Grid-Interop™

Transactive Control Architecture

Ron Ambrosio

GridWise® Architecture Council

IBM T.J. Watson Research Center

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Transactive Approaches

- There are a variety of approaches today
  - Some are more centralized, some more distributed
- Common characteristics
  - Use of economic (business) constructs
    - Markets, economic signals, etc.
  - Address reliability (operational) objectives
  - Valuation of objectives and constraints in decisions
    - Both operational and business objectives and constraints
- How do we design a framework to support this?
  - Focus on supporting the distributed model
    - Centralized model becomes a simplification of that

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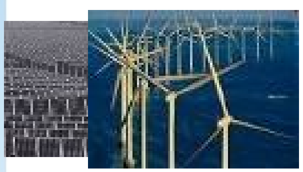
Transactive Control Definition

A highly-distributed overlay approach utilizing economic signals as a distributed control system signal

- All *business* and *operational* objectives and constraints can be valuated and thereby incorporated into the signal

Transactive Incentive Signal (TIS): reflects economic valuation of electricity at any given point

Generation **Transmission** **Distribution** **Customers**



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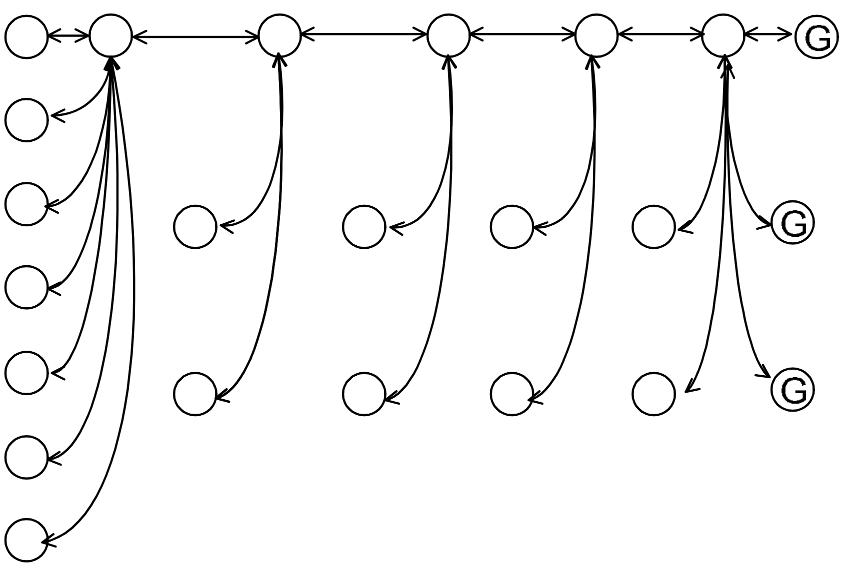
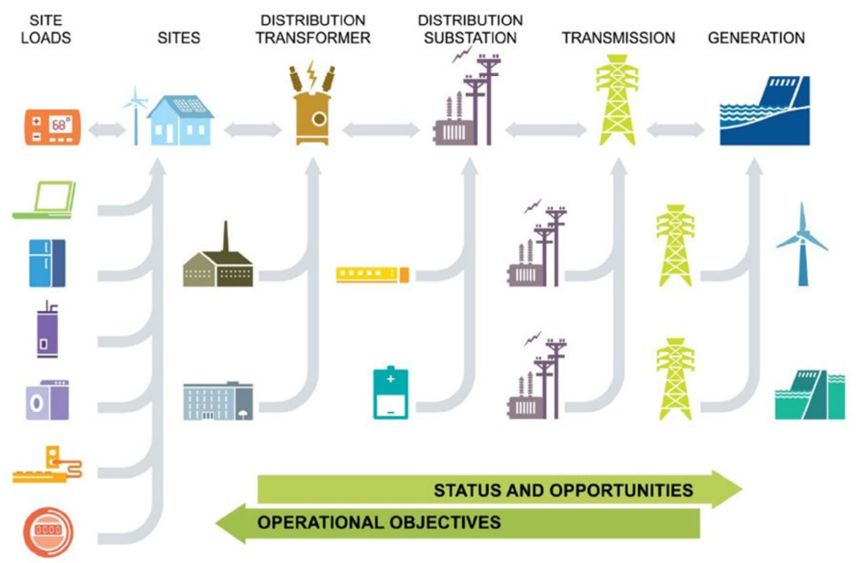
Transactive Feedback Signal (TFS): reflects anticipated consumption in time

