

Engineering a Clinical Decision Support Framework for Point of Care Use

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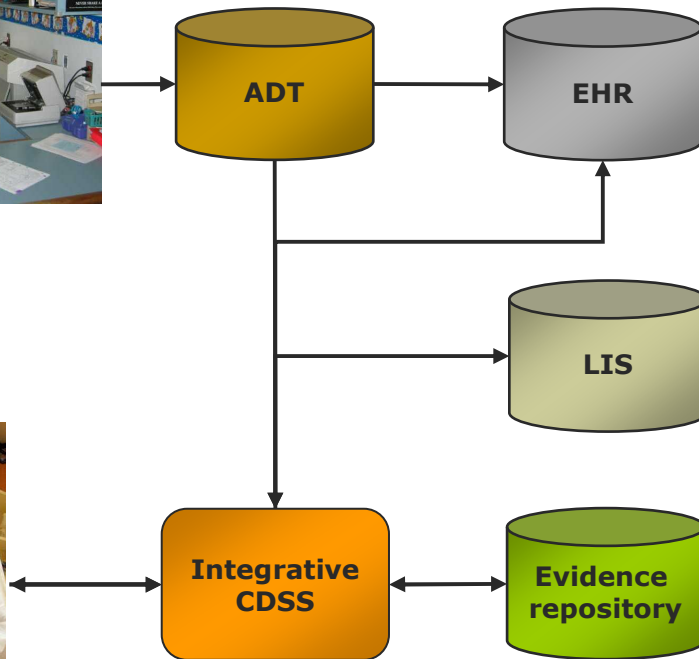
Outline

- Integrative clinical decision support at the point of care (ICDS@POC)
- MET-A³Support framework and O-MaSE methodology
- MET-A³Support and its O-MaSE process
- Management of pediatric asthma and MET-A³Support-Asthma
- Conclusions and future plans

Integrative Clinical Decision Support at the Point of Care (ICDS@POC)

- Intensive, but disjoint research on:
 - Hospital information systems (HIS), including electronic health record (EHR)
 - Clinical decision support systems (CDSS)
 - Computerized clinical practice guidelines (CPG)
 - Repositories of clinical evidence
- Our goal is to develop ICDS@POC framework integrating clinical data, decision support and evidence

Scenario: Managing a Patient in the ED



1. Patient is registered. The ADT notifies the EHR and the CDSS.
2. The physician uses the CDSS to record and retrieve patient data.
3. The physician asks for diagnostic support. The CDSS provides a diagnostic suggestion.
4. The physician orders a test and the CDSS passes this request to the LIS.
5. ...
6. Upon prescription of a treatment, the CDSS consults an embedded CPG.
7. The physician requests the evidence. The CDSS retrieves it from the evidence repository.
8. ...

