# A Modeling Environment for Patient Portals

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# Introduction

- Clinical Information Systems (CIS) integrate IT with organizational components across healthcare environments
- Potential to increase productivity and patient safety, but…
- Must handle complex infrastructures & human interactions
  - Poorly-designed CIS can cause major system and care errors
    - Difficult to detect what, or where, errors occur
    - Not easy to audit, evolve, or reconfigure
- Goal: Provide a formal way to represent and evaluate CIS
  - Separate high-level abstractions from implementation details
  - Reason about the current, but also future, system

# Overview

- Introduction
- Background & Motivation
  - Portals
  - Service Oriented Architectures
- Methods
- Results
- Discussion
- Conclusions

# Why Portals?

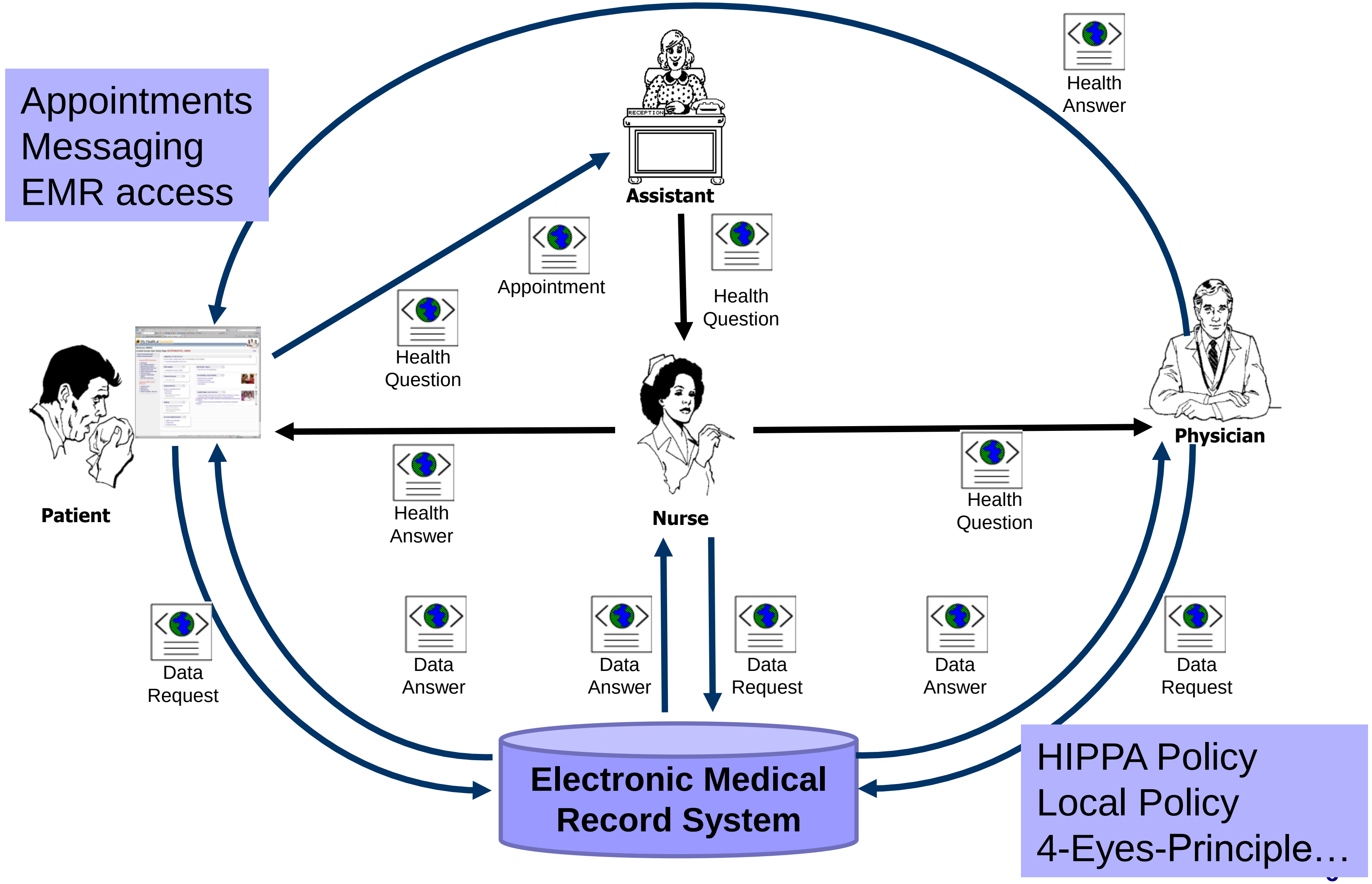
- Online availability and archiving of medical records is a complex societal challenge
  - □ Potentially affects the health and well-being of **every citizen**
  - □ Embeds the need for **critical infrastructure**
  - □ Substantial computer and network **security** requirements
  - □ **Regulatory** and ethical mandates for data privacy protection

- Growing trend in healthcare to address the challenge is the **"patient portal"**
  - □ Secure and personalized customer services over the **Internet**
  - □ Opportunity to deploy **individualized** services
  - □ Can implement **diverse** health-related functions
  - □ **Patients are proactive** in the maintenance of their medical records and care decisions

# Portals, Privacy, Security, & Access

- NIH has supported projects to provide patients with secure access to their medical records via the Internet for over a decade
  - PCASSO (UCSD)
  - PATCIS (Columbia)
  - My Doctor’s Office (Colorado)
  - Web messaging (UC Davis)
- Summary of Findings:
  - Personal health information has value to patients
  - Patients want electronic access
  - Providers fear being overwhelmed by patient interactions and ‘information toxicity’ will occur when patients see technical info they don’t understand
  - Security breaches not reported (yet) in portal systems

# Behind the Portal: Workflows & Services



Appointments
Messaging
EMR access

HIPPA Policy
Local Policy
4-Eyes-Principle…

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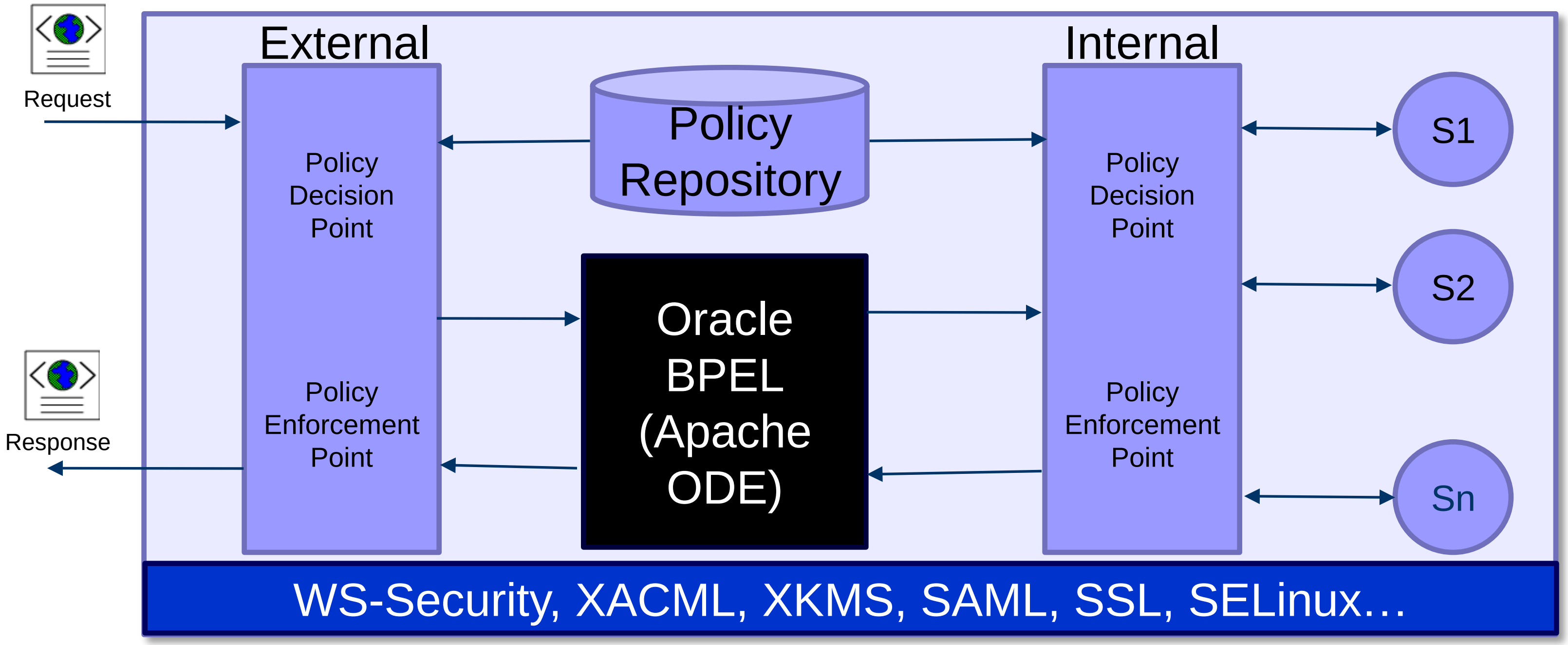
# Existing Architecture & Framework

- Service Oriented Architectures (SOA)
  - Rely on existing standards, such as SOAP, WSDL, WS-Security, XACML
  - Exploit open-source implementation of integration platforms (Active BPEL, Apache ODE)



Standards do not guide integration of security technologies with applications

# SOA, Models & the Clinical Realm

- SOA is applicable to existing CIS*
  - Aids the design of medical decision support systems
  - Facilitates the integration of standards, such as HL7

- Model-based approaches support documentation, communication, and standardized development of health information systems**
  - Model-driven architectures: Generic approach isolates technology changes from logic, but no unified application;
  - Business Process Modeling: Process abstraction via standardized platforms, but excludes organizational resources, data typing, & business rules

*Kawamoto K, Lobach D. JAMIA. 2007.

