The Component Interaction Domain: Modeling Event-Driven and Demand-Driven Applications

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Outline

- Interaction between Software Components
- Software Framework Examples
  - The CORBA Event Service
  - The Click Modular Router
- The Component Interaction (CI) Domain
- Demonstration
- Current Status and Future Work

Aspects of Component Interaction

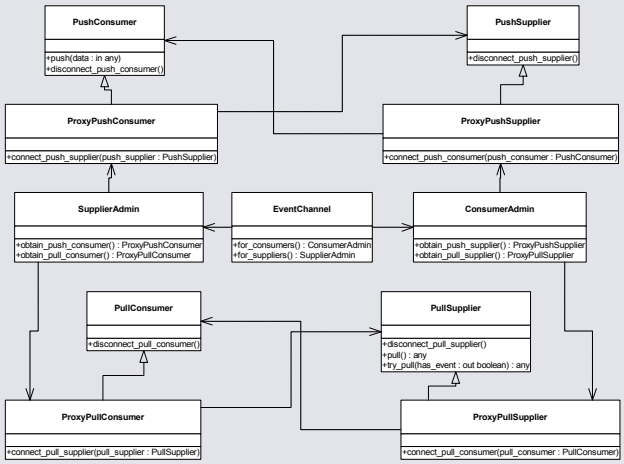
- Making sense of the information exchanged
  - E.g. a pure event notification, or an array of floating-point numbers
  - Managed by the type system
- The communication protocol
  - E.g. rendezvous, or read from/write to a FIFO queue
  - Managed by a model of computation

Aspects of Component Interaction

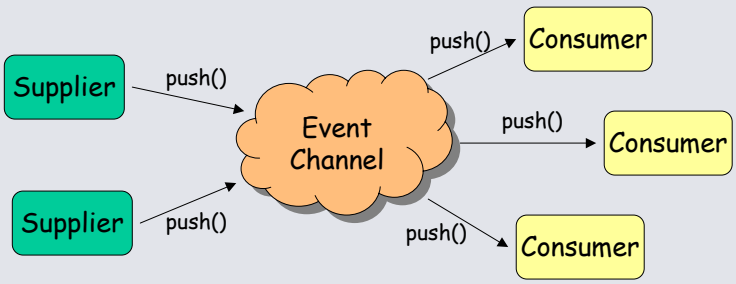
- Initiation
  - Which participant initiates the interaction?
  - What components can initiate interaction?
- Control flow
  - How do interacting components obtain the execution context?
- Timing…

The CORBA Event Service

- Support asynchronous, decoupled communication between objects

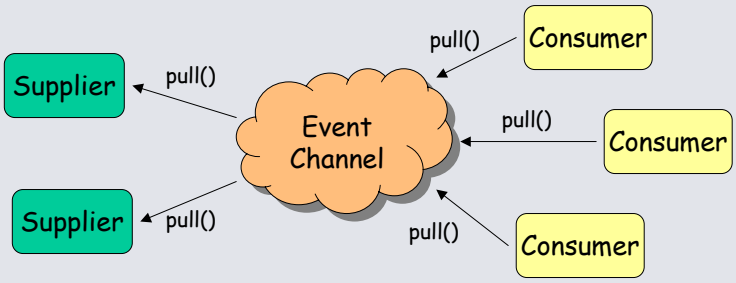


The Push Model



- The supplier initiates the transfer of data
- The consumer reacts to supplied data
- The event channel provides the execution context for the consumer

