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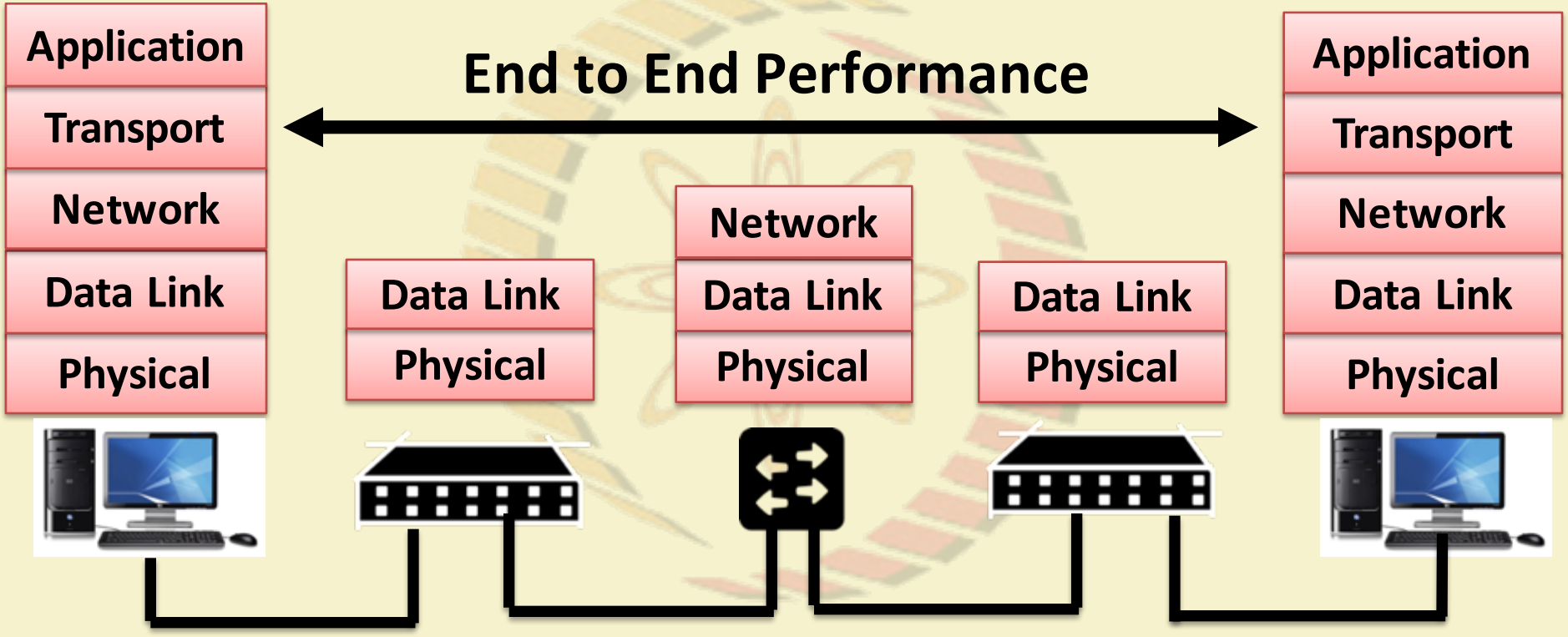
NPTEL ONLINE
CERTIFICATION COURSES

COMPUTER NETWORKS AND INTERNET PROTOCOLS

SOUMYA K GHOSH
COMPUTER SCIENCE AND ENGINEERING,
IIT KHARAGPUR

SANDIP CHAKRABORTY
COMPUTER SCIENCE AND ENGINEERING,
IIT KHARAGPUR

Transport Layer - VI (Performance)



Bandwidth Delay Product

- **Bandwidth Delay Product (BDP) = Link Bandwidth x Link Delay** – an important metric for flow control

- Consider Bandwidth = 50 Kbps, one way transit time (delay) = 250 msec
  - BDP 12.5 Kbit
  - Assume 1000 bit segment size; BDP = 12.5 segments

- Consider the event of a segment transmission and the corresponding ACK reception – this takes a round trip time (RTT) – twice the one way latency.

