Toward Understanding Congestion in Tor

DC-area Anonymity, Privacy, and Security Seminar

January 24th, 2014

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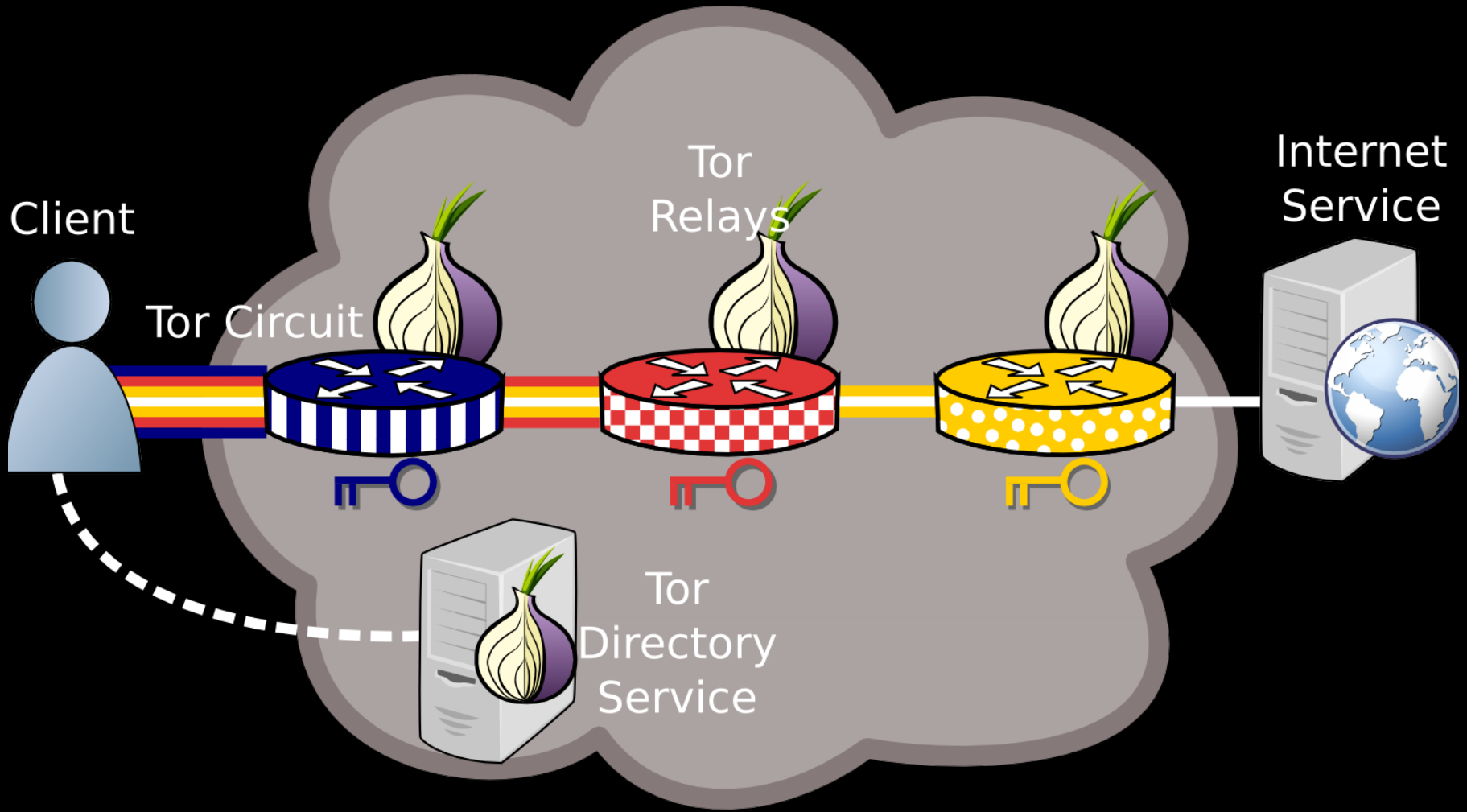
U.S. Naval Research Laboratory

*Joint with John Geddes, Chris Wacek, Micah Sherr, Paul Syverson

Tor for ~~Awesomeness~~ Anonymity



Tor is Slow!!! Research*

- PCTCP: Per-Circuit TCP-over-IPsec Transport for Anonymous Communication Overlay Networks (CCS ‘13)
- Reducing Latency in Tor Circuits with Unordered Delivery (FOCI ‘13)
- How Low Can You Go: Balancing Performance with Anonymity in Tor (PETS ‘13)
- The Path Less Travelled: Overcoming Tor's Bottlenecks with Traffic Splitting (PETS ’13)
- An Empirical Evaluation of Relay Selection in Tor (NDSS ‘13)
- LIRA: Lightweight Incentivized Routing for Anonymity (NDSS ‘13)
- Improving Performance and Anonymity in the Tor Network (IPCCC ‘12)
- Enhancing Tor's Performance using Real-time Traffic Classification (CCS ’12)
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- Throttling Tor Bandwidth Parasites (USENIX Sec ‘12)
- LASTor: A Low-Latency AS-Aware Tor Client (Oakland ‘12)
- Congestion-aware Path Selection for Tor (FC ‘12)

*Not a comprehensive list

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Where?

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Outline

- Where is Tor slow?
  - Understand Tor relay architecture
  - Measure and analyze relay congestion in realistic Tor networks
- Design focused solutions

