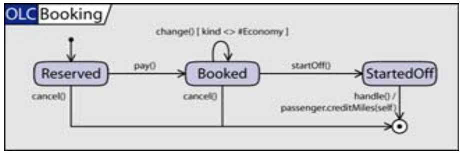
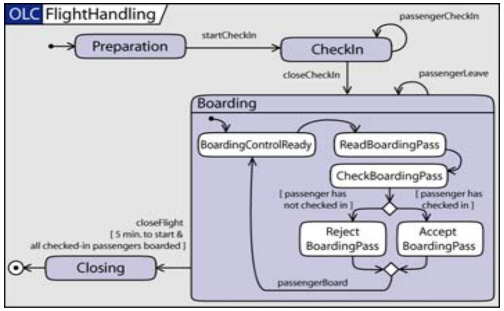
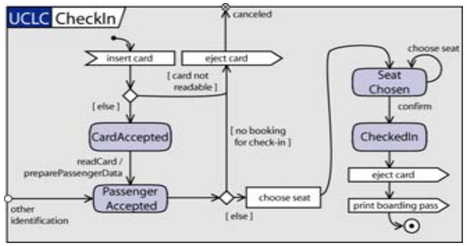
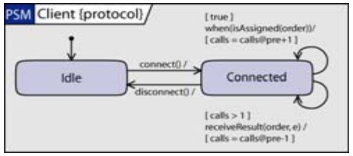
Unified Modeling Language 2

State machines









History and predecessors

- 1950’s: Finite State Machines
  - Huffmann, Mealy, Moore

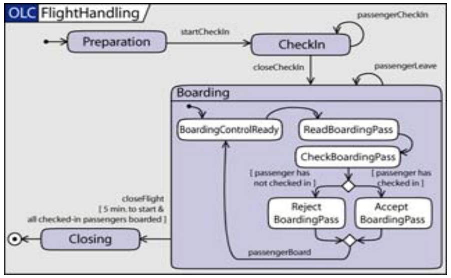
- 1987: **Harel Statecharts**
  - conditions
  - hierarchical (and/or) states
  - history states

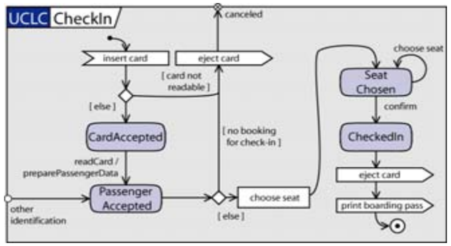
- 1990’s: Objectcharts
  - adaptation to object orientation

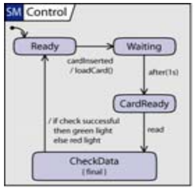
- 1994: **ROOM Charts**
  - run-to-completion (RTC) step

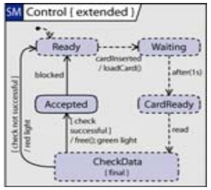
Usage scenarios

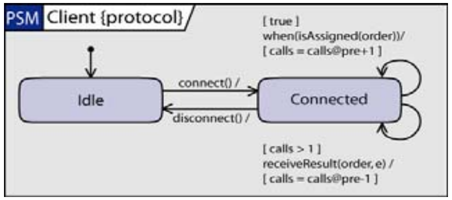
- **Object life cycle**
  - Behaviour of objects according to business rules
  - in particular for active classes
- Use case life cycle
  - Integration of use case scenarios
  - Alternative: activity diagrams
- Control automata
  - Embedded systems
- **Protocol specification**
  - Communication interfaces





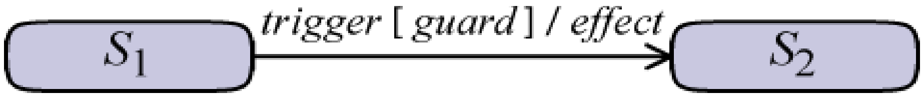

SM Control
Ready
Waiting
cardInserted / loadCard()
after(1s)
CardReady
/ if check successful then green light else red light
read
CheckData
{ final }

