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

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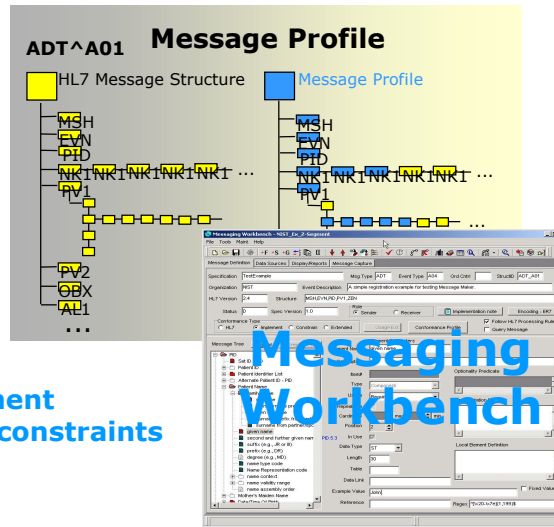
# Outline

- 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



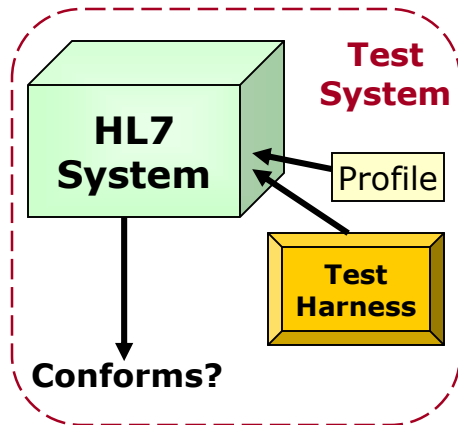
- ✓ Universal design
- ✓ Riddled with optionality
- ✓ Implementation chaos
- ✓ Interoperability difficult



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

```
<?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"
```

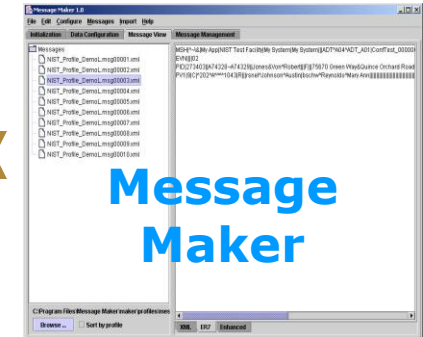
- ✓ Need for test messages



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

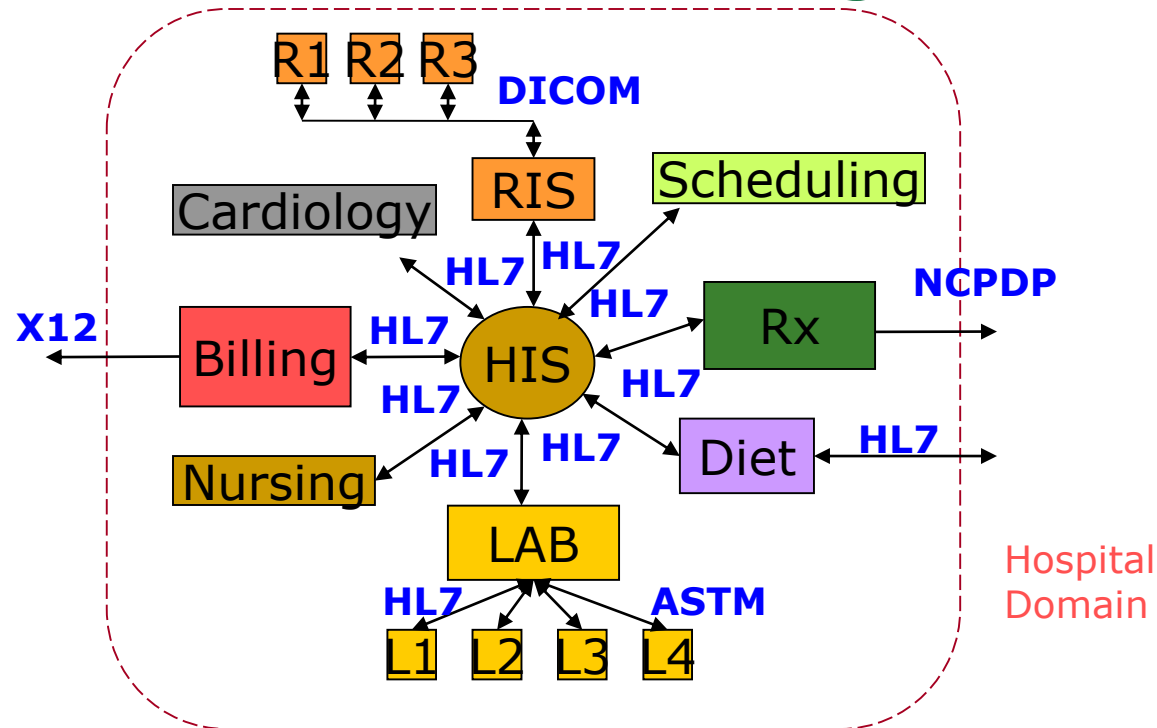


- ✓ Profile based
- ✓ Suite of test messages
- ✓ Suitable for conformance testing