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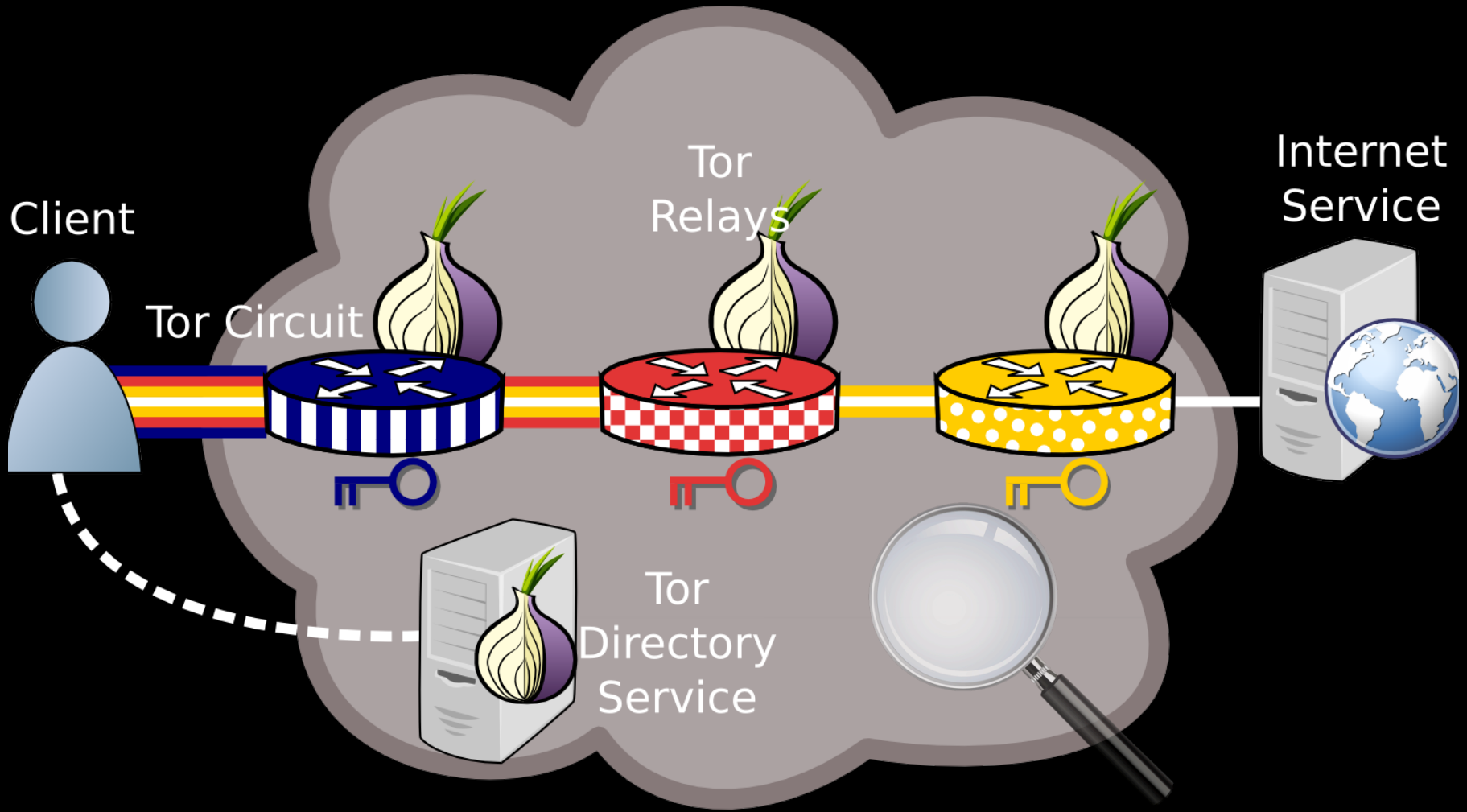
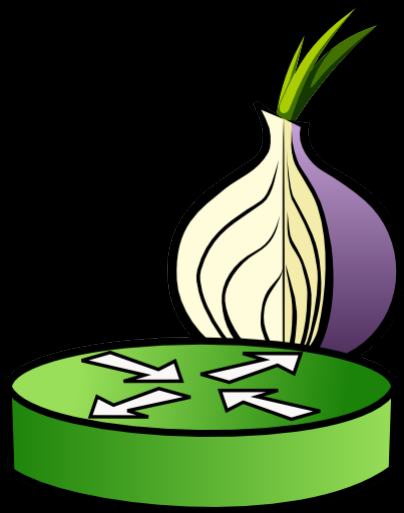
The Tor Network



Relay Overview



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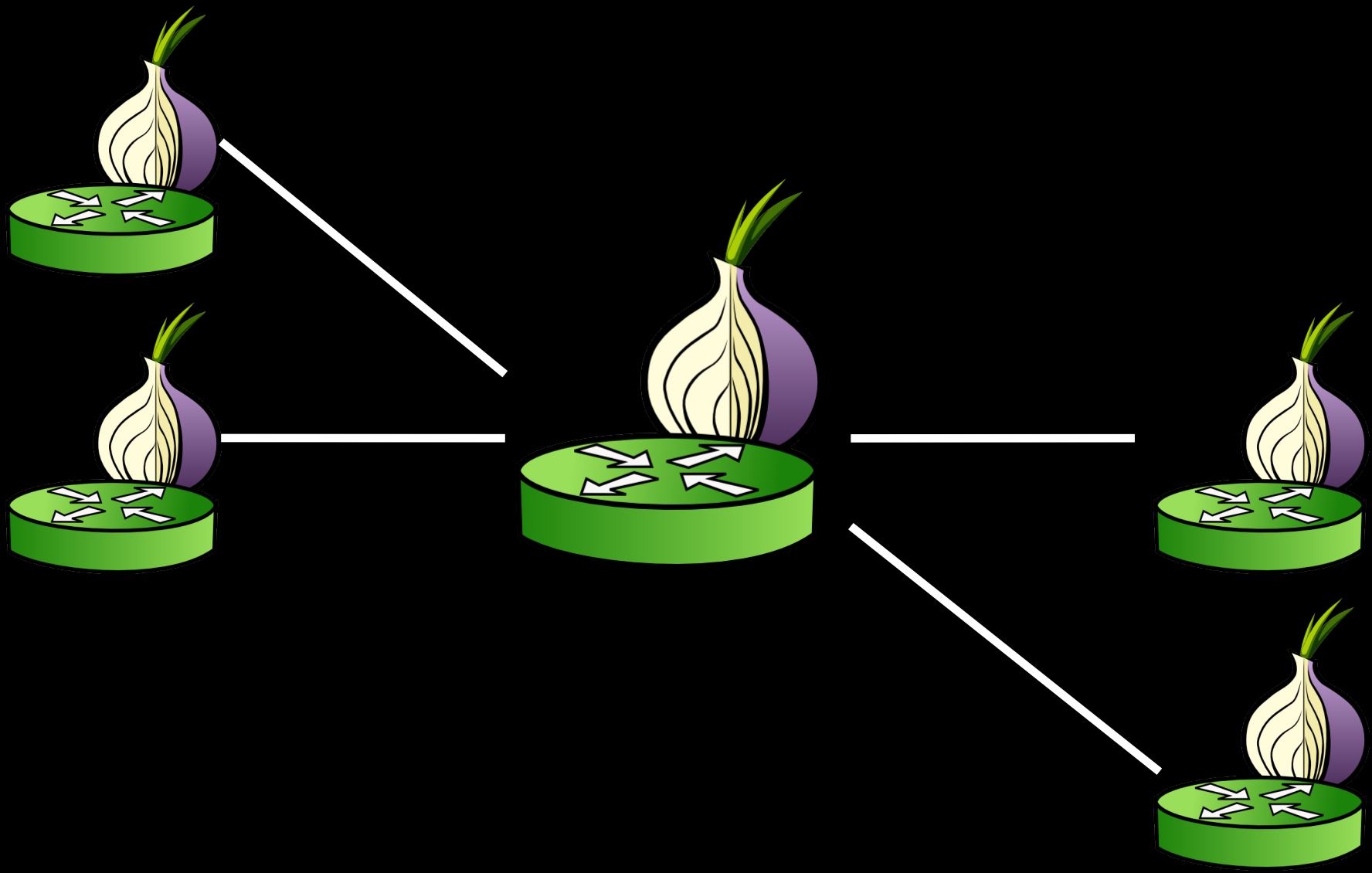

