Open Source Tools for Multimedia Desktop Conferencing and Media Streaming over IPv6: Comparison Criteria and Survey

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***Abstract* – Internet Protocol version 6 (IPv6) has been recognized as the core protocol for the next generation Internet, as well the 3rd generation network UMTS. As IPv6 is incompatible with the IPv4 currently in use, IPv6-enabled applications are relatively scarce. This paper presents a survey of open source and free tools for multimedia desktop conferencing and media streaming over IPv6 as of October 2004. We also propose comparison criteria and testing scenarios for such tools, and run selected tools in an experimental IPv6 network in order to share our experiences with, and provide recommendations to potential users.**

Keywords: IPv6, multimedia, audio, video, conferencing, streaming

I. INTRODUCTION

Internet Protocol version 6 (IPv6) has been designed as the successor to current IP version 4 (IPv4), and has also been adopted as the core network protocol in the 3rd generation network Universal Mobile Telecommunication System (UMTS). The fact that the two IPs are not compatible, although they represent the same layer in the Internet protocol stack, initiated the ongoing development of new applications, as well as porting the existing ones to IPv6. The purpose of this paper is to give an overview of open-source and/or free desktop conferencing and media streaming tools with IPv6 support. We also propose comparison criteria and testing scenarios for such tools, and run selected tools in an experimental IPv6 network, in order to share our experiences with, and provide recommendations to potential users.

For the purposes of this paper, we consider desktop conferencing tools as software providing two or more users the ability to communicate "live" in (near) real-time, with transmission of audio, video, messages, and shared content. Media streaming tools include software tools used for distribution and receiving of audio and video content, with media streaming being mostly unidirectional. The initial list of tools of interest, compiled from various sources found on the Web and in literature, includes the following tools:

- Digital Video Transport System – DVTS [1]
  http://www.sfc.wide.ad.jp/DVTS/
- GnomeMeeting
  http://www.gnomemeeting.org/
- High-quality Audio Tool – HAT
  (not available, development completed in 2001 according to http://mmlab.snu.ac.kr/)
- Icecast
  http://www.icecast.org/
- ISABEL [2]
  http://isabel.dit.upm.es/
- MPEG4IP
  http://mpeg4ip.sourceforge.net/
- Network Text Editor – NTE
  www-mice.cs.ucl.ac.uk/multimedia/software/nte
  (ported from old MBone tool [3])
- OpenH323 [4]
  http://ouranos.ceid.upatras.gr/openh323/
- Robust Audio Tool – RAT
  www-mice.cs.ucl.ac.uk/multimedia/software/rat/
- Session Directory Tool – SDR
  www-mice.cs.ucl.ac.uk/multimedia/software/sdr/
- Trondheim Underground Radio – TUR
  http://www.turmusic.no/
- Video Conference Tool – VIC
  www-mice.cs.ucl.ac.uk/multimedia/software/vic
  (ported from old MBone tool [5])
- VideoLAN
  http://www.videolan.org/
- Video-over-IP – VIP
  http://vip.telin.nl/
- Whiteboard – WBD
  http://www-rp.lip6.fr/~kabassan/
  (IPv4 version from University College London)
- 6UMS
  (not available, appears within the Euro6IX project: serverwas.lab.telin.nl/WP5Apps/Applications.html)

This paper is organized as follows. Section II introduces the classification of desktop conferencing and media streaming tools, according to the type of media they support and their purpose, and proposes four tool classification criteria and seven scenarios for functionality testing. The classification criteria are further described in terms of characteristics. Section III lists and compares the characteristics of selected tools. Section IV summarizes and discusses the results, and concludes the paper.

II. CLASSIFICATION OF SELECTED TOOLS

To classify the tools of interest, we group them according to the type of media they support (audio, video, shared content, messages, session management) and their purpose (conferencing, streaming), into five groups:

- tools for audio and video conferencing
- tools for audio and video streaming
- tools for collaborative editing

- tools for text messaging
- tools for session management

Tables I-V give an overview of each group of tools.

