IHE EUROPE | Integrating the Healthcare Enterprise

Validation Tools for Connectivity Testing

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Objectives

- Introduction
- Validation Tools
- Simulation Tools
- Supporting tools (data generation, data capture…)
- Test Management tools

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INTRODUCTION

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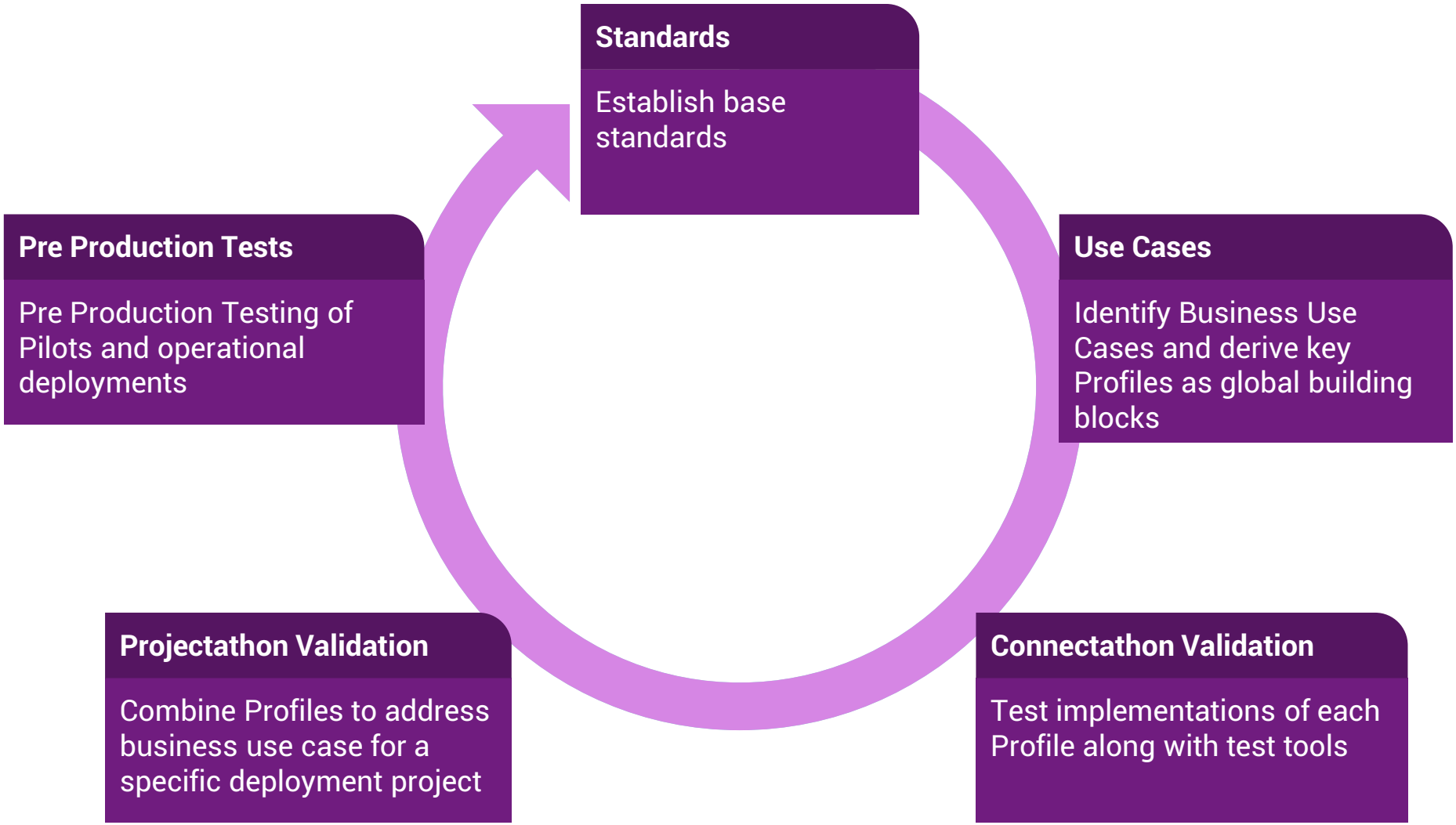
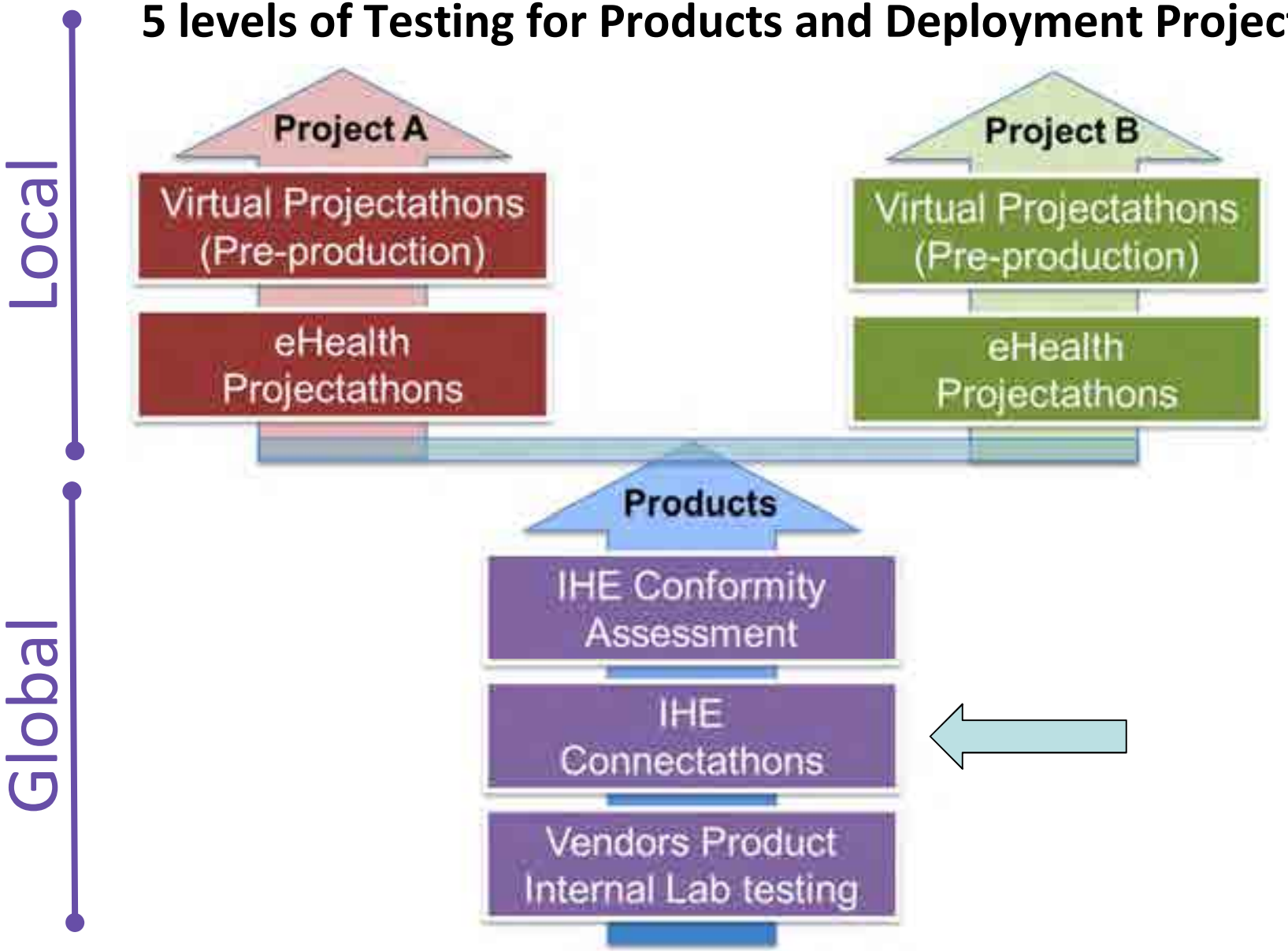
Realizing Interoperability is about teamwork



Gazelle: for the overall testing continuum

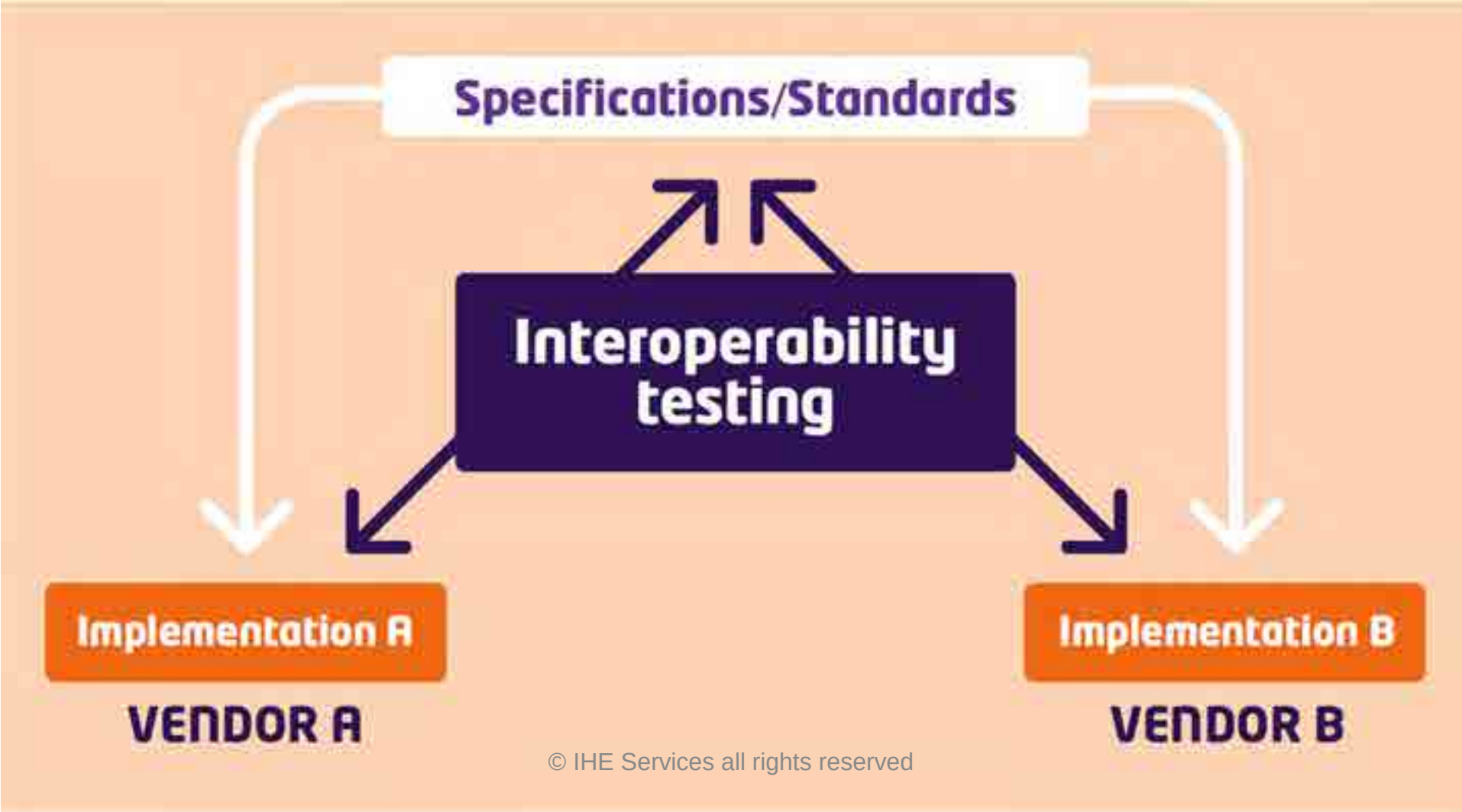
5 levels of Testing for Products and Deployment Projects




Connectathon
Bern 2012
Istanbul 2013
Vienna 2014
Vienna 2017

- Open invitation to vendor and other implementers community
- Advanced testing tools (GAZELLE, a GITB platform)
- Testing organized and supervised by project management team and monitors
- Thousands of cross-vendor tests performed
- Results recorded and published

What is the Connectathon ?



The secrets behind the IHE Connectathon

- It all starts with an interoperability problem faced by users (clinicians, health authorities, provider organizations) and engaging the vendors➔ Use Case
- Use case(s) are transformed by IHE Domains Committees (IHE International) into one or more IHE Profiles, a standards based detailed specification.
- Connectathon Participants have to bring an implementation of one or more IHE Profiles. It is not about evaluation of emerging standards (e.g. *HL7 FHIR Connectathon*) nor a hack-a-thon (*invent as you implement*).
- Participants have to pass “pre-connectathon tests” before showing up here, and here they are to follow the test plans set by IHE, that are monitored for correct execution.

