Breakout Session 3: Decentralized Energy Paradigms

International

Energy Systems Integration Workshop

18-19 Feb 2014

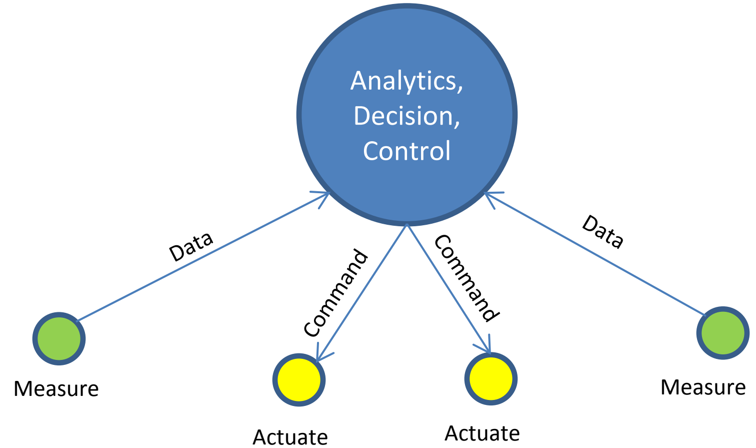
Participants

- Ron Ambrosio
- Venkat Banunarayanan
- Paul DiMartini
- David Elzinga
- Santiago Grijalva
- Ben Kroposki
- Jefferey Taft
- Sarah Truitt
- Carl Imhoff
- Sila Kiliccote
- Clyde Loutan
- Kevin Lynn
- Mark McGranaghan
- Sauro Pasini
- David Sun
- Le Tang
- Michael Walsh

A Few Definitions, Part 1

- Centralized Architecture

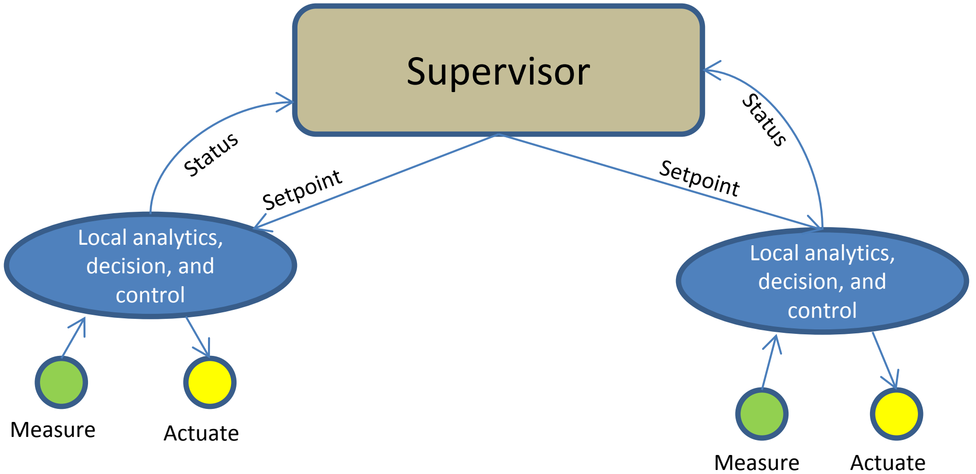
Data processing, command and control are performed from a single place; communication to any remote elements is hub-and-spoke



- De-centralized Architecture

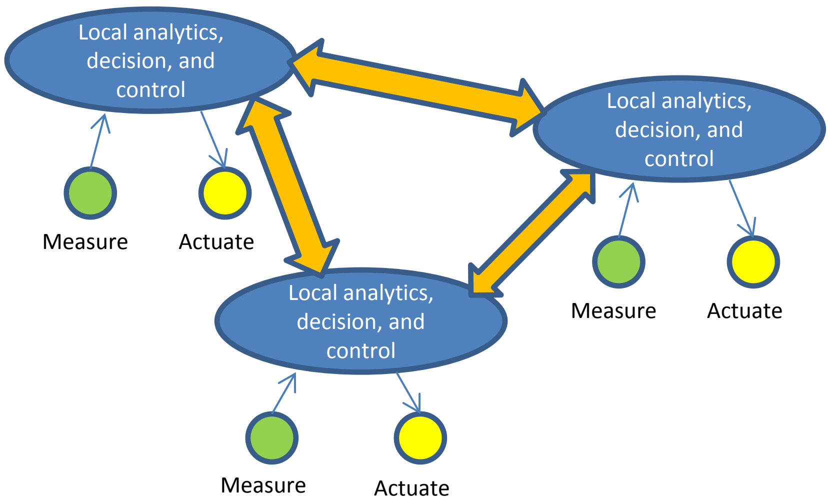
Data processing and control exist in multiple locations <u>but work independently</u>;

there may be centralized supervision of the remote nodes



A Few Definitions, Part 2

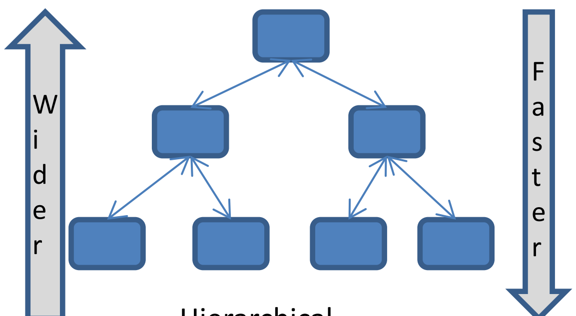
- Distributed Architecture



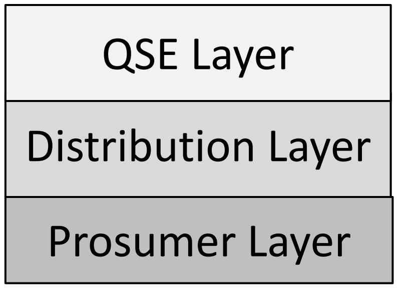
Data processing and control exist in multiple locations and <u>cooperate on solving a common problem;</u> connectivity may be arbitrary peer-to-peer; supervision may also exist

