Critical Infrastructure Protection and Recovery Working Group
January 30, 2022

INCOSE International Workshop 2022

CIPR WG MBSE Efforts
Daniel Eisenberg | CIPR WG Chair

My Goals: Get You Involved

- ***Understand*** CIPR Application Domain

- ***Implement and Use*** CIPR Models

- ***Help Set Goals*** for INCOSE IW 2023

- Invite for ***Collaboration and Review***

Agenda

1. Introduction to CIPR Technical Projects
2. Current State of Projects and Future Goals
   1. DHS SysML Model – Adebonojo
   2. Resilient Hospital Model – Juhasz
   3. COVID Last-Mile Supply – Sutton
3. Next Steps

CIPR Technical Projects Timeline

1. Held Workshop at INCOSE IW to Determine Projects (Jan 2021)

2. Assigned Roles and Responsibilities to CIPR Leadership (Feb 2021)

3. Dassault Systemes Provided Cameo for Modeling Effort (Mar – Apr 2021)

4. Mid-year Modeling Workshop (Aug 2022)

5. Version 1.0 of Models Now Available (to be posted to Yammer)

Recap of INCOSE IW in Jan 2021

1. **(M) Adebonojo: DHS CI SysML Model (1)**
2. (A) Eisenberg: Measures for How DHS is Changing
3. (M) Sutton: Semantic Models for Infrastructure Defense
4. (M) Mackey: Monitoring Nuclear Weapons
5. **(A) Lykins: Resilient Hospital Reference Model (2)**
6. (S) Delamare: INCOSE + ASME Standards Dev
7. (M) Sutton: Model of Immigration Policy
8. **(M) Sutton: Modeling the Vaccine Distribution Last Mile (3)**
9. (A) Sutton: Model of COVID-19 Response
10. (T) Eisenberg: CIPR Table-Top Exercises (TTX)
11. (T) Carpenter: (mini) EarthEx
12. **(S) Weiss: Sensing & Data Security Standards**

Key
M: Model
A: Analysis
S: Standard
T: Training
O: Other

Technical Projects Use MBSE

CIPR Technical Projects use Model-Based System Engineering (MBSE)

- Cameo Teamwork Cloud Donated by Dassault Systemes for CIPR Use

- Provides Tools and Systems for Distributed Model Development and Coordination across Teams

- Helps Coordinate Standards for Model Development and Analysis
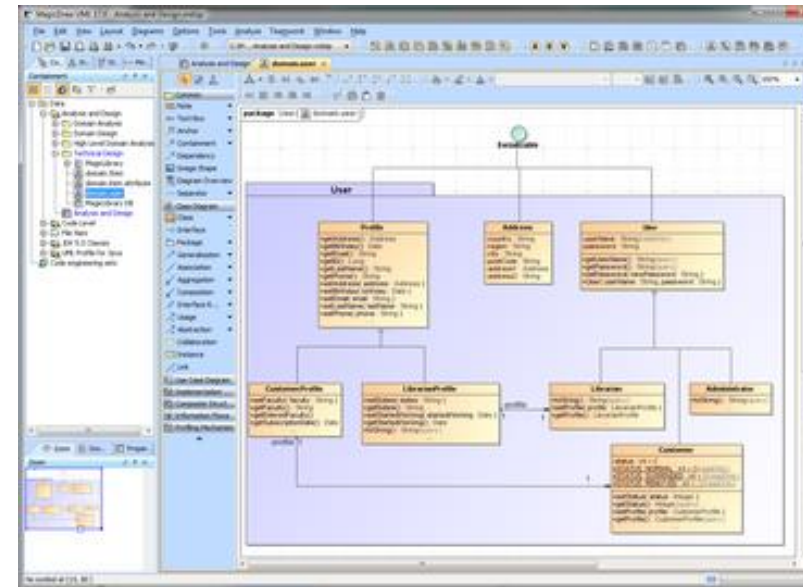
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DHS SysML Model Project: Problem

16 Critical Infrastructure Sectors & Corresponding Sector-Specific Agencies

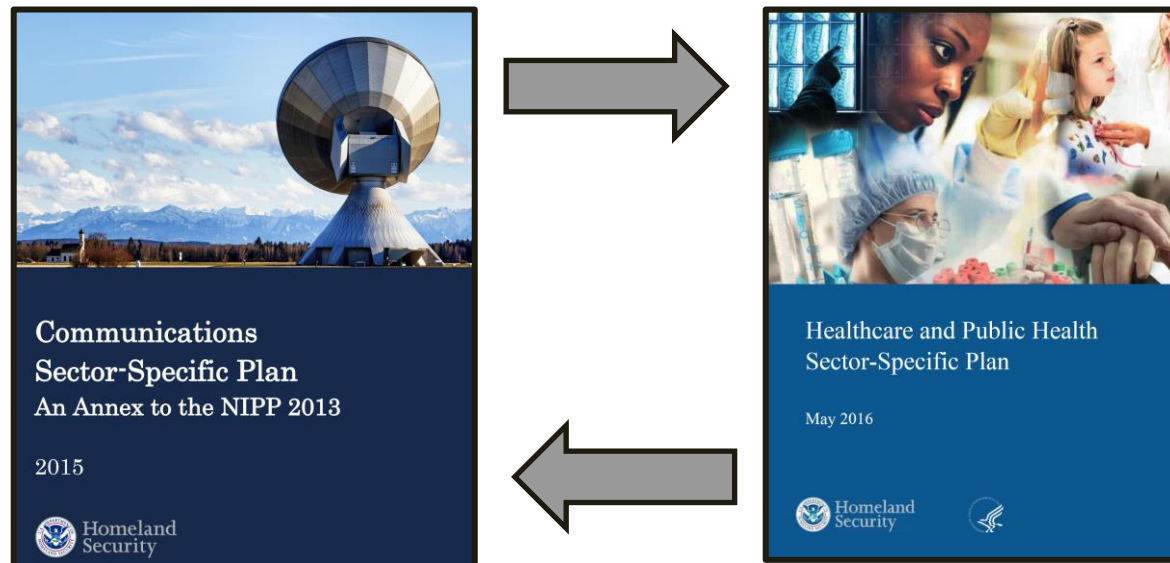| Sector	Agency
CHEMICAL	DHS (CISA)
COMMERCIAL FACILITIES	DHS (CISA)
COMMUNICATIONS	DHS (CISA)
CRITICAL MANUFACTURING	DHS (CISA)
DAMS	DHS (CISA)
DEFENSE INDUSTRIAL BASE	DOD
EMERGENCY SERVICES	DHS (CISA)
ENERGY	DOE
FINANCIAL	Treasury
FOOD & AGRICULTURE	USDA & HHS
GOVERNMENT FACILITIES	GSA & DHS (FPS)
HEALTHCARE & PUBLIC HEALTH	HHS
INFORMATION TECHNOLOGY	DHS (CISA)
NUCLEAR REACTORS, MATERIALS AND WASTE	DHS (CISA)
TRANSPORTATIONS SYSTEMS	DOT & DHS
WATER	EPA

CISA CYBER+INFRASTRUCTURE

Michael A. Dailey   July 16, 2019

DHS SysML Model Project: Goals

► **Goal 1: Integrated Block Diagram of all 16 sectors**

    ► Document Integrated Model down to level revealed in DHS Hosted Sector Specific Plans (SSPs)

    ► Types revealed in SSPs allow for further analysis (Types of "stadiums" as example facilitate risk identification and interdependencies)

        ► Allow for changes when DHS publishes new additions/updates

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► **Goal 2: Sector Interdependencies**

    ► Lifeline Functions already documented in SSPs

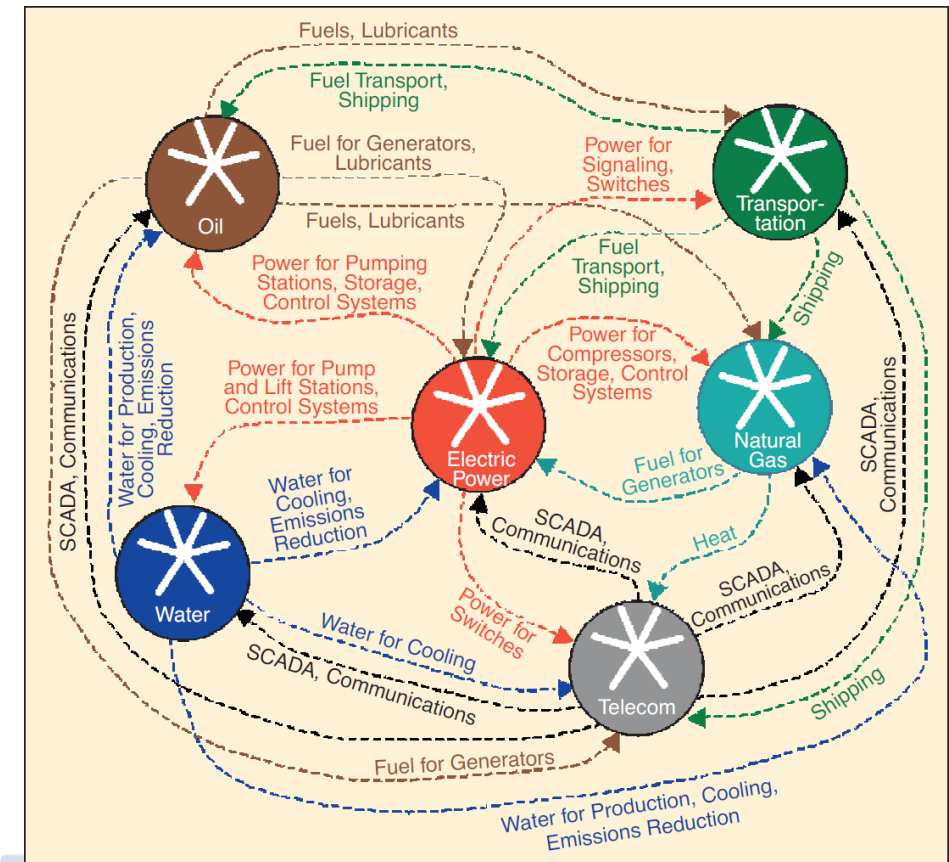Sector interdependencies already docu Failures:

Classes of Dependencies:

- *Physical*
- *Geographic*
- *Cyber*
- *Logical*

Classes of Failures:

- *Cascading*
- *Escalating*
- *Common-cause*

From: Rinaldi et al. (2001)

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► **Goal 3: National Critical Functions (NCF)**

CONNECT
▪ Operate Core Network
▪ Provide Cable Access Network Services
▪ Provide Internet Based Content, Information, and Communication Services
▪ Provide Internet Routing, Access, and Connection Services
▪ Provide Positioning, Navigation, and Timing Services
▪ Provide Radio Broadcast Access Network Services
▪ Provide Satellite Access Network Services
▪ Provide Wireless Access Network Services
▪ Provide Wireline Access Network Services

Classes of Functions:
- *Connect*
- *Distribute*
- *Manage*
- *Supply*

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- **Goal 2: Sector Interdependencies**
    - Lifeline Functions already documented in SSPs
    - Sector interdependencies already documented as well
- **Goal 3: National Critical Functions (NCF)**
- **Goal 4: Publish Model Results with metadata to HTML Website**

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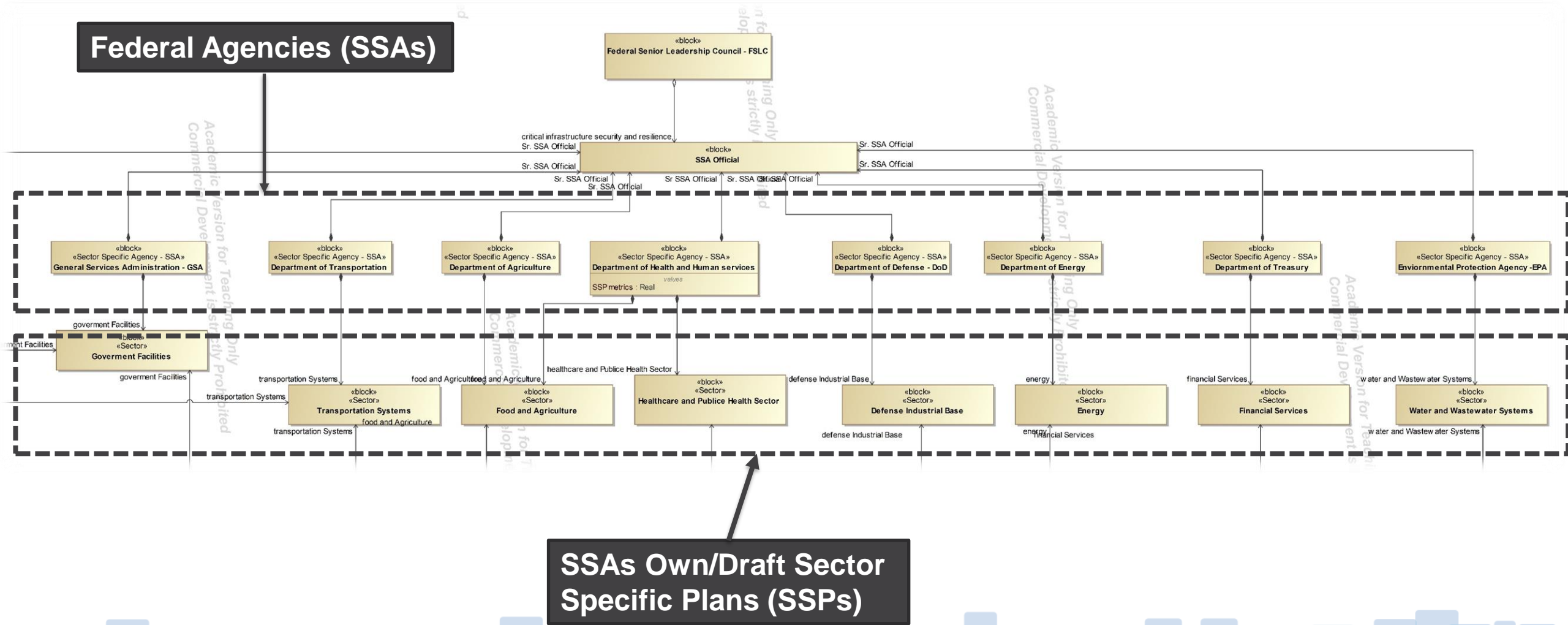   - Allow for changes when DHS publishes new additions/updates
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Sector Specific Agencies (SSAs) and SSPs

Federal Agencies (SSAs)

SSAs Own/Draft Sector Specific Plans (SSPs)

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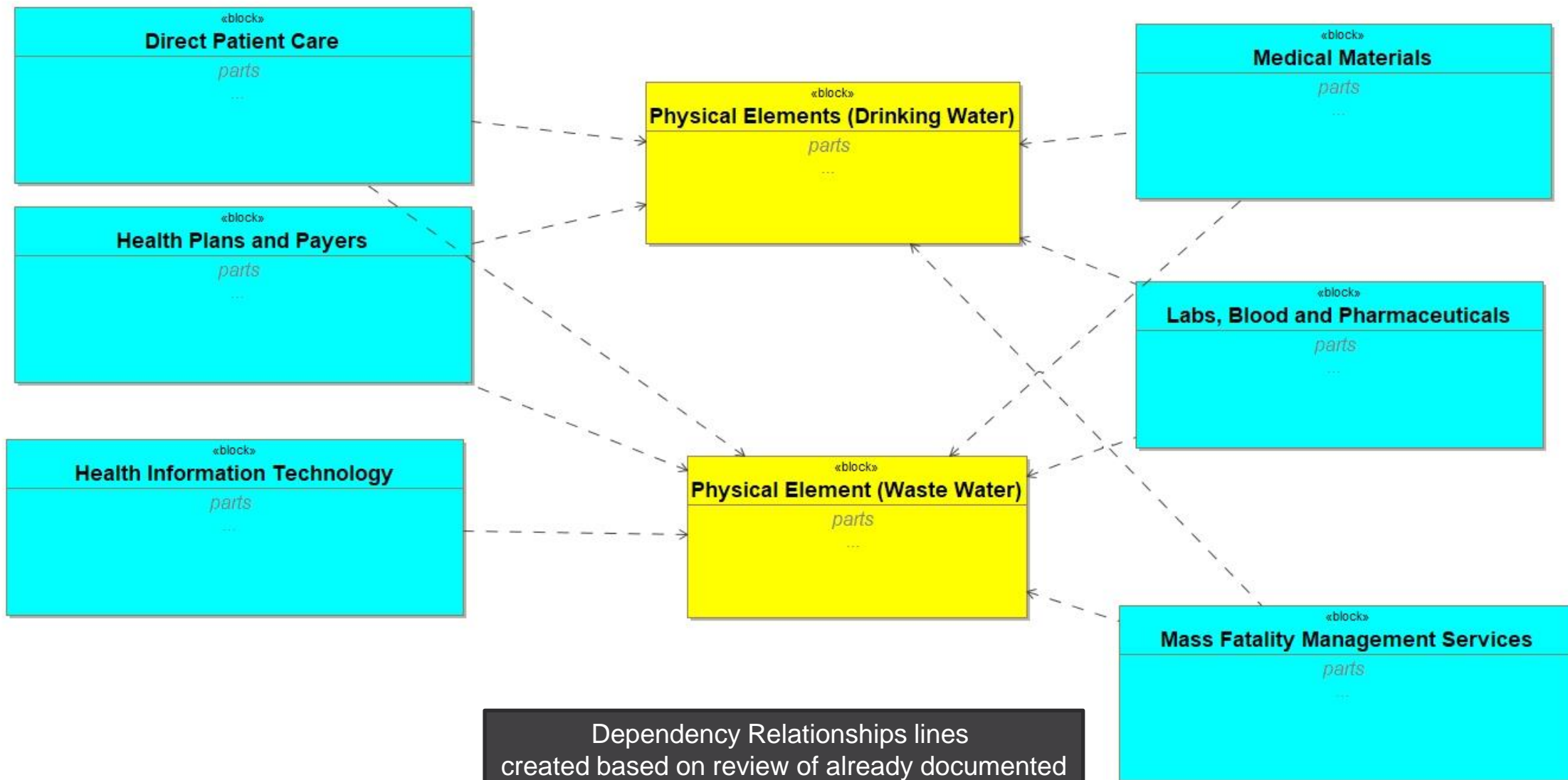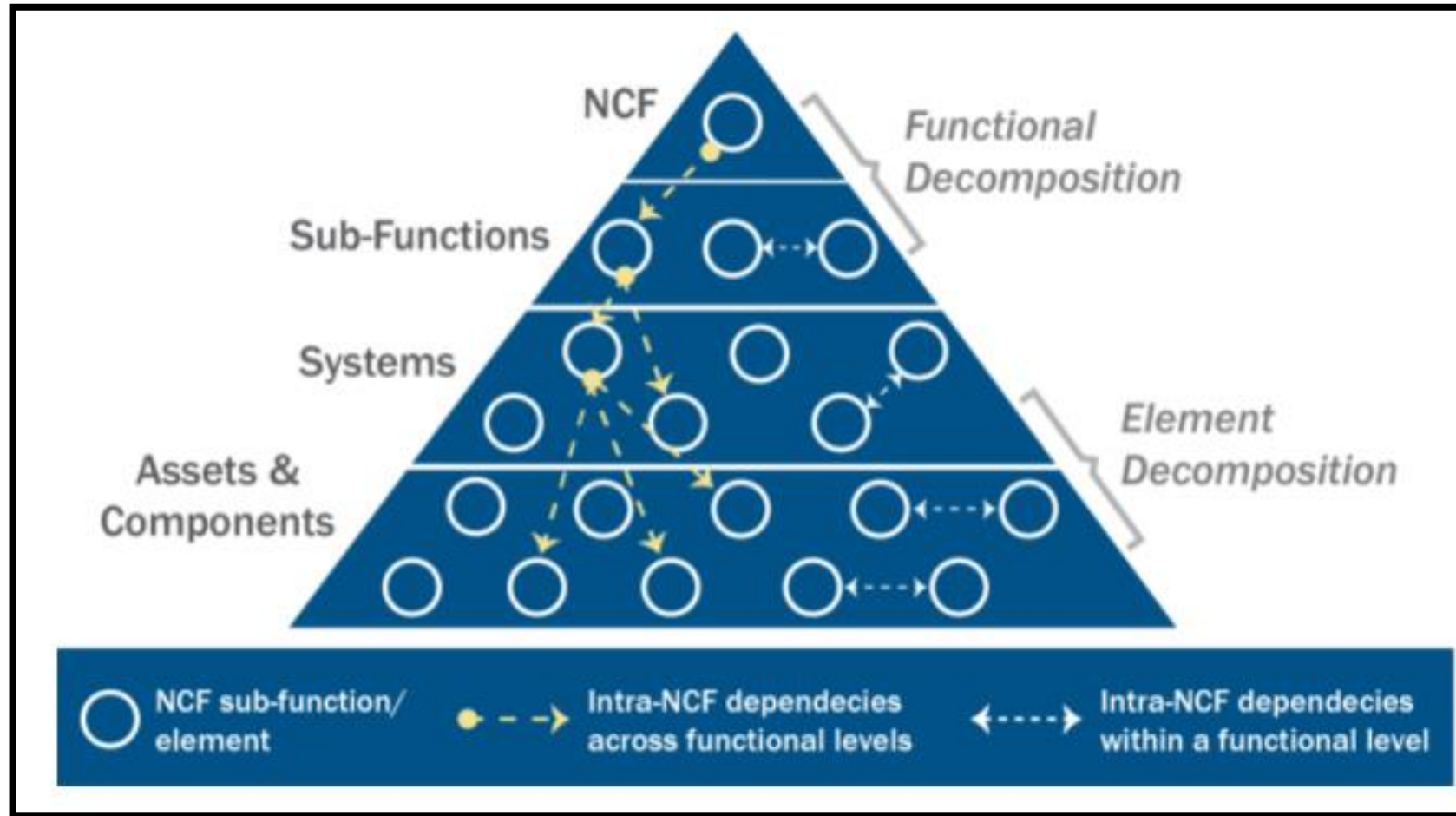# Health Care Sector Dependency Matrix (Relations Only)

