0 What: IEC 61850 Objects/DNP3 Mapping (6.2.2)

0.1 Abstract:

DNP3 is the de facto communication protocol used at the distribution and transmission level. However, DNP3 does not possess all of the desirable attributes for use in the Smart Grid. A means must be found to enable transport of Smart Grid management functions over these legacy DNP3 networks.

0.2 Description:

The DNP3 protocol was designed for low-bandwidth SCADA operations. Data acquisition consists of anonymous instances from three object classes: binary inputs, analog inputs, and counters. Supervisory control consists of commands to instances of the classes of binary points and analog points. Although this protocol allows any DNP data to be transported between any two points, the semantic content of the messages depends upon lists of tables, which are not machine readable.

The desire is to ensure that seamless transport of situational semantics can flow between devices, even when the communication is constrained by the DNP3 protocol.

Mapping of objects in each direction presents different challenges.

0.3 Objectives:

- Agree upon a consistent algorithm to map a selected subset of IEC 61850 object to a corresponding DNP3 object.
- Provide a method to map between DNP3 objects and IEC 61850 objects. Because DNP3 uses less-specific semantics than IEC 61850, this is only an approximate mapping. The DNP3 specification (Volume 8 clause 8.4 and its Appendix 1 clause 2) presents the approach recommended by the DNP3 Technical Committee, which uses XML to perform this mapping. This DNP mapping approach is referenced in Annex E of IEC 61400-25-4.

0.4 Why:

Although DNP3 is the dominant SCADA communication protocol in the USA, it lacks some of the features envisioned for the Smart Grid. A mapping between 61850 and DNP3 will allow presently communicated SCADA information to be used in new ways, while also providing the ability to create new applications while using the existing DNP3 infrastructure.

This will enable the addition of new control and monitoring functions to be used with legacy DNP3 equipment while still providing a solid path to a full IEC 61850-based communications system in the future. Furthermore, the integration issues between the two types of systems will be minimized by a consistent mapping solution.

If a mapping between these two protocols is not accomplished, then existing DNP3 systems will need to be modified in an ad-hoc fashion to integrate each new control and monitoring function. If the legacy DNP3 system is ever replaced with a IEC 61850 system, then the entire

communication network would need to be replaced at the same time. This would cause enormous additional expense and disruption to any existing applications.

The impact of the mapping will affect all users of data presently sourced by DNP3 devices. System planners and grid operations management would be among the stakeholders most affected.

0.5 Where:

Transmission and distribution domains at the application layer.

0.6 How:

The integration of DNP3 and IEC 61850 systems will be accomplished by the insertion of protocol translators at the Master/Client side. In general, these protocol translators will consist of a configurable software module.

The key problem is that this configuration must be made as automatically as possible in order to reduce the possibility of injection of translation errors into the system.

Both DNP3 and 61850 use XML files for configuration, but these files contain different types of information. On the DNP3 side, the XML file contains a one-to-one mapping of DNP3 objects to 61850 object attributes. On the IEC side, there is also a one-to-one mapping of the data attributes to a (type-less) “short address”. The missing piece is the algorithm needed to transfer the data value and data semantic between the system.

Adding the information to DNP3 XML files is a possibility, although the DNP3 XML format forbids extensions which are not built into the DNP3 specification. Here DNP3 has the advantage wherein the specification can be extended without lengthy balloting reviews.

Adding the information to the IEC XML file is actually much simpler because multiple extension rules are built into the 61850 System Configuration Language (SCL) standard. One set of extension rules, known as “private data”, allows new (usually vendor-specific) information to be added almost anywhere within SCL. Another set of rules, “extension schemas”, allows more targeted extensions.

It is unknown at this time which extensions to each of the XML file format will yield the optimal object transfer mechanism.

0.6.1 Task Descriptions

0.6.1.1 Task 1

Define the Use Cases for transfer of information. The Use Cases will begin with DNP devices throughout the system and add 61850 devices at various points in the system. Data transfer needs will be developed for each Use Case

0.6.1.2 Task 2

Gap Analysis: Identify to what extent DNP XML supports the use cases and what the gaps are. It is understood at the outset that 61850 supports much richer data semantics which will not be transferrable to a 61850 system

0.6.1.3 Task 3

Identify how 61850 SCL can make the external reference to DNP3 objects. 61850 presently support a “sAddr” field, but this might not be able to contain enough information to provide a complete mapping to DNP3

0.6.1.4 Task 4

Gap Analysis: Verify how SCL could support all use cases. Verify that SCL mechanisms exist to perform the entire mapping of semantics to DNP3

0.6.1.5 Task 5

Define rules for associating DNP XML and 61850 SCL in supporting use cases. External reference to DNP Objects (Mapping points in DNP up to 61850 object models, so we don’t duplicate that file in the SCL file). Ensure that mapping in both directions is complete.

0.6.1.6 Task 6

Develop Guidelines for use of 61850 and DNP integration strategies. Need to provide guidance to users on how to choose optimal migration straegies.

0.6.1.7 Task 7

Create Example DNP XML file mappings. The example DNP XML file will illustrate most of the object conversion issues as possible in a single file.

0.6.2 Deliverables

The following deliverables are identified as result of these activities:

- Use case diagram
- Gap analysis in the existing XML file formats
- Extension rules and needs for both XML files
- Guidelines on integration strategies
- Example DNP (and SCL) configuration files

0.7 Who:

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0.8 When:

Task Description	Completion Date
Task 1: Define Use Cases	2009-10
Task 2: Gap Analysis: Identify to what extent DNP XML supports the use cases and what the gaps are	2009-12
Task 3: Identify how 61850 SCL can make the external reference	2009-12
Task 4: Gap Analysis: Verify how SCL could support all use cases	2009-12
Task 5: Define rules for associating DNP XML and 61850 SCL in supporting use cases?	2010-03
Task 6: Create Example DNP XML file mappings	2010-05
Task 7: Develop Guidelines for use of 61850 and DNP integration strategies	2010-06