Project #8

18-649 Embedded System Engineering

Electrical & Computer ENGINEERING

Carnegie Mellon

Announcements and Administrative Stuff

- **Project 8 posted**
- **Project 8 is due Thursday Oct. 23th by 10pm**
- **Presentation template posted – complete for your assigned controller**
    - Door Control - 1,4,7,10,13,16, 19, 22
    - Drive Control– 2,5,8,11,14,17, 20
    - Dispatcher– 3,6,9,12,15,18, 21
  - Focus on statecharts through testing

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

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 • Write a monitor for RT 9
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

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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**
  - $x(t) = x_0 + v_0 * t + ½ * a * t^2$
  - $v_f^2 - v_0^2 = 2*a*\Delta x$

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

Only Service Landings with Pending Calls

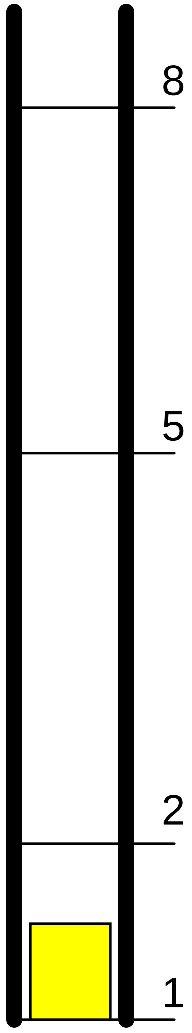
- **Elevator must only stop at floors/hallways that need to be serviced**

- **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

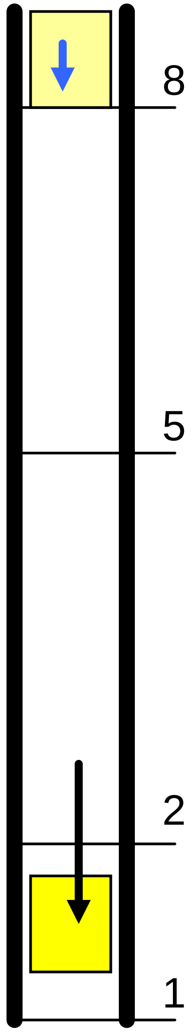
- **Update desired floor/direction based on current state of hall/car calls**
  - When is it OK to update these?
- **For example:**
  - If the elevator is stopped and opening its doors
    AND there is no pending call at the current floor
    AND there is a pending call at another floor
    THEN:
    - 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



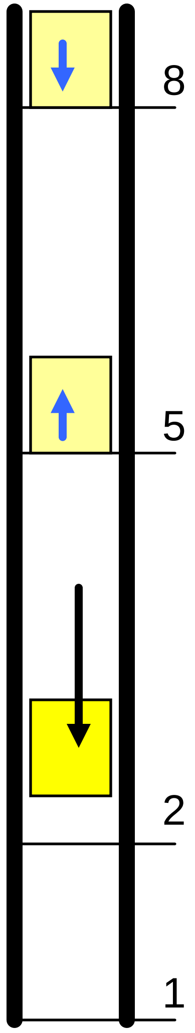
- **Suppose car is initally at floor 1 and stopped**
  - No calls
  - Desired Floor = (1, stop)

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

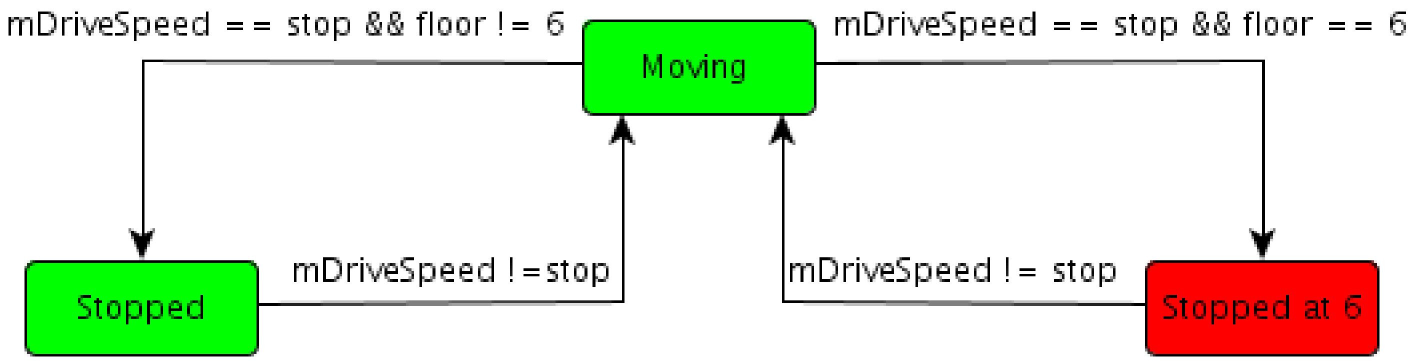
- **Why monitor?**
  - Helps to catch complex corner cases in Drive Control and Dispatcher
  - Helps discover design problems conflicting with high level requirements
  - Finding problems sooner allows for easier fixes

- **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


mDriveSpeed == stop && floor != 6
Moving
mDriveSpeed == stop && floor == 6
Stopped
mDriveSpeed !=stop
mDriveSpeed != stop
Stopped at 6

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!**