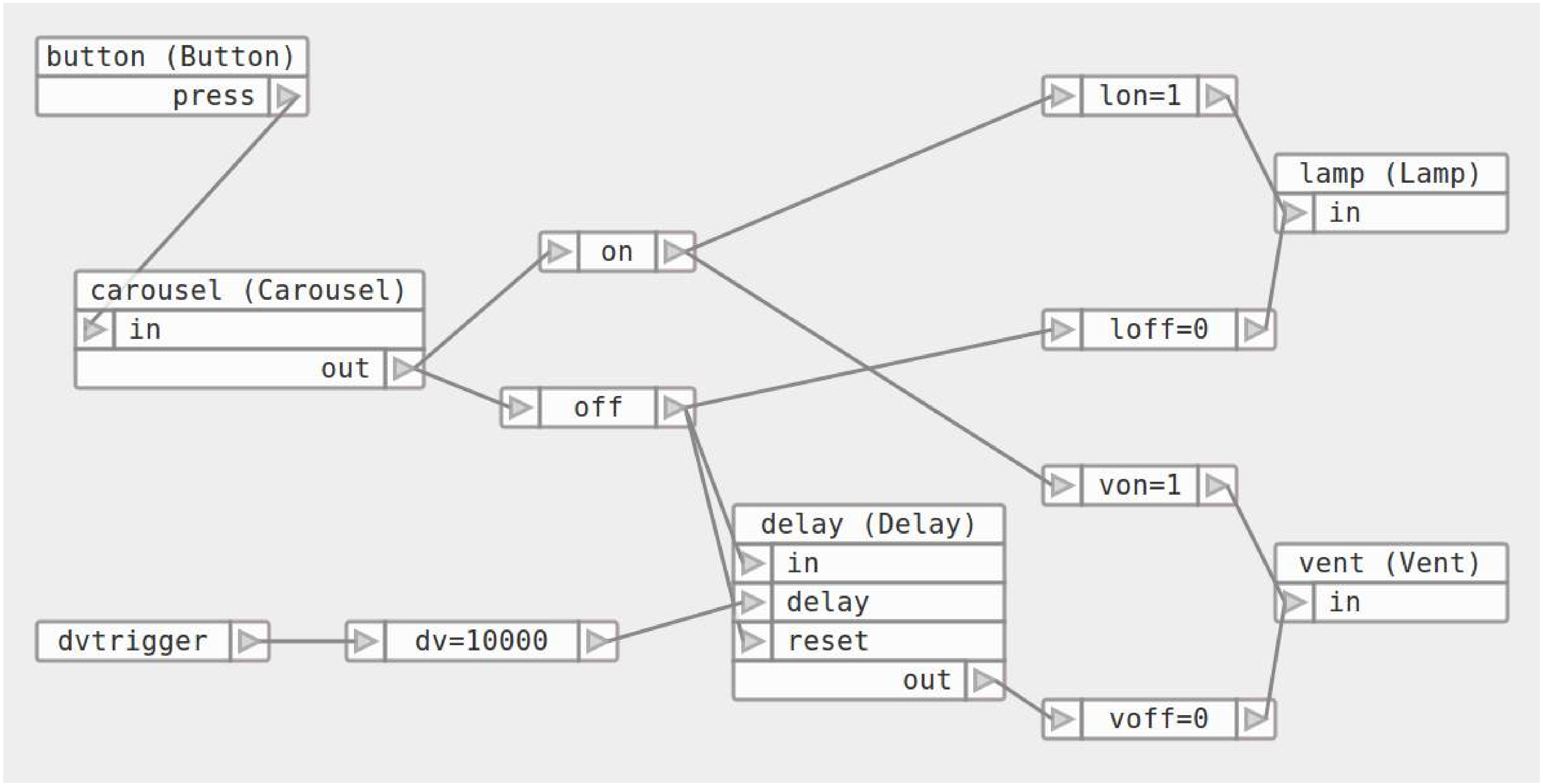
Dataflow Programming



ern0 - http://linkbroker.hu

Basics

Definition
Component & Port
Data Types
Source, Processor, Sink

Advanced

Component: Native vs Composite
Scheduling: Synchronous vs Asynchronous
Triggering: Push vs Pull
Execution: Parallel, Multi Host

Dataflow Systems

Unix Pipe, Spreadsheet, Make etc.

Practice

App Creating vs Programming, Component Programming, Application Building

Benefits

Rapid Prototyping, Reusability, Transparency

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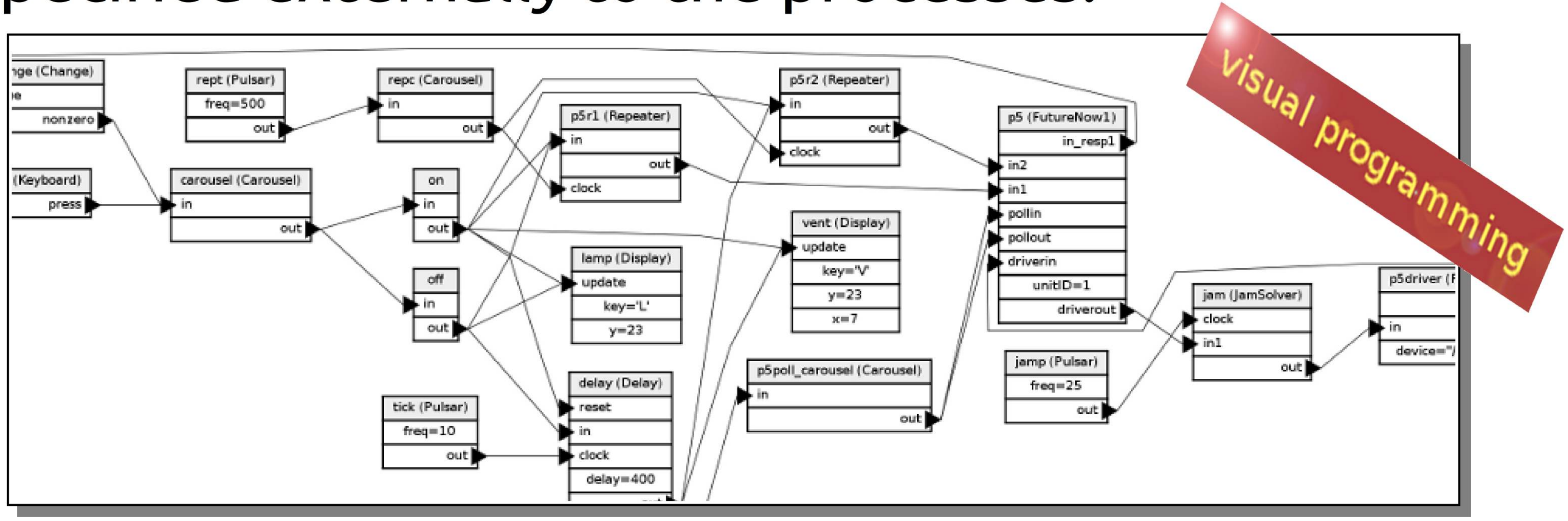
Definition

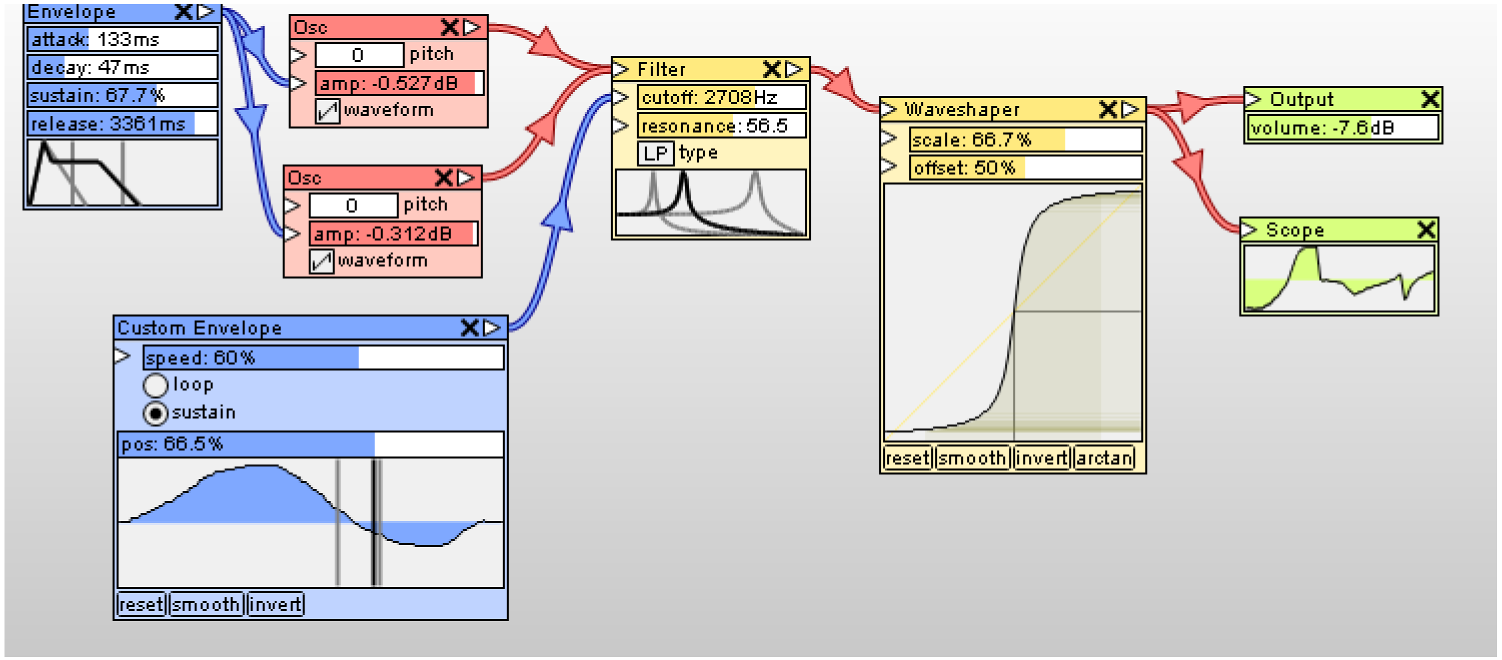
Programming paradigm / software architecture: computation is modelled as a directed graph.

Applications is a network of "black box" processes, which exchange data across predefined connections by message passing, where the connections are specified externally to the processes.



