3.6 State Diagrams

Subject/Topic/Focus:

- Introduction to State Diagrams

Summary:

- States
- Transitions
- Events
- Composition
- Concurrency
- Branch
- History

Literature:

- [Fowler99]
- [Booch98]

State Machines in UML

A state machine

- specifies **state changes** which an object performs triggered by events or signals received from other objects,
- specifies the **reactions** of the object on events,
- specifies **actions** in states,
- defines **protocols**, i.e., legal sequences of operation calls of a class or interface or of interactions by signals.

- is attached to exactly one class
- can be inherited by subclasses
  (where the concept of the refinement is not defined exactly)

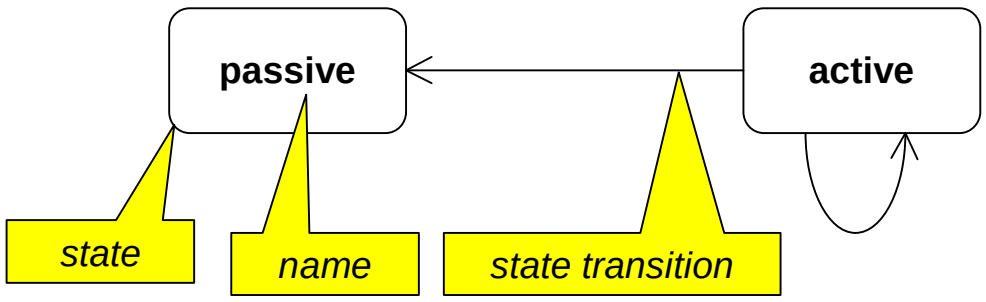
States and State Diagrams

A **state diagram** is a graph consisting of

- **states**
  - simple states
  - composite states (simple states refined by nested state diagrams)
- **state transitions** connecting the states.

A **state** is a constraint or a situation in the life cycle of an object, in which a constraint holds, the object executes an activity or waits for an event.

Notation:



Start and Final States

Start state: State transition is executed immediately during the creation of the object.

Only possible event: create(parameter)

Java: constructor (new)

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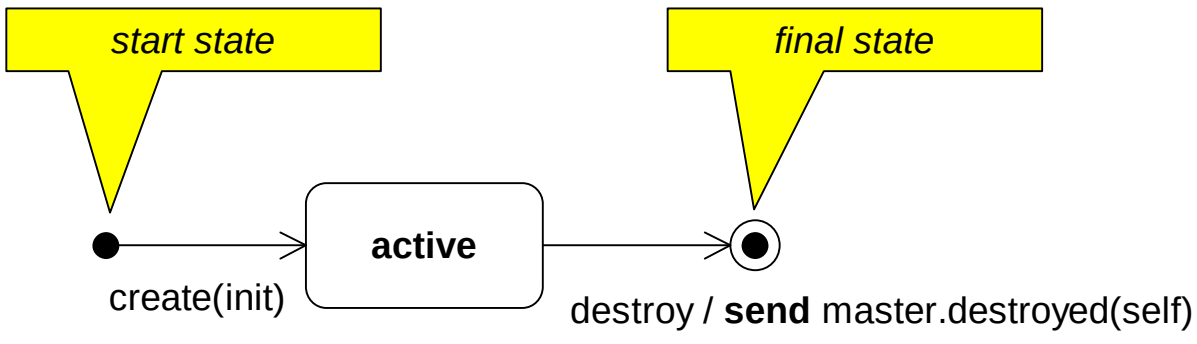

Transitions

A transition connects two states and shows the flow of control.

A transition can include a **triggering event**, a **guard** and **actions** to be executed.

Transitions without event and guard are executed **immediately** when an activity is finished respectively all sub states were passed through.

