BASIC APPLICATION PROFILES FOR IEC 61850

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Wolfgang Brodt, Heiko Englert
Contents

- Motivation
- Objectives
- Scope
- Concept of BAP
- Example
- Status & Next Steps
IEC 61850 offers a broad and flexible basis for high variety of SAS applications

Issues:
- Out of this broad basis, specific subsets are implemented in products and solutions – these subsets could differ – for interoperability these require overlapping to a certain extent
- SAS applications differ dependent on user type, region and philosophy
- User groups officially request guidelines and tools to improve interoperability in projects

Challenge: Find a common concept/guideline to both improve interoperability and meet expectations of different projects
Objective of profiles:
- Reduce complexity
- Clarify vague or ambiguous specifications
- Improve interoperability

Basic Application Profiles (BAP)
- Based on domain specific basic application functions descriptions (IEC/TR 61850-7-500)
- Agreed-upon selection and interpretation of relevant parts of the IEC 61850 standard
- Intended to be used as building blocks for interoperable user/project specifications

BAPs include
- Application description (in accordance to IEC 61850-5, IEC/TR 61850-7-500)
- Relevant data models
- Interaction diagrams
- Communication services
- BAP specific MICS, PICS and PIXIT
Basic application profiles are valid for specific application domains e.g. Substation automation, DER management, hydro power …

BAPs are intended to represent the common denominator of a recommended implementation of substation automation functions defined in IEC 61850-5, IEC/TR 61850-7-500

BAPs are not intended to cover all possible implementation options

BAPs must not have options, all selected criteria are mandatory to achieve interoperability -> if variants of BAPs for an application function are needed -> different BAPs for the same application function have to be defined (e.g. centralized interlocking, decentral interlocking)
BAP Framework / Big Picture
Building blocks to improve project interoperability

1 Substation Automation (IEC 61850-5)
2 IEC 61850-7-x, IEC 61850-8-x
BAP Framework / Big Picture
Inside a BAP, interaction of LNs in IEDs

1 Substation Automation
2 IEC 61850
Key idea

- BAPs are **elements in a modular framework** for specific application domains
- Combination of different BAPs are used in real projects as **building blocks**
- Project specific refinement is required to implement the real projects
- Extensions or changes of the IEC 61850 specification might be necessary to meet specific requirements

**BAPs include**

- Application description (in accordance to IEC 61850-5, IEC/TR 61850-7-500)
- Interaction diagrams of IEDs
- Relevant data models and IED interface descriptions
- Communication services for common implementation variants
- Respective MICS, PICS and PIXIT
- All criterias are mandatory, no options allowed

**BAPs do not include**

- More than „black box“ functional behavior specification
- Algorithms and functional code
- Detailed instance definitions
**User Benefits**

- **Reduced risk of interoperability problems** by BAP’s
  - Verified and documented support by products
  - Projects can select from BAP framework and can rely on product support
  - Request for interoperability tested BAP’s (by certification bodies) of products
  - Significantly reduced effort for extension and fault location of projects

**System Integrator**

- **Easy selection of products** conformant with BAP’s
- **Request for certified products** (conformant with BAP’s tested by certification bodies)
- Significantly reduced efforts for integration of subsystems or devices

**Vendor**

- **Verified and documented support** of BAP’s by products
  - Products provide list of supported BAPs
  - BAP’s used for system-test before product release
General

- BAPs are developed, managed and published through IEC (e.g. by using a TS)
- Users and user groups pickup the BAP for their specifications
- Users and user groups provide feedback through IEC processes (memberships, national committees, liaisons)
- IEC TC 57 WG10 did set up a special taskforce “User Feedback” to process feedback from user organizations
- UCA provide BAP certification schema and interoperability testing (e.g. plug-fests)
- UCA may host agreed-upon domain and user-specific profiles
Input for Basic Application Profiles from various IEC 61850 activities are available

- Application descriptions from DKE (AK 952.0.1)

- IEC/TR 61850-7-500 „Use of logical nodes for modeling applications and related concepts and guidelines for substations“