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

# HL7 and Healthcare Integration

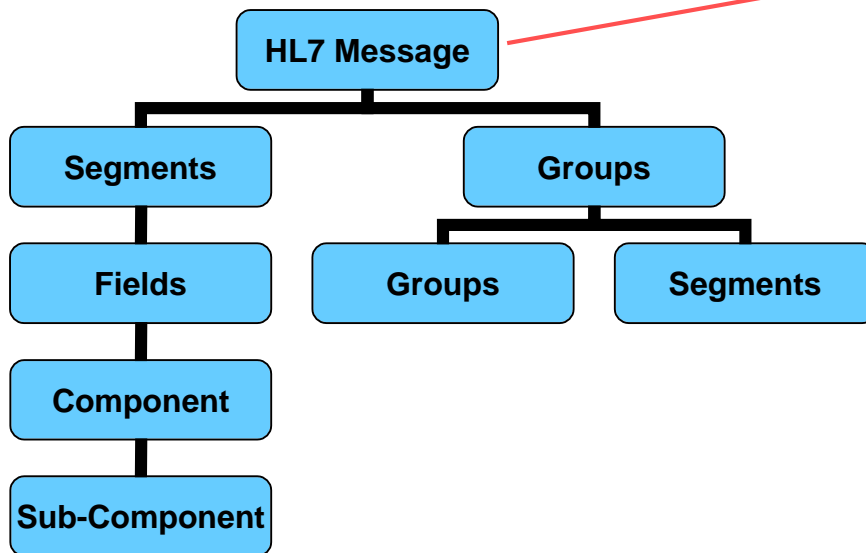


- HL7 (Health Level Seven) Messaging Standard (Application level) – **Version 2**
- Standards for the exchange, management, and integration of data for clinical care
  - Messages model real world events
  - e.g., Messages for registering a patient or requesting a lab order
- HL7 provides a flexible framework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



- 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	XP	R	Y		00108	Patient Name
6	250	XP	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)>

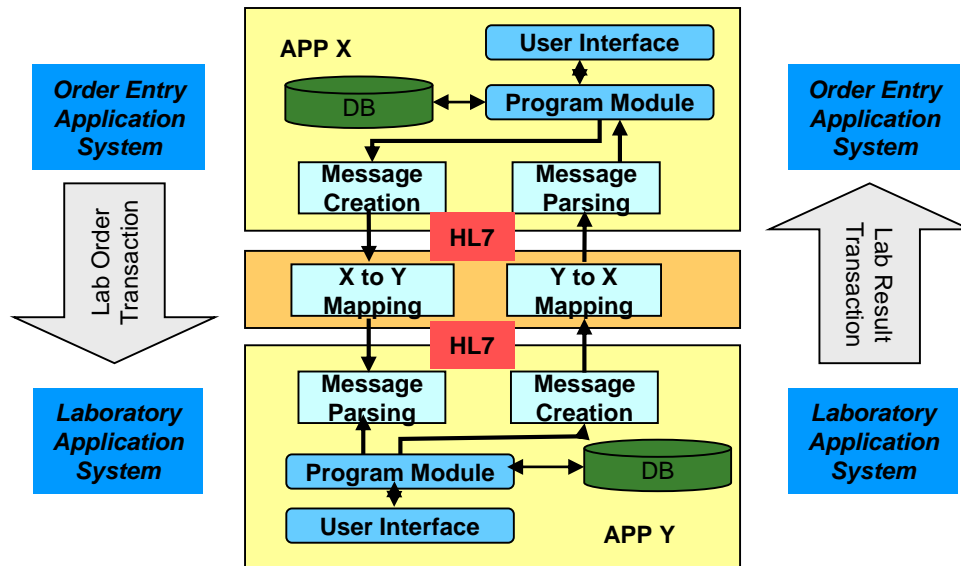
**Subcomponents of name context:** <identifier (ST)> & <text (ST)> &  
<name of coding system (IS)> & <alternate identifier (ST)> & <alternate text (ST)> &  
<name of alternate coding system (IS)>

