Outdoor Installation 2:

Lightning Protection and Grounding

Training materials for wireless trainers

Goals

- To understand the importance of lightning protection and proper earth grounding
- To see some practical examples of how to properly install and ground radio equipment
- To appreciate the risks (to personnel and equipment) of improper grounding

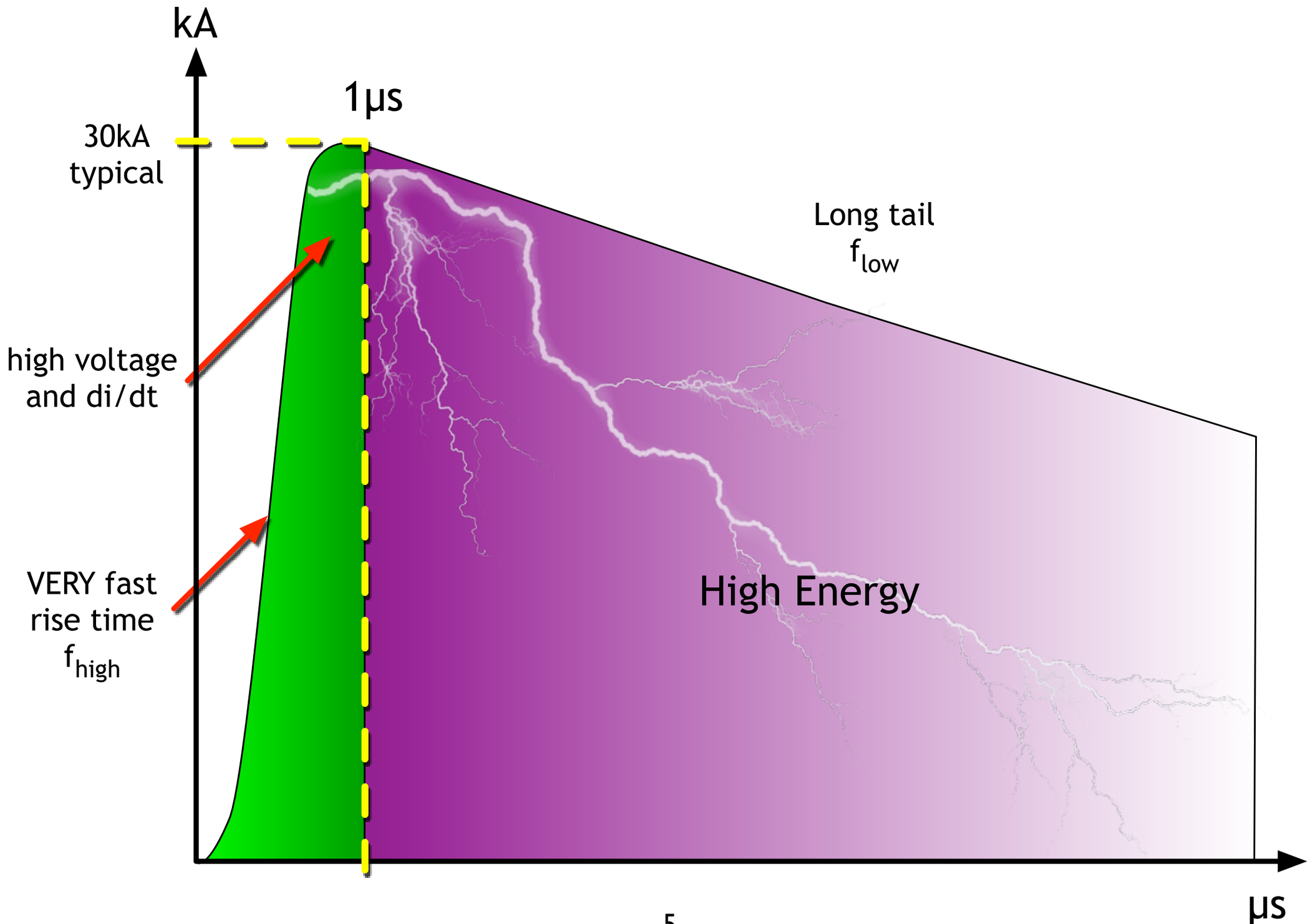
Photo by flickr user phatman

Electrostatic damage

- Caused when current passes from one object to another.
- Usually high voltage, but low current.
- A typical 1 cm electrostatic arc from a finger to a doorknob is around 19,000 volts!
- Although damage is not usually visible with electrostatic discharge, it is the leading cause of electronic equipment failure.
- Humidity and temperature can help control electrostatic energy, but physical protection must also be deployed to prevent damage.