Definitions:
a) Lifeline Function:
This refers to the **transportation, water, energy, and communications**,
Whose reliable operations are so critical
that a disruption or loss of one of these functions will
directly affect the security and resilience of critical infrastructure
within and across numerous sectors. That is they are critical to all sectors
b) Dependency: refers to all other sectors that exhibit a dependency relationship
To another sector but is NOT a lifeline function by DHS definition

DRAFT

Legend
↗ Dependency

Row	Comm. Sector	Broadcast Components	Cable Components	Wireline Components	Emerg. Services Sector	Emergency Medical Services	Fire and Rescue Services	Specialized Capabilities	Energy Sector	Electricity Distribution	Electricity Production	Transportation Systems Sector	Aviation	Maritime	Postal & Shipping	Water and Wastewater Sector	Physical Element (Waste Water)	Physical Elements (Drinking Water)
Healthcare and Public Health Sector		2	8	8		7	5	1		6	6		2	1	7		8	7
Direct Patient Care	2		↗	↗	2	↗	↗		2	↗	↗	1			↗	2	↗	↗
Federal Response and Program Offices	3	↗	↗	↗								1			↗	2	↗	↗
Healthcare and Public Health Sector			5	5		6	4	1		5	5		1	1	4		5	4
Health Information Technology	2		↗	↗	3	↗↙	↙		2	↗	↗					2	↗	↗
Health Plans and Payers	2		↗	↗	2	↗	↗		2	↗	↗	1			↗	2	↗	↗
Labs, Blood and Pharmaceuticals	2		↗	↗	2	↙	↙		2	↗	↗	1			↗	1	↗	
Mass Fatality Management Services	2		↗	↗	1	↗			2	↗	↗	1			↗	2	↗	↗
Medical Materials	2		↗	↗	3	↙	↙	↙	2	↗	↗	3	↗	↗	↗	2	↗	↗
Public Health	3	↗	↗	↗								2	↗		↗	2	↗	↗

Health Care to Water/Wastewater Sector Dependencies

«block»
Direct Patient Care
parts
...

«block»
Health Plans and Payers
parts
...

«block»
Health Information Technology
parts
...

«block»
Physical Elements (Drinking Water)
parts
...

«block»
Physical Element (Waste Water)
parts
...

«block»
Medical Materials
parts
...

«block»
Labs, Blood and Pharmaceuticals
parts
...

«block»
Mass Fatality Management Services
parts
...

Dependency Relationships lines
created based on review of already documented
SSP stated dependencies between sectors

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National Critical Function Decomposition

National Critical Function Decomposition

		Function	Definition	SSP Equivalent
Connect	1	Operate Core Network	Maintain and operate communications backbone infrastructure for voice, video, and data transmission that connects to users through broadcasting, cable, satellite, wireless, and wireline access networks	Telecommunications SSP Commercial Facilities SSP

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Yammer Development in Progress….

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Project Support

- Using Cameo Enterprise Architecture tool
  - Thanks to Dassault Systemes
- Contributors:
  - Modeling team
  - Domain experts, including
    - ◆ Charles (Chuck) Manto
    - ◆ Mike Pafford
    - ◆ James Terbush, MD MPH
  - Additional domain experts as needed

Objective: Healthcare Resilience

WHAT are we building??

- A product **(Reference Model)** intended to provide vital DECISION SUPPORT for hospitals to deal with threat scenarios, thereby achieving new levels of "Resilience"...
  (Cyber threats, Solar Flares – GMD, Electromagnetic - EMP, Physical, Pandemic, Complex Threats)
- INITIAL threat consideration is dealing with **catastrophic power outage** (widespread, long duration)
- Principal Focus is application of MBSE methods & tools to develop useful models of hospitals:

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WHY do we need this??

- Medical Facilities / Emergency - struggling with complexity of planning for various threat scenarios
- Systems Engineering & Model-based methods are seen as significant decision support means in:
    - Planning for "Black Sky" events
    - Executing plans during Black Sky conditions
    - Continuous improvement toward greater resilience

Hospital Domain and Context

We are in our first round of modeling

- Single hospital

- First, "Blue sky" (i.e., normal operations)

- Second, "Black sky" (catastrophic power loss)

