

Software Design & Analysis

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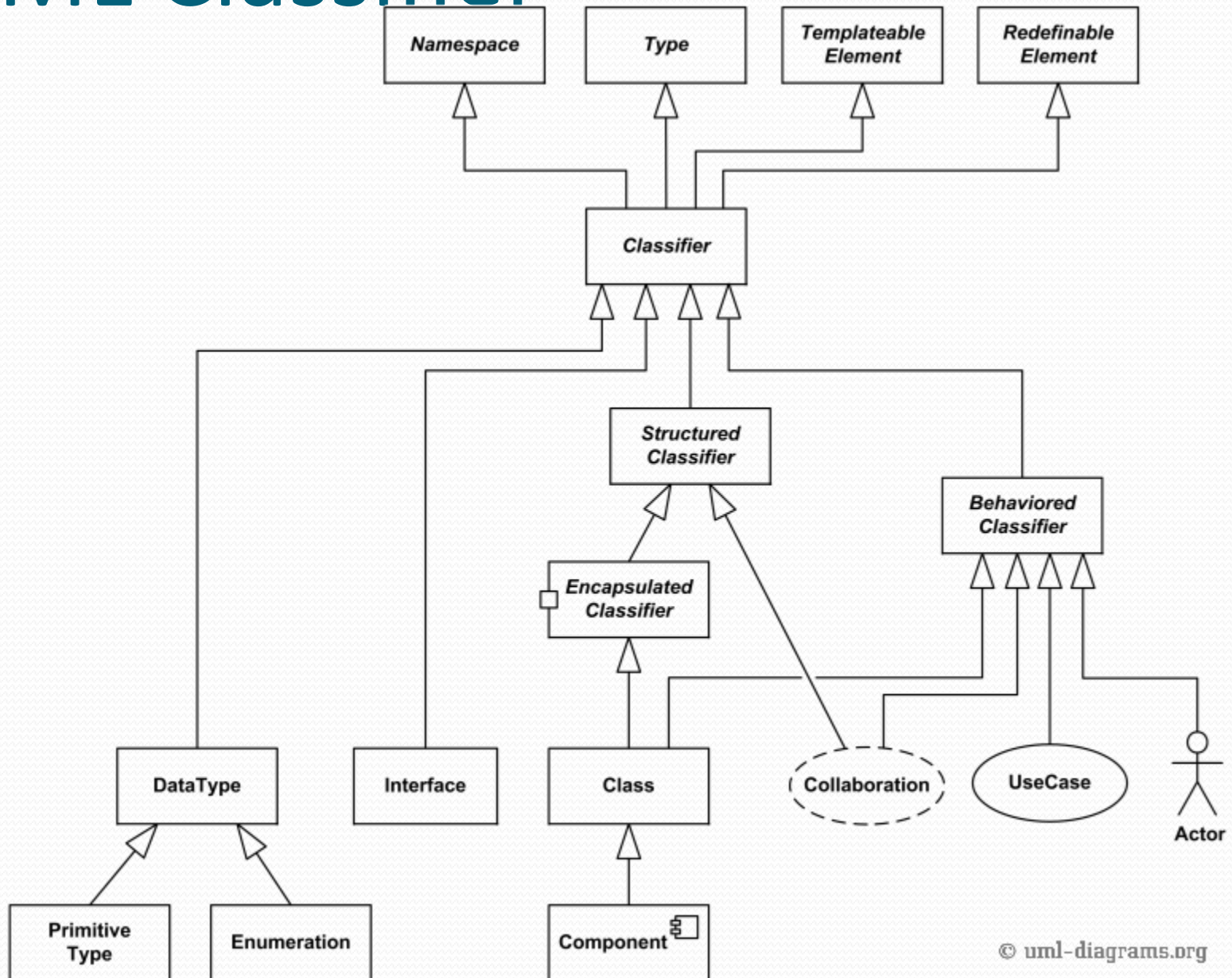
interaction diagrams

Timing Diagrams

Timing Diagrams

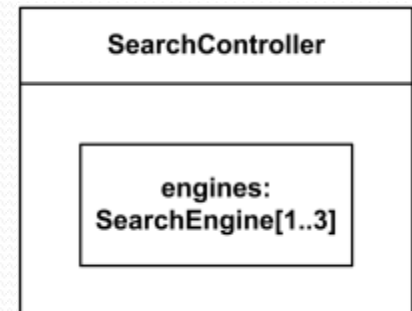
- A timing diagram allows you to show the interaction of objects and changes in state for those objects along a time axis.
- A timing diagram provides a convenient way to show active objects and their state changes during their interactions with other active objects and system resources.
- The X-axis of the timing diagram has the time units, while the Y-axis shows the objects and their states.
- Timing diagrams describe behavior of both individual **classifiers** & **interactions of classifiers**, focusing attention on time of events causing changes in the modeled conditions of the lifelines.

UML Classifier



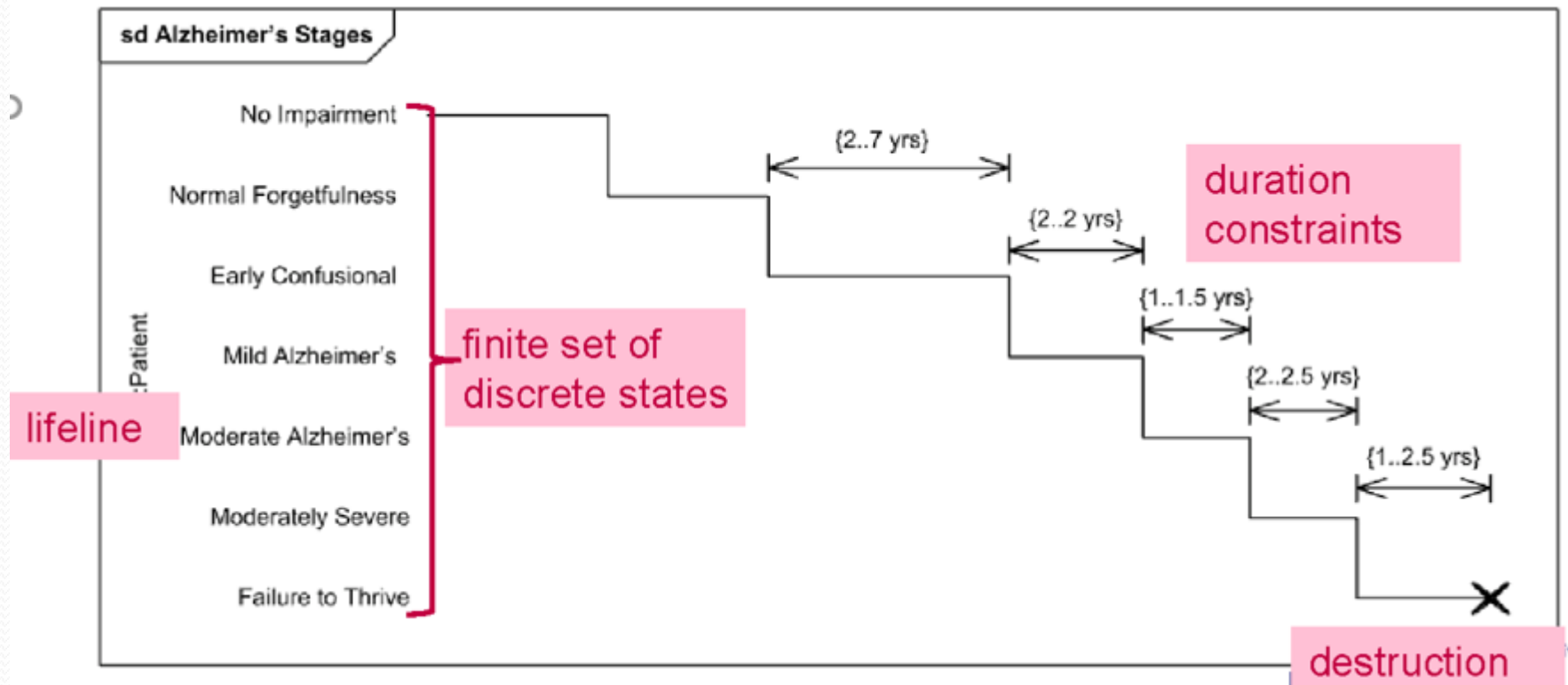
Part

- **Part** is a **property** which is contained by classifier using **composition**. It means that all parts are destroyed when the containing classifier instance is destroyed.
- A **part** is shown by graphical nesting of a box symbol with a solid outline representing the part in a separate compartment within the symbol representing the containing classifier.
- E.g, *Search Controller has 1 to 3 engines - Search Engine **part***



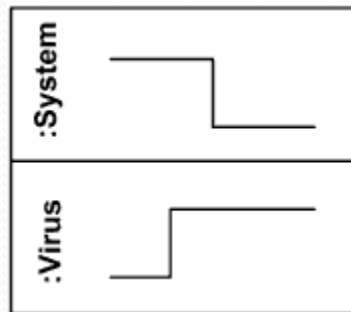
Timing Diagrams

- Timing Diagrams are Interaction diagram for reasoning about time.
- **Basic elements:** lifelines, states, duration/time constraints, destruction, events, messages



