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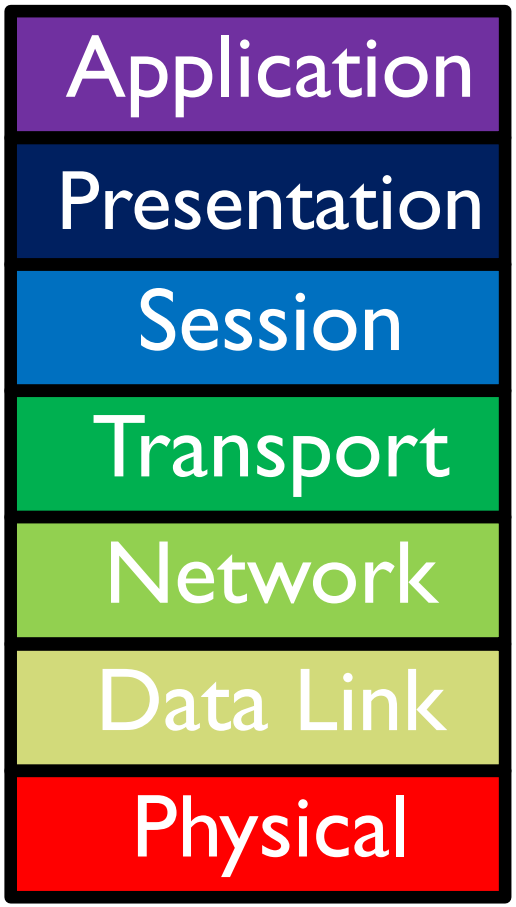
CS4700/5700: Network fundamentals

Physical layer.

1: Physical layer

Physical Layer



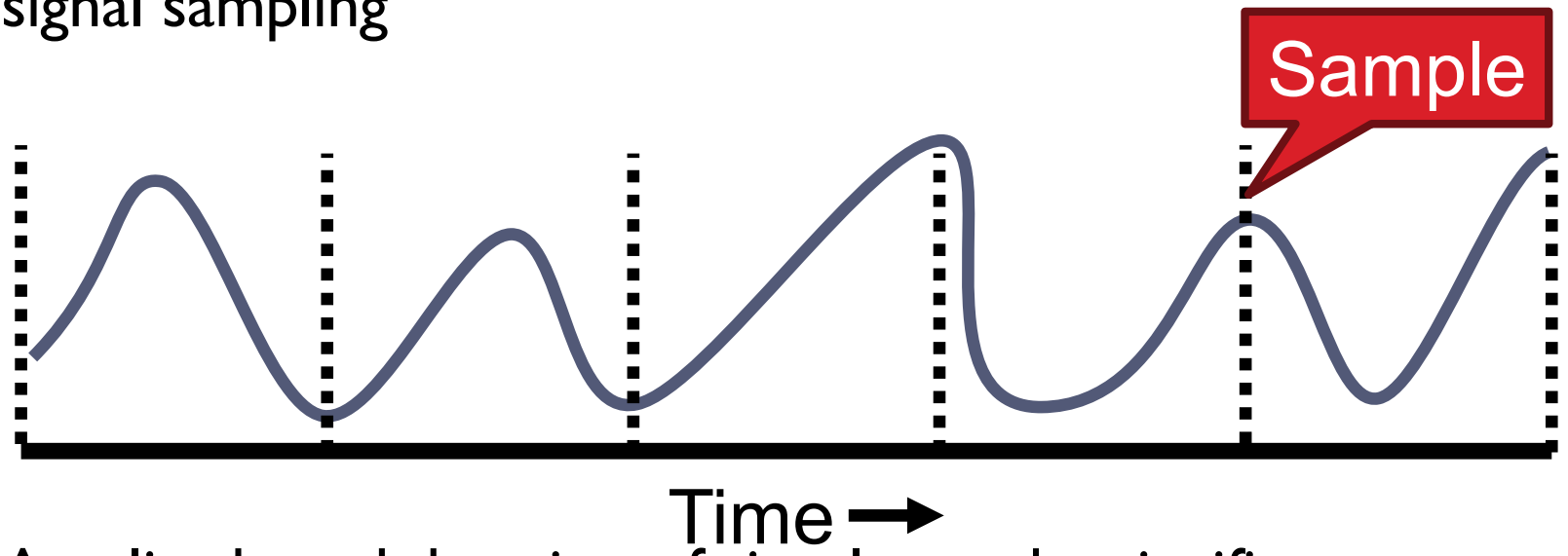
- Function:
  - Get bits across a physical medium
- Key challenge:
  - How to represent bits in analog
  - Ideally, want high-bit rate
  - But, must avoid desynchronization

