DIM UML development

- Initial UML model programmatically derived from 11073-10201:2004 in early 2012
- Work on applications begun FY 2013
- Manual revisions performed
- Supporting models integrated
  ○ IEEE11073:10101 Nomenclature (RTMMS)
  ○ IEEE11073:20101 (ASN.1 Simple Types)
  ○ Device Profiles
  ○ Metamodel (represents 10201 UML in web applications)
  ○ Printed Standard
  ○ Conformance Statements (work in progress)
This shows only the classes defined by the standard. There are ~350 classifiers total in the DIM model. The Device Profiling application relies on several other supporting models (MetaInformation, Nomenclature, DeviceProfile, etc.) that interact with the DIM model. The Device Profiling application implements ~440 classes specific to the application.
The Model is the Standard

Why?

- Computable
- Artifacts programmatically derived from a common source help to ensure harmonization.
  - Printed Standard
  - Software tools (Device Profiling, Validation, ...)
  - XML Schema
  - Conformance Statements
UML to Artifacts: Challenges

● UML (or UML tools) has trouble expressing some constructs in a convenient way
  ○ Class instance variables
  ○ BNF (i.e. ASN.1)
  ○ BIT STRING

● Each UML element type used has to be implemented for each builder plugin that produces an artifact. Lots of work the first time you do it and every time you build a new plugin.

● Keep the standard ‘pure’ vs. supporting the functionality that artifacts require.
Programmatically Derived / Generated From UML

- Device Profile Editor web application
  - ~ 3,000 lines of in-memory code per classifier
- XML Schema
- ASN.1
- Relational database schema
- Rich Ruby API for interacting with DIM objects
- .docx
- JSON meta-information
Workflow (Simplified)

- MagicDraw
  - Create / Edit UML

- Prometheus Plug-ins
  - Ruby implementation of UML
  - GUI specification for interaction with modeled entities
  - Relational Database Schema
  - JSON that be parsed into a Java implementation of the UML

- XML Schema

- Hand written code

- Integrated Web Applications
  - Device Profiling Tool
  - Model Manager
  - Document Creation Tool

- PDF of Standard
  - Formatted ASN.1
API Example

```ruby
p = MyDevice::PCDProfile.create(name: "Infusion", intended_use: 'Normative (11073)', purpose: 'Demonstration')
mds = DIM::System::SinglePatientMDS.create(name: "Infusion Pump MDS")
mds.set_ref_id "MDC_DEV_PUMP_INFUS_MDS"
p.profileroot = mds
p.save
v = DIM::Medical::VMD.create(name: "Infusion Pump VMD")
v.set_ref_id "MDC_DEV_PUMP_INFUS_VMD"
mds.vmds_add v
mds.save
delivery_ch = DIM::Medical::Channel.create(:name => "Delivery Channel")
v.channels_add delivery_ch
delivery_ch.set_ref_id "MDC_DEV_PUMP_INFUS_CHAN_DELIVERY"
```
API in REPL

main 003(0) > DIM::Medical::VMD.first

=> #<DIM::Medical::VMD @values={:id=>1, :class_reserved_id=>nil, :name_binding_id=>nil, :ref_id_id=>5818, :ext_obj_relations_id=>nil, :ext_obj_relations_class=>nil, :label_string_id=>nil, :label_string_class=>nil, :type_id=>nil, :locale_id=>nil, :locale_class=>nil, :alertoralertstatus_id=>nil, :alertoralertstatus_class=>nil, :position_id=>nil, :position_class=>nil, :compatibility_id_dim_id=>nil, :compatibility_id_dim_class=>nil, :operating_hours_id=>nil, :operating_hours_class=>nil, :operation_cycles_id=>nil, :operation_cycles_class=>nil, :instance_number_id=>nil, :vmd_model_id=>nil, :vmd_status=>nil, :measurement_principle=>nil}>

main 011(0) > DIM::Medical::VMD.attributes.keys #=> [:vmd_status, :measurement_principle]

main 012(0) > DIM::Medical::VMD.associations.keys

Device Profile Editor
Existing Capabilities 1/3

● Assemble DIM objects into device profile containment trees.
  ○ Composition constrained by the standard
  ○ View the containment tree

● Allow creation of Normative (11073-103xx) and User Defined device profiles.

