GridWise Architecture Council: A Brief History

Jaime Kolln, PNNL - GWAC Origin
Ron Ambrosio - Interoperability
David Forfia - Transactive Energy
Ron Cunningham – Electric Industry Visions and Future States

Intro : Jaime's Perspective

The Council:

- Experienced
- Diverse
- Innovators

Value comes from outreach, new and diverse members, and offering advancements to the GWAC's "smart grid" mission/vision

GWAC Offers:

- Thought Leadership
- Education
- Impact

GridWise Architecture Council - Origin

- Funded by DOE
  - Sponsor Eric Lightner –Director of the Office of Electricity Federal Smart Grid Task Force in the Office of Electricity Delivery and Energy Reliability
  - GridWise Initiative activity but ***not*** *to be confused with the GridWise Alliance*
- GridWise Architecture Tenets & Illustrations – Steve Widergren2003
  - **Mission Statement**: *"The Architecture Board gathers great minds in related fields of interest to capture and describe the abstract underpinnings for information exchange and control of a society of devices, subsystems, and businesses, that by the nature of their transactions and local decisions will improve the performance of the electric power system as a whole. This board must do this with the full knowledge of the existing and emerging mechanisms for information exchange that serve collaboration between organizations in the economy in general"*

GridWise Architecture Tenets & Illustrations

20 later – influence and observations

Tenets:

- Value is best judged in a fair market environment… exposed to all levels of the system
- Changes will include organizational boundaries… forms of collaboration between system components

Achitecture:

- Common Language: Concepts and information exchange must be clearly described/defined

Illustrations:

Flavor of layered architecture – further refined by Jeff Taft (GWAC Emeritus) expanded to layered decomposition

Facility Controlled DER – Expanded later by GWAC and others through interoperability efforts to DER Facility and ESI

Interoperability Path Forward White Paper GWAC 2005

Describes Interoperability in context of information exchange, symantics, expectations, and quality of service

- "Plug and play"
- Today (2005) and "Desired Destiny"

  With aspirational goal of advancing grid architecture to self-defining and self-configuring smart grid
- Stakeholder engagement
  - Develop common understanding
  - Classify interop needs and issues
  - Debate, prioritize and delegate
  - Measure fulfillment
  - Interoperability Constitution

Interoperability Constitutional Convention December 2005

Interoperability

Ron Ambrosio

The Emergence of the Constitution

- Focused 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)

Consensus through multiple revisions

- The Constitution: a work in progress
  - Initial principles were assessed, commented and revised
  - A broad spectrum of interviewees were consulted (close to 100 to date), representing each sector
  - Iterations of feedback and revision
- The constitution is not perfect or finalized, but is in reasonable shape to discuss with an even greater audience

→ The Constitutional Convention

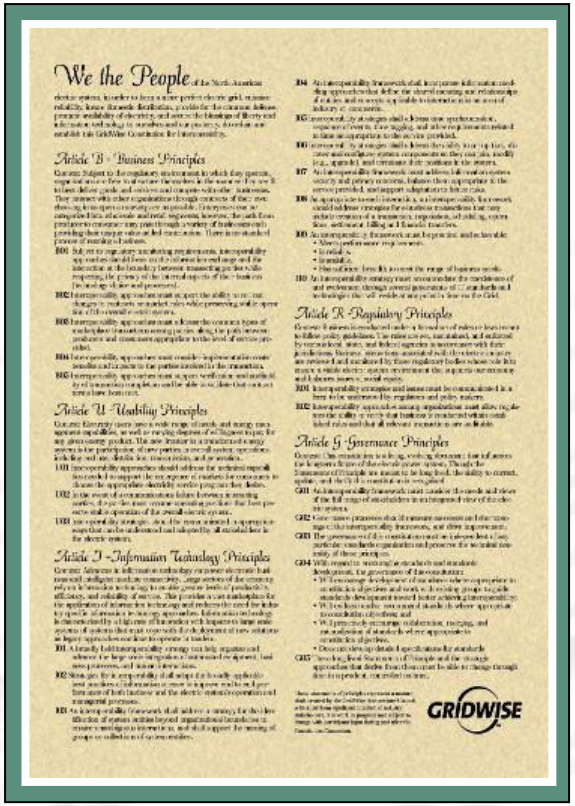
The Constitutional Convention

- Maturing statements ready for a broader audience: input still needed
- Interactive, organized, breakout sessions
  - Attendees become engaged in determining a path forward
  - Community is being asked to become part of the process
  - Champions will emerge and alignment increase

→ Read the Constitution Whitepaper

→ Participate in the Convention

Constitution:



We the People of the North American electric system, in order to form a more perfect electric grid, to ensure reliability, to meet network flexibilities, provide for the common defense, promote availability of electricity, and secure the blessings of liberty and information technology to ourselves and our progeny, do ordain and establish this GridWise Constitution for Interoperability.

Article B - Business Principles

Article U - Usability Principles

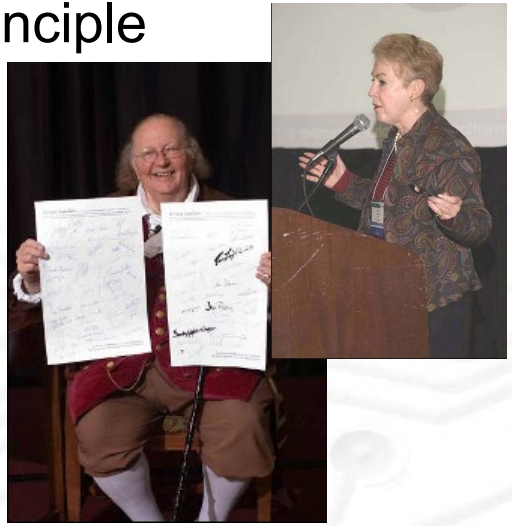
Article I - Information Technology Principles

Article R - Regulatory Principles

Article G - Governance Principles

GRIDWISE

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

Creating the Framework

[Initial discussion May 2005; substantially defined by Sept 2006]

