



**MEMBER 2000**

**ANSI Accredited  
Standards Developer**

# INTRODUCTION TO Health Level 7

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Duke University Medical Center

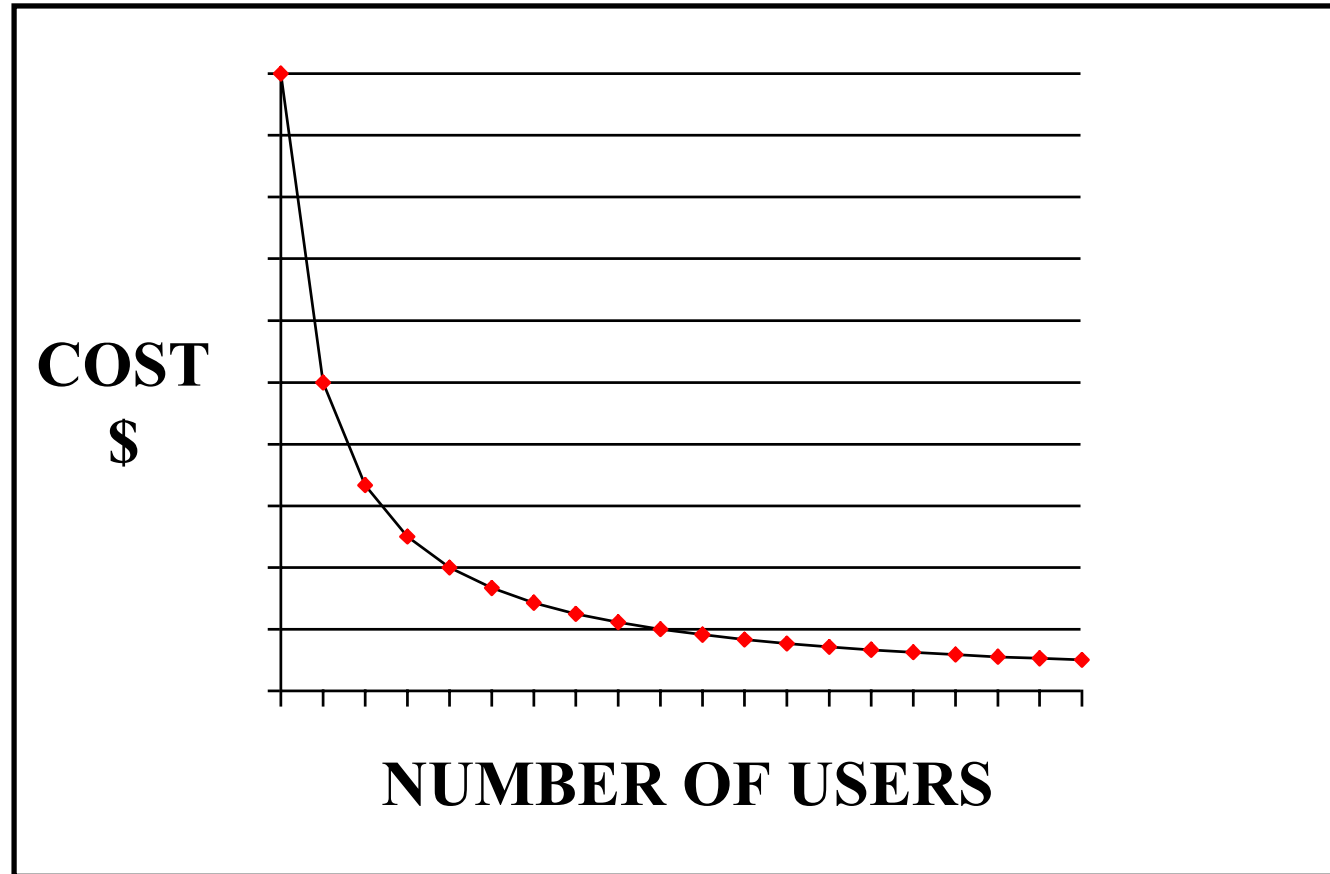
# Presentation Overview

- Need for standards
- HL7 organization and functioning
- HL7 Standard, Version 2.n
- HL7 Standard, Version 3
- Messaging and more

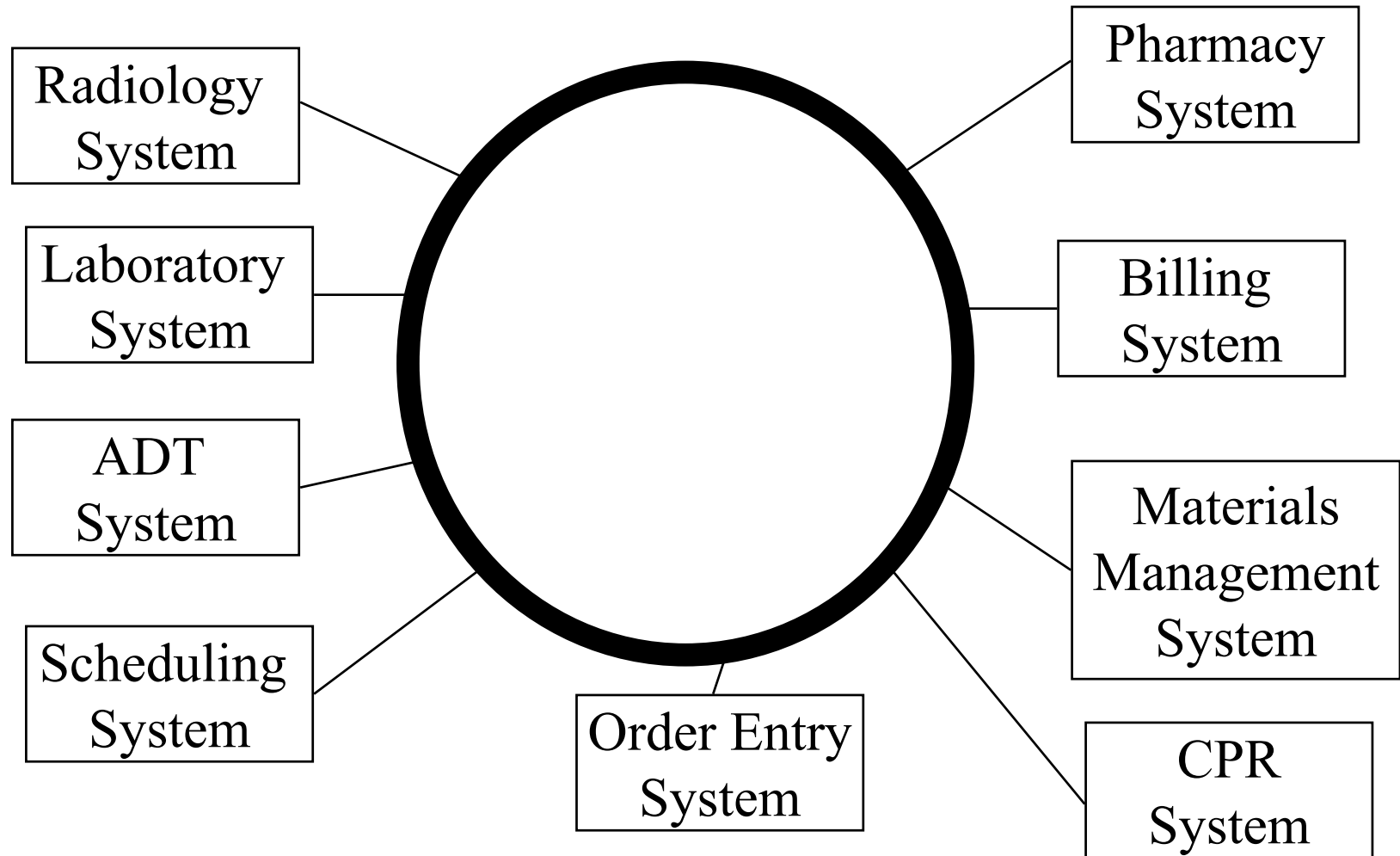
# Why Standards?

In the late 1980s, messaging standards were introduced to support the development of heterogeneous “best of breed” integrated hospital information systems.

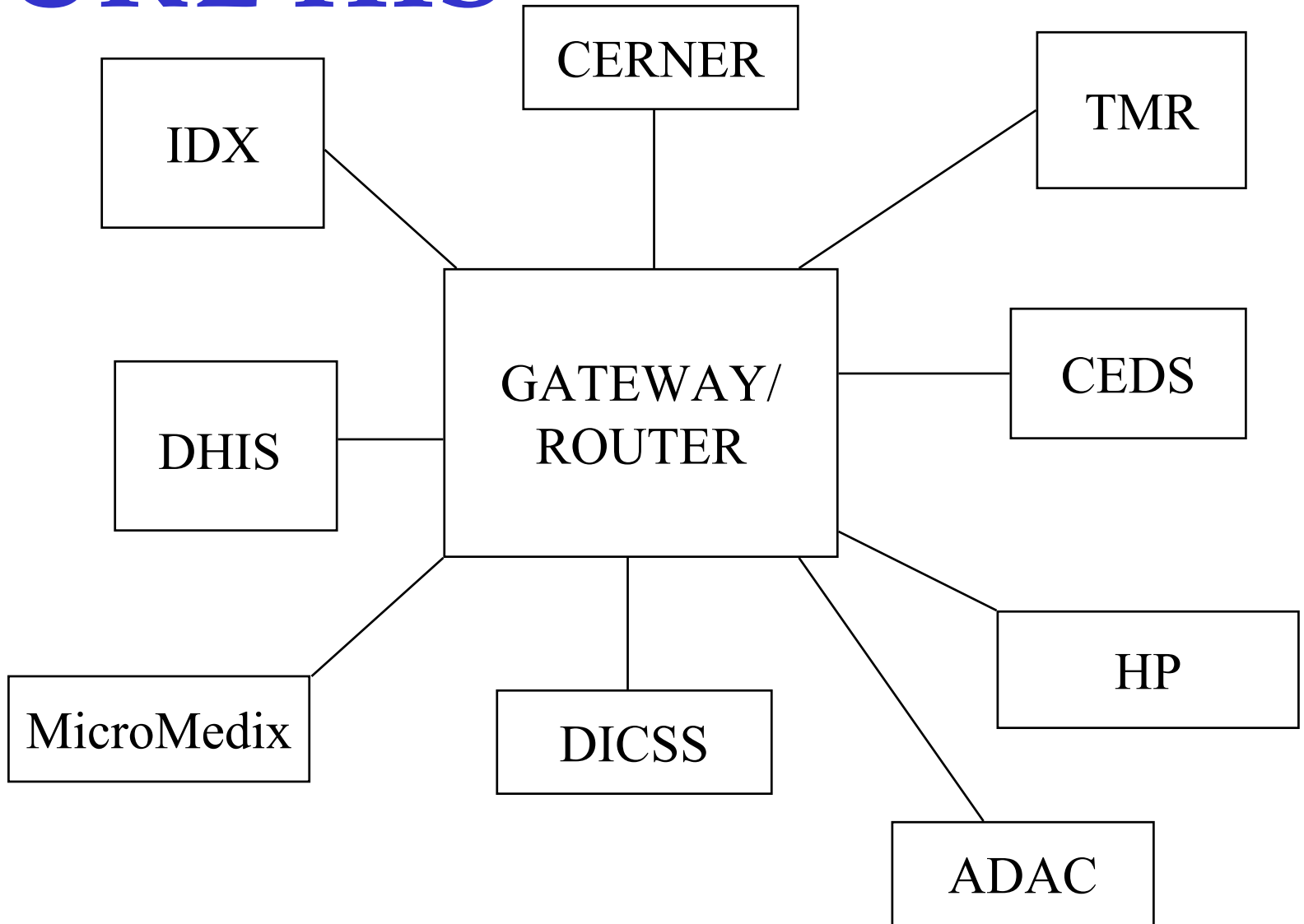
# Economics Driving Standards



# Best of Breed HIS



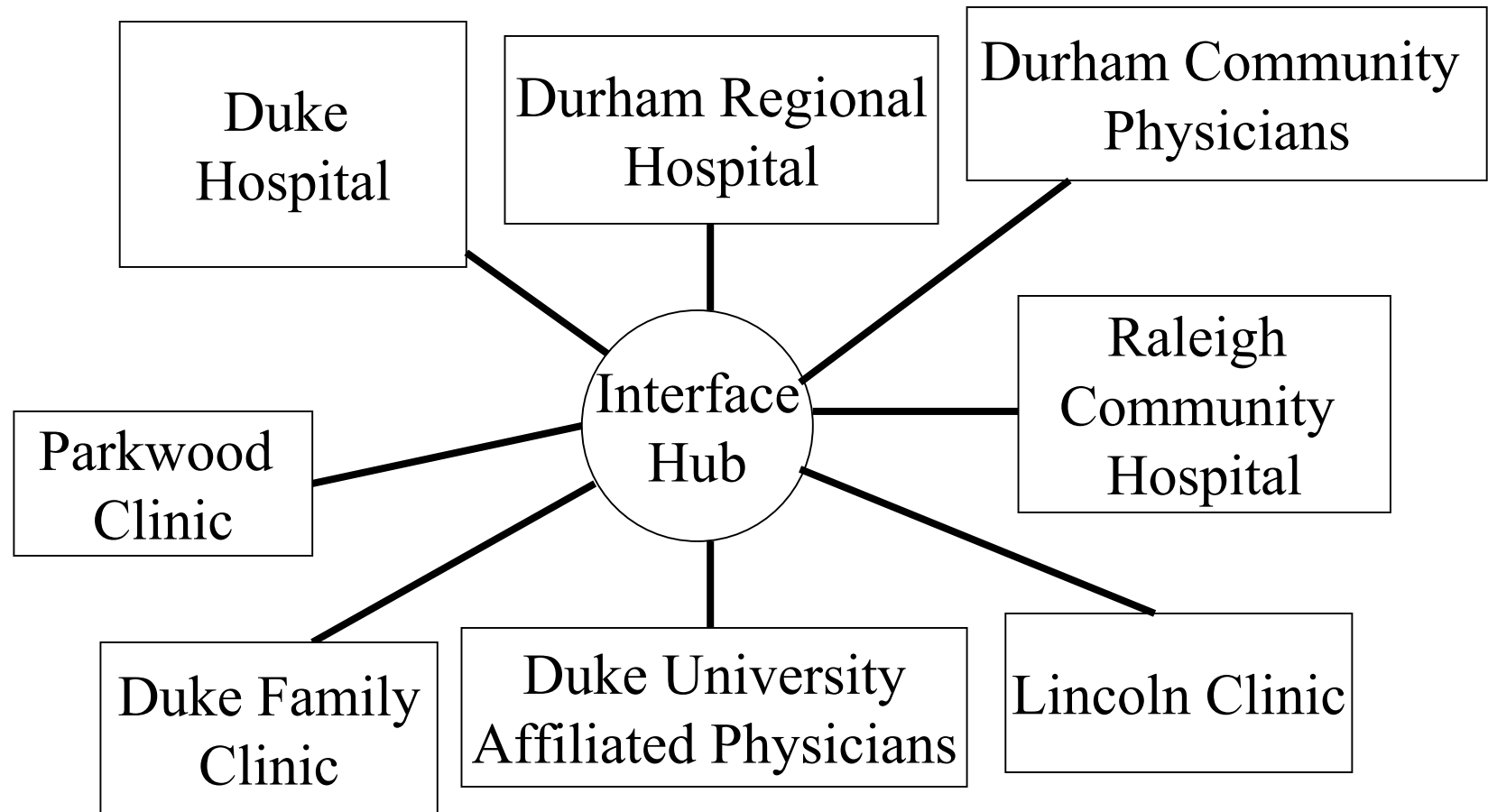
# DUKE HIS



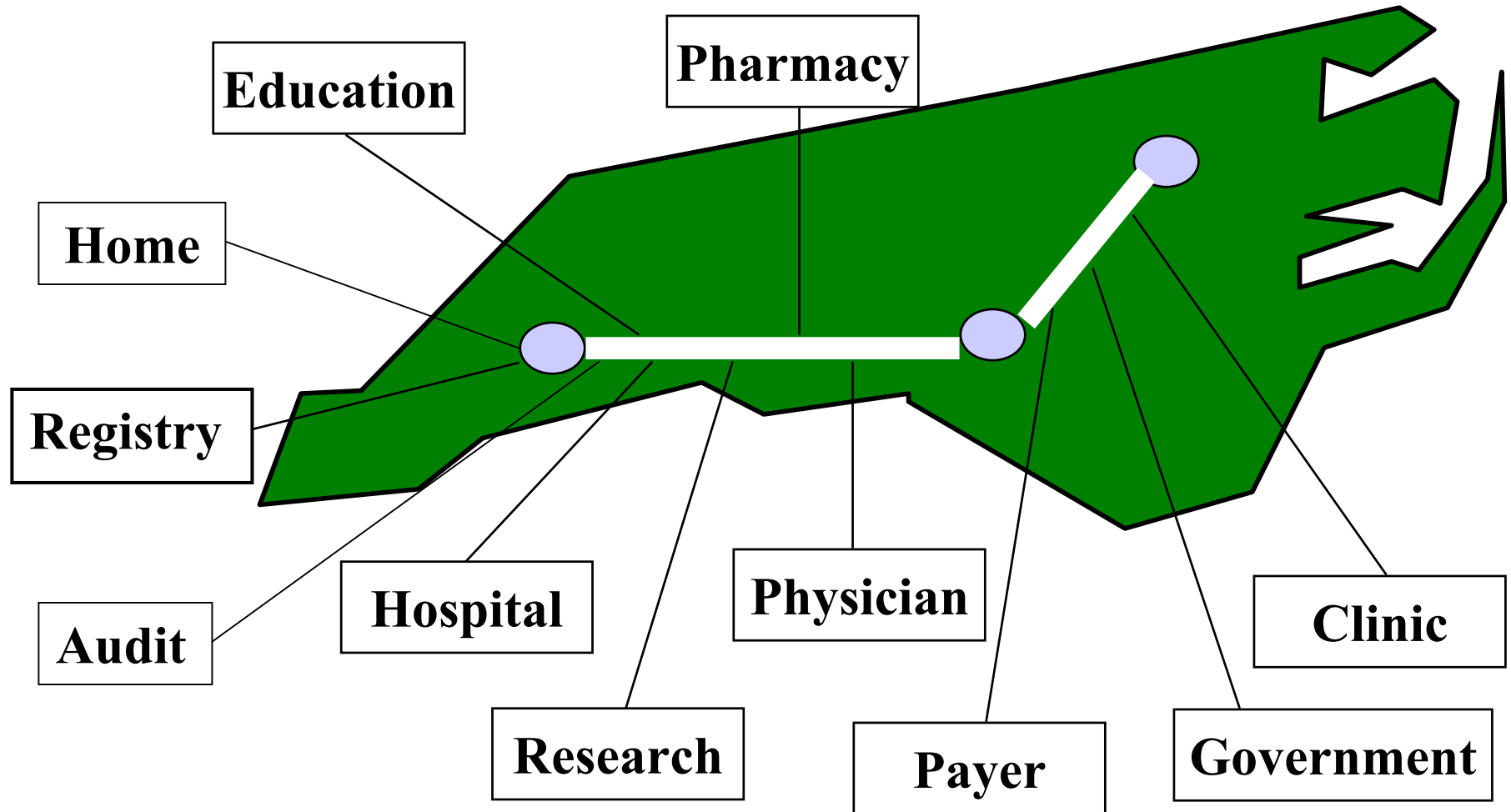
# What was integrated?

