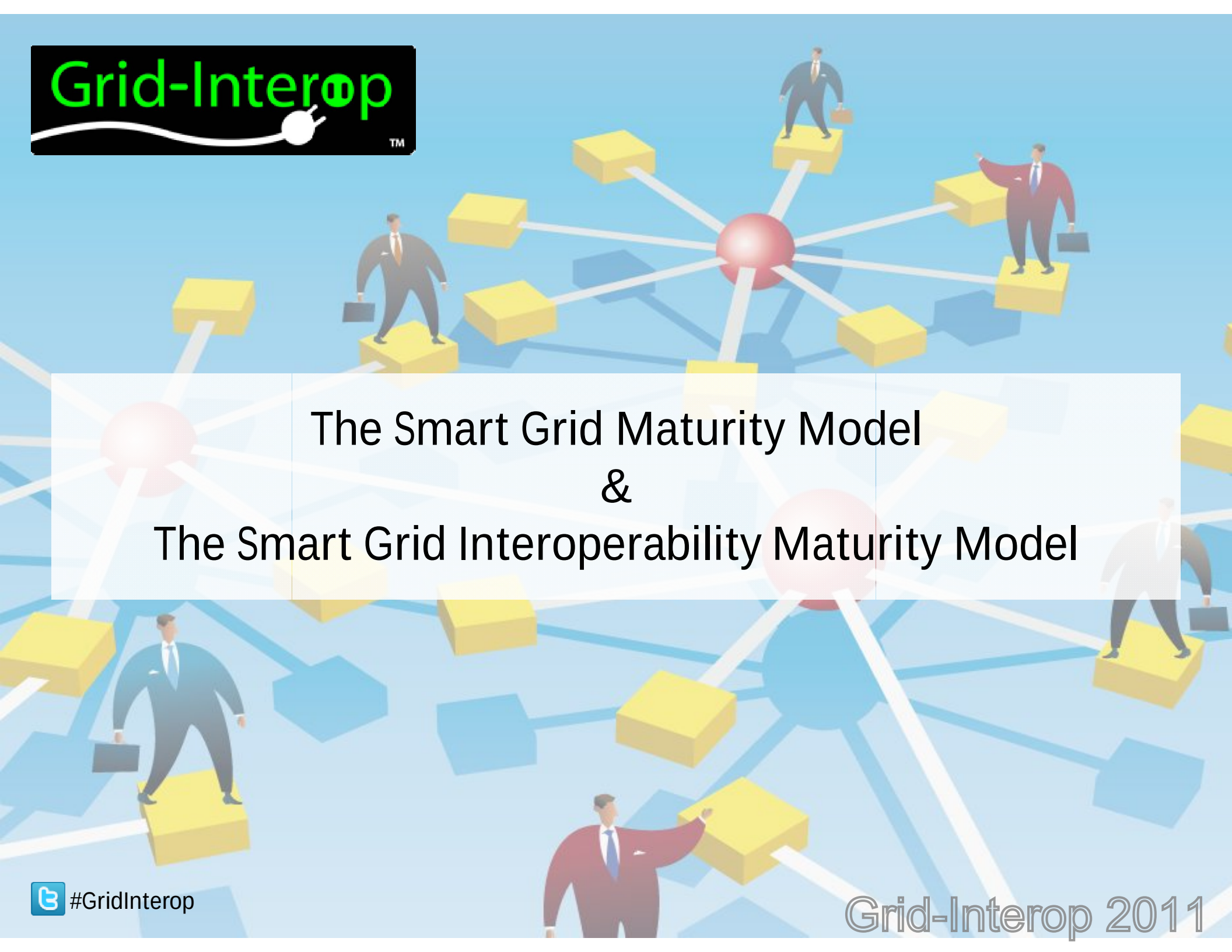


The Smart Grid Maturity Model
&
The Smart Grid Interoperability Maturity Model

#GridInterop

Grid-Interop 2011

Maturity Models – Dueling or Complementary ?

SGMM?

SGIMM?

SGMM?

SGIMM?

How Mature is Your Piece of Smart Grid?

- Technology has been evolving ever since the industry was born
- Technology today is moving faster than our ability to respond to it
- To achieve Smart Grid will require interoperability across a wide spectrum of participants and systems
- In systems of systems this large, we need to focus on:
  - Human
  - Organizational
  - Policy
  - Hardware and
  - Software components
- So where do SGMM and SGIMM fit into this?

SGMM and SG IMM

- The SGMM and SG IMM have different but potentially complementary purposes and uses
  - SGMM
    - Is a management tool to support utility smart grid planning and implementation;
    - It references interoperability as a key element of smart grid maturity
    - It does not focus on how to achieve it
  - SG IMM
    - Is specifically designed to assist stakeholders in achieving interoperability between devices and systems that support smart grid capabilities
- The SGMM and SG IMM teams are exploring ways to collaborate for the benefit of users of the two tools

