UCL

HACK: HIERARCHICAL ACKS FOR EFFICIENT WIRELESS MEDIUM UTILIZATION

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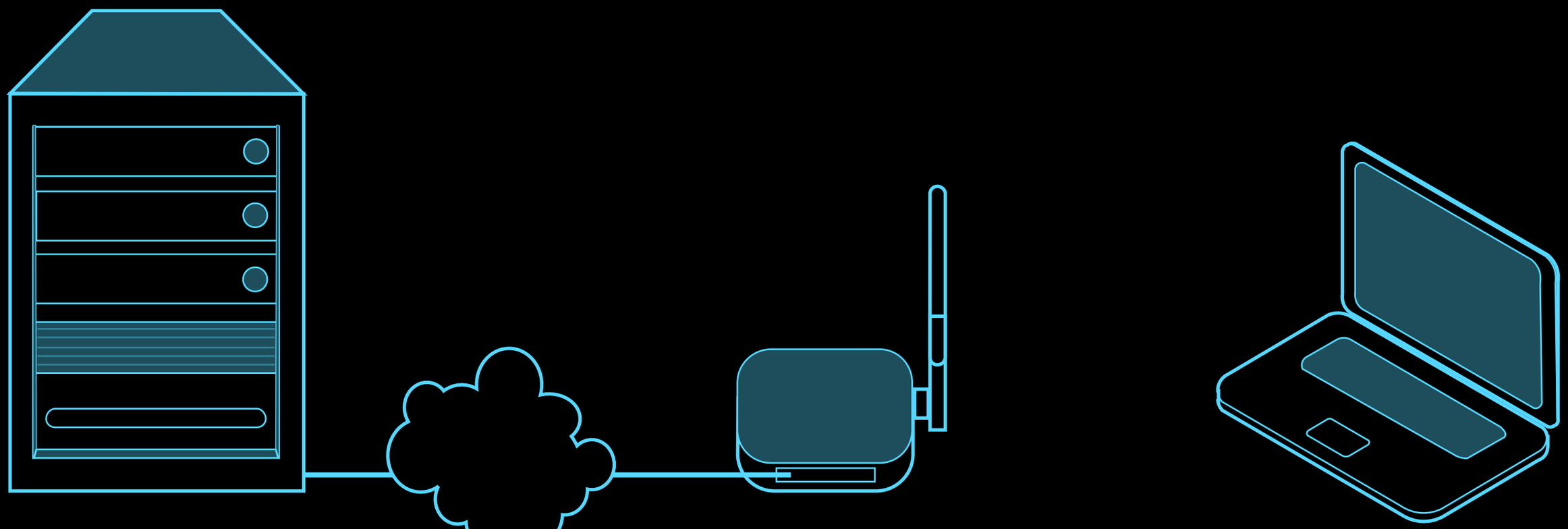
WIFI MOSTLY USED FOR TCP DOWNLOADS



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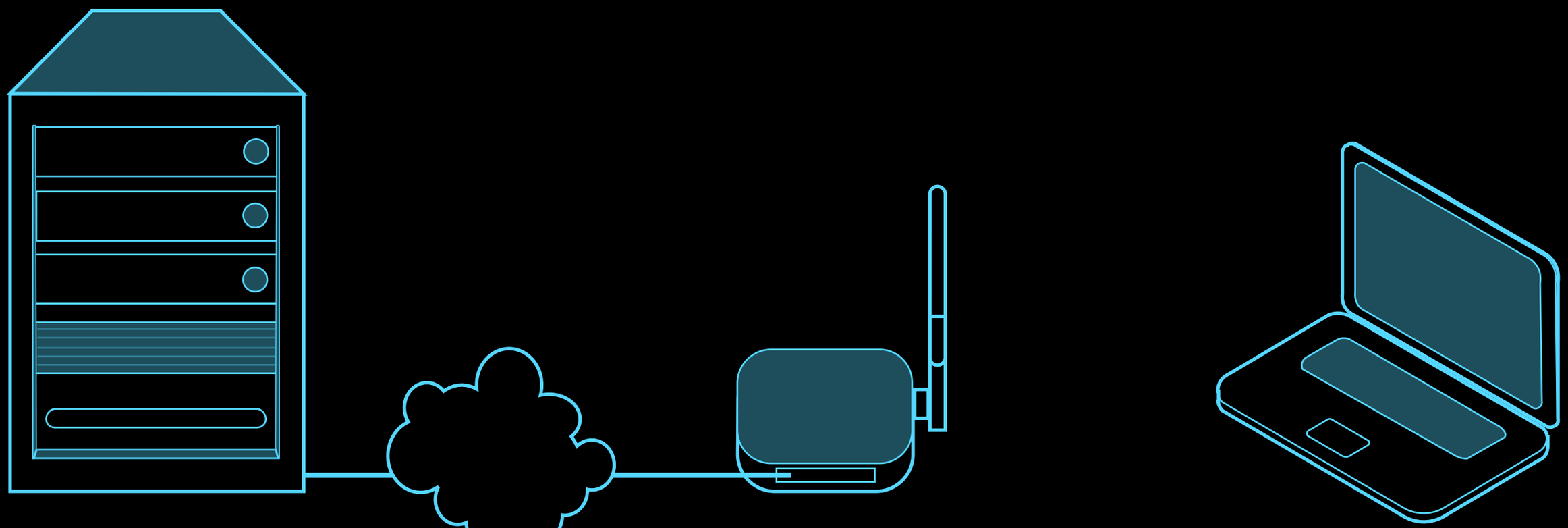


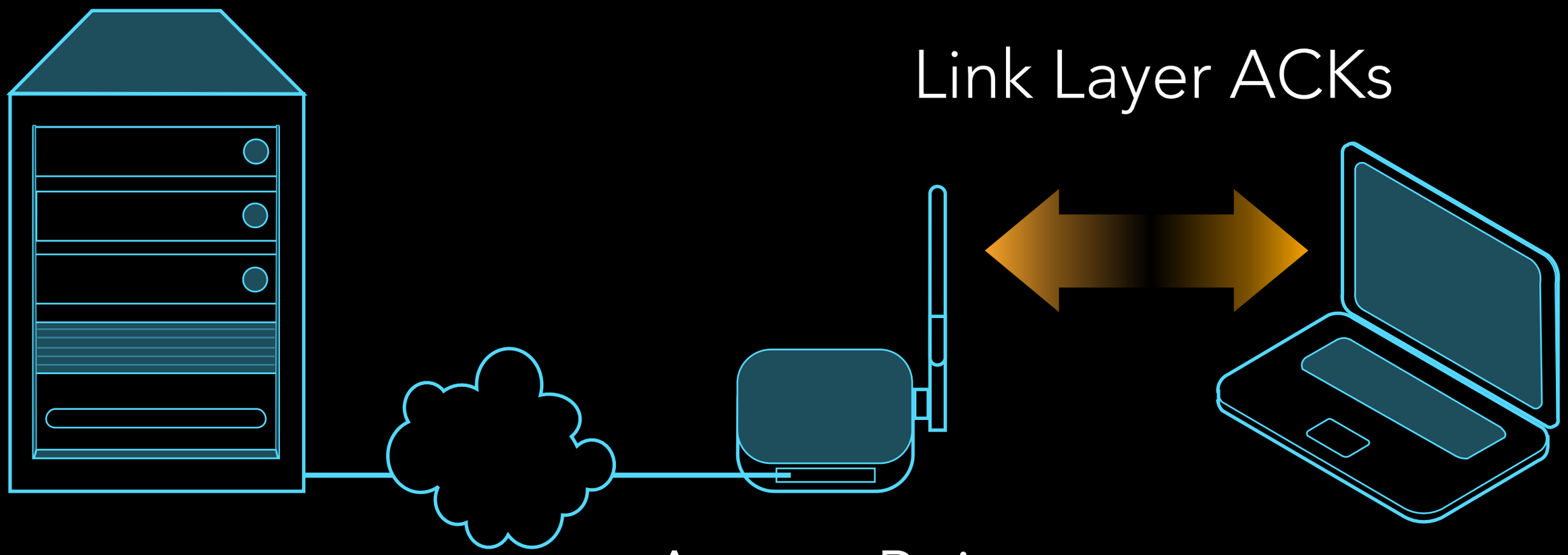
Server

Access Point (AP)

