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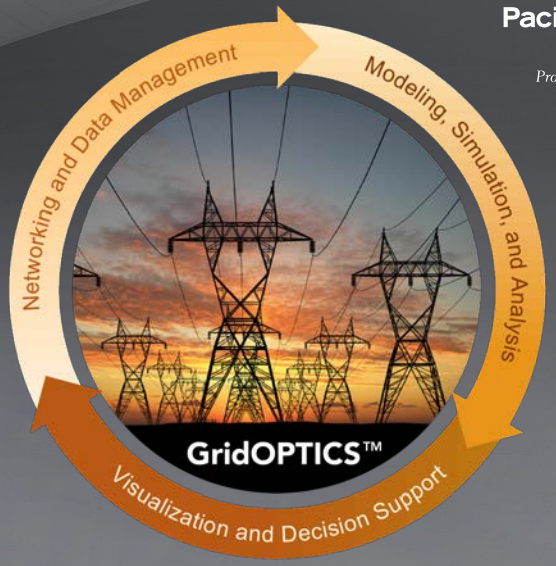

Future Power Grid Initiative

NIAC DAY@PNNL

Presented by: Henry Huang, Jeff Dagle

Richland, WA
March 18, 2014

FPGI Delivers GridOPTICS™ Architecture:
Link Data to Computation to Visualization

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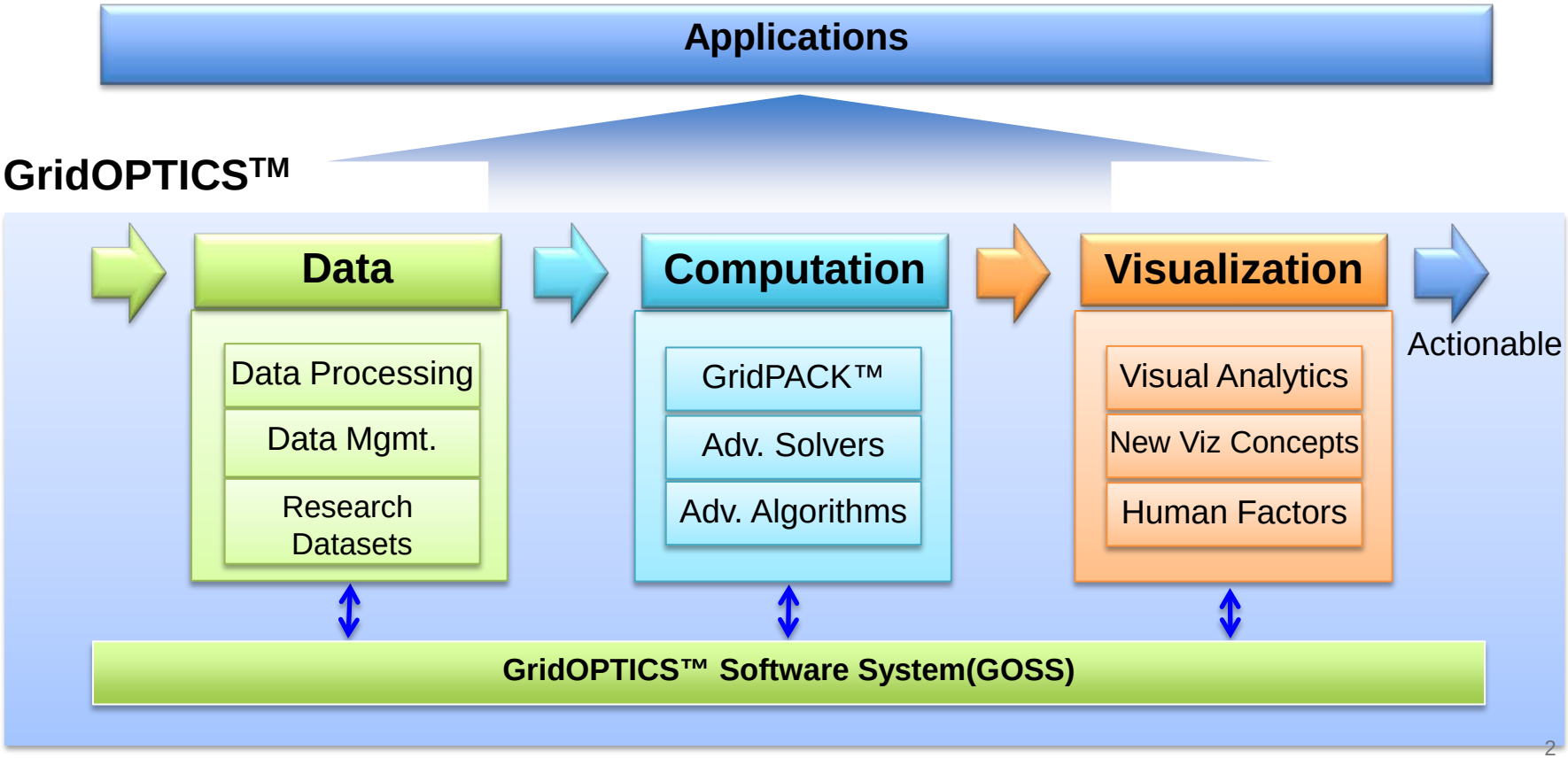
- Open Source; Open Format; Open Forum
  - Enhance interoperability of software tools
  - Overcome barriers for accelerated development of advanced technologies and tools for the future power grid.



