Separation of Data Path and Data Flow Sublayers in the Transport Layer

<draft-asai-tsvwg-transport-review-00>

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Smart Network from End-to-End Principle

- End-to-End Principle
  - Dumb network with smart end-hosts
- Smarter network → Non-standardized (or ad-hoc sometimes) architecture for intra-domain services
  - QoS
    - DiffServ
    - Segment routing

    } path-aware but transparent
  - Middlebox
    - Firewall
    - Content caching, Transcoding
    - TCP acceleration

    } e.g., force rerouting to a waypoint with policy-based routing
  - New distributed computing paradigm
    - Pub/sub model for machine-to-machine communication
    - Edge computing
    - In-network computing

    } e.g., overlay networking

Transport Layer Functionality: Data Path vs. Data Flow

- Data Path
  - Trajectory & waypoint handling
  - Bidirectional connection
  - Resource monitoring (e.g., congestion)
  - Congestion control
  - Data flow multiplexing
  - Packet duplication for packet loss recovery (like FEC)

→ Stateless or per-path/per-connection states

- Data Flow
  - Retransmission for reliable data communication
  - Flow control (buffer management)
  - Flow prioritization
  - End-to-end security
  - Inverse multiplexing for multipath protocols

→ Per-flow states

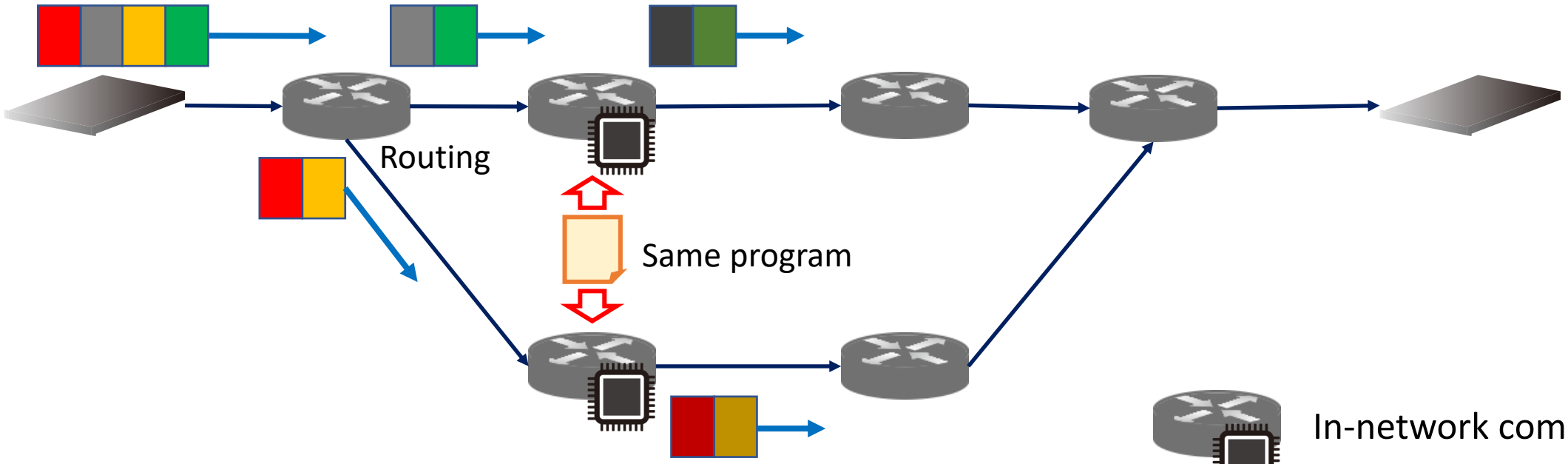
Use Cases

- Multipath transport protocols
- Congestion control acceleration
- In-network computing
- Flow arbitration
- etc…

In-network Computing

- In-network computing
  - Compute chain
    - Active network
    - Service function chaining
  - Data aggregation and redistribution
    - All-Reduce in distributed deep learning

