RVU Protocol:

Networked Home Entertainment With Pixel Accurate Remote Graphics

White Paper

Abstract

RVU allows the television viewer to watch live or recorded programming on various manufacturer-branded TVs or clients while experiencing a consistent user interface—no matter which client device is employed.

RVU supports networking on existing home infrastructure. RVU-compliant TVs and clients are networked in the home with an RVU server. Once connected, the TV viewer can watch the same or different content from any room of the home. Viewers can access either pre-recorded or live content, premium content such as high definition or ultra-high definition video and multi-channel audio, or personal content such as photos and videos via the media server. RVU supports a novel remote user interface that allows user interactions such as trick play (e.g., pause and rewind) and the running of interactive applications—all via a *thin client*.

The RVU protocol addresses the digital video industry's need for commonality and flexibility. It is available to consumer electronics (CE) manufacturers via the *RVU Protocol Specification*. RVU is based on open standards such as UPnP), to simplify software integration and enable cost effective solutions that CE manufacturers can leverage to create RVU clients such as TVs.

In short, RVU eases the provision of home networked commercial entertainment content while heightening the user experience.

An Introduction to RVU

What Customers Want

Customers expect flexibility and simplicity in a home networking environment. They want to be able to access personal and broadcast data throughout the home with minimum cost and effort. They expect a common user interface that allows them easy access to all content, and they expect the content to be high quality, including high-definition broadcast or recorded data.

In particular, customers want to:

- access high-definition programming from any TV in the home
- record and play back high-definition programming from any TV in the home
- access personal media content (e.g., videos and photos) from any TV in the home
- interact with weather, enhanced sports, and other interactive applications from any TV in the home
- receive the same experience at every TV through the same look and feel
- get content on mobile devices

What CE Manufacturers Want

CE manufacturers are eager to meet customer needs in the most efficient, cost-effective manner possible. Their goal is to create devices within a system that:

- leverages open standards to maximize interoperability
- enables premium content branded by multiple system operators (content or service providers) to be accessed via a remote UI technology
- provides a secure way to access copyrighted content
- features a consistent quality of service (QoS) targeted for video distribution
- allows software upgrades to enable feature updates after deployment
- offers validation tools to ensure proper implementation

Content Service Providers Want

- to provide a user experience that can be deployed in the home with a single update in the RVU-based media server appearing on all subscribing thin client CE devices.
- identical user experience on all clients
- content flowing directly to non-service provider provisioned mobile devices
- easier customer service calls – service provider applications are identical for all client types
- a server-controlled, common user experience enables the rapid introduction of new features and applications

The RVU Answer

The RVU protocol is an industry consortium standard based on a client-server architecture that establishes a flexible, non-proprietary solution to address these needs.

The server is typically supplied by a content service provider that allows the distribution and management of video and a consistent user experience to one or many thin client CE devices.

Figure 1 - The RVU Server-Client Solution

RVU allows users to easily access digital content throughout the home. A single server can be connected to programming (e.g., via a cable, telco or satellite feed) that can be recorded or watched live. The server can also access pictures, home movies, and other personal content from connected storage devices. All of this content can be accessed seamlessly from anywhere inside the home, allowing users in multiple rooms to view the same or different content from the server simultaneously.

The answer for the consumer is simple:

Get a content service provider compatible RVU server, multiple RVU TVs, and network them together.

The answer for CE manufacturers is simple:

Create RVU-compatible TVs or other client devices to bring the power of easily accessible content to the consumer.

The answer for Content Service Providers is also simple:

Deploy RVU servers and compatible client devices to bring a common user experience to the consumer that eases new applications and features.

A key benefit of RVU is its remote user interface (RUI) implementation. The objective of RVU is to keep the clients as process-light as possible. The RVU RUI design implements the majority of the user interface (UI) functionality, such as trick play, on the server. Remote key presses are passed directly from each client to the server. The server interprets them, responds appropriately (for example, changes channels), and blends UI graphics planes. It then delivers bitmapped and/or vector graphic user interface data plus any video and audio streaming data back to the client for display. The result is a robust, consistent UI experience throughout the home via thin clients as opposed to implementations with an entire UI via client-side software.

RVU's answer includes all these competitive features:

- thin client-server architecture open standard
- digital content throughout the home
- consistent user interface
- seamless connectivity

RVU Architecture

The RVU Advantages

Multiple Thin Clients, One Server

One of the most important advantages of the RVU system is its suitability for implementation on lightweight platforms.

Aside from the benefit of allowing data to be stored in a central location (the server), thin clients—if designed appropriately—offer numerous other advantages as well. They are less expensive: to build, to purchase, and to maintain. Having less processing capability (simpler software), they consume less power, require less maintenance, and last longer.

