Improving Distribution System Reliability With High-Density Coordination and Automatic System Restoration

John Thorne and David Nahay
Alabama Power Company

Cole Salo, Jeremy Blair, and Gautham Ashokkumar
Schweitzer Engineering Laboratories, Inc.

High-Density Coordination
Simplifying distribution protection

- Improved feeder protection

- Simplified deployment

- Reduced customer impact of permanent faults

- No communications required

Measuring reliability

Distribution system metrics

- SAIDI

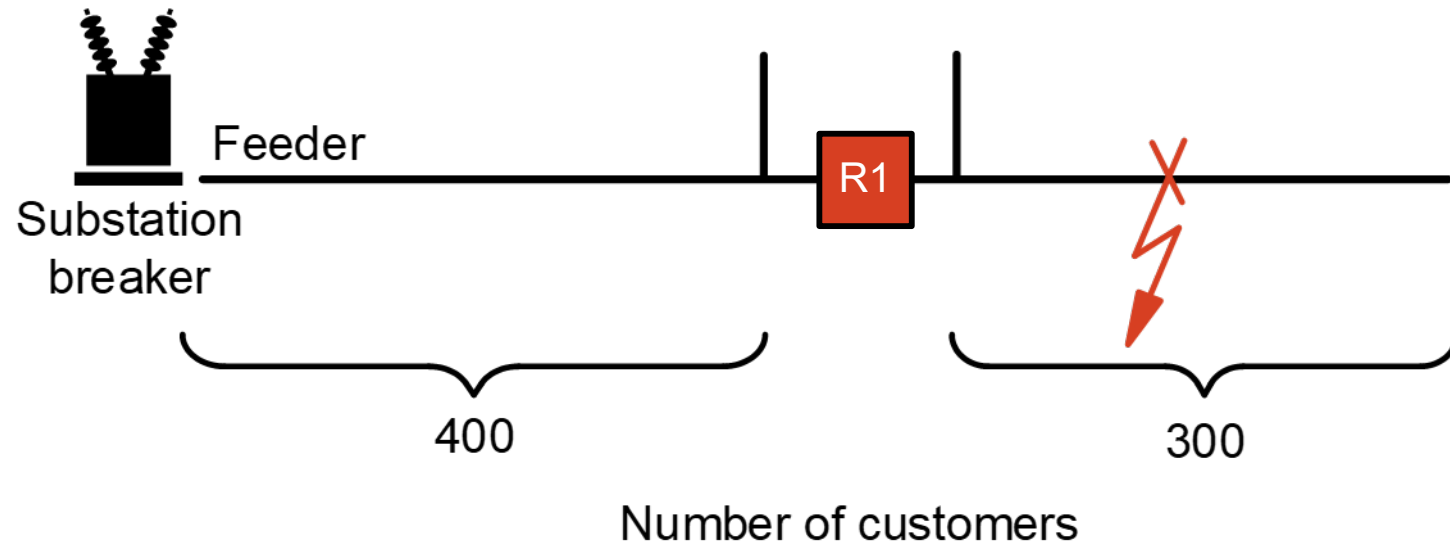 Customer minutes interrupted/total customers served

- SAIFI

  Customers interrupted/total customers served

- CAIDI

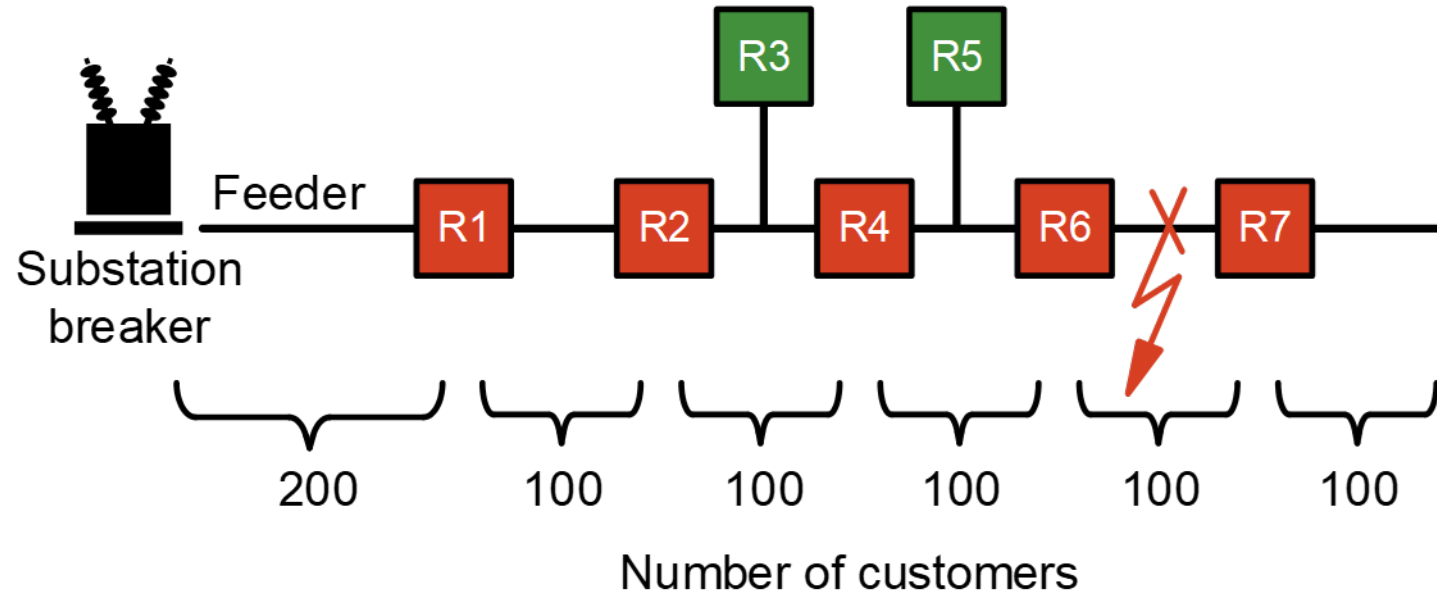 Customer minutes interrupted/customers interrupted

