ILLINOIS INSTITUTE OF TECHNOLOGY

Research Thrust: Advanced Distribution Automation

Prof. Alex Flueck

PhD Student: Cuong Nguyen

In collaboration with S&C Electric

ILLINOIS INSTITUTE OF TECHNOLOGY

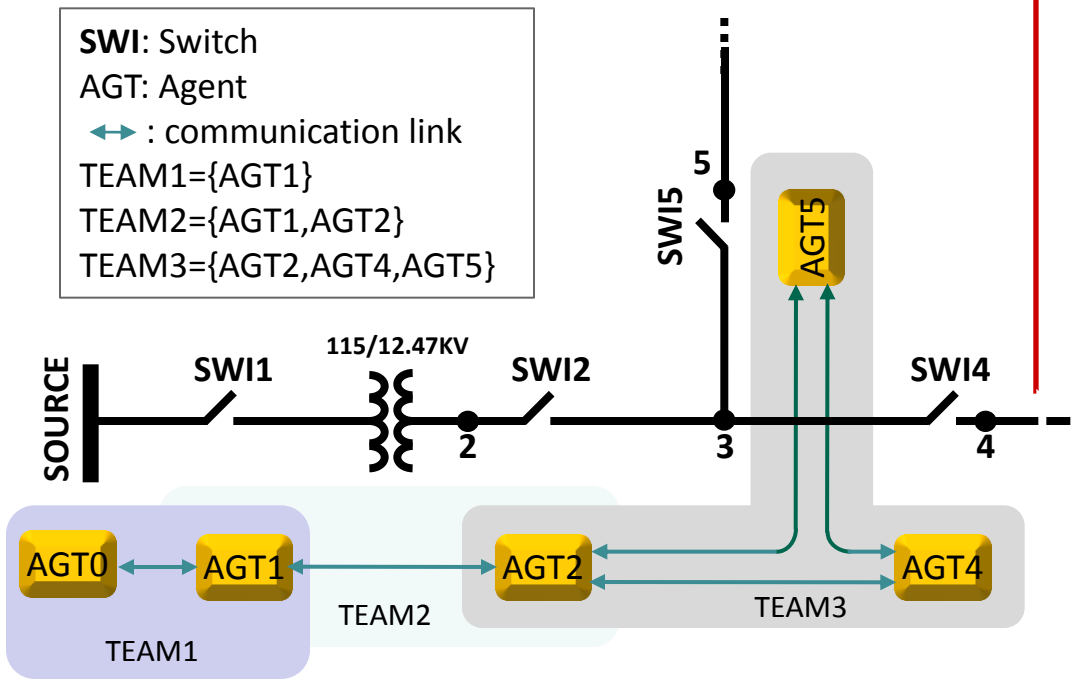
Advanced Distribution Automation

- Modeling
  - Conductors, communication and control
- Distributed Autonomous Agents
- Communication Latency
- Future Work
  - Visualization
  - Preventing Outages with Distributed Generation & Storage
  - Optimizing Resource Allocation