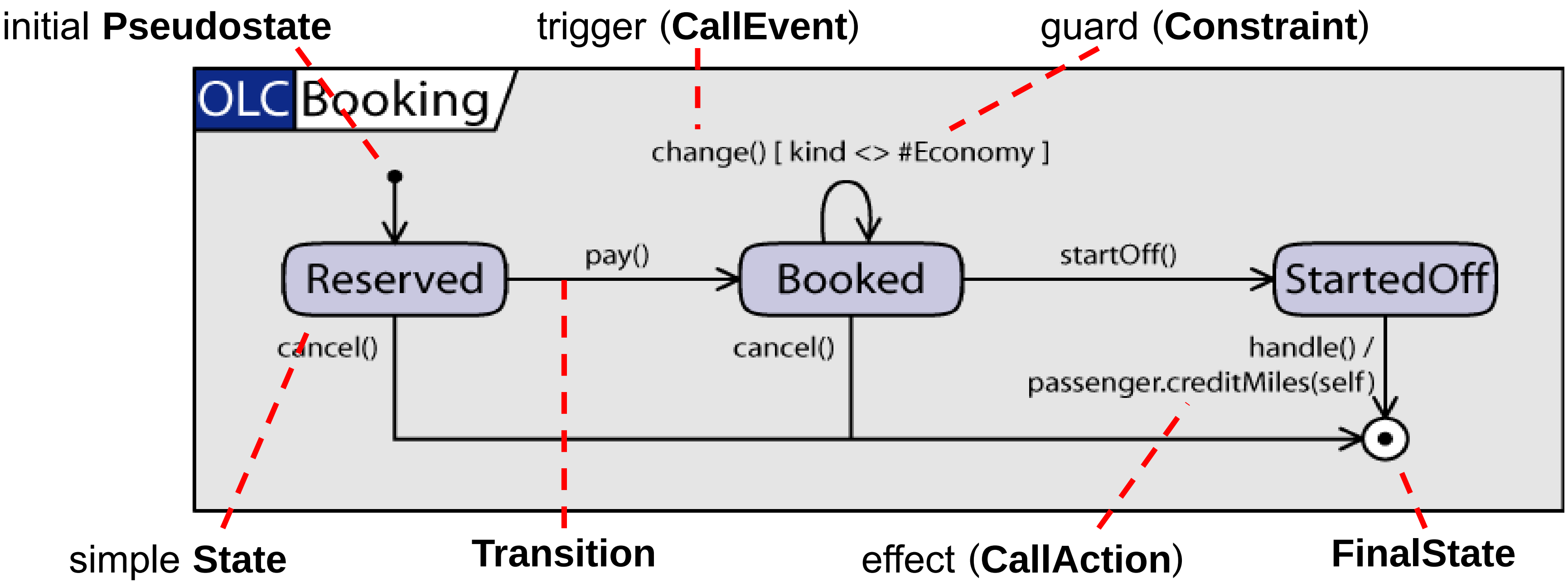




States and transitions

- State machines model behaviour
  - using **states** interconnected …
  - with **transitions** triggered …
  - by **event** occurrences.





Relation to class diagrams

- State machines are defined in the context of a BehavioredClassifier.