Customers interrupted

700 customers
100-minute outage
70,000 customer minutes interrupted
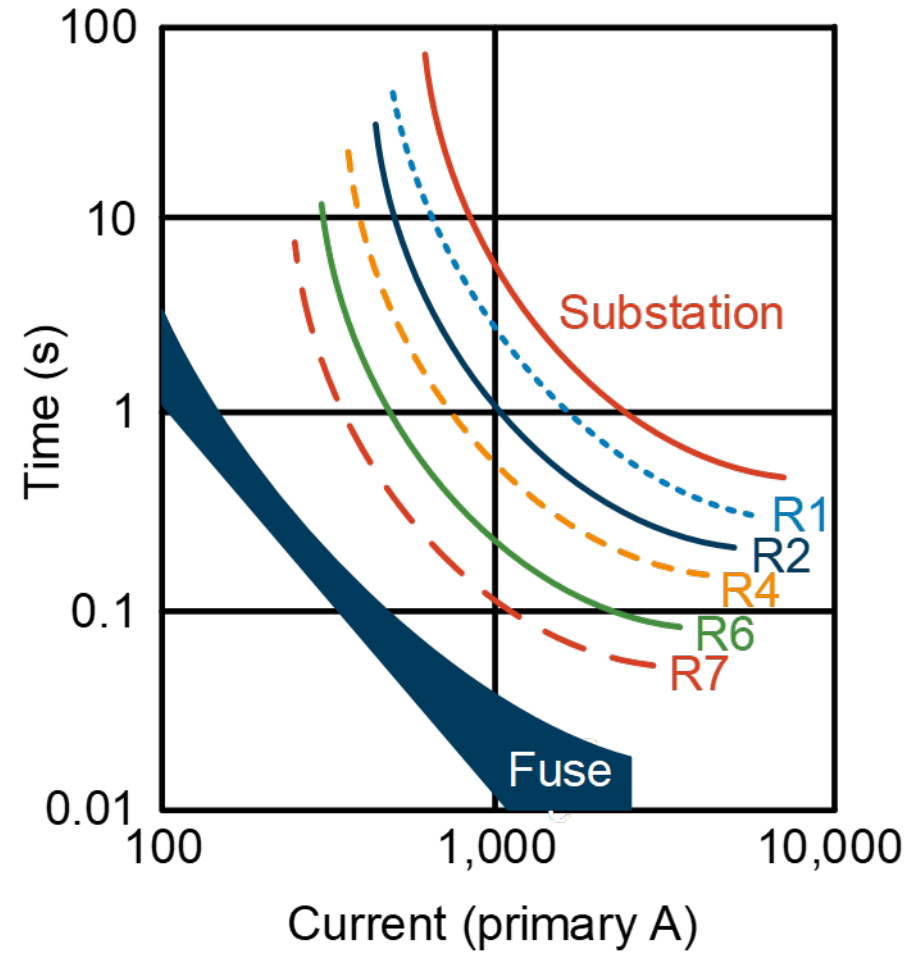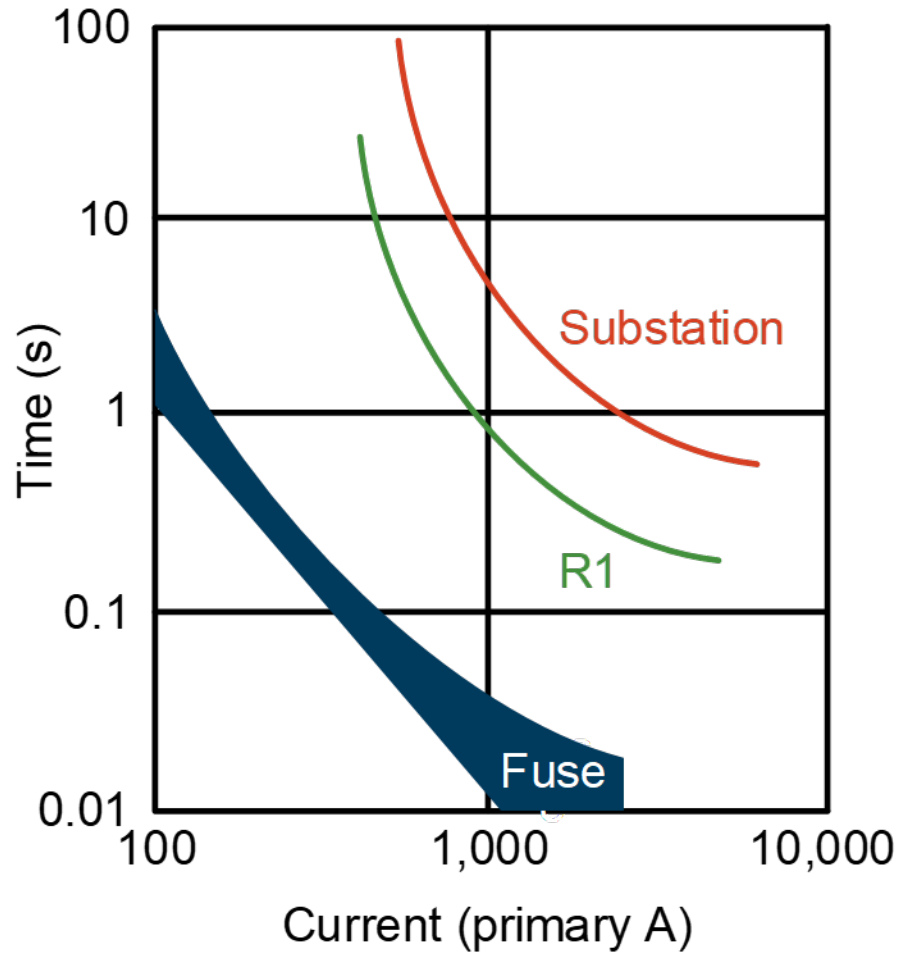
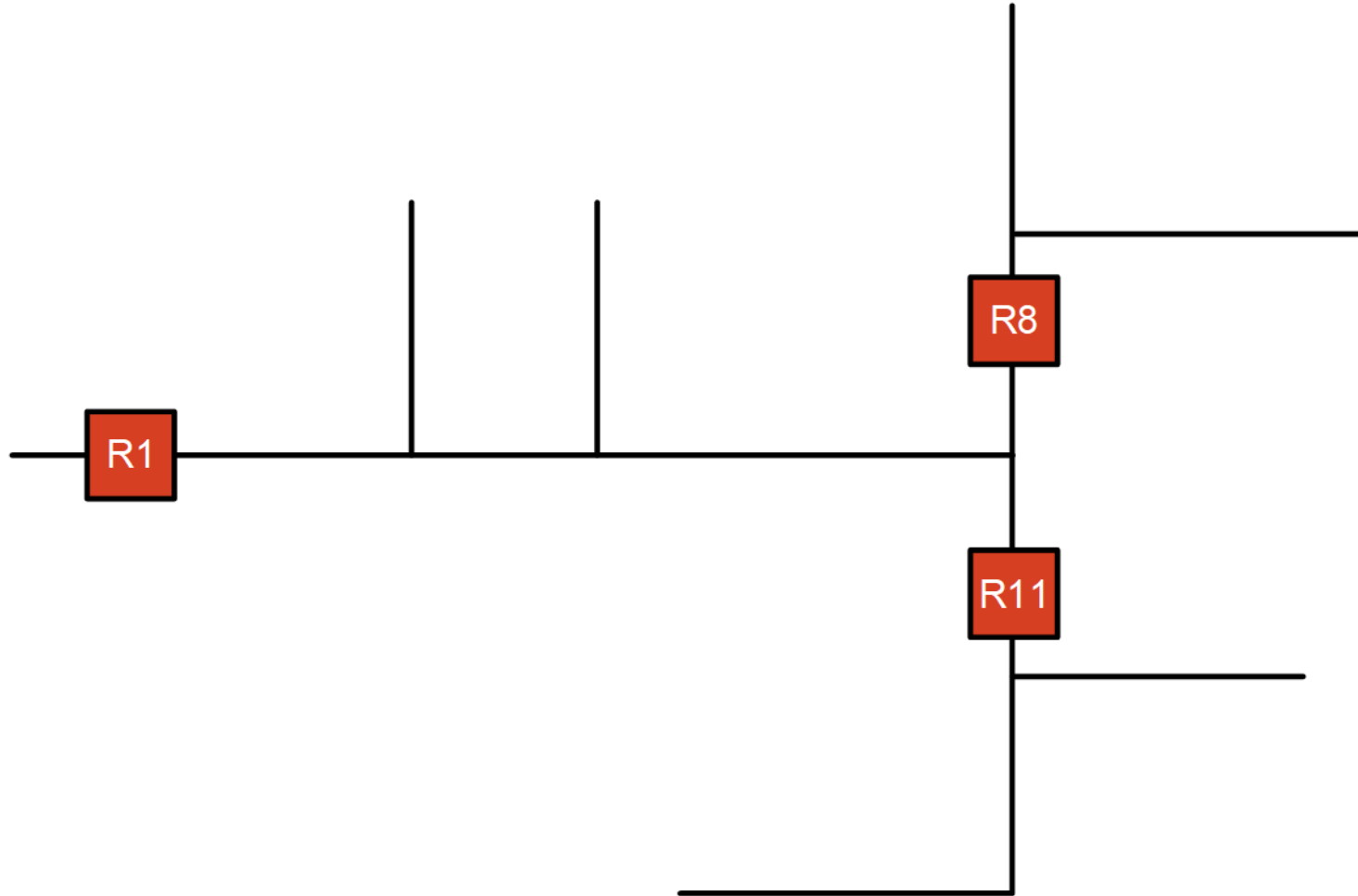# One is good, high-density is better

