ENTSO-E ACTION PLAN TO IMPROVE IEC 61850 DATA MODELS AND ENGINEERING PROCESS

TOWARDS EFFICIENT IEC 61850 MULTI-VENDOR INTEROPERABILITY OVER THE SYSTEMS LIFECYCLE

IEC 61850 Europe Conference 2017

Amsterdam, The Netherlands, 27 September 2017

Grégory Huon, Elia & ENTSO-E AhG IEC 61850 convenor

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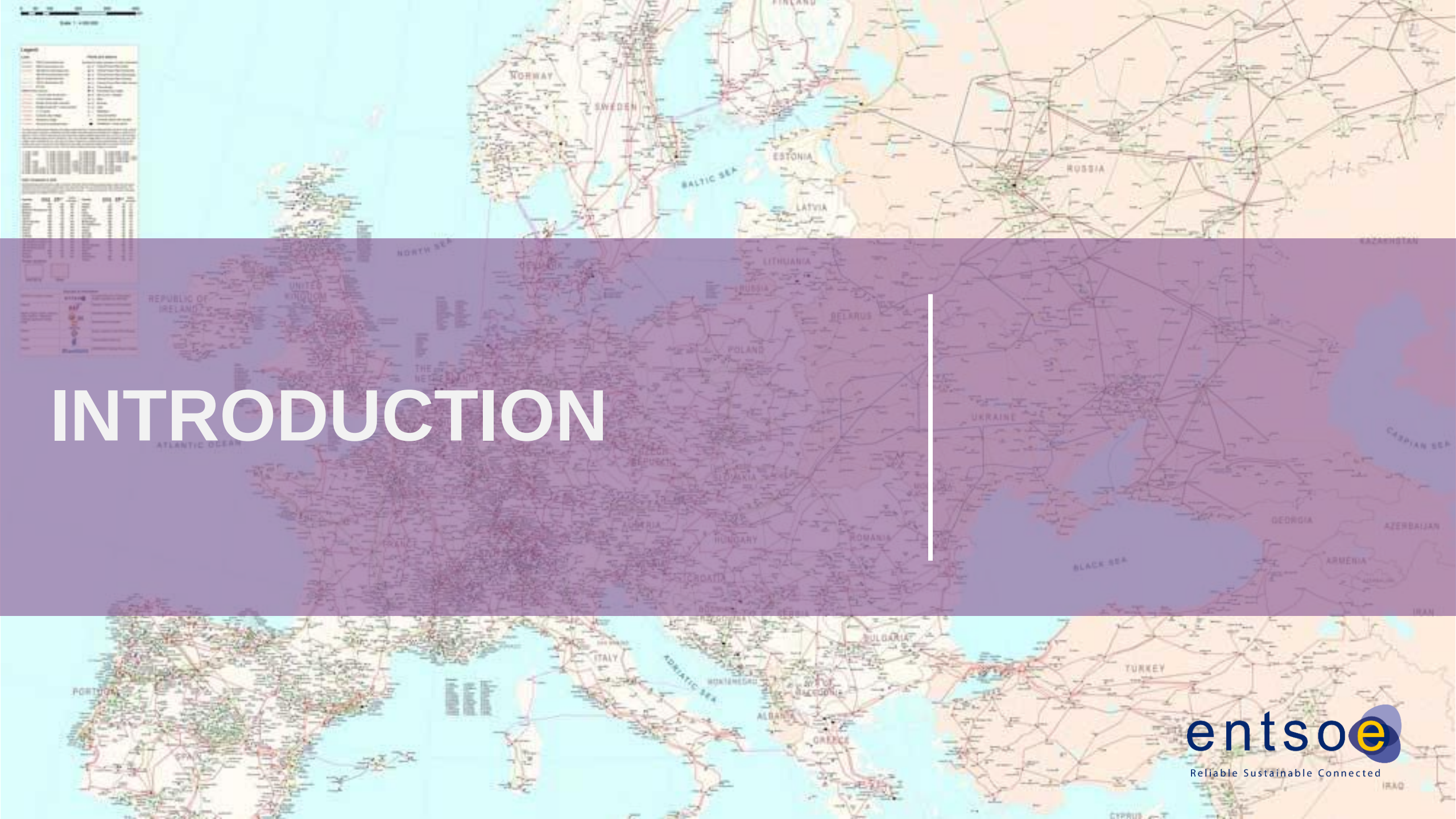

