COMP 3700: Software Modeling and Design

(Architectural Design)

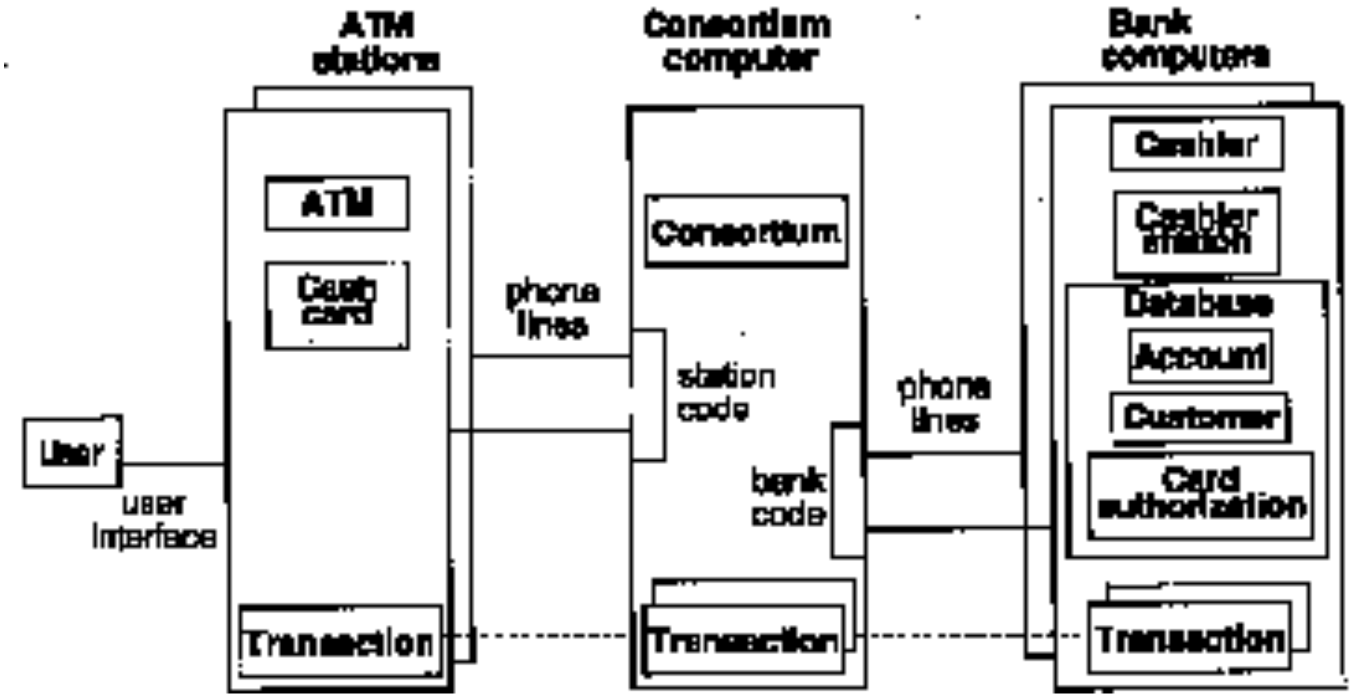
Objectives

- To introduce architectural design and to discuss its importance
- To explain why multiple models are required to document a software architecture
- To describe types of architectural model that may be used
- To discuss how domain-specific reference models may be used as a basis for product-lines and to compare software architectures

Objectives

- **Establishing the overall structure of a software system**

Architecture = Component + Connections + Style



Architectural Design

- An early stage of the system design process
- Represents the link between specification and design processes
- Often carried out in parallel with some specification activities
- It involves identifying major system components and their communications

Architectural Design Process

- System structuring
  - The system is decomposed into several principal sub-systems and communications between these sub-systems are identified
- Control modelling
  - A model of the control relationships between the different parts of the system is established
- Modular decomposition
  - The identified sub-systems are decomposed into modules

Subsystems and Modules

- A sub-system is a system in its own right whose operation is independent of the services provided by other sub-systems.
- A module is a system component that provides services to other components but would not normally be considered as a separate system

Architectural Models

- Static structural model that shows the major system components
- Dynamic process model that shows the process structure of the system

