Controls Challenges for CPS: A GE Perspective

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Outline

- Global CPS Research
- CPS in GE
- CPS Challenges

Cyber Physical Systems
Ubiquitous in GE Systems with Controls

Wind

IGCC

Nuclear

Power Gen

4000 Controls Technologists Supporting GE's diverse applications

Platforms

Healthcare

Oil & Gas

Aviation

Transportation

Water

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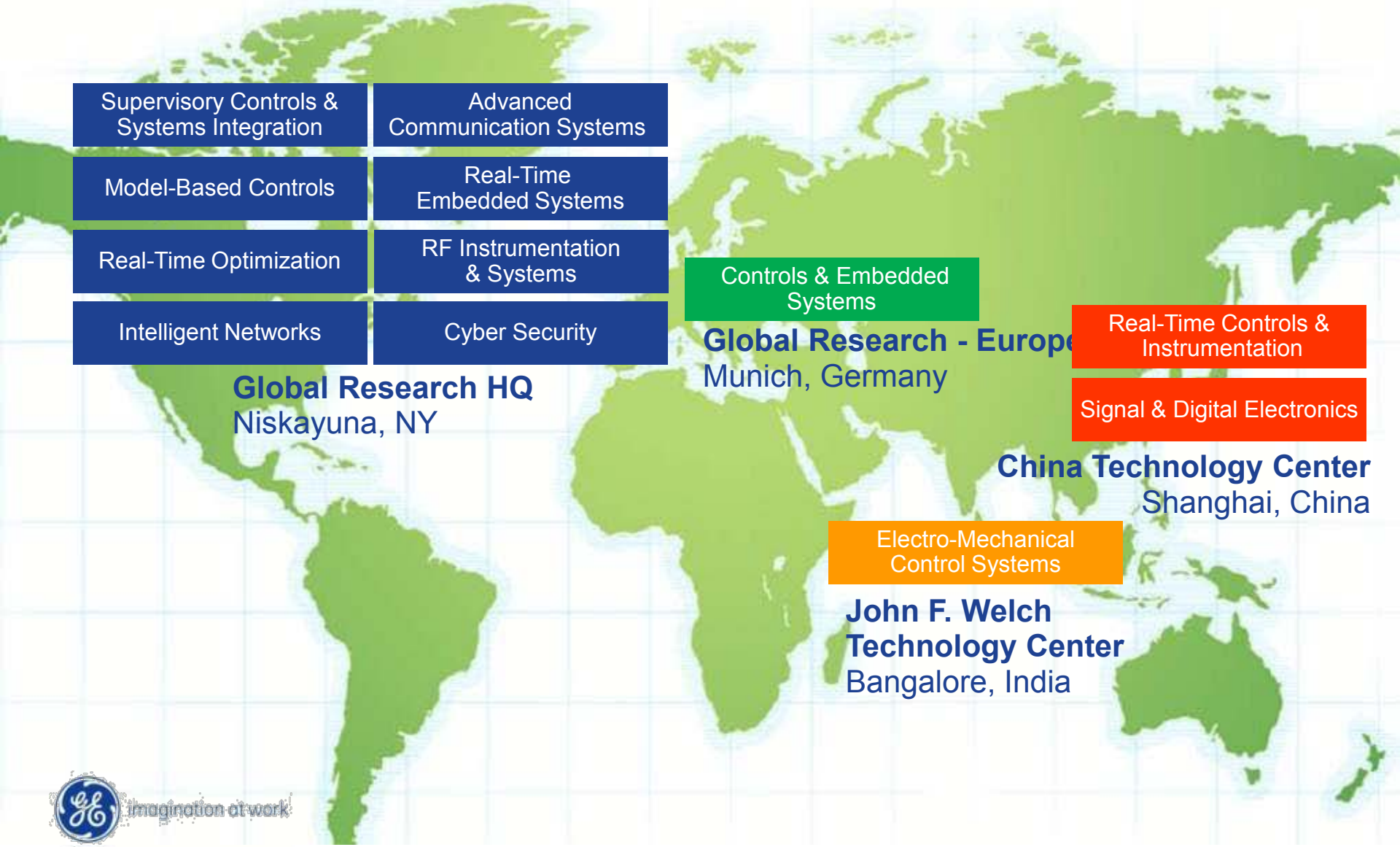
Global Cyber Physical Research Labs



