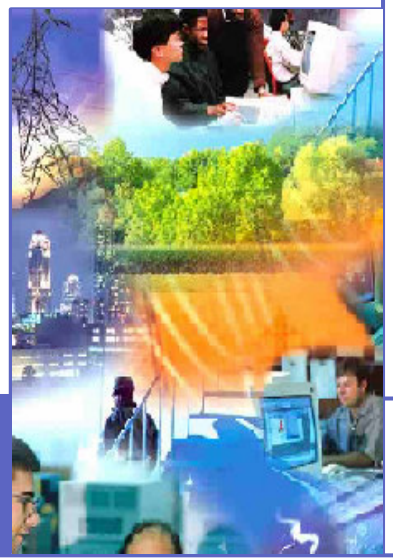
Klaus-Peter Brand

April 2006



Engineering according to IEC 61850

Content

IEC 61850
Engineering
Reference to IEC 61850-6

- SCL
- Engineering process
- Tools

Formal description of system structure

To provide interoperability

- a **formal** description of the Substation Automation System with all *communication links* is needed
- all *IED capabilities* have to be described **formally** in an unambiguous way
- all *communication services* applicable have to be described **formally** in an unambiguous way
- the relationship between the switchgear (*single line*) and the functions of the substation automation system represented by objects (LD, LN, etc.) have to be described **formally** in an unambiguous way

Formal description means SCL

The formal description is provided by the
Substation Configuration description Language (SCL)

- based on XML
- defined in part 6 of the standard (IEC 61850-6)
- usable for

  - IED Capability Description (ICD) files

  - System Configuration Description (SCD) file

  System functional specification (SSD)

The engineering information
is exchangeable between tools,
the tools get interoperable !!!bb

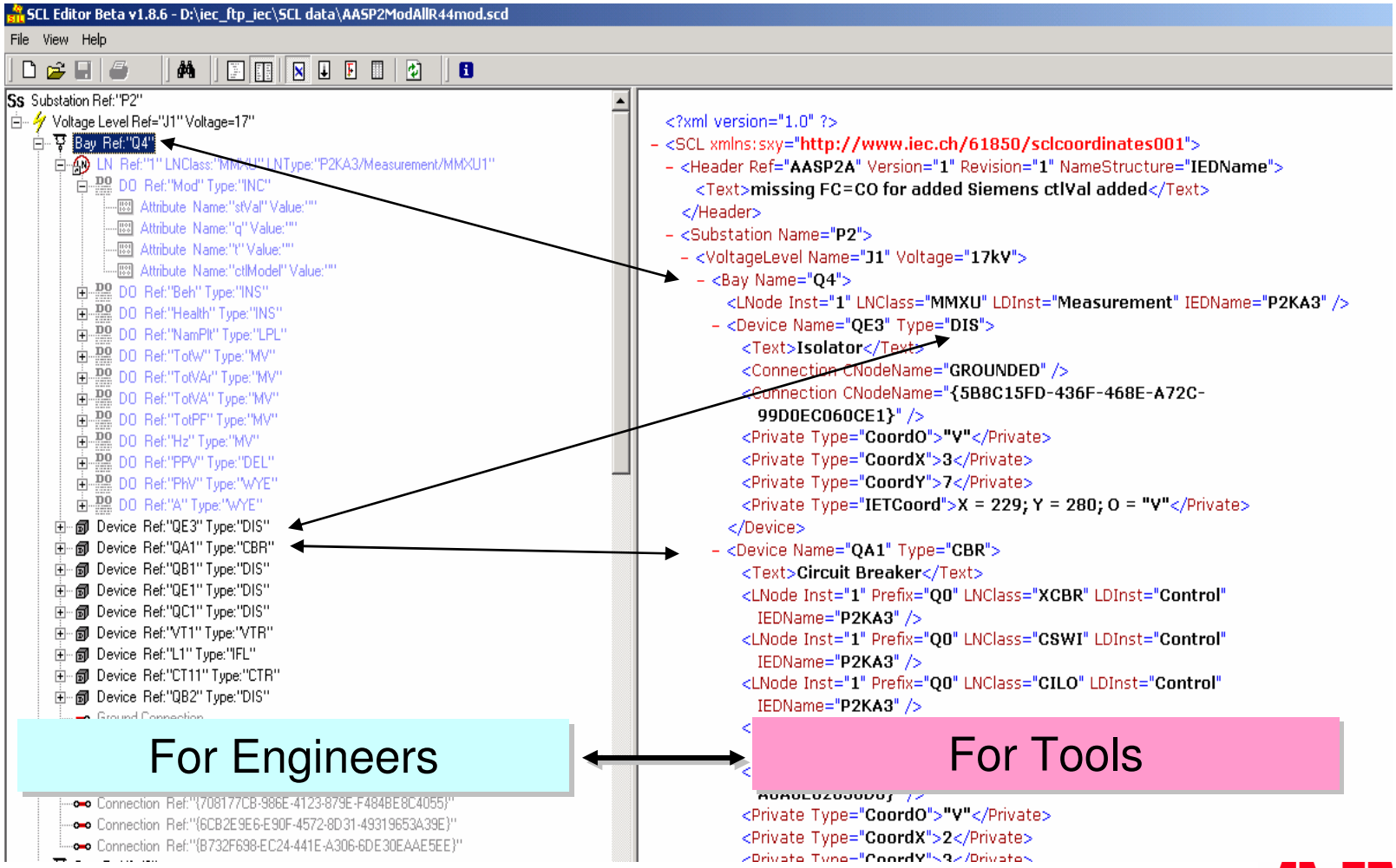
Example for SCL

```
<Substation Ref="">
   <VoltageLevel Ref="E1">
      <Bay Ref="Q1">
         <Bfunction Ref="">
            <Device Ref="QA1" Type="CBR">
               <Connection NodeRef="L1"/>
               <LNode Ref="1"
LNClass="CSWI"/>
            </Device>
            <Device Ref="QB1" Type="DIS">
               <Connection NodeRef="L1"/>
               <LNode Ref="2"
LNClass="CSWI"/>
            </Device>
         </Bfunction>
      </Bay>
   </VoltageLevel>
</Substation>
```

Described is a substation with the **bay E1Q1**, the **Circuit breaker QA1** and the **Isolator QB1**, both electrical connected in **Connection Node L1**.
The Controller is represented by - **LN CSWI** controls both switches.

