Wide Area Networks (WANs)

CS 687
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Outline

- WAN
- Fiber Optical Network
- SONET
- WiMAX
NIST Framework

End-to-End Smart Grid (High-Level Taxonomy)

"End-to-End" Smart Grid (High-Level Taxonomy)

- Integrated Enterprise-Wide Advanced Control Systems
- Customer Energy Management Systems
- Smart Grid Applications Layer
  - Utility Control and Management System (U/M) Applications
  - End-Use Data for Application 1
  - Distributed Generation and Storage Data
  - Home Appliance Data and Control
  - AMI
- Communications Layer
  - WAN
  - HAN
- Power Layer
  - Generation
  - Transmission
  - Substation
  - Distribution
  - Home Building
  - Distributed Generation and Storage
Wide Area Networks

• A wide area network (WAN) is a telecommunication network that spans a large geographical area (i.e., any network that links across metropolitan, regional, or national boundaries).
• Examples of WANs
  – ISDN
  – X.25
  – Frame Relay
  – ATM
  – SONET (Synchronous Optical Network)
  – WiMAX

Fiber Optical Networks
Fiber Optics

- Fiber Optics are cables that are made of optical fibers that can transmit large amounts of information at the speed of light.

The Cable

- Fiber Optic have three major characteristics
  - Composed of fibers either glass or plastic and sometimes both

  - Are very flexible

  - Have different tips
Components

- Outside Jacket
- Cladding
- Core

Glass Fibers
Characteristics

- Glass Core
- Glass Cladding
- Ultra Pure Ultra Transparent Glass
- Made Of Silicon Dioxide
- Low Attenuation
- Popular among industries

Total Internal Reflection in Fiber
Advantages of Optical Transmission

- Large bandwidth permits high data transmission, which also supports the aggregation of voice, video, and data
- Technological improvements are occurring rapidly, often permitting increased capacity over existing optical fiber
- Immunity to electromagnetic interference reduces bit error rate and eliminates the need for shielding within or outside a building
- Glass fiber has low attenuation, which permits extended cable transmission distance
- Light as a transmission medium provides the ability for the use of optical fiber in dangerous environments
- Optical fiber is difficult to tap, thus providing a higher degree of security than possible with copper wire
- Light weight and small diameter of fiber permit high capacity through existing conduits

Disadvantages of Optical Transmission

- Cable splicing:
  - Welding or fusing: you must clean each fiber end, then align and carefully fuse the ends using an electric arc.
    - Time consuming
    - Least amount of signal loss between joined elements.
  - Gluing
    - Bonding material that matches the refractive index of the core of the fiber.
    - Time consuming
    - Higher loss of signal power than fusing.
  - Mechanical connectors
    - Considerably facilitate the joining of fibers,
    - More signal loss than do the other two methods
    - Can reduce the span of the fiber to a smaller distance.
Cost

• On a (bit/s)/km basis, the fiber cost will always be less than that for copper cable.

• Some organizations may require only a fraction of the capacity of the optical fiber.
  – It is often difficult to justify fiber to the desktop and similar applications where the cost of copper cable may be half or less than the cost of fiber.

SONET/SDH

• Current transmission and multiplexing standard for high speed signals
  – North America: Synchronous Optical Network (SONET)
  – Europe, Japan and rest of the world: Synchronous Digital Hierarchy (SDH)