Analytics on the Industrial Internet

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THE INDUSTRIAL INTERNET IS EMERGING

From servers to people and now "things," the Internet is powering connections to trillions of entities around the world. More connections mean more knowledge, more conversations and more optimization, and in the next wave of the Internet — the Industrial Internet — these connections will lead to smarter technologies that help to move, cure, power and build out the world we live in. From high speed trains to hospitals to the appliances in your kitchen, everything will be more efficient and more convenient for people.

Facebook for your flights? Smart jet engines give status updates real-time while in flight and on the ground, so airlines can keep better track of maintenance and get passengers from place to place more quickly and efficiently. Air travelers across the globe "Like" it!

The energy grid is getting even smarter, with utilities now able to monitor power transformers, diagnose hiccups and plan for disruptions. When things move smoothly behind the scenes, customers never have to worry about being inconvenienced by power shortages.

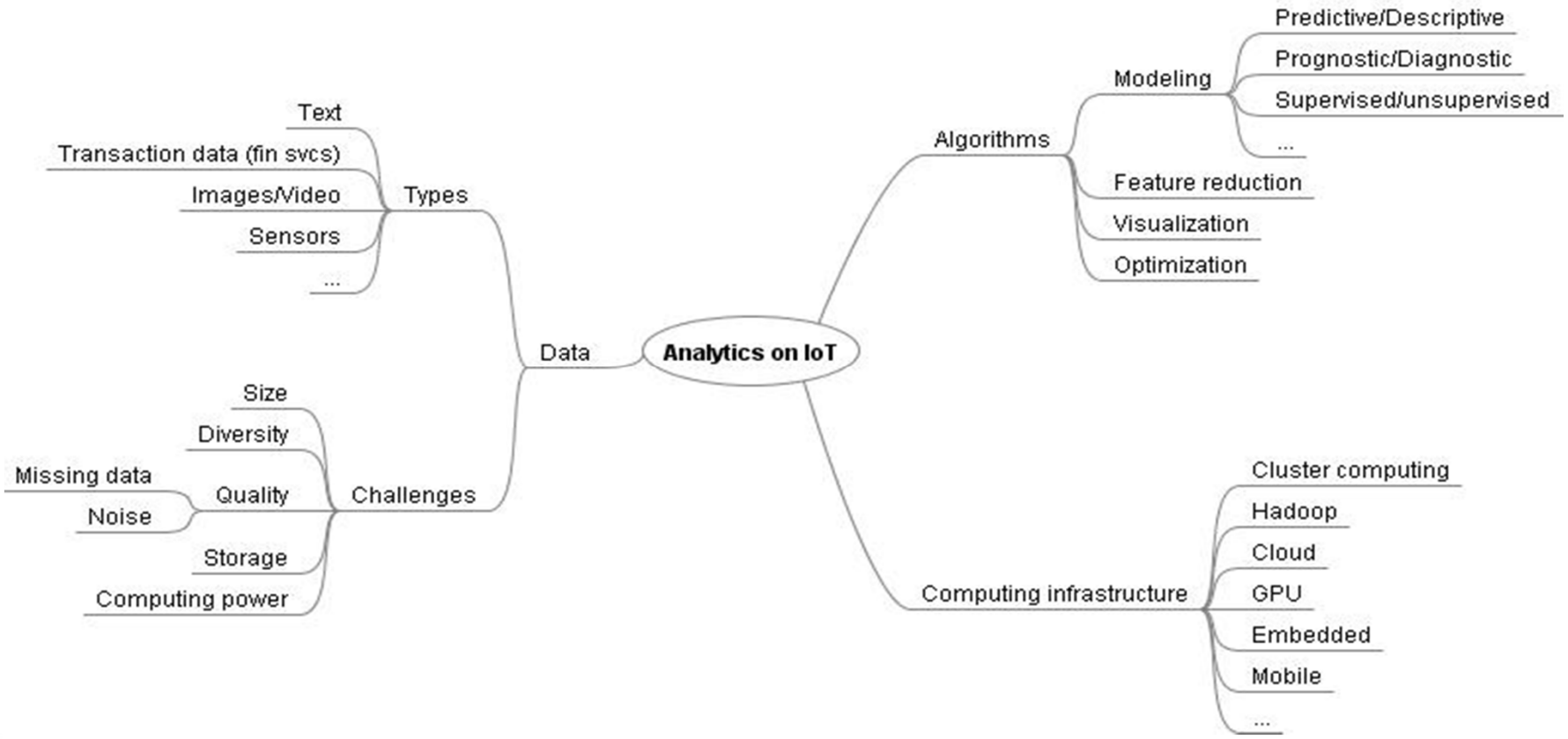
Optimizing rail: Faster trips with less hassle for travelers: train networks get clogged because every individual locomotive's trip has to be