Propagation of signals

Incentive and feedback signals propagate through an information network that overlays the electrical network; the signals are processed and possibly modified by the *Transactive Control Nodes* in this network



Information Network



Physical Network

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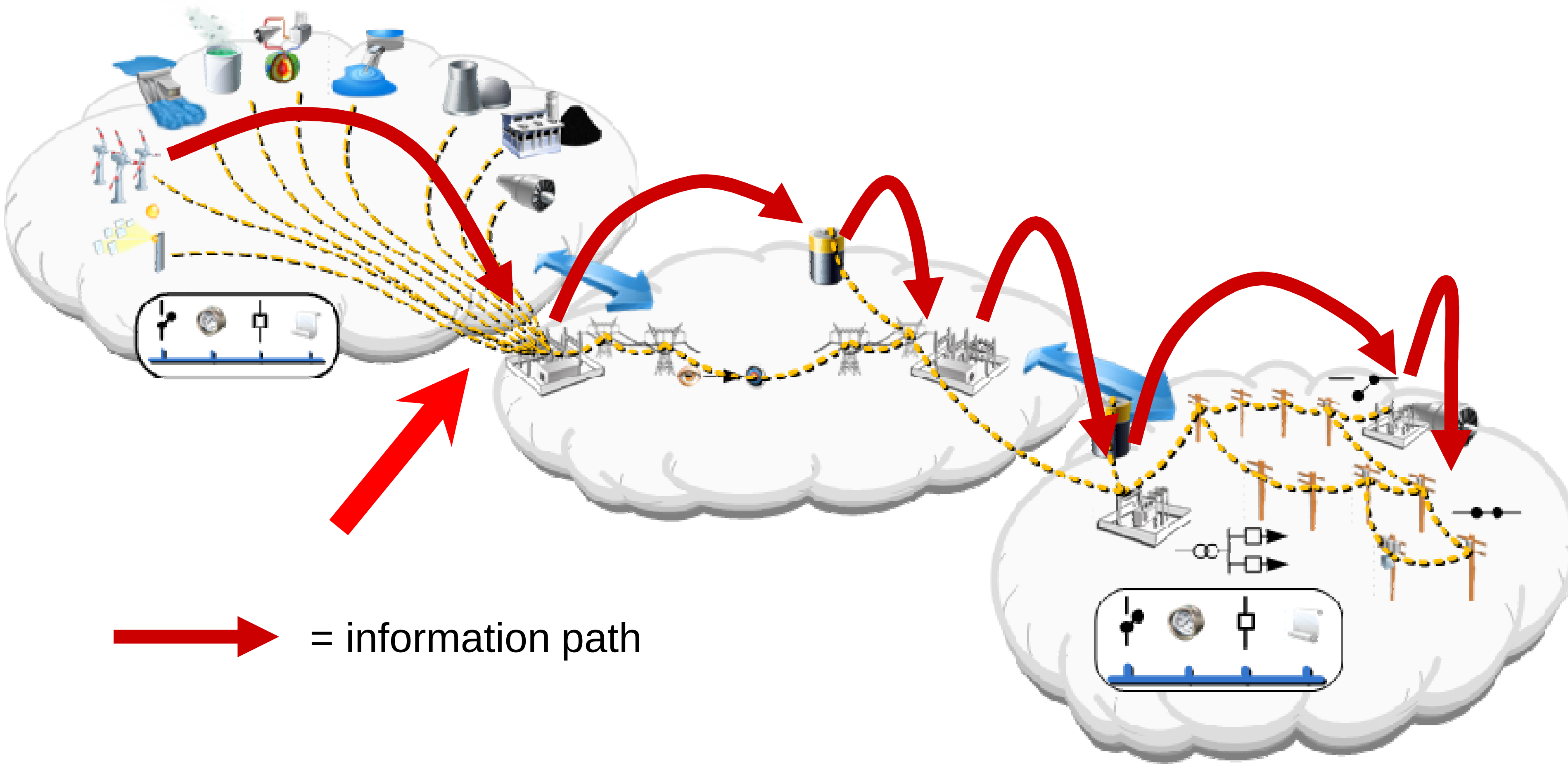
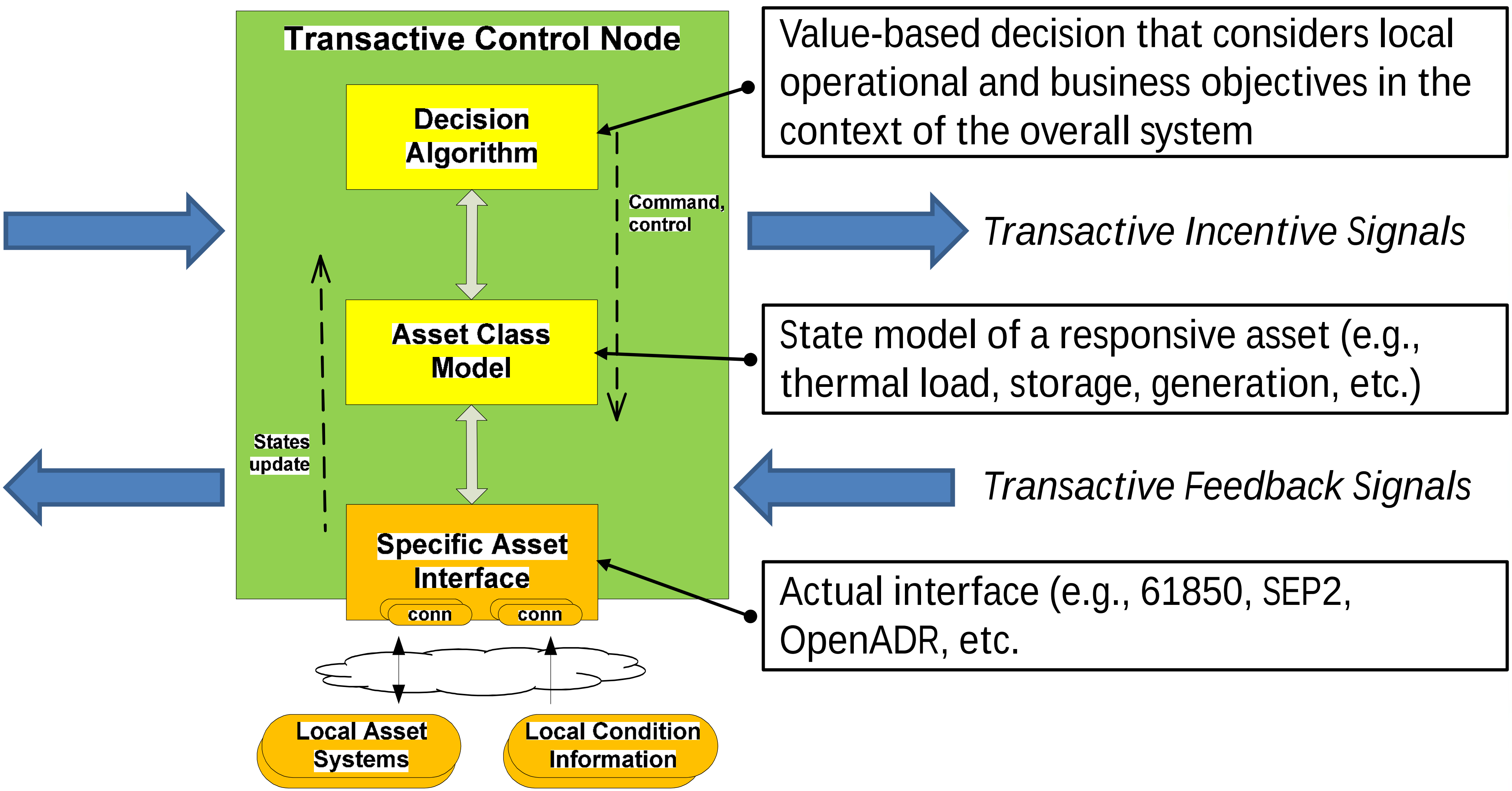
Example Incentive Signal Flow