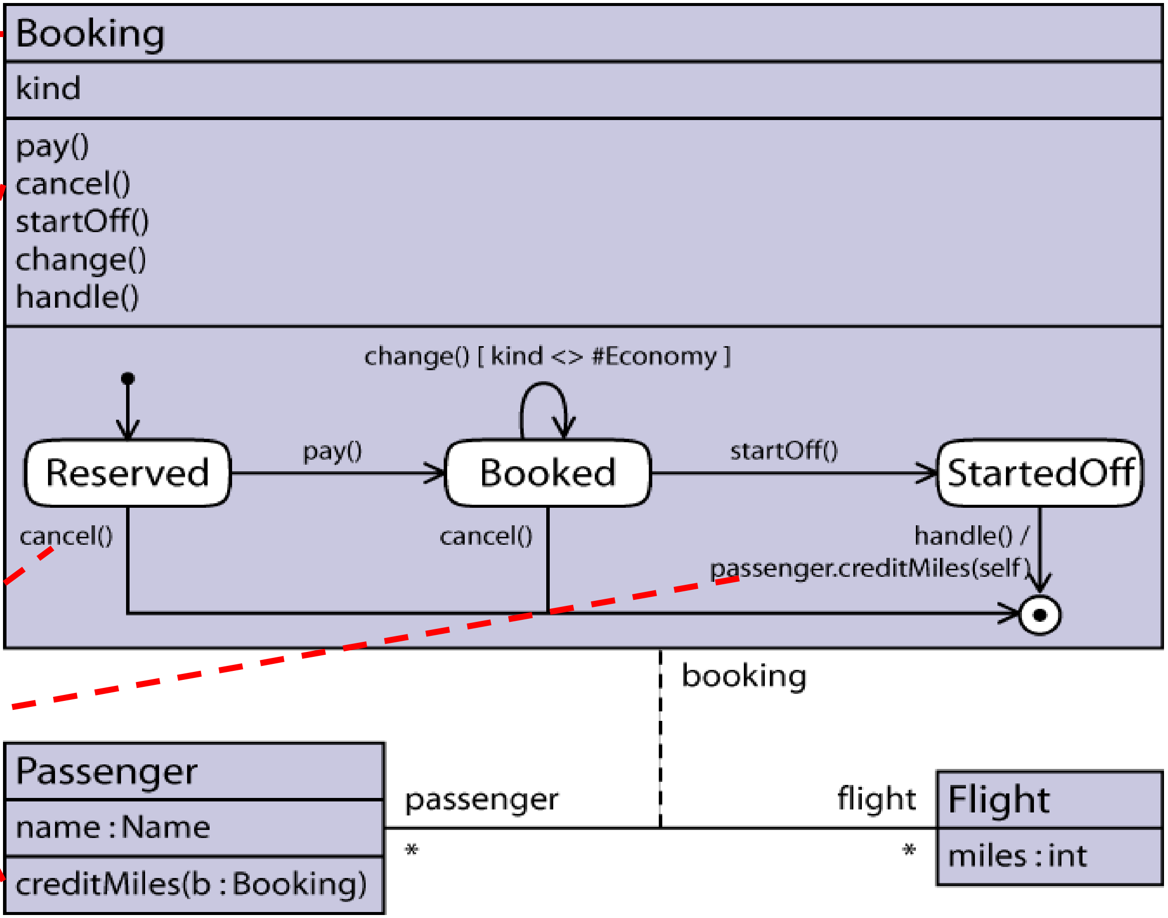
- **Context** defines which
  - events can occur
  - features are available