  – Hospital is in island mode

  – Electrical power loss of unknown duration

    ● Too long for backup generators and fuel

How to prepare for and deal with this situation?
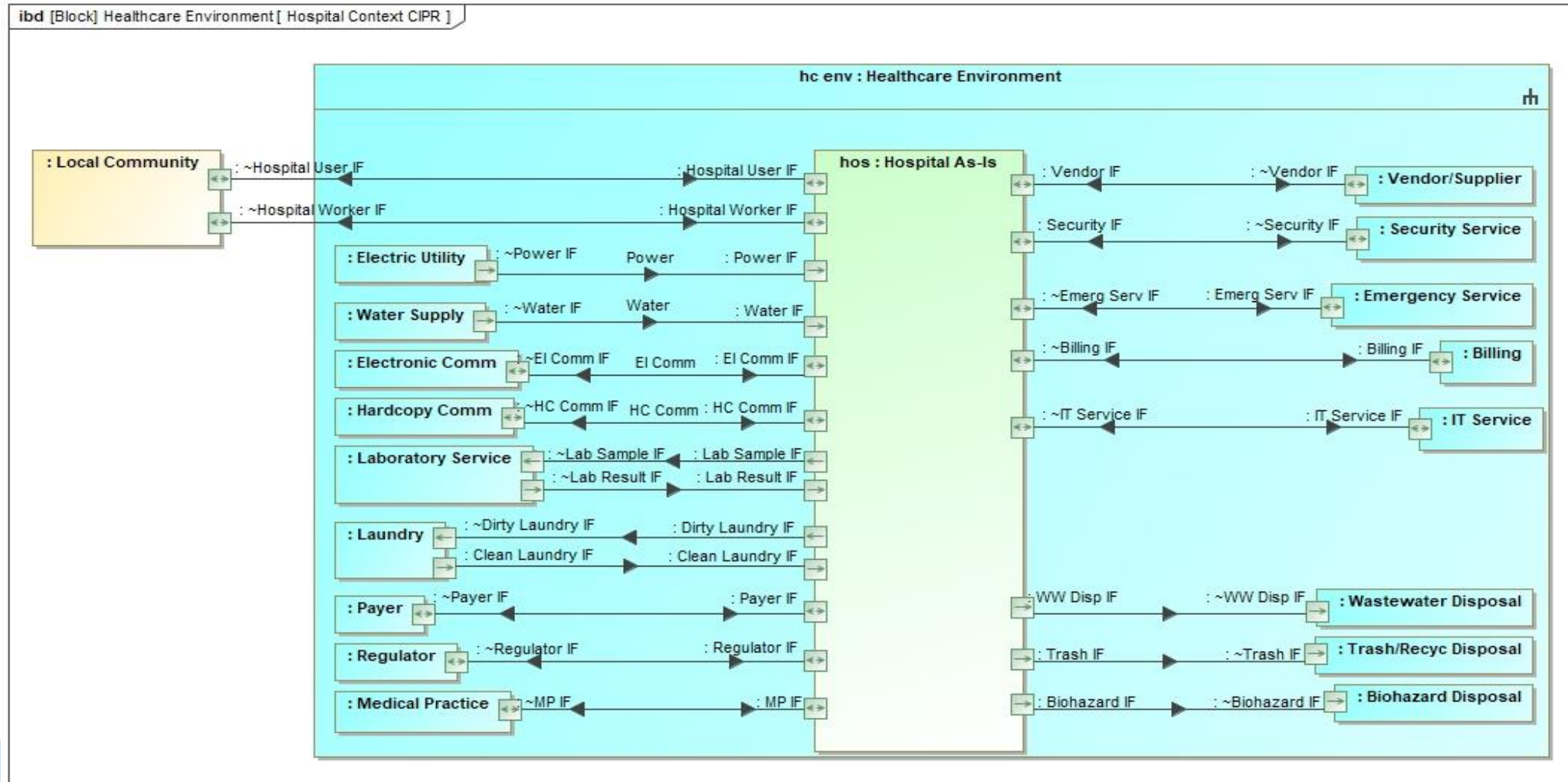
Overall Healthcare Domain
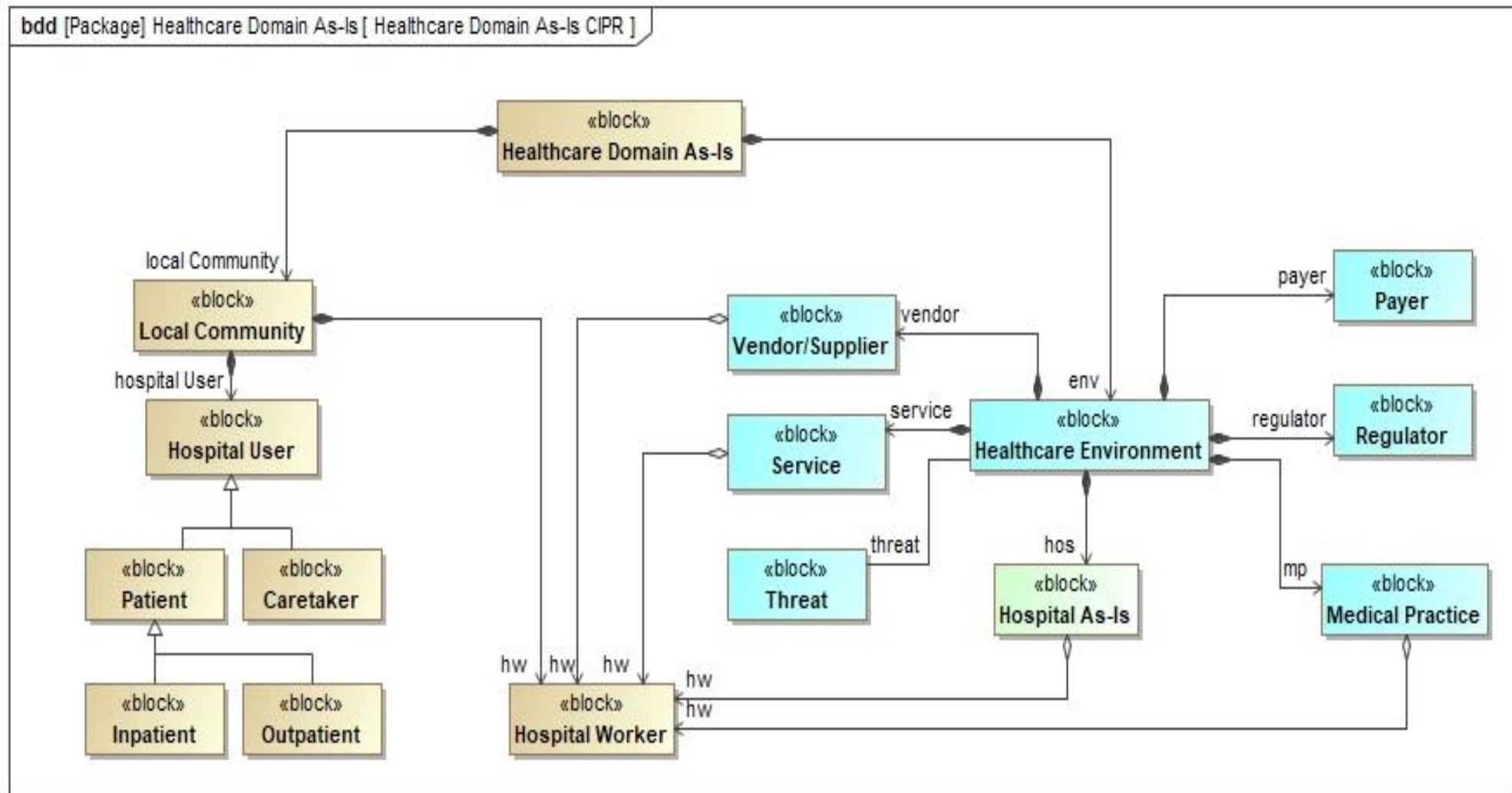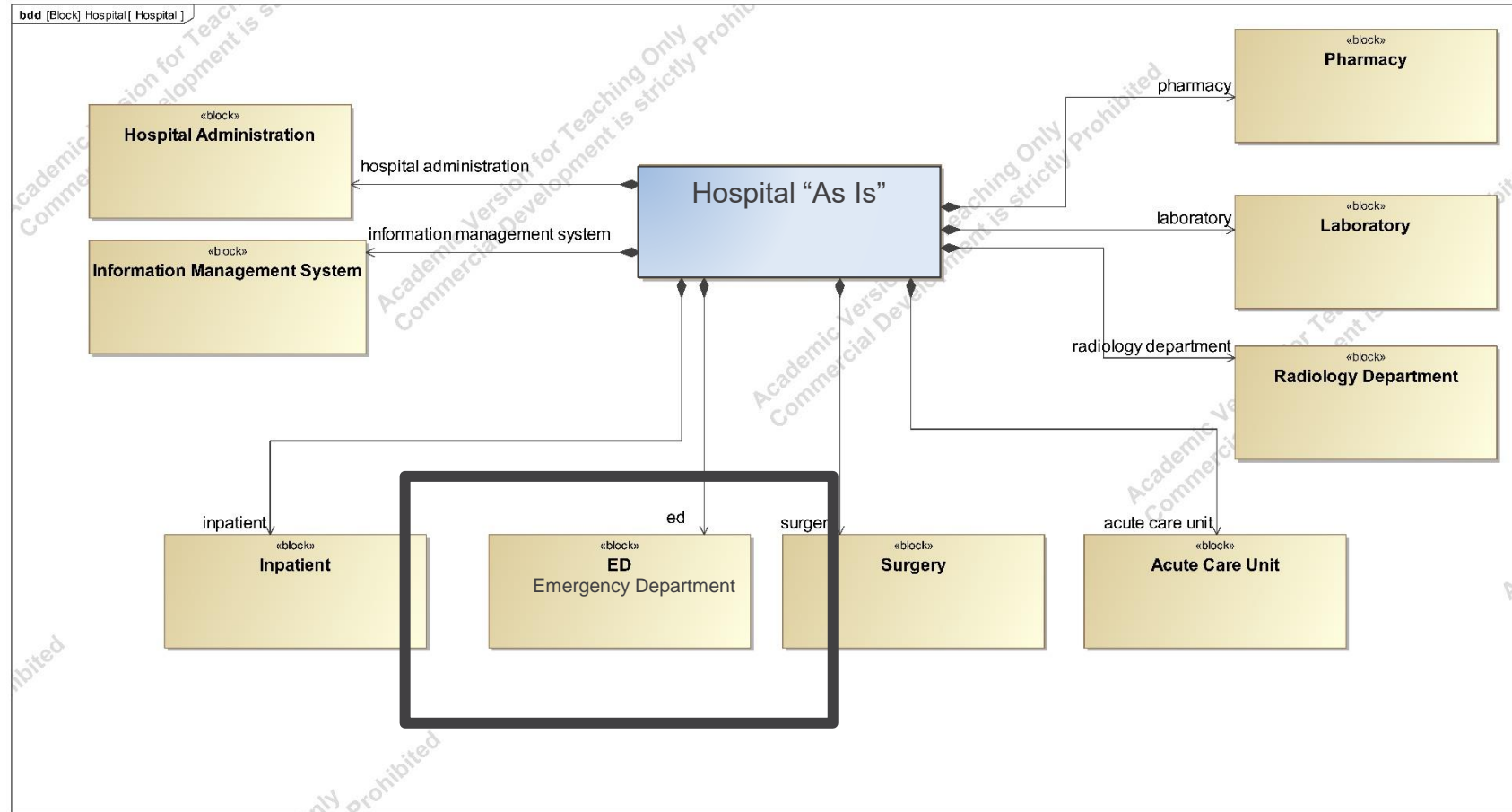
Generic Hospital Organization
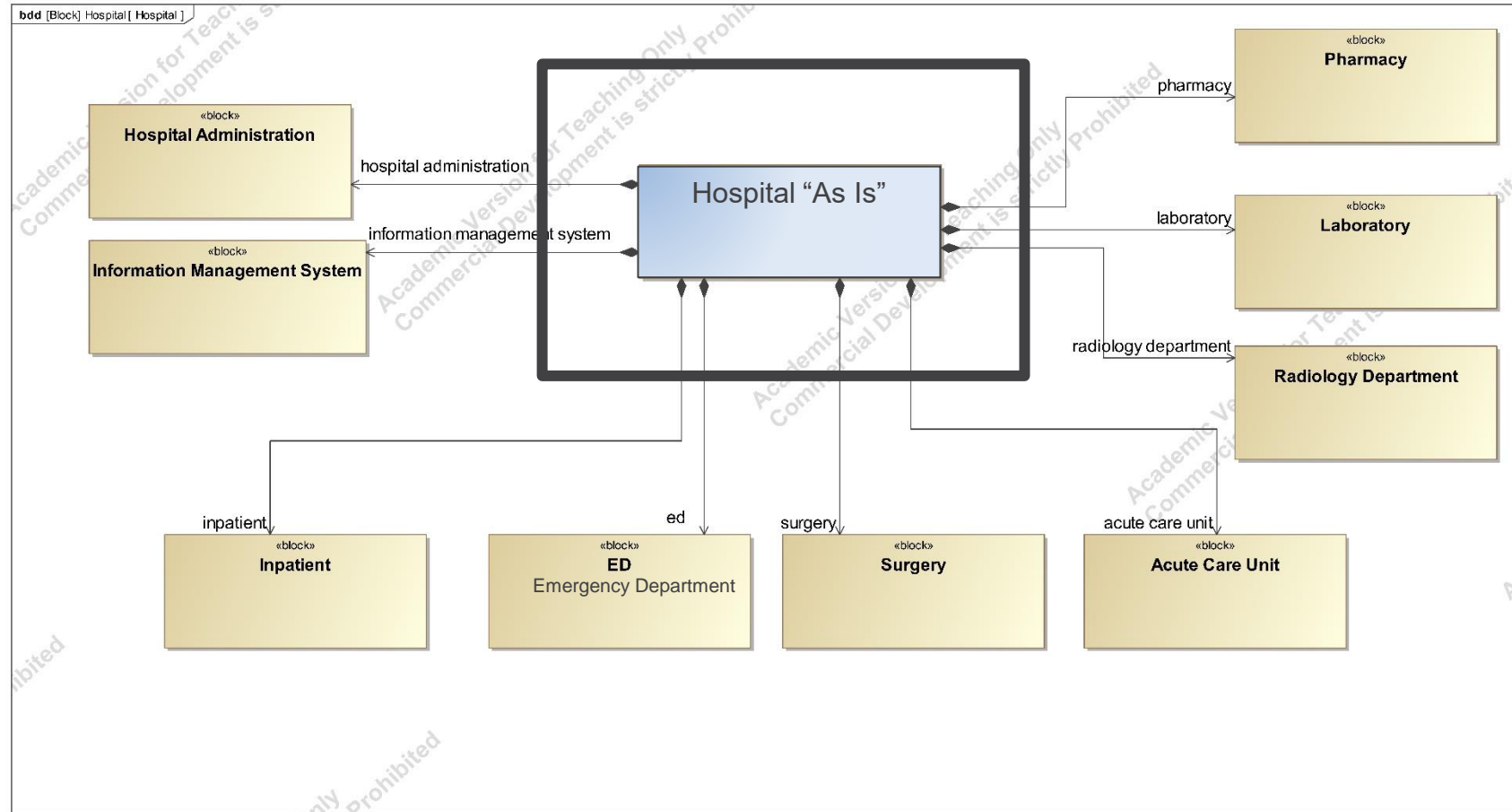
Hospital Context Diagram