- Maximum number of segments that can be outstanding during this duration = 12.5 x 2 = 25 segments

Bandwidth Delay Product – Implication on Window Size

- Maximum number of segments that can be outstanding within this duration = 25 + 1 (as the ACK is sent only when the first segment is received) = 26
  - This gives the maximum link utilization – **the link will always be busy in transmitting data segments**

- Let **BD** denotes the number of frames equivalent to the BDP, **w** is the maximum window size

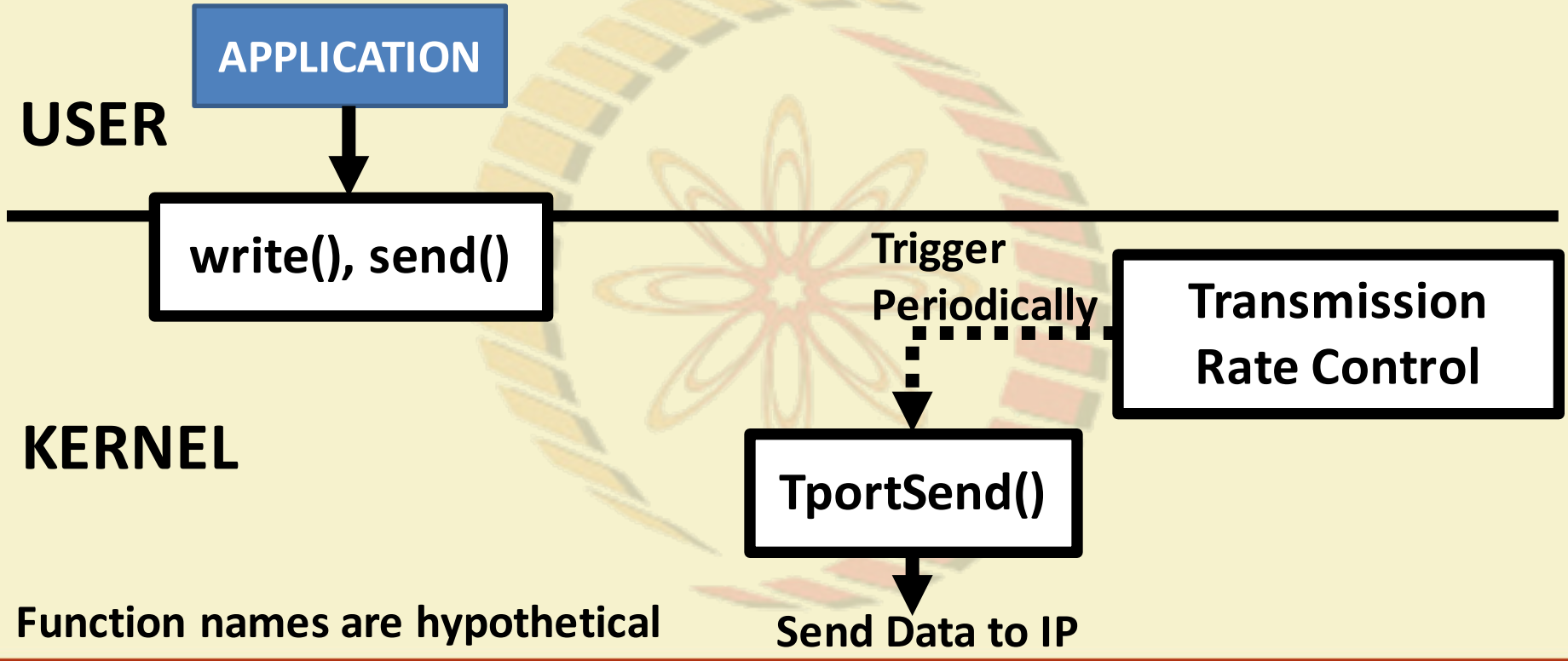
- So, **w = 2BD + 1** gives the maximum link utilization – **this is an important concept to decide the window size for a window based flow control mechanism**

Implication of BDP on Protocol Design Choice

- Consider the link bandwidth = 1Mbps, Delay = 1ms
- Consider a network, where segment size is 1 KB (1024 bytes)
- Which protocol is better for flow control?
  - (a) stop and wait,
  - (b) Go back N,
  - (c) Selective Repeat

