Electrical & Computer ENGINEERING

18-642:

Software Architecture & High Level Design

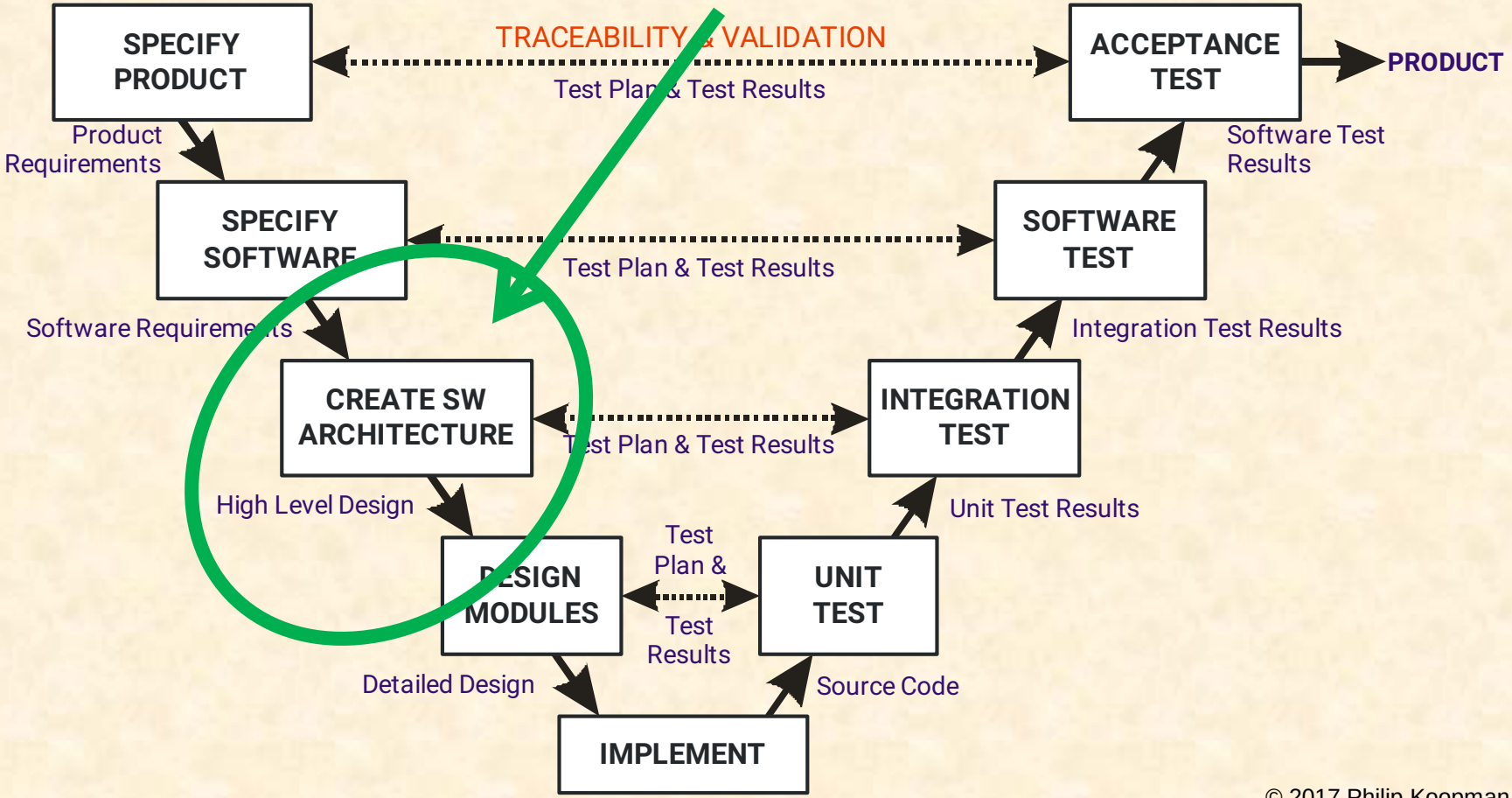
9/27/2018

All the really important mistakes are made the first day.

