

Adaptation of Multisource Video Streaming in Heterogenous Environment of National Telepresence Infrastructure with Advanced Elements of Processing Visual Recordings to Multimedia Archive

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Abstract—Paper deals with the implementation of video streaming from multiple sources with integration of multimedia archive of stream and videoconference recordings. The overall chain for multisource livestream ability in web environment will be described related to interconnection from processing the various inputs from video source encoder (cameras, room systems or also UAV), via transportation of stream through streaming server, delivering live video on web-based player to viewers and processing the recording in archive. All these functions were implemented in the resulting integrated portal in real heterogenous environment of large National telepresence infrastructure (NTI) partially located on Slovak Academic Network (SANET).

Keywords— Video streaming, Multimedia archive, Videoconferencing, Telepresence infrastructure

I. INTRODUCTION

Currently there is a huge demand for livestreaming services not only in e-learning [1] and related applications [2] but also in industry adaptation [3]. To prove a proper functions of modern video streaming concepts it is appropriate to adapt and test them on large heterogenous infrastructure. We can find such a large heterogenous environment in Slovak's National telepresence infrastructure to support research, development and technology transfer. NTI was originally created under Slovak Centre of Scientific and Technical Information in 2015 [4] and now it has many challenges and till now has many challenges how to adapt 7 years old infrastructure to rapid technologies changes, compatibility restrictions [5] and overall remote communication [6] expectation during or after COVID. During the existence of NTI it provides videoconferences for more than hundreds of thousands connections, realized almost thousands of managed livestreams and provides thousands of recording to hundreds of thousands viewers.

The previous work on NTI was focused on balanced distribution of infrastructure, critical nodes identification

and creating a new booking solution. To integrate a necessary functions not only for mentioned previous methods but in further activities for a modern video streaming with multimedia archive a new NTI portal solution was developed from a scratch.

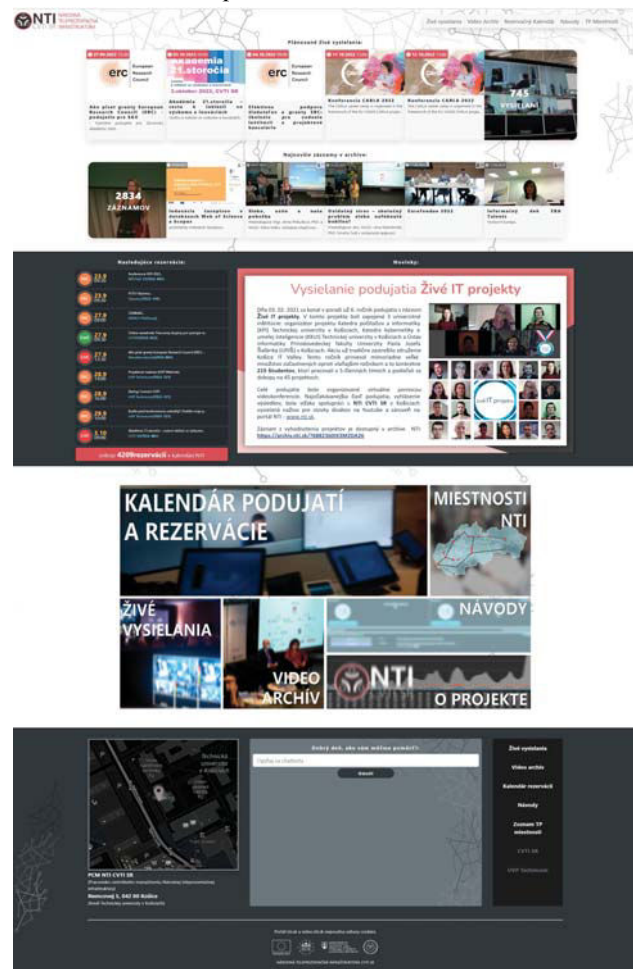


Figure 1. Homepage of new NTI portal

As you can see on Fig.1 the introduction section of NTI portal is the first crossroad for NTI services users showing the next five upcoming livestreams, last five archived video recording in multimedia archive, upcoming videoconference reservations, navigation, contacts, chatbot etc.