Elements of Smart Grid Maturity

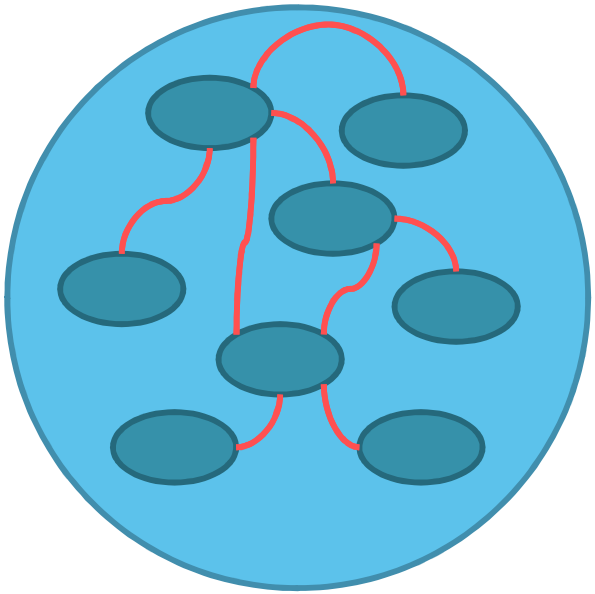
BUSNESS PROCESS
& OPERATIONS

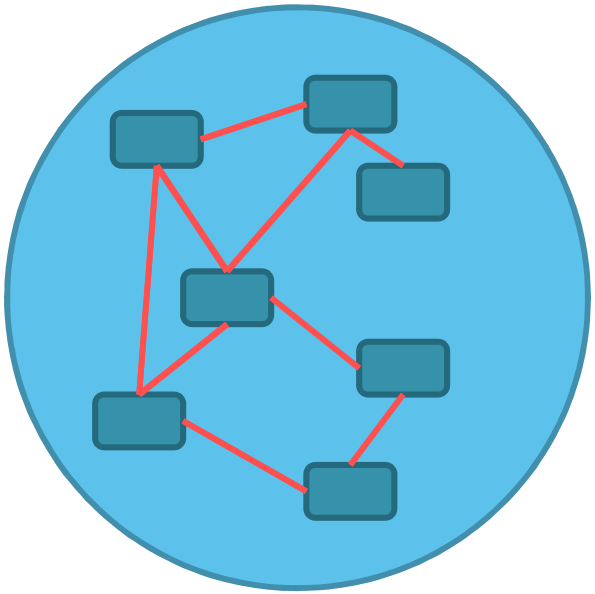
DATA, INFORMATION, &
SYSTEMS INTEGRATION

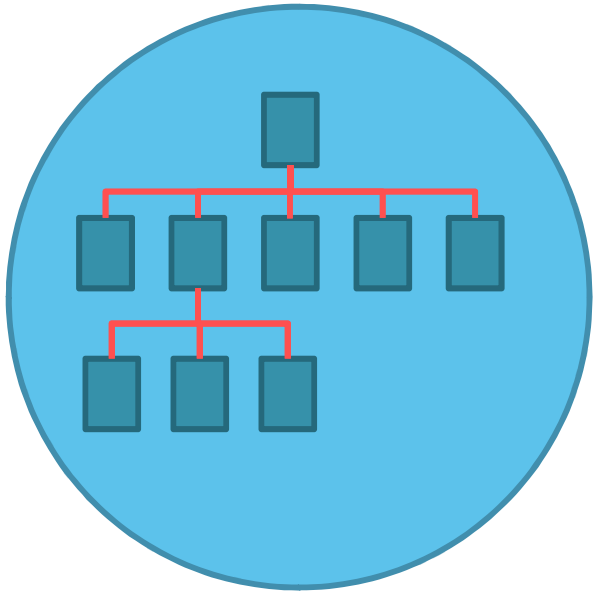
ORGANIZATION, STRUCTURE,
& REGULATION

Several key elements referenced in SGMM and SGIMM

Elements of Smart Grid Maturity

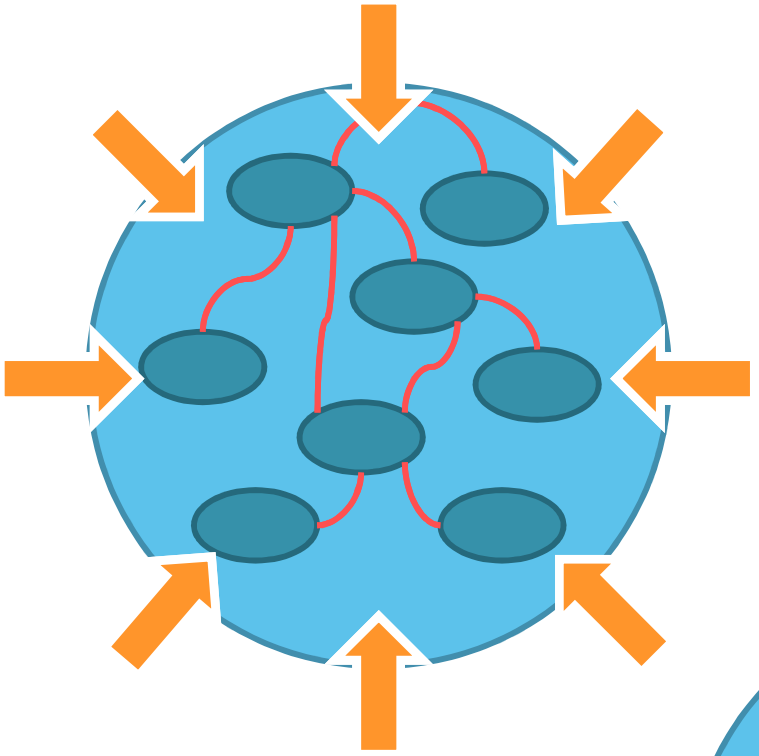


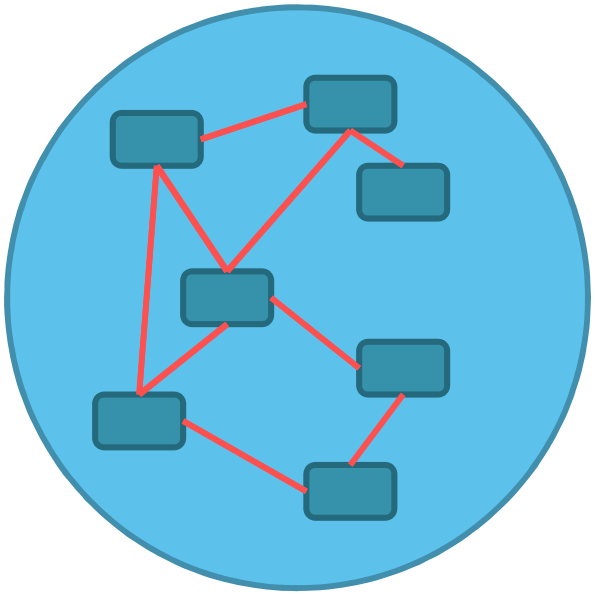


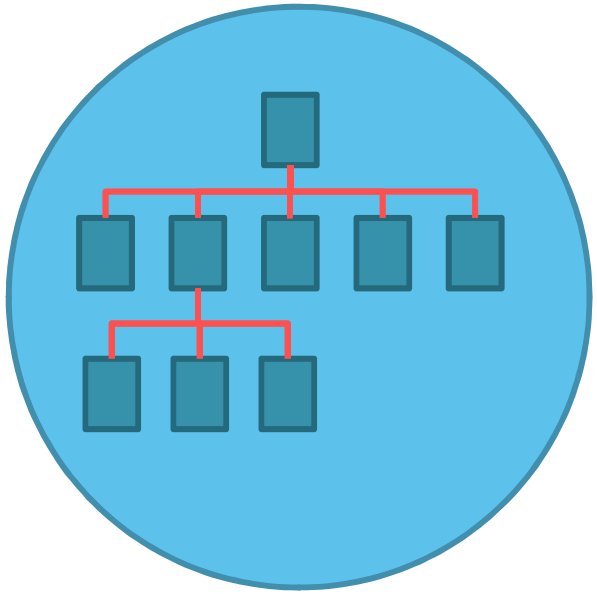


Several key elements referenced in SGMM and SGIMM

Elements of Smart Grid Maturity

