Tame ACK (TACK) in QUIC

draft-li-quic-optimizing-ack-in-wlan-00

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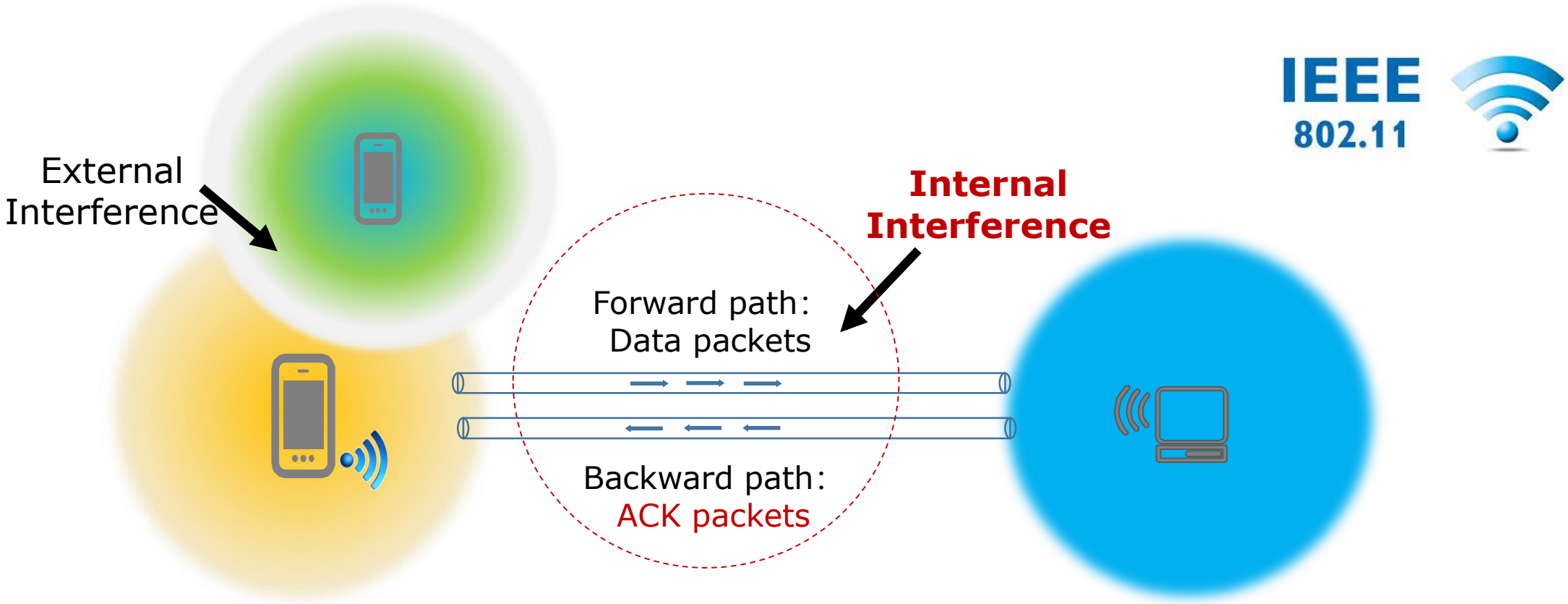
Scenarios: ACKs cause internal interference



External Interference: Between wireless devices on the same channel
Internal Interference: Between data packets and ACKs in the same connection

In theory, ACKs cause almost similar medium access overhead as data packets.

TACK Achieves Required Minimal ACK Intensity

$$f_{tack} = min\left\{\frac{bw}{L \cdot MSS}, \frac{1}{\alpha}\right\} = min\left\{\frac{bw_{max}}{L \cdot MSS}, \frac{\beta}{RTT_{min}}\right\}$$

$$\boldsymbol{if\ bdp < L \cdot \beta \cdot MSS}$$

(Byte-counting ACK)

