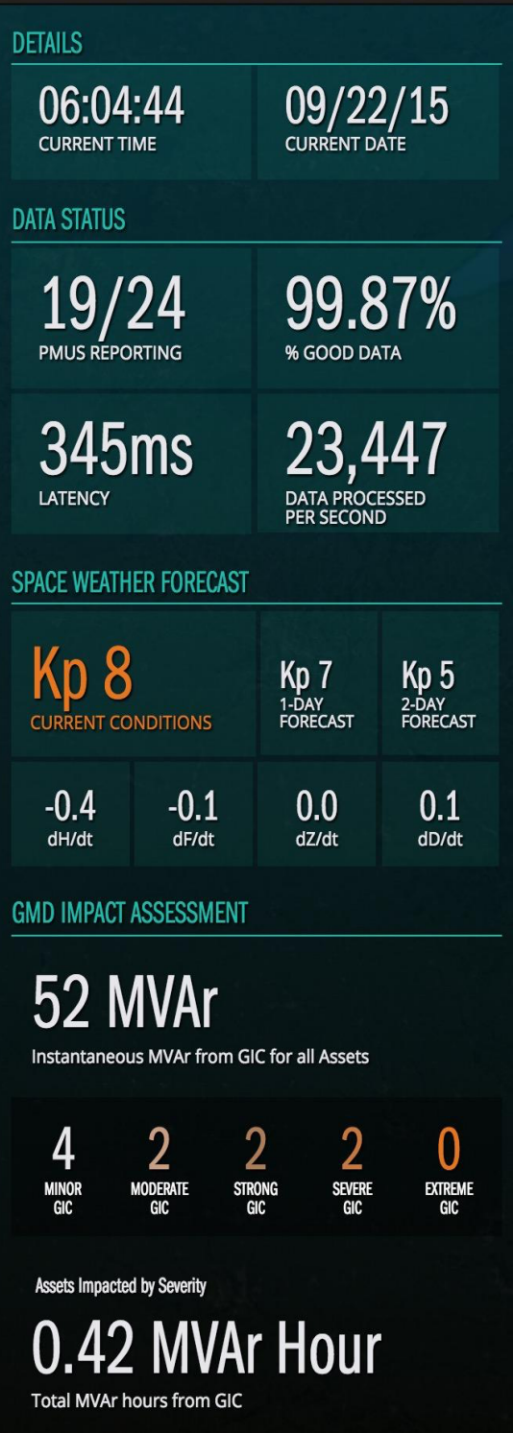


Unlocking the Value of PMU Data

By Sean Patrick Murphy and Jerry Schuman

CIGRE Grid of the Future, 2016

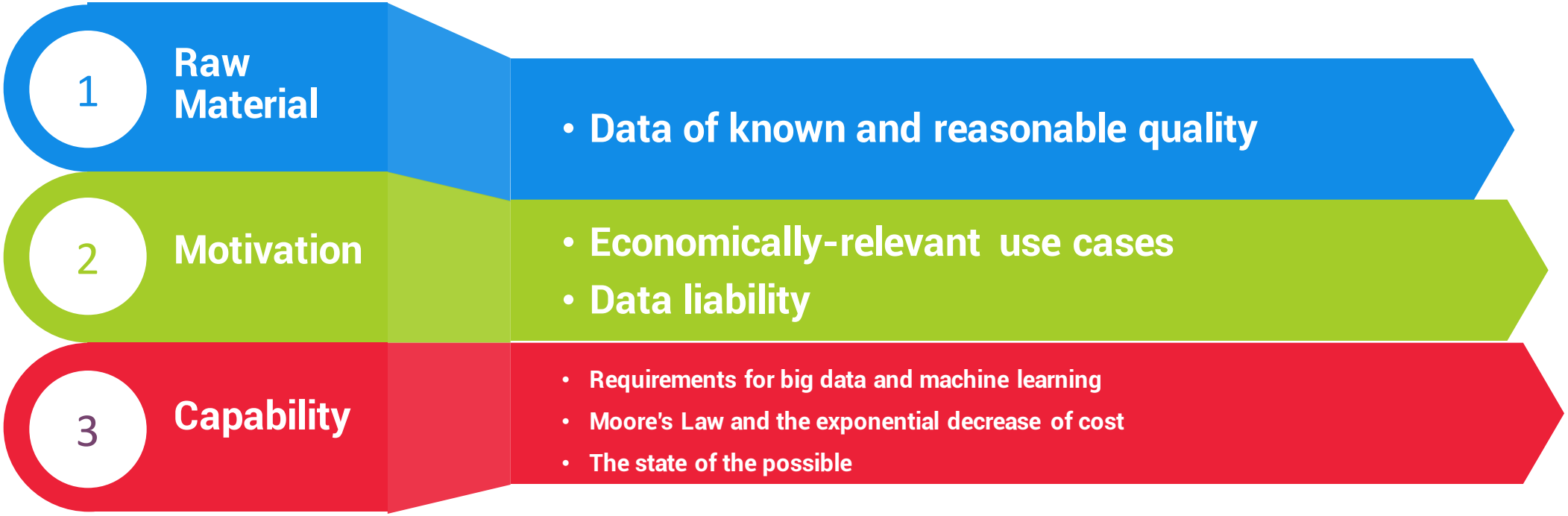
Philadelphia, PA

ABSTRACT

With the advent and subsequent deployment of synchrophasor technology across the transmission portion of the grid, the electric utility industry and federal government have made a significant and public investment toward a more data-oriented future over the last two decades. We will argue that all of the necessary ingredients are now available to leverage the data produced by these new sensors to generate far greater ROI than had originally been anticipated.

To unlock the latent value in this data, utilities need the (1) appropriate raw material in the form of high quality data, (2) suitable financial motivation to use the data to solve known and unknown problems, and (3) capability to realize the use cases in a scalable and cost effective fashion. This paper will show that data quality is a readily solvable issue despite having not been adequately addressed. It is neither a technology nor an algorithm problem, but appears to be one of organizational will. Significant incentive to use PMU and other next generation sensor data exists in many forms. PMU data can be leveraged to reduce unnecessary costs for utilities and enhance operational visibility without the need for additional investment in equipment and systems. We also note that other industry sectors have evolved the state of the art in big data storage and analysis and that the utility industry could capitalize on the value that those investments have produced.