- Hierarchical/Layered Architectures

Decentralized nodes are organized in a structured fashion – hierarchy or multiple layers; connectivity is arranged accordingly



Hierarchical



Layered

Identifying the Challenges

- Challenge - Existing fleets lack flexibility (40-50% min gen on conventional fleet)
- Challenge - more distributed assets are being deployed without controls that are linked to larger system stability.
  - Need active voltage/frequency control of DER
  - Need incentives for DER (DG and DR) to provide grid services
- No framework for multi-scale optimization – unclear of the impacts of local energy system optimization on the larger system

Needs

- Framework that allows for evaluation of possible outcomes. From this it would be able to define what controls are necessary to meet requirements.
- Need model that can evaluate various control architectures. Needs to include value of services (energy/power and ancillary)
- Need to define what objective functions (Key Qualities) are used for control (utility values? Consumer value?)
- Vision – at the end of the day, are you delivering the right services to customers?
- Segment customers and their needs for energy and participation level

Needed Energy System Key Qualities

Consumer List

- Low-cost energy
- Enough Reliability to run my loads
- Environmentally friendly
- Customer choice
- Safe
- Enough Power Quality to run loads
- Resiliency – ability to withstand and recover from problems
- Perception of control (probabilistic vs. deterministic) - predictability of performance
- ease of use (simplicity)
- Privacy
- Access to value (piece of the action)

Supplier List

- Energy Security
- Enough Reliability to run my loads
- Flexibility to operator
- Low cost
- Right incentives to ensure infrastructure build out needs
- Access to connect to grid and market
- Visibility – grid state and market conditions
- Forecastability of resources
- Enough long-term view to extract maximum value (future proofing)
- Performance requirements

Services/Value Streams

- Continuity of svc
- Energy/power
- Voltage/PQ
- Frequency
- Information
- Financial
- Maintenance
- Asset management
- Storage

- Issue about incompleteness and need for support causing interdependence

- Energy/power
- Balancing
- Frequency regulation
- Voltage/Var control
- Reactive power
- Inertia
- Harmonic management
- Phase balancing
- Aggregation
- Resource forecasting
- Black start support
- Settlement
- Asset utilization opt
- Remedial action support
- Critical load support during outage
- (see Paul's value stream list, Sandia list)
- Storage as a serviced

What are the Major Barriers

- No mechanisms for pay for services or ways to monetize
- Overhead of monitoring services: settlement
  - Response monitoring
- Market designs,
- lack of standards and enforcement for DER installations
- Workforce availability
- Inertia in existing protection schemes (Special Protection scheme evolution to adaptive protection)
- How to show comparisons of central vs decentral system to inform legislators/regulators?
- How to resolve control governance?
- Existing systems seen as least cost and stil working, so why invest?
- Present decentralized deployments are not forward looking so are a barrier to moving forward
- Political and consumer inertia – change mgmt issue
- It’s coming faster than we can get ahead of it
- Uncertainty in what the endpoint will be (where are we going?)
- Information networks and cyber security

Rewards if we do it well

- Leverage capital from consumers and non-classical utility financing sources
- Realize greater economic efficiencies (can US switch NG use from CC to CHP?)
- Opens up energy innovation possibilities and opportunities
- Increased robustness across multiple energy futures
- Extension of connectivity beyond electricity to smart cities and beyond
- Provide graceful industry transitions
- Improved sustainability and consumer economics

Examples from History

Where have decentralized paradigms have successfully been implemented already?

- Printing
- Computing
- Power protection systems
- Power plants
- Denmark – (minimal changes needed to migrate to decentralized/hierarchical control, but need market integration, Heat and Electricity markets)

Taking Action: Roadmap

- Baseline with stakeholder groups in first year
  - Understand the services
- Engage stakeholders groups early
  - How to structure engaging the stakeholders?
  - Take advantage of DOE convening power
- Identify theory/knowledge gaps in first year or 2
- Engage various parties to fill the gaps
- Focus on public goods issues to help pull-thru
- Identify 1^{st} mover opportunities
- Inventory of global existing pilots
- ID metrics and test beds for engineering work
- Revisit and revise value of services models
- Capture lessons learned form existing pilots
- List the stakeholder groups
- Fill knowledge gaps
- Early opportunity: flexibility services (pilot?)
- Create and update interconnection grid codes
  - Identify barriers (assess then update)
- Educate /advise the stakeholders
- Organized approach to communicating roadmap to wider community
- Technology transfer program
- Select key problem, define requirements for test/demo
- Test at key scale and penetration thresholds or other key paradigms and provide open demo for all levels of power systems

How to Collaborate

- Nobody wants a new org, so use a convener to arrange collaboration
- Review existing orgs and interested parties
  - who can help?
- Need incentives for participating
- Links to smart city/grid collaborations in place now? Have to leverage existing efforts
- NIST/SGIP Model / EU SGAM?
- Roadmap/report can help build community –”best way to collaborate is to do something”
- Periodic face-to-face that leverages an existing meeting or conference (piggy-back)
- Find commonality of interests to help accelerate markets