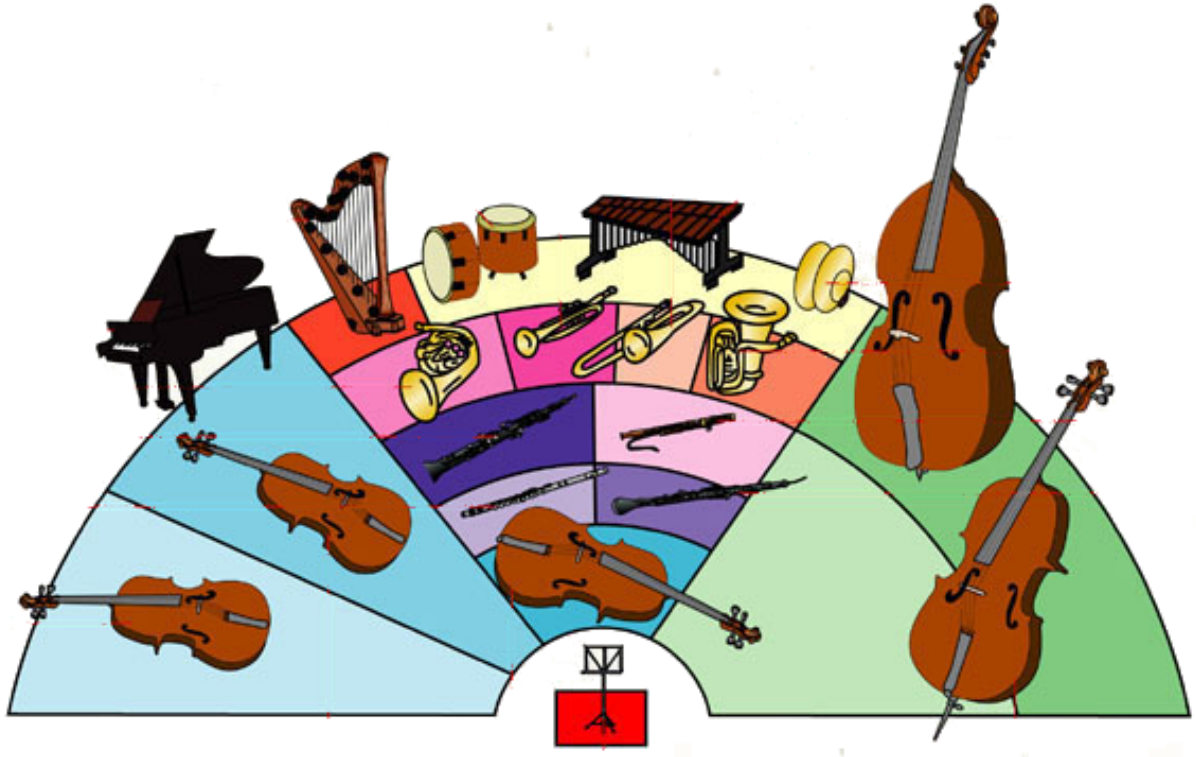


MUSIC

the Multi-Simulation Coordinator

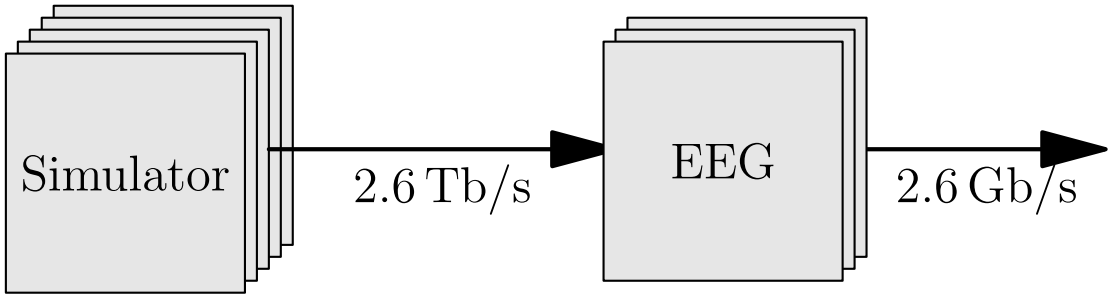
Mikael Djurfeldt, INCF/KTH and Örjan Ekeberg, KTH

Introduction

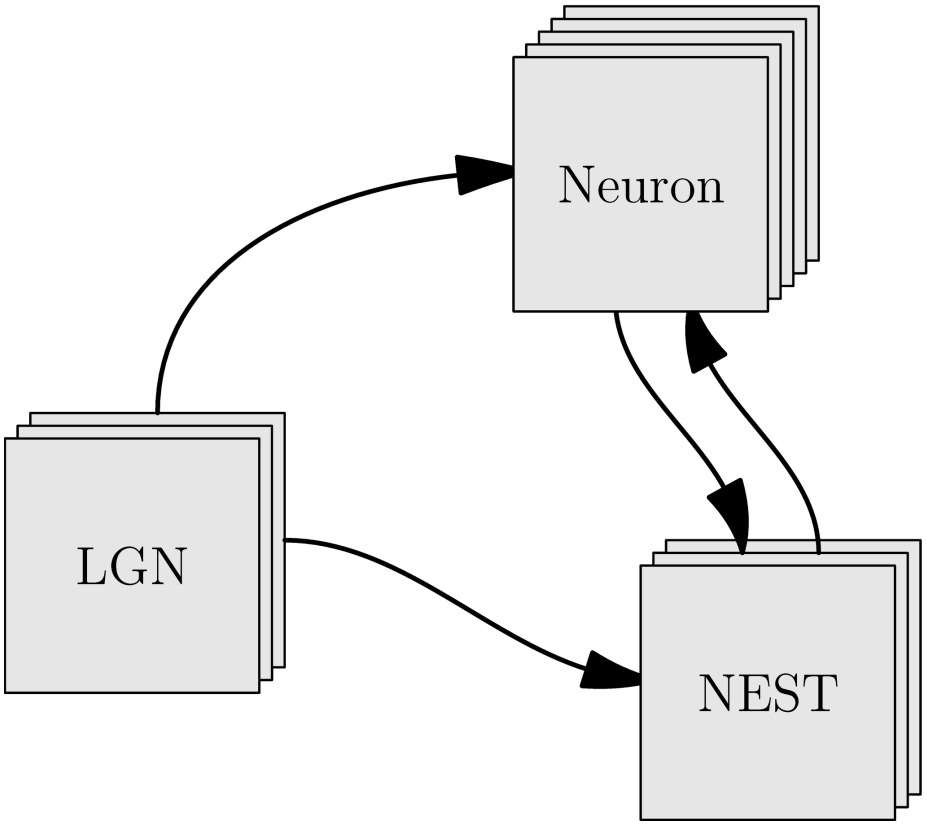
What is MUSIC?

