Retrofitting Digital Substations

Michael Rotzinger, Senior SAS – Project Manager
Berlin, 27th November 2019 - Digital Substations

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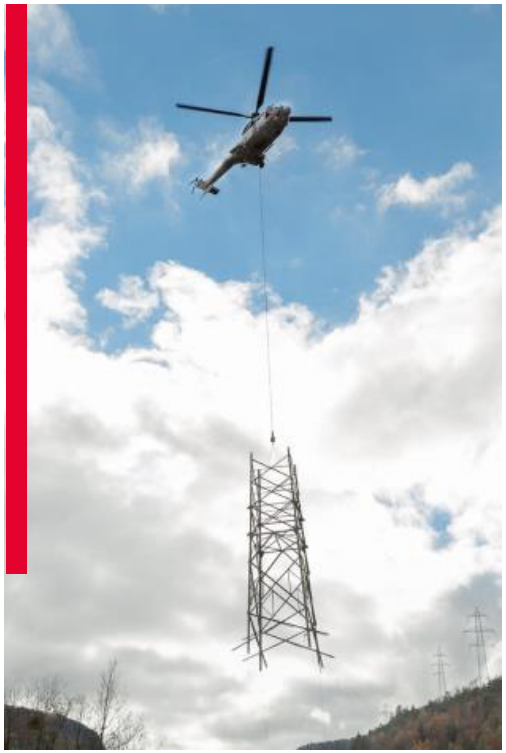
Agenda



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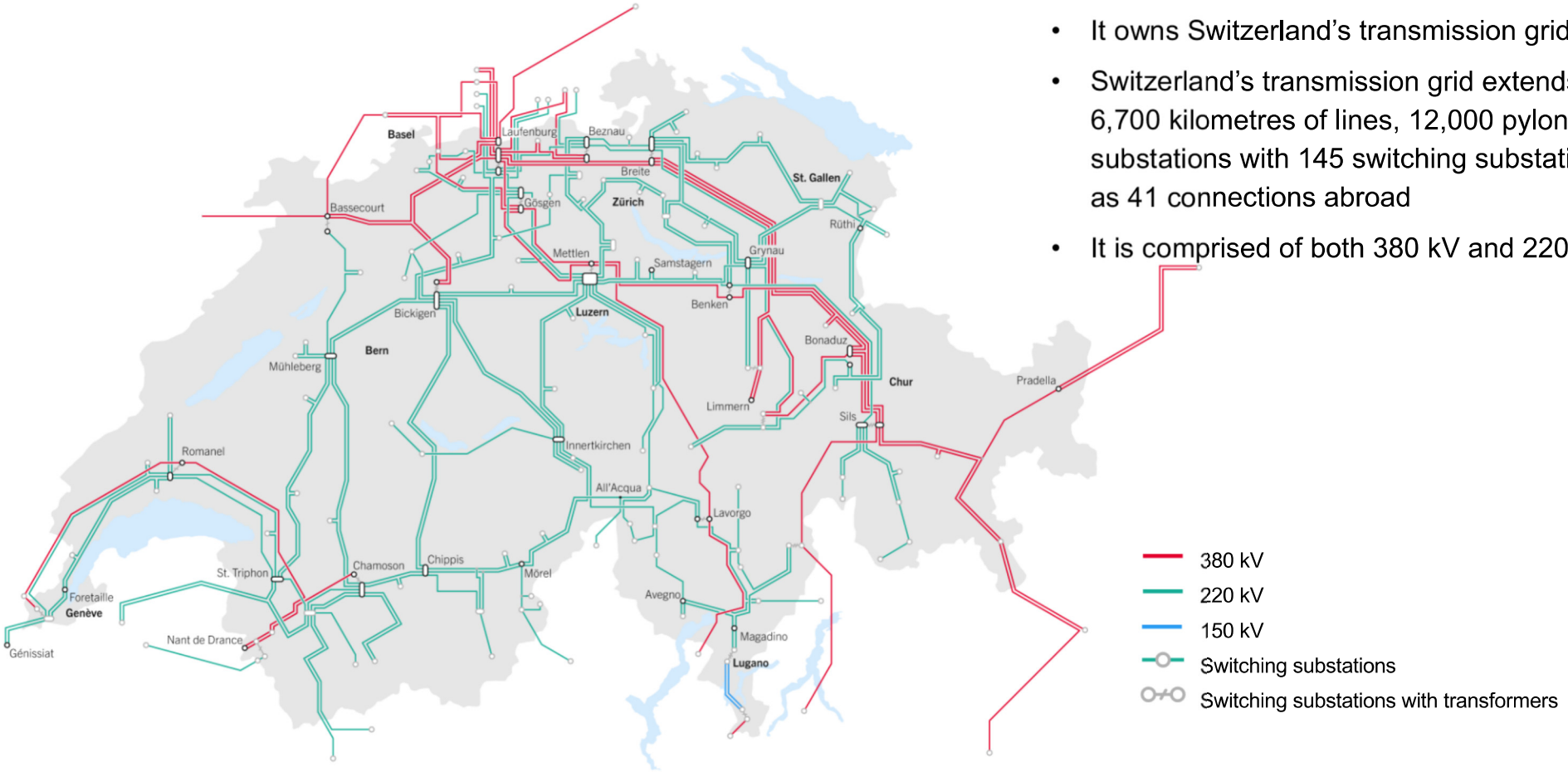
Swissgrid is the one and only TSO in Switzerland