**Tuomainen M, et al. MEDINFO. 2007.

# Overview

- Introduction
- Background & Motivation
- Methods
  - □ Our Software: MODECIS
  - □ MODECIS Abstractions
  - □ MODECIS Infrastructure
- Results
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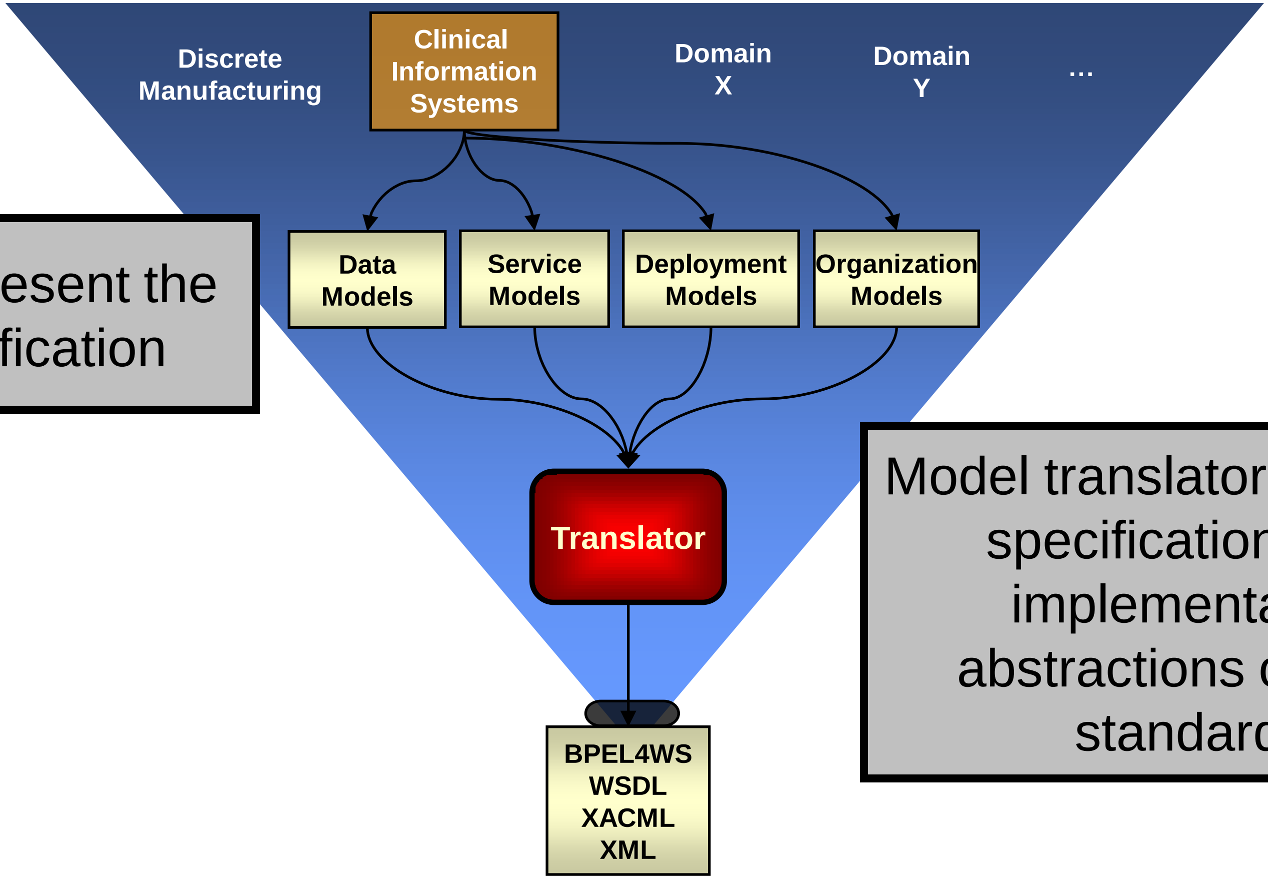
# MODECIS: Model-based Design Environment for Clinical Information Systems

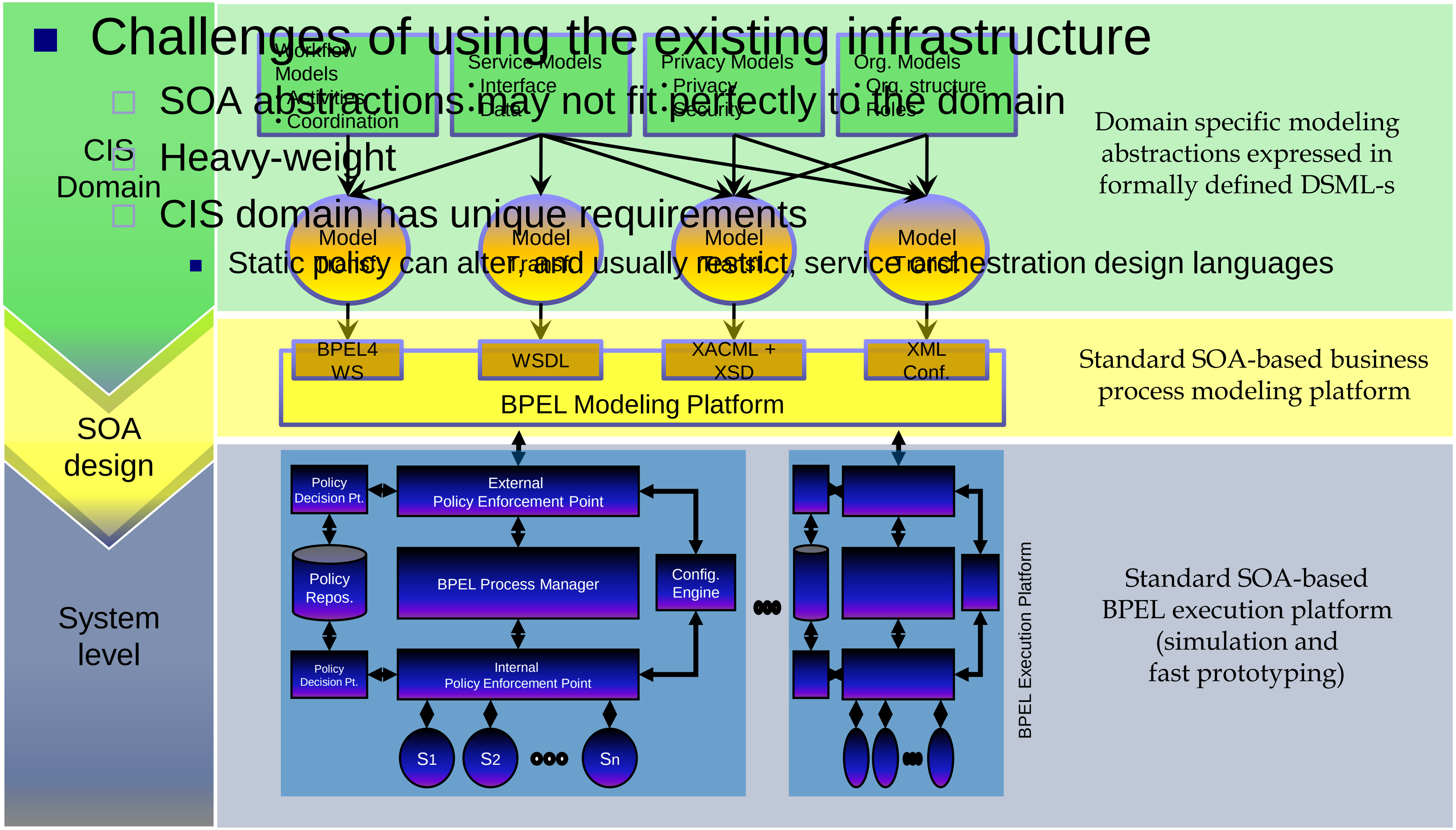
Models represent the CIS specification



Model translators map the specification onto implementation abstractions of SOA standards

