Chapter 10
Architecture Design Styles

Objectives

- To introduce two of the three complementary architectural styles covering organisation, decomposition and control
- To discuss reference architectures used to communicate and compare architectures

Topics covered

- 10.1 Decomposition styles
- 10.2 Control styles
- 10.3 Reference architectures

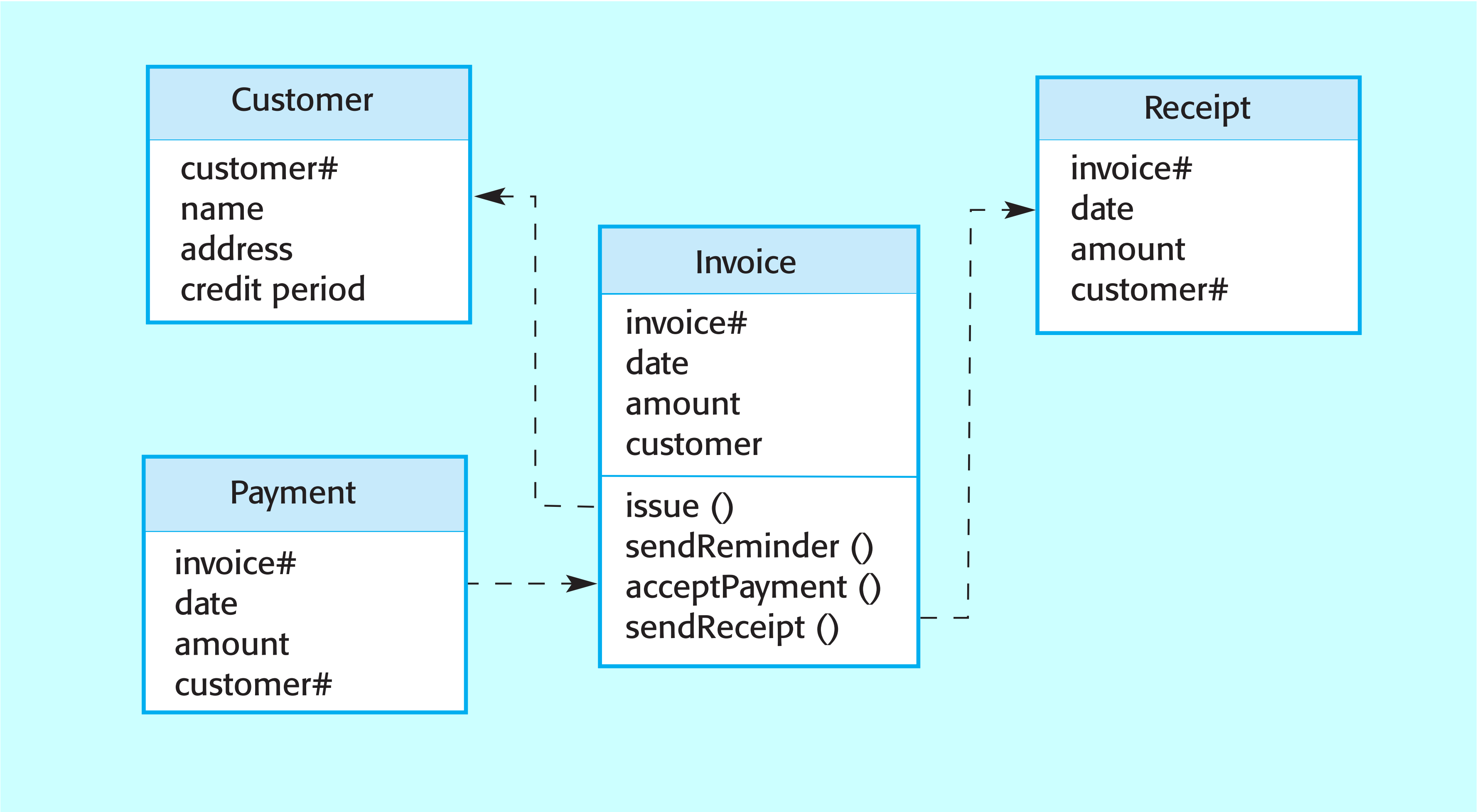
Modular decomposition

- Another structural level where sub-systems are decomposed into modules.
- Two modular decomposition models covered
  - An object model where the system is decomposed into interacting object;
  - A pipeline or data-flow model where the system is decomposed into functional modules which transform inputs to outputs.
- If possible, decisions about concurrency should be delayed until modules are implemented.

