Developing Control Structures for Complex Sociotechnical Systems

Polly Harrington, Graduate Assistant
Rodrigo Rose, Graduate Assistant
Prof. Nancy Leveson, PhD
John Thomas, PhD
Massachusetts Institute of Technology

Stephen Powell, DHA, MSc
Daniel Wyman, MD, MPH
Alana Keller, BA, PMP®
Synensys

For U.S. FDA Contract # 75F40122C00112

June 7th, 2023

Disclaimer

- The opinions expressed in this presentation are those of the research team members. They do not purport to reflect the opinions or views of the U.S. Food and Drug Administration (FDA), its affiliates, or the organizations included in the research.

What is difficult about modeling complex socio-technical systems

This is not a trivial problem

- Interdisciplinary – technical, management, economic

- No one understands the whole system

- Analyst may be unfamiliar with system – Where to start? What are the bounds? What are the relevant components?

Starting out

- What information do you know?

- What do you know you don't know?

- How do you obtain more information? → **Interviews**

  - Interview those you already know

  - Ask interviewees who else you should talk to

  - Aim to interview a broad range of people across the system

Conducting Interviews

- Interviewees don't know about STPA

- Go over interview goals and rudimentary STPA intro with interviewee

  - Define and show a basic control loop (with examples)

  - Later you may also need to define

    - What is a control structure (with examples)

    - What are losses and hazards (with examples)

- Pre-reads can be helpful as the project progresses

- Intro will get more in depth as project progresses

Conducting Interviews

- Leave initial questions open ended

  - Most helpful information is not what you anticipate

- Ask more specific follow up questions

  - Translate what they said into "STPA terms" and confirm that you interpreted them correctly

- Showing the control structure has advantages and disadvantages

  - May inspire new connections
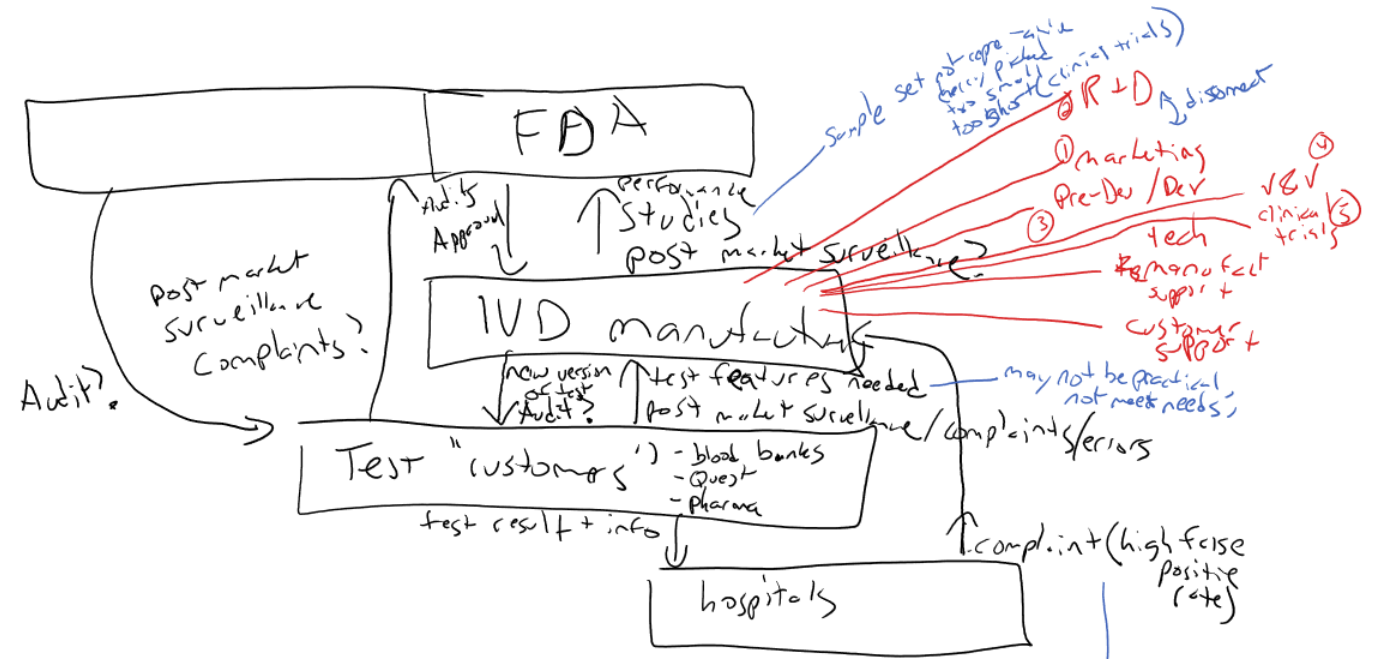
  - Can also bias what they say or do not say