Lifeline

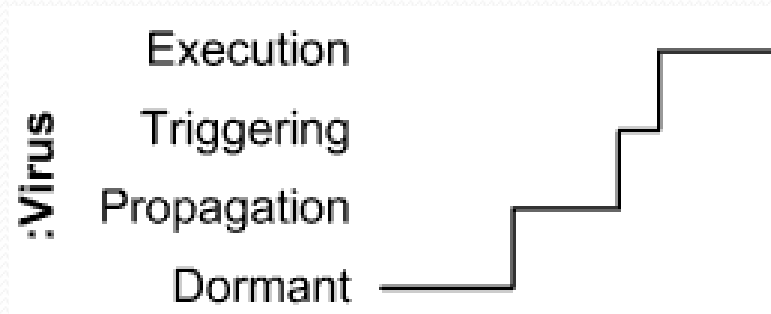
- **Lifeline** is a **named element** which represents an **individual participant** in the interaction. While **parts** and structural features may have multiplicity greater than 1, lifelines represent **only one** interacting entity.
- Lifeline on the timing diagrams is represented by the **name** of classifier or the instance it represents. It could be placed inside diagram frame or a "swimlane".



***Lifelines** representing instances of
System and Virus*

State or Condition Timeline

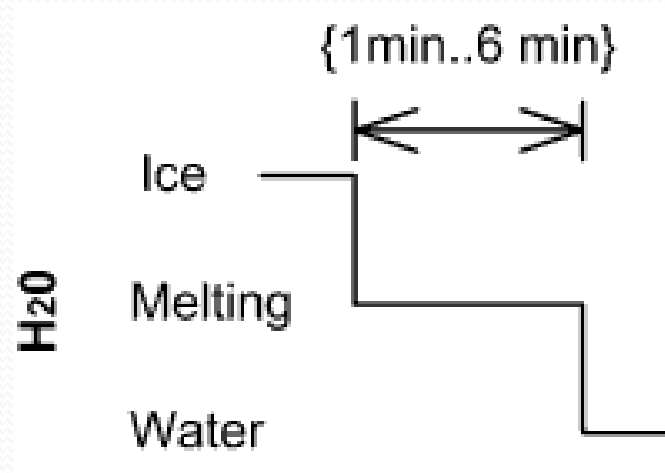
- Timing diagram could show **states** of the participating **classifier** or attribute, or some testable **conditions**, such as a discrete or enumerable value of an attribute.



- *Timeline shows Virus changing its state between Dormant, Propagation, Triggering and Execution state*

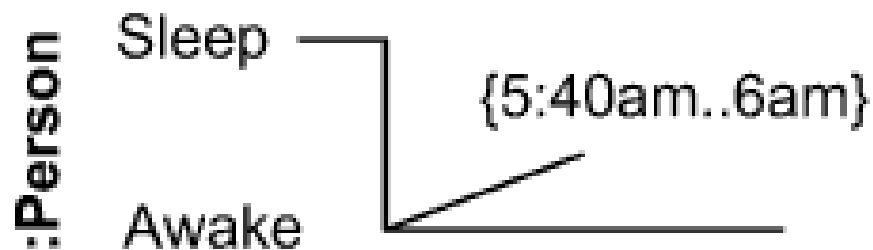
Duration Constraint

- **Duration constraint** is an **interval constraint** that refers to a **duration interval**. The duration interval is duration used to determine whether the constraint is satisfied.
- E.g., *Ice should melt into water in 1 to 6 minutes*



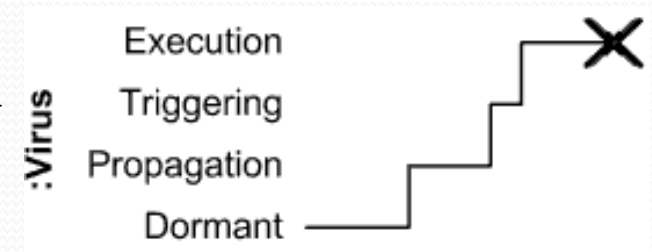
Time Constraint

- **Time constraint** is an **interval constraint** that refers to a **time interval**. The time interval is time expression used to determine whether the constraint is satisfied.
- Typically this graphical association is a small line, e.g., between an occurrence specification and a time interval.
- E.g., *Person should wake up between 5:40 am and 6 am*



Destruction Occurrence

- **Destruction occurrence** is a **message occurrence** which represents the destruction of the instance described by the **lifeline**.
- It may result in the subsequent destruction of other objects that this object owns by **composition**.
- No other occurrence may appear after the destruction event on a given lifeline.
- **Notation**
- The destruction event is depicted by a cross in the form of an **X** at the end of a timeline.

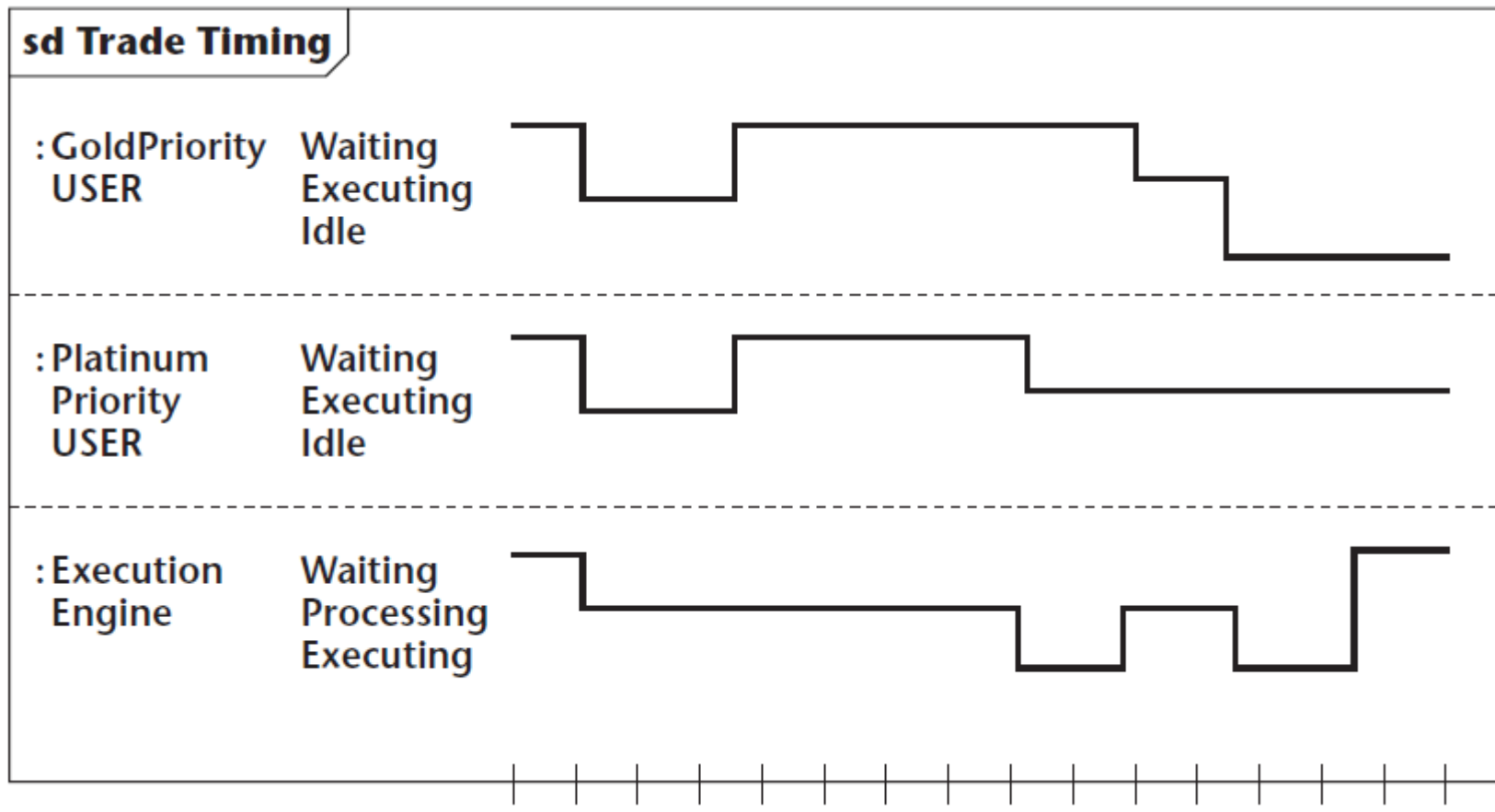


Example 1

- Figure 6.19 shows a case where two active objects share a common resource. In this case, both objects show a trade that requires the execution engine for some time. One object is for a “platinum” user who is guaranteed a trade within 10 time units, and the other is a “gold” user who has no performance guarantee. The user objects have a waiting and executing state along with an idle state. The execution engine has a processing state that takes five time units for each trade and an executing state that takes two time units.

