

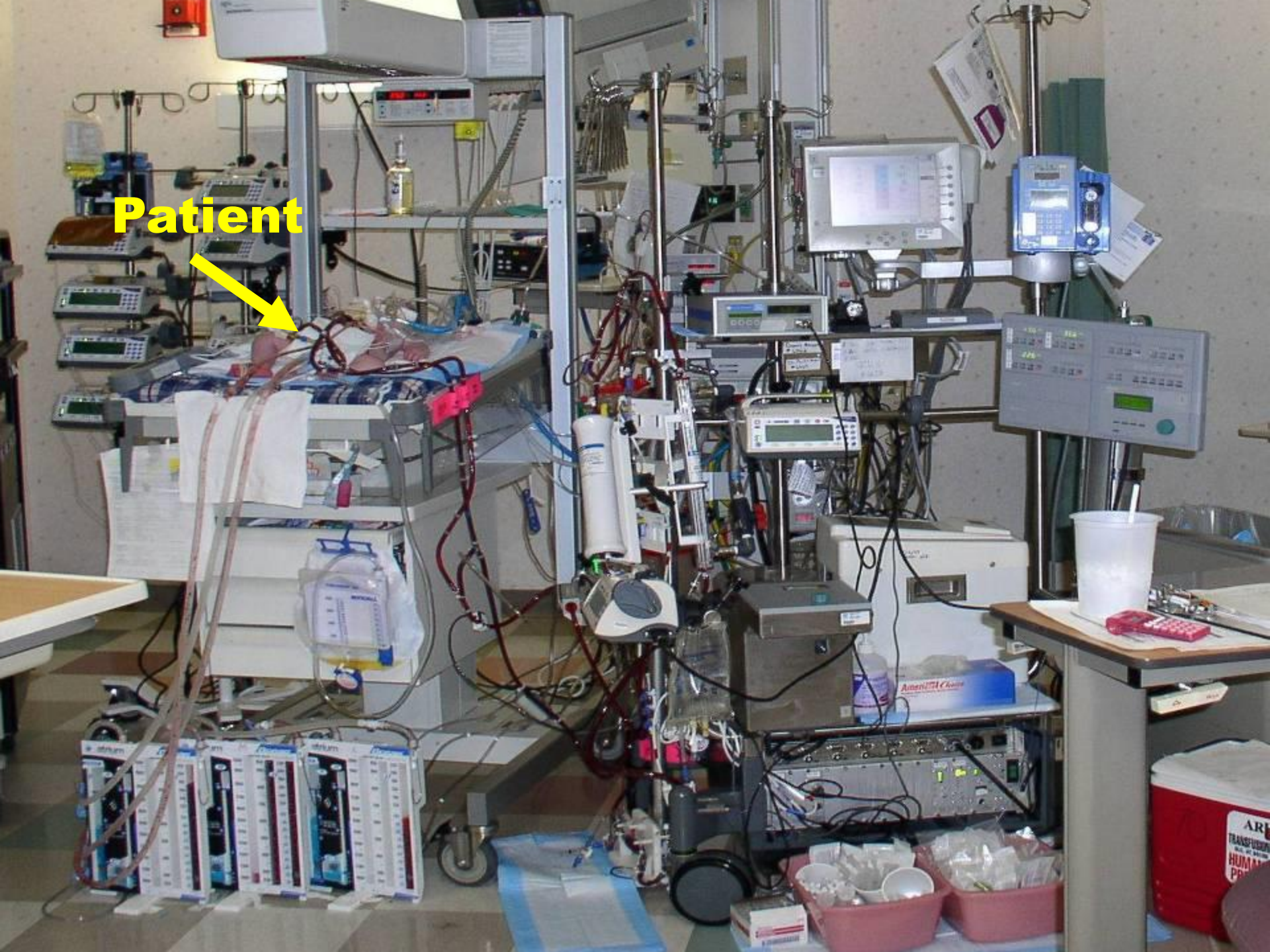
# Information models as a basis for Interoperability

SemTechBiz  
June 3-5, 2013

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**Patient**



# Core Assumptions

‘The complexity of modern medicine exceeds the inherent limitations of the unaided human mind.’

~ David M. Eddy, MD, Ph.D.

‘... man is not perfectible. There are limits to man’s capabilities as an information processor that assure the occurrence of random errors in his activities.’

