

Environment/EMC/ EMI

18-849b Dependable Embedded Systems

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Required Reading: “Noise and Interference ... a different game” by Daryl Gerke and Bill Kimmel

Best Tutorial: EDN’s Designer’s Guide to Electromagnetic Compatibility
EDN Magazine, January 20, 1994

Authoritative Books: Any EMC handbook

**Carnegie
Mellon**

Overview: Environment/EMC/EMI

◆ Introduction

- Why is electromagnetic interference (EMI) a problem?

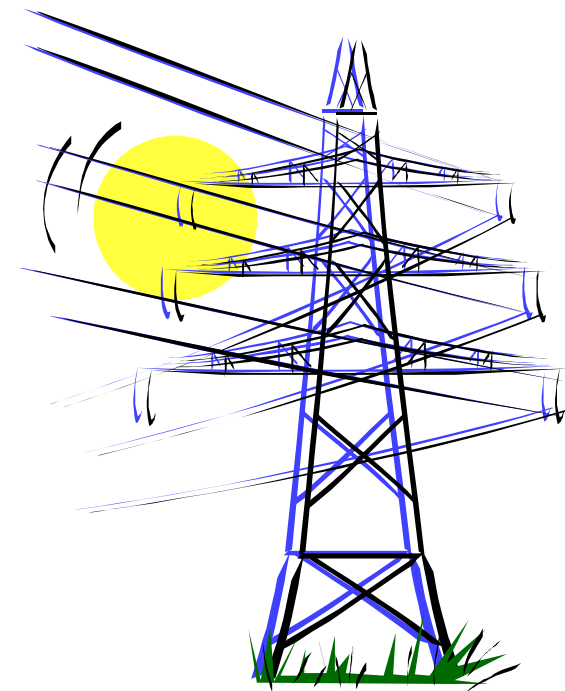
◆ Key concepts

- Sources and Receptors of EMI
- EMC Design Considerations
- Environmental Reliability Testing
- EMI Regulations