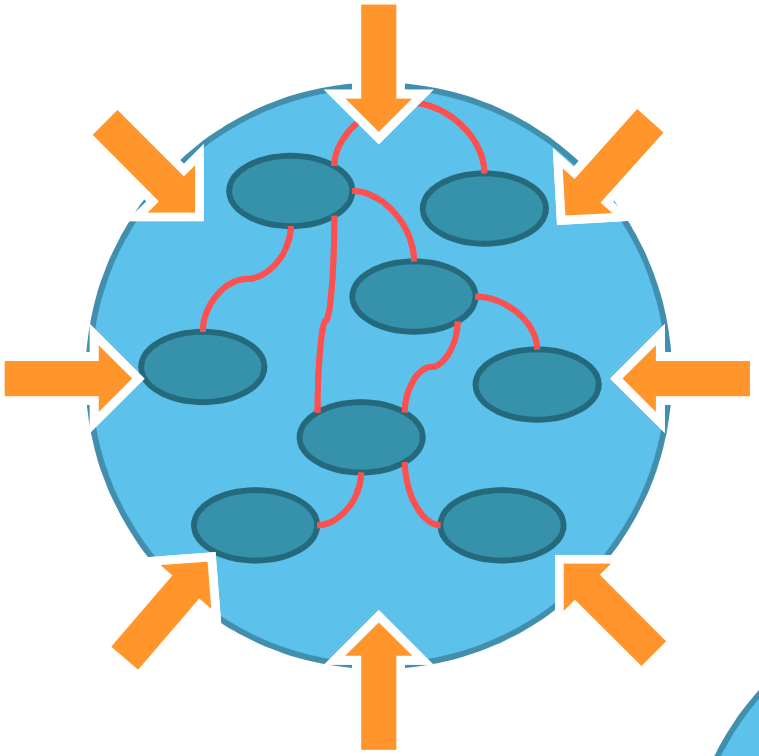


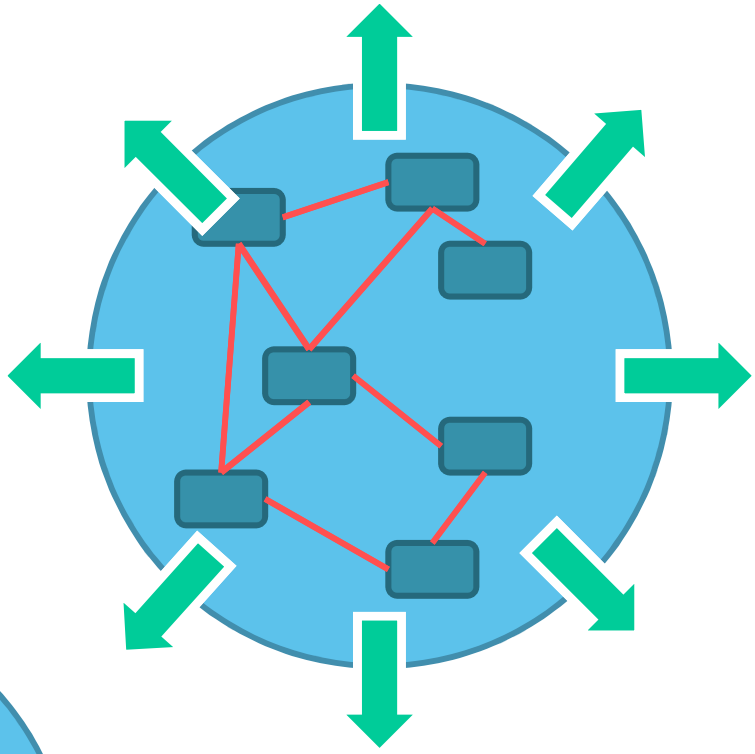


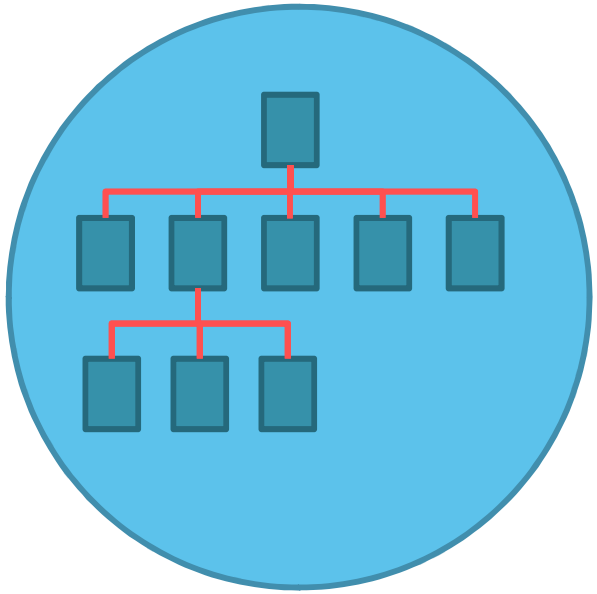


SGMM can be viewed largely as an internal focus

Elements of Smart Grid Maturity

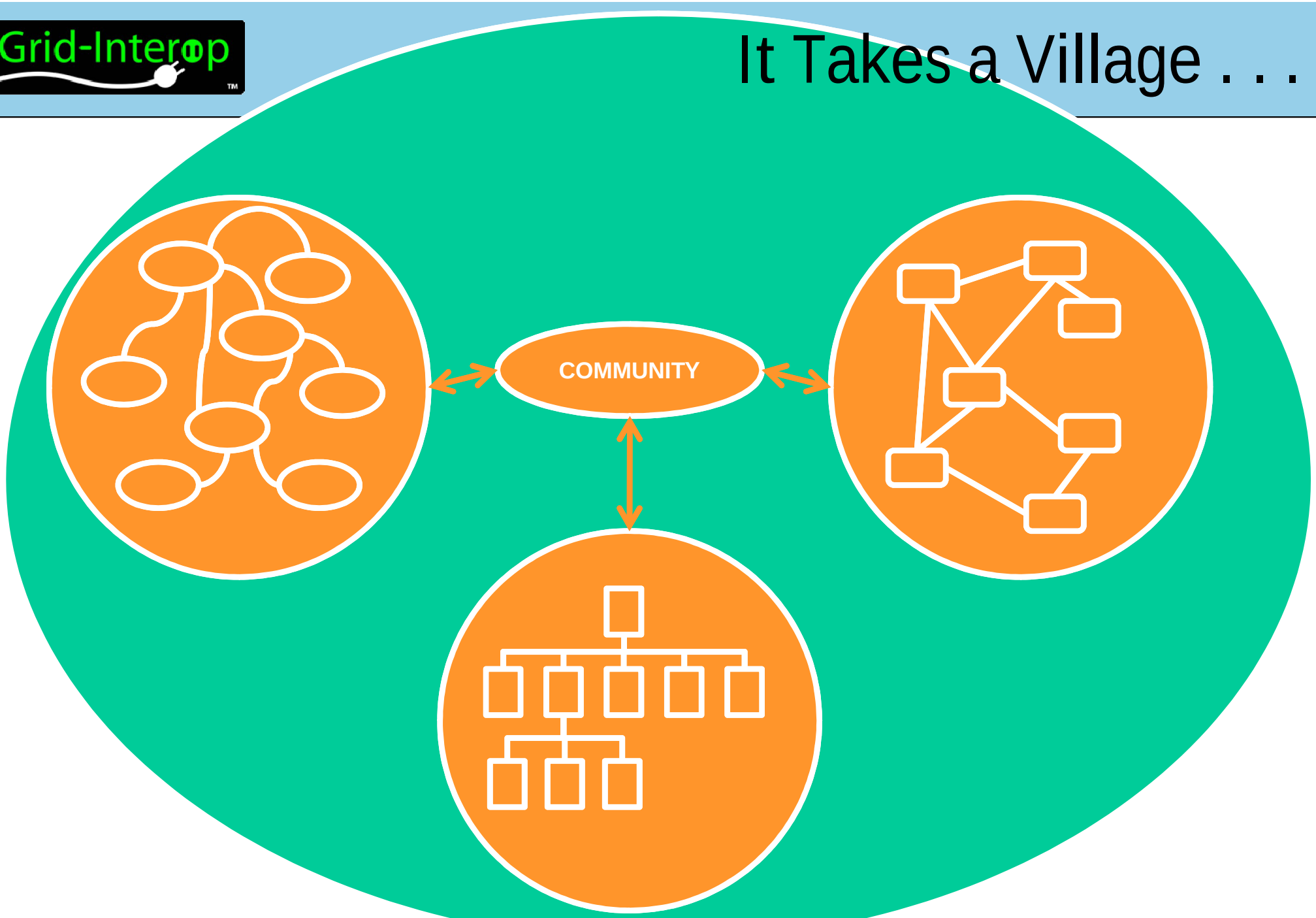






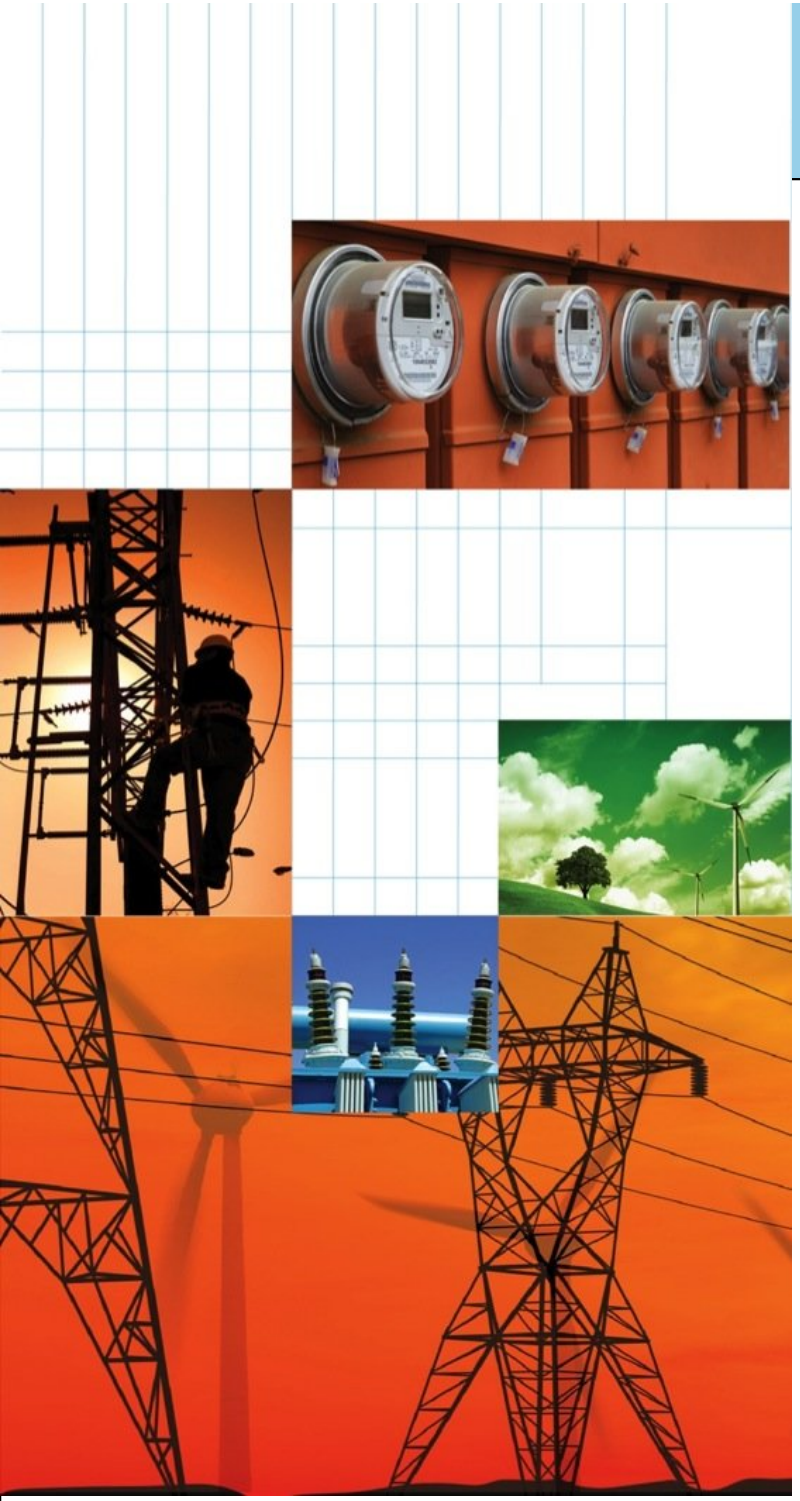
SGIMM can be viewed largely as an external focus

It Takes a Village . . . .



SGMM has external focus through a user community

Smart Grid Maturity Model



How can utilities

- Develop effective roadmaps?
- Track progress?
- Understand their posture in comparison to peers?