- Hospital service-related functions, as ADT, Order Entry, Result Reporting, Materials Management, Patient Accounting, Medical Chart
- Departmental systems, as Clinical Laboratory, Pharmacy, Radiology, Pathology
- Resource management, scheduling, physician billing

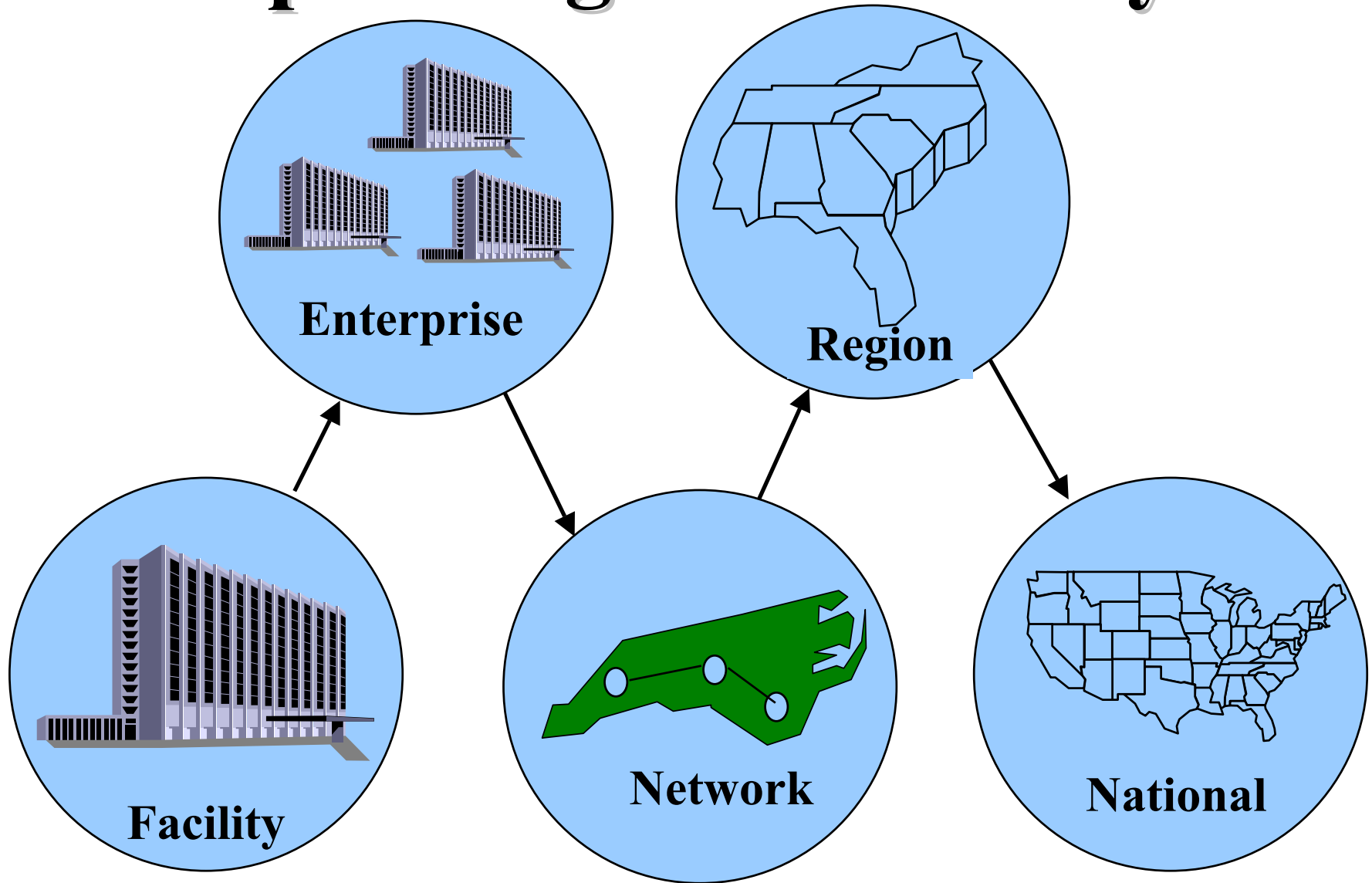
# Enterprise Systems



# State-wide Information Network



# Expanding Connectivity



# Why Do We Need Standards?

- For creating a hospital information system from a heterogeneous set of vendors
- Connect the hospital to the clinics
- For the reimbursement process
- For reporting as required by federal requirements
- For research (clinical trials)

# **New Value Sets for Health Care**

- Consolidation of health care organizations
- Increased emphasis on quality
- Increased documentation required for reimbursement
- Population databases and registries
- Data mining for knowledge
- Increased consumer involvement

**What's it all about?**

**INTEROPERABILITY**

# **Influence Drivers**

- **Users**
- **Vendors**
- **National Standards Organizations**
- **Governments**
- **International Standards Organization**

# **What standards are needed?**

- Communication standards
- Data interchange standards
- Information model standards
- Vocabulary standards
- Security standards

# HL7 Mission Statement ...

To provide standards for the exchange, management and integration of data that supports clinical patient care and the management, delivery and evaluation of healthcare services. Specifically, to create flexible, cost effective approaches, standards, guidelines, methodologies, and related services for interoperability between healthcare information systems.

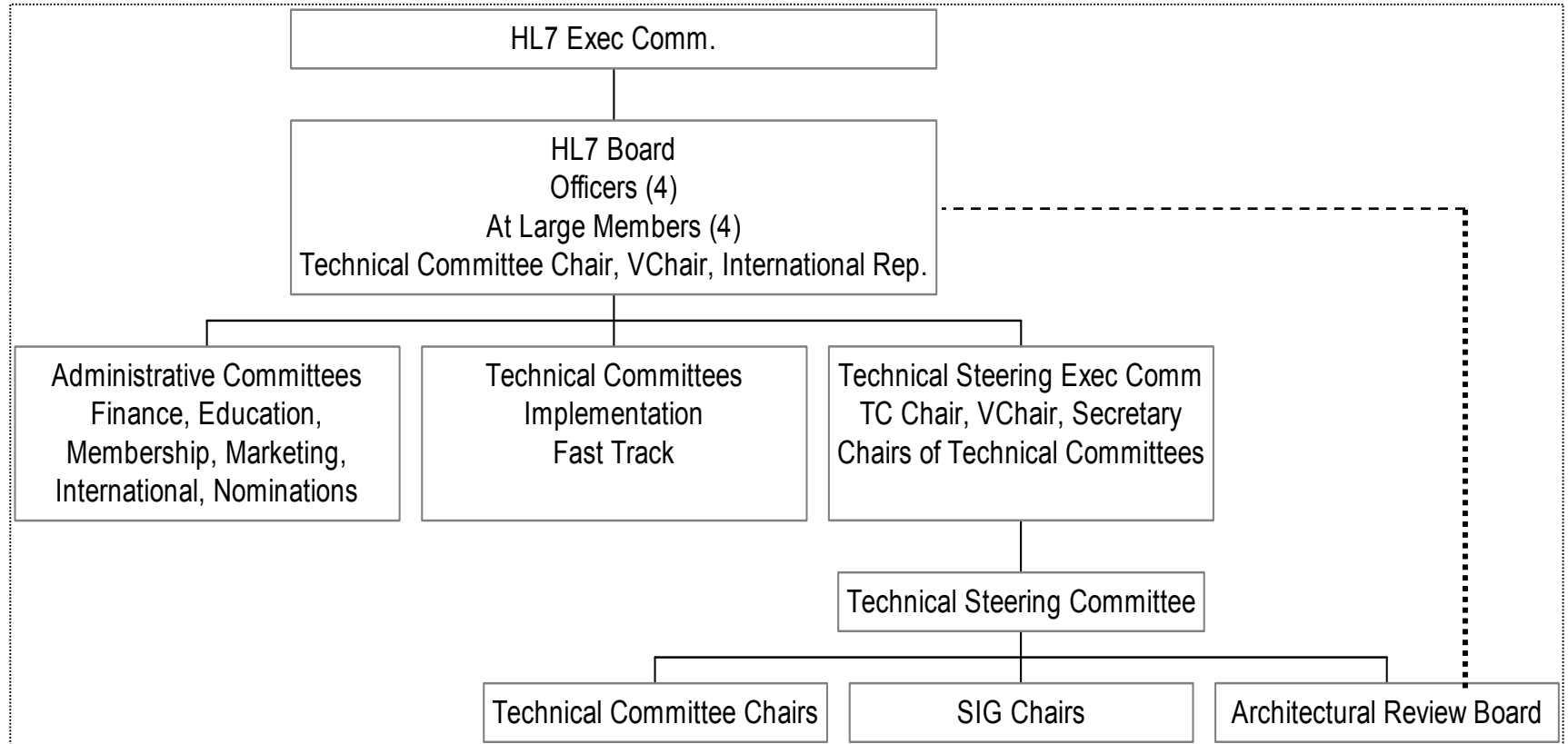
# **HL7 Mission Statement (2)**

These efforts enable effective, efficient communication between the constituents of the healthcare community as represented by our membership, which consists of an international community of healthcare organizations, vendors, developers of healthcare information systems, consultants and systems integrators, related public and private healthcare services agencies.

# ... HL7 Mission Statement

The mission of HL7 encompasses the complete ‘life cycle’ of a standards specification -- development, adoption, market recognition, utilization and adherence. The HL7 specifications are **unified by shared reference models of the healthcare and technical domains.**

# HL7 Organization



# Milestones of HL7 (1)

- 1987      Organizational meeting, U of PA
- 1987      Version 1.0 (Scope definition)
- 1989      Version 2.0 (Demonstration)
- 1990      Version 2.1 (Implementable)
- 1991      ANSI member
- 1992      Charter member ANSI HISPP
- 1994      Version 2.2

# Milestones of HL7 (2)

- 1994      ANSI accredited SDO
- 1995      V2.2 became ANSI Standard
- 1997      Version 2.3 (expanded scope)
- 1997      V2.3 became ANSI Standard
- 1998      V2.3.1 published
- 1999      CCOW published
- 1999      Arden Syntax V2.0 published

# Milestones of HL7 (3)

- 1999 Version 2.3.1 (current ANSI standard)
- 2000 HIMSS 2000 Demo
- 2000 Version 2.4
- 2000 Clinical Document Architecture
- 2001 Version 3.0 to be published

# Organization & Meetings...

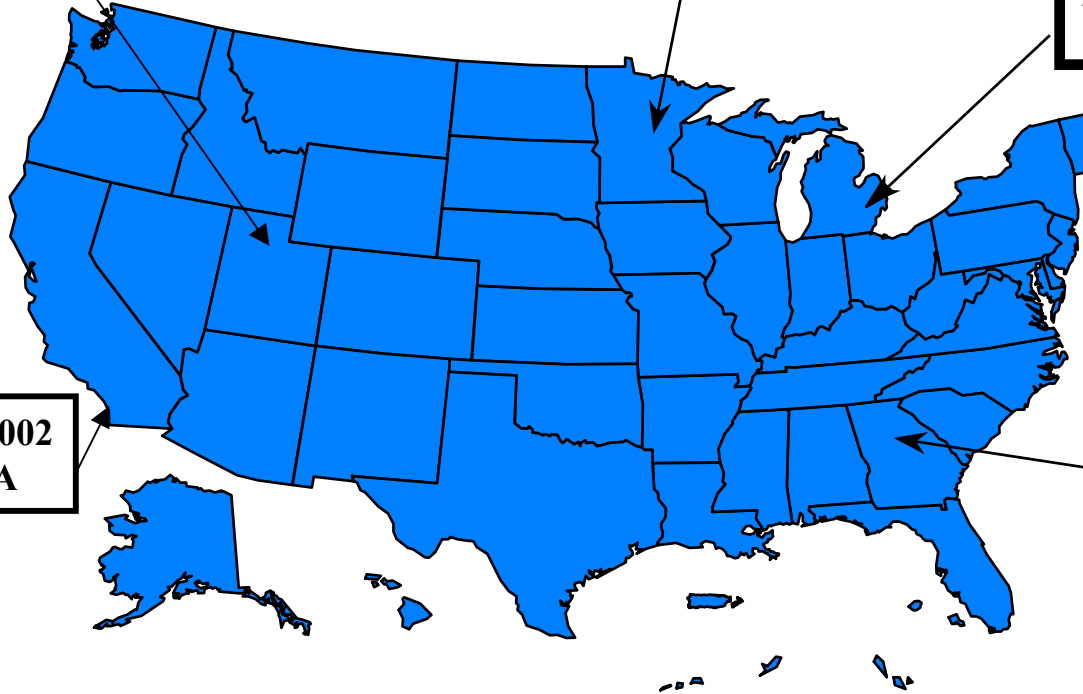
**October 1-5, 2001  
15 annual plenary  
meeting  
Salt Lake City, UT**

**May 7-11, 2001  
Working Group Meeting  
Minneapolis, MN**

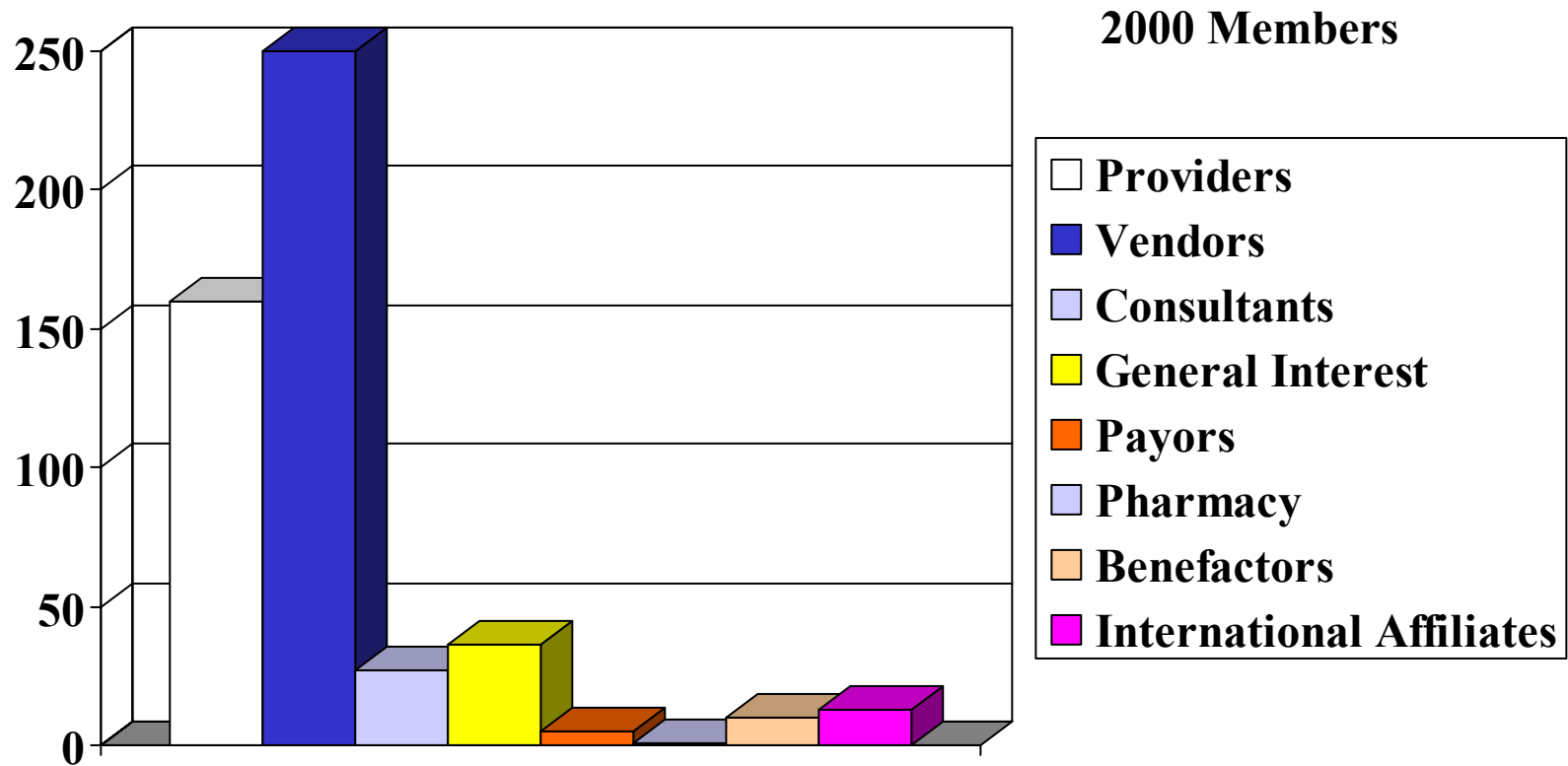
**Mark McDougall  
Executive Director  
Health Level Seven  
3300 Washtenaw Ave, Suite 227  
Ann Arbor, MI 48104-4250  
Phone: 313 677-7777**

**January 7-11, 2002  
San Diego, CA**

**April 29 - May 3, 2002  
Working Group Meeting  
Atlanta, GA**



# Membership, January 2001



# International Affiliates

- 
- *HL7 Argentina*
  - *HL7 Australia*
  - *HL7 Canada*
  - *HL7 China*
  - *HL7 Finland*
  - *HL7 Germany*
  - *HL7 India*
  - *HL7 Japan*
  - *HL7 Korea*
  - *HL7 New Zealand*
  - *HL7 South Africa*
  - *HL7 Switzerland*
  - *HL7 Taiwan*
  - *HL7 The Netherlands*
  - *HL7 Turkey*
  - *HL7 United Kingdom*

# HL7 Technical Committees

- Clinical Context Object Workgroup (CCOW)
- Clinical Decision Support
- Control/Query
- Medical Records/Information Management
- Modeling and Methodology
- Orders/Observations
- Patient Administration/Financial Management
- Patient Care
- Scheduling and Logistics
- Structured Documents
- Vocabulary

# Special Interest Groups (1)

- Accountability, Quality and Performance
- Arden Syntax
- Attachments
- Blood Bank
- Clinical Trials
- Community Based Health Services
- Conformance
- Government Projects
- Guideline Interchange Format
- Imaging Integration

# Special Interest Groups (2)

- Laboratory, Point of Care, and Automated Testing
  - Patient/Provider Messaging
  - Personnel Management
  - Security & Accountability
  - Templates
  - XML
- 
- Electronic Health Record
  - Clinical Specialties Advisory Group

# HL7 Coverage

## Usage

- **Orders and reports**
- **Medical transcriptions**
- **Electronic medical record/data repository**
- **Care planning**
- **Scheduling**
- **Public health**
- **Special studies**
- **Patient administration**

## Contents

- **lab**
- **radiology**
- **pharmacy**
- **medicine administration**
- **nuclear medicine**
- **dietary**
- **respiratory therapy**
- **physical therapy**
- **EKG**
- **EEG**
- **discharge summary**
- **op note**
- **clinic note**
- **outcomes**
- **...other studies, services, reports and therapies**
- **administrative data**

# **What is required to exchange data among heterogeneous systems?**

- Data Interchange Standard
  - Reference Information Model (Objects)
  - Common Data Types
  - Common Vocabulary
  - Trigger Events
  - Content (semantics)
  - Syntax

# **What is required to exchange data among heterogeneous systems?**

- Security
- Conformance requirements
- Document standards
- Underlying communications and wiring protocols

# Data Interchange Standards

- Based on a message transmitted as a result of a real world event
- The content of the message (**semantics**) may be defined as an abstract message
- The encoding rules for sending the message or the **syntax** varies among the different standards groups.

