Lessons from the Past – Resiliency Planning for the Future

A brief history of telecom hardening, and the lessons that can be applied to a data-centric world.

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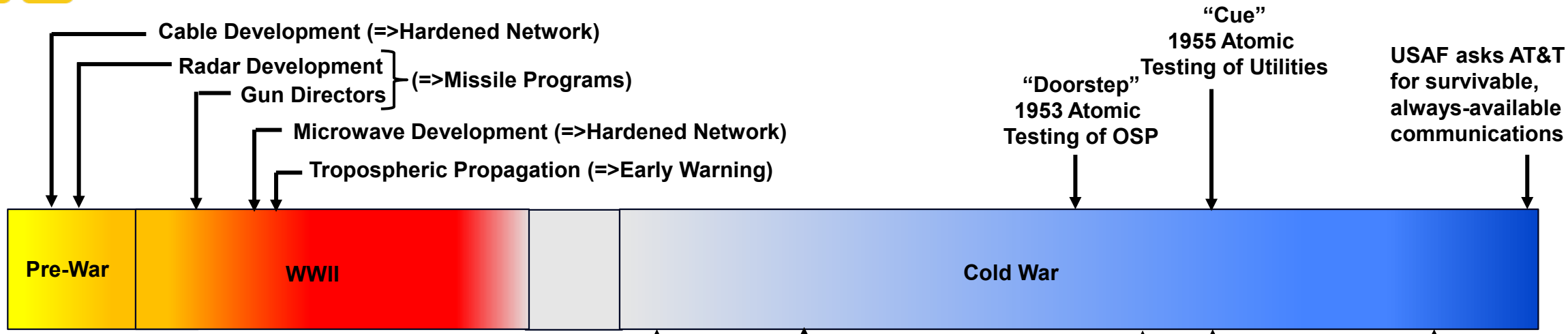
Telecom Timeline 1935-1959



The Cast:

- AT&T
- Bell Labs
- Western Electric
- Long Lines
- *… and the rest*

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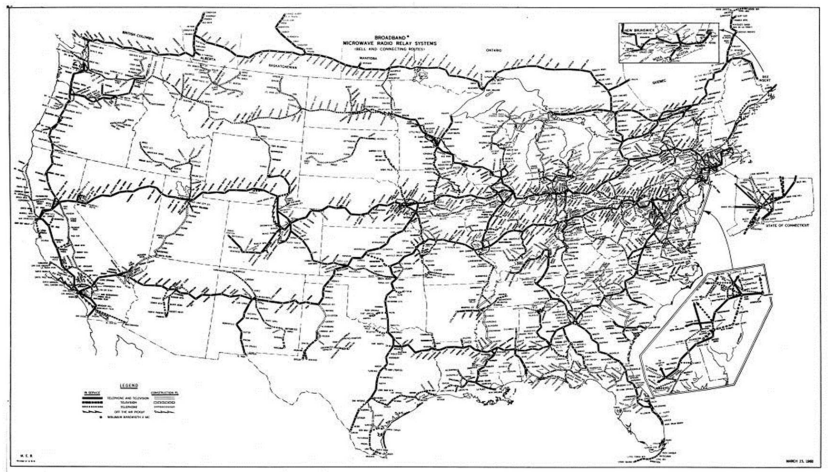
Request to Provide Survivable, Always-Available Communications



By 1960, the network looked like this.

Wait…we just finished building this thing, and now you want it hardened?

