



int:net

Interoperability Network for
the Energy Transition

Interoperability at all Levels

Ludwig Karg

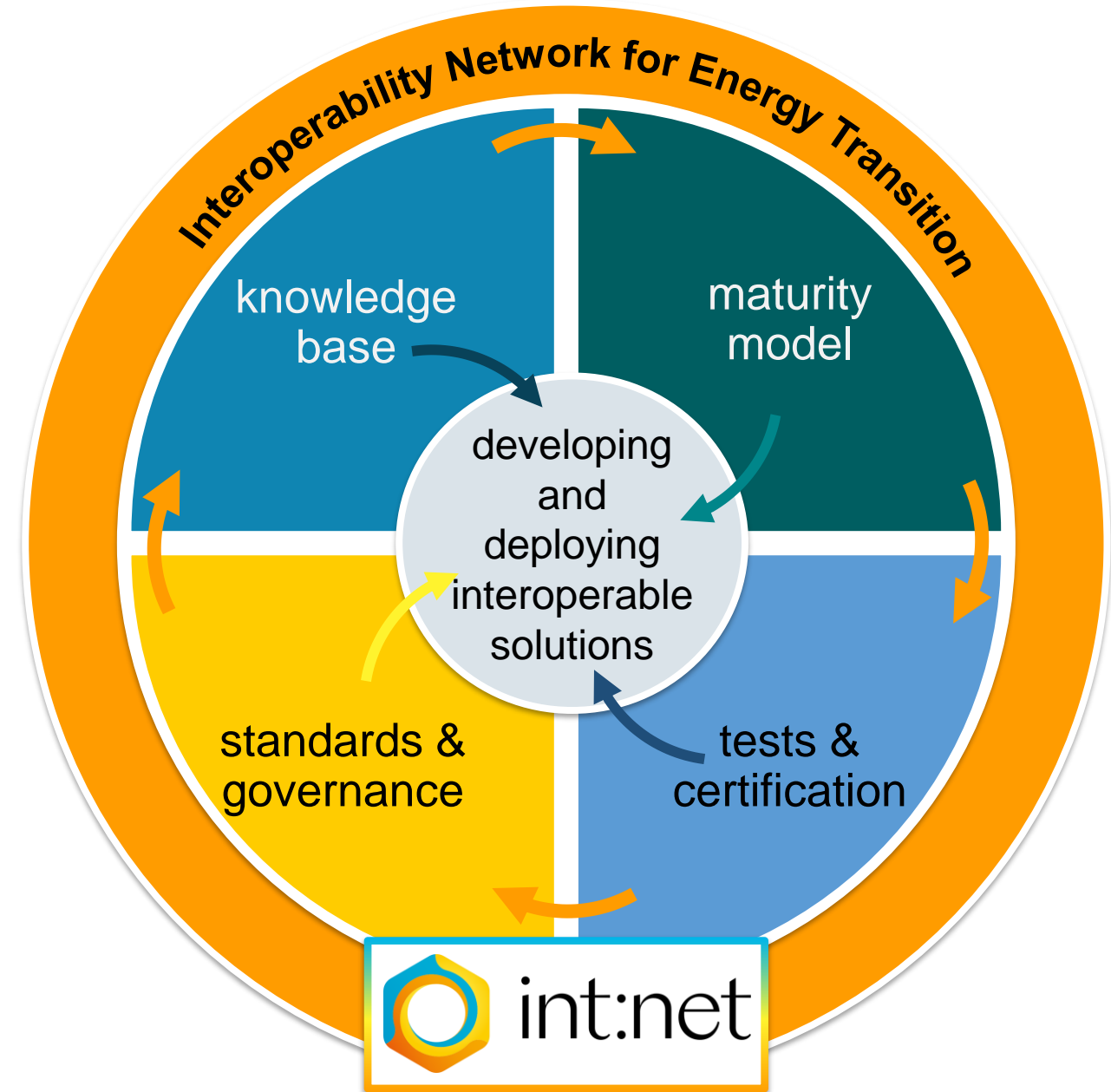
B.A.U.M. Consult München / Berlin



03.04.2025

int:net – building an open and cross-domain interoperability community for the energy system

“Within the int:net interoperability network we bring together all stakeholders relevant for the European energy sector to jointly work on **developing, testing and deploying interoperable energy services.**”

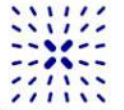


int:net general information

- Horizon Europe call HORIZON-CL5-2021-D3-01-03
- Coordination & Support Action (CSA)
- Duration: 42 months
- Runtime: 01.05.2022 – 31.10.2025
- Consortium: 12 Partners
7 Countries
1 Associated Partner
- Budget: 5 M€



The Ecosystem



Energy Data Spaces Projects

DATA CELLAR

EDDIE
EUROPEAN DISTRIBUTED DATA INFRASTRUCTURE FOR ENERGY

Enershare

SYNERGIES

omega-x

ODEON

HEDGE-IoT

TwinEU

interstore

BEGONIA



int:net
Interoperability Network for the Energy Transition

DATA SPACES SUPPORT CENTRE

And other domains:



Energy Interoperability Task Force

INTERNATIONAL DATA SPACES ASSOCIATION

Data Management WG + other WGs

bridge



Interoperability?

Interoperability refers to the ability of **two or more devices** from the same vendor, or different vendors, to **exchange information** and use that information for correct cooperation. (IEC 61850)

Interoperability is the ability of two or more **networks, systems, devices, applications, or components to interwork, to exchange and use information** in order to perform required functions. (CEN-CENELEC-ETSISG-CG)

Fähigkeit unterschiedlicher Systeme, möglichst nahtlos zusammenzuarbeiten.
Ability of **different systems to work together** as seamlessly as possible. (Duden)

Interoperability ...

... is a characteristic of a **product or system** to work with other products or systems. While the term was initially defined for information technology or systems engineering services to allow for information exchange, **a broader definition takes into account social, political, and organizational factors** that impact system-to-system performance.

Types of interoperability include syntactic interoperability, where two systems can communicate with each other, and **cross-domain interoperability, where multiple organizations work together and exchange information.**

WIKIPEDIA

Interoperability!

We ...

- acknowledge that **numerous definitions** of interoperability exist
- consider that those definitions are **context-dependent**
- identify two main categories of definitions:
 - **narrow** (focused on the level of devices)
 - **broad** (focused on the level of organisations)
- recognise that the interoperability of devices is a **prerequisite** for the interoperability of organisations



int:net Results

Studies and Concepts

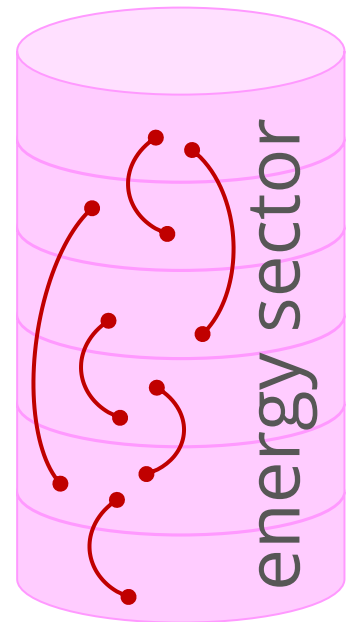
- ✓ Testing concepts and procedures harmonisation
- ✓ Regulatory framework relevant for int:net
- ✓ Interoperability Maturity Model
- ✓ Creation of a common knowledge in Europe for interoperability
- ✓ Definition of procedures for interoperability testing and development of a network of labs
- ✓ Verification with real Hackathon
- ✓ Coordination of EU Projects on data spaces

Guidelines and Tools

- ✓ Engagement towards interoperability in governance (whitebook), including
 - ✓ SGAM layer 6
 - ✓ The Tube in the Cube
- ✓ Interoperability Network for the Energy Transition
- ✓ EMINENT and IntMAS
- ✓ The Interoperability Compass
- ✓ [int:net Interoperability Community](#)
- ✓ [Interoperability Projects and People Connector \(IPPC\)](#)

