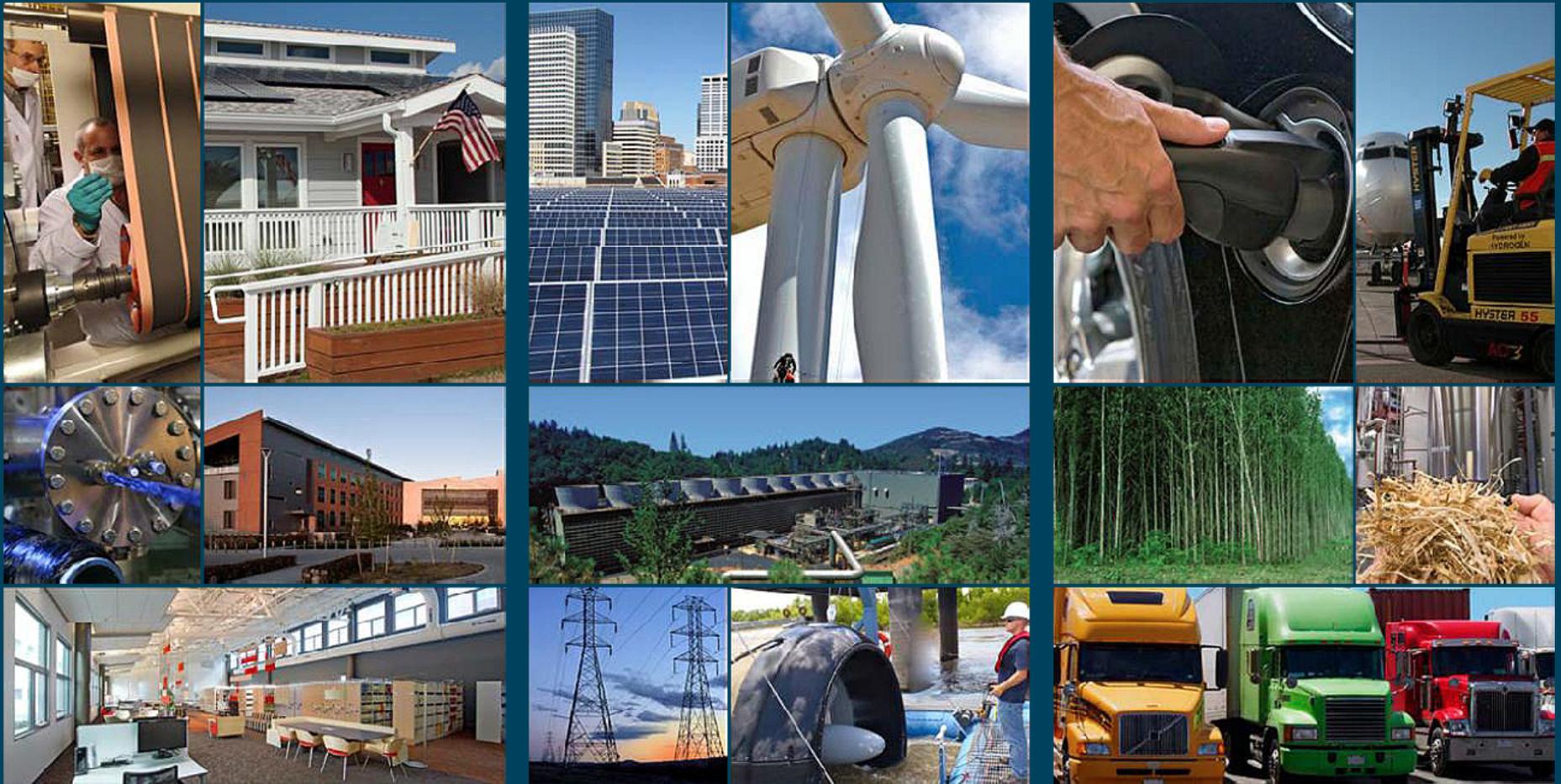# Motivation for the Transaction-Based Reference Platform

Or How I learned to Stop Worrying and Love Transactions

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Challenges

- Application Challenges
  - Integrating variable distributed generation
    - Solar
    - Wind
  - Integrating storage at multiple layers
  - Integrating electric vehicles (EV)
  - Managing end-use loads
    - Residential
    - Commercial
    - Industrial
  - Enabling energy coordination and trading between buildings and trading between buildings and grid
- Technology Challenges
  - Rapid deployment of networked (grid, buildings, etc.) sensors and controllers
  - Scalable control and diagnostics
  - Secure and reliable communication

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Distributed Systems Call for Distributed Solutions

- Are there solutions that we can leverage that will improve efficiency (reduce energy and emissions) while supporting grid reliability and integration of distributed variable renewable generation?

- What happens in a neighborhood where everyone has solar panels on the roof and there is intermittent unexpected cloud cover?
  - If a cloud cover is anticipated, what changes can you make locally to mitigate that in advance?

