

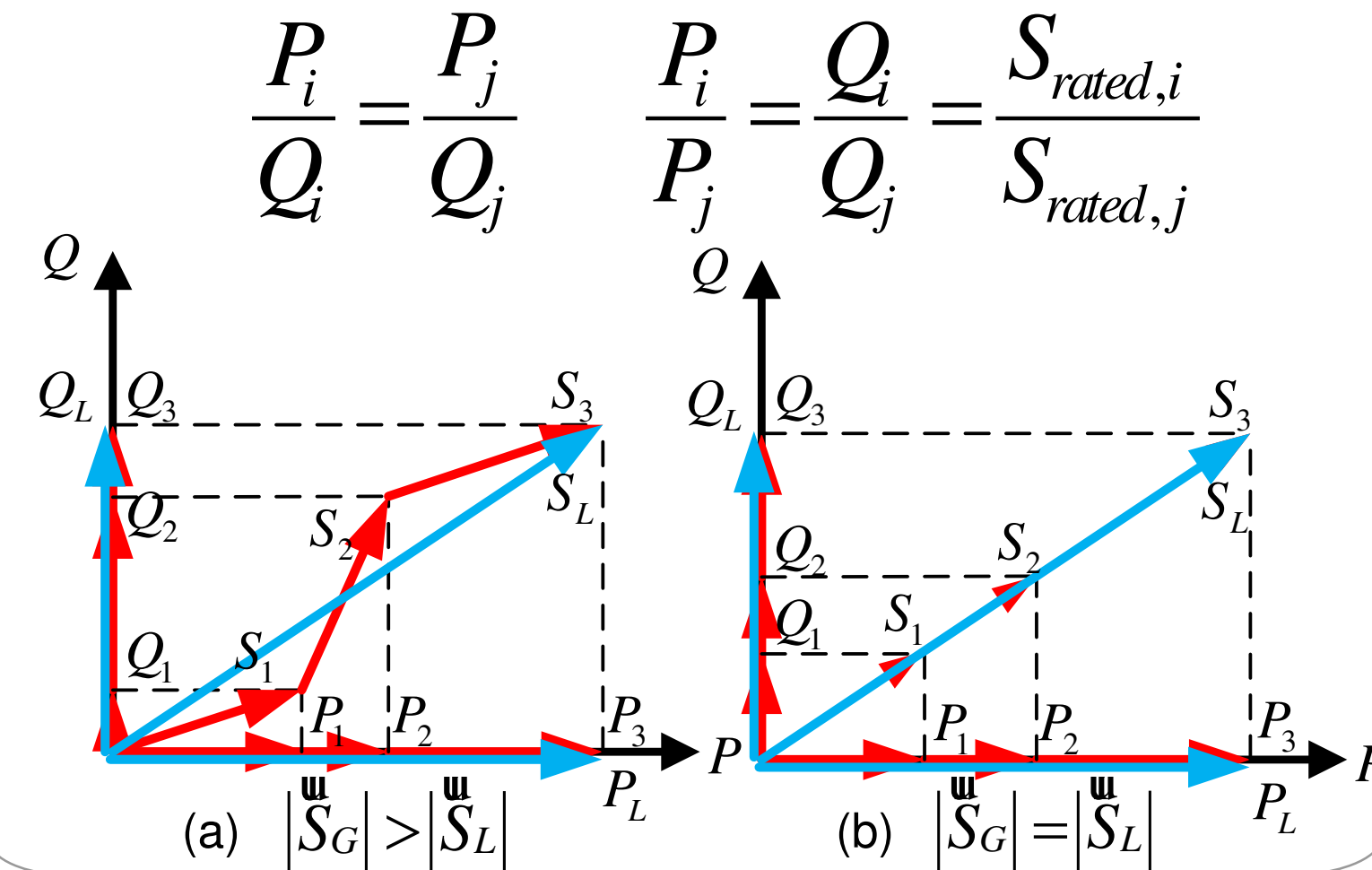
Overview

Microgrids are ideally suited for distributed control solutions. However, challenges exist when realizing the developed distributed controller under hardware level:

- ✓ Sufficient computational capability to support small iterative time step;
- ✓ Time synchronization management of concurrency among all the nodes
- ✓ Exchange information in a fast and accurate manner;
- ✓ Scalable controller and hardware implementation;
- ✓ Device interaction codes development VS Core control codes development;
- ✓ ...