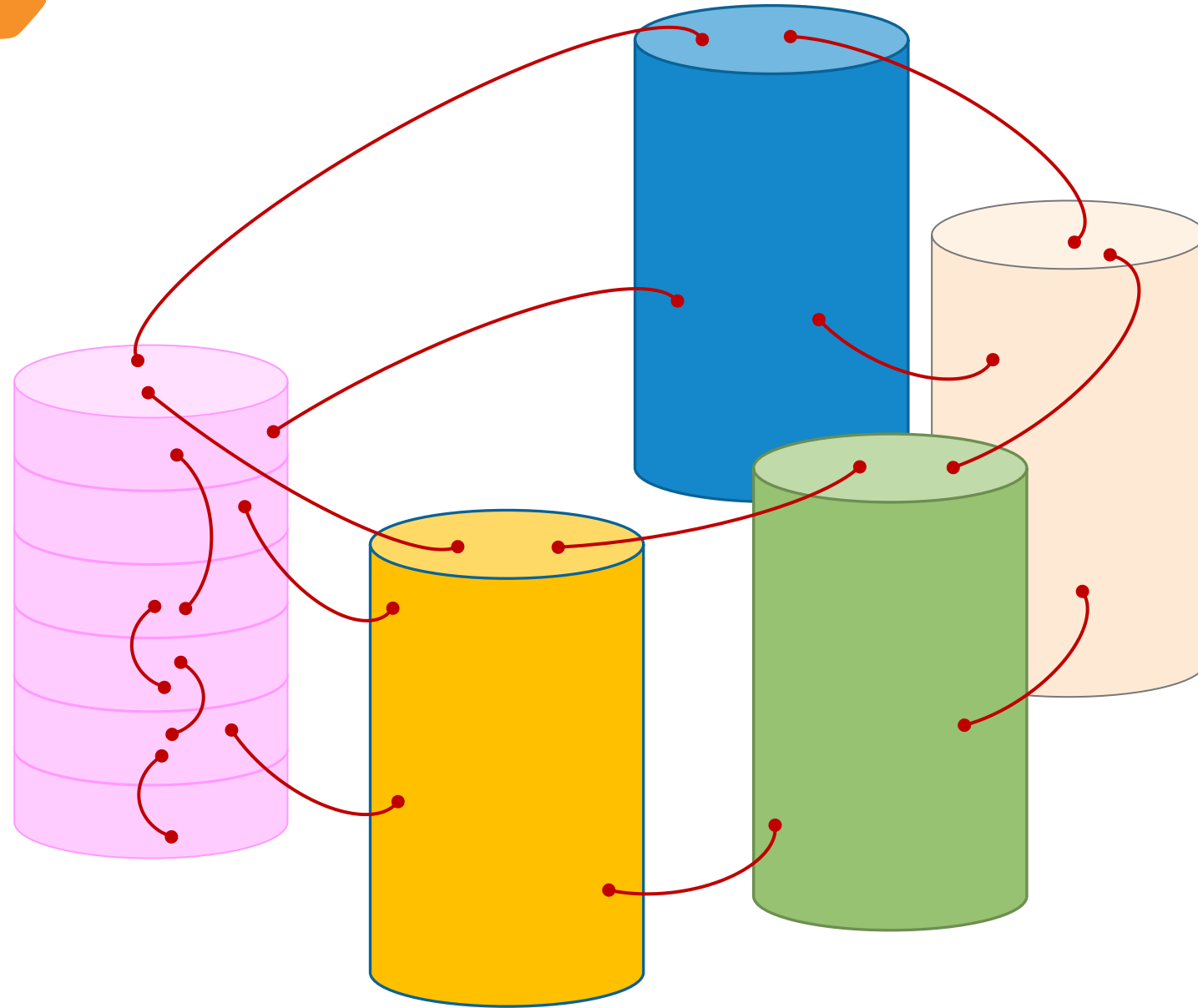
Working in Silos

international
transnational
national
regional
local
on-premise

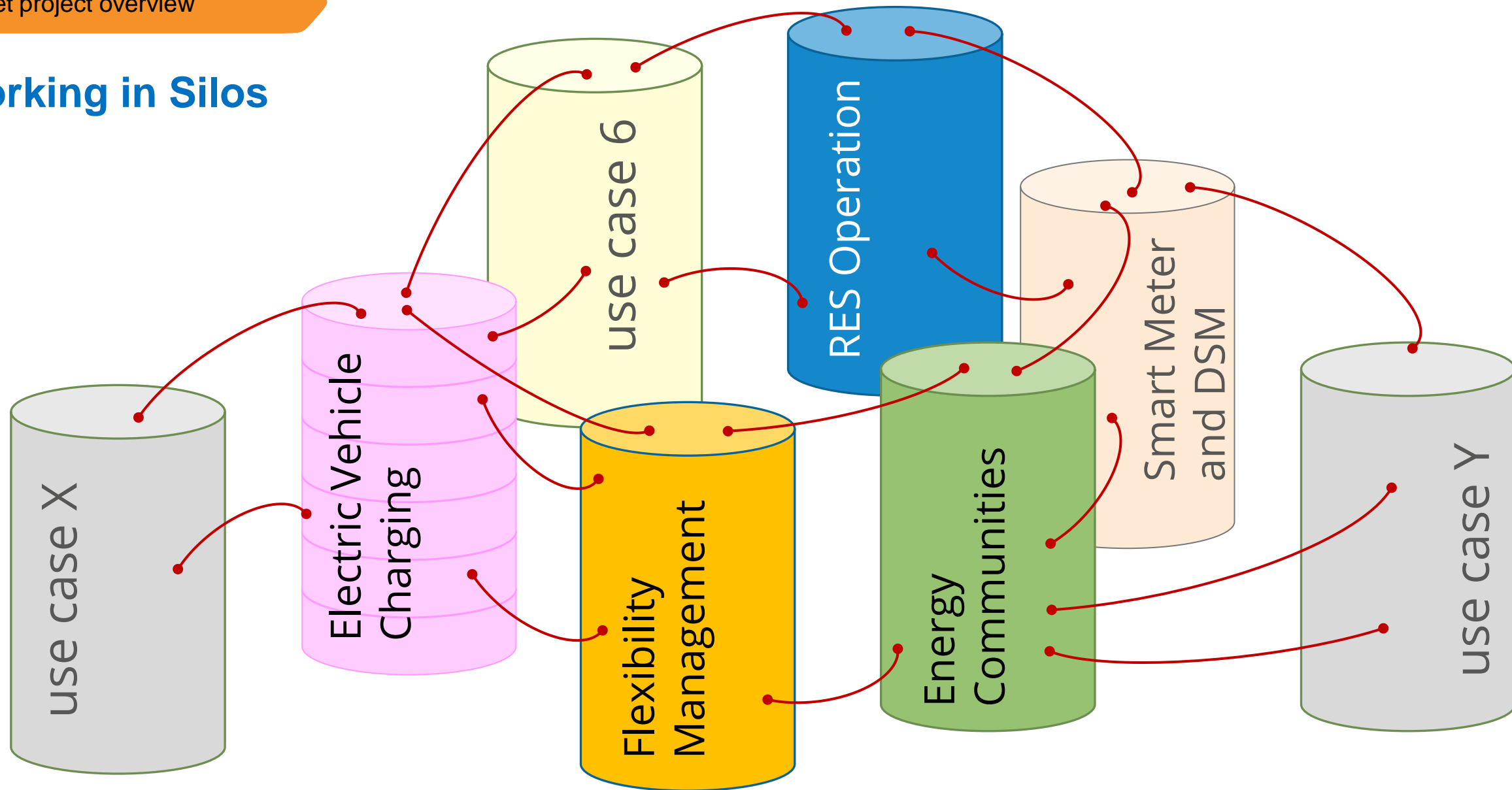


international energy associations
cross border energy groupings
national associations
regional cooperations
local energy suppliers
energy (sharing) communities

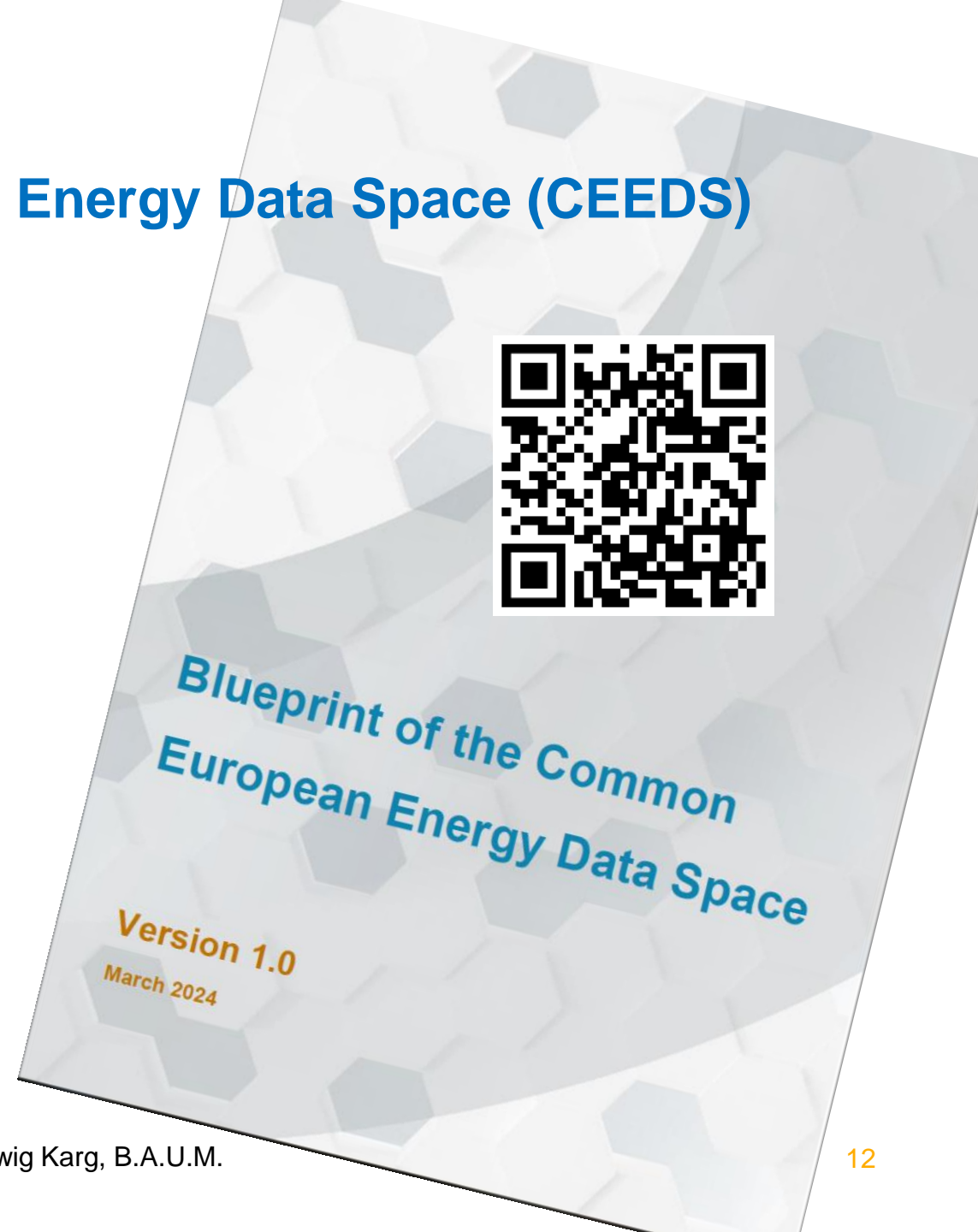
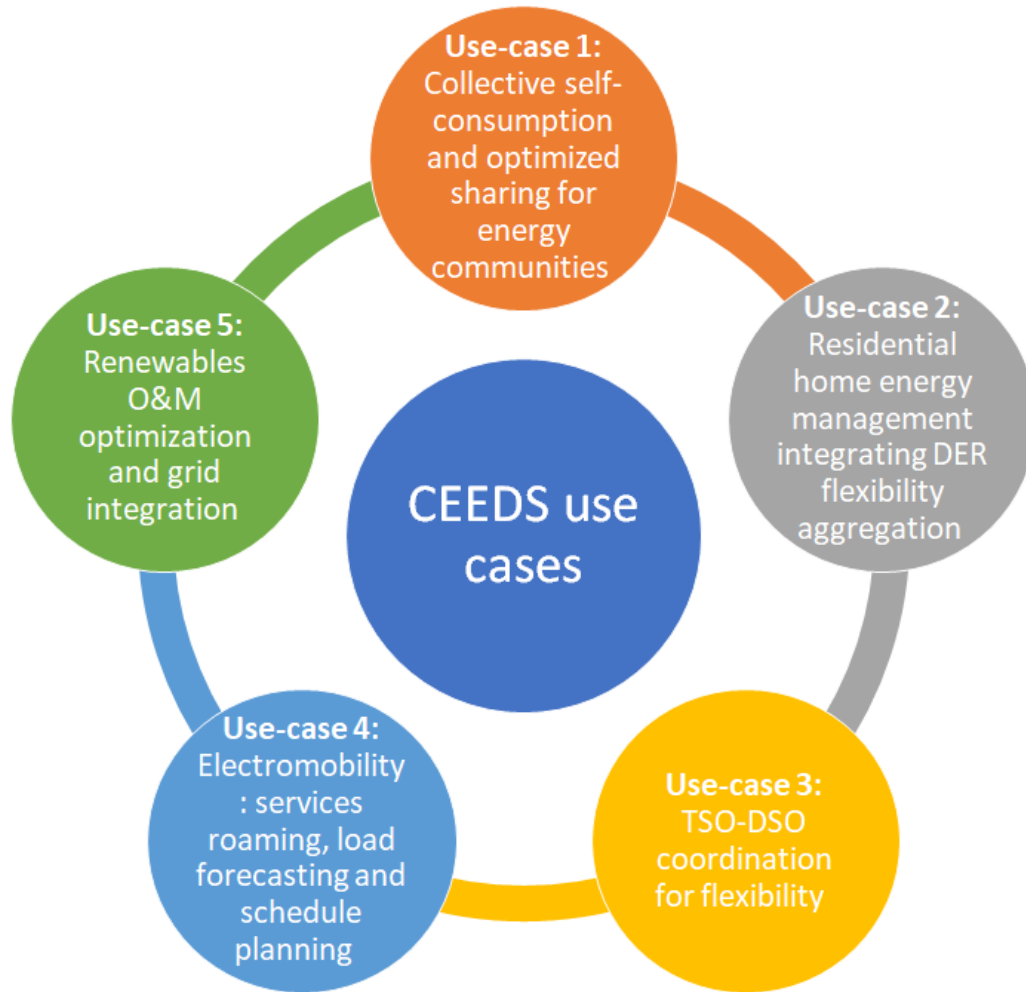
Working in Silos



