Network performance, scalability & reliability
The 09_kahn way

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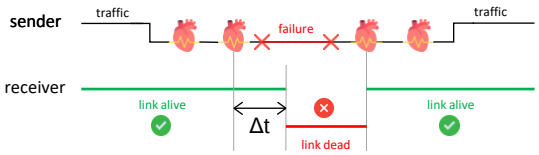
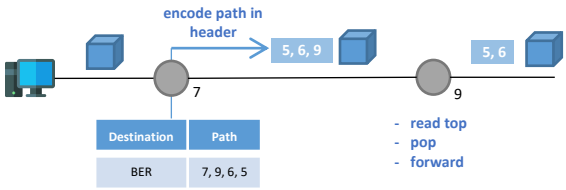
Failure detection

- Send heartbeats only if you're not sending regular traffic
- If you're not receiving any traffic → link is dead

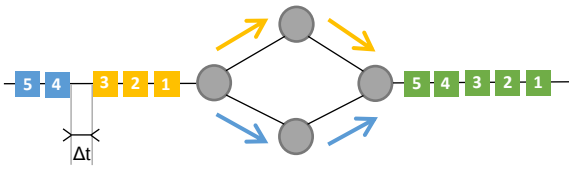


Static path encoding



- **Reduces packet processing time** in intermediate switches
- Only the source switch does a table lookup and encodes the entire path statically in the packet header

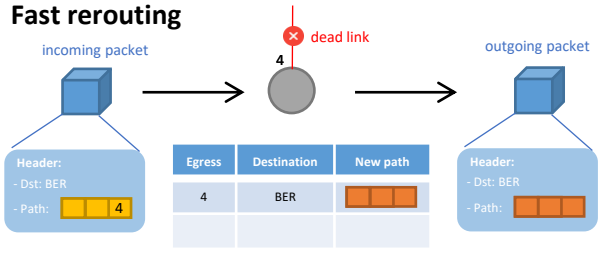
Flowlet-based routing for TCP



Δt = avg(host_to_host_round_trip_time)

Fine-grained routing decisions **without packet reordering** at the destination

Fast rerouting

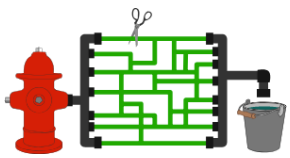


- Alternative path per (link, destination) pair
- Enables **fast sub-optimal convergence**
- Once the controller updates forwarding details, optimal paths are used

Load balancing & traffic engineering

TCP

Per-flowlet



Max flow algorithm based on available **bandwidth** capacity

UDP

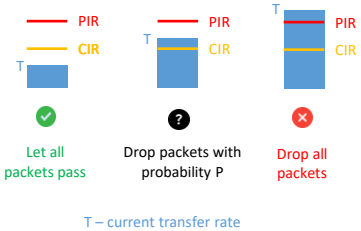
Per-packet

$P\{p_1, p_2, \ldots, pn\}$ Set of best paths

where $delay(p_n) \leq 1.25 * delay(p_1)$

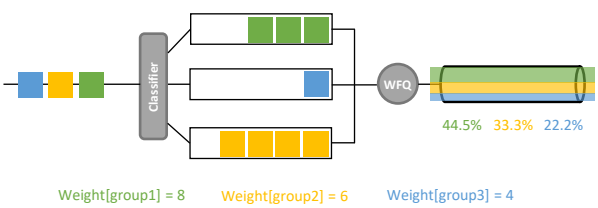
$$x_i = \frac{1}{delay(pi)^3} \qquad probability_i = \frac{x_i}{\sum_i x_i}$$

Minimizing overall delay by load balancing across several shortest paths



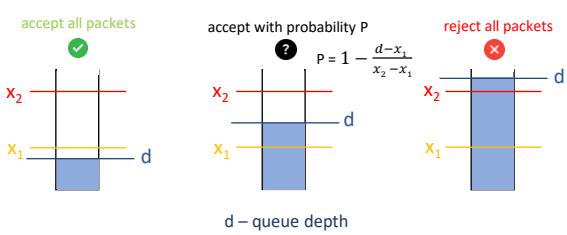
Prevent flow groups from taking monopoly over the link by **rate limiting**

Weighted fair queuing



- Prevents high-traffic flows from taking **monopoly** over links
- **Allows flow prioritization** by defining weights

Buffer acceptance – Random Early Detection



- Control TCP sending rate **preventively**, before the queue is filled
- **Prevents** TCP flow **synchronization**