3 Components to Unlocking the Value of Data



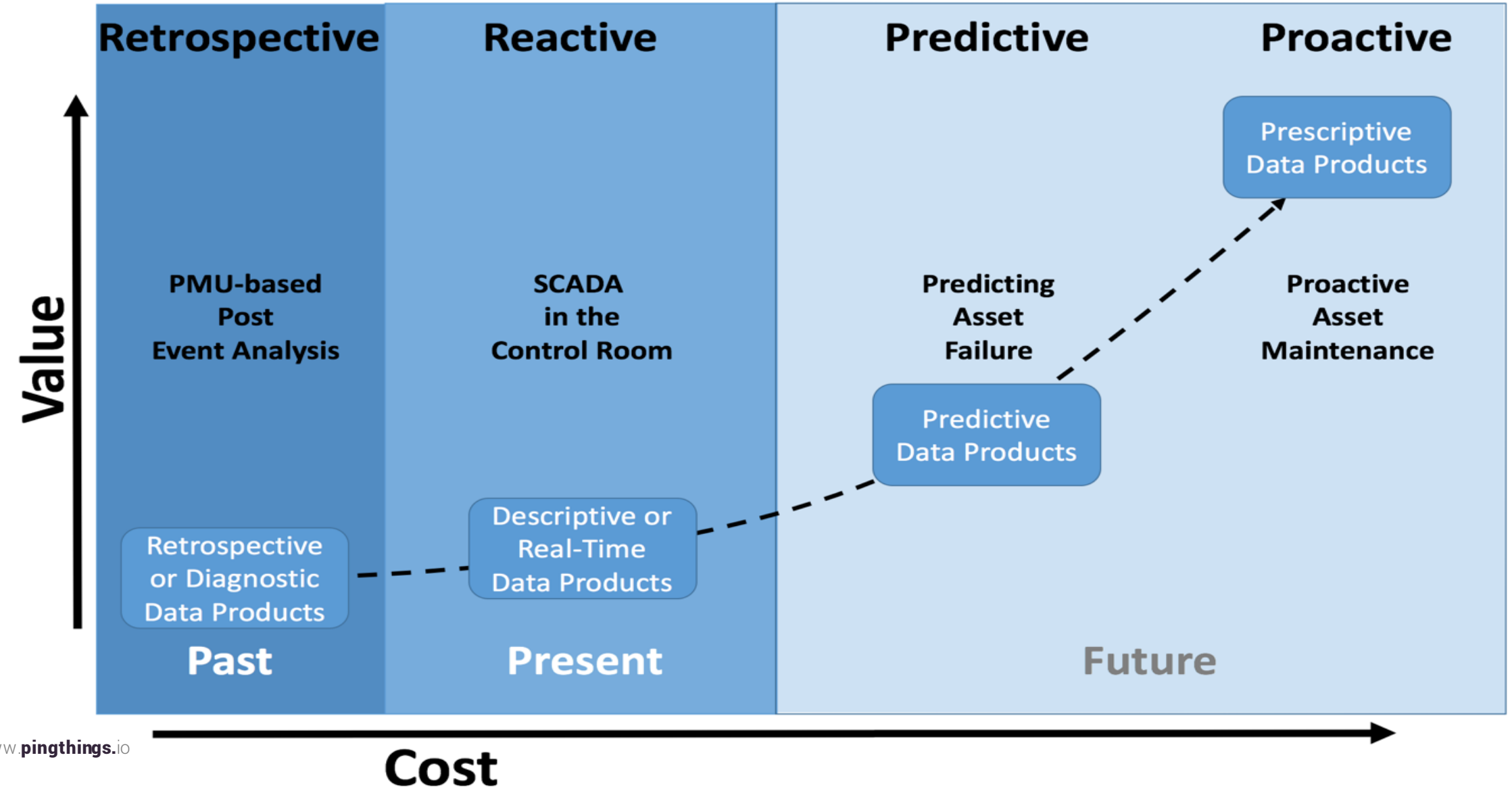
Synchrophasor Data Quality

> *Data is just like crude. It's valuable, but if unrefined it cannot really be used. It has to be changed into gas, plastic, chemicals, etc. to create a valuable entity that drives profitable activity; so must data be broken down, analyzed for it to have value.*

M. Palmer, "Data is the new oil," http://ana.blogs.com/maestros/2006/11/data_is_the_new.html

Synchrophasor Data Quality

Value Creation as a Function of Cost and Time Period



Known Use Cases

"BPA used synchrophasor data to recalibrate the 1,100 MW Columbia Nuclear Generating Station without needing to take the unit off line, ***providing $100,000 to $700,000 in estimated savings for this type of generator outage****."*

"ISO-NE event analysis applications automatically collect and analyze synchrophasor data from PMUs all across New England, enabling engineers to quickly identify and analyze disturbances. ***With the improved efficiency, ISO-NE is able to analyze two or three events per week – up from two events per year – using the same resources.****"*

