GRID MODERNIZATION INITIATIVE PEER REVIEW

GMLC 1.2.2 Interoperability

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19 April 2017

GMLC Peer Review Meeting

Sheraton Pentagon City, Arlington, VA

PNNL-SA-124939

1.2.2 Interoperability
High-Level Project Summary

The ability of two or more systems or components to exchange information and to use the information that has been exchanged.
ISO/IEC/IEEE 24765

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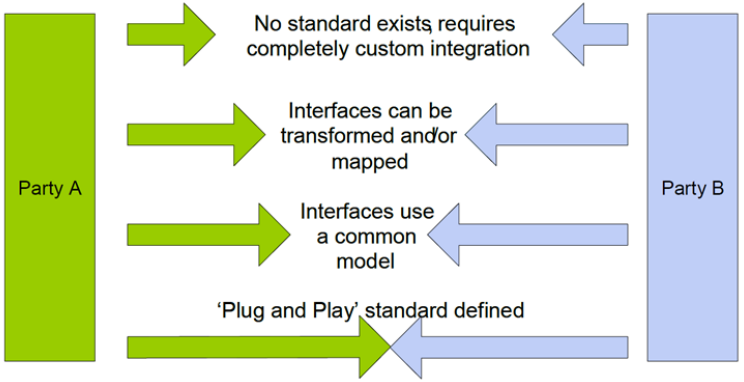
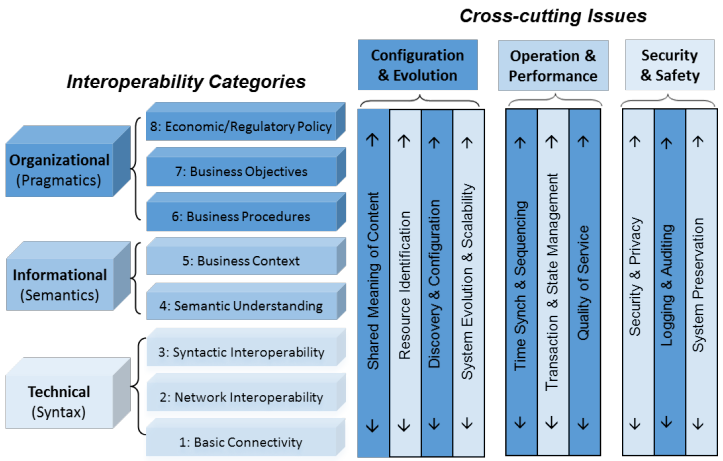
Project Description

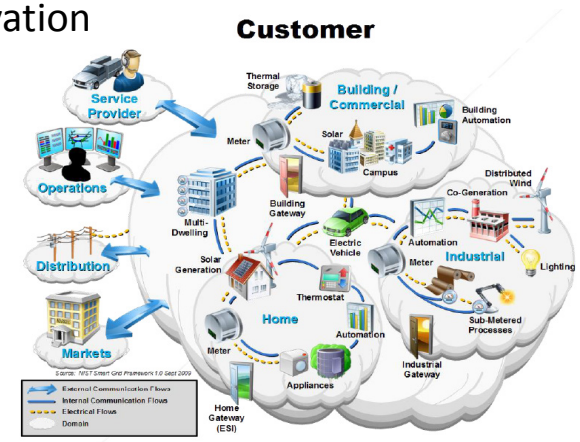
Align stakeholders on a strategic vision for devices and systems integration and develop measures and tools to support interoperability





Value Proposition

- ✓ Reduction of cost and effort for system integration
- ✓ Improve grid performance, efficiency and security
- ✓ Increase in customer choice and participation
- ✓ Establishment of industry-wide best practices
- ✓ Catalyst of innovation



Expected Outcomes

- ✓ Establish an interoperability strategic vision
- ✓ Describe the state, challenges, and path forward to advance interoperability
- ✓ Offer tools to facilitate gap analysis, develop roadmaps, and demonstrate vision concepts