Enabling care traffic control: every medical device in the emergency section of a hospital now has a "pager" and will be able to tell rushed doctors and nurses where they can be found and whether they need to be cleaned or recharged — saving crucial time and lives in the process. Software helps schedule shifts and anticipate bottlenecks based on realtime data — like incoming messages from ambulances en route to the ER.

Source: www.gereports.com

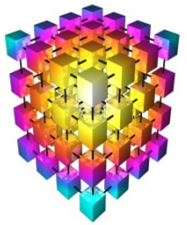
The analytics challenge

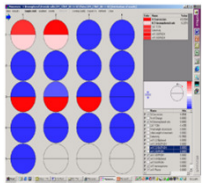
Energy	Transportation
Financial Services	Healthcare …

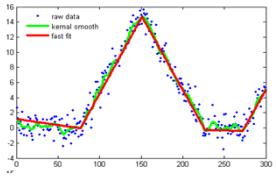


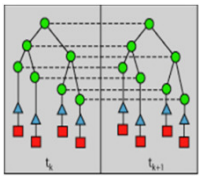
Analytics in energy services

Capture Raw Data → *Modeling* → Create Actionable Information → *Decision support* → Discover, Create, and Grow Value → *Validation of results*









Pervasive Information Acquisition

- Sensors
- Cameras
- Field reports (text)
- Data from smart grid?

Analytics and Modeling to Convert Data into Information

- Computing & storage resources differ along the line (e.g. Fault detection on on-site monitors vs. RM&D centers)
- Visualization tools for multi-dimensional time series data
- Working with compressed data
- Text mining

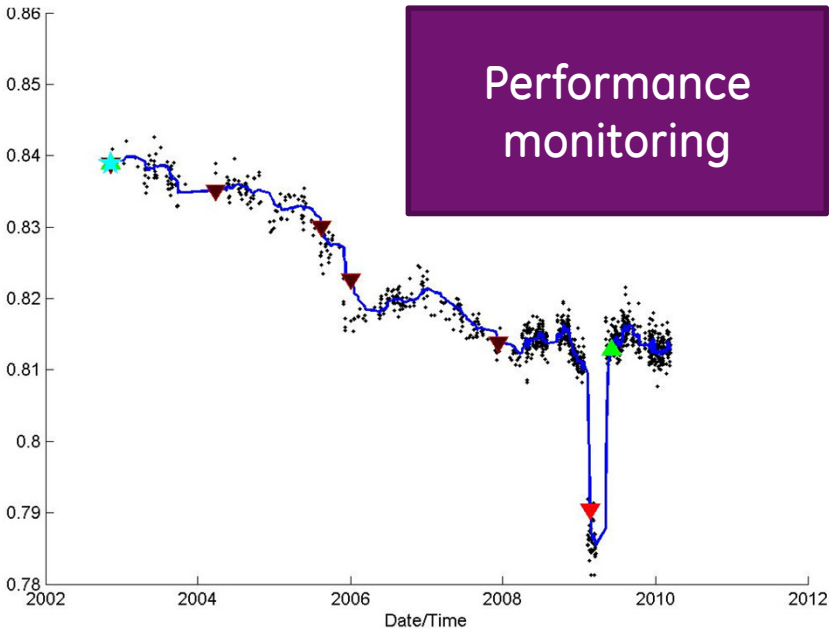
Advanced Decisioning Engines Through Artificial & Computational Intelligence