Quality in Interoperability is strategic

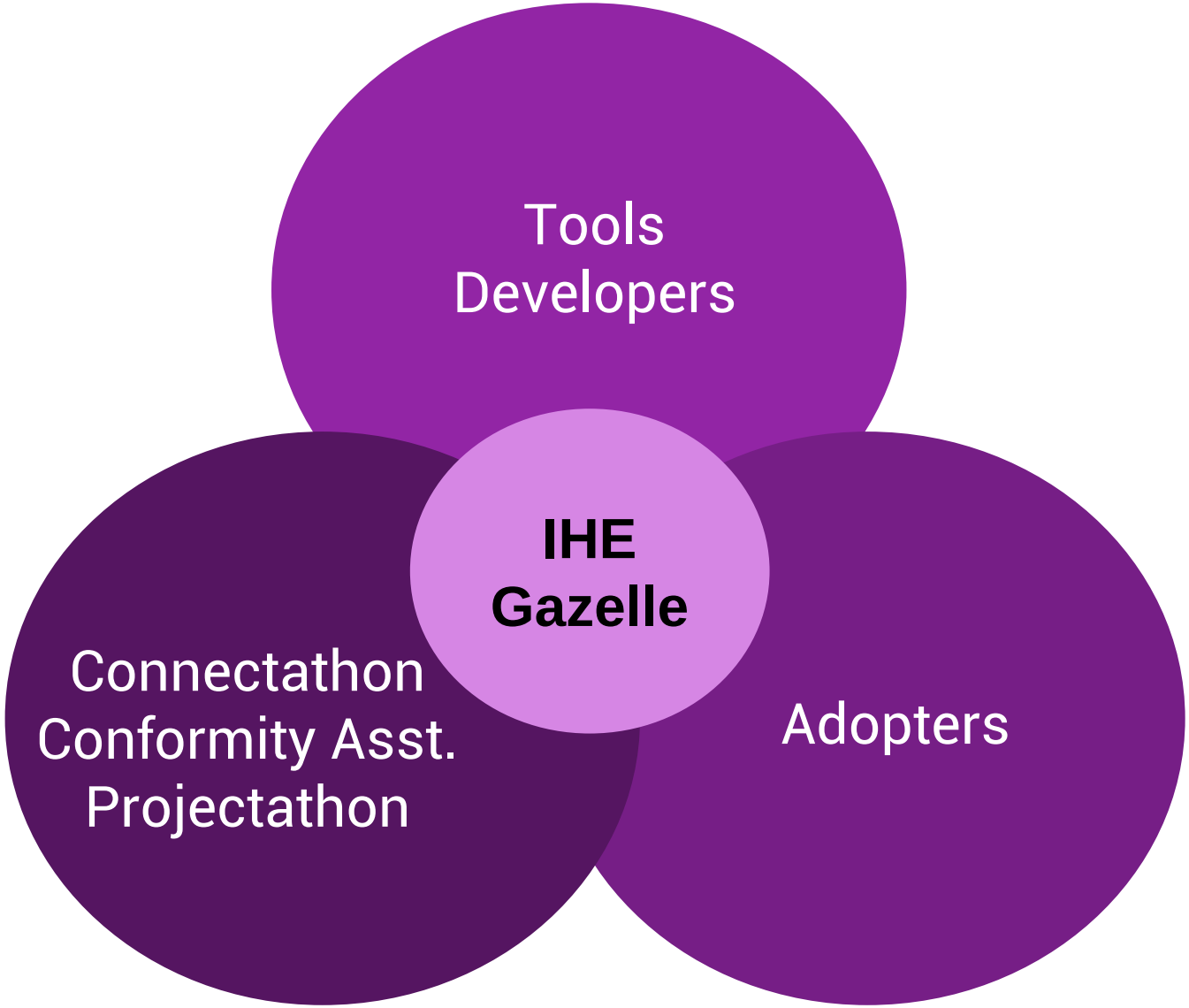
- Testing rigor is driven by:
  - Follow the Gazelle driven predefined test plans
  - Participants have to test with at least three different other parties
  - Testing is overseen and results validated by neutral “monitors”
  - All testing (incl. bugs) is tracked and orchestrated by the Gazelle Test Management Platform
- Connectathon Participants are undergoing a culture change:
  - You can only succeed if you collaborate with the other vendors
  - Others can help you better understand the profiles and underlying standards
  - It is more effective to comply with a profile to address your customers needs (while keeping some flexibility)

Meeting new challenges in 2020
Restructuring the Connectathon to be Online

20 plus years of experience with face-to-face Connectathon needs to be ***re-invented as an online*** process:

- Face-to-face facilitates building trust among the participants, collaboration is critical, we cannot afford to loose those critical ingredients by moving online.
- New challenges arise:
  - Creating physical connectivity, as simple as being on a local area network, when you have Internet, firewalls, cyberthreats, exposed product interfaces, performance
  - Each testing participant has to interact with hundreds of other participants, tens of monitors, and….
  - synchronize with the Gazelle tool, get impromptu support and solution to their issues to progress.
  - This is well beyond the typical video conferencing and chat tools of today.
  - And the challenges we will discover this week….

Gazelle: Test Platform Communities Ecosystem

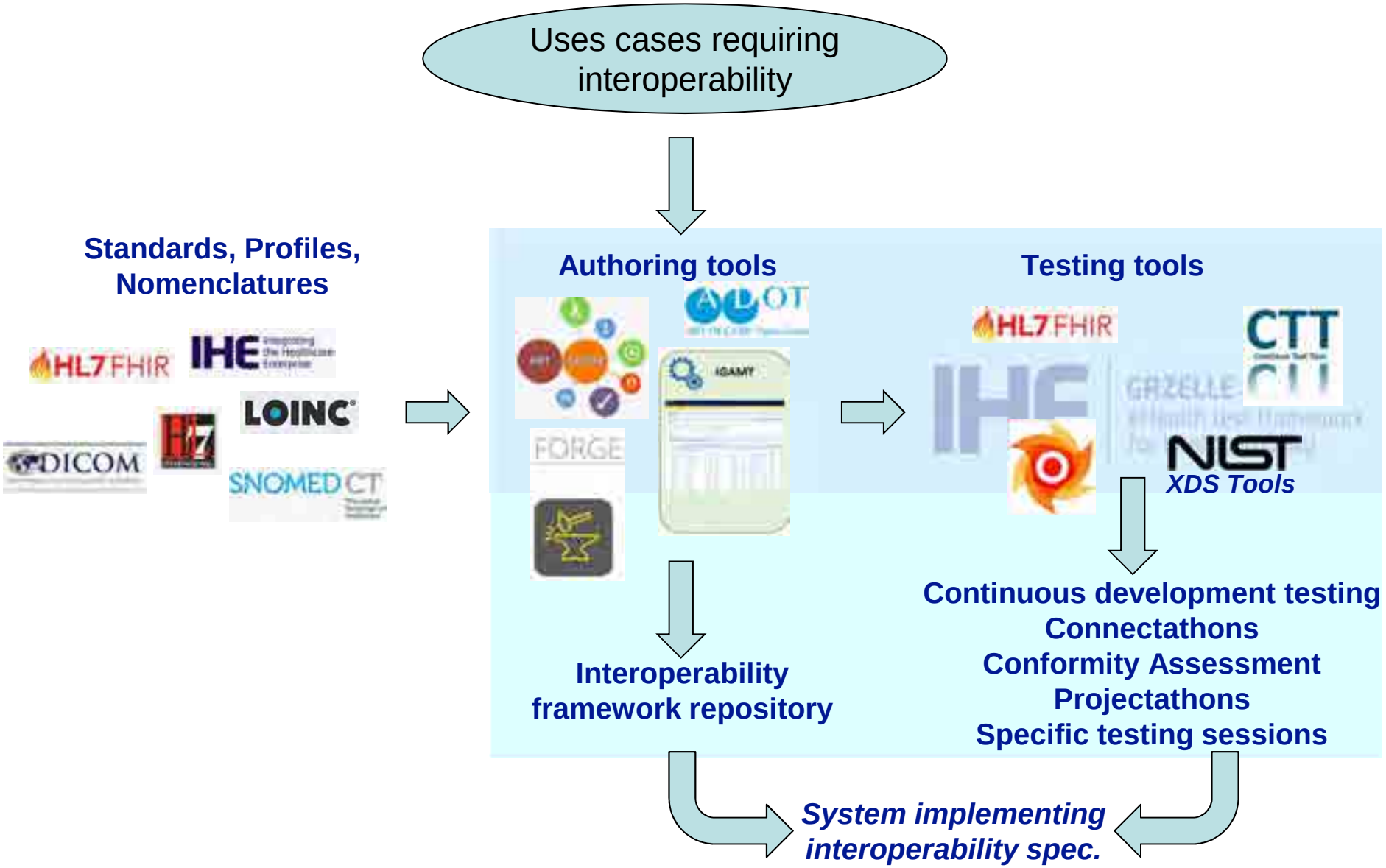


Why Gazelle?

- Gazelle was born to automate testing during IHE Connectathons
  - Test management suite
  - Robust: over 400 simultaneous users, three times each year
- Automates interactions and content checks (documents, APIs, messages, tokens, etc), across diverse standards
- Simulates actors and transactions from IHE Profiles
- Integrates open source third party tools into one unique end user environment
- Integrates testing with specification authoring tools (CDA/Art-décor/Object Checker, HL7V2/IGAMT, ATNA/Audit Events, etc.)
- Links test plans back to specifications
- Bi-yearly updates supported by a stable core maintenance team

➔ Gazelle is an Ecosystem

Gazelle Ecosystem



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GAZELLE IN NUMBERS

Gazelle in Numbers

- > 14 years of development (Jboss 4, 5, 7)
- > 40 IHE Connectathon/Projectathon (USA, EU, Japan, China, Korea, Ireland, Swiss…)
- Ca 2M lines of code (https://www.openhub.net/p/ihe-gazelle)
- > 100 FTE invested
- Used with >400 simultaneous users
- > 700 vendors using it
- > 800 test cases
- >1500 users
- >35000 CDA validations
- >50000 test instances verified
- …

Gazelle Instances (2019)

Used by 11 national & 3 regional ehealth programs, 5 vendors internal labs, 5 IHE Connectathons

1. Arsenal.IT (Italy Venice Region)
2. Abrumet-Brussels eHealth (Belgium)
3. Insiel SPA (Italy)
4. InteropSanté - France
5. GE
6. Agfa
7. Medical PHIT (NL)
8. Technikum Wien (Austria)
9. IHE USA
10. IHE-Europe
11. IHE China
12. IHE Japan
13. Agence eSanté-Luxembourg
14. InterAMC France
15. eHealth Finland
16. eHealthSuisse & Federal MoH
17. eHealthPlatform Belgium
18. EU DG Santé-European Cross Border
19. Sequoia-USA
20. EFS-French Blood Transfusion-France
21. Saudi Arabia eHealth: SHC-KSA
22. Ireland eHealth (HSE)
23. French ehealth (ASIP)

Gazelle in Numbers

- 5 Running instances (for IHE)
  - USA, Europe, Japan, Korea, China
- Running instances (non IHE specific projects) EP2
  - Arsenàl IT (I),
  - Agence Nationale Santé (ANS), (F)
  - Agence eSanté Luxembourg (L)
  - eHealth Brussels (B),
  - DG Santé (EU commission)
  - Kela Finland (FI),
  - Sequoia Project (USA)
  - eHealthSuisse (CH)
  - Technikum Universität Wien (AT)
  - Inter-AMC (F)
  - Etablissement Français du Sang (EFS) (F)
  - InteropLab (NL)
  - Insiel (I)
- Running instances on vendor facilities
  - Agfa (B), GE (India)
- Used by Vendors for Continuous integration
  - Rough idea but no real figure (Cpage at least)

Slide 18

EP2 Alexander peux-tu mettre à jour si besoin la liste si dessous? En particulier je ne suis pas certain d'être à jour avec les installation belges et néerlandaises.... Dans le contexte ça peut-etre utile. Merci.