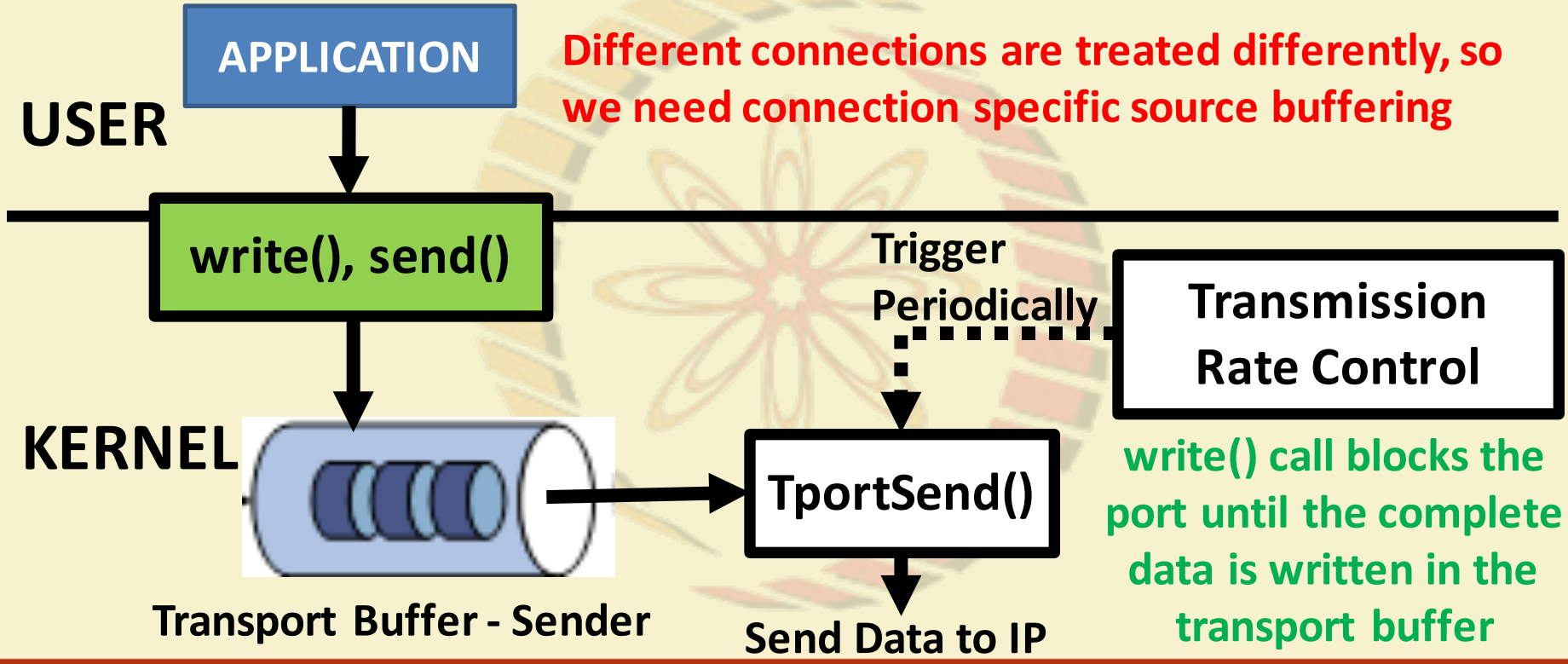
- **BDP = 1 Mbps x 1ms = 1 Kb (1024 bits)**
- **The segment size is eight times larger than the BDP -> the link can not hold an entire segment completely**
- **Sliding window protocols do not improve performance**
- **Stop and Wait is better – less complexity**

