# Eat all you can in an all-you-can-eat buffet: A case for aggressive resource usage

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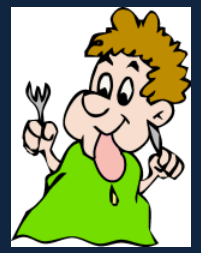
# Avoiding hunger

Alice walks into a restaurant

How much to eat to minimize the chance of getting hungry before the next meal?

1. As much as stomach space allows; or
2. Based on expected time until next meal

# Avoiding packet loss

Bob needs to transmit data over a noisy wireless channel

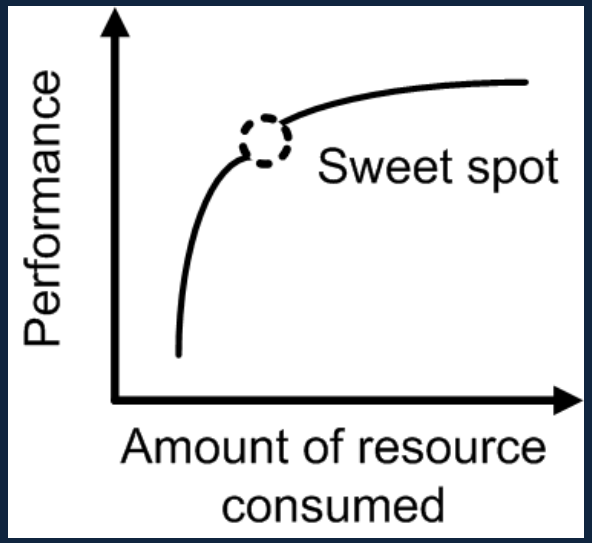
How much FEC to add to minimize the chance of losing packets?

1. As much as the available spectrum; or
2. Based on expected bit error rate

# The focus on efficiency in current designs

Operating at the sweet spot tends to be the goal

- Low efficiency beyond it

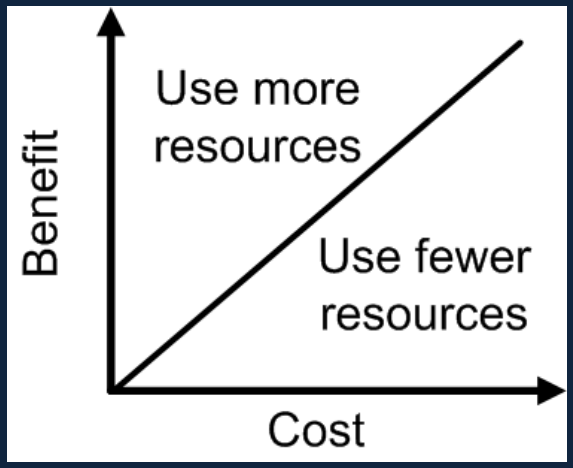



Inappropriate in many scenarios

- If the resource is of “use it or lose it” kind
- If the sweet spot is hard to determine

# The Buffet principle

*Continue using more resources as long as the marginal cost **can be driven** lower than the marginal benefit*



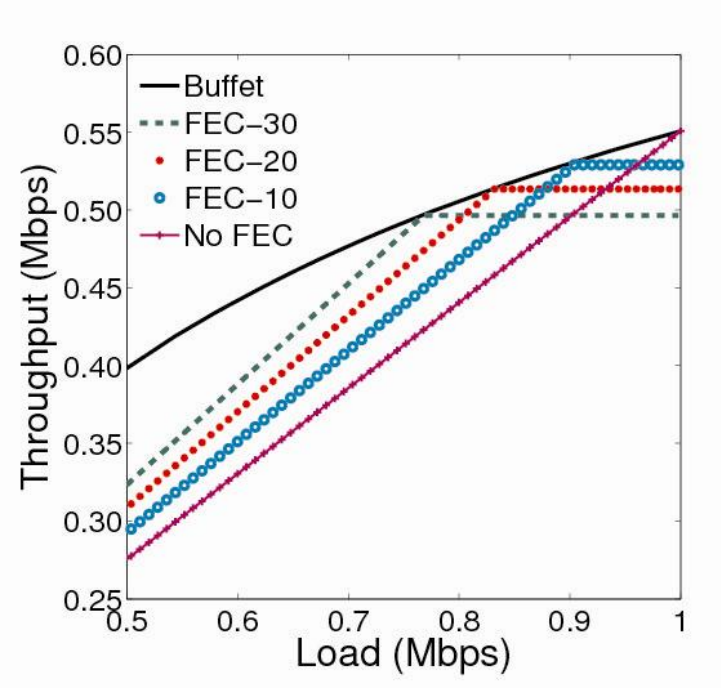

Key strength: performance limited by available resources, not artificial design choices

Key challenge: the default way to aggressively use resources is often problematic