II. IMPLEMENTATION OF NEW NTI LIVESTREAM AND MULTIMEDIA ARCHIVE FUNCTIONS

Transformed NTI solution with enhanced compatibility and innovated booking of infrastructure sources is still connected to the original parts of former database created in 2015 to preserve old API integration with outdated but still functional telepresence devices. To follow up with the development of new NTI portals, we designed a components for video livestreaming and multimedia archive, that are interconnected via extended database and overall communication with efficient streaming and videoconference resources distribution mechanism was handled (Fig. 2).

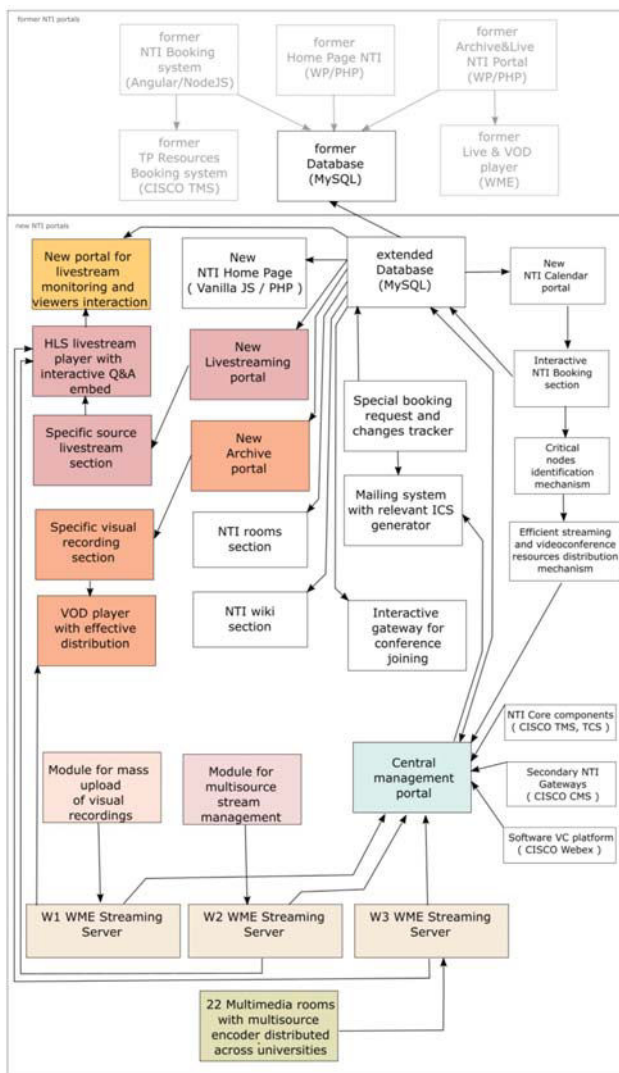


Figure 2. Interconnection of new NTI portals components for video streaming and multimedia archive

Design of the video streaming function is based on developing livestreaming portal section with subsection

for providing specific video source details with integration of HLS livestream player. Web-based HLS player was designed with interactive layer for Q&A, which will transfer the text interaction to the livestream monitoring and viewers interaction section. Livestream processing chain was designed using 2 clustered Wowza Media Engine streaming servers (W2 and W3). W2 is able to process live video feeds from various livestream encoders such as FFMPEG, FMLE or enhanced solutions like Open Broadcaster Studio or vMIX with connection of various type of video capturing devices with camera, screen output, UAV video feed etc. Module for multisource stream management was designed to manage the source authentication and stream identification for W2 distribution mechanism. W3 is designed to handle livestream from integrated RTP and RTMP hardware encoders in room systems in 22 big room halls of main Slovak's universities on SANET network originally installed in NTI in 2015.