Operation

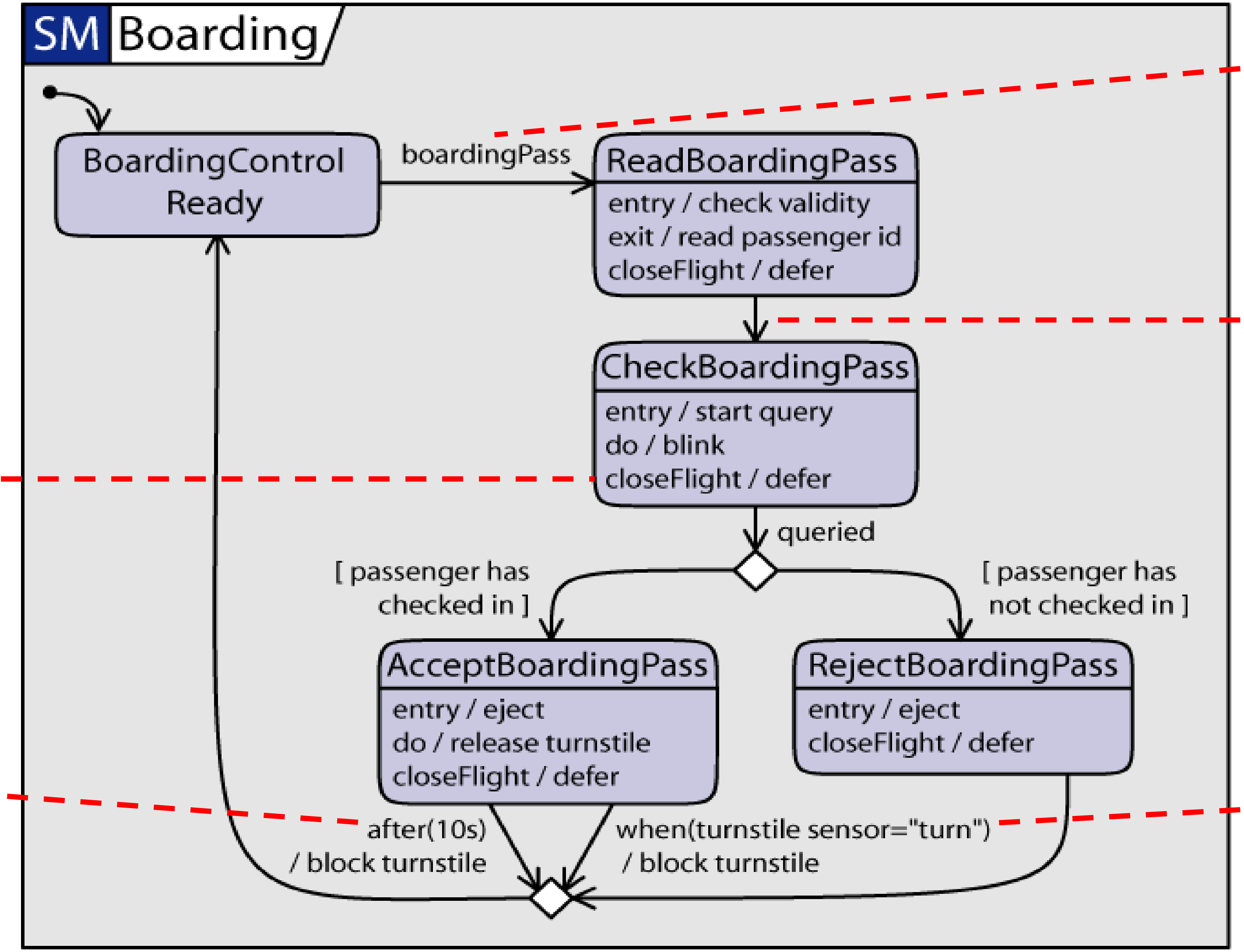
corresponding **CallEvent**

CallAction

called **Operation**



Triggers and events (1)



SignalEvent

completion event (no explicit trigger)

deferred event

TimeEvent (relative)

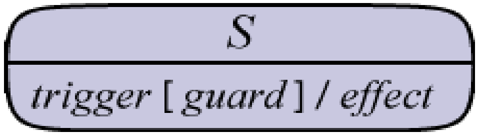
ChangeEvent

Triggers and events (2)

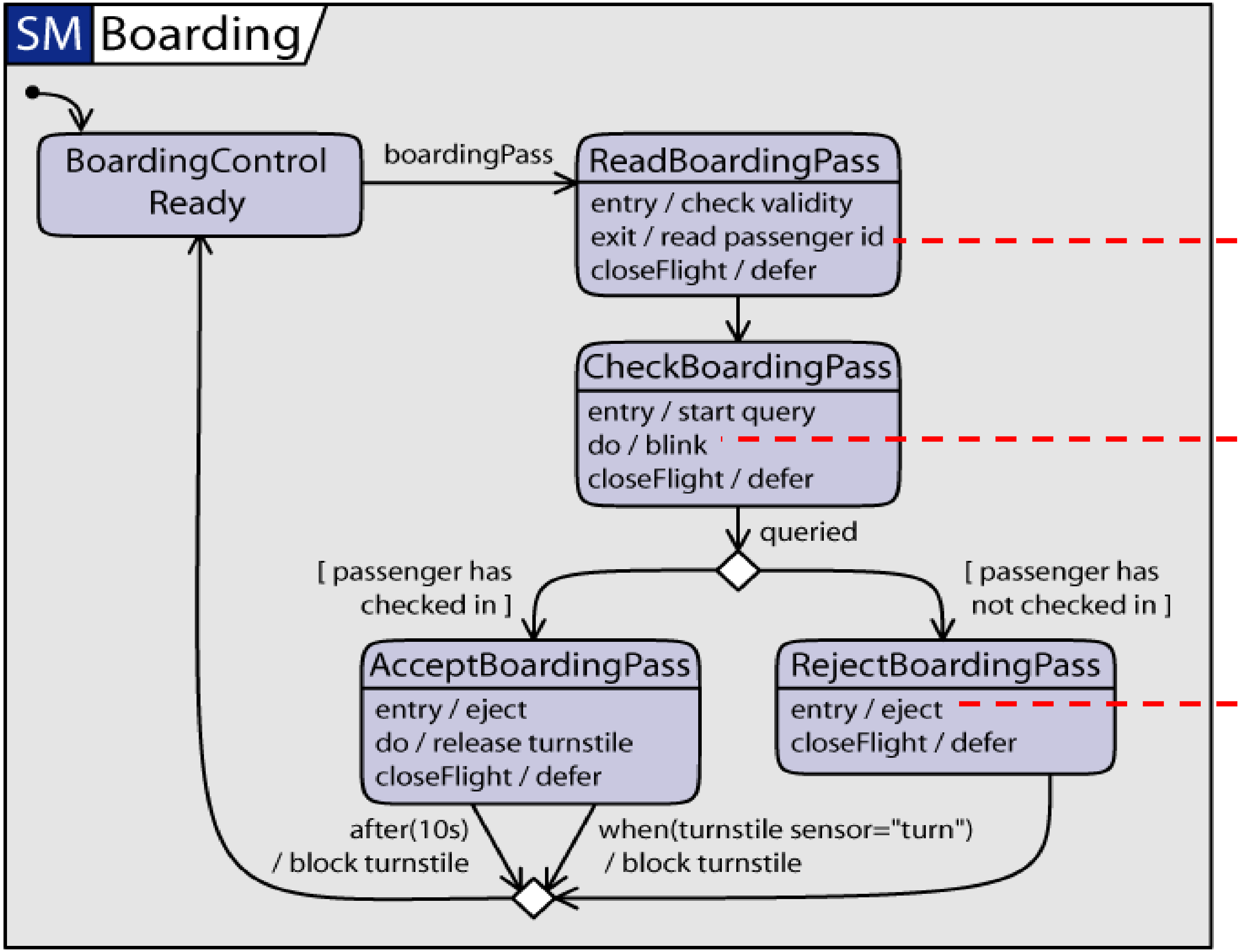
- **CallEvent**
  - receipt of a (a)synchronous Operation call
  - triggering after Behavior of Operation executed
- **SignalEvent**
  - receipt of an asynchronous Signal instance
  - reaction declared by a Reception for the Signal
- TimeEvent
  - absolute reference to a time point (at *t*)
  - relative reference to trigger becoming active (after *t*)
    - presumably meaning relative to state entry
- ChangeEvent
  - raised each time condition becomes true
    - may be raised at some point after condition changes to true
    - could be revoked if condition changes to false