Object models

- Structure the system into a set of loosely coupled objects with well-defined interfaces.
- Object-oriented decomposition is concerned with identifying object classes, their attributes and operations.
- When implemented, objects are created from these classes and some control model used to coordinate object operations.

Invoice processing system



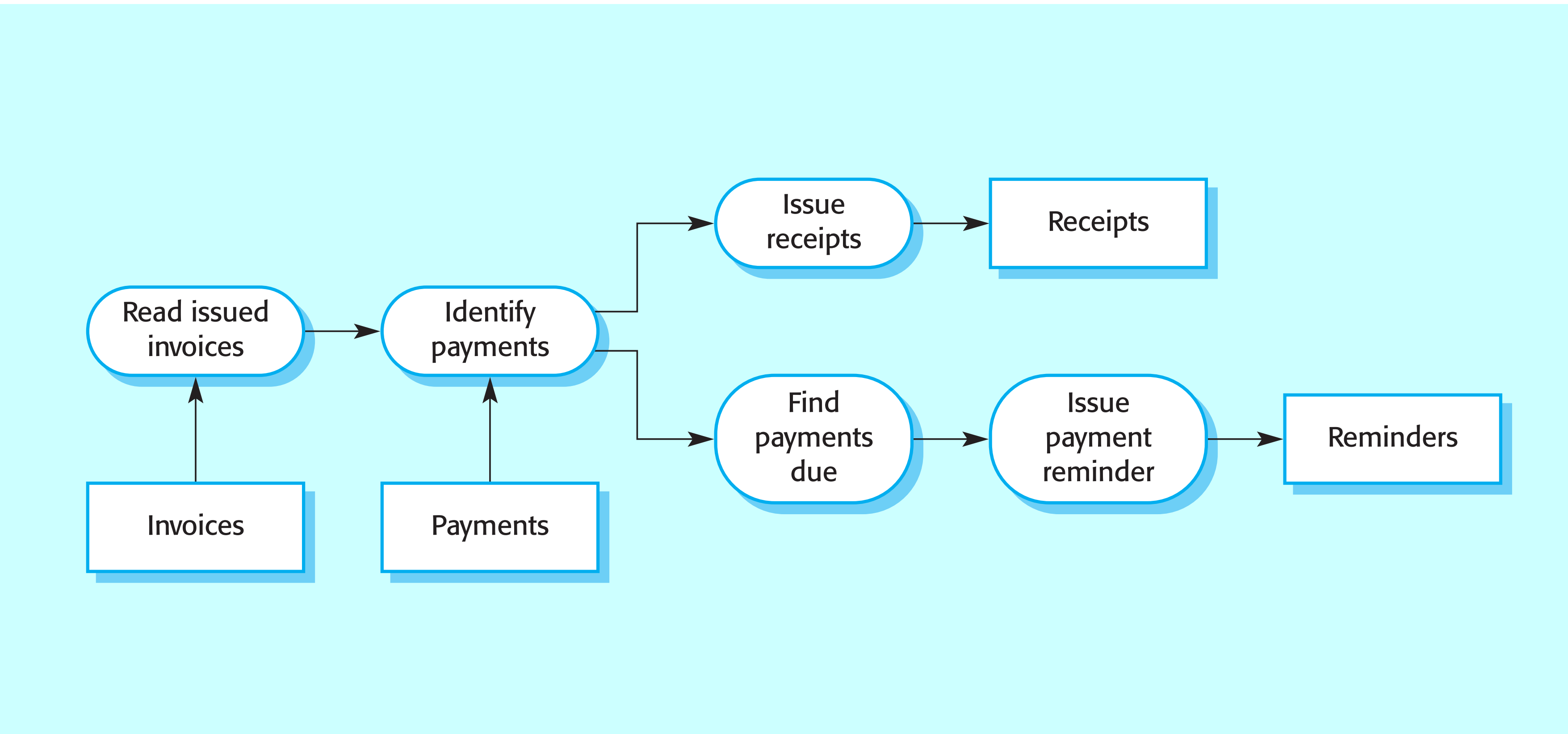
Object model advantages

- Objects are loosely coupled so their implementation can be modified without affecting other objects.
- The objects may reflect real-world entities.
- OO implementation languages are widely used.
- However, object interface changes may cause problems and complex entities may be hard to represent as objects.

