Towards Systematic Model-Based Development of Patient Management Systems

Lisa Weavind MD
VUMC, Vanderbilt University

Dan Albert
Informatics Center , Vanderbilt University

Janos Mathe, Andras Nadas
ISIS, Vanderbilt University

June 22, 2010

Outline

- Brief project overview
  - Long Term Goal
  - Sepsis and the ICU

- Early Warning: The Listening Application
  - Preliminary Data

- Improving Compliance: Process Management
  - A Prototype and Plan for Improvement

- Clinical Trial and Implementation

Brief Project Overview

- Provide electronic support for complex decision making in health care which improves quality of care. Make tools that analyze patients' electronic records and…
  - Assist in diagnosis of multiple diseases.
  - Improve adherence to evidence-based guidelines in disease management.

Sepsis and the ICU…

- Sepsis
  - Common, Deadly
  - Affects inpatients
  - Difficult to diagnose
  - Early treatment is superior
  - Effective treatment requires an array of multi-step interventions.
- The ICU
  - Instability in multiple organ systems
  - Information rich
  - Decision rich
  - Rapidly growing use of protocols

Early Warning: The Listening Application

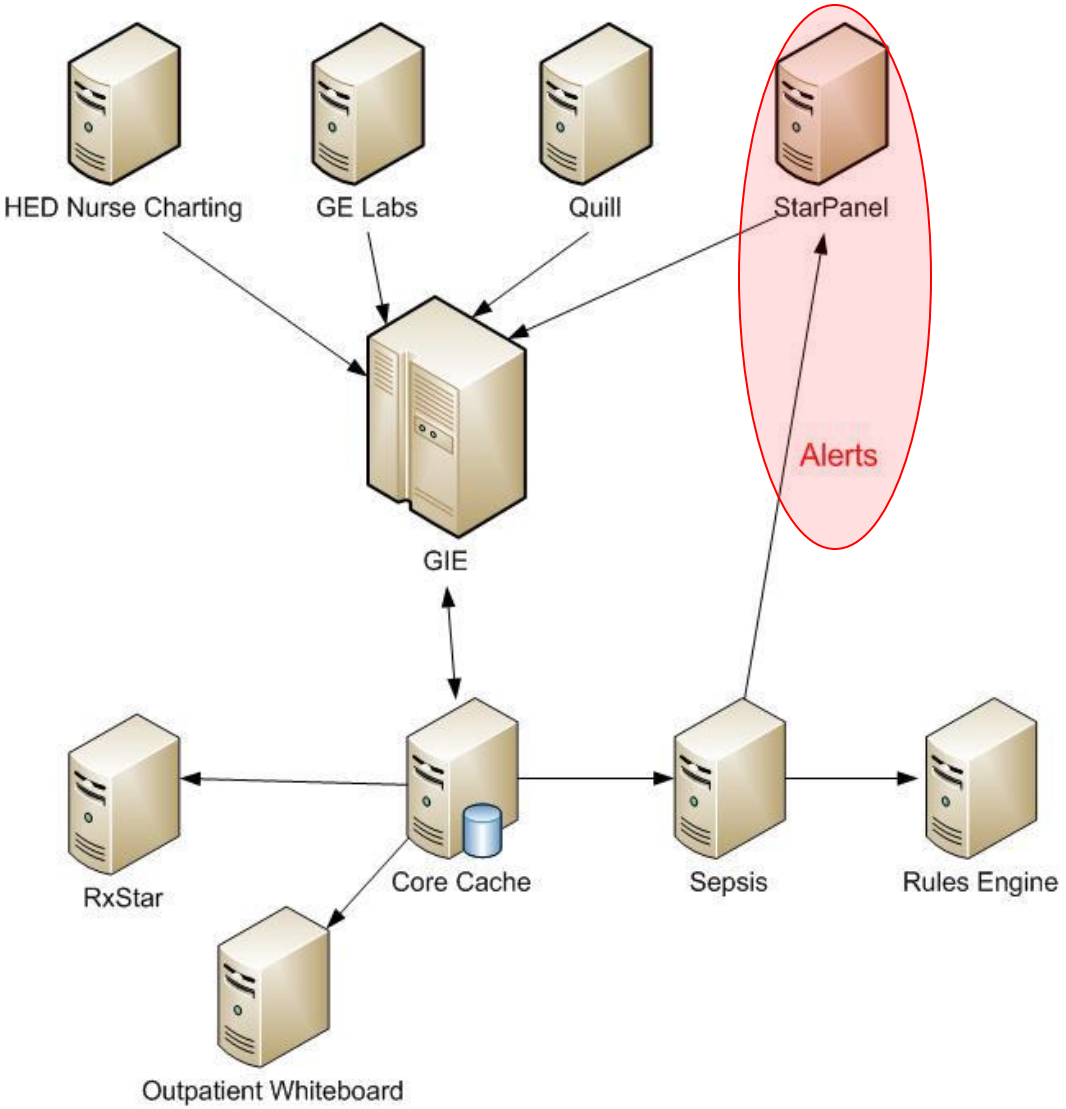
- An application positioned within our system to monitor patient data (flow sheet data, laboratory data, etc.).
- Programmed to generate alerts to physicians (via the dashboard and pager system) when certain criteria are met.
- Rules engine able to “filter” alerts and ensure that only new or pertinent alerts are generated.
- May be applied to many disease processes.

Early Warning: The Listening Application

- Applied to sepsis in our pilot project.
- Monitors for modified SIRS criteria.
- When criteria are met,

- Rules engine ensures that information is new and pertinent.
- Has been deployed in the MICU and SICU.

Listening Application

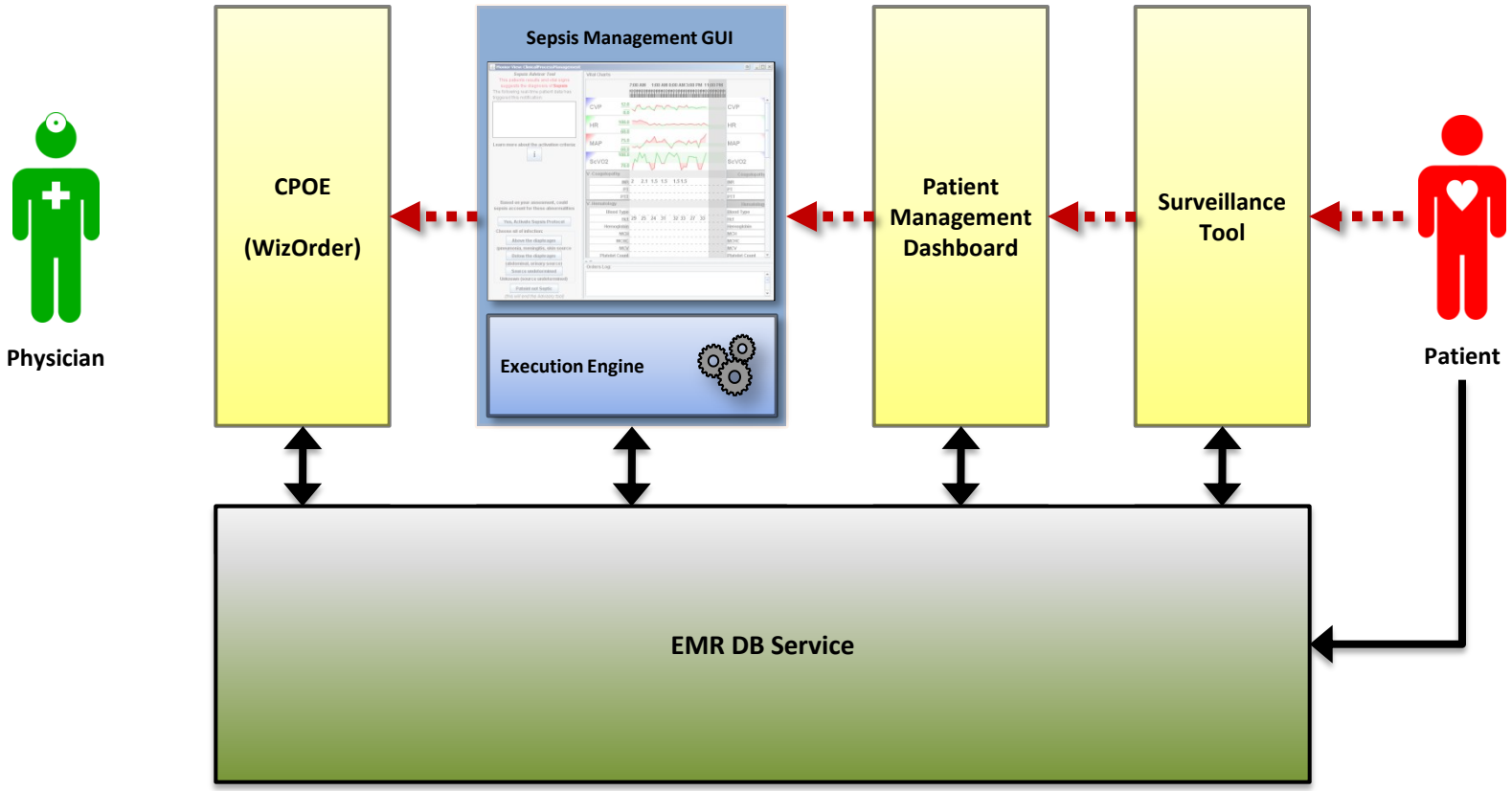


The Listening Application

Preliminary Data from the MICU (80 pts.):