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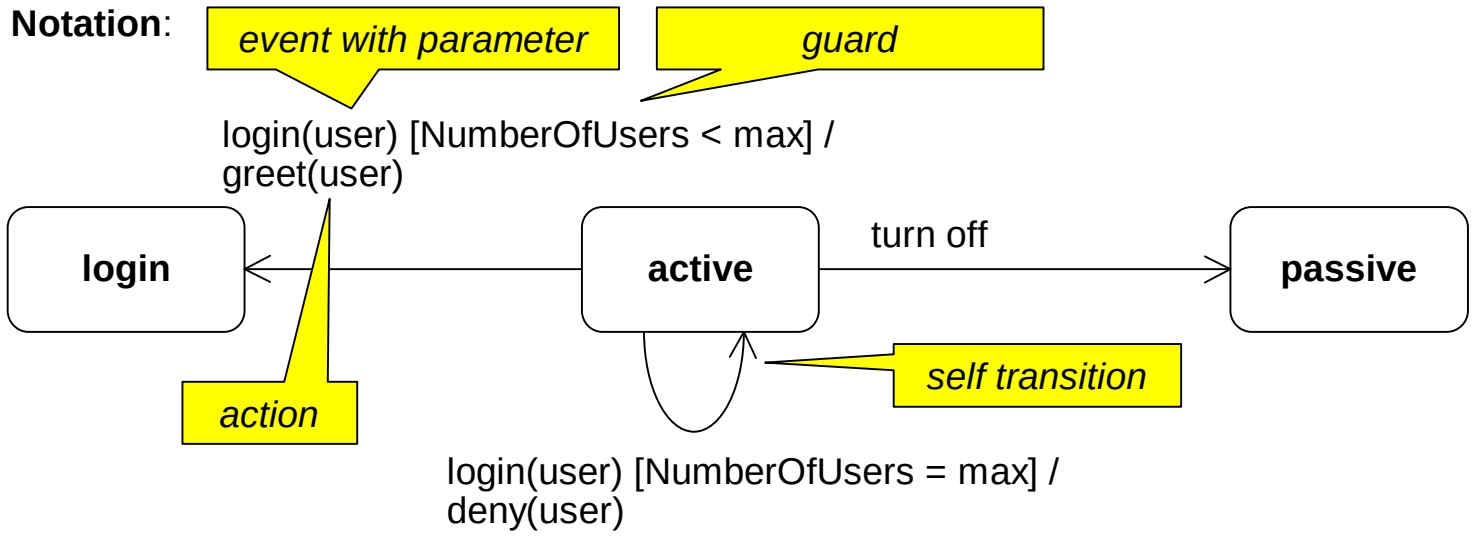
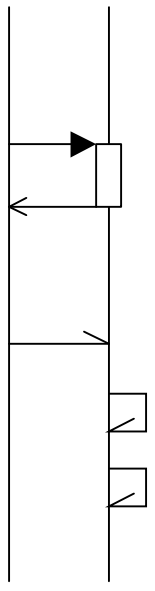


Events

An **event** is a phenomenon in space and time significant for the modeled system.

An event can appear synchronously or asynchronously.

- **synchronous** events:
  - **call event:** triggered by call
  - **exception event:** triggered by called object at return
- **asynchronous** events:
  - **signal event:** signal sent by other object
  - **change event:** triggered by side effects on object attributes
  - **time event:** spontaneously triggered by boolean guard over **`time`**



An event can trigger state changes.

Signal Events and Call Events

Signals are **asynchronous**, i.e., the sender does not wait until the receiver received the signal or reacted on it.

A **call event** is triggered by a (synchronous) operation call.

Call events are **synchronous**, i.e., the sender waits until the receiver reacted on the event.

In the state automaton signals and call events are indistinguishable from each other.

The receiver can

- **ignore** the event (the event is lost),
- execute its **trigger event** or
- execute an **operation**.