The Smart Grid Maturity Model was developed by utilities to address these concerns

The Smart Grid Maturity Model is

A management tool

that provides a

common language and framework

for defining key elements of

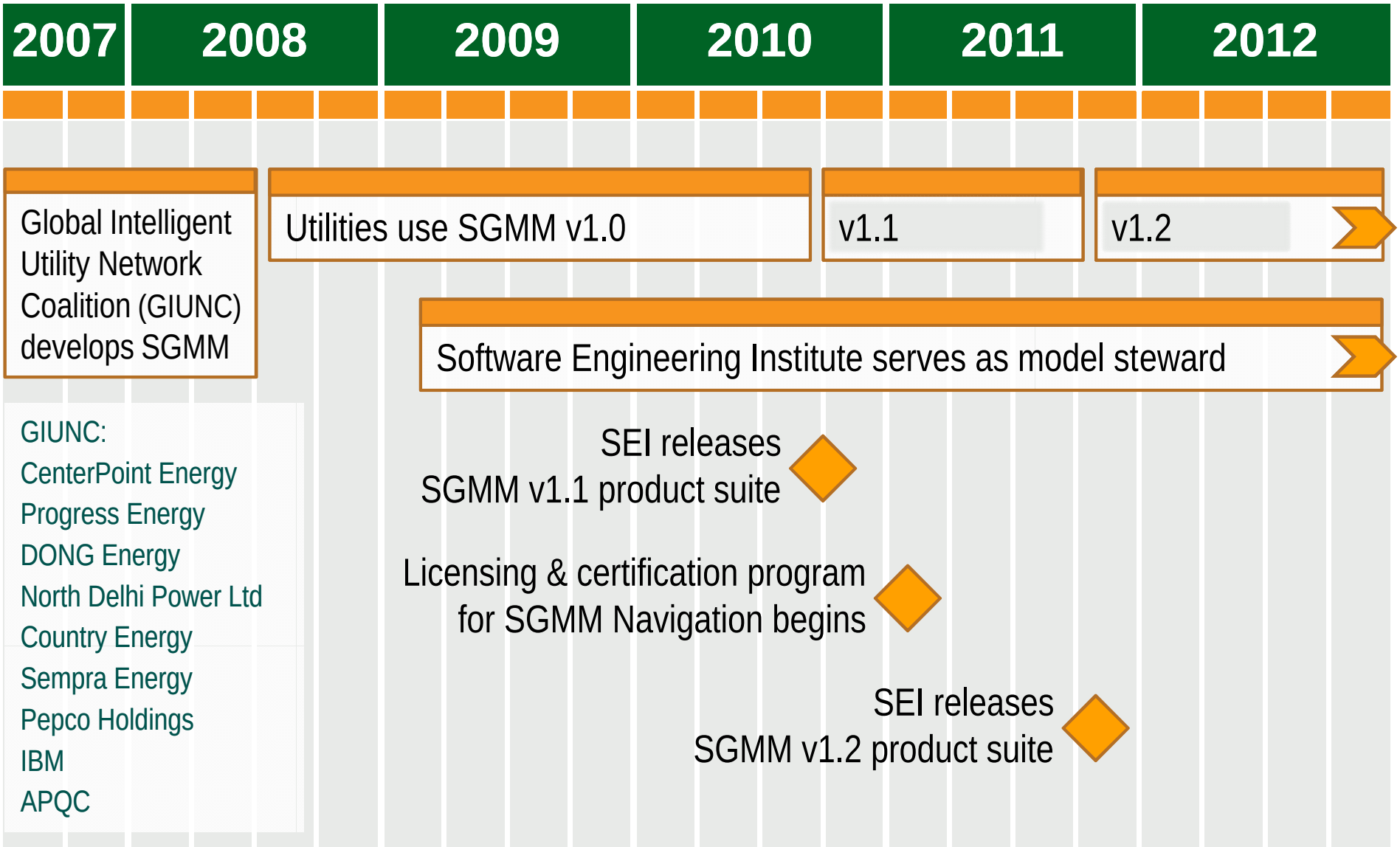
smart grid transformation

and helping utilities develop a

programmatic approach

and track their progress

SGMM timeline



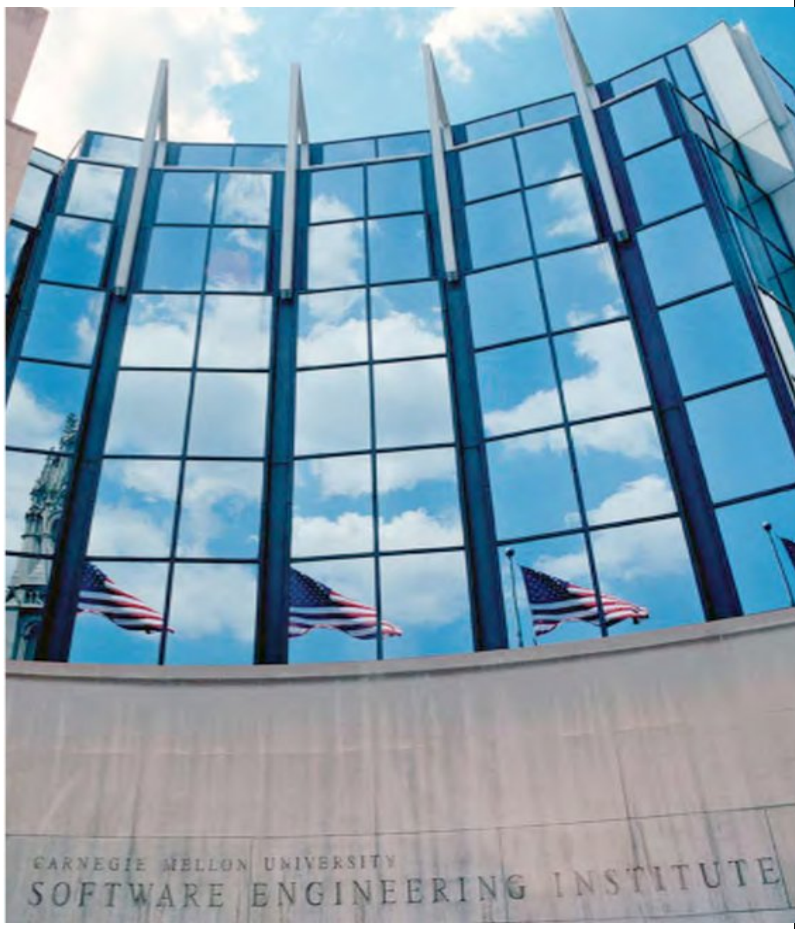
Developed by utilities for utilities

Software Engineering Institute

SEI is a federally-funded research and development center at Carnegie Mellon University, a global university recognized worldwide for its energy and environmental research initiatives.

A trusted, objective source of best practices, methods and tools to organizations worldwide, SEI is a global leader in software and systems engineering, process improvement and security best practices – all critical elements of smart grid success.

SEI collaborates in public-private partnership with government and industry on important cyber security, architecture, and interoperability challenges of the smart grid.



