شبكات الحواسيب

Computer Networks

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مفردات المنهاج

- أساسيات شبكات الحواسيب
  - بنية وهيكلية شبكات الحواسيب
- **طبقات شبكات الحواسيب (الشبكة، النقل، التطبيقات)**
  - **البروتوكولات والطرق والخوارزميات المستخدمة في كل طبقة**
- تطبيقات شبكات الحواسيب في مجال انترنت الأشياء IOT

طبقات شبكات الحواسيب (الشبكة، النقل، التطبيقات)

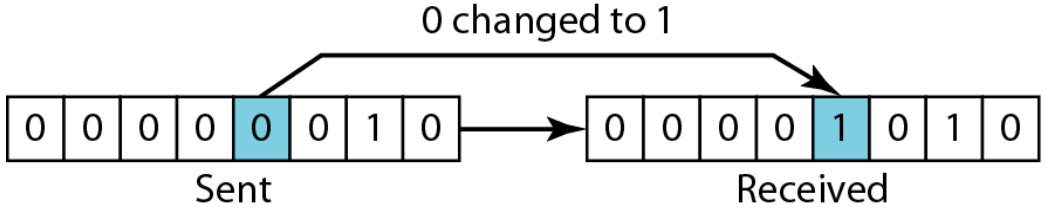
- تتضمن كل طبقة مجموعة من البروتوكولات التي تنظم عمل هذه الطبقة وتفاعلها مع الطبقات الأعلى والأدنى منها
- سنبدأ أولاً بالبروتوكولات المستخدمة في طبقة ربط البيانات:
  - الخدمات التي تقدمها طبقة ربط البيانات:

1. *framing:*
   - encapsulate datagram into frame, adding header, trailer
2. *Medium Access Control*
   - determine which node can transmit frames onto the shared link in order to avoid/detect collision
3. *flow control:*
   - a service aiming at preventing the sender from overwhelming the receiver.
4. *error control:*
   - Error detection
     - errors caused by signal attenuation, noise.
     - receiver detects presence of errors
   - Error correction: receiver identifies *and corrects* bit error(s) without resorting to retransmission

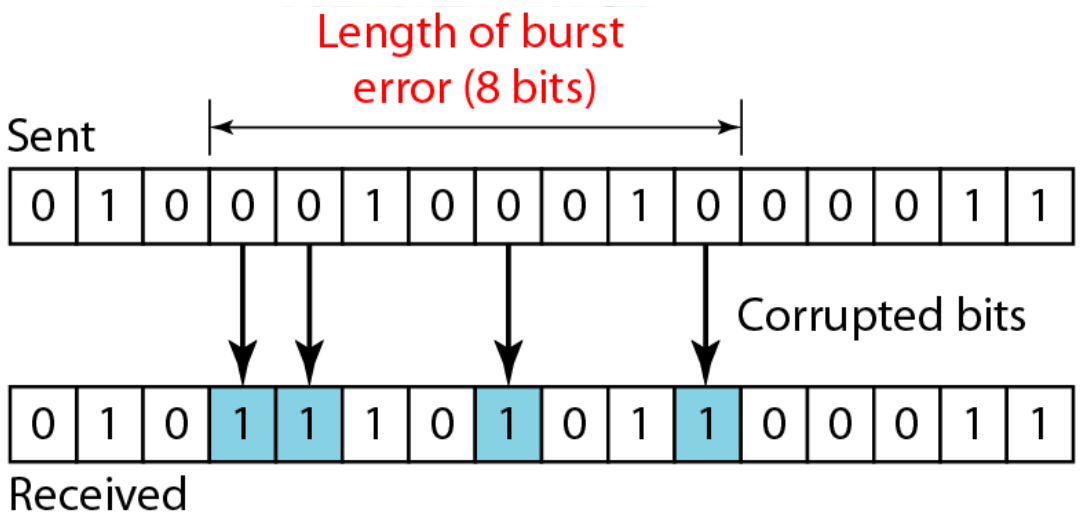
طبقات شبكات الحواسيب (الشبكة، النقل، التطبيقات)

- error detection, correction
  - Bits between nodes are subject to unpredictable changes (1->0 or 0->1) because of **interference**.
    - interference can change the shape of the signal

1. single-bit error:



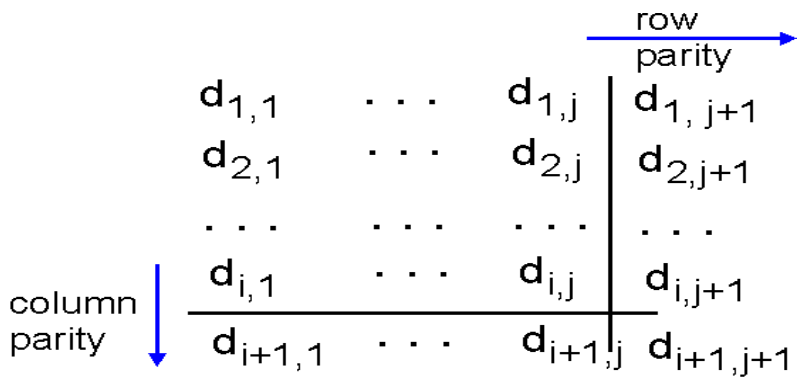
2. burst error:

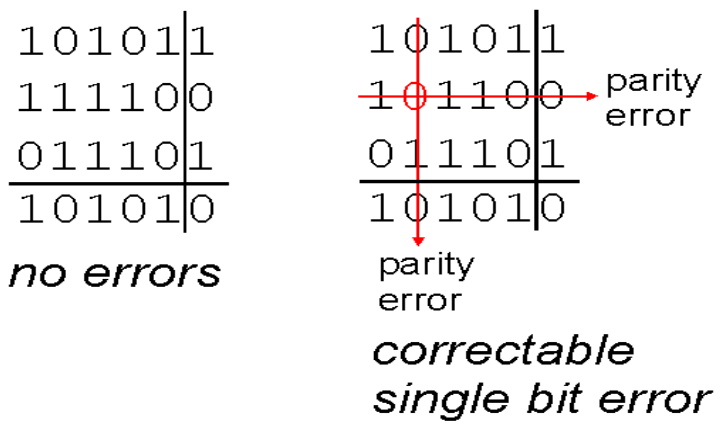


طبقات شبكات الحواسيب (الشبكة، النقل، التطبيقات)

- Parity checking
  - single bit parity:
    - detect single bit errors

  - two-dimensional bit parity:
    - detect and correct single bit errors





طبقات شبكات الحواسيب (الشبكة، النقل، التطبيقات)

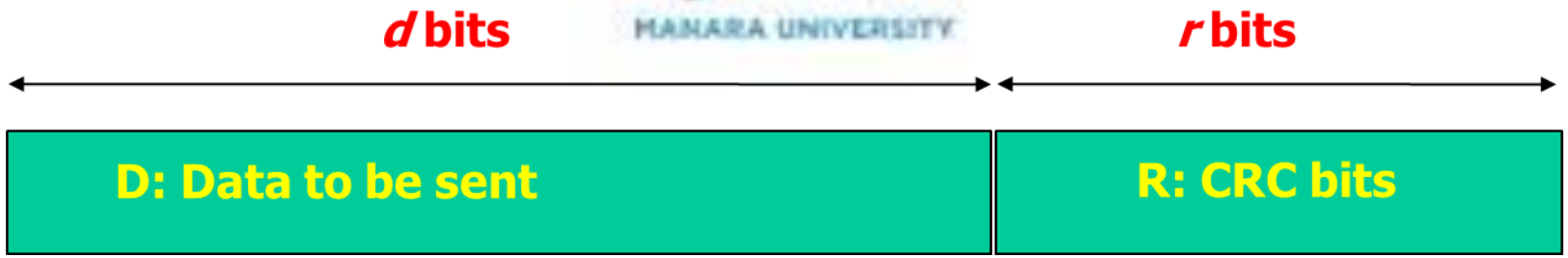
- Internet checksum
  - goal: detect “errors” (e.g., flipped bits) in transmitted packet (note: used at transport layer only)
  - sender:
    - treat segment contents as sequence of 16-bit integers
    - checksum: addition (1’s complement sum) of segment contents
    - sender puts checksum value into packet checksum field
  - receiver:
    - compute checksum of received segment
    - check if computed checksum equals checksum field value:
      - NO - error detected
      - YES - no error detected. But maybe errors nonetheless?
  - Example:

		1	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0
		1	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
wraparound	1	1	0	1	1	1	0	1	1	1	0	1	1	1	0	1	1
sum		1	0	1	1	1	0	1	1	1	0	1	1	1	1	0	0
checksum		0	1	0	0	0	1	0	0	0	1	0	0	0	0	1	1

  - .

