International Telecommunication Union

ITU-T Study Group 05

Principles of Protection

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Introduction

The lack of adequate protection may cause extensive damage and malfunction in telecommunication equipment, and may even jeopardize human life.

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Sources of Surges

The threats on equipment and human beings are caused by overvoltages and overcurrents imposed on power and telecommunication lines, which are generally referred as surges.

The three most important sources of surges are:

- Lightning discharges;
- Induction from power lines;
- Direct contact with power lines.

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Lightning

Lightning discharges may impose surges on metallic lines by three distinct mechanisms:

- Direct strikes;
- Coupling due to earth potential rise;
- Electromagnetic induction.

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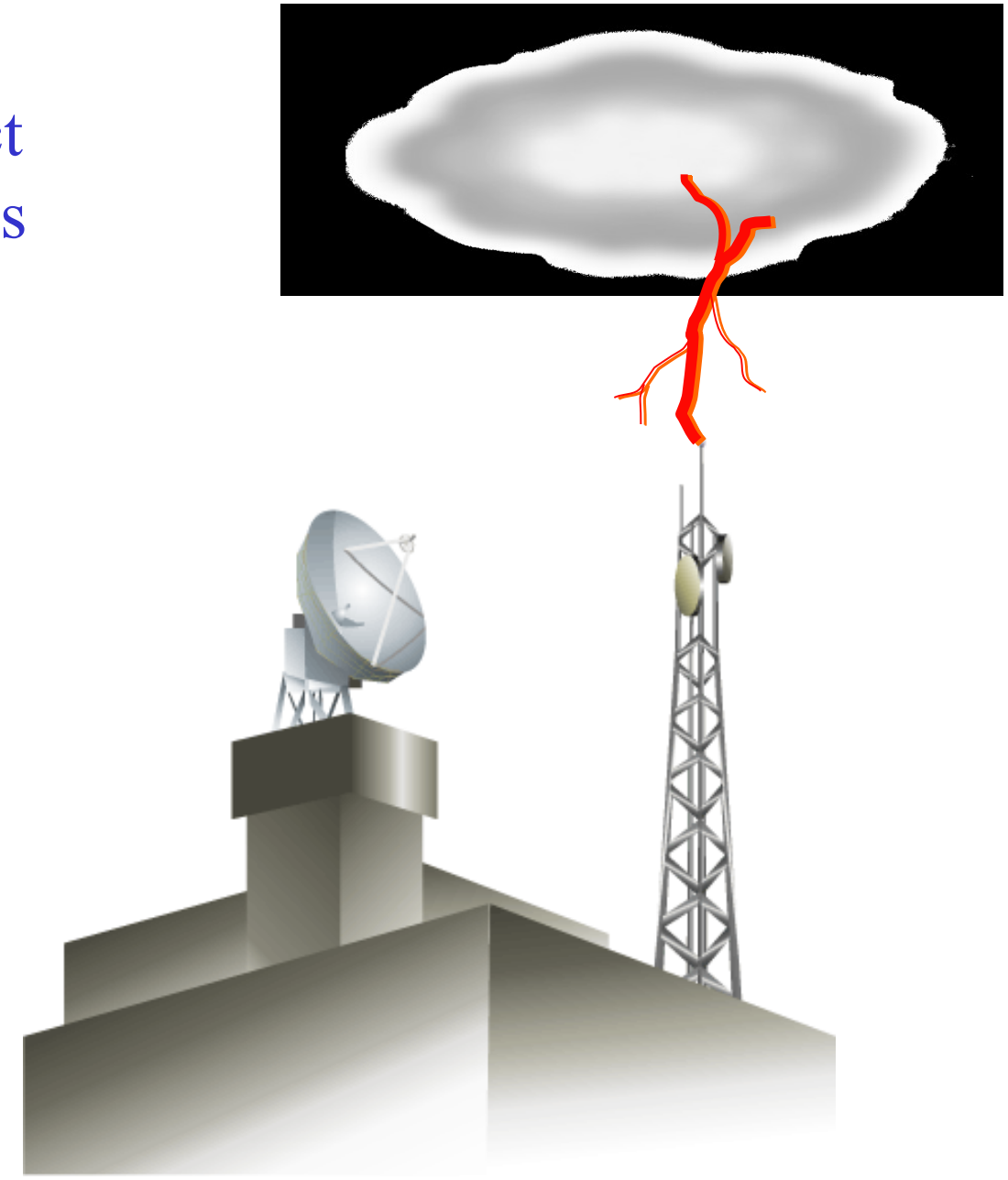
Direct strikes



