners and implementors responsible for deploying Digital Broadband Delivery Systems.

1.2 Scope

This document describes the complete Digital Broadband Delivery System (DBDS), which is defined as an end-to-end system and therefore encompasses a variety of components and subsystems from multiple vendors. While the DBDS components and subsystems provided by Scientific-Atlanta are the primary focus of this document, a system-wide discussion provides the necessary context for understanding the functions of the S-A products. However, not all system components and subsystems are described in detail in this document. Several DBDS components are treated as “black boxes,” with no discussion of the architecture and operation of these components beyond a brief description.

This document is limited in scope to a discussion of the DBDS capabilities that will be supported with the Phase 1.0 release of the Scientific-Atlanta DBDS components and subsystems.

2. System Overview

Figure 1 represents a traditional cable system, in which services are transported from the source to the headend via primary service delivery systems, and from the headend to the home terminal via a secondary service delivery system.

Traditional Cable System Model

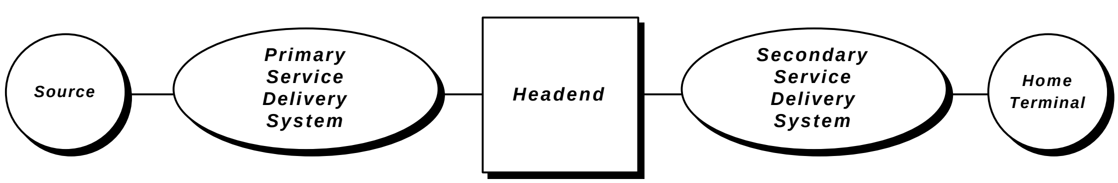

Figure 1

Sources may include video cameras, video tape players, and video game servers. Primary service delivery systems transport analog services from the source to the headend. Typical primary service delivery systems include satellite and terrestrial broadcast distribution systems.

At the headend, a variety of input signals from primary service delivery systems are terminated, processed, multiplexed, and input to the secondary service delivery system. The headend may also house local sources, which are directly interconnected with the secondary service delivery system.

The secondary service delivery system transports the services to home terminals. The secondary service delivery system is typically a traditional trunk and feeder coax network, or more recently a Hybrid Fiber / Coax (HFC) network with fiber optic cables extending from the headend to neighborhood nodes and a coax distribution network extending from the nodes to home terminals.

The DBDS is an extension of the traditional cable system, incorporating digital technology with analog and thereby expanding the capacity of the traditional system and providing a platform for offering interactive services such as Internet Access and Video On Demand. Within the DBDS, the sources and primary service delivery systems are represented as Value-Added Service Provider (VASP) systems. In addition to the typical analog sources and distribution systems, VASP systems may also include digital servers, digital satellite and terrestrial broadcast distribution systems, and Wide Area Networks such as the Internet. The DBDS headend houses traditional analog headend equipment as well as digital headend equipment and local digital sources. Fiber optic transmission systems and HFC networks are employed as secondary service delivery systems in the DBDS. The DBDS home terminal is a sophisticated digital transceiver capable of supporting digital services in addition to traditional analog services. Figure 2 is a generic model of a DBDS. This generic model will be used as a reference throughout this document.

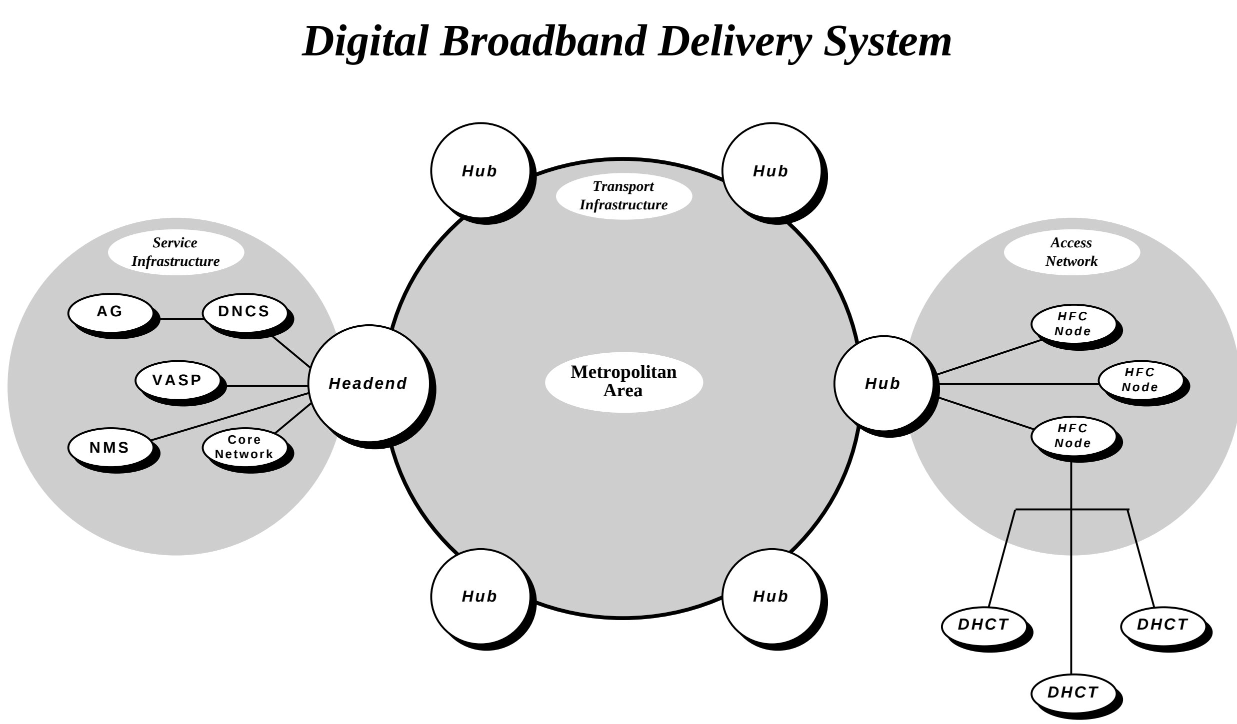

Figure 2

The DBDS is comprised of a service infrastructure, a headend, a transport infrastructure, hubs, access networks, and Digital Home Communications Terminals (DHCTs). The service infrastructure consists of Value-Added Service

Provider (VASP) systems, the Scientific-Atlanta Digital Network Control System (DNCS), the Administrative Gateway (AG), the Network Management System (NMS), and the Core Network, which interconnects other Service Infrastructure components with the headend. The headend provides an interface between the service infrastructure and the transport infrastructure. The transport infrastructure provides an interconnection from the headend to hubs. The hubs each serve an access network, which consists of HFC nodes connected via a coax bus network to DHCTs. Each instance of a DBDS provides service to a metropolitan area.

The DBDS can be implemented in a variety of configurations to fit the circumstances of a particular service environment. For example, headend equipment may be deployed within the headend, within the hub, or as part of a VASP system. DNCS components may be deployed within the headend or distributed among the hubs. The transport infrastructure may utilize SONET add/drop multiplexing, analog fiber technology, or other transmission technologies.

The components and subsystems of the DBDS will be discussed further in Section 4.2. But first, the service capabilities of the DBDS are described in the following section.

3. System Service and Feature Capabilities

This section outlines the general service and feature capabilities of a Digital Broadband Delivery System (DBDS) incorporating the Phase 1 release of Scientific-Atlanta DBDS components and subsystems. This list is not necessarily exhaustive. The DBDS will likely provide additional service and feature capabilities to support new services and features as they are developed with little or no modification to the DBDS components or subsystems.

A specific implementation of a DBDS may not fully support all capabilities described below.

3.1 Service Capabilities

3.1.1 Analog Broadcast Service

S-A DBDS components and subsystems are capable of delivering non-scrambled NTSC signals accessible by all subscribers. This capability enables the system operator to utilize existing analog service infrastructure to provide traditional broadcast television service.

3.1.2 Secure Analog Broadcast Service

S-A DBDS components and subsystems are capable of scrambling NTSC signals and restricting access to only those subscribers pre-authorized via the PowerKEY™ Conditional Access system. This capability enables the system operator to utilize existing analog service infrastructure to provide subscription-based services. (Note: Operation of secure analog broadcast service will be described in a future revision of this document according to the schedule identified in the Product/System Description Revision Plan.)

3.1.3 Analog Pay-Per-View Service

S-A DBDS components and subsystems are capable of granting access to scrambled NTSC signals during a specified interval to subscribers pre-authorized via the PowerKEY™ Conditional Access system. This capability enables the system operator to utilize existing analog service infrastructure to provide PPV services. (Note: Operation of analog PPV service will be described in a future revision of this document according to the schedule identified in the Product/System Description Revision Plan.)

3.1.4 Analog Impulse Pay-Per-View Service

S-A DBDS components and subsystems are capable of granting access to scrambled NTSC signals during a specified interval to qualified subscribers who request authorization via the Digital Home Communications Terminal (DHCT). This capability enables the system operator to utilize existing analog service infrastructure to provide IPPV services. (Note: Operation of analog IPPV service will be described in a future revision of this document according to the schedule identified in the Product/System Description Revision Plan.)

3.1.5 Digital Broadcast Service

S-A DBDS components and subsystems are capable of delivering non-encrypted MPEG-2 Programs accessible by all subscribers. This capability enables the system operator to greatly increase the number of services that can be offered by transmitting several digital broadcast services within the same bandwidth required by a single analog broadcast service.