**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.

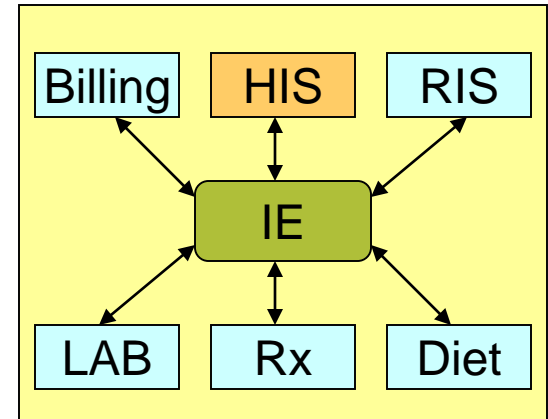
# Why Conformance Profiles are needed

## ■ 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

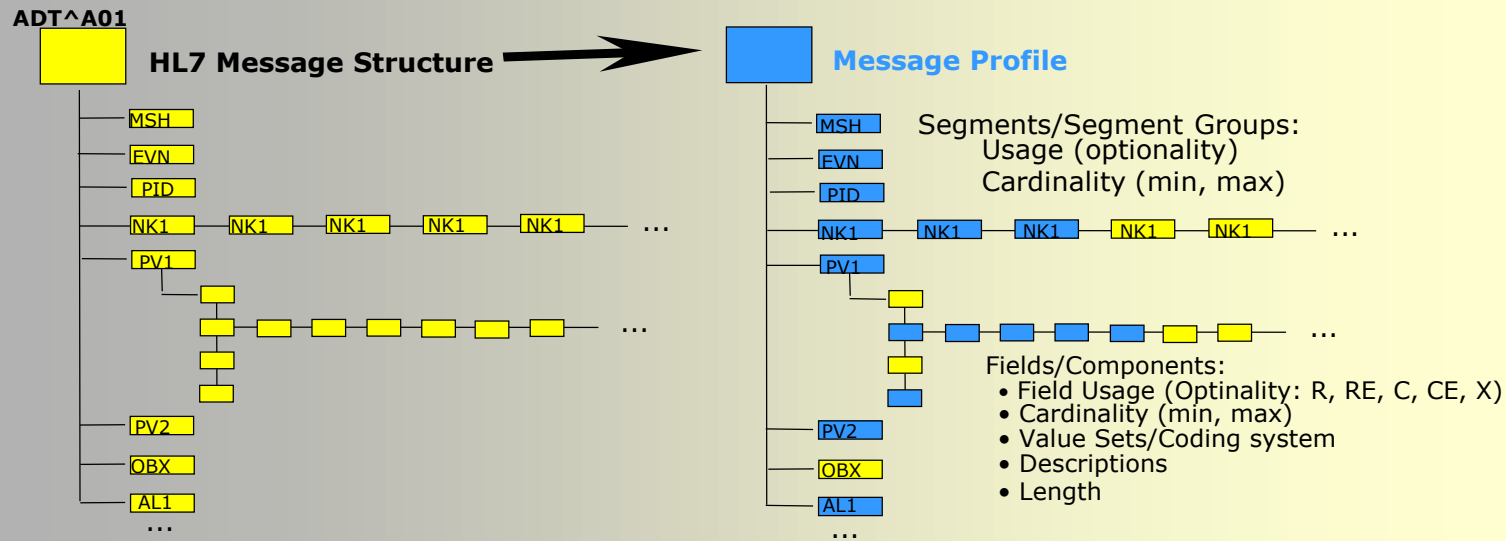
- ❑ Applies implementation specific constraints to the standard
- ❑ Principles drawn from HL7 V3 development efforts
- ❑ The solution for today



# 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



# 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	St
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

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# 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***
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# 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*

