Balancing Substation Design Service Life to Meet Changing Service Conditions and Maximize Useful Life

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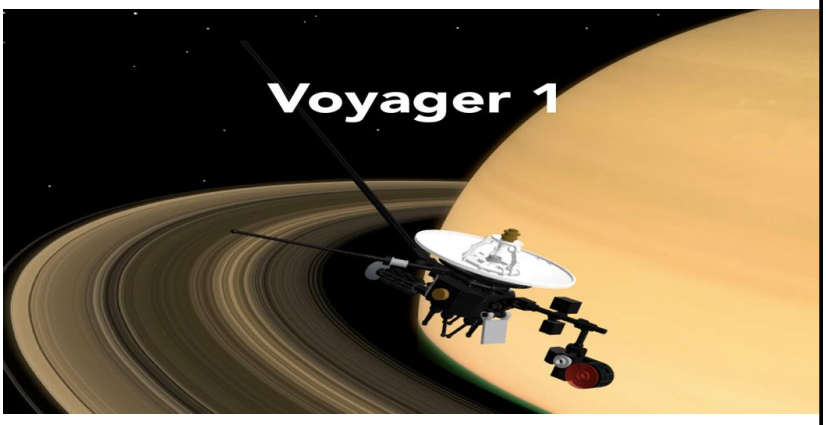
Building it to last

After almost 45 years in deep space, Voyager 1 is still functioning…



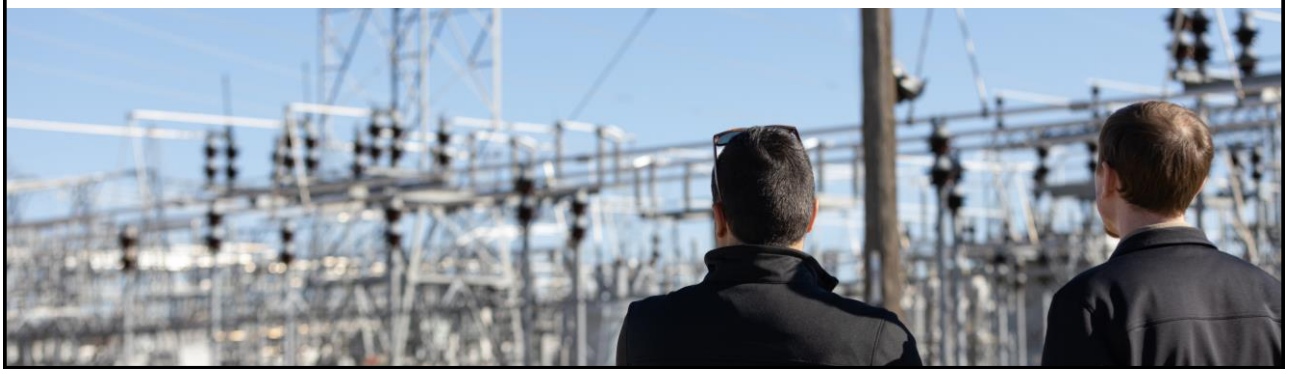
What is the useful life of your protection and control?

- Design life
- Safety and service life
- Device and system durability service life
- Business service life
- Upgrade and modernization strategies

