A Perspective of Software Engineering at GE Global Research
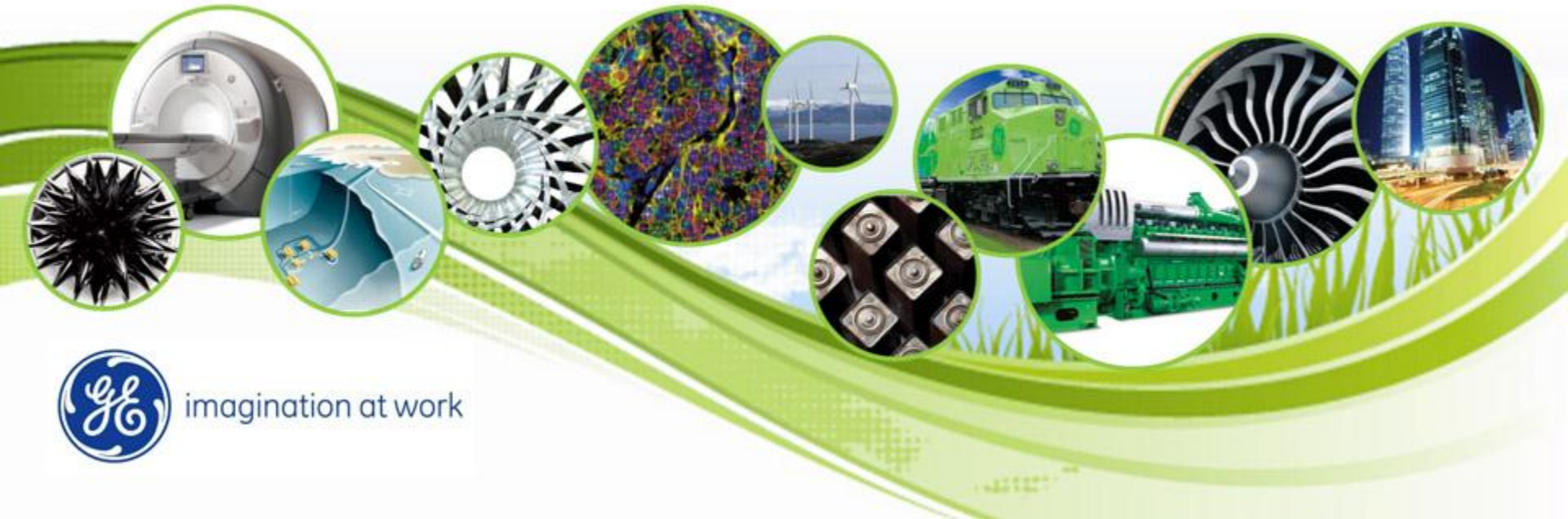
Bowden Wise
wisegb@ge.com
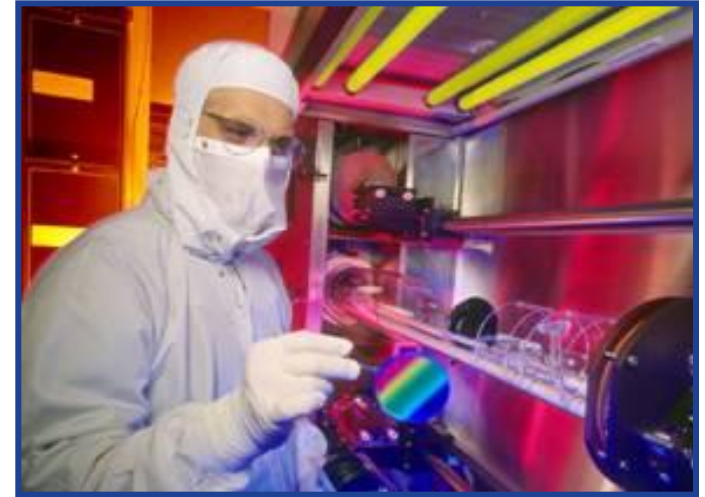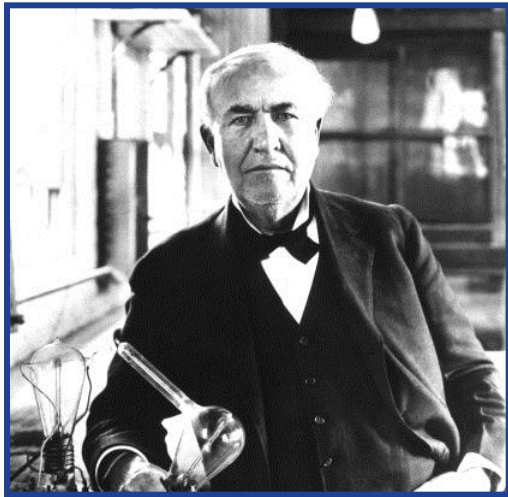2/4/2013