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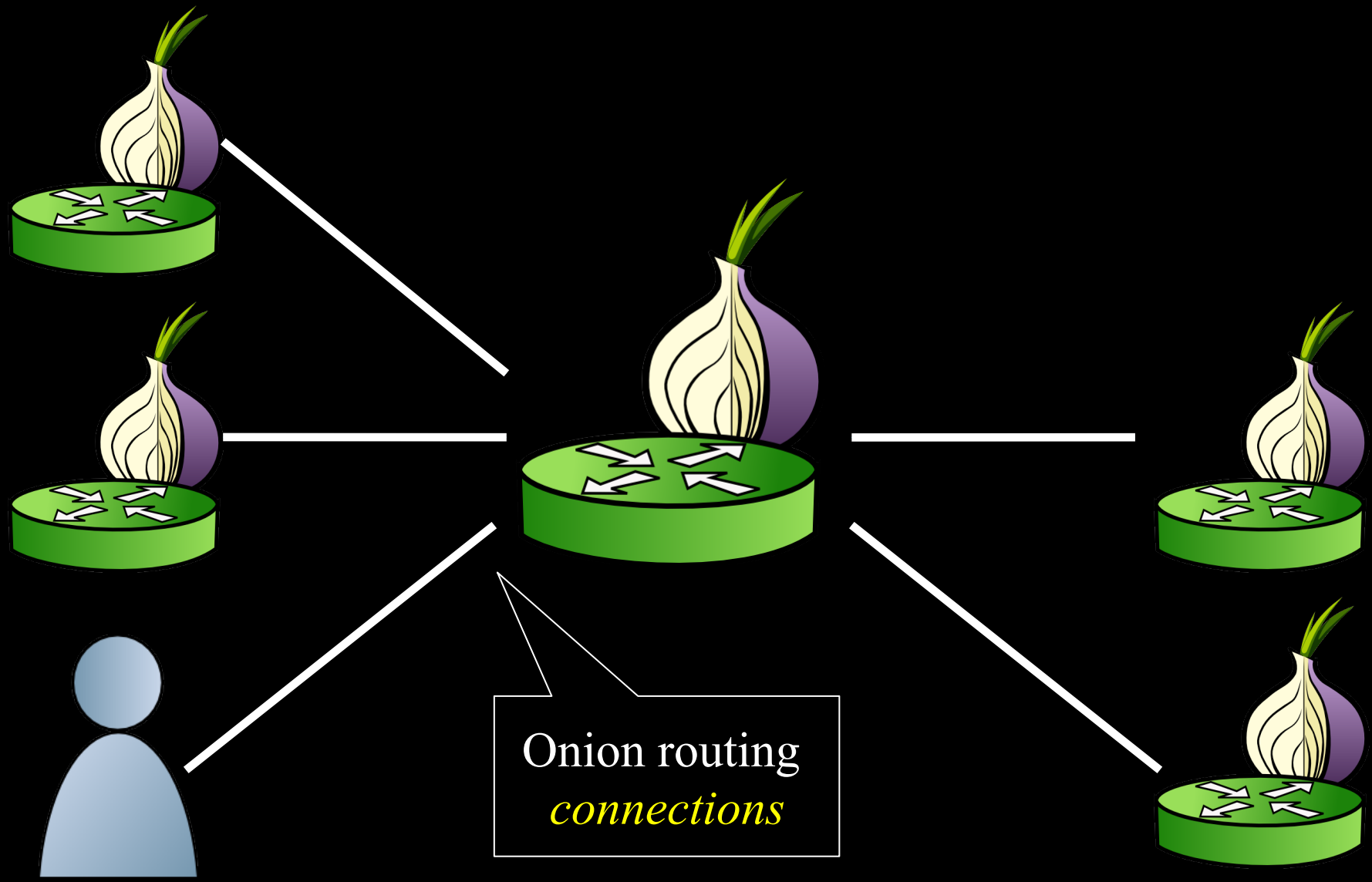

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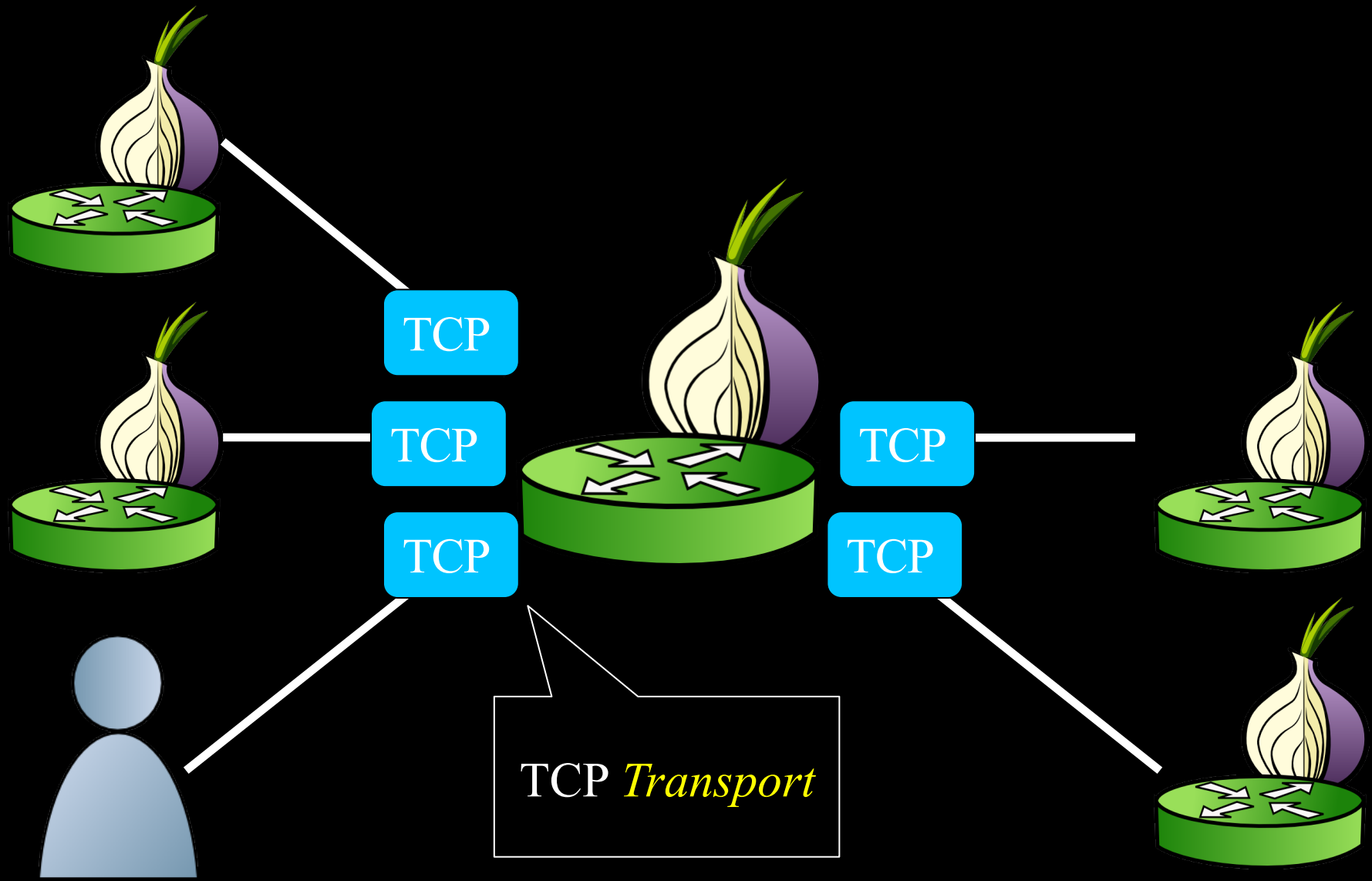

