



HD Radio™

Advanced Applications Services (AAS)

Overview

Software Rev. 4.2

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1 Scope

1.1 System Overview

The iBiquity Digital Corporation HD Radio™ system is designed to permit a smooth evolution from current analog amplitude modulation (AM) and frequency modulation (FM) radio to a fully digital in-band on-channel (IBOC) system. This system delivers digital audio and data services to mobile, portable, and fixed receivers from terrestrial transmitters in the existing medium frequency (MF) and very high frequency (VHF) radio bands. Broadcasters may continue to transmit analog AM and FM simultaneously with the new, higher-quality, and more robust digital signals, allowing themselves and their listeners to convert from analog to digital radio while maintaining their current frequency allocations.

1.2 Document Overview

The HD Radio system allows multiple services to share the broadcast capacity of a single station. First generation (core) services include the Main Program Service (MPS) and the Station Information Service (SIS). Second generation services, referred to as Advanced Application Services - or AAS, include new information services providing, for example, multicast programming, electronic program guides, navigation maps, traffic information, multimedia programming and other content. The AAS Framework provides a common infrastructure to support the developers of these services. Within the Framework, the Importer Software and the Importer Application Programming Interface (API) are key components which enable service providers to develop their software and to deliver advanced services. This document describes the concepts and foundation for the Advanced Application Services Framework. The intended audiences for this document are service providers and software programming teams wishing to add AAS features to their product offerings.

2 Abbreviations, Symbols, and Conventions

2.1 Introduction

Section 2 presents the following items pertinent to a better understanding of this document:

- Abbreviations and Acronyms
- Presentation Conventions
- Mathematical Symbols
- System Parameters

Note: A glossary defining the technical terms used herein is provided at the end of this document.

2.2 Abbreviations and Acronyms

AAS	Advanced Application Services
AM	Amplitude Modulation
API	Application Programming Interface
FM	Frequency Modulation
HDC	HD Codec
HDP	HD Program
IBOC	In-Band On-Channel
IC	Importer Configuration
ID	Identification
IP	Internet Protocol
MPS	Main Program Service
PSD	Program Service Data
QoS	Quality of Service
RLS	Radio Link Sub-System
RSVI	Reading Service for Visually Impaired
SDK	Software Development Kit
SIG	Service Information Guide
SIS	Station Information Service
SPS	Secondary Program Service
TCP/IP	Transmission Control Protocol / Internet Protocol
XML	Extended Markup Language

2.3 Presentation Conventions

Unless otherwise noted, the following conventions apply to this document:

- Information enclosed in braces { } is either unavailable at the present time or subject to change.
- Glossary terms are presented in italics upon their first usage in the text.
- In drawings and tables, the leftmost bit is considered to occur first in time.
- Bit 0 of a byte or word is considered the least significant bit.
- When presenting the dimensions of a matrix, the number of rows is given first (e.g., an $n \times m$ matrix has n rows and m columns).
- In timing diagrams, earliest time is on the left.
- Binary numbers are presented with the most significant bit having the highest index.
- In representations of binary numbers, the least significant bit is on the right.

3 AAS Overview

3.1 Introduction

HD Radio broadcast systems are one-way content delivery systems. The content delivered via the AAS Framework is scheduled by the source, i.e. the provider of the service. There is no ability on the part of the user (or a client receiver) to directly influence the service. Within the AAS Framework, the user accesses the service(s) rather than accessing a server (in contrast to the Internet model where users access source servers). There are several objectives involved in the design of coherent model of services. The model must:

- Be flexible and expandable to accommodate capacity growth available with all-digital modes and to accommodate hard-to-anticipate future requirements
- Support multiple, simultaneous, services to be delivered by independent service providers
- Support stream and object services
- Support dynamic introduction, removal and modification of services
- Provide investigatory capability: what services exist? what are their characteristics?
- Support services which are “local” to a given station and services which are “global” across multiple stations

To meet these objectives, the AAS Framework has been partitioned into 3 main components:

1. Core Importer Software – These represent the necessary subsystems that simultaneously accept distinct services for broadcast and support operational control over services base on contractual, bandwidth & security obligations. Examples of Importer functionality include HDC encoding for multicast programming, RLS encoding for data services, bandwidth management, and broadcast system administration.
2. Importer API – A common interface to manage service providers, services, channel bandwidth and configuration of HD Radio enabled AM/FM stations.
3. Example Client Software – These are example client applications that exercise the Importer API and provide full functionality to the Importer. While this software combined with the Core Importer software can be used to provide a stand alone solution, it is anticipated and expected that Importer manufactures, studio automation developers, and service providers replace these clients with their own customized solutions.

