

SCENIC AND GSTREAMER ON STAGE : COLLABORATIVE THEATER ADVENTURES

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SOCIETY FOR ARTS
AND TECHNOLOGY

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- Developing GStreamer applications since 2021
- R&D at **Society for Arts and Technology**
- Backend, network, CI

JEAN-MICHAËL CELERIER

- Researcher & engineer in all sorts of things media arts since 2013
- Director of technological development at **SAT**
- Free software advocacy, C++ and real-time

INTRODUCING THE SAT



SOCIETY FOR ARTS
AND TECHNOLOGY



DEDICATED TO
DIGITAL CULTURE
SINCE 1996



Creative Hub

 CREATION

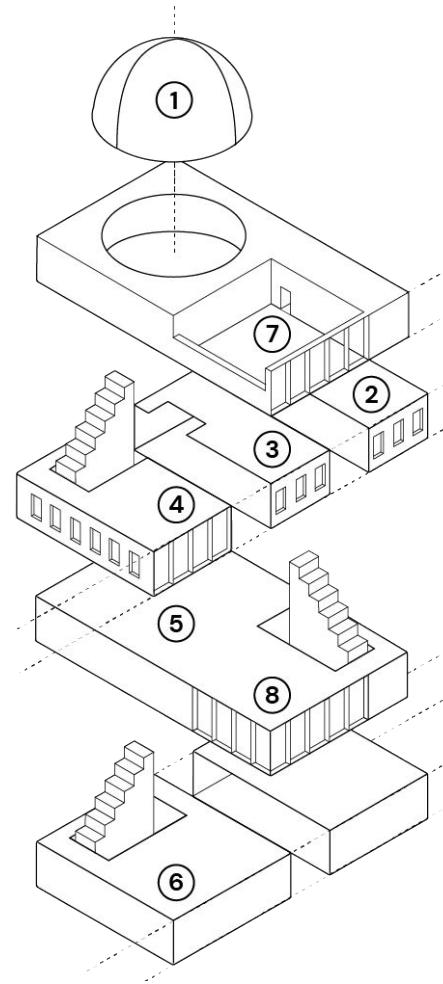
 SATOSPHERE

 SPACE SAT

 FOODLAB

 TRAINING

 R&D



TELEPRESENCE AT SAT

SCENIC TELEPRESENCE

An innovative solution enabling remote artists and professionals to collaborate in immersive shared spaces.

- A social network for connected venues:
Réseau Scènes Ouvertes
- **Hardware:**
Scenic Stations
- **Free & open-source Software:**
Scenic, Switcher, Shmdata, ScenicOS



SCÈNES OUVERTES NETWORK

- 23 venues deployed across Québec since 2017
- 3 new deployments outside Québec
 - Centre Culturel Franco-Manitobain, Winnipeg, MB
 - Moncton University, NB
 - Avignon University, France



SCENIC STATION (2017)

Linux PC optimized for real-time audio / video streaming

Hardware video encoders (NVENC)

Multiple inputs and outputs, varied protocols:

- MIDI
- XLR
- SDI
- HDMI
- NDI
- OSC



SCENIC MOBILE PROTOTYPE (2023)

Headless Internet appliance

Smaller footprint than original station

Same wired connectivity

Adds a built-in Wi-Fi and 5G router

3 prototypes built

Multiple art residencies & shows



SCENIC MOBILE (2024)

Tour-ready version of the prototype

Replacement of the soundcard to open more IP-based connectivity capabilities (Dante, AES67, etc.)

Requires good support for **AES67** in our OS.

