Towards Interoperable Healthcare Information Systems: **The HL7 Conformance Profile Approach**

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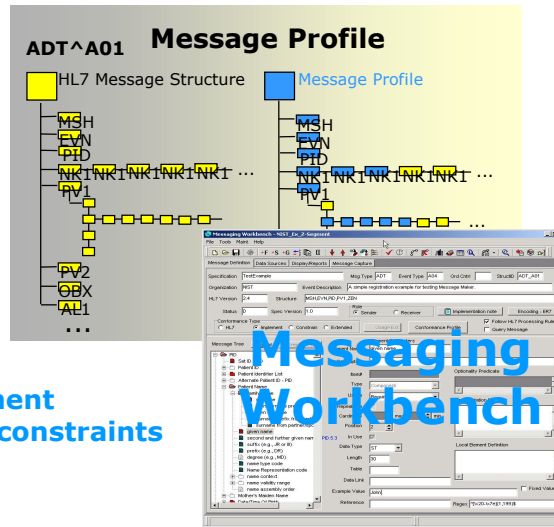http://www.nist.gov/messagemaker

Outline

- Overview the HL7 Standard

- HL7 Message Structure

- Problems with the HL7 Standard

- Using conformance profiles to improve interoperability

- Tools to support conformance profiles

- Conformance profiles in practice
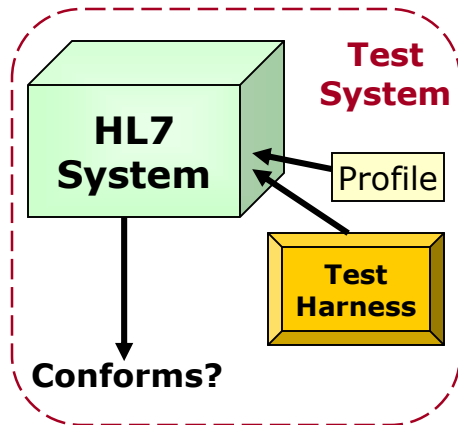
- Summary

HL7 and Conformance: The Big Picture

HL7 Standard

- ✓Universal design
- ✓Riddled with optionality
- ✓Implementation chaos
- ✓Interoperability difficult

✓Agreement
✓Define constraints

Message Profile

ADT^A01

☐ HL7 Message Structure   ☐ Message Profile

MSH
EVN
PID
NK1 NK1 NK1 NK1 NK1 ...
PV1
...
PV2
OBX
AL1
...

Messaging Workbench

✓Tools to build profiles
✓e.g., MWB (VA)
✓XML representation

```xml
<?xml version="1.0"?>
<HL7v2xConformanceProfile H
<MetaData Name="CALINX" Or
<Encodings>
<Encoding>ER7</Encoding>
</Encodings>
<DynamicDef AccAck="NE" Ap
<HL7MsgType="ADT"
EventType="A01
<MetaData Name="CALINX" >
<Segment Name="MSH" LongN
<Field Name="Field Separator" Us
</Field>
<Field Name="Encoding Characters"
<Reference>2.16.9.2</Reference
</Field>
<Field Name="Sending Application"
```
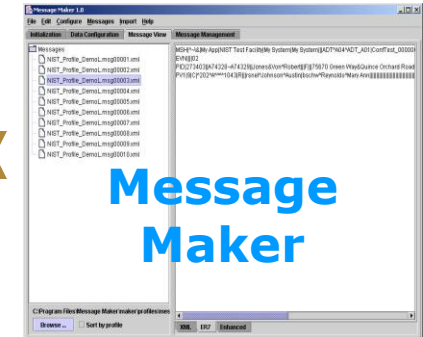
✓Need for test messages

Message Maker

✓Tools to build messages
✓Message Maker (NIST)
✓Automated and adaptable

Test System

HL7 System

Profile

Test Harness

Conforms?

- ✓Conformance testing needed
- ✓Improves reliability and interoperability
- ✓Testing Framework

```
MSH|^~\&|REGA
EVN|A05|199901
PID|1||191919^
NK1|1|MASSIE^E
NK1|2|MASSIE^I
...
```

- ✓Profile based
- ✓Suite of test messages
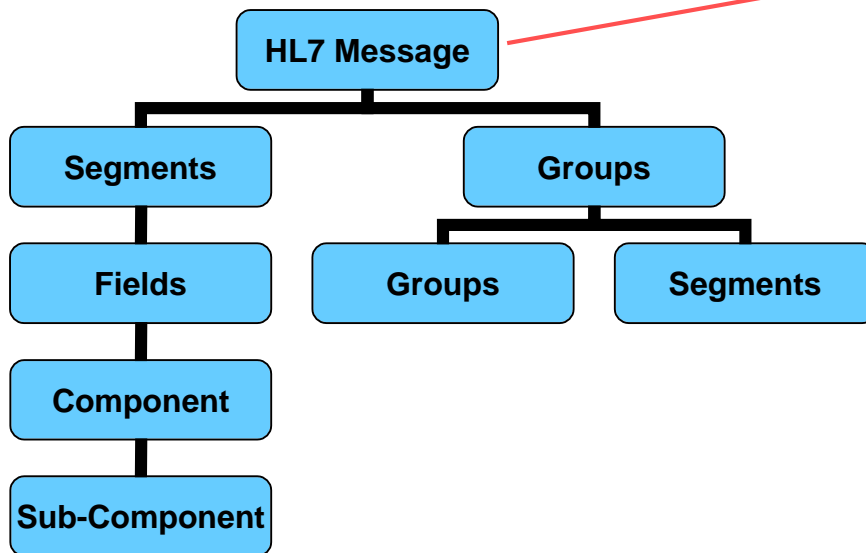- ✓Suitable for conformance testing