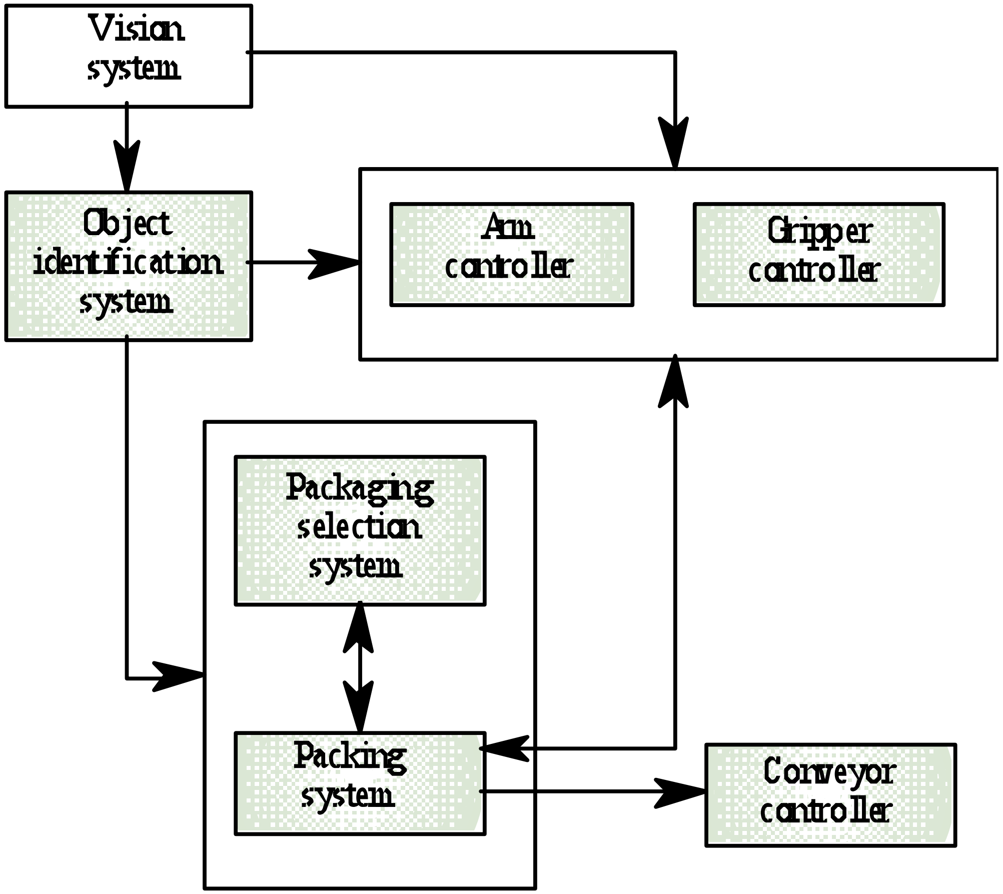
Architectural Styles

- The architectural model of a system may conform to a generic architectural model or style
- An awareness of these styles can simplify the problem of defining system architectures
- However, most large systems are heterogeneous and do not follow a single architectural style

System Structuring

- Concerned with decomposing the system into interacting sub-systems
- The architectural design is normally expressed as a block diagram presenting an overview of the system structure