Eric Poiseau, 26/10/2020

- Gazelle
  - a **test management** tools oriented toward interoperability & conformance testing
  - a suite of IHE actors **simulators**
  - a suite of IHE **conformance checking** tools
  - a suite of tools for testing support
    - Tools for data generation
    - Tools for automation of testing

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Outline

- Gazelle Architecture
- Validation tools
  - HL7v2 messages validator
  - CDA document validator
  - Audit message validator
  - Gazelle X Validator
  - Use of WS for CI
- Simulators
  - Patient Manager Simulator
  - Order Manager Simulator
  - Gazelle Security Suite
  - XDS Tools
- Test Supporting tools
  - Gazelle Proxy
  - Gazelle SVS Simulator
  - Gazelle DDS
- Gazelle Test Management & Connectathon
- Conformity Assessment testing

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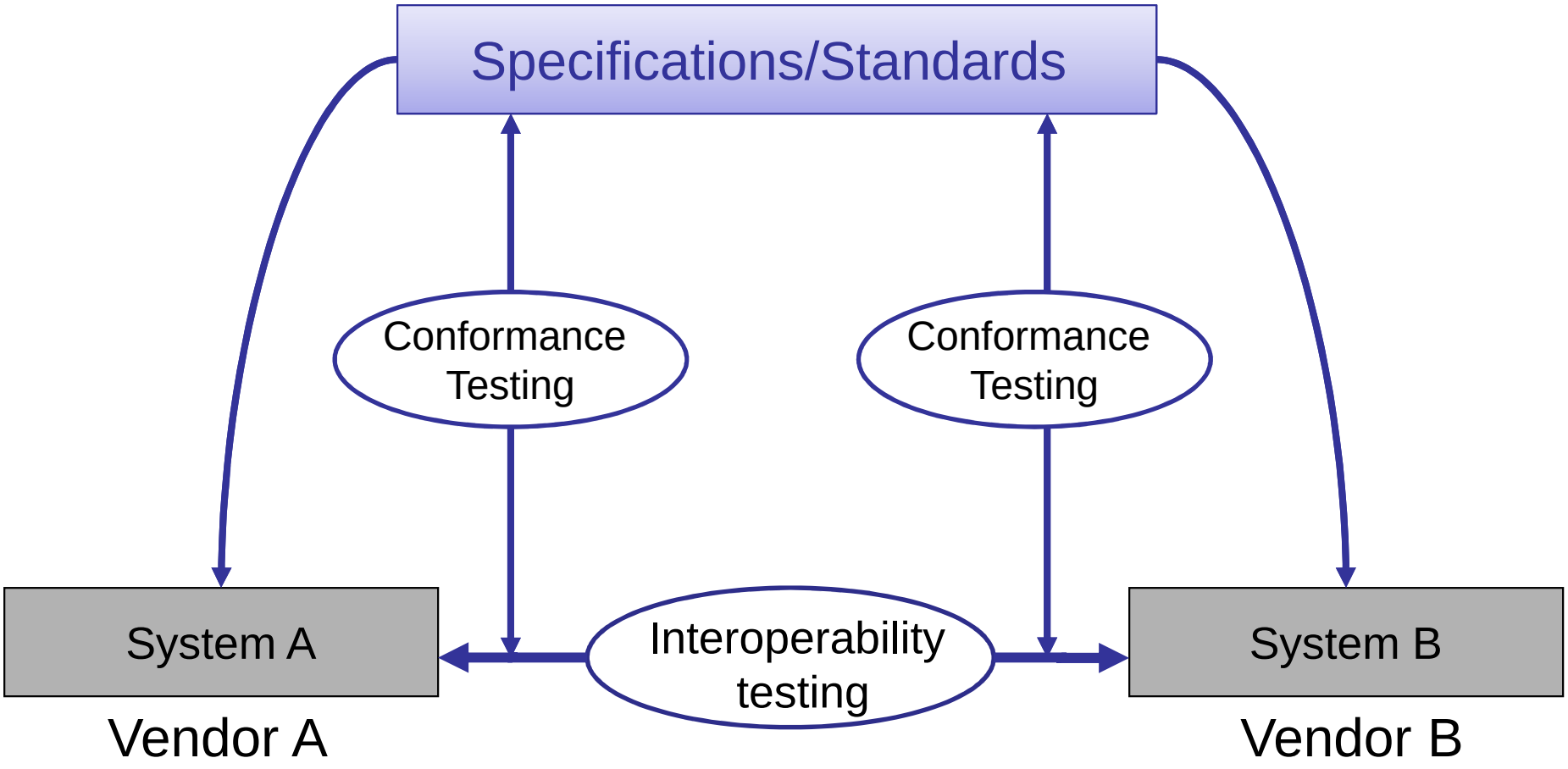
GAZELLE TEST BED ARCHITECTURE

Introduction

- A set of tools for testing the interoperability and the conformance of eHealth Information Systems
  - For IHE connectathon
  - For Vendors implementing eHealth Standards
  - For Users deploying and using eHealth Information Systems
  - For conformity assessment testing

- Developed in Rennes for IHE
  - 2001-2006 → KUDU a test management tool based on PHP + Postgresql (University of Rennes 1 + INRIA)
  - 2006-2011 → Gazelle, 2nd generation, INRIA
  - 2011-today → transfer of development team to Kereval

Conformance / Interoperability Testing



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THREE TIER MODEL

Three-tier architecture

- Logic :
  - **Validators**
  - **Simulators**
  - Test Management
- Model:
  - UML models (XML documents validation)
  - HL7 Message profiles
  - Concepts
  - Test Definitions
- Data:
  - Value sets
  - Simulated data
  - Coded values

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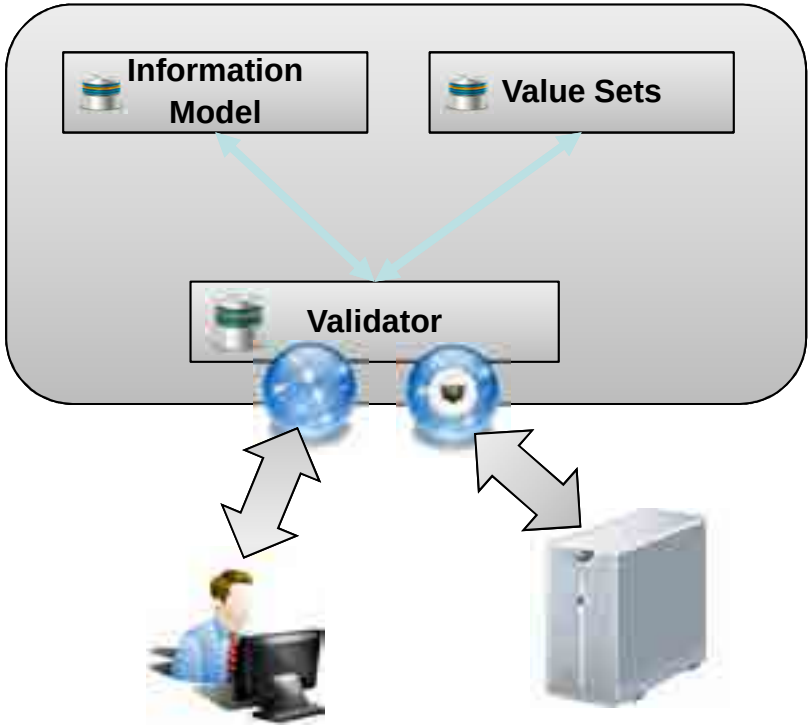
CONFORMANCE CHECKING TOOLS

Conformance Checking tools

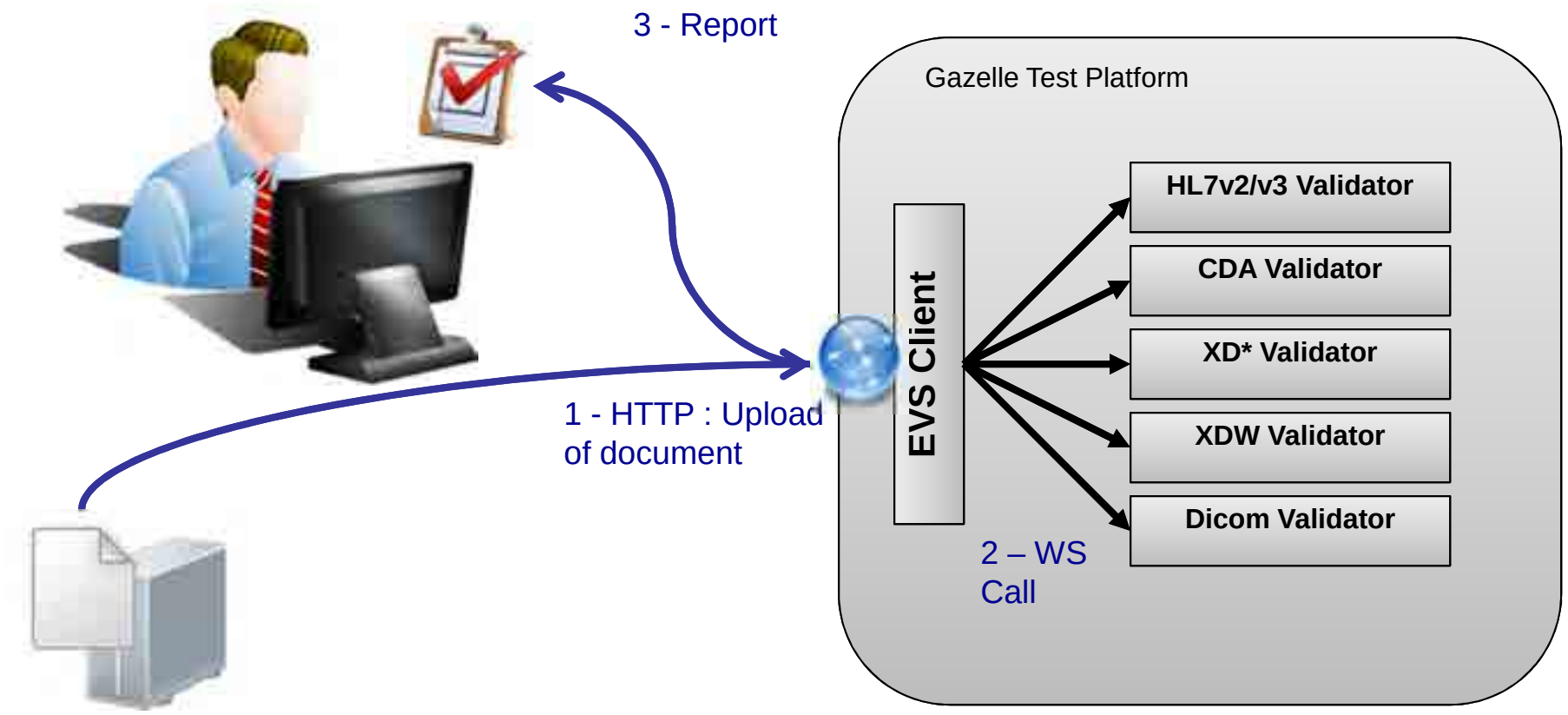
- Goal
  - Verify that messages/documents are conform with the specifications
- Target
  - Developers
  - Testers
  - Other tools like simulators
- Interface
  - GUI for users
  - Web services for tools



Existing tools

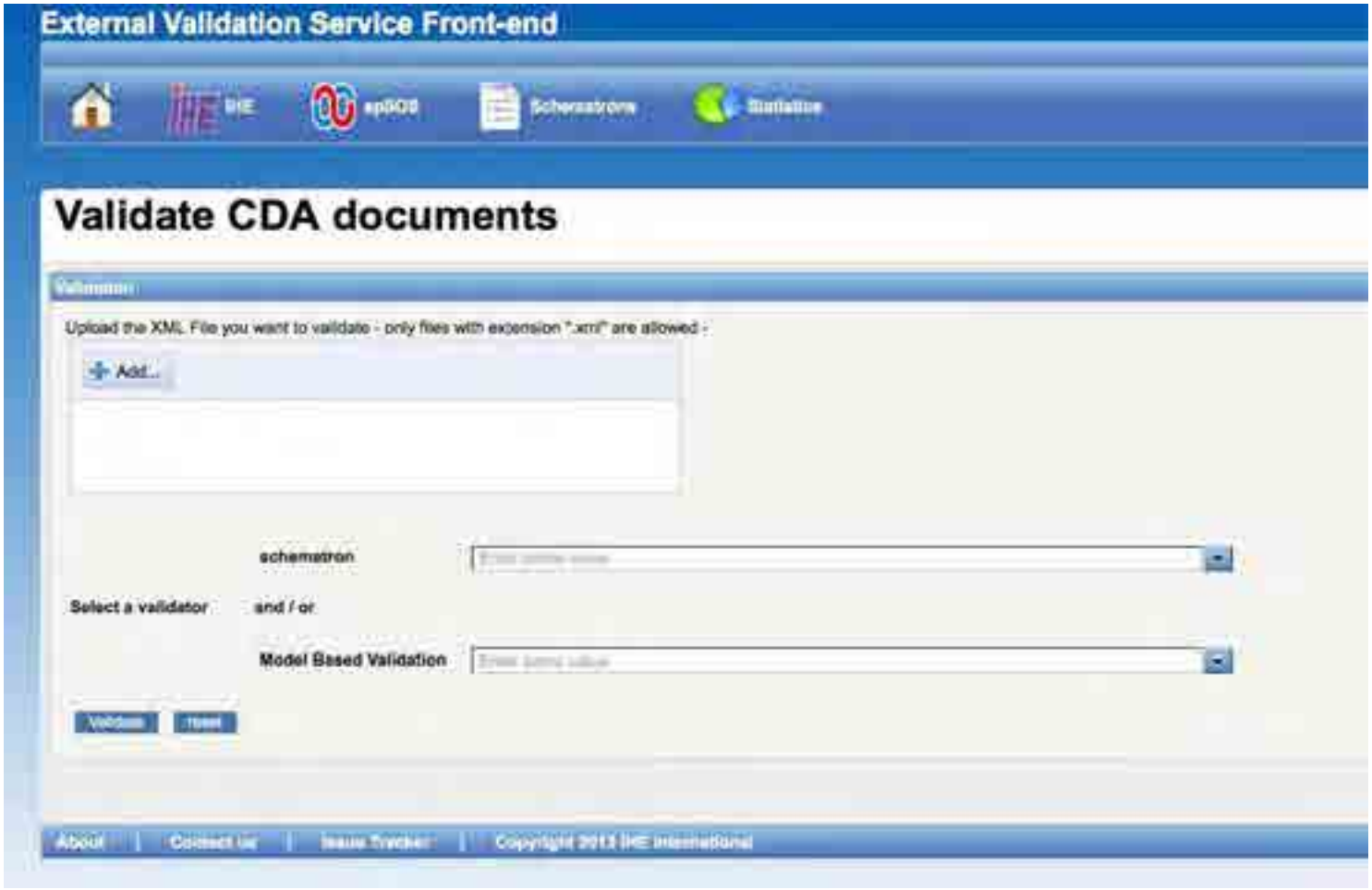
- HL7 CDA Structured Document (ObjectsChecker)
- HL7v2, HL7v3, FHIR
- IHE XD* transactions
- Sharing Value Set content
- Workflow documents
- ATNA audit messages
- X509 certificates
- SAML Assertions
- …