HL7 and Healthcare Integration
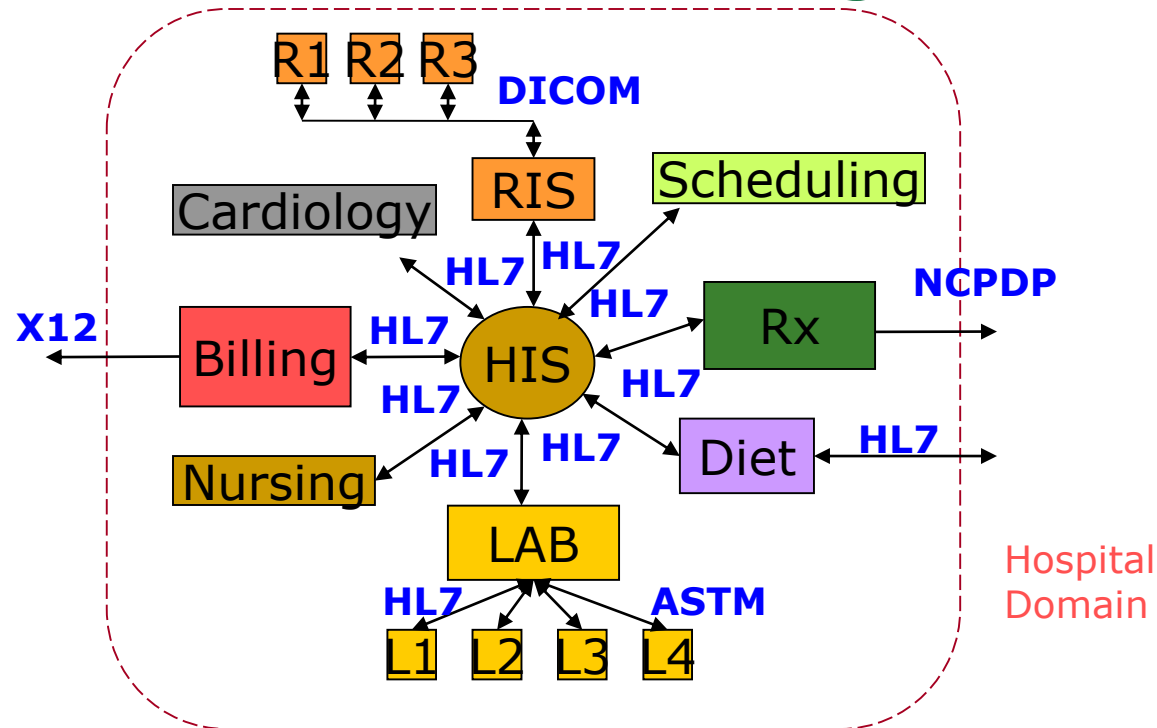
- HL7 (Health Level Seven) Messaging Standard (Application level) – *Version 2*
- Standards for the exchange, management, and integration of data for clinical care
  - Messages model real world events
  - e.g., Messages for registering a patient or requesting a lab order
- HL7 provides a flexible framework to build messages
- Widely used; 90% of hospitals

HL7 Message Framework

- Hierarchy of Message Elements
  - Groups, Segments, Fields, Components, and Sub-Components
  - Groups and Segments can contain additional elements
  - Fields and Components can contain additional elements or are primitive elements
  - Sub-components are primitive elements (i.e., can data values)

```
                    HL7 Message
                   /            \
            Segments            Groups
               |               /      \
            Fields        Groups    Segments
               |
          Component
               |
       Sub-Component
```

- Many Message Events
- Model Real World Events, such as
- Admit/Discharge/Transfer (ADT)
  - ADT A04 (Register Patient)
  - ADT A08 (Update Patient Data)
  - Etc.
- Lab Orders (ORM)
  - ORM O01 (Order Message)
- Lab Results (ORR)
  - ORR O02 (Order Response)
- Etc.
- Hundreds of message events

Anatomy of an HL7 Message

PID Segment

ADT^A04^ADT_A01

MSH
EVN
PID
[PD1]
[{ ROL }]
[{ NK1 }]
  PV1
[PV2]
.
.
.
[{ GT1 }]
[{
   IN1
  [IN2]
  [{ IN3 }]
  [{ ROL }]
}]
[ACC]
[UB1]
[UB2]
[PDA]

SEQ	LEN	DT	OPT	RP/#	TBL#	ITEM#	ELEMENT NAME
1	4	SI	O			00104	Set ID - PID
2	20	CX	B			00105	Patient ID
3	250	CX	R	Y		00106	Patient Identifier List
4	20	CX	B	Y		00107	Alternate Patient ID - PID
5	**250**	**XPN**	**R**	**Y**		**00108**	**Patient Name**
6	250	XPN	O	Y		00109	Mother's Maiden Name
7	26	TS	O			00110	Date/Time of Birth
8	1	IS	O		0001	00111	Administrative Sex
...							
37	80	ST	O			01541	Strain
38	250	CE	O	2	0429	01542	Production Class Code