3.1.6 Secure Digital Broadcast Service

S-A DBDS components and subsystems are capable of encrypting MPEG-2 Programs and restricting access to only those subscribers pre-authorized via the PowerKEY™ Conditional Access system. This capability enables the system operator to greatly increase the number of subscription-based services that can be offered.

3.1.7 Digital Pay-Per-View Service

S-A DBDS components and subsystems are capable of granting access to encrypted MPEG-2 Programs during a specified interval to subscribers pre-authorized via the PowerKEY™ Conditional Access system. This capability enables the system operator to greatly increase the number of PPV events that can be offered.

3.1.8 Digital Impulse Pay-Per-View Service

S-A DBDS components and subsystems are capable of granting access to encrypted MPEG-2 Programs during a specified interval to qualified subscribers who request authorization via the Digital Home Communications Terminal (DHCT). This capability enables the system operator to provide subscribers with the ability to purchase PPV events from the DHCT, and to obtain an authenticated record of each purchase.

3.1.9 Digital Near Video On Demand Service

S-A DBDS components and subsystems are capable of supporting the delivery of simultaneous MPEG-2 Programs carrying IPPV events with staggered start times. An NVOD application may then coordinate access to these events. This capability enables the system operator to broadcast multiple showings of a popular program such that the subscriber will have at most a short delay before the program is available for purchase, and will be able to jump from one showing to another, similar to the pause, fast forward, and rewind features of a Video Cassette Recorder.

3.1.10 One-way Real-time Datagram Service

The DBDS is capable of delivering broadcast Internet Protocol (IP) data packets either via a digital transmission channel or a forward data channel. DHCTs are capable of receiving broadcast datagrams via a digital transmission channel or a forward data channel. This capability enables the system operator to send information such as Emergency Alert System messages to all DHCTs.

3.1.11 Two-way Real-time Datagram Service

The DBDS is capable of delivering addressed Internet Protocol (IP) data packets either via a digital transmission channel or a forward data channel. The DBDS can route IP packets to the IP address of a DHCT or VASP system. This capability enables the system operator to offer two-way connectionless data communications services such as Internet Access and electronic commerce.

In support of this service, the DBDS provides a Directory of DHCTs for Value-Added Service Providers (VASPs).

3.2 Feature Capabilities

3.2.1 Closed Caption

S-A DBDS components and subsystems are capable of passing Closed Caption material inserted on line 21 of the Vertical Blanking Interval (VBI) of NTSC signals to the outputs of the DHCT. S-A DHCTs are also capable of passing this information to DHCT applications for further processing. This capability enables the system operator to offer analog broadcast services with Closed Caption material.

S-A DBDS components and subsystems are also capable of passing Closed Caption material inserted as user data within MPEG-2 Packetized Elementary Streams to the DHCT and inserting the material on line 21 of the VBI of the output NTSC signal prior to routing the signal to the DHCT outputs. S-A DHCTs are also capable of passing this information to DHCT applications for further processing. This capability enables the system operator to offer digital services with Closed Caption material.

3.2.2 VBI Data

S-A DBDS components and subsystems are capable of passing North American Broadcast Teletext System (NABTS) data inserted on Vertical Blanking Interval (VBI) lines 10-21 of NTSC signals to the outputs of the DHCT. S-A DHCTs are also capable of passing NABTS data to DHCT applications for further processing. This capability enables the system operator to utilize VBI lines as a means of distributing NABTS data to DHCTs.

3.2.3 Copy Protection

S-A DBDS components and subsystems are capable of supporting the Macrovision™ copy protection system on digital services. This capability enables the system operator to restrict unauthorized subscribers from copying Digital Pay-Per-View, Digital Impulse-Pay-Per-View, and Digital Near Video On Demand events.

3.2.4 Multi-channel Audio

S-A DBDS components and subsystems are capable of BTSC-encoding baseband stereo inputs received at the headend, decoding the BTSC stereo at the DHCT, and providing the decoded stereo on the DHCT baseband outputs. This capability enables the VASP to provide stereo sound with analog services.

S-A DBDS components and subsystems are also capable of delivering Musicam and AC-3 encoded audio received at the headend, decoding the encoded audio at the DHCT, and providing the decoded audio on the DHCT baseband outputs. S-A DHCTs are capable of downmixing 5.1-channel AC-3 encoded audio into two-channel Dolby Pro Logic™ encoded audio. Dolby Pro Logic™ encoding by a VASP audio source is transparent to S-A DBDS components and subsystems. This capability enables the VASP to provide stereo sound (and surround sound) with digital services.

3.2.5 Multi-lingual Audio

S-A DBDS components and subsystems are capable of delivering a Secondary Audio Program (SAP) for analog services, and multiple audio streams for digital services. The DHCT outputs the audio program selected by the subscriber via the user interface.

3.2.6 Blackout

S-A DBDS components and subsystems are capable of supporting service blackouts. Each DHCT can be provisioned with coordinates, and authorization to receive a service can be revoked from those DHCTs whose coordinates fall within a defined range.

3.2.7 Emergency Alert System

S-A DBDS components and subsystems are capable of supporting the Emergency Alert System as defined by the FCC.

3.3 Operational Capabilities

3.3.1 Software Download

S-A DBDS components and subsystems are capable of reconfiguring the resident operating system and application software with software downloaded via the DBDS. This capability enables the system operator to upgrade S-A DBDS components and subsystems, including the DHCT, to a new software version via the DBDS.

4. System Architecture

Figure 3 depicts the various communications paths that can be established to the DHCT. The DBDS can support forward and reverse communications paths. The forward path supports analog transmission channels (ATCs), digital transmission channels (DTCs), and forward data channels (FDCs). An ATC is an AM-VSB waveform with a bandwidth of 6 MHz used for transporting an NTSC signal from a headend to a DHCT. A DTC is a QAM waveform with a bandwidth of 6 MHz used for transporting an MPEG-2 Transport Stream from a headend to a DHCT. An FDC is a QPSK waveform with a bandwidth of 1 MHz used for transporting data from a hub to a DHCT.

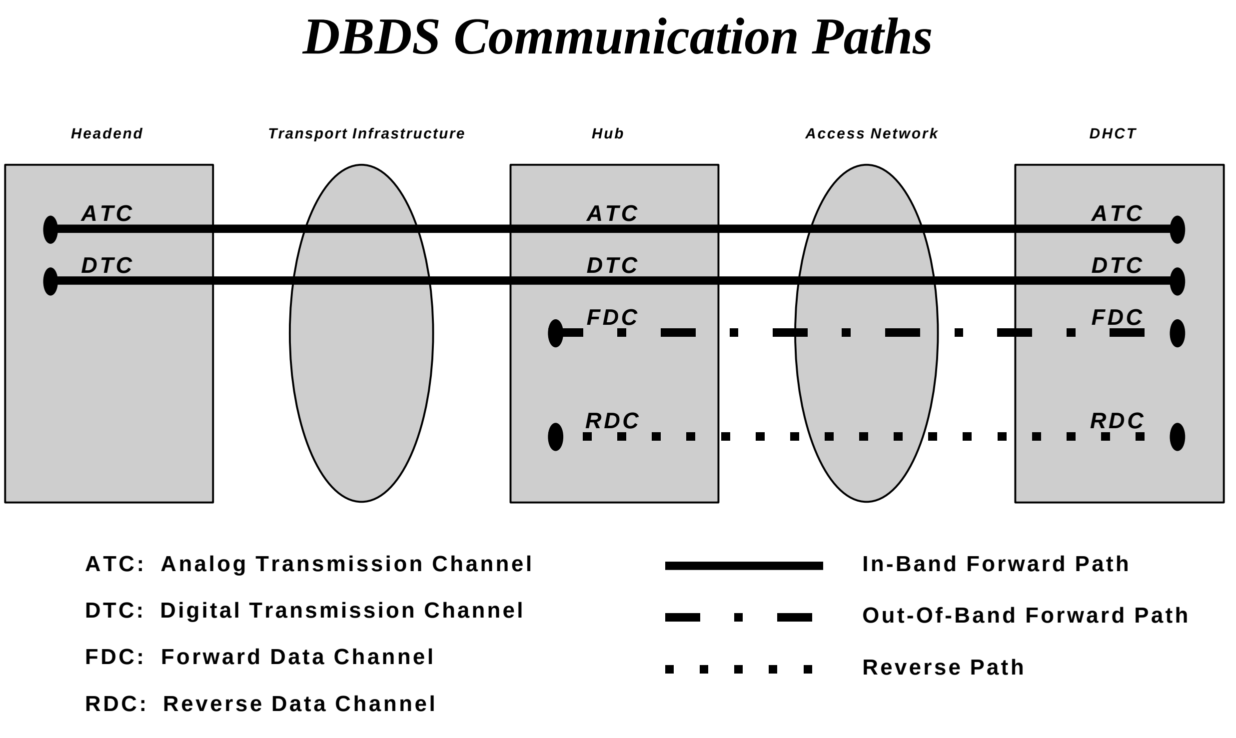

Figure 3

The analog and digital transmission channels are often referred to as "in-band" channels; these are the subscriber-tunable channels and hidden channels that the DHCT may automatically tune to while the subscriber is not using a service. Information carried on the in-band channels is typically service-related.

Forward data channels are often referred to as “out-of-band” channels; these channels are typically used to deliver system messages to a DHCT without interfering with a subscriber’s use of services, A DHCT typically has one FDC on which it receives application and control messages from other DBDS components and subsystems.

