Maturity Models 101

Based on the paper "*A Primer for Applying Maturity Models to Smart Grid Security, Resilience, and Interoperability*"

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Software Engineering Institute | Carnegie Mellon

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Smart Grid Drivers

- Smart Grid is relevant to the entire energy infrastructure from generation to consumption.
- The nature of connectivity of devices and systems in smart grid applications requires the alignment of many stakeholders.
- Given the great number of parties involved, efforts are progressing to provide an open, standards based, framework for the integration of devices and services.
- Includes both technical and cognitive abilities.
- Must optimize technical, social, political, and organizational factors that impact system to system performance across multiple parties

"IEEE PES ISGT 2013, Maturity Model for Advancing Smart Grid Interoperability", Knight, Widergren, Mater, Montgomery

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What is a Maturity Model

- In its simplest form, a maturity model is a set of characteristics, attributes, indicators, or patterns that represent progression and achievement in a particular domain or discipline.
- Architecturally, maturity models typically have “levels” along an evolutionary scale that defines measurable transitions from one level to another.
- Having measurable transition states between the levels enables an organization to use the scaling to
  - define its current state
  - determine its future, more “mature” state
  - identify the attributes it must attain to reach that future state
- For a maturity model to be effective and have impact, the “measurable transitions” between levels should be based on empirical data that has been validated in practice.

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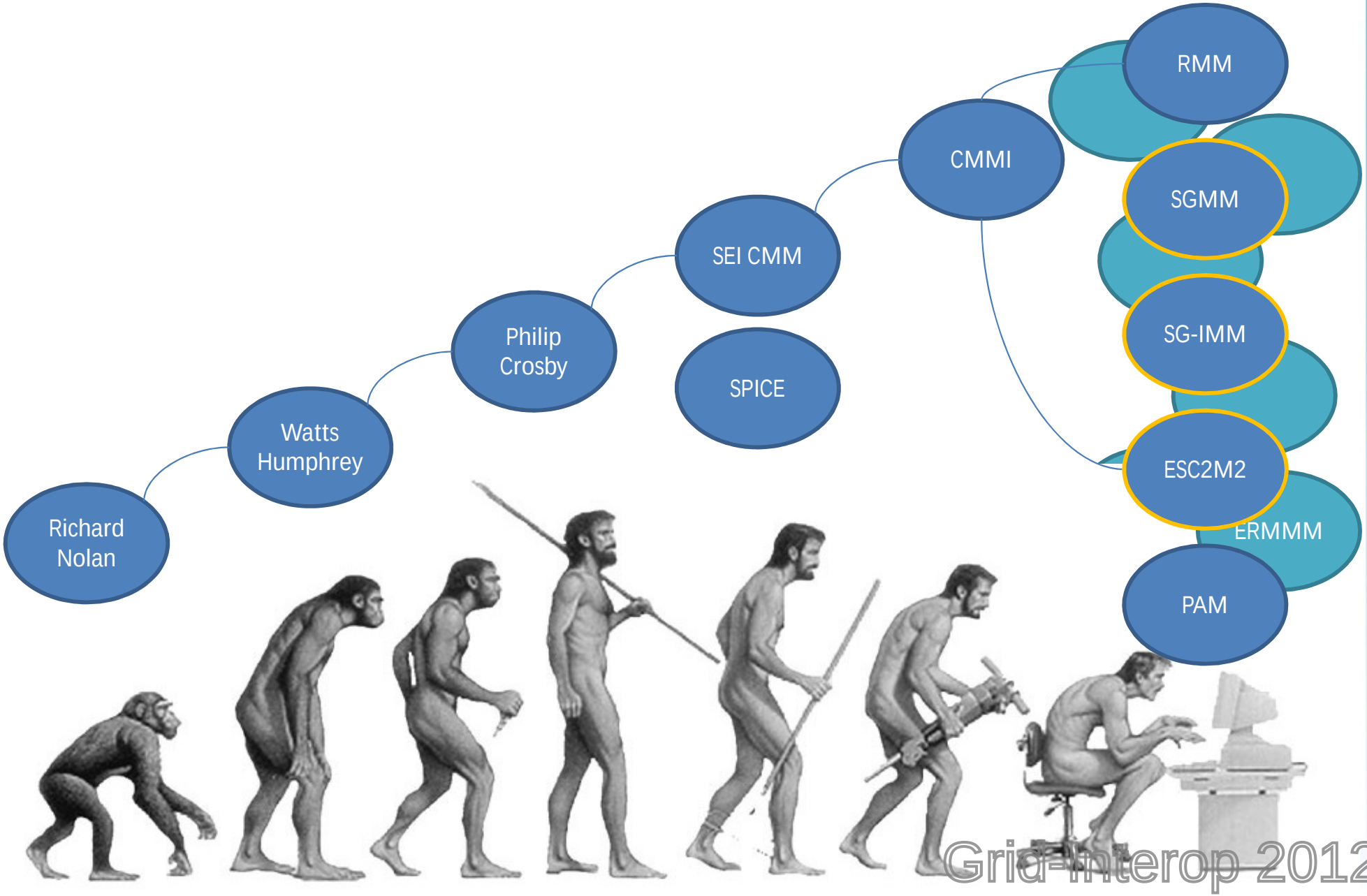
The Evolutionary Process



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Benefits of Maturity Models

- Benchmark internal performance
  - organizations can determine where they are in their improvement journey and set targets for future investments in performance improvement
- Catalyze performance improvement
  - over a period of time, organizations can use the model as the basis for continuous performance improvement
- Catalyze improvements in community performance
  - organizations can not only compare their performance against peer organizations but also determine a “community” performance profile
- Create and evolve a common language
  - create a consistent way of thinking and communicating about a domain that is embodied in model language or taxonomy

