Recitation #4

18-649 Distributed Embedded Systems

Friday 19-Sep-2014

Electrical & Computer ENGINEERING

Note: Course slides shamelessly stolen from lecture

Carnegie Mellon

Announcements and Administrative Stuff

- **Project 4 posted**
- TA office hours
  - http://www.ece.cmu.edu/~ece649/admin.html#info
  - Monday: PH 126A 5:00-600 (Sajjan)
  - Tuesday: WEH 5328 5:00-6:00 (Felix)
  - Wednesday: WEH 5310 6:00-7:00 (Patrick)
  - Thursday: PH A22 5:00-6:00 (Jeff)
  - Friday: WEH 5328 5:00-6:00 (Felix)
- **Submission Mistakes**
  - Please place portfolio files in the project root directory with no additional directories.
    - Correct: proj3\(portfolio files)
    - Incorrect: proj3\portfolio\(portfolio files)
  - Minimum Contribution chart in peer review folder.

TA Office Hours

- **If you have questions about grading on a project**
  - Go see the TA that graded your project if possible

- **For grade correction requests or disputes**
  - You must submit a written (paper) request including:
    - Your name
    - TA name that graded the assignment
    - Specific issue with grading
  - Within 1 week of when the grade is posted to blackboard
    - We'll be a little flexible with projects 1&2 since it took a while to settle down office hours

Project 3 in Review

- **Anyone have to update sequence diagrams to add missed behaviors?**
  - This is expected
  - Good design process helps identify these bugs ***before*** implementation!

- **Some common things some might have missed:**
  - Turning hall and car button lights OFF
    - If you see the button has already lit up, would you press it again?
  - Setting car position indicator
    - How does the passenger known when to get off the elevator?
  - What about safety cases?

- **Other notes:**
  - Why do mHallLight and mCarLight exist?
    - Typically used for fancy dispatchers and fault tolerance
    - For state chart traceability, you can mark these as "future expansion"
      - » But, any reasonable approach is fine so long as it is consistently applied

Project 4 Overview

- Convert your event-triggered requirements to time-triggered
- Create state charts using time-triggered requirements
- Traceability between requirements and state charts
- Log any changes to requirements, sequence diagrams, etc.

Previous: Event-Triggered

- **An event triggers a message to be sent ONCE**
  - E.g. “Passenger presses a button”
- **Controllers take actions when they receive a particular message**
  - Receiving a message is an event that triggers some action
- **Controllers can only act on one new message at a time**
  - If actions require more than one message, controller has to store them

Now: Time-Triggered

- **Think of messages as periodic updates of system state variables**
  - E.g. Repeatedly check “Is the button currently pressed?”

- **Controllers take actions based upon the current state of the system**
  - Controllers run control loops at regular intervals
  - Constantly monitor the most recent values of messages
    - Actions performed once the most recent values match a particular set of conditions

- **Controllers keep the most recent copy of messages**
  - Current state = most recent copies of messages

Another Magic Formula

- **Time-triggered system**
  - ***(Null or <message value> , … <message value>)***
    and *(Null or <variable value test>, … <variable value test>)*
    shall result in *<message transmitted>, …*
    <variable value assigned>
  - Can trigger on zero or more messages; zero or more variables
    - Need one or more total triggers
    - OK for left hand side trigger to ONLY be a state variable (or always be true)
    - Right hand side can have zero or more messages; zero or more variable values
    - "Shall" and "should" are both acceptable
  - OK to assign multiple messages, OK to assign multiple values
  - **EVERY VERB GETS A NUMBER**

Correct and Incorrect TT Requirement Examples

- **Correct:**

  R1. If *X* and *Y* then

    R1.a. *M* shall be set to *m*

    R1.b. *N* shall be set to *n*

  - One number per verb
  - Reminder: Trace to the sub-numbered bullets

- **Wrong:**

  R1. If *X* and *Y* then *M* shall be set to *m* and *N* shall be set to *n*

    Problem: More than one verb per traceable numbered requirement

Time-Triggered Requirements Guidance

- **Use typical message format to refer to the most recent copy**
  - You don't have to explicitly store the newest copy

- **Example:**

  R1. If (mAtFloor[g,b] is true) and (mDesiredFloor.f = = g), then

    R1.a. mCarCall[g,b] shall be set to false, and

    R1.b. CarLight[g,b] shall be set to false, and

    R1.c. mCarLight[g,b] shall be set to false.