- What happens in a neighborhood where everyone owns an EV and everyone comes home at the same time on a hot day and start to charge?

- What if appliances in your house could communicate with each other to coordinate energy usage and shift load to off-peak times?
  - Customer sees lower bills
  - Utilities get more predictable and even load
  - Quicker response to mitigate variable distributed power generation

- If we are going to invest in infrastructure to mitigate the above challenges, can we leverage the same distributed solution to support condition-based maintenance of equipment and improve operational efficiency of building systems?

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Grid Modernization Initiative

Seamlessly integrating emerging technologies into the grid in a safe, reliable, and cost-effective manner is critical to enable deployment at scale.
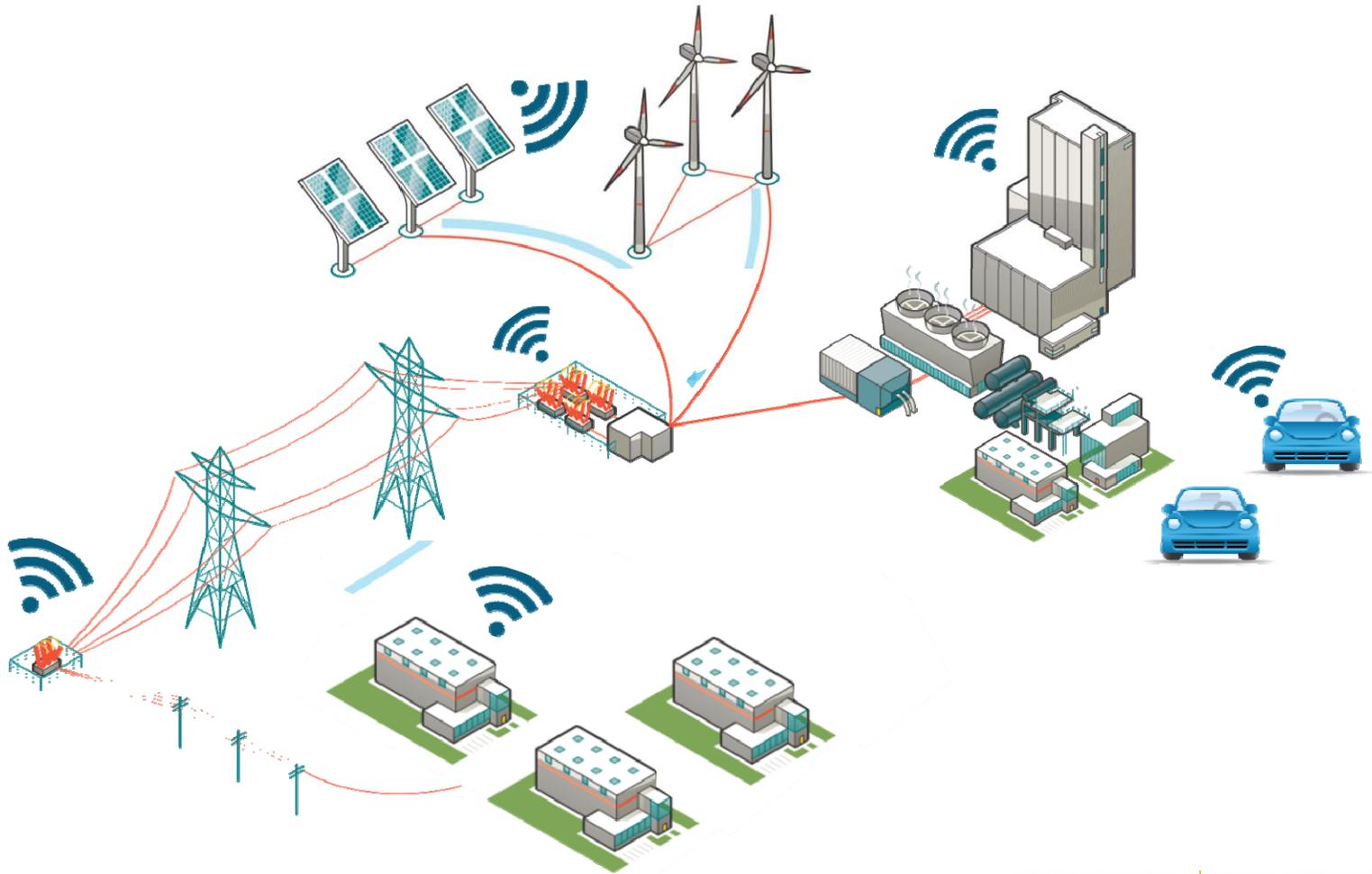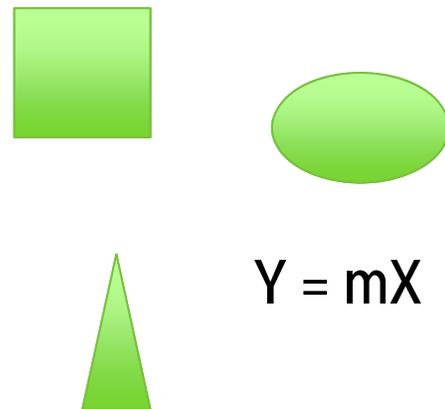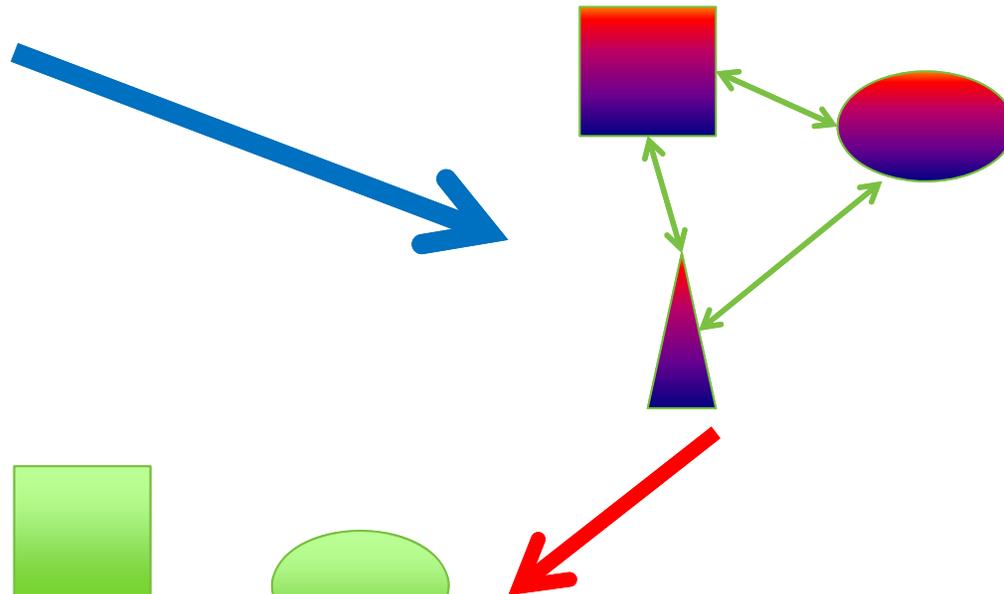
Technology Solution Attributes

