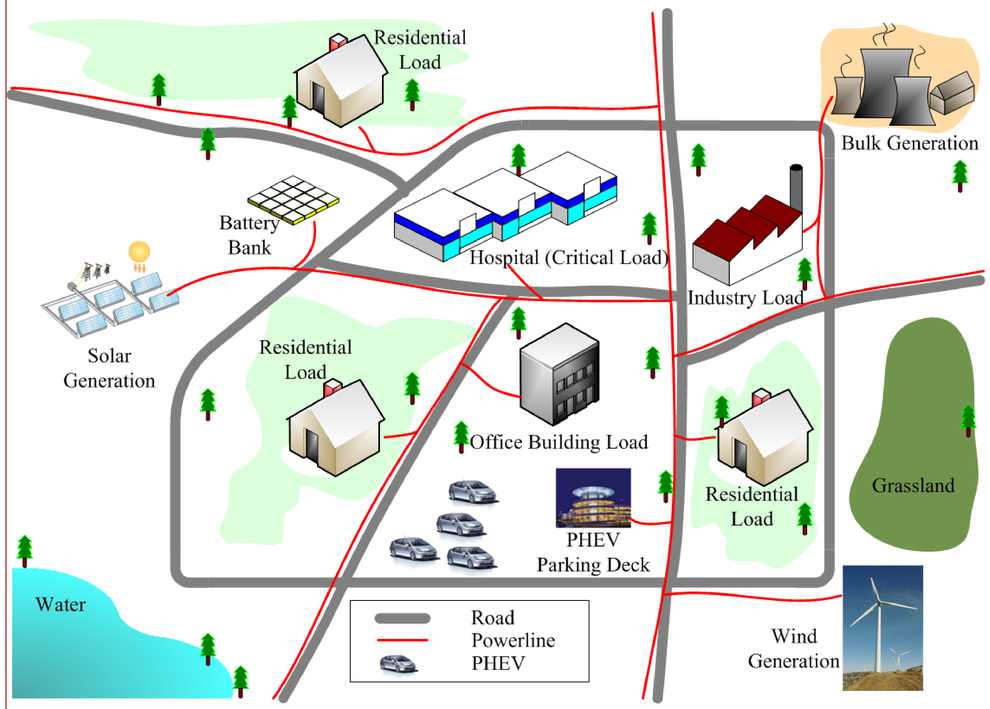
NC STATE UNIVERSITY

Smart Grid Operation and Control

ADAC

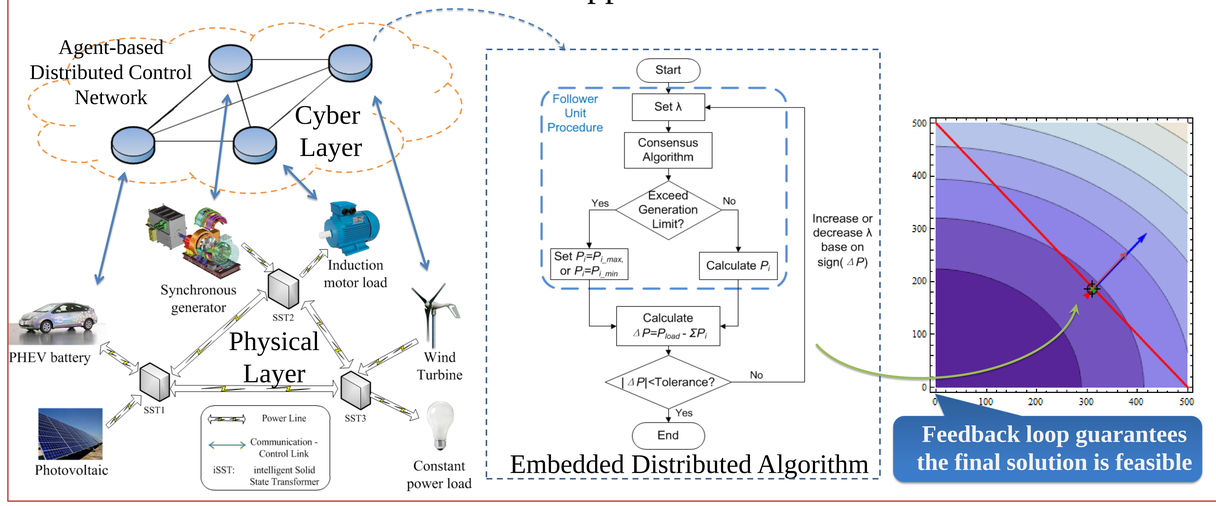
Spatial, Temporal and Event based Simulator



- **Spatial Information**
  - ✓ Geographic
  - ✓ Weather spatial profile
  - ✓ Load spatial profile
- **Temporal Information**
  - ✓ Weather trend
  - ✓ Load trend
- **Event Catalogs**
  - ✓ Fault-related events
  - ✓ Load shedding
  - ✓ Islanding