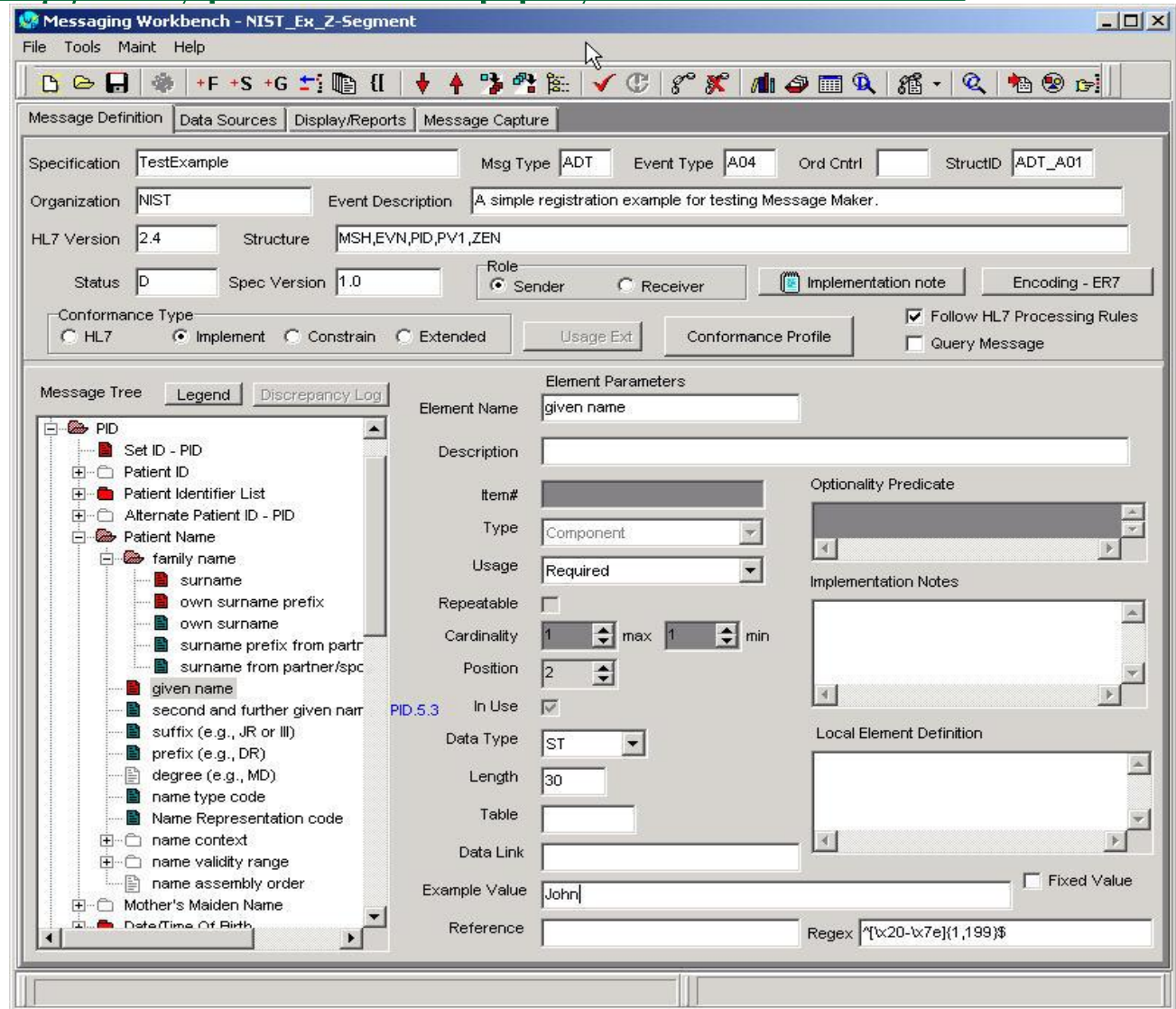
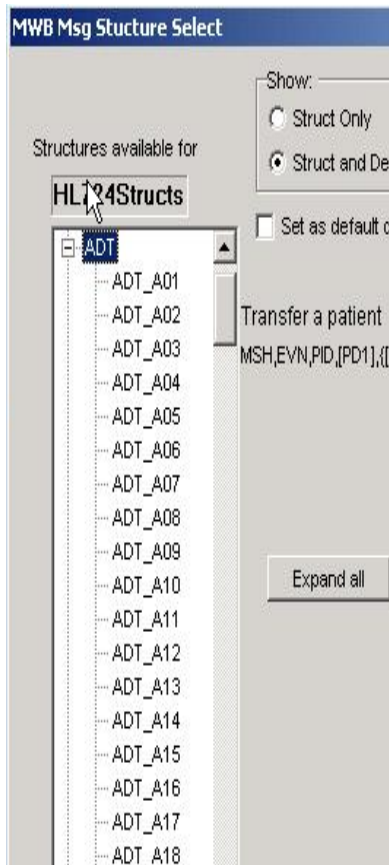
- *VA MWB Validation Server*
-

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# 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

Value needs  
to be in  
table 0333

SSN not  
supported

License is required  
and must appear  
exactly one time

```
<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="10">
      </Component>
      <Component Name="expiration date" Usage="R" Datatype="DT" Length="30">
        </Component>
      </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>
          </Component>
        </Field>
      </Component>
    </Field>
  </Component>
</Field>
Table="0333">
```