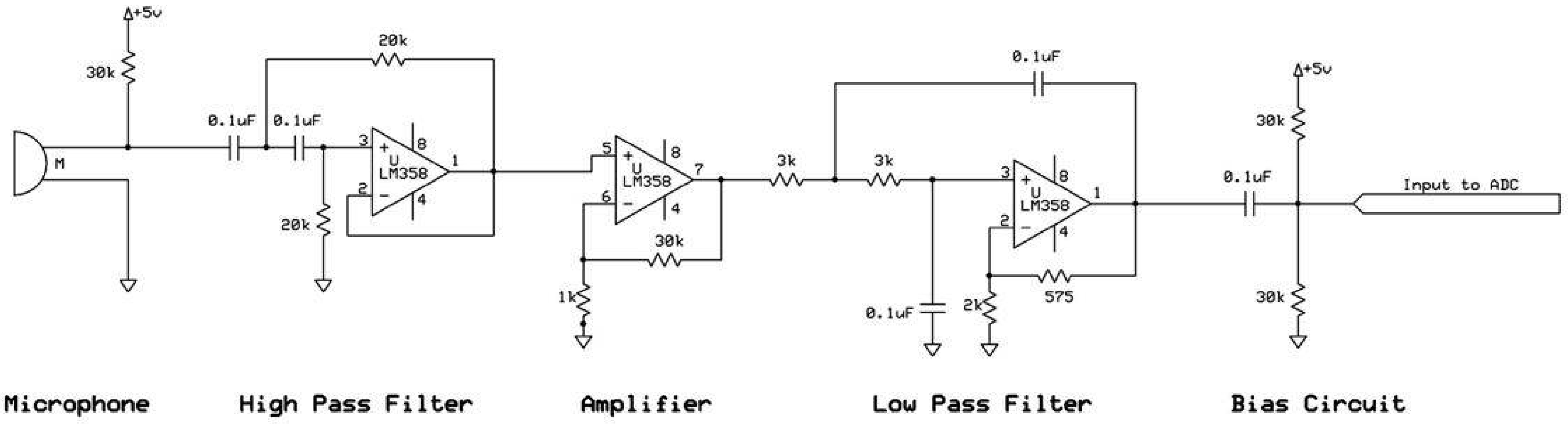
Domains

- Synth/sampler/workstation
- Audio/video processing
- Animation rendering
- Industrial/home automation
- Spreadsheet
- Task automation



Similar, See Also...

Flow Based Programming
Reactive Programming
Functional Programming
Event-Driven Programming
PLC (Ladder Logic, Functional Block Diagram)
Microservices
Kahn Process Networks, Petri Net
Electricity
etc.



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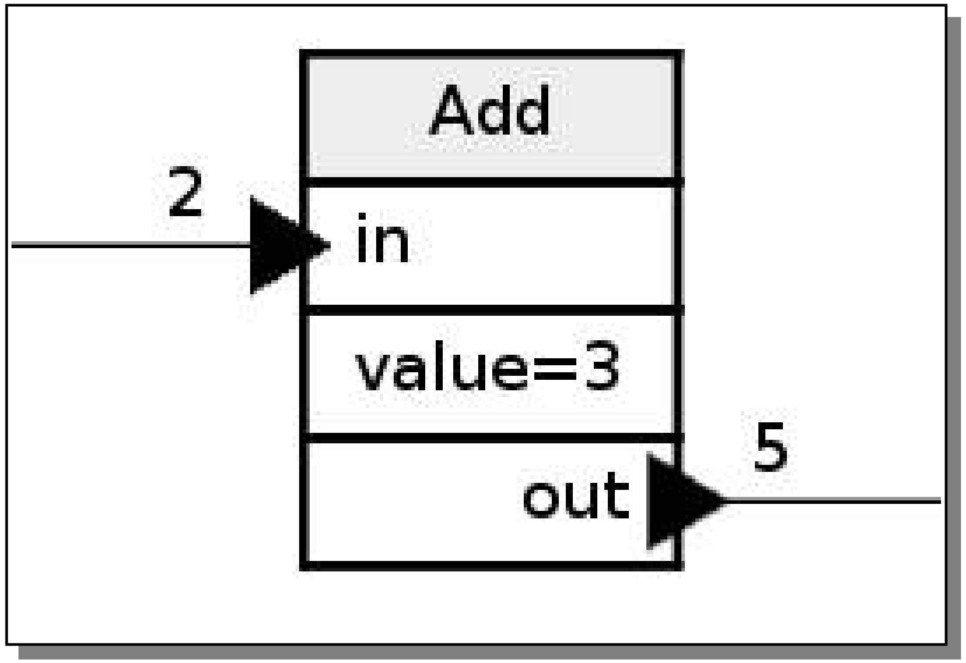
Component & Port

- consumer (input)
- property / parameter
- producer (output)

Component library:
platform, “language”



stateful components

APPROVED

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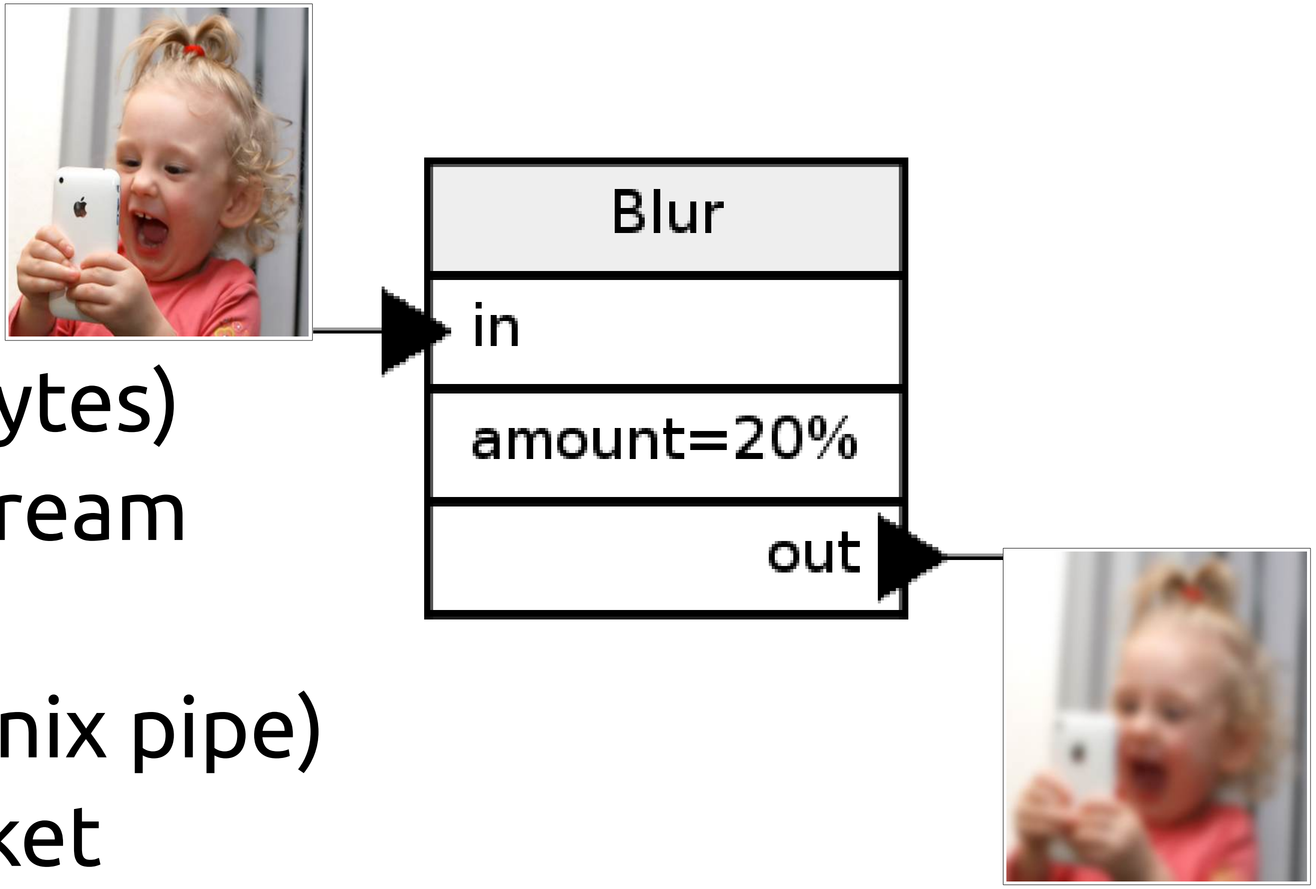
Data Types

- Trigger
- Integer
- Packet (some bytes)
- Image, video stream
- Audio stream
- Lines of text (Unix pipe)
- Composite packet



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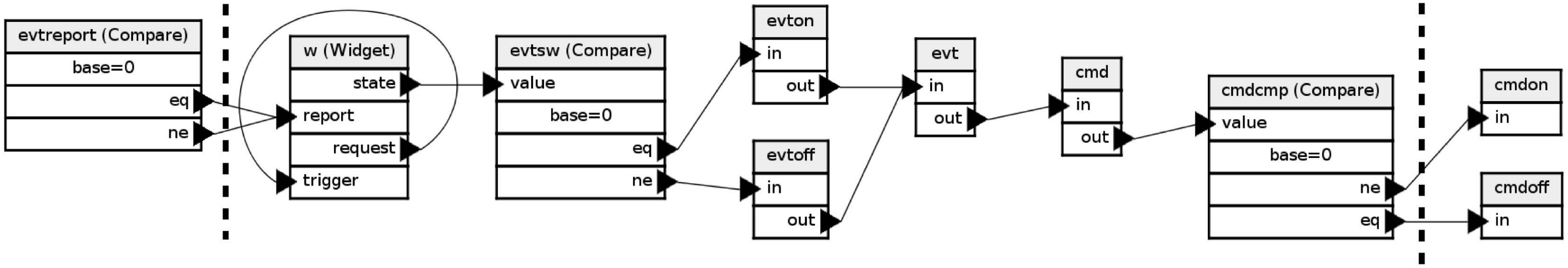
Component Function Types



source	processor	sink
external input	data process	result presentation
import, feed	transform	export
network receive	path select	network send
	process control	

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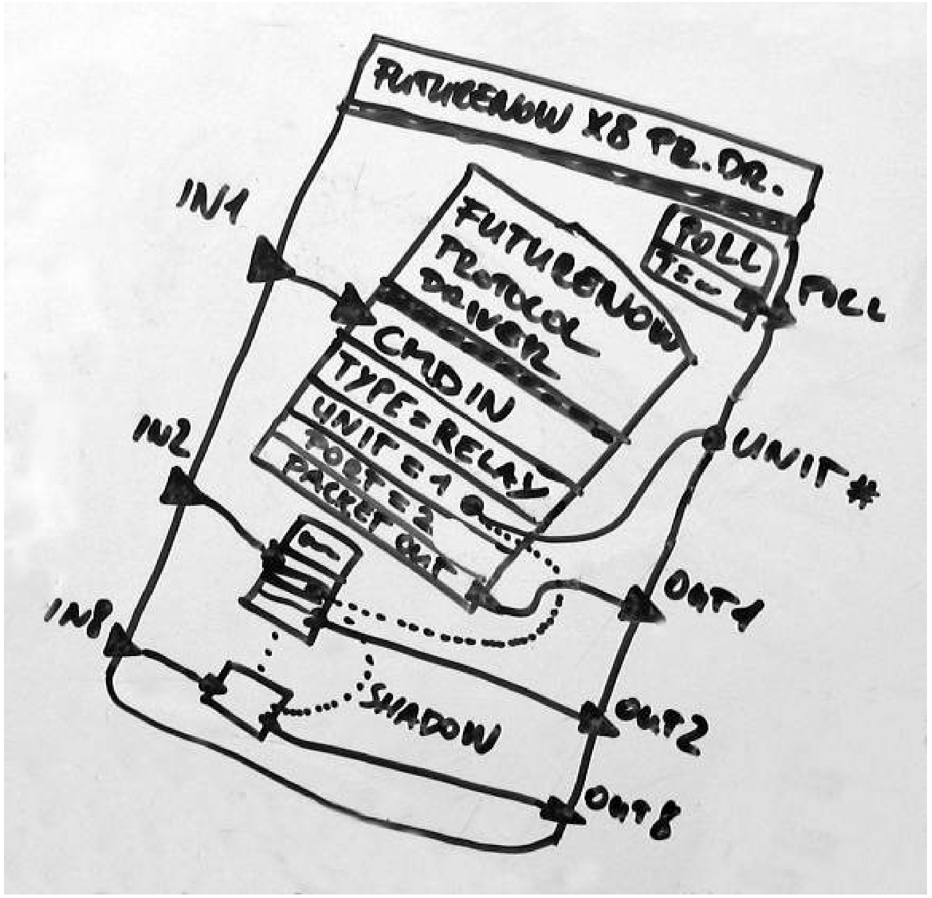
Component Implementation Modes

