
Conformance Testing and Interoperability: A Case Study in Healthcare Data Exchange

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Las Vegas, Nevada, July 16th, 2008*

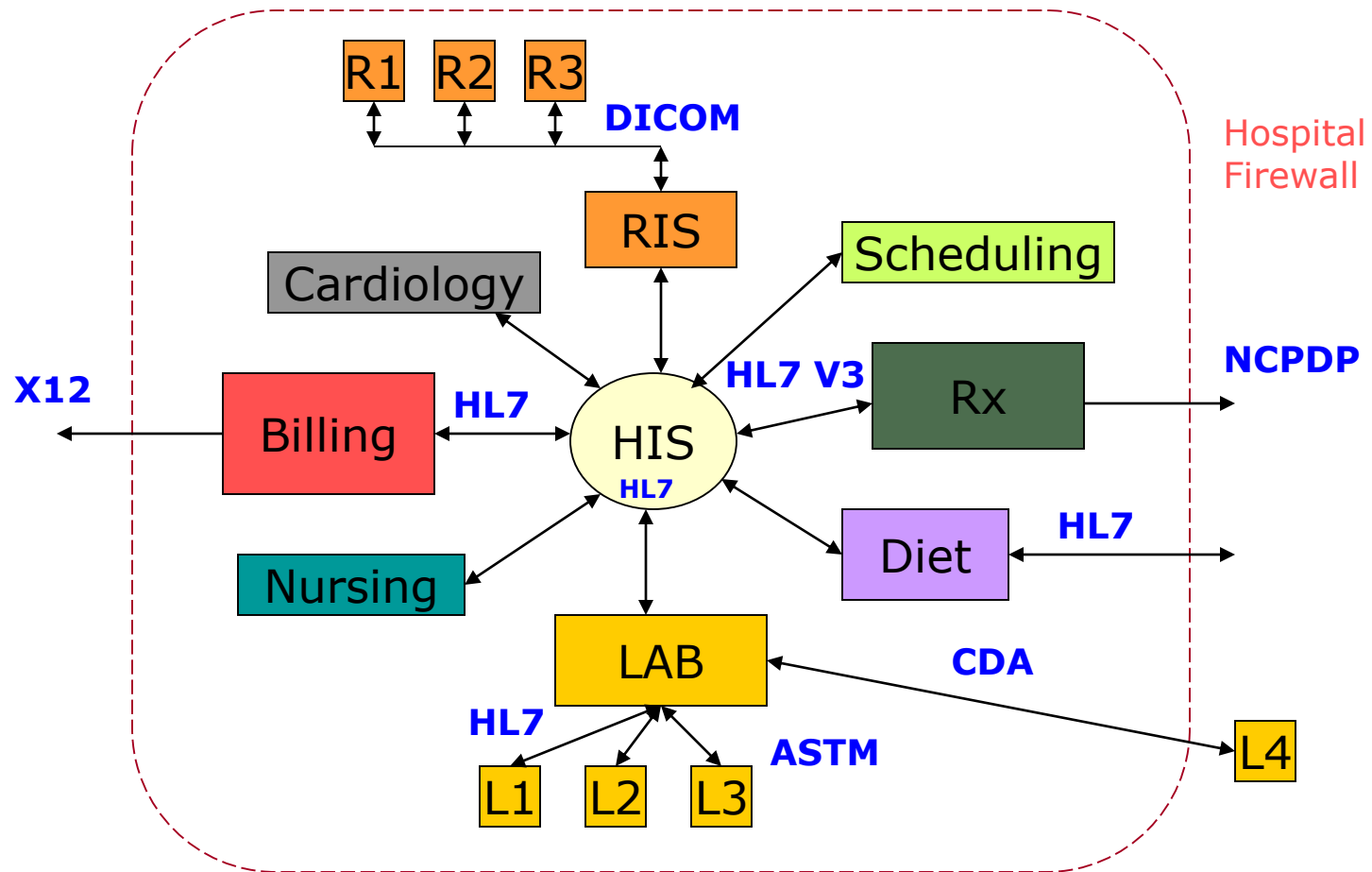
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*National Institute of Standards and Technology (NIST)
Gaithersburg, Maryland*

Outline

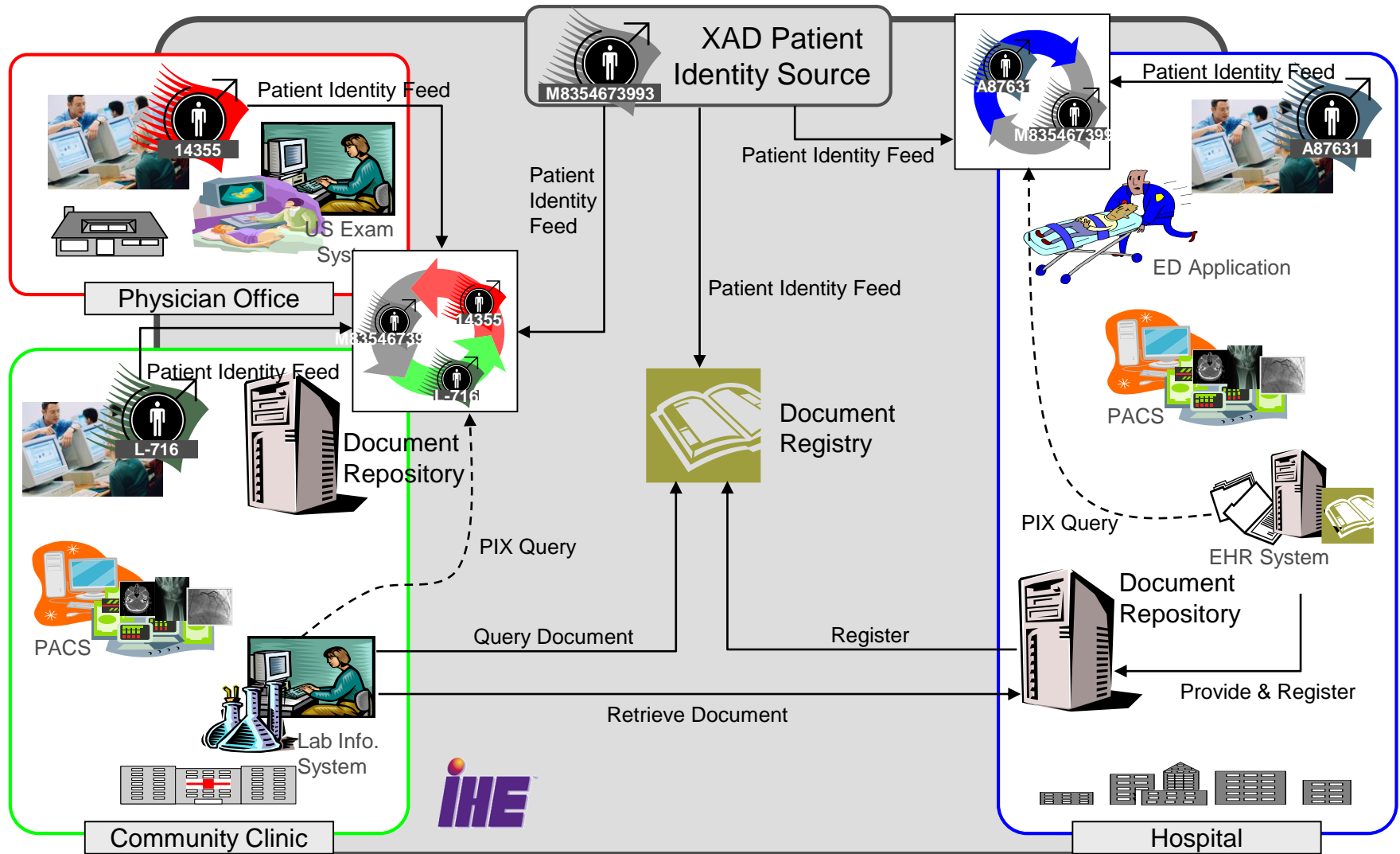
- Overview
 - Conformance and Interoperability Testing
 - Healthcare Messaging Standards
 - Message Profiles
 - Testing Approaches
 - Testing Framework
 - Summary
-