~ Clement J. McDonald, MD

# Clinical System Approach

Intermountain can only provide the highest quality, lowest cost health care with the use of advanced clinical decision support systems integrated into frontline workflow

# Decision Support Modules

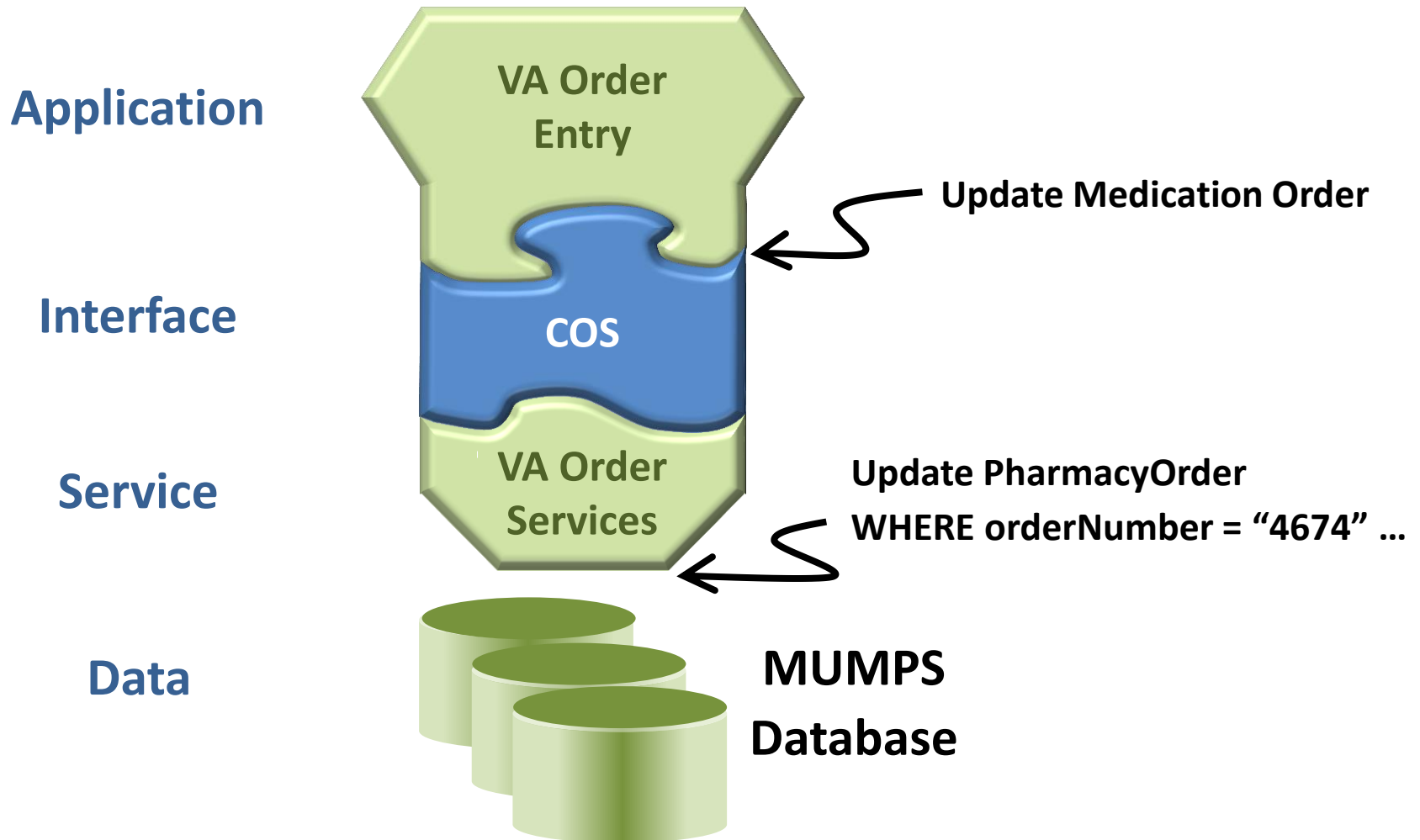
- Antibiotic Assistant
- Ventilator weaning
- ARDS protocols
- Nosocomial infection monitoring
- MRSA monitoring and control
- Prevention of Deep Venous Thrombosis
- Infectious disease reporting to public health
- Diabetic care
- Pre-op antibiotics
- ICU glucose protocols
- Ventilator disconnect
- Infusion pump errors
- Lab alerts
- Blood ordering
- Order sets
- Patient worksheets
- Post MI discharge meds



