SEATTLE CITY LIGHT DISTRIBUTION AUTOMATION

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Project manager

01/27/2016

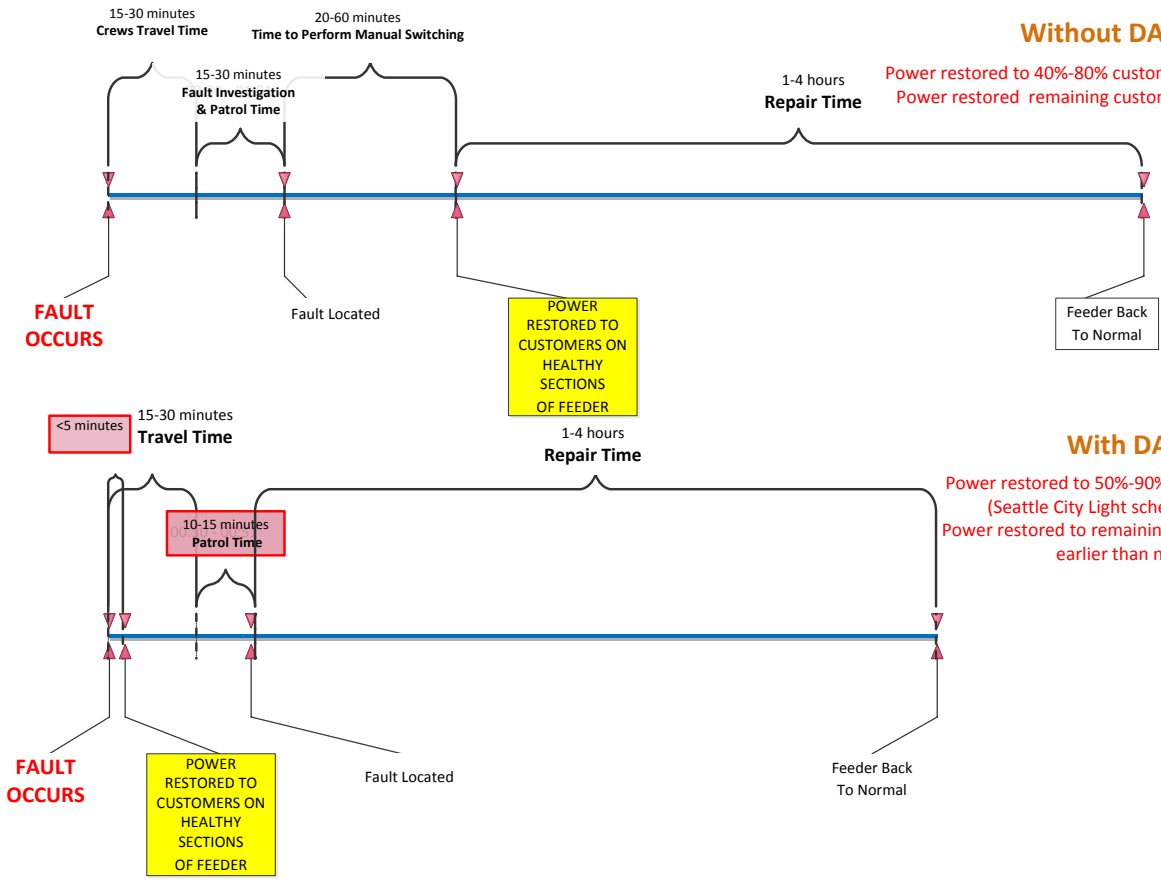
AGENDA

1. Distribution automation background
2. Seattle City Light pilot project
3. System performance – windstorm 08/29/15
4. Lessons learned

FAULT LOCATION, ISOLATION AND SERVICE RESTORATION (FLISR) SYSTEM

- Self-healing grid
- Distribution Automaton

RESTORATION TIME LINE WITH AND WITHOUT DA

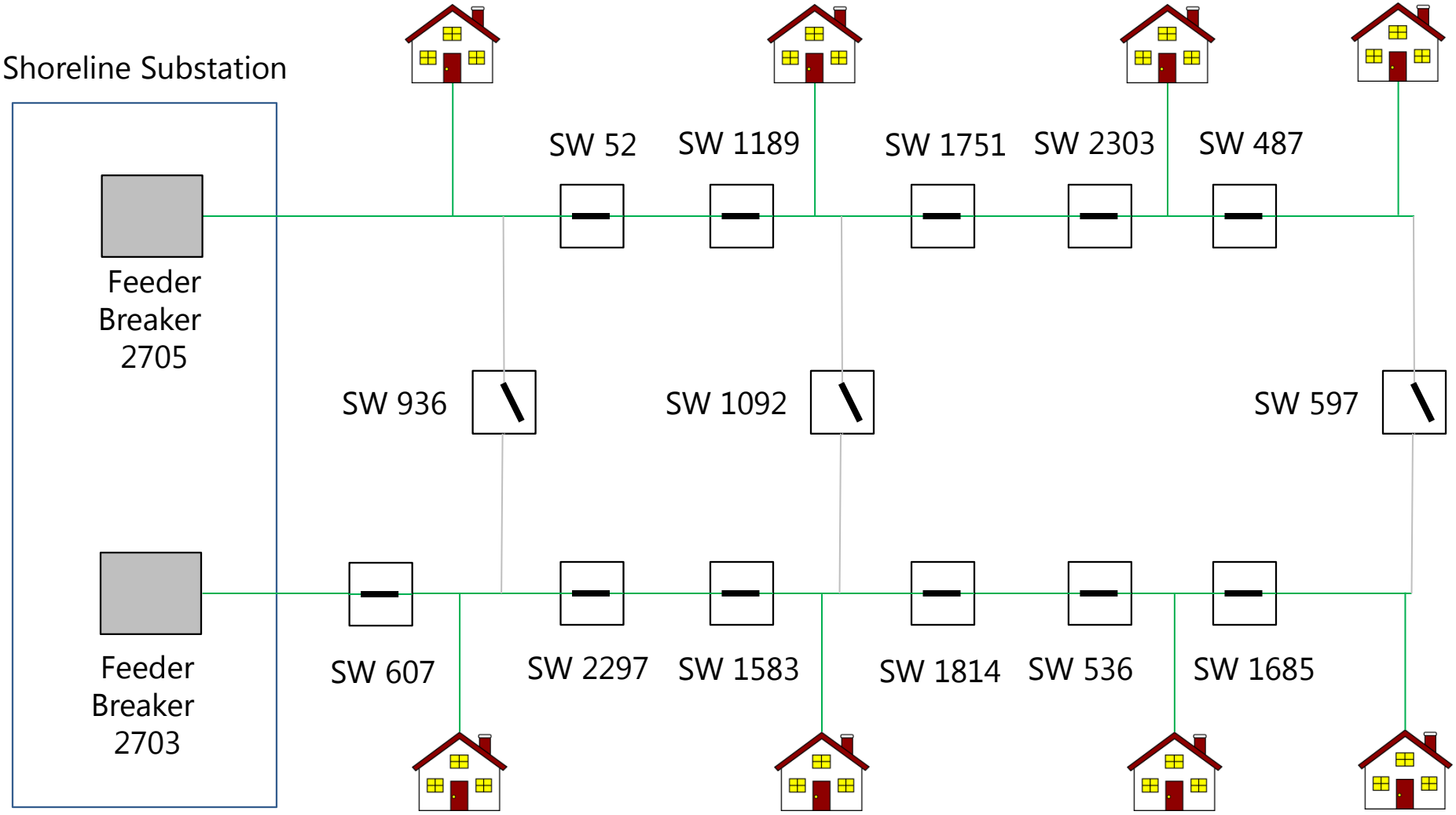


Without DA

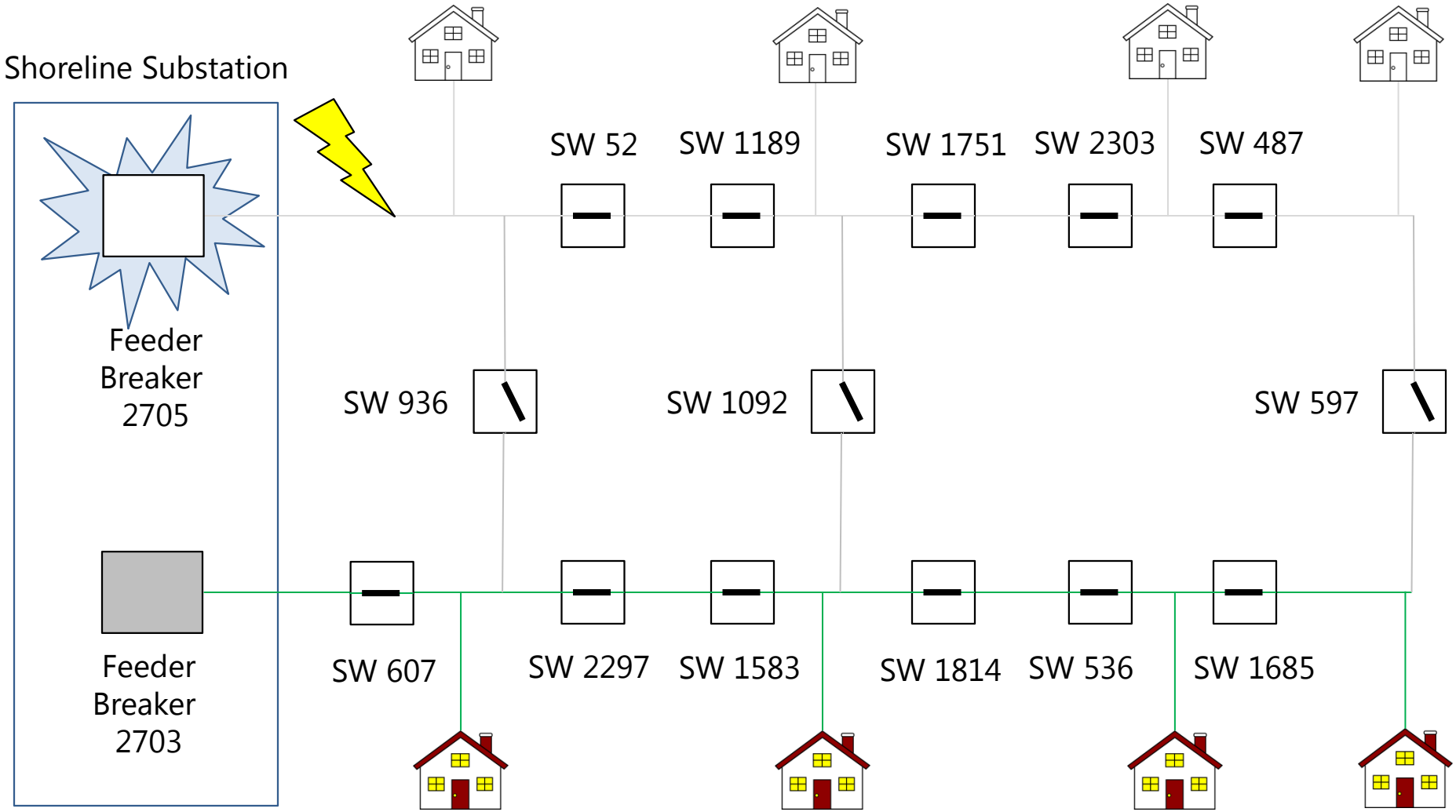
Power restored to 40%-80% customers in 50-120 minutes
Power restored remaining customers in 1-4hours later

With DA

Power restored to 50%-90% customers within 5 minutes
(Seattle City Light scheme: within 30 seconds)
Power restored to remaining customers in 30-75 minutes
earlier than non-DA feeders.