Healthcare Integration

Problem: Exchanging data reliably

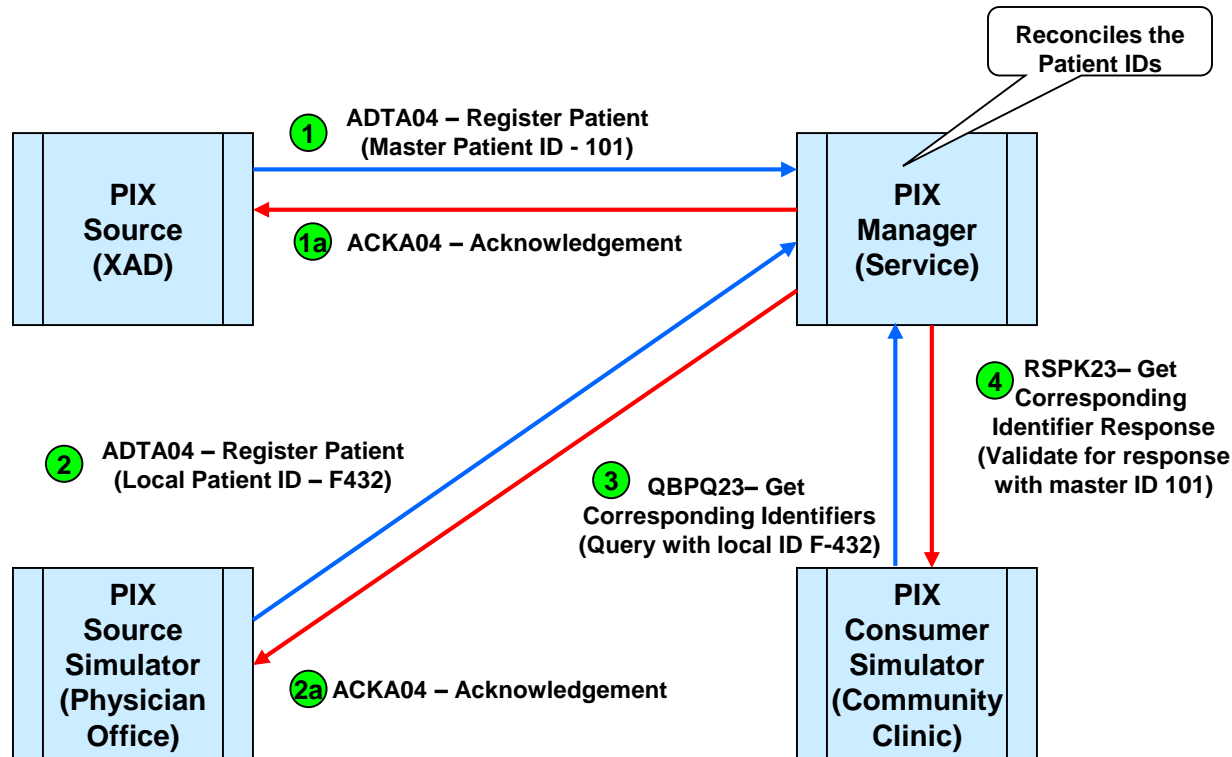


Look-up XDS Patient ID w/local PIX Service



A Test Scenario:

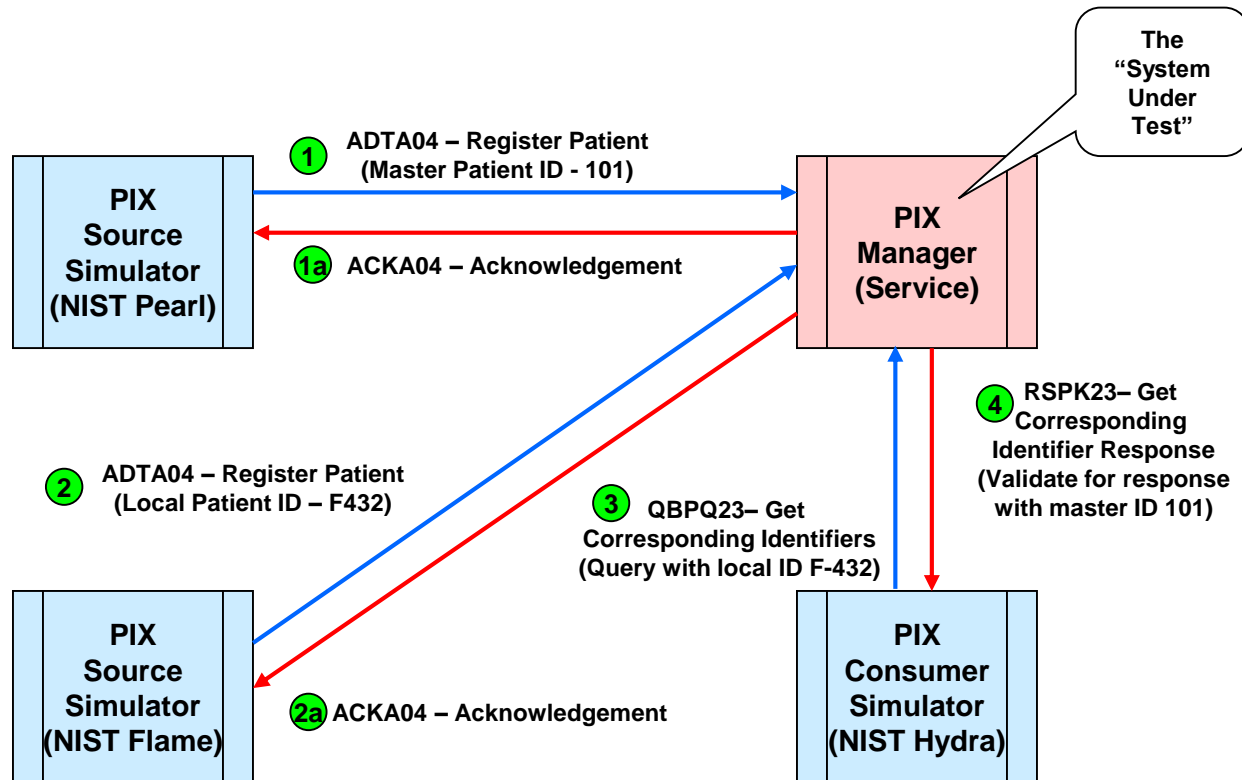
Retrieve Document using a Patient Identifier



What we're looking to test

- Functionality of the Patient Reconciliation Service (i.e., the PIX Manager)
- Send it