- Survey the state of the art in such frameworks
  - Engage experts, e.g., Dr. Tolk
  - Review literature
  - Report best fit prospects
- Clarify objectives and scope
  - Context for interoperability issue discussions
  - Consistent with constitution
  - Conceptual, non-prescriptive
  - Comprehensive – a tree to hang interoperability ornaments (issues & work items)
- Outline internal document
- Write internal document (10-20 pages)
- Identify target audiences
- Develop material for targeted audiences
  - Papers, presentations, brochures

Constitutionally Consistent

Based on statements in the GridWise Interoperability Constitution

- Focus on interaction at the boundary (B01)
  - Respect each party's privacy and independence
- Support changes w/o system disruption (B02)
- Support verification and audits (B05, R02)
- Go to system-safe corner in event of communication failure (U02)
- Communicate concepts across stakeholder base (U03, R01)
- Adopt broadly applicable (cross-sector) best practices (I02)
- Heterogeneous environment (I10)
  - Coexistence of multiple IT standards and technologies
- Consider needs of the full range of stakeholders (G01)
- Be practical (I09, B04)

Framework can incorporate checklist for GridWise interoperability evaluation

Multiple Audiences

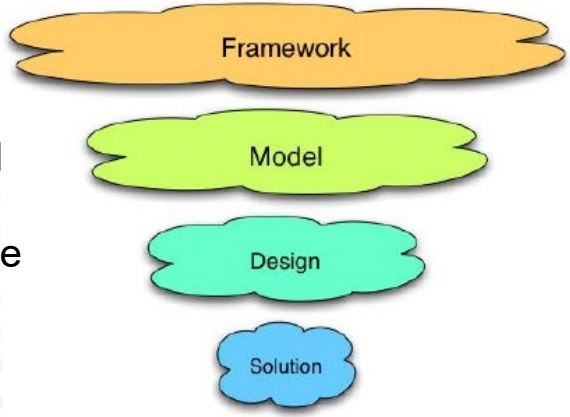
- Interoperability Framework Document
  - Experts familiar with large system integration and interoperability issues
  - Does not replace enterprise architecture frameworks (e.g., DoDAF, TOGAF, Zachman, RM-ODP, etc.)
    - Layers and crosscutting issues support various views / approaches
  - Input from review of over 45 system integration experts
    - **Workshop held in April 2007**
- Other targeted audiences
  - Designers, business decision-makers, policymakers, across various industry sectors
  - Executive summaries, checklists, cross-cutting issue papers, use case scenarios

Interoperability Framework

- Organizing concepts
  - 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"?

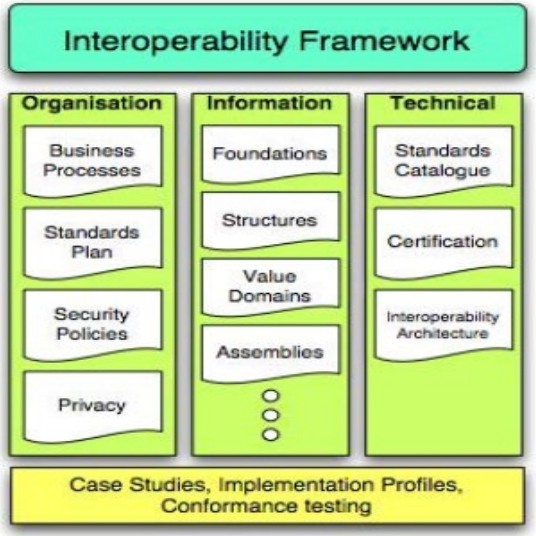
- *Framework* organizes concepts and provides context for discussion of detailed technical aspects of interoperability
- *Model* identifies a particular problem space and defines a technology independent analysis of requirements
- *Design* maps model requirements into a particular family of solutions
  - Uses standards and technical approaches
- *Solution* manifests a design into a particular developer software technology
  - Ensures adherence to designs, models, and frameworks.



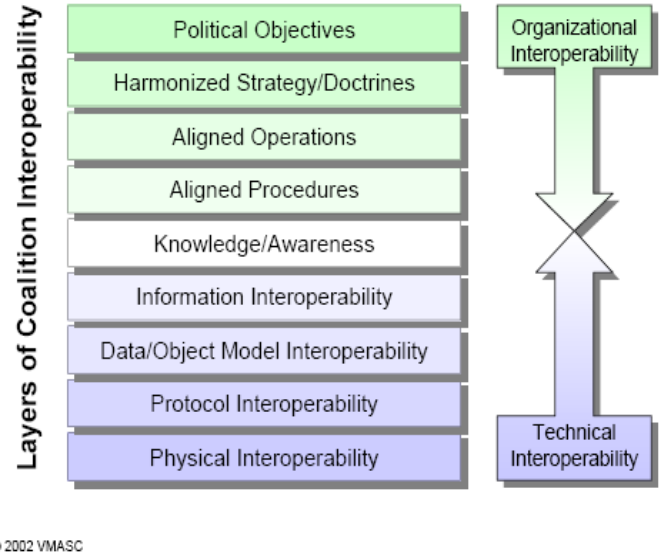
Borrowed from NEHTA: Australian National E-Health Transition Authority