Design of multimedia archive section is based on subsection with specific visual recording screen containing related recordings and information with integrated VOD web-based player with effective mp4 source distribution. Visual recording processing and distribution was designed using VOD instance of W1 streaming server.

Resulting implementation of livestream section showing upcoming livestreams in infrastructure and list of previously realized with interconnection to archive can be seen on Fig. 3

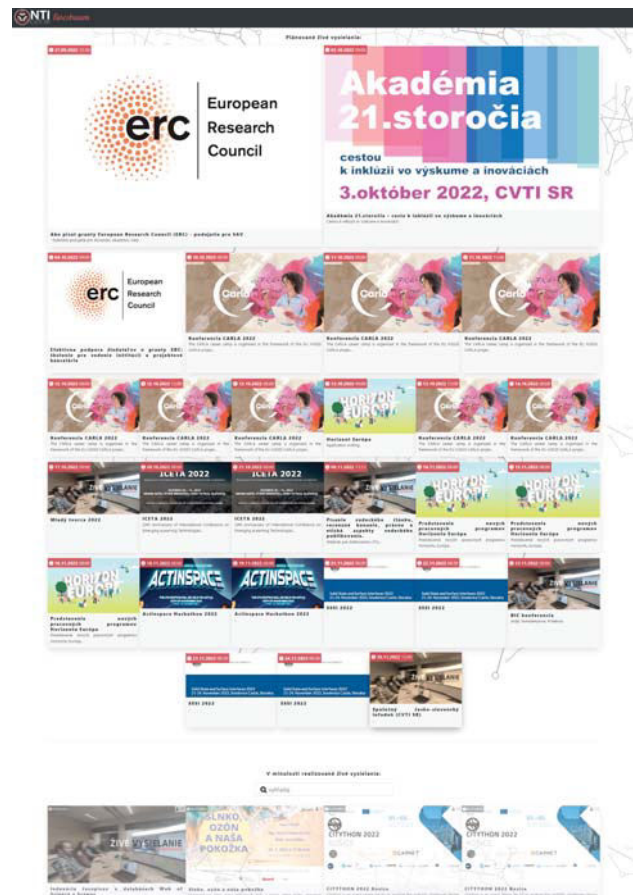


Figure 3. NTI Livestream section with upcoming livestreams

Subsection for specific video source stream delivery (Fig. 4) contain the embedded layer for viewers for various text interaction in form of viewers name collection or writing questions directly to the livestreamed channel. Under the hood there is customized Video.JS HLS player interconnected to W2 and W3 streaming servers playing the specific video source stream. Custom module for stream availability was developed with ability to dynamically check if the stream source is ready and automatically play or pause stream independently of his current state without need of page refresh. From the sight of livestream viewers there can be defined various additional information beside name and description of broadcast such as link to the conference agenda, participant registration etc.

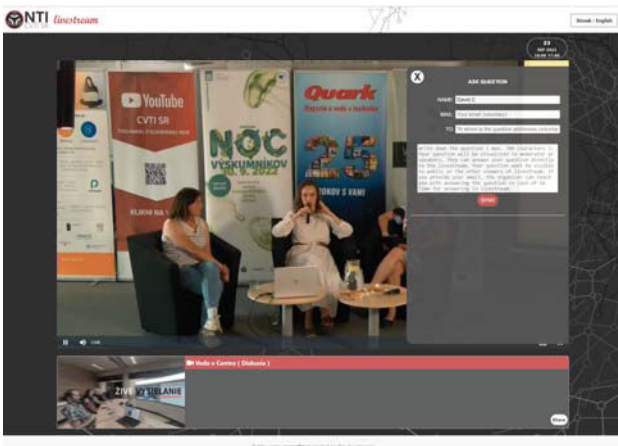


Figure 4. Subsection for specific video source delivery with embedded Q&A layer

Additional authentication was deployed on section for moderators (Fig. 5) to see a live statistic in form of list of viewers with names and time of connection to livestream. In this subsection there is also queue for dynamically showing live question form the livestream remote audience with ability to hide the answered ones. Statistics of specific livestream can be also exported in form of csv with livestream viewers list and all Q&A for live feed.

