

Streaming Science Globally: CERN's Live Streaming Service

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April 2024

Presentation

Hi there! I'm René!

- Software engineer
- Working at CERN since 2015
- Working on Videoconference, Transcription and Translation and Web lectures services
- Currently Live Streaming Service
 Manager





CERN

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1. A bit of history: From 1999 to 2010

First CERN webcast website: 1999

- Real Media, QuickTime Server, • PHP
- **Apache Server** •
- Clicking links to open the player •

RealServer

Powered by php'







In 2010:

- Wowza Streaming Engine •
- Still PHP .
- Flash .
- Microsoft IIS (Internet Information • Services)



	Could not participate in CERN School of Computing 99 ? click here to find out more about the CSC99 webcast 1				
Webcaşt	Welcome !				
main	From here you will be able to watch live and archived webcasts, using RealNetworks streaming				
live	technology.				
about	From <i>archive</i> page you can browse our growing archive of webcasts or search for particular subject being of interest to you.				
news					
docs	The projects page will take you to some ongoing CERN activities related to streaming media				
projects	technology.				
archive	The <i>about</i> page will tell you more about this service and people managing it.				
	Our documentation page should explain how to watch archived and live webcasts, how these are				
	19				

Doo 100 Interested in modern Internet Software Technologies ?

- 🐼 CERN Document Server SEARCH SUBMIT CONVERT BULLETIN AGENDA WEBCAST LIBRARY
- WEBCAST SERVICE Welcome Home page What's on ? (lectures and events Archive Archived lectures Archived events Search Video Tapes Acad. Training Lect. Sum. Student Lect. See also Last Live Event Video Service LIVEfromCERN Videoconferencing Web Univ. Pilot Related sites

CERN Webcast Service Streamed videos of Archived Lectur Streamed videos of Archived Lectures and Live Events Welcome to the CERN Webcast Service! The CERN Webcast Service opens CERN lectures and seminars to universities, schools and to the general public.

This service allows you to watch live webcasts 'as they happen' or watch archived lectures at your convenience.

Recently recorded lectures and events (eg: recorded workshops, conferences or important talks) can be quickly found from our What's on rubrik. The complete collection is also available from the 'archive' links on the left menu

This site is dedicated to particle physics lectures that are recorded and put available on the Internet. You can find archived web lectures and live webcasts through our site. Currently, we are using mainly RealNetworks media streaming technology.

Specific searches for CERN Academic Training or Summer Student lectures can also be easily performed. Not all of them are actually encoded but CERN members can also consult or borrow the Video Tapes when available.

Finally, we also provide you with links to the last or current Live transmission and









1. Nowadays

✓ Wowza Streaming Engine
 FLASH - HLS (HTTP Live Streaming)
 IIS - Openshift
 PHP – Python and React



UPCOMING LIVE EVENTS



Measurement of D^0 D0-- \overline{D}^0 D0 mixing and search for CPCP violation with $D^0 \to K^+\pi^-$ D0 $\to K^+\pi^$ decays

by Roberto Ribatti

 $\ensuremath{\stackrel{\text{\tiny def}}{=}}$ Tuesday 26 Mar 2024, 11:00 \rightarrow 12:15 (Europe/Zurich)

◀ 500/1-001

Indico

More Information >



ATLAS Weekly by Manuella Vincter

Tuesday 26 Mar 2024, 14:00 → 15:40 (Europe/Zurich)

4 40/S2-C01



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2. Architecture



2. Architecture in a nutshell





2. Architecture Zoom In: Input and Encoders (1/2)

- Currently support for 21 CERN rooms integrated with Indico
- Input: SDI/HDMI
- Output: RTMP
- Encoders:
 - Epiphan Pearl Nano
 - Matrox Monarch HDX (phasing out)
 - Matrox Monarch HD (pashing out)
- Devices allow not only streaming but also recording





April 2024

2. Architecture Zoom In: Input and encoders (2/2)





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2. Architecture Zoom In: Streaming servers (1/2)

- WOWZA Streaming Engine
 - Streaming infrastructure run on-premise
- Puppet Managed servers
 - Centos 7 -> RHEL 9
- Origin Servers:
 - Bare metal machines
 - In charge of the transcoding of the input signal
 - 2 servers: 1 primary / 1 backup
 - Input: RTMP

Edge Servers

- Middlemen between the origin server and the client
- Pull the stream chunks from the origin servers if they don't have them yet.
- Clients connect to these servers
- 15 servers (Openstack Virtual Machines)
- Output: HLS
- Support for other clients: LST telescopes or the NP detectors.





