

# Interactive Transmissions of Medical Live Cases

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SITOLA



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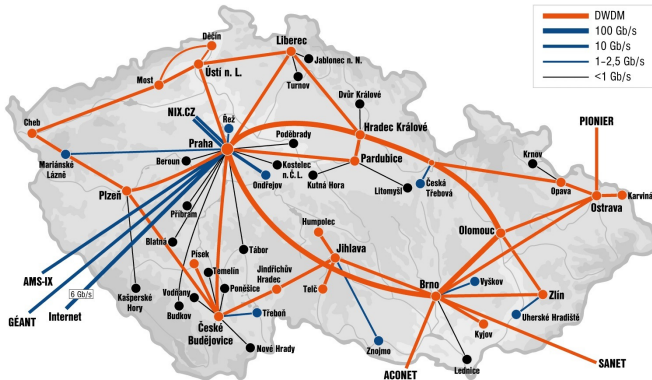
## CESNET Introduction

- CESNET, Association of Legal Entities, was established in 1996 by the Czech universities and Academy of Sciences
- Non-for-profit organisation oriented to major activities:
  - Development and operation of NREN in the Czech Republic – to support science & research (non-public operator)
  - Research and development of advanced network technologies and applications
  - Broadening knowledge about the advanced networking topics
  - International cooperation
    - ◆ Participation in projects - GN3+, GLIF, EGI (European Grid Infrastructure) and many others
    - ◆ Dante shareholder, TERENA member, Internet2 affiliate member, CEENet member



# Network Communication Infrastructure

- Advanced DWDM optical and IP/MPLS infrastructure (connected to GEANT, GLIF)
- IP Connectivity, Dedicated circuits, Lambda services, Photonic services, Eduroam



# UltraGrid Platform

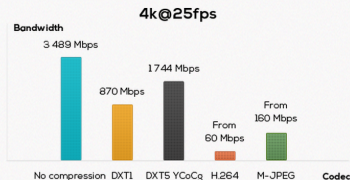
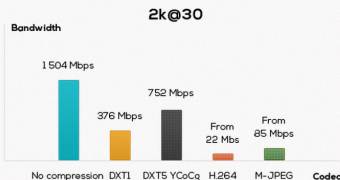
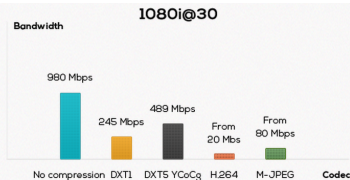
- Technology
  - an affordable platform for very high-quality interactive video (up to 8K) and audio transmissions
  - use of commodity (gaming) hardware
    - ◆ Linux and Windows PC and Mac OS platforms
    - ◆ commodity video capture cards
    - ◆ commodity GPU cards
    - ◆ commodity sound cards
    - ◆ any reasonable network
  - as low latency as possible on commodity hardware
  - open-source software, BSD (GPL) license
- Community, user support

# Networking

- UDP/RTP based transport
- Custom RTP extension (backward compatible) to allow for e.g., autoconfiguration of receiving UltraGrid
- Forward Error Correction
  - Low-density Generator Matrix LDGM
    - ◆ CPU and GPU implementations
    - ◆ packet loss up to 10% can be mitigated with reasonable overhead
    - ◆ can make JPEG survive up to 25% packet loss
  - Reed-Solomon codes

# Bandwidth Requirements

*See the measured bandwidth including overhead with 9000B Ethernet frames. Uncompressed signal was 8-bit YUV422.*



## Compression Performance

- Compression throughputs (Intel® Core™ i7-4960X CPU @ 3.6GHz (6 cores), NVIDIA GeForce GTX 960 GPU (Maxwell))

| <i>Compression Type</i> | Highest Achievable Resolution/Framerate |
|-------------------------|-----------------------------------------|
| RTDXT:DXT1              | 4K 60 fps                               |
| RTDXT:DXT5              | 4K 60 fps                               |
| GPU DXT                 | 4K 60 fps                               |
| GPU JPEG:90             | 4K 120 fps or 8K 30 fps                 |
| H.264 (ffmpeg)          | 4K 30 fps                               |
| H.265 (ffmpeg)          | 4K 24 fps (almost)                      |
| H.264 and H.265 (NVENC) | 4K 60 fps                               |