Employ Test Agents (Actors)



HL7: Healthcare Messaging Standard

- Standards for the exchange, management, and integration of data for clinical care
 - Application level messaging standard
 - Deployed in 90% of US hospitals, international use growing
 - Messages, for example
 - ADT
 - Lab order
 - Lab results
 - “A framework for negotiation”
-

Master Source to Manager Feed

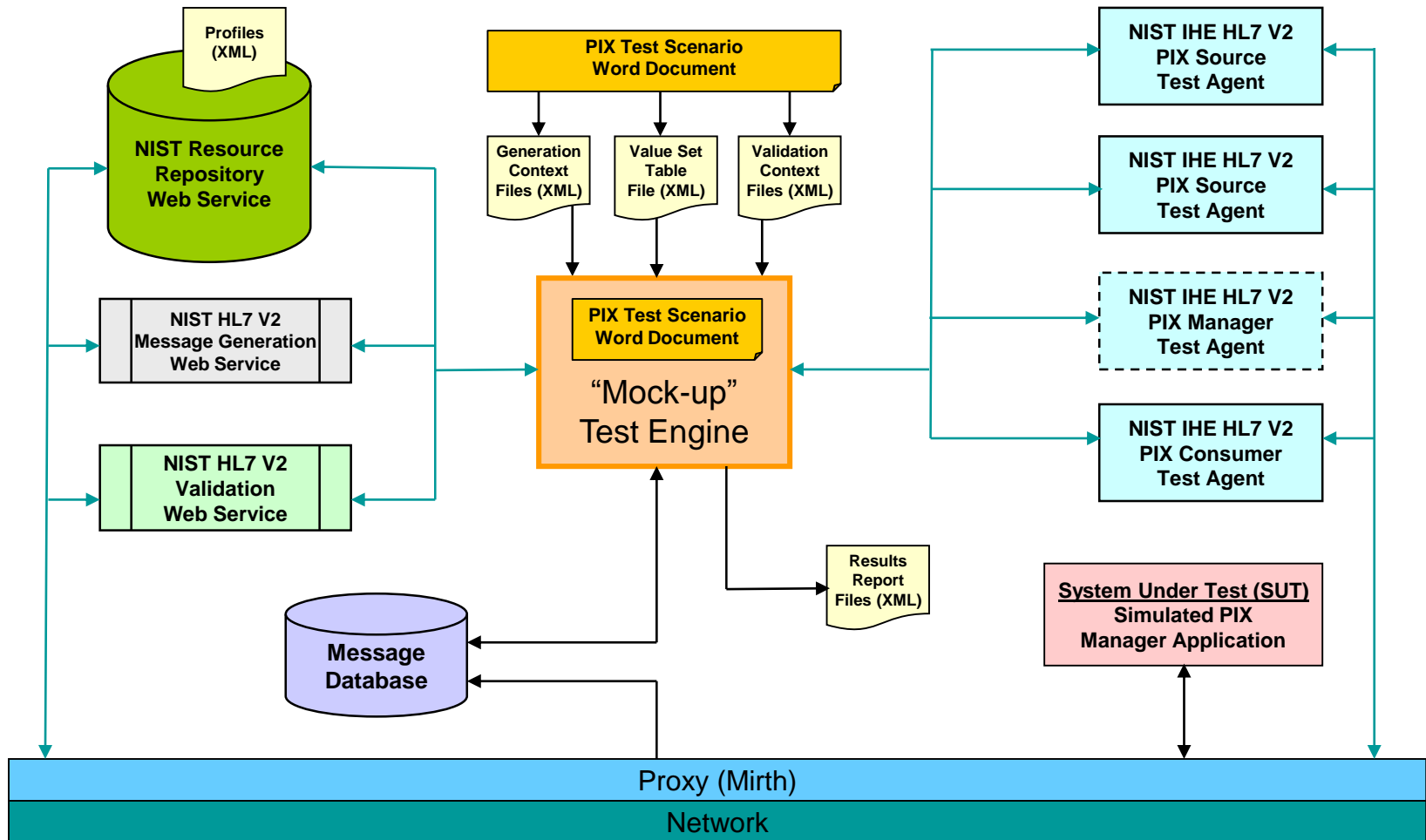
MSH|^~\&|NIST Pearl PIX Source|NIST Pearl|NIST Swan PIX Manager|NIST
Swan|20080523110113||ADT^A04^ADT_A01|Pearl-000001|P|2.3.1

EVN|A04|23

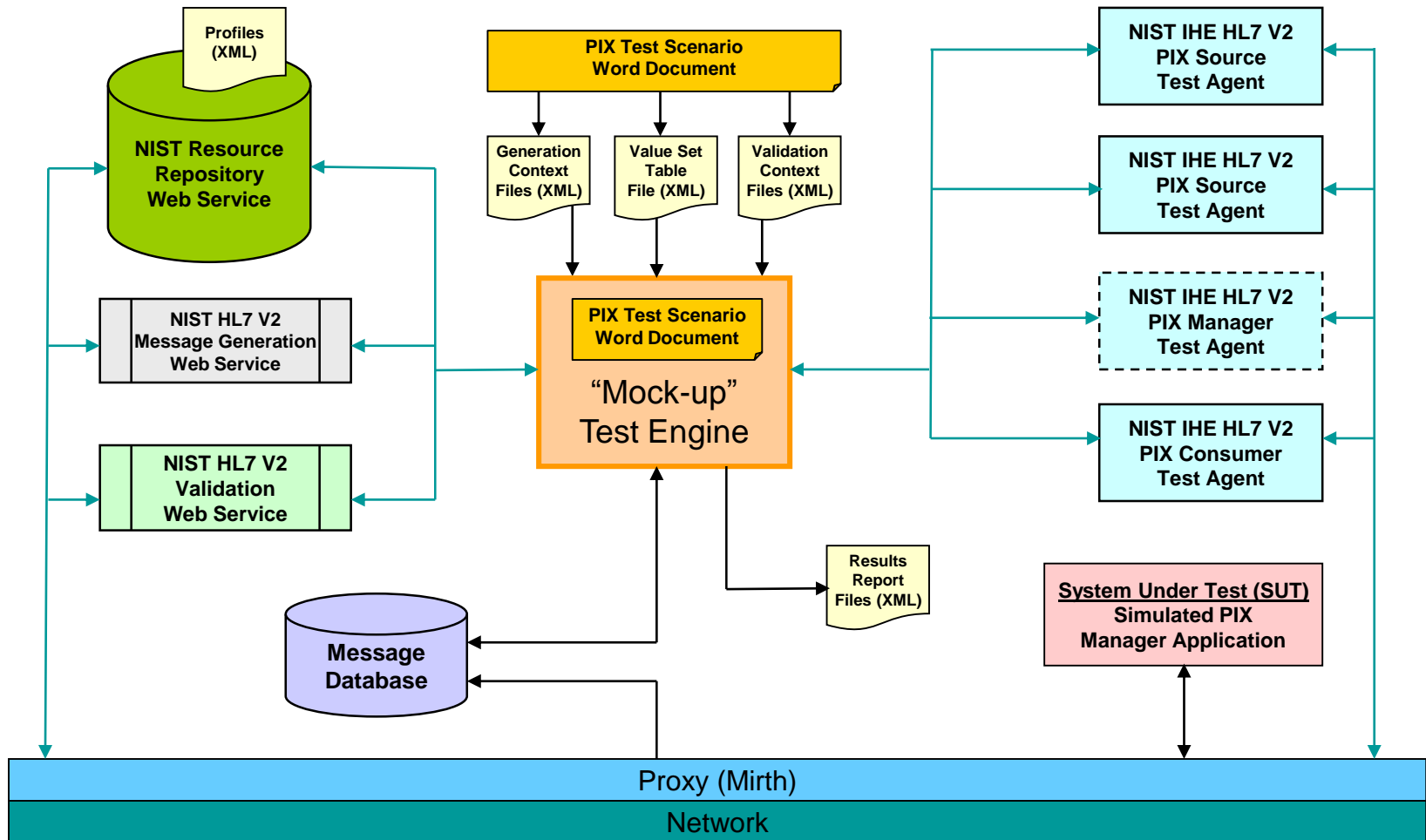
PID|||**101^^IHENA&1.3.6.1.4.1.21367.2005.3.7&ISO**^PI||FARNSWORTH^STEVE|B
arnes^|19781208|M|||820 JORIE BLVD^^CHICAGO^IL^60523||312-555-1234|312-555-
6789|||||163-12-5432|^

