Electro-Magnetic Pulse (EMP) Discussion

29 Nov 2017

Outline

- What is EMP
- High-Altitude EMP (HEMP) Threat Concerns
- HEMP Overview
  - HEMP effects on military system
  - HEMP effects on civilian infrastructure
  - HEMP protection
- Summary

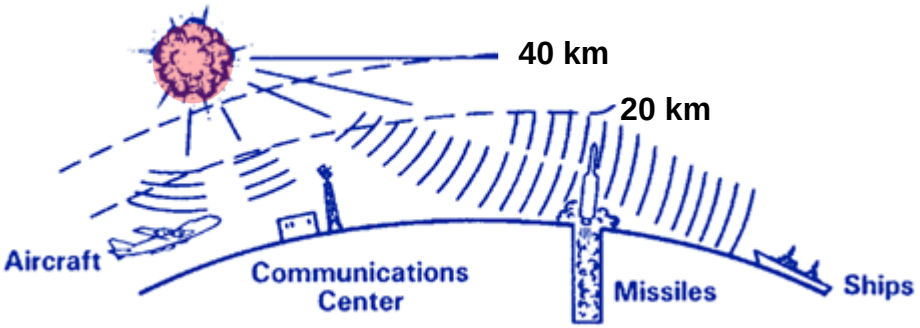
The Electromagnetic Pulse

- A nuclear EMP can be viewed as a series of intense electromagnetic fields that result from the detonation of a nuclear weapon.

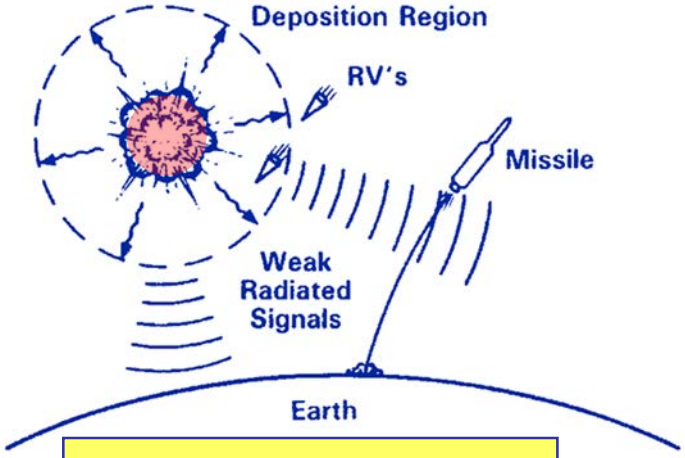
- The occurrence and the characteristics of these pulses depend primarily on the weapon design, yield, height of burst, and burst location.

- HEMP covers a broad frequency range from below 1 Hz up to 1 GHz and covers large areas in line of sight (up to millions of square kilometers).

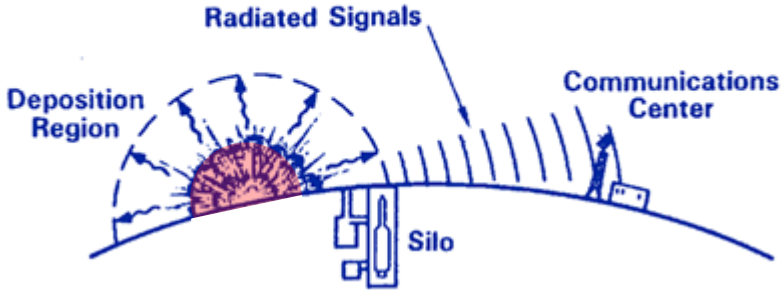
Different Types of EMP



High-Altitude EMP (HEMP) (Alt > 40km)



Air Burst EMP (Alt<40km)



Source Region EMP (SREMP) (Surface/near surface)

High Altitude Nuclear Bursts

- Wide coverage from a single weapon
  - Ground
  - Sea
  - Air
  - Space
- Wide range of effects
  - Atmospheric effects
  - Prompt and delayed radiation damage
  - HEMP