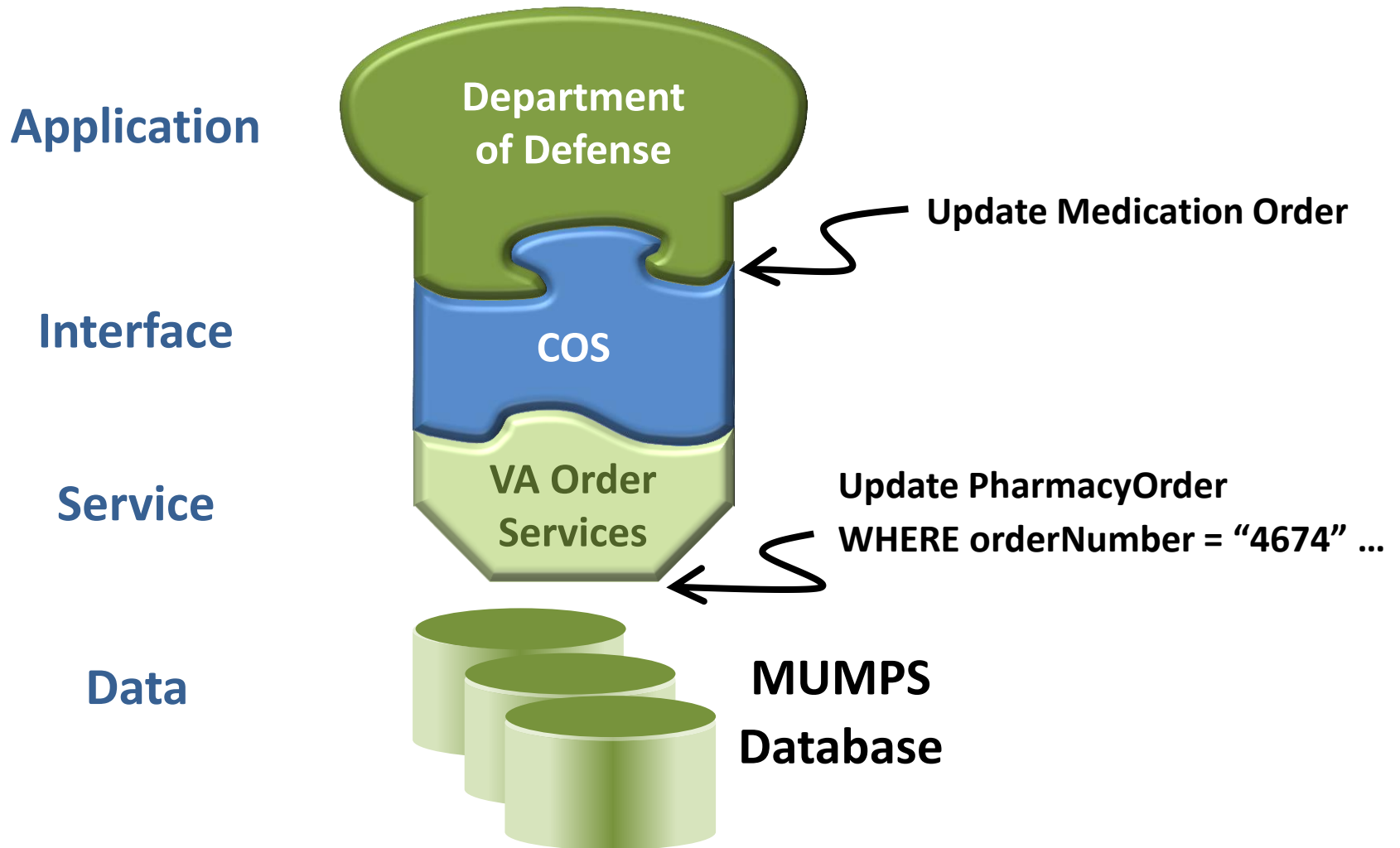
# Strategic Goals

- Minimum goal: Be able to share applications, reports, alerts, protocols, and decision support with ALL customers of our same vendor
- Maximum goal: Be able to share applications, reports, alerts, protocols, and decision support with anyone in the WORLD

