

Application of Direct Transfer Trip for Prevention of DG Islanding

Reigh Walling
GE Energy



GE imagination at work

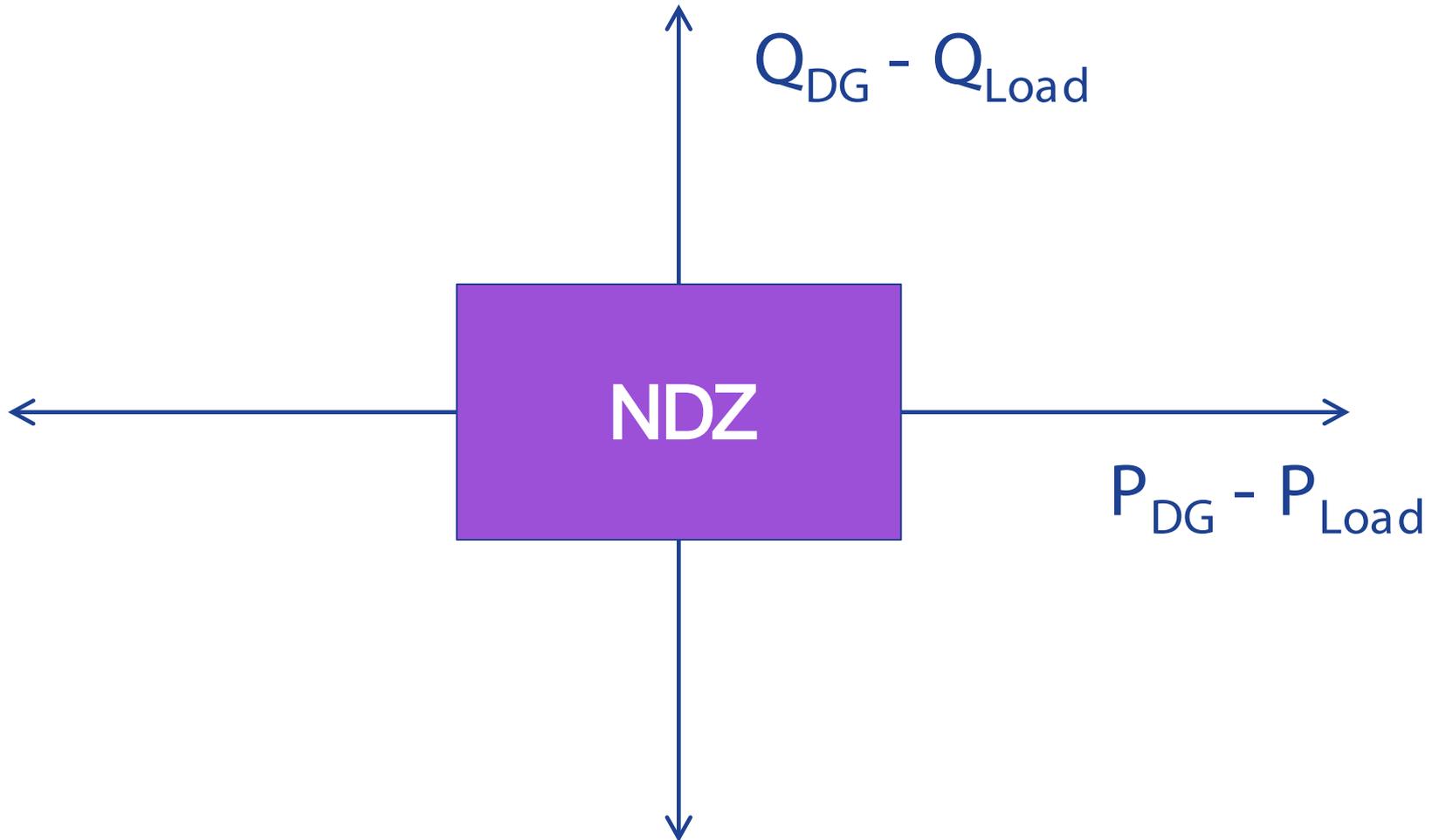


Background

- Most distribution systems have radial topology
 - DG can become easily islanded
 - Operation of any upstream breaker, recloser, fuse, or switch can establish an islanded subsystem
- Widely accepted that DG should not continue to energize an island
 - Safety
 - Overvoltages
 - Lack of utility control; potential liability
 - Potential for out-of-phase reclosing
- IEEE 1547 requires DG to cease energization of island in 2 sec
 - Active anti-islanding (AAI) algorithms
 - Direct transfer trip (DTT)

