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Electrical Protection Considerations for an All Internet Protocol Network

Presented by: Ernie Gallo, Director, Ericsson
Larry Payne, Network Design Engineer, AT&T

A High Level View of Internet Protocol Transport via Copper Cable

- IP resides in Layer 3 of the OSI Reference Model
- Transported over twisted pair copper conductors via DSL, VDSL, and Ethernet
- Originally designed as an intra-building computer data interface
- Two types of Ethernet circuits
  - Digital signals with no DC power
  - Digital signals with DC power (PoE)

High Level View of IP Copper Transport (Continued)

- Generally transported via Category 3 or higher twisted pair cable, usually unshielded
- Data rates range from 10 megabits per second to 10 Gigabits per second
- Connections are typically made with an 8-pin modular connector, i.e. an RJ45 type connector

Power over Ethernet (PoE)

- A Powering technique used over the existing Ethernet wiring link
- The Ethernet wiring carries both the data signal and DC power
- Two major advantages for PoE
  - The Ethernet devices are not required to be placed next to electrical outlets
  - Power cables are no longer required to be planned and installed for the network

Network Evolution

- Public Switched Telephone Network (PSTN)
- An Analog Circuit Switched
  - Switching Systems
    - Electromechanical
      - Step by Step
      - #5 Crossbar
      - Crossbar Tandem
      - 4A Crossbar
      - Stored Program Control
        - » 1A ESS
        - » 2ESS
        - » Others

Network Evolution (Continued)

- Analog Circuit Switched (Continued)
  - Transport Systems
    - N-Carrier (N1, N2, N3)
    - Analog Microwave Radio (4Ghz Band)
    - Voice frequency, loaded and non-loaded
      - E6 Repeaters
      - V4 Repeaters
      - MFTs (Metallic Facility Terminals)
      - REGs (Range Extenders with Gain)

Network Evolution (Continued)

- Time Division Multiplexing (TDM) Transport and Switching
  - Switching Systems
    - Digital Switching Systems – Terminated DS1s rather than individual voice frequency circuits
      - 4ESS Toll
      - 5ESS Local
      - DMS 10
      - DMS 100
      - DMS 200
      - Siemens

Network Evolution (Continued)

- TDM Transport and Switching (Continued)
  - Transport Systems
    - T1, T1C Carrier
    - Digital Microwave Radio (2, 6, and 11 GHz Bands)
    - Asynchronous Fiber Systems
    - Synchronous Optical Network (SONET) based Fiber Systems

IP Network of the Future

- Will closely resemble the internet, with routers and servers switching packets of data that contain voice, data, and video
- Backhaul network between routers and servers will initially be very similar to today's telecommunications network
  - Optical fiber outside plant cable
  - Connecting very sophisticated and high capacity multiplexer systems

IP Network of the Future (Continued)

- Copper in last few hundred feet will likely remain for some time
- Interface to servers will most likely be directly by fiber or metallic Ethernet ports
- The fiber optic OSP cables must be properly bonded and grounded as they are today
- Both the multiplexers and copper Ethernet cable will be eliminated one day, leaving only fiber transport

Electrical Protector Differences

- Today's Main Frame Protectors
  - Both voltage and current protection
  - "4-Type" five pin protectors with a gas discharge tube (GDT) or Solid State overvoltage protectors
  - GDTs are preferred for VDSL and Ethernet
  - Overcurrent protection, normally a heat coil
    - The impedance of a heat coil, particularly at higher frequencies, will cause significant signal degradation and should not be used for VDSL and Ethernet

Electrical Protector Differences (Continued)

- Two other types of current limiting for Main Frame Protectors
  - Positive Temperature Coefficient (PTC) thermistors
  - Electronic Current Limiters (ECLs)
    - Both of these are almost purely resistive
    - Very flat attenuation characteristics as a function frequency

Protectors at Remote Outside Plant Cabinets and Customer Premises

- Normally voltage only protectors at RT sites
  - Gas Tube
  - Solid State
  - GDTs should be used for VDSL and Ethernet
- Customer Premises, i.e. Station, Protectors are always gas tubes with no current limiting

Ethernet Signals Delivered Directly to a Customer Premises

- Possible a combination Primary and Secondary Protector Design
  - Gas tube as primary protector and
  - Secondary protection circuitry to limit let through voltages to levels that will not damage an Ethernet port
- Separate primary gas tubes, and secondary Ethernet protectors placed at the Ethernet ports may also be used

Power Supply and Battery Backup
Customer Premises Equipment Protection

- IP based networks will not have network power, i.e. -48 volts
- On premises power supply units and battery backup units (PSU/BBU) will power the terminal equipment at the customer premises
- Type 7 port as defined in GR 1089
- Intra-building communications ports, i.e. those that do not directly connect to the OSP designed to meet the criteria of Type 4a or 4b ports as defined in GR 1089

Cable Shield Bonding and Grounding

- Outside Plant Cables, copper or fiber with metallic members need to be grounded according to today's existing standards
- Network interface devices (NIDs) for copper cables or Optical Network Units (ONUs) will also need to be ground as they are today
- National Electrical Safety Code and National Electrical Code
  - Will undergo changes as the IP network evolves
  - Both will most certainly apply to the all IP network of the future

Copper Pairs Without Sealing Current

- No DC current flowing on copper pairs
- Possible corrosion at splices
- This will need to be addressed
  - Possible new connectors
  - Encapsulate

Switching Equipment Differences

- IP network will be via servers and routers
- Significantly shorter life span than traditional TDM electronic switch deployed today
- Life spans of 5 years rather than 20 years plus will be typical
- Probable changes to reliability standards for the IP switching systems that is quite different from today's standards such as Telcordia GRs 1089 and 63

Concluding Thoughts

- Electrical protection, bonding and grounding as well as corrosion strategies, such as sealing current, will change to adapt to the IP Network
- Oversight to these areas could result in
  - Safety issues
  - Equipment damage
  - Reduced network reliability