PV1||

Prototype Implementation



Prototype Implementation



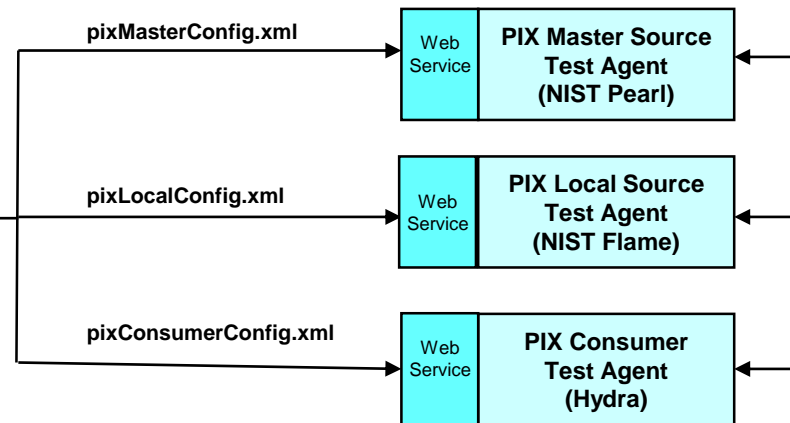
Configure Test Agents

"Mock-up" Test Engine

1. **start(pixMasterConfig.xml);**
2. **start(pixLocalConfig.xml);**
3. **start(pixConsumerConfig.xml);**

Note: Gazelle control system will create the configuration files for use in the test engine. Also the SUT needs to be instructed on how to configure itself.

Test Agent	Machine Name	IP Address	Port
PIX Master Source	xreg2.nist.gov	129.6.24.107	8000
PIX Local Source	xreg2.nist.gov	129.6.24.107	8001
PIX Manager	P624501.sdct.nist.gov	129.6.58.40	8003
PIX Consumer	xreg2.nist.gov	129.6.24.107	8002



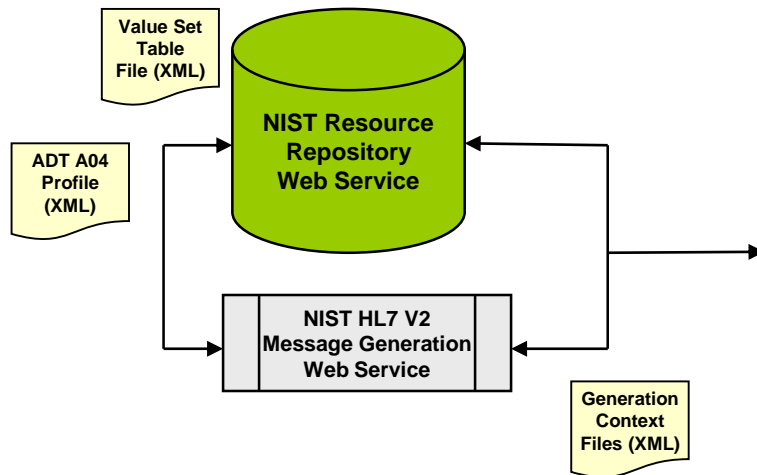
`pixManagerConfig.xml`

System Under Test (SUT)
Simulated PIX
Manager Application

Proxy (Mirth)

Network

Generate PIX Source Messages



“Mock-up” Test Engine

Create PIX Master Source Message via Generation WS

1. Retrieve PIX Master Source message generation context file (in the future it will be from the repository)
2. Test engine has references to profile and table
3. `pixMasterMessage.er7= generate(profileRef, tableRef, generationContext);`

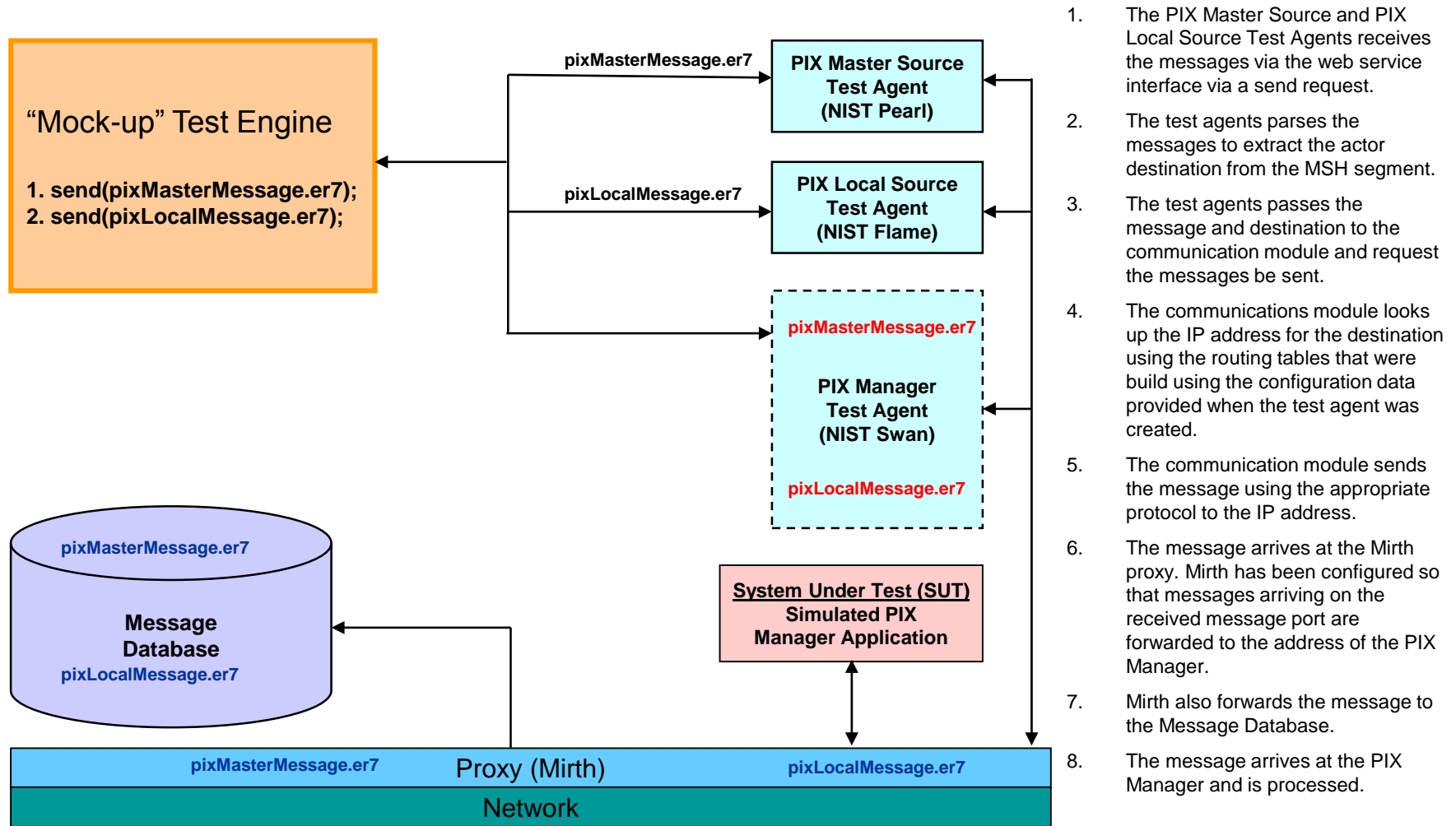
Create PIX Local Source Message via Test Agent