Problem Formulation

- Within islanded microgrid, sum of generated apparent power could be greater than the demand ($|\vec{S}_G| > |\vec{S}_L|$);
- To properly utilized the generated apparent power ($|\vec{S}_G| = |\vec{S}_L|$), following conditions should be met:



Distributed Microgrid Apparent Power Control

- Frequency and active power sharing :

$$\omega = \omega^* - m_i(P_i - P_i^*) + \Omega_i^*$$

$$\Omega_i^* = \Omega_i - m_i P_i^*$$

$$k_i \frac{d\Omega_i}{dt} = -(\omega - \omega^*) - \sum_{j=1}^n a_{ij}(\Omega_i - \Omega_j)$$

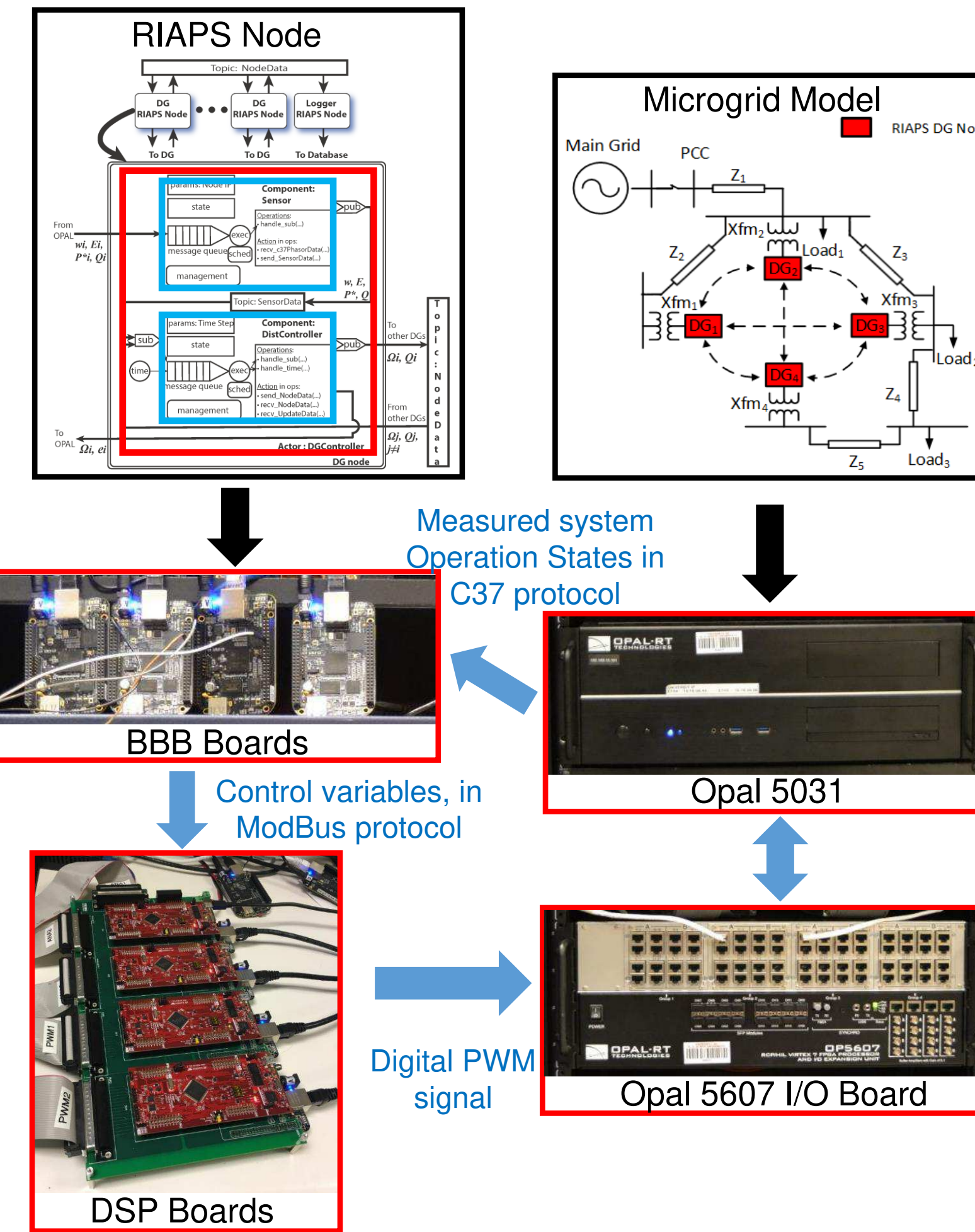
- Voltage and reactive power sharing :

$$E_i = E^* - n_i(Q_i - Q_i^*) + e_i$$

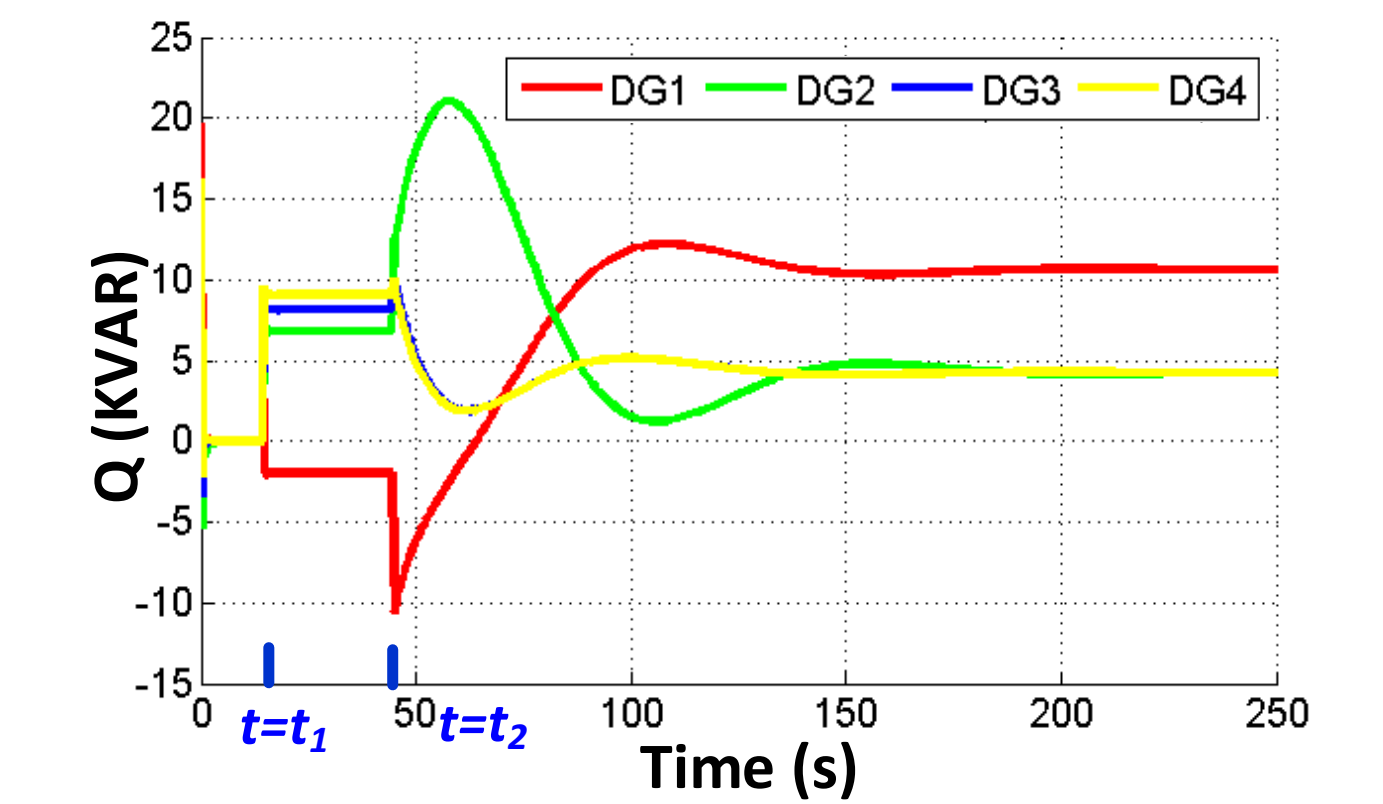
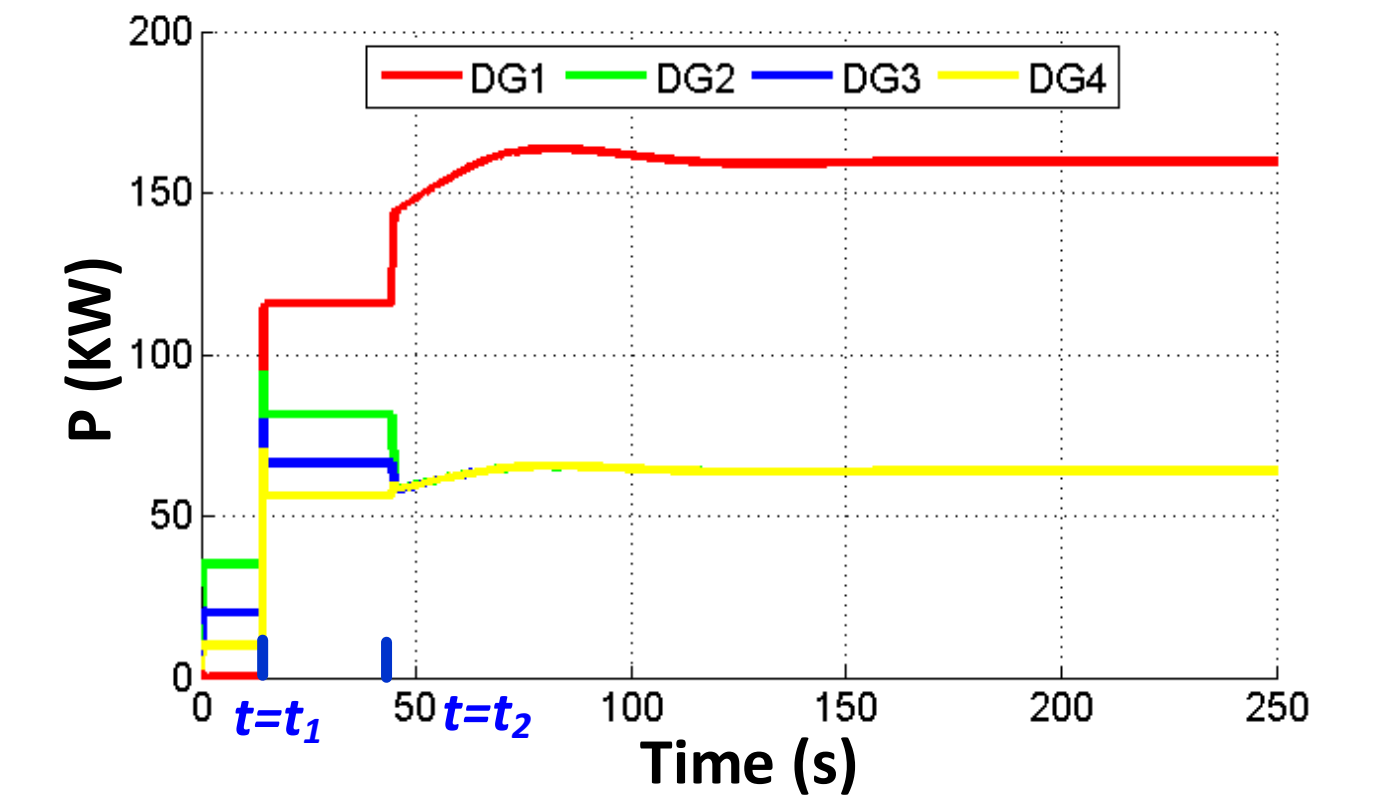
$$Q_i^* = Q_i / S_{rated,i}$$

$$k_i \frac{de_i}{dt} = -\beta_i(E_i - E^*) - \sum_{j=1}^n b_{ij}(Q_i - Q_j)$$

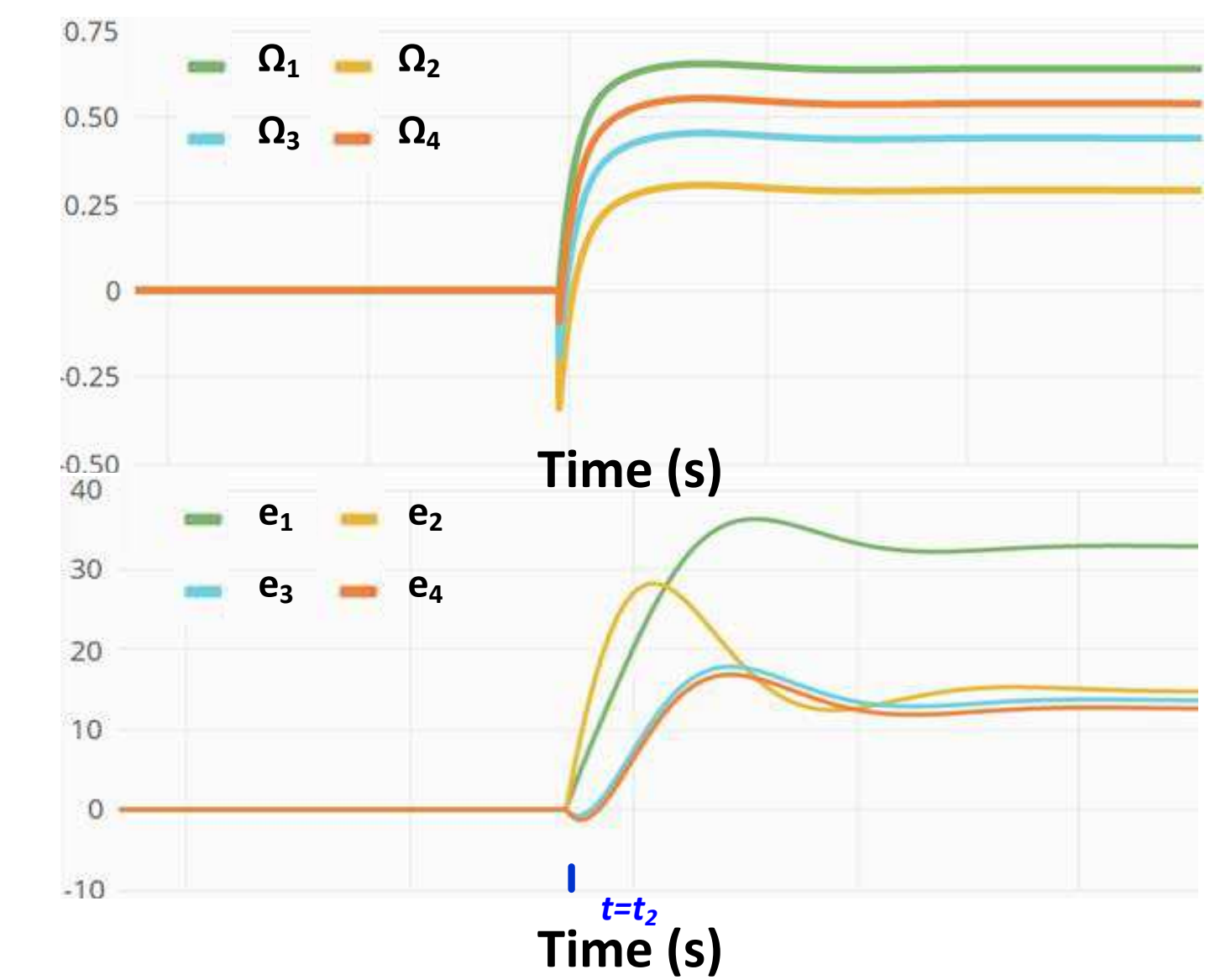
Hardware Realization by RIAPS



Experimental Results



Data Captured in Opal-RT

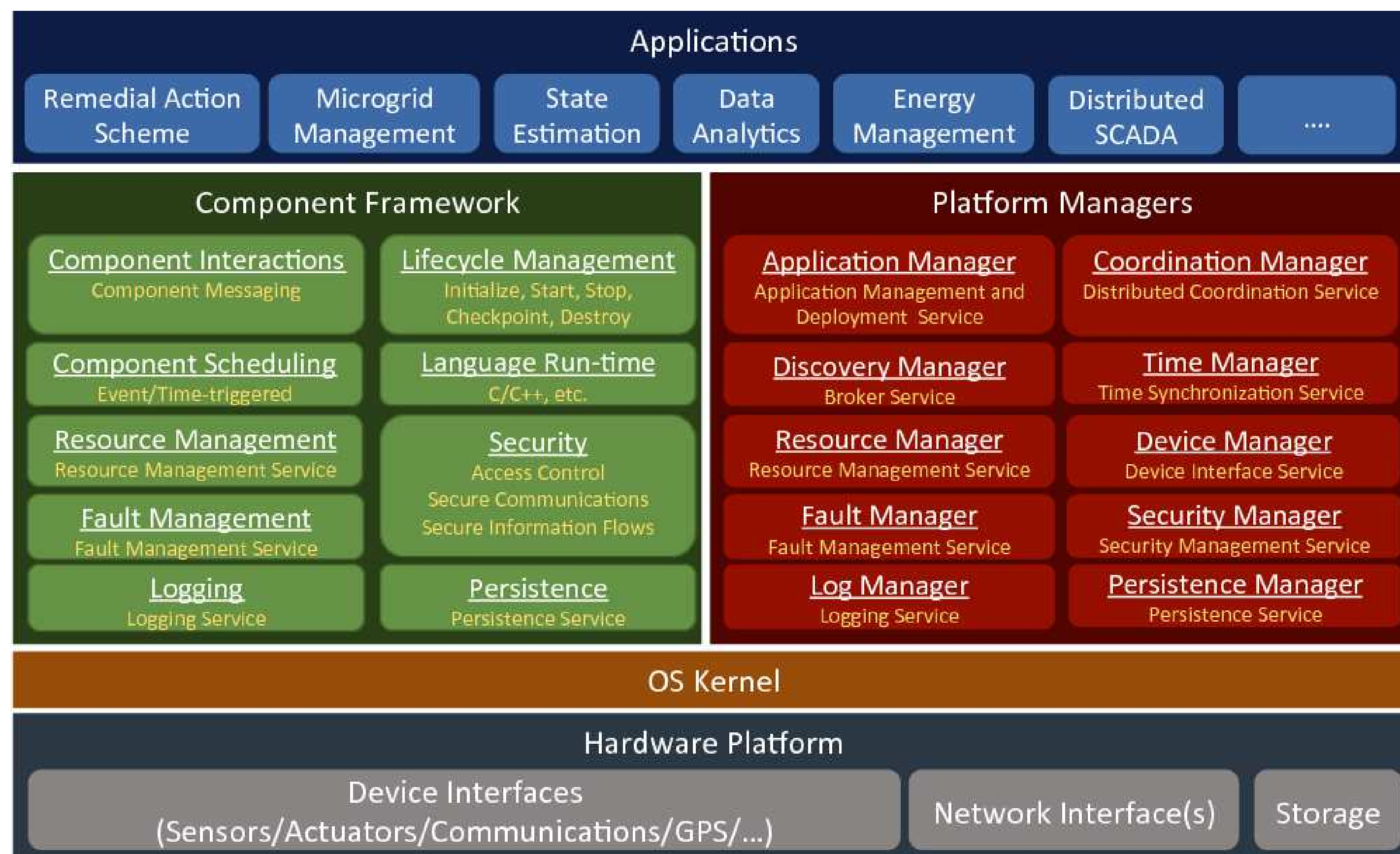


Data Captured in RIAPS Logger

Links

<https://riaps.isis.vanderbilt.edu/>

RIAPS System Architecture Overview



Hardware Testbed Setup