Function-oriented pipelining

- Functional transformations process their inputs to produce outputs.
- May be referred to as a pipe and filter model (as in UNIX shell).
- Variants of this approach are very common. When transformations are sequential, this is a batch sequential model which is extensively used in data processing systems.
- Not really suitable for interactive systems.

Invoice processing system



Pipeline model advantages

- Supports transformation reuse.
- Intuitive organisation for stakeholder communication.
- Easy to add new transformations.
- Relatively simple to implement as either a concurrent or sequential system.
- However, requires a common format for data transfer along the pipeline and difficult to support event-based interaction.

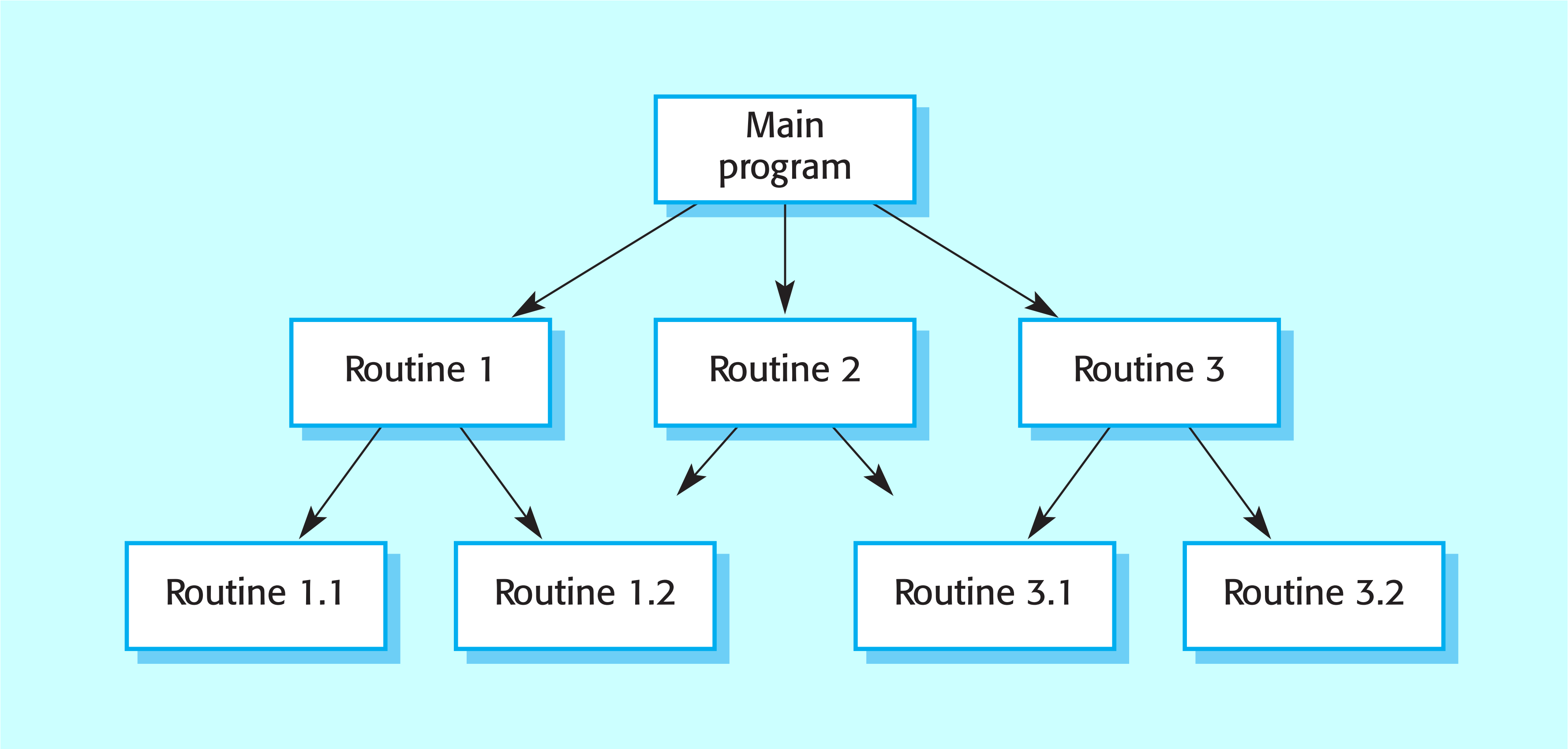
Control styles

- 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.