- Performance optimization
- Improved CFD models, feedback for design of newer equipment
- Diagnostics & prognostics – performance monitoring, fault detection, root cause analysis
- Plant-level analytics and decisioning
- Flow up to contractual services

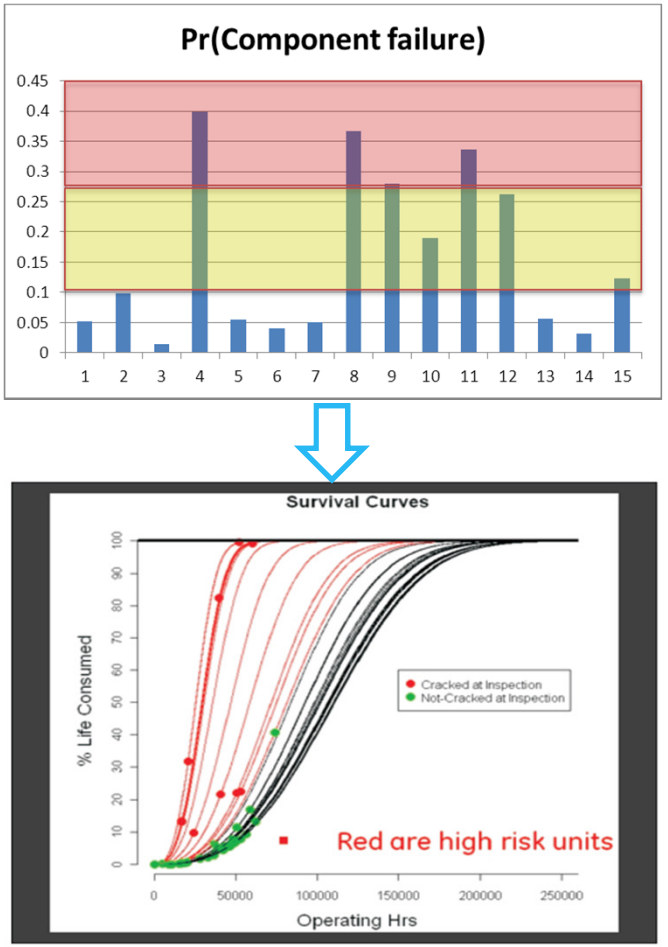
Robust, Secure, Long-Lasting Decision Systems

- Real-time adaptive behaviour
- Systems that evolve along with the data

Performance monitoring → Diagnostics → Prognostics → Lifecycle management



Performance monitoring

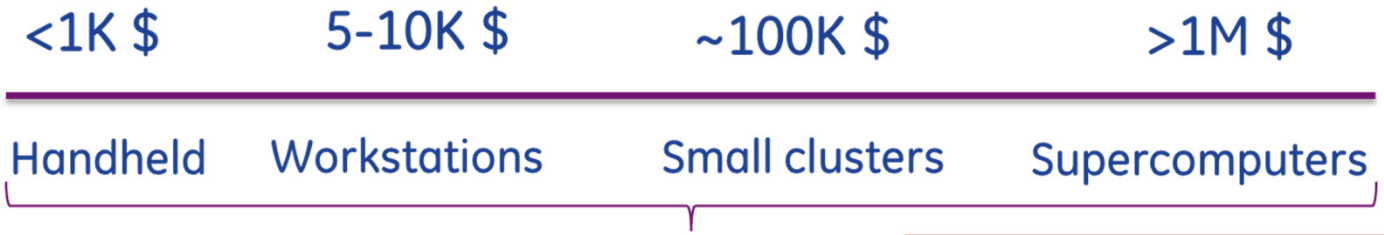


Source: Rajagopalan C., Debasis Bal, Roopesh Ranjan. *The Power Of Analytics In Equipment Diagnosis*. JFWTC Journal. Vol. 7 (3-4). 2011.