Framework Inspirations

NEHTA Interop Framework



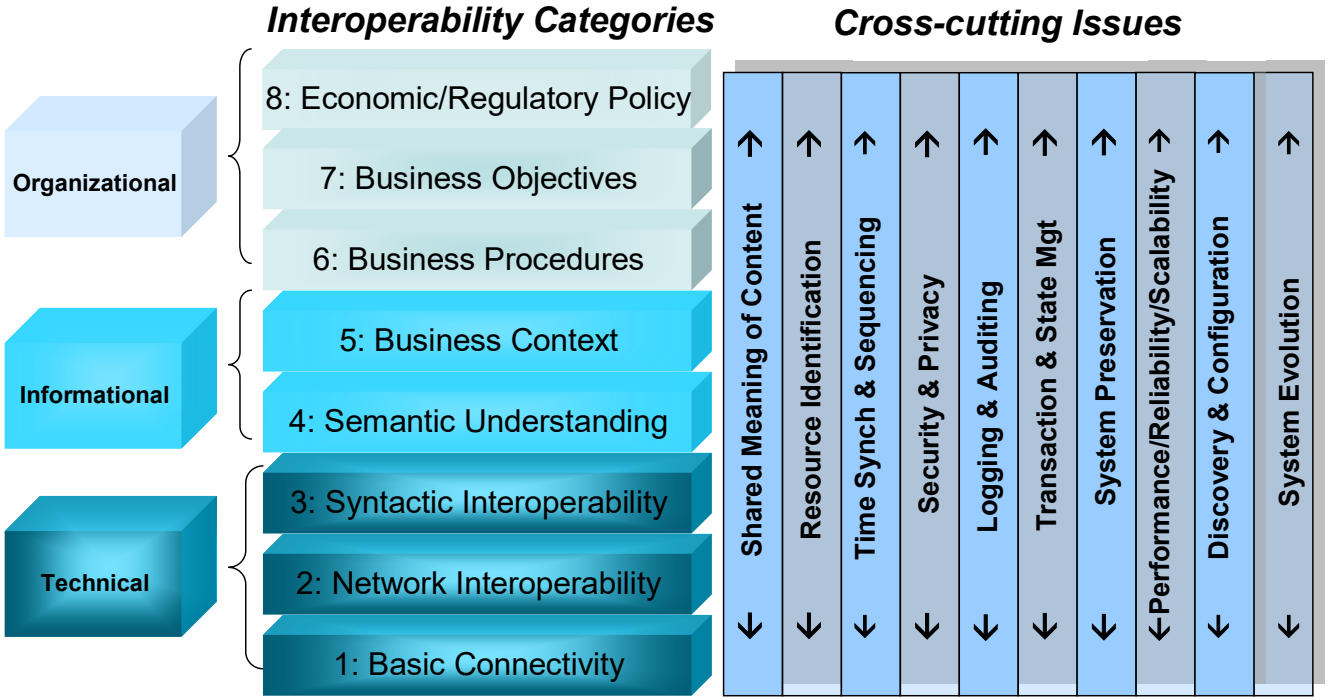
Layers of Coalition Interoperability



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

Interoperability Framework

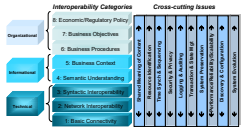
Cross-Cutting Issues



Workshop - Introductory Phase [2007]

Workshop Proceedings

Framework V1.0

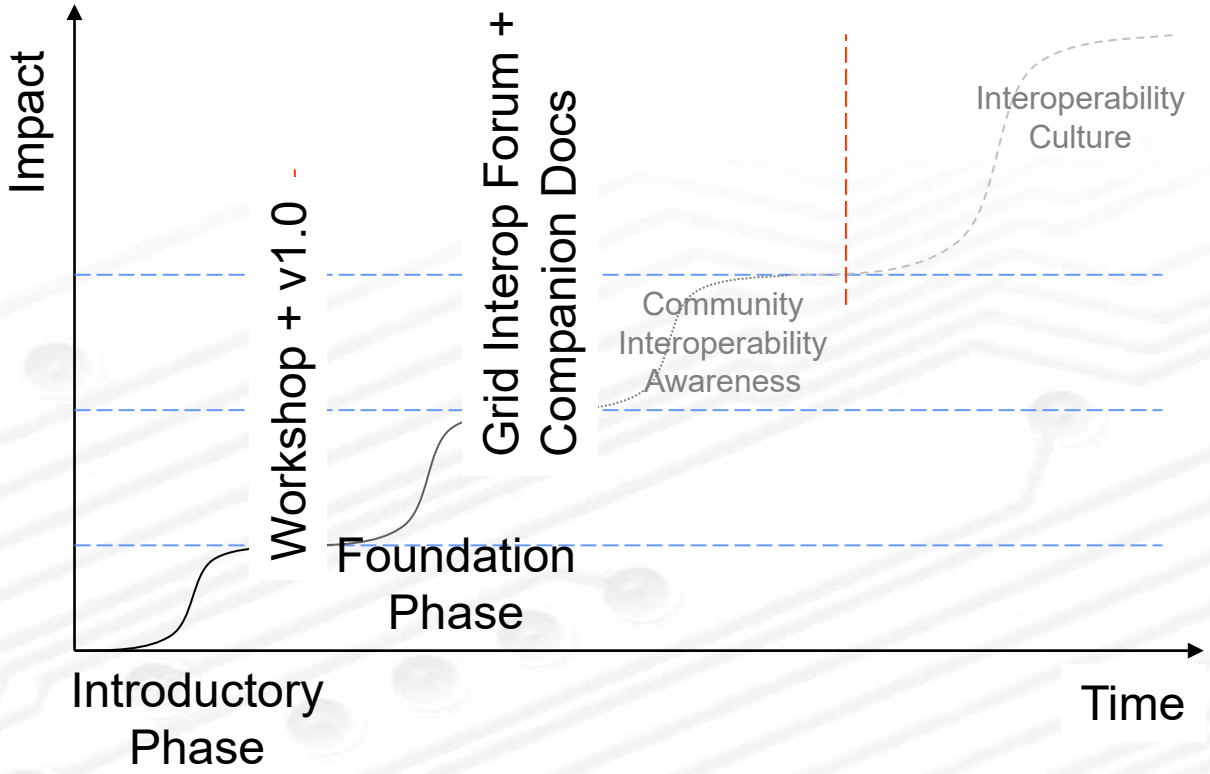


COMING SOON!