Example 1

- Different priority objects shown on a timing diagram.

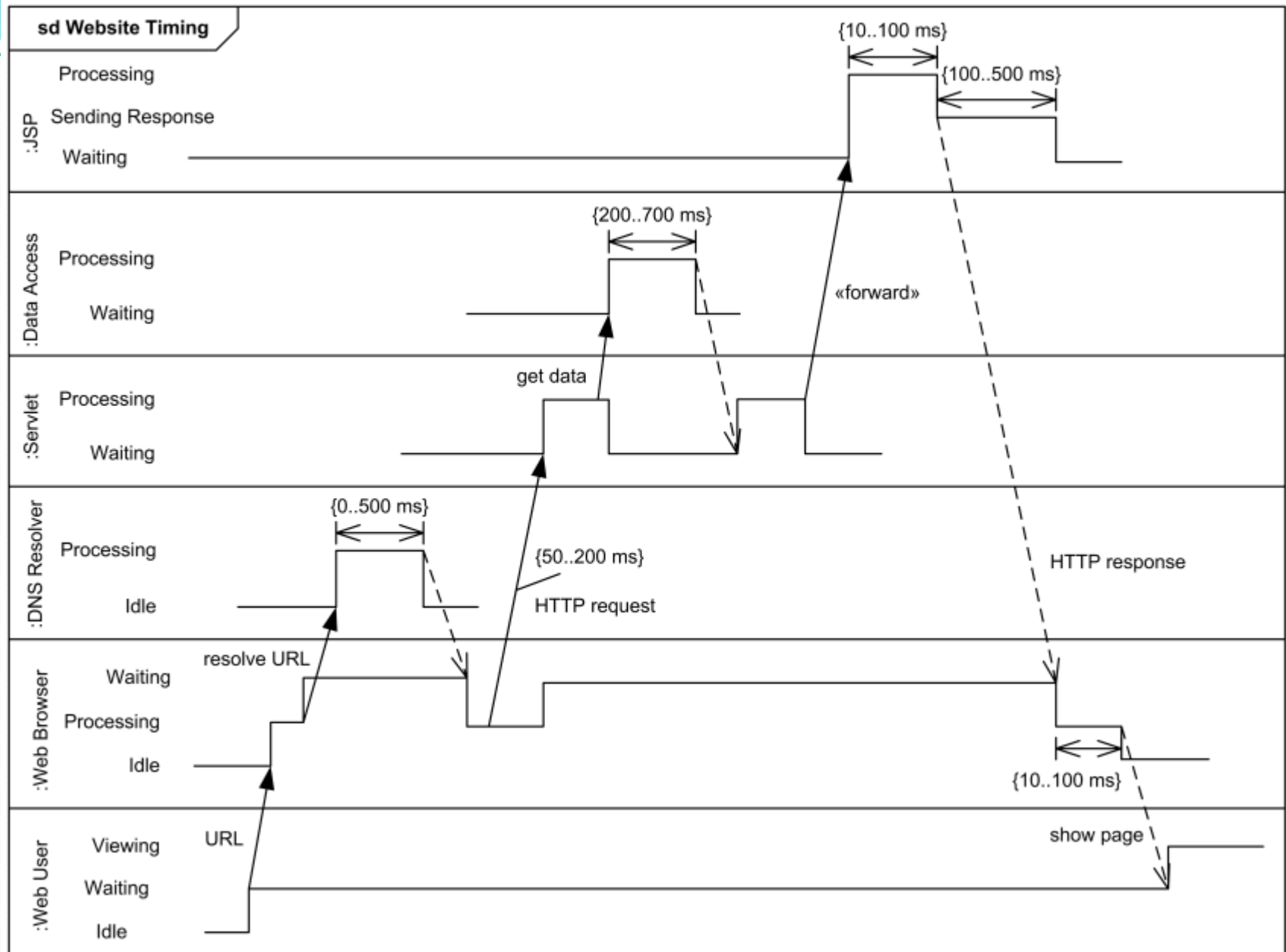


Ex 2: Website Latency

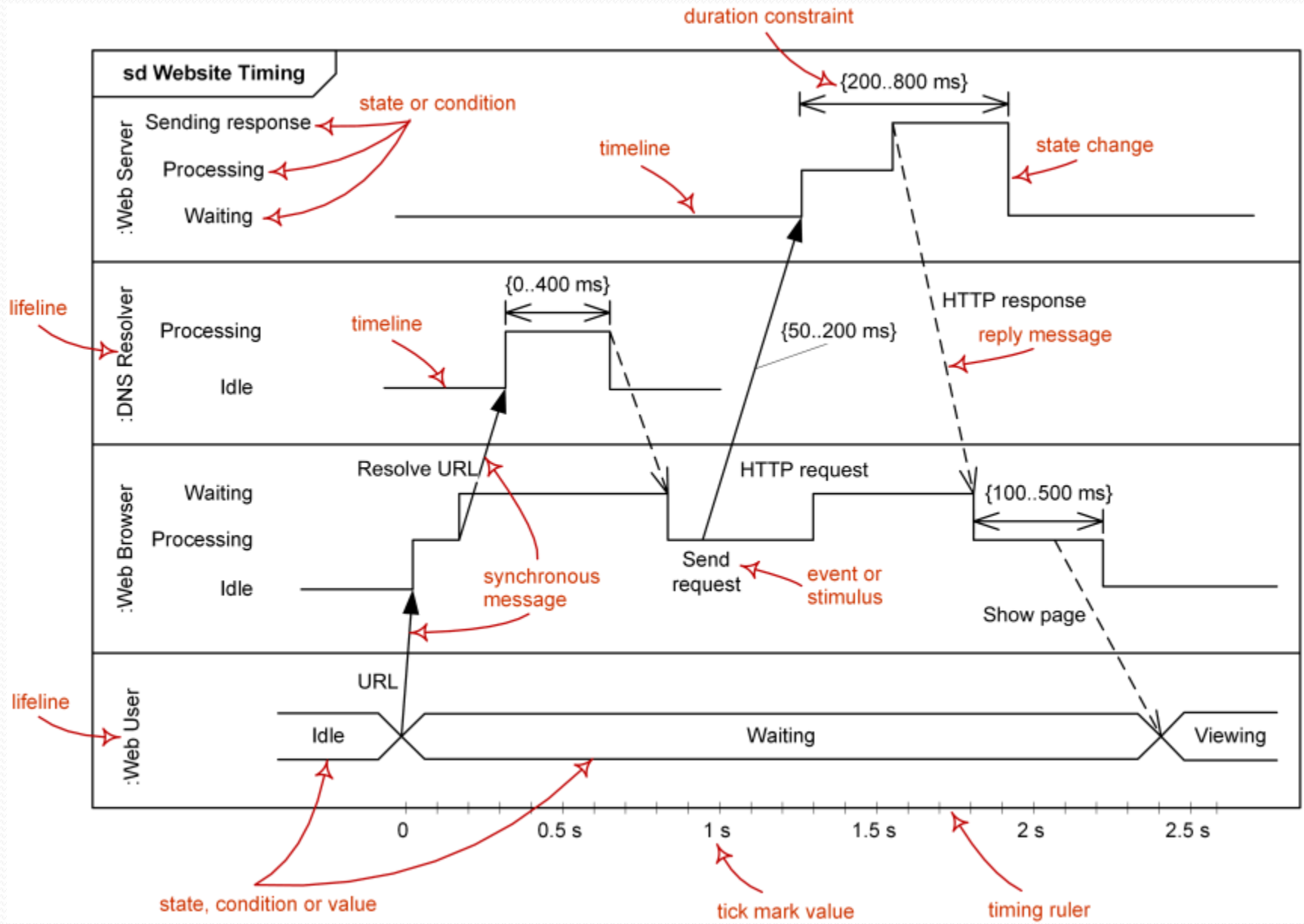
- An example of **timing diagram** which shows some **duration constraints** for a fabricated website to evaluate how long web user should wait to see something rendered on his/her display.
- After web user enters web page URL, the URL should be resolved to some IP address. DNS resolution can add some tangible waiting time to the response latency as perceived by user. Latency delays related to DNS resolution could range from 1 ms (local DNS cache) to several seconds.

Ex 2: Website Latency

- With simple Model–View–Control (MVC) implementation, Java servlet gets control and requests some data from "model". Communication with data sources usually takes some discernible time. After data is received and processed, servlet forwards request processing to JSP ("view"). Buffered HTTP response is sent back to the browser.
- Web browser takes some time to process HTTP response and HTML page to start rendering the page view to the web client. (Note, that after that it could take even more time for the web browser to request other resources like CSS, JavaScript, images, which is not shown on the diagram.)



