

Broadband Power line Communications and Characteristics

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Communications Considerations

Energy Requirements for:

- Industry
- Business
- Residential homes
- Control of Carbon emissions and other gases
- Control of electrical and electronic devices
- Intelligent communications

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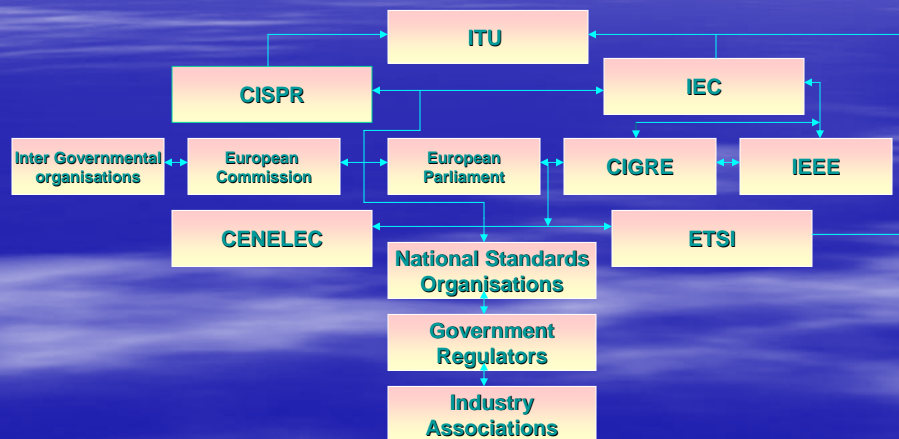
Communications standards

- IEC CISPR22 – world standards body
- IEEE low and high frequency standards
- European , Cenelec standardisation body
- European EMC committee
- International telecommunications Union, ITU
- IEC TC 57 High Voltage Powerline Systems
- Key area of interest for these committee's – Broadband Power Line Communications