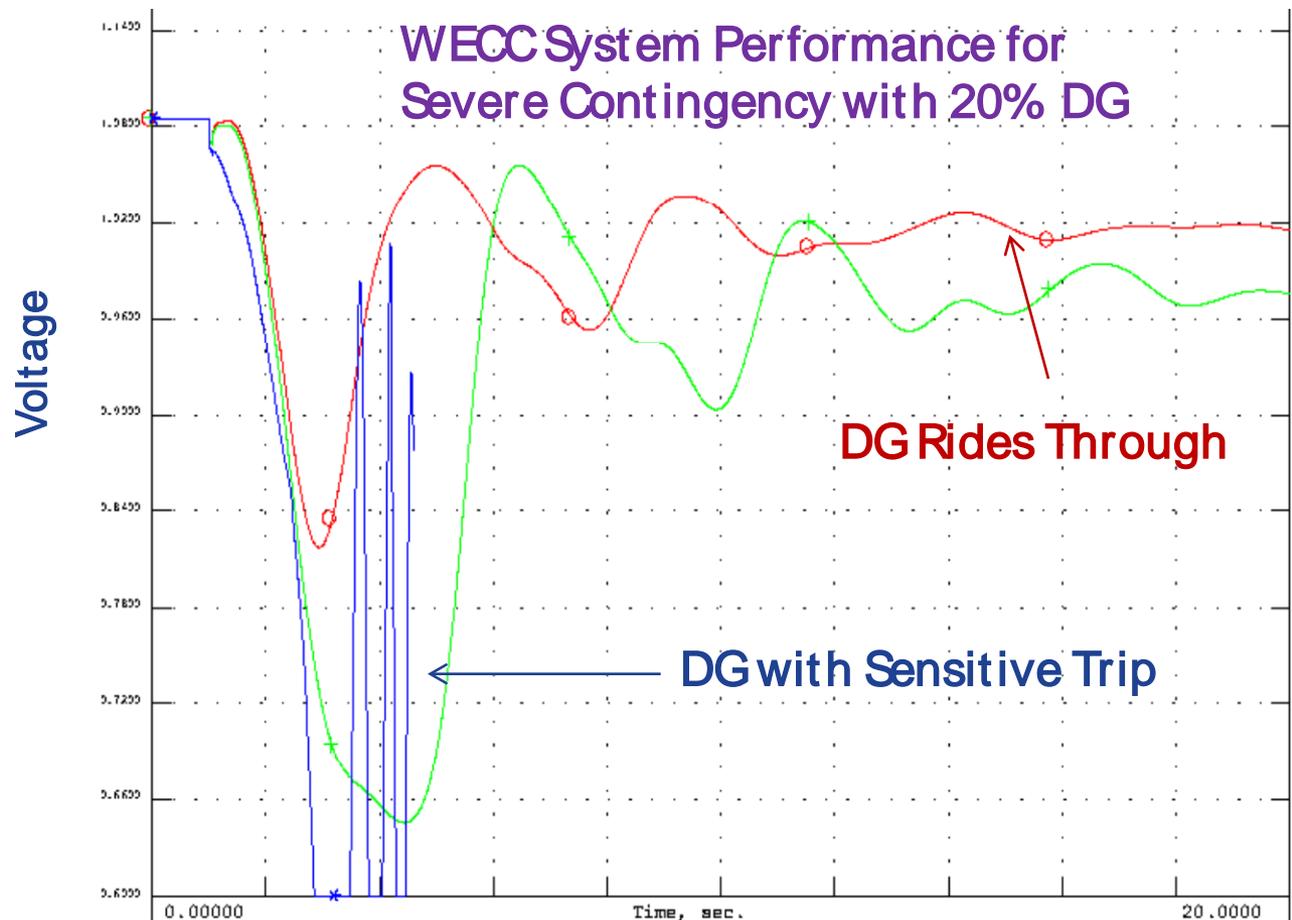
Limitations of Active Anti-Islanding

- AAI schemes have a non-detection zone (NDZ)



