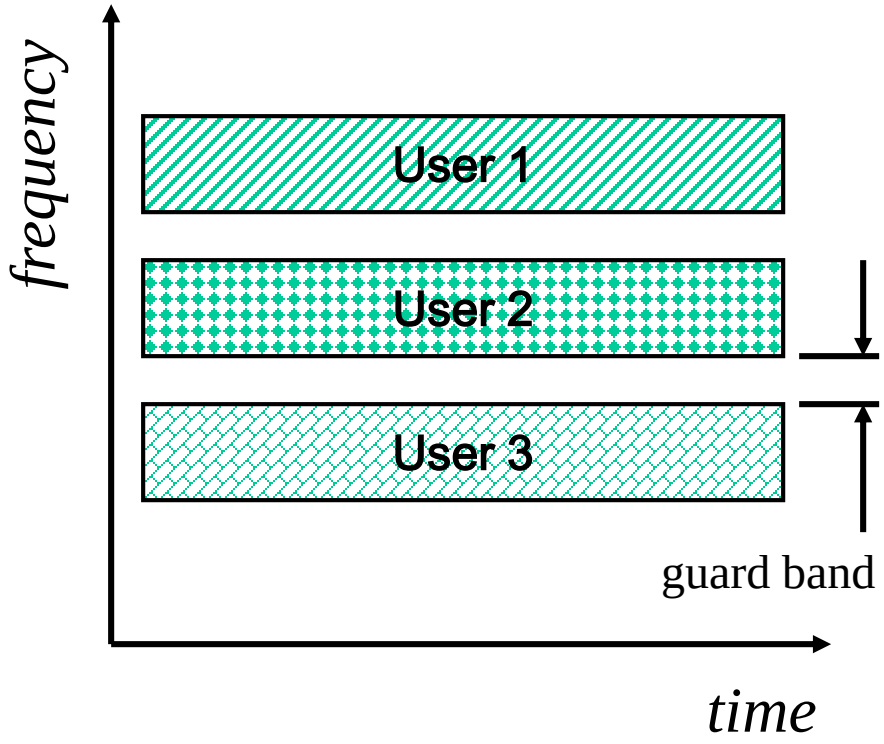
MULTIPLE ACCESS

Multiple Access Medium Sharing

- Multiple channels (users) often want to share a single medium (wire, air,…)
- Common schemes
  - Frequency division multiple access
  - Time division multiple access
    - Time slots assigned per user
  - Shared Frequency and Time
    - Somehow users must separate their data from others'
    - Example: Code division multiple access (CDMA)

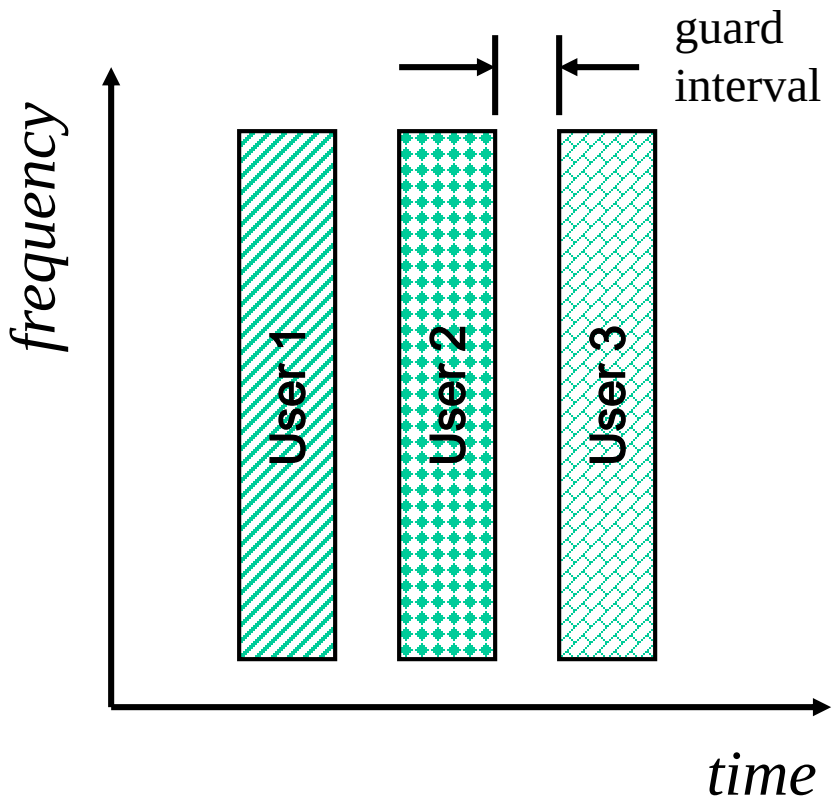
Frequency Division Multiple Access (FDMA)

- Frequency bands assigned per "user"
- All users active over all time
- Examples
  - AM and FM radio
  - Broadcast television