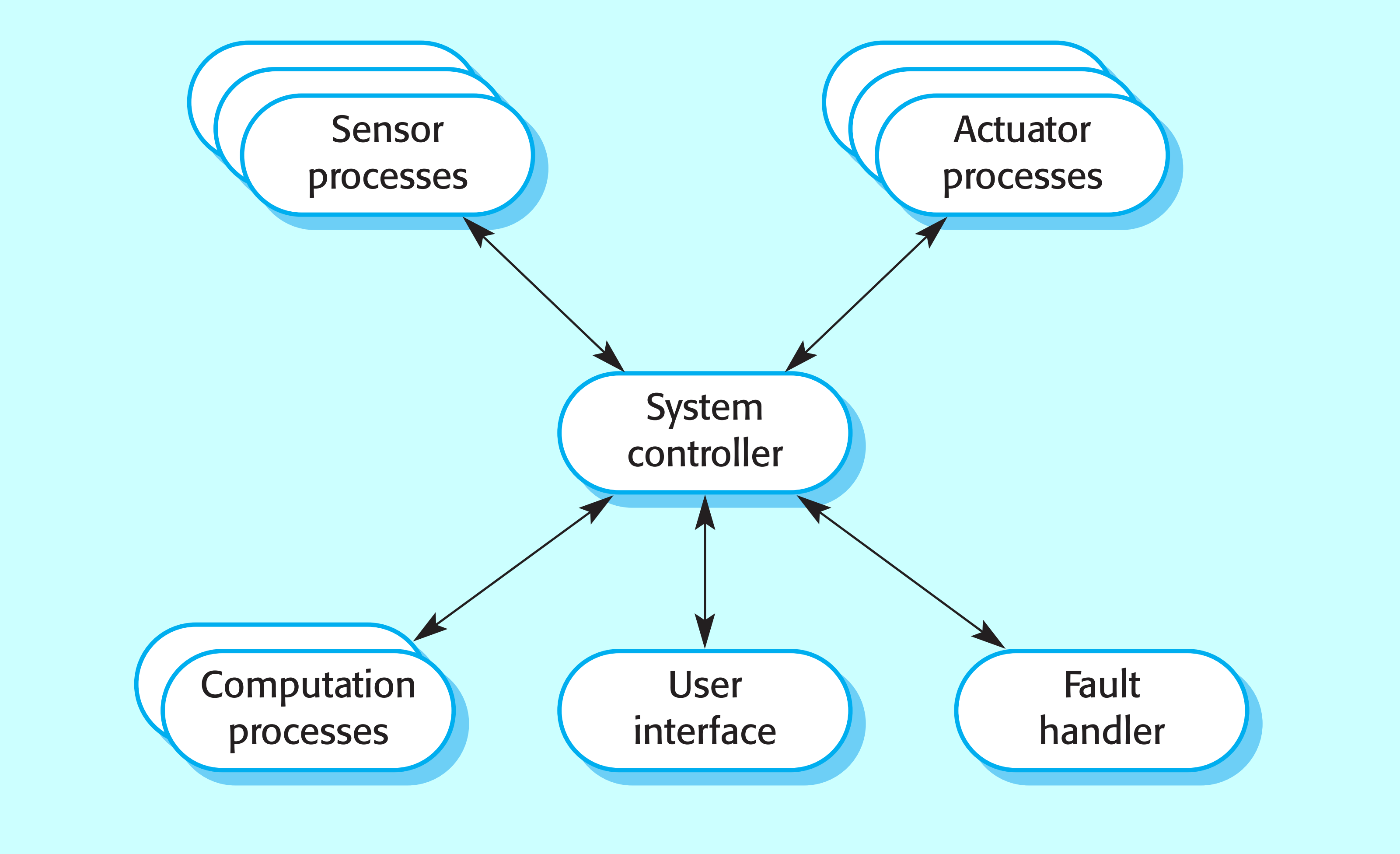
Centralised control

- 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 coordination of other system processes. Can be implemented in sequential systems as a case statement.

Call-return model



