

Middlebox Cooperation Protocol

Technical Considerations

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measurement and architecture for a middleboxed internet

measurement

architecture

experimentation



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PARENTAL ADVISORY EXPLICIT COOPERATION



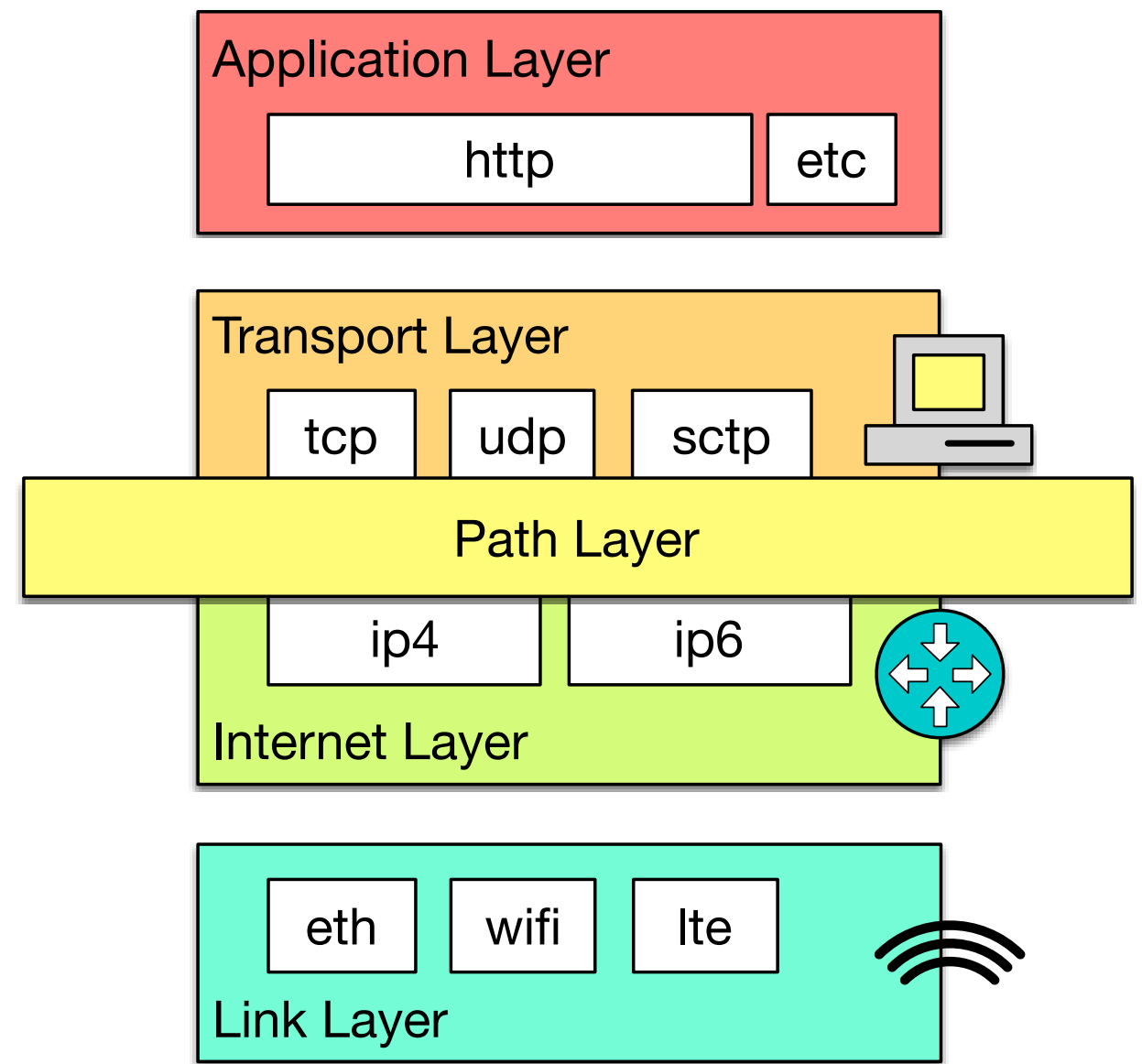
Explicit Cooperation

- “Implicit cooperation” between endpoints and middleboxes **already widespread in the Internet**,
 - where “cooperation” may be the wrong term: some hacks and workarounds are quite hostile.
- **Explicit cooperation** under **endpoint control** may be a way to reduce tension in this tussle
 - Declarative, advisory signaling with no trust required between endpoint and path.
- **Encrypt everything devices on path don’t need to see** (including transport headers), to prevent future unauthorized “implicit cooperation”.