– Eberhardt Rechtin, System Architecting

Carnegie Mellon University

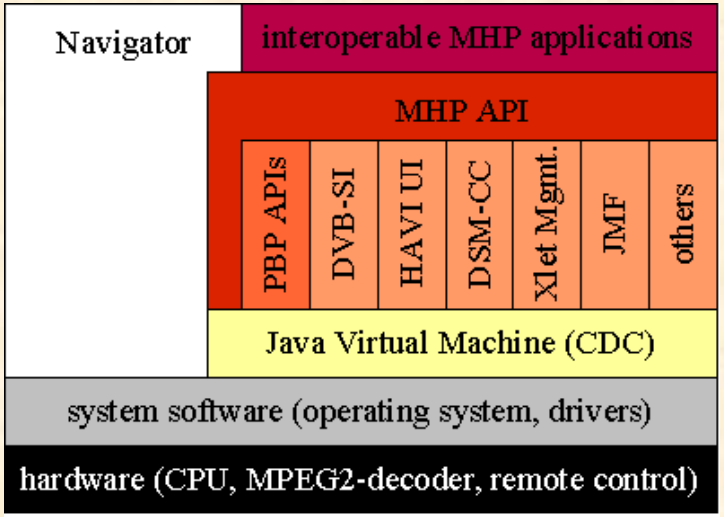
YOU ARE HERE



Architecture & High Level Design (HLD)

Anti-Patterns:

- **Skipping from requirements to code**
- **No picture that shows how all the components fit together**
- **"Wedding cake" layer diagram that omits interface information**



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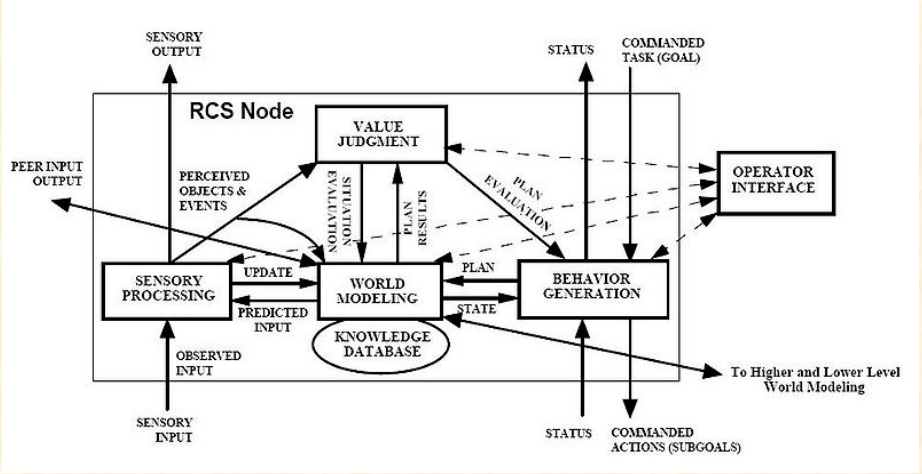
Elements of High Level Design

- Architecture: boxes, arrows, interfaces
  - Arrows/interfaces show communication paths between components
  - Recursive: one designer's system is another designer's component
- High Level Design (HLD) = architecture (nouns) + requirements (verbs)
  - Sequence Diagrams (SDs) show interactions

Architecture: Boxes and Arrows

- **Software architecture shows the big picture**
  - Boxes: software modules/objects
  - Arrows: interfaces
  - Box and arrow semantics well-defined
    - Meaning of box/arrow depends on goal
  - Components all on a single page
    - Nesting of diagrams is OK