- **Time-triggered requirements act on the current state of the system**
  - Don't refer to a message "being received" or some other event

How Does This Impact Sequence Diagrams?

- **Message arcs represent the change in value**
  - Event-triggered: The time when a single message value is broadcast
  - Time-triggered: The time when a periodic message value changes
  - So, the number of message arcs should remain about the same

- **Time-triggered requirements may simplify your sequence diagrams**
  - You may not need to explicitly store variables now
  - Some of your variable assignment bubbles might need to be removed

- **Update sequence diagrams if a behavior is changed, added, or removed**

- **Yes, if you modify sequence diagrams you must update traceability**
  - ***You must enter each change in the issues log if it is a defect rather than an enhancement***
    (Until mid-semester, almost everything you change will be due to finding a defect)

State Charts

- **Event-Triggered:**
  - Arcs are taken in response to received message
  - Asynchronous state machine
    - Only does something when an event occurs
    - Action inside a state takes place exactly ***once*** per arc transition
  - Switch statements for state machine are executed once per arriving arc

- **Time-Triggered:**
  - Arcs are taken periodically if conditions are true
  - Synchronous state machine
    - Does something on regular period regardless of changes
    - Actions inside state occur repeatedly (every period)
  - Switch statement for state machine executed once per period

- **What's the difference?**
  - What happens when you increment a variable within a state in an event-triggered state machine vs time-triggered?

State Charts

- **Create state charts based on your time-triggered requirements**
  - Each state must set all outputs of the control interface in every state
  - Make decisions based ONLY on the current state of the system
  - Have mutually excluding transitions
    - No two guard statements can be simultaneously true on arcs from same state
    - Implicit "stay in same state" guard condition if no other guards are true
  - Note that action inside a state happens every time state chart is evaluated
    - So if you have "set light to on" and the state chart runs at 10x/second, the light gets an "on" command 10 times per second
  - For now you can run state charts as fast as you want
    - (In general run them at least as fast as the fastest message repetition rate)