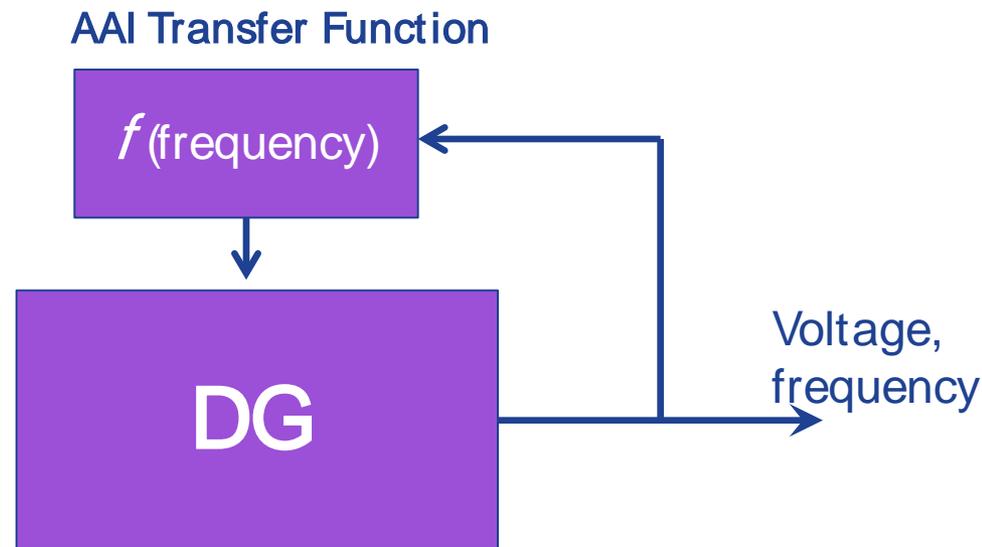
Limitations of Active Anti-Islanding

- Decreasing NDZ requires increasing sensitivity
 - Increased potential for false trips
 - Potential bulk grid reliability impact for high penetration



Limitations of Active Anti-Islanding

- Some AAI schemes act as a Power System *Destabilizer*
 - The entire grid is an island, what about high penetration?
 - These schemes are contrary to the PSS functions required of conventional power plants



Limitations of Active Anti-Islanding

- Some AAI schemes are based on perturbing system or injection of a probing signal
 - Speed and effectiveness depend on amount of perturbation
 - Tradeoff between sensitivity and power quality impact
- Different AAI schemes may counteract each other
 - E.g., one DG biased to drift frequency up, another biased to drift frequency down

Direct Transfer Trip

- Direct transfer trip (DTT) communicates a trip signal to a remote location
 - Example: substation relay detects fault on feeder
 - Trip signal communicated to DG location
 - DG breaker tripped by DTT signal
- Advantages
 - Positive avoidance of long-duration island
 - Avoids negative impacts of AAI schemes
- Disadvantages
 - Traditionally viewed as costly
 - Complicated to implement where feeders can be reconfigured
 - Generally does not avoid a short-duration island