Introducing the Path Layer

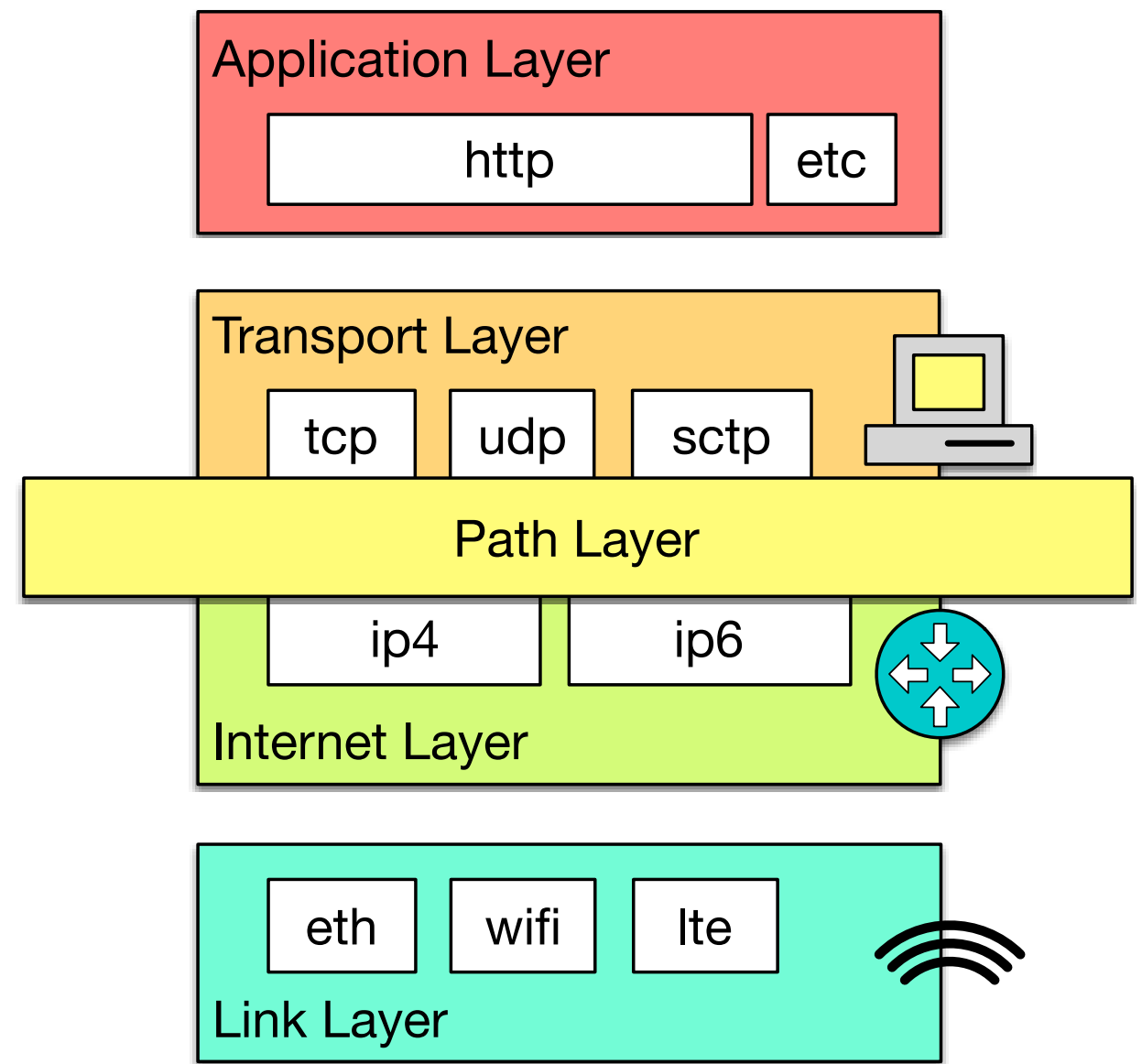
- Network: hop-by-hop, no data-plane state.
- Transport: end-to-end, stateful.
- Implicit layer in between where all the state in the network lives.
- PLUS makes this explicit.





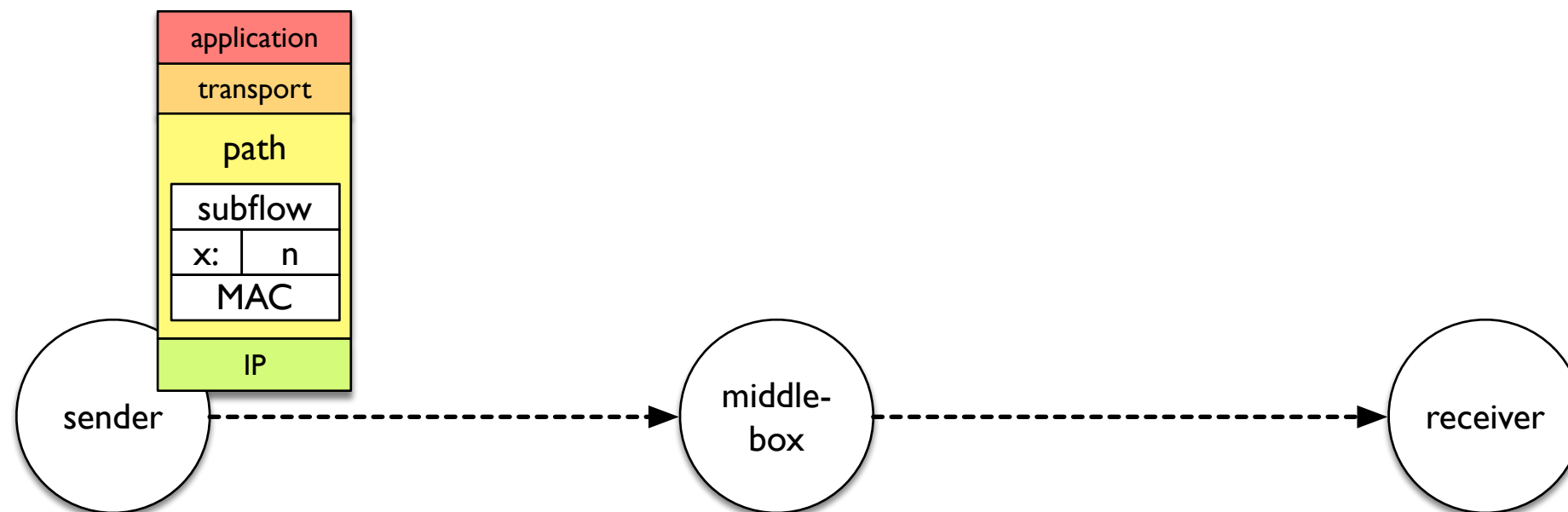
Three and a half mechanisms to make the path layer explicit