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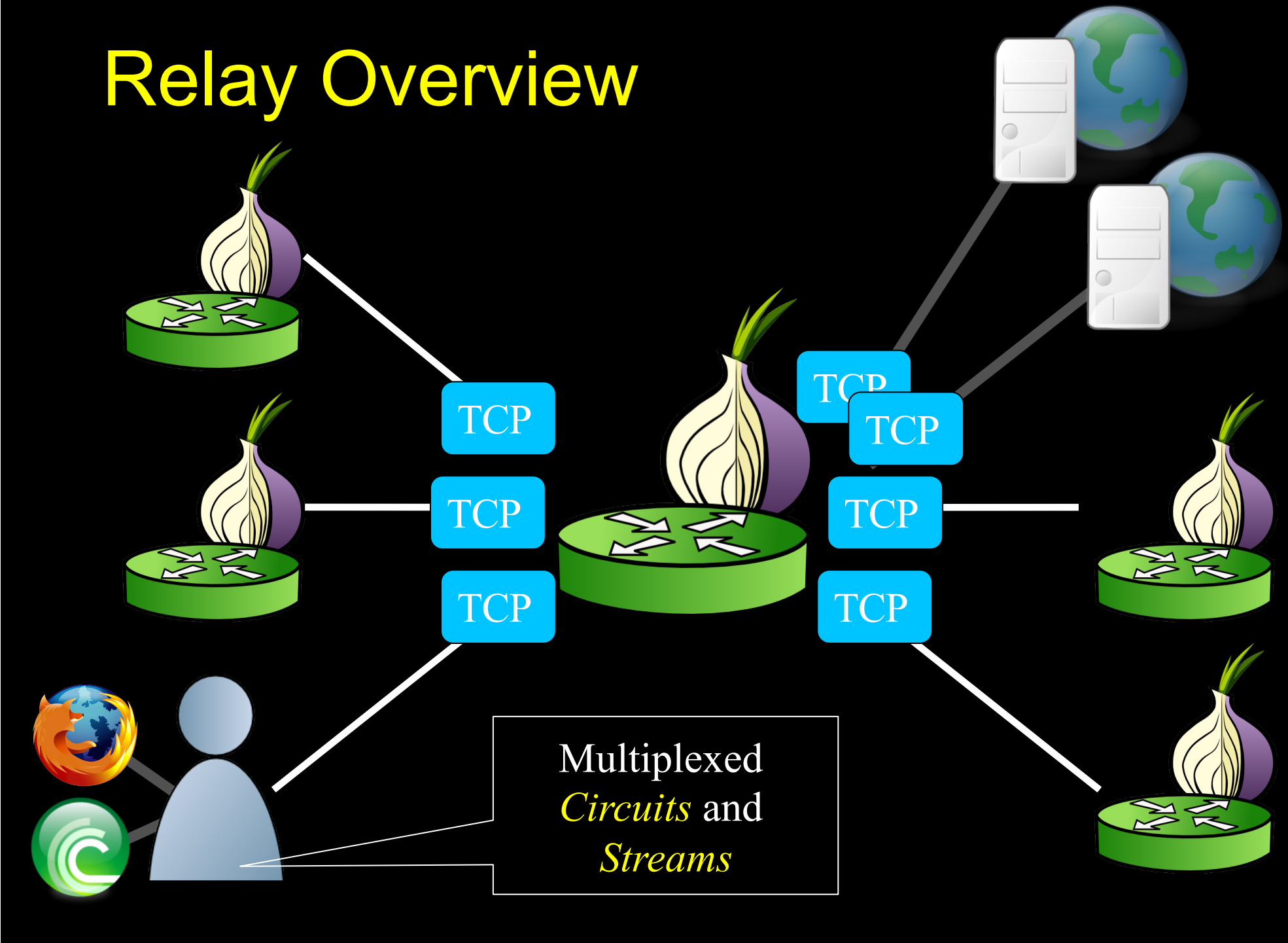