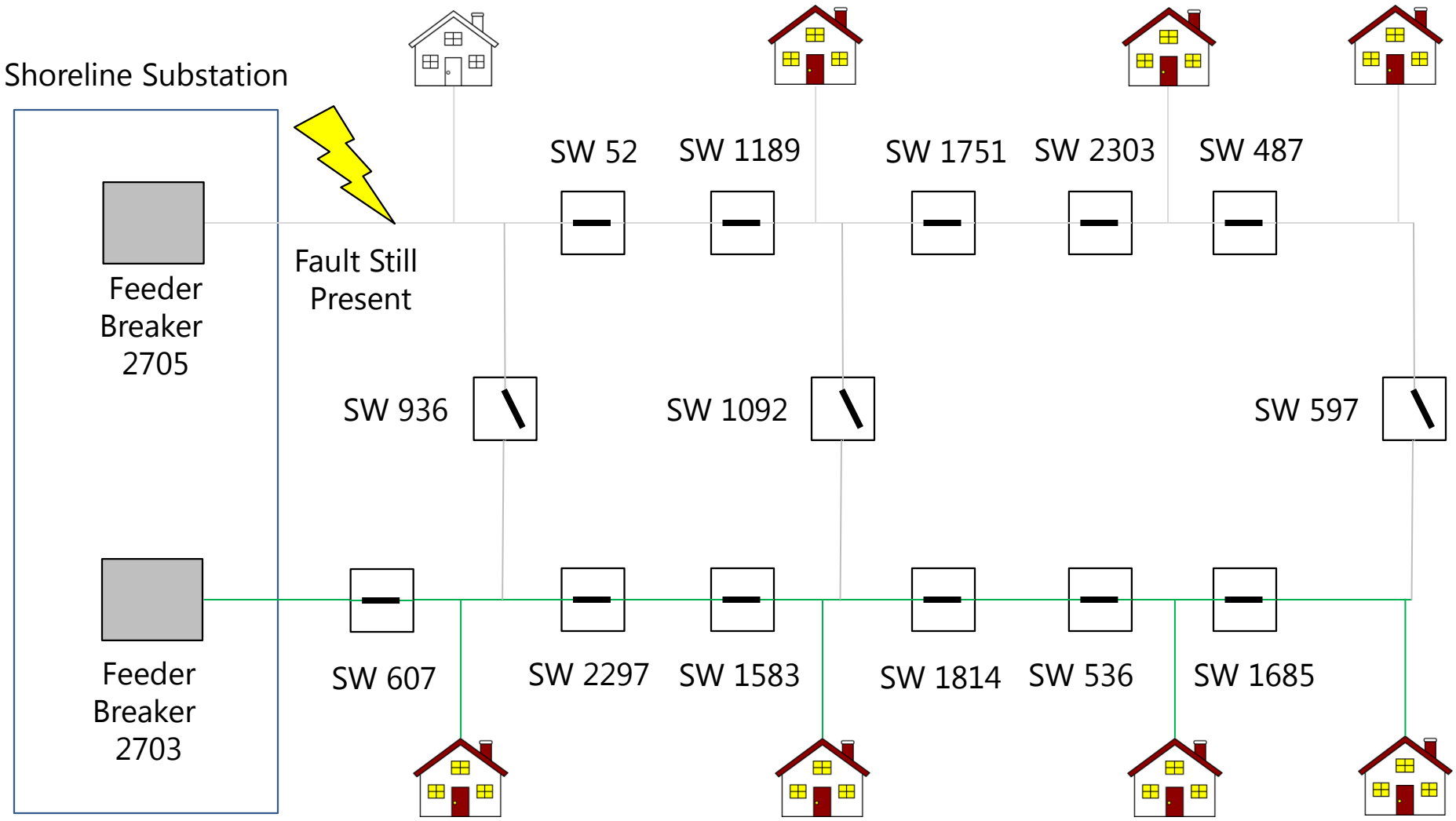


Event: System Normal



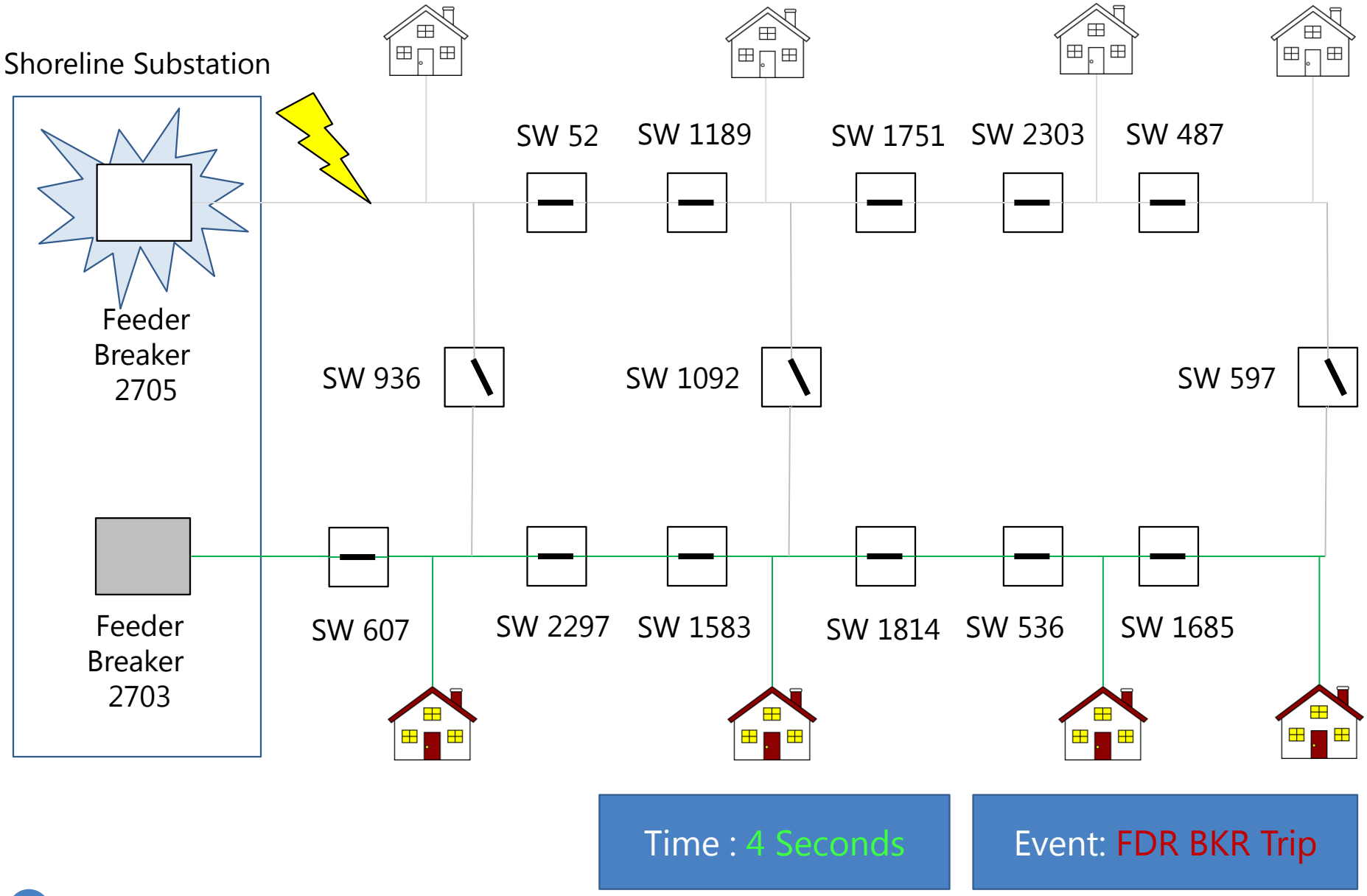
Time : 0 Seconds

Event: Fault appear- FDR BKR Trip



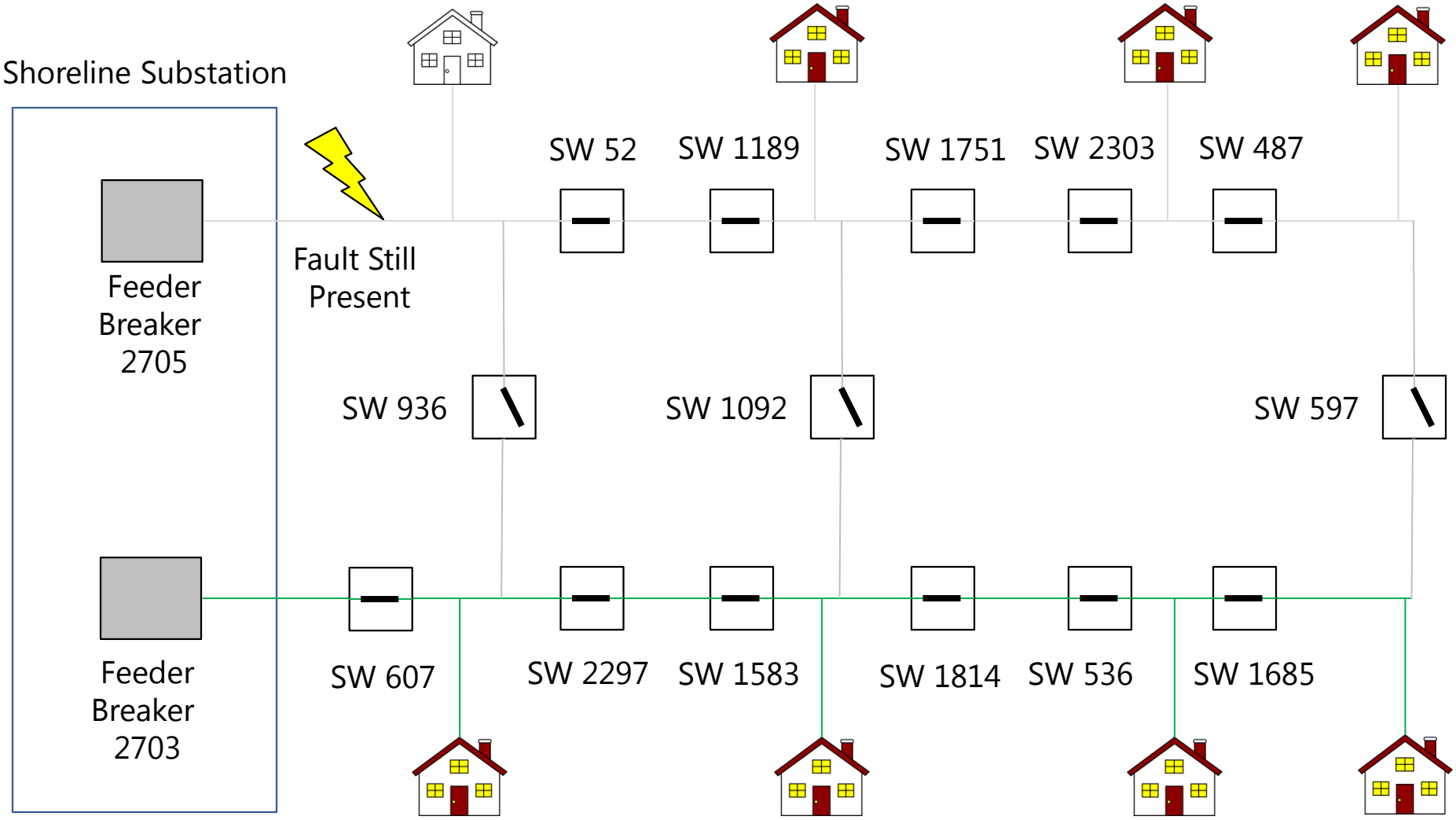
Time : 4 Seconds

Event: FDR BKR Reclose Attempt #1



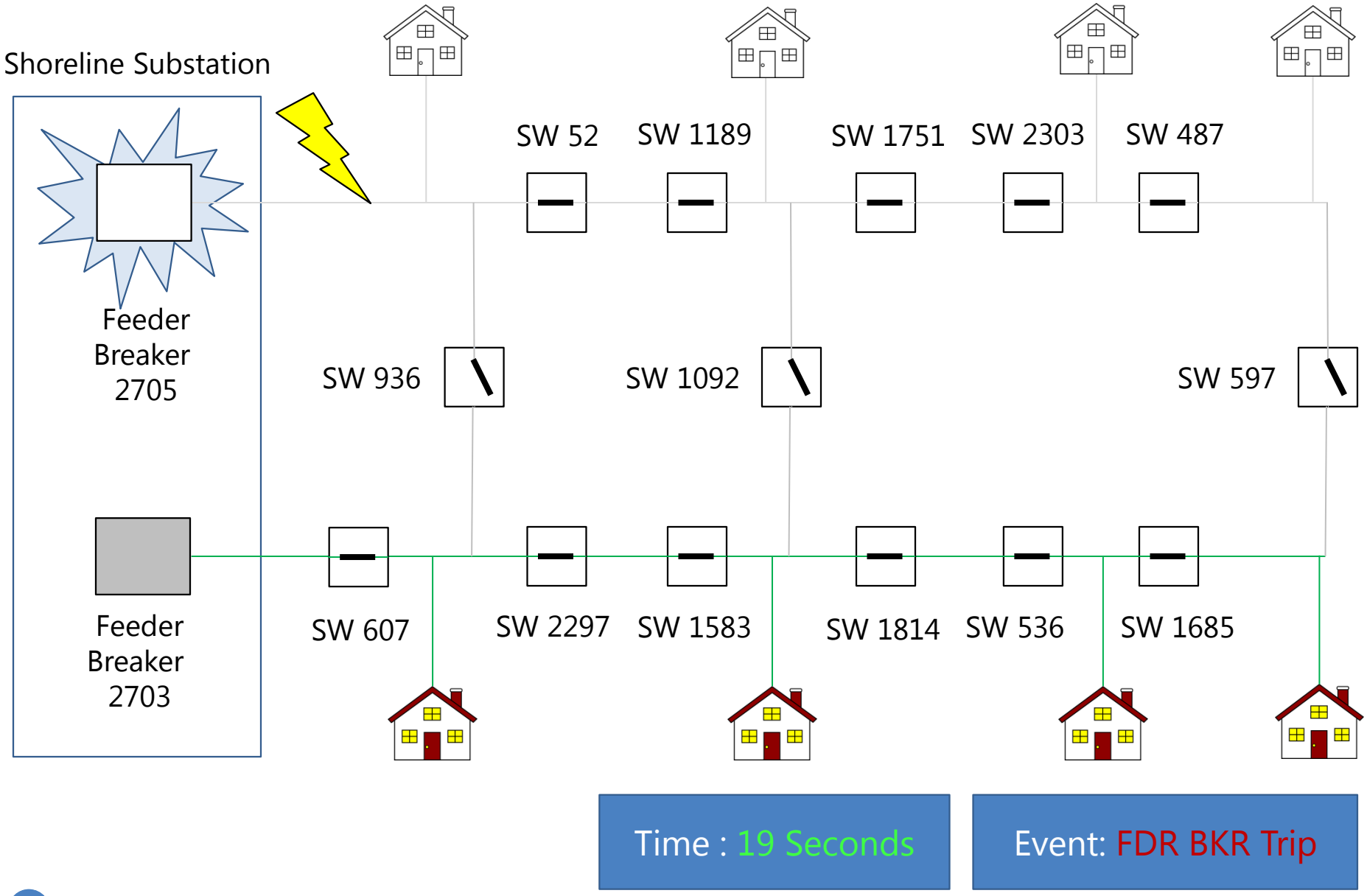
Time : 4 Seconds

Event: FDR BKR Trip



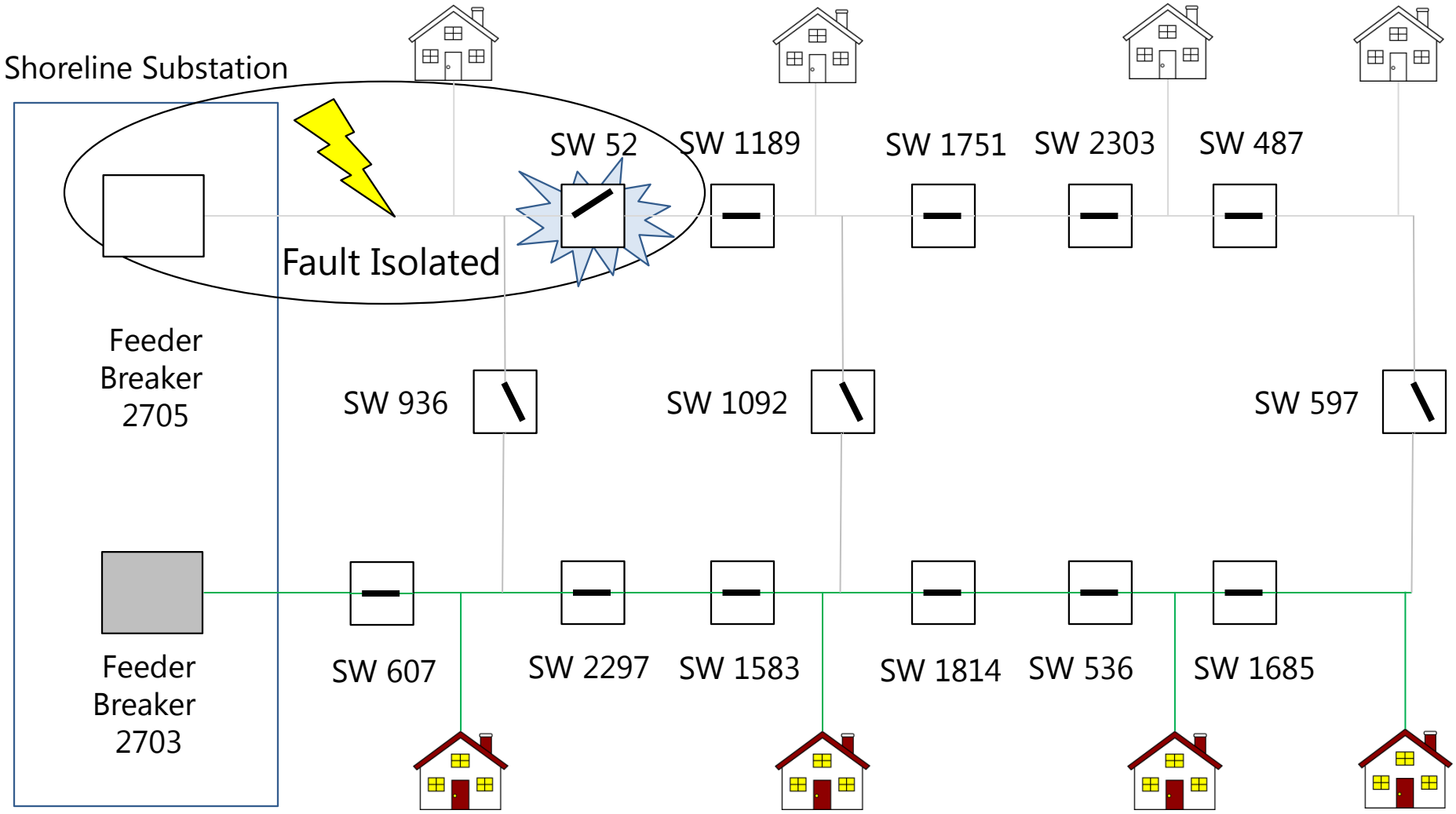
Time : 19 Seconds

Event: FDR BKR Reclose Attempt #2



Time : 19 Seconds

Event: FDR BKR Trip



Time : 25 Seconds

Event: SW 52 Trip

Shoreline Substation

Feeder Breaker 2705

Feeder Breaker 2703

SW 52 SW 1189 SW 1751 SW 2303 SW 487

SW 936 SW 1092 SW 597

Close tie switch

SW 607 SW 2297 SW 1583 SW 1814 SW 536 SW 1685

Time : 30 Seconds

Event: Close tie SW, restore power

DA- TWO BIG QUESTIONS:

- DA Intelligence Style
- Communication option

CENTRALIZED VS SUBSTATION CENTERED VS DISTRIBUTED INTELLIGENCE - 1

- Centralized intelligence
  - Distribution Management System (DMS) serves as the "brain" of the DA system
  - Full system view for restoration, optimize the restoration in the large scale.
  - Integrate with other system and applications.
  - Cons:
    - Longest deployment time
    - Integration with DMS, fine-tuning, are time-consuming
    - Expensive
    - Slowest restoration times
    - A point-to-multi-point system can be overwhelmed.

CENTRALIZED VS SUBSTATION CENTERED VS DISTRIBUTED INTELLIGENCE - 2