# General Architecture

- Challenges of using the existing infrastructure
  - SOA abstractions may not fit perfectly to the domain
  - Heavy-weight
  - CIS domain has unique requirements
    - Static policy can alter, and usually restrict, service orchestration design languages

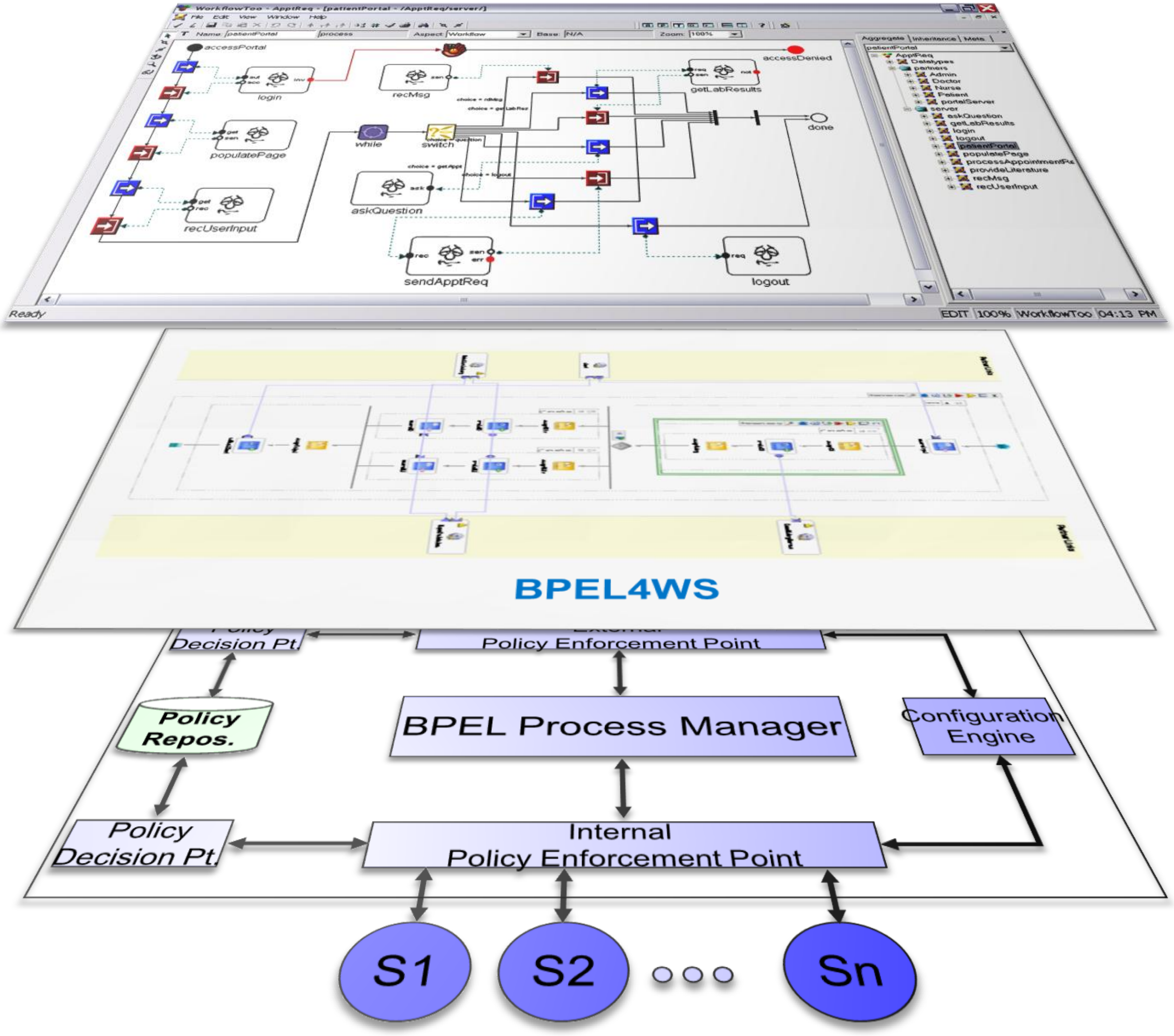


Domain specific modeling abstractions expressed in formally defined DSML-s

Standard SOA-based business process modeling platform

Standard SOA-based BPEL execution platform (simulation and fast prototyping)

# Layers of Abstraction



Domain specific modeling abstractions expressed in formally defined DSML-s. TRUST research focus

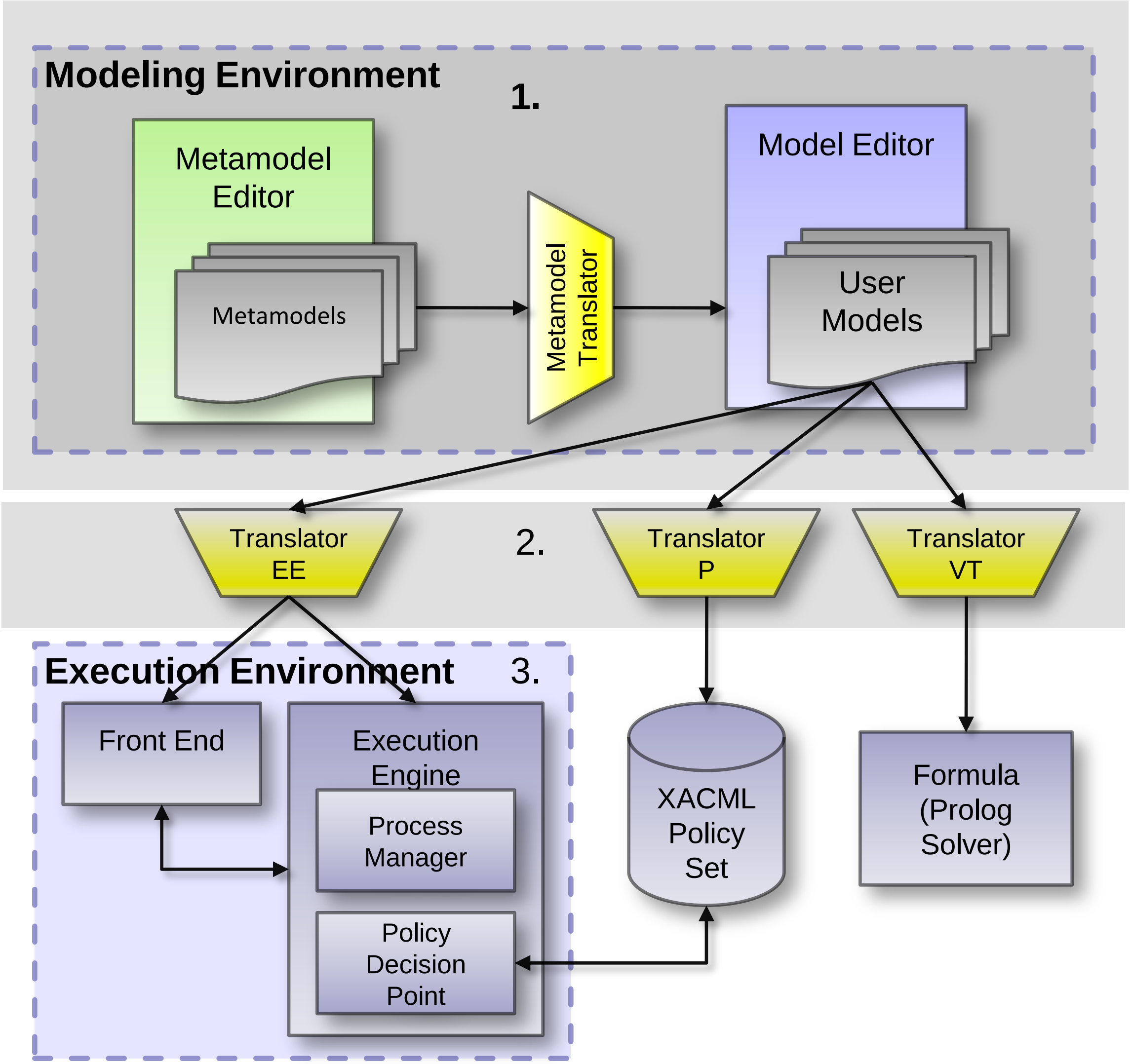
SOA-based, standard, business process modeling platform

SOA-based, standard, execution platform (simulation/fast proto.tng)

