Vendor-Neutral Instrumentation Configuration with IHAL and the IHAL API

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John L. Hamilton
Knowledge Based Systems, Inc.
Agenda

- Problem and Solution
- IHAL Background
- What is IHAL?
- What is the IHAL API?
- RCC Standardization
- Multi-vendor Demonstration
- IHAL Language Overview
- Related Reading
- Points of Contact
- Discussions and Questions
The Problem

Diverse ISS Development Environments

Vendor-Specific Hardware Representations

N x M Translations

Version Management

ISS 1

ISS 2

ISS 3

ISS m

Hardware Component 1

Hardware Component 2

Hardware Component 3

Hardware Component 4

Hardware Component n
The Solution

ISS 1
ISS 2
ISS 3
ISS m

Hardware Component 1
Hardware Component 2
Hardware Component 3
Hardware Component 4
Hardware Component n

Ease of Integration
XML-Based
N + M Translations
Vendor Neutral

IHAL
IHAL Background

- Initially Developed by Knowledge Based Systems, Inc. (KBSI)
- Sponsored by Edwards AFFTC as a Small Business Innovative Research (SBIR) project.
  - Currently in Phase II
- Currently being reviewed by the RCC Telemetry Group for standardization
  - 2-year process
  - Managed by the Vehicular Instrumentation/Transducer Committee
What is IHAL?

- “Instrumentation Hardware Abstraction Language”
- XML-Based
- Vendor-neutral way to describe and configure instrumentation hardware.
- Focus is on the “configurable attributes” (i.e. settings) available on each device.
What is the IHAL API?

- Application Programming Interface
- A defined set of functions implementable by vendors that provides an interface into existing configuration engines.
- Each function takes IHAL text as input, and outputs descriptions in IHAL.
- Implemented as a RESTful Web Service
  - Net-centric
  - Language and platform independent
Purpose of the API

- Enables a single, standards-based application to configure multiple vendors’ hardware
- Enables configuration as an interactive process
  - Request a setting change, receive immediate feedback.
- Eliminates the need to expose vendor proprietary configuration logic
Purpose of the API

Standards - based Software
- Instrumentation Visualization
- Instrumentation Selection
- Instrumentation Configuration

Vendor Proprietary Software (Multiple Vendors)
- Hardware Programming
- Configuration Logic

IHAL API Implementation
- Request configuration
- IHAL Hardware Tree
- IHAL configuration change
- IHAL Impact

IHAL Hardware

Instrumentation Configuration

Logic Rules for parameter setting

Standards - based Software
- Instrumentation Visualization
- Instrumentation Selection
- Instrumentation Configuration

Vendor Proprietary Software (Multiple Vendors)
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IHAL API Implementation
- Request configuration
- IHAL Hardware Tree
- IHAL configuration change
- IHAL Impact

Logic Rules for parameter setting
RCC Standardization

- Develop a standard for describing instrumentation hardware.
  - Follows in the same spirit as the original intention of the TMATS ‘H’ section.
- Make use of the progress already achieved by KBSI with the IHAL project.
- Includes both a language AND an API specification
- 2 year duration
RCC Standardization

- **Working Group Composition**
  - VI/T Committee Members (Government)
  - Instrumentation Vendors
  - KBSI Team Members
  - Other T&E Community members (Government & Private)

- **Task Coordination**
  - Monthly Telecons
  - Online Collaboration Portal

- **Current Status**
  - End of 1st year in September 2011
  - Multi-Vendor Demonstration held at ITC 2011
  - Pink Sheet Review starting in June 2012
  - Final Publication Expected in IRIG 106-13
Multi-vendor IHAL Demonstration

- Displayed in KBSI’s booth at ITC 2011
- Interfaced with 2 different vendors
- KBSI’s InstrumentMap™ as client
- Configured 3 analog signal conditioners from each vendor
- Utilized 4 IHAL API Function calls
  - Get Configuration List
  - Get Specific Configuration
  - Get Instrument Pool
  - Modify Existing Configuration
IHAL – LANGUAGE DETAILS
IHAL Overview

