Project #8

18-649 Embedded System Engineering

Carnegie Mellon

Announcements and Administrative Stuff

- **Project 8 posted**
- **Project 8 is due Thursday Oct. 29th by 10pm**
- **Presentation template posted – complete for your assigned controller**
  - Focus on statecharts through testing
  - Slides due by Monday Oct. 26th at 5pm - submit by email

Project 8

- **Pass all three Project 7 acceptance tests**
  - Scripts will pick random seeds, test your design thoroughly!
  - Good idea to create scripts that will run acceptance tests in the background

- **Start designing fast speed drive and smart dispatcher**
  - You will need to add:
    - Scenarios and sequence diagrams
    - Time-triggered requirements
    - Traceability

New Requirements

- **R-T6: The Car shall only stop at Floors for which there are pending calls.**
- **R-T7: The Car shall only open Doors at Hallways for which there are pending calls.**
- **R-T8: The Car Lanterns shall be use in a way that does not confuse passengers.**
  - R-T8.1: If any door is open at a hallway and there are any pending calls at any other floor(s), a Car Lantern shall turn on.
  - R-T8.2: If one of the car lanterns is lit, the direction indicated shall not change while the doors are open.
  - R-T8.3: If one of the car lanterns is lit, the car shall service any calls in that direction first.
- **R-T9: The Drive shall be commanded to fast speed to the maximum degree practicable.**
- **R-T10: For each stop at a floor, at least one door reversal shall have occurred before the doors are commanded to nudge.**

New Requirements - conflicts

- **IMPORTANT!**
- **If any of the new requirements conflict with any prior requirements given for the controller, your elevator needs to be modified to satisfy the NEW requirements.**

Project Road Map

Project 8: Advanced Elevator Design	• Sequence Diagrams and Time Triggered Behaviors for the new elevator design satisfying the new high level requirements RT 6-10 • Clean up Project 7 code • Write a monitor for RT 6 & 7
Project 9: Implement Dispatcher	• Implement Dispatcher and DoorControl • Write Unit Tests for Dispatcher and DoorControl
Project 10: Implement DriveControl	• Implement DriveControl and Lanterns • Write Unit Tests for DriveControl and Lanterns • Write a monitor for RT 10
Project 11: Network Scheduling	• Adjust Network Traffic for 200 Mb/s • Pass all your unit tests • Write some integration tests
Project 12: Testing and Validation	• Write Acceptance Test Generator, and run 100 tests • Pass all your unit tests, write and pass all integration tests • Write a monitor for RT 8
Project 13: Handin	• Pass all unit, integration, and acceptance tests, with no warnings • Make portfolio clean and consistent

*

Fast Drive Speed

- **Simulator assumes that car can instantly stop from slow speed**

- **Need to ramp down speed from fast in time to stop at desired floor**
  - Cannot instantly stop from fast speed (engages emergency brake)

- **Commit Point:**
  The elevator position at which you must decide whether to stop at particular floor
  - Occurs when elevator reaches the stopping distance from that floor location
  - Think of it as a "point of no return"

Fast Speed Drive - Commit Point

- **Stop speed = 0.00 m/s**
- **Slow speed = 0.25 m/s**
- **Fast speed = 5.00 m/s**
- **Constant acceleration/deceleration = 1.00 m/s^2**

- **Calculate the maximum stopping distance of the elevator**
  - $x(t) = x_0 + v_0 * t + \frac{1}{2} * a * t^2$
  - $v_f^2 - v_0^2 = 2 * a * \Delta x$

- **Include slack for:**
  - Sensor granularity (CarLevelPosition is in 10 cm increments)
  - Delay of DriveControl control loop
  - Be conservative!!

*

Only Service Landings with Pending Calls

- **Elevator must only stop at floors/hallways that need to be serviced**

- **DesiredFloor**
  - Floor – the floor we intend to go to next
  - Direction – the direction we intend to go **after** we reach the desired Floor
  - Hallway – which doors should open

Only Service Landings with Pending Calls

- **Update desired floor/direction based on current state of hall/car calls**
  - When is it OK to update these?

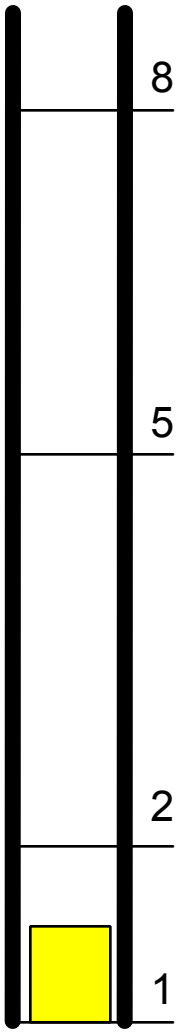
- **For example:**
  - If the elevator is stopped and opening its doors
    AND there is no pending call at the current floor
    AND there is a pending call at another floor
    THEN:
    - DesiredFloor.Floor must NOT BE current floor by the time the doors are fully open

- **What about between floors?**

- **When should you NOT update these values?**

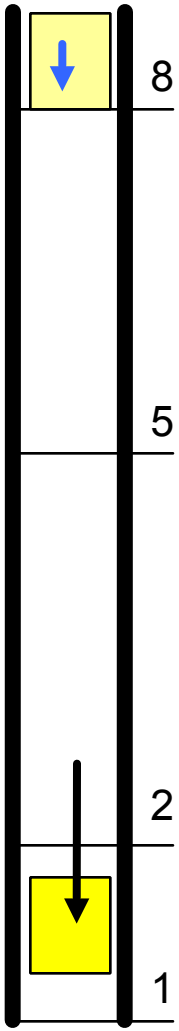
- **Above example is not a hard requirement**
  - Follow the requirements and do what makes sense for your design