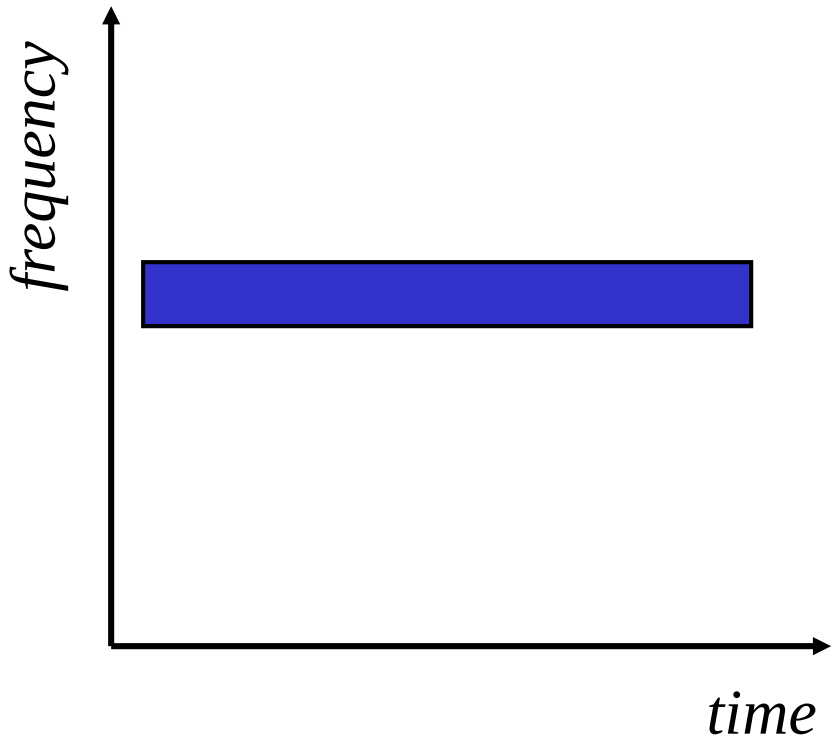
Time Division Multiple Access (TDMA)

- Time intervals assigned per "user"
- All users active over all frequencies
- Examples
  - Public address system in a store
  - Ethernet



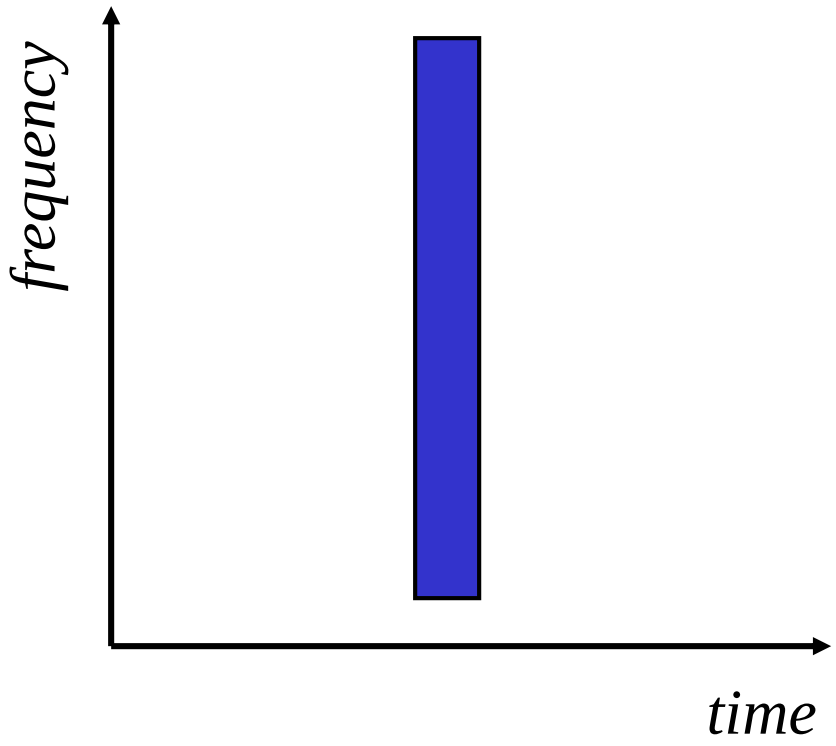
Interference Narrowband

- Interference commonly very strong in a narrow frequency channel
- Can be a problem for FDMA
- Examples
  - Nearby electronics (e.g., clock frequency in a computer)
  - 60 Hz power grid
  - Nearby radio transmitter



Interference Impulse

- Interference commonly very strong in a narrow time period
- Can be a problem for TDMA
- Examples
  - Lightning
  - Power surge (e.g., light switch)
  - Machines with arcing (e.g., motor or generator)