Call Events

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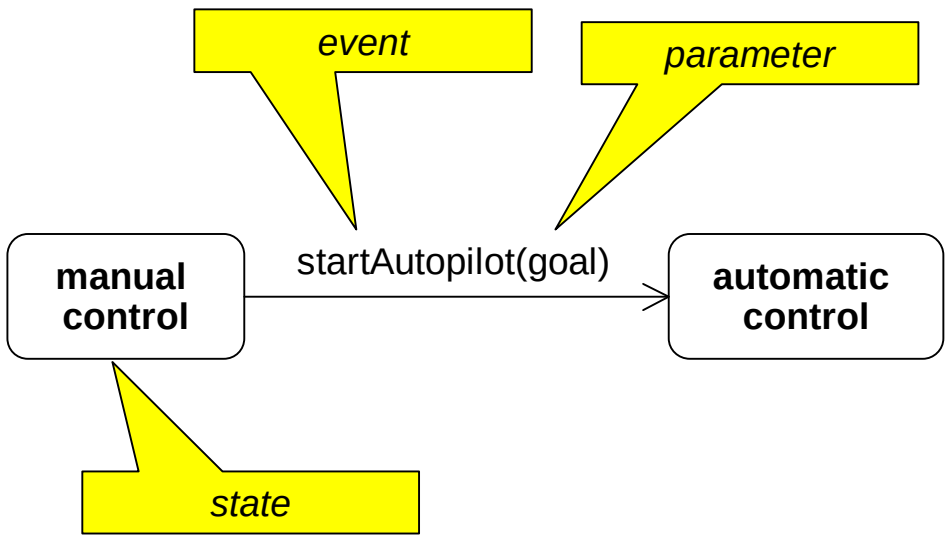

Name and parameter of the event must be compatible to methods of the class.

Time and Change Events

A **time event** appears after the expiration of a time period.

A **change event** occurs if a specific constraint is fulfilled. The constraint is a boolean expression on the attributes of the actual object.

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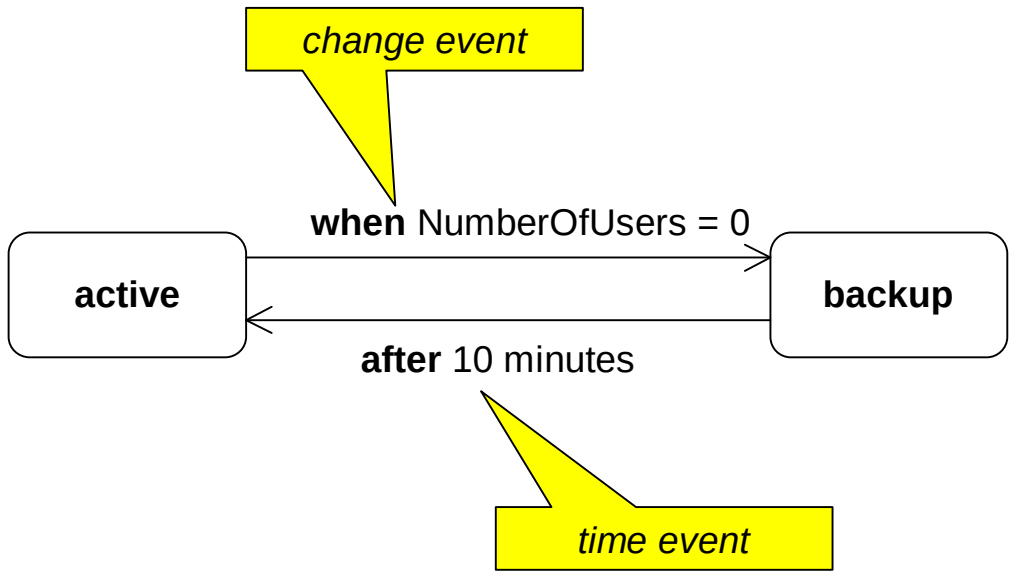

Sending Signals

Signals can be sent to other objects during a transition.