INTRODUCTION

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ENTSO-E at a glance

43 TSOs in
36 countries

300 000 km of
transmission lines

7 times the earth's unconference

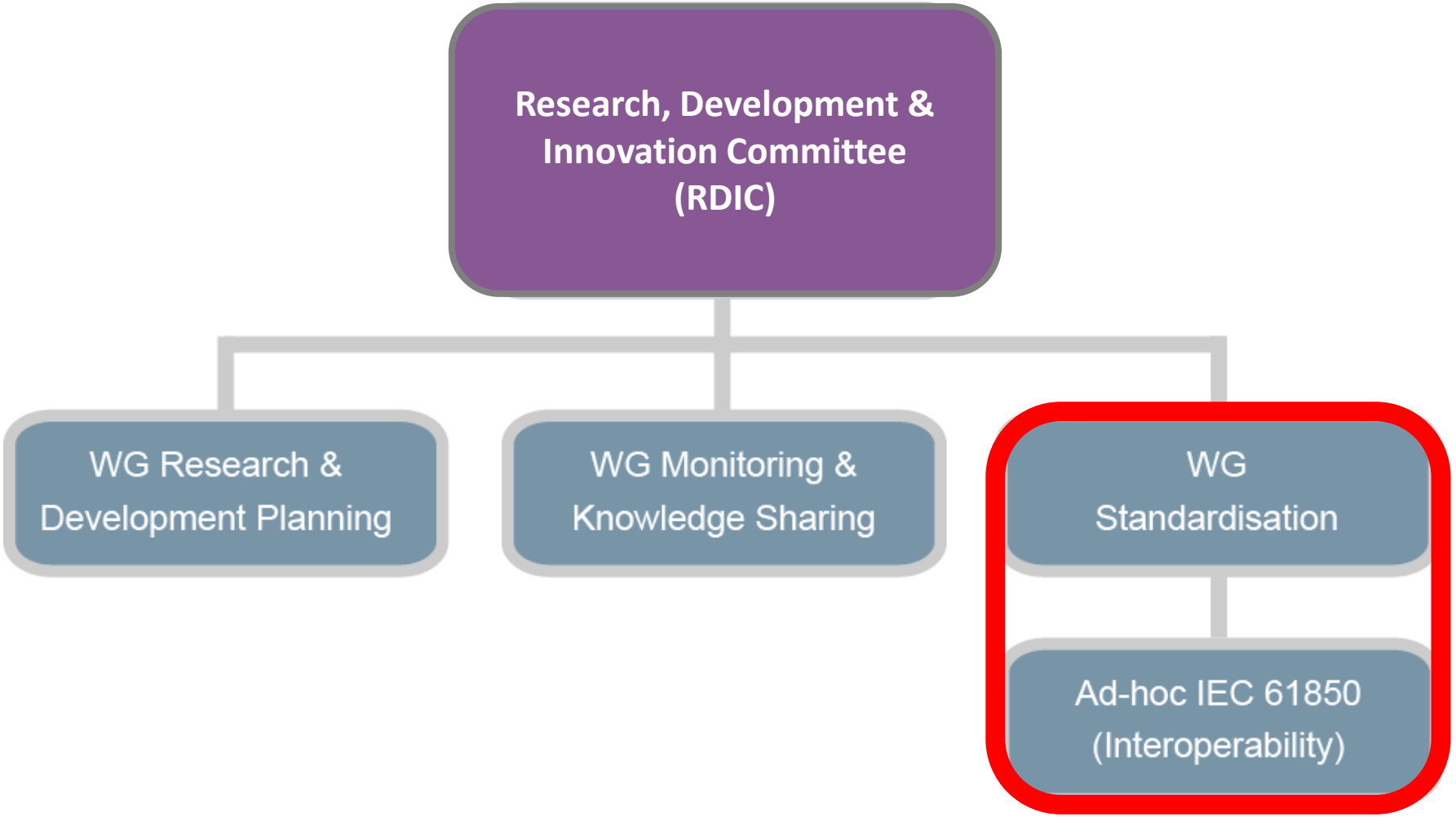
3300 TWh electricity
consumption

15%

of the global
electricity
consumption

over 500 million
customers served

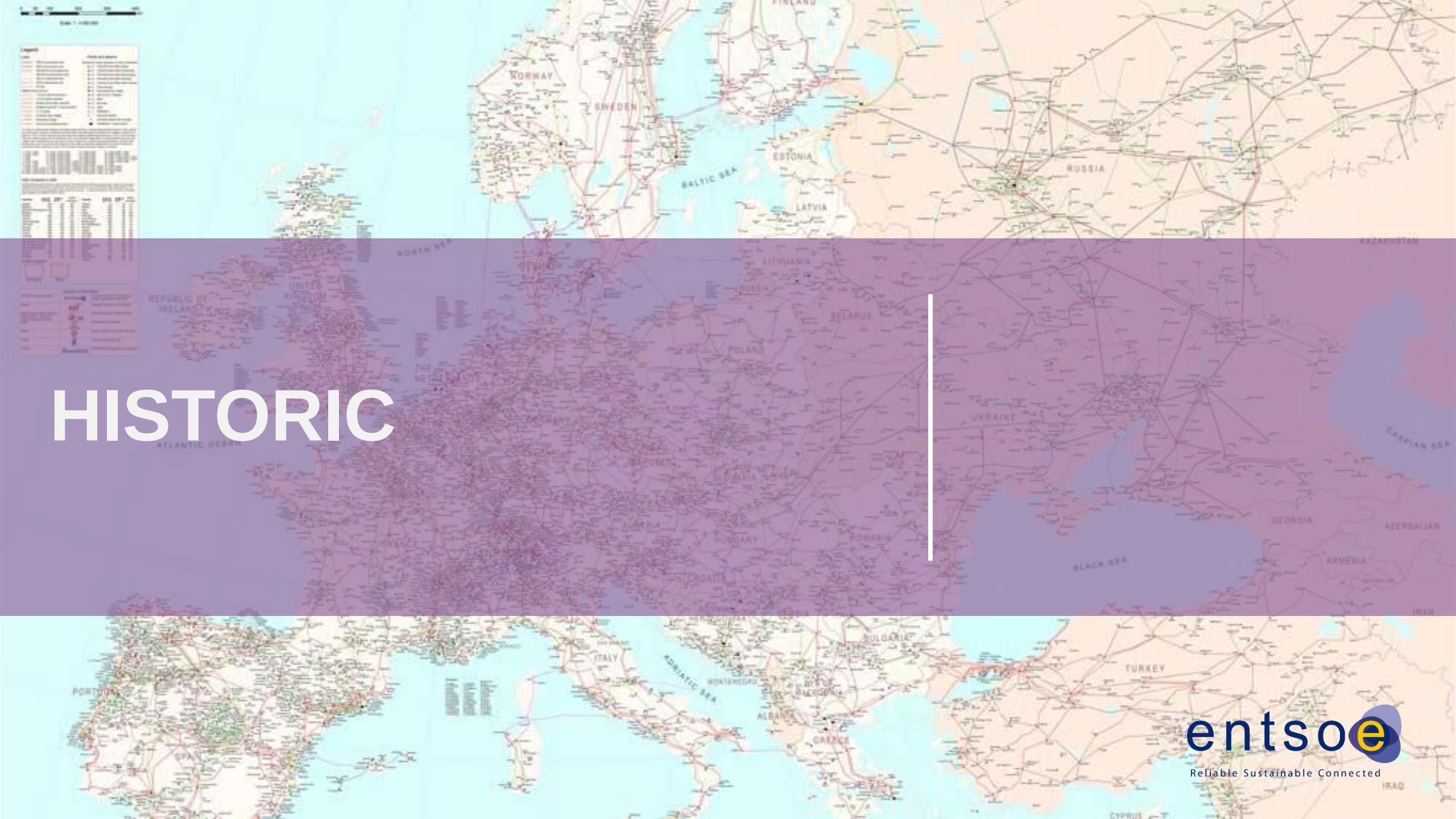
ENTSO-E organizational structure / Standardisation (1/2)



ENTSO-E organizational structure / Standardisation (2/2)

Subdomains of TC57	Working Groups
Power system IED communication and associated data models – IEC 61850 (Substation automation)	**IEC TC 57 - WG 10**
Energy management system application program interface (EMS - API) - IEC CIM 61970 for grid exchanges	**IEC TC 57 - WG 13**
System interfaces for distribution management (SIDM) – IEC CIM 61968 (TSO to DSO interfaces)	**IEC TC 57 - WG 14**
Data and communication security	**IEC TC 57 - WG 15**
Deregulated energy market communications - IEC CIM 62325 for market exchanges	**IEC TC 57 - WG 16**

ENTSO-E since 2009 contributes in both CIM 61970 & 62325 series, for grid and market exchanges respectively.



HISTORIC

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Historic - April 2012: ENTSO-E statement on IEC 61850 standard

Observations:

- **Multi-vendor systems very scarce** 10 years after 1st standard publication
- **Implementation complexity**

Recommendations:

- Improve **interoperability**, **over life cycle** of the systems of Assets
- **Mask complexity** by ergonomic tools

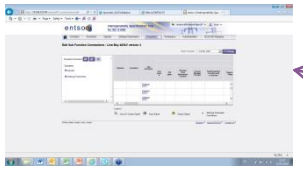
Stakeholders:

- **standardization bodies** : **IEC**, … ; **Suppliers** ; **Conformance testing companies**: **UCA Iug**, … ;

Users (associations): ENTSO-E, …

ENTSO-E work structure around IEC 61850

ISTool



ENTSO-E punchlist

ENTSO-E profile

Additional releases

1st release

ENTSO-E Technical Specification

Punch list

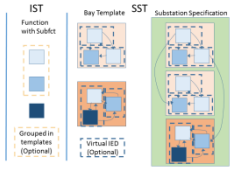
Interoperability scheme

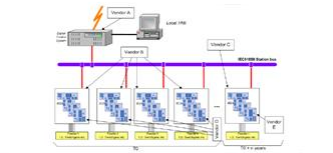
ENTSO-E statement

On going

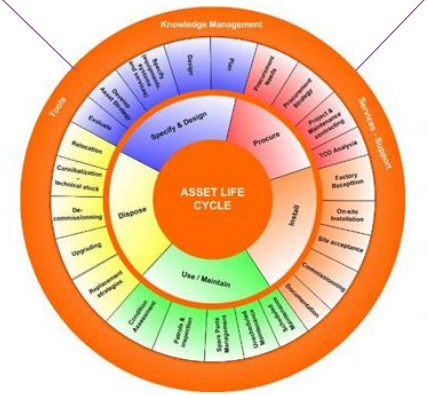
Done

Engineering Process
IEC DC



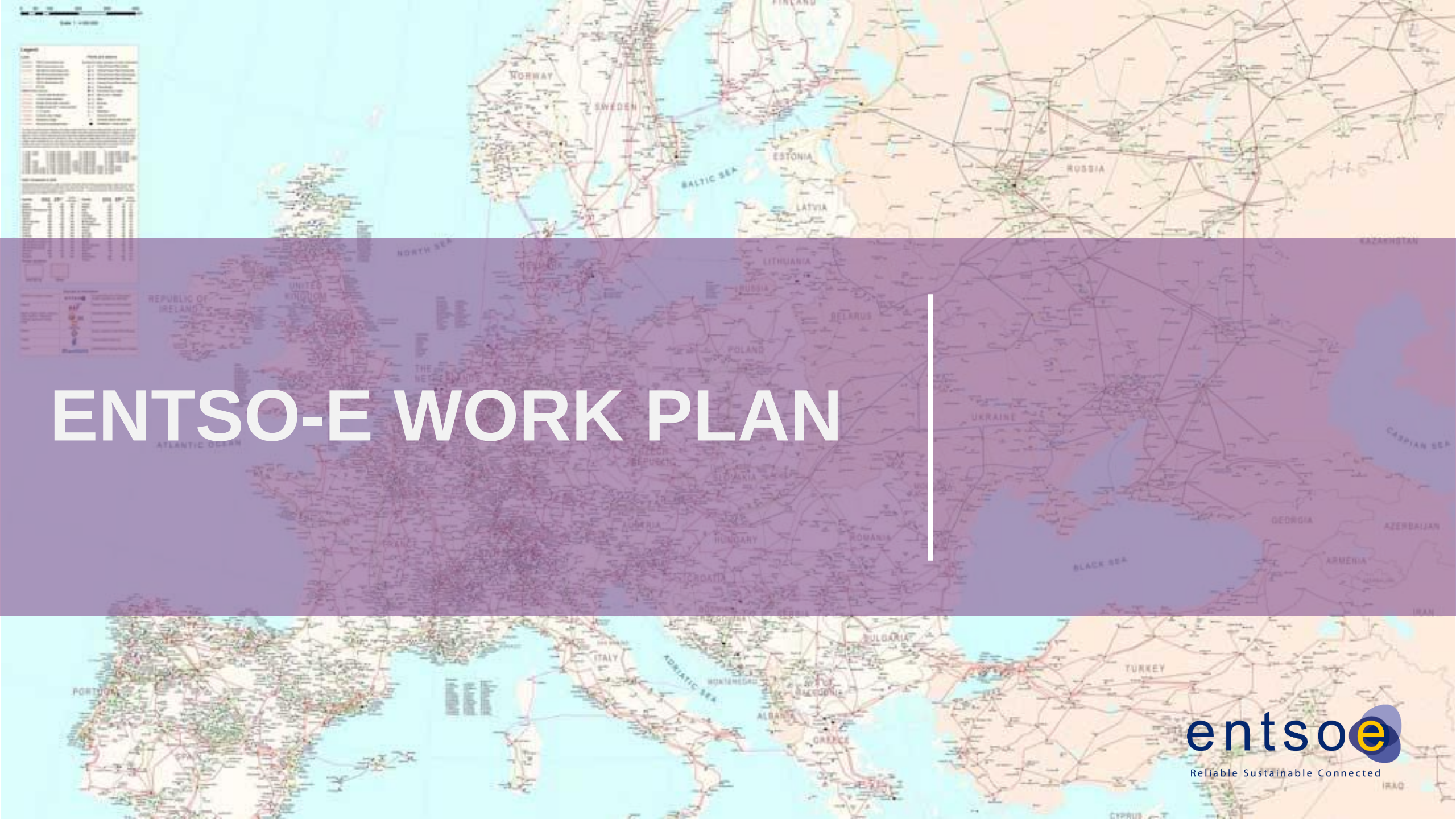


Interoperability scheme from ENTSO-E perspective



1. Specify & Design / Plan
2. Procure / Acquire
3. Install / Commission
4. Use / Maintain / Extend
5. Dispose / Decommission