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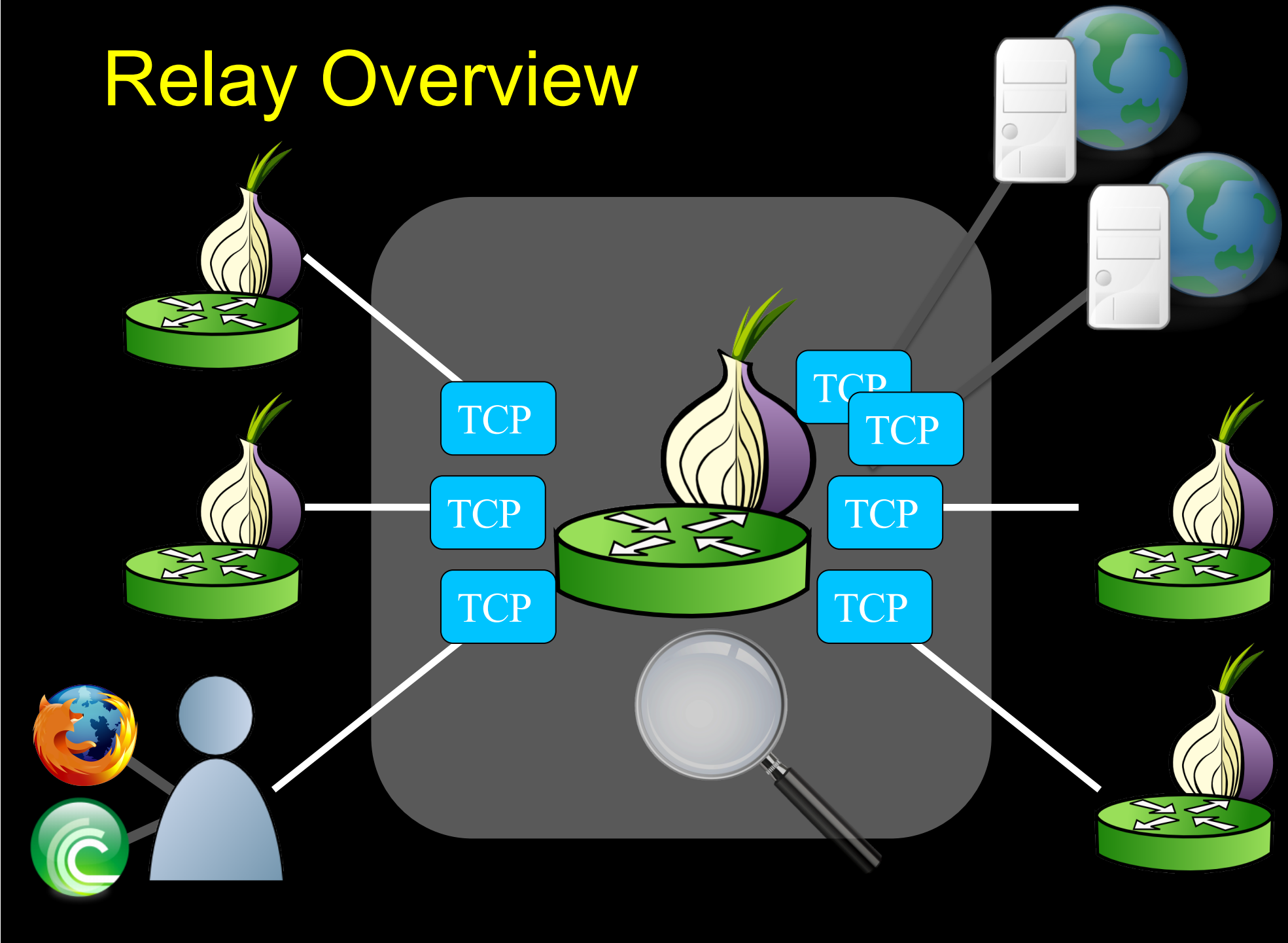
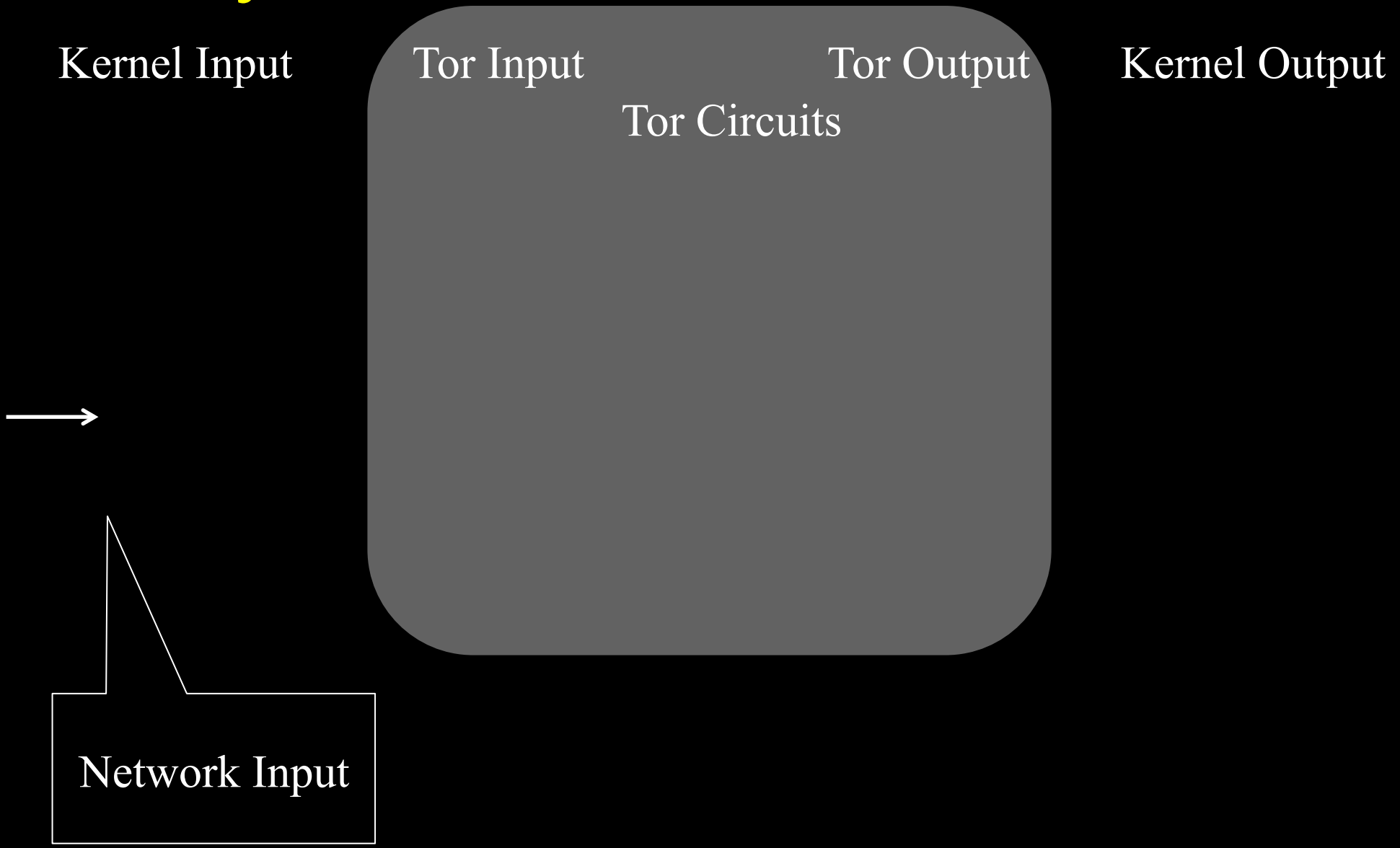