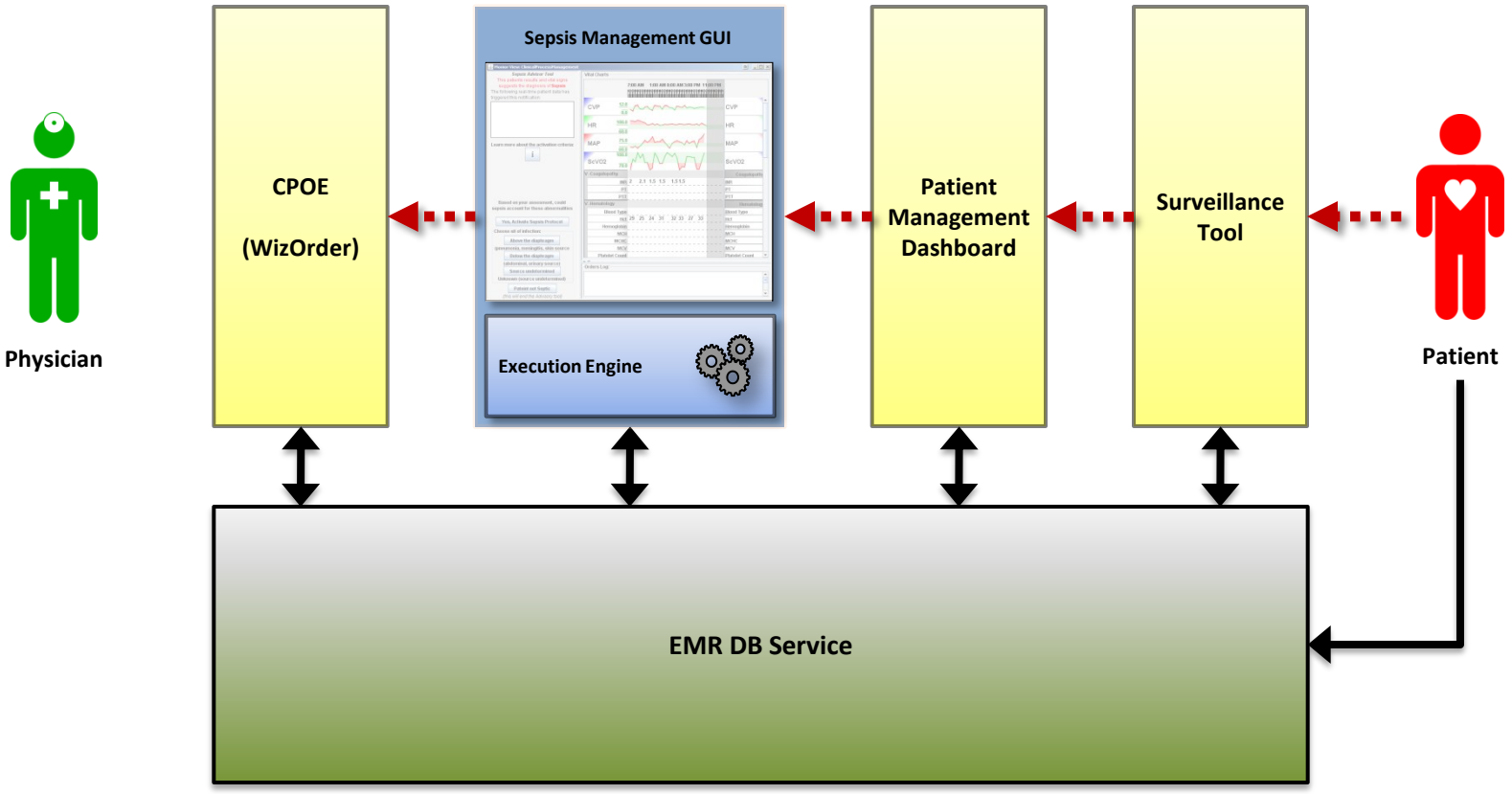
- 100% sensitive for sepsis
- ~60% specific for sepsis
- Did not alter behaviors, including time to 1st antibiotics, time to change of antibiotics, ICU time, vent time, shock time, mortality.
  - This is not unexpected within the MICU, where provider:patient ratio is low, suspicion for sepsis is high.
  - 10% of patients had not received antibiotics at the time of the alert…

Sepsis Management System

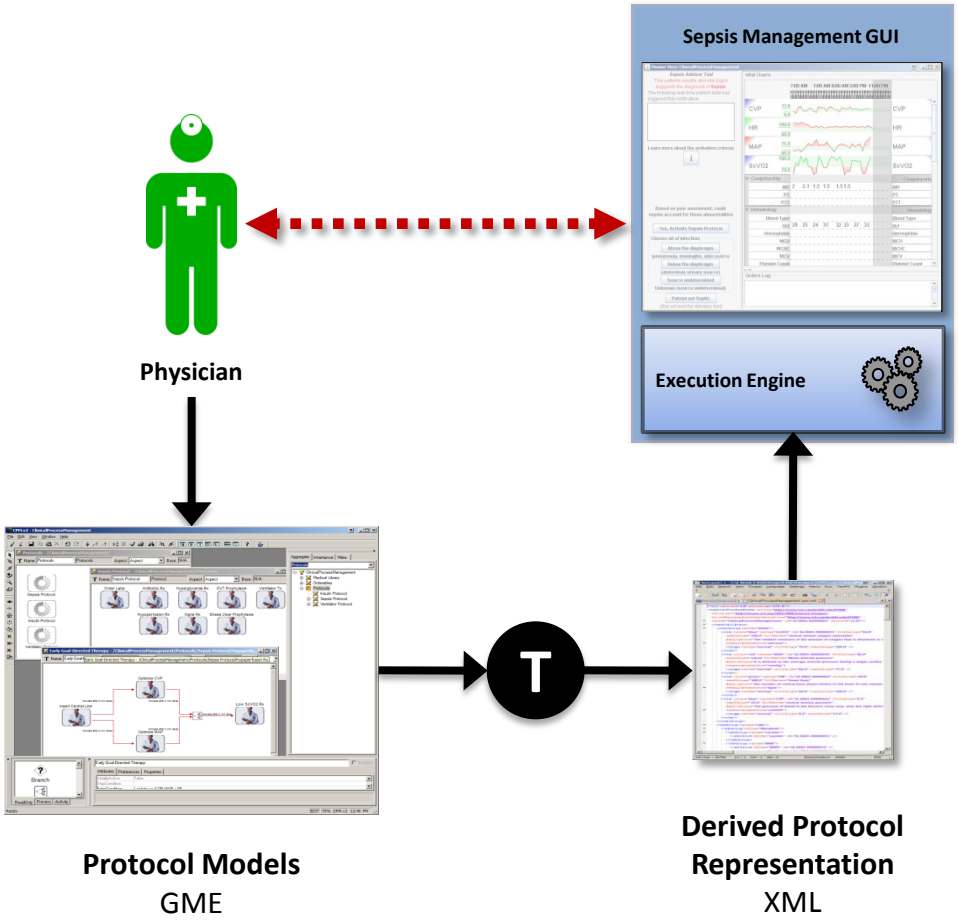


1. Identify patients based on modified SIRS criteria
2. Prompt clinical teams
3. Provide real-time process management recommendations based on live patient data
4. Process confirmed orders

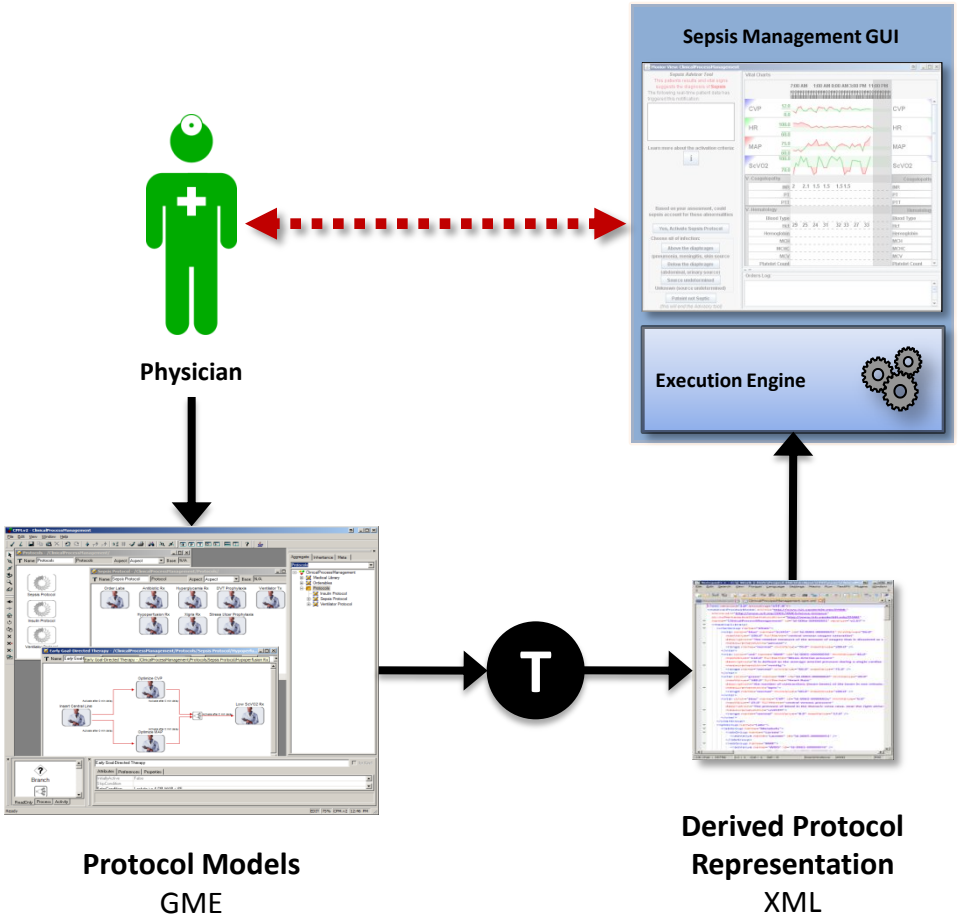
Creation and Deployment of Treatment Models



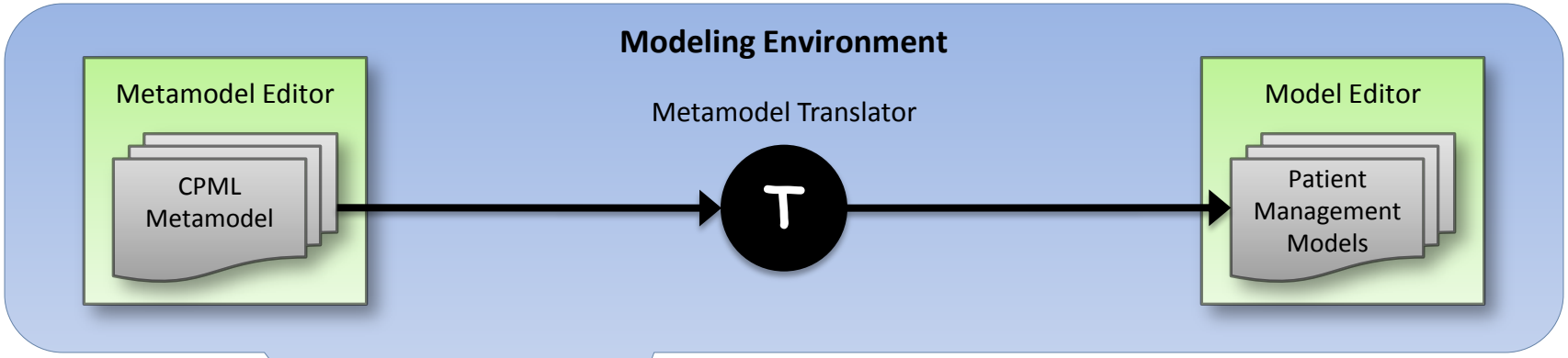
Creation and Deployment of Treatment Models