The reverse path supports reverse data channels (RDCs), which are QPSK waveforms with a bandwidth of 1 MHz used for transporting data from a DHCT to a hub. A DHCT typically utilizes one RDC for sending both application data and control messages at any given time, and negotiates with headend equipment to use the RDC. The DBDS may also be configured such that multiple RDCs are available to a DHCT at any given time, though the DHCT will only use a single RDC at any given time for sending application data and control messages.

4.1 System Configurations

The DBDS can be configured as a one-way or two-way system. Both a forward and reverse path is established in two-way systems, while only a forward path is established in one-way systems. Both configurations support addressable services, though one-way systems do not support impulse-purchasable or two-way services. Also, remote monitoring of the DHCT can not be performed in one-way systems.

A two-way system can maintain limited operation in the event an RDC is not available, and a one-way system can maintain limited operation in the event an FDC or DTC is not available. Table 1 describes the scenarios for one-way and two-way operation.

Table 1: Operational Scenarios

System Configuration	System Transport Facilities:	Services Supported
Two-Way	Analog Transmission Channel Digital Transmission Channel Forward Data Channel Reverse Data Channel	Analog Broadcast Digital Broadcast Secure Digital Broadcast Digital PPV Digital IPPV Digital NVOD Two-Way Datagram
One-Way w/ FDC	Analog Transmission Channel Digital Transmission Channel Forward Data Channel	Analog Broadcast Digital Broadcast Secure Digital Broadcast Digital PPV Digital IPPV (limited by credit/count) Digital NVOD (limited by credit/count)
One-Way w/o FDC	Analog Transmission Channel Digital Transmission Channel	Analog Broadcast Digital Broadcast

		Secure Digital Broadcast (default authorizations)
One-Way Analog only	Analog Transmission Channel	Analog Broadcast

Two-way operation enables all DBDS services to be supported. One-way operation with an FDC supports all DBDS services with the exception of Two-Way Real-Time Datagram service, and Digital IPPV and NVOD event purchases are limited by the subscribers' IPPV Credit and Count parameters until such time the RDC can be utilized to transmit purchase data from the DHCT to the DNCS. One-way operation without an FDC supports Analog Broadcast, Digital Broadcast, and Secure Digital Broadcast services. However, in this scenario new subscribers will typically be provisioned with a a system-operator-defined default set of authorizations (sent via a DTC) for Secure Digital Broadcast services until such time the FDC can be utilized to transmit subscriber-specific authorizations. One-way analog-only operation supports just Analog Broadcast services.

4.2 System Components and Subsystems

The DBDS consists of the following components and subsystems:

- Analog Headend Equipment
- Real-Time Encoder
- Broadband Integrated Gateway*
- QAM Modulator*
- QPSK Modulator*
- QPSK Demodulator*
- LAN Interconnect Device
- Transport Infrastructure
- Access Network
- Digital Home Communications Terminal*
- Digital Satellite Distribution System
- Digital Terrestrial Distribution System
- Application Server
- Digital Media Server
- Application Data Carousel*
- Digital Network Control System*
- Administrative Gateway
- Core Network
- Network Management System
- PowerKEY™ Conditional Access System*

(* Scientific-Atlanta DBDS Phase 1 product.)

As described in Section 4, the DBDS components and subsystems may be deployed in a variety of configurations. Figure 4 and Figure 5 represent a typical deployment of DBDS components and subsystems within the headend and hub, respectively.

Headend Components and Subsystems

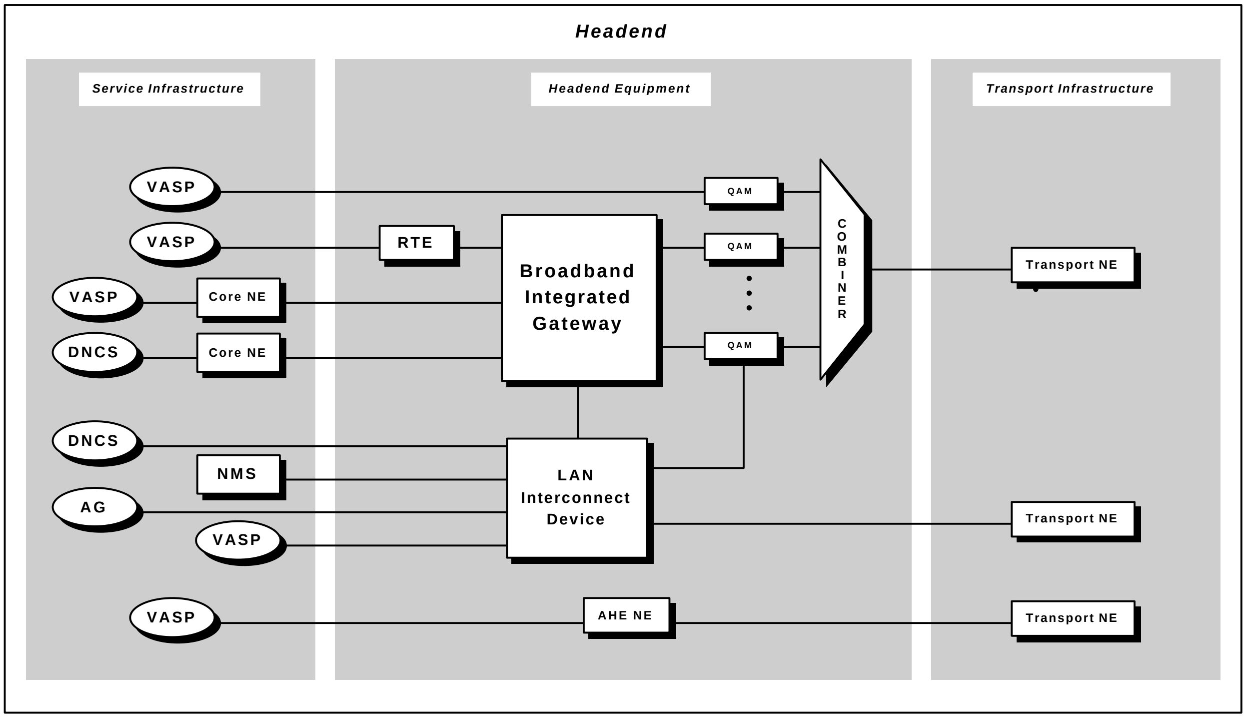

Figure 4

Hub Components and Subsystems

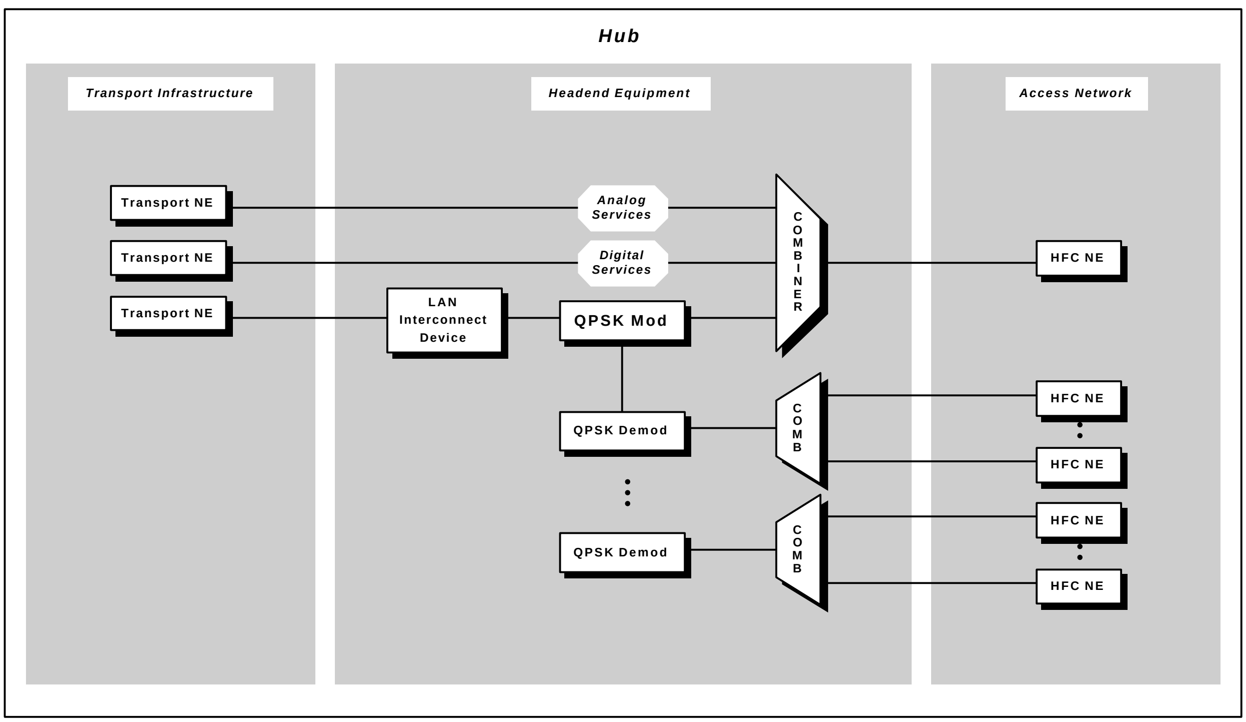

Figure 5

Brief functional descriptions of the DBDS components and subsystems are provided in the following sections.

4.2.1 Headend Equipment

The term "headend equipment" refers to the equipment described in the following sections. While the majority of headend equipment is physically located within the headend, it may also be located in other facilities, such as the hub or remote VASP facility.