TABLE I. AUDIO AND VIDEO CONFERENCING TOOLS

Name	Purpose	Audio	Video	Additional capabilities
GnomeMeeting (*)	audio and video conferencing	yes	yes	chat
ISABEL	video and audio conferencing	yes	yes	whiteboard
Robust Audio Tool – RAT(*)	audio conferencing and streaming	yes	no	sending audio files, speech recording
Video Conference Tool – VIC (*)	video conferencing	no	yes	–

TABLE II. AUDIO AND VIDEO STREAMING TOOLS

Name	Purpose	Audio	Video	Additional capabilities
Digital Video Transport System – DVTS	digital video streaming (from IEEE1394)	yes	yes	–
High-quality Audio Tool – HAT	MP3 music streaming	yes	no	–
Icecast (*)	music streaming	yes	no	Internet radio, private jukebox
MPEG4IP	multimedia content streaming	yes	yes	MP3 streaming
Trondheim Underground Radio – TUR	music streaming, Internet radio	yes	no	–
VideoLAN (*)	video streaming	yes	yes	sending files, multimedia content presentation
Video-over-IP – VIP	audio-visual content streaming	yes	yes	searching through video archives

TABLE III. COLLABORATIVE EDITING TOOLS

Name	Purpose	Audio	Video	Additional capabilities
ISABEL	video and audio conferencing	yes	yes	whiteboard, uploading PostScript and GIF files
Network Text Editor – NTE (*)	collaborative text editing	no	no	uploading text (ASCII) files
Whiteboard – WBD (*)	collaborative whiteboard	no	no	uploading PostScript files

TABLE IV. TEXT MESSAGING TOOLS

Name	Purpose	Audio	Video	Additional capabilities
GnomeMeeting (*)	audio and video conferencing	yes	yes	chat
6UMS	messaging	no	no	–

TABLE V. SESSION MANAGEMENT TOOLS

Name	Purpose	Audio	Video	Additional capabilities
Session Directory Tool – SDR (*)	session management (SIP, SDP)	–	–	support for SAP protocol
OpenH323	session management (H.323)	–	–	–

For each tool, we state the purpose of the tool, its capability to support audio and/or video (rendering), and additional capabilities (if any). We also mark (*) the tools we test later in our experimental IPv6 network.

Having classified the selected tools, the next step was to establish the comparison criteria and functionality testing scenarios.

A. *Comparison Characteristics*

We propose four groups of characteristics to compare the tools, namely:

- Availability
- Codec support
- Protocol support
- Multicast support

Each of these groups comprises several attributes for each tool.

Availability comprises such information as the latest stable version (as of 10/2004) and the date of its release, operating system for which it was developed, terms of use, source code and documentation availability, and list of additional applications and required libraries.

Codec support comprises list of supported audio and video codecs for conferencing and/or streaming, as well as additional input data and document file formats.

Protocol support comprises list of protocols for transmission and transmission management of multimedia content, as well as session management protocols the tool uses. Fig. 1 shows the protocol stack with its most important protocols, used in majority of multimedia applications. Protocols used in such applications are mainly application layer protocols, running over TCP/IP, UDP/IP, or UDP/IP multicast. In terms of functionality, they may be divided into three groups:

- *Session management protocols*

– Session Description Protocol (SDP); RFCs 2327 and 3266

– Session Announcement Protocol (SAP); RFC 2974

– Session Initiation Protocol (SIP); RFC 3261
– ITU-T H.323 family of protocols

- *Multimedia content transport and transport control protocols*
  – Real-time Transport Protocol (RTP); RFC 3550
  – RTP Control Protocol (RTCP); RFC 3550
- *Media streaming control protocols*
  – Real Time Streaming Protocol (RTSP); RFC 2326

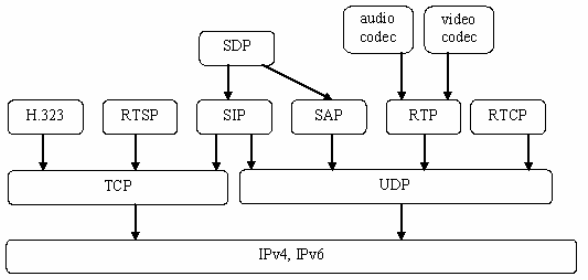

Figure 1. Multimedia applications' protocol stack

Multicast support describes whether the tool has a multicast support or not, and whether it uses native IP multicast or a special multi-point distribution server.

B. Scenarios for functionality testing

To test the functionality of selected tools, we adopted the scenario-based approach. Each scenario consists of a series of actions usually performed in intended use of the tool. The goal of the testing was not to assess the correctness of software specification or its performance, but rather to observe the software behavior, or general "usability" from the user's point of view. Some scenarios may test several tools at the same time, for example, a tool for audio conferencing may be used together with the associated tool for session management, which is then used to define audio conference parameters.

