

# ICN as an Enabler for New Forms of Multimedia Experience

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*Collaborative work by many - see <http://named-data.net> and <http://remap.ucla.edu>*

The *contexts* in which ICN-based streaming *will* be happening.

# Some current targets for NDN & multimedia

Efficient video distribution, cache configuration

Robust mobile publishing and multipath support

Reduced power consumption

Simplified addressing and discovery, esp. for IoT

Data-centric verification and access control

# Example NDN Application Research Related to Multimedia

## Past

Instrumented environments – Authenticated lighting control (TR-0011)

Random-access video playout - NDNVideo (TR-0007, TR-0031),  
later tested with 1000 int'l clients over NDN testbed by Crowley, et al.

## Recent (last 2 years)

Real-time conferencing - NDNCon / NDN-RTC (TR-0033)

Instrumented environments –

Building mgmt (IEEE Network '14),  
NDNoT kit for Raspberry PI (in submission),  
NDN-CPP-Lite for Arduino (just in Github)

Real-time vision-based person tracking – OpenPTrack

Live performance control systems – Ananke / Los Atlantis

# A different type of NDN talk

No slides to recap the architecture.

NDN shifts the common layer of the Internet from IP to named, signed data with web semantics at packet granularity.

Based on last 16 months of multimedia work, just a bit of ICN.  
What are the “shared visions” that emerge from—and could shape—a future Internet?

Three parts:

What is multimedia becoming,

Who will be authoring it,

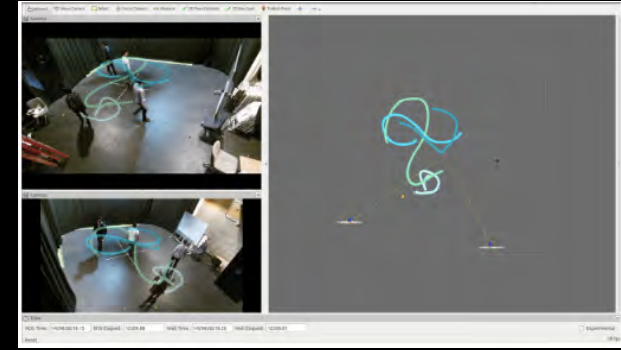
What ICN can offer.

# (Re)formulating Multimedia

“It is widely accepted that creative design is not a matter of first fixing the problem and then searching for a satisfactory solution concept; instead it seems more to be a matter of **developing and refining together both the formulation of the problem and ideas for its solution...**”

- Cross & Dorst (1999), quoted by Brooks (2010)

# UCLA REMAP 2014-2015



Pay attention to the edges



# Pay attention to the edges

- Multimedia experiences are created by designers and storytellers based on available technologies.
- Occasionally their goals directly motivate technologies.
- What motivates designers and storytellers?
- Where are they pushing forward? Is it CDNs?
- What's the equivalent of research challenges that motivate us?
- The edges: of aesthetics, storytelling, interaction, design, etc.



## Tomorrow's network for tomorrow's multimedia

ICN Thought Experiment:

Where does the cutting edge of multimedia creation intersect with ICN research challenges?

# #1 - Tomorrow's multimedia

Hasten the death of streamed “content”  
(even video) as static or monolithic

## YouTube's latest experiment: multiple camera angles



by [Richard Lawler](#) | [@rjcc](#) | February 4th 2015 At 2:33pm



[Sports broadcasts](#) were among the first to give viewers the chance to pick how they watch the action on the internet, but now YouTube is giving the feature a try. A [video of artist Madilyn Bailey performing](#) at YouTube Music Night lets users click through a choice of four camera angles as they watch, without

leaving. We got the best results by telling the video host what he wanted before he came on stage and from there, telling

# THE JOHNNY CASH PROJECT

REGISTER / SIGN IN

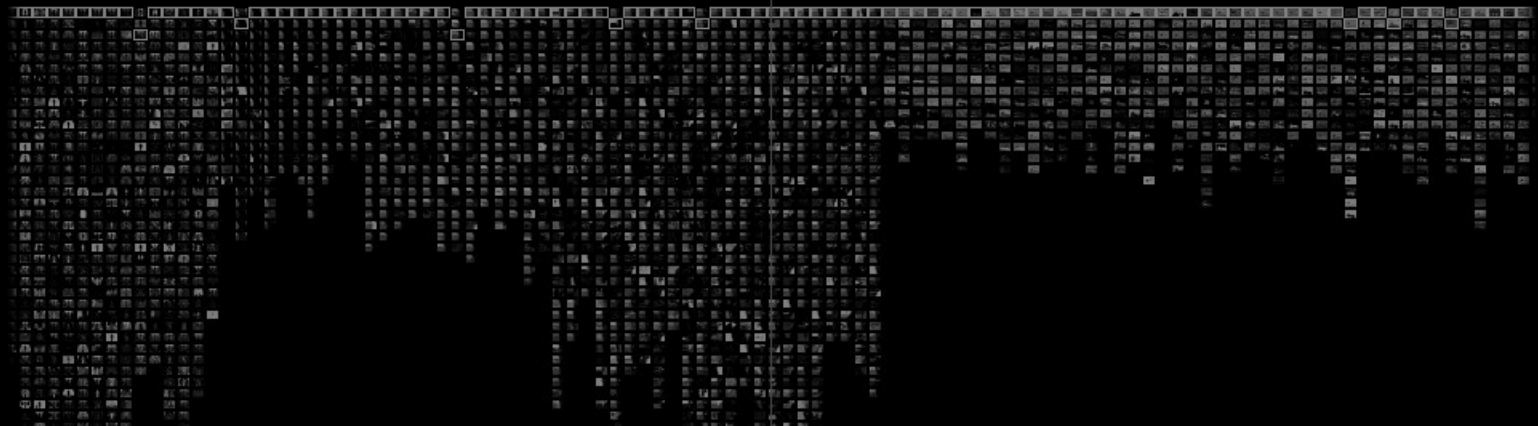
Explore ▾ | Contribute | About | Credits