ibd [Block] Healthcare Environment [Hospital Context CIPR]

hc env : Healthcare Environment

hos : Hospital As-Is

: Local Community
- : ~Hospital User IF — Hospital User IF
- : ~Hospital Worker IF — : Hospital Worker IF

: Electric Utility — : ~Power IF — Power — : Power IF
: Water Supply — : ~Water IF — Water — : Water IF
: Electronic Comm — : ~El Comm IF — El Comm — : El Comm IF
: Hardcopy Comm — : ~HC Comm IF — HC Comm — : HC Comm IF
: Laboratory Service — : ~Lab Sample IF — : Lab Sample IF
: ~Lab Result IF — : Lab Result IF
: Laundry — : ~Dirty Laundry IF — : Dirty Laundry IF
: Clean Laundry IF — : Clean Laundry IF
: Payer — : ~Payer IF — : Payer IF
: Regulator — : ~Regulator IF — : Regulator IF
: Medical Practice — : ~MP IF — : MP IF

: Vendor IF — : ~Vendor IF — : Vendor/Supplier
: Security IF — : ~Security IF — : Security Service
: ~Emerg Serv IF — : Emerg Serv IF — : Emergency Service
: ~Billing IF — : Billing IF — : Billing
: ~IT Service IF — : IT Service IF — : IT Service
: WW Disp IF — : ~WW Disp IF — : Wastewater Disposal
: Trash IF — : ~Trash IF — : Trash/Recyc Disposal
: Biohazard IF — : ~Biohazard IF — : Biohazard Disposal

