A Practical Guide of Troubleshooting
IEC 61850 GOOSE Communication
Wei Huang, ABB Inc.
A Practical Guide of Troubleshooting IEC 61850 GOOSE Communication

Speakers

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– ABB Inc.
– Lake Mary, FL
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Agenda

- Introduction
- IEC 61850 GOOSE Application
- GOOSE Configuration and Communication Message
- Troubleshooting of GOOSE Communication
- Summary
Troubleshooting of GOOSE Communication

Introduction

- Review IEC 61850 GOOSE Applications
- Analyze IEC 61850 Data Mode and GOOSE Configuration
- Introduce a Systematic Troubleshooting Approach
Troubleshooting of GOOSE Communication

Introduction

Average commission time per IED is reduced from 2.61 hours to 0.66 hour.

Reduce System Commissioning Time by 75%.
Troubleshooting of GOOSE Communication

IEC 61850 GOOSE Applications

- Automatic BUS Transfer Scheme

- Bus protection scheme

- Sympathetic Tripping Logic

- Load Tap Changer Control
Troubleshooting of GOOSE Communication

IEC 61850 GOOSE Applications

Typical network scheme of a GOOSE application.
Troubleshooting of GOOSE Communication

IEC 61850 GOOSE Configuration

IEC 61850 GOOSE

Data Model
- Semantic Hierarchical Object Data Model

GOOSE Configuration
- GOOSE Data Set
- GOOSE Control Block
- GOOSE Subscription

LogicDevice.LogicNode.DataObject.DataAttribute

Ctrl.CBCSW11.Pos.stVal
LD0.PEMMXU1.TotW.mag.f

FirstName.LastName@Country.Company.Organization

wei.huang@us.abb.com
Troubleshooting of GOOSE Communication

IEC 61850 GOOSE Configuration

IEC 61850 GOOSE

Data Model
– Semantic Hierarchical Object Data Model

GOOSE Configuration
– GOOSE Data Set
  • List of data points
– GOOSE Control Block
– GOOSE Subscription

GOOSE Data Set

- Data set entries

CTRL.CBCSWI1.Pos.sSel (ST)
CTRL.CBCSWI1.Pos.q (ST)
LD0.PEMMXU1.TotW.mag.f (MX)
LD0.PEMMXU1.TotW.q (MX)
LD0.PEMMTR1.DmdWh.actVal (ST)
LD0.PEMMTR1.DmdWh.q (ST)
LD0.PHPTOC1.Op.general (ST)
LD0.PHPTOC1.Op.q (ST)
LD0.PHPTUV1.Op.general (ST)
LD0.PHPTUV1.Op.q (ST)
Troubleshooting of GOOSE Communication

IEC 61850 GOOSE Configuration

IEC 61850 GOOSE

Data Model
- Semantic Hierarchical Object Data Model

GOOSE Configuration
- GOOSE Data Set
  - List of data points
- GOOSE Control Block
  - Define how to send these data points
- GOOSE Subscription

GOOSE Control Block
## Troubleshooting of GOOSE Communication

### IEC 61850 GOOSE Configuration

**Data Model**
- Semantic Hierarchical Object Data Model

**GOOSE Configuration**
- GOOSE Data Set
  - List of data points
- GOOSE Control Block
  - Define how to send these data points
- GOOSE Subscription
  - Map GOOSE receiving IED to the data set
Troubleshooting of GOOSE Communication
A Systematic Approach

New Technologies and Challenges

- OSI 7 layer Model
- Object Oriented Design
- Unified Modeling Language
- Publish – Subscribe Model
- XML
- ...

Troubleshooting of GOOSE Communication
A Systematic Approach

New Technologies and Challenges
- OSI 7 Layer Model
- Object Oriented Design
- Unified Modeling Language
- Publish – Subscribe Model
- XML
Troubleshooting of GOOSE Communication
A Systematic Approach

A Systematic Approach
– Network Scheme
  • Check actual wiring against design
– Hardware Connection
– GOOSE Publishing
– GOOSE Receiving
– Redundancy

Network Scheme
Troubleshooting of GOOSE Communication
A Systematic Approach

A Systematic Approach

- Network Scheme
- Hardware Connection
  - LED Status
  - Network Port Status
  - Ping
- GOOSE Publishing
- GOOSE Receiving
- Redundancy

Network Status
Troubleshooting of GOOSE Communication
A Systematic Approach

A Systematic Approach

– Network Scheme
– Hardware Connection
– GOOSE Publishing
  • GOOSE Capture
  • Parameters
  • Data Points
  • VLAN
– GOOSE Receiving
– Redundancy

GOOSE Communication Capture
Troubleshooting of GOOSE Communication
A Systematic Approach

A Systematic Approach
- Network Scheme
- Hardware Connection
- GOOSE Publishing
  - GOOSE Capture
  - Parameters
  - Data Points
  - VLAN
- GOOSE Receiving
- Redundancy

GOOSE Communication Capture

- Network Scheme
- Hardware Connection
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Troubleshooting of GOOSE Communication

A Systematic Approach

- Network Scheme
- Hardware Connection
- GOOSE Publishing
  - GOOSE Capture
  - Parameters
  - Data Points
  - VLAN
- GOOSE Receiving
- Redundancy

