IMPROVING SERVICE PROVISION OF MODERN TELECOMMUNICATION NETWORKS BY INCREASING THE NETWORK IMMUNITY TO UNRELIABLE POWER

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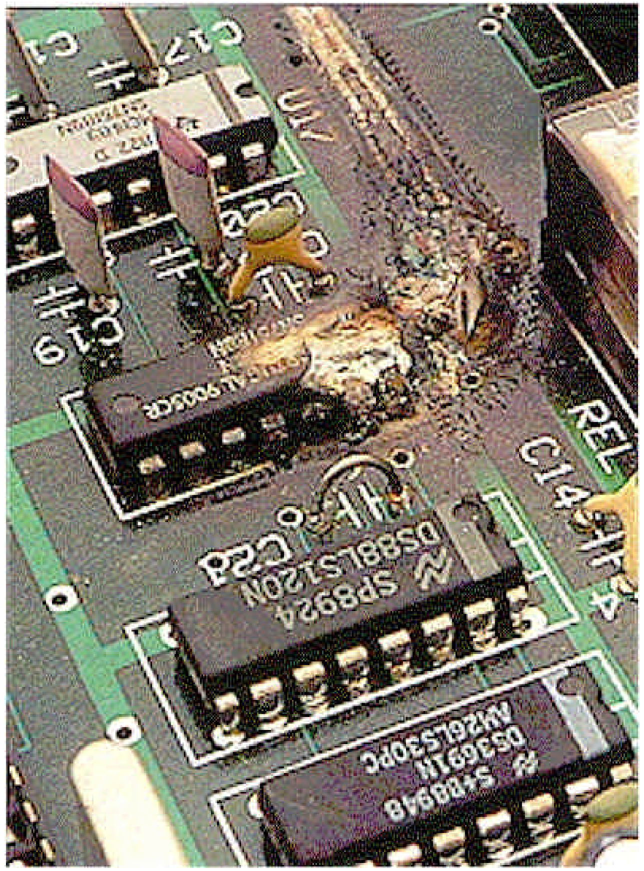
TOPICS

- Power Irregularities in Modern Telecom Networks – The Problem
- Sensitivity of Modern Telecom Networks to Power Irregularities
- Methods to Eliminate Power Irregularities
- AC Power Surges
- Surge Protection Technology – Overview
- Case Studies: Improving Network Reliability
- Conclusion

POWER IRREGULARITIES – THE PROBLEM

Modern telecommunication networks rely on the use of high-end electronic equipment based on semiconductor technology:

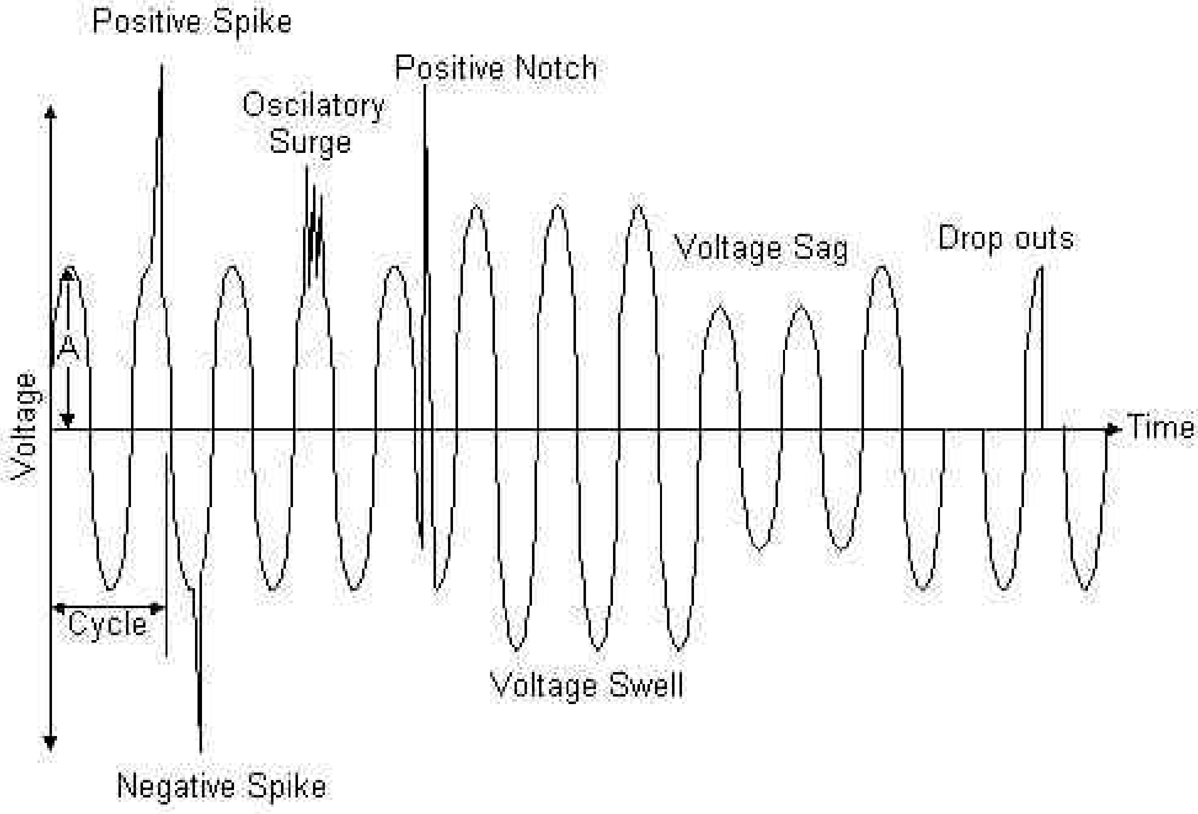
- **Microcontrollers**
- **Electrical to RF conversion modules**
- **Amplifiers (RF, optical)**
- **Signal processing and data storage units**
- **Computer-based monitoring and remote operation hardware**



Equipment damage due to transient overvoltage on the power line

TYPES OF POWER IRREGULARITIES

- Voltage Swells
- Voltage Sags
- Dropouts
- Transient Overvoltages



SENSITIVITY OF MODERN TELECOMMUNICATION NETWORKS TO POWER IRREGULARITIES (1)

A. Traditional Fixed Line PSTN Network Topology

- **One Central Office** including all active equipment of the network
- Street cabinets include only **passive equipment**, insensitive to power irregularities
- Central office equipped with all necessary backup power equipment, power regulators, filters, overvoltage protectors

Protecting the central office from power irregularities ensures reliability of traditional PSTN networks.

SENSITIVITY OF MODERN TELECOMMUNICATION NETWORKS TO POWER IRREGULARITIES (2)

B. Modern Broadband Network Topology

- Broadband services (high-speed internet, VoIP, real-time audio and video, etc) require a **distributed** network topology
- The network includes **remote active equipment** installed into street cabinets close to the end-users
- The remote active equipment is powered **directly from the utility grid**
- Extensive use of sensitive semiconductor components has improved the network's performance but increased the rate of power-related failures

Protecting the network from power irregularities is absolutely necessary to increase the reliability of the network

SENSITIVITY OF MODERN TELECOMMUNICATION NETWORKS TO POWER IRREGULARITIES (3)

C. Mobile Telecommunications Network Topology

- It consists of a distributed grid of Base Stations (BTS)
- Each BTS can act as either end-BTS, serving one particular cell, or nodal-BTS, which links several end-BTSs and repeaters
- BTSs and repeaters are active pieces of equipment **powered by the utility grid**
- High exposure to power irregularities, especially power surges due to lightning strikes

Mobile telecommunication networks require protection from power irregularities on every piece of active equipment

EFFECT OF POWER-RELATED FAILURES ON MODERN TELECOMMUNICATION NETWORKS

Power-related failures can cause:

- Reduction of network availability
- Reduction of bandwidth in broadband networks
- Loss of coverage or reduction of capacity in cellular networks
- Poor quality of bandwidth-demanding applications

The reduction of network reliability due to equipment failures caused by power irregularities result in significant loss of revenue due to:

- Loss of income due to interruption of services
- Cost of replacement materials
- Labor cost
- Need for increased number of maintenance personnel to repair damages
- Need for stock in critical components (power supply units, converters, amplifiers, distribution panels, automatic transfer switches, etc)
- Customer dissatisfaction due to poor quality of services

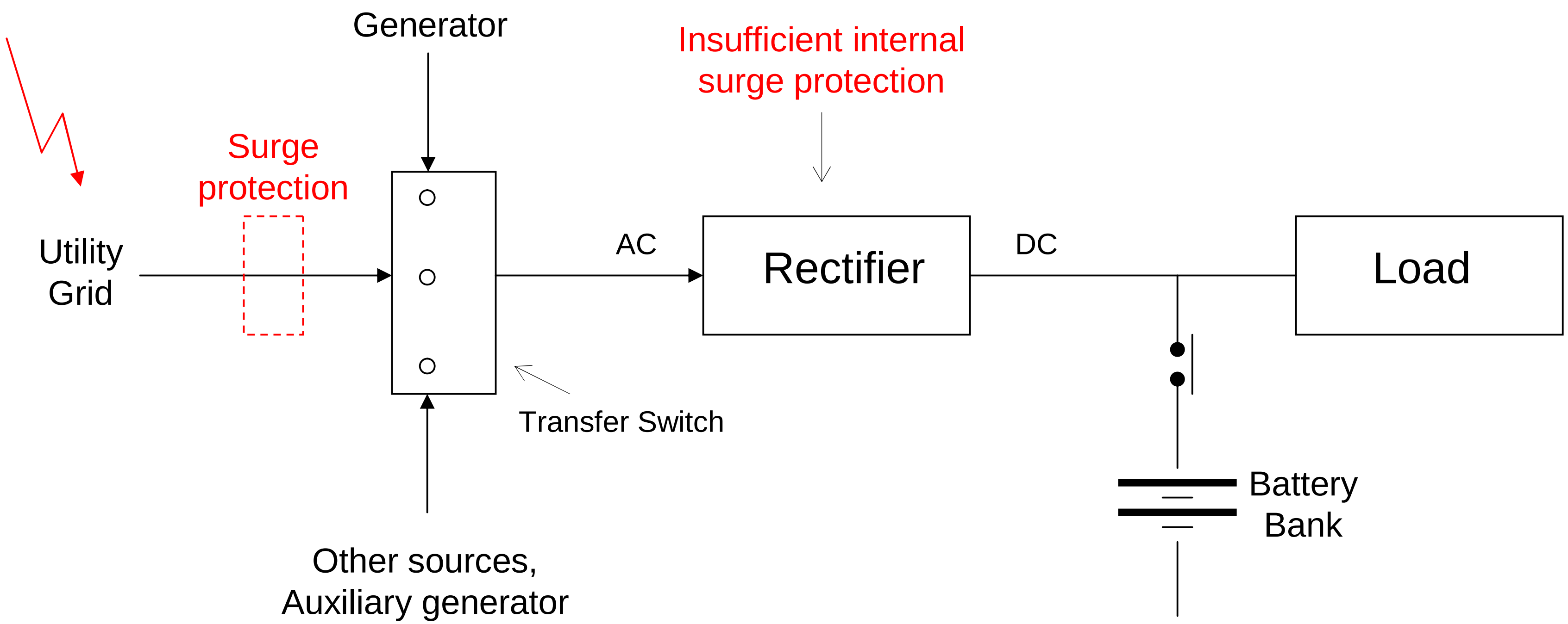
METHODS TO ELIMINATE POWER IRREGULARITIES

Voltage swells, voltage sags and dropouts can be avoided using:

- **Uninterruptible Power Supplies (UPSs).** UPS systems regulate the output voltage preventing voltage swells and sags to affect the load
- **Backup generators.** Used in combination with automatic transfer switches (ATS) and occasionally with renewable energy sources (eg. photovoltaic arrays) to provide power in case of prolonged power loss
- **Voltage Regulators.** Regulation of frequency and amplitude of output voltage

The above systems are <u>not</u> designed to protect from transient phenomena

TYPICAL POWER SUPPLY CONFIGURATION OF A TELECOM SITE



- Rectifiers have been changed to **switching mode** power supplies: High efficiency, low-cost, small size, but **sensitive to power surges**

Experience shows that the need for power surge protection is underestimated by the telecommunication network engineering community

POWER SURGES – THE PROBLEM

Power Surges and Transient Overvoltages are due to the sudden change in the electrical conditions of a circuit and the release of large amounts of energy stored in the inductance and capacitance elements of the system.