# What is HL7?

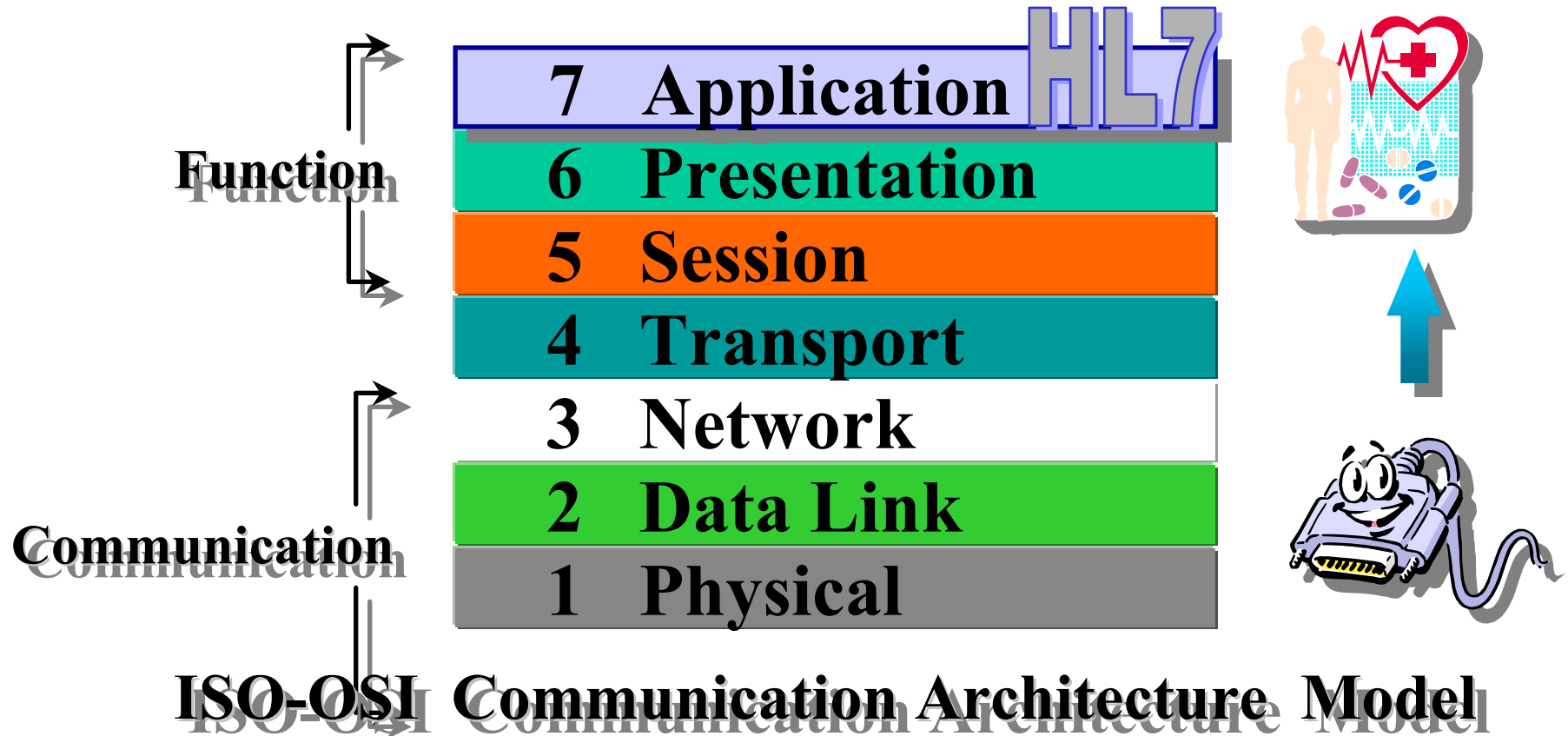
- A standard for the interchange of healthcare data
- A set of message-based transactions between healthcare applications
- Message protocol supports unsolicited messages as well as solicited messages
- Encoding rules produce human-readable variable length delimited ASCII messages

# What is HL7 NOT?

- An application
- A data structure or data base specification
- An architecture for designing health applications
- A specification for a message router or gateway

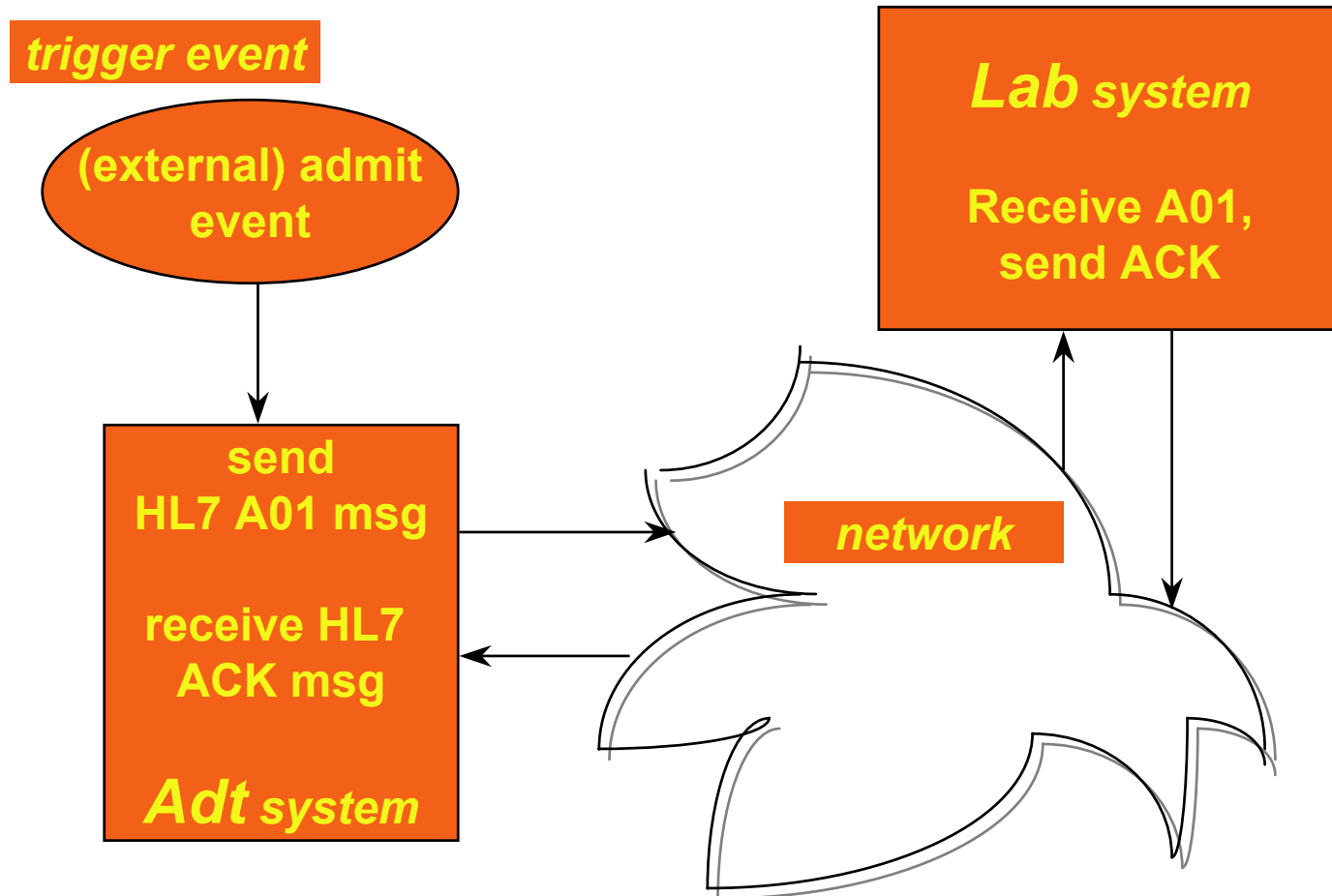
# What does “HL7” stand for?

**A domain-specific, common protocol for the exchange of health care information.**



A specific message is defined by the trigger, representing a real world event. HL7 defines the content of the message as an abstract set of data elements contained in data segments.

# The HL7 basic “transaction model”



# Abstract Message

- May be defined using an abstract language independent of syntax
- Likely candidate is ISO Abstract Syntax Notation One (ASN.1)

# HL7 MESSAGE COMPOSITION

- MESSAGE
  - SEGMENT
    - DATA FIELD
      - DATA ELEMENT

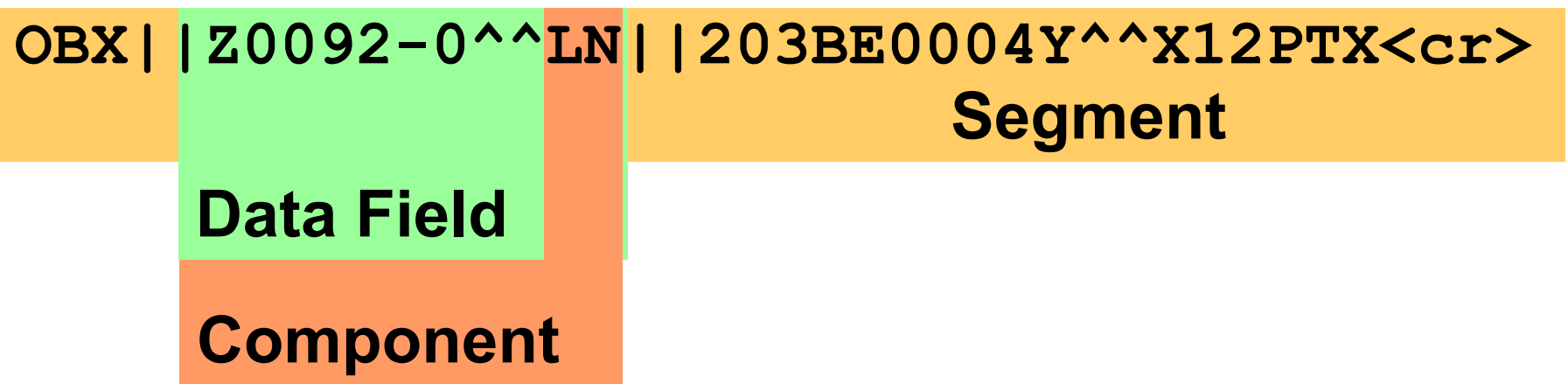
# Segments

- Segments contain fields
- Fields may contain components (sub-fields) and sub-components (sub-sub-fields)
- Fields may be defined as repeating within a segment, and the maximum number of repetitions may be repeated
- Field definitions are in terms of HL7 datatypes
- A limited set of HL7-defined escape sequences is supported

# Fields

- If a field or component refers to a table, that table may be of three types
  - *HL7 defined* with a set of values
  - *user-defined*: values must be defined as part of the site interface specification
  - *externally defined*: values are defined by reference to existing controlled vocabulary set such as SNOMED, ICD9, ICD10, LOINC. The external reference is specified by a component in the CE data type
- HL7-defined tables may be extended on a site-specific basis with “z-values”

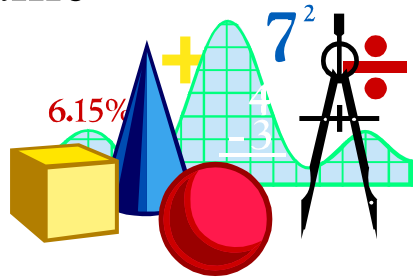
# HL7 Segment



# Data types

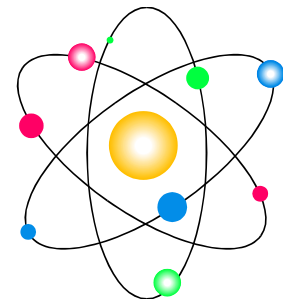
## Compound Data types

- Address
- Amount
- Code
- Date
- DateTime
- Identifier
- PersonName
- Phone
- Time



## Simple Data types

- Description
- Indicator
- Name
- Number
- Percentage
- Quantity
- Text



# CE (coded element) datatype

**<identifier>^<text>^name of coding system>^**

**<alternate identifier>^<alternate text>^<name of alternate coding system>**

|                   |          |                         |          |                      |
|-------------------|----------|-------------------------|----------|----------------------|
| <b>11289-6</b>    | <b>^</b> | <b>Body Temperature</b> | <b>^</b> | <b>LN</b>            |
| <b>Identifier</b> |          | <b>Text Name</b>        |          | <b>Coding System</b> |

# **International Character Sets**

- **8 -bit ISO 8859/1 through 8859/9**
- **multi-byte by site agreement**
- **DICOM/HL7 escape sequences to support encoding of Japanese character sets name fields**
  - **Japanese character sets specification clarified and updated in 2.3.1**

# Delimiters used to encode/decode HL7 messages

| Delimiter               | Suggested Value | Encoding Character Position | Usage                                                                         |
|-------------------------|-----------------|-----------------------------|-------------------------------------------------------------------------------|
| Segment terminator      | <cr><br>hex OD  | end of segment              | Terminates a record. Cannot be changed (not site definable).                  |
| Field Separator         |                 | after each field            | After segment ID, and between each pair of adjacent data fields in a segment. |
| Component Separator     | ^               | 1                           | Separates 2 adjacent components within a data field, where allowed.           |
| Sub-Component Separator | &               | 4                           | Separates 2 adjacent sub-components within a component where allowed.         |
| Repetition Separator    | ~               | 2                           | Separates multiple occurrences of a field, where allowed.                     |
| Escape Character        | \               | 3                           | Used in TX or FT fields.                                                      |

# **What we need to send an order message**

- **Information about the message (MSH segment)**
- **Information about the patient (PID, AL1, PV1 Segments)**
- **Information about the order: (ORC, order detail segment, OBX, BLG)**

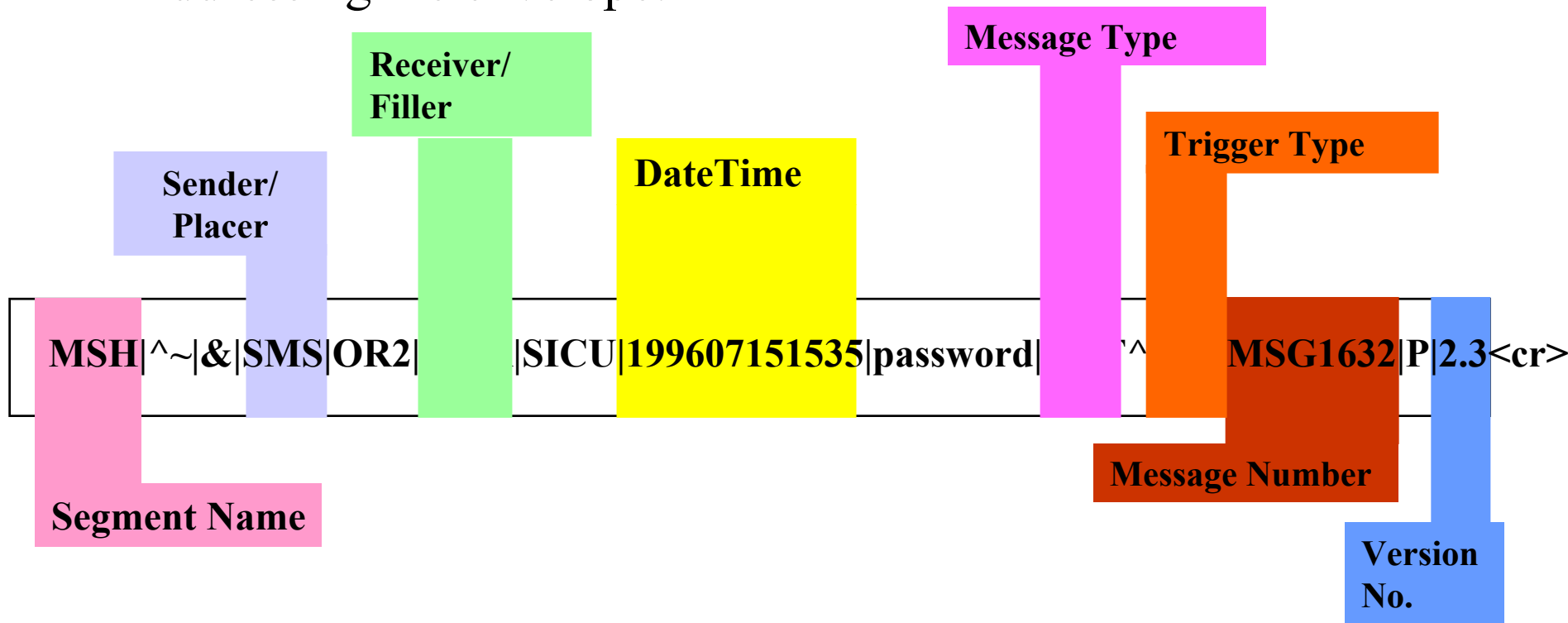
# Definitions

- Order
  - a request for material or service
- Observation
  - performance of the service including result data
- Placer
  - application initiating the order
- Filler
  - application that provides the observation

# HL7 Message

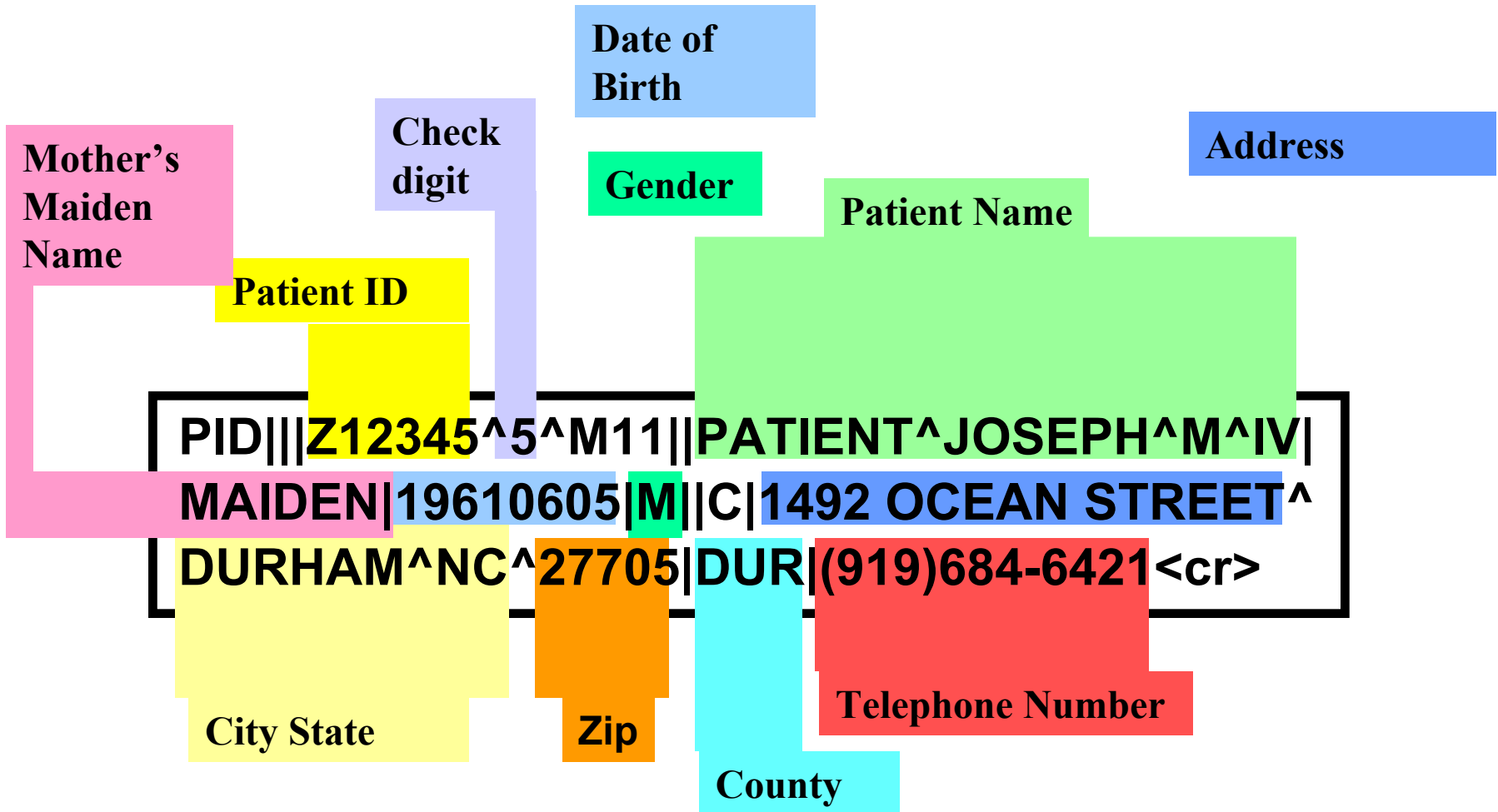
## Message Header - MSH

Addressing the envelope:



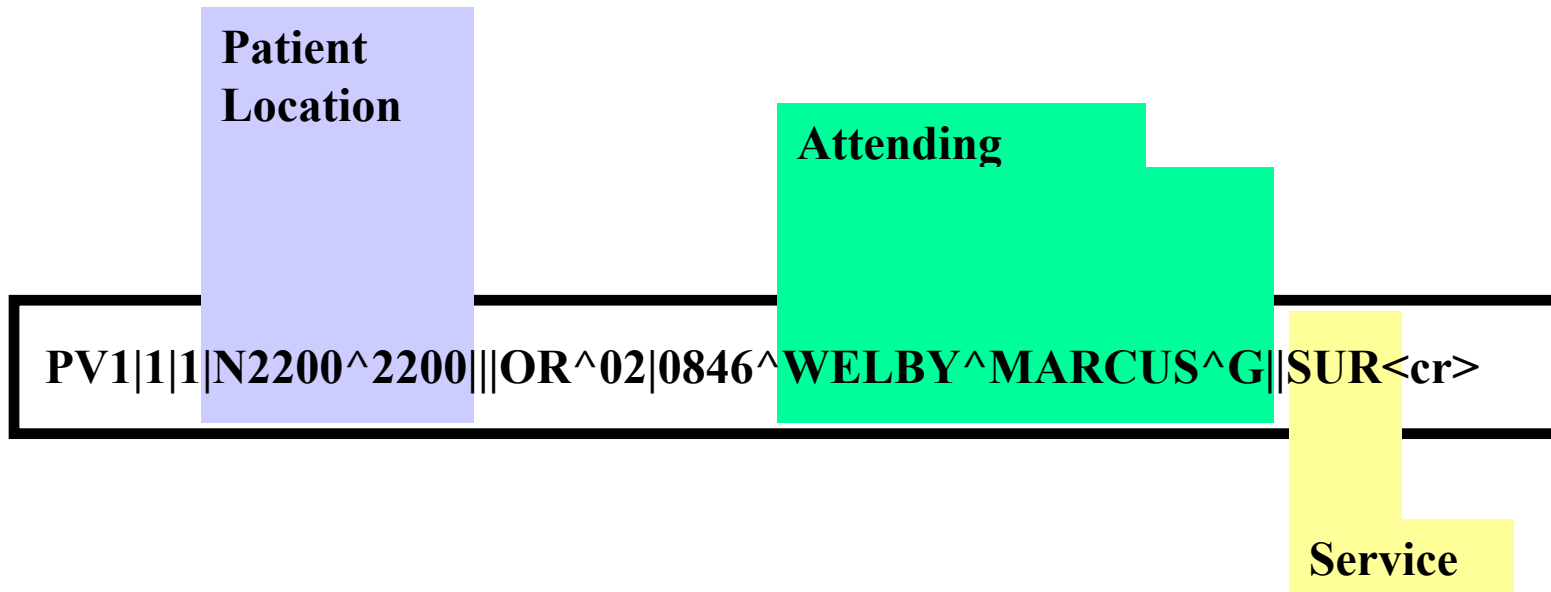
# HL7 Message - PID Segment

Identify the patient:



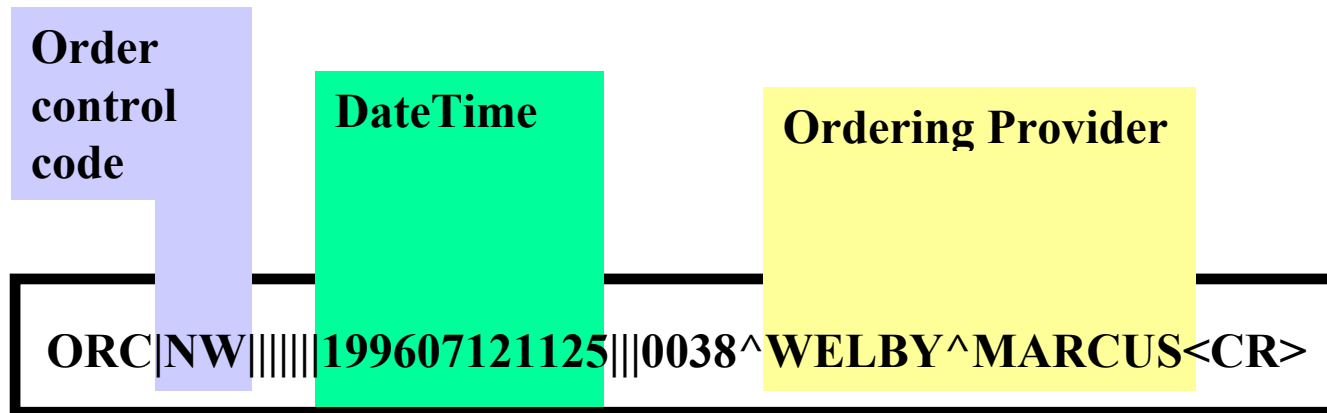
# HL7 Message PV1 Segment

Define the visit or encounter



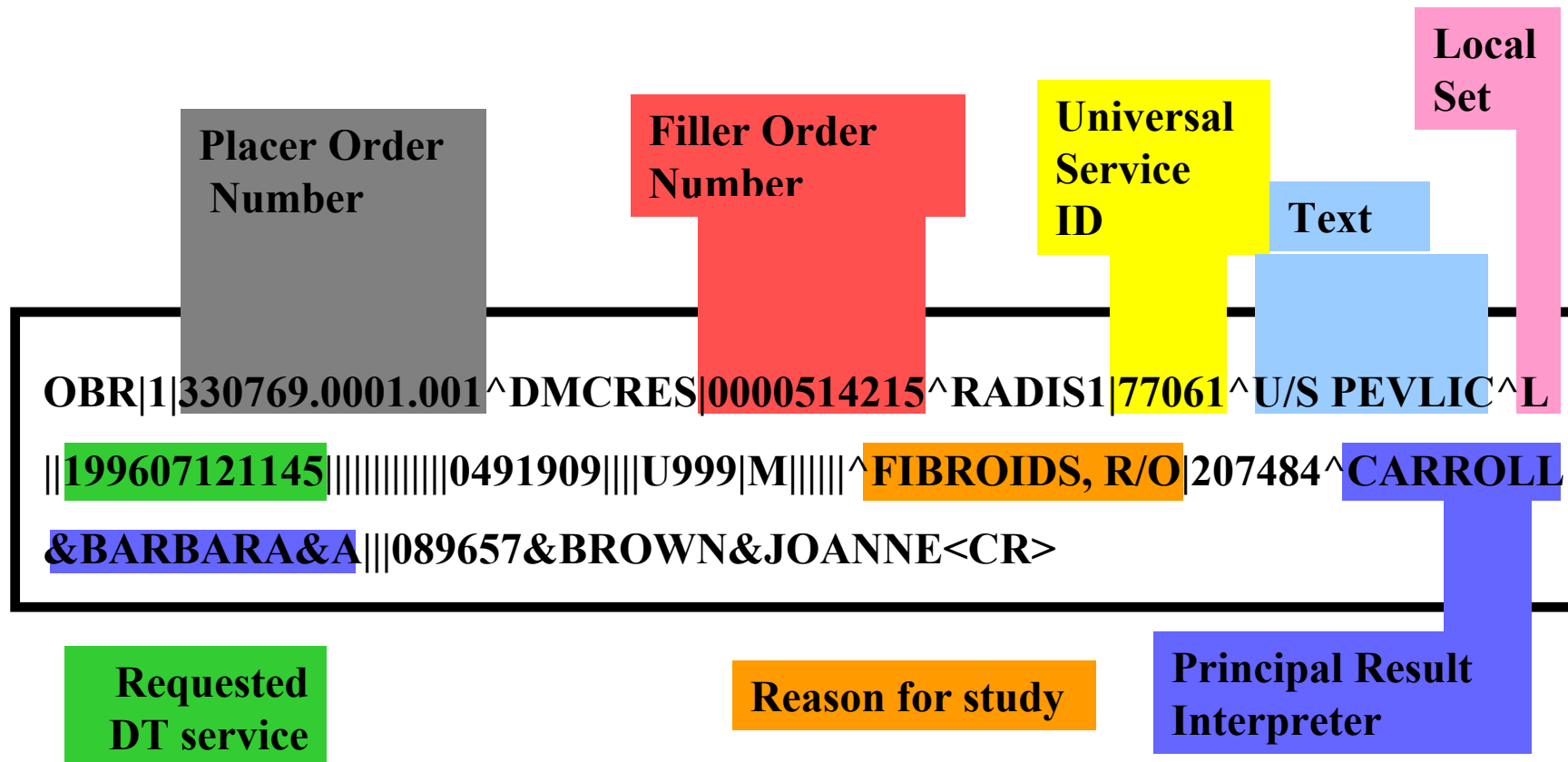
# HL7 Message ORC Segment

Define common order characteristics



# HL7 Message OBR Segment

Defines information specific to an order



# HL7 Result Message (ORU)

```
MSH|^~\&|||||19981105131523||ORU^R01<cr>  
PID|||100928782^9^M11||Smith^John^J<cr>  
OBR|||Z0063-0^^LN<cr>  
OBX||XCN|Z0063-0^^LN||2093467^Smith^J^<cr>  
OBX||Z0092-0^^LN||203BE0004Y^^X12PTX<cr>
```

# OBX: the flexible segment

Other data fields include: date of observation, identity of provider giving observation, normal ranges, abnormal flags

A code that identifies the *datatype* of OBX-5

OBX-5: Data

Status

OBX | | NM | 11289-6^^LN | | 38 | C^^ISO+ | | | | F

A code that identifies the data in OBX-5 (Temp Reading)

A code that identifies the units of numerical data in OBX-5

# OBX: with a coded value

A code that identifies the *datatype* as a coded element

The code is from LOINC

The code is from SNOMED

OBX||CE|883-9^Blood Group^LN||F-D1250^Group O^SMI|

A code that identifies the data in OBX-5  
(ABO Blood Group)

OBX-5: Data  
A code for Group O

# HL7 Message OBX Segment

Contains result

**OBX||TX|FIND^FINDINGS^L|1|FINDINGS: PELVIC ULTRASOUND  
PERFORMED TRANSABDOMINALLY. THE UTERUS MEASURES  
12.8 X 7.9 X 5.6 CM. NORMAL ENDOMETRIAL THICKNESS.  
SEVERAL SMALL FIBROIDS ARE PRESENT. BOTH OVARIES  
WERE SEEN AND ARE SONOGRAPHICALLY NORMAL.  
PREVIOUSLY NOTED CYCTS HAVE RESOLVED.**

# Example: Radiology Data

MSH|^~\&|XRAY||CDB|||ORU^R01|K172|P<cr>  
PID|1|123456-1||GRUNCH^BUBBA^T|||||98211111<cr>  
OBR|1|X89-1501^OE|78912RD|71020^CHEST XRAY AP &  
LATERAL|R|199807141530|199807141000||JBM|N<cr>  
OBX|1|CE|71020&IMP^RADIOLOGIST'S  
IMPRESSION|4||^MASS LEFT LOWER LOBE|1||A||F<cr>  
OBX|2|CE|71020&IM|2|^INFILTRATE RIGHT LOWER  
LOBE|||A||F<cr>  
OBX|3|CE|71020&IMP|3|^HEART SIZE NORMAL|||N||F<cr>  
OBX|4|FT|71020&GDT|1|circular density (2 x 2 cm) is seen in  
the posterior segment of the LLL. A second, less well-defined  
infiltrated circulation density is seen in the R mid lung field and  
appears to cross the minor fissure|||||<cr>  
OBX|5|CE|71020&REC||71020^Follow up CXR 1 month||30-  
45|||F<cr>

# Order Messages

- ORM - general order message
  - Trigger event - O01
- ORR - general order response message
  - Trigger event - O02
- QRY - original mode display query
  - Trigger event Q01,Q02
- QSQ/QSR - query for order status
  - Trigger event - Q06

# ORM Message

| <b><u>ORM</u></b> | <b><u>General Order Message</u></b>  | <b><u>Chapter</u></b> |
|-------------------|--------------------------------------|-----------------------|
| MSH               | Message Header                       | 2                     |
| [{NTE}]           | Notes and comments for header        | 2                     |
| [                 |                                      |                       |
| PID               | Patient Identification               | 3                     |
| [PID1]            | Additional Patient Identification    | 3                     |
| [{NTE}]           | Notes and comments about patient     | 2                     |
| [PV1              | Patient Visit                        | 3                     |
| [PV2]]            | Patient visit additional information | 3                     |
| [{IN1             | Insurance Information                | 6                     |
| [IN2]             | Insurance additional information     | 6                     |
| [IN3]             | Insurance additional information     | 6                     |
| }]                |                                      |                       |
| [GT1]             | Guarantor Information                | 6                     |
| [{AL1}]           | Allergy Information                  | 3                     |
| ]                 |                                      |                       |

# ORM Message (cont.)

| ORM                   | General Order Message         | Chapter |
|-----------------------|-------------------------------|---------|
| {                     |                               |         |
| ORC                   | Common Order                  | 4       |
| [Order Detail Segment |                               | 4       |
| [{NTE}]               | Notes and comments on detail  | 2       |
| [{DG1}]               | Diagnosis                     | 6       |
| [{                    |                               |         |
| OBX                   | Observation/Result            | 7       |
| [{NTE}]               | Notes and comments on results | 2       |
| }]                    |                               |         |
| ]                     |                               |         |
| [{CT1}]               | Clinical Trial Identification | 7       |
| [BLG]                 | Billing Segment               | 4       |
| }                     |                               |         |

# ORM Detail Segments

- **General: OBR**
- **Supply Orders: RQD, RQ1**
- **Medication/Treatment: RXO**
- **Dietary: ODS, ODT**

# Observation Examples

- Radiology Reports
- EKG Reports and waveform data
- Surgical Pathology Reports
- Discharge Summaries
- Operative Notes
- Laboratory Results
- Clinical Encounter Notes
- Nursing Data and others

# Example: EKG Order

**MSH|...**

**PID|...**

**ORC|NW|A226677^PC||946281^PC||N|3^QAM||199807141132|P1  
2345 ^ AQITANE^ELLINORE^""^""^""^MD|||4 EAST<cr>**

**//EKG Order**

**OBR|||8601-7^EKG**

**IMPRESSION^LN|||||||P030^SMITH^MARTIN^  
""^""^""^MD|||||||3^QAM<cr>**

**BLG|...**

**ORC|...      //Other orders may follow**

# Pharmacy Messages

- RDE/RRE
  - Encoded order message and acknowledgement
- RDS/RRD
  - Dispense message and acknowledgement
- RGV/RRG
  - Give message and acknowledgement
- RAS/RRR
  - Administration message and acknowledgement

# Example: RX Order

**MSH|...**

**PID|...**

**ORC|NW|1000^OE|||E**

**RXO|||||500 mg Polycillin Q6H for 10 days, dispense 40 Tablets**

# Example: Alternate RX Order

**MSH|...**

**PID|...**

**ORC|NW|100^OE||||E|^Q6H^D10^^^^R**

**RXO|^Polycillin 500 mg TAB|500||MG||||Y||40**

**RXR|PO**

# Emergency Department (Partial)

MSH|^~\&||||19981105131523||ORU^R01|  
PID|||100928782^9^MOD11||Smith^John^J

OBR||||11291-2 ^^LN<cr>

OBX||CE|11291-2^^LN||12||||||F

OBR||||15511-9^^LN

OBX||NM|11289-6^^LN||38|C^^ISO+||||||F

OBX||CE|11290-4^^LN||4^^DEEDS4.27||||||F

# Clinical Trial Messages

- CRM - clinical study registration message
- CSU - unsolicited study data message
- CM0, CM1, CM2 - master file messages

# Z Segments

Used to extend HL7 protocol  
for local use

**ZCH|Donor^Eyes~Donor^Heart~Donor^Lungs**

**ZCH|ADE^DO NOT RECESITATE**

# HL7 QUERY FILTERS

- Who subject filter
- What subject filter
- What department data code
- What data code value qualifier
- Query results level
- Where subject filter
- When data start date/time

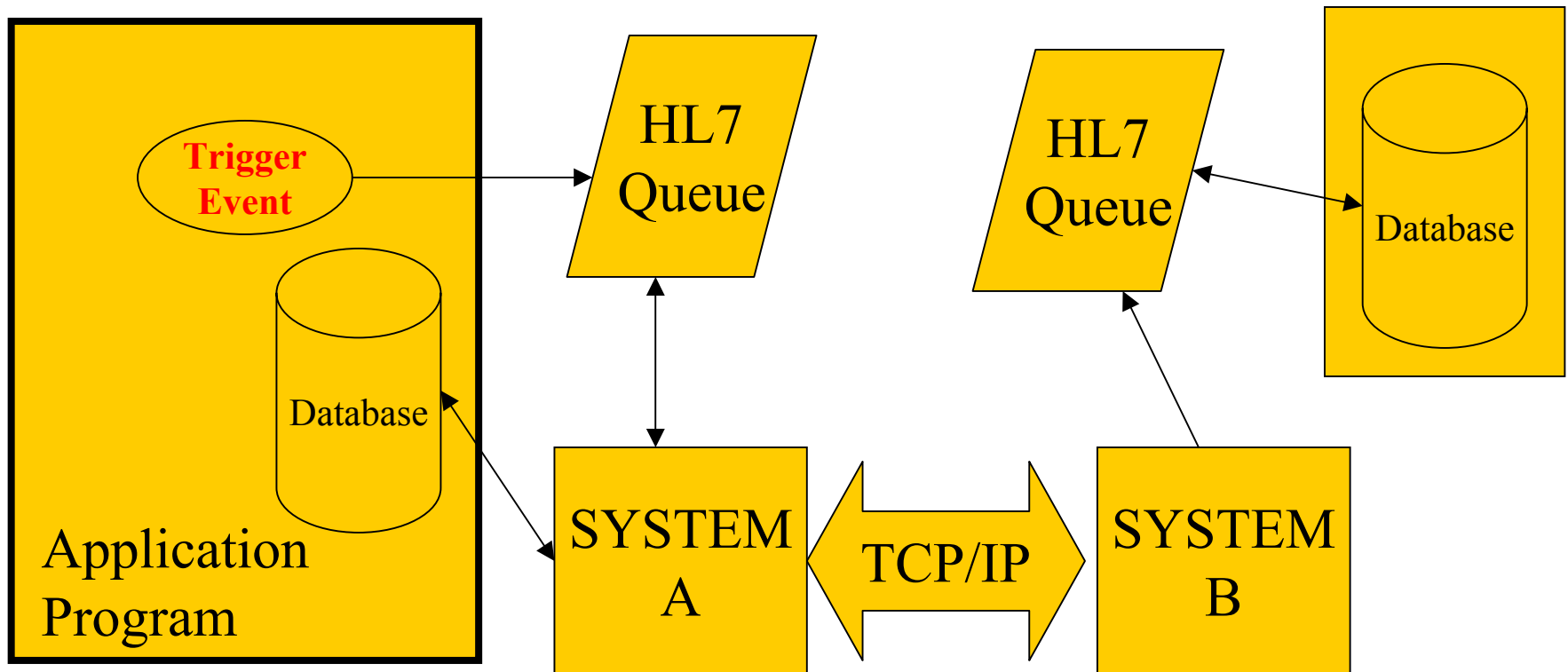
# HL7 QUERY FILTERS (cont.)