The Pull Model



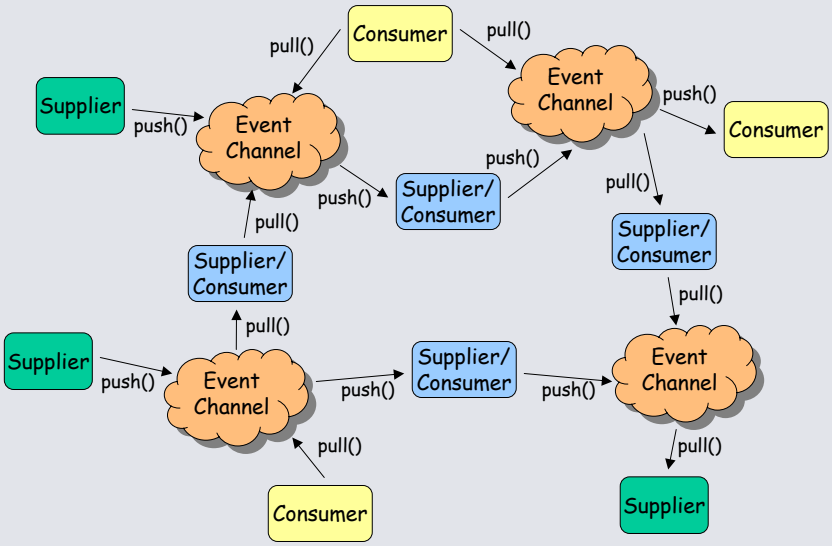
- The consumer initiates the transfer of data
- The supplier reacts to demand of data
- The event channel provides the execution context for the supplier

Mixed Models

- Push supplier and pull consumer
  - The event channel acts as an event queue

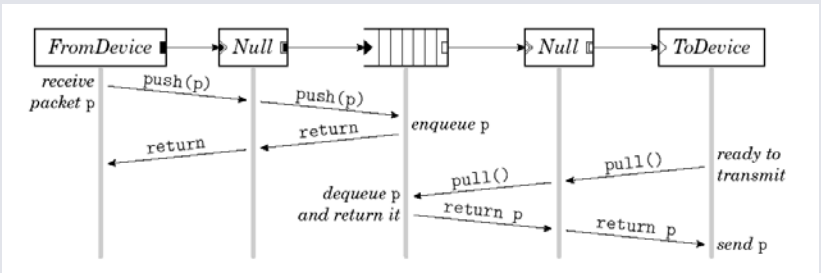
- Pull supplier and push consumer
  - The event channel must act as an active mediator for any interaction to take place

Complex Mixture



The Click Modular Router

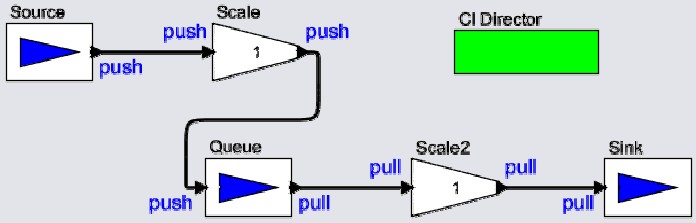
- Elements are C++ objects that interact by making method calls
- Packets are passed as method argument or return value
- Flexible, configurable, and highly efficient routers have been built with this software architecture



E. Kohler et al., "The Click Modular Router," *ACM Transactions on Computer Systems*, 18(3), August 2000, pages 263-297.

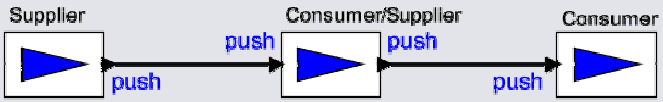
The Component Interaction Domain

- Push/pull interaction
- Active/passive actors
- Multi-threaded execution



Push/Pull Interaction

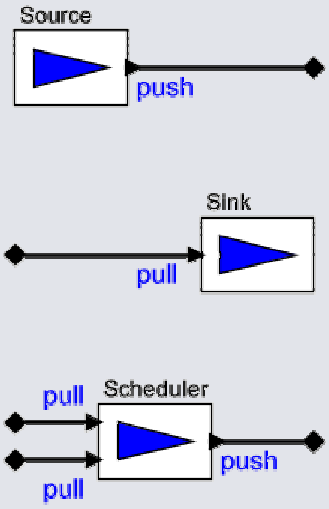
- Push model
  - Event-driven applications