Standalone Document/Message Validation



- LINK DO VIDEO ON YOUTUBE
- https://www.youtube.com/watch?v=ae8KrRH0J_Q&list=PL41WsYuE9IdSWJXa5BdKZgqZ-zzkpGOCn&index=10&t=14s

Validation Tool Example : CDA Document



- CDA Validation tool for IHE / epSOS / ASIP /…
  - Link


Validation result
Validation test report including a summary of the results
Details of the validation, including tree of templates

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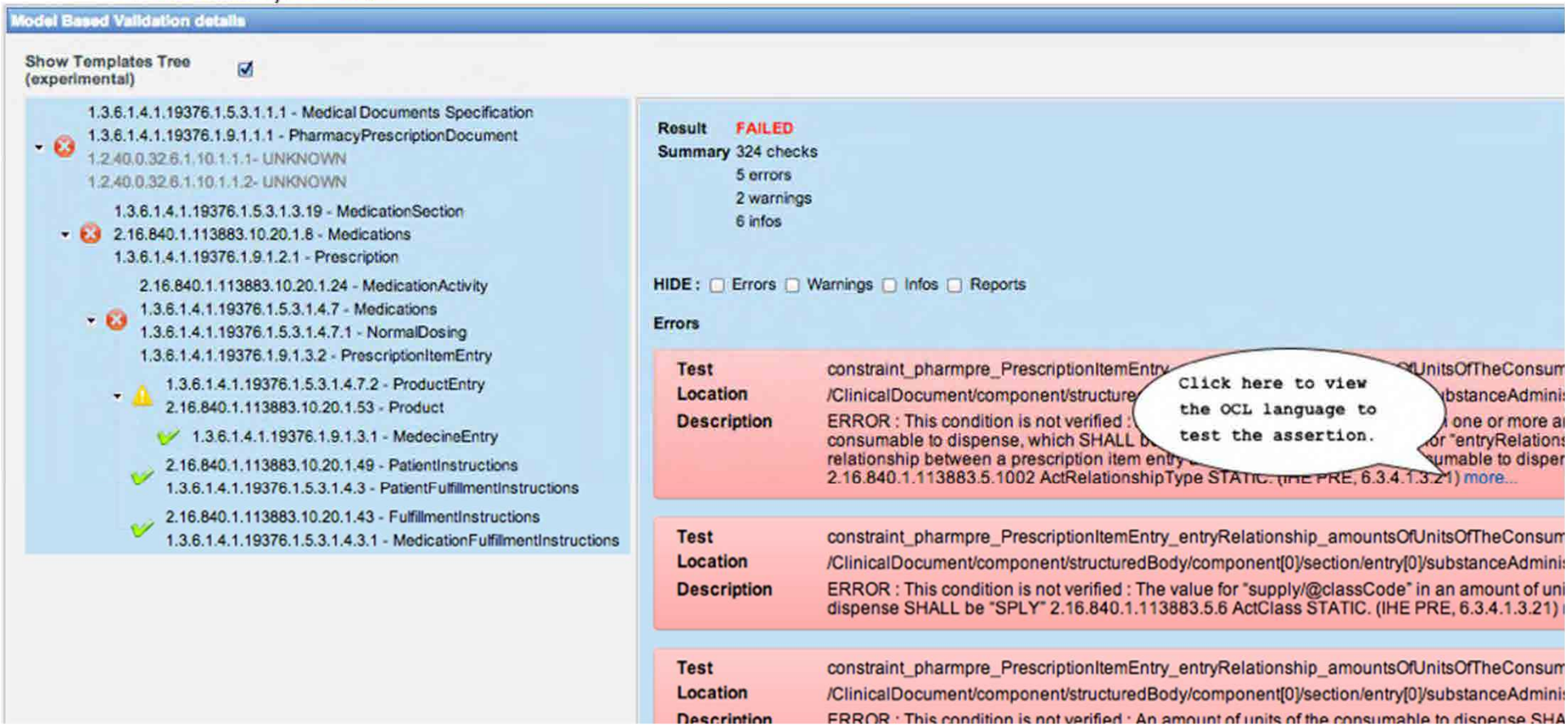

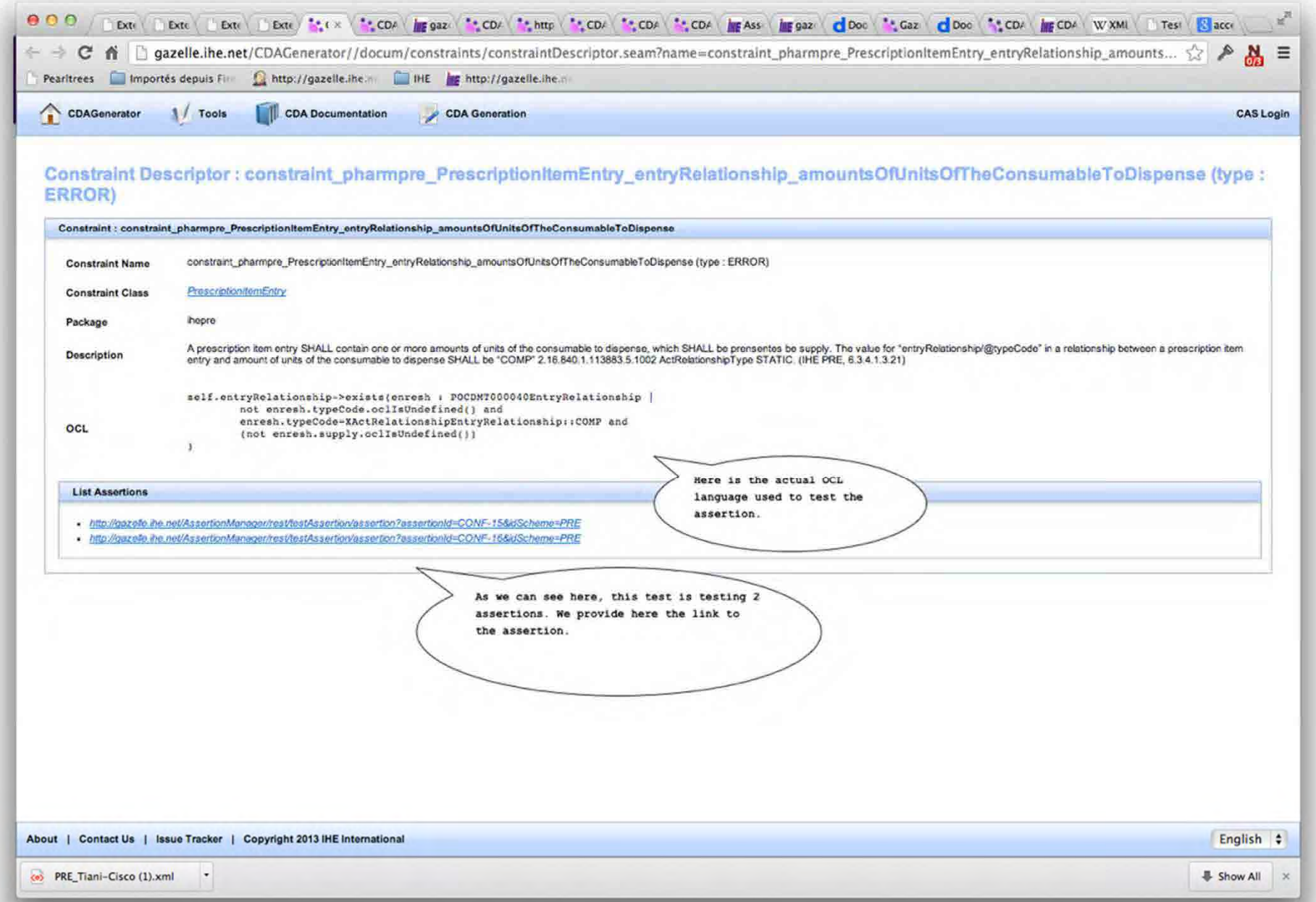
gazelle.ihe.net/CDAGenerator//docum/constraints/constraintDescriptor.seam?name=constraint_pharmpre_PrescriptionItemEntry_entryRelationship_amounts...
CDAGenerator
Tools
CDA Documentation
CDA Generation
CAS Login
Constraint Descriptor : constraint_pharmpre_PrescriptionItemEntry_entryRelationship_amountsOfUnitsOfTheConsumableToDispense (type : ERROR)
Constraint : constraint_pharmpre_PrescriptionItemEntry_entryRelationship_amountsOfUnitsOfTheConsumableToDispense
Constraint Name
constraint_pharmpre_PrescriptionItemEntry_entryRelationship_amountsOfUnitsOfTheConsumableToDispense (type : ERROR)
Constraint Class
PrescriptionItemEntry
Package
ihepre
Description
A prescription item entry SHALL contain one or more amounts of units of the consumable to dispense, which SHALL be prensentes be supply. The value for "entryRelationship/@typeCode" in a relationship between a prescription item entry and amount of units of the consumable to dispense SHALL be "COMP" 2.16.840.1.113883.5.1002 ActRelationshipType STATIC. (IHE PRE, 6.3.4.1.3.21)
OCL
self.entryRelationship->exists(enresh : POCDMT000040EntryRelationship |
not enresh.typeCode.oclIsUndefined() and
enresh.typeCode=XActRelationshipEntryRelationship::COMP and
(not enresh.supply.oclIsUndefined())
)
List Assertions
http://gazelle.ihe.net/AssertionManager/rest/testAssertion/assertion?assertionId=CONF-15&idScheme=PRE
http://gazelle.ihe.net/AssertionManager/rest/testAssertion/assertion?assertionId=CONF-16&idScheme=PRE
Here is the actual OCL language used to test the assertion.
As we can see here, this test is testing 2 assertions. We provide here the link to the assertion.
About | Contact Us | Issue Tracker | Copyright 2013 IHE International
English
PRE_Tiani-Cisco (1).xml
Show All

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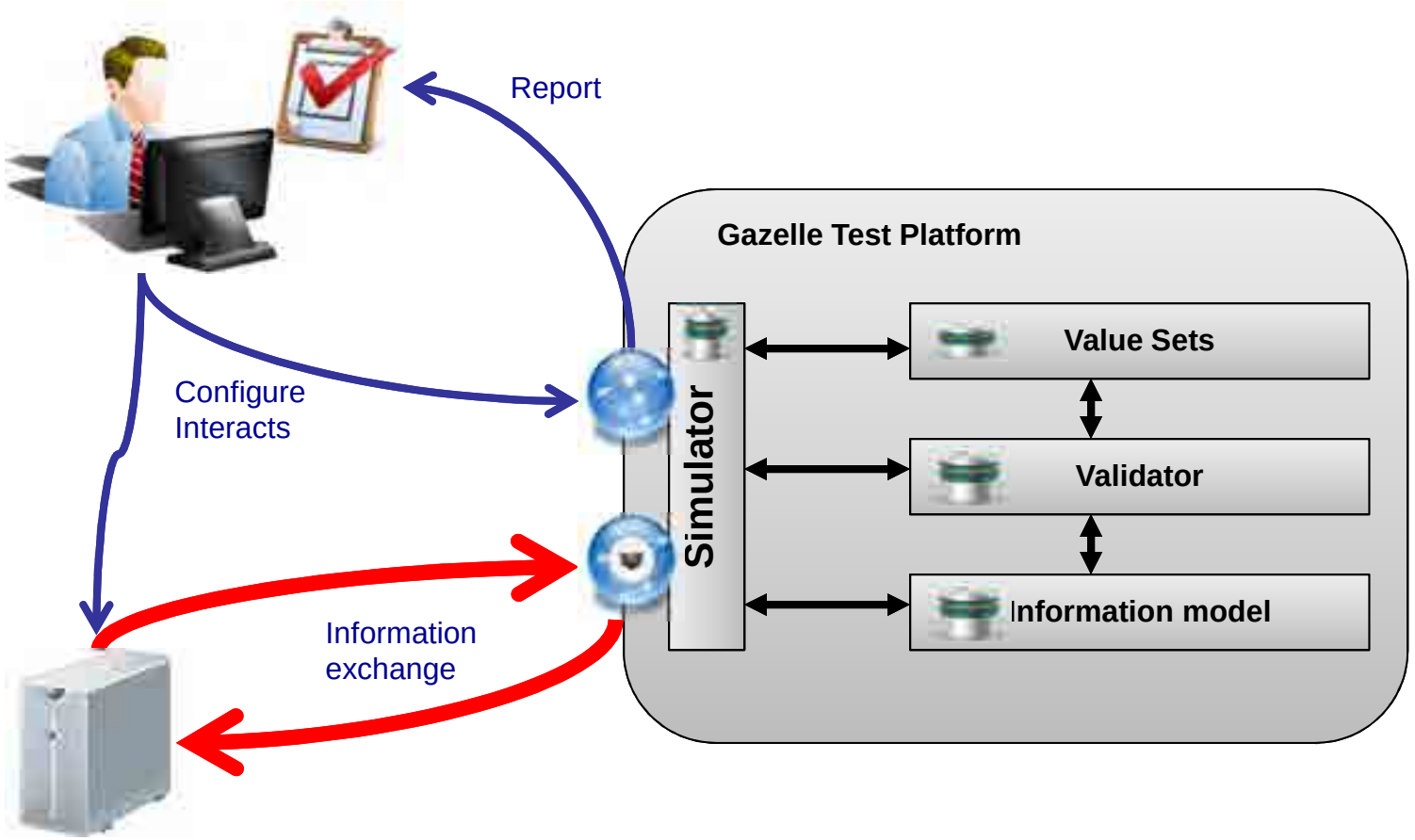
SIMULATORS