Native

```
class ChangeComponent {

  void messageHandler(Msg* message) {

    int v = message->getValue();
    int l = last->getValue();

    if (v == l) return;
    last->setValue(v);

    changePort->fire(v);

    if (v == 0) {
      zeroPort->fire(v);
    } else {
      nonzeroPort->fire(v);
    }

  } // messageHandler()

} // class
```

Composite



unlimited depth

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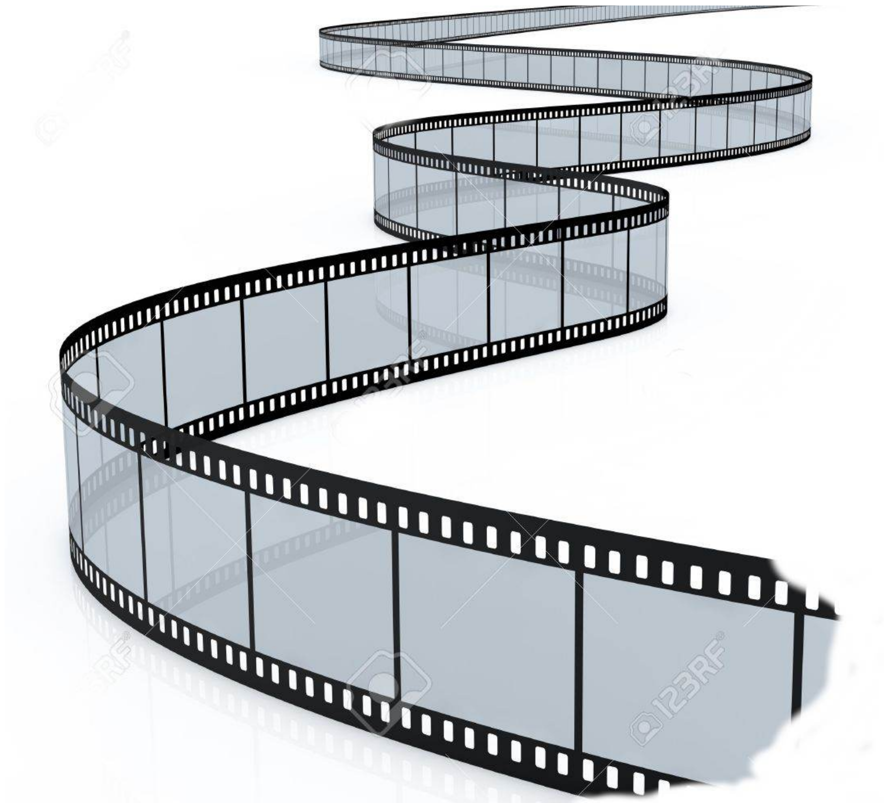
Scheduling Modes

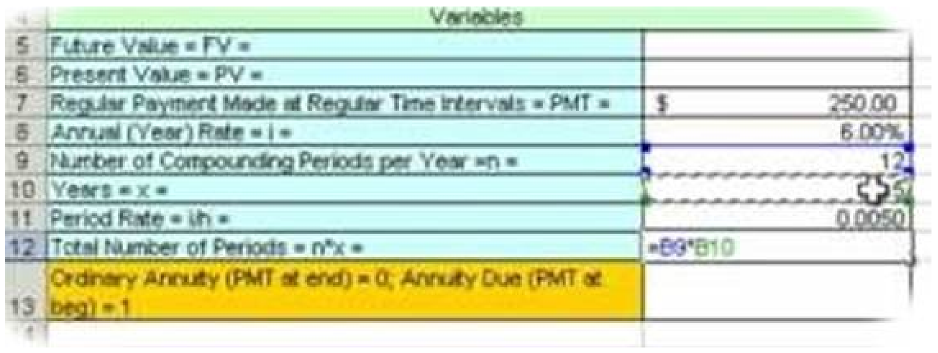
Synchronous

system clock



Asynchronous

trigger



	Variables	
5	Future Value = FV =	
6	Present Value = PV =	
7	Regular Payment Made at Regular Time Intervals = PMT =	$ 250.00
8	Annual (Year) Rate = i =	6.00%
9	Number of Compounding Periods per Year =n =	12
10	Years = x =	5
11	Period Rate = i/n =	0.0050
12	Total Number of Periods = n*x =	=B9*B10
13	Ordinary Annuity (PMT at end) = 0; Annuity Due (PMT at beg) = 1	

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Triggering Modes

Push	Pull
data/event driven	demand driven
active source component	passive source component
overload, unneeded messages	response delay, improper sampling

buffering

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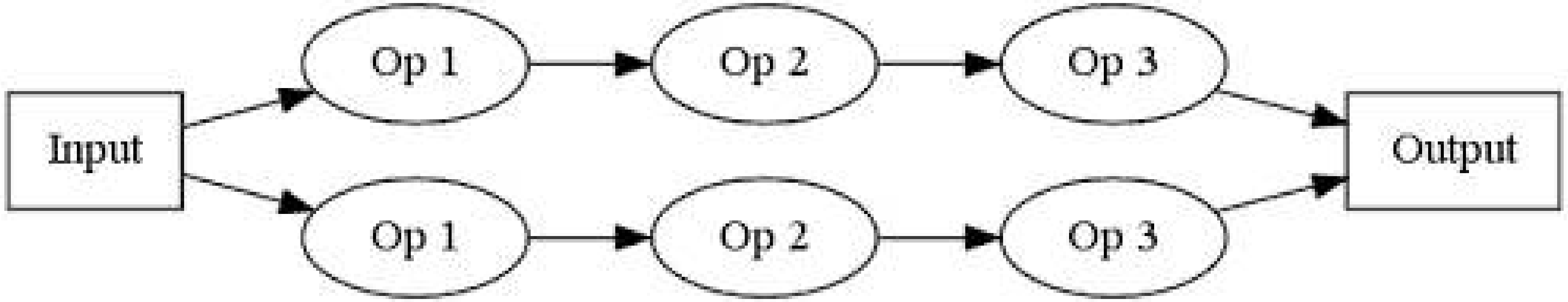
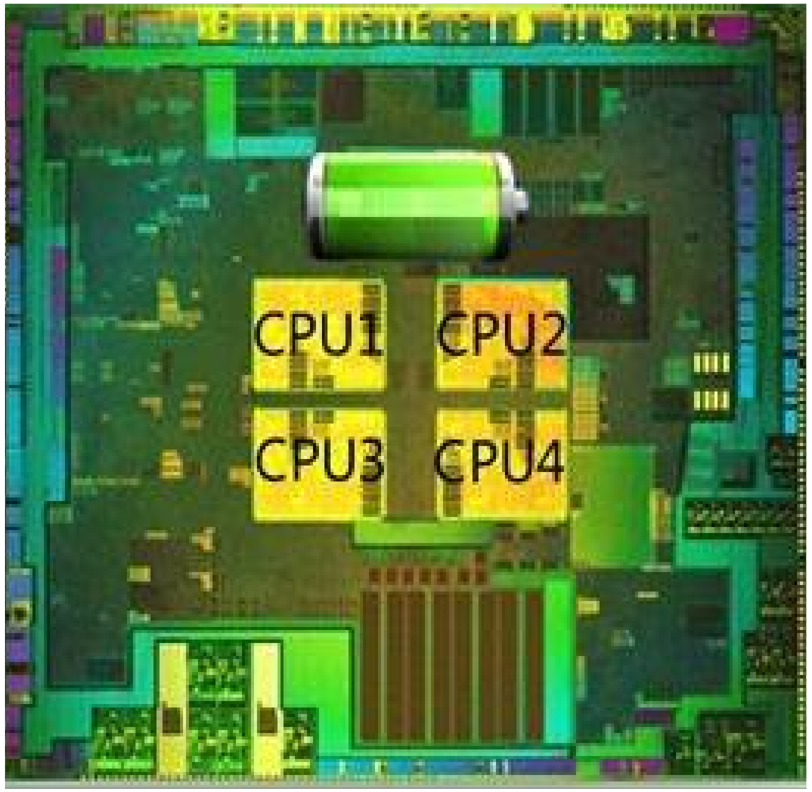
Parallel Execution



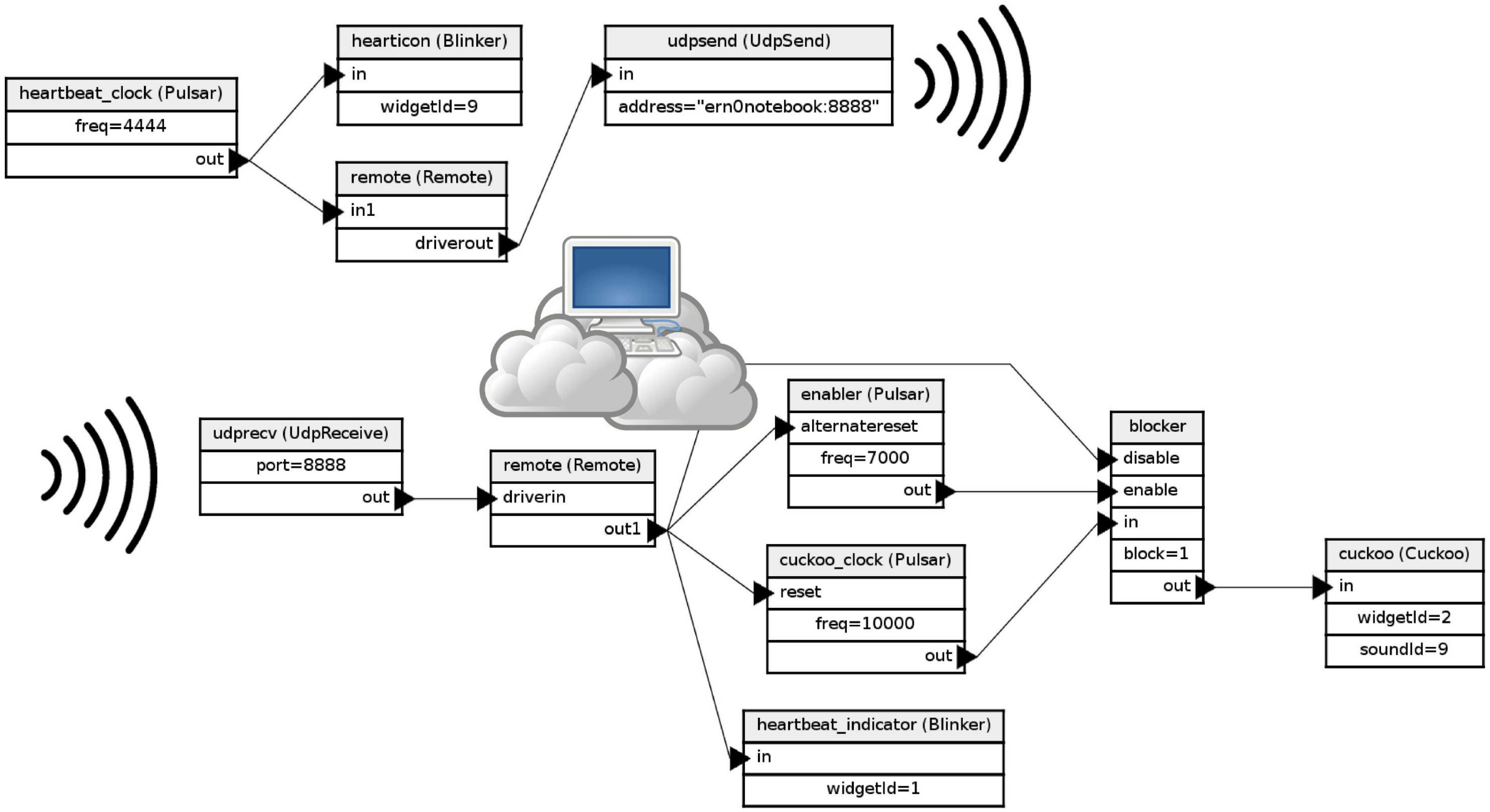
Converts single-threaded algorythms to multi-threaded