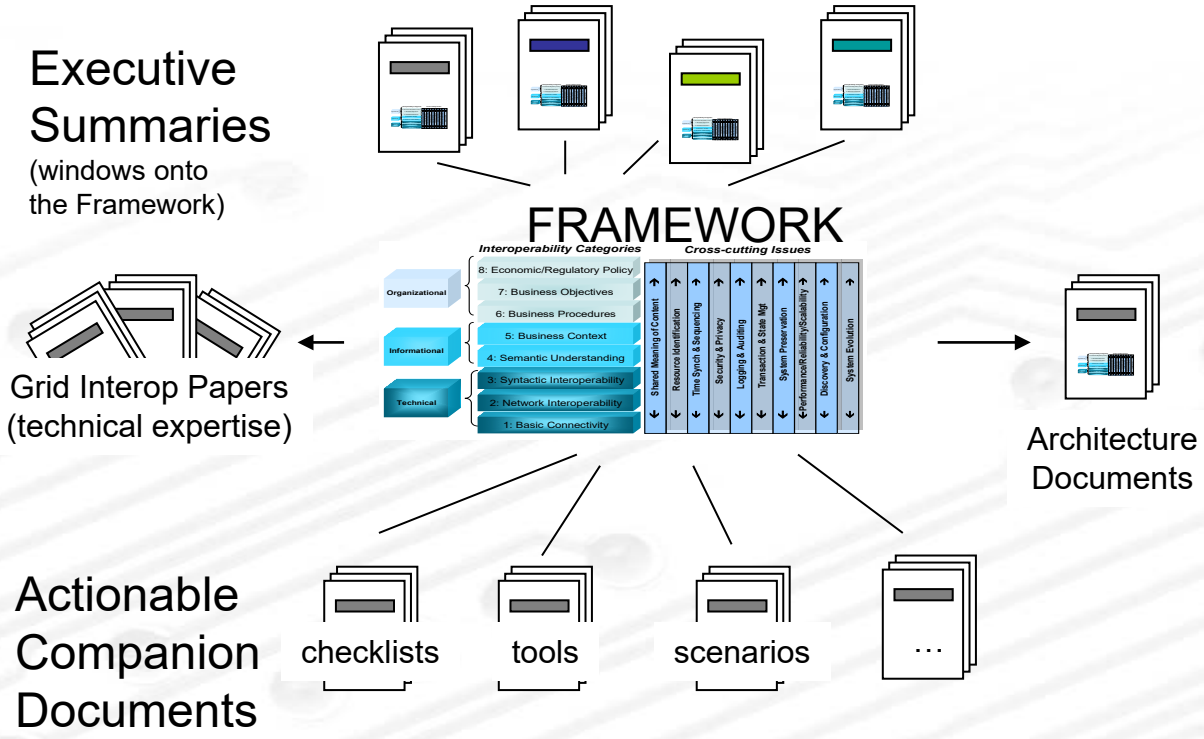
Technical Framework Introduction Document v1.0
Plus Workshop of Technical Experts

Available at www.gridwiseac.org

Framework Progression



Framework Material



First Grid Interop Conference

- Objective: Engage electricity community for actionable steps to address interoperability issues
- Logistics: November 7-9, 2007, Albuquerque, New Mexico
- Call for Papers
  - Abstracts due July 30, 2007, see www.gridwiseac.org
  - Business track topics
    - Business services vision & interoperability role
    - Business constraints and barriers
    - Benefits of interoperability
    - Regulatory policy: support and impediment
    - Alignment for critical infrastructures in the information age (ensure nation's security)
  - Technical track topics
    - Cross-cutting issues
      - ID, security, time, configuration/discovery, etc.
    - Case studies of interoperability across multiple domains
    - Complex systems of systems and unintended consequences
    - Tools and methods

NIST Smart Grid Interoperability Panel (SGIP)

- Congress directed NIST to engage GWAC in the 2007 EISA Legislation
  - The NIST lead was Jerry FitzPatrick, with Dave Wollman as his second in command
  - GWAC helped NIST organize the SGIP based on the Council's work
- GWAC members served on Governing Board and formed and led the Architecture Committee and Testing & Certification Committee
- GWAC members were actively involved in the Domain Expert Working Groups (DEWGs) and the Priority Action Process (PAP) activities, often in leadership positions

Transactive Energy

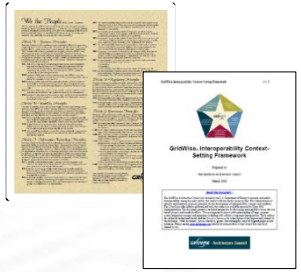
David Forfia

GWAC Progress & Accomplishments

2006 – Interoperability Constitution

2007 – Interoperability Decision Maker's Checklist

2008 – Interoperability Context Setting Framework



2009 – Interoperability Benefits Papers

- *Environmental Benefits*
- *Financial Benefits*
- *Reliability Benefits*

2010 - Interoperability Decision Maker's Checklist update

2011 – Smart Grid Interoperability Maturity Model Beta Version

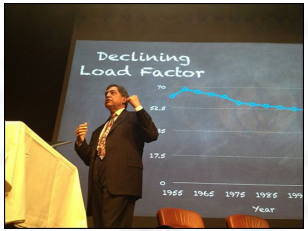
Electrical Power Engineering Academic Landscape

2007-2012 – Grid-Interop Forum

2011-current – Transactive Energy Workshops, Framework & Checklist

TESC History

- 2011 – Transactive Energy Workshop – OATI, Redwood Shores, CA
- 2012 – Transactive Energy Workshop – T.J. Watson Research Cente
- 2013 – 1st International Transactive Energy Conference – Portland, C
- 2014 – 2nd Transactive Energy Conference – Portland, OR
- 2016 – 3rd International Transactive Energy Systems Conference – Portland, OR
- 2017 – 4th International Transactive Energy Systems Conference – Portland, OR
- 2018 - 5th International Transactive Energy Systems Conference – MIT Cambridge, MA
- 2019 – 6th International Transactive Energy Systems Conference – University of Minnesota, Minneapolis, MN
- 2020 – 7th International Transactive Energy Systems Conference – Virtual
- 2022 – 8th International Transactive Energy Systems Conference – Virtual