https://www.entsoe.eu/about-entso-e/research-and-development/standardisation/



ENTSO-E WORK PLAN

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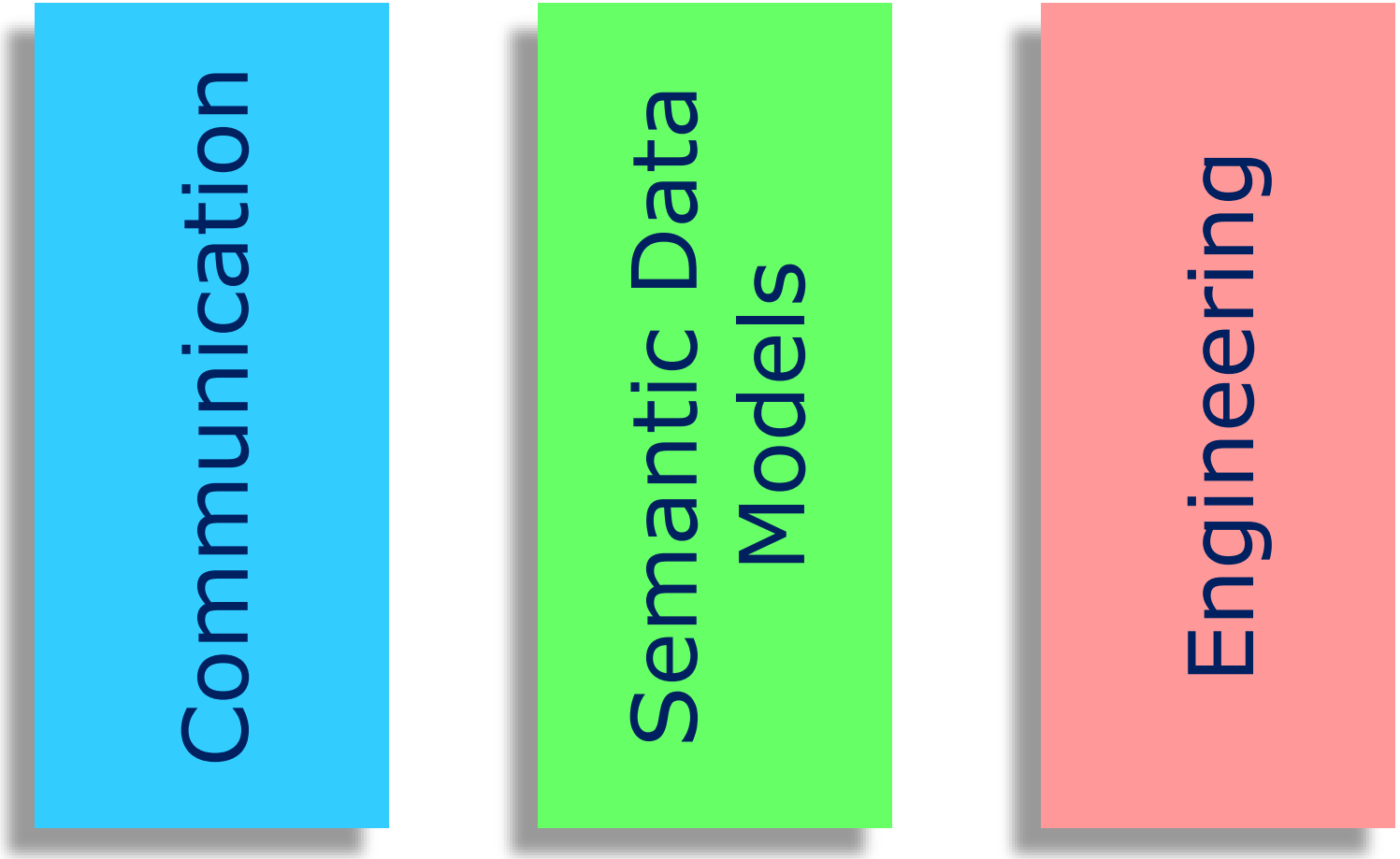
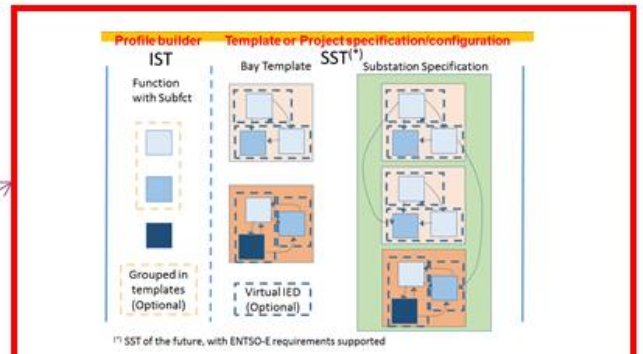
The three components of IEC 61850 – Interoperability ambition



Mapping of ENTSO-E activities



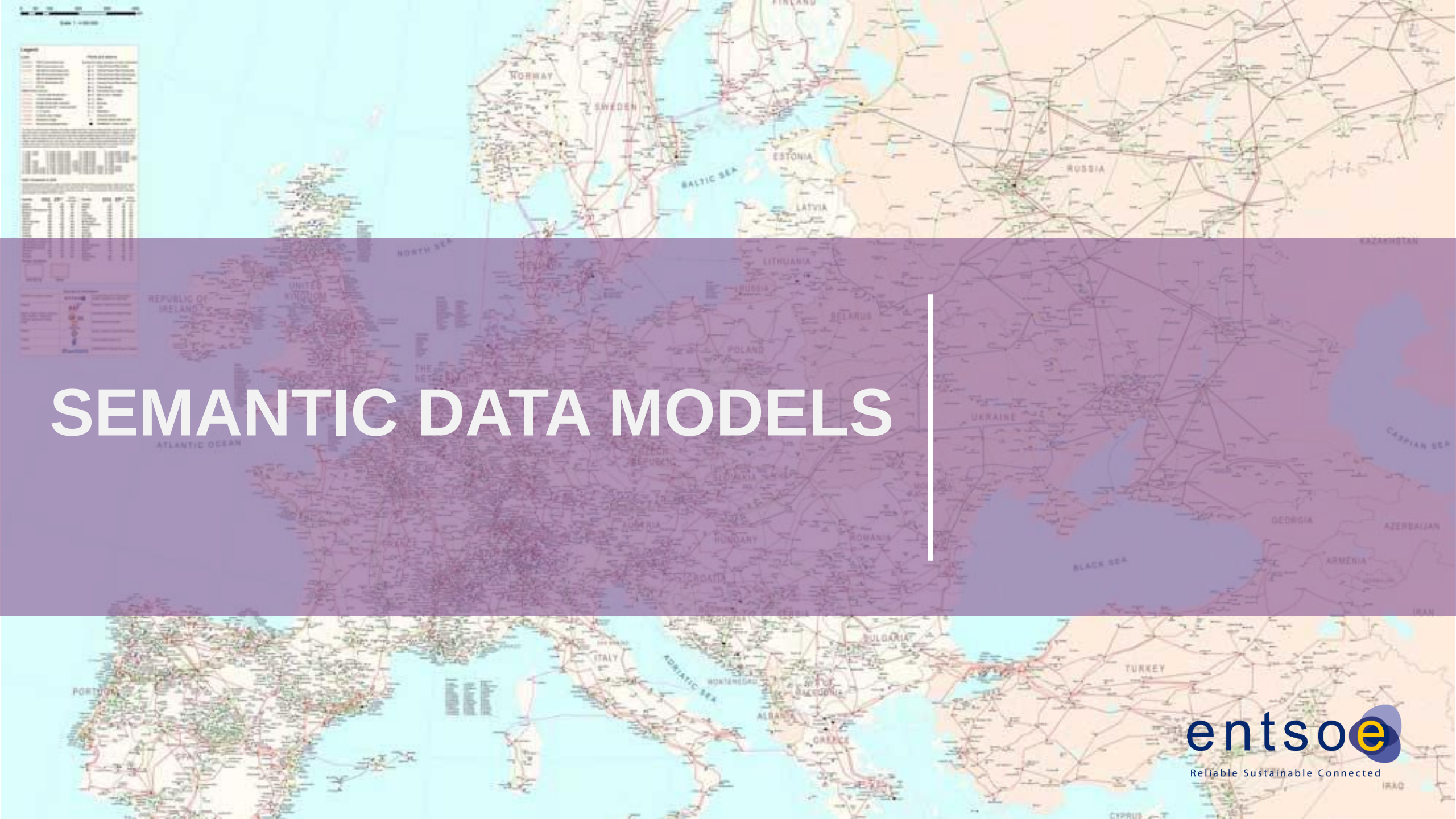
ENTSO-E requirements on Engineering Process

