A Globally Distributed Real Time Infrastructure for World Wide Collaborations

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Abstract

The aim of this paper is to introduce and describe worldwide used videoconferencing and collaboration system called "Virtual Rooms Videoconferencing System" (VRVS). VRVS is being developed by Caltech (California Institute of Technology) in order to provide a low cost, bandwidth-efficient, extensible means for videoconferencing and remote collaboration over networks within the High Energy and Nuclear Physics community and with extensions also to other research communities. New features of recent version 3.3 (released in August 2004) will be presented. Key improvements concern among others: web navigation system, Pocket PC platform support, VIC and RAT end clients and services (based on the MonALISA project) to monitor real-time activity, oversee and manage the whole distributed system in a dynamic way. VRVS continues to expand and implement new digital video technologies and this paper provides a brief look at the future of VRVS - next milestone version 4, which will present brand new quality of VRVS system.

1. Introduction

The Caltech "Virtual Rooms Videoconferencing System" [1] (http://www.vrvs.org) is based on the Virtual Rooms concept. Several participants from different geographical places can have a conference (text, audio, video and shared applications) in a unique virtual area. We call this space a "Virtual Room". VRVS provides a videoconference service over IP networks via an intuitive web-based graphical user interface for non-expert users. VRVS has no frontier and has more than 10 700 active users spread in 106 countries and more than 700 world wide meetings involving more than 3000 users (total 46000 hours) per month. VRVS works on all the major operating systems and deals with several videoconference protocols at the same time to let the user choose the way he wants to connect to the meeting. The development of the next generation of the VRVS system is currently underway; details are described in further sections of this document. As a software-based collaborative infrastructure, VRVS is now recognized as the only multi-user videoconferencing and collaboration system capable of scaling to provide future collaboration services.

2. VRVS Description

2.1 Booking System

The VRVS web site is designed to allow a fast and intuitive navigation. VRVS provides a web based booking system where the participants can organize meetings manually or through a "booking wizard". This powerful booking system lets the user see in one click all his last reservations. Moreover a user can easily cancel, move or copy his reservation. In the middle of a meeting, the author of the reservation can extend dynamically the duration of his meeting if necessary. The user can protect a meeting with an additional password. A specific interface provides a quick view of all the meetings for a selected date. In addition, the world time zones are automatically managed by the system, so each user will see the time in his local GMT, whatever is his location.

2.2 Reflectors

VRVS supports inter-connectivity among the most popular videoconferencing tools running in different operating systems either over unicast or multicast networks. The reflectors' backbone provides a pure software-based MCU (Multipoint Connection Unit) with peer to peer structure, sophisticated real time multipoint algorithm with low cost and maintenance. In addition to improve dramatically the scalability and security, the system provides tunneling between peer reflectors, TCP connection and the NAT (Network Address Translation) support. Current status is 81 VRVS reflectors deployed world wide in 28 different countries.

2.3 Connection Interface

In one shot the VRVS user can see all the on-going meetings and can decide to join the one he wishes. A simple click on a dynamic web-based interface connects transparently the user to the nearest reflector. Then he can

see a nice view of all the currently connected participants as you can see in the Figure 1.

Fig. 1. VRVS meeting with VIC and RAT clients.

Via a java panel he can select the kind of videoconference client that he wants to start. Several web conference services are provided during the connection time. A chat, private messages, broadcasts of URLs (web addresses) and a sharing service (share of applications and computer desktop) are available on each Virtual Room. VRVS is the unique multi-user videoconferencing system where different types of videoconference clients can communicate together. The user does not have to take care of the protocol nor the network aspects. VRVS is able to connect together the H.323 clients (software or hardware based), the "Mbone" clients (VIC – Video Conferencing Tool [4] and RAT – Robust Audio Tool [5]), the QuickTime Players and SIP clients (for example Microsoft Messenger). VRVS provides four video modes: (1) Voice switched - the default mode for H.323 clients, receiving one video stream at a time; (2) Timer switched - browses through all the video streams based on preset timer, receiving one video stream at a time; (3) Selected Streams – the default mode for VIC client. Click among the video participants to view selected video streams (one or several streams are available), which is useful for limited bandwidth network connections and/or legacy lowpower local computing systems; and (4) All Streams - VIC will receive all the video streams involved in meeting. This is the best mode for full interactivity, if the network will support the data flow. Moreover VRVS bypasses the limitation of some videoconference clients. A H.323 participant, for instance, can select the video displayed in his clients (that is not possible in a normal H.323 conference). A QuickTime Player participant receives automatically the video of the current speaker and the mixed audio from all the other participants. In VRVS the user can select the bandwidth that he wants to send according to his need and his capabilities. In the same philosophy VRVS is compatible with different operating systems (the most popular): Windows, Linux, Mac OS X.

