

Mapping Multiple Independent Synchronous Dataflow Graphs

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Goal

- **Automated code generation of real-time applications for heterogeneous architectures**

Method

- **New model of computation that allows nondeterminate communication between independent dataflow graphs**

Target Specification

- **Hierarchical object-oriented target specification**
 - **Parent and child targets**
 - **Information hiding**

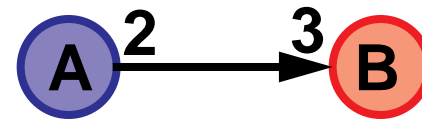


- **Compile-time scheduling**
- **Synthesize C and assembly code**

Application Specification

Synchronous Data Flow (SDF)

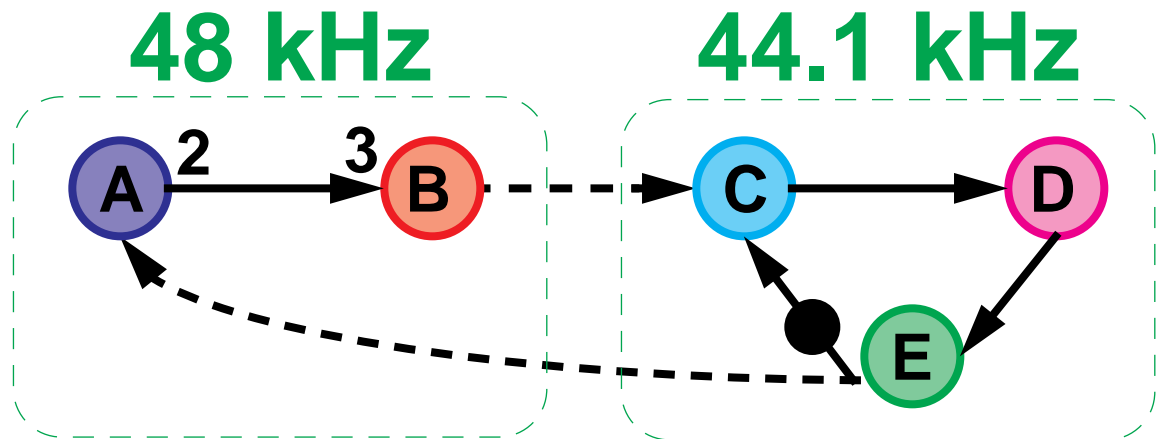
AABAB



Multiple Independent SDF Graphs

3(A)2(B)

