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On the Integration of OpenCL into a Software Defined Radio

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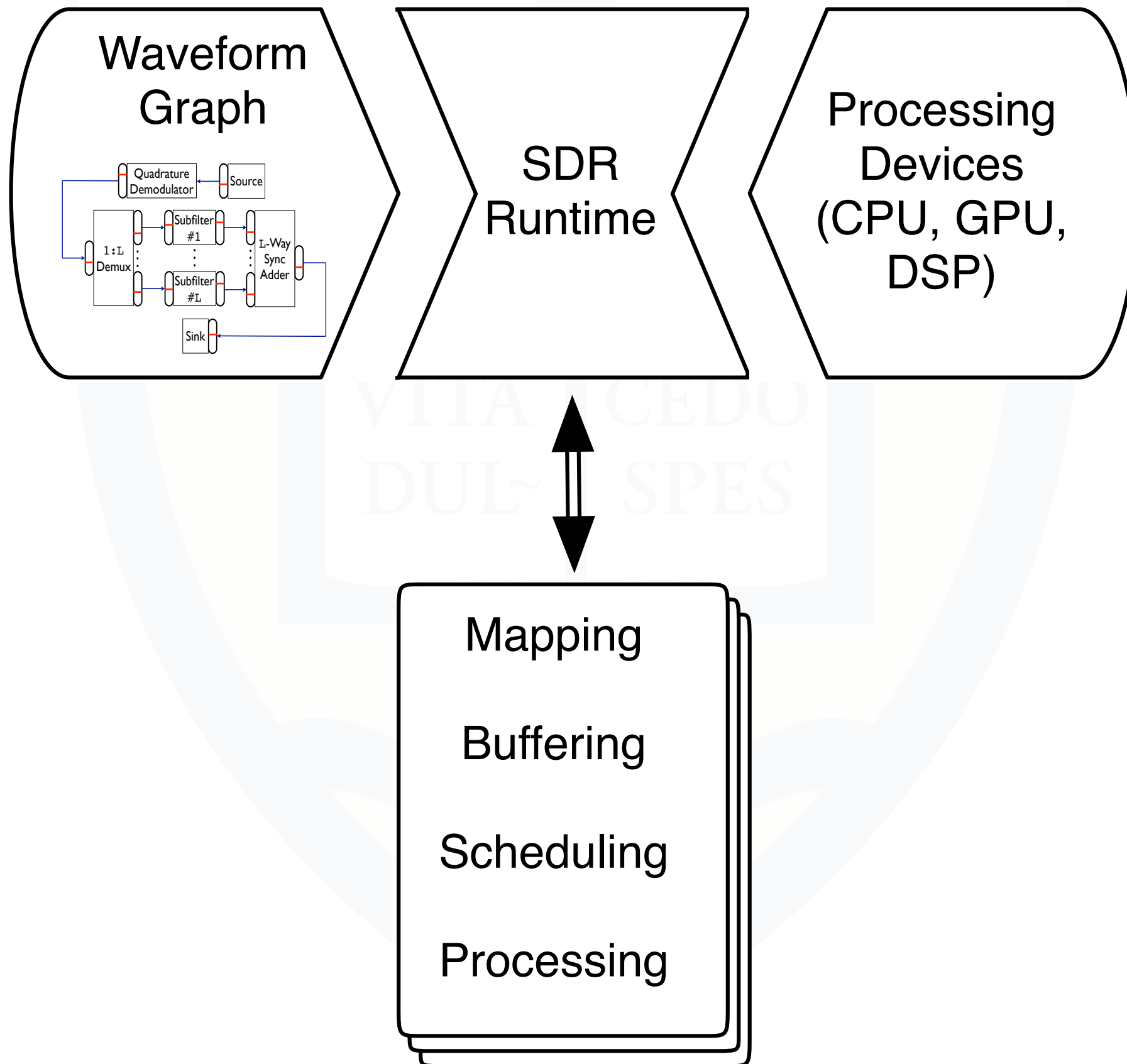
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Software Defined Radio

- ➔ Real-time signal processing, using a class of radios that can be reprogrammed and reconfigured primarily via software
- ➔ Digitize as close to the antenna as possible
- ➔ Still significantly dependent on hardware