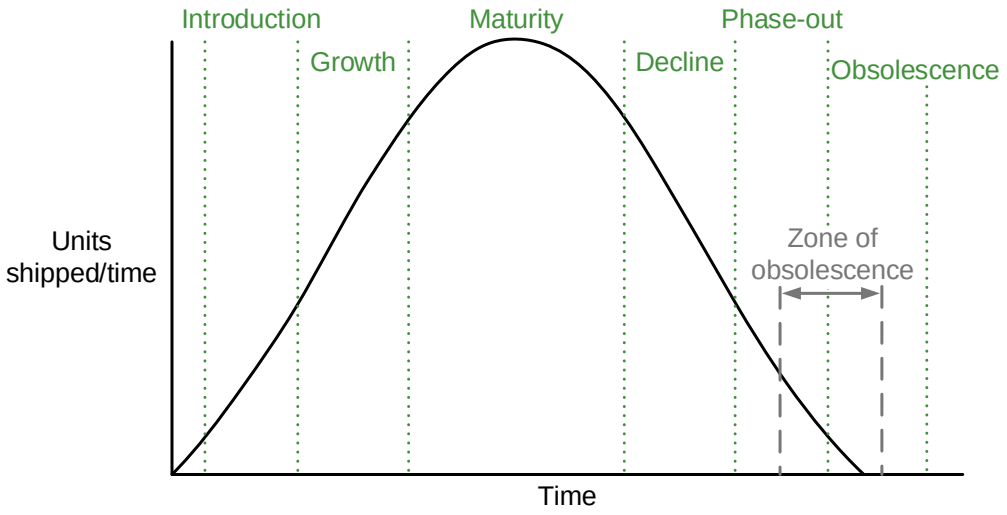
Substation business service life

Business needs unchanging over time (stable) best served by **durability**

Business needs changing over time (unstable) best served by **resiliency**



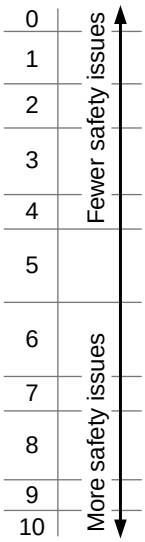
IEEE substation design life



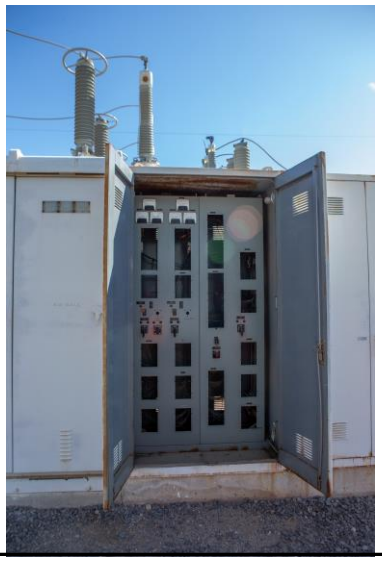
Source: *IEEE Trans. On Components and Packaging Technologies*

Severity of failure: one metric of useful life

FAA failure metrics		NERC failure metrics		Business failure metrics	
Severity category	**Passenger symptoms**	**Severity category**	**EDS interruption (MW)**	**EDS damage**	**Public safety**
Catastrophic	Fatal to all	5	≥10,000	$$$$$	Directly fatal (e.g., electrocution)
Hazardous	Fatal to few	4	5,000–10,000	$$$$	Indirectly fatal (e.g., fire or failed emergency service)
Major	Discomfort	3	2,000–5,000	$$$	Discomfort
Minor	Inconvenient	2	300–2,000	$$	Inconvenient
—	—	1	<300	$	Not observed

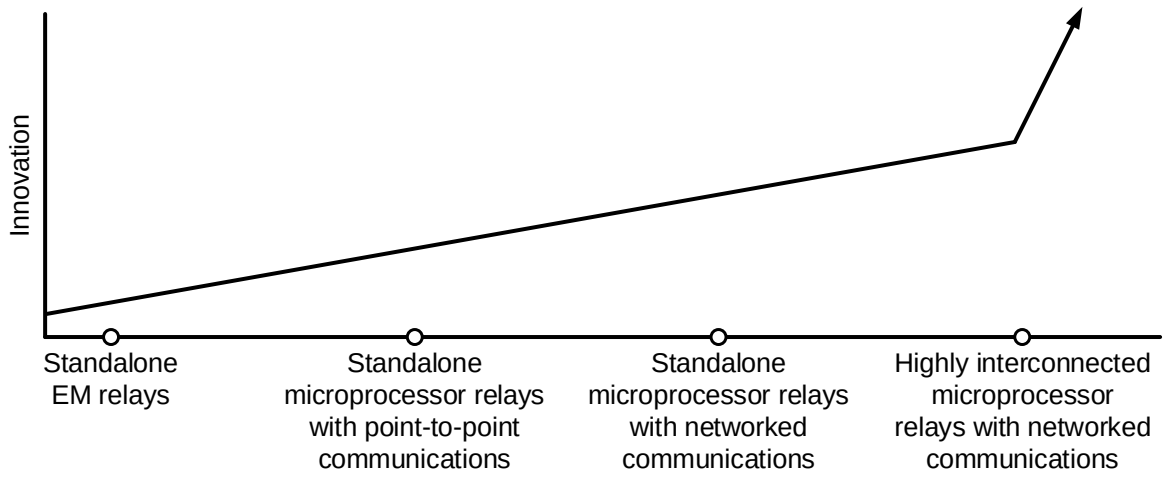


Durability extends useful life



System durability and resiliency, more than sum of the parts

Innovative advancements enable business resiliency



Challenges affecting system design lifespans

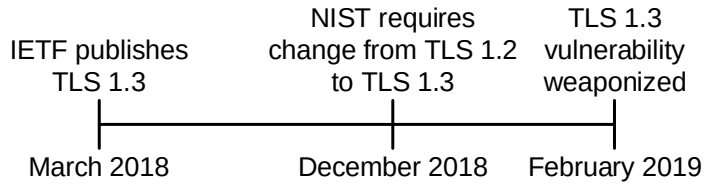
Perishable technology shortens lifespan – TLS

