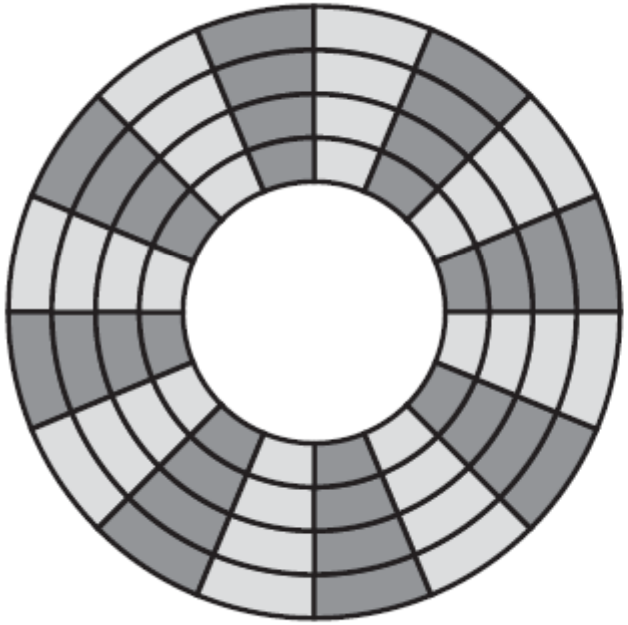
DATA STORAGE TECHNOLOGIES & NETWORKS

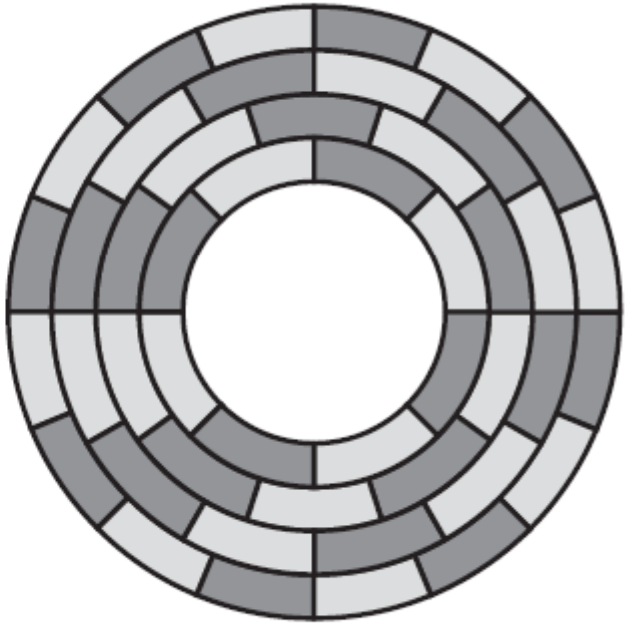
(CS C446, CS F446 & IS C446)

LECTURE 12– STORAGE

Multiple Zone Recording



(a) Constant angular velocity



(b) Multiple zoned recording

Zoned Bit Recording

- In older disks
  - Outer tracks have same sectors as inner track [data density is low in outer track]
- Zoned bit recording
  - Divide disk into zones – typical number is 16
  - Each zone has fixed bits/sectors per track
  - Utilizes disk efficiently
  - Groups tracks into zones based on their distance from center of the disk

Zoned Bit Recording

- Zones are numbered – outer most zone is 0
  - A zone near the center of the platter has fewer sectors per track than the ones in outer edge.
  - Tracks with in a particular zone has same # of sectors
- More complex circuitry to adjust for different data rates as heads move farther out.

Formatting

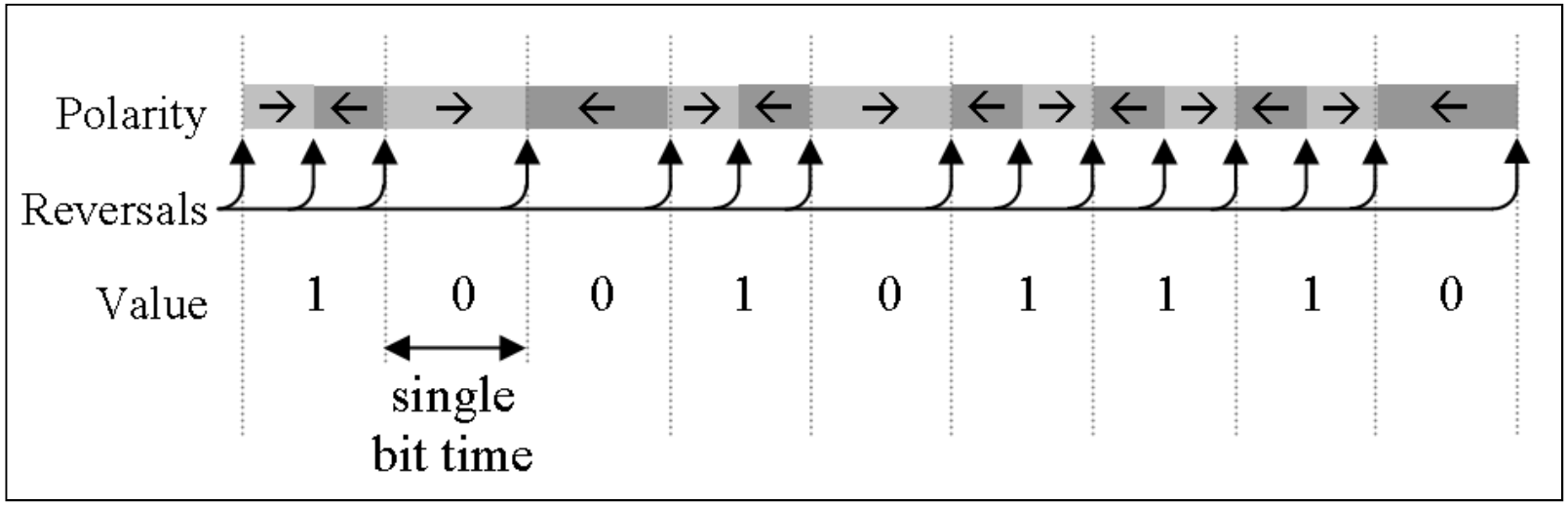
- Two kinds of formatting
  - Low level – allows hard drive to find sectors
  - O/S level – allows for file system
- Must be able to identify start of track and sector
- Format disk
  - Additional information not available to user
  - Marks tracks and sectors

