

MOBILE COMPUTING

Unit-1

Introduction

Multiplexing Techniques

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Source & References:

The materials presented in this lecture has been taken from internet sites and books. This can be used only for academic purpose only.

- 1. J. Schiller, Mobile Communications, Pearson, 2nd Ed**
- 2. Asok K. Talukder, Mobile Computing-Technology, Applications & Service Creation, TMH**

What is Multiple Access

- Multiple users want to communicate in a common geographic area
- Cellular Example: Many people want to talk on their cell phones. Each phone must communicate with a base station.
- If only one person could talk on their cell phone at a time!
- **Problem:** How should we share our resources so that as many users as possible can communicate simultaneously
- The concept behind multiple access is to permit a number of users to share a common channel. The two traditional ways of multiple access are Frequency Division Multiple Access (**FDMA**) and Time Division Multiple Access (**TDMA**).



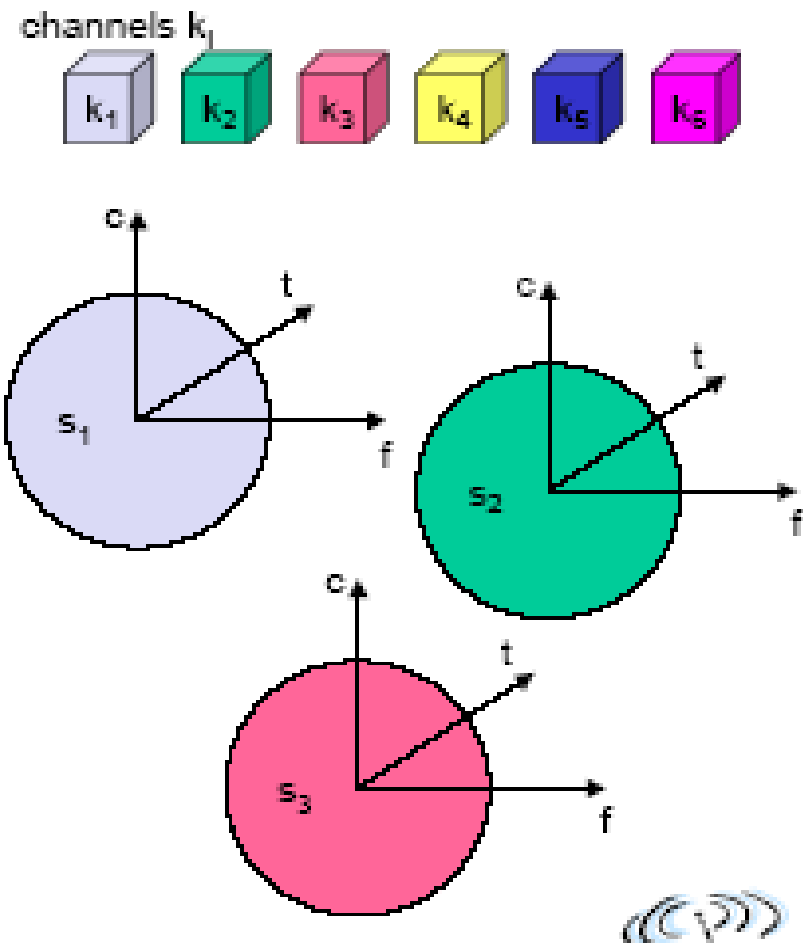
Multiplexing

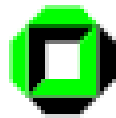
Multiplexing in 4 dimensions

- space (s_i)
- time (t)
- frequency (f)
- code (c)

Goal: multiple use
of a shared medium

Important: guard spaces needed!





