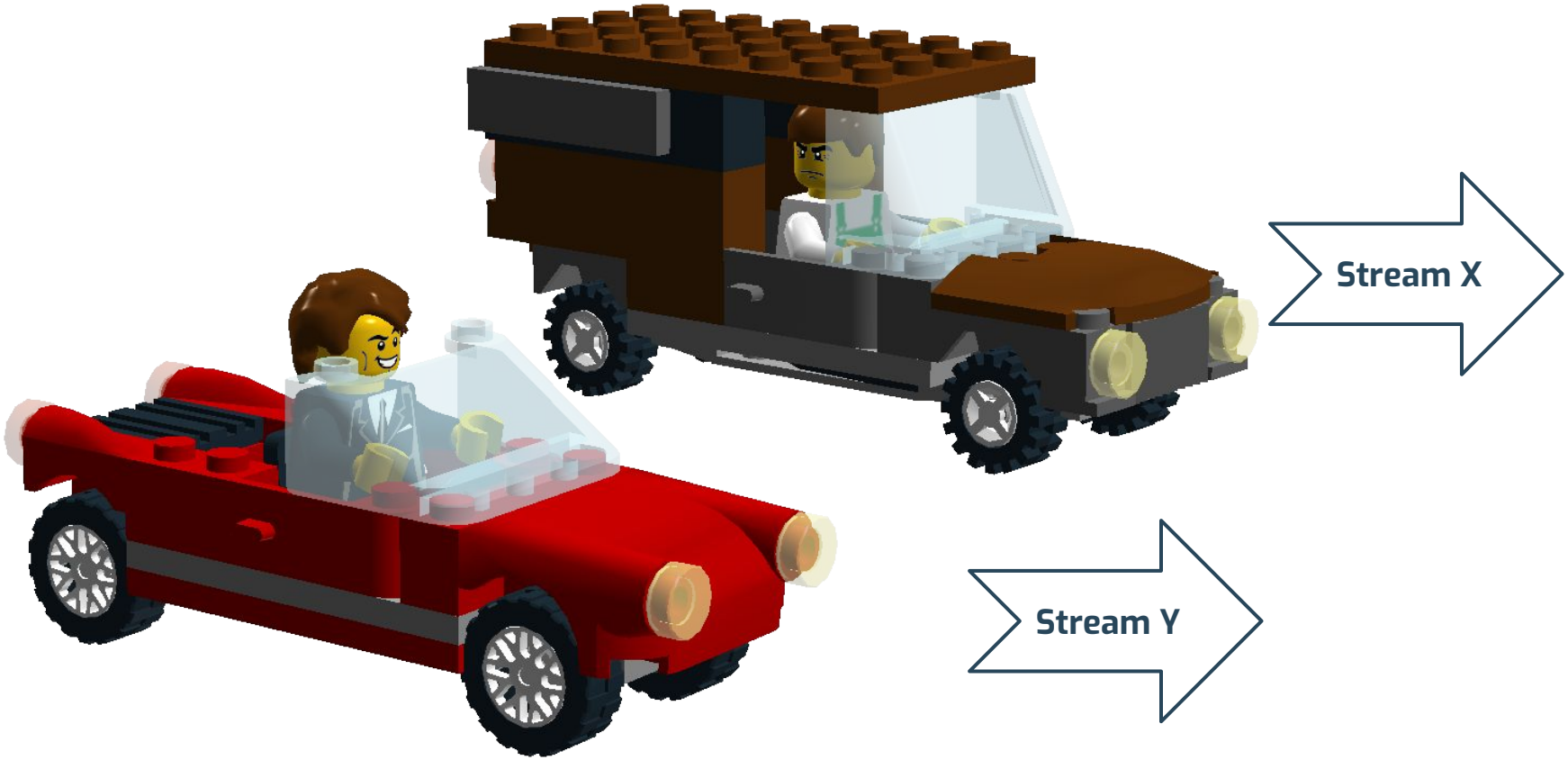
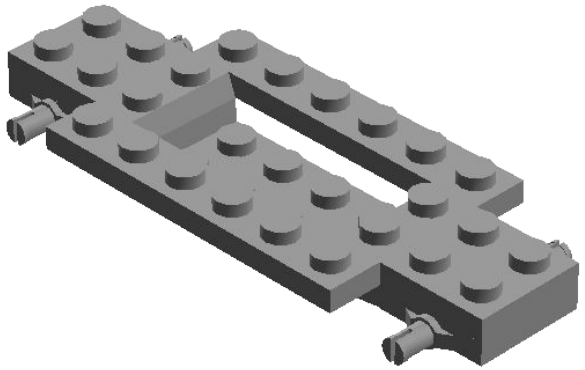
Deadlocking