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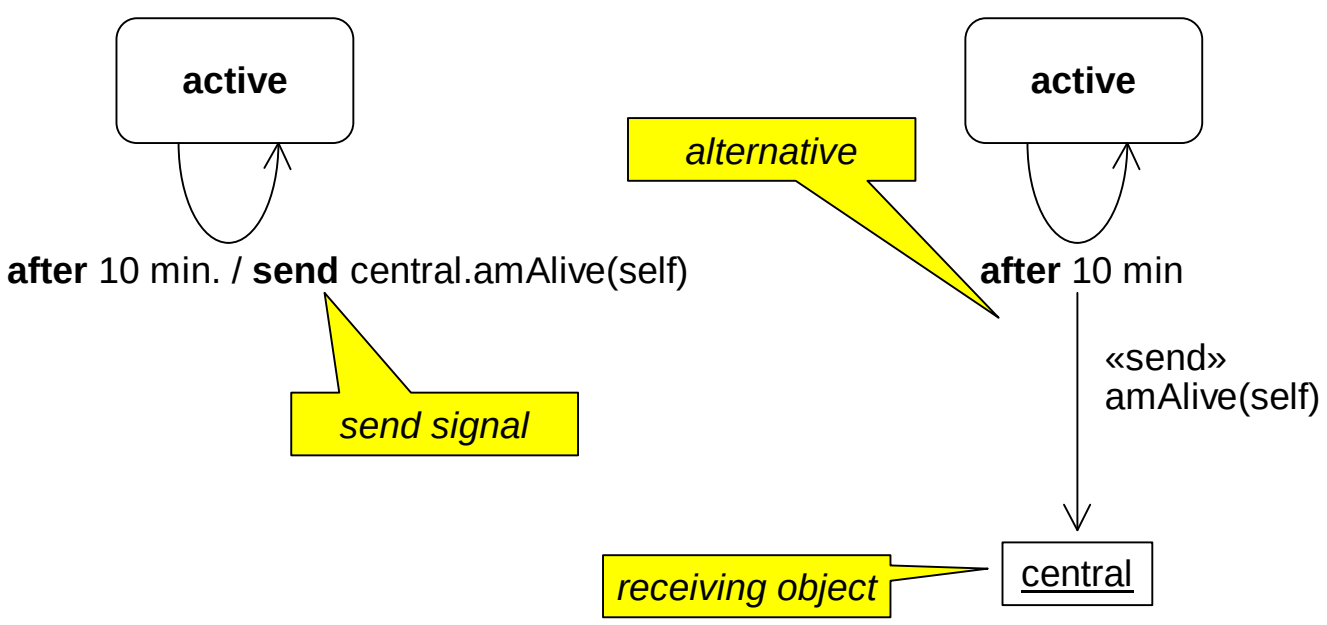

Triggering Actions

Possible actions:

- ❑ send signal
- ❑ perform call
- ❑ perform access

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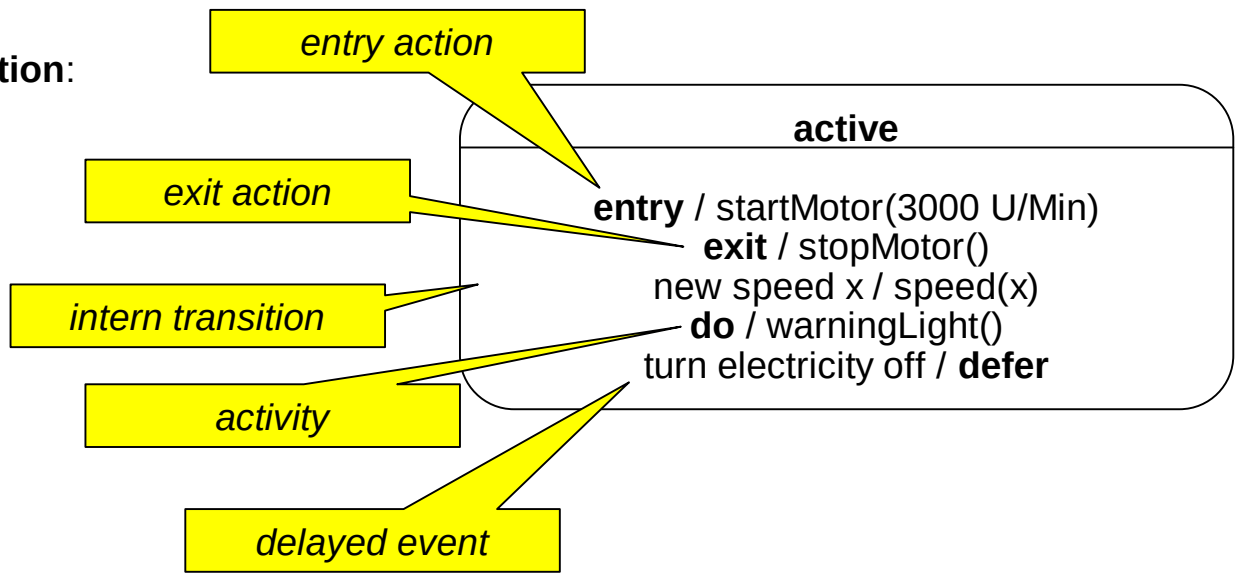

Composite States

A state can be refined hierarchically by composite states.