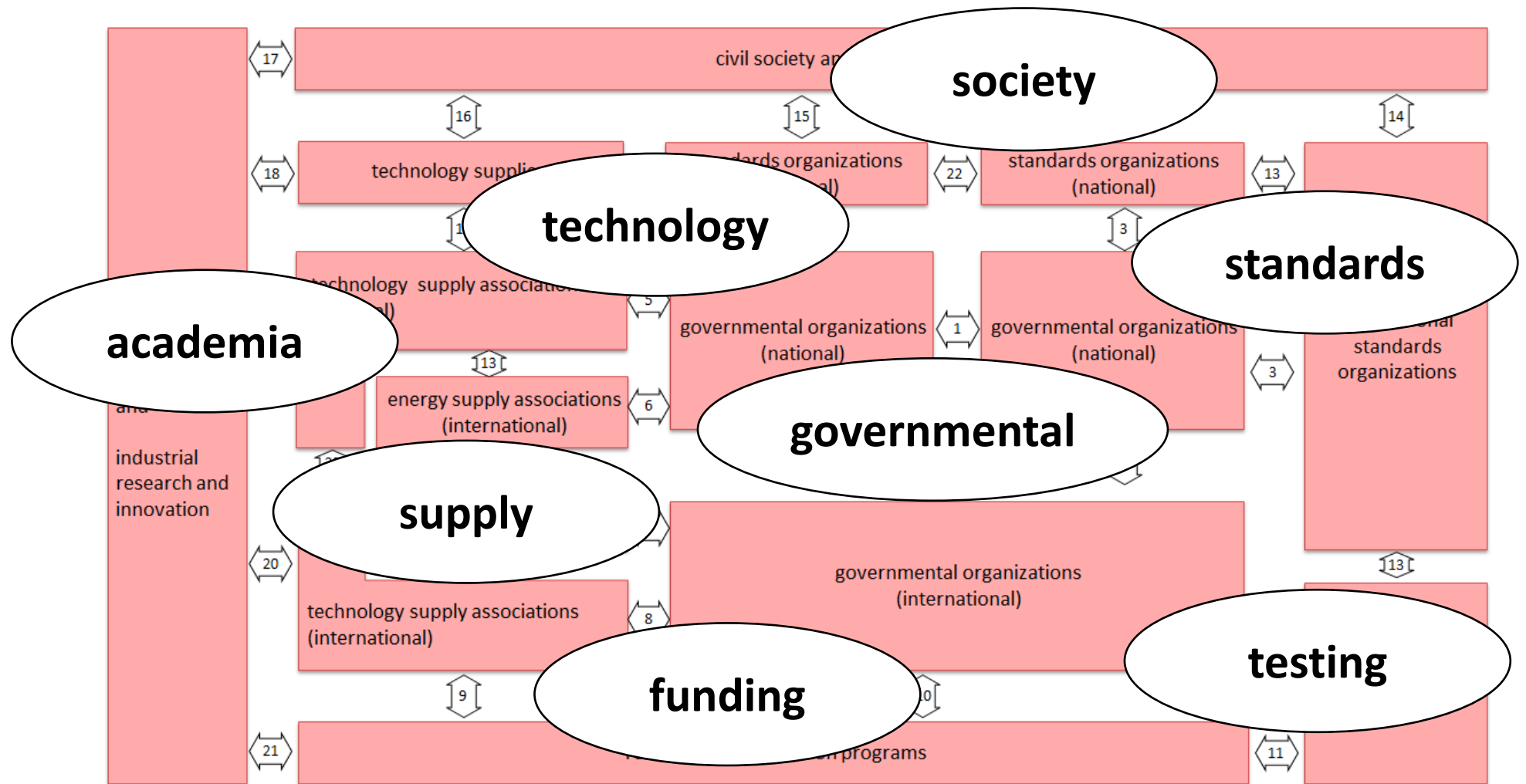
Working in Silos



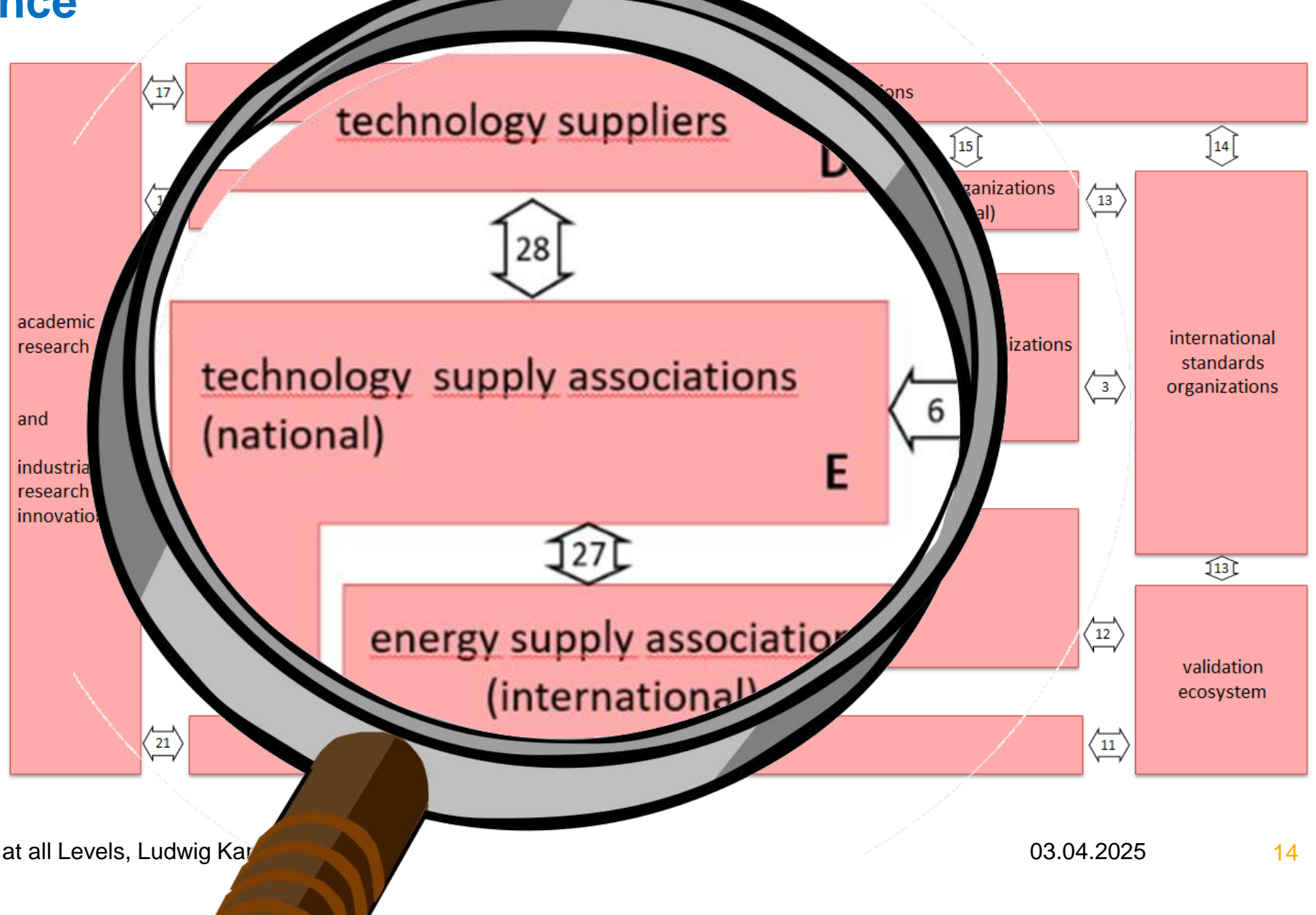
Reference use-cases for Common European Energy Data Space (CEEDS)



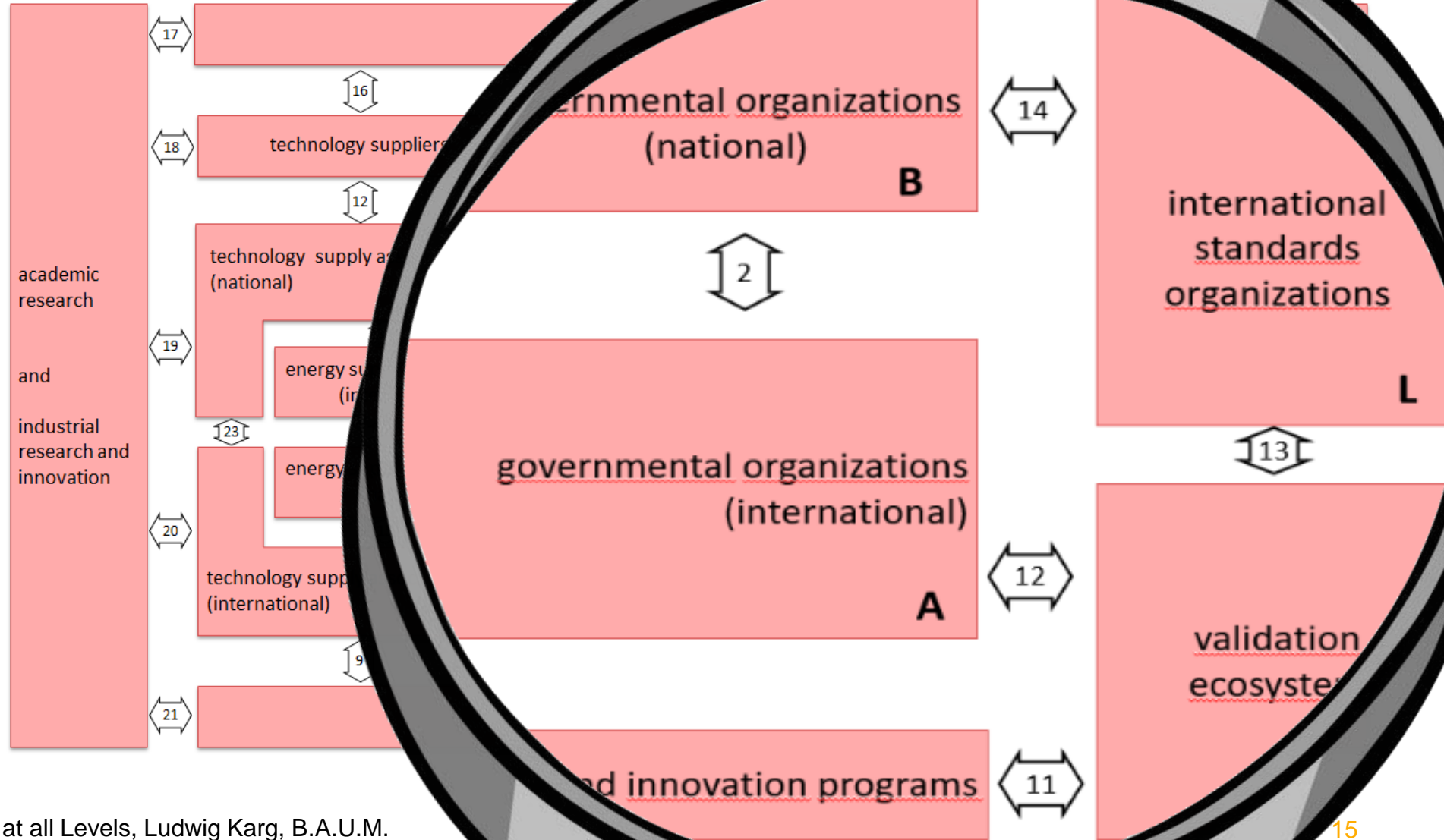
Systemic Governance



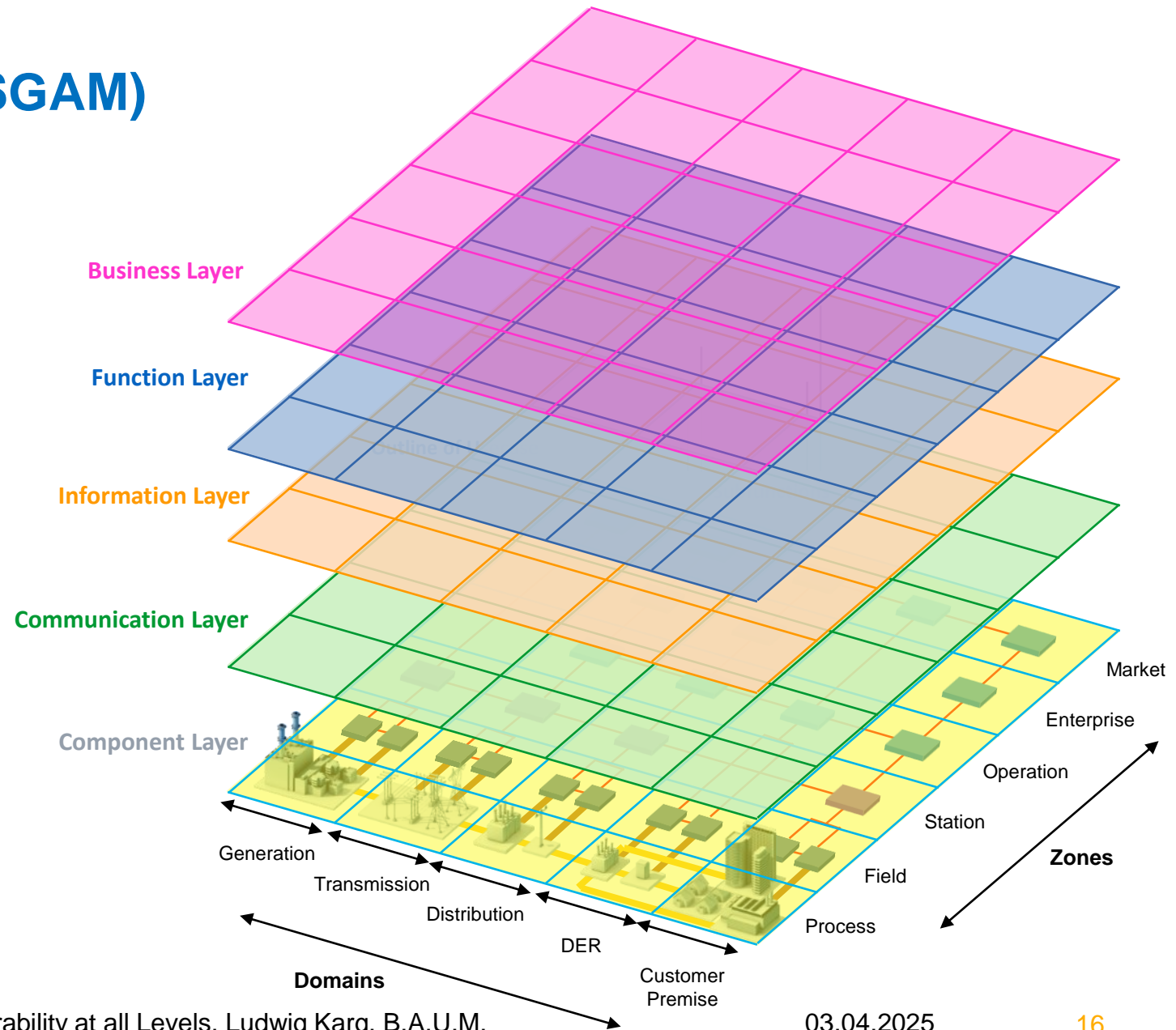
Systemic Governance



Systemic Governance



Smart Grid Architecture Model (SGAM)



