

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

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

Services/Features

- Data buffering
- Acknowledgement
- Guaranteed delivery (retry)
- Synchronization
- Dynamic reconfiguration
- Multiple sources/sinks
- Invocation
- Transactions
- Load balancing
- Scheduling

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)