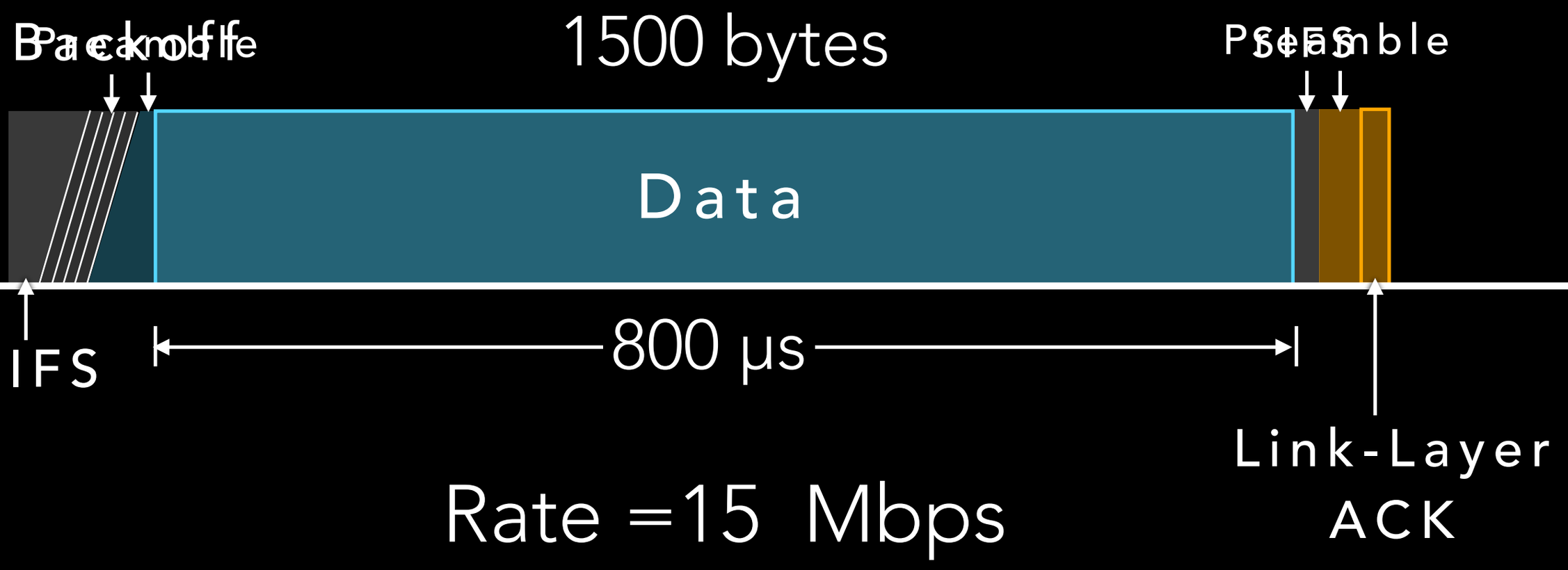
Client

TCP ACKs

WIFI MOSTLY USED FOR TCP DOWNLOADS



WIFI MEDIUM ACQUISITION INCURS OVERHEAD



* Diagram to Scale

WIFI MEDIUM ACQUISITION INCURS OVERHEAD

Rate =15 Mbps

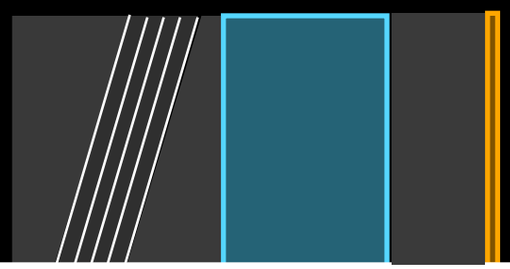
~80% Utilization

WIFI MEDIUM ACQUISITION INCURS HIGH OVERHEAD

Rate = 60 Mbps

~51% Utilization

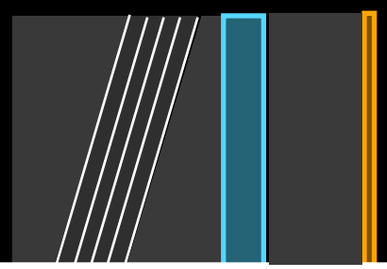
WIFI MEDIUM ACQUISITION INCURS HIGH OVERHEAD



Rate = 150 Mbps

~29% Utilization

WIFI MEDIUM ACQUISITION INCURS HIGH OVERHEAD

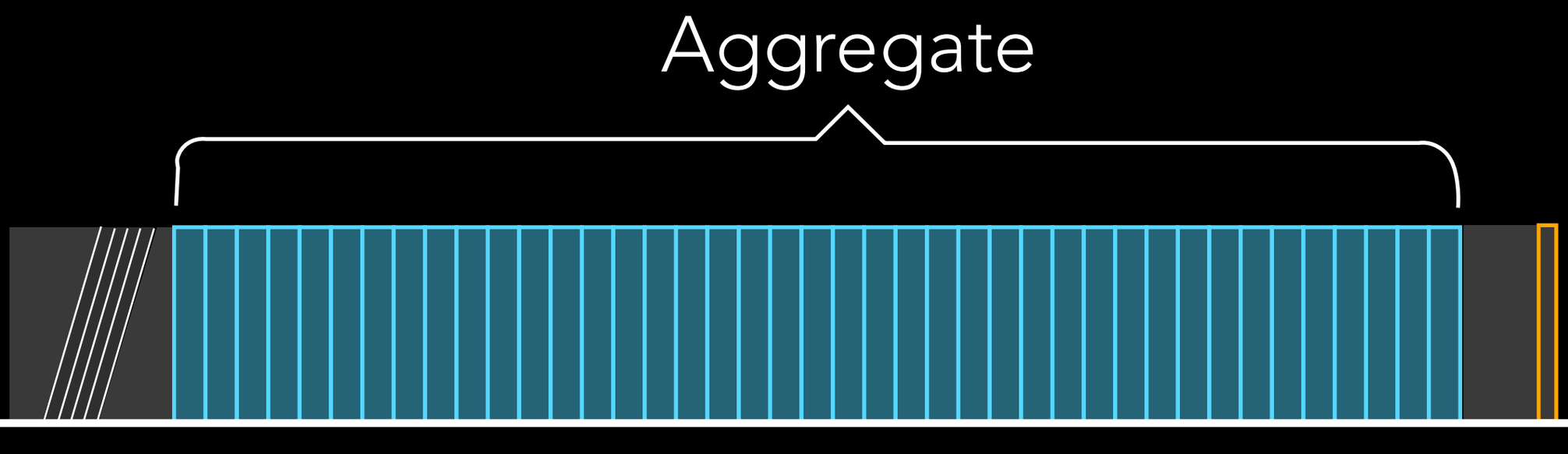


ACK

Rate = 600 Mbps

~9% Utilization

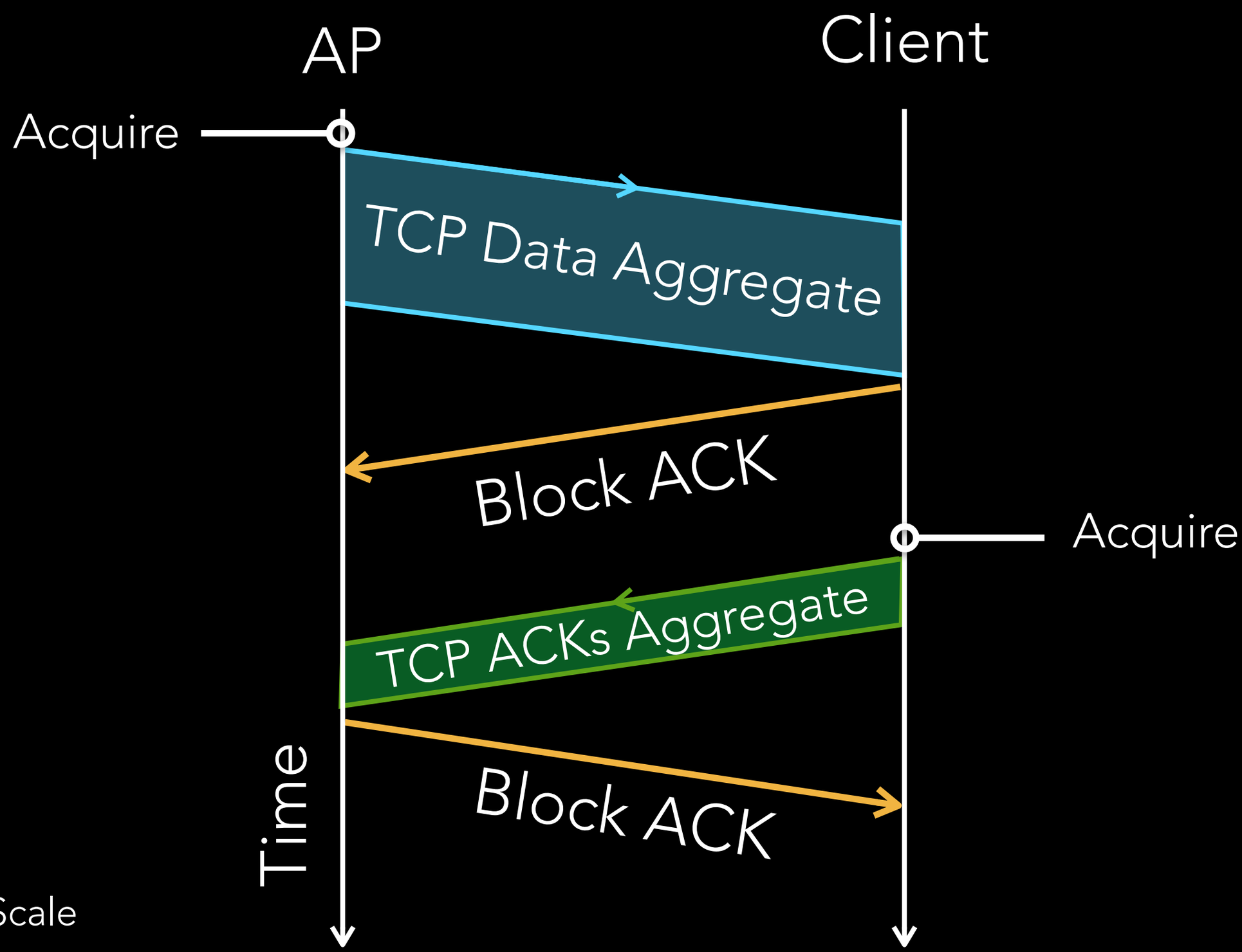
AGGREGATION INCREASES UTILIZATION AT HIGH RATES



Rate = 600 Mbps

~80% Utilization

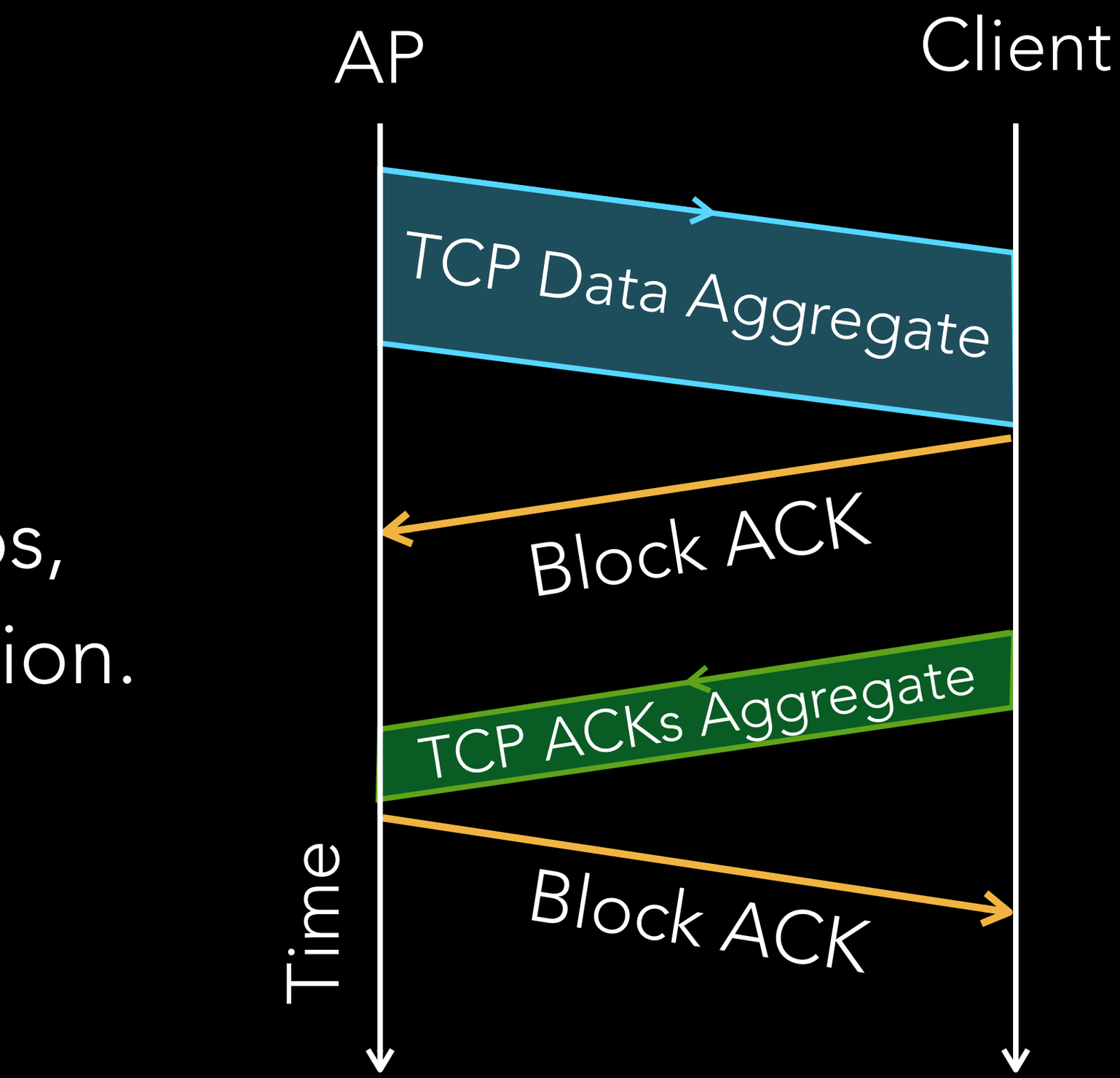
TCP DOUBLES MEDIUM ACQUISITIONS



* Not to Scale

TCP DOUBLES MEDIUM ACQUISITIONS

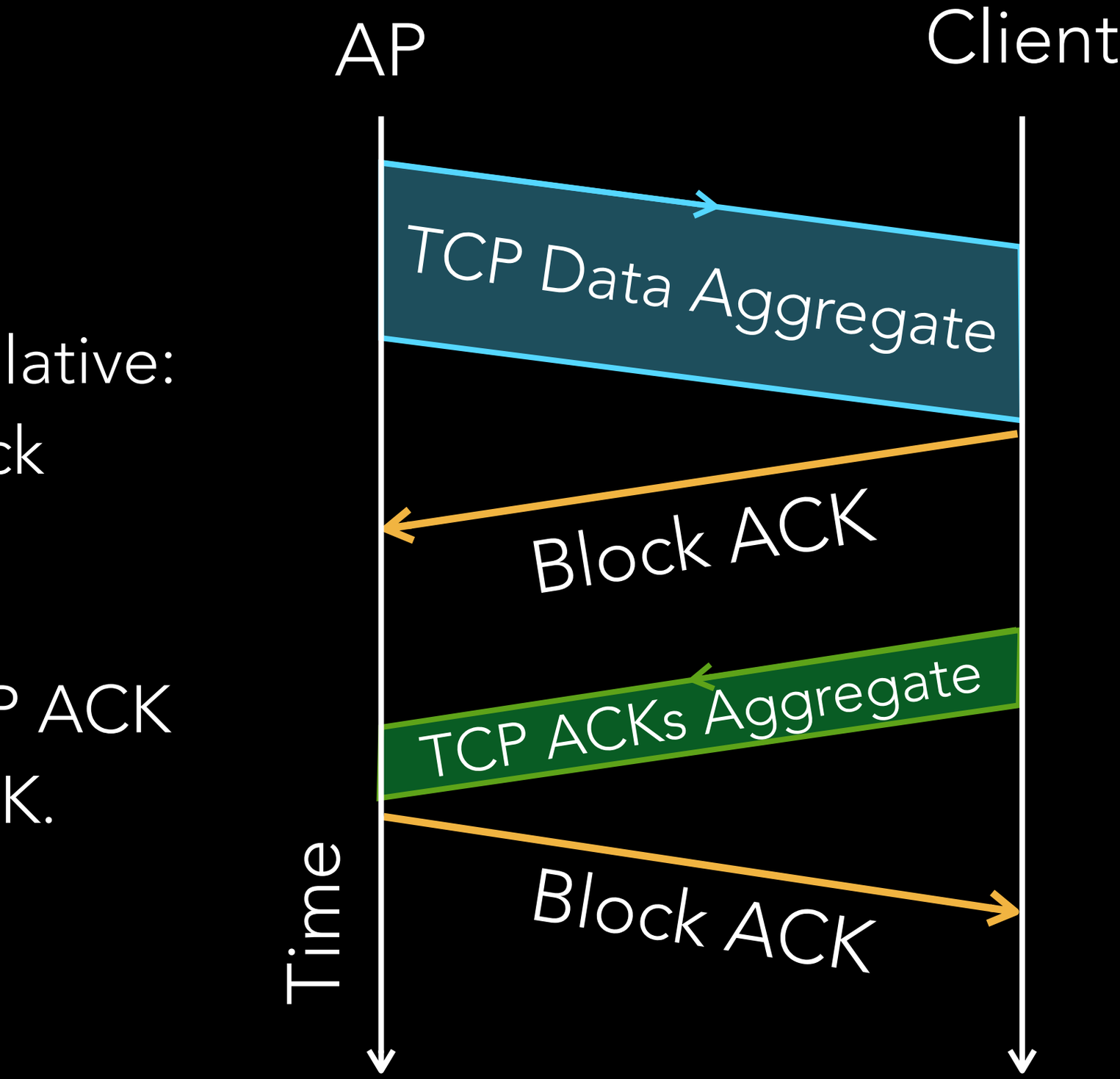
At 600 Mbps,
~61% utilization.



DO WE NEED TO ACQUIRE THE MEDIUM FOR FEEDBACK?