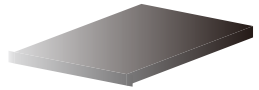
Stateless per-packet in-network computing



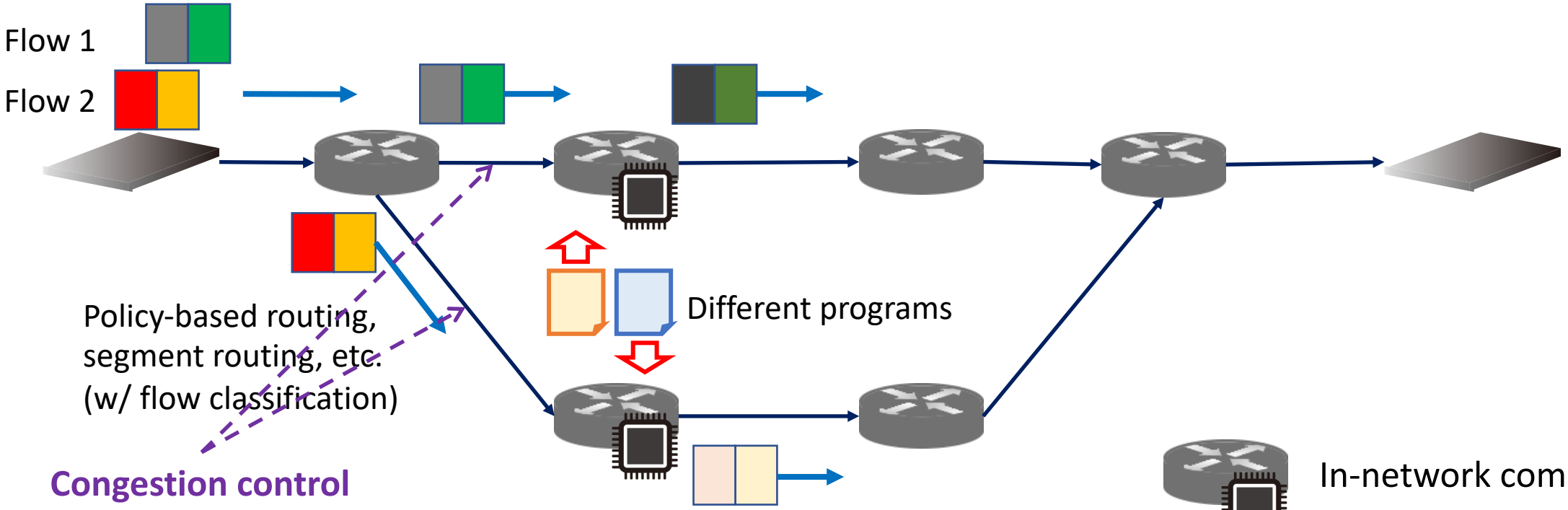
ECMP can be leveraged if the in-network computing routers do not store any states.