1.2.2 Interoperability
Project Team

Project Participants and Roles

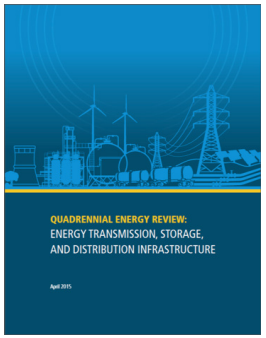
National Lab	FY16 Funding	FY17 Funding	FY18 Funding	Total Funding
PNNL	$500,000	$450,000	$500,000	$1,450,000
NREL	$200,000	$200,000	$200,000	$600,000
LBNL	$150,000	$200,000	$150,000	$500,000
ANL	$150,000	$150,000	$150,000	$450,000
Total	$1,000,000	$1,000,000	$1,000,000	$3,000,000

PNNL – lead, strategic vision, measurement tool
NREL – gaps and roadmap methodology
LBNL – support interop assessment (buildings)
ANL – support interop assessment (elec vehicles)

Partners: SGIP (now SEPA), NIST, GWAC, EPRI, IEEE, IEC, IIC, GSA, ENERGY STAR, USACE, SEI-CM, SAE, LonMark, NEMA, ASHRAE, CTA

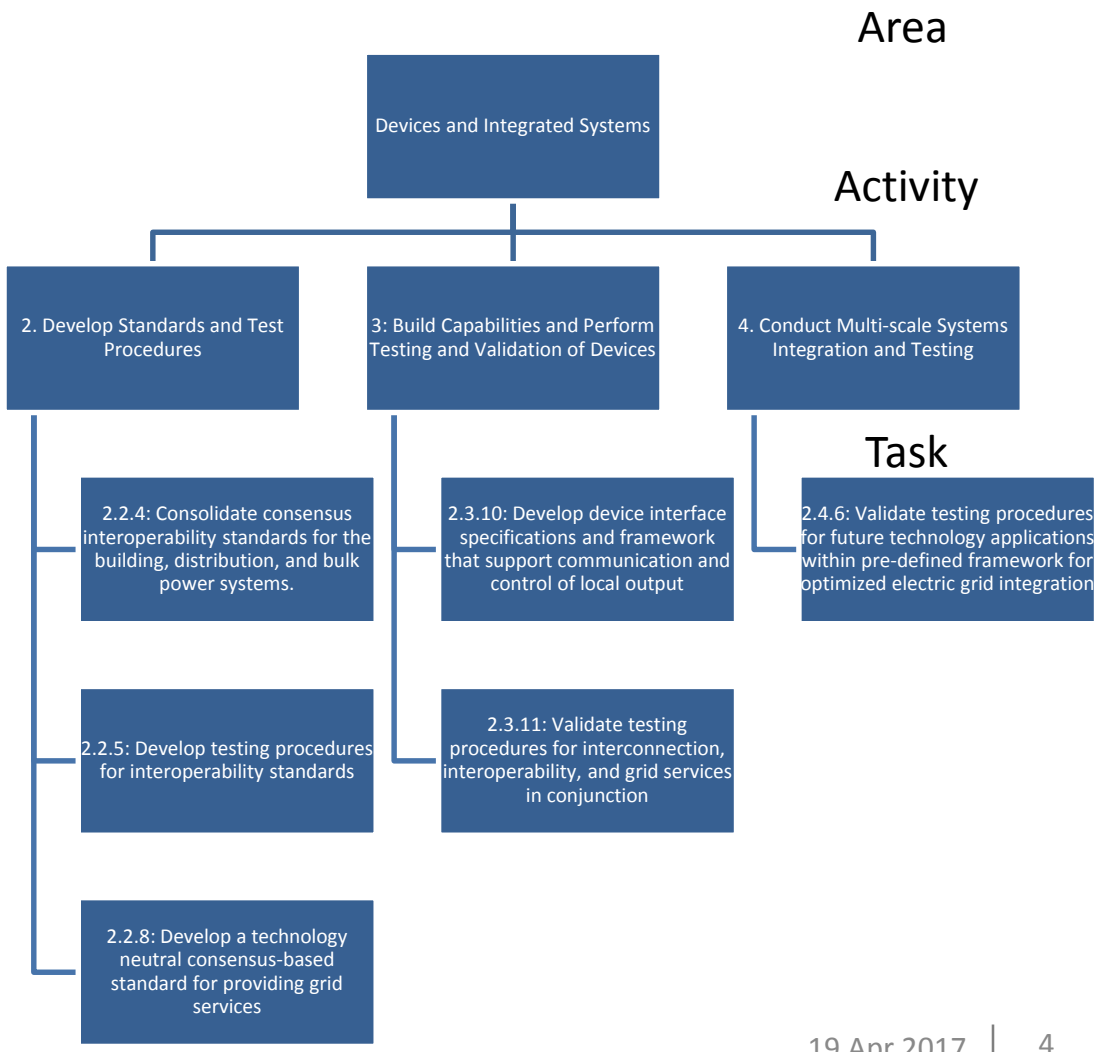
1.2.2 Interoperability
Relationship to Grid Modernization MYPP