Frequency multiplex

Separation of the whole spectrum into smaller frequency bands

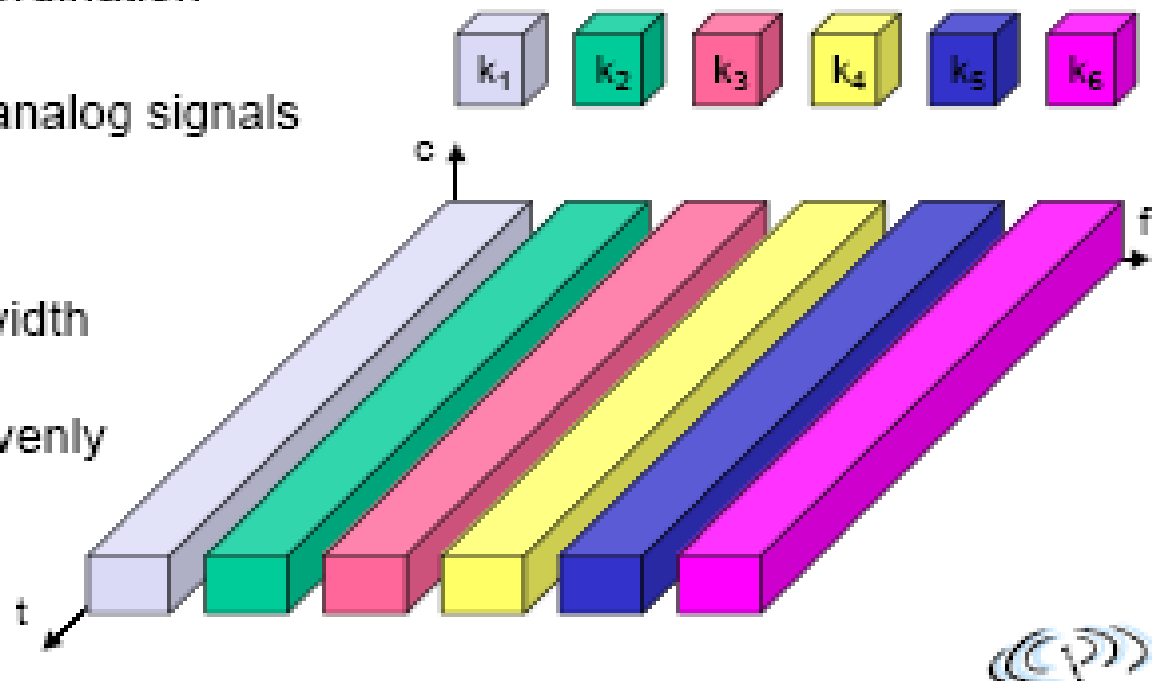
A channel gets a certain band of the spectrum for the whole time

Advantages:

- ❑ no dynamic coordination necessary
- ❑ works also for analog signals

Disadvantages:

- ❑ waste of bandwidth if the traffic is distributed unevenly
- ❑ inflexible
- ❑ guard spaces





Time multiplex

A channel gets the whole spectrum for a certain amount of time

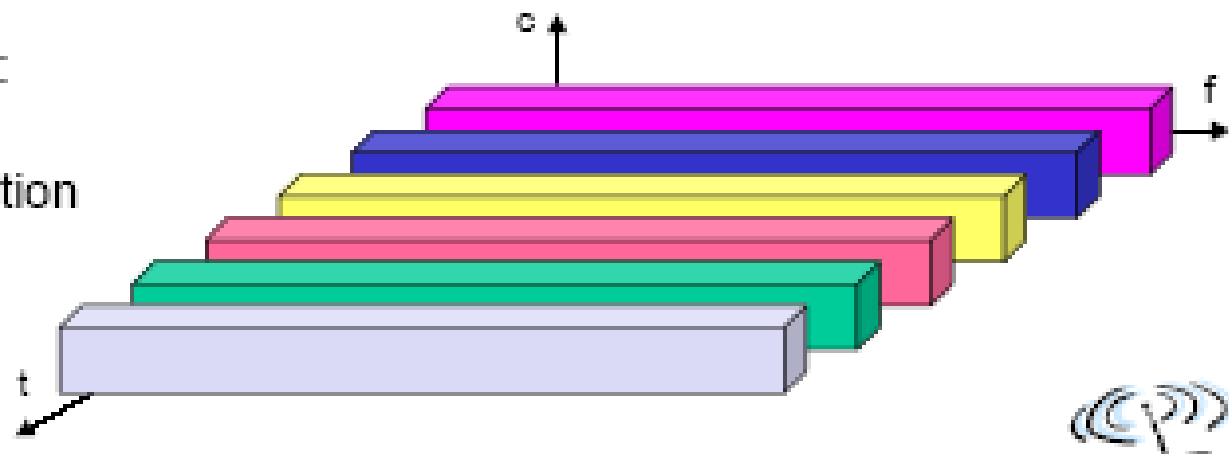
Advantages:

- ❑ only one carrier in the medium at any time
- ❑ throughput high even for many users



Disadvantages:

- ❑ precise synchronization necessary





Time and frequency multiplex

Combination of both methods

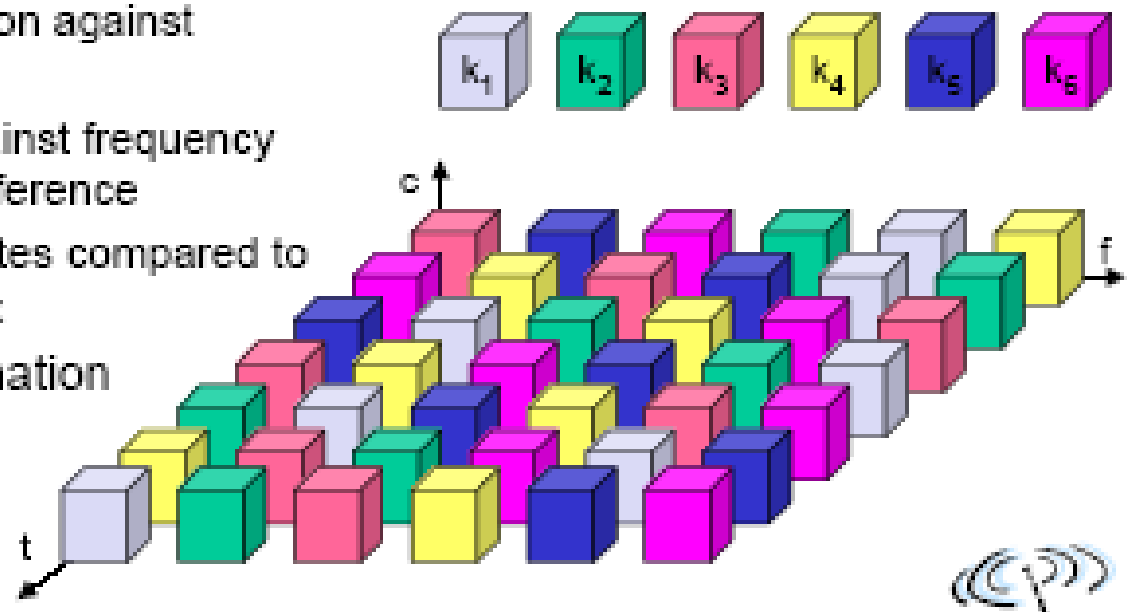
A channel gets a certain frequency band for a certain amount of time

Example: GSM

Advantages:

- better protection against tapping
- protection against frequency selective interference
- higher data rates compared to code multiplex

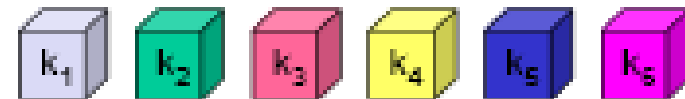
but: precise coordination required





Code multiplex

Each channel has a unique code



All channels use the same spectrum at the same time

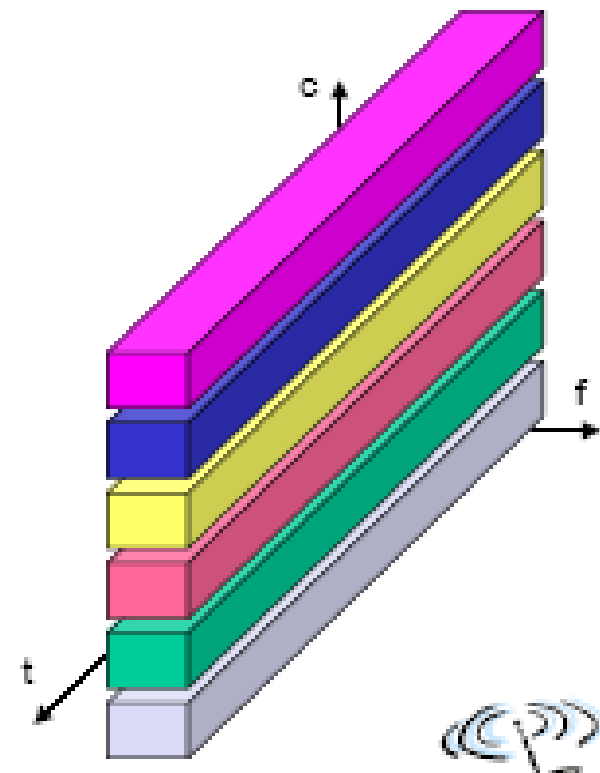
Advantages:

- bandwidth efficient
- no coordination and synchronization necessary
- good protection against interference and tapping

Disadvantages:

- lower user data rates
- more complex signal regeneration

Implemented using spread spectrum technology



Access Scheme

FDMA

- In Frequency Division Multiple Access, the frequency band is divided in slots. Each user gets one frequency slot assigned that is used at will. It could be compared to AM or FM broadcasting radio where each station has a frequency assigned. FDMA demands good filtering.