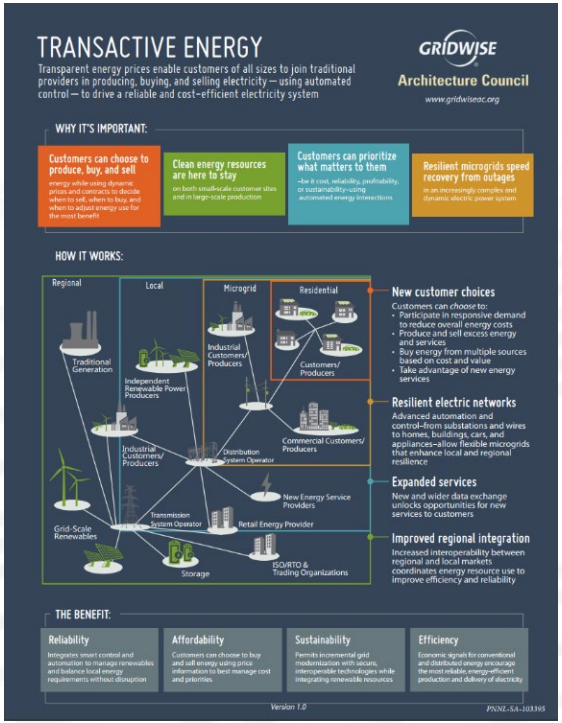


TE Publications

- 2011 – Transactive Energy Workshop
- 2012 – Transactive Energy Workshop
- 2013 – 1st International Transactive Energy Conference –
- 2014 – 2nd Transactive Energy Conference
- 2016 – 3rd International TES Conference –
- 2017 – 4th International TES Conference –
- 2018 - 5th International TES Conference -
- 2019 – 6th International TES Conference -
- 2020 – 7th International TES Conference -
- 2022 – 8th International TES Conference -

- 2014 – Transactive Energy Principles
  Transactive Energy Infographic
  Transactive Energy in < 1000 Words
- 2015 – Transactive Energy Framework 1.0
  Valuation of Transactive Energy
- 2016 – TE Decision Maker's Checklist
- 2017 – TE Roadmap Draft
- 2018 - TE Roadmap
- 2019 – TE Framework 1.1
- 2020 – Smart Buildings as Transactive Hubs
  Transactive Energy FAQ
  Reliability and Resiliency Considerations for TES

The Transactive Energy Infographic



http://www.gridwiseac.org/pdfs/te_infographics_061014_pnnl_sa_103395.pdf

Transactive Energy Principles

Highly automated, coordinated self-optimization	Provide non-discriminatory participation by qualified participants
Transacting parties are accountable for standards of performance	Observable and auditable at interfaces
Maintain system reliability and control while enabling optimal integration of distributed energy resources	Scalable, adaptable, and extensible across a number of devices, participants, and geographic extents

Principles: High-level requirements for TE systems that provide an additional point of reference for communicating with stakeholders and identifying common ground within the transactive energy community.

From GridWise Architecture Council's Transactive Energy Framework
http://www.gridwiseac.org/about/transactive_energy.aspx

TE Framework 1.0 and 1.1

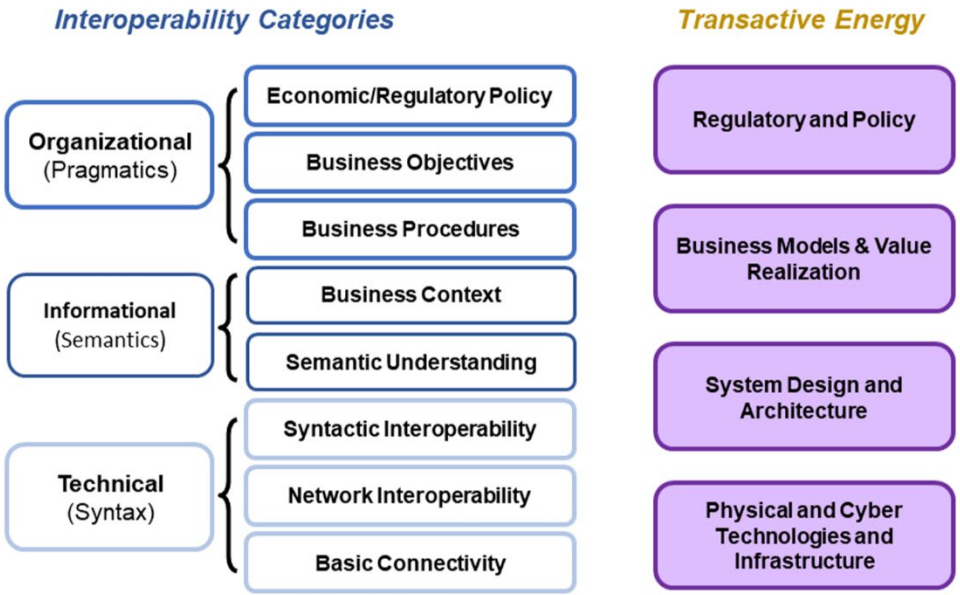
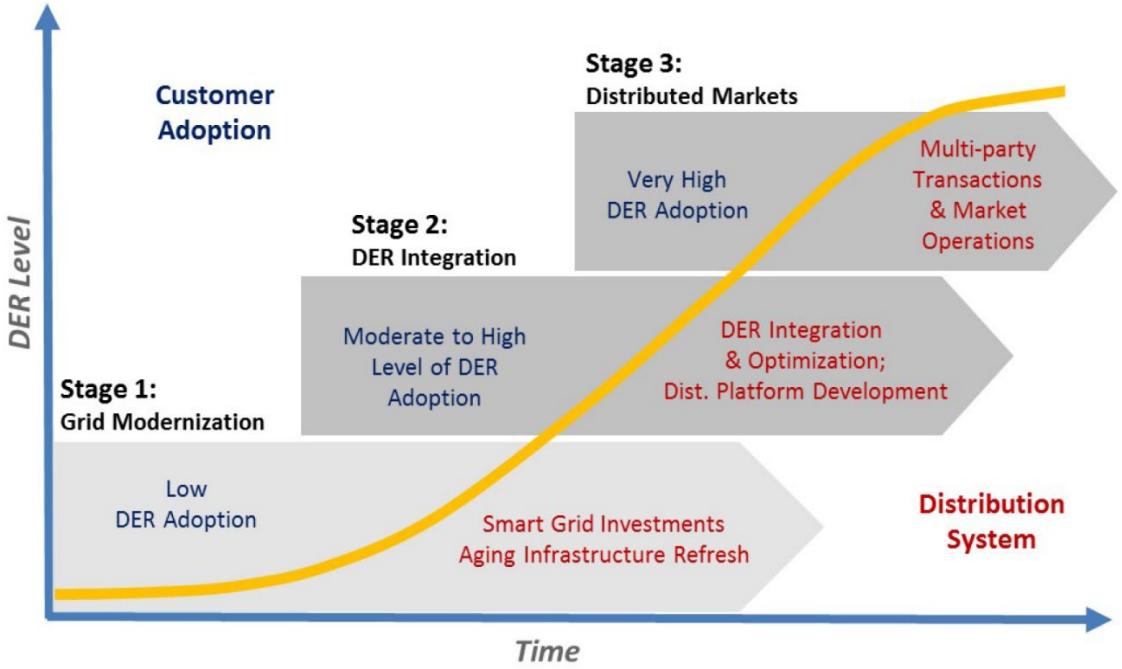
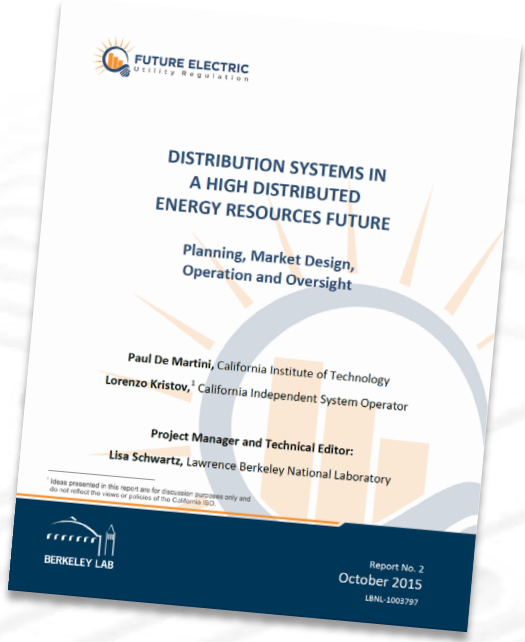