Who did we interview?

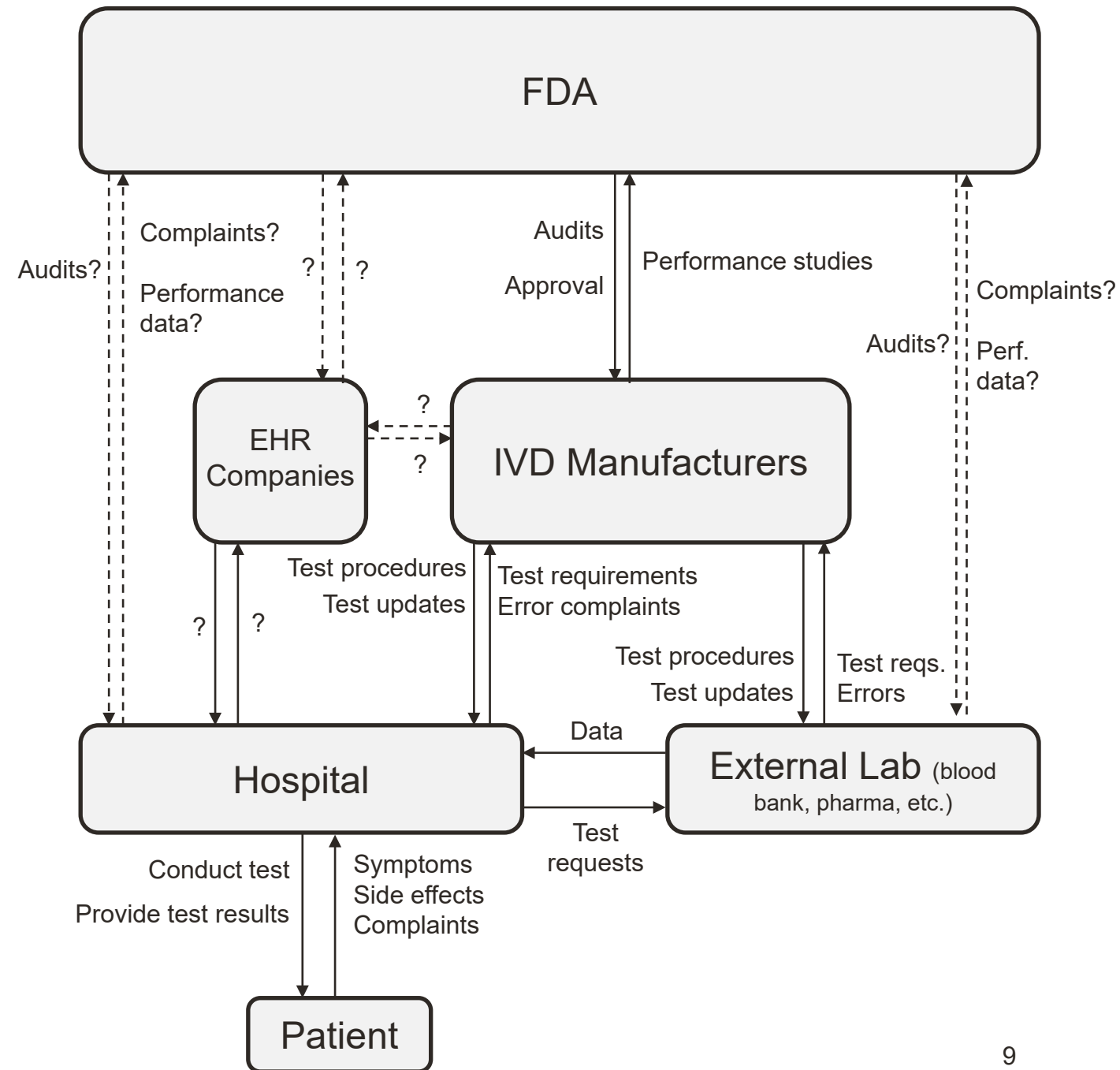|				
Regulatory	Accreditation	Health Data Naming + Coding Standards	Laboratory Systems	Laboratorians
Health Information Exchanges	Public Health Agencies/ Health Data Registries	Patients	Payors	Providers