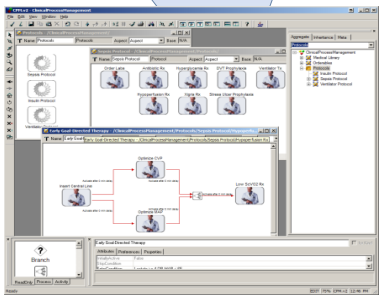


Design of the Clinical Process Modeling Language



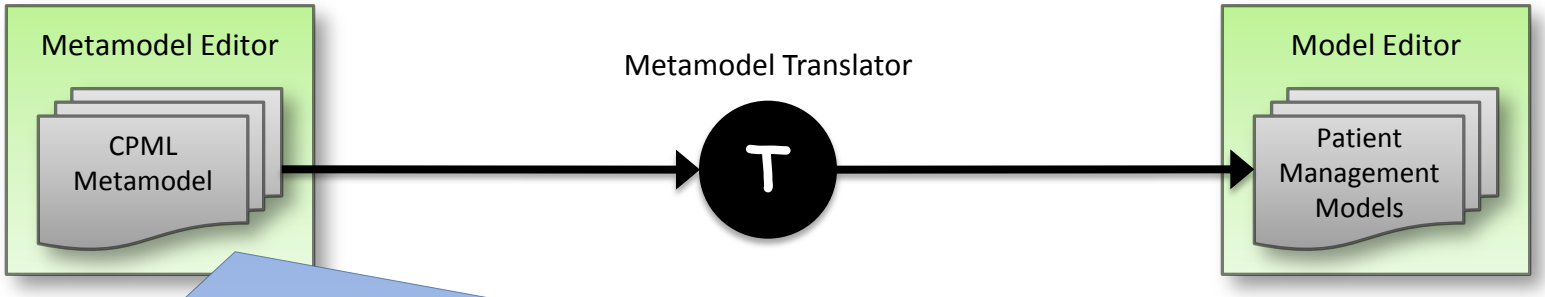
Inside the Modeling Environment 1/9





Protocol Models
GME

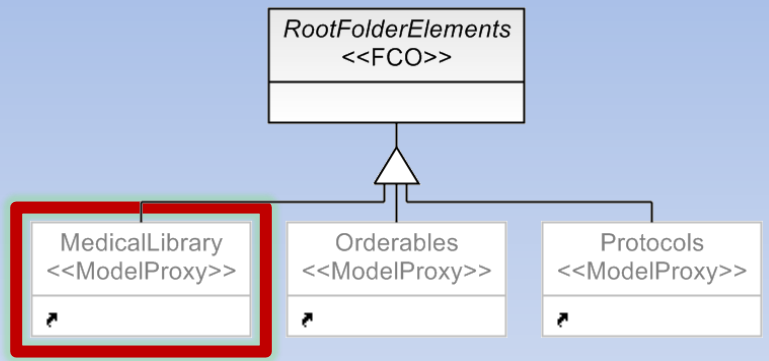
Inside the Modeling Environment 3/9



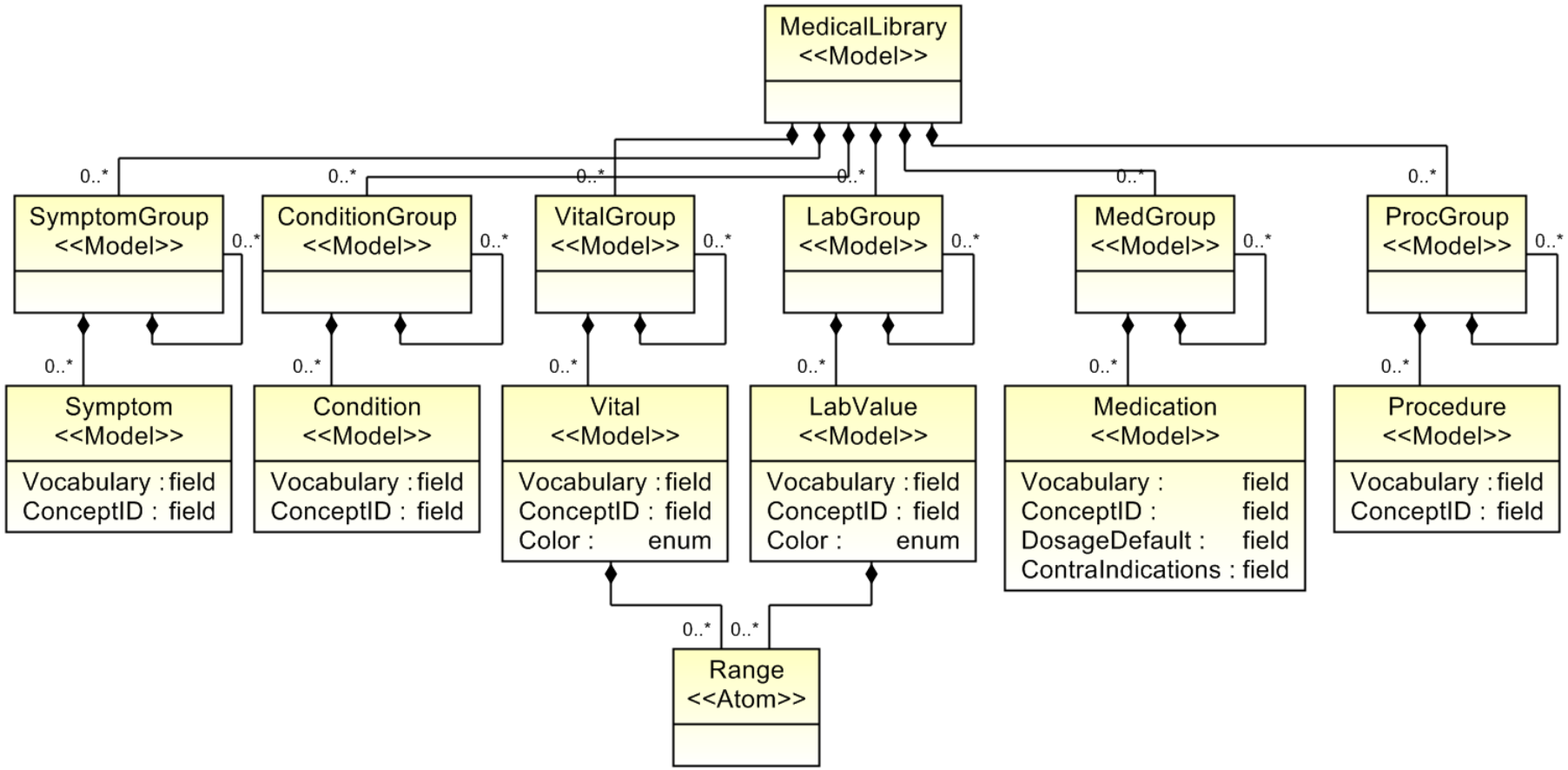
Medical Knowledge

1. General medical ontology

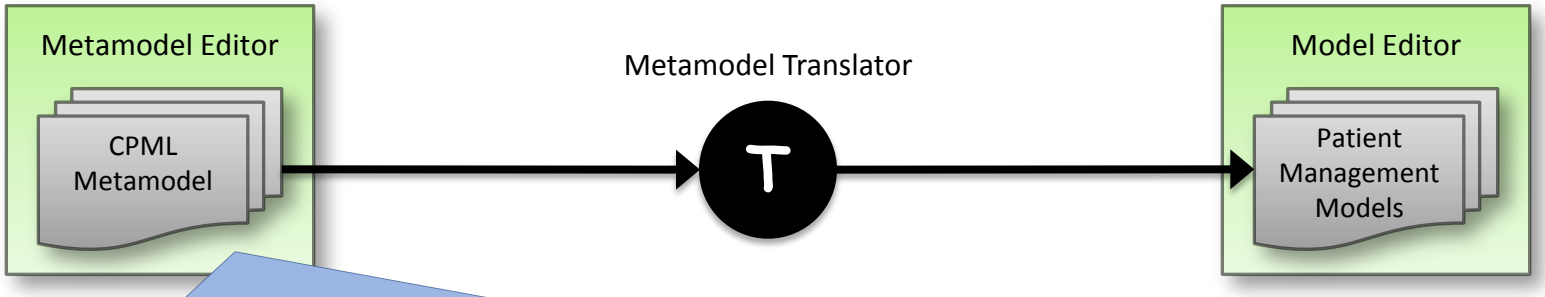
CPML



CPML: Ontology Elements



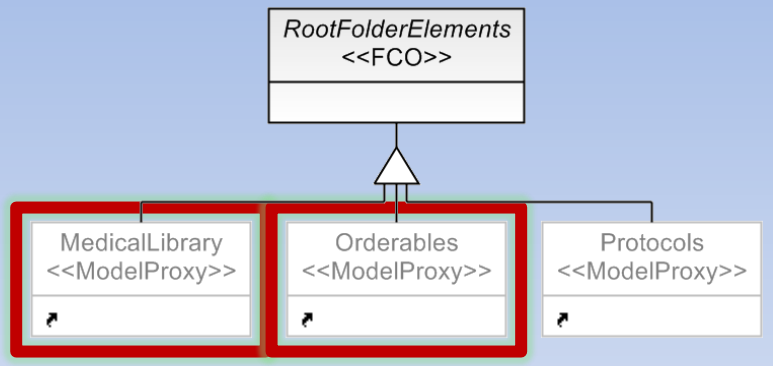
Inside the Modeling Environment 4/9



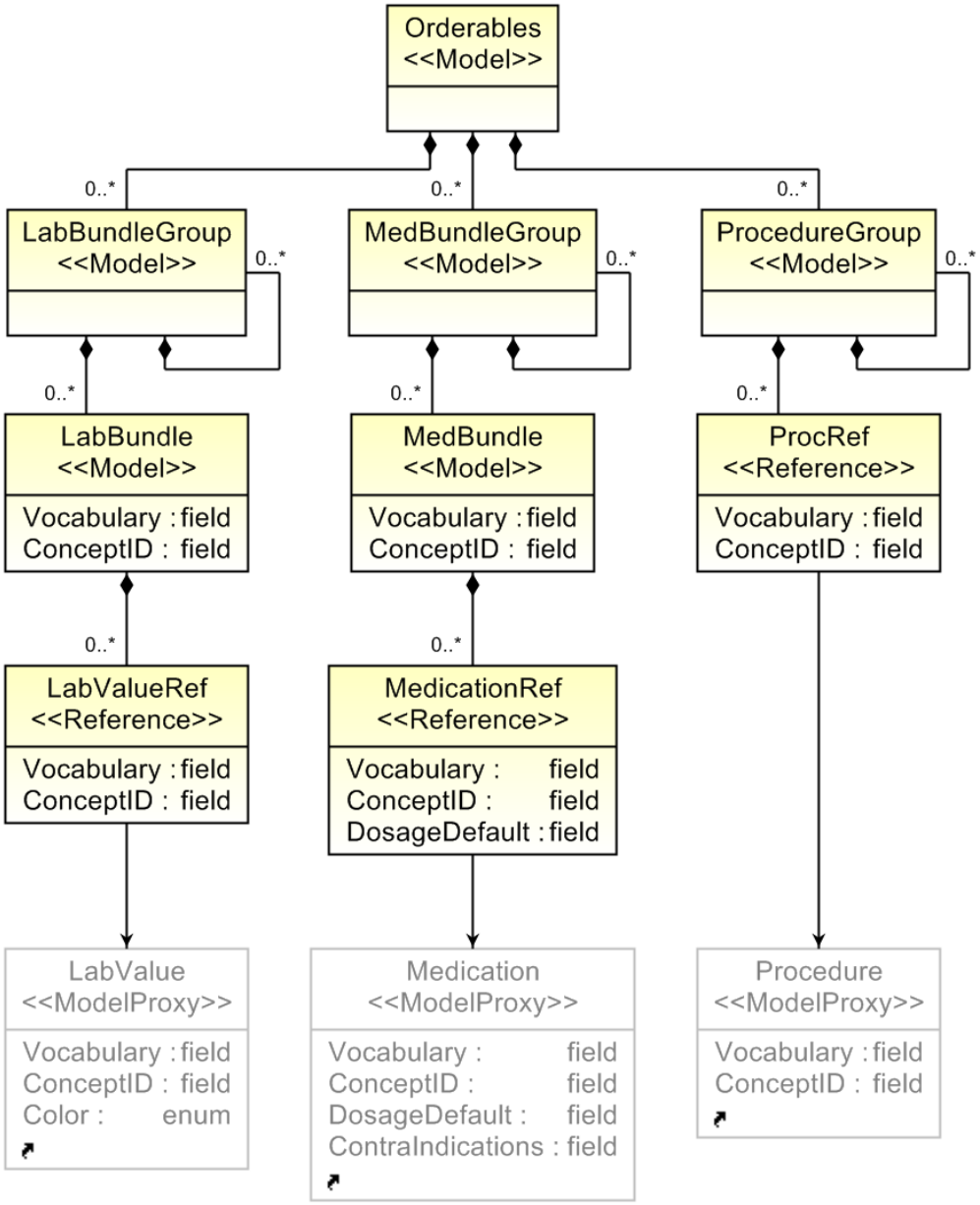
Medical Knowledge

1. General medical ontology
2. HCO-specific ontology

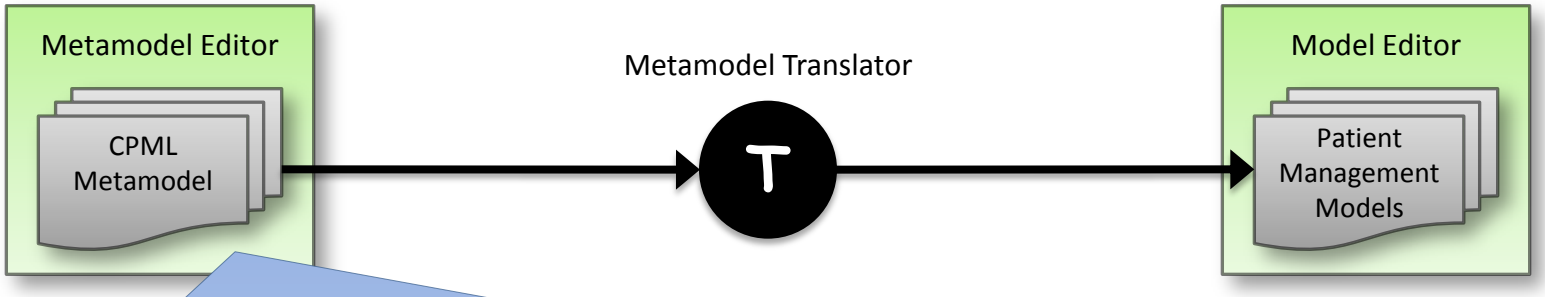
CPML



CPML: HCO-specific Ontology



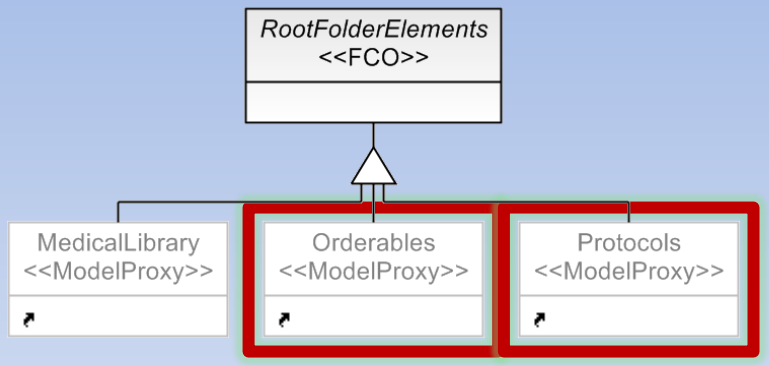
Inside the Modeling Environment 5/9



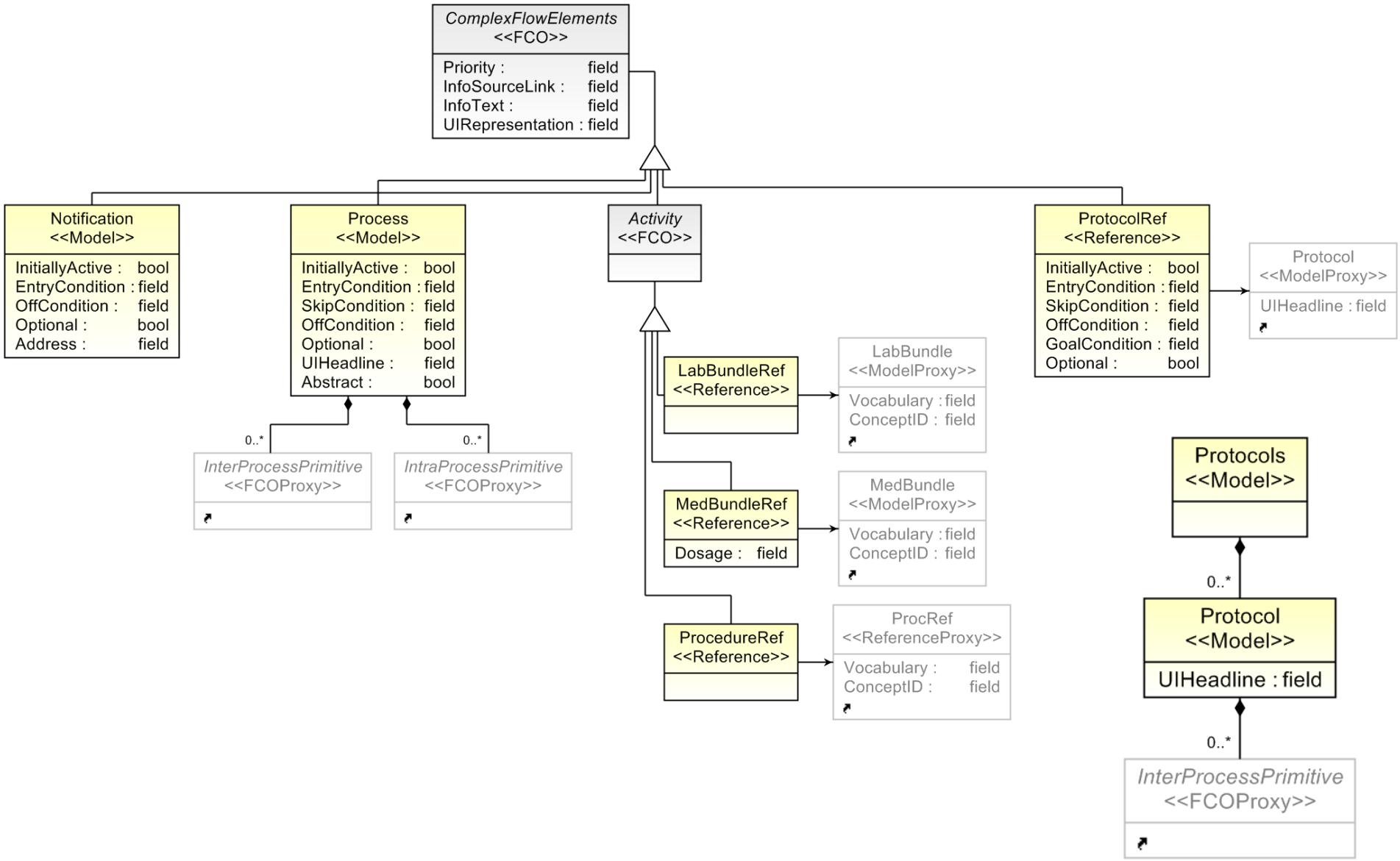
Medical Knowledge

1. General medical ontology
2. HCO-specific ontology
3. Patient management protocols
   - Conditions
   - Constraints and Well-formedness Rules
   - Execution Flow
   - Composition