Figure 6. GWAC Stack with strata of transactive energy

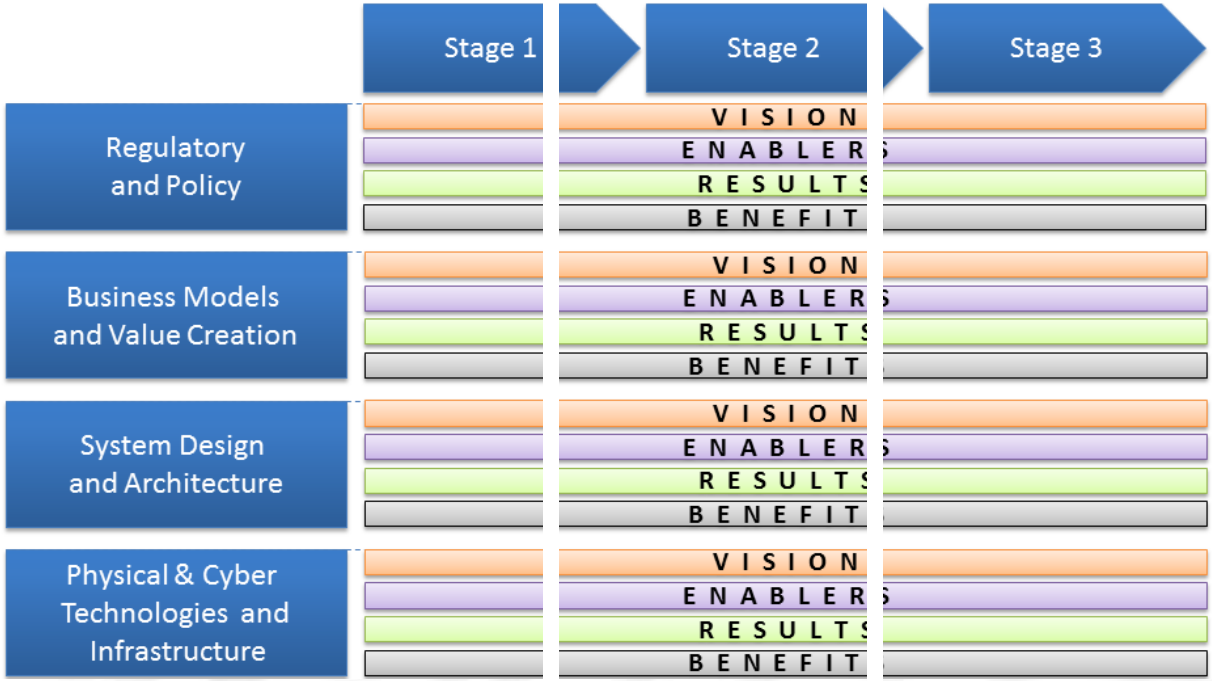
Decision Makers Checklist

TE Roadmap Stages

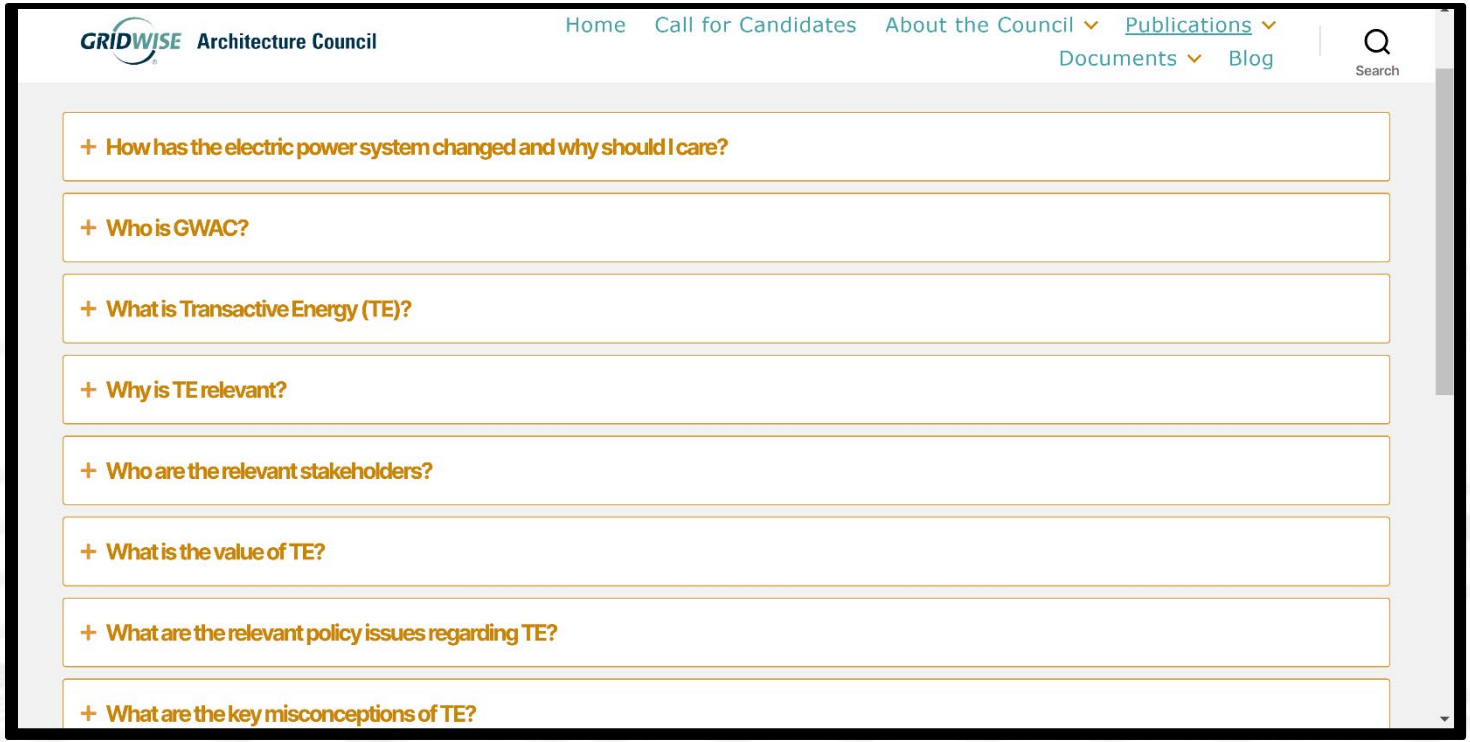




Roadmap by Stages & Framework Areas



TE FAQ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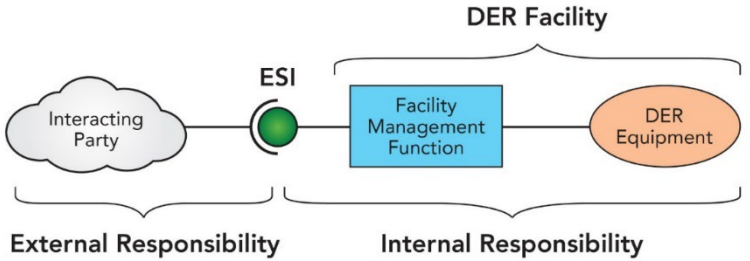
+ How has the electric power system changed and why should I care?
+ Who is GWAC?
+ What is Transactive Energy (TE)?
+ Why is TE relevant?
+ Who are the relevant stakeholders?
+ What is the value of TE?
+ What are the relevant policy issues regarding TE?
+ What are the key misconceptions of TE?

Smart Buildings as Transactive Hub

Figure 1.2. Building Systems and the TE Hub API Interfaces



Electric Industry Visions & Future States Project

Ron Cunningham

Electric Industry Visions & Future States Project

PROVENANCE – GRID 3.0 → GWAC

OBJECTIVES

POTENTIAL GWAC

WORK ITEMS

WORKPLAN

> ARCHITECTURAL

CHALLENGES

PAPER STATUS

> GWAC INSIGHTS – NEEDS

RON CUNNINGHAM

Remember Grid 3.0?

- **The organization**: an informal/ad-hoc collaboration of electric industry organizations to engage stakeholders and develop roadmap(s) needed to achieve resilient, flexible, highly-interactive grid of the future – Grid 3.0.

- There are multiple electric grid/industry Visions in the industry.
- Is it likely to get to an electric grid Vision, as Grid 3.0 FutureState (A) states “Develop and publicly document a well-articulated, industry shaped consensus on future states of the electric power grid through a collaborative process” across the various electric grid industry stakeholders?

Grid 3.0 FutureStates (14 plus added telecom)

- stakeholder consensus on futurestates
- clearly defined multi-jurisd. regulatory models
- clear sustainable business models & value propositions
- tool enabled stakeholders have equal place at table