Triggers and events (3)

- **Completion event**
  - raised when all internal activities of a state are finished
    - do activity, subregion
    - no metamodel element for completion events
  - dispatched before all other events in the event pool
- Deferred events
  - events that cannot be handled in a state but should be kept in the event pool
    - reconsidered when state is changed
    - no predefined deferring policy
- Internal transitions
  - … are executed without leaving and entering their containing state
    - normally, on transition execution states are left and entered



Behaviours

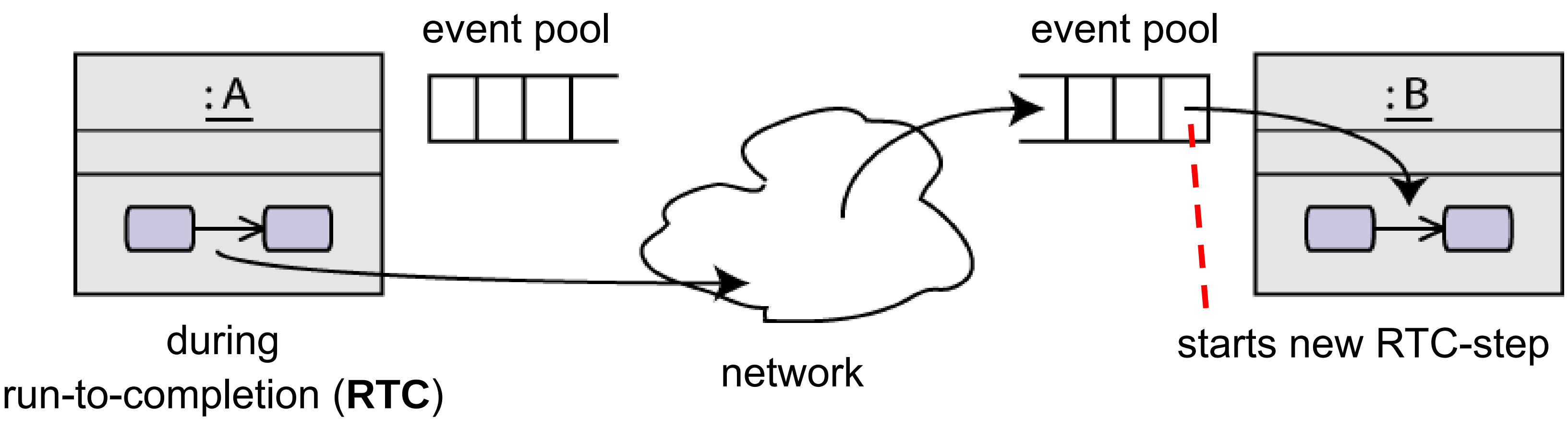


exit **Behavior**
(on exiting a state)