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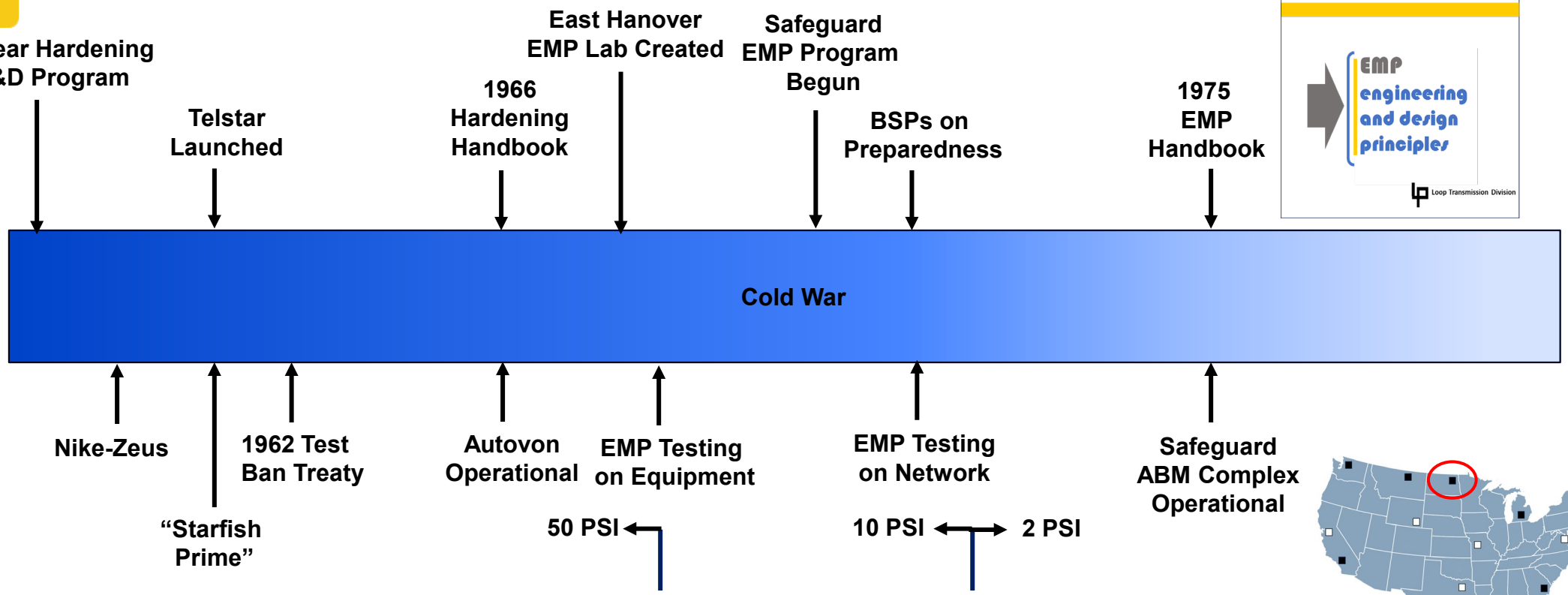
Telecom Timeline 1960-1979