TIME: 00:00:19



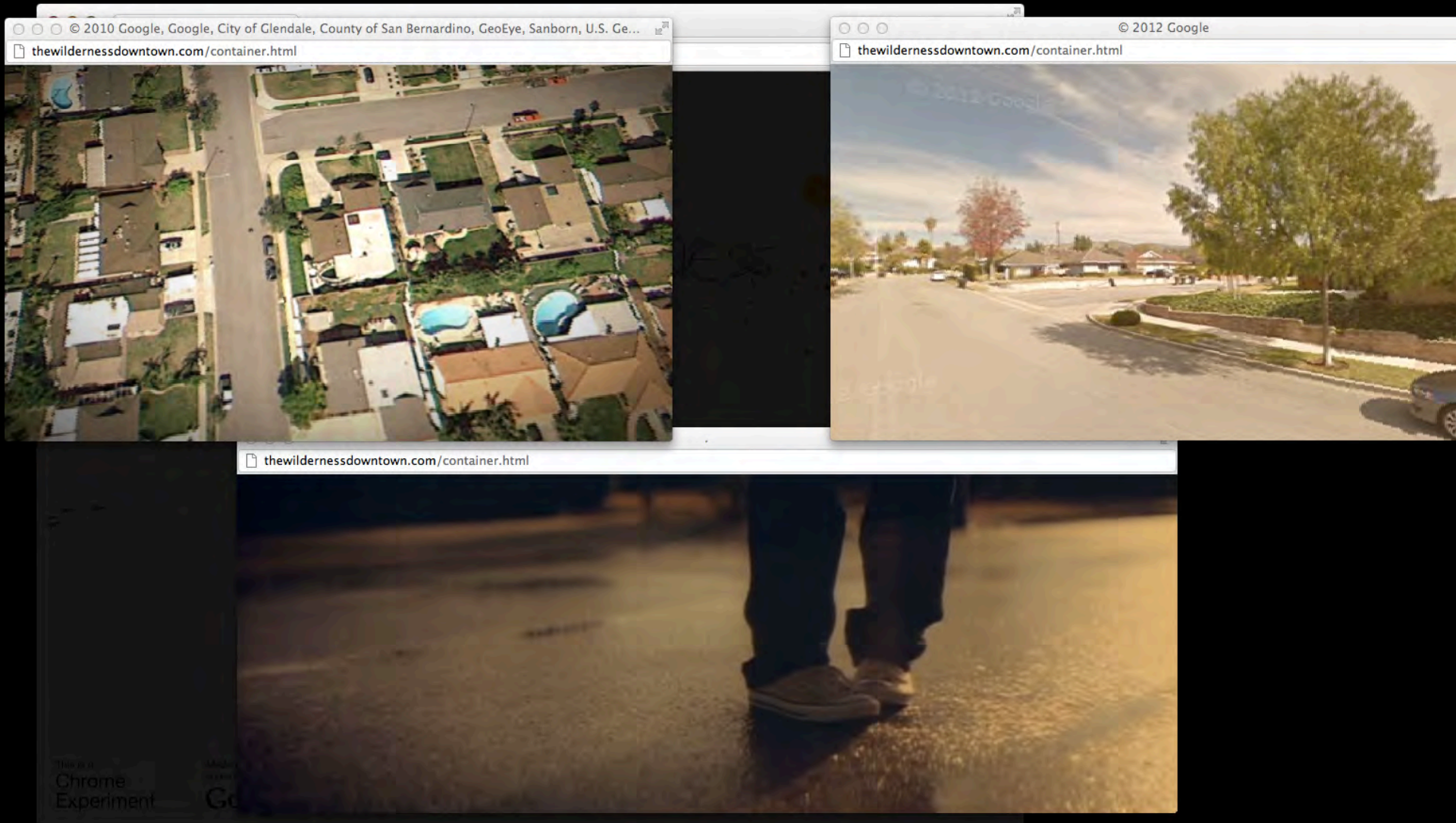
FRAME: 151



<http://thejohnnycashproject.com/>



# The Wilderness Downtown



<http://thewildernessdowntown.com/>

Content streaming is means to an end

ICN Thought Experiment:

How to best enable just-in-time client-side  
composability of streaming media elements?



Embrace real-time assembly  
from multiple “streams” / assets

# Gaming drove real-time rendering forward



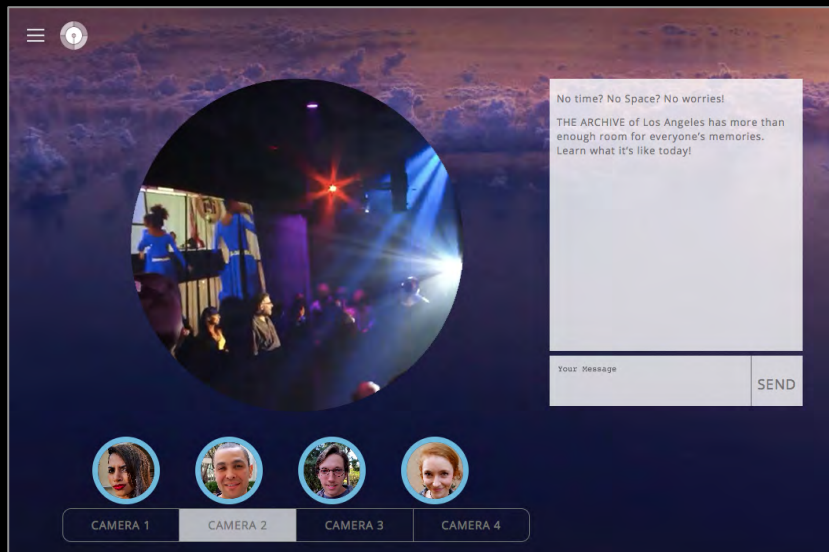
The Blogger Project, UCLA Dept. of Theater, 2006

# Maze Runner (Fox, 2014)



<https://www.youtube.com/watch?v=64-iSYVmMVY>

# Los Atlantis (UCLA, 2015)



Supported by a Google Focused Award.