Data structure and SCL

Hierarchical Data Structure ⟷ SCL description



Engineering and IEC 61850

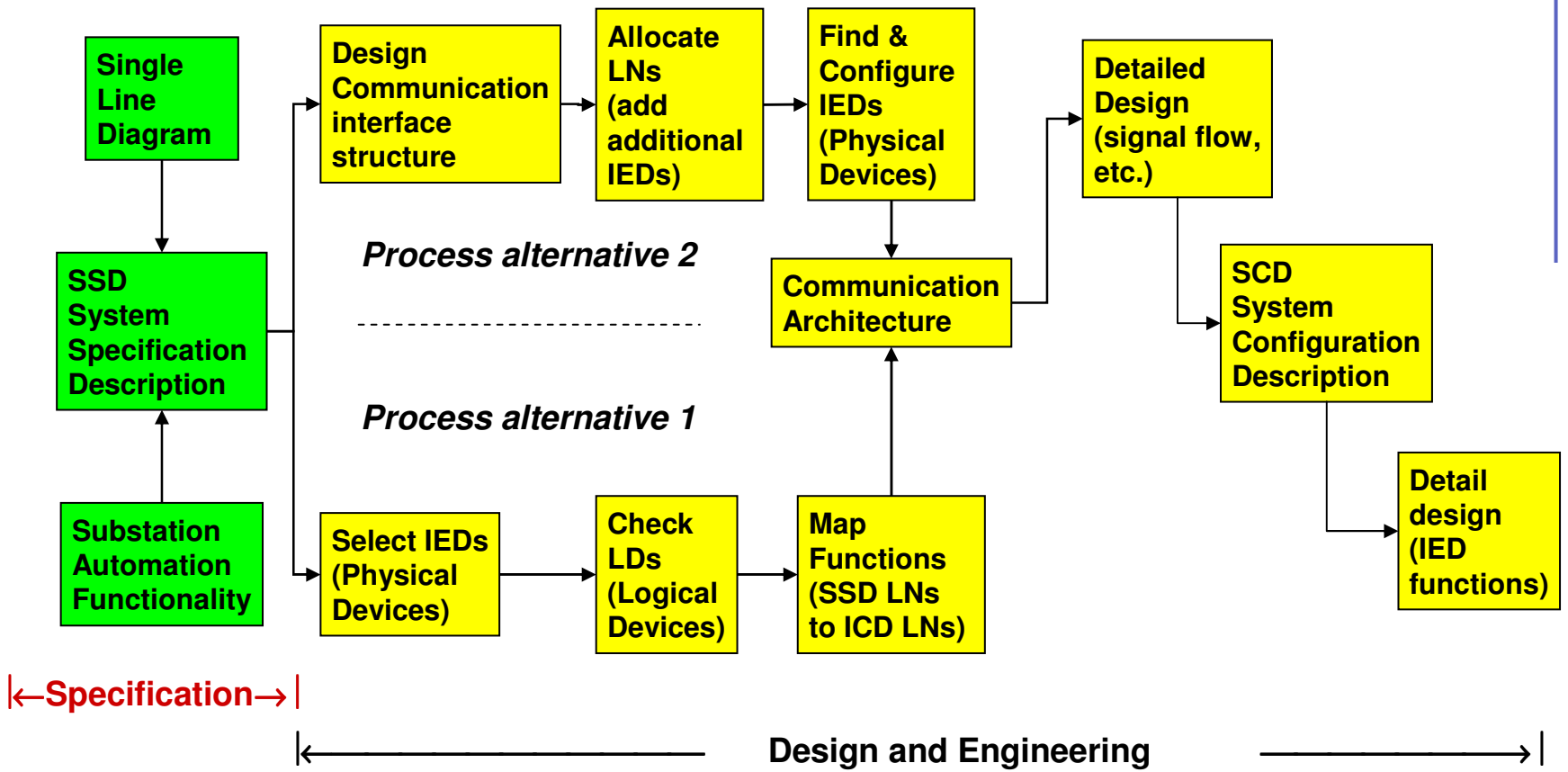
Reminder:

- The SA functions and devices are not standardized
- The SA architecture is not standardized
- Data and data exchange is standardized

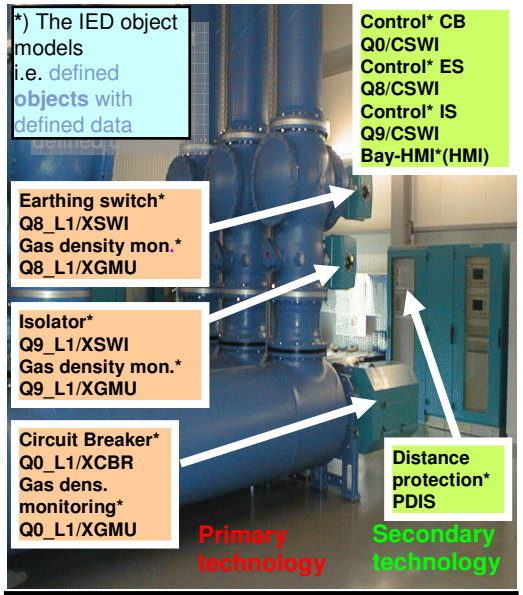
Note:

- The engineering tools are not standardized
- The engineering process is not standardized
- The configuration description is standardized (SCL)

Process from Specification to Solution



Engineering according to IEC 61850



Data modeling: GIS substation

Device capability

Device data

Device (IED)

CID

Device specific tool

Device Configuration

Device selection

ICD

Device capability

System Configuration tool

SCD

System Configuration Description

Device data

System Topology & Functionality

SSD

System specification

Functionality

Substation Topology

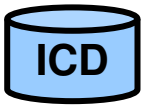
Communication Architecture

System Documentation

System documentation

The system SCD file may be reused for any maintenance action and for any extension projects after years and with state-of-the-art tools compliant with IEC 61850.

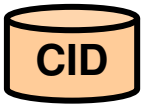
Engineering according to IEC 61850



IED Capability Description file
Device on the shelf - mandatory

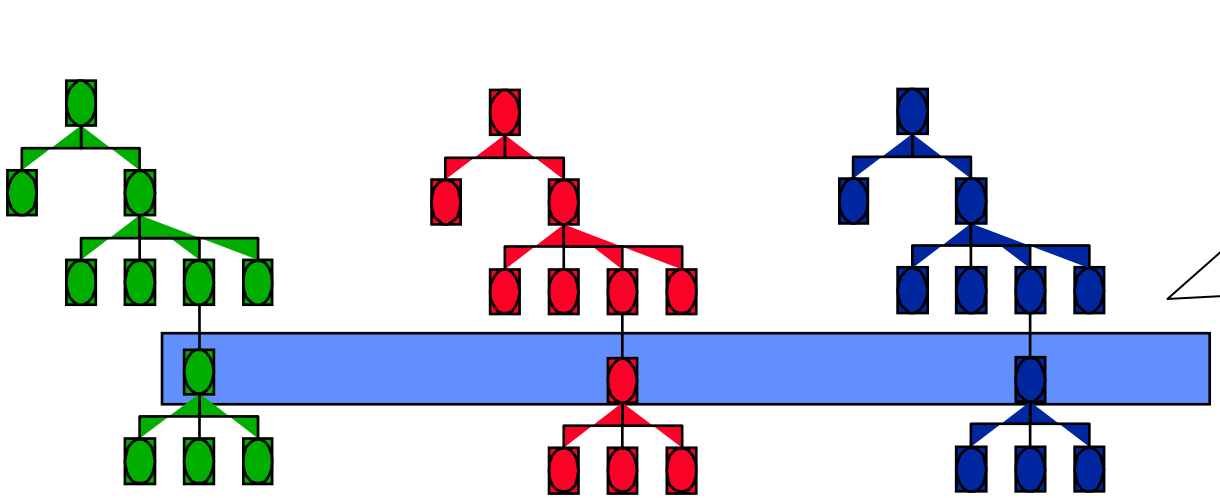
System Specification Description file
Single line and function allocation

System Configuration Description file
Configured system description



Configuration IED Description file
Configured IED description incl.
device specific data beyond IEC 61850

