Ontology Mapping between HL7 Versions 2 and 3 and OpenEHR for Observations Messages

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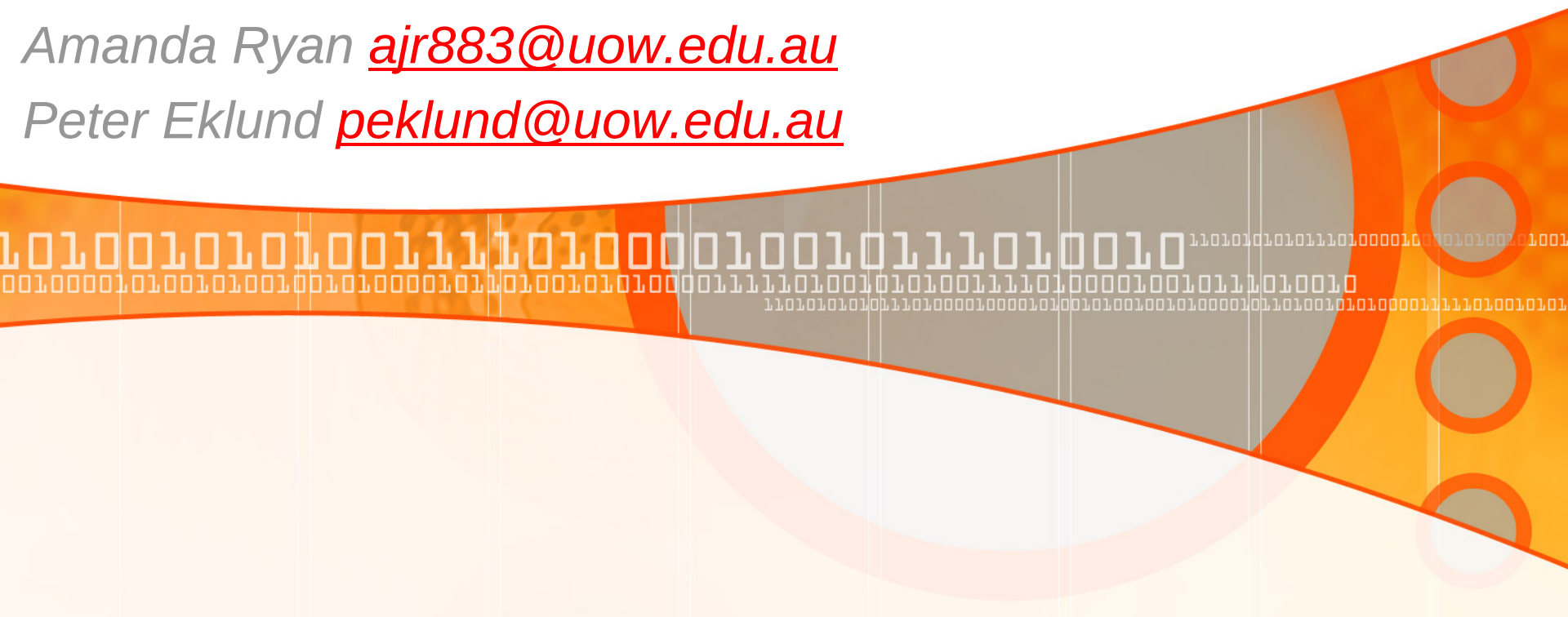


Outline

- *Background on Interoperability and Terminology*
- *HL7 Version 3 Message Models based on SNOMED CT*
- *Mapping between HL7 versions 2 and 3 datatypes*
- *XSLT Mapping between HL7 V2 and HL7 V3 XML*

Outline

- *OpenEHR Observations representation*
- *XSLT Mapping between HL7 V3 and OpenEHR XML*
- *Health Service Bus Interoperability Framework*

Interoperability in Healthcare

- *Three levels of Interoperability:*
  - *Technical*
  - *Semantic*
  - *Process*

- *Semantic Interoperability is the most difficult to solve, and the most important*

Three Levels of Interoperability

- *Technical Interoperability:*
  - simple connectivity - the ability to ensure that a message is exchanged completely and in correct format
- *Semantic Interoperability:*
  - the meaningful exchange of information in association with its context
  - communicating the intent or meaning of the data as well as message structure
- *Process Interoperability:*
  - refers to social or workflow engineering aspects of interoperability

The Role of Terminology

- *An important part of semantic interoperability*
  - *To ensure exact meaning is preserved from sender to receiver*
- *A defined set of terms means that everyone is talking about the same thing*
- *SNOMED CT is used within this work*

SNOMED CT

- *universal and international standard terminology for healthcare*
- *contains more than 344,000 active concepts*
- *most comprehensive clinical vocabulary available in any language*
- *Multiple-inheritance hierarchy of clinical concepts and their relationships*