# All media streamed from YouTube, typ. 1080p

YouTube DE

- What to Watch
- My Channel
- My Subscriptions 5
- History
- Watch Later 7

## PLAYLISTS

- Friday, June 5
- Remix
- Down the Rabbit Hole
- 2B - Coding
- Agora
- 1A-Departure
- Sunset
- Rachel
- 1B-Home
- 1C-Polaroids
- Live
- Sense Memories
- 1D-Underpass
- Liked videos
- Los Atlantis

## SUBSCRIPTIONS

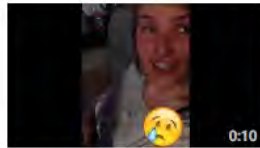
- Foodie
- Various Artists - ... 5
- Browse channels
- Manage subscriptions

The Archive Videos Playlists Channels Discussion About



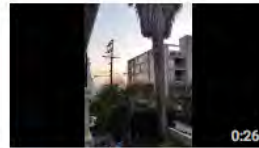
Duffy

4 views • 1 month ago



Happy crying

1 view • 1 month ago



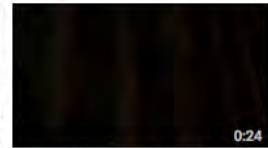
Palms

6 views • 1 month ago



Union Station Chandelier

7 views • 1 month ago



Neon Light on Gothic B

3 views • 1 month ago



DTLA at Night\_Jesucristo

6 views • 1 month ago



DTLA at Night\_A Poor Soul

8 views • 1 month ago



Chinatown Noir 02

3 views • 1 month ago



Chinatown Noir 01

11 views • 1 month ago



Chinatown Neon B

6 views • 1 month ago



huh

5 views • 1 month ago



Chinatown Neon A

1 view • 1 month ago



DTLA at Night\_Ominous Walkway

6 views • 1 month ago



Chinatown Noir 03 a

12 views • 1 month ago



DTLA at Night\_Scaffolding

10 views • 1 month ago



DTLA at Night\_Ominous lot

15 views • 1 month ago



Neon Light on Gothic A

5 views • 1 month ago



Chinatown Noir 03 b

8 views • 1 month ago



Chinatown Neon C

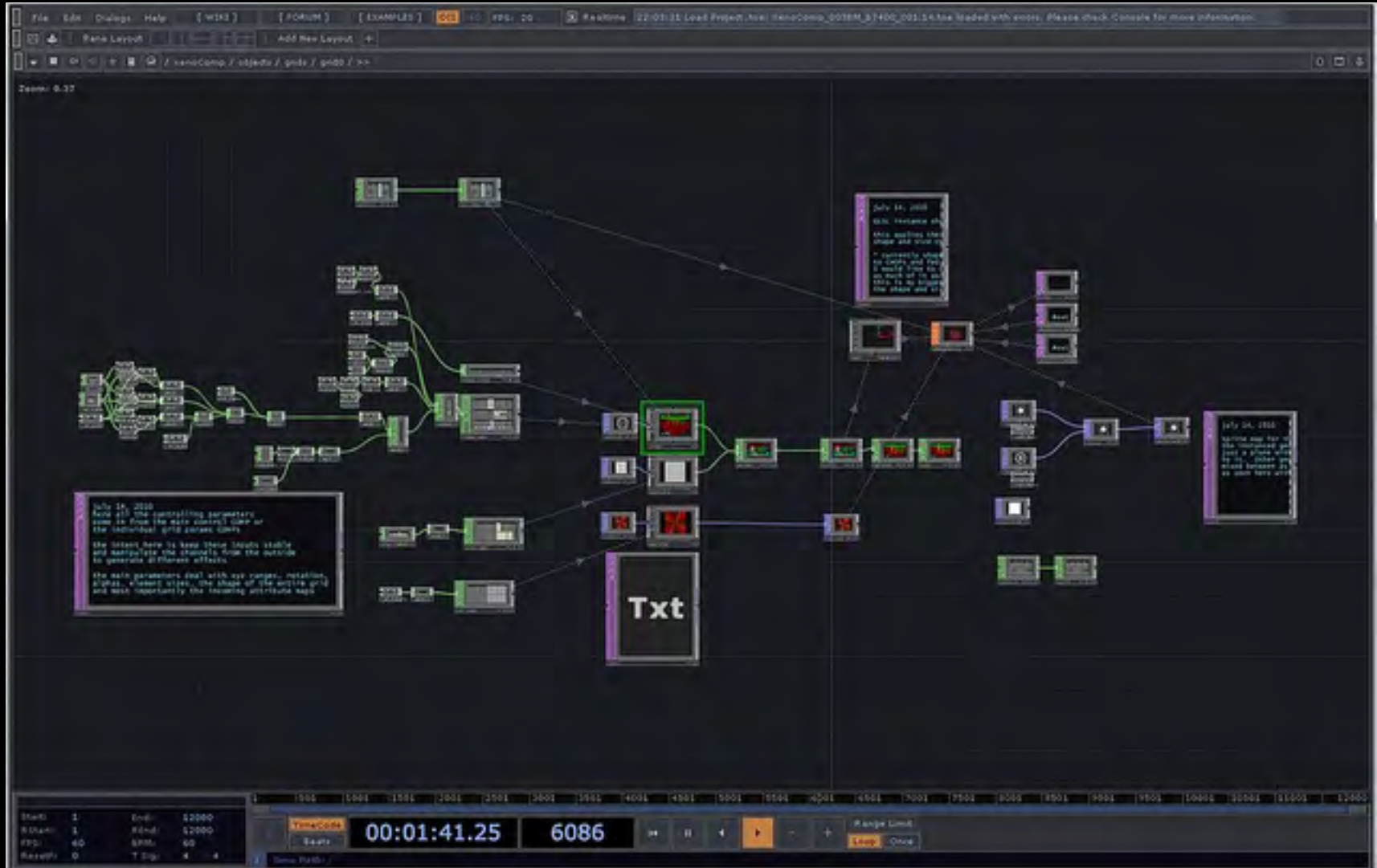
8 views • 1 month ago



Chef's Night 11

3 views • 1 month ago

# Processing performed in real-time by Touchdesigner



# Control via a Web Component based HTML5 interface

```
# Body

.AGORA 1: Finding the Others

*OLF: Widen out to show as much of the Agora as possible.*

RACHEL
(They turn to see her)
Hey...

<<@cue-publisher
(t      = Video play as they turn,
cid     = 10)>>

EDDIE
Look, it's Rachel!

RACHEL ^
Eddie. Where were you?

EDDIE
Here, waiting for you *I'm not* Sheena look I told you she'd come.
```