Communication

Semantic Data Models

Engineering

ISTool development ENTSO-E Profile



SEMANTIC DATA MODELS

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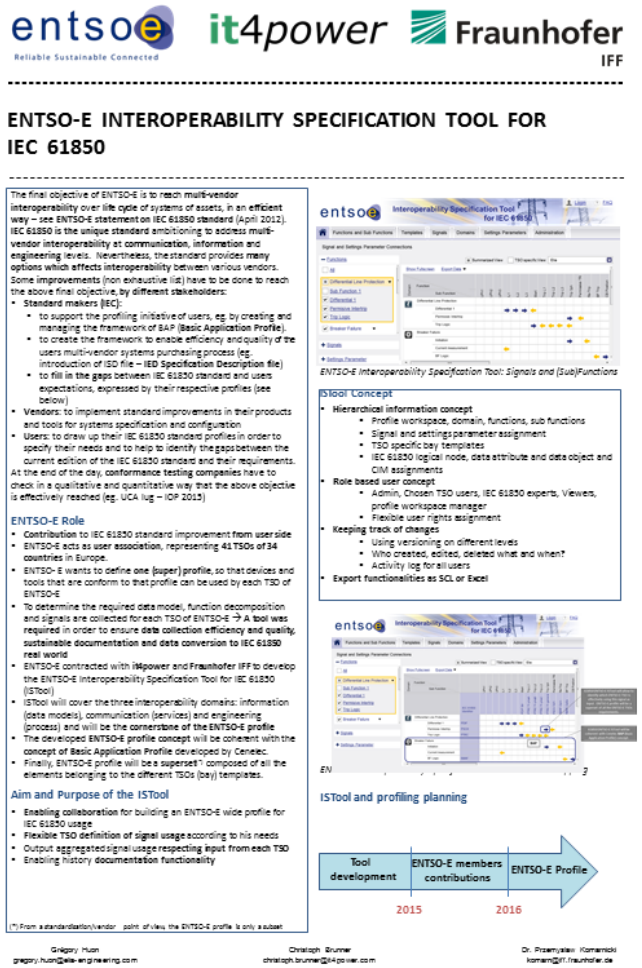
Improvement @ information level / ISTool

Communication

Semantic Data Models

Engineering



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ENTSO-E INTEROPERABILITY SPECIFICATION TOOL FOR IEC 61850

The final objective of ENTSO-E is to reach multi-vendor interoperability over life cycle of systems of assets, in an efficient way – see ENTSO-E statement on IEC 61850 standard (April 2012). IEC 61850 is the unique standard ambitioning to address multi-vendor interoperability at communication, information and engineering levels. Nevertheless, the standard provides many options which affects interoperability between various vendors. Some improvements (non exhaustive list) have to be done to reach the above final objective, by different stakeholders:

- Standard makers (IEC):
  - to support the profiling initiative of users, eg. by creating and managing the framework of BAP (Basic Application Profile).
  - to create the framework to enable efficiency and quality of the users multi-vendor systems purchasing process (eg. introduction of ISD file – IED Specification Description file)
  - to fill in the gaps between IEC 61850 standard and users expectations, expressed by their respective profiles (see below)
- Vendors: to implement standard improvements in their products and tools for systems specification and configuration
- Users: to draw up their IEC 61850 standard profiles in order to specify their needs and to help to identify the gaps between the current edition of the IEC 61850 standard and their requirements.

At the end of the day, conformance testing companies have to check in a qualitative and quantitative way that the above objective is effectively reached (eg. UCA lug – IOP 2013)

ENTSO-E Role

- Contribution to IEC 61850 standard improvement from user side
- ENTSO-E acts as user association, representing 41 TSOs of 34 countries in Europe.
- ENTSO- E wants to define one (super) profile, so that devices and tools that are conform to that profile can be used by each TSO of ENTSO-E
- To determine the required data model, function decomposition and signals are collected for each TSO of ENTSO-E → A tool was required in order to ensure data collection efficiency and quality, sustainable documentation and data conversion to IEC 61850 real world
- ENTSO-E contracted with it4power and Fraunhofer IFF to develop the ENTSO-E Interoperability Specification Tool for IEC 61850 (ISTool)
- ISTool will cover the three interoperability domains: information (data models), communication (services) and engineering (process) and will be the cornerstone of the ENTSO-E profile
- The developed ENTSO-E profile concept will be coherent with the concept of Basic Application Profile developed by Cenelec.
- Finally, ENTSO-E profile will be a superset(*) composed of all the elements belonging to the different TSOs (bay) templates.

Aim and Purpose of the ISTool

- Enabling collaboration for building an ENTSO-E wide profile for IEC 61850 usage
- Flexible TSO definition of signal usage according to his needs
- Output aggregated signal usage respecting input from each TSO
- Enabling history documentation functionality

(*) From a standardisation/vendor point of view the ENTSO-E profile is only a subset

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ENTSO-E Interoperability Specification Tool: Signals and (Sub)Functions

ISTool Concept

- Hierarchical information concept
  - Profile workspace, domain, functions, sub functions
  - Signal and settings parameter assignment
  - TSO specific bay templates
  - IEC 61850 logical node, data attribute and data object and CIM assignments
- Role based user concept
  - Admin, Chosen TSO users, IEC 61850 experts, Viewers, profile workspace manager
  - Flexible user rights assignment
- Keeping track of changes
  - Using versioning on different levels
  - Who created, edited, deleted what and when?
  - Activity log for all users
- Export functionalities as SCL or Excel

ISTool and profiling planning

PDF Document

Objectives of the Interoperability Specification Tool

→ Tool for **DSAS(*) (sub)functions and signals collection** @ ENTSO-E level
= profile builder (it is not a specification/configuration tool)

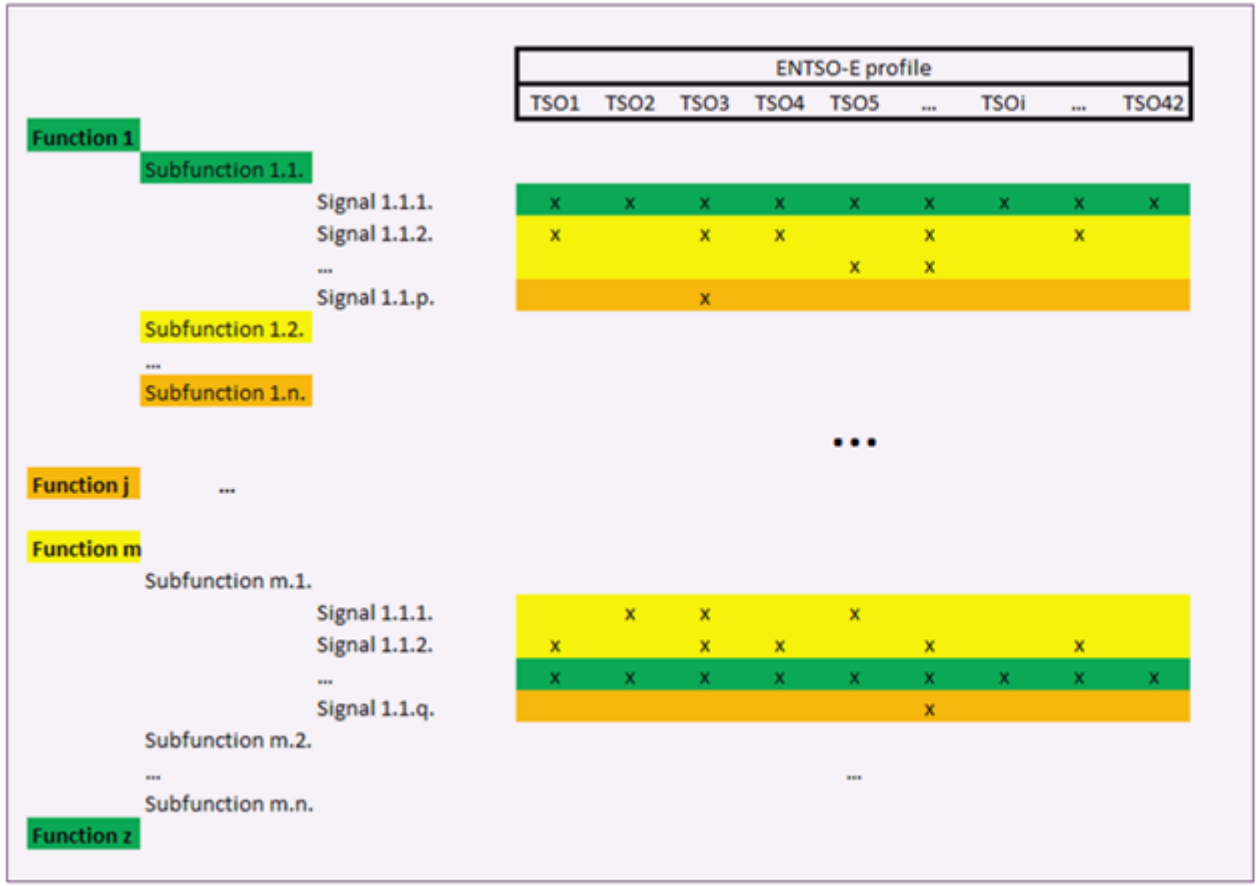
→ **Future proof** (e.g. integration of settings parameter, CIM, interfaces with system specification and configuration tools, …)

→ Basis for **gap analysis** between IEC 61850 and user requirements

→ **Facilitator** between IEC 61850 complex world (through IEC 61850 UML model) and utility world, finally enabling multi-vendor interoperability over system life cycle in an efficient and sustainable way

(*) Digital Substation Automation Systems

ENTSO-E profile will be a superset of requirements



"Super" common denominator
(used by all ENTSO-E members)