Components: <family name (FN)> ^ <given name (ST)> ^
<second and further given names or initials thereof (ST)> ^ <suffix (e.g., JR or III) (ST)> ^
<prefix (e.g., DR) (ST)> ^ <degree (e.g., MD) (IS)> ^ <name type code (ID) > ^
<name representation code (ID)> ^ <name context (CE)> ^
<name validity range (DR)> ^ <name assembly order (ID)>

Subcomponents of family name: <surname (ST)> ^ <own surname prefix (ST)> ^
<own surname (ST)> ^ <surname prefix from partner/spouse (ST)> ^ <surname from partner/spouse (ST)>

Subcomponents of name context: <identifier (ST)> & <text (ST)> &
<name of coding system (IS)> & <alternate identifier (ST)> & <alternate text (ST)> &
<name of alternate coding system (IS)>

Subcomponents of name validity range: <date range start date/time (TS)> &
<date range end date/time (TS)>

HL7 0001 - Admin Sex	
A	Ambiguous
F	Female
M	Male
U	Unknown

Problem with HL7 Base Standard
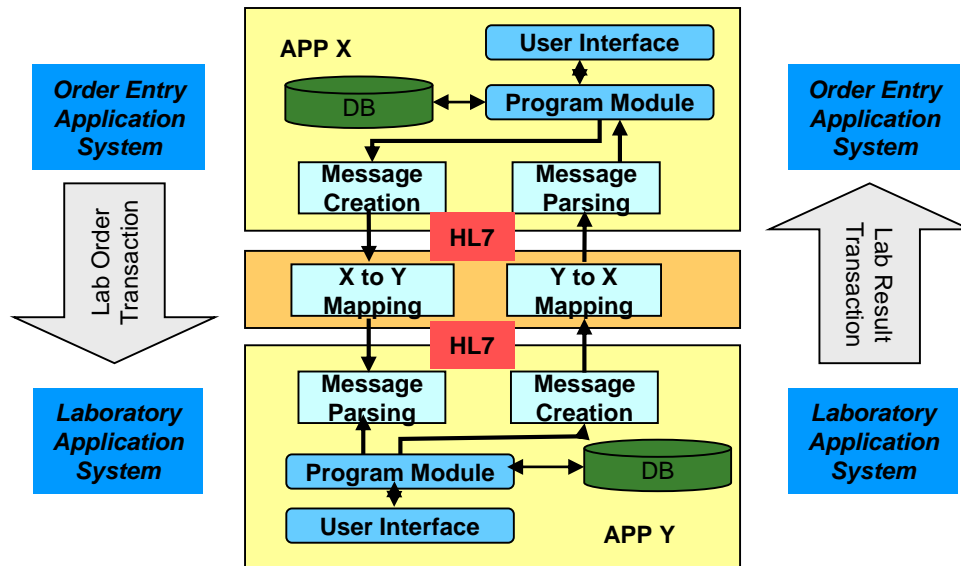
- **Overwhelmingly large with many optional features**
  - Framework for negotiations, but still need to work out the details
  - Lacks a standard methodology for establishing trading partner agreements
  - Local Extensions (e.g., Z-segments) complicate matters further
- **Interoperability Issues – "HL7 Flavors"**
  - Two systems could be HL7 compliant but not interoperable
  - e.g., a sending system could support 10 repetitions of a field while the receiving systems may only support 5.

Why Conformance Profiles are needed

- ## State-of-the-Art Today
  - Ad hoc build-as-you-go solutions
  - Interface Engines (Message Mapping)
- ## HL7 Version 3 (Object Technology)
  - Explicit conformance model
  - Design based on *consensus* Reference Information Model
  - Many good ideas to support interoperability…
  - …but too complex and many years from practical deployment
- ## HL7 Version 2 Conformance (or Message) Profiles
  - Applies implementation specific constraints to the standard
  - Principles drawn from HL7 V3 development efforts
  - The solution for today
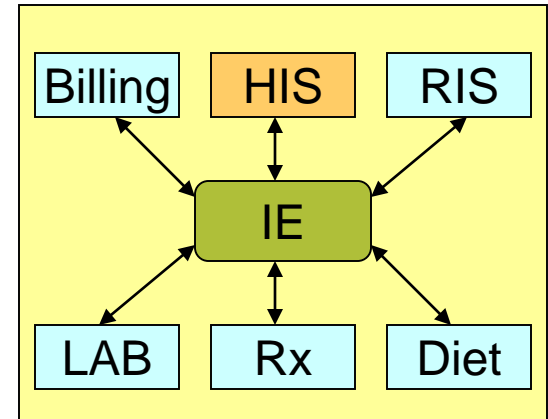
The Message Profile Approach

- Refinement of the HL7 Standard (applies implementation constraints)
- Agreement between Trading Partners
- Profiled at each level in the message structure (.i.e., segment, field, etc.)
- Each element attribute is constrained (e.g., usage)
- Specification can be directly implemented

Building a Message Profile

ADT^A01

HL7 Message Structure → **Message Profile**

MSH
EVN
PID
NK1 — NK1 — NK1 — NK1 — NK1 — ...
PV1
...
PV2
OBX
AL1
...