HL7 Version 3

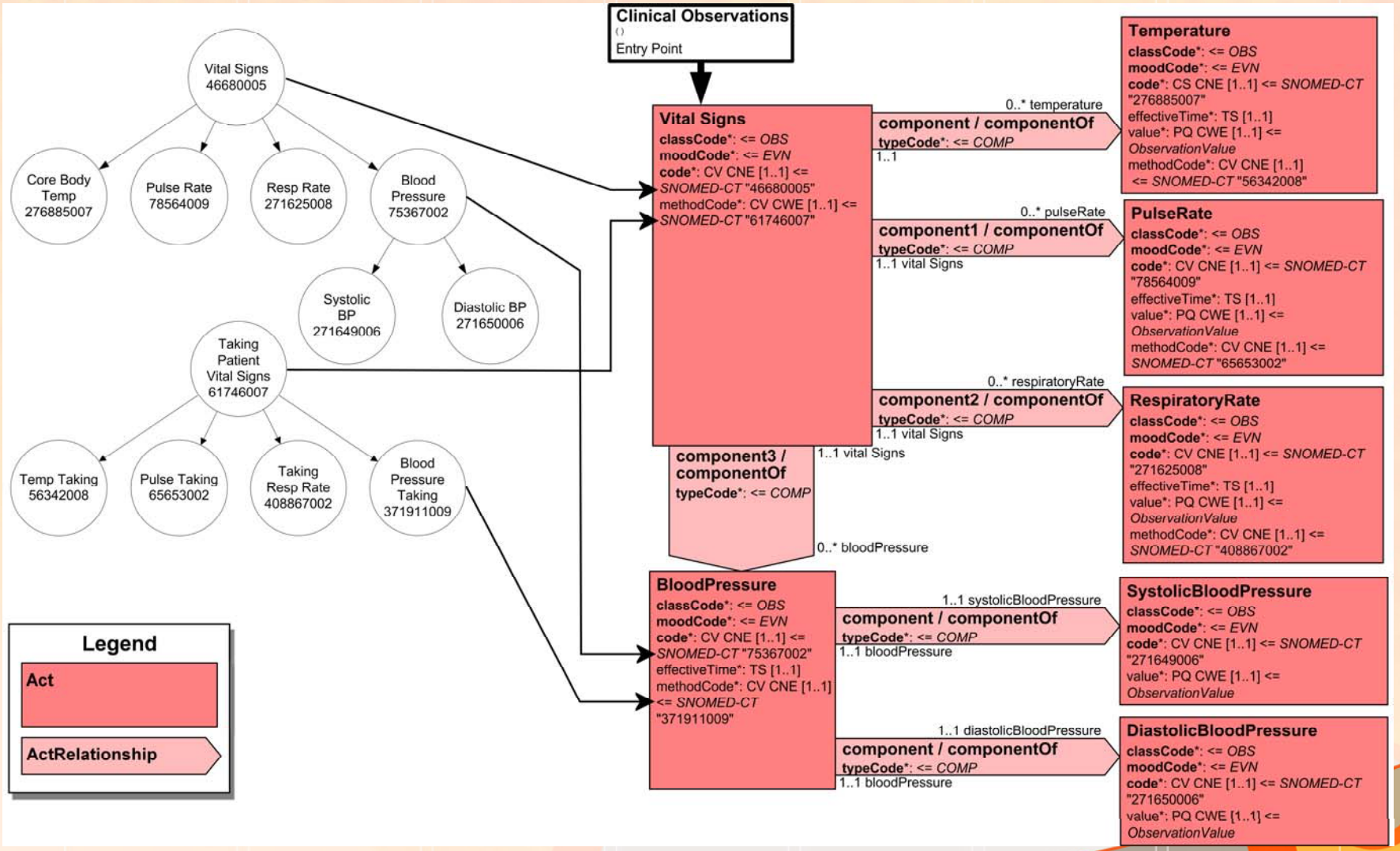
- *Object-Oriented method of modelling health constructs*
- *Based on a Reference Information Model (RIM) which is an object model in the form of a large Unified Modelling Language (UML) representation of clinical data*
- *HL7 Version 3 was chosen for our work because of its object-oriented nature and goals which are in line with the Semantic Web*

HL7 V3 Models based on SNOMED CT

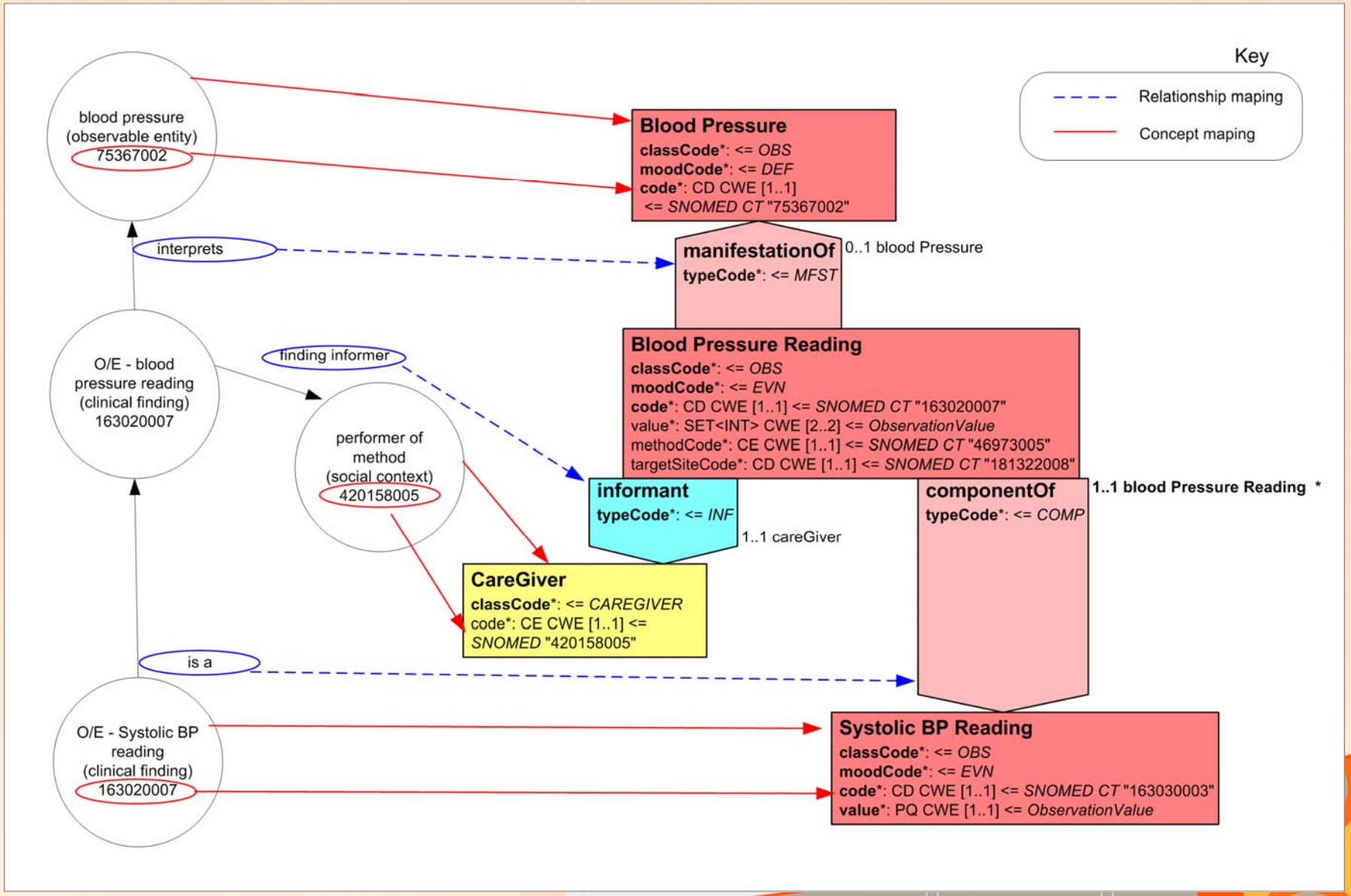
- *SNOMED CT contains clinical concepts with defined relationships to each other*