Quadrennial Energy Review (QER) 6th recommendation: *Improve grid communication through standards and interoperability*



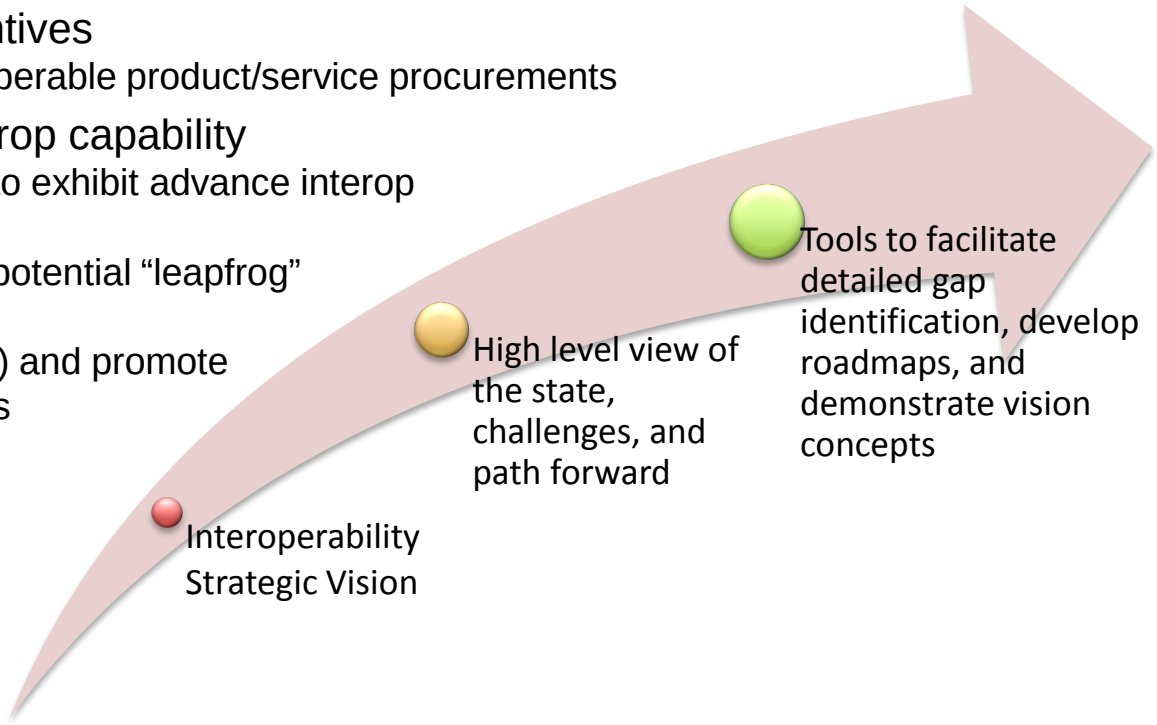
MYPP:

Frames interoperability as a fundamental quality that needs attention for grid modernization. The chart shows some of the main activities with linkages



1.2.2 Interoperability
Approach

- Strategic vision
  - State of interoperability and desired integration experience
  - Document with stakeholder buy-in, socialization
- Gaps & roadmaps
  - Tools to measure interoperability/ease of integration
  - A roadmap methodology for technology communities to set goals and a path to achieve them
- Industry engagement incentives
  - Tools to encourage interoperable product/service procurements
- Demonstrate visionary interop capability
  - Industry directed contest to exhibit advance interop concepts
  - Identify priority gaps and potential “leapfrog” capabilities
  - Conduct project/contest(s) and promote results for follow-on efforts



