

High Reliability Alternatives to Network Systems

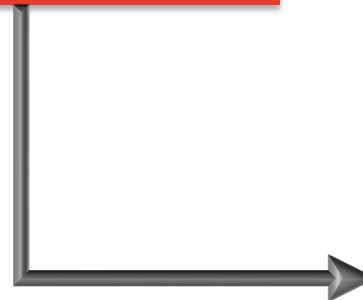
CIGRE Grid of the Future - Chicago November 2022

Overview of Network Systems

How did network systems develop?

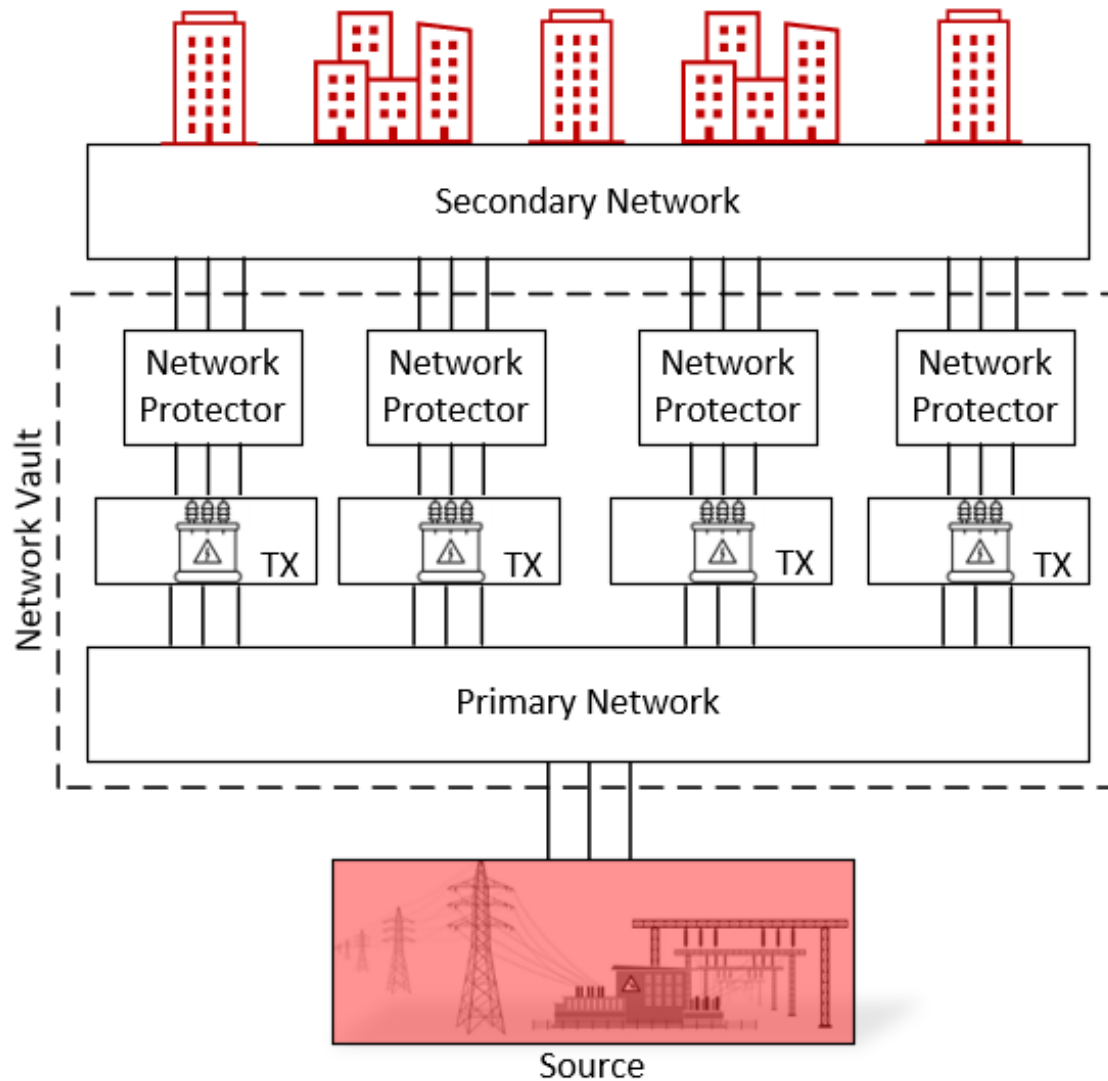


Why did they develop?



What do they look like now?