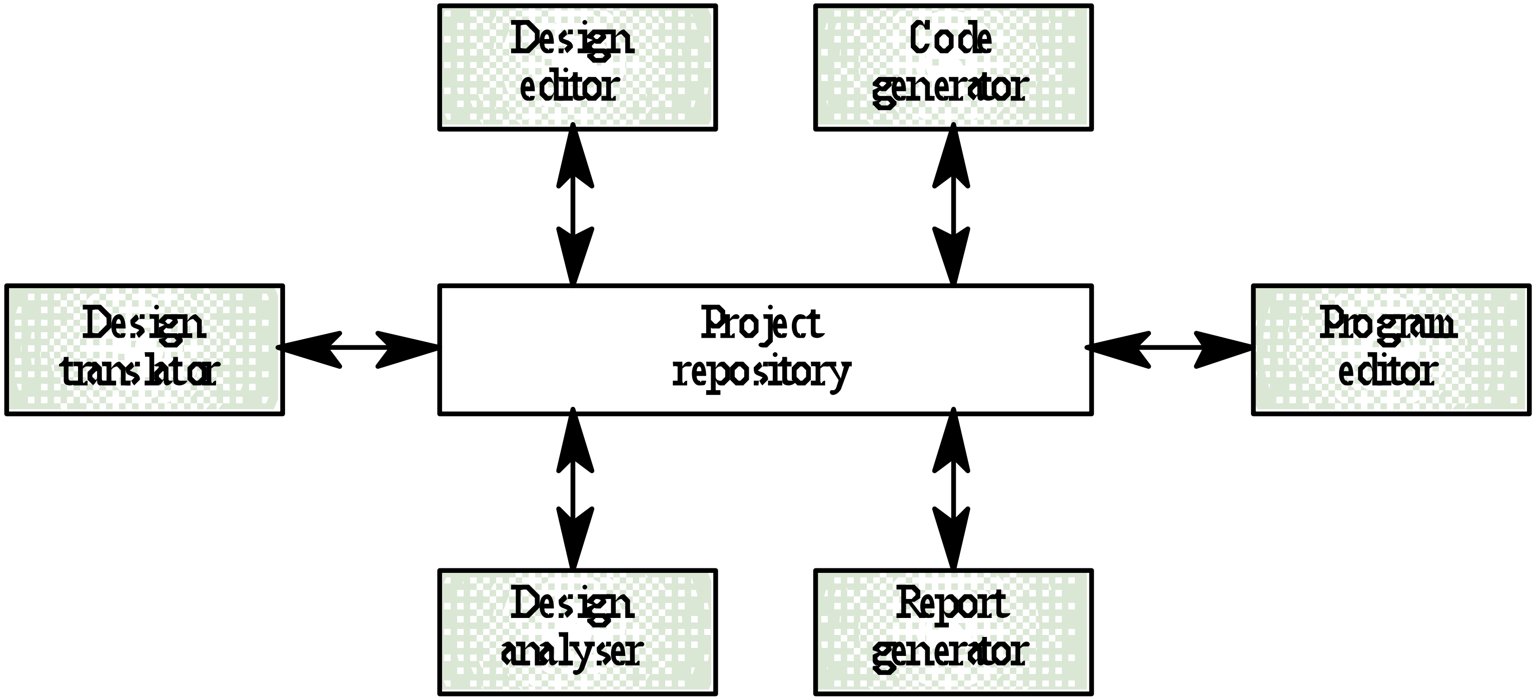
Packing Robot Control System



The Repository Model

- Sub-systems must exchange data. This may be done in two ways:
  - Shared data is held in a central database or repository and may be accessed by all sub-systems
  - Each sub-system maintains its own database and passes data explicitly to other sub-systems
- When large amounts of data are to be shared, the repository model of sharing is most commonly used

