Design of a Test Suite for NCAP-to-NCAP Communication based on IEEE 1451


University of Houston,
394 Technology Bldg. T2,
Houston, TX 77204-4021 USA

Presented by:
Anshul Singla
Motivation

- Lack of interoperability of transducers.
- Increased cost of equipment.
- Lack of a “TESTBED” to test standardization of transducers.
Conventional Control Network Vs IEEE 1451

- Have proprietary transducer interfaces.
- Have proprietary network communication.
- Lack of intelligent algorithms and applications.
- Faulty nodes need to be manually tracked as they are hardwired.

IEEE 1451 Network

- Have open network for communication.
- Have standardized transducer interfaces.
- Runs intelligent algorithms and applications on nodes.
- Nodes can be accessed and controlled anywhere in the network.
Outline

1. Introduction
2. Functions of NCAP (followed by test procedures)
   a. NCAP Plug and Play
   b. Transducer Configuration
   c. Transducer Control and Access
   d. Data Access
3. Conclusion and Future Work
NCAP to NCAP Communication

- The central monitoring NCAP monitors activities of all nodes.
- The nodes can communicate among each other.
- The central monitoring NCAP can also **control and access** information from transducers of other NCAPs.

Valve image taken from: http://www.global-b2b-network.com/direct/dbimage/50323640/Resilient_Seated_Gate_Valve.jpg
Testing

Conformance Testing
• Header formats

<table>
<thead>
<tr>
<th>Byte</th>
<th>Interpretation</th>
<th>Details</th>
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<tr>
<td>0-1</td>
<td>Magic Number, Version</td>
<td>0xF7, 0x04</td>
</tr>
<tr>
<td>2-3</td>
<td>Total Message Length</td>
<td>0xNN NN</td>
</tr>
<tr>
<td>4-5</td>
<td>Header Length</td>
<td>0xNN NN</td>
</tr>
<tr>
<td>6</td>
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<td>0x02 [NCAP_BLOCK_-ANNOUNCEMENT]</td>
</tr>
<tr>
<td>7-14</td>
<td>Publ. Domain</td>
<td>0xFF FF FF FF FF FF FF FF</td>
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<tr>
<td>15-16</td>
<td>Publication Topic</td>
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</tr>
<tr>
<td>17-21+N</td>
<td>Publication Contents</td>
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</table>

NCAP Block announcement packet

The header format conforms to Stennis Space Center, SSC 1451.1 on-the-wire v0.4 document.

Functional Testing
• It tests the behavior of a Node under test.
• The tests check the NCAP for constraints laid down by the standard regarding its expected behavior.
• The test cases take into account such scenarios where an NCAP may not behave as expected.
2 level Plug and Play

- Any network protocol

**Level 2 PnP**

- Network Interface
- NCAP
- Intelligent Algorithms and Applications
- TIM comm. module
- STIM
- TEDS
- A/D converter
- Signal Conditioning

**Level 1 PnP**

- NCAP client
- PSK_REQUEST_NCAPBLOCK
- PSK_NCAPBLOCK_ANNOUNCEMENT
  - (object_tag, object_dispatch_address)
- NCAP server

- **Object dispatch address:**
  - IP address.
  - Port number.
  - Object ID (unique identifier).

- **Object tag** – Configurable end to end identifier.

**TEDS** are Transducer Electronic Data Sheets which provides calibration and other important information about the transducer.

- It helps in identification of the transducer which makes it plug and play.
Test Case for NCAP Plug and Play

Tester node waits

PSK_REQUEST_ncapblock_announcement

PSK_NCAPBLOCK_announcement (object_tag, object_dispatch_address)

No dynamic announcement.
Announcement not configured.
Announcement received and validated.

Other NCAP attributes:
• Manufacturer ID
• Model number
• Block Version
• NetworkVisibleServerObjectProperties

PSK – Publish Subscribe Key. The recipient nodes should subscribe to the publication in order to receive these messages.
Transducer Configuration

• SetTEDS operation modifies TEDS data for a sensor on another NCAP.
• For example, Celsius converted to Fahrenheit.

Test Procedure
• The return packets are checked for arguments.
• TEDS and data is accessed to confirm the change.
Transducer Control and Access

- NCAP A can access the transducer on NCAP B.
- The transducer samples at a particular *sampling frequency*.
- Packets are sent to NCAP A at a set *update frequency*.

**Test Procedure**
- Update frequency is always less than sampling frequency.
- Sampling frequency and update frequency can be configured and acquired to be tested.
Data Access - 1

- Start function triggers the multicast publication of data stream.

**Test Procedure**
- Update method is tested.
- Reception of data is tested.
- Sample contents are validated.
Data Access - 2

- Start function triggers the sending of data stream.
- Return messages are also sent (as acknowledgement).

Test Procedures
- Update method is tested.
- Reception of data is tested.
- Sample contents are validated.
Data Access - 3

- A request/response data retrieval process.
- Data is sent after reception and processing of request.

Test Procedures
- Update method is tested.
- Reception of data is tested.
- Sample contents are validated.
Conclusion and Future Work

• The test procedures will help ease the acceptance of IEEE 1451.
• Acceptance of the standard would promote the growth in sensor networks.
• Standardization would reduce the cost of transducers.
• More test cases need to be developed to incorporate more operations from the standard.
• Network performance evaluation.
Thank you!