1. Retrieve PIX Local Source message generation context file (in the future it will be from the repository)
2. Test engine has references to profile and table
3. `pixLocalMessage.er7 = generateMessage(profileRef, tableRef, generationContext);`

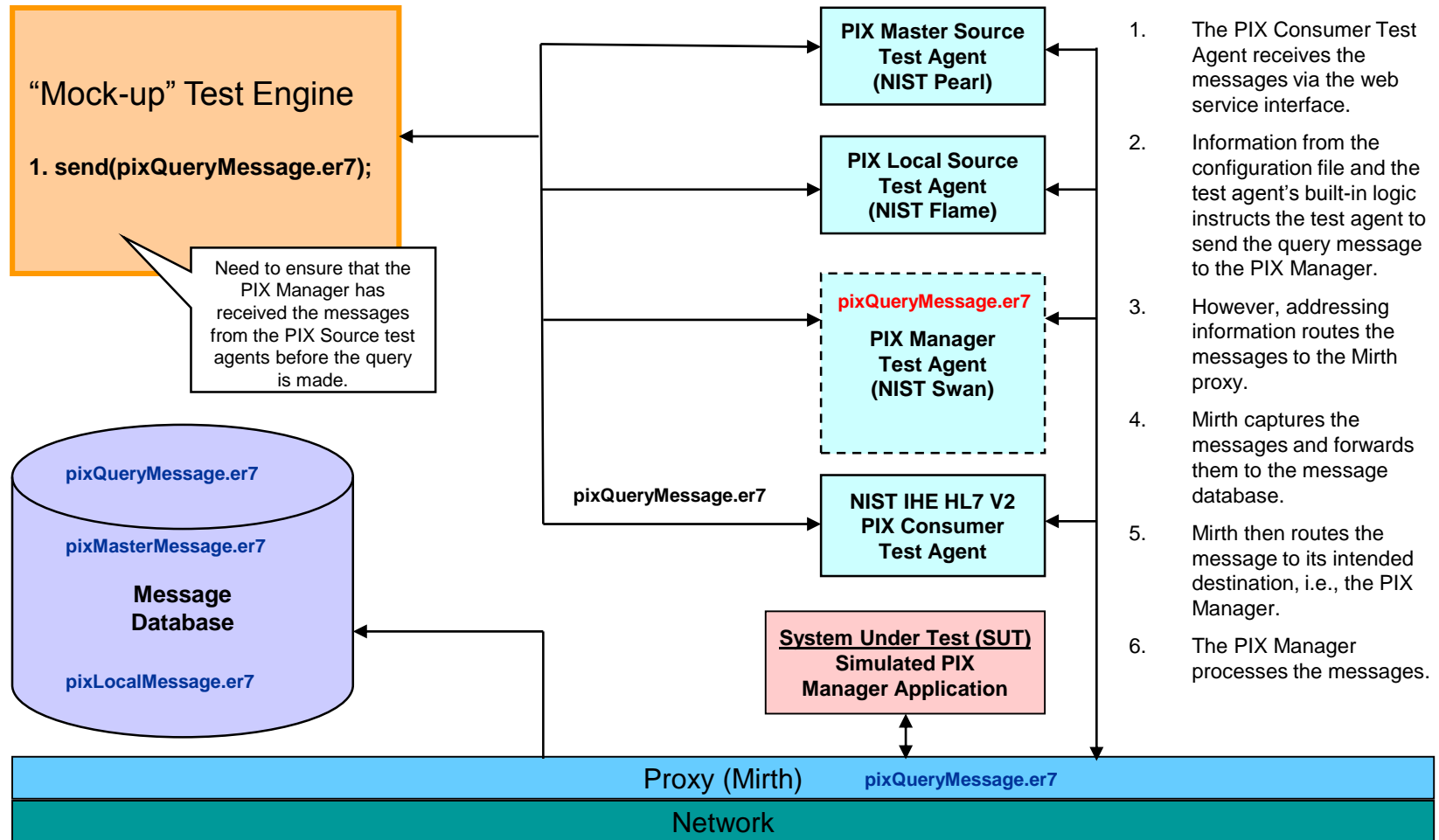
There are different options for obtaining the messages:

1. Test Engine used web service to generate using generation context file
2. Test Engine retrieves pre-canned messages from repository
3. Test Engine receives messages from Gazelle control system
4. Test Engine instructs Test Agents to create messages using generation context file