Real-time system control



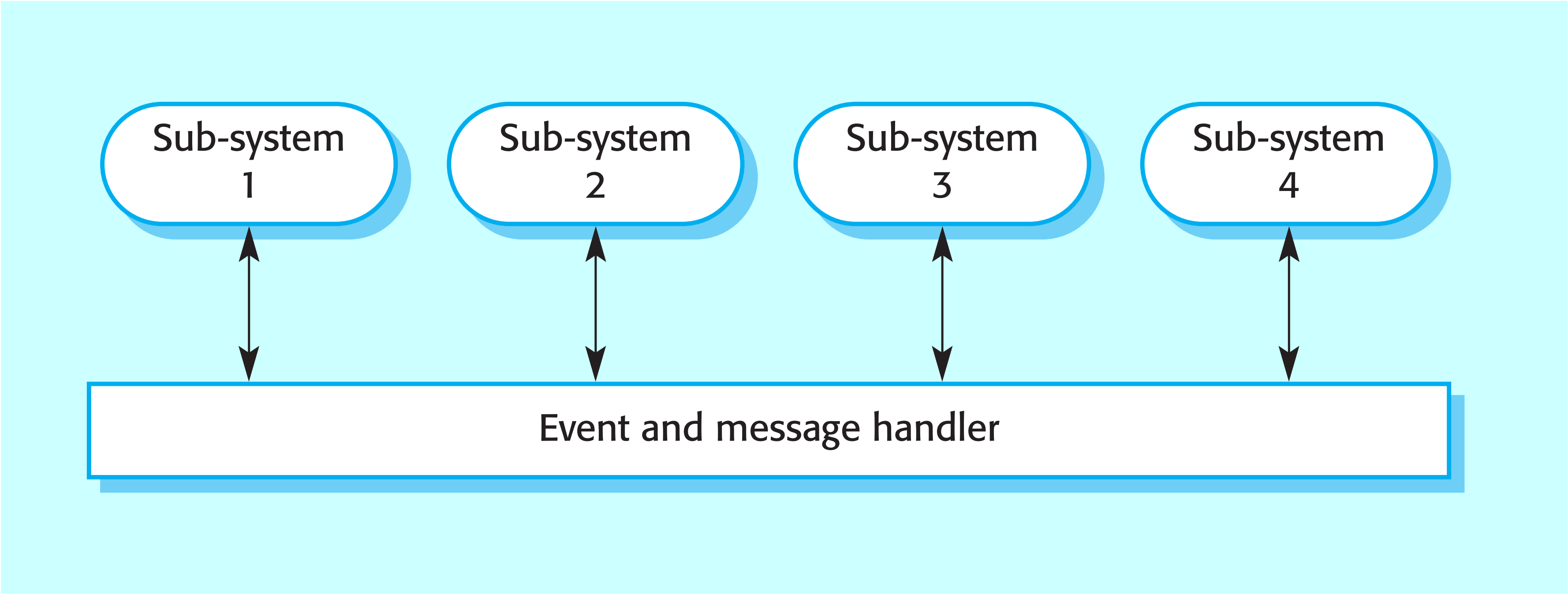
Event-driven systems

- Driven by externally generated events where the timing of the event is outwith 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.