Relay Internals



Relay Internals

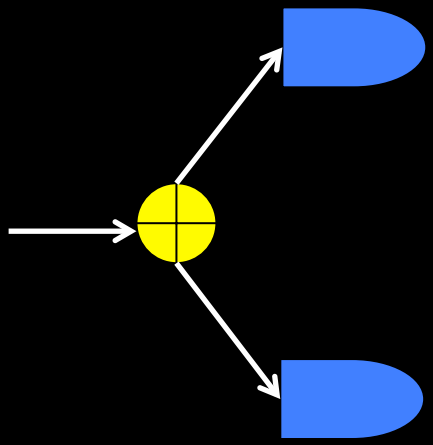
Kernel Input

Tor Input

Tor Output

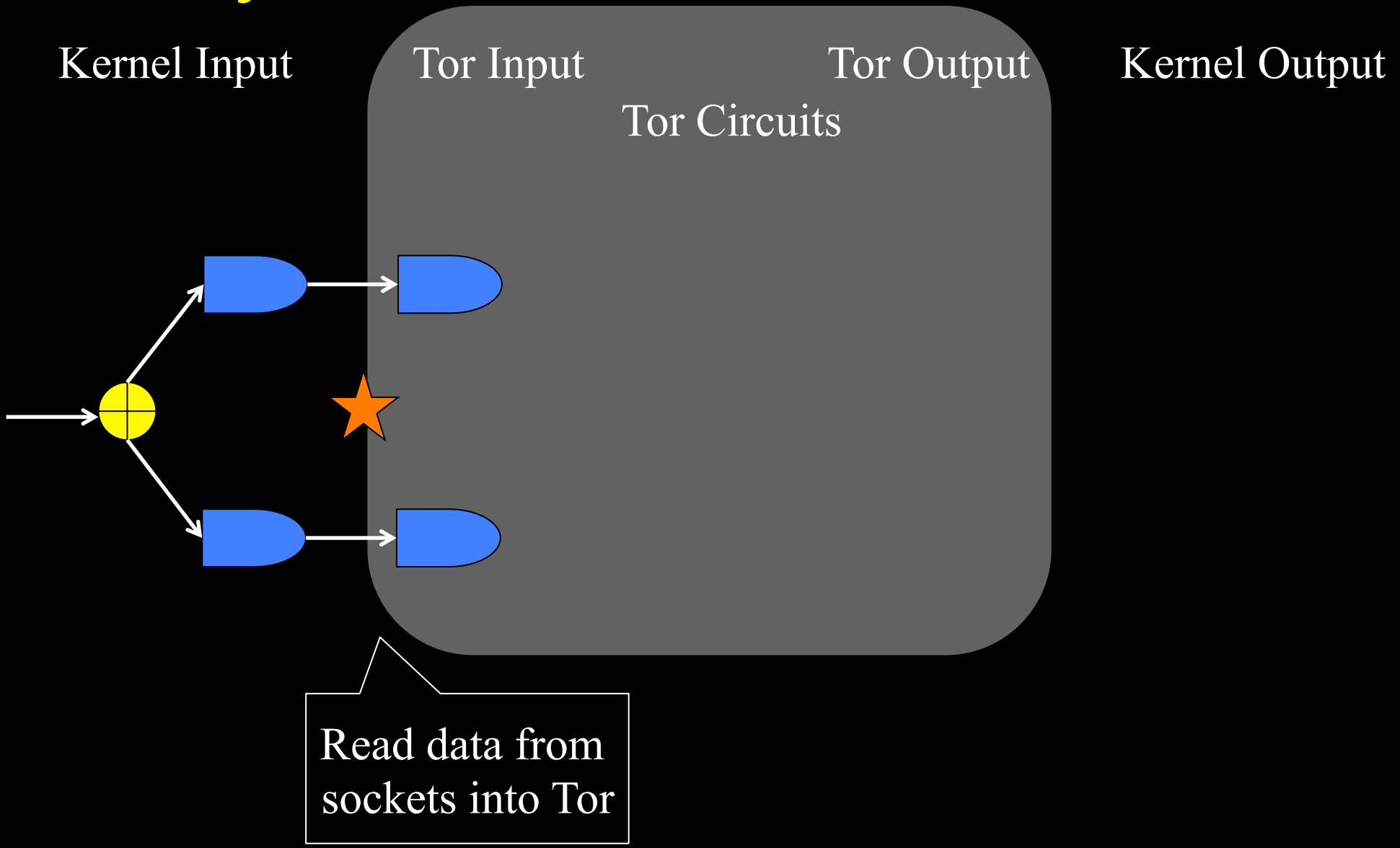
Kernel Output

Tor Circuits



Split data into socket buffers

Relay Internals



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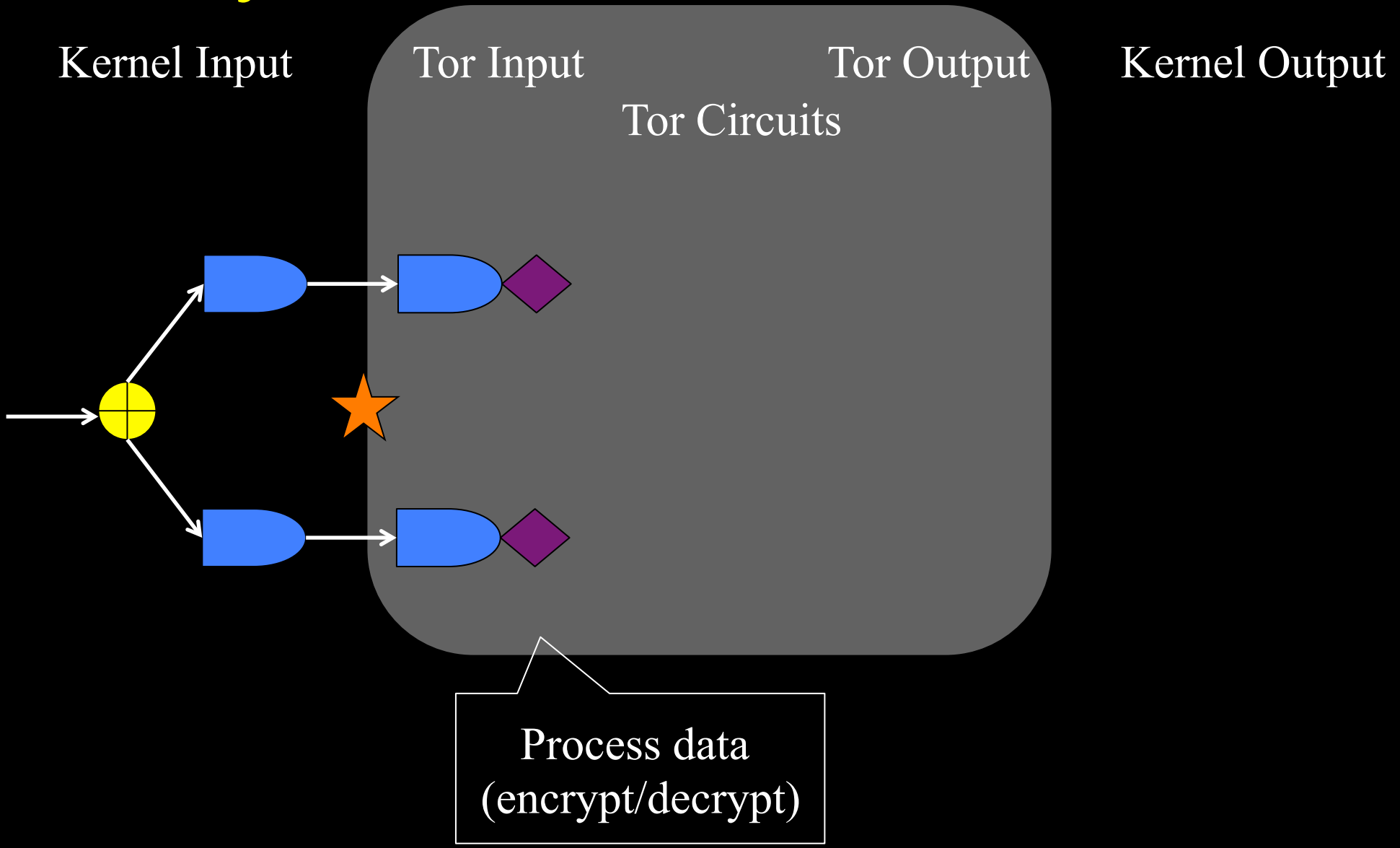