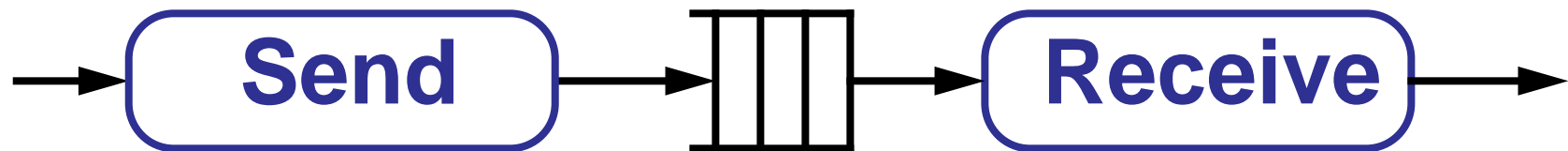
CDE



Communication Actors

- **Send/Receive**

Multiprocessor self-timed SDF graphs



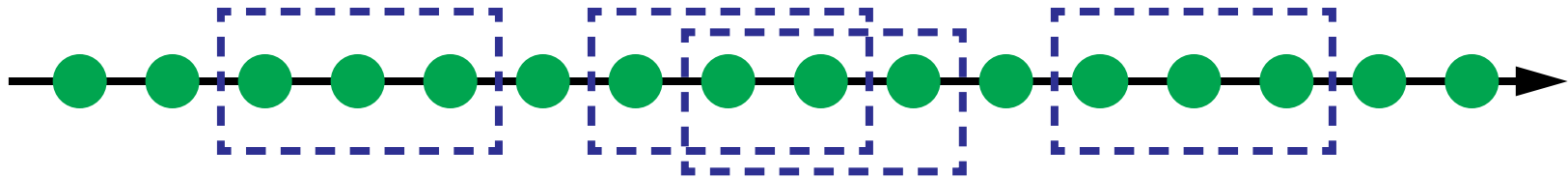
- **Peek/Poke**

**Multiple independent SDF graphs
(multiprocessor and/or uniprocessor
systems)**

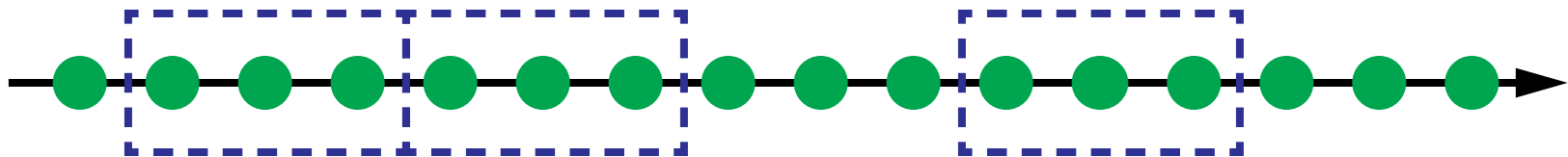


Peek/Poke Properties

- Update rate is **explicit, implicit or event driven** (change of value)
- **Single Sample**
- **Sliding Window**



- **Block aligned**



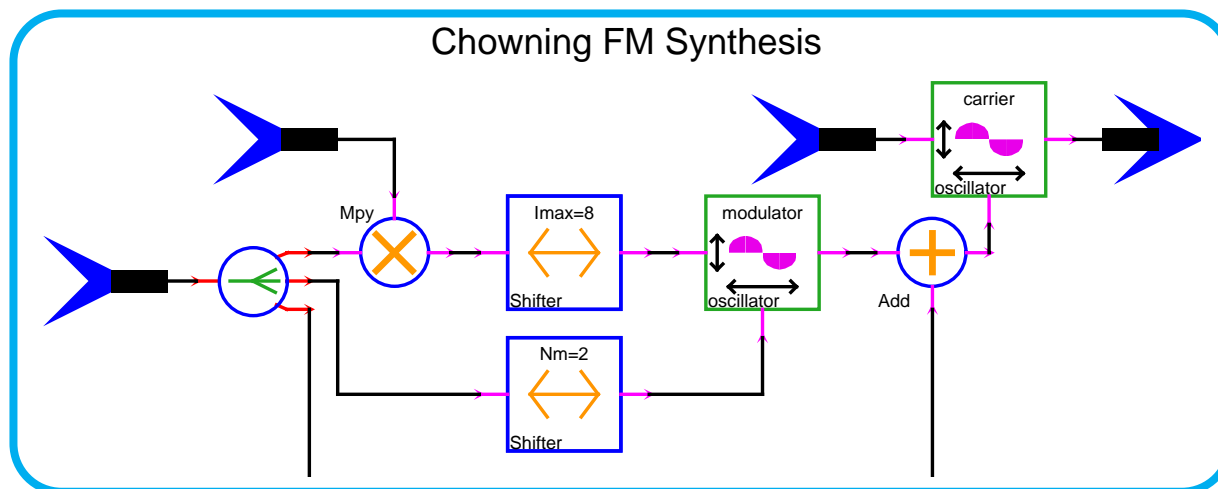
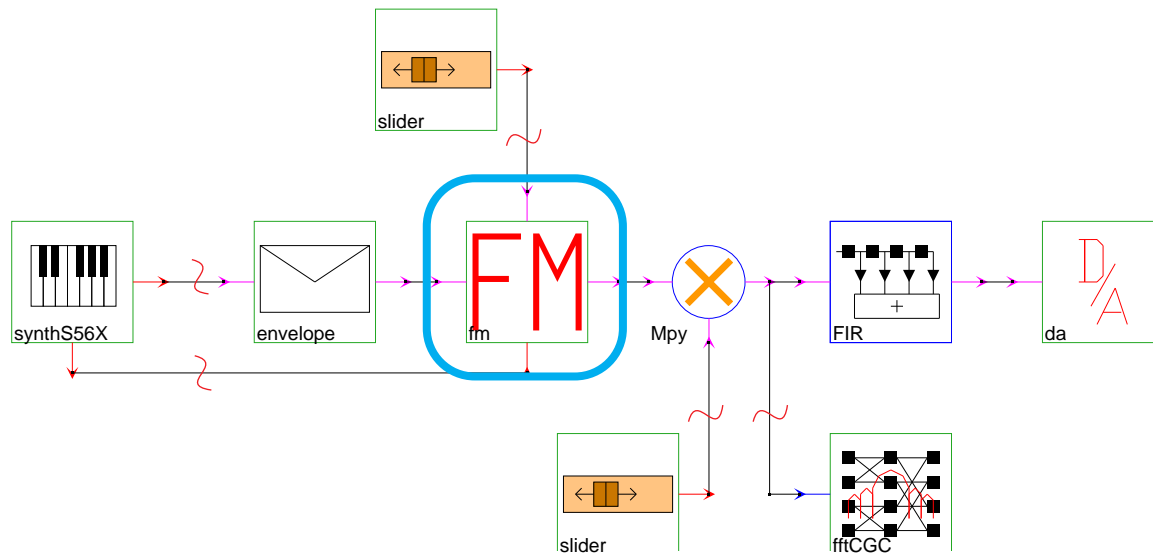
Static Scheduling