MSH
EVN
PID
NK1 — NK1 — NK1 — NK1 — NK1 — ...
PV1
...
PV2
OBX
AL1
...

Segments/Segment Groups:
Usage (optionality)
Cardinality (min, max)

Fields/Components:
- Field Usage (Optinality: R, RE, C, CE, X)
- Cardinality (min, max)
- Value Sets/Coding system
- Descriptions
- Length
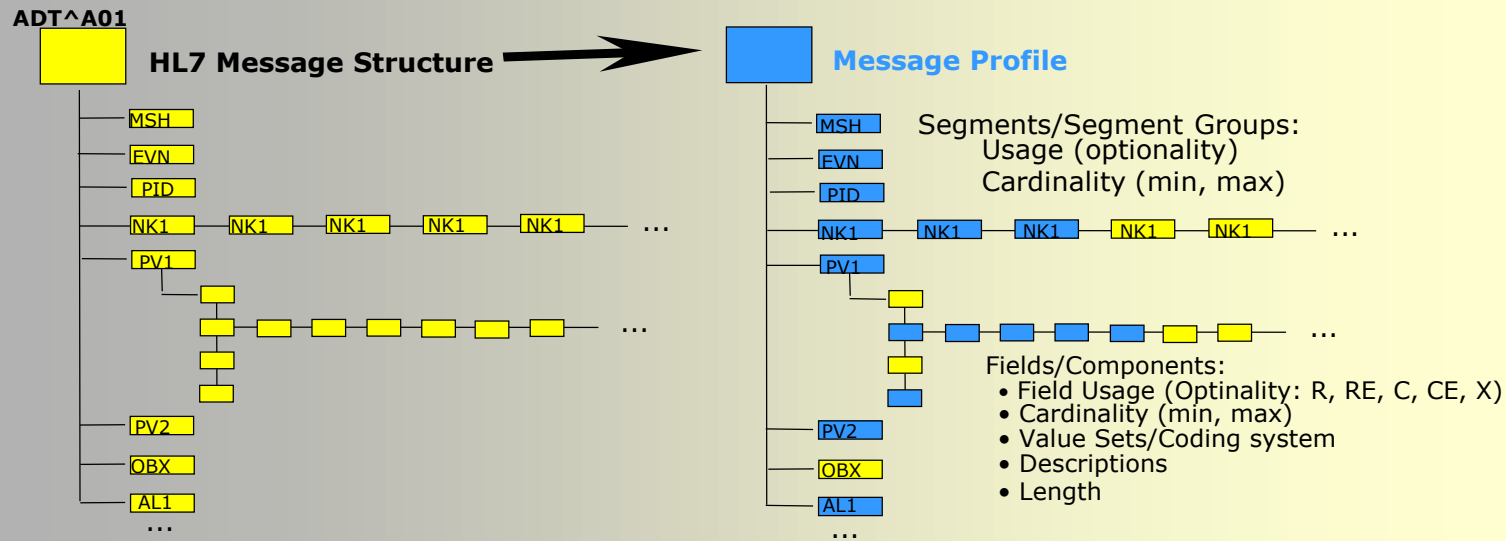
Example Profiling: Field Level

SEQ	LEN	Min Len	Max Len	DT	OPT	OPT	RP/#	RP# Min	RP# Max	TBL#	ITEM#	ELEMENT NAME
1	4	1	4	SI	O	R					00104	Set ID - PID
2	20			CX	B	X					00105	Patient ID
3	250	1	150	CX	R	R	Y	1	3		00106	Patient Identifier List
4	20			CX	B	X	Y				00107	Alternate Patient ID - PID
5	**250**	**10**	**200**	**XPN**	**R**	**R**	**Y**	**1**	**3**		**00108**	**Patient Name**
6	250			XPN	O	X	Y				00109	Mother's Maiden Name
7	26	4	26	TS	O	R					00110	Date/Time of Birth
8	1	1	1	IS	O	R				0001	00111	Administrative Sex
9	250			XPN	B	X	Y				00112	Patient Alias
10	250	3	20	CE	O	RE	Y	0	8	0005	00113	Race
11	250	1	300	XAD	O	R	Y	1	3		00114	Patient Address
12	4			IS	B	X				0289	00115	County Code
13	250	10	30	XTN	O	RE	Y	1	3		00116	Phone Number - Home
14	250	10	30	XTN	O	RE	Y	1	3		00117	Phone Number - Business
...												
37	80			ST	O	X					01541	Str
38	250			CE	O	X	2			0429	01542	Pr

Each table reference contains the allowed values

* Also regular expressions to constrain data content of primitive elements

Benefits of Conformance Profiles

- Agreement between trading partners
- Eliminates the potential ambiguities that the standard allows as implementation alternatives
- Provides a better way to conduct and document interface negotiations
- Standardized XML representation
  - Profile Registries
    - Reuse
    - Comparison
  - Enables interoperability among tools
  - Automated message validation
  - Automated message generation
  - Can expose vendors' value added product features
- Provides a clear method to document localizations
- ***Facilitates conformance and interoperability testing***

Tools to Support Conformance Profiles

- **Profile Builder**
  - *VA Messaging Workbench (MWB)*
- **Test Generation**
  - *NIST Message Maker*
- **Test Administration and Analysis**
  - *NIST Testing Framework*
  - *NIST Web Services*
    - *Message Generation and Message Validation*
  - *VA MWB Validation Server*

Messaging Workbench (MWB)

- Created by Pete Rontey at the U.S. Veterans Administration (VA)

- Productivity tool to build message profiles

- Incorporates all HL7 Version 2.x artifacts as MWB libraries

- Reverse engineering from sample message

- Multiple reports (profile, tables, etc.)

