### Interoperability 101 Introduction and Overview

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# • A Simple Example



# Reference Material

- Interoperability Context Setting Framework
- GridWise® Interoperability Constitution
- GWAC Interoperability Benefits Papers
  - Economic

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- Reliability
- Environmental
- GWAC Smart Grid Interoperability Maturity Mode
- Available at: <u>www.gridwiseac.org/about/publications.aspx</u>

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## **GWAC Mission - Interoperability**

### Organization/Human

- Business process
- Interrelations
- Issues
- Policies
- Communities

### Information

- Semantics
- Syntax
- Data
- Business domains

Technical/ (systems)

- Standards
- Interconnectivity
- Compliance

Interoperable Software -Expected Impact:

- Reduces integration cost
- Reduces cost to operate
- Reduces capital IT cost
- Reduces installation cost
- Reduces upgrade cost
- Better security management
- More choice in products
- More price points & features

All items provide compounding benefits

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### Interoperability – Integration at Arm's Length

- Exchange of actionable information
  - between two or more systems
  - across organizational boundaries



- Shared meaning of the exchanged information
- Agreed expectation with consequences for the response to the information exchange
- Requisite quality of service in information exchange
  - reliability, fidelity, security

# Heterogeneity – Vive la Difference!

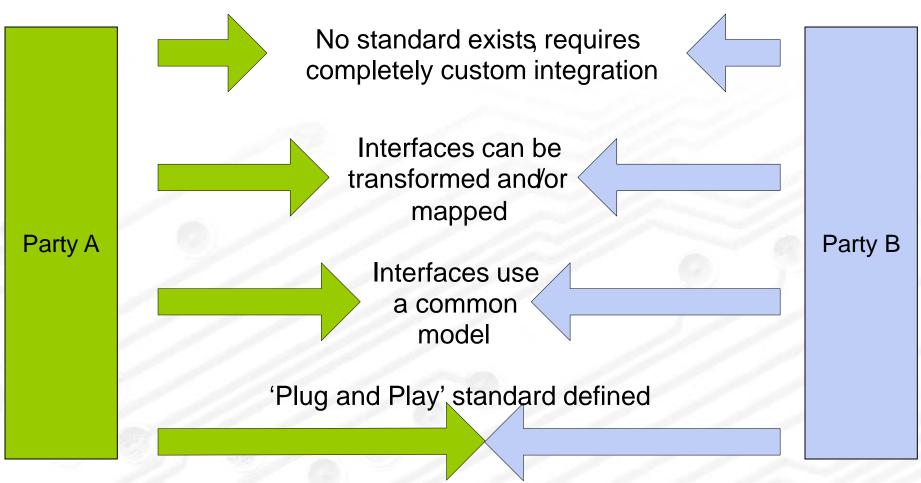
- Multiple versions and mixtures of technology
  Including today's tech with <u>tomorrow's</u> innovations
- Multiple vendors with multiple products
- Multiple services needing integration
- Multiple organization structures
  - IOUs

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- Rural Co-ops
- Munis

# Distance to Integrate

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Credit: Scott Neumann, UISol position paper

### Where we started – The Constitution

### • What is GridWise? A vision...

- Information technology will revolutionize power grid modernization jusication jusication jusication ar
- IT will form the "nervounew distributed techno response, distributed g with traditional grid gei distribution assets.

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 Responsibility for man shared by a collaborat and entities.

### The Nutshell

- Objective
  - Principles and concepts to advan CRIDWISE
- Challenges
  - Electric system is too vast for one
- New players from other industries
- Evolving heterogeneous, 24x7 sy
- GridWise Architecture Council (G'
- Neutral, cross-sector, voluntary g
- Plan of Attack

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- Develop a common agenda and f
  Reference framework, levels for i
- Involve industry sectors and po
- Identify and address priorities
- Standards, regulatory issues, me

### The Emergence of the Constitution

- Focus is on developing broad-based buy-in and input on the interoperability statements of principle to support the GridWise architecture vision
- A set of fundamental, strategic statements that will facilitate the interoperation of electric system components and those parties involved in the production, transport, and use of electricity
- A vehicle to establish consensus surrounding fundamental principles
- Statements are relevant to all operations of the electric system, including end use, distribution, transmission, and generation.
- Striving for longevity (thirty years or more)

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## • Constitution:

### We the People at a vertication

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### Interoperability Statements of Principle



"B04~ (v2.0) Interoperability approaches must consider implementation costs/benefits and impacts to the parties involved in the transaction."