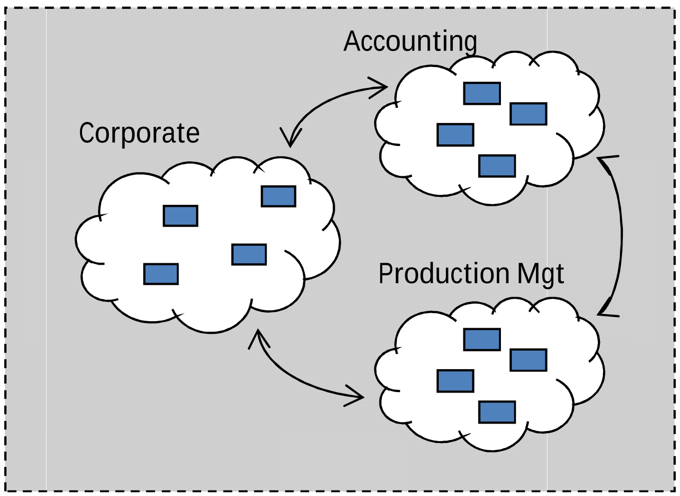
Transactive Control Node



So what kind of architecture framework will support this?

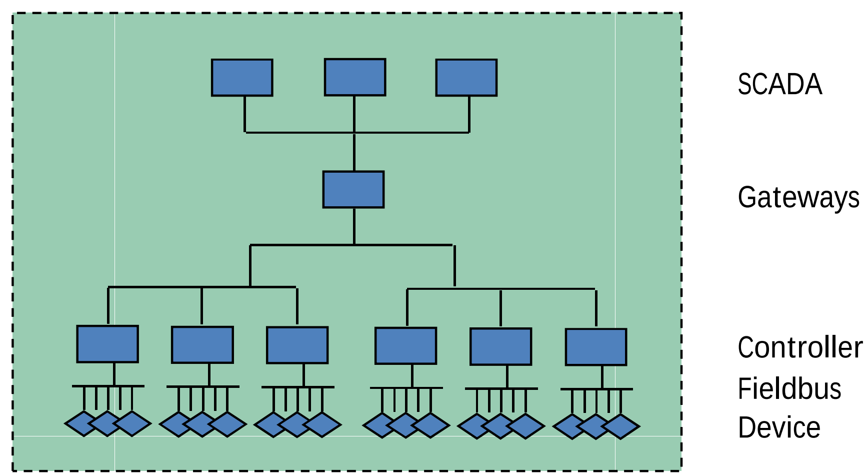
Operational Integration Today

Conventional Enterprise Computing



Traditional operations integration (MES, ERP, Database, ...)