1.2.2 Interoperability
Key Project Milestones

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Task Name
Interop1-2-2Plan
Strategic Vision
Assemble Vision Team and Partners
Define Interop Requirements for Vision
Draft Strategic Vision
Socialize Strategic Vision & Assignments
Gaps and Roadmaps
Establish Tools to Gauge Interop Maturity
Define Interop Roadmap Methodology
Trial Interoperability Roadmap Methodology
Draft Interop GridMod Roadmap
Socialize Interop GridMod Roadmap
Support Domain Roadmaps
Industry Engagement Incentive Mechanisms
Identify Engagement Incentive Alternatives
Develop Interop Procurement Tools
Policy Support to Advance Interop
Measure Interoperability Progress Using IMM
Demonstrate Visionary Interoperability Capability
Plan Interop Challenge/Prize
Identify Priority Interop Gaps from Vision/Roadmap
Create Interop Gap Challenge/Prize
Conduct Interop Gap Competition

1.2.2 Interoperability
Accomplishments to Date

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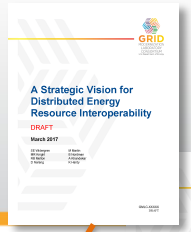
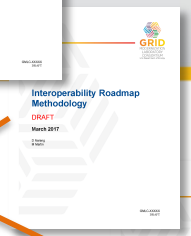
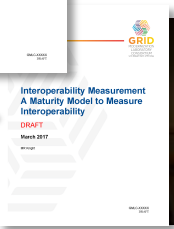
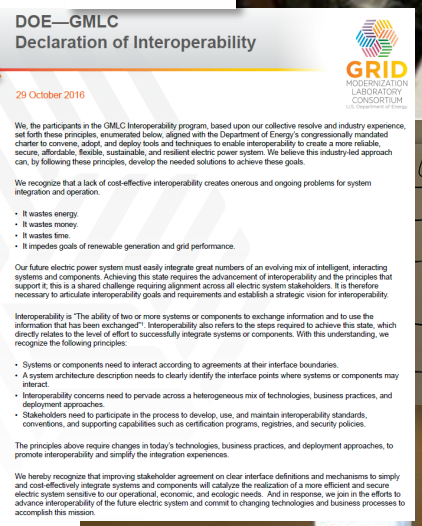
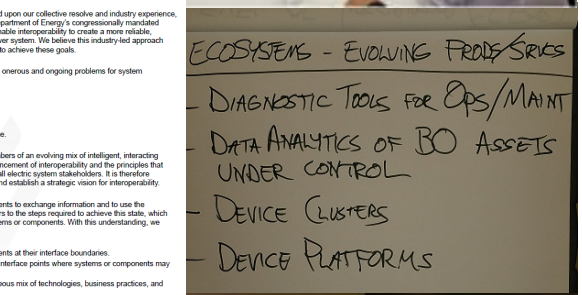
- ✓ Drafted interoperability strategic vision, measurement, and roadmap methodology
  - ➢ Declaration of Interoperability
  - ➢ Interoperability Strategic Vision
  - ➢ Interoperability Maturity Model (IMM)
  - ➢ Interoperability Roadmap Methodology
  - ➢ Public Utilities Fortnightly article, April 2017
- ✓ Demonstrable public stakeholder involvement
  - ➢ Established partnership with 16 organizations and held 7 web meetings
  - ➢ Sep 2016 stakeholder technical meeting with ~50 participants from diverse industry segments
  - ➢ Consensus voiced through unanimous vote in favor of the project's objectives and plan
  - ➢ Interoperability goals/requirements statements tested
  - ➢ Significant feedback on integration vision stories
  - ➢ Nov 2016 outreach at SGIP annual meeting reviewed Declaration, interop criteria, and roadmap methodology plan