ILLINOIS INSTITUTE OF TECHNOLOGY

Multi-agent System (MAS) in Advanced Distribution Automation

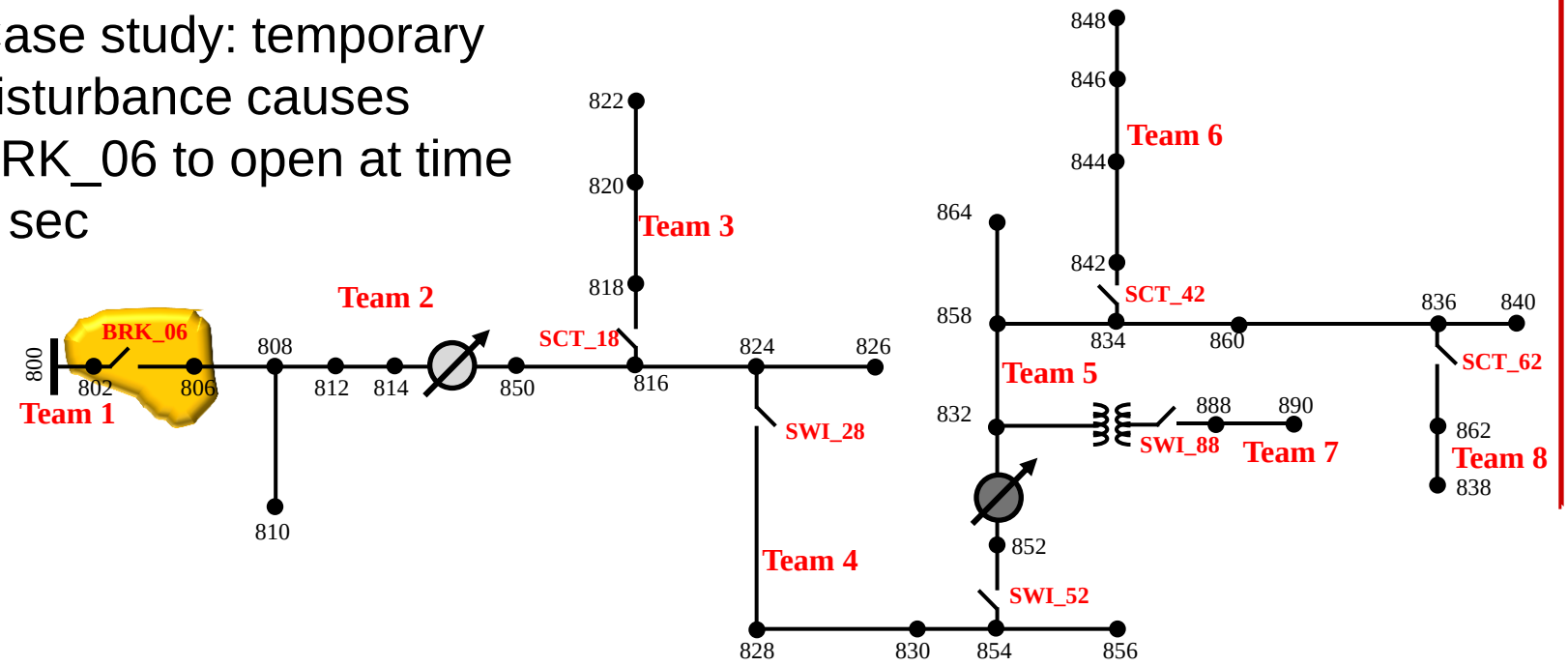
- Fault detection & isolation, then reconfiguration
- Agents send messages
- Communication latency - critical!