4.2.1.1 Analog Headend Equipment

For the purposes of this document, analog headend equipment includes all components and subsystems associated with processing analog broadcast signals received from VASP systems and providing the signals as inputs to the transport infrastructure. In diagrams within this document, analog headend equipment is represented as a "black box" labeled Analog HeadEnd Network Element (AHE NE).

4.2.1.2 Real-Time Encoder

The Real Time Encoder (RTE) digitally compresses analog video and audio signals received at its input into MPEG-2 Packetized Elementary Streams, and outputs a single-program MPEG-2 Transport Stream containing the PES packets. The RTE is typically used to digitize live programming transmitted on an analog satellite or terrestrial broadcast delivery system in order to improve the bandwidth utilization of the DBDS.

4.2.1.3 Broadband Integrated Gateway

The Broadband Integrated Gateway (BIG) is an MPEG-2 Transport multiplexor capable of multiplexing multiple MPEG-2 Programs into multi-program MPEG-2 Transport Streams. The BIG terminates the input signals received from the service infrastructure and reconstructs the MPEG-2 Transport Stream packets and IP datagrams. Under the direction of the DNCS, the BIG filters the rebuilt Transport Stream packets by Packet Identifier (PID), and inserts packets with selected PIDs into multi-program MPEG-2 Transport Streams. The BIG may change the PID of incoming packets if necessary to prevent PID collision within an outgoing Transport Stream. The BIG inserts rebuilt IP datagrams into the appropriate outgoing MPEG-2 Transport Streams, performing re-timestamping as necessary.

The BIG is capable of inserting MPEG-2 Transport Stream packets with a selected PID into multiple outgoing MPEG-2 Transport Streams. The BIG does not perform IP-level routing of IP packets received at its inputs. IP packets input to the BIG within ATM cells are inserted into a particular outgoing MPEG-2 Transport Stream based on the VPI/VCI of the input ATM cells. IP packets input to the BIG within MPEG-2 private data sections are inserted into a particular outgoing MPEG-2 Transport Stream based on the PID of the input MPEG-2 Transport Stream packet.

The BIG generates up to six outgoing MPEG-2 Transport Streams, and passes each Transport Stream to the appropriate QAM modulator.

A more detailed functional description and product specifications can be found in [Ref. 1].

4.2.1.4 QAM Modulator

The QAM Modulator extracts MPEG-2 Transport Stream packets from the input signal received from the service infrastructure or the BIG and, under the direction of the DNCS, filters the extracted packets by Packet Identifier (PID). Accepted packets are inserted into the outgoing MPEG-2 Transport Stream. The QAM Modulator remaps PIDs as necessary to prevent PID collisions within the outgoing Transport Stream. The QAM Modulator also generates packets containing MPEG-2 Program-Specific Information (PSI) and System Information (SI) based on information received from the DNCS and inserts them into the outgoing Transport Stream.

The QAM Modulator is equipped with the PowerKEY™ Service Encryption and ECM Streamer Module (see Section 4.2.6.1) which, under the direction of the PowerKEY™ Control Suite, encrypts the MPEG-2 Transport Stream packets of a selected MPEG-2 Program, and generates and inserts PowerKEY™ Entitlement Control Messages (ECMs) into the appropriate outgoing Transport Stream.

The QAM Modulator performs DAVIC-compliant randomization, forward error correction, and interleaving of the packet data. Randomization is performed in order to reduce patterns in the data. The data is coded using a Reed-Solomon Forward Error Correction code to protect the data from transmission errors. Interleaving is done to evenly distribute burst errors which may occur during transmission. The processed data is inserted into DAVIC-compliant transmission data frames, which are modulated using either the QAM technique. The QAM-modulated RF signal is output for distribution via the transport infrastructure and access network to the DHCT.

A more detailed functional description and product specifications can be found in [Ref. 2].

4.2.1.5 QPSK Modulator

The QPSK Modulator originates the forward data channel from the hub to the DHCT and, together with the QPSK Demodulator, terminates the reverse data channel from the DHCT to the hub. The QPSK Modulator also provides an interface to other DBDS components and subsystems. The QPSK Modulator extracts IP packets received at its input and segments the DHCT-bound packets for insertion into ATM cells. The QPSK inserts the ATM cells into DAVIC-compliant Signaling Link Extended Superframe (SL-ESF) transmission data frames, and outputs a QPSK-modulated RF signal for distribution to the DHCT via the access network. The QPSK Modulator performs DAVIC-compliant randomization, forward error correction, and interleaving of the packet data prior to modulation.

The QPSK Modulator provides an interface to up to eight QPSK Demodulators. The QPSK Modulator receives ATM cells from the QPSK Demodulators containing either application data or Media Access Control (MAC) protocol messages and reassembles the IP packets. The IP packets containing application data are passed to the LAN Interconnection Device for routing to the appropriate destination. The IP packets containing MAC protocol messages are passed to the MAC Controller function within the QPSK Modulator.

The MAC Controller function within the QPSK Modulator performs the MAC functionality as specified by DAVIC. This functionality includes responding to

MAC-layer initialization requests from DHCTs, providing DHCTs with provisioning information such as the frequency of the appropriate reverse data channel to utilize, and dynamically allocating reverse data channel bandwidth (slots) such that bandwidth utilization is optimized. The MAC Controller function, under the direction of the DNCS, also sets up connections for application messaging between the DHCT and VASP systems.

A more detailed functional description and product specifications can be found in [Ref. 3].

4.2.1.6 QPSK Demodulator

The QPSK Demodulator, together with the QPSK Modulator, terminates the reverse data channel from the DHCT to the hub. The QPSK Demodulator demodulates the QPSK signal from the DHCT, performs error correction on the data, extracts the ATM cells containing either application messages or MAC protocol messages, and passes them to the QPSK Modulator via an ATM-25 interface. The QPSK Demodulator monitors the power level and slot timing of the incoming signal and provides the MAC Controller function within the QPSK Modulator with power level and timing performance information.

Up to eight QPSK Demodulator may be connected to a single QPSK Modulator. Each QPSK Demodulator connected to a common QPSK Modulator tunes to a unique frequency for receiving reverse path QPSK signals. The MAC Controller function within the QPSK Modulator provides the DHCTs with the frequency on which to transmit the reverse data channel.

A more detailed functional description and product specifications can be found in [Ref. 4].

4.2.1.7 LAN Interconnect Device

LAN Interconnect Devices (LIDs) are used to establish ATM and IP connectivity between the service infrastructure, headend equipment, and transport infrastructure. LIDs will typically be deployed within the headend and hub. The headend LID will typically provide ATM and Ethernet interfaces to the service and transport infrastructures, maintain ATM Permanent Virtual Circuits (PVCs), and perform IP packet segmentation, reassembly, and routing functions. The headend LID may also be used to establish firewalls to control access to individual LAN segments within the DBDS.

Hub LIDs will typically provide an ATM interface to the transport infrastructure and an Ethernet interface to other headend equipment within the hub. Therefore, hub LIDs will also maintain ATM Permanent Virtual Circuits (PVCs) and perform IP packet segmentation, reassembly, and routing functions.

4.2.2 Transport Infrastructure

The transport infrastructure is a network of switching and transmission equipment used to deliver information between the headend and hubs. The transport infrastructure may incorporate a variety of technologies, including ATM, SONET, DS-3, and AM fiber.

Within this document, the transport infrastructure is viewed as a "black box" which provides a two-way transmission system between the headend and hubs capable of delivering the various types of information output by the headend equipment within those facilities. Components of the transport infrastructure are represented generically as transport network elements in diagrams within this document.

4.2.3 Access Network

The access network provides the forward and reverse paths between a hub and the DHCTs it serves. The DBDS access network is a Hybrid Fiber / Coax (HFC) network consisting of fiber optic transmission systems extending from a hub to HFC nodes, and a coax bus network extending from the HFC nodes to the DHCTs within subscribers' homes.

Within this document, the access network is viewed as a "black box" which provides a two-way transmission system between the hub and DHCTs capable of delivering the various types of information output by the DHCT and headend equipment.

4.2.4 Digital Home Communications Terminal

The Digital Home Communications Terminal (DHCT) provides an interface to the access network and supports the reception of analog and digital services. For analog services, the DHCT tunes to the selected analog transmission channel, extracts the NTSC signal, and outputs the signal to the television, VCR, or other home electronics device.

For digital services, the DHCT tunes to the appropriate digital transmission channel, demodulates the QAM signal, extracts the MPEG-2 Transport Stream packets and decrypts them (if applicable), decompresses the video and audio streams, and generates an NTSC output signal. If private data is present in the MPEG-2 Transport Stream, the DHCT reconstructs the IP packets (if applicable) and passes the data to the operating system for proper routing within the operating system or to a DHCT application.

For two-way real-time datagram service, the DHCT tunes to the appropriate forward data channel, reconstructs the IP packets it receives, and passes the data to the operating system for proper routing within the operating system or to a DHCT application. The DHCT also sends IP packets to the QPSK Demodulator via the reverse data channel for routing to the appropriate DBDS component or subsystem.

The DHCT also supports the features described under Section 3.2.

The DHCT is comprised of a hardware platform, an operating system, and client applications. Brief descriptions of the Scientific-Atlanta Explorer™ 2000 DHCT hardware platform and the PowerTV™ Operating System are provided below. DHCT hardware platforms and operating systems designed for the DBDS will have similar characteristics as the Scientific-Atlanta Explorer™ 2000 and the PowerTV™ Operating System, respectively.