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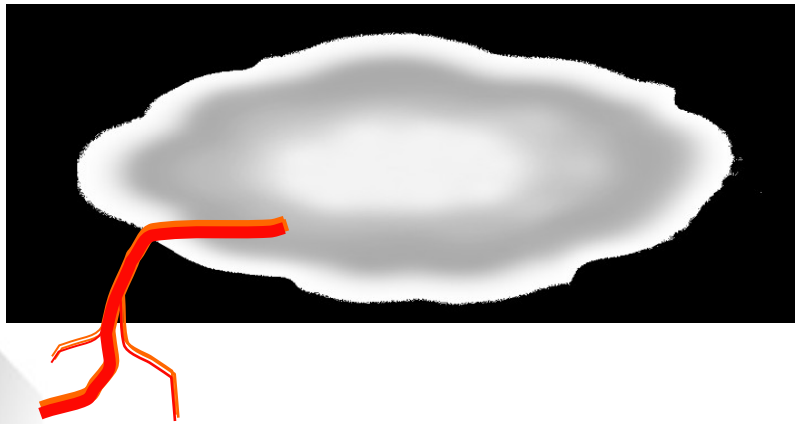

Coupling through the earth

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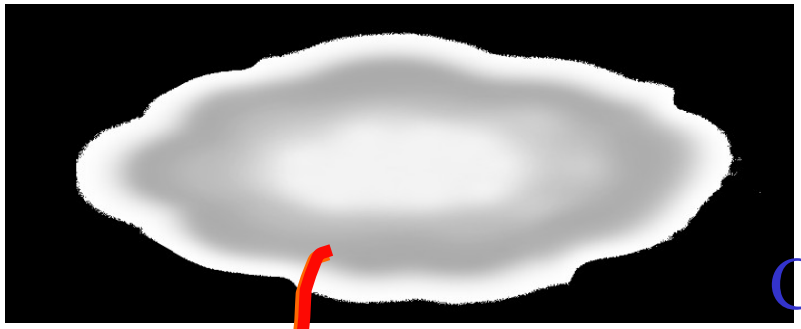
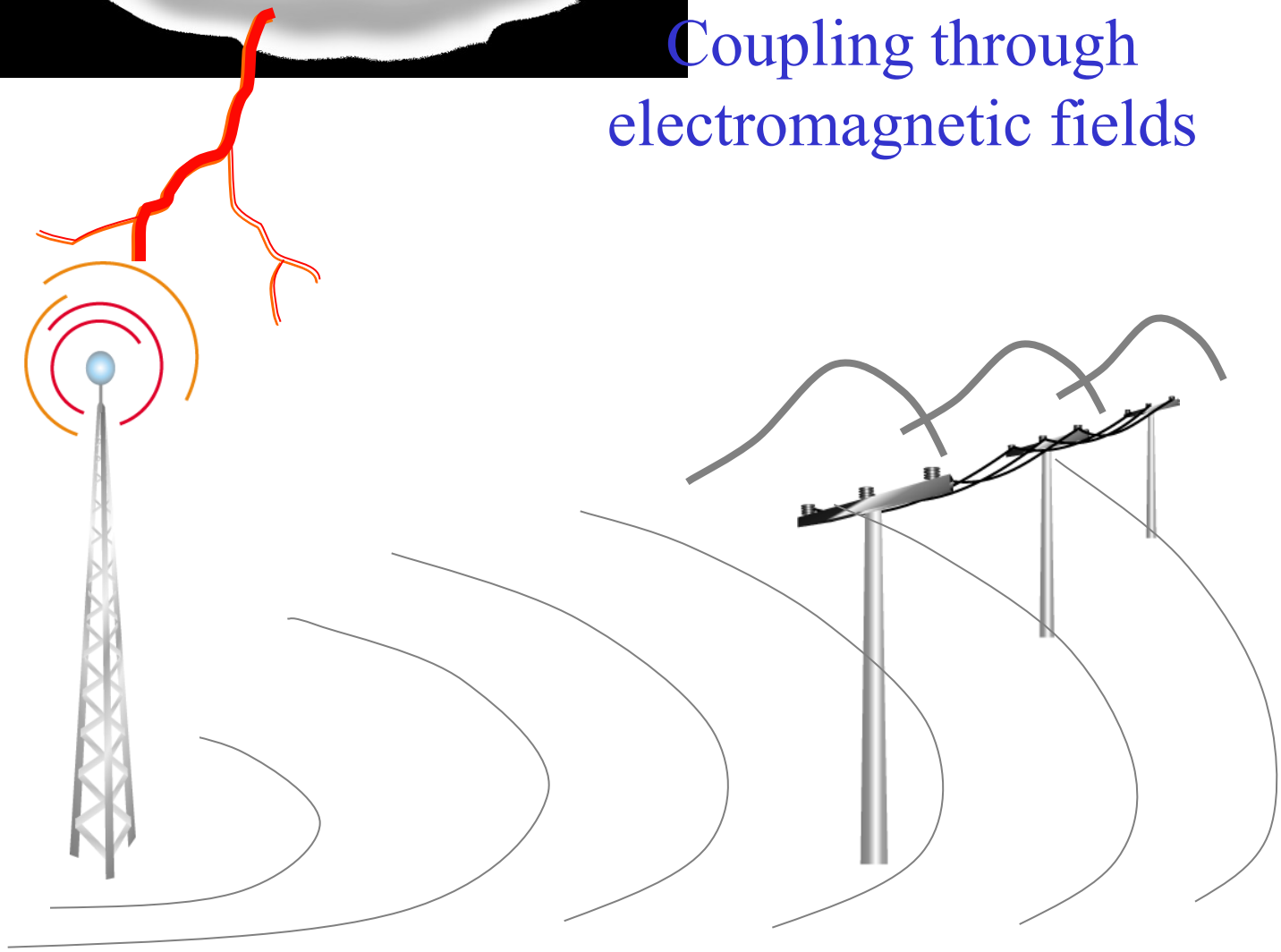
Coupling through electromagnetic fields





