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"Transition Strategies for IEC 61850”

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February IntelliGrid Smart Grid Informational Webcast
February 26, 2013

Agenda

- Introduction
- Business Process Change
- The Need for Tools
- Implementation Details
  - Migration Strategies, Mixed Environments & DNP Mapping
- Voice of the Industry
- Conclusion

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Introduction

- Utility Current State
  - Adoption rates of IEC 61850 continue to increase in North America and across the globe
  - The use of GOOSE for protection, control and automation was well established, and use within critical protection applications was being widely adopted as well.
  - Most implementations described were occurring in “Greenfield” installations rather than upgrades of existing stations, and in these cases, IEC 61850 was typically being used to the exclusion of all other protocols.

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Introduction

- Utility Current State
  - The impacts of IEC 61850 deployments to organizational structures were seen to be significant; as IEC 61850 crosses the traditional boundaries between P&C and IT groups.
  - Among the gaps and issues noted, lack of available mature and advanced engineering and testing tools continued to be a significant barrier for implementations
  - Workforce training for the new skill sets required was also identified as key to a successful deployment
  - Indicated cyber security affects the way in which utilities architect and deploy their systems

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Introduction

- Utility Current State
  - Costs and benefits continue to be refined as more utilities gain experience with IEC 61850.
  - Organizational commitment is essential for any IEC 61850 deployment
  - Full understanding of the true benefits of the IEC 61850 technology are just beginning to emerge and further monitoring of implementation progress is warranted.

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Introduction

- Several issues that remain are:
  - Impact on the organizational structures
  - Lack of mature and advanced engineering and testing tools
  - Vendor independent (or multi vendor capable) tools are needed to aid integration, commissioning and maintenance activities.
  - Workforce training for the new skill sets required is critical to a successful deployment.
  - Workforce training regarding design/deployment of IEC 61850 from a testability perspective.
  - Organizational commitment is essential

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Business Process Change

- Review of Typical Process
  - Legacy Process

MEMORANDUM

DATE ____________

FROM: Manager, Power System Protection
TO: Relay Shop Supervisor:
SUBJECT: Relay Setting Changes
FILE: POW 3.8 BC

LOCATION: **Substation A** KV: **12.47** BAY: **3**
APPLICATION: **FEEDER PHASE OVERCURRENT** TIME CHARACTERISTIC: **EXTREMELY INVERSE**
TYPE: **IAC77** MODEL/STYLE **12IAC77B811A** INST. BOOK: **GEK-34055** CURVE: ____
TAPS: **1.5, 2, 2.5, 3, 4, 5, 6, 7, 8, 10, 12** INST. RANGE **10 - 80**
OTHER NAME PLATE DATA: **SET TSI @ 2.0 A**

(50/51)

BREAKER NUMBER	BC 132	BC 133	BC 134	BC 135		DESIRED TIME			ACTUAL TIME		
Aϕ R	9067	9071	9075	9079		14.0	2.9	0.75			
Bϕ R											
Cϕ R	9068	9072	9076	9080		14.0	2.9	0.75			
GND R											
RECL. R						200%	400%	800%	200%	400%	800%
VOLT. R					These relays trip						
FREQ. R					the above breakers.						
DEM AMP											

PRESENT SETTINGS		CHANGE TO BE PERM.[X] TEMP.[ ]	
CT. RATIO: **600/5**	PT RATIO :	CT RATIO : **600/5**	PT RATIO :
TAP : **4.0**		TAP: **4.0**	
LEVER: **9.0**		LEVER: **9.0**	
INST.: **10.0**		INST.: **15.0**	
TIME CHARACTERISTIC: **EXTREMELY INVERSE**		TIME CHARACTERISTIC: **EXTREMELY INVERSE**	
FIRST RECLOSE:	SECONDS	FIRST RECLOSE:	SECONDS
SECOND RECLOSE:	SECONDS	SECOND RECLOSE:	SECONDS
THIRD RECLOSE:	SECONDS	THIRD RECLOSE:	SECONDS
ATTEMPT RESET:	SECONDS	ATTEMPT RESET:	SECONDS
DRUM SPEED (LOCKOUT):	SECONDS	DRUM SPEED (LOCKOUT):	SECONDS
IF ITE-79M, NUMBER OF INST. TRIPS:		IF ITE-79M, NUMBER OF INST. TRIPS:	
OVER VOLTAGE:	UNDER VOLTAGE:	OVER VOLTAGE:	UNDER VOLTAGE:
TIME:		TIME:	
UNDER FREQ.:	OVER FREQ.:	UNDER FREQ.:	OVER FREQ.:
TIME:		TIME:	

BY: Junior Engineer CK. BY: Senior Engineer

REASON FOR CHANGE: INSTANTANEOUS CHANGE. MEMO UPDATE.

REMARKS:

Manager, Power System Protection

EXAMPLE

Sample Legacy Relay Setting Sheet

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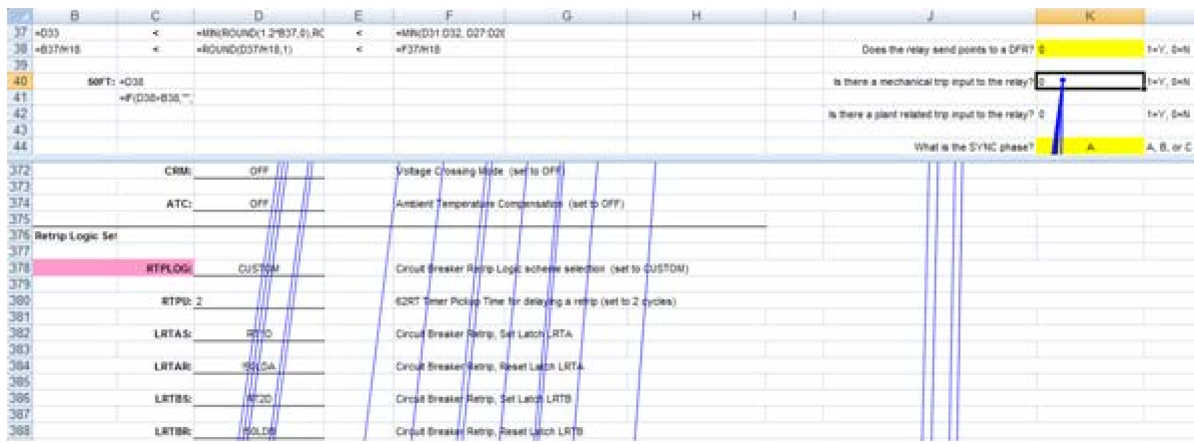
Business Process Change

- Review of Typical Process
  - Newer Method

STATION:	Substation	**DEVICE:**	11
BREAKER:	OR762	**RELAY #:**	R-99872
REMOTE:	TX bank 1	**NAME:**	Protection Engineer
		FIRMWARE:	MFR-999-2-R505-V0-Z103103-D2
		Part #:	MFR99921325H6X4X1
SERIAL #:	2012282270	**IP Address:**	N/A



Sample Spreadsheet Logical Cell Linkages

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Business Process Change

- Review of Typical Process
  - Newest Method

    - Advanced Systems for Power Engineering, Inc. (ASPEN) http://www.aspeninc.com

    - CAPE (Computer-Aided Protection Engineering) software http://www.electrocon.com from Electrocon International, Inc

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The Need for Tools

- IEC 61850 Process
  - Part 4 of the standard entitled System and Project Management specifies the following (4):
    - The specifications of this part pertain to the system and project management with respect to:
      - the engineering process and its supporting tools;
      - the life cycle of the overall system and its IEDs;
      - the quality assurance beginning with the development stage and ending with discontinuation and decommissioning of the UAS and its IEDs.

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The Need for Tools

- IEC 61850 Process - Classification
  - Parameters are data, which control and support the operation of:
    - hardware configuration (composition of IEDs);
    - software of IEDs;
    - process environment (primary equipment and auxiliaries);
    - HMI with different supporting tools; and
    - telecommunication environment

in an automation system and its IEDs in such a way that the operations of the plant and customer specific requirements are fulfilled.

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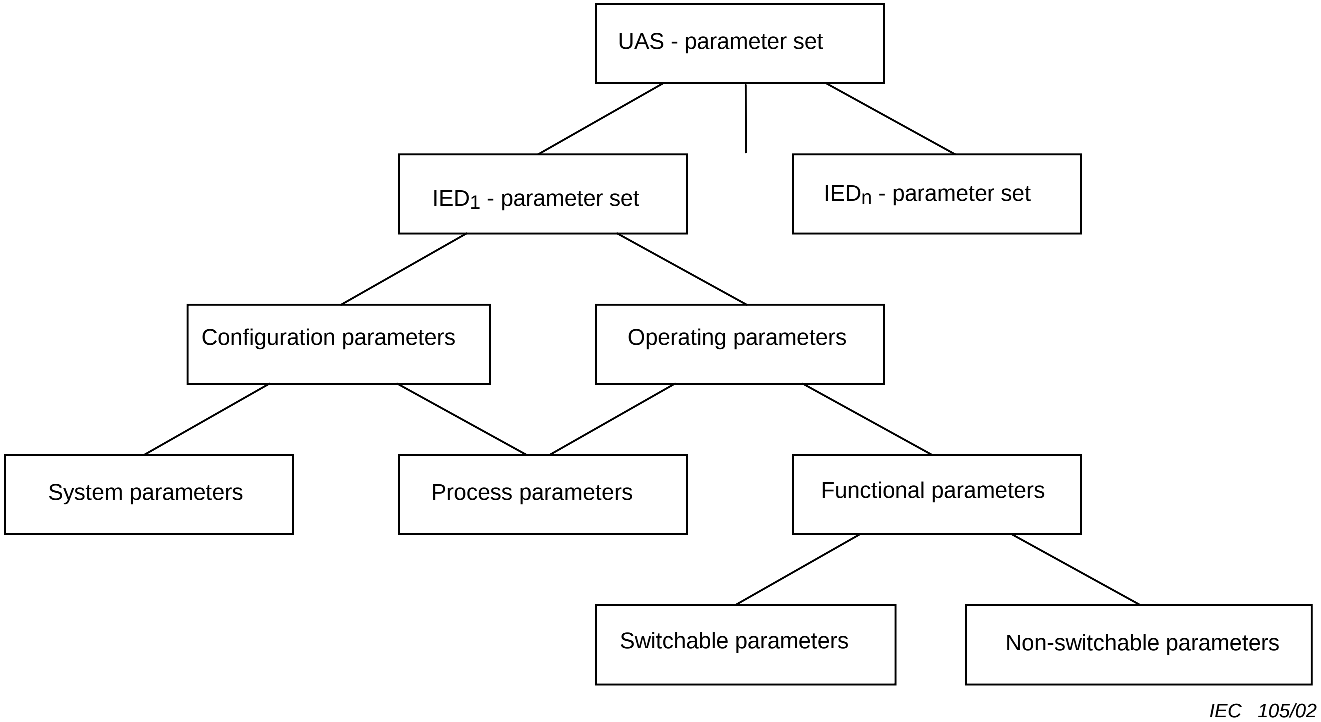
The Need for Tools