Data Encoding

- Data is not stored as two directions of magnetic polarization corresponding to two values, 1 and 0.
- Reasons:
  - Hard drive heads detect the *changes* in magnetic direction, not the direction of the field
  - Difficult to read large blocks of all ones or all zeros – eventually controller would lose synchronization
- One method for storing data uses a clock to define the bit positions, and by watching how the magnetic field changes with respect to that clock indicates presence of one or zero

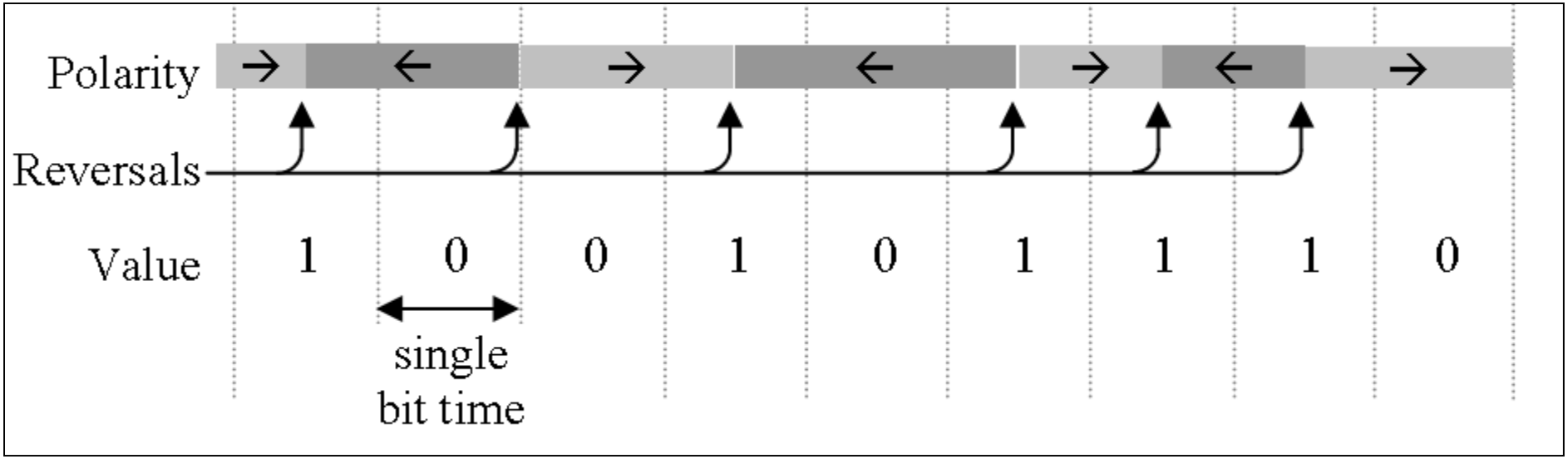
FM Encoding

- A magnetic field change at the beginning and middle of a bit time represents a logic one
- A magnetic field change only at the beginning represents a logic zero
- Referred to as *Frequency Modulation* (FM)