Retrospective

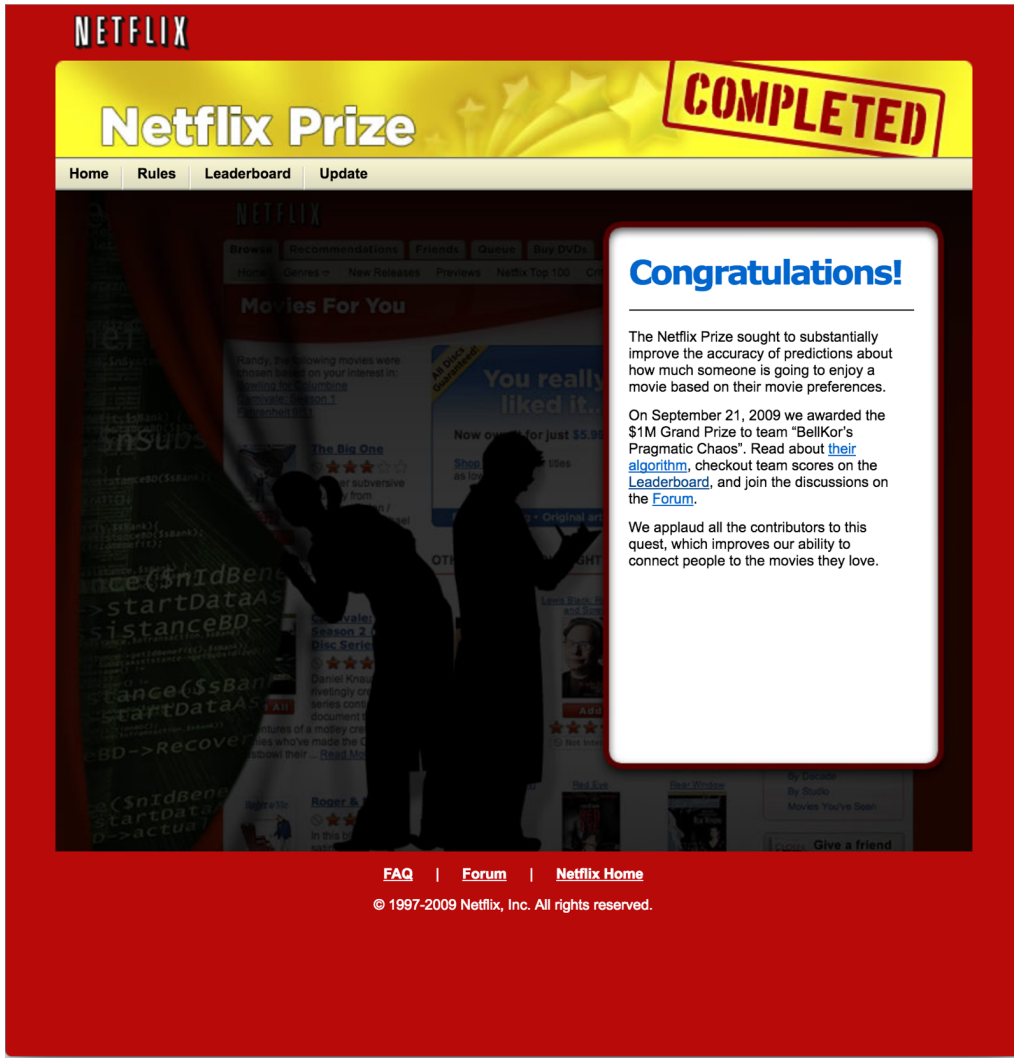
- Operator Training and Event Simulation
- Forensic Event Analysis