4.2.4.1 DHCT Hardware Platform

The Scientific-Atlanta Explorer™ 2000 hardware platform includes several S-A proprietary Application Specific Integrated Circuits (ASICs), a 32-bit Reduced Instruction Set Computer (RISC) microSPARC™ II microprocessor, various memory modules, and a Secure Element. ASICs perform RF tuning, QAM demodulation, MPEG-2 Transport Stream parsing and decryption, MPEG-2 video and audio decompression, NTSC encoding, graphics, QPSK modulation and demodulation, and MAC functions.

The DHCT includes ROM, DRAM, Flash, and EEPROM memory modules. Standard and optional memory configurations are available for the DHCT.

The DHCT graphics subsystem provides support to the operating system and DHCT applications for on-screen displays and user interfaces.

The DHCT Secure Element (DHCTSE) is a component of the Scientific-Atlanta PowerKEY™ Conditional Access System that provides the cryptographic functions of authentication, confidentiality, data integrity, access control, and key management. Refer to Section 4.2.6 for a description of the PowerKEY™ DHCT Secure Element.

The DHCT provides an ISO-7816-based smart card interface slot to enable the conditional access system to be upgraded or renewed, if necessary, and to enable the use of a conditional access system other than PowerKEY™.

The DHCT provides an interface to a remote control and is capable of receiving, decoding and responding under application software control to infra-red (IR) signals.

A more detailed functional description and product specifications can be found in [Ref. 5].

4.2.4.2 Operating System

The Explorer™ 2000 DHCT operates with the PowerTV™ Operating System (OS). The PowerTV™ OS includes functions specifically designed for the DHCT environment. The PowerTV™ OS also provides Application Programmatic Interfaces (APIs) to enable client applications to utilize the resources managed by the OS for delivering broadcast and interactive services.

The DHCT-specific functions of the PowerTV™ OS include:

- maximizing the utilization of the limited memory resources within a DHCT
- providing a logical channel tuning interface to DHCT applications based on a configurable channel tuning table
- processing MPEG-2 Transport Streams
- providing access to the System and Application Data Carousels for OS upgrades, DHCT applications, and data (see Sections 4.2.5.1 and 4.2.5.2).

The PowerTV™ OS includes the PowerKEY™ Security Manager, which provides an interface between DHCT applications and the DHCT Secure Element. The Purchase Manager module of the PowerTV™ Operating System provides an interface between the Security Manager and DHCT applications which control impulse-purchasable services such as Digital IPPV.

A more detailed functional description of the PowerTV™ Operating System can be found in the [Ref. 6].

4.2.4.3 DHCT Applications

DHCT applications are software programs executed on the DHCT that provide a user interface and other functionality necessary to provide analog and digital services. Figure 6 provides a generic model of the logical interfaces between the DHCT applications and other entities within the DBDS. DHCT applications interact with the DHCT operating system via APIs to request the use of the resources managed by the operating system. DHCT applications typically also interact with server applications. However, not all DHCT applications require a counterpart server application. DHCT applications may be stored in persistent DHCT memory, or may be downloaded when needed to support a subscriber's service selection.

DBDS Application Interfaces

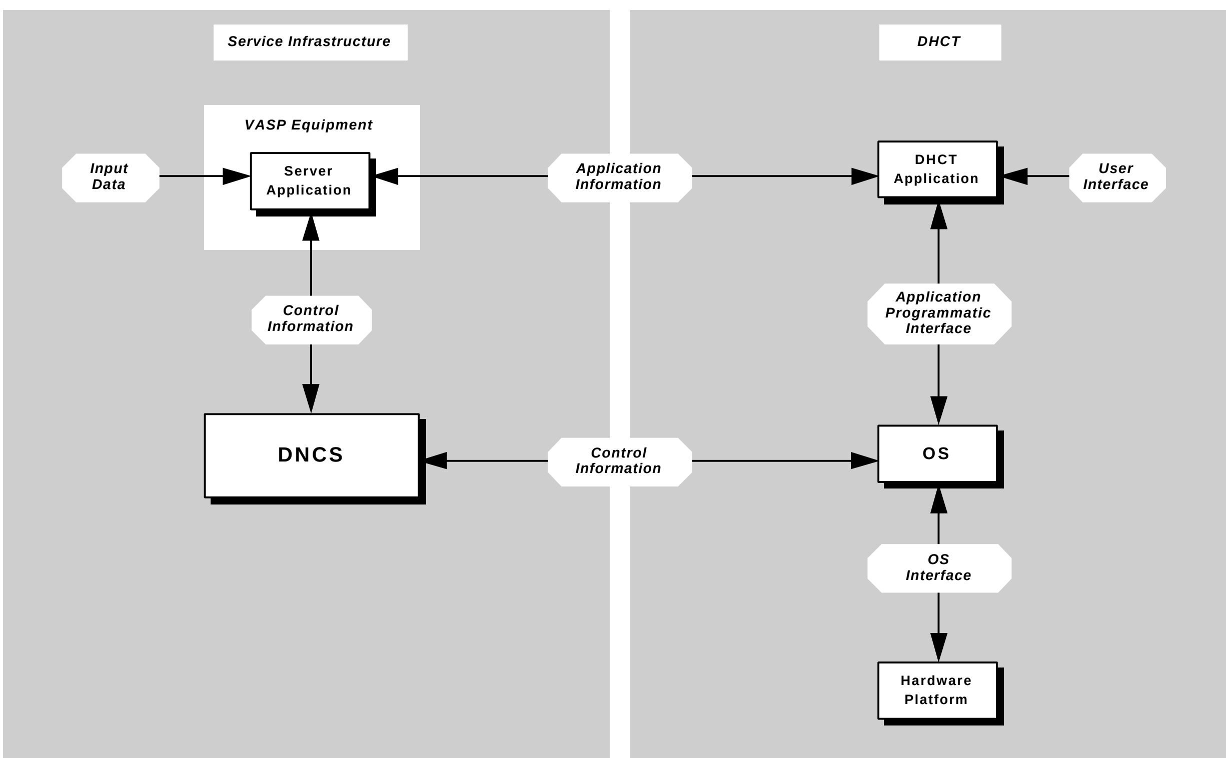

Figure 6

Listed below are some of the DHCT applications required for implementing the services supported by the DBDS as described in Section 3.1. Each of these DHCT applications require a server application counterpart. (Note: The DHCT applications described below are not developed by S-A.)

Navigator

A Navigator application presents a dynamic view of the services available to the subscriber and a user interface to enable the subscriber to select a service. For example, the Navigator may present a menu of services that includes the broad categories of Broadcast Television, Interactive Games, Movies On Demand, Internet Access, and Interactive Shopping Mall. The Navigator application may also provide support for the Emergency Alert System.

Interactive Program Guide

An Interactive Program Guide (IPG) application typically presents a broadcast programming schedule. For example, the IPG application may present a table of programs that are available for viewing (or for purchase), including the program name, start and end times, description, and rating. The IPG application may be incorporated with a Navigator application such that a single user interface may enable the subscriber to select a service category such as Broadcast Television and subsequently select a program from the IPG display.

Impulse-Pay-Per-View

An Impulse-Pay-Per-View (IPPV) application is necessary to enable a subscriber to purchase an IPPV event. For example, when a subscriber selects an IPPV event from the IPG, the IPPV application may present a menu of purchase options for the event, including a description and cost of each purchase option. The IPPV application may track the purchase window of each IPPV event, and only allow purchases within the purchase window. The IPPV application may forward a subscriber's purchase request to the DHCT Secure Element for approval, and provide an appropriate response to the subscriber if the purchase request is not approved.

4.2.5 Service Infrastructure

The service infrastructure is a logical grouping of components and subsystems that provide analog and digital services and control the operation of the DBDS. The service infrastructure may be physically located within the headend, or dispersed among the headend, hubs, and other VASP and system operator facilities. The service infrastructure components and subsystems are described in the sections below.

4.2.5.1 Value-Added Service Provider Components and Subsystems

Value-Added Service Providers (VASPs) originate all broadcast services within the DBDS, and provide delivery of broadcast services to the headend for distribution to the DHCTs. A DBDS may include multiple VASPs, each providing a unique set of services. VASP systems may include the traditional analog sources and distribution systems as well as digital servers and digital satellite and terrestrial broadcast distribution systems.

The following sections provide brief functional descriptions of selected VASP components and subsystems.

Digital Satellite Distribution System

A VASP may employ a digital satellite distribution system to distribute MPEG-2 Transport Streams from the source to the headend. The digital satellite distribution system typically includes an uplink earth station, a satellite, a downlink satellite dish located at the headend, and an Integrated Receiver / Transcoder (IRT) at the headend. The system may also include Real-Time Encoders at the uplink facility for encoding analog source material.

The IRT provides an interface to the DBDS digital headend equipment. The IRT outputs MPEG-2 Transport Streams for distribution to the DHCTs. The digital headend equipment may be required to process these streams and translate the system and program-specific information contained within the streams to DBDS-compatible formats.

Server Applications

Server applications are required to support many of the applications that run on the DHCT. As shown in Figure 6, server applications typically provide an interface for inputting (or downloading) application data such as IPG schedule information. Server applications pass application and system data to the DHCT application. This data may be broadcast, for example, by a data carousel or addressed to an individual DHCT and delivered on an out-of-band forward path. The server applications may also establish an interface with the DNCS for coordinating service and billing information, for example.