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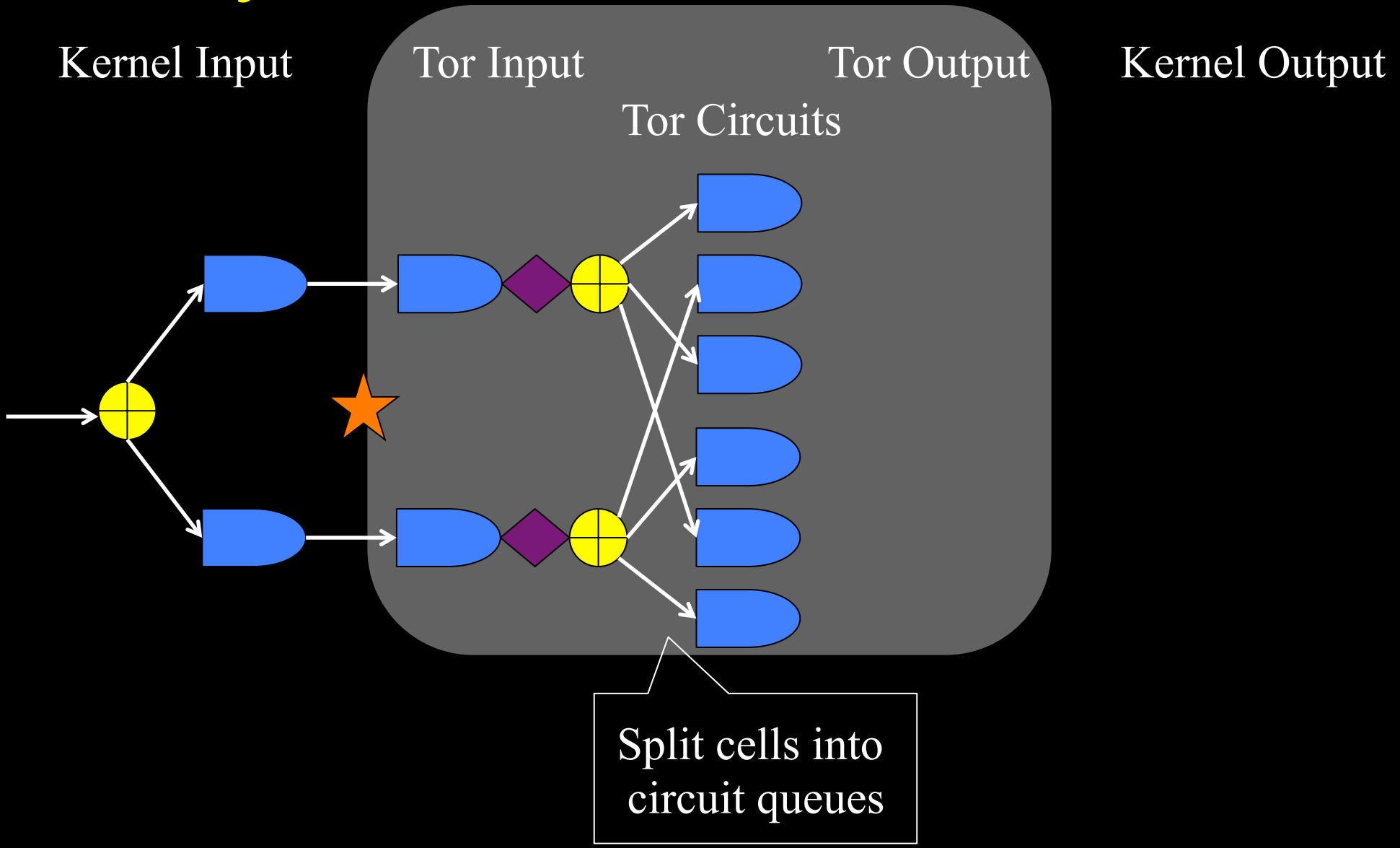

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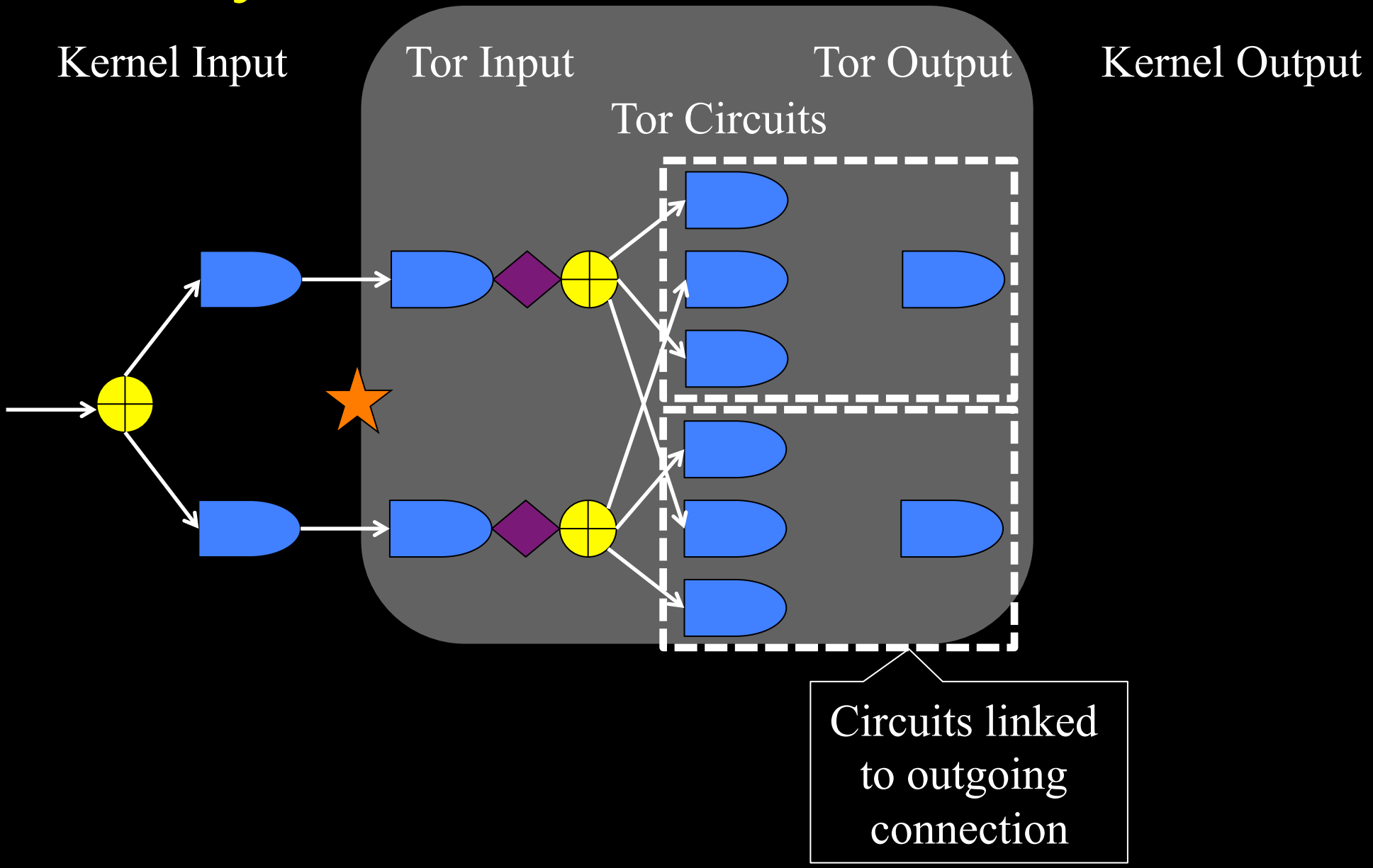