Scalable, resource-aware analytics

- Big data (X) + Small data (Y)
- Data quality
- Scalable, reusable analytics
- Complexity challenge: How to use domain knowledge to improve the bias-variance trade-off
- Computational challenge: “Big” is in the eye of the computer!

Computing Challenge

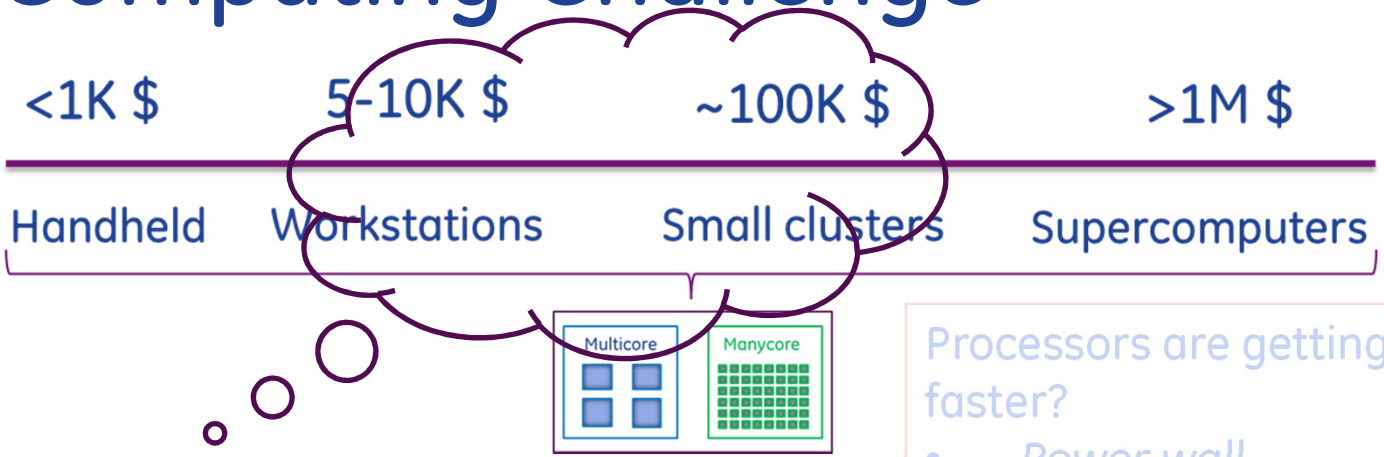


Processors are getting wider and not faster?

- Power wall
- Memory Bottleneck
- ILP (Instruction Level Parallelism)

- **More cores**: need change in programming paradigms/architecture
- **Power consumption**
  - Supercomputing challenge – exascale computing <= 20MW
  - Low end devices need more features, more performance, better battery life – low power many-core computing
- **Memory** – bandwidth, cost, power (low memory footprint computing)
- Higher **performance** at lower **cost**

Computing Challenge



Many analytics and applications in GE may be required to run on a heterogeneous computing platform