“Active script”  
in screenplay markdown

## AGORA 1: FINDING THE OTHERS

```
                                OLF: Widen out to show as
                                much of the Agora as
                                possible.

                                RACHEL
                                (They turn to see her)
Hey...

                                10 : Video play as they turn

                                stand by      GO

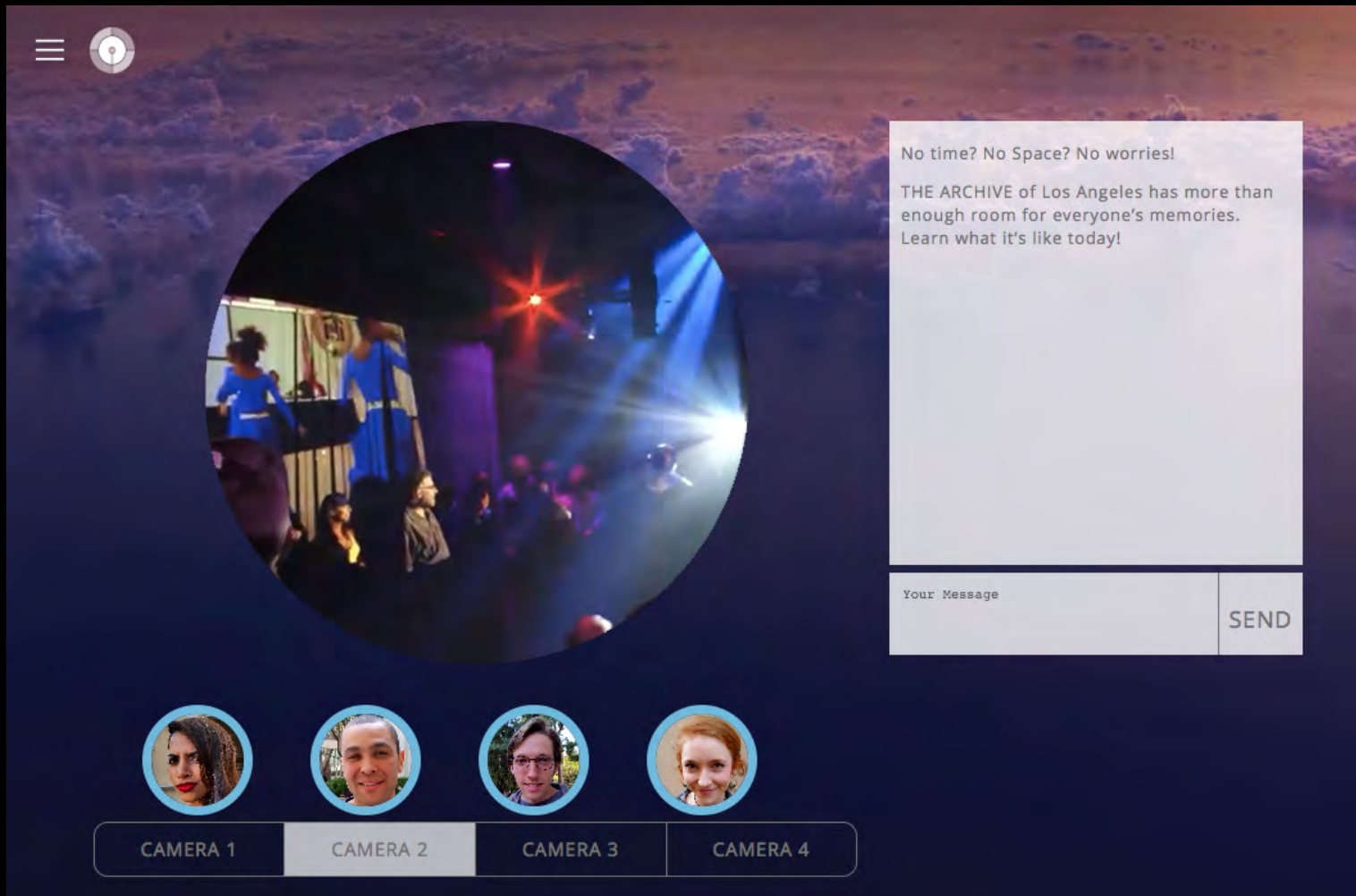
cue-publisher
-----
                                EDDIE
                                Look, it's Rachel!

                                RACHEL
                                Eddie. Where were you?

                                EDDIE
                                Here, waiting for you I'm not Sheena look I
                                told you she'd come.
```