- It owns Switzerland's transmission grid
- Switzerland's transmission grid extends across 6,700 kilometres of lines, 12,000 pylons and 125 substations with 145 switching substations, as well as 41 connections abroad
- It is comprised of both 380 kV and 220 kV lines

380 kV
220 kV
150 kV
Switching substations
Switching substations with transformers

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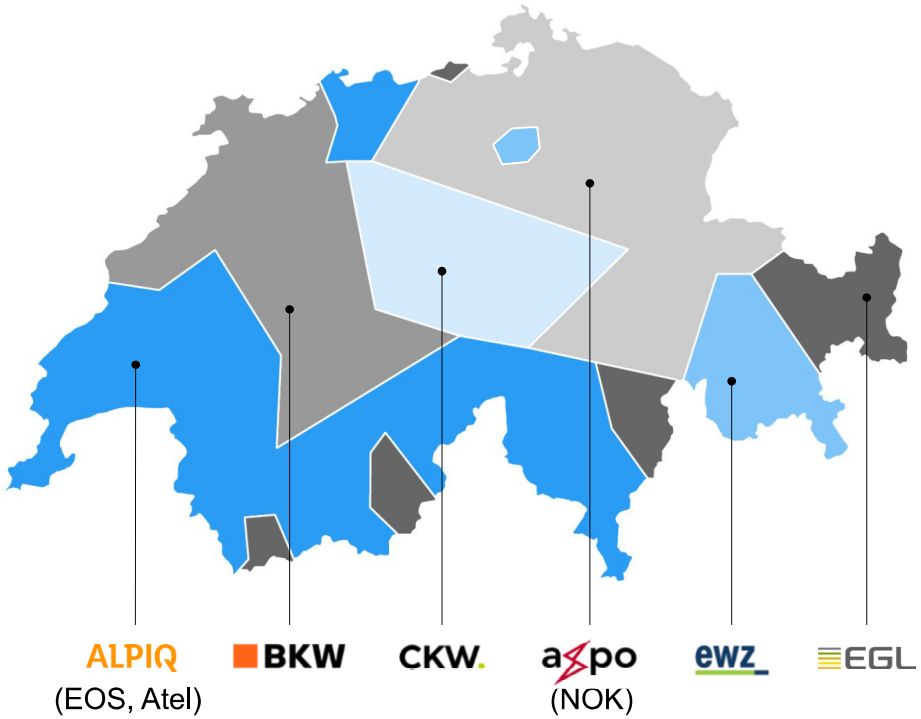
Historical grown



(EOS, Atel) (NOK)

2006 Various companies operate the grid, including Alpiq, BKW, CKW, Axpo, ewz and EGL.

2009 Swissgrid is responsible for the operation of the Swiss transmission grid.

2013 Swissgrid takes over the high voltage grid and thus the ownership responsibility.

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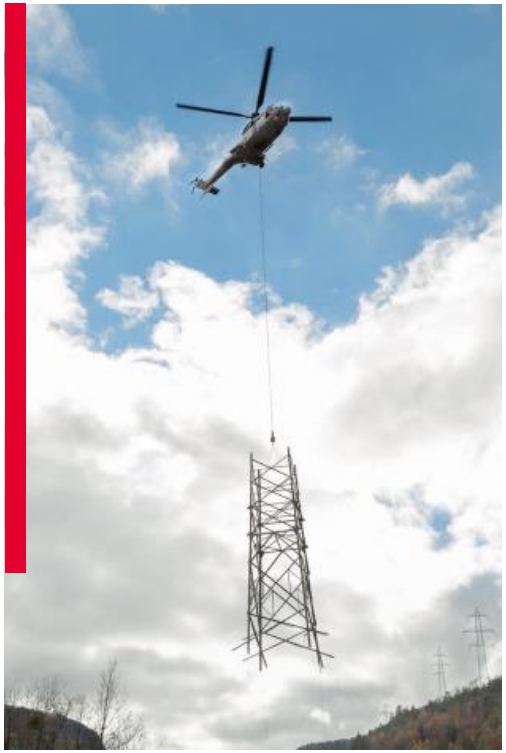