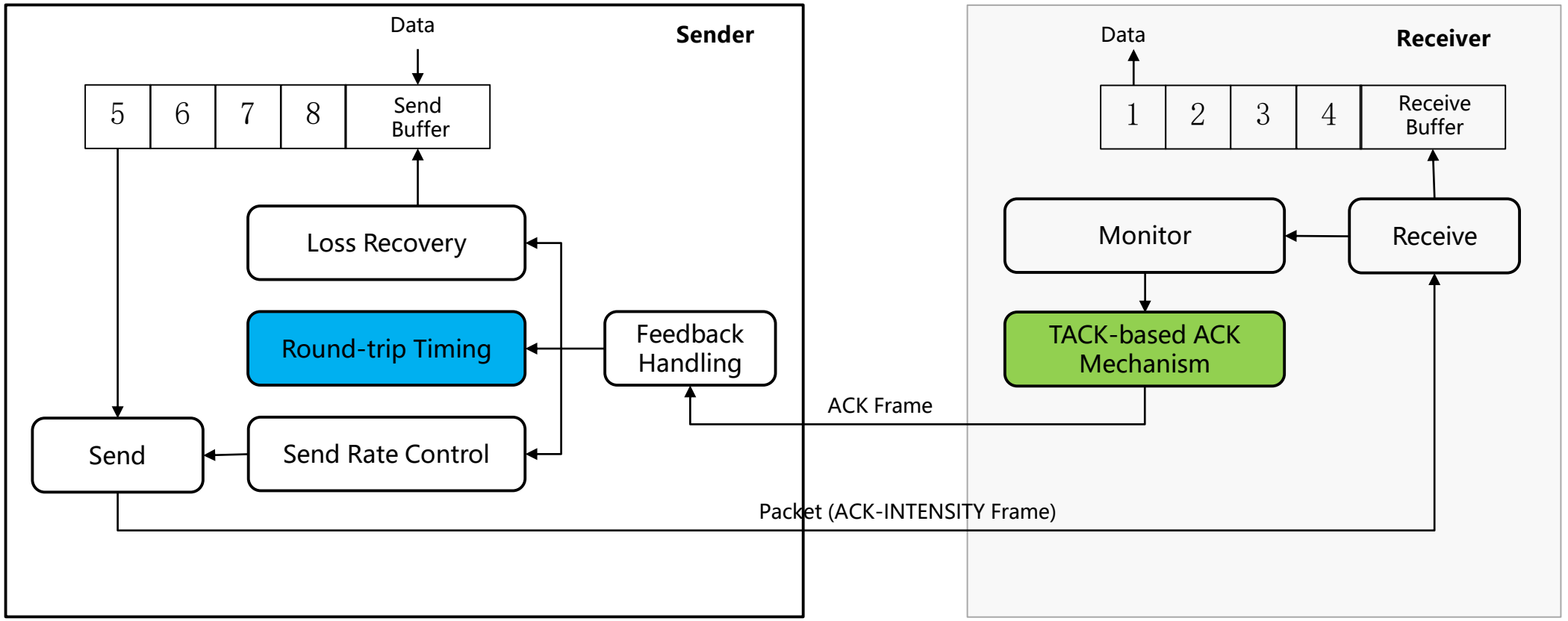
$$\boldsymbol{if\ bdp \geq L \cdot \beta \cdot MSS}$$

(periodic ACK)

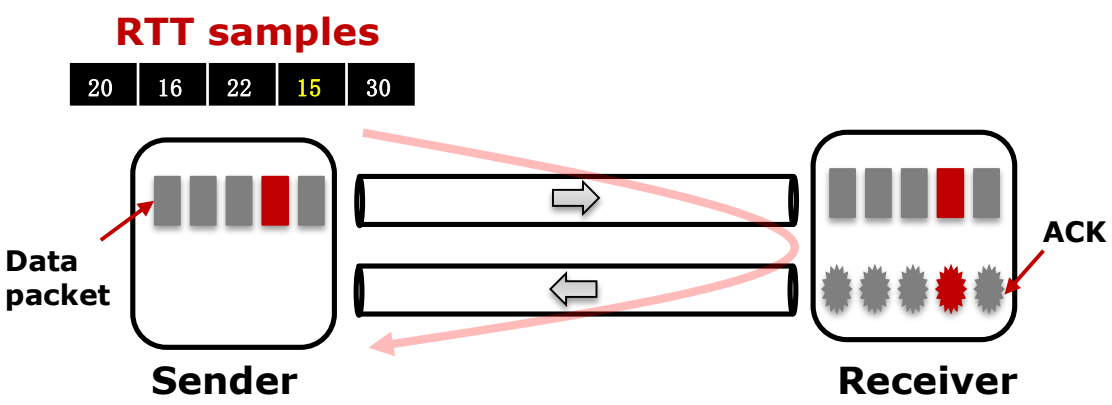
- **f**: ACK frequency with unit of Hz, i.e., number of ACKs per second
- **L**: number of full-sized packets counted before sending an ACK