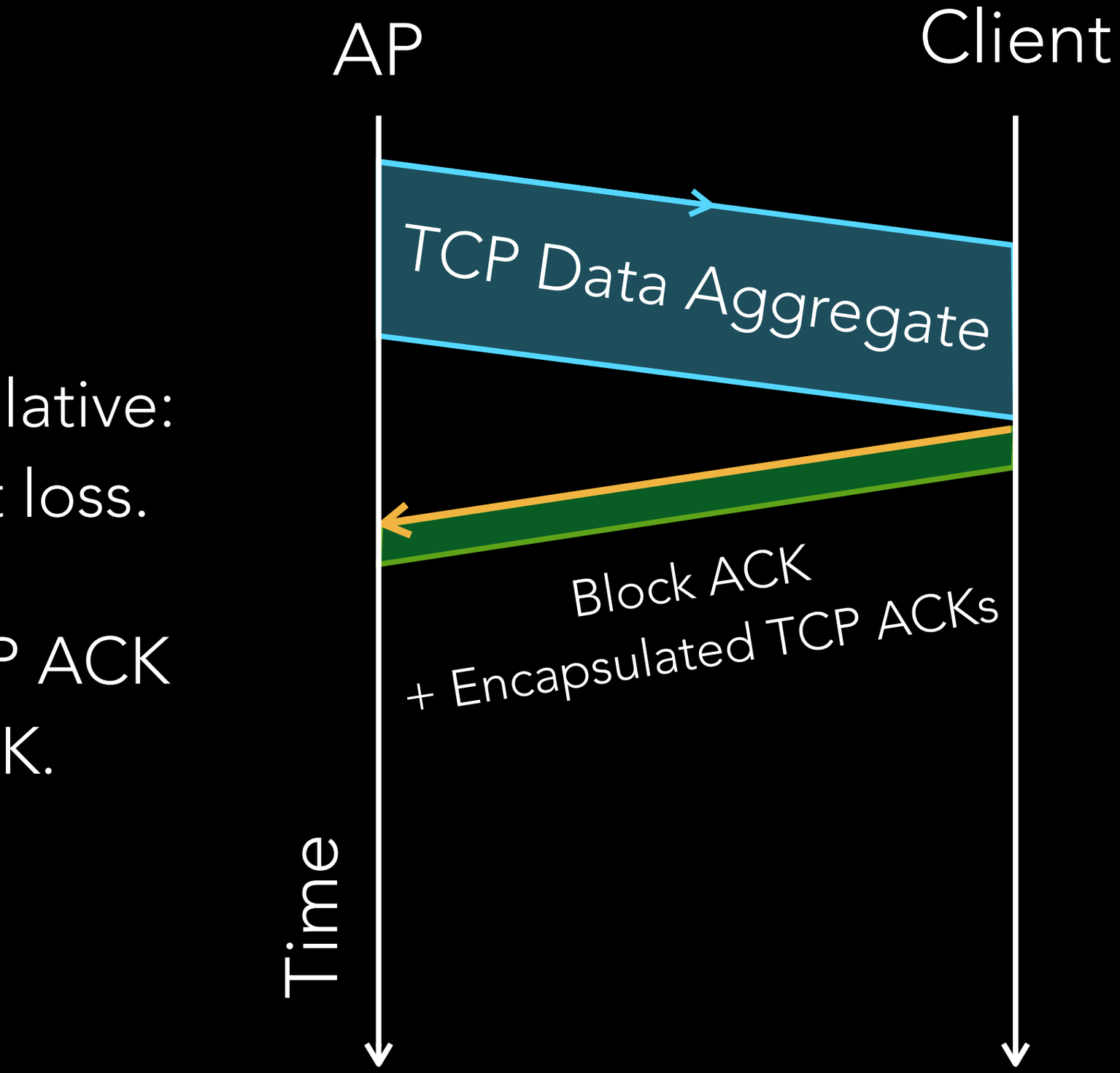
- TCP ACKs cumulative: no need for Block ACK.

- Encapsulate TCP ACK in Link-Layer ACK.



DO WE NEED TO ACQUIRE THE MEDIUM FOR FEEDBACK?

- TCP ACKs cumulative: robust to packet loss.
- Encapsulate TCP ACK in Link-Layer ACK.



HACK: HIERARCHICAL

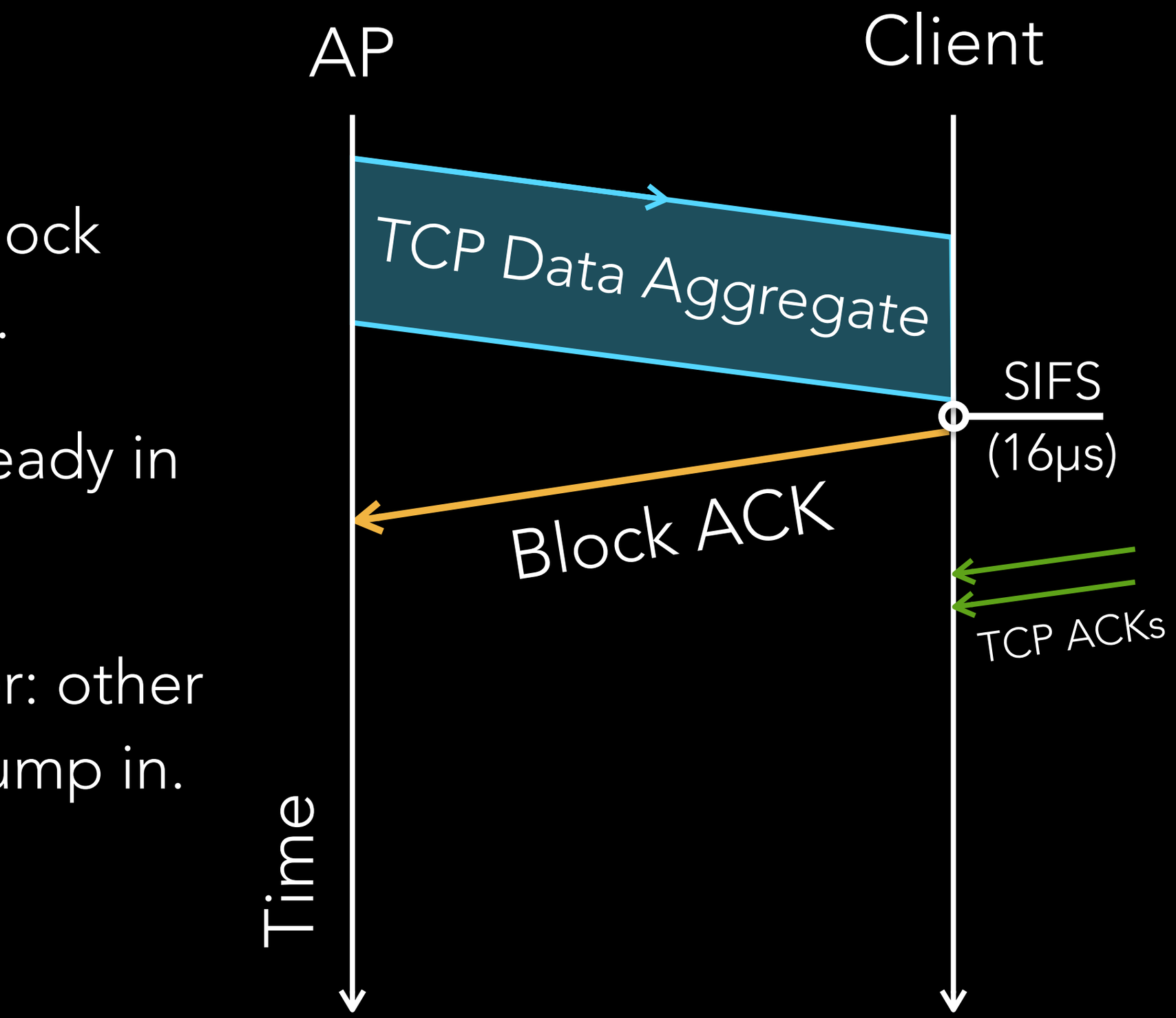
ACKNOWLEDGEMENTS

GOALS

- Coexistence with stock 802.11.
- Simple NIC changes.
- No TCP changes.
- Robustness to loss.

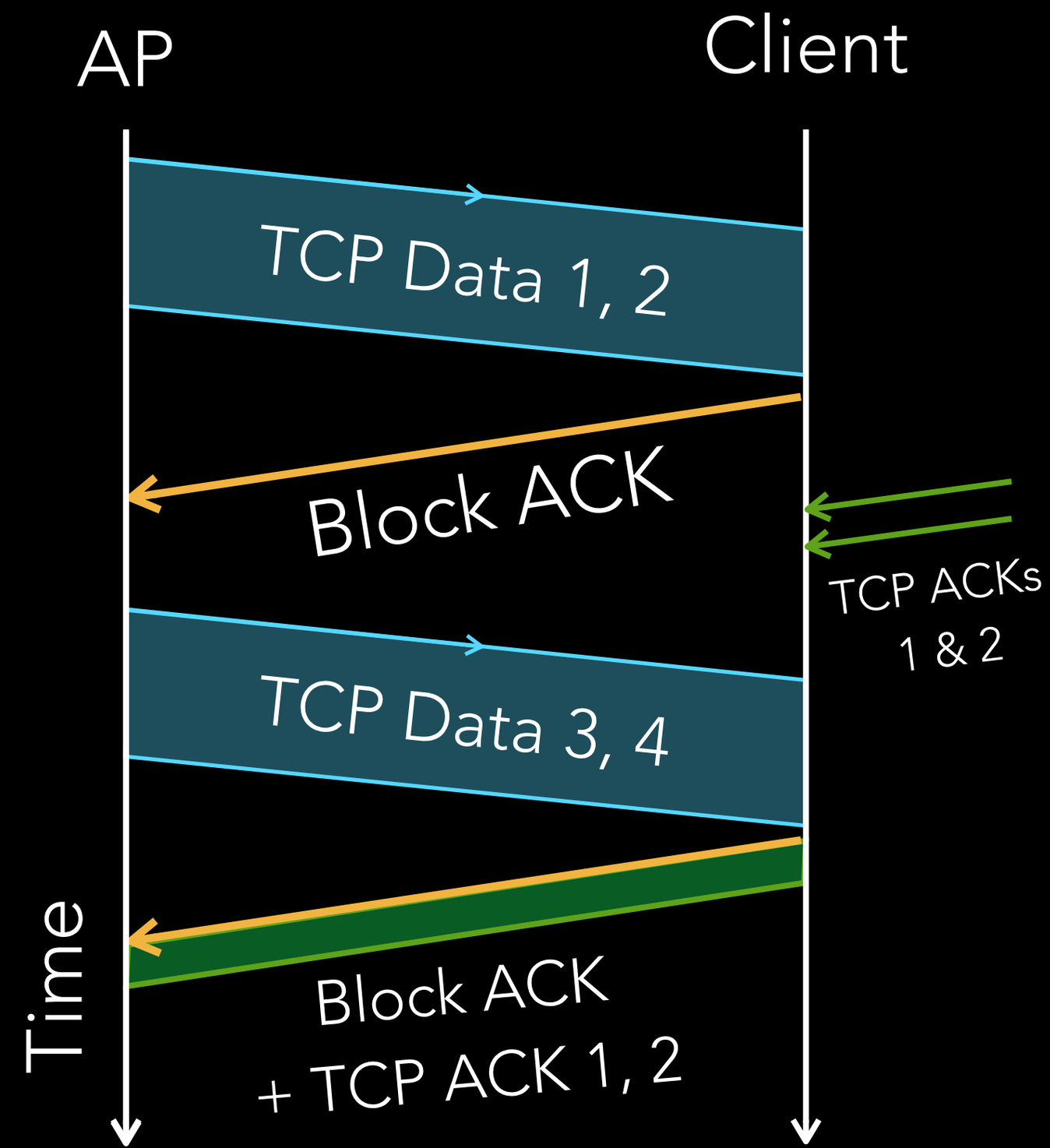
BLOCK ACKS MUST MEET HARD DEADLINE

- Need to send Block ACK within SIFS.
- TCP ACKs not ready in time.
- Can’t wait longer: other senders might jump in.



TCP ACKS DON'T HAVE A HARD DEADLINE

- TCP ACKs can afford to wait.
- Append them to the next Link-Layer ACK.



CONSECUTIVE TCP ACKS ARE REDUNDANT

TCP ACK Header
(20 Bytes)

CONSECUTIVE TCP ACKS ARE REDUNDANT

TCP ACK 1

CONSECUTIVE TCP ACKS ARE REDUNDANT

TCP ACK 1

TCP ACK 2

CONSECUTIVE TCP ACKS ARE REDUNDANT

TCP ACK 1

TCP ACK 2

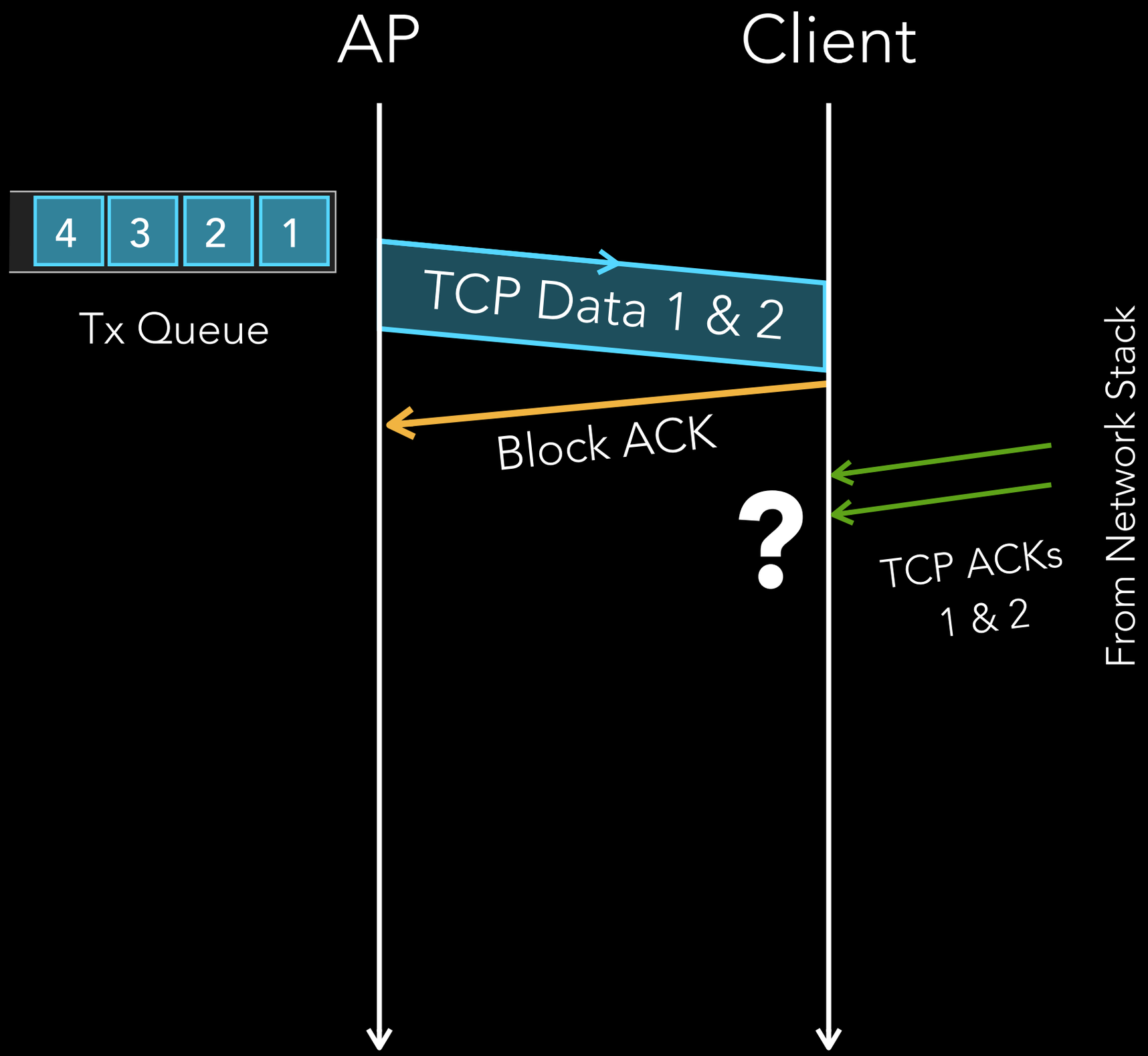
HACK USES ROHC FOR EFFICIENT COMPRESSION