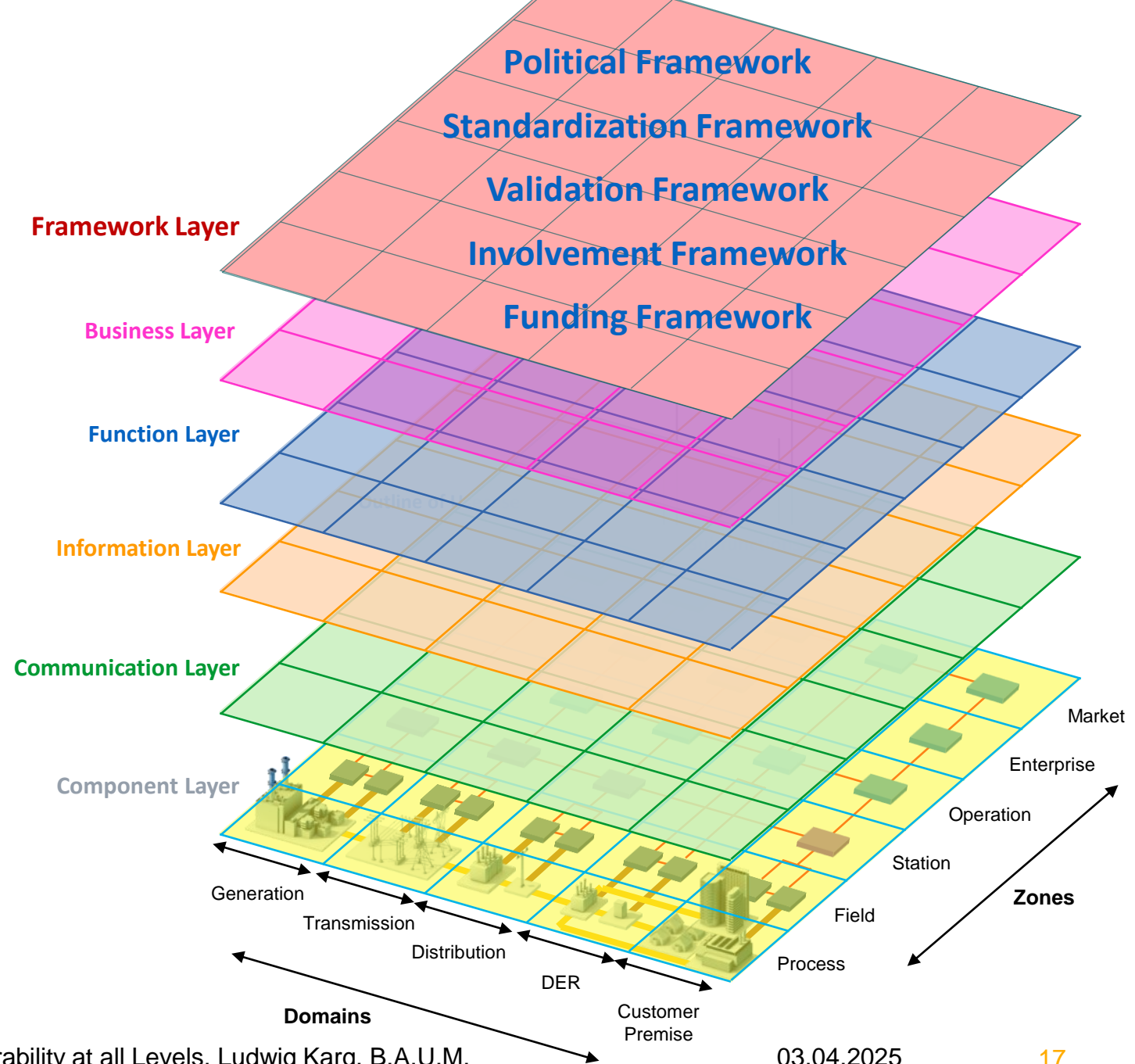
SGAM and Governance

A 6th layer of SGAM (“**framework layer**”) to allow for describing dependencies of

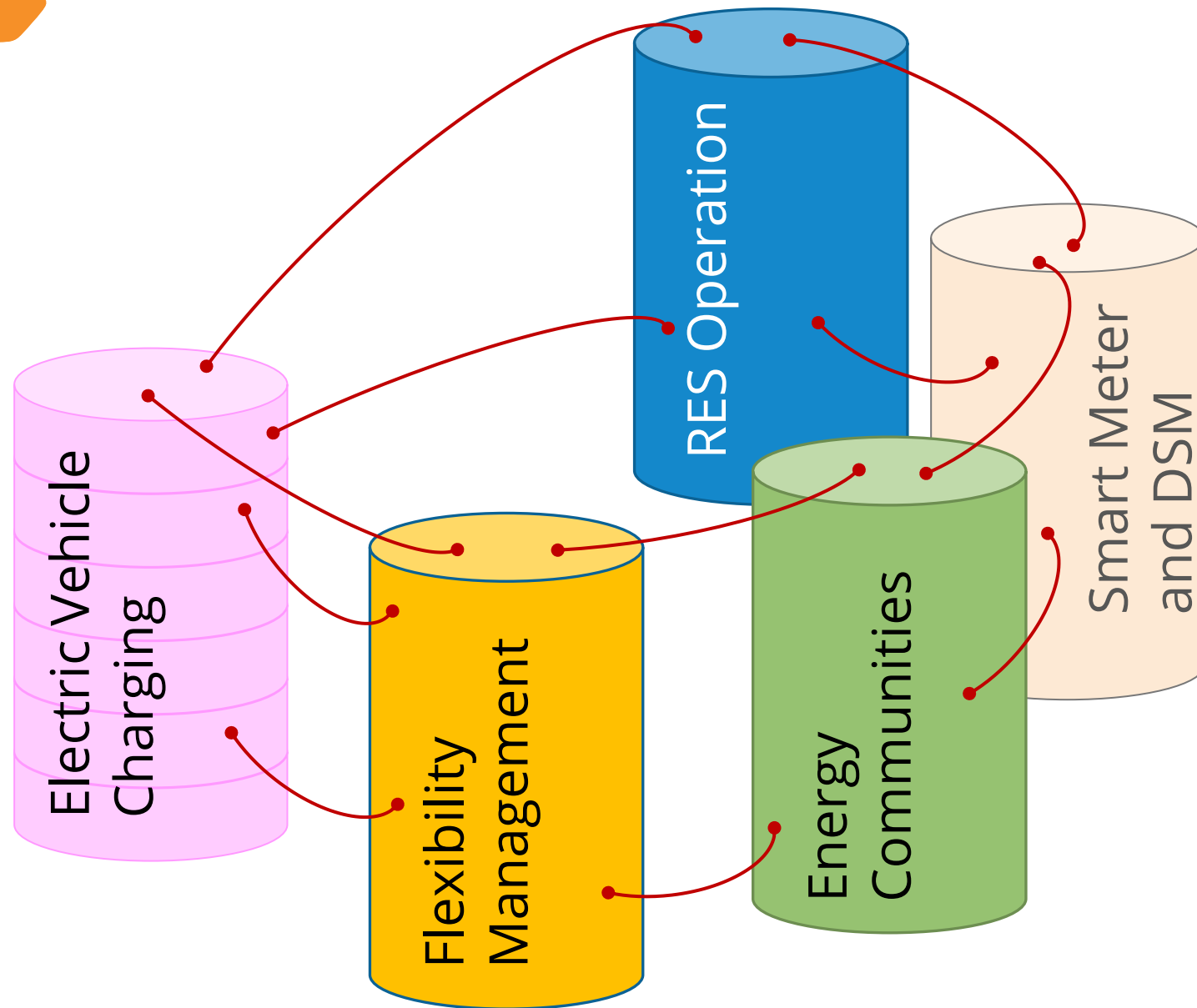
- Governing bodies and institutions
- Technology & Industry associations
- Standardization & validation organizations
- Research and innovation organizations
- Consumer and civil society organizations

And map **relevant interactions**, e.g. according to

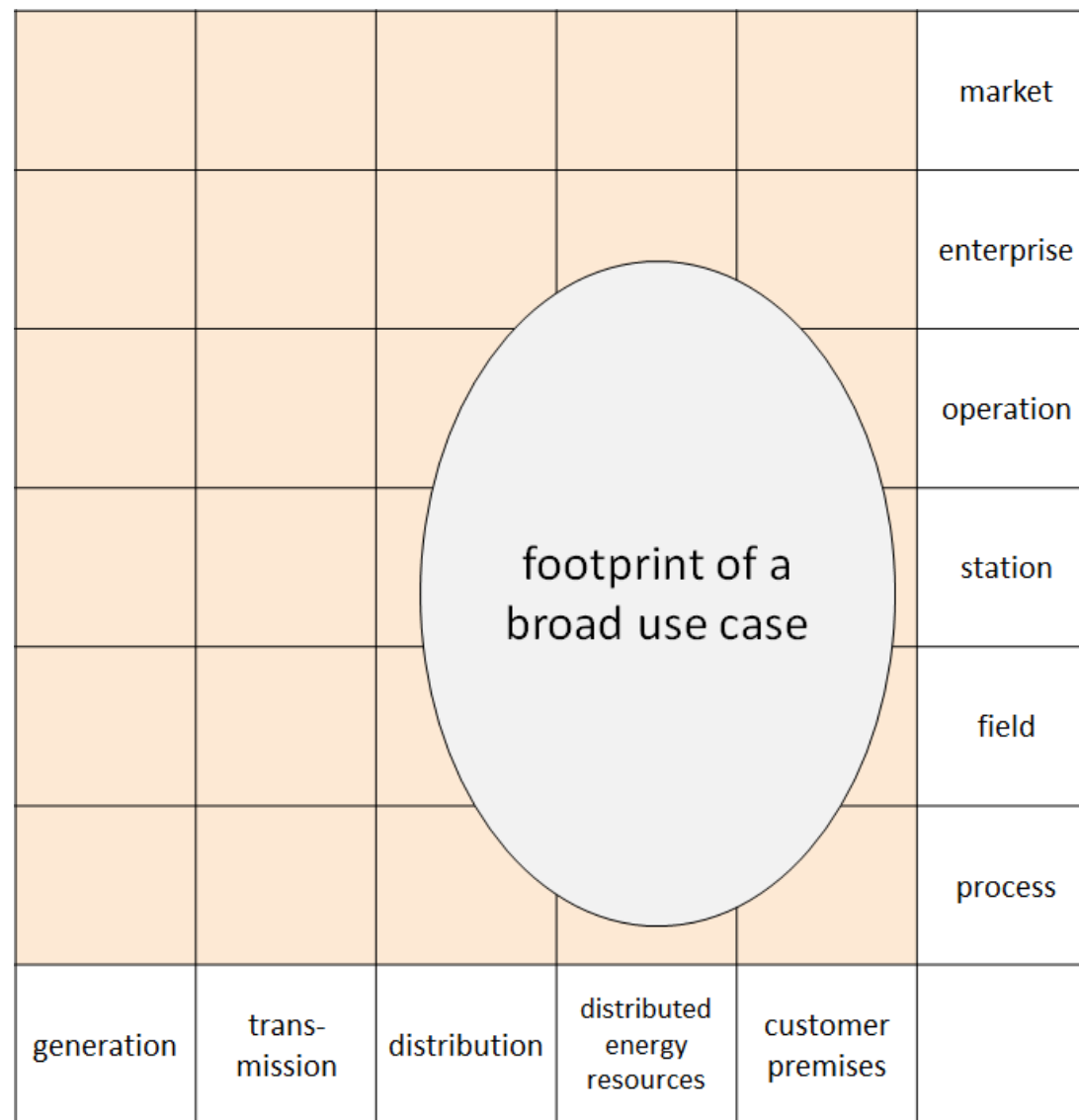
- Organizational structures
- Governance artifacts
- Processes & procedures
- Roles & Responsibilities