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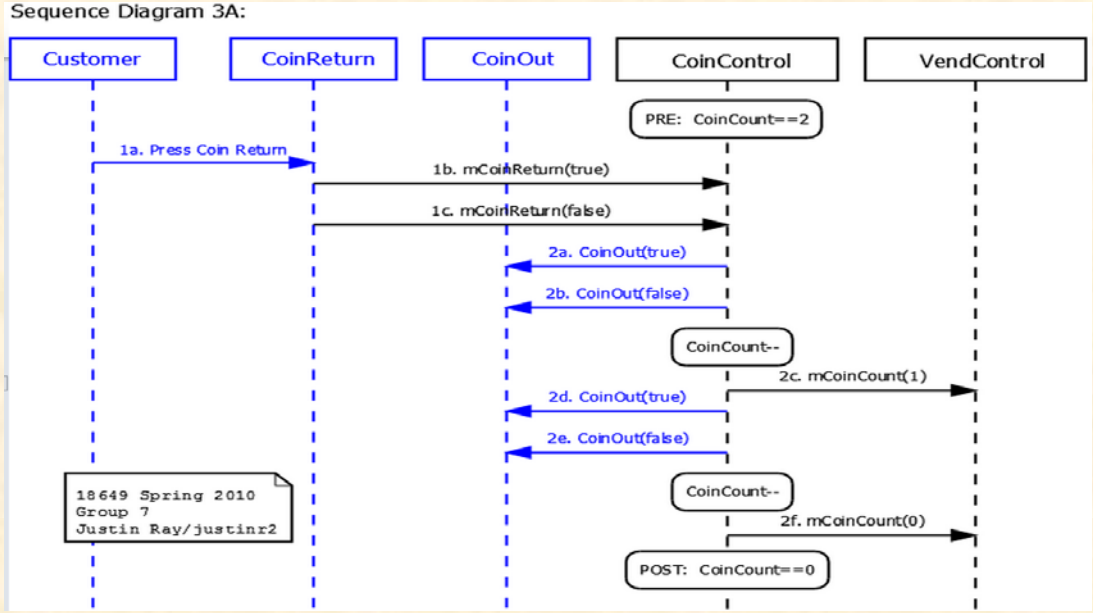
- **Many different architecture diagrams are possible, such as:**
  - Software architecture (components and data flow types)
  - Hardware architecture with software allocation
  - Controls architecture showing hierarchical control
  - Call graph showing run-time hierarchy

Sequence Diagram as HLD Notation

- **SD construction:**
  - Each object has a time column extending downward
  - Arcs are interactions between objects

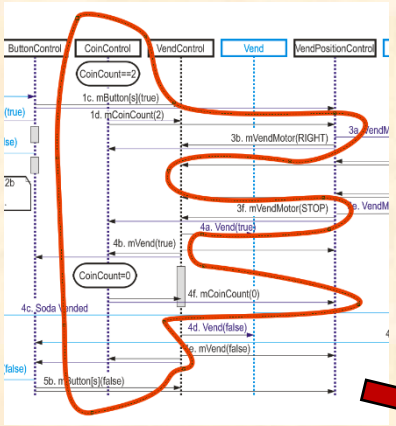


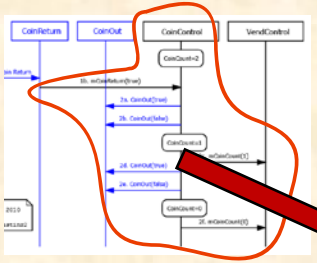
- **Each SD shows a scenario**
  - Top ovals are preconditions
  - Middle ovals are side effects
  - Bottom ovals are postconditions

- **SD is a *partial* behavioral description for objects**
  - Generally, each object participates in *multiple* SDs; each SD only has *some* objects
  - The set of all SDs forms the HLD for all objects in the system