- *Basing HL7 models on the SNOMED CT constructs preserves relationships between concepts, as well as avoiding ambiguity via the use of terminology*

HL7 V3 Models based on SNOMED CT



HL7 V3 Models based on SNOMED CT



HL7 V3 Models based on SNOMED CT

- *The HL7 models based on SNOMED CT provide a representation of clinical concepts based on defined clinical constructs*

- *The next step is translation to other formats to open up more avenues of communication*

Mapping Between HL7 V3 and V2

- *HL7 Version 2 is still the most widely used version of HL7 in Australia*
- *HL7 Versions 2 and 3 both have defined XML specifications*
- *XSLT can be used to translate between the two in simple cases*
  - *Our case was clinical observations*

Mapping Between HL7 V3 and V2

- *All message models are made from the "building blocks" of datatypes*
- *Datatypes in HL7 Versions 2 and 3 are similar*
- *Start with mapping between the datatypes*

HL7 Datatype Mapping

Basic Data Types

Version 2	*Version 3*
ST String Data	*ST Character String*
NM Numeric	*INT Integer Number or REAL Real Number*
DTM Date/Time	*TS TimeStamp*
ID Coded Value for HL7-defined tables	*CS Coded Simple Value (used for coded values with a single HL7-defined value set)*

HL7 Datatype Mapping

More Complex Datatypes

Version 2	***Version 3***
NR Numeric Range *- Composed of 2 NMs for low and high value*	*IVL<INT> or IVL<REAL>* *- A set of consecutive INTs or REALs*
DR Date/Time Range *- Composed of 2 DTMs*	*IVL<TS> Interval of Time Stamps* *- A set of consecutive values of time-stamps*
CQ Composite Quantity with Units *- Composed of an NM and a CWE*	*PQ Physical Quantity* *- Composed of a REAL and a CS*

HL7 Datatype Mapping - Codes

- *An explanation of code types before going into mapping:*
  - *Code datatypes are types which are used to represent a code from a code table or a concept from an outside terminology, i.e. SNOMED CT*
  - *Code datatypes consist of the code itself, the name of the terminology the code is from, and other details of the code and coding system.*

HL7 Datatype Mapping - Codes

Code Field Mapping

HL7 Version 2 – CNE	***HL7 Version 3 – CE***
Identifier (ST)	*Code (ST)*
Text (ST)	*Display Name (ST)*
Name of Coding System (ID TBL#0396)	*Code System (UID)*
	Code System Name (ST)
Code System Version Id (ST)	*Code System Version (ST)*
Original Text (ST)	*Original Text (ST)*
Alternate Code Fields	*Translation (SET<CE>)*

HL7 Datatype Mapping - Codes

Explanation of Mapping Code System ID

- *The V2 field "Name of Coding System" is an ID*
- *Recall an ID is a code from a HL7-defined table, in this case Table #0396*
- *To translate between V2 and V3, a mapping of this table to the UIDs (universal identifiers) of terminologies is required*
- *Translating from this field to the V3 field "Code System" is now done through this mapping table, and vice versa*

HL7 Datatype Mapping - Codes

Explanation of Mapping Code System ID

- *V3 also has the field "Code System Name" to assist in human-readability – the UID is a series of numbers. The V2 "Name of Coding System" is copied directly into this field.*

- *In our work, we exclusively used SNOMED CT which cut down some of this mapping cost*

HL7 Datatype Mapping - Address

Some Background:

- *V2 has the datatype Street Address (SAD):*

V2 SAD
Street or Mailing Address (ST)
Street Name (ST)
Dwelling Number (ST)

- *V3 has the datatype Address Part (ADXP):*
  - *Is actually a ST*

V3 ADXP
Part Type (CS)

HL7 Datatype Mapping - Address

V2 Extended Address XAD	***V3 Postal Address AD***
Street Address (SAD)	*Street Address Line (ADXP) or House Number (ADXP) and Street Name (ADXP)*
Other Designation (ST)	*Additional Locator (ADXP)*
City (ST)	*City (ADXP)*
State or Province (ST)	*State or Province (ADXP)*
Zip or Postal Code (ST)	*Postal Code (ADXP)*
Country (ID TBL #0399)	*Country (ADXP)*
Address Type (ID TBL #0190)	*Use Code (CS Table 20)*