Items 2 and 3 along with the accompanying documentation constitute the SDKs for the AAS Framework.

The remainder of this section discusses the architecture of the core Importer components as well as the example client modules provided as part of the Importer SDK. However, in order to understand the Importer architecture it is first worthwhile to introduce a number of terms used when administrating or operating the Importer.

3.2 Terminology

A **Broadcaster** (or broadcast group) is the owner/manager of an HD Radio broadcast **Station** and transmission equipment. The Station transmits over a fixed frequency range and coverage area licensed by the FCC. The FCC licenses several stations for broadcast within a given Market by allocating non-interfering frequencies and power levels to each station. Each HD Radio station is able to broadcast the digital Main Program Service (MPS) simultaneous with its existing analog signal. In addition, FM HD Radio stations incorporating the Importer, support additional services. As such, an HD Radio broadcaster typically serves as the administrator of the Importer; making available the additional bandwidth provided

by the HD Radio system to various **Service Providers**. A Service Provider is a corporate organization (or consortium) defining and delivering **Services**. The term Service is used simply to refer to unique content being delivered via the HD Radio System. Service Providers can be the broadcaster themselves, as in the case of providing content for multicast programs, or external organizations such as traffic map providers. In order for service providers to connect to the Importer and send their services, service providers must be registered with the Importer. Each service provider must have at least one “**contract**” with the Importer. This contract identifies the type of service along with the specifications for that service (e.g., bandwidth, Qos, etc...). Service Providers register their Contracts and Services using the Administrative portion of the Importer API as demonstrated in the WebAdmin Client*. Once the contracts are established, service providers deliver their services through client modules. These clients use the Importer API to interface with the Importer components.

Because of the constraints of the HD Radio system, the Importer must be configured with a known number of SPS & MPS services. The Importer software currently supports 18 different **base configurations** for MPS and SPS audio in the various service modes MP1-MP6. The currently supported base configurations are shown in Table 3-1. Table 3-1 shows the Configuration Number, the Service Mode, the total throughput for that mode, the number of audio programs supported, and the logical channel and default bit-rate for each audio service supported. When audio services share a common channel, the bit-rate allocation between the audio services can be manipulated from the default values shown in Table 3-1, as long as these three rules are followed:

1. The total bit-rate cannot exceed the total bit-rate for the channel
2. The total MPA bit-rate cannot be less than 32 kbps
3. The minimum bit-rate for any audio service is 10 kbps

Therefore, the Importer base configuration specifies how many audio services are available and on which logical channel they will be transmitted. The bit-rates of the various audio services can be manipulated by the user as long as the aforementioned three rules are followed.

Data services can be added by decreasing the bandwidth of the MPS or SPS services on any configuration as long as the 3 rules are not violated.

Figure 3-1 demonstrates the relationship between service providers, services, contracts and Importer base configurations. Figure 3-1 shows that on the first level there are registered service providers. Each service provider has a number of services associated with it. Each of these services is then assigned to an **Importer Configuration (IC)**. Each IC is associated with one of the 18 Importer base configurations. ICs determine the bandwidth allocation, channel location, and Qos for each service assigned and is based on the contract the service provider has with the broadcaster. Importer base configurations can have multiple ICs associated to it. For example, Figure 3-1 shows 3 services providers with 6 different services. For base configuration 1 there is only one IC associated and only a MPS service defined. Base configuration 2, however, has 2 ICs with different combinations of services from the 3 service providers.

The Importer contains various system resource parameters to aid broadcasters and service providers in identifying and describing their services. Two of the most important of these resource parameters are the Mime Type and Service Genres. A service genre is used as a broad classification of the type of content being broadcast by that service. For audio services it typically categorizes the type of audio programming being offered by the service (e.g. Rock, News, Talk, etc...). For data services it is used to categorize the type of data being delivered (e.g. Traffic, Weather, Navigation, etc..).