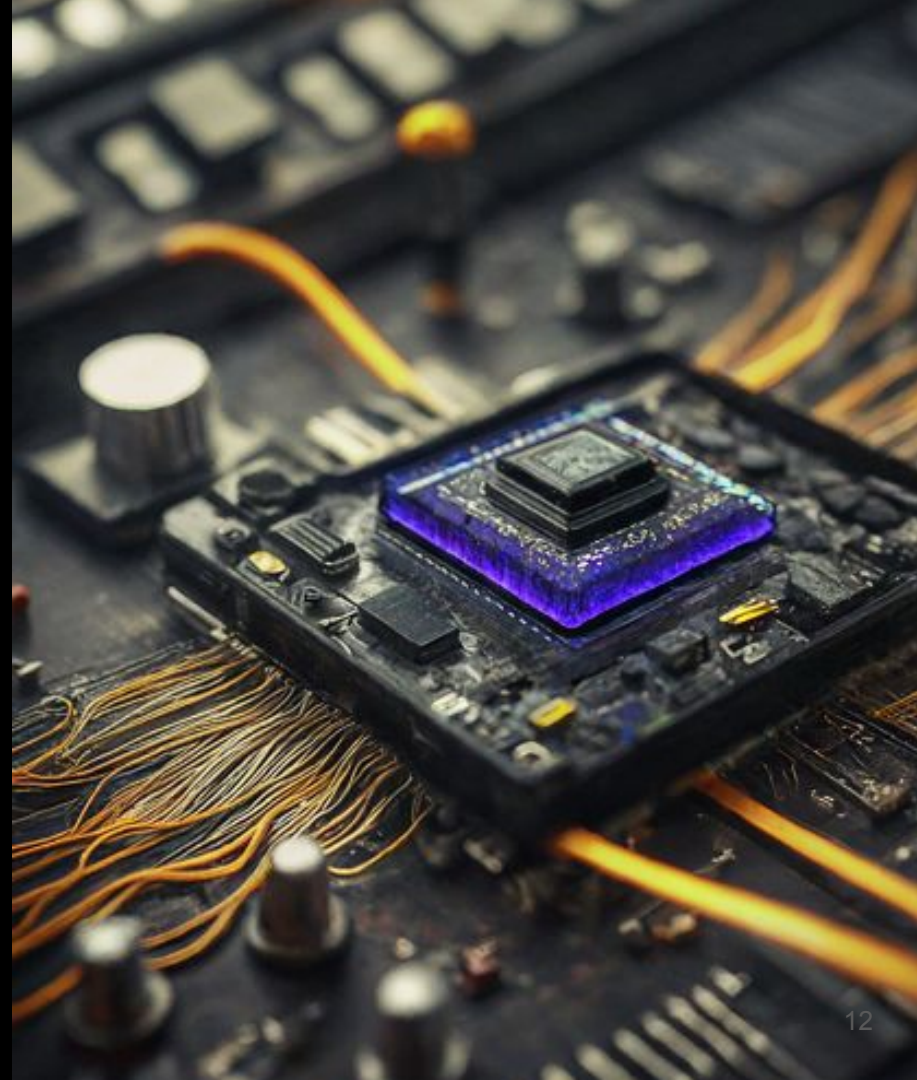
Thankfully, supported by GStreamer, pipewire, aes67-linux-daemon



SCENIC MINI (2025/26)

Next target: embedded SBC-based 1/2 in/out tailored for telepresence-specific use cases

Some SBCs now come with interesting features for us: RK3588 with HDMI-IN (waiting for mainline support!)



NEW FORMS OF TELEPRESENCE

CONNECTING IN NEW WAYS

Experimentations in

- Theatre
- Music
- Dance
- Cultural mediation
- Conference and training

– <https://telepresence-scenic.ca/en/telepresence-projects>

Telepresence projects

Filters Filter by city Filter by category Search Propose a project



Improvisation Published on 15/01/24

Category Improvisation
Tags Participatory
Rouyn-Noranda, Gaspé

Un match d'improvisation en téléprésence a connecté deux villes, permettant aux équipes de jouer dans leurs théâtres locaux. Des laboratoires ont exploré l'interaction entre improvisateurs et la connectivité entre salles. Les liens partagés ont témoigné du succès de cette initiative innovante!

Read More



Graffitis numériques Published on 01/12/23

Category Cultural mediation
Tags Performance, Participatory

Deux marchés de Noël sont connectés en téléprésence et proposent aux passants de réaliser des murales éphémères. Avec des palettes de couleur complémentaires, il est facile d'identifier la contribution de chaque lieu et la collaboration est de mise.

Read More



CorresponDance de guerre Published on 18/01/23

Category Show
Tags Theatre, Dance
Joliette, Saint-Jean-sur-Richelieu

Basé sur la correspondance réelle d'un soldat québécois parti au front en Europe pendant la première guerre mondiale, CorresponDance de guerre est un spectacle multidisciplinaire reliant le théâtre, la danse et la technologie numérique.