- **Must know relative rates of graphs**
 - **Explicitly:** Specified by user
 - **Implicitly:** Derived from real-time actors
- **Static schedule for example:**
 - **Concatenated:**
160(3(A)2(B)) 147(CDE)
 - **Interleaved:**
13(3(A)2(B)) 147(3(A)2(B)CDE)

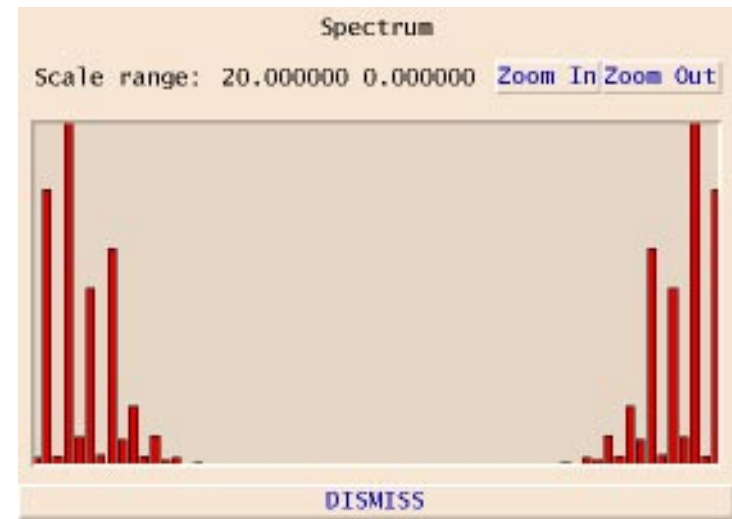
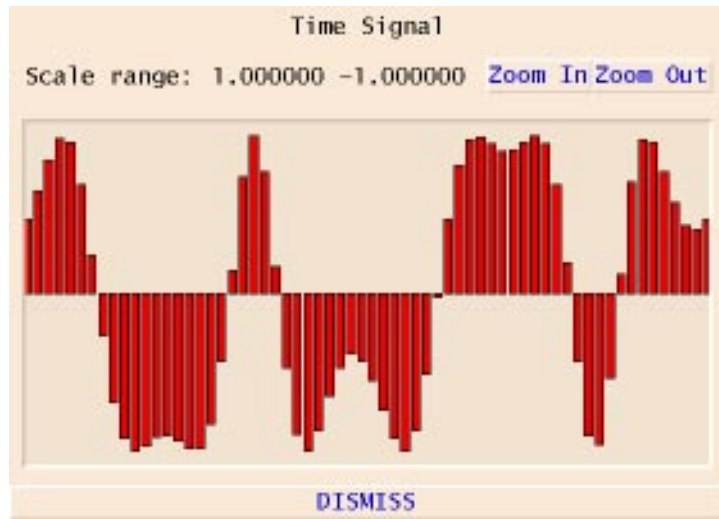
Dynamic Scheduling