- IEC 61850 Process – Structure of UAS and IED parameters



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The Need for Tools

- IEC 61850 Process – Engineering Process Actors
  - System planner
  - Substation planner
  - System / plant engineer for secondary equipment
  - Project / design engineer for secondary equipment
  - System integrator
  - Device (IED) parameter setting engineer
  - Construction engineer
  - System verification engineer
  - Device tester
  - Assembly, installation technician
  - Commissioning engineer

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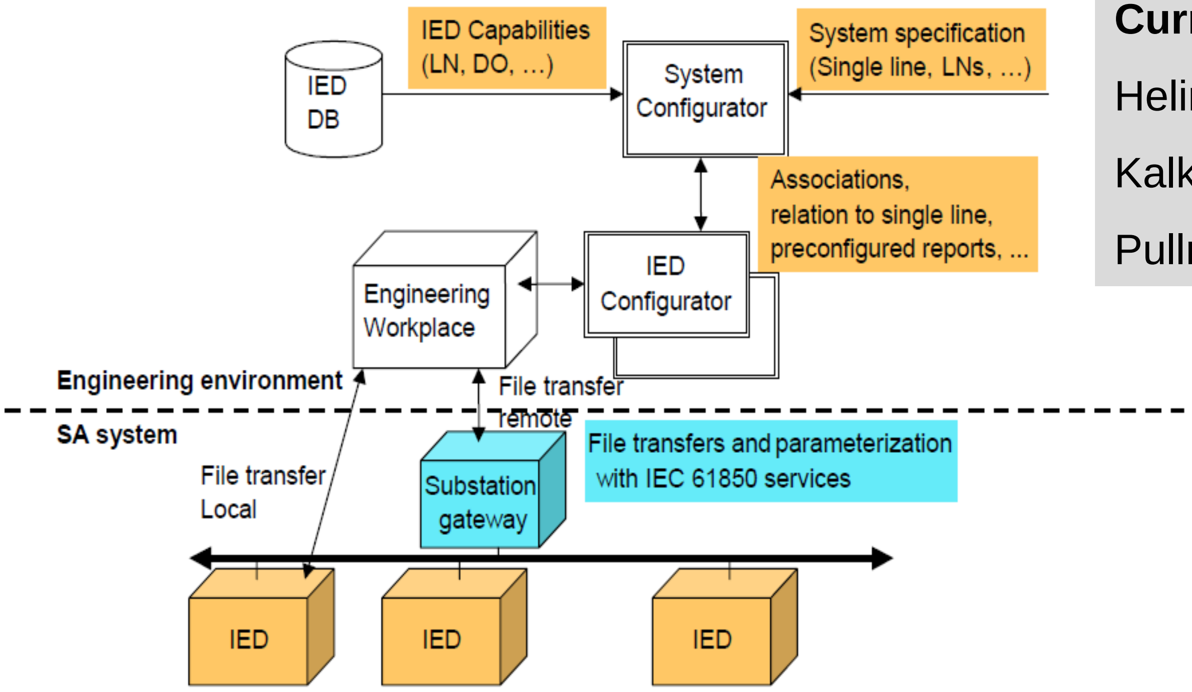
The Need for Tools

- Reference model for information flow in the configuration process



Current Providers of SCL Tools

Helinks - www.helinks.com.

Kalkitech - www.kalkitech.com

Pullnet Co - www.pullnet.com/atlan

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Example Utility Process

- Typically a utility will develop a set of protection standards

345KV Standard Line Unit
345KV Standard Bus Unit
345KV Standard Breaker Unit
345/138KV Standard Transformer Unit
138KV Standard Line Unit
138KV Standard Bus Unit
138KV Standard Breaker Unit

For example 345/138KV autotransformer Standard Transformer Unit design

345KV Primary Differential – Overall
138KV Primary Differential – Transformer Bank
345KV Back-up
138KV Backup

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The Need for Tools

- These utility specific standards get applied, as applicable, to modifications in the primary system. So in the case of a 345/138KV autotransformer addition they would apply the 345/138KV Standard Transformer Unit design. In this case that would consist of the following specific utility standards:
  - 345KV Primary Differential – Overall
  - 138KV Primary Differential – Transformer Bank
  - 345KV Back-up
  - 138KV Backup

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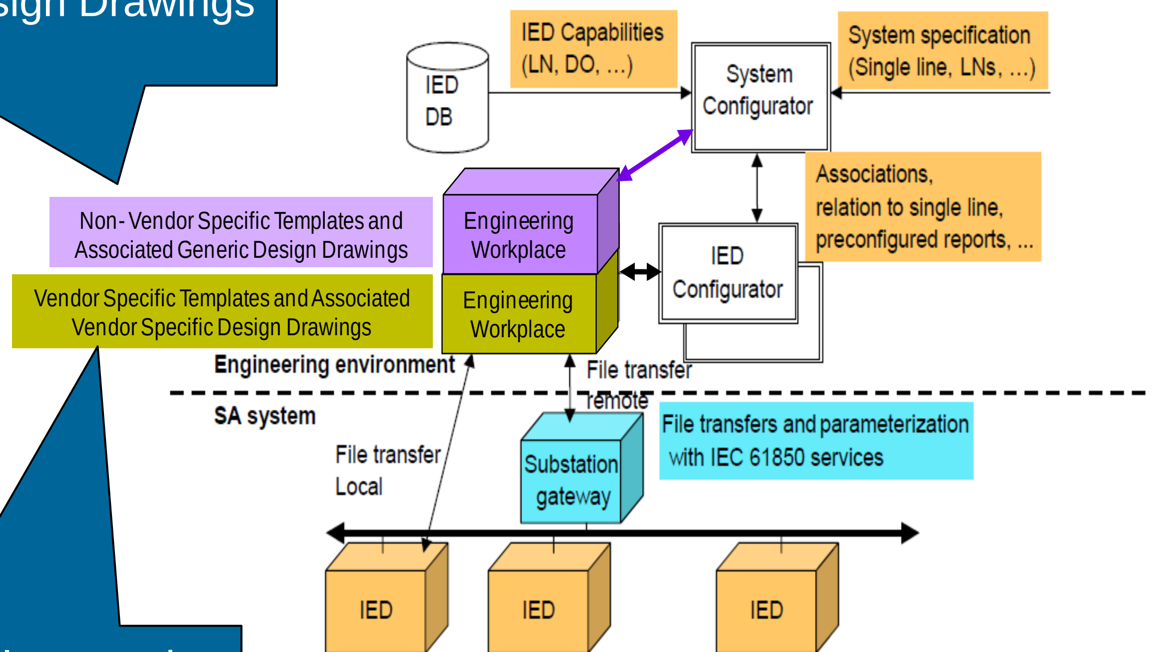
The Need for Tools

Non- Vendor Specific Templates and Associated Generic Design Drawings



“Vendor Specific Templates and Associated Vendor Specific Design Drawings”.