TCP ACK 1

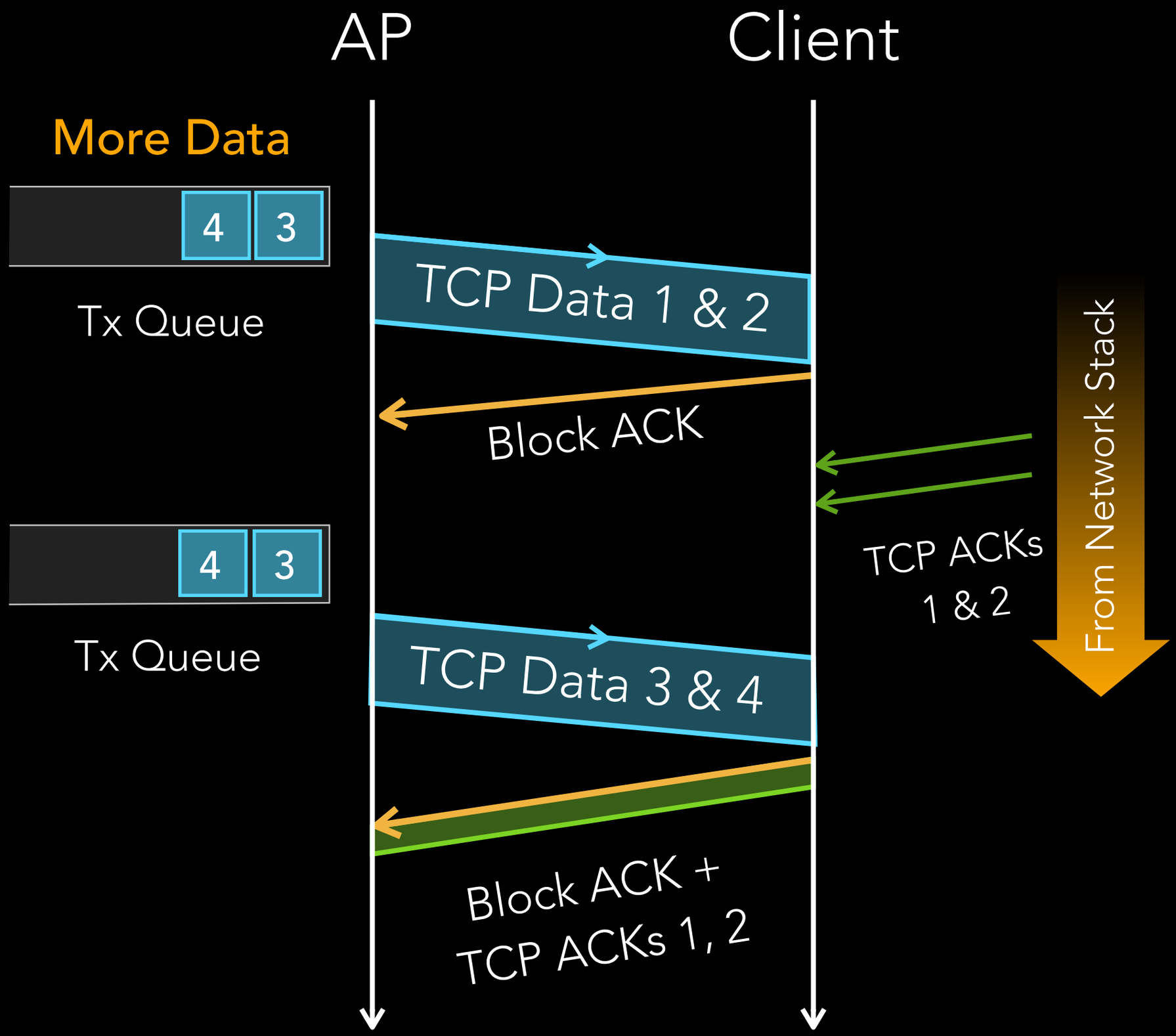
TCP ACK 2

- HACK uses Robust Header Compression (ROHC, RFC 6846)
- ROHC shrinks a TCP ACK to about 5 bytes

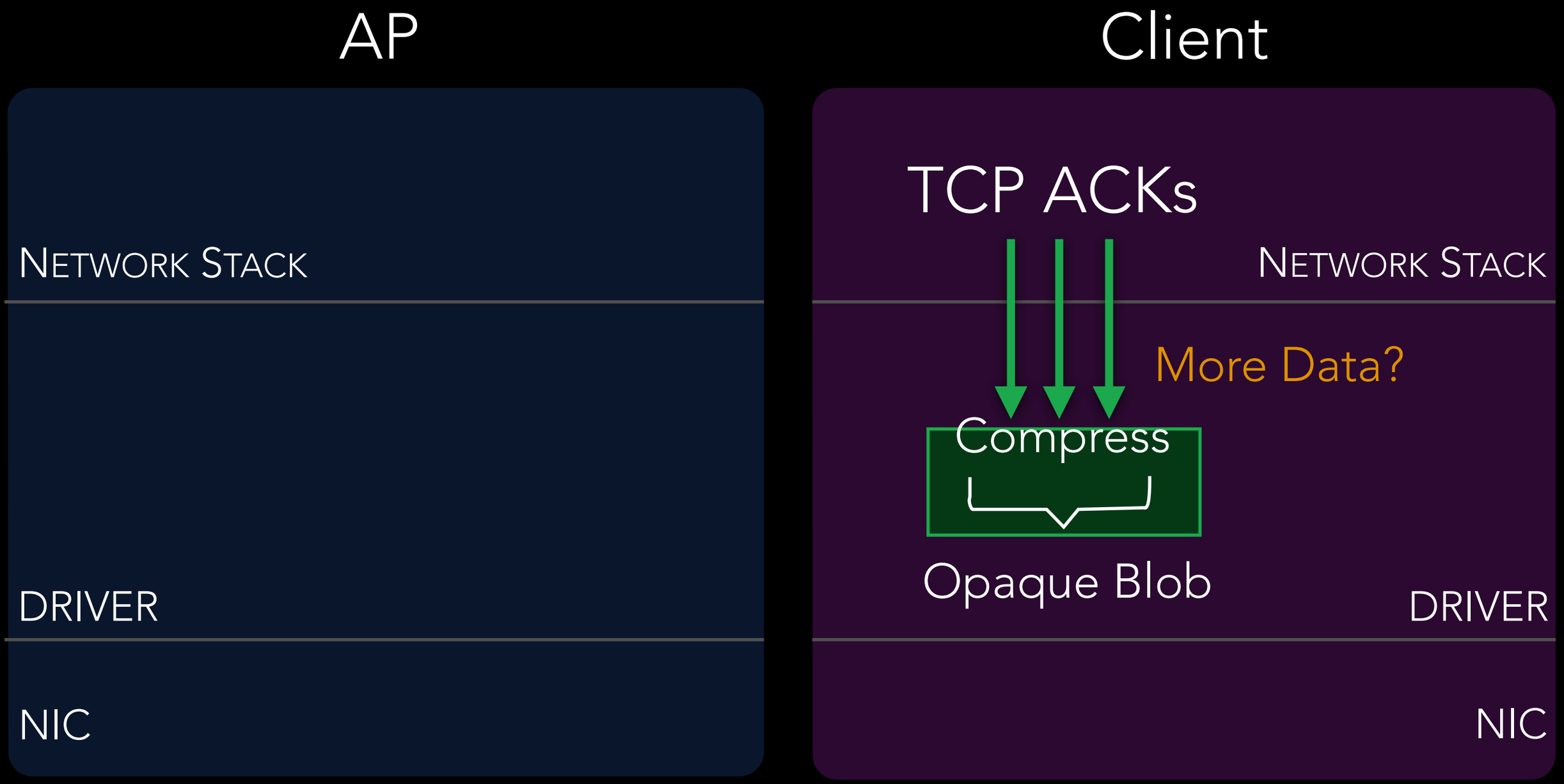
TO HACK OR NOT TO HACK?



TO HACK OR NOT TO HACK?



NIC NEEDS NO TCP KNOWLEDGE



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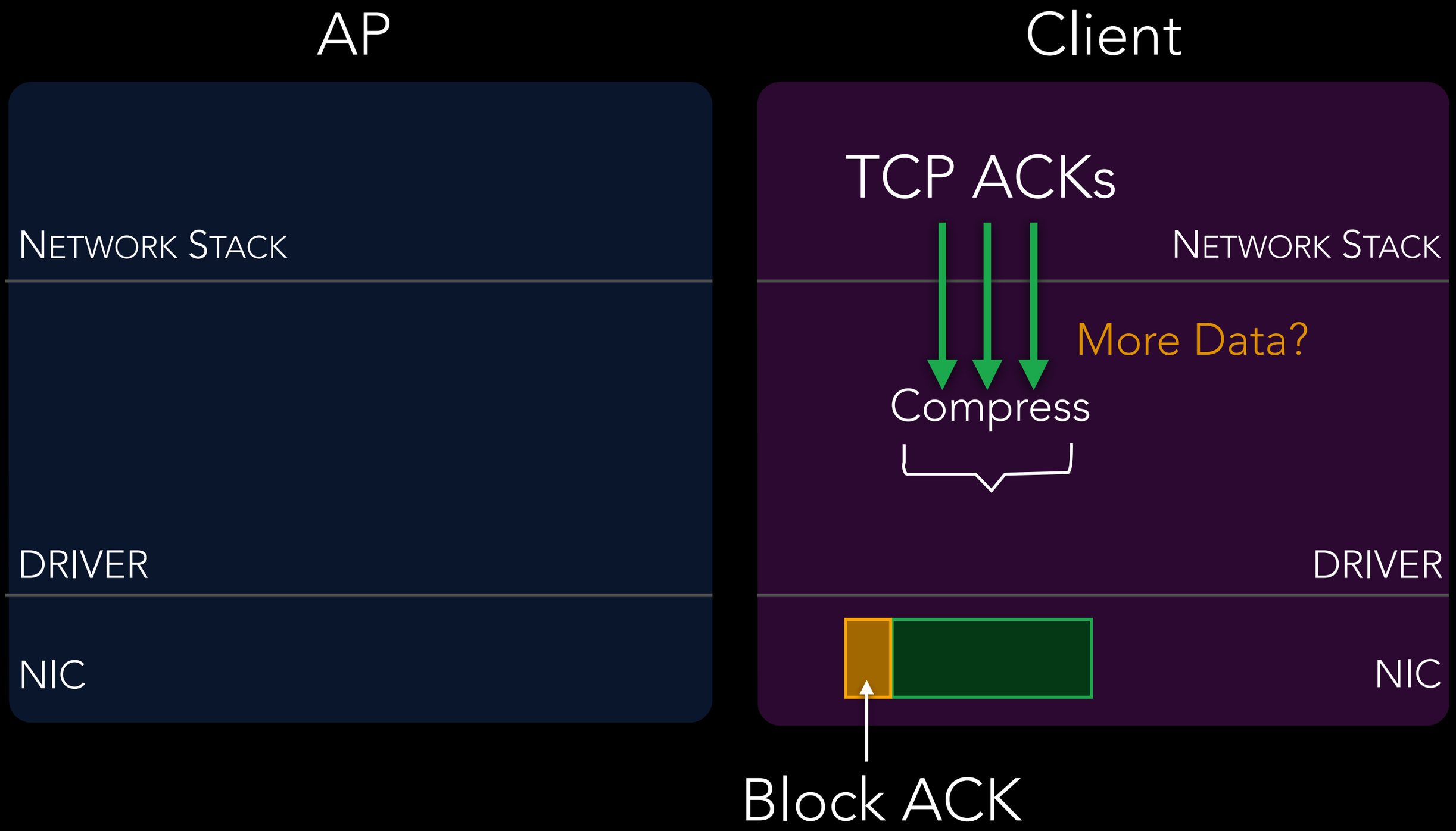