do activity **Behavior**
(concurrently while in state, may be interrupted)

entry **Behavior**
(on entering a state)

How state machines communicate



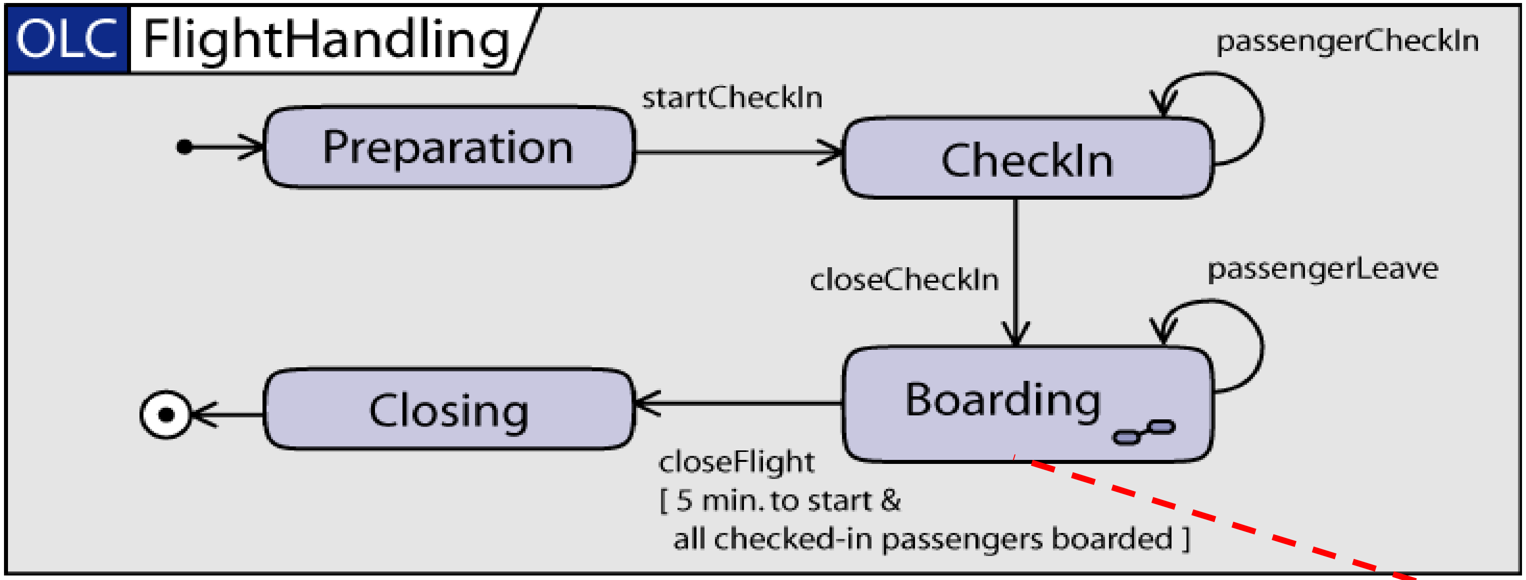
signals: *asynchronous* (no waiting)
calls: *asynchronous* or *synchronous* (waiting for RTC of callee)

No assumptions are made on timing between
event occurrence, event dispatching, and event consumption.

Event occurrences for which no trigger exists may be discarded
(if they are not deferred).