Load balancing, merging problems

Utilizes multi-core CPUs



Multi-host Application



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Dataflow Systems

Unix Pipe, Spreadsheet, Make etc.

Practice

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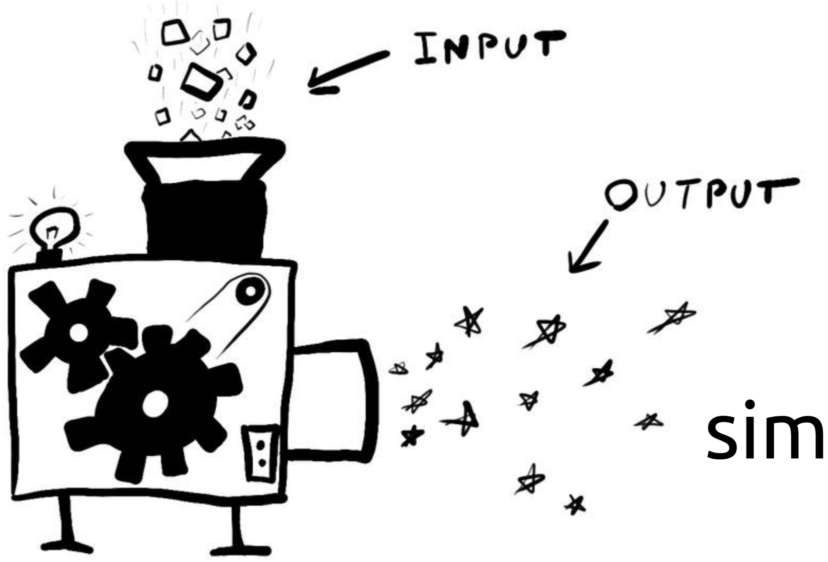
Benefits

Rapid Prototyping, Reusability, Transparency

Unix Pipe

- All the commands are components by default
- One, universal data type: lines of text
- Restricted graph: 1-in-1-out (+ files)
- No editor required, CLI syntax (c1 | c2 | c3)
- Parallel execution (check it: ps)
  (MS-DOS: single, using tmp files)



/bin/cat
/usr/bin/tee

simple architecture

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Dataflow Systems

Unix Pipe, **Spreadsheet**, Make etc.

Practice

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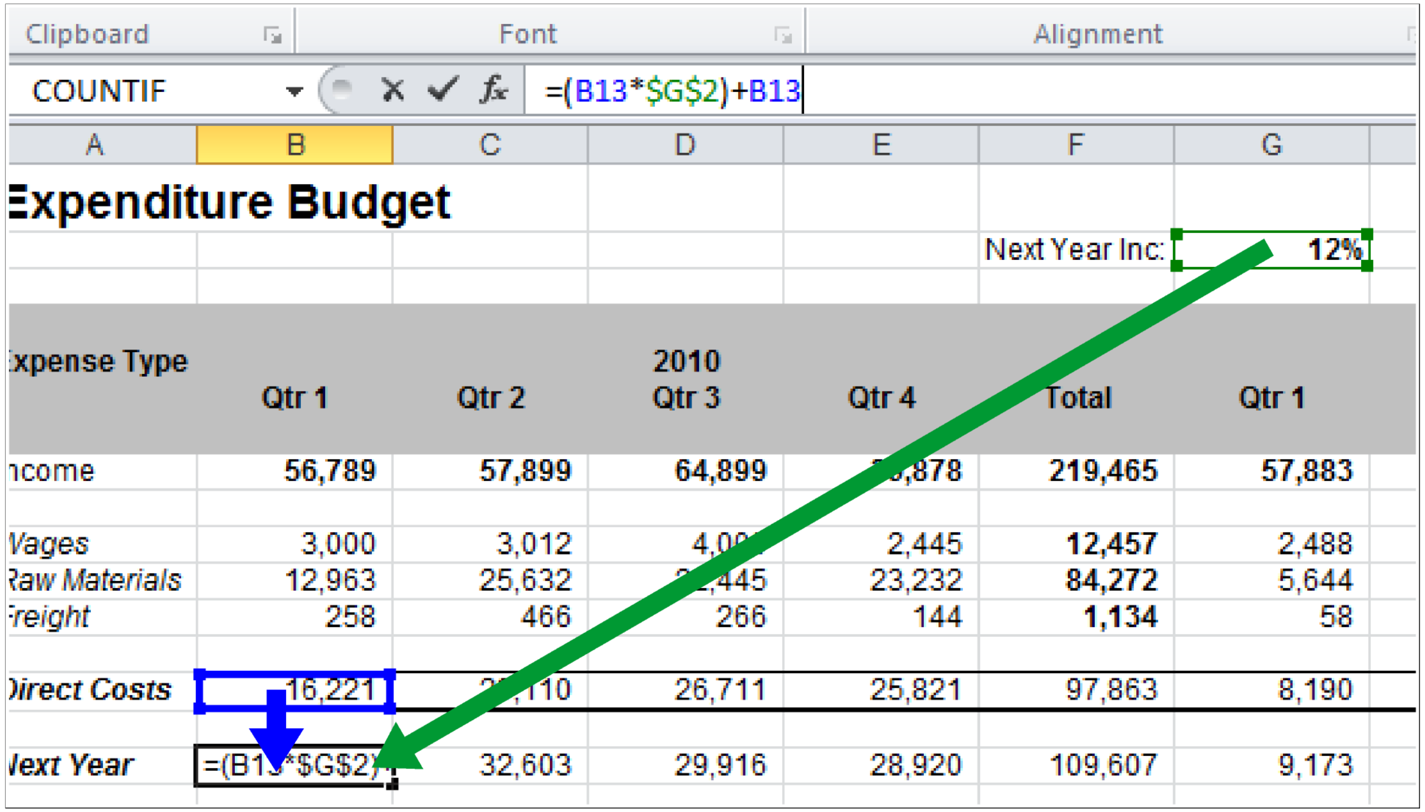
Spreadsheet

- Formula components (issue: no repository)
- Data types: numeric, date, string
- Graph defined by 2D+ cell coordinate references



COUNTIF | =(B13*G2)+B13

A	B	C	D	E	F	G
Expenditure Budget						
					Next Year Inc:	12%
xpense Type			2010			
	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Total	Qtr 1
ncome	**56,789**	**57,899**	**64,899**	**[illegible],878**	**219,465**	**57,883**
Vages	3,000	3,012	4,0[illegible]	2,445	**12,457**	2,488
Raw Materials	12,963	25,632	[illegible],445	23,232	**84,272**	5,644
reight	258	466	266	144	**1,134**	58
Direct Costs	16,221	[illegible],110	26,711	25,821	97,863	8,190
Next Year	=(B1[illegible]*G2)	32,603	29,916	28,920	109,607	9,173

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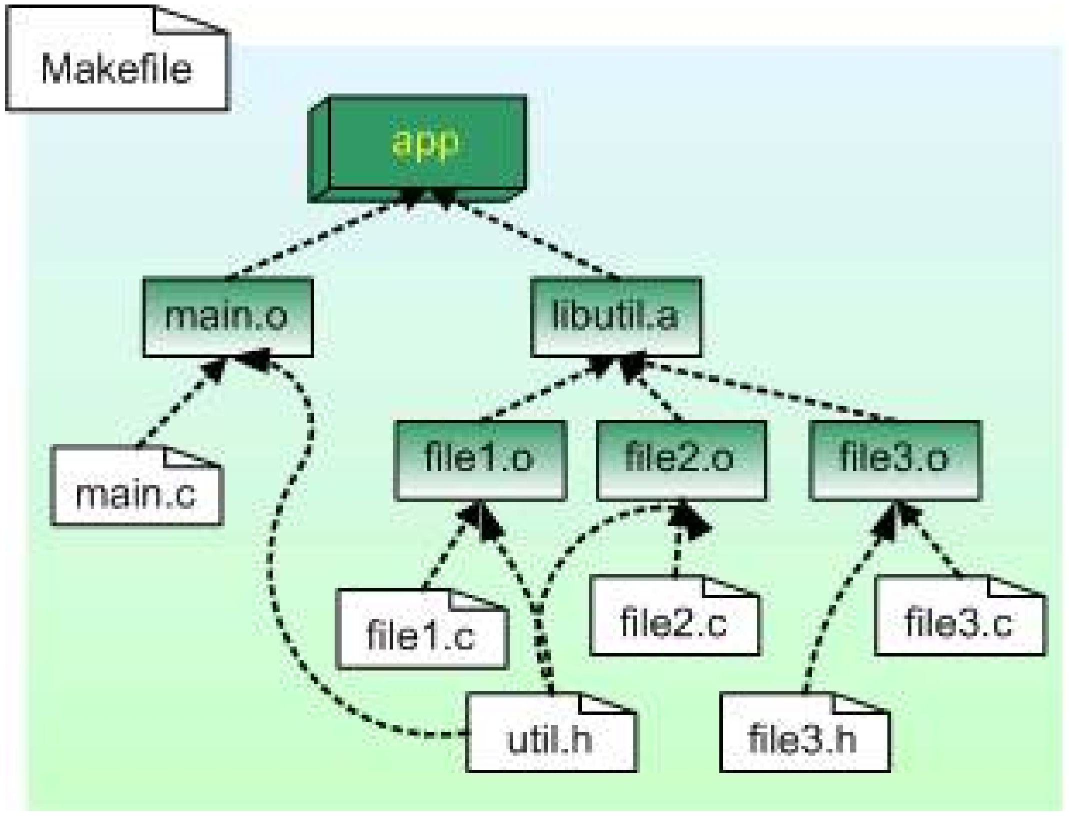
Make