- 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

Introduction

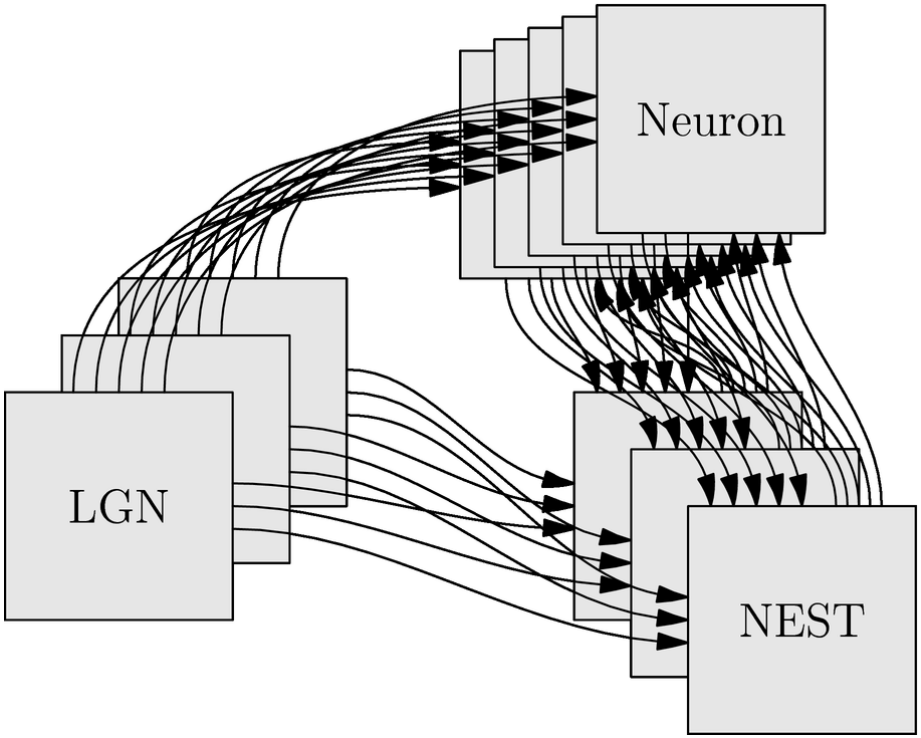


Introduction




```
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
```

Introduction



Introduction

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

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

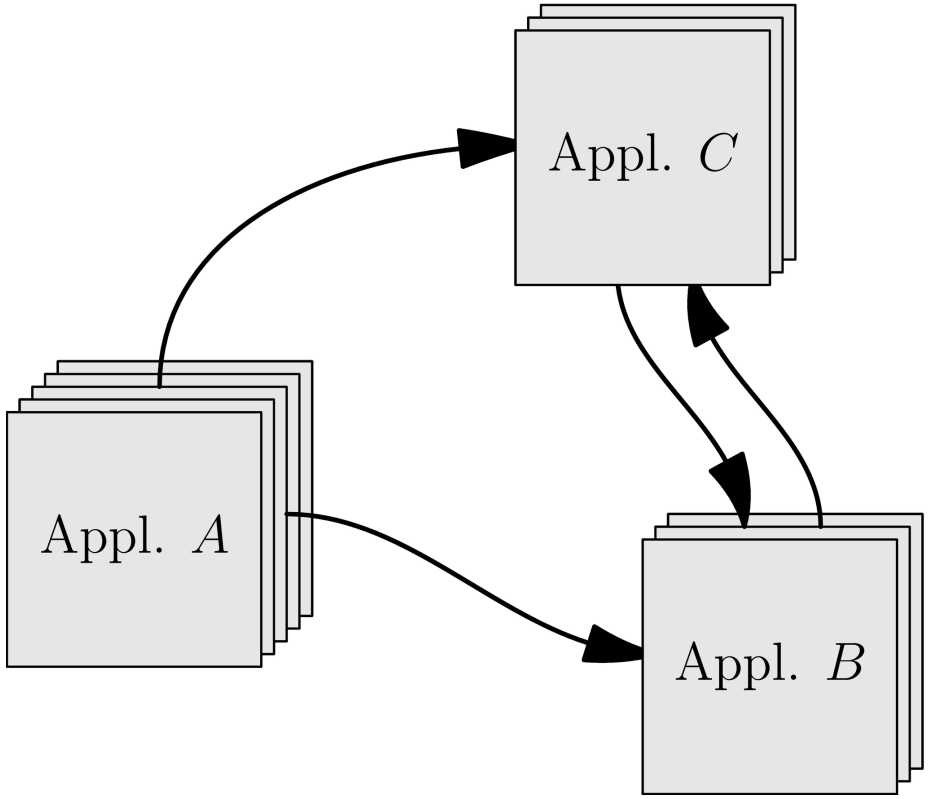
Users View of MUSIC

What is communicated?