- Substation centered intelligence
  - Use main logic controls at the distribution substations
  - Pros and Cons are somewhere between Centralized and Distributed

CENTRALIZED VS SUBSTATION CENTERED VS DISTRIBUTED INTELLIGENCE - 3

- Distributed intelligence
  - Peer-to-Peer Devices
  - Fastest restoration
  - Fastest to deploy
  - Able to be deployed with or without DMS or GIS.
  - Cons:
    - Less efficient in large scale restoration optimization

COMMUNICATION

- Main Criteria:
  - Capacity & latency
  - Reliability
  - Cost
  - Security
  - Traffic types & networking standards
  - Reputation
  - Coverage
  - Other Smart Grids usage

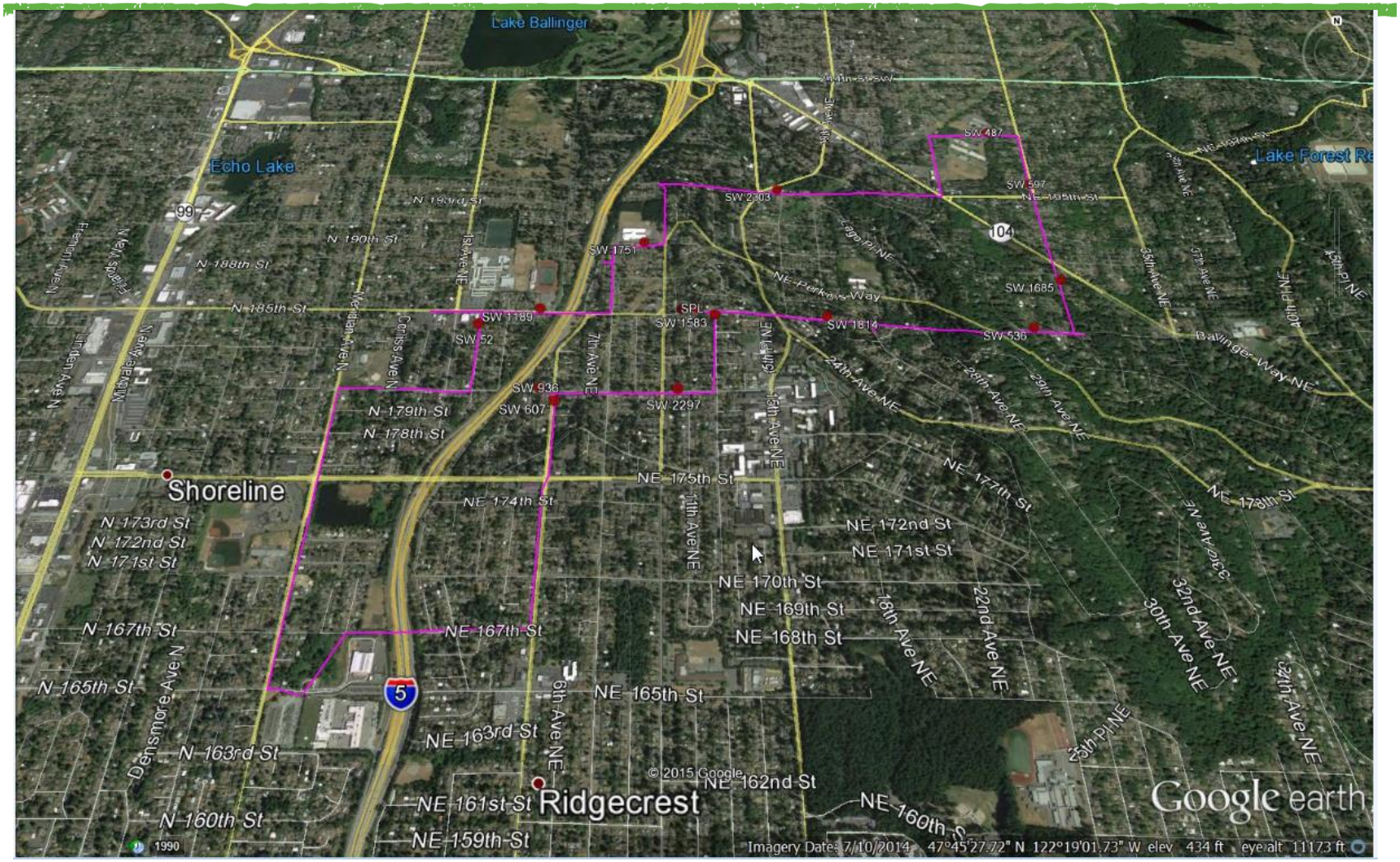
COMMUNICATION OPTIONS FOR DA

- Fiber
  - Wide bandwidth, fast, secure, reliable, well-established technology, lot of rooms for future growth, applications and for other Smart grid projects
  - Expensive
- Radio
  - Least expensive

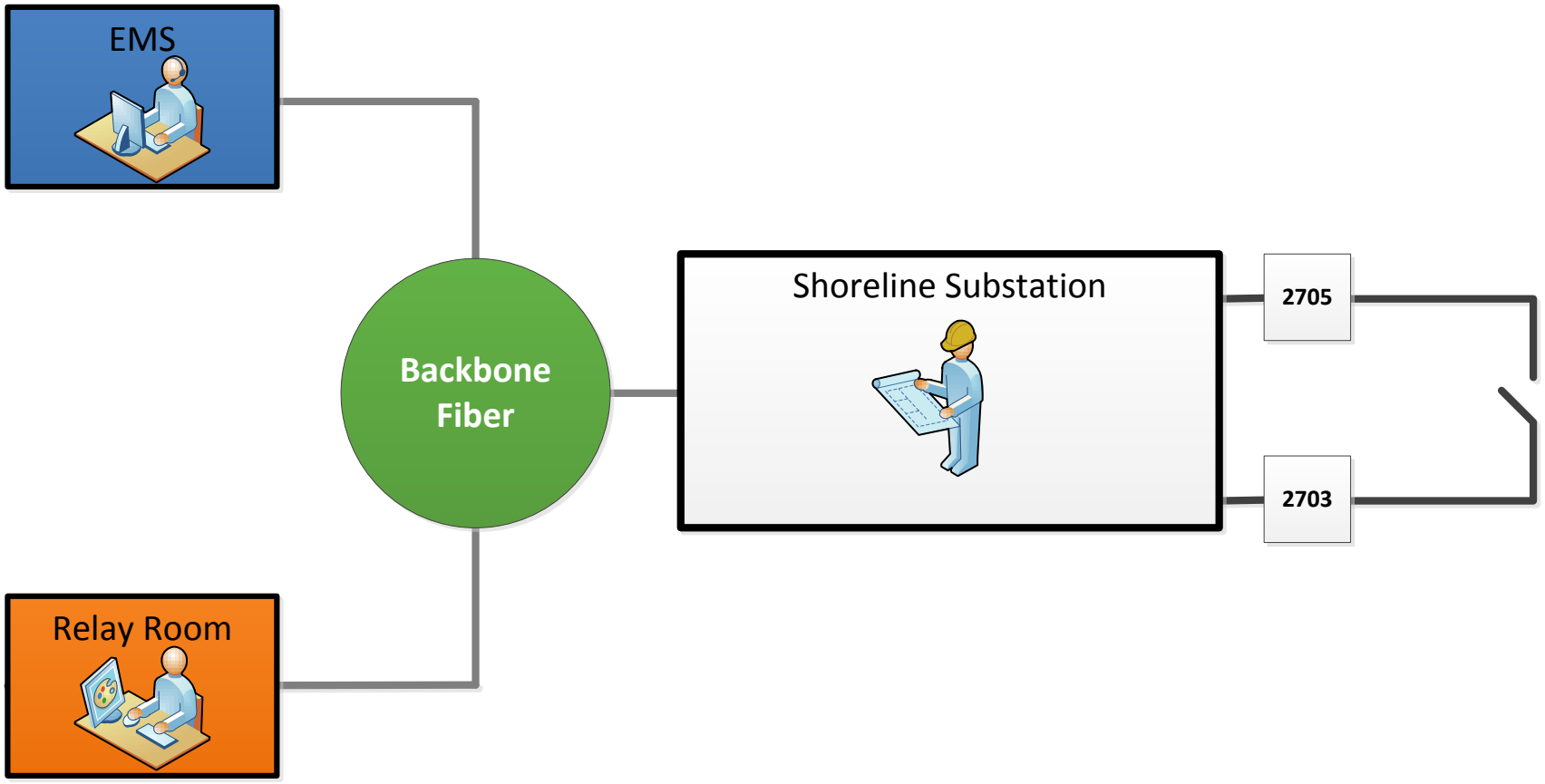
DA PILOT SYSTEM OVERVIEW

- Deployed on two feeders out of Shoreline substation: 2703 and 2705 at Shoreline & Lake Forest Park
- Utilizing distributed intelligence
- S&C ScadaMate switches
- Communication: fiber optics loop
- Integrated with EMS, PI historian
- Fully automated, supervisory and remote control
- Fast, secured remote access for relay technicians
- Online since 6:30 am 06/27/2015