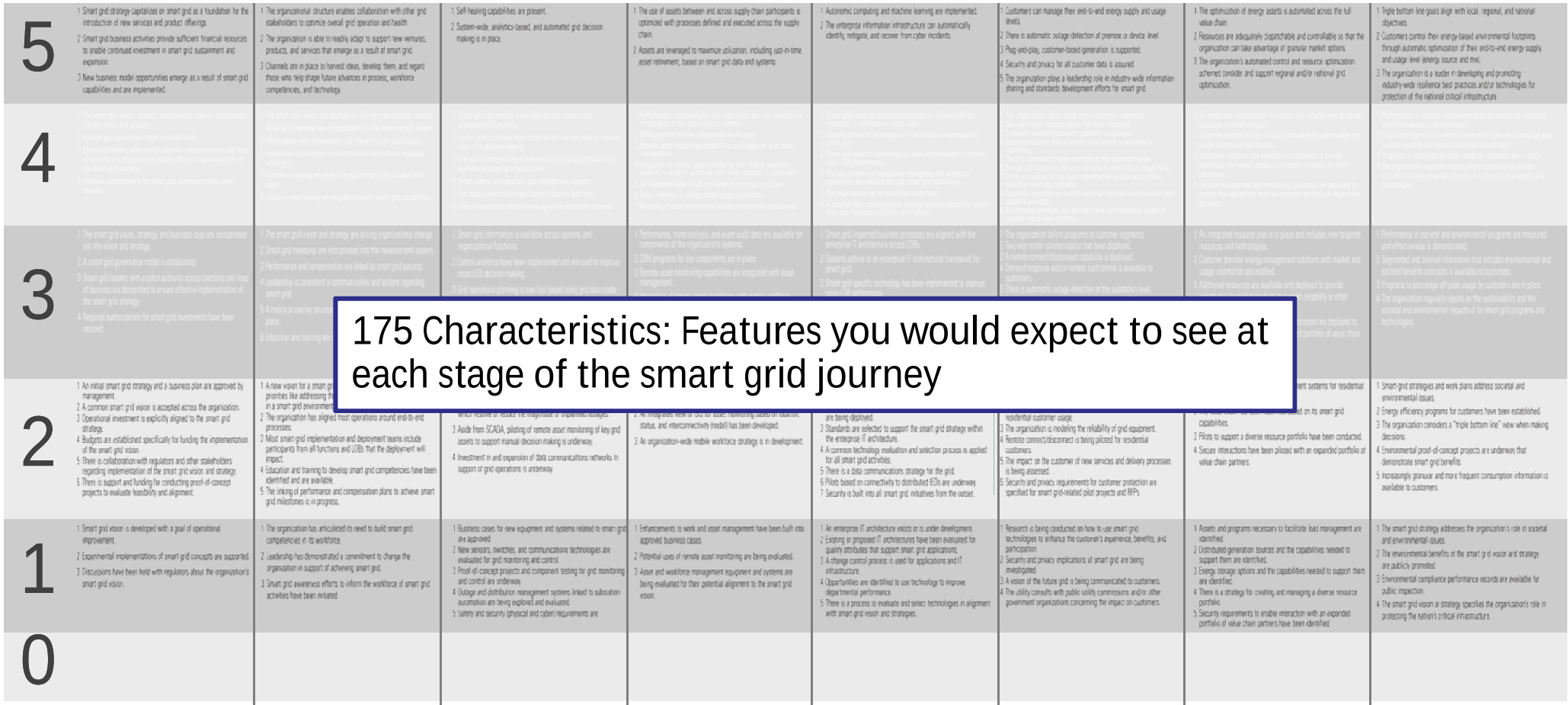
Carnegie Mellon University

SEI's Role as Steward of the SGMM

- Provide **governance** working with multiple stakeholders
- Enable **widespread availability**, adoption,
and use of the model for the benefit of the community
- **Evolve the model** based on stakeholder needs, market developments, user feedback, and interactions with domain experts
- Develop **transition** mechanisms—education, training, awareness, research collaboration—
to support the model
- Grow the SGMM **community** of users worldwide

SGMM at a glance

6 Maturity Levels: Defined sets of characteristics and outcomes



175 Characteristics: Features you would expect to see at each stage of the smart grid journey

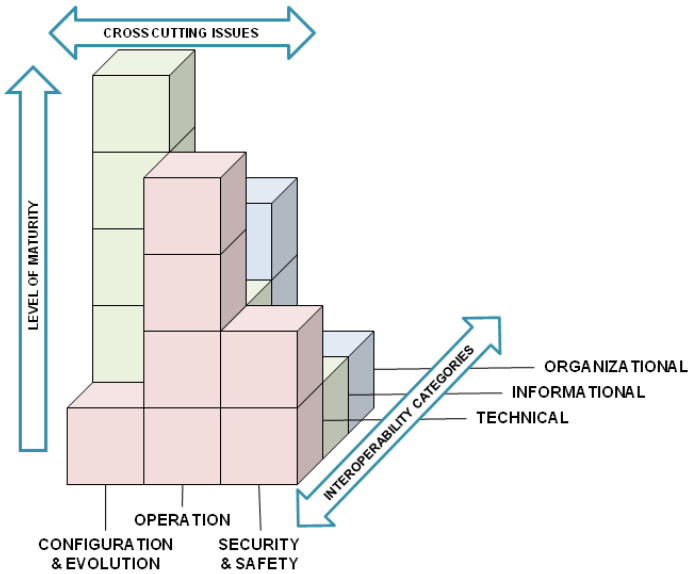
SMR	OS	GO	WAM	TECH	CUST	VCI	SE
Strategy, Management, & Regulatory	Organization & Structure	Grid Operations	Work & Asset Management	Technology	Customer	Value Chain Integration	Societal & Environmental

8 Domains: Logical groupings of smart grid related characteristics

SGIMM at a glance

	Configuration & Evolution	Operation	Security & Safety
Organizational	CE-O	O-O	SS-O
Informational	CE-I	O-I	SS-I
Technical	CE-T	O-T	SS-T

The intersection of a Context Setting Domain and a Cross Cutting Domain forms an Interoperability Area.



SGIMM at a glance

Smart Grid Maturity Model – levels

PIONEERING **5**	Breaking new ground; industry-leading innovation
OPTIMIZING **4**	Optimizing smart grid to benefit entire organization; may reach beyond organization; increased automation
INTEGRATING **3**	Integrating smart grid deployments across the organization, realizing measurably improved performance
ENABLING **2**	Investing based on clear strategy, implementing first projects to enable smart grid (may be compartmentalized)
INITIATING **1**	Taking the first steps, exploring options, conducting experiments, developing smart grid vision
DEFAULT **0**	Default level (status quo)

SGIMM - levels

Maturity Level	Community/ Governance	Documentation	Integration	Test/ Certification
Level 1: **Initial**	management is ad hoc	documentation is ad hoc	integration is a unique experience	testing is ad hoc
Level 2: **Managed**	managed by project agreement	documented in a project specification	integration is repeatable, with customization expected	tested to plan with results captured
Level 3: **Defined**	managed by community agreement	references community standard with some customization	integration repeatable with predictable effort	tests exist for community with certification Members claim compliance to standard
Level 4: **Quantitatively Managed**	processes ensure currency and interoperation	references a community standard w/o customization	integration metrics are defined and measurements collected reference implementations exist	community test processes demonstrate interoperability members claim interoperable conformance
Level 5: **Optimizing**	managed by a community quality improvement process	adopts an open, community standard	integration metrics used for improvement of the standard	test processes are regularly reviewed and improved

Smart Grid Maturity Model – domains

SMR	Strategy, Mgmt & Regulatory *Vision, planning, governance, stakeholder collaboration*	TECH	Technology *IT architecture, standards, infrastructure, integration, tools*
OS	Organization and Structure *Culture, structure, training, communications, knowledge mgmt*	CUST	Customer *Pricing, customer participation & experience, advanced services*
GO	Grid Operations *Reliability, efficiency, security, safety, observability, control*	VCI	Value Chain Integration *Demand & supply management, leveraging market opportunities*
WAM	Work & Asset Management *Asset monitoring, tracking & maintenance, mobile workforce*	SE	Societal & Environmental *Responsibility, sustainability, critical infrastructure, efficiency*

SGMM

Smart Grid Maturity Model

V 1.2 Product Suite

Model	**Fully described in the Model Definition document**
Compass Survey	**Questionnaire-based assessment yields maturity ratings and comparisons**
Navigation Process	**Expert-led workshops to complete Compass and use results to develop consensus aspirations**
Training	**Overview Seminar and SGMM Navigator Course**
Partner Program	**License organizations and certify individuals to deliver Navigation process**

www.sei.cmu.edu/smartgrid

SGMM Compass Survey

WAM Work and Asset Management

PIONEERING 5	1 The use of assets between and across supply chain participants is optimized with processes defined and executed across the supply chain. 2 Assets are leveraged to maximize utilization, including just-in-time asset retirement, based on smart grid data and systems.
OPTIMIZING 4	1 A complete view of assets based on status, connectivity, and proximity is available to the organization. 2 Asset models are based on real performance and monitoring data. 3 Performance and usage of assets is optimized across the asset fleet and across asset classes. 4 Service life for key grid components is managed through condition-based and predictive maintenance, and is based on real and current asset data.
INTEGRATING 3	1 Performance, trend analysis, and event audit data are available for components of the organization's systems. 2 CBM programs for key components are in place. 7 Modeling of asset investments for key components is underway.
ENABLING 2	1 An approach to track, inventory, and maintain event histories of assets is in development.
INITIATING 1	into approved business cases. 2 Potential uses of remote asset monitoring are being evaluated. 3 Asset and workforce management equipment and systems are being evaluated for their potential alignment to the smart grid vision.
DEFAULT 0	

WAM-3.2 Condition-based maintenance programs for key components are in place.

WAM-2.1 An approach to track, inventory, and maintain event histories of assets is in development.

- Contains
  - One question for each expected characteristic in the model and
  - Attribute and performance questions

Example questions:

WAM-3.2 For what percentage of key components have you implemented condition-based maintenance that uses real-time data from asset monitoring to drive maintenance and replacement decisions?

A. 0%
B. 1 - 25%
C. 26 - 50%
D. 51 - 75%
E. 76 - 100%

WAM-2.1 Have you established an approach to track, inventory, and maintain event histories of assets using smart grid capabilities?