# Order Entry API (adapted from Harold Solbrig)



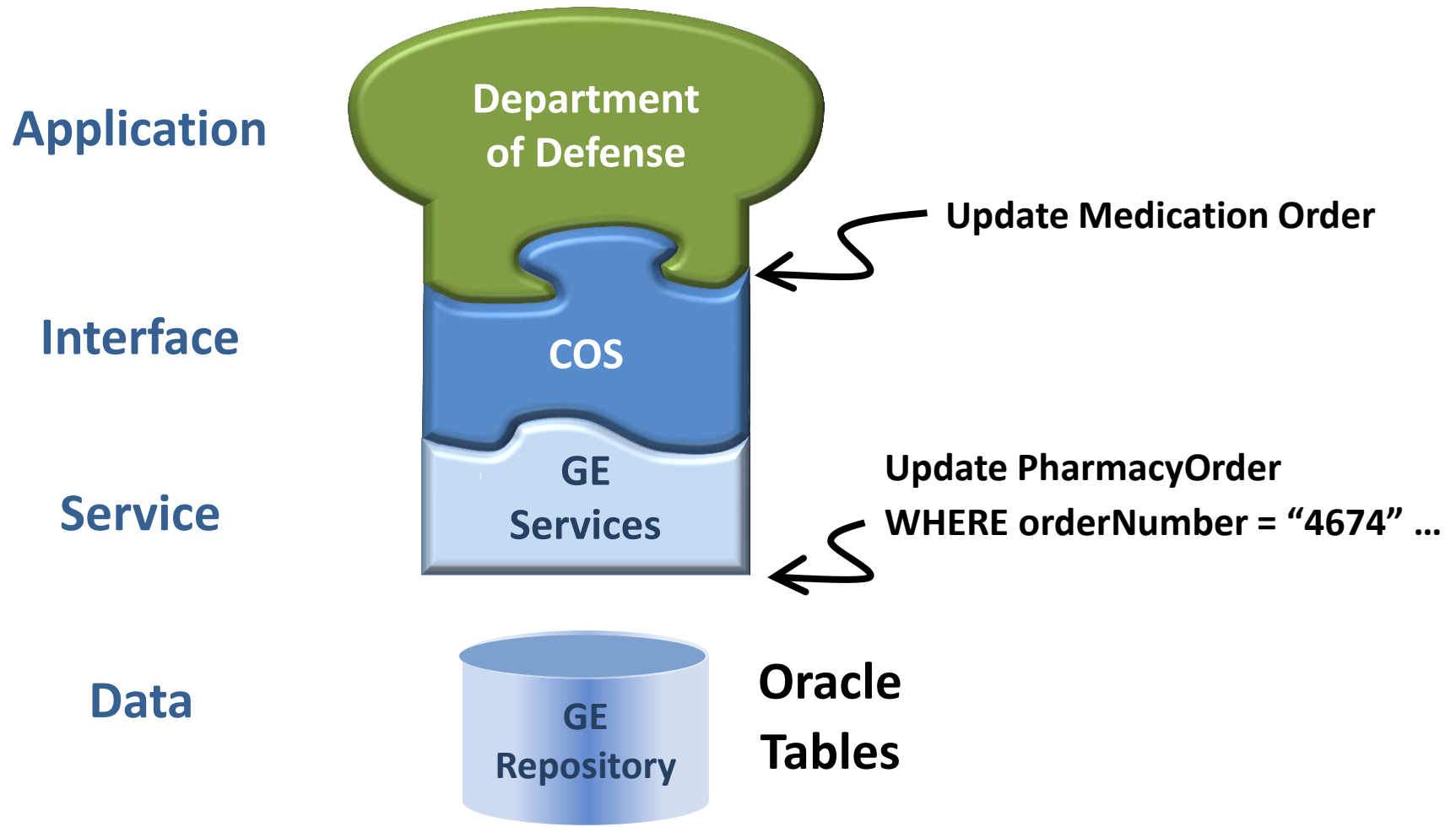
# Order Entry API: Different Client, Same Service (adapted from Harold Solbrig)