Rendered html

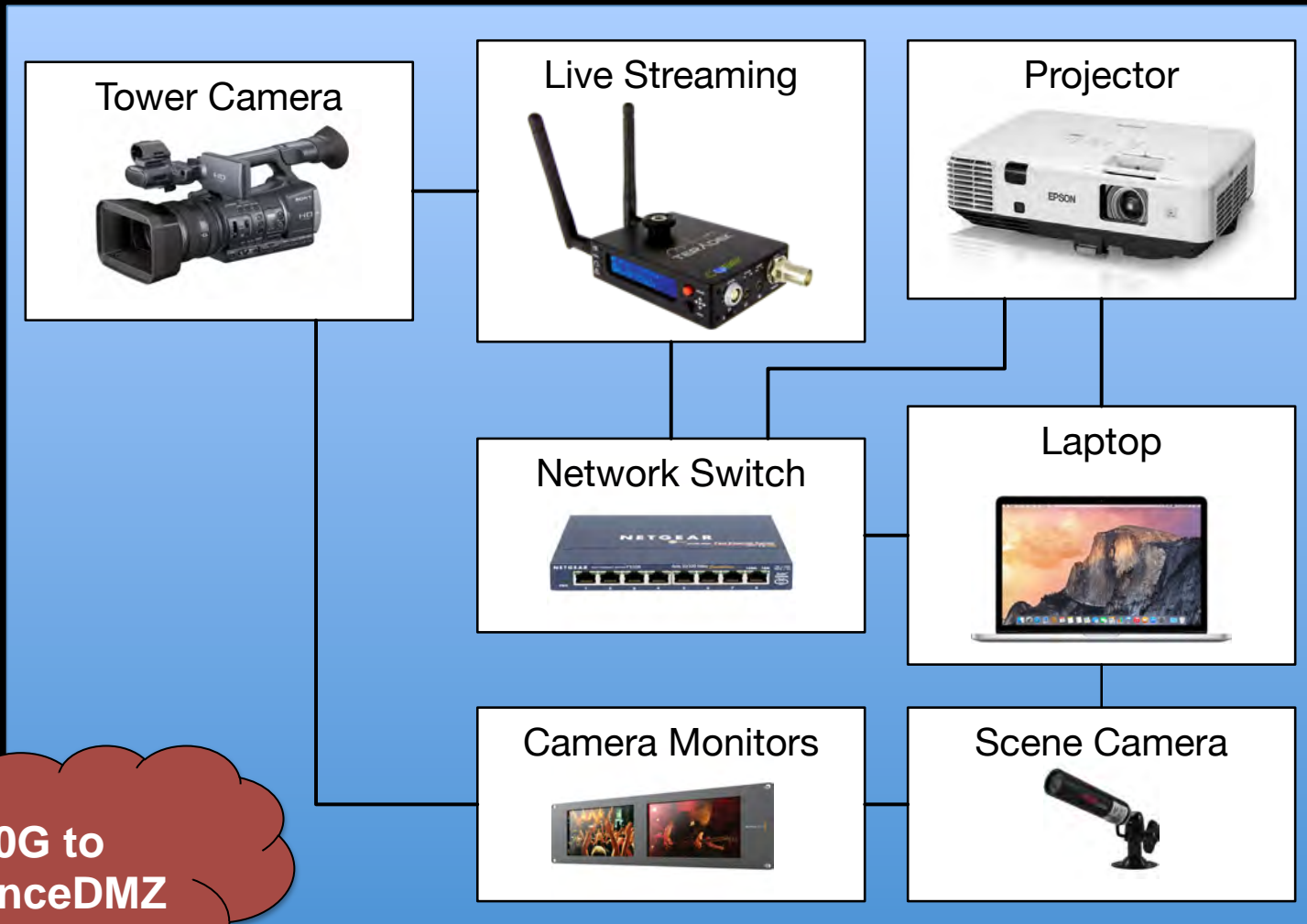
# Live online and mobile components



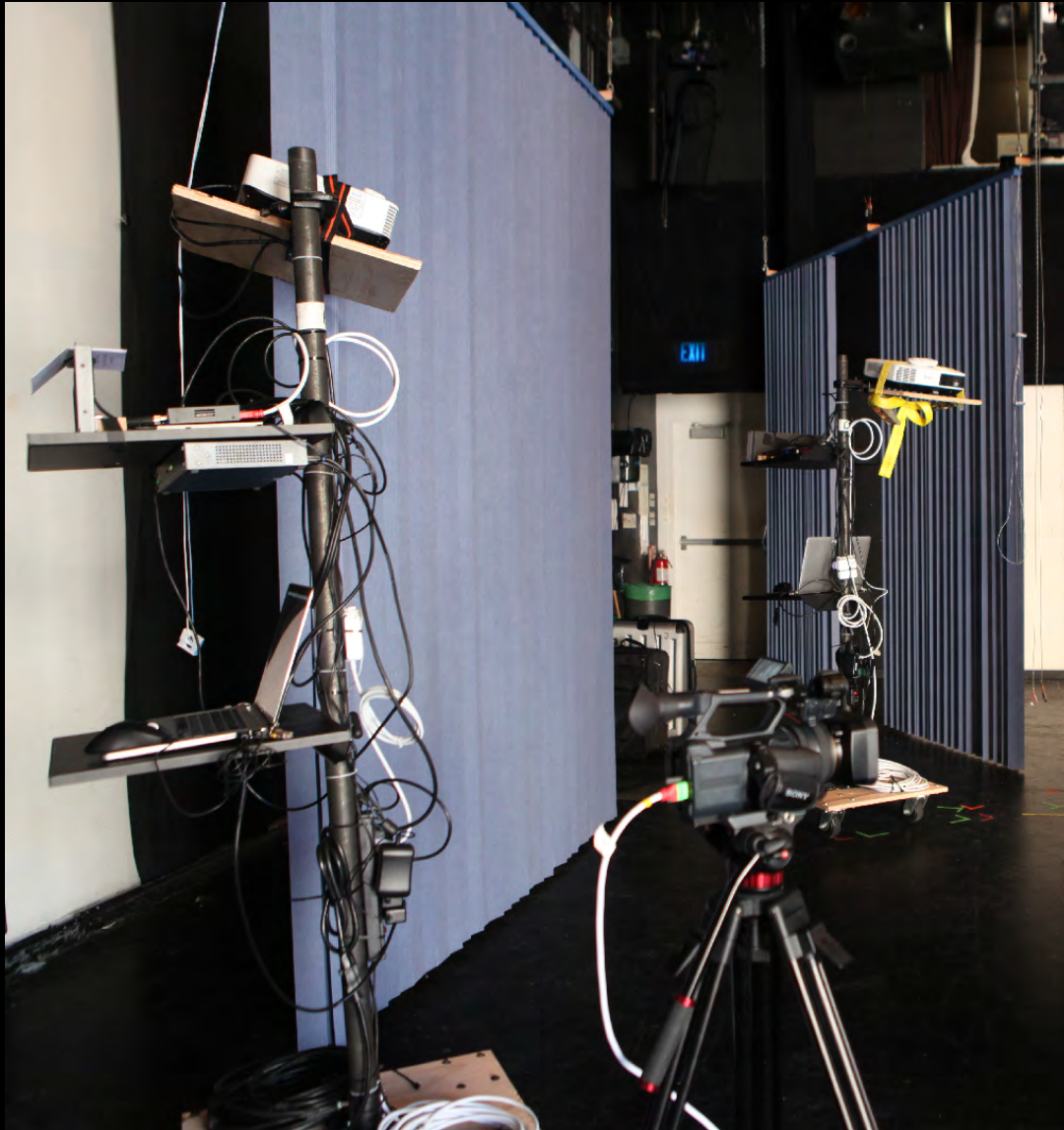


# 4 x Mobile Projector Tower

3-16Mbit/s down, 6+Mbit/s up ea.



# Expeditionary & contested, multipath



## Map existing application namespaces to ICN

ICN Thought Experiment:

How to best expose an internal multimedia application's namespace to an ICN network?

# Name things other than content!

Internal namespace of the stream processing pipeline could be used directly on the network in a manner consistent with network names!