1961 Annual Report: "In communications, defense of the nation comes first."

BTL's Prediction: Smaller warheads, greater accuracy, more sensitive electronics

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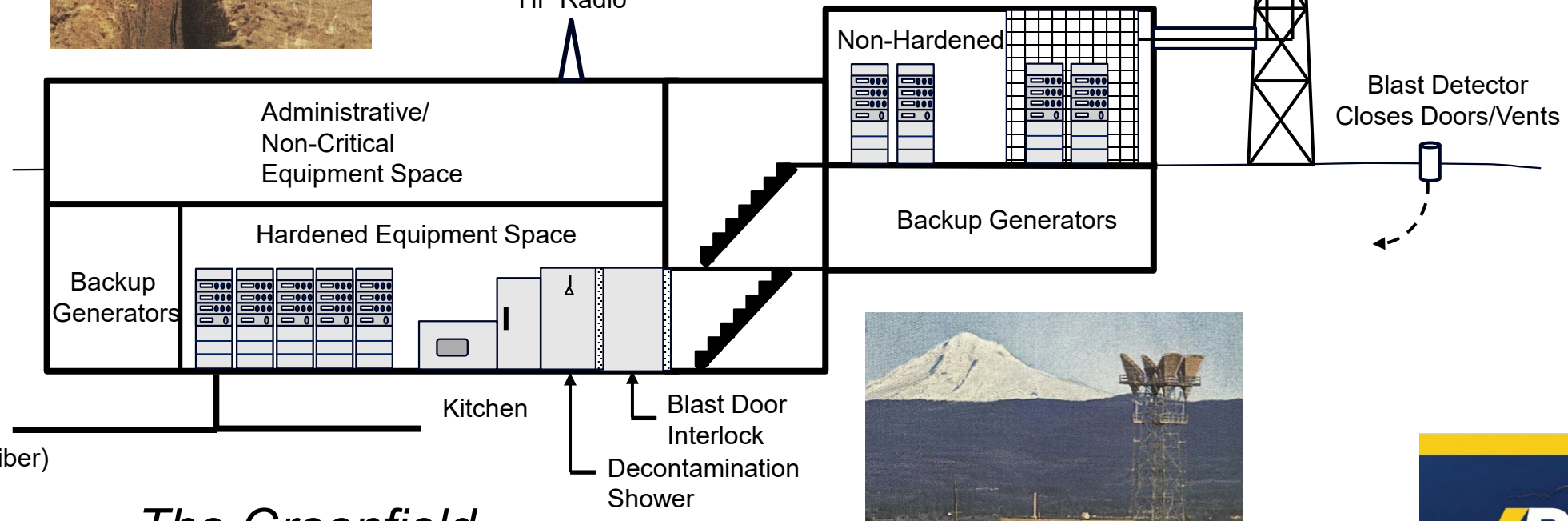
Greenfield vs. Brownfield Hardening Decisions

The Brownfield



The Greenfield

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The ***DASH*** Principle

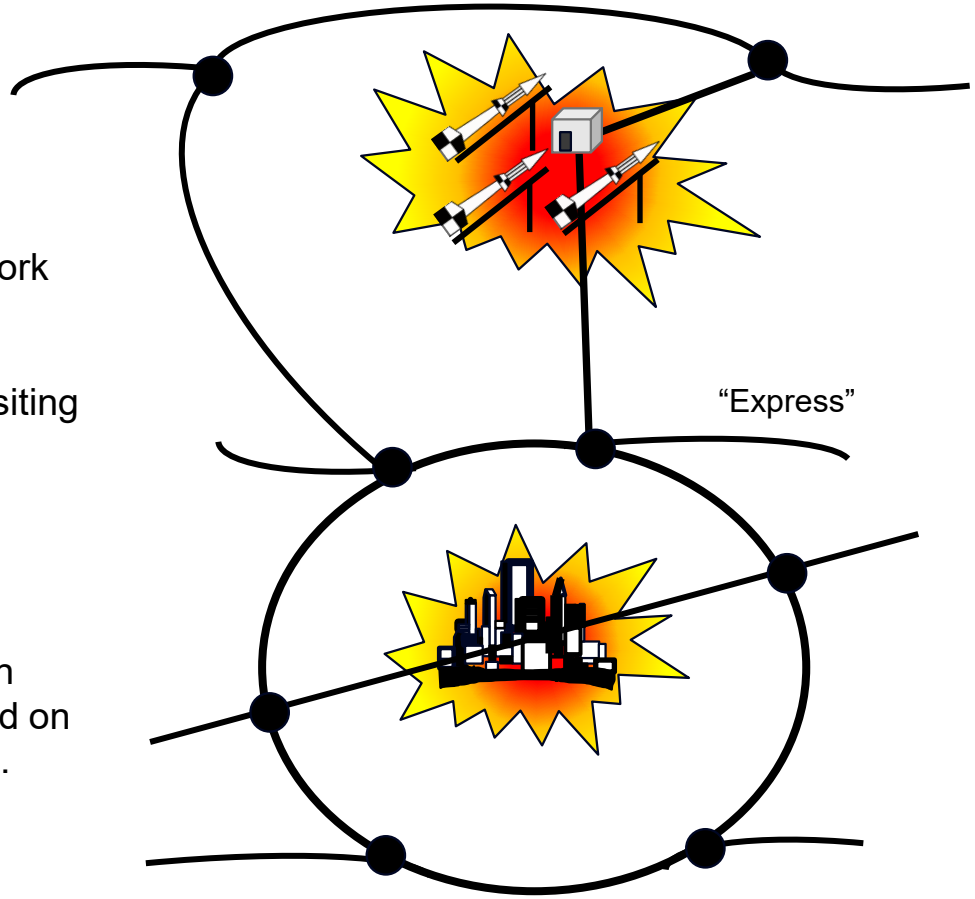
Diversity: ensures that there is more than one route or asset class supporting critical network functions, services, or infrastructure.