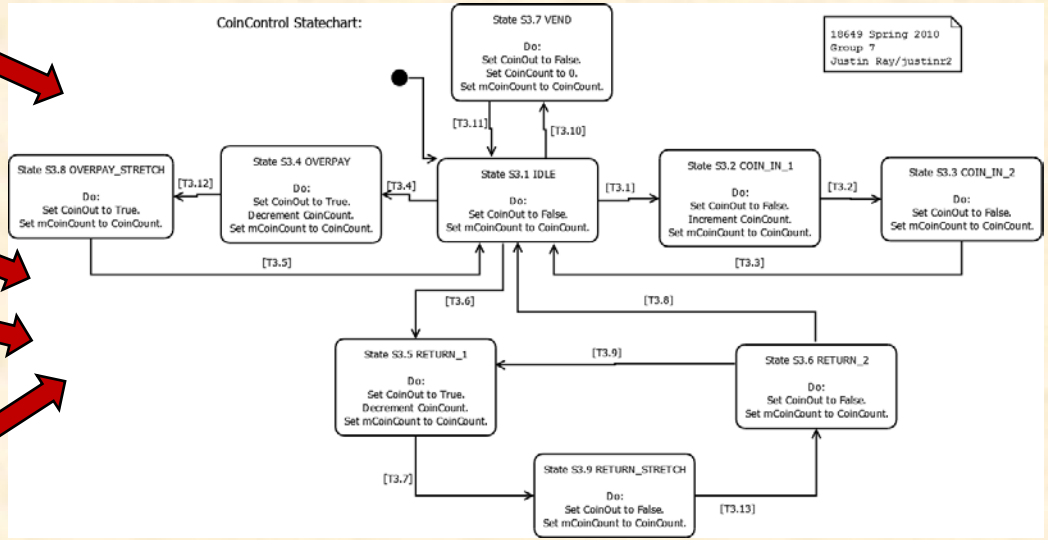
StateChart to SD Relationship

- **For each object in each SD: identify input & output arcs**
  - Detailed Design: design statechart that accounts for all SD behaviors