- Multiple reports formats (html, xml, etc.)

- Supports localizations

Select Message Type and Apply Constraints
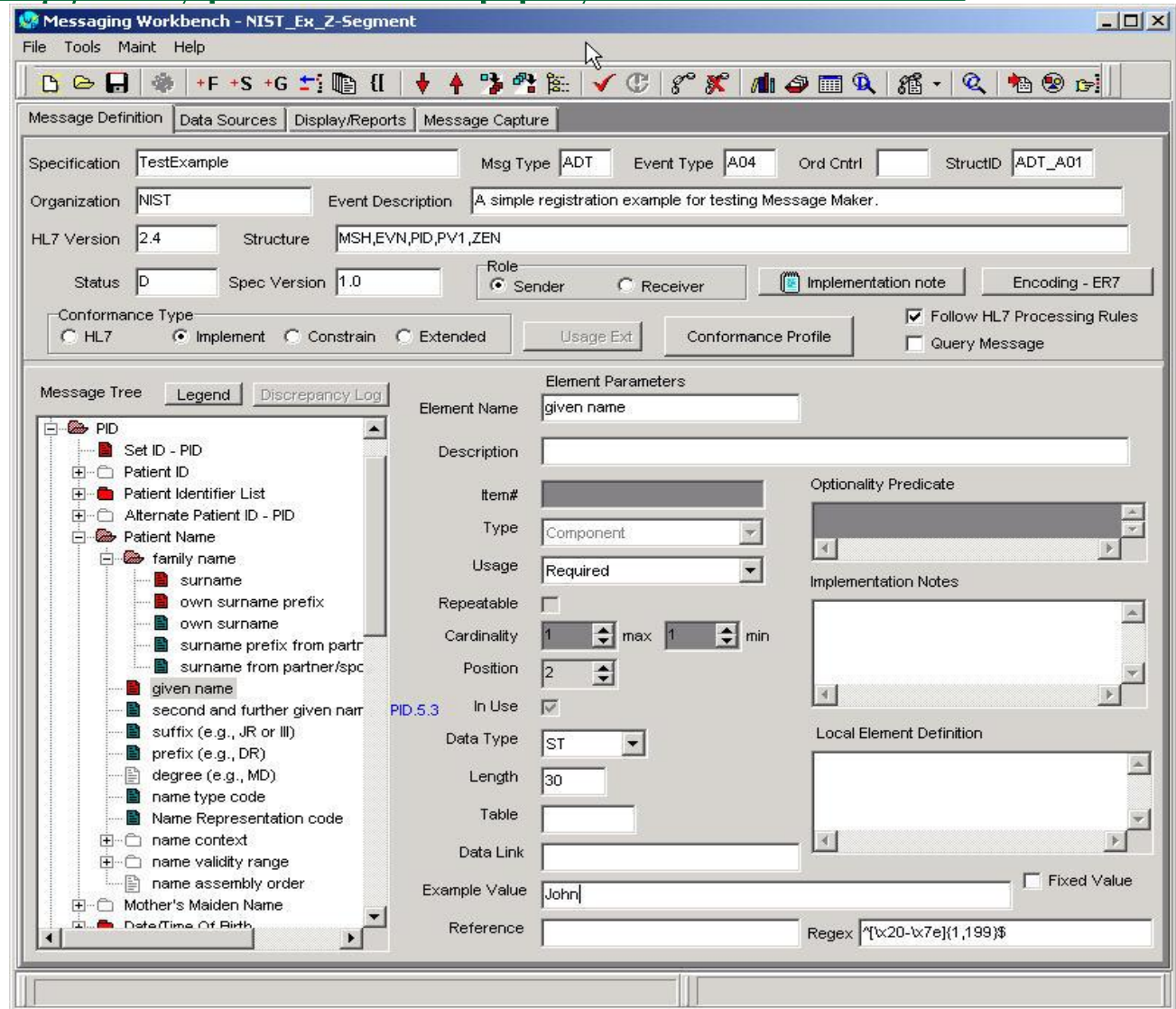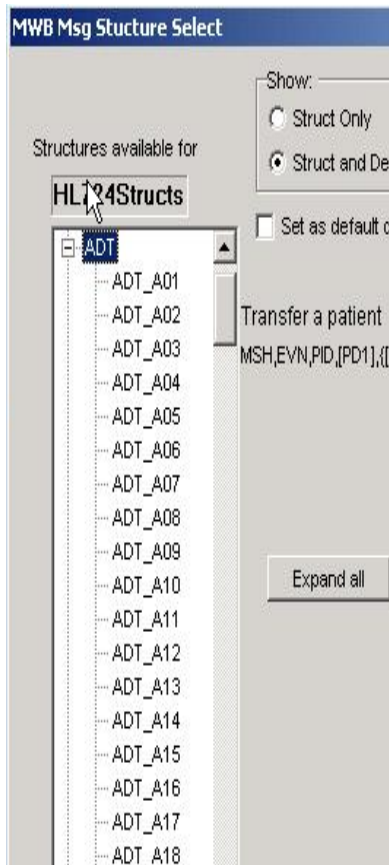
Message Profile Example (XML)