- Describes Instrumentation at 2 levels:
  - The “Pool” level: describes hardware according to its capabilities and configurability.
    - Model #
    - What does it do?
    - How can it be configured?
  - The “Use” level: describes a specific configuration of instrumentation hardware.
    - Serial #
    - How is it currently configured?
    - What is it currently connected to?
IHAL Overview

**Use** - Level

**Pool** - Level
IHAL Pool

- All of the information you would typically find in a spec sheet.
  - Size, weight, power consumption, etc.
  - Number of channels
  - Functions the device performs
  - Settings that are configurable, and what values they can be set to.
IHALL Pool - Card

**Unique ID**
- **id**: Unique identifier.

**Descriptive Info**
- **name**: Descriptive characteristics of the device.
- **customID**: An optional customID to be used by vendor or 3rd-party applications.
- **manufacturerName**: The name of the manufacturer of the instrument or transducer.
- **partNumber**: The instrument or transducer part number.

**Functionality And Settings**
- **additionalHardware**: Additional hardware functionalities.

A card is an instrument that cannot operate stand-alone. It must be connected to another instrument in order to function.
This card has 8 of these channels

Channel Description

Channel performs the “analog signal conditioning” function

Descriptive Info
IHAL Functions

- Part of a device’s pool-level description
- Define a unit of functionality
- May be associated with a specific channel (for multi-channel devices)
- Composed of:
  - Attributes (either configurable or not)
  - Sub-functions
IHAL Attributes

- Associated with a function
- Can be configurable or not
- Can be defined as a string, number, or boolean.
- If configurable, valid values can be defined as:
  - A range of numbers
  - An explicit list of values (i.e. an “enumeration”)

IHAL Pool - Function

Sub-Functions

Attributes

Custom Attributes And Sub-Functions
IHHL Use-level descriptions

- Define a complete instrumentation configuration.
- All devices, and how they are connected to each other
- How each device is configured (e.g. the current value for each of its settings)
- Make references to pool-level items.
IHAL Use-level: Configuration

configuration
- Container for multiple networks, defines a single configuration or "project"

- attributes
  - ihalconfig:description
  - ihalconfig:dateCreated
  - ihalconfig:dateImplemented
  - ihalconfig:testArticle
  - ihalconfig:systemUnderTest
  - ihalconfig:location
  - ihalconfig:attachedFile

- instrumentationGraph
  - ihalinstgraph:InstrumentationGraphType
    - attributes
      - ID
    - instrumentationGraph
      - ihalinstuse:instrumentUse
      - ihalinstgraph:connection

Generated by XMLSpy
www.altova.com
IHALL Device Use Descriptions

- References a device from the pool
- Identifies instance information (serial number, location, etc)
- Contains a collection of “set” and “restricted” attributes
  - Set attributes define the current values of each setting
  - Restricted attributes override the pool-level descriptions of attributes by further restricting the set of valid values.
IHAL Instrument Use

Device-Level Settings

Settings for channels

References the ID of a device in the pool

References the ID of a channel in the pool and specifies a channel number
IH AL Instrument Use

```
<ihalinstuse:instrumentUse ID="IUse1" Ref="ACMEASC1234-1"/>
<ihalinstuse:serialNumber>A123456790</ihalinstuse:serialNumber>
<ihalinstuse:channelAttributeSettings>
  <ihalinstuse:channelUse ID="channeluse1" Ref="ACMEASC1234-1-channel">
    <ihalinstuse:channelNumber>0</ihalinstuse:channelNumber>
    <ihalinstuse:attributeSettings>
      <ihalinstuse:setAttribute ID="setAttribute1" Ref="voltageamplificationfunctiongain1">
        <ihalinstuse:setConfigurableNumericAttribute>
          <ihalattribute:value>20</ihalattribute:value>
        </ihalinstuse:setConfigurableNumericAttribute>
      </ihalinstuse:setAttribute>

      <ihalinstuse:restrictedAttribute ID="restrictedAttribute1" Ref="offset1">
        <ihalinstuse:attributeRestriction>
          <ihalattribute:configurableNumericAttribute>
            <ihalattribute:minimumValue>
              <ihalattribute:value>0</ihalattribute:value>
            </ihalattribute:minimumValue>
            <ihalattribute:maximumValue>
              <ihalattribute:value>5</ihalattribute:value>
            </ihalattribute:maximumValue>
          </ihalattribute:configurableNumericAttribute>
        </ihalinstuse:attributeRestriction>
      </ihalinstuse:restrictedAttribute>
    </ihalinstuse:attributeSettings>
  </ihalinstuse:channelUse>
</ihalinstuse:channelAttributeSettings>
</ihalinstuse:instrumentUse>
```
Generic Concepts in IHAL