Hierarchical states (1)

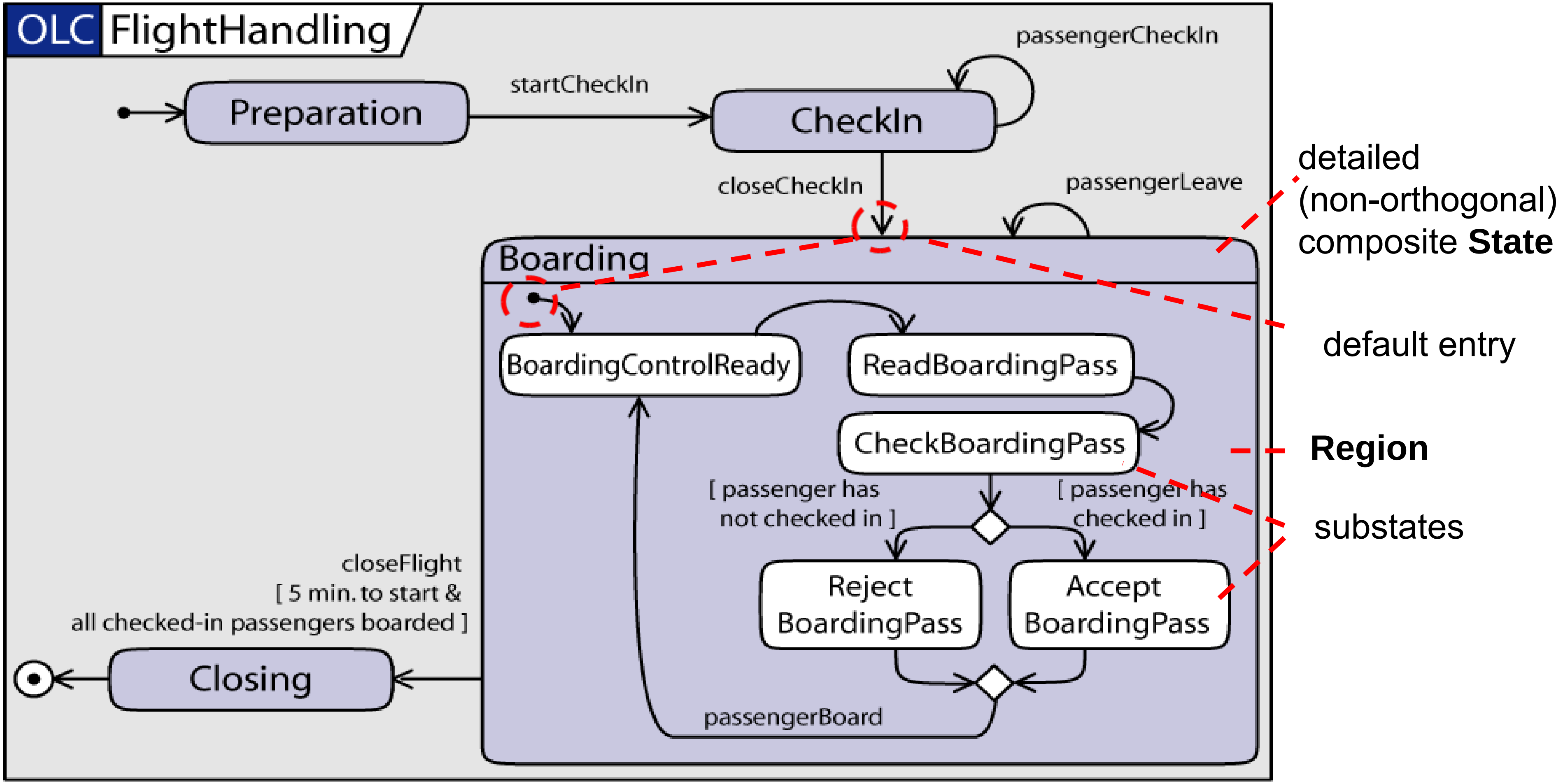
- Hierarchical states allow to **encapsulate** behaviour and facilitate reuse.
- However, they are rarely used this way.
- UML 2.0 provides concepts supporting this usage.
  - entry and exit points



composite **State**

Transition triggering is **prioritized** inside-out, i.e., transitions deeper in the hierarchy are considered first.

Hierarchical states (2)


OLC FlightHandling
Preparation
startCheckIn
CheckIn
passengerCheckIn
closeCheckIn
passengerLeave
Boarding
BoardingControlReady
ReadBoardingPass
CheckBoardingPass
[passenger has not checked in]
[passenger has checked in]
Reject BoardingPass
Accept BoardingPass
passengerBoard
closeFlight [5 min. to start & all checked-in passengers boarded]
Closing
detailed (non-orthogonal) composite **State**
default entry
Region
substates