Managing Knowledge-Based Interoperability in P5 Medicine
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Speakers (in alphabetical order)

• Bernd Blobel, PhD, FACMI, FACHI, FHL7, FEFMI, FIAHSI, Professor and Former Head of the German National eHealth Competence Center at the Medical Faculty, University of Regensburg, Germany;
• Mauro Giacomini, PhD, Professor, Dept. of Informatics, Bioengineering, Robotics and System Engineering (DIBIRS), University of Genoa, Italy;
• William T.F. Goossen, PhD, Director, Results 4 Care B.V., Amersfoort, The Netherlands;
• Sefano Lotti, Enterprise Architect, INVITALIA Government Agency for Inward Investment Promotion and Enterprise Development
• Frank Oemig, PhD, FHL7, Deutsche Telekom Healthcare and Security Solutions GmbH, Essen, Germany
• Stefan Schulz; MD, Professor, Institute for Medical Informatics, Statistics and Documentation, Medical University Graz, Austria.
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**Agenda**

- Workshop Speakers and Program (Bernd Blobel) (1 min.)
- Introduction: Need and challenges of knowledge representation and management for enabling advanced interoperability supporting healthcare transformation to P5 Medicine (Bernd Blobel) (8 min.)
- Formal ontologies and multilingual terminologies as tools for knowledge level interoperability in the biomedical domain (Stefan Schulz) (8 min.)
- Implementable administrative concepts represented as FHIR resources (Frank Oemig) (8 min.)
- Concept representation and management in microbiology and laboratory sciences (Mauro Giacomini) (8 min.)
- ISO 13972 Health Informatics – Clinical Information Models, status and future revisions (William Goossen) (8 min.)
- Executable clinical pathway design deploying OMG’s Health Services Reference Architecture and business process modeling tools (Stefano Lotti) (8 min.)
- ISO DIS 23903 Health Informatics – Interoperability and Integration Reference Architecture (Bernd Blobel) (8 min.)
- Q&A, Summary and Closing (3 min.)
Introduction: Need and challenges of knowledge representation and management for enabling advanced interoperability supporting healthcare transformation to P5 Medicine

Prof. Dr. habil. Bernd Blobel, FACMI, FACHI, FHL7, FEFMI, MIAHSI
Former Head of the German National eHealth Competence Center at the Medical Faculty, University of Regensburg, Germany
Visiting Professor, First Medical Faculty, Charles University Prague, Czech Republic
Past-Chair HL7 Germany
Past-Chair, EFMI WGs “EHR” and “Security, Safety and Ethics” and Past Co-Chair of the HL7 Security WG
Past-Chair of the German Health Informatics Standards Mirror Group and Former Head of the German Delegation to ISO TC 215 and CEN TC 251
Ellen Friedman, MAPR: Even if you're not a data scientist, you may hold one of the most valuable skills in data science: the ability to understand your own business. And that is one type of expertise that data science specialists may lack.
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A Practical P5 Medicine Definition

• Healthcare transformation leads to the organizational, methodological and technological paradigm changes resulting in highly dynamic and highly complex personalized, preventive, predictive and participative precision medicine (P5 Medicine), individualizing diagnosis and therapy by considering individual health state, conditions and contexts, genomics, proteomics, micro-biomics, etc., frequently turning the subject of care to the health manager.

• P5 Medicine implies cooperation of many different sovereign stakeholders from different policy domains in a multi-disciplinary approach including medicine, natural sciences, engineering, but also social, legal and political sciences as well as their consideration of systems from elementary particle to society using domain-specific methodologies, terminologies, knowledge, skills, performed through any type of principals (person, organization, device, application, component, object). Such approach requires the explicit and formalized representation and harmonization of involved knowledge and skills.

• Being realized independent of time and location, P5 Medicine needs the deployment of new technologies such as mobile, bio-, nano- and molecular technologies, knowledge representation & management, autonomous systems & AI, Big Data & Business Analytics, NLP, Social Business, IoT as well as related computing technologies (Cloud, pervasive, autonomous, cognitive computing).
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Meeting the aforementioned interoperability requirements leads to different interoperability levels for ensuring comprehensive cooperation.