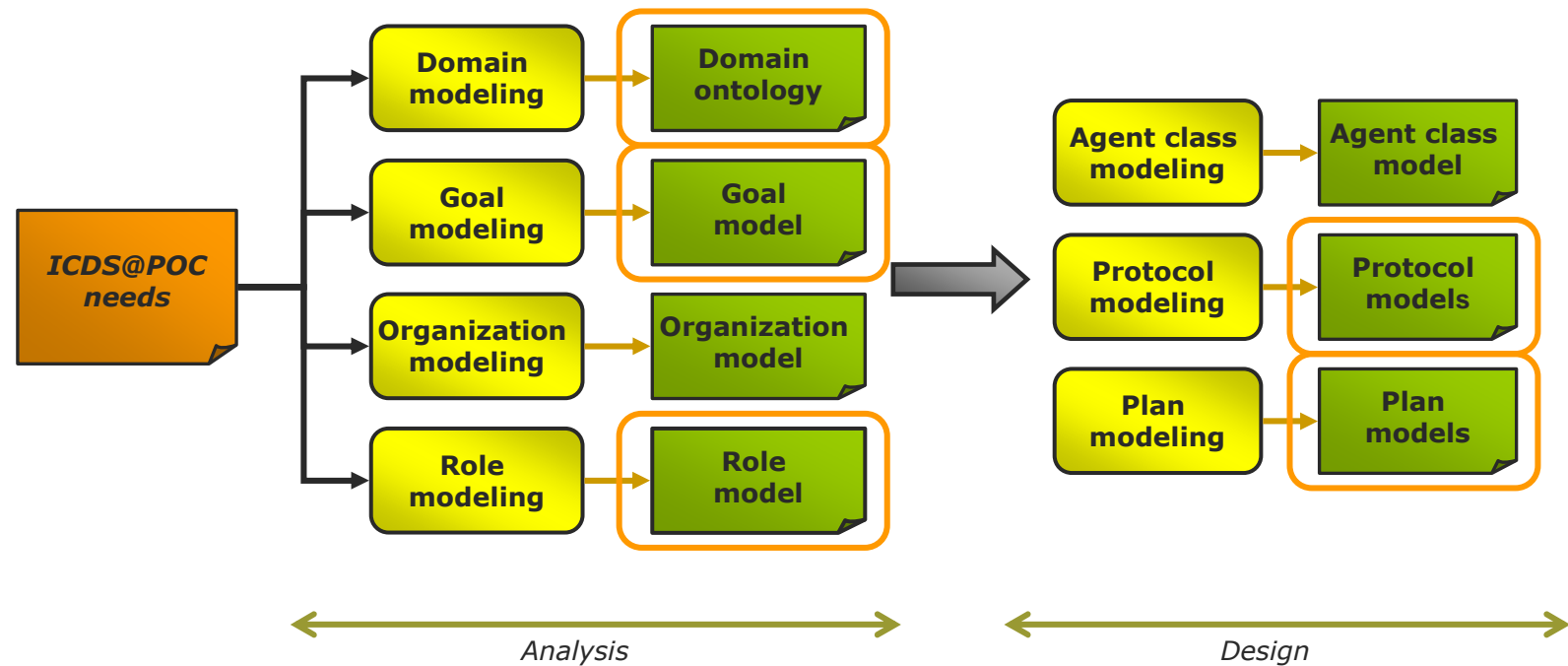
Requirements for ICDS@POC

- Need to manage and support multiple clinical decision problems
- Need to retrieve dispersed data and provide evidence