42 Stakeholders interviewed

Initial Sketches

- We didn't have a control structure in our first interview
- We sketched this rough diagram live during initial interviews
- Shows the interviewee we are listening
- Gives interviewee ability to correct us

First Control Structure

- Start to formalize control structure
- Identify relationships you might be missing
- During interviews you can draw on the diagrams "live"
- Being wrong is usually okay, people love to make corrections
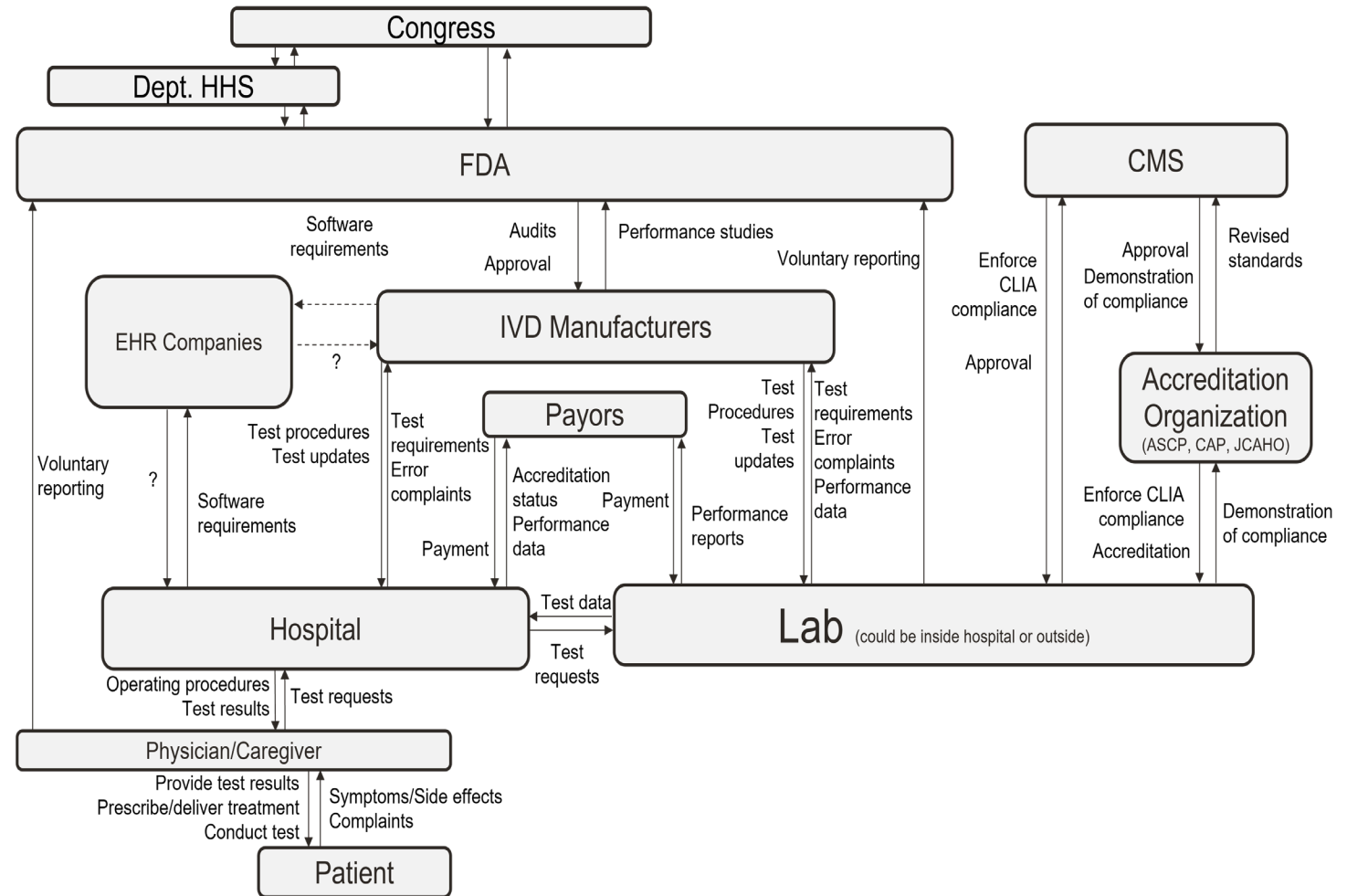- Rougher drafts will make people more comfortable making corrections
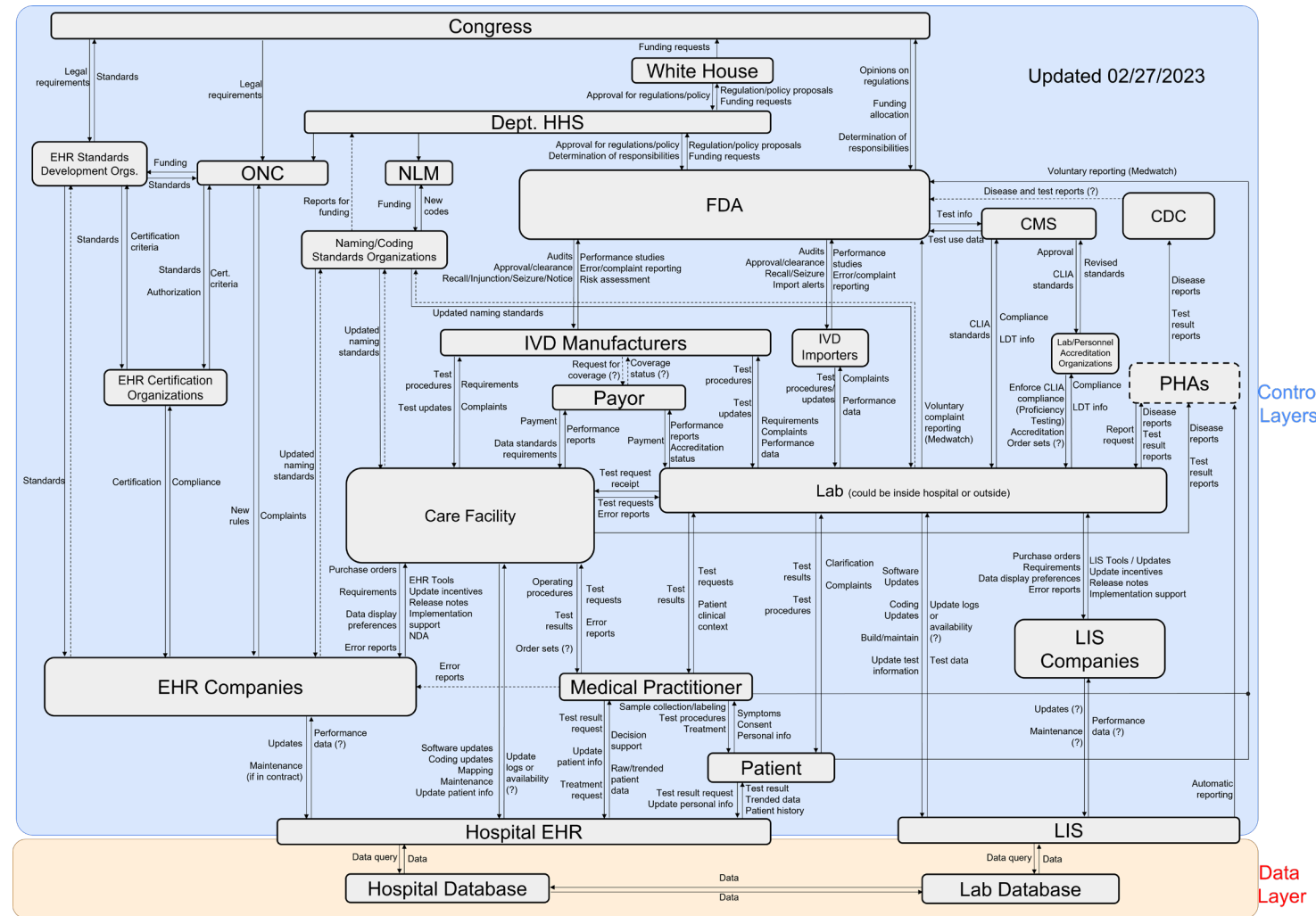
Iterating

