Multipresence: towards videoconference and collaboration in multi-use environments

Valter Roesler[1], Luiz Eduardo de Souza Coelho[2], Guilherme Longoni[1], André Marins[2], Leonardo Crauss Daronco[3], Leandro Ciuffo[2], Renato Duarte[2]

[1] Federal University of Rio Grande do Sul (UFRGS),
[2] Brazilian Research and Education Network - Rede Nacional de Ensino e Pesquisa (RNP),
[3] Mconf Technology

E-mails: roesler@inf.ufrgs.br (+55-51 3308-6167); luiz.coelho@rnp.br; guilhermelongoni@gmail.com; amarins@rnp.br; daronco@mconf.com; leandro.ciuffo@rnp.br; renato.duarte@rnp.br

Paper type

Technical Paper.

Abstract

The objective of this paper is to present an architectural and technological view of a new video conference and collaboration system called "Multipresence", which adapts to various physical environment settings and enables the interoperability of various technologies.

The Multipresence system allow interoperation of many technologies to comply with a multitude of devices and communication standards, such as the following:

- Telepresence room in high definition (Full HD).
- Ultra-telepresence room in ultra-high definition (UHD 4K).
- Content sharing among the participants (simultaneous upload, rearrangement and visualization of images, texts and applications)
- Legacy videoconferencing systems.
- High definition videoconferencing through a personal computer application program.
- Web conferencing (web browser).
- Mobile devices and SIP phones.

There is a video demonstration of the Multipresence system with English subtitles at https://www.youtube.com/watch?v=lud2KwzstCM. This video was shot during an event called *Forum RNP* (RNP is the Brazilian NREN and one of the sponsors of the project), in august, 2015.

Keywords

Multipurpose rooms; remote collaboration; mobile conferencing; web conferencing; telepresence.

1. Introduction

Regarding the physical space, meeting rooms, as well as classrooms, can be transformed in multimedia spaces that foster collaboration. Computers, projectors, large displays, videoconference systems and wi-fi networks are examples of IT infrastructures commonly used in modern rooms. Active Learning spaces are changing the design of classrooms (Finkelstein, 2015), and new ideas are flourishing to allow collaboration and interaction as well as plenary talks. Figure 1 shows one of these new designs from University of Windsor (Finkelstein, 2015).

Figure 1 – New designs in classrooms allowing interaction and collaboration.

However, the investment to transform a traditional classroom in a digital learning space must be spent efficiently to justify the invested resources. The cost of any physical space depends on how often it is used. Keeping an idle physical structure has a high associated cost.

The interoperation of many technologies proposed by the multipresence system enables different applications in the same room, like local and remote classes, local and remote group dynamics, meetings in U, board meetings, among others, as seen in Figure 2. Each application has its own communication demands in terms of quality, interoperation and collaboration. We will discuss the physical as well as the technological view to create such a space.

Figure 2 - Different uses for the proposed room.

1.1. Physical view of the room

Physically, one must have the possibility to move chairs, computers and monitors in the room, as well as power and data outlets (if needed), in order to compose multiple environments. Figure 3 and Figure 4 show examples of possible configurations, where one can observe the flexibility to move furniture, electrical and logical.