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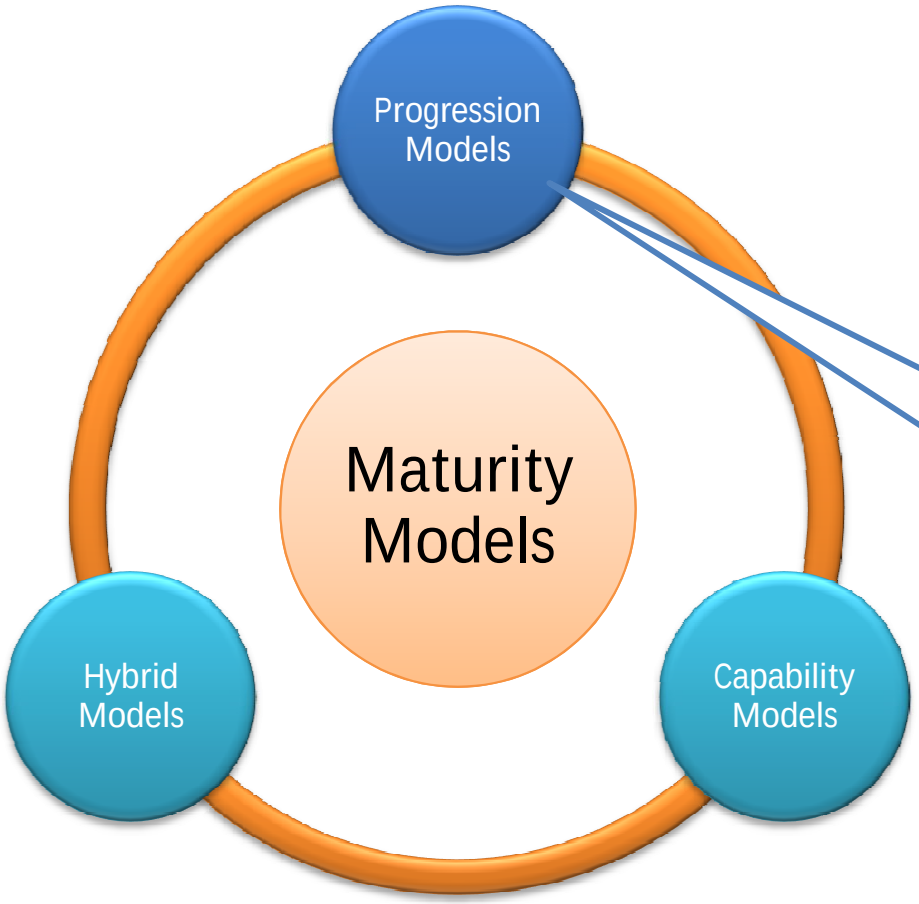
Types of Models - Progression



Progression maturity models represent a simple progression or scaling of an attribute, characteristic, pattern, or practice. the movement up the maturity levels indicates some progression of maturity

For Example

SGMM

pencil and paper ⇨ abacus ⇨ calculator ⇨ computer

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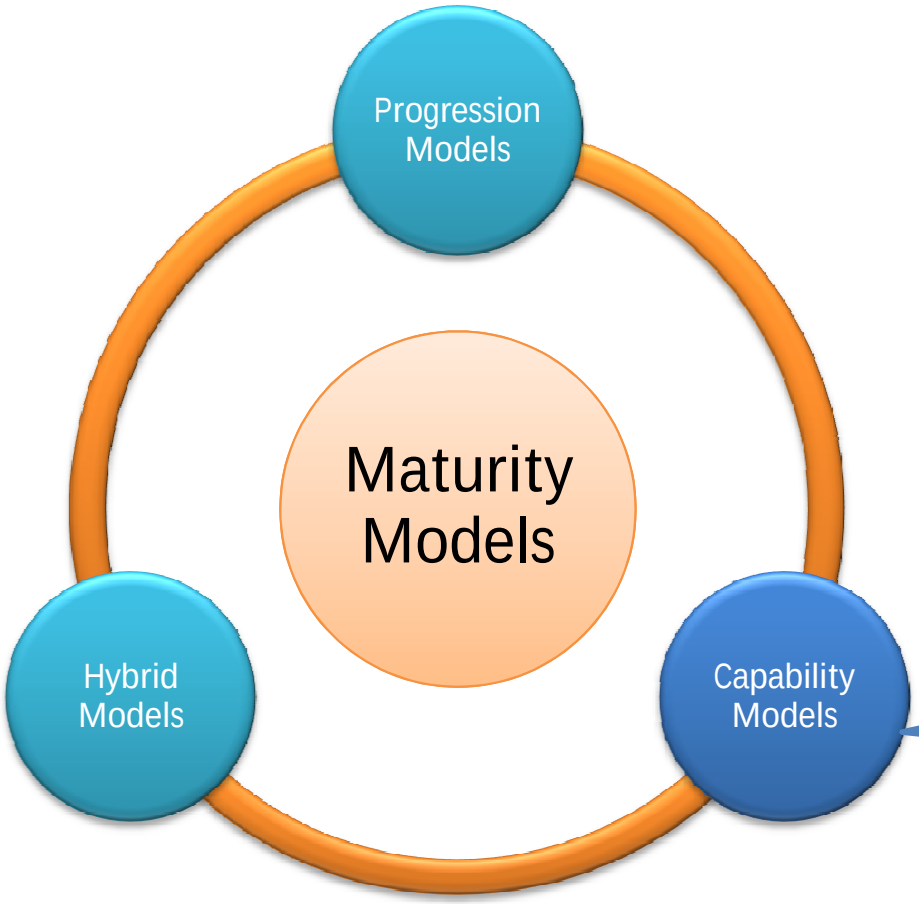
Types of Models - Capability



A unique application of the maturity model concept. In a capability maturity model, the dimension that is being measured is a representation of organizational capability around a set of attributes, characteristics, patterns, or practices.