GOOSE Value and Quality

<table>
<thead>
<tr>
<th>Bit(s)</th>
<th>IEC 61850-7-3</th>
<th>Bit-String</th>
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<tbody>
<tr>
<td>0-1</td>
<td>Validity</td>
<td>Value</td>
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<tr>
<td></td>
<td>Good</td>
<td>0 0</td>
</tr>
<tr>
<td></td>
<td>Invalid</td>
<td>0 1</td>
</tr>
<tr>
<td></td>
<td>Reserved</td>
<td>1 0</td>
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<tr>
<td></td>
<td>Questionable</td>
<td>1 1</td>
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<tr>
<td>2</td>
<td>Overflow</td>
<td>TRUE</td>
</tr>
<tr>
<td>3</td>
<td>OutOfRange</td>
<td>TRUE</td>
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<tr>
<td>4</td>
<td>BadReference</td>
<td>TRUE</td>
</tr>
<tr>
<td>5</td>
<td>Oscillatory</td>
<td>TRUE</td>
</tr>
<tr>
<td>6</td>
<td>Failure</td>
<td>TRUE</td>
</tr>
<tr>
<td>7</td>
<td>OldData</td>
<td>TRUE</td>
</tr>
<tr>
<td>8</td>
<td>Inconsistent</td>
<td>TRUE</td>
</tr>
<tr>
<td>9</td>
<td>Inaccurate</td>
<td>TRUE</td>
</tr>
<tr>
<td>10</td>
<td>Source</td>
<td>Process</td>
</tr>
<tr>
<td></td>
<td>Substituted</td>
<td>1</td>
</tr>
<tr>
<td>11</td>
<td>Test</td>
<td>TRUE</td>
</tr>
<tr>
<td>12</td>
<td>OperatorBlocked</td>
<td>TRUE</td>
</tr>
</tbody>
</table>
Troubleshooting of GOOSE Communication
A Systematic Approach

- Network Scheme
- Hardware Connection
- GOOSE Publishing
  - GOOSE Capture
  - Parameters
  - Data Points
  - VLAN
- GOOSE Receiving
- Redundancy

VLAN for GOOSE Application

Ethernet Switch

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Troubleshooting of GOOSE Communication

A Systematic Approach

- Network Scheme
- Hardware Connection
- GOOSE Publishing
- GOOSE Receiving
  - GOOSE Communication Status
  - On-line Mode
- Redundancy
- GOOSE Receiving

GOOSE Communication Status

[Image of monitoring interface showing reset counters, received messages, transmitted messages, and state changes]
Troubleshooting of GOOSE Communication

A Systematic Approach

- Network Scheme
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- GOOSE Receiving
  - GOOSE Communication Status
  - On-line Mode
- Redundancy
- GOOSE Receiving

On-line Mode
Troubleshooting of GOOSE Communication

A Systematic Approach

- Network Scheme
- Hardware Connection
- GOOSE Publishing
- GOOSE Receiving
- Redundancy
  - Disable Redundancy
  - Enable Redundancy

PRP (Parallel Redundancy Protocol) Network
Troubleshooting of GOOSE Communication

A Systematic Approach

- Network Scheme
- Hardware Connection
- GOOSE Publishing
- GOOSE Receiving
- Redundancy
## Troubleshooting of GOOSE Communication

### Result

<table>
<thead>
<tr>
<th>Substation</th>
<th>SS-A</th>
<th>SS-B</th>
<th>SS-C</th>
<th>SS-D</th>
<th>SS-E</th>
<th>SS-F</th>
<th>SS-G</th>
<th>SS-H</th>
<th>SS-I</th>
<th>SS-J</th>
<th>SS-K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of IED</td>
<td>46</td>
<td>95</td>
<td>21</td>
<td>22</td>
<td>25</td>
<td>17</td>
<td>17</td>
<td>61</td>
<td>60</td>
<td>48</td>
<td>62</td>
</tr>
<tr>
<td>Commission Hours</td>
<td>120</td>
<td>184</td>
<td>40</td>
<td>24</td>
<td>40</td>
<td>24</td>
<td>24</td>
<td>73</td>
<td>46</td>
<td>35</td>
<td>41</td>
</tr>
<tr>
<td>Average Commission Hours</td>
<td>2.61</td>
<td>1.94</td>
<td>1.90</td>
<td>1.09</td>
<td>1.60</td>
<td>1.41</td>
<td>1.41</td>
<td>1.20</td>
<td>0.77</td>
<td>0.73</td>
<td>0.66</td>
</tr>
</tbody>
</table>
Troubleshooting of GOOSE Communication

Result

Average Commission Time Per IED reduced from 2.61 hour to 0.66 hour.

Reduce System Commissioning Time by 75%.
Troubleshooting of GOOSE Communication

Summary

• Introduction
• IEC 61850 GOOSE Application
• GOOSE Configuration and Communication Message
• Troubleshooting of GOOSE Communication
  - Network Scheme
  - Hardware Connection
  - GOOSE Publishing
  - GOOSE Receiving
  - Redundancy
Q&A and Contact information
If you have questions, please contact me further

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