2.4 Virtual Access Grid

VRVS provides VAG (VRVS AG Gateway; or Virtual Access Grid) which has full connectivity to Access Grid [6] and full functionality. The VAG has been shown to support a full Access Grid session on a laptop, consuming a few Mbps of bandwidth (or less, under user control), and can run over 802.11a or 802.11g wireless networks without packet loss. VAG reflectors have been installed in Internet2 [2], and at Argonne National Laboratory, and will be deployed on institutional AG nodes as needed, based on users' requests. A VAG reflector is functionally identical to other VRVS reflectors, is very easy to configure. VRVS users connected to Access Grid Virtual Venues or any multicast videoconference have the maximum flexibility to choose from Mbone RAT and VIC, H.323, SIP, QuickTime, JMF (Java Media Framework). Moreover, an audio transcoder is used to transcode AG linear L16-16-Mono to the ITU H.323 standard G.711 μ-Law and audio mixer which supports H.323 audio mixing and avoids blocked video because of a noisy site injecting noise into the session.

2.5 Administration Interface

Administration interface of VRVS system provides an intuitive and powerful mechanism to set, modify and tune the VRVS database. An Apache Tomcat, set with XML and Servlets composes its engine. VRVS administrators access via a web interface secured by an authentication mechanism and an SSL encryption of the navigation. This web site provides the best way to administrate all aspects of the main SQL database, with internal process that checks coherence of the tables, of modifications and of insertions, it allows administrator to check the state of all the reflectors, connect or remove any user from a Virtual Room and provides access to various dynamic statistics.

2.6 Internal Monitoring and Management

One of the key features of VRVS is the integration of the MonALISA (Monitoring Agents in Large Integrated Services Architecture) [3] monitoring service into the system (Figure 2). MonALISA was adapted and deployed on the VRVS reflectors. Dedicated modules to interact with the VRVS reflectors were developed: to collect information about the topology of the system; to monitor

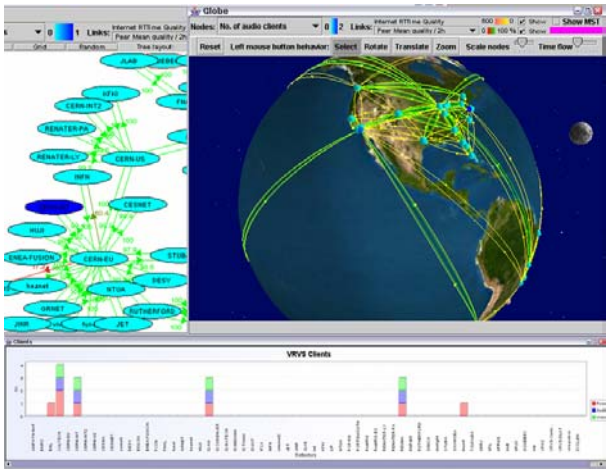

Fig. 2. MonALISA monitoring system.

and track the traffic among the reflectors and report communication errors with the peers; and to track the number of clients and active virtual rooms. In addition, overall system information is monitored and reported in real time for each reflector: such as the load, CPU usage, and total traffic in and out. For each VRVS reflector, a MonALISA service is running as a registered JINI service. A dedicated GUI for the VRVS version was developed as a java web-start client. This GUI provides real time information dynamically for all the reflectors which are monitored. To dedicate monitoring modules and filters for the VRVS system, agents have been developed, able to supervise the running of the VRVS reflectors automatically. In case a VRVS reflector does not answer correctly to the monitoring requests, the agent tries to automatically restart it. We are developing agents able to provide an optimized dynamic routing of the videoconferencing data streams. These agents require information about the quality of alternative connections in the system and they solve a minimum spanning tree problem to optimize the data flow at the global level. These agents are capable to take system actions and may be dynamically loaded and digitally signed by developers with trusted certificates (for security reasons).

3. Recent Version 3.3 and its Key Features

Current production version 3.3 was released in August 2004 and brings several improvements and newly developed parts.

Java applet has been improved to be able automatically download newer versions of VRVS audio and video applications, which means that users will not have to take care of updating of these clients as well as VRVS developers will have guaranty that users use the latest versions of these applications. Moreover applet now automatically starts and stops RAT and VIC clients.

With new web navigation users can easily (with one click) obtain overview of all ongoing meetings in all communities and then clicking on selected virtual room join the meeting. Moreover users can obtain overview of all booked meetings in all communities depending on selected date. All displayed information can be sorted according to selected category (virtual room, subject, time when meeting starts or finishes, etc.). Since version 3.3 communities can contain different groups of users which allows to organize users in more clear and flexible way.