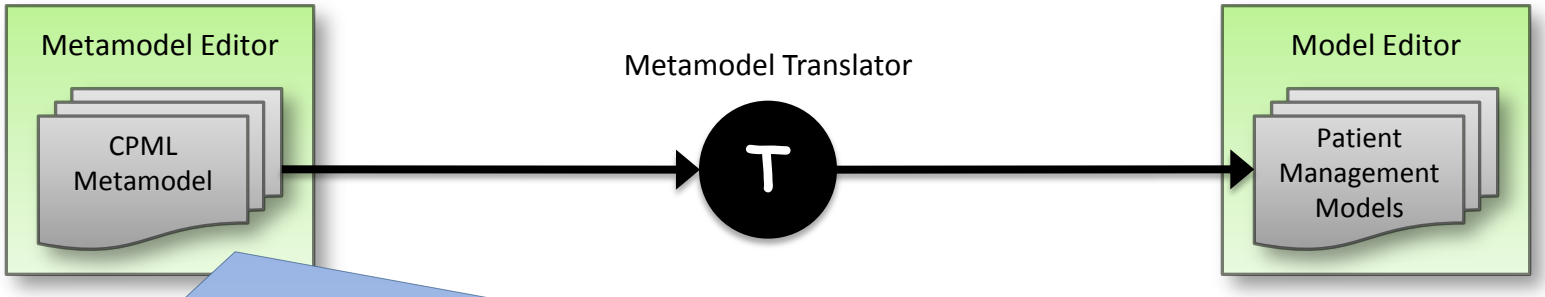
CPML



CPML: Patient management protocol



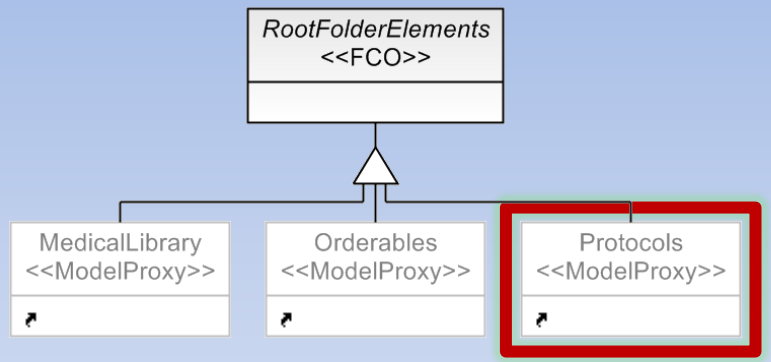
Inside the Modeling Environment 6/9



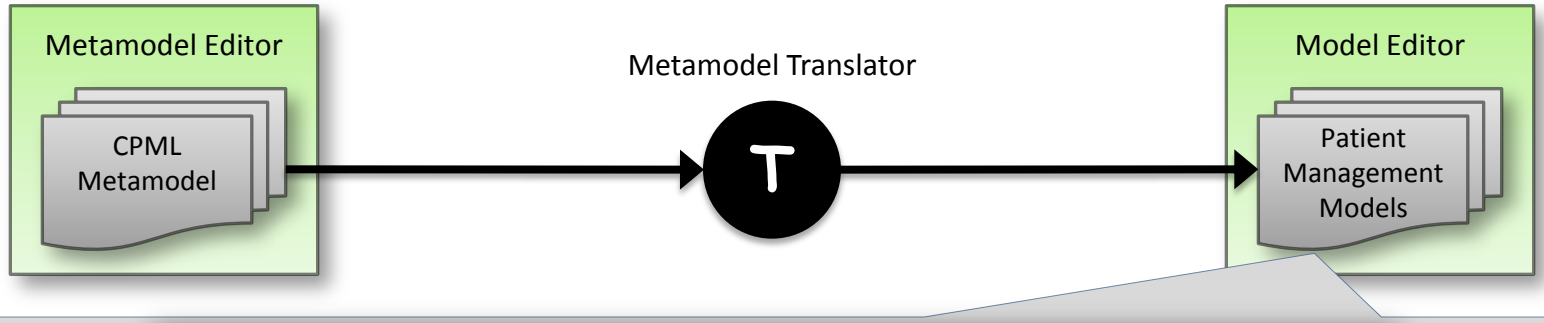
Medical Knowledge

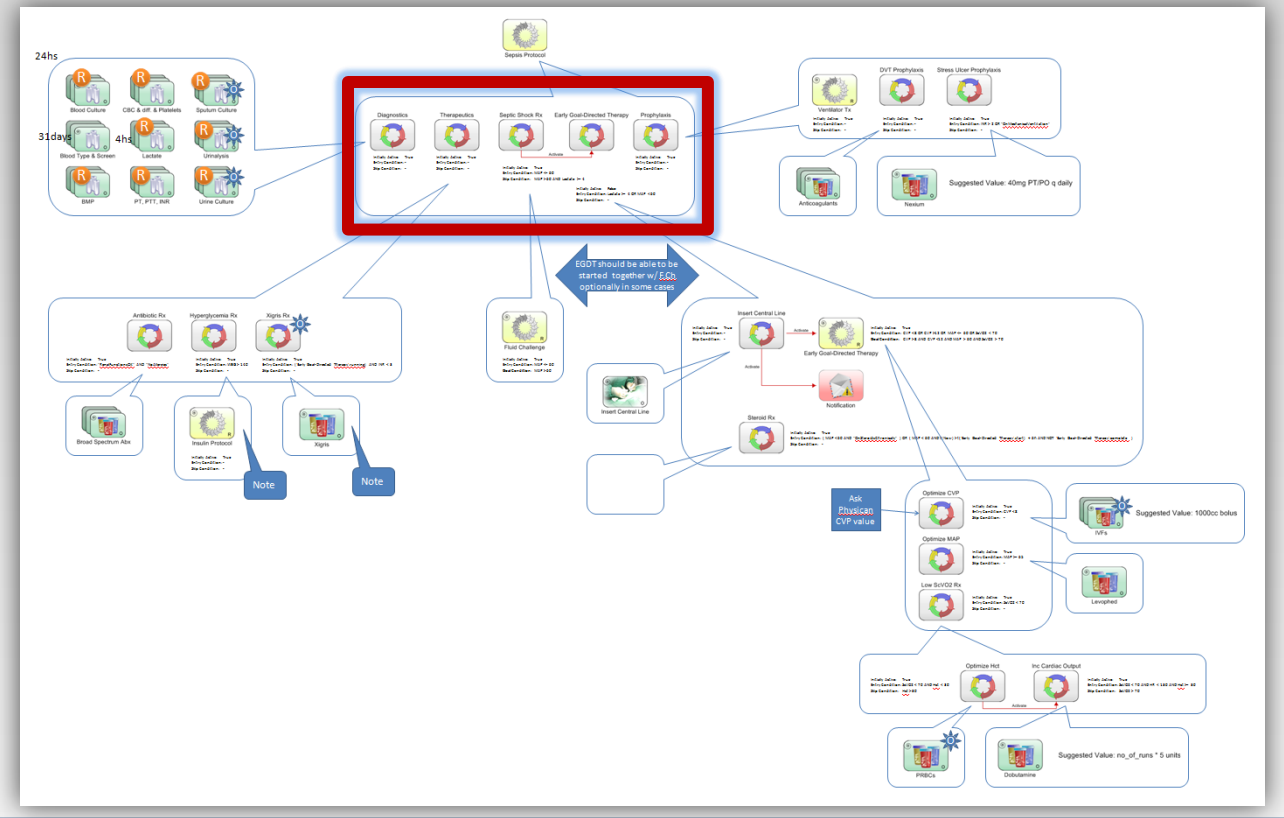
1. General medical ontology
2. HCO-specific ontology
3. Patient management protocols
   - Conditions
   - Constraints and Well-formedness Rules
   - Execution Flow
   - Composition