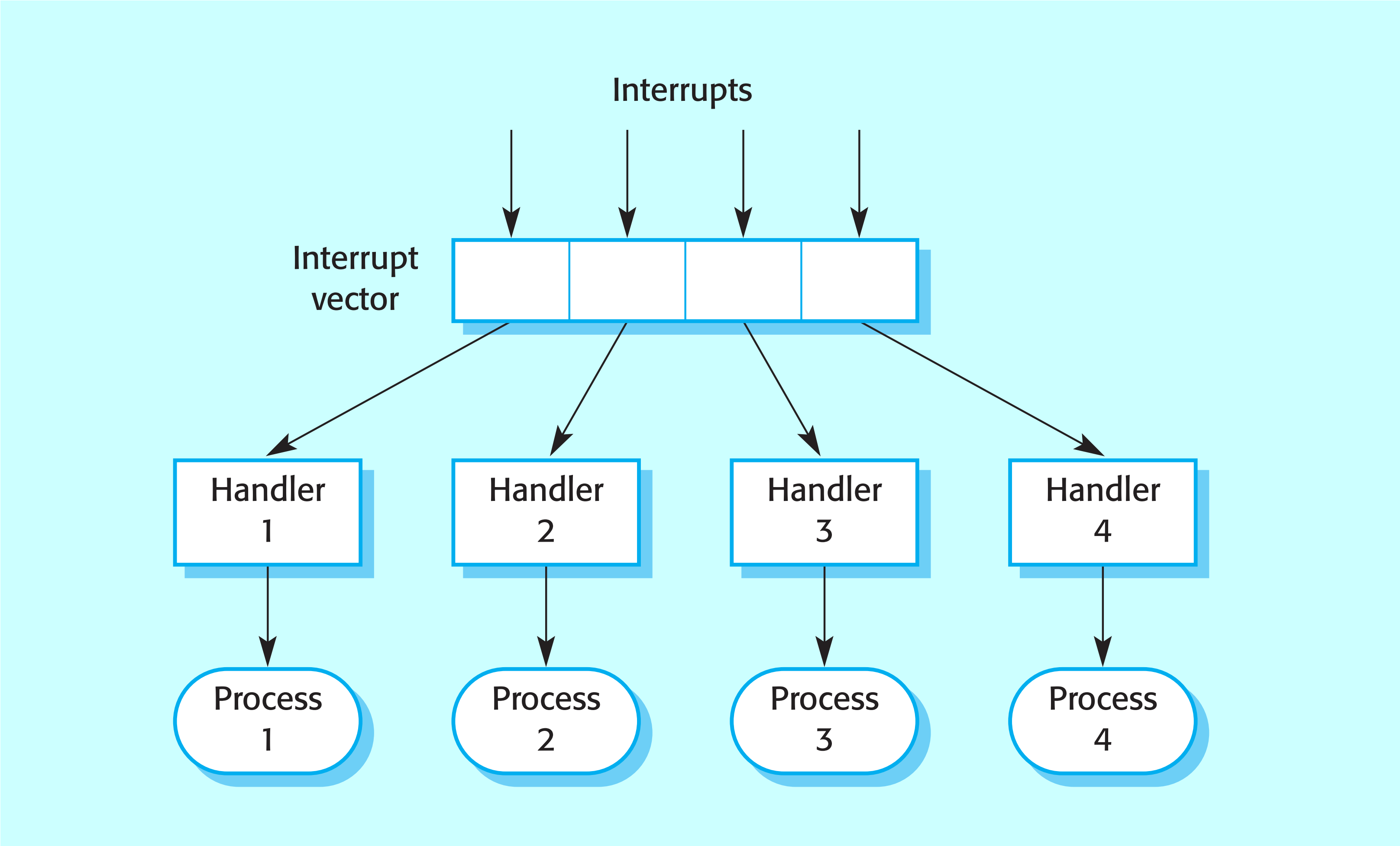
Selective broadcasting



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.