Let's get digital

- Digital computers
  - 0s and 1s
- Analog world
  - Amplitudes and frequencies

Assumptions

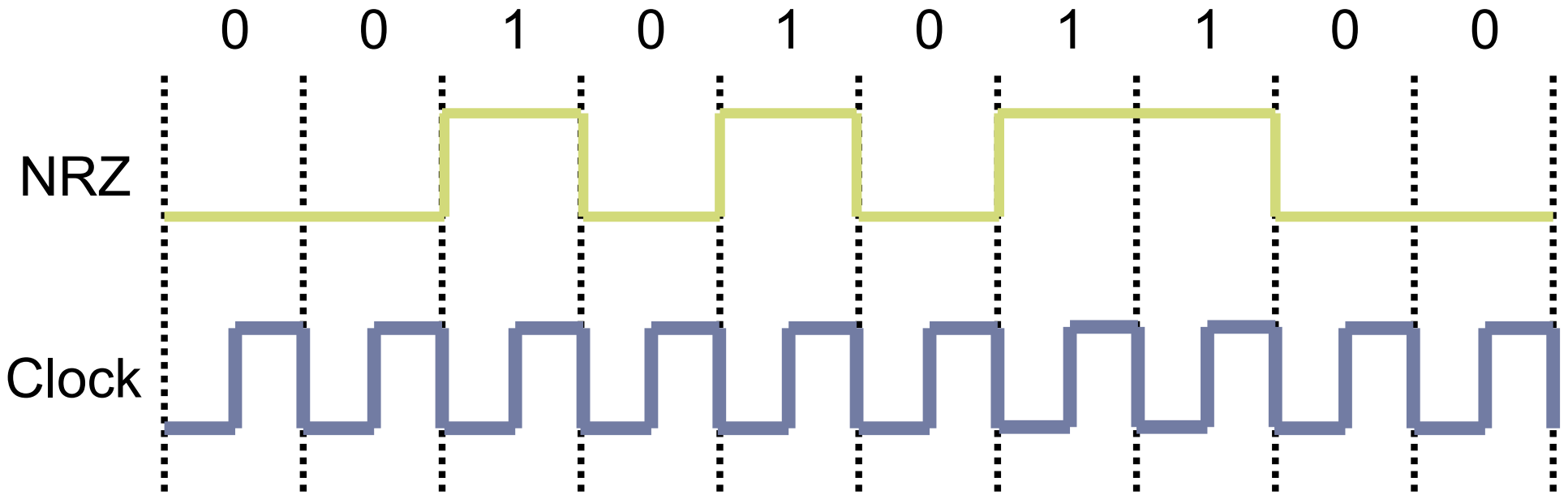
- We have two discrete signals, high and low, to encode 1 and 0
- Transmission is synchronous, i.e. there is a clock that controls signal sampling



- Amplitude and duration of signal must be significant

Non-Return to Zero (NRZ)

