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:

GRÍDWISE

- 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



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Interoperability Constitutional Convention December 2005





https://gridwiseac.org/pdfs/Interoperability_Path_Forward_Whitepaper.pdf

GridWise® Architecture Council

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

- 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
 - \rightarrow Participate in the Convention



Constitution:

We the People as we wanted

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Article B - Business Principles

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GRÍDWISE Cashing Transformer, Street, or other

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

GRÍDWISE

[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

GRÍDWISE

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 (109, 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

GRÍDW<u>ISE</u>

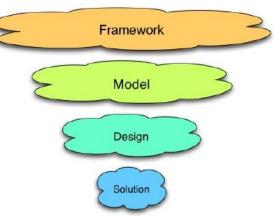
- Organizing concepts
 - Taxonomy, definitions, levels, tenets
- Attempts to simplify the complex
 Warning it's still complex
- Aids communication between community members
 Careful semantics remain a stumbling block
- Provides perspective from selected viewpoints
- Reveals points where agreement simplifies 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.



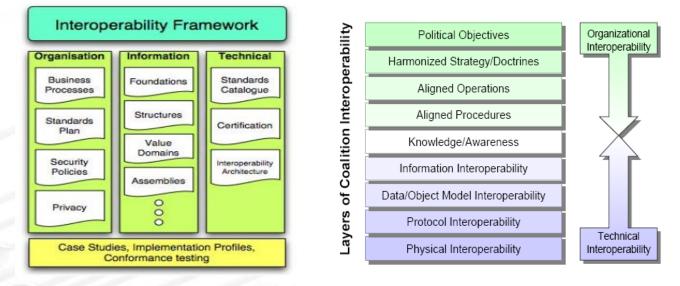
Borrowed from NEHTA: Australian National E-Health Transition Authority



Framework Inspirations

NEHTA Interop Framework

Layers of Coalition Interoperability

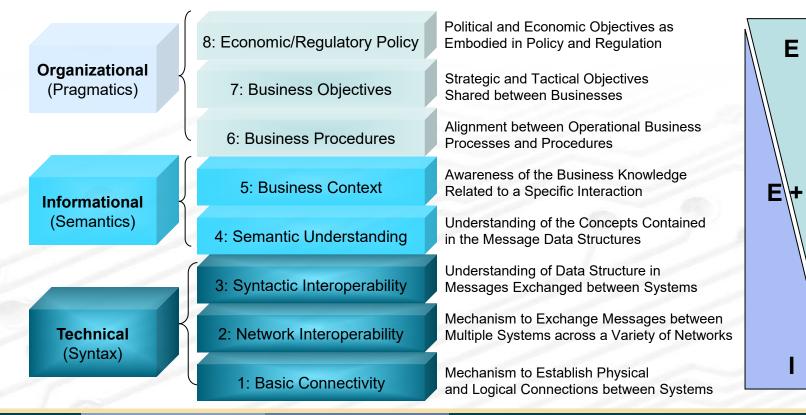


© 2002 VMASC

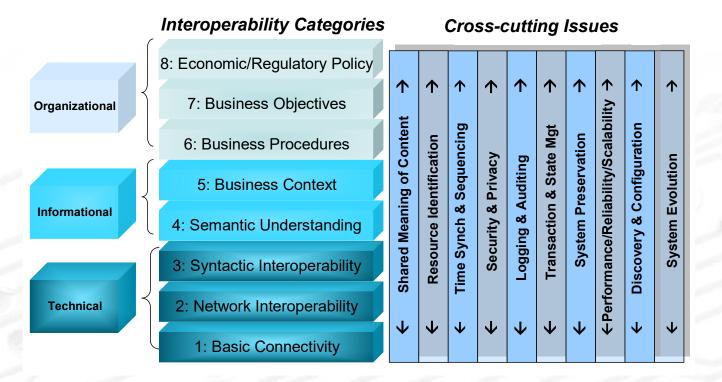
A. Tolk, Beyond Technical Interoperability, 8th CCRTS, National Defense University, Jun 03