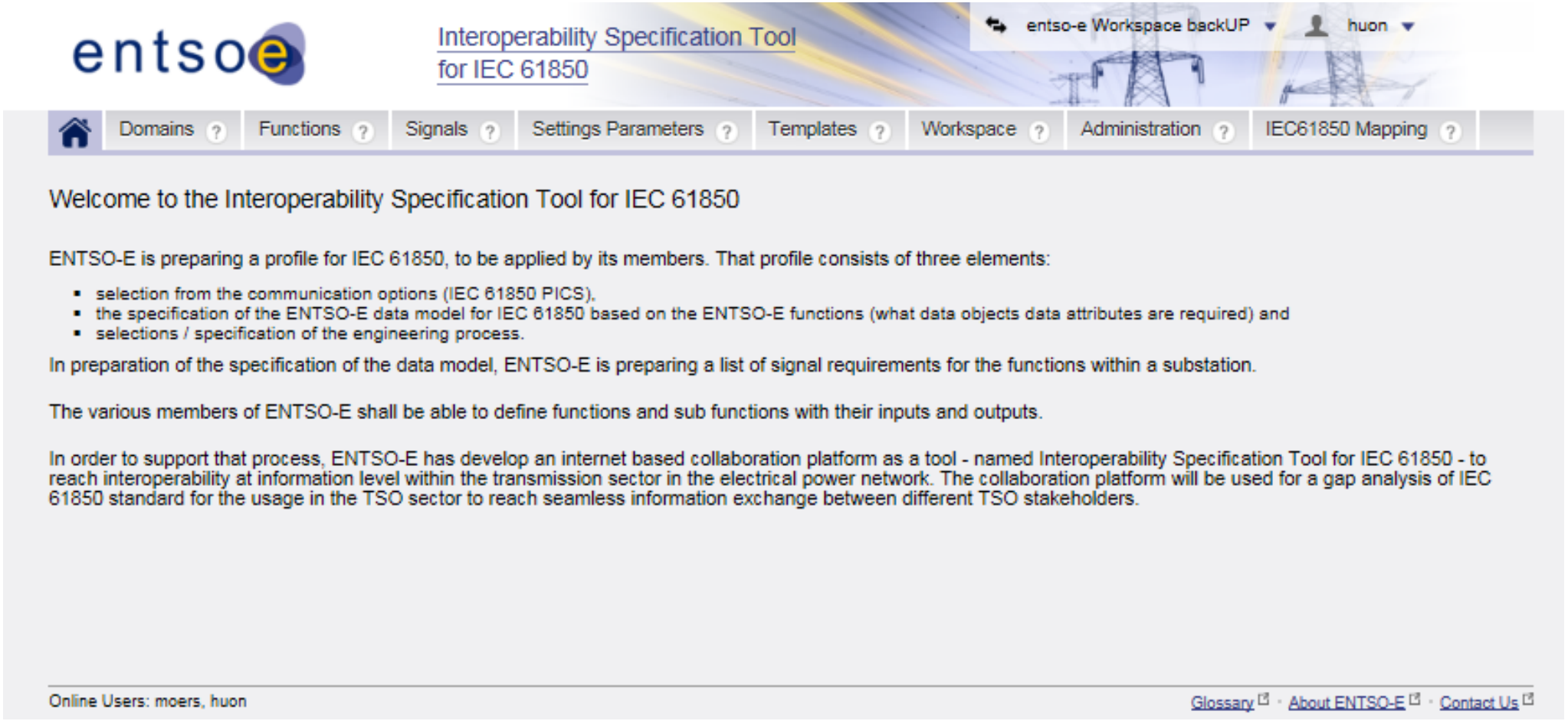
+

"Sub" Common denominator
(used by some ENTSO-E members)

+

TSO specific
(used by only 1 TSO)

Interoperability Specification Tool – The ENTSO-E profile builder



Pilot project on distance protection

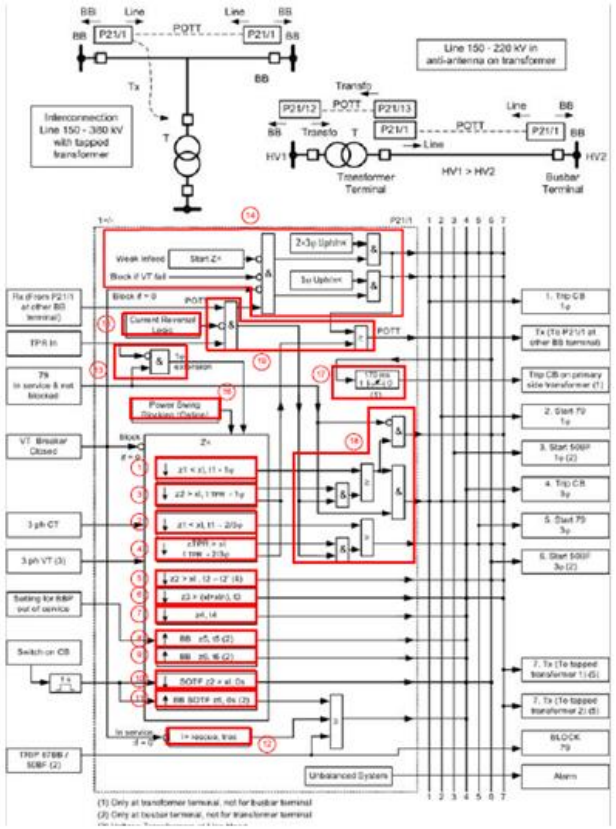
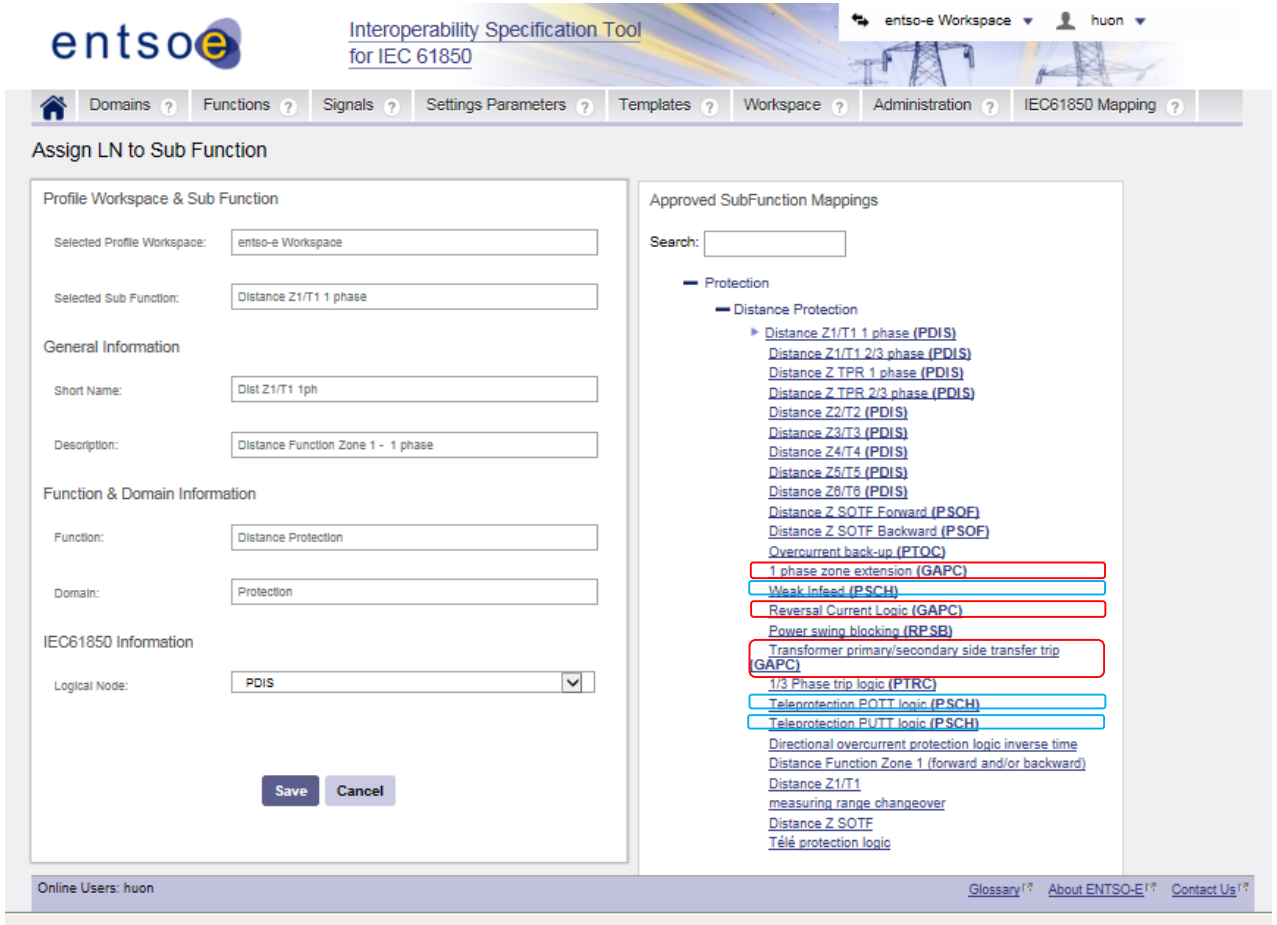


Illustration Elia approach – Conventional schemes decomposition

Several methods to build up the profile

- Conventional schemes decomposition
- Start from existing IEC 61850 modelling
- From scratch

Pilot project on distance protection – Gap identification



2 types of GAP were identified:

- **No IEC 61850 LN in the model**
- **Not enough granularity in the model**

Pilot project on distance protection achieved

Domain	Function	Subfunction
− Protection		
	− Distance Protection (Elia)	
		+ Distance Z1/T1 1 phase
		+ Distance Z1/T1 2/3 phase
		+ Distance Z TPR 1 phase
		+ Distance Z TPR ... phase
		+ Distance Z2/T2
		+ Distance Z3/T3
		+ Distance Z4/T4
		+ Distance Z5/T5
		+ Distance Z6/T6
		+ Distance Z SOTF Forward
		+ Distance Z SOTF Backward
		+ 1 phase zone extension
		+ Weak Infeed
		+ Reversal Current Logic
		+ Power swing blocking
		+ Distance Z1/T1
		+ Distance Z SOTF
		+ 3 phase zone extension