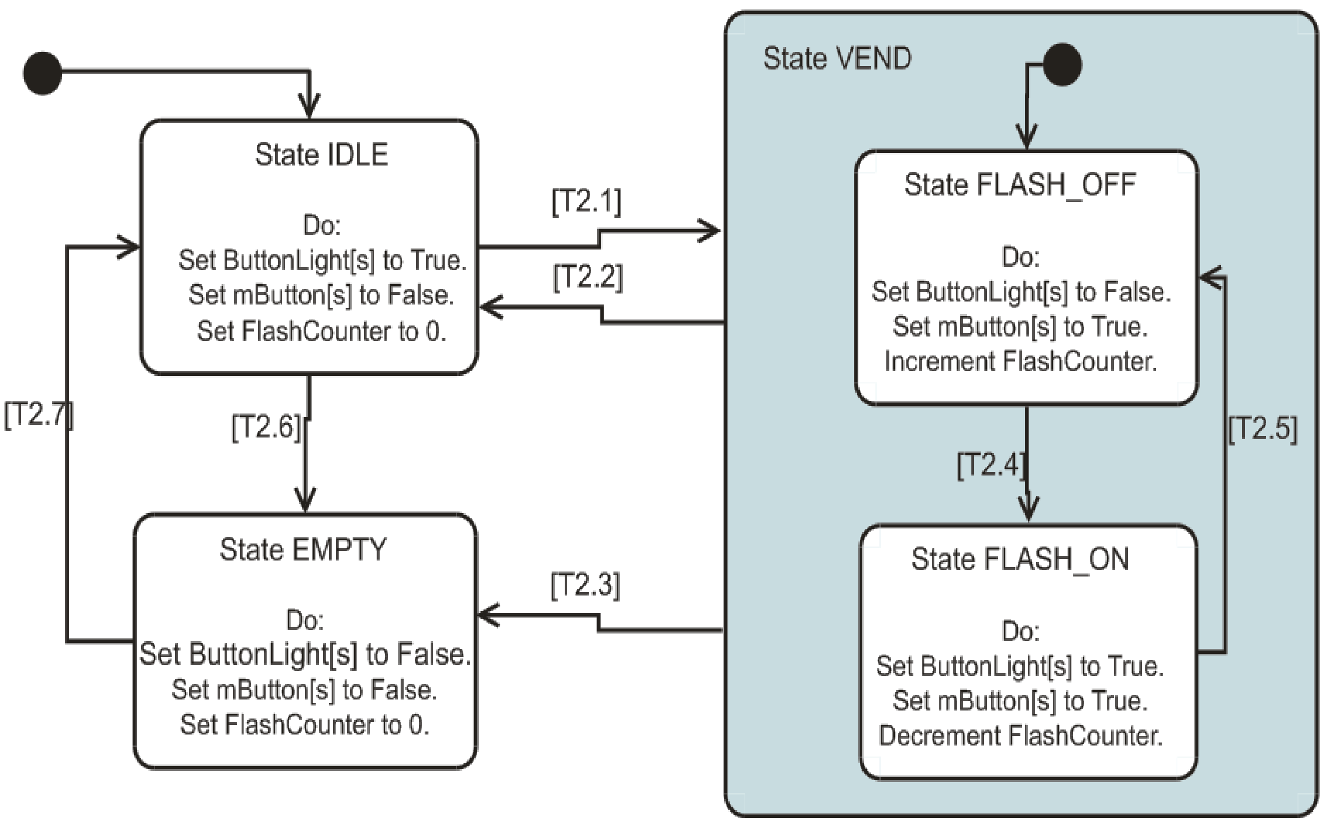
- **Create three tables per state chart**
  - State activities table
  - Transitions table
  - Traceability for states and transitions to requirements
  - See examples

State Charts

- **Forbidden**
  - No actions on arcs
    - All actions performed in the state
  - No entry actions (actions occuring only once upon entry)
  - No branches in transitions
    - Just make more than one transition
- **Avoid:**
  - Using a state variable to collapse states
    - Break it down into two separate states
    - Compact does ***not*** mean easier to read / understand / implement!
  - Nested state charts
    - There's examples of how to do it correctly in the Soda Machine
    - Still not recommended