Overview of Network Systems



Benefits of Network Systems

Reliability

- Due to system redundancy, network systems are highly reliable
- Outage duration tends to be longer on network systems, but number of outages is less than that of a radial system

Metric	2015	2016	2017	2018	2019	5 Year Avg.
Network						
SAIFI	0.027	0.017	0.025	0.023	0.056	0.030
CAIDI	8.39	7.42	7.11	7.29	5.29	7.10
Radial						
SAIFI	0.35	0.49	0.36	0.40	0.53	0.41
CAIDI	1.95	1.89	1.92	1.99	2.73	2.10

*Example considered in graph is a large network system compared to an overhead radial system

Limitations of Network Systems

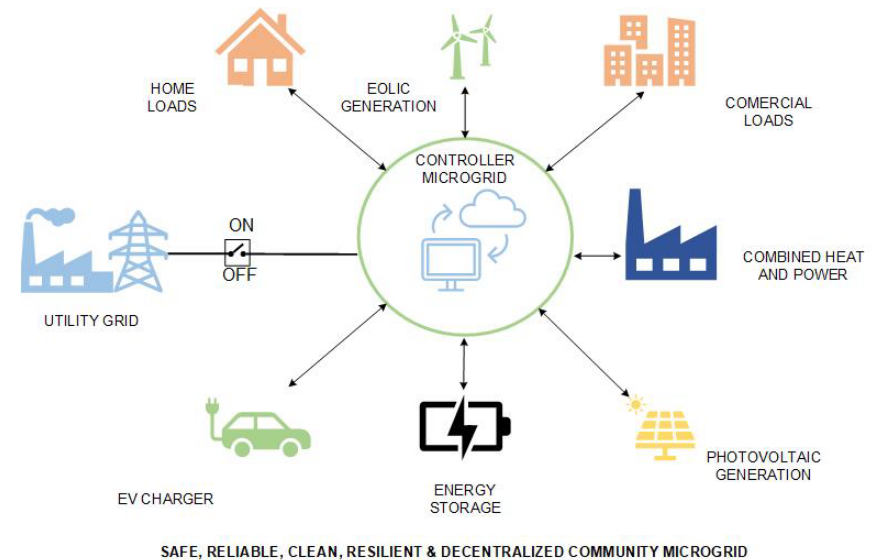
- Safety Concerns
 - Hard or impossible to visually verify de-energized status, higher fault current
- Difficulty with DER Integration
 - Key protection component is reverse power flow detection
- Upfront cost of a network system is estimated to be 175-200% more expensive than radial networks
 - This figure does not account for maintenance costs



Alternatives to Network Systems

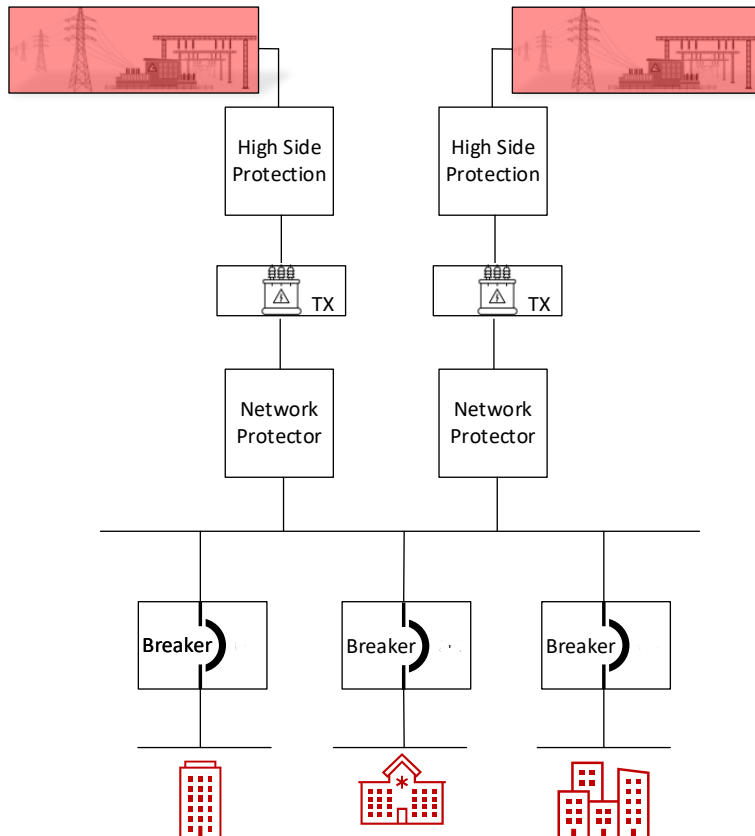
Microgrids & DER

- Microgrid ➡ A group of interconnected loads and DERs within clearly defined electrical boundaries
- Allow for the extension of system boundaries
- Can be used to feed critical loads
- Help form decentralized networked systems
- Development of self-sufficient power systems that balance local generation
- Allow for integration of sustainable energy sources