For Example

CMMI
CERT-RMM

ad hoc ⇨ managed ⇨ defined ⇨ quantitatively managed ⇨ optimized

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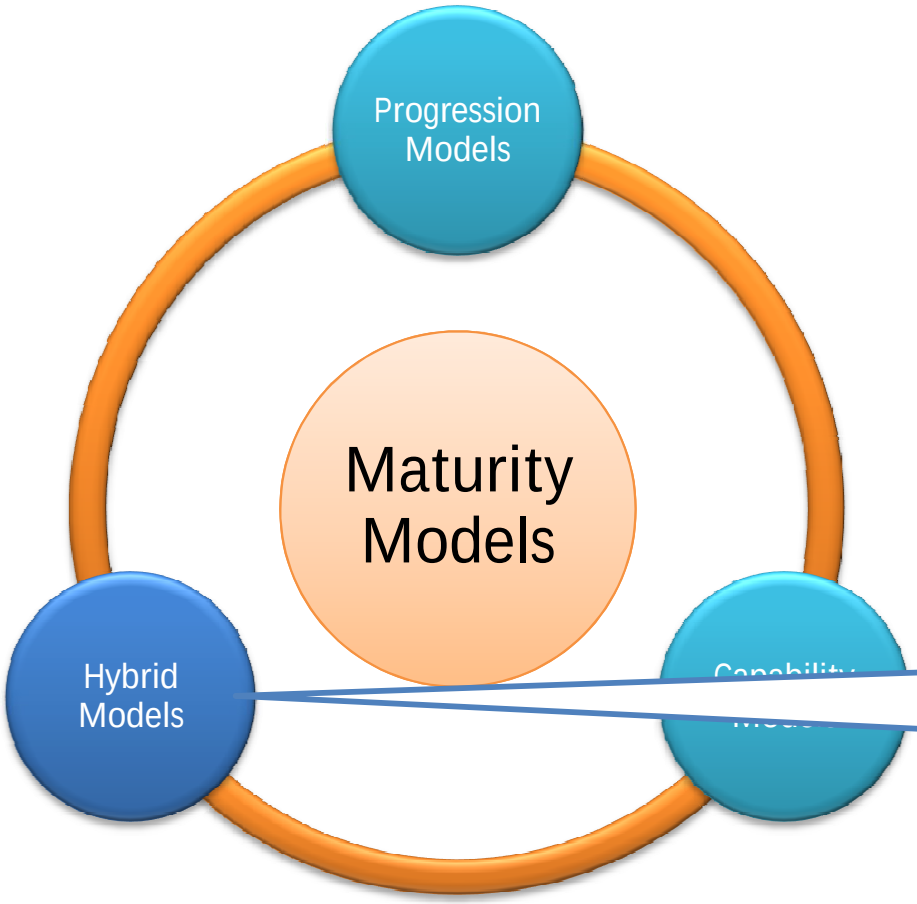
Types of Models - Hybrid



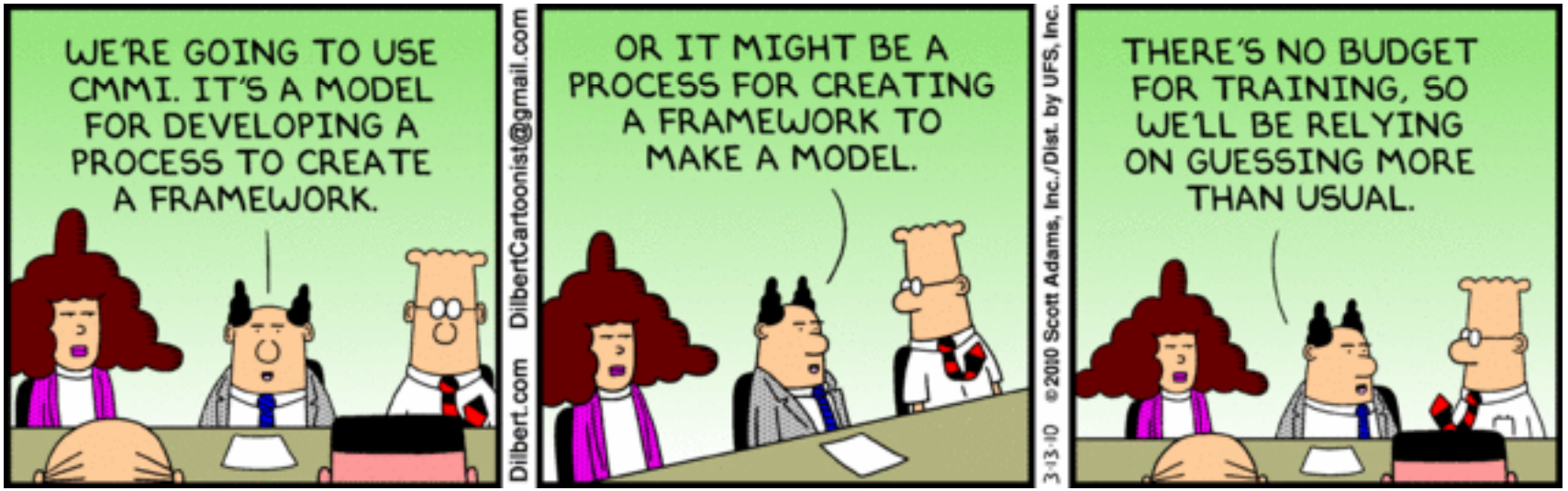
A hybrid maturity model can be created by overlaying characteristics of the progressive model with capability attributes from capability maturity models.

For Example

SG-IMM
ESC2M2

Useful for focusing on specific subject matter to assess maturity from the perspective of how well standards & best practices have been included into an organization's capabilities.

Types of Models - Capability



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Essential Components

- Levels
  - may describe a progressive step or plateau, or an expression of capability or other attribute that can be measured by the model
- Model Domains
  - a means for grouping like attributes into an area of importance for the subject matter
- Attributes
  - typically based on observed practice, standards, or other expert knowledge
- Appraisal and Scoring Methods
  - developed to facilitate assessment using the model to ensure consistency of appraisals and a common standard for measurement
- Improvement Roadmaps
  - prescribed methods for identifying an improvement scope, diagnosing current state, and then planning and implementing improvement and verifying that it has occurred