Snippet from PID segment

> SSN not supported

> License is required and must appear exactly one time

> Value needs to be in table 0333

> Value must be a valid date

```xml
<Field Name="SSN Number - Patient" Usage="X" Min="0" Max="*" Datatype="ST" Length="16" ItemNo="00122">
        <Reference>3.4.2.19</Reference>
</Field>
<Field Name="Driver's License Number - Patient" Usage="R" Min="1" Max="1" Datatype="DLN" Length="250" ItemNo="00123">
        <Reference>3.4.2.20</Reference>
        <Component Name="Driver's License Number" Usage="R" Datatype="ST" Length="100">
        </Component>
        <Component Name="Issuing State, province, country" Usage="R" Datatype="IS" Length="" Table="0333">
        </Component>
        <Component Name="expiration date" Usage="R" Datatype="DT" Length="30">
        </Component>
</Field>
<Field Name="Mother's Identifier" Usage="X" Min="0" Max="*" Datatype="CX" Length="250" ItemNo="00124">
        <Reference>3.4.2.21</Reference>
        <Component Name="ID" Usage="X" Datatype="ST" Length="3">
        </Component>
        <Component Name="Check digit" Usage="X" Datatype="ST">
        </Component>
        <Component Name="code identifying the check digit scheme employed" Usage="X" Datatype="ID" Length="3" Table="0061">
        </Component>
```

Provides impetus for conformance and interoperability; e.g., message creation, validation, etc.

NIST Testing Services

- Message Management
- Profile Validation
- *Message Validation*
- Message Generation
- Encoding Transformation
- Logging
- HL7 Actors (Simulations)
- Communication
- Test Framework

Provided as a set of Java APIs which can be used to develop applications, web services, and web applications