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<tr>
<th>Information Perspective</th>
<th>Organization Perspective</th>
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<td></td>
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<tr>
<td>Technical</td>
<td>Interoperability Level</td>
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<tr>
<td>Technical plug&amp;play, signal &amp; protocol compatibility</td>
<td>Light-weight interactions</td>
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<td>Structural</td>
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<td>Simple EDI, envelopes</td>
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<td>Syntactic</td>
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<td>Messages and clinical documents with agreed vocabulary</td>
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<td>Advanced messaging with common information models and terminologies</td>
<td>Knowledge sharing at IT concept level in computer-parsable form</td>
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<tr>
<td>Coordination</td>
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<td><strong>Organization/Service</strong></td>
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<tr>
<td>Common business process</td>
<td>Knowledge sharing at business concept level</td>
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<td></td>
<td>Agreed cooperation</td>
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<td><strong>Knowledge based</strong></td>
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<td>Multi-domain processes</td>
<td>Knowledge sharing at domain level</td>
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<td></td>
<td>Cross-domain cooperation</td>
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<td><strong>Skills based</strong></td>
<td></td>
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<tr>
<td>Individual engagement in multiple domains</td>
<td>Knowledge sharing in individual context</td>
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<td></td>
<td>Moderated end-user collaboration</td>
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## Managing Knowledge-Based Interoperability in P5 Medicine

### Comparing Data Model Levels and Dimensions of Modeling with ISO 23903 and ISO 10746

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<th>Model Scope</th>
<th>Dimension of Modeling</th>
<th>Interop. Reference Architecture</th>
<th>Examples</th>
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<td>Business domains stakeholders</td>
<td>Scope, requirements and related basic concepts of business case</td>
<td>Knowledge space</td>
<td>Business View</td>
<td>ISO/CEN Interoperability Reference Architecture</td>
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<td>High-level data model</td>
<td>Business domains stakeholders</td>
<td>Relevant information and representation &amp; relationships of basic concepts</td>
<td>Knowledge</td>
<td>Enterprise View</td>
<td>DCM, CSO</td>
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<td>Logical data model</td>
<td>Data modelers and analysts</td>
<td>Layout &amp; types of data and object relationships</td>
<td>Information</td>
<td>Information View</td>
<td>HL7 V3 (CMETs), HL7 CIMI, openEHR Archetypes, FHIM</td>
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<tr>
<td>Physical data model</td>
<td>Data modelers and developers</td>
<td>Implementation-related and platform-specific aspects</td>
<td>Data</td>
<td>Engineering View</td>
<td>HL7 FHIR</td>
</tr>
</tbody>
</table>
Formal ontologies and multilingual terminologies as tools for knowledge level interoperability in the biomedical domain

Stefan Schulz, Medical University of Graz, Austria
Problem

Babylonian language confusion in biomedical semantics & knowledge representation

- What kinds of knowledge need to be represented?
- Is a more principled framework possible?
- How do biomedical formal ontologies and multilingual terminologies fit in this picture?

Knowledge map

Universals

Symbols

Individuals

C. K. Ogden and I. A. Richards (1923) The Meaning of Meaning

"perro", "dog", "canino", “Hund" "canis", "dog" NCBI:txid9615 "Marley"
Universals

Individuals

Symbols

Marley lives in Florida

Marley is a dog

"dog" is a noun

"canis familiaris" and "dog" are synonyms

dogs are vertebrates

dogs are possible vectors of rabies

dogs are vertebrates

Knowledge map
Ontological "knowledge":
Axioms that are universally true

Contingent knowledge:
typical, likely, possible

Symbolic knowledge:
Statements about properties and meaning of signs of language

Factual knowledge:
Statements about concrete entities and their relationships
Factual knowledge:
Statements about concrete entities and their relationships
Ontological knowledge:
Axioms that are universally true

Contingent knowledge:
typical, likely, possible

Symbolic knowledge:
Statements about properties and meaning of signs of language

Factual knowledge:
Statements about concrete entities and their relationships
Symbolic knowledge