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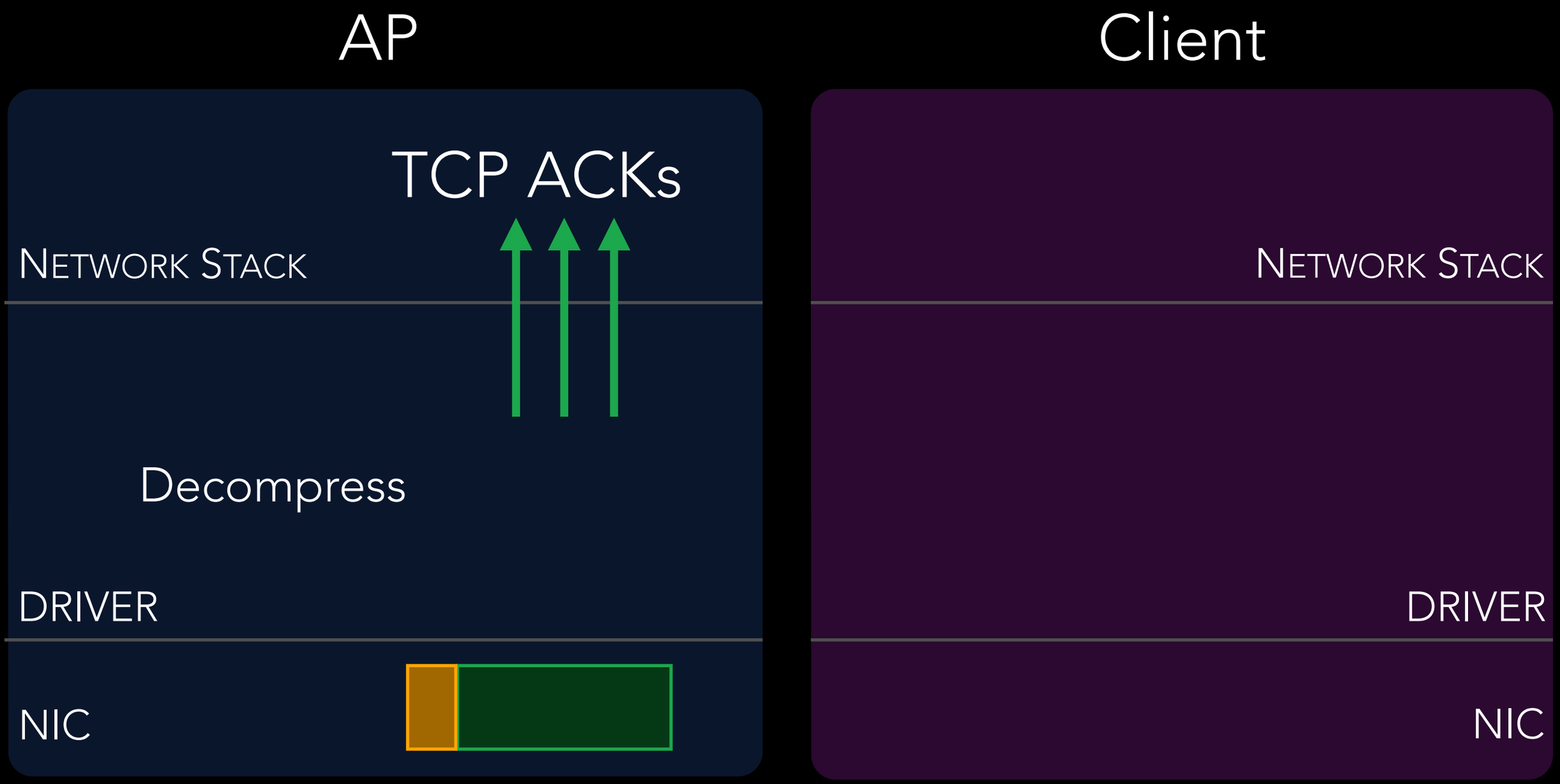
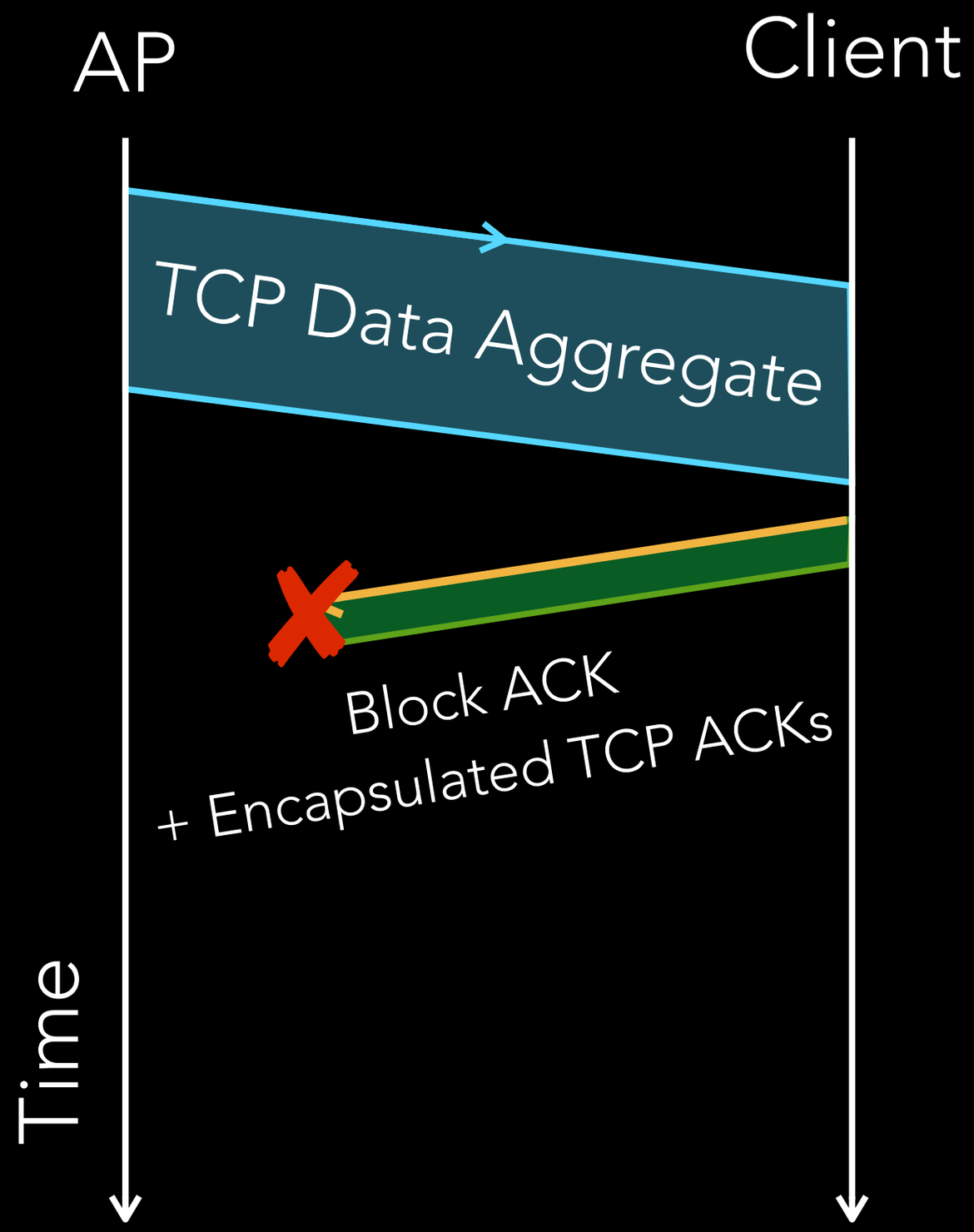


WHAT ABOUT LOSS OF BLOCK ACKS?

- TCP can tolerate loss of ACKs.
- ROHC cannot: endpoints should remain in sync.
- HACK should be robust against loss.
- Details in paper.



EVALUATION

Microsoft's Software Radio (SoRa):

- 802.11a (no aggregation).

ns-3 simulator

- 802.11n (aggregation).

TCP GOODPUT EXPERIMENT

SoRa	NS-3
802.11a	802.11n
54 Mbps	150 Mbps

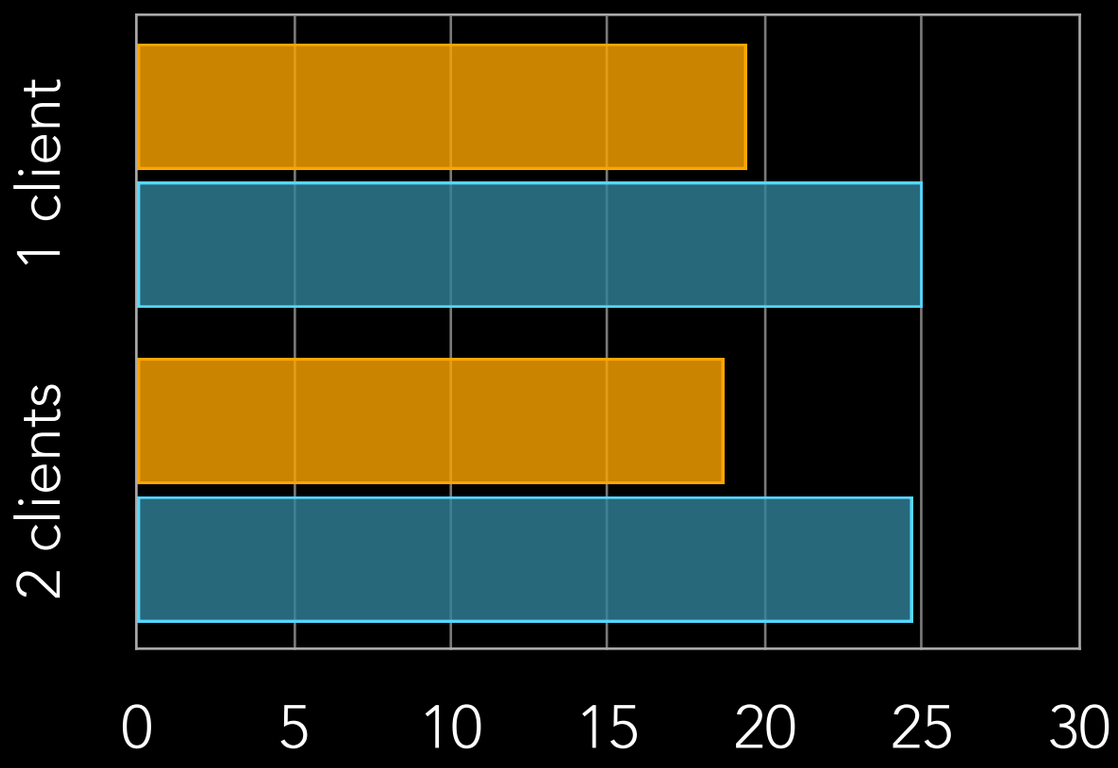
High Quality Link

1, 2 Clients	Up to 10 Clients

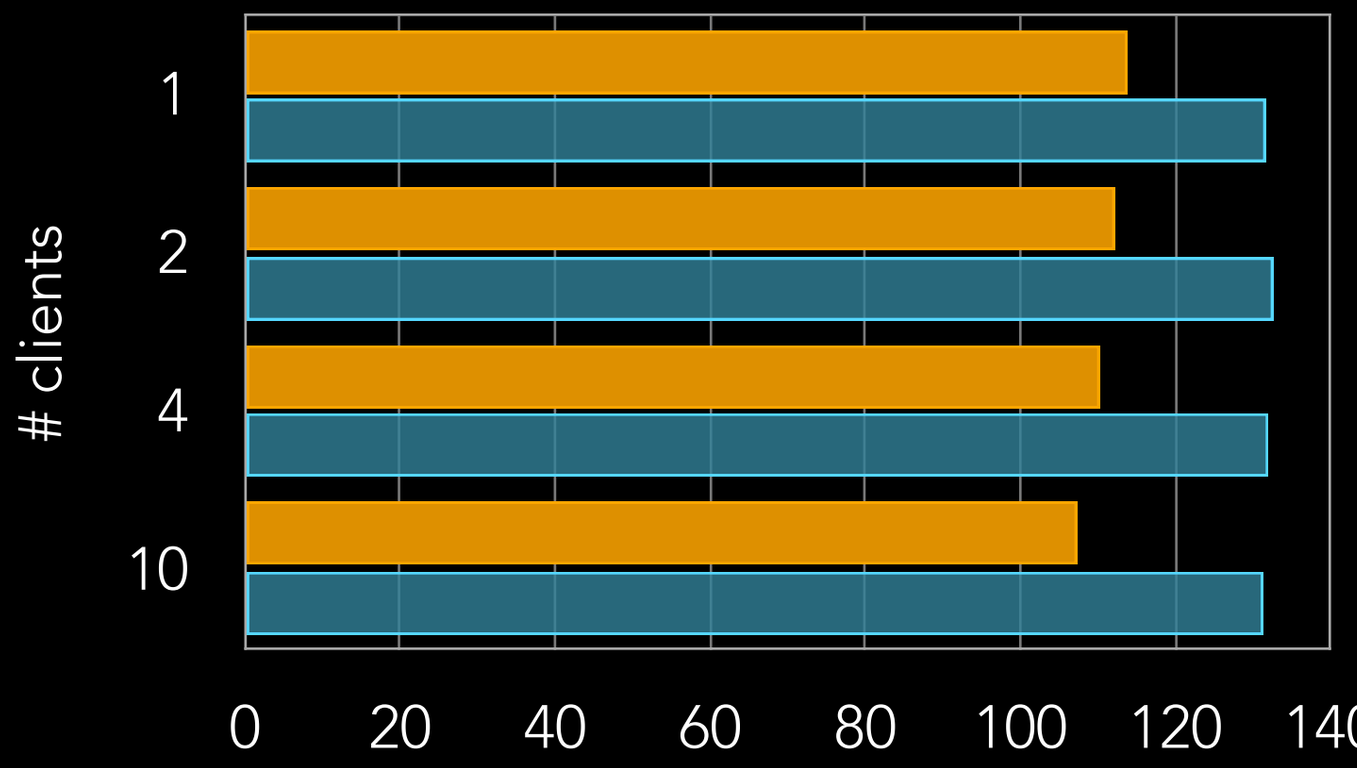
Measure steady state aggregate goodput

HACK IMPROVES TCP GOODPUT

SoRa (802.11a)



ns-3 (802.11n)

