Development of an Open-Source Platform for Advanced Distribution System Management – GridAPPS-D™

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Pacific Northwest National Laboratory

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GridAPPS-D

Objectives & Outcomes

Provide an open source, standards based platform for developing advanced distribution system planning and operations applications.

Evaluate the benefits of advanced applications that take advantage of a data rich, data driven environment.

Transition the capability to industry.

Technical Scope

Applying agile software development process to creation of V1.0 of GridAPPS-D

Establishing a formal application evaluation methodology

Deployment of platform to multiple project team organizations for their development of example advanced applications.

Formal evaluation of the example applications.

Life-cycle Funding Summary ($K)

<table>
<thead>
<tr>
<th>Year 1, authorized</th>
<th>Year 2, authorized</th>
<th>Year 3, requested</th>
<th>Out-year(s)</th>
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<td>$3.7M</td>
<td>$3.3M</td>
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<td>$0.7M</td>
<td>$0.6M</td>
<td>$0.7M</td>
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Line 1 – PNNL
Line 2 – NREL
PROJECT CONTENT
Industry Need & Project Response

Three barriers:

• Cost and complexity of integration of multiple systems
• Quantitative evaluate of benefits of advanced distribution system applications
• Availability of solutions to utilities of all sizes

Project response:

• Open source, standards based, platform for application development (GridAPPS-D™)
• Formal evaluation of advanced applications
• Transition of results to industry sustained maintenance and enhancement of the platform
Expected Benefits

Enabling utilities to choose applications meeting their specific needs should improve their reliability and resilience in an affordable and sustainable manner.

Develop Once - Deploy on Multiple Vendor Systems

- Utility choice of apps
- Vendor expanded functionalities, via variety of apps
- App developed - access to customer

Innovation - Enabled!
GridAPPS-D™ – enabling distribution utility flexibility in future planning and operations

• In the future distribution utilities will have to operate a data rich, distributed system with
  • Diverse resource mix including customer and 3rd party owned DER
  • Increasing number of “smart” devices and systems
  • New market interactions
  • Automated operation
• While maintaining situational awareness, reliability and resiliency
• GridAPPS-D enables cost-effective development and integration of applications for these future needs
Expected Outcomes

- Enables standards-based development of advanced applications that can be deployed on any vendor’s compliant system, reducing cost to develop, integrate and maintain future systems while increasing utility options.

- Data-rich, data-driven applications will improve distribution system reliability with increasing penetration of distributed energy resources.

- Provides a common platform for distribution system planning and operations research and development within the DOE labs and industry.
GridAPPS-D™ conceptual architecture

- Reference implementation
- Open architecture
- Open source
- Standards based
- Well defined logical data abstractions
- Extensible and adaptable for distributed applications and distributed data sources
- Interoperable with existing systems
Functional Elements of GridAPPS-D™

Partially implemented in Release Cycle 2

Partially implemented in Release Cycle 1
GridAPPS-D™ & The CIM

- Load distribution system models
- Manipulate system models
- Share system models

- Manage data from simulations based on system models
- Manage data from existing systems
- Manage data from applications

- Provide uniform data model for app developers
- Provide uniform API for app developers
- Enable transportable applications

Model Manager

Data Manager

App Hosting Manager & Data I/O
PROJECT STATUS
Overall Time Line and Key Tasks
GridAPPS-D Development

- Release cycle 1 completed in May
- Release cycle 2
  - add remainder of functional elements
  - Transition from SQL to triple-store data management
- Release cycle 2 completes mid-October
- Release Cycle 3 – V1.0 – all functional elements – May 2018
- GridLab-D release completed in April 2018
Advanced Applications

- Data rich, data driven, advanced architectures
- Application developer workshops
- Evaluation methodology – formally defined
- Utility application “hosts”
- Currently working on application specifications
- Beta version of apps – January 2018
- V2.0 of evaluation methodology – April 2018
# Applications and Utility Hosts

<table>
<thead>
<tr>
<th>App</th>
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<th>&quot;Host&quot; Utility</th>
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Transition Planning

- Beginning discussion on transition of GridAPPS-D from DOE research project to industry supported reference implementation

- Two threads:
  - GridAPPS-D code base and documentation
  - Utility application “hosts”

- Discussing with interested utilities, EPRI, NRECA, venture capitalists

- Next step – meeting / Workshop with interested parties

- Transition plan draft for review – February 2018
FY2018 / PROJECT YEAR 2 PLAN
# Key Tasks, Milestones