Supervisory Controls & Systems Integration

Advanced Communication Systems

Model-Based Controls

Real-Time Embedded Systems

Real-Time Optimization

RF Instrumentation & Systems

Intelligent Networks

Cyber Security

Global Research HQ
Niskayuna, NY

Controls & Embedded Systems

Global Research - Europe
Munich, Germany

Real-Time Controls & Instrumentation

Signal & Digital Electronics

China Technology Center
Shanghai, China

Electro-Mechanical Control Systems

John F. Welch Technology Center
Bangalore, India

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GE Complex Cyber Physical Systems Integration

- GE develops critical infrastructure (Energy, Aviation, Oil & Gas, Healthcare, Rail)
- Products are becoming more complex, distributed and networked.
- Our challenge is to develop safety critical, certifiable, affordable, high performing and cyber secure systems.
- Our approach is model based, and are developing formal methods for verification and validation.

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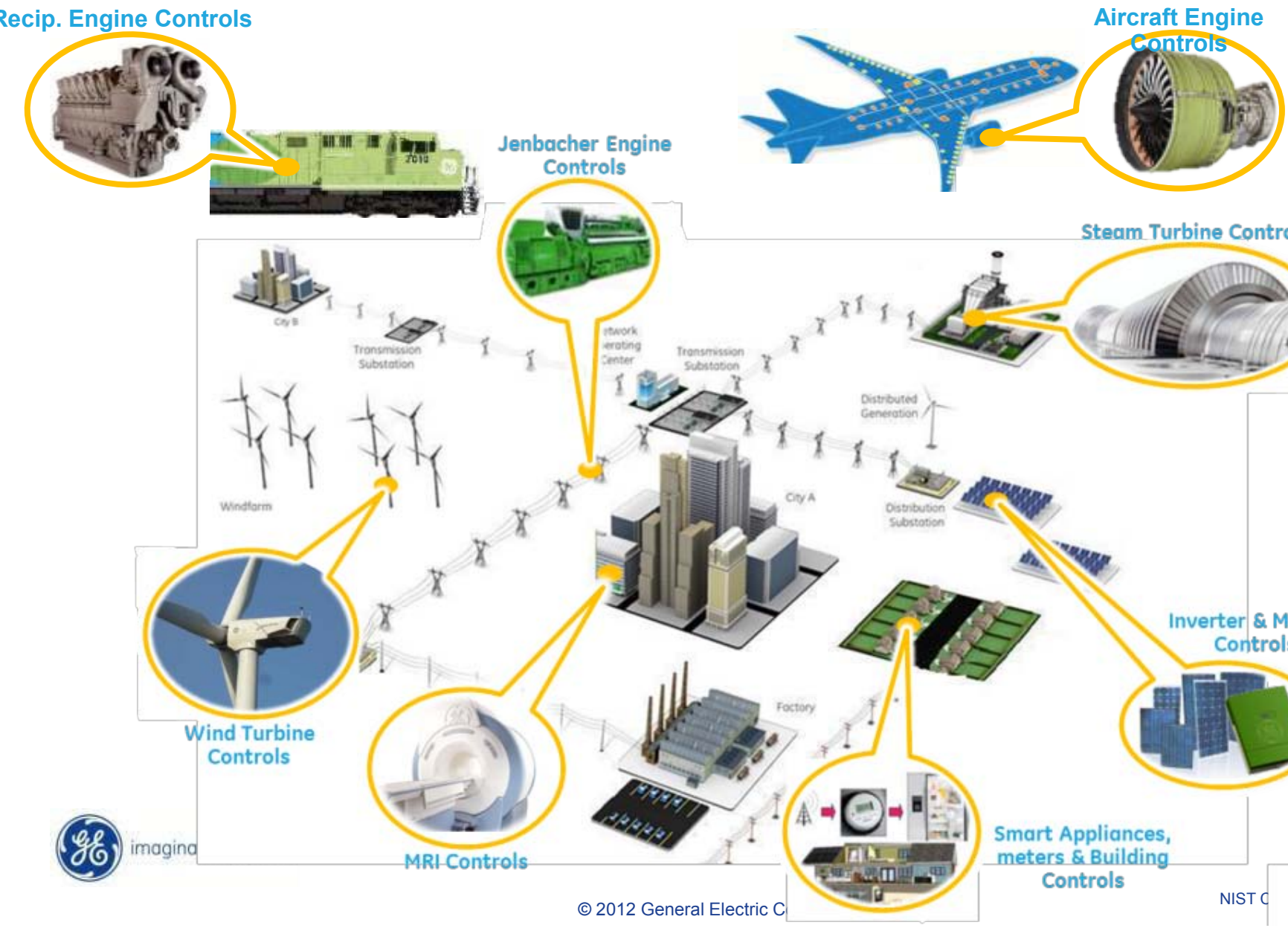
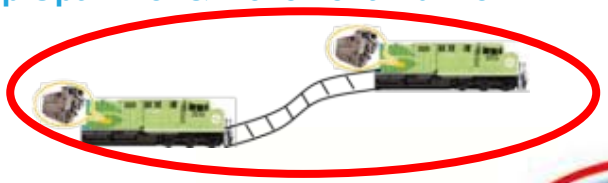
Today: Excellence in **Unit** Controls