# Case: Adding FEC to data transmissions

Current practice: # of FEC bits is independent of load and available spectrum

Buffet: aggressively use available spectrum for FEC bits




Simulation results with 1000-byte packets, 1 Mbps channel, $10^{-6}$ BER

# Making Buffet FEC practical

Greedy addition of FEC can hurt with multiple transmitters

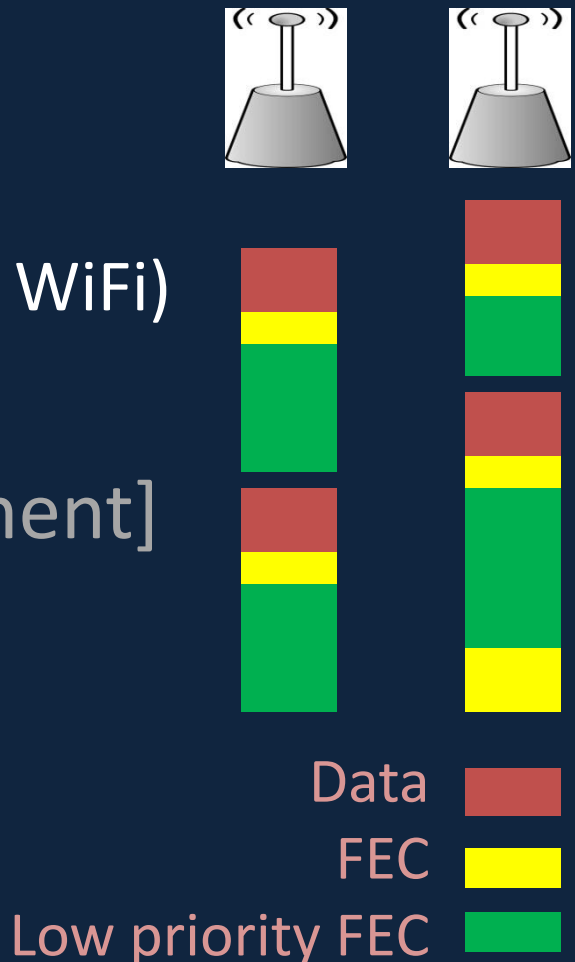
- Especially for CSMA systems (e.g., WiFi)

Possible solution [under development]

a) Embed bits in separate packets

b) Send at low priority

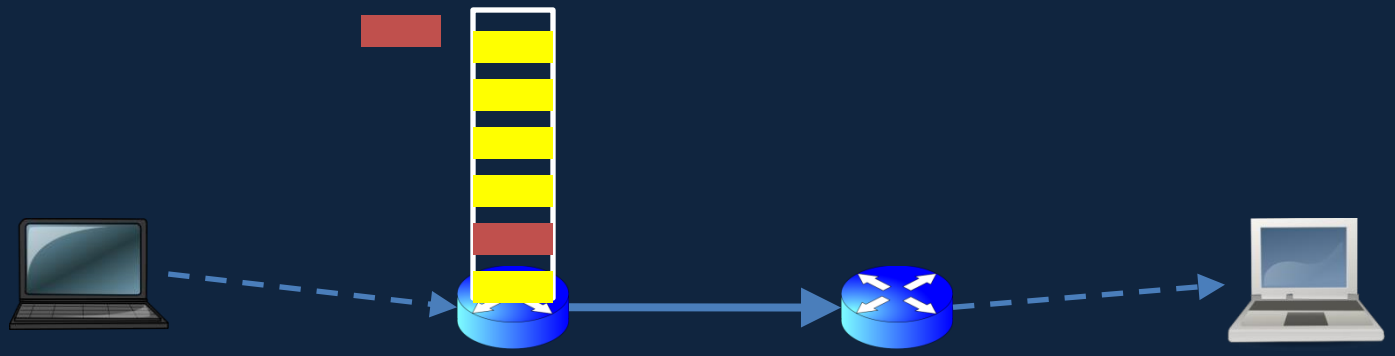
c) Keep FEC packets small



# Case: Erasure coding for lossy paths

Current practice: balance # of coded packets and bandwidth cost

Buffet: aggressively uses all available capacity



Managing the impact of aggressive redundancy

- Use priority on packets if router support is available
- Transmit only when queue is empty [under development]

# More case studies

Mobility updates in ad hoc networks

- Must balance freshness of info and bw overhead
- Buffet: Aggressively send updates per spare capacity
  - Prioritization can minimize impact on data transfers

Routing in delay-tolerant networks (DTNs)

- Must balance message delivery prob. and fairness
- Recent design (RAPID) uses the Buffet principle
  - A utility-driven framework prevents disproportionate resource usage by some messages

# Yet more case studies

Using replication to boost reliability

- Across disks within a computer
  - Use background tasks to manage overhead
- Across multiple computers
  - Use background transfers to manage overhead

Pre-loading binaries into memory

Pre-fetching Web pages into caches

Speculative execution of program branches

# Considerations in applying the Buffet principle

What are the challenges?

What resources does it apply to (naturally)?

What are the side-effects?

# Challenges in applying the principle

Aggressive resource usage should not detract from productive work

- Helpful techniques: explicit or implicit priorities; opportunistic usage; and utility-driven usage

Quantifying the marginal cost and benefit

- Must include the impact of side-effects as well
- Precise accounting not needed in many situations

# Applicable resources

More natural for non-conservable resources

- E.g., storage, bandwidth, computation
- Feasible for others as well (e.g., battery)

Easier when the resource is not shared with non-Buffet users

# Side-effects of aggressive resource use

New bottlenecks or concerns

- E.g., disk I/O bw, energy consumption

Increased hardware wear-and-tear

Task completion latency may increase

Performance is now coupled with load

# Conclusions

*Continue using more resources as long as the marginal cost **can be driven** lower than the marginal benefit*

The Buffet principle advocates aggressive resource usage instead of a singular focus on efficiency

It has the potential to provide the best performance for the level of available resources