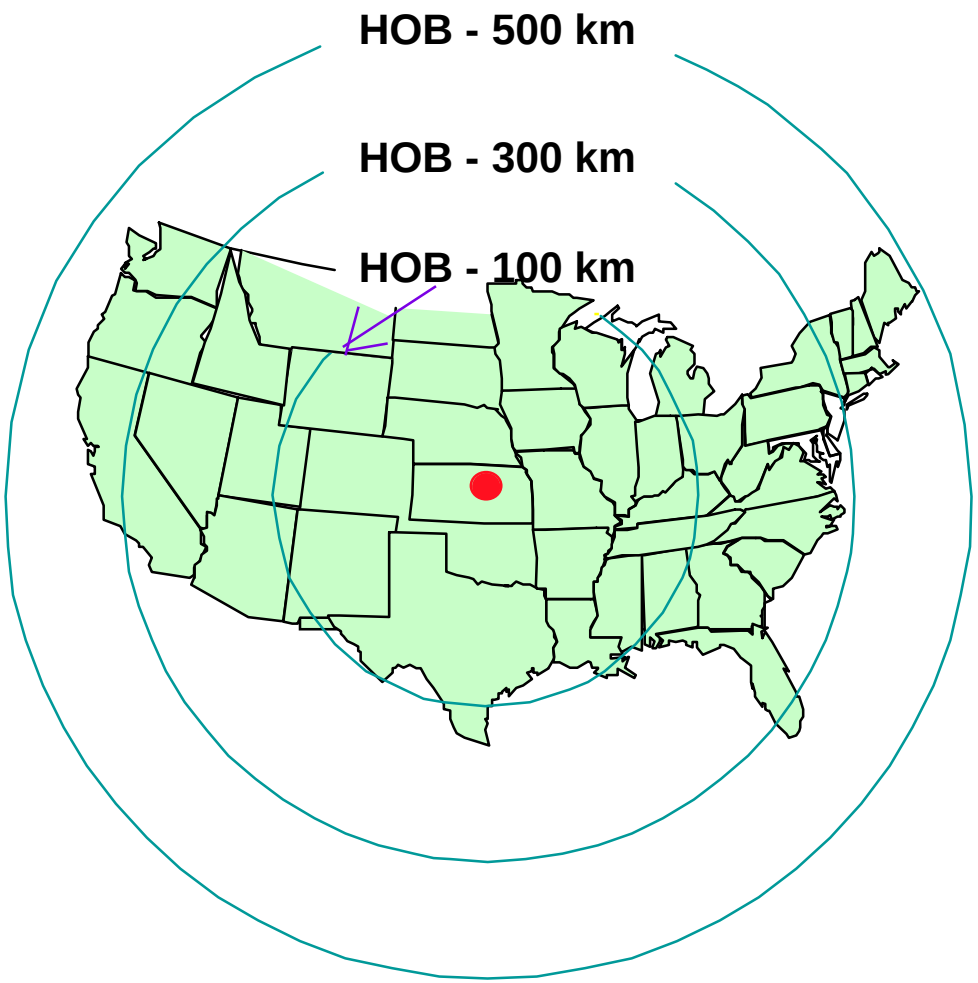
IMPACT: **Disruption or failure of critical military systems (land, air, sea, space) and infrastructure**

HEMP Threat Concerns

- HEMP poses a real threat to systems on the ground and in the atmosphere.
- For the DoD, our main concern is the *catastrophic failure of a mission*.
- Threats have diversified since the end of Cold War
  - Hostile attack against US or US forces by an adversary
  - Theater threats or collateral effects on US or allied forces due to conflicts between third parties
  - Terrorist use of improvised nuclear device (IND) or small stolen device

HEMP Effects Depend on Many Factors

Notional ranges of HEMP Environment (*NOT* cutoffs)



- Impact depends on:
  - Height of Burst (HOB)
  - Weapon design
  - Location of burst
- Affects a broad frequency range
  - i.e., potential threat to all electronics in area covered