# From Language Design to Workflow Execution

1. Via model Based Design (MBD) we express domain specific modeling (DSM) abstractions as formal language (DSML)
2. Configure *Generic Modeling Environment* (*GME*), based on DSML, to build domain specific models
3. Models are translated to Service Oriented Architectures (SOA) standards, including
    - Business Process Execution Language (BPEL)
    - Web Services Definition Language (WSDL)
    - eXtensible Access Control Markup Language (XACML)
4. Translated models can be used to drive an execution engine / platform
5. Models can also be translated for verification or simulation system

# MODECIS Architecture



**1. Modeling environment**

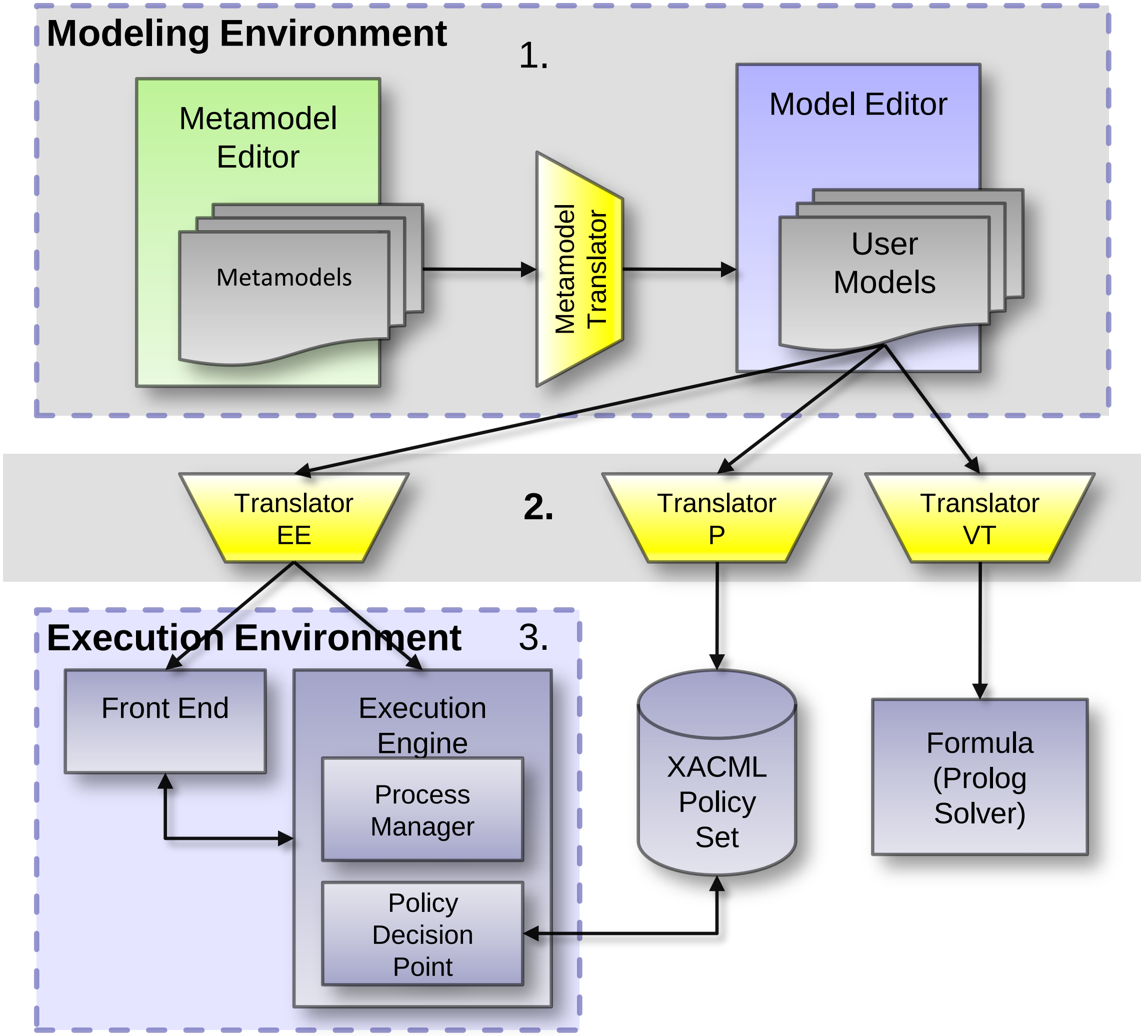
"Metamodels" define the domain specific modeling language and define the abstract syntax of domain models

User models represent a specific CIS instance through a set of modeling abstractions

**Technology Applied**

Generic Modeling Environment (GME)

# MODECIS Architecture



## 2. Translators

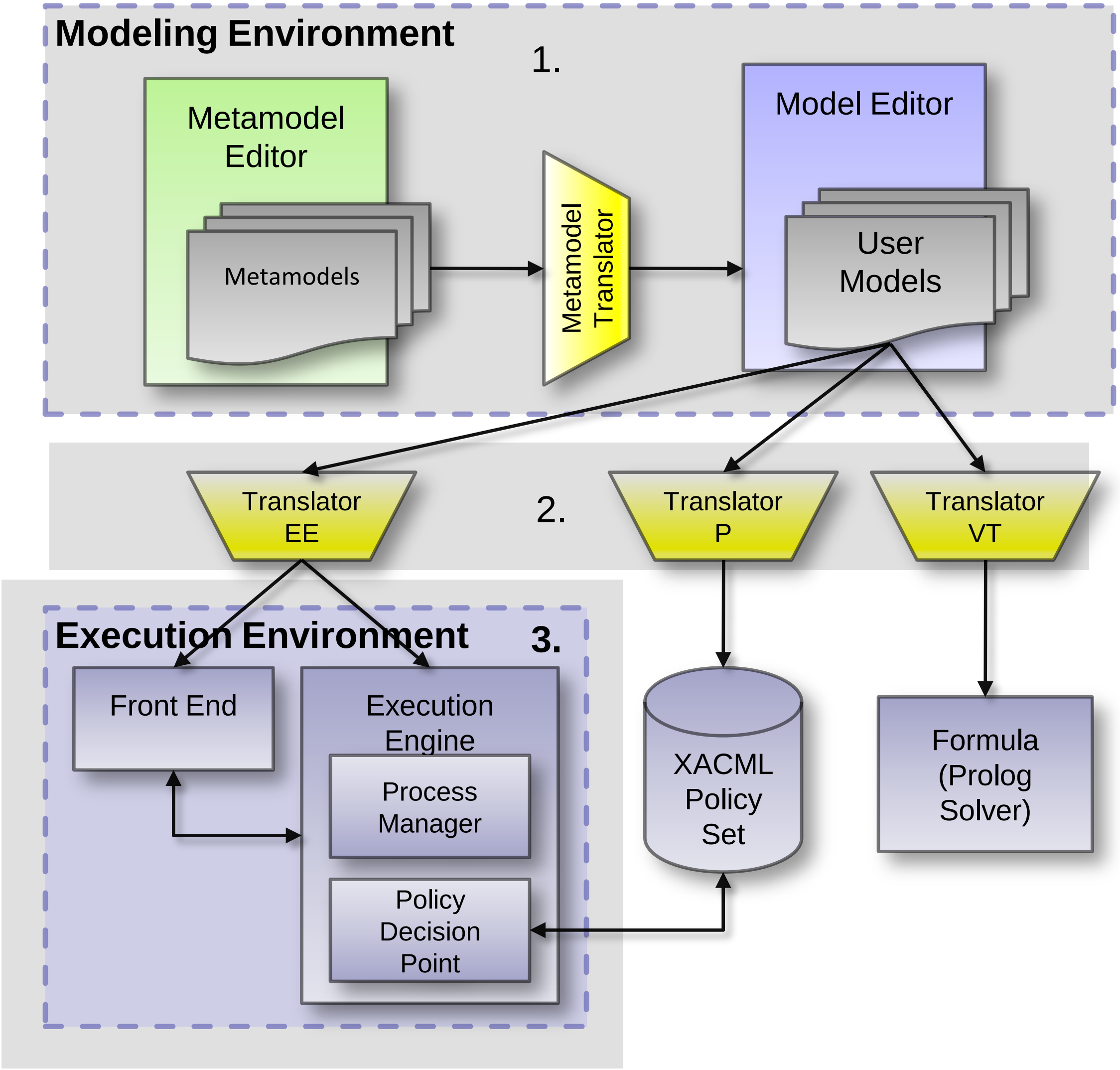
Transform user models into BPEL deployment code