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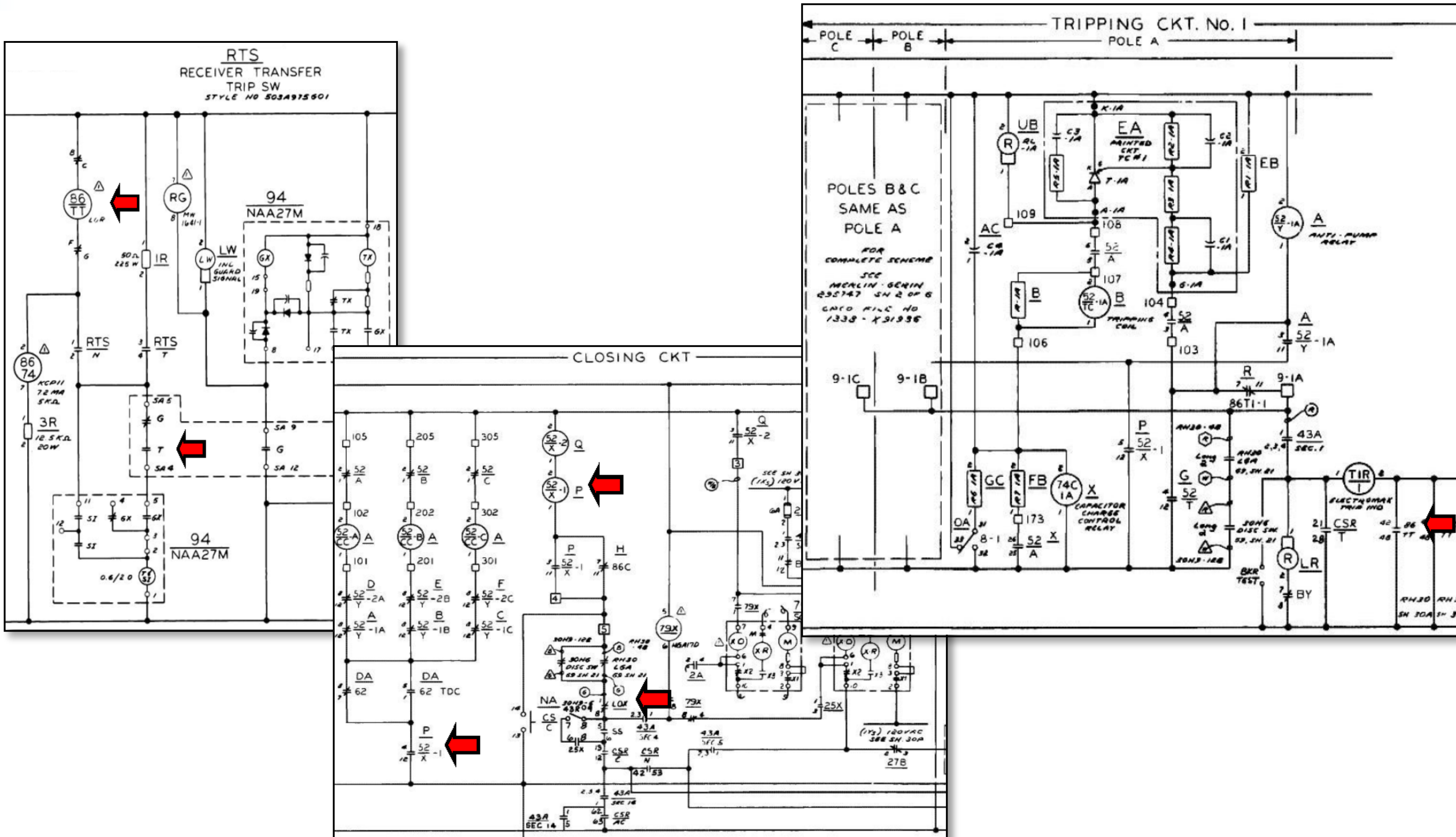
Lockout Relay Example



Legacy drawing based approach needs to be replaced by linked automated approach

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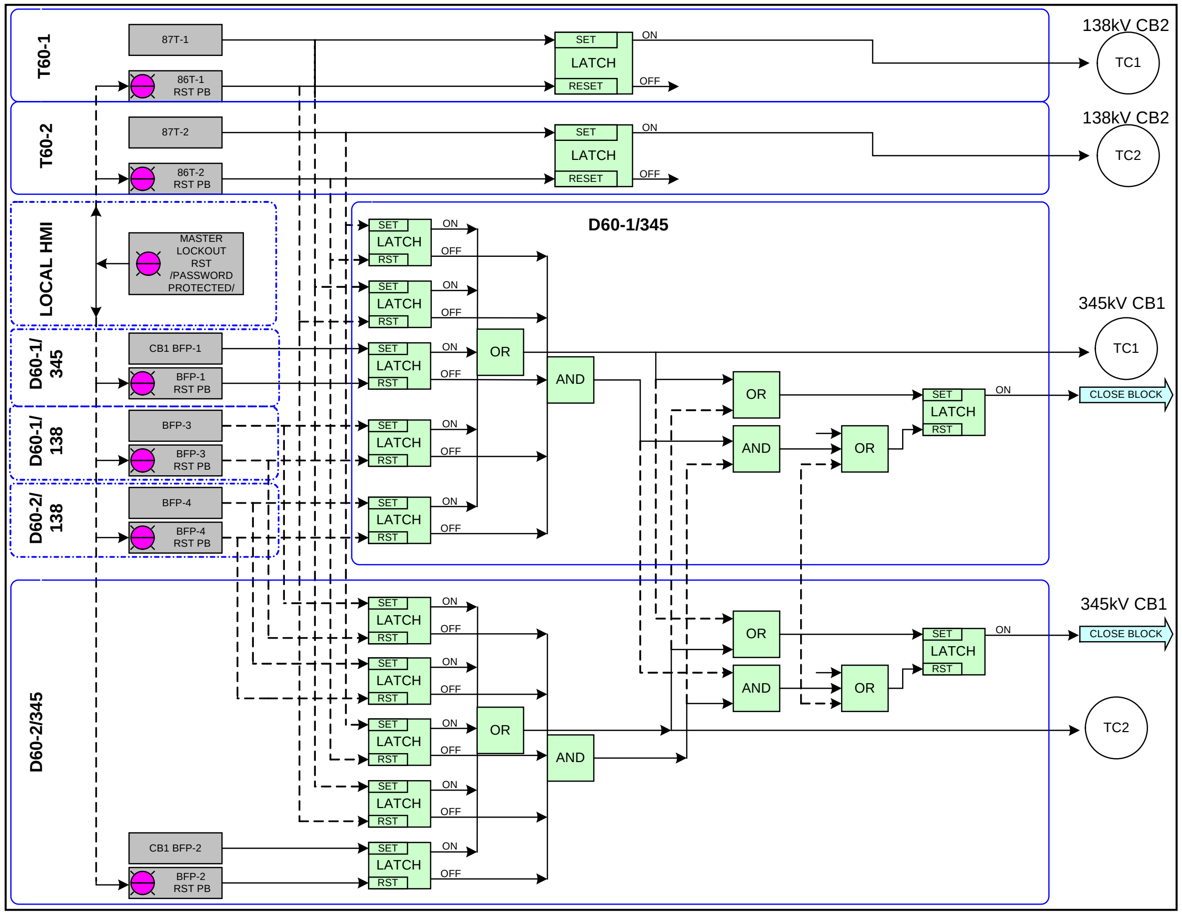
Example Logic Diagram for Distributed Lockout



New method needs to be able to develop utility standard models that can be transferred into a vendor specific implementation

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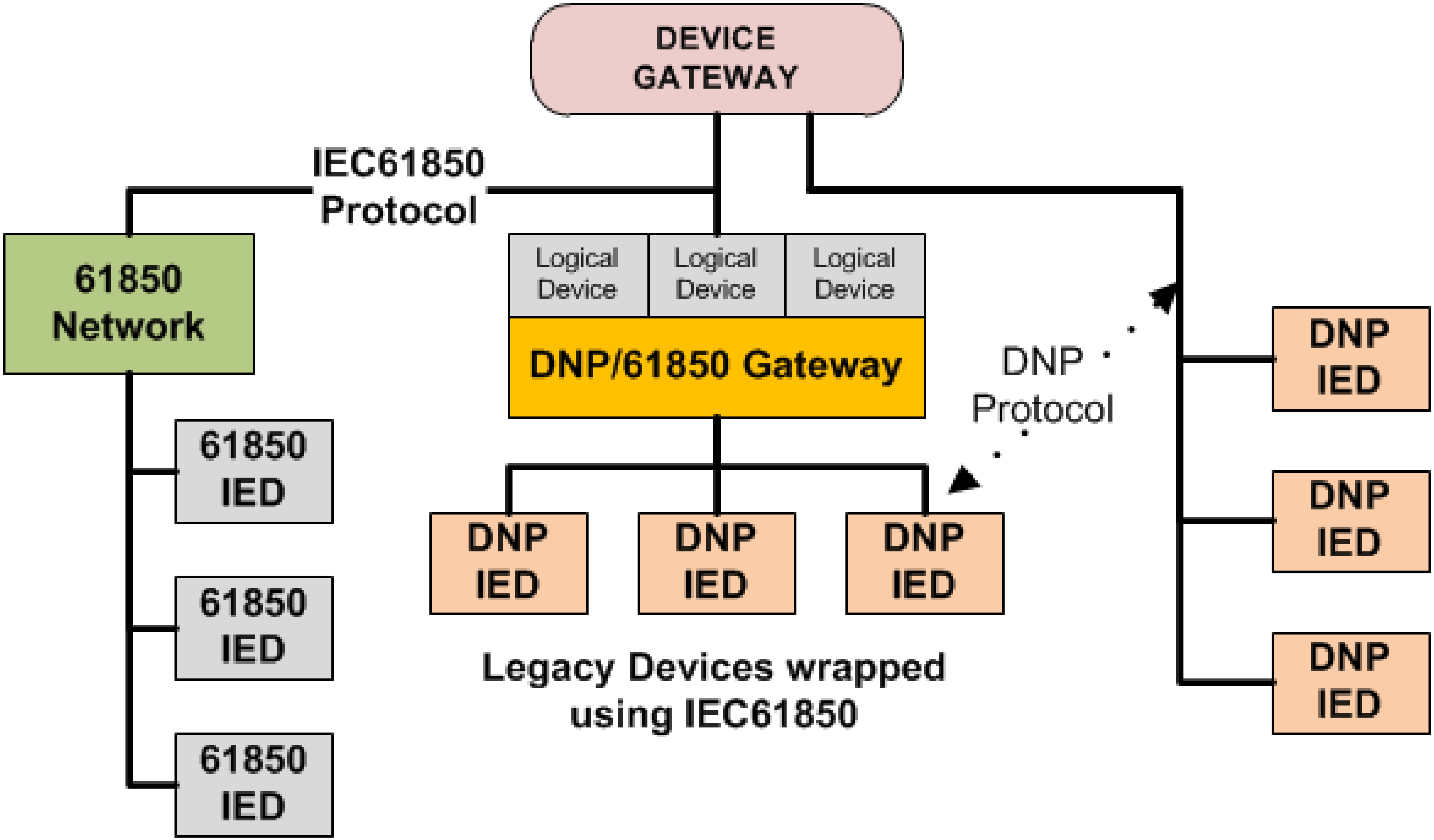
Implementation Details