- Pull model
  - Demand-driven applications

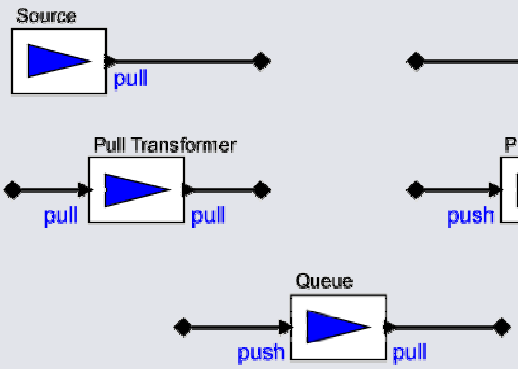
Active Actors

- Active actors initiate all computation in the model
  - Source actors with push output
  - Sink actors with pull input
  - Actors with pull input and push output



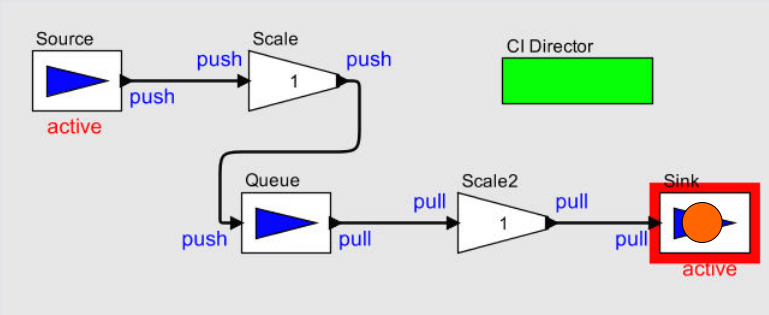
Passive Actors

- Passive actors react to pushed event or pull demand

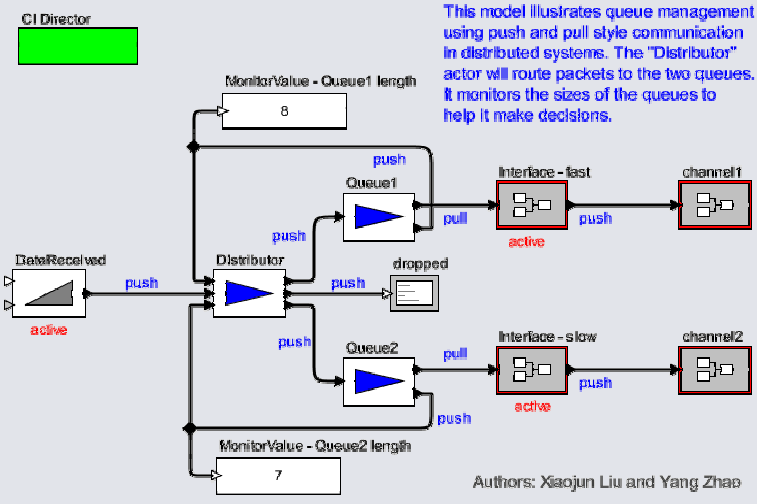


Multi-Threaded Execution

- Each active actor has its own execution thread
- Passive actors share the same execution thread as the director



A Router Model in the CI Domain



CI vs. the Click Router Architecture

- Click is a specialized, highly efficient, runtime software architecture based on object-oriented programming. Router elements interact by making method calls. The control flow is fixed once the router is built.
- The CI domain provides a more general model architecture based on actor-oriented programming. Actor interaction is mediated by the director, so is more decoupled. The director (or code generator) can partition a model and choose a different analysis/scheduling strategy for each part.

Current Status and Future Work

- Current status
  - A preliminary implementation is included in the current release
- Future work
  - Design the infrastructure for building actors with mixed push/pull input ports and output ports
  - Partitioning of CI models for scheduling and allocating execution threads
  - Explore the relation to dynamic dataflow that uses both data-driven and demand-driven execution strategies