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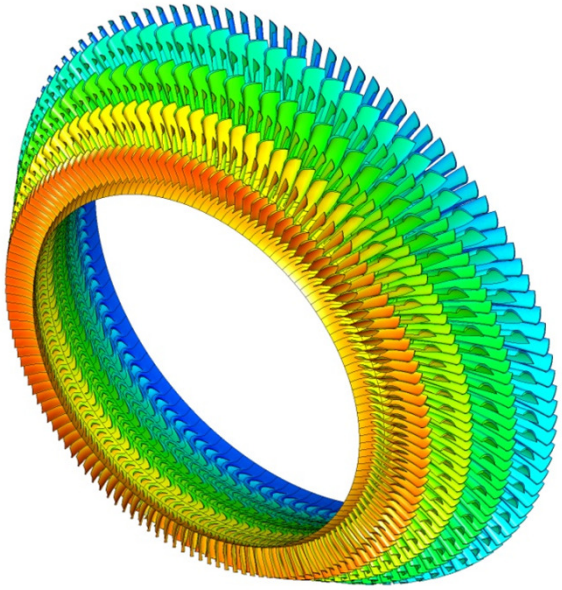
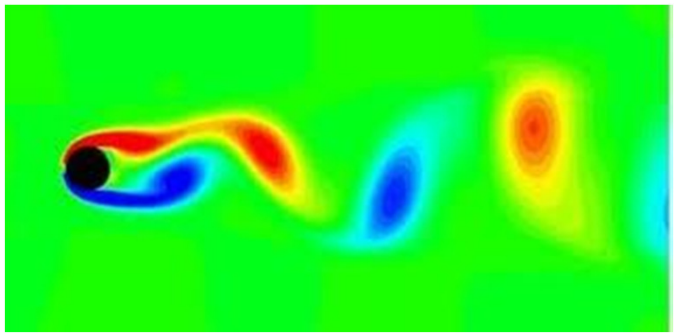
Analytics and Computing

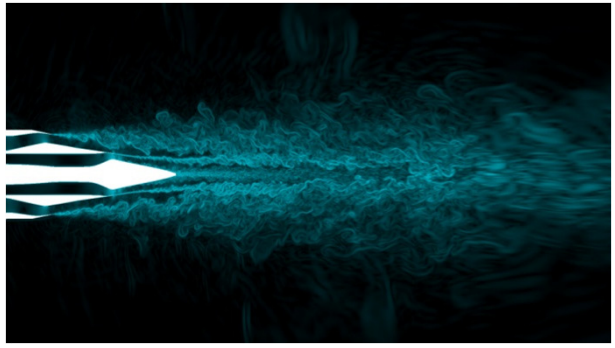
- Low-cost sensors combined with low-cost low-power processors to pre-process the data and send back only the bits that need further analysis
- Low-cost computing infrastructure to enable analytics capabilities
- Self-provisioning systems to connect analytical algorithms with the cloud
- Examples include remote monitoring, engineering applications, image analytics, etc.

Computing @ GE Global Research

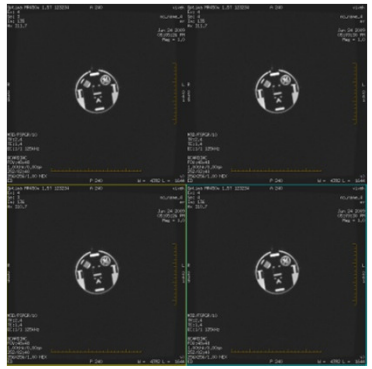


Low pressure turbine simulation @ Oak Ridge National Lab (Jaguar)