Migration Strategies, Mixed Environments & DNP Mapping

Scott Sternfeld

Mixed 61850/DNP environment



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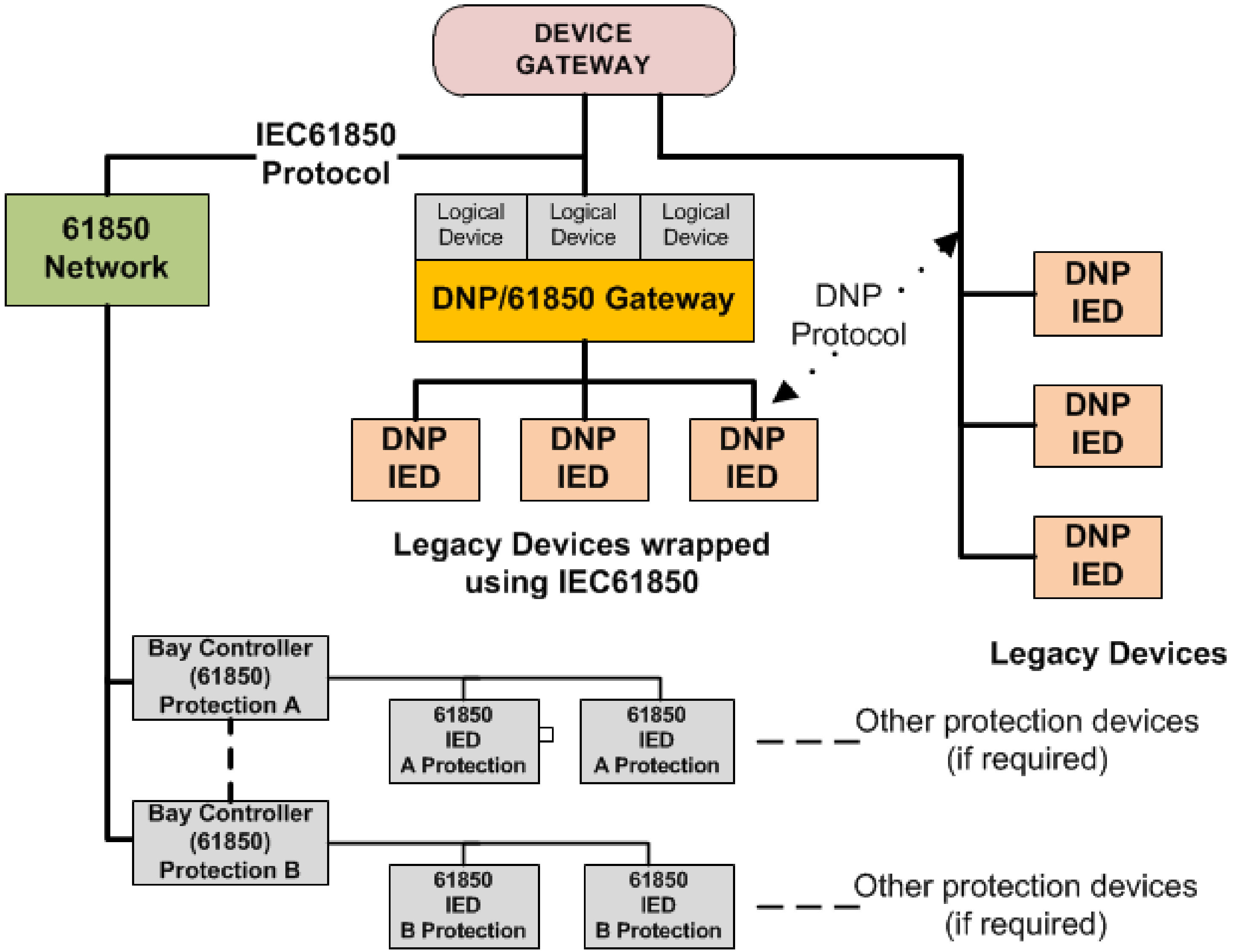
Mixed 61850/DNP environment



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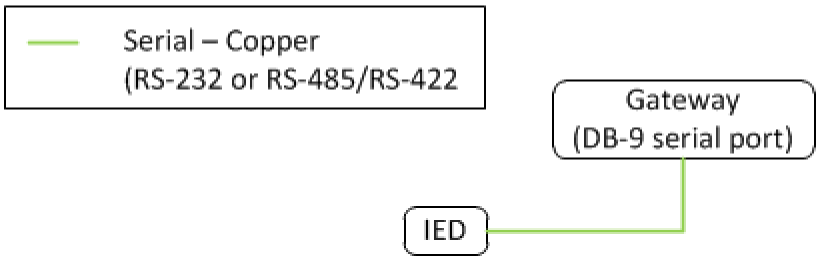
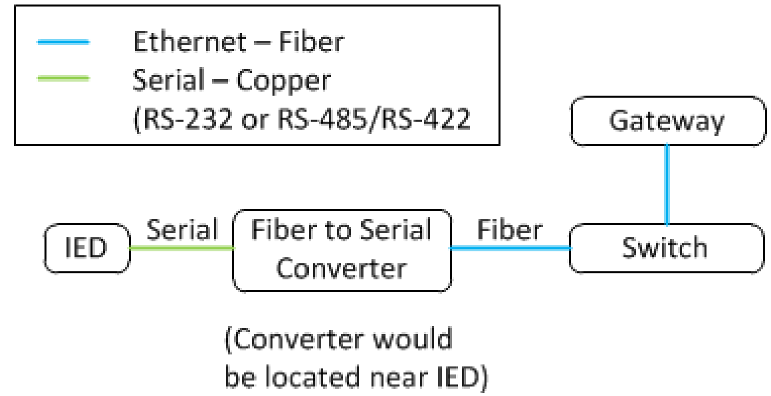
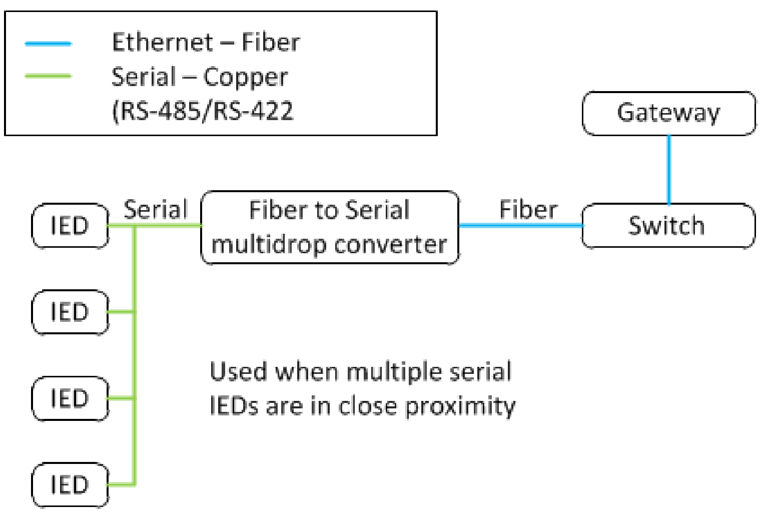
Cabling options: converters/adapters



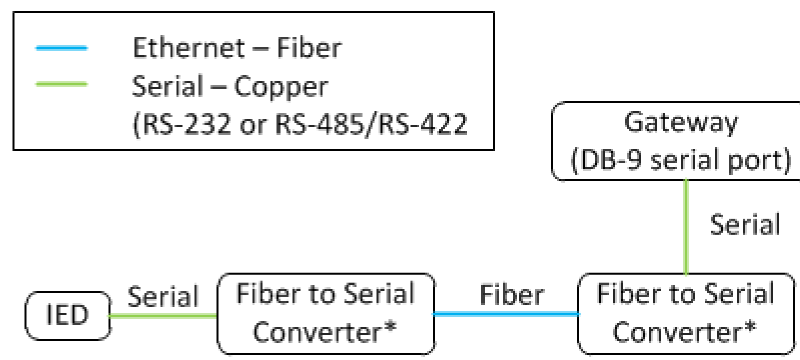
Typical serial connection direct to gateway
"Serial via copper / copper connections"



Serial connection to gateway using fiber optic converter
"Serial via copper and fiber optic converter"



Serial multidrop connection to gateway using fiber optic converter
"Serial via copper and fiber optic converter"



*Converters with IRIG-B capability (optional)

Serial connection to gateway using two fiber optic converters
"Serial via fiber optic converter to fiber optic converter"