System boundaries may change

For example

- New regulatory authorities

- Higher level agents

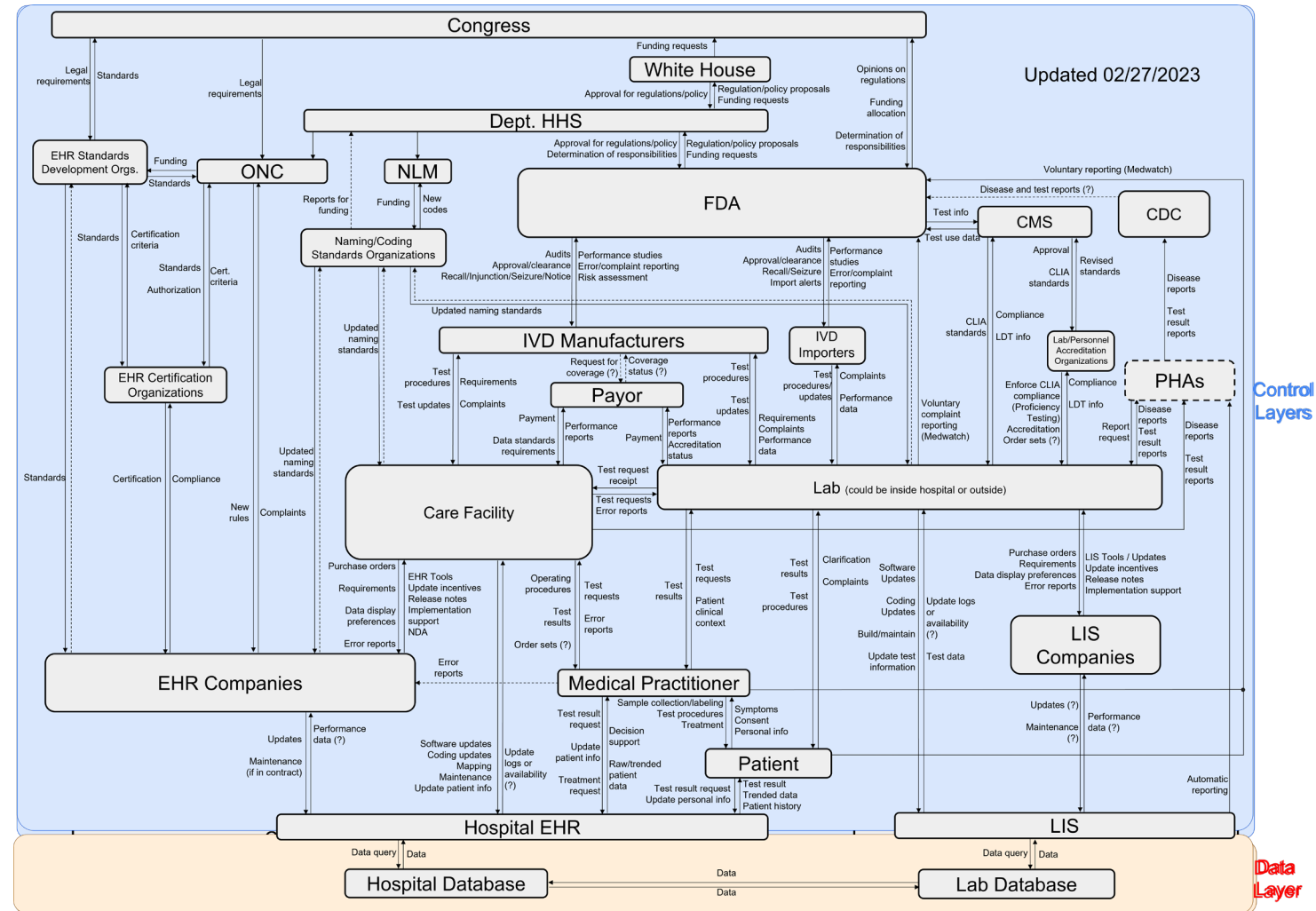You can always trim back later

Iterating

- Things may start to get extremely complicated
- Think about where abstraction may be required
- Make compromises to help your interviewees map their understanding