Connection	Origin of Connection	Type	− Signal Description ENTSO-E	− Signal Description Connected TSO	− Signal Translation Connected TSO	− Allocated Communication Service
− Operate by Z1/T1 1 phase						
	Elia System Operator SA, (Distance protection Elia)	O	Op by zone 1 phase to ground distance function (for signalling to CC)	Operate Z1 1ph		
	TenneT TSO GmbH, (TenneT TSO)	O	Op by zone 1 phase to ground distance function (for signalling to CC)	Operate Z1 1ph		
	Red Eléctrica de España S.A., (Line Bay 400 kV)	O	Op by zone 1 phase to ground distance function (for signalling to CC)	Operate Z1 1ph		
	Fingrid Oyj, (Fingrid 400kV Distance Protection)	O	Op by zone 1 phase to ground distance function (for signalling to CC)	Operate Z1 1ph		
	HOPS d.o.o., (Line Bay 110 kV)	O	Op by zone 1 phase to ground distance function (for signalling to	Operate Z1 1ph		

ENGINEERING PROCESS

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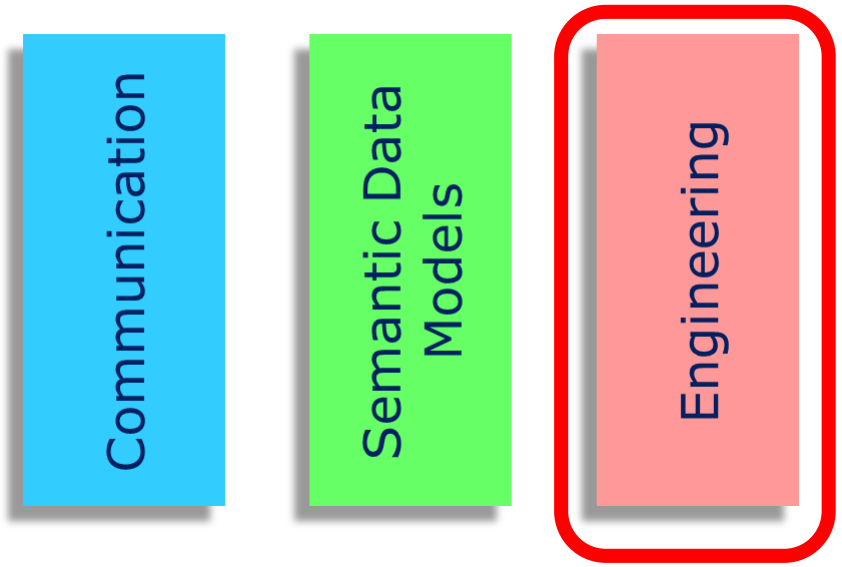
Improvement @ engineering level



ENTSO-E issued in September 2016 new requirements to further enhance the engineering using IEC 61850

- Input & data flow modeling
- Introduction of virtual IED for vendor independent design (transparent purchasing process)
- Include key primary system data for efficient system engineering
- Include telecommunication network description

ENTSO-E issued a Document for Comment (DC) to IEC

PDF Document

57/1771/DC

For IEC use only

2016-09-02

INTERNATIONAL ELECTROTECHNICAL COMMISSION

TECHNICAL COMMITTEE 57: POWER SYSTEMS MANAGEMENT AND ASSOCIATED INFORMATION EXCHANGE

Proposed new work items by ENTSO-E to introduce additional specification features of IEC 61850 based systems within SCL

IEC 61850: COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION
– Part 6: Configuration description language for communication in electrical substations related to IEDs
– Part 4: System and project management

It should be noted that a category D liaison exists between ENTSO-E and TC 57 WG 10, which enables ENTSO-E to directly submit proposals to TC 57 for new work items.

1 Background

Edition 2 of IEC 61850-4 was published in 2011. Edition 2 of IEC 61850-6 was published in 2009. Ultimately, this DC, framed by the ENTSO-E statement and example of engineering process, aims to serve the market in order to reach the multi-vendor interoperability of systems in an efficient way.

Additionally the DC aims to clarify,
- If the proposed requirements (and the resulting extensions within IEC 61850) are supported widely by the national committees and are within the scope (or extended scope) of IEC 61850.
- If priority can be allocated within WG 10 to progress with the below proposals.

The work proposals have first been presented to WG 10 at the February 2016 meeting and they have been discussed in more detail at the June 2016 meeting in Rome. The outcome of the DC will not necessarily be a new part, it will most probably be extensions to the existing part 6 of IEC 61850. WG 10 also agreed, that in a first step, some investigations are required. ENTSO-E does not have the required detailed expertise to perform this and WG 10, while basically agreeing to the proposals, would like to get an official mandate from the National Committees to follow the work.

Besides each of the 3 items proposed below, a target date for accomplishment is mentioned in order to indicate the respective priority as evaluated by ENTSO-E.

a) Input and data flow modelling / Virtual IED - Introduction of additional specification features of IEC 61850 based systems within SCL / Target date: 12/2017

In order to increase engineering process efficiency for users, additional specification features to be introduced in the SCL (Substation Configuration Language) shall enable (in an interoperable way):

- the possibility to define inputs for subfunctions and functions during specification stage and add references to the source data object related to this input. This will allow the definition of signal flow without obligation to specify virtual IEDs (Intelligent Electronic Devices). If virtual IEDs are used, a standard way defining how to interpret signal flow shall be provided. This shall be possible independently of the user specification level (bay template, substation template, system template);
- the possibility to group sub-functions into functions (if not yet included in 61850-6 Ed 2.1);
- the possibility to define requirements for IEDs in a vendor independent way (virtual IEDs - or so called "ISD - IED Specification Description" file), ie to specify in SCL their specified IED capability in terms of modelling and communications aspects;
- the possibility to develop tool mechanisms to compare and provide qualitative and quantitative results between a user specified IED capability (virtual IEDs) and a particular IED vendor-specific ICD file; the relationship between an ISD and an ICD file can be 1 to 1 or 1 to n;

The expected tasks are listed below.

- Use cases for the specification process
  - Specification of signal flow
  - Hierarchical function specification
  - Specification of IED requirements
  - Verification of IED characteristics against specification
- Gap analysis – Verify existing capabilities of IEC 61850 Ed 2.1 against use case requirements
- Extensions required in IEC 61850-6
  - Process descriptions
  - Schema extensions

b) System engineering efficiency - Introduction of additional specification and configuration features of IEC 61850 based systems within SCL / Target date: 12/2018

In addition, in order to increase engineer process efficiency and user maintenance efficient, further specification and configuration features to be introduced in the SCL shall enable (in an interoperable way):
- the possibility to define key primary system data (e.g. CT or VT ratio) and link them to other Data Object elements inside the SCL file that are dependent of it (e.g. global variable inherited through the SCL structure), ensuring therefore data coherency in an efficient way;
- the possibility to specify and maintain within the SCL file, the overall system functional requirements as ANSI/IEEE C37.2 code numbers together with data regarding the number and type of modelling functions related to that code number;
- to enhance the efficiency of the engineering/purchasing process, gaps shall be identified to fully support the formal description of IED requirements. For example, BRCB capabilities, disturbance recording capabilities, accuracy, temperature ranges for monitoring purposes;

The expected tasks are listed below.

1. Use cases for the specification process
   a. Specification including key primary system data
   b. Specification including ANSI/IEEE C37.2 code numbers
   c. Formal specification of IED requirements
2. Gap analysis – Verify existing capabilities of IEC 61850 Ed 2.1 against use case requirements
3. Extensions required in IEC 61850-6
   a. Process descriptions
   b. Schema extensions

c) Communication Network Description - Introduction of additional specification and configuration features of IEC 61850 based systems within SCL/ Target date: 12/2018

In order to increase efficiency of engineering processes and maintenance of users, additional specification and configuration features to be introduced in the SCL shall enable, in an interoperable way, the complete description of the communication network, including topology, characterization of the network nodes (switches and routers), VLANs, etc. This would allow a seamless integration of a Network Engineering Tool, capable of importing a SCD file (see IEC TR 61850-90-4, clause 12.4). The configuration of the switches and routers would then be automatic from the SCD file.

The expected tasks are listed below.

1. Use cases for the specification and design process
   a. Specification of the communication network
   b. Configuration of the communication network equipment
2. Gap analysis – Verify existing capabilities of IEC 61850 Ed 2.1 against use case requirements
3. Extensions required in IEC 61850-6
   a. Process descriptions
   b. Schema extensions

4. Extensions required in data models
   a. Extensions to the model described in IEC TR 61850-90-4

The work to be carried out could be facilitated by the following three groups within WG 10 (as per *Figure 1* below):
- Existing TF SCL/Functional Modelling: Input & Data Flow Modelling including Virtual IED (ISD)
- New TF to be created: System Engineering including capability description extension to enhance purchasing process
- TF 90-4 (to restart): Communication Network Description

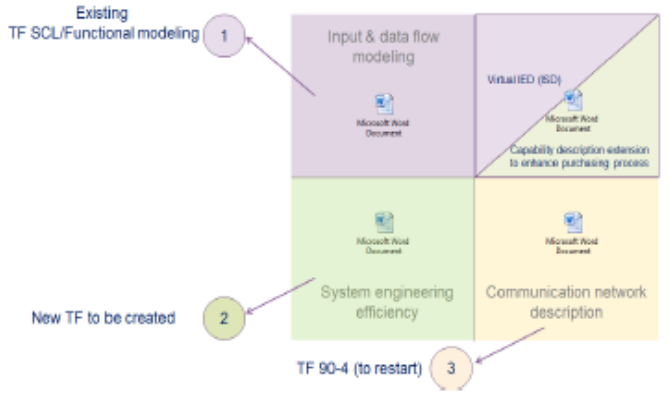


Figure 1 – Sharing of the proposed work requirements between task forces within WG 10

2 Action

IEC national committees with P-membership status in TC 57 are invited to submit comments on the above new work items proposed by ENTSO-E:

by 2016-10-14 at the latest

using the IEC electronic commenting / voting system. Their comments will be considered at the coming TC 57 WG 10 meeting (week of 24 October in Glasgow).