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Challenges – Internal

Infrastructure

• 145 unique pieces of art, aka “switching stations”	No standardisation –previous owner
• Overaged Systems	Operational need for renewal is rising

Knowledge

• Old Systems	Knowledge is retired
• New Engineers	Knowledge needs to be built and maintained
• Reasonable aged topic about Cyber Security	Knowledge is there but not refined

Political

• Pressure for renewal is raising	Awareness and urge to do something
• Prioritization: IT vs. OT	Awareness for Cyber Security risks

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Challenges – Internal

OT – Services vs. IT Cyber Security

• Zone Concepts	design the network and split it in certain zones
• Segmentation of Subnets	usage of different subnets for different services
• Segmentation of VLAN`s	different VLAN`s for different services
• Substation Data	extend your Datasets according your business model – Big Data
• Remote Access	Providing access to the substation for maintenance issues – Station PC, IED`s, Switches etc…
• Substation Jump Server	Access to a local Machine for Sniffing, adopt of Setting & Maintenance
• Disturbance File Transfer	Providing automatically transfer of the disturbances to the data-center

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Challenges – External

Environment

• Long Lifecycles	What we do now will be with us for a long time
• Different Lifecycles	What fits together today needs to be able to adapt
• Rapid technological development	What is built requires interfaces for future functions
• Physics does not change	What do we need to change
• Demand for a smarter Grid	What is smarter grid
• More control	
• More System protection	
• More interconnectivity	
• Big Data	
• Cyber Security functions for OT will keep to develop	What is the right level of implementation

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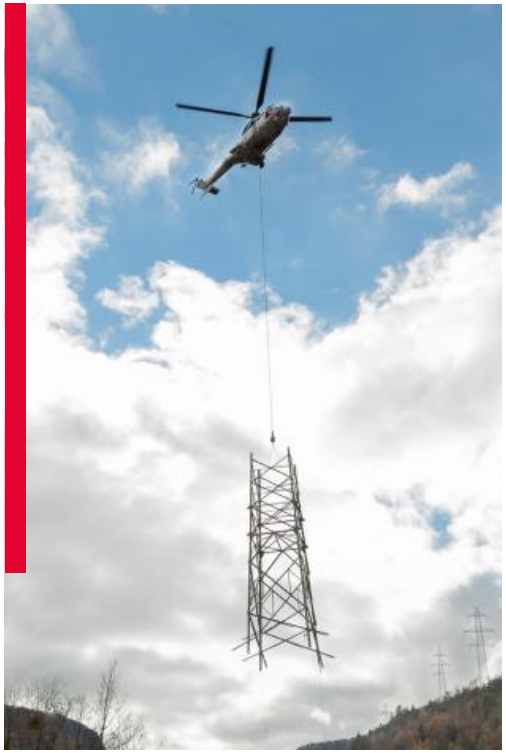