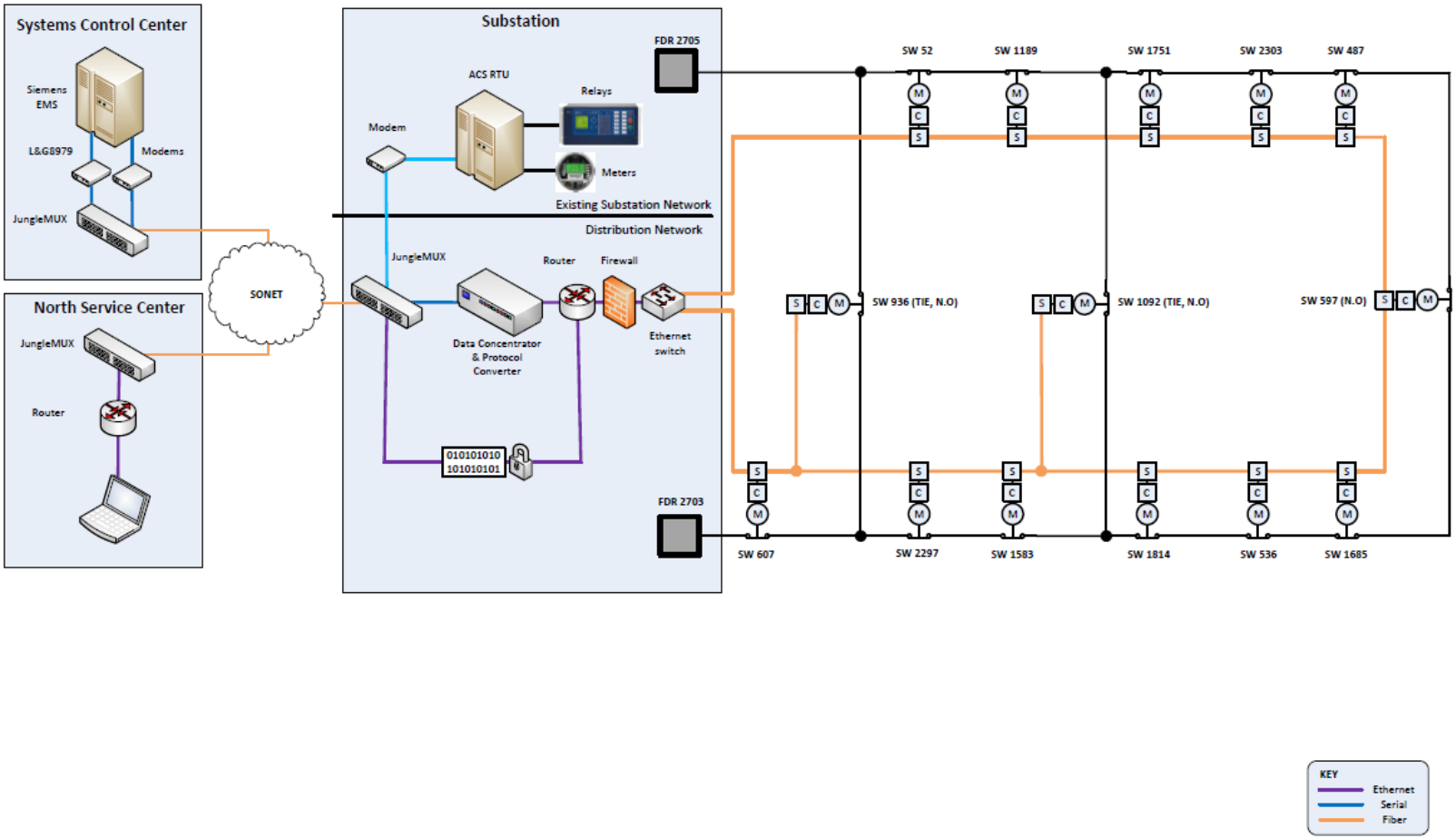
DA PILOT SYSTEM – GOOGLE EARTH MAP



SIMPLIFIED NETWORK DIAGRAM



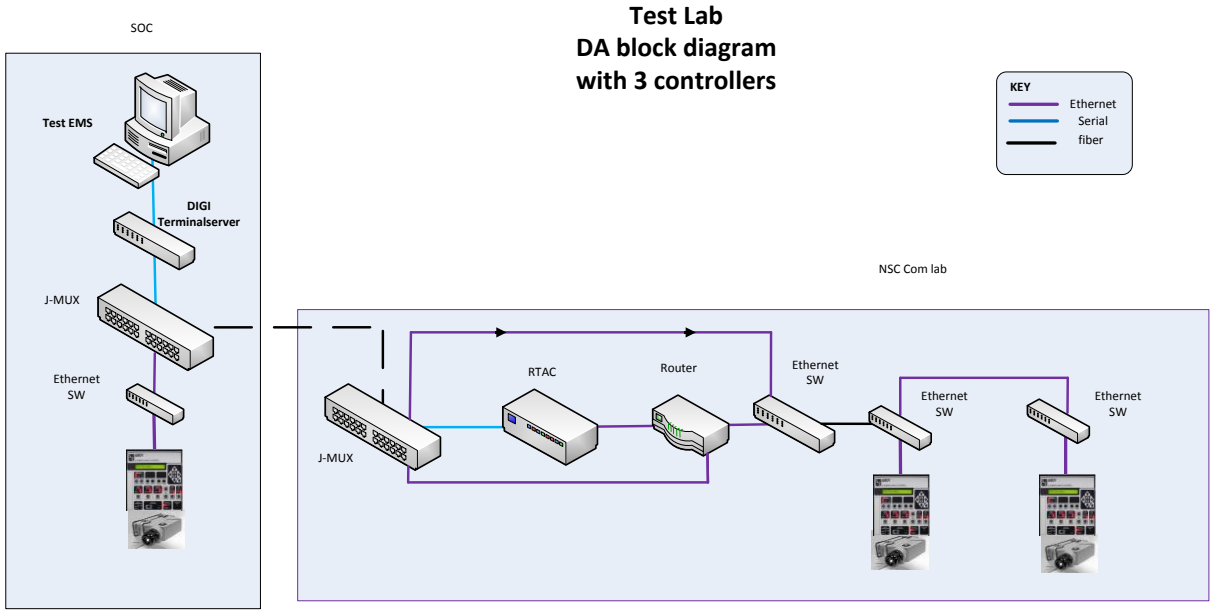
SHORELINE DA NETWORK DIAGRAM



LOOP COMMUNICATION FAULT RECOVER

- IEEE 802.1D Spanning Tree Protocol (STP)
  - Fault recovery time is too slow ~ one minute
- IEEE 802.1w Rapid Spanning Tree Protocol (RSTP)
  - Faster than STP, but still low for our scheme ~ few seconds
- Vendors' proprietary protocols
- Siemens' enhanced RSTP
  - Fast recovery time: in ms
- Interoperability

TEST LAB – DA BLOCK DIAGRAM



STANDARDIZATION

- Allows to program and configure devices in an efficient manner with minimal errors
- Familiarity from job to job for engineers, constructions crews, communication and relay technicians
- Reduce debugging time.
- IP, DNP, Modbus, point lists
- Naming convention
- Equipment, constructions.

PS286

1751

NEW DESIGN SCADAMATE SWITCH WITH GROUND LEVEL DISCONNECT HANDLE

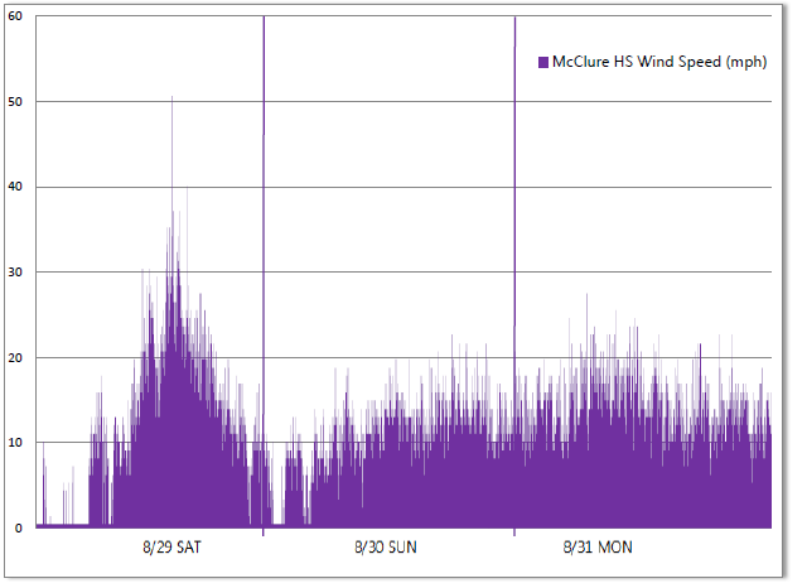
GROUND LEVEL DISCONNECT HANDLE

SUMMER STORM 08/29/2015

- http://cliffmass.blogspot.com/2015/08/the-strongest-summer-storm-in-northwest.htm
- **The Strongest Summer Storm In Northwest History**
- Saturday was a historic day during a historic summer.
  On that day western Oregon and Washington was lashed by the **strongest summer windstorm in its historic record.**

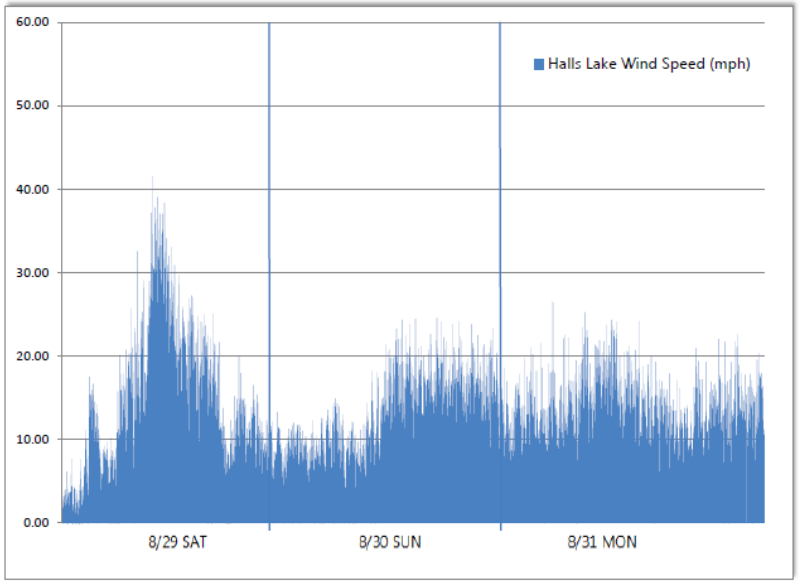
WINDSTORM 08/29/2015
WIND SPEED

WIND SPEED REPORT FROM UW



MAX GUST SPEED (MPH)			
Date	Time	Speed	Gust
8/29/2015	12:52	16.9	50.6

WIND SPEED REPORT FROM SNOPUD

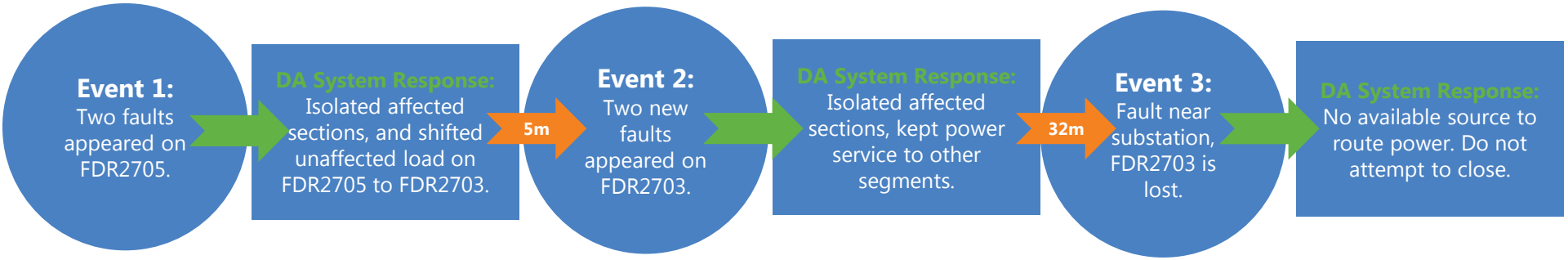


MAX GUST SPEED (MPH)			
Date	Time	Speed	Gust
8/29/2015	12:23	NA	41.6

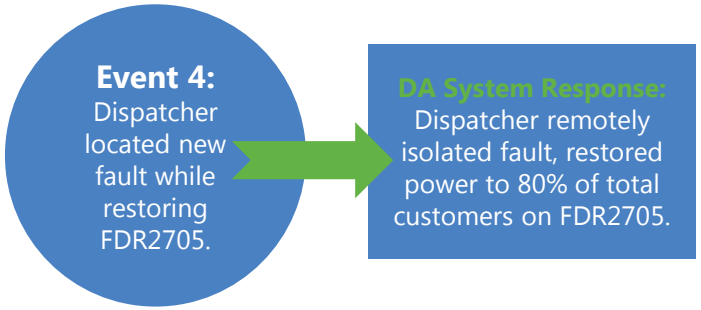
WINDSTORM DIAGNOSTIC OVERVIEW

- The DA system handled four different storm contingencies and executed logic to mitigate as many customer outages as possible.
- In both automatic and manual modes, the system functioned properly.