- When data end start/time
- What user qualifier other
- QRY subject filter
- Which date/time qualifier
- Which date/time status qualifier
- Date/time selection qualifier

# Enhanced query paradigms

- Embedded Query Language (EQQ)
  - SQL or other query language
- Virtual Query Request (VQQ)
  - HL7 segments can be considered virtual tables
- Stored Procedure Requests (SPQ)
- Event Replay Queries (ERQ)

# HL7 Application



# Versions of HL7

- V2.2 - Functional areas include ADT, Registration, Orders, Results, Patient Financial and Master Files
- V2.3 - Additions include non-ASCII character sets, query language support, immunization reporting, adverse drug reactions, clinical trials, scheduling, referrals, medical transcriptions, problems and goals

# Versions of HL7

- Version 2.4
  - A new query paradigm - conformance-based queries
  - Further internationalization support
  - Personnel management transactions
  - Clinical lab automation transactions
  - Network Application Management transactions

# Limitations of Version 2.x

- Implicit information model, not explicit
- Events not tightly coupled to profiles
- Need for controlled vocabularies
- Limited to a single encoding syntax
- No explicit support for newer technologies
  - Object Technologies
  - XML and Web Technologies
- No explicit support for security functions
- Optionality is ubiquitous and troublesome

# Current Implementation Problems with Version 2.x

**Complex integration: at least 2-4 months to install HL7 interfaces**

## Problem

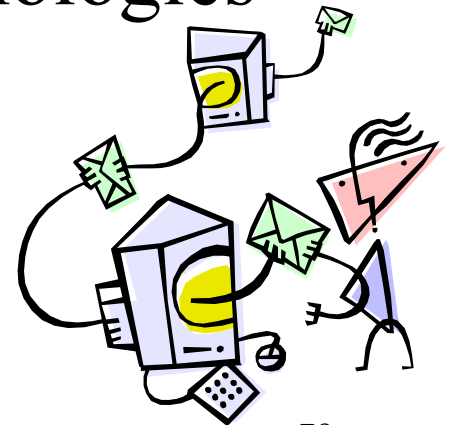
- Honest misunderstanding of specifications
- Misleading conformance claims

## Cause

- Different implicit information models
- No vocabulary to describe conformance concepts

# Version 3 Goals

- Provide a framework for coupling events, data elements and messages
- Improve clarity and precision of specification
- Improve adaptability of standards to change
- Take advantage of emerging technologies such as XML
- Begin to approach  
*“plug and play”*



# Version 3 Principles (1)

- Explicit Scope, Target Users
- Support for Legacy Systems
- Loosely Coupled Systems
- Internationalization
- Compatibility with Versions 2.X (limited)
- Management - ANSI and by-laws
- Uniform Trigger Event Model
- Information System Role

# Version 3 Principles (2)

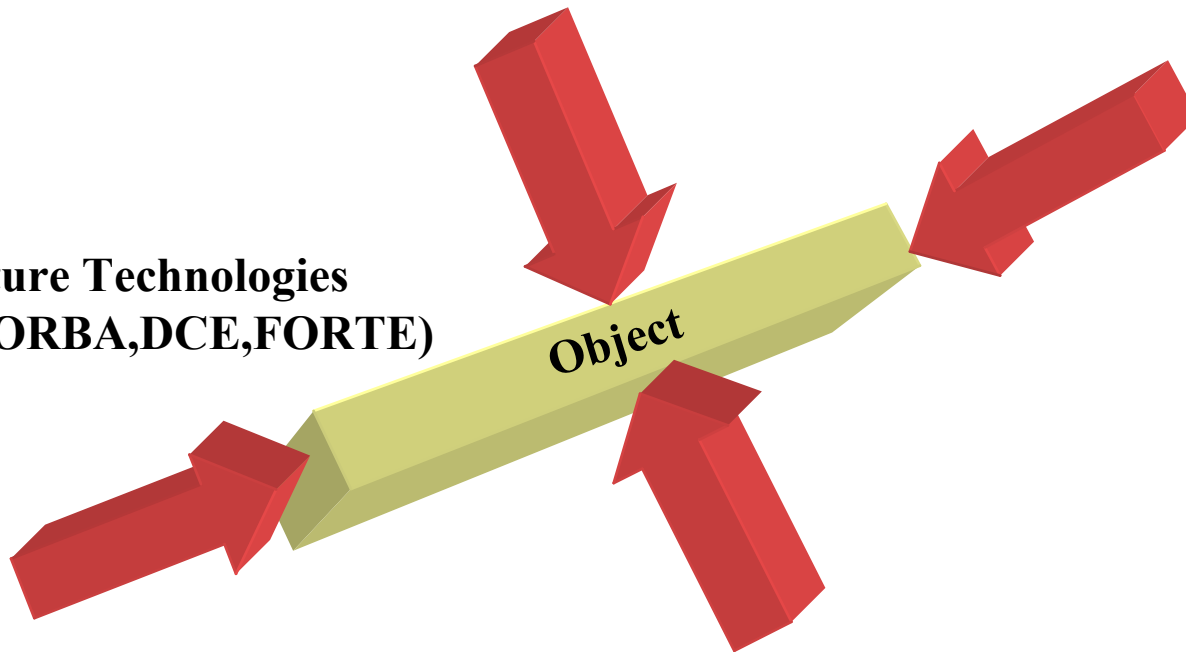
- Conformance Claims
- The Version 3 Development Process
- Project Scope
- Version 3 Methodology - **MDF**
- Quality Assurance Processes
- Process Support
- Confidentiality of Patient Information
- Authenticated Authorization for Services
- Security, Privacy, and Integrity

# Object Technologies

**OOA/OOD Methods**  
(Objectory, SOMA)

**Notation**  
(UML)

**Architecture Technologies**  
(COM,CORBA,DCE,FORTE)



**Implementation Technologies**  
(C++,Smalltalk,Ada,Java,OODB)

# Healthcare Objects

## Object Management Group (OMG):

- CorbaMed

## Microsoft:

- Common Object Model (COM)
- Distributed COM

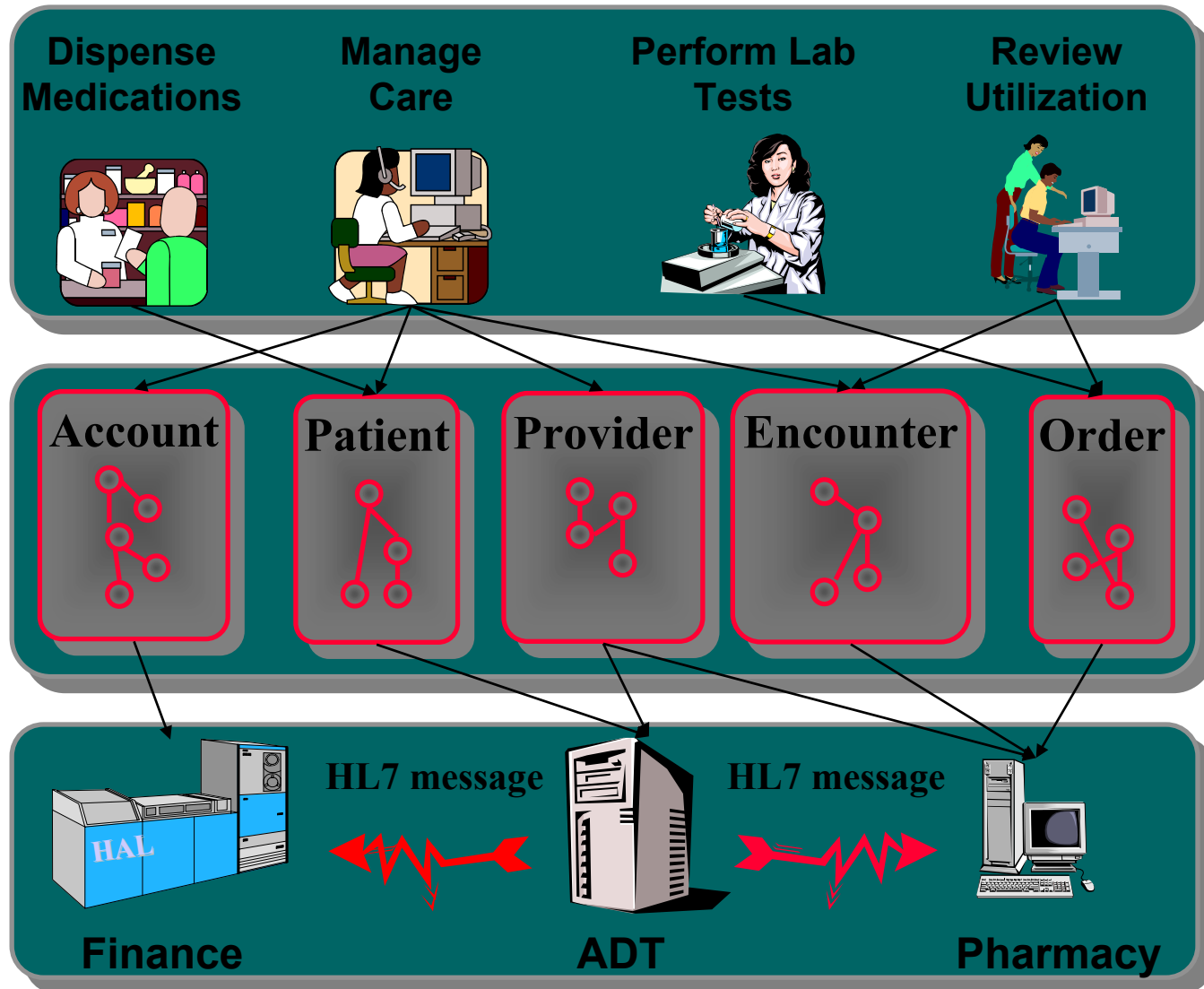
# HL7 Modeling

## Abstractions:

**Activities**  
(Use Case Model)

**Objects**  
(Information Model)

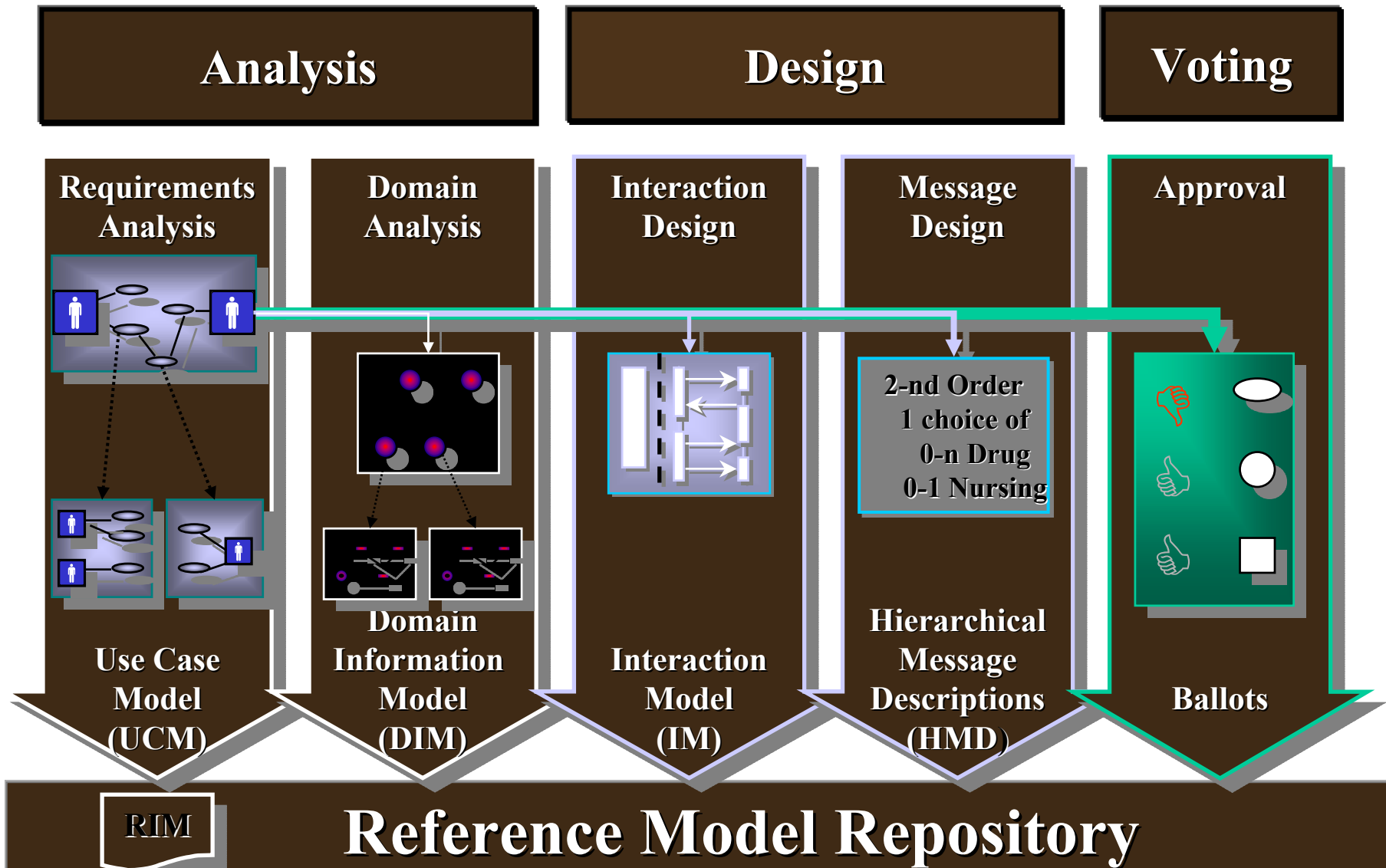
**Communication**  
(Interaction and Message Models)



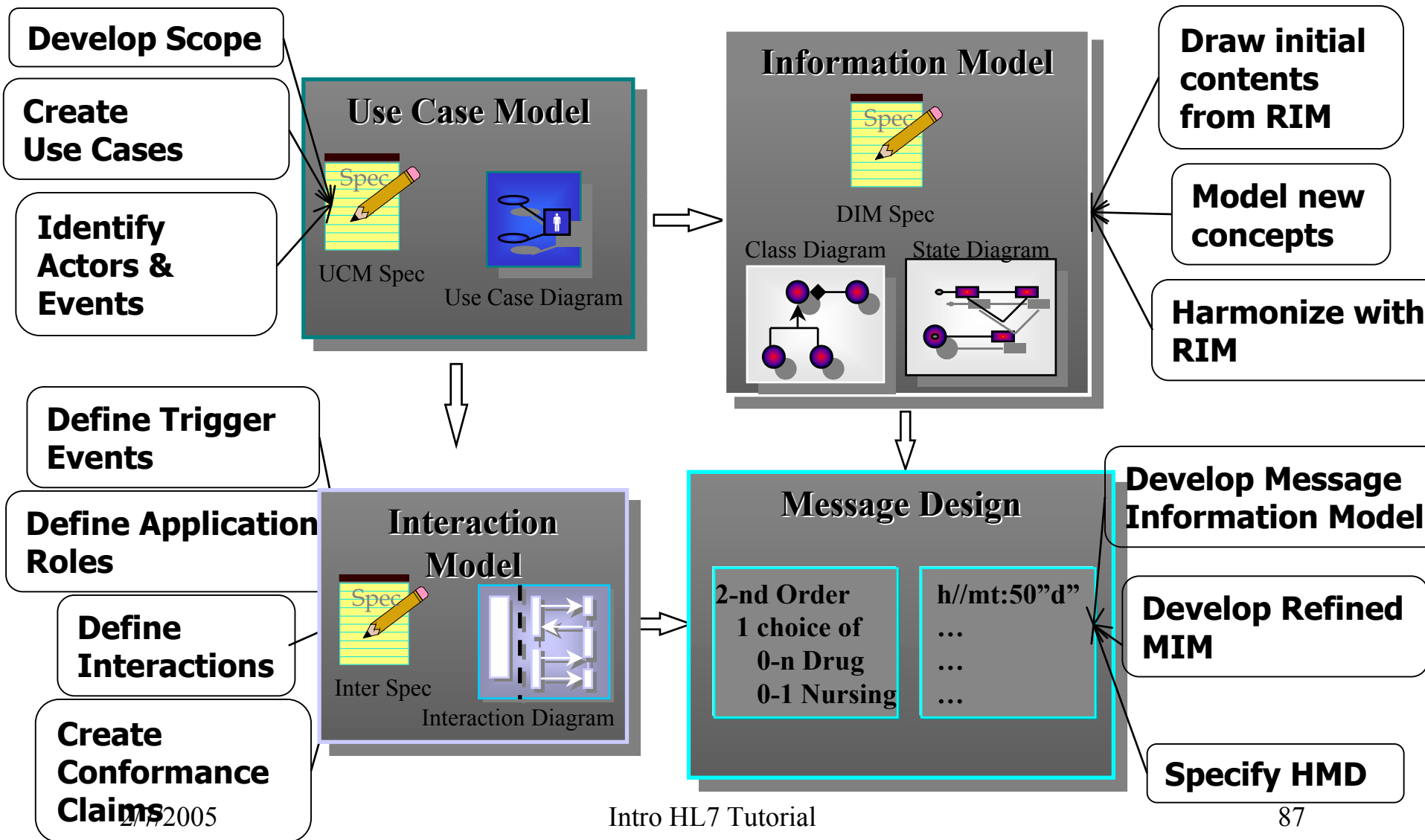
# Version 3.0

- Use-case Model
- Reference Information Model
- Domain Information Model
- Message Information Model
- Message Object Diagram
- Hierarchical Message Description
- Common Message Element Definition

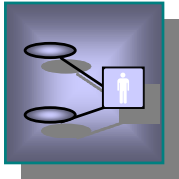
# MDF Model Relationships



# Models developed in Phases

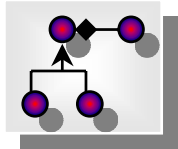


# V3 process is documented in the Message Development Framework (MDF)



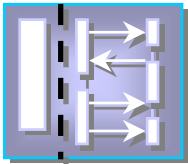
## Use Case Model

- Captures healthcare requirements
- Defines scope for TSC approval



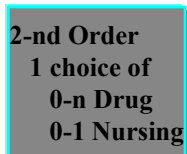
## Information Model

- Specifies data and its semantics
- Specifies major state transitions
- Specifies vocabulary for domains



## Interaction Model

- Defines information flows
- Defines communication roles
- Forms basis for conformance claims



## Message Specification

- Defines message contents
- Apply constraints to the information model and vocabulary

# Methodology in a nutshell

1. Define a consensus reference information model (RIM) that defines the data of interest in the healthcare domain.
2. Assemble the terminologies and data types necessary to express the attributes of the RIM
3. Apply the model, vocabulary and types to: messages, patient record DTDs, medical logic modules, component specifications, etc.
4. For any particular application, draw from the RIM to construct an abstract message structure - the Hierarchical Message Description (HMD)
5. For any particular implementation technology, define an implementation technology specification (ITS) for mapping the HMD to that technology.
6. When the message (or equivalent) is sent, the HMD is used to marshal the data, and the ITS is used to format the data for communication.

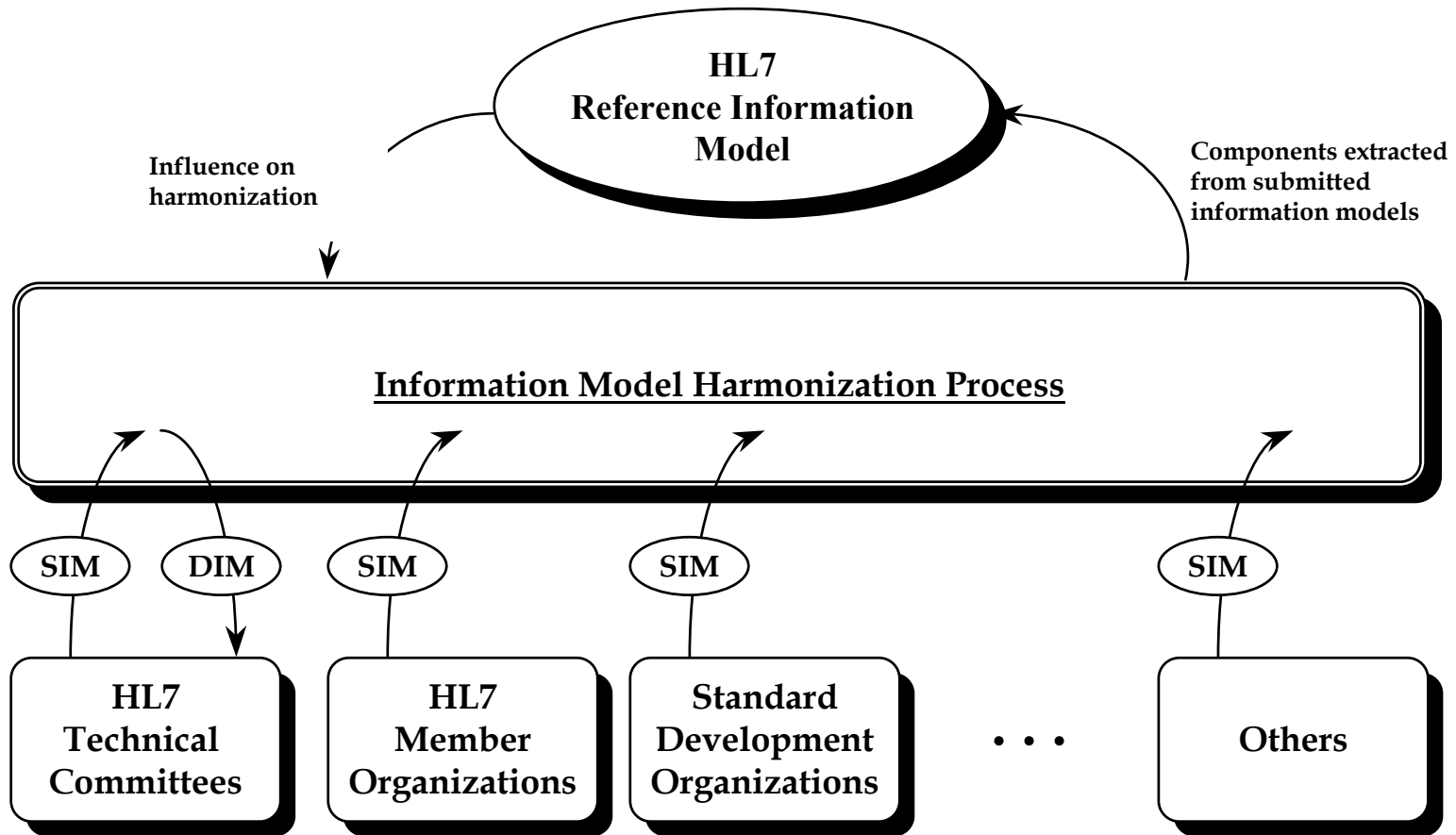
# **Reference Information Model (RIM)**

- The RIM is a coherent shared information model including all of the content of HL7 messages
- Belongs to the Working Group as a whole
- Built using the functional knowledge of the Technical Committee
- Serves as a source to support new development
- Reconciliation to RIM gives consistency to HL7 messages