Project Structures / Engineering Aspects



an object with different aspects designation adopted from different structures

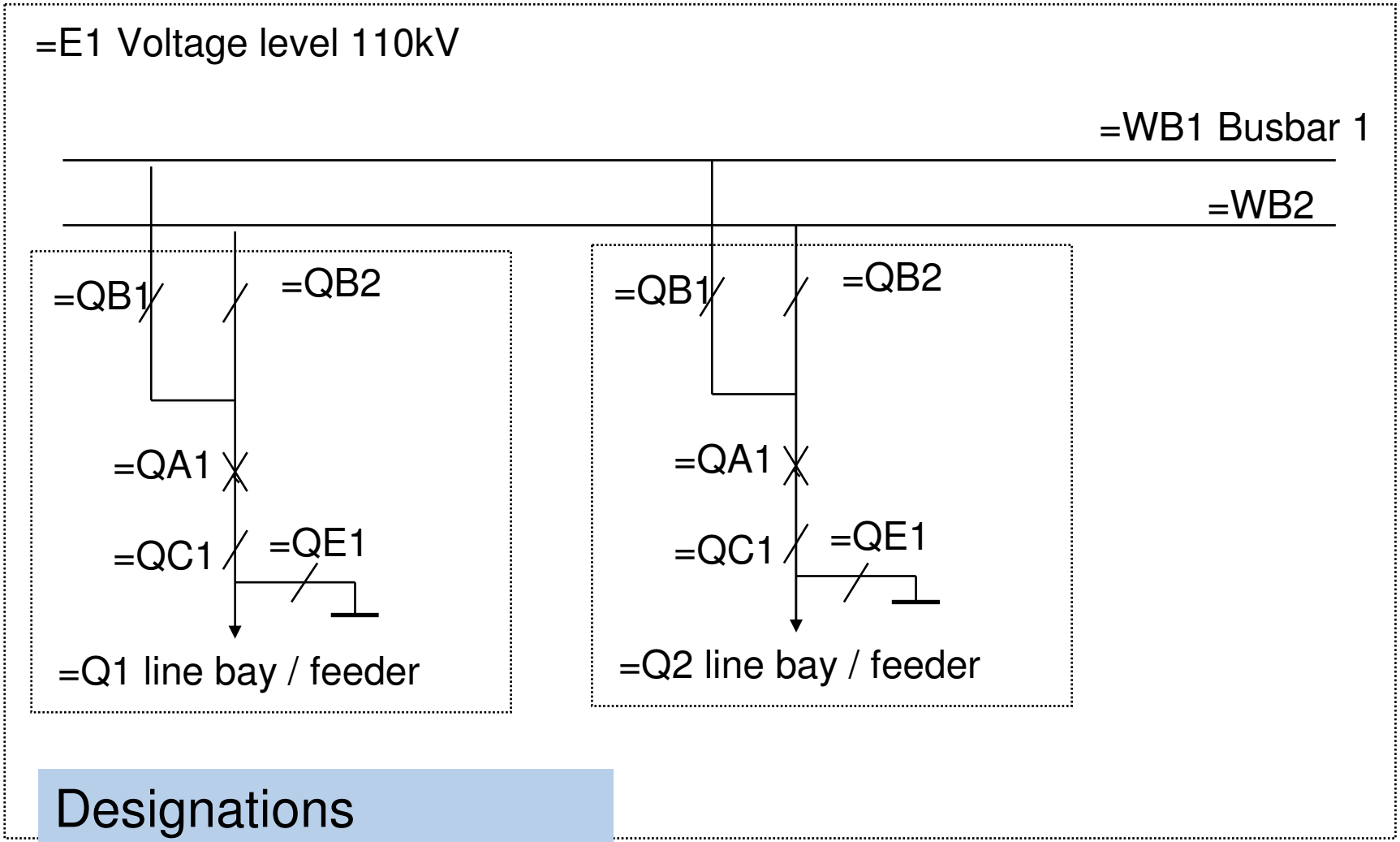
Geographic, Location, Placement structure

Function, Software, Data (Product) structure

Devices / Physics, Hardware (Product) structure

Interface to environment or external world

SCL Contents – Single Line Diagram

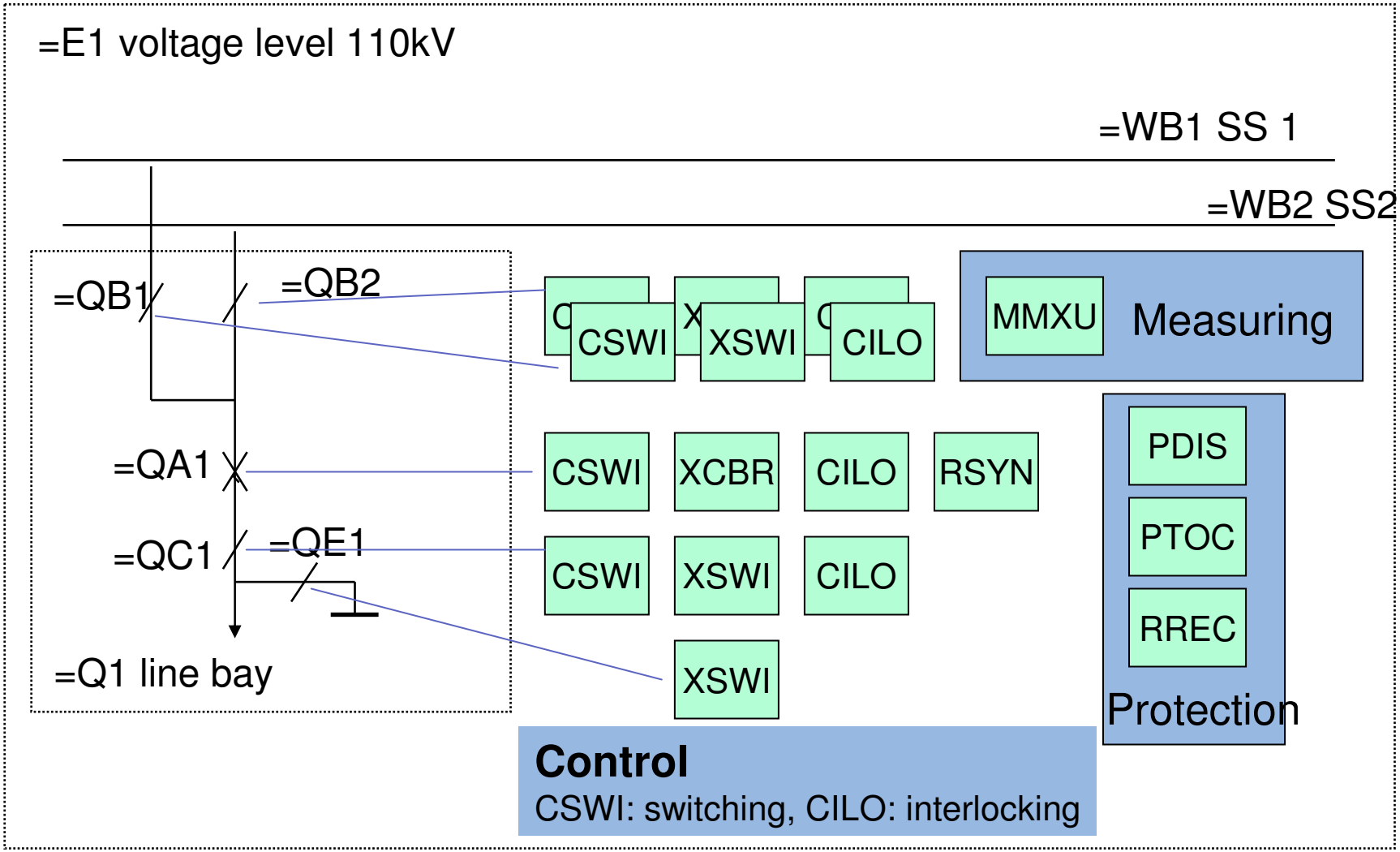


Designations according to IEC 61346

SCL Contents – Single Line Diagram

- Hierarchy **Station** / **Voltage level** / **Bay** / **Apparatus** / **apparatus part (Phase)** acc. IEC 61346-1
  - Electrical connections between apparatusses
  - Several stations model a power network
  - Focus: Naming hierarchy of substation functions
- Model is compatible with IEC 61970
  - Different data exchange formats (although XML based
  - Data integration needs identical naming
    - *WG19: global Identifier, Identification server*