## Video Processing Namespace

```
<root>/losatlantis/<show_id>/  
  <node_name>/<version>/  
    <processing_net_path>
```

```
/ndn/edu/ucla/remap/losatlantis/  
  nodeA/%FD%00%00%01M%E4%BB%7ER/  
    project1/table1.text
```

## Processing nodes express interests

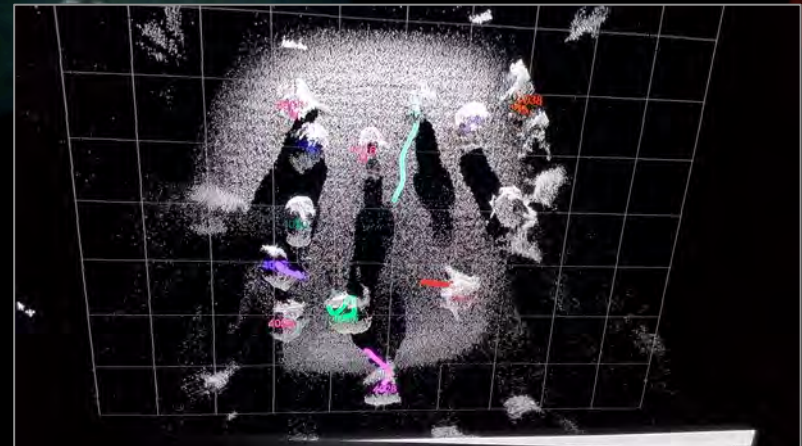
- every 50ms for <node\_name> prefix
- exclude previous versions
- leftmost child selector



Empower the browser  
as stream mux/demux



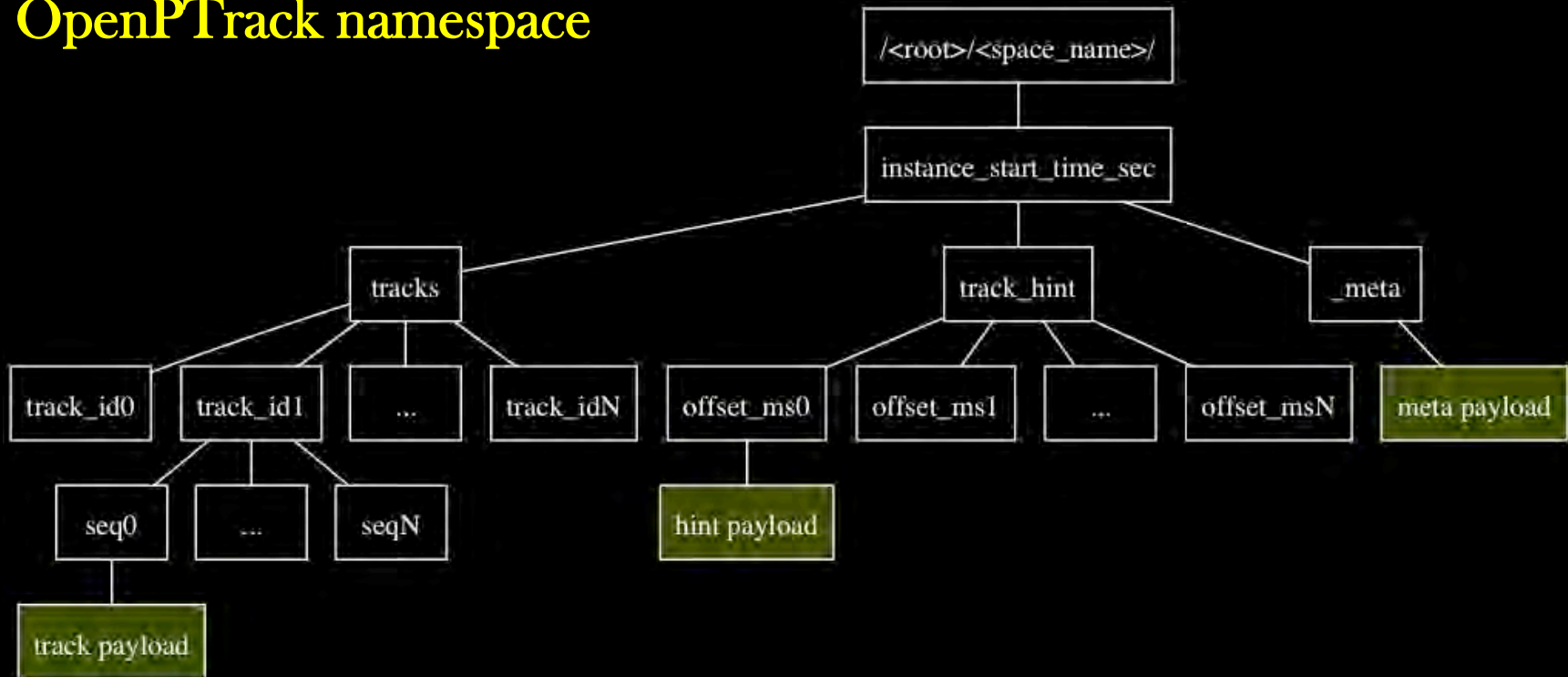
# OpenPTrack & Interpretive Digital Media



<https://vimeo.com/131848108>  
<https://vimeo.com/channels/864928>

# Data exchange between browsers and server via NDN

## OpenPTrack namespace



Client: NDN-JS (Javascript) in browser.

Publisher: NDN-CPP (C++) hooked to ROS message bus.

The browser is closer to an OS than an app

ICN Thought Experiment:

How can we move our stacks (and apps) into browsers, to promote experimentation in the epicenter of multimedia apps?



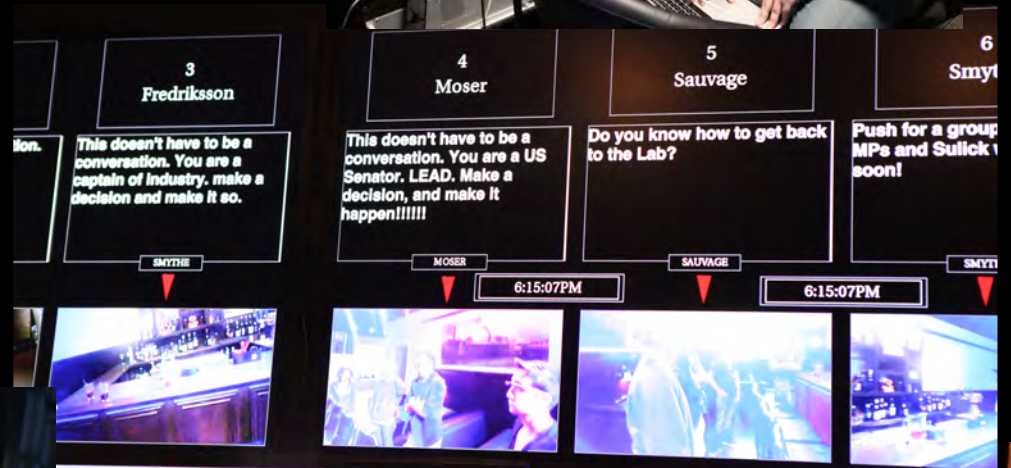
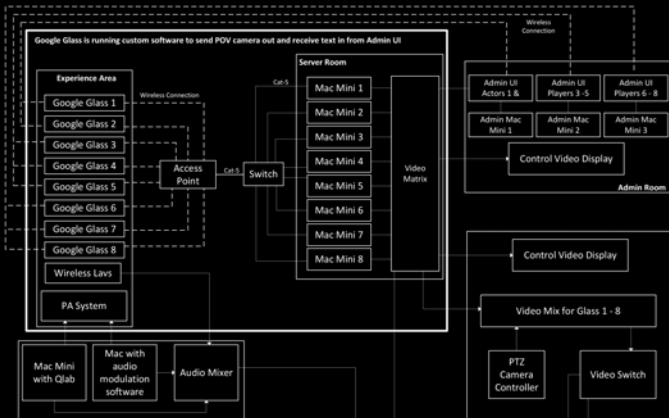
## #2 – Tomorrow's authors