Avoidance: looks at terrain and proximity to potential military or industrial targets to avoid siting facilities or routes in areas at risk of attack.

Separation: requires that the geographic distance between routes or critical facilities is sufficient so that an EMP or nuclear event does not take out a pair of diverse routes.

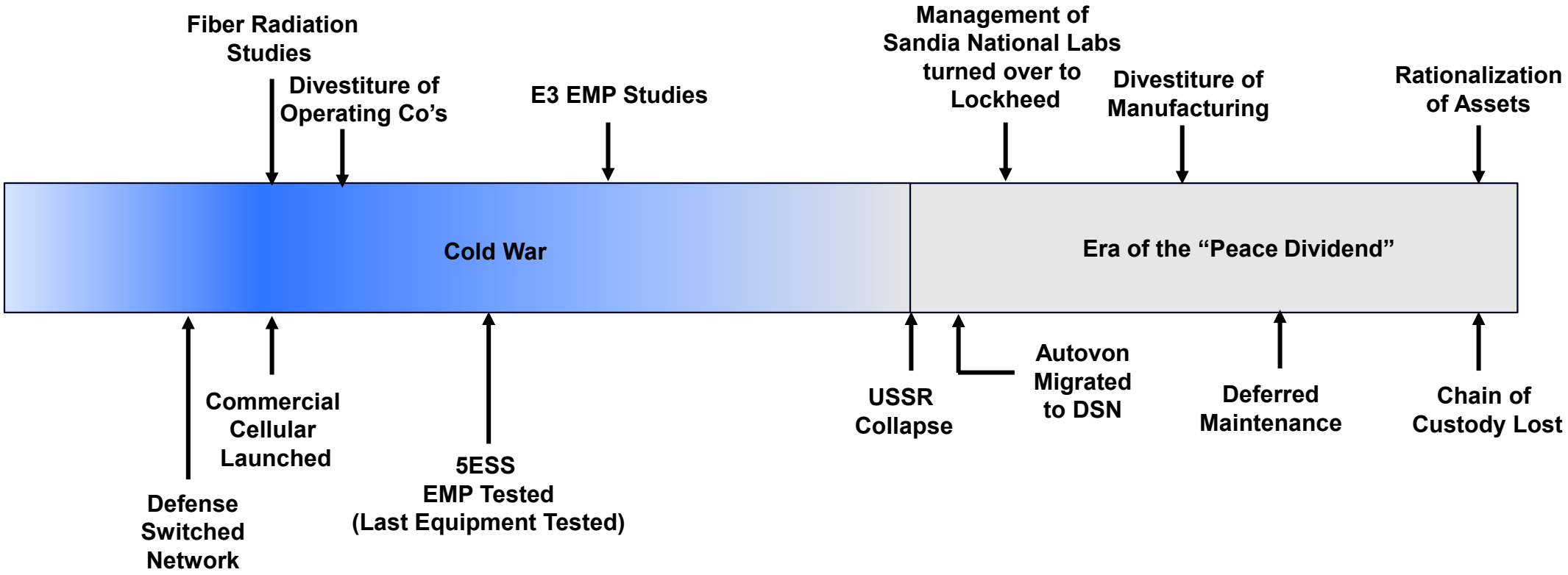
Hardening: all-encompassing, addressing blast, shock, debris, thermal, EMP, and radiation effects of a nuclear attack. Hardening criteria, or the amount of protection required, is based on proximity to high-risk areas as well as criticality to network function and supported services.

The ***DASH*** Principle can be applied to routes, facilities, and equipment within the facility.