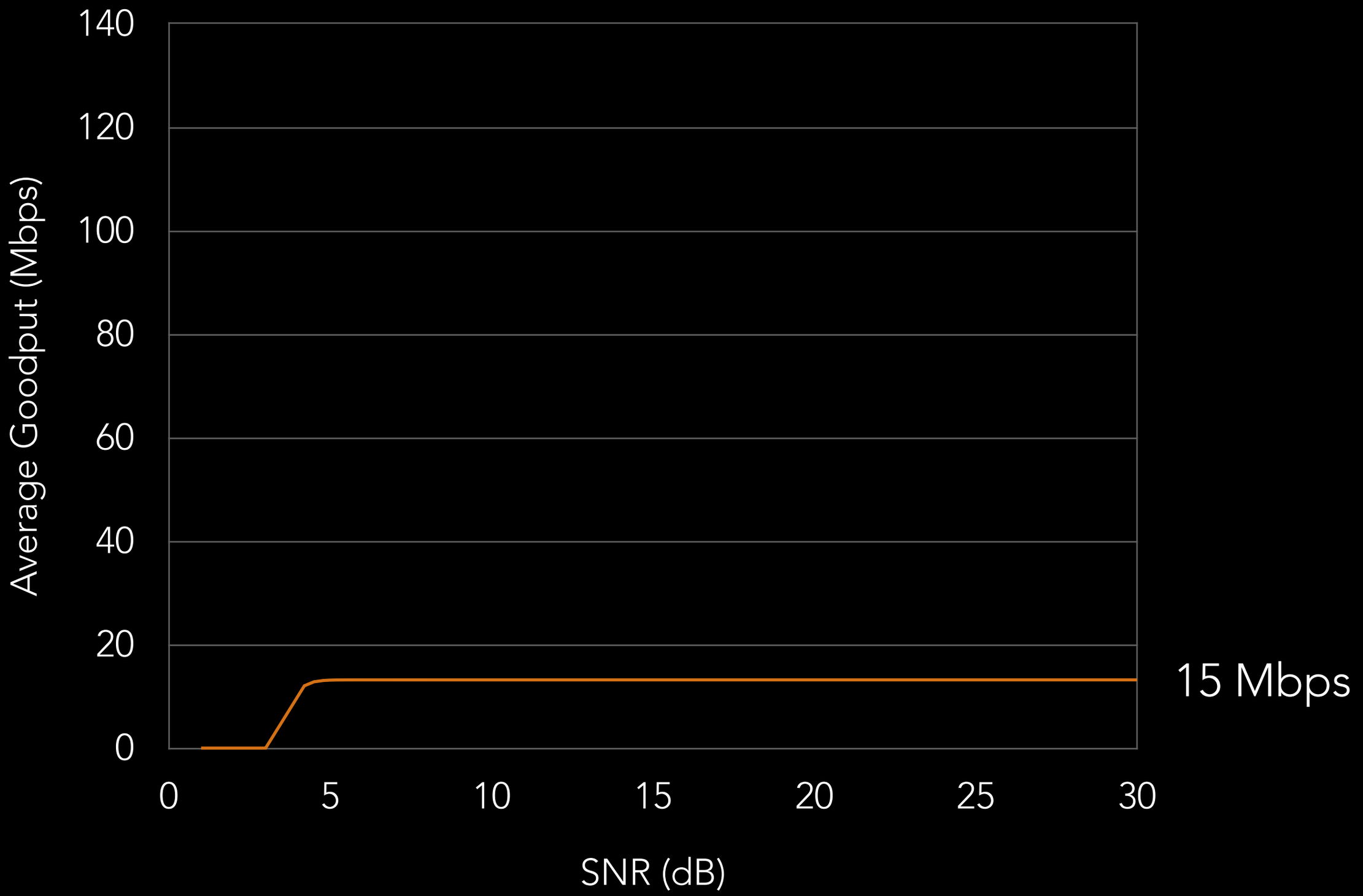


TCP/Wifi TCP/HACK

29 - 32 % Improvement

15 - 22 % Improvement

HACK IMPROVES GOODPUT ACROSS FULL RANGE OF LINK RATES



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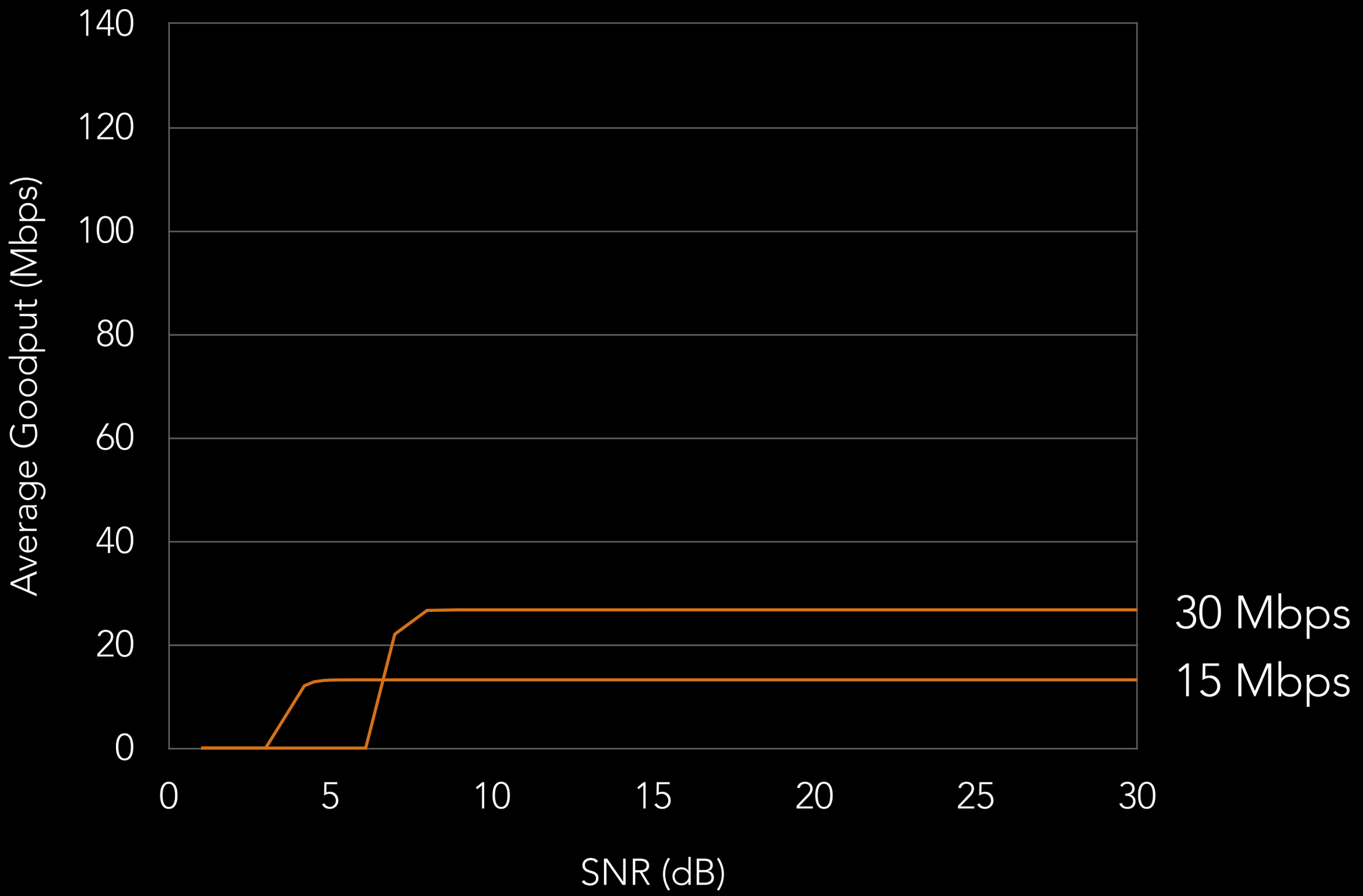

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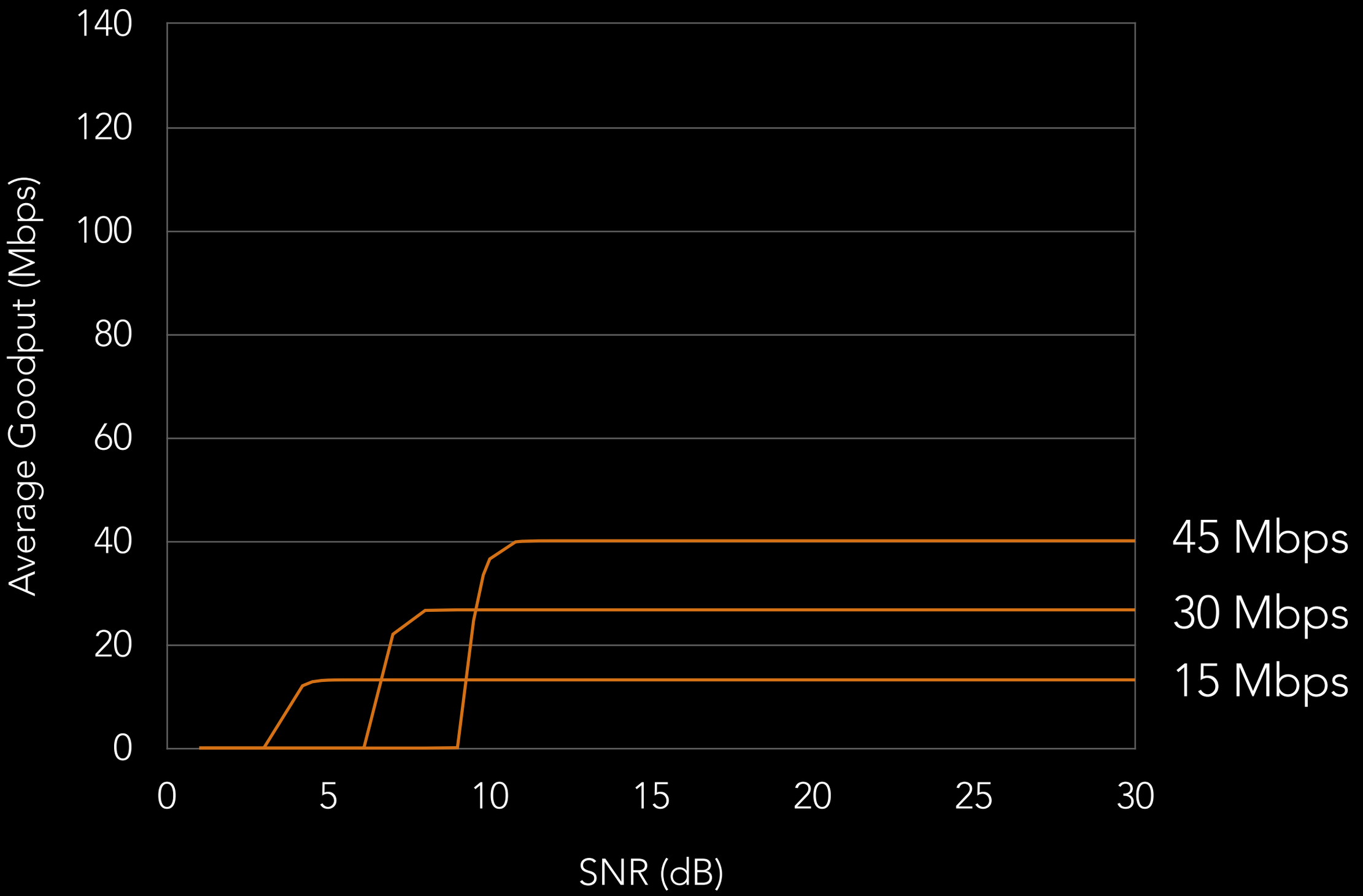

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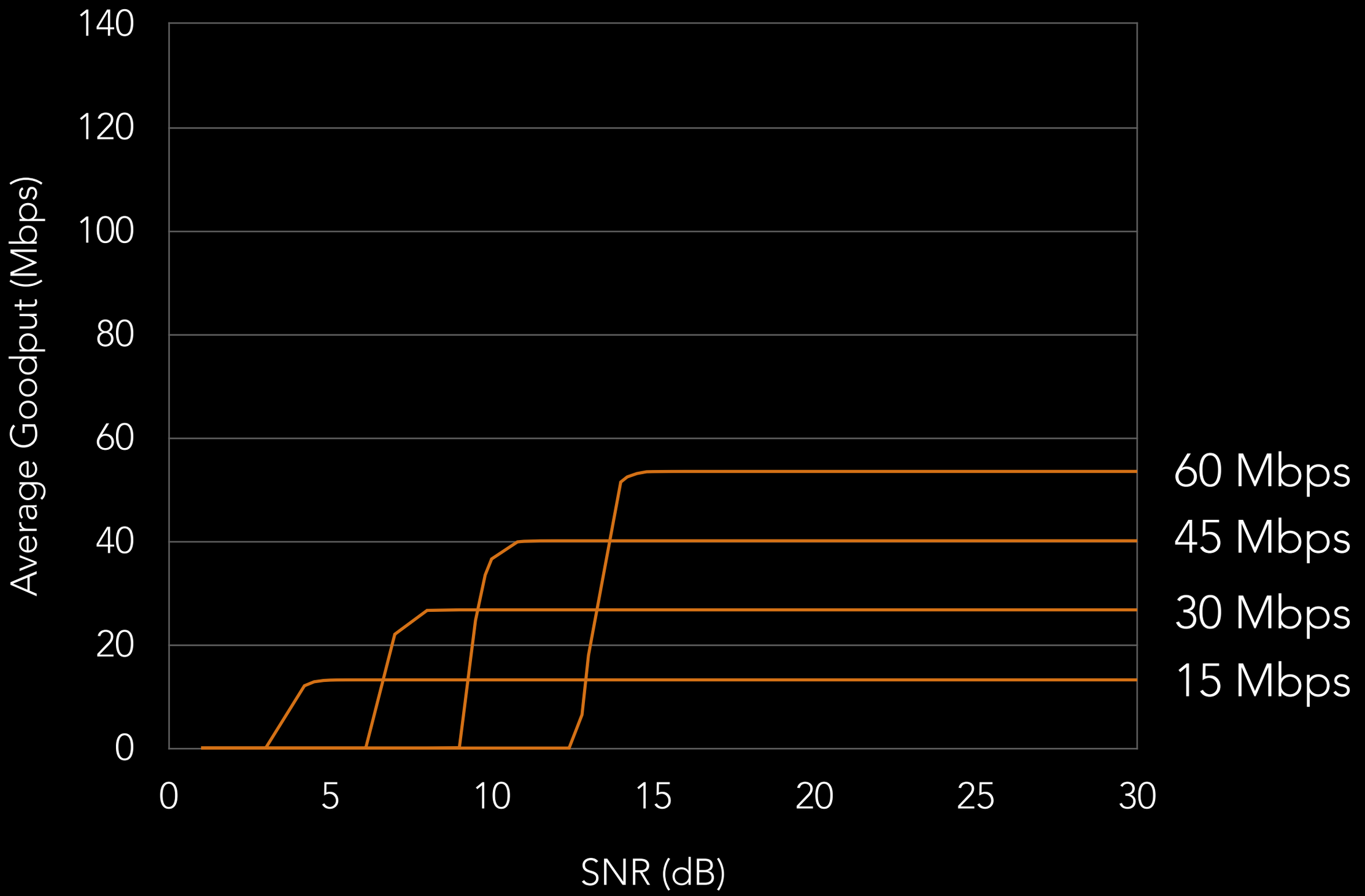