Example



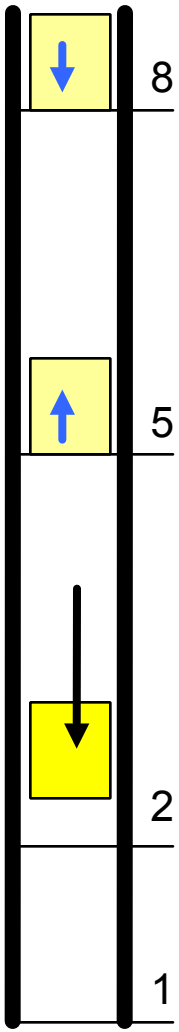
- **Suppose car is initally at floor 1 and stopped**
  - No calls
  - Desired Floor = (1, stop)

Example



- **Get a hall call for (8, down)**
  - Car begins moving up
    - Current direction = Up
  - DesiredFloor.floor = 8
  - DesiredFloor.direction = Down
    - Where we're going after servicing floor 8

Example



- **Get a hall call for (8, down)**
- **Then receive a hall call for (5, up)**
  - Dispatcher decides to service floor 5 first
    - –Depends on your algorithm
  - Current direction remains Up
  - DesiredFloor.floor = 5
  - DesiredFloor.direction = Up
    - –Where we're going after we service floor 5

- **How do you decide where to go next?**
  - Based on current set of car/hall calls
  - Anything that meets the requirements is OK
    - –Example: Sweeping up and down servicing calls in the current direction first

Modifying the Network Interface

- **You can make ONE of the following modifications to the interface**
  - Add mCarPositionIndicator to the input of the Dispatcher and DriveControl, OR
  - Add mDriveSpeed and mCarLevelPosition to the input of the Dispatcher.

- For any other modifications you need TA approval

- Remember to Completely Update Traceability if you make any changes.

Runtime Monitor

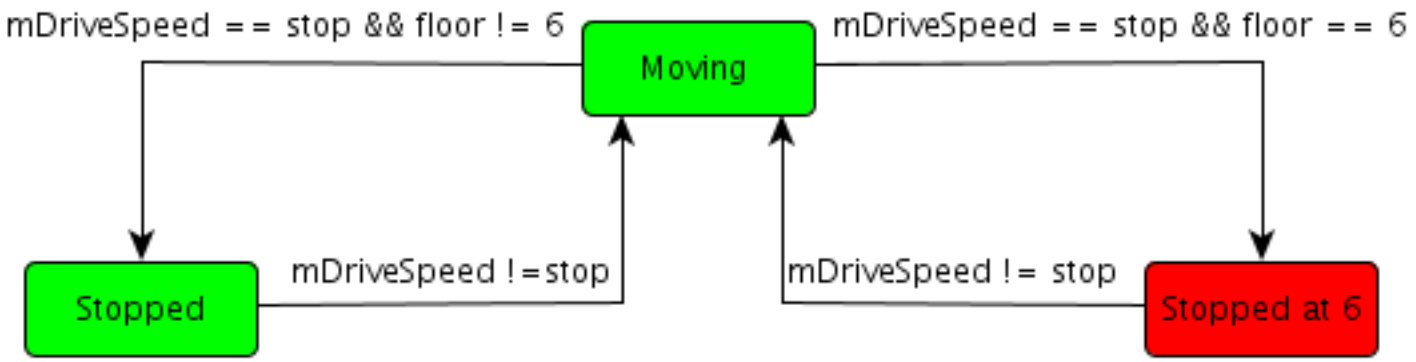
- **Why monitor?**
  - Helps to catch complex corner cases in Drive Control and Dispatcher
  - Helps discover design problems conflicting with high level requirements
  - Finding problems sooner allows for easier fixes

- **Safety Monitors vs Performance Monitors**
  - Performance monitors give a numeric value.
    - How Fast?
    - Number of overweight sensor trips?
  - Safety monitors are boolean.
    - Did we do something wrong?

- **We monitor high level requirements**
  - Safety monitors, or performance?
    - Safety since they answer the boolean question “Did we behave properly?”

Monitor State Chart Example

- **High Level Requirement: "The elevator shall never stop at floor six"**
- **State charts should:**
  - Mirror the actual state of the elevator
  - Contain both valid and invalid states
  - Throw a warning in invalid states



*

The monitor is NOT a new controller

- **Monitor takes mostly physical payloads (few network messages)**
- **receive( ) function executes when the physical payload is sent**

```
public void receive(DriveSpeedPayload msg) {
   checkFastSpeed(msg);
}

private void checkFastSpeed(DriveSpeedPayload msg) {
   // Update variables and check for violations
   // If between floors, at some point must go faster than slow speed
   // If reach a new floor and haven't, then print violation
```

- **Monitor must use SystemTimer objects (if you need them)**
  - Don't use Timer objects (only use these in your controllers)
  - This prevents the runtime monitor from contributing to randomness in simulation

Project 8 Monitor

- **RT 6 & RT 7**
  - Pending calls
- **Run your monitor on project 7 code**
  - with proj7acceptance 1.pass
- **Will you find violations in monitoring proj7?**
  - Probably, since the Sabbath elevator doesn't work this way.
  - Log one of them (seed and timestamp)
  - Log a place where there's not a violation.

Questions? Come to office hours!

*