- Specification, result and documentation of already performed interoperability test-events (e.g. available from UCA)

- Existing profile specifications of various organizations (user-groups, national bodies (e.g. FNN), ENTSO-E…)

- Publications of various standardization bodies (CIGRE, CENELEC ..)
Example: Substation Interlocking (source: FGH InterOP Specification)

Description

The interlocking function is used to check switching devices' control availability. The decision whether a switchgear's actuation is blocked or released requires evaluating logical links from the local virtual environment of the device to be actuated and of relevant process information. The logical node for interlocking (LN IIL) is used to indicate the interlocking result held by each Switch Controller (LN SWC). The interlocking function itself determines the status of its data and thus permits the closing/opening of the device when TRUE. The control service checks this value before it controls "Close/On" / "Open/Off" a switch at the selection and execution phases.

Figure 4-1 shows the principal procedure of interlocking in a bay when a command is given. Upon receipt of a switching command, the control logic checks if the intended control can be released (CIL). The interlocking logic provides the release or blockade information. When calculating the interlocking result, not only the field-internal status and release information but also information of other bay units is considered. Moreover, the interlocking logic provides other bay units with the calculated status and release information. In case of release, the command is issued to the process, in case of blockade no command is issued.

Course of events

Use case name: Switching by 50 Hz with interlocking equation enabling switch
Use case id: [IEC 61850]
Version: 1.0
Goal: Successful operation of a switching device
Summary: Successful operation of a switching device with interlocking equation depending on bay state and element state.
Actors: User, IIL_CONT (Switching device owner, Interlocking involved device owner), IIL_STATION

Preconditions: P11 IIL_CONT is in remote control mode. No other control is selected in this bay.
P12 Switching device has open status.
P13 IIL_CONT is in normal operation mode, no output operation (production function or switching operation) is running.

Triggers: T1 Switching device closing request by user

Course of events:

C1 USER requests IIL_CONT1 selection of closing key switching device.
C2 IIL_CONT1 confirms user request.
C3 IIL_CONT1 checks for interlocking result.
C4 IIL_CONT1 interlocking equation enables the control.
C5 USER requests IIL_CONT1 to close key switching device.
C6 IIL_CONT1 confirms user request.
C7 IIL_CONT1 checks for interlocking result.
C8 IIL_CONT1 interlocking equation enables the control.
C9 IIL_CONT1 closes key switching device.
C10 IIL_CONT1 reports USER successful switching operation.

Postconditions: P11 Bay switching device has closed status.
P12 IIL_CONT is in normal operation mode, no output operation (production function or switching operation) is running.

Data-Model Communication Services

Communication Concept

Table 4-2 Switching by 50 Hz with communication interface IEC 61850 Client/Server

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<tr>
<th>Use case data</th>
<th>IEC 61850 data</th>
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Table 4-3 Switching by 50 Hz with communication interface IEC 61850-COSE

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List of BAPs for substation automation

**General**
- Substation supervision

**Control**
- Control Blocking
- Control 1-out-of-n
- Control Authority Management
- Substation Interlocking
- Synchro-Check

**Protection**
- Reverse Blocking
- Auto-recloser Coordination

**Dedicated Applications**
- Busbar Voltage Replica
- Disturbance Recording Transfer
- Breaker Failure Protection
- …
Status

- BAP concept proposal is defined
- BAP example for substation interlocking is drafted
- BAP concept slides are available
- Various publications are adopting BAP concept
- Interest of users for BAPs is visible (ENTSO-E, CIGRE)
BAPs should lead to a win-win situation for the “IEC 61850 eco-system”

- The benefit for Utilities is the chance to harmonize the various company specific application function variants to a common denominator for each basic application function as a base of standardized BAP’s

- The benefit for Vendors which will use standardized BAP’s in their products is the reduction of project specific or utility specific variants of application functions and therefore reduce product complexity and parameterization efforts

- The benefit for Certification Bodies / Test-Labs is the ability to perform interoperability tests based on BAP’s and create out of the need for interoperability a new business case.
Thank you for your attention and contribution