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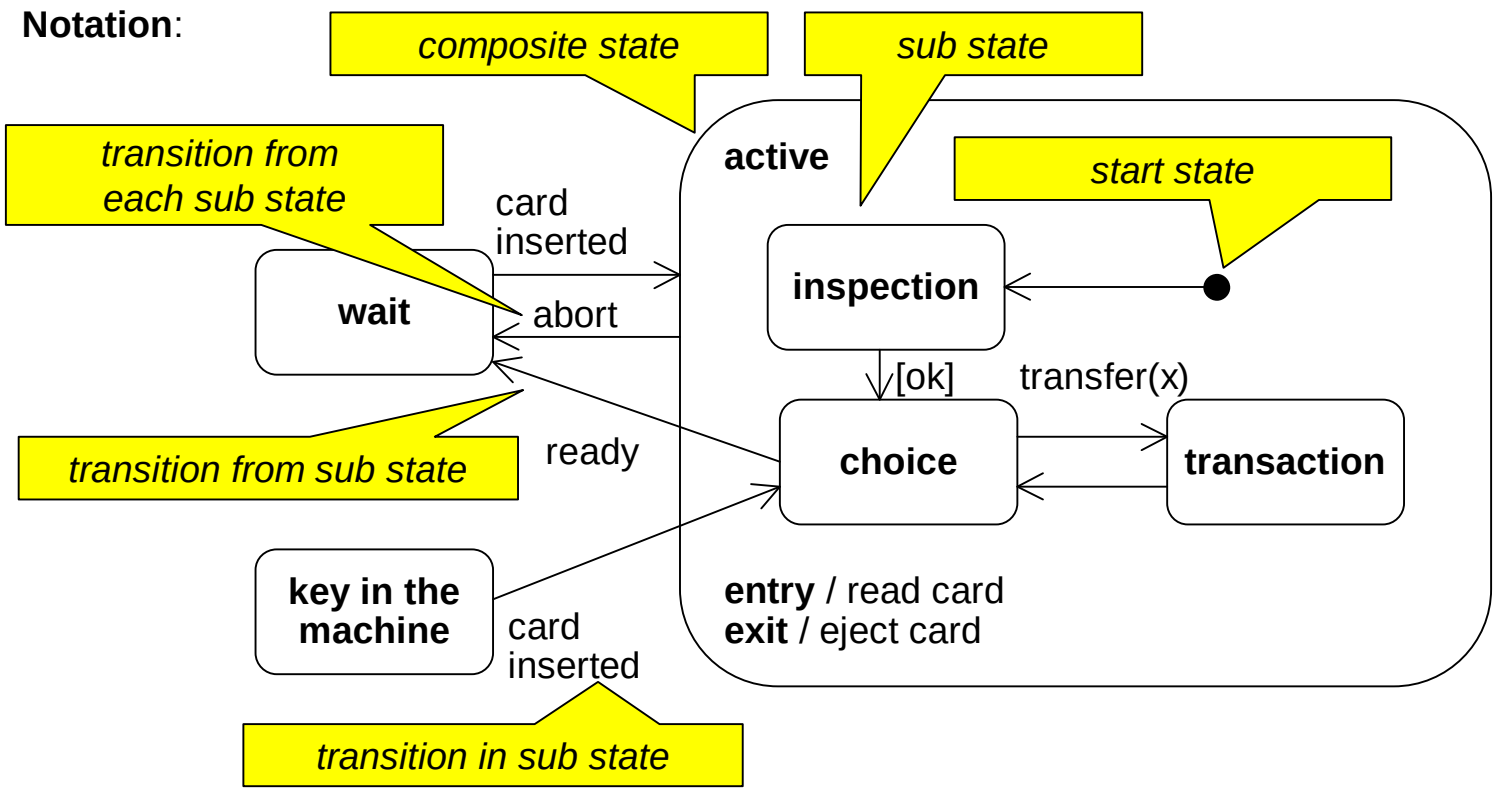

Concurrent Sub States

In a state several sequences of sub states described by own state machines can be performed concurrently.