GE … a heritage of innovation

- Founded in 1892

- 300,000 employees worldwide

- $150 billion in annual revenues

- Only company in Dow Jones index originally listed in 1896

imagination at work

GE today

Energy Management

Oil & Gas

Power & Water

Healthcare

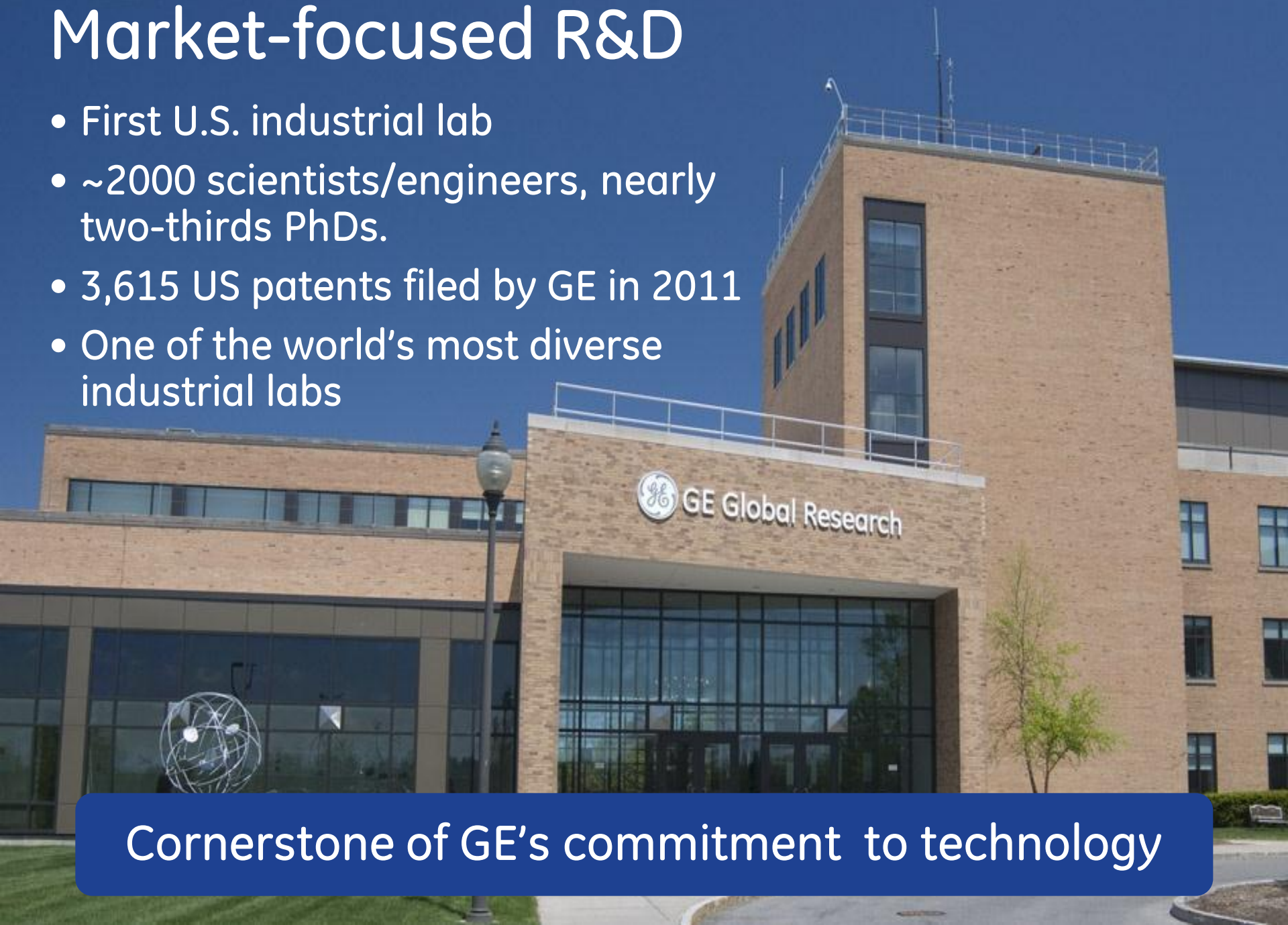**Aviation**

Transportation

GE Capital

Home & Business Solutions

Aligned for growth

Market-focused R&D

- First U.S. industrial lab
- ~2000 scientists/engineers, nearly two-thirds PhDs.
- 3,615 US patents filed by GE in 2011
- One of the world's most diverse industrial labs

Cornerstone of GE's commitment to technology

GE Global Research
Market-focused R&D

Global Research Center
Niskayuna, NY

India Technology Center
Bangalore, India

China Technology Center
Shanghai, China

Global Research Europe
Munich, Germany

Advanced Manufacturing & Software Technology Center
Ann Arbor, MI

Global Software Center
Silicon Valley, CA

Brazil Technology Center
Rio de Janeiro, Brazil

- ~2000 scientists/engineers, nearly two-thirds PhDs.
- 3,615 US patents filed by GE in 2011
- One of the world's most diversified industrial research organizations, providing innovative technology for all of GE's businesses

Cornerstone of innovation for GE

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A tradition of innovation

1909	Ductile tungsten
1913	Medical X-ray
1927	First television broadcast reception
1932	Langmuir Nobel Prize in chemistry
1938	Invisible/glareless glass
1942	First US jet engine
1953	LEXAN™ polycarbonate
1955	Man-made diamonds
1962	Semi-conductor laser
1973	Giaever Nobel Prize in physics
1984	Magnetic resonance imaging
1994	GE90® composite fan blade
1999	Digital X-ray
2004	Lightspeed VCT
2009	Wide Bore 1.5T MR System
2010	Energy Smart^R LED
2012	Durathon Battery

GE imagination at work

Building the "Industrial Internet"

