RIAPS
Resilient Information Architecture Platform for Smart Grid
The Energy Revolution: Big Picture

From centralized to decentralized and distributed energy systems

RIAPS Vision

Microgrid Control Problem

Applications:
- F & V Restoration
- Load Shedding
- Fault Transition Scheme (FTS)

In Islanded Mode
- Protection
- Inlanding Detection
- μ-grid Membership

In Grid-Connected Mode
- Resynchronization
- Islanded Outage
- μ-grid Membership
- Int. Islanding

Needs
Fault-tolerant, distributed controller that interacts with local inverters, loads, and grid operators

Source: NCSU/S. Lukic

System Impedance: 0.0075 + j0.1851 p.u.

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RIAPS Vision

Microgrid Control Problem

Needs:
Fault-tolerant, distributed controller that interacts with local inverters, loads, and grid systems/operators

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System Impedance: $0.0075 + 0.1851 \text{ p.u.}$

LEGEND:
- Protection Device (SEL 751)
- Asset Switch (SEL 751A)
- RIAPS Protection Node
- RIAPS Load Node
- RIAPS DER Node

Bus 1_0

RIAPS Node:
- Computing Platform
- Network I/F
- Sensors
- Actuators

Source: NCSU/S. Lukic
RIAPS Vision

- Push computation and control to the *edge*
- Use a *common* technology stack
- Facilitate the *integration* of heterogeneous devices
- Provide core services to enable the *rapid* development of *smart* apps

Example Power System: IEEE 30 bus system

Control Room
RIAPS Layers

### Apps:
- microgrid control
- distributed SCADA
- RAS
- EMS

### Linux (with real-time features)

### NIC (with IEEE-1588)
What is RIAPS?

- **Distributed Real-time Embedded Computing Platform**
  - Component-based application software architecture
  - Networking/messaging details are transparent to app developers
  - Strictly limited concurrency – well-defined interaction patterns

- **Run-time services**
  - Fault-tolerant, peer-to-peer service discovery
  - High-precision time-synchronization
  - App deployment and management
  - Device encapsulation and management
  - Logging and log management

- **App languages:** Python, C++

- **Resource management**
  - Resource quota monitoring and enforcement

- **Fault-tolerance**
  - Automatic app restart upon failure
  - Automatic network reconnect
  - Peer-to-peer notifications

- **Distributed coordination**
  - Dynamic group communications
  - Leader election, consensus

- **Security**
  - Secure deployment, communications
  - Apps strictly isolated
  - Privileged access to devices

- **Model-driven development tools (IDE)**
Where is RIAPS in the Architecture?

RIAPS is the platform to implement monitoring, control, analytics,... functions at the edge.
Example application - Microgrid Control

https://riaps.isis.vanderbilt.edu/demonstrations.html
Summary

- RIAPS is a platform for building distributed apps for Smart Grids.
- It has been demonstrated with:
  - Microgrid control app
    - Islanding/reconnection, distributed control
  - Remedial action scheme app
    - Generation curtailment and under-frequency load-shedding
  - Transactive energy app
    - Prosumer ‘traders’ buy and sell energy, use a blockchain to record trades
  - ...

https://riaps.isis.vanderbilt.edu/
https://riaps.github.io/
https://github.com/RIAPS
https://www.youtube.com/watch?v=U6P3jPcvkhE

RIAPS was made possible by support from the US DOE ARPA-E
Thank You!