Simulator Tools

- Goal
  - Test the interoperability of an application
  - Simulator is not a reference implementation
  - Simulator controlled to perform test cases
- Target
  - Developers
  - Testers
- Interface
  - GUI for humans to interact with the tool
  - Network socket for the protocol tested
  - Web service to call validation tool,
  - Dynamic access to coded value set

Simulator Architecture



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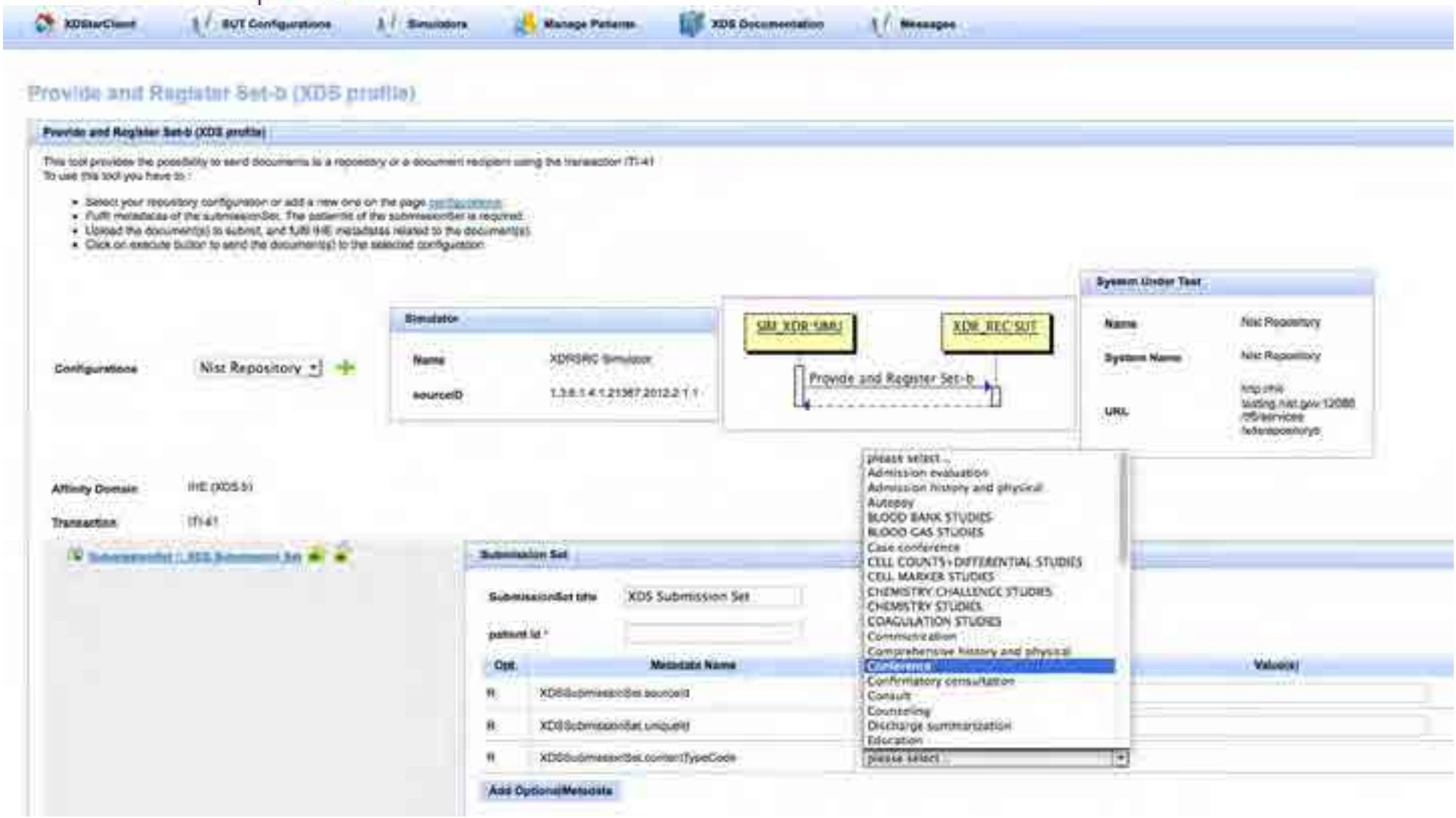

Existing Simulators

- XD* Suite of simulator
  - IHE and eHDSI
- Order Management
  - Radiology, Laboratory, Cardiology, Eyecare
- Patient Management
- Sharing Value Set
- Security (TLS)
- …

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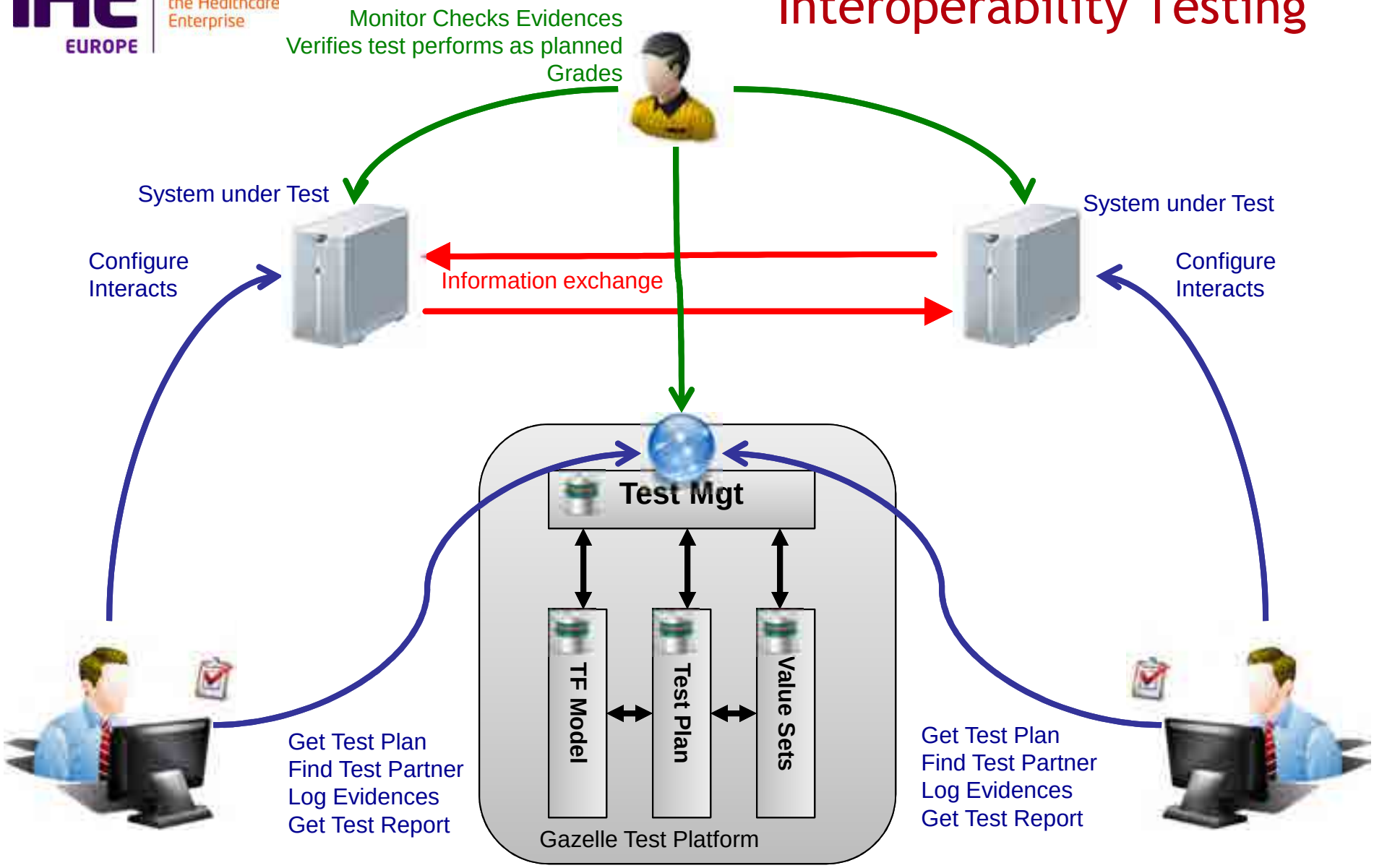
TEST MANAGEMENT TOOL

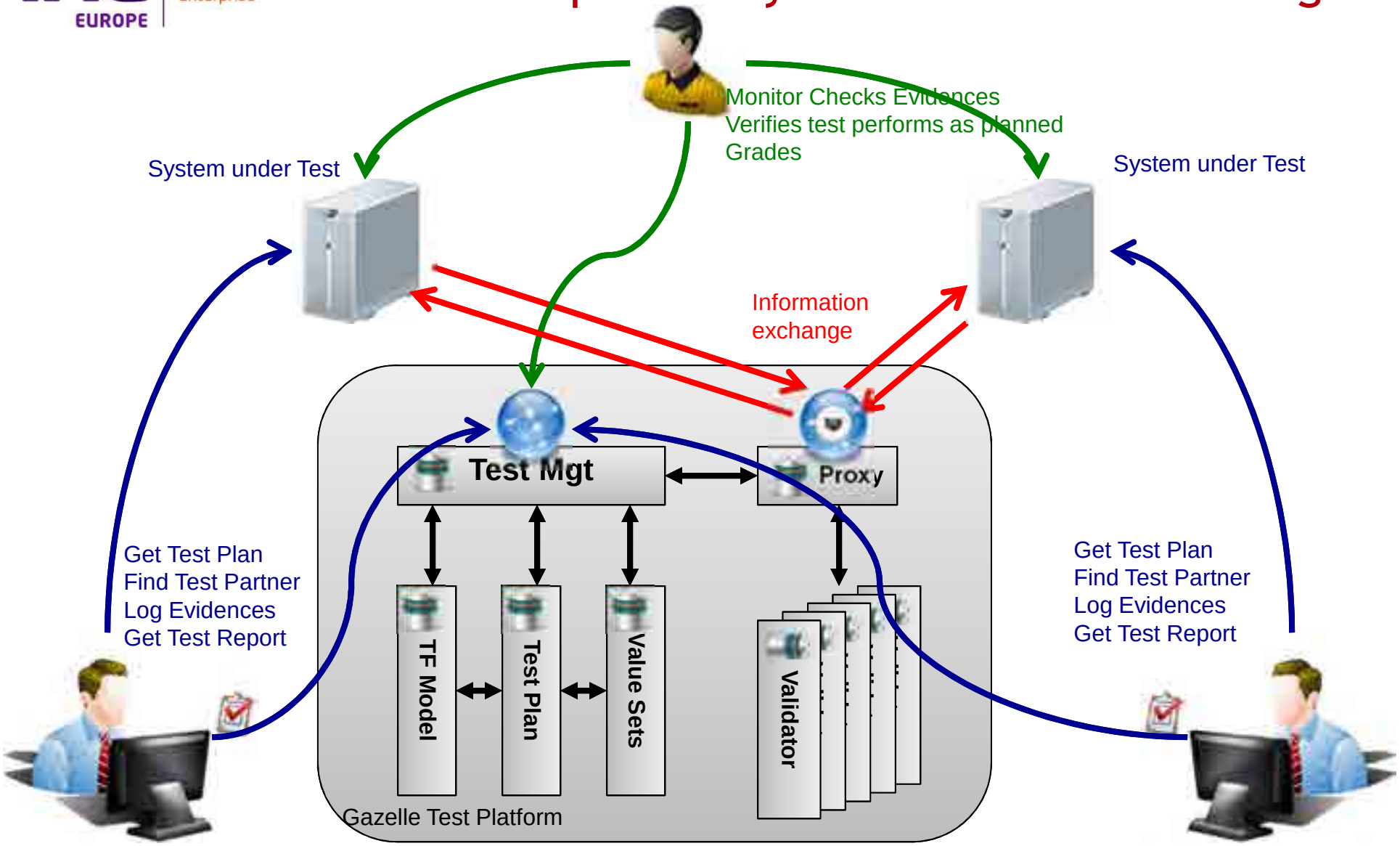
Test Management Platform

- Registration of systems
  - What to test -> select test plan(s)
- Provide list of test to perform
  - Conformance testing (test to be executed before meeting the actual test partners)
    - Simulators + validators
  - Interoperability testing (test to be executed system to system)