And etc for other more obscure address parts…

HL7 Datatype Mapping - Address

'Address Type' to 'Use Code' Table Mapping

V2 Table 0190	***V3 Table 20***
H Home	*H Home Address*
	HP Primary Home
C Current or Temporary	*TMP Temporary*
V Vacation	*HV Vacation Home*
O Office/Business	*WP Work Place*
BA Bad Address	*BAD Bad Address*

HL7 Datatype Mapping

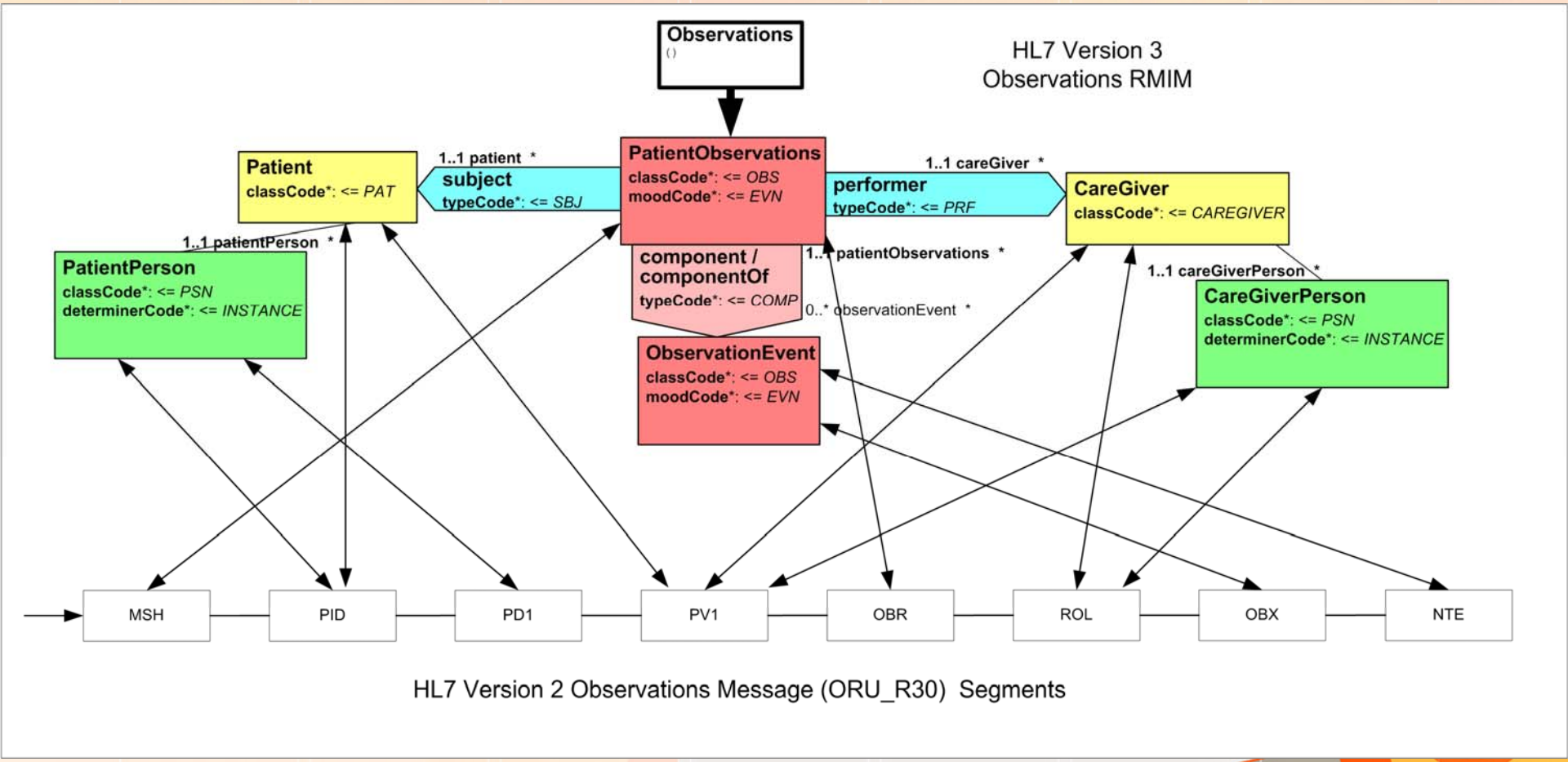
- *Other complex datatypes of the same nature as address such as Person Name (PN) were mapped in the same way.*

- *The datatype mapping prepared us for the message model mapping, which is a very similar process due to the nature of the datatypes*

Mapping Between HL7 V3 and V2

- *Case Study: Observations Messages*
- *The HL7 V3 models developed based on SNOMED CT are for Clinical Observations messages*
- *The Version 2 Observations message model we mapped these models to is the ORU message model, referring to “Point-of-Care Observations”*

Mapping Between HL7 V3 and V2



Mapping Between HL7 V3 and V2

V2 field	description	mapping to V3 (class::attribute)
PID.3	Patient Identifier List	patient::id
PID.5	Patient Name	patientPerson::name
PID.7	Date/Time of Birth	patientPerson::birthTime
PID.8	Administrative Sex	patientPerson::administrative-GenderCode
PID.11	Patient Address	patient::addr
PID.13	Phone Number - home	patient::telecom
PID.14	Phone Number - business	patient::telecom

V2 Patient XML

```
<PID>
    <!-- Patient Id -->
    <PID.3>
        <CX.1>012</CX.1>
    </PID.3>
    <!-- Patient Name -->
    <PID.5>
        <XPN.1>
            <FN.1>Ryan</FN.1>
        </XPN.1>
        <XPN.2>Amanda</XPN.2>
        <XPN.3>Joanne</XPN.3>
        <XPN.7>L</XPN.7>
    </PID.5>
    <!-- Date/Time of Birth -->
    <PID.7>
        <DTM>19810510</DTM>
    </PID.7>
    <!-- Administrative Sex -->
    <PID.8>F</PID.8>
</PID>
```