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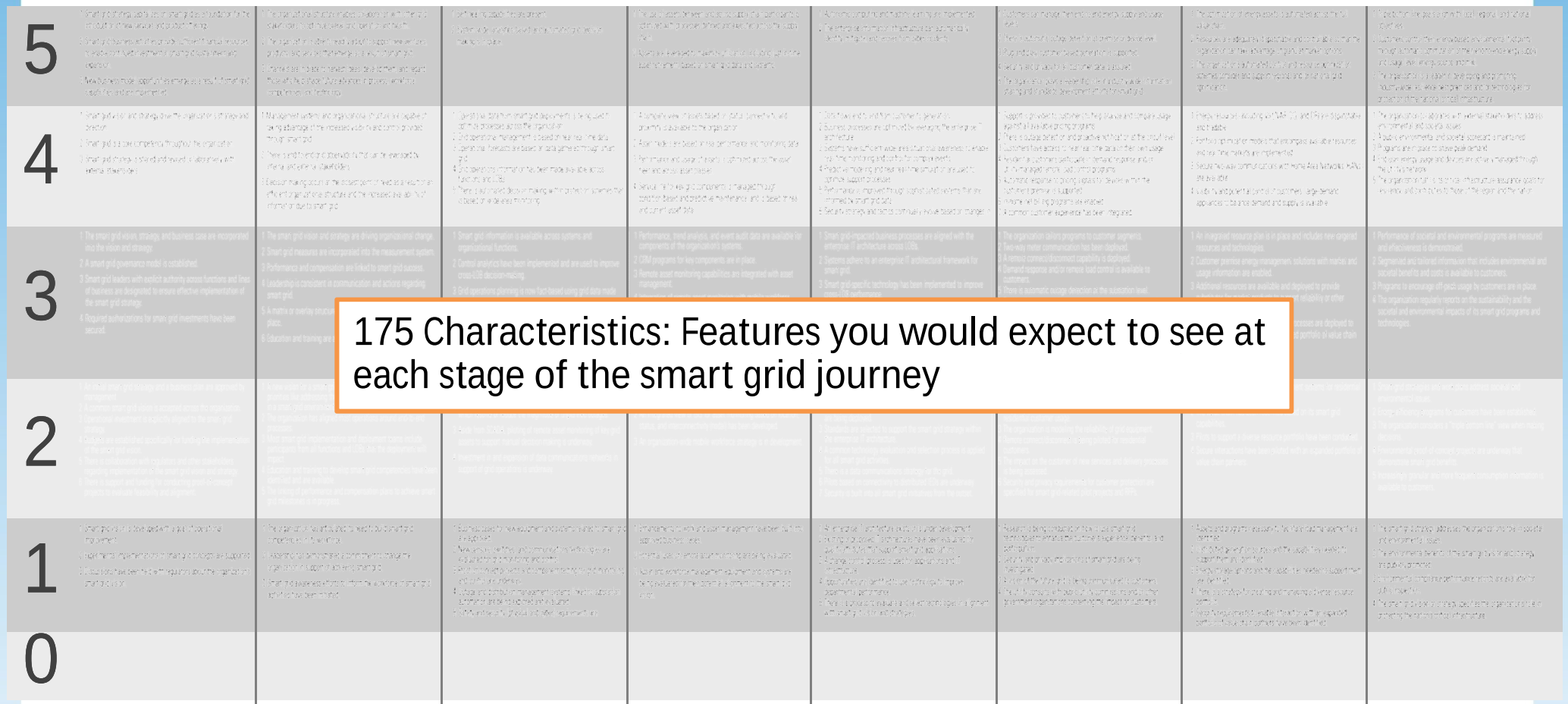
SGMM Example

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

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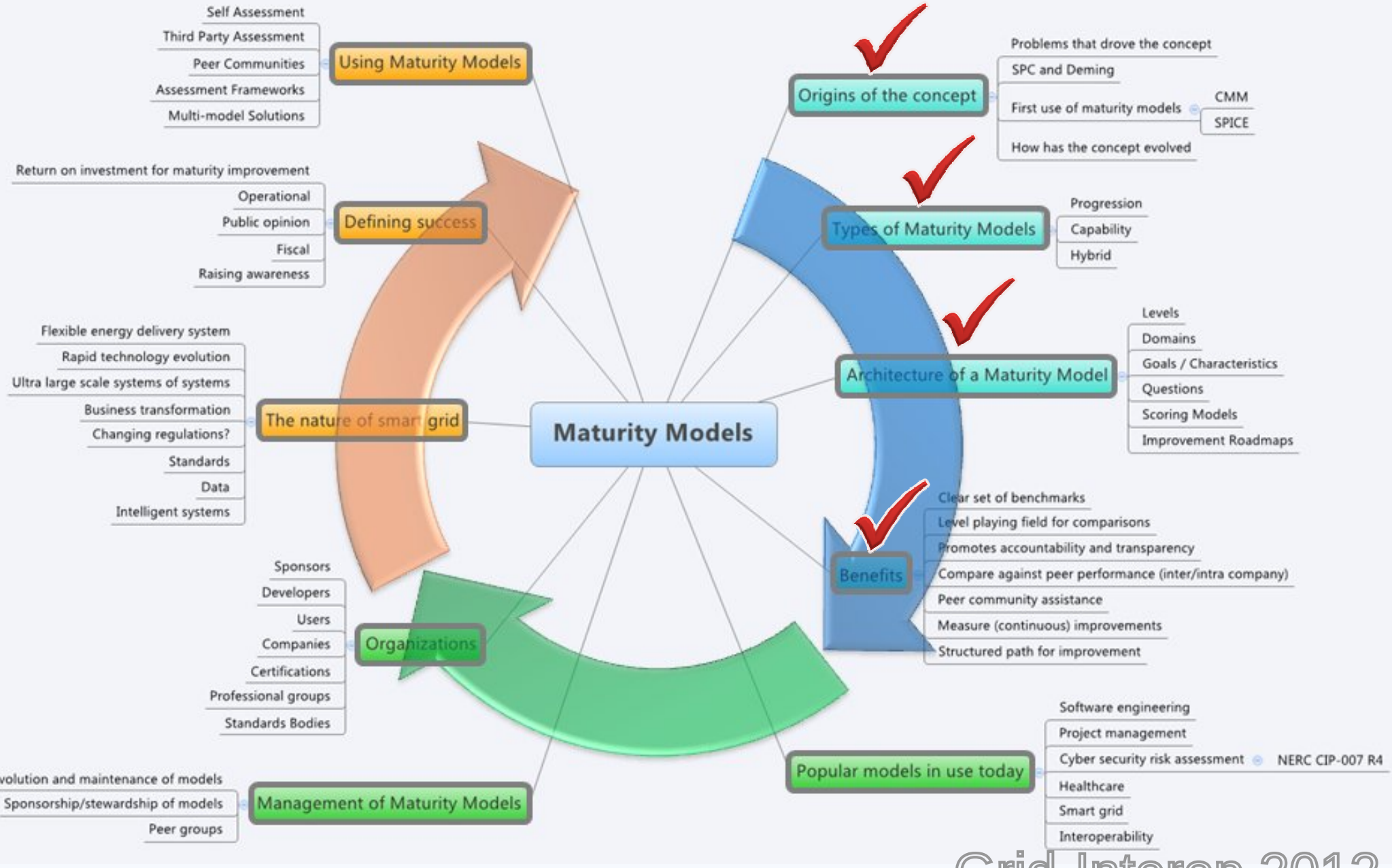
Moving Forward