The RVU server does indeed "serve" its thin clients. In this network architecture, it's the server that does most of the heavy lifting: tuning, streaming live content, recording, playing back content, creating user interface graphics for the client to display, processing trick play requests, managing content, downloading new software, maintaining parental controls, and processing interactive applications.

Consistent User Interface

Another advantage to having multiple thin clients and one RVU server is the consistent look and feel of the user interface throughout the system.

With the RVU protocol, the same media server can support an ultrahigh-definition (UHD) television in the living room at the same time it is streaming video to other UHD/HDTVs throughout a household. In all cases, RVU-enabled clients will have exactly the same user interface and respond in exactly the same way.

Protected Content

All content requested by clients is sent from server to client using DTCP-IP (Digital Transmission Content Protection over Internet Protocol). Protected content remains secure throughout the RVU system.

Open Connectivity and Interoperability

The ability for RVU enabled clients to find the RVU server quickly and seamlessly is another advantage of the RVU system. RVU uses Universal Plug and Play (UPnP) technology to allow RVU clients and servers to locate each other and discover respective device capabilities, resulting in a high level of connectivity and interoperability.

Feature Sets

Any features that the RVU server utilizes will be available to its thin clients. This additional functionality can include such capabilities as interactive applications or video on demand (VOD).

The result is that RVU clients are able to offer the power and diversity of an RVU server's multiple features without additional processing.

Network Topology

The design of the RVU protocol allows for a number of different network topologies. Servers and clients using the RVU protocol can be deployed in a service provider provisioned network, where all network entities utilize the RVU protocol. An RVU deployment in a service provider provisioned network is shown in Figure 1. Another option is to deploy RVU servers and clients alongside other network elements such as personal computers and other network-enabled devices that are not necessarily RVU compliant as shown in Figure 2

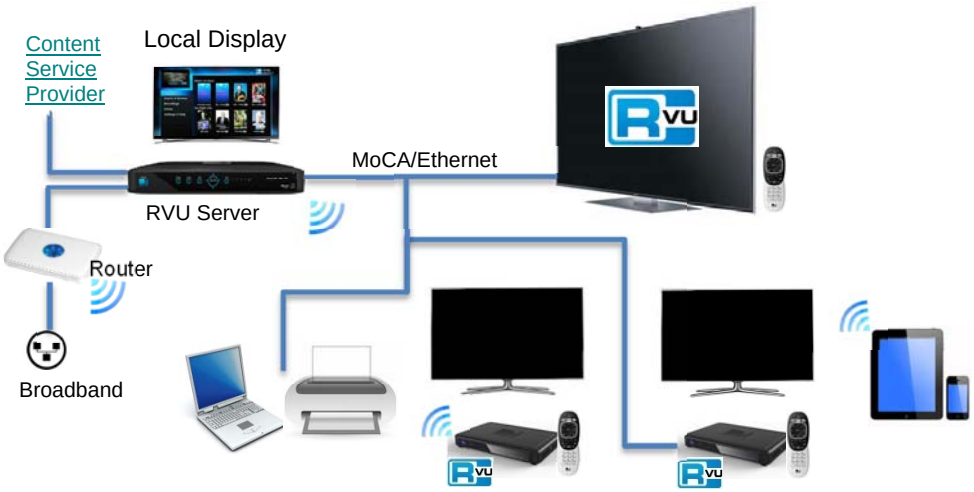

Figure 2 - Example Open Network

The sources of external content in both Figure 1 and Figure 2 can be of any kind to which the server may add a RUI or simply pass through to home network devices, for example, ATSC, satellite, telco, cable, broadband, or broadband over-the-top media content (OTT).

The home network elements in Figure 2 can be any number of network-enabled PCs, routers, mobile devices, internet gateway devices, etc.

Open Standards

The RVU protocol for clients and servers is built upon a set of open and widely accepted non-proprietary standards. The quest to provide a popular, robust, dynamic, and competitive future for this new protocol led to establishing the following open standards as RVU's foundation:

- DLNA (Digital Living Network Alliance)
- UPnP (Universal Plug and Play)

The rationale for choosing these protocols is explained in the sections that follow.

Digital Living Network Alliance

The RVU remote user interface (RUI) protocol complements devices implementing content streaming protocols of the DLNA Interoperability Guidelines. The concept of a remote user interface for clients is not new. However, the idea that clients should be able to provide a full-featured user interface by implementing minimal functionality, leaving most of the "hard work" to the server, is unique to RVU.