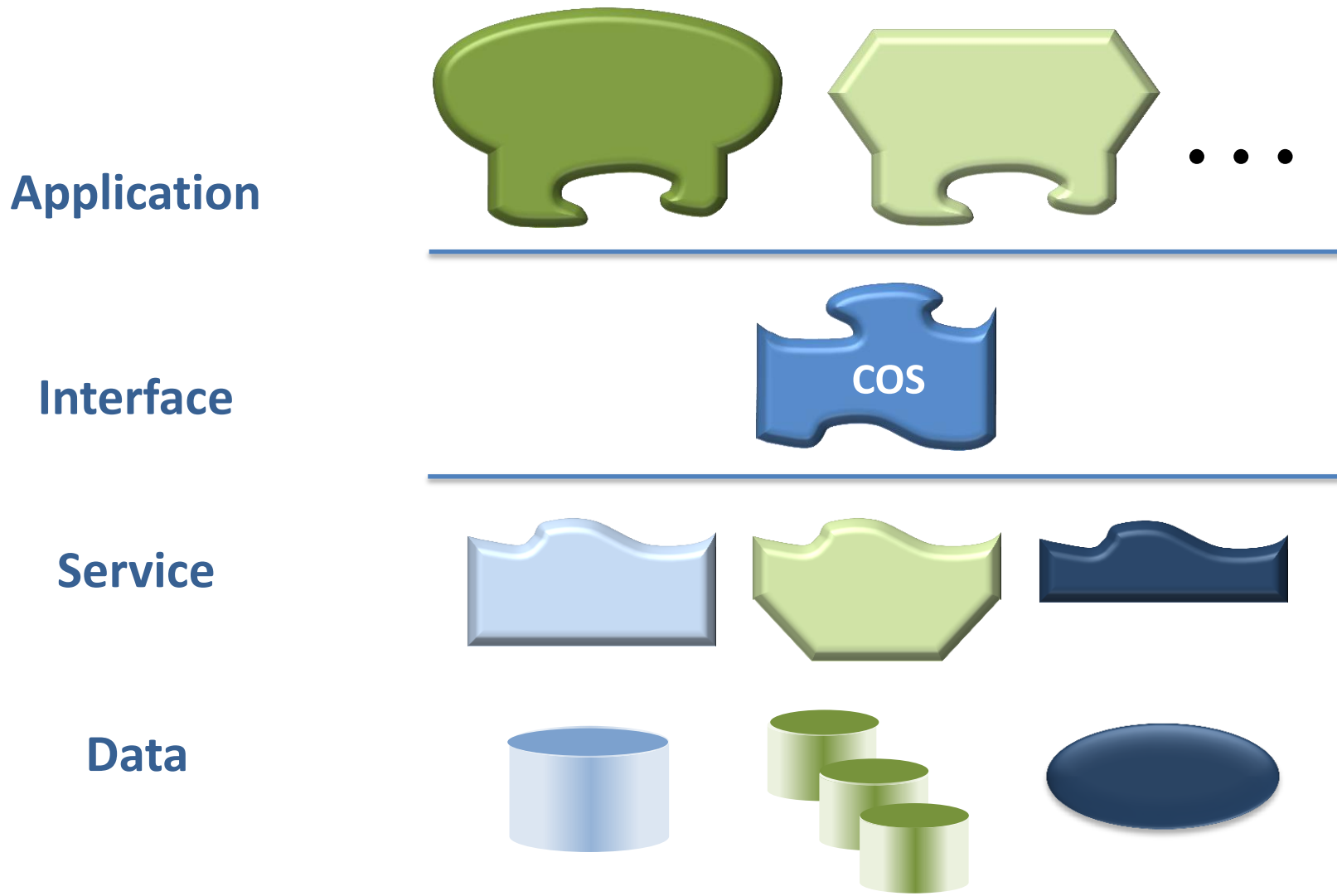


# Order Entry API:

## Different Server, Same Client (adapted from Harold Solbrig)



# Order Entry API (adapted from Harold Solbrig)



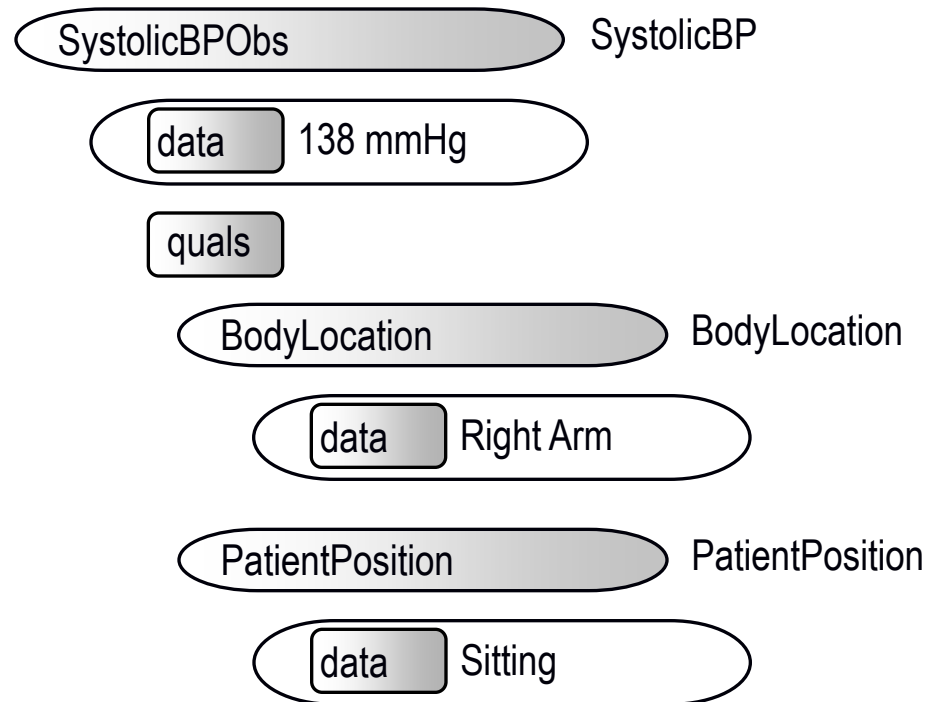
# What Is Needed to Create a New Paradigm?