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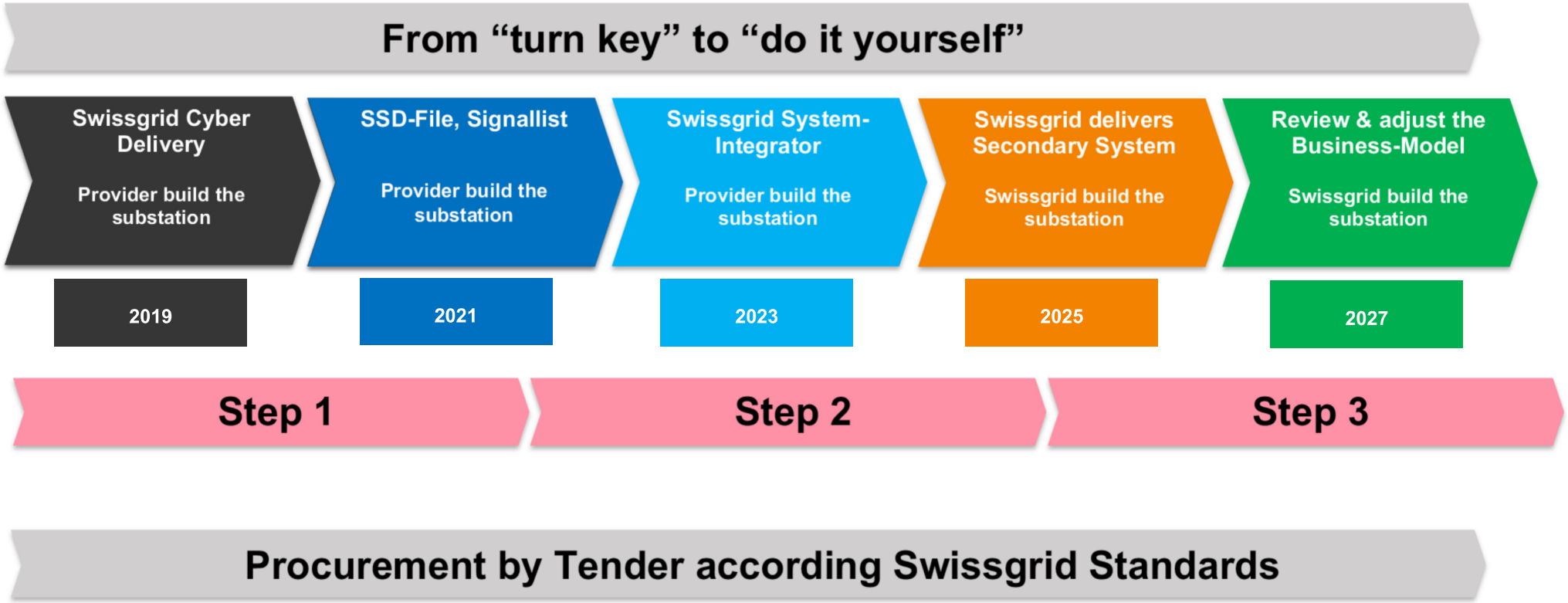
Business-Model Swissgrid



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Business Model Step 1 (Rollout already started)

Cyber Specification

• usage of intrusion detection systems	Avoid intruders, supervise frames
• usage of Substation Firewall	Service controlled, Remote Access
• usage of specified Notebook`s for maintenance	AD connected, supervised Access
• Virtualize your Substation SCADA	AD connected, supervised Access
• “usage of IED Role & Password Concept”	“the right man with the specific access”

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Business Model Step 2

Act as System-Integrator

• IEC61850 Editor (Helinks) for Tender	Specification SSD and Datalist for Tender (SG)
• Prequalification C & P IED`s	POC for Control & Protection IED`s – Frame Contracts (ext.)
• Prequalification of IT Components	POC for Switches, Firewalls (SG)
• usage of IED Templates	Templates are provided for each Feeder (SG)
• usage of Zenon (Copadata) as local SCADA	Import of Project SCD File to represent the local SCADA (SG)
• usage of standardized IO-Lists	All IED IO`s are predefined to terminals (ext.)
• usage of standardized Panel`s & Terminals	Common “Look & Feel” of each Feeder Type (ext.)

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Business Model Step 3

Responsible for the supply chain – secondary System

• Providing Feeder Panels	outsourced – according our Standards (ext.)
• FAT takes place at Swissgrid premises	Cyber Security Test-Environment, OT Operations, SNMP, Syslog, Metering (SG)
• IT Components provided by Swissgrid	local SCADA PC (VM`s), Firewall and Switches (SG)
• IED Configuration & Communication Templates	around 95% matching Config & CID-Files (SG)
• usage of Zenon as local SCADA	Import of Project SCD File to represent the local SCADA (SG)
• Predefined Tests during FAT	HW-Wiring Tests, C & P Tests, Redundancy OT Operation, Partner Interfaces, IT Security Alert Testing (SG)
• Delivery, Mounting, Wiring & Commissioning	outsourced mounting & wiring, insourced Commissioning (ext.)

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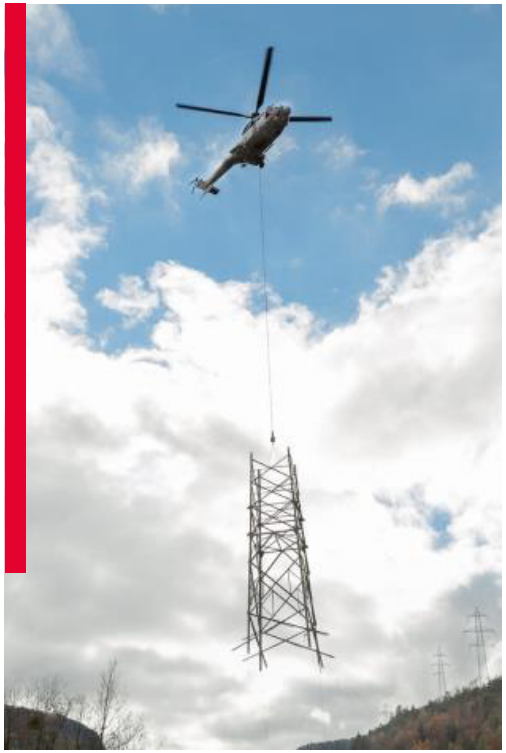