DARPA says “IT TLS doesn’t belong in OT relays”

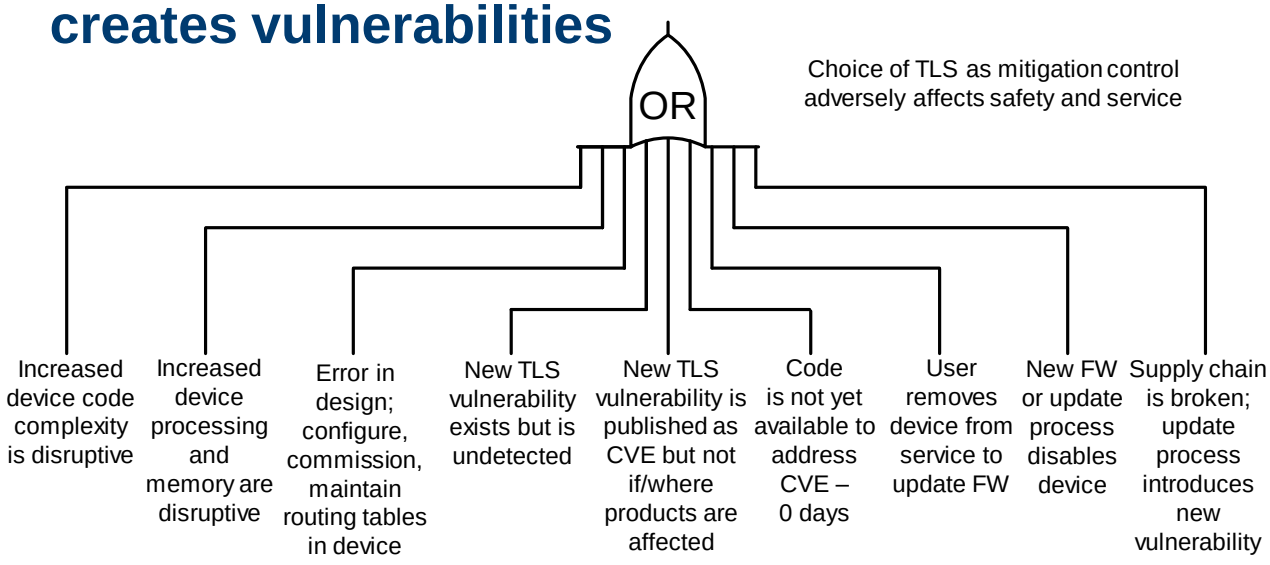
TLS 1.3 vulnerability enables hackers to eavesdrop on encrypted traffic

Feb 15, 2019
NEWS by Rene Millman

Researchers have demonstrated how to break the TLS 1.3 encryption protocol using a variation of the Bleichenbacher attack.



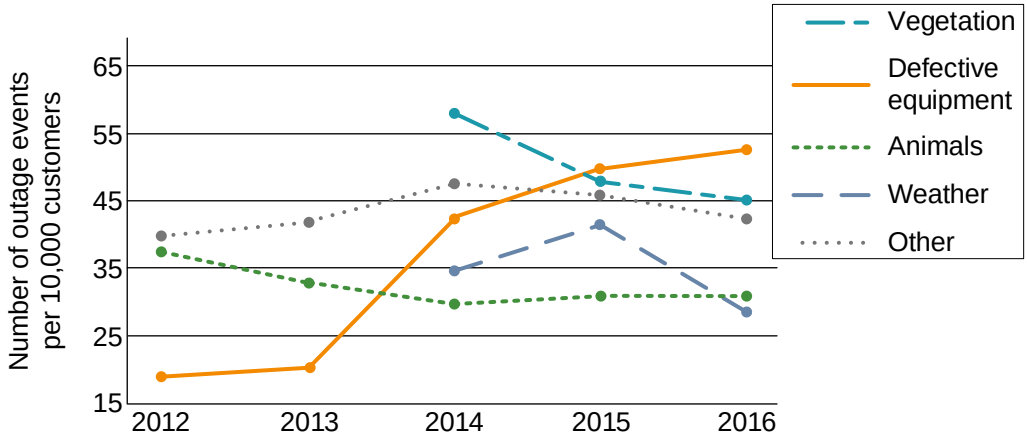
Lack of technical durability creates vulnerabilities



Device durability service life factors

SAIDI impact by defective equipment growing

Are relays involved?