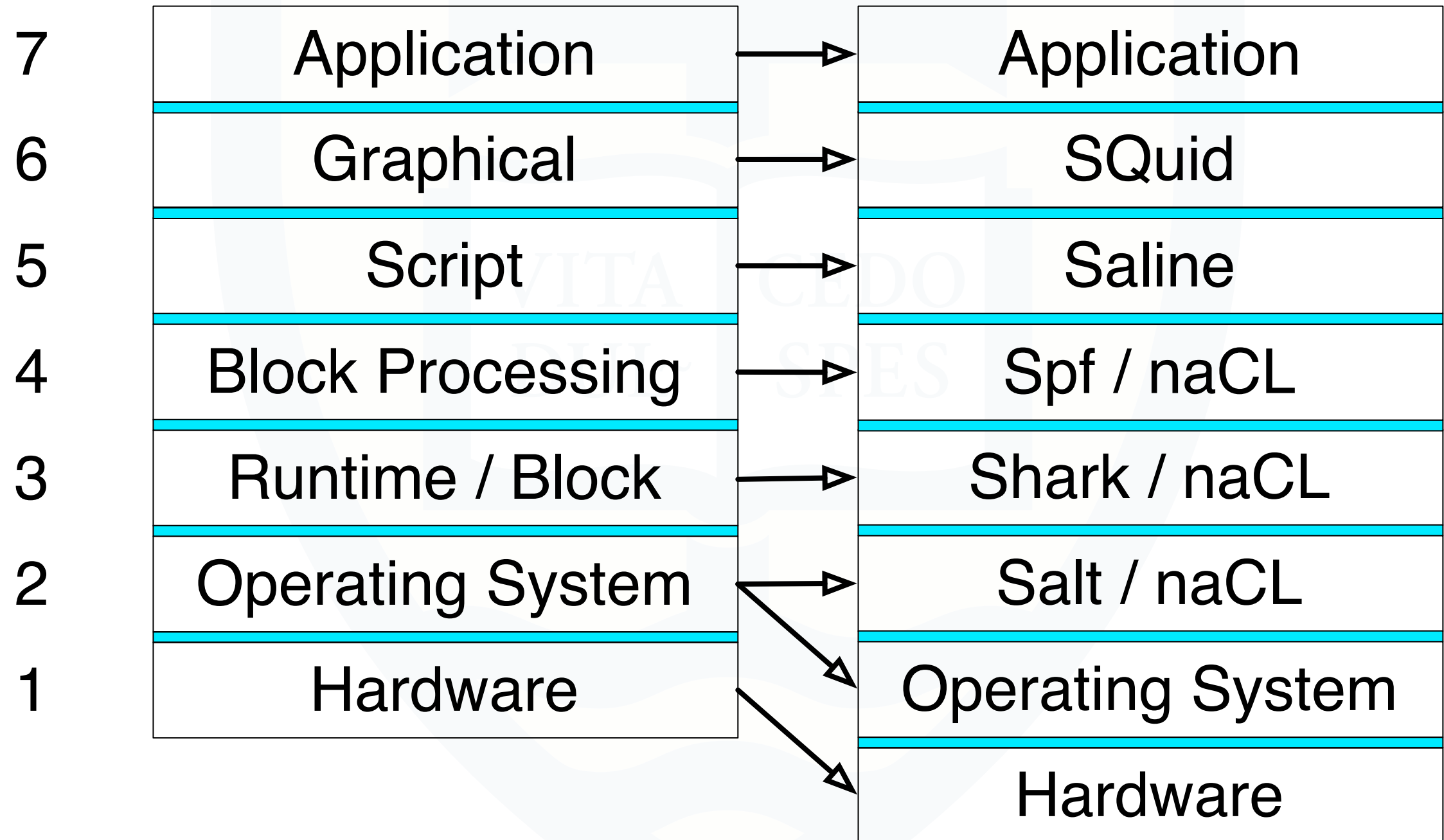
SDR Runtime



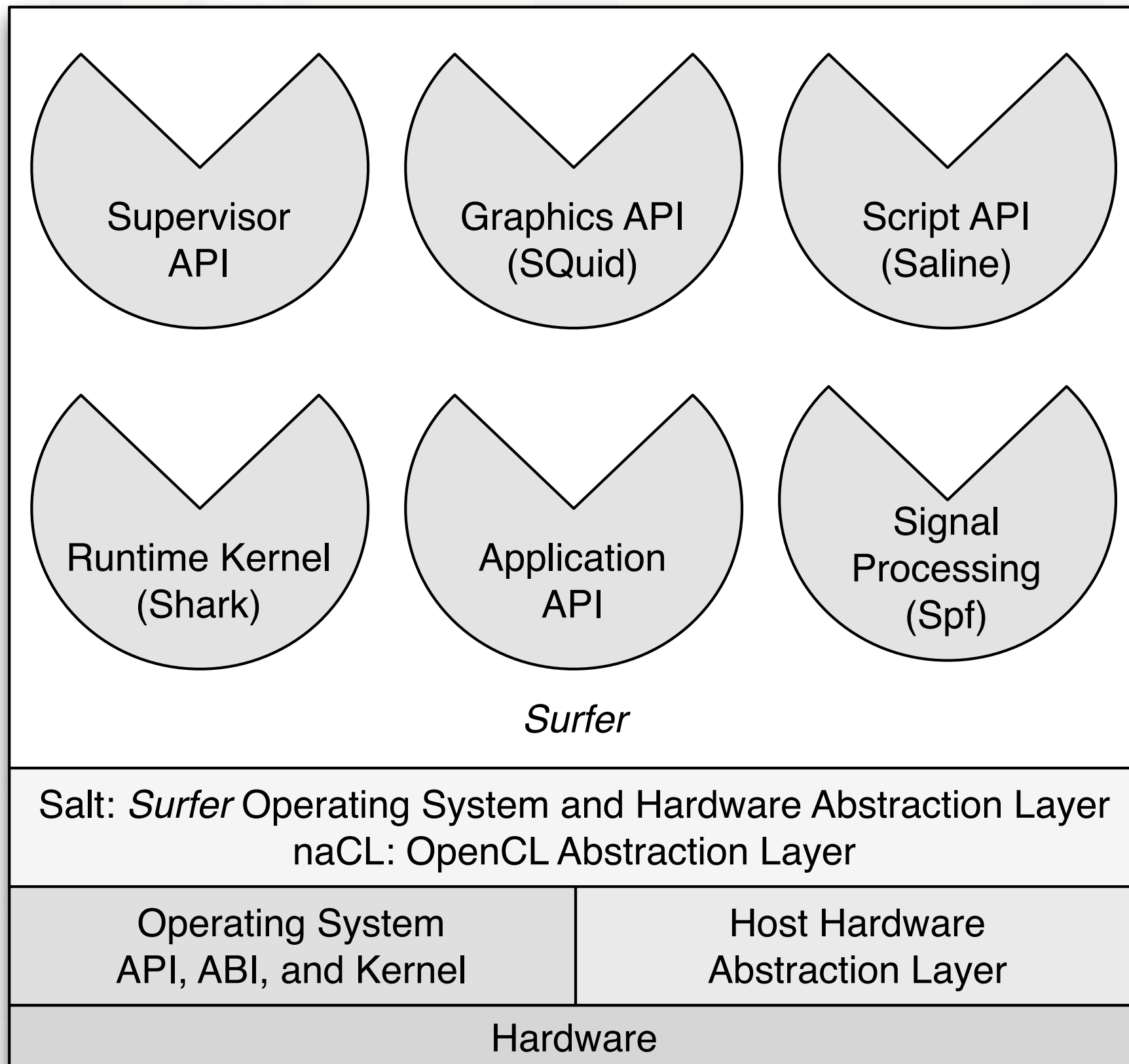
Overview

- *Surfer* Overview
- Key Features
- NBFM Example
- OFDM Demo
- Conclusions
- Future Work