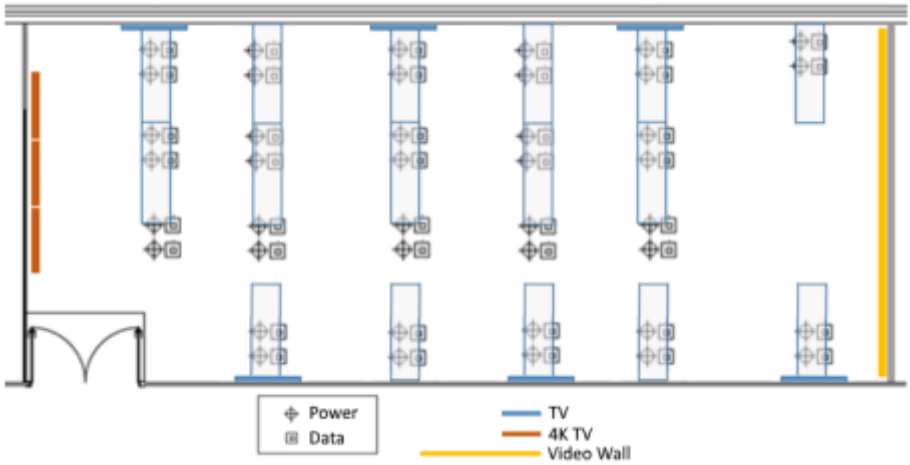

Figure 3 - Multi-purpose room configured for classroom

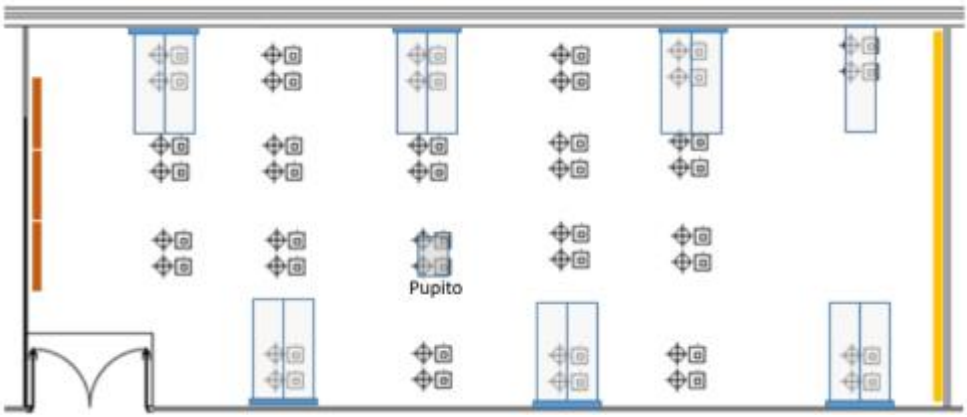

Figure 4 - Multi-purpose room configured for group dynamics

1.2. Technological view of the system in the room: the Multipresence solution

The multipresence system architecture allows the inclusion of equipment in a modular way, which can range from a simple TV, notebook or mobile device, up to the model presented in Figure 5, which shows a specific configuration integrating telepresence, videoconference room, web conferencing and slide presentation, where the focal point is a surgery in ultra-high definition. Figure 6 shows other configuration where the focal point is a SAGE2 collaboration environment[1], with a 4K TV showing some reference images for the meeting or class.

Figure 5 - Configuration with multiple displays with a 4K television in the center

[1] Scalable Amplified Group Environment (www.sagecommons.org)

Figure 6 - Configuration with a video wall plus a 4K television

The High Definition communication is performed through a software module called "PRAV Player", being an evolution of a mature surgical room project already developed by the PRAV laboratory at UFRGS. This project is called MIR (Multimedia Integrated Room) (Roesler, 2014), (Klinger, 2014).

The webconference module is also responsible for the integration with mobile devices (Android and iOS), SIP phones and legacy videoconferencing room systems. This module is called "Mconf", and is also developed by the PRAV laboratory at UFRGS in partnership with BigBlueButton (Roesler, 2012a, 2012b, 2013a, 2013b, 2013c).

The content sharing module, which allows simultaneous upload, rearrangement and visualization of images, texts and applications, was created through an integration of the Multipresence system with the open source collaboration system SAGE2 (Sage, 2015), developed by the Illinois and Hawaii Universities.

The tablet control interface is developed by PRAV laboratory as part of the Multipresence system, with a great focus on usability.

It is important to say that the display configuration is very easily changed according to the specific profile to be used in the room. Figure 7 shows three different examples, where each square represent a display (TV or monitor), and the number inside the square represents a running application (collaboration with SAGE2, web conference with Mconf and High Definition videoconference). So, for example, if the meeting focus is collaboration, maybe the center profile is more adequate. The remote participants can be in similar rooms (with the same or different number of displays), in computers, in mobile devices, in legacy conference rooms, and so on. To change from one profile to another takes less than 10 seconds.