Statements about properties and meaning of signs of language
Representations SKOS / Linked Data

```
:ex:Dog rdf:type skos:Concept
:ex:Dog skos:prefLabel "dog"@en;
:ex:Dog skos:prefLabel "perro"@es;

:ex:Animal rdf:type skos:Concept
:ex:Animal skos:broader ex:Dog

wr:dog lemon:sense wr:dog-English-Noun-1
wr:dog lemon:sense wr:dog-English-Verb-1
wr:dog-English-Noun-1 wt:hasPoS wt:Noun
```

Syntax TURTLE : https://www.w3.org/TR/turtle/
Wiktionary: http://wiki.dbpedia.org/wiktionary-rdf-extraction
Ontological knowledge: Axioms that are universally true

Contingent knowledge: typical, likely, possible

Symbolic knowledge: Statements about properties and meaning of signs of language

Factual knowledge: Statements about concrete entities and their relationships
Ontological knowledge:
Axioms that are universally true

dogs are vertebrates
Representation OWL

Dog subclassOf Vertebrate
Vertebrate subclassOf Animal
Vertebra subclassOf Bone
Vertebrate equivalentTo Animal and has-part some Vertebra

Computable inference (e.g. HermiT or Fact++ OWL reasoner)

There is no dog that has no bones

OWL Manchester Syntax: https://www.w3.org/TR/owl2-manchester-syntax/
HermiT reasoner: http://www.hermit-reasoner.com/
Fact++ reasoner: http://owl.man.ac.uk/factplusplus/
Ontological knowledge:
Axioms that are universally true

Contingent knowledge:
Typical, likely, possible

Symbolic knowledge:
Statements about properties and meaning of signs of language

Factual knowledge:
Statements about concrete entities and their relationships
Contingent knowledge: typical, likely, possible

Dogs are possible vectors of rabies
Triple representation

- No formal semantics!
- Different, mostly complex interpretations
- Don’t use formal languages for this

<table>
<thead>
<tr>
<th>Subject</th>
<th>Predicate</th>
<th>Object</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dog</td>
<td>vector-of</td>
<td>Rabies</td>
</tr>
<tr>
<td>Tobacco</td>
<td>causes</td>
<td>Cancer</td>
</tr>
<tr>
<td>Aspirin</td>
<td>treats</td>
<td>Pain</td>
</tr>
<tr>
<td>Fever</td>
<td>suggests</td>
<td>Malaria</td>
</tr>
<tr>
<td>Bird</td>
<td>capable-of</td>
<td>Flying</td>
</tr>
</tbody>
</table>

-Dog subclassOf vector-of some Rabies
-Tobacco subclassOf causes some Cancer
-Aspirin subclassOf treats some Pain
Ontological knowledge:
Axioms that are universally true

Contingent knowledge:
typical, likely, possible

Symbolic knowledge:
Statements about properties and meaning of signs of language

Factual knowledge:
Statements about concrete entities and their relationships
**Ontological knowledge**
Axiomatic layer of clinical terminology systems

**Contingent knowledge**
Clinical guidelines

- UniProtKB - Q71M42 (PC11X_PANTR)
  - Protein: Protocadherin-11 X-linked
  - Gene: PCDH11X
  - Organism: Primates (Chimpanzees)
  - Status: Reviewed - Annotation score: 4/4
  - GO - Molecular function:
    - GO:1295140: calcium ion binding
  - GO - Biological process:
    - GO:0008150: cell adhesion

**Symbolic knowledge**
Lexical layer of terminology systems

**Factual knowledge**
Clinical Information Models

- HL7 FHIR
  - Condition (DomainResource)
  - identifier: Identifier [0..*]
  - clinicalStatus: CodeableConcept [0..1]
  - severity: CodeableConcept [0..1]
Implementable Administrative Concepts represented as FHIR Resources

Dr. Frank Oemig, FHL7
Senior eHealth Architect, Deutsche Telekom Healthcare and Security Solutions GmbH, Essen, Germany
CTO HL7 Germany
Past-Affiliate Director, Co-Chair of the HL7 Conformance WG and V2 Management Group
Chair Interoperability WG, German Vendor Association for IT in Healthcare
Care-Taker IT-Infrastructure and Co-Founder of IHE Germany
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Modelling Encounters in FHIR (Example from Practice)

Inpatient Encounter

- Episode of Care 1
- Encounter 1
  - 2.1
  - 2.2
  - 2.3
- Account C
- Account A
- Account B

Outpatient Encounter

- Episode of Care 1
- EoC 2
- Encounter 1
- Encounter 2
  - 1. Quarter
  - 2. Quarter
  - ..