Working in Silos

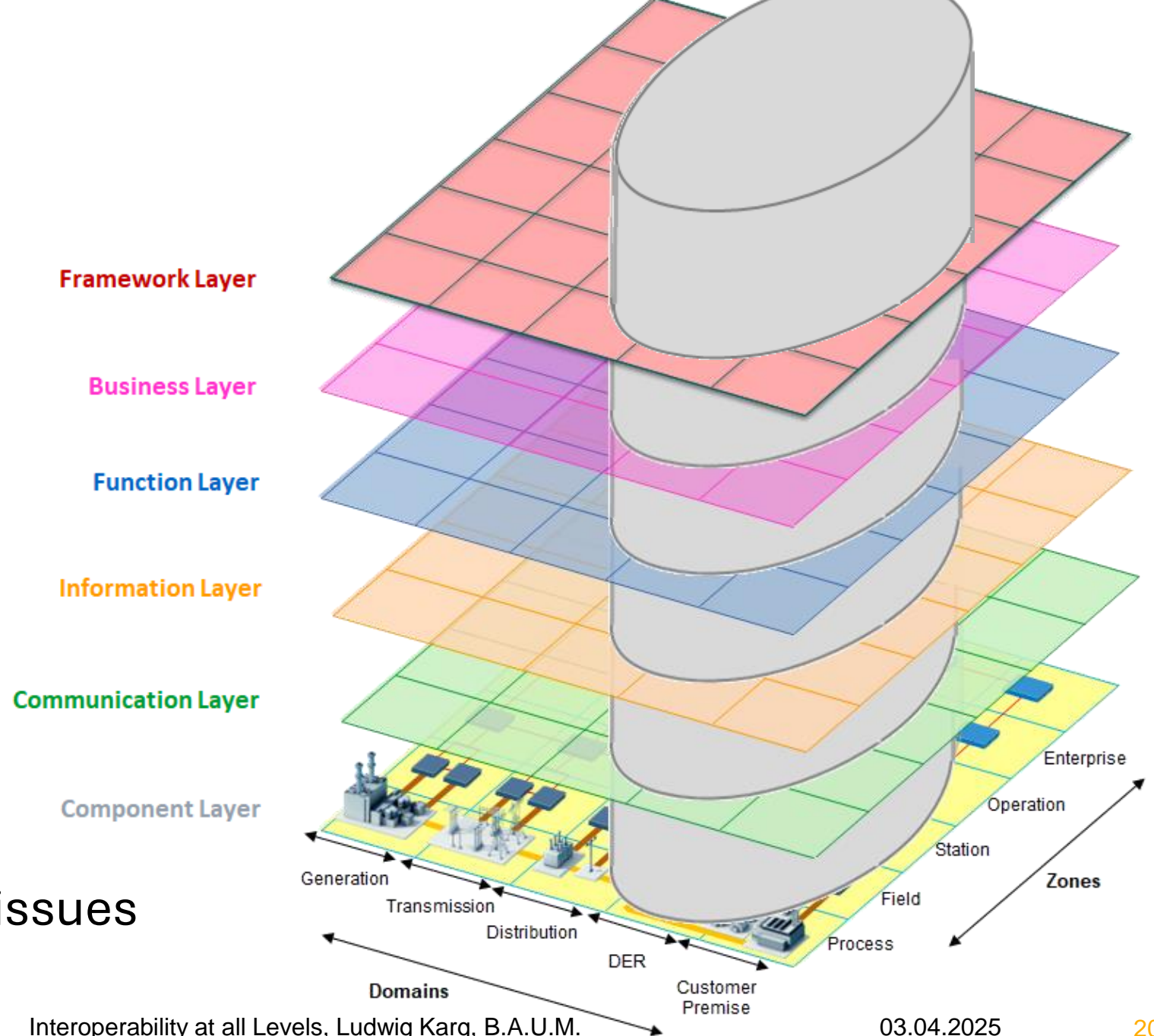


Scope of a Use Cases in SGAM

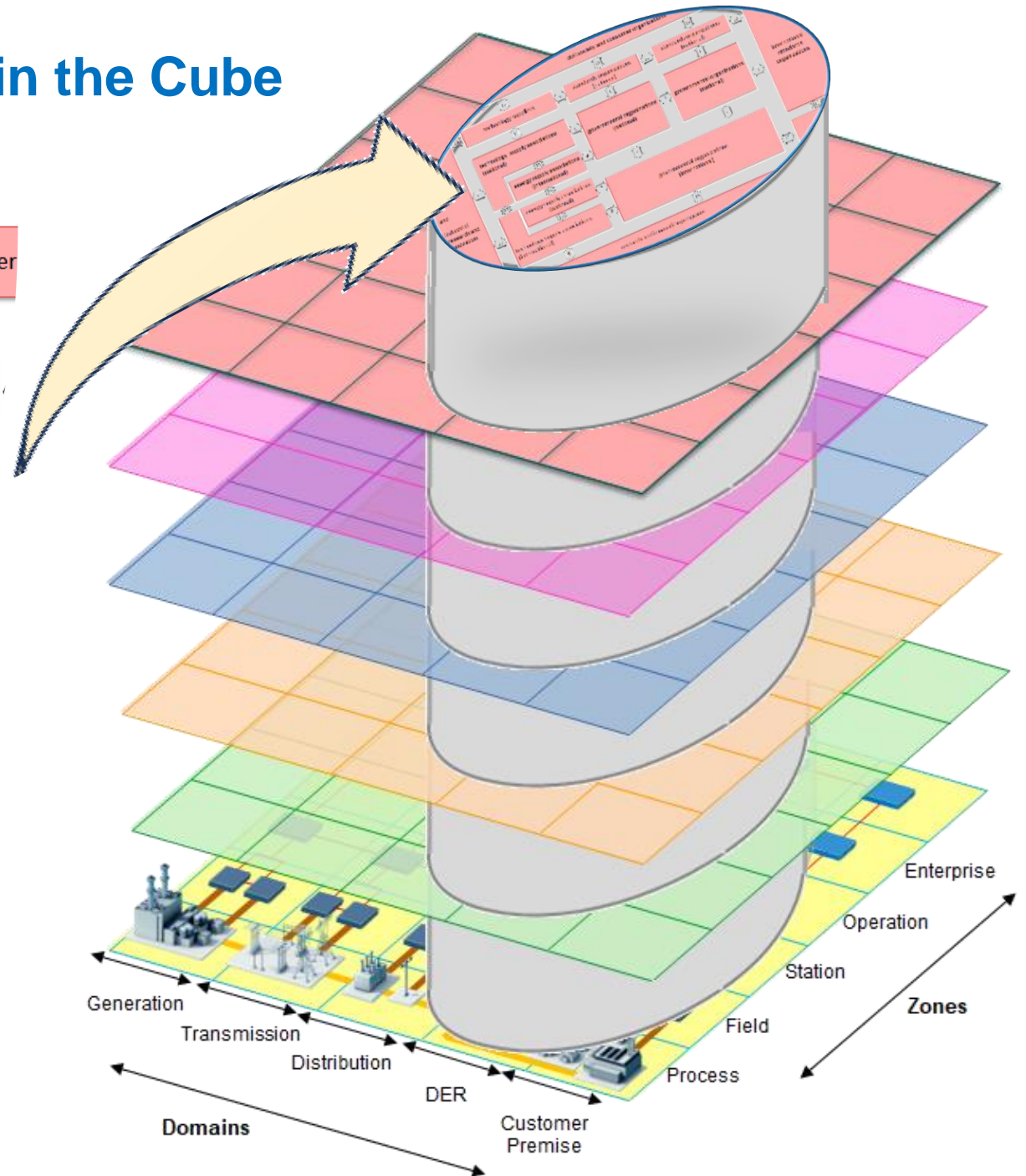
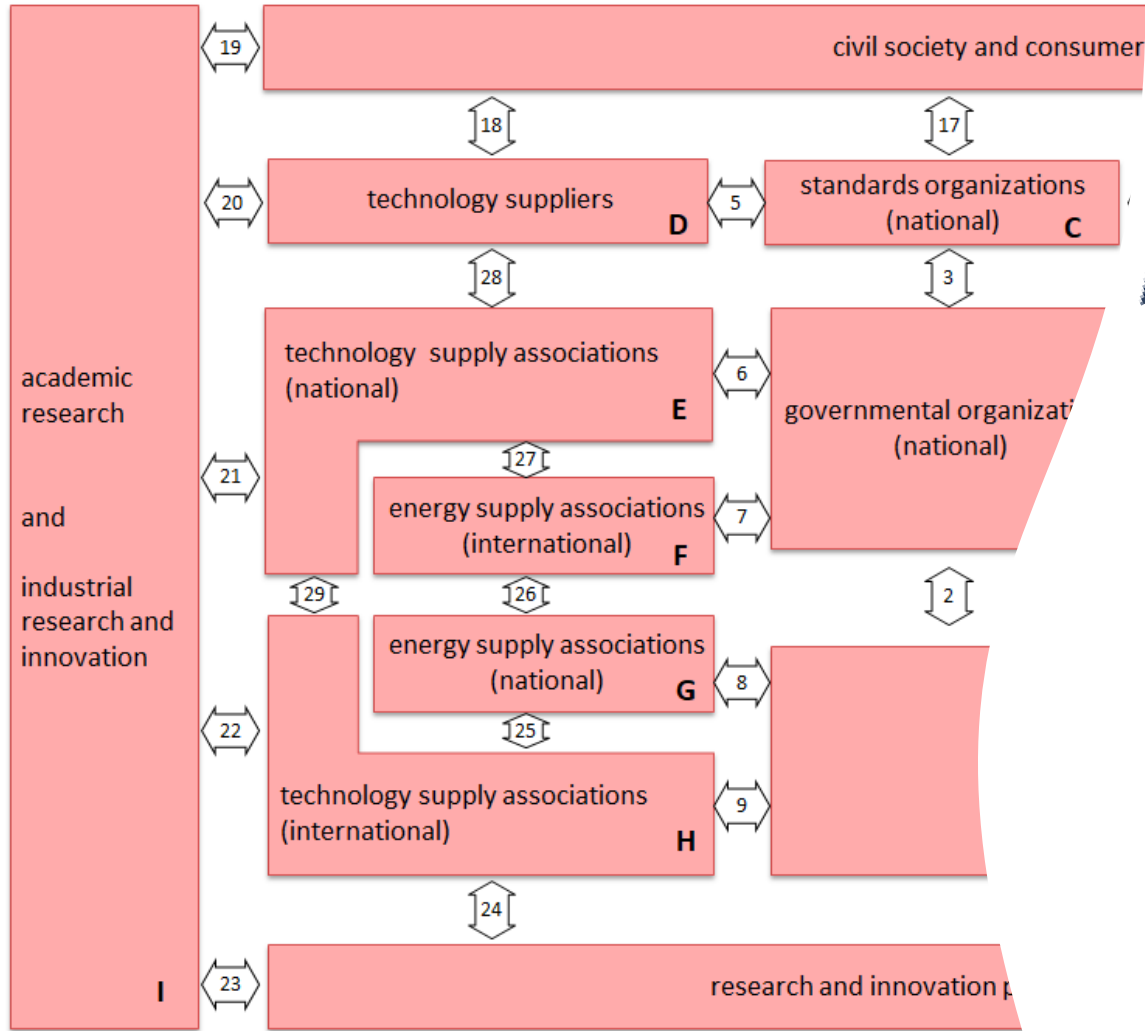


The Tube in the Cube

- Relating the **footprint** to the full interoperability spectrum forms “a **tube**”
- By taking the 6th layer perspective on a tube, **communities** can
 - Align early on
 - Accelerate technology development processes
 - Avoid the emergence of issues



Layer 6 and The Tube in the Cube



From Awareness to Action

interoperability awareness

monitoring
memberships
motivation

interoperability activities

adoption of standards
adherence to common rules
associating with test facilities

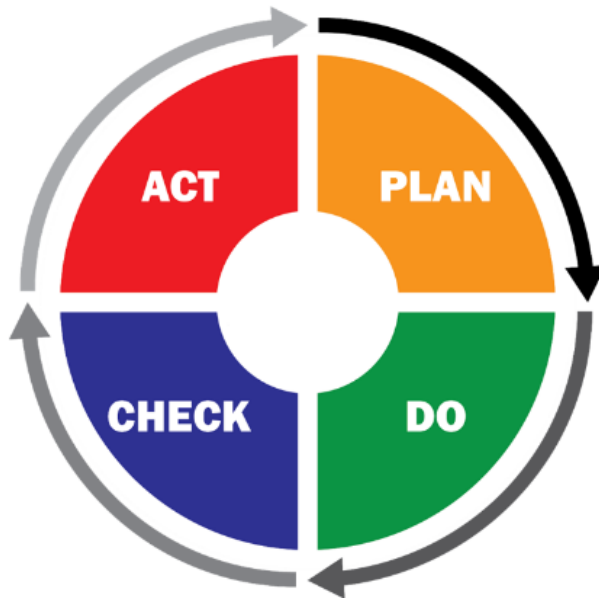
interoperability management

policy
processes
publications

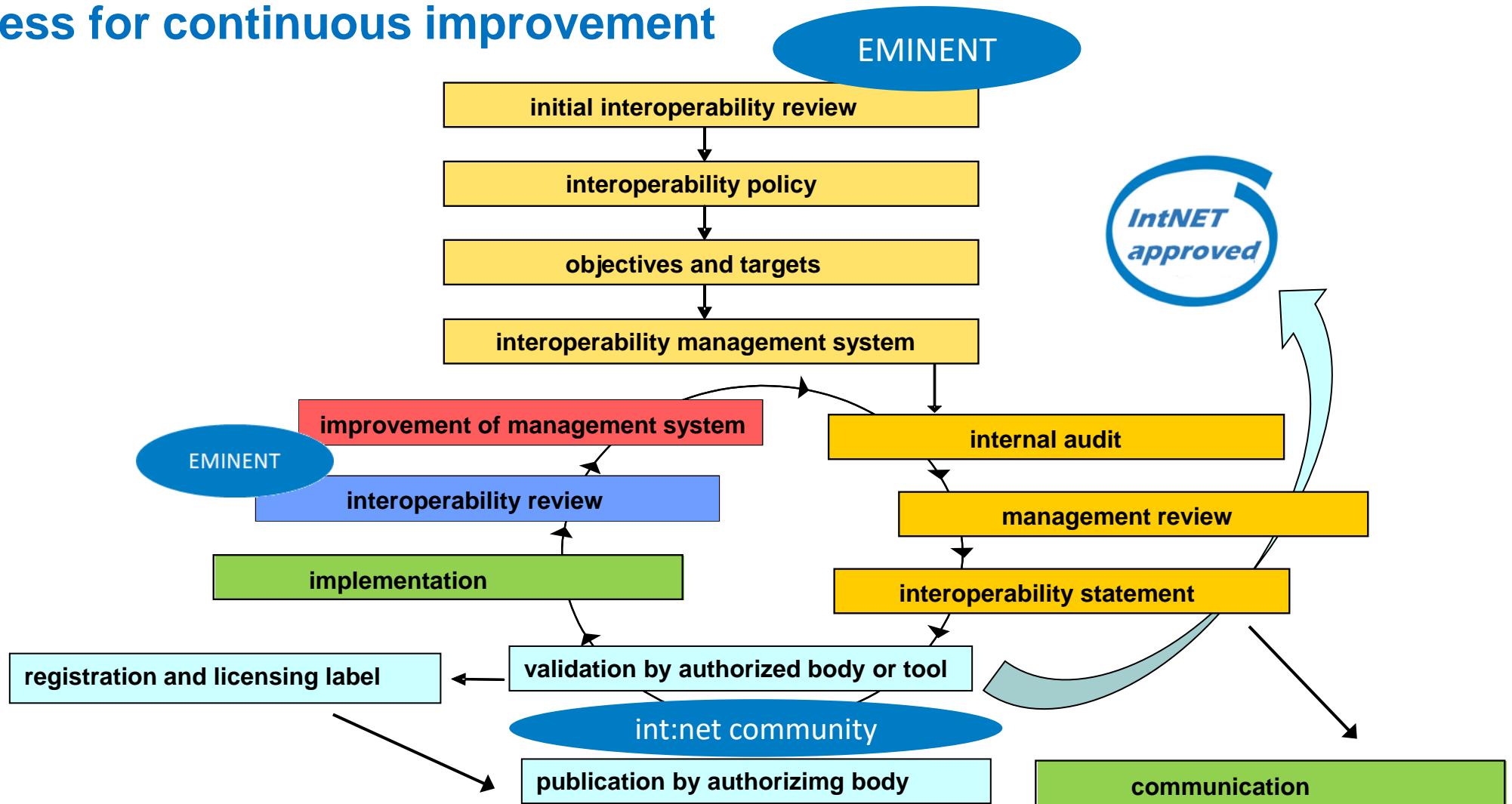
continuous improvement

regular audits
revisiting goals
renewing program

Measuring and Labelling Interoperability: Interoperability Management and Audit Scheme (IntMAS)