- **Relative firing rates may not be exactly known (i.e. driven by separate hardware clocks)**
- **Might need preemption (i.e. execution time of one actor may exceed the period of another real-time actor)**
- **Rate-monotonic** priority assignment for the independent graphs scheduled dynamically using a **real-time** operating system

FM Synthesis: Specification



FM Synthesis: GUI



Control panel

[GO](#) [PAUSE](#) [STOP](#)

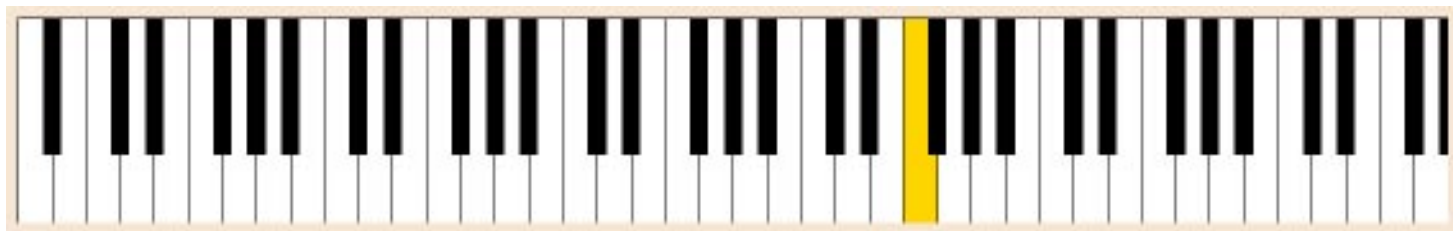
Number of Iterations:

Volume: 1.0000

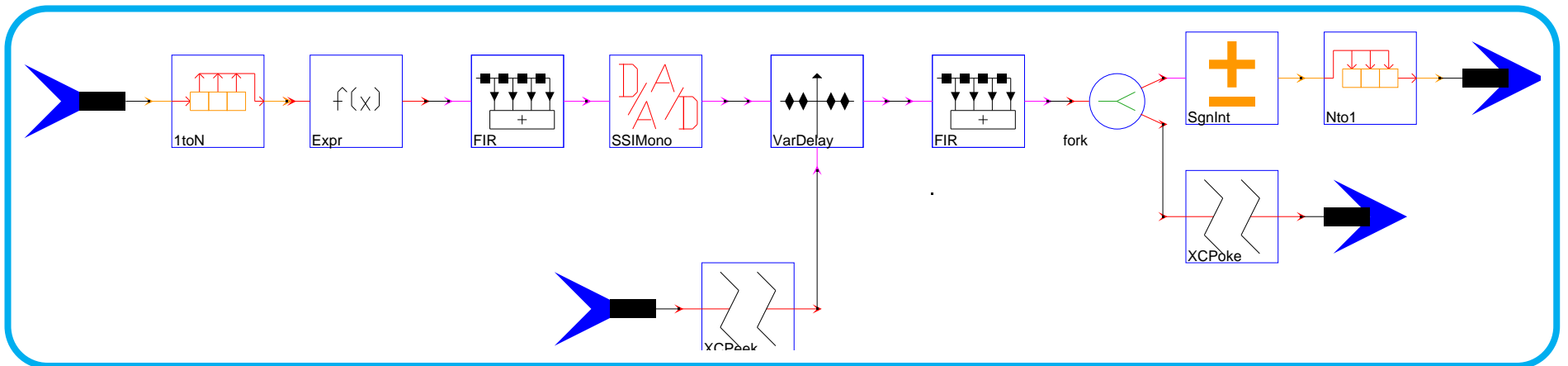
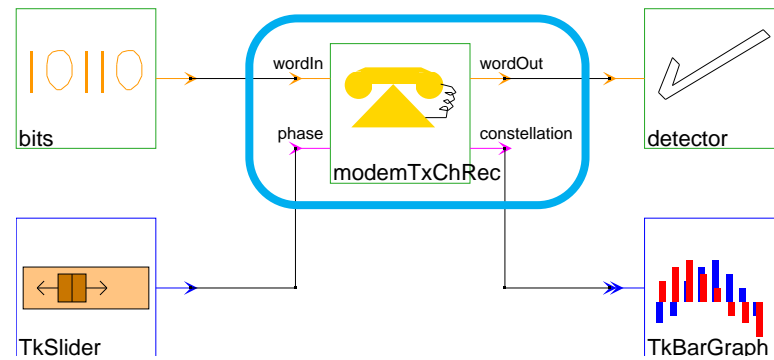
FM_Index: 0.7800