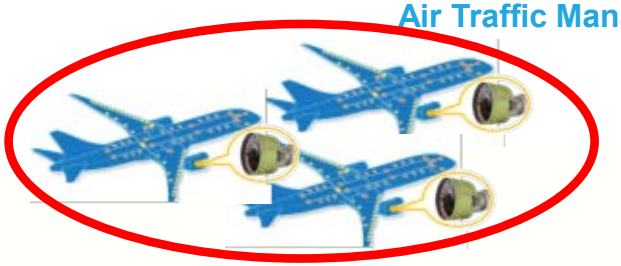


Emerging: Excellence in **Systems**

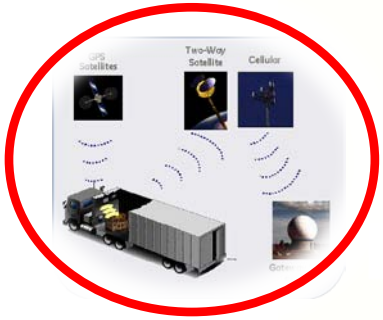
Trip Optimizer & Movement Planner



Air Traffic Management



Asset Intelligence
Intelligent Space
Ecosystems



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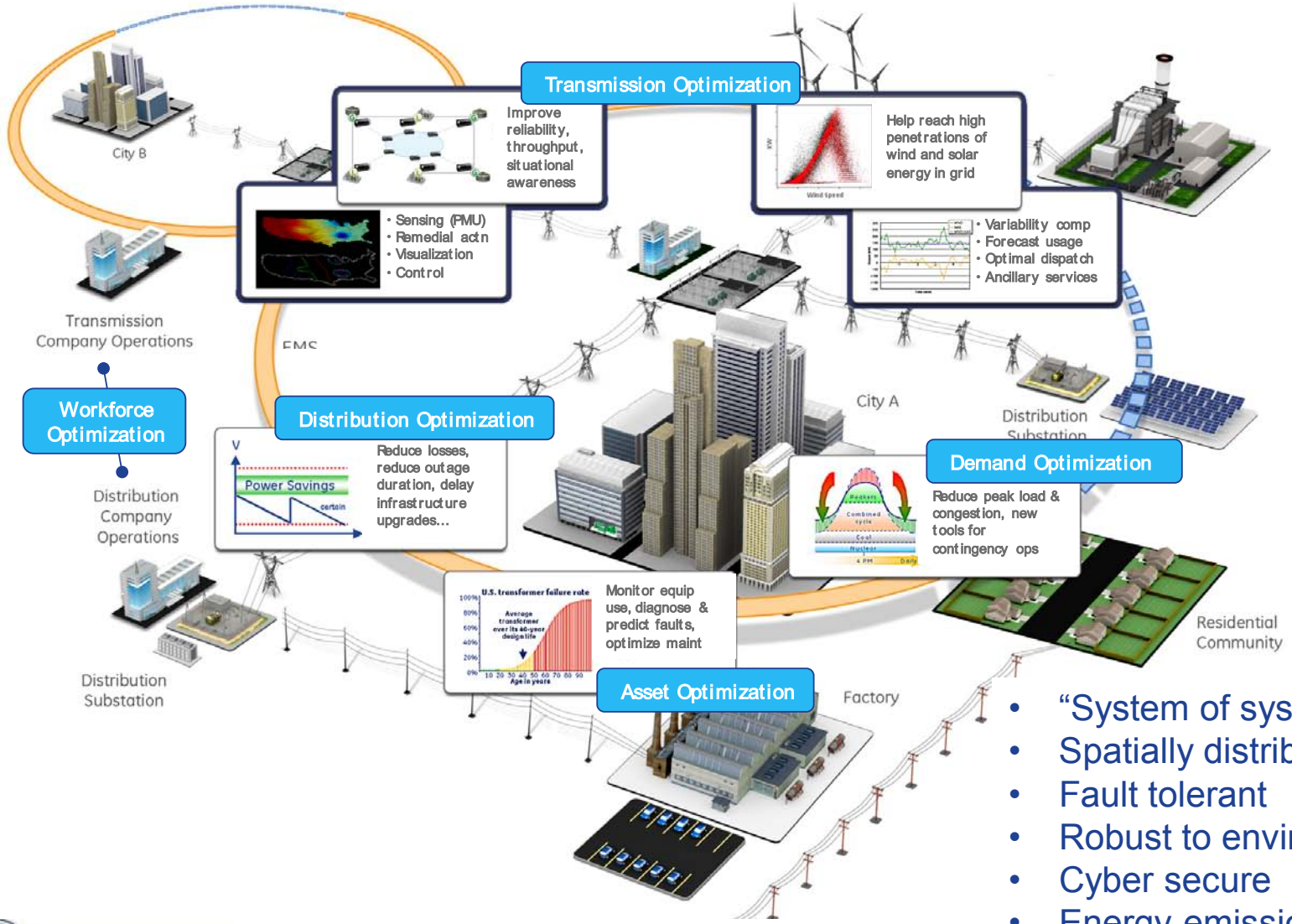
Tomorrow: **Enterprise** Systems



- "System of systems"
- Spatially distributed
- Fault tolerant
- Robust to environment
- Cyber secure
- Energy-emissions optimal
- Economically justifiable

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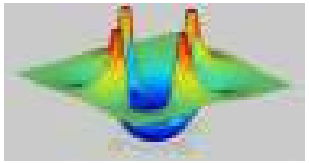
Recurring Themes & Challenges

Multivariable & Model-based



- Designer proficiency
- Complexity
- Computational efficiency
- Multiple time scales

Towards Systems & Enterprise

- Architecture, design & analysis
- Security
- Spatially distributed
- Interoperability
- Validation & verification
- On-line optimization & RT simulation
- Human “on the loop” consideration

Prognostics & Life Mgmt

- Physics-based and empirical life models
- Failure prediction
- Life-extending control