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

Communicated through named ports
presented by the application

Users View of MUSIC



A multi-simulation where several parallel applications exchange runtime data

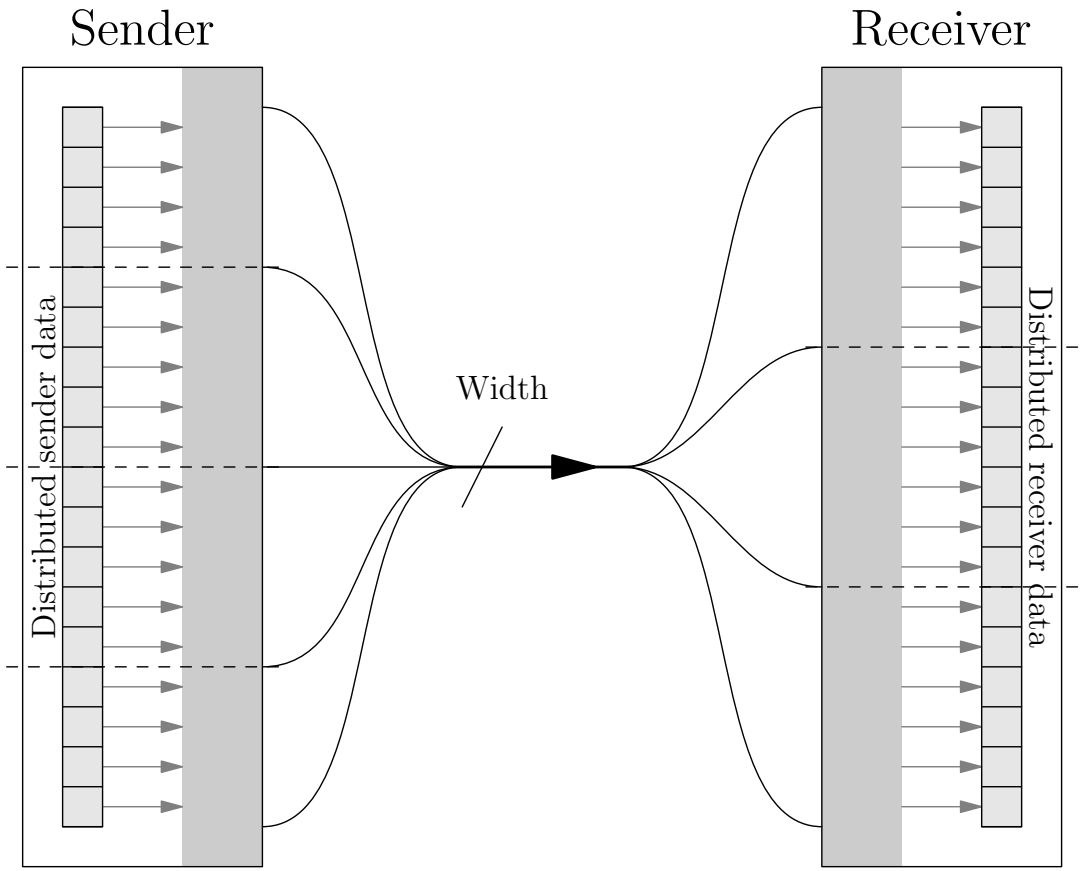
Users View of MUSIC

Typical configuration file `my_simulation.music`:

```
stoptime=1.0
[A]
  binary=my_lgn_model
  np=5
  out -> B.in
  out -> C.in
[B]
  binary=nest
  args=...
  np=3
  to_L5_pyramidal -> C.in
  from_L5_pyramidal <- C.out
[C]
  binary=nrniv
  args=my_simulation.hoc
  np=3
```