Engineering process / ENTSO-E requirements

Profile builder

IST

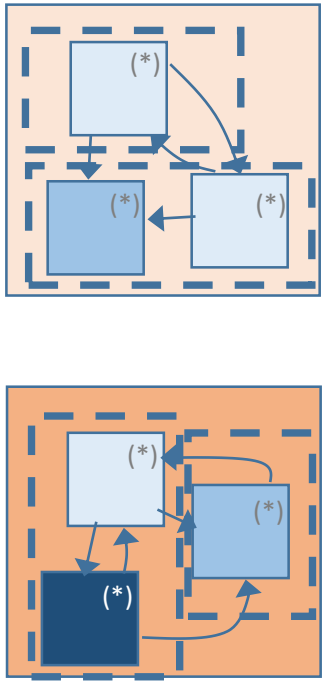
Function with Subfct

Grouped in templates (Optional)

Template or Project specification/configuration

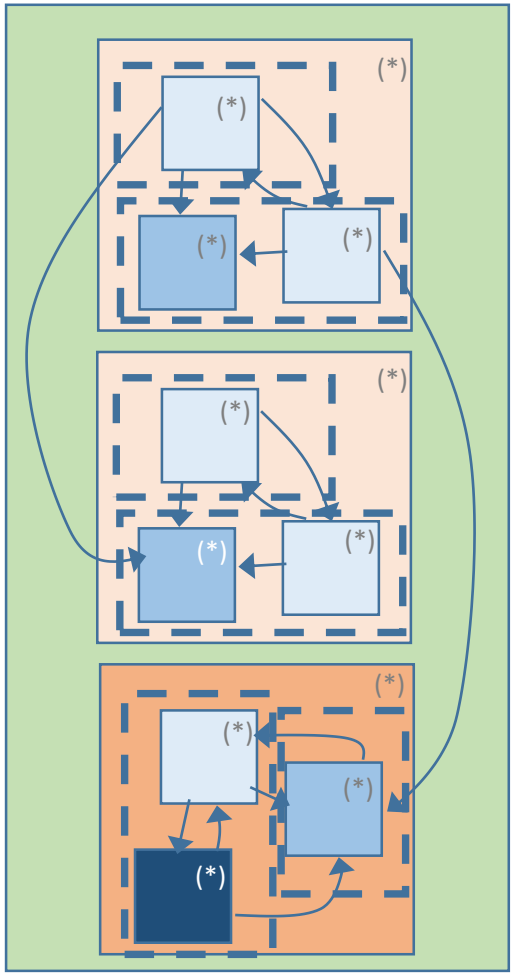
SST(**)

Bay Template



Virtual IED (Optional)

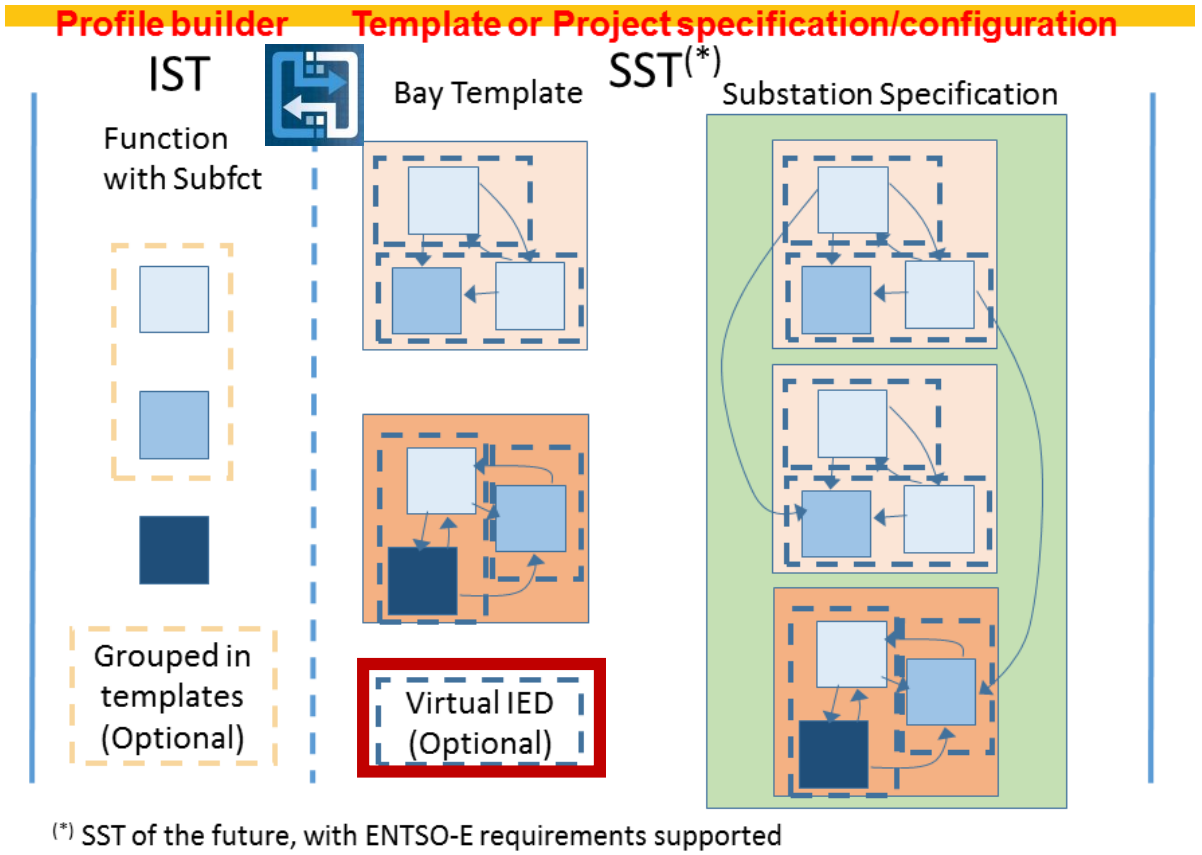
Substation Specification



(*) instantiated

(**) SST of the future, with ENTSO-E requirements supported

ENTSO-E engineering process – (Some) next steps



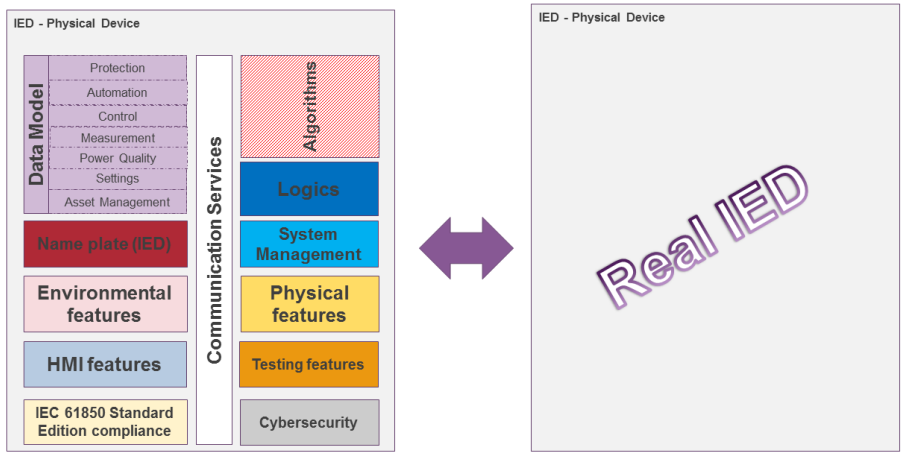
(*) SST of the future, with ENTSO-E requirements supported