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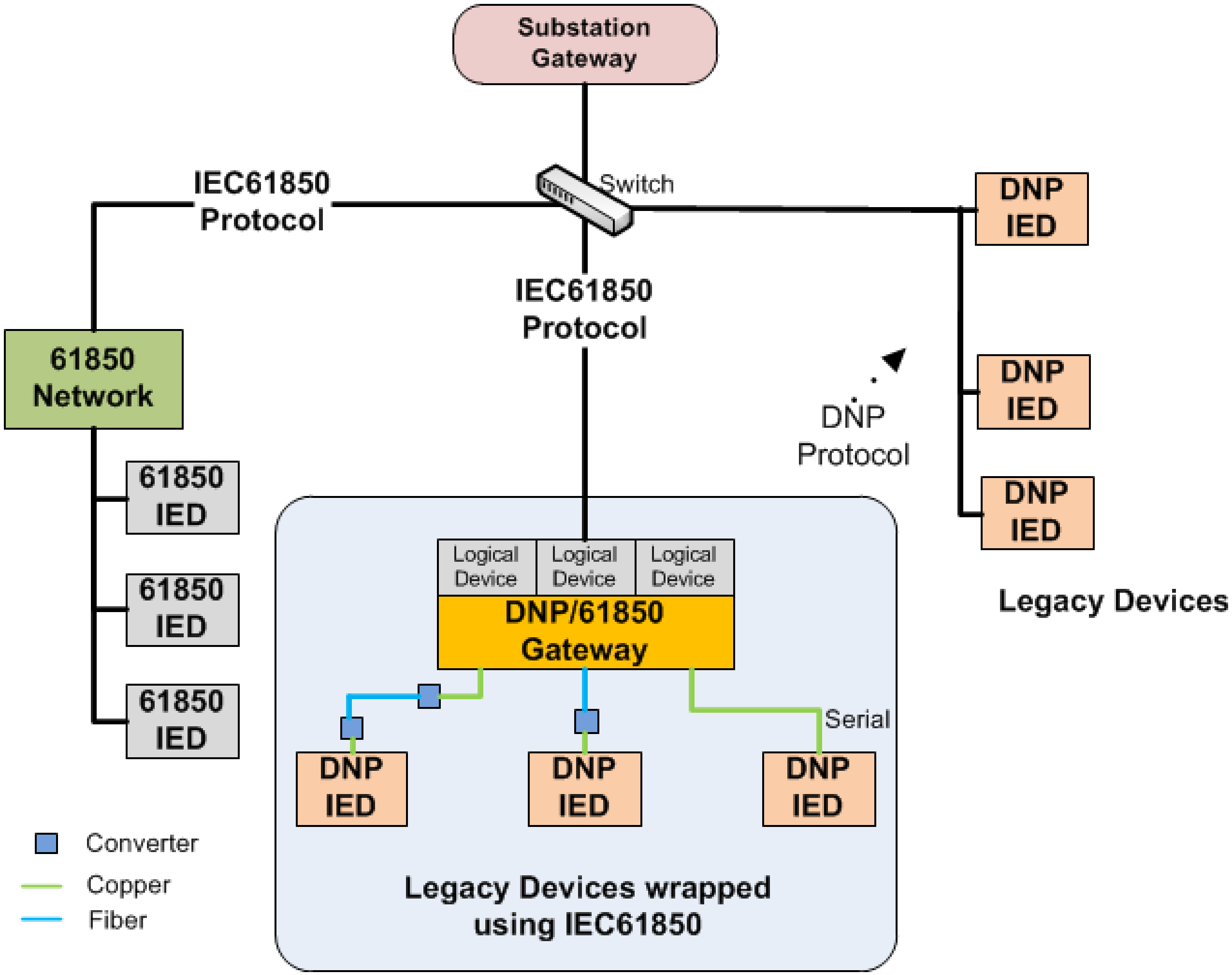
Migration strategies



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Naming convention: "Tag Name"

- Create a naming convention for DNP points to mimic names when IEC 61850 devices are used. (Similar to CID or ICD file)

- Should follow edition 2 of the IEC 61850 naming standard since it provides for a more detailed definition of the data-point names and for a broader range of devices and signals.

- Sample arrangement: Substation name or number, line voltage, protection circuit, device identification, and IEC 61850 data point.
  - SUB_LINEVOLT_PROTID_DEVID/YLTC.TapPos.stlNum
  - SUB_LINEVOLT_PROTID_DEVID/MMXU.totW.mag
  - SUB_LINEVOLT_PROTID_DEVID/ZBAT.BatFail.stVal
  - SUB_LINEVOLT_PROTID_DEVID/MMXU1.PPV.phsAB.mag

User defined — Defined in IED

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Naming convention limitations

- Testing in EPRI Smart Grid Substation Lab verified some vendor name length limitations varying from 44, 66 or 255 characters.

Examples:

```
DEVPREFIX_LINEVOLT_PROTID_DEVID/MMXU1.PPV.phsAB.mag
```

(51 characters)

Would need to be reduced to the following:

```
PX_LINEVOLT_PROTID_DEVID/MMXU1.PPV.phsAB.mag
```

(44 characters)

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IEEE P1815.1: DNP←→61850 mapping

Draft Standard for Exchanging Information between networks implementing IEC 61850 and IEEE Std 1815 (DNP3)

- This document specifies the standard approach for mapping between IEEE Std 1815 (Distributed Network Protocol (DNP3)) and IEC 61850 (Communications Networks and Systems for Power Utility Automation). Two primary use cases are addressed;
  - (A) Mapping between an IEEE Std 1815 based master and an IEC 61850 based substation LAN and
  - (B) Mapping between an IEC 61850 based master and an IEEE Std 1815 based substation LAN.

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P1815.1 – PAR Scope Change

- Mapping aspects included in the standard are: conceptual architecture; general mapping requirements; the mapping of Common Data Classes, Constructed Attribute Classes and Abstract Communication Service Interface (ASCI); **cyber security requirements,** the architecture of a gateway used for translation and requirements for embedding mapping configuration information into IEC 61850 Substation Configuration Language (SCL) and DNP-Profile.
- This specification addresses a selection of features, data classes and services of the two standards.