V3 Patient XML

```
<subject>
    <patient>
        <id root="UoW" id="012" />
        <patientPerson>
            <name>
                <given>Amanda</given>
                <given>Joanne</given>
                <family>Ryan</family>
            </name>
            <administrativeGenderCode code="248152002"
                codeSystem="2.16.840.1.113883.19.6.96"
                codeSystemName="SNOMED CT"
                displayName="female" />
            <birthTime>19810510</birthTime>
        </patientPerson>
    </patient>
</subject>
```

V2 to V3 XSLT

```
<subject>
    <patient>
        <id root="UoW">
            <xsl:attribute name="id">
                <xsl:value-of select="/PID/PID.3/CX.1"/>
        </xsl:attribute>
        </id>
        <patientPerson>
            <name>
                <given>
                    <xsl:value-of select="/PID/PID.5/XPN.2"/>
                </given>
                <given>
                    <xsl:value-of select="/PID/PID.5/XPN.3"/>
                </given>
                <family>
                    <xsl:value-of select="/PID/PID.5/XPN.1/FN.1"/>
                </family>
            </name>
        </patientPerson>
```

V2 to V3 XSLT – Code translation

```
<administrativeGenderCode>
    <xsl:attribute name="code">
        <xsl:choose>
            <xsl:when test="/PID/PID.8 = 'F'">
                <xsl:text>248152002</xsl:text>
            </xsl:when>
            <xsl:when test="/PID/PID.8 = 'M'">
                <xsl:text>248153007</xsl:text>
            </xsl:when>
            <xsl:when test="/PID/PID.8 = 'U'">
                <xsl:text>394743007</xsl:text>
            </xsl:when>
            <xsl:when test="/PID/PID.8 = 'T'">
                <xsl:text>365873007</xsl:text>
            </xsl:when>
            <xsl:when test="/PID/PID.8 = 'N'">
                <xsl:text>394744001</xsl:text>
            </xsl:when>
        </xsl:choose>
    </xsl:attribute>
```

HL7 XSLT Mapping Summary

- *Full XSLT mappings were completed in both directions (from V2 to V3 and from V3 to V2), in the case of observations messages*
- *This is a lightweight solution to mapping, which was sufficient for our application*
- *Future ideas are to create an XML database of XSLT "chunks" and create a translation engine which will query the DB for chunks on an element-by-element basis and be able to carry out a more general translation between versions*

Mapping to Other Standards

- *HL7 Version 3 is a good standard for messaging*
- *Other standards are better for other purposes, e.g. OpenEHR for Health Records*
- *Mapping from HL7 V3 to OpenEHR can ensure semantic meaning from messages can be continued into a continuous record of care*

OpenEHR Observations

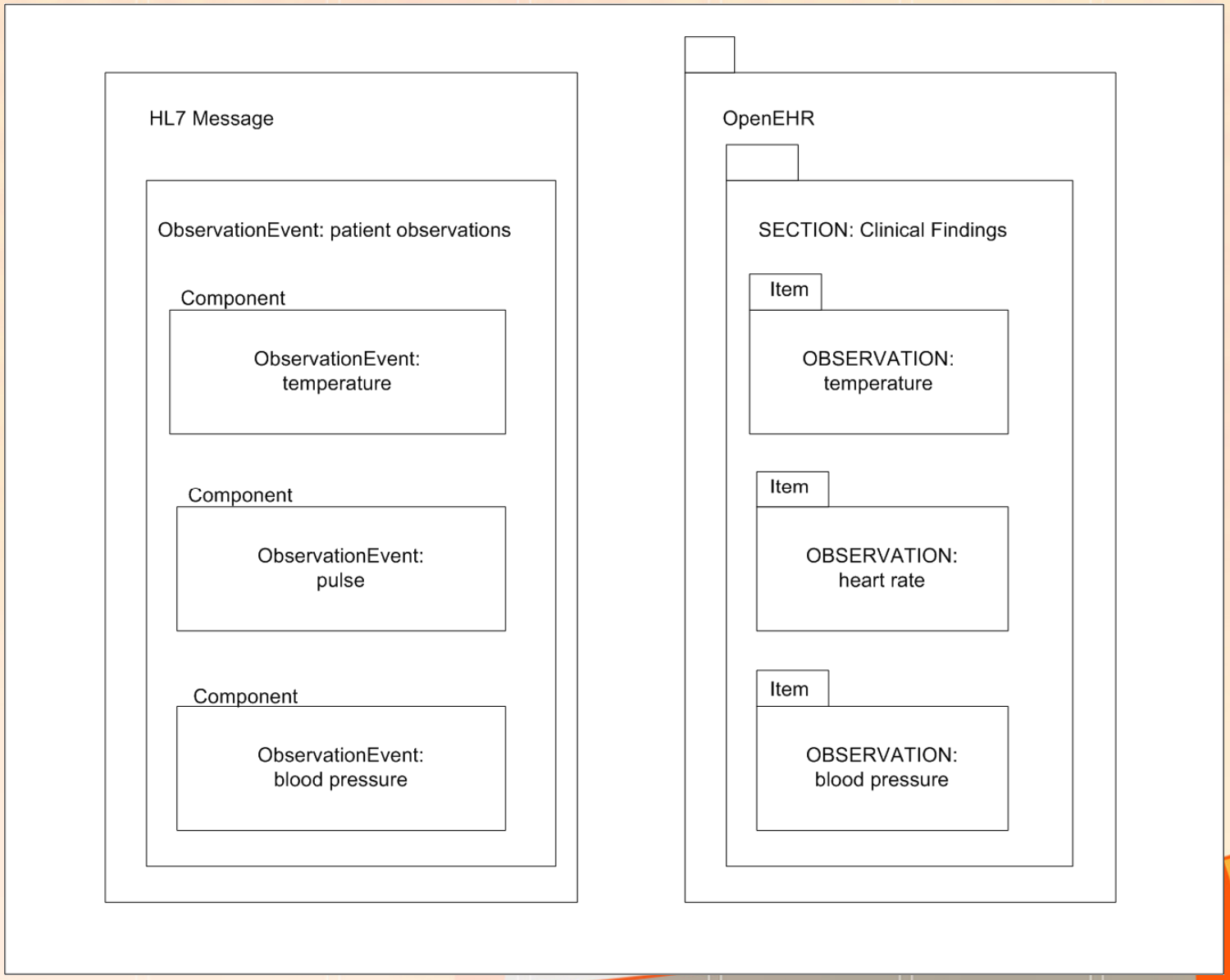
- *OpenEHR is built on the principle of a two-layer modelling approach*
  - *Information model - a reference model of generic concepts describing the structure of health records*
  - *Domain model - specific constructs of health such as “blood pressure observation”, called archetypes*
- *The OpenEHR archetype employed in our work was the Clinical Findings Section, which is composed of Observation Entries*