In-network computing router

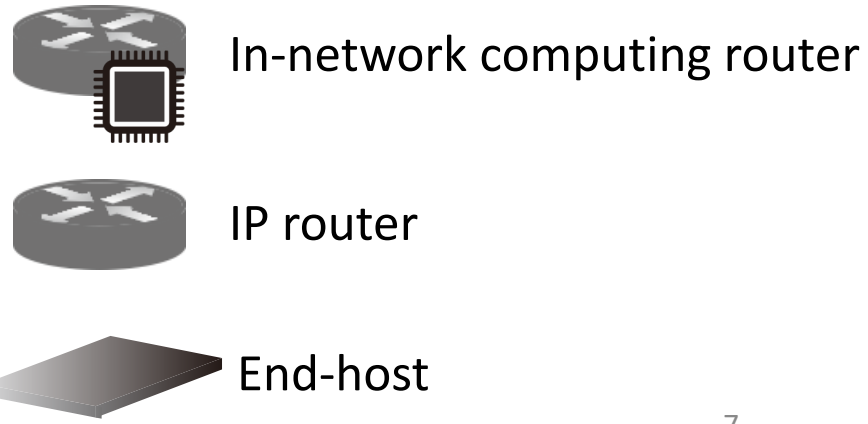

IP router


End-host

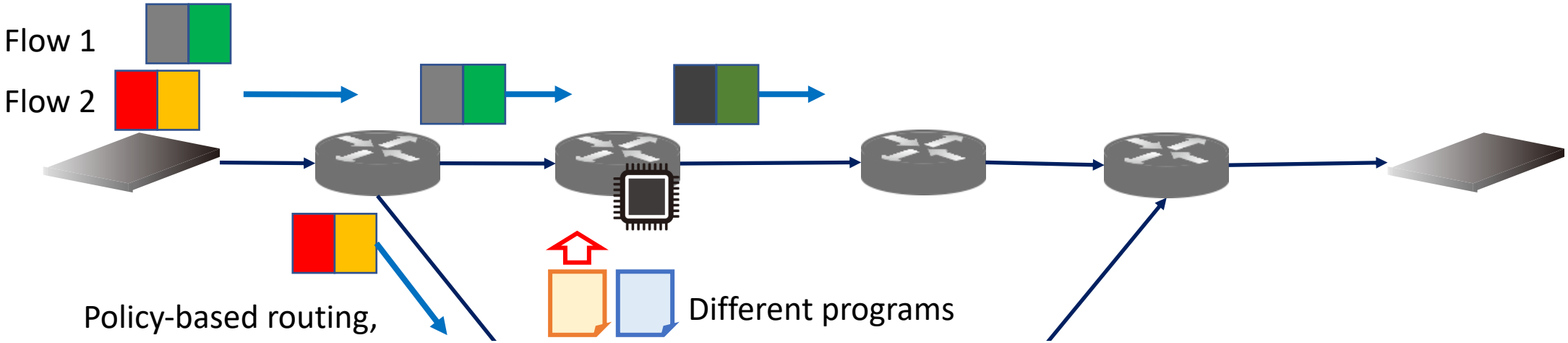
Stateful per-packet in-network computing

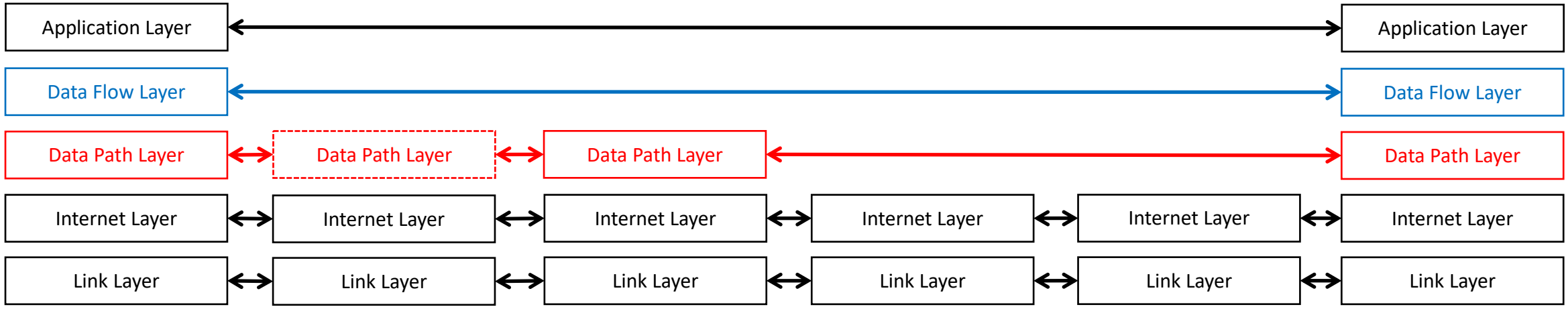


A waypoint must be designated and controlled;
i.e., stateful for data paths but stateless for data flows