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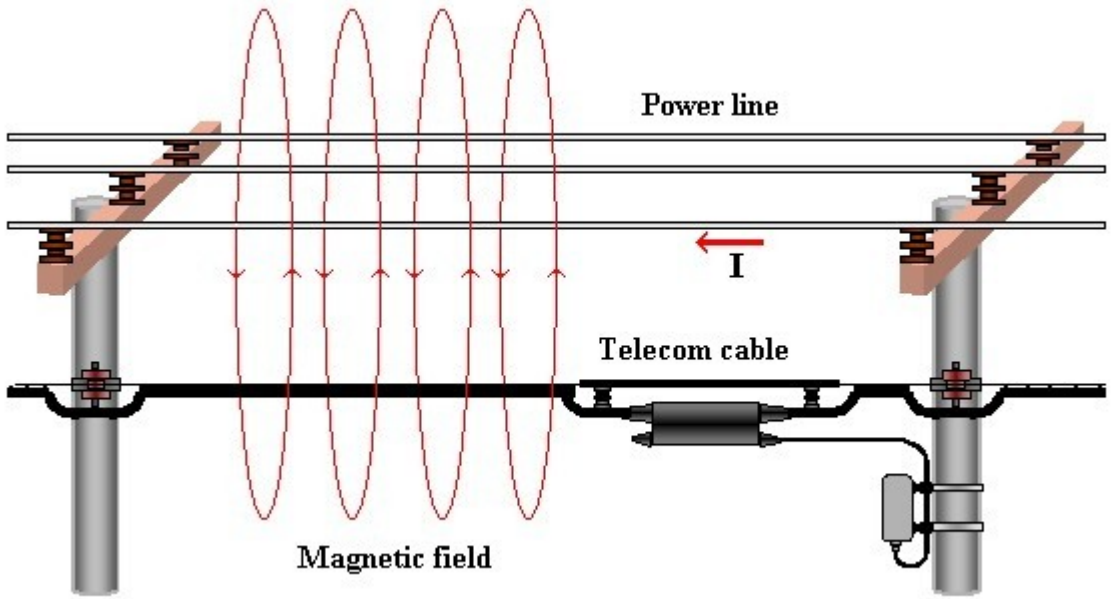
Power induction

Power induction is caused by power lines that run in parallel with telecommunication lines. High values of power induced surges are related to power lines with earth return, such as power distribution lines based on single-phase with earth return, and earthed three phase lines during a phase-to-earth fault.