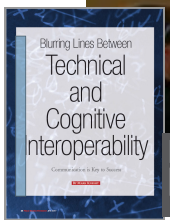






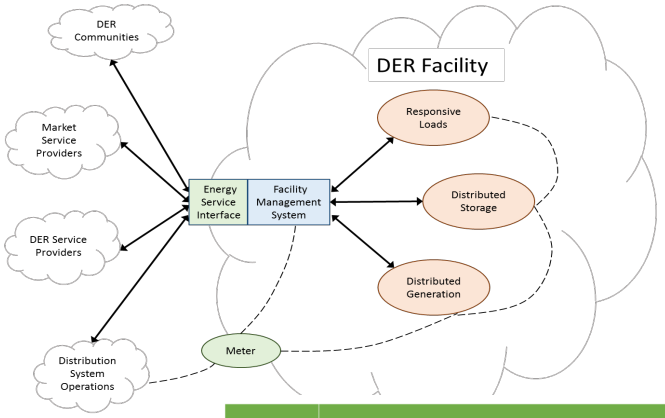


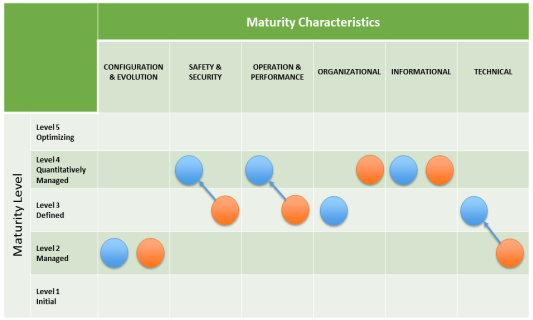


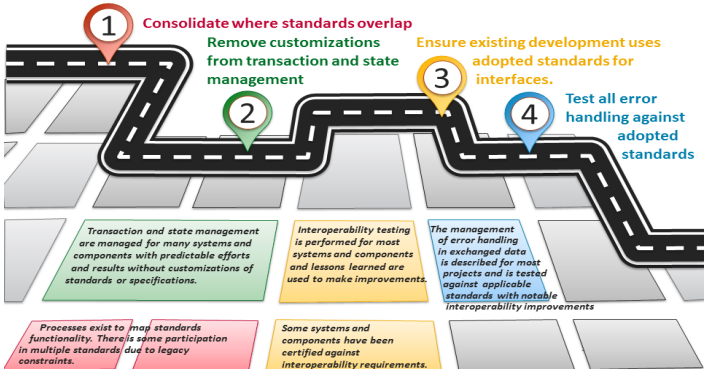


1.2.2 Interoperability

A Strategic Vision Example: DER Integration







- Layered decomposition architecture =>modular, resilient coordination framework with less facility-grid interfaces => less standards
- Grid services ref. model => performance characteristics => external DER facility interfaces non-device type specific while internal interfaces evolve independently
- Vision provides direction across all DER device type ecosystems
- Interoperability maturity model measures DER ecosystem state and exposes gaps for roadmap consideration
- Roadmaps emerge for specific DER ecosystems

1.2.2 Interoperability
Response to November 2016 Program Review

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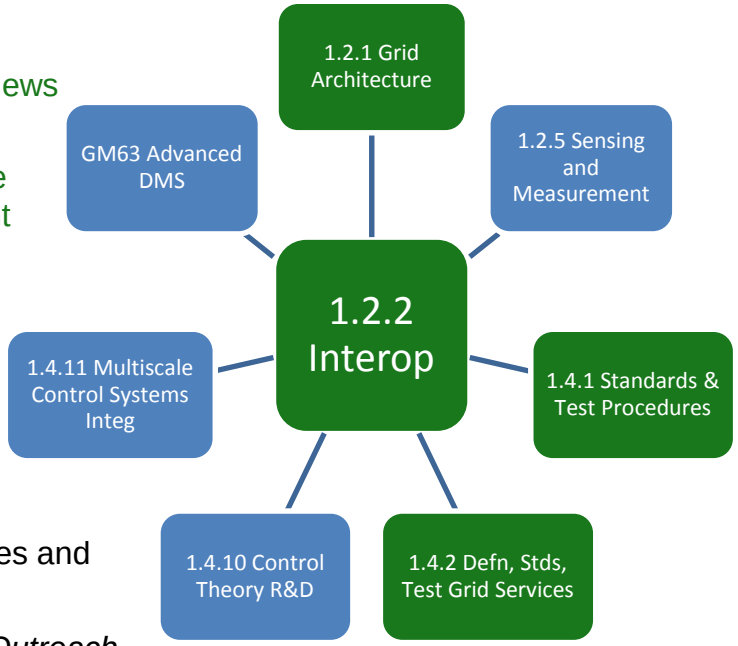
Recommendation	Response
Please share the "Declaration of Interoperability Principles" and the progress made on the assessment tool more broadly across DOE to get feedback from program managers.	Coordinating with DOE leads to distribute introductory material and the Declaration with DOE program managers.
Please set up a webinar with DOE program managers to share the results of this project to date. We want to do the same with Grid Architecture and Sensing and Measurement.	Planning with DOE leads to hold 2, 90 minute meetings at DOE-HQ in late May or June. Will encourage follow-up discussion to incorporate interoperability concerns in respective programs.