Server application components may be required to support the DHCT applications described in Section 4.2.4.3.

Application Server

An application server is a computer system that executes server applications. An application server may also execute other software, such as a DSM-CC data carousel.

For Two-Way Real-time Datagram services, the application server will perform rate control so as not to exceed the bandwidth limitations of the forward data channels.

Digital Media Server

A digital media server constructs MPEG-2 Transport Streams for delivering high-bandwidth digital video services to the DHCT. A digital media server may also output IP packets which carry information related to the digital video services. A digital media server is typically used as a source of digital interactive services such as Video On Demand, but may also be used as a source of broadcast services such as Digital Impulse-Pay-Per-View or promotional channels.

For digital services, the digital media server will perform rate control so as not to exceed the bandwidth limitations of the digital transmission channels or the forward data channels.

Application Data Carousel

The MPEG-2 Digital Storage Media-Command and Control (DSM-CC) specification [Ref. 15] defines a Data Carousel as a mechanism for periodically downloading information from a Server to a Client (in DSM-CC context). The Data Carousel layer resides below the application layer and above the transport layer, and employs the download protocol defined in the DSM-CC specification. The Data Carousel establishes a digital transmission channel or forward data channel for transmitting the data received from the Server to the Client(s). The downloaded data may be addressed to an individual Client, or broadcast to all Clients. The Data Carousel provides a directory mechanism which enables the Client to determine which downloaded data it requires.

A VASP may employ an Application Data Carousel to cyclically broadcast application data via an in-band and/or out-of-band forward path to DHCTs. For example, a Data Carousel may be used to broadcast IPG data to the DHCT IPG application.

The Application Data Carousel will perform rate control so as not to exceed the bandwidth limitations of the digital transmission channels or the forward data channels.

4.2.5.2 Digital Network Control System

The Scientific-Atlanta Digital Network Control System (DNCS) is a family of products which provide a comprehensive solution for the management and control of services supported by the DBDS. The DNCS products included in the Phase 1 release of Scientific-Atlanta DBDS components and subsystems are the Broadcast Control Suite and the PowerKEY™ Control Suite. A set of common DNCS functionality is incorporated with these control suites. Functional descriptions of these control suites, and the associated common functionality, are provided below.

Broadcast Control Suite

The Broadcast Control Suite provides comprehensive control of digital broadcast services. The four primary roles of the Broadcast Control Suite are:

- processing and managing digital broadcast service definitions
- assigning DBDS resources for transporting digital broadcast services
- communicating System Information to the DHCT population, and
- informing the conditional access system of the security requirements of digital broadcast services.

The Broadcast Control Suite maintains a database of service definitions based on information provided by the Administrative Gateway (AG) via the Business Operations Support System (BOSS) Interface. The service definitions provide the basis for the System Information generated by the Broadcast Control Suite. The service definitions also define the security requirements of digital broadcast services.

The second key function of the Broadcast Control Suite is the allocation of network resources for digital broadcast services. Requests for resources come to this suite from VASP systems via DSM-CC signaling messages. Upon receipt of a resource request, the Broadcast Control Suite will allocate the appropriate DBDS resources and store this allocation within its database system. The Broadcast Control Suite provides a user interface screen from which DSM-CC based resource requests can be issued and managed. This user interface enables DBDS resources to be allocated for digital broadcast services stemming from VASP systems not capable of generating DSM-CC resource requests.

The Broadcast Control Suite will draw from the service definitions and resources allocations stored within its database system to formulate the System Information necessary to enable a DHCT to locate and tune to the broadcast services available from the DBDS. The Broadcast Control Suite generates a subset of the standard ATSC System Information.

Finally, the Broadcast Control Suite informs the conditional access system of the security requirements of digital broadcast services according to the service definitions maintained in its database system.

PowerKEY™ Control Suite

The PowerKEY™ Control Suite provides the conditional access management and control functions for the PowerKEY™ Conditional Access system. Refer to Section 4.2.6.1 for a description of the PowerKEY™ Control Suite.

DNCS Common Functionality

At the heart of each DNCS product is a set of base functionality which provides a common look and feel across the product family. This Common Functionality ensures that the DNCS products operate in a unified and cohesive manner as they work together for the delivery of DBDS-supported digital services. Items such as a common hardware and software platform, and a uniform user interface developed into each DNCS product allows for this consistent operation across the family.

In addition to the common look and feel provided by these common functions, a base set of operational functions are also provided. DNCS-supported functions such as provisioning of DBDS hardware elements, DHCT configuration and management, a family-wide Network Inventory and Directory, comprehensive Element Management, and a base set of operational and signaling interfaces add to the DNCS Common Functionality.

The DNCS Common Functionality includes a System Data Carousel for cyclically broadcasting system data via an in-band and/or out-of-band forward path to DHCTs. For example, the System Data Carousel may be used to broadcast DHCT operating system upgrades to DHCTs. The System Data Carousel includes a directory which identifies the information carried on the carousel. This directory can be utilized by the DHCT operating system to determine when to retrieve information from the System Data Carousel.

A comprehensive description of each DNCS product plus the DNCS Common Functionality can be found in [Ref. 7].

4.2.5.3 Administrative Gateway

The Administrative Gateway (AG) is responsible for providing subscriber and service provisioning and authorization information to the DNCS for use in controlling access to the DBDS and its services. The AG is also responsible for providing VASP provisioning information to the DNCS for use in establishing communications with VASP systems. The AG may be embodied within a billing system, or may be an interface between a billing system and the DNCS. The DNCS views the AG as the single source of service provisioning and authorization information in the DBDS. The AG communicates with the DNCS using the protocol specified in the Scientific-Atlanta Business Operations Support System (BOSS) Interface**.**

4.2.5.4 Core Network

The Core Network interconnects other Service Infrastructure components with headend equipment. For the purposes of this document, the Core Network is assumed to be comprised of ATM-based switching and transmission facilities capable of supporting Permanent Virtual Circuits (PVCs). In diagrams within this document, Core Network equipment is represented as a “black box” labeled Core Network Element (Core NE).

4.2.5.5 Network Management System

A Network Management System (NMS) typically maintains a database of system status and performance information to provide fault isolation and recovery capabilities. A NMS typically interfaces with network elements via a standard network management protocol such as Simple Network Management Protocol (SNMP) to obtain status and performance information and to enable control of such elements by the system operator.

(Note: An NMS is not required for proper operation of the DBDS.)

4.2.6 PowerKEY™ Conditional Access System

The Scientific-Atlanta PowerKEY™ Conditional Access System is a collection of DNCS, headend, and DHCT components that together provide security and conditional access services.

In order to securely control access to services, the DBDS must be equipped with components capable of performing the following functions:

1. encrypting the service content
2. encrypting the control words used for service encryption
3. passing the encrypted control words in secure Entitlement Control Messages (ECMs) to DHCTs
4. managing a subscriber authorization database
5. passing subscriber authorization information in secure Entitlement Management Messages to DHCTs
6. retrieving the control words and authorizations at the DHCT, and
7. decrypting the service content.

These requirements are met by the following PowerKEY™ Conditional Access System components:

- PowerKEY™ Stream Encryption & ECM Streamer Module
- PowerKEY™ Control Suite
- PowerKEY™ Transaction Encryption Device
- PowerKEY™ Service Decryptor Module
- PowerKEY™ Security Manager
- PowerKEY™ DHCT Secure Element

Figure 7 depicts a typical configuration of these components for securing digital services within the DBDS.

PowerKEY System Interfaces for Digital Services

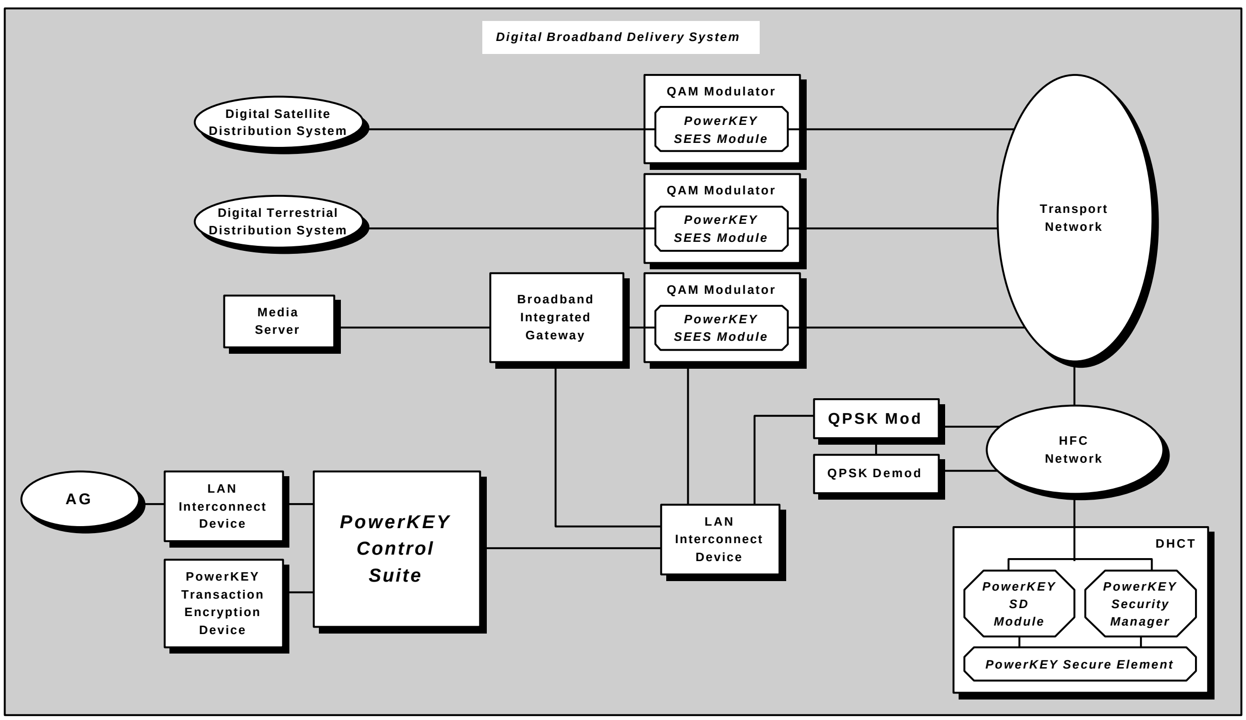

Figure 7

4.2.6.1 Functional Description of PowerKEY™ System Components

This section provides a functional description of each of the PowerKEY™ system components.