ButtonControl Time Triggered Statechart

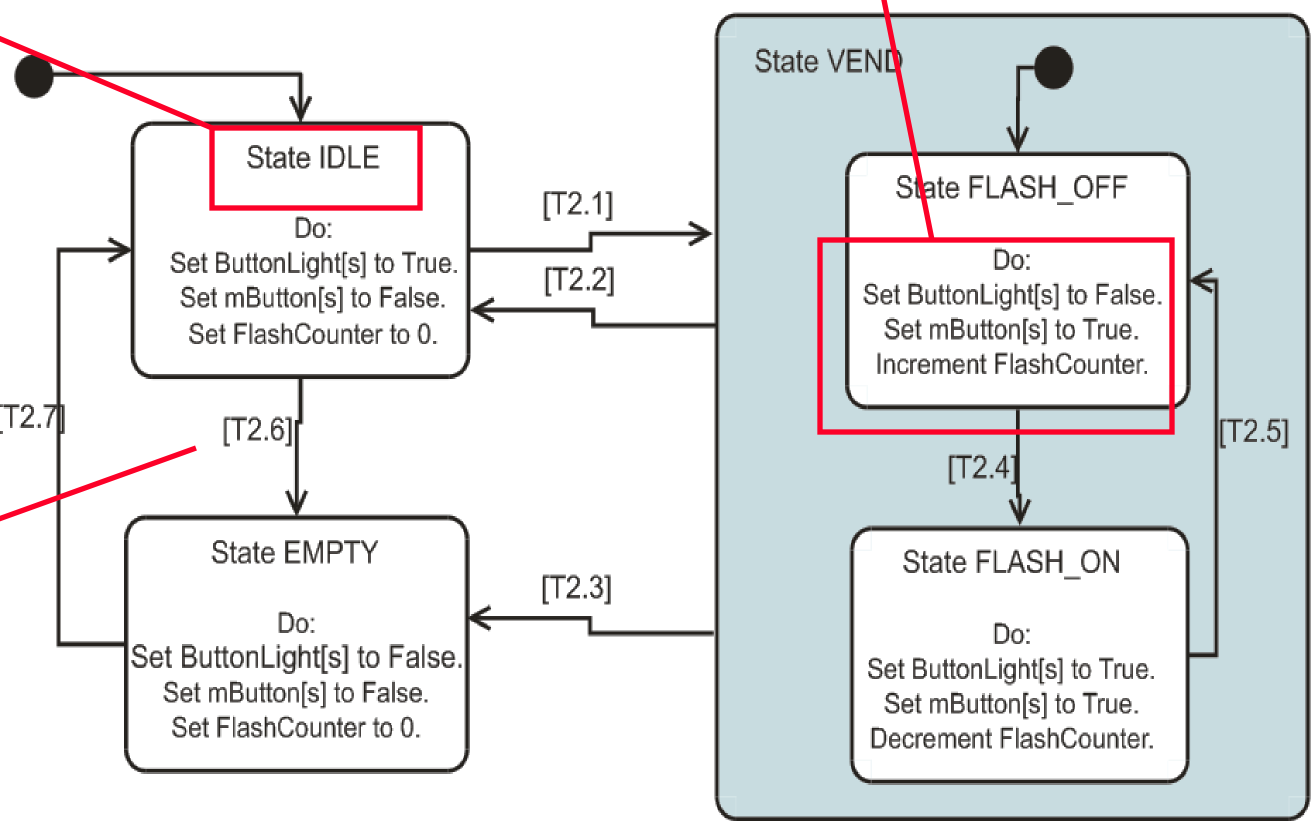
Transition #	Guard
T2.1	mButton[s] ← True AND mEmpty[s] ← False
T2.2	mVend ← True AND mEmpty[s] ← False
T2.3.	mVend ← True AND mEmpty[s] ← True
T2.4.	FlashCounter > FlashLimit
T2.5.	FlashCounterLimt ← 0
T2.6.	mEmpty ← True
T2.7.	mEmpty ← False



ButtonControl Time Triggered Statechart

Each state updates all interface outputs (and possibly variables)