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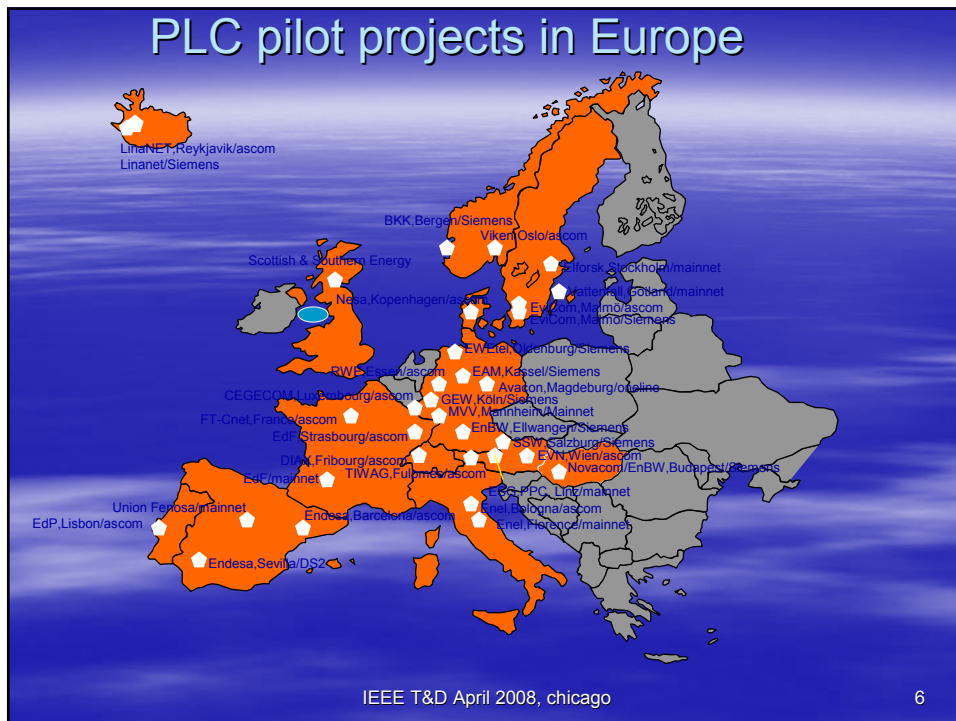
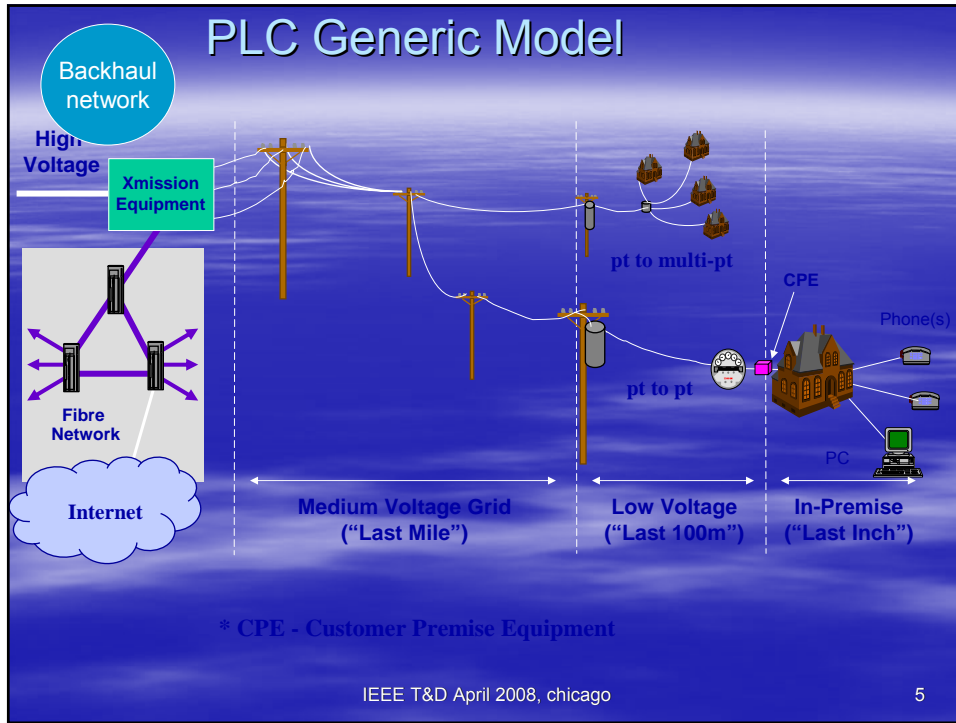
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Regulatory Landscape for PLT