- Component: job (compiler script)
- Data: file (sources, objects, executable)
- Dependency tree
- Parallel execution

make -j



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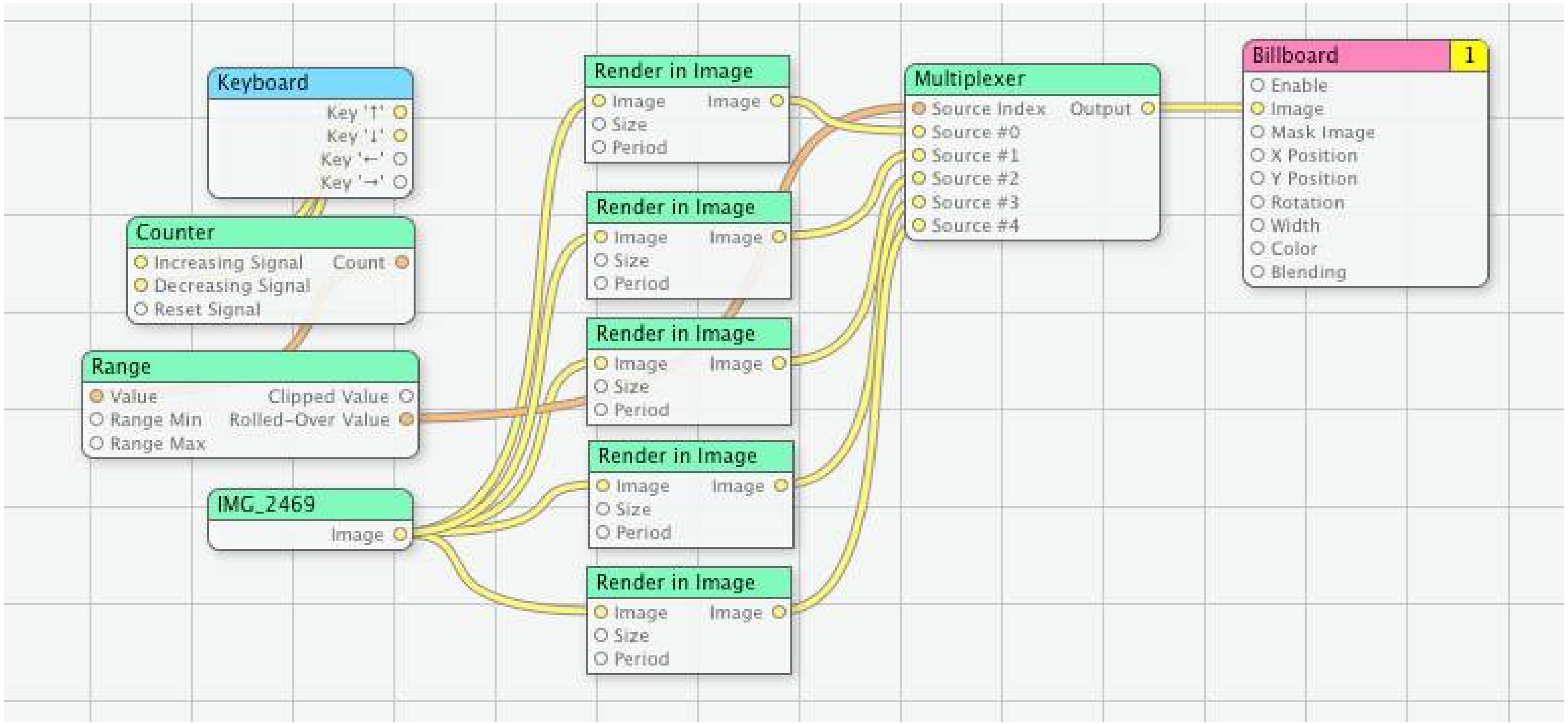
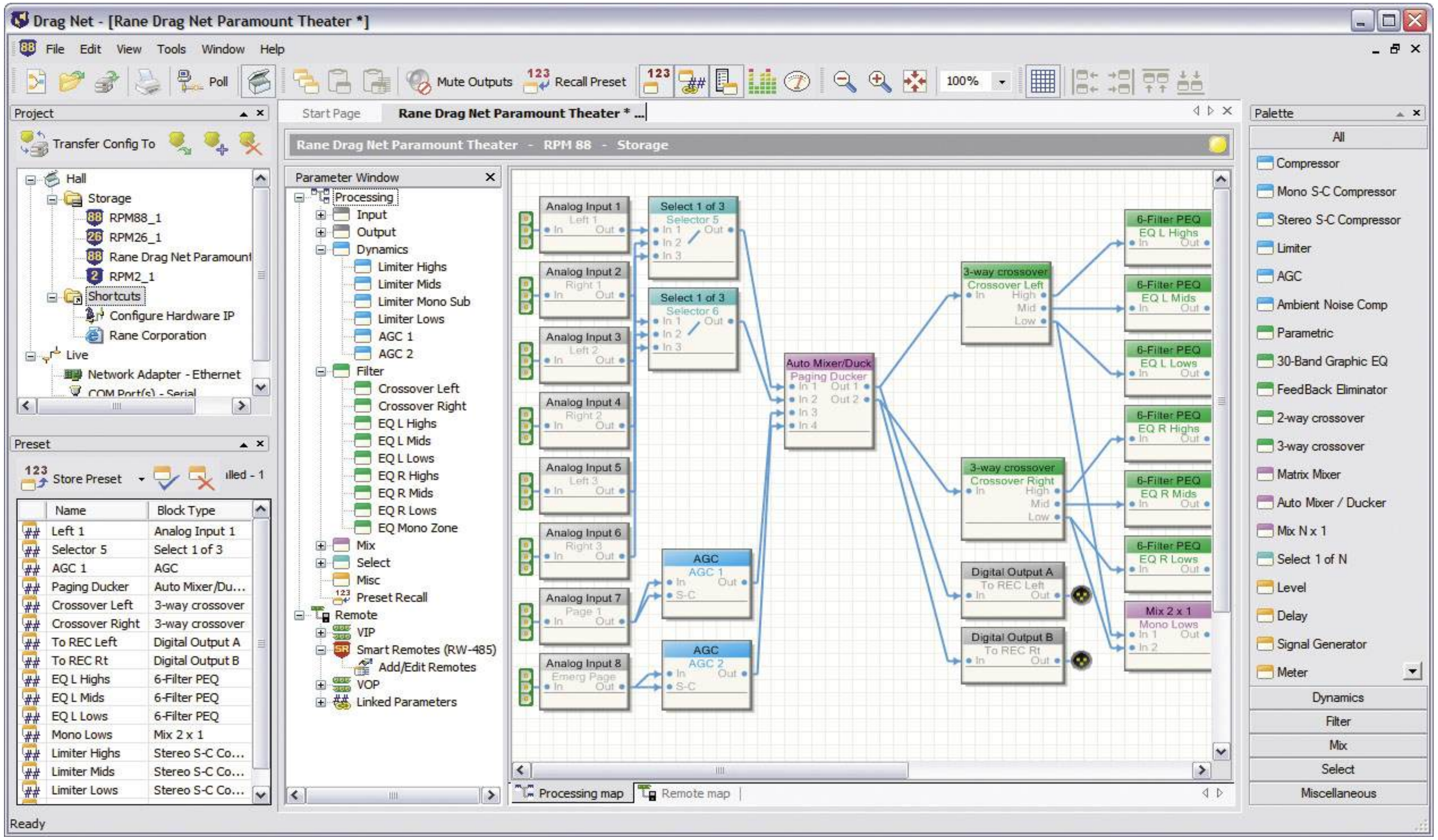
Quartz Composer

- Graphics purpose
- Comes with Mac OS X



Rane DragNet

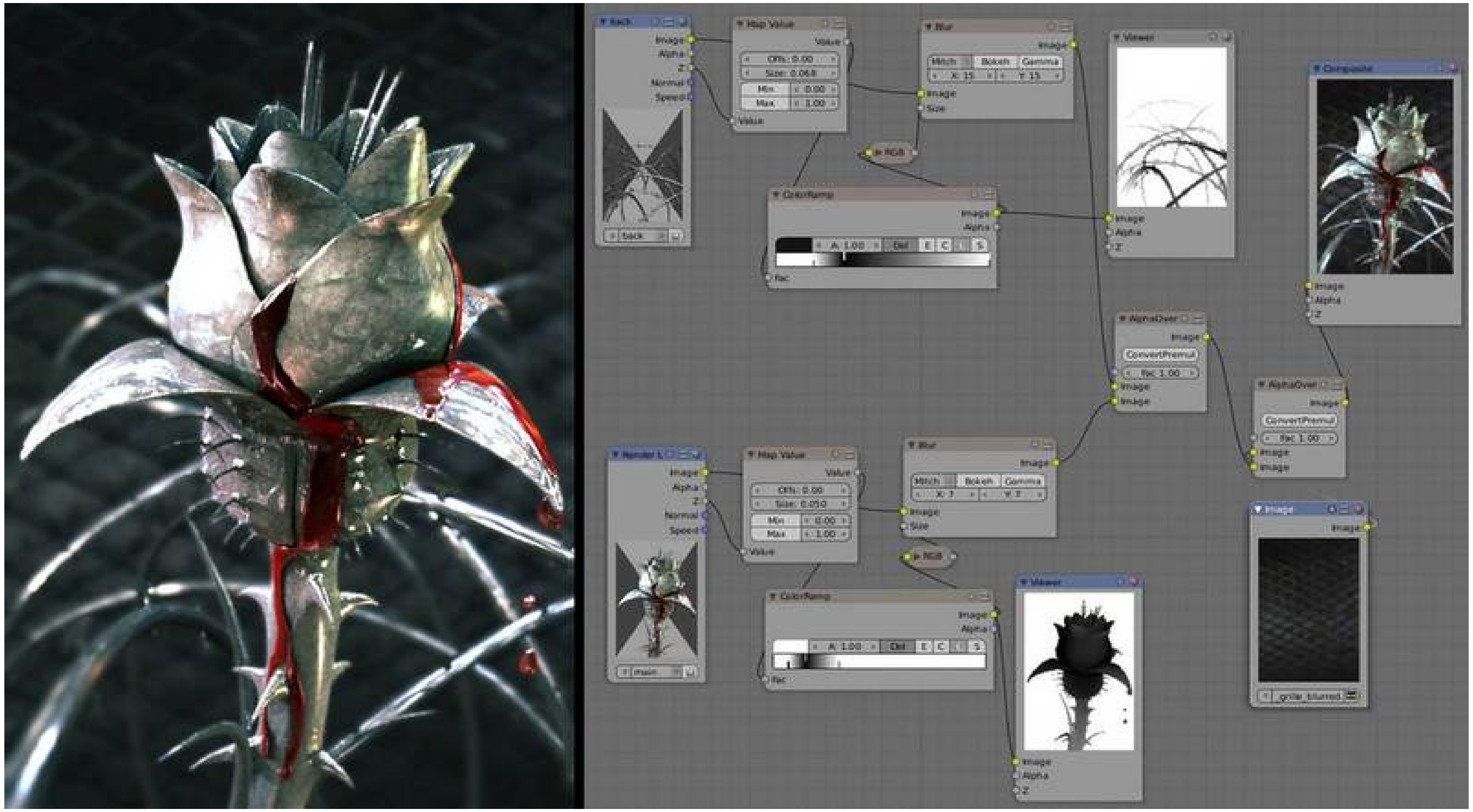
Audio system



Name	Block Type
Left 1	Analog Input 1
Selector 5	Select 1 of 3
AGC 1	AGC
Paging Ducker	Auto Mixer/Du...
Crossover Left	3-way crossover
Crossover Right	3-way crossover
To REC Left	Digital Output A
To REC Rt	Digital Output B
EQ L Highs	6-Filter PEQ
EQ L Mids	6-Filter PEQ
EQ L Lows	6-Filter PEQ
Mono Lows	Mix 2 x 1
Limiter Highs	Stereo S-C Co...
Limiter Mids	Stereo S-C Co...
Limiter Lows	Stereo S-C Co...