QUIC Down Under

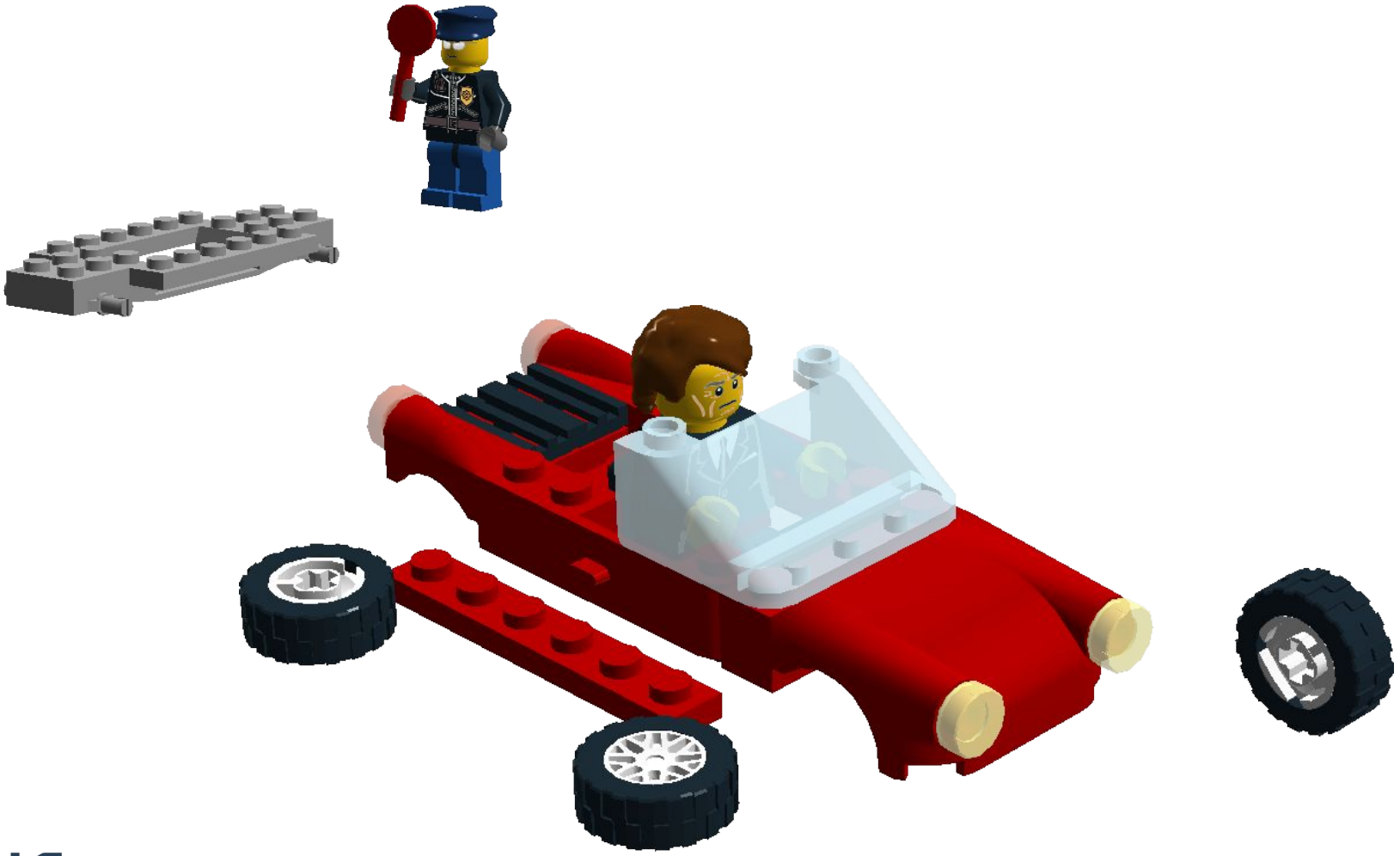
Maybe everything is totally independent



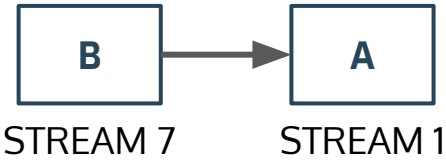
But exploiting commonality is a good pattern