Create XACML policy decision points

## Technology Applied

- GREAT
- Builder Object Network (BON) interface

# MODECIS Architecture



**3. Execution Environment**

BPEL execution engine

Policy execution engine

Web server for user interaction

**Technology Applied**

- OracleBPEL
- ActiveBPEL
- SunXACML

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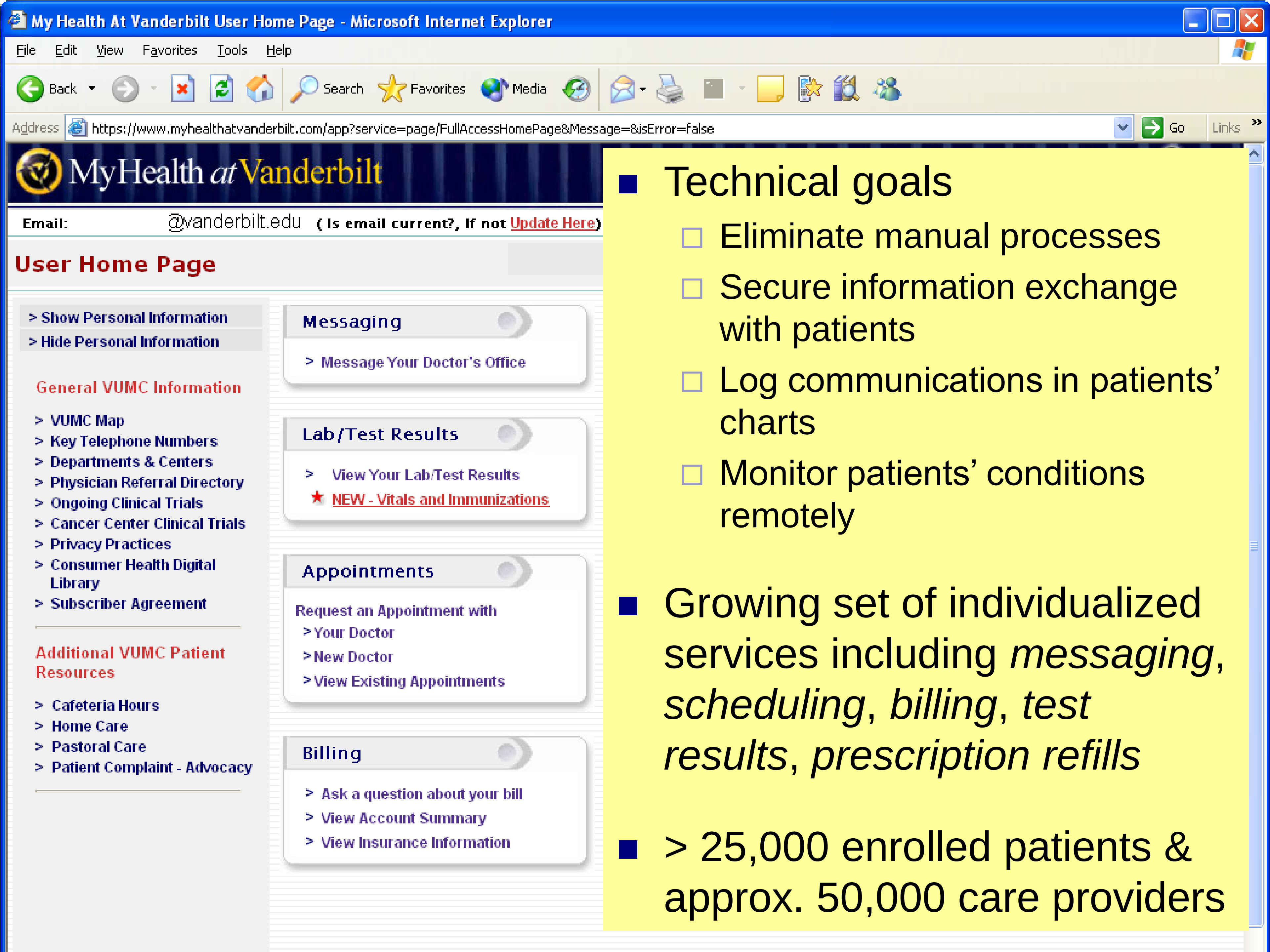
My Health At Vanderbilt User Home Page - Microsoft Internet Explorer
File
Edit
View
Favorites
Tools
Help
Back
Search
Favorites
Media
Address
Go
Links

https://www.myhealthatvanderbilt.com/app?service=page/FullAccessHomePage&Message=&isError=false

MyHealth *at* Vanderbilt

**Email:** @vanderbilt.edu ( Is email current?, If not Update Here)

User Home Page

> Show Personal Information
> Hide Personal Information

General VUMC Information

> VUMC Map
> Key Telephone Numbers
> Departments & Centers
> Physician Referral Directory
> Ongoing Clinical Trials
> Cancer Center Clinical Trials
> Privacy Practices
> Consumer Health Digital Library
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Additional VUMC Patient Resources

> Cafeteria Hours
> Home Care
> Pastoral Care
> Patient Complaint - Advocacy

Messaging

> Message Your Doctor's Office

Lab/Test Results

> View Your Lab/Test Results
★ NEW - Vitals and Immunizations

Appointments

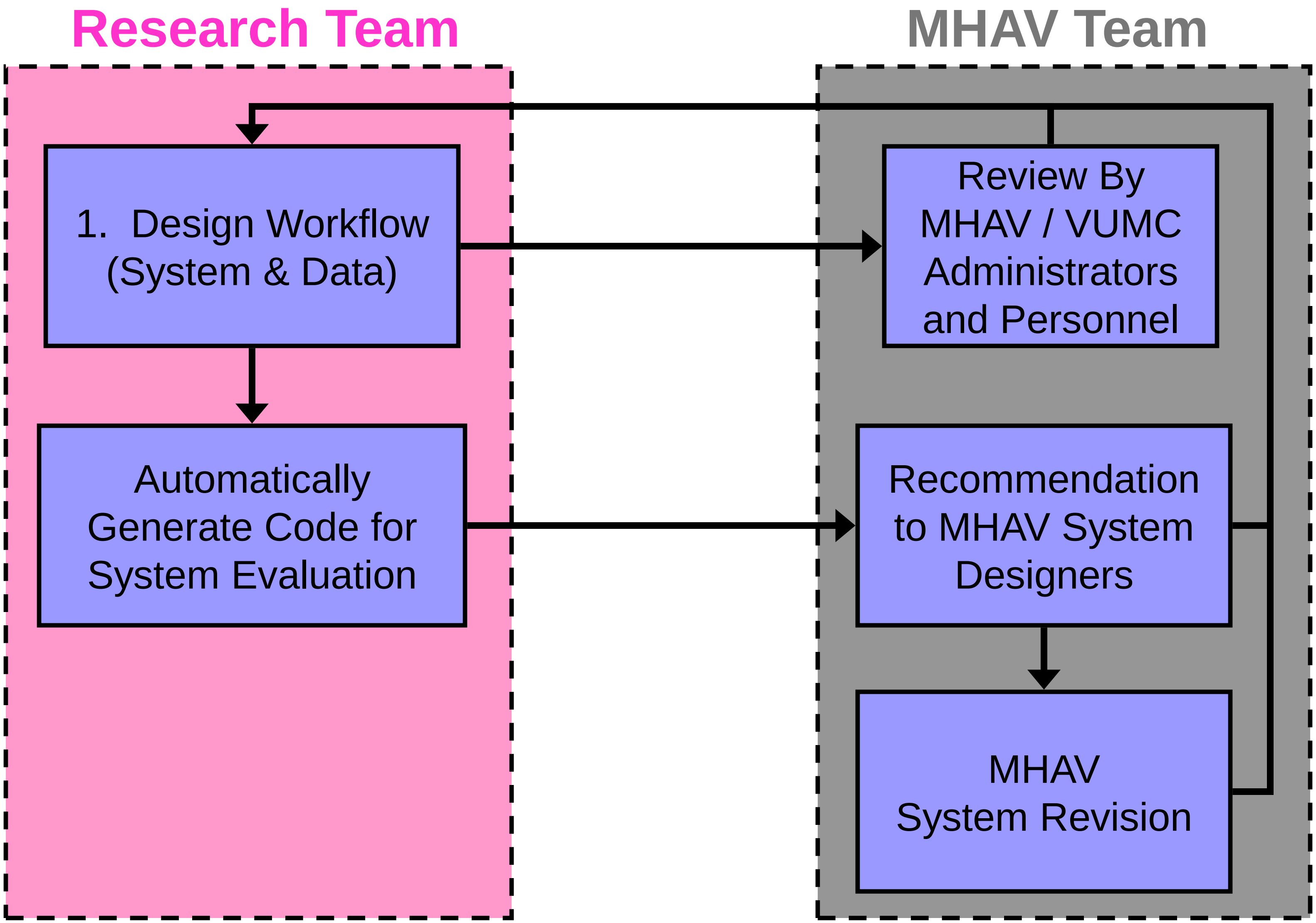
Request an Appointment with
>Your Doctor
>New Doctor
>View Existing Appointments