Interrupt-driven control



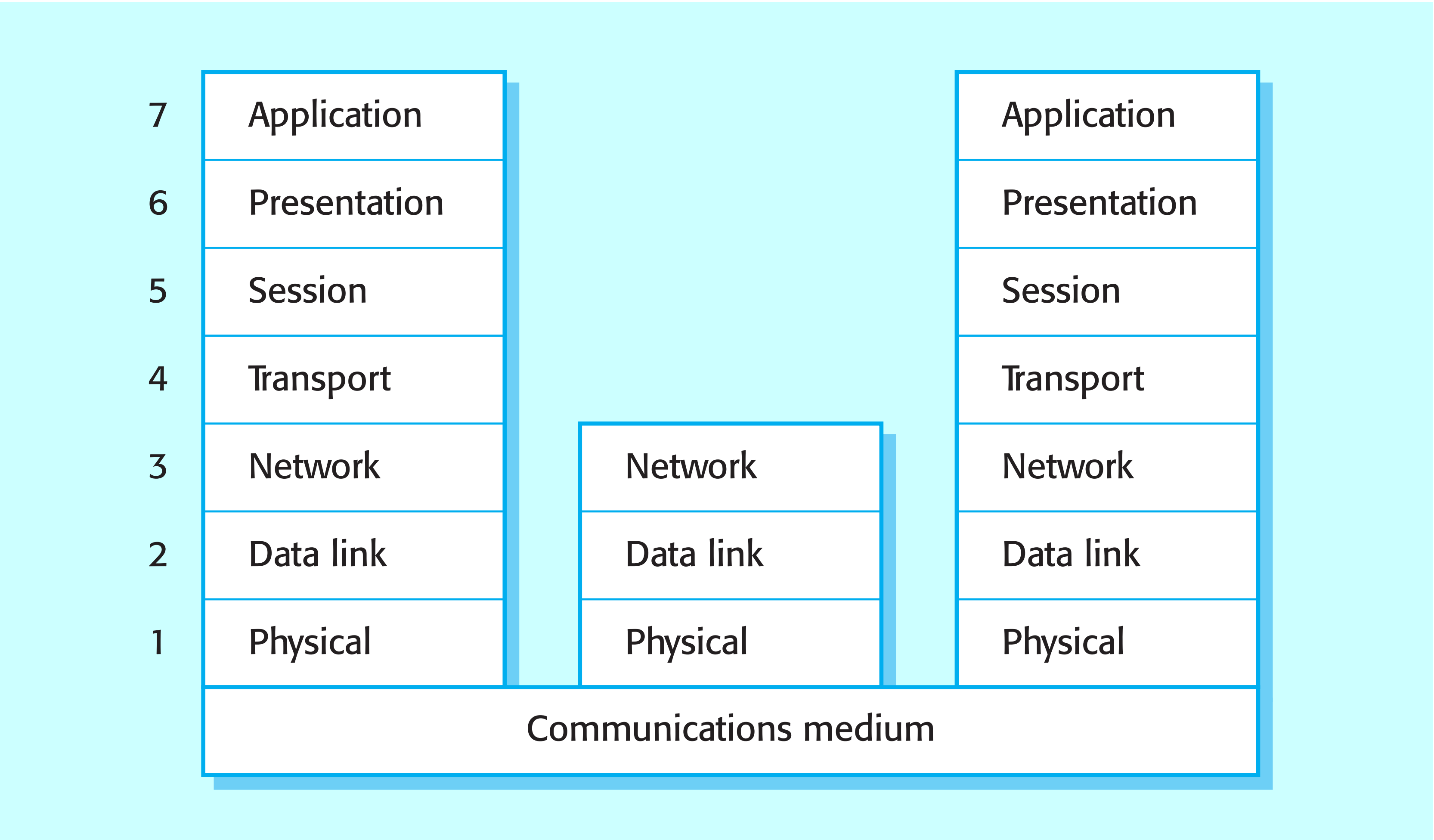
Reference architectures

- Architectural models may be 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. Covered in Chapter 13.
  - 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.

Reference architectures

- Reference models are derived from a study of the application domain rather than from existing systems.
- May be used as a basis for system implementation or to compare different systems. It acts as a standard against which systems can be evaluated.
- OSI model is a layered model for communication systems.

OSI reference model



Case reference model

- Data repository services
  - Storage and management of data items.
- Data integration services
  - Managing groups of entities.
- Task management services
  - Definition and enaction of process models.
- Messaging services
  - Tool-tool and tool-environment communication.
- User interface services
  - User interface development.

The ECMA reference model