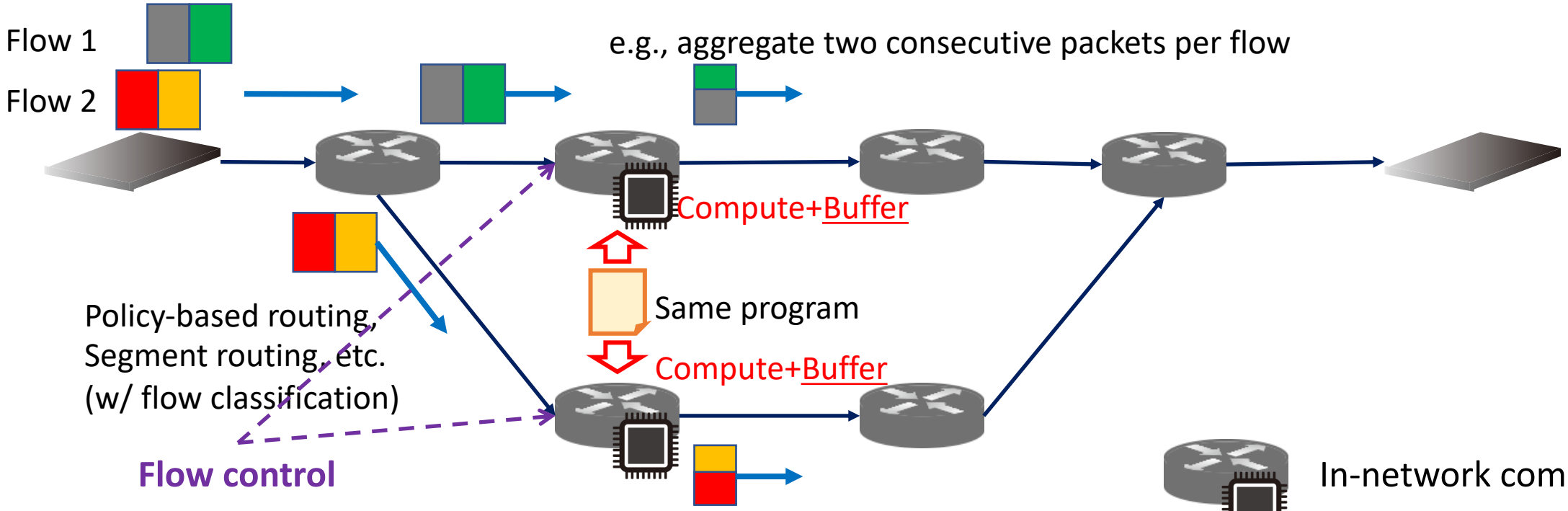


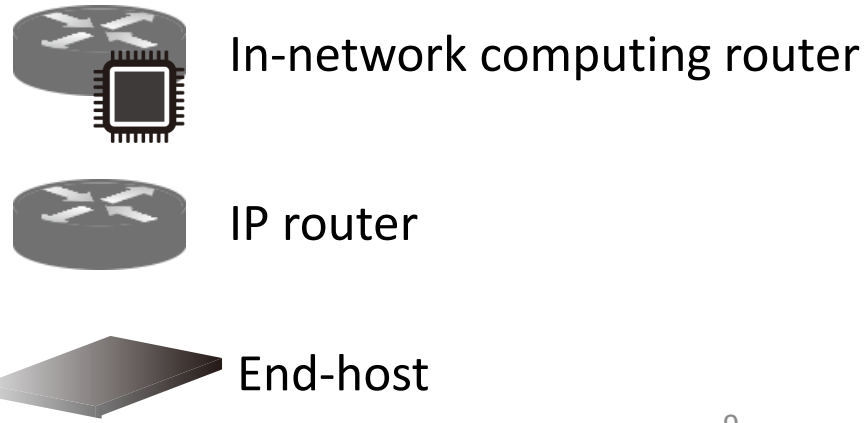
Stateful per-packet in-network computing