Read More



Bluff Published on 24/08/22

Category Show
Tags Theatre
Rouyn-Noranda, Saint-Camille, Montréal

Cette pièce de théâtre, dédiée à la téléprésence, réunit trois



Isidore Remix Published on 25/11/21

Category Show
Tags Music
Alma, Rimouski

Le spectacle Isidore Remix réunit des musiciens répartis dans deux villes différentes qui jouent en



Ailleurs Ensemble Published on 18/09/21

Category Show
Tags Music
Rimouski, Saint-Camille, Montréal

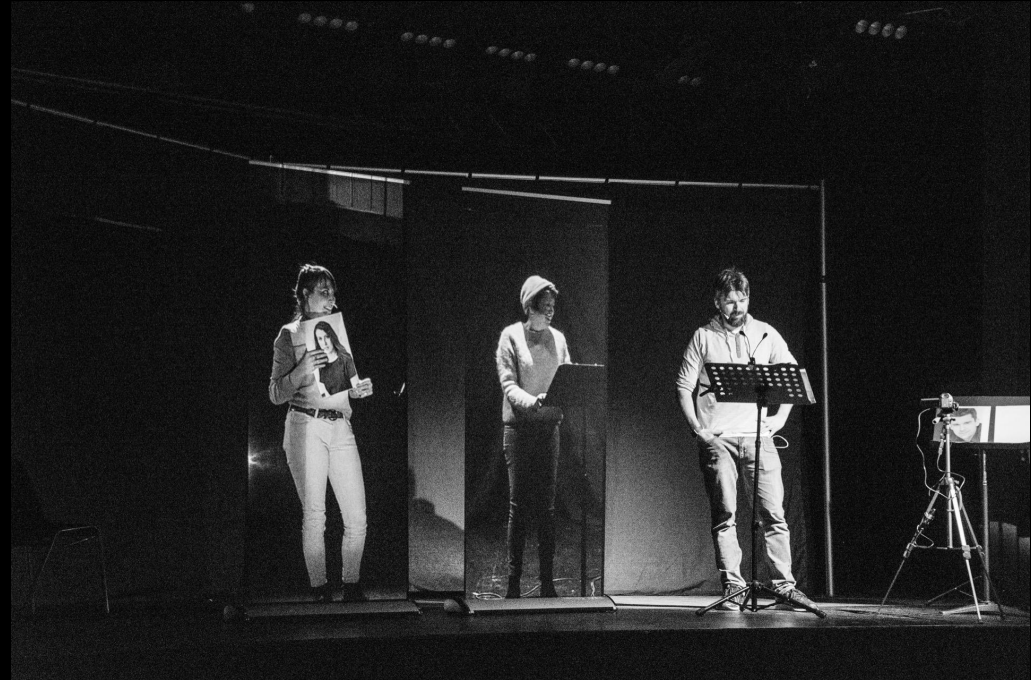
13 artistes québécois ont créé une œuvre musicale unique en

BLUFF (2022)

Toured in 6 cities around province

3 actors, playing together on stage
in 3 cities

9 direct A/V connections



IMPROV THEATRE (2024)

