Networked Music Performance over Information-Centric Networks

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Outline

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- NMP over ICN
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Motivation

- NMP: Networked Music Performance
  - Stringent latency and reliability requirements
  - Quality of Experience (QoE) is paramount
- ICN: Information Centric Networking
  - Focuses on information rather than on endpoints
  - Most importantly, it supports native multicast
- NMP over ICN
  - Native multicast can be exploited
  - An MCU may not be needed
  - Reduced delay and network overhead

Background: NMP

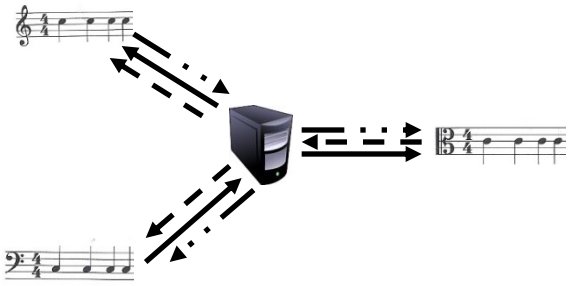
- Delay and reliability requirements
  - Very low mouth-to-ear latency, as low as 25 ms
  - Consists of processing and transmission delays
  - Decoding/encoding require 8 ms at least
  - Reliability requires introducing redundancy
  - Important to select well-provisioned paths
- NMP is *not* conferencing!
  - In NMP we want all streams, not a single one
  - Live interaction requires very low delays
  - Multicast would allow bypassing the MCU

Background: ICN

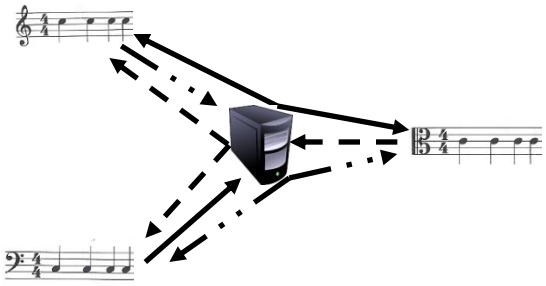
- Publish Subscribe Internet (PSI) architecture
  - Publishers advertise available data
  - Subscribers express interest in data
  - A Rendezvous Network matches the two
  - The Topology Manager creates paths between them
- Stateless forwarding in PSI
  - Paths are encoded as source routes
  - Each path consists of a set of links
  - A Bloom filter includes the corresponding link tags
  - Routes are pre-selected and remain pinned

NMP over ICN

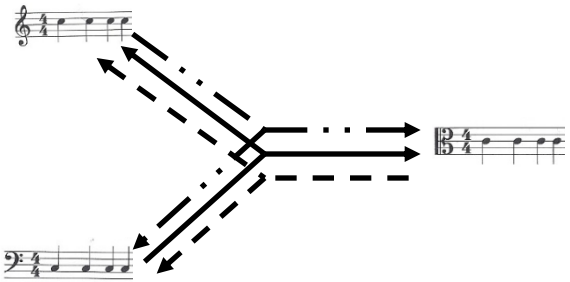
- Many ways to deploy NMP over ICN
  - Each musician publishes a media stream
  - Each musician subscribes to some media streams
  - Server-based or direct communication
  - a. A server may unicast all streams
  - b. A server may multicast all streams
  - c. Musicians may multicast all streams