# The Reference Information Model

- Expresses the information content for the collective work of the HL7 Working Group in UML notation.
- A coherent, shared information model that is the source for the data content of all HL7 messages.
- Maintained by a collaborative, consensus building process involving all Technical Committees and Special Interest Groups.
- RIM change proposals are debated, enhanced, and reconciled by technical committee representatives and applied to the RIM during the iterative model harmonization process

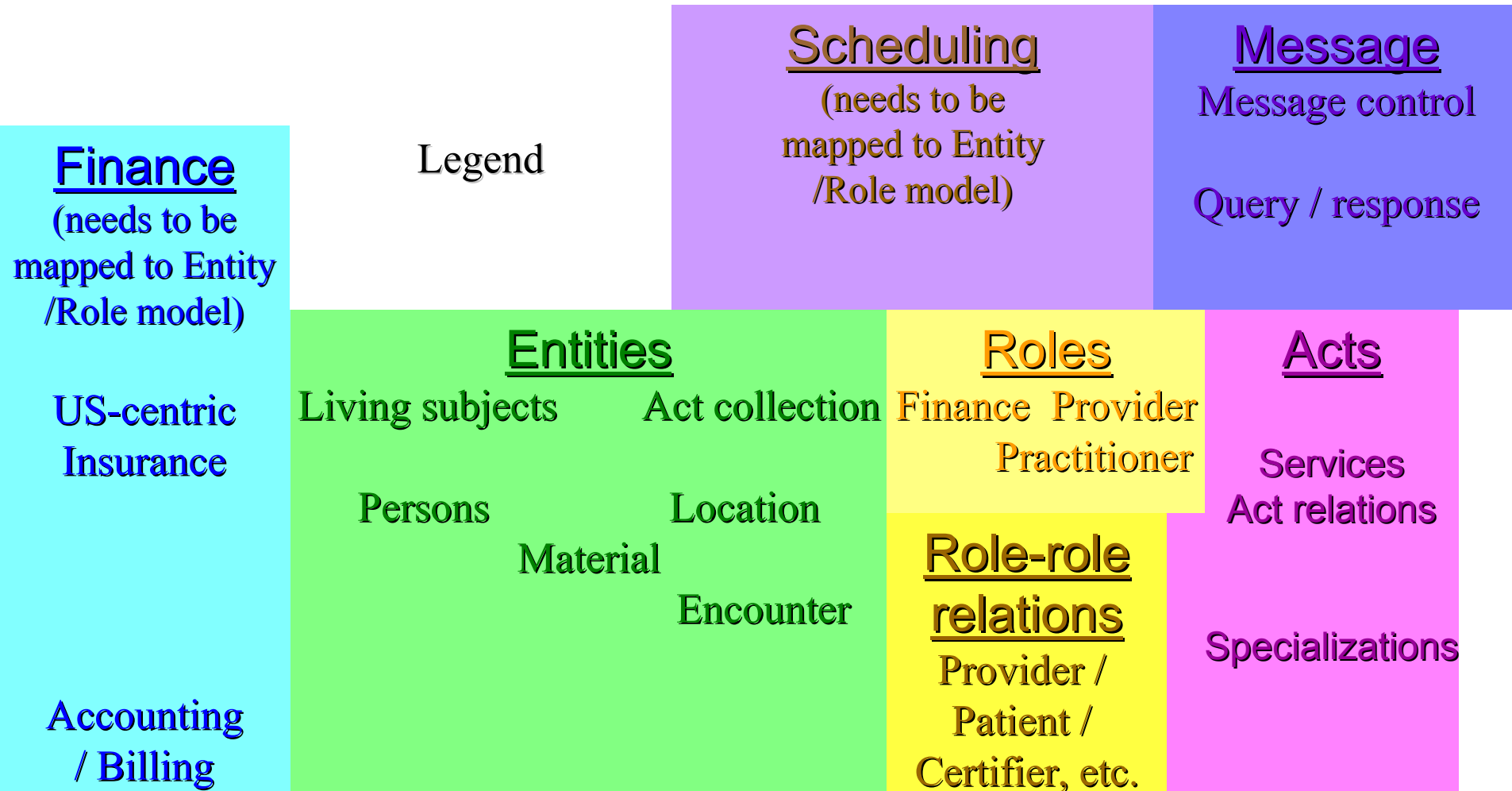
# Reference Information Model Approach



# Models Used as Input Sources

- HL7 ADT
- HL7 Finance
- HL7 Medical Records
- HL7 Orders/Results
- HL7 Patient Care
- CEN TC251
- DICOM
- Eli Lilly & Company
- HBO & Company
- Health Data Sciences
- IBM Worldwide
- Kaiser Permanente
- Mayo Foundation & Hewlett Packard
- SMS

# RIM Class Diagram - v0.99



# Parts of the Information Model

- Classes, Attributes, and Relationships
  - Documented in the Reference Information Model, the Domain Information Model, and the Message Information Model
  - Consistency ensured by a Style Guide
- State Transition Models
  - For certain selected classes (Subject Classes)
- Data Types and Constraints
  - Vocabulary definitions, Domains, Types

# Model Statistics

- 110 Classes
- 532 Attributes
- 167 Association Relationships
- 30 Inheritance Relationships
- 2 Aggregate Relationships
- 38 Subject Areas
- Maintained in MSAccess database, expressed in UML

# Domain Information Models

- Committees and SIGs generally work with a small subset of the RIM
- Each subset is focussed on a particular area of group interest; this area is referred to as a **DOMAIN** (or subject domain)
- A subset of the RIM expressed using the same tools is known as a Domain Information Model or **DIM**
- The DIMs are completely under committee control - these are committee models

# USAM

- USAM
  - is the Unified Service Action Model
  - has been introduced to the RIM in stages over the last 24 months
  - binds the core concepts underlying clinical care and patient management into a unified set of classes
  - defined by classes plus “structural codes” -- coded attributes that represent what otherwise might be a RIM structural relationship
  - published in RIM and document “The Unified Service Action Model -- Documentation for the clinical Area of the HL7 Reference Information Model”

[http://www.hl7.org//Library/data-model/Support\\_material/Usam\\_2\\_6.pdf](http://www.hl7.org//Library/data-model/Support_material/Usam_2_6.pdf)

# Examples of constructs enabled by USAM

- Representing Knowledge
  - Defining service concepts and semantic relationships
  - Take a stab at the vocabulary problem
- Workflow Management
  - Defining and managing collaborative processes.
  - Timed and conditioned care plans and clinical guidelines.
- Accountability, security, privacy
  - Application layer-based approaches
  - Integrated in the information model

# Health Care Services are:

- what **patients** seek, to improve or maintain health
- what physicians, nurses, and other **providers** offer
- what produces **information** (observation!)
- what produces **costs** (accounting!)
- what requires **resources** (scheduling!)
- what influences/produces **outcome** (studying!)
- what **quality** management is about (controlling!)

The service brings patient, provider, resources, outcome, and cost together.

**The Service is the center of our universe.**

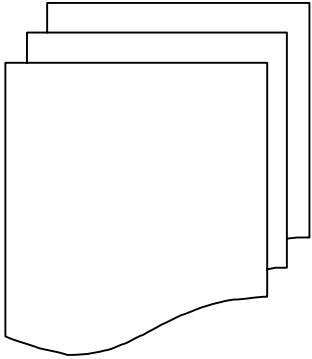
# Examples of service in USAM

- Examples for services in health care are:
  - a clinical test;
  - an assessment of health condition (such as problems and diagnoses);
  - the setting of healthcare goals;
  - the performance of treatment services (such as medication, surgery, physical and psychological therapy);
  - assisting, monitoring or attending;
  - training and education services to patients and their nexts of kin;
  - notary services, such as advanced directives or living will;
  - etc.

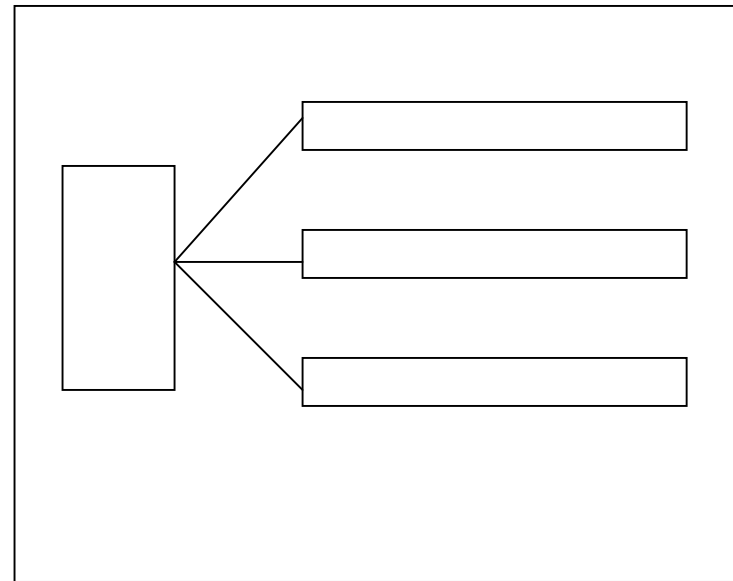
# HL7 V3 Deliverables

- Use case model
  - Hierarchy of tasks and actors
- Information model
  - Classes, relationships, states, and lifecycles
- Interaction model
  - Trigger events, abstract messages and application profiles
- Message design model
  - Abstract message definitions (HMDs)