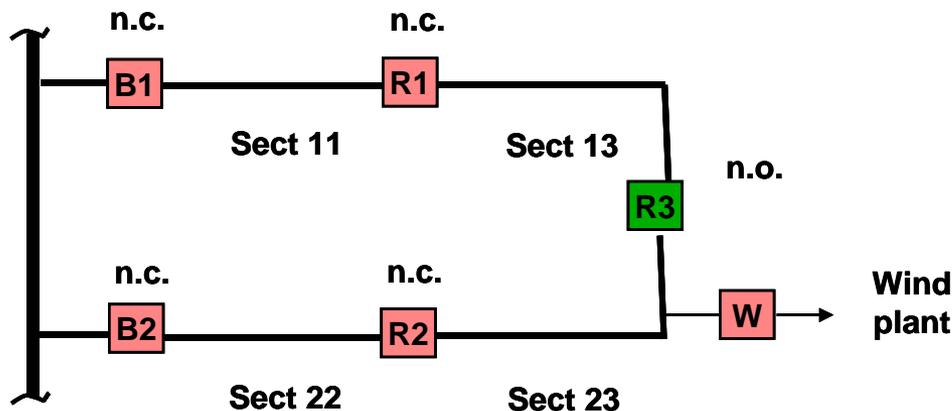
DTT Communications

- Communication media
 - Leased telephone lines
 - Dedicated fiber
 - Radio
- Packaged radio systems can make DTT less costly and thus more practical
- Can use “smart grid” comm infrastructure if channels are available with:
 - Low latency
 - Protection-grade security
- Loss of communications needs to be considered
 - Redunancy (expensive)
 - Make DG operation contingent on comm availability

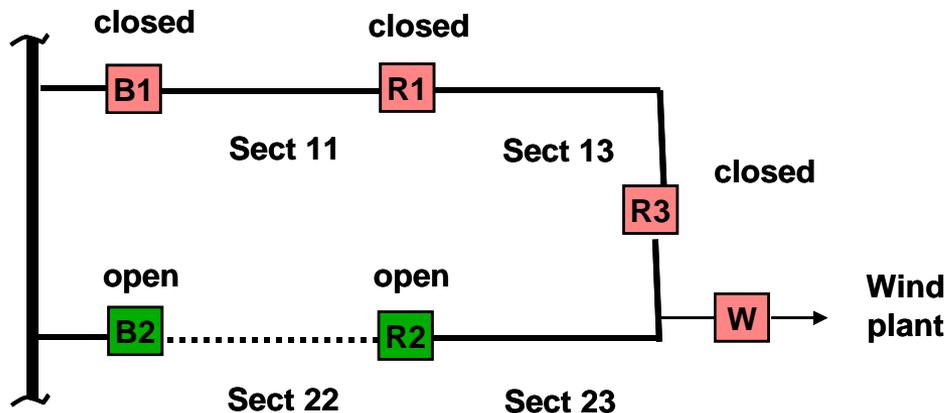
Reconfigurable Feeders

Simple Auto-Loop Scheme

Normal Configuration



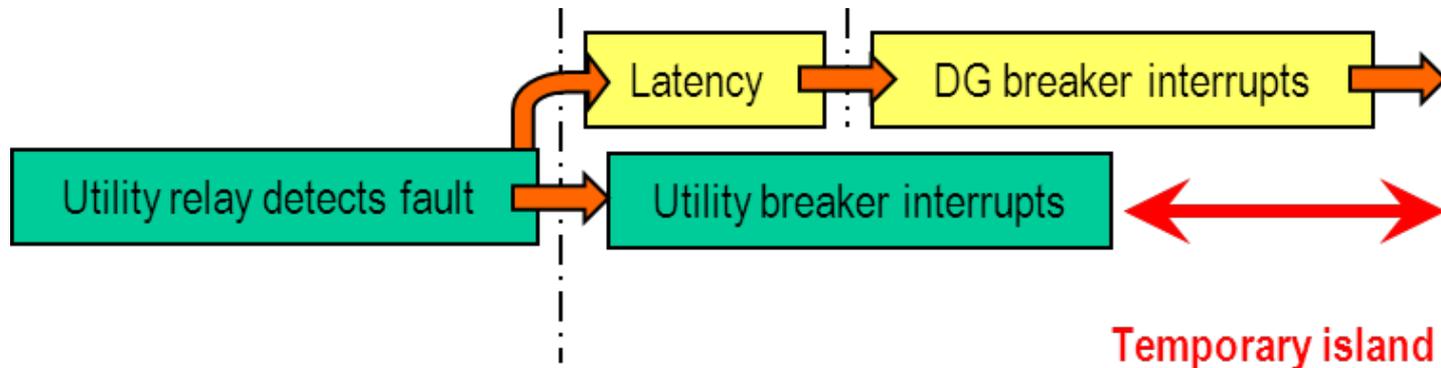
Post-Fault Configuration



- DTT must be received from any interrupting device that can island DG
- In normal configuration
 - DG (W) must receive DTT from both B2 and R2
- Fault on Section 22 causes B2 and R2 to open, R3 to close
- In backup configuration
 - DG must receive DTT from B1, R1, and R3
- Logic to implement DTT on an automated feeder can be complex