Message Validation
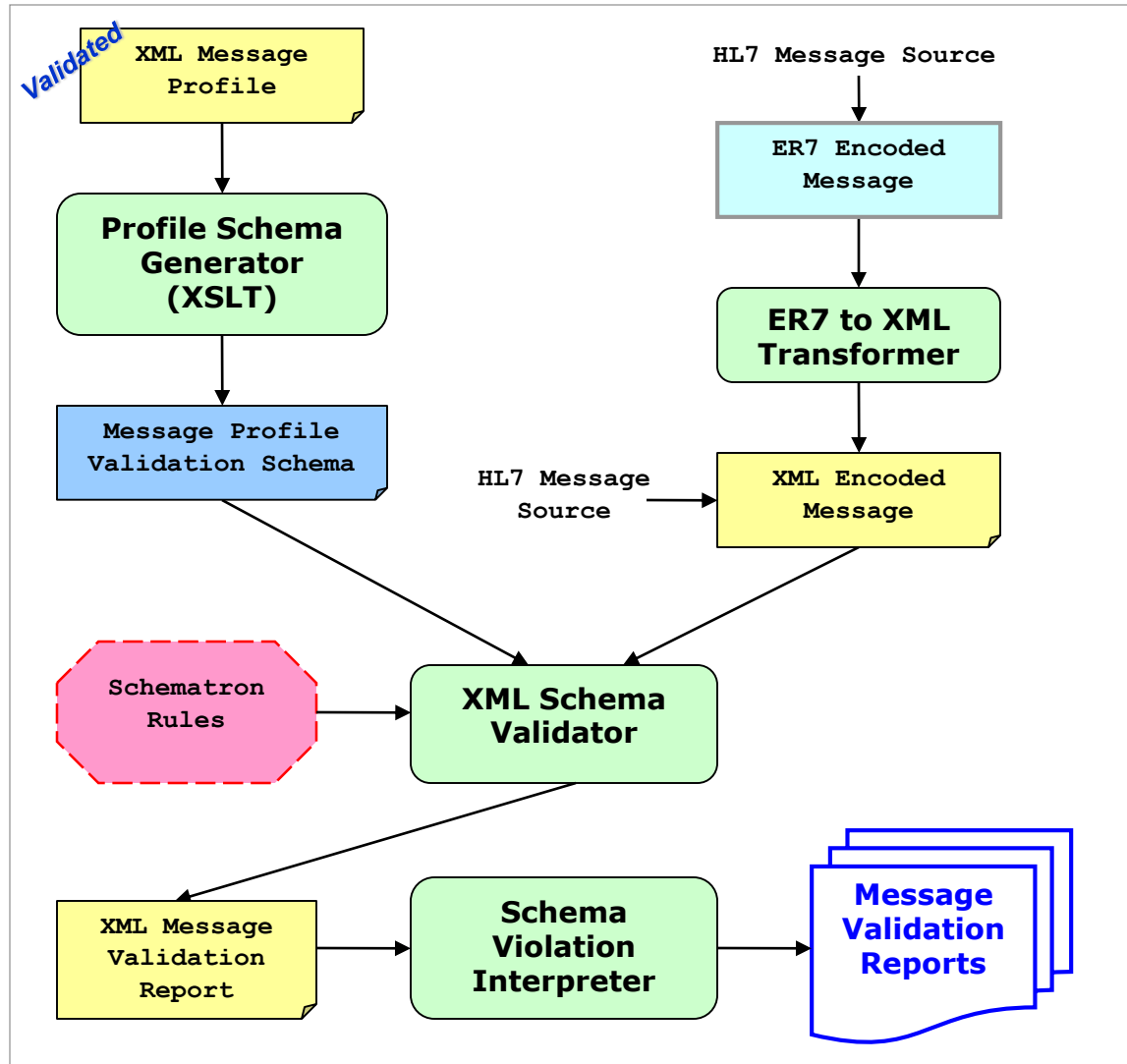
The Need for Dynamic Message Creation
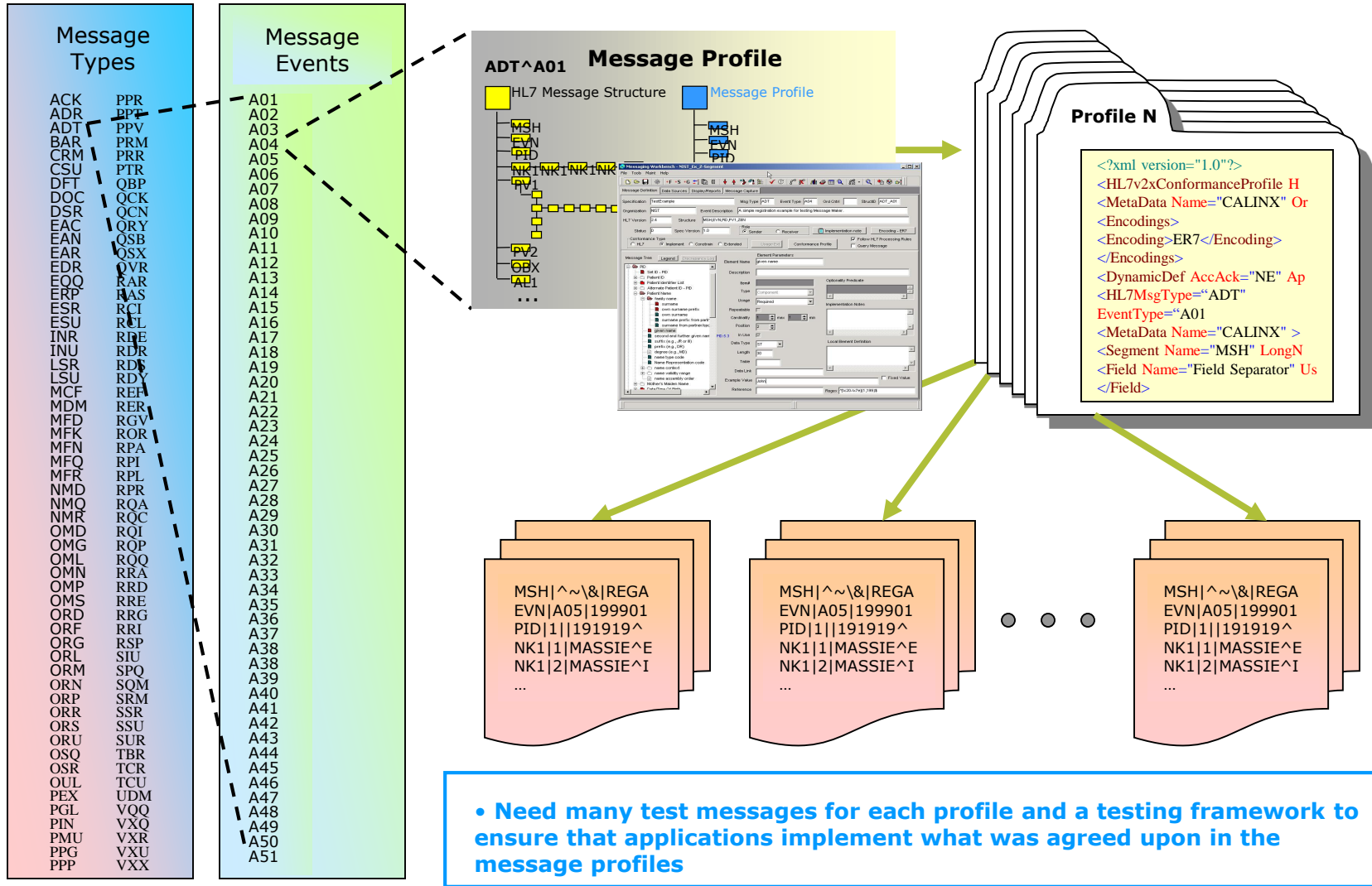
• **Need many test messages for each profile and a testing framework to ensure that applications implement what was agreed upon in the message profiles**