* See Section 3.3 for a brief description of the WebAdmin Client

Table 3-1 Importer Configurations

Base Configuration Number	Service Mode	Total System Rate (kbps)	Number of Programs	MPS				SPS 1		SPS 2	
				Core		Enhanced		Channel	Rate kbps	Channel	Rate kbps
				Channel	Rate kbps	Channel	Rate kbps				
1	MP1	98	1	P1	97	-	-	-	-	-	-
2	MP1	98	2	P1	65	-	-	P1	32	-	-
3	MP1	98	3	P1	65	-	-	P1	16	P1	16
4	MP2	98	1	P1	97	-	-	-	-	-	-
5	MP2	108	2	P1	97	-	-	P3	12	-	-
6	MP2	108	2	P1	64	-	-	P1	32	-	-
7	MP2	108	3	P1	64	-	-	P1	32	P3	12
8	MP2	108	3	P1	64	-	-	P1	16	P1	16
9	MP3	120	1	P1	97	-	-	-	-	-	-
10	MP3	120	2	P1	97	-	-	P3	24	-	-
11	MP3	120	2	P1	64	-	-	P1	32	-	-
12	MP3	120	3	P1	65	-	-	P1	32	P3	24
13	MP3	120	3	P1	64	-	-	P1	16	P1	16
14	MP5	108	1	P1	24	P2	72	-	-	-	-
15	MP5	108	2	P1	24	P2	40	P2	32	-	-
16	MP5	108	3	P1	24	P2	40	P2	32	P3	12
17	MP6	96	1	P1	48	P2	48	-	-	-	-
18	MP6	96	2	P1	48	P2	16	P2	32	-	-

Mime Types, and associated Mime Hashes, are used by data service provider to uniquely identify the service to receiver applications. In the HD Radio system all data services share a common protocol: Radio Link Subsystem (RLS). The data is typically bound for numerous different types of receiver rendering applications; which may or may not exist on a radio. RLS uses a dynamic port numbering method to distinguish the various different services sharing a particular station’s bandwidth. A Service Information Guide (SIG) is broadcast to identify services being received on the various port numbers. Mime types are converted to a Mime Hash and broadcast on the SIG along with the service’s port number. Receiver applications then look for their specific Mime Hash in the SIG to identify if and on what port number their data is being broadcast.

In order to preserve the uniqueness of Mime Types and associated Mime Hashes across the whole broadcast industry, iBiquity manages and maintains a master list of assigned Mime Types and Mime Hashes. The managing entity is the HD Registry. The HD Registry serves as the central repository and management system for all the global system parameters associated with the HD Radio technology (Broadcast & Receive). In addition to Mime types and service genres, the HD Registry is also responsible for other resource parameters such as global audio & data processing types (e.g. surround sound), radio station facility IDs and country codes, Importer license keys, Service Provider IDs, and Service IDs. The Service Provider IDs and Service IDs are key components when Conditional Access is

employed. The Service ID allows the Conditional Access system the ability to uniquely identify the service such that proper entitlements and access keys can be generated for that service.

The Importer possesses multiple tiers of functionality in support of the various business licensing models. Currently, there are 2 tiers supported. These are summarized below:

Tier II

- Multicast only – limited to 2 SPS in hybrid modes MP1-MP3
- No data services
- Base Configurations 1-9

Tier I

- Fully Functional Importer

3.3 Components

Figure 3-2 shows a high level block diagram of the core Importer software components and the client modules delivered as part of the SDK.

The following paragraphs provide a brief description of the various Importer components.