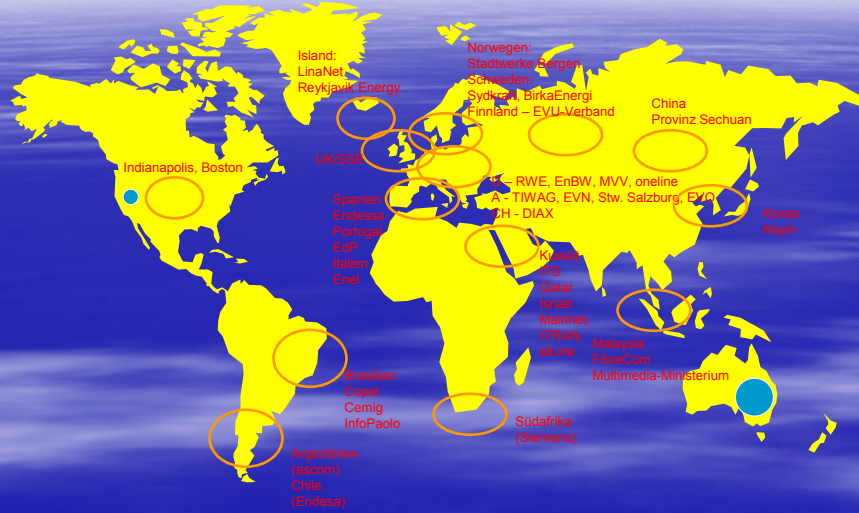


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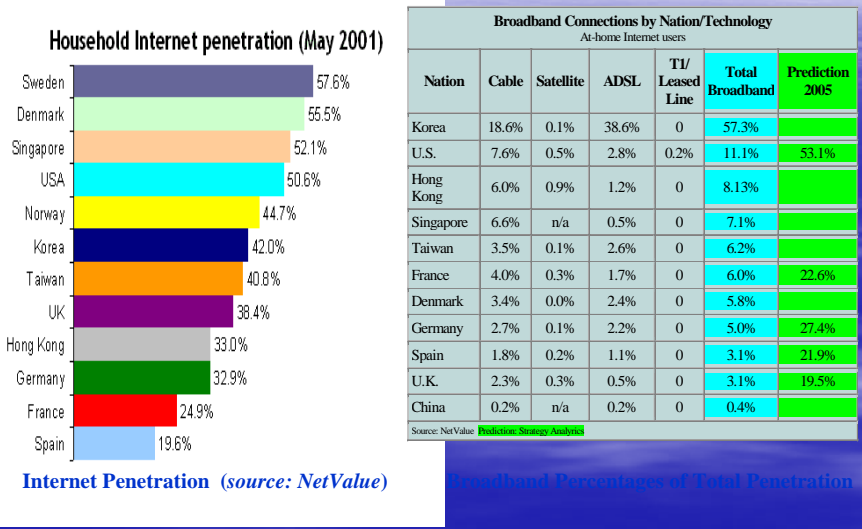
Worldwide PLC Activities



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Broadband Access Market



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Broadband PLT developments

- Wire –Line Systems include :
- ADSL technologies
- Cable Modem systems
- High Frequency Power Line systems
- Electrical network architecture
- Emissions –conducted and radiated
- Noise floor
- Interference Mechanisms

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Frequency Spectrum

Low Frequency Power Line Transmission

- USA: 50KHz to 450KHz(IEEE)
- Europe:3Khz to 148.5KHz(Genelec)
- High Frequency Transmission
- 1MHz to 30MHz underground
- USA 1MHz to 60MHz for underground and overhead
- Access Band 1.6MHz to10MHZ
- In-house Band 10MHZ to 30MHZ

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Standard Deterministic Communication Characteristics

- Unique frequency specification
- Characteristic impedance
- Minimum noise
- Constant bandwidth
- Standard architecture
- No common mode current and
- No Radiated emission to cause interference

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Standard Communication characteristics PLT systems

- Unique frequency specification
- Characteristic impedance
- Minimum noise
- Constant bandwidth
- Standard architecture

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Leaky cables @1Mhz to 30Mhz

- At these frequencies not all the signal is transmitted down the cable-it leaks power
- So some of the high frequency signal emanates as electromagnetic radiation
- Hence power cables can be considered as linear antennas and
- Low efficiency

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Access Band Communications

- Communication between Sub-station and Customers
- Distances involve 50 metres to 250metres according to Urban or Rural location
- Urban Customers number \approx 50 to 250
- Rural Customers number \approx 1 to 20
- Subject to varying noise levels
- Frequency range 1MHz to 10MHz