● Use any device profile as a template for a new device profile via cloning
New Features: Composition Tree Pane, Mandatory Attributes Listed, Attribute Types Shown (mostly)
Device Profile Editor
Existing Capabilities 2/3

- Allow user to view metadata about DIM classes and attributes (i.e. what is found in the paper standard)
- Associate device profile elements with terms from RTMMS.
- Fetch new and updated terms from RTMMS.
Examples from RTMMS web service created by Nicolas Crouzier @ NIST:

```json
[{
  "referenceId": "MDC_AREA_BODY_SURF_ACTUAL",
  "termCode": 188744,
  "systematicName": "Area | Actual | BodySurface | Body",
  "commonTerm": "Patient body surface area",
  "acronym": "",
  "termDescription": "The actual body surface area of the patient, calculated from patient actual weight and patient actual length.",
  "updateDate": "Oct 31, 2014 4:03:33 PM",
  "status": "APPROVED",
  "type": "METRIC",
  "sources": ["HRTM", "RTM"],
  "units": ["MDC_DIM_SQ_X_M"]
},
{
  "referenceId": "MDC_ATTR_AL_COND",
  "termCode": 68012,
  "systematicName": "",
  "commonTerm": "",
  "acronym": "",
  "termDescription": "",
  "updateDate": "Dec 17, 2014 5:49:55 PM",
  "status": "APPROVED",
  "type": "ENUMERATION",
  "sources": ["HRTM", "RTM"],
},
{
  "referenceId": "MDC_EVT_STANDBY_WARN",
  "termCode": 258048,
  "systematicName": "",
  "commonTerm": "",
  "acronym": "",
  "termDescription": "",
  "updateDate": "Nov 7, 2014 4:24:18 PM",
  "status": "APPROVED",
  "type": "LITERAL",
  "sources": ["RTM"]
},
{
  "referenceId": "pump-stopped-transitioning",
  "updateDate": "Nov 7, 2014 4:29:22 PM",
  "status": "PROPOSED",
  "type": "TOKEN",
  "sources": ["RTM"]
},
{
  "referenceId": "_UOM_CONC_GAS",
  "type": "UNITGROUP",
  "sources": ["RTM"],
  "units": ["MDC_DIM_PERCENT", "MDC_DIM_VOL_PERCENT", "MDC_DIM_KILO_PASCAL", "MDC_DIM_MMHG"]
},
{
  "referenceId": "_MDC_ATTR_AL_COND_DELETED",
  "type": "ENUMGROUP",
  "sources": ["RTM"],
  "enums": ["MDC_EVT_SYRINGE_NUT_ENGAGED", "MDC_EVT_SYRINGE_PATIENT_PRESSURE_ALARM", "MDC_EVT_SYRINGE_PRESSURE_DISC", "MDC_EVT_SYRINGE_PLUNGER", "MDC_EVT_HANDSET_DETACHED", "MDC_EVT_SYRINGE_FLANGE", "MDC_EVT_SYRINGE_LEVER"]
}]
```

* New features in bold.
Device Profile Editor
Existing Capabilities 3/3

- Summary XML (Rosetta Containment Hierarchy) representation of a device profile
- Detailed HTML report of containment and terminology
- Comprehensive representation of Device Profile in XML
- Comprehensive representation of Device Profile in JSON (same info as XML, different format).
PCD Profile: Test Pulse Ox

Purpose: For testing
Intended Use: Normative (11073)
Owning Company: C4MI

Containment Tree

<table>
<thead>
<tr>
<th>MDI Prototyping Project PulsOx MDS (SinglePatientMDS)</th>
<th>MDC_DEV_ANALYZE_SAT_O2_MDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PulsOxim AlertMonitor (AlertMonitor)</td>
<td>MDC_MOC_VMO_AL_MON</td>
</tr>
<tr>
<td>Alert Scanner (AlertScanner)</td>
<td>Untyped</td>
</tr>
<tr>
<td>MDC_DEV_ANALYZE_SAT_O2_VMD (VMD)</td>
<td>MDC_DEV_ANALYZE_SAT_O2_VMD</td>
</tr>
<tr>
<td>MDC_DEV_ANALYZE_SAT_O2_CHAN (Channel)</td>
<td>MDC_DEV_ANALYZE_SAT_O2_CHAN</td>
</tr>
<tr>
<td>MDC_DEV_PULS_CHAN (Channel)</td>
<td>MDC_DEV_PULS_CHAN</td>
</tr>
</tbody>
</table>