2 teams of 3 players in 2 cities

1000 kilometers distance

2 residencies of 1 week

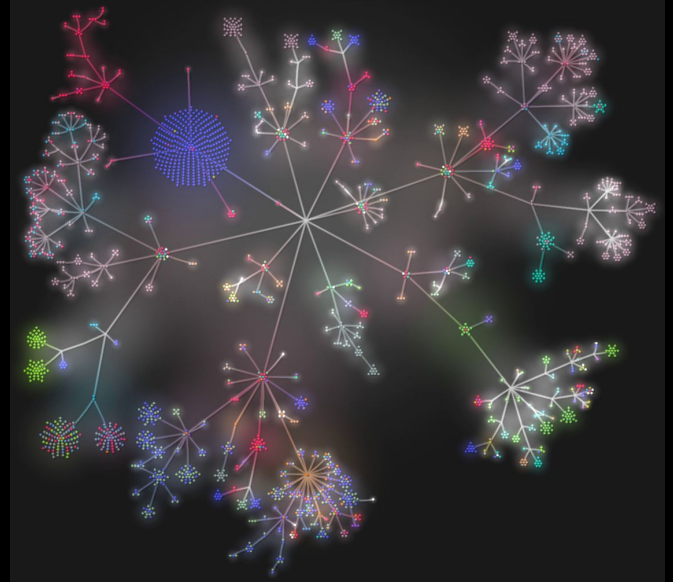
Live show connecting publics



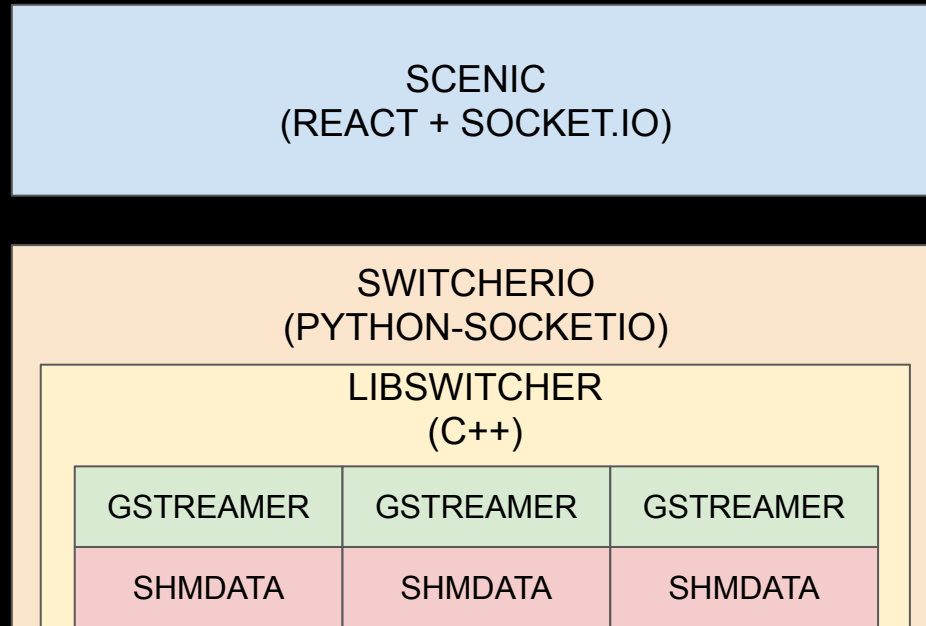
GSTREAMER AT SAT

MORE THAN 16 YEARS

- Contributions on jackaudiosrc dating 2008
- Work on engine Switcher started 2012
- Work on GUI Scenic started 2013



SCENIC SOFTWARE STACK



SCENIC WEB APP

- Inputs and outputs
- Sources assignments
- Remote sources
- Contact list
- System monitoring

The screenshot displays the Scenic Web App interface in a Mozilla Firefox browser window. The page title is "Scenic | Société des arts technologiques". The browser address bar shows the URL "smc.tail55053.ts.net:8080/?endpoint=smc.tail55053.ts.net:8000".

The main interface features a navigation menu on the left with the Scenic logo and options for "MATRICE", "PARAMÈTRES", and "AIDE". The central area is titled "Sources" and "Destinations" and contains a matrix of source assignments. The sources are listed as SAT2_SDI1, SAT2_SDI2, and SAT2_SDI3, each with a video preview and a lock icon. The destinations are labeled "SAT2_MONITOR1", "SAT2_MONITOR2", "SAT2_MONITOR3", and "Montréal | Société des Arts Technologiques 1".

Below the matrix, there is a section for "Montréal | Société des Arts Technologiques 1" showing a list of sources (SAT) with their respective video previews and lock icons.

On the right side, there is a sidebar with a session partner list ("Partenaires de session") showing "Montréal | Société des Arts Technologiques 1" and a contact list ("Carnet d'adresses") with entries for "Reflector Service", "Montmagny | Les Arts de la Scène", "Alma | Ville d'Alma Spectacles", "Laval | Salle André-Mathieu", "Sherbrooke | Centre culturel de l'UdeS", "Trois-Rivières | Culture Trois-Rivières", "Québec | Musée de la civilisation", "Gaspé | CD Spectacles", and "L'Assomption | Théâtre Hector-Charland".

At the bottom, there is a system monitoring bar showing CPU usage, memory usage (19%), network interface (eno2), and IP address (172.20.101.123).