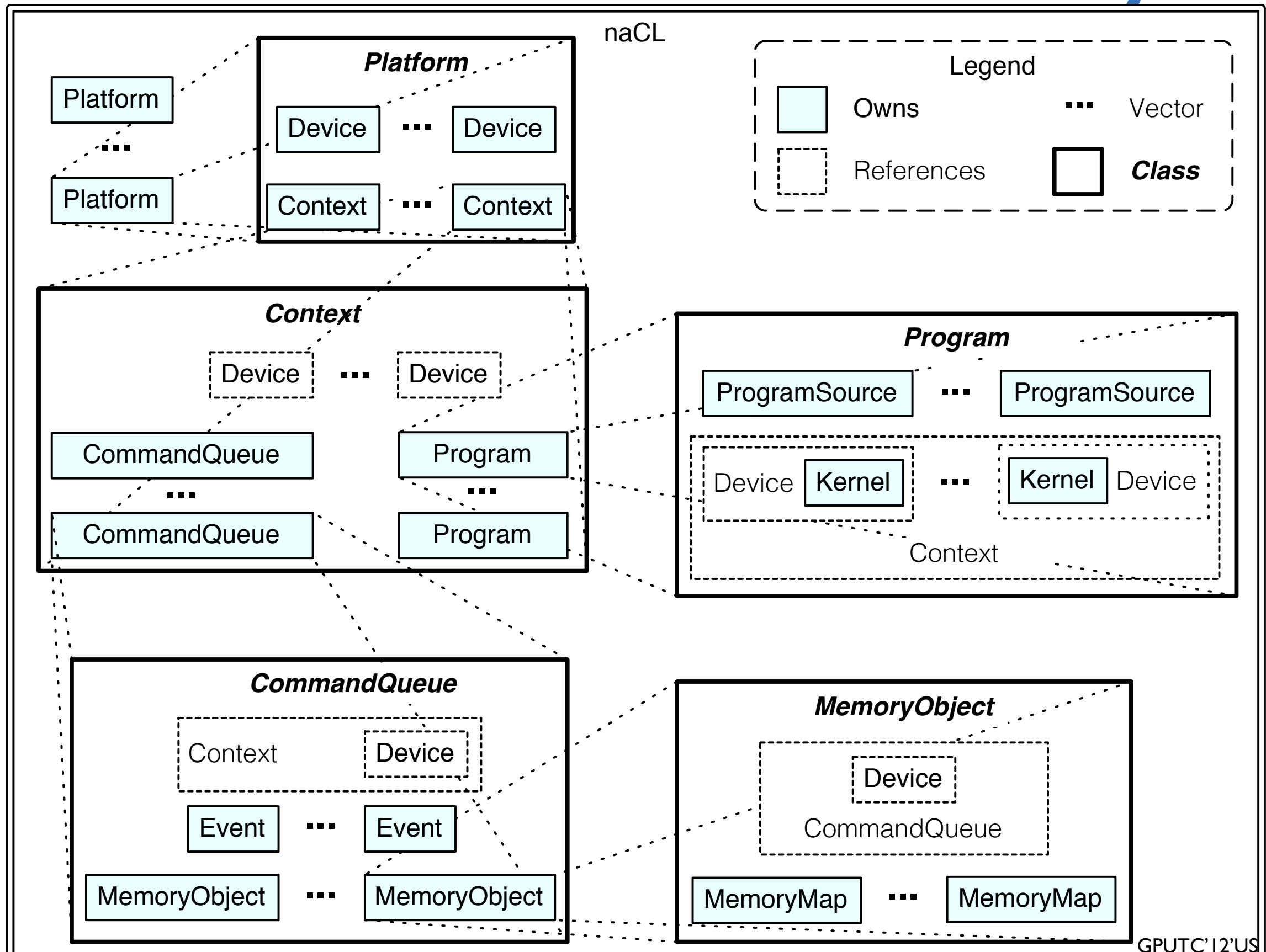
SDR Layers Model



Surfer Overview



naCL Class Hierarchy

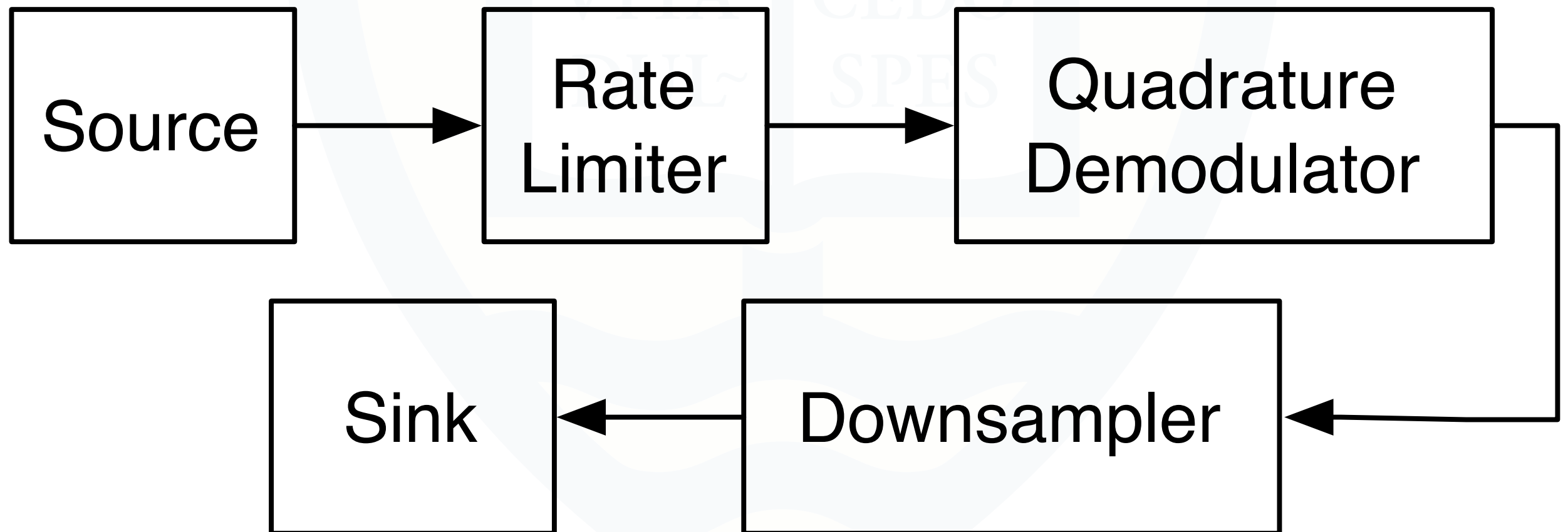


Key Features

- 1 Signal processing *flavors*, providing a new form of dynamic runtime reconfiguration and heterogeneous processing
- 2 Use of thresholds for scheduling, to allow direct control over throughput and latency
- 2 Use of runtime statistics for modifying system runtime behavior, using a Supervisor

NBFM Example

- Demodulate narrowband FM signal and downsample to typical audio rate

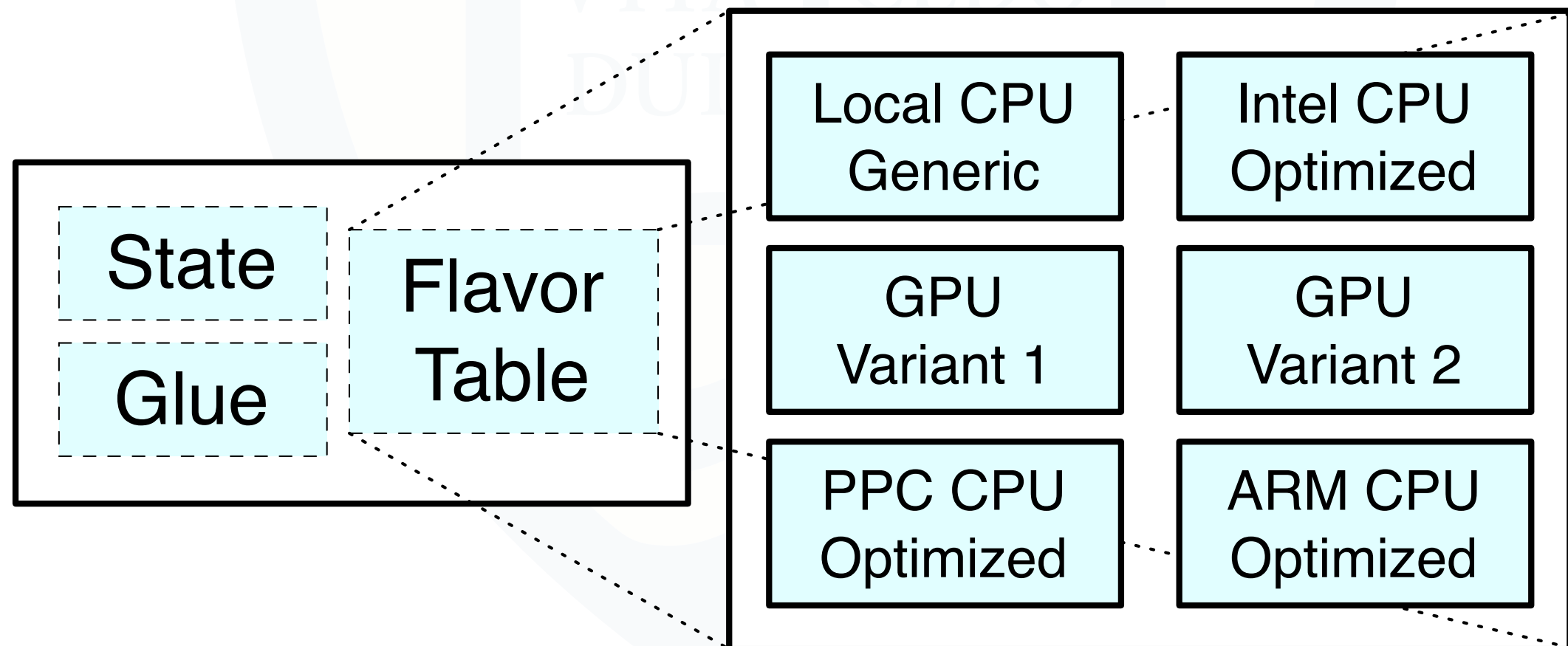


Flavors

- 1 Signal processing flavors, providing a new form of dynamic runtime reconfiguration