- Need to integrate with "services" (e.g., labs) provided by the hospital
- Need to support continuity of care (within POC)

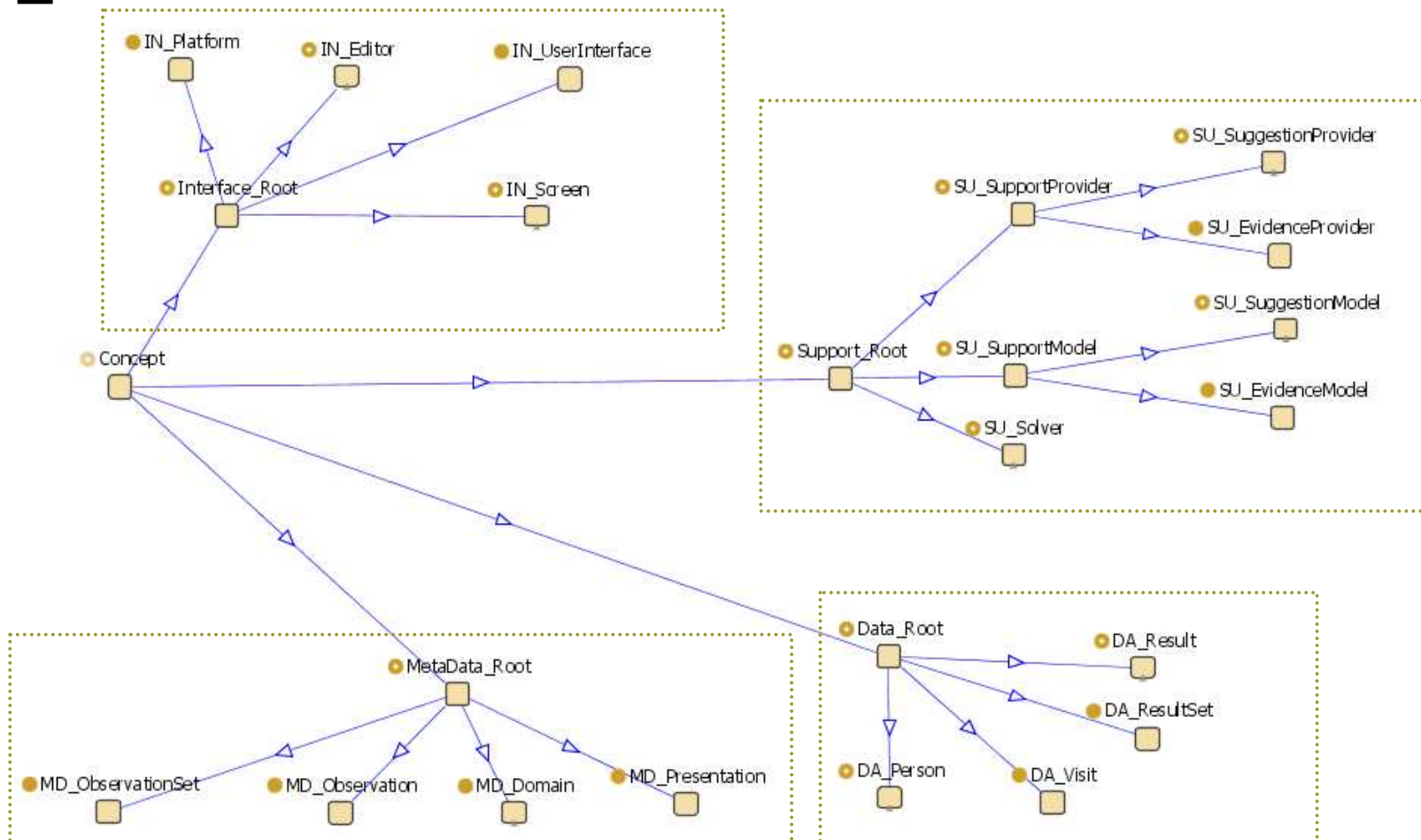
[MET-A³Support: Framework for ICDS@POC]