Service Encryption & ECM Streamer Module

The PowerKEY™ Service Encryption and ECM Streamer (SEES) module is an optional component of the QAM Modulator that performs encryption of MPEG-2 Transport Stream packets under the direction of the PowerKEY™ Control Suite.

The SEES generates the control words used for service encryption and creates Entitlement Control Messages (ECMs) for transporting the control words together with the encrypted service content within the outgoing MPEG-2 Transport Stream. The SEES encrypts the ECMs with Multi-Session Keys generated by the PowerKEY™ Transaction Encryption Device (TED).

Service Decryptor Module

The PowerKEY™ Service Decryptor module is a component of the DHCT that performs decryption of MPEG-2 Transport Stream packets. The Service Decryptor receives the control words to be used for service decryption from the PowerKEY™ DHCT Secure Element (DHCTSE). The DHCTSE controls which Transport Stream packets are decrypted by only passing the control words for authorized services to the Service Decryptor.

Security Manager

The PowerKEY™ Security Manager is a software module of the DHCT operating system that provides an interface between PowerKEY™-supported applications and the DHCTSE.

Secure Element

The PowerKEY™ DHCT Secure Element (DHCTSE) is a component (or peripheral) of the DHCT that provides the cryptographic functions of authentication, confidentiality, data integrity, access control, and key management for the DHCT. The DHCTSE is a microprocessor contained in tamper-proof packaging that decrypts and processes ECMs and EMMs from the SEES and Control Suite, and maintains the subscriber's authorizations accordingly. The DHCTSE grants access to secure services based on the subscriber's authorizations. The DHCTSE provides the control words necessary to decrypt a service to the Service Decryptor module within the DHCT. The DHCTSE records purchase information for impulse-purchasable services such as Digital IPPV and stores the purchase data securely until the data is successfully forwarded to the Control Suite. The DHCTSE maintains its own private / public key pair, as well as the public keys of the Conditional Access Authority and the Entitlement Agent.

Control Suite

The PowerKEY™ Control Suite is a member of the DNCS family of products that controls the encryption of services performed by the SEES based upon input from the DNCS Broadcast Control Suite. The PowerKEY™ Control Suite also maintains a database of subscriber authorizations based upon transactions received from the Administrative Gateway (AG) via the Scientific-Atlanta Business Operations Support Systems (BOSS) Interface. The PowerKEY™ Control Suite generates Entitlement Management Messages (EMMs) for communicating subscriber authorizations and other conditional access parameters to the DHCTSE.

The PowerKEY™ Control Suite acts on behalf of an Entitlement Agent (EA), which is a logical entity responsible for managing the authorizations available to subscribers of a PowerKEY™-based system. The EMMs generated by the Control Suite for communicating subscriber authorizations and other conditional access parameters to the DHCTSE are encrypted with the private key of the EA, which is maintained by the PowerKEY™ Transaction Encryption Device (TED). The DHCTSE maintains the public key of the EA for use in decrypting these EMMs.

The PowerKEY™ Control Suite enables the establishment of a Conditional Access Authority (CAA), which is a logical entity entrusted by the DHCTSE to introduce the Entitlement Agent to the DHCTSE. The EMMs generated by the Control Suite for securely passing the public key of the Entitlement Agent to a DHCTSE are encrypted with the private key of the CAA, which is maintained by the TED. The DHCTSE is pre-provisioned with the public key of the CAA for use in decrypting these EMMs.

Transaction Encryption Device

The PowerKEY™ Transaction Encryption Device (TED) serves as a peripheral to the PowerKEY™ Control Suite. The TED, under the direction of the Control Suite, encrypts and signs various PowerKEY™ messages, including EMMs. The TED generates the Multi-Session Keys (MSKs) used by the SEES to encrypt ECMs. The TED decrypts and verifies the authenticity of PowerKEY™ Forwarded Purchase Messages sent from the DHCTs. The TED maintains the private keys of the CAA and the EA. The TED applies a digital signature to EMMs using the private key of the CAA and EA as appropriate for the EMM.

4.2.6.2 PowerKEY™ Service and Application Support

PowerKEY™ can be utilized to secure the operation of a service or to provide security services to applications. PowerKEY™-secured services do not rely upon the security of the DHCT application that supports the service. For example, Digital Impulse-Pay-Per-View (IPPV) is a service which PowerKEY™ is capable of fully securing without relying upon the security of the DHCT IPPV application. Access to IPPV events is ultimately controlled by PowerKEY™. A DHCT IPPV application can not authorize an IPPV event purchase (or a purchase cancellation) directly; the application must request authorization for such actions from PowerKEY™.

DHCT applications may utilize PowerKEY™ to perform security services. For example, a DHCT application that requires downloaded information from a server application may request PowerKEY™ to authenticate the downloaded information, but the acceptance or rejection of downloaded information that could not be authenticated by PowerKEY™ is ultimately controlled by the DHCT application.

A comprehensive description of the PowerKEY™ Conditional Access System can be found in [Ref. 8].

5. System Interfaces

This section provides a description of the interfaces between DBDS components and subsystems. An overview of the interfaces employed within the DBDS is provided first, followed by a specification of the set of interfaces applicable to S-A DBDS components and subsystems.

5.1 Electrical Interface Descriptions

5.1.1 Upper-Layer interfaces

5.1.1.1 MPEG-2 Video/Audio

MPEG-2 Video [Ref. 13] and MPEG-2 Audio (Musicam) [Ref. 14] specifies the coded representation of video and audio, respectively, and the decoding process required to reconstruct pictures. MPEG-2 video and audio is used within the DBDS to reduce the bandwidth required to deliver a service and to improve the signal quality of the delivered service.

5.1.1.2 AC-3 Audio

The ATSC AC-3 Audio standard [Ref. 18] specifies a coded representation of audio. AC-3 Audio is used within the DBDS to reduce the bandwidth required to deliver audio signals and to improve the signal quality of the delivered service.

5.1.1.3 DSM-CC

The Digital Storage Media-Command & Control (DSM-CC) is a set of protocols which provides the control functions and operations specific to managing MPEG-1 and MPEG-2 bitstreams. DSM-CC User-to-Network messages are used within the DBDS for providing configuration information to DHCTs and for establishing Continuous Feed Sessions for transporting digital broadcast services.

5.1.1.4 BOSS Interface

The Business Operations Support System (BOSS) Interface [Ref. 10] is a Scientific-Atlanta specification of the transactions supported by the DNCS for managing VASP and DHCT profiles, subscriber authorizations, bandwidth segments, event sources, packages, and system information within the DNCS.

The BOSS Interface specifies the use of Open Network Computing (ONC) Remote Procedure Calls (RPCs) for sending transactions requests and responses. All calls and responses are asynchronous to each other.

5.1.1.5 DHCT Operating System APIs

The DHCT operating system provides Application Programmatic Interfaces (APIs) to enable DHCT applications to utilize the resources managed by the OS for delivering analog and digital broadcast services.

5.1.2 Middle-Layer Interfaces

5.1.2.1 MPEG-2 Transport

MPEG-2 Systems [Ref. 12] defines a multiplexed structure, the Transport Stream, for combining video, audio, and auxiliary data, and a means for representing the timing information needed to replay synchronized sequences in real-time. MPEG-2 Transport Streams are used for transmitting MPEG-2 video, MPEG-2 audio, and auxiliary data from VASP systems to DHCTs.

5.1.2.2 ATM

Asynchronous Transfer Mode (ATM) is a digital switching and transport technology capable of supporting digitized voice, video, and packet data in standard fixed-length cells. ATM supports the carriage of a variety of information classes using ATM Adaptation Layers (AALs) for encapsulating the data. ATM relies upon a high-speed physical layer technology such as SONET for transmission over a network.

ATM Permanent Virtual Circuits (PVCs) are used to provide connectivity (via the Core Network) between ATM-based VASP systems (and the DNCS) and BIG ATM OC-3C cards. Each of these elements have one or more physical connections or links to the Core Network. A VASP system may have several ATM links to multiple BIGs. A BIG has one link for each ATM card in the chassis. Each link can have many virtual paths to different locations in the DBDS. Virtual Paths are statically provisioned in the ATM network and a map of the virtual paths is provisioned in the DNCS.