The original ordering of terms formed the abbreviation “DSAH”, but ***DASH*** is a pronounceable acronym providing a sense of energetic quickness.

Telecom Timeline 1980-1999



Attribute	Then	Now	Implications
Mission	Provide a hardened network that will survive for 30 days after a first-strike to scramble USAF/SAC fighters, bombers, and ICBMs in retaliation.	Find the most cost-effective means to compete in communications and data services.	A new mission is needed to improve electromagnetic resiliency. A *mission* is preferred over a *mandate*.
Philosophy	Pre-Event Preparation – No damage, no disruption	Post-Event Management – Disruption acceptable as long as network can recover.	"Disaster Recovery" by itself is insufficient to restore communications after a HEMP event. Race conditions may be a problem after disruption.
Network	Traffic originated, is carried, and terminated on one network	Traffic might originate on one network, be carried by a second, and terminate on a third.	Industry-wide approach to improving electromagnetic resiliency is required. Wireless Emergency Alerts need all carriers to be operational.
Traffic	Voice, TV, data messaging. Valuable data/records stored on paper off site.	Data, voice, messaging, video, data storage.	Increased value in data requires increased protection.
Facility Staffing at Central Offices	8-10 employees on-site, full time, likely to be present during an attack and must therefore be protected from blast and fallout.	a. One person on site, full time at central office/MTSO b. Remote staff for repeaters, cell sites c. Traveling technician shared across multiple sites	It's unlikely there are sufficient resources either on staff or outsourced to restore a nationwide telecom outage caused by a HEMP event.

Attribute	Then	Now	Implications
Equipment Manufacturing	Designed, manufactured, and operated by the same company, enabling customized hardened solutions.	Equipment made overseas, with some domestic suppliers. Hardened equipment generally not available for commercial applications.	Procurement oversight required to ensure equipment and components are not manufactured by adversaries.
Equipment Size	Large footprint and standard rack size	Telecom considerably smaller, but significant densification for data center applications. Vulnerability of components may be greater.	Potential loss per rack much greater. Additional EMP protection may be warranted per rack.
Power	-48v DC	-48v DC, AC, higher voltage AC	May require special resiliency solutions.
Cooling	Air, underfloor	Air and water, delivered to the rack, rack door, chip, variable speed fans, controls	May require special resiliency solutions.
Back-Up Power	Diesel and Kerosene Generators – 30-day running time.	Diesel, solar, gas-fired, propane, battery energy storage systems	Continued operations with diversified power as long as fuel supply can be maintained and there are no embedded kill switches in the control units.

Attribute	Then	Now	Implications
Point-to-Point Radio	All-indoor with only passive components exposed to nuclear effects. Indoor components in a shielded room.	All-indoor, split-mount, tower-top.	Risk of damage for non-hardened equipment increases with outdoor exposure.
Connectivity	Microwave, Cable, Troposcatter, Satellite	Wireless (cellular), Fiber, Satellite	Cellular never intended to be hardened at the time. Though buried, few fiber routes today are hardened.
Mobile Radio => Cellular	Low BW, FM capture, few towers per city	Wireless (cellular) 100K+ cells across all carriers, wide geographical distribution	Ubiquitous hardening unnecessary due to macroscopic diversity. Geographic separation a major plus.
Timing	Centralized, terrestrial	Satellite-based GPS	Cells go out of sync within 24 hours after loss of timing signal. (ATIS is addressing this.)
Enterprise	Company-owned infrastructure at customer's location.	Enterprise customer may own premises equipment.	Achieving resiliency for Enterprise customers may be more difficult.
Threats	Nuclear, HEMP, Physical, CME	Cyber, Physical, IEMI, CME, Solar Flare, Nuclear, HEMP, UAS, AI?	Resiliency solutions protect against natural and manmade electromagnetic attacks.
DASH	Pre-Event protection policy	Pre- and Post-Event Strategy	DASH, along with a priori risk assignment, can be used to orchestrate and manage recovery in software-defined networks.