Generic Hospital Organization

Use Case Interactions
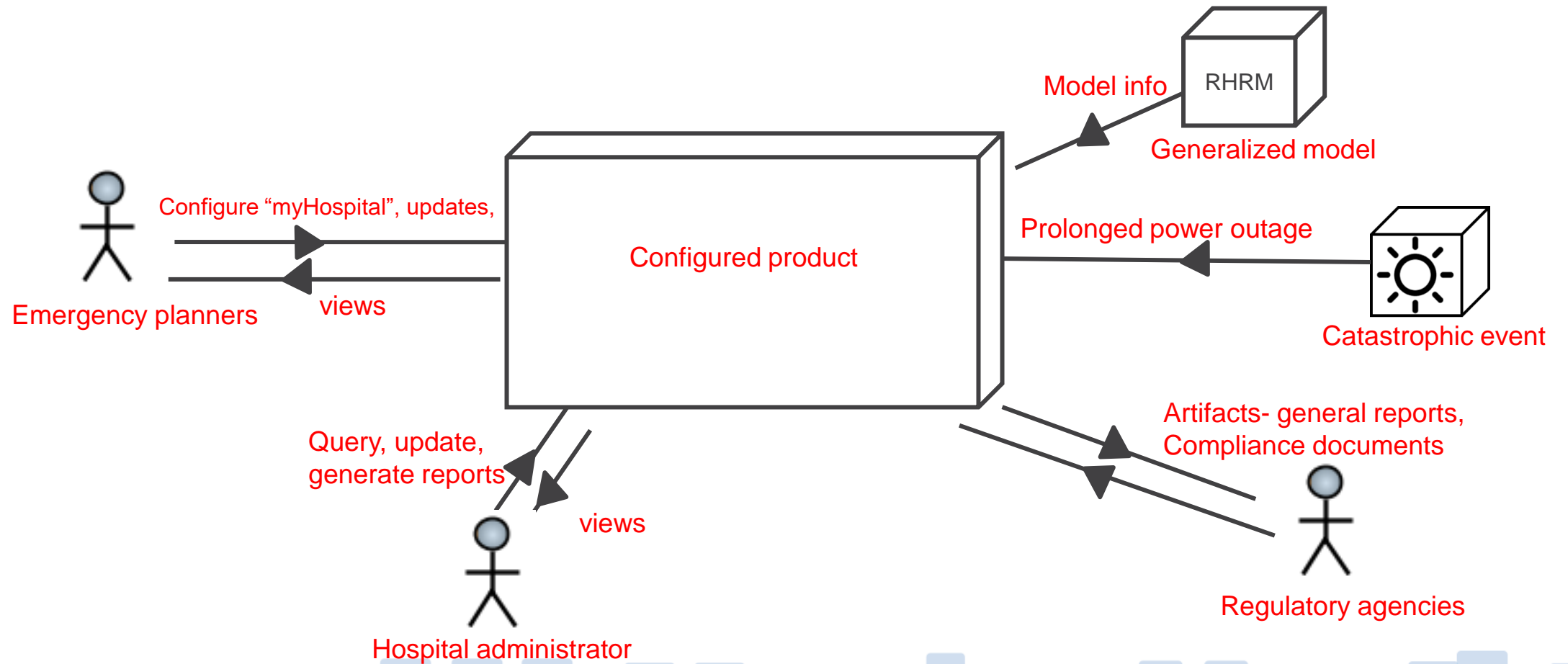
Use Case Interactions
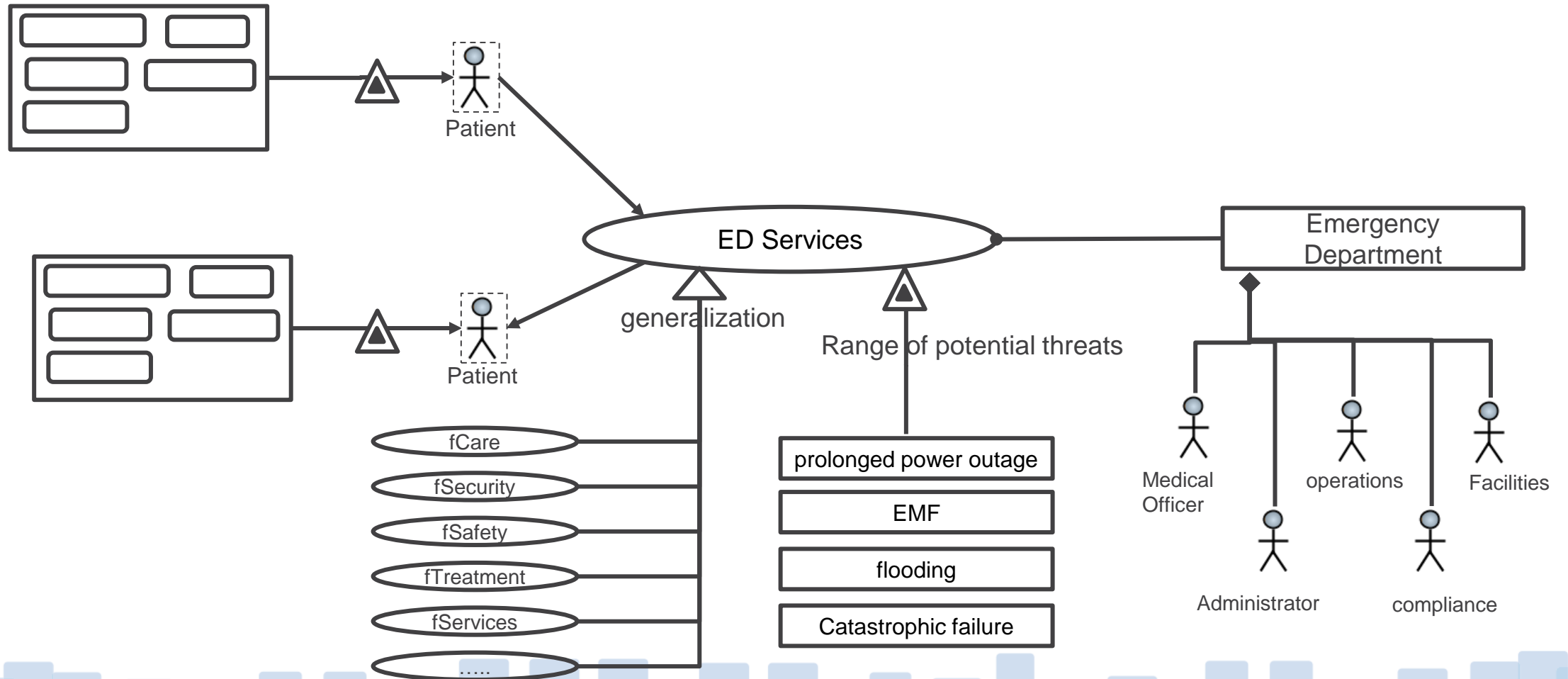
Emergency Department: Structure
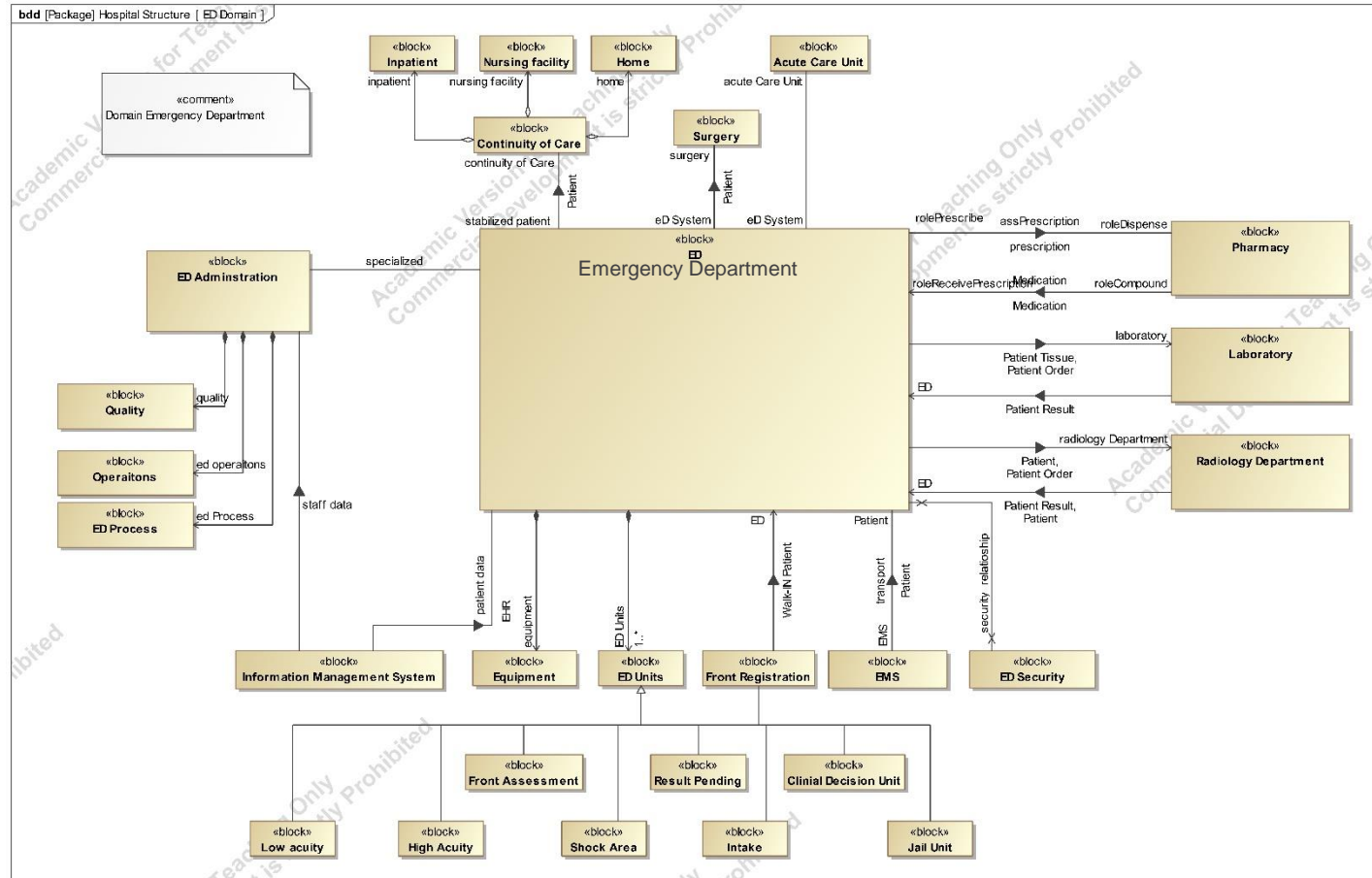
ED System - Patient inflow, data flow
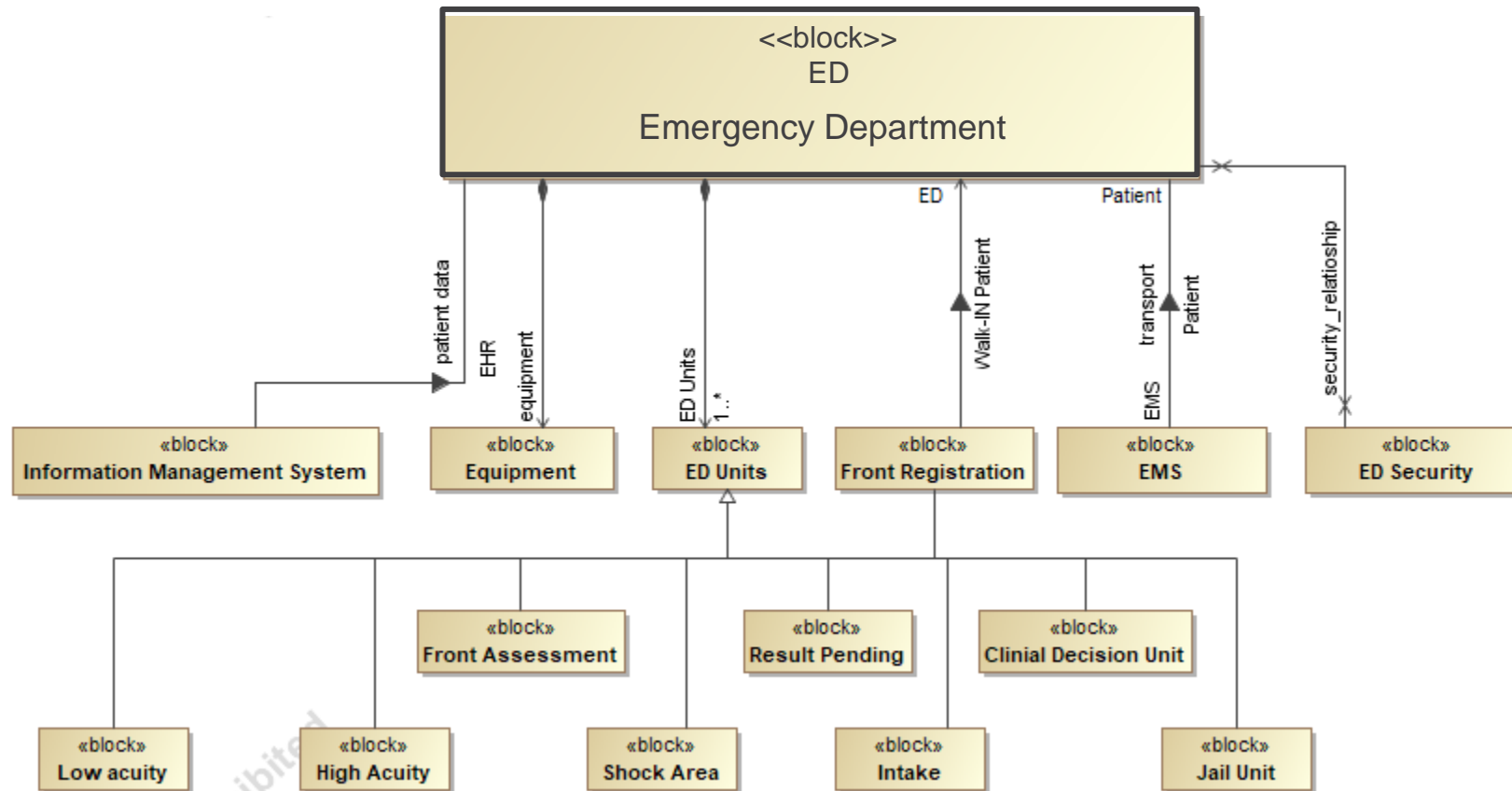
ED MOP - Dependence on Critical Services
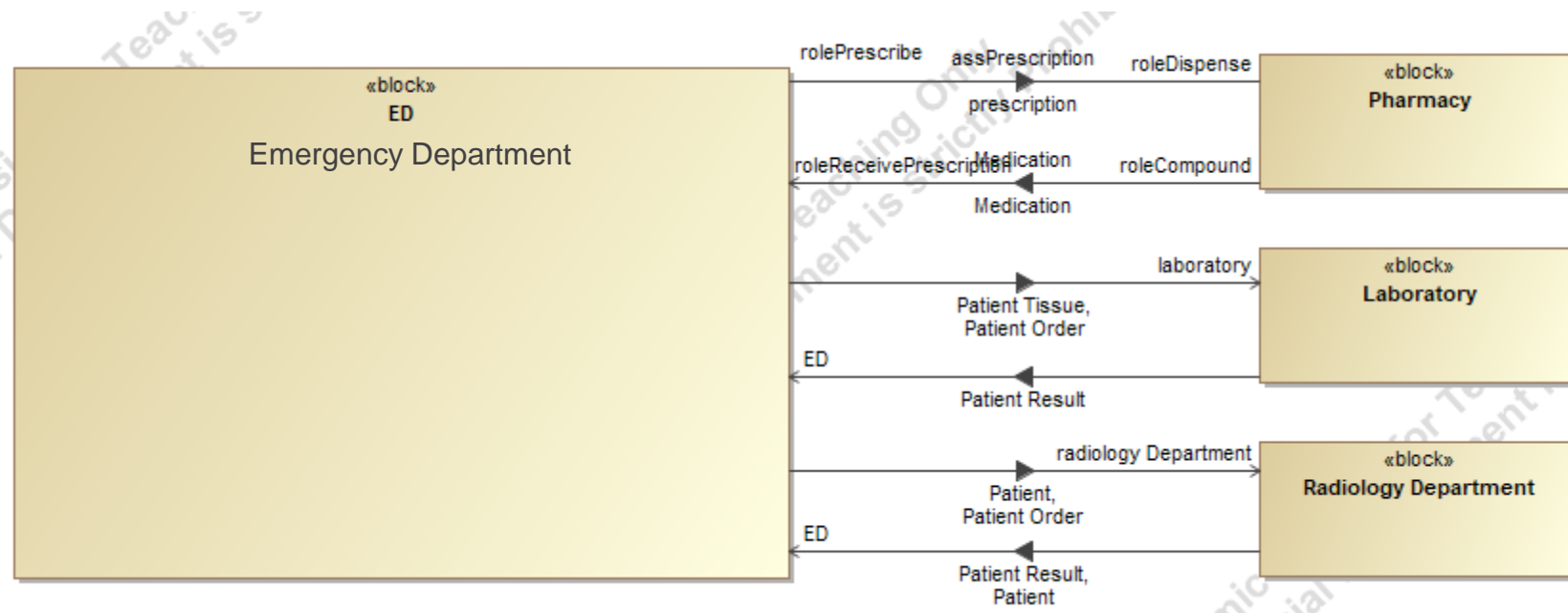
ED - MOE Patient Outflow
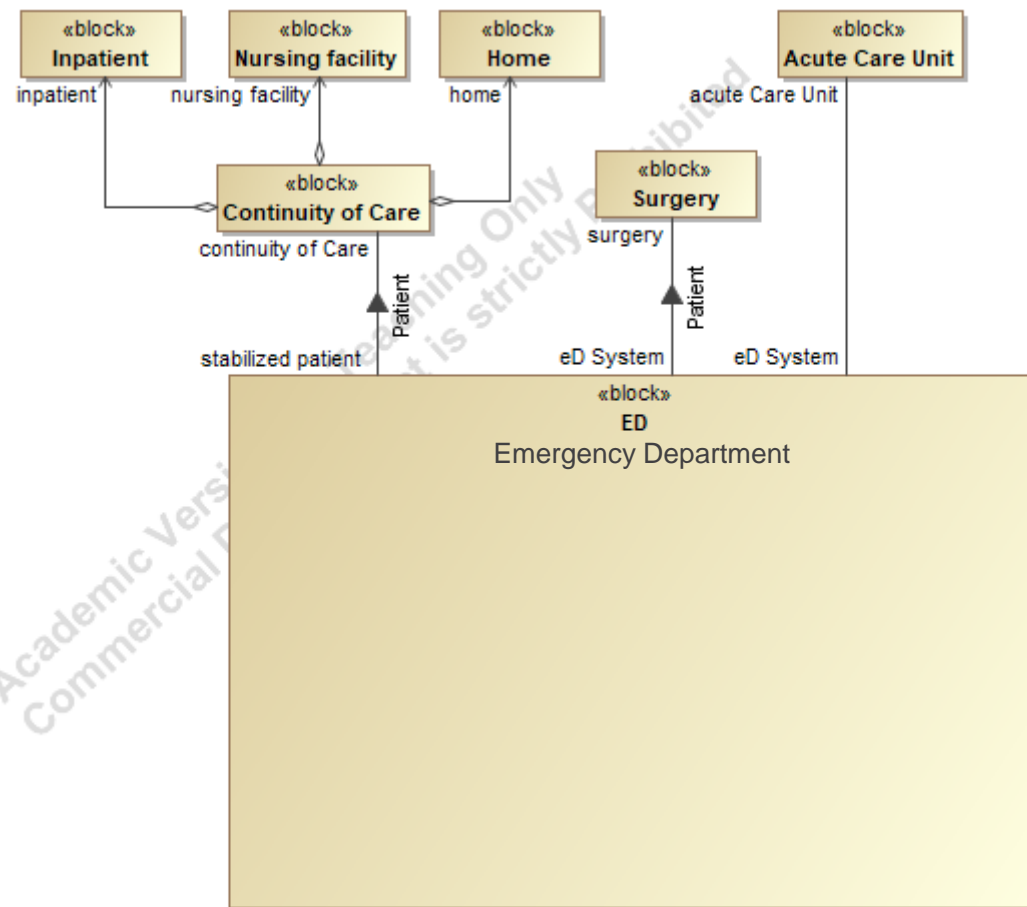
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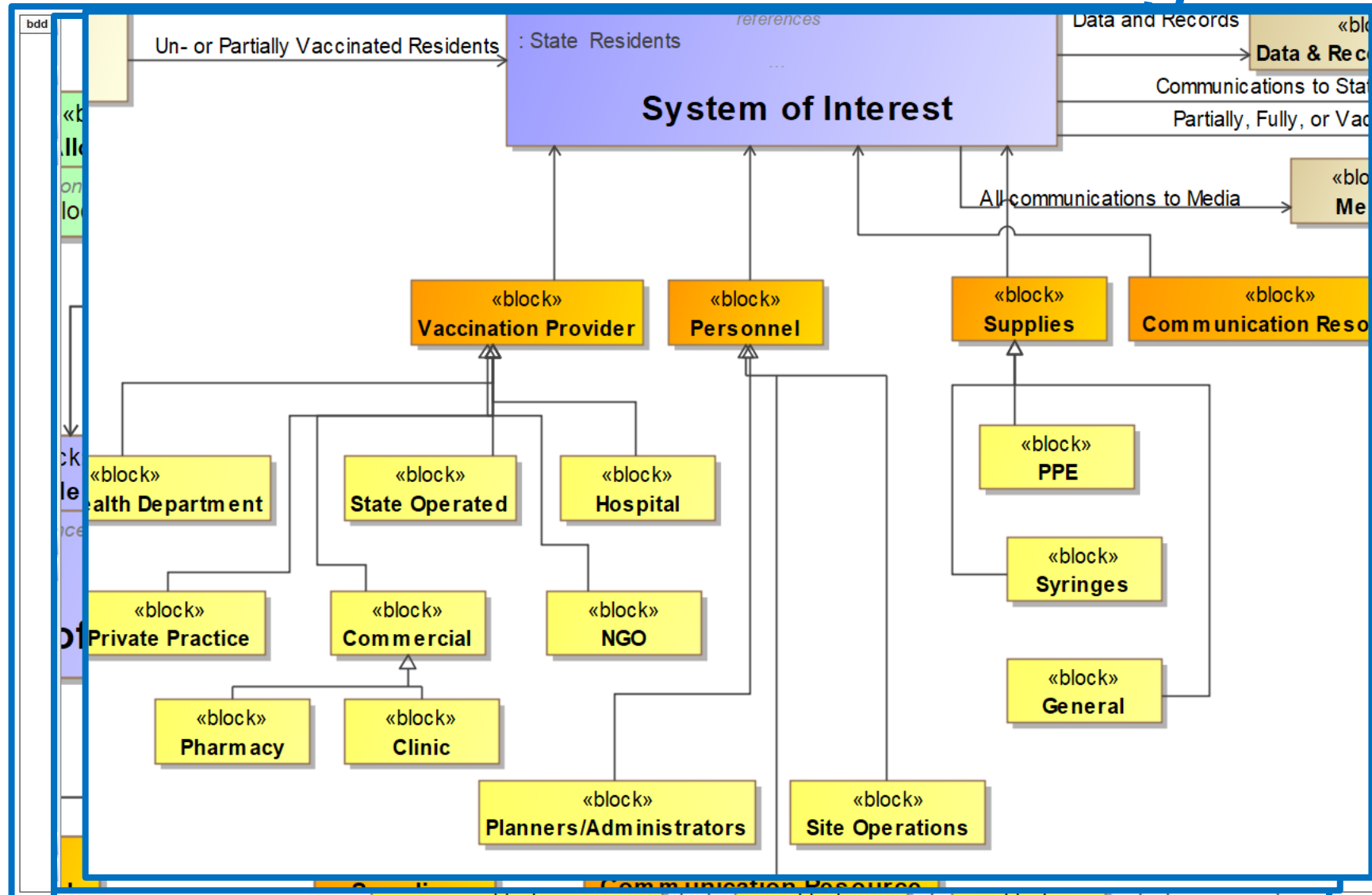   3. **COVID Last-Mile Supply – Sutton**
3. Next Steps