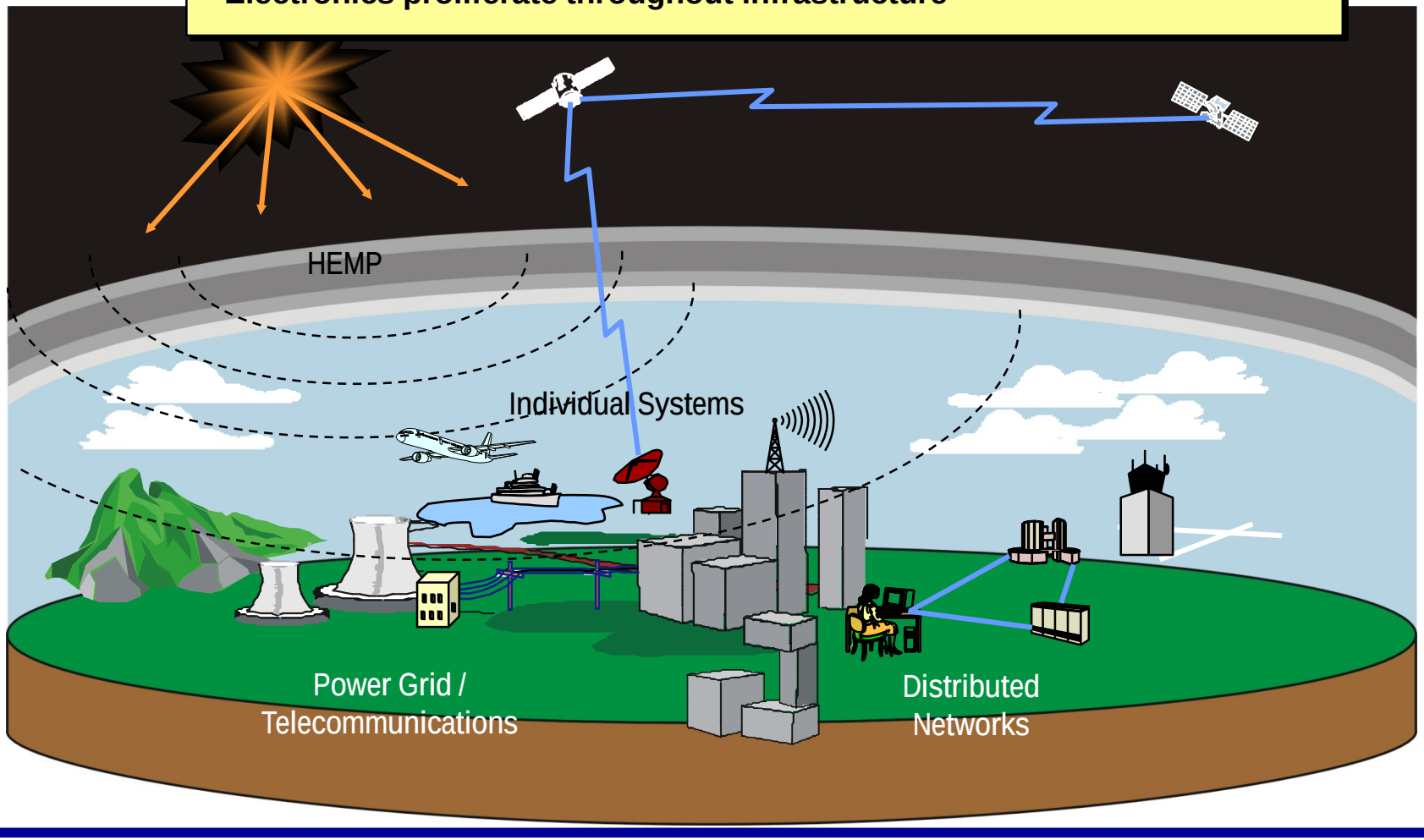
Note: strength of the field drops as HOB increases (i.e., as rings get larger)

DTRA standards and handbooks define hardness levels and mitigation approaches for DoD

- HEMP Environments
  - MIL-STD-2169C (S) (HEMP Threat Environment for E1, E2, and E3)
- Strategic Ground Based Systems
  - MIL-STD-188-125-1 (Fixed Ground Based C4I Facilities)
  - MIL-HDBK-423 (Fixed Ground Based C4I Facilities)
  - MIL-STD-188-125-2 (Transportable Ground Based C4I Facilities)
- Strategic and Tactical Systems
  - MIL-STD-3023, HEMP Protection for Aircraft
  - MIL-STD-4023, Ship HEMP Standard

HEMP effects on the Infrastructure

- **HEMP affects a wide area and infrastructure nodes nearly simultaneously**
- **Electronics proliferate throughout infrastructure**



Broad range of systems are susceptible to electromagnetic pulse (EMP)

- Two general mitigation approaches
  - Stress reduction – shielding and filters that reduce EMP strength at susceptible components
  - Immunity enhancement – electronic designs that strengthen component resiliency
- EMP hardness should be designed to be maintained and surveilled
  - Corrosion and other environmental effects can degrade hardness
  - Uncontrolled modifications during normal maintenance can undo protective measures
- Susceptible systems should be designed to make testing feasible
  - Partition system within transient protection devices at interfaces

Hardening of Assets to EMP

Surface assets can also be hardened against the effects of EMP from a high-altitude burst

Shielding

- Faraday Cage
- Point of Entry (POE) Control
- EM Gaskets
- Connector Shells

Interface Design

- Terminal Protection Devices
- Filters
- Current Limiting
- Transformer Isolation