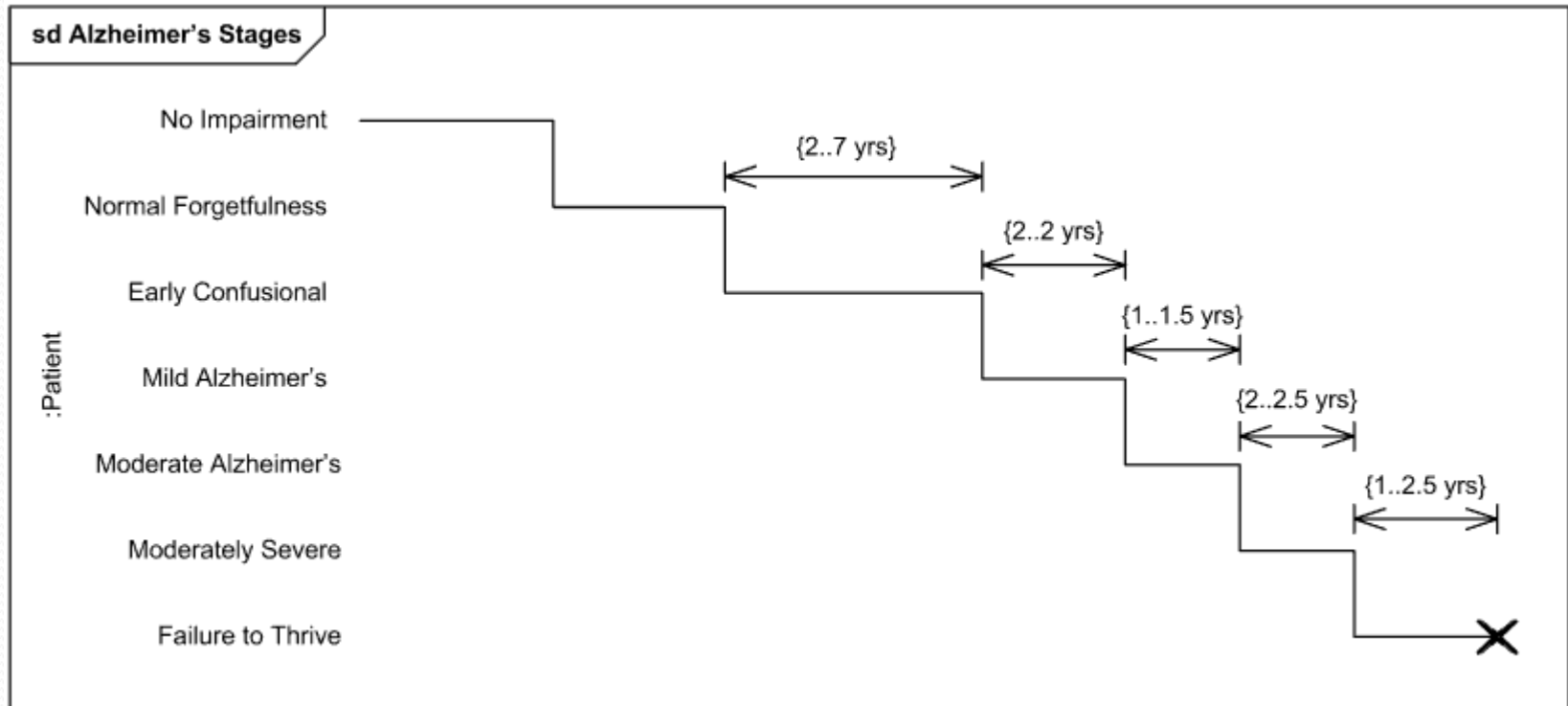
Ex2 : Notations



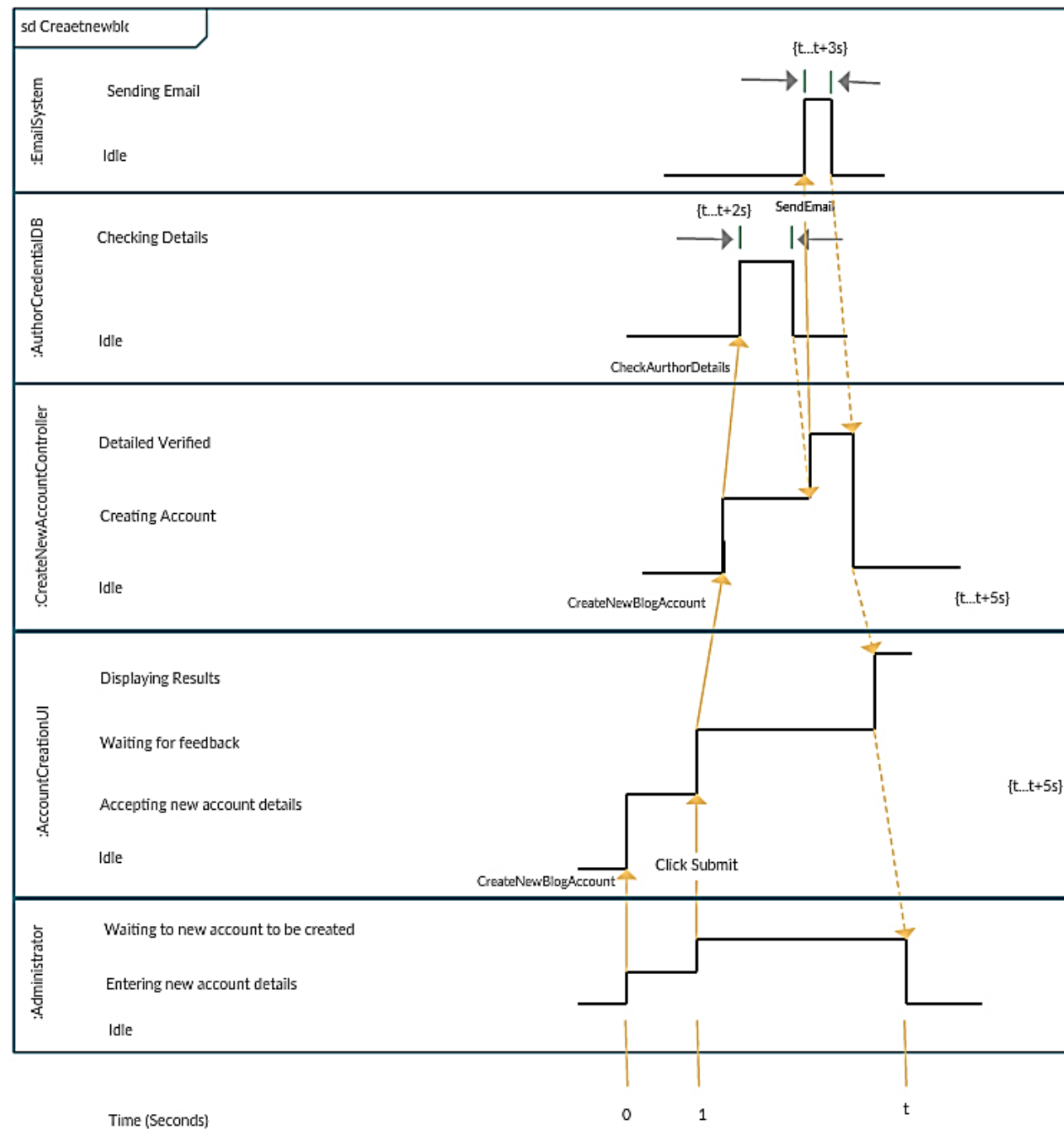
Ex 3: Stages of Alzheimer's Disease

- **Alzheimer's disease** (AD) is a a progressive, ultimately fatal brain disease that causes loss of memory and intellectual abilities. The cause of the disease is unknown. AD has no cure and is one of the leading causes of death in the United States.
- For Alzheimer's disease doctor may use a diagnostic framework with three to seven levels (stages). Progression through these stages may last from 8 to 10 years, and in some cases up to 20 years from the time neuron changes start.
- Example of timing diagram below shows timing for the seven stage framework.