A. No
B. In documented plan including committed schedule and budget
C. In development
D. Being piloted
E. Completed

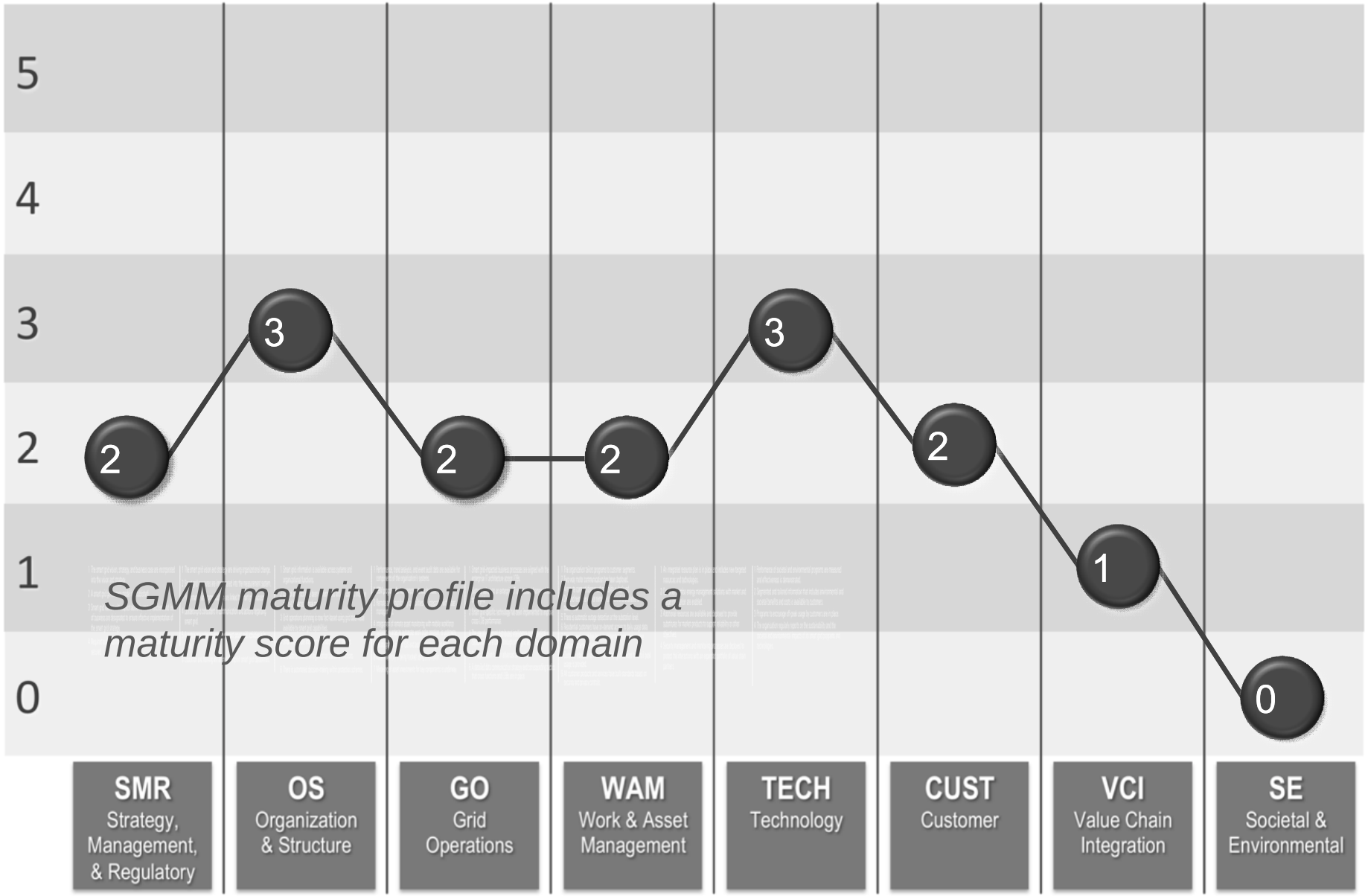
SGMM Navigation: five-step, expert-led process

Stakeholders complete SGMM Compass survey
Discussion and consensus answers lead to internal alignment on current state

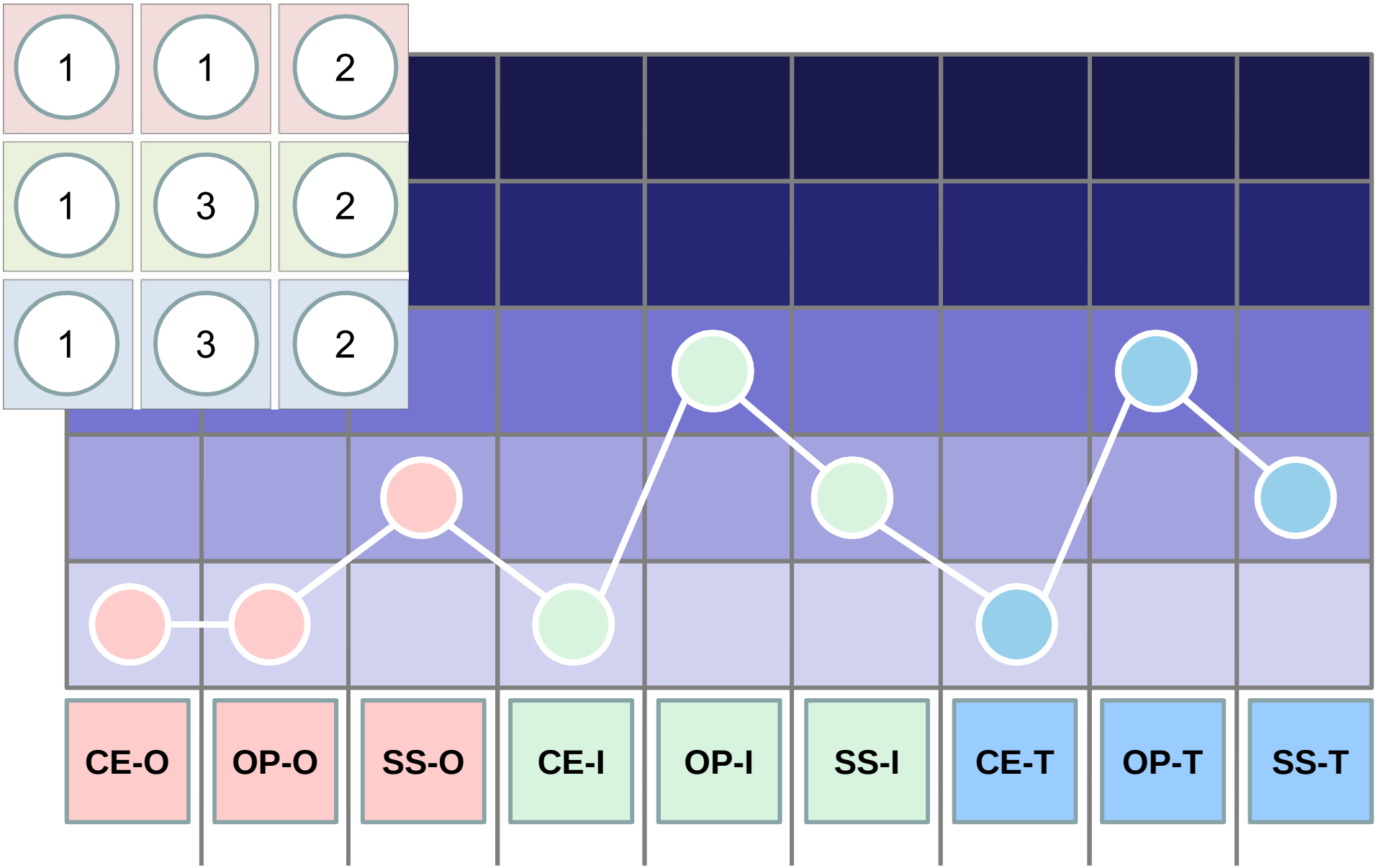
Stakeholders review survey findings & set aspirational profile
Consensus on aspirational state and identification of motivations, actions, and obstacles to achieve it

Compass results: maturity profile

example results



What Does SGIMM Maturity look like?