Value must  
be a valid  
date

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

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# NIST Testing Services

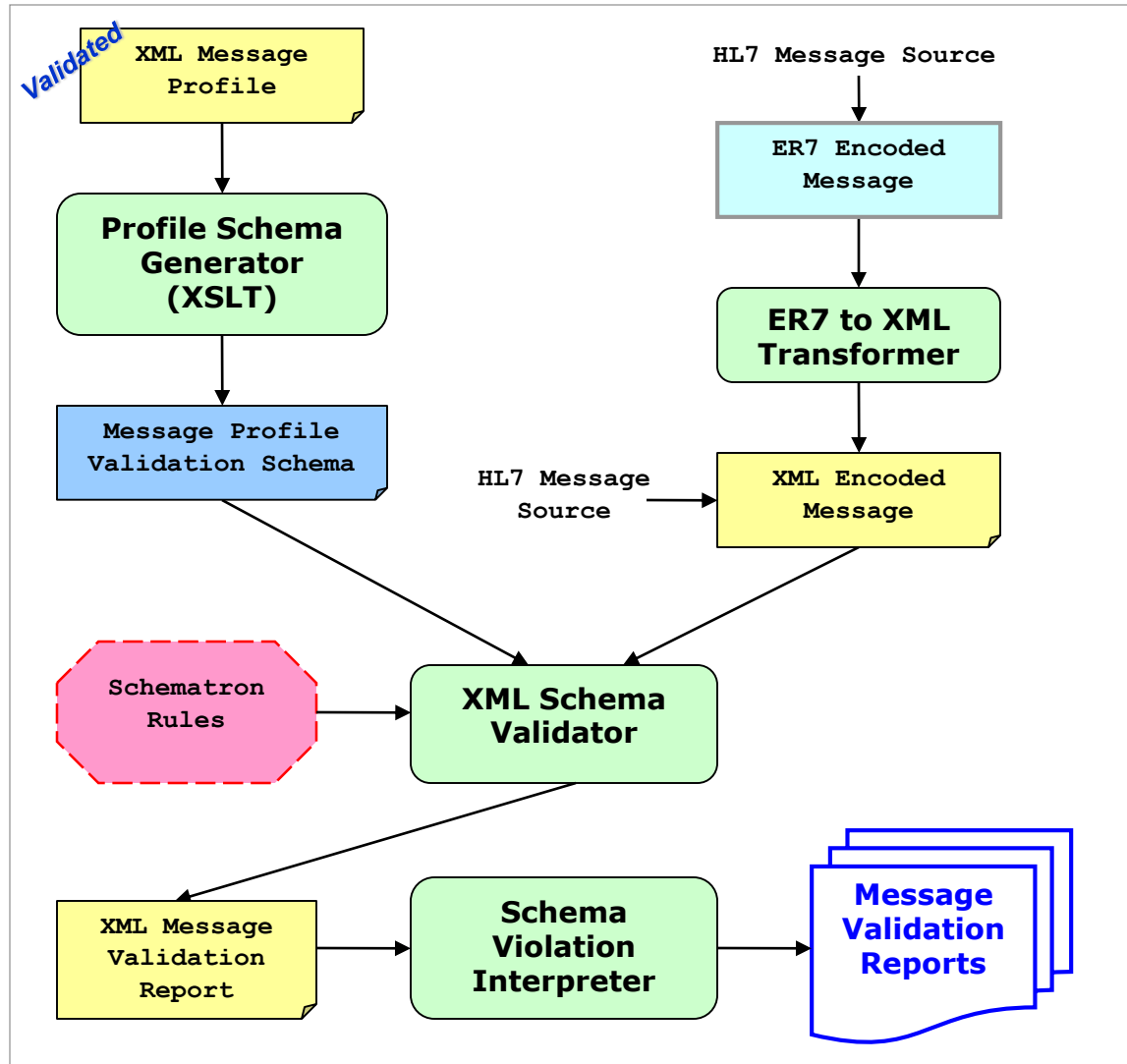
- Message Management
- Profile Validation
- *Message Validation*
- Message Generation
- Encoding Transformation
- Logging
- HL7 Actors (Simulations)
- Communication
- Test Framework

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

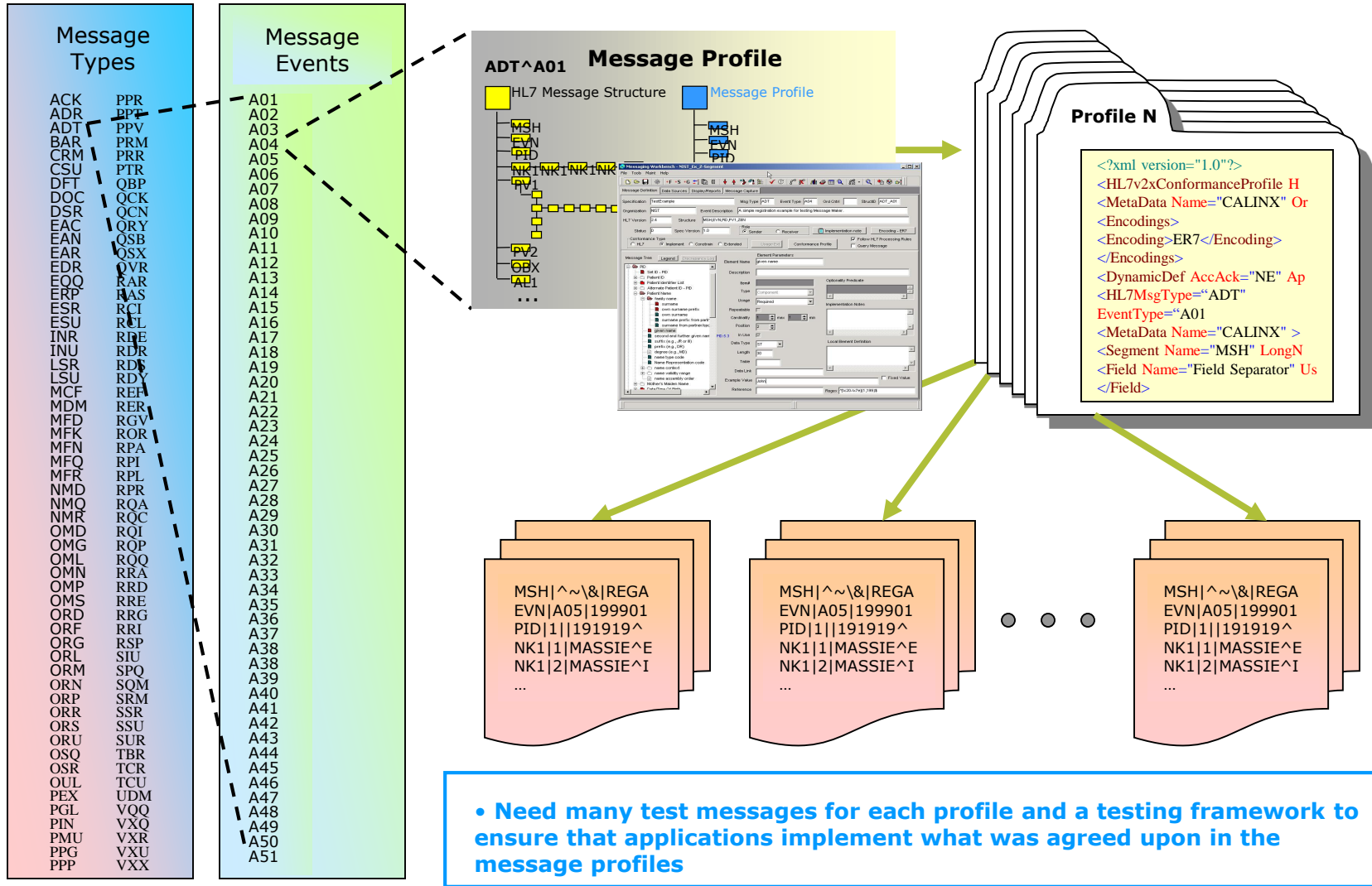
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# Message Validation