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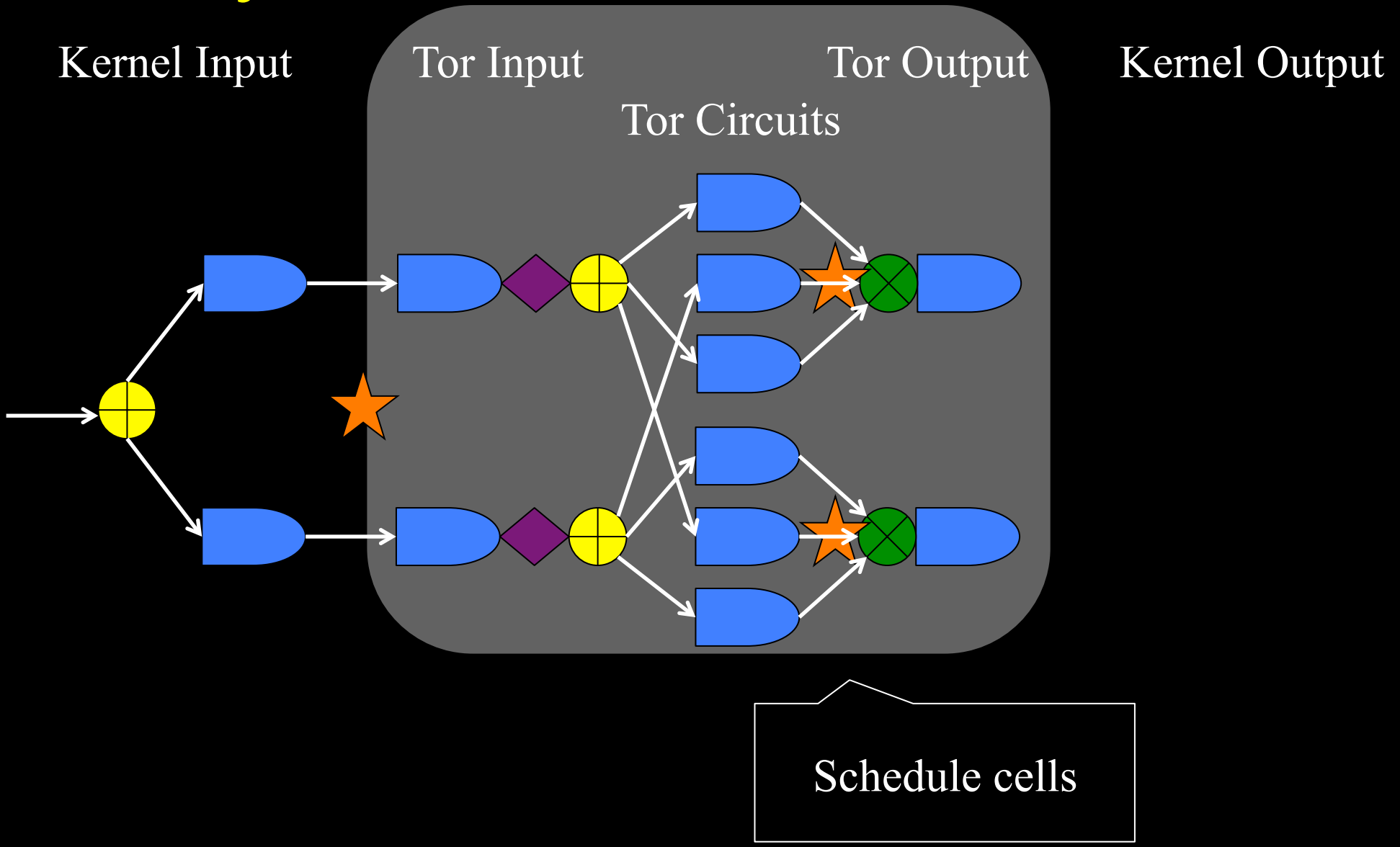

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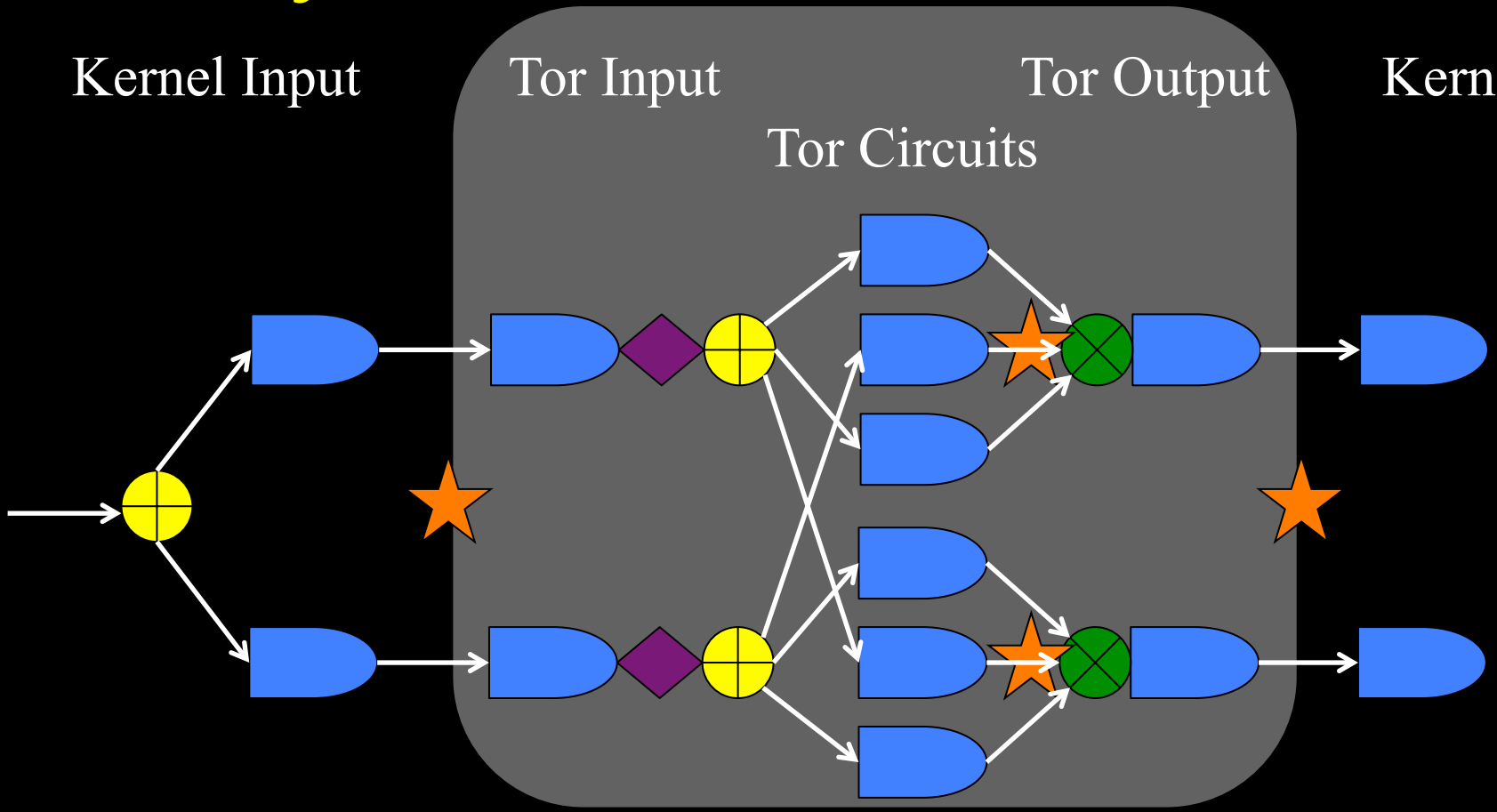