Reactive

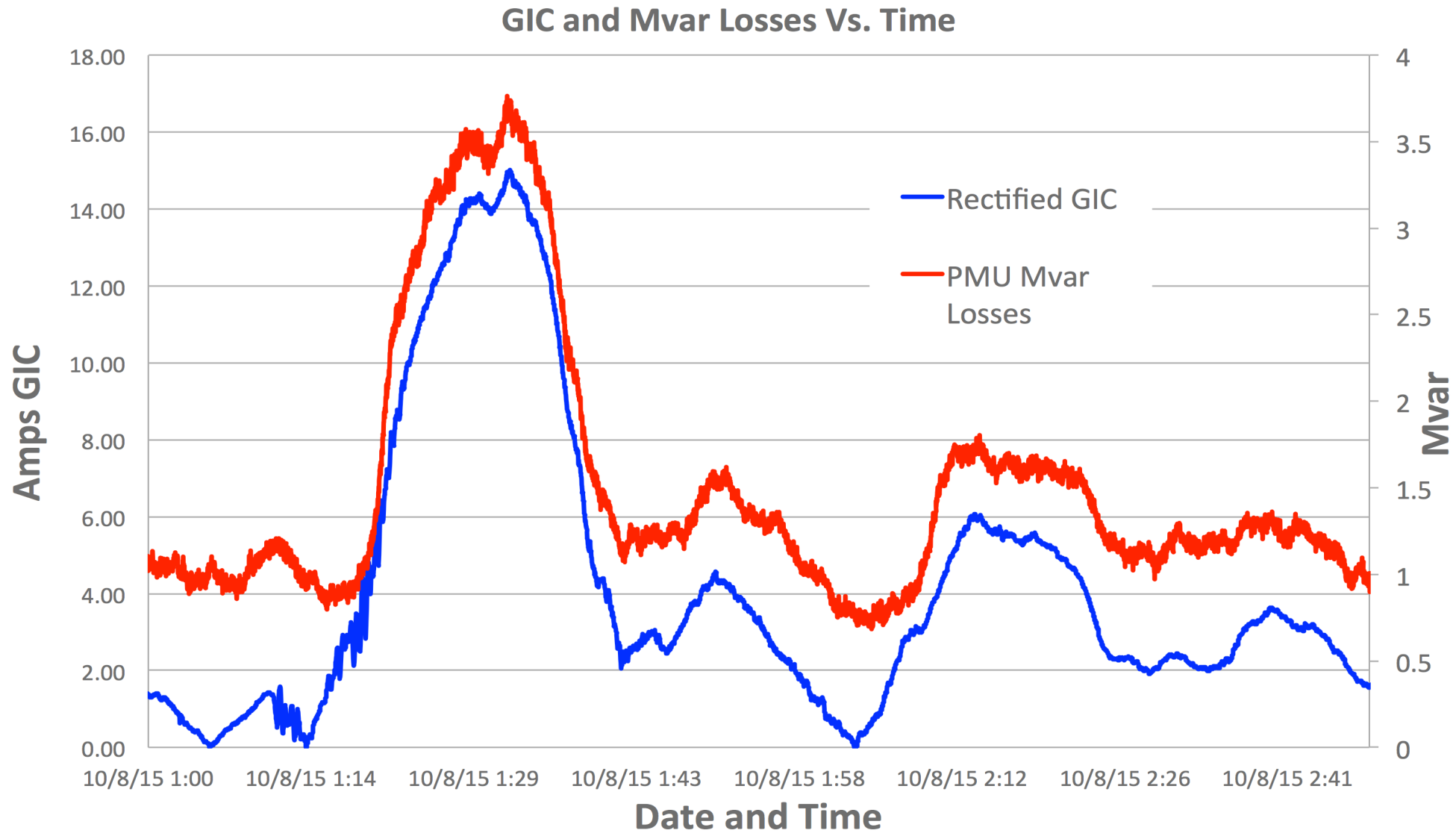
- Wide Area Situational Awareness
- Oscillation Detection
- Phase Angle Monitoring
- Voltage Stability Monitoring and Management

The Value Proposition for Synchrophasor Technology, Itemizing and Calculating the Benefits from Synchrophasor Technology Use, Version 1.0, North American Synchrophasor Initiative NASPI Technical Report, October 2015