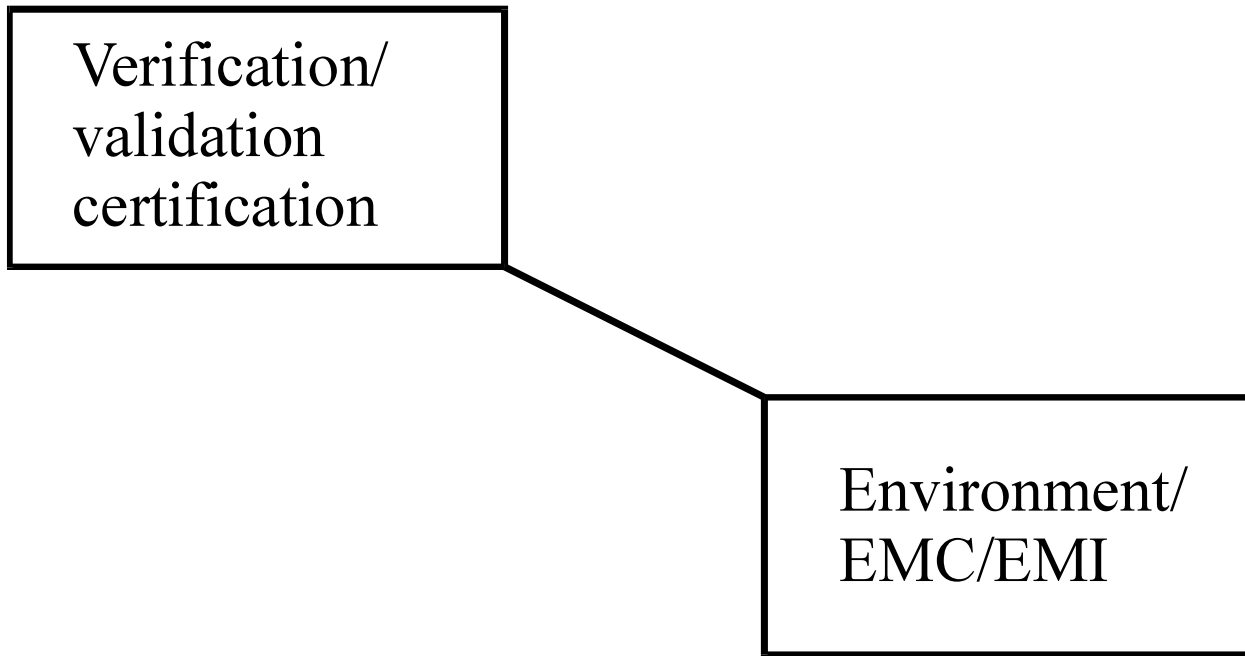
◆ Tools / techniques / metrics

◆ Relationship to other topics

◆ Conclusions & future work



YOU ARE HERE MAP

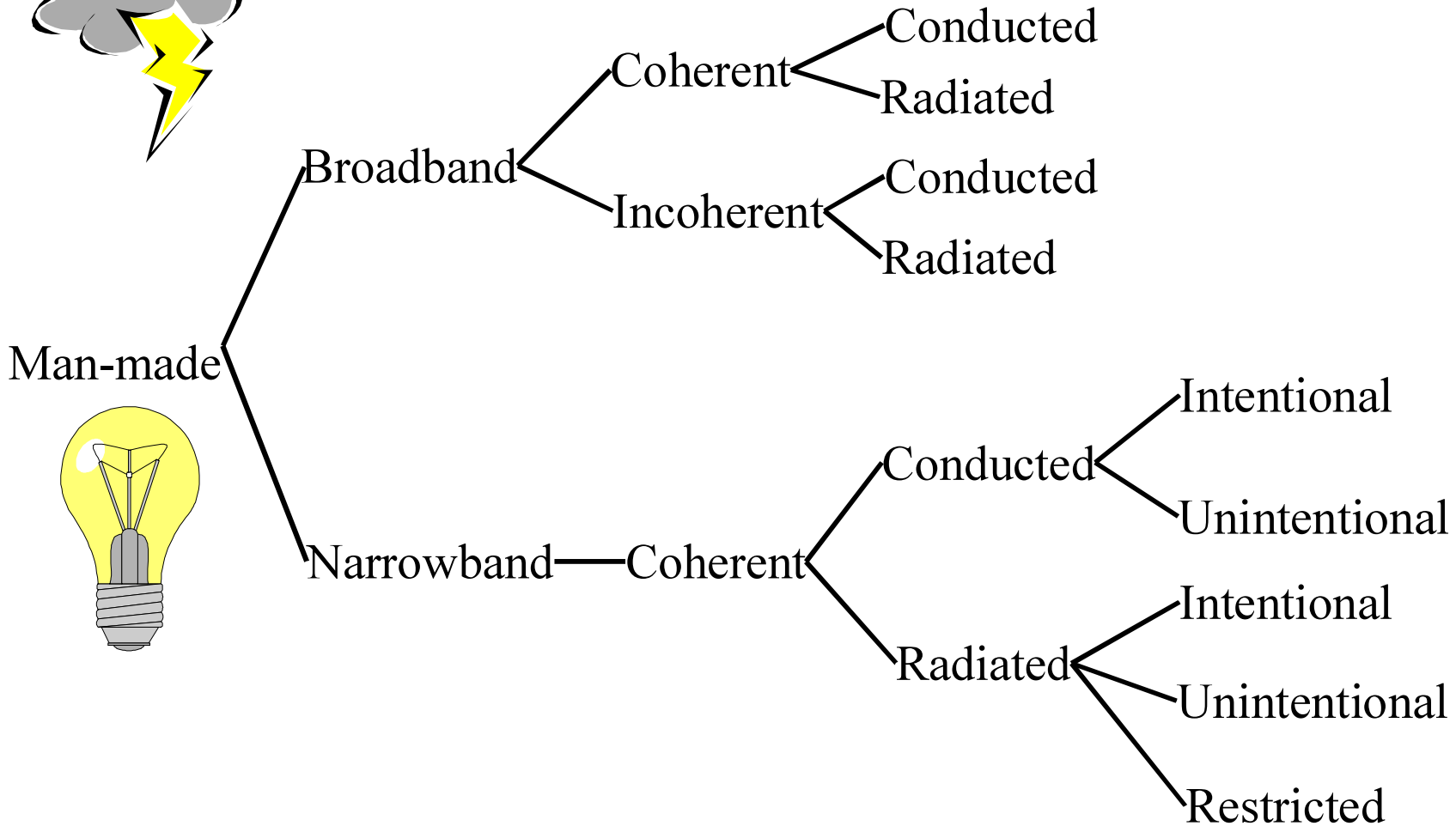


Description of Topic

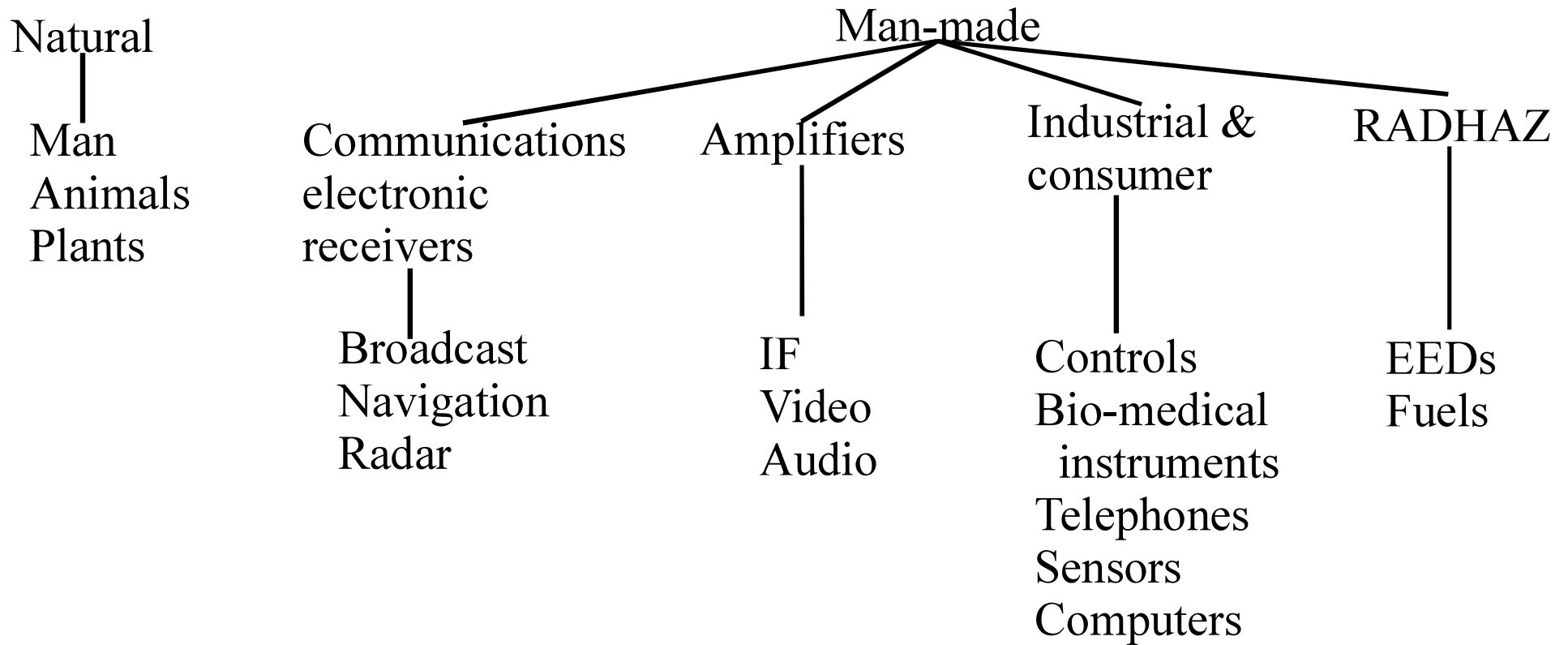
- ◆ EMI consists of unwanted, spurious, conducted, or radiated signals of electrical origin that can cause unacceptable degradation of system or equipment performance.
- ◆ Electromagnetic compatibility (EMC) is the ability of systems to function as designed, without malfunction or unacceptable degradation of performance due to EMI within their operational environment.
- ◆ Intersystem EMI vs. intrasystem EMI
 - **intersystem EMI** - EMI between 2 discrete systems
 - **intrasystem EMI** - EMI between elements with the same system