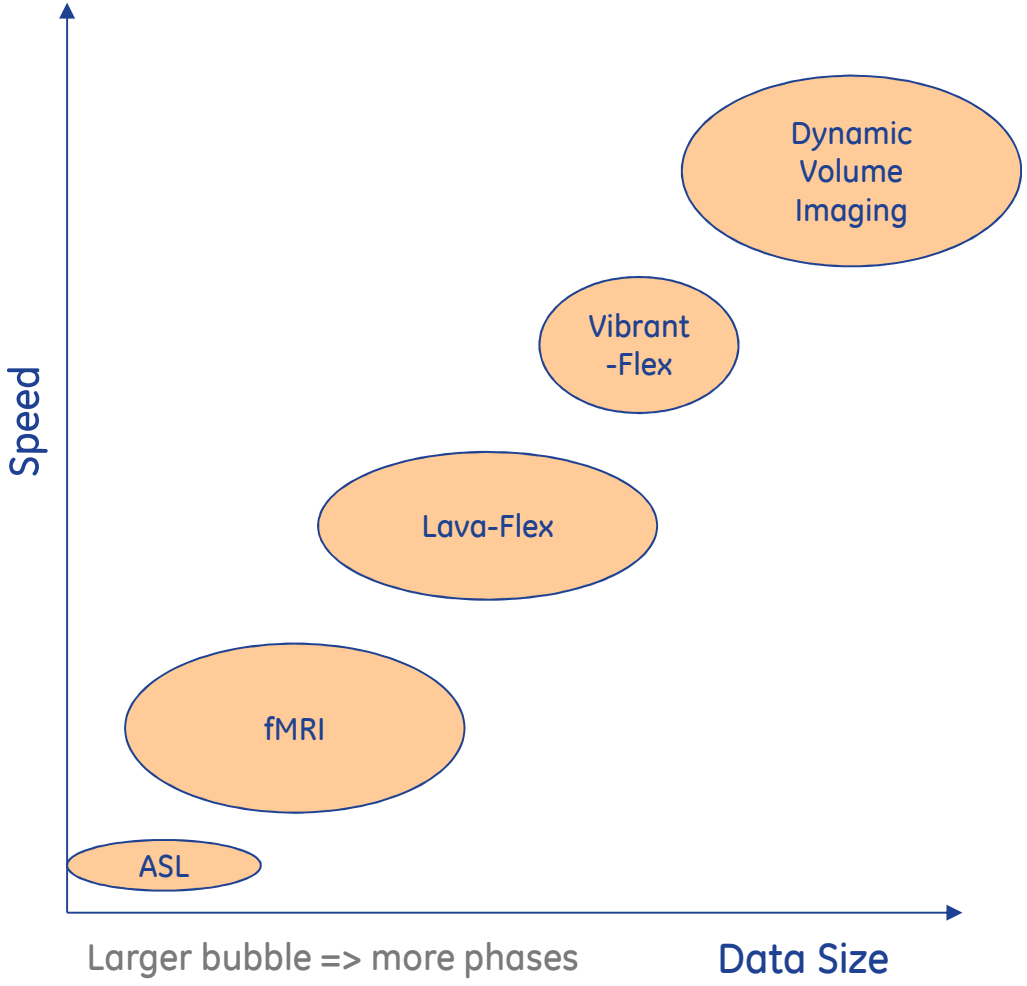




Turbojet engine simulation at Aragonne National Lab (BlueGene/P)

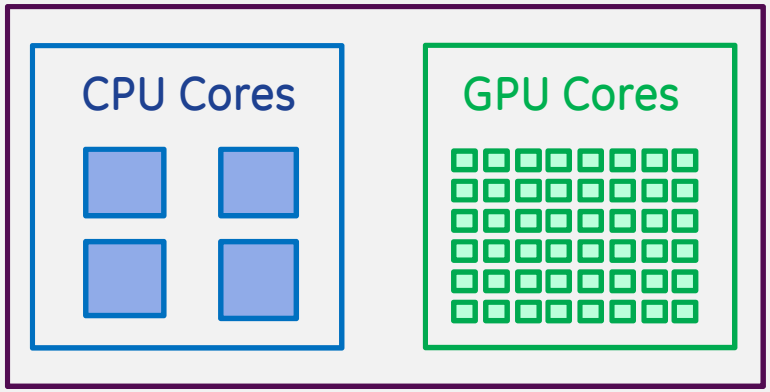


Fast Recon on GPU



Towards Higher Resolution, Higher Acceleration, Multiple Phases ! More complex iterative Algorithms!! Low Recon Lag at Low Cost !!!

GPU-Based Recon as a Solution



+ Fewer powerful CPU cores vs. 100's of massively parallel GPU cores
+ Low incremental cost
- Parallel Algorithm design and development

imagination at work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