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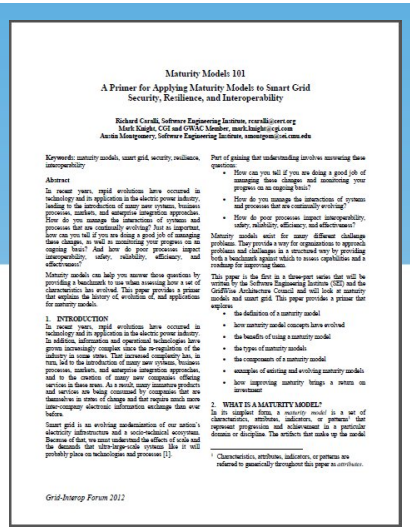
Thank You



Maturity Models 101

A Primer for Applying Maturity Models to Smart Grid Security, Resilience, and Interoperability

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Keywords: maturity models, smart grid, security, resilience, interoperability

Abstract

In recent years, rapid evolution have occurred in technology and its application in the electric power industry, leading to the introduction of many new systems, business processes, markets, and enterprise integration approaches. How do you manage the interactions of systems and processes that are continually evolving? Just as important, how can you tell if you are doing a good job of managing these changes, as well as monitoring your progress on an ongoing basis? And how do poor processes impact interoperability, safety, reliability, efficiency, and effectiveness?

Maturity models can help you answer these questions by providing a benchmark to use when assessing how a set of characteristics has evolved. This paper provides a primer that explains the history of, workings of, and applications for maturity models.

1. INTRODUCTION

In recent years, rapid evolution have occurred in technology and its application in the electric power industry. In addition, information and operational technologies have grown increasingly complex since the re-regulation of the industry in some states. That increased complexity has, in turn, led to the introduction of many new systems, business processes, markets, and enterprise integration approaches, and to the creation of many new companies offering services in these areas. As a result, many innovative products and services are being consumed by companies that are themselves in states of change and that require much more inter-company electronic information exchange than ever before.

Smart grid is an evolving modernization of our nation's electricity infrastructure and a socio-technical ecosystem. Because of that, we must understand the effects of scale and the demands that ultra-large-scale systems like it will probably place on technologies and processes [1].

Part of gaining that understanding involves answering these questions:

- How can you tell if you are doing a good job of managing these changes and monitoring your progress on an ongoing basis?
- How do you manage the interactions of systems and processes that are continually evolving?
- How do poor processes impact interoperability, safety, reliability, efficiency, and effectiveness?

Maturity models exist for many different challenge problems. They provide a way for organizations to approach problems and challenges in a structured way by providing both a benchmark against which to assess capabilities and a roadmap for improving them.

This paper is the first in a three-part series that will be written by the Software Engineering Institute (SEI) and the GridWise Architecture Council and will look at maturity models and smart grid. This paper provides a primer that explores:

- the definition of a maturity model
- how maturity model concepts have evolved
- the benefits of using a maturity model
- the types of maturity models
- the components of a maturity model
- examples of existing and evolving maturity models
- how improving maturity brings a return on investment

2. WHAT IS A MATURITY MODEL?

In its simplest form, a *maturity model* is a set of characteristics, attributes, indicators, or patterns[1] that represent progression and achievement in a particular domain or discipline. The artifacts that make up the model

[1] Characteristics, attributes, indicators, or patterns are referred to generically throughout this paper as *attributes*.

Grid-Interop Forum 2012

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SG-IMM

An Introduction to the GWAC Smart Grid Interoperability Maturity Model

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Agenda

- What is a Maturity Model? ✓
- What is Interoperability?
- What Domains, Attributes, or Framework can we use to assess maturity?
- The structure of the SG-IMM

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What is “Fast”?

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What is Interoperability?

- Interoperability is a measurable property of diverse entities that allows them to work together across technical, social, political, and organizational boundaries.
- Higher levels of interoperability maturity among diverse entities results in lower integration costs, faster connection of the entities and fewer operating problems once connected and communicating.
- “The capability of two or more networks, systems, devices, applications, or components to exchange information between them and to use the information so exchanged”
  - Interop framework, referenced from “EICTA Interoperability White Paper”, European Industry Association, Information Systems Communication Technologies Consumer Electronics, 21 June 2004.

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Interoperability Maturity Model

- The Smart Grid Interoperability Maturity Model (SG-IMM) provides *a measurable model for determining the interoperability capabilities of the interfaces between various entities in the electric power system*.
- It is a crucial step towards defining metrics for determining the current quality and levels of interoperability among interacting entities.
- It identifies areas for improvement and provides a roadmap for how to make incremental improvements in the interface, and standards and their application (if applicable).
- Interface
  - (n) a common boundary or interconnection between systems, equipment, concepts, or human beings
  - (v) to bring together; connect or mesh

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The Path Is a Spiral

Advancing interoperability is a process improvement problem

Act

Plan

Do

Check

As our electric world evolves, sustaining progress requires a culture change

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A Maturity Model for Interoperability

- Interoperability questions for a community/ecosystem
  - How well do participating systems integrate?
  - Which interfaces need the most improvement?
  - What areas of the interface deserve the most attention?
- What should an interoperability maturity model (IMM) accomplish?
  - Offer gap identification and guidance for improving interoperability
  - Provide a means for measuring interoperability progress in a community
  - Encourage a standards-based interoperability-aware culture with individual and shared roadmaps for improvement
  - Be both descriptive and prescriptive