Automatic Mode

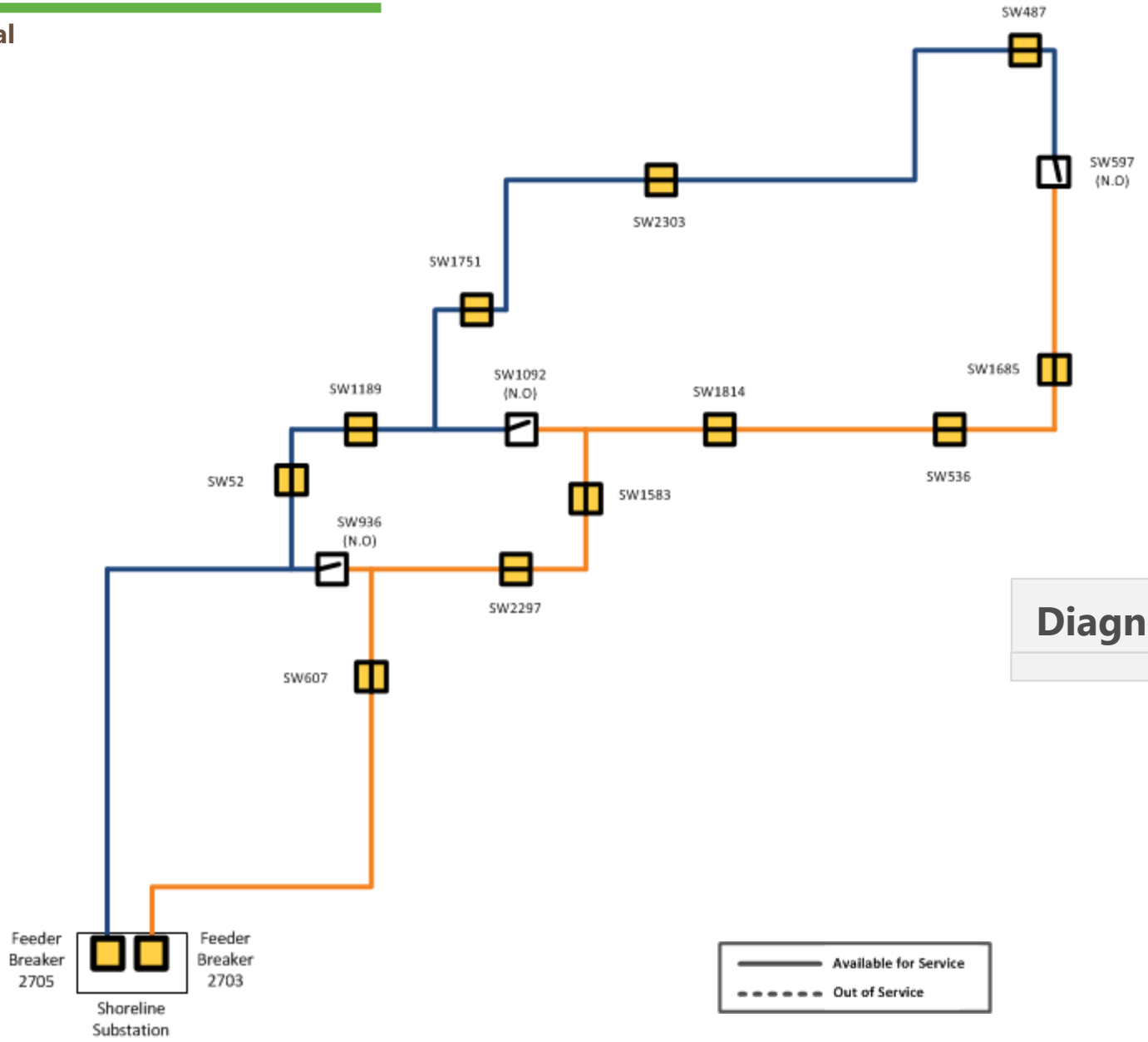


Manual Mode



08/2015 WINDSTORM

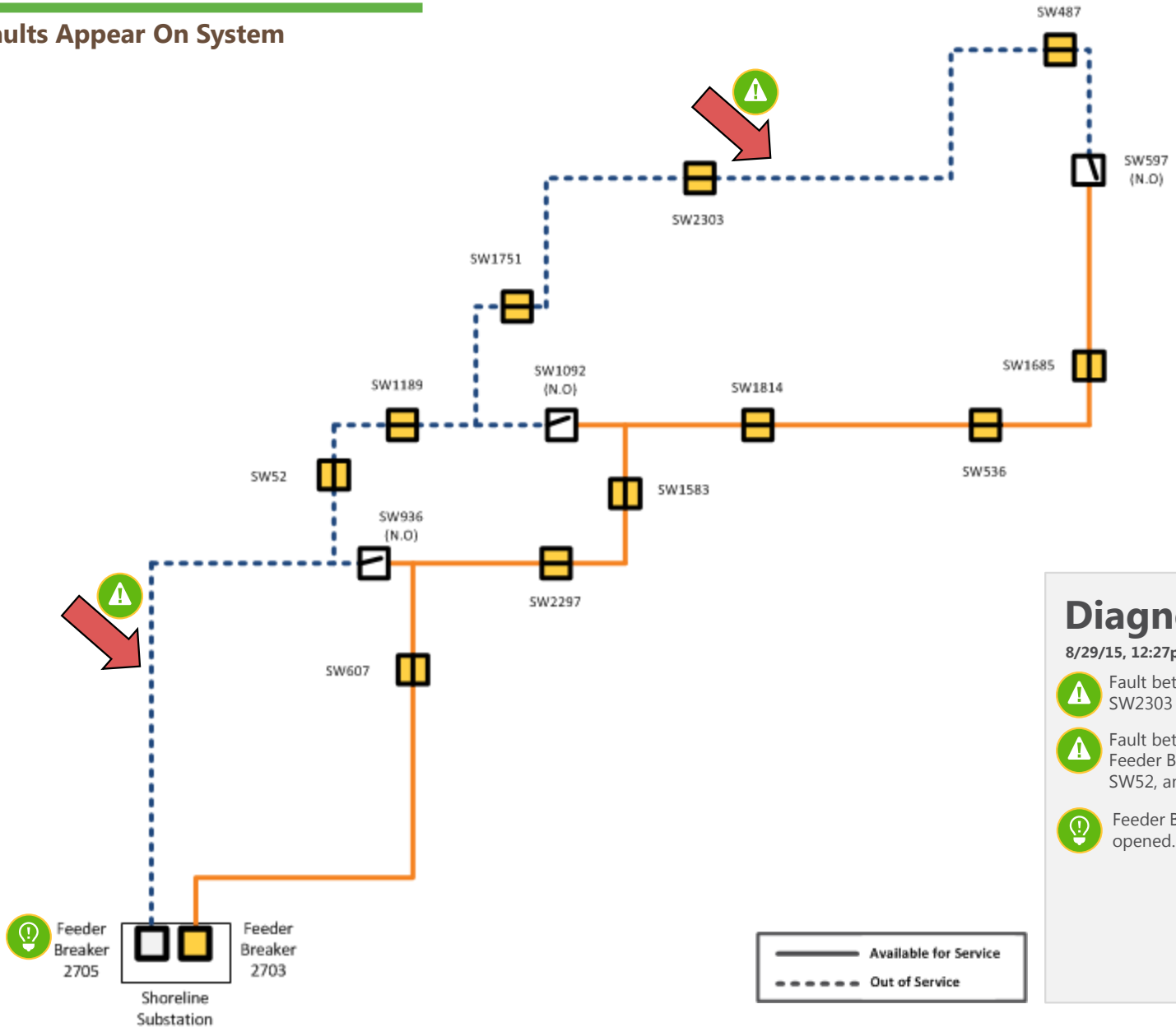
System Normal



Diagnostics

08/2015 WINDSTORM

Event 1: Faults Appear On System



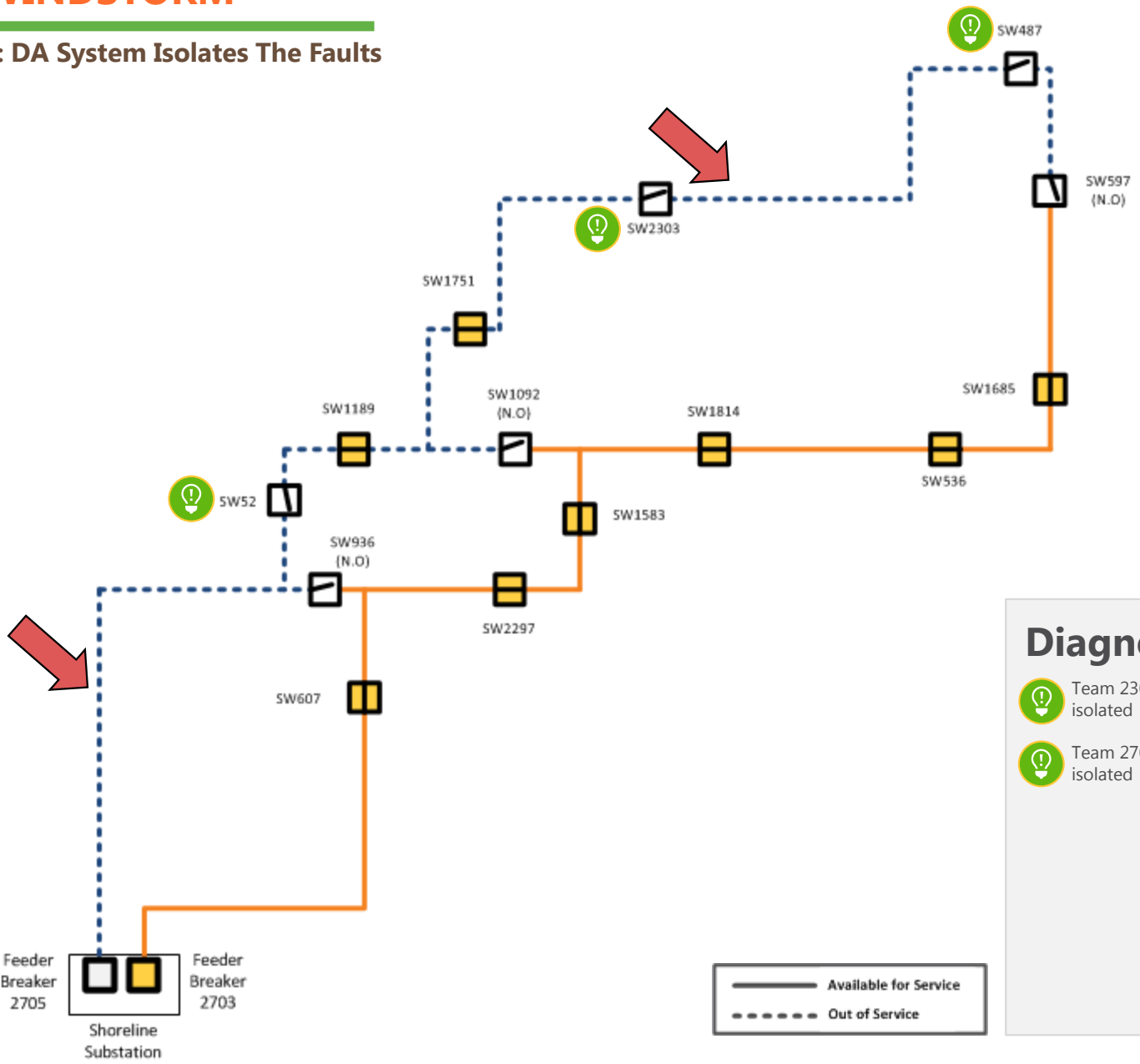
Diagnostics

8/29/15, 12:27pm

- Fault between SW2303 and SW487.
- Fault between Feeder Breaker 2705, SW52, and SW936.
- Feeder Breaker 2705 opened.

08/2015 WINDSTORM

Event 1 (cont.): DA System Isolates The Faults



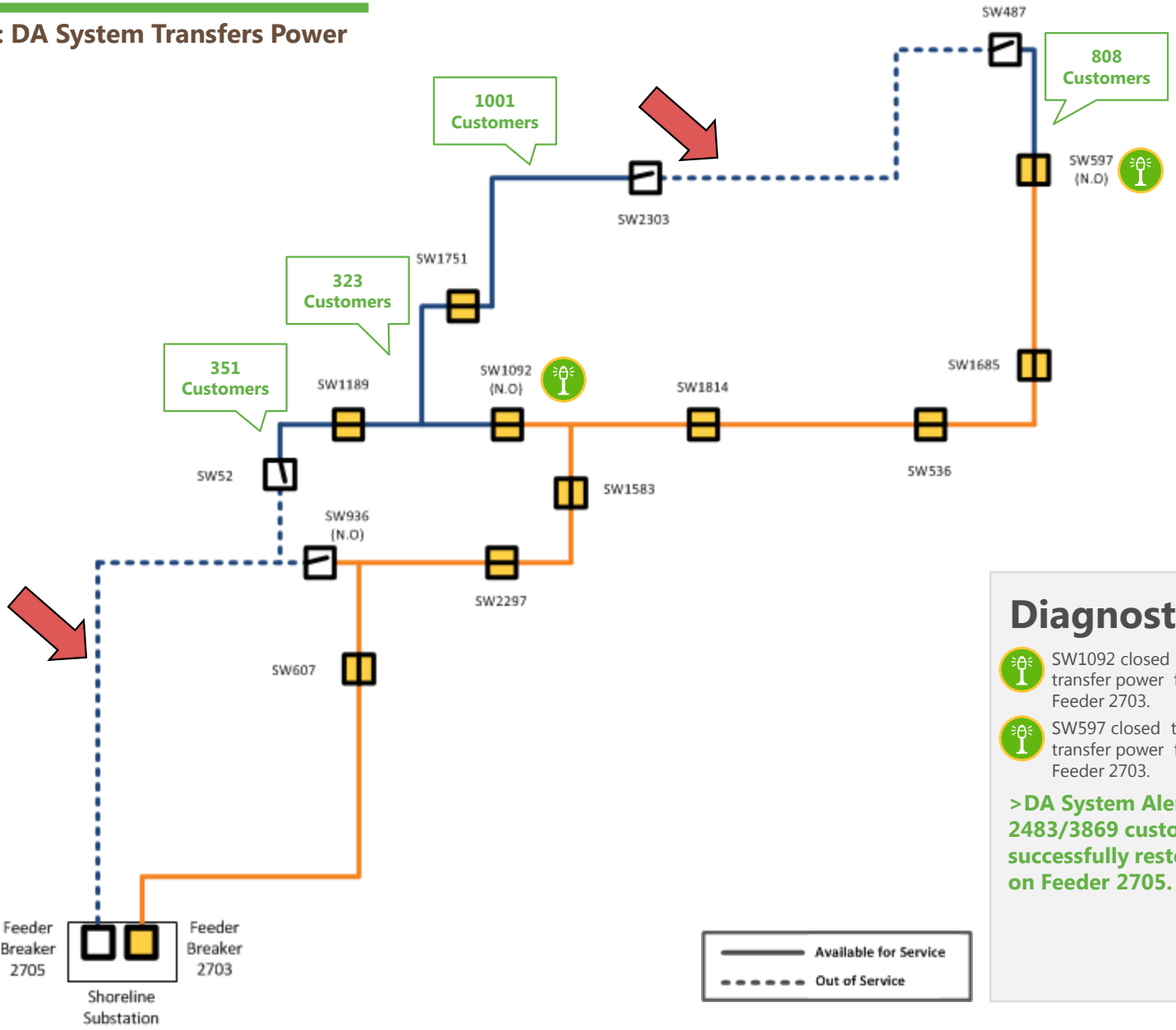
Diagnostics

Team 2303-487 isolated the fault.