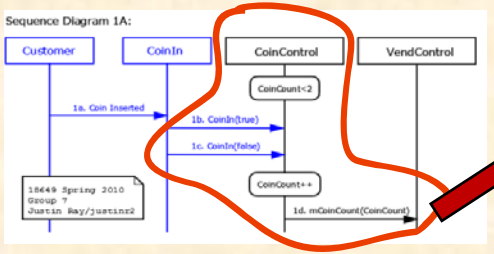




Statechart Must Exhibit All Those Behaviors



SD set specifies behaviors

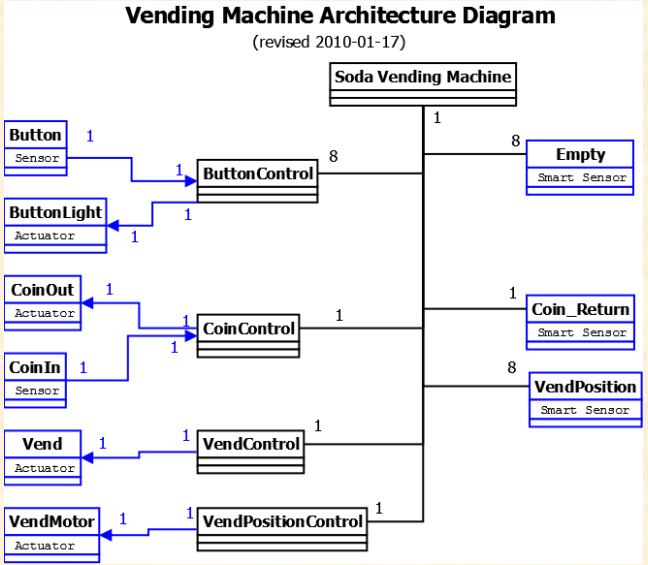


Requirements Revisited: Levels of Abstraction

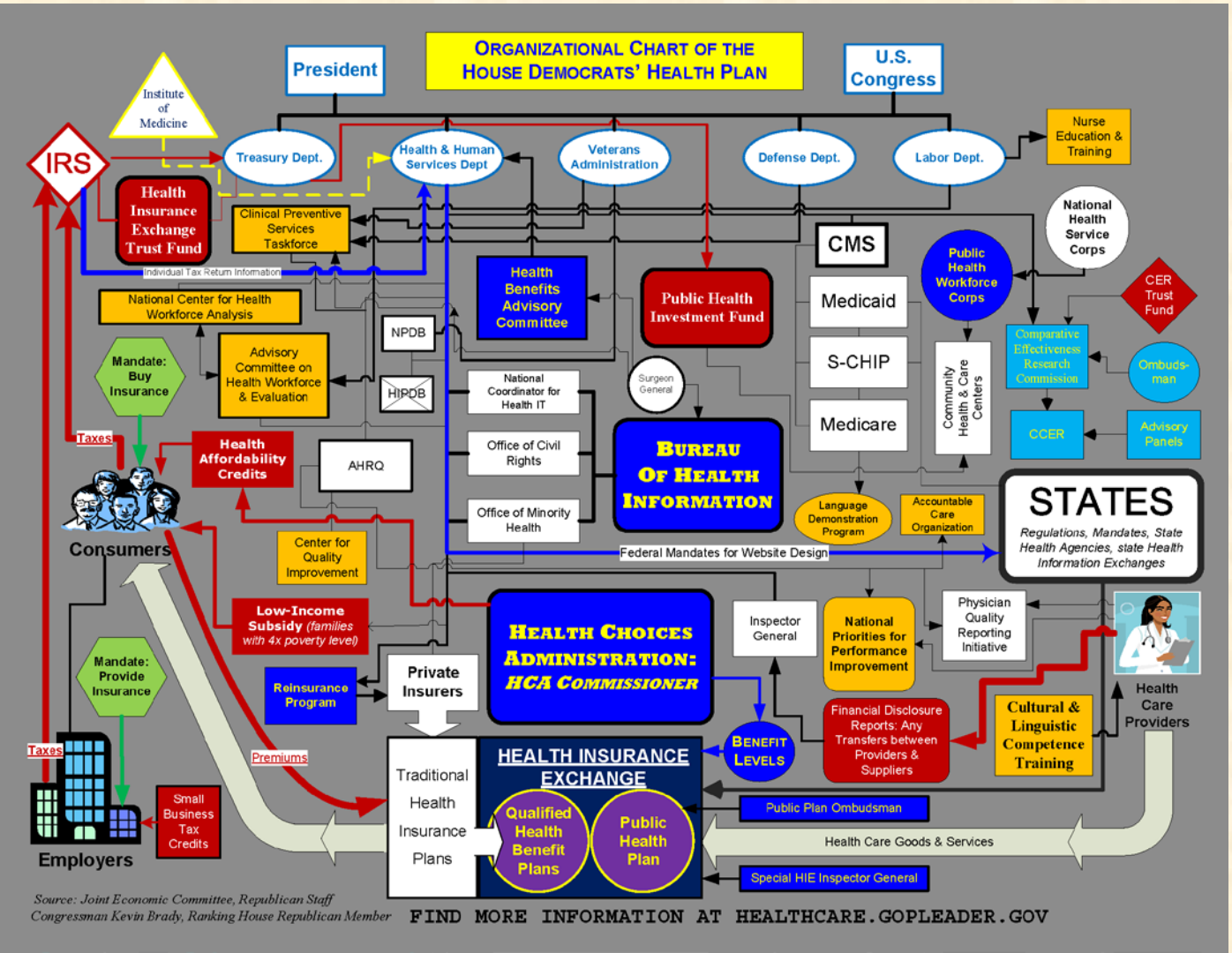
- **Modes vs. States**
  - State: corresponds to internal state machine
    - "When in state S1 the system shall display current time"
  - Mode: user-visible change in operations
    - "When in stopwatch mode, pressing Button 1 shall do XYZ"
- **State-type descriptions in HLD should be modes**
  - Input & output behaviors can change depending upon mode
    - **GOOD:** Pressing X in Mode Y displays Z
      - » Mode Y tells you which sequence diagram applies
    - **NOT:** Pressing X in state S1 changes state to S2
      - » There is no point describing the detailed design this way

