Lesson 3-7a: Dynamic Models

Object-Oriented Modeling & Applications
Lesson Objectives

- Understand behavior analysis
- Understand the following terms:
  - State
  - Event
  - Decision tables
- Learn how to develop:
  - Scenarios
  - Event Traces
  - STDs (Moore Machine & Mealy Machine, etc.)
Modeling Behavior

• The modeling notation that are used to model behavior, must captures the concepts of:
  – Behavior
  – Transition
  – The calculation of “next mode of behavior” given the “present mode of behavior” and the occurrence of a particular “transition condition”

• One simple technique to model behavior is State Transition Diagram (STD).

• Other behavior modeling techniques are:
  – Petri Nets
  – An algorithm
  – Decision Tables
  – State Charts
Events

• Event is something that happens at a point of time.
• An event has no duration.
• An event is simply an occurrence that is fast compared to the granularity of the time scale of a given abstraction.
• One event may logically precede or follow another, or the events may be unrelated.
• Two events that are unrelated are said to be concurrent; they have no effect on each other.
• In MODELING, DO NOT establish an ordering between concurrent events because they can occur in any order.
Events (cont’d)

• Any realistic model of a distributed system must include concurrent events and activities.

• Every event is a unique occurrence. Examples: Flight 1001 departs from Reno and Flight 1234 departs from Cairo are both instances of event class called airplane flight departs.

• An event conveys information from one object to another.

• Events include error conditions as well as normal occurrences. Examples: time-out and transaction aborted are typical error events.
Scenarios

• A scenario is a sequence of events that occurs during one particular execution of a system.
• A scenario can include all events in the system or can only include these events that are generated by a certain object in that system.
• A scenario can be a historical record of executing or simulating the execution of a system or an object.
Example: Scenario for a Phone Line

- Caller lifts receiver
- Dial tone begins
- Caller dials digit (5)
- Dial tone ends
- Caller dials digit (5)
- Caller dials digit (5)
- Caller dials digit (1)
- Caller dials digit (2)
- Caller dials digit (3)
- Caller dials digit (4)

- Called phone begins ringing
- Ringing tone appears in calling phone
- Called party answers
- Called phone stop ringing
- Ringing tone disappears in calling phone
- Phones are connected
- Called party hangs up
- Phones are disconnected
- Caller hangs up
Event Trace Diagram

- Each event transmits information from one object to another.
- Example:
  - dial tone begins event transmits a signal from the phone line to the caller.
- In Event Trace:
  - Identify sender and receiver objects of each event.
- Event Trace Diagram (ETD) shows the sequence of events and the object exchanging these events.
- ETD shows object as a vertical line and each event as a horizontal line from the sender to the receiver.
**Event Trace Diagram for a Phone Call**

<table>
<thead>
<tr>
<th>Caller</th>
<th>Phone line</th>
<th>Callee</th>
</tr>
</thead>
<tbody>
<tr>
<td>caller lifts receiver</td>
<td>dial tone begins</td>
<td>phone rings</td>
</tr>
<tr>
<td>dial tone begins</td>
<td>dials (5)</td>
<td>answers phone</td>
</tr>
<tr>
<td>dials (5)</td>
<td>dial tone ends</td>
<td>ringing stops</td>
</tr>
<tr>
<td>dial tone ends</td>
<td>dials (5)</td>
<td></td>
</tr>
<tr>
<td>dials (5)</td>
<td>dials (1)</td>
<td></td>
</tr>
<tr>
<td>dials (1)</td>
<td>dials (2)</td>
<td></td>
</tr>
<tr>
<td>dials (2)</td>
<td>dials (3)</td>
<td></td>
</tr>
<tr>
<td>dials (3)</td>
<td>dials (4)</td>
<td></td>
</tr>
<tr>
<td>dials (4)</td>
<td>ringing tone</td>
<td></td>
</tr>
<tr>
<td>ringing tone</td>
<td>tone stop</td>
<td></td>
</tr>
<tr>
<td>tone stop</td>
<td>phone connected</td>
<td></td>
</tr>
<tr>
<td>phone connected</td>
<td>connection broken</td>
<td></td>
</tr>
<tr>
<td>connection broken</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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What are STDs?

• STD stands for State Transition Diagram

• A STD is a graphical representation of a finite state machine (FSM).

• FSM is an abstract behavioral model of a real imaginary thing.

• The thing exists in one of a finite number of states between which it can transition or can be made to transition under certain conditions.

• The allowed transitions between states must be determined or postulated.
What are STDs? (cont’d)

- A state is mode of behavior and denoted by a box.
- Transitions between the modes are shown as directed lines labeled by a transition condition.
- A “transition condition” is any expression “X” in When X”
  - “When the water boils...” is an event
  - “When it is raining outside ...” is a proposition
  - “When it is 9 am and it is sunny or cloudy...” is a logical expression.
- A transition only occurs out of a mode when one of its exit transition conditions becomes true.
What are STDs? (cont’d)

- Transitions back to the same mode are allowed, for transition conditions containing events.
- Several conditions may be present between any two modes.
- Every mode must be associated with one or more transitions.
- An initial transition must be shown.
- A mode should be appropriately named.
What are STDs? (cont’d)

- Moore Machines or Moore’s STDs
- Mealy Machines or Mealy’s STDs
- Harel’s State Charts
Discussion Questions

What is an event?

What is a scenario? What is equivalent to a scenario?

What is an event trace?

What is a state? What are the state properties?

What is a transition? What are the transition properties?

Name several techniques for model behavior