MFM Encoding

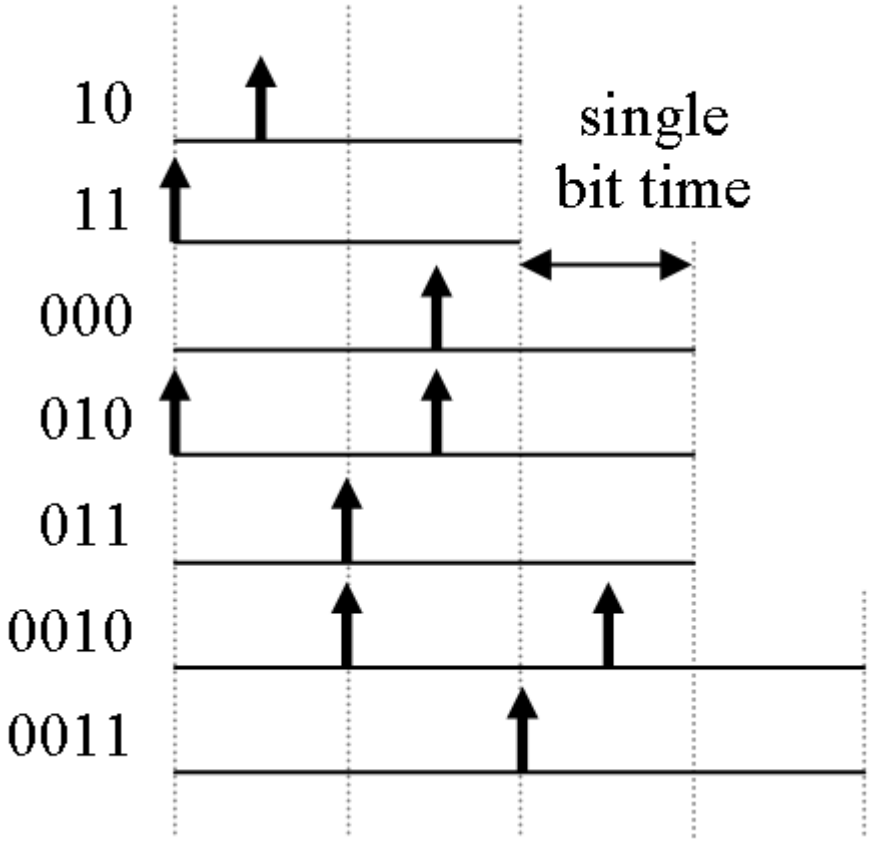
- Just like FM except that changes at beginning of bit time are removed unless two 0's are next to each other
- Called *Modified Frequency Modulation* (MFM)



RLL Encoding

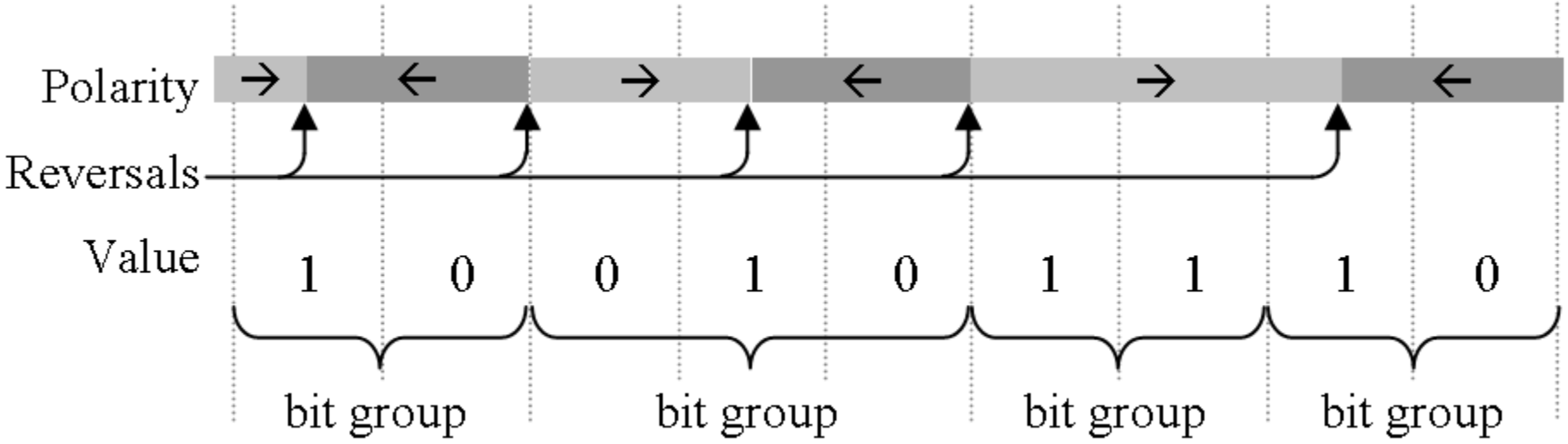
- Run Length Limited (RLL) Goals of encoding:
  - to ensure enough polarity changes to maintain bit synchronization;
  - to ensure enough bit sequences are defined so that any sequence of ones and zeros can be handled; and
  - to allow for the highest number of bits to be represented with the fewest number of polarity changes
- RLL uses polarity changes to represent sequences of bits rather than individual 0's or 1's

RLL Encoding



RLL Encoding

- Note that the shortest period between polarity changes is one and a half bit periods.
- This produces a 50% increased data density over MFM encoding.



Advanced Encoding Techniques

- Partial Response, Maximum Likelihood (PRML) and Extended PRML (EPRML) encoding
  - Increases amount of data storage by 40%
  - Replaces “detect one peak at a time” (analog) model to digital signal processing model
  - Controller analyzes the analog data stream it receives from the heads by using digital signal sampling, processing, and detection algorithms (this is the partial response element) and
  - Predicts the sequence of bits the data stream is most likely to represent (the maximum likelihood element)