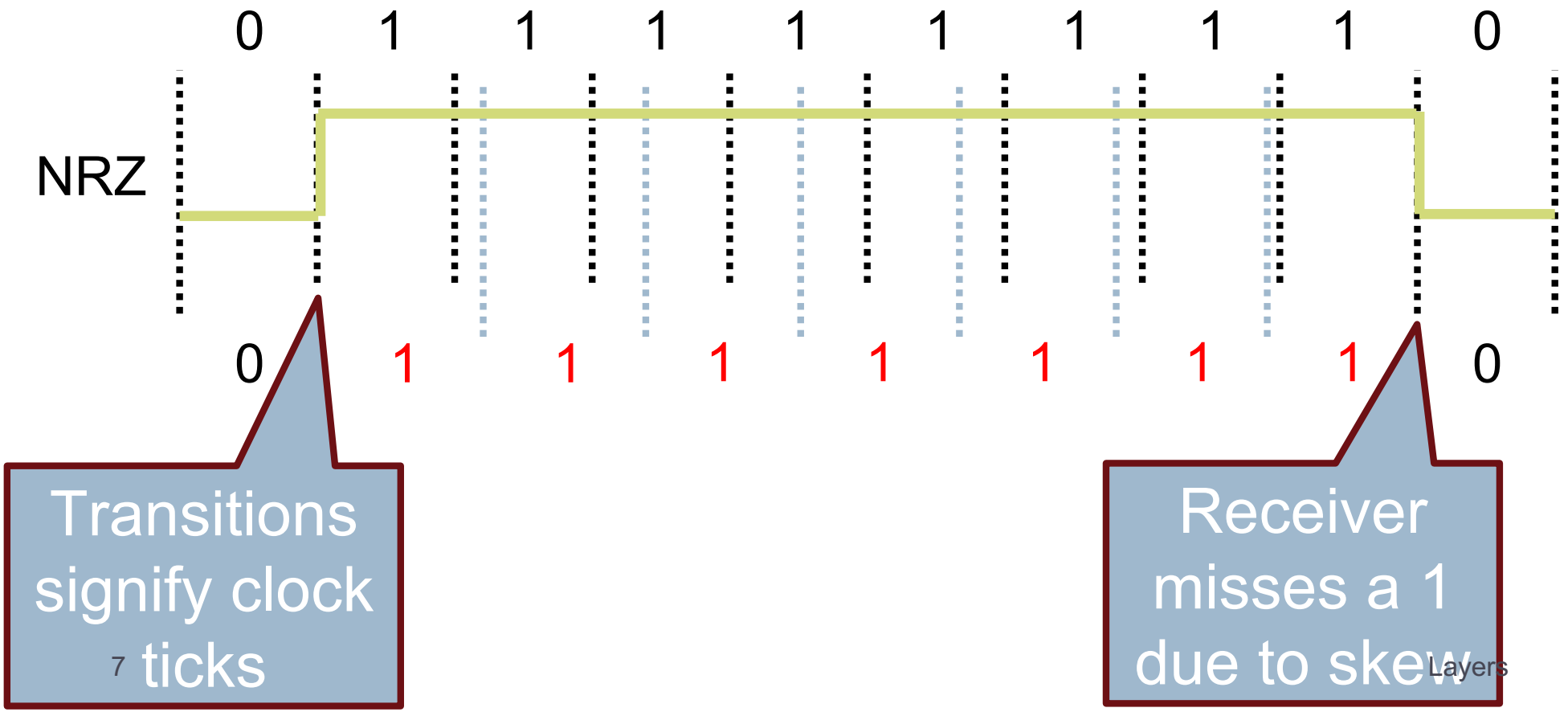
- 1 → high signal, 0 → low signal



- Problem: long strings of 0 or 1 cause desynchronization
  - How to distinguish lots of 0s from no signal?
  - How to recover the clock during lots of 1s?

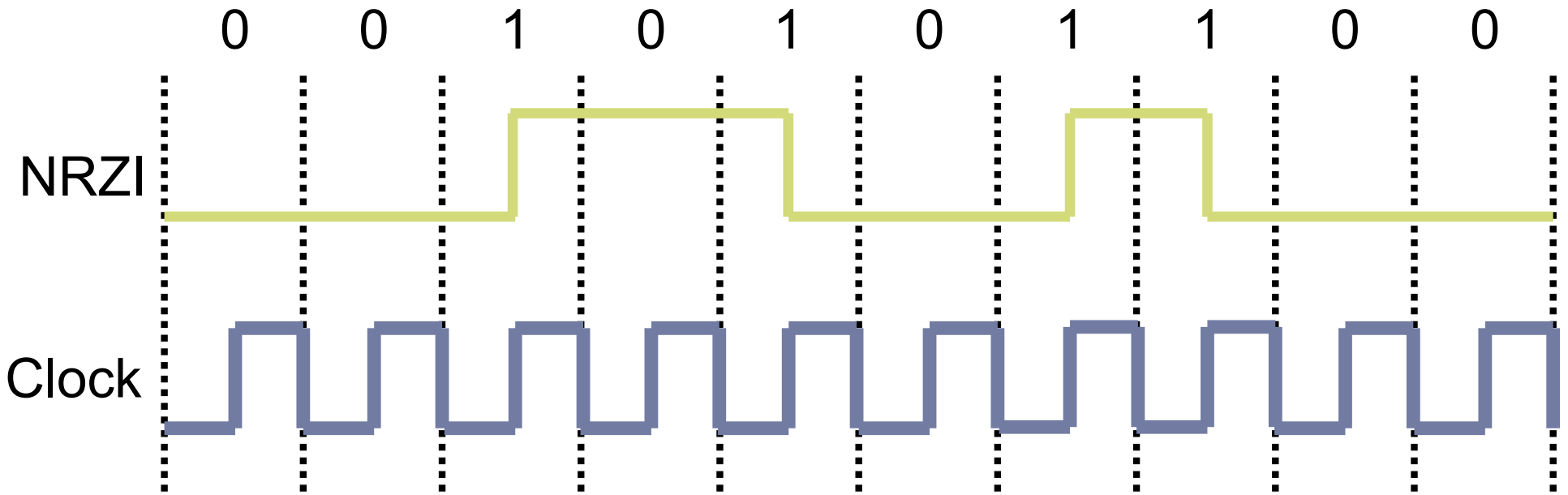
Desynchronization

- Problem: how to recover the clock during sequences of 0's or 1's?