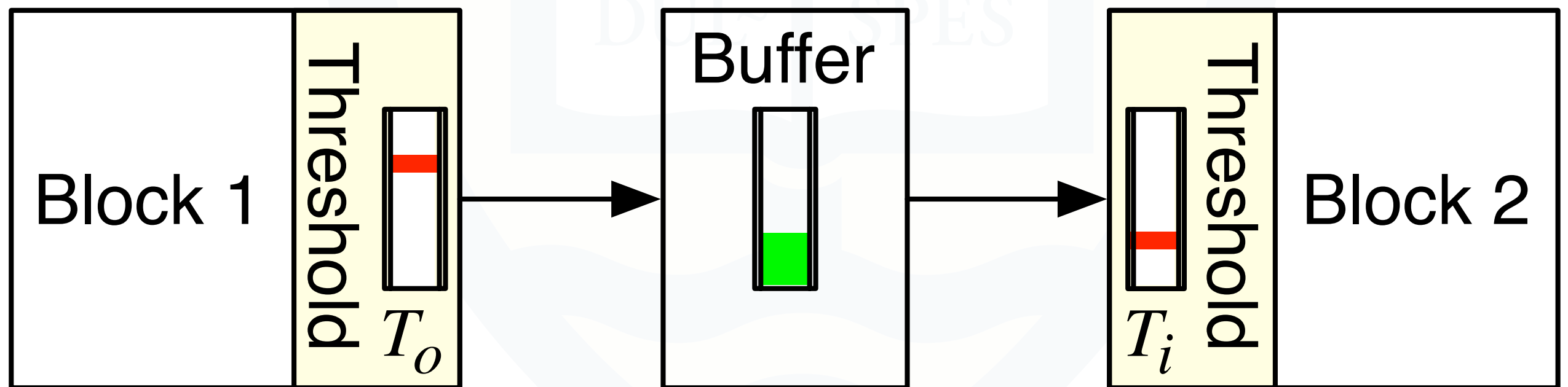
Block

Processing Flavors

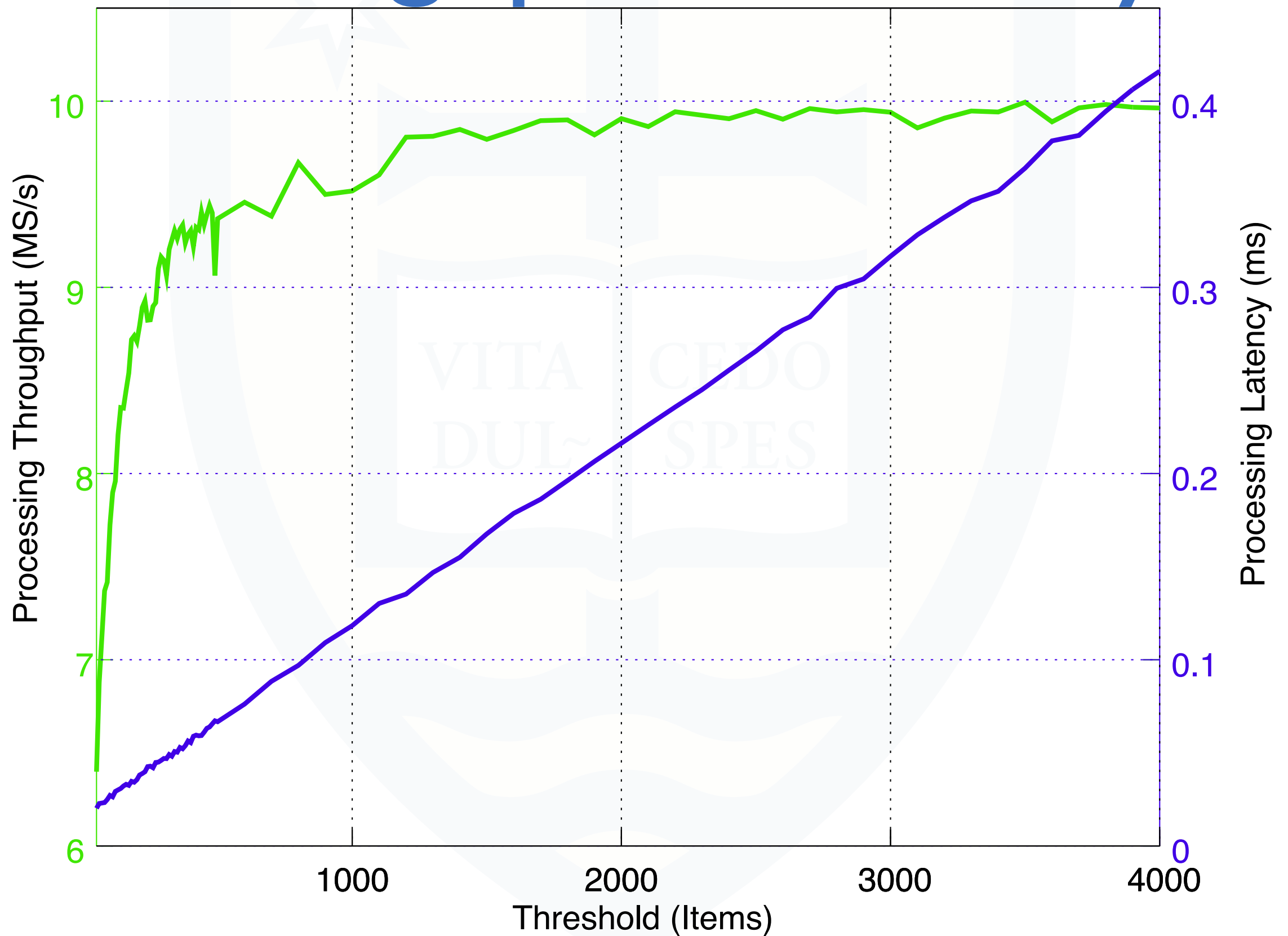


Thresholds

- 2 Use of thresholds for scheduling, to allow explicit control over throughput and latency