- Sender – Path Signaling
- Path – Receiver Signaling
 - with encrypted feedback to sender
- Direct Path – Sender Signaling



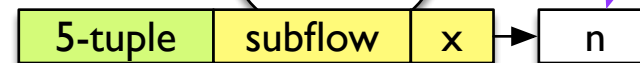
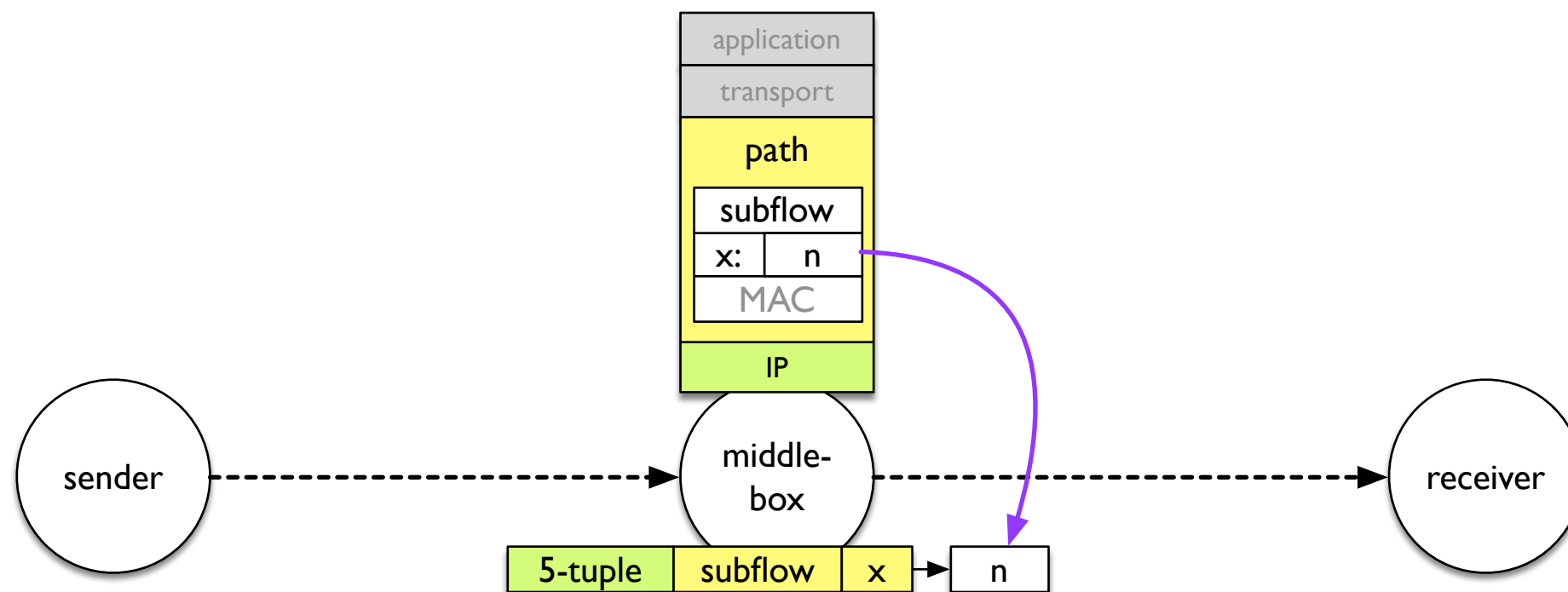


Sender to Path (sender-side)