- *Importer Database:* The persistent data for the functioning of the Importer is stored in the Importer database. All the Administrative functionality is handled by interaction with this database. Importer components like the Connection Manager and the Logistics Processor write data about their functioning into the Importer Database.
- *Administration (Admin Module):* Administration is basically an offline activity to enable broadcast stations to configure the Importer according to their requirements. The Admin Module also communicates with the Exciter or Exporter to configure these sub-systems into the appropriate operational modes based on the desired service mode and bandwidth allocations. The Admin Module handles all the registration of service providers, services, contracts, and Importer configurations. Finally, the Admin module communicates all the necessary information to the Exporter for transmission over the SIS channel.
- *Logistics Processor:* The Logistics Processor is responsible for the data reception from the service providers in accordance with the specific protocol chosen for that particular service. For example, if the service is a multicast audio service, the Logistics Processor is responsible for the HDC encoding of the audio program. For data services, including PSD, the Logistics Processor is responsible for encoding the data using the Radio Link Subsystem (RLS). In addition to encoding data using the proper transmission protocol, the Logistics Processor is also responsible for managing the bandwidth and QoS for each service as defined in the configurations between the service provider and the broadcast station. It communicates with the Connection Manager as well as an Exciter or Exporter. It also communicates with the Importer Database in order to retrieve configuration information and save its performance data.

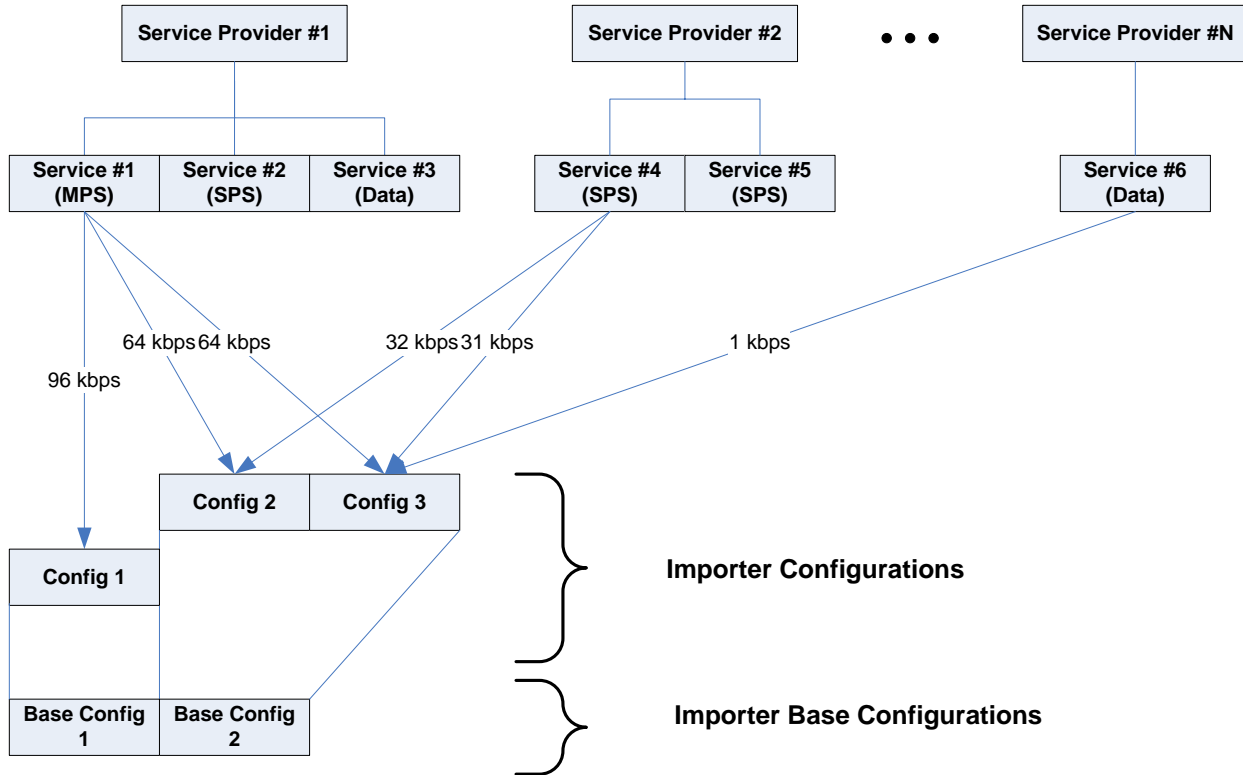


Figure 3-1 Relationships between Service Providers, Contracts, Services, and Importer Configurations

- Connection Manager (CM):** The Connection Manager is responsible for managing the connections from the various services. It authenticates service providers and delivers the specific information regarding the Contracts and Services for each service provider. It provides the mechanism for service providers to deliver data services to the Importer. It allows multiple service providers to connect to the Importer and multiple services to be delivered by each service provider. The Connection Manager connects to the Importer Database for authentication information as well as to the Logistics Processor for bandwidth and QoS information. The Connection Manager is also responsible for the construction and management of the Service Information Guide (SIG).
- Control Panel:** Although not shown in Figure 3-2, the Importer software includes a module that can be used to control, configure, and monitor the main Importer components.
- Data Link Manger:** Although not shown in Figure 3-2, the Importer software includes a module that is used to communicate with the other broadcast system equipment.