200 customers
100-minute outage
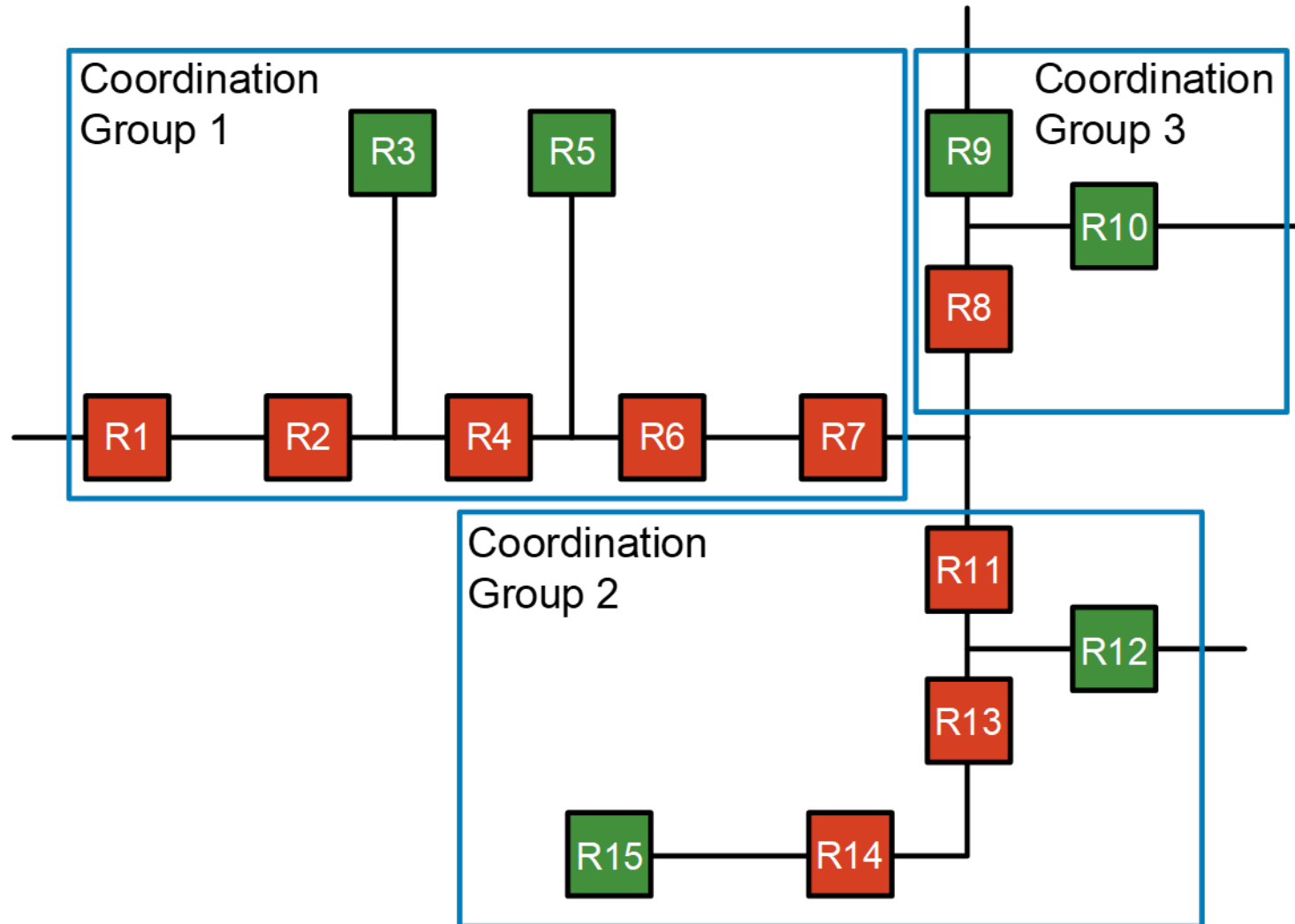20,000 customer minutes interrupted

High-density installation concerns
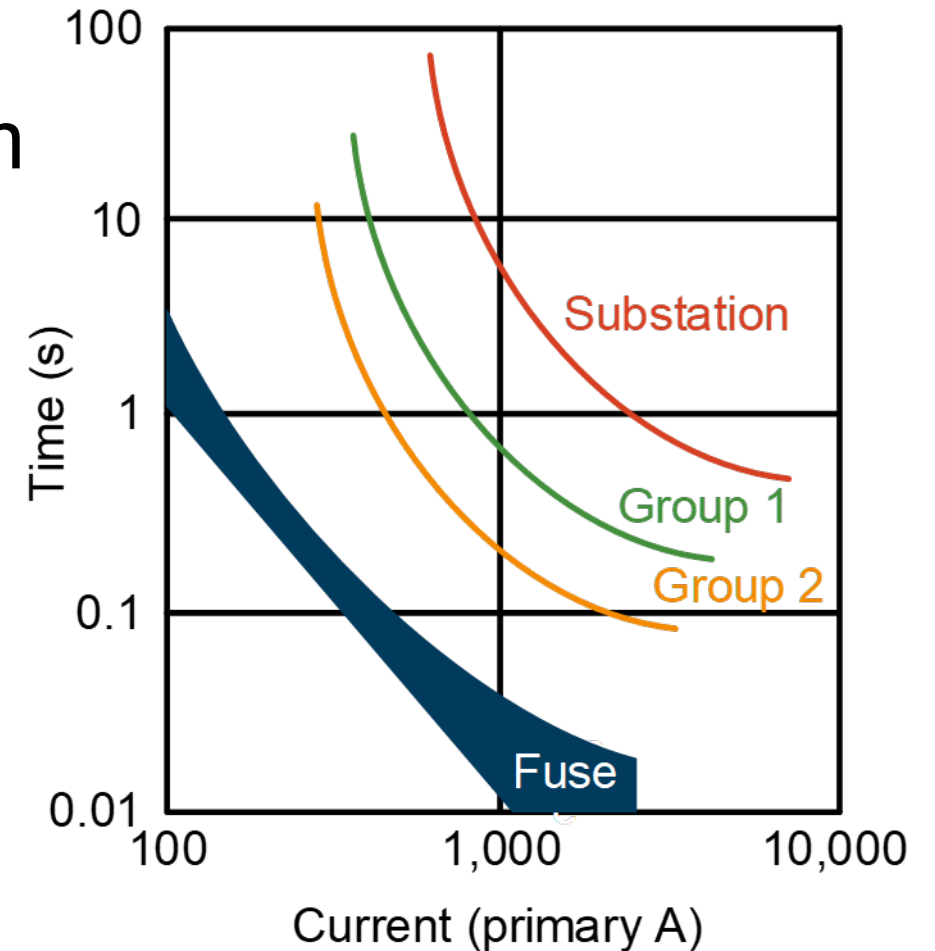
Simplified one-line example