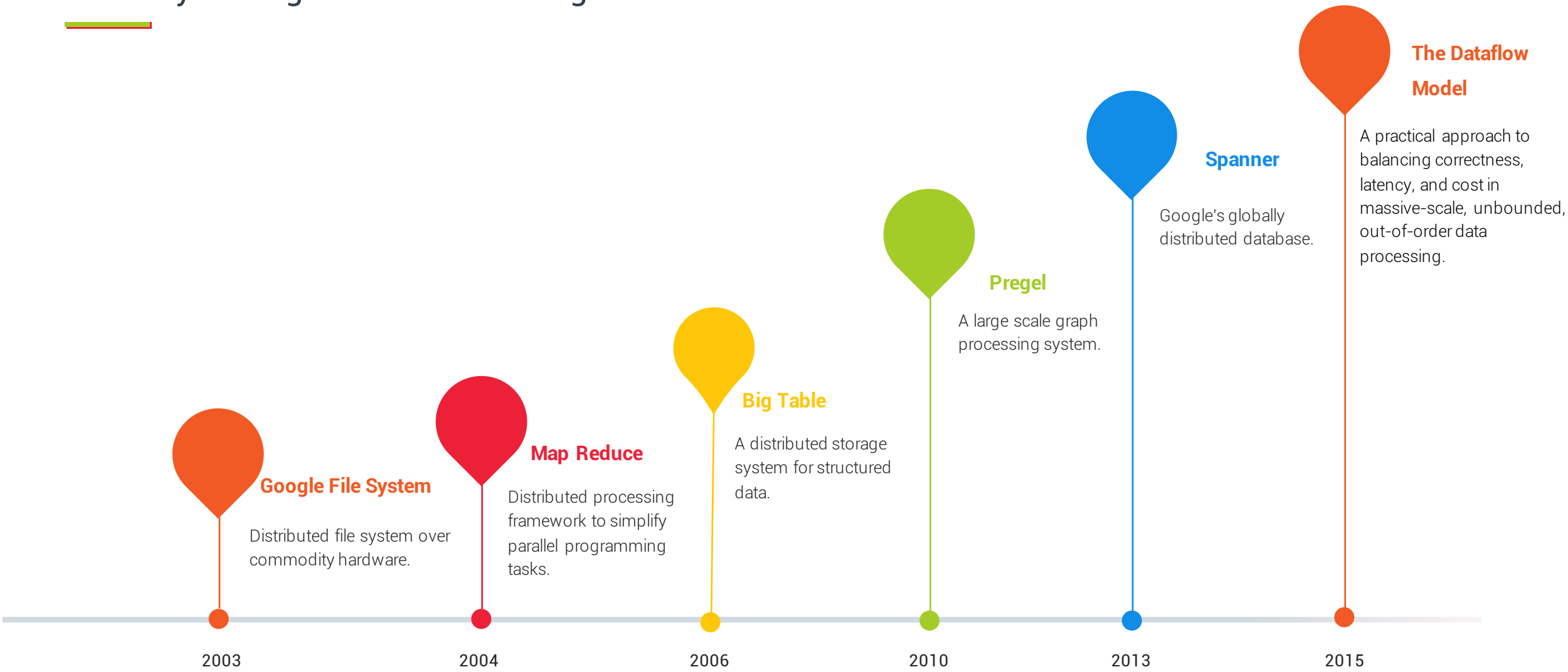
Unexpected Use Cases from Data



Unexpected Use Cases for PMU Data