Medical Interpretation

Reality

Accounting Interpretation

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Improved Modelling Encounters in FHIR
(Example from Practice)
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**Improved Modelling Encounters in FHIR**
(Example from Practice)
Improved Modelling Encounters in FHIR (Example from Practice)
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Newest Modelling Approach

Diagram showing a hierarchical structure with Hospital at the top, Specialty in the middle, and Ward at the bottom. The dynamic, patient-related section includes Organisation, Episode of Care, Encounter, and Account.

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Summary

• Use Case driven Approach
• Domain Information Models as foundation with clear semantics
  – Linked with each other
• Translation into Technical Representation comes last
  – Not first or only
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Management of Semantics in Structured Laboratory Reports through LOINC

Prof. Mauro Giacomini PhD
University of Genoa, Department of Informatics, Bioengineering, Robotics and System Science (Debris)
Health Informatics Section of Bioengineering Laboratory
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Starting from a regional project in 2016...
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**Introduction: surveillance networks**

- **Italian level:**
  - *National Prevention Plan (PNR) 2014-2018* (extended to 2020): among the objectives “the decrease of infections / priority infectious diseases frequency with particular reference to antibiotic resistance, infections related to assistance and infectious emergencies”
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Introduction: the goal

1. To monitor and notify MDRO
2. To monitor hospital and not drug prescription related to infections and microbiology data
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Materials and methods: project plan

Monitoring Germs MDRO and correlated infections
Notification of infective diseases and adverse reaction to vaccines
Monitoring antibiotic usage in hospital and landscape
Implementation of support actions for a better antibiotic prescription
Monitoring/early diagnosis of TBC
Screening/early diagnosis of HIV

Local codes
LOINC® codes

Materials and methods:
Project plan
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Materials and methods: semantic harmonization
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Materials and methods: syntactic harmonization

Clinical Document Architecture Release 2 (CDA R2)

Ministero della Salute Ospedaliera (SDO)

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Scheda di Dimissione Ospedaliera (SDO)

HL7 Italia

Services specification project

HSP

healthcare

HL7 FHIR

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Results: overall architecture

[Diagram showing the overall architecture with components such as HIS, HRMS, HTS, and extraction clients connected to a central repository.]
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The tool

Terminology Service:

• to easily perform the transcoding from local codes to LOINC® codes
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Terminology Service - main features

- "co-working" between different Laboratories (suggestions from other Labs regarding the same concept, sharing of work)
  - ...to reduce erroneous mapping
  - ...to accelerate mapping activity
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Terminology Service - main features

- **overlook** of historical changes
- ...to better manage the work
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Terminology Service - main features

• most frequently performed lab tests are highlighted
  • ...to have an order to perform transcoding
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MANY THANKS!
ISO TS 13972 revision for MIE 2020

Dr William Goossen
Director, Results 4 Care b.v., the Netherlands
Former head of delegation for NEN to CEN TC 251 and ISO TC 215
Former co-chair HL7 WG Patient Care
Former board member IMIA - NI
wgoossen@results4care.nl
Scope of ISO 13972 (DIS phase)

- Specifies **clinical information models** (CIMs) as health and care concepts that can be used to define and to structure information for various purposes in health care, also enabling information reuse.

- Describes **requirements** for CIMs content, **structure** and context and specification of their data elements, data element relationships, meta-data and versioning, and provides guidance and examples.

- Specifies key **characteristics** of CIMs used in conceptual and logical analysis for use cases such as (reference) architectures, EHR and PHR, interoperability, use of data e.g. for public health reporting, etc., etc.

- Defines a **Quality Management System (QMS)** for a systematic and effective governance etc.

- Provides **principles** to be followed in the transformation and application of clinical information models, etc.
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What is a CIM?