1.2.2 Interoperability
Project Integration and Collaboration

GMLC Project Liasons

- 1.2.1 Grid Arch: device/systems interface points, grid services, system views
- 1.2.5 Sensing & Measurement: sensor frameworks
- 1.4.1 Standards & Test Procedures for Interconnect and Interop: provide status assessment and gap identification tools & community engagement process
- 1.4.2 Definitions Standards and Test Procedures for Grid Services: coordinating on a common set of grid services
- 1.4.10 Control Theory R&D: consider control theory implications on interoperability
- 1.4.11 Multiscale Integration of EMS/DMS/BMS: consider control system interfaces that affect interoperability at different levels
- GM63 Advanced DMS: consider DMS interfaces to DER and field devices and integration implications



Communications

- Aug - Invitation to join project to advance interoperability
- Sep - stakeholder technical meeting with ~50 participants
  - Unanimous vote in favor of the project's objectives and plan
  - Interoperability goals/requirements statements tested
  - Declaration of Interoperability
- Nov - interoperability project session at SGIP, WA DC
- Jan - AHR Expo presentation to buildings community
- Feb - partner interaction at GWAC, San Diego
- GMLC website: https://gridmod.labworks.org/projects/interoperability

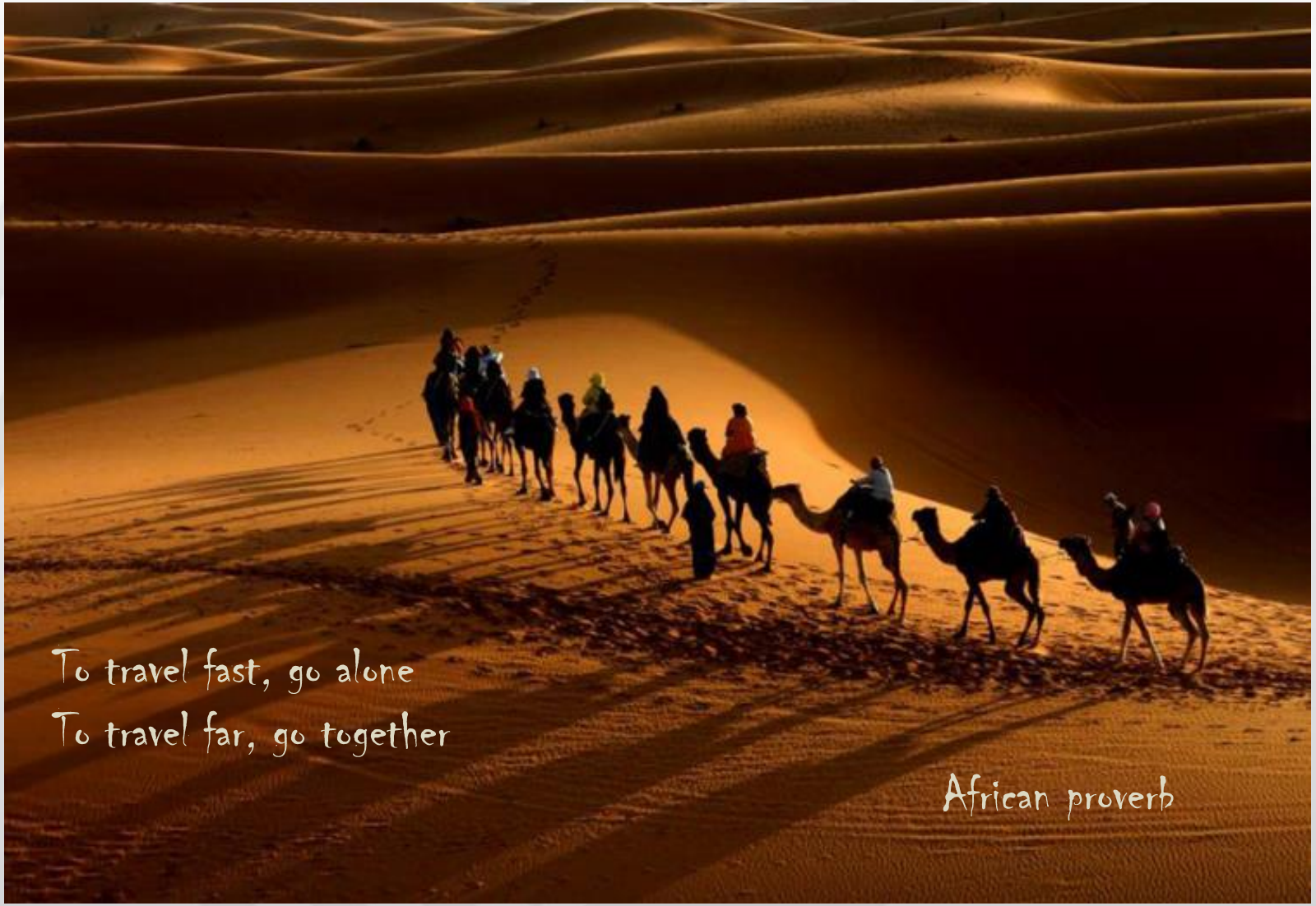
Upcoming Outreach

- Apr – article in Public Utilities Fortnightly
- Apr – IEEE ISGT panel presentation, Wa, DC
- May – stakeholder technical review meeting, Columbus, OH
- Jul – IEEE PES Smart Buildings, Loads, & Consumer Systems Committee meeting, Chicago, IL
- Jul – SEPA annual meeting, technical session, Wa, DC
- Jun – TES Conference, Portland, OR
- Continue regular partners web meetings

1.2.2 Interoperability
Next Steps and Future Plans

- **May 2017**: socialize an interoperability strategic vision document with vision scenarios and interoperability goals/requirements
  Impact – align stakeholder community on vision for integration
  - Technical Review Meeting, Columbus, OH, 10-11 May
- **September 2017**: complete an interoperability roadmap methodology with an interoperability assessment tool and trial in a technology domain (e.g., electric vehicle or automated buildings domains)
  Impact – demonstrate interop measurement and path forward
- **March 2018**: complete draft of interoperability procurement tools with industry stakeholders participation
  Impact – incentives for industry participation to advance interop
- **March 2018**: identify where commonality across technology domains can reduce the uniqueness in the number of DER interface agreements (standards) by 50%
  Impact – set course for standards convergence

Begin by Listening



1.2.1 Interoperability
Technical Details

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Backup slides follow

Declaration of Interoperability