SCL Contents – Function specification



LN classes acc. IEC 61850

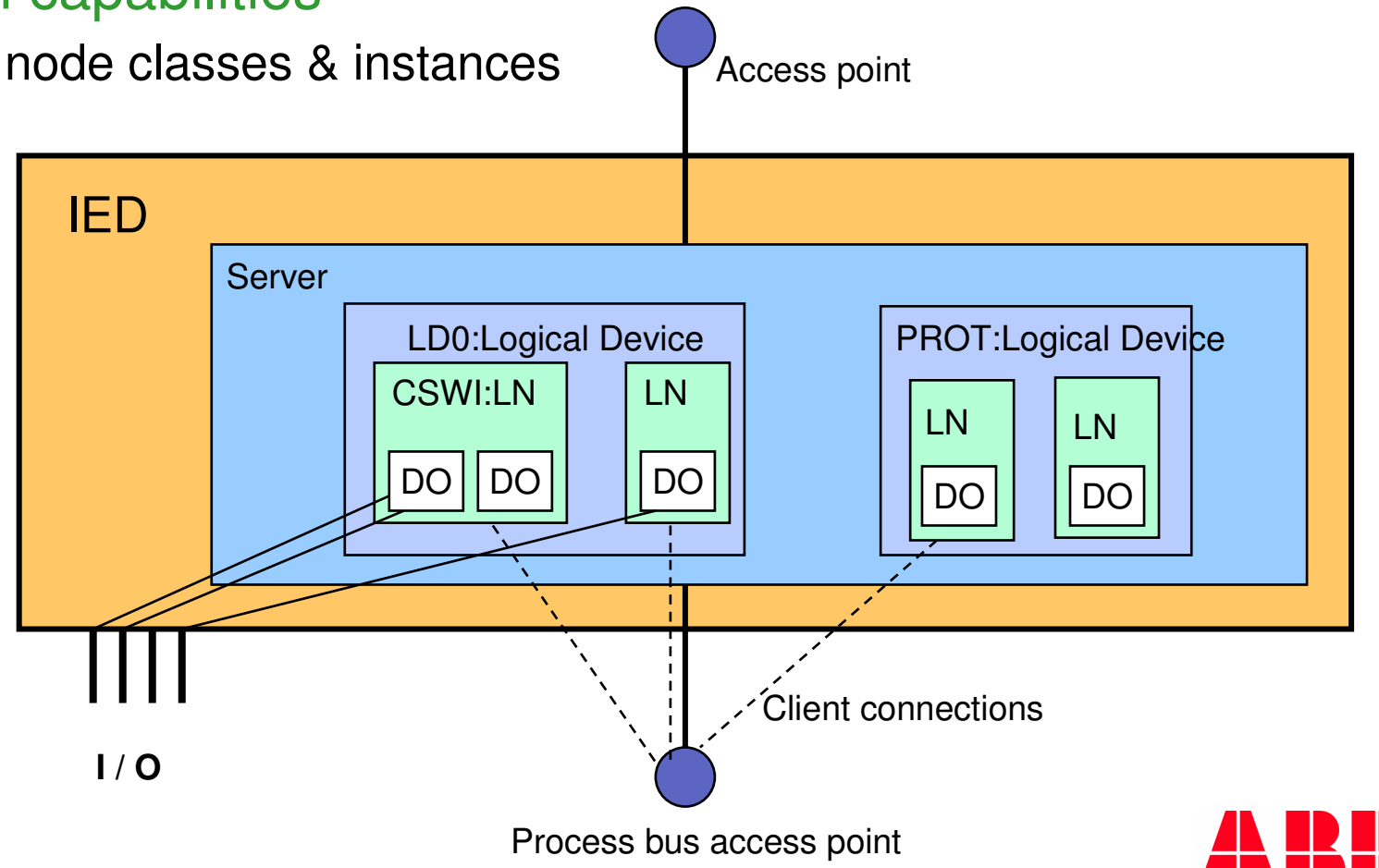
SCL Contents – IED Capabilities

Communication capabilities

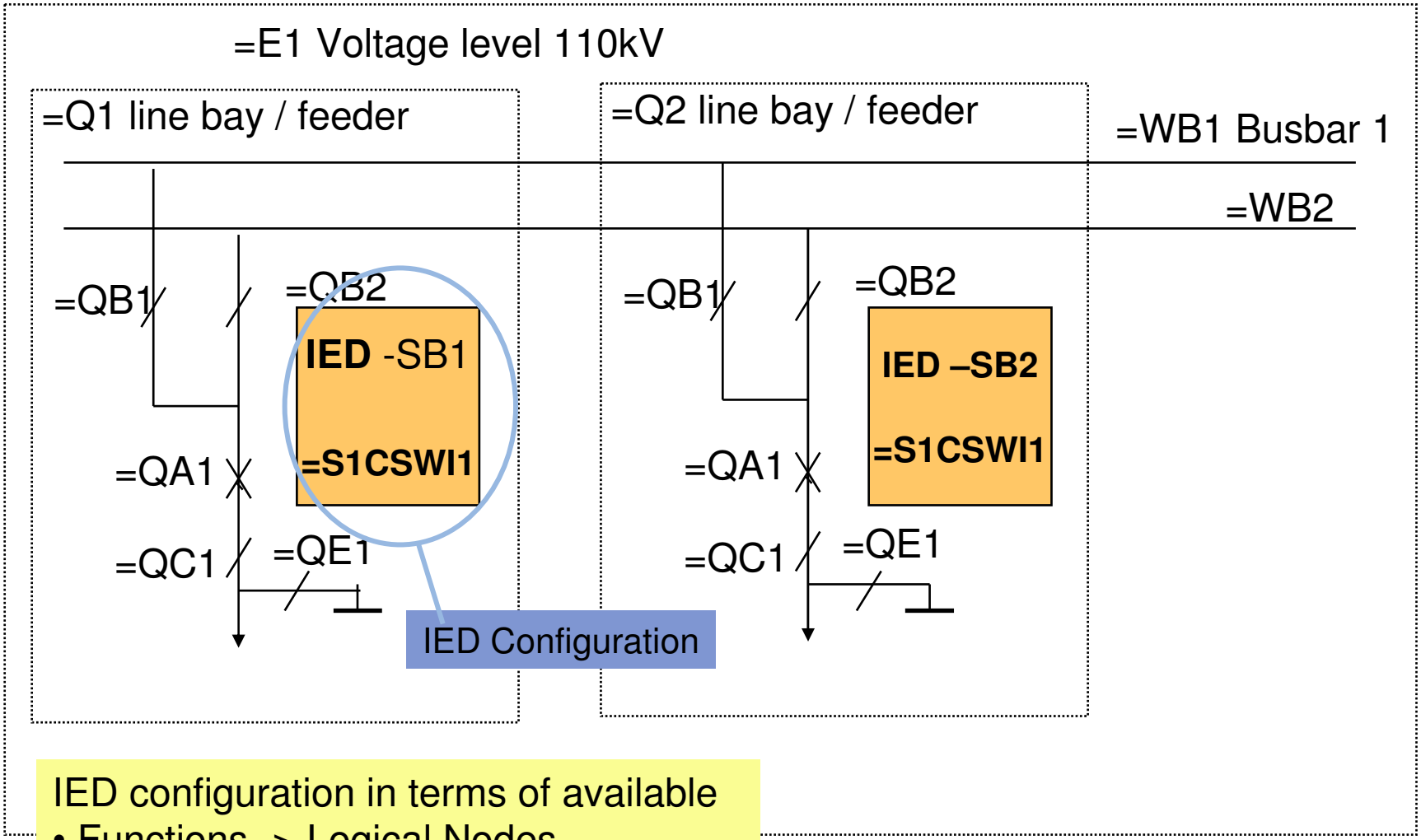
Services, limits

Function capabilities