Interoperability Testing



Interoperability + Conformance Testing



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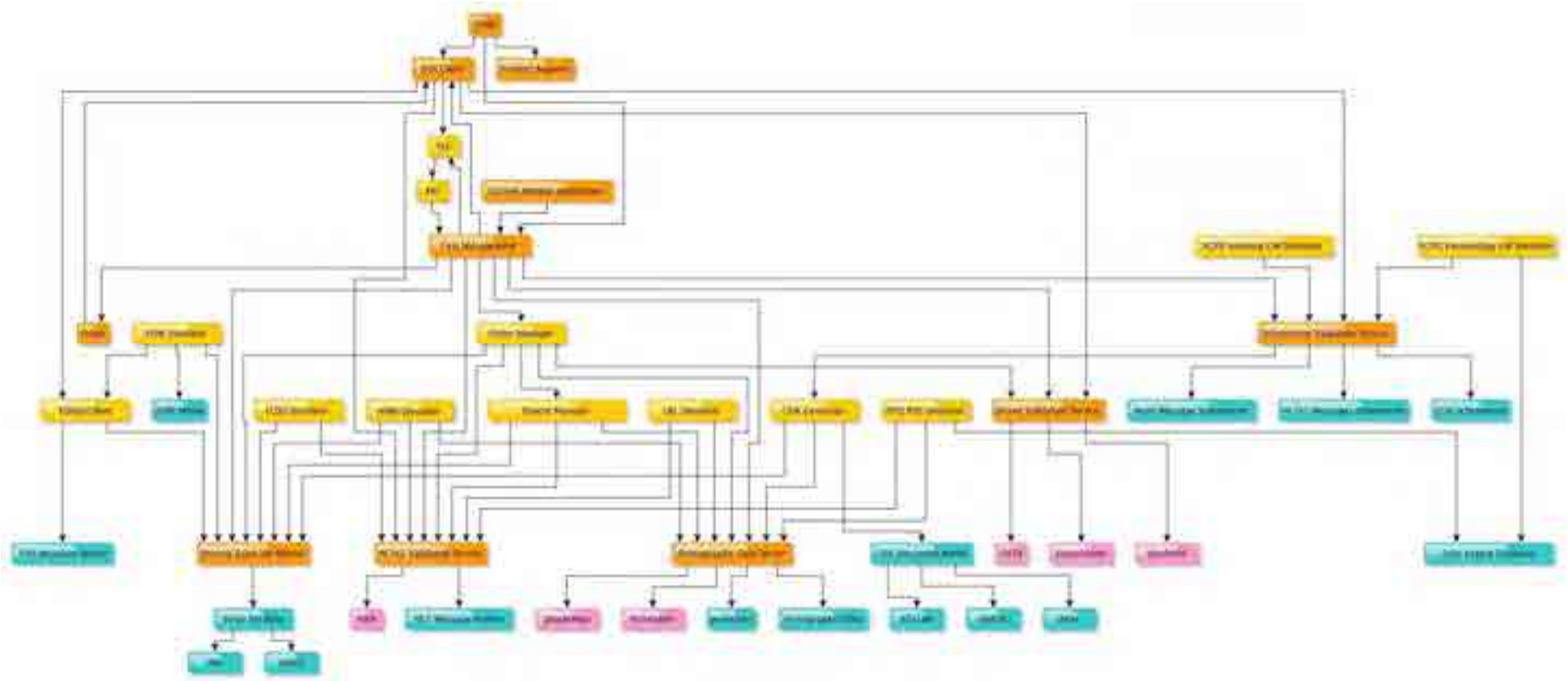
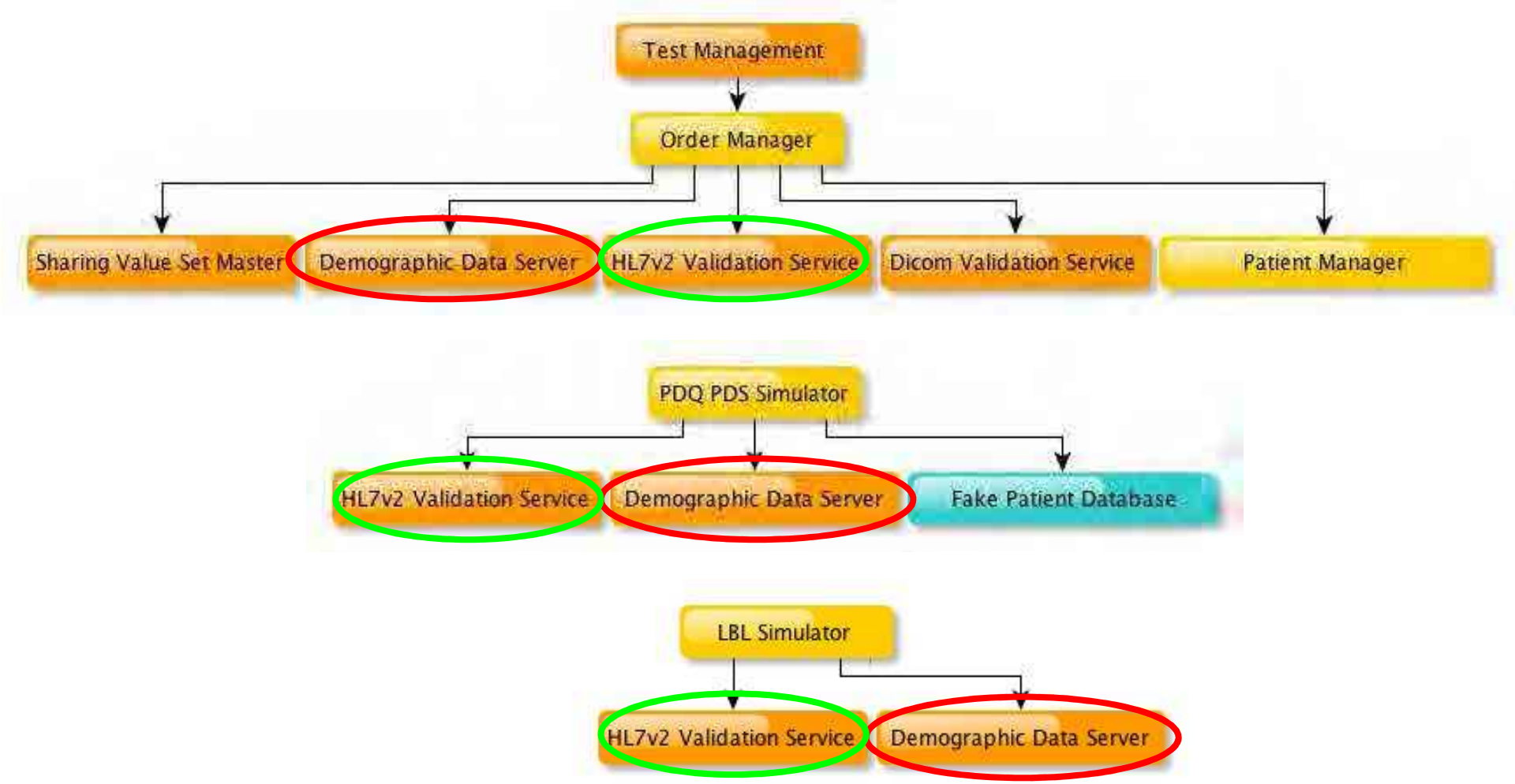
Tools overview



Examples


Test Management
Order Manager
Sharing Value Set Master
Demographic Data Server
HL7v2 Validation Service
Dicom Validation Service
Patient Manager
PDQ PDS Simulator
HL7v2 Validation Service
Demographic Data Server
Fake Patient Database
LBL Simulator
HL7v2 Validation Service
Demographic Data Server

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OVERVIEW OF VALIDATION TOOLS

Outline

- Overview of Validation tools
  - HL7v2 messages validator
    - HL7v2 message profiles
    - HL7v2 data tables
    - Validation of HL7v2 messages using EVS Client
  - CDA document validator
    - Art-Décor as an authoring tool
    - Gazelle ObjectsChecker
    - Validation using EVS Client
  - Audit message validator
    - Definition of audit messages in GSS
    - Validation using EVS Client
  - Model Based Validation
    - HL7v3, HPD,..
  - Gazelle X Validator
    - What it does
  - Use of WS for CI
    - Example with SOAP UI
    - epSOS Architecture

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HL7 V2 MESSAGES

HL7v2 Message Validation

- Input :
  - Message to validate
  - Message profile
  - Some context data
- Tool :
  - https://gazelle.ihe.net/GazelleHL7v2Validator

HL7 Message profile

- An XML expression of the constraint in the specifications
  - http://gazelle.ihe.net/GazelleHL7v2Validator/viewProfile.seam?oid=1.3.6.1.4.12559.11.1.1.11
- The profile makes references to tables
  - http://gazelle.ihe.net/GazelleHL7v2Validator/viewResource.seam?oid=1.3.6.1.4.12559.11.1.3.1.5#0309
- HL7 v2 Message profiles authoring tool
  - Messaging workbench (RIP)
  - IGAMT : https://hl7v2.igamt.nist.gov/igamt/

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CDA DOCUMENTS

Getting specifications right: The **ART-DECOR** Framework

- ...is an open-source tool and a methodology for various **multidisciplinary** stakeholders of healthcare information exchange
- ...supports **collaboration of team members** within and between governance groups and allows separation of concerns with different views on one **single documentation for different domain experts**
- ...supports **creation and maintenance of templates**, value sets, data sets and more
- …supports shared **building block repositories** for templates, value sets and data sets

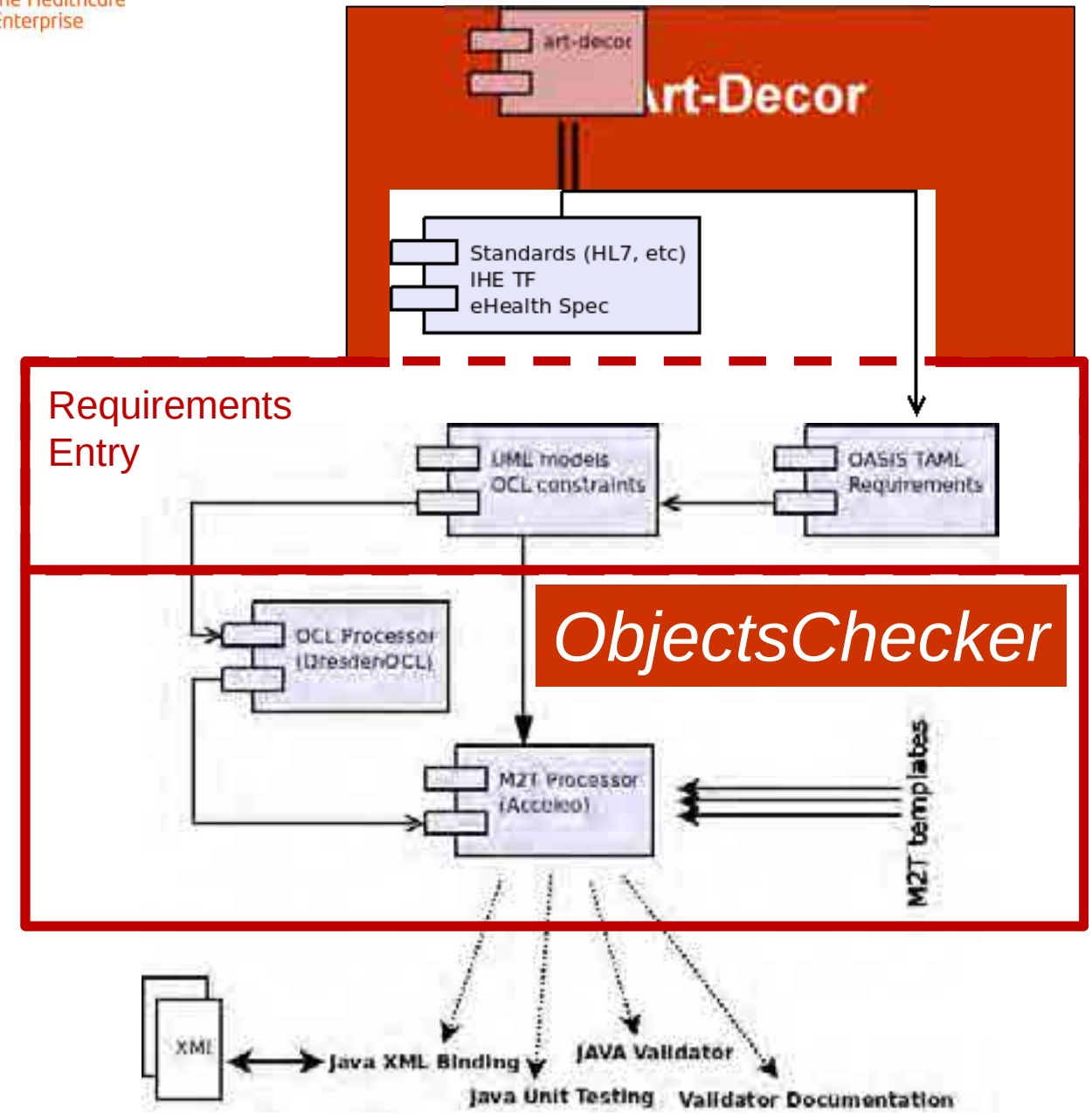
ART-DECOR in Europe

- Shared repositories with collection of artifacts
  - Template Repository (building bocks for clinical document definitions) and Value Sets (code lists)
  - Functional Models (datasets)
  - Sharing artifacts between countries has already started by Germany, Austria, Netherlands
- ART-DECOR specs → Input for Testing Tool

ART-DECOR & IHE Europe

- Memorandum of Understanding signed:
  - **Synergistic tooling: ART-DECOR Framework** and **IHE Gazelle ObjectsChecker**
    - → facilitate the creation and consistent standardized documentation of CDA based specifications and
    - → support rigorous compliance validation and testing.
- The overall goal is:
  - to provide these projects with easy-to-use efficient **combined tooling** that enhance the quality of their implementations and information exchange.