CPML

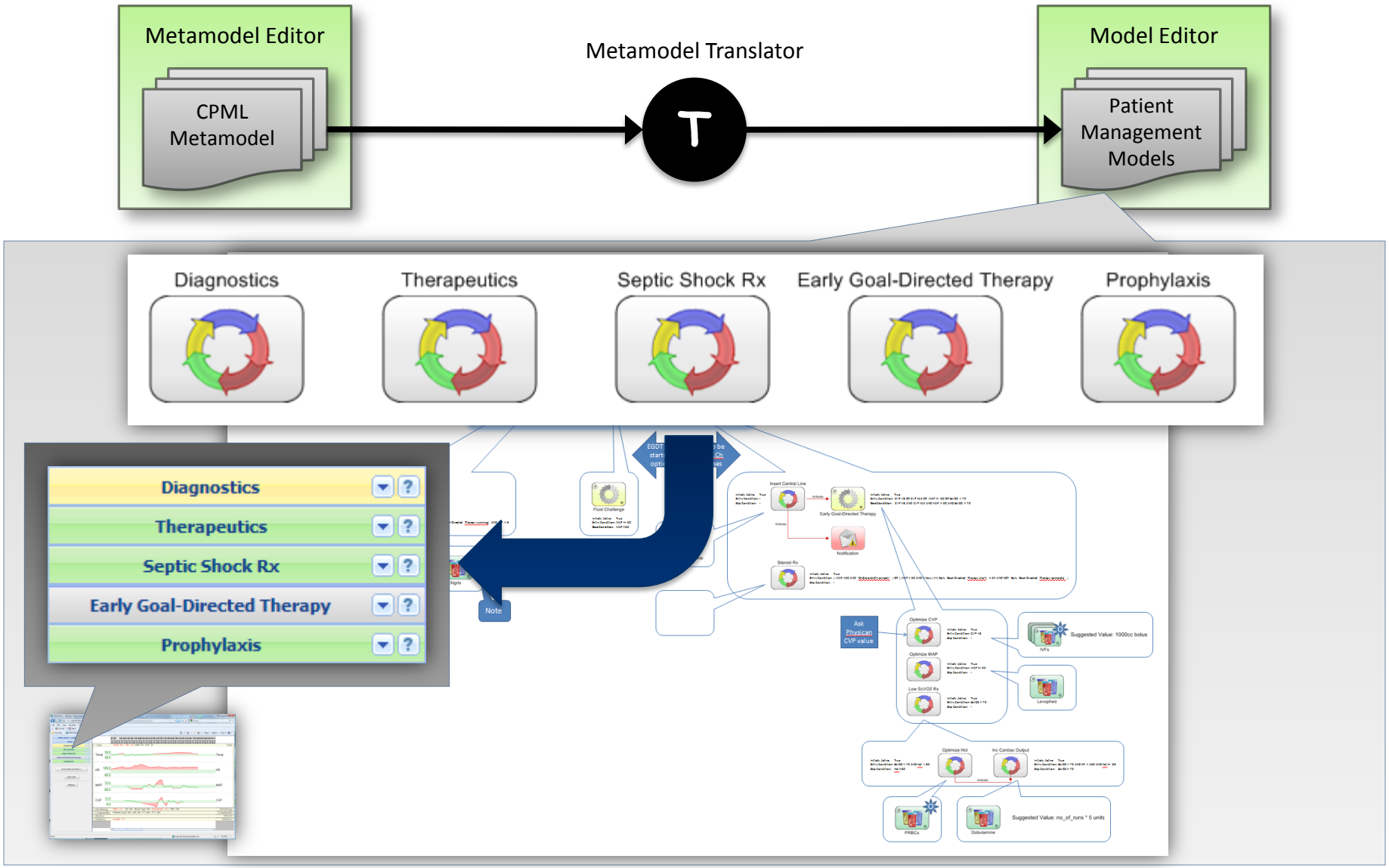


Inside the Modeling Environment 7/9

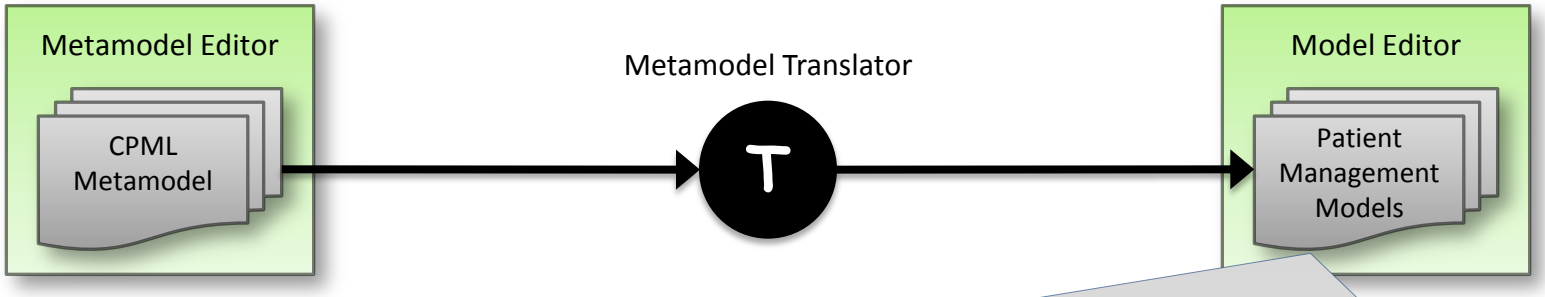


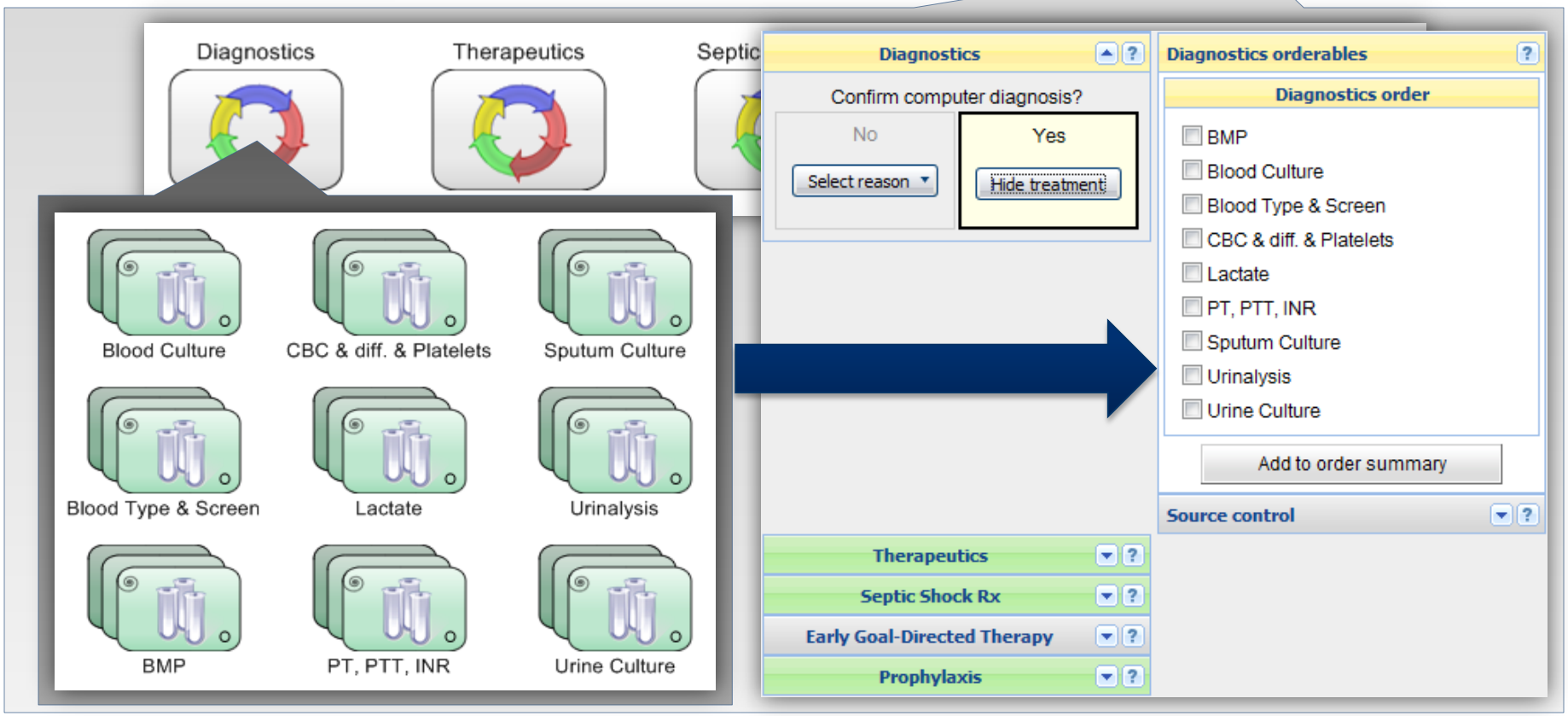


Inside the Modeling Environment 8/9



Inside the Modeling Environment 9/9

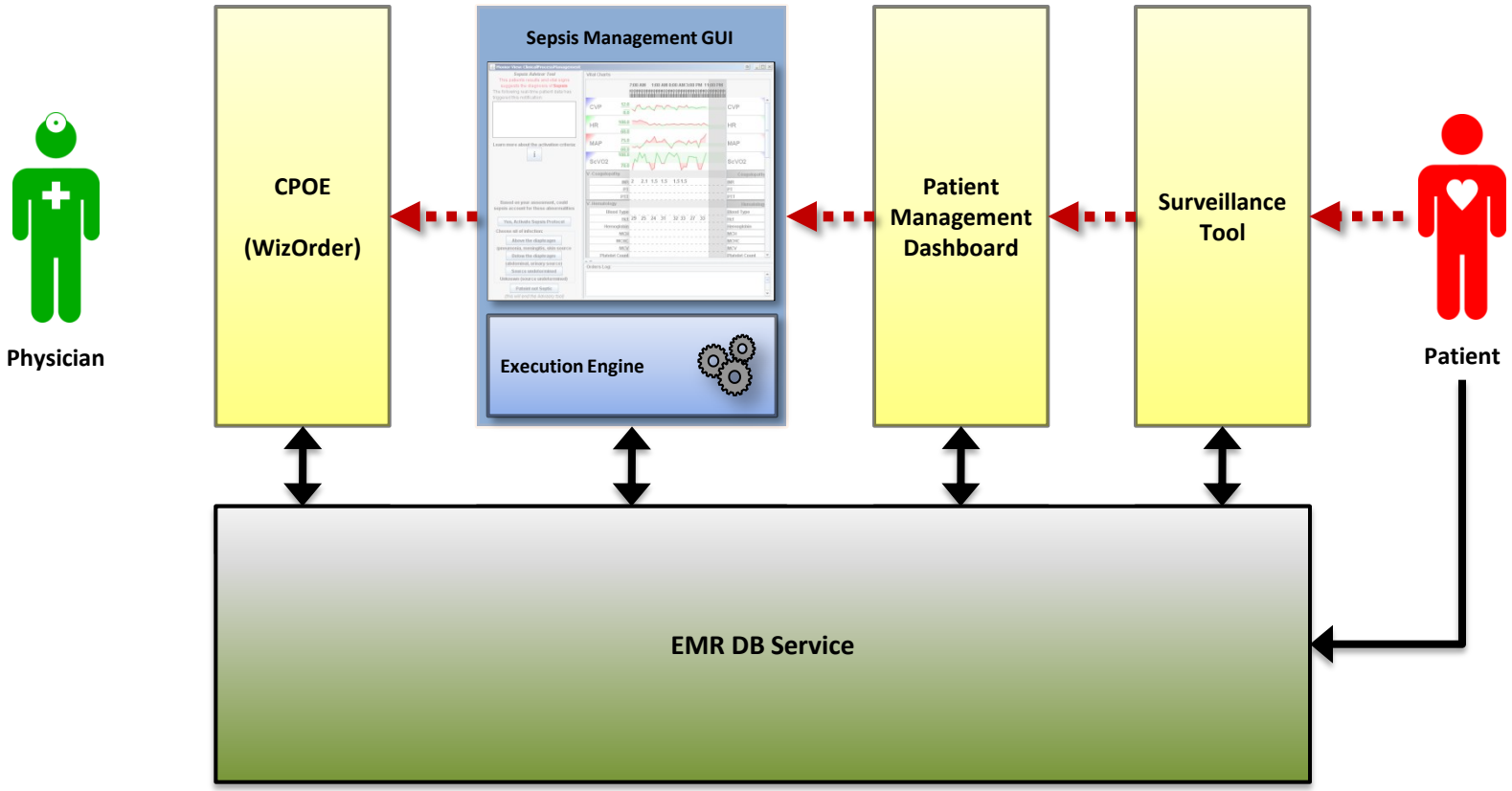




Content

1. Principles
2. Protocol modeling language for a sepsis management
3. Engine for Model-integrated patient management and decision support systems

Introduction to the CPM GUI and Execution Engine

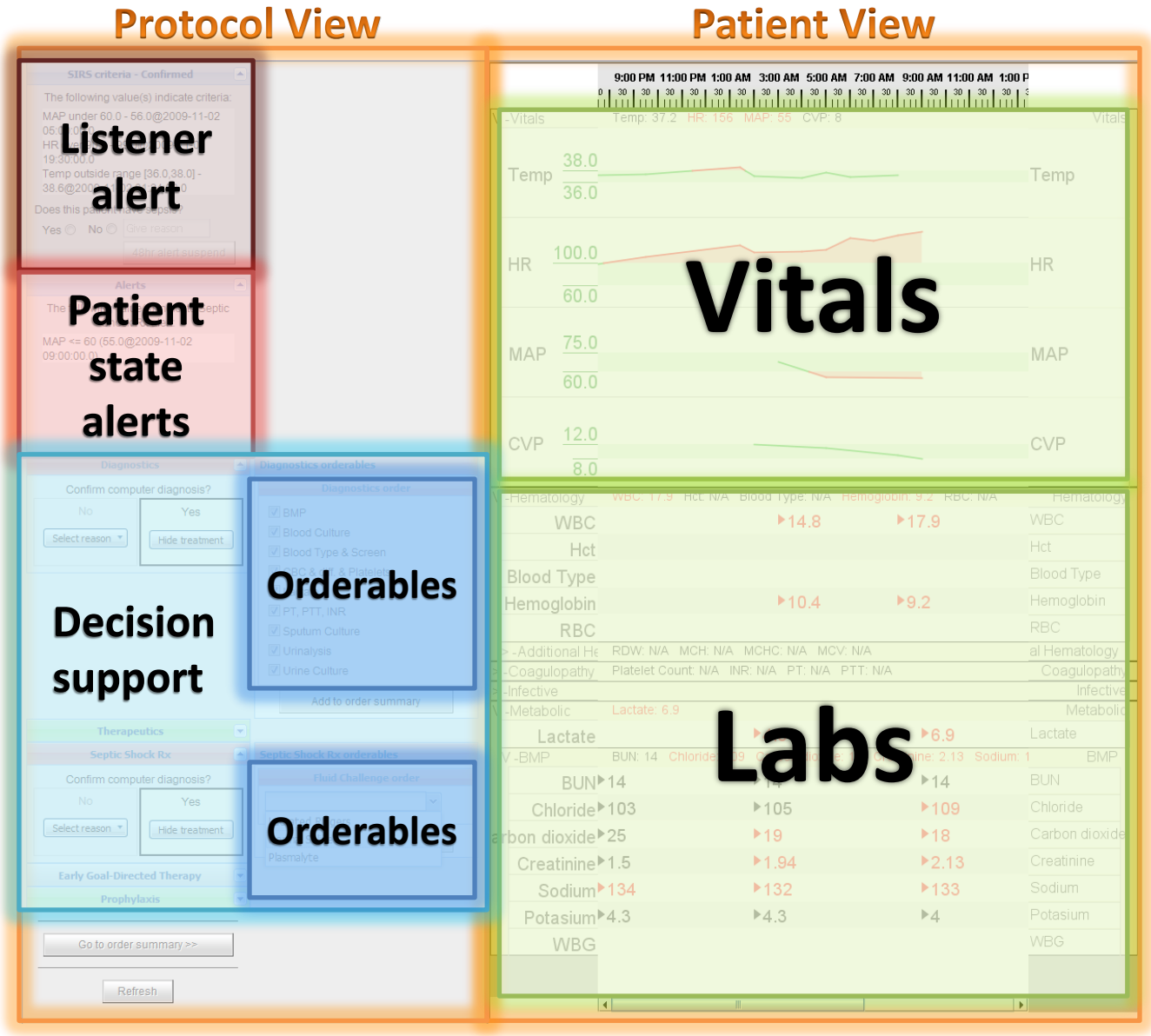