Source: Review of Florida's Investor-Owned Electric Utilities 2016 Service Reliability Reports

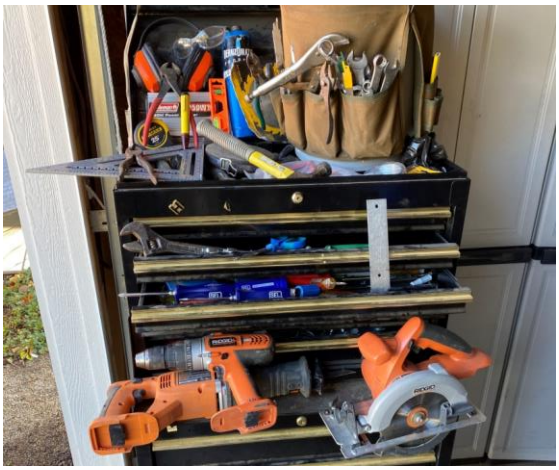
Service requirements and business resiliency affect system service life

Business expenditure service life factors


Capital replacement programs


Rapid technology changes

Durable and perishable workforce skills



Maintain, enhance, or replace protection and control systems?

"Based on data, microprocessor-based relays manufactured from high-quality materials, using high-quality processes, can reliably perform within specification during, and beyond, their intended service life of 20 years."

—*The Useful Life of Microprocessor-Based Relays: A Data-Driven Approach*

Challenges encountered with new system designs

- Meet requirements of Federal Information Technology Acquisition Reform Act
- Submit report for anything with microprocessor
- Manage supply chain risk
- Update training practices and facilities

Dominion Energy challenges

- Useful life of microprocessor relays is far from over
- Skilled engineers are aging out and retiring: takes three years to train in-house
- New technologists are looking for exciting careers in digital technology
- Dominion wants to showcase the new protection and control as a rewarding and cool career

Dominion grid transformation

- Year-over-year increase of DSS is 50%
- Dominion is focused on greenfield and substation replacement
- Modularity and fiber optics are key
- Grid modernization includes IEC 61850
- New digital design is springboard for Dominion innovations

Commonwealth Edison has four active designs

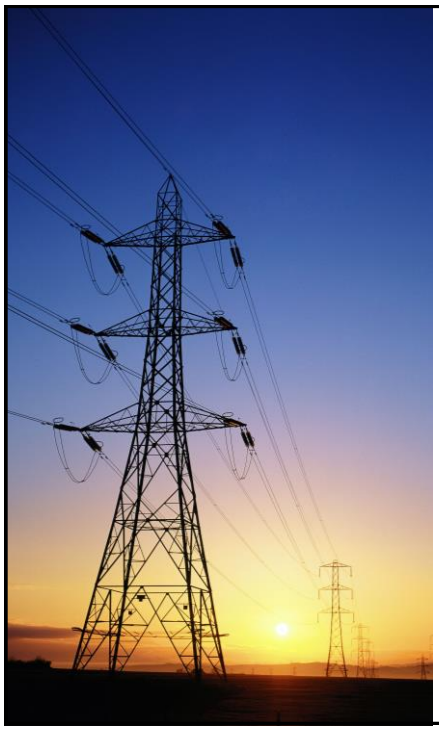
A	Hardwire, IRIG, serial SCADA and EA, MIRRORED BITS communications interlocks
B	A plus Ethernet SCADA, EA, time synchronization, and GOOSE interlocks
C	B plus MIRRORED BITS communications and GOOSE tripping
D	C plus digitized process analogs via sampled values and time-domain link

Commonwealth Edison system benefits

- After 13 tornadoes, power restored to 500,000 customers within 24 hours rather than two weeks previously
- 3-year cycle of comprehensive testing changed to 10-year cycle based on continuous supervision
- Personnel were much better informed and kept safe
- New designs anticipate 20+ year safety and service life

Conclusion

- There are many interrelated factors of useful life
- Durability and resiliency influence enhancement strategies
- Regulations, supplier issues, asset depreciation, and O&M expense planning influence replacement programs
- Planned and scheduled system upgrades can reduce cost, improve operations, raise customer satisfaction, and improve reliability



Questions?