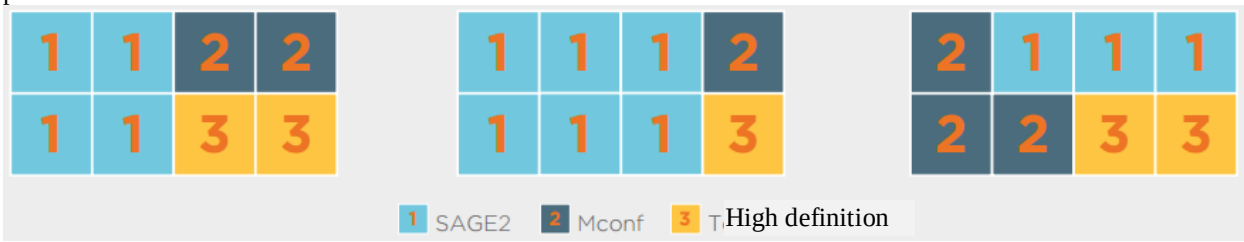

Figure 7 – Three different display configurations according to the meeting

2. Multipresence software

The Multipresence architecture is depicted in Figure 8, and consists of an application with a very simple user interface running on a tablet, a *Process Manager* that runs in background on each PC in the room, and opens and closes the desired view in each TV according to the selected profile, and a webservice, that keeps the entire system synchronized. The system counts also with a *message server* and the applications (*PRAV Player*, *Mconf*, *SAGE2*, etc).

Using the tablet, the user is able to turn on and off the entire system, change the profile, make a call to another Multipresence room, videoconference system or Mconf meeting, and control each display.

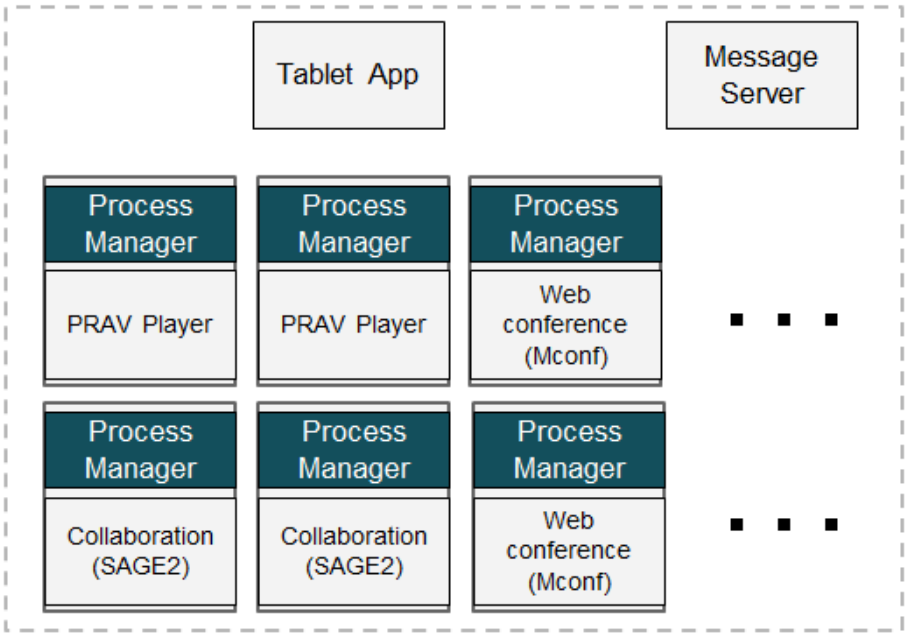

Figure 8 – Main entities of the architecture

The message server interacts with all applications and controls them in order to:

- Send a chat message to a web conference meeting
- Select which videos will be exhibited in the web conference display
- Control the SAGE2 panel
- Upload content to SAGE2 panel
- Volume control
- Camera preset selection
- Set the quality and bandwidth of the PRAV Player transmissions
- Among others

The application *PRAV Player* and the *Process Manager* are developed in *C++*. The Tablet interface is a web application, and the server uses two frameworks: *Ruby on Rails* to generate the tablet views and interact with the database, and *Node.js* to orchestrate the solution using message exchange. The Mconf-Live, the system responsible for the web conference, is based on flash, but there is an ongoing development in order to change it to use WebRTC.

Regarding licensing and Intellectual Property, as the system is an integration of other projects together with new developments, it inherits some different types of licenses. Mconf and PRAV Player are both part open source and part closed source. SAGE is open source. The offering of the system as a service or a product will be defined in the future.