Sources of power surges can be **external** or **internal**

External Sources

- Lightning
- Power line disconnection and re-connection
- Transformer Switching on/off
- Electrostatic discharges
- Power utility load switching
- Poor power transmission & distribution grid

Internal Sources

- Operation of circuit breakers or fuses
- Electric motors
- Air-conditioners
- Generators

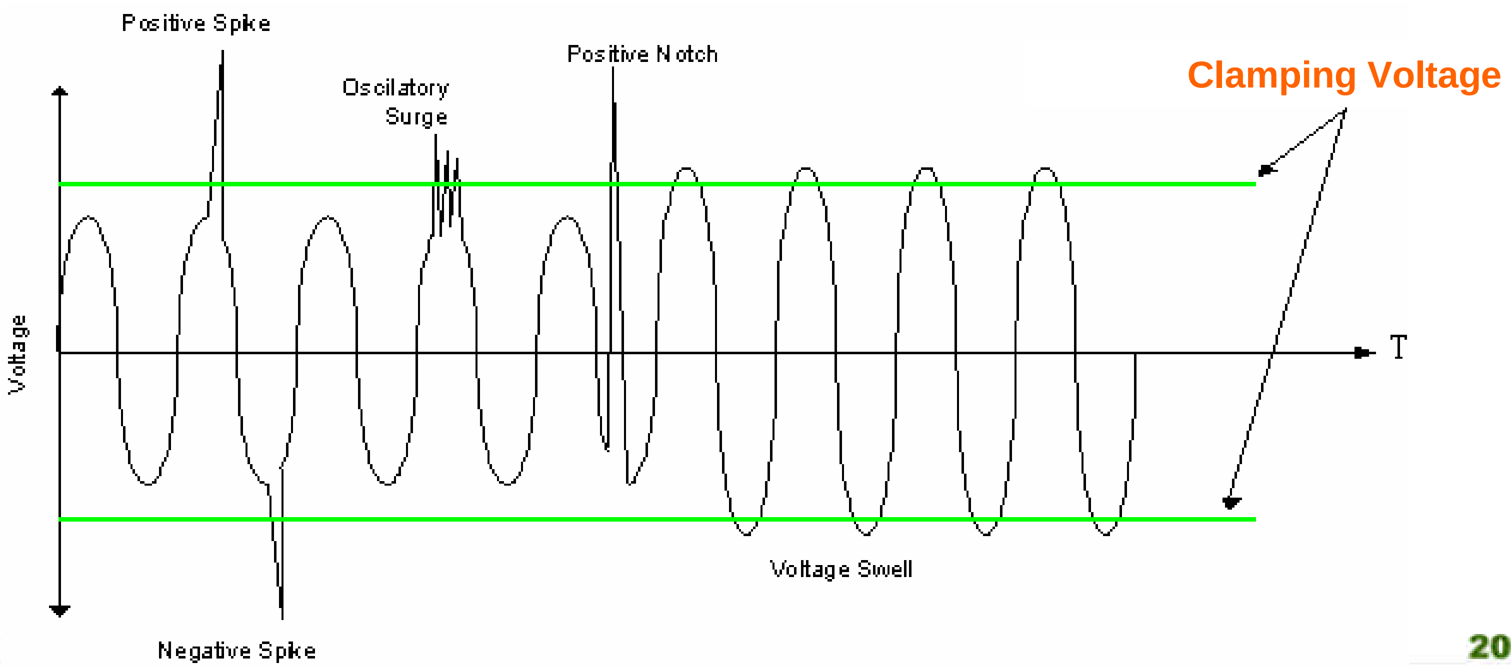
Severe weather phenomena, frequently appearing during the last decade, deteriorate the problem of power surges

