Y9.ET1.1: Integration of Secure DGI algorithms with Testbeds

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1. Project Goals

The primary goal of this project is to integrate DGI into the testbeds and to support DGI application development. For several years, the DGI and HIL teams have worked closely together to co-develop the HIL testbed and DGI. In year 9, we intend to carry this work forward to fully integrate DGI into the GEH and to link DGI with the LSSS.

2. Role in Support of Strategic Plan

Strategically, the integration project delivers the FREEDM system to all major testbeds integrating the software applications and systems software to produce a true system.

3. Fundamental Research, Technological Barriers and Methodologies

This is an implementation project. The technological barriers are multiple languages, implementation platforms, and the challenges of fitting systems designed for SCADA control into a distributed environment.

4. Achievements

(Including Previous Years, but with an Emphasis on the Current Year)

The DGI's components have been built up over the last 9 years starting with the center's existence. Figure 1 shows the DGI's principal components:

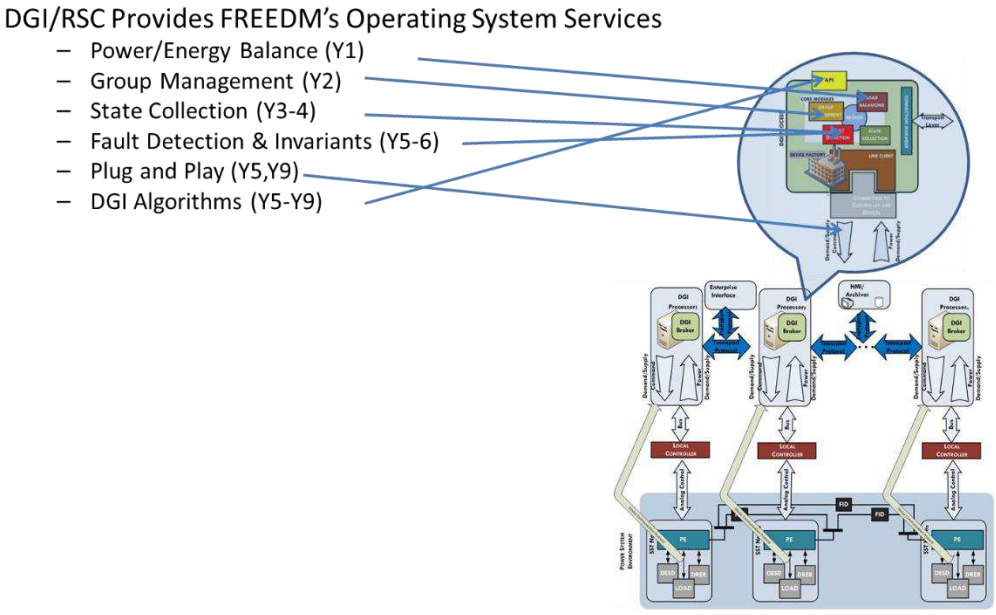

Figure 1: Principal Components of the DGI

In Year 9, due to requirements for an integrated simulation environment between the large scale systems work and the HIL testbed, OpenDSS & HIL/LSSS integration continues the ongoing DGI

HIL/LSSS/GEH project. The idea is to establish a scalable LSSS TB integrated with both the HILTB and with OpenDSS, link DGI into OpenDSS and ensure full compatibility between HILTB version and the LSSS TB. Technologically, this requires that we build a DGI-openDSS interface similar to that of the current DGI-PSCAD, DGI-HIL interface. Work has been challenging as openDSS's interfaces are not well documented and not designed for such an interface, but as of Q2, in Year 9, a working prototype has been developed.

Work with the HIL team has integrated Federated DGI to support larger systems in real time. Conceptually, the LSSS can integrate the existing LSSS into HIL with DGI application support and this is scheduled for Q3.

Secure application development under the DGI for power, voltage, energy, and configuration management as driven by center engineers. This includes CoDES and Volt-Var.

The NCSU GEH team has received an integrated MQTT/DGI for deployment of DGI within the GEH environment as shown in Figure 2.

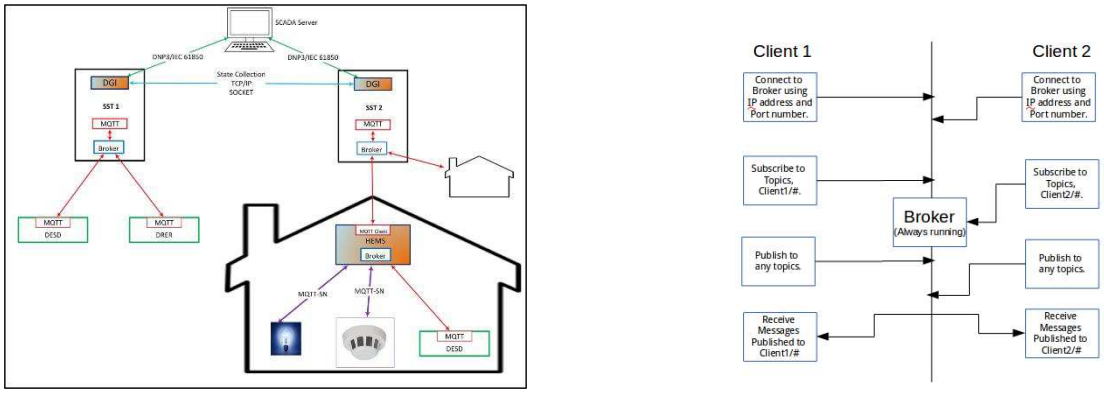

Figure 2: DGI/MQTT integrated environment

5. Other Relevant Work Being Conducted Within and Outside of the ERC

The SGIP openFMB led by Duke is the closest related activity and PI McMillin is working with them on a FREEDM-like security analysis of the openFMB architecture. The Singapore University of Technology and Design is using similar methods of system protection in their water and smart grid testbeds, but they are not distributed systems like FREEDM.

6. Milestones and Deliverables

Q3 (9/30/2016) – CODES and Volt/VAR implemented in HIL controlling the system
Q4 (12/31/2016) –openDSS interface with DGI, Successful installation of DGI in GEH
Q1 (3/31/2017) – CODES, Volt/VAR, and Configuration Management working with LSSS resilient to security attacks and system failures.
Q2 (6/30/2017) – CODES, Volt/VAR working in GEH

7. Plans for Next Five Years

Work with industrial consortia and other research facilities to implement FREEDM concepts to build resilience cyber-physical systems and further develop the science of cyber-physical security.

8. Member Company Benefits

The security work and work done on DGI can provide models, particularly for Duke and the openFMB project on secure distributed algorithms for electric power system management.

9. References

All work has been code development and is not publishable.