CASE Toolset Architecture



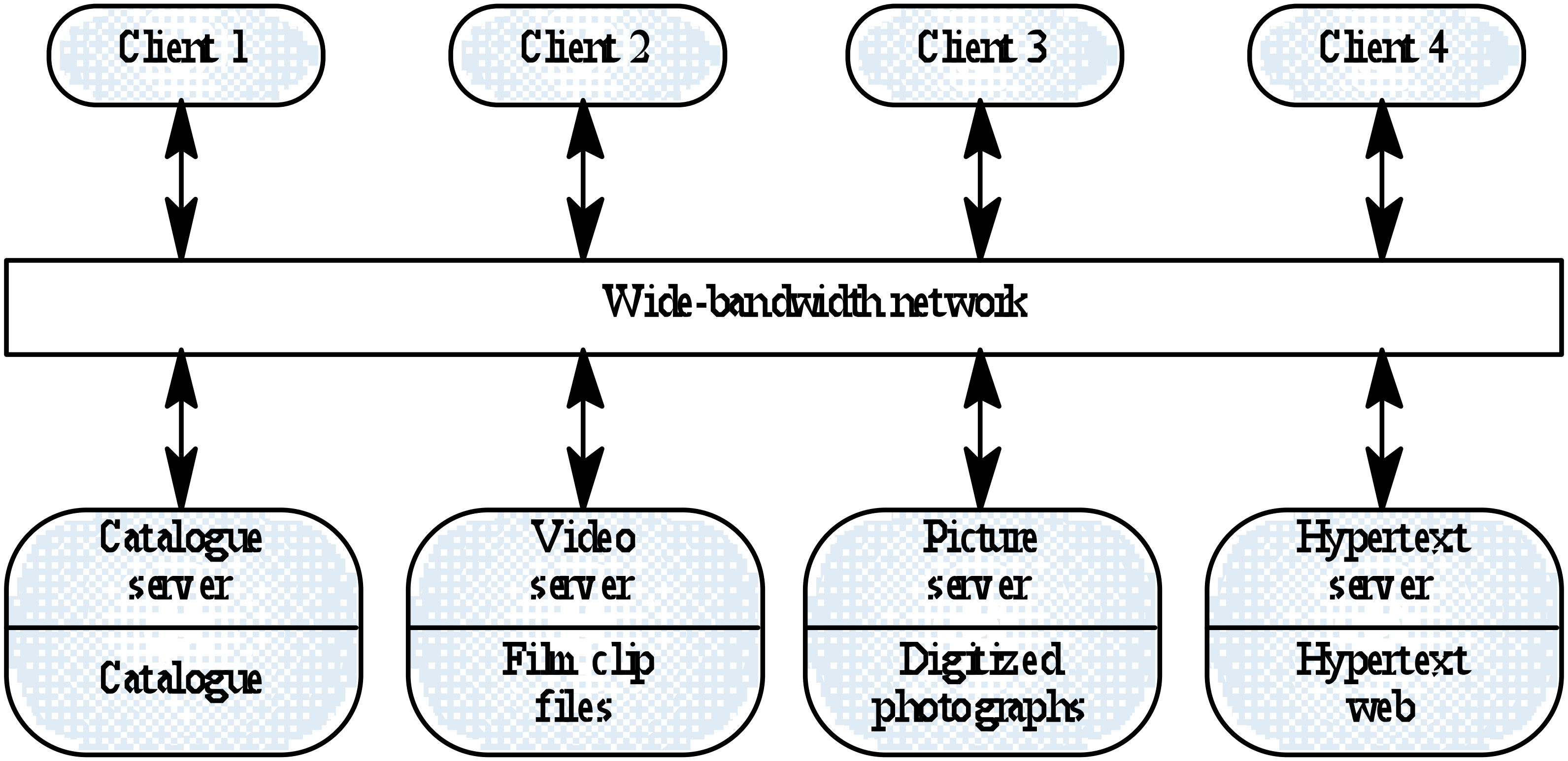
Repository Model Characteristics

- Advantages
  - Efficient way to share large amounts of data
  - Sub-systems need not be concerned with how data is produced Centralised management e.g. backup, security, etc.
  - Sharing model is published as the repository schema
- Disadvantages
  - Sub-systems must agree on a repository data model. Inevitably a compromise
  - Data evolution is difficult and expensive
  - No scope for specific management policies
  - Difficult to distribute efficiently

Client-Server Architecture

- Distributed system model which shows how data and processing is distributed across a range of components
- Set of stand-alone servers which provide specific services such as printing, data management, etc.
- Set of clients which call on these services
- Network which allows clients to access servers