2. Architecture Zoom In: Streaming servers (2/2)



ERN

3. Architecture Zoom In: Live Events Website (1/2)

Website:

- Backend:
 - Python (Flask)
 - Postgres
- Frontend:
 - React

Technologies:

- Server: Openshift (Containers)
- Authentication: OpenID (Keycloak)
- Registry: Harbor
- CI/CD: Gitlab CI



UPCOMING LIVE EVENTS



Measurement of D^0 D0-- \overline{D}^0 D0 mixing and search for CPCP violation with $D^0 \rightarrow K^+\pi^-$ D0 $\rightarrow K^+\pi^$ decays

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2. Architecture Zoom In: Live Events Website (2/2)





2. Architecture Zoom Out



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3. Other Important pieces of our system



3. Live Stream Player: Paella Player v7

- Paella Player v7
- Opensource player
 - Developed by UPV (Universitat Politècnica de València, Spain)
- Multiple layouts
- Multiple qualities
- Dual streams
- Used as well for VOD and as Opencast default player

Accelerating Science		لد	gged in as: Rene Fernandez Sanchez (fernanre)	Logout	Directo
CERN CE Webcas	RN t Website	Home Webcast Service	: Docs උද CDS Archive උ		
by Maria Giron	RN openlab Technical Workshop				
🖬 🖽 Main view	Camera 🖽 Slides		0		
Image: Control of the second seco	chine Learning for causal inference PROTO	Y Y Castion BI/R-003C	I ssues during the playback? Contact us using this form.		
CERN	About ■ Webcast Service ? Documentation ► Webcast Test Channel	Subscribe All events Live events Upcoming events	Contact ? Report an issue ● Contact CERN		



Permanent live eve

3. Live events backup website

Static website created with Astro

When an event is updated in the main website, we create its homonym in the fallback website.

- We use the Gitlab API to create a commit in the repository
- The commit triggers the CI that builds the site

Completely static (HTML + JS)

Hosted in EOS

We can disable authentication manually if needed

We keep the same URL structure to redirect our users transparently from OpenShift.

- https://live.cern.ch/event/i12345
- <u>https://webcast-lite.web.cern.ch/event/i12345</u>
- We use Nginx





3. Gitlab CI/CD overview

- CI improved our productivity
- Workflow:
 - Dependencies:
 - Using Poetry and Npm to manage and cache Python and Node dependencies.
 - Test and code quality:
 - Using Pre-commit, Eslint, Flake8 and Mypy.
 - Searching for secrets and vulnerabilities.
 - Test
 - Build and Deployment:
 - Building Docker images
 - Storing images in Harbor
 - Deploying them in Openshift



4. Integration with other services

Recordings / <u>Weblecture Service</u>

- CES: Tool used to manage the encoders and the recordings for VoD
- Fully integrated with Indico
- Otherservices: Indico, CDS and CDS Videos

Zoom / <u>Videoconference Service</u>

- Zoom allows to set up a custom live streaming service that is integrated with our streaming servers.
- It was widely used during the pandemic.

Transcription and Translation / <u>Transcription and Translation Service</u>

- Offline captions: Generated by pilot service: TTaaS. Custom model adapted for HEP, trained with ~500k
 publications from the CERN Document Server (CDS)
- Live captions: Not (yet) available. Investigating how to integrate them with Wowza.
- Very good feedback from our user community
- 2 official languages: English and French



5. Numbers!



5. Monitoring

Using ELK stack

- Elastic
- Logstash
- Kibana

Internal usage

- Memory, Disk, CPU, Server Usage
- Countries

Public usage (Grafana)

• Unique viewers per event







5. Live Events per year

- Live events
 - ~200 per year.
 - Peak in 2018 with almost 300.
- Unique viewers
 - Numbers can vary a lot depending on the event.
 - From 20 people connected to ~5000.
- Events most watched of the last 2 years
 - 10th Anniversary of Higgs Discovery.
 - ~5000
 - DG's presentations to personnel.
 - ~2000
- Relying on live streaming for larger and more visible events



5. Capacity

- ~ 3400 6000 users with our infra
 - ~ 10Gbps bandwidth
- We measure our capacity using Apache Jmeter
 - Reference: 1080p ~ 3Mbps
- Peak:
 - During the Higgs Boson 2012 announcement
 - 50k simultaneous connections
 - 500k unique viewers
 - 40 Gbps bandwidth peak
- With our CDN, we don't have to worry





5. CDN (Content Delivery Network)

• Using Edgio

- Instead of connecting to the edge servers, clients connect to Edgio servers
- Edgio has more than 300 pop (Points of presence) around the world.
- Events expecting high traffic or from different locations in the world.
- Reduces latency if clients are far from origin.



6. Lessons learnt



Openshift auto scale doesn't fit our use case.

A chain is only as strong as its weakest link

If a dependency fails, the whole system can follow.

Live streaming events can be very challenging

Not much time to fix errors Everything must be well tested beforehand. Response must be fast!



7. Future directions

Goodbye Webcast, hello Live Streaming

- Rebranding after 20 years to align with industry.
- Moving to 1 stream
 - Using a composite view. Less bandwidth consumption. More scalable. Align with industry.

Live transcriptions

• Science must be accessible. Studying the possibility of automatic close captioning.

• Other improvements:

- Secure tokens: Used to secure the stream distribution.
- Moving to Load Balancing as a Service: Aim to improve the stability with the streams and ensure affinity.
- Low Latency HLS (LLHLS): ~5 seconds instead of 30. Useful for monitoring or Q&A



8. Conclusions



Very stable: Service with more than 20 years.

Goal: Aimed at high visibility broadcasts

On-premise: Full control and privacy

Future: Greater accessibility and reliability



Thank you!



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