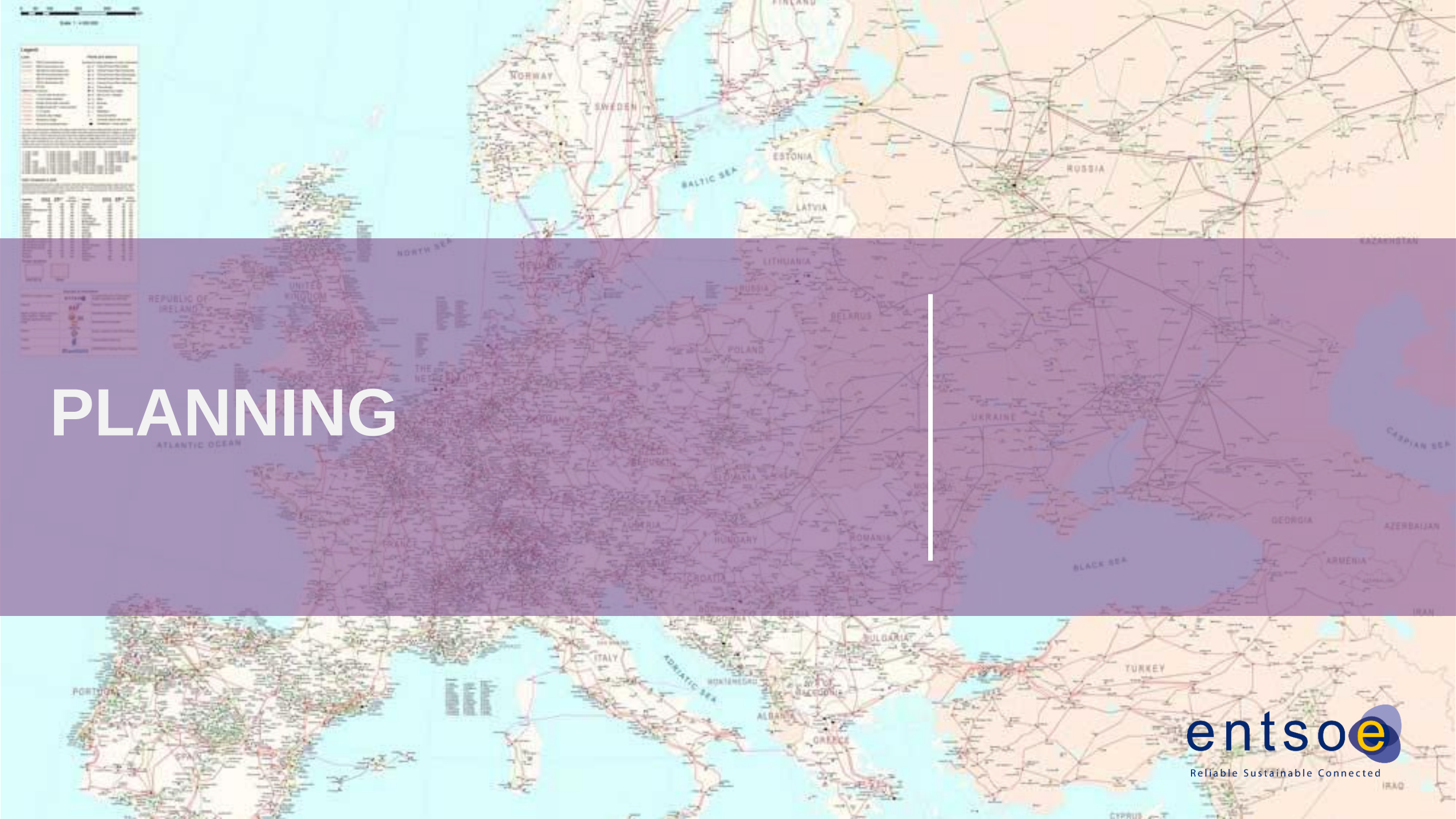
ENTSO-E test case @ UCA Iug IOP 2017
15-19th October 2017

ISTool

SSTool

Transparent & efficient purchasing/engineering process





PLANNING

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Enforced cooperation ENTSO-E with IEC TC57 WG10

Schedule TC57 WG 10
Meeting October 23 – 27, 2017, New Orleans, USA

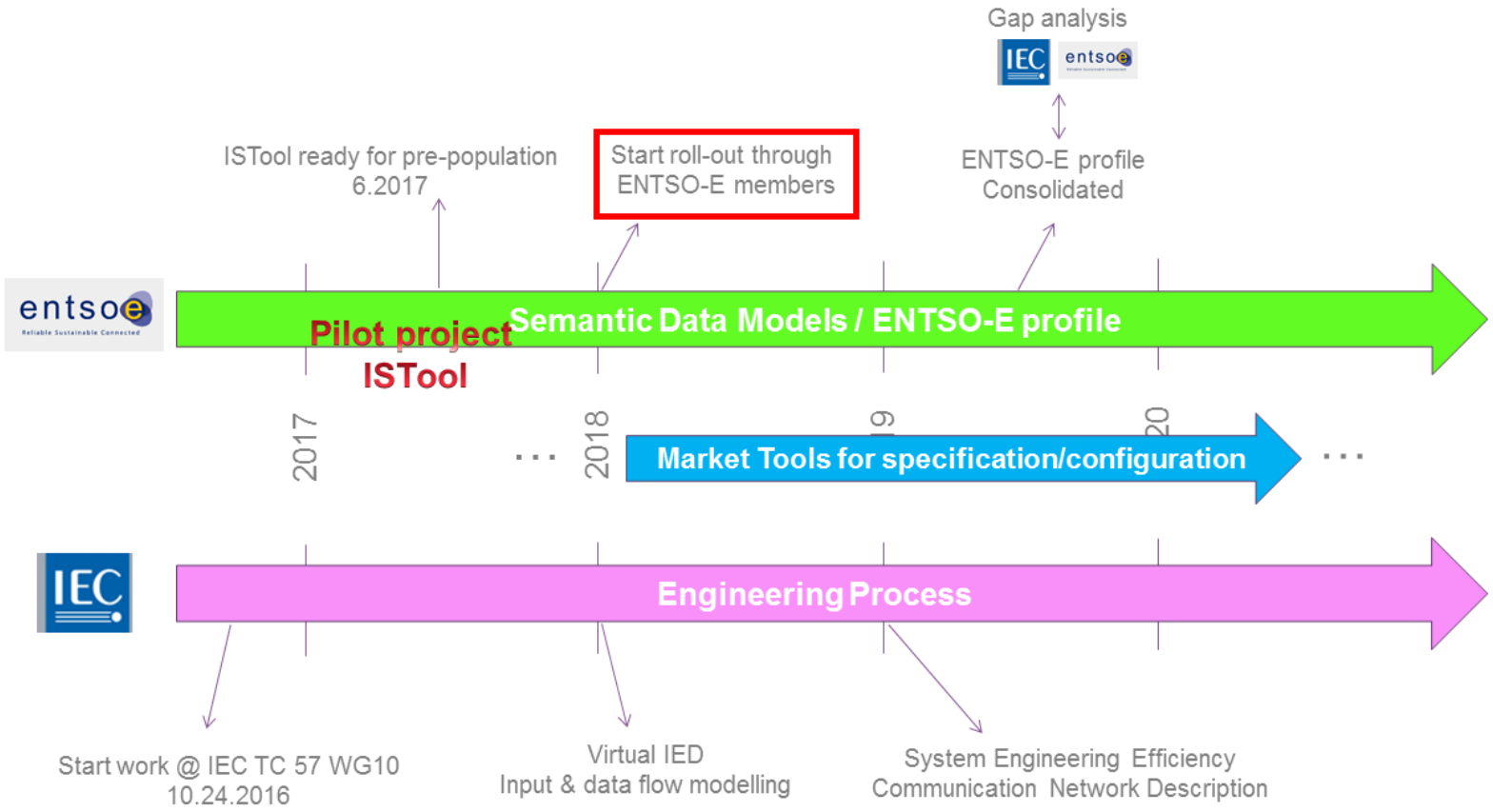
Monday October 23, 2017	08.30 – 12.30	**Plenary** • Welcome, General topics (Ch. Brunner) • Update from ENTSO-E (G. Huon) • Update IEC status (web-publishing, code components, etc) (Laurent Guise)			
	13:30 – 17:30	**TF 1-2 (Guide ext 61850)** • Prepare draft CD	**TF 7-6 (BAP)** • Prepare 2nd DC	**TF 5 (Comm Req)** • Prepare CDV of Amd	**TF ENTSO-E** • According to specific agenda
Tuesday October 24, 2017	08:30 – 12:30	**TF 7-5 (Modelling concepts** • Finalize 1st DC	**Ad hoc TF Engineering** • Work on topics	**TF 80-5 (Modbus Mapping)** Prepare DTS	•
	13:30 – 17:30	**TF 90-18 (Alarm handling)** • Prepare first DC	**TF 6-100 (Fct Mod in SCL)** • Work on draft	**62351-6** According to specific agenda	•
Wednesday, October 25, 2017	08:30 – 12:30	**TF 90-14 (FACTS)** • Prepare DTR	**TF UF** • Resolution of IOP issues	**TF 90-12 (WAN Guideline)** Work on revision draft	•
	13:30 – 17:30	**TF 90-11 (Logic Modeling)** • Prepare 2nd DC	**TF 6-2 (HMI)** • Work on draft	**TF 90-13 (Det Networks)** • Work on scope / 1st draft	•
Thursday, October 26, 2017	08:30 – 12:30	**TF 90-21 (Trvl wave Flt Loc** • Work on scope / 1st draft	**TF UF** • Resolution of Issues • Feedback IEEE H30	**TF 90-13 (Det Networks)** Work on scope / 1st draft	**TF 90-19 (RBAC)** • Work on draft
	13:30 – 17:30	**TF 90-20 (Redundant IEDs)** • Work on draft	**TF 10-5 (Functional testing)** • Review comments received on DC	**AHWG PWI China** • Discuss possible PWI presented in Seoul	•
Friday, October 27, 2017	08:30 – 12:30	**Plenary**			
	13:30 – 17:30	• TF report with in depth discussions • Document status (Ch. Brunner) • Technical discussions ○ time issues (H. Kirrmann) • Action items (J. Greene) • Liaison reports • Future work • Next and Future meetings			

ENTSO-E profile challenge

Engineering process
ENTSO-E requirements

UCA Iug IOP – Feedback loop

Global planning & enablers in preparation



Enablers in preparation to make this roadmap happen:

- Enforcement resources (and commitment) at ENTSO-E (members) side
- (Some) ENTSO-E members participation in EC funded Osmose project, with key market players involved

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