Networking Technologies and Applications

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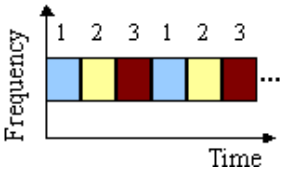
Networking basics

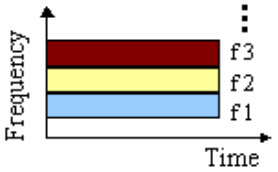
- The different access networks often are using a ***shared transmission medium***
  - Many others can hear me, I can hear many others
  - Providing a dedicated channel to every subscriber might be either impossible, or too expensive

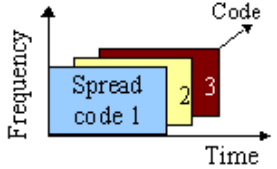
- The problem is to solve the ***access control*** to the transmission medium
  - Users do not know about each other who wants to send and when
  - Access to the medium has to be coordinated

Multiple Access

- **Solutions based on fixed allocations**
  - **TDMA – Time Division Multiple Access**
    - Each user has its own timeslot to send
    - Can use the entire frequency band
  - **FDMA – Frequency Division Multiple Access**
    - The spectrum is split into channels
    - Each user has its own channel
  - **CDMA – Code Division Multiple Access**
    - Each user communicates over the entire frequency domain, all the time
    - Traffic is separated based on code theory
      - The sender multiplies the signal with a spreading code, and sends over the result
      - The eceiver multiplies again the received signal with the same spreading code, to reproduce the original signal
      - Codes are orthogonal
        - » Multiplying two different codes returns a series of 0s







Multiple Access vs. Multiplexing vs. Duplexing

- **Multiple Access (TDMA, FDMA, CDMA)**
  - Regulating channel access in case of many parallel sources
  - Normally in the uplink direction
- **Multiplexing (TDM, FDM, CDM, …)**
  - Combining multiple signals, from one or many sources, onto the same shared medium
  - Uplink or downlink direction
- **Duplexing (TDD, FDD)**
  - Regulating the resources for downlink and uplink traffic
  - FDD – Frequency Division Duplexing
    - „Paired” frequencies, separate uplink and downlink channels
  - TDD – Time Division Duplexing
    - „Unpaired” frequencies, divided adaptively between uplink and downlink traffic

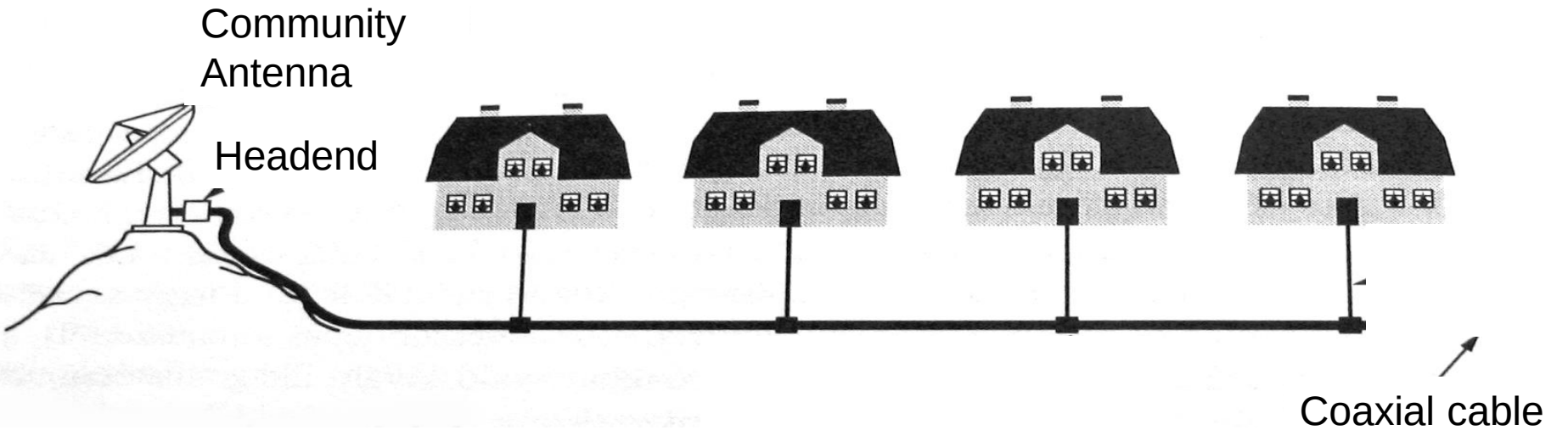
Multiple Access

- Fixed allocation is not efficient if traffic is sparse, and bursty
- **Contention-based Channel Access**
  - **Polling**
    - **Reserving and scheduling resources** based on current demand
  - **Random access**
    - A node starts sending when it wants, no previous reservation
    - If several nodes start speaking in the same time, collision occurs, the packet should be retransmitted later
    - ALOHA, Slotted ALOHA, CSMA/CD

Why cable TV?