Throughput / Latency



Supervisor / Statistics

3 Use of runtime statistics for modifying system runtime behavior, using a Supervisor

→ Load

- Host Processor
- *Surfer*
- Any *Surfer* Thread

→ User Defined

- Energy Use

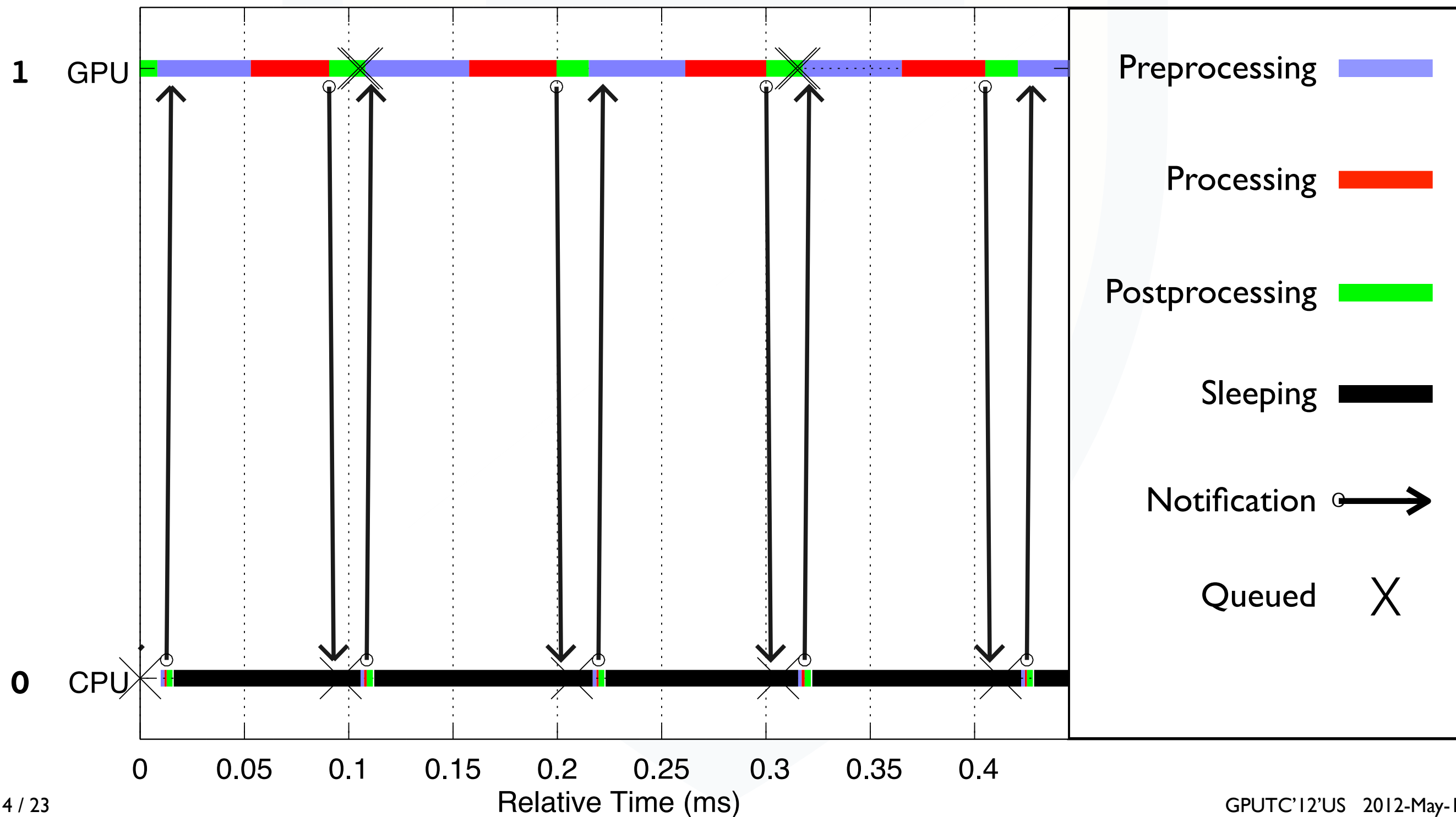
→ Block Timing

- Queued
- Dequeued
- Processing Start
- Processing End
- Finished

Data Flow by Thread

Thread

Legend