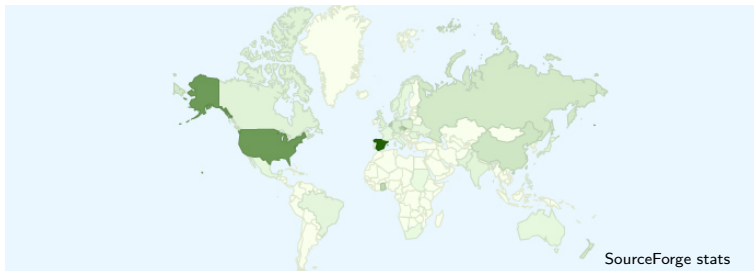
Table : Compression throughputs.

# Latency

- End-to-end latency (capture to playback) in local network
  - <150 ms for interactivity: ITU-T rec G.114
- latency depends on capture/playback HW (and framerate and compression):  
1.75–5.5 frames (30–183 ms)



## Users Worldwide



- Distribution
  - source, binaries (<http://www.ultragrid.cz/>, SourceForge)
  - embedded in SAGE (<http://www.sagecommons.org/>)
- Installations around the world

JISC, Kònic Thtr Barcelona, Artanim Interactive, Hochschule Bon-Rhein-Sieg, SFJAZZ, University of Nevada Las Vegas, TU Munchen, Arantia Research and Development, NTT, Laboratory of Computer Networks and Architecture Universidade de Sao Paulo, Hospital for Special Surgery, I2Cat, Dogan TV, Rochester Institute of Technology, Digital Film Central, Aalborg University, Polish Public TV, Greyslake Community High School District 127, New World Symphony, NYSERNet, Università Politecnica delle Marche, EVL, PSNC, The Arctic University of Norway, Female Laptop Orchestra, Kent State University, Moving Forward Studios, FN Brno, Les Champs Libres, Telekom Malaysia R&D, Harvard School of Engineering and Applied Science, Exploratorium – The Museum of Science, Art and Human Perception, University of Southern California School of Cinematic Arts, NIH, US Dept. Of Health & Human Services, Music CSI High School for International Studies



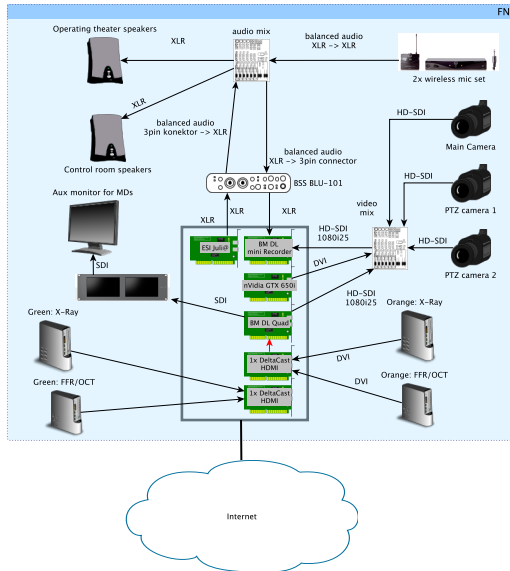
## Medical Live Cases Transmissions

- Multipoint transmissions from operating theatres in hospitals usually to medical congress w. audio/video backchannel
- Usually rather adverse hospital networks
- Trade off between bandwidth, video and audio quality and latency (interactivity)
- High demands on interactivity, video and audio quality
- Tons of audio/video equipment to handle