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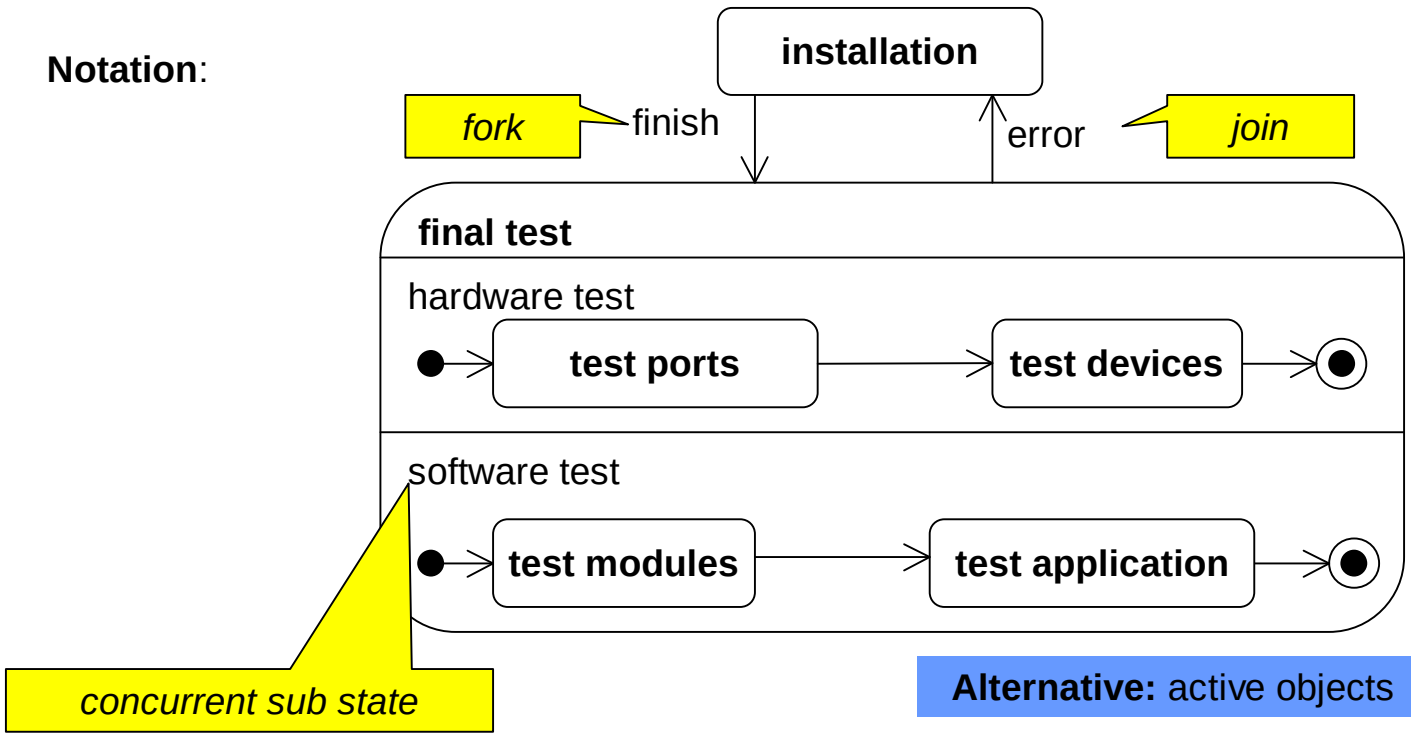

Concurrent Sub States: Alternative