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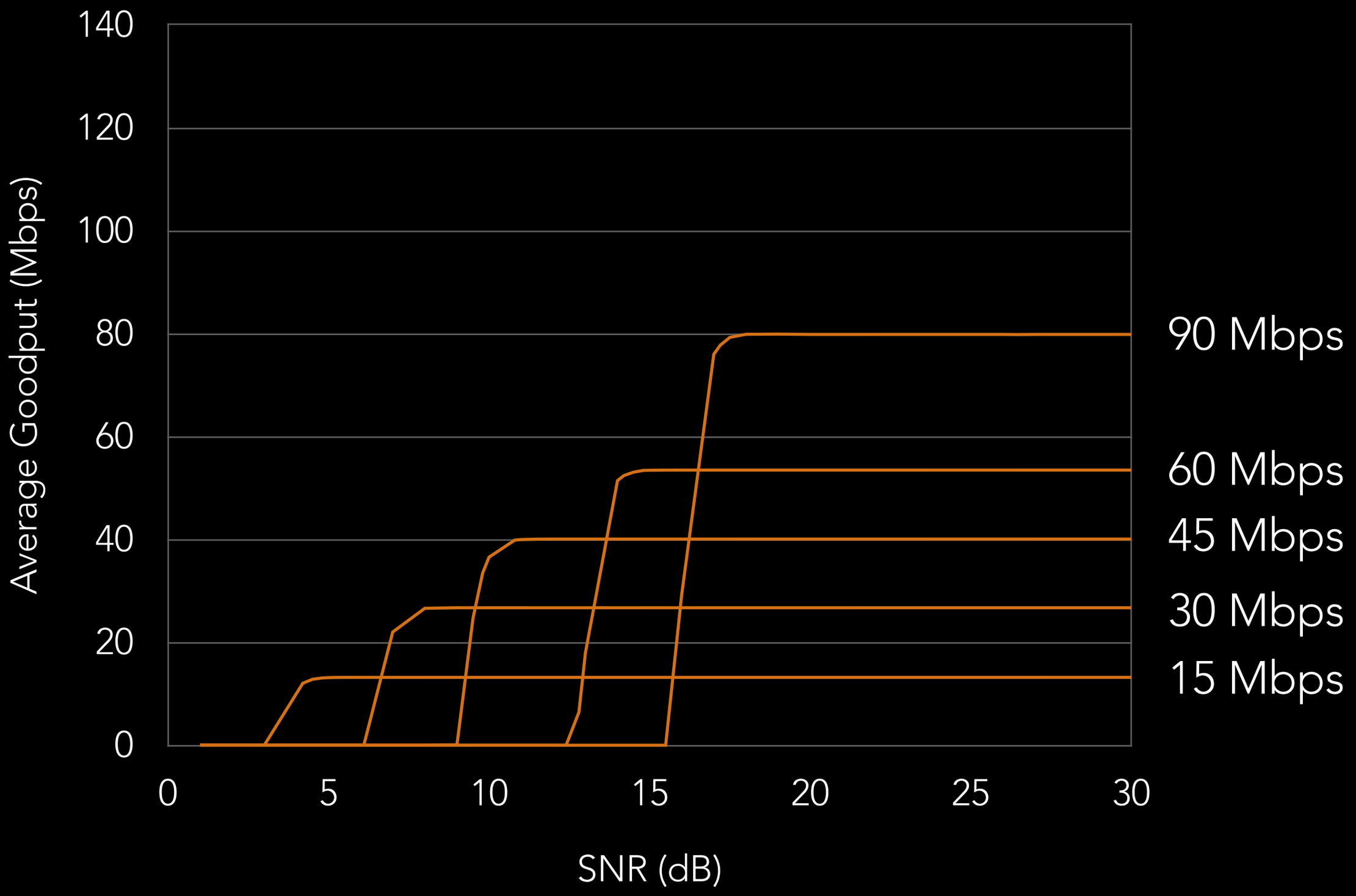

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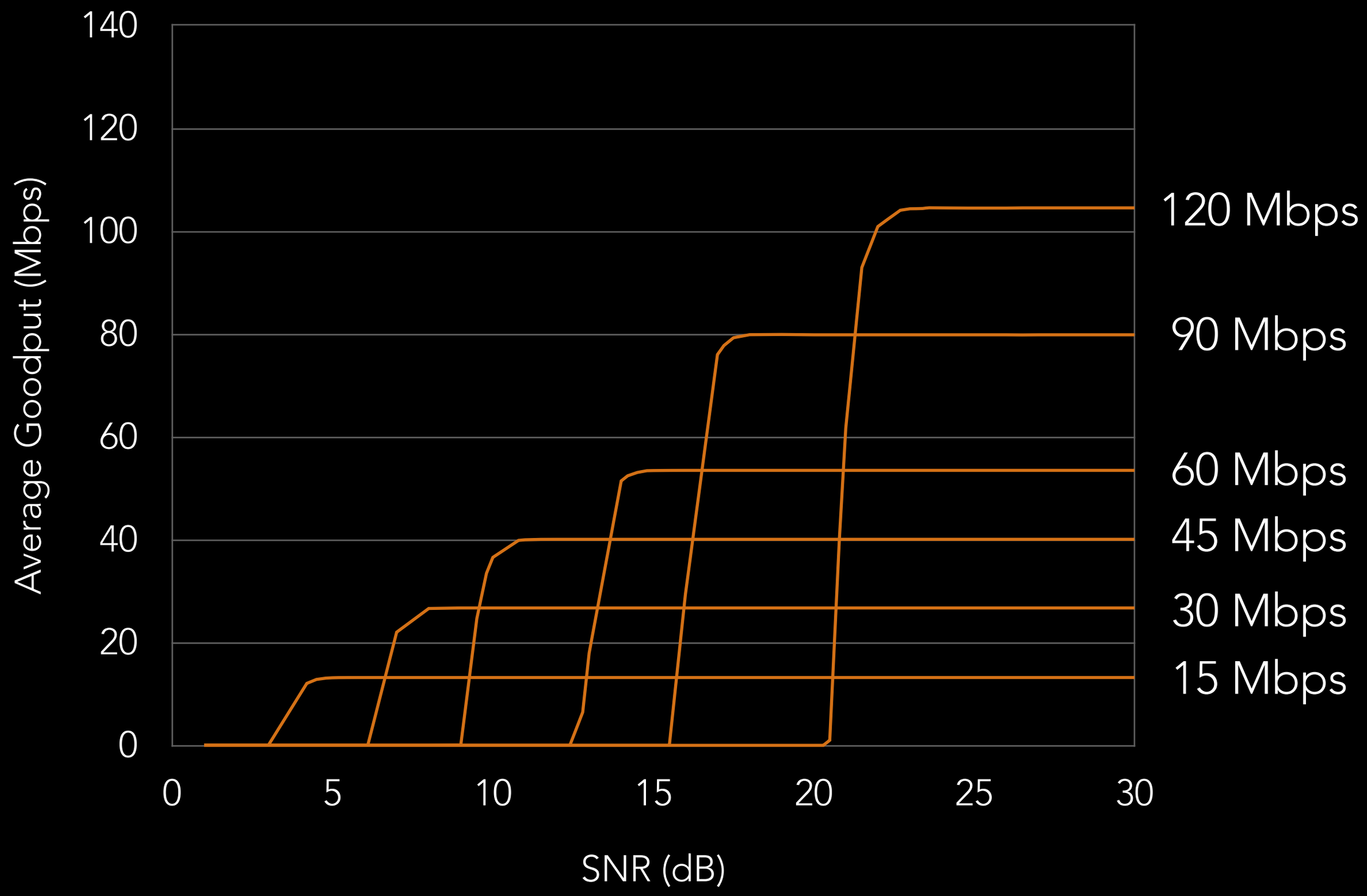

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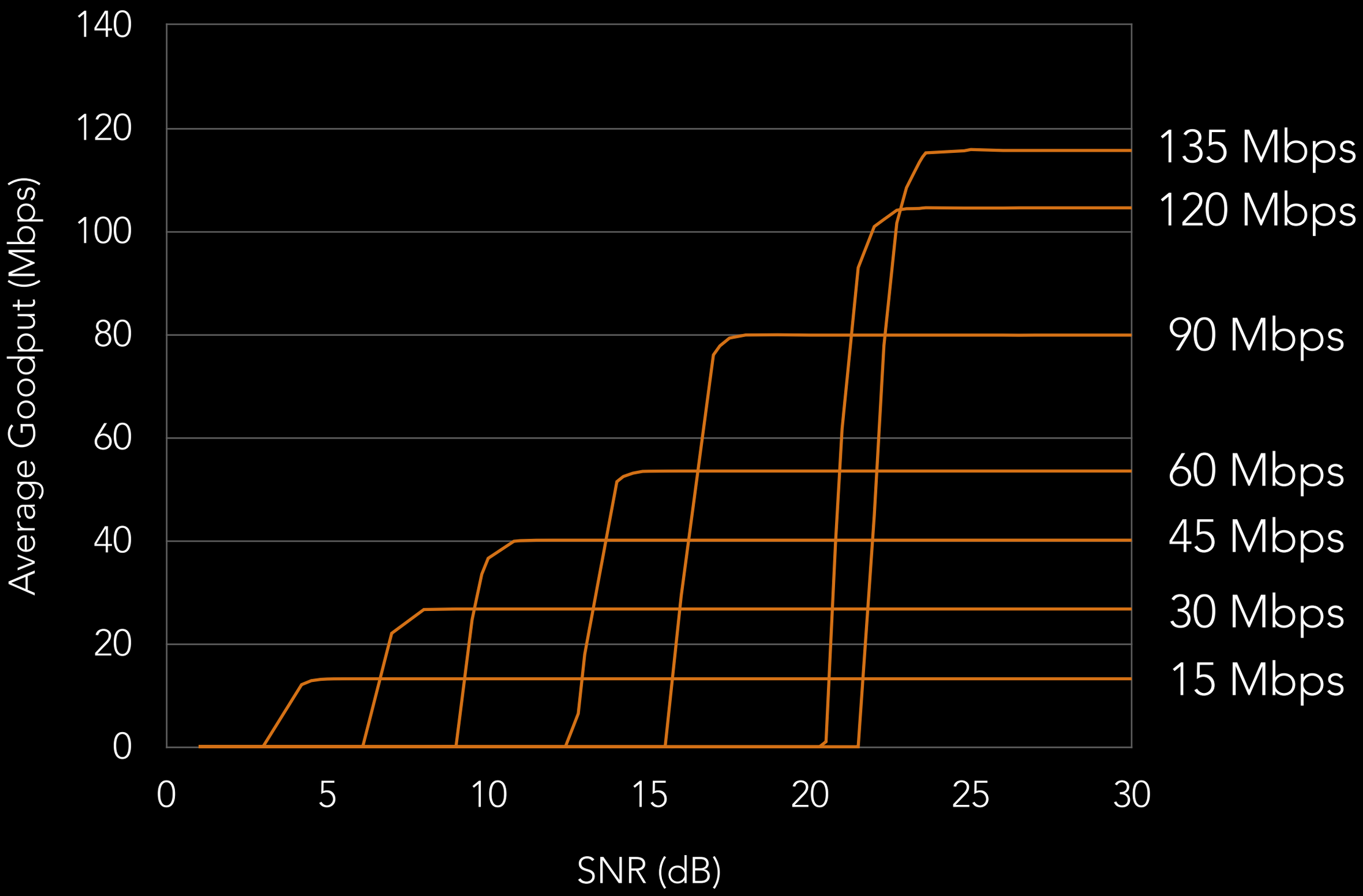