Billing

> Ask a question about your bill
> View Account Summary
> View Insurance Information

- Technical goals
  - Eliminate manual processes
  - Secure information exchange with patients
  - Log communications in patients' charts
  - Monitor patients' conditions remotely
- Growing set of individualized services including *messaging*, *scheduling*, *billing*, *test results*, *prescription refills*
- > 25,000 enrolled patients & approx. 50,000 care providers

# Design and Development Process



Research Team

1. Design Workflow (System & Data)

Automatically Generate Code for System Evaluation

MHAV Team

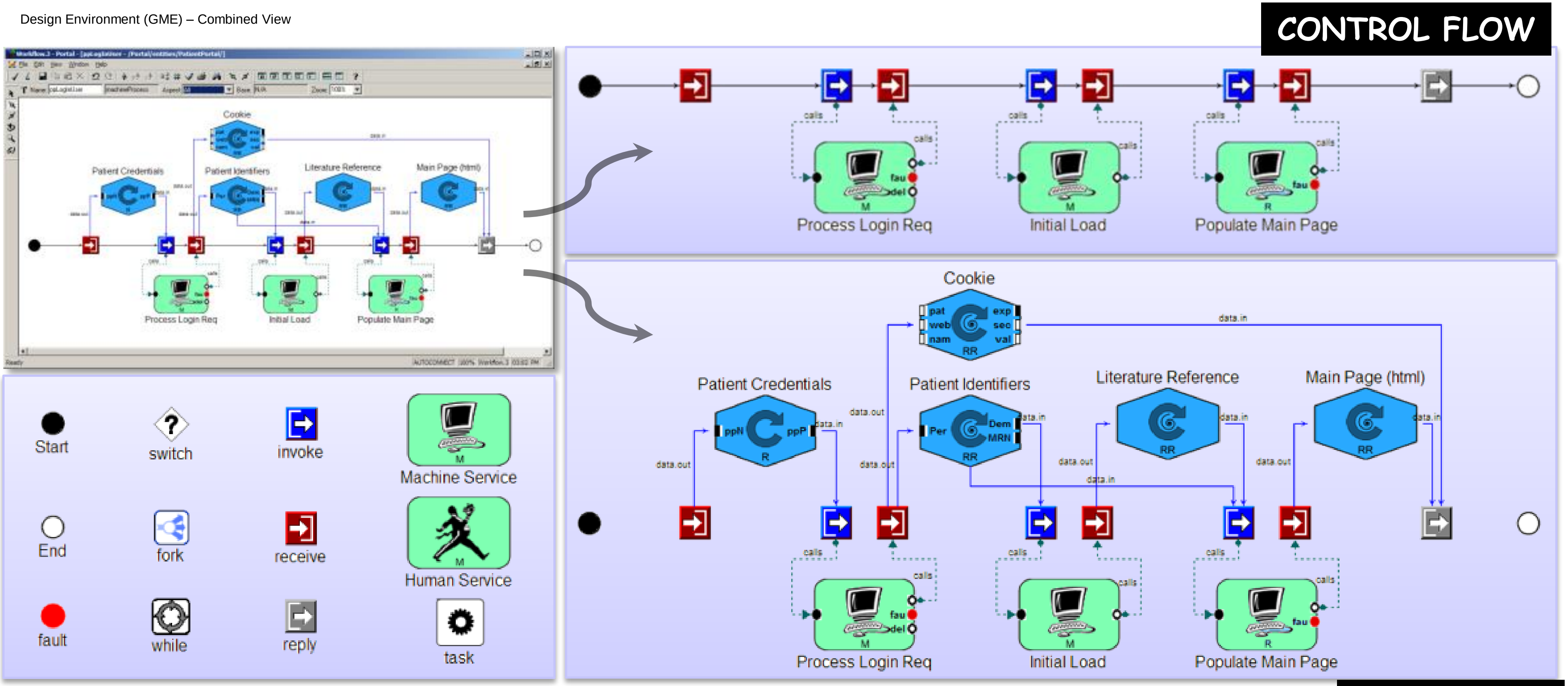
Review By MHAV / VUMC Administrators and Personnel

Recommendation to MHAV System Designers

MHAV System Revision

# Service Abstractions

Design Environment (GME) – Combined View



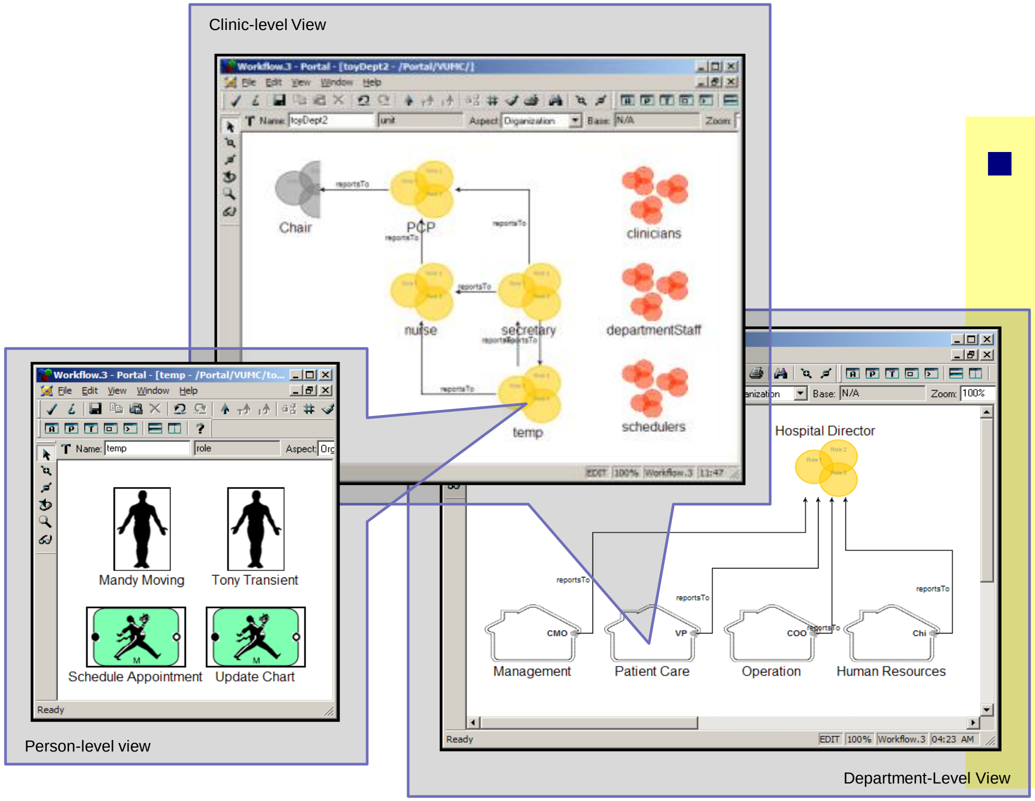
Component View

DATA FLOW

- Service models capture business logic
  - □ Workflows of hospital staff and portal-related software
  - □ Control flows for service invocations
  - □ Data flow for transmission of information

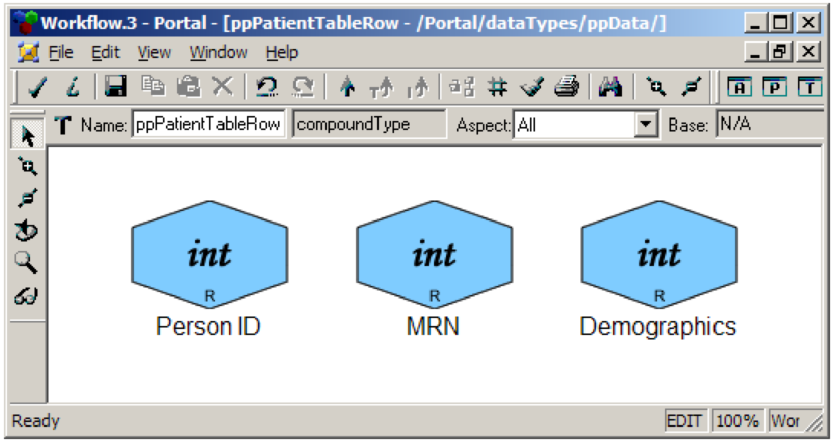
# Organizational Abstractions

- **Interdepartmental**: communication between separate clinical entities
  - e.g. hardware servers and human care providers in different departments (referrals)



- **Intradepartmental**: information flows within single clinical department
  - Entities modeled with multiple roles to reflect assignments to multiple departments
  - Ex: a billing assistant that works for the gastroenterology and emergency depts.