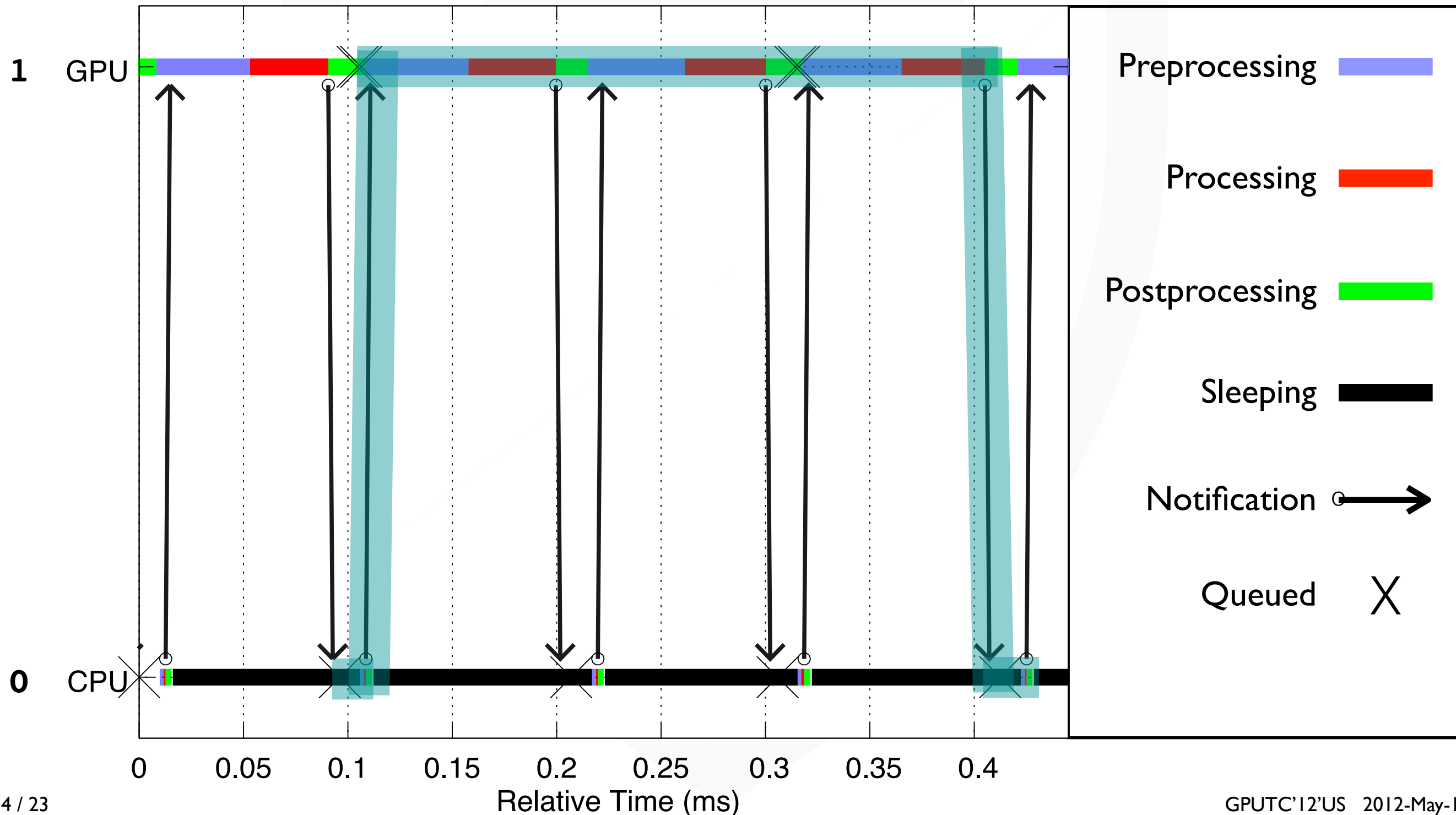


Data Flow by Thread

Thread

Source to Sink Latency

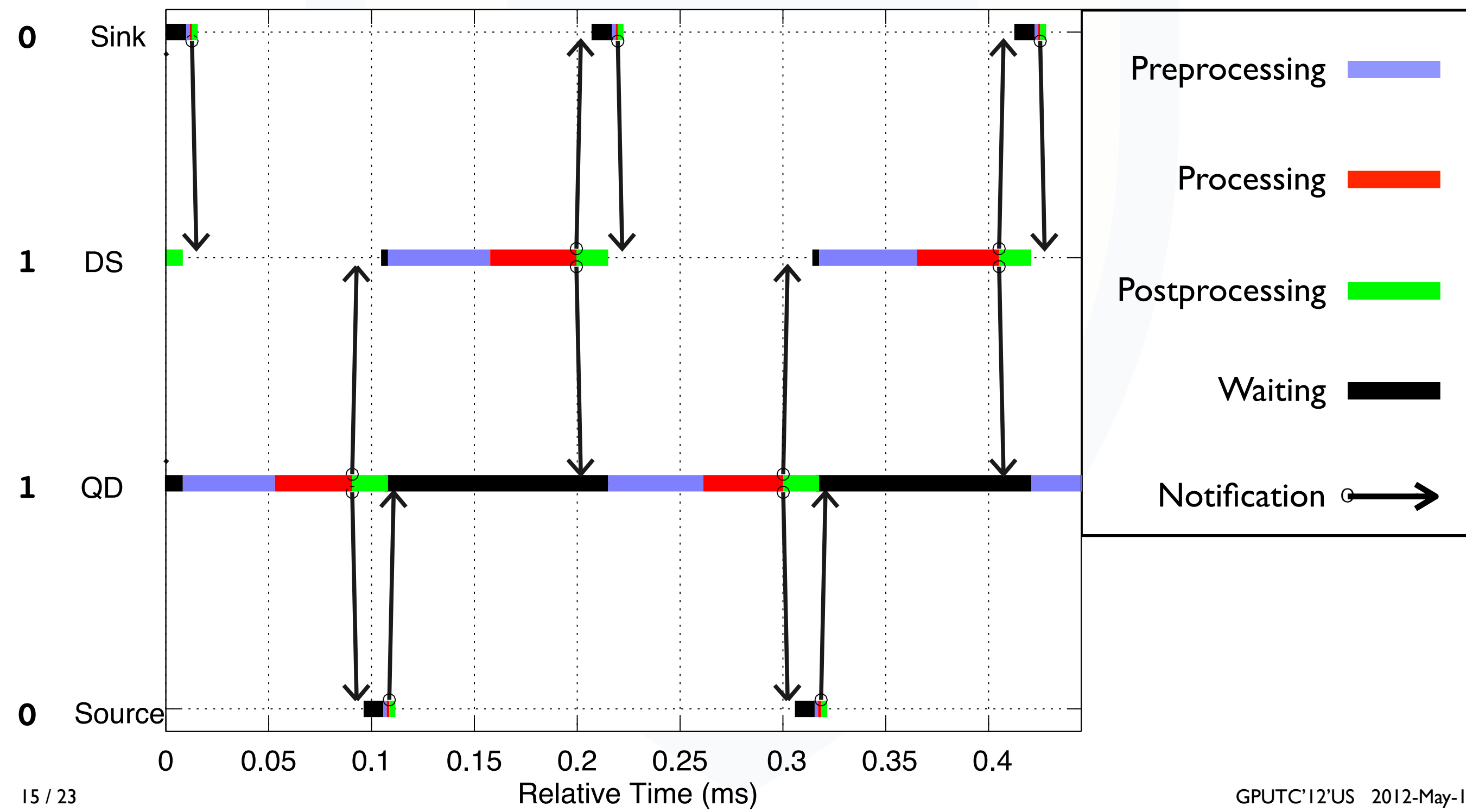
Legend



Data Flow by Block

Thread

Legend

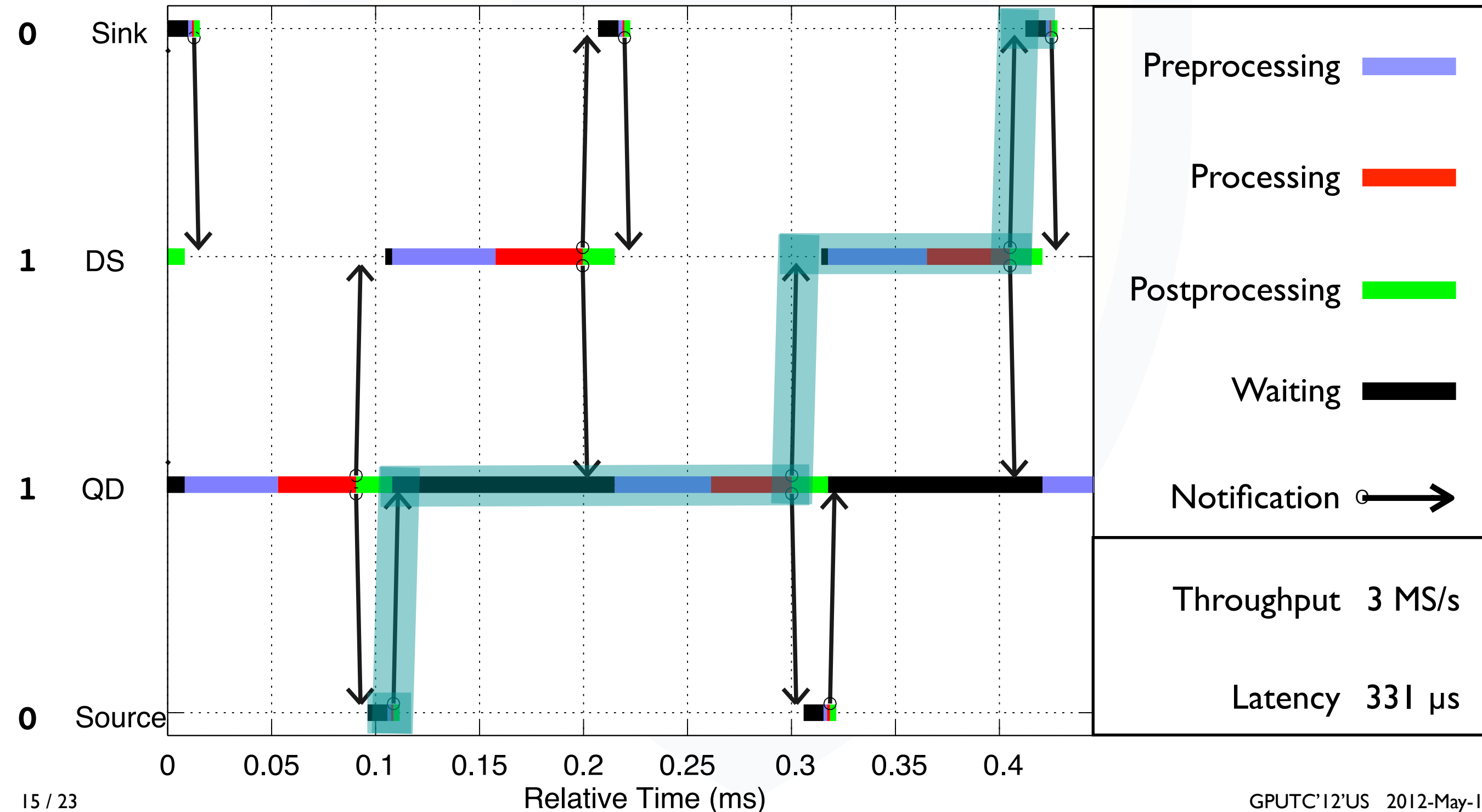


Data Flow by Block

Thread

Source to Sink Latency

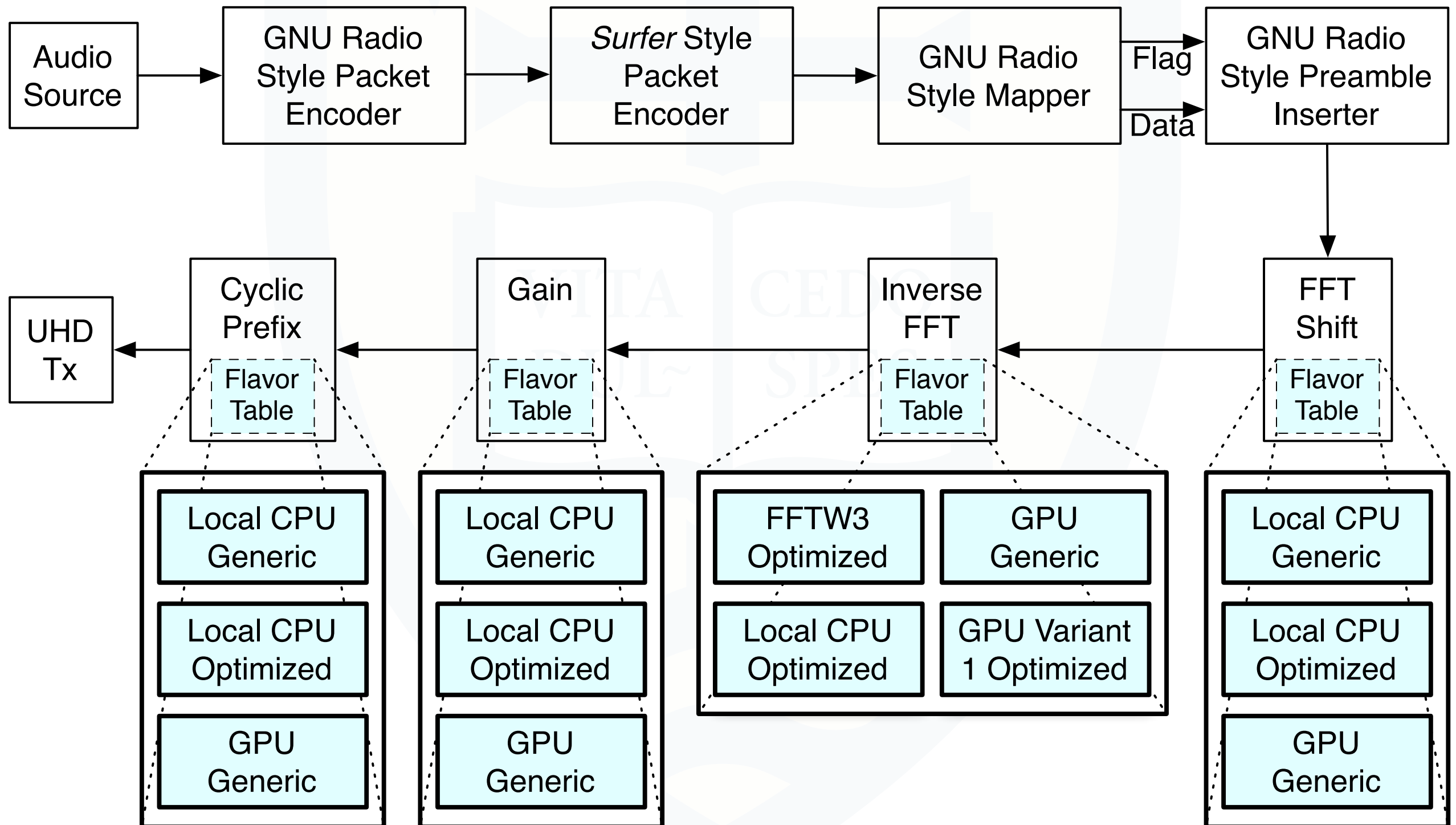
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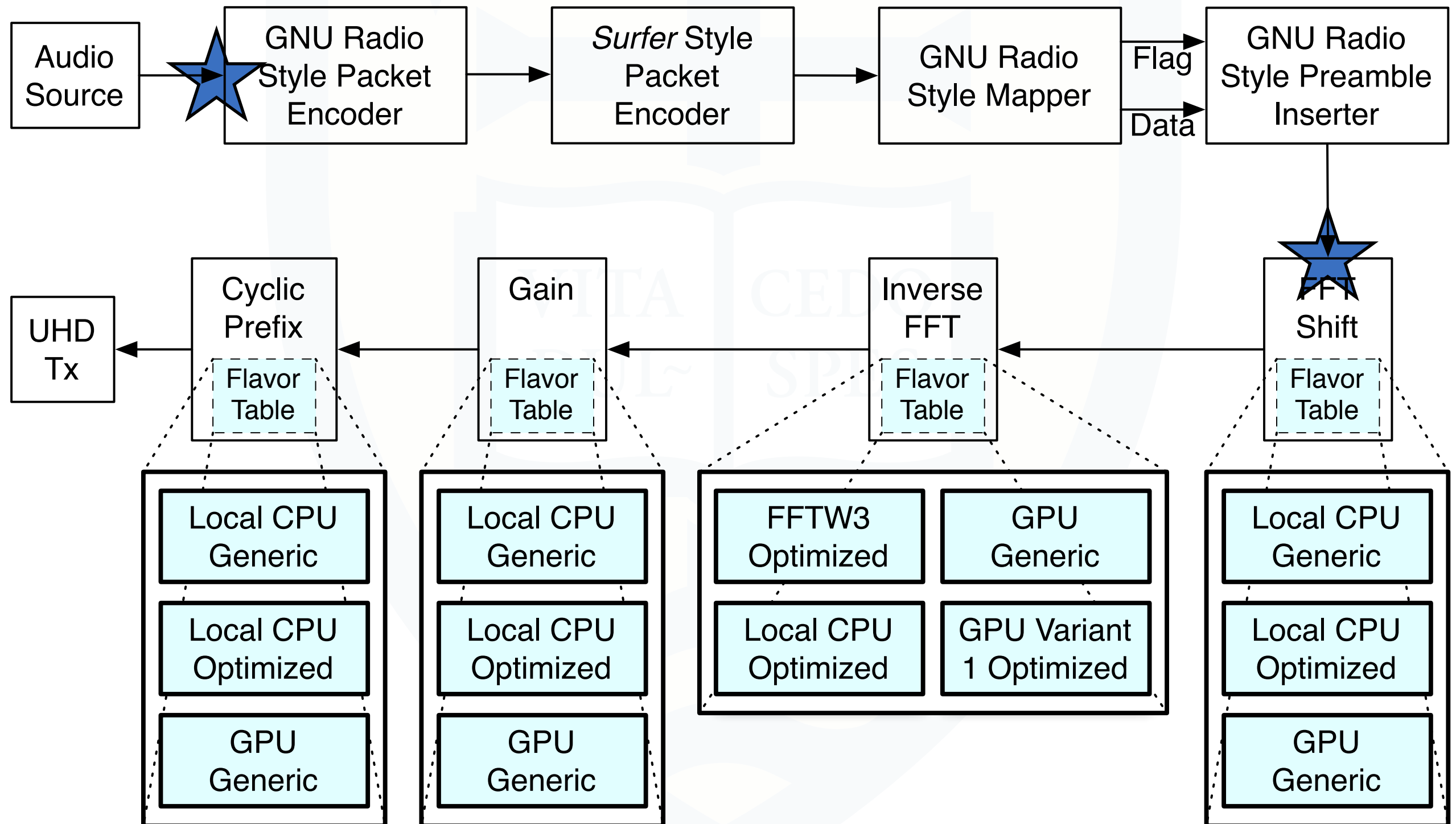
OFDM Demo