- System design along multi-agent system architecture (MAS) principles
- Structured translation of needs into functional requirements using O-MaSE methodology
 - Abstraction of object-oriented paradigm (agents are specialized objects)
 - Support separation of ontologies from their processing and introduced creation of an domain ontology as important part of analysis

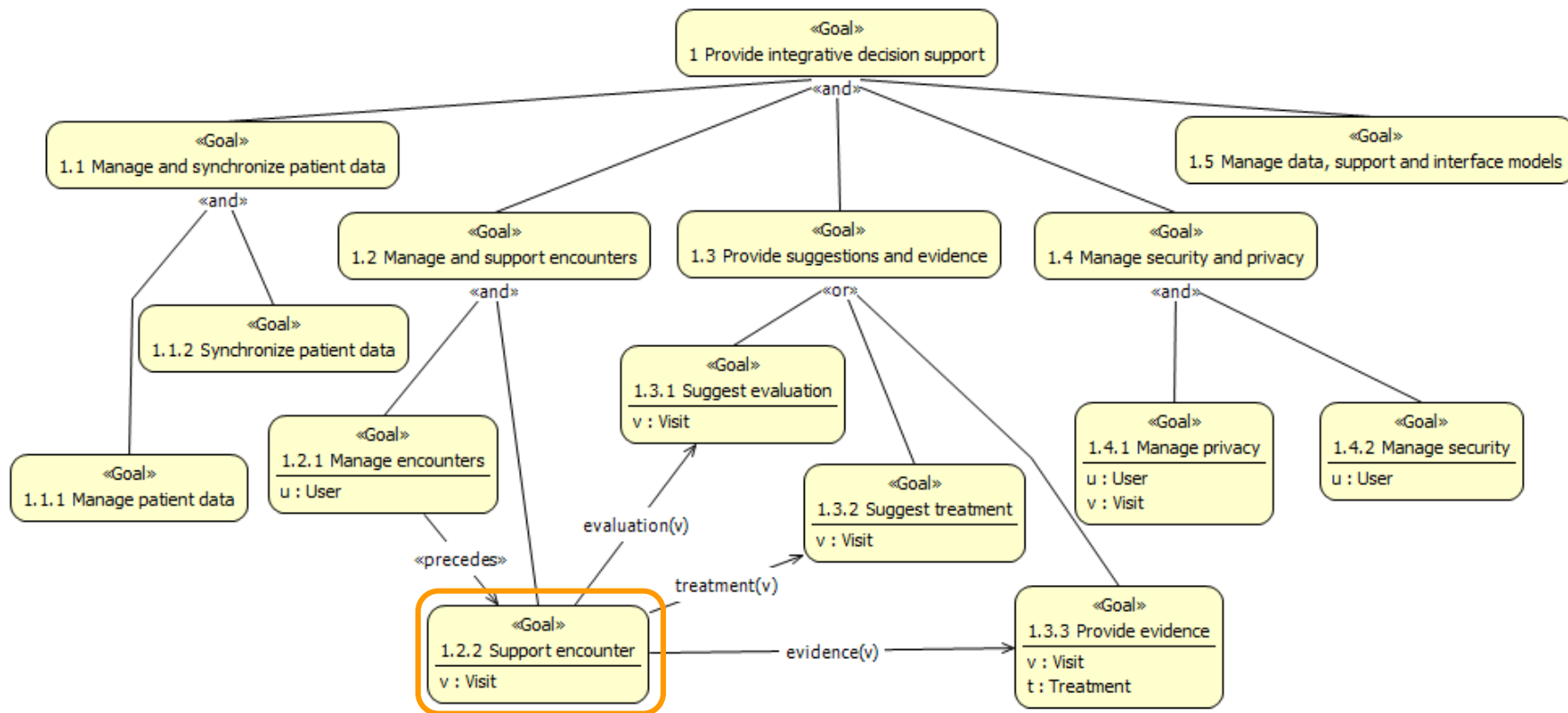
O-MaSE Process for MET-A³Support



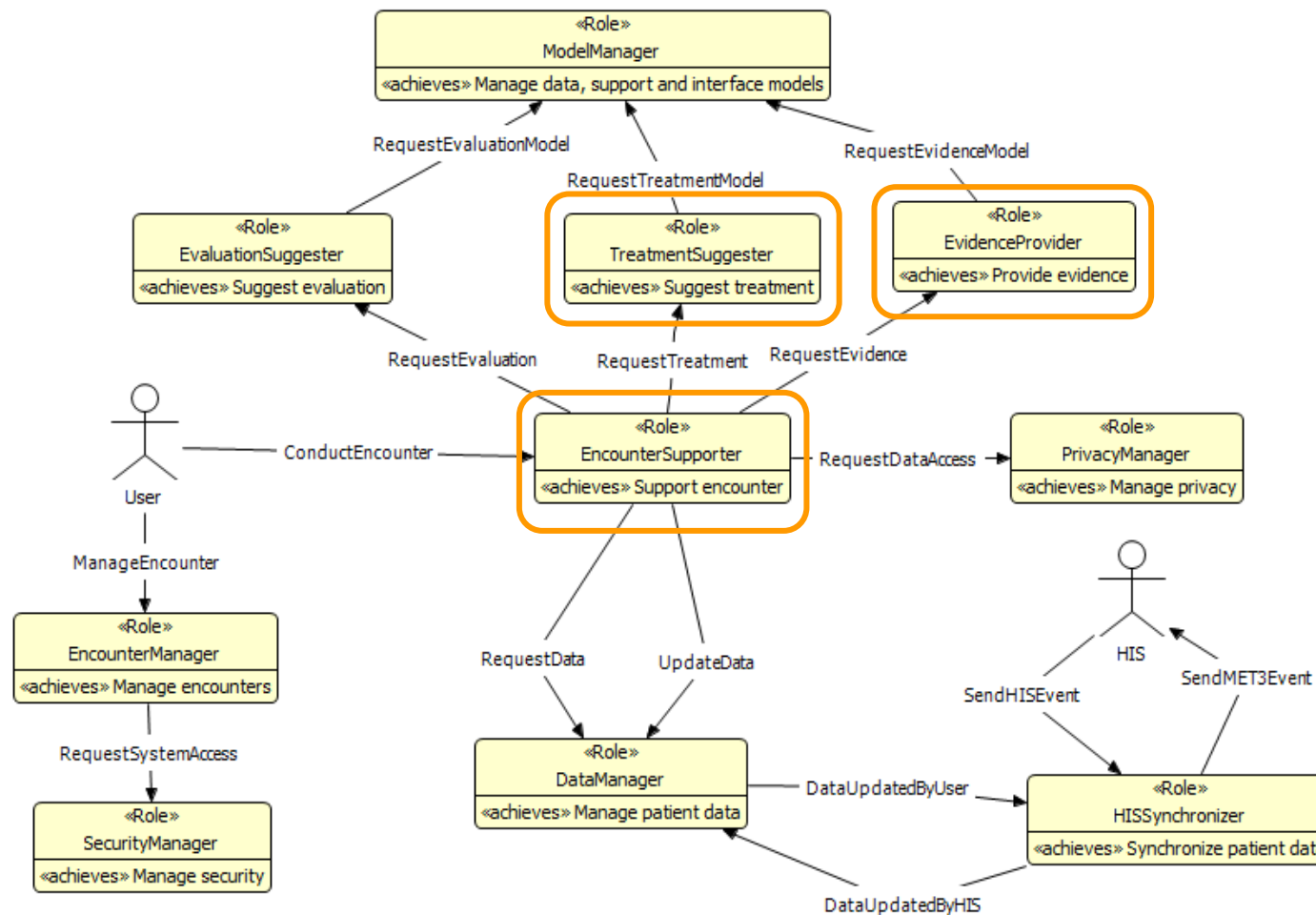
Domain Ontology



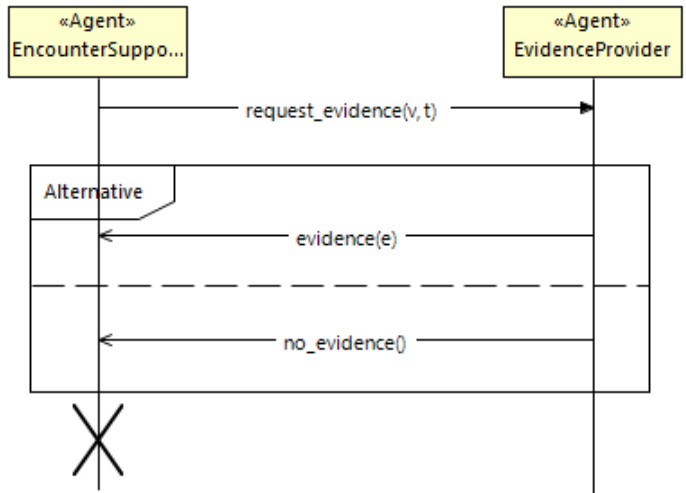
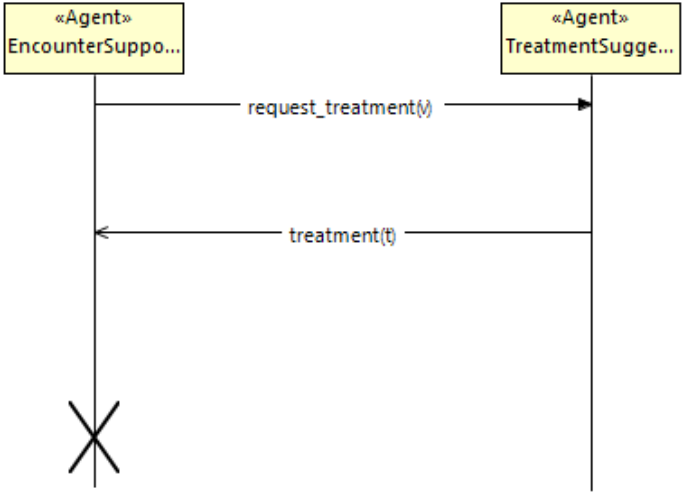
Goal Model