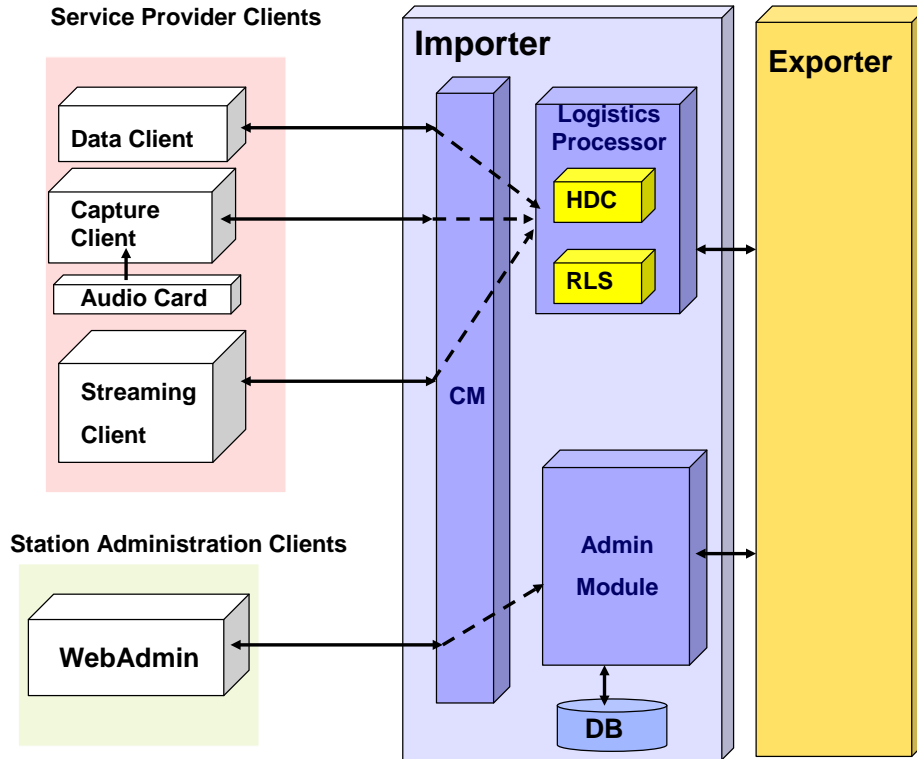


Figure 3-2 High Level block diagram of the Core Importer software modules (blue) and the example client modules (white).

The following paragraphs provide a brief description of the various example client applications. Their intent is to assist developers by providing simple applications demonstrating the use of the Importer API. These client applications are only meant to serve as examples and are not meant to be delivered as commercial software.

- **Data Client:** The Data Client is a generic implementation of the Service Provider portion of the Importer API. It can be used to transmit any type of discrete data packets as long as the data is formatted in the generic data client format[†] and the Service Provider has obtained a broadcast token from iBiquity. The tool allows quick prototyping of data applications by relieving the developer from having to write their own data clients.
- **Capture Client:** The Capture Client captures audio streams from a Direct X compatible audio card and sends them into the Importer using the Service Provider portion of the Importer API. This client also accepts Program Service Data (PSD) data packets in HDP format and sends these to the Importer for multiplexing and encapsulation within the encoded audio streams.
- **Streaming Client:** The Streaming Client application can be used to create play-lists from audio stored locally in files, add PSD data to the audio in the play lists and to send both to the Importer using the Service Provider portion of the Importer API. This example application can be used to operate the Importer when no external audio source is available.
- **WebAdmin (Administration) Client:** The Web Admin Client is used to configure the Importer through the Administrative portion of the Importer API. The WebAdmin Client provides a web-based graphical user-interface combining for Importer administration.