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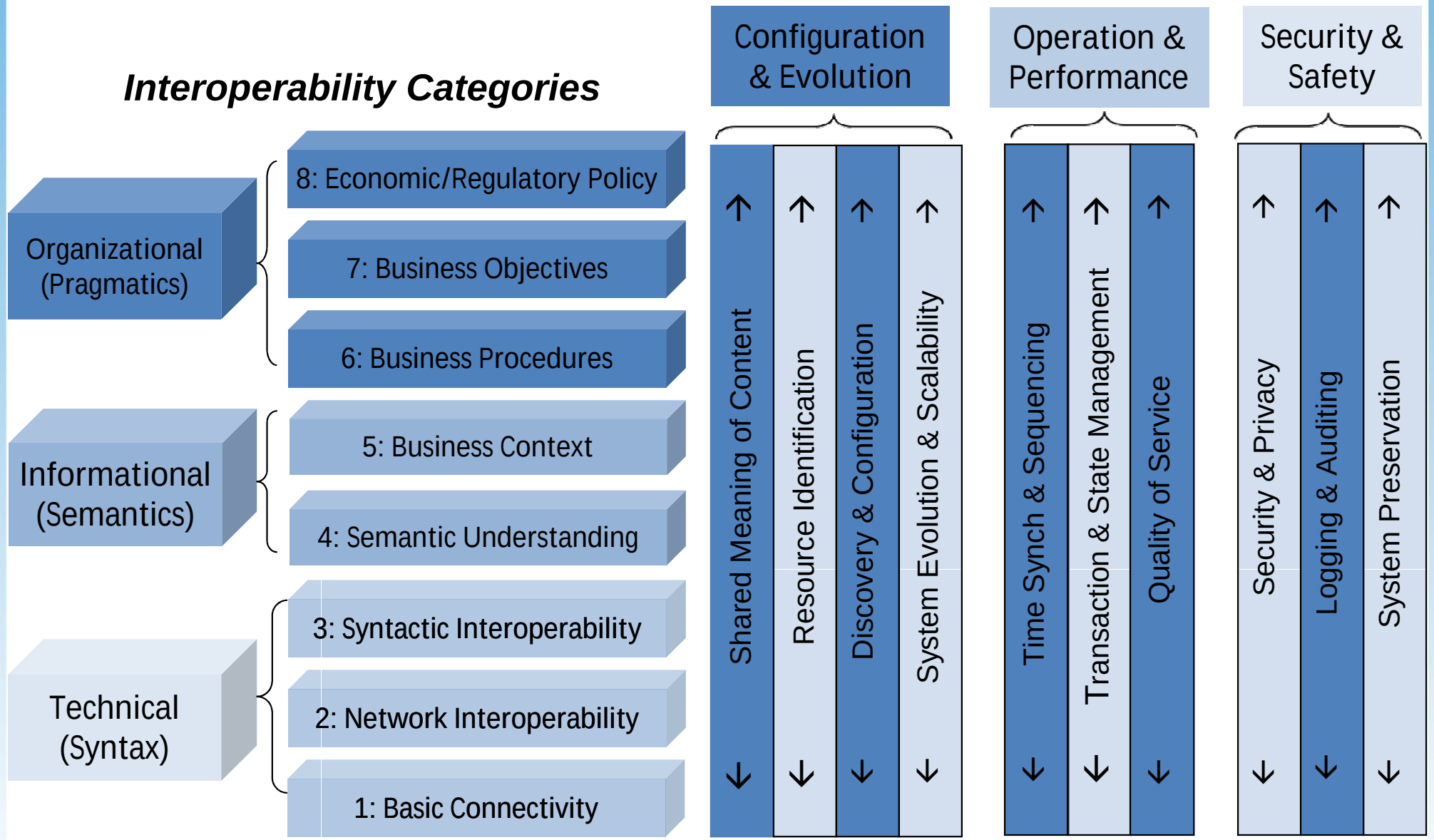
Context-setting Framework

Cross-cutting Issues

Interoperability Categories



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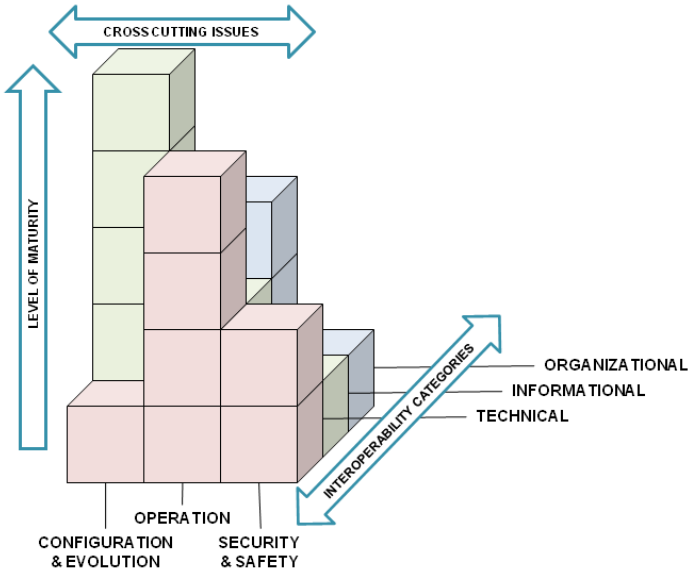
GWAC Stack and X-Cutting Issues

	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.