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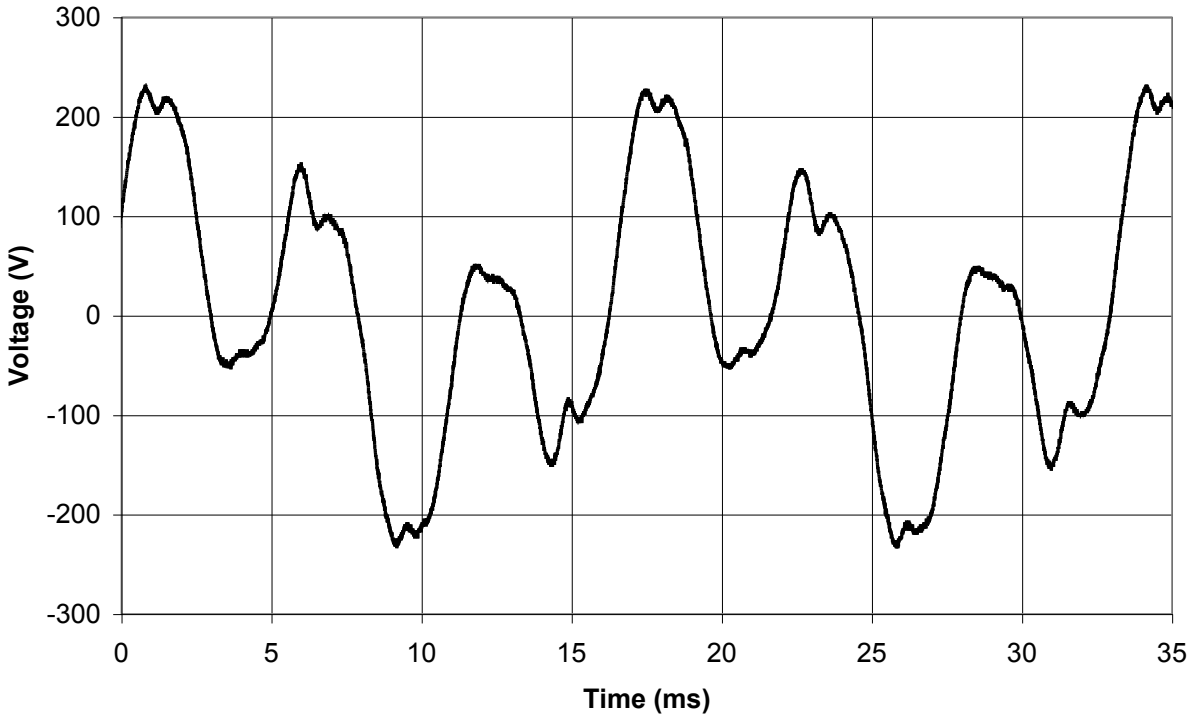
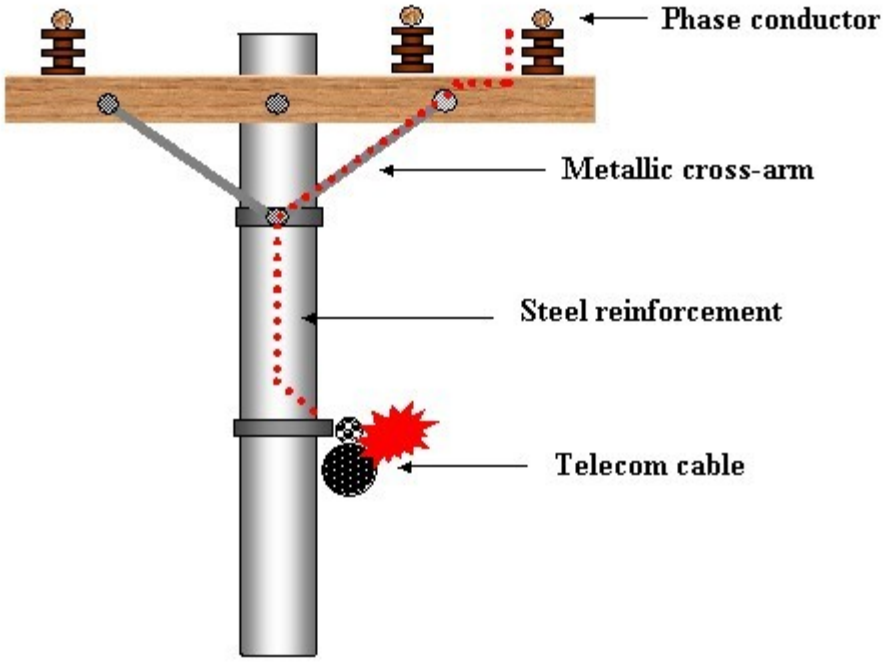
Power induction