Essential components of ISO DTS 13972

- Medical knowledge and context
- Specification of data elements & relations
- Binding to 1-n medical terminologies
- Meta information: authors, approval,
- Versioning
- Conceptual and Logical Model (see next)
- Repository and Governance
- Technical implementation specifications unlimited via transformations
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ISO/DIS 23903 ‘Interoperability and Integration Reference Architecture’ - CIM position in Cube

Domain n

Domain 2

Domain 1

Business Concepts

Relations

Networks

Aggregations

Details

System Component Composition

System Domain

System Viewpoint

Business View

Enterprise View

Information View

Computational View

Engineering View

Technology View

DAM

FM

SFM

CIM

RIM

D-MIM

CMET

CDA

ITS

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Process: ISO 13972 CIM

CIM QMS Maintenance

CIM Governance

CIM Process Monitoring & Improvement

CIM Development Processes

CIMs

Stakeholder Acceptance, Adoption & Usage

Stakeholders Requirements

Stakeholder Participation

CIMs

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From content to HL7/13606

Concept

CIM logical model

HL7 v3 XML clinical statements
or FHIR
or ADL
or OWL
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Transform CIM to HL7 FHIR example

Show a very basic mapping from a Body Weight CIM to FHIR Observation Profile

```json
{
  "resourceType": "StructureDefinition",
  "url": "http://cim.org/fhir/StructureDefinition/cim-BodyWeight-Observation",
  "status": "draft",
  "mapping": [
    {
      "identity": "cim",
      "name": "CIM",
      "uri": "http://cim.org/
    }
  ],
  "kind": "resource",
  "type": "Observation",
  "abstract": false,
  "baseDefinition": "http://hl7.org/fhir/StructureDefinition/Observation",
  "differential": {
    "element": [
      {
        "path": "Observation",
        "label": "Body Weight",
        "mapping": {
          "identity": "cim",
          "map": "NL-CM:10.0.0"
        }
      },
      {
        "path": "Observation.code.coding.system",
        "fixedString": "http://loinc.org"
      },
      {
        "path": "Observation.code.coding.code",
        "fixedString": "29463-7"
      },
      {
        "path": "Observation.valueQuantity",
        "label": "Body Weight Value",
        "mapping": {
          "identity": "cim",
          "map": "NL-CM:10.0.1"
        }
      },
      {
        "path": "Observation.valueQuantity.system",
        "fixedString": "http://unitsofmeasure.org"
      }
    ]
  }
}
```
HL7 HIRA – Healthcare Interoperability Reference Architecture and Clinical Pathway

Stefano Lotti
HL7 International SOA WG CoChair
HL7 Italy CTO
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HIRA Goal and Objectives

In the coming slides we can have an idea of the emerging work on HL7 HIRA with a projection on Clinical Pathway (based on the work of BPM+Health program of OMG).

The objective of the HL7 Healthcare Interoperability Reference Architecture (HL7-HIRA) is to support the design of medium/large scale eHealth architectures based on HL7 services and standards.

The project organizes adopted HL7 Service Functional Models, Functional Profiles and Domain Models as a basis for:

- a formalized Enterprise Service Inventory (Normative)
- an Architectural Patterns Catalog (Normative)
- guidelines for enterprise Service Discovery and Orchestration (Informative)

It can be viewed as a tool that can be used in different method contexts such as EA framework (as Togaf, NAF, DoDAF etc.) or approach as ISO DIS 23903.
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**HL7-HIRA as a tool**

- HIRA represent a tool for architects and CIOs.

- The basic consideration behind HIRA is that HL7 based standards support almost all the possible scenarios of eHealth interoperability.

- However, the architectural viewpoint needed to bring these standards together is not specifically addressed. The relevant information are dispersed in several document that frequently support different view point (e.g. Technical Implementation).

- This lack of support increases the design and planning barriers to realizing HL7 based architectures. This can also lead to relevant HL7 standards being omitted from, or misused in, medium and large-scale environments.

- HIRA takes into consideration the needs of architects and CIOs to undertake a fully pervasive, sound, balanced and cost effective HL7 Service design for Enterprise interoperability.
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Functional models and technical projections

- The intent of the HL7-ERSA is to support the process of architectural design with a map of building blocks and solution patterns based on existing HL7 Standards.

- HIRA should be useful to navigate and select Health Standards without mandatory reference of a specific method even if surely the use of an architecting methodology is strongly suggested.