Future Power Grid Initiative Uses a Holistic Approach to Tackle Power Grid Challenges

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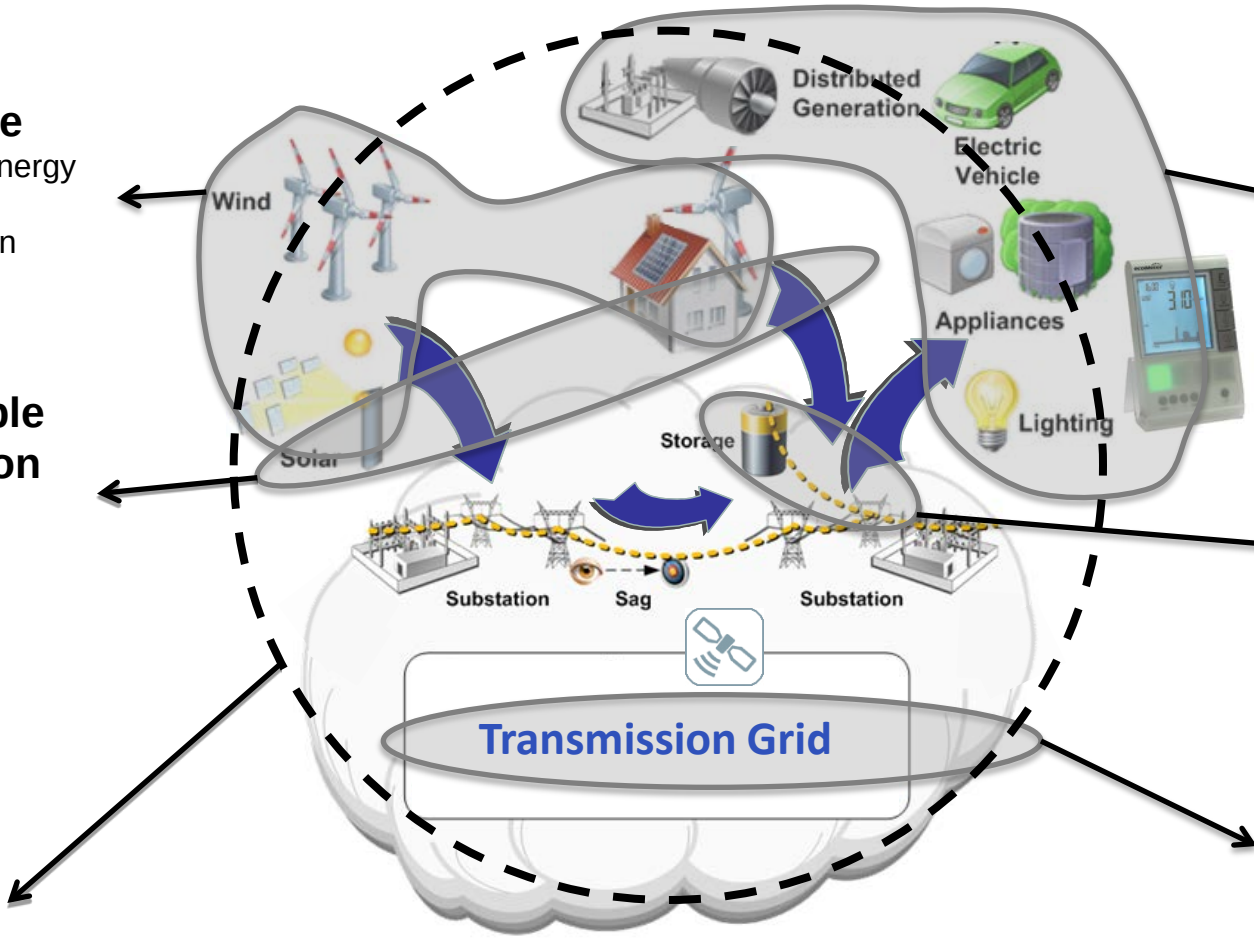
Renewable
(Renewable energy technology, interconnection standards)

Renewable Integration
(Renewable Integration Modeling)



Smart Grid
(Deployment of smart devices, empowering customer involvement and innovation)

Storage and Storage Integration
(Deployment of cost-effective storage)

Transmission Reliability
(Advanced measurement and control technology, e.g., synchrophasors)

Future Power Grid Initiative

With end-to-end grid in mind, address questions:

- What can we use the data for (what data network is required?)
- How will we address the complexity in order to understand the grid?
- How will we run such a complex grid?

Data and Computational Complexity:
Opportunities for NIAC/PNNL Synergy

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	Today – SCADA data	Tomorrow – Phasor data	Improvement
Variety	voltage + current	+ phase angle	more information
Velocity	1 sample/4 seconds	30-120 samples/second	~200x faster
Volume	8 terabytes/year	1.5 petabytes/year	~200x more data*
Veracity	unseen ms-oscillations	oscillations seen at ~10ms	greater accuracy

* Transmission level only

	0-2 years	3-5 years	6-10 years +
Model Size	**10^4** (major transmission elements)	**10^5** (+ major renewable and major loads)	**10^6** (+ renewable, loads, DGs)
Simulation Time to Solution	**2-4 minutes**	**2-4 seconds**	**10 msec – 1 sec**
• State Estimation	100 MFLOPS	10 GFLOPS	10 ExaFLOPS
• Contingency Analysis	100 MFLOPS	1 TFLOPS	10 PFLOPS
• Dynamic Simulation	1 MFLOPS (10x slower than real-time)	100 GFLOPS (10x faster than real-time)	10 TFLOPS (10x faster than real-time)
• Small Signal Stability	10 GFLOPS	100 TFLOPS	1 ExaFLOPS