Compass results: dashboard

example results

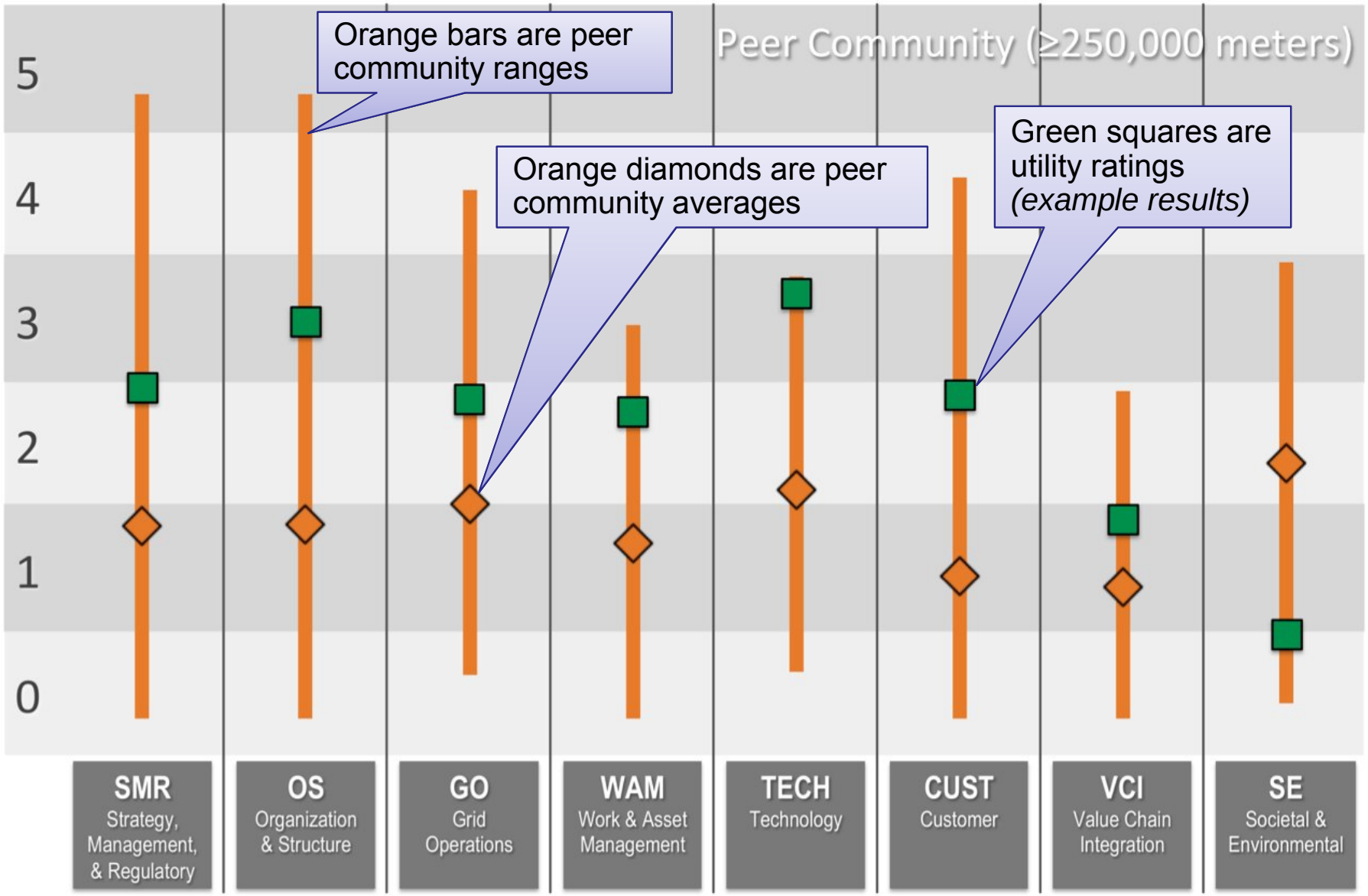
Sample Results

Level	Strategy, Management & Regulatory	Organization & Structure	Grid Operations	Work & Asset Management	Technology	Customer	Value Chain Integration	Societal & Environmental
5	0.53	0.50	0.25	0.00	0.00	0.20	0.30	0.30
4	0.57	0.17	0.28	0.30	0.40	0.36	0.25	0.40
3	0.65	0.75	0.57	0.47	0.73	0.59	0.58	0.35
2	1.00	0.82	0.93	1.00	1.00	0.92	0.58	0.76
1	0.90	1.00	1.00	1.00	0.84	0.85	0.78	0.68
0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

	Point Range	Meaning
	≥ 0.70	Green reflects level compliance within the domain
	≥ 0.40 and < 0.70	Yellow reflects significant progress
	< 0.40	Red reflects initial progress
	= 0	Grey reflects has not started

Compass results: peer community comparison

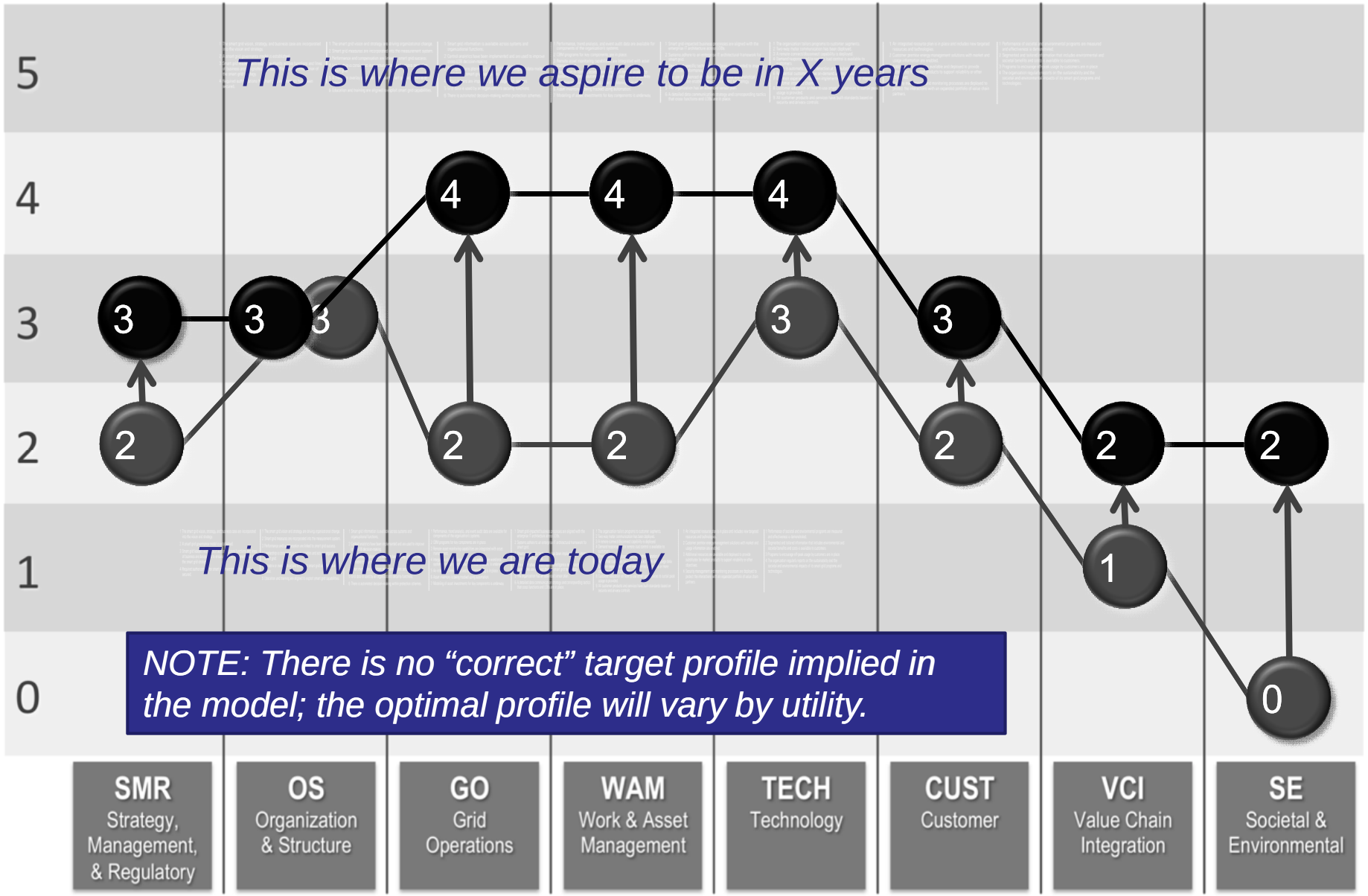
example results



Community data as of September 2011

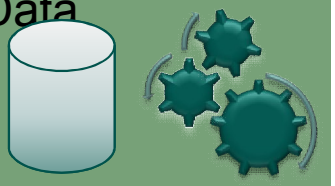
Navigation results: consensus aspirations

example results



SGMM benefits – a community view

Use of SGMM by utilities

Utilities	SGMM Partners	DOE	SEI
Guidance, common language, & means to track progress	Product to help customers and participation in roadmap development	Another mechanism to support grid modernization	Maturity & Performance Data 

"What works" patterns to inform strategies, services, & programs.

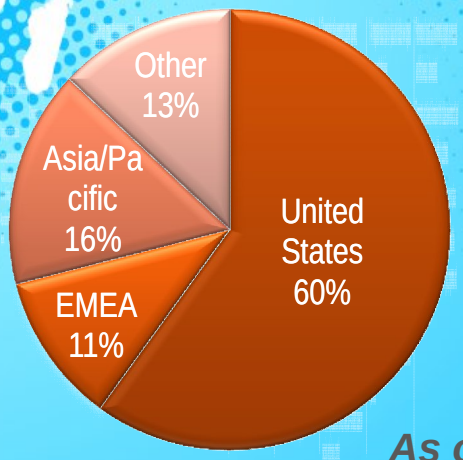
Demonstrations of the value of grid modernization.