IntMAS: process for continuous improvement

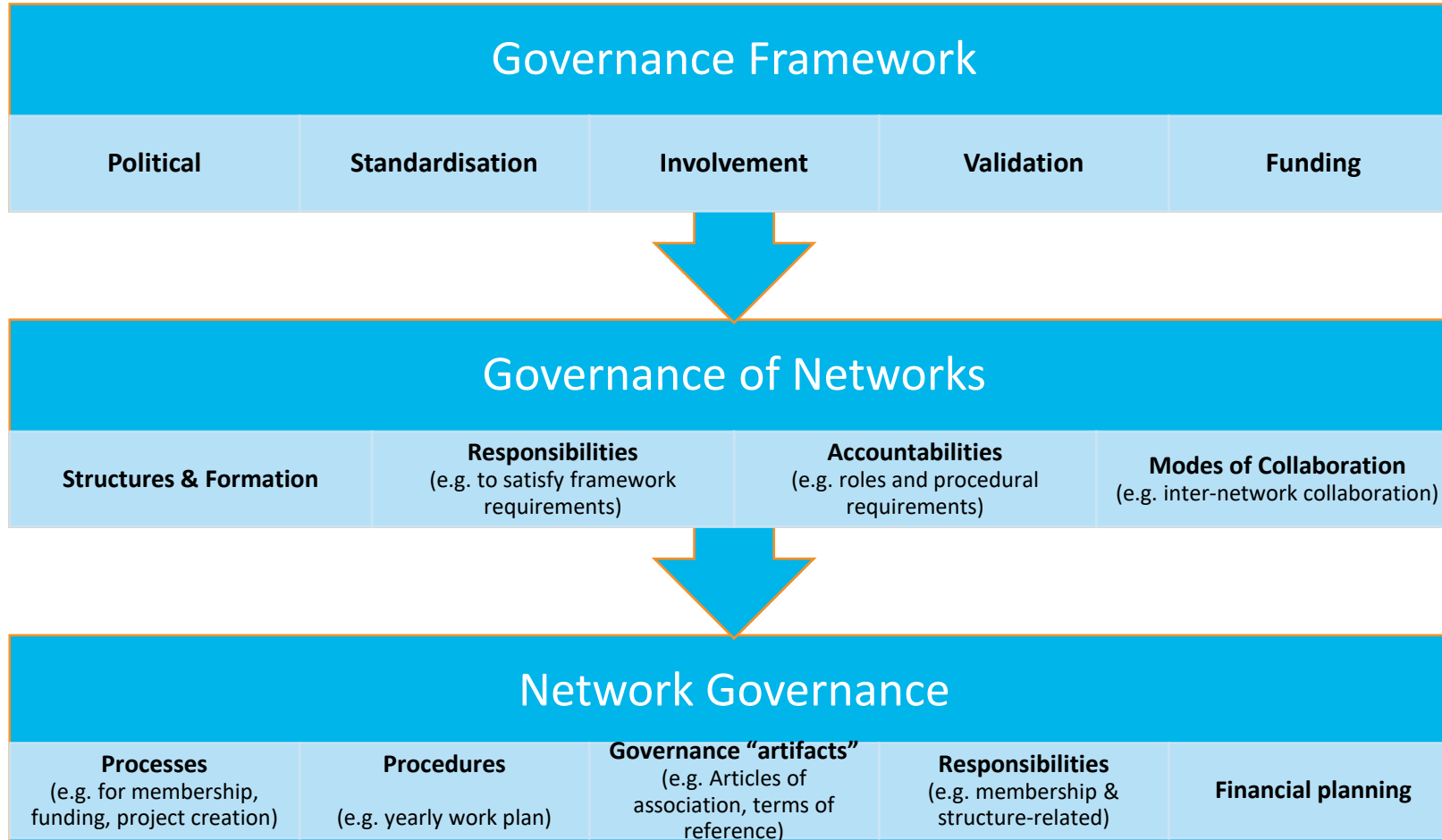


The IntMAS guideline

- ✓ reference to backgrounds
- ✓ goals and requirements
- ✓ work process
- ✓ references and links to tools
- ✓ summary of steps
- ✓ step by step guidance
- ✓ key points and hints



Multi-level network Governance



Governance Frameworks provide overarching goals and rules

Governance of Networks fosters alignment of networks and cohesion

Network Governance empowers networks to participate in frameworks

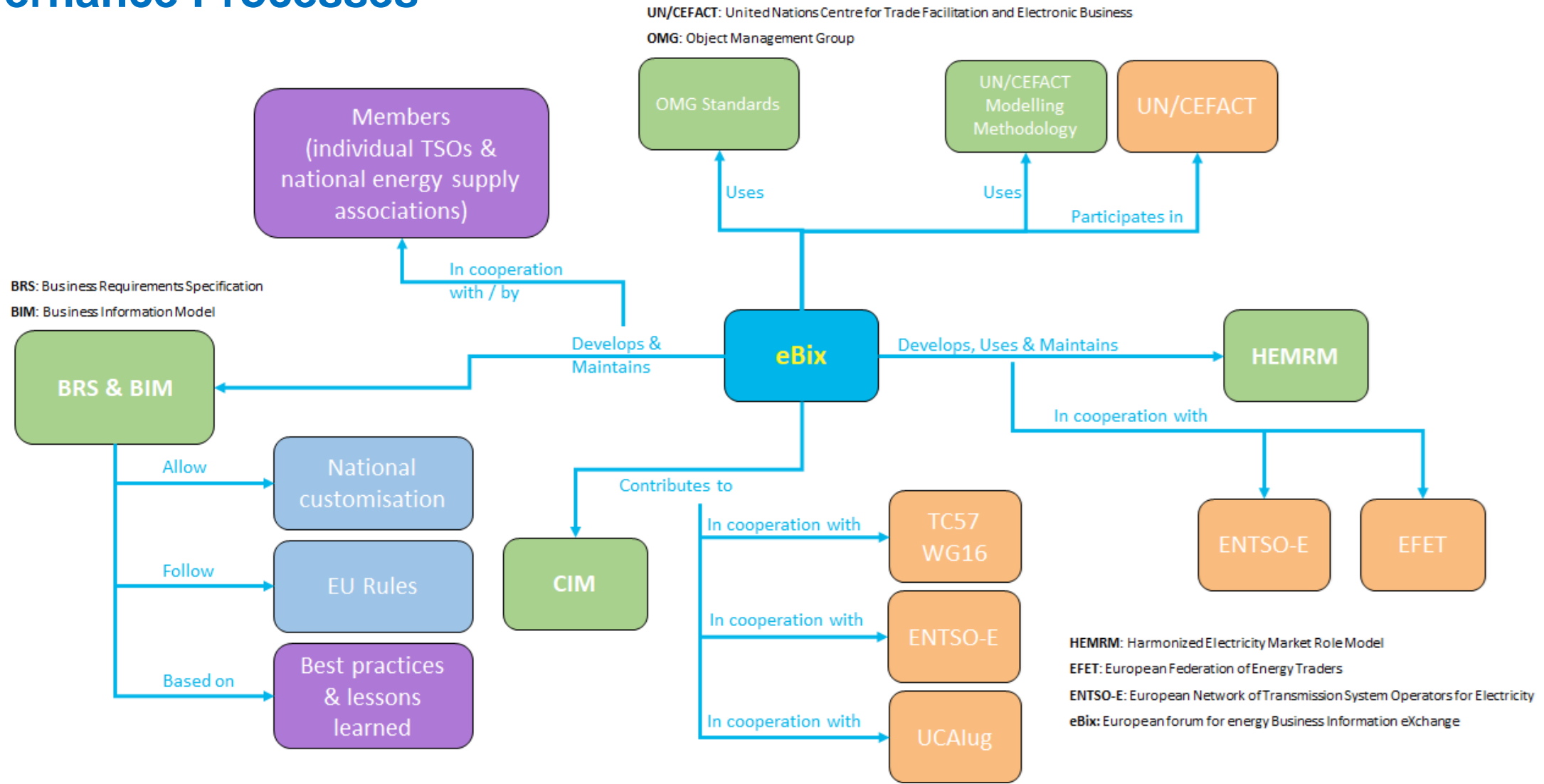
Analysis of Interoperability Initiatives

- more than 100 initiatives analyzed and described

Category	Description									Categorization					
	Name	Responsible Organization (s)	Last Update Date	Start Date	Scope	Website links	Short description	Added-value of the initiative (What is the main service provided? What is the main useful result? How it is used?)	Collaborative Project	Working group	Ongoing standards activity	Policy	Player (SDOs, policy makers, regulators, etc.)	Best practice	Framework
Common framework	Smart Grid Architecture Model (SGAM) framework	CEN, CENELEC, ETSI	2012 (tbc)	2012	European	https://energy.ec.europa.eu/documents_en?%5B0%5D=document_title%3Aarchitecture	A unified standard for smart grid use-case and architecture design. This reference architecture aims to give a global view of a Smart Grid system by mapping its different actors and devices on a Smart Grid Plane subdivided in Domains and Zones. The framework is described in the document "expert_group_1_reference_architecture.pdf"	With its five layers highlighting different interoperability conditions, the SGAM framework aims to cover the interoperability issues of a system		*					