Photo by flickr user Brujo+

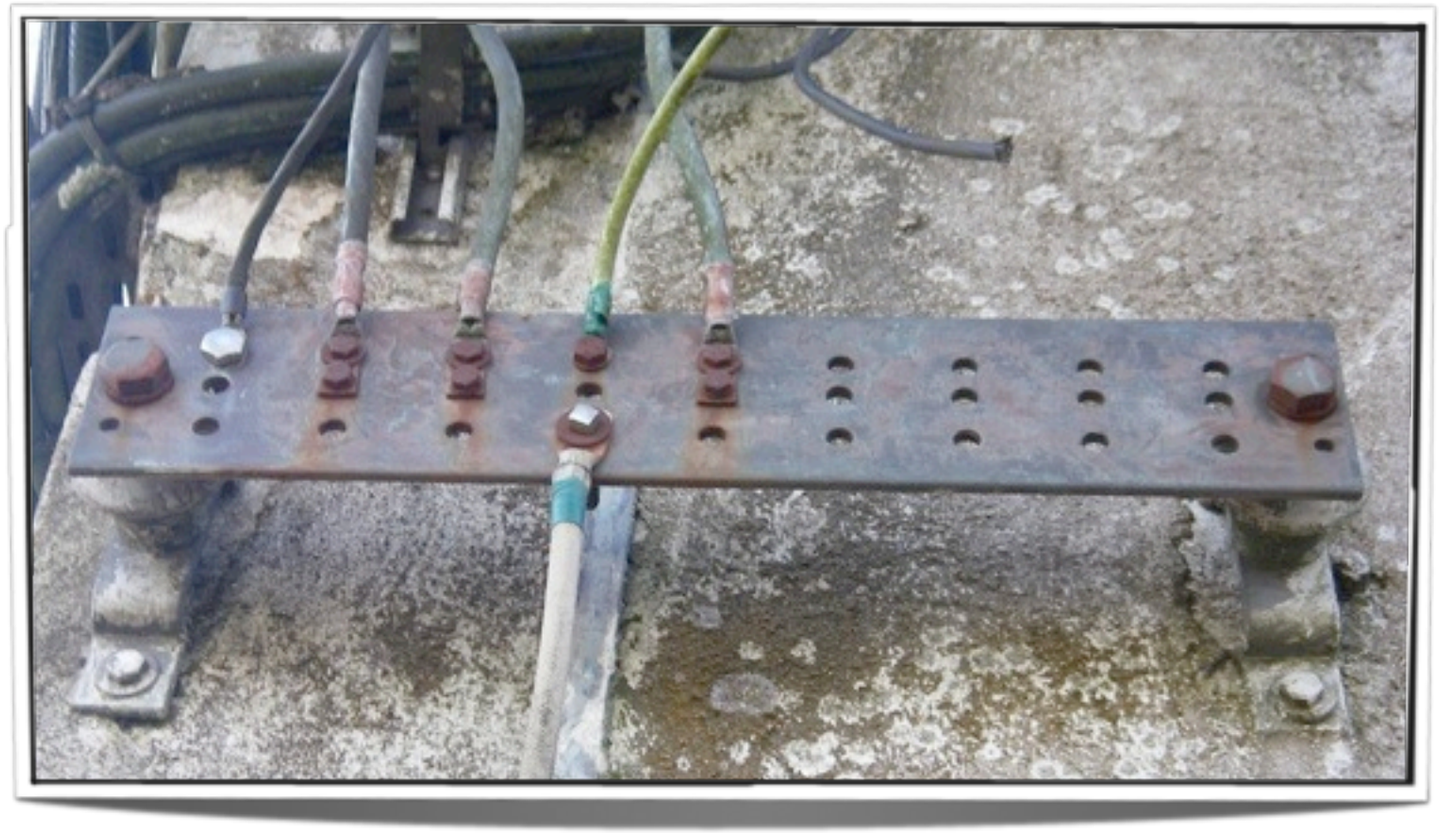
Lightning impulse characteristics



Grounding & Bonding

Why use proper grounding?