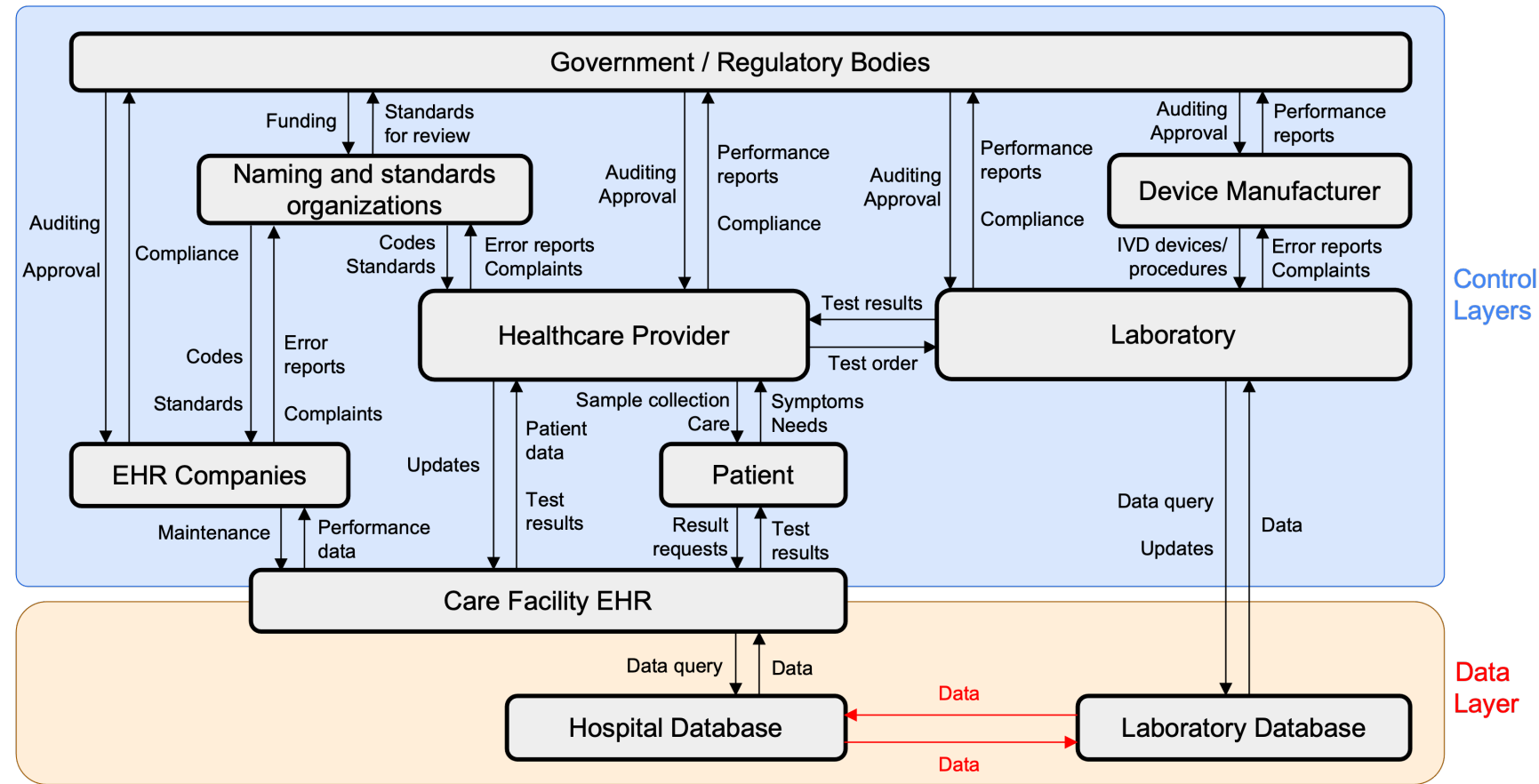 - We added a "data layer" as the controlled process

Iterating

- As you gain more information, question your assumptions about the original model

- Control hierarchy may change
  - EHR/Care Facility example
- Boxes and arrows may merge or split
  - Standards organizations example