Logical node classes & instances

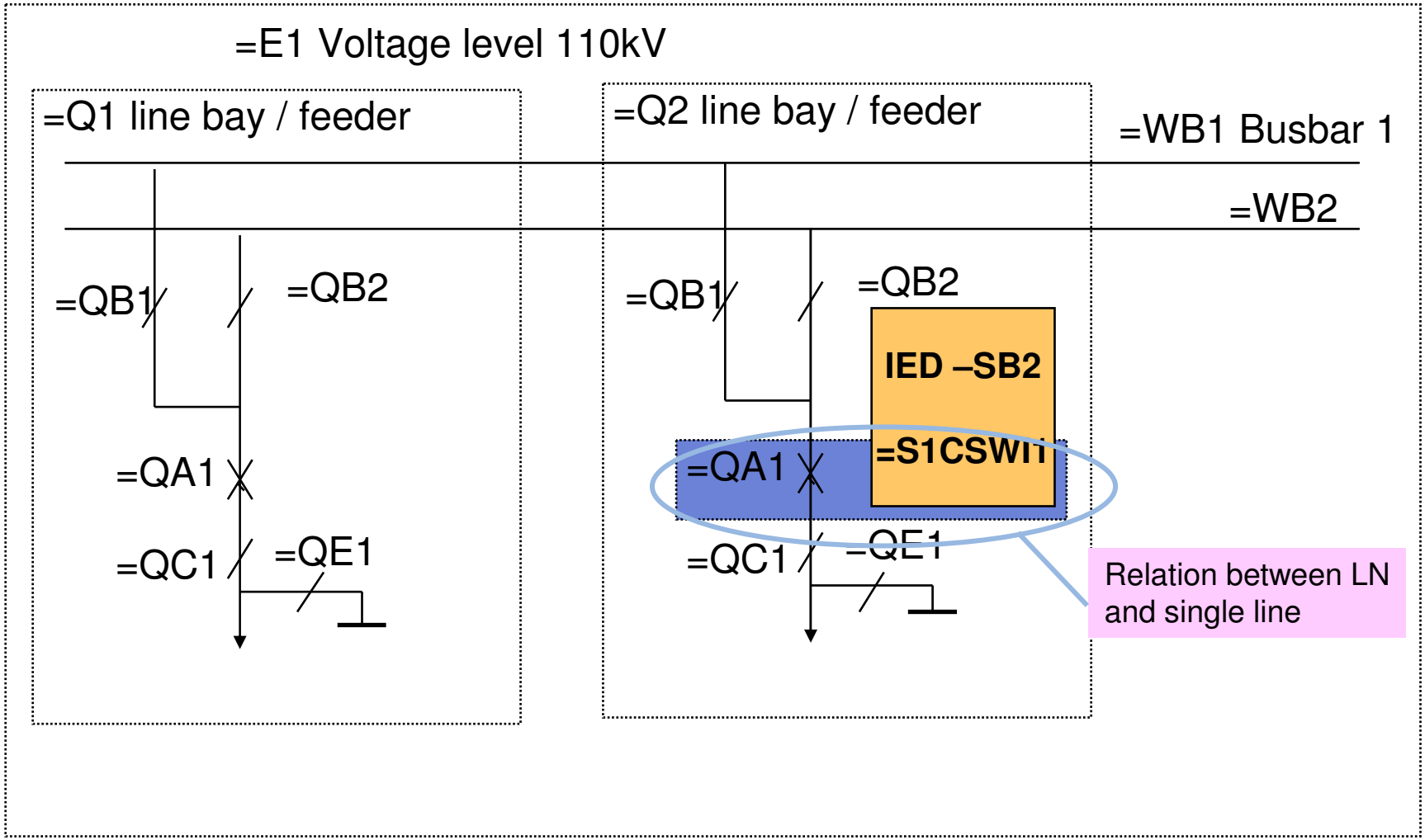


SCL Contents – IED Configuration

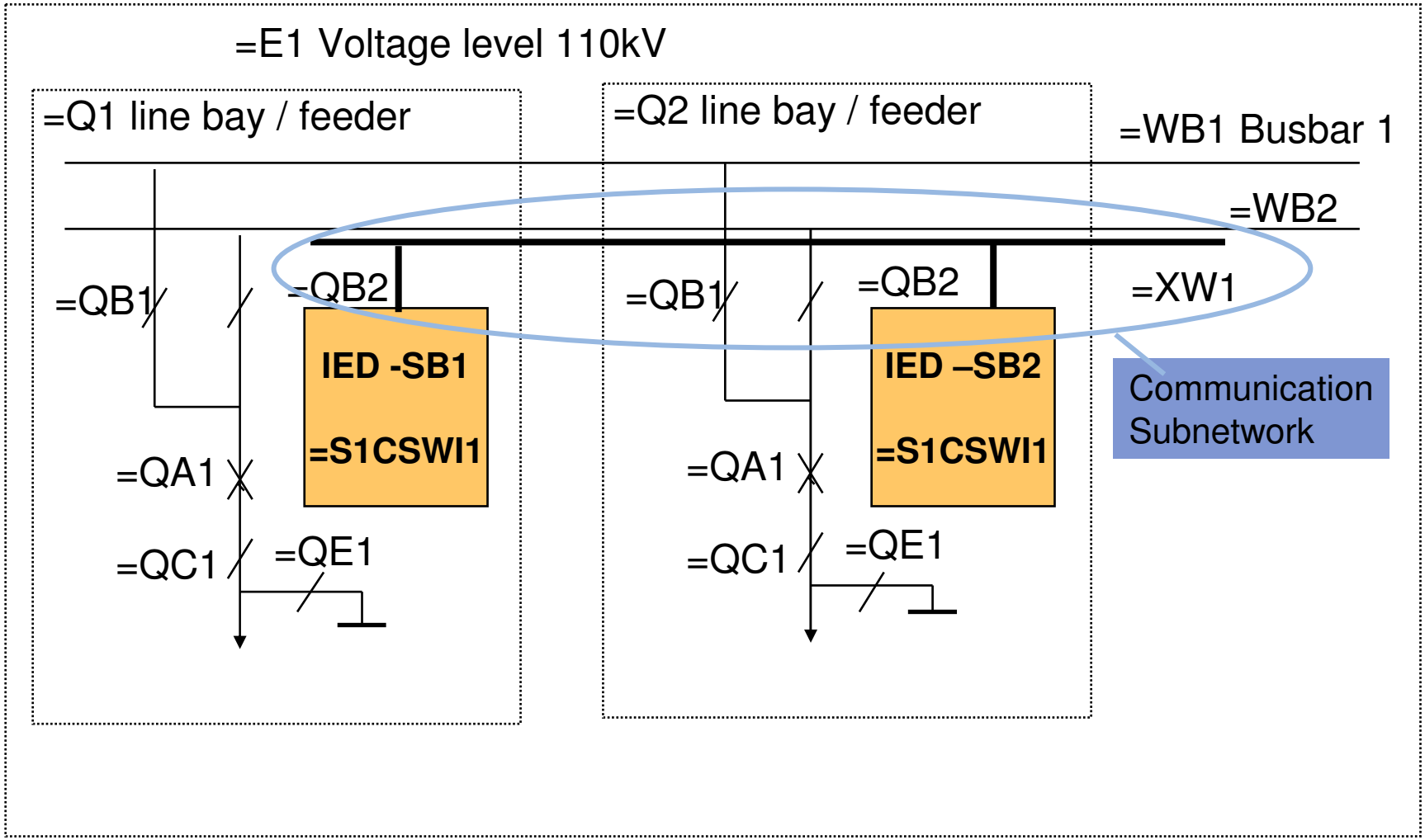


IED configuration in terms of available
- Functions -> Logical Nodes
- Sent data -> Data sets, Control blocks