OpenEHR and HL7 V3

- *The structure of the OpenEHR Clinical Findings archetype is very similar to the structure of our HL7 model*

- *A more direct translation from one model to the other was carried out in this case, without mapping every data type first*

OpenEHR and HL7 V3



HL7 V3 Observations XML

```
<observationEvent>
    <code code="75367002" codeSystem="2.16.840.1.113883.19.6.96"
          codeSystemName="SNOMED CT"
          displayName="blood pressure" />
    <effectiveTime value="200705031011" />
    <methodCode code="371911009" codeSystem="2.16.840.1.113883.19.6.96"
          codeSystemName="SNOMED CT"
          displayName="measurement of blood pressure using cuff method" />
    <component contextControlCode="OP">
          <observationEvent>
                <code code="407554009" codeSystem="2.16.840.1.113883.19.6.96"
                      codeSystemName="SNOMED CT"
                      displayName="sitting systolic blood pressure" />
                <value value="120" units="mm[Hg]" />
          </observationEvent>
    </component>
    <component contextControlCode="OP">
          <observationEvent>
                <code code="407555005" codeSystem="2.16.840.1.113883.19.6.96"
                codeSystemName="SNOMED CT"
                displayName="sitting diastolic blood pressure" />
                <value value="60" units="mm[Hg]" />
          </observationEvent>
    </component>
</ObservationEvent>
```

OpenEHR Observations XML

```
<ITEM_LIST archetype_node_id="at0003">
    <name>
        <value>blood pressure</value>
        <mappings>
            <match>at0003</match>
            <target>
                <terminology_id>SNOMED-CT(2007)</terminology_id>
                <code_string> 75367002 </code_string>
            </target>
        </mappings>
    </name>
    <items>
        <ELEMENT archetype_node_id="at0004">
            <name>
                <value>systolic</value>
                <mappings>
                    <match>at0004</match>
                    <target>
                        <terminology_id>SNOMED-CT(2007)</terminology_id>
                        <code_string> 407554009 </code_string>
                    </target>
                </mappings>
            </name>
            <value>
                <magnitude>120</magnitude>
                <units>mm[Hg]</units>
            </value>
        </ELEMENT>
```

OpenEHR Observations XML

```
<state>
    <ITEM_LIST archetype_node_id="at0007">
    <name>
        <value>state structure</value>
     </name>
    <items>
        <ELEMENT archetype_node_id="at0008">
            <name>
                <value>position</value>
             </name>
                <value>
                    <value>sitting</value>
                    <defining_code>
                        <terminology_id>local</terminology_id>
                        <code_string>at1001</code_string>
                    </defining_code>
                </value>
         </ELEMENT>
   </items>
   </ITEM_LIST>
</state>
```

HL7 to OpenEHR Mapping Summary

- *Full XSLT mappings were completed in both directions in the case of observations messages, just as between HL7 v2 and V3*
- *To translate from HL7 V2, first translate to V3 and then to OpenEHR.*
- *Again, this is a lightweight solution to mapping, which was sufficient for our application*
- *Future work in this direction would be to find a better solution for translating patient state information, starting with how to represent this information in HL7 V3.*