Ex 3: Stages of Alzheimer's Disease

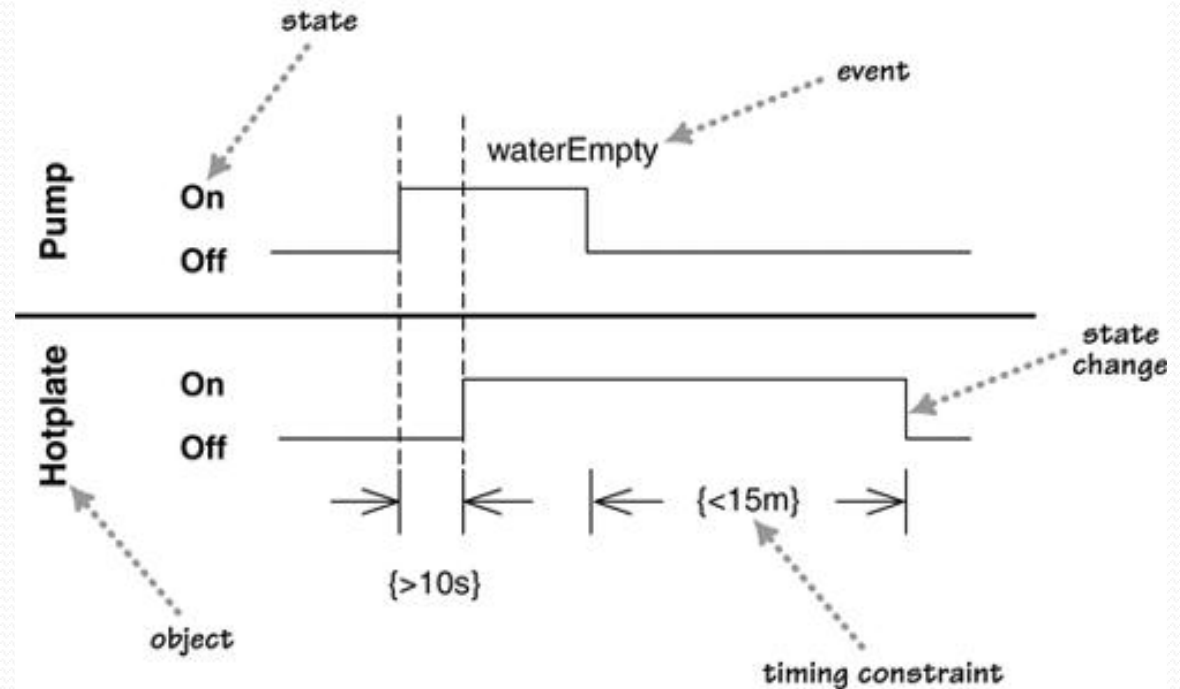


Ex : 4



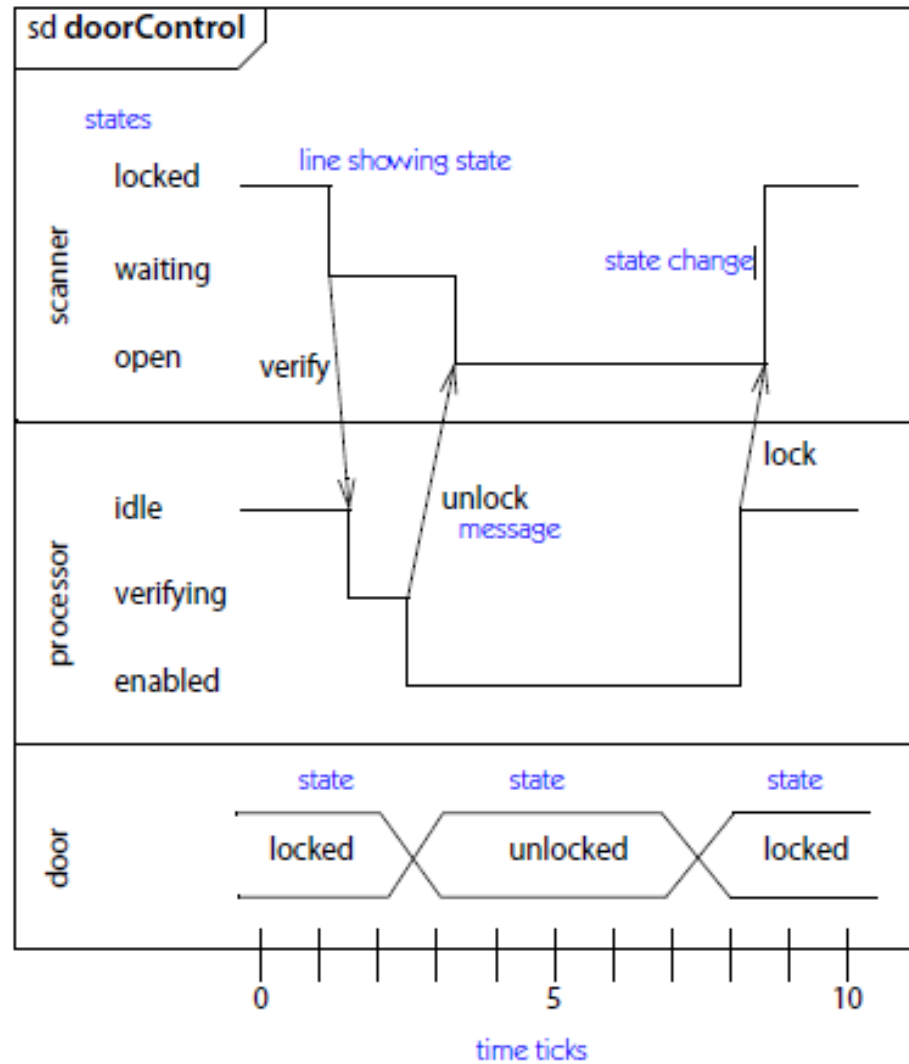
Ex 5: coffee pot

- Let's take a simple scenario based on the pump and hotplate for a coffee pot. Let's imagine a rule that says that at least 10 seconds must pass between the pump coming on and the hotplate coming on. When the water reservoir becomes empty, the pump switches off, and the hotplate cannot stay on for more than 15 minutes more.

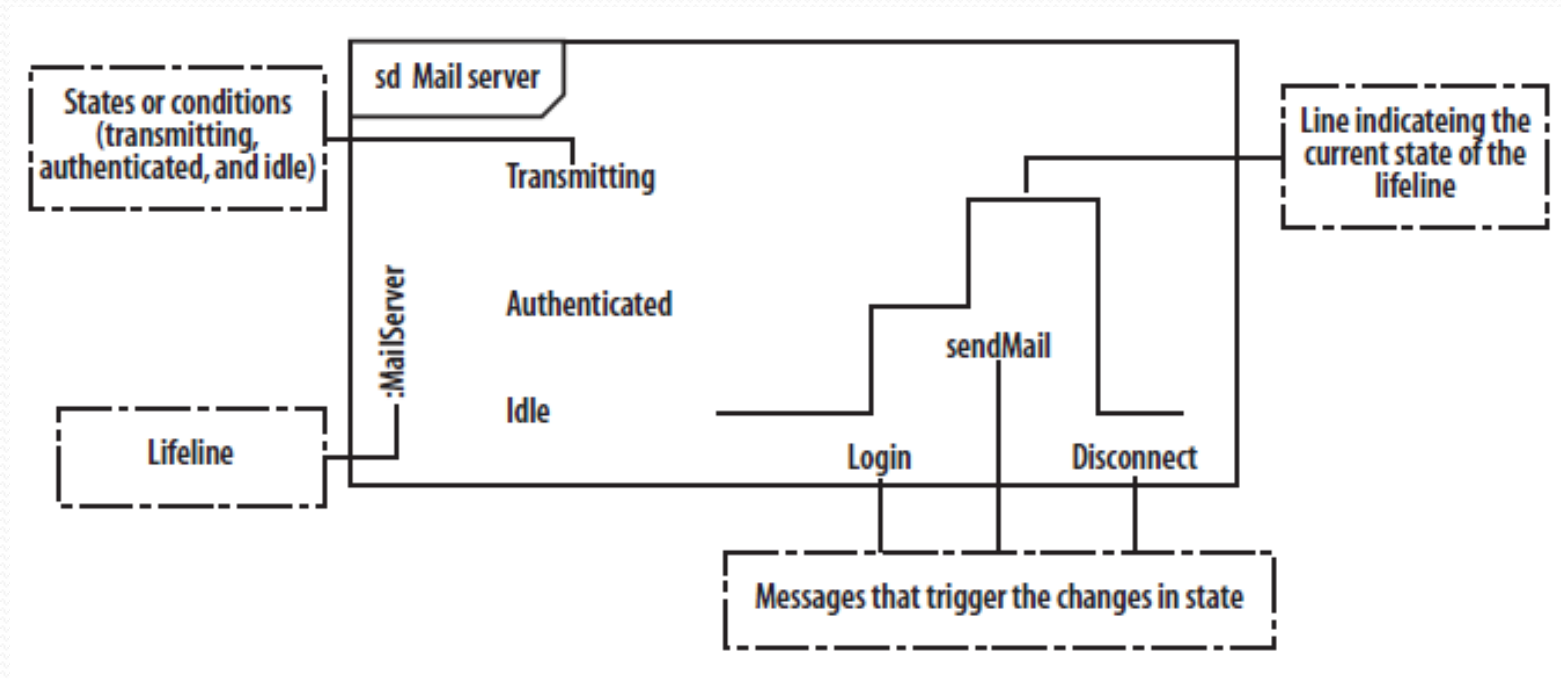


Ex 6:

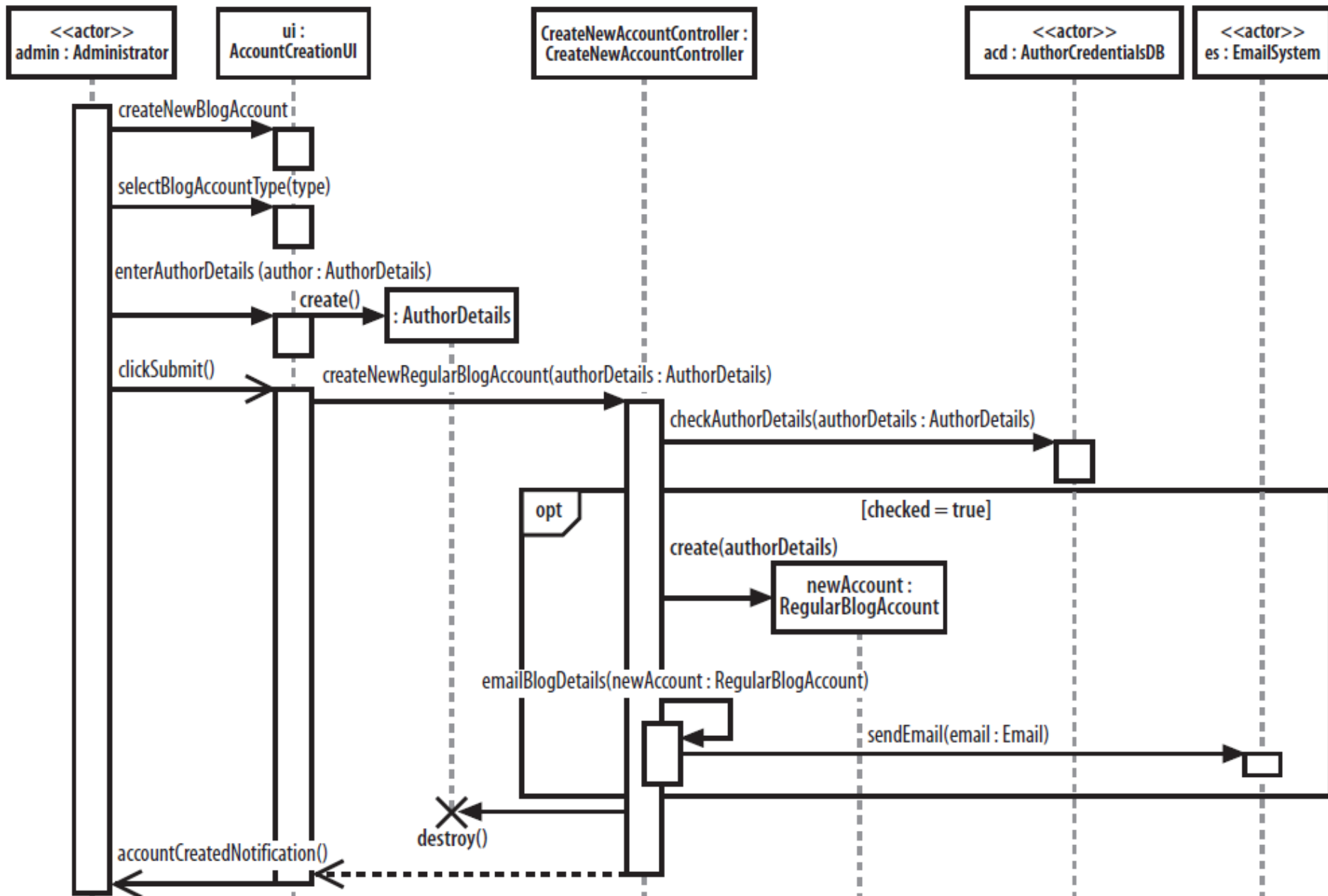
timing diagram



Ex 7: timing diagram for a mail server

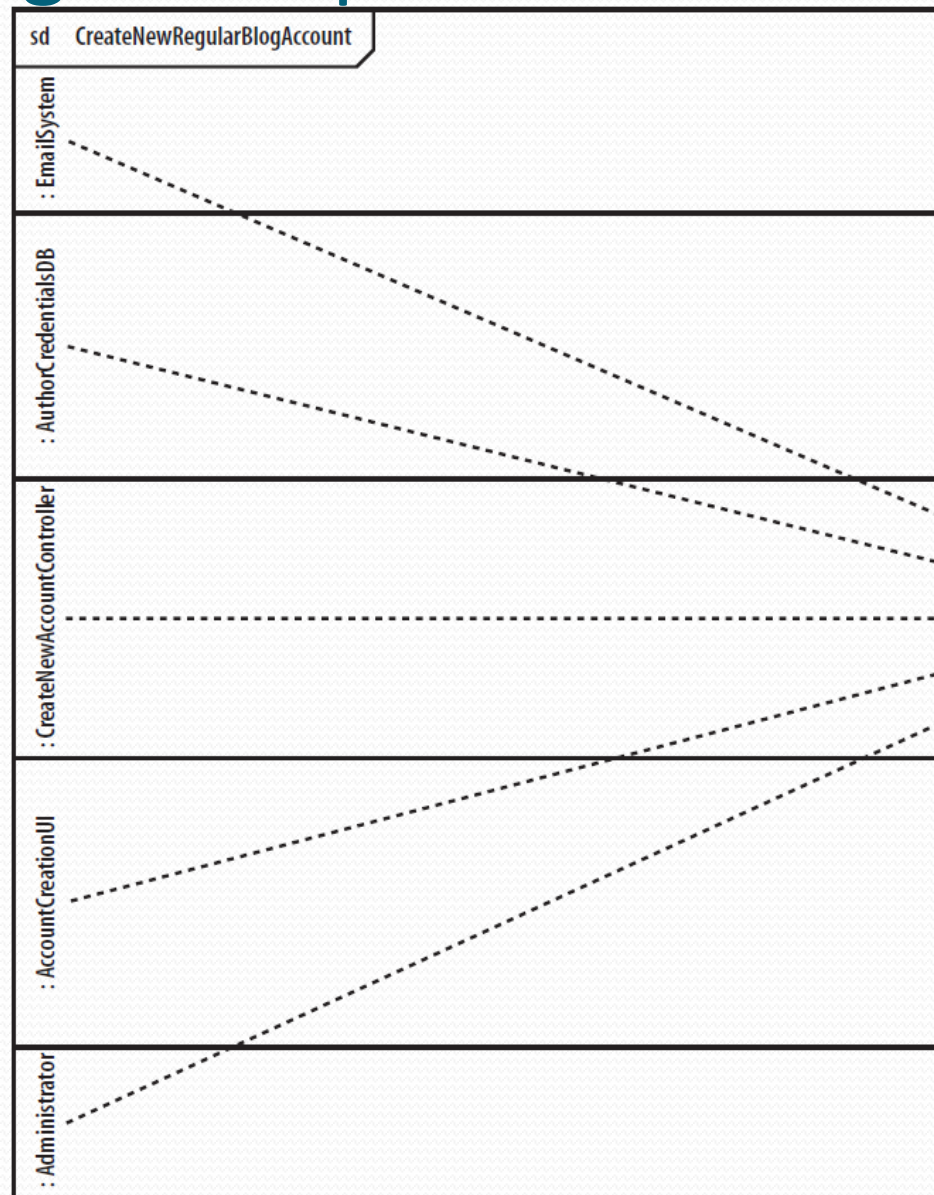


Building a Timing Diagram from a Sequence Diagram



sequence diagram contains very little, about timing, and its main focus is the order of events within an interaction