Summary

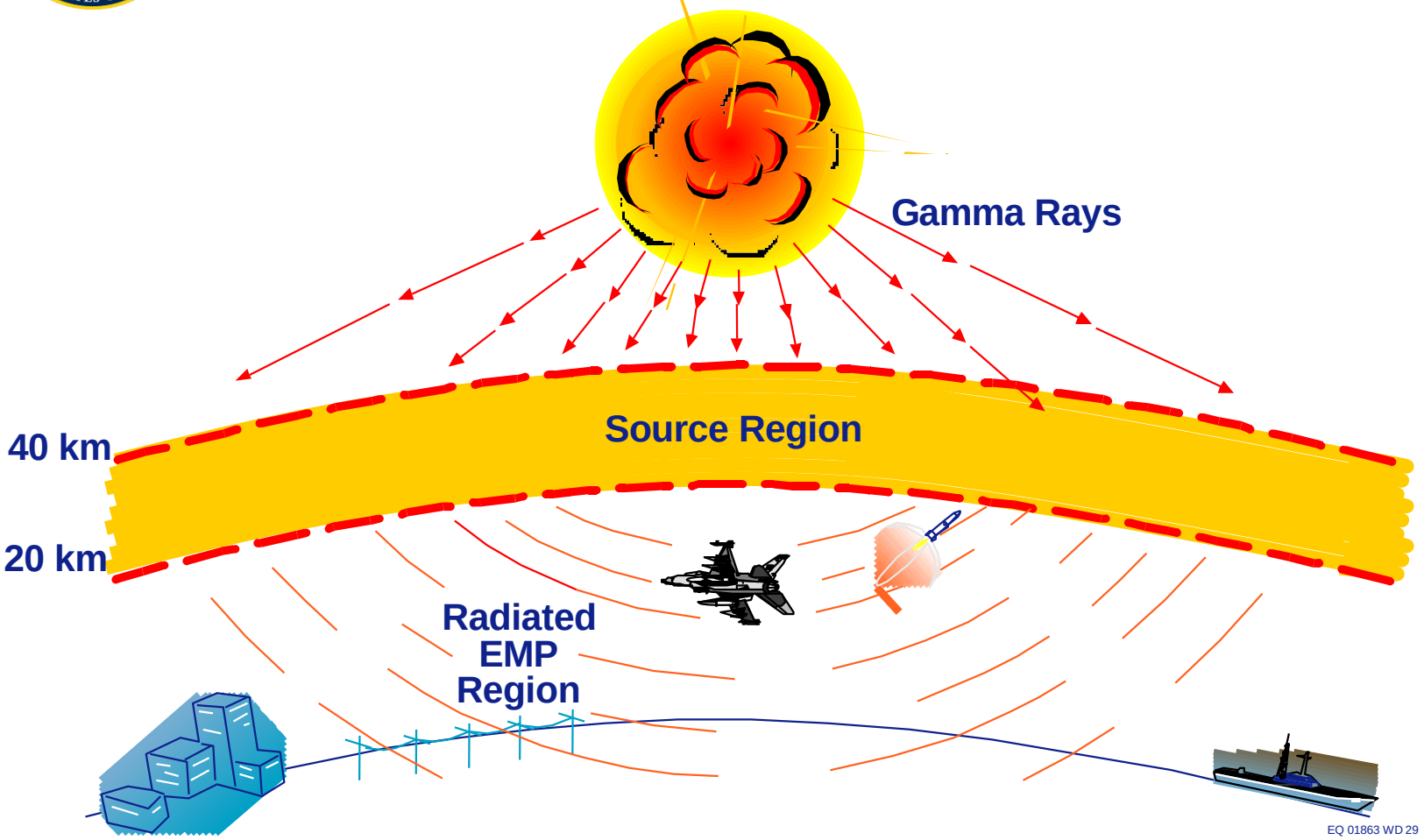
- HEMP is real and serious threat
  - One of many nuclear High Altitude Burst effects
- HEMP provides wide area coverage over wide frequency range and damages or upset electronics
- HEMP protection & testing are mature engineering sciences
- Recent congressional interest
  - Sen Corker (Foreign Affairs) mentioned interest in HEMP (Jan 17)
  - HASC professional staff member interest on EMP protection of micro power grid and the currency of DTRA HEMP standards