Example of line-to-earth induced voltage in a 12 km telecom cable in joint-use with a power distribution line. Note the high content of 3rd harmonic.



Power contact

Power contact is usually caused by physical failures of power lines that share the same poles with telecommunication lines (joint-use) or at crossings.



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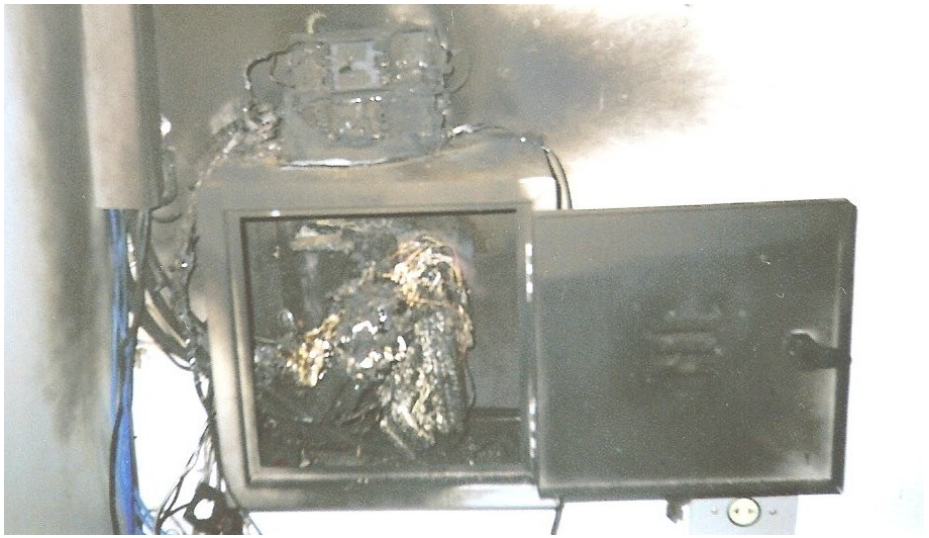
Power contact

Example of telecommunication indoor cabinet burned-down due to power contact in joint-use outside plant.



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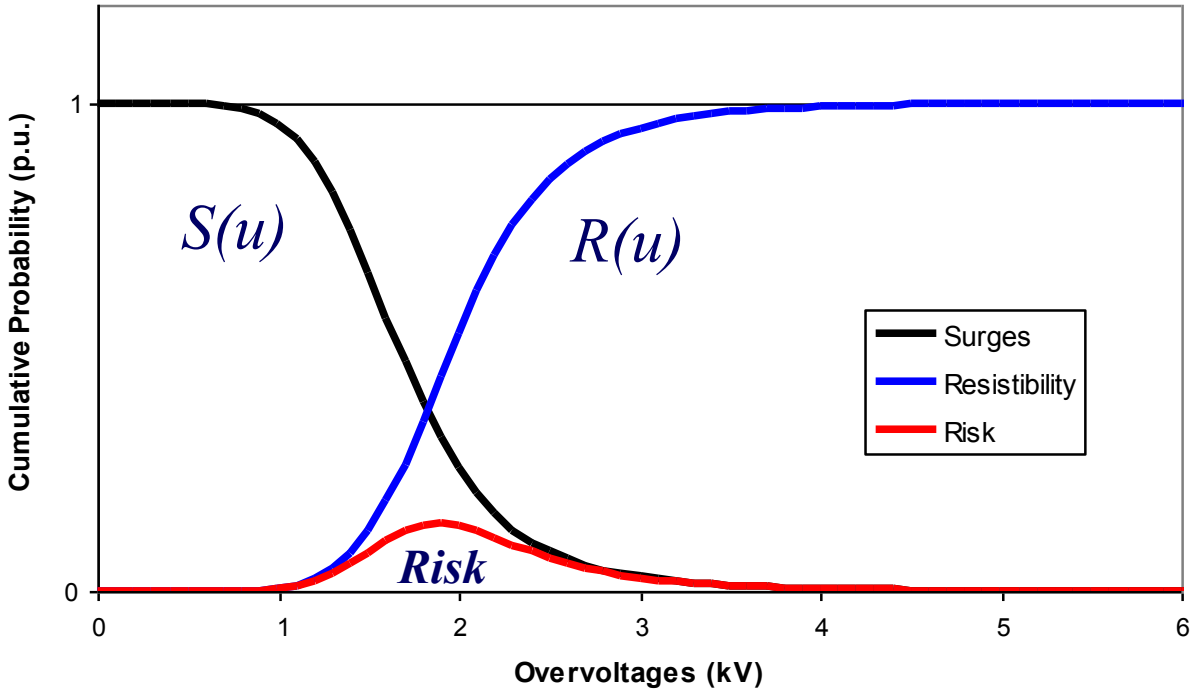
Principles of protection