- Protect equipment from high voltages caused by lightning and power faults
- Protect personnel from dangerous conditions
- Dissipate electrostatic charges
- Provide a zero volt reference
- Reduce noise and interference



Definition of ground

Ground: A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth, or to some conducting body that serves in place of the earth.

--John Cadick, Electrical Safety Handbook

Definition of bonding

Bonding: The permanent joining of metallic parts to form an electrically conductive path that will ensure electrical continuity and the capacity to conduct safely any current likely to be imposed.

--John Cadick, Electrical Safety Handbook

Grounding system components

The two areas of grounding that pertain to telecommunications equipment are:

- Equipment grounding system (safety ground)
- Grounding electrode system (earthing system)

Electrical power faults

Types of electrical system faults:

- Phase-to-phase faults
- Phase-to-neutral faults
- Phase-to-ground: more than 90% of electrical system faults are phase-to-ground faults
- A phase-to-phase or phase-to-neutral fault will almost always trip the overcurrent device (circuit breaker or fuse)
- But a phase-to-ground fault will ***not*** trip the overcurrent device if the impedance of the equipment grounding system is too high.

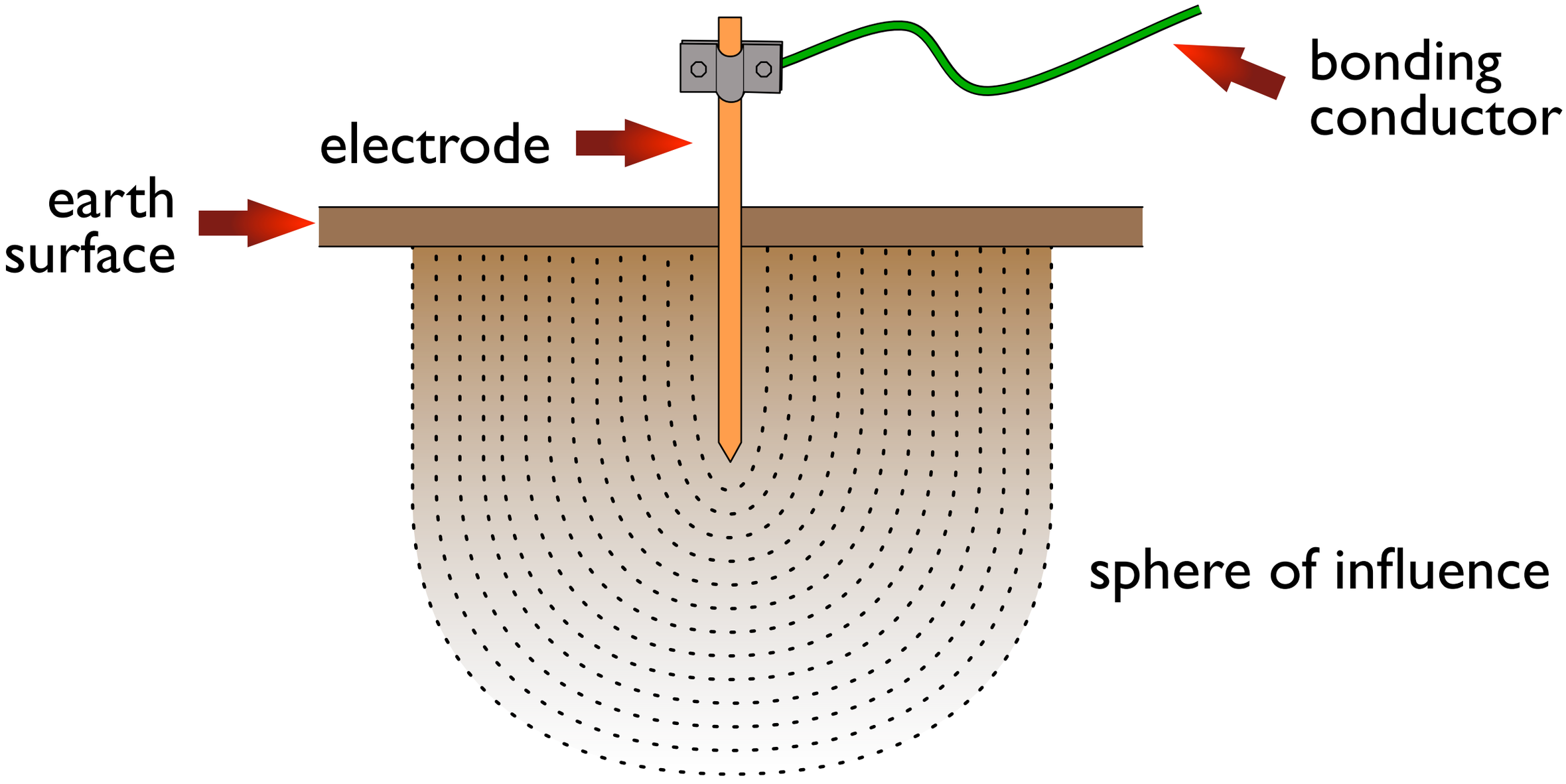
What should be grounded?