[QUIT](#)

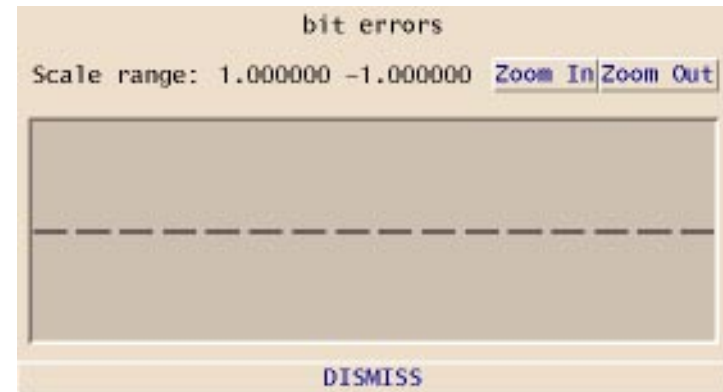
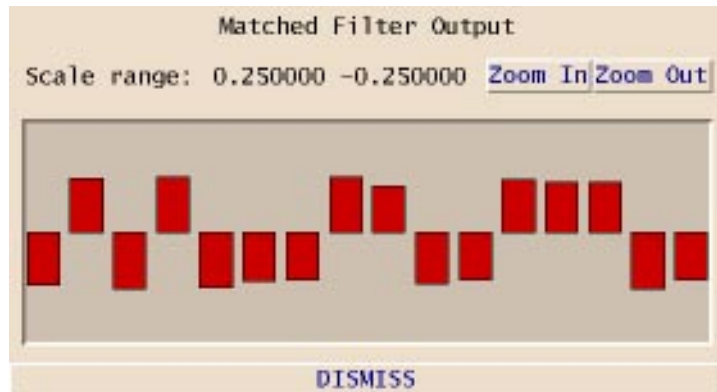
The Control panel contains several interactive elements. At the top, there are three buttons: 'GO', 'PAUSE', and 'STOP'. Below these, there is a text input field for 'Number of Iterations' with the value '-1'. There are two sliders: 'Volume' with a value of 1.0000 and 'FM_Index' with a value of 0.7800. At the bottom, there is a 'QUIT' button.



Acoustic Modem: Specification



Acoustic Modem: GUI



Control panel

[GO <Return>](#) [PAUSE <Space>](#) [STOP <Escape>](#)

Number of Iterations:

TimingPhase: 0.9600

QUIT

This control panel includes buttons for 'GO <Return>', 'PAUSE <Space>', and 'STOP <Escape>'. It features a text input field for 'Number of Iterations' with the value '-1', and a slider for 'TimingPhase' with the value '0.9600'. A 'QUIT' button is located at the bottom.

Conclusions

- **Extended synchronous dataflow with nondeterminate **peek/poke** communication actors**
- **Static scheduling** for implicit or explicit graph rates
- **Dynamic scheduling** for unknown graph rates
- **Ideal for interactive controls and displays**

Future Work

- **Hierarchical** scheduling framework to mix
 - Multiprocessor schedulers (general and specialized)
 - Uniprocessor schedulers
- Efficient real-time **dynamic scheduling**
 - prioritized multithreaded execution
 - non-preemptive rate monotonic scheduling