Coordinate groups, not devices

The basics of coordination groups

- Each recloser uses same settings
- All reclosers operate for downstream fault in group – group tripping
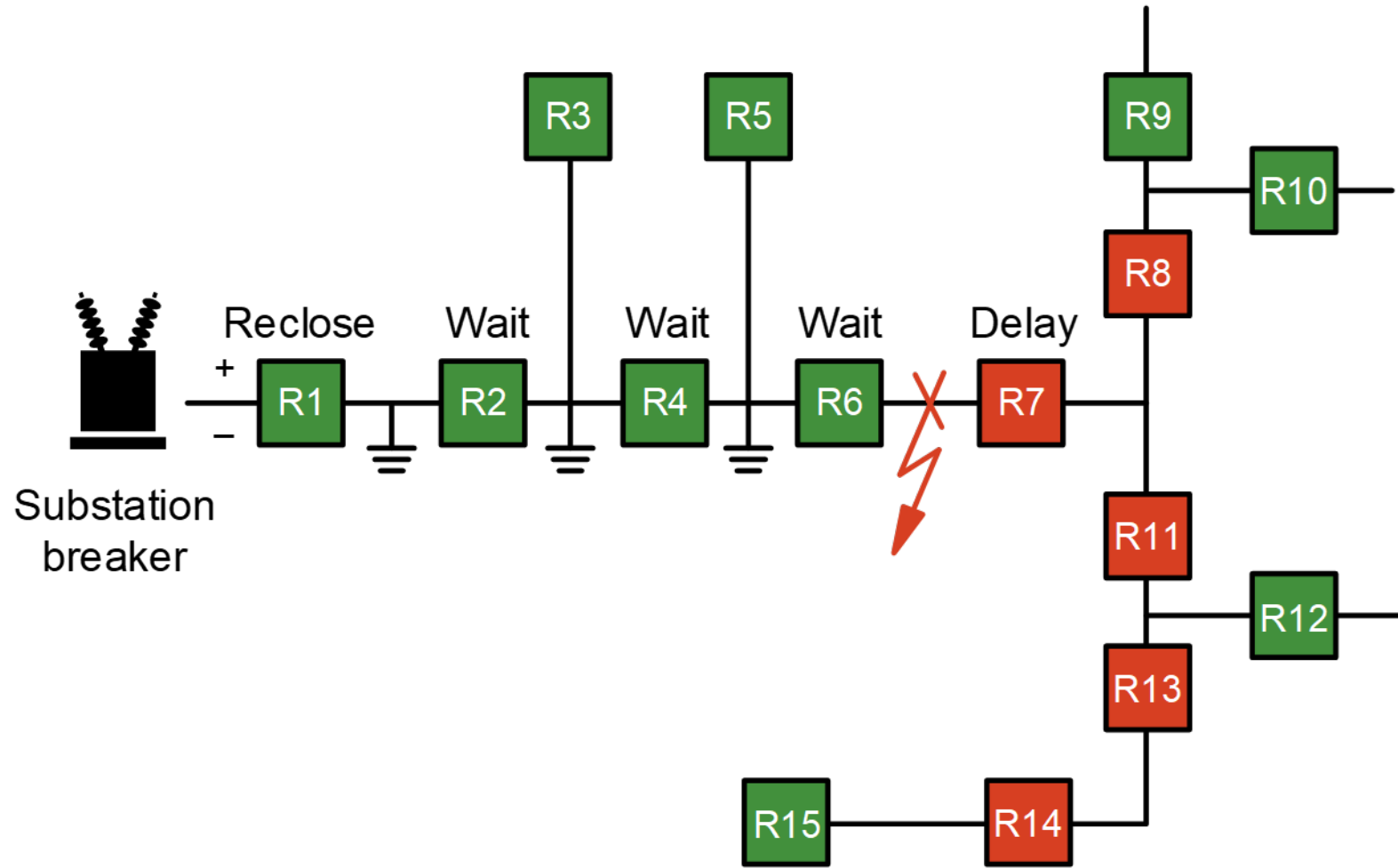- Each recloser uses locally measured voltage to start RECLOSE sequence

The basics of stepped reclosing

- As CLOSE command is issued, fast curve is enabled – security provided by 2nd harmonic element (switch-on-to-fault)