a. Centralized unicast



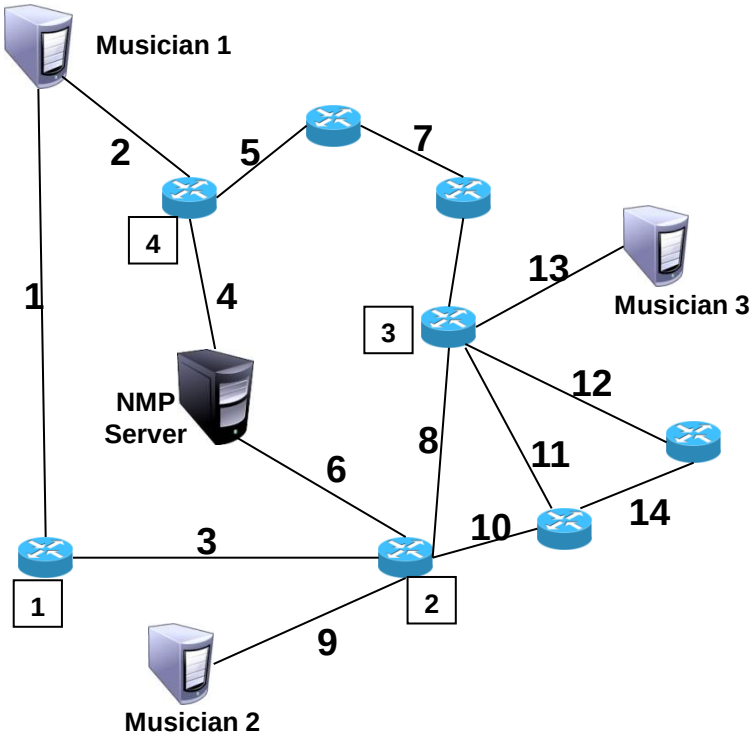
b. Centralized multicast



c. Decentralized multicast

Experimental setup

- Implementation of NMP over ICN
  - Based on PSI prototype
  - Based on VoPSI application
  - Server-based or serverless
- Deployed over PlanetLab
  - Three musicians involved
  - All on the same network
  - Routers around Europe
  - Shortest path multicast trees
  - Server at the “center”



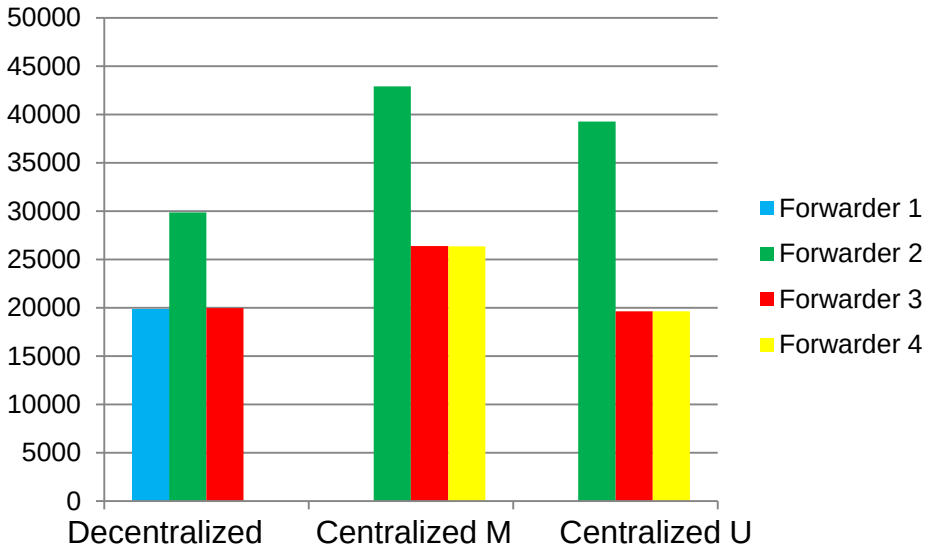
Performance evaluation: latency

- Average latency seen by each musician
  - Across all sources (musicians)
  - Both server-based solutions are similar
  - Decentralized is clearly superior

	Decentralized	Centralized M	Centralized U
Musician 1	111,31	121,11	117,74
Musician 2	84,19	110,45	113,16
Musician 3	92,39	118,81	121,46

Performance evaluation: load

- Number of packets in selected routers
  - Centralized multicast suffers from loopback
  - Centralized unicast suffers from duplication
  - Decentralized is again clearly superior



Conclusions

- ICN *does* have something to offer for NMP
  - Native multicast obviates the need for servers
  - Both delay and network load are reduced
- Future work in the MUSINET project
  - Include ultra low delay audio/video coding
  - Add loss tolerance mechanisms
  - Deploy over a real high-speed network
  - Perform experiments with live musicians