- forums/processes to enable regional coop/collab across stakeholder groups
- set of conceptual arch models across domains as starting point for sustainable business models
- well defined points of IOP via agreed upon, used by all electric industry stakeholders
- well defined decision support environ. for efficient data & stakeholder knowledge
- coordinated set ref designs & documentation that supports stakeholder choices concerning electricity
- well defined & understood privacy ecosystem
- well defined & understood proactive security ecosystem
- improved security clearance processing cycle times
- environment that retrains, attracts workforce to work in evolving electric industry
- clearly defined and used for changing electric system

Grid 3.0 → GWAC

GWAC assimilated the GRID 3.0 intent of searching out coordination and collaboration opportunities across electric industry stakeholder groups to:

- call attention to key industry challenges and areas needing improvement
- leveraging the stakeholder groups in-scope skill sets & proficiencies
- leverage and build on prior industry research and work deliverables rather than duplicating already worked and resolved challenges

One of the 1st efforts is the Electric Industry (including grid) Stakeholder Groups' Visions & Future States Assessment Project

GWAC Vision/FutureStates Project Scope, Work Plan, expected Deliverables and Outcomes

- Assess Electric Industry stakeholder organizations' Vision & FutureStates Reports (9 stakeholders assessed, 3 recent ones recognized)
- Characterize: timelines; identify similarities, differences/divergence of assessed content
- Provide GWAC insights: challenges-barriers; stakeholder impacts; architecturally significant challenge/gap areas; industry & grid drivers and systemic issues; GWAC IOP stack relevance to Grid Architecture
- Publish project results as whitepaper(s) and socialize with industry stakeholder groups