Temporary Island with DTT

- If substation breaker and DG breaker have the same operating time, DG is disconnected after island already occurs



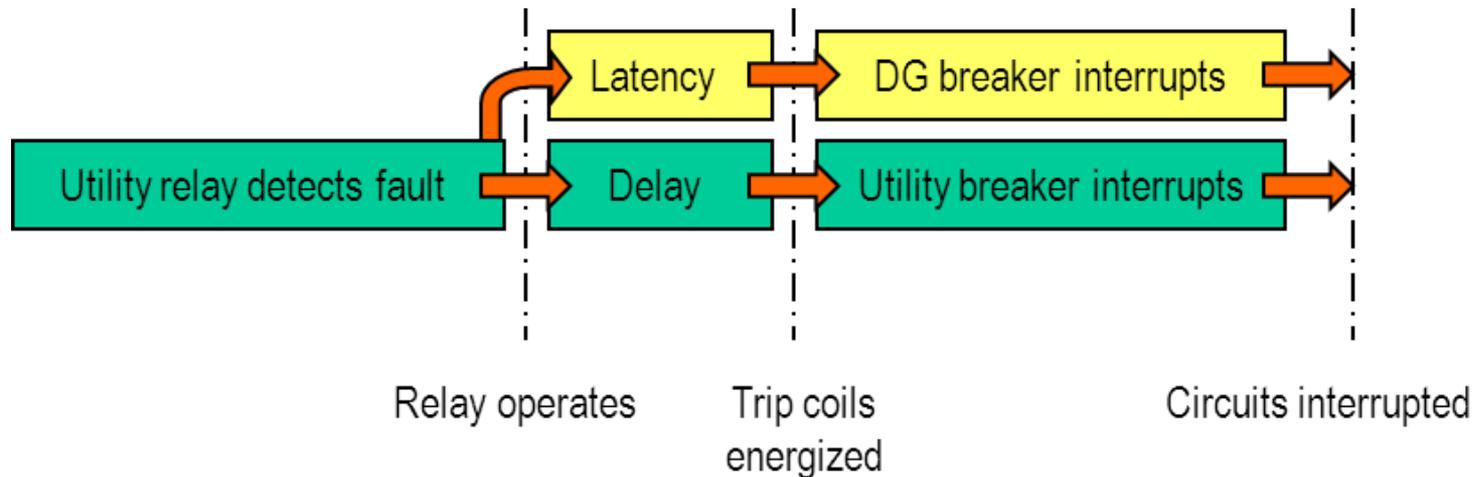
- Duration of island equals communication latency

The Case for *Preventing* Islands

- AAI takes from a few cycles to a few seconds to identify islanded state
- Islanding can cause overvoltages
 - Abrupt change in driving point impedance seen by a current-regulated DG inverter
 - Loss of ground reference
- Islanded system has very low short-circuit ratio
 - Outside of typical inverter spec
 - Control instabilities may occur
- Delayed reclosing can affect power quality

Coordinated Direct Transfer Trip - CDTT

- Intentional delay between relay operation and energization of substation breaker trip coil
- If interruption times are equal, delay \cong latency



- Much shorter delay needed if CDTT is direct to inverter

Conclusions

- AAI based on local measurements can have adverse impacts
- Local AAI can only detect island after it has already been created
- Direct transfer trip can provide more reliable islanding protection
- CDTT can avoid island if protection delays are used
- DTT / CDTT can be complex in feeders with multiple possible sources

Thank You!