Improvements to SGMM product suite.

Correlations of performance to maturity patterns and other analyses

SGMM community: 119 utilities in 21 countries

USA	70	Netherlands	2	Japan	1
Canada	10	Belgium	1	Philippines	1
India	9	Denmark	1	Poland	1
Australia	5	France	1	Spain	1
Brazil	4	Hong Kong	1	Sweden	1
China	3	Ireland	1	Switzerland	1
Mexico	3	Israel	1	UK	1



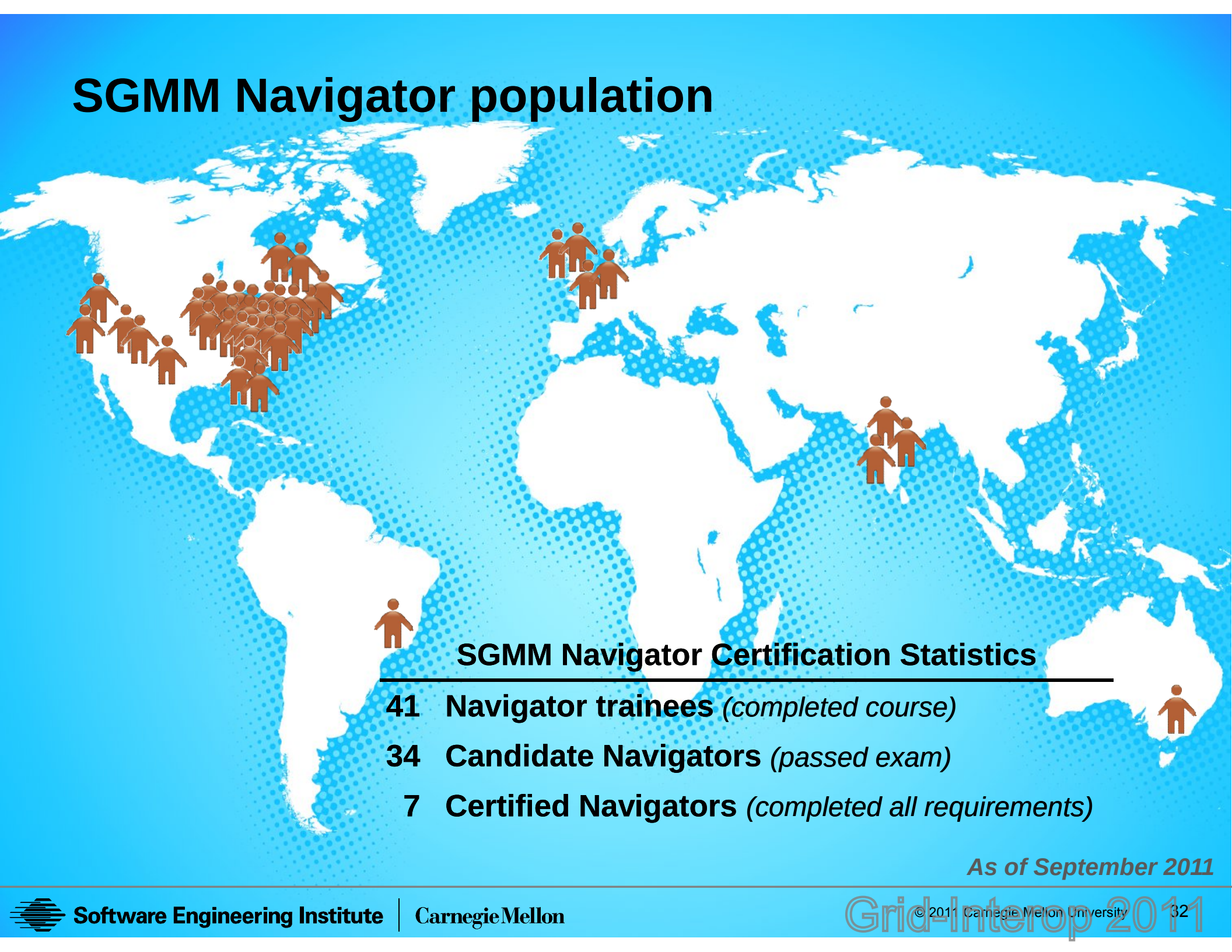
As of September 2011

SGMM Partners

- SGMM Partners are licensed by the SEI to provide official SGMM services, which are delivered by SEI-Certified SGMM Navigators

For the current list of SGMM Partners, visit:
www.sei.cmu.edu/partners/sgmm

SGMM Navigator population



SGMM Navigator Certification Statistics

41 **Navigator trainees** *(completed course)*

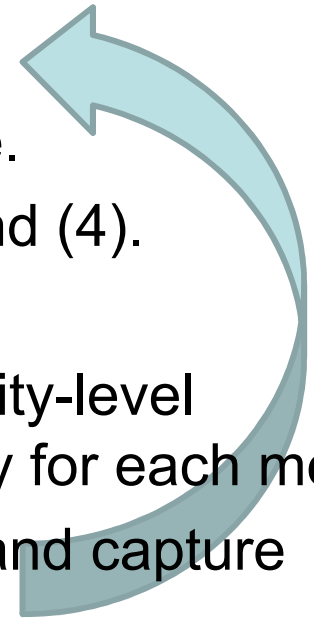
34 **Candidate Navigators** *(passed exam)*

7 **Certified Navigators** *(completed all requirements)*

As of September 2011

Why use the SG IMM

1. Assess how best to leverage the context-setting framework.
2. Group cross-cutting issues into groups.
3. Develop high-level goals for each framework level.
4. Develop high-level goals for each cross-cutting issue.
5. Develop detailed goals for each intersection of (3) and (4).
6. Construct metric statements for the goals.
7. Create a matrix of maturity characteristics and maturity-level statements to provide guidance in assessing maturity for each metric.
8. Construct an evaluation sheet to apply the SG IMM and capture interoperability maturity for an interoperability area.
9. Assess scoring models.



Participation and feedback are essential

Example Use Cases

- Energy Market Operations
- Retail Service Provider/Vendor Technology Community
- A Multi-Player, Smart Grid Research Project
- An Enterprise Smart Grid Application

Energy Market Operations

- Focus on the transactions associated with buying and selling energy
- Trading of energy generation resources in real-time, day-ahead or longer term timeframes
- Bringing demand-response and ancillary service resources into the markets
- Bilateral agreements between various parties
- Interface between these players includes the exchange of information about price, schedule, quantity, and other attributes of the energy being traded
- As a sample use case, a power exchange market uses the SG IMM as an assessment tool for understanding and developing an evolutionary roadmap for their trading platform. The outcome provides a more automated, efficient, and reliable mechanism for a new participant to join the market.

Retail Service Provider/Vendor Technology Community

- The community around a smart meter interface
- Vendors of smart meters, retail service providers, retail customers, and integration partners
- Improve the standardization of the meter data interface and information exchange
- A stakeholder alliance working group uses the SG IMM to evaluate impediments to achieving interoperability goals
- Business goals of service providers, regulators, and vendors are not aligned for interoperability
- Set requirements that there be an independent test and certification authority. Develops technology procurement guidelines to assist in evaluating interoperability of specific vendor proposals

Multi-Player, Smart Grid Research Project

- Testing new business models and new technologies within an institutional structure such as an electric power market
- While intended to be applied to communities, SGIMM use with an experimental project can be useful
- Develop a significantly more sophisticated business and technical model for energy market operations
- Determine whether a scalable communication signal about the price of energy can be used to modify overall system behavior
- Develop signaling technology to test if new distributed, price-based, control system can provide efficiently scalable system for managing complex power flows and transactions
- Identify regulatory and business issues to be addressed for the most efficient scaling of the technology

Enterprise Smart Grid Application

- Smart grid capabilities require the integration of applications and systems that have typically operated in separate parts of an enterprise in the past
- Interoperability between myriad applications both within a utility enterprise and with its partners becomes the foundation or a prerequisite to deploying the next generation of services
- Applications may have been developed independently (to different standards) without long-range design for integration with other systems
- The enterprise is a community of systems
- Conduct an assessment of the interfaces between a bidirectional metering application, the smart meter, the advanced metering system, and the billing system in order to better understand the architecture and design issues that cause integration challenges to occur
- Better understanding of interoperability issues at the senior management level and with the regulator

In Summary

- A lot of similarities
  - Processes
  - Documentation
  - Systems
  - Regulation
  - Interoperability
  - Maturity levels
  - Based on measuring current situation and defining goals through questions
- Trying to harmonize the approaches
  - Areas of focus
  - Terminology
  - Maturity levels
  - Characteristics
  - Provide a roadmap to higher maturity levels
  - Scoring?

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Notices