Workshop on Streaming Systems
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Second-Order Challenges in Streaming Systems

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Vanu, Inc. Overview

Founded 1998

MIT LCS spin-off

Supply signal processing software to radio manufacturers

"The software in software radio"

Focus on software engineering and portability

GSM basestation

Monitoring system

Public safety terminal

Some definitions

Waveform

An RF communications standard. Includes all layers.

Software Defined Radio (SDR)

An RF communications device where the waveform supported can be changed through a software load.

X is portable to Y

The cost of getting X running on Y is a small fraction of X's original development cost.

Second-order challenges

Many good, useful ideas for streaming languages/systems have already been described in this workshop

To support applications like those built at Vanu, Inc., there are additional challenges that must be addressed

- **Dynamic processing graphs**
- **Large-scale processing graphs**
- **Variable cost kernels**
- **Portable source representation**
- **Hybrid applications**

Dynamic processing graphs

GSM waveform implementation

- **many options negotiated during call setup**
- **for efficiency, have specialized modules for different options**
- **after options known, instantiate specialized processing pipeline and connect into existing graph**
- **delete this pipeline during call teardown**

Graph surgery must occur in 10s of milliseconds without processing interruptions (elsewhere in graph) > ~1 msec.

Large-scale processing graphs

Simple analog FM waveform	**5 kernels**
AMPS channel	**30 kernels**
Full AMPS basestation	**> 1500 kernels**

This was with coarse kernels

Want finer granularity to exploit compiler strip-mining, etc.

Recommend compiler algorithms designed for 500 kernels in tightly optimized unit, 100k kernels in full application.

Variable-cost kernels

Traditional DSP algorithms have constant cost/sample.

***Much* better average-case performance possible with variable cost/sample.**

- **Convolutional decoding based on Djikstra shortest-paths search**
- **CCK decoding using initial (+1, -1, X) discriminator**

Recommend scheduling based on bounded variability rather than invariant costs.

Portable source representation

Want common source representation for DSP, FPGA, complex SOC (e.g. Vertex II), etc.

- **Complex, expensive signal processing software**
- **Different architectures used on different platforms**

OK if output code is not optimal (but must be Pretty Good™)

Big US DOD SDR program pushing hard for this

- **"A major goal of the JTRS program is to use these [independently procured] waveforms across the family of JTRS radios regardless of manufacturer."**

Hybrid applications

Most real-world applications are hybrid

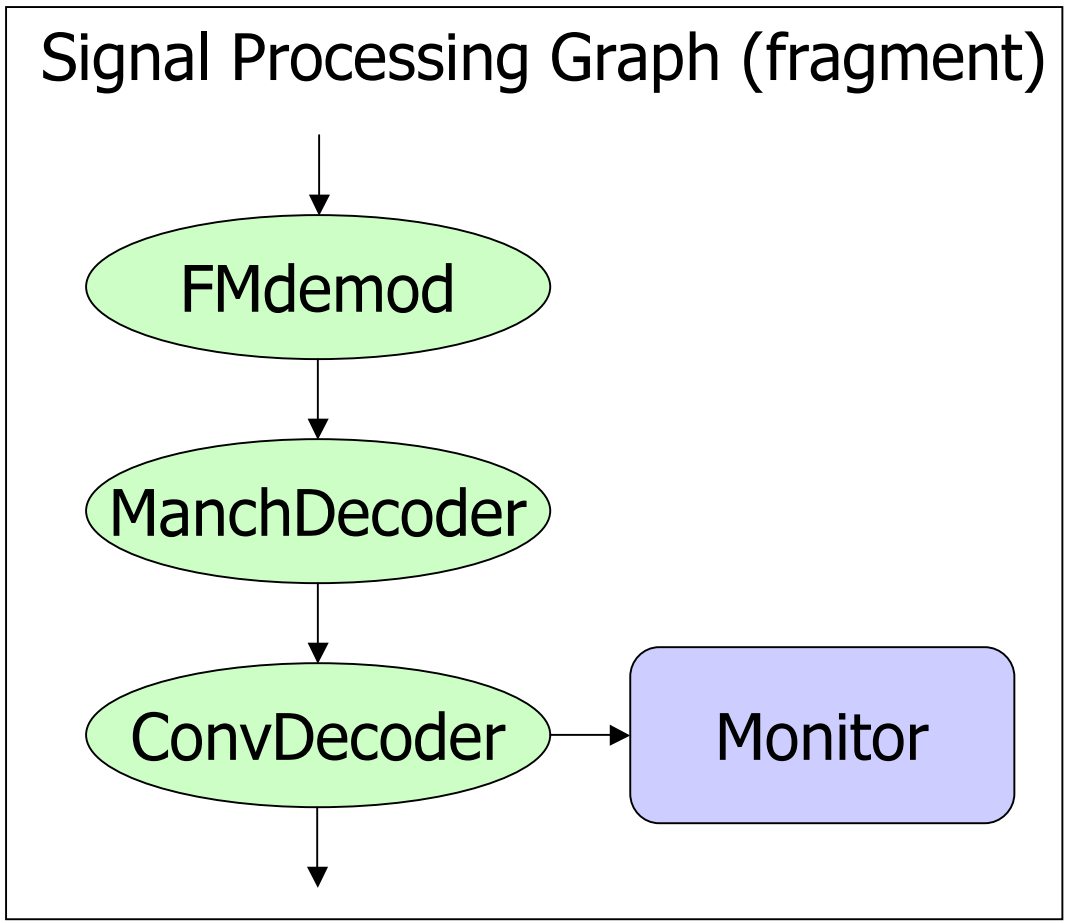
- **streaming code for signal processing**
- **non-streaming code for control, networking, human interface, ...**

Need portable, efficient constructs for

- **configuring/controlling/monitoring**
- **moving high speed data streams back and forth**
- **moving events and parameters back and forth**

Must be able to debug as an integrated single application.

How RDL handles hybrid applications



C++ code

```
class MyMonitor :
  public SigProcExt {
    void SigProcEvent();
}

SPS.Register(
  “Monitor”,
  new MyMonitor()
);
```

Summary

This talk identified 5 challenges in the full streaming-system problem that go beyond the obvious initial challenges.

- **Dynamic processing graphs**
- **Large-scale processing graphs**
- **Variable cost kernels**
- **Portable source representation**
- **Hybrid applications**