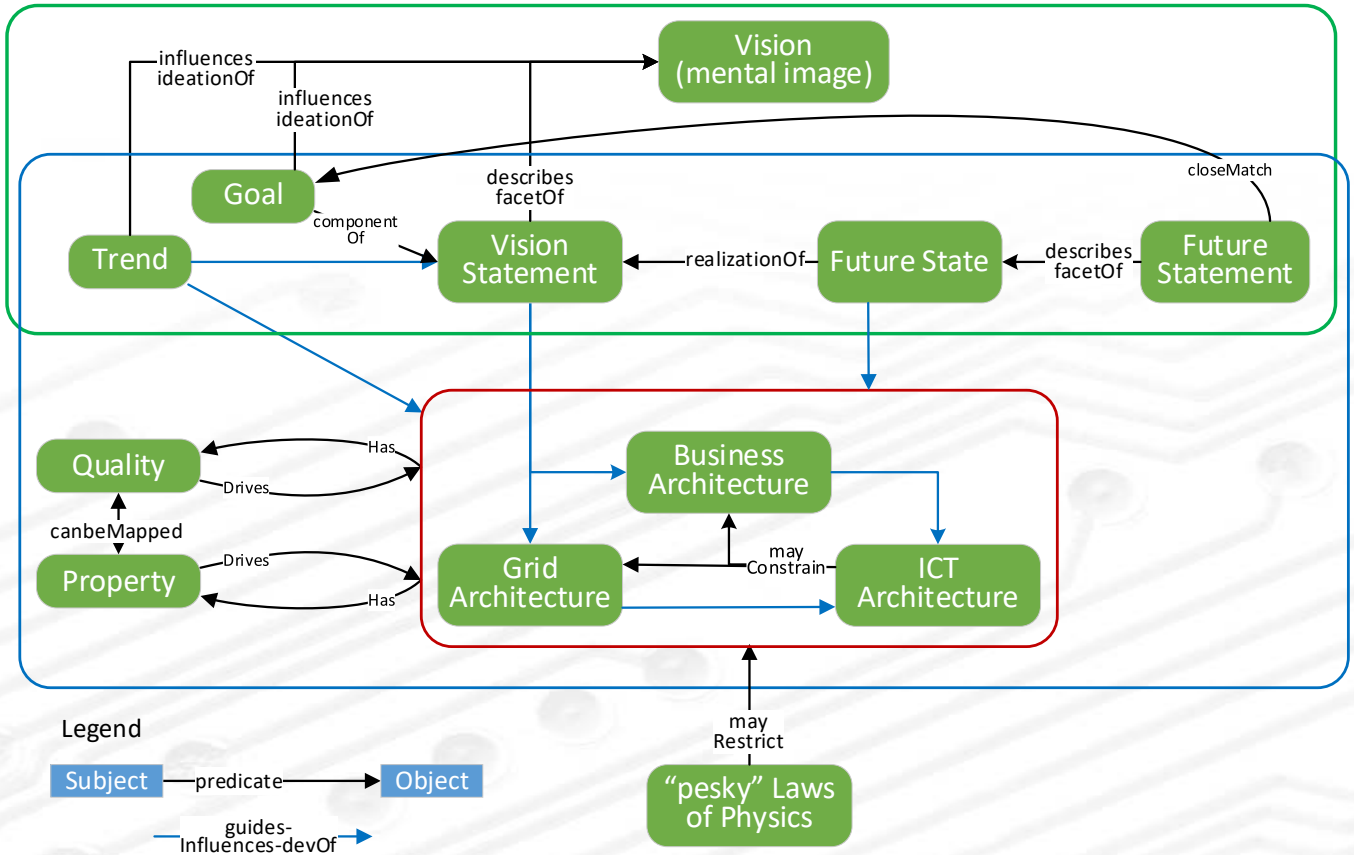
Grid FutureState White Paper TOC – initial draft

- Abstract
- Executive Summary
- Vision & Future States good, bad
- Found Stakeholders' Visions /FutureStates Assessed/Recent
- Vision/FutureStates:
  - Timeline, Similarities, Differences

- GWAC Insights:
  - Vision/Futurestates Challenges -barriers
  - Stakeholder impacts
  - Architectural Challenge-gaps
  - Industry Grid Drivers / Systemic Issues
  - GWAC IOP Stack Relevance
- Terms & definitions
- Complete rest of TOC sections e.g. next steps

legend - wip-tbd

GWAC Vision & Future States Terms Relations



Future Statements – 2nd Refactoring

Count of FutureStatements	Source											Architectural Type						
Decomposed /Refactor 2 - topic categories	CSIRO	DSPx	EPRI IEN	GWA	IEEE USA	IESO NWA-Markets	IESO TD-IOP Frmwrk	NIST IOP Frmwrk rel4	PEI	UTC	Item Total	Arch-BusModel	Arch-srvc-Funct/Rqmts	Arch-Strategy	Arch-trend/driver	Energy-trend/driver	Item Total
comm network										10	10	3	2		5		10
customer	4	1	1	3					2		11	1	5	1	4		11
energy	3		2		3						8			4	2	2	8
environmental			2		1						3			1		2	3
grid		3	3	5		1		18		1	31	4	16	5	6		31
grid assets/tech			1	8		2	3	2	1	1	18	1	8	4	5		18
grid coord				6		7	21				34	27	5	1	1		34
value-benefit-optimize		1	4	6		2	2	7			22	1	9	7	2	3	22
Total	7	5	13	28	4	12	26	27	3	12	137	37	45	23	25	7	137

Potential GWAC work Items – Architectural

- Transition from centralized to distributed
- Transition from silos to platforms
- Standardization of Interfaces and structures
- Leveraging structures accommodating large quantities DER
- Developing effective data communications enabling control and coordination in distributed structures
- Developing new industry structures

Potential GWAC work Items – probing Qs

- under what scenarios are different architectural structures applicable to a stakeholder consensus Vision & Future State?
- is it possible that all stakeholders' goals and future states be satisfied equitably? What does it take to pull off?
- are the numerous stakeholder and societal goals achievable in their timelines while maintaining grid reliability, or will more localized or region outages to become the norm?
- what architectural techniques can be brought to improving supply change resilience?