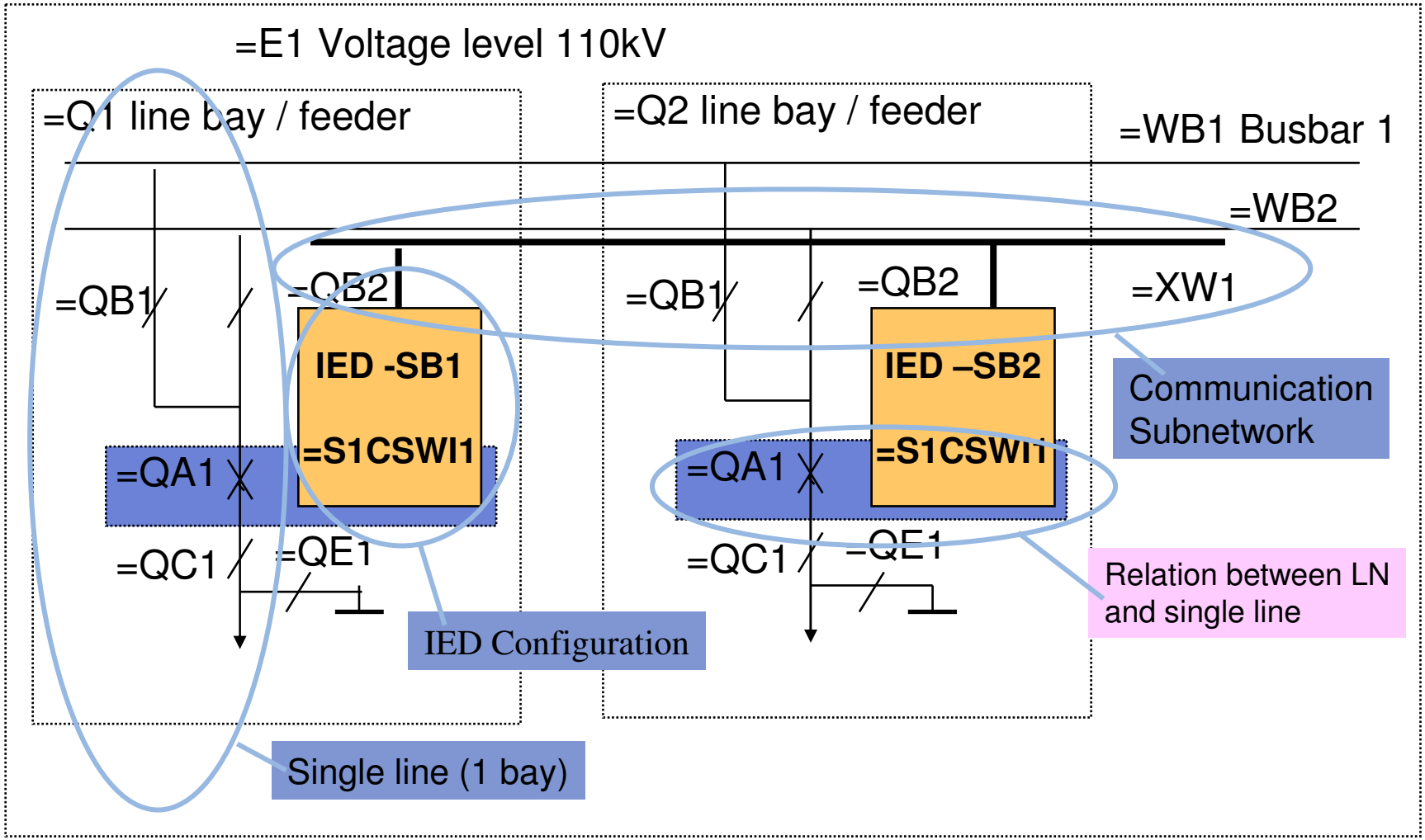
SCL Contents – Function relation



SCL Contents – Communication relation



SCL Contents illustrated



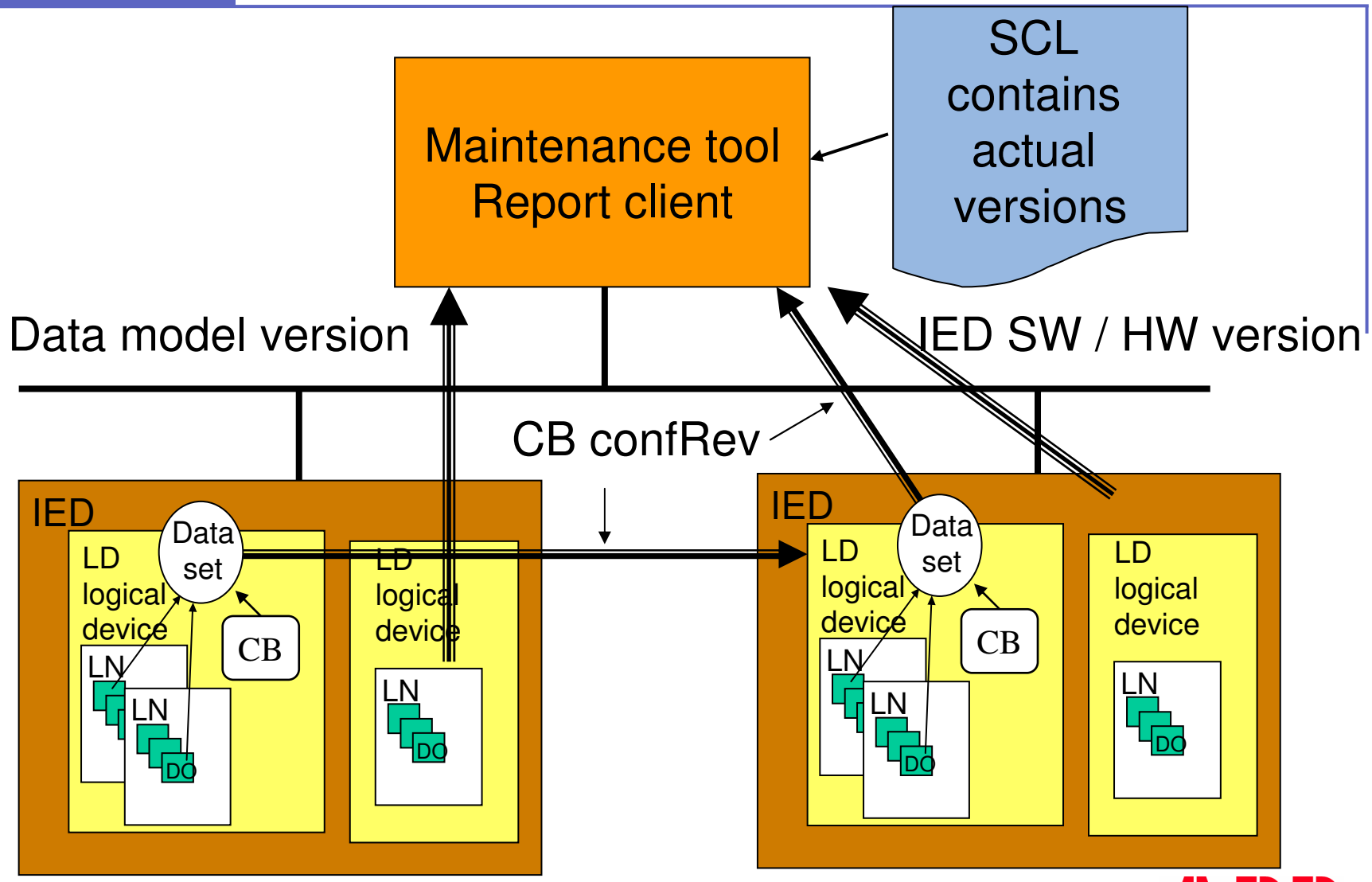
IEC 61850: standardized semantics

- The IEC 61850 IED data model and SCL language provides….
  - A standardized description of
    - Substation Automation System functionality
    - Communication system logical structure
    - Binding of IEDs and their functions to the switch yard
- .. And thus enables
  - Automated configuration of **communication** and **function**
  - System **performance checking** (performance)

Next Engineering steps

- Import of SCD into IED (-Tool)
- Detail engineering of IED, as necessary
  - Marshalling of inputs / outputs to terminals
  - Eventual additional logics, HMI, texts, ….
  - Marshalling of external (communication-)signals to application inputs
- Loading of configuration onto the IED
- Integration into system communicationwise and fucntionwise

Distributed Systems Consistency

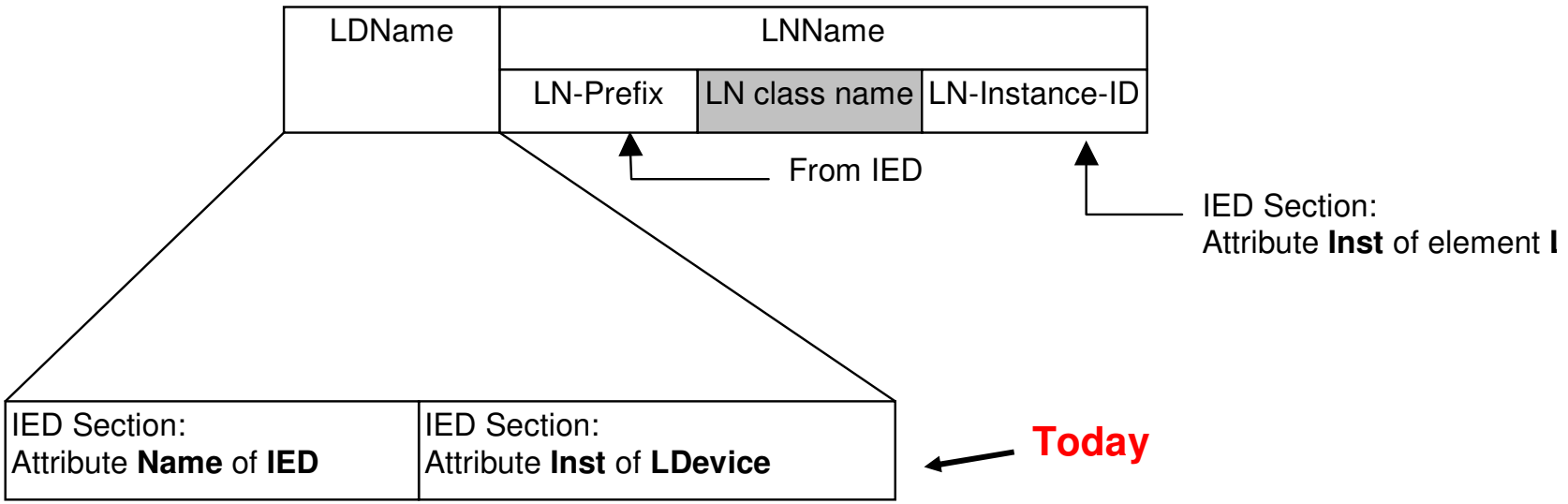


Real time confRev is always sent with data

Distributed Systems Consistency

- Configuration revision information (project specific)
  - Data model revision
  - Communication related configuration: data set / control block revision