3. Preliminary results

In august of 2015 a prototype of the solution was presented during the event "Forum RNP", in Brasilia, Brazil. The results showed clearly the great potential of the system. Figure 9 shows the demonstrated video panel. The four displays on the left were, at the instant when the photo was taken, showing the SAGE2 collaboration panel with logos, images and applications being exchanged between Brasilia and Porto Alegre, 2.000 km away. The two displays on the bottom right showed the high definition videoconference between Porto Alegre and Brasília. The two displays on the upper right showed the integration with the Mconf web conference system, with the display on the left showing two videos (one from a user in a tablet and another from a user in a laptop) and the display on the top right showing the slides of a presentation. The big TV on the far right showed a real time transmission in ultra-high definition (also known as 4K) from Porto Alegre, where a YUV file of 3Gbit/s was compressed in real time to about 20Mbit/s and sent to Brasilia.

Figure 9 – Multipresence Panel, during the event Forum RNP 2015

Figure 10 shows the same setup during another moment where the video panel was configured to a different layout. In this case, SAGE2 was in three displays (the three on the upper left), Mconf was also in three displays, two of them showing videos (on the bottom left) and one of them showing the slides presentation (on the upper right). One of the two displays with Mconf was showing the complete video mosaic, and the other showing only one video enhancing one participant (in this case the red shirt guy participating using his laptop). The 4K video being transmitted was showing a microscopic image of an ocean drop and the microorganisms inside it (courtesy of CineGrid Exchange repository). The two displays on the bottom right of the panel continued to show the high definition videoconference with Porto Alegre.


Figure 10 – Multipresence Panel, during the event Forum RNP 2015

The videoconference quality was excellent, compatible with a telepresence room. The configured bandwidth was about 4Mbit/s each high definition video, and this rate could be decreased without considerable quality loss. Figure 11 shows one moment of the videoconference. The delay was imperceptible, in the order of about 150 ms.

It is important to notice that the remote locations were both connected to RNP's backbone, a high speed network that connects several R&E institutions in Brazil. This network has bandwidth enough to allocate all high definition and ultra definition streams, even though it is a shared network used by institutions across the country. Remote

participants using more restricted networks would still be able to connect to the system, advisedly via web conference or mobile devices using commercial 3G networks.

Figure 11 – Details of the High Definition videoconference in two TVs

4. Final remarks and future plans

This paper presented a low cost telepresence system called Multipresence, which is able to easily reconfigure a video wall with arbitrary size (number of displays) to many different configurations. The innovation promoted by the system is the modularity and ubiquity offered, which is not seen in similar systems. With it, 4K communication systems can interact with telepresence rooms in full HD, with room systems, stand-alone computers via web conferencing in low-speed networks and mobile devices. The room can be reconfigured quickly and easily to accommodate different collaboration environments, optimizing space and allowing better use of resources.

The project is right now in a pilot phase, being deployed in eight institutions from north to south of Brazil. Three institutions are health institutions (one Cancer Institute, one Hospital and one Medicine School). Two are Universities, two are private companies and one is a large government communication enterprise. The pilot objective is to simplify and improve the interfaces and prepare the system for production. Up to the end of this year there will be the assessment of the study cases and we plan to discuss the results in future works.

Acknowledgements

This work is being funded mainly by RNP (National Education and Research Network), the Brazilian NREN, through the WG (Working Groups) programs, and Mconf Technology. The high definition software of the base system was funded by FINEP (Financing Agency for Studies and Projects).

References

FINKELSTEIN, A. and WINER, L. (2015) *Bigger Can Be Better: Designing Large Classrooms to Support Active Learning*. In Educause 2015, Indianapolis, IN.

ROESLER, V. et. al. (2014) *MIR: A Low Cost Digital Operating Room*. In IEEE Healthcom 2014, Natal, RN, Brazil. 16th International Conference on E-health, Networking, Application & Services.

KLINGER, A et. al. (2014) *A Low Cost Digital Operating Room*. In: SAC: Symposium On Applied Computing, 2014, Gyeongju, Korea. 29th Symposium On Applied Computing.