Interoperability Framework

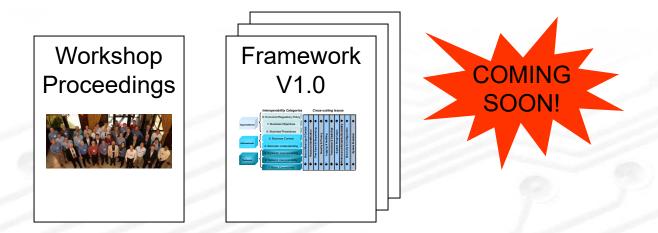


Cross-Cutting Issues





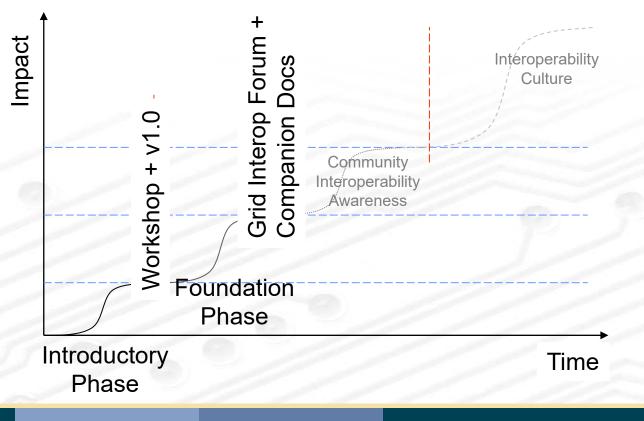
GRÍDWISE



Technical Framework Introduction Document v1.0 Plus Workshop of Technical Experts Available at <u>www.gridwiseac.org</u>

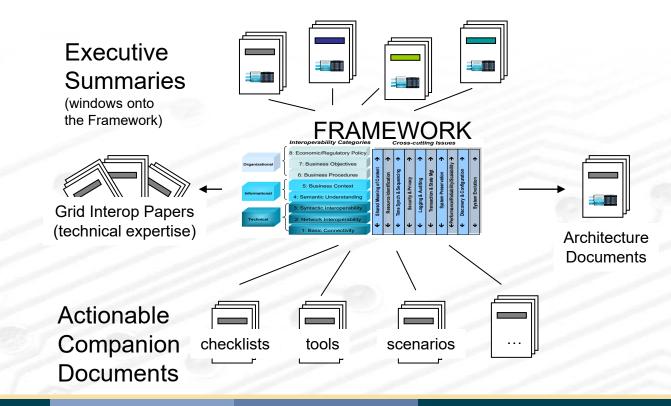


Framework Progression





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 <u>www.gridwiseac.org</u>
- 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

GridWise[®] Architecture Council

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 Center
- 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



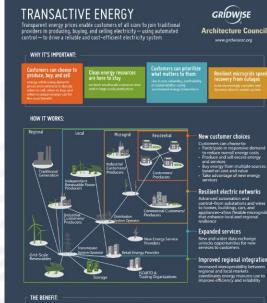


TE Publications

- 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



Reliability	Affordability	Sustainability	Efficiency	
Integrates smart control and automation to manage renewables and balance local energy requirements without disruption	Customers can choose to buy and sell energy using price information to best manage cost and priorities	Permits incremental grid modernization with secure, interoperable technologies while integrating renewable resources	Economic signals for conventional and distributed energy encourage the most reliable, energy-efficient production and delivery of electricit	
		sion 1.0	PNNL-SA	

http://www.gridwiseac.org/pdfs/te_infogr					
aphics_061014_pnnl_sa_103395.pdf					



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Transactive Energy Principles

Highly automated, coordinated self- optimization	Provide non-discriminatory participation by qualified participations
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

Interoperability Categories

GRÍDW<u>ISE</u>

Economic/Regulatory Policy **Regulatory and Policy** Organizational **Business Objectives** (Pragmatics) **Business Procedures Business Models & Value** Realization **Business Context** Informational (Semantics) Semantic Understanding System Design and Architecture Syntactic Interoperability **Technical Network Interoperability Physical and Cyber** (Syntax) **Technologies and Basic Connectivity** Infrastructure