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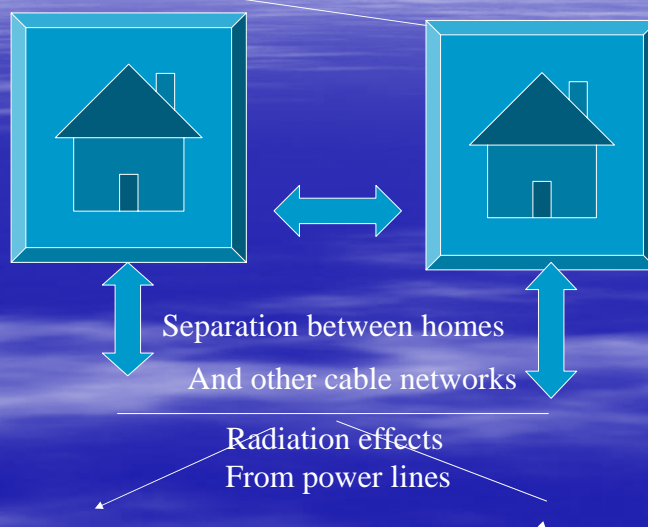
In-House Communications

- Limited to inside buildings of all types;
- Industrial
- Commercial
- Residential
- Different electrical structures: single and 3 phase :Ring Main & Tree & Branch
- wide range of services
- Frequency range 10 to 30Mhz

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Emissions from homes



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Key Parameters for Investigation

- Investigation of Key parameters of Broadband Power Line Carrier communications
- Impedance of the power Line over the frequency range 3KHz to 30MHz
- Signal Injection Power
- Conducted current
- Common mode current -
Radiated emission from power line

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Key Parameters for Investigation(2)

- Longitudinal Conversion Loss (LCL)
- Regression of signal
- K Factor
- Noise Floor measurements
- Relationship between the Impedance of Line , LCL, with type of devices connected to the line.
- Effects of network architecture on radiated emission
- Mechanisms for understanding emissions in terms of these parameters

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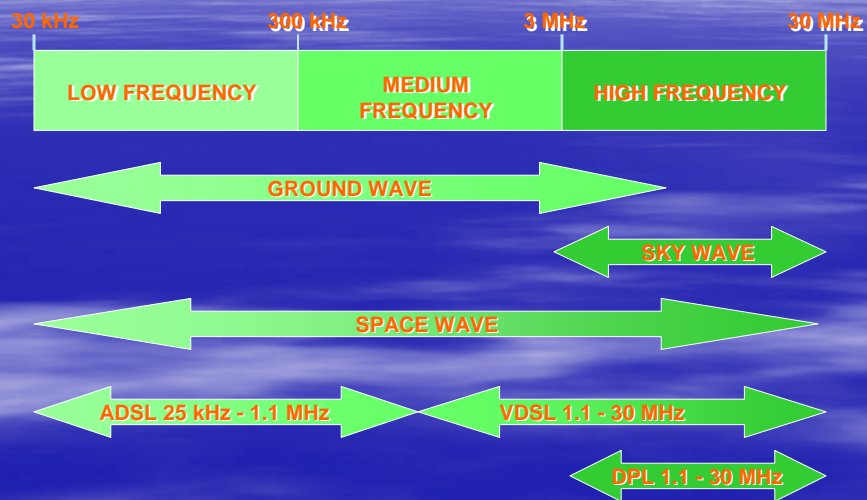
Established Communication Services in the 1MHz to 30MHz

- Broadcasting Channels
- Amateur Radio
- Mobile Communications
- Distress frequencies
- Military communications
- Radio astronomy