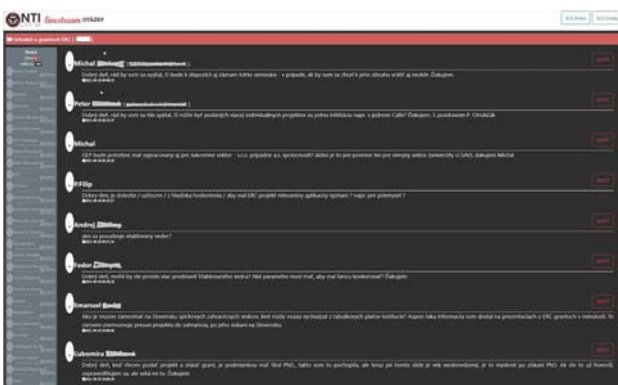


Figure 5. Subsection for moderators of specific livestream with live viewers list and live questions feed.

Resulting implementation of multimedia archive section (Fig. 6) showing the last video recordings in from of thumbnails, tag cloud with video categorization and the most viewer video chart.

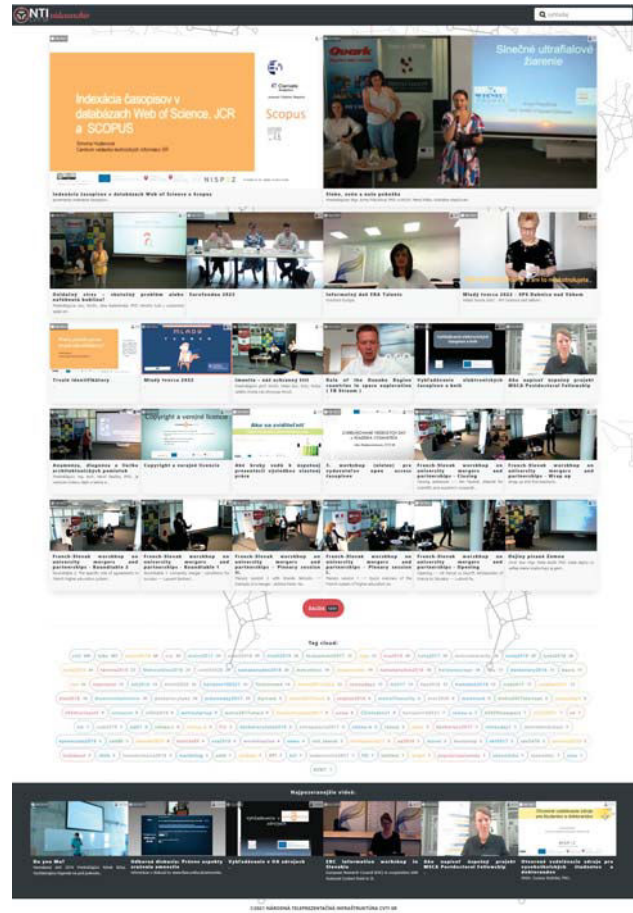


Figure 6. Multimedia archive section with last video recordings

Subsection for specific visual recording delivery (Fig. 7) content integrated VOD web-based player based on Video.JS interconnected with WME instance of W1 streaming server. Subsection also contains the related video content recommendation.