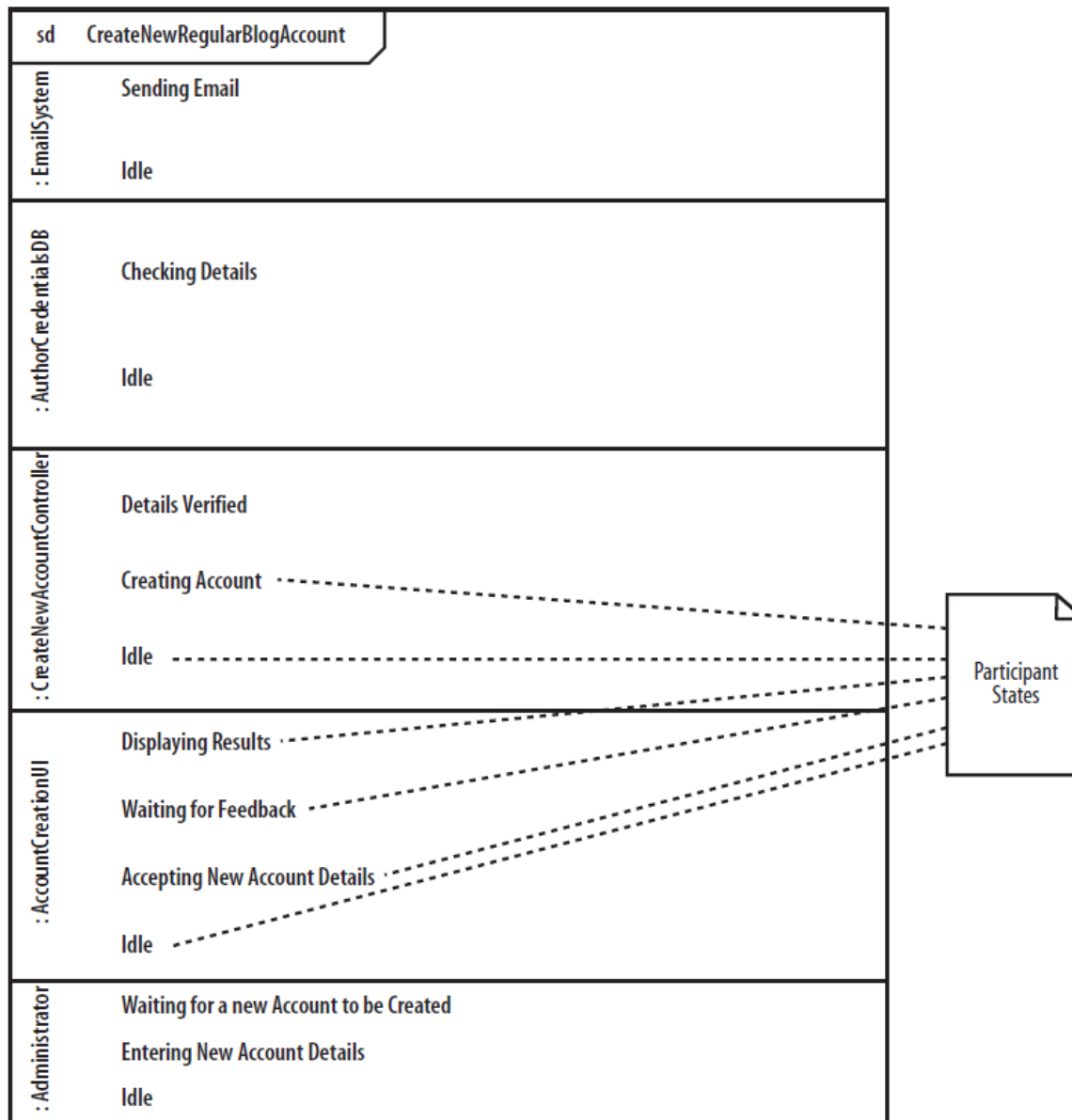
Applying Participants to a Timing Diagram



The names of the main participants involved in an interaction are written vertically on the lefthand side of a timing diagram