Abstraction

- Abstract out for your own clarity and modeling
- Interviewees may want to see themselves clearly
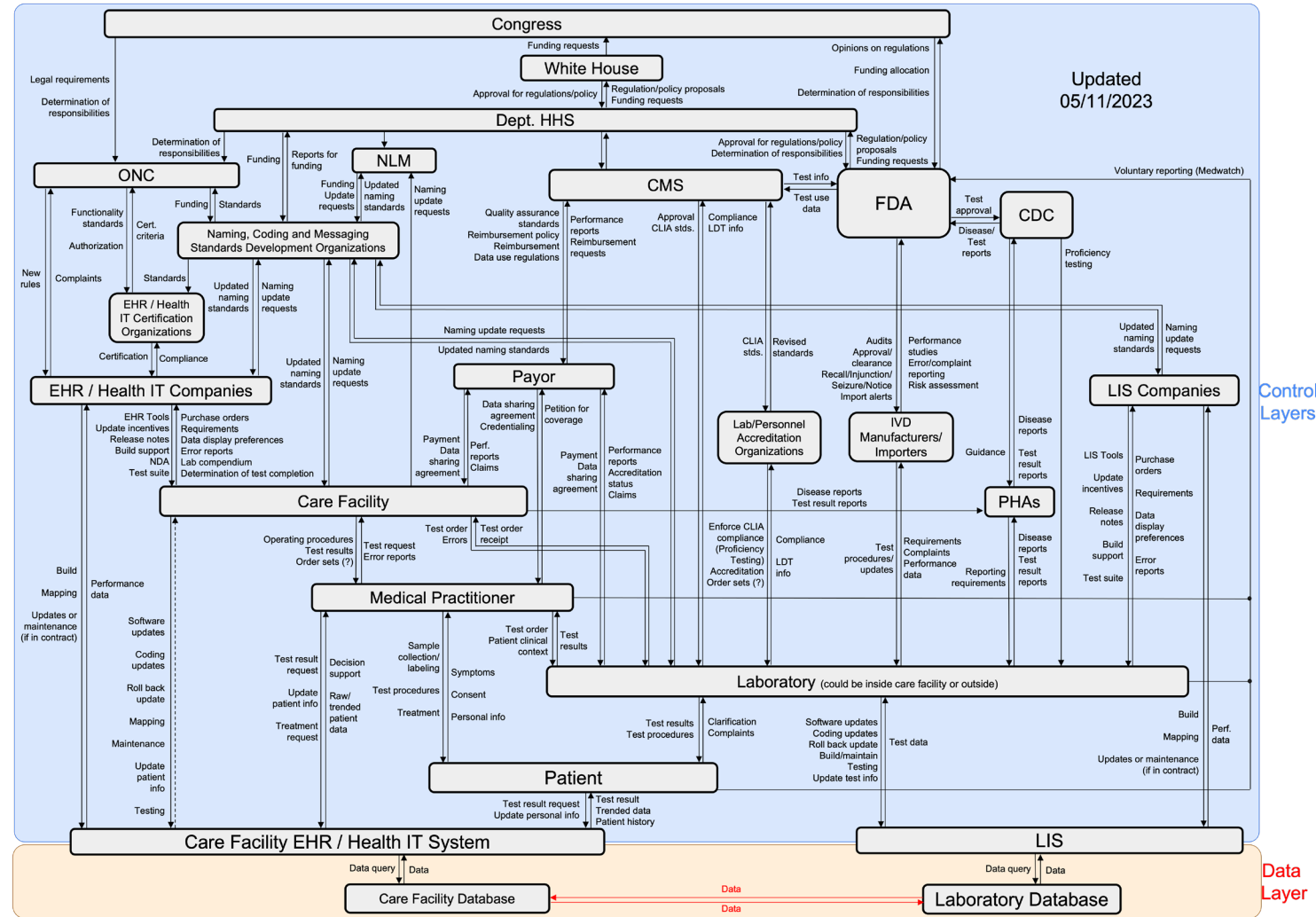- Look for ways to abstract in the detailed version as well

Later Stage Interviewing

- Once the control structure gets more complete, shift interviews towards UCA and Scenario generation
  - Giving examples can help the interviewee understand what you are looking for

- Ask interviewees about the connections to other agents
  - "Have you seen situations like these arise?"
  - "Could you see situations like these arising?"
  - "Can you think of other situations you have seen or could see arising?"

- Show control structure at the end, for validation (or corrections)

Converging

- At the end, your goal is that with every interview, fewer and fewer changes happen in the control structure

- Converge on an acceptable (and **useful**) model of the system, even if it is not complete

Final Notes

- Control structure is a tool, not the end product
- Transcripts are useful
  - You might not fully appreciate information from initial interviews
- Difficult to speak same language as interviewees
  - Make sure you use language they are familiar with
  - Ask them to clarify their language
- Continually evaluate what is working and what is not

Acknowledgments

- Association of Public Health Laboratories
- The College of American Pathologists
- Deloitte Consulting, LLP
- J P Systems, Inc.
- LOINC ® from Regenstrief Institute
- Office of the National Coordinator for Health IT (ONC)
- Safe Health Systems, Inc.
- SNOMED International
- State University of New York at Buffalo
- Stratametrics, Inc.
- Sujansky and Associates, LLC
- Synensys, LLC
- University of Nebraska Medical Center
- University of Pennsylvania

Questions, Comments, Observations, Discussions, Feedback, Follow-up