- The starting point in HIRA for Enterprise Service Catalog are standard business capabilities and shown how these capabilities can be realized with different technical standards (Technical Model Projections).
Modeling language for HIRA

• Modeling language are fundamental in this effort and the choice for Hira used for HIRA is the OMG UAF (Unified Architecture Framework).

• UAF is a modeling language based on UML/SysML and also integrated with BPMN2 and SoaML. The UAF scope is the representation of complex Architectures.

• For Hira UAF seems a correct mix of high level concept and capability to co down to details when appropriate.

• The capability to be integrated with other language, as BPMN2 and other, is also relevant.
The Unified Architecture Framework (UAF https://www.omg.org/uaf/) defines how representing an enterprise architecture that enables stakeholders to focus on specific areas of interest in the enterprise while retaining sight of the big picture.

UAF meets the specific business, operational and systems-of-systems integration needs of commercial and industrial enterprises as well as the U.S. Department of Defense (DoD), the UK Ministry of Defence (MOD), the North Atlantic Treaty Organization (NATO) and other defense organizations.

UAF requirements were derived from military frameworks however these requirements were combined with requirements from the business sector (because 90% of concepts and themes captured in the military frameworks are equally applicable in the commercial domains).

So UAF, as a framework, supports the needs of the commercial sector as well as the military.
HIRA and the Others

• An initial release of HIRA (mainly centered on the service catalog) will be balloted in the next HL7 Cycle.

• Before a little deep view on HIRA is important to underline that a benefit for HIRA is to progressively include in the model references on frameworks that can guide a meaningful architecting path.

• The already cited Enterprise Architecture framework and methods should have the appropriate “connection point” in HIRA.

• The questions should be:
  – When an appropriate business case is selected in HIRA Architectural pattern and/or in the catalog, how can be managed in an architecture framework or method?
  – The HIRA, as a whole, when can be used in an architecture development?
HIRA Model

- The big picture of the model include 8 components:
  1. High level Business Functions
  2. The Service Inventory that include:
     a) Composite services (that include Service Functional Model and Service Technical Model)
     b) Enabling Services (that include Service Functional Model and Service Technical Model)
     c) Supporting Functionality
  3. Resources Information
  4. Data Source Systems
  5. Infrastructure Systems
• “A service inventory is an independently standardized and governed collection of complementary services within a boundary that represents an enterprise or a meaningful segment of an enterprise.” (Thomas Erl)

• For each service the main implementable projections (FHIR, SOAP, XD* ...) are mapped
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Service Capabilities and Technical Projections

Functional Model

Technical Standard Projections

Taxonomy Table

Functional model to Interfaces mapping

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Patterns general structure

- The diagram is a simplified fragment of SPMS (OMG Structured Patterns Metamodel v1.2)
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Pattern Example

- This part of the RA is under development
The OMG BPM+Health Program is an interesting test area for HIRA.

The program released a Field Guide to Shareable Clinical Pathways focused on a model-based approach to define the workflow of care and decision-making at the level of granularity that reveals information needs.

The approach of the Field Guide is to apply standard techniques for business process modeling (BPMN and CMMN) and for decision modeling that are proven for other industries and apply them to the distinct aspects of the workflow of care and decision-making.
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HIRA and BPM+Health

- Beyond the BPM+ methods, after we have a sound model of a clinical pathway the issue is to select the appropriate standard specifications to support interoperability.
- Component of a Clinical patway are surely Decision Service and Workflow/Case management engine but we should also interoperate with several systems as: identification, ordering, scheduling, record management and terminology.
- Each workflow/case management imply an architecture that must be identified and designed.
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Reference

• OpenGroup, TOGAF (https://www.opengroup.org/togaf)
• ISO DIS 23903 (https://www.iso.org/standard/77337.html)
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Thank You

HSRA HL7 Confluence Page
https://confluence.hl7.org/pages/viewpage.action?pageId=35720450
ISO DIS 23903 Health Informatics – Interoperability and Integration Reference Architecture

Project Lead:

Prof. Dr. habil. Bernd Blobel, FACMI, FACHI, FHL7, FEFMI, MIAHSI
Professor and Former Head of the German National eHealth Competence Center at the Medical Faculty, University of Regensburg, Germany
Visiting Professor, First Medical Faculty, Charles University Prague, Czech Republic
Past-Chair HL7 Germany
Past-Chair, EFMI WGs “EHR” and “Security, Safety and Ethics” and Past Co-Chair of the HL7 Security WG
Past-Chair of the German Health Informatics Standards Mirror Group and Former Head of the German Delegation to ISO TC 215 and CEN TC 251
Objectives of ISO DIS 23903

• Translational medicine requires the advancement communication and cooperation from data level (data sharing) to concept/knowledge level (knowledge sharing).