# TFT Future Storytelling Summer Institute



<https://vimeo.com/131609063>

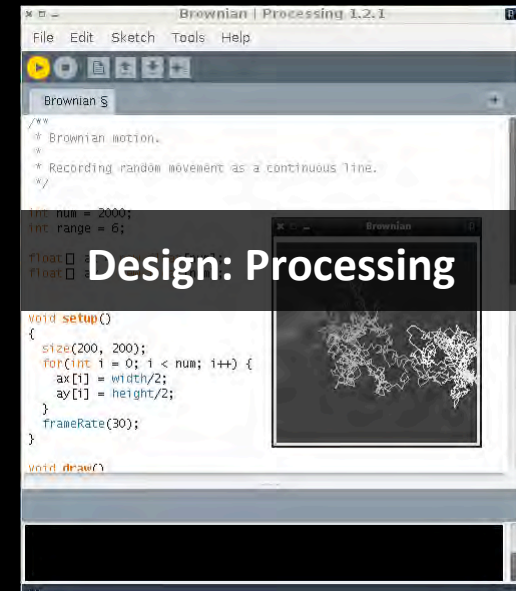
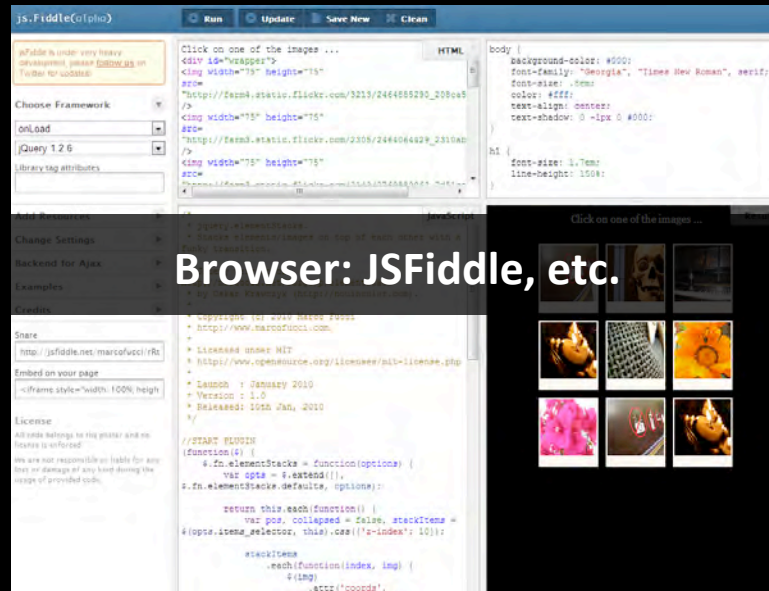
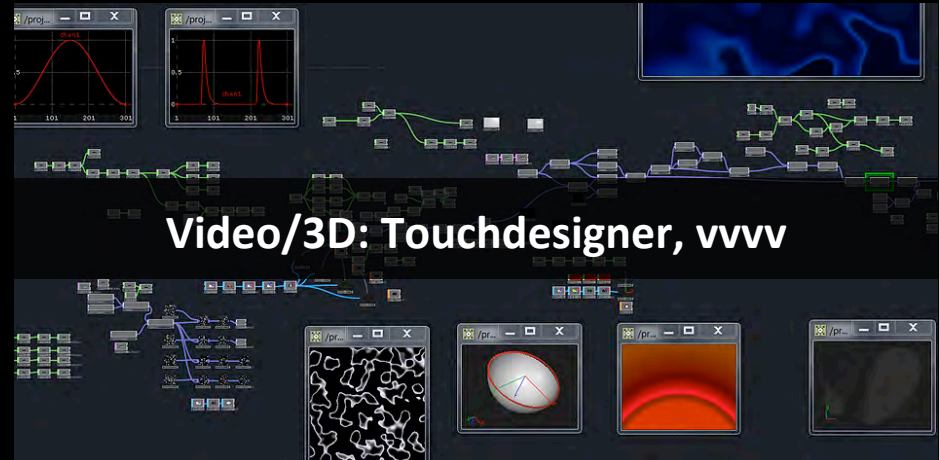
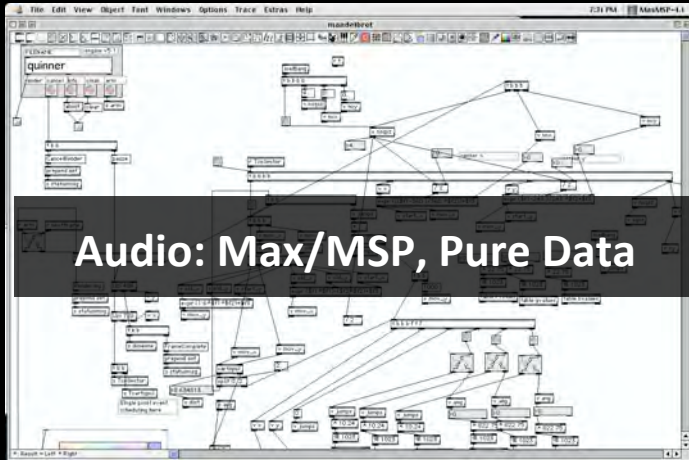
# Grace Plains: Live-action Role Playing with Google Glass (2014)