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Use Case (a): DNP to 61850

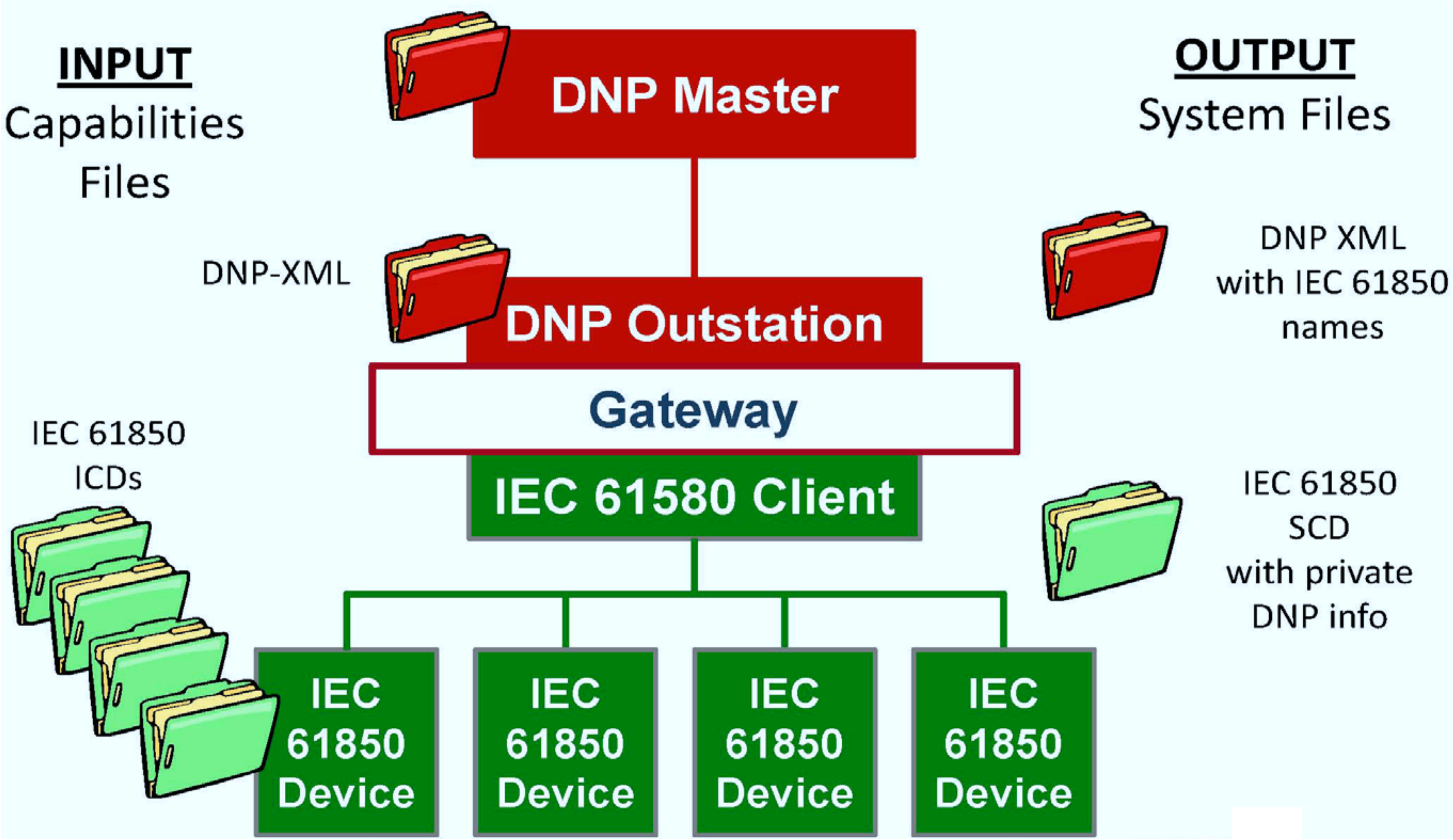

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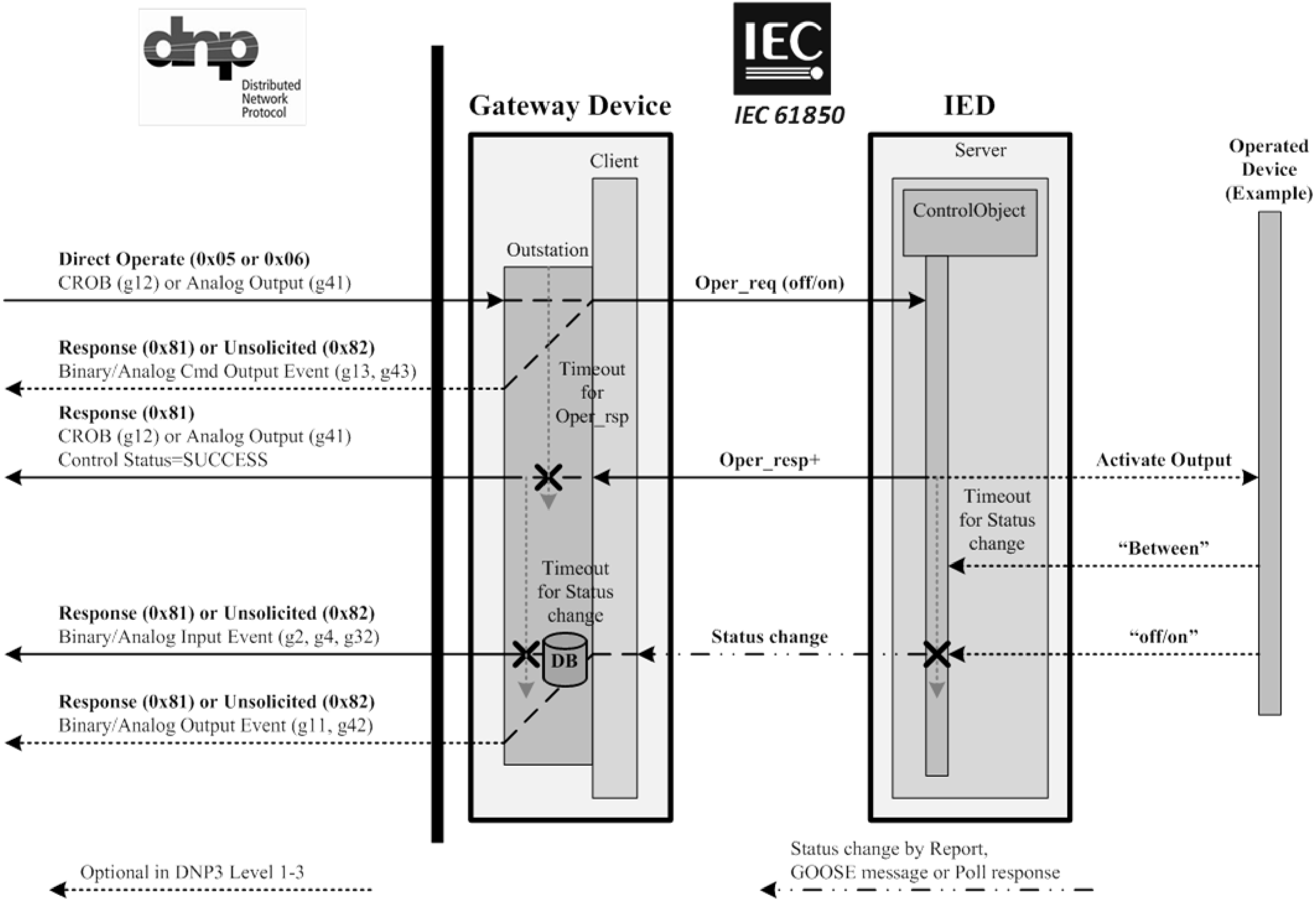
Figure 29— Direct Control, Normal Security, Use Case (a) – Positive Case



Note - Figure Reference from IEEE P1815.1/D4.00, June 2012

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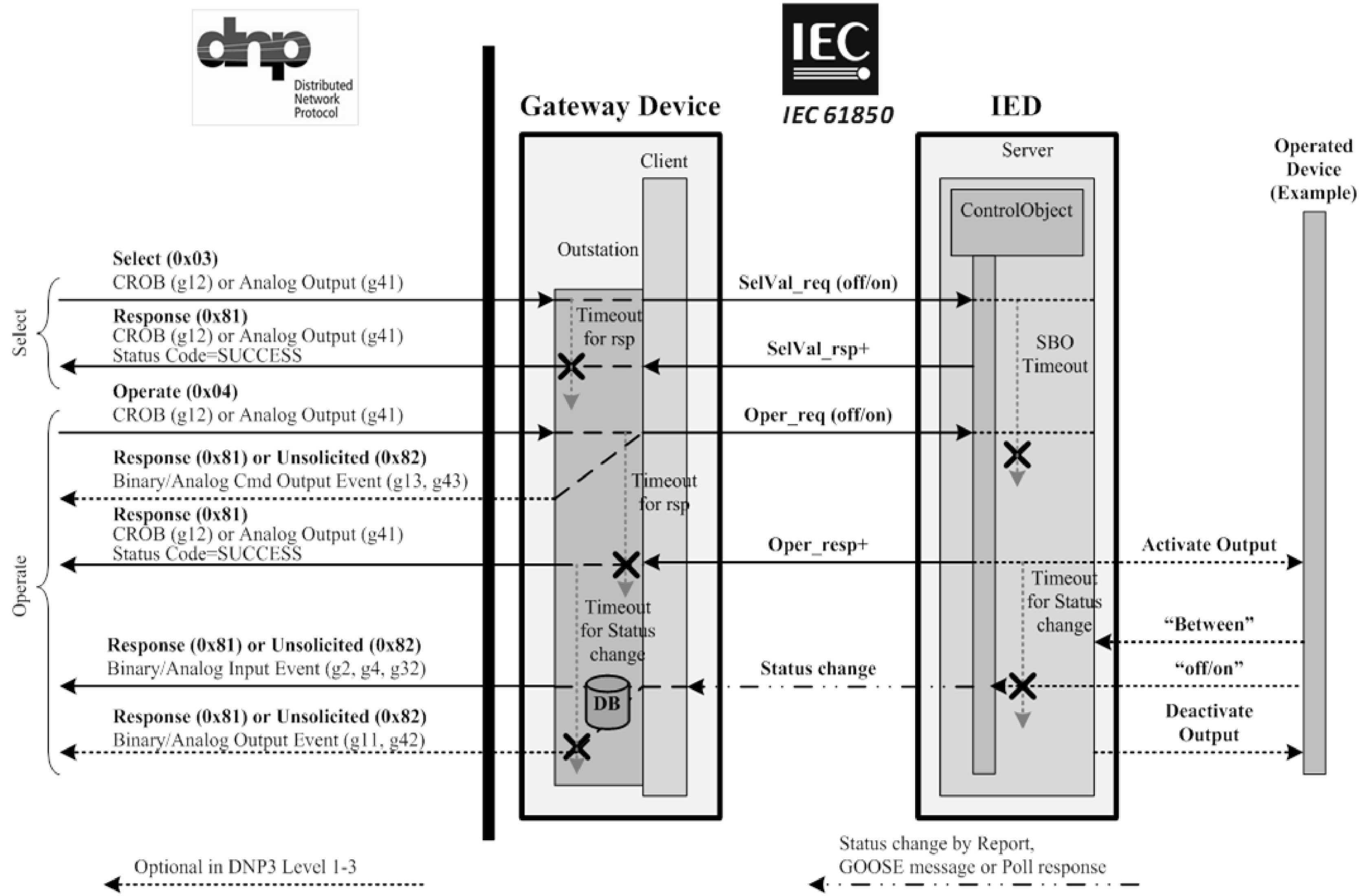
Figure 47— SBO Control, Normal Security, Use Case (a) – Positive Case