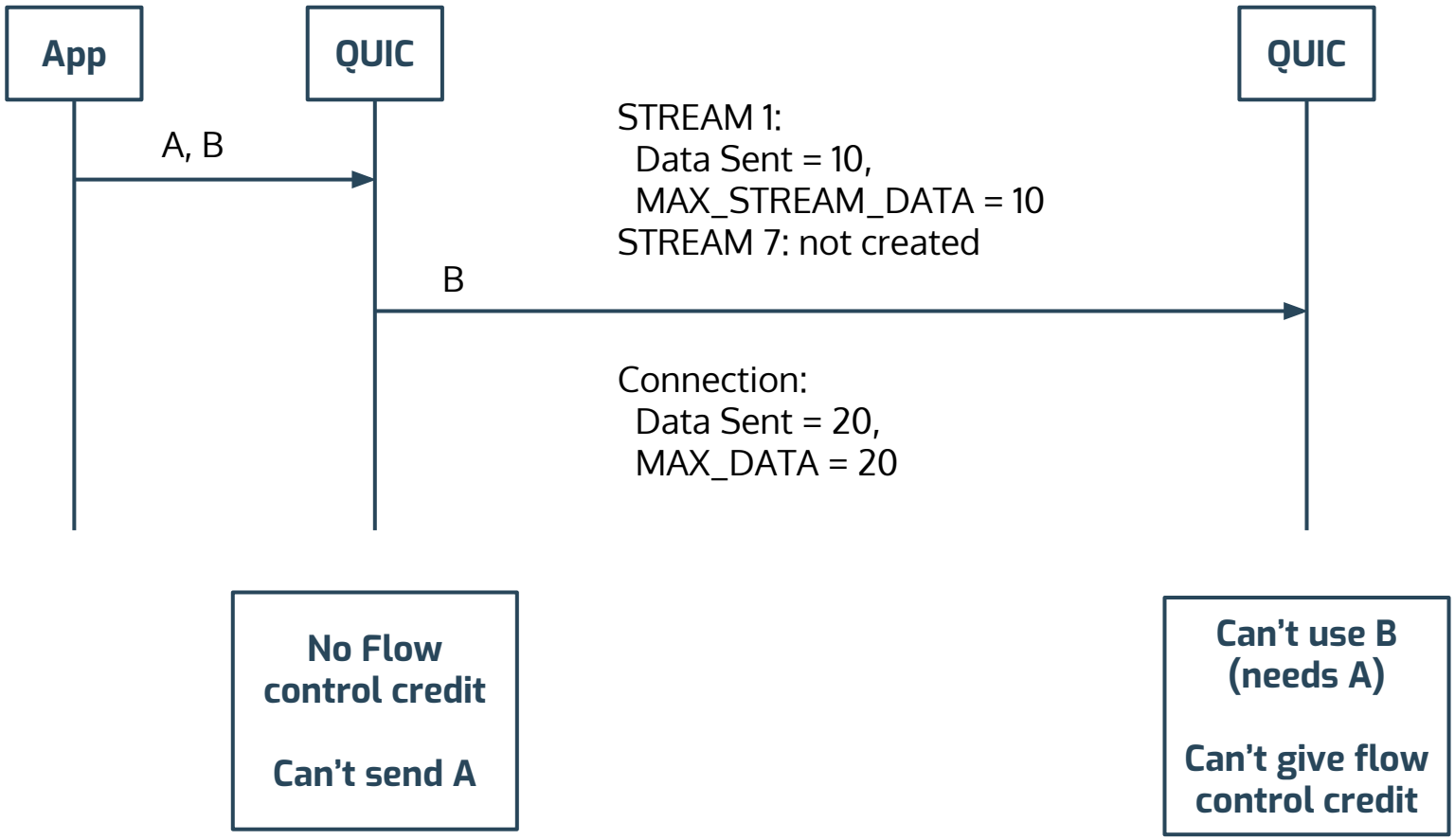


Concurrency is tempting but it leads to problems



Simple Problem





Simple solution

Block or reject the write of B until A has flow control credit

This ISN'T guaranteeing that A is sent before B

- Instead: B is only accepted if A is

No commitment to ordering of delivery

- Not for the first send attempt
- And especially not receipt at the peer

Intermediaries are awesome

A transport-layer intermediary that is ignorant of the application protocol can create this problem

In the previous example, imagine that A and B arrive from another QUIC peer rather than an application protocol

The intermediary doesn't know that B depends on A

> Clearly B can make progress, so it sends B

Options

1. Don't do that

   Get acknowledgment at the application layer

   ... before sending anything that is dependent on that data

2. Eat the memory cost

   Give flow control credit even if you can't use something

3. Time out, cancel, and retry

4. Something, something intermediary

Something, something intermediary

If you terminate the QUIC connection

... then you are responsible

If you declare that you support an ALPN token

... then you support the protocol it identifies

If “hq” compression uses unacknowledged dependencies

... then the entity terminating the connection copes

Something else

Flow control is end-to-end

Intermediaries MUST NOT advertise more flow control credit than they have received

These intermediaries will break certain features anyway

- TLS exporters (and exported authenticators)
- Client certificates