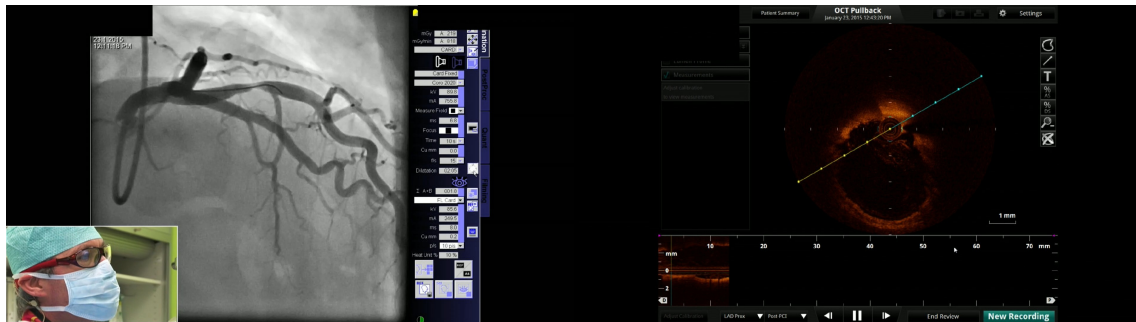
## Cardiology – Transmissions Characteristics

- Highly interactive
- Full HD (at least)
- Huge number of different modalities with different video signals
- Usually not very dynamic scenes

# Cathlab Setup

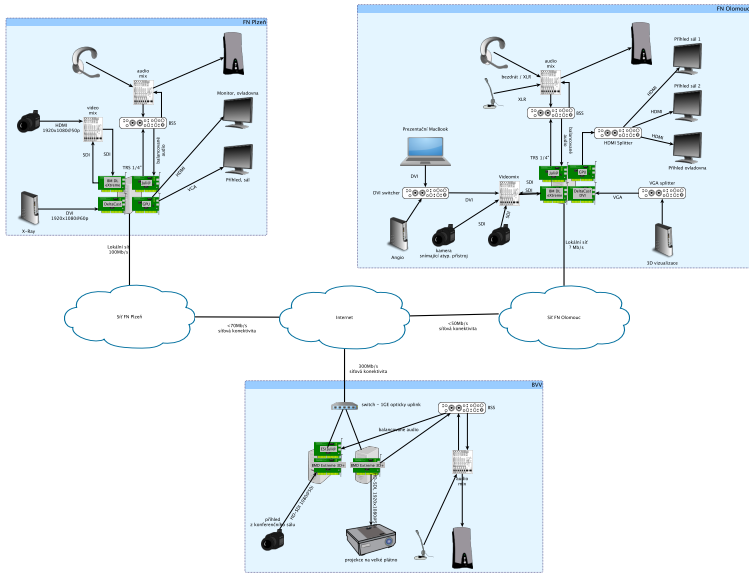


# Live Cardio Case Transmission



## Transmission Setup

- It can get much more complex ;-)
- We have been connecting up to 6 sites during one event

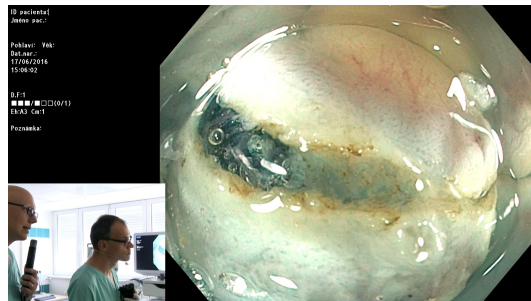
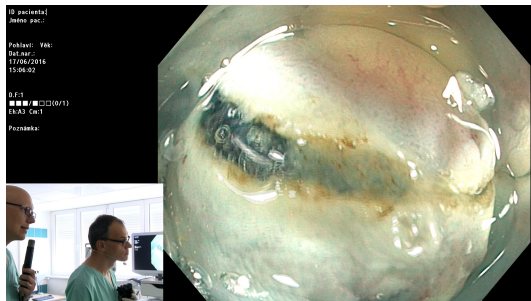


## Gastroenterology – Transmissions Characteristics

- Highly interactive
- Full HD
- Single camera + Endoscopic tower usually using standard video signals/connections
- Highly dynamic scenes
- Necessary to transmit the video signal from the endoscopic towers all the way to the projector unchanged

# Those "Weird" Signals

- Interlaced vs. progressive scan





## Transmission Setup



50 Mb/s public link





# What Does it Take to Implement High-quality Transmissions

- Commodity HW is cheap, much cheaper than e.g., HW videoconferencing equipment
- Network is ubiquitous, even in hospitals
- People



**KEEP  
CALM  
IT'S NOT  
ROCKET  
SCIENCE**

Thank you for your attention!

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