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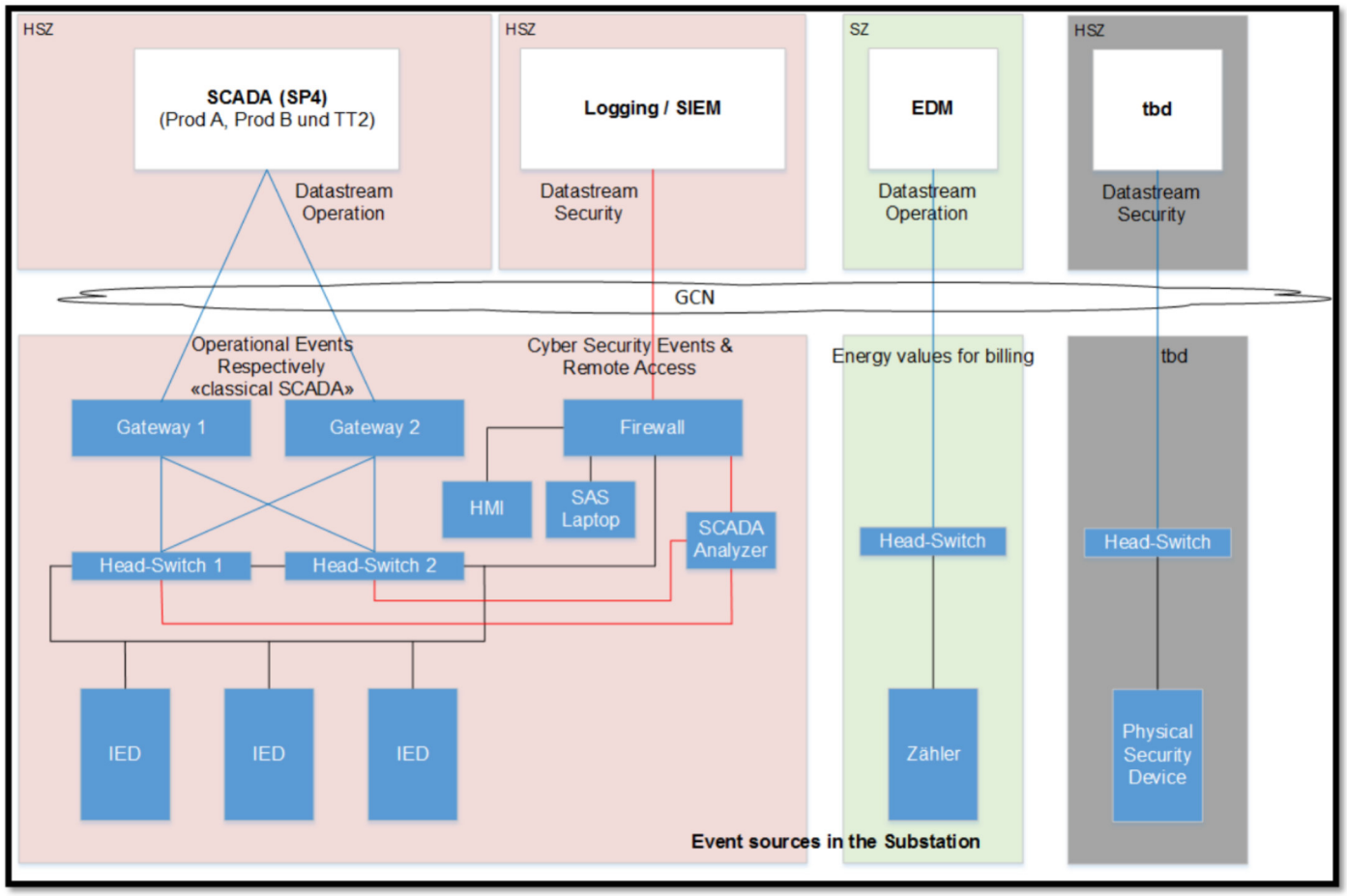
Architecture – digital substation



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Architecture Concept – mandatory collaboration IT-OT

Security Specification

• DMZ – HSZ Substation	build demilitarized zone for your substations
• VLAN`s	use VLAN`s so segment the services
• IDS-System (SCADA Analyzer)	IDS System to detect cyber issues
• SIEM	Security Information & Event Management
• Substation Notebook	to protect unwanted access to the substation component
• Password Protection	connect all IT Components to the AD according rules and right