1. The Layout of the CPM User Interface
2. The Anatomy of the CPM Runtime (Execution Engine)
3. Execution Semantic of the Runtime (Execution Engine)

Layout of the CPM User Interface

Provides guideline based decision support in the context of the patient

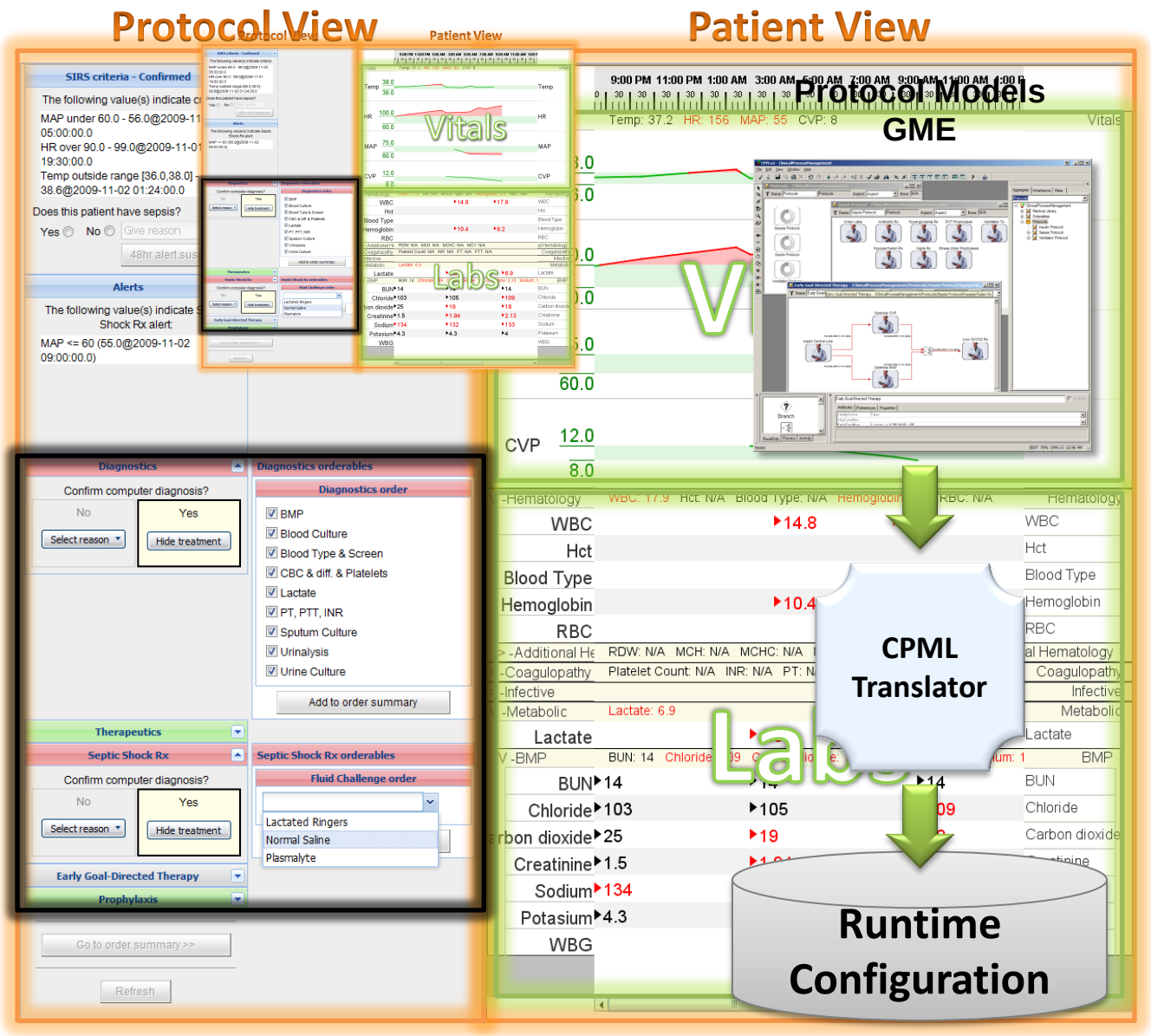
1. Patient View – shows patient health status
2. Protocol View – shows status of the personalized protocol
3. Patient Alerts - helps situation awareness
4. Listener and Orderables - Integration into Clinical workflow