- If close holds, switch to delayed curve

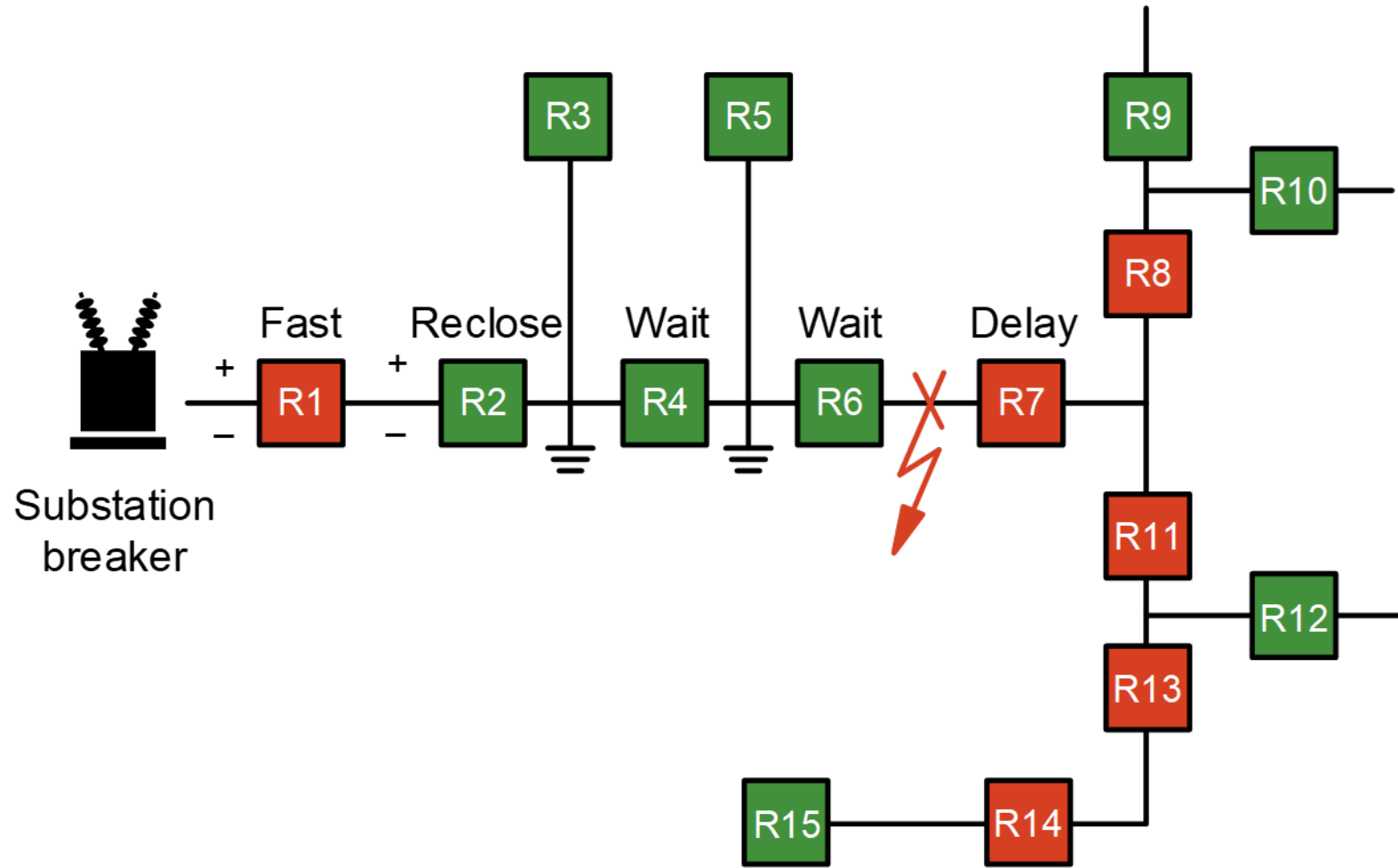- Next downstream device measures voltage and begins reclosing sequence (stepped reclosing)
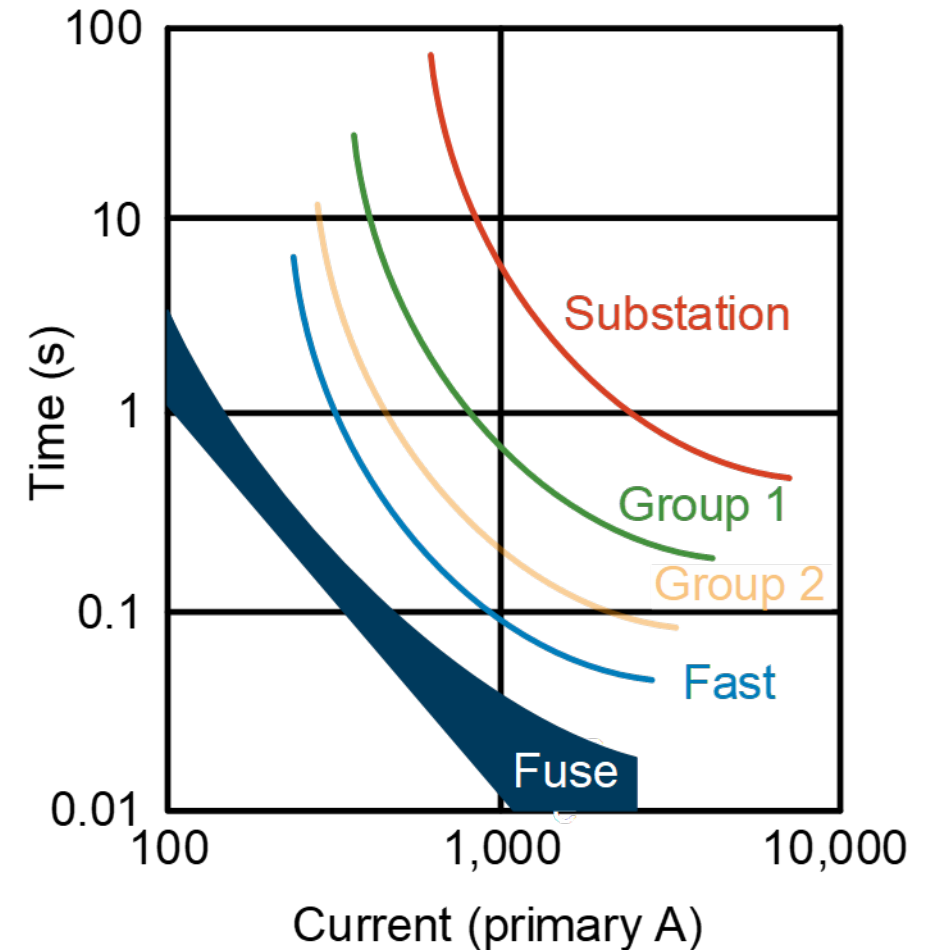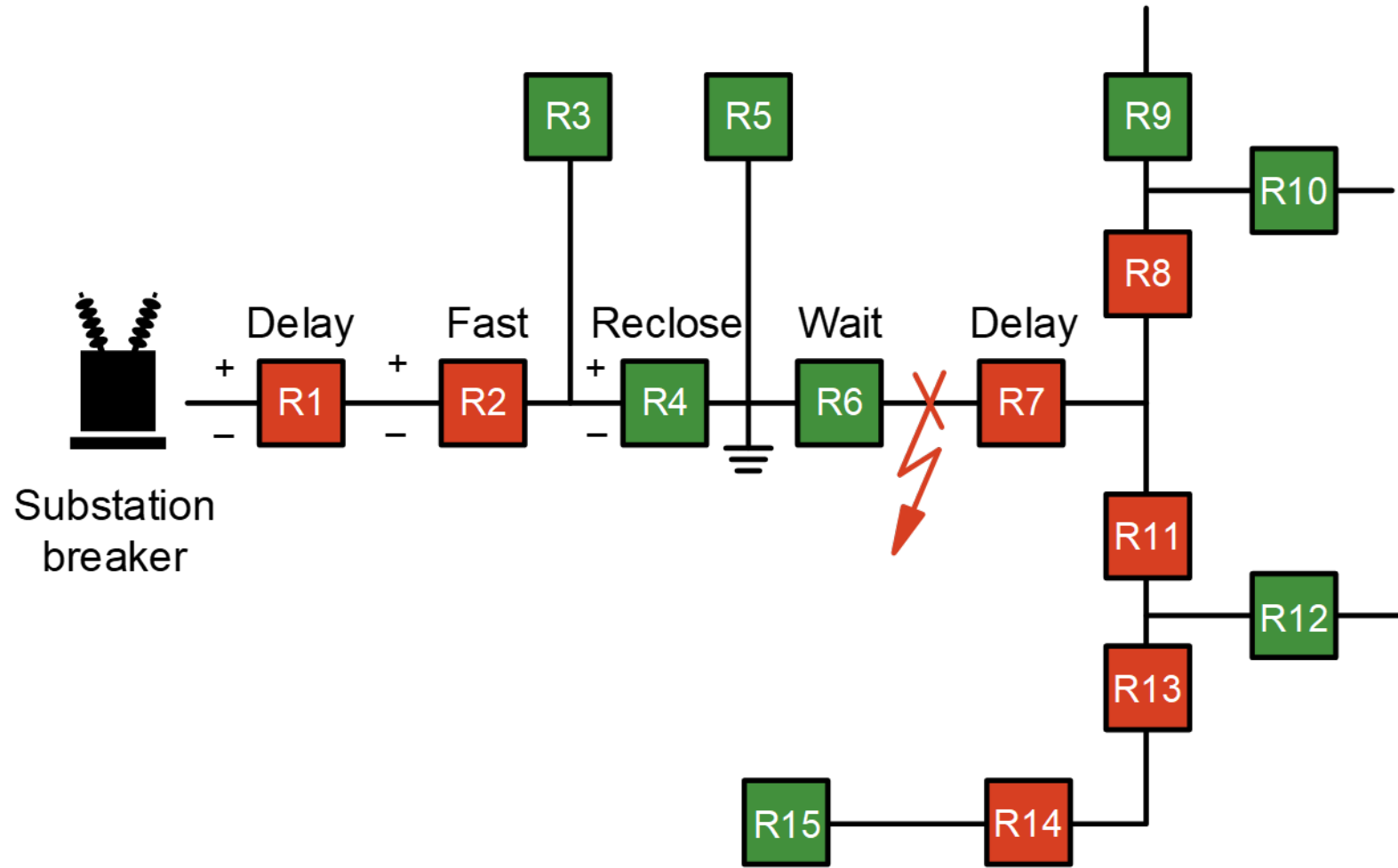
Fault occurs