History of Big Data from Google



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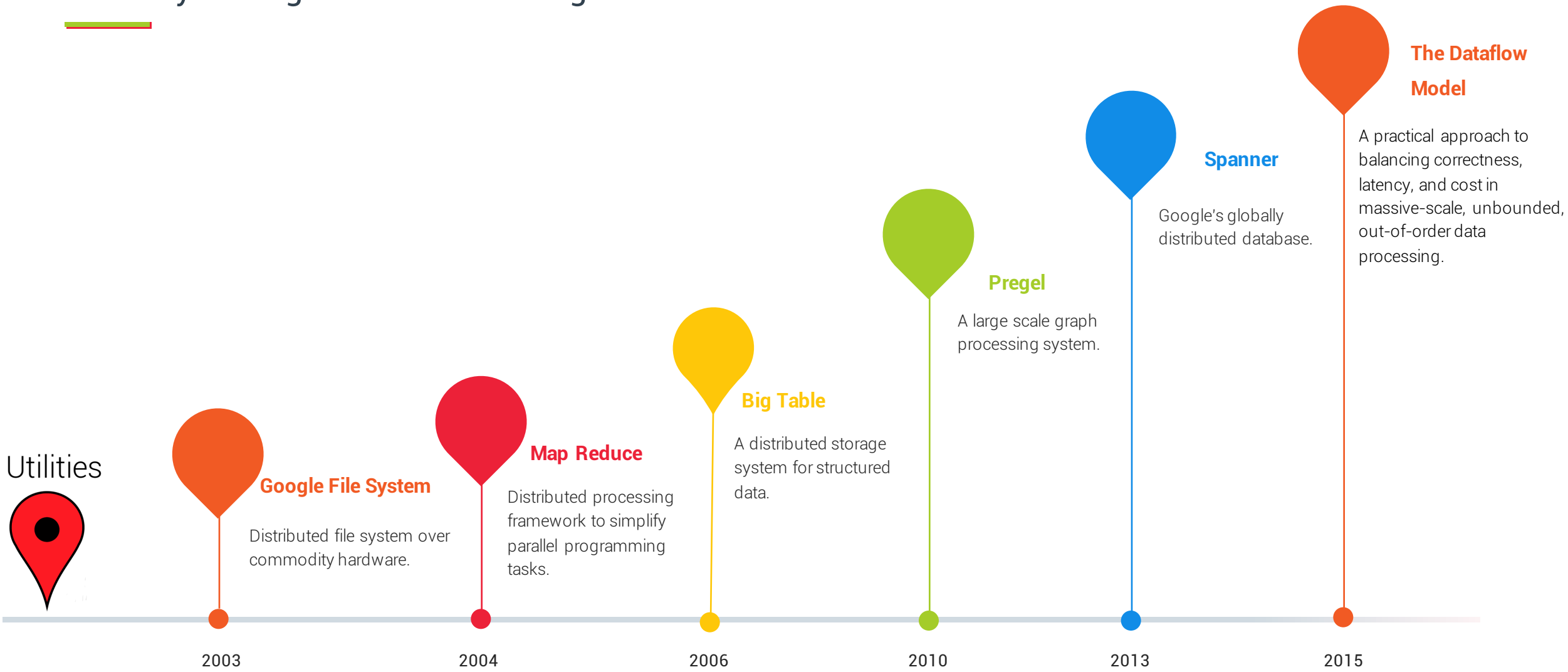