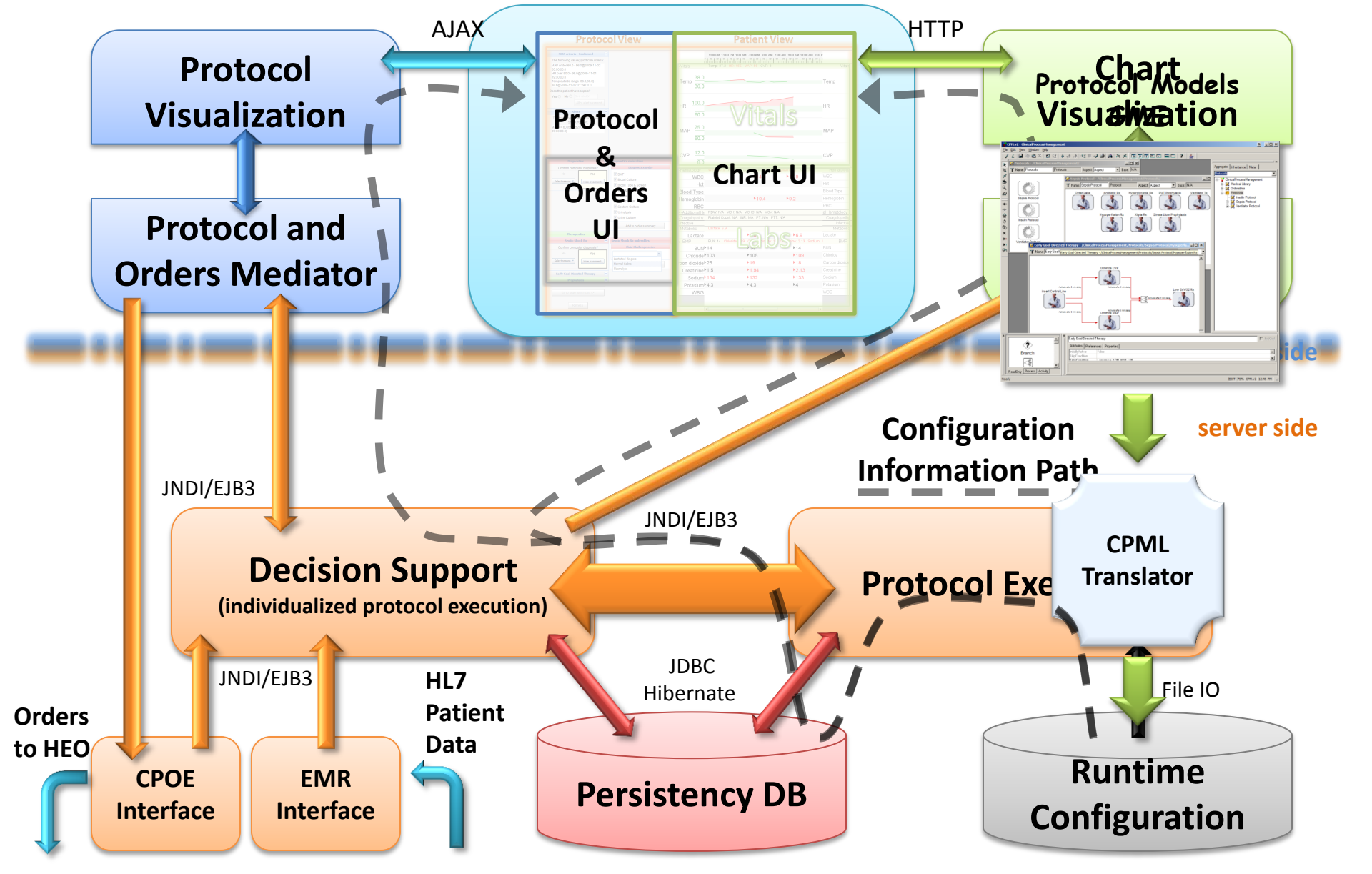
Anatomy of the CPM Runtime

Provides guideline based decision support in the context of the patient

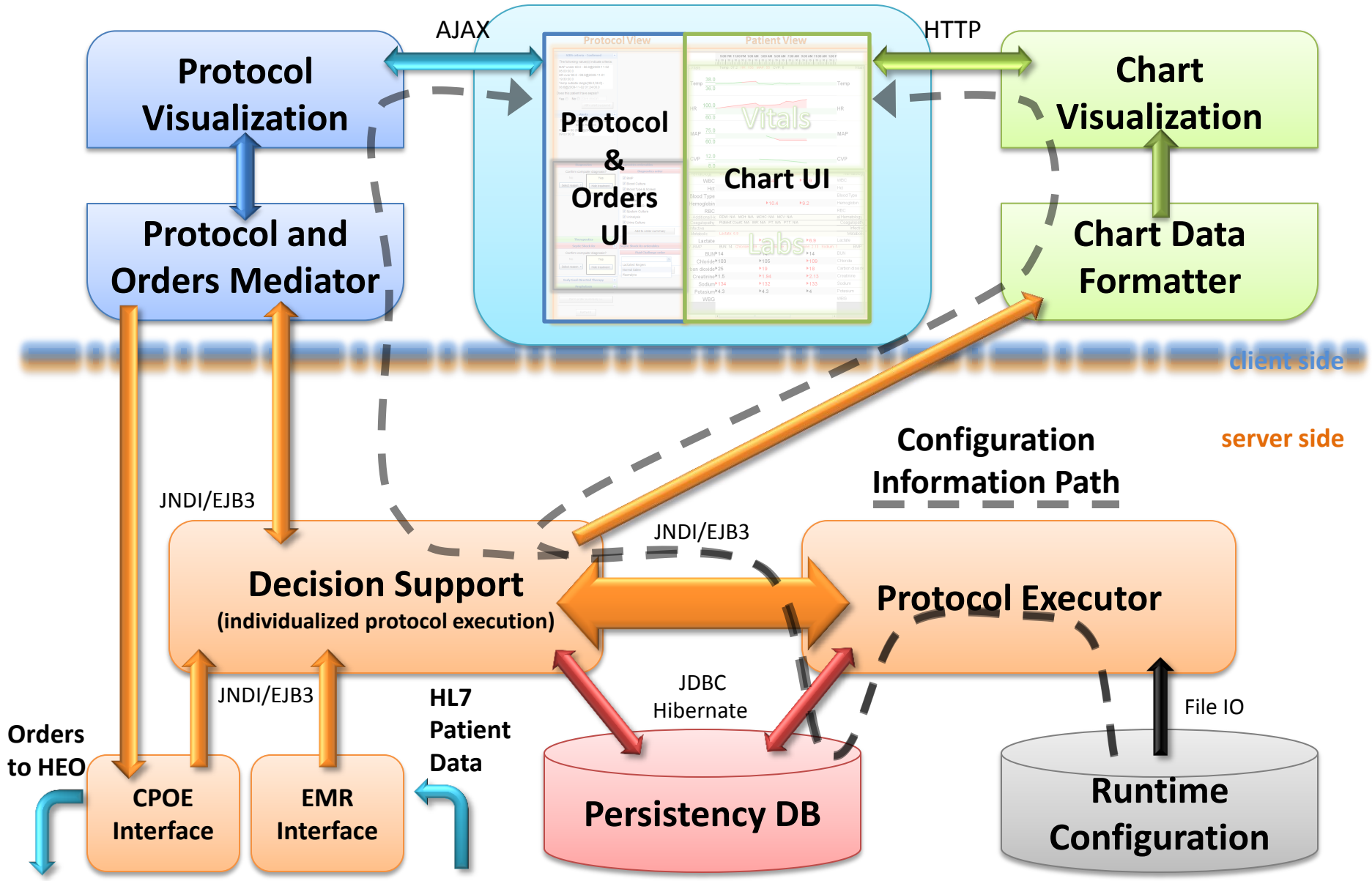
1. Patient View – shows patient health status
2. Protocol View – shows status of the personalized protocol
3. Patient Alerts - helps situation awareness
4. Listener and Orderables - Integration into Clinical workflow