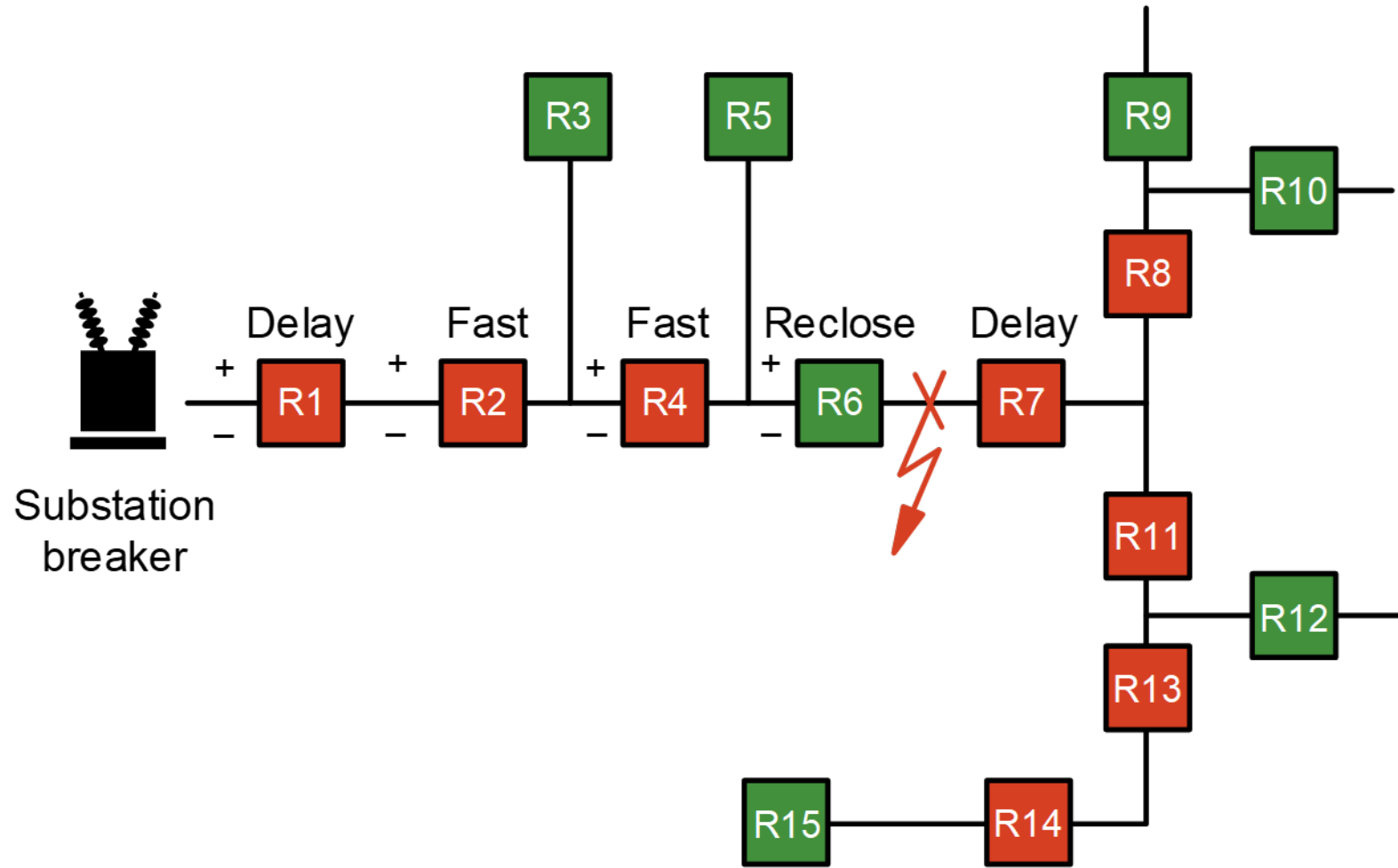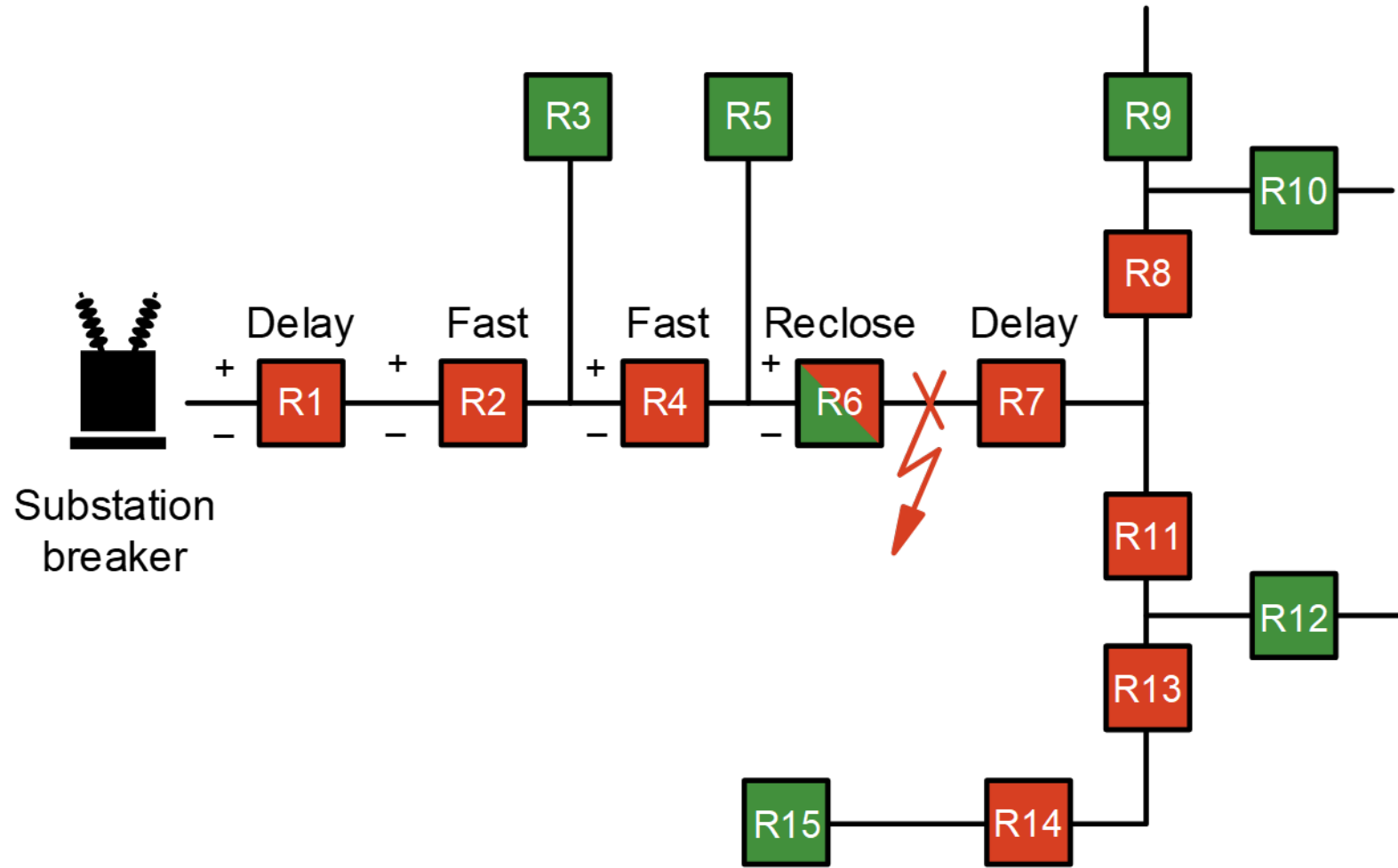Indicates no voltage measured in segment