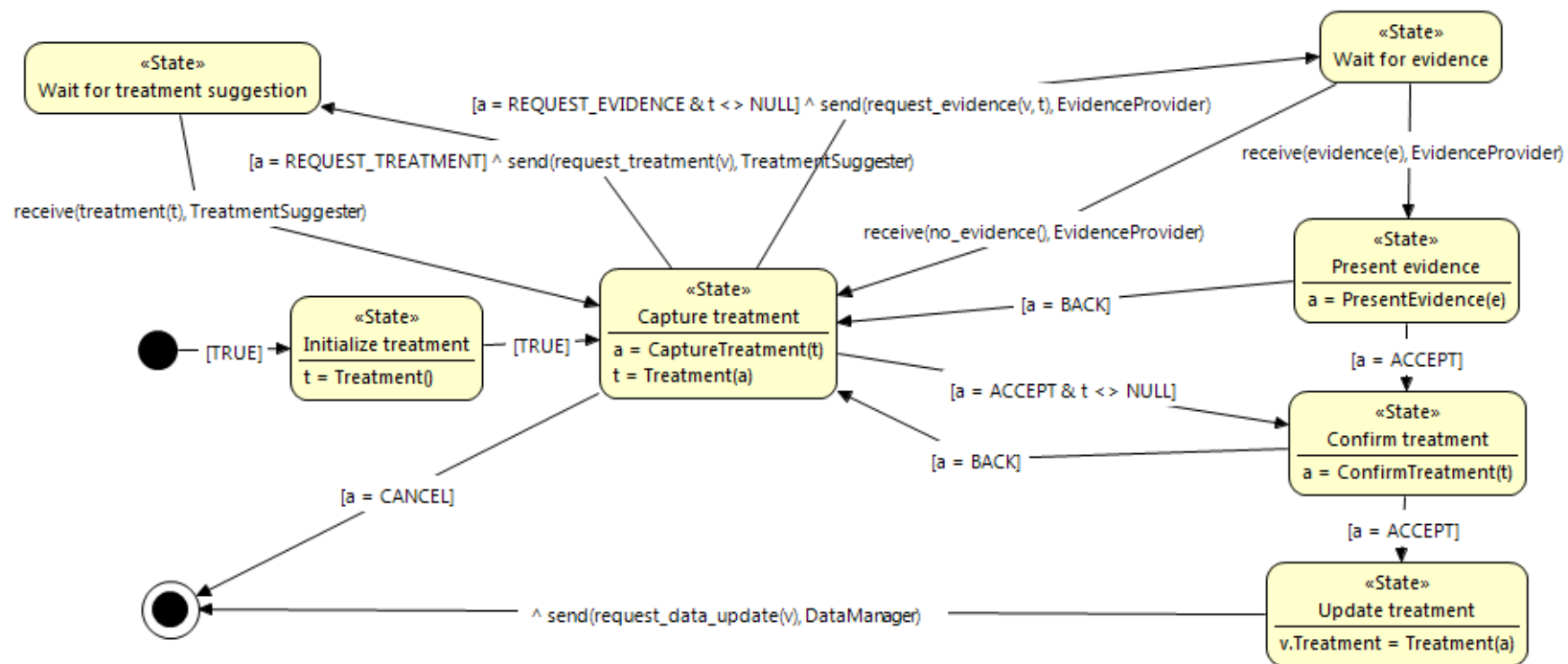
Role Model



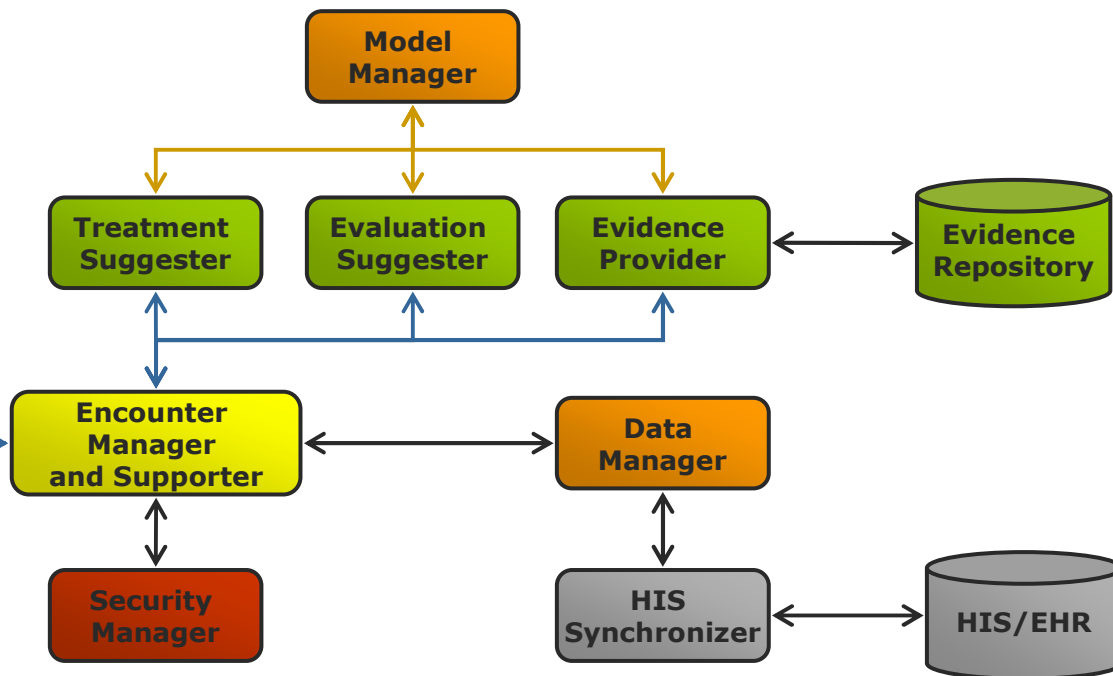
[Protocol Models]