Application Transport Interfacing – Sender Side

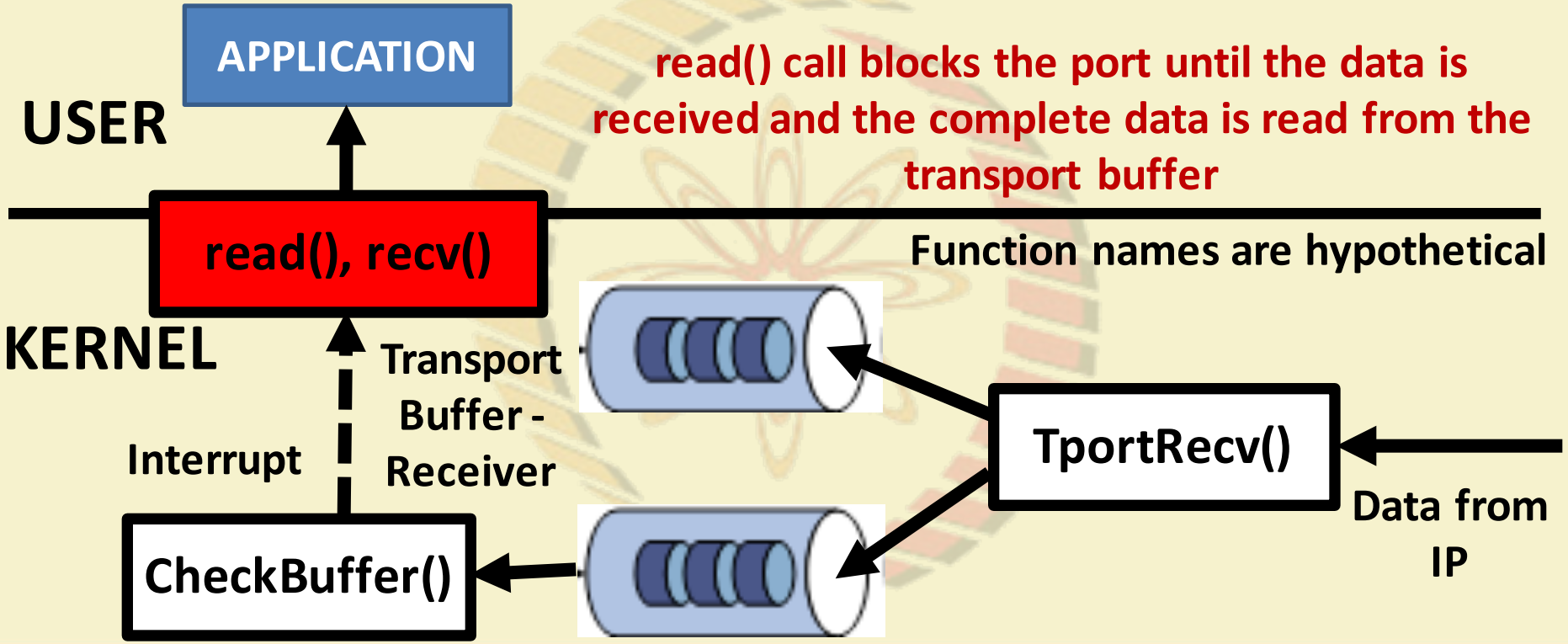


Function names are hypothetical

Application Transport Interfacing – Sender Side

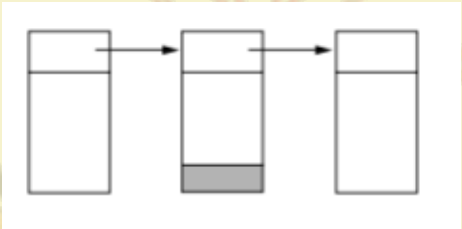


Application Transport Interfacing – Receiver Side



Organizing Transport Buffer Pool

- If most segments are nearly the same size, organize the buffer as a pool of identically sized buffers (one segment per buffer)
- For variable segment size – **chained fixed sized buffer** (buffer size = maximum segment size)

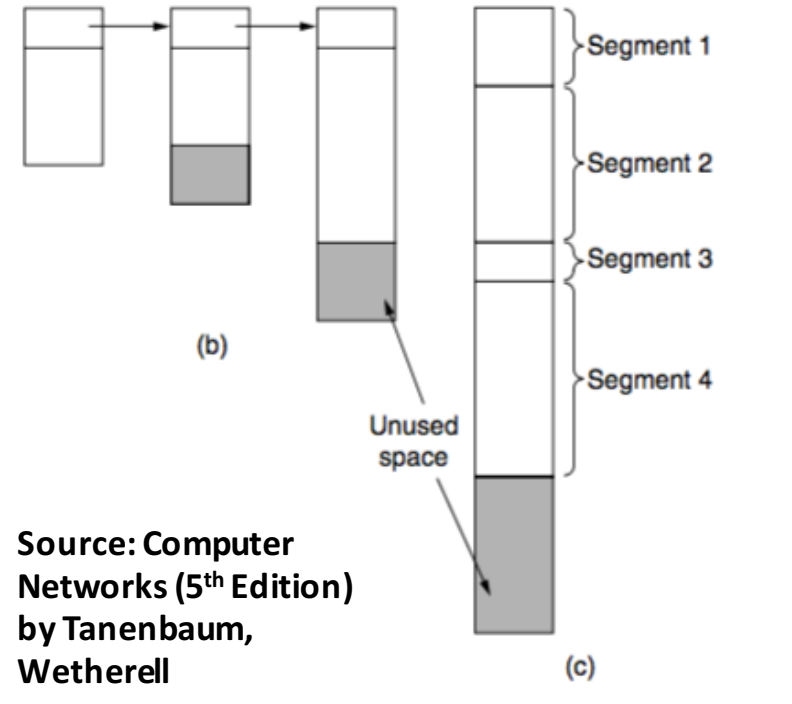


- Space would be wasted if segment sizes are widely varied
- Small buffer size – multiple buffers to store a single segment – added complexity in implementation

Organizing Transport Buffer Pool

- **Variable size buffers (b)**
  - Advantage: better memory utilization
  - Disadvantage: Complicated implementation

- Single large **circular buffer** for every connection (c)
  - Good use of memory only when connections are heavily loaded



Source: Computer Networks (5th Edition) by Tanenbaum, Wetherell


thank you!