## The Framework: Context for Interoperability Dialog

# Interoperability Framework

• Organizing concepts

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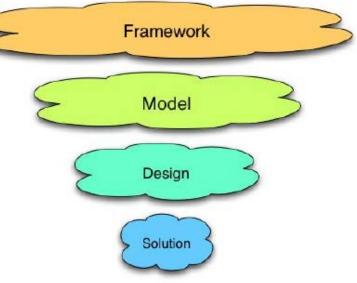
- Taxonomy, definitions, levels, tenets
- Attempts to simplify the complex
  - Warning it's still complex
- Aids communication between community members
   Careful semantics remain a stumbling block
- Provides perspective from selected viewpoints
- Reveals points where agreement simplifies integration
- Focus plight of integrator, not component developer

## • What do we mean by "Framework"?

 Framework organizes concepts and provides context for discussion of detailed technical aspects of interoperability

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- Model identifies a particular problem space and defines a technology independent analysis of requirements
- Design maps model requirements into a particular family of solutions
  - Uses standards and technical approaches
- Solution manifests a design into a particular developer software technology
  - Ensures adherence to designs, models, and frameworks.



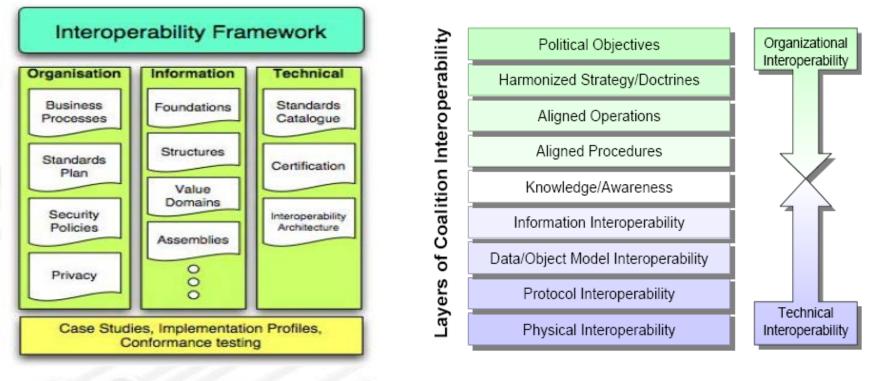
Borrowed from NEHTA: Australian National E-Health Transition Authority

# • Framework Inspirations

### **NEHTA Interop Framework**

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Layers of Coalition Interoperability



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A. Tolk, Beyond Technical Interoperability, 8th CCRTS, National Defense University, Jun 03

# System Integration Philosophy

- Agreement at the interface
  - Create an interaction contract
  - Terms and conditions, consequences for failure to perform...
- Boundary of authority
  - Respect privacy of internal aspects on either side of the interface (technology choice and processes)
- Decision making in very large networks
  - Decentralized/autonomous decision-making
  - Multi-agent v. hierarchical approach
  - Addresses scalability, evolutionary change, eases integration
- Role of standards in the framework
  - Encourages standards for improving interoperation
  - Agnostic to specific standards and technologies

## Interoperability Framework

Organizational

Informational

Technical

- 8: Economic/Regulatory Policy
  - 7: Business Objectives
  - 6: Business Procedures
    - 5: Business Context
  - 4: Semantic Understanding
  - 3: Syntactic Interoperability
  - 2: Network Interoperability
    - 1: Basic Connectivity

Political and Economic Objectives as Embodied in Policy and Regulation

Strategic and Tactical Objectives Shared between Businesses

Alignment between Operational Business Processes and Procedures

Awareness of the Business Knowledge Related to a Specific Interaction

Understanding of the Concepts Contained in the Message Data Structures

Understanding of Data Structure in Messages Exchanged between Systems

Mechanism to Exchange Messages between Multiple Systems across a Variety of Networks

Mechanism to Establish Physical and Logical Connections between Systems

# Example: Demand Pricing Signal

- Economic/Regulatory Policy
  - PUC issues retail real-time price signal policy
- Business Objectives
  - Electricity retailer objectives align with building services providers to aggregate demand
  - Building owners choose service provider with package that best meets their needs
- Business Procedures
  - Hour ahead price sent by electricity retailer to building service providers, acknowledgement returned with forecast next hour demand
- Business Context
  - Tailored portion of CIM, e.g., model building and energy price information
- Semantic Understanding
  - IEC 61968/61970 Common Information Model (CIM) in W3C OWL
- Syntactic Interoperability
  - SOAP messaging, UDDI registry and discovery, XML
- Network Interoperability
  - TCP/IPsec
- Basic Connectivity
  - IEEE 802.11 wireless mesh network to building controller