A remote user interface eliminates the need for clients to implement UI software to handle graphics, events, buffers, and complex messaging. Instead, clients can implement relatively simple software to send key events to the server and display the graphics and audio received in response. The server bears responsibility for generating the user interface graphics and audio data for the client to render. It is also responsible for interpreting the key events passed to it by the client.

Other technologies are available to provide remote user interface capabilities to clients. Some require clients to parse HTML and draw graphics from the HTML specifications. However, this leads to the possibility that different clients will interpret the HTML differently and thus display an inconsistent user interface. Still other protocols provide full-blown graphics rendering capabilities but require a large implementation effort on the part of client device manufacturers. The RVU RUI protocol is designed to strike a balance between these two choices, offering a consistent, lightweight, full-featured UI solution.

Universal Plug and Play

One of the principal building blocks of DLNA is UPnP (see www.UPnP.org). UPnP provides mechanisms for handling discovery and description to allow servers and clients to find each other within a home network. UPnP also provides services that enable session management and control.

RVU Scenarios

Plugging in Your Client

Suppose you have an RVU server set up in your house. You drive to your favorite electronics store and buy an RVU-enabled television. What will happen when you bring it home, plug it in, and connect it to your RVU network?

Once the TV is switched on, it will automatically search for and find the RVU server. It will ask the server about networking details, such as IP addresses and protocols, device services, etc, without bothering you with queries about such parameters. It will handle all networking issues and start talking.

Once communication with the server is established, the TV will set up a connection to the server's RVU remote user interface, giving you access to all content on the server plus any other content to which the server has access, including family photos and home movies stored anywhere on the same network as the server (such as on your personal computer).

From this point on, whenever you do something at your TV—such as change channels, pause, rewind, or press a button in response to an interactive application prompt—the TV will pass these commands on to the server. The server will process the request appropriately (for instance, by changing channels or pausing video), create and send any user interface graphics (such as a channel banner) to the TV, and stream new video, audio, or application data back to the TV for display. A remote command not relevant to the RVU server is used when returning to TV native screens.

Watching Television

One Server, One Show, Two Rooms

After work you settle into your favorite chair in the living room and start watching the game. Fifteen minutes later you suddenly remember that you are hosting friends for dinner in 45 minutes.

This is exactly why you put that smaller, RVU-capable TV in the kitchen in the first place. Your user interface is the same and you don't have to

worry about taking up more space on the counter with another set-top box and more cables.

Switch the kitchen TV on and tune to the same channel to pick up the game without missing a beat. You can take advantage of RVU's DVR capabilities, pausing the action to continue dinner preparation, and recording, rewinding, and replaying the remaining plays in slow motion later.

One Server, Two Shows, Two Rooms

Your son and his friend are watching their favorite TV show in the living room, but your neighbors are on their way over to see the home videos and photos from your recent vacation. You were hoping to watch them on the living room TV, instead of crowding around the little monitor in your office.

With RVU, you can pause your son's show on the living room set, and set him up in the family room with the RVU TV tuned to his show. Apply some parental controls so he doesn't go wandering off onto the wrong channel. Now, go back to the living room, access your photos and home movies from the client in there, press pause, and wait for the neighbors to arrive—everything is queued. Your neighbors are entertained while they can sit on the comfy sofa and see a big-screen TV while delighting in your global travels.

Changing Channels

If the user selects a channel change, the TV (RVU client) informs the RVU server that the "channel up" key was pressed. The server interprets this as a channel change request, switching the video and audio streams as well as generating a channel banner. The new video is sent to the TV together with the RUI data. Figure 3 shows an example of this scenario.