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We, the participants in the GMLC Interoperability program, based upon our collective resolve and industry experience, set forth these principles, enumerated below, aligned with the Department of Energy's congressionally mandated charter to convene, adopt, and deploy tools and techniques to enable interoperability to create a more reliable, secure, affordable, flexible, sustainable, and resilient electric power system. We believe this industry-led approach can, by following these principles, develop the needed solutions to achieve these goals.

We recognize that a lack of cost-effective interoperability creates onerous and ongoing problems for system integration and operation.

> It wastes energy. **>** It wastes money. **>** It wastes time. **>** It impedes goals of renewable generation and grid performance.

Our future electric power system must easily integrate great numbers of an evolving mix of intelligent, interacting systems and components. Achieving this state requires the advancement of interoperability and the principles that support it; this is a shared challenge requiring alignment across all electric system stakeholders. It is therefore necessary to articulate interoperability goals and requirements and establish a strategic vision for interoperability.

Interoperability is "The ability of two or more systems or components to exchange information and to use the information that has been exchanged". Interoperability also refers to the steps required to achieve this state, which directly relates to the level of effort to successfully integrate systems or components. With this understanding, we recognize the following principles:

- Systems or components need to interact according to agreements at their interface boundaries.
- A system architecture description needs to clearly identify the interface points where systems or components may interact.
- Interoperability concerns need to pervade across a heterogeneous mix of technologies, business practices, and deployment approaches.
- Stakeholders need to participate in the process to develop, use, and maintain interoperability standards, conventions, and supporting capabilities such as certification programs, registries, and security policies.

The principles above require changes in today's technologies, business practices, and deployment approaches, to promote interoperability and simplify the integration experiences.

We hereby recognize that improving stakeholder agreement on clear interface definitions and mechanisms to simply and cost-effectively integrate systems and components will catalyze the realization of a more efficient and secure electric system sensitive to our operational, economic, and ecologic needs. And in response, we join in the efforts to advance interoperability of the future electric system and commit to changing technologies and business processes to accomplish this mission.

ISO/IEC/IEEE 24765: Systems and software engineering — Vocabulary. International Organization of Standards. 2010.