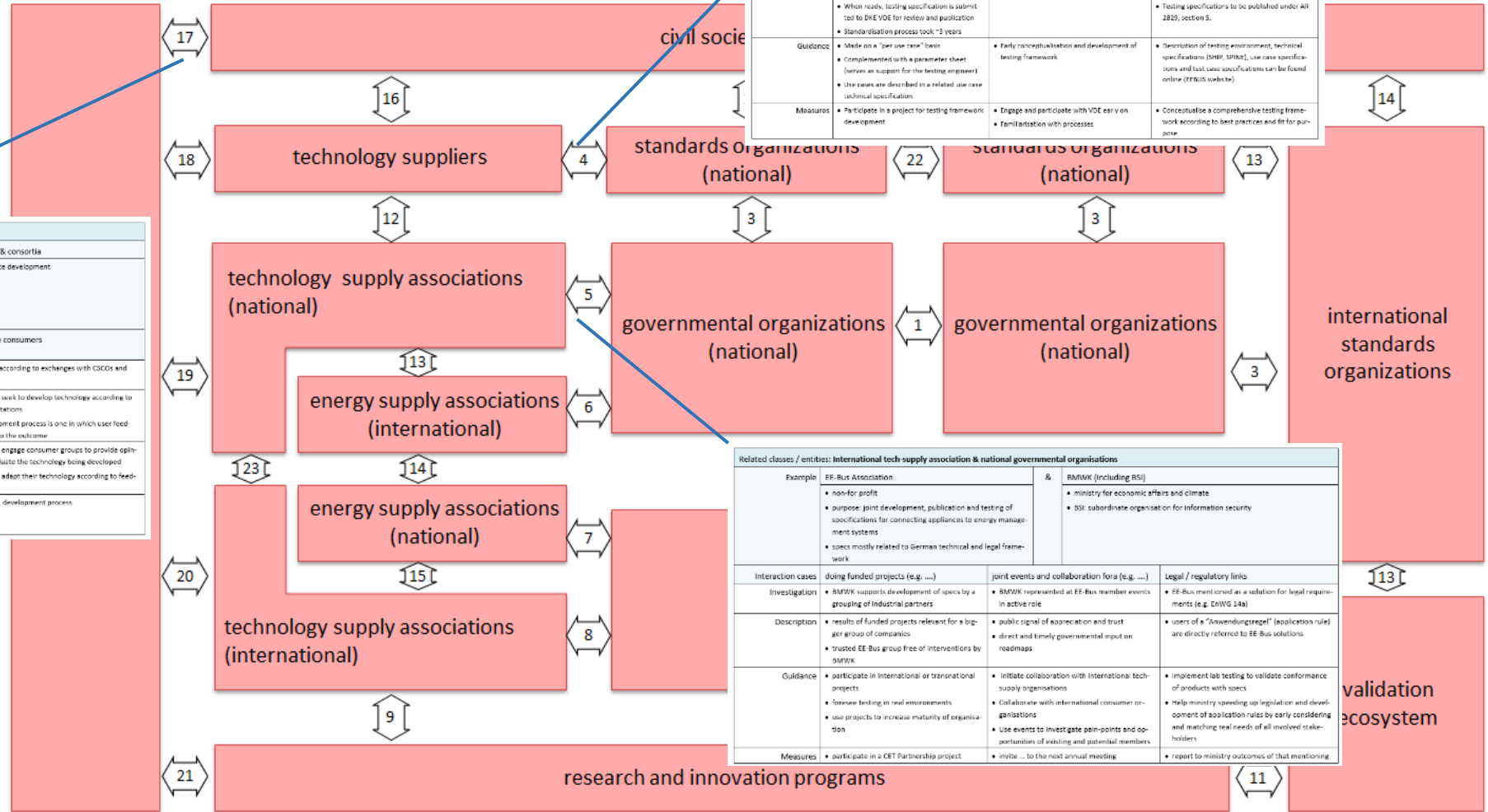
Governance Processes



Whitebook on Systemic Governance

Related classes / entities: Civil society and consumer organisations (CSCO) & Academic research and Industrial R&I (ARI)	
Example BEUC members (link) From BEUC member profiles: <ul style="list-style-type: none"> Austria: Represent and strengthen consumer interests by informing and educating consumers about their rights and responsibilities Bulgaria: Protect the rights and interests of consumers by providing information, assistance, and representation at national and international level 	& Research projects & consortia <ul style="list-style-type: none"> Product and service development ...
Interaction cases Understand consumer's concerns towards a specific technology, as well as the problems and needs of civil society	Adapting technology to consumers
Investigation <ul style="list-style-type: none"> Researchers engage with CSCOs to understand the needs of civil society 	<ul style="list-style-type: none"> ARI adapts technology according to exchanges with CSCOs and consumers
Description <ul style="list-style-type: none"> Technology developers may be biased towards their own preferences and context There is a lack of understanding between technology developers and CSCOs 	<ul style="list-style-type: none"> Technology developers seek to develop technology according to users' needs and expectations The technology development process is one in which user feedback becomes central to the outcome
Guidance <ul style="list-style-type: none"> Usage of tailored tools and relevant indicators to engage with citizens and consumers on specific topics Communication expert involvement, particularly those specialised in bridging technology and CSCOs 	<ul style="list-style-type: none"> Technology developers engage consumer groups to provide opinions, to test and to evaluate the technology being developed Technology developers adapt their technology according to feedback
Measures <ul style="list-style-type: none"> Incorporate actors and actor exchanges from the beginning of the project (planning) Have as R&I program requirement 	<ul style="list-style-type: none"> Feedback loops in tech. development process

Related classes / entities: Validation ecosystem & National Standards Organisations		
Example EEBUS <ul style="list-style-type: none"> non-for profit purpose: joint development, publication and testing of specifications for connecting appliances to energy management systems specs mostly related to German technical and legal framework 	& DKE VDE <ul style="list-style-type: none"> Technical-scientific association Testing, standardisation, certification and application consulting in the field of electrical engineering 	
Interaction cases Test specification development	Review	Publishing
Investigation <ul style="list-style-type: none"> EEBUS submits testing specification to VDE 	<ul style="list-style-type: none"> testing specification is reviewed by VDE 	<ul style="list-style-type: none"> Testing specification is published by VDE
Description <ul style="list-style-type: none"> The testing specification and framework is developed in-house, together with EEBUS members (i.e. with industry) When ready, testing specification is submitted to DKE VDE for review and publication Standardisation process took ~3 years 	<ul style="list-style-type: none"> VDE reviews testing specification Adjustments are proposed and specification is made ready for publishing 	<ul style="list-style-type: none"> VDE application rules include description of use cases, SHIP, SPINE, Implementation with SHIP/SPINE under AR-2829, sections 1 - 4 Testing specifications to be published under AR-2829, section 5.
Guidance <ul style="list-style-type: none"> Made on a "per use case" basis Complemented with a parameter sheet (serves as support for the testing engineer) Use cases are described in a related use case technical specification 	<ul style="list-style-type: none"> Early conceptualisation and development of testing framework 	<ul style="list-style-type: none"> Description of testing environment, technical specifications (SHIP, SPINE), Use case specifications and test case specifications can be found online (EEBUS website)
Measures <ul style="list-style-type: none"> Participate in a project for testing framework development 	<ul style="list-style-type: none"> Engage and participate with VDE early on Familiarisation with processes 	<ul style="list-style-type: none"> Conceptualise a comprehensive testing framework according to best practices and fit for purpose

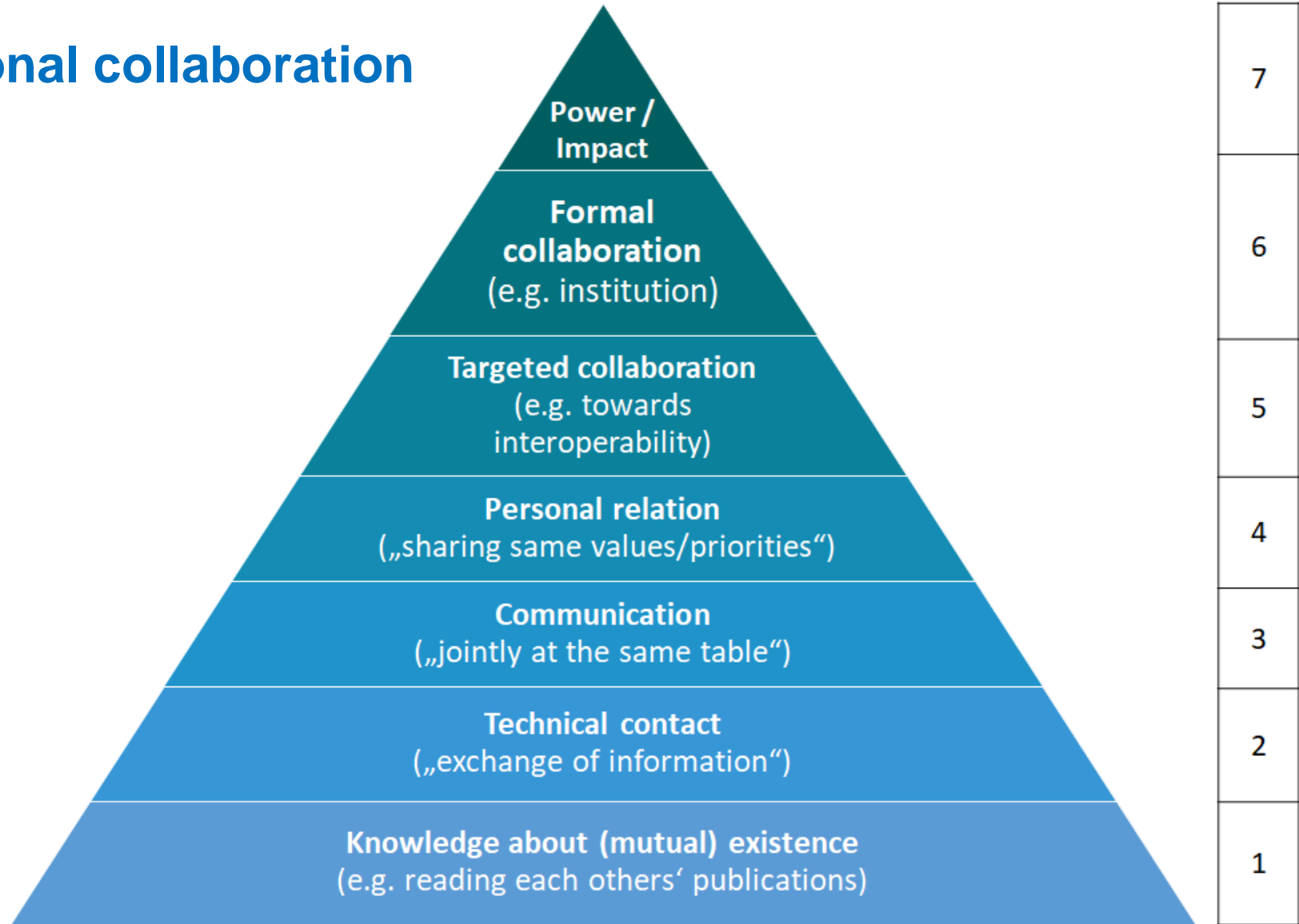


Related classes / entities: International tech supply association & national governmental organisations		
Example EE-Bus Association <ul style="list-style-type: none"> non-for profit purpose: joint development, publication and testing of specifications for connecting appliances to energy management systems specs mostly related to German technical and legal framework 	& BMWK (Including BSI) <ul style="list-style-type: none"> ministry for economic affairs and climate BSI: subordinate organisation for information security 	
Interaction cases doing funded projects (e.g. ...)	joint events and collaboration fora (e.g. ...)	Legal / regulatory links
Investigation <ul style="list-style-type: none"> BMWK supports development of specs by a grouping of industrial partners 	<ul style="list-style-type: none"> BMWK represented at EE-Bus member events in active role 	<ul style="list-style-type: none"> EE-Bus mentioned as a solution for legal requirements (e.g. ENWG 14b)
Description <ul style="list-style-type: none"> results of funded projects relevant for a bigger group of companies trusted EE-Bus group free of interventions by BMWK 	<ul style="list-style-type: none"> public signal of appreciation and trust direct and timely governmental input on roadmaps 	<ul style="list-style-type: none"> users of a "Anwendungsregel" (application rule) are directly referred to EE-Bus solutions
Guidance <ul style="list-style-type: none"> participate in international or transnational projects foresee testing in real environments use projects to increase maturity of organisation 	<ul style="list-style-type: none"> Initiate collaboration with international tech-supply organisations Collaborate with international consumer organisations Use events to investigate pain-points and opportunities of existing and potential members 	<ul style="list-style-type: none"> Implement lab testing to validate conformance of products with specs Help ministry speeding up legislation and development of application rules by early considering and matching real needs of all involved stakeholders
Measures <ul style="list-style-type: none"> participate in a CET Partnership project 	<ul style="list-style-type: none"> invite ... to the next annual meeting 	<ul style="list-style-type: none"> report to ministry outcomes of that meeting

Governance Classes and their Relations

Related classes / entities: Validation ecosystem & National Standards Organisations			
Example	EEBUS	&	DKE VDE
	<ul style="list-style-type: none"> • non-for profit • purpose: joint development, publication and testing of specifications for connecting appliances to energy management systems • specs mostly related to German technical and legal framework 		<ul style="list-style-type: none"> • Technical-scientific association • Testing, standardisation, certification and application consulting in the field of electrical engineering
Interaction cases	Test specification development	Review	Publishing
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Measures	<ul style="list-style-type: none"> • Participate in a project for testing framework development 	<ul style="list-style-type: none"> • Engage and participate with VDE early on • Familiarisation with processes 	<ul style="list-style-type: none"> • Conceptualise a comprehensive testing framework according to best practices and fit for purpose

Quality of inter-organisational collaboration



int:net Community Platform

- efficient networking in Interoperability Focus Groups (IFG)
- Sharing documents and videos and promoting events
- Interoperability Projects and People Connector (**IPPC**)
(to be launched in summer 2025)



The Vienna Week

23-27 June 2025

- Summer School
- Think Tank
- Symposium

- Lab Visits
- IHE Connectathon

Vienna Week, 23-27 June, 2025

[Events - Int:net](#)

2025			Monday 23rd June		Tuesday		Wednesday		Thursday		Friday 27th June	
Organizer	Responsibility	Time	Title	Target Groups / Topics	Title	Target Groups / Topics	Title	Target Groups / Topics	Title	Target Groups / Topics	Title	Target Groups / Topics
IHE		Morning	?		IHE Connectathon							
		Afternoon	?									
CETP / OFFIS / int.net	Rene Kuchenbuch	Morning	Testing?		Testing?		Testing?		Testing?		Testing?	
		Afternoon										
int:net Summer School	Sarah Huber	Morning			Interoperability Maturity Models (EMINENT, etc.) Interoperability Management	Target groups: Topic #1	The Think Tank on Governance in Energy Interoperability	Target groups: High level representatives from administrative bodies & industry + Attendants of the summer school! Topics: - Focus on cases & experience - Practice and lessons in implementation - How to integrate interoperability into existing processes			Wrap Up	Target groups: all interested participants of summer school and symposium
		Afternoon	Introduction to energy interoperability, get interoperability con int.net Social dinner	Summer School							The Think Tank	
CETP + int.net + IHE?	Angela Berger	Morning								3rd Cross-Sector Symposium on Interoperability	Target groups: Experts and policy makers Topics: - Multi-stakeholder governance to develop a wide range of deliverables - Convergence to international standards	
		Afternoon								Symposium		
EC D4E working groups		Morning								Symposium		
		Afternoon								EC D4E SEEG Meeting		
CETP Knowledge Community + ERA-NET	Alphin Tom	Morning										
		Afternoon								CETPartnership & JPP SES		
ERA-Net STB / TRI5	Angela Berger	Morning										
		Afternoon										
LPS Workshop "Interoperability"		Morning			Hackathon							
		Afternoon								Austrian R&D aerospace		