• Data sharing between independently developed applications with proprietary data format is enabled by transferring them into a standardized EDI format defined by communication standards such as UN/EDIFACT, ebXML, ANSI X.12, HL7, etc.

• In analogy, cross-domain concept/knowledge sharing, mapping as well as integration of, and interoperability between, independently developed specifications and related products is enabled by transferring proprietary into a standardized concept representations without requiring any revisions.

• ISO 23903 is a system-oriented, architecture-centric, ontology-based, policy-driven approach including development processes following ISO 42010 and ISO 10746. Thereby, it extends the latter and details OMG’s Model Driven Architecture (MDA) Computation Independent Modeling.
Managing Knowledge-Based Interoperability in P5 Medicine

Interoperability and Integration Mediated by the ISO Interoperability and Integration Reference Architecture Model

- ICT Specs.
- Business Admin. Representations
- Medicine Representations
- Legal/Regulatory Affairs Representations
- Patient Representations
- Human Resources Representations
- Biomed. Technologies Representations
- Biology Representations
- Ethics Representations
- Health Professional Representations

Reference Architecture Model & Framework

EFMI

HL7 International
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ISO DIS 23903 Mandatory Architecture Model

- Business VP
- Enterprise VP
- Information VP
- Computational VP
- Engineering VP
- Technology VP

- Business Concepts
- Relations Networks
- Aggregations
- Details

Domain 1
Domain 2
Domain n

ICT Ontologies
Domain Ontologies
System Component Composition
System Domain
System Viewpoint
Managing Knowledge-Based Interoperability in P5 Medicine

ISO DIS 23903 Mandatory Framework

- Business Concepts
- Relations
- Aggregations
- Details
- Transformation/instantiation/specialization
- Harmonization (mapping, matching)

Domain 1
Domain 2
Domain n

Business VP
Enterprise VP
Information VP
Computational VP
Engineering VP
Technology VP

ICT Ontologies

ISO DIS 23903 Mandatory Framework
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ISO/IEC 21383 Upper Level Ontologies in ISO DIS 23903

Business VP
Enterprise VP
Information VP
Computational VP
Engineering VP
Technology VP

Domain n
Domain 2
Domain 1

Business Concepts
Relations Networks
Aggregations
Details

transformation/instantiation/specialization
harmonization (mapping, matching)

specialization / generalization
Managing Knowledge-Based Interoperability in P5 Medicine

System-theoretical, ontology-based, policy-driven abstract Interoperability Reference Architecture model and framework representing any system’s components, their functions and interrelations.

Existing domain-specific models, specifications and solutions

Harmonization and transformation using logics, meta-languages, etc., at the level needed

Formalized components, missing existing components, their functions and interrelations, re-engineered in the use-case-specific Interoperability Reference Architecture instance

Mapping of instances
Normative References and Conclusions

Normative References

- ISO/IEC 10746-1-4 *Information technology - Open distributed processing - Reference model*
- ISO 22600-1-3:2014 *Health informatics – Privilege management and access control*
- ISO/IEC DIS 21838-1-2 *Information technology – Top-level ontologies*
- OMG *Ontology Definition Metamodel V1.1*

Conclusions

- For participating in data exchange, all applications had to implement the interface to the chosen communication standard for being part in the game.
- In analogy, all systems, work products or artifacts developed independently under different perspectives and contexts (e.g. standards, components, FHIR resources, etc.) have to be formally represented according to ISO 23903 to interrelate them with other ones via integration or interoperability.
Thank you very much for your kind attention!
The presentations will be available through the EFMI Website.
If there are still questions or open issues, please feel free to contact the related presenter directly.