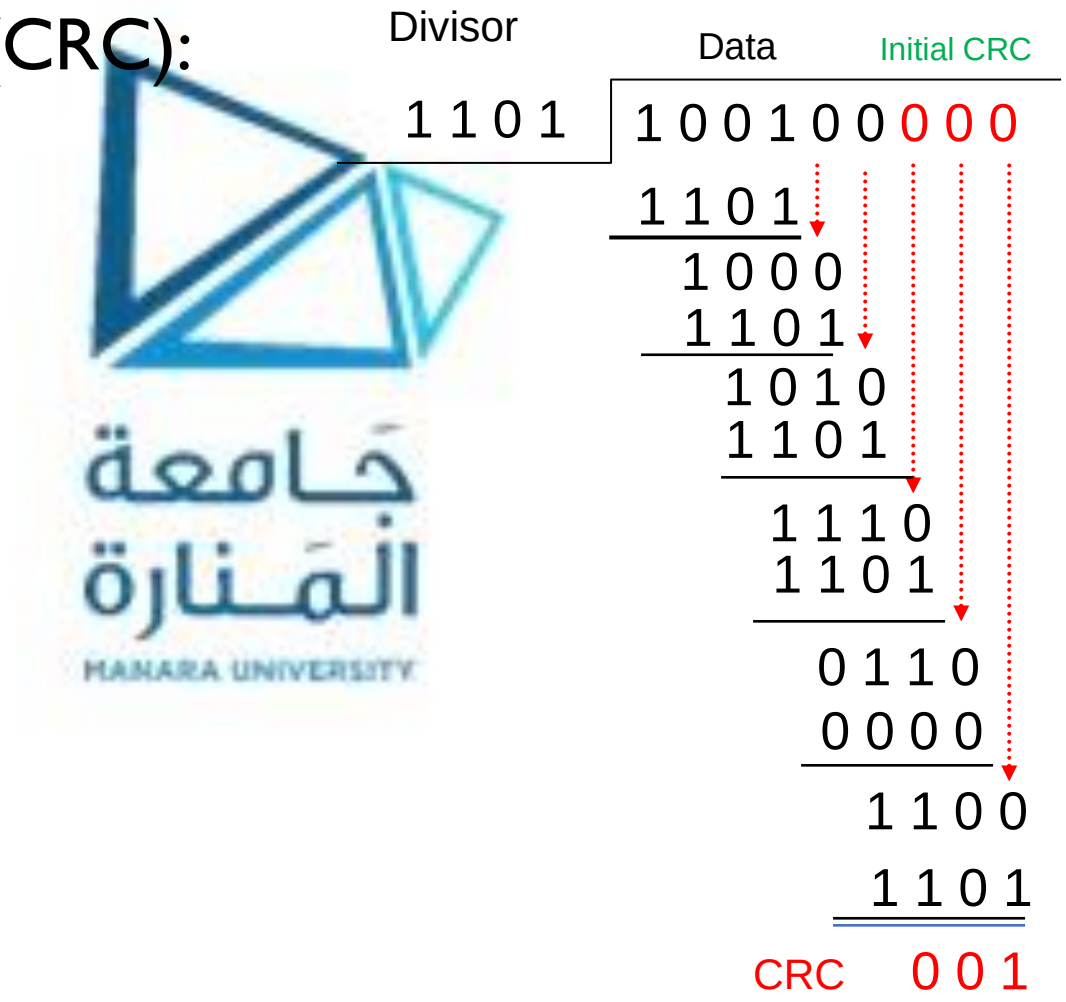
طبقات شبكات الحواسيب (الشبكة، النقل، التطبيقات)

- Cyclic Redundancy Code (CRC):
  - To detect errors using CRC, add extra r bits, the CRC, to a d-bit message
    - data is viewed as a string of coefficients of a polynomial (D)
    - A Generator polynomial is chosen (=> r+1 bits), (G)
      - G is known by sender and receiver
    - Multiply D by 2r (i.e., shift left r bits).
    - Divide (modulo 2) the polynomial D * 2r by G.
    - Append the remainder (R) to D.