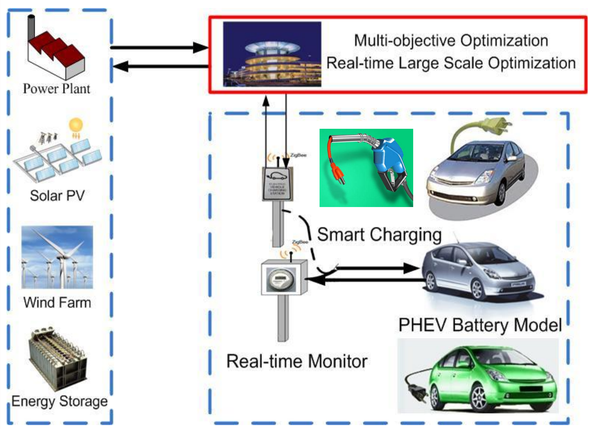
Distributed Power/Energy Management on FREEDM Systems

- Consensus and gossip based distributed control algorithms
- Complex network with inertial loads and generators considered
- Time-varying power grid topology and communication topology
- Time-sensitive and data-sensitive applications

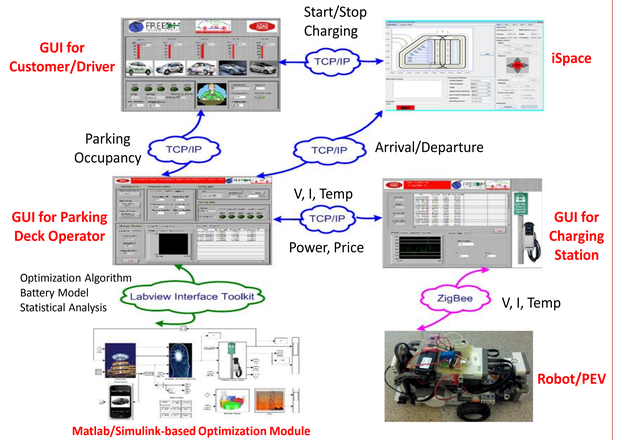


Performance Optimization of Large-scale PHEV Enabled Charging Infrastructure

- Estimation of Distribution Algorithm (EDA) for large-scale energy management
- Demand Side Management (DSM) and Vehicle-to-Grid (V2G) technology
- Low-cost and effective communication considering communication delay, bandwidth constraints, packet drop, security issues



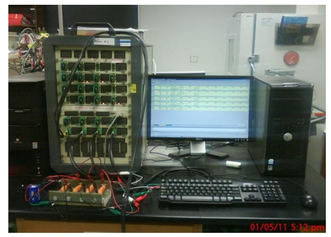
Envisioned Large-scale PHEV/PEV Charging/V2G Infrastructure in a Smart Grid Environment

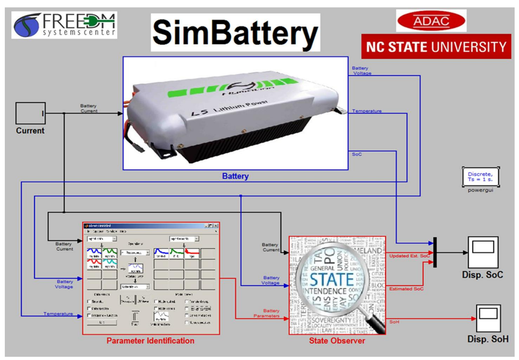


Envisioned Communication Architecture for a Large-scale PHEV/PEV Enabled Parking Deck

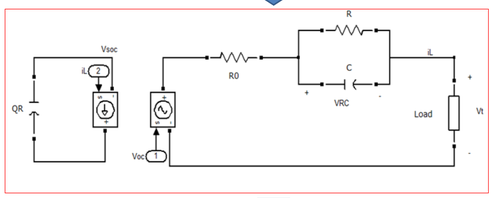
Adaptive Nonlinear Battery Modeling and State Estimation

- Accurate real-time battery parameter identification
- Real-time State of Charge (SoC) and State of Health (SoH) estimation based on the identified parameters.
- Precise temperature and aging effect modeling
- Suitable for online applications





Battery monitoring system



$$\begin{bmatrix} \dot{S_{oc}} \\ \dot{V_{RC}} \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & -\frac{1}{RC} \end{bmatrix} \begin{bmatrix} S_{oC} \\ V_{Rc} \end{bmatrix} + \begin{bmatrix} 1/Q_R \\ 1/C \end{bmatrix} I$$

$$V_t = \begin{bmatrix} b_1 & 1 \end{bmatrix} \begin{bmatrix} S_{oC} \\ V_{RC} \end{bmatrix} + R_0 I + b_0$$

$$V_{OC} = f(S_{oC}) \cong b_0 + b_1 S_{oC}$$

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