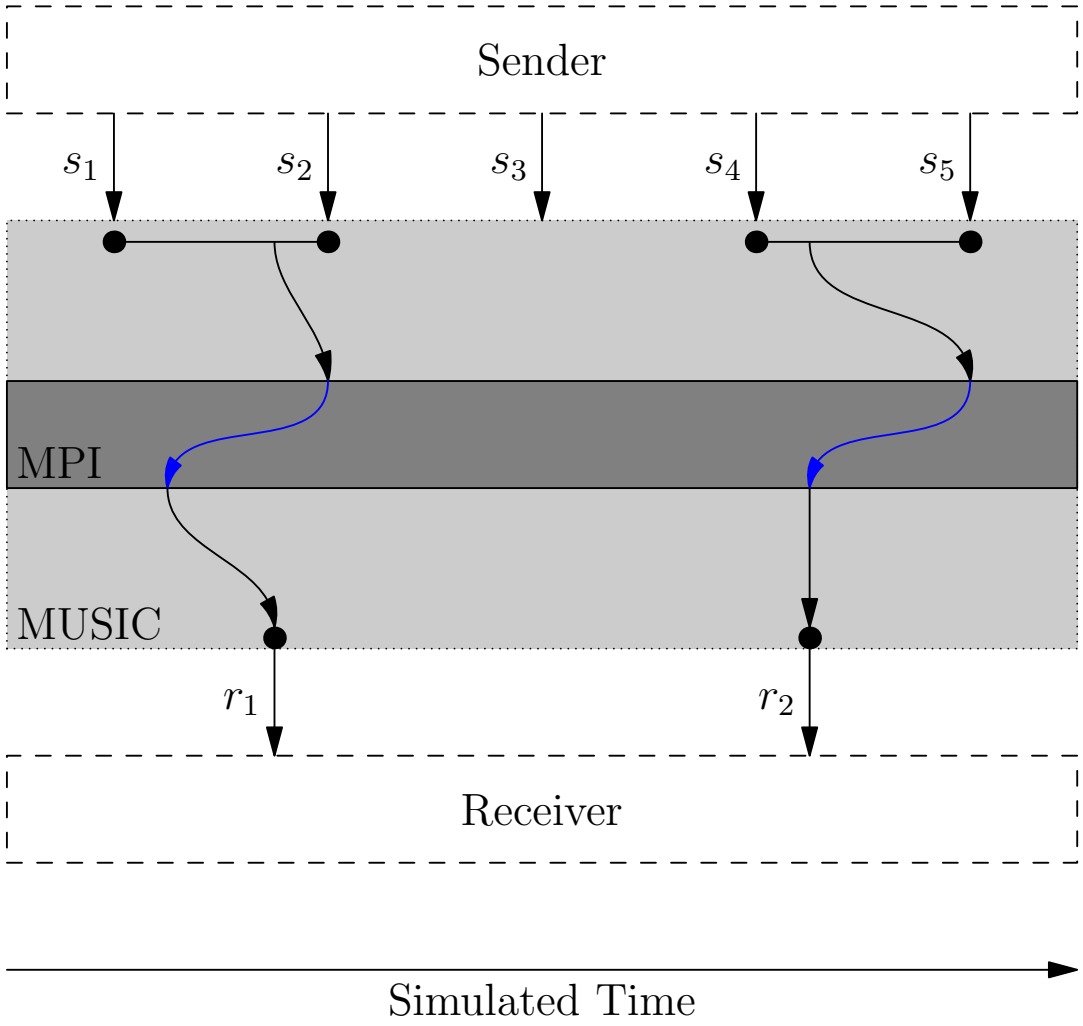
```
mpirun -np 11 music my_simulation.music
```

Spatial Aliasing—different distribution of data



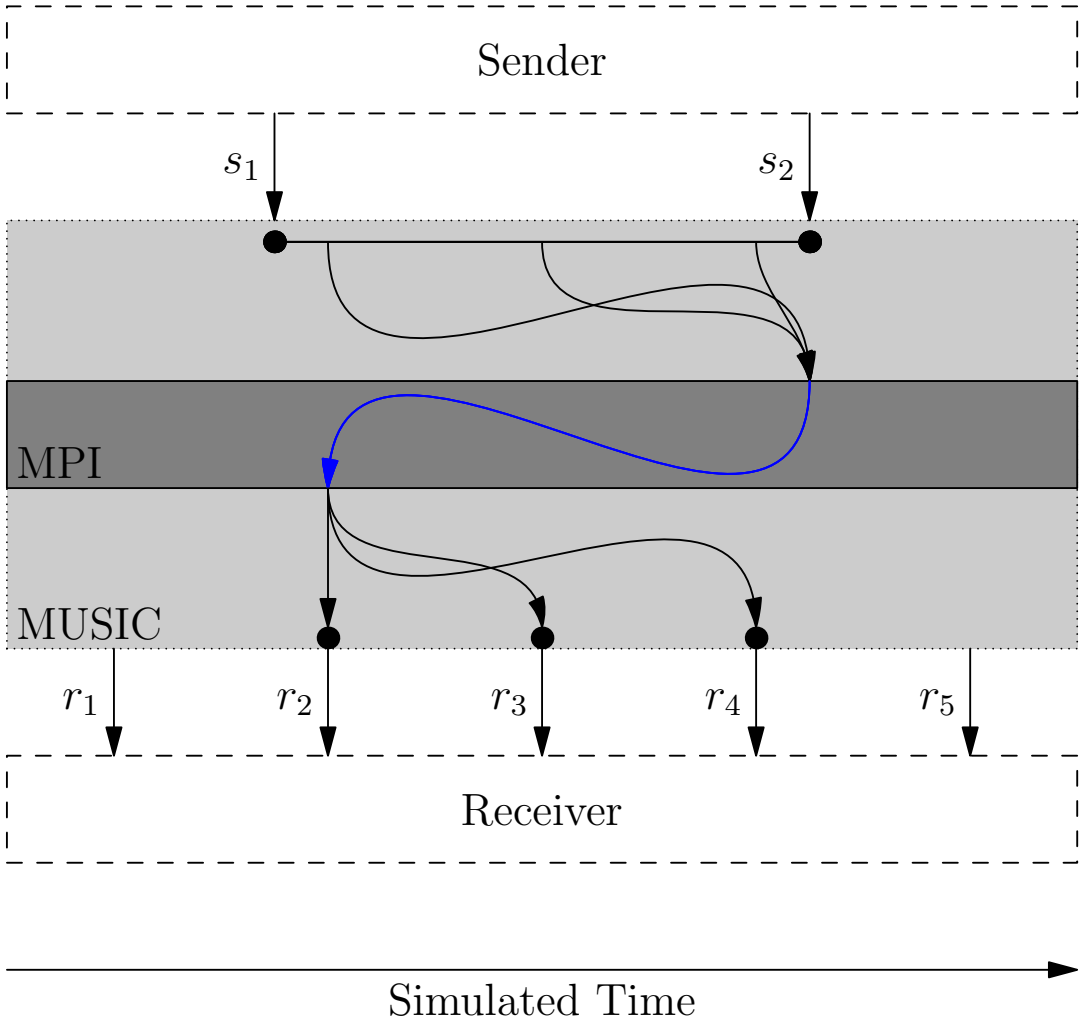
Temporal Aliasing—different time steps

Case 1: Sender ticking faster than receiver



Temporal Aliasing—different time steps

Case 2: Sender ticking slower than receiver



Developers View of MUSIC

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

Developers View of MUSIC

Each application is responsible for:

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

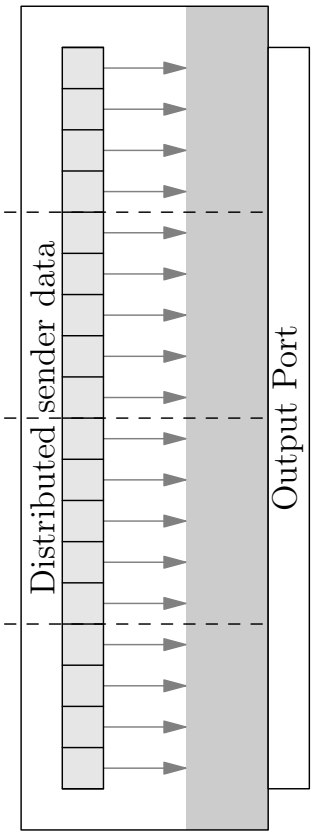
Developers View of MUSIC

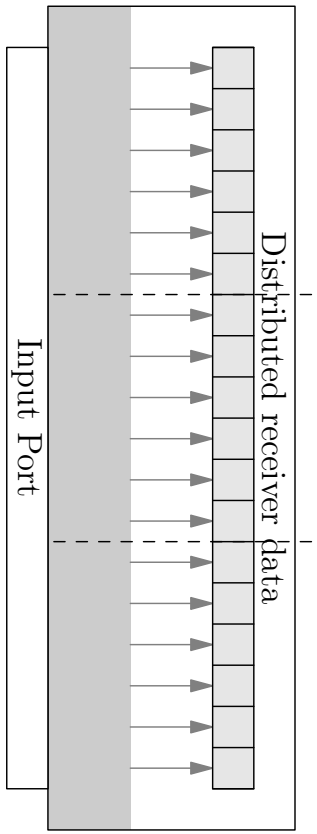
Initializing MUSIC

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

Developers View of MUSIC

Programs announce willingness to send or receive data via ports





Developers View of MUSIC

Creating and mapping a port

```
p = setup->publishContOutput ("out");

ArrayData m (state_vars, MPI::DOUBLE,
             mybase, mysize);
p -> map (&m);
```

Developers View of MUSIC

Supported Data Types

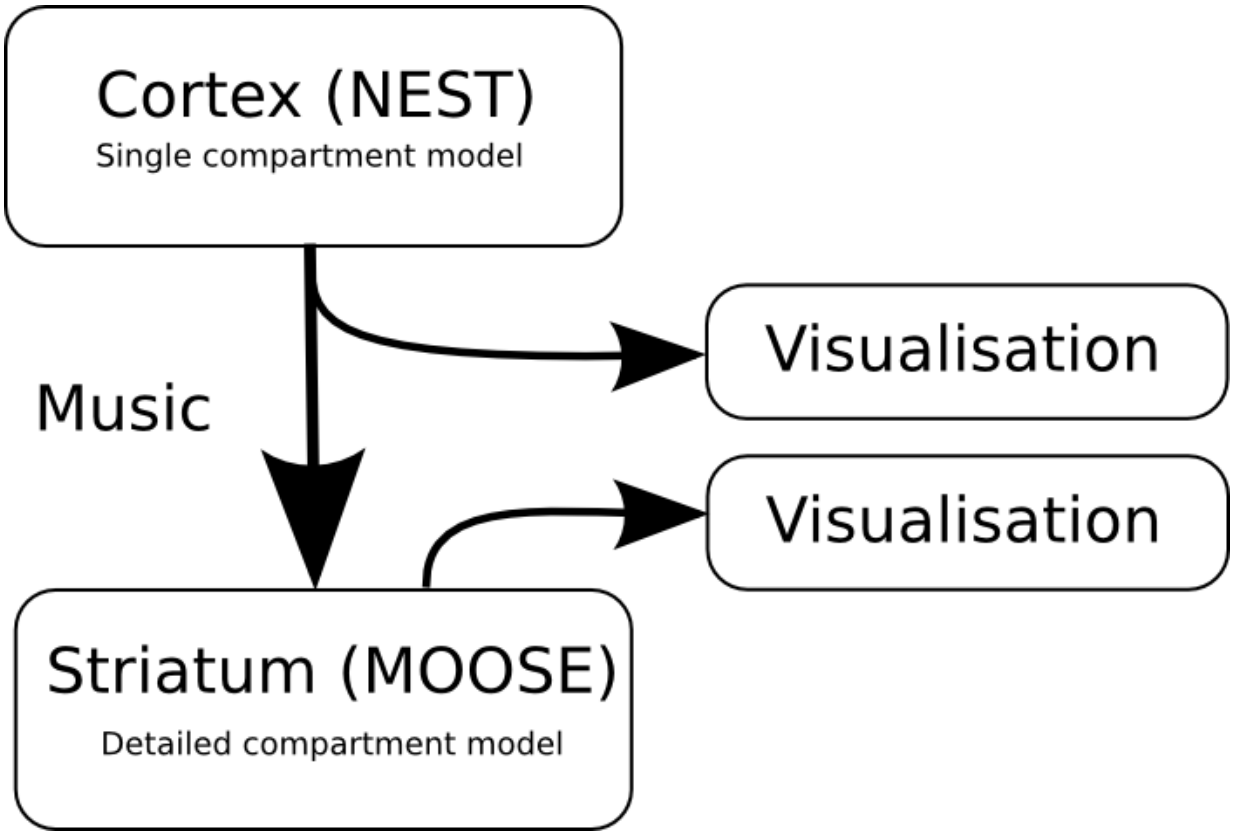
- Continuous — Time varying values
  - Sender: Reading from user data structures
  - Receiver: Writing into user data structures
- Events — Spikes
  - Sender: User calls an insertion function
  - Receiver: MUSIC calls user-supplied handler
- Messages — Arbitrary strings of bytes
  - Sender: User calls an insertion function
  - Receiver: MUSIC calls user-supplied handler