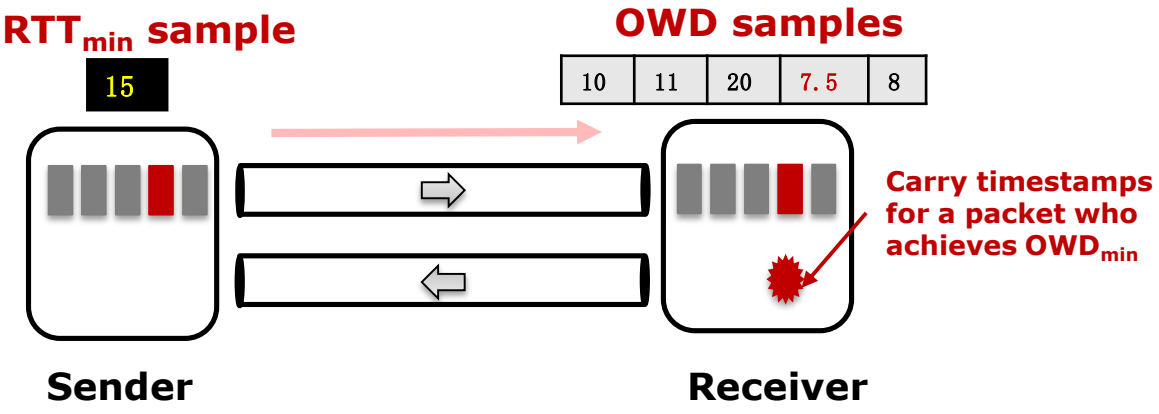
$\boldsymbol{bw_{max}}$: the maximum bandwidth estimate
$\boldsymbol{RTT_{min}}$: the minimum RTT estimate
$\boldsymbol{\beta}$: the number of ACKs per RTT_{min}
bdp: the bandwidth and delay product ($bw_{max} \times RTT_{min}$)

Implementation and Interoperability



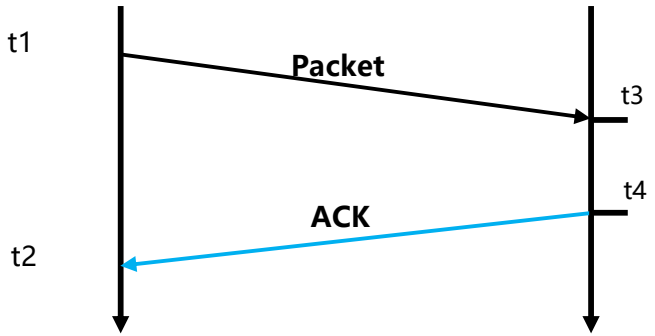
Advancements in Round-trip Timing





Legacy way: sender-side RTT sampling

Receiver-side one-way delay (OWD) sampling without maintaining too many states



RTTmin_sample = t2 (ACK arrival) – t1 (packet with OWDmin departure) - delta_t (ACK Delay)

delta_t = t3 (packet with OWDmin arrival) – t4 (ACK departure)

What's new for QUIC protocol deployed with TACK?

1. **Transport Parameter: ack-intensity-support**

A new field named ack-intensity-support should be added for negotiation between both parties whether starting the dynamic ACK intensity function in QUIC connection.

2. **ACK-INTENSITY Frame**

A new frame should be added for exchange the updated ACK intensity calculated by the sender**.**

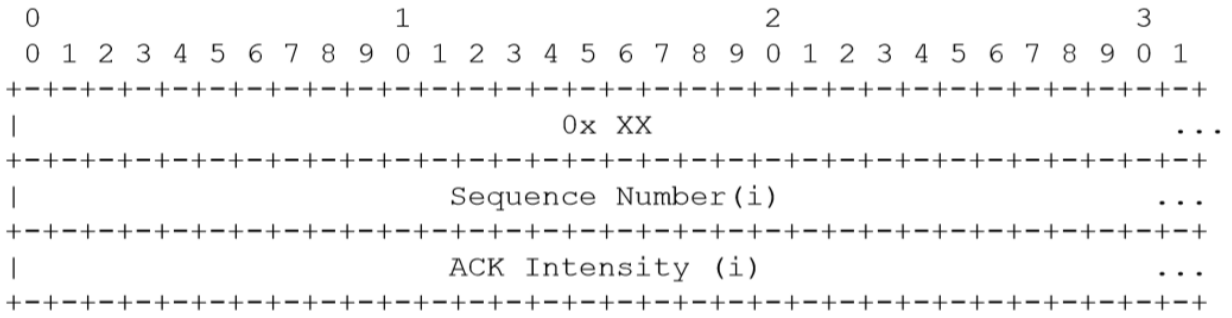


Figure 1: ACK-INTENSITY Frame

3. **OWD-based RTTmin Estimation**

```
ACK Frame {
  Type (i) = 0x02..0x03,
  Largest Acknowledged (i),
  ACK Delay (i),
  ACK Range Count (i),
  First ACK Range (i),
  ACK Range (..) ...,
  [ECN Counts (..)],
}
```

Change "ACK Delay = t3 (the largest acknowledged packet arrival) – t4 (ACK departure) "
To: "ACK Delay = t3 (packet with OWDmin arrival) – t4 (ACK departure)"

Next Steps

1. **OWD-based RTTmin Estimation** might also be applicable for other ACK thinning mechanisms.

2. **Advancements in loss recover** should be considered:

- Reuse packet number of QUIC
- TACK + Instant ACK Frame

3. **Advancements in send rate control** should be considered:

- Congestion control: Pacing
- Flow control: Instant ACK Frame

Any comments welcome