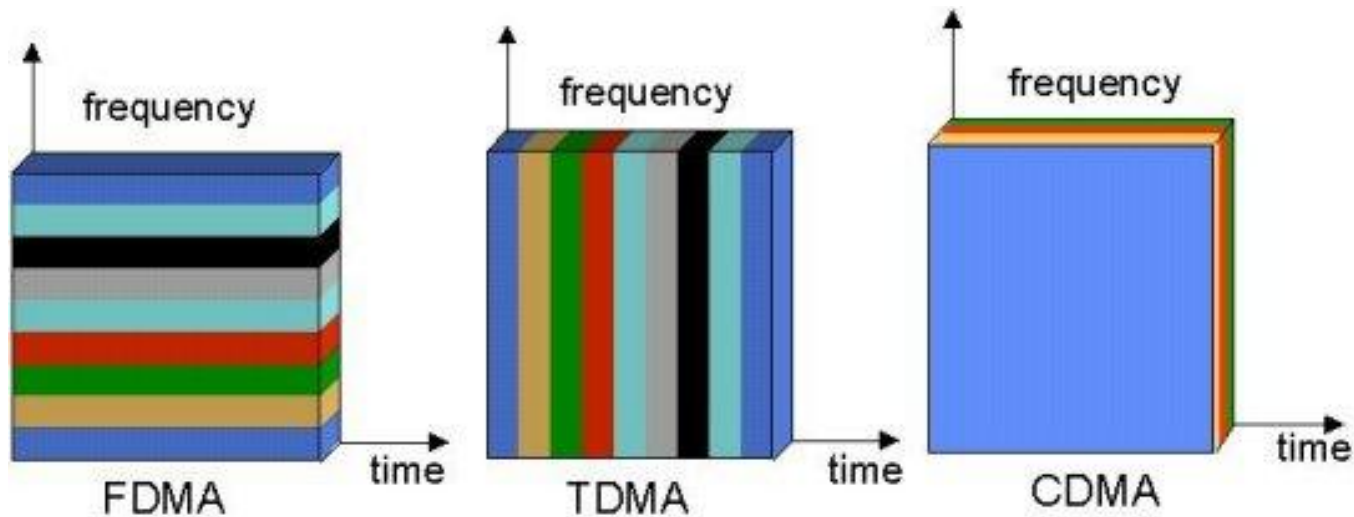
TDMA

- In Time Division Multiple Access, the frequency band is not partitioned but users are allowed to use it only in predefined intervals of time, one at a time. Thus, TDMA demands synchronization among the users

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Access Scheme (CDMA)

CDMA

- CDMA, for Code Division Multiple Access, is different than those traditional ways in that it does not allocate frequency or time in user slots but gives the right to use both to all users simultaneously. To do this, it uses a technique known as *Spread Spectrum*. Each user is assigned a code which spreads its signal bandwidth in such a way that only the same code can recover it at the receiver end. This method has the property that the unwanted signals with different codes get spread even more by the process, making them like noise to the receiver.

Access Scheme (CDMA)

- CDMA (Code-Division Multiple Access) refers to any of several protocols used in so-called second-generation (2G) and third-generation (3G) wireless communications. As the term implies, CDMA is a form of multiplexing, which allows numerous signals to occupy a single transmission channel, optimizing the use of available bandwidth. The technology is used in ultra-high-frequency (UHF) cellular telephone systems in the 800-MHz and 1.9-GHz bands.
- CDMA employs analog-to-digital conversion (ADC) in combination with spread spectrum technology. There are trillions of possible frequency-sequencing codes, which enhances privacy and makes cloning difficult.

Access Scheme (CDMA)

- The CDMA channel is nominally 1.23 MHz wide. CDMA networks use a scheme called soft handoff, which minimizes signal breakup as a handset passes from one cell to another. The combination of digital and spread-spectrum modes supports several times as many signals per unit bandwidth as analog modes. CDMA is compatible with other cellular technologies; this allows for nationwide roaming.
- The original CDMA standard, also known as CDMA One and still common in cellular telephones in the U.S., offers a transmission speed of only up to 14.4 Kbps in its single channel form and up to 115 Kbps in an eight-channel form. **CDMA2000** and **wideband-CDMA** deliver data many times faster.

SDMA VS TDMA VS FDMA VS CDMA

Approach	SDMA	TDMS	FDMA	CDMA
Idea	Segment Space into cells/ sectors	Segment sending Time into disjoint time-slots	Segment the frequency band into disjoint sub-bands	Spread the spectrum using orthogonal codes
Terminals	Only one terminal can be active in one cell/ one sector	All terminals are active for short periods of time on same frequency	Every Terminal has its own frequency, uninterrupted	All terminals can be active at the same place at the same moment, uninterrupted
Signal separation	Cell structure directed antennas	synchronization in the time domain	Filtering in the frequency domain	Code plus special receivers

SDMA VS TDMA VS FDMA VS CDMA

Approach	SDMA	TDMA	FDMA	CDMA
Handoff	Hard	Hard	Hard	Soft
Battery Life	Low, due to high transmitter power	Very Good due to simple protocol	Low, due to high transmitter power	Lower due to high demands of CDMA power control
Encoding	Digital	Digital	Analog	Digital

**Thank You
Any Questions**