- The idea appeared at the end of the 40's
  - Better signal quality for people living in suburbs, or in the mountains
- Community Antenna Television – CATV
  - A big antenna on the top of a hill
  - Headend
  - Coaxial cable
- Family business, anyone could deploy its own network
  - If more users, new cables and amplifiers needed
- One-way traffic, only from the head-end towards the subscriber

Early cable TV system



The development of cable TV

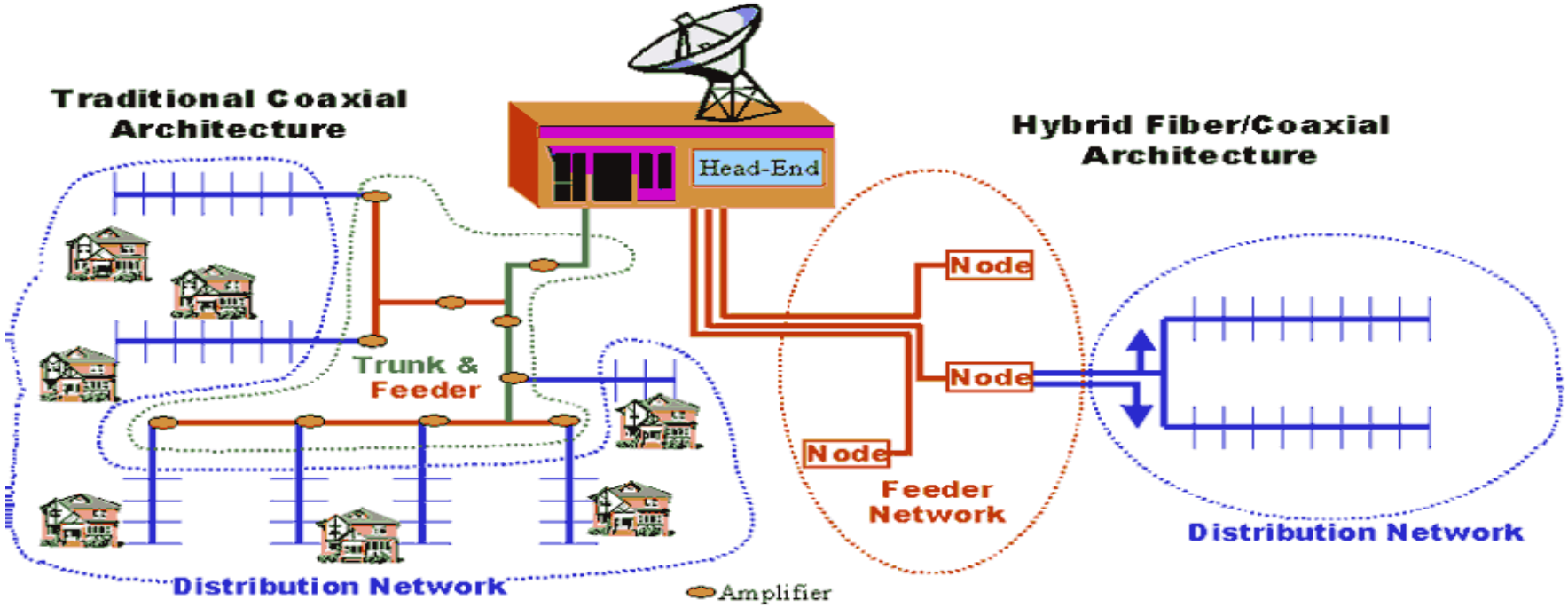
- Thousands of independent systems in the 70's
- HBO starts in 1974, as the first TV channel transmitted exclusively on cable
  - Many new thematic cable TV channels – news, sports, cooking, etc.
- Big companies start to buy the small local networks, and extend them with new cables
  - Cables linking the different cities
  - Similar process to the evolution of the PSTN networks
- The inter-city links changed later for optical fiber

HFC system

- HFC - Hybrid Fiber Coax
  - Optical fiber to span large distances
  - Coaxial cable to reach the homes

  - Fiber optic node
    - Electro-optical converter
      - Converts optical signals to electrical ones, and vice-versa
  - One optical cable can feed many coaxial cables
    - Much larger bandwidth

Modern Cable TV system



Internet on the cable