Developers View of MUSIC

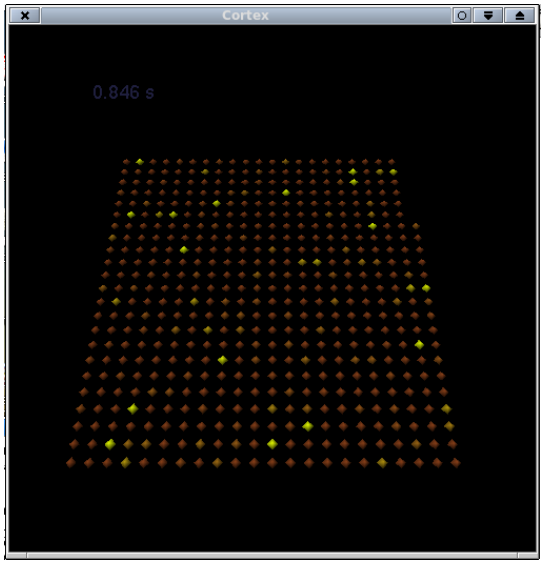
Initiating the runtime phase

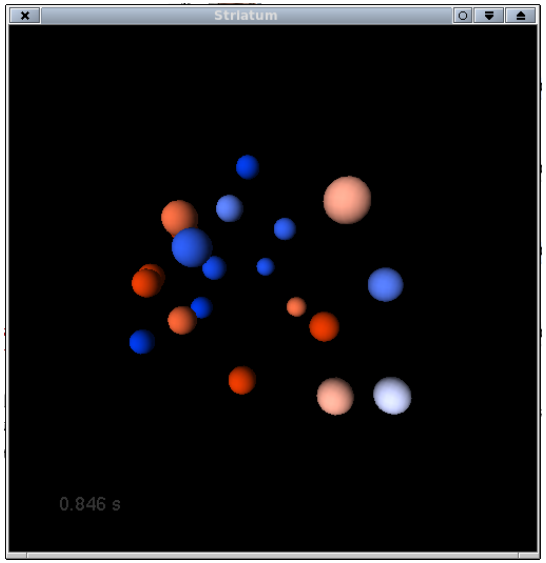
```
...
runtime = new MUSIC::Runtime (setup, 0.0001);

while (runtime->time () < stoptime)
  {
    ...
    runtime->tick ();
    ...
  }
```