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Operational Technologies / Services

Data Acquisition (Big Data) – Stakeholders

• Operation Data	Dispatchers, N-1 Calc, Operational Planning….
• Cyber Information	Detects of threats, attacks, unknown IT ….
• Emergency Information	break-in substation, fire alarm system….
• Network Supervision	SNMP, SYSLOG, Communication supervision
• Metering	Energy Data Management System
• MOC (coming soon)	Maintenance Operation Center, evaluation of primary events – e.g. counting pump starts for CB`s

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Strategy / Organisation Swissgrid

Organisation - Emergency Group (stand-by-duty)

• Operation Bridge	IT-Group – Data Center Supervision
• SOC	Security Operation Center
• PSS	Physical Security Center – Emergency Center
• NOC	Network Operation Center
• OSC	Operation Support Center
• MOC	Maintenance Operation Center

Provides 7/24 services, right information – on time – to the expert groups

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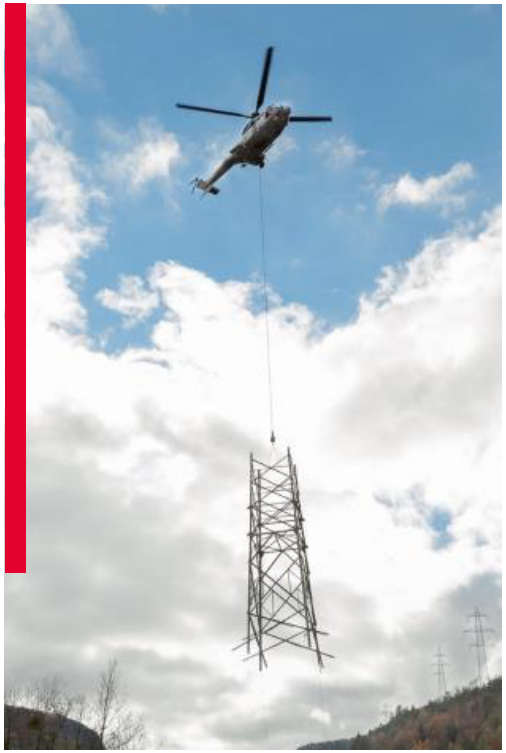

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Current status / coming back to the challenges

Legacy substations - brownfield

- Swissgrid Grid Planning 2025 – defined which substation has to be renewed, fully or partial (secondary system)
- Most Primary switchyards remains for approximately 10 years
- Secondary equipment has to be replaced, end of life time
- Use of different vendor protection unit for lines is mandatory according the swissgrid standards
- How can we replace the secondary side with new technologies in a brownfield?
- How can we handle the tele protection with the remote end side?
- How can we provide Line Differential Protection over MPLS?
- What`s about predictive maintenance?

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Technical solutions – cost efficient

Realisation with IEC61850

- Interoperability of IEC61850 provides the customer vendor independent integration

- Brownfield Upgrading/Replacement - divide the secondary side in two parts
  - Primary connection to the marshalling panel – from the marshalling panel to the secondary panel (IED`s)
  - IEC61850 Ring Architecture, PRP providing communication redundancy

- Tele protection will be realised by using the MPLS Network
- PTP time synchronisation will be used to ensure Line Differential protection over MPLS
- Replace both Line-End side Protection IED`s for Differential Protection

- Extend the datasets from the substation to provide all needed information to the maintenance group

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Boundaries – stakeholders group / Substation

Primary Process (Maintenance-Group)

- Defined Standardized Interface to the switchyard – Marshalling Panel

Communication to the Data-Center (Network-Group)

- Defined and Standardized Interface to the Grid Control Network – MPLS, IEC60870-5-104, Remote Access, Metering

Communication to Partners (DSO`s) (SAS-Group)

- IEC60870-5-101 Interface for Cyber Security Reasons
- Hardwired Interface – providing Trip`s, Blockings and Interlockings

Auxiliary Services (SAS-Group)

- Standardized Interface to all auxiliary services

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Supply Process – digital standardized Substation

Primary Process

- Standardized Panels per Feeder Type

Wiring

- Standardized Interfaces from the Secondary Panel to the Marshalling Panel

IED Configuration

- Standardized Configuration per Feeder Type and Vendor

IED Communication IEC61850

- By using the IED Configuration – CID-Files should match around 95%

Auxiliary Services

- Standardized Interface to all auxiliary services

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Leveraging opportunities to a reasonable usage of IEC61850

