Supernova: Multicore Support for SuperCollider

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Outline

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SuperCollider

- Object-oriented programming language, real-time safe, designed for audio synthesis.
- Audio synthesis server for dynamically changing synthesis graphs.
- Separation between language and server, communication via OSC.
- Written by James McCartney for MacOS9 in the 1990s.
- Released as open source in early 2000, ported to Linux by Stefan Kersten.

Modular System

Synthesis Server

Scsynth, audio synthesis server with OSC interface. **Supernova** is a drop-in replacement. Unit Generators are loaded as plugins.

Synthesis Control Language

Typically **sclang** with its class library. Alternative scsynth clients in other languages like scala, scheme, clojure, haskell, ...

Editors/IDEs

Scapp (OSX), Scate (Kate), Sced (Gedit), Scvim (Vim), Scel (Emacs), PsyCollider (windows), Eclipse.

GUI Systems

Cocoa (Scapp), Swing (Java), Qt.

Some SC Concepts I

SynthDefs

Instrument definitions, created in the language, loaded into the server.

Synths

SynthDef instantiation on the server.

Busses

Server-side routing system, used for synth communication.

Some SC Concepts II

- "There's more than one way to do it"
- Raw OSC Communication, Classes, Events, Patterns, JitLib.
- Many implicit assumptions and syntactic sugar.

Synth

Listing 1: Creating Synths

```
// Raw OSC Messages
s.sendMsg("/s_new", "default", s.nextNodeID, 0, 1);

// SCLang nodes
a = Synth.new(\default); a.set(\freq, 442)

// Events
().play; (freq: 440).play // implicit

// Functions
{
    Pulse.ar(440 ! 2,
        LFTri.kr({Rand(0.1, 0.2)}! 2)) * 0.1;
}.play
```

Patterns

Listing 2: Patterns

```
// Patterns
p = Pmono(\default,
    \dur, Pwrand([0.4, 0.05, 0.025],
        [0.5, 2, 2].normalizeSum,
        inf),
    \degree, Pseq([
        Prand([0, 2, 3, 5], 6),
        Prand([0, 4, 6], 6)
    ], inf),
    \pan, Prand([-1, 0, 1], inf),
    \scale, Scale.new((0..11), 12, \just)
).play
```

SC Node Graph

Groups

Lists of nodes, define order of execution, address multiple nodes as one entity.

Nodes

Synths and Groups.

Node Hierarchy

Nodes form a tree hierarchy, each server has a root group and a node tree.

Order of Execution

User is responsible to ensure correct node order

Listing 3: Node Ordering

```
g = Group(s);
a = Synth.head(g, \default);
b = Synth.after(a , \fx);
```

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Supernova

- Reimplementation of scsynth with a multiprocessor-aware synthesis engine.
- Loads slightly patched unit generators.
- Implements Node Graph Extensions to express parallelism explicitly.

Parallel Groups

- Groups without node ordering constraint
- Group elements can be executed in parallel
- Parallel groups can be nested to build more comples structures

Parallel Groups - An Example

Listing 4: Node graph with 4 generators and 1 effect

```
var gen_group, fx;
gen_group = ParGroup.new;
4.do {
    Synth.head(gen_group, \myGenerator)
};
fx = Synth.after(gen_group, \myFx);
```

Parallel Groups

Pro:

- Easy to use & understand
- Compatible with groups

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Contra:

- User has to ensure correctness
- Each node has two dependency relations

Beyond Parallel Groups

- Parallel Groups at not optimal for all use cases
- Some synths just need ordering constraints in relation with one node
- Synths without input signals (generators)
- Synths without output signals (peak meters, disk/sample recording synths)