## **Cross-Cutting Issues**

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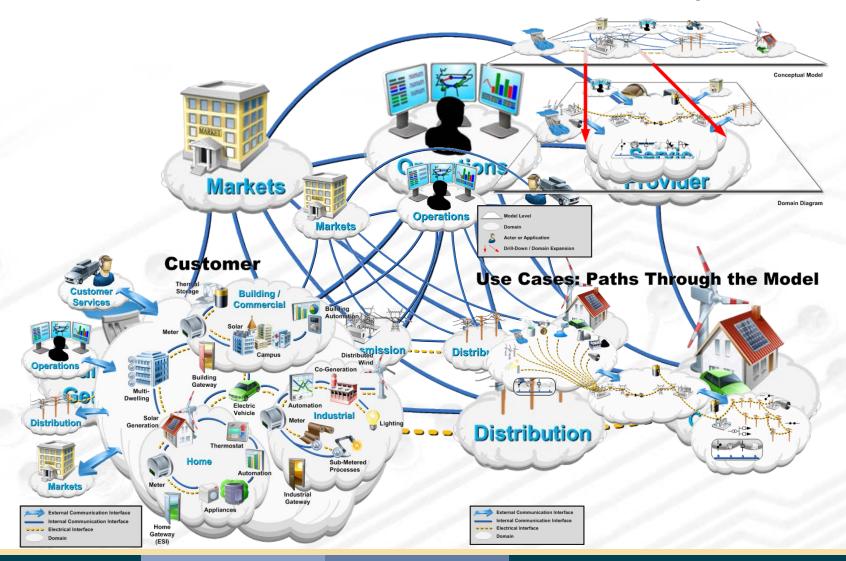
### Interoperability Categories Cross-cutting Issues 8: Economic/Regulatory Policy 个 $\mathbf{\Lambda}$ $\mathbf{\Lambda}$ $\mathbf{\Lambda}$ $\mathbf{\Lambda}$ 个 $\mathbf{\Lambda}$ $\mathbf{\Lambda}$ $\mathbf{\Lambda}$ $\mathbf{\Lambda}$ 7: Business Objectives Organizational Erformance/Reliability/Scalability Shared Meaning of Content **Discovery & Configuration** Sequencing State Mgt **System Preservation Resource Identification** 6: Business Procedures Privacy Logging & Auditing System Evolution **5: Business Context Transaction &** Security & Time Synch & Informational 4: Semantic Understanding **3:** Syntactic Interoperability 2: Network Interoperability **Technical** $\mathbf{r}$ $\mathbf{\Lambda}$ $\mathbf{\Lambda}$ $\mathbf{V}$ $\mathbf{r}$ $\mathbf{V}$ $\mathbf{V}$ $\mathbf{V}$ 1: Basic Connectivity

## Using the Conceptual Model

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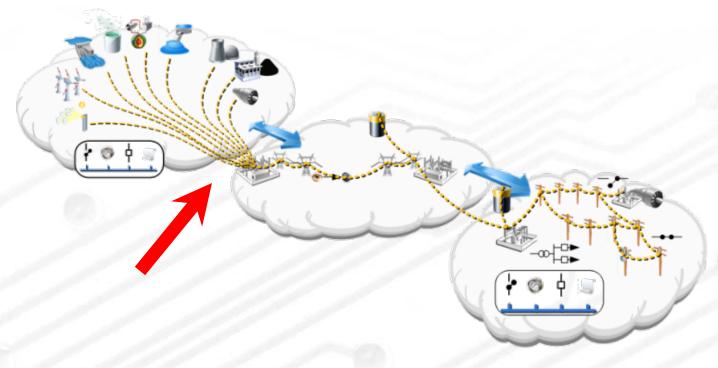
**Levels of the Conceptual Model** 





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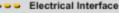
### Inter- vs. Intra-System Interoperability Use Cases: Paths Through the Model





External Communication Interface

Internal Communication Interface



Domain

## • The GWAC Stack and the Model

Organizational

(Pragmatics)

Informational

(Semantics)

**Technical** 

(Syntax)

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8: Economic/Regulatory Policy

7: Business Objectives

6: Business Procedures

5: Business Context

4: Semantic Understanding

3: Syntactic Interoperability

2: Network Interoperability

1: Basic Connectivity

Analyze interoperability at key inter-system points in the use case paths through the Conceptual Model ...

... using the GWAC Stack top-down to define lowest layer that must be addressed