Hiring **400** software engineers over next 2 years
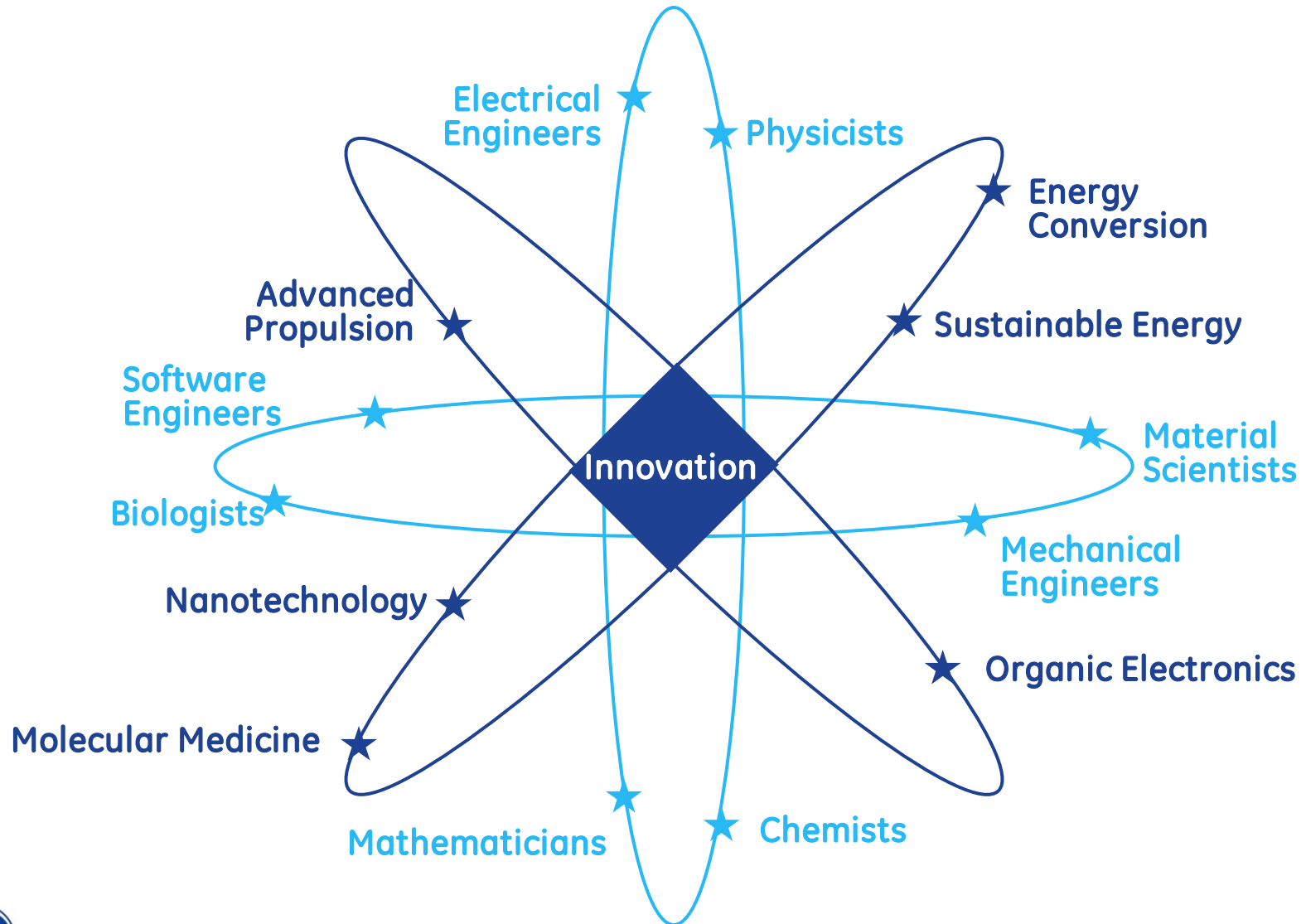

GE's Rail Edge
Movement Planner

Smarter, more efficient
machines & systems

- Putting "Big Data" to work

- Developing software that connects people and businesses to the machines and systems that move our world

- Creating a 'living network' of *things* that provide real-time information and make everything from jet engines to energy distribution to hospital care more efficient and productive

- Minds + machines conference (Jeff Immelt keynote)

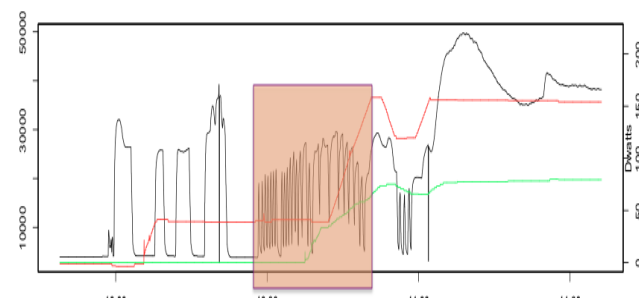## Software a "core competency" supporting every GE business