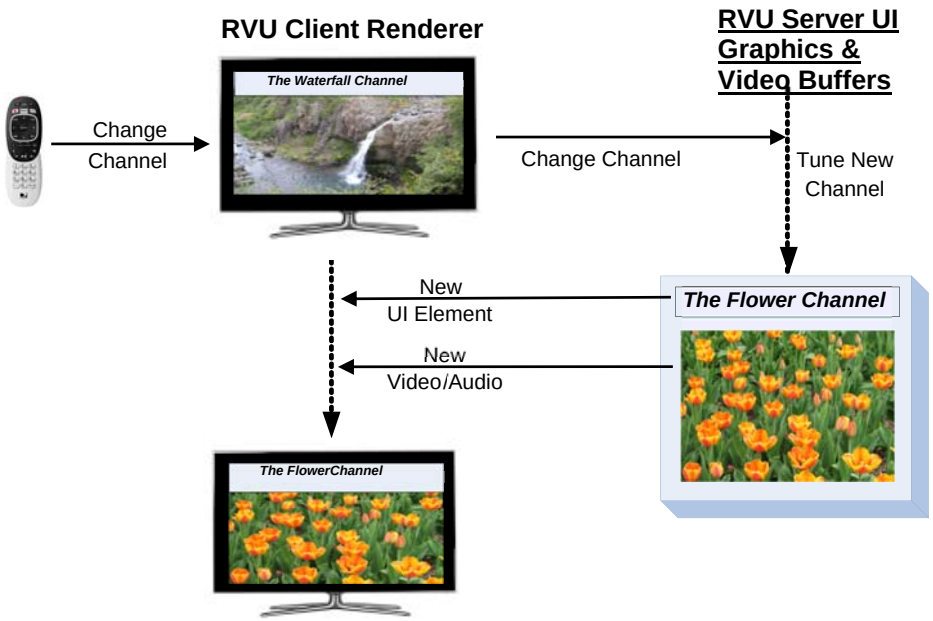

Figure 3 - RUI Commands between Client and Server

Making an Invalid Selection

If the user makes an invalid selection, such as pressing Fast Forward while watching live video, the TV still passes on the key press to the server. The server then responds appropriately, perhaps by sending back visual feedback (a warning message) or audio feedback (a "bonk") to alert the viewer that the input was received but is not valid.

Activating an Application

RVU can be used to interact with applications on the server such as games or weather tickers. As with all RVU transactions, the client TV passes any user key presses to the server. The server will then interpret these appropriately—for instance, by changing the city whose weather forecast is displayed—and send back to the client any appropriate UI elements or video/audio in response to the user's input.

Handling TV-Specific Interactions

An RVU TV will still be able to handle some key presses on its own, such as volume control, source input and brightness. Such key presses affect the TV alone and have no impact on the server or on the data it streams back to the client. Thus, these key presses will not be sent to the server.

RVU Documentation

RVU's Protocol Specification

The *RVU Protocol Specification* contains details on the UPnP devices and services required to support an RVU-enabled client's access to server content. The detailed protocol areas are:

- Addressing, Discovery, and Description
- Session Management
- Remote User Interface
- Media Transfer
- QoS and Network Connection Diagnostics

The document also contains:

- UPnP definitions and templates for RVU-defined services and devices
- Flowcharts and sequence diagrams

The *RVU Protocol Specification* does not contain specific hardware or software requirements for the server or client, but rather describes the type of protocols the server and client are expected to use, and respond to, for requests from other RVU components.

Addressing, Discovery, and Description

Based primarily on the UPnP specification, RVU's Addressing, Discovery, and Description protocol encompasses how servers and clients acquire IP addresses and discover the presence and capabilities of other devices on the network.

Session Management

The Session Management protocol describes the process of establishing a remote user interface (RUI) connection. For the connection to the RUI server, the client must determine whether it has the capabilities required to allow the connection. Session Management also encompasses how clients acquire the information they need to perform the connection to the RUI server.

Remote User Interface

One of the unique features of RVU is the area of the protocol specifically designed for the thin clients' interaction with the RVU Server: the Remote User Interface (RUI). Clients, in concert with the rendering capabilities of the server, offer a complete UI with a common look-and-feel, without requiring extensive custom UI software on the clients, and with a small memory footprint on the clients.

Media Transfer

RVU's Media Transfer protocol describes the mechanism used to securely deliver content data (e.g., video and audio) via HTTP from the server to the client. A key feature of media transfer is the ability to stream live as well as pre-recorded content.

The Media Transfer protocol uses DTCP-IP to ensure secure transmission of stored or streamed data. Content is typically encrypted as it is received by the server. Once it leaves the server, content must also be protected until it reaches the client. DTCP-IP provides this security by employing a set of copy protection rules, allowing digital content to be accessed using devices that are authorized through key exchange.

QoS and Network Connection Diagnostics

The QoS and Network Connection Diagnostics protocol includes standards for ensuring a consistently high quality of service throughout the segment of network elements using RVU.

Summary

The unique and exciting new RVU protocol fulfills the promise of home networked commercial entertainment. It leverages the cutting-edge interoperability of UPnP/DLNA—along with other open standards—enhancing them with a new RUI design to meet the demand of RVU's innovative new thin client.

Any CE manufacturer, and any content service provider (cable, telco or satellite), can create or use RVU clients, or servers, that talk to each other—advancing the home networking user experience.

RVU makes use of the thin-client, server-based architecture, which enables the easy growth of any home network. It also provides a much-needed common user interface between all clients.

Using open standards that continue to grow, RVU is perfectly positioned to evolve with the burgeoning global home networking technology. Cable, telco and satellite service providers can work directly with any CE manufacturer to implement and deploy RVU-enabled products.

RVU is here to serve the advance of networked home entertainment. To join the RVU Alliance, see www.rvualliance.org.