Sources of EMI

Natural — Broadband — Incoherent — Radiated — Unintentional



Receptors of EMI



EMC Design Considerations

- ◆ Cable wiring and harnessing
- ◆ Connectors
- ◆ Grounding
- ◆ Shielding
- ◆ Radio frequency interference (RFI)
- ◆ Electrostatic discharge (ESD)
- ◆ EMI control in components and circuits

Environmental Reliability Testing

◆ Development Tests

- Product characterization
- Accelerated life tests
- Materials and methodology evaluations
- Test, analyze, and improve testing

◆ Verification Tests

- Fatigue/durability tests
- STRIFE testing

◆ Production Tests

- Environmental stress screening (ESS)

EMI Regulations

◆ Federal Communications Commission (FCC)

- Computing devices conform to FCC Rules and Regulations Part 15J. Two classes are defined.
- **Class A:** “A computing device that is marketed for use in a commercial, industrial, or business environment; exclusive of a device which is marketed for use by the general public, or which is intended to be used in the home.”
- **Class B:** “A computing device that is marketed for use in a residential environment notwithstanding use in commercial, business, and environmental environments.”
- A device that passes Class B limits may be used in a Class A environment.

◆ The International Special Committee on Radio Frequency Interference (CISPR)

- Sponsored by the IEC.
- Responsible for setting uniform limits on electromagnetic emissions from equipment so that trade would not be inhibited between member countries as a result of different emissions specifications.

Tools / Techniques

- ◆ EMI-level testing
 - **Low-level testing** - Component, equipment, and subsystem testing.
 - **Intermediate-level testing** - System and vehicle testing.
 - **High-level testing** - Electromagnetic environment (EME) interaction with the test item.
- ◆ 3 categories of EMI testing
 - **Compliance testing** - To verify that a product meets appropriate EMI requirements
 - **Engineering testing** - To uncover potential problems early in the design process
 - **Audit testing** - To verify that the design is intact throughout its product life.

Relationship To Other Topic Areas

◆ **Verification/validation/certification**

- EMC testing and environmental reliability testing are part of the verification/validation process. Certification based on these testing results.

◆ **Electrical/Electronic reliability**

- EMI affects the reliability of electrical/electronic components.

Conclusions & Future Work

- ◆ **EMI is a major problem in the development of embedded systems due to the extremely noisy environment they exist in.**
- ◆ **EMC must be taken into consideration during the design stage.**
- ◆ **Environmental reliability testing is used to eliminate potential problems the system can experience when it is operating in its natural environment**
- ◆ **Future work**
 - Harmonization of EMC standards in different countries and different sectors.
 - Issue of compatibility among transmitters that are designed to work together.

Noise and Interference ... a different game

- ◆ **This paper gives an introduction to EMC.**
- ◆ **Major Points**
 - There are three elements to any EMI problem - source, path, receptor
 - The five threats facing EMC designers today are ...
 - Regulations
 - Radio Frequency Interference
 - Electrostatic discharge
 - Power disturbances
 - Self-jamming