Objective: Model Vaccination System

- Background
  - Confusion and frustration over vaccine distribution and scheduling of shots – Why is this so difficult?
- Goals
  - Provide understanding of a process for distributing vaccines to users
  - Identify improvements for the next time
- Plan
  - SysML artifacts to define a process (use Maryland as basis)
  - Simulation to show performance metrics
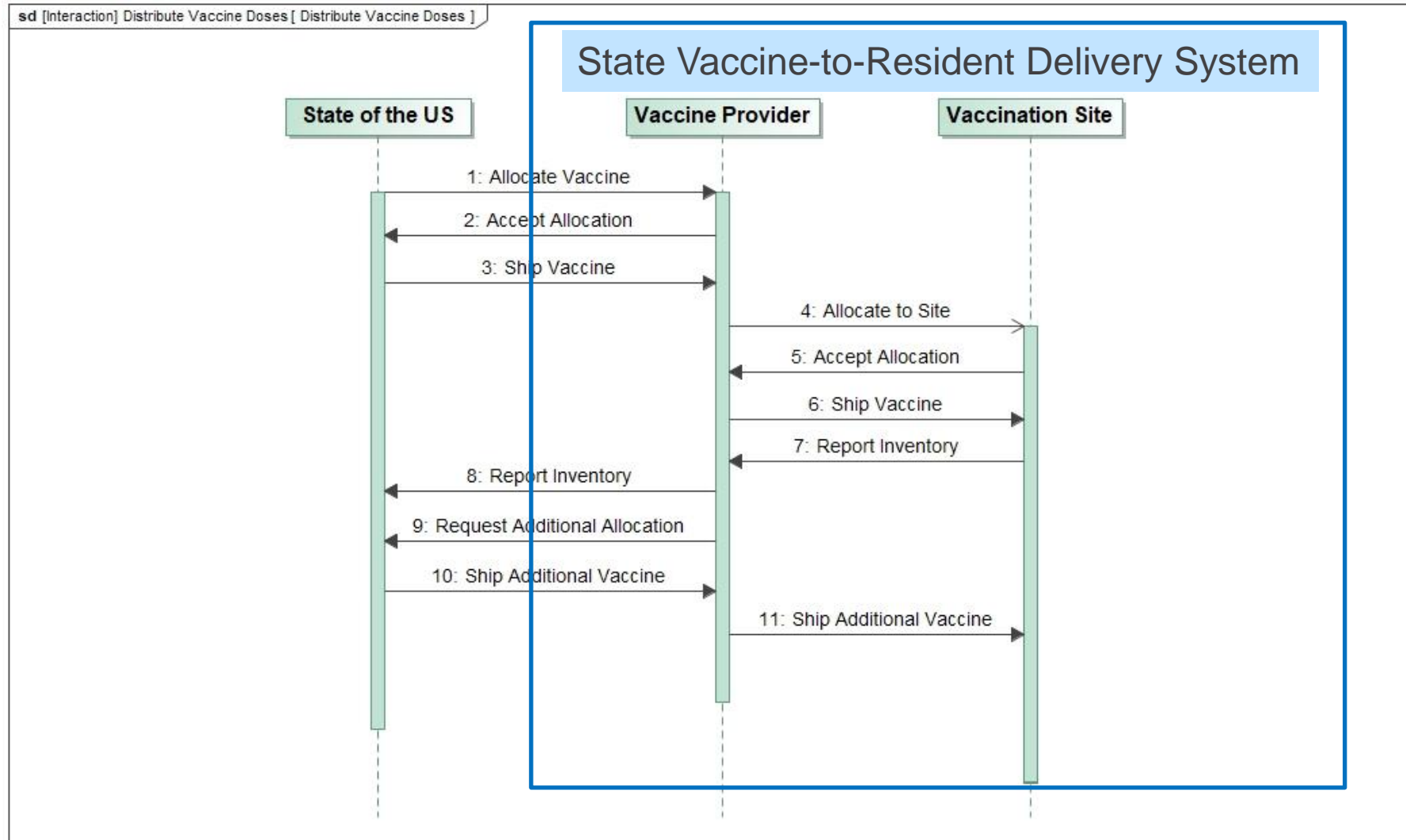 - Report results to WG and to local government decision makers