We specify seven basic scenarios as follows:

1) Establishing audio (video) conferencing by using a session management tool

- the session initiator defines session parameters by using a session management tool
- the session is being announced, new participants join the session upon the announcement; or the session initiator (user) directly invites a new user into existing session
- during the session, the user sends audio (video) stream
- other participant(s) receive and render audio (video) streams
- in course of the session, the sending user successfully changes the codec and/or other session's parameters (*optional*)
- the session initiator terminates the session, or its duration automatically expires

2) Establishing audio (video) conferencing without a session management tool

- same as the first scenario except for session initiation, where the session initiator specifies session parameters when starting the tool, and directly invites new participants

3) Starting collaborative editing by using a session management tool

- the session initiator defines session parameters by using a session management tool
- session initiator loads an existing document, or creates a new one
- the session is being announced, new participants join this session upon the announcement; or the session initiator (user) directly invites a new user into existing session
- in course of the session, the user alters (parts of) document's content
- the session initiator (user) stores shared content locally
- the session initiator terminates the session, or its duration automatically expires

4) Starting collaborative editing without a session management tool

- same as the third scenario except for session initiation, where the session initiator specifies session parameters when starting the tool, and directly invites new participants

5) Establishing streaming of previously stored audio (video) content

- server side: stored audio (video) clip is being sent to recipient(s)
- client side: audio (video) is being received and rendered on the user side
- client side: user controls the presentation of audio (video) content (fast-forwarding and rewinding the data stream, positioning forward/backward in the data stream, temporarily pausing the stream)

6) Establishing streaming of live audio (video) content

- server side: audio (video) is being recorded live by using a microphone (camera) and sent to recipient(s)
- client side: audio (video) is being received and rendered on the user side

7) Establishing a messaging session

- client joins the session
- presence information is displayed to the client
- the user sends text messages to, and receives messages from, other active users
- live communication takes place, directly or by using multi-user server (unicast or multicast)

The scenarios described here can be applied in both unicast and multicast configurations, with multicast support being more suitable for sessions with three or more participants. Thus, multicast configuration has been given the priority when performing the tests. In addition to functionality testing, subjective impressions about particular tool features (graphical interface, usability, etc.) and quality of rendered audio and/or video were noted.

III. TESTING IN AN EXPERIMENTAL IPV6 NETWORK

Selected tools were tested in the experimental IPv6 network (Fig. 2). The network consists of 3 PC's (Intel Pentium 4 @ 3.06 GHz; 1 GB RAM; 80 GB HDD; with a small Web camera, microphone, and headphones).

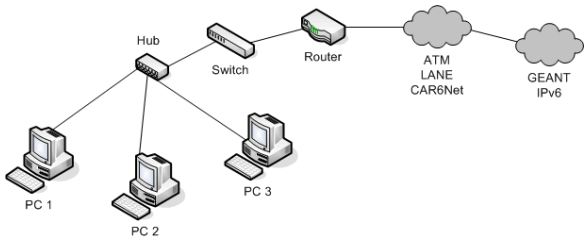

Figure 2. Topology of the experimental IPv6 network

Each PC is configured as a dual boot machine, with Microsoft Windows XP and Linux Mandrake 10.0 operating systems installed. PC network interface is configured so as to support both IPv4 and IPv6, and contains both auto-configured link-local scope IPv6 address, and manually assigned global scope IPv6 address. PCs are connected through a switch and a router to CAR6Net, the Croatian Academic and Research Network (CARNet) experimental IPv6 network, and further to the multi-gigabit pan-European research network GÉANT (the IPv6 deployment in GÉANT became operational in November 2003). The experimental IPv6 network did not have a DNS server available at the time.

A. Selected tools characteristics

First the basic characteristics – availability, codec support, protocol support and multicast support – are determined, followed by functionality testing. Table VI provides information about tools' availability, and Table VII gives an overview of available audio and video codecs, as well as additional input data file formats.

Table VIII gives an overview of transport layer (UDP, TCP) and application layer protocols (RTP, RTCP, RTSP) used by selected tools, and also presents session management tools and protocols which can (or, can not) be used together with the selected tools.