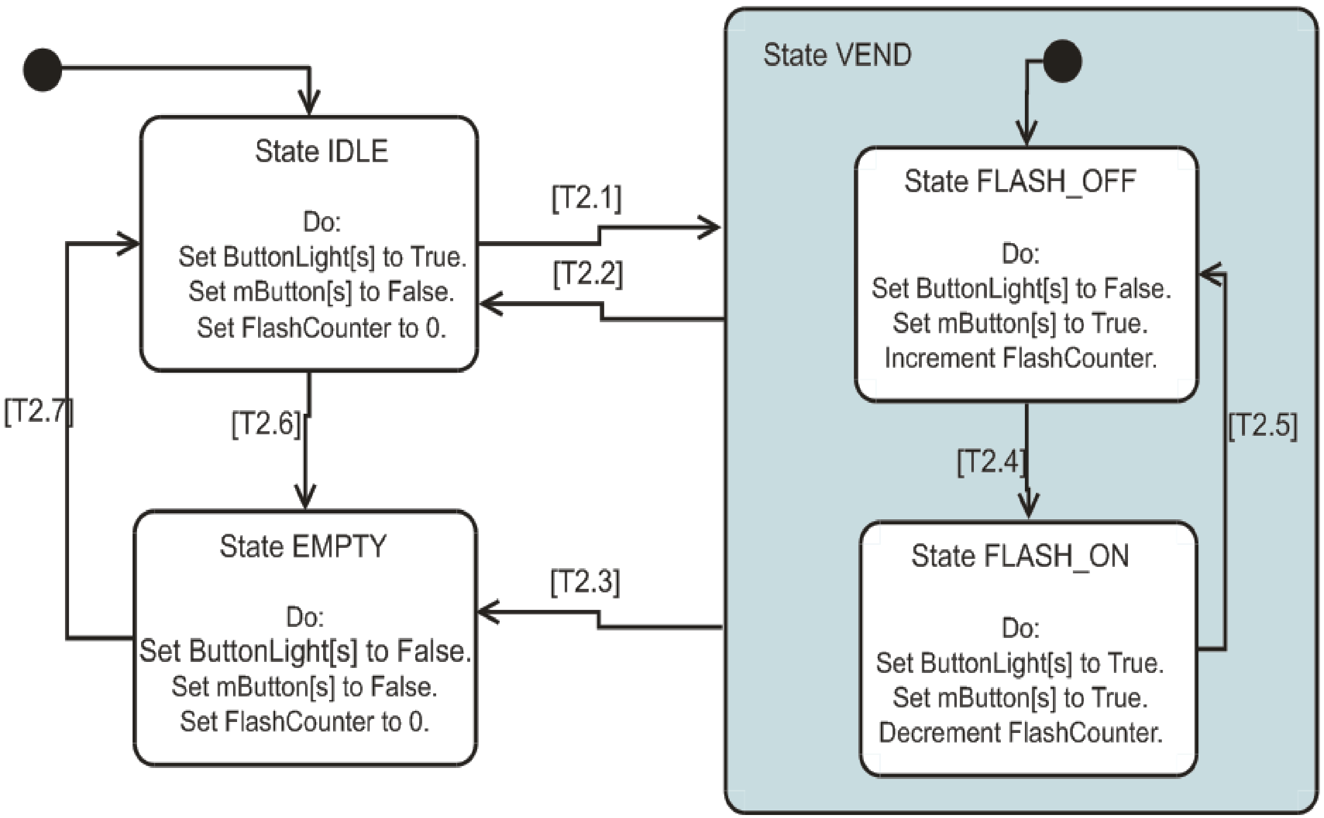
Each state gets a name



All transitions are numbered

A Brief Word Nested State Charts

- **They're tricky**
  - Can make implementation and traceability a pain too sometimes
- **Avoid nested state charts (the stuff in the blue box)**
  - Your state charts aren't going to be complex enough to need this



Traceability

- **Forward:**
  - Does every requirement map to at least one state or transition?
- **Backward:**
  - Does every state or transition map to at least one requirement?
- **Include this table in your behavioral requirements**

Requirements-to-Statecharts Traceability

	Requirements					
States	R2.1	R2.2	R2.3	R2.4a	R2.4b	R2.5
IDLE	x		x			x
EMPTY	x	x				x
VEND	x			x	x	
FLASH_OFF	x			x	x	
FLASH_ON	x			x	x	
Transitions						
T2.1				x	x	x
T2.2			x			
T2.3		x				
T2.4					x	
T2.5					x	
T2.6		x				
T2.7			x			

Traceability Updates and Issues Log

- **If you change or add a behavior, update your sequence diagrams**
- **Update your issues log**
- **Retrace *sequence diagram* arcs to *requirements* to *state charts***
- **We require end-to-end traceability**
  - It takes longer than you would like, make sure you leave time for it!

Notes On Defect Tracking

- **If you find a problem while you are working on something, don't bother logging it**
  - Defects "count" once you try to unit test, peer review, or check code in
  - In other words, start counting defects when you think an item is ready to push to the next phase

- **For peer review record defects on a peer review log**
  - Only promote to the Issue log if not fixed by the weekly due date
    (i.e., for every "not fixed" entry in a review log there should be an entry in the issue log added that week)
  - When reporting defects in presentation metrics, include peer review defect count, even if defect was closed that week

- **For tests, record defects in test log AND issue log**
  - You can add all review defects to issue log if you want for consistency, but it is optional

Questions?