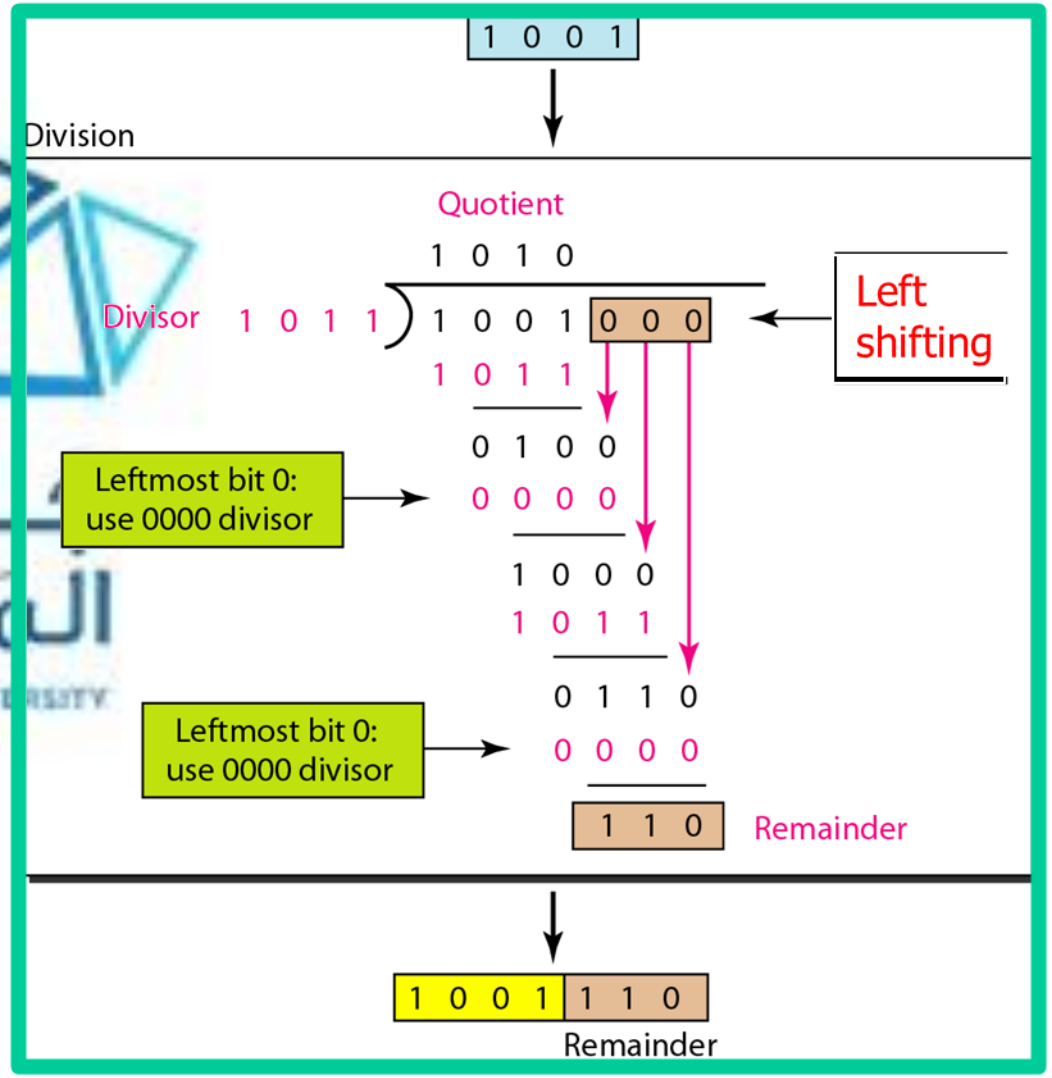
طبقات شبكات الحواسيب (الشبكة، النقل، التطبيقات)

- Cyclic Redundancy Code (CRC):
  - Example:
    - Data: 100100 (6 bits)
    - G: 1101
    - r = 3
    - Data to be sent is:
      - 100100001