A Paradigm Shift

Old Paradigm - Software Engineering

- Humans write the code
- Limited by ability to describe exactly what must be done without error

Deep Blue beats Gary Kasparov 1997

New Paradigm - Machine Learning

- Data teaches algorithms to perform function or task
- Limited by the amount of data and algorithms
- Algorithms need ***ALL*** available data

Watson beats champions 2011

AlphaGo beats Lee Sedol 2016

Cramming More Components onto Integrated Circuits

The experts look ahead

Cramming more components onto integrated circuits

With unit cost falling as the number of components per circuit rises, by 1975 economics may dictate squeezing many as 65,000 components on a single silicon chip

By Gordon E. Moore

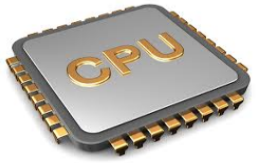
Director, Research and Development Laboratories, Fairchild Semiconductor division of Fairchild Camera and Instrument Corp.

The future of integrated electronics is the future of electronics itself. The advantages of integration will bring about a proliferation of electronics, pushing this science into many new areas.

Integrated circuits will lead to such wonders as home computers—or at least terminals connected to a central computer—automatic controls for automobiles, and personal portable communications equipment. The electronic wristwatch needs only a display to be feasible today.

But the biggest potential lies in the production of large systems. In telephone communications, integrated circuits in digital filters will separate channels on multiplex equipment. Integrated circuits will also switch telephone circuits and perform data processing.

Computers will be more powerful, and will be organized in completely different ways. For example, memories built of integrated electronics may be distributed throughout the

	CPU	RAM	Storage	Software
				
	Cost per Gigaflop	**Cost per Gigabyte**	**Cost per Gigabyte**	**Enterprise Data Systems**
1995	$42,000	$32,000	$60,000	Million$
2015	$0.03	$5	$0.05	Free, Open source

The RAM required to hold a month's worth of PMU data for the entire North American continent costs approximately $10K

Conclusions

- Data quality is a solvable issue.
- Data liability is a looming issue for the industry.
- Vast motivation exists to pursue synchrophasor data applications.
- Moore's law and open source software have provided the capabilities to handle PMU data.

PingThings PredictiveGrid:DQA

Sean Murphy

CURRENT SYSTEM DATE AND TIME

06:04:22 | 10/13/16

DATA STATUS

19/24 PMUS REPORTING

94.27% % GOOD DATA

344ms AVERAGE LATENCY

557ms MAX LATENCY

13,176 DATA POINTS PROCESSED PER SECOND

DATA QUALITY - SYSTEM LEVEL

94.27% Good Data

- 1.67% Missing Values
- 0.97% Null Values
- 1.00% Zero Values
- 0.95% Out of Range Values
- 1.16% Repeated Values

Show Table View

0%
20%
40%
60%
80%
100%

Questions?

PingThings
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Sean Murphy
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