- Standard set of detailed clinical data models coupled with...
- Standard coded terminology
- Standard API's (Application Programmer Interfaces) for healthcare related services
- Open sharing of models, coded terms, and API's
- Sharing of decision logic and applications

Why do we need detailed  
clinical models?

# A diagram of a simple clinical model

## Clinical Element Model for Systolic Blood Pressure



# Need for a standard model

- A stack of coded items is ambiguous (SNOMED CT)
  - Numbness of right arm and left leg
    - Numbness (44077006)
    - Right (24028007)
    - Arm (40983000)
    - Left (7771000)
    - Leg (30021000)
  - Numbness of left arm and right leg
    - Numbness (44077006)
    - Left (7771000)
    - Arm (40983000)
    - Right (24028007)
    - Leg (30021000)

# What if there is no model?

Site #1

Dry Weight:

Site #2

Weight:

- Dry
- Wet
- Ideal



# Too many ways to say the same thing

- A single name/code and value
  - *Dry Weight is 70 kg*
- Combination of two names/codes and values
  - *Weight is 70 kg*
    - *Weight type is dry*

# Model fragment in XML

## Pre-coordinated representation

```
<observation>  
  <cd>Dry weight (LOINC 8340-2) </cd>  
  <value>70 kg</value>  
</observation>
```

## Post-coordinated (compositional) representation

```
<observation>  
  <cd>Weight (LOINC 3141-9) </cd>  
  <qualifier>  
    <cd> Weight type (LOINC 8337-8) </cd>  
    <value> Dry (SNOMED CT 13880007) </value>  
  <qualifier>  
    <value>70 kg</value>  
</observation>
```

# Relational database implications

Patient Identifier	Date and Time	Observation Type	Observation Value	Units
123456789	7/4/2005	Dry Weight	70	kg
123456789	7/19/2005	Current Weight	73	kg

Patient Identifier	Date and Time	Observation Type	Weight type	Observation Value	Units
123456789	7/4/2005	Weight	Dry	70	kg
123456789	7/19/2005	Weight	Current	73	kg

How would you calculate the desired weight loss during the hospital stay?

# More complicated items:

- Signs, symptoms
- Diagnoses
- Problem list
- Family History
- Use of negation – “No Family Hx of Cancer”
- Description of a heart murmur
- Description of breath sounds
  - “Rales in right and left upper lobes”
  - “Rales, rhonchi, and egophony in right lower lobe”

# What do we model?

- All data in the patient's EMR, including:
  - Allergies
  - Problem lists
  - Laboratory results
  - Medication and diagnostic orders
  - Medication administration
  - Physical exam and clinical measurements
  - Signs, symptoms, diagnoses
  - Clinical documents
  - Procedures
  - Family history, medical history and review of symptoms

# How are the models used in an EMR?

- Data entry screens, flow sheets, reports, ad hoc queries
  - Basis for application access to clinical data
- Computer-to-Computer Interfaces
  - Creation of maps from departmental/external system models to the standard database model
- Core data storage services
  - Validation of data as it is stored in the database
- Decision logic
  - Basis for referencing data in decision support logic
- Does **NOT** dictate physical storage strategy