ILLINOIS INSTITUTE OF TECHNOLOGY

Simulation on IEEE 34 node feeder

Case study: temporary disturbance causes BRK_06 to open at time 1 sec

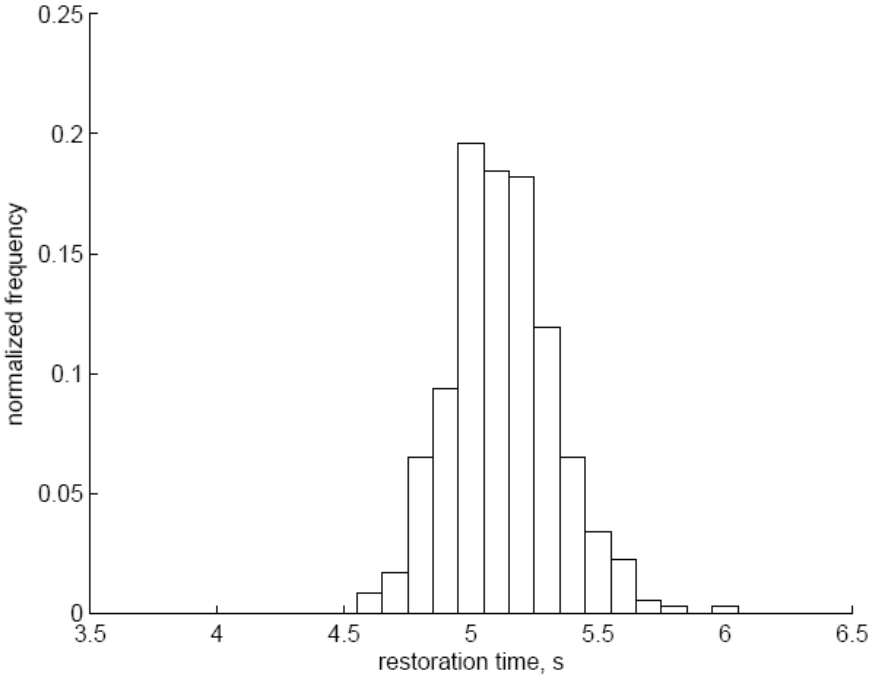


NORMAL RANDOM DISTRIBUTION OF COMMUNICATION LATENCY

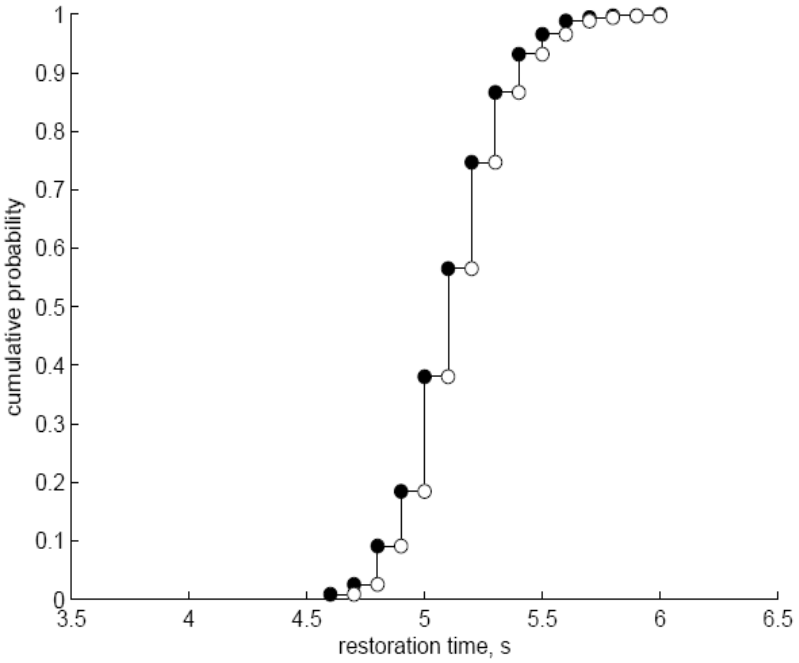
Point	1	2	3	4	5	6	7	8	9	10
Latency (s)	0.0333	0.0667	0.1000	0.1333	0.1667	0.2000	0.2333	0.2667	0.3000	0.3333
Probability	0.0060	0.0120	0.0361	0.1265	0.6328	0.1265	0.0361	0.0120	0.0060	0.0060

Simulation Results

- Statistical results after 500 simulations with same event.



(a) Histogram



(b) Cumulative distribution

Why DESS is needed ?

- In “Grid 2030 Vision” report, Department of Energy has identified two of the top five concerns for the future smart grid:
  - **Distributed Energy Storage System(DESS)**
  - **Distributed Intelligence and Smart Control(DISC)**
- DESS application is very flexible:
  - Generation system: **spinning reserve, firm up intermittent renewable energy sources**
  - Transmission system: **support load carrying capacity and stability, support voltage dip, peak shaving**
  - Distribution system: **peak shaving, power quality improvement; dynamic islanding**

Reference DESS Installations (Electronic Converter Storage)

Source: American Electric Power

Three 2MW NaS Battery installations in AEP distribution system, 2008

1MW NaS Battery installation for 11MW Wind Farm in Xcel Energy, 2009

Source: SandC Electric

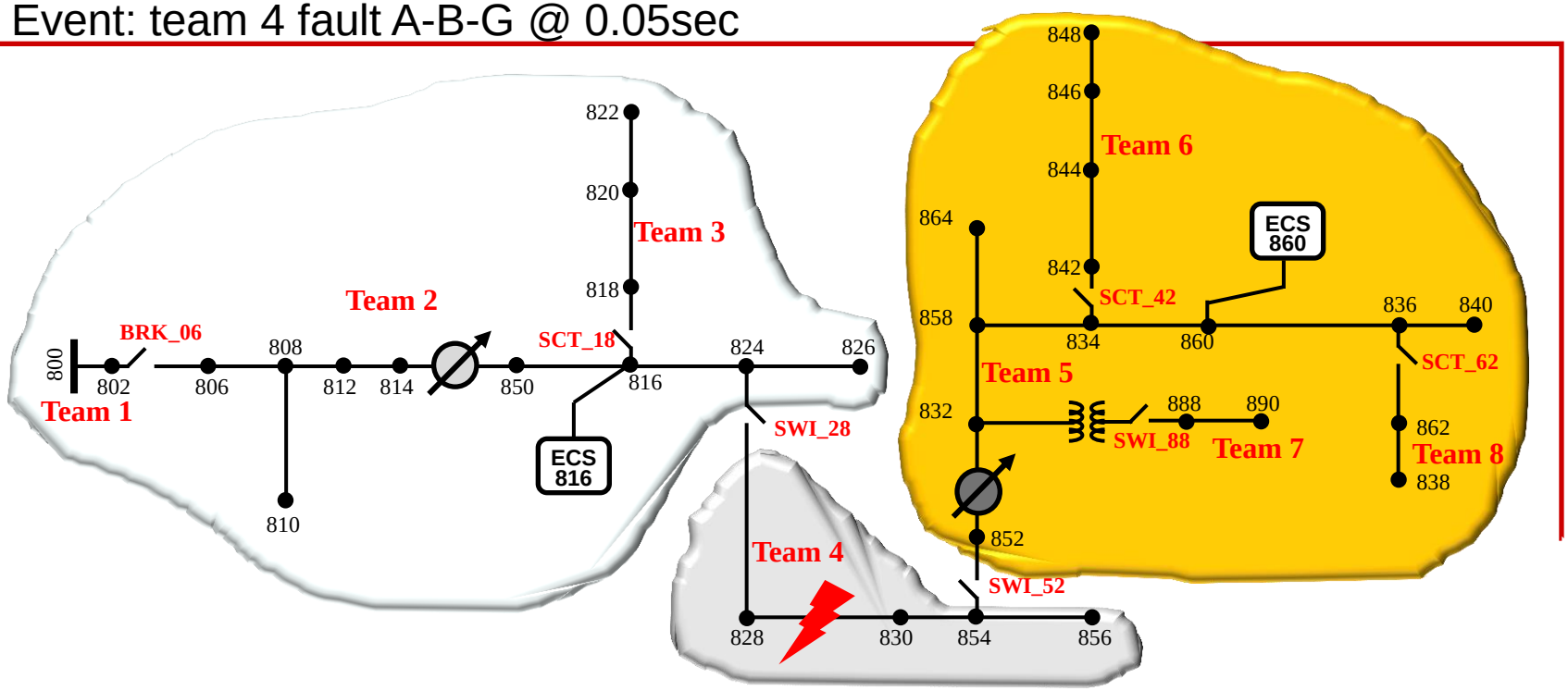
34 MW NaS battery installation for 51MW Wind Farm, Japan, 2008