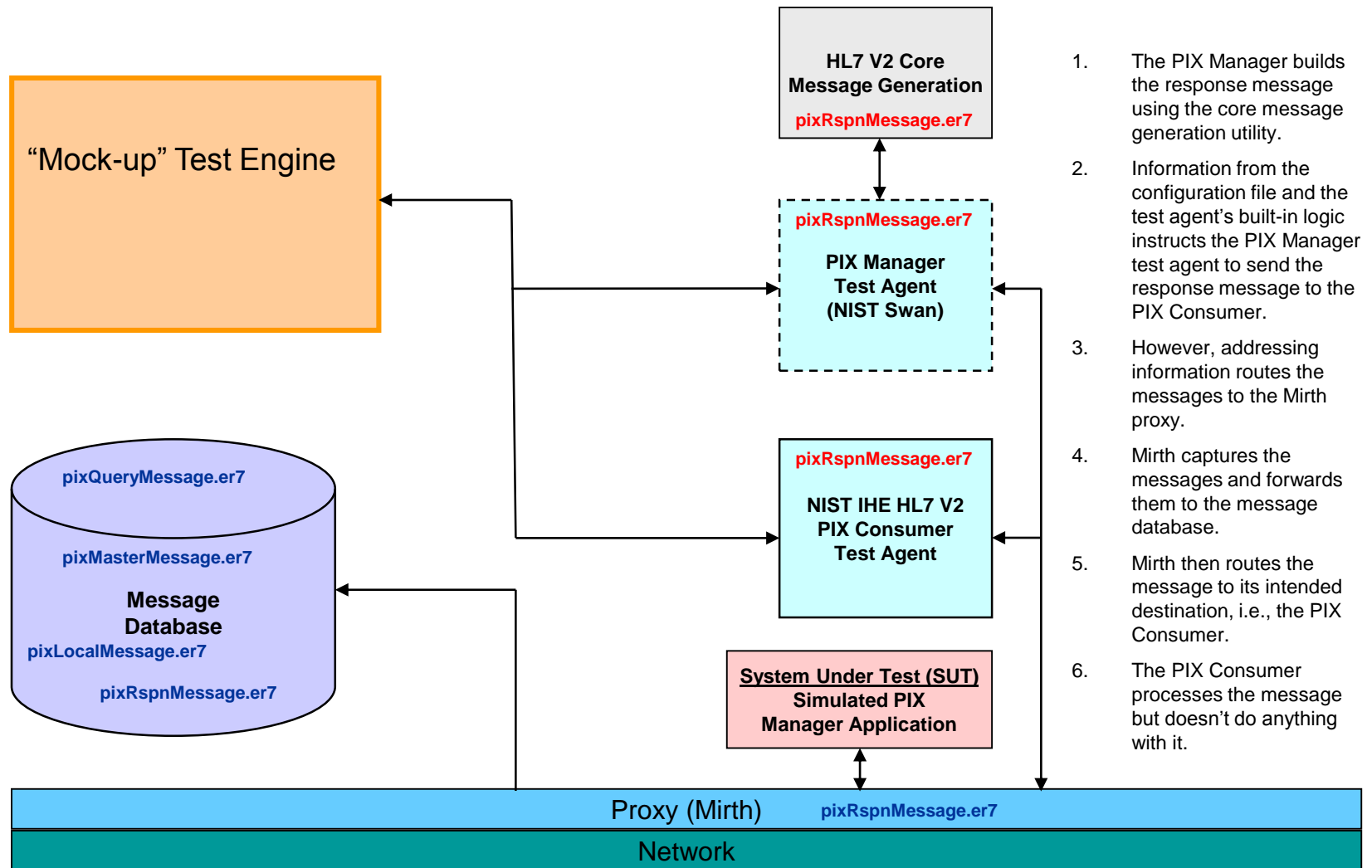
Push a test message to the PIX Source Test Agents