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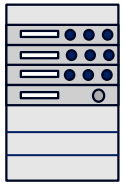
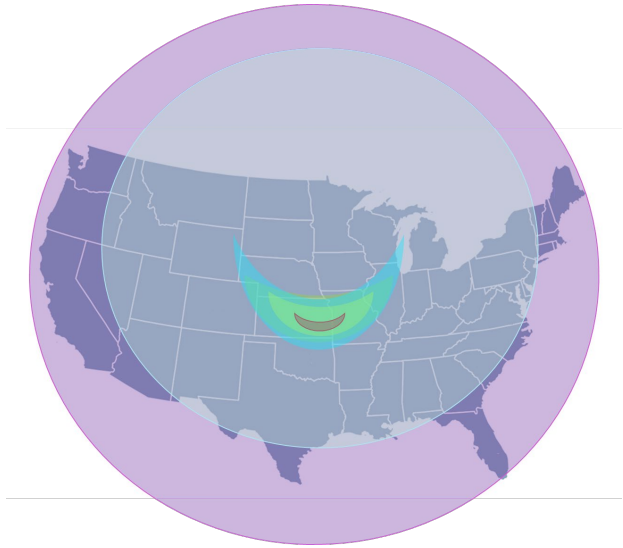
Why Recovery and Sparing Alone Won't Work – Day 1

0:00 Cyber-Attack activates kill switches, disabling

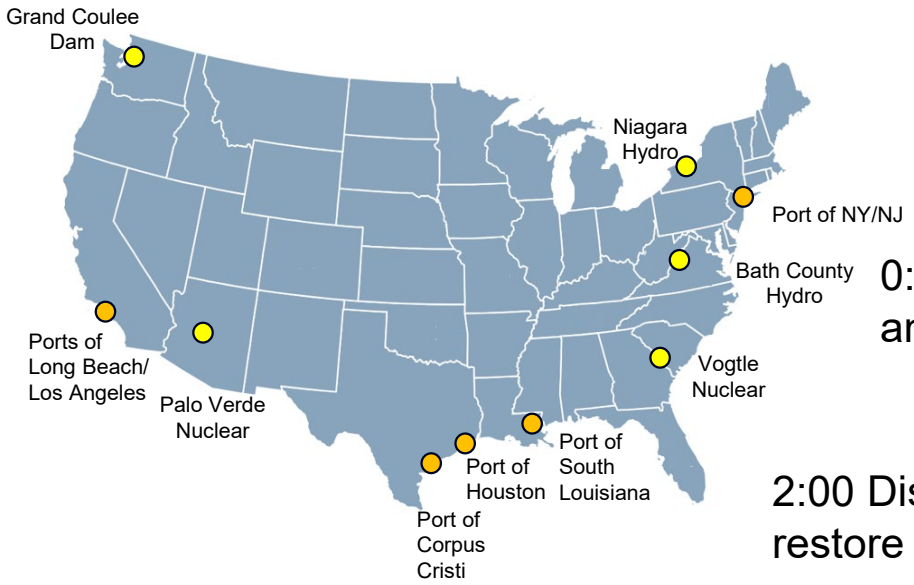


- Port cranes,
- Substation transformers,
- Solar inverters,
- SCADA elements
- Charging stations

0:15 GPS Satellites targeted and disabled, knocking out GPS timing, navigation, and communications



0:30 HEMP detonation 480 kM above the center of the country



0:35 SLBM 1 MT strikes against ports and major generation facilities.

2:00 Disaster Recovery Teams are activated to restore critical functions with warehoused spares.