VIC and RAT are the most used videoconference clients today in VRVS and version 3.3 brings their new enhanced versions with support to the most popular OS (Windows, Linux, Mac OS X). The new VIC and RAT are coming with new GUI, which is more user-friendly and allows these applications (together with new Speaker mode implemented in VIC) behave (visually) like one audio/video client. New VIC has better compatibility with hardware H.323 clients due to fixed problems in H.261 video codec part and new feature which prevents video packet reordering causing "frozen" video on some H.323 clients. One of the new features of VIC is possibility to send still image instead of live video, which can be useful in case when user don't have camera or has restricted bandwidth and want to send picture of his face. New display modes allow managing and arranging video windows on the screen. Possible choices are: *"normal windows size"* which displays CIF sized windows arranged as tiles, *"small windows size"* which displays tiled QCIF video windows, *"speaker only"* which displays only CIF sized video of the current speaker and finally *"all with speaker"* which displays current speaker in one CIF sized window and all participants as QCIF tiled windows. Above mentioned Speaker mode is part of last two scenarios.

Another new development that VRVS Team has released as a part of version 3.3 is the pocket PC platform support. As with all computer technologies today, handheld computers are becoming more and more powerful. They are now able to run the software codecs needed to process the real-time audio and video streams needed for a fluid videoconference. Wireless connections are also becoming faster and sending full audio and video streams over a wireless connection is now practicable. More cameras for handheld computers are coming on the market every day. These cameras work at faster frame rates and higher resolutions than before, and more videoconferencing clients for handheld computers are becoming available. There are now H.323 and SIP clients for handheld computers which could be integrated into VRVS. VRVS also would like to contribute to this area and in version 3.3 introduces a VRVS audio/video client (called Pocket VRVS) that runs on a Pocket platform (Figure 3).

Fig. 3. Pocket VRVS client and main menu of web interface for handheld clients.

It supports H.261 video standard and G.711 (μ-Law) audio standard. Due to lack of CPU performance current version of Pocket VRVS client doesn't allow sending of live video from Pocket PC camera; however users can send CIF sized still image stored in JPEG format. A new web based interface for Pocket PC clients (designed for smaller screens) has been created and it includes all the controls available for all the clients (meeting scheduler, booking, etc) and moreover also possibility to connect H.323 device. For handheld videoconferencing it is only practical to display one video at a time because of the limited screen resolution of a handheld computer. This task is carried out by VRVS reflectors, which send to handheld clients only the video of current speaker. Being able to choose easily which video of the participants in the meeting to view could be important in the future, especially when using a handheld for Virtual Access Grid in which each venue can hold 30 or more videos. Using wireless handheld computers with audio and video capabilities, anyone will be able to participate in a meeting at any time anywhere.

4. *Version 4 – Future of VRVS*

Next version of VRVS will represent fully re-architected system with the aim to become a Globally Distributed Self Managed End-to-End Real-time and Secure Infrastructure to support all type of collaborations via video, audio, shared applications and instant messaging serving the research and academic community.

Reflectors in version 4 will provide communication channel not only for audio/video but also for shared applications and Instant Messaging. New reflector software will be written in Java and its new functionality will include among others: automatic and secure code update, continuous monitoring of network quality (packet loss, jitter, latency), automatic rerouting to obtain the best performance and quality, encryption between reflectors and between reflector and VRVS clients, automatic alarm notifications when monitored parameters (system or network) go beyond a preset threshold and finally access to real-time and historical data.

New Java-based VRVS client with multi OS support will get services (video, audio and data) that match the current resources and capabilities to end user applications. The client will automatically detect system parameters (CPU, memory, etc.) hardware components (audio card, video card, etc.), service capabilities (video, audio, etc.), and network environment (wireless, DSL, available bandwidth, etc.). Continuous monitoring of network quality and automatic alarm notifications when monitored parameters (system or network) go beyond a preset threshold will be also components of new end client.

The next version of VRVS will provide several conference scenarios suitable for various kinds of collaboration (i.e. e-learning, collaboration meeting, broadcasting, etc.) with privileged users (as sessions' chairman), which will be able to mute/un-mute the video/audio of any participant in real time, decide who the speaker is and which video should be sent to the remote participants.

Other enhancements will include implementation of new audio (G.722) and video (H.263, H.264) codecs for RAT, VIC and Pocket VRVS clients which will bring better quality, performance and compatibility with existing devices. Using the MonALISA monitoring software, the system will be able to monitor different type of parameters or processes and send different type of alarms associated with different type of actions.

VRVS Team will continue to develop and expand the system, with the new available technologies, adding, among others features the ones described in this document, in a way to provide the most powerful tool available for collaborative environments, bringing a unique, independent, flexible and scalable platform, for a professional collaborative experience.

References

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