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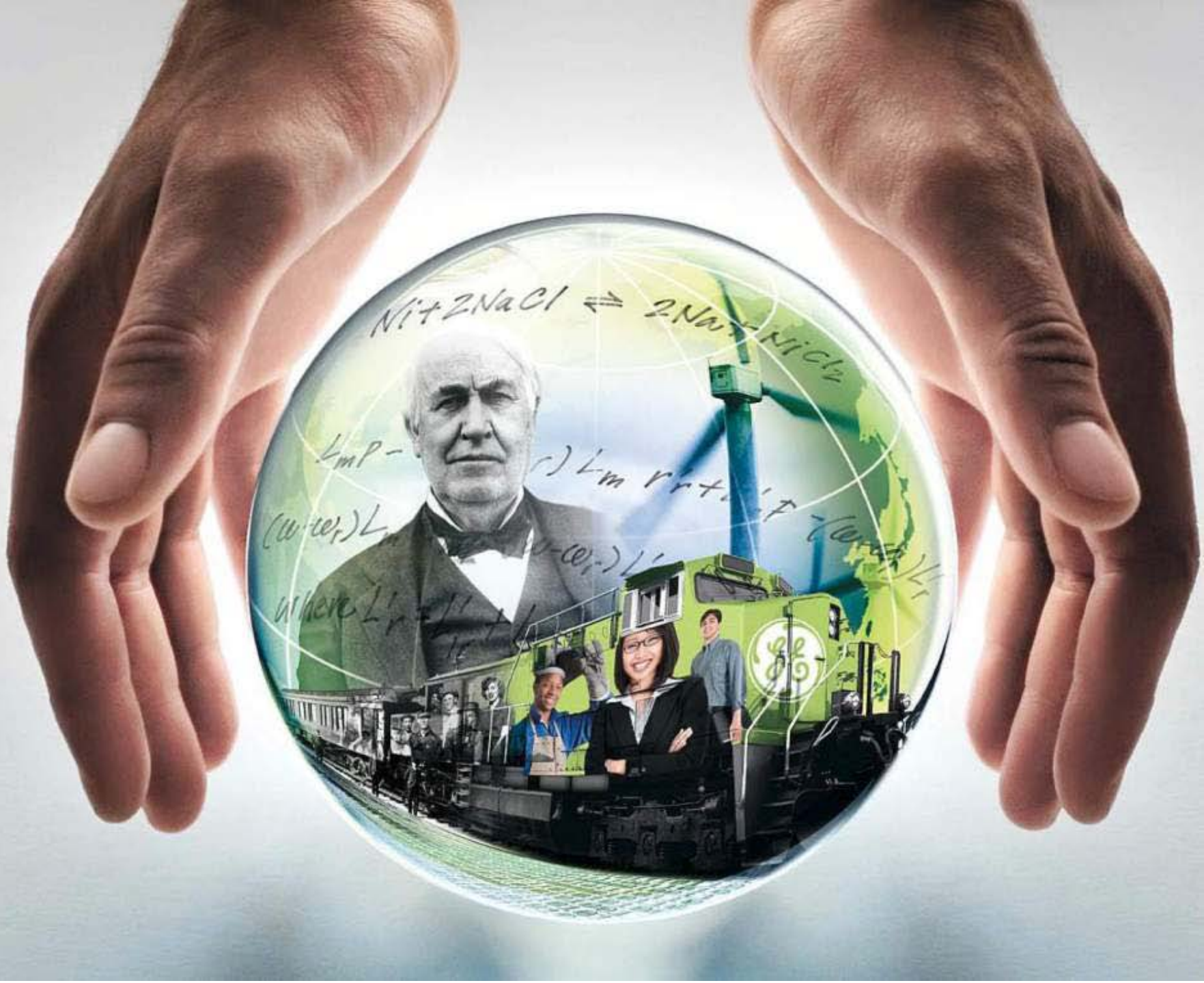
Key CPS Challenges to GE

- ✓ Cyber and Physical security across disbursed heterogeneous systems
- ✓ QOS and relevant new theory (or rediscovery) to find achievable performance limits including stability of complex systems
- ✓ Comprehensive modeling tools for design and simulation of heterogeneous, physics based continuous and discrete systems
- ✓ Novel frameworks for verification and validation of complex controls software for distributed systems
- ✓ New ideas on how to educate the general public, and non-expert stakeholders (congress) to understand CPS technologies and the benefits and risks of complex offerings

….All while achieving a profitable enterprise to continue to attract investment in CPS!


Ni+2NaCl ⇌ 2Na+NiCl2

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