Film and Picture Library



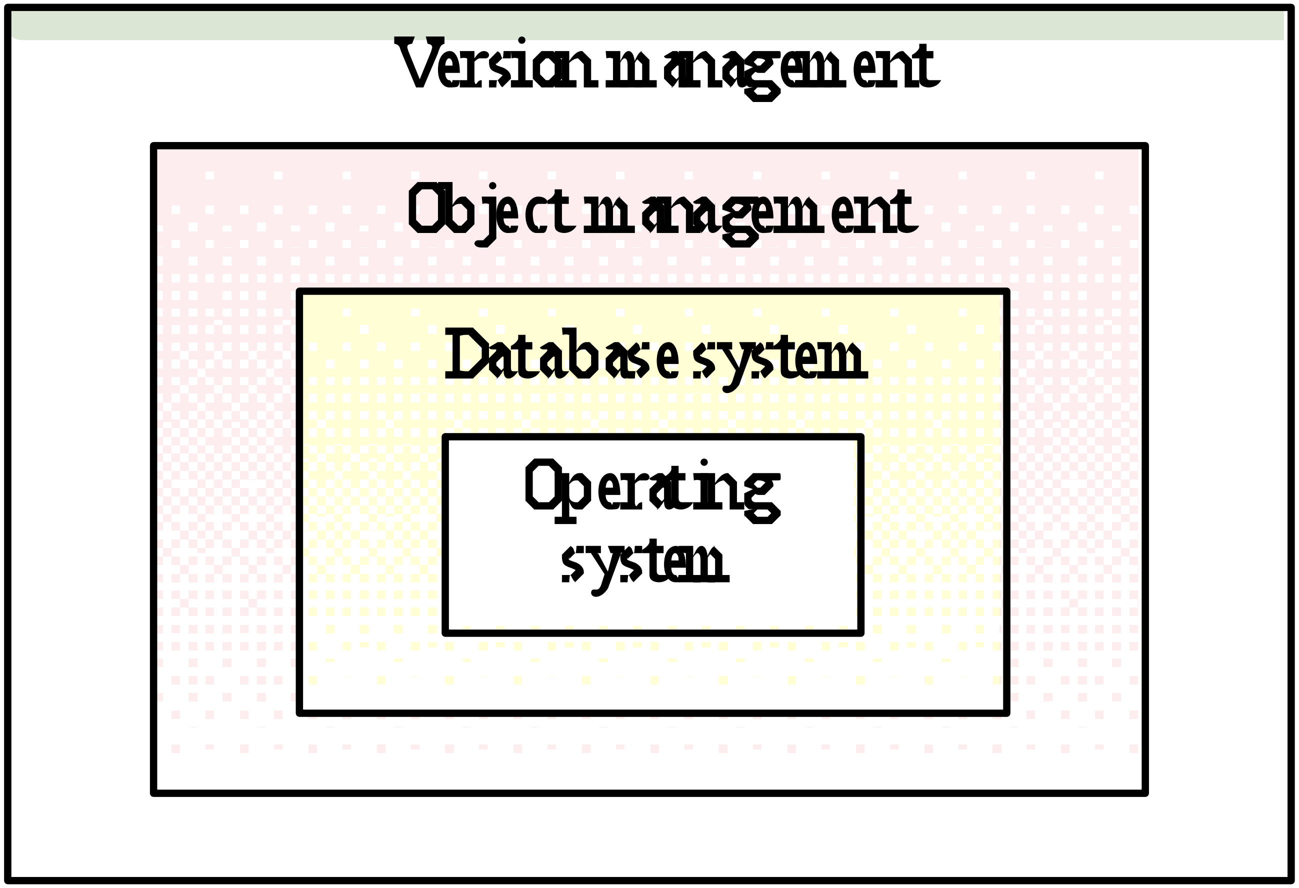
Client-Server Characteristics

- Advantages
  - Distribution of data is straightforward
  - Makes effective use of networked systems. May require cheaper hardware
  - Easy to add new servers or upgrade existing servers
- Disadvantages
  - No shared data model so sub-systems use different data organisation. data interchange may be inefficient
  - Redundant management in each server
  - No central register of names and services - it may be hard to find out what servers and services are available

Abstract Machine Model

- Used to model the interfacing of sub-systems
- Organises the system into a set of layers (or abstract machines) each of which provide a set of services
- Supports the incremental development of sub-systems in different layers. When a layer interface changes, only the adjacent layer is affected
- However, often difficult to structure systems in this way

Version Management System



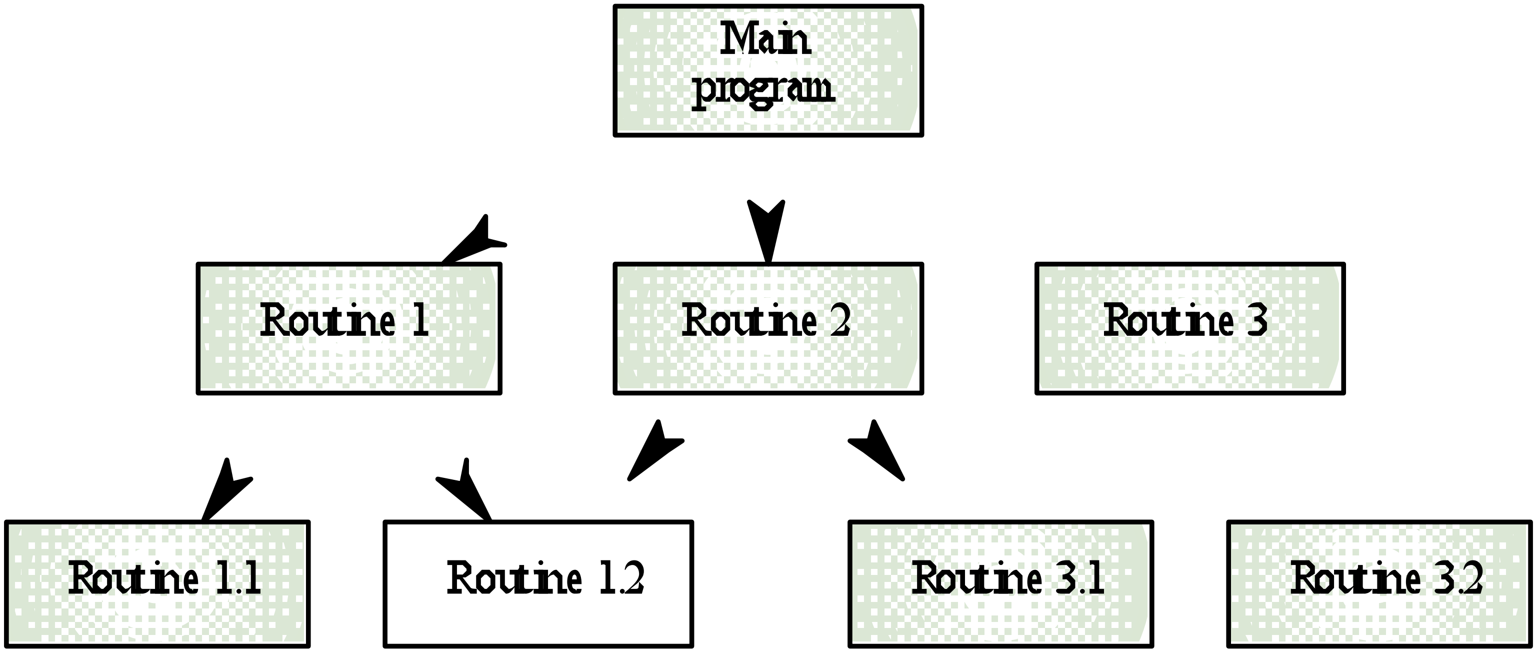
Control Models

- Are concerned with the control flow between sub-systems. Distinct from the system decomposition model
- Centralised control
  - One sub-system has overall responsibility for control and starts and stops other sub-systems
- Event-based control
  - Each sub-system can respond to externally generated events from other sub-systems or the system's environment