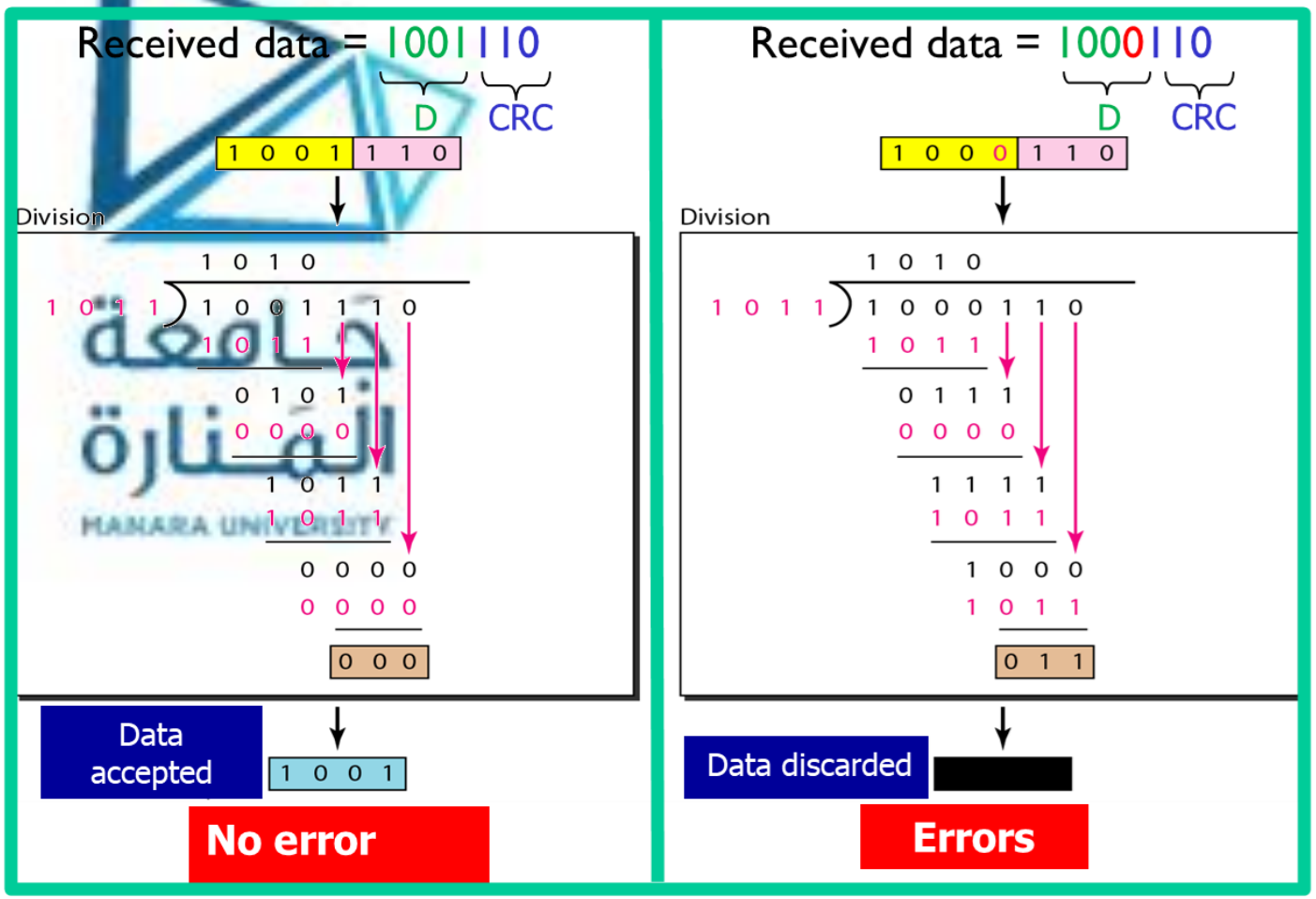
طبقات شبكات الحواسيب (الشبكة، النقل، التطبيقات)

- Cyclic Redundancy Code (CRC):
  - Another example:
    - D: 1001
    - G: 1011
    - R = 110
    - Data to be sent => 1001110



طبقات شبكات الحواسيب (الشبكة، النقل، التطبيقات)

- Cyclic Redundancy Code (CRC):
  - Example for received Data



طبقات شبكات الحواسيب (الشبكة، النقل، التطبيقات)

- Multiple access protocols:
  - single shared multipoint link (or broadcast channel)
  - two or more simultaneous transmissions by nodes: interference
    - collision if node receives two or more signals at the same time
  - Features:
    - distributed algorithm that determines how nodes share channel, i.e., determine when node can transmit
    - communication about channel sharing must use channel itself!
    - no out-of-band channel for coordination
  - Classification: three broad classes:
    - channel partitioning
      - divide channel into smaller “pieces” (time slots, frequency, code)
      - allocate piece to node for exclusive use
    - random access
      - channel not divided, allow collisions
      - “recover” from collisions
    - “taking turns”
      - nodes take turns, but nodes with more to send can take longer turns

طبقات شبكات الحواسيب (الشبكة، النقل، التطبيقات)

- Multiple access protocols:
  - Classification: three broad classes:
    - channel partitioning, by time, frequency or code
      - Time Division, Frequency Division
    - random access (dynamic),
      - ALOHA, S-ALOHA, CSMA, CSMA/CD
      - carrier sensing: easy in some technologies (wire), hard in others (wireless)
      - CSMA/CD used in Ethernet
        - Using binary (exponential) backoff:
          - after mth collision, NIC chooses K at random from {0,1,2, …, 2m-1},
          - NIC waits K·512 bit times, and returns to sensing the channel
      - CSMA/CA used in 802.11
    - taking turns
      - polling from central site, token passing
      - Bluetooth, FDDI, token ring