Team 2705-52-936 isolated the fault.

08/2015 WINDSTORM

Event 1 (cont.): DA System Transfers Power



Diagnostics

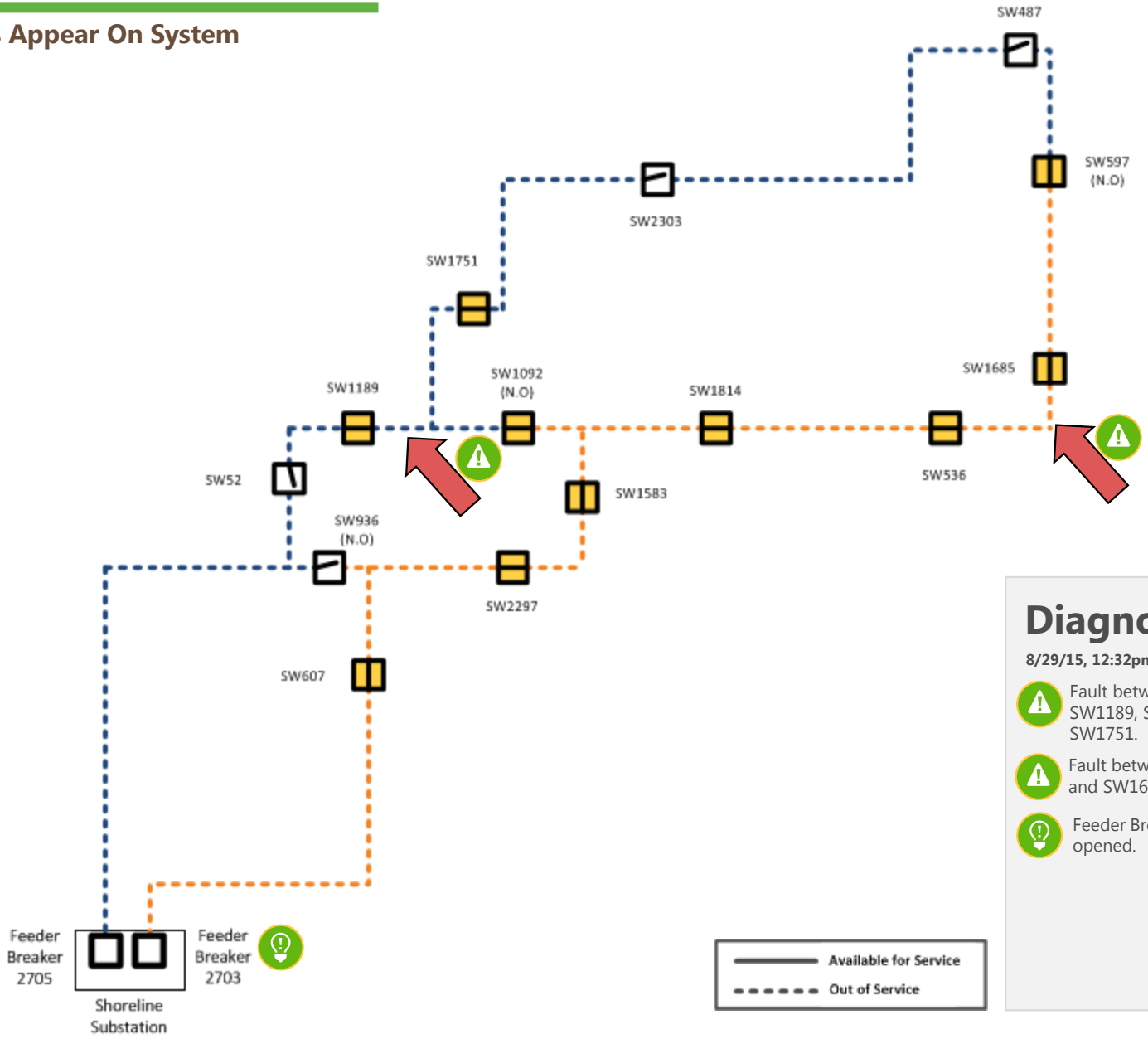
SW1092 closed to transfer power from Feeder 2703.

SW597 closed to transfer power from Feeder 2703.

>DA System Alert: 2483/3869 customers successfully restored on Feeder 2705.

08/2015 WINDSTORM

Event 2: Faults Appear On System



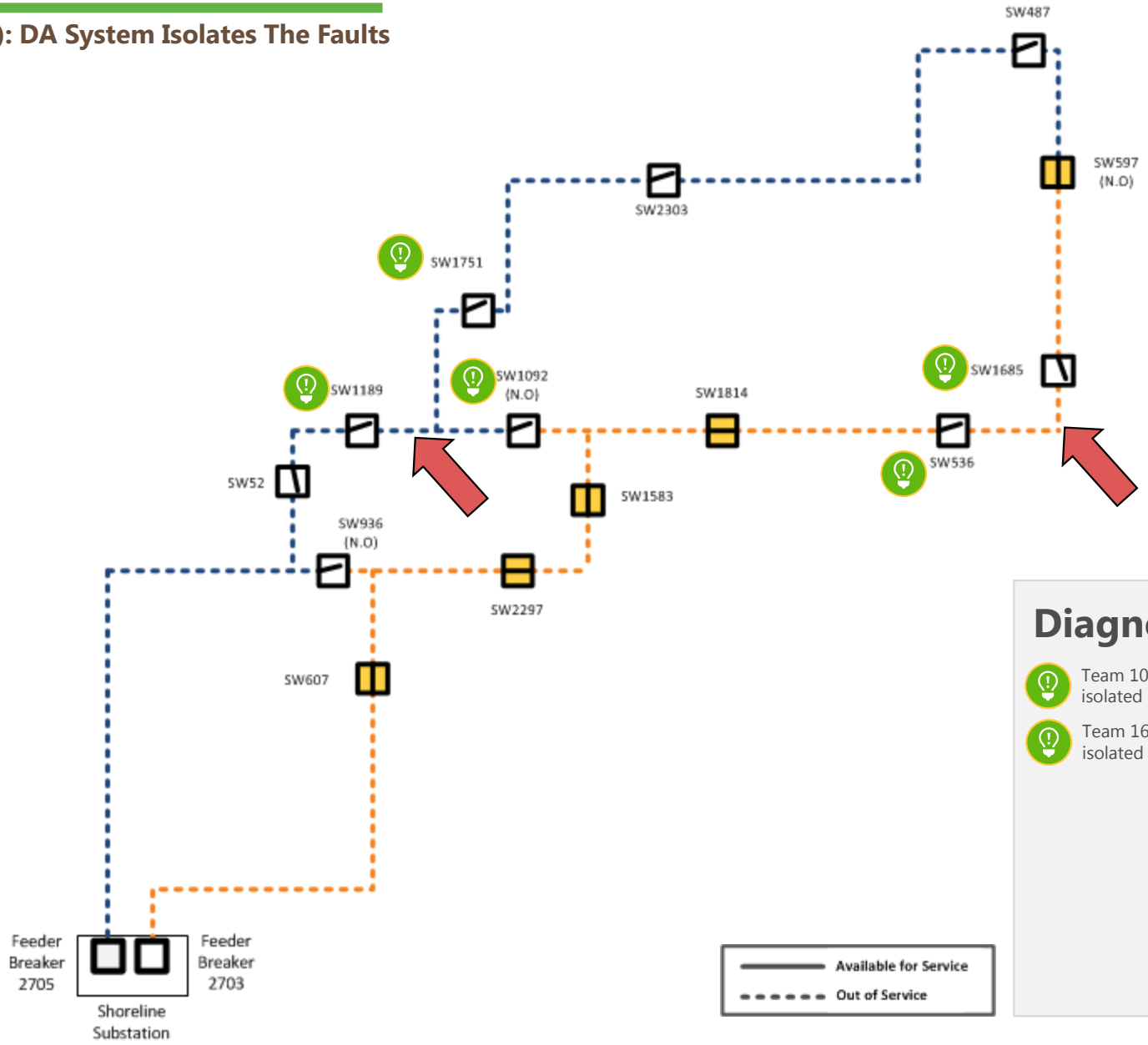
Diagnostics

8/29/15, 12:32pm

- Fault between SW1189, SW1092, SW1751.
- Fault between SW536 and SW1685.
- Feeder Breaker 2703 opened.

08/2015 WINDSTORM

Event 2 (cont.): DA System Isolates The Faults

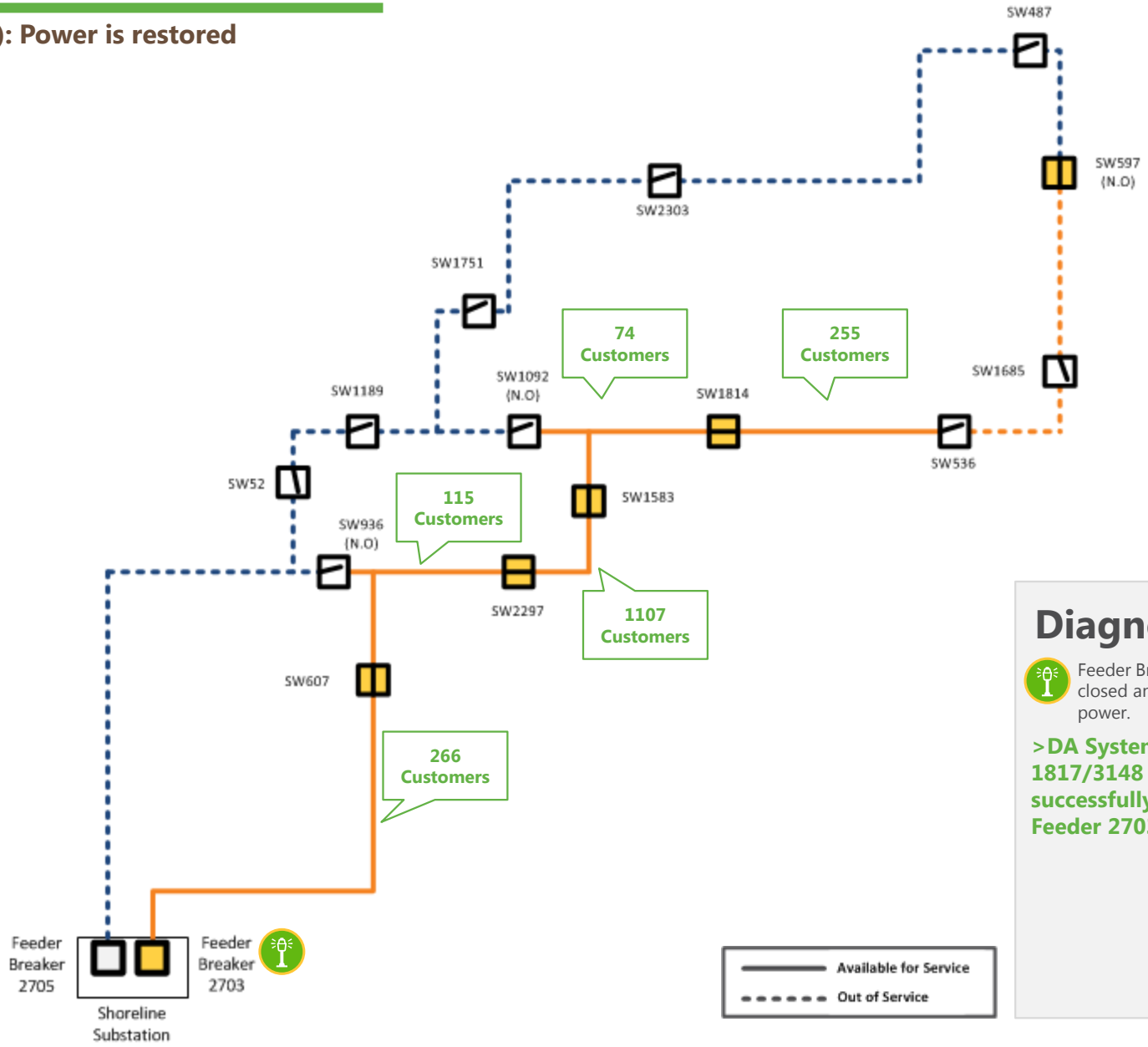


Diagnostics

- Team 1092-1189-1751 isolated the fault.
- Team 1685-536 isolated the fault.