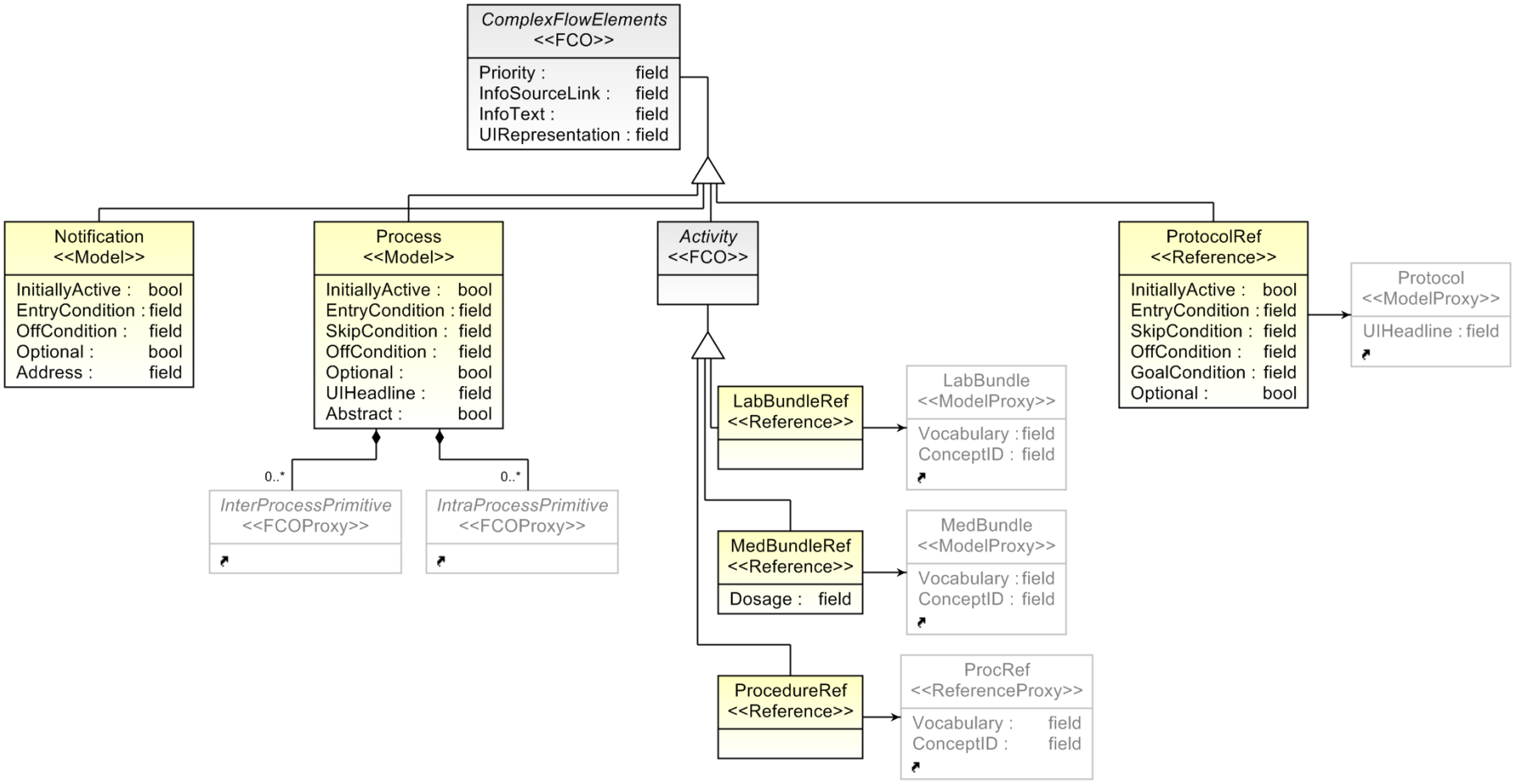
Anatomy of the CPM Runtime



Protocol Engine Semantics



Protocol Engine Semantics

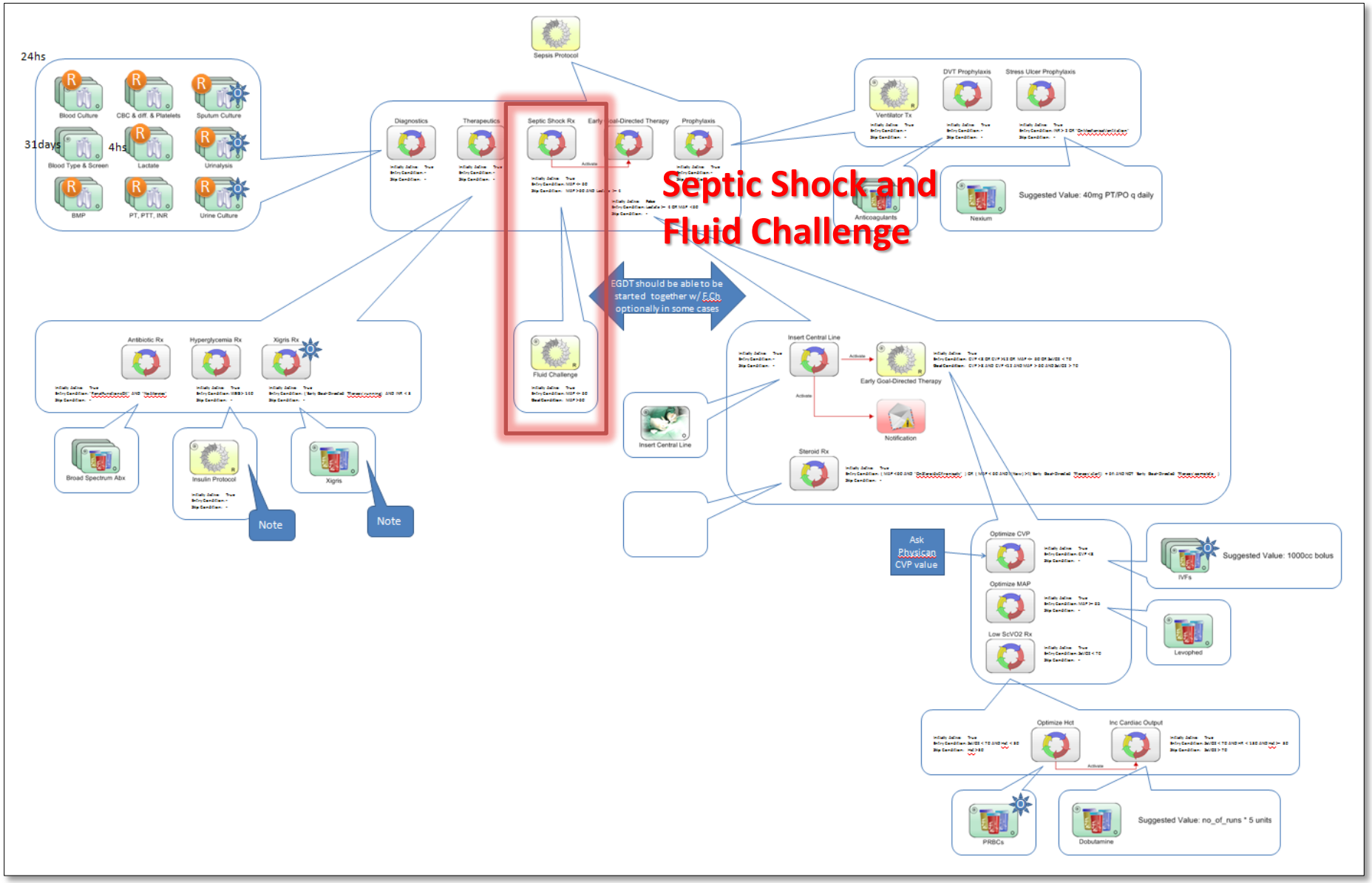


Decision Support
(individualized protocol execution)

Protocol Executor

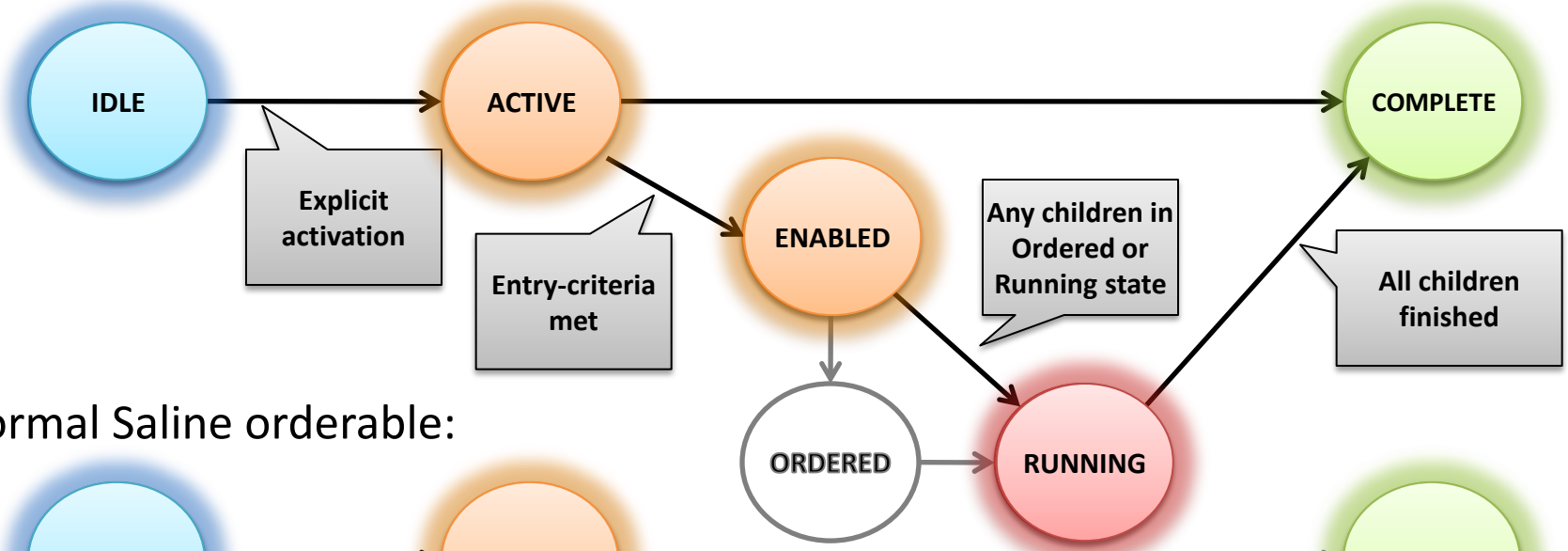
Example:

Fluid Challenge in Septic Shock

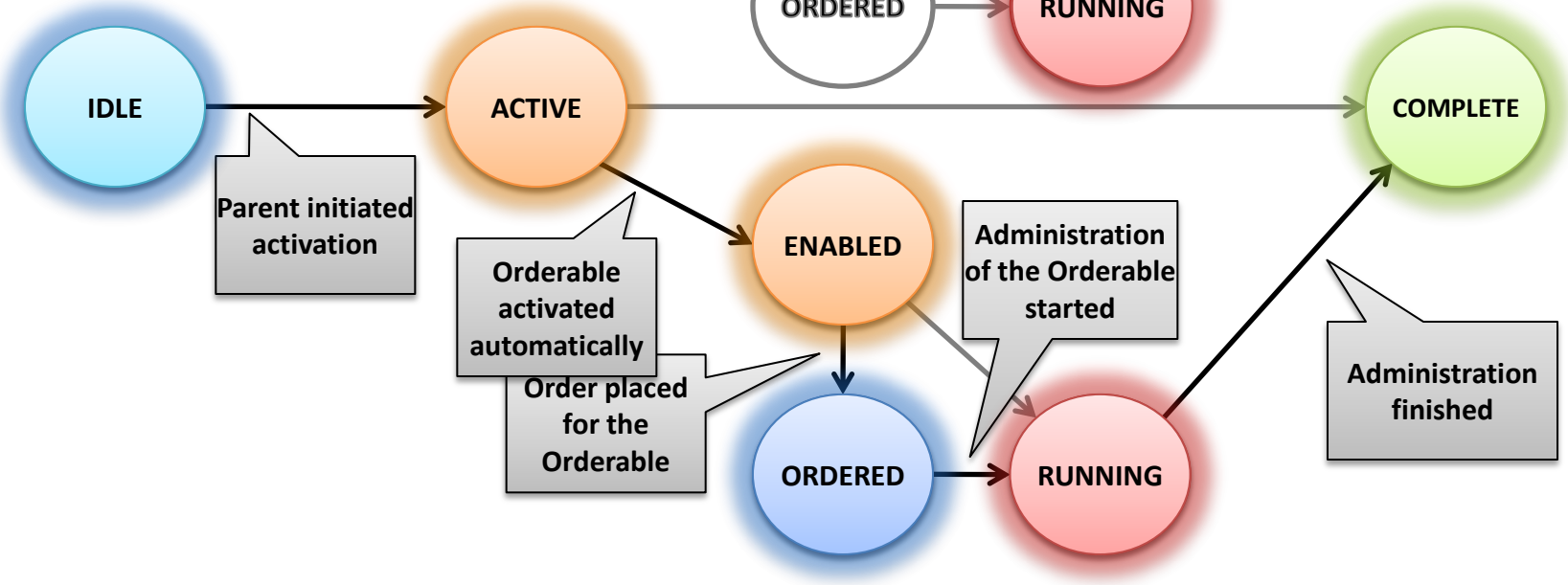


Example:
Fluid Challenge in Septic Shock

Fluid Challenge process: Entry-criteria MAP < 60



Normal Saline orderable:



Thank You

Questions?