The BIG OC-3C ATM card accepts ATM cells carrying single-program MPEG-2 Transport Stream packets within AAL5 Payload Data Units as described by the ATM FORUM. The ATM card also accepts ATM cells carrying IP packets mapped according to RFC 1453. ATM cells carrying MPEG-2 Transport Stream packets are identified with a different VPI/VCI pair than ATM cells carrying IP packets. The ATM card is capable of supporting uni-directional Permanent Virtual Circuits (PVCs) only.

The BIG OC-3C ATM card relies upon connections being established via the DNCS to provide connection parameters. One of these parameters indicates the data rate of the connection. This rate must be policed by either the source or by other network devices such as an ATM switch. The OC-3C ATM card does not provide any feedback nor flow control mechanism to regulate the data rate of the source.

5.1.3 Lower-layer Interfaces

5.1.3.1 QAM

Quadrature Amplitude Modulation (QAM) is a means of encoding digital data for transmission within an RF signal. QAM is used for encoding MPEG-2 Transport Streams for transmission within the DBDS transport infrastructure and access networks.

5.1.3.2 QPSK

Quaternary Phase Shift Keying (QPSK) is another means of encoding digital data for transmission within an RF signal. QPSK modulation is used for the forward and reverse data channels. QPSK is specified for its error performance, spectral efficiency, and low peak-to-average power, which are particularly critical in the 8-26.5 MHz operating range of the reverse data channels.

5.1.3.3 DAVIC Media Access Control (MAC)

The Media Access Control (MAC) Protocol specified by DAVIC [Ref. 16] defines the messages and procedures for establishing forward and reverse data channels between the DHCT and QPSK Modulator and Demodulator. The MAC Protocol supports the establishment of multiple forward and reverse channels to and from each DHCT.

Table 2 provides the MAC Protocol definitions for channels and connections. (A channel is represented by a frequency, whereas a connection is the allocation of all or part of the bandwidth of a channel.)

Table 2: DAVIC MAC Protocol Definitions

Item	Description
MAC Control Channel	A forward data channel associated with n Upstream Channels. Used by QPSK Modulator to send selected MAC Protocol messages to DHCTs.
Upstream Channel	A reverse data channel associated with a MAC Control Channel. Used by DHCT to send selected MAC Protocol messages as well as DNCS messages to QPSK Modulator / Demodulator.
Provisioning Channel	The forward data channel used by the QPSK Modulator for sending initialization, provisioning, and sign-on information to the DHCT.
Service Channel	The reverse data channel used by the DHCT for responding to sign-on request messages from the QPSK Modulator.
Default Connection	A low-bit-rate, permanent, two-way out-of-band connection between the QPSK Modulator / Demodulator and the DHCT. Provides a path for the DHCT to communicate with the DNCS. A contention-based or contentionless access protocol may be specified for the Default Connection.

MAC Protocol messages can be broadcast to all DHCTs served by the QPSK Modulator, or addressed to an individual DHCT using the DHCT's MAC address.

In addition to the MAC Protocol, DAVIC specifies the MAC mechanisms for accessing the reverse data channel. These mechanisms include contention-based access, TDMA, and reservation-based access. The contention-based access mechanism specified by DAVIC defines how DHCTs share a reverse data channel. Contention-based access enables DHCTs to transmit reverse path messages without a dedicated connection to the QPSK Demodulator. Contention-based access provides equal access to the DHCTs that share the reverse data channel, and enables detection and recovery from reverse path collisions that occur when two or more DHCTs transmit a reverse path message simultaneously.

Refer to [Ref. 16] for more information about the DAVIC MAC Specification.

5.1.3.4 ATM-25

ATM-25 defines a standard ATM interface operating at 25.6 Mbps.

5.1.3.5 SONET

The Synchronous Optical Network (SONET) standard defines a high-speed physical-layer protocol for carrying various types of payloads, including ATM cells. SONET provides advanced multiplexing and demultiplexing functions that enable efficient utilization of network bandwidth.

5.1.3.6 SWIF

The Single-Wire Interface (SWIF) is a Scientific-Atlanta-proprietary physical-layer interface which Specifies a means of delivering MPEG-2 Transport Stream packets at a constant rate of 54 MHz over a plastic optical cable. The actual throughput of the SWIF link is determined by the rate at which the packets are input to the link. Pseudo-random data is used to fill the gaps between input packets to as necessary to maintain a constant rate of 54 MHz.

5.2 Human Interface Descriptions

5.2.1 DNCS User Interface

The Digital Network Control System (DNCS) provides a user interface for the control and monitoring of DBDS operation. The initial presentation of the DNCS allows a system operator to build a topological view of the forming network. From this high-level view of the system, the DNCS user interface will allow specific locations to be specified and selected. Then equipment can be introduced and provisioned into the network, including digital headend equipment, PowerKEY™ components, and DHCTs. Additionally, the user interface allows for the configuration of communications paths to external equipment.

A second key aspect of the DNCS user interface allows for the monitoring and maintenance of the DBDS. Basic alarm indications, alarm and event logging, and equipment monitoring are all provided. Administration and maintenance functions of the DNCS itself are also enabled through the user interface. The ability to monitor the system database, backup and restore system data, and administer system access are examples of these functions.

To help maintain portability, the DNCS user interface is implemented under the guidelines of the POSIX Part 1 (IEEE 1003.1-1990) compliant operating environment. Additionally, conformance to the OSF/Motif guidelines for user interface development are incorporated.

5.2.2 DHCT User Interface

One or more DHCT applications provide a user interface for the subscriber to select a service, define a favorite channel list, set parental control parameters, review IPPV purchases, and other similar functions.

6. Standards Compliance

S-A DBDS components and subsystems are compliant with the following standards as described in this document:

- DAVIC 1.1 Specification Part 08, Lower-layer Protocols and Physical Interfaces (draft as of September, 1996)

- MPEG-2 Systems, Video, Audio, and a subset of DSM-CC

- ATSC AC-3

- A subset of ATSC System Information
- ATM Forum MPEG-2 / AAL5 mapping recommendations

7. Appendix A: Glossary of Terms

Table 3 provides the definition of selected terms as applicable within this document.

Table 3: Glossary of Terms

Term	Definition
Analog Transmission Channel	An AM-VSB waveform with a bandwidth of 6 MHz used for transporting an NTSC signal from a headend to a DHCT.
Analog Broadcast Service	One or more events transmitted via an analog transmission channel without access control.
Bandwidth Segment	A reference to an analog transmission channel or a specific MPEG-2 Program carried via a digital transmission channel during some time interval, which may be undefined. A bandwidth segment carries one or more events.
Digital Broadcast Service	One or more events transmitted via a digital transmission channel without access control.
Digital Impulse Pay-Per-View Service	One or more encrypted PPV events transmitted via a digital transmission channel which may be decrypted by qualified subscribers who request authorization via the DHCT.
Digital Near-Video-On-Demand Service	A coordinated supply of encrypted NVOD events transmitted via multiple digital transmission channels which can only be decrypted by qualified subscribers who request authorization via the DHCT.
Digital Pay-Per-View Service	One or more encrypted PPV events transmitted via a digital transmission channel which may be decrypted by subscribers pre-authorized to receive the PPV events.
Digital Transmission Channel	A QAM waveform with a bandwidth of 6 MHz used for transporting an MPEG-2 Transport Stream from a headend to a DHCT. A digital transmission channel is capable of supporting a data rate of 29.172 Mbps (after FEC) when modulated using 64-QAM, or 38.896 Mbps (after FEC) when modulated using 256-QAM.
Event	A unit of programming, such as a movie, an episode of a television show, a newscast, or a sports game. An event may also be a series of consecutive units of programming.
Flag	A Boolean variable (can take one of two values).
Forward Data Channel	A QPSK waveform with a bandwidth of 1 MHz used for transporting data out-of-band from a hub to a DHCT. A forward data channel is capable of supporting a data rate of 1.544 Mbps.

Forward Path	A physical connection from a hub to a DHCT. A forward path may support multiple analog transmission channels, digital transmission channels, and forward data channels.
Interactive Program Guide	A service application that presents a schedule of services and service content information, such as the name, description, cast, and rating of a programming unit. The IPG also provides the Source ID of a selected service to another service application or DHCT operating system for tuning to the service.
Multiplex	An MPEG-2 Transport Stream.
Package	A set of one or more PowerKEY™-controlled events which is offered to subscribers for purchase.
Package Name	A descriptive name assigned to a package.
Pay-Per-View Event	An event with a defined start time and end time offered for purchase as part of a PPV and/or IPPV service.
Reverse Data Channel	A QPSK waveform with a bandwidth of 1 MHz used for transporting data out-of-band from a DHCT to a hub. A reverse data channel is capable of supporting a data rate of 1.544 Mbps.
Reverse Path	A physical connection from a DHCT to a hub. A reverse path may support multiple reverse data channels.
Secure Digital Broadcast Service	One or more encrypted events transmitted via a digital transmission channel which can only be decrypted by subscribers pre-authorized to receive the service.
Service Application	An application that facilitates the use of a service. A service application may be a stand-alone or a client/server application. Examples of service applications include an IPPV application and an Interactive Program Guide.
Source	An originator of one or more events.
Source ID	Uniquely identifies the source of one or more events.
Two-Way Real-Time Datagram Service	A connectionless service (when a FDC is utilized) which routes IP datagrams from a VASP to a DHCT and from a DHCT to a VASP.
Virtual Channel	A virtual channel provides an access path to an event by pointing to an analog transmission channel, a digital transmission channel, or a forward data channel where the service associated with the virtual channel can be found.