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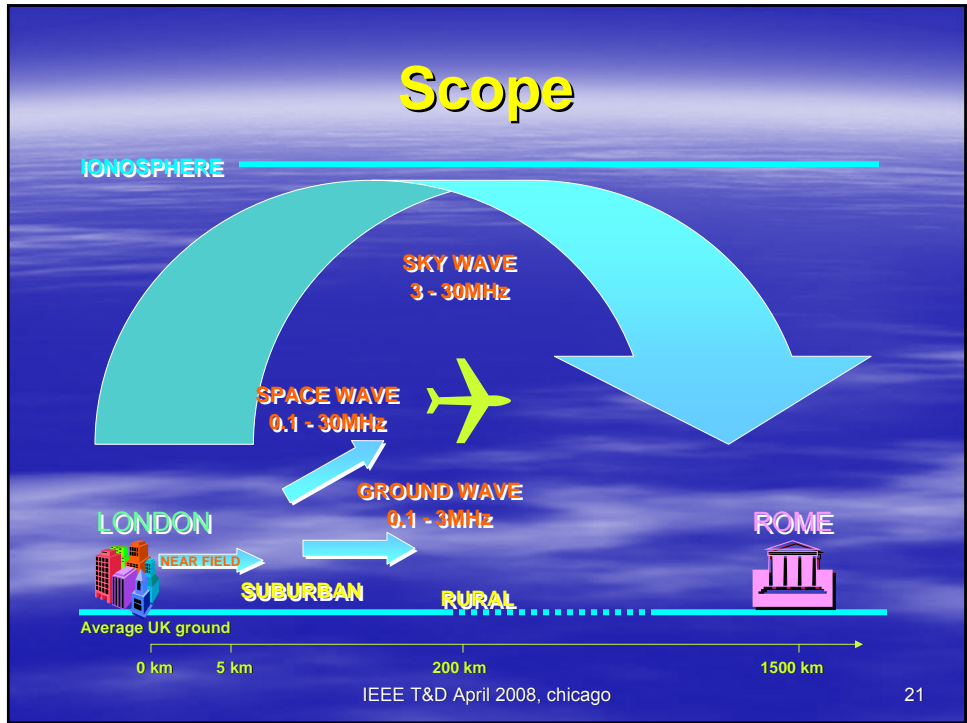
Spectrum & Technologies