Beyond Parallel Groups

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satellite nodes

Satellite Nodes - Proposed Interface

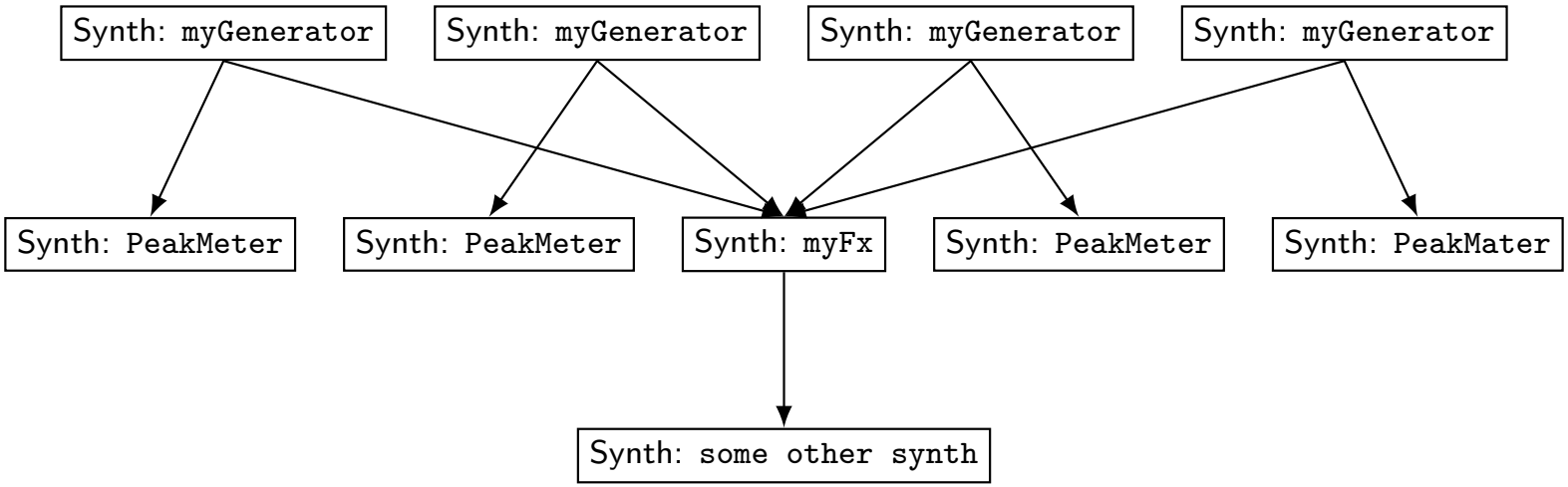
- 2 new node constructors: `Node.preceding` & `Node.succeeding`
- 2 new add actions

Listing 5: Satellite node example

```
var fx = Synth.new(\myFx);
4.do {
    var gen = Synth.preceding(fx,
        \myGenerator)
    Synth.succeeding(gen, \peakMeterSynth)
};
```

Satellite Nodes - Dependency Graph

Figure: Dependency Graph for Satellite Nodes Example



Satellite Nodes - Semantics

- **Satellite nodes** are ordered in relation with one other node
- Each node can have multiple **satellite predecessors** and **satellite successors**
- Satellite nodes may have satellite nodes themselves
- Satellite nodes can be addressed by the parent group of their reference node
- Satellite nodes are freed, if their reference node are freed.

Satellite Nodes

Pro:

- Increases the parallelism for many use cases
- Optimized for 'node graph progress': Satellite nodes have a lower priority than other nodes
- The combination of satellite nodes and parallel groups can handle most use cases in a nearly optimal manner

Contra:

- Incompatible with scsynth (unless one implements it!)
- Increased complexity (dependency graph vs hierarchy tree)
- Experimental implementation in Supernova

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Best Practices

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- Avoid scheduling overhead: don't parallelize light-weight work like control-rate synths.
- Avoid contention: accessing to the same resources from parallel synths may harm the performance.
- Do not use satellite nodes if the code should run on scsynth.
- Parallel groups are well tested, satellite nodes are experimental.

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SuperCollier 3.5

SuperCollider 3.5 will be a **big** release!

- Migration to git and cmake
- Supernova: alternative to scsynth
- QtCollider: new cross-platform GUI system based on Qt
- ScDoc: new help system

QtCollider

- Developed by Jakob Leben, merged late 2010
- Qt-based implementation of the Cocoa widgets
- Better sclang integration, cocoa compatibility and responsiveness compared to SwingOSC.

ScDoc

- Developed by Jonatan Liljedahl, merged early 2011
- Browser-based doc system with on-the-fly rendering
- Simple markup language

Conclusion

Thanks!
Questions?

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