Conventional Operational Control



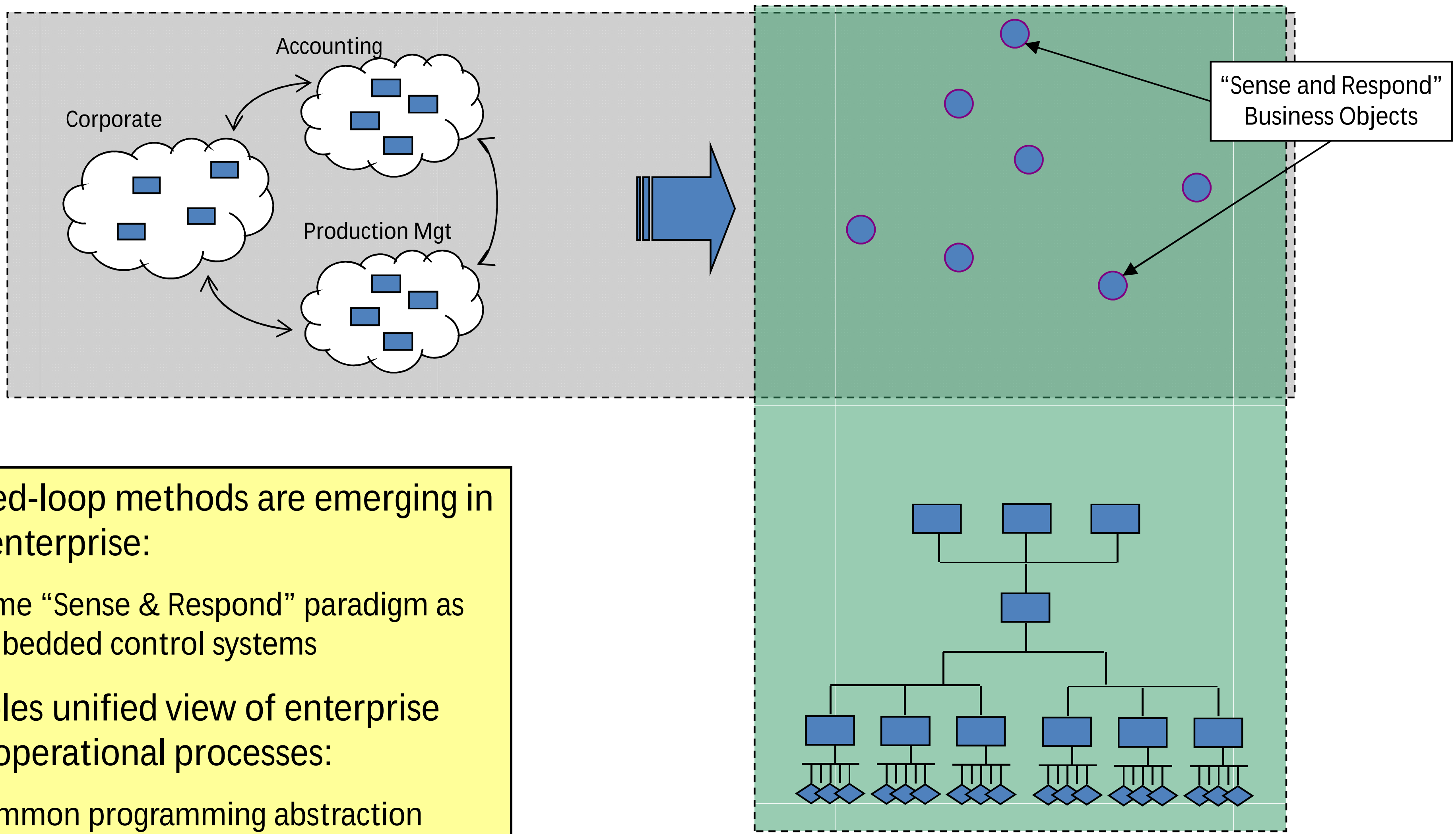
Today's environment:

- Enterprise & embedded control domains are loosely coupled
- Different programming models