If it is made of metal, it should be grounded.

- Electrical boxes
- Electrical conduits
- Equipment cases and doors
- Antennas
- Lightning arrestors
- Towers
- Guy wires

Grounding system components

The grounding electrode system consists of:



Electrodes

Electrodes specifically designed and installed for grounding:

- Buried ground rods
- Buried ground rings
- Buried metal plates
- Chemical ground rods
- Concrete encased electrodes

Grounding electrode system

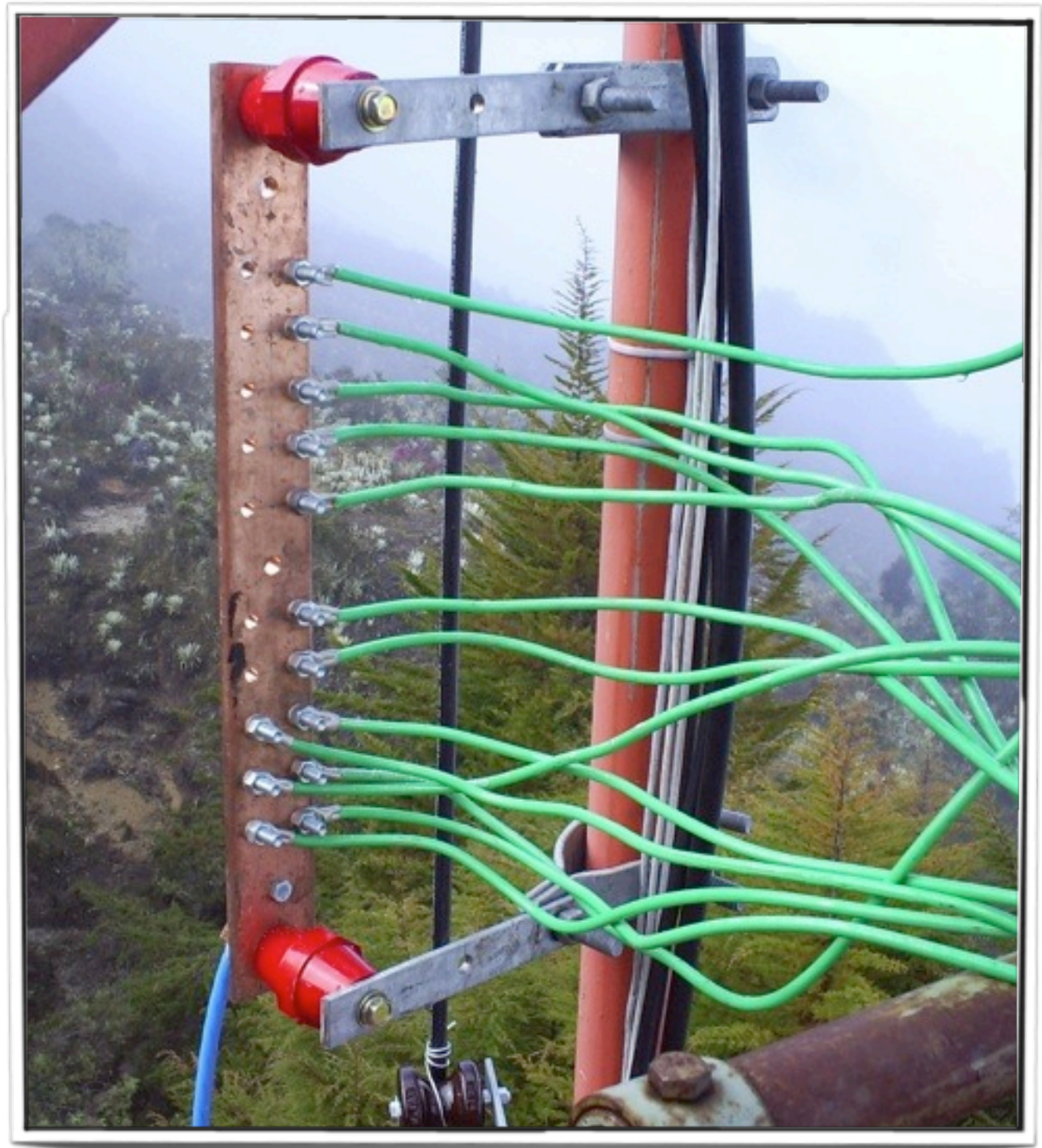
Grounding electrode:

- Metallic conductor (e.g., rod), pipe, plate, ring (or other metallic object) in contact with the earth used to establish a low resistance current path to earth.

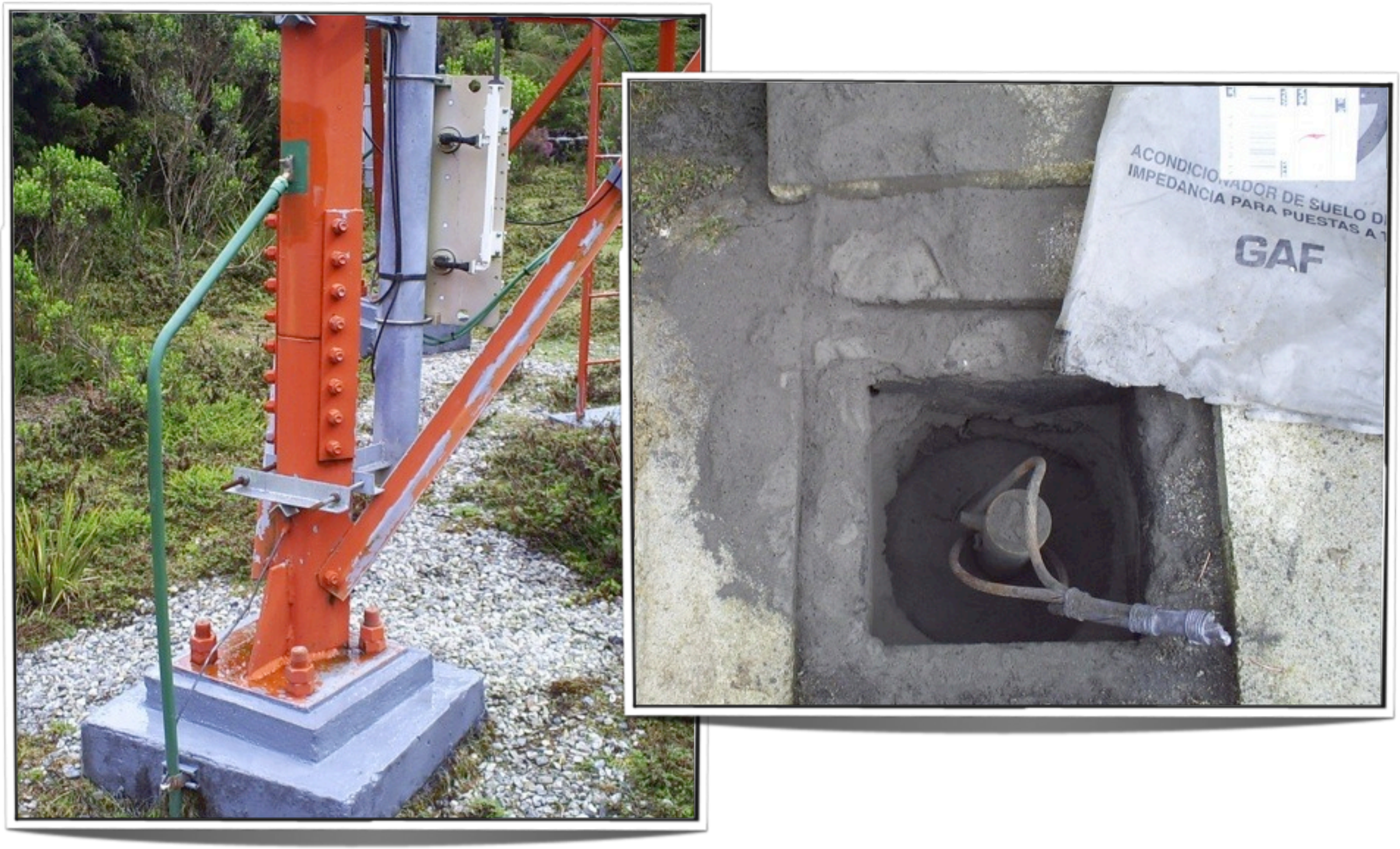
Grounding Electrode System:

- Network of electrically connected ground electrodes used to achieve an improved low resistance to earth.

Tower grounding



Tower grounding



Installing a grounding ring

A grounding ring consists of non-insulated conductors buried in the shape of a ring.

- Buried a minimum depth of 80 cm
- Minimum size is 2 AWG (7.91 mm) and 6 m in length

Installing a grounding ring

Using cold water pipes

- Historically the first choice for ground
- Provides low resistance to earth
- Must be electrically continuous: no plastic pipes or couplers. Any discontinuities should be bonded across.
- Should be used to lower the system resistance to ground.
- Must **not** be used as the only ground source, but only in conjunction with a primary electrode.

Electrolytic potential

When two different metals are in moist contact their electrolytic potential should be as close as possible to minimize ***electrolytic corrosion***.

Dissimilar metals produce an electrical potential difference, which will corrode the metal material.