Art-decor and Gazelle *ObjectsChecker* coupling



Advantages of coupling ObjectsChecker with art-decor

- Art-decor moves rigor at point of Content Profiles/Impl. Guides documentation and avoid discovery of issues/gaps at the time *ObjectsChecker* input is created.
- Reduces gaps and misunderstanding of CDA specifications
- Automate the generation of formal OCL description avoiding test tool manual entry
- https://art-decor.ihe-europe.net
- https://gazelle.ihe.net/CDAGenerator

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AUDIT MESSAGES

Audit Messages

- Definition of the message in Gazelle Security Suite
  - https://gazelle.ihe.net/gss
- Audit message structure is well defined
- GSS provides an authoring tool.
- GSS provides a service for validation

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GAZELLE X VALIDATOR

Gazelle X Validator

- WORK IN PROGRESS
- Purpose
  - 1,n inputs checks for coherence content in the inputs according to rules
  - https://gazelle.ihe.net/GazelleXValidatorRuleEditor
- Use cases
  - Coherence between query and responses
    - Question : “what is the PID for **John Doe**” ?” (syntax is ok)
    - Response : “The PID for **Ann Clark** is X50452” (syntax is ok)
    - Cross validation fails : This is not the response to the question ! Ann Clark is not John Doe !

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OVERVIEW OF SIMULATION TOOLS

Outline

- Overview of Simulators
  - Patient Manager Simulator
    - What it does and how to use it
    - Example of the automation
    - https://gazelle.ihe.net/PatientManager
  - Order Manager Simulator
    - What it does and how to use it
    - https://gazelle.ihe.net/OrderManager
  - Gazelle Security Suite
    - What it does and how to use it
    - https://gazelle.ihe.net/gss
  - XDS Tools
    - What it does and how to use it

Patient Manager

- Used for the following profiles
  - PIX, PDQ (v2, v3 and FHIR)
    - DSTU2 version
    - DSTU3 version
    - R4
    - And future ones …
  - PAM
  - XCPD

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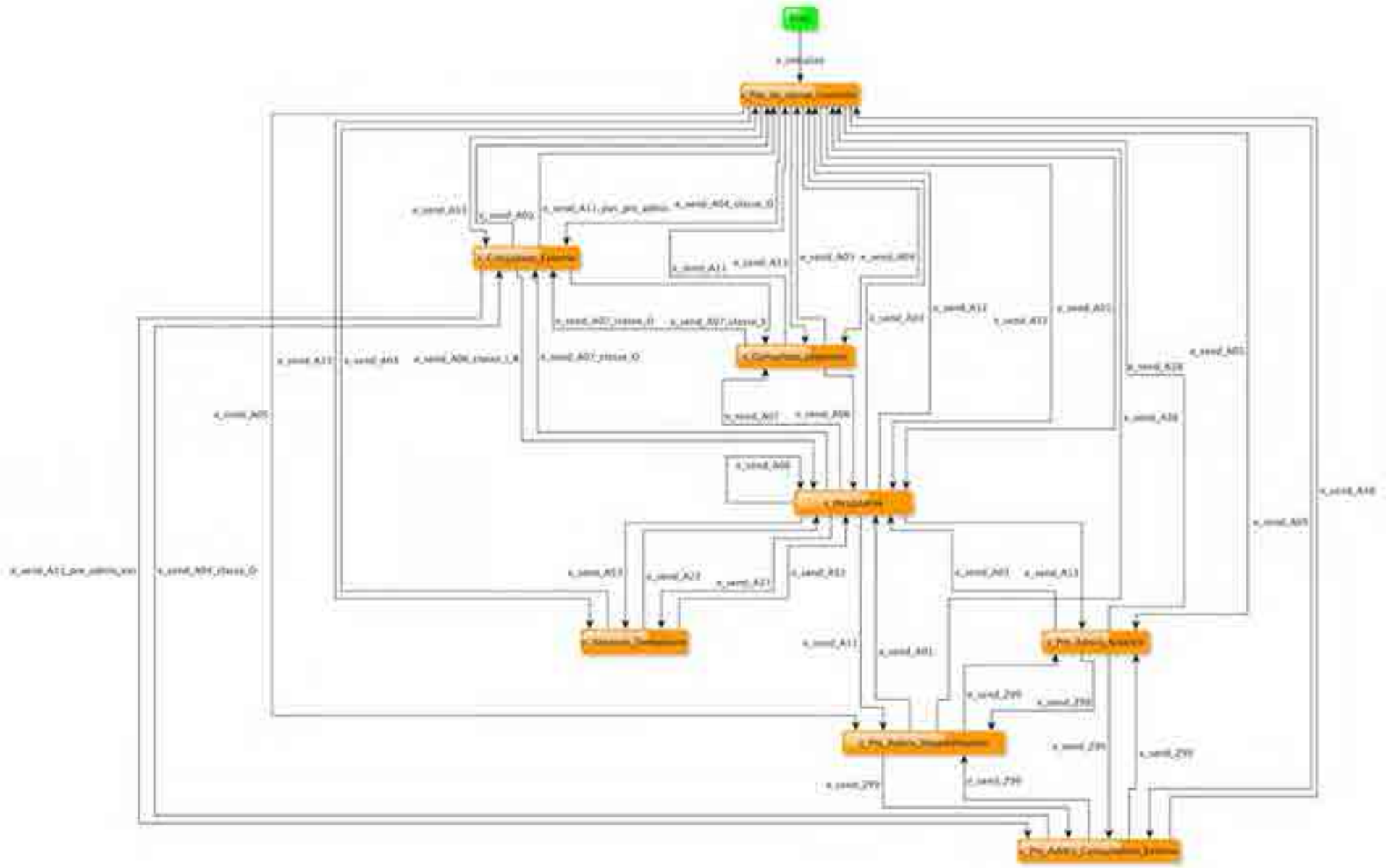
PAM Test Automation



PAM Test Automation

- For example : simulate the sending of messages in order to visit all the edge in the previous graph.

- About 380 HL7v2 messages need to be send in order to visit all edges.
  - Simulator can automate it
  - Test can be fully automated if combined with SUT specific checking
    - Using selenium or similar tools to verify patient status in the GUI of the SUT
    - Using web services to query the status of the patient in the SUT
- Feature currently being extended
  - Facilitate usage in CI environment of implementers (vendors, editors)

Gazelle Order Manager

- Used for the following profiles
  - SWF, SWF.b
  - PaLM (lab) and Eyecare ordering
- LBL added in 2017
- To come LCSD

Gazelle Security Suite

- Generation/signature of certificates for testing purposes
  - https://gazelle.ihe.net/gss
- Front-end to simulate a TLS connexion with a server or a client
  - Support for HL7v2
  - Support for DICOM
  - Support for webservices
  - Support for syslog

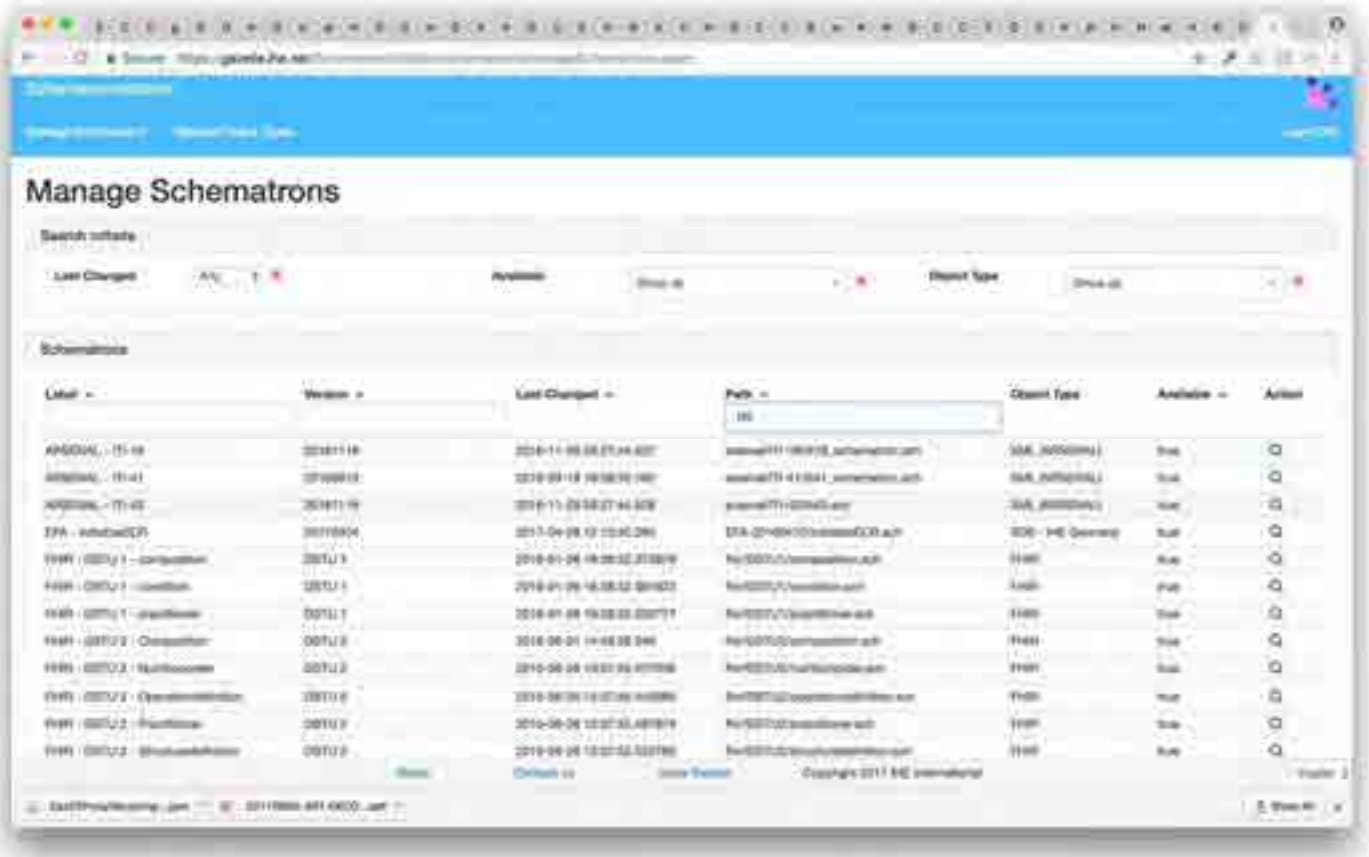
- Definition of Audit Messages
- SAML Assertion provider
  - https://gazelle.ihe.net/picketlink-sts?wsdl
  - https://docs.google.com/spreadsheets/d/18dG9yKJizxOBQl8JKiTr2_OPHGhgRd-4Ue0NBNHWC60/edit#gid=0

XDS tools

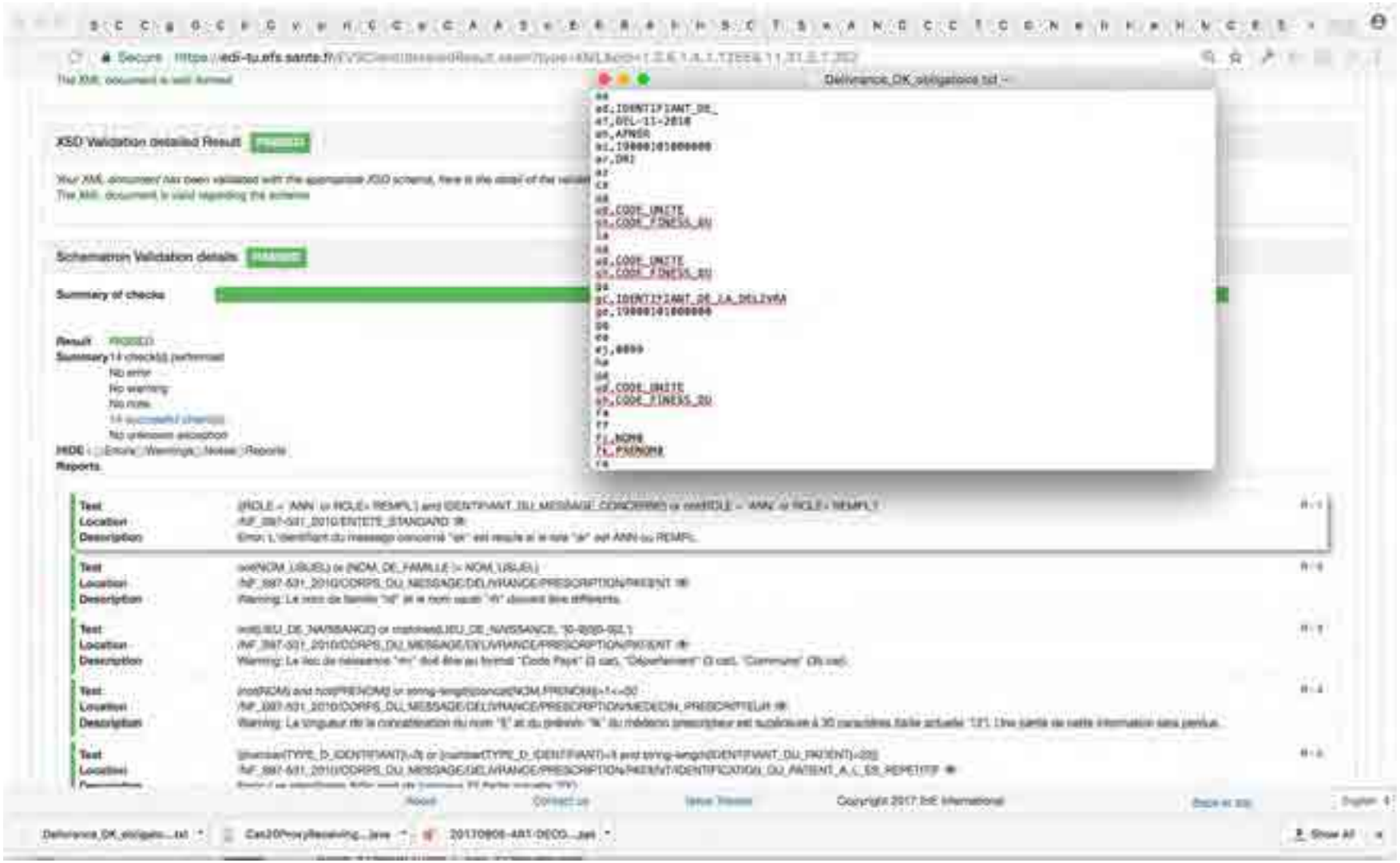
- 2 Tools (not competing)
- NIST Toolkit
  - http://ihexds.nist.gov/
- Gazelle XD* Client
  - https://gazelle.ihe.net/XDStarClient