Table IX gives a comparison of multicast support for selected tools. It is interesting to note that many tools support IP multicast. Some tools that do not support native IP multicast use a special multi-point distribution server ("reflector") for more efficient delivery of multimedia content in multi-user conferences.

B. Scenario-based testing

We tested eight selected tools (SDR, RAT, VIC, NTE, WBD, Icecast, VLC player, and GnomeMeeting) in six scenarios under Microsoft Windows XP. The selection of applications and scenarios was made taking into account the compatibility of equipment available in the experimental network. To summarize the results, we list by group those which gave the most favorable impression in terms of stability, documentation, user interface, and technical parameters (codecs, multicast, etc.):

- tools for audio and video conferencing: RAT and VIC
- tools for audio and video streaming: VideoLAN
- tools for collaborative editing: NTE and WBD
- tools for text messaging: GnomeMeeting
- tools for session management: SDR

The set of MBone tools, namely SDR, RAT, VIC, NTE and WBD, can be used collectively and this, as well as being based on prevalent IETF standards (SIP, SDP), are definitely some of their advantages.

TABLE VI. TOOLS' AVAILABILITY

Name	Version	Date	Operating system	Terms of use	Source code	Documentation	Additional applications
Purpose: Audio and video conferencing							
GnomeMeeting	1.02 (0.98.5)	4.5.2004. (2003.)	Linux	free, open source, GNU/GPL	yes	excellent	OpenH323, PWLib
ISABEL	4.8	not available	Linux SuSe 8.1	demo version	no	excellent	–
Robust Audio Tool – RAT	4.2.24	11.9.2003.	Windows, Linux, Irix, Solaris, FreeBSD / NetBSD, SunOS	open source	yes, C, Tcl/Tk	good	SDR, VIC compatible with NTE, WBD
Video Conference Tool – VIC	2.8 ucl 1.16	11.9.2003.	Windows, Linux Red Hat 8.0	open source	yes	good	SDR, RAT compatible with NTE, WBD
Purpose: Audio and video streaming							
Digital Video Transport System – DVTS	1.0e	30.5.2004.	Linux, Mac OS X, Windows, NetBSD, FreeBSD	open source	yes	average	–
Icecast	2.0.1	12.5.2004.	Windows, Linux, FreeBSD, Solaris, OpenBSD	free, open source	yes	good	IceS, libshout

TABLE VI. TOOLS' AVAILABILITY (CONT'D)

Name	Version	Date	Operating system	Terms of use	Source code	Documentation	Additional applications
MPEG4IP	1.1	18.05.2004.	Linux, FreeBSD, BSD/OS, Mac OS X, Solaris, Windows	LGPL, MPL	yes, C, C++	good	MPEG4IP player
Trondheim Underground Radio – TUR	not available	2001.	Windows, Linux, FreeBSD	free	no	poor	Windows Media Player, FreeAmp, Zinf, mpeg123
VideoLAN	0.7.2	21.5.2004.	Windows, Mac OS X, Linux	free, GPL, open source	yes, C	excellent	no
Purpose: Collaborative editing							
Network Text Editor – NTE	2.2	25.05.2001.	Linux, Windows, Solaris, FreeBSD	open source	yes, C, Tcl/Tk	good	SDR
Whiteboard – WBD	1.0.4	16.02.1999.	Linux, Windows	open source	yes, C, Tcl/Tk	good	SDR, Ghostscript
Purpose: Session management							
OpenH323	1.15.1	30.9.2004.	BeOS, Mac OS X, Windows, BSD, Linux	open source, MPL	yes, C++	excellent for IPv4; poor and incomplete for IPv6	command line H.323 client, H.323 MCU, H.323 gatekeeper, GnomeMeeting, GUI based H.323 client for Unix etc.
Session Directory Tool – SDR	3.0	25.8.2000.	Windows, Linux Red Hat 8.0	open source	yes	good	VIC, RAT, NTE, WBD