Transactive Energy

Figure 6. GWAC Stack with strata of transactive energy

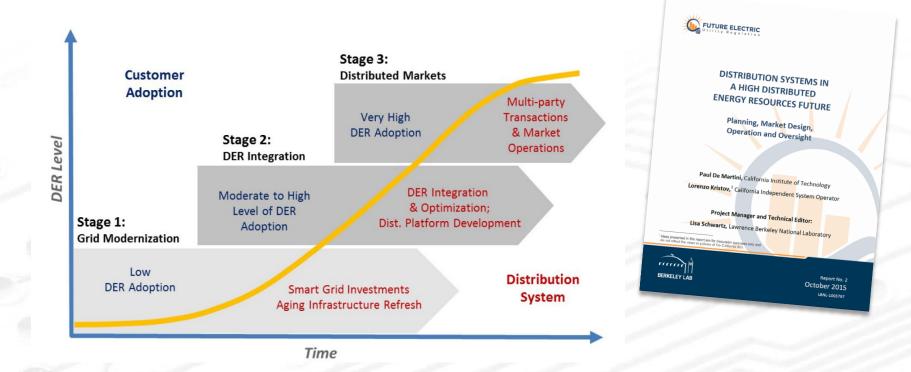


Decision Makers Checklist





TE Roadmap Stages



Roadmap by Stages & Framework Areas

	Stage 1	Stage 2	Stage 3
Regulatory and Policy		VISION ENABLER RESULTS BENEFIT	
Business Models and Value Creation		VISION ENABLER RESULTS BENEFIT	
System Design and Architecture		VISION ENABLER RESULTS BENEFIT	
Physical & Cyber Technologies and Infrastructure		V I S I O N E N A B L E R R E S U L T S B E N E F I T	



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TE FAQ

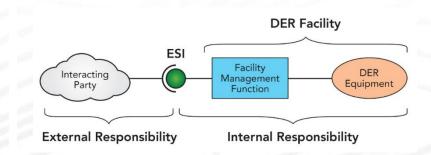
GRIDWISE Architecture Council	Home	Call for Candidates	About the Council 🗸 Docur	Publications	Q Search	
+ How has the electric power system changed	d and why sho	uld I care?				
+ Whois GWAC?						
+ What is Transactive Energy (TE)?						
+ Why is TE relevant?						
+ Who are the relevant stakeholders?						
+ What is the value of TE?						
+ What are the relevant policy issues regardin	g TE?					
+ What are the key misconceptions of TE?						-

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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 \rightarrow GWAC	
0	OBJECTIVES	POTENTIAL GWAC
WORK ITEMS		2 7 0
0	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, highlyinteractive 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

GRÍDWISE

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- 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 \rightarrow 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

legend - wip-tbd

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

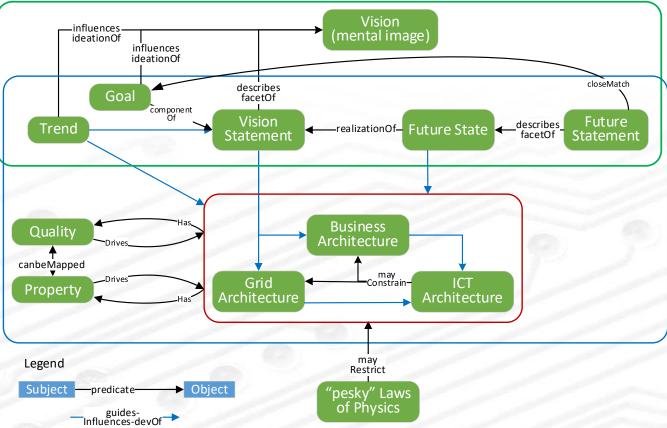
 Timeline, Similarities, Differences

- 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



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GWAC Vision & Future States Terms Relations





Future Statements – 2nd Refactoring

Count of FutureStatements Source								Architectural Type										
Decomposed /Refactor 2 - topic categories	CSIRO	DSP _X	EPRI IEN	GWA	lEEE USA	IESO NWA-Mari	lESO TD-IOP E	NIST IOP Frmush	PEI WIK reld		Item Total	Arch-BusModel	Arch-srvc-Funce	Arch-Strategy	Arch-trend/drive	Energy-trend /	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?



