

MUSIC

the Multi-Simulation Coordinator

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What is MUSIC?

- An API allowing large scale neuron simulators which use MPI internally to exchange data during runtime
- ► An implementation of a C++ library providing this API

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Introduction



mpirun -np 3 -hostfile h1 my_lgn_model
mpirun -np 5 -hostfile h2 nrniv my_simulation.hoc
mpirun -np 3 -hostfile h3 nest my_simulation.sli

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The purpose of MUSIC:

Allow multiple applications to run together and communicate within the parallel computer

- On-line pre- or post-processing of huge amounts of data for a parallel simulator within the cluster
- Connect models developed for different parallel simulators
- Run multiple instances of the same simulator on different parameter sets in one parallel job
- Promote re-usability through modularity

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MUSIC - an INCF project

Recommendation from the report of the 1st INCF Workshop on Large-scale Modeling of the Nervous System:

"Implement an experimental framework for connecting software components. A feasibility study should be performed regarding the possibility of on-line communication between different software modules, for example two parallel simulators. INCF should allocate resources for implementing a software library with a communication interface."

- MUSIC standard and software provided and supported by the International Neuroinformatics Coordinating Facility (INCF)
- Developed by the CSC, KTH in a collaborative partnership with the INCF
- Released publicly under the GPL license through the INCF Software Center in early 2009

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Users View of MUSIC

What is communicated?

- Continuous Time varying values
- Events Spikes
- Messages Arbitrary strings of bytes

Communicated through named ports presented by the application

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Users View of MUSIC

Appl. A

MUSIC



A multi-simulation where several parallel applications exchange runtime data

Appl. C

Appl. B

Users View of MUSIC

Typical configuration file my_simulation.music:

```
stoptime=1.0
[A]
  binary=my_lgn_model
  np=5
  out \rightarrow B.in
  out \rightarrow C.in
[B]
  binary=nest
  args=...
  np=3
  to_L5_pyramidal \rightarrow C.in
  from _L5 _ pyramidal <- C.out
[C]
  binary=nrniv
  args=my_simulation.hoc
  np=3
```

mpirun -np 11 music my_simulation.music

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Spatial Aliasing-different distribution of data

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Sender Receiver data ributed receiver sender Width Distributed

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Temporal Aliasing—different time steps

Case 1: Sender ticking faster than receiver



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Simulated Time

Temporal Aliasing—different time steps

Case 2: Sender ticking slower than receiver



Simulated Time

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Execution goes through three phases

Launch phase

Outside the control of the application

Setup phase

Declaration and mapping of ports

Runtime phase

Simulation and transfer of data

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Each application is responsible for:

- 1. Initializing MUSIC
- 2. Creating Ports
- 3. Mapping Ports
- 4. Initiating the Runtime Phase
- 5. Advancing Simulation Time

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Initializing MUSIC

```
int main (int argc, char *argv[])
{
  setup = MUSIC::Setup (argc, argv);
  comm = setup->communicator ();
  ...
}
```

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Programs announce willingness to send or receive data via ports





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Creating and mapping a port

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Supported Data Types

Continuous — Time varying values
 Sender: Reading from user data structures
 Receiver: Writing into user data structures

Events — Spikes

Sender: User calls an insertion function Receiver: MUSIC calls user-supplied handler

Messages — Arbitrary strings of bytes Sender: User calls an insertion function Receiver: MUSIC calls user-supplied handler

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Initiating the runtime phase

```
runtime = new MUSIC::Runtime (setup, 0.0001);
while (runtime->time () < stoptime)
{
    ...
    runtime->tick ();
    ...
}
```

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n(i,x): number of music channels per population

- mop: music_out_proxy
- mip: music_in_proxy
- k: number of connections from/to population
- pn: parrot_neuron

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Benchmark



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- Released in the beginning of March, 2009
- Downloadable at the INCF Software Center http://software.incf.org
- Supported by the INCF
- Users manual

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Music interfaces:

- NEST Moritz Helias and Jochen Eppler
- MOOSE Niraj Dudani and Johannes Hjorth
- Neuron Michael Hines

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