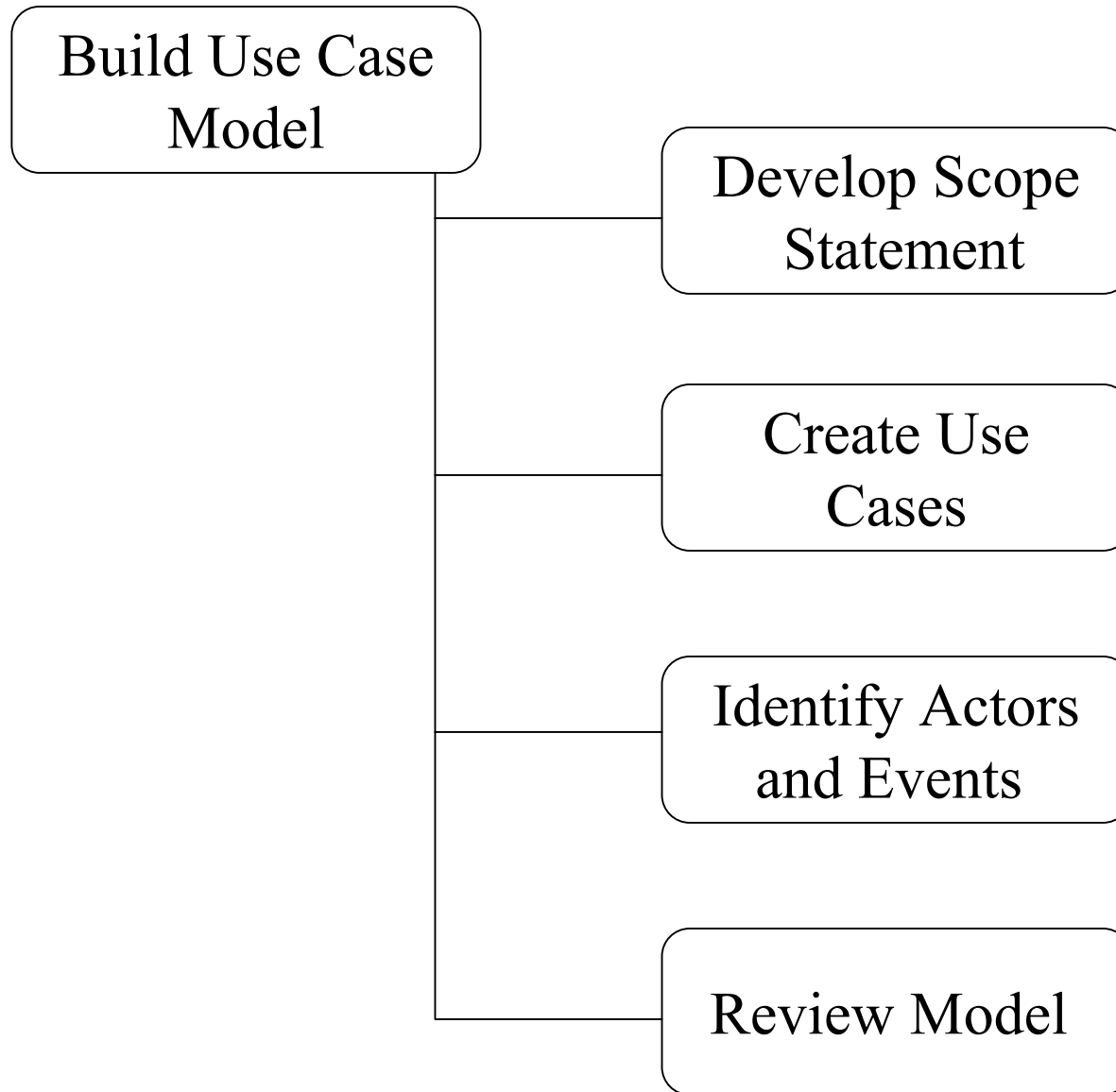
# USE CASE MODEL



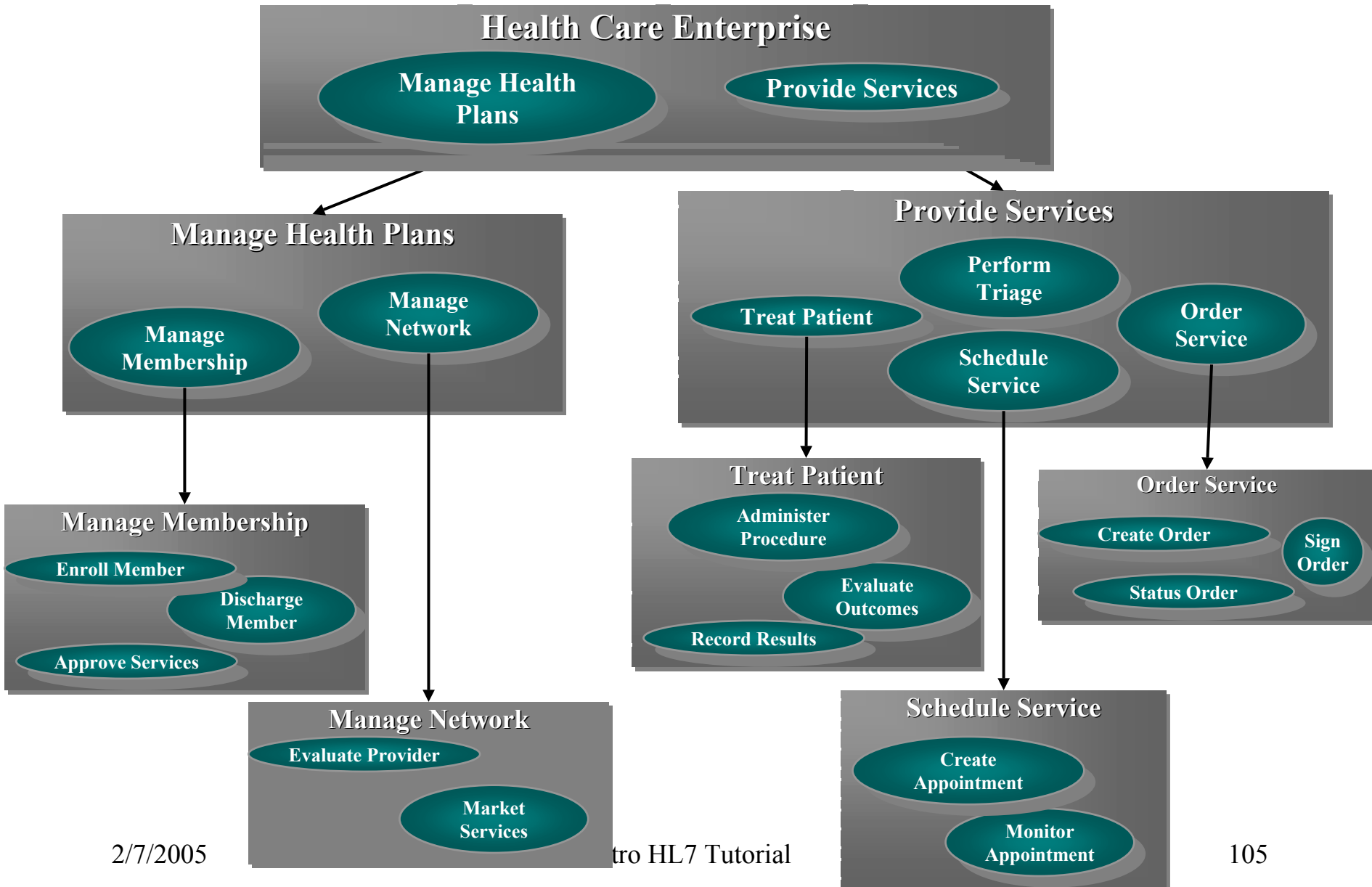
Use Case  
Model Spec



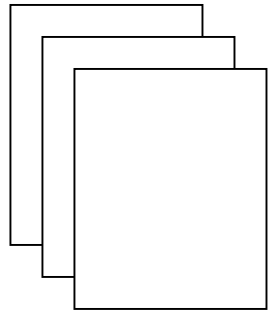
Use Case Diagram



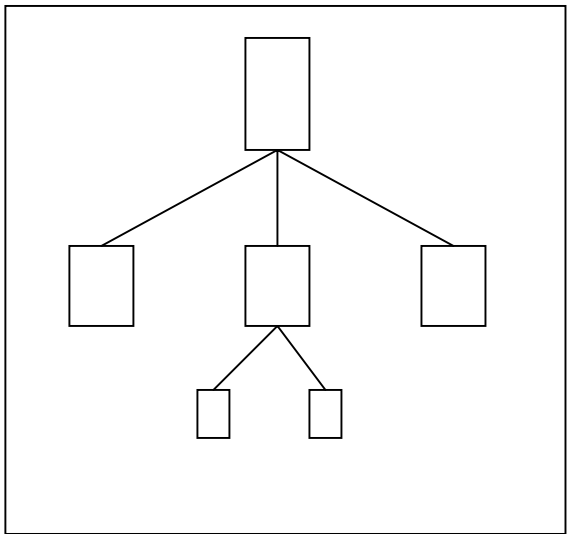
# Sample Use Case Model



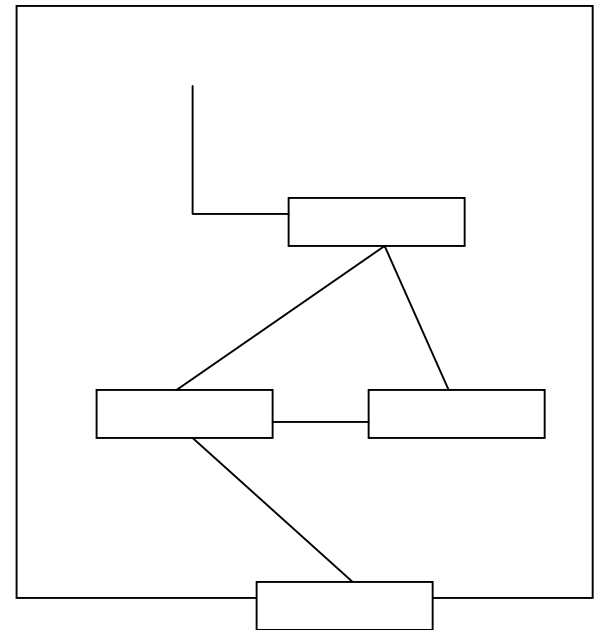
# INFORMATION MODEL



Information Model  
Spec



Class Diagram

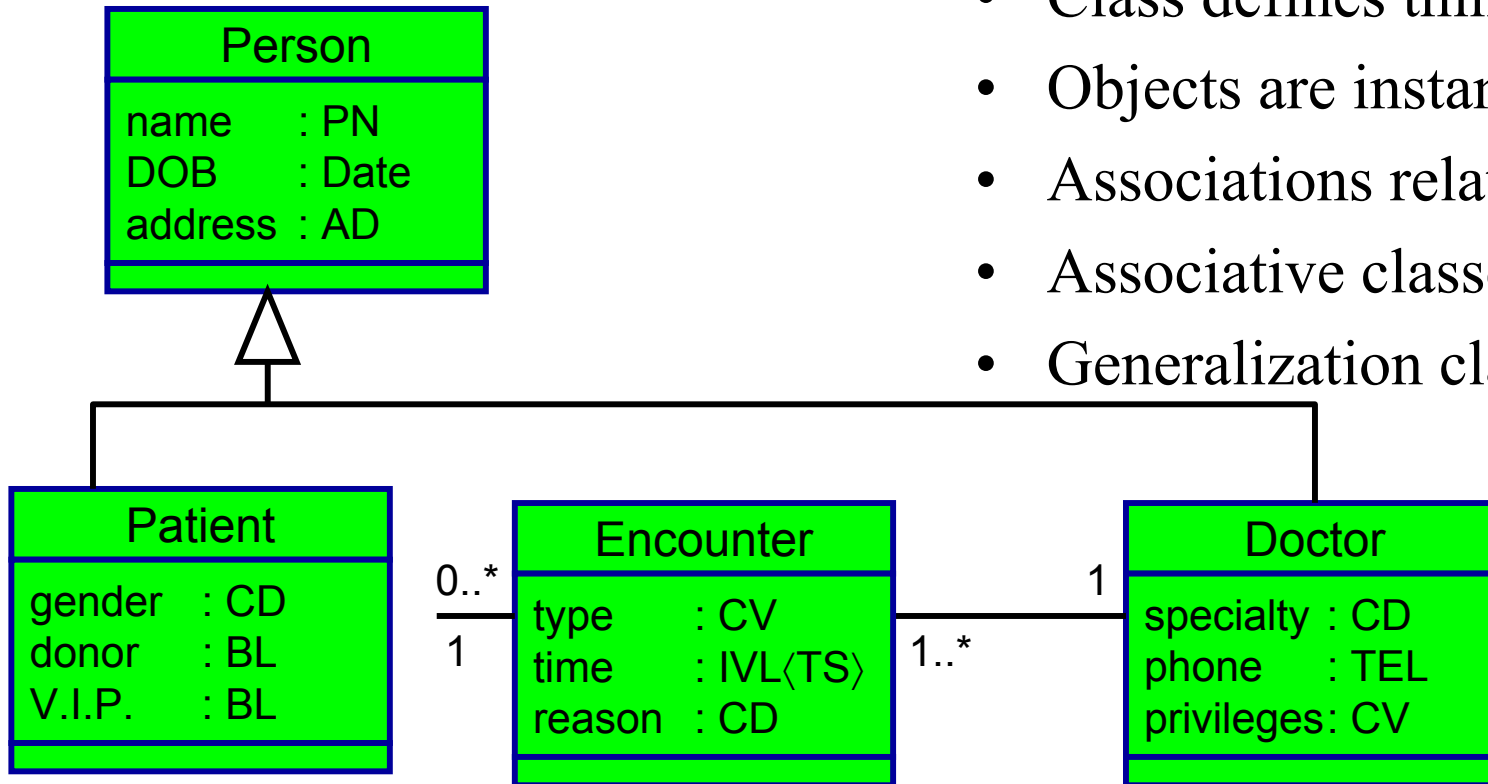


State Diagram

# The Information Model

- Defines HL7 Messages
  - A detailed and precise definition for the information from which the data content of *all* HL7 messages are drawn.
- UML Class Model
  - Follows object-oriented modeling and diagramming techniques, and is centered on a depiction of the classes that form the basis for the objects in HL7 messages.
- Unifies Data Definitions and Semantics
  - Provides a means for expressing and reconciling differences in data definition independent of message structure.
- Shared by all HL7 bodies
  - Forms a shared view of the information domain used across all HL7 messages.

# Information Modeling Language

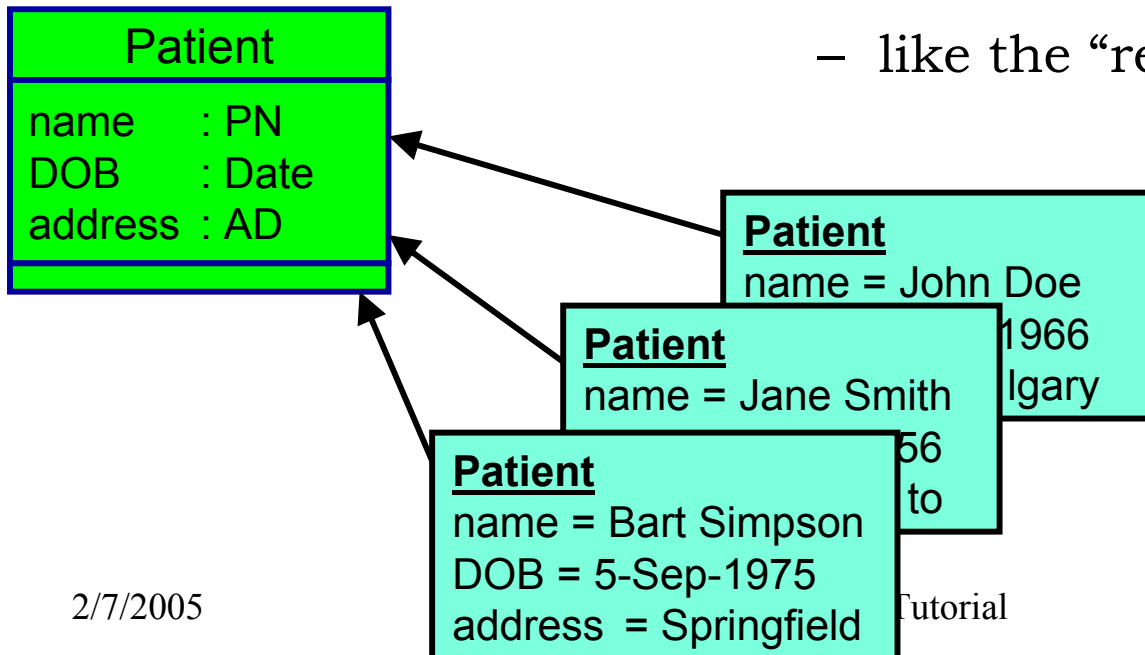


- Class defines things
- Objects are instances
- Associations relate things
- Associative classes
- Generalization classes

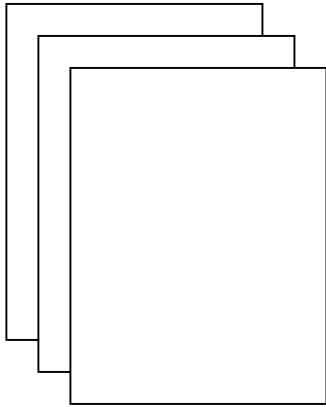
- Generalization classes can simplify the model
  - through reuse of common concepts
  - express logical truths of the application domain
  - work the other way as “specialization classes”

# Information Modeling Language

- Class defines things
- Objects are instances
  - individuals of which classes are a definition
  - have values assigned to attributes
  - have identity that's invariant when other values change
  - like the “records” of a data base

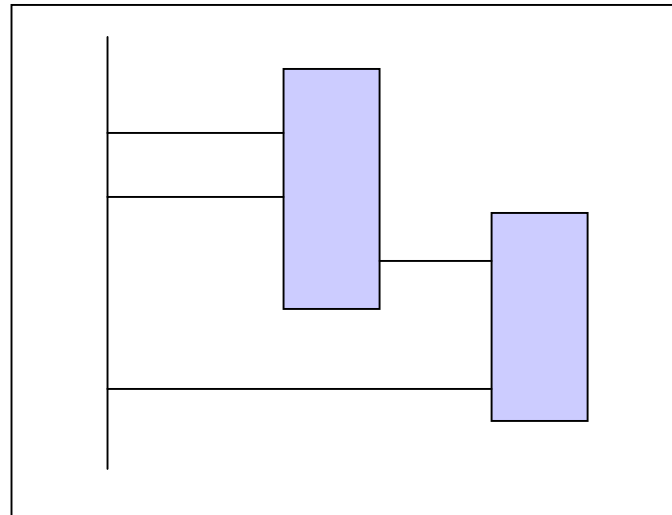


# INTERACTION MODEL



Interaction Model  
Spec

Interaction Diagram

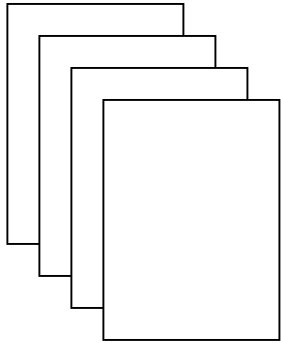


# Application Roles

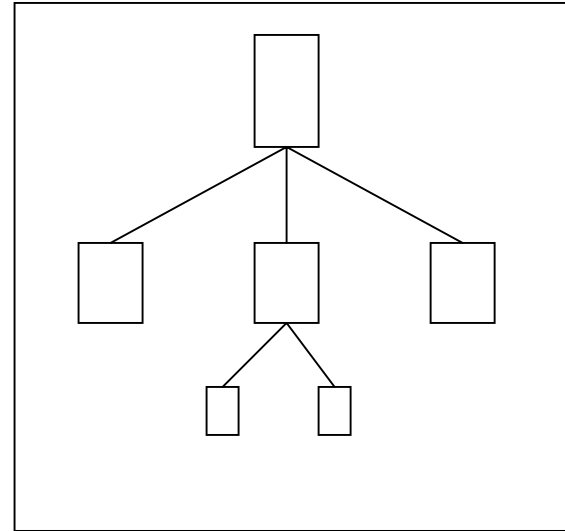
- All Application Roles that participate in the interactions for a trigger event must be identified
- All trigger events that a particular application role participates in must be identified
- All Classes that participate in the interactions must be identified
- Captured in an Application Role Diagram

# MESSAGE DESIGN MODEL

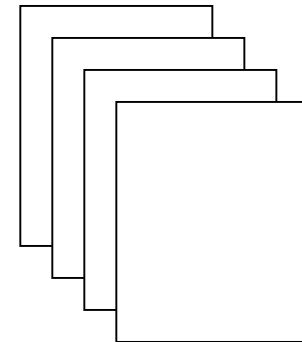
Class Diagram



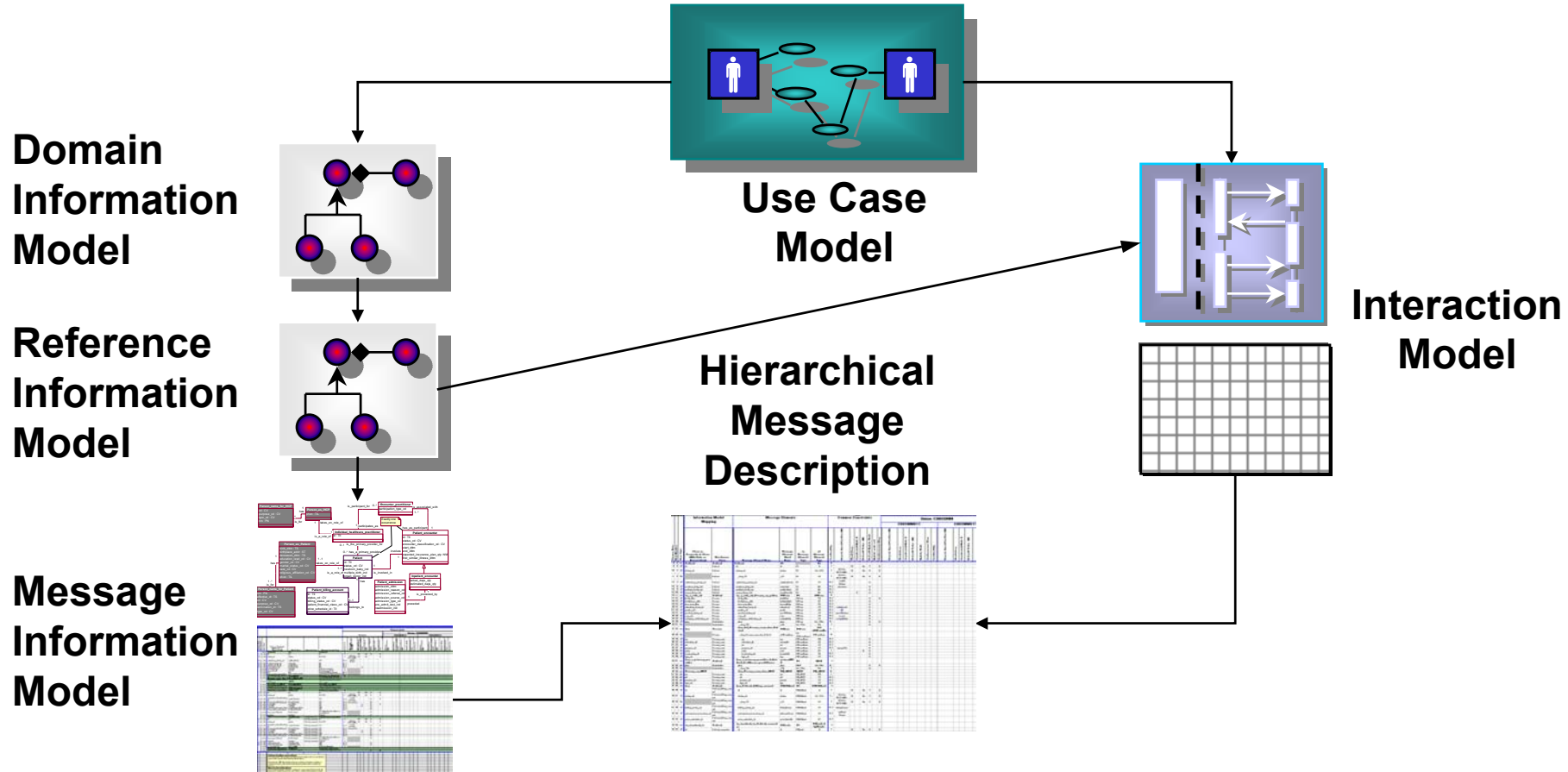
Hierarchical  
Message  
Descriptor



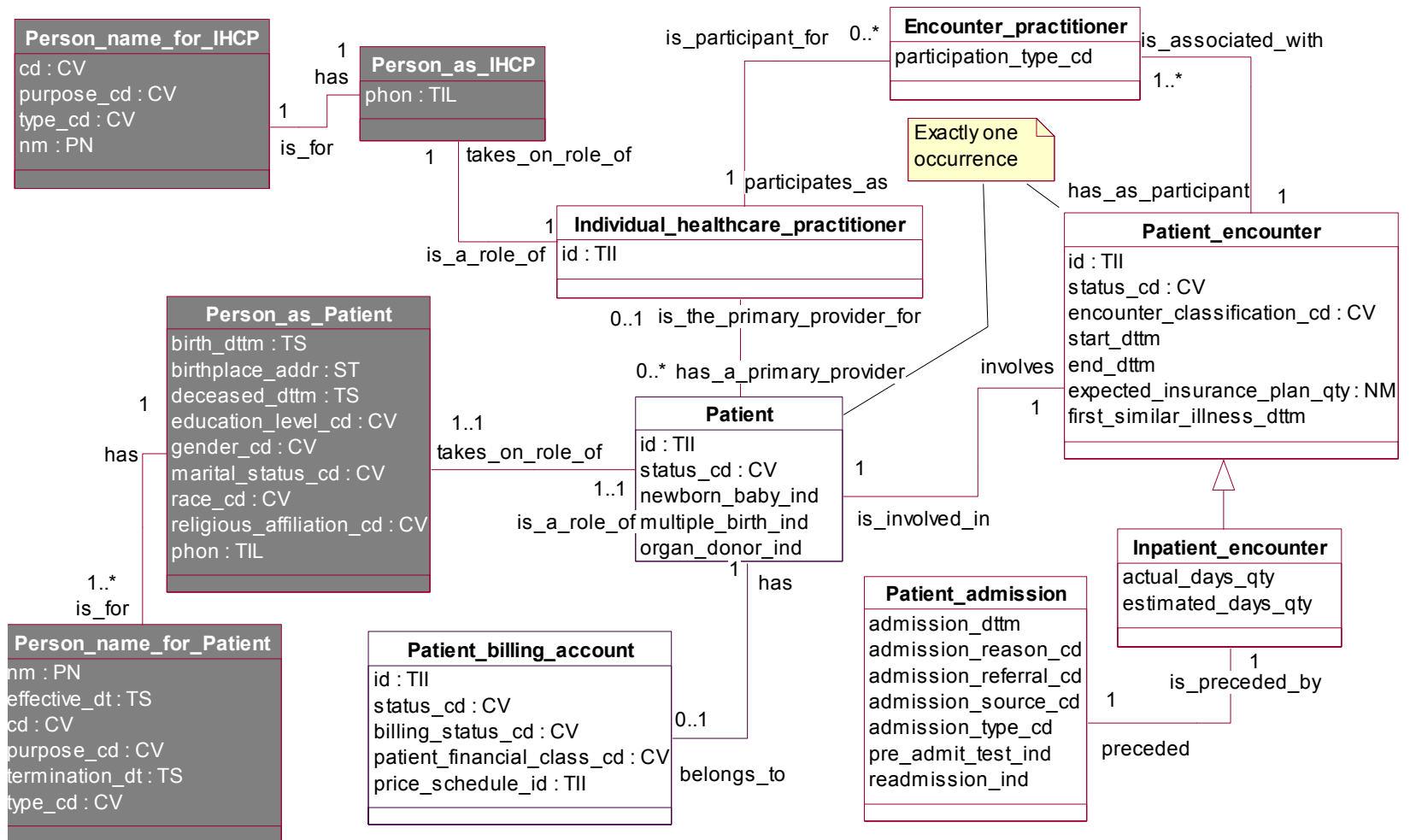
Implementable  
Message Specification



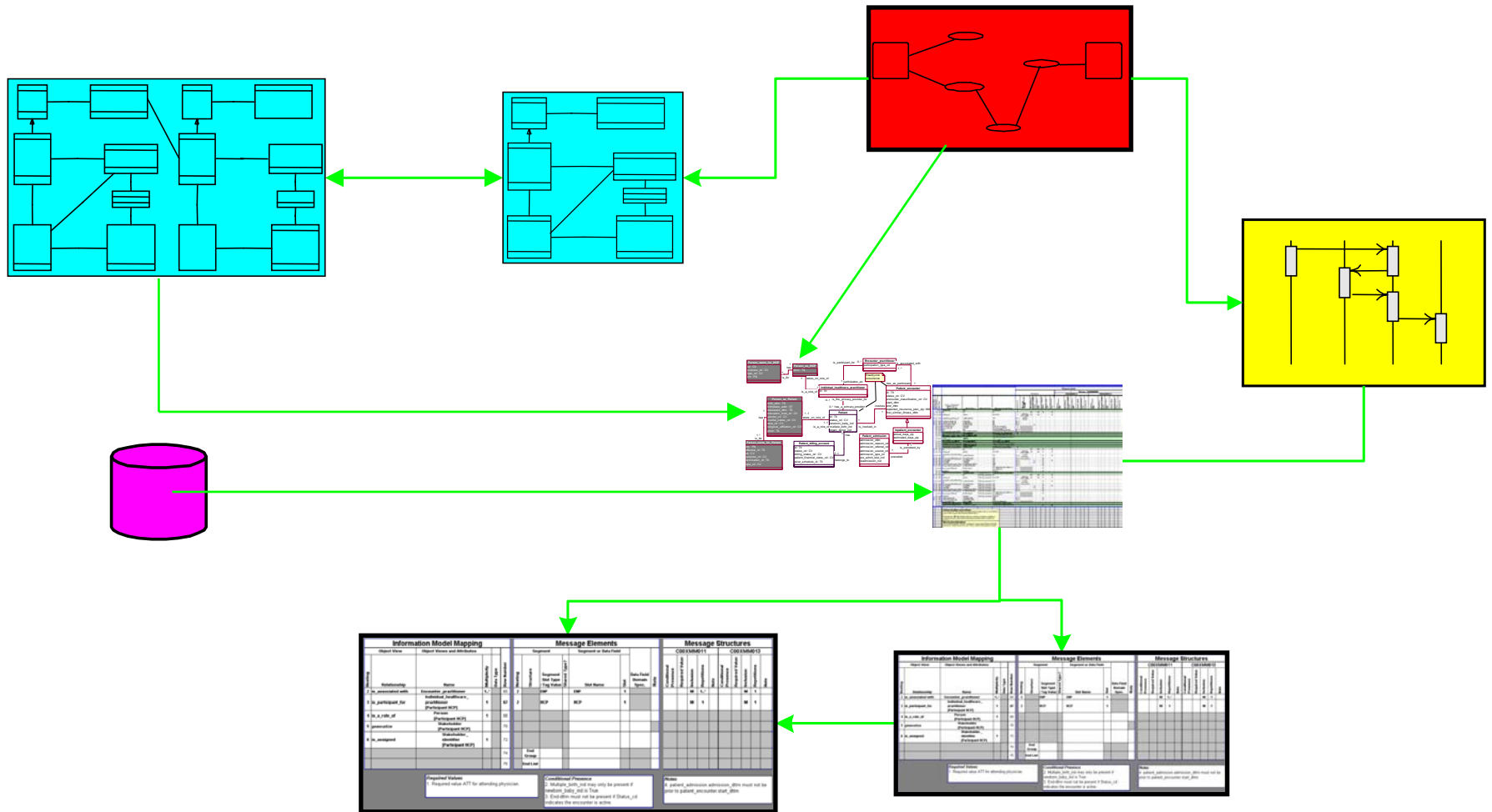
# Message Specification



# Message Information Model (MIM)



# Models are used to build the HMD



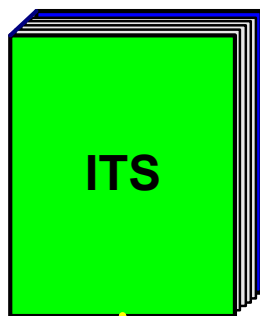
# The HMD & ITS then give messages

Implementation  
Technology  
Specifications

"Send as ASCII  
string in XML  
format"