- Open, flexible and modular software platform
- Ease of application development
- Interoperable across vendors and applications
- Hides power and control system complexities from developers
- Object oriented, modern software development environment
- Language agnostic. Does not tie the applications to a specific language such as Java
- Broad device and control systems protocols support built-in
  - ModBUS, BACNet, DNP3, and others
- Multiple types of controllers and sensors
- Low CPU, memory and storage footprint requirements
- Supports non-Intel CPUs
- Secure
- Security libraries and cryptography built-in
- Manage applications to prevent resource exhaustion (CPU, memory, storage)
- Robust against denial-of-service (e.g., does not crash when scanned via network mapper)
- Supports modern application development environments

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Linear vs BLOBULAR
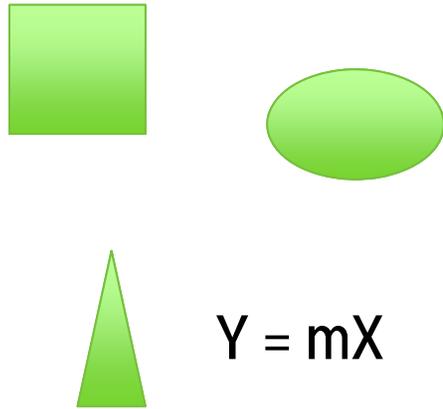
$$u(t) = MV(t) = K_p e(t) + K_i \int_0^t e(\tau)\, d\tau + K_d \frac{d}{dt} e(t)$$

Y = mX

Y = mX

Automated Transaction

- "Automated transaction" means a transaction conducted or performed, in whole or in part, by electronic means or electronic records, in which the acts or records of one or both parties are not reviewed by an individual in the ordinary course in forming a contract, performing under an existing contract or fulfilling an obligation required by the transaction.

- OregonLaws.org

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Software Agent(s)

- In computer science, a software agent is a computer program that acts for a user or other program in a relationship of agency, which derives from the Latin agere (to do): an agreement to act on one's behalf. Such "action on behalf of" implies the authority to decide which, if any, action is appropriate.

- A multi-agent system (M.A.S.) is a computerized system composed of multiple interacting intelligent agents within an environment. Multi-agent systems can be used to solve problems that are difficult or impossible for an individual agent or a monolithic system to solve.

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Transactional Network Controls

- Buildings need to be smarter to participate in transactions within the building, with other buildings, and with grid entities.

- Sensors and controls at the whole building level and at the component level are fundamental to optimize DER and the grid.

- **The transactional network enables energy saving retrofit solutions**

  AND

  the networked systems to transact with all grid connected devices (e.g. EV, storage) and with the grid to help mitigate DER related disturbances.

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