Surges $S(u)$: depend on environment and installation

Resistibility $R(u)$: depends on equipment design

$$\text{Risk} = \int_0^\infty S(u)R(u)du$$



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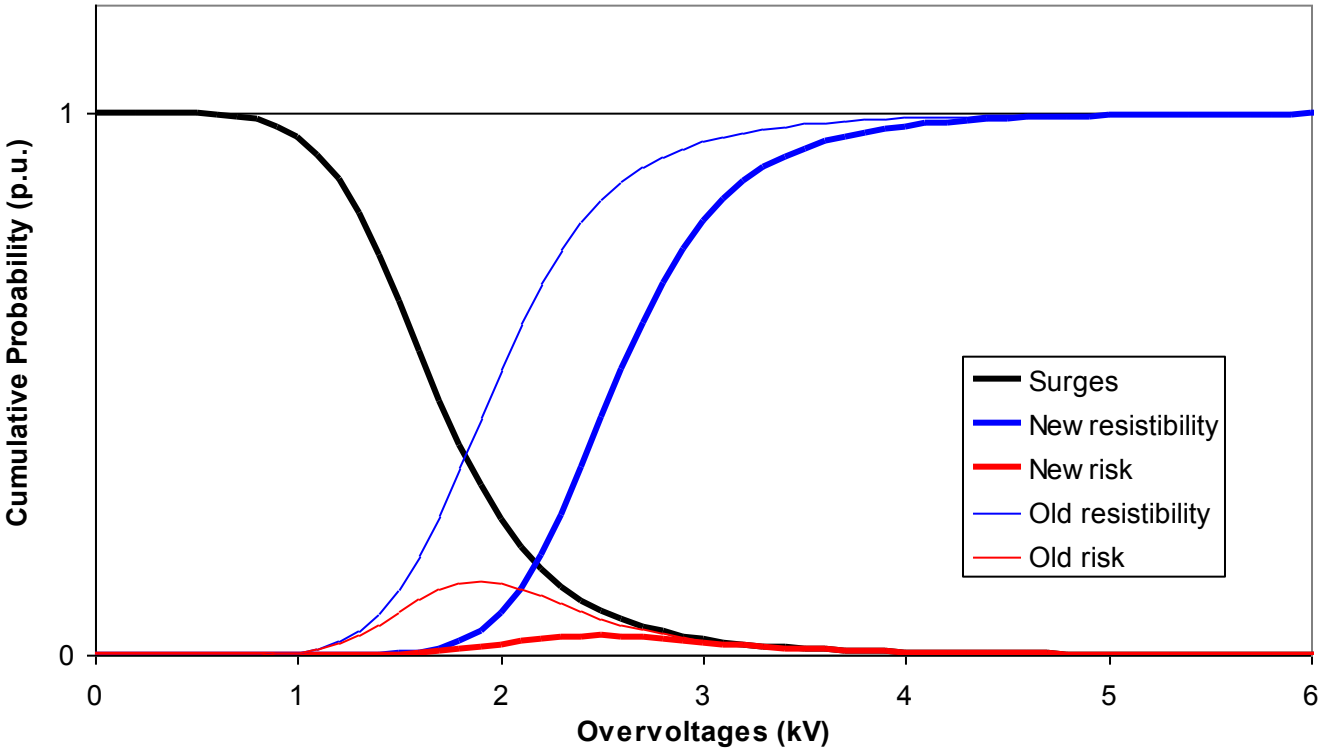
Principles of protection

To increase the equipment resistibility reduces the risk.