ROESLER, V. et. al. (2013a) *Mconf: collaboration proposal to form a global infrastructure for web conferencing based on open source*. Proceedings of the Asia-Pacific Advanced Network, v. 35, p. 28, 2013.

ROESLER, V. et al. (2013b) *Mconf: a global web conferencing network based on open source and collaborative work*. In: Techs In Paradise, 2013, Honolulu, HW. TIP 2013: Techs In Paradise, 2013.

ROESLER, V. et. al. (2013c) *Interoperable multi conferencing technology as a basis for an open, global web conferencing network*. In Proceedings and report of the 6th UbuntuNet Alliance annual conference.

ROESLER, V. et. al. (2012a) *Mconf: towards a global webconference system*. In: TERENA Networking Conference, Reykjavik. TNC 2012.

ROESLER, V. et. al. (2012b) Mconf: An Open Source Multiconference System for Web and Mobile Devices. Edited by Ioannis Karydis. (Org.). *Multimedia - A Multidisciplinary Approach to Complex Issues*. 1ed.: , 2012, p.

1-27.

SAGE (2015) *Electronic Visualization Laboratory, University of Illinois at Chicago; Laboratory for Advanced Visualization & Applications, University of Hawai'i at Manoa. SAGEnext: Next Generation Integrated Persistent Visualization and Collaboration Services for Global Cyberinfrastructure*. 2015 Si2 PI Workshop Forum, National Science Foundation. February 17, 2015.

Biographies

Valter Roesler has a Bachelor´s degree in Electrical Engineering (1988), Master's degree (1993) and PhD degree (2003) in Computer Science. Today he is a professor at the Federal University of Rio Grande do Sul, Brazil. He has experience in Multimedia, Digital TV, Video Encoding, e-Health and Network Monitoring. He coordinates the PRAV laboratory (Projects in Audio and Video) – www.inf.ufrgs.br/prav, with about 30 researchers and projects related to Remote Education and e-Health, in traditional computers and mobile devices. He is the coordinator of the Multipresence project.

Luiz Eduardo de Souza Coelho is with RNP (National Education and Research Network). He is the director and national coordinator of Superior Network Training Institute (ESR). He has Professional degree in Project Management from IAG/Master of PUC/Rio and Bachelor's degree in Data Processing from Pontifical Catholic University of Rio de Janeiro.

Guilherme Longoni is the project manager of the Multipresence solution at Federal University of Rio Grande do Sul (UFRGS) in Brazil. From 2011 to 2014 he worked as software developer in MIR project (Multimidia Integrated Room), working with low latency Full-HD surgery transmissions. He is a computer science student at UFRGS.

André Marins is graduated in Computer Engineering at Pontifícia Universidade Católica do Rio de Janeiro – PUC-Rio (1996), with MBA in Executive Management at IBMEC Business School (2001). MSc in Computer Science from PUC-Rio (2008). IT Manager at Cadê (1996-1999). IT Manager and Director at Starmedia (1999-2002). IT Consultant at Vogal (2003-2006). IT researcher at TecGraf, PUC-Rio (2007). R&D project manager at RNP since 2008.

Leonardo Crauss Daronco has a Master's degree in Computer Science from the Federal University of Rio Grande do Sul (UFRGS), Brazil (2009). He has experience in multimedia, video encoding, software development and web development. He's a technical leader of the Mconf project since its beginning (2010). In early 2013 he co-founded Mconf Tecnologia, a Brazilian company that provides professional services on top of Mconf and related technologies.

Leandro Ciuffo is Manager of Research and Development projects at RNP. Since 2011 he works with user engagement in the scope of the FIBRE Future Internet testbed. He also coordinates the RNP's R&D Programme on Advanced Applications for Remote Visualization, which includes streaming of ultra-high-definition media. From 2006 to 2009 he worked with Grid Computing and e-Science projects at INFN-Catania (Italy), being responsible for dissemination and user support activities. Leandro holds a M.Sc. in Computer Science from the Federal Fluminense University (UFF) in Brazil.

Renato Duarte started working at RNP (National Education and research Network) in 2006 and he has worked as IT Coordinator there since 2013. He works in the educational technology area. He graduated in Computer Science at Unicarioca in 2006. He specialized in IT Project at UFRJ.