Schematron Validator

- A tool that performs a schematron validation of XML document
  - https://gazelle.ihe.net/SchematronValidator/home.seam

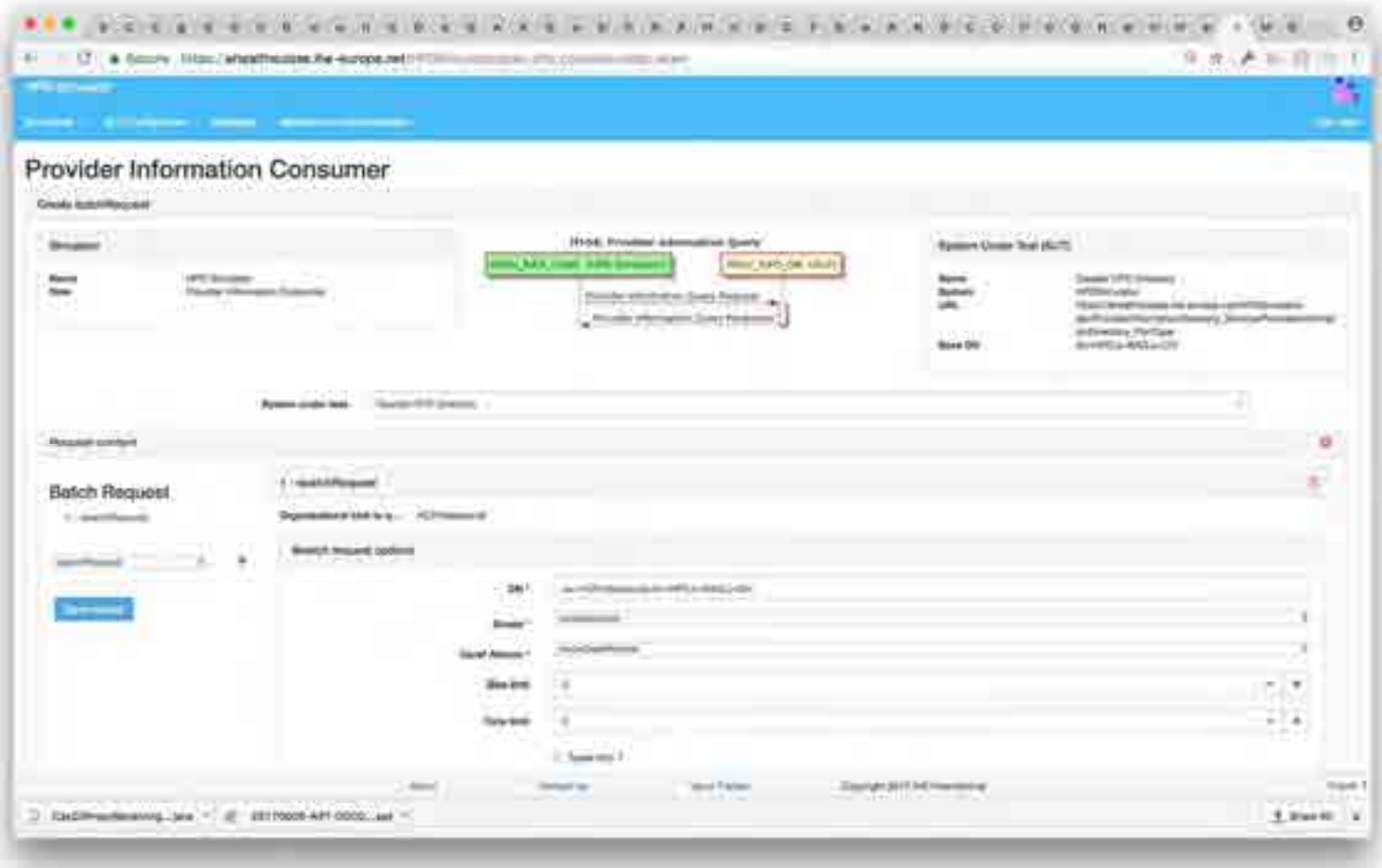


Schematron Validator extension



HPD Simulator

- Simulate the HPD profile
  - https://gazelle.ihe.net/HPDSimulator/home.seam



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OVERVIEW OF TEST SUPPORTING TOOLS

Outline

- Test Supporting tools
  - Gazelle Proxy
    - The man in the middle
    - https://gazelle.ihe.net/proxy
  - Gazelle SVS Simulator
    - The mean to easily customize tool to different flavor of codes
    - https://gazelle.ihe.net/SVSSimulator
  - Gazelle DDS
    - Get fake but realistic patient data, get some variety in your test data.
    - https://gazelle.ihe.net/DDS
  - Assertion Manager
    - Link between the specifications and the tests
    - https://gazelle.ihe.net/AssertionManagerGui

Proxy

- Capture of messages exchanged between partners
- Plays the role of the man in the middle.
- Neutral
- Supports Dicom, HL7v2, Syslog, http (Webservices)
- Bound to EVS Client for validation of captured messages
- https://gazelle.ihe.net/proxy

Sharing Value Sets

- SVS Simulator is both a simulator and a support tool
  - Simulates actors in the SVS profile
- We have extended the SVS profile for our testing needs:
  - https://gazelle.ihe.net/RetrieveValueSet?id=1.3.6.1.4.1.21367.101.103
  - https://gazelle.ihe.net/RetrieveValueSet?id=1.3.6.1.4.1.21367.101.103&random=true
  - https://gazelle.ihe.net/RetrieveValueSet?id=1.3.6.1.4.1.21367.101.103&code=A
- Allow customization of tools to different deployment environment

Demographic Data Server

- Generation of demographic data on the demand.
- Used by simulators
- Used by Test Management for complex scenarii design (cross community access)
- https://gazelle.ihe.net/DDS

Assertion Manager

- Management of Requirements
- Objective is to answer the 2 following questions :
  - How much of the specs do the test cover
  - When I have performed a test campaign, how much of the specs did I cover
- https://gazelle.ihe.net/AssertionManagerGui

Assertion Manager

Test-001
Test-002
Test-003
Test-…
Test-…
Test-xxx

What was tested

Req-001
Req-002
Req-003
Req-…
Req-…
Req-vvv

Req-001
Req-002
Req-003
Req-…
Req-…
Req-nnn

What should be tested

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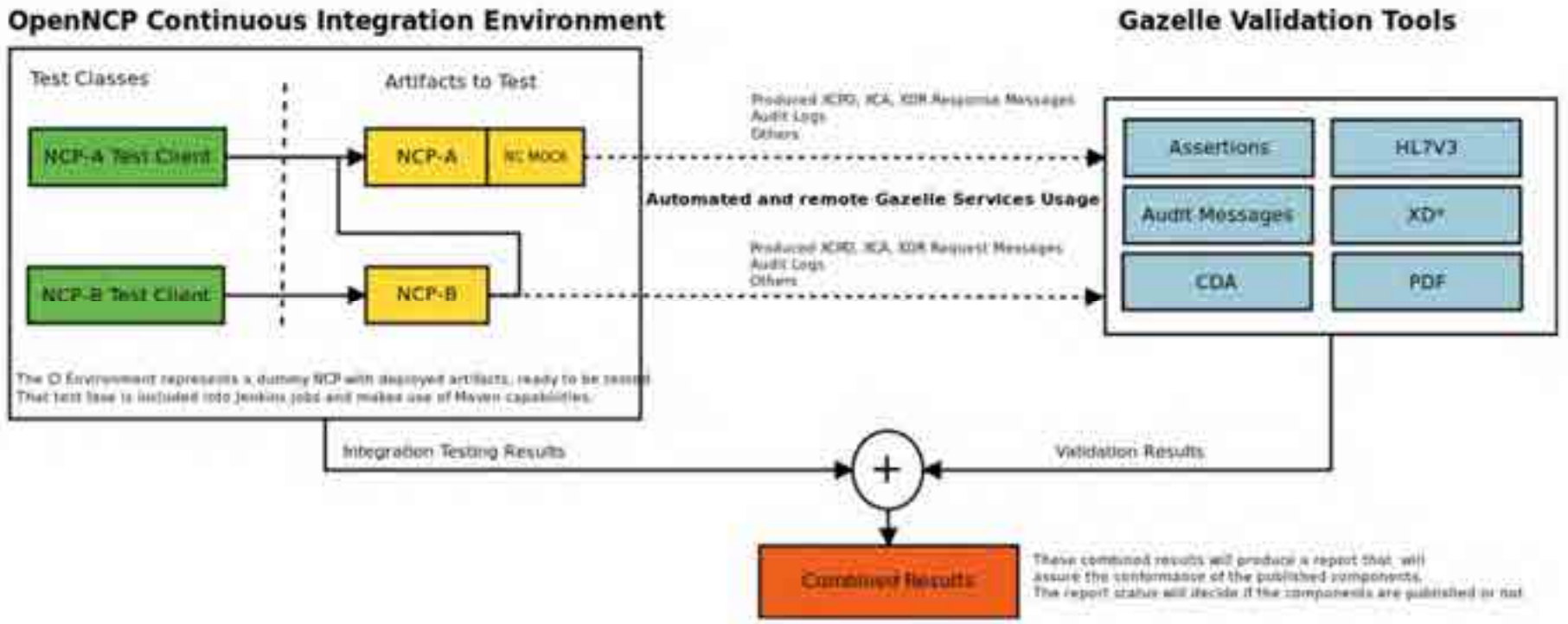
USE OF VALIDATION SERVICES FOR CI

Continuous Integration

- Example of openNCP project
  - WS call to verify that the new code is not breaking the conformity of messages/documents



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GAZELLE PROJECT MANAGEMENT

Sources Management

- Hosted on the INRIA Forge at
  - https://gforge.inria.fr/projects/gazelle/
- Managed by SVN
- Sources accessible on Read-Only
  - Need to be a know developer to commit
  - Procedure to become a developer
    - Add an account on the forge
    - Request binding of account with project to Eric
- Apache 2.0 License
  - You can do what ever you want !

Project Management

- We use jira atlassian https://gazelle.ihe.net/jira
  - Bug tracking
  - Feature Requests
  - Agile development management.
  - Time tracking on project

Documentation

- Documentation is hosted on https://gazelle.ihe.net
- Huge work on re-documentation of the tools started
  - Objectives better compliance with ISO 17025
  - Easier distribution of documentation in link with the different version of the tools
  - https://gazelle.ihe.net/gazelle-documentation

Jira : Greenhoper plugin : Agile View

Continuous integration

- We use jenkins
  - https://gazelle.ihe.net/jenkins

Testing

- Testlink
  - repository of tests for the applications developed within the project
  - https://gazelle.ihe.net/testlink
- Static code analysis
  - https://gazelle.ihe.net/sonar

Artifact Repository

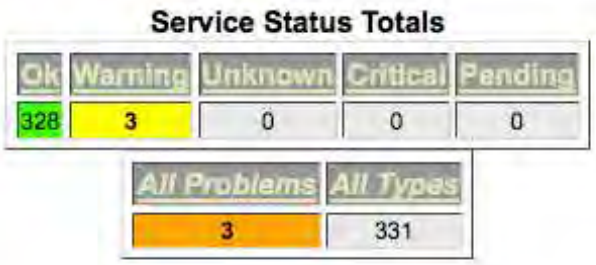
- We use nexus
  - https://gazelle.ihe.net/nexus
  - Repository of the artifacts used by the different applications

Internationalization

- All our components are (or will) use crowdin :
  - https://crowdin.net/project/gazelle

Service Level

- Nagios3 for service monitoring
  - https://gazelle.ihe.net/nagios3/



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Licensing

- All our development is licensed under the Apache2.0 license
- Test plans are distributed using a specific licence derived from CC and Apache2.0