System-Integration with IEC61850

• Standard IED Config – Vendor independent	IO & Function matches our Standards
• Standard CID Config – Vendor independent	Common Data Sets, RCB`s
• IEC61850 Editor for Tender & Integration	Helinks IEC61850 Engineering Tool – provides Specification
• HMI-SCADA – IEC61850 Interface	Zenon generates your HMI automatically
• IEC61850 Editor for Gateways	Automatically generation of GW-Loadfiles out of Helinks
• Comparable System Integration	Compare your “as built” configuration with the tender one, by comparing the SCD-Files
• “on the fly” Parameter adoption	IEC61850 dynamic Parameter-Value Change

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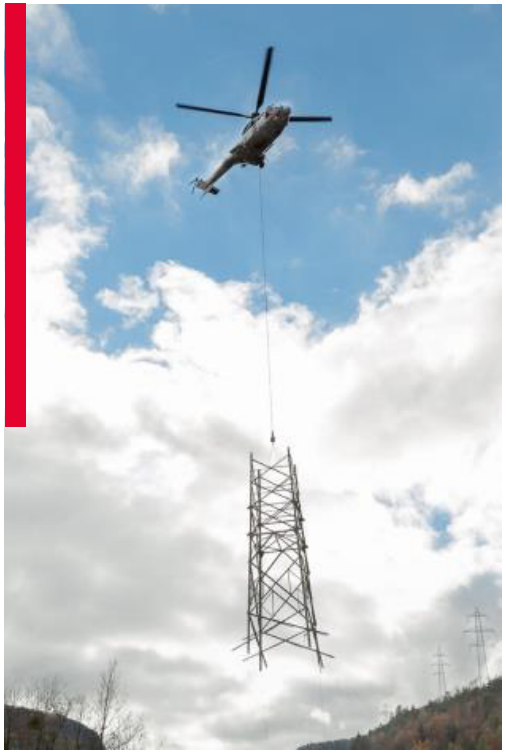

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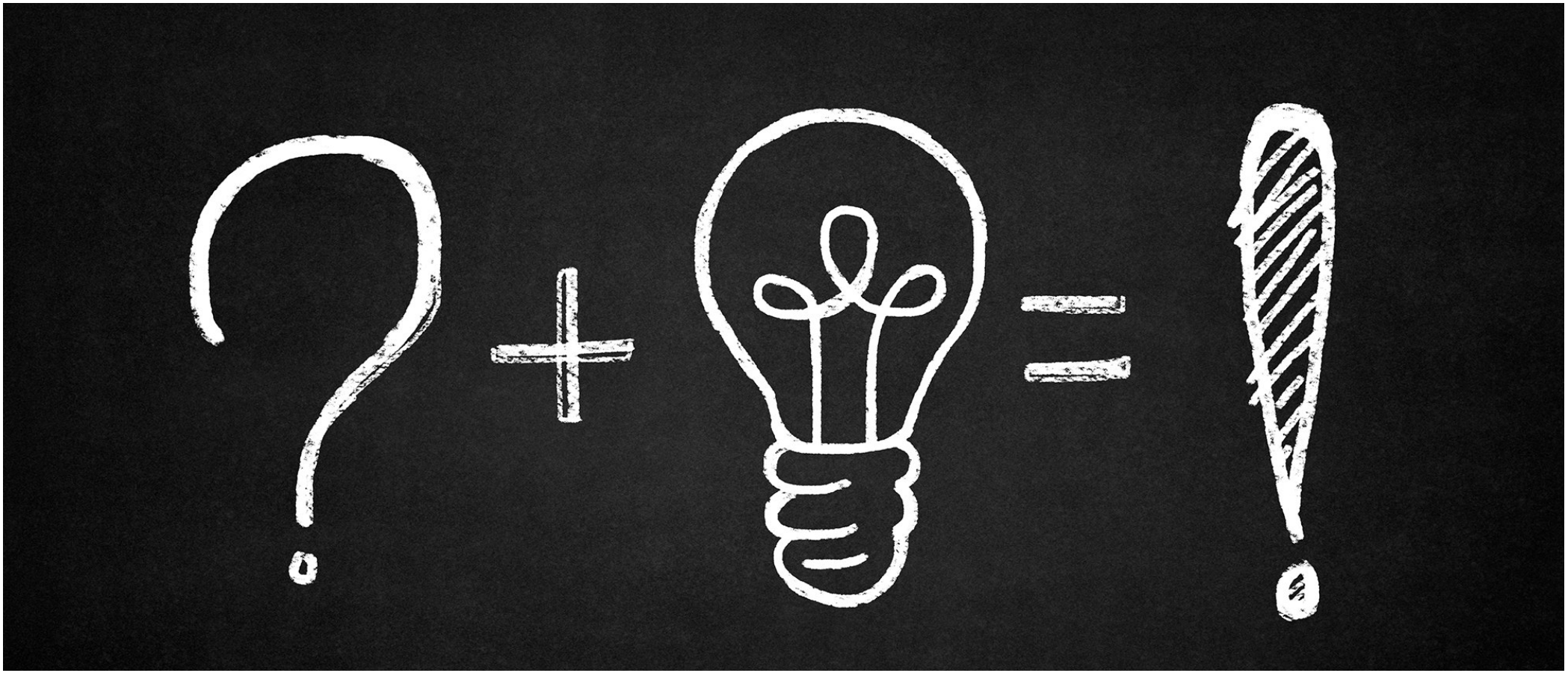

