STATECHARTS: A Visual Formalism for Complex Systems

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STATECHARTS - 1

■ Visual formalism for the specification of reactive systems
  – not a support, but the way itself

■ Extension of State Transition Diagram of Finite State Machines
  – State/Event Description
STATECHARTS - 2

- Flat FSM - too complex

- Mechanisms to enhance the descriptive power:
  - Hierarchy
  - Orthogonality
HIERARCHY - 1

- Boxes denotes states
- Encapsulation express hierarchy
  - different state levels
- Arrows can originate and terminate at any level
- Arrows labeled with events
  - optionally: parenthesized conditions
HIERARCHY - 2

- XOR Decomposition
- Way to economize arrows
HIERARCHY - 3

- Default states
HIERARCHY - 4

- Entering a group of states - History
  – State most recently visited
HIERARCHY - 5

- Entering a group of states - History
  – Only at one level
HIERARCHY - 6

- Entering a group of states - History*
  – through the hierarchy
HIERARCHY - 7

- Entering a group of states - Condition
HIERARCHY - 8

- Entering a group of states - Selection
HIERARCHY - Summary

- XOR Decomposition
- Default states
- Entering a group of states
  - History
  - History*
  - Condition
  - Selection
ORTHOGONALITY - 1

- Boxes splitted by a dashed line express orthogonality
- Independency and/or Concurrency

![Diagram showing orthogonality and independency/concurrency]
ORTHOGONALITY - 2

- AND Decomposition
- Way to economize states

\[ N = N_1 \times N_2 \]

\[ N = N_1 + N_2 \]
MORE FEATURES....

- Time Constraints
- Unclustering
- Actions and Activities
TIME CONSTRAINTS

- Delays
  - timeout(event, number)
- Time Bounds

\[ \Delta t_1 < \Delta t_2 \]

A

timeout (A, bound)
UNCLUSTERING

- Laying out parts outside the natural neighborhood
ACTIONS AND ACTIVITIES

- Connection with the “real world”
  - ACTIONS (zero time)
  - ACTIVITIES (non-zero time)

- Actions to control activity X
  - start(X)
  - stop(X)
ACTIONS AND ACTIVITIES

- Extension of State Transition Diagram
SUMMARY

- Extended State Transition Diagram
  - Hierarchy
  - Orthogonality
- Default states
  - enter by (history, condition, selection)
- Time constraints
- Actions and Activities
WATCH
WATCH INTERFACE

■ OUTPUT
   - Main Display Area, 4 Smaller Display Areas
   - Two-Tone Beeper

■ INPUT
   - 4 Control Buttons: a, b, c, and d
   - Battery
WATCH FUNCTION

- Display Time (am/pm or 24 hour) or Display Date (day, month, date of week)
- Two Independent Alarms
- A Stopwatch (lap and regular modes, and a 1/100 s display)
- A Light for Illumination
- A Weak Battery Blinking Indication
- Beeper Test
### WATCH USER’S GUIDE

<table>
<thead>
<tr>
<th>Button</th>
<th>Current State</th>
<th>Function</th>
</tr>
</thead>
</table>
| a      | Normal         | Select displays  
          | (time/date, alarm setting, chime setting, stopwatch) |
| b      | Normal         | Press with button d enter Beep-test |
|        | Update or Setting | Exit current update or setting |
|        | Stopwatch      | Run/Stop |
| c      | Update or Setting | Select Update Content |
| d      | Time           | Time/Date switch |
|        | Alarm Setting  | Turn on/off |
|        | Chime Setting  | Turn on/off |
|        | Normal         | Press with button b to enter Beep-test |
|        | Stopwatch Run  | Regular/Lap display |
|        | Stopwatch Stop | Clear stopwatch to zero |
|        | Update or Setting | Resume |
STATECHART: watch

- watch
- main-etc
- dead
- battery inserted
- battery removed / clear (main H*)
- weak battery dies / clear (main H*)
STATECHART:
main//alarm1-status//alarm2-status//chime-status//light//power

We are here
STATECHART: displays

We are here
STATECHART: beep-test

We are here →
STATECHART: update

We are here →

2 sec in wait

update

mon → c → hr

date → c → 10 min

day → c → year

dead

main

We are here

inserted

weak battery

dies
STATECHART: alarm1, update1

We are here
STATECHART: chime

We are here →

chime

off

don

H

dead

watch

main battery

inserted battery

weak battery

dies
STATECHART: stopwatch

We are here →

stopwatch

zero

H*

dead

battery

inserted

removed

weak battery

dies

display

reg

lap

run

on

off

(in on)

(in off)

da

b

b
STATECHART: alarms-beep

T hits T1 (P1)
alarms-beep
alarm1 beeps

any button pressed

30 sec in alarms-beep
alarm2 beeps

T hits T2 (P2)
both beep

T hits T1 (P)

T1: time setting of alarm1
T2: time setting of alarm2
P1: alarm1_enabled ^ (alarm2_disabled V T1!=T2)
P2: alarm2_enabled ^ (alarm1_disabled V T1!=T2)
P: alarm1_enabled ^ alarm2_enabled ^ T1=T2

We are here →
STATECHART: alarm1-status

alarm1-status

- disabled (in alarm 1.off)
- enabled (in alarm 1.on)

We are here ➔
STATECHART: alarm2-status

We are here →

We are here →

We are here →
STATECHART: chime-status

chime-status

- disabled
  - d (in chime.on)
  - d (in chime.off)

- enabled
  - quiet
    - T is whole hour
  - beep
    - 2 sec in beep

We are here
STATECHART: light

![State Chart Diagram]

We are here →
STATECHART: power

- power
  - ok
  - battery weakens → blink
  - weak battery dies

We are here