POWER SURGES – TVSS DEVICES

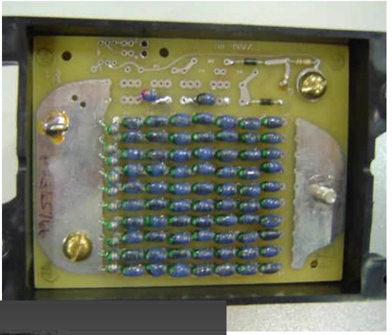
TVSS (Transient Voltage Surge Suppressor): A device which limits the voltage within an acceptable range

The **ideal TVSS** should:

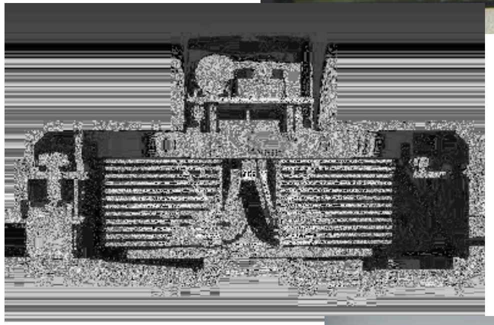
- Absorb all energy above a preset voltage level and safely dissipate it.
- Not cause interruption of the normal function of the load
- Be reliable and work consistently without wearing out.



SURGE PROTECTION TECHNOLOGY – OVERVIEW

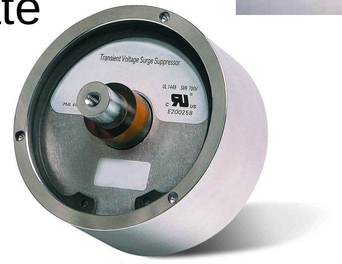


- **SADs:** (Silicon Avalanche Diodes) **:** Very low surge handling capacity. Suitable only for secondary protection of individual circuits.



- **Spark Gaps:** Not suitable to be installed in front of sensitive electronic equipment.

- **Parallel MOVs:** Adequate level of protection but fast aging.



- **Single MOV:** High level of protection, slow ageing. Ultimate protection for sensitive telecommunication equipment.

SURGE PROTECTION SPECIFICATIONS FOR TELECOMS

Network design engineers often use low-performance power surge protection equipment.

The ideal power surge protection device should provide:

- **High current handling capability**
- **High endurance to repetitive surges**
- **Maintenance free** (no replacement parts, modules, fuses, etc)
- **Continuous protection to the equipment** (no fuses or disconnects)
- **Robust housing** to ensure safe operation
- **Low residual voltage**, below the immunity level of the electronic equipment

IMPROVING NETWORK RELIABILITY

Case Study A: Fixed Line Network

Power surge protection installed in:

- Microwave transmission stations
- Central Offices
- Wireless rural telephony base stations
- Optical node units for broadband access networks

Extensive study for 3 years after installing protection:

- Measurement of number of failures per station
- Estimation of the cost of the replacement parts and labor work per station
- Estimation of the average loss of revenue.

Results:

- **Payback period** of the investment in **less than 18 months**.

IMPROVING NETWORK RELIABILITY

Case Study B: Mobile Telecommunications Network

Power surge protection installed in:

- End Base Stations (End-BTS)
- Nodal Base Stations (Nodal-BTS)

Extensive study after installing protection:

- Measurement of number of failures per station
- Estimation of the cost of the replacement parts and labor work per station
- Estimation of the average loss of revenue.

Results:

- **Payback period** of the investment in **less than 20 months**.

CONCLUSIONS

- Modern telecommunication networks are prone to power irregularities
- Significant loss of revenue and degradation of the quality of service due to power related failures
- Power supply regulation on every active part of the network is absolutely necessary
- Adopting the recent developments in power supply regulation and surge suppression will improve the reliability of the networks, minimizing at the same time the loss of revenue to the operators.