- Generic attributes, functions, and devices exist for two reasons:
  - To enable the definition of vendor-specific concepts not explicitly supported in the IHAL Schema
  - To support re-usability and consistency within the schema itself.
    - For example, the description of all devices in IHAL is based on a generic device concept.
IHAL API DETAILS
IHAL API Functions

- API specification requires 4 functions:
  1. Retrieve the vendor’s pool
  2. Retrieve a list of available configurations
  3. Retrieve a specific configuration
  4. Modify a configuration (i.e. change setting values)
## Retrieve the Vendor’s IHAL Pool

<table>
<thead>
<tr>
<th>URL:</th>
<th><code>&lt;vendor API Location&gt;/pool/units</code> to retrieve the units pool</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><code>&lt;vendor API Location&gt;/pool/instrument</code> to retrieve the instrument pool</td>
</tr>
<tr>
<td>HTTP Verb:</td>
<td>GET</td>
</tr>
<tr>
<td>Function Input:</td>
<td>None</td>
</tr>
<tr>
<td>Return Value:</td>
<td>Complete IHAL <code>&lt;instrumentPool&gt;</code> or <code>&lt;unitsPool&gt;</code> element.</td>
</tr>
</tbody>
</table>
Retrieve a List of Available Configurations

<table>
<thead>
<tr>
<th>URL:</th>
<th>&lt;vendor API Location&gt;/configurations/</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTTP Verb</td>
<td>GET</td>
</tr>
<tr>
<td>Function Input:</td>
<td>None</td>
</tr>
<tr>
<td>Return Value:</td>
<td>A partial &lt;ihal&gt; specification containing 0 or more EMPTY &lt;configuration&gt; elements, each with only the basic required information. No pools should be returned.</td>
</tr>
</tbody>
</table>
# Retrieve a Specific Configuration

## URL:

```
/vendor API Location> /configurations/<configurationID>
```

<configurationID> contains a unique identifier returned as the “id” attribute from a call to “Retrieve a list of Configurations”

## HTTP Verb:

GET

## Function Input:

None

## Return Value:

A complete IHAL `<configuration>` element
## Modify a Configuration

| **URL:** | `<vendor API Location>/configurations/<configurationID>/`  
|          | `<configurationID> contains a unique identifier returned as the “id” attribute from a call to “Retrieve a list of Configurations”` |
| **HTTP VERB:** | PUT |
| **Function Input:** | A partial `<configuration>` element. This element contains only the settings that the user wishes to modify. |
| **Return Value:** | – The “impact”: A partial IHAL `<configuration>` element containing only the new settings for everything that has changed:  
|          |   – The new values for the settings the user requested (may or may not match the original request)  
|          |   – Any additional settings that changed as a result  
|          |   – Any attribute “restrictions” that changed as a result |
Related Reading

**ITC Papers**

- **2006:**
  - “An Instrumentation Hardware Abstraction Language”

- **2008:**
  - “Extensions to the Instrumentation Hardware Abstraction Language”

- **2010:**
  - “IHAL and Web Service Interfaces to Vendor Configuration Engines”

- **2011:**
  - “Complete Vendor-Neutral Instrumentation Configuration with IHAL and TMATS XML”
  - “Utilizing IHAL Instrumentation Descriptions in iNET Scenarios”
Points of Contact

- John Hamilton (JLHamilton@kbsi.com)
  - KBSI, Hosts monthly telecons
- Charles Jones (Charles.Jones@edwards.af.mil)
  - Edwards AFFTC, Technical POC for SBIR project
- Ray Faulstich (rfaulstich@csc.com)
  - PAX River, Chair of the RCC’s VI/T committee
- http://ihal.kbsi.com
  - KBSI’s public IHAL website
QUESTIONS