Object Details

SinglePatientMDS: MDI Prototyping Project PulsOx MDS

MDC_DEV_ANALYZE_SAT_O2_MDS

AlertMonitor: PulsOxim AlertMonitor

MDC_MOC_VMO_AL_MON

AlertScanner: Alert Scanner

VMD: MDC_DEV_ANALYZE_SAT_O2_VMD

MDC_DEV_ANALYZE_SAT_O2_VMD

Channel: MDC_DEV_ANALYZE_SAT_O2_CHAN

MDC_DEV_ANALYZE_SAT_O2_CHAN
<?xml version="1.0" encoding="UTF-8"?>
<PCDProfile company_owner="C4MI" intended_use="Normative (11073)" name="Test Pulse Ox" profile_mode="Baseline" profile_type="Agent" purpose="For testing" xml_date="2015-01-22 01:06:15 +0000" description_content="" xmlns="http:prometheuscomputing.com/schemas/dim"
xmlns:="http:prometheuscomputing.com/schemas/dim">
<single_patient_mds cardinality="1" system_capability="sc-multiple-context" application_area="area-unspec" line_frequency="line-f-60hz" mds_status="disconnected" patient_type="adult" power_status="onMains" class="NO_REF_ID::Unknown" name_binding="MDC_ATTR_ID_HANDLE::2337" handle="">
<system_type partition="nom-part-obj" code="MDC_DEV_ANALY SAT_O2_MDS::4105"/>
<nomenclature_version nom_major_version="majorVersion1" nom_minor_version="1"/>
<system_model manufacturer="" model_number=""/>
<production_specification spec_type="serial-number" prod_spec="" component_id_dim=""/>
<production_specification spec_type="protocol-revision" prod_spec="" component_id_dim=""/>
<locale charset="charset-unspec" country="" language="" str_spec=""/>
<scanner cardinality="1" operational_state="" handle="55" reporting_interval="2"/>
<vmds cardinality="1" vmd_status="vmd-standby" handle="">
<type partition="nom-part-metric" code="MDC_DEV_ANALY SAT_O2 VMD::4106"/>
<channels cardinality="1" handle="">
<type partition="nom-part-obj" code="MDC_DEV_ANALY SAT_O2_CHAN::4107"/>
<metric cardinality="1" handle="">
<type partition="nom-part-metric" code="MDC_PULS_OXIM SAT_O2::150456"/>
<metric_specification access="sc-opt-normal" category="auto-measurement" relevance="rv-unspec" update_period="8192">
...
Recent Efforts

- Implementation of object level read/write permissions via [NIST Policy Machine](#) (still in progress)
- Improvements to “Model Manager” application
- Generation of MS Word artifacts for DIM classes and ASN.1 data types.
- Review of “Revisions and Comments” spreadsheet
FY2016 Remaining Goals 1/2

● Finish implementation of r/w permissions in web application
● Comprehensive audit of updated DIM model / application with respect to 11073:10201© 2004
● Easier access to metadata and information from the DIM standard for device profile users
FY2016 Remaining Goals 2/2

- User documentation / help for device profiling application
- Move from Alpha to Beta testing to release
- Deploy to NIST server
- Resolve critical issues on “Revisions & Comments”
- Release Device Profiling app for general use
- Generate camera ready IEEE standard in MS Word
- Conformance statements from the profile editor
dim.prometheuscomputing.com

user: dim
password: 11073
Alpha / Beta Testing

- Create base/normative profiles
- Create device profiles from cloned normative profiles
- Use output XML and provide feedback
- Use XML schema as input to C4MI tools
Questions? Comments?

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