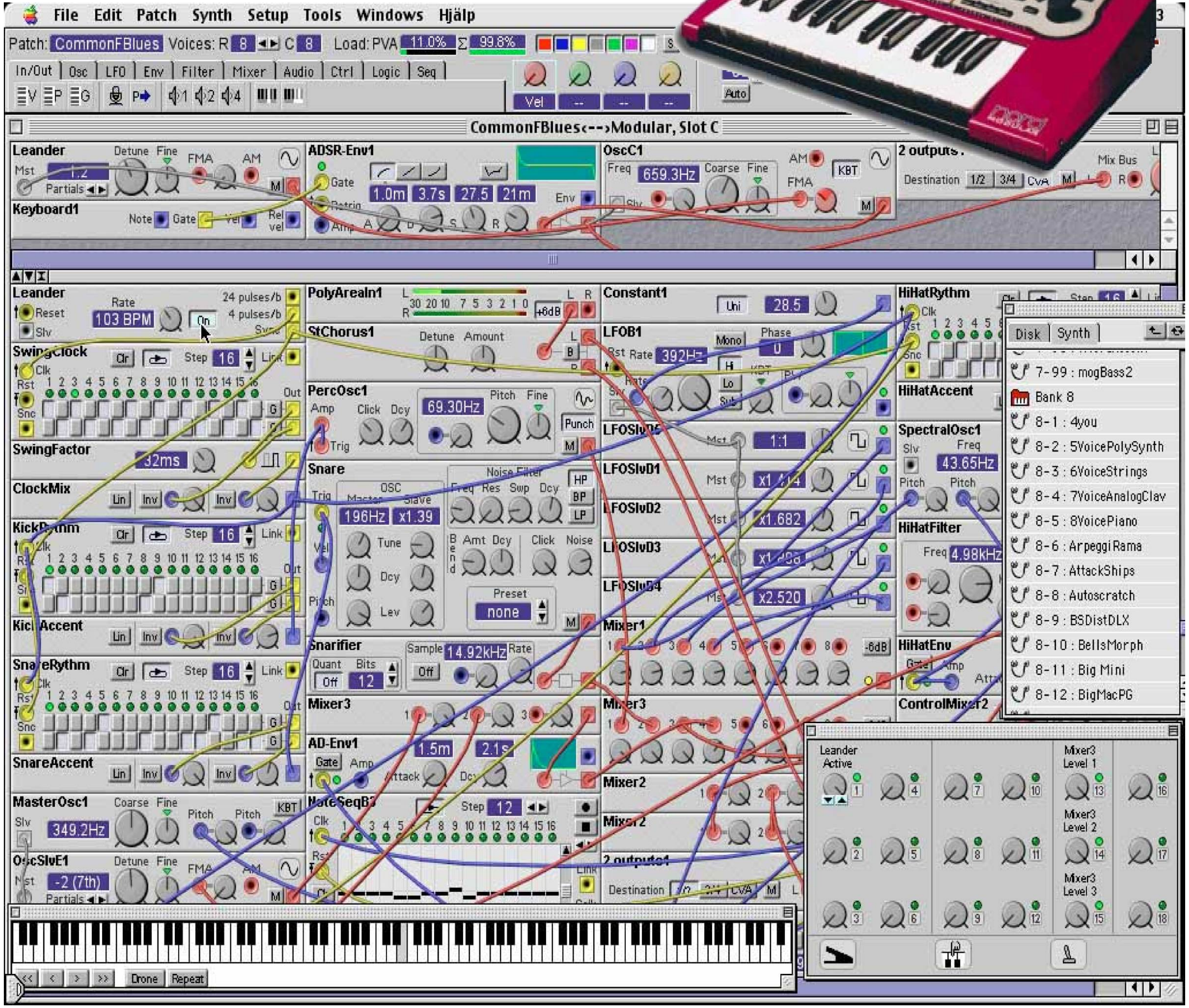
Blender

- Video system
- Open source



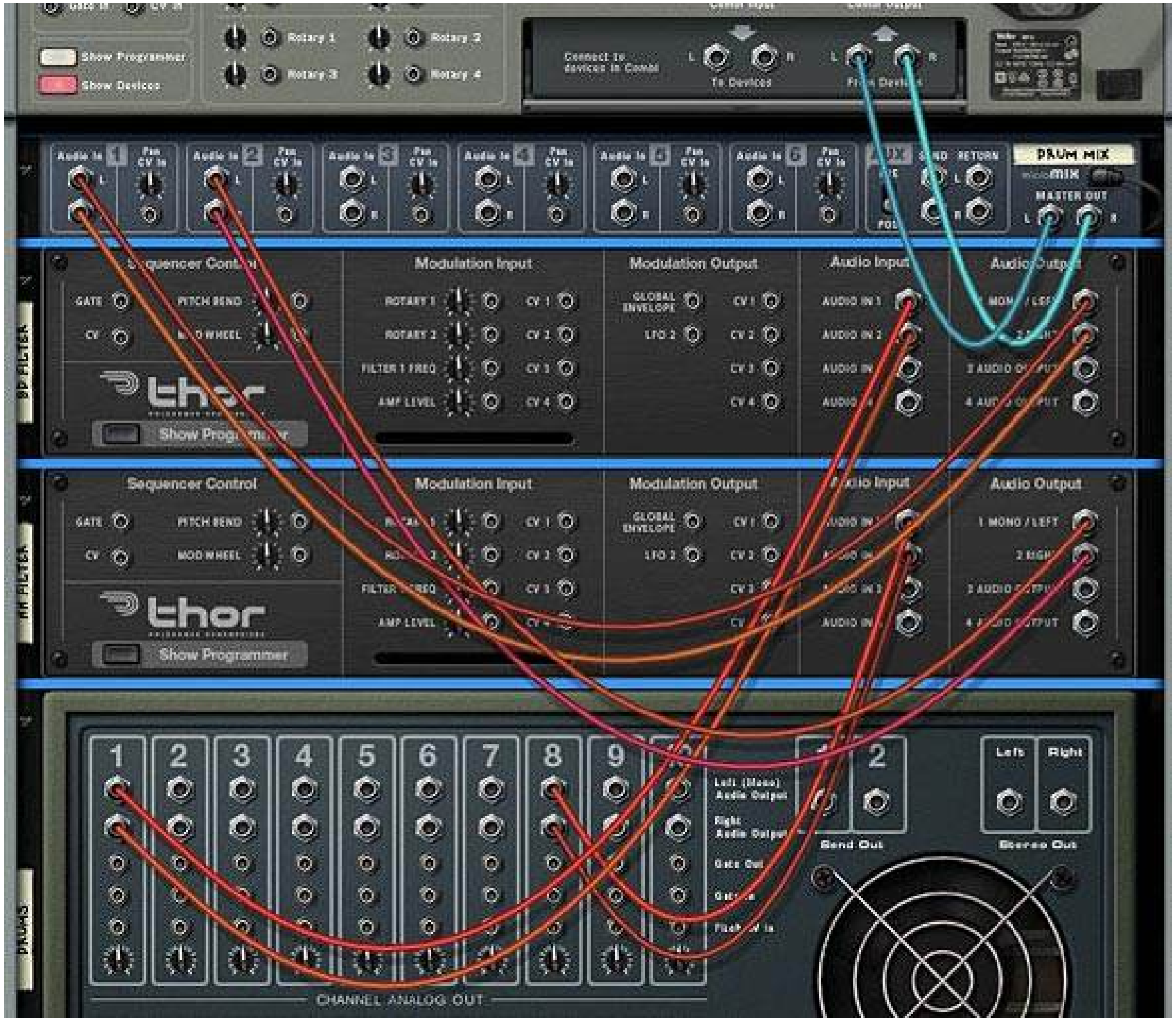
Clavia Nord Modular

- Music
- Win32 editor



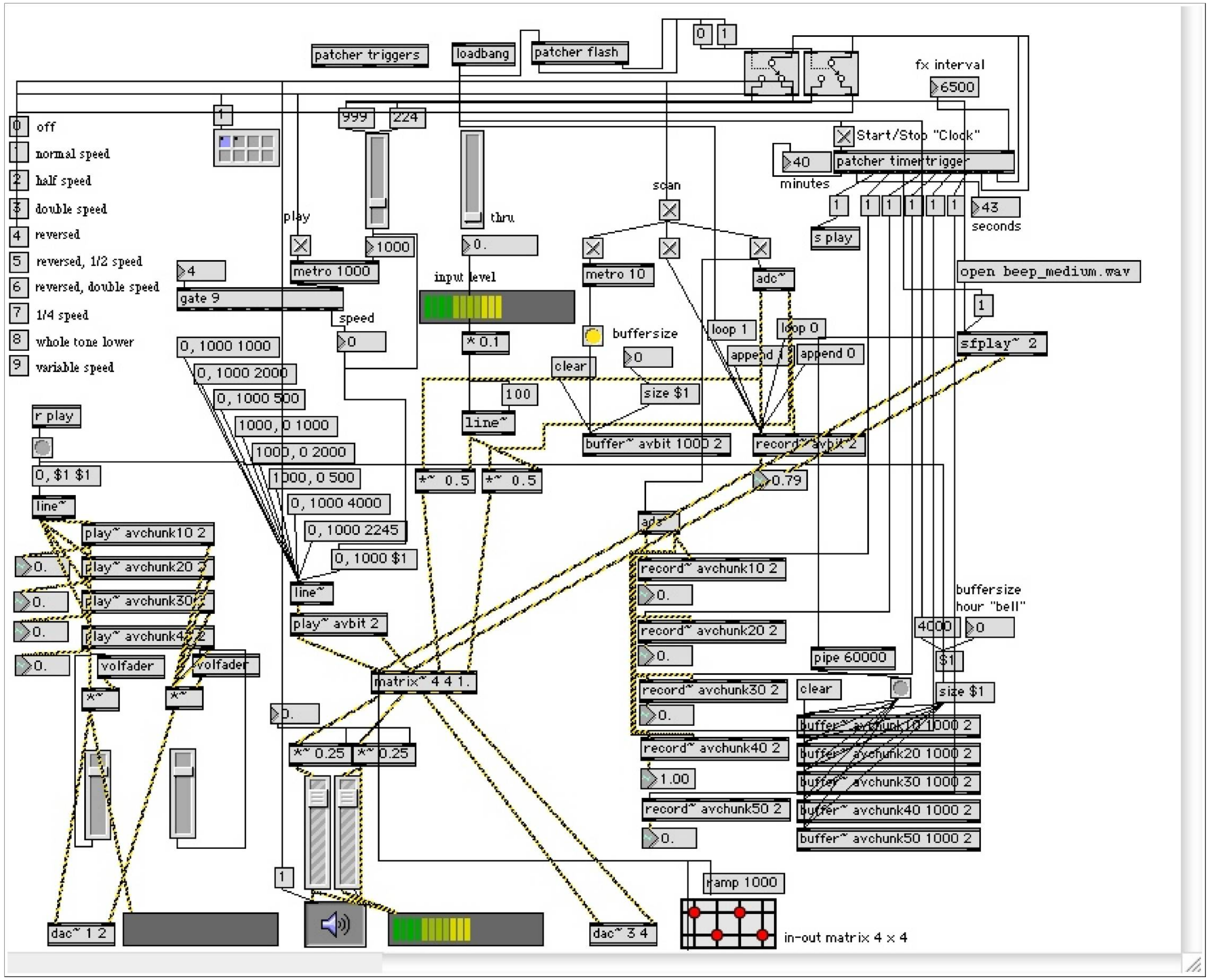
Propellerhead Reason

- Audio workstation
- Rack+wire metaphor



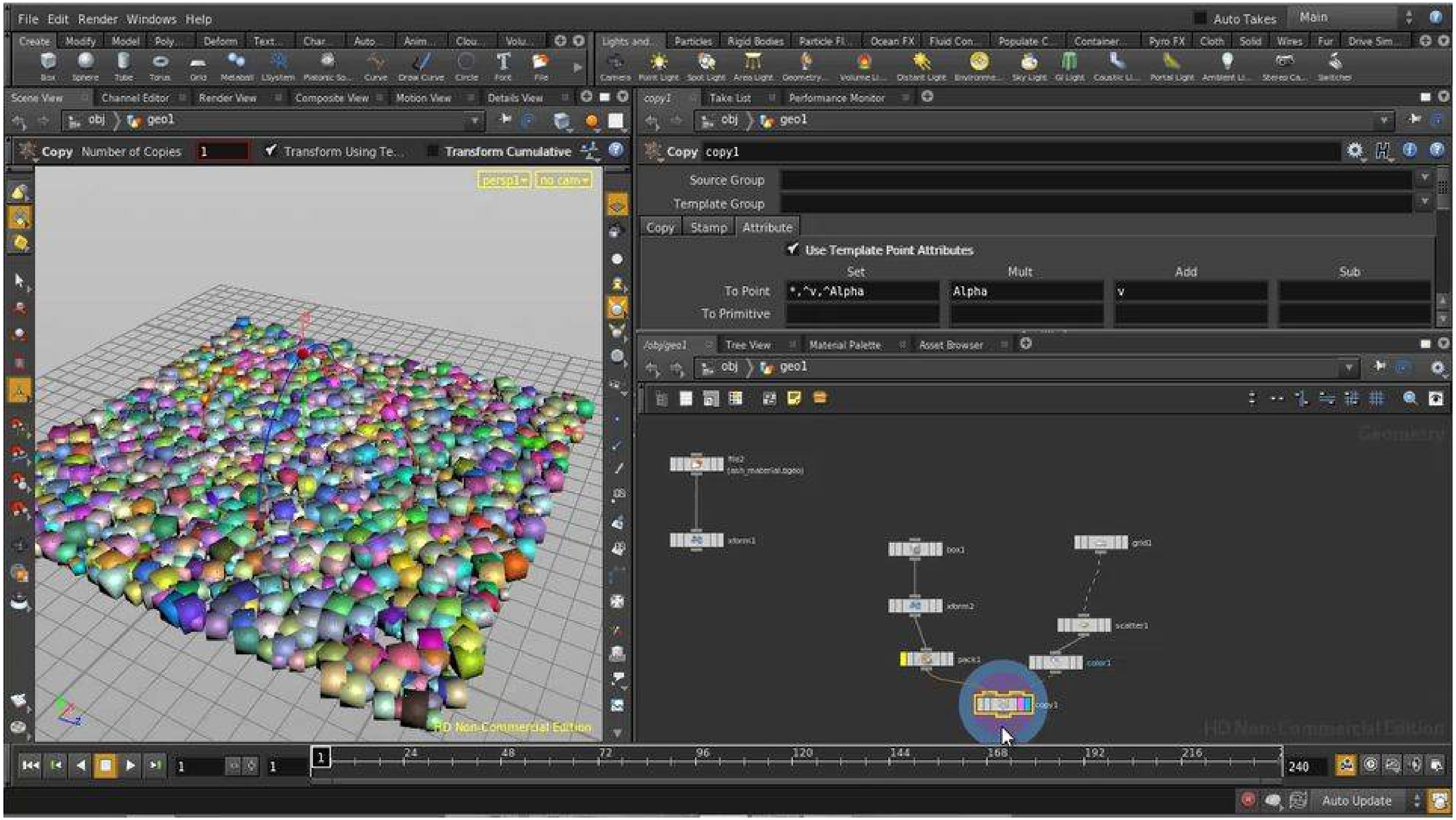
MaxMSP

Audio/video magic



Houdini

3D Animation



TinyOS

Embedded Systems

```
// CounterSounder
Main.StdControl -> CounterSounderM.StdControl;

// TimerC
CounterSounderM.Timer -> TimerC.Timer[unique("Timer")];
Main.StdControl -> TimerC.StdControl;

// LedsC
CounterSounderM.Leds -> LedsC.Leds;

// Sounder
CounterSounderM.SounderControl -> Sounder.StdControl;
```

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Rapid Prototyping, Reusability, Transparency

Good News

creating application ≠ programming

People Are Different

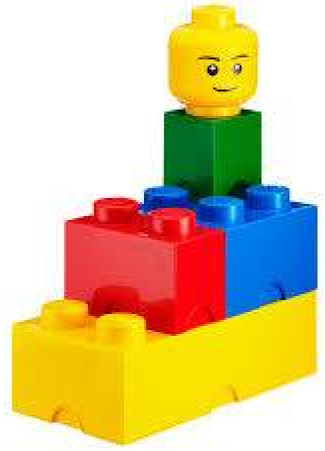
another image, pls

People Are Different

creating application ≠ programming

<u>application builder</u>

domain knowledge
user contact
customization
integration
maintenance



<u>programmer</u>

programming
supporting app builder

```
GroupDesc::ElementDesc elDesc;

std::string sp_name = item->Attribute( [illegible]
std::string spritename = item->Attribute( [illegible]