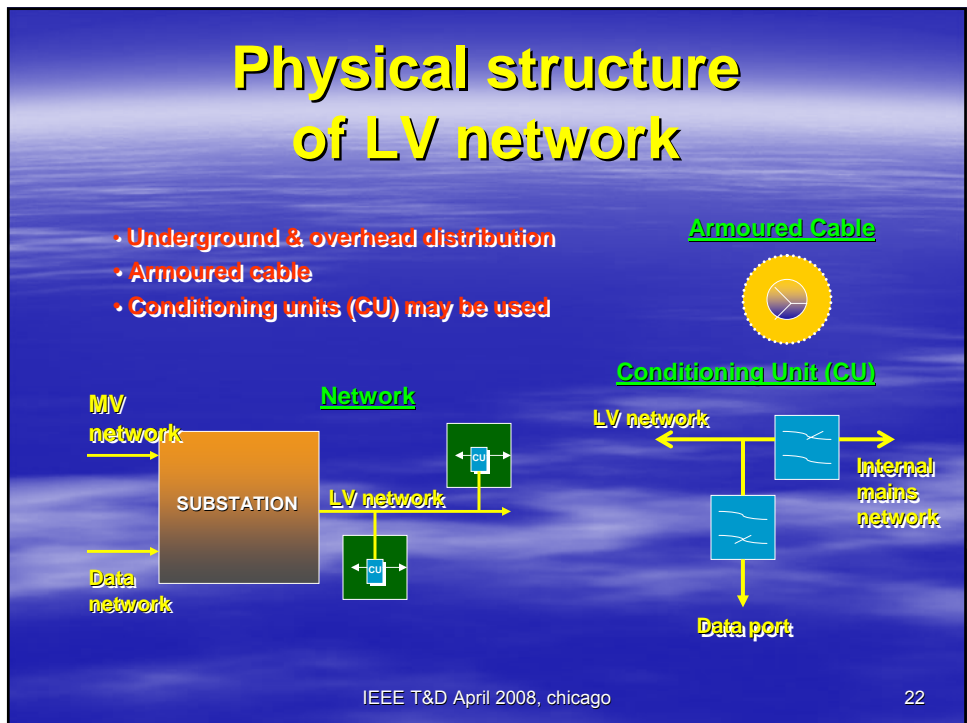
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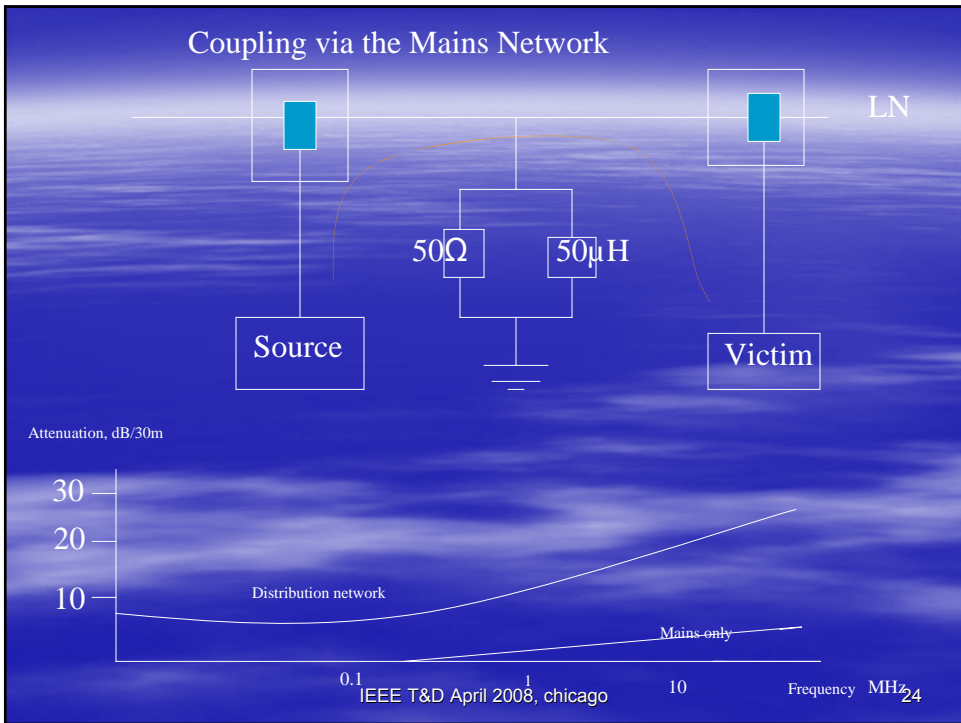
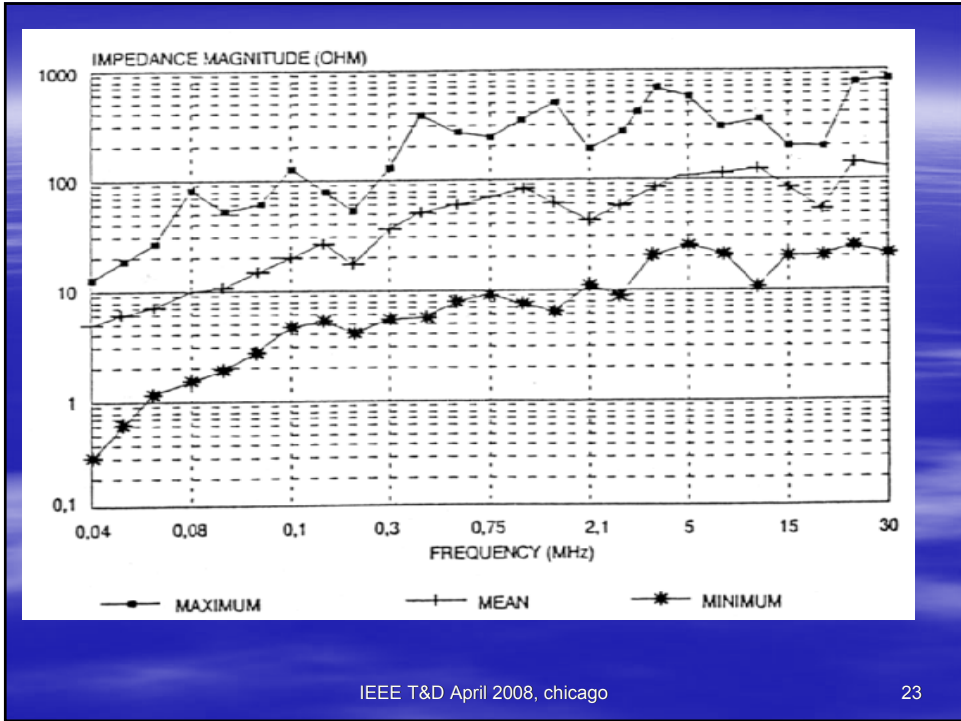
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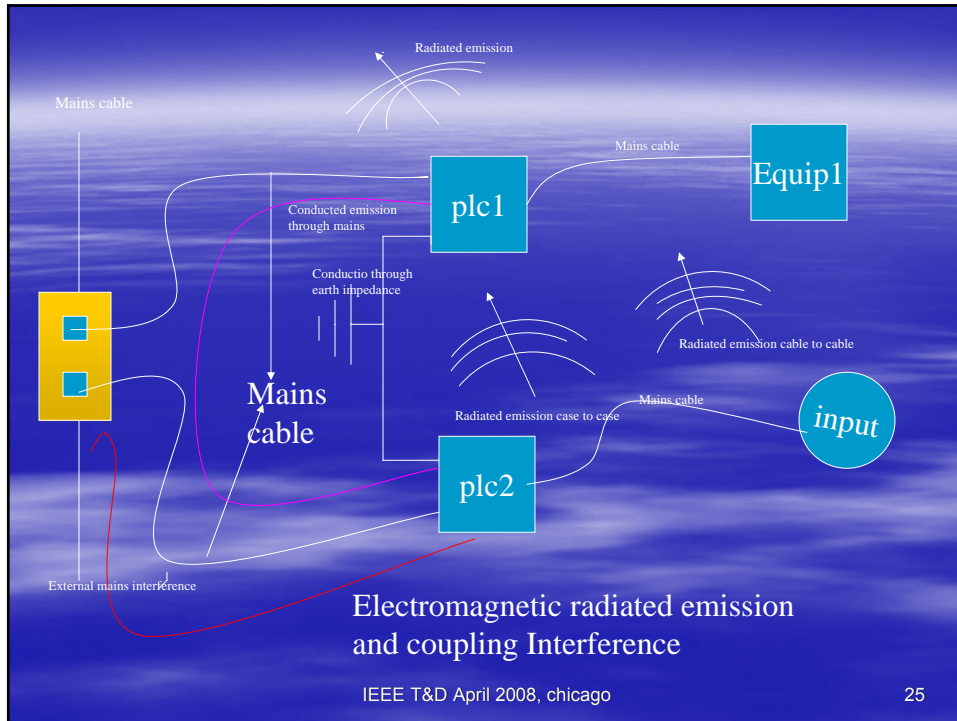
Scope



Physical structure of LV network







Coupling Paths

- Radiated Coupling path:
- Capacitive coupling
- Inductive coupling or
- Far field coupling
- Conducted Coupling Path
- Coupling through common impedance
- Both common and differential mode

Maximum Capacity of the network

Dependent on the following electrical and communication parameters of the network

- Communication channel bandwidth
- noise level
- signal level
- Robustness of the modulation system

Shannon's Equation

Predicts the maximum error-free capacity of a channel under white Gaussian noise for a given signal to noise ratio and channel bandwidth.

$$C = B \cdot \log_2(1 + S/N) \text{ bits/sec}$$

C is the capacity of the power line in bits/sec

where B is the available bandwidth in Hertz

S/N is the signal to noise ratio



Conclusions and Developments

- Develop Network architectures for HV ,MV and LV systems
- Establish measurement methods for Conducted emission and radiated emission
- Establish local networks for homes and businesses