Source: www.ngk.co.jp

ILLINOIS INSTITUTE OF TECHNOLOGY

Simulation on IEEE 34 Node Feeder

Event: team 4 fault A-B-G @ 0.05sec



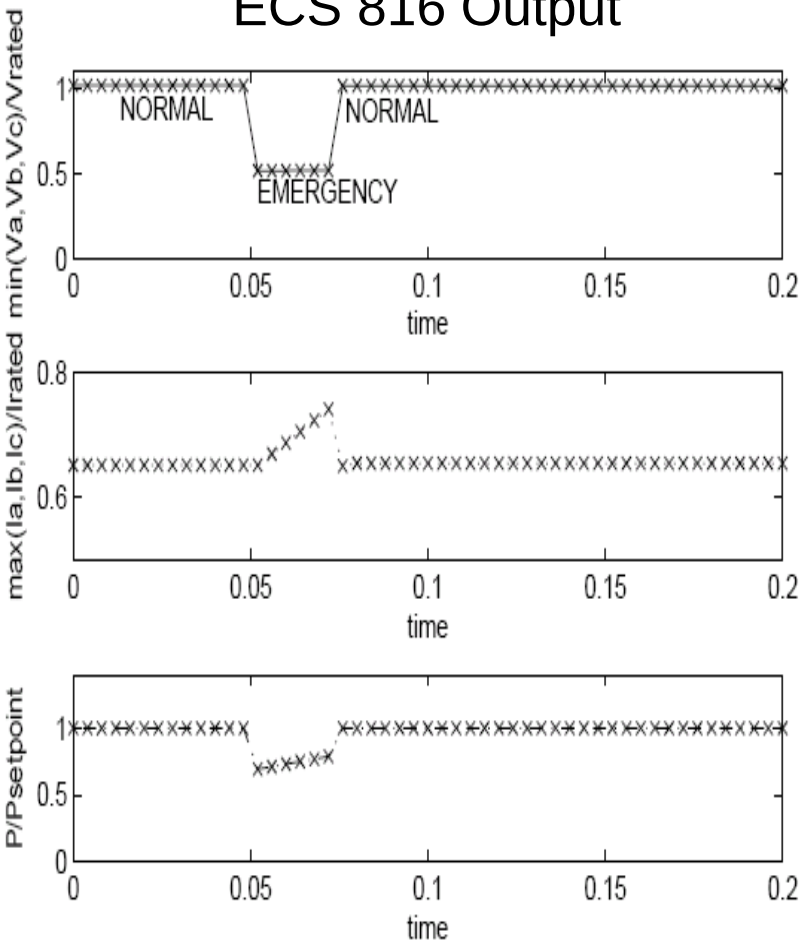
Electronic Converter Storage Data

Equipment ID	RatedKVA KVA	Rated KV KV	Stored KWH KWH	MaxKW KW	Setpoint Power, KW	Power Factor, %	Tinc, sec	Tover, sec	Tshut, Cycles
ECS 816	750	24.9	1000	750	500	100	0.100	4.000	2
ECS 860	1500	24.9	1700	1500	1200	100	0.067	2.000	3

ILLINOIS INSTITUTE OF TECHNOLOGY

Simulation Results

ECS 816 Output



ECS 860 Output