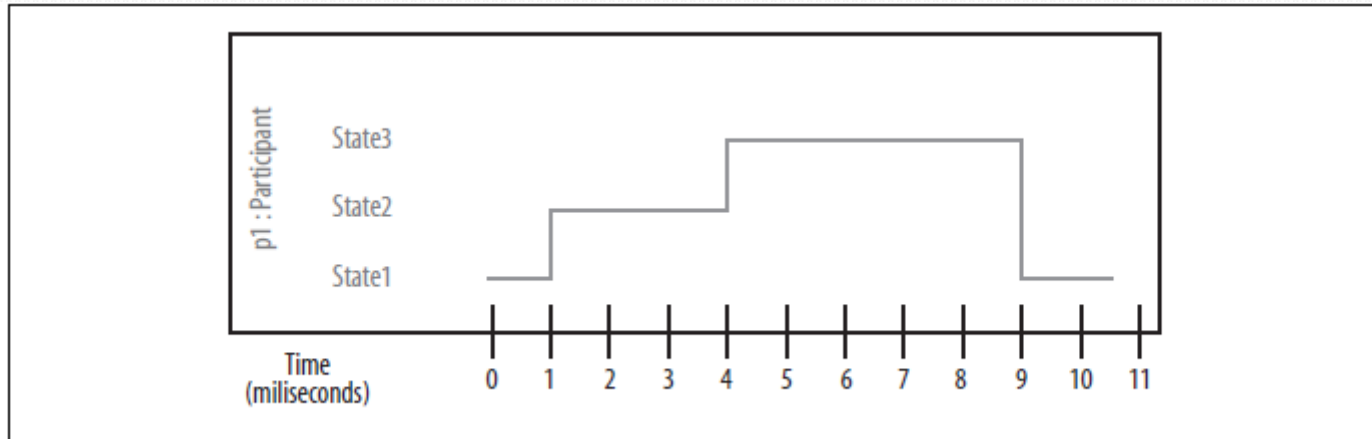
The Timing Diagram's Participants

States

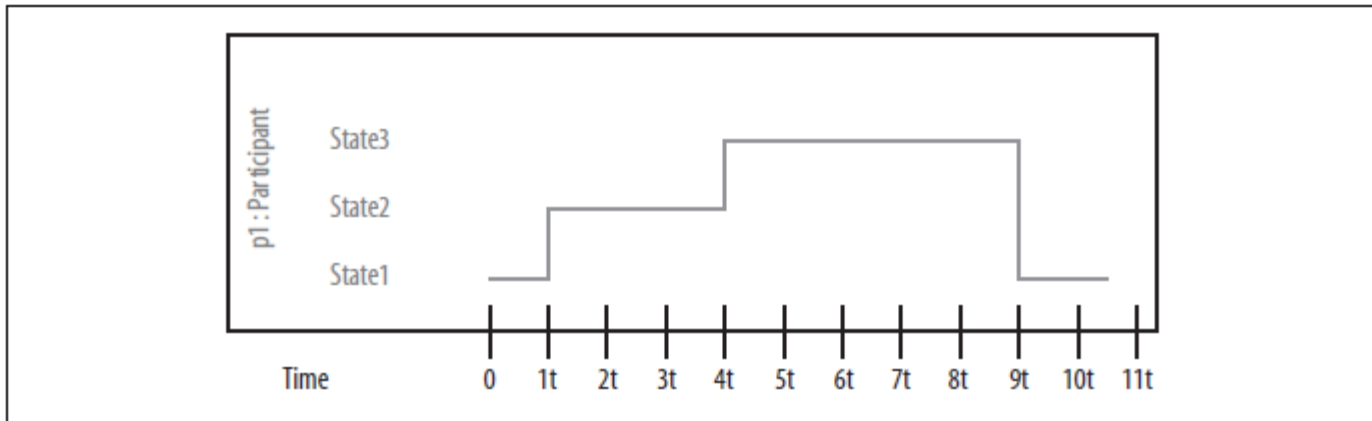


Exact Time and Relative Time Indicators

- Exact time measurements



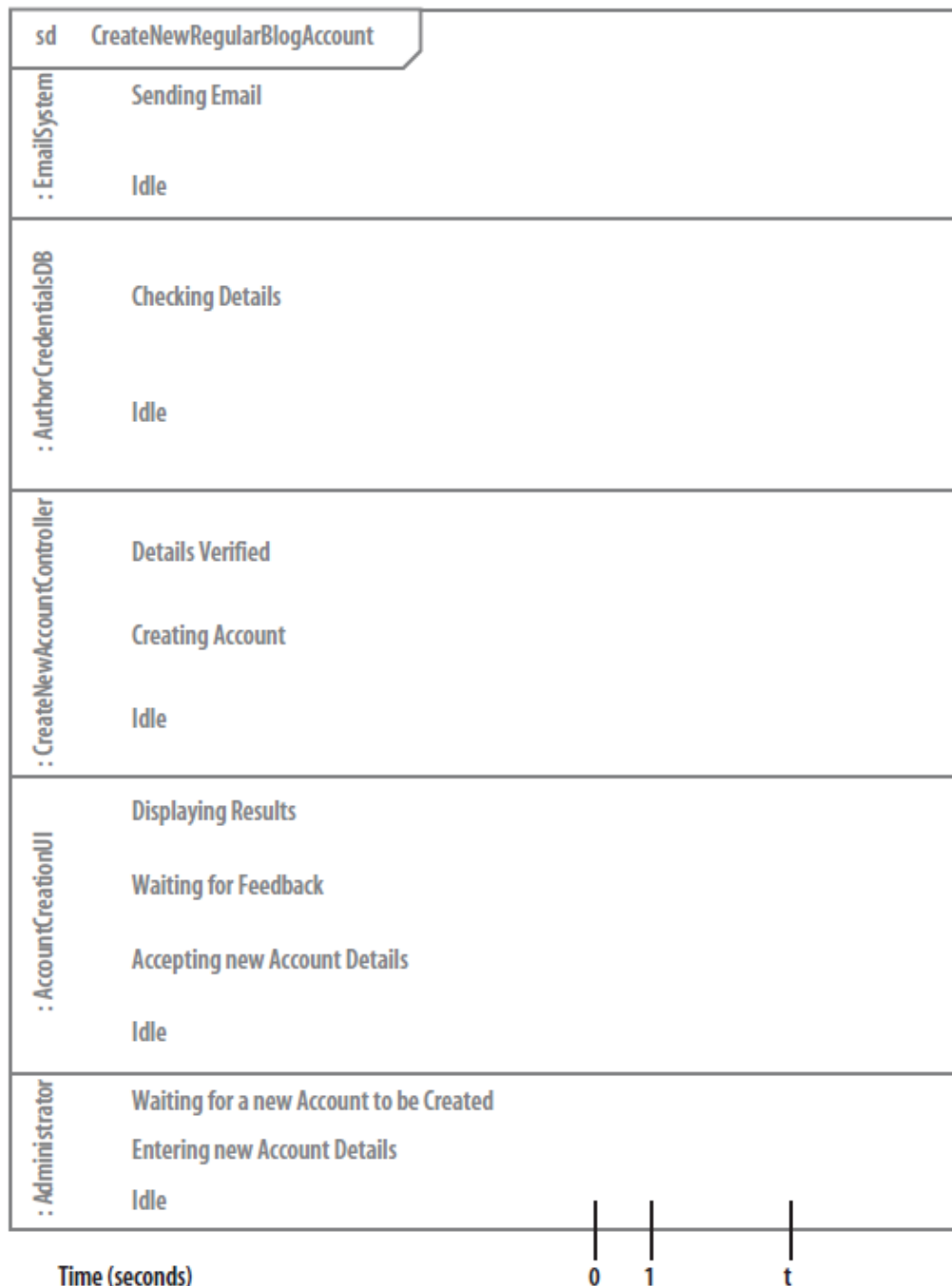
- Relative time indicators



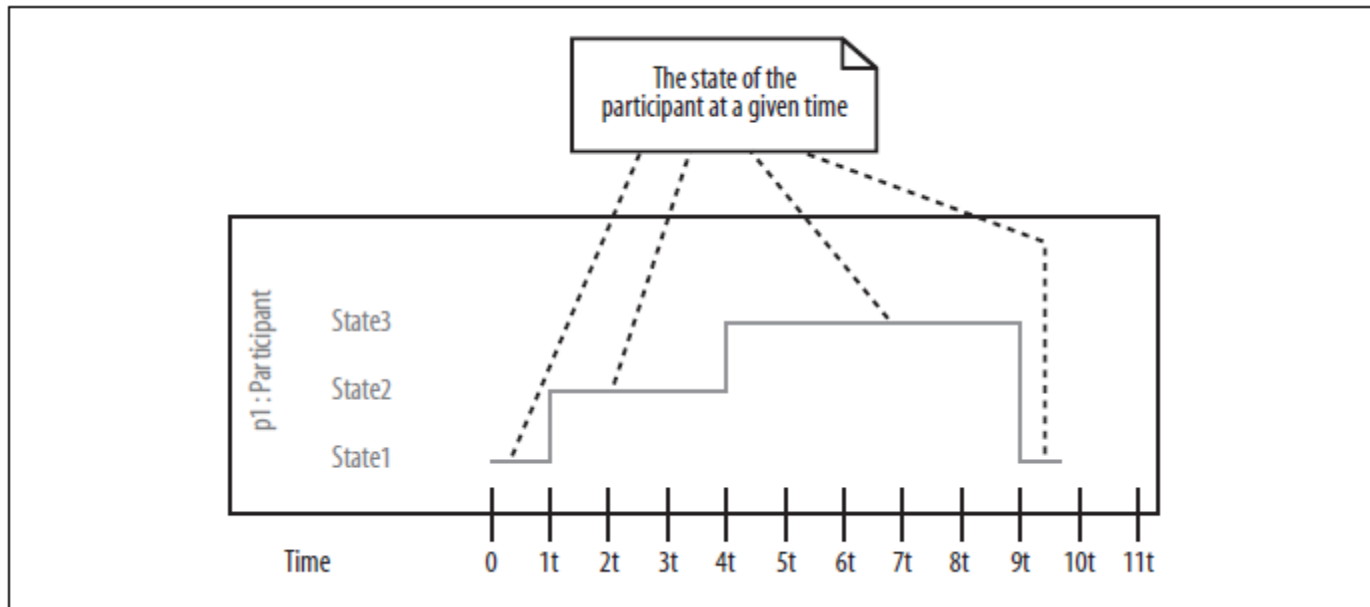
- Relative time indicators are particularly useful when you have timing considerations such as "ParticipantA will be in State1 for half of the time that ParticipantB is in State2"

Exact Time Measurements and Relative Time Indicators

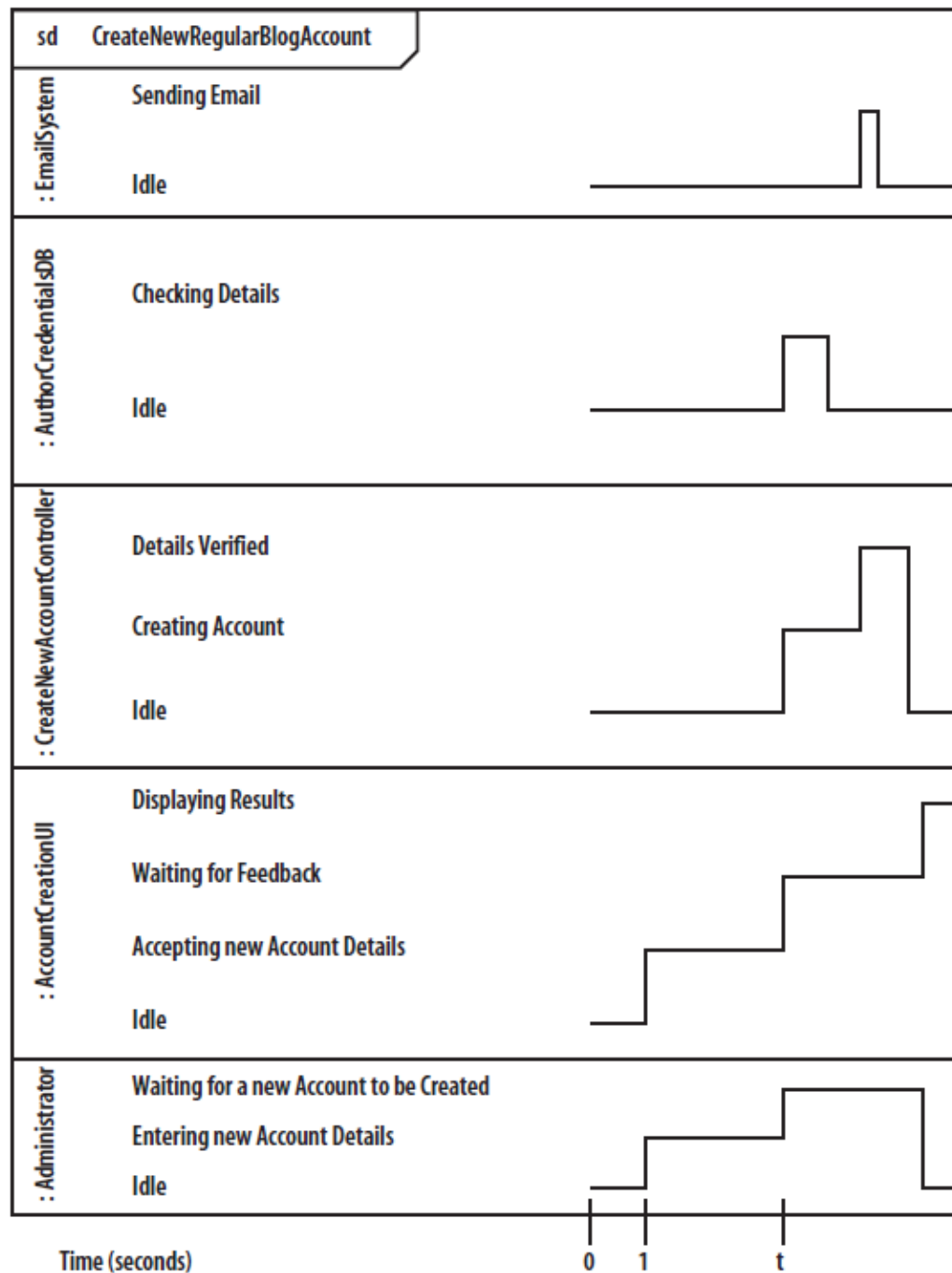
- In a timing diagram, t represents a point in time that is of interest. You don't know exactly when it will happen because it may happen in response to a message or event, but t is a way to refer to that moment without knowing exactly when it is. With t as a reference, you can then specify time constraints relative to that point t .
- Adding time to the diagram we've been putting together so far is tricky because we don't have any concrete timing information in the original requirement.
- Figure 9-8. The timing constraints are a blend of exact and relative timings -> next page



A Participant's State-Line



- In this example, *p1:Participant's state-line indicates that it is in State1 for 1 unit of time, State2 for three units of time, and State3 for roughly five units of time (before returning to State1 at the end of the interaction)*
- *Each of the participants needs to have a corresponding state-line to indicate their state at any given point in time -*
> next page



Events and Messages

- The distinction between messages and events is not as important on a timing diagram as it is on sequence diagrams. The important thing to remember is that *whatever the event is, it is shown on a timing diagram to trigger a change in the state* of a participant.

- Events on a timing diagram can even have their own durations, as shown by event1 taking 1 unit of time from invocation by p1:Participant1 and reception by p2:Participant2