Hierarchical  
Message  
Definition

"Discontinue  
pharmacy order"



| Information Model Mapping |                    |                                                      |              |           |            | Message Elements |           |                               |              |           |      | Message Structures      |      |                      |                |           |             |
|---------------------------|--------------------|------------------------------------------------------|--------------|-----------|------------|------------------|-----------|-------------------------------|--------------|-----------|------|-------------------------|------|----------------------|----------------|-----------|-------------|
| Object View               |                    | Object Views and Attributes                          |              |           |            | Segment          |           | Segment or Data Field         |              |           |      | C00XMM011               |      | C00XMM013            |                |           |             |
| Heading                   | Relationship       | Name                                                 | Multiplicity | Data Type | Row Number | Heading          | Structure | Segment Slot Type / Tag Value | Shared Type? | Slot Name | Slot | Data Field Domain Spec. | Note | Conditional Presence | Required Value | Inclusion | Repetitions |
| 2                         | is_associated_with | Encounter_practitioner                               | 1..*         | 65        | 2          | Structure        | EMP       | EMP                           |              | 1         |      |                         |      |                      |                |           |             |
| 3                         | is_participant_for | Individual_healthcare_practitioner [Participant HCP] | 1            | 67        | 2          | HCP              | HCP       |                               |              | 1         |      |                         |      |                      |                |           |             |
| 4                         | is_a_role_of       | Person [Participant HCP]                             | 1            | 68        |            |                  |           |                               |              |           |      |                         |      |                      |                |           |             |
| 5                         | generalize         | Stakeholder [Participant HCP]                        |              | 70        |            |                  |           |                               |              |           |      |                         |      |                      |                |           |             |
| 6                         | is_assigned        | Stakeholder Identifier [Participant HCP]             | 1            | 72        |            |                  |           |                               |              |           |      |                         |      |                      |                |           |             |
|                           |                    |                                                      |              | 74        |            | End Group        |           |                               |              |           |      |                         |      |                      |                |           |             |
|                           |                    |                                                      |              | 75        |            | End List         |           |                               |              |           |      |                         |      |                      |                |           |             |

**Required Values**

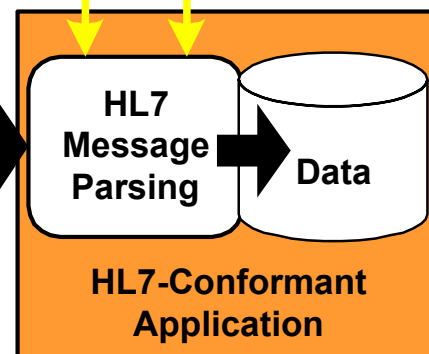
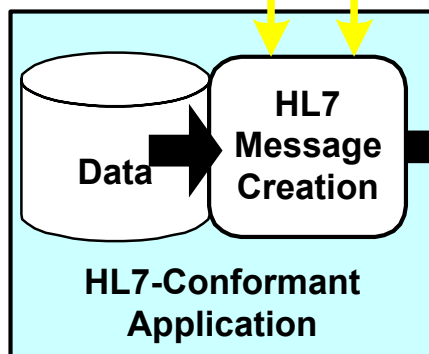
1. Required value ATT for attending physician.

**Conditional Presence**

2. Multiple\_birth\_ind may only be present if newborn\_baby\_ind is True.  
 3. End-dtm must not be present if Status\_cd indicates the encounter is active.

**Notes**

4. patient\_admission.admission\_dtm must not be prior to patient\_encounter.start\_dtm



# Build the HMD

- All of the information of the MET and CMET is documented in a Hierarchical Message Description – HMD
- Tabular
- Stored in the repository
- Final specification of a particular message
- Contains conformance parameters

# An HL7 V2.3 Message

```
MSH|^~\&|LABGL1||DMCRES||199812300100||ORU^R01|LABGL1199510221838581|P|2.3
||NE|NE
PID||6910828^Y^C8||Newman^Alfred^E||19720812|M||W|25 Centscheap Ave^^
Whatmeworry^UT^85201^^P|| (555) 777-6666| (444) 677-7777||M||773789090
OBR||110801^LABGL|387209373^DMCRES|18768-2^CELL COUNTS+DIFFERENTIAL TESTS
(COMPOSITE)^LN||199812292128||35^ML|||||IN2973^Schadow^Gunther^^^^MD^UPIN
||||||^Once|||||CA20837^Spinosa^John^^^^MD^UPIN

OBX||NM|4544-3^HEMATOCRIT (AUTOMATED)^LN||45||39-49
|||F||199812292128||CA20837
OBX||NM|789-8^ERYTHROCYTES COUNT (AUTOMATED)^LN||4.94|10*12/mm3
|4.30-5.90||||F||199812292128||CA20837
```

A sample results message

# V3 XML Prototype - same data

```
<Labrs3P00 T="Labrs3P00">
  <Labrs3P00.PTP T="PTP">
    <PTP.primrPrsnm T="PN">
      <fmn T="ST">Sample</fmn>
      <gvn T="ST">George</gvn>
      <mdn T="ST">H</mdn>
    </PTP.primrPrsnm>
  </Labrs3P00.PTP>
  <Labrs3P00.SIOO_L T="SIOO_L">
    <SIOO_L.item T="SIOO">
      <SIOO.filrOrdId T="IID">LABGL110801</SIOO.filrOrdId>
      <SIOO.placrOrdId T="IID">DMCRES387209373</SIOO.placrOrdId>
      <SIOO.InsncOf T="MSRV">
        <MSRV.unvSvcId T="CE">18768-2</MSRV.unvSvcId>
        <MSRV.svcDesc T="TX">CELL COUNTS+DIFFERENTIAL TESTS (COMPOSITE)</MSRV.svcDesc>
      </SIOO.InsncOf>
      <SIOO.SRVE_L T="SRVE_L">
        <SRVE_L.item T="SRVE">
          <SRVE.name T="CE">4544-3</SRVE.name>
          <SRVE.svcEvntDesc T="ST">HEMATOCRIT (AUTOMATED)</SRVE.svcEvntDesc>
          <SRVE.CLOB T="CLOB">
            <CLOB.obsvnValu T="NM">45</CLOB.obsvnValu>
            <CLOB.refsRng T="ST">39-49</CLOB.refsRng>
            <CLOB.clnRlvnBgnDtm T="DTM">199812292128</CLOB.clnRlvnBgnDtm>
          </SRVE.CLOB>
          <SRVE.spcmRcvdDtm T="DTM">199812292315</SRVE.spcmRcvdDtm>
        </SRVE_L.item>
      </SIOO_L.item>
    </Labrs3P00.SIOO_L>
  </Labrs3P00>
```

# Summary of V3 Features

- Internal consistency - enforced in models
- Sound definitions - captured in a repository
- Enables variety of implementation technologies
  - ranging from ASCII to ORBs and EDIFACT to XML
- Reduces rampant optionality in the messages
  - vastly reduces implementation effort
- Application roles are a basis for component functional specifications
- Provides verifiable conformance claims

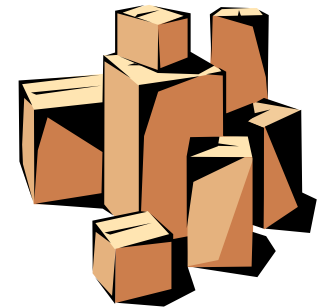
# Benefits of V3 to HL7

- Reduces optionality:  
results in more specific messages
- Uncovers hidden assumptions about  
application boundaries
- Improves internal consistency of the  
standard
- Facilitates defining clear, fine-grained,  
conformance claims



# Benefits of V3 to Vendors

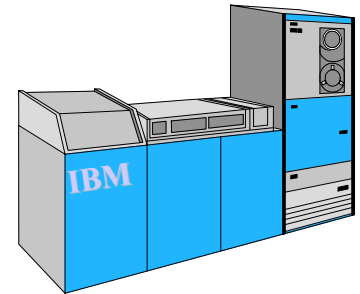
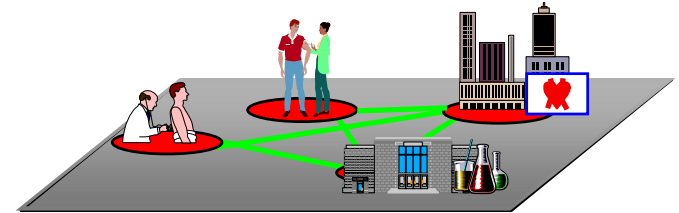
- ◆ Provides improved protocol for interconnecting heterogeneous systems
- ◆ Reduces installation effort
  - reduces site-specific negotiations
  - simplifies interface programming
- ◆ Promotes vendor specialization by allowing segmentation of product lines into niche market spaces



# Benefits of V3 to Providers

Deals with complexity of the HC environment:

- ◆ Facilitates integration of heterogeneous systems
- ◆ Increases choices of innovative best-of-breed solutions
- ◆ Provides support for legacy systems
- ◆ Allows reliable verification of vendors' conformance claims



# HL7 Diversifies ...

- Electronic Data Exchange in Healthcare Environments
- Arden Syntax
- Visual Integration (CCOW)
- Patient Record Architecture
- Vocabulary Tables and Models
- Clinical Guidelines, Templates

# Vocabulary

Assures that HL7 messages use a coded vocabulary that will enable the exchange of clinical data and information so that sending and receiving systems have a shared, well defined, and unambiguous knowledge of the meaning of the data transferred.

# Vocabulary Technical Committee

- Standardize vocabulary naming models for all HL7 messages
- Use existing controlled vocabulary sets
- Map vocabulary into NLM UMLS
- Initial efforts on drug naming model
- Responsible for population of vocabulary

# Goals of Vocabulary Technical Committee

- Decrease time and cost of implementations
- Approach “plug-and-play”
- Enable data sharing
  - Mergers due to managed care
  - Regional or national clinical studies
  - Disease prevention and control
- Enable sharing of decision support modules
  - Alerts
  - Protocols
  - Clinical pathways

# HL7 Vocabulary Development Strategy

- Reference existing vocabularies
- Collaborate with other SDO's
- Add value by creating linkage between HL7 messages and existing vocabularies
- Only add items that do not already exist
- Collaborate with vocabulary developers

# Vocabulary and Domains

- Attributes in the RIM must be associated with a Domain to have meaning
- Domains are associated with Vocabularies
  - Held in the Domain Specification Database
- The vocabulary and domain define the values that may be taken on by an attribute in a defined message
  - Set of coded values or defined words/phrases
  - Statements in a constraint language

# Vocabulary Development Strategy

- Reference existing vocabularies
- Collaborate with other SDO's
- Add value by creating linkage between HL7 messages and existing vocabularies
- Only add items that do not already exist
- Collaborate with vocabulary developers

Each coded attribute **must** have a domain specification

***Class: Patient***

***Description:*** A person who may receive, is receiving, or has received healthcare services.

***Associations***

**is\_a\_role\_of (1,1) :: Person**

**is\_source\_for (0,n) :: Specimen\_sample**

***Attributes***

**birth\_order\_number**

**birth\_dttm (from Person)**

**gender\_cd <Gender, Ext:CWE>**

# Vocabulary and RIM Synchronization

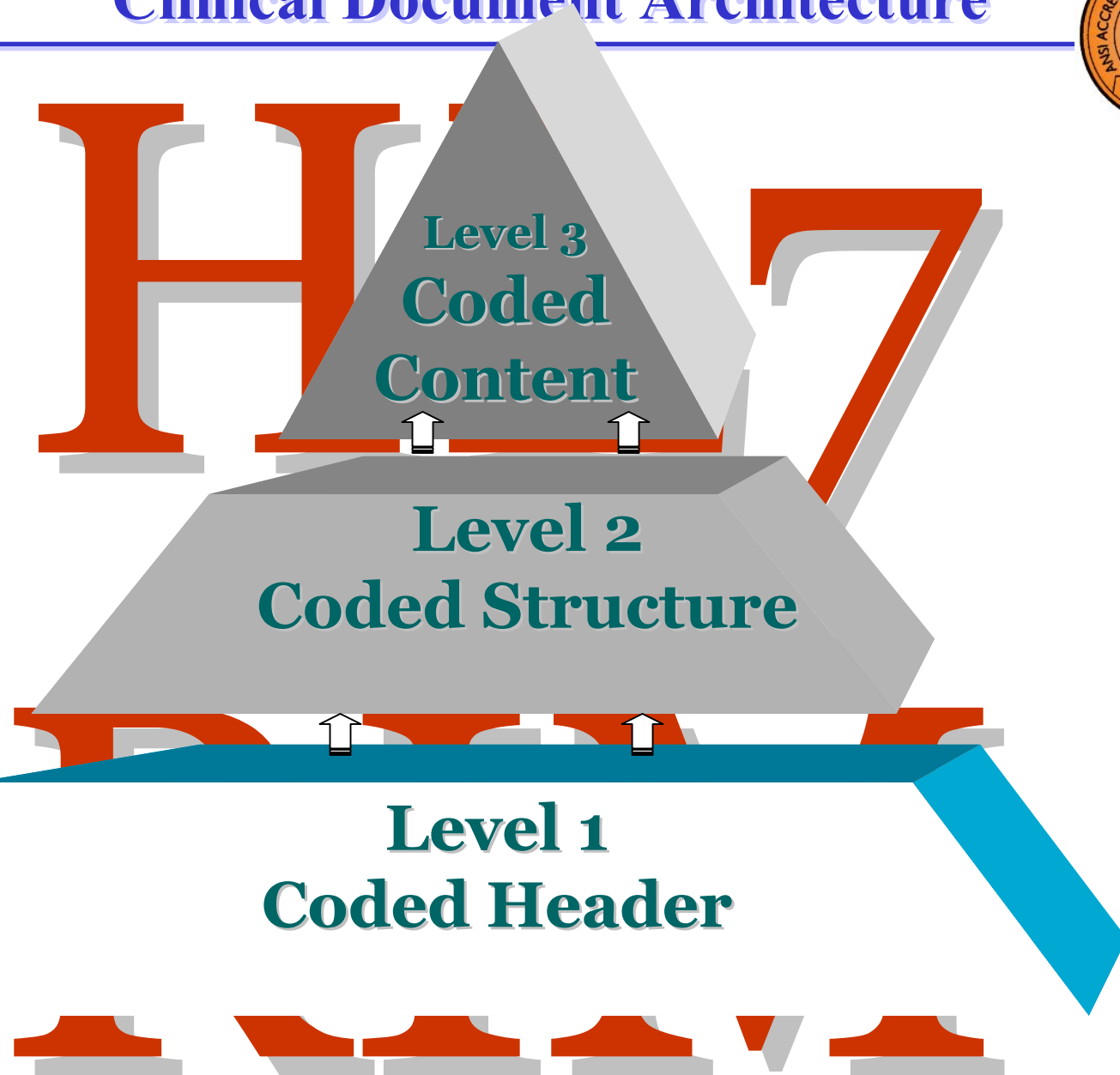
- Vocabulary has an iterative harmonization process as well
- RIM attributes that are assigned to a vocabulary definition must have a work thread in the vocabulary committee
- RIM and Vocabulary harmonization are done together
- More information in the vocabulary tutorial and committee meetings

# Domain specification table maintenance

- Available on HL7 web site
  - All members can read tables
- Edit Permissions table
  - who can edit which domains
  - vocabulary co-chairs maintain permissions table
- Assigned persons make edits (proposed status)
- Entries reviewed by Vocab Review Committee
- Reports presented to RIM harmonization process
- Approved changes reflected by status changes
- HL7 standard versions synch'ed with edit versions

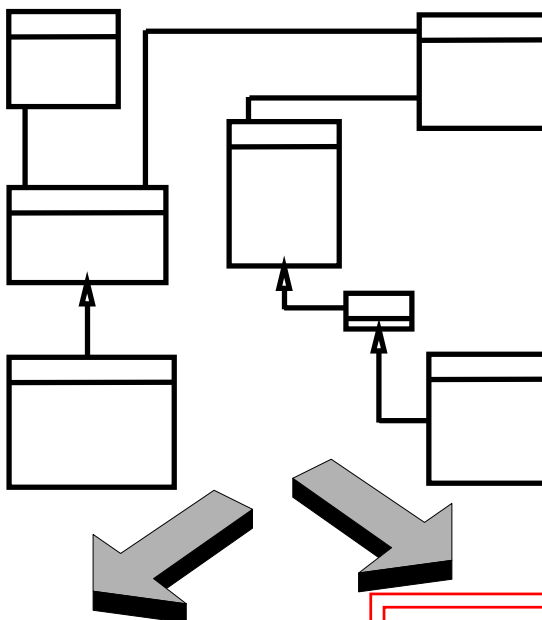
# **XML**

- Candidate for HL7 Syntax
  - Option for Version 2.n
  - Will be syntax for Version 3
- Used to define complex data elements
- Used to define transmission of domain specific data sets
- Component Data Architecture (PRA)



\*The current specification only includes Level 1

## HL7 Reference Information Model



## HL7 V3 Message

```
<observation>
  <service_cd V="6298-8" S="LOINC"
    PN="POTASSIUM: SCNC: PT: BLD"/>
  <result_dttm V="20000522"/>
  <value V="4.5" U="mg/dl"/>
</observation>
```

## HL7 CDA

```
<HL7.Document>
  <clinical_document_header>
    <document_metadata>
    <encounter_data>
    <patient_data>
    <provider_data>
  </clinical_document_header>
  <body>
    ...
  </body>
</HL7.Document>
```

# **Arden Syntax - Definition**

- Arden Syntax is an HL7/ANSI standard specification for defining and sharing medical knowledge-base information.
- Current approved version is 2.0

# **Arden Syntax - Rationale**

**Arden Syntax arose from the need to make medical knowledge available for decision making at the point-of-care**

- **Make the knowledge and logic explicit**
- **Allow sharing within and between institutions**
- **Standardize the way medical knowledge is integrated into hospital information systems**

# **Medical Logic Module**

- **The Medical Logic Module (MLM) is a stream of text stored in an ASCII file in statements called slots.**
- **Slots are made up of of a slot-name and slot-body.**
- **Slots are grouped into three categories: maintenance, library and knowledge.**

# Library Slots - Example

library:

purpose: To alert the health care provider of new or worsening serum creatinine level.;;

explanation: If the creatinine is at or above a threshold (1.35 mg/dl), then an alert... ;;

keywords: renal insufficiency; renal failure ;;

citations: Proceedings of the Fifteenth Annual Symposium on Computer Applications in Medical Care; 1991 Nov 17-20; Washington, D.C. New York: IEEE Computer Society Press, 1991.

links: URL "NLM Web Page", <http://www.nlm.nih.gov/>  
;;

# **Clinical Context Object Working Group (CCOW)**

- Supports Integration at the Desktop
- Also known as Visual Integration
- Technology-neutral component specifications
- Well-defined interfaces that enable specific ways of using components as part of systems whose nature has not been fully defined

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