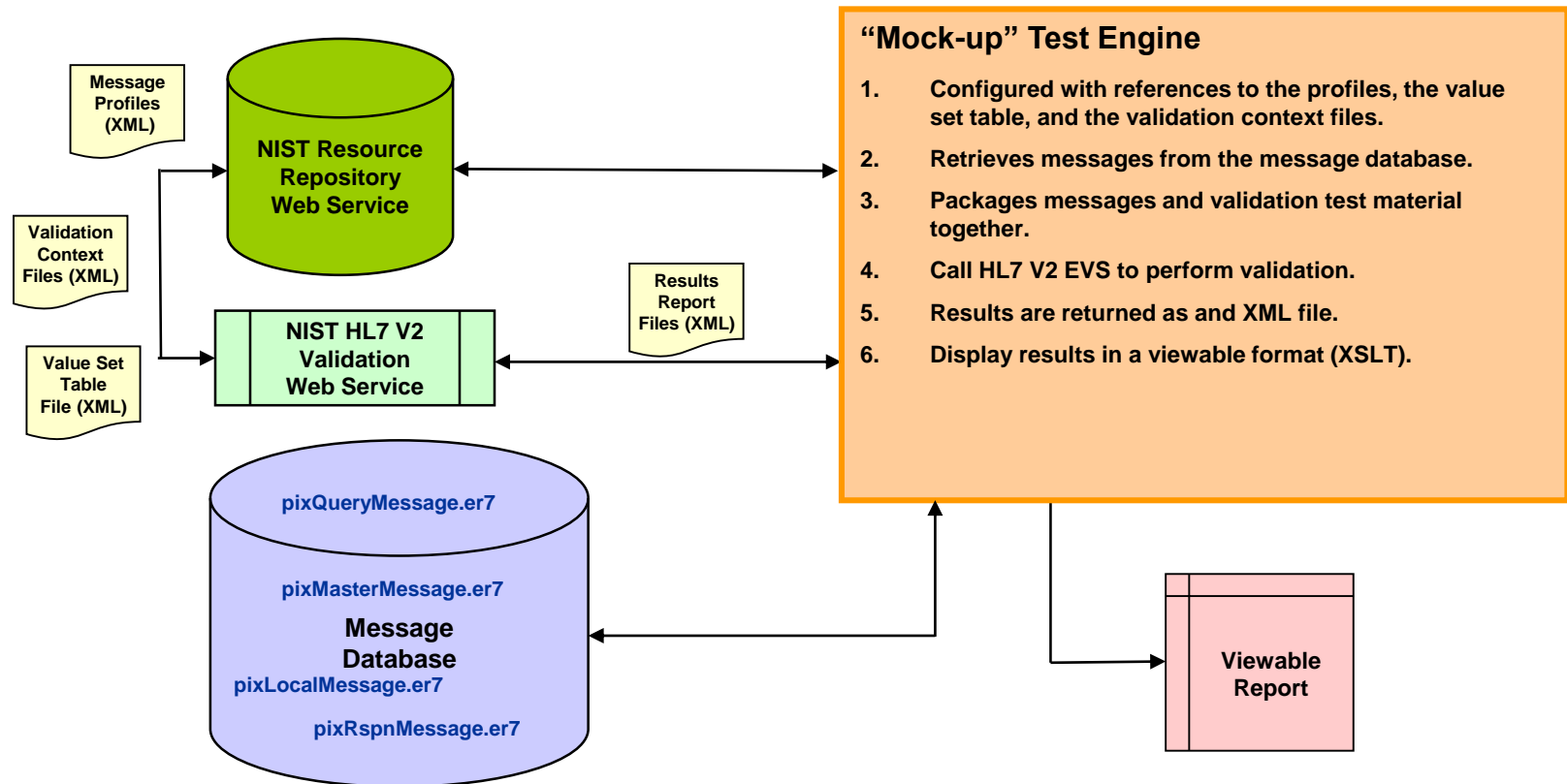
PIX Consumer Queries PIX Manager



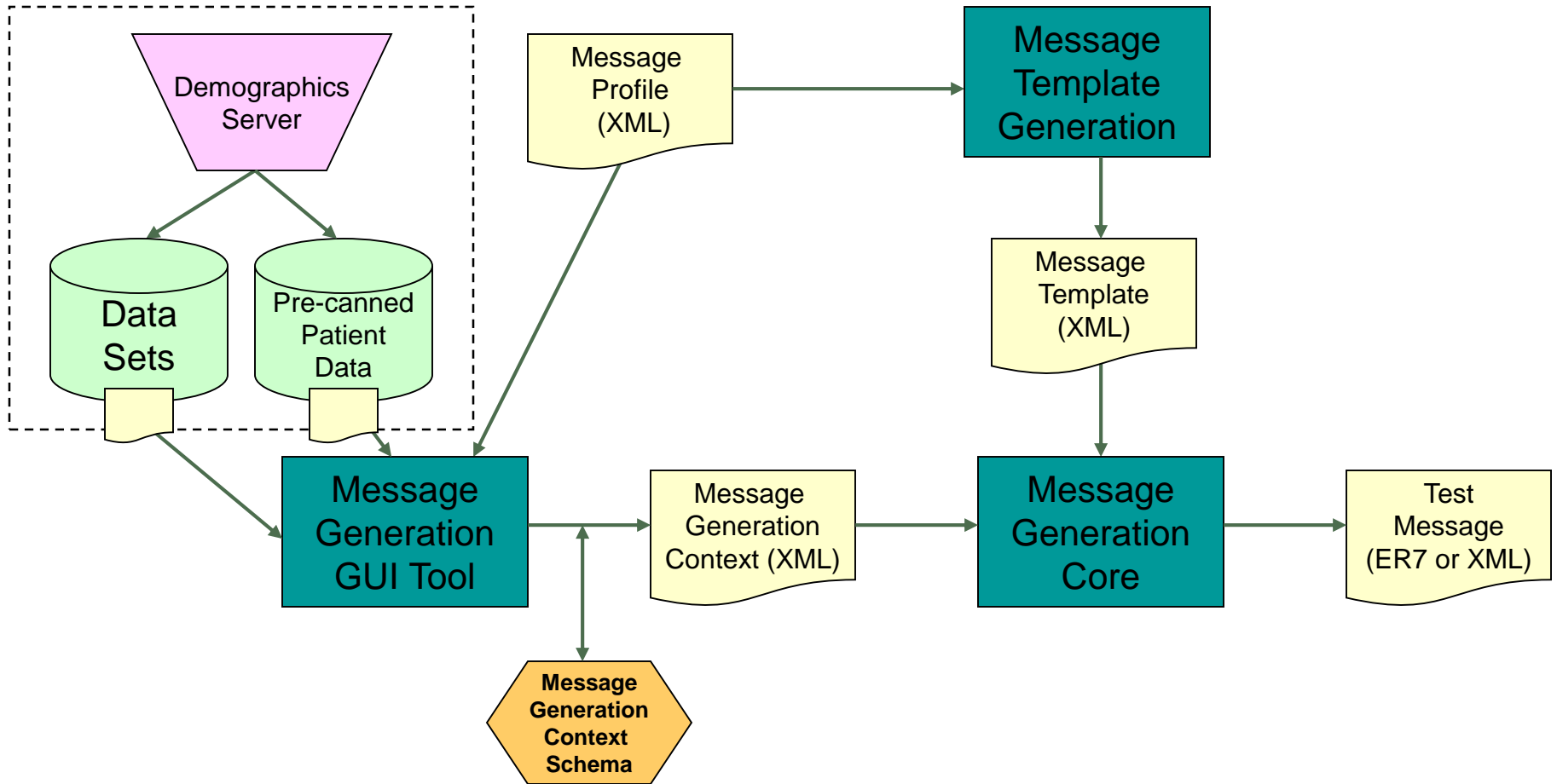
PIX Manager sends Response Message



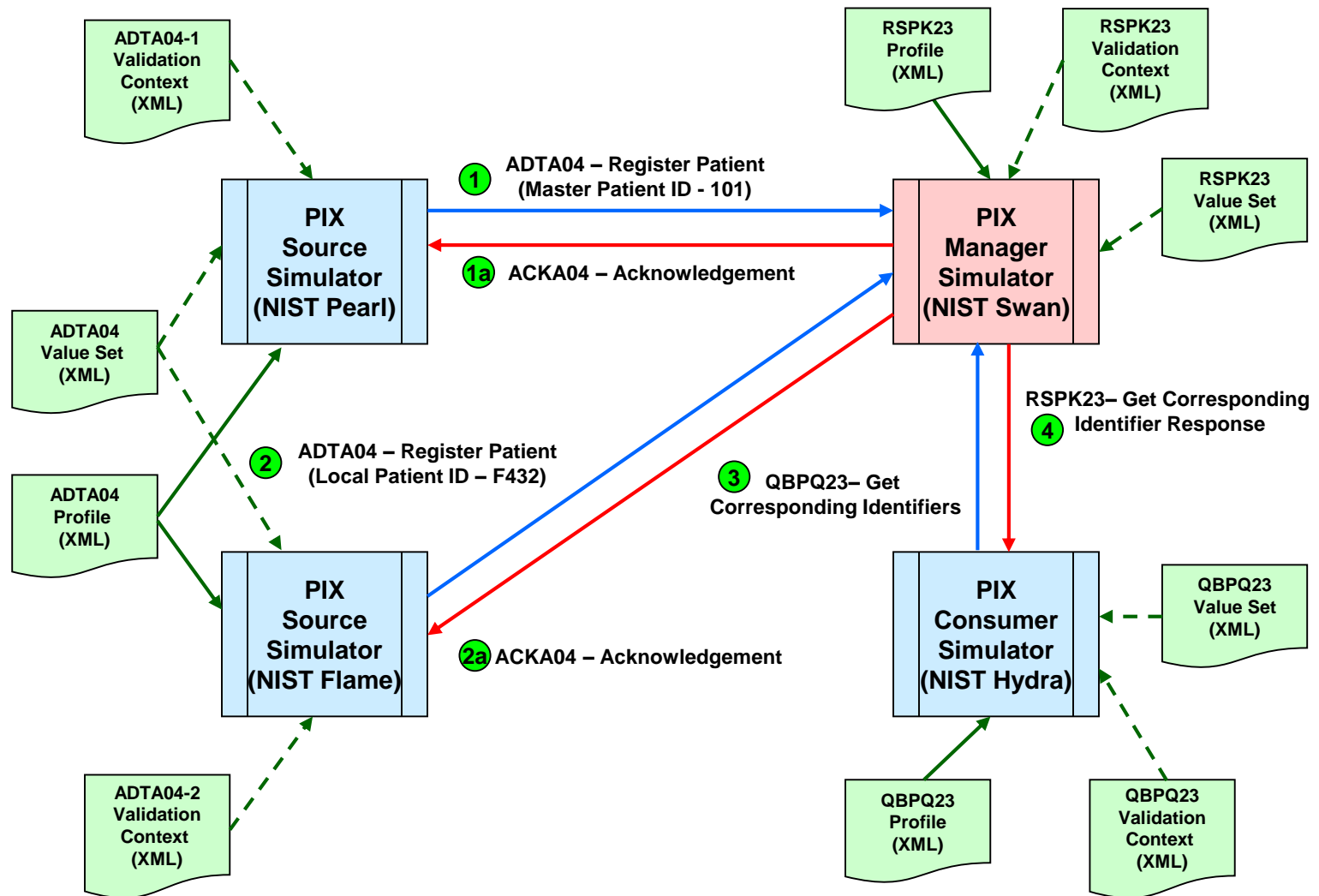
Analyze Results



Message Validation Design



Support Files for Validation



PIX Manager: Message Validation Context File

```
<?xml version="1.0" encoding="UTF-8" ?>
<NIST_HL7_V2_ValidationContextDefinition>
<FailureInterpretation>
  <Failure Type="VERSION" Level="ERROR" />
  <Failure Type="LENGTH" Level="IGNORE" />
  <Failure Type="DATATYPE" Level="ERROR" />
  <Failure Type="MESSAGE_STRUCTURE" Level="ERROR" />
  <Failure Type="MESSAGE_STRUCTURE_ID" Level="ERROR" />
  <Failure Type="DATA" Level="ERROR" />
  <Failure Type="MESSAGE_VALIDATION_CONTEXT" Level="USER" />
</FailureInterpretation>
<MessageInstanceSpecificTests>
<!-- PIX Manager RSP K23 -->
<!-- MSH 3.1 -->
<DataValidationLocationItem>
  <Segment Name="MSH" InstanceNumber="1" />
  <Field Name="Sending Application" InstanceNumber="1" />
  <Component Name="namespace ID" InstanceNumber="1" />
  <Value>NIST Swan PIX Manager</Value>
</DataValidationLocationItem> <!-- MSH 4.1 -->
<DataValidationLocationItem>
  <Segment Name="MSH" InstanceNumber="1" />
  <Field Name="Sending Facility" InstanceNumber="1" />
  <Component Name="namespace ID" InstanceNumber="1" />
  <Value>NIST Swan</Value>
</DataValidationLocationItem> <!-- MSH 5.1 -->
<DataValidationLocationItem>
  <Segment Name="MSH" InstanceNumber="1" />
  <Field Name="Receiving Application" InstanceNumber="1" />
  <Component Name="namespace ID" InstanceNumber="1" />
  <Value>NIST Hydra PIX Consumer</Value>
</DataValidationLocationItem> <!-- MSH 6.1 -->
```

```
<!-- PID 3.1 -->
<DataValidationLocationItem>
  <Segment Name="PID" InstanceNumber="1" />
  <Field Name="Patient Identifier List" InstanceNumber="1" />
  <Component Name="ID" InstanceNumber="1" />
  <Value>101</Value>
</DataValidationLocationItem> <!-- PID 3.4.1 -->
<DataValidationLocationItem>
  <Segment Name="PID" InstanceNumber="1" />
  <Field Name="Patient Identifier List" InstanceNumber="1" />
  <Component Name="assigning authority" InstanceNumber="1" />
  <SubComponent Name="namespace ID" InstanceNumber="1" />
  <Value>IHENA</Value>
</DataValidationLocationItem> <!-- PID 3.4.2 -->
<DataValidationLocationItem>
  <Segment Name="PID" InstanceNumber="1" />
  <Field Name="Patient Identifier List" InstanceNumber="1" />
  <Component Name="assigning authority" InstanceNumber="1" />
  <SubComponent Name="universal ID" InstanceNumber="1" />
  <Value>1.3.6.1.4.1.21367.2005.3.7</Value>
</DataValidationLocationItem> <!-- PID 3.4.3 -->
<DataValidationLocationItem>
  <Segment Name="PID" InstanceNumber="1" />
  <Field Name="Patient Identifier List" InstanceNumber="1" />
  <Component Name="assigning authority" InstanceNumber="1" />
  <SubComponent Name="universal ID type" InstanceNumber="1" />
  <Value>ISO</Value>
</DataValidationLocationItem>
```

Will need support to create the validation context files dynamically to support connectathon type testing. A GUI based tool is also needed to build initial validation context files.

PIX Scenario: Sample Validation Results File (XML)

- Common file to report results for all EVSs (final specification forthcoming)
- Sections for general, specific, and extended results
- Need to standardize on HL7 V2 reporting

```
<Error FailureType="DATA" FailureSeverity="NORMAL">
  <Description>The value 'K' specified in the message does not
  match any of the values in the table '0001' specified in the profile.
</Description>
  <Location>