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Developing world-class talent

Innovation

- Electrical Engineers
- Physicists
- Energy Conversion
- Advanced Propulsion
- Sustainable Energy
- Software Engineers
- Material Scientists
- Biologists
- Mechanical Engineers
- Nanotechnology
- Organic Electronics
- Molecular Medicine
- Mathematicians
- Chemists

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Knowledge Discovery Lab

Discovering patterns in data

Capturing & leveraging GE Knowledge

Enabling Big Data analytics

Why software now?

Customers are evolving

- Rising expectations for cost/simplification
- Demand for productivity, new capabilities
- Major industry initiatives like Smart Grid
- Software at center of growth

Technology emerging

- Industrial asset becoming intelligent
- Infrastructure and IT companies converging from different angles
- Systems and architectures key
- Aggressive acquisitions/partnerships
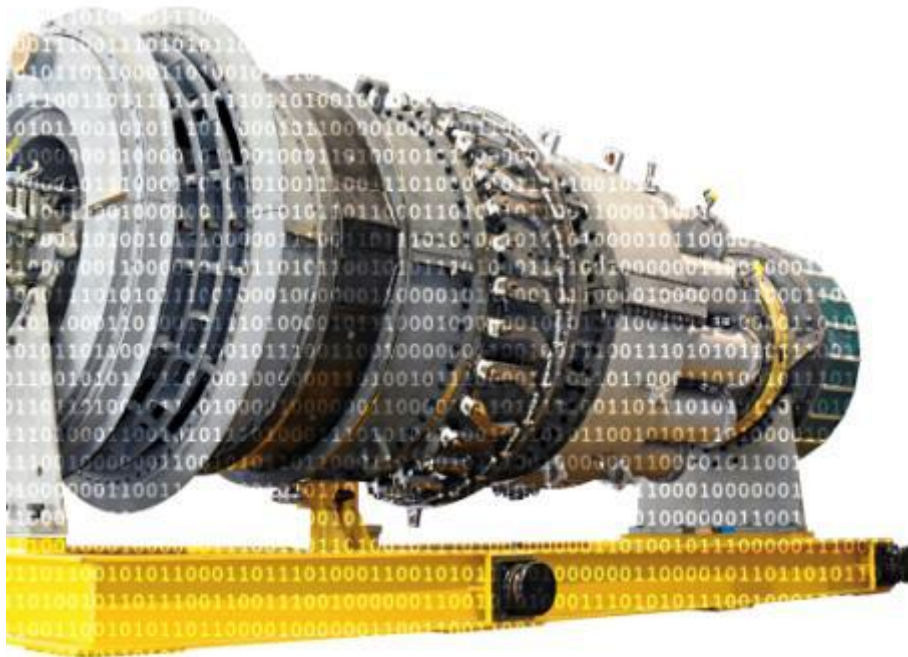
Cross-GE Initiatives for Software