SWITCHER

- C++ library (libswitcher)
- Socket.IO API (SwitcherIO)
- Plugin system
 - Wrapping GStreamer pipelines
- Connections using shmdata

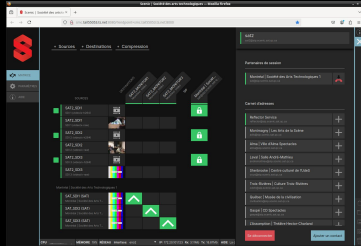
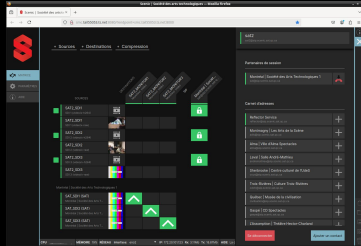


CURRENT WORK

LEGACY SIP BACKEND OVERHAUL

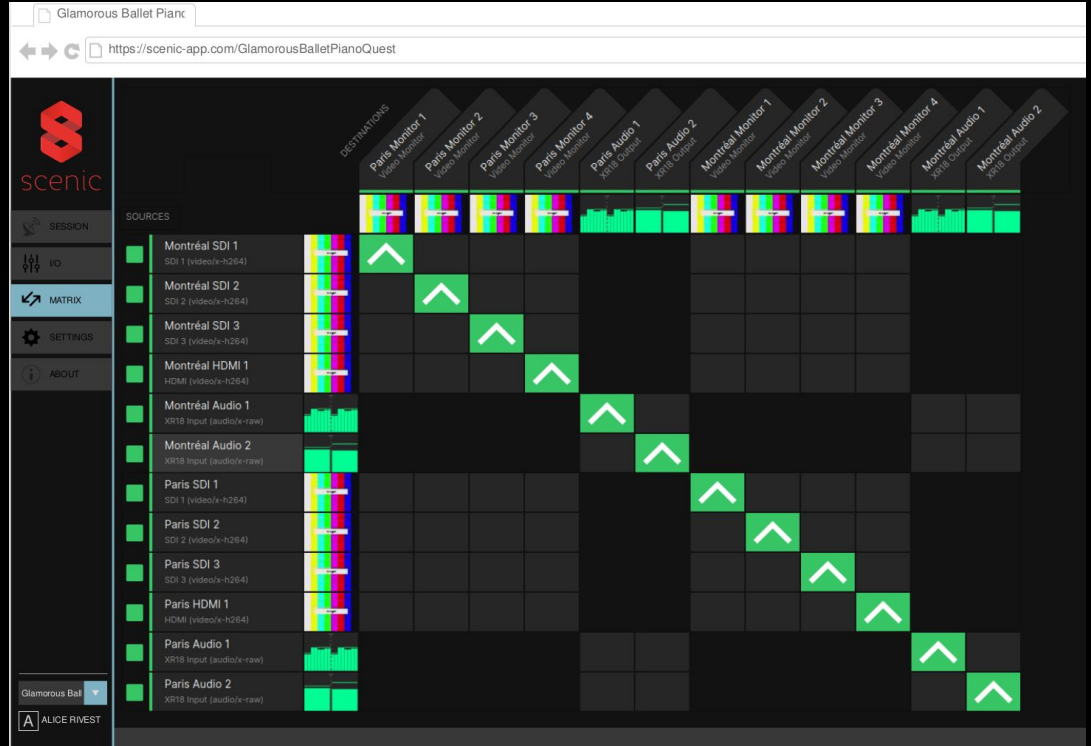
- Aging design dating from 2016
- Unorthodox SIP signaling
- Uncommon use of FreeSWITCH without media
- Custom integration between PJSIP and rtpbin
- Fixed jitterbuffer and bitrates
- Contact list and calls at each ends
- One Scenic session per location

SINGLE SCENIC SESSION



Glamorous Ballet Pianc

https://scenic-app.com/GlamorousBalletPianoQuest



scenic

SESSION

MATRIX

SETTINGS

ABOUT

Glamorous Bal

A ALICE RIVEST

DESTINATIONS

- Paris Monitor 1 Video Monitor
- Paris Monitor 2 Video Monitor
- Paris Monitor 3 Video Monitor
- Paris Monitor 4 Video Monitor
- Paris Audio 1 XRB Output
- Paris Audio 2 XRB Output
- Montréal Monitor 1 Video Monitor
- Montréal Monitor 2 Video Monitor
- Montréal Monitor 3 Video Monitor
- Montréal Monitor 4 Video Monitor
- Montréal Audio 1 XRB Output
- Montréal Audio 2 XRB Output