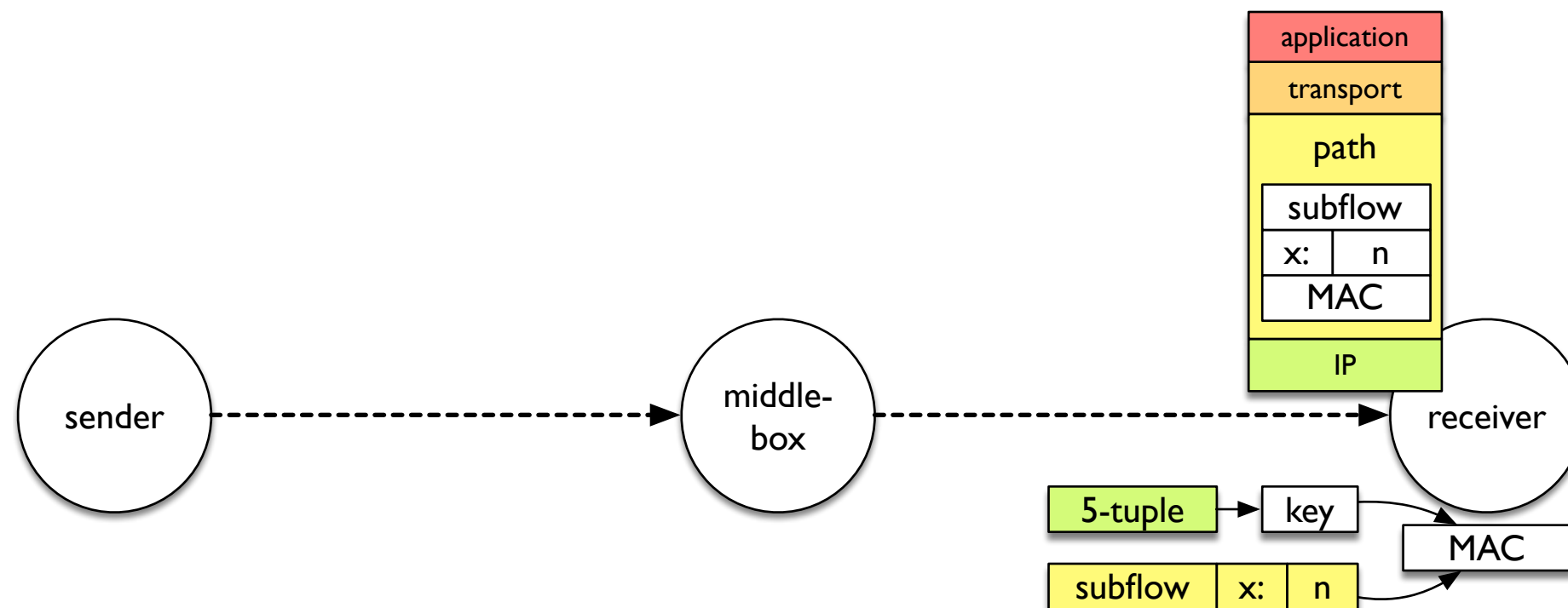


Sender to Path (on-path)



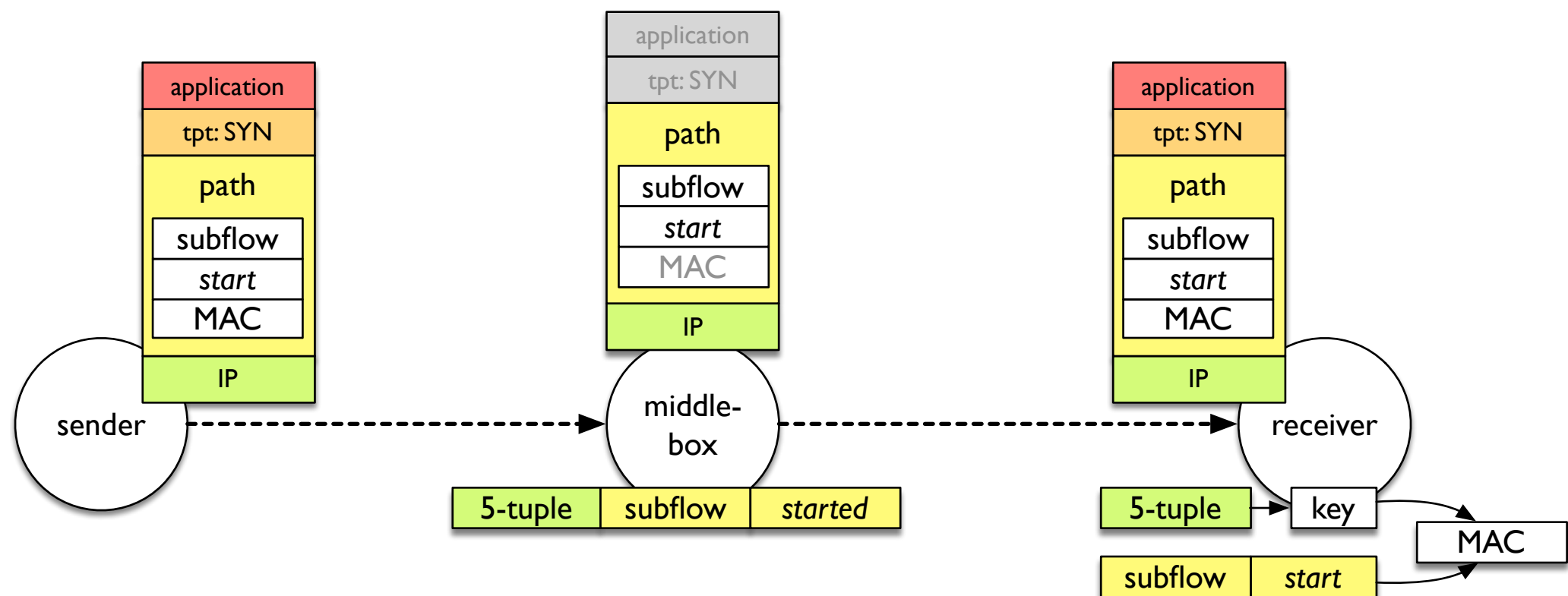


Sender to Path (receiver-side)