<table>
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<tr>
<th>Task or Milestone</th>
<th>Deliverable</th>
<th>Date</th>
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<tr>
<td>IAB</td>
<td>Hold IAB Meetings</td>
<td>Annual F2F, Quarterly web</td>
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<tr>
<td>GridAPPS-D</td>
<td>Completion of Release Cycles</td>
<td>May 2017, October 2017, May 2018</td>
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<tr>
<td>Implementation</td>
<td>Software and Docs online</td>
<td>June 2018</td>
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<tr>
<td>GridAPPS-D V1.0 Release</td>
<td>Test Harness release 1.0</td>
<td>January 2018</td>
</tr>
<tr>
<td>GridAPPS-D SWQA &amp; Testing</td>
<td>Demo of EIOC HW &amp; SW supporting project</td>
<td>April 2018</td>
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<tr>
<td>EIOC Operating Environment</td>
<td>Evaluation Framework V2.0 complete</td>
<td>April 2018</td>
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<td>Application validation / evaluation</td>
<td>Beta version of each app</td>
<td>January 2018</td>
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<tr>
<td>Application Development</td>
<td>GridLAB-D Annual release</td>
<td>April 2017, 2018, 2019</td>
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<td>Platform modeling and sim</td>
<td>Plan Draft for DOE review</td>
<td>February 2018</td>
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Year 2 Schedule Summary

- Implementation Release Cycle 2
- V0.6
- Specification and Design of Advanced Applications
- Transition Plan Development
- Transition Plan Workshop
- GridLAB-D Maintenance and Development
- Refine and Test Validation Plan
- V2.0
- Validation Plan
- ^ App Development Workshop 3
- ^ Betas
- ^ App Betas
- ^ Draft Trans. Plan
- V1.0

Timeline:
- April
- June
- Aug
- Oct
- Nov
- Jan
- March
## Project Risk Management

<table>
<thead>
<tr>
<th>Risk</th>
<th>Consequence</th>
<th>Mgmt Strategy</th>
<th>Mitigation Plan</th>
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<tbody>
<tr>
<td>Data “ingest” capabilities – lack of vendor API documentation</td>
<td>Limits the scope of vendor systems GridAPPS-D can interact with</td>
<td>Mitigate</td>
<td>Schedule contigency, prioritize order of vendor interactions, vendor training</td>
</tr>
<tr>
<td>Proposed CIM extensions not well formed</td>
<td>Rework of portions of GridAPPS-D</td>
<td>Mitigate</td>
<td>Involve SME’s, establish review process, participate in CIM working groups</td>
</tr>
<tr>
<td>Losing code repository in GitHub</td>
<td>Work lost – significant time to recover</td>
<td>Mitigate</td>
<td>Establish backup processes</td>
</tr>
<tr>
<td>Real-time simulation performance lacking</td>
<td>Limits scope of application development</td>
<td>Mitigate</td>
<td>Testing guides optimization and diversify to include OpenDSS</td>
</tr>
</tbody>
</table>

Examples from risk register (currently 18 total risks documented)
TECHNOLOGY TRANSFER ACTIVITIES
Presentations and Publications

Completed

• Multiple presentations including:
  – ISGT 2016 and 2017
  – 2017 IEEE PES General Meeting and
  – presentations to several utilities

Planned

Journal Papers

• PNNL ADMS overview 2/1/2018
• PNNL VVO application 4/1/2018
• PNNL SE/PE application 4/1/2018
• PNNL Transactive application 4/1/2018
• NREL State Forecasting Application 4/1/2018
• NREL Online-OPF Application 4/1/2018
• WSU VVO OPF Application 12/31/2017
• WSU Resilient Restoration 7/31/2018

Conference

• PNNL Graph Theory paper
• PNNL ISGT 2018
• WSU ISGT Control of DERs

Trade Journals

• MGS TBD
• INCSYS TBD

Project reports and documentation associated with major tasks
Open Source Development

- BSD License
- GitHub repository
  https://github.com/GRIDAPPSD/GOSS-GridAPPS-D
- Read the Docs documentation site
  http://gridappsd.readthedocs.io
- Referring interested parties directly to results
Thank You

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GitHub Repository:
https://github.com/GRIDAPPSD/GOSS-GridAPPS-D

ReadTheDocs:
http://gridappsd.readthedocs.io