float x = boost::lexical_cast<float>( [illegible]
float y = boost::lexical_cast<float>( [illegible]
float offset = boost::lexical_cast<float>( [illegible]
unsigned layer = 50; // default
if ( item->Attribute( "layer" ) != NULL )
{
        layer = boost::lexical_cast<unsigned>( [illegible]
}

[illegible].name_ = sp_name;
```

separating roles

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Component Programming

- Simple, small code (100 – 1000 lines)

  Homeaut.com component sizes:

JamSolver:	497 lines
Scheduler:	628 lines
SimpleSequencer:	815 lines

- Loose coupling: default (Hollywood principle etc.)
- Ready for unit testing
- No customer demands
- No legacy code to learn and modify

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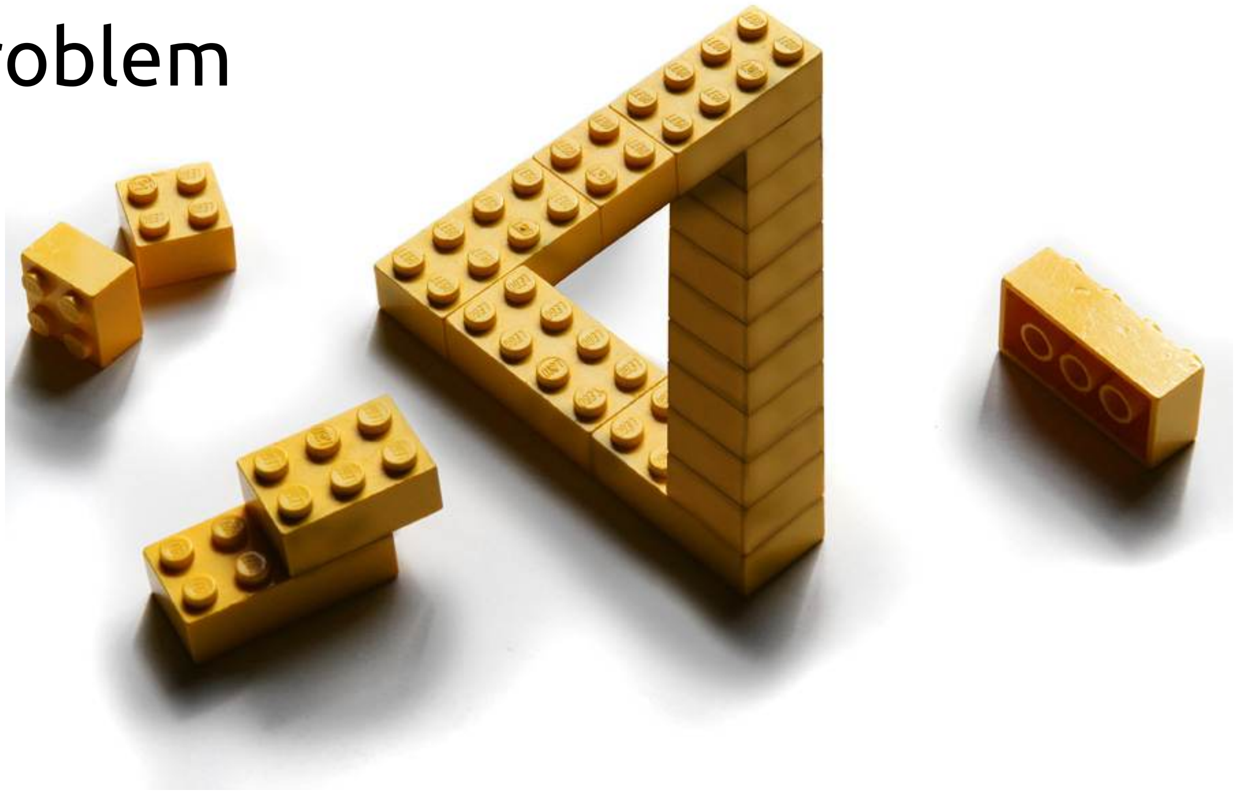
Application Building

- No programming skills required
- Even the user can create apps
- Visual programming
- Convert patterns to composite components
- Focusing on the problem
- Different world



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Rapid Prototyping

- No programming required
- Mock missing components
- Mock missing resources (data source, user input etc.)
- Discover missing components to be implemented