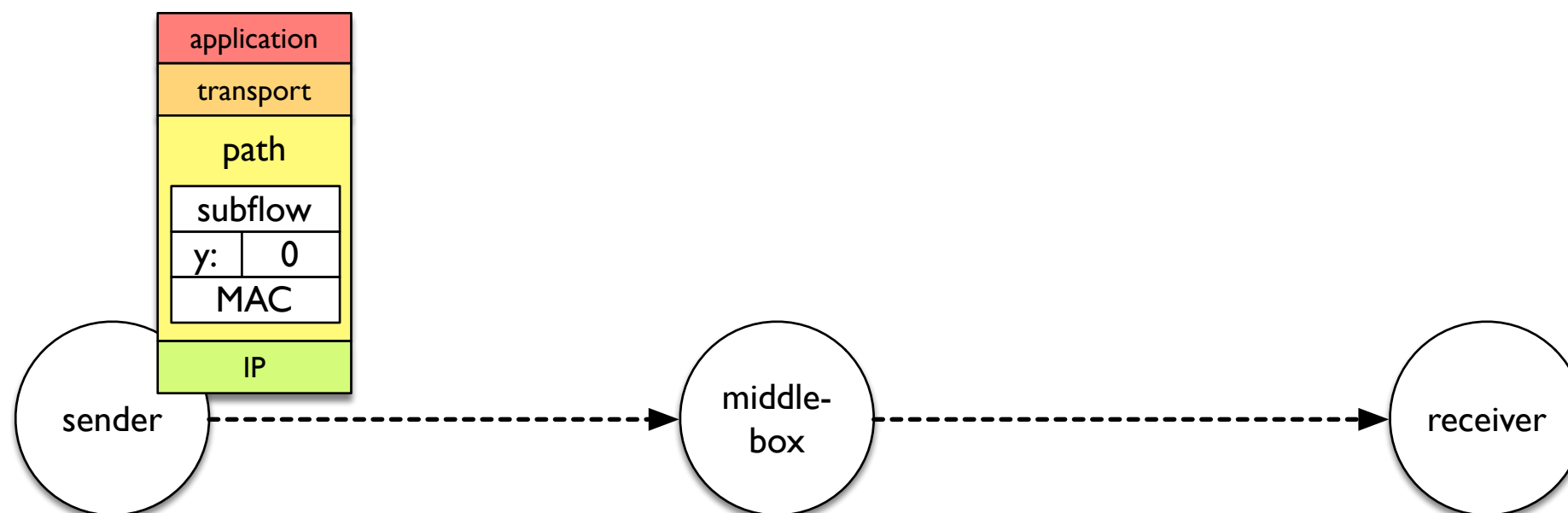


Sender to Path Transport State Signaling



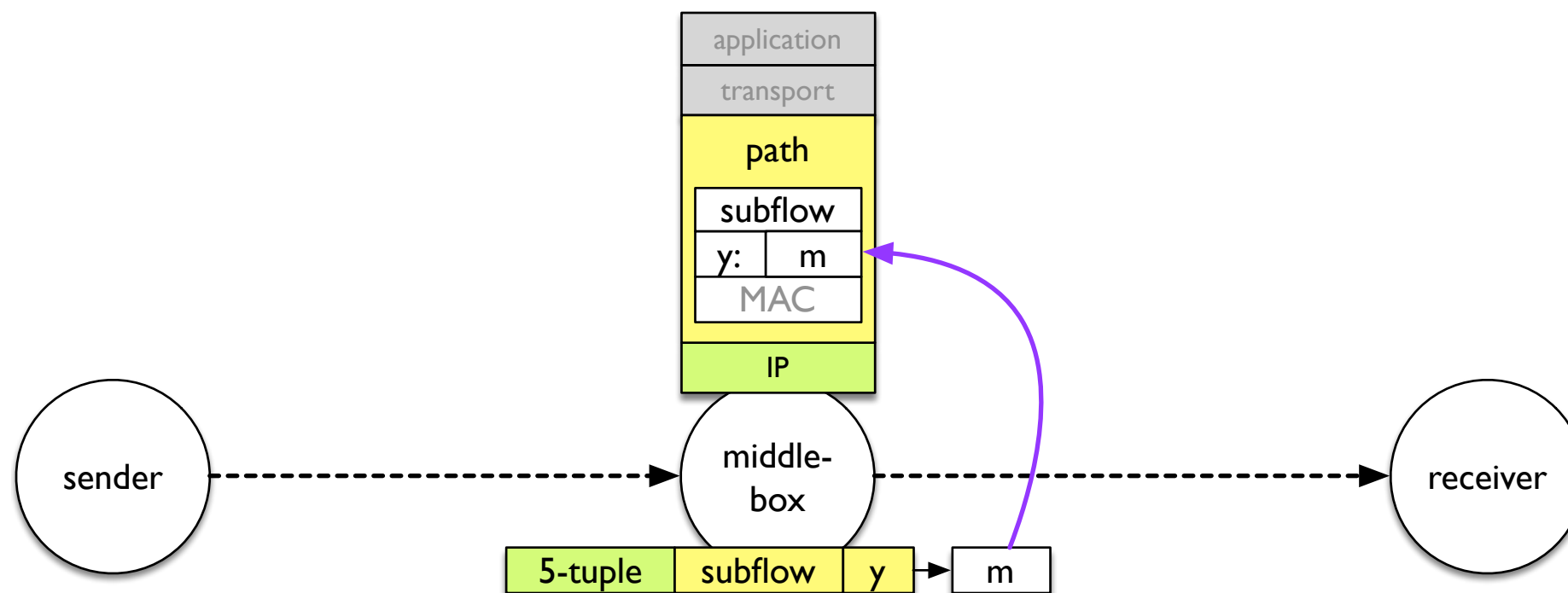


Path to Receiver (sender-side)