NIST Message Maker
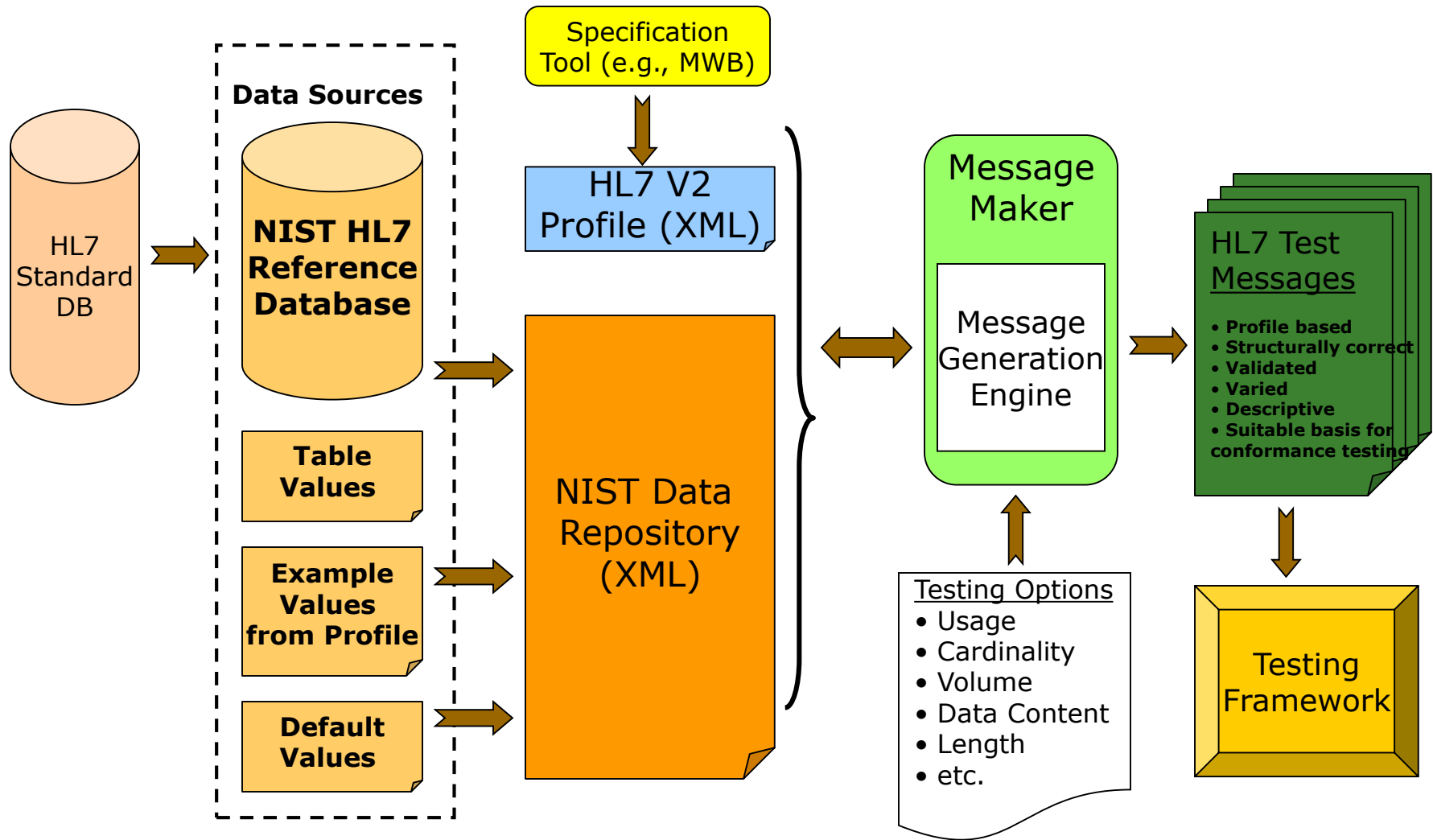
Message Maker: Select Tests

Description: The Manual Test Selection allows you to pick a specific location in the profile and the type of test you'd like. Tests can be valid or invalid. A number of error messages have been requested above.

Message Maker: Browse and Edit Data

Message Maker: Message Views

NIST HL7 Test Framework

Conformance Profiles in Practice

- Adoption of conformance profiles is gaining momentum

- Example Installations
  - U.S. Veterans Administration
  - IHE: Integrating the Healthcare Enterprises
  - ELINCS: The EHR-Lab Interoperability and connectivity specification
  - HITSP: Healthcare Information Technology Standards Panel

- Anticipated increase usage adoption as latest versions of HL7 make it into implementations (conformance added in HL7 Version 2.5)

- Support from vendors increasing

Summary

- Data exchange among healthcare systems is problematic due to inadequate messaging standards
- Conformance profile approach provides a roadmap
- Approach:
  - Incorporate and refine conformance concepts into standards
  - Provide tools that support the conformance concepts
    - Profile Builder
    - Message Generation
    - Profile and Message Validation
    - Testing Framework and Support Utilities
  - Work with industry to demonstrate the feasibility and benefits of the methodology with use case example implementations supported by organizations such as IHE and HITSP
- End result is improved interoperability of healthcare information systems