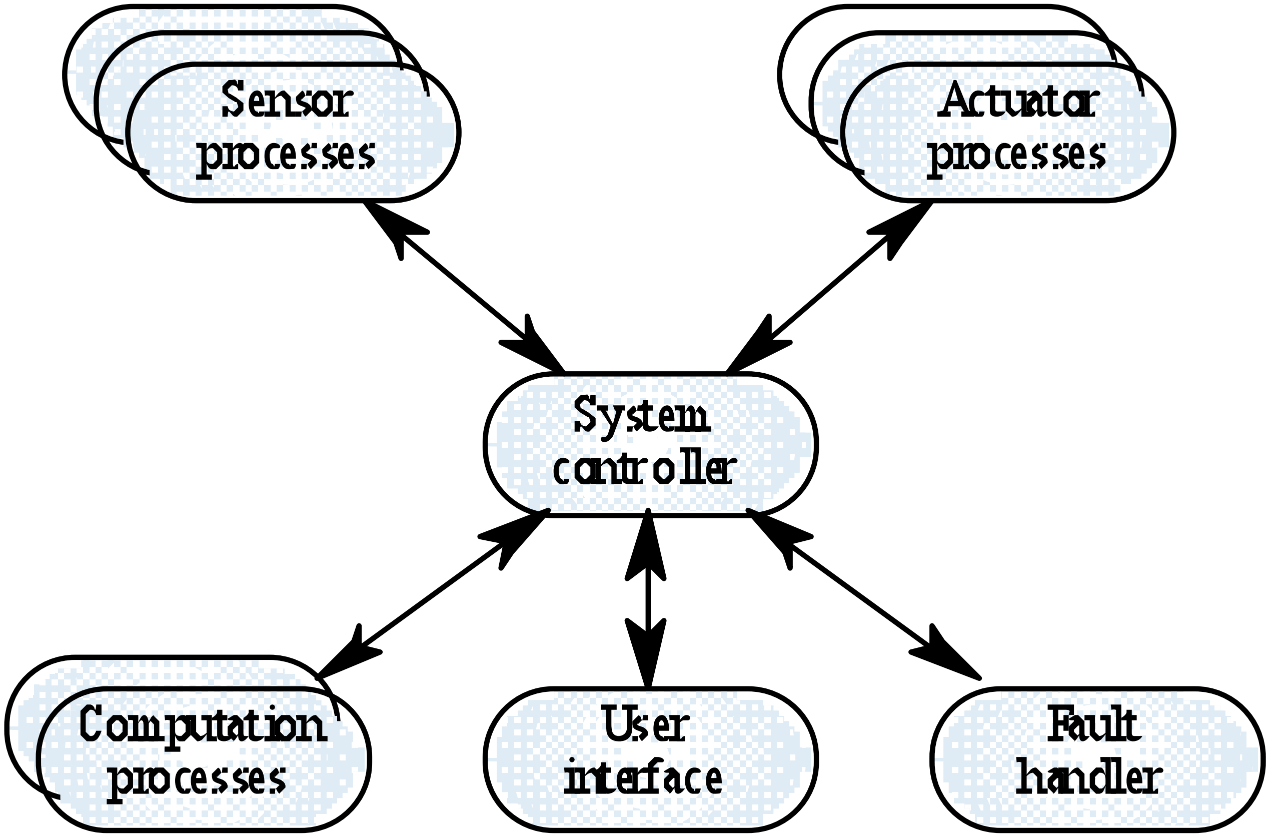
Centralized Control

- A control sub-system takes responsibility for managing the execution of other sub-systems
- Call-return model
  - Top-down subroutine model where control starts at the top of a subroutine hierarchy and moves downwards. Applicable to sequential systems
- Manager model
  - Applicable to concurrent systems. One system component controls the stopping, starting and co-ordination of other system processes. Can be implemented in sequential systems as a case statement