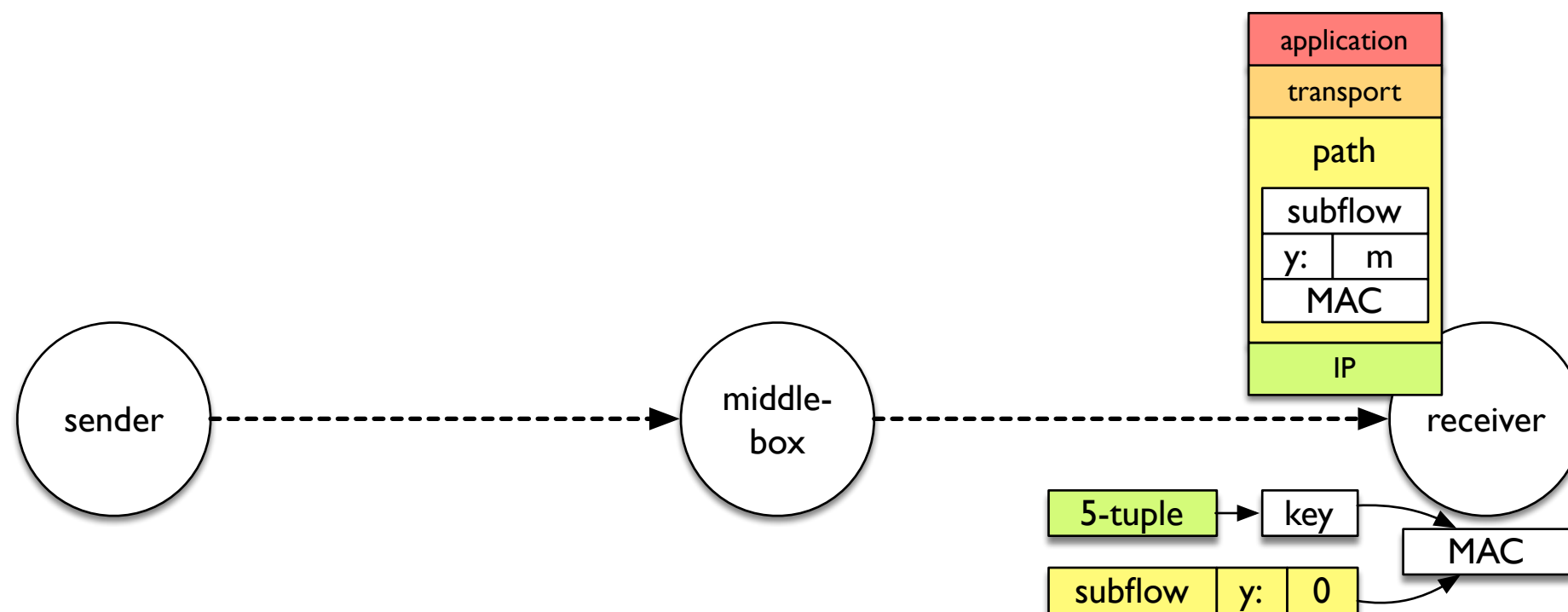


Path to Receiver (on-path)



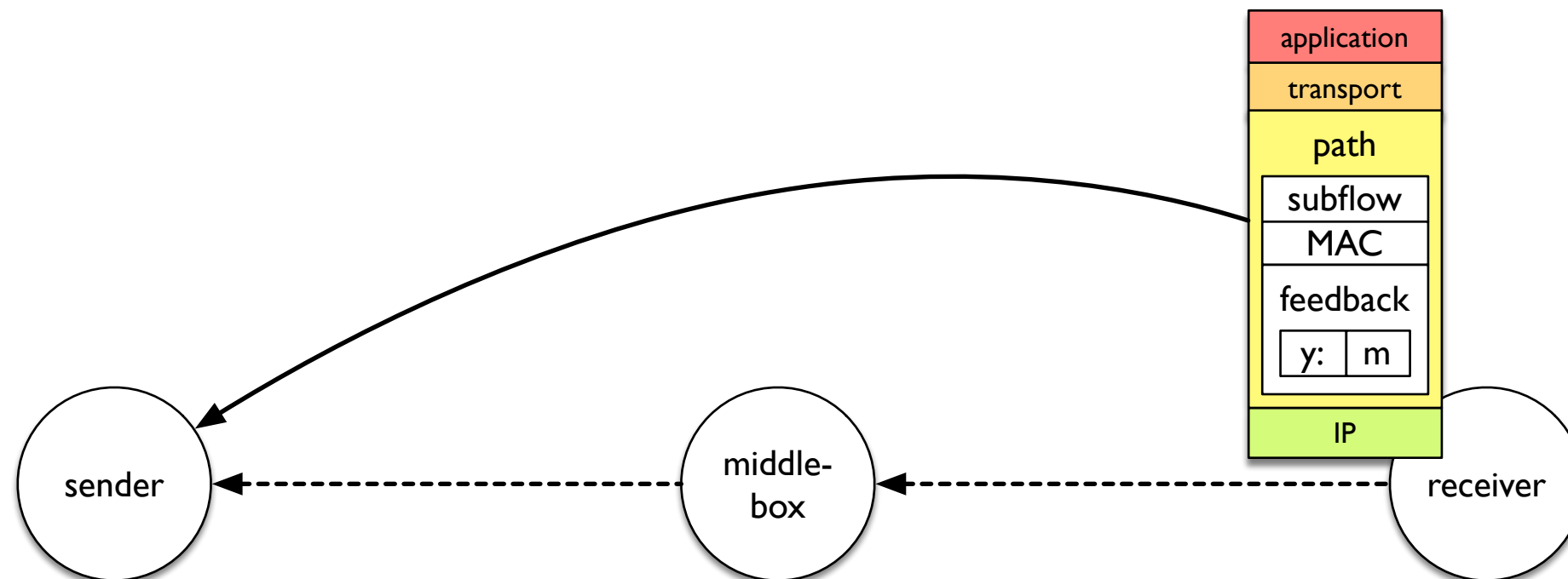


Path to Receiver (receiver-side)



