

# Connectors

(Shaw and Garlan)

*Connectors mediate interactions among components: that is, they establish the rules that govern component interaction and specify any auxiliary mechanisms required*

# Taxonomy of Connectors

- Nikunj R. Mehta, Nenad Medvidovic, and Sandeep Phadke. "Towards a Taxonomy of Software Connectors." *Proceedings of the 22nd International Conference on Software Engineering*, Limerick, Ireland, pp. 178-187, 2000.

# Atomic Elements

- Ducts
  - Interaction channel with no associated behavior
- Data transfer mechanisms
- Control transfer mechanisms
- Internal mechanisms
  - Storage
  - Computation

# Connector Service Categories

- Services to the system, not to the end user
- *A service category represents the broad interaction role the connector fulfills --*  
*Mehta et al.*
  - **Communication (t)**: transmission of data
  - **Coordination (o)**: transfer of control
  - **Conversion (x)**: typically converting data formats so that components can interact
  - **Facilitation (f)**: mediation and optimization

# Services/Features

- Data buffering
- Acknowledgement
- Guaranteed delivery (retry)
- Synchronization
- Dynamic reconfiguration

- Multiple sources/sinks
- Invocation
- Transactions
- Load balancing
- Scheduling

# Connector Types

- **Procedure call** (ot): methods, fork-exec, callback, system calls
- **Event** (ot): user actions, interrupts, page faults, traps
- **Data access** (tx): database queries, CORBA repository access, heap/stack memory access, information caching
- **Linkage** (f): buses, dependency relationships
- **Stream** (t): pipes, sockets, client/server protocols
- **Arbitrator** (fo): synchronization, concurrency control, service level negotiation, scheduling, load balancing
- **Adaptor** (x): virtual memory translation, virtual function tables, DeLine packagers
- **Distributor** (f): DNS, routing, switching

# Example Connectors

- Remote procedure calls
- Schedulers
- Adaptors
- Packagers
- Active interfaces
- Fault-tolerant arbiters
- Real-time filters

- Shared variables
- Table entries
- Buffers
- Linker instructions
- Procedure calls
- Network protocols
- Pipes
- SQL

# Linux Case Study

## Higher-Order Connectors

- File facade
  - Contention management (arbitration), transparency (adaptation), OS interface (coordination)
- Shared memory
  - (data access)
- Process scheduler
  - Controls access to resources (arbitrator)