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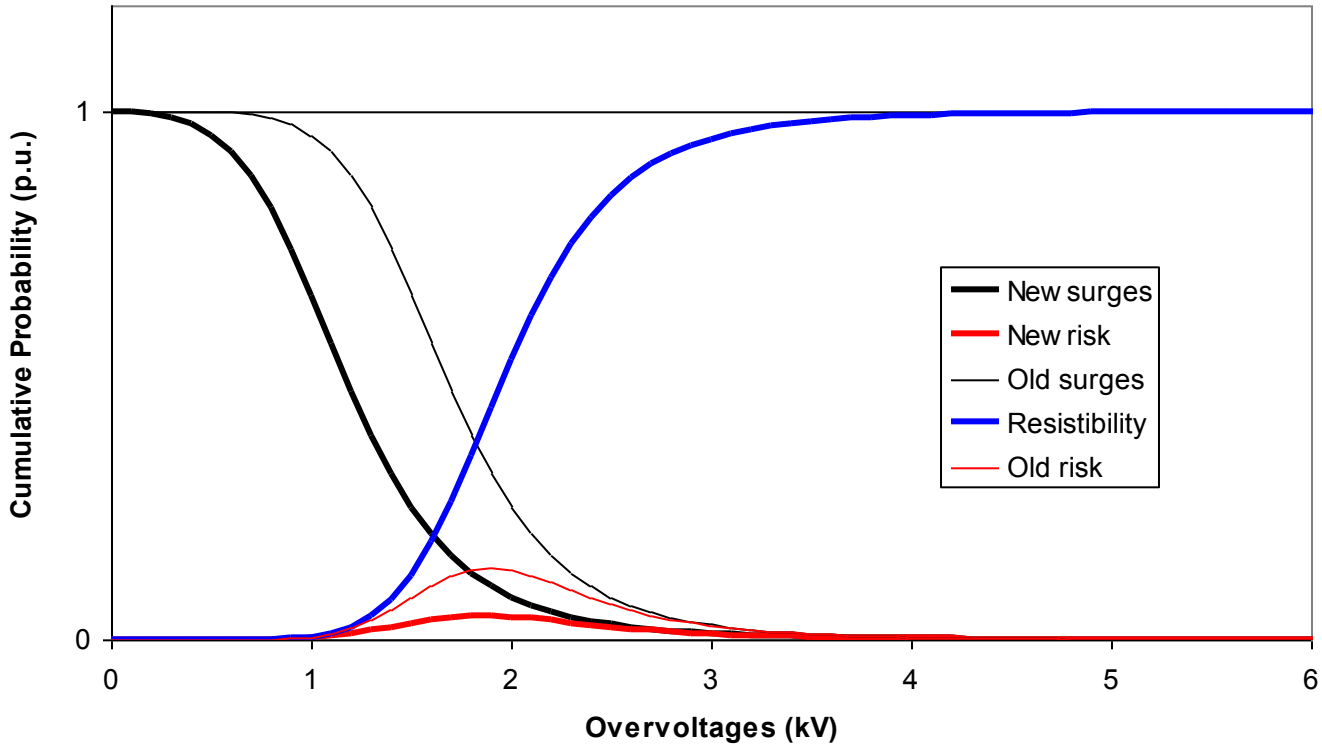
Principles of protection

To improve the installation reduces the risk.