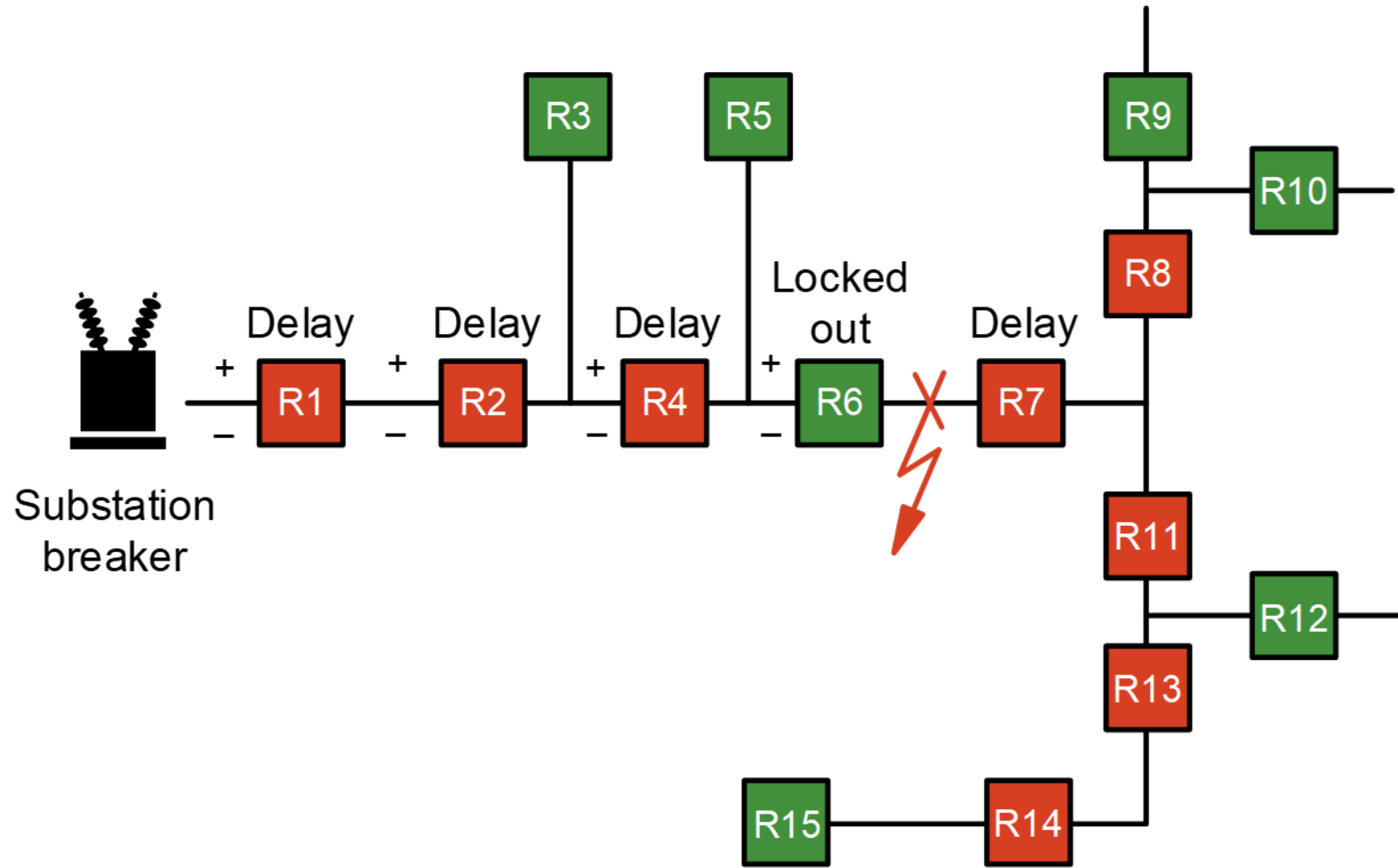# System restoration

Stepped reclosing
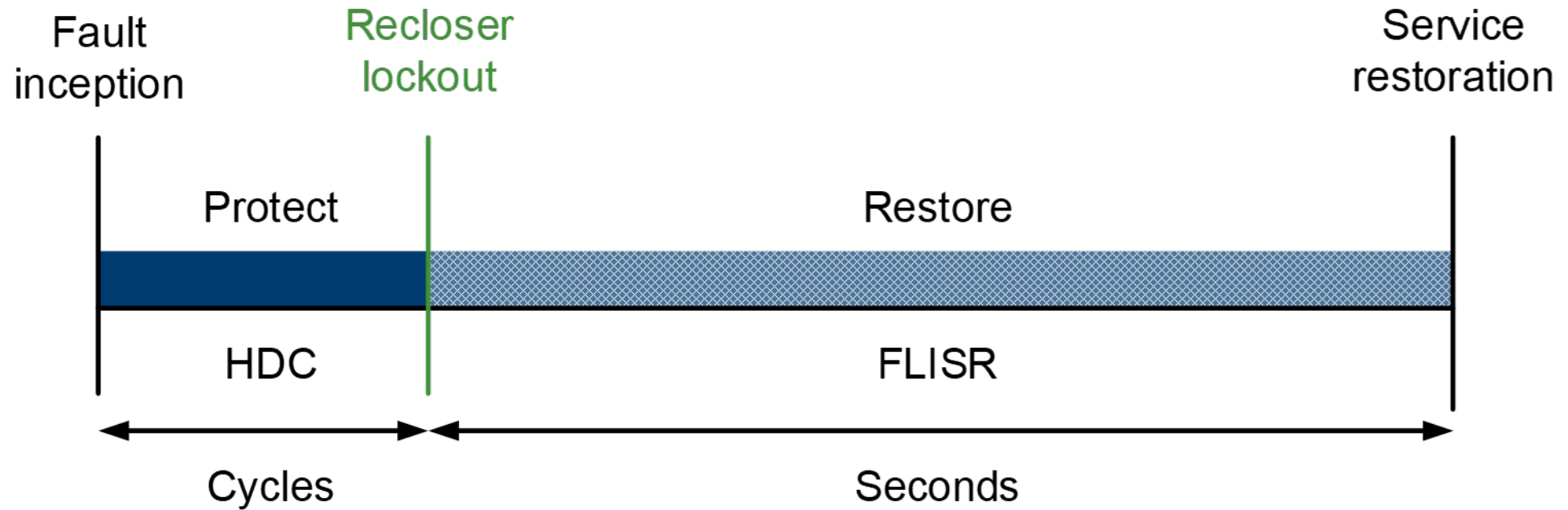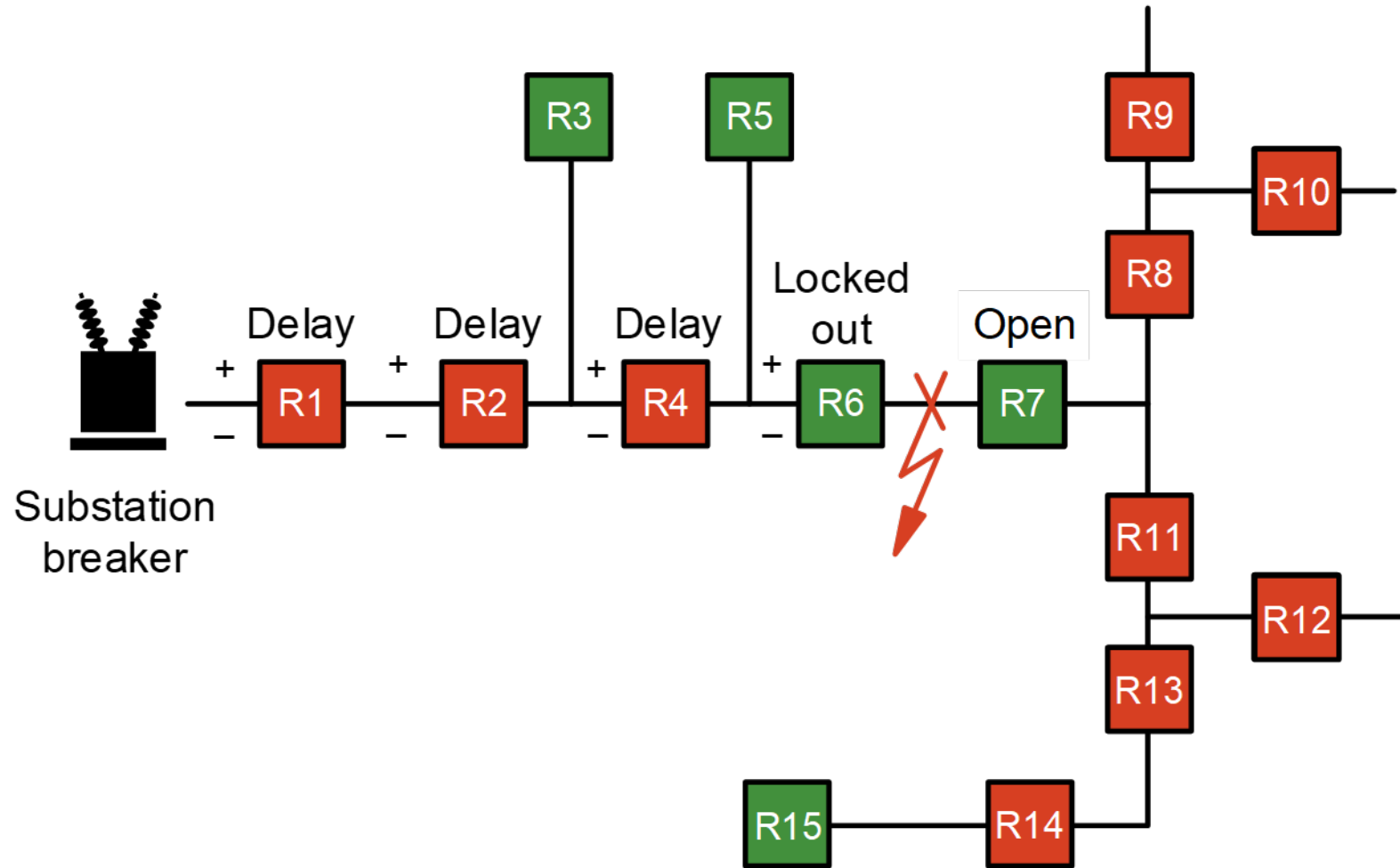
Getting closer