BACKUP

The EMP Family

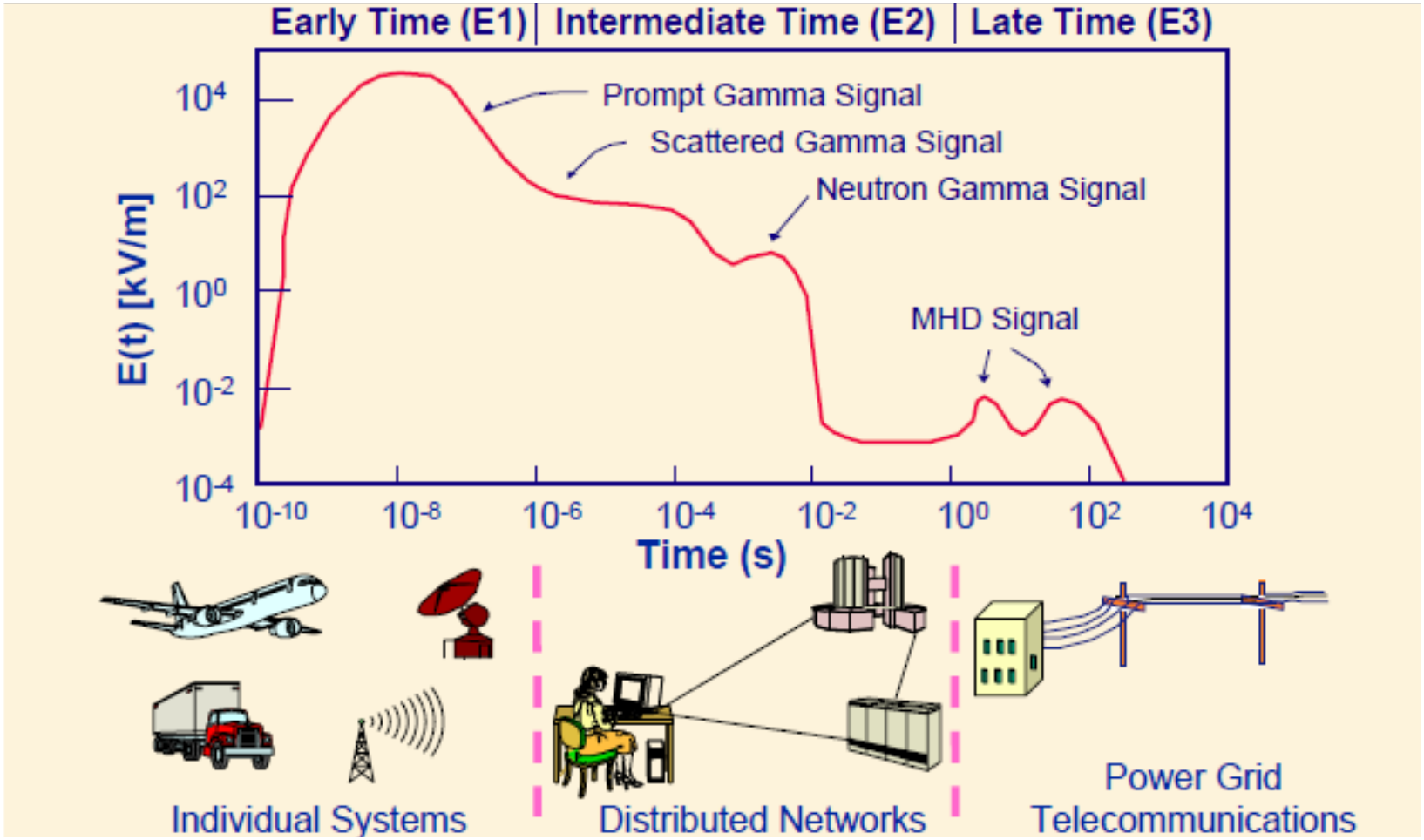
- HEMP : High Altitude EMP
- SREMP : Source Region EMP
- SGEMP : System Generated EMP
- ECEMP : Electron Caused EMP
- DEMP : Dispersed EMP

HEMP Production



Can expose all systems within line of sight

HEMP Pulse has three components



U.S. has Long History of HEMP Testing

- Atmospheric tests and system tests in EMP simulators have demonstrated that unhardened systems can be affected by HEMP
- Russia also has an extensive EMP testing program with the same experience
- Modeling and Simulation becoming increasingly important

STARFISH Prime Caused HEMP

- Starfish Event – 1962
- Yield – 1.4 MT, 400 km above Johnston Island
- Effects produced on varied systems over a wide area of the Pacific
  - Transmitter
  - Military Radio
  - Street Lights
  - Undersea Cables
- Consistent with Russian experience with damage and disruption effects on power and telecommunications networks
- Electronics technologies have changed significantly over the past 40 years

Starfish Fireball Seen In Honolulu (U)
800 miles away

- (U) Many lights are still on
- (U) Some were ‘knocked out’