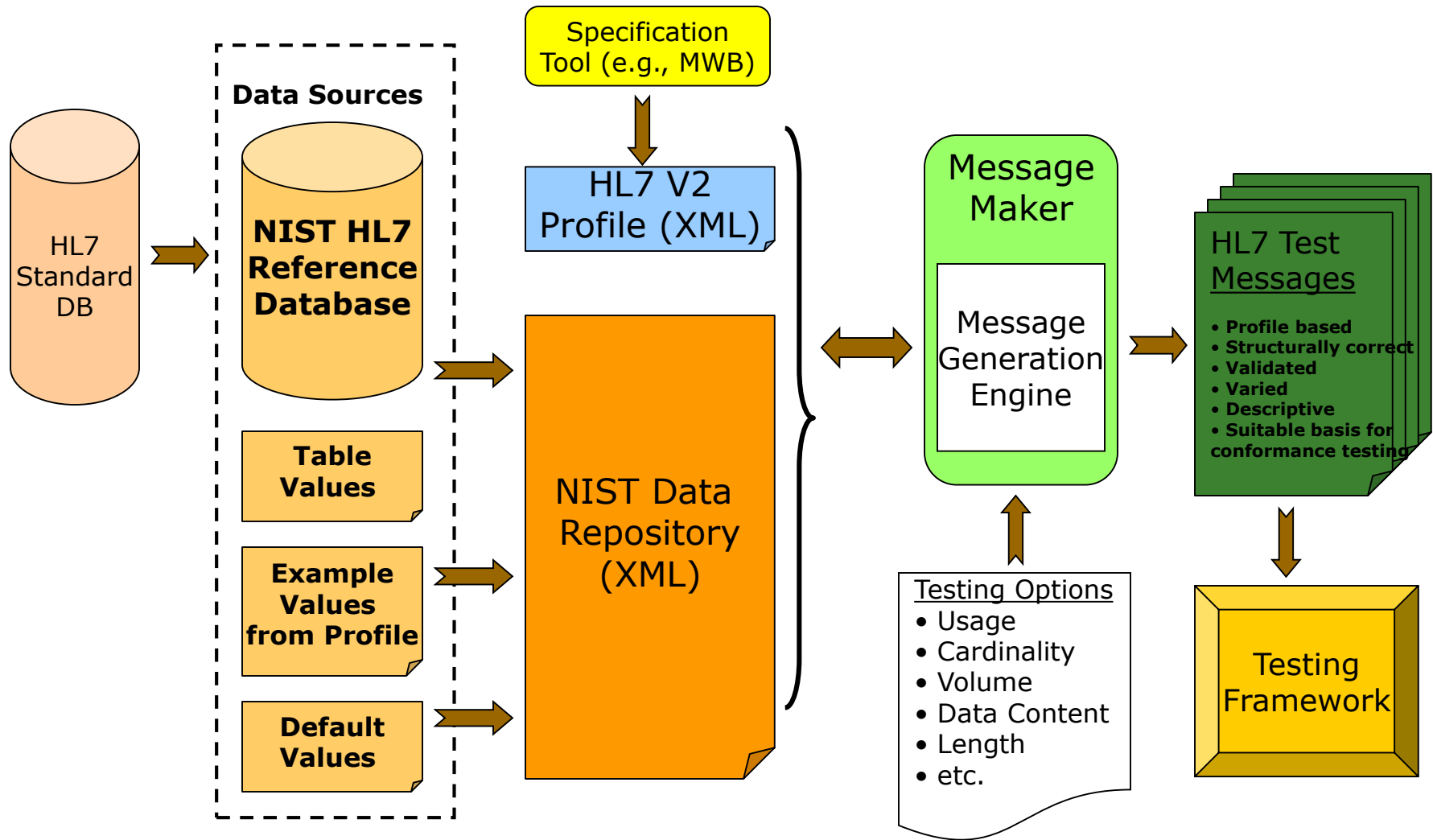


# The Need for Dynamic Message Creation



• 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

**Manual Test Selection**

Type of messages: **INVALID**

Element

- C:\Program Files\Message Maker\maker\testing\Simple\NIST
- MSH
- EVN
- PID
  - Set ID - PID
  - Patient ID
  - Patient Identifier List
  - Alternate Patient ID - R
  - Patient Name
  - Mother's Maiden Name
  - Date/Time Of Birth
  - Administrative Sex
  - Patient Alias
  - Race
  - Patient Address
  - County Code
  - Phone Number - Home
  - Phone Number - Business
  - Primary Language
  - Marital Status
  - Religion
  - Patient Account Number
  - SSN Number - Patient
  - Driver's License Number - Patient
    - Driver's License Number
    - Issuing State, province, country
    - expiration date
  - Mother's Identifier
  - Ethnic Group
  - Birth Place
  - Multiple Birth Indicator
  - Birth Order
  - Citizenship

Cardinality	Usage	Value
<input type="checkbox"/> 1..1	<input type="checkbox"/> R	
<input type="checkbox"/> 1..1	<input type="checkbox"/> R	
<input type="checkbox"/> 1..1	<input type="checkbox"/> R	
<input type="checkbox"/> 1..1	<input type="checkbox"/> R	
<input type="checkbox"/> 1..3	<input type="checkbox"/> X	
<input type="checkbox"/> 1..1	<input type="checkbox"/> X	
<input type="checkbox"/> 1..1	<input type="checkbox"/> R	
<input type="checkbox"/> 1..1	<input type="checkbox"/> X	
<input type="checkbox"/> 1..1	<input type="checkbox"/> R	
<input type="checkbox"/> 1..1	<input type="checkbox"/> X	
<input type="checkbox"/> 1..1	<input type="checkbox"/> X	
<input type="checkbox"/> 1..3	<input type="checkbox"/> R	
<input type="checkbox"/> 1..1	<input type="checkbox"/> X	
<input type="checkbox"/> 1..1	<input type="checkbox"/> R	
<input checked="" type="checkbox"/> 1..1	<input checked="" type="checkbox"/> R	0001
<input checked="" type="checkbox"/> 1..1	<input checked="" type="checkbox"/> R	0333
	<input type="checkbox"/> R	
	<input type="checkbox"/> X	
	<input type="checkbox"/> X	
	<input type="checkbox"/> X	
	<input type="checkbox"/> X	
	<input type="checkbox"/> X	
	<input type="checkbox"/> X	
	<input type="checkbox"/> X	

Number of Message Variants: 5

Apply Undo Modification Clear All Close

**Request either valid or invalid**

**Navigate to specific location in the profile**

**Not supported element is populated with a value**

**Element is populated with value that is NOT in the code set**

**Required element is NOT populated with a value**

**Vary the cardinality of this element such that it is outside the valid cardinality range**

**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 1.3

File Configure Messages Tools Help