High Level Design Best Practices

- **HLD should include:**
  - One or more architecture diagrams
    - Defines all components & interfaces
    - HW arch., SW arch., Network arch., …
  - Sequence Diagrams
    - Both nominal and off-nominal interactions
    - See 18-649 soda machine for a fully worked example
  - HLD must co-evolve with requirements
    - Need both nouns + verbs to define a system!
- **High Level Design pitfalls:**
  - Diagrams that leave out interactions
  - Boxes and arrows don't have well defined meanings
  - HLD that bleeds into detailed design information
    - Should have separate Detailed Design per component

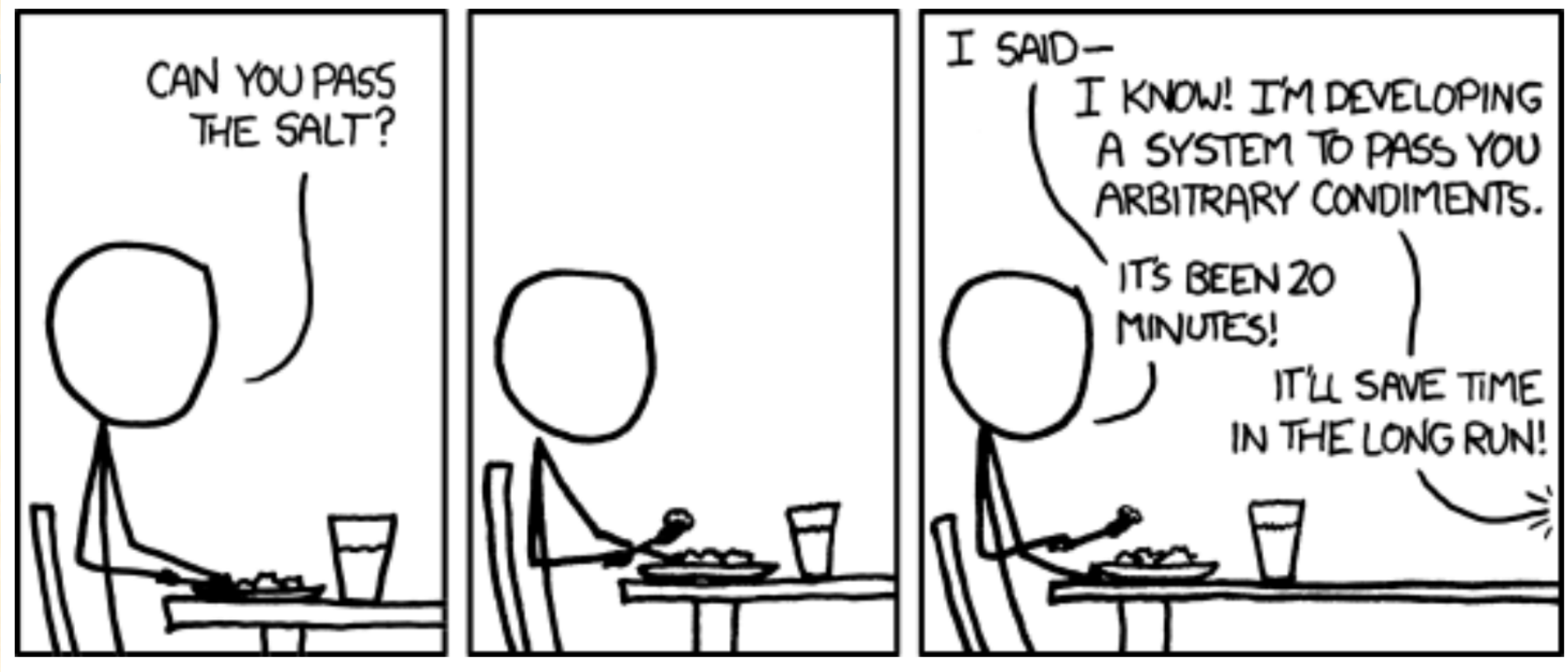


http://www.ece.cmu.edu/~ece649/project/sodamachine/index.html



2011 Health Plan Flow Chart: What's wrong with this as an architecture diagram?

https://donyoung.house.gov/uploadedfiles/house-democrats-health-plan.pdf



https://xkcd.com/974/