Call-return Model



Real-time System Control



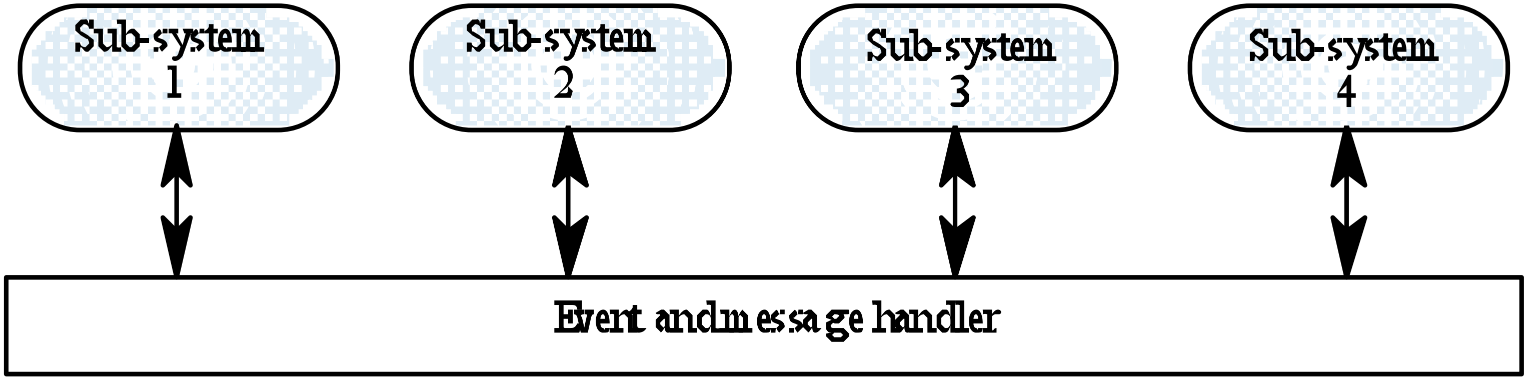
Event-driven Systems

- Driven by externally generated events where the timing of the event is out with the control of the sub-systems which process the event
- Two principal event-driven models
  - Broadcast models. An event is broadcast to all sub-systems. Any sub-system which can handle the event may do so
  - Interrupt-driven models. Used in real-time systems where interrupts are detected by an interrupt handler and passed to some other component for processing
- Other event driven models include spreadsheets and production systems

Broadcast Model

- Effective in integrating sub-systems on different computers in a network
- Sub-systems register an interest in specific events. When these occur, control is transferred to the sub-system which can handle the event
- Control policy is not embedded in the event and message handler. Sub-systems decide on events of interest to them
- However, sub-systems don’t know if or when an event will be handled

Selective Broadcasting



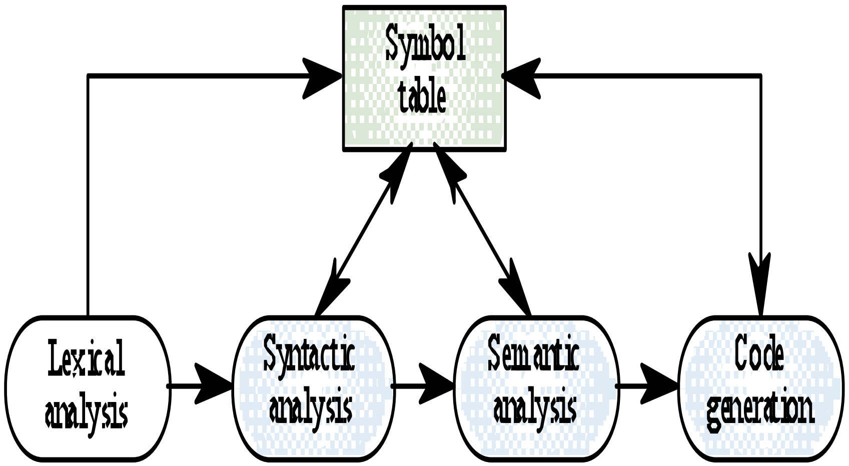
Interrupt-driven Systems

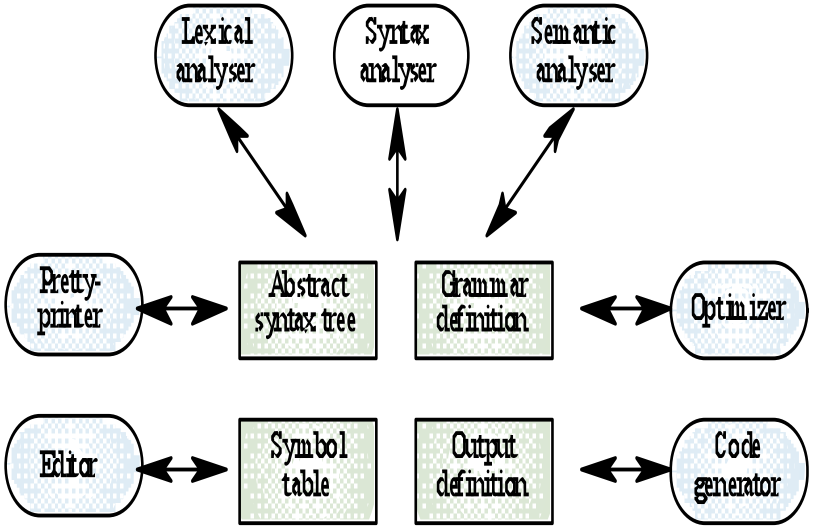
- Used in real-time systems where fast response to an event is essential
- There are known interrupt types with a handler defined for each type
- Each type is associated with a memory location and a hardware switch causes transfer to its handler
- Allows fast response but complex to program and difficult to validate