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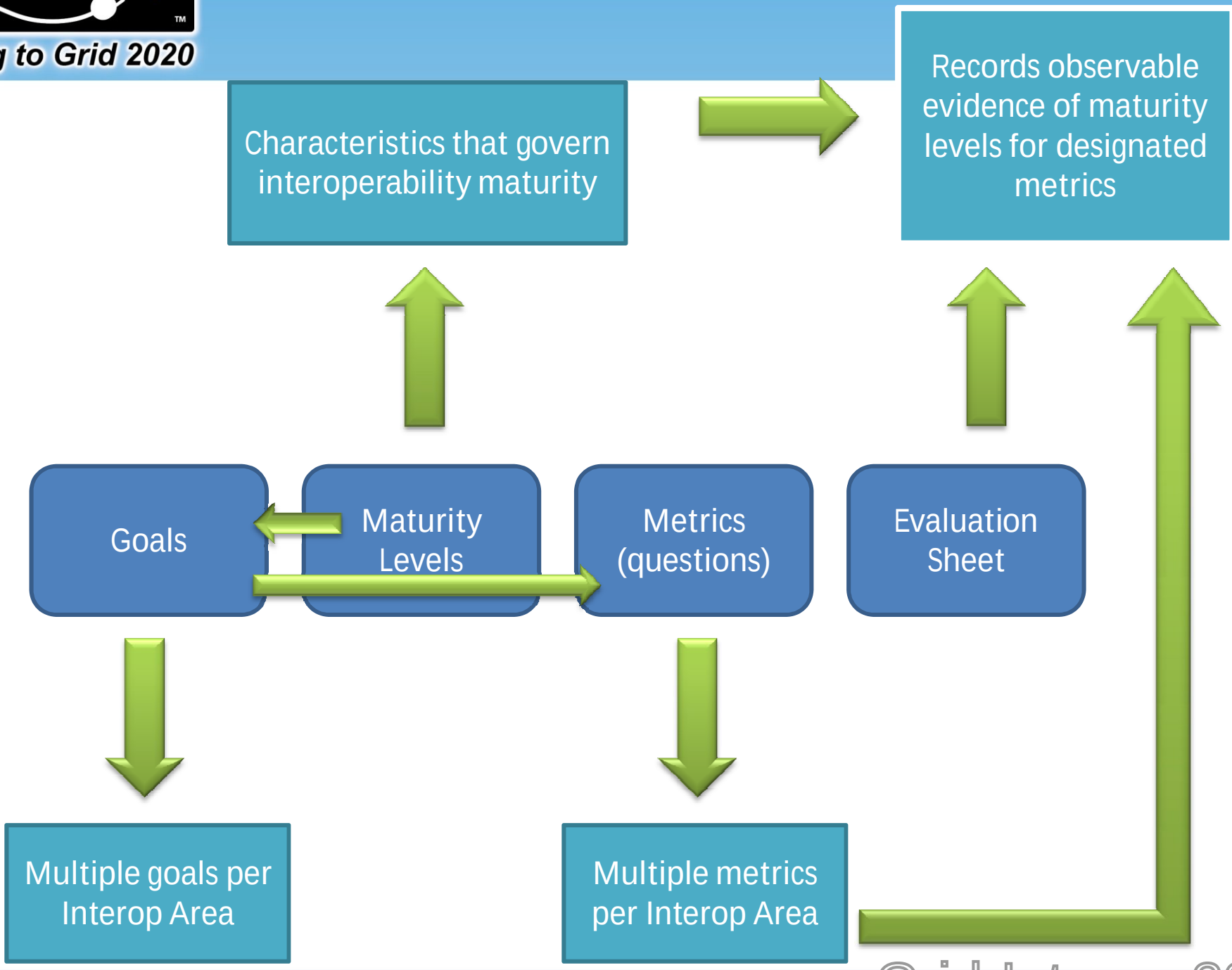

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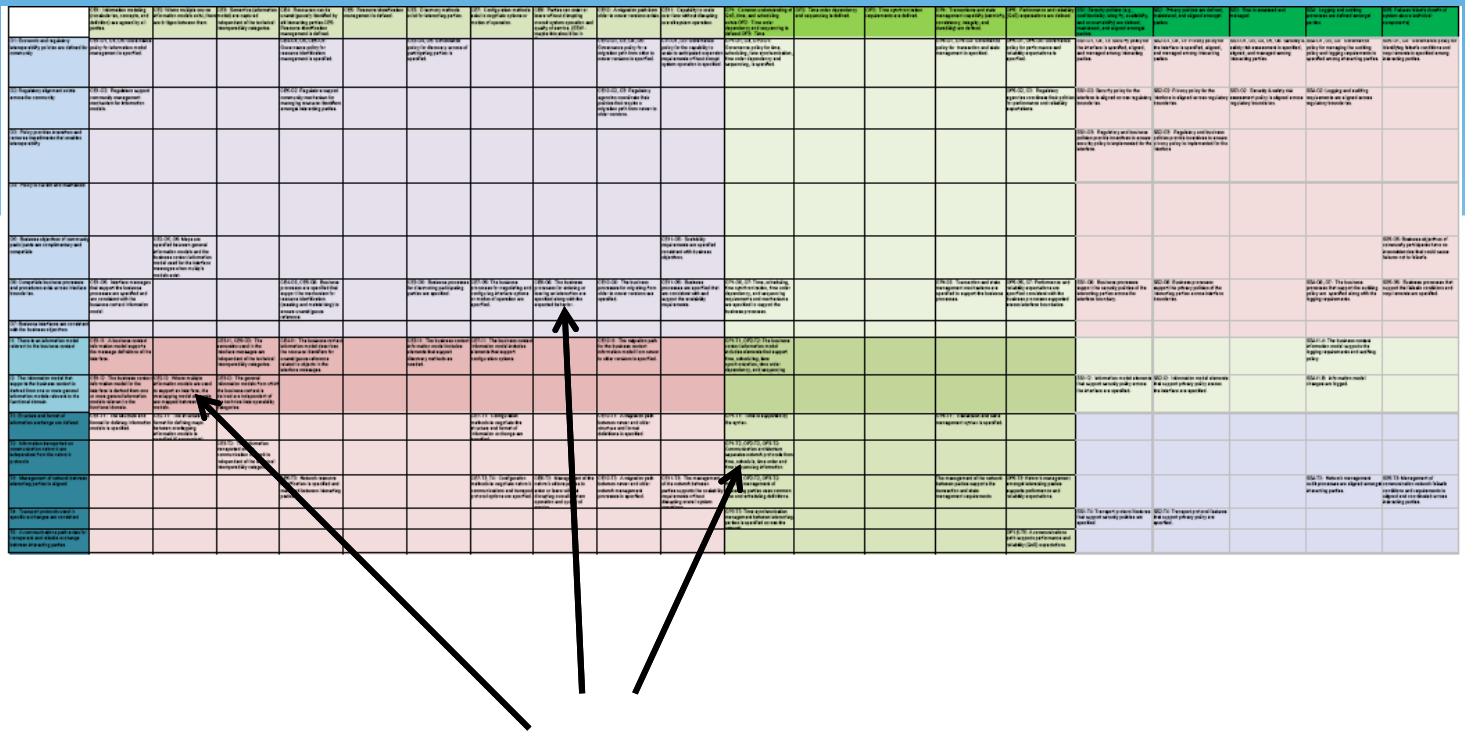

Goals

Maturity Levels

Metrics (questions)

Evaluation Sheet

OP1-O1, O4, OP3-O1: Governance policy for time, scheduling, time synchronization, time order dependency and sequencing, is specified.

OP1-O6, O7: Time, scheduling, time synchronization, time order dependency, and sequencing requirements and mechanisms are specified to support the business processes.

OP5-O6, O7: Performance and reliability expectations are specified consistent with the business processes supported across interface boundaries.