[†] This format is described in the “HD Radio Importer Service Providers SDK” document.

4 Overview of the Importer API

4.1 Introduction

The Importer is a set of software components that simultaneously accept distinct services for broadcast. The Importer provides operational control over services based on contractual, bandwidth and security obligations between the service provider and the station owner (broadcaster). The Importer provides the functional implementation of the Importer API. The Importer API serves two main functions:

1. Provides configuration control over the Importer. The configuration establishes which Service Providers and Services are allowed to connect to the Importer and to be broadcast over the Station. The configuration also establishes bandwidth allocations and quality of service characteristics for each Service.
2. Provides a common interface for a service providers to access and deliver their services over the available bandwidth provided by HD Radio enabled AM or FM stations.

The Importer API is written in XML and client software connects to the Importer via TCP/IP connections. This allows developers to write their custom client applications on any platform (e.g., Unix, Linux, etc..) and also allows client software to access the Importer from remote locations. Using XML has the added benefit of being easily extensible, allowing for future expansion of the Importer API.

All XML messages are Command/Response. Every request from a client results in a response from the Importer and visa versa. If an error occurs, the response message indicates the error. The majority of commands originate with the client software, the only exception occurs with service data (generic data and SPS audio) being delivered to the Importer. In this case, data is delivered to the Importer using the “pull” model (asynchronous protocol). The Importer requests data from the service (Command) and the client software responses with the requested data. Depending on the amount of data delivered and the bandwidth allocated to the service the Importer requests may be frequent or infrequent. The Importer tries to keep its internal buffering at optimal levels. If for some reason the client software does not deliver data in a timely fashion, the Importer will fill the allocated bandwidth with the equivalent of “Zeros”. If a data client does not respond to a request for data, the Importer will not continue to send requests. Instead it will wait for the response from its request before it issues another request.

If for some reason the TCP/IP connection is lost, it is the responsibility of the client software to re-establish the connection.

5 Supporting Documentation

This sections lists and briefly describes all the supporting documentation available to Importer manufactures and developers.

5.1 General Documentation

- **TX_HDD_5007 - HD Radio™ Broadcast System Architecture**
This document provides a brief overview of the HD Radio Broadcast System Architecture (BSA). It introduces each major subsystem within the BSA and its associated framework. It also provides references that can be used to find more detailed information about each framework
- **SY_AAS_2021 – HD Radio™ AAS Overview**
This document.
- **TX_MAN_5078 – HD Radio™ Importer Users Guide**
This document describes the hardware and software requirements for the Importer, how to install the core Importer components and example client software (Importer Tools), and how to connect an Importer to an Exciter/Exporter. It also describes how to use the Importer components for stand alone operation.
- **TX_HDD_2002 – HD Radio™ Importer Hardware Reference Design**
This document describes the hardware used for the iBiquity Digital reference Importer.
- **TX_MAN_2030 – HD Radio Importer Streaming Client Users Guide**
This document provides details about how to use the Streaming Client Application.

5.2 Importer API

- **SY_API_2022 – HD Radio™ Importer API.**
This document provides the full Importer API XML specification.

5.3 Importer SDK Documentation

- **SY_API_2029 – HD Radio™ Importer Administrative SDK**
This document provides the details of how to use the administrative portion of the Importer API and describes the WebAdmin Client and example software.
- **SY_API_2020 – HD Radio™ Importer Service Providers SDK**
This document provides details on how to use the Service Provider aspects of the Importer API and describes the generic data client and the capture client.

5.4 HDP Documentation

- **SY_SDD_2010 – HD Radio™ HDP PSD SDK v1.0 for Linux/Windows OS**
This document provides details on how to create applications that produce PSD content in HDP format for the both MPS and SPS applications.
- **TX_TN_2036 – HD Radio™ HDP PSD SPS Application Note**
This document provides examples of how to use the HDP SDK to provide PSD to SPS clients.
- **TX_SDD_2253 - HD Radio™ HDP Specification**
This document provides a detailed description of the HDP Protocol.

6 Glossary

In order to better understand the concepts in this document, the following definitions apply:

GLOSSARY