Initialization Data Configuration Message View Message Management

Alternate Patient ID - PID  
Patient Name  
Mother's Maiden Name  
Date/Time Of Birth  
Administrative Sex  
Patient Alias  
Race  
Patient Address  
County Code  
Phone Number - Home  
[[999]] 999-9999 [X99999][C any text]  
telecommunication use code  
telecommunication equipment  
Email address  
Country Code  
Area/city code  
Phone number  
Extension  
any text  
Phone Number - Business  
Primary Language  
Marital Status  
Religion  
Patient Account Number  
SSN Number - Patient  
Driver's License Number - Patient  
Mother's Identifier  
Ethnic Group  
Birth Place  
Multiple Birth Indicator  
Birth Order  
Citizenship  
Veterans Military Status

Values

(608)885-2312  
(240)765-1455  
(972)444-2222  
(972)765-1994  
(240)222-1212  
(214)444-5473  
(301)191-9999  
(412)287-7733  
(240)765-1214x5924  
(972)233-1992x63741  
(972)666-1992x6444C Press 2  
233-4422  
221-0548  
(412)221-7218  
(814)284-9218  
(703)463-9900  
(301)392-6372  
(214)444-5471X7342  
(412)446-5423x123  
(814)442-5473x22C After 6:00  
(301)444-5473B951  
834-5473  
221-4753C local number  
693-3432  
818-6438X44  
49 (301)444-5473

New Add Remove Edit Cancel

Name: [[999]] 999-9999 [X99999][C any text]

Message Maker 1.3

File Configure Messages Tools Help

Initialization Data Configuration Message View Message Management

PID

Set ID - PID  
Patient ID  
Patient Identifier List  
Alternate Patient ID - PID  
Patient Name  
Mother's Maiden Name  
Date/Time Of Birth  
Administrative Sex  
Patient Alias  
Race  
Patient Address  
County Code  
Phone Number - Home  
Phone Number - Business  
Primary Language  
Marital Status  
Religion  
Patient Account Number  
SSN Number - Patient  
Driver's License Number - Patient  
Mother's Identifier  
Ethnic Group  
Birth Place  
Multiple Birth Indicator  
Birth Order  
Citizenship  
Veterans Military Status  
Nationality  
Patient Death Date and Time  
Patient Death Indicator  
Identity Unknown Indicator  
Identity Reliability Code  
Last Update Date/Time

Table Number: 0001 - Table Name: Administrative sex - Version: 2.4

Code	Value
A	Ambiguous
F	Female
M	Male
N	Not applicable
O	Other
U	Unknown

New Add Remove Edit Cancel

S Special

Save the HL7 Table Save As ...