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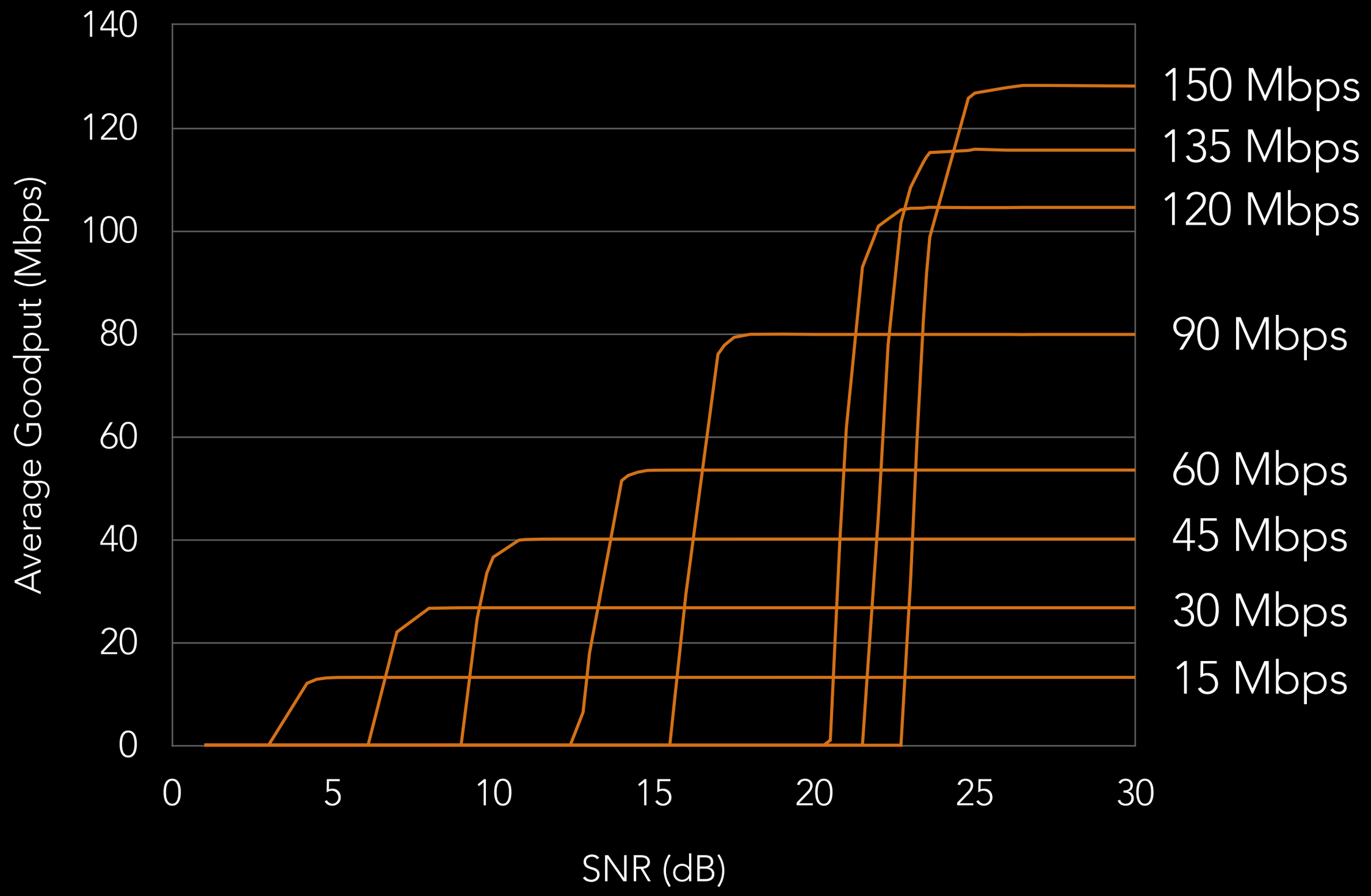

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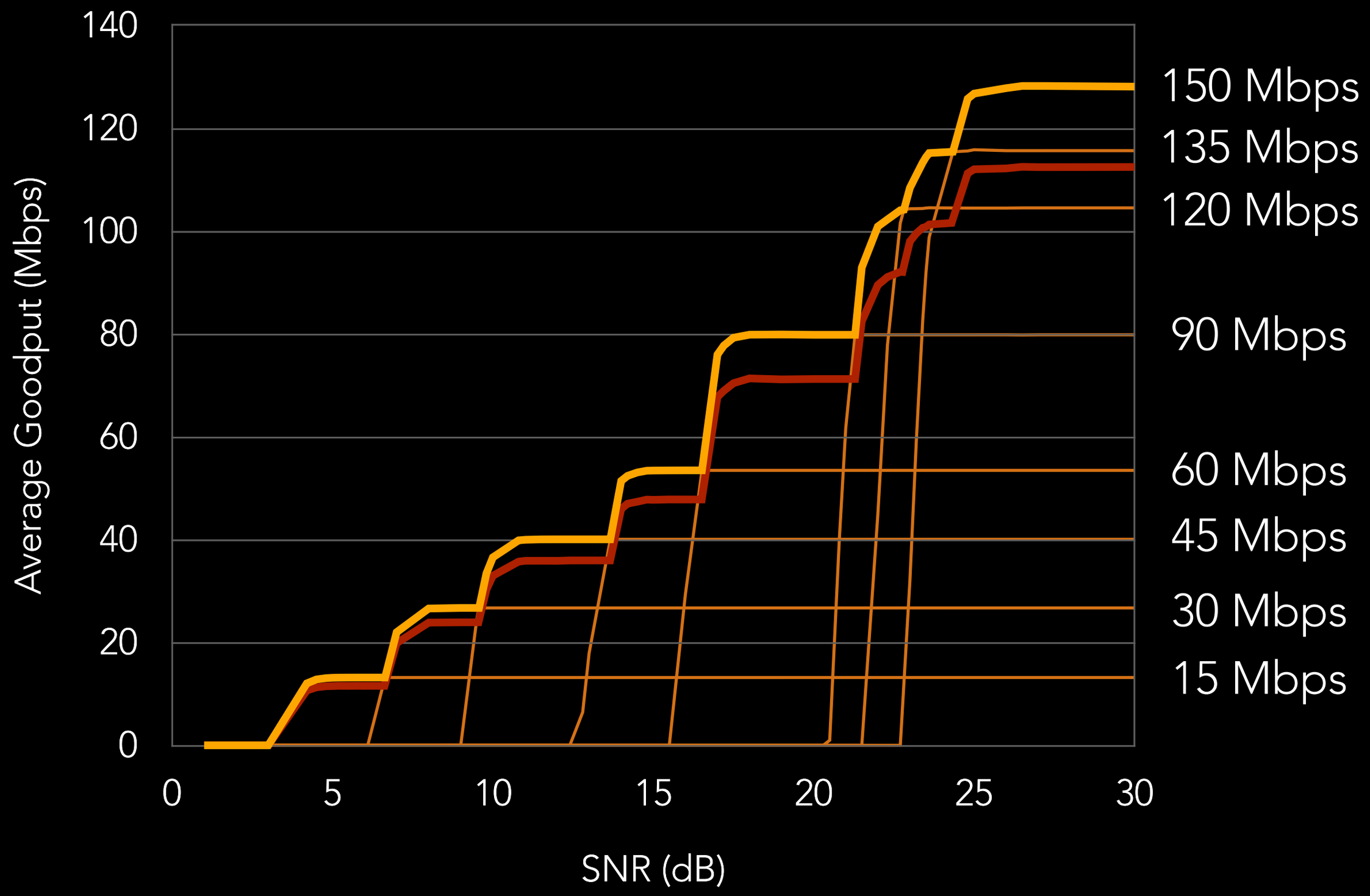

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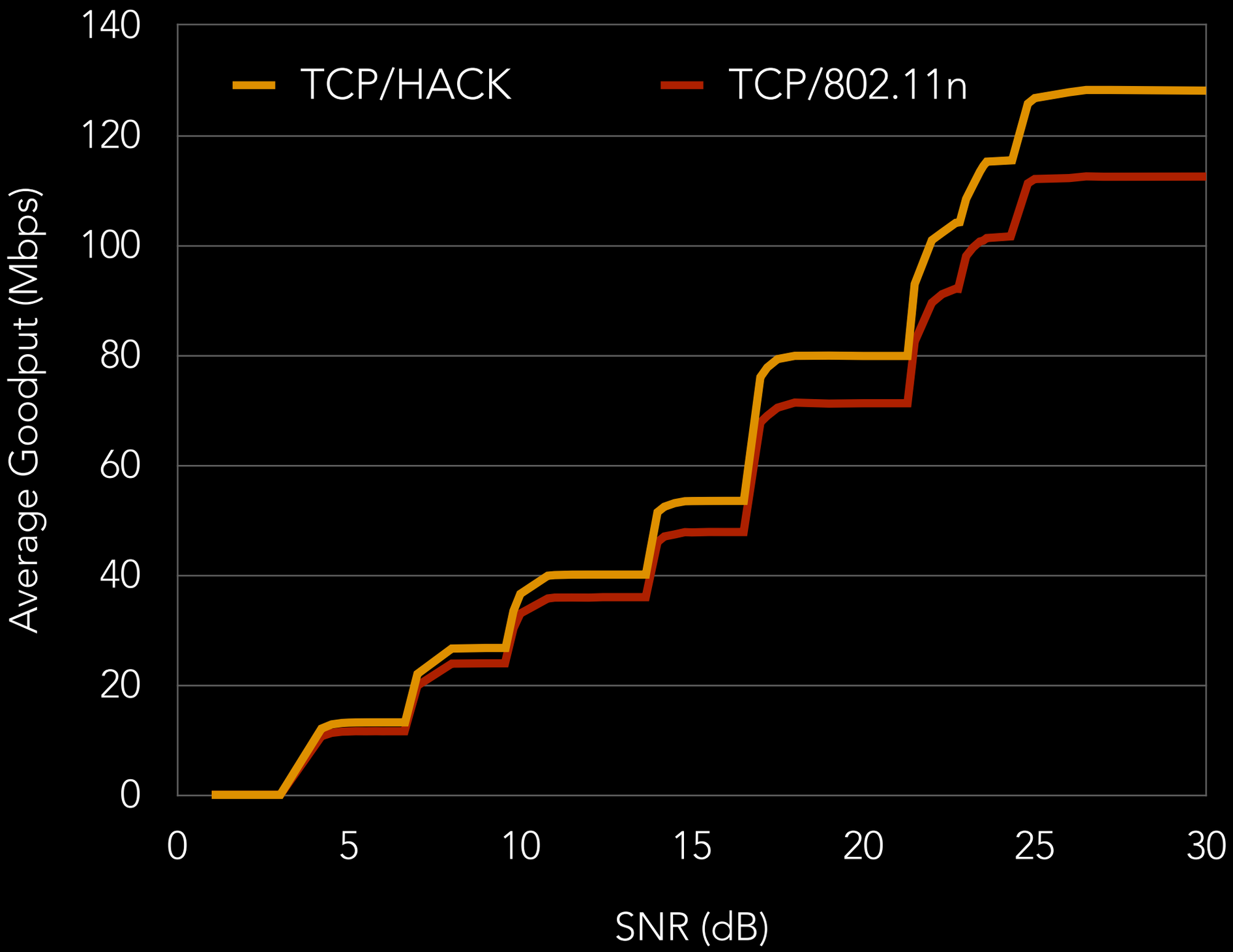

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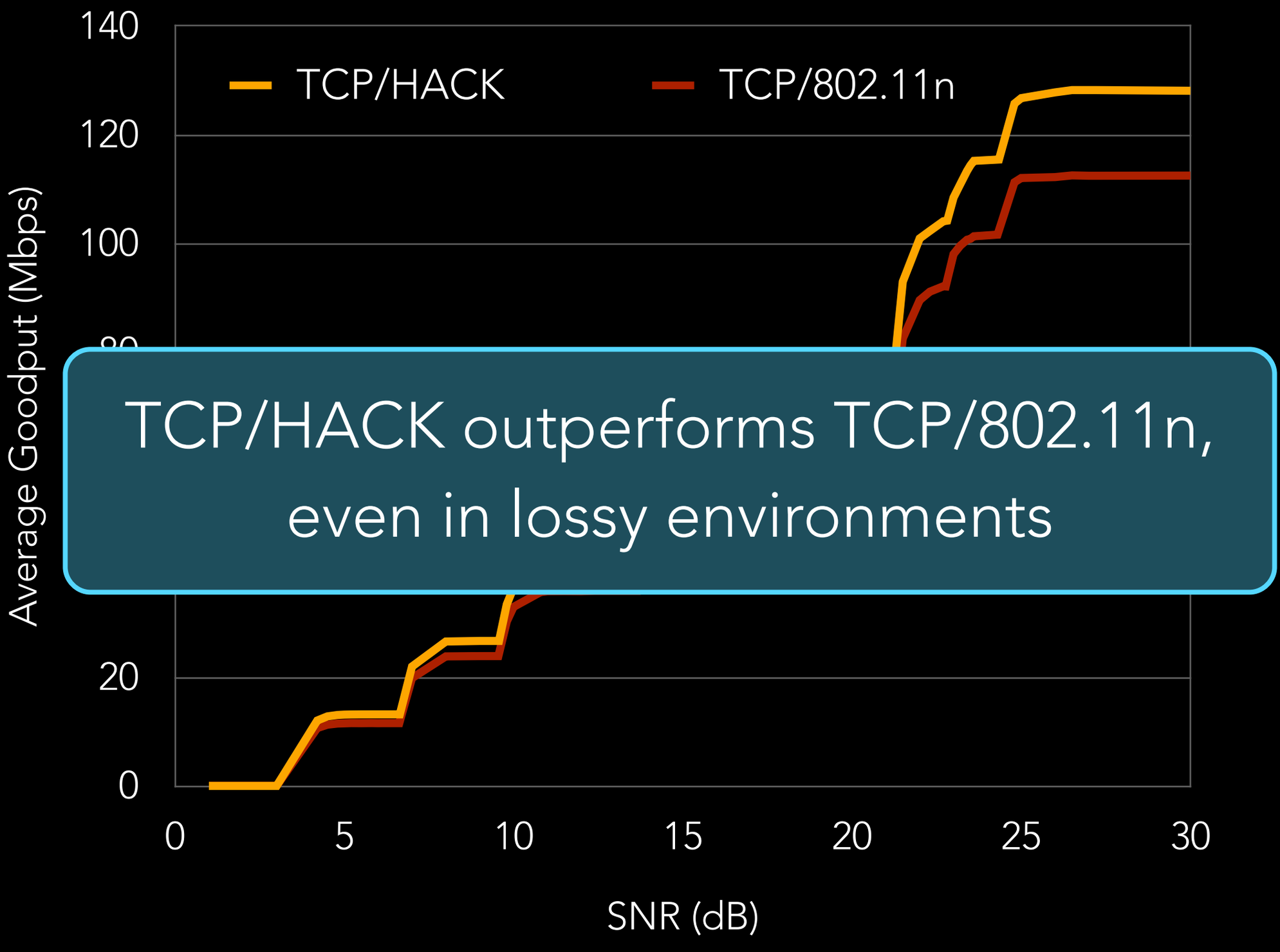

TCP/HACK outperforms TCP/802.11n, even in lossy environments

CONCLUSIONS

- TCP/HACK reduces medium acquisitions.
- Increases goodput by:
  - ~29 - 32% with no aggregation
  - ~11 - 20% with aggregation
- Practical to deploy on real NICs.

http://www0.cs.ucl.ac.uk/staff/A.Zhushi/hack/index.html