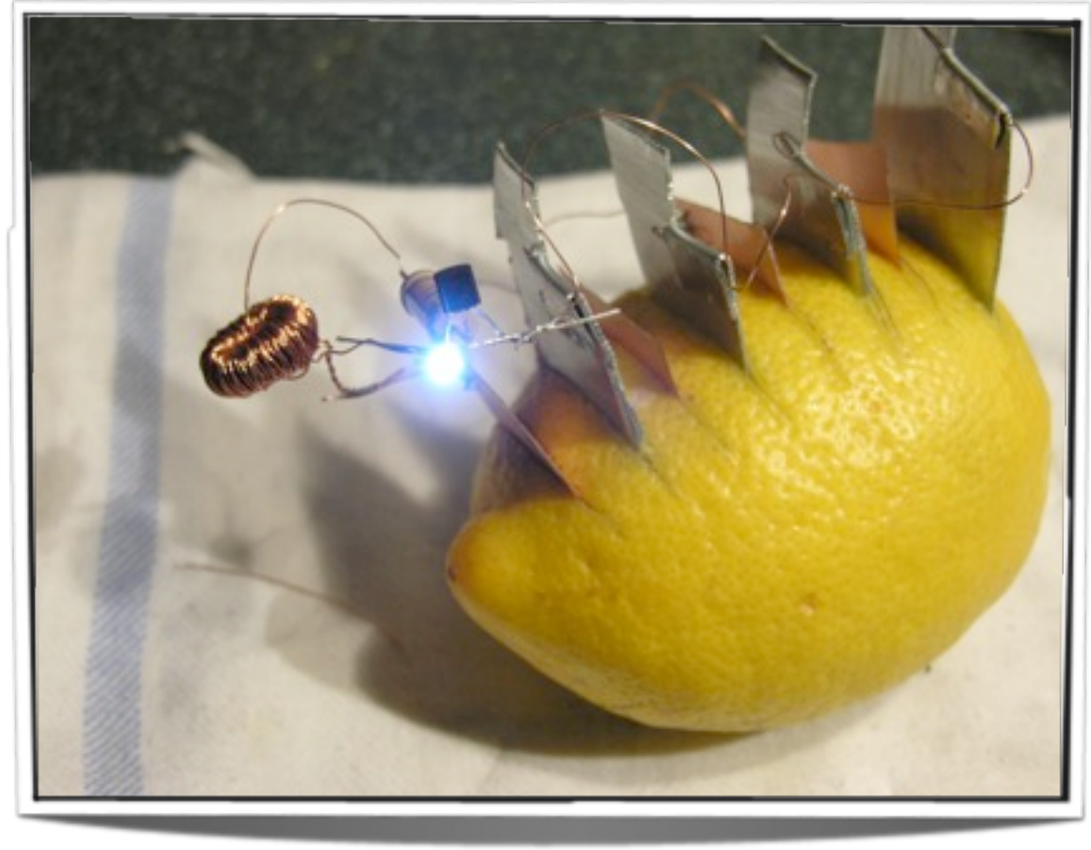


Photo by Flickr user s8

Metal corrosion

Copper should never touch galvanized material directly without proper joint protection. Water shedding from the copper contains ions that will wash away the galvanized (zinc) tower covering.

Earth resistance

Generally speaking, "earth resistance" is the resistance of soil to the passage of electrical current.

The earth is a relatively poor conductor of electricity compared to normal conductors like copper wire. But if the path for current is large enough, the resistance can be quite low and earth can be a good conductor.

Soil doping

The earth is a conductor because of the number of ionic salts present in the soil. Conductivity can be improved by adding more ions to the soil.

Soil doping can be done by either adding water or a saline solution to the soil around the grounding system. If the soil already has a sufficient amount of naturally occurring salts, adding water will free the ions and improve conductivity.

If few natural ions are available, Epsom salts can be added to the soil to increase the conductivity.

Depending on the amount of rainfall, doping the ground system radials with 10 kg of salt per per rod may last approximately two years.

Coils and pigtails

Coils and pigtails introduce an inductance to the ground path. Inductance resists changes in current.

If there is too much inductance in your ground line, then a surge might find it easier to go through the equipment rather than the now restrictive ground path.

Avoid sharp bends in ground conductors. Corona effect at the bends will cause the wire to heat and melt.

Lightning arrestors

- Coaxial lightning arrestors will shunt high voltages on an antenna line to ground.
- UTP lightning arrestors will protect Ethernet lines from power surges.
- Properly grounded surge protectors (power strips) can help protect AC equipment.

Lightning rods

A ***lightning rod*** is a conductor installed at the top of a tower or tall building, intended to attract lightning away from sensitive equipment and divert the strike directly to ground.

Photo of Eiffel Tower lightning rod
by Flickr user elbragon

Conclusions

- Proper grounding is critical to avoid damage from electrostatic charges and lightning.
- Improper wiring can damage equipment and endanger lives.
- Ground protection is an active system that requires engineering and maintenance.
- To maximize grounding system life, avoid direct contact between dissimilar metals.

Thank you for your attention

For more details about the topics presented in this lecture, please see the book ***Wireless Networking in the Developing World***, available as free download in many languages at:

http://wndw.net/