(e.g., equipotential bonding, earthing, shielding, use of SPD, etc …)



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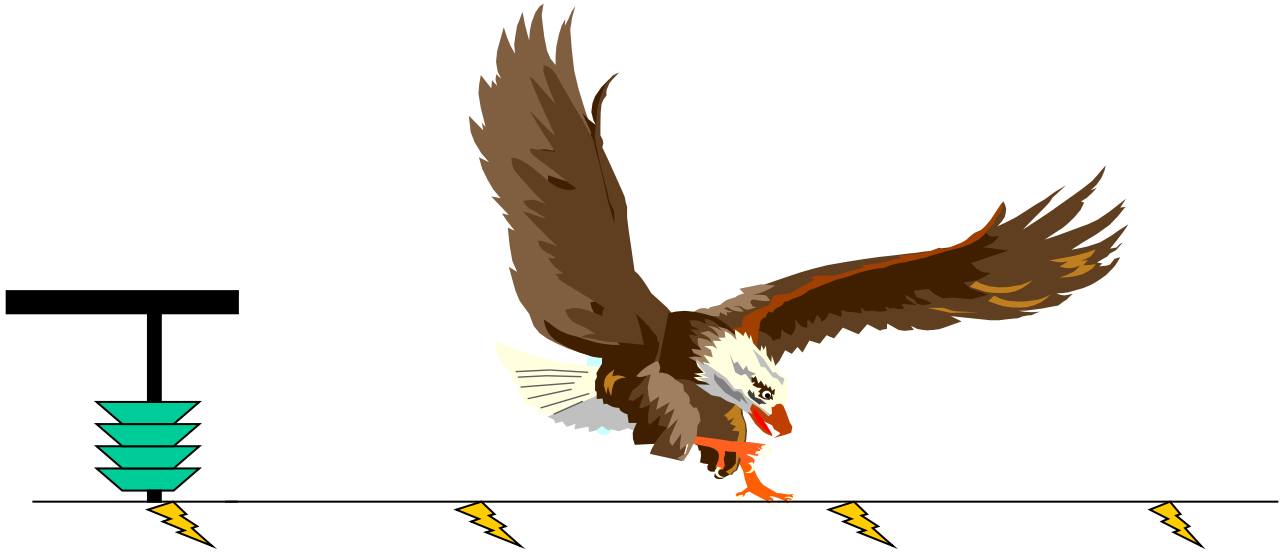
Equipotential bonding

Although the potential of a high-voltage conductor may be at several hundred kV above earth potential, it is harmless to a bird …



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Equipotential bonding

… provided the bird doesn't touch and earthed structure!

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Equipotential bonding

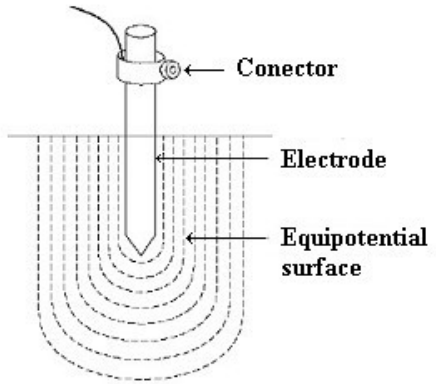
Fortunately, aircraft manufacturers apply the equipotential bonding concept in airplane design …

As they can't use earthing anyway!

Earthing

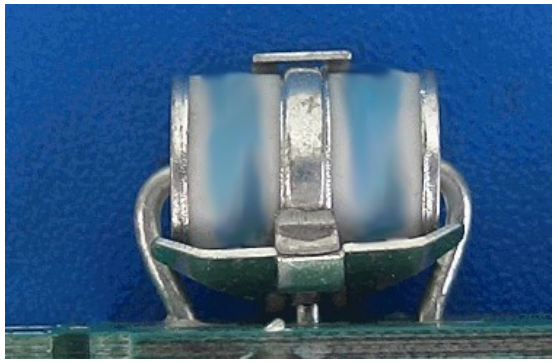
The main functions of earthing are:

- Provide a safe path to the flow of surge current to earth (e.g., from lightning);
- Reduce the current and voltage propagating along a transmission line (e.g., a telecom cable);
- Reduce the voltage between the telecom line and local earth;
- Provide sufficient current for the tripping of circuit breakers in case of a power to earth fault.



Use of SPD

The use of SPD limits the surge voltage and / or the surge current at its location. Typical voltage limiting devices are gas discharge tubes (GDT), varistors (MOV), diodes and thyristors. Typical current limiting devices are termistors (PTC), fusible resistors, fuses and electronic current limiters.



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Next presentations

The next presentations will address in detail the following issues:

- Equipment resistibility
- Earthing and bonding
- Surge protective devices

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Thank you!