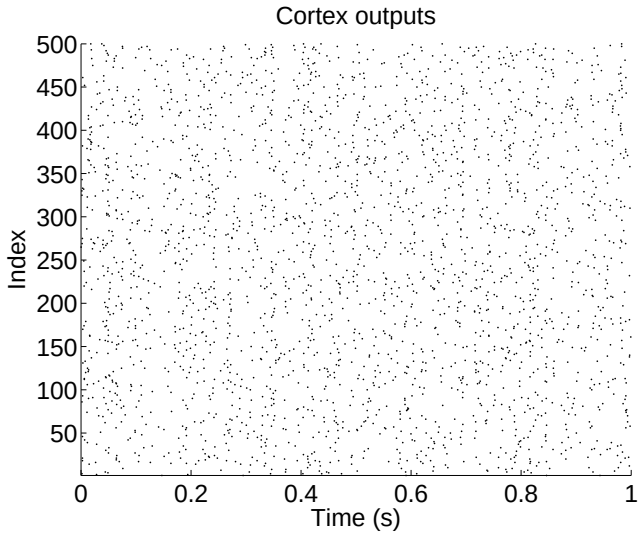
MUSIC Demo

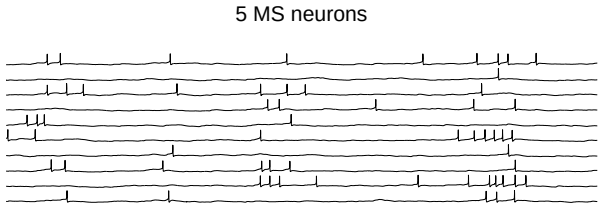


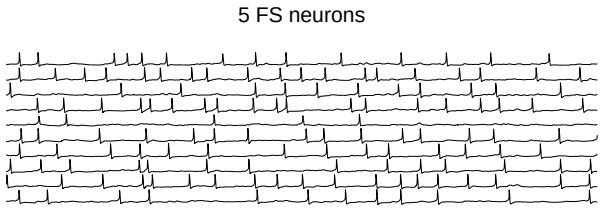
MUSIC Demo


Cortex
0.846 s

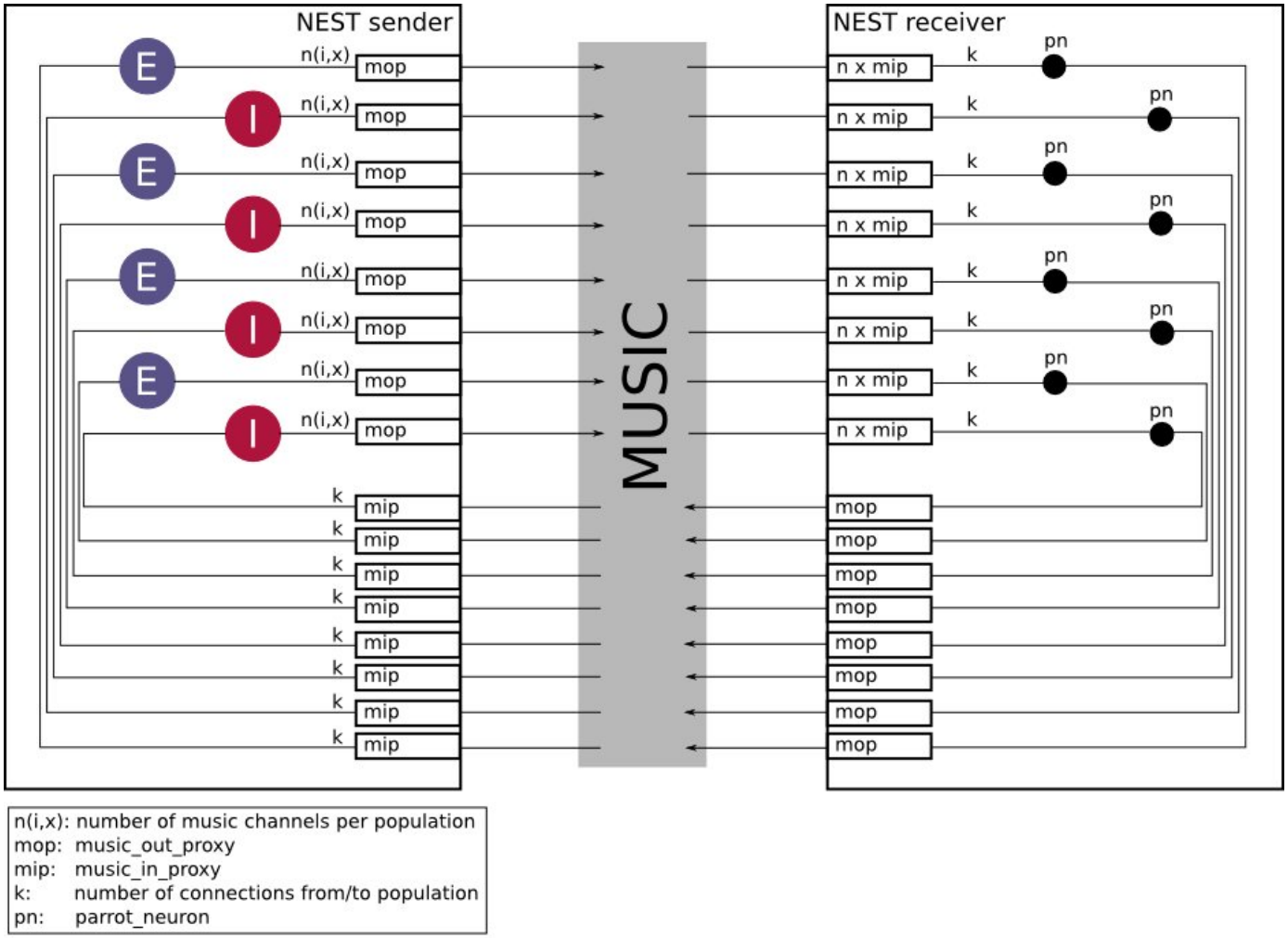

Striatum
0.846 s


Cortex outputs
Index
500
450
400
350
300
250
200
150
100
50
0
0.2
0.4
0.6
0.8
1
Time (s)