Closed Loop Control in the Business Domain

Conventional Enterprise Computing

Integrated Business Automation



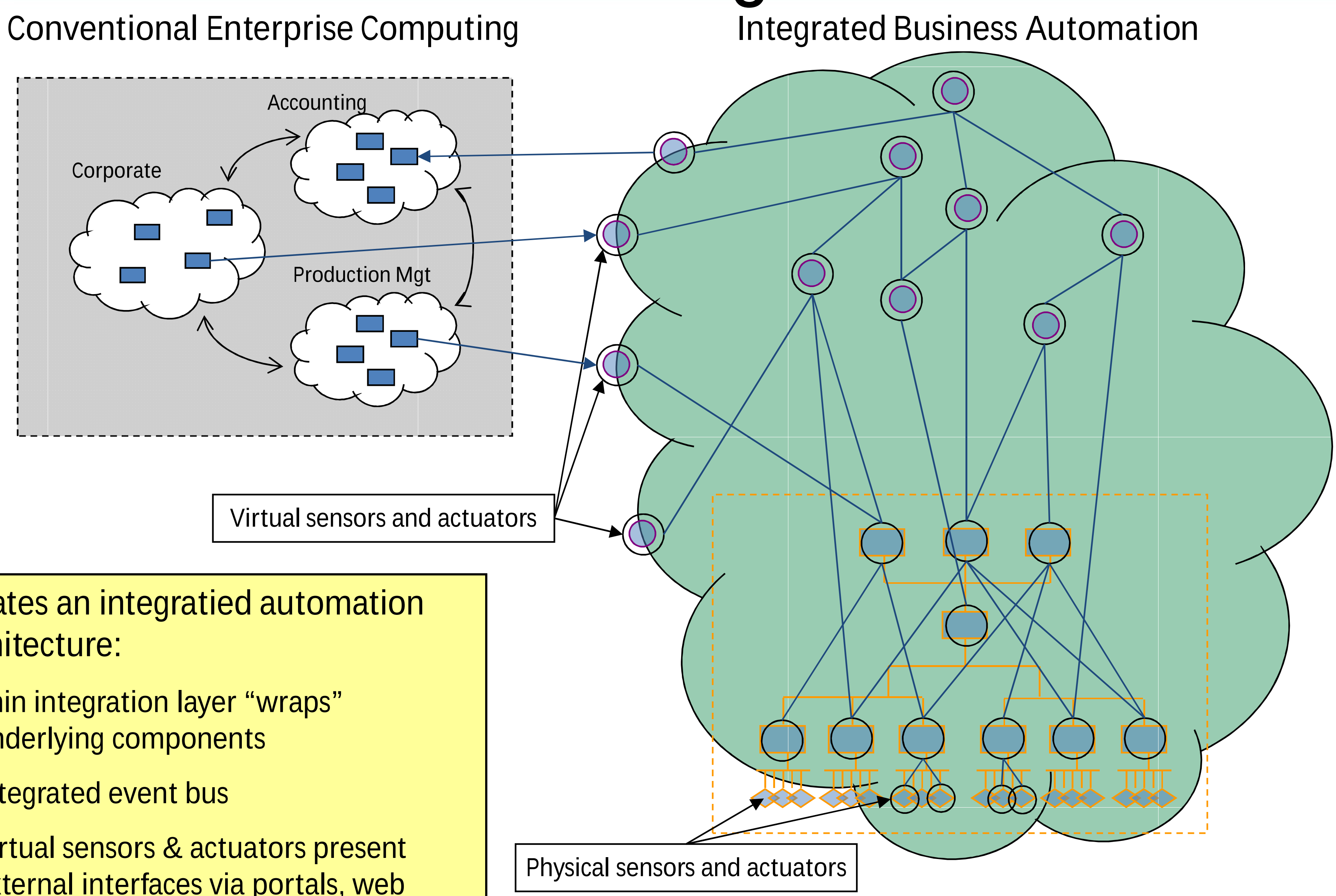
Closed-loop methods are emerging in the enterprise:

- Same "Sense & Respond" paradigm as embedded control systems

Enables unified view of enterprise and operational processes:

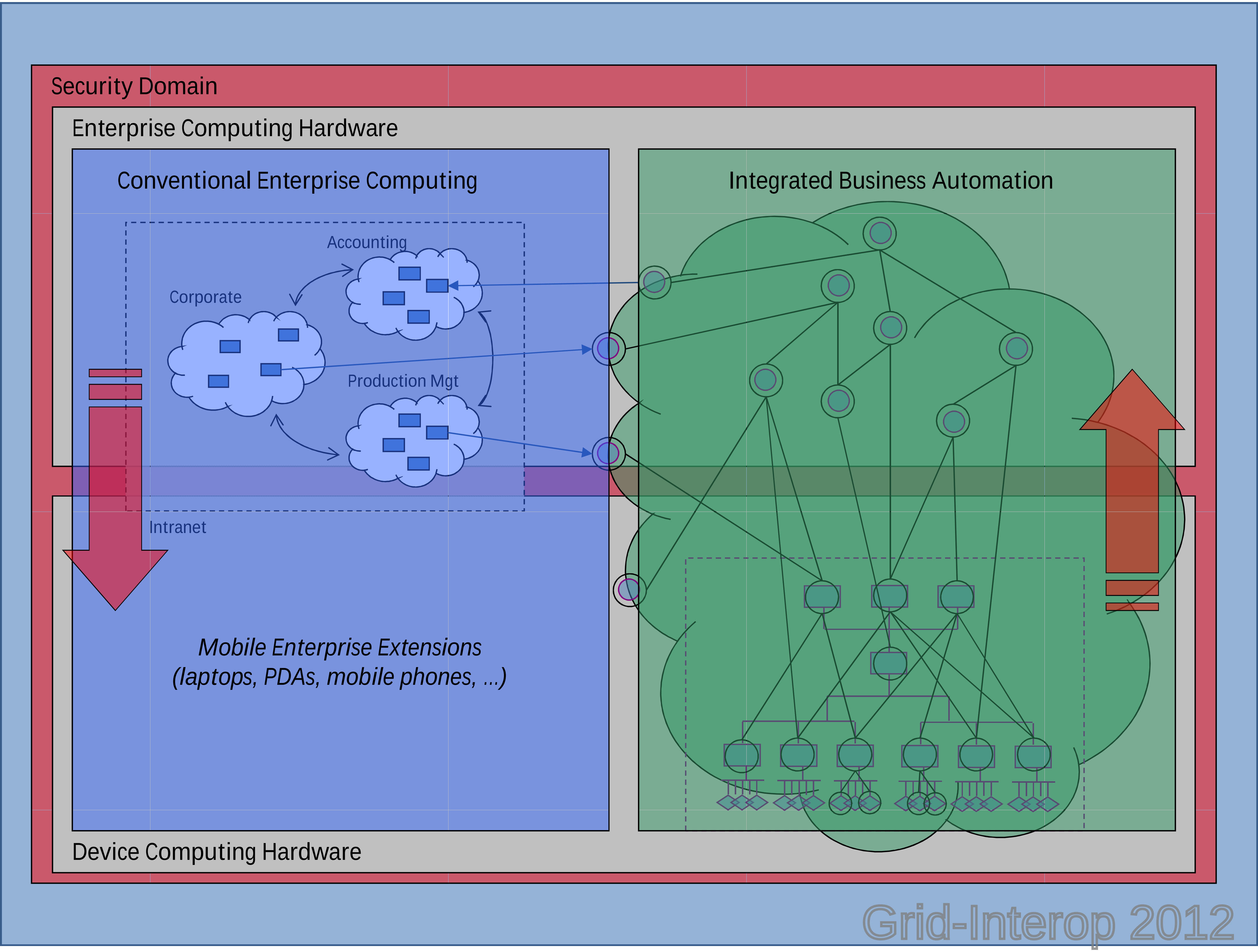
- Common programming abstraction
- Shared or interoperable infrastructure

Establish a flexible event-based integration model



Creates an integratied automation architecture:

- Thin integration layer “wraps” underlying components
- Integrated event bus
- Virtual sensors & actuators present external interfaces via portals, web services, …



Security Domain
Enterprise Computing Hardware
Conventional Enterprise Computing
Integrated Business Automation
Accounting
Corporate
Production Mgt
Intranet
Mobile Enterprise Extensions
(laptops, PDAs, mobile phones, ...)
Device Computing Hardware
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A Cyber-Physical System