Spot Networks

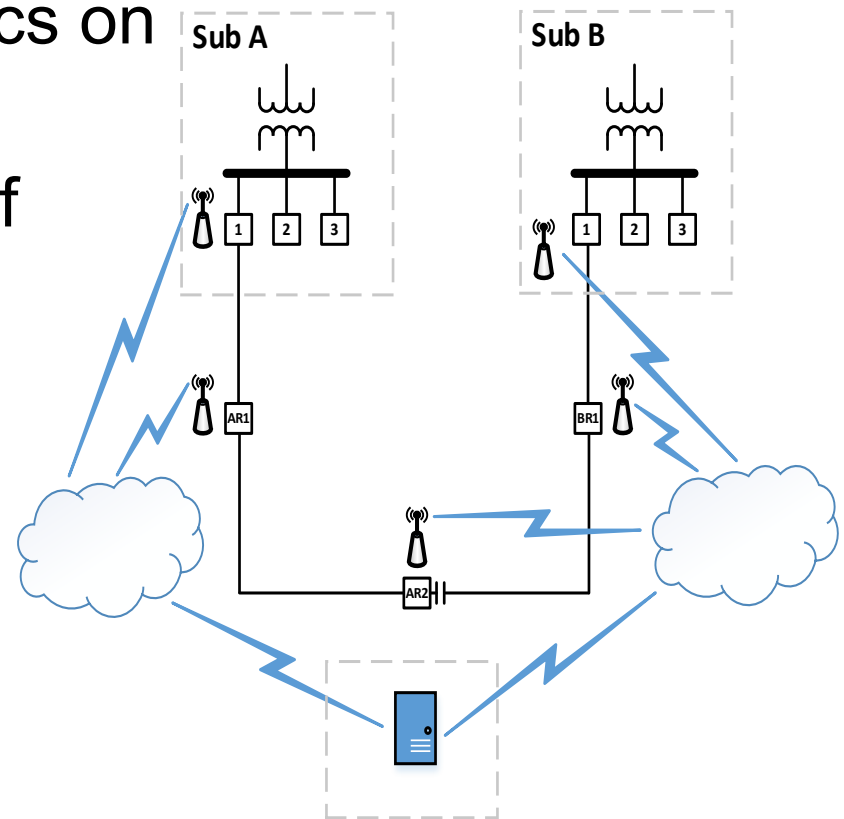
- Architecturally similar to network systems, containing same equipment and protection
- Footprint smaller than a network system



- Reliability depends on demands of loads, ratings of equipment and contingencies
- Design considerations are similar to network systems
- Limits fault currents compared to large network system

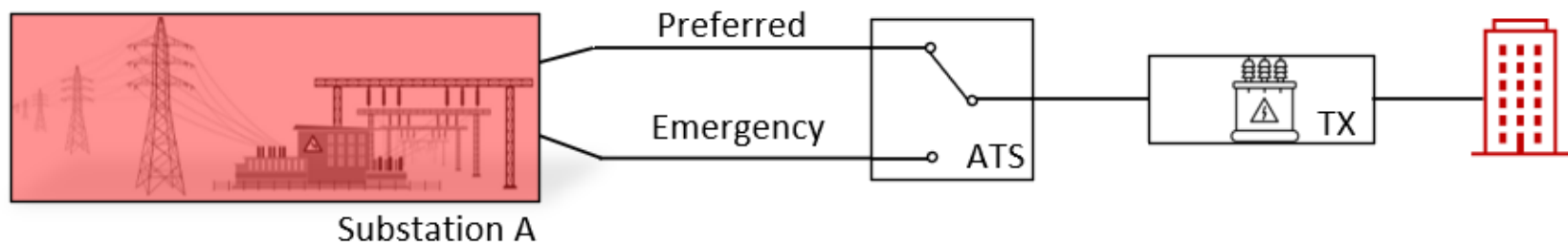
FLISR

- FLISR → Fault Location Isolation Service Restoration
- FLISR enables automated reconfiguration of radial feeders under abnormal conditions
- Increases reliability metrics on radial systems
- Solves safety concerns of network systems
- Can be integrated with DER
- Still causes momentary customer outages



Selective Service

- Make use of an automatic transfer switch to provide two separate sources to a load
- Decreases need for redundant equipment
- Open or closed transition ATS can be used depending on load
- Smaller footprint than network systems and can be integrated within building service vaults
- Maintenance needed to ensure reliable operation



Conclusion

<u>Solution</u>	<u>Cost</u>	<u>Reliability</u>	<u>Safety</u>	<u>Maturity</u>	<u>Other</u>
Microgrids	High-Very High	High	Medium	Low-Medium	Integrations/Protection Complexity
Spot Networks	Medium	High	Low-Medium	High	Easier Transition Known Technology
FLISR	Medium	Medium-High	High	Medium-High	Highly Deployed Modernization Projects, Momentary Outages
Selective Service	Medium	Very High	High	High	Used in many large cities, easy to implement on radial systems