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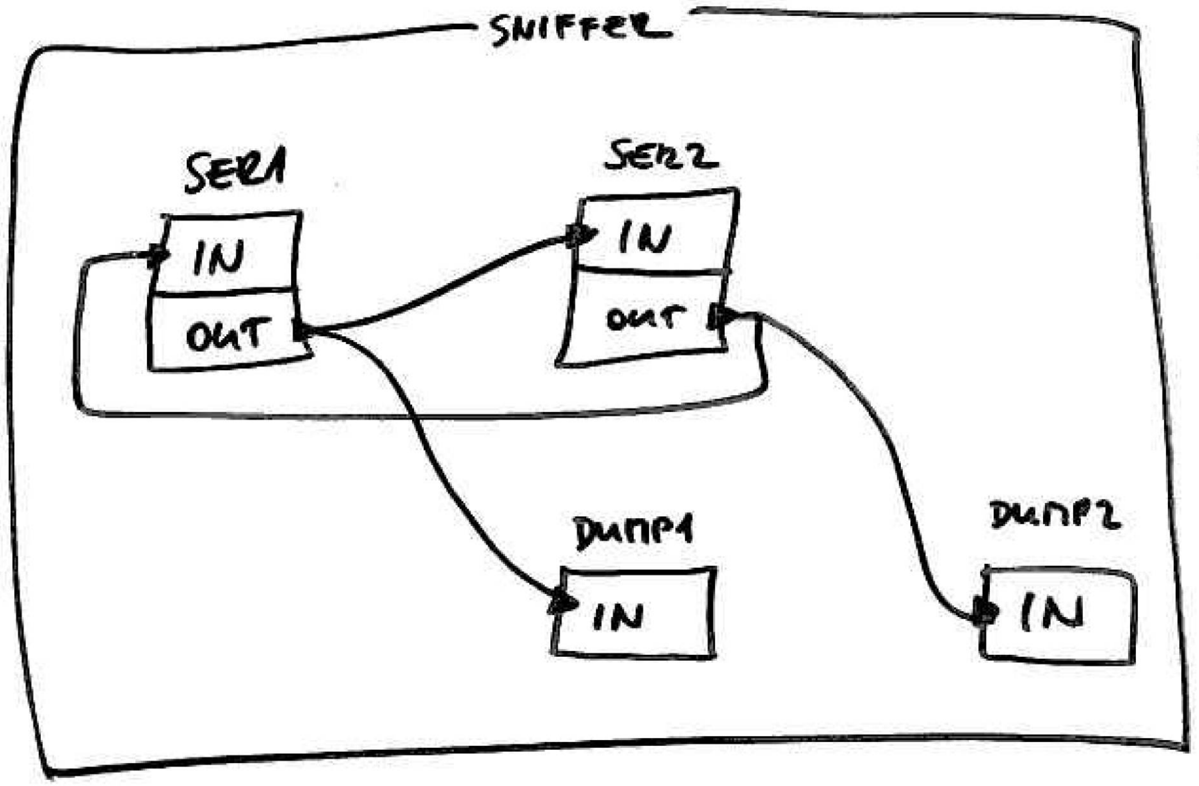
Reuse. Really.

THE PROJECT I INHERITED HAS WEAK CODE. I NEED TO REWRITE IT FROM SCRATCH.
WILL THERE EVER BE AN ENGINEER WHO SAYS, "THAT LAST GUY DID A GREAT JOB. LET'S KEEP ALL OF IT"?
I'M HOPING THE IDIOT YOU HIRE TO REPLACE ME SAYS THAT.
Dilbert.com DilbertCartoonist@gmail.com
8-12-14 © 2014 Scott Adams, Inc./Dist. by Universal Uclick

OOP promised reusability.
It was a lie.

Reusability Example

Serial sniffer with home automation components



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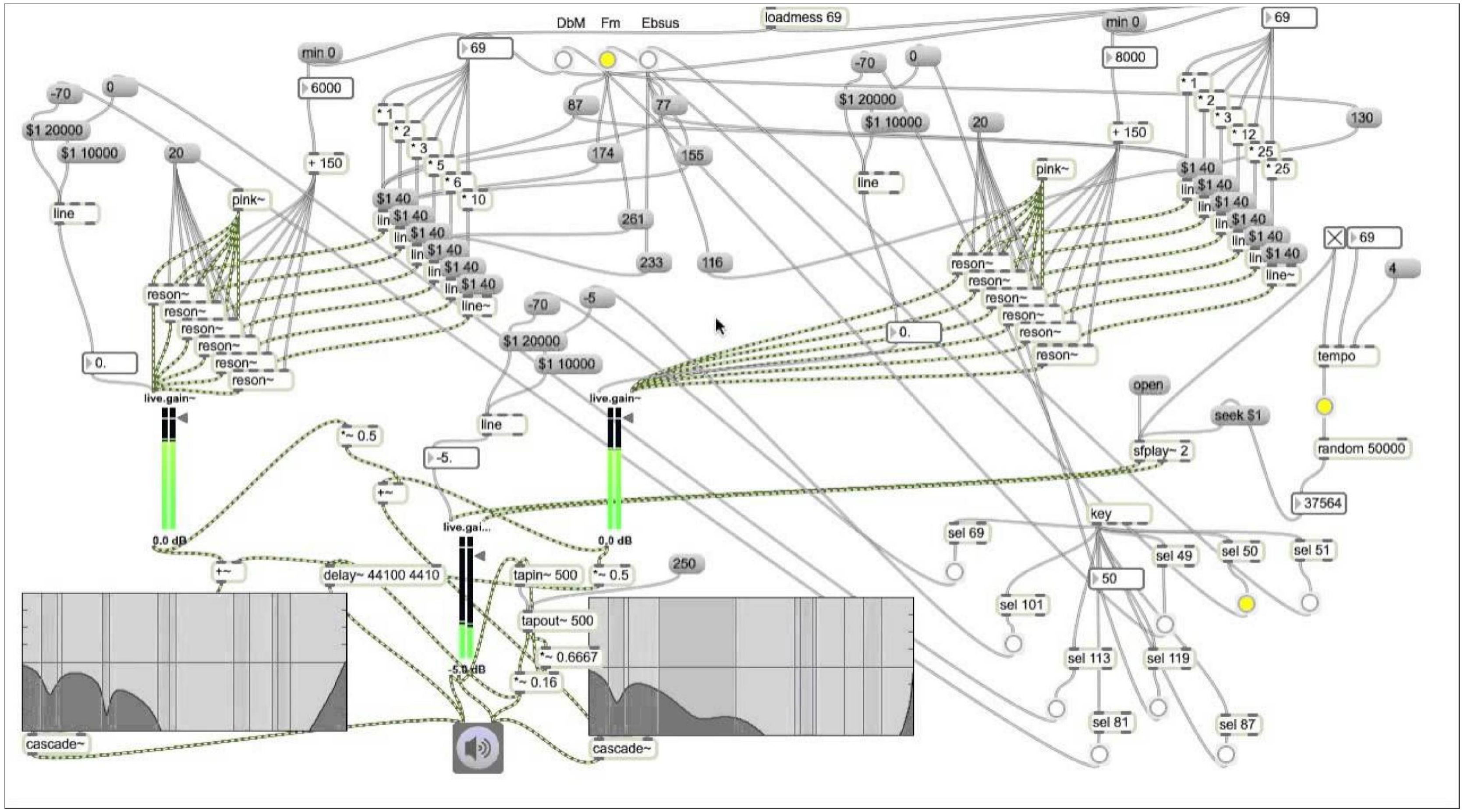
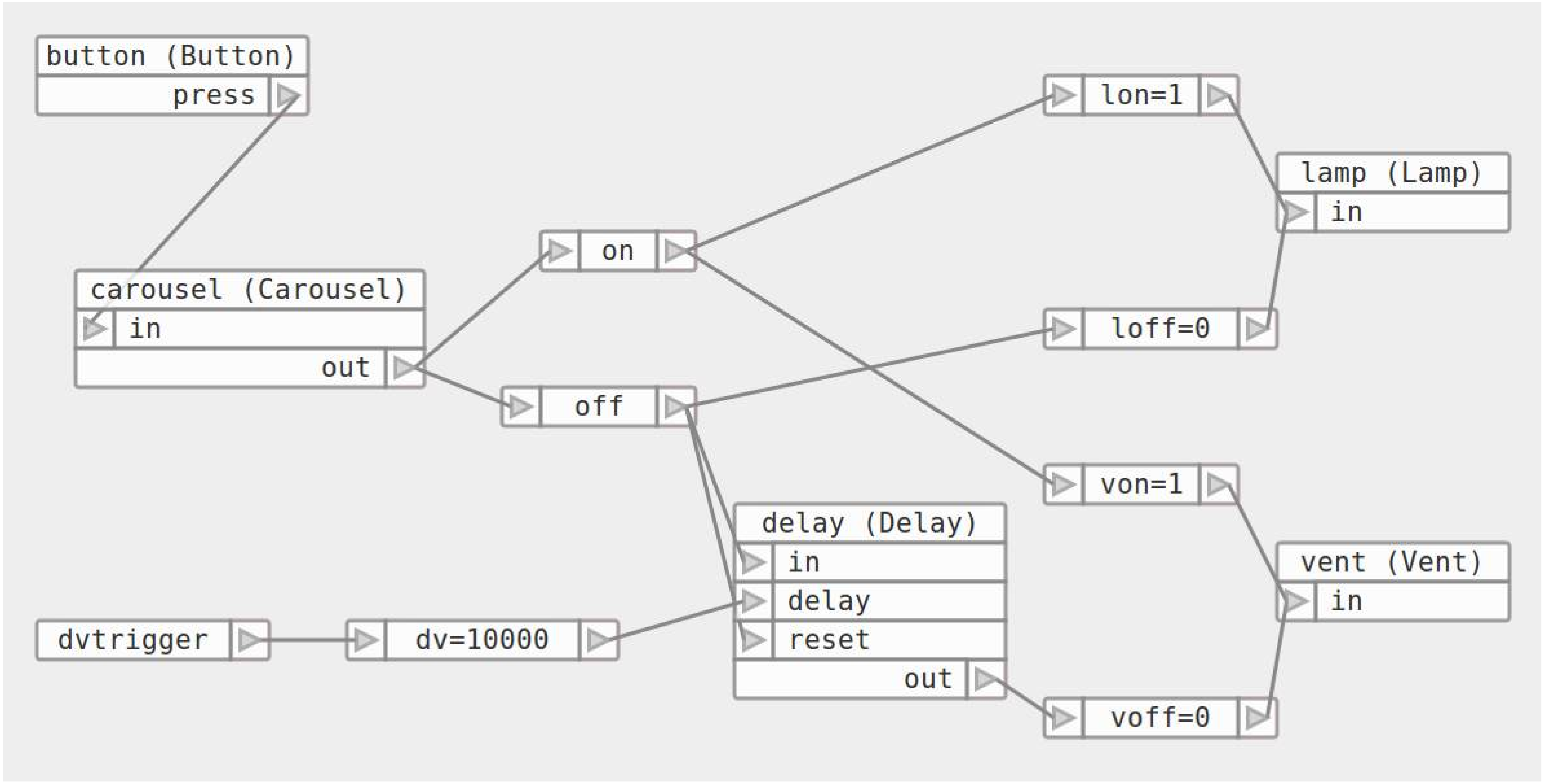
Transparency

- Automatic documentation of the application
- Well-separated layers



THE END



My favourite application. Can you find the bug?