Found it

Lockout recloser closest to fault
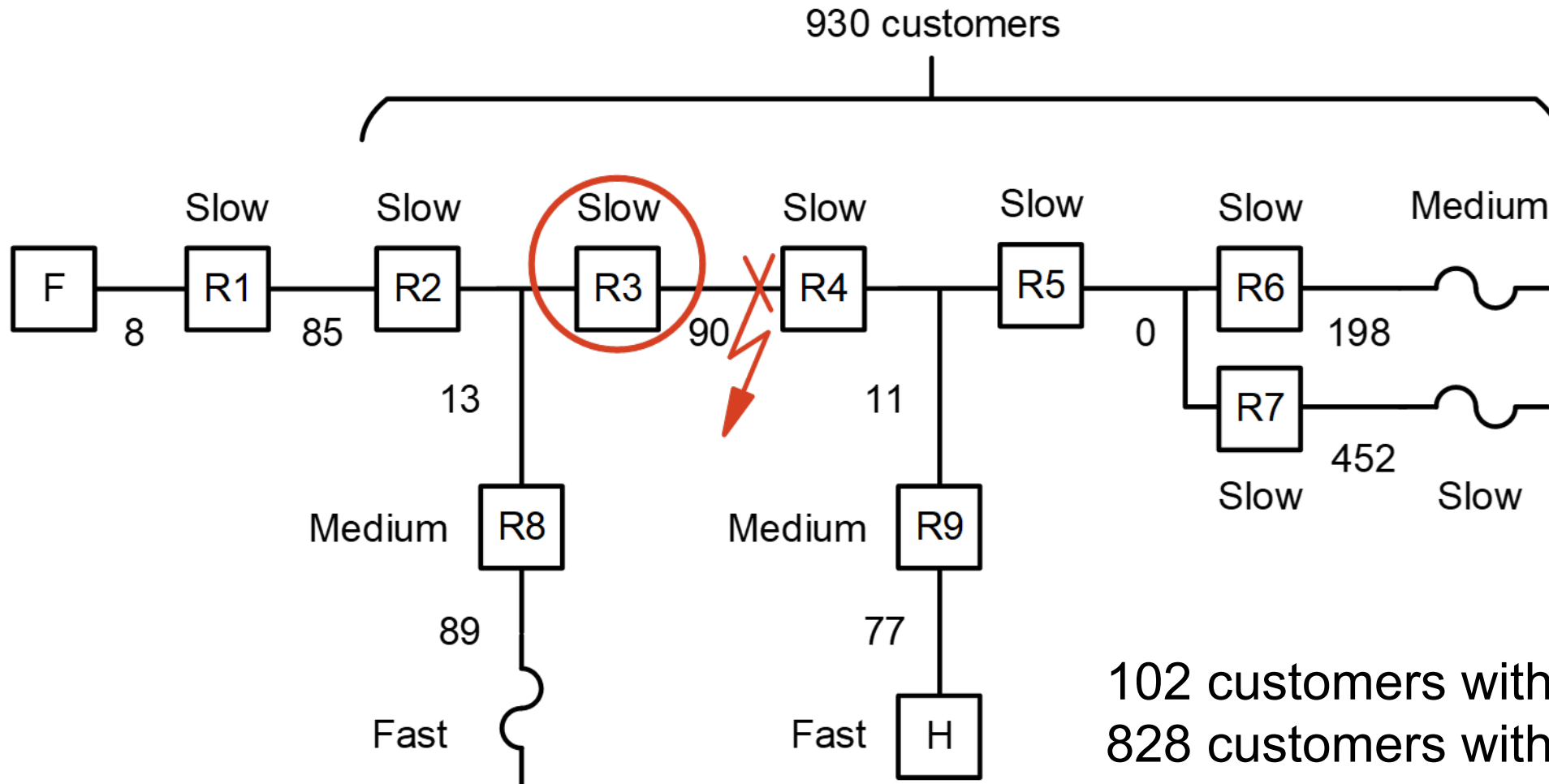
Protect first, then restore

Handoff to FLISR

Additional benefits

- Reduced protection and settings complexity

- Speed of deployment

- Accurate fault location

- Mitigation of conductor slap (miscoordination)

- Fast fault clearing, reducing through-fault damage

Alabama Power's experience

930 customers

| F | R1 (Slow) | R2 (Slow) | R3 (Slow) | R4 (Slow) | R5 (Slow) | R6 (Slow) | Medium |
8 — 85 — 13 — 90 — 11 — 0 — 198 — 452

R8 (Medium) — 89 — Fast

R9 (Medium) — 77 — Fast — H

R7 (Slow) — Slow

102 customers with no outage
828 customers with reduced outage
27,216 reduction in CMI

Questions?