Non-Return to Zero Inverted (NRZI)

- 1 → make transition, 0 → remain the same



- Solves the problem for sequences of 1s, but not 0s

4-bit/5-bit (100 Mbps Ethernet)

- Observation: [illegible]rks as long as no sequences of 0
- Idea: [illegible]s with no more than one leading 0 and two trailing 0

8-bit / 10-bit used in Gigabit Ethernet

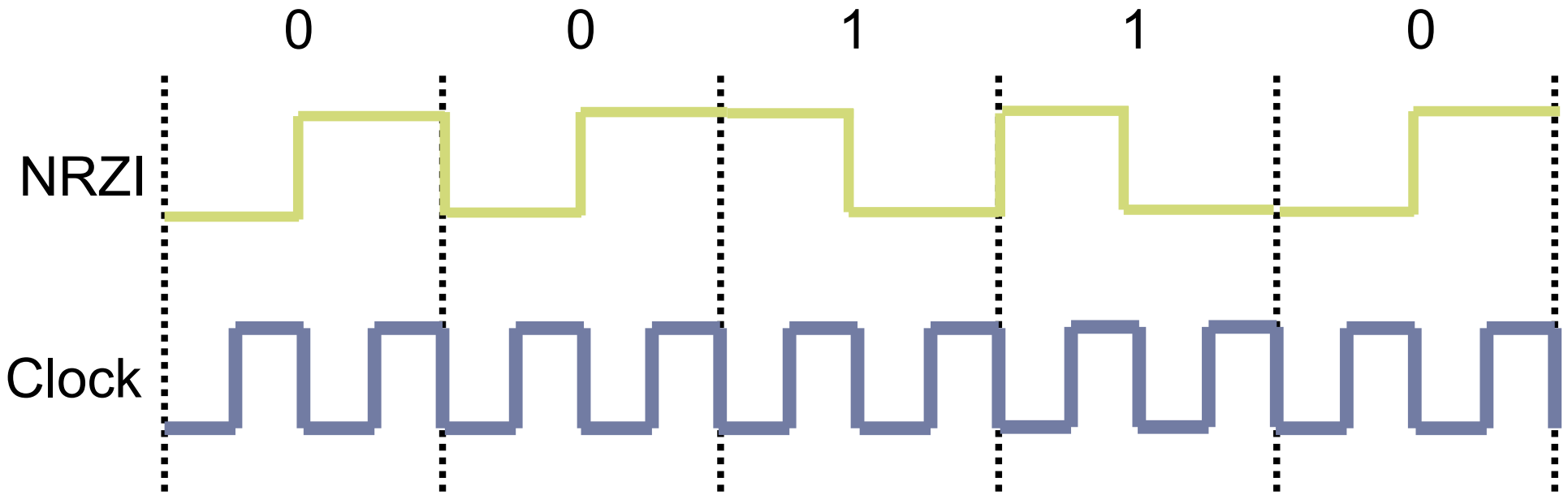
4-bit	5-bit
0000	11110
0001	01001
0010	10100
0011	10101
0100	01010
0101	01011
0110	01110
0111	01111

4-bit	5-bit
1000	10010
1001	10011
1010	10110
1011	10111
1100	11010
1101	11011
1110	11100
1111	11101

- Tradeoff: efficiency drops to 80%

Manchester

- 1 → high-to-low, 0 → low-to-high



- Good: Solves clock skew (every bit is a transition)
- Bad: Halves throughput (two clock cycles per bit)

General comment

- Physical layer is the lowest, so…
  - We tend not to worry about where to place functionality
  - There aren't other layers that could interfere
  - We tend to care about it only when things go wrong
- Physical layer characteristics are still fundamentally important to building reliable Internet systems
  - Insulated media vs, wireless
  - Packet vs. circuit switched media
  - Propagation speed, energy consumption, cost, …