- Information is available online and in SCL file
  - **Real time services** always have **revision** of data sets **in the sent message**. The receiver checks this always to assure configuration compatibility.
  - **Reporting version** information can be read **on demand**
  - **Data model version** and IED HW / SW version can be read **on demand**
  - Comparison with released SCL configuration file can be automated

SCL name definition: IED based names

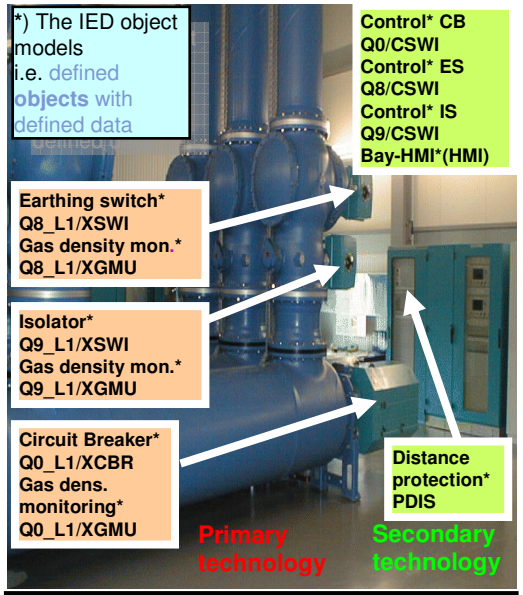


Next version:

- LDName= Domain name, freely customer definable
- Default: as today
- IED name stays always as SCL reference

Engineering Process

Engineering according to IEC 61850



Data modeling: GIS substation

Device capability

Device data

Device (IED)

CID

Device specific tool

Device Configuration

Device selection

ICD

Device capability

System Configuration tool

System Configuration Description

SCD

Device data

System Topology & Functionality

SSD

System specification

Functionality

Substation Topology

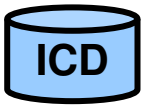
Communication Architecture

System Documentation

System documentation

The system SCD file may be reused for any maintenance action and for any extension projects after years and with state-of-the-art tools compliant with IEC 61850.