Suggested Data Link: Copy Values

# Message Maker: Message Views

ER7  
Encoding

XML  
Encoding

Enhanced  
View

Test  
Description  
describes  
the purpose  
of the test  
message

The image displays three overlapping screenshots of the Message Maker 1.3 software interface, illustrating different message views. The top-left screenshot shows the 'ER7 Encoding' view, displaying a message in ER7 format. The top-right screenshot shows the 'XML Encoding' view, displaying a message in XML format. The bottom-right screenshot shows the 'Enhanced View', displaying a message in a structured, hierarchical format with a tree view on the left and a detailed message body on the right. The 'Enhanced View' includes a 'Test Description' section that describes the purpose of the test message.

**ER7 Encoding**

MSH|^~\&NIST Test Sending Application|NIST Test Facility|NIST Test Receiving Application|NIST EVN||20040328134602.1234+0600||02  
PID|99||A74329~A74323~A74323||Reynolds&den^Robert||20040328134602.1234+0600||U|||7567  
PV1|1|B|^403^B^M|A|||afav^Johnson^Connor~200^Birdseye^Victoria|1234^Simmons^Victoria||

**XML Encoding**

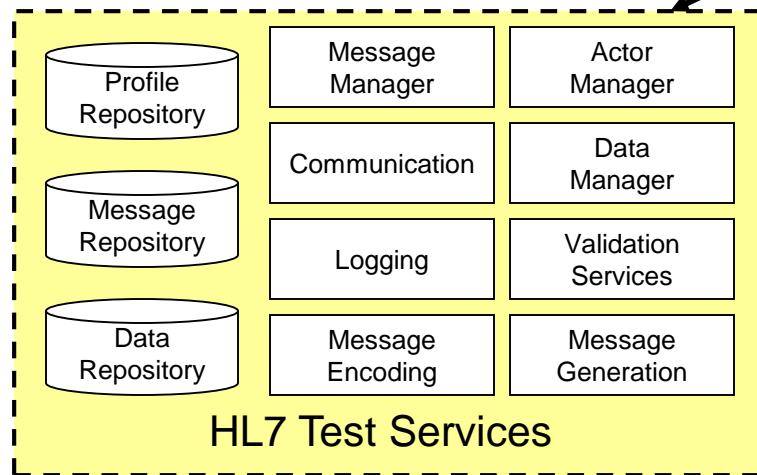
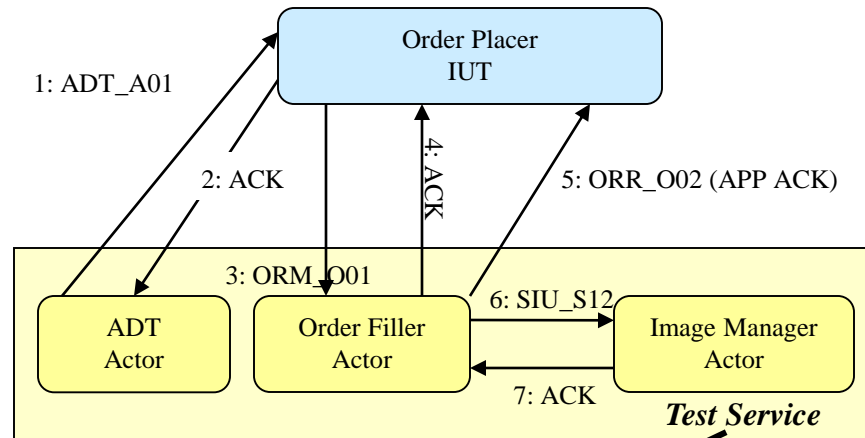
<?xml version="1.0" encoding="UTF-8"?>  
<ADT\_A01>  
<MSH>  
<MSH.1>|</MSH.1>  
<MSH.2>^~^&|</MSH.2>  
<MSH.3>

**Enhanced View**

ADT\_A01  
MSH  
EVN  
PID  
PID.1 99  
PID.3  
PID.5  
PID.7  
PID.8 N  
PID.11  
PID.13  
PID.18  
PID.20  
DLN.2 GA  
DLN.3 2004  
PV1  
PV1.1 4  
PV1.2 C  
PV1.3  
PV1.4 N  
PV1.7  
PV1.8  
PV1.18 G  
PV1.19  
PV1.44  
PV1.45  
PV1.46 2567.87  
PV1.47 78.99  
PV1.49 14.85

INVALID: Required element not present.  
Specific test location: Segment: PID  
Field: Driver's License Number - Patient  
Component: Driver's License Number  
Sequence number in the message: PID.20.1

# NIST HL7 Test Framework



**Test Script (XML)**

- Actor(s) Config
- Messages
- Validation Requirements
- Simulation

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# 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