# Data Abstractions

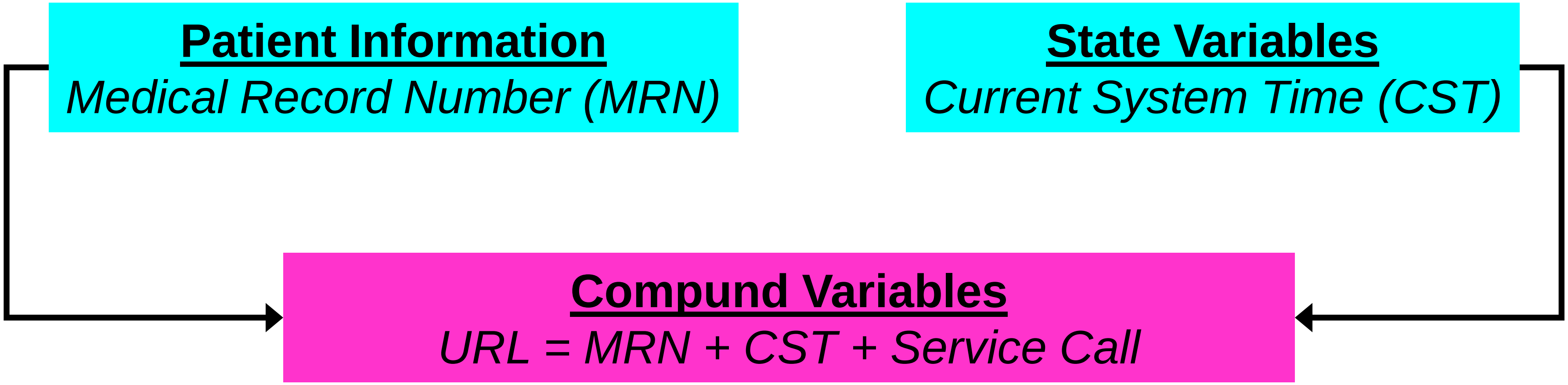


Workflow.3 - Portal - [ppPatientTableRow - /Portal/dataTypes/ppData/]
File Edit View Window Help
Ready
EDIT
100%
Wor
int
R

Name: ppPatientTableRow
compoundType
Aspect: All
Base: N/A

Person ID
MRN
Demographics

- Data models
  - Specify the information in the CIS
  - Simple and compound data types in hierarchical form

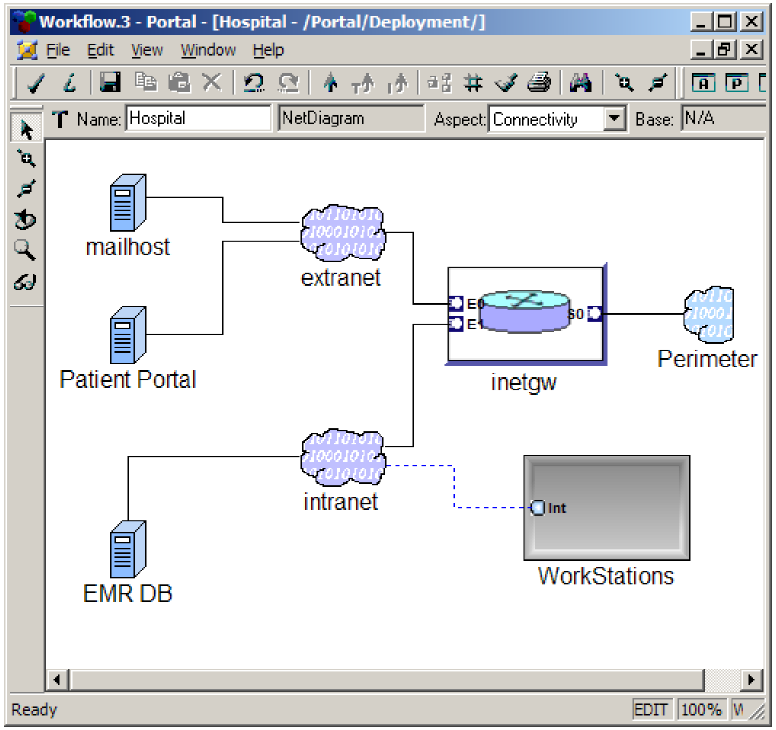


**Patient Information**
*Medical Record Number (MRN)*

**State Variables**
*Current System Time (CST)*

**Compund Variables**
*URL = MRN + CST + Service Call*

# Deployment Abstractions



Workflow.3 - Portal - [Hospital - /Portal/Deployment/]

Name: Hospital

NetDiagram

Aspect: Connectivity

Base: N/A

Ready

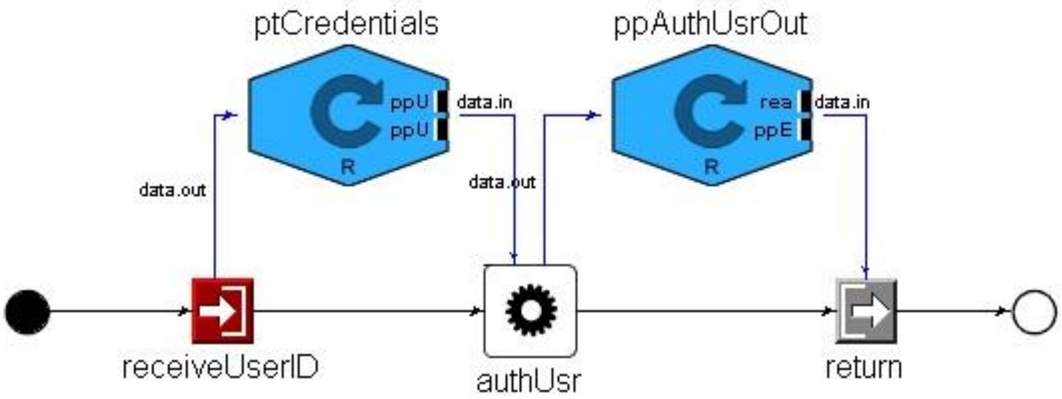
EDIT

100%

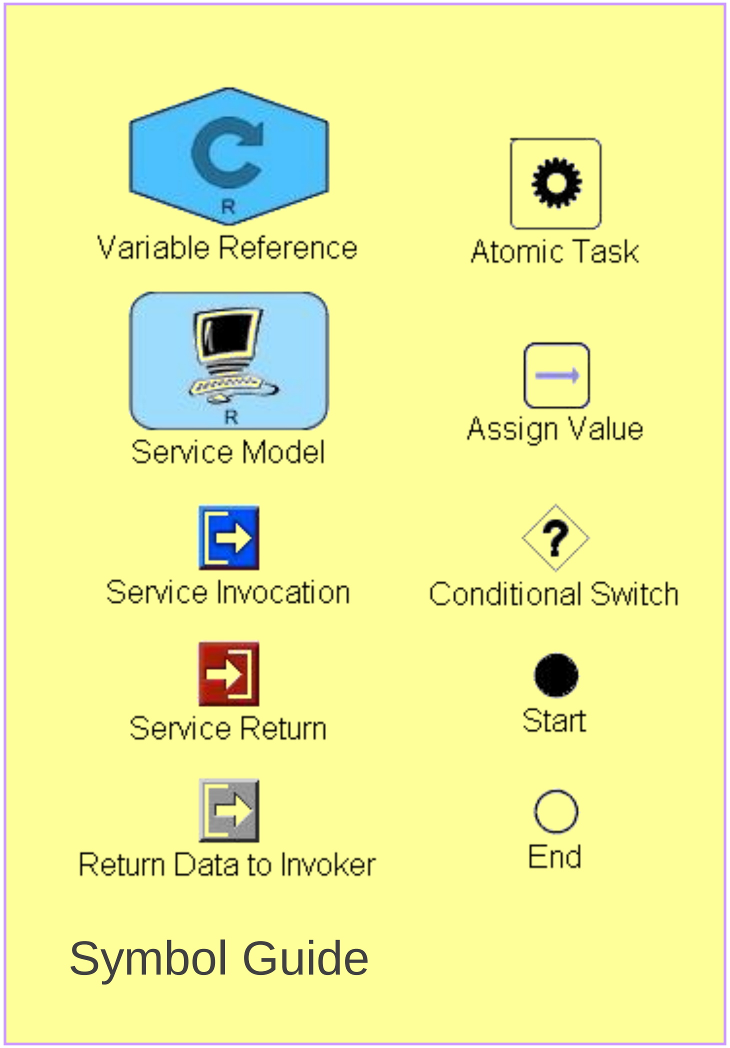
- Deployment models: capture coordination of machines in CIS
- Network Architecture
  - □ Servers and workstations
  - □ Service deployment
  - □ Secure sessions
  - □ Access control