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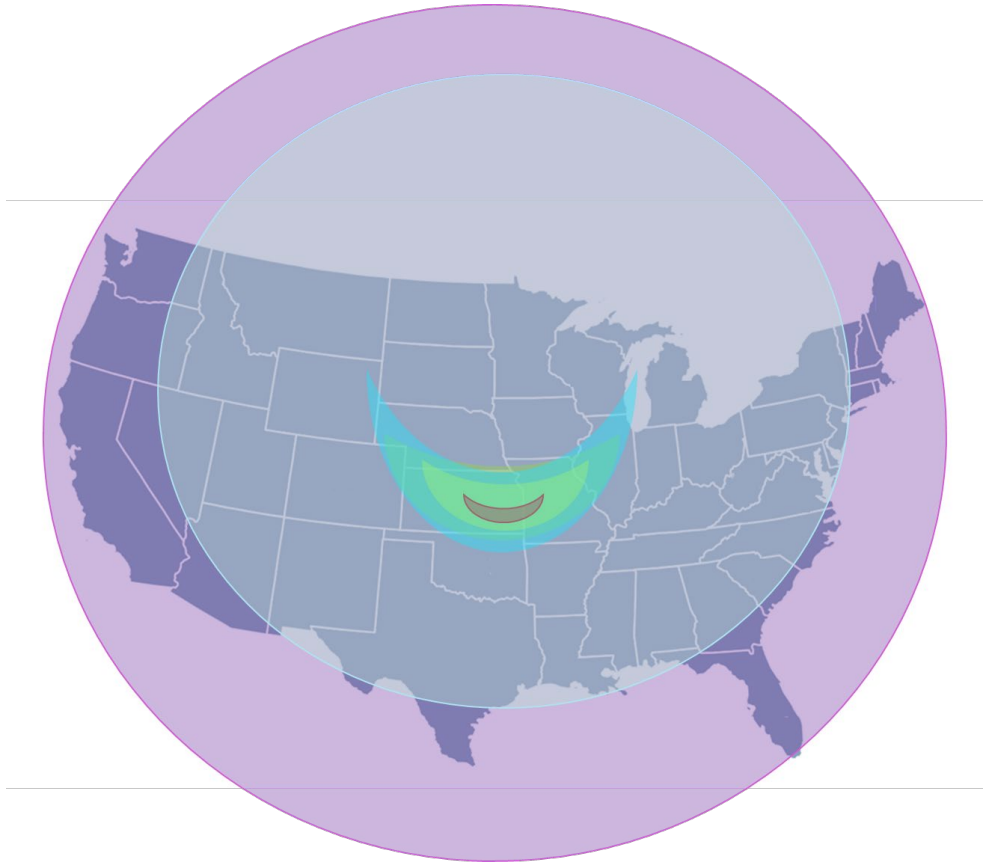
Why Recovery and Sparing Alone Won't Work – Day 10

Second HEMP detonation on Day 10
480 kM above the center of the country
destroys spares deployed in recovery.



Historically, local or regional telecom recovery has depended on resources brought in from outside the disaster area. That's why DR teams and warehoused spares are distributed across the country. In a nationwide emergency, that help is not coming quickly, if at all.

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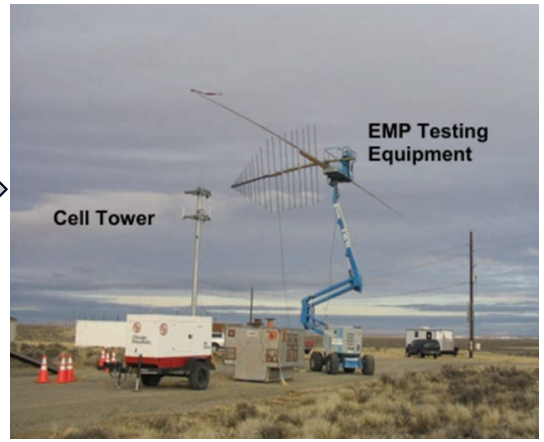
Key Take Aways

EMP – It's not business as usual – do the door locks fail open or closed?

U.S. Government – Partner with the Federal Government to define a new mission.
- – Take advantage of government research on equipment testing.
- – Take an industry-wide approach, leverage buying power to get suppliers to build electromagnetically resilient equipment.
- – Incentive: Wireless Emergency Alerts only work on networks that can recover post-event.