08/2015 WINDSTORM

Event 2 (cont.): Power is restored



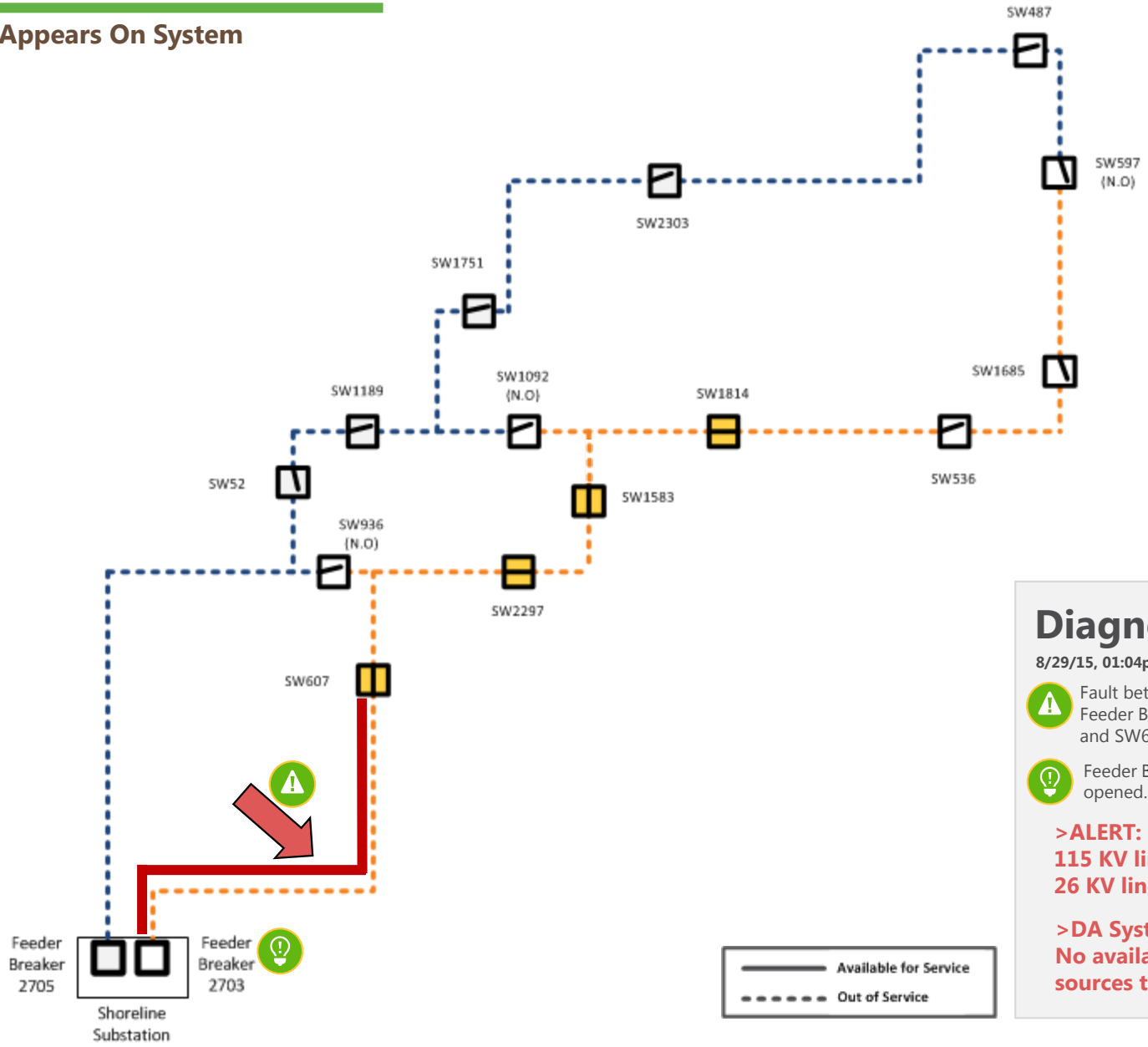
Diagnostics

Feeder Breaker 2703 closed and restored power.

>DA System Alert: 1817/3148 customers successfully restored on Feeder 2703.

08/2015 WINDSTORM

Event 3: Fault Appears On System



Diagnostics

8/29/15, 01:04pm

Fault between Feeder Breaker 2703 and SW607.

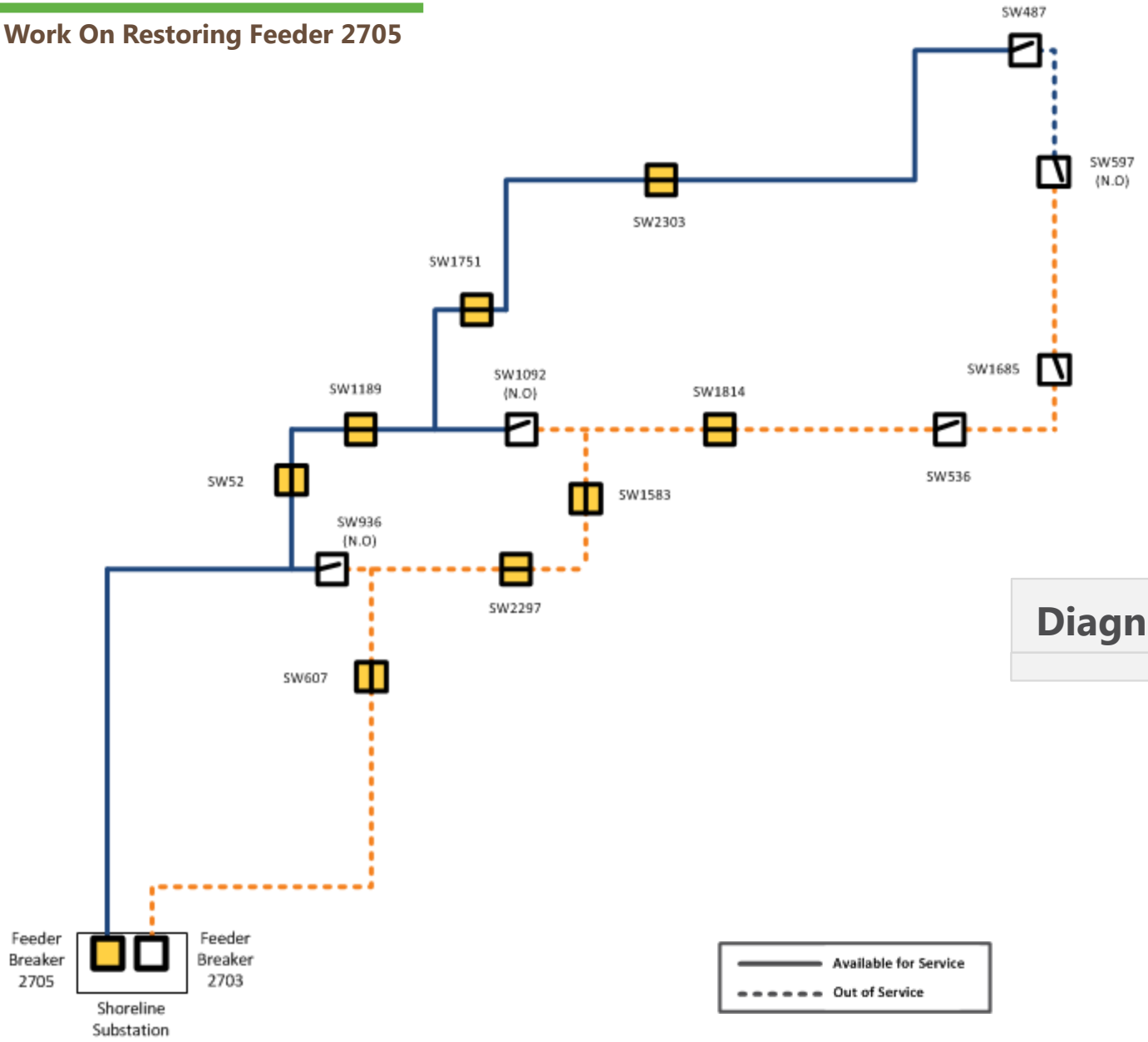
Feeder Breaker 2703 opened.

>ALERT:
115 KV line fell onto 26 KV line.

>DA System Alert:
No available power sources to reroute.

08/2015 WINDSTORM

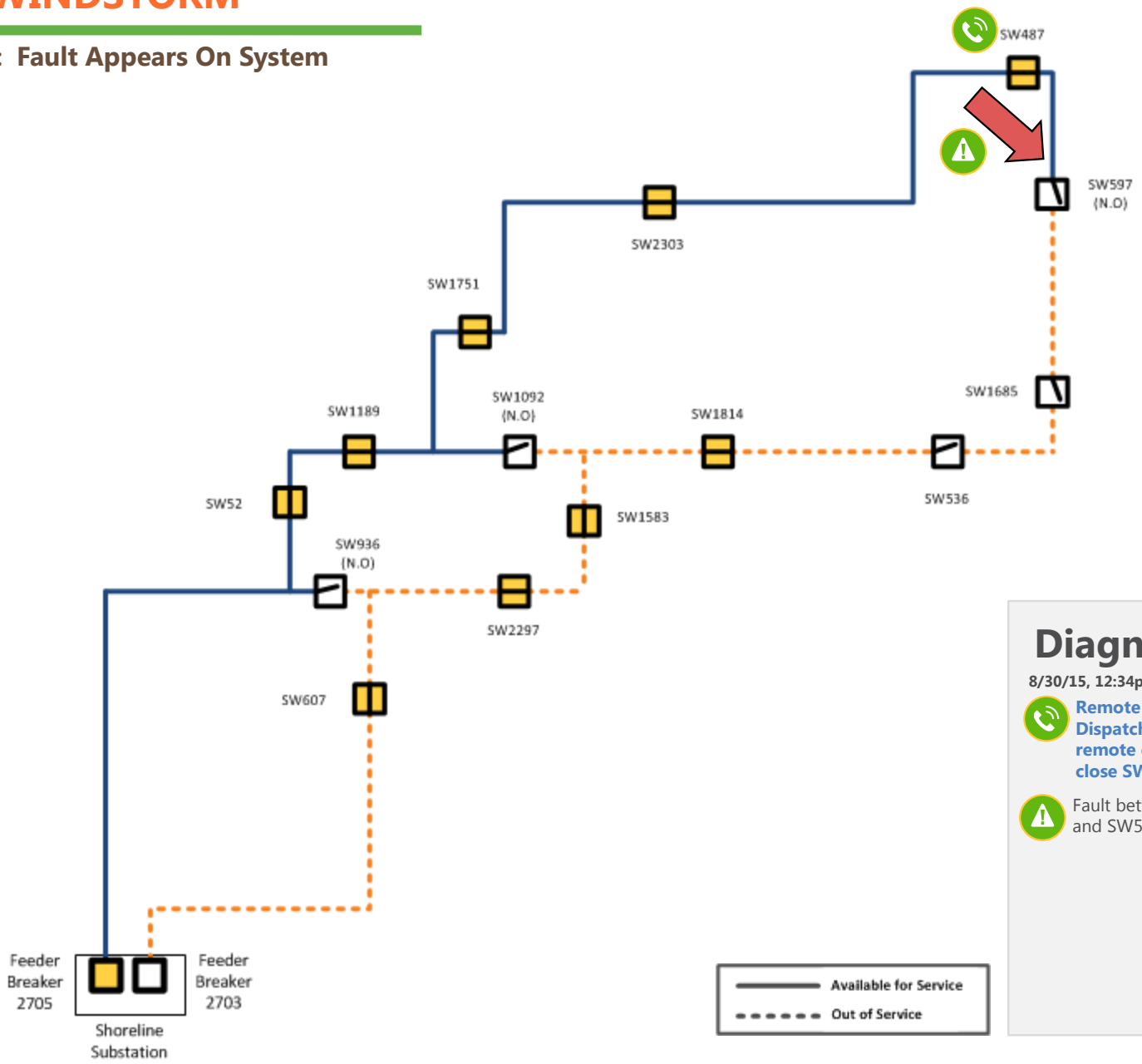
Event 4: Crews Work On Restoring Feeder 2705



Diagnostics

08/2015 WINDSTORM

Event 4 (cont.): Fault Appears On System



Diagnostics

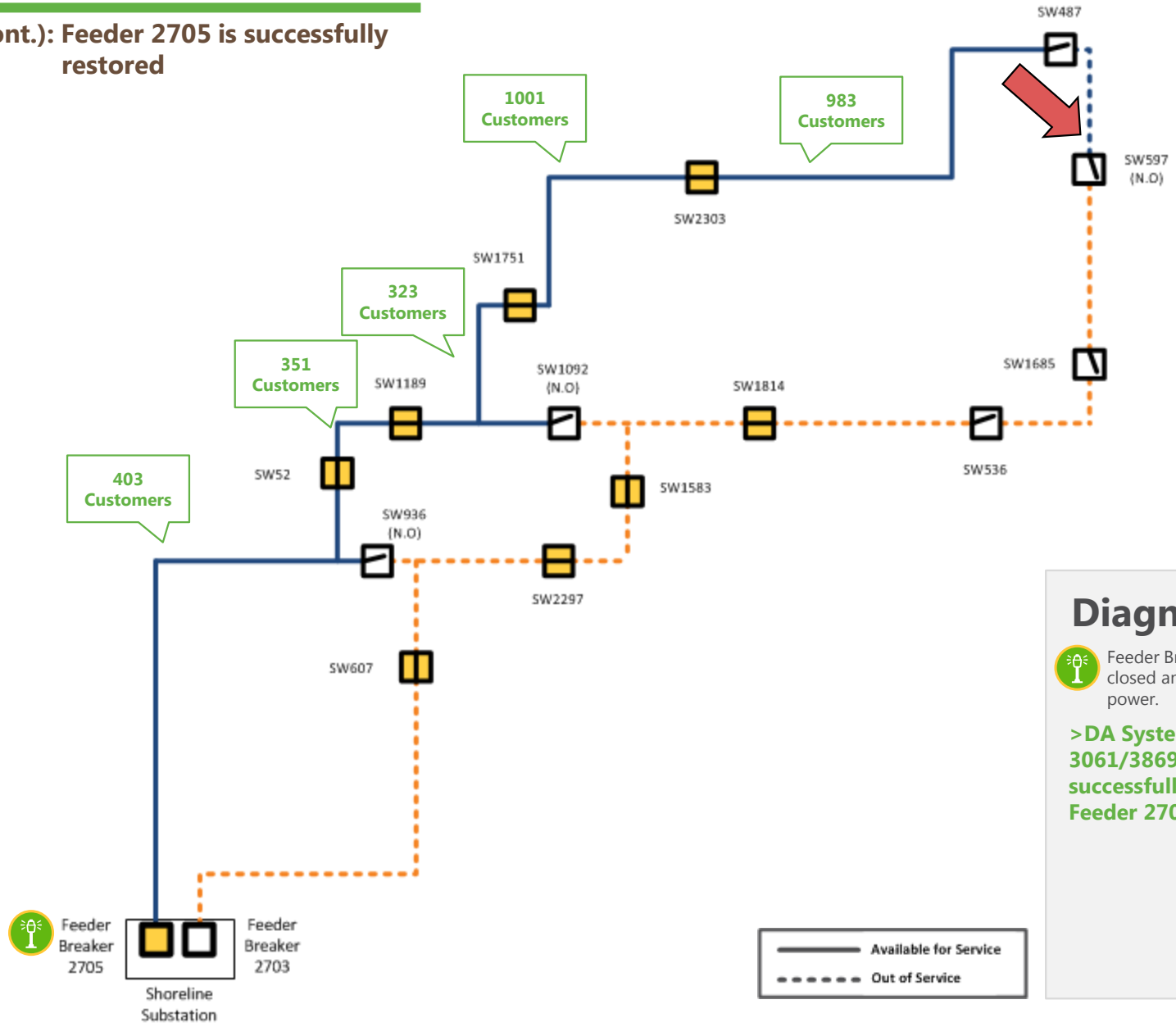
8/30/15, 12:34pm

Remote Action: Dispatcher has sent remote command to close SW487.