GE Businesses

- Business Models
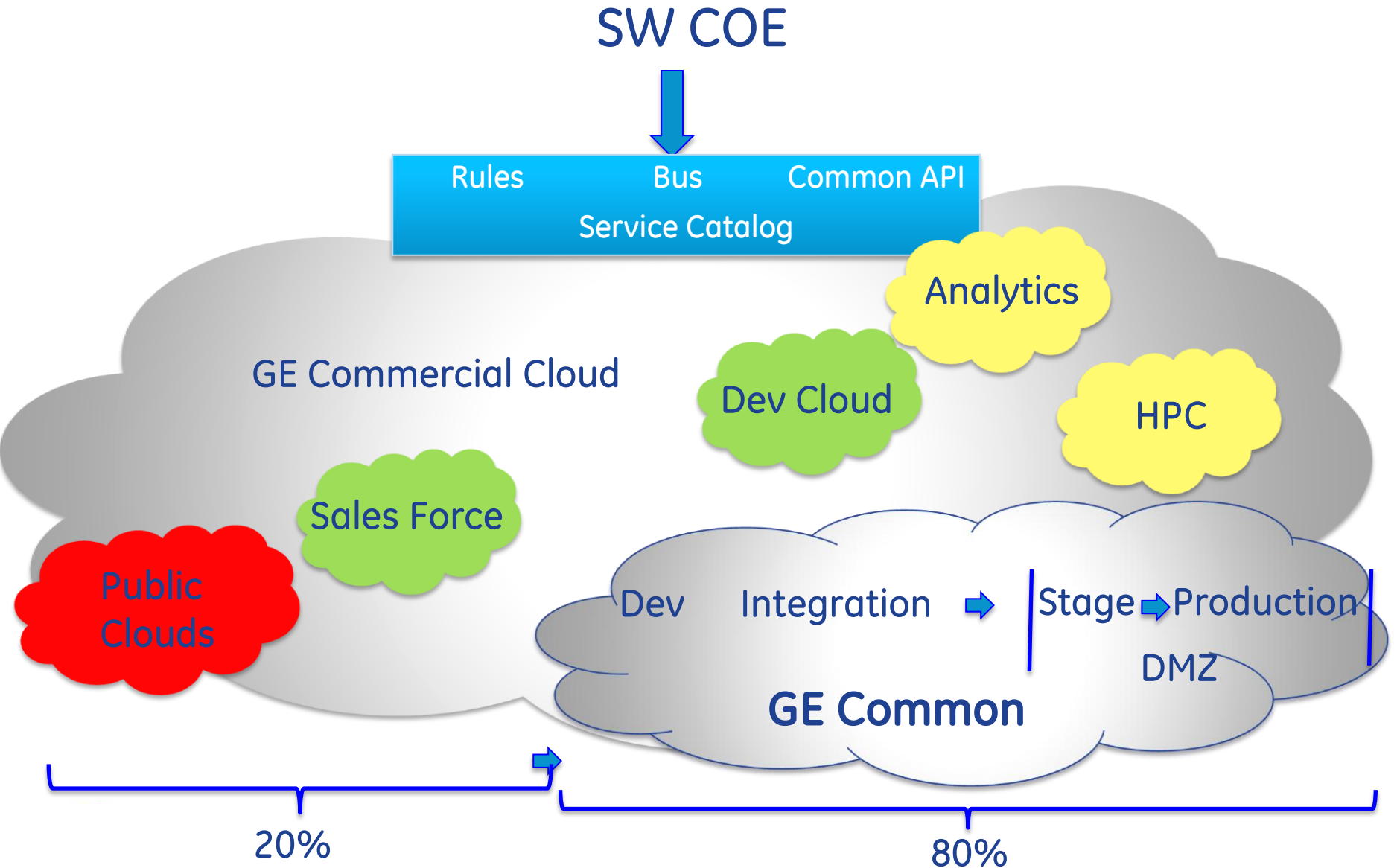- Software Portfolio
- Cross-Vertical Opportunities