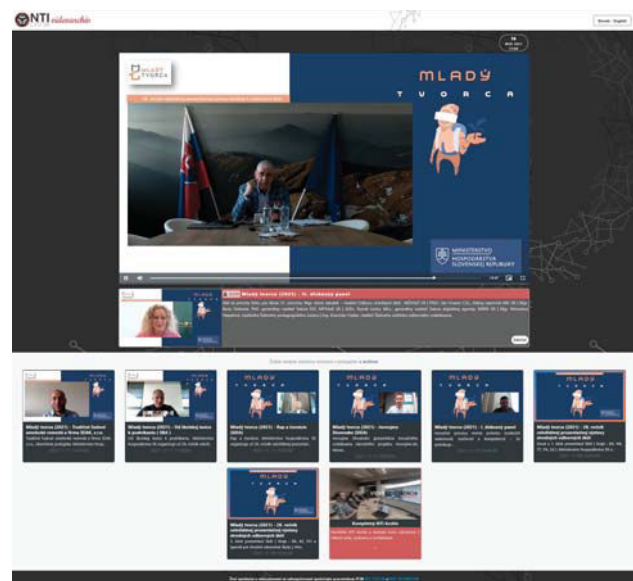


Figure 7. Subsection for specific visual recording delivery with VOD player and related content

III. MULTISOURCE LIVE STREAM ON NTI RESOURCES AND MASS UPLOAD IN MULTIMEDIA ARCHIVE

Management of streaming source can be realized via custom module for stream source binding in managerial section of NTI portals (Fig. 8). This module is handling interconnection of source to link with subsection for playing with HLS player for viewers and also with link for interactive Q&A feed for moderation. Live stream source binding can be defined as RTMP stream with instance and stream name definition of W2 or W3 Streaming servers. Also, there is possibility to define numbers of expected livestream viewer for effective resources distribution, public or private visibility of stream or visibility of Q&A layer over the livestream window.

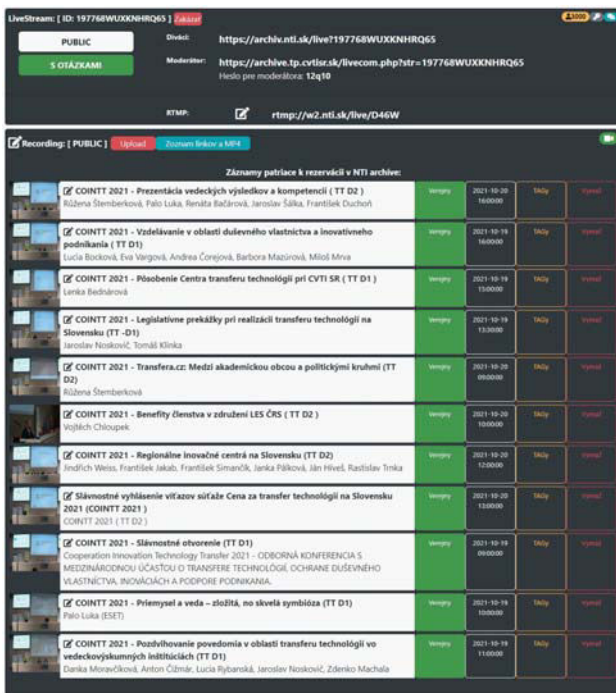


Figure 8. Managerial section with modules for live streaming sources definition and visual recording in archive processing.

Beside the streaming source control in the managerial section there is also ability to manage visual recordings processing and appearance in multimedia archive. Recording modules were implemented on WME streaming server cluster W2 and W3, where all live streamed content is also recorder. In case additional visual processing of resulting videos there is necessary to upload new content with persisting the binding to original live streamed source. For this reason, a mass upload module (Fig. 9) for visual recordings was implemented with ability to upload large number of tens of gigabytes files by chunking method with showing progress of uploading.

After uploading processed videos can be completed with additional information such as name, description, date, categorization tags or public visibility. Easy distribution of mass uploaded processed visual recordings related to specific live streamed event is handled by generating the list of multimedia archive links or direct links to mp4 files of processes recordings.