Note - Figure Reference from IEEE P1815.1/D4.00, June 2012

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Use Case (b): 61850 to DNP

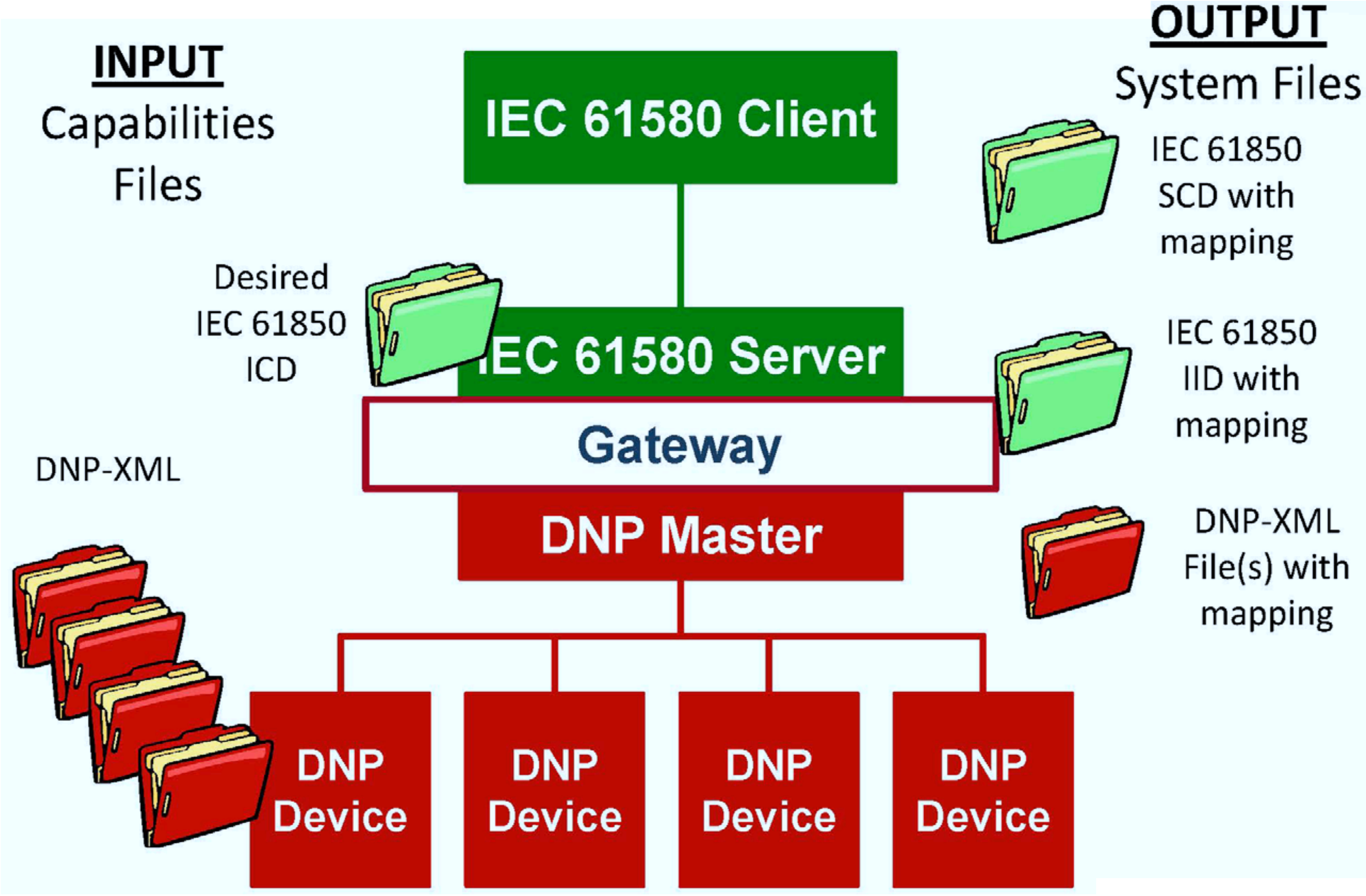

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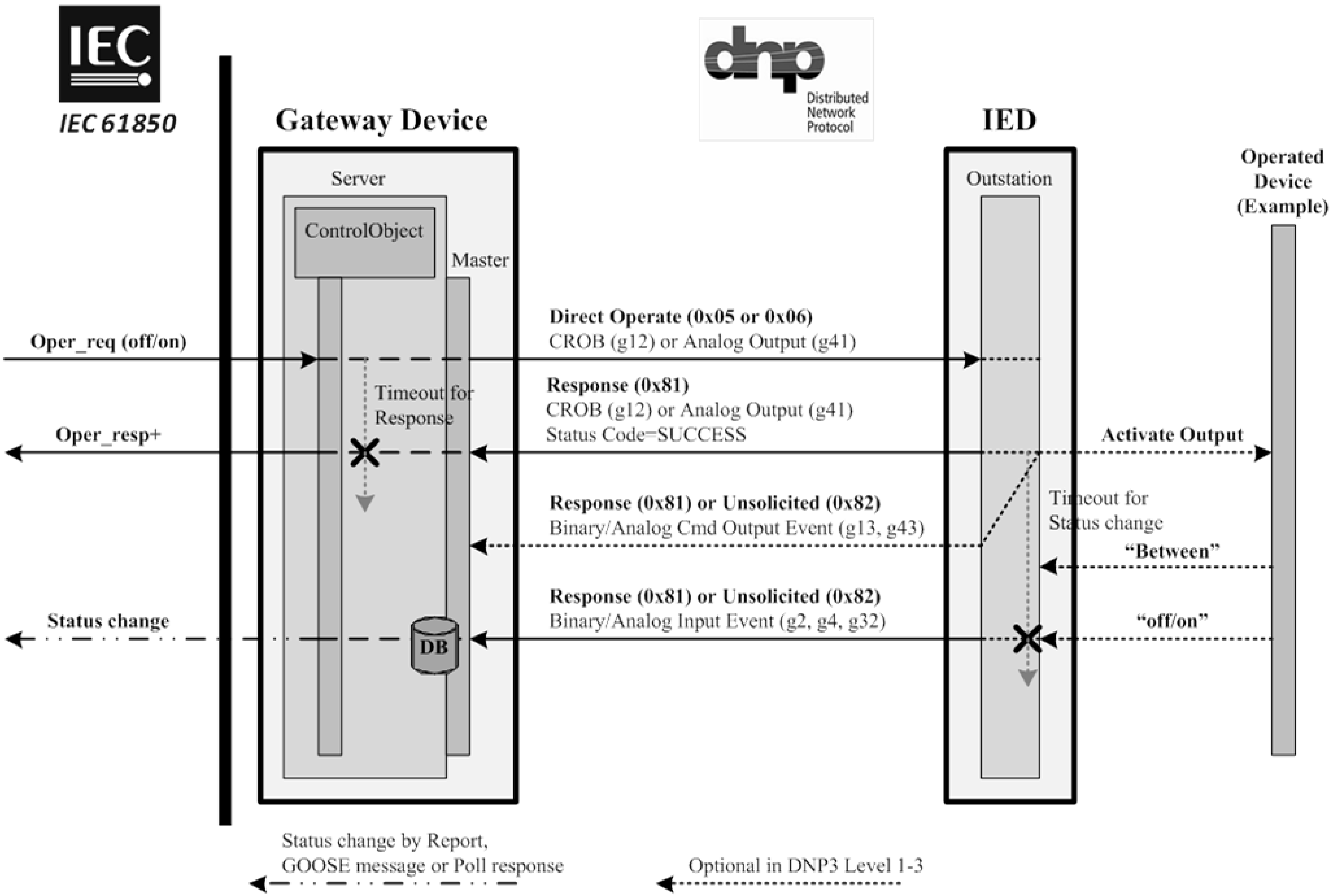
Figure 33— Direct Control, Normal Security, Use Case (b) – Positive Case



Note - Figure Reference from IEEE P1815.1/D4.00, June 2012

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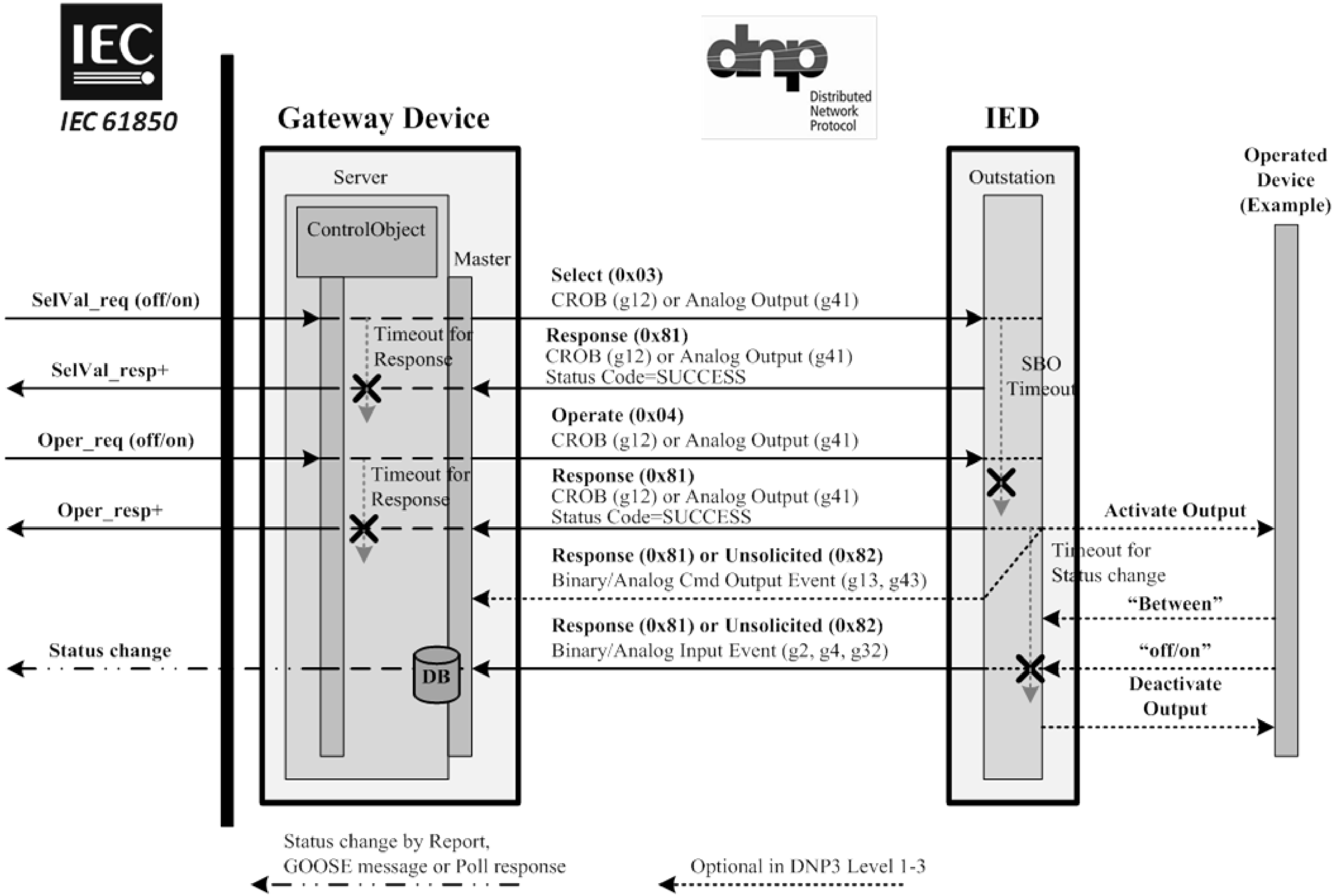
Figure 53— SBO Control, Normal Security, Use Case (b) – Positive Case



Note - Figure Reference from IEEE P1815.1/D4.00, June 2012

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“Enhanced security”

- IEC 61850-7-2 permits controls with **enhanced security,** meaning that after sending a response to the control request, the server waits for a physical indication that the control has operated before sending a **CmdTerm** message. The corresponding component in DNP3 is an Output Event. There are two concerns with this mapping of CmdTerm to Output Event:
  - **Both IEC 61850-7-2 enhanced security and DNP3 Output Events are optional.** They shall always be used together. If one side of the gateway does not support enhanced security, the other shall not use it. The client or master shall never be promised a level of reliability that the other side of the gateway cannot support.
  - **DNP3 has no equivalent for a negative CmdTerm message.** Using DNP3 the gateway can only confirm that the control successfully operated. The gateway cannot notify the DNP3 master that the control did not operate. In use case (a), the DNP3 master has no method to determine that the control did not operate other than to time out waiting for the Output Event. In use case (b), the IEC 61850-7-2 client similarly has no alternative other than to time out waiting for the negative CmdTerm message because the DNP3 IEDs cannot send a negative indication to the gateway.