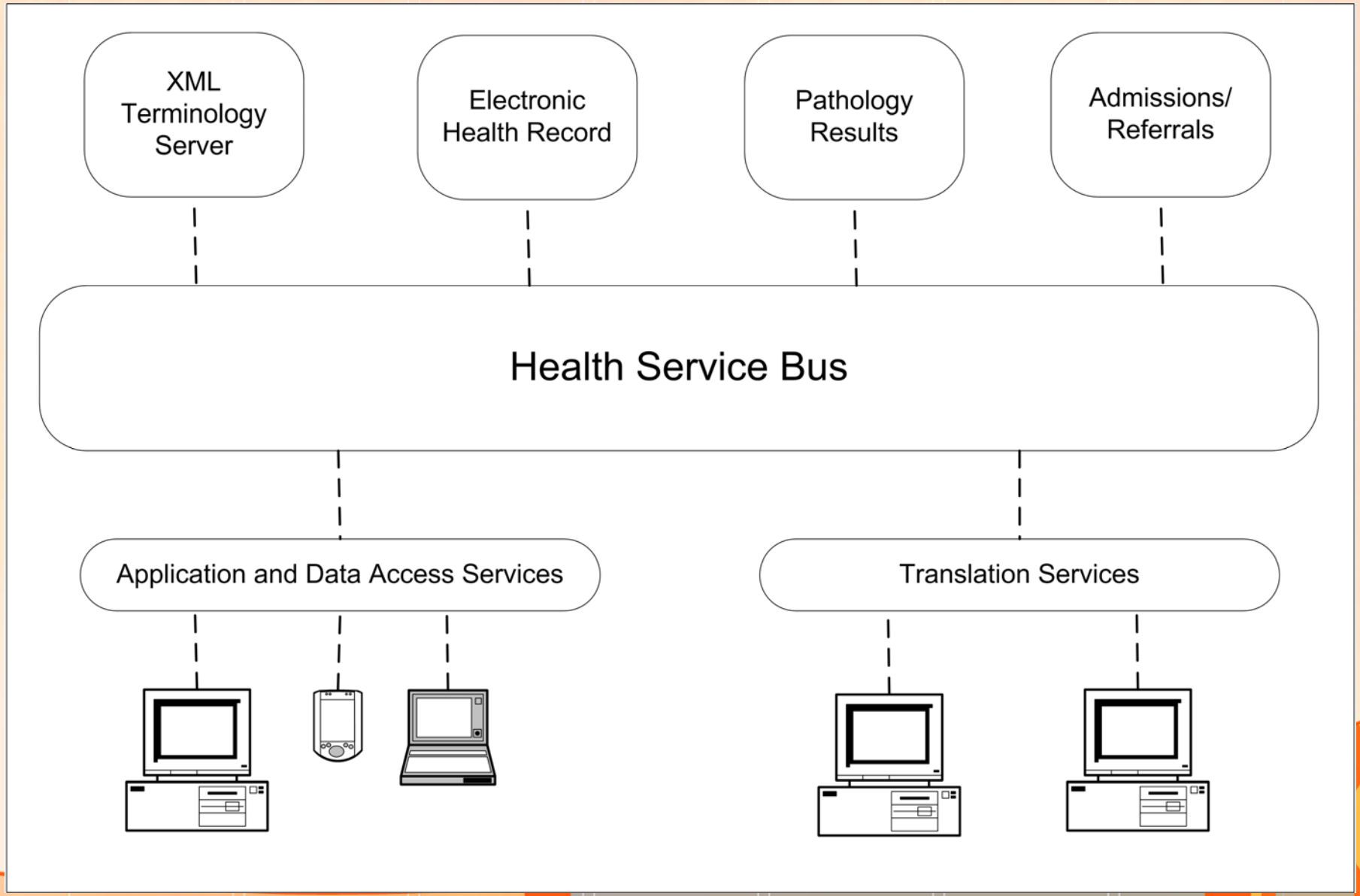
Health Service Bus

- *The resulting XSLT from mapping between these standards was used within a health interoperability framework called the Health Service Bus (HSB).*
- *Referring back to the three definitions of interoperability, the HSB framework provides technical and process interoperability*
- *The standards-based XML messages, terminology and translations provide semantic interoperability*