COVID-19 Last Mile Context Diagram

COVID-19 Last Mile Use Case Diagram

uc [Model] COVID-19 Project [Use Case-Last Mile Vaccination Distribution]

Register for Vaccine

Provide Vaccine Status

Schedule Appointment

Request Vaccine Doses

Provide Vaccination Elligiblity Criteria

Distribute Vaccine Doses

Communicate Information to Residents and Media

State of the US

Resident

US Dept of Health and Human Services

Media

Vaccine Provider

Provider controls its vaccine sites

■ = Use Case Narrative Drafted

Example Sequence Diagram – Distribute Vaccine Doses

Links to Simulation: AnyLogic Model

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Next Steps

- ## You Can Help!

  - Join the CIPR WG Effort. Propose Models, Updates, Analyses…

- ## Disseminate and Share Models Broadly

  - HTML to be posted to Yammer

  - Regular updates based on feedback

- ## Regular Meetings / Integration:

  - Monthly CIPR WG Meetings

  - Monthly MBSE Team Meetings

  - Mid-year workshops

CIPR WG Workshop + Contact

Join Zoom Meeting

https://incose-org.zoom.us/j/91326068478?pwd=SXpmdGVLV2NkVXdLUmRDakJXdk1qUT09

Meeting ID: 913 2606 8478

Passcode: 268927

Dial by your location

- +1 669 900 6833 US (San Jose)
- +1 253 215 8782 US (Tacoma)
- +1 346 248 7799 US (Houston)
- +1 301 715 8592 US (Washington DC)
- +1 312 626 6799 US (Chicago)
- +1 929 205 6099 US (New York)
- 877 853 5257 US Toll-free
- 888 475 4499 US Toll-free

Contact Information:

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Research Assistant Professor | Operations Research

Deputy Director | Center for Infrastructure Defense

Naval Postgraduate School

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Backup Slides

Can You Help?

- Interested in helping?
  – Simulation
  – Developing other artifacts
  – Review and critique of artifacts
  – Help to liaison with local officials (doesn't matter locality)

Questions & Discussion 3

Methodology Used for Health Care Sector Dependency Matrix

- Finished Taxonomy of all related sectors per SSP in model
  - Modeled to lowest level in SSP Document
  - Created multiple Dependency Matrix Starter Diagrams (Using SysML Requirements Diagram type) and (6) related sectors/subsectors manually to top level Health Care/Public Health Sector elements via analysis.
  - Created Dependency Matrix in Cameo to produce what you see here – Results based on manual analysis (See backup slides) but you can add dependency relationships in model as they are discovered between sectors.
  - This work was done to illustrate the dependency matrix capability in the tool.
  - **Done to show the ability to create such Dependency matrices across sectors**

Health Care/Public Health Sector Dependency Matrix

Mapping Lean Startup Workshop Terminology
Stakeholder, Persona, Needs to MBSE

stakeholder

External entities and actors

Actor:
Chief Medical Officer
CMO
PFM5 **(persona)**
roles/responsibilities →
Expertise provide safe
effective services

User story col F

CMO User Story
Operational use
Predict level of staffing

Operational Analysis

Capture "as is" **Scenario**

CMO's Need minimal staffing

System Requirement
Functional and non functional

CMO need: **UC predict level of staffing**

As is current operations

To be system

**Define Capability:
Extend Operational activity**

transition

capability

System: RHRM

System Function:
Plot staffing need

System
analysis

"To be" Scenario
SD, STM

Exa_____ne

Use Case: REGISTER FOR VACCINE | **Narrative**

	3.	~~Changing appointment location, date/time.~~
	4.	Walkup Registration / Appointment
Requirements		
A. Functional	1.	The System shall register Residents for the vaccine.
	2.	The System shall securely hold the Residents' information and vaccine status.
	3.	The System shall allow Residents to make appointments with a specific provider, on a specific date/time, and at a specific location.
	4.	The System shall maintain an information base for all Residents requesting appointments
B. Performance	1.	The System shall provide access to registration within xxx seconds for Residents who register via a "smart" communications device.
	2.	The System shall provide access to registration within yyy seconds for Residents who register via telephone.
	3.	The System shall provide confirmation of an appointment within XXX seconds.
	4.	TBD
C. Non-Functional	1.	The System shall protect the information it holds against unauthorized disclosure IAW HIPAA and TBD.
	2.	The System shall have an Availability of TBD.

Example Activity Diagram: Request for Vaccine
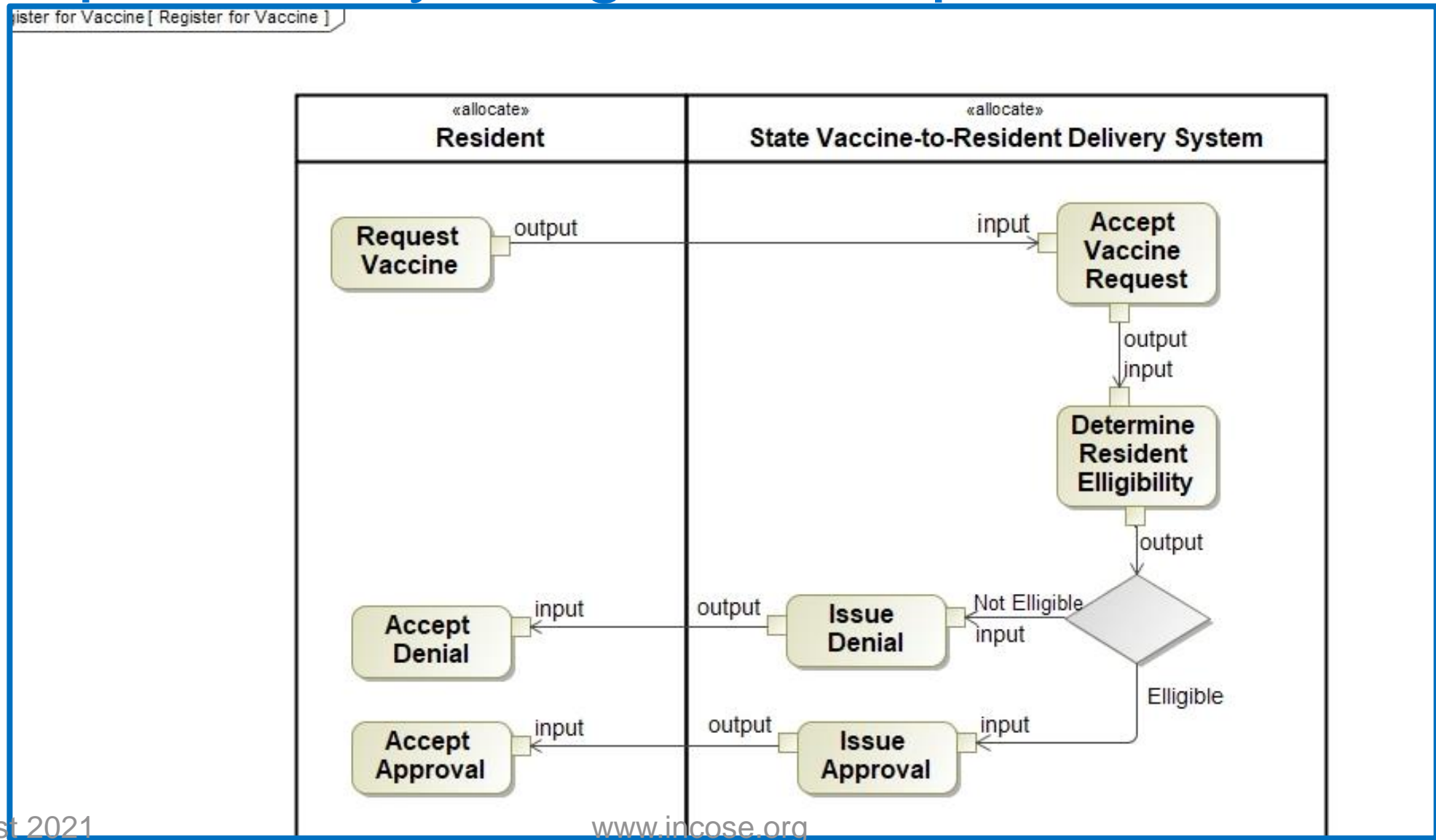
Status

- Artifacts developed
  - Context Diagram
  - Use Case Diagram
  - Use Case Narratives
  - Activity Diagram
  - Sequence Diagram