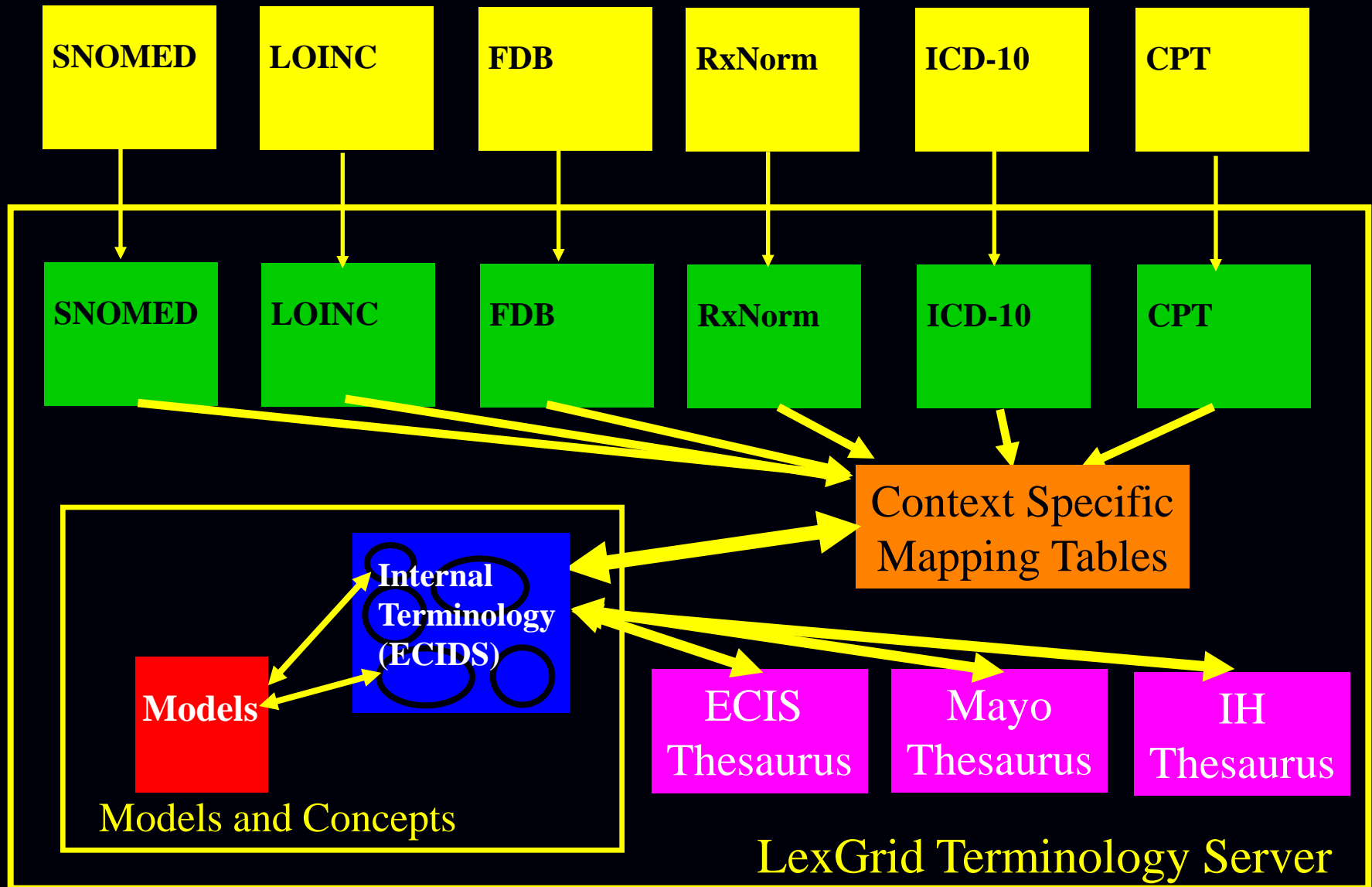
# Detailed clinical models and terminology



# Model & terminology must be done together

- Terminology models and information models
  - models made by data modelers (message standards)
  - models made by terminology groups (maintenance of terms)
- “Impedance mismatch” arises when one group is making terms and another group is making the model
- Post coordination in a single field in the model is just another style of modeling – it is important to make the semantics explicit

# Model Centered Data Representation



We assume that the  
model is used in  
association with a  
terminology server.