Fault between SW487 and SW597.

08/2015 WINDSTORM

Event 4 (cont.): Feeder 2705 is successfully restored

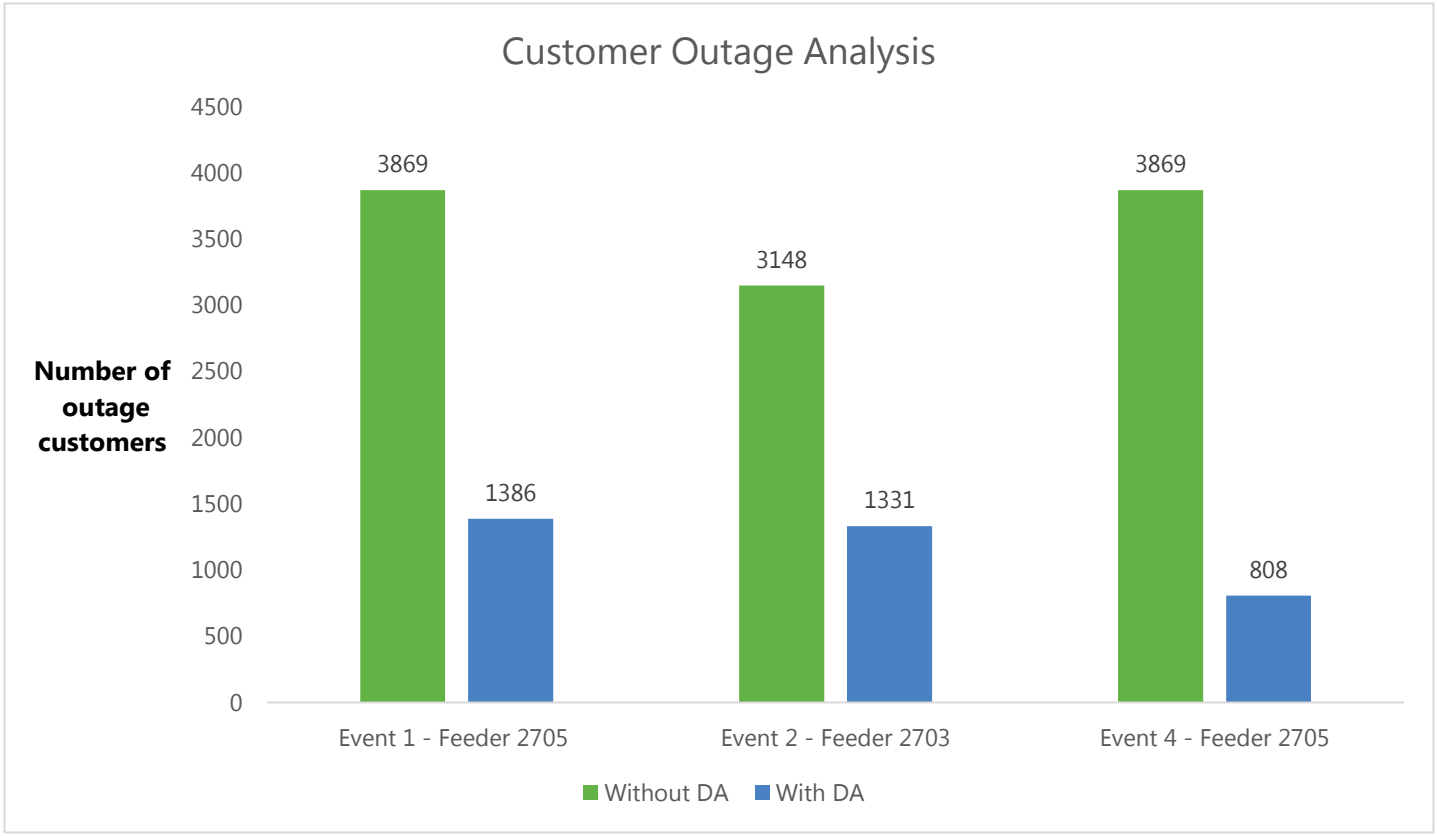


Diagnostics

Feeder Breaker 2705 closed and restored power.

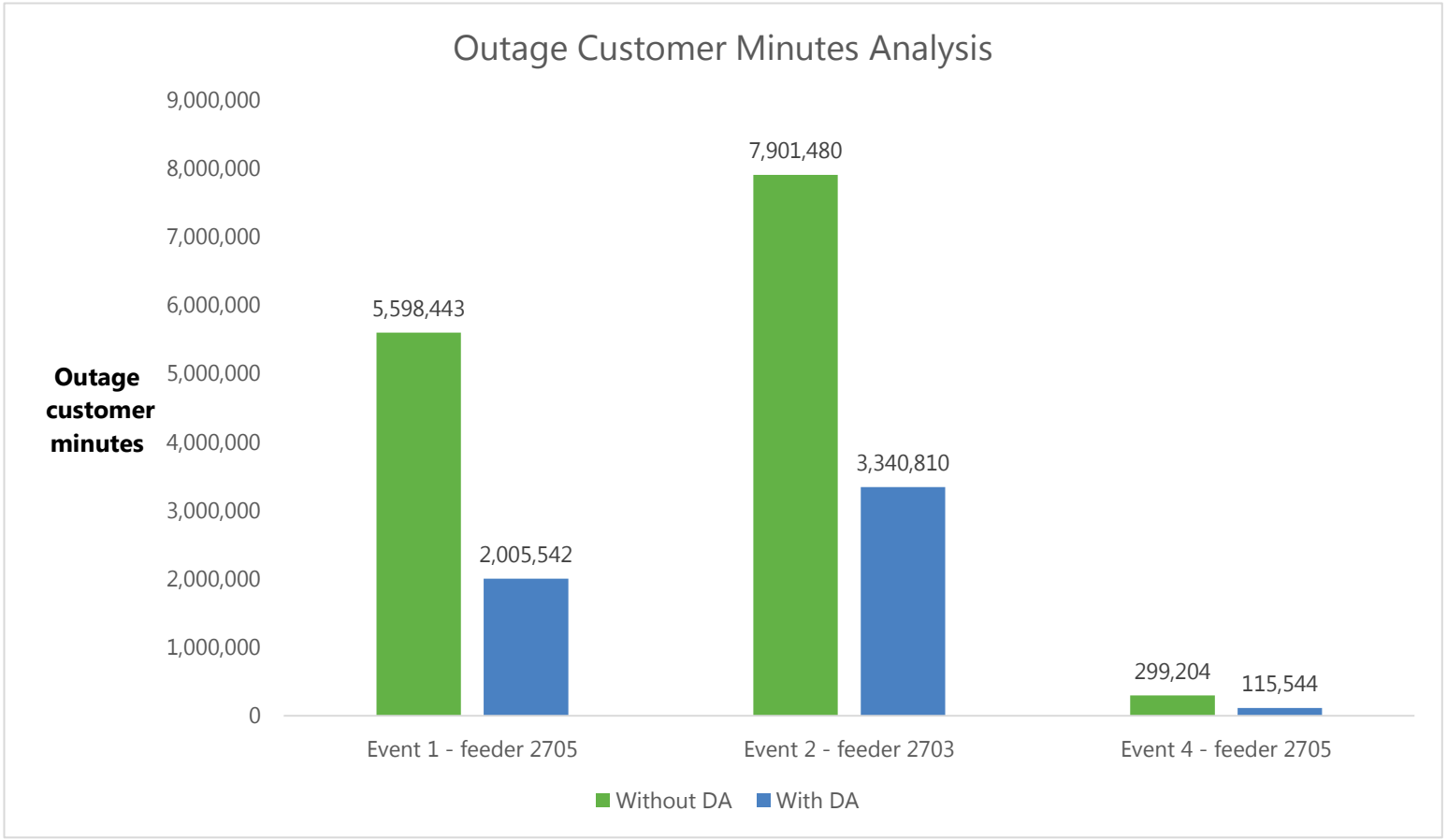
>DA System Alert: 3061/3869 customers successfully restored on Feeder 2705.

WINDSTORM 8/29/15 – DISTRIBUTION AUTOMATION (DA) SYSTEM PERFORMANCE



Assuming the event 3 which involved 115 kV outage had not occurred

WINDSTORM 8/29/15

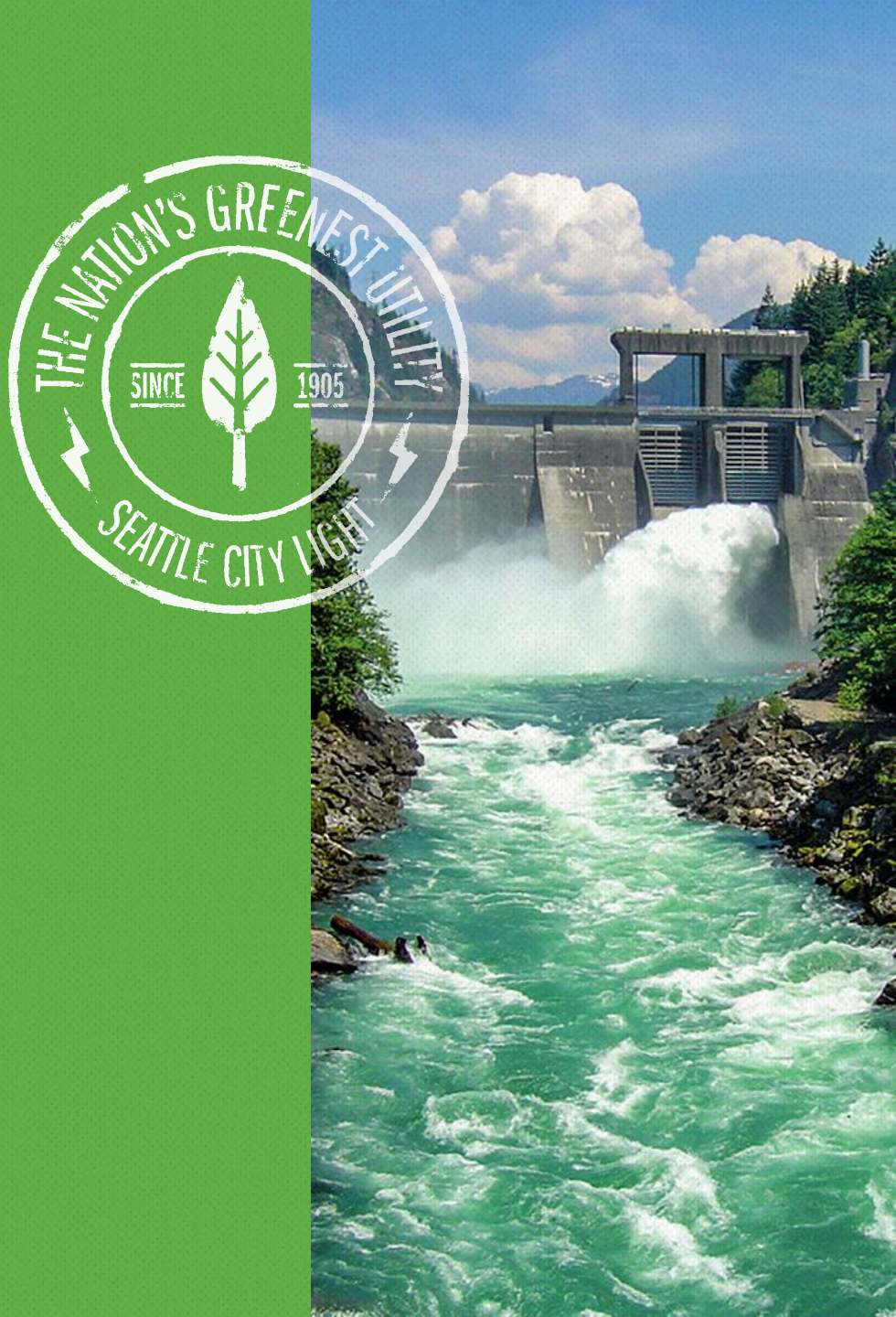


Assuming the event 3 which involved 115 kV outage had not occurred

LESSONS LEARNED

- A lab, even small one, is critical for testing, troubleshooting and training.
- Fiber optics loop was intact throughout the serve storm
- The fast, secure remote access greatly reduce crew times for event data retrieval and configuration update
- Secure WIFI is a nice feature, reduce operation cost, and enhanced crew safety
- The system performed as intended. The Distribution Automation scheme identified, isolated, and rerouted after the faults appeared.
- Dispatchers were able to identify and send line crews to fix affected line segments faster than conventional methods.

Seattle City Light



QUESTIONS?

THANK YOU