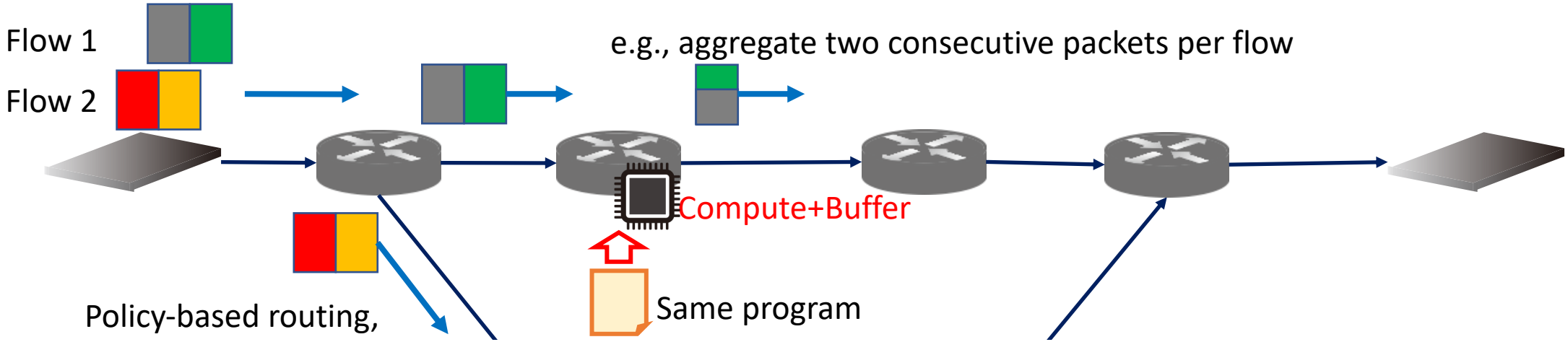
More complex computing; e.g., per-flow in-network computing

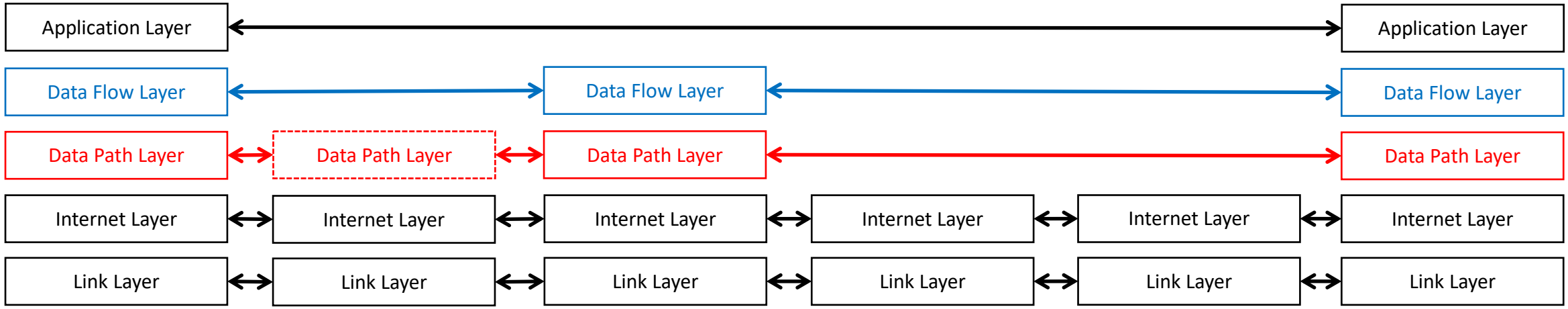




A waypoint must be designated and controlled.
In-network computing router must be aware of flows.

More complex computing; e.g., per-flow in-network computing





Summary & Next Step

- Summary: Separation of data path and data flow layers
  - Data path: Aware of network resources and trajectory or waypoints
  - Data flow: Aware of computing resource and flow-level integrity
- Next Step
  - Improve the I-D
    - Add analysis of existing protocols
      - e.g., TCP's ACK for congestion control and integrity
        - Existing TCP accelerators need a buffer to send back an ACK on behalf of receivers
    - Add more use cases and examples
  - Protocols for data path and data flow layers