Software COE

- Virtual SW Factory
  - ❖ Agile Methodology
  - ❖ Cloud enabled

- Architecture / Tech Stack
  - ❖ GE Wide
  - ❖ Industry Specific

- Emerging Markets
  - ❖ GE Wide: industrial internet
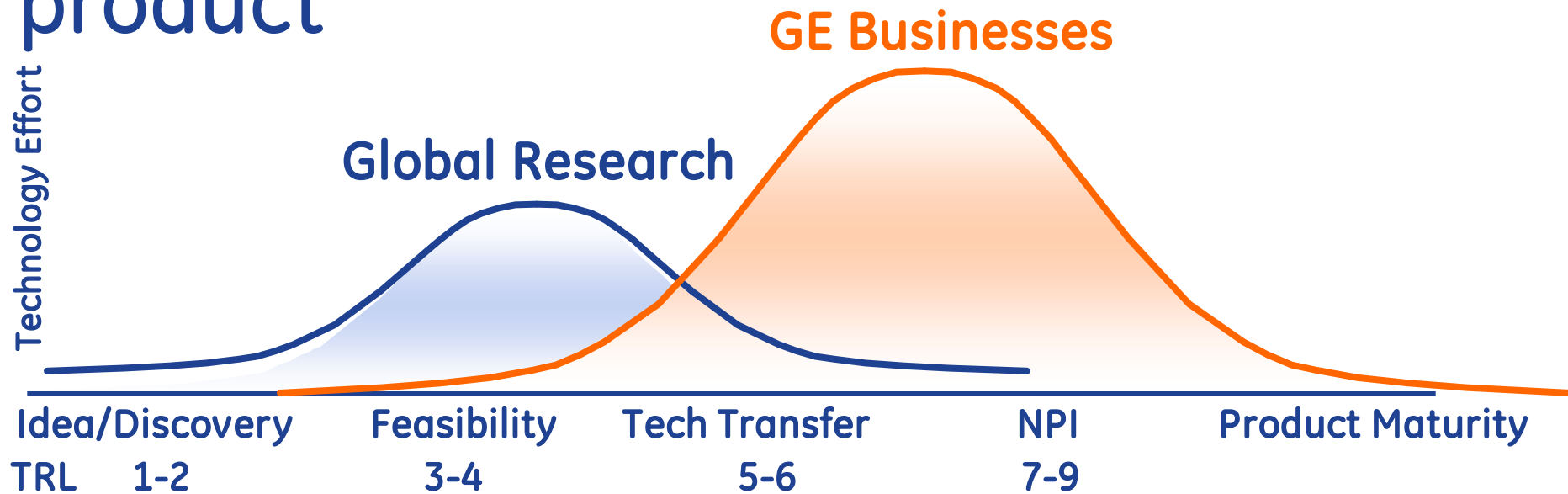 - ❖ Industry specific: digital oil field

Research

- Analytics
- Big Data
- Prognostics
- Machine Learning
- Semantic Technology
- Intelligent Devices
- Automation and Provisioning

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AaaS is enabled by the Analytics Cloud

Rigorous innovation and transition to product

Technology Effort

Global Research

GE Businesses

Idea/Discovery	Feasibility	Tech Transfer	NPI	Product Maturity
TRL 1-2	3-4	5-6	7-9	

- Common language between Global Research & the businesses

- Plan, manage projects vs Technology Readiness Level (TRL) & Manufacturing Readiness Level (MRL) progression

- Evaluate readiness for business transition

Software Development at GE Research

Diverse Teams

- Researchers: Physicists, materials scientists, computer scientists, etc.

- Business/Customers: domain experts

Deliver Solutions

- From research prototypes to products

- Build new solutions, provide value faster

Challenges

- **Globally Distributed Teams**
  - ❖ Research / Business teams often not co-located

- **Many Platform**
  - ❖ Windows / Unix; Variety of hardware / OS

- **Many Languages and Tools**
  - ❖ Java / C++ ; Matlab / Excel / etc

- **Domain Knowledge**
  - ❖ Work closely with business

- **Research to Business Transition**
  - ❖ Different IT environments; standards, processes

Software Engineering Processes

SW Processes

- Waterfall (outdated, does not fit)

- Iterative

- Agile

SW Phases

- Requirements

- Design

- Development

- Transition / Operation

- Maintenance / Support

Most projects follow an iterative style,
applying agile methods where applicable

Software Tools

Development

- Eclipse IDE

- SCM: cvs/svn/git

- Maven

- DB Tools

- Many languages: java c/c++, matlab

- Dev cloud

Collaboration

- Wikis

- Blogs

- E-Mail

- Issue trackers

- Task scheduling tools

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Questions ?

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