5 MS neurons

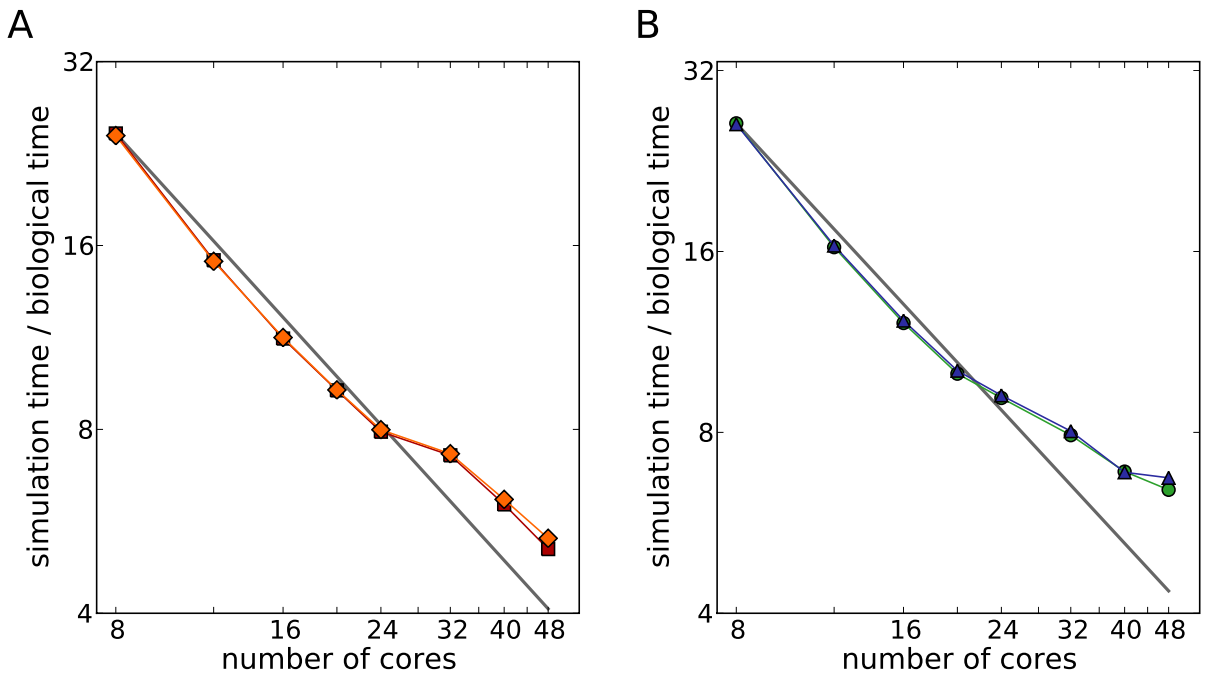

5 FS neurons

Benchmark



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

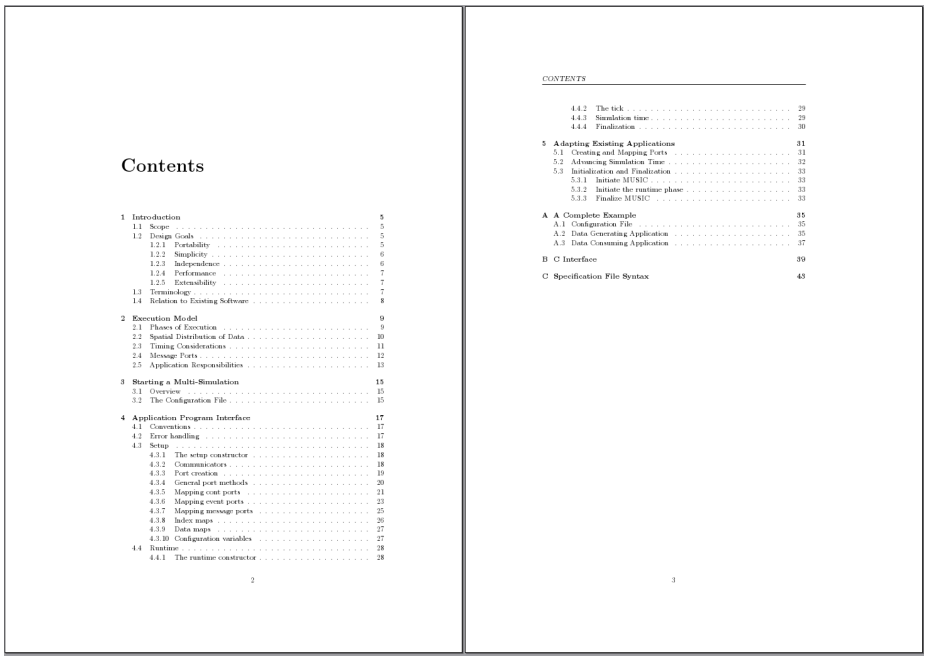
Benchmark


A
B
simulation time / biological time
number of cores
32
16
8
4
8
16
24
32
40
48

Status

- Released in the beginning of March, 2009
- Downloadable at the INCF Software Center

  http://software.incf.org
- Supported by the INCF
- Users manual

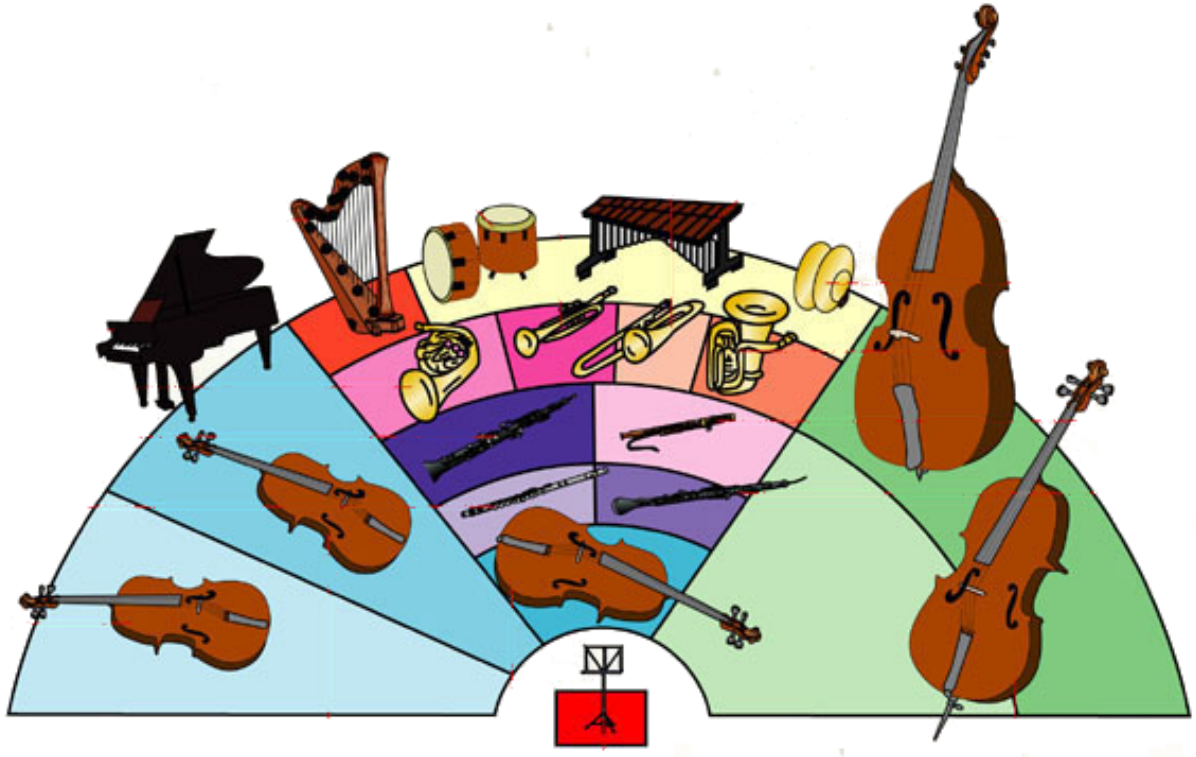


Contents

Status

Music interfaces:

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



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