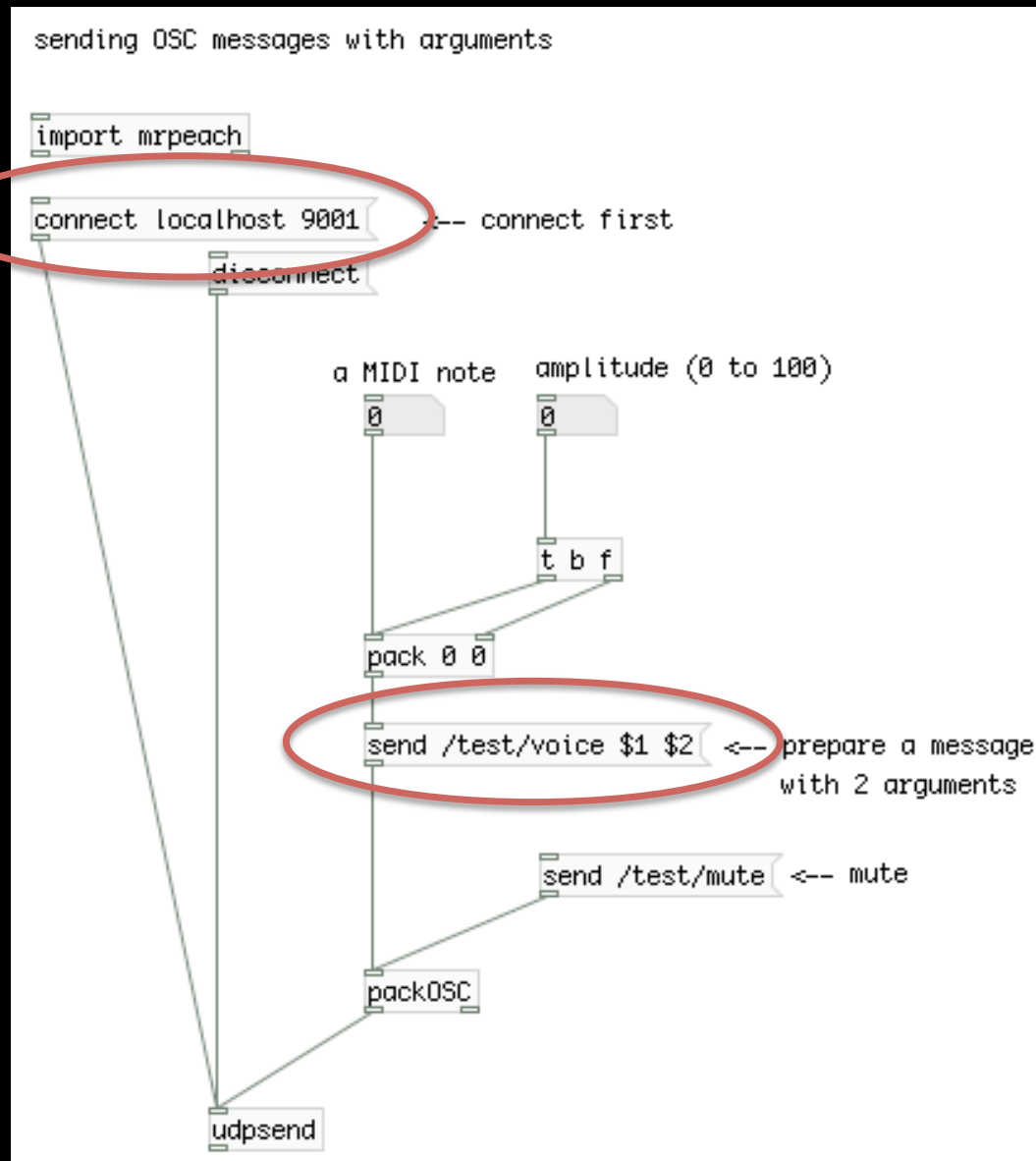
Inspire and enable authors  
to build networked experiences



# Lower the barrier for experimentation



# Networking Example: Open Sound Control



**Make networked multimedia easier to code**

ICN Thought Experiment:

These tools transformed real-time media,  
hardware hacking, and graphic design;  
how to integrate ICN overlay capability  
and engage this dynamic community?

## #3 – What ICN can offer



## (Re)formulating Multimedia

- Hasten the death of static content
- Embrace real-time assembly
- Empower the browser
- Inspire and enable authors

## (Re)formulating Multimedia

Multimedia works are increasingly systems themselves: networking of components is crucial.

=> **Focus on messaging & control as well as streamed content.**

Experience happens locally. The cloud alone is unlikely to solve the challenges of live, real-time experience that relies on integration of local elements. (Think AR, Hololens, etc.)

=> **Enable consistent addressing of content and devices.**

=> **Consider ICN benefit for local communication, not just internet scale.**

## (Re)formulating Multimedia

Decision-making by code, based on data, is intermingled with media assets and increasingly important to story itself.

=> Chaining processing blocks a common metaphor, but hard to do securely on the network. ICN could help.  
e.g., Tschudin et al.'s NFN

That data is often personal.

=> Not just big data, but small data (N=1) streams.  
e.g., Estrin et al.'s Small Data

Security by isolating communication channels doesn't work well in an increasingly integrated environments.

=> Develop new trust models for multimedia systems.  
e.g., Exploring this at UCLA.

# (Re)formulating Multimedia

Names matter – explore further how ICN can quickly help applications that already use hierarchical naming internally.

=> Motivation for more work on namespace synchronization as a higher level transport.

=> Tussle between app, security, network requirements for naming is really challenging.

Examples in this talk include:

- Scene graphs for streaming 3D (Game engines)
- Processing networks for streaming 2D (Touchdesigner)
- App-level protocols in experimental multimedia (Open Sound Control)
- Message bus protocols (Robot Operating System)

Real, immediate benefit as an overlay?

Moving small chunks of data with low latency shouldn't be harder / less consistent than web requests, but it currently is.

=> **ICN stacks could supplant a lot of middleware, soon.**

The notion of “connection” is outdated and perhaps unnecessary it keeps causing problems in our own overlay uses.

=> **Don't reintroduce it, or let it bubble up, even when ICN is provided as an overlay on IP.**

# Stories will be told with IoT, too. What approach will best bring IoT and multimedia together?

## SENSING

prop/witchstaff/1/acceleration  
prop/witchstaff/1/position  
prop/witchstaff/1/batterylevel

## MEDIA

microphone/gertrude/audio/





Thank you!

**Register for NDNComm 2015 @ UCLA, September 28-29.**  
Hosted by the UCLA School of Theater, Film and Television.

jburke@ucla.edu - <http://named-data.net>