int:net

Interoperability Network for
the Energy Transition



<https://intnet-project.eu/>



<https://www.linkedin.com/company/int-net-project/>



info@intnet-project.eu

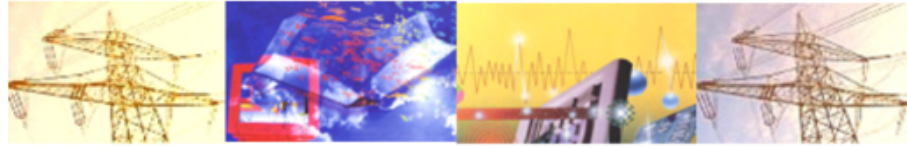


L.Karg@baumgroup.de

C.Ayon@baumgroup.de

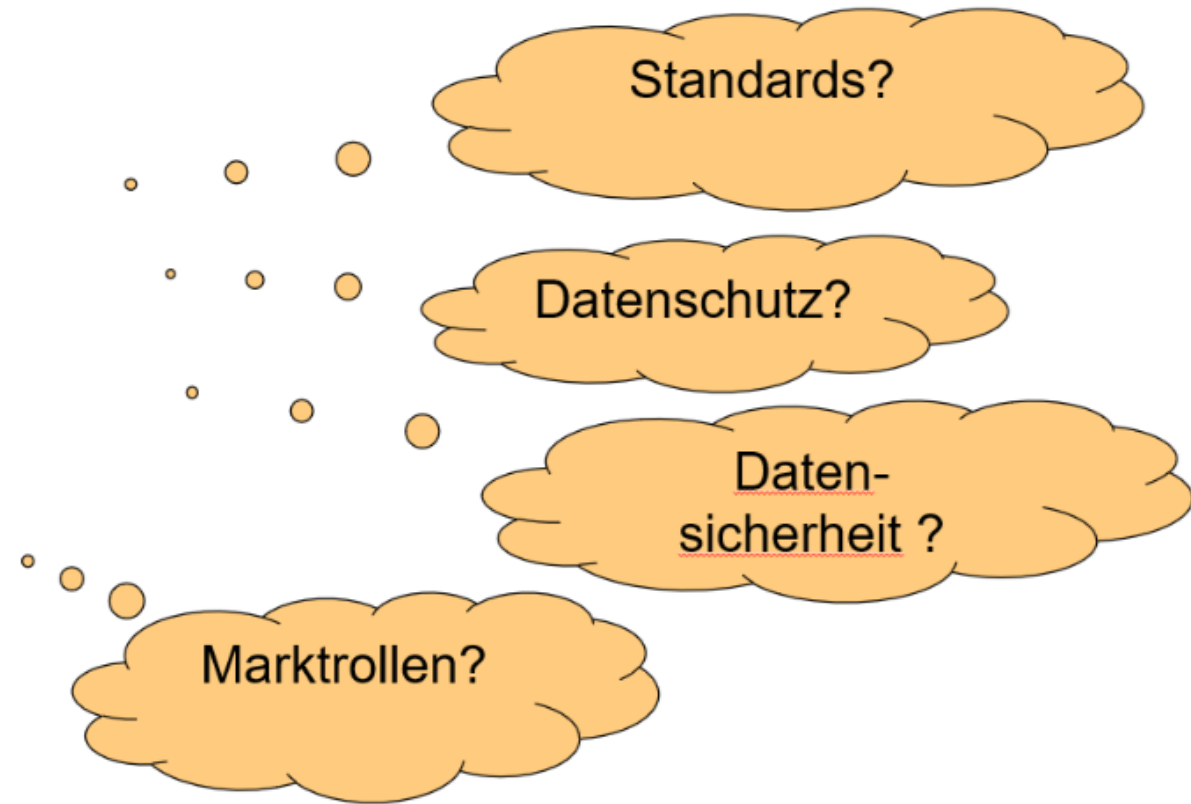


Extension



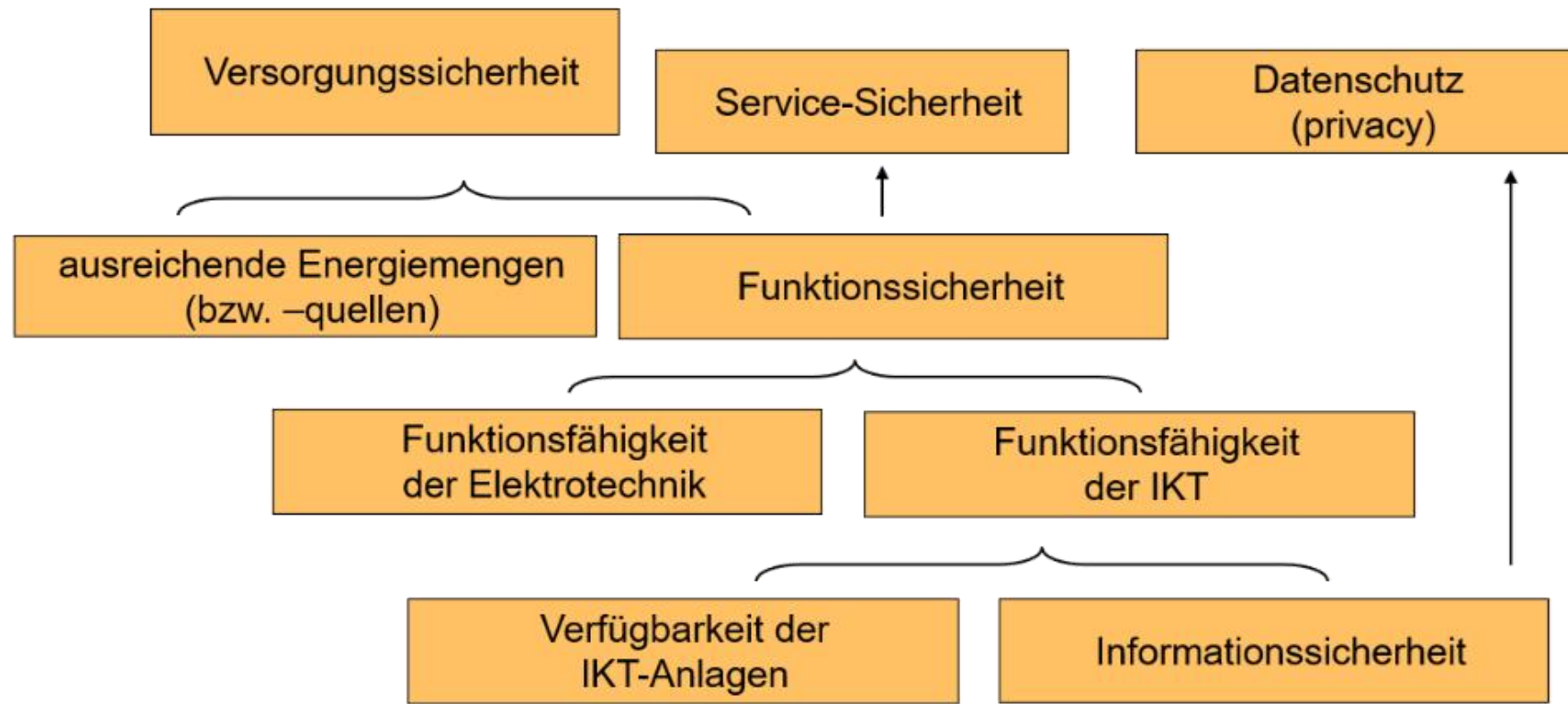
E-Energy Fachgruppen

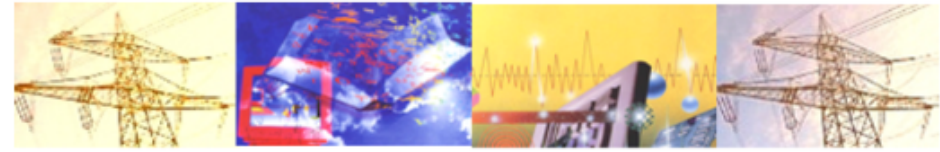
- Systemarchitektur
- Interoperabilität
- Rechtsrahmen
- Marktentwicklung



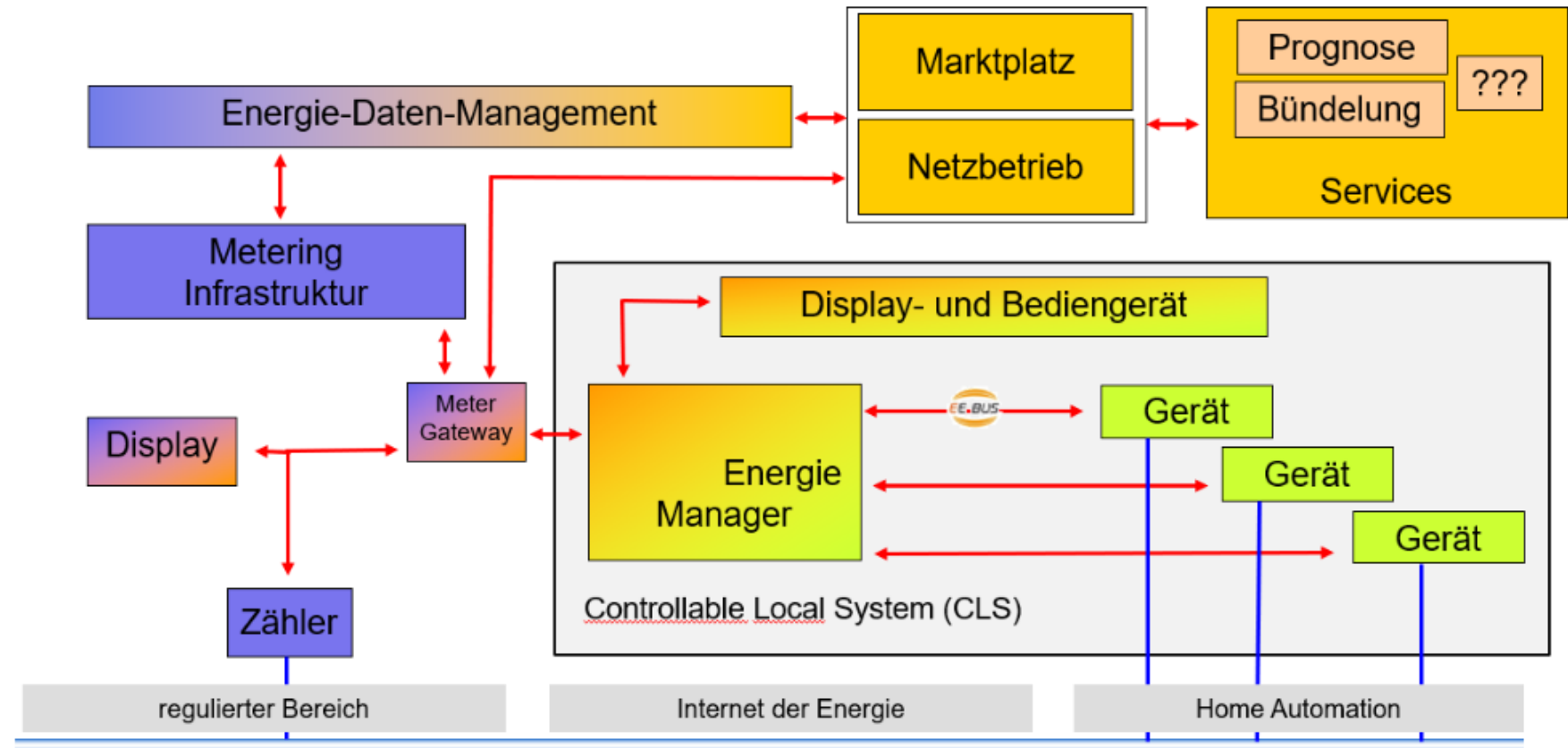


Sicherheit geht vor!





Smart Grid + Smart Home + Smart Market: Zentrale Funktionalitäten



IntMAS artefacts for management and communication

Interoperability Policy (IP)

- commitment
- strategic goals

Interoperability Performance Programme (IPP)

- SMART objectives
- action plan with selected measures (for 3 years)

Interoperability Management System (IMS)

- management goals and assignments
- management structures and responsibilities



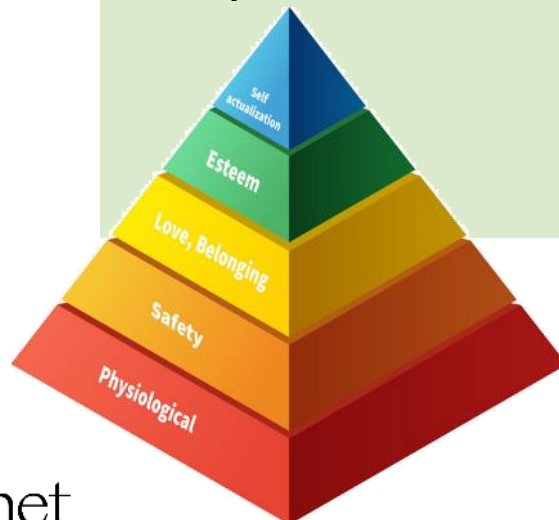
IntMAS
approved
organisation

Interoperability Performance Statement (IPS)

- clear messages for communication and dialogue with interested parties
- full Interoperability Policy (IP)
- summaries of IMS and IPP
- result of validation

It's about people

personal needs	objective needs	expressed wishes
<ul style="list-style-type: none">• fundamental intrinsic requirements for well-being and functioning• physical, emotional, social, and psychological aspects	<ul style="list-style-type: none">• can be identified and measured by external criteria or standards• assessed through observation or evaluation• often used in planning and assessment processes.	<ul style="list-style-type: none">• specific desires or preferences that an individual communicates• can be influenced by personal needs and objective needs, but ...• can be the result of PR or marketing and can thus quickly change



Maslow's Pyramide of Needs