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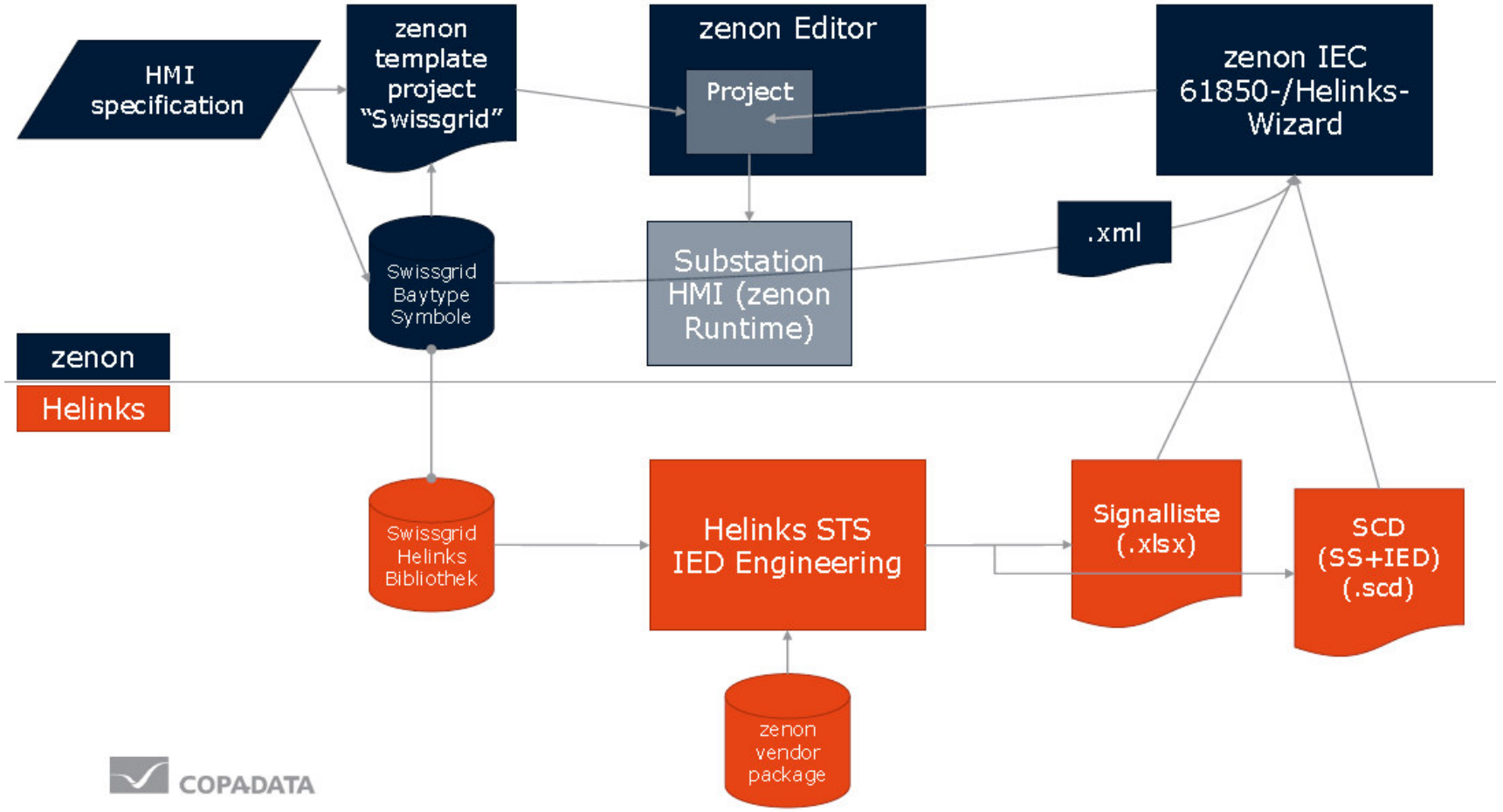
Backup Slides: Systemintegration Engineering Process



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