Plan Models



MET-A³Support: Implementing MAS



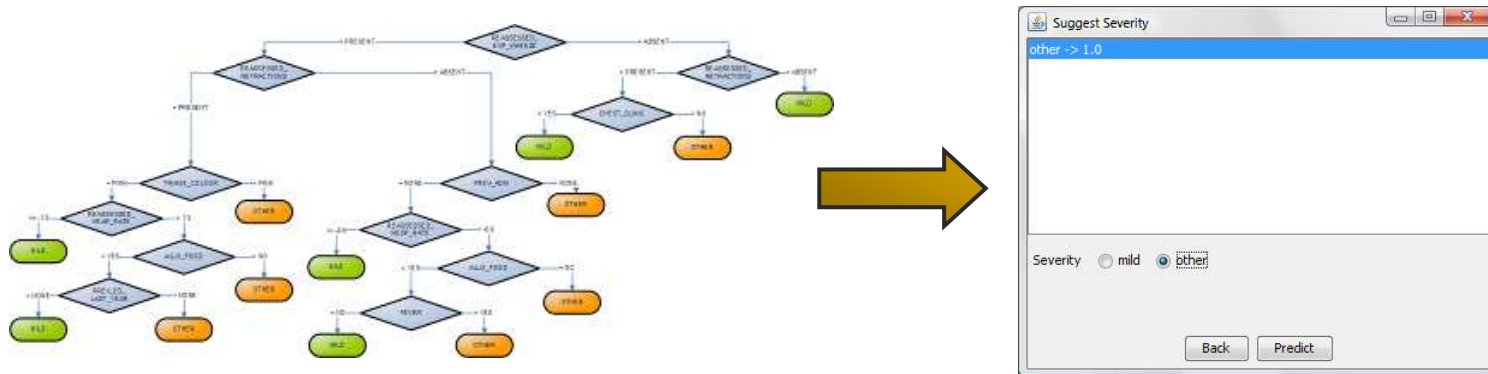
[MET-A³Support-Asthma]

- ED management of pediatric asthma patients
 - Supports early management (around 1 hour after triage)
 - Designed for physicians and nurses @ POC
 - Integrates with HIS (ADT, EHR) to share patient data and with the *Cochrane Library* to retrieve evidence
 - Uses decision model for predicting severity and integrates with the CPG for treatment options
 - Uses indexing and retrieval model for identifying and providing patient-specific evidence

- Provides user-driven support

Evaluation Suggester: Predicting Severity of Exacerbation

- Tree-based model was developed from prospective data using data mining techniques enhanced with
 - Secondary clinical knowledge
 - Contextual normalization
- Model is customized for local settings, readable and interpretable



Treatment Suggester Suggesting Treatment Options

- Rule-based model developed from the CAEP Pediatric Asthma CPG
- Links severity prediction or assessment with treatment options
- Easy to maintain and update