SOURCES

- Montréal SDI 1 SDI 1 (video/x-h264)
- Montréal SDI 2 SDI 2 (video/x-h264)
- Montréal SDI 3 SDI 3 (video/x-h264)
- Montréal HDMI 1 HDMI (video/x-h264)
- Montréal Audio 1 XRB Input (audio/x-raw)
- Montréal Audio 2 XRB Input (audio/x-raw)
- Paris SDI 1 SDI 1 (video/x-h264)
- Paris SDI 2 SDI 2 (video/x-h264)
- Paris SDI 3 SDI 3 (video/x-h264)
- Paris HDMI 1 HDMI (video/x-h264)
- Paris Audio 1 XRB Input (audio/x-raw)
- Paris Audio 2 XRB Input (audio/x-raw)

SOURCES	Paris Monitor 1	Paris Monitor 2	Paris Monitor 3	Paris Monitor 4	Paris Audio 1	Paris Audio 2	Montréal Monitor 1	Montréal Monitor 2	Montréal Monitor 3	Montréal Monitor 4	Montréal Audio 1	Montréal Audio 2
Montréal SDI 1	✓											
Montréal SDI 2		✓										
Montréal SDI 3			✓									
Montréal HDMI 1				✓								
Montréal Audio 1					✓							
Montréal Audio 2						✓						
Paris SDI 1							✓					
Paris SDI 2								✓				
Paris SDI 3									✓			
Paris HDMI 1										✓		
Paris Audio 1											✓	
Paris Audio 2												✓

BACKEND MODERNIZATION

- Single Scenic session, all locations
- RTC as a core feature
- Pub/Sub streams (instead of calls)
- Replace JPEG thumbnails with browser live video
- Participate in upstream rswebrtc development

USING UPSTREAM GSTREAMER

BUILD SYSTEM IMPROVEMENTS

- Distribution package 1.16 (2020)
- Tracking Ubuntu LTS releases
- One GStreamer update each 2 years
- Cerbero integration starting from 1.22 (2023)
- Bleeding edge rswebrtc plugin build

HARDWARE ENCODER OVERHAUL

- Replaced custom NVENC
- nvcudah264enc
- Simpler and faster build
- Removed 2016 nvEncodeAPI.h
- Pruned 5516 lines (3643 headers)

The screenshot displays a software interface for configuring hardware encoders. The interface includes a sidebar with navigation options: MATRIX, SETTINGS, and HELP. The main area is divided into three sections: Sources, Destinations, and Compression. Under Sources, there are three entries: urisrc1 (audio/x-raw), urisrc2 (video/x-raw), and videnc1 (video/x264). Under Destinations, there are three entries: videop1 (video/x-raw), videop2 (video/x-raw), and videop3 (video/x-raw). Under Compression, there are three entries: sp, SAT Dev 1 - 2, and SAT Dev 1 - 2. A terminal window in the foreground shows the output of the command 'nvidia-smi -q -d UTILIZATION'. The terminal output includes the following information:

```
Wed Nov 8 12:47:37 2023
=====NVSMI LOG=====
Timestamp                : Wed Nov 8 12:47:37 2023
Driver Version           : 525.125.06
CUDA Version             : 12.0
Attached GPU             : 1
GPU 00000000:01:00.0
Utilization
  Gpu                : 1 %
  Memory             : 0 %
  Encoder            : 18 %
  Decoder            : 0 %
GPU Utilization Samples
  Duration           : 78.16 sec
  Number of Samples : 71
  Max                : 1 %
  Min                : 0 %
  Avg                : 0 %
Memory Utilization Samples
  Duration           : 78.16 sec
  Number of Samples : 71
  Max                : 0 %
  Min                : 0 %
  Avg                : 0 %
ENC Utilization Samples
  Duration           : 78.16 sec
  Number of Samples : 71
  Max                : 19 %
  Min                : 14 %
  Avg                : 16 %
DEC Utilization Samples
  Duration           : 78.16 sec
  Number of Samples : 71
  Max                : 0 %
  Min                : 0 %
  Avg                : 0 %
```

GPU	GI	CI	PID	Type	Process name	GPU Memory Usage
0	N/A	N/A	985	G	/usr/lib/xorg/xorg	4M1B
0	N/A	N/A	72481	C	python3	128M1B