TABLE VII. AUDIO/VIDEO CODECS AND FILE FORMATS FOR SELECTED TOOLS

Name	Audio codecs	Video codecs	Data formats
Digital Video Transport System – DVTS	DAT (IEC 61119)	DV formats (IEC 61883, IEC 61834)	–
GnomeMeeting	iLBC, GSM-06.10, MS-GSM, G.711-A law, G.711-μ law, G.726, Speex audio codecs, G.723.1 (with a Quicknet card)	H.261	–
Icecast	MP3, OGG	–	–
ISABEL	PCM, GSM, LPC, G.711	H.261, H.263, MPEG-1,-2,-4	PostScript, GIF
MPEG4IP	AAC, MP3, CELP, AC3, PCM	MPEG-4, H.261	–
Network Text Editor – NTE	–	–	ASCII text
OpenH323	GSM FR (06.10), LPC-10, G.711 μ-law, G.711 A-law; also supports G.723.1, G.728, G.729 with appropriate hardware	H.261	–
Robust Audio Tool – RAT	LPC, GSM, WBS, G.726, G.711 PCM-A law, G.711 PCM-μ law	–	–
Session Directory Tool – SDR	–	–	SDP
Trondheim Underground Radio – TUR	MP3	–	–
Video Conference Tool – VIC	–	H.261, H.263	–
VideoLAN	MPGA, MP3, VORB, FLAC, SPX	MPEG-1,-2,-4 and H.263	–
Whiteboard – WBD	–	–	PostScript, text

TABLE VIII. PROTOCOL SUPPORT

Name	Transport and application protocols	Session management
Digital Video Transport System – DVTS	RTP/UDP	no
GnomeMeeting	UDP/TCP, RTP/RTCP	H.323
Icecast	UDP/TCP, RTP/RTSP	no, but there exists an alternative solution with liveCaster application
ISABEL	TCP/UDP	SIP, H.323
MPEG4IP	RTP/RTCP, RTSP, UDP	SIP
Network Text Editor – NTE	UDP	SIP, SAP
OpenH323	UDP/TCP	H.323 stack
Robust Audio Tool – RAT	RTP/RTCP, UDP	SIP, SAP
Session Directory Tool – SDR	UDP	SIP, SAP
Trondheim Underground Radio – TUR	UDP, RTP/RTSP	no, but there exists an alternative solution with liveCaster application
Video Conference Tool – VIC	UDP, RTP/RTCP	SIP, SAP
VideoLAN	UDP, RTP/RTCP	SIP, SAP, SLP
Whiteboard – WBD	UDP	SIP, SAP

TABLE IX. MULTICAST SUPPORT

Name	Multicast support	Special multi-point server
Digital Video Transport System – DVTS	yes	–
GnomeMeeting	no	yes, Internet Locator Server (ILS)
Icecast	no	yes, liveCaster
ISABEL	yes	–
MPEG4IP	yes	–
Network Text Editor – NTE	yes	–
Robust Audio Tool – RAT	yes	–
Session Directory Tool – SDR	yes	–
Trondheim Underground Radio – TUR	no	yes, liveCaster (only for IPv4)
Video Conference Tool – VIC	yes	–
VideoLAN	yes	–
Whiteboard – WBD	yes	–

The biggest disadvantage of this approach is that this solution is not integrated – meaning that each single tool must be downloaded, installed and configured for itself, which may not be acceptable for "average" and/or non-technically inclined Internet users. From that point of view, GnomeMeeting seems a better solution since it integrates desktop audio/video conferencing capabilities with text messaging in a single tool. Unfortunately, we were unable to test multi-user conferences (three users or more) nor the use of a session management tool, so definitive conclusions could not be made.

IV. CONCLUSIONS AND FUTURE WORK

In this paper, we presented comparison criteria and functionality testing scenarios, as well as a survey of open source and free desktop conferencing and media streaming tools with IPv6 support. We describe our limited experiences with selected tools in an experimental IPv6 network with equipment and compatibility constraints.

Our early results show that tools for multimedia applications with IPv6 support are still relatively scarce and mainly being developed by porting the existing software to IPv6. As this development is not coordinated, the tools were found to be in different stages of development, varying availability, and dubious stability. Development in open-source community is mostly directed towards Linux and Microsoft Windows platforms. As for codecs and protocols, all the tools we found are based on standards, which is a prerequisite for interoperability. It is also worth mentioning that most of the tools provide multi-user support, either by using native IP multicast or by way of a special multi-point server. In general, availability of software and documentation vary. Our future work will be geared towards testing under Linux, as well as addressing interoperability over various tools and platforms.

ACKNOWLEDGEMENT

This work was partially supported by the Croatian Academic and Research Network – CARNet under project number 95-100-503. The functionality testing was performed by our students Dalibor Budimir, Željka Čivčija, Goran Kmetski and Rajko Kovačević, and their contribution is hereby gratefully acknowledged.

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