Other Sectors – Identify highest priority sectors to work with and understand their communication needs.
- – Utility Sector
- – Transportation Sector

DASH
- – Use diversity for protection.
- – Don't locate back-up facilities in target areas.
- – Don't locate back-up facilities in areas inaccessible to personnel (consider the impediments of bridges, tunnels and elevated highways congested with inoperable cars/trucks)
- – Don't group "like" facilities together.
  - – Take advantage of macroscopic diversity – don't harden every cell site.
- – When it's advantageous to centralize, then choose hardening.
- – Use *DASH* and a priori risk assessments to support recovery of SDNs and influence restoration priorities.

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Key Take Aways

Brownfield
– It costs less to improve shielding on previously hardened facilities than sites that have never been hardened.
– Use the new ATIS 40 dB standard, not Mil-Std 80 dB.
– Filter incoming power first, penetrations second, improve shielding third.
– If physical integrity is compromised, so is electromagnetic resiliency.
– Don't let deferred maintenance compromise shielding effectiveness.
– Don't let "RIP'd" equipment occupy protected space.
– Breaking the chain of custody undervalues hardened assets:
(e.g., don't put skylights in hardened underground facilities to save electricity costs, don't sell off the parking lot which is your disaster recovery staging area).

Greenfield
– It's cheaper to build effective resiliency during construction than to add it later.
– Newer materials and designs offer greater resilience than what was available 70 years ago.
– Locate new infrastructure to take advantage of back-up power opportunities:
- Microgrids
- On-site or near-site generation facilities
- Railroads – ROWs already host fiber routes, locomotives can serve as portable generators coupled to a string of tank cars providing fuel.
- Ports – ships can provide offboard power

Cyber Security begins with Procurement.
– Don't buy equipment or components from adversaries.
– Be aware that the "kill switch" threat may extend to other sectors beyond communications.

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Key Take Aways

BEAP – Include EMP and nuclear policies in each Building Emergency Action Plan
- – Employees at work when EMP occurs
- – Employees at home when EMP occurs
- – Elevator policy

Contingency Plans (Management Training) – Add a local (10-mile) “EMP” assignment to national strike-duty assignment.

RP List – Ensure EMP and nuclear target risks are included in establishing restoration priorities.

Black-Start Disaster Recovery Exercises – Make EMP DR exercises more realistic:
- – Tell the DR team to leave their cell and satellite phones at home – they can only use HF radio.
- – Tell the DR team they cannot use their vehicle navigation system to drive to the exercise.
- – Day 1 – Randomly choose 25% of the DR team and tell them not to show up,
  choose another 25% to show up 5 hours late
- – Days 2 and 3 – Of the remaining team members, randomly choose 10% to go home each day.

HF Radio (SHARES) – Ensure HF radios and stations are hardened as they are the network of last resort.
- – Equip an HF radio at critical facilities, offices, and fleet vehicles.

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What's Happening with Revising the ATIS EMP Standard?

ATIS-0600320 ABOVE-BASELINE ELECTRICAL PROTECTION
FOR DESIGNATED INFORMATION AND COMMUNICATIONS TECHNOLOGY (ICT) FACILITIES
AGAINST ELECTROMAGNETIC PULSE (EMP)

- **Dec. 2024** – 21 pages focused on requirements to improve electromagnetic protection at a Telco facility.

- **Dec. 2025** – 33 pages added focusing on the EMP environment, the distinction between Mil-Std and Telco approaches, resiliency thresholds, facility assessment, shielding effectiveness, and measurements. (We're striking a balance between the theoretical and the procedural found in other standards documents.)

- **TBD** – Completion of the facility assessment section. Additional editorial clean-up, and deciding whether a new section on *EMP Defense Preparation and Recovery Planning* should be developed before the next release.

References

AT&T Annual Reports, 1945-1975.

Fagan M.D., *A History of Engineering and Science in the Bell System – National Service in War and Peace (1925-1975),* Bell Telephone Laboratories, Inc.,1978.

Furman, N.S., *Sandia National Laboratories, The Postwar Decade*, University of New Mexico Press, Albuquerque, 1990.