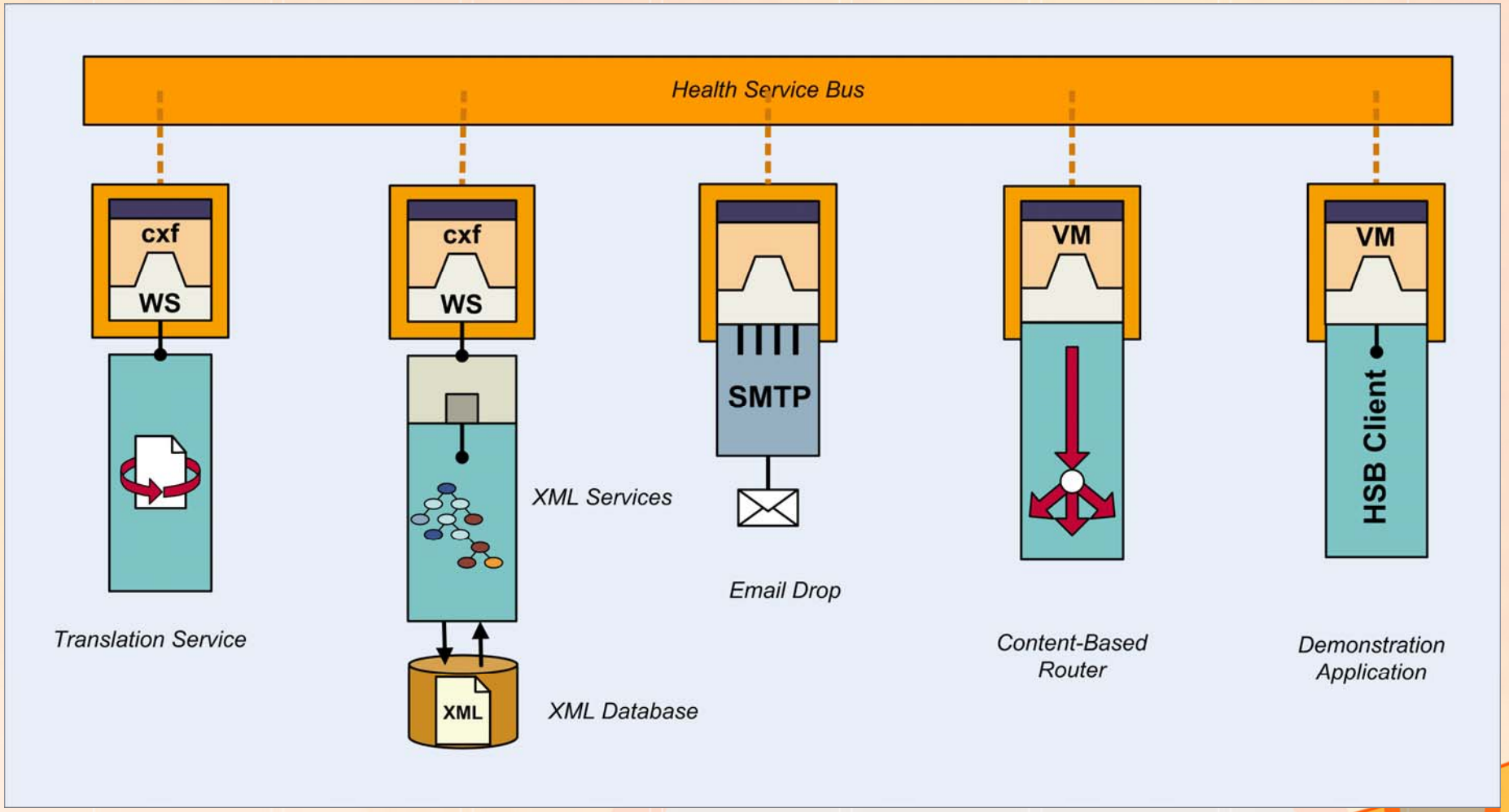
Health Service Bus

- *Based on Enterprise Service Bus architecture*
- *distributed enterprise integration solution*
- *provides communication between disparate health systems which can all be connected*

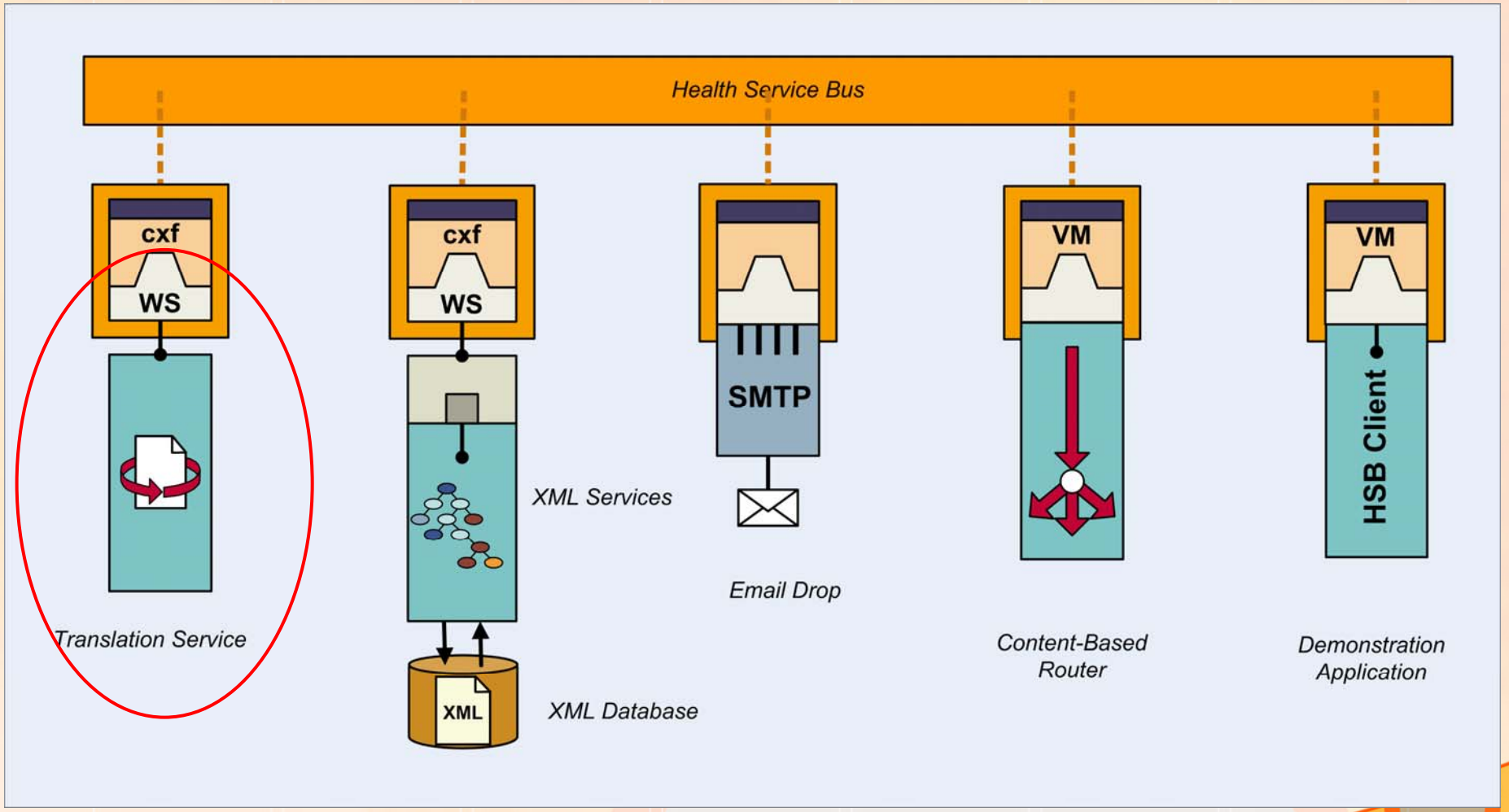
Health Service Bus



Health Service Bus



Health Service Bus



Conclusions

- *There are many standards and terminologies used in Health Informatics for different purposes.*

- *Mapping different information models and terminology structures can enable semantic interoperability:*
  - *Communication may be achieved between systems using differing standards*
  - *Exploiting the strong points of each and using standards harmoniously enriches the overall data model.*

Conclusions

- *Mapping HL7 Versions 2 and 3 allows communication with legacy systems.*
- *Mapping HL7 to OpenEHR allows continuing exact semantic meaning into the EHR.*
- *Heavy-weight systems are not always needed to translate between health standards – a working knowledge of the standards and some XML is all that is needed in simple cases to create a practical translation solution.*

Thankyou

Questions?

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