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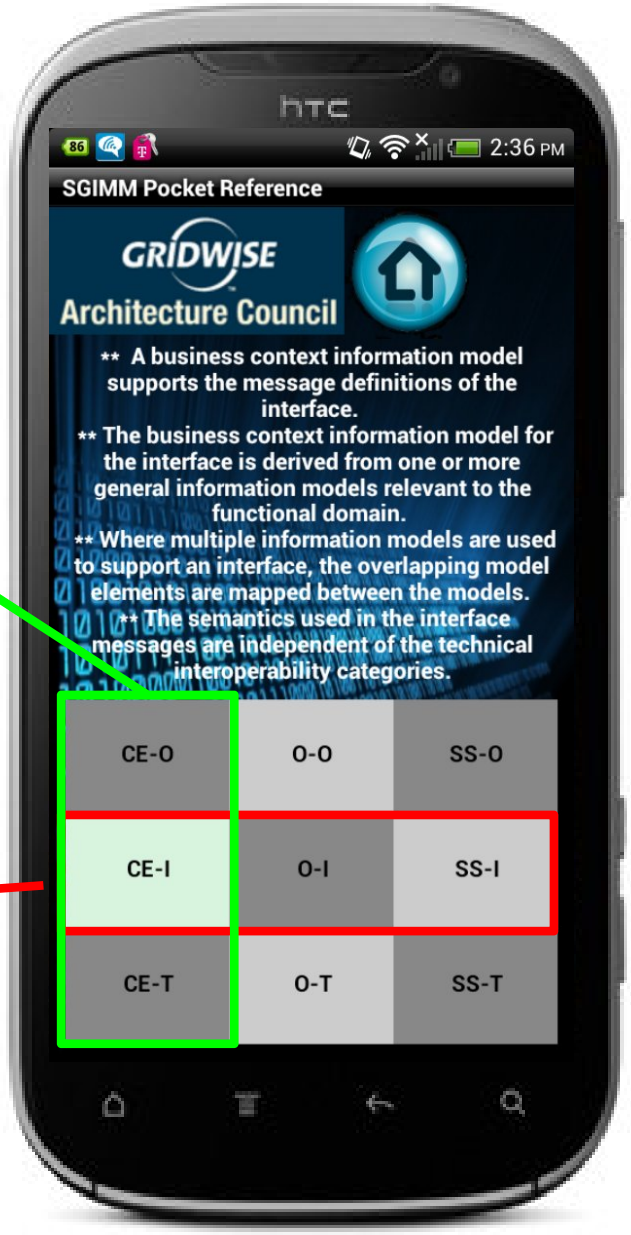
SG-IMM Pocket Reference

Configuration & Evolution

Informational



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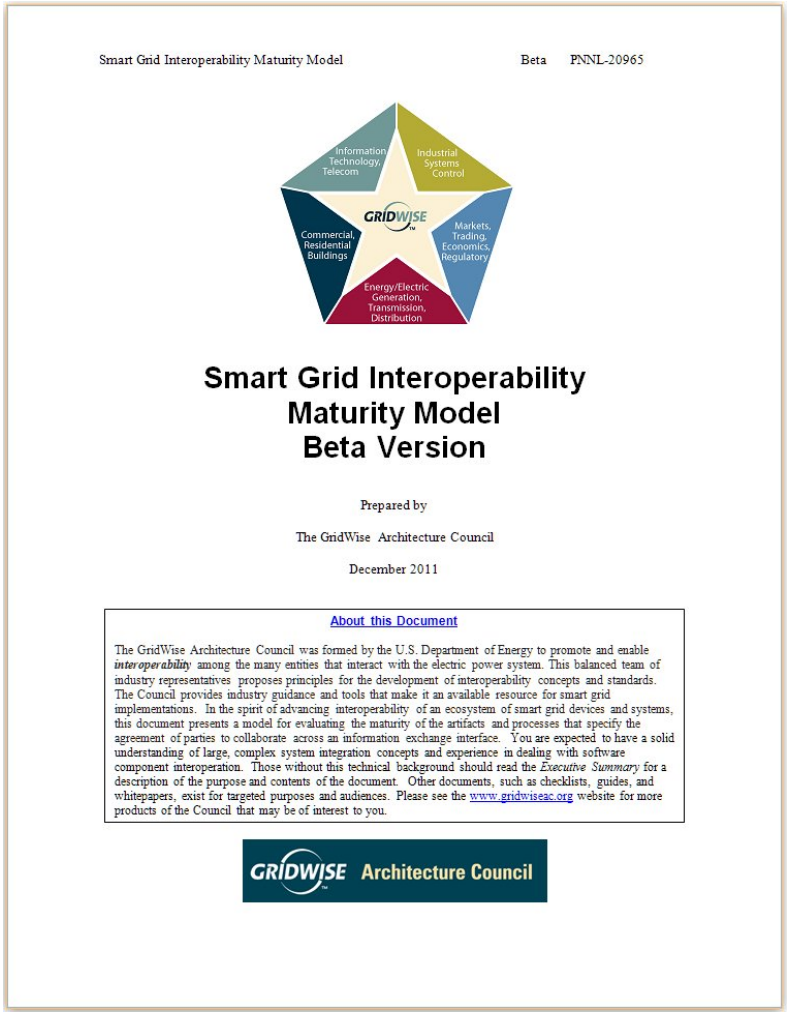
Smart Grid Interoperability Maturity Model Beta PNNL-20965

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Industrial Systems Control
GRIDWISE
Commercial, Residential Buildings
Markets, Trading, Economics, Regulatory
Energy/Electric Generation, Transmission, Distribution

Smart Grid Interoperability Maturity Model Beta Version

Prepared by

The GridWise Architecture Council

December 2011

About this Document

The GridWise Architecture Council was formed by the U.S. Department of Energy to promote and enable ***interoperability*** among the many entities that interact with the electric power system. This balanced team of industry representatives proposes principles for the development of interoperability concepts and standards. The Council provides industry guidance and tools that make it an available resource for smart grid implementations. In the spirit of advancing interoperability of an ecosystem of smart grid devices and systems, this document presents a model for evaluating the maturity of the artifacts and processes that specify the agreement of parties to collaborate across an information exchange interface. You are expected to have a solid understanding of large, complex system integration concepts and experience in dealing with software component interoperation. Those without this technical background should read the *Executive Summary* for a description of the purpose and contents of the document. Other documents, such as checklists, guides, and whitepapers, exist for targeted purposes and audiences. Please see the www.gridwiseac.org website for more products of the Council that may be of interest to you.

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Questions