Domain-specific Architectures

- Architectural models which are specific to some application domain
- Two types of domain-specific model
  - Generic models which are abstractions from a number of real systems and which encapsulate the principal characteristics of these systems
  - Reference models which are more abstract, idealised model. Provide a means of information about that class of system and of comparing different architectures
- Generic models are usually bottom-up models; Reference models are top-down models

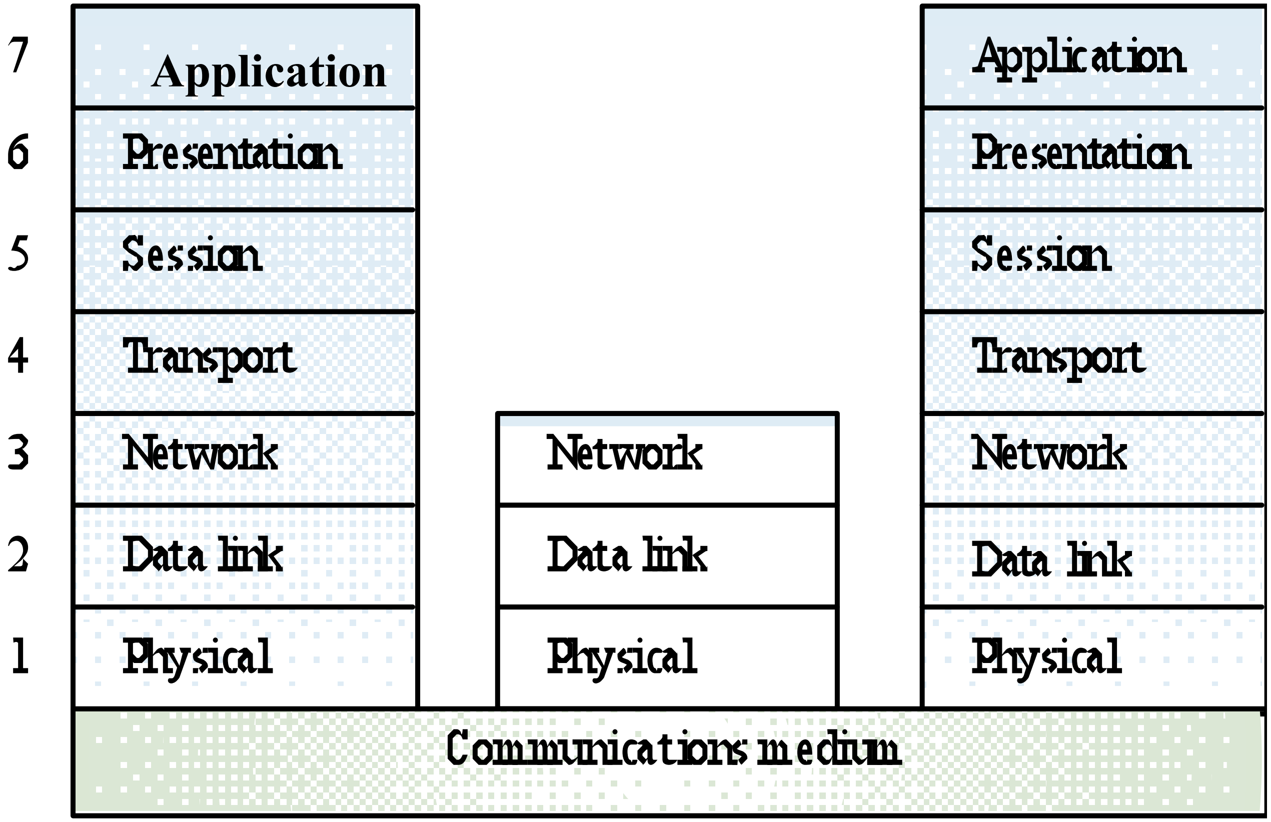
Generic architectural Models





Repository

OSI Reference Model



7 Application Application

6 Presentation Presentation

5 Session Session

4 Transport Transport

3 Network Network Network

2 Data link Data link Data link

1 Physical Physical Physical

Communications medium