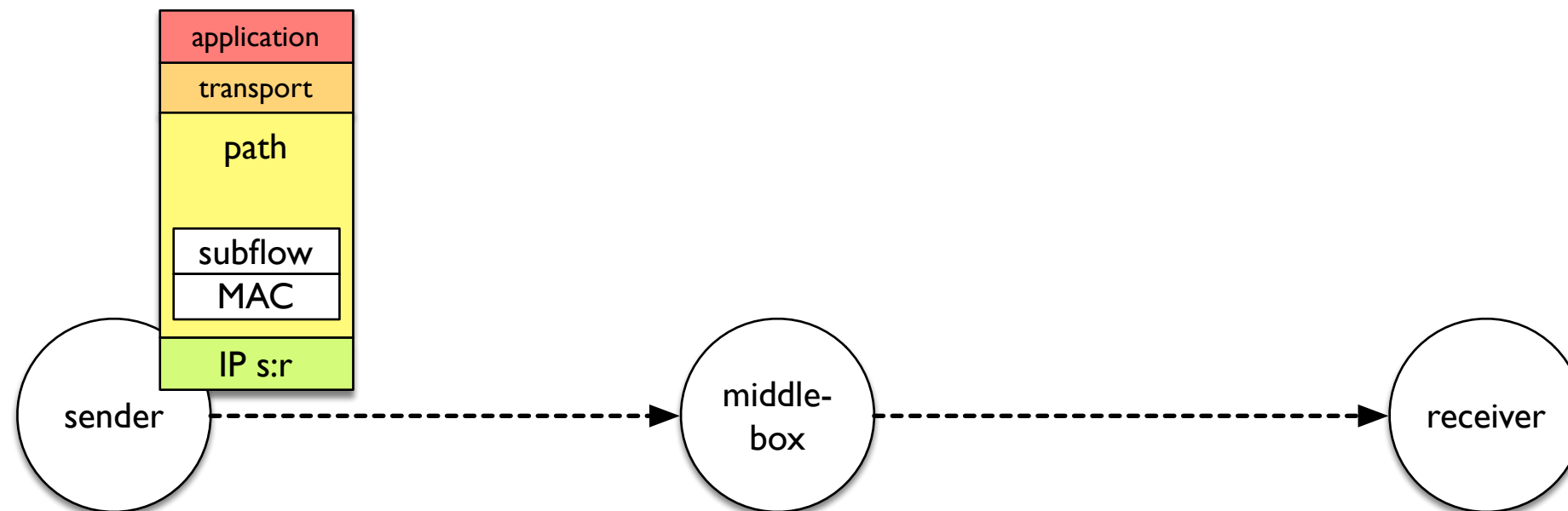


Receiver Feedback



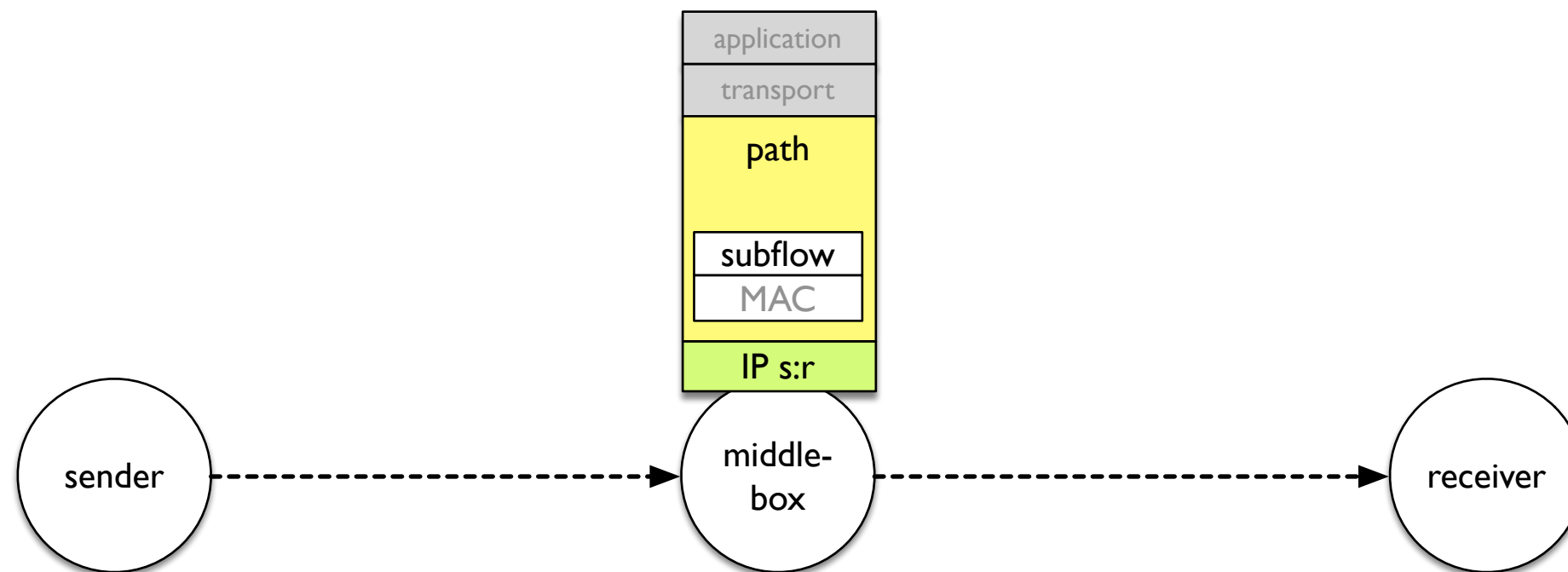


Path Direct to Sender (sender-side)