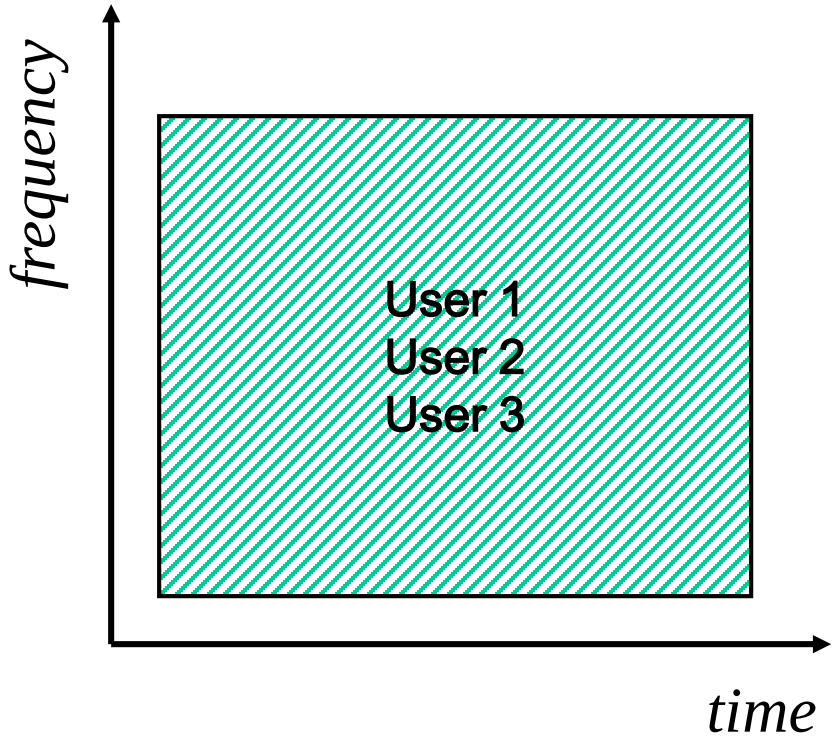


Spread Spectrum

- Transmission bandwidth much greater than data bandwidth
- Resistant to noise and interference
- Spread spectrum applications
  - Multiple users
  - Single user
- Examples
  - Frequency hopping
  - Direct Sequence Spread Spectrum (DSSS)
    - Waveform produced by multiplication of data bits by spreading code
    - Multiplied code bits called “chips”

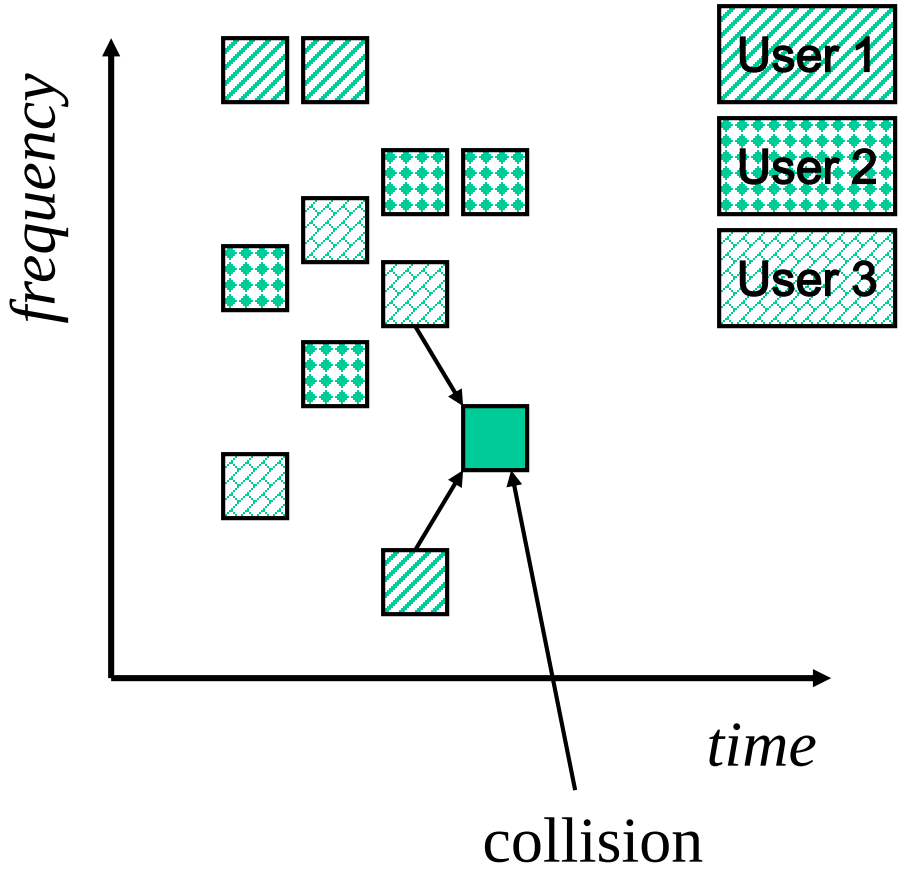
Code Division Multiple Access (CDMA)

- Users separated by a unique and specially-chosen *code*
- All users active over all frequencies and all time
- "Spread spectrum"
  - Generally more secure
- Examples
  - IS-95 digital cell phone standard



Frequency Hopping

- Signal briefly transmitted at pseudo-randomly chosen narrow frequency channels
- "Spread spectrum"
  - Looks like spread spectrum over a long time interval
  - Generally more secure
- Collisions may be unavoidable
  - One solution: retry
- Example
  - Bluetooth 2.4 GHz low-rate PAN, ~1 Mb/sec



Spread Spectrum Interference Resistance

- Spread spectrum generally resistant to common interference (unintentional and intentional)
- Early research and applications in military communications