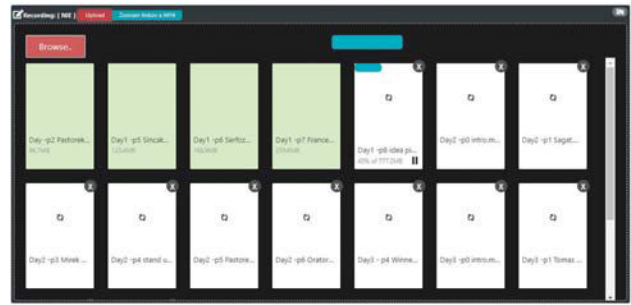


Figure 9. Implementation of mass upload module.

Various scenarios of multisource streaming adaptation were verified on NTI platform. From standard streaming from video capture cards with connected cameras, live streaming from RTP/RTMP encoders in large room multimedia systems to specific live stream simulation from UAV video feed. One of the realized multisource live stream adaptations was tested using 3 simulated UAV video feeds (Fig. 10) based on 3 microcomputers with camera running FFMPEG instance for RTP stream distribution to W2 streaming server.

Middleware video mix platform was used to monitor and process multiple RTP stream sources to 3 simultaneously RTMP streams transporting broadcast back to the W2 server in standard live instance. On the W2 streaming server side there was transcoder to transform RTMP to proper HLS output to live stream section of NTI portal. Another multisource stream adaptations were realized by using NGINX HTTPS live streaming or with OBS middleware.

These multisource simulation with video mix middleware were very helpful for processing the video feeds and transferring to another computer vision application based on advanced gesture recognition [7]. Also it was tested by using as multisource video inputs for object size estimation methods [8] based on various human description formats [9] connected to external devices [10]. Another example is using UAV multisource stream with implementing methods for human face detection algorithms [11].

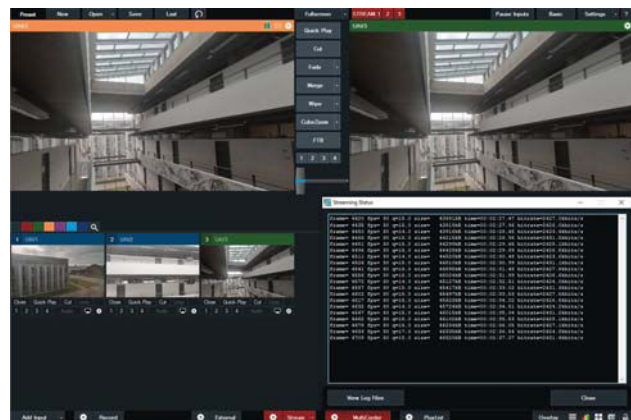


Figure 10. Multisource live stream from 3 simulated video sources from UAV interconnected with W2 streaming server

IV. CONCLUSION

Resulting implementation of multi-source video live streaming with advance elements of processing video recording in multimedia archive was deployed and tested in real National telepresence infrastructure environment. This large heterogenous infrastructure based on combination of communication and streaming devices from different vendors on different networks distributed over Slovakia with thousands of broadcasts realizations and thousands of visual recordings archive was proper environment for validate the concepts.

New version of NTI portal now disposes a fully functional section for livestreaming realization scaled to thousands of viewers with interactive elements for viewers feedback and also section for categorized multimedia archive with effective visual recordings delivery. Implemented managerial modules provide enhanced abilities for stream source definition and visual recordings process. Further work will be focused on improve the managerial section of NTI portals and creating one-point management place for monitoring and altering booking resources, livestreaming distribution, or multimedia archive's recordings processing.

ACKNOWLEDGMENT

This publication was written thanks to the generous support under the Operational Program Integrated Infrastructure for the project „Research in SANET network and possibilities of its further use and development“, Project No. 313011W988 (60%) and the project "Research Centre for Data Analysis and Data Protection - Stage II", Project No. 313021W479 (20%) and the project "Intelligent operating and processing systems for UAVs", Project No. 313011V422 (20%), co-financed by the European Regional Development Fund.

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