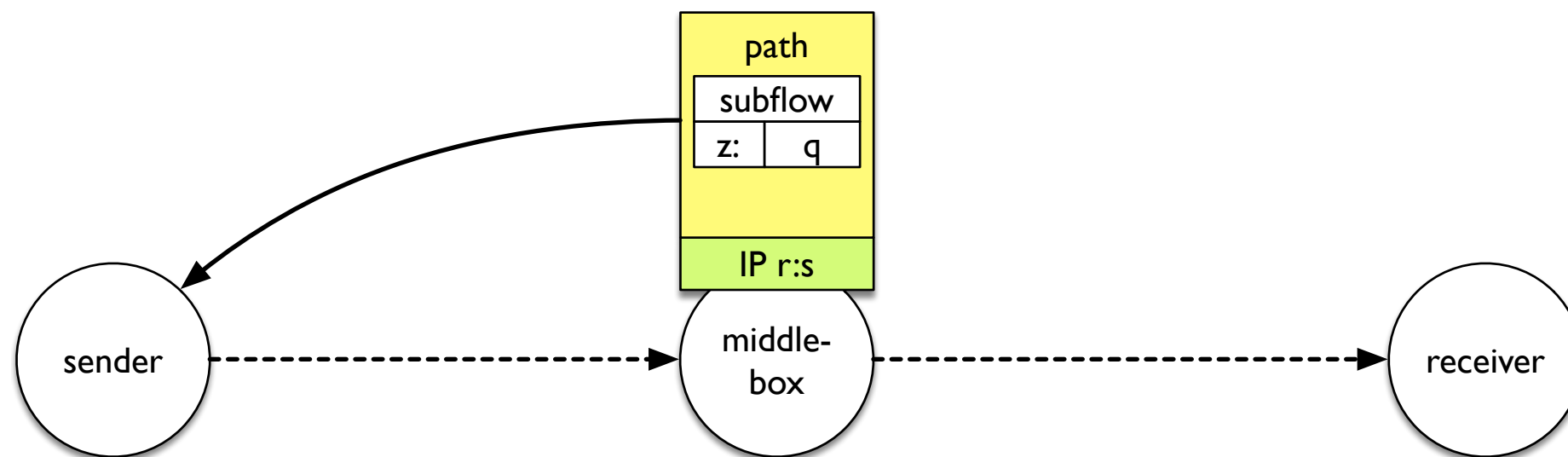


Path Direct to Sender (on-path)



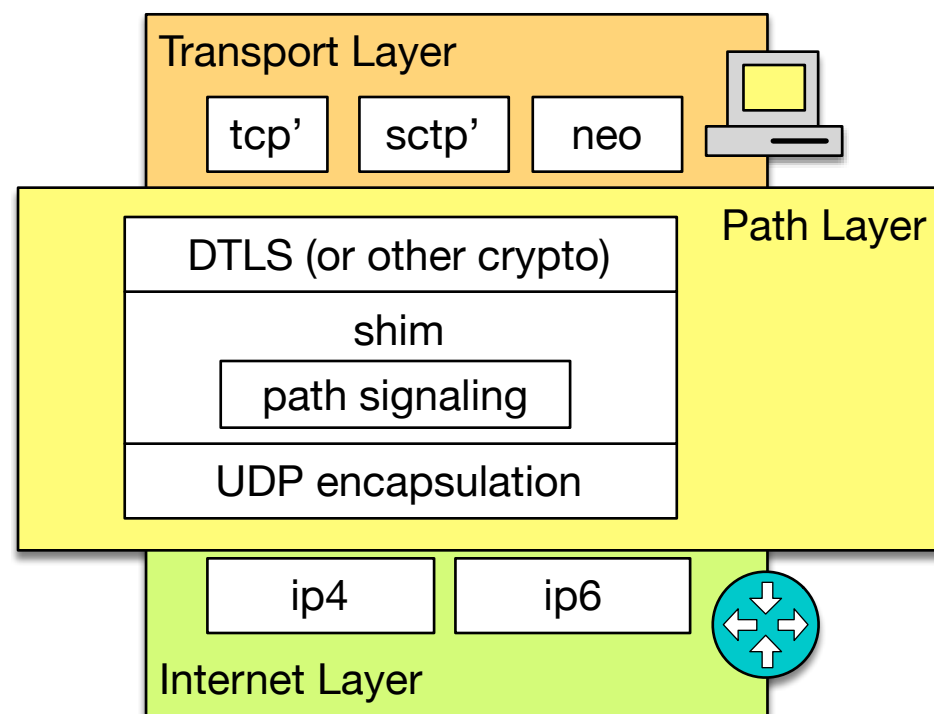


Path Direct to Sender (feedback)





Anatomy of the Path Layer



- UDP encapsulation
 - userspace implementation
 - ports for NAT
 - ~95% deployable today
- encoding for signaling mechanisms
- crypto to protect transport headers and above