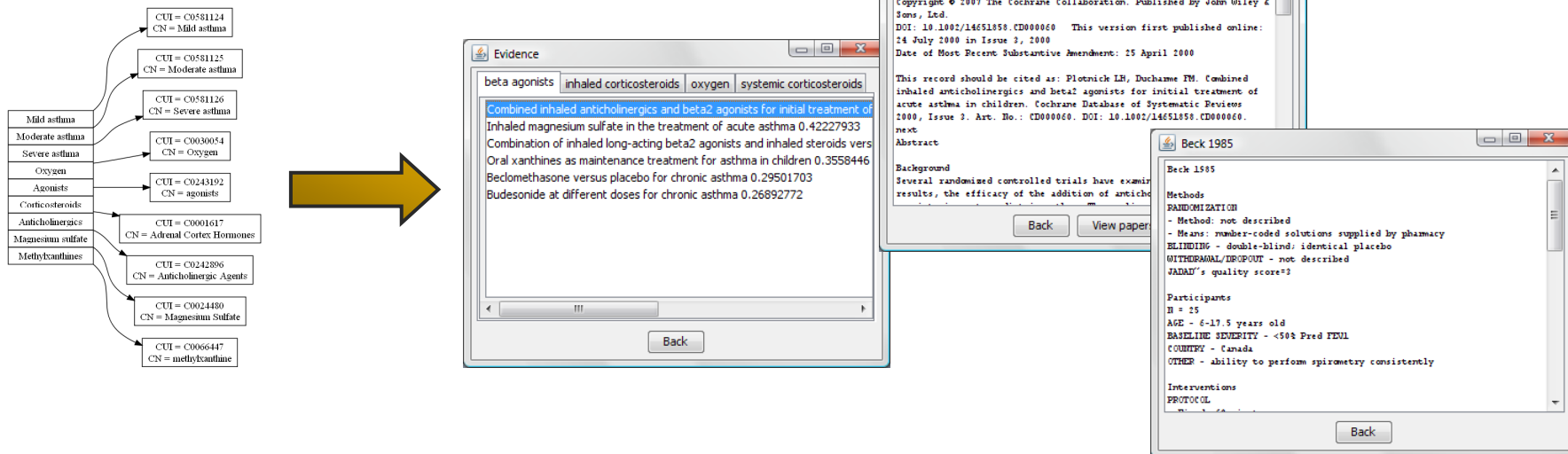
ASSESSMENT	PRE-TREATMENT	TREATMENT
MILD <ul style="list-style-type: none"> nocturnal cough exertional dyspnea increased use of β-agonists good response to β-agonists 	<ul style="list-style-type: none"> O_2 saturation $>95\%$, PEF, FEV₁ $>75\%$ predicted or personal best 	<ul style="list-style-type: none"> $\pm O_2$ β-agonists consider systemic corticosteroids
MODERATE <ul style="list-style-type: none"> normal mental status abbreviated speech dyspnea at rest partial relief with β-agonists and required more than q 4h 	<ul style="list-style-type: none"> O_2 saturation $>92-95\%$, PEF, FEV₁ 50-75% predicted or personal best 	<ul style="list-style-type: none"> O_2 100% β-agonists systemic corticosteroids consider anticholinergics
SEVERE <ul style="list-style-type: none"> altered mental status difficulty speaking laboured respirations persistant tachycardia no pre-hospital relief with β-agonists at usual dose 	<ul style="list-style-type: none"> O_2 saturation $<92\%$ PEF, FEV₁ $<50\%$ predicted or personal best 	<ul style="list-style-type: none"> 100% O_2 frequent or continuous β-agonists systemic corticosteroids systemic magnesium sulfate consider anticholinergic consider methylxanthines
NEAR DEATH <ul style="list-style-type: none"> exhausted, confused diaphoretic, cyanotic apnea decreased resp. effort falling heart rate 	<ul style="list-style-type: none"> O_2 saturation $<80\%$ (despite supplemental O_2) PEF, FEV₁ not appropriate 	<p>IF NEAR DEATH OR DETERIORATING ↓ RAPID SEQUENCE INTUBATION</p>



CAEP = Canadian Association of Emergency Physicians

Evidence Provider: Providing Relevant Evidence

- Complex model of UMLS concepts was developed for customized indexing of Systematic Reviews and referenced articles in the Cochrane Library
- Retrieval methodology enables patient-specific queries



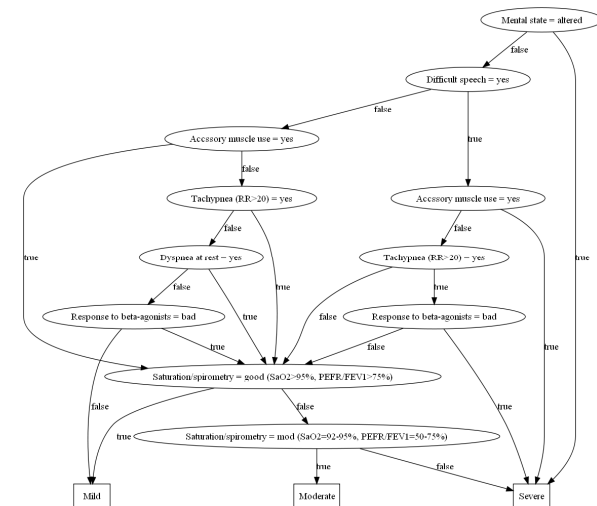
[MET-A³Support: Conclusions]

- Requires structured engineering methodology to translate complex needs into successful design
- Meets the requirements for ICDS@POC
- Brings together data, decision support, and evidence
- Combines MAS and ontology-driven design for decision/information retrieval models

- MET-A³Support-Asthma brings together data from HIS and collected at POC, severity prediction model, CAEP CPG, and evidence from Cochrane

Future Directions & Challenges

- Pilot clinical trial in the ED at the Children's Hospital of Eastern Ontario
- Using guidelines as models of clinical workflow to drive the process of intelligent integration of information and services



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