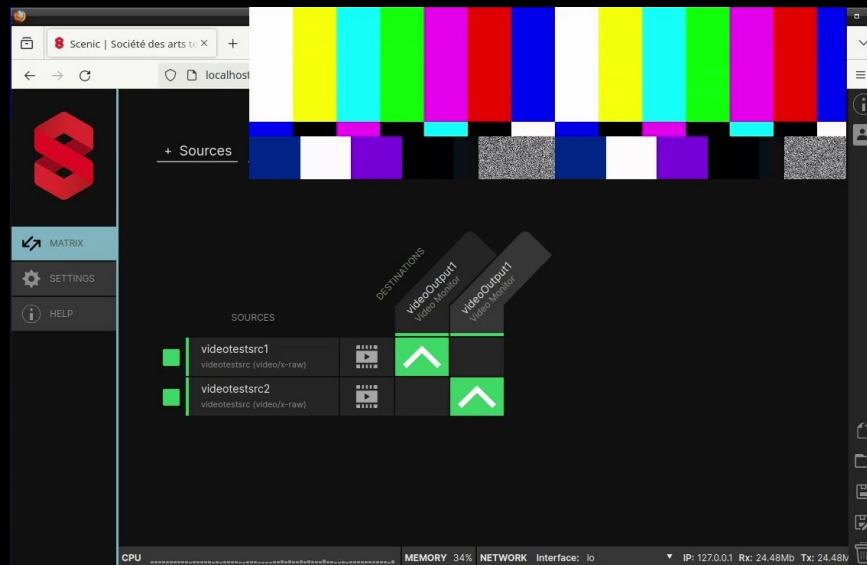
EXPERIMENTATIONS

SCENIC WEBRTC PUB/SUB

- Multiple nodes in same session
- Local sources publishing
- Remote sources subscription
- webrtcsrc/webrtcsink

Features wanted in rswebrtc signaling:

- Authentication
- Concept of rooms
- SFU (janusvrwebrtcsink?)

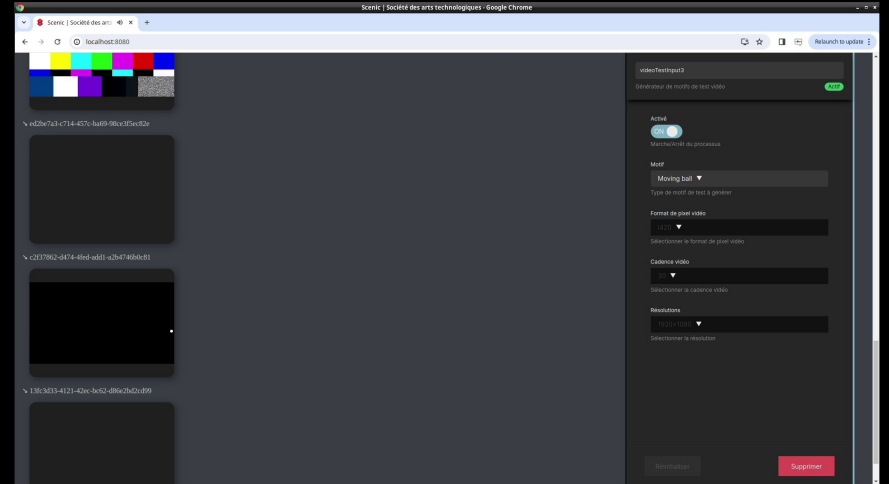


SCENIC BROWSER VIDEO

- Replace slow JPEG thumbnails
- Full-motion video previews
- Javascript API `gstwebrtc-api`

Next steps:

- Integrate video divs into React app
- Publish A/V sources from browser



FUTURE WORK

OSC SUPPORT

- Port of oscsrc / oscsink plugin to GStreamer element
- application/x-libloserialized-osc
- Transport OSC via data channels

MORE THAN 63 CHANNELS

- Test new fix for >63 channels
- [!6819](#) “audioconvert: Support converting >64 channels”
- 157 speakers in SAT’s dome
- Many spatialisation projects

LESSONS LEARNT

ON THE ROAD TO NATIVE WEBRTC

- “all-batteries-included” approach got us farther than webrtcbin!
- gstwebrtc-api authentication, room, SFU integration
- Echo cancellation: webrtcdsp integration in rswebrtc?
- Multi-channel audio: hard to go over stereo
- WHIP/WHEP support: add whipclientsrc

QUESTIONS