    <Segment Name="PID" InstanceNumber="0" />
    <Field Name="Sex" InstanceNumber="1" />
    <Line>3</Line><Column>7</Column>
    <EPPath>PID[1].8</EPPath>
  </Location>
</Error>
<Error FailureType="DATA" FailureSeverity="NORMAL">
  <Description>The value 'NIST' at the given location in the
  message does not match the expected value 'NIST Pearl'.
</Description>
  <Location>
    <Line>4</Line><Column>7</Column>
  </Location>
</Error>
<Error FailureType="DATA" FailureSeverity="NORMAL">
  <Description>The value " at the given location in the
  message does not match the expected value 'P'.
</Description>
  <Location>
    <Line>4</Line><Column>7</Column>
  </Location>
</Error>
<Error FailureType="DATA" FailureSeverity="NORMAL">
  <Description>The value '999101' at the given location in the
  message does not match the expected value '101'.</Description>
  <Location>
    <Line>4</Line> <Column>7</Column>
  </Location>
</Error>
<Error FailureType="DATA" FailureSeverity="NORMAL">
  <Description>The value 'badDate' at the given location in the
  message does not match the expected value '19781208'.
</Description>
  <Location>
```

PIX Scenario: Sample Validation Results

File (HTML)

Message Validation Report

Date: 2008-06-19T17:52:42.809-04:00

Profile	Name	PIF
	Id	1.2.814.99999.1.349
	Type	ADT*A04*ADT_A01
	HL7 Version	2.3.1
	File	PAT_IDENTITY_SRC-ITI-8-ADT_A04-ADT_A04.xml

Message	Type	ER7
	Id	
	File	Error_1_pixSourceM to pixManager.er7

Failure Type	Failure Level
VERSION	ERROR
MESSAGE_STRUCTURE	ERROR
LENGTH	IGNORE
CARDINALITY	ERROR
USAGE	ERROR
DATATYPE	ERROR
MESSAGE_VALIDATION_CONTEXT	USER
DATA	ERROR
TABLE_NOT_FOUND	USER
AMBIGUOUS_PROFILE	ERROR
MESSAGE_STRUCTURE_ID	ERROR

Message Validation Results	Errors	10
	Warnings	0
	Ignored	17
Other Warnings	Missing Tables	0
	Context Errors	0

Error Details

1	Type:	Data
	Description:	The value 'NIST' specified in the message does not match any of the values in the table '0300' specified in the profile.
	Location:	Canonical Form: MSH[1].4.1

3	Type:	Cardinality
	Description:	MSH[1].11 is present 0 times whereas it must be present at least 1 times
	Location:	Canonical Form: MSH[1].11
	Segment:	MSH
	Field:	Processing ID
4	Type:	Datatype
	Description:	The value 'badDate' is not valid with respect to the format specified for datatype 'NM'
	Location:	Canonical Form: PID[1].7.1
	Segment:	PID
	Field:	Date/Time Of Birth
	Component:	Date/Time
5	Type:	Data
	Description:	The value 'K' specified in the message does not match any of the values in the table '0001' specified in the profile.
	Location:	Canonical Form: PID[1].8
	Segment:	PID
	Field:	Sex
6	Type:	Data
	Description:	The value 'NIST' at the given location in the message does not match the expected value 'NIST Pearl'.
7	Type:	Data
	Description:	The value " at the given location in the message does not match the expected value 'P'.
8	Type:	Data
	Description:	The value '999101' at the given location in the message does not match the expected value '101'.
9	Type:	Data
	Description:	The value 'badDate' at the given location in the message does not match the expected value '19781208'.
10	Type:	Data
	Description:	The value 'K' at the given location in the message does not match the expected value 'M'.

Resources

■ Cypress

- ❑ Google group (cypress-tools@googlegroups.com)
- ❑ Wiki (<http://collaborate.nist.gov/twiki-cypress/bin/view/Cypress/WebHome>)
- ❑ Contact: Rob Snelick (rsnelick@nist.gov)

■ Gazelle

- ❑ Google group (ihe-gazelle-software@googlegroups.com)
- ❑ Wiki
(<http://ihewiki.wustl.edu/wiki/index.php/Gazelle>)
- ❑ Contact: Steve Moore (moores@mir.wustl.edu)