- Depict hospital servers and workstations with services they provide
- Ex: MHAV server is housed separately than hospital’s EMR servers, but both contribute to patient portal services

# MODECIS Example



a simple service that checks the user’s credentials and authorizes access to other services



Symbol Guide

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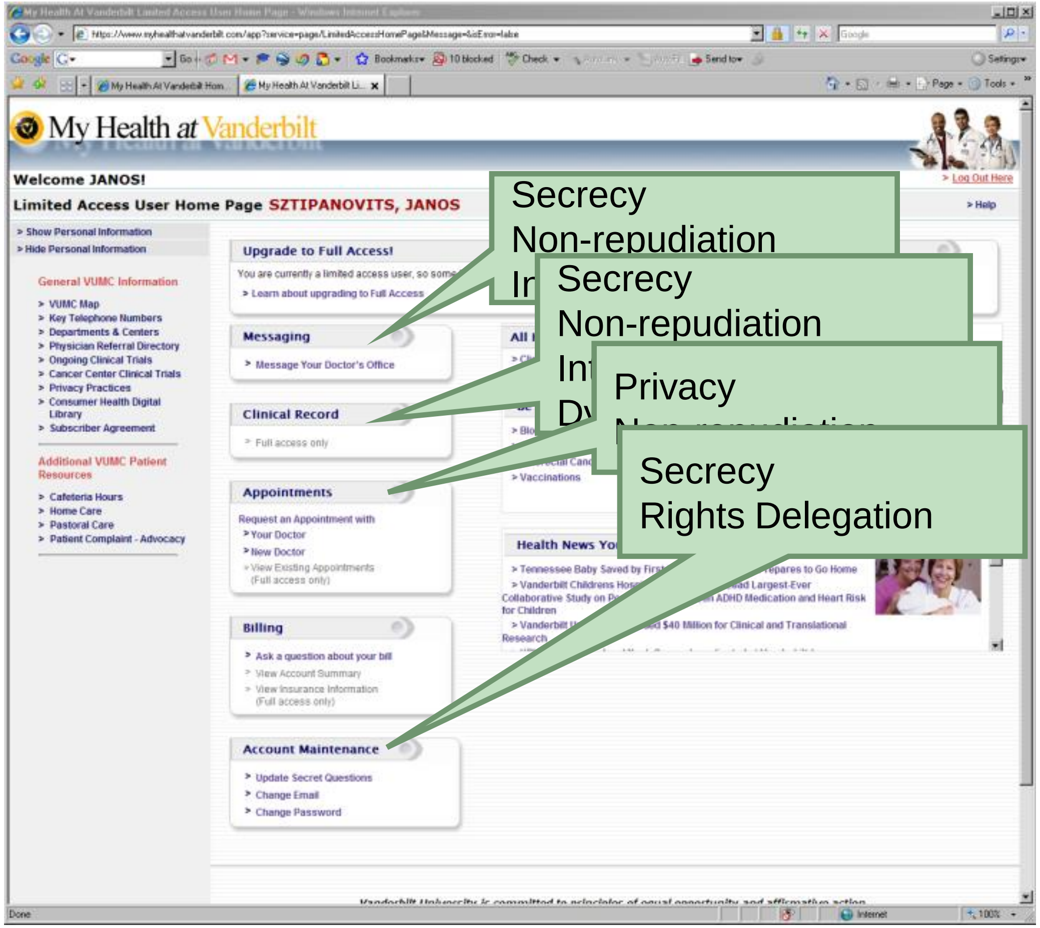
# Design Opportunities



My Health At Vanderbilt Limited Access User Home Page - Windows Internet Explorer

https://www.myhealthatvanderbilt.com/app?service=page/LimitedAccessHomePage&Message=&isError=false

My Health at Vanderbilt

Welcome JANOS!

Limited Access User Home Page SZTIPANOVITS, JANOS

> Log Out Here

> Help

> Show Personal Information
> Hide Personal Information

General VUMC Information

- VUMC Map
- Key Telephone Numbers
- Departments & Centers
- Physician Referral Directory
- Ongoing Clinical Trials
- Cancer Center Clinical Trials
- Privacy Practices
- Consumer Health Digital Library
- Subscriber Agreement

Additional VUMC Patient Resources

- Cafeteria Hours
- Home Care
- Pastoral Care
- Patient Complaint - Advocacy

**Upgrade to Full Access!**

You are currently a limited access user, so some

> Learn about upgrading to Full Access

**Messaging**

> Message Your Doctor's Office

**Clinical Record**

> Full access only

**Appointments**

Request an Appointment with

> Your Doctor
> New Doctor
> View Existing Appointments (Full access only)

**Billing**

> Ask a question about your bill
> View Account Summary
> View Insurance Information (Full access only)

**Account Maintenance**

> Update Secret Questions
> Change Email
> Change Password

> Vaccinations

Health News Yo

> Tennessee Baby Saved by First … repares to Go Home
> Vanderbilt Childrens Hos… ad Largest-Ever Collaborative Study on P… n ADHD Medication and Heart Risk for Children
> Vanderbilt … ed $40 Million for Clinical and Translational Research

Vanderbilt University is committed to principles of equal opportunity and affirmative action.

Done

Secrecy
Non-repudiation
In

Secrecy
Non-repudiation
Int
Dy

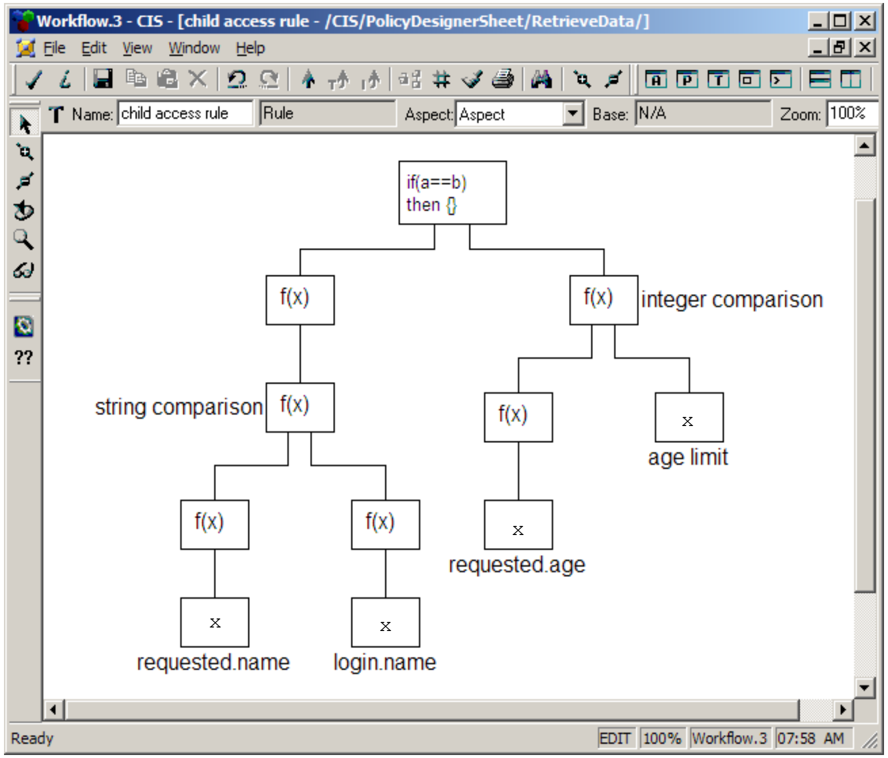
Privacy
Non-repudiation

Secrecy
Rights Delegation

- Perspective:
  - formal modeling of system designs
  - Policy-driven control of information flows
  - formal modeling of access control and privacy policies

- Enable systems design that satisfies high-level requirements
  - privacy, secrecy,
  - integrity,
  - non-repudiation,
  - dynamic access control,
  - rights delegation

# Policy Abstractions



Workflow.3 - CIS - [child access rule - /CIS/PolicyDesignerSheet/RetrieveData/]

Name: child access rule

Rule

Aspect: Aspect

Base: N/A

Zoom: 100%

Ready

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- Policy models
- Static policies that can be evaluated based on system specifications
- Dynamic policies that can be evaluated at run-time

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# Conclusions

- MODECIS tool suite provide a graphic modeling environment tailored to CIS
  - □ Initial support for BPEL and XACML code generation
  - □ Supports rapidly reconfigurable design of complex clinical environments
- Future Work
  - □ Create translators for
    - Security enforcement
    - Front-end generation
    - Model verification
  - □ Disseminate and conduct studies on usability

# Acknowledgements

- Research Team

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Jan Werner

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  - Jim Weaver
- Vanderbilt
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TROST
Team for Research in Ubiquitous Secure Technology

# Questions? Comments?

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