- ➔ Extended audio loopback
- ➔ Keyboard-based Supervisor runtime system control
 - Rotate through flavors
 - Increase and decrease processing threshold

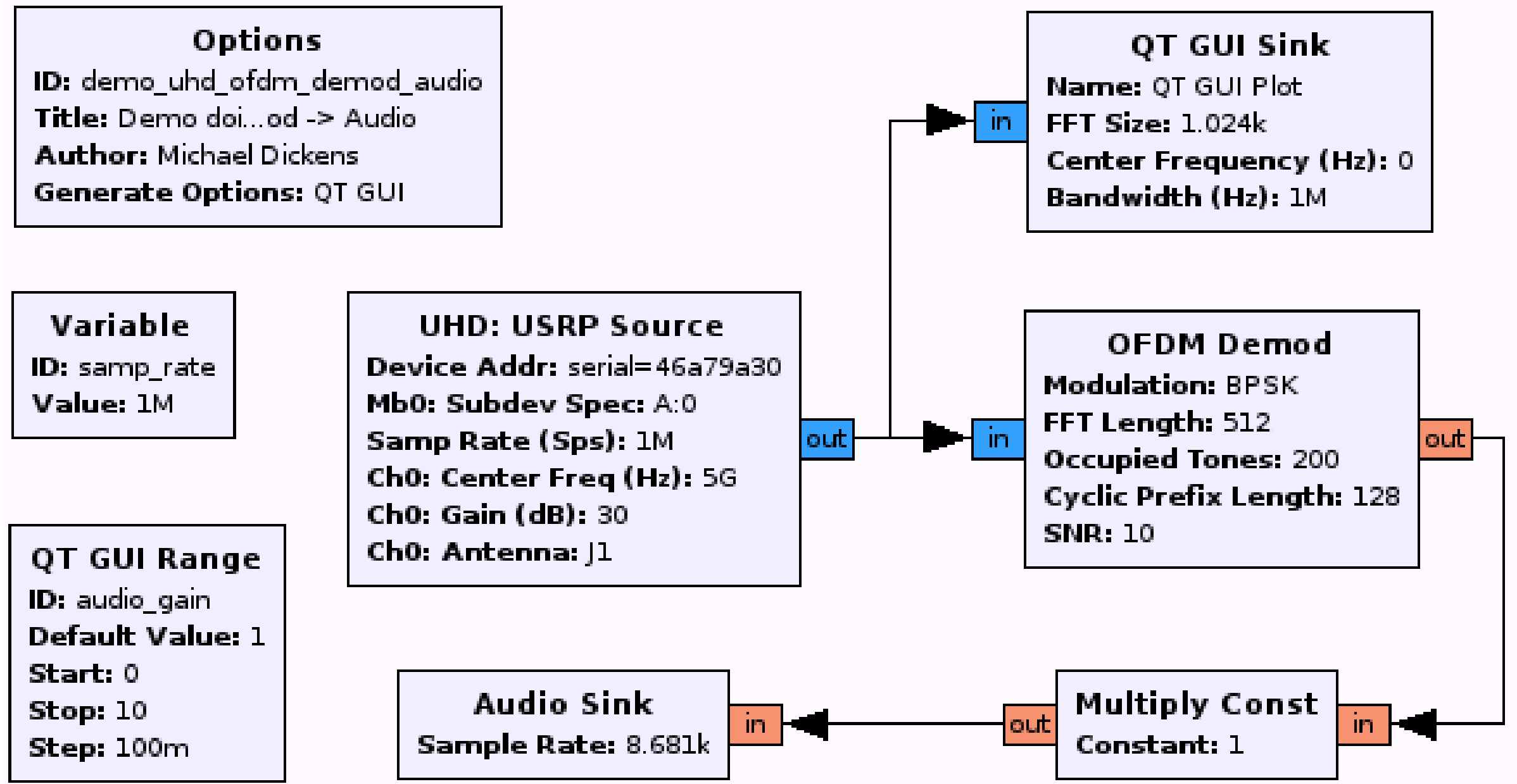
OFDM Demo Tx



OFDM Demo Tx



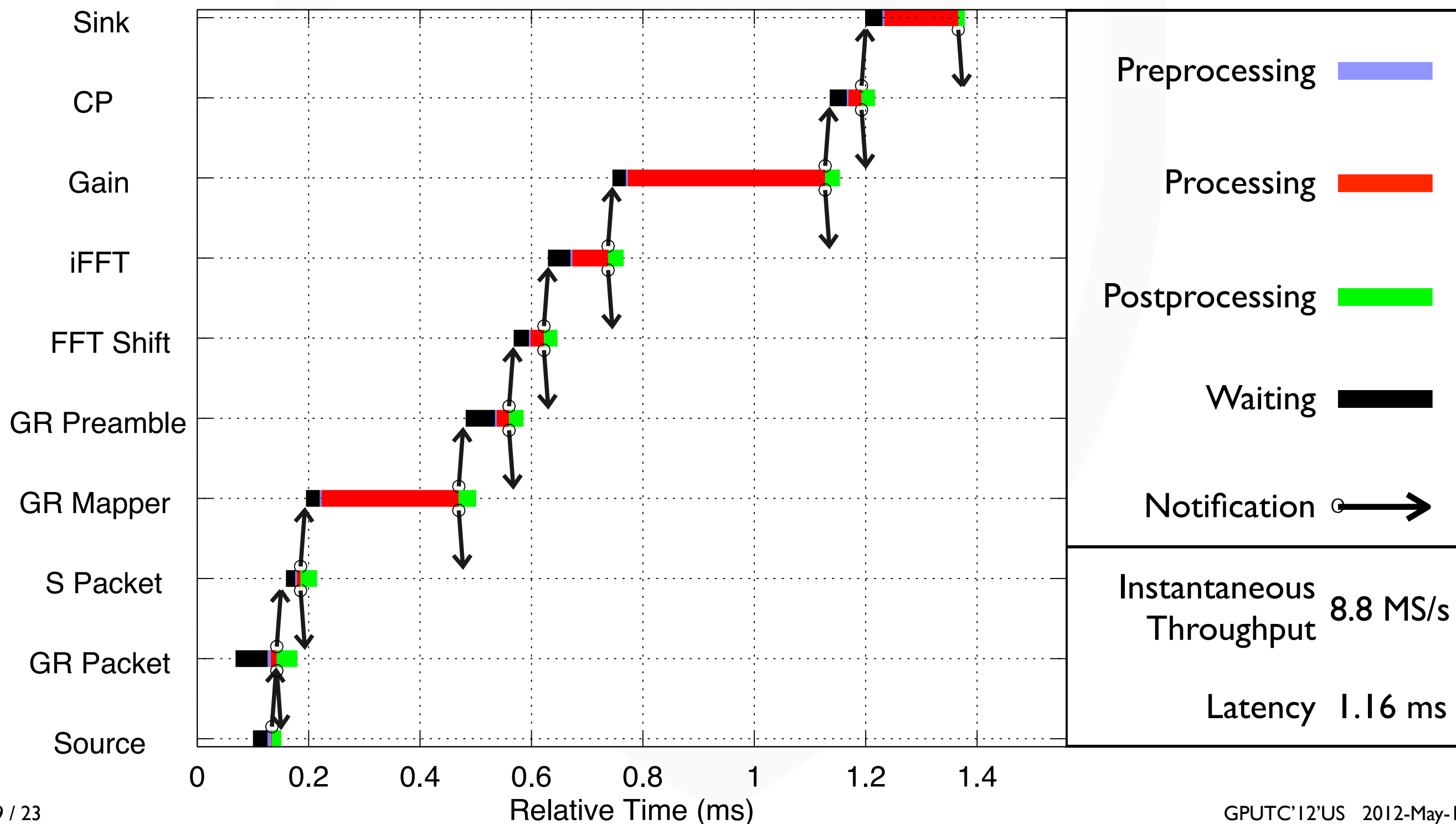
OFDM Demo Rx



Default Settings

Source to Sink Latency

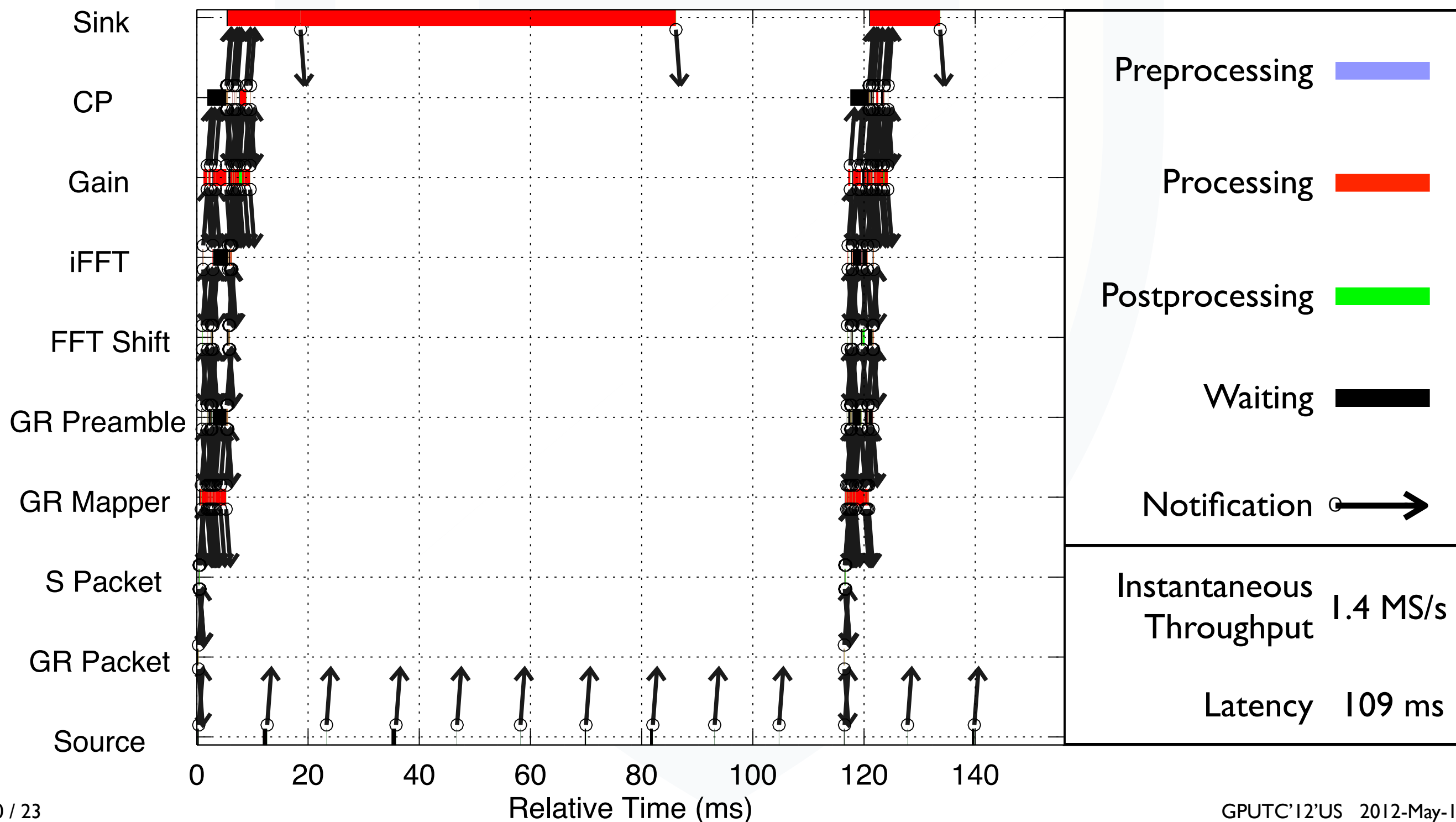
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GR Packet Encoder

Source to Sink Latency

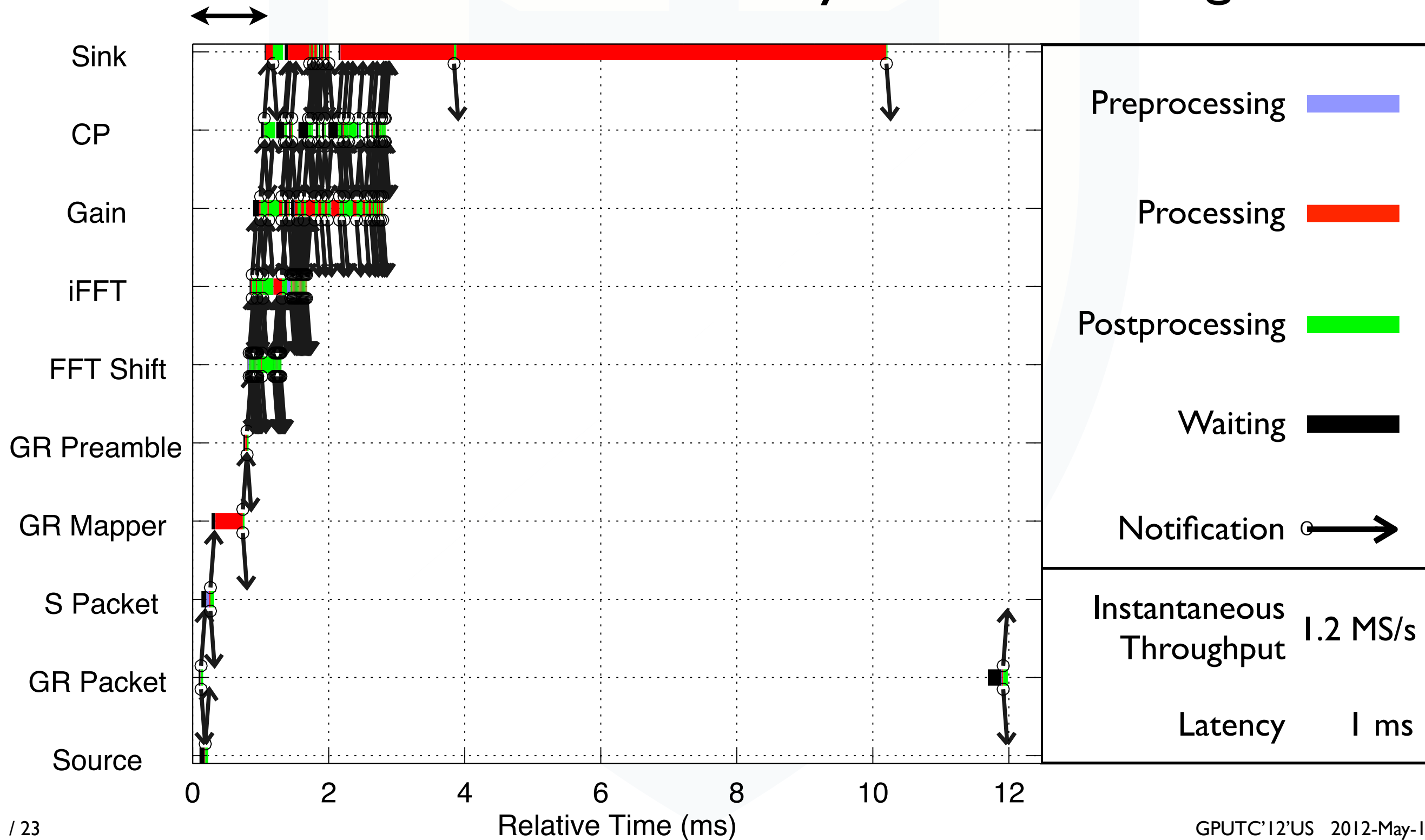
Legend



FFT Shift

Source to Sink Latency

Legend



Conclusions

- ➔ Evolving software defined radio runtime to exploit heterogeneous processing
- ➔ Key Features: Flavors, Thresholds, Statistics and Supervisor
- ➔ Supervisor can use statistics to set thresholds and flavors, providing runtime system control of throughput / latency, and mapping

Future Work

- ➔ GUI using Qt (SQuid)
- ➔ Flavors for CUDA and other processors
- ➔ Better optimized GPU flavors
- ➔ Interval / cluster mapping
- ➔ QoS-based adaptive runtime
- ➔ Using more embedded graph information



Thank you!

Questions?