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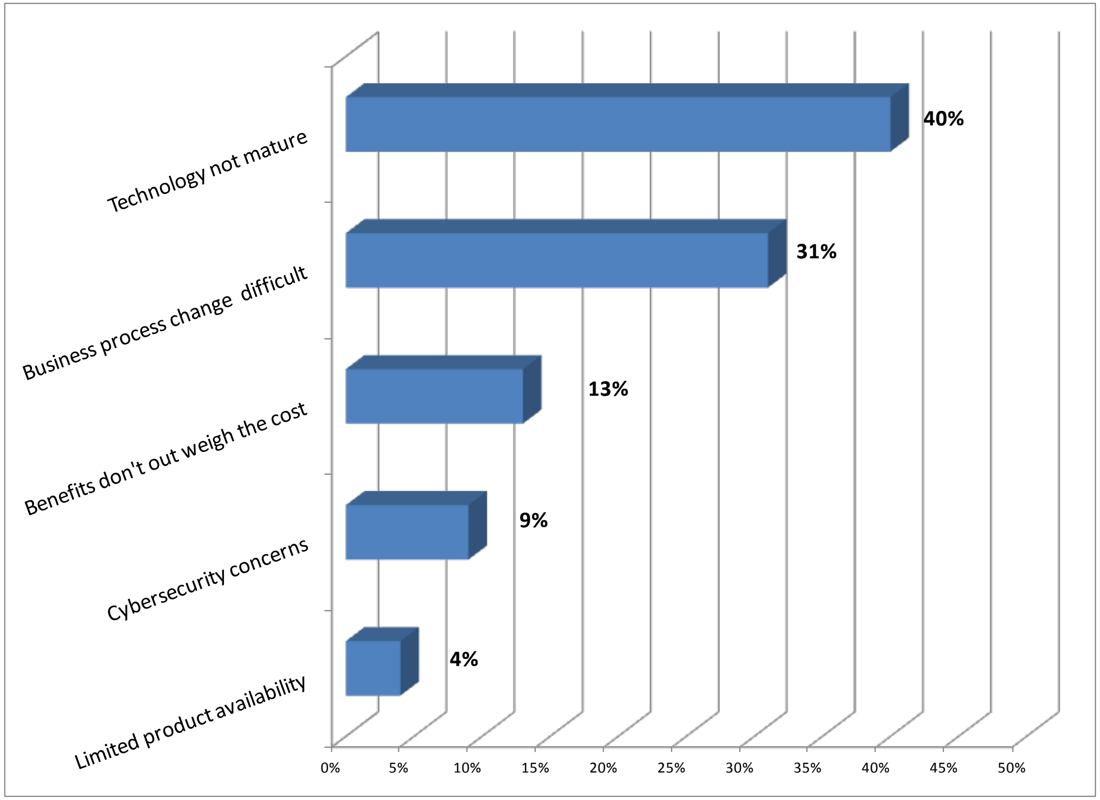
Voice of the Industry

Paul Myrda

Voice of the Industry

- Chart of IEC 61850 Major Implementation Obstacles – 61850 Group



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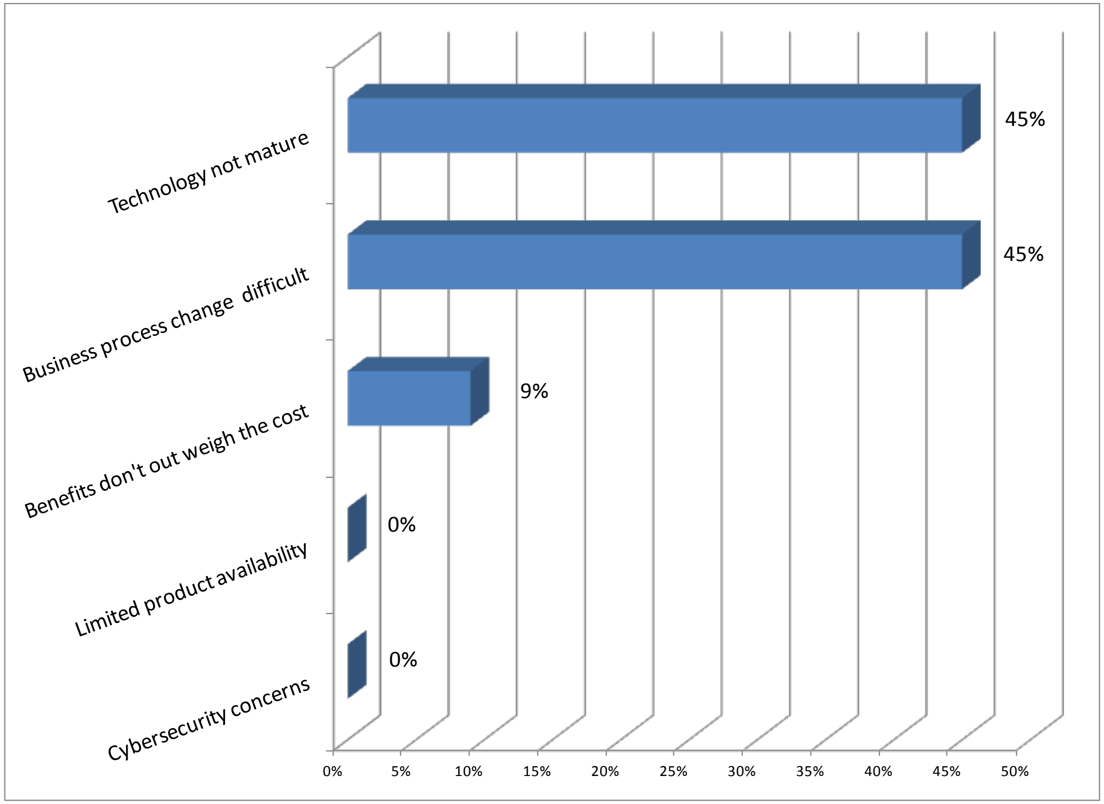
Voice of the Industry

- Chart of IEC 61850 Major Implementation Obstacles – PSPE Group



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Other References

Study Committee B5 Colloquium 2011 September 12-17 Lausanne, SWITZERLAND

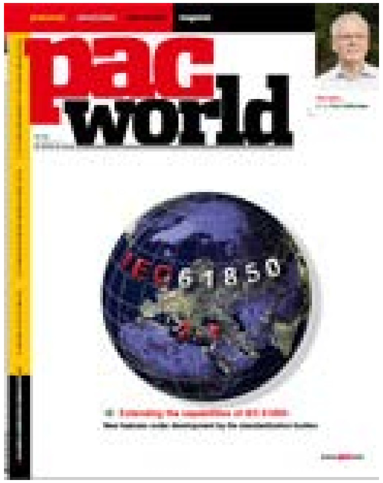
SPECIAL REPORT FOR STUDY COMMITTEE B5

(Protection and Automation)

PS1: IEC 61850: Which tools for which user?

Anders JOHNSSON (Sweden)

- PACWorld - http://www.pacw.org/
  - Frequent articles on IEC 61850



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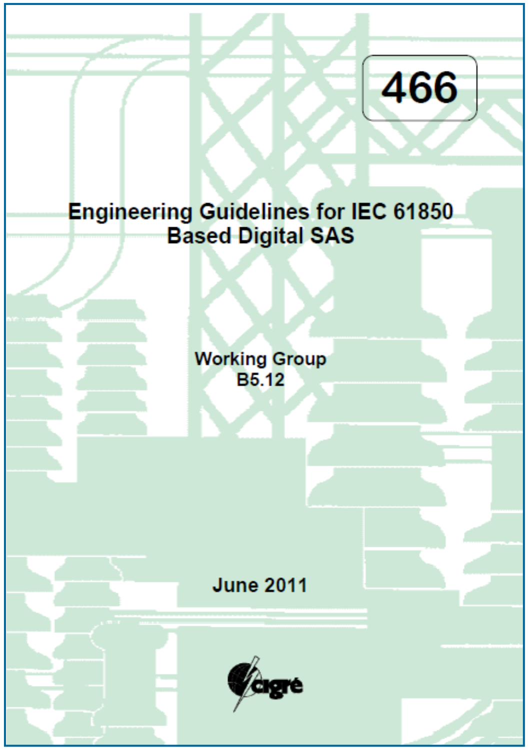
Good reference

- Engineering Guidelines for IEC 61850 Based Digital SAS
- CIGRE Report 466 – June 2011
- Working Group - B5.12
- Members

  Javier Castellanos (ES), Anders Johnsson (SE), Ksenija Žubrinic (HR), Claude Racine (CH), Rodolfo Pereda (ES), Daniel Espinosa (MX), Allan Cascaes (BR), Rogério Dias Paulo (PT), Phil Beaumont (UK), Luc Hossenlopp (FR), Craig McTaggart (UK), Julio Pérez (AR), Daniel Mellado (AR), Mathias Grädler (FI), Darren Webb (UK), Jukka Tuukkanen (FI), Ignacio Garcés (ES), Juergen Heckel (DE), Bogdan Kasztenny (CA), Keiichi Kaneda (JP), Yan-ming Ren (CN), Zhang Jie (CN), Ho-Yeup Song (Korea)



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Conclusion

- IEC 61850 continues to gain ground and improve with each installation.
- The only way for IEC 61850 to improve is through utility applications and feedback to the standards body on issues.
- As the market expands , vendors will enhance the tools needed to facilitate the processes

Recent EPRI Reports

– 1024299-IEC 61850 Implementation
– 1024300-Transition from Legacy Protocols to IEC61850

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