# Model and Terminology

## Model

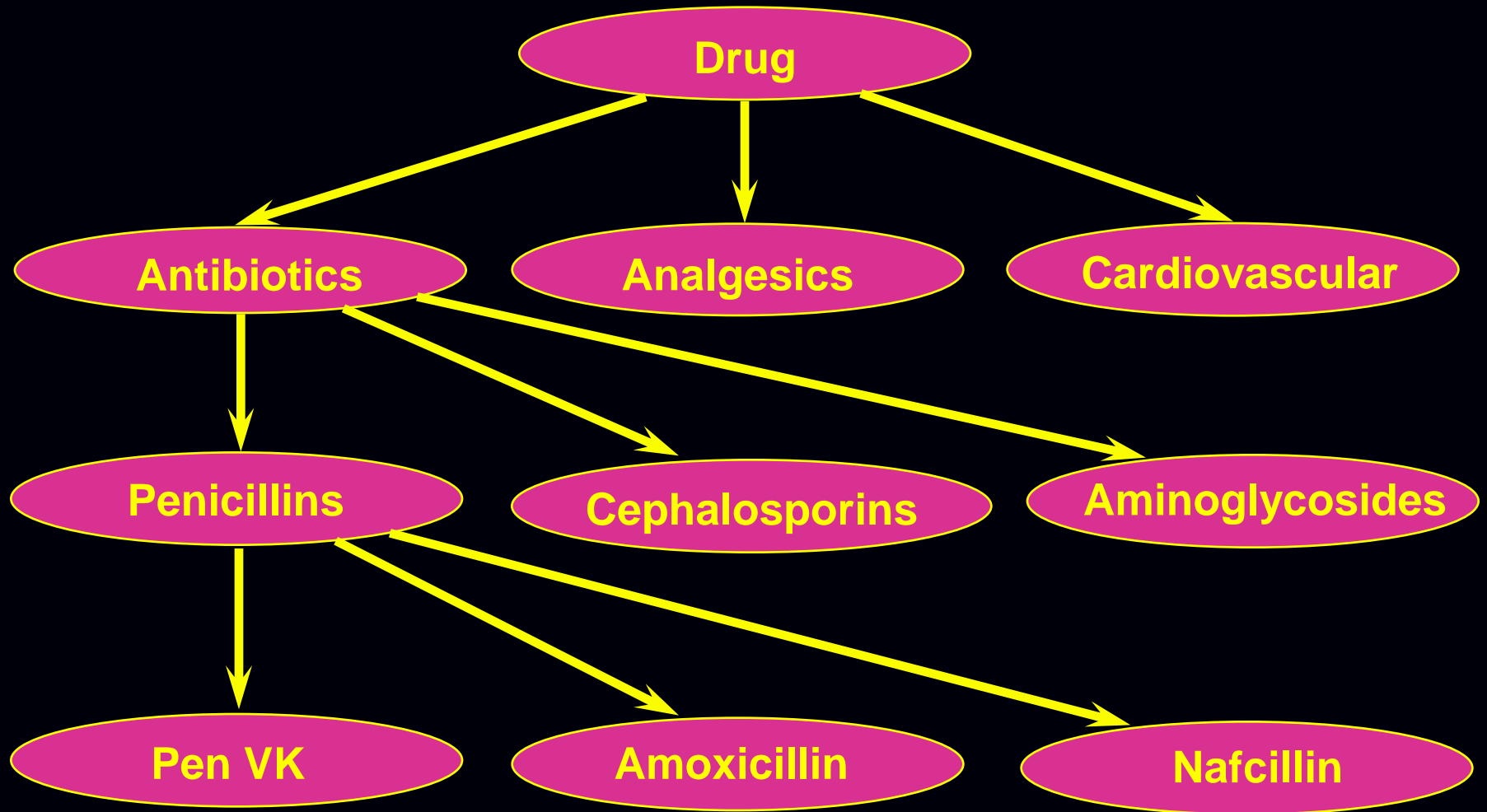
## Instance data

```
MedicationOrder ::= SET {  
    drug          Drug,  
    dose          Decimal,  
    route         DrugRoute,  
    frequency     DrugFrequency,  
    startTime     DateTime,  
    endTime       DateTime,  
    orderedBy     Clinician,  
    orderNumber  OrderNumber}
```

```
MedicationOrder {  
    drug          PenVK,  
    dose          250,  
    route         Oral,  
    frequency     Q6H,  
    startTime     09/01/95 10:01,  
    endTime       09/11/95 23:59,  
    orderedBy     Don Jones, M.D.,  
    orderNumber  A234567 }
```

If the medicationOrder.drug is\_a “antibiotic”  
then notify the infection control officer.

# Concept Semantic Network



# Denormalized Semantic Network

<b>Drugs</b>	<b>has-child</b>	<b>Antibiotics</b>
<b>Drugs</b>	<b>has-child</b>	<b>Analgesics</b>
<b>Drugs</b>	<b>has-child</b>	<b>Cardiovascular</b>
<b>Antibiotics</b>	<b>has-child</b>	<b>Penicillins</b>
<b>Antibiotics</b>	<b>has-child</b>	<b>Cephalosporins</b>
<b>Antibiotics</b>	<b>has-child</b>	<b>Aminoglycosides</b>
<b>Penicillins</b>	<b>has-child</b>	<b>Pen VK</b>
<b>Penicillins</b>	<b>has-child</b>	<b>Amoxicillin</b>
<b>Penicillins</b>	<b>has-child</b>	<b>Nafcillin</b>
<b>Drugs</b>	<b>has-member</b>	<b>Antibiotics</b>
<b>Drugs</b>	<b>has-member</b>	<b>Penicillins</b>
<b>Drugs</b>	<b>has-member</b>	<b>Pen VK</b>
<b>Drugs</b>	<b>has-member</b>	<b>Amoxicillin</b>
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