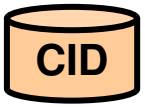
Engineering according to IEC 61850



IED Capability Description file
Device on the shelf - mandatory

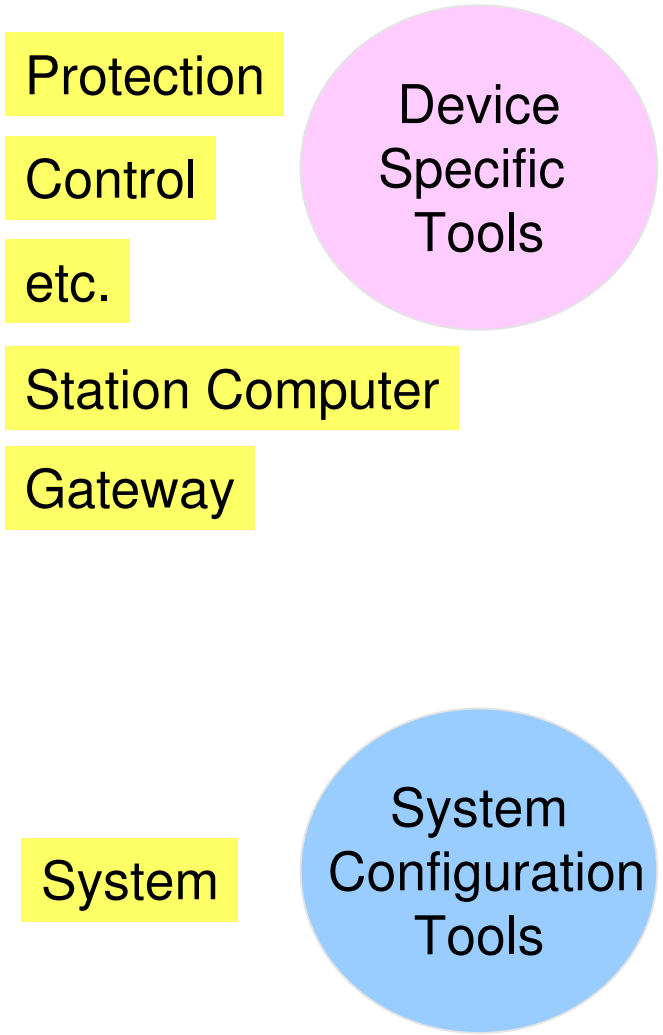
System Specification Description file
Single line and function allocation

System Configuration Description file
Configured system description



Configuration IED Description file
Configured IED description incl.
device specific data beyond IEC 61850

Two group of tools



Typical features of Device Specific Tools

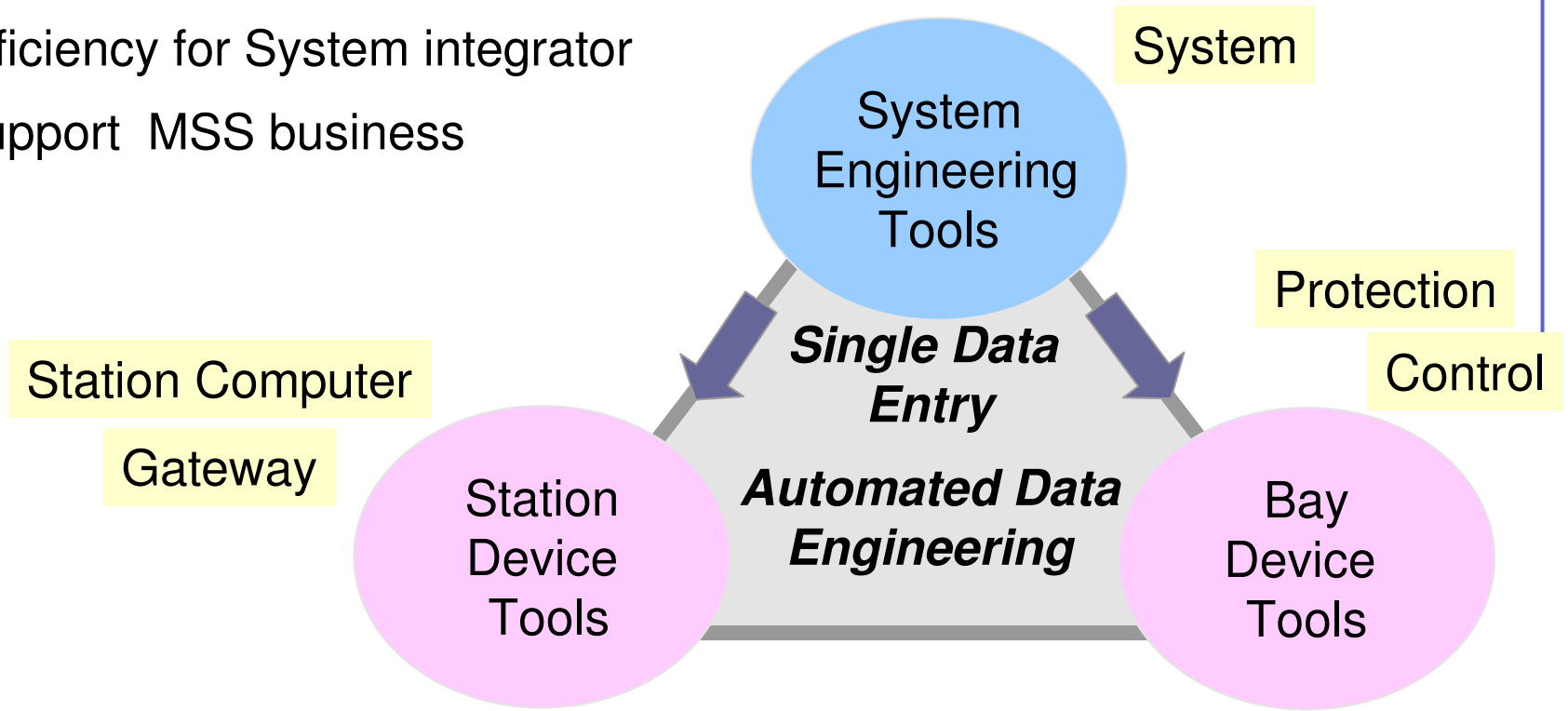
- are strong in configuring dedicated device features also beyond IEC 61850
- work with application libraries
- do normally not handle the single line diagram since it is beyond one device
- working on-line with the devices

Typical features of System Configuration Tools

- allow top-down Engineering
- support the engineering of systems off-line from the specification
- are strong in reusing solutions and combining solution parts
- provide the administration of other project data like cubicle layouts
- support the creation of comprehensive project documentation

Main dependencies between tools

- Efficiency for System integrator
- Support MSS business



- State of the art tool support
- Automated configuration
- Open interfaces

- State of the art device tool support
- Eng./Test/Com. Efficiency
- Common look and feel

Engineering, Architecture, General

- Etz-Report 34, VDE Verlag 2004 (allgemein + Engineering, German)
- Praxis profiline, IEC 61850, Juli 2005 (general + Engineering)
- Design of IEC61850 based Substation Automation Systems according to Customer Requirements, CIGRE B5 PS1 2004, Brand, Brunner, Wimmer
- IEC 61850 SCL – more than interoperable data exchange, PSCC 2005 Liege, Wimmer
- Safety related distributed functions in Substations and the standard IEC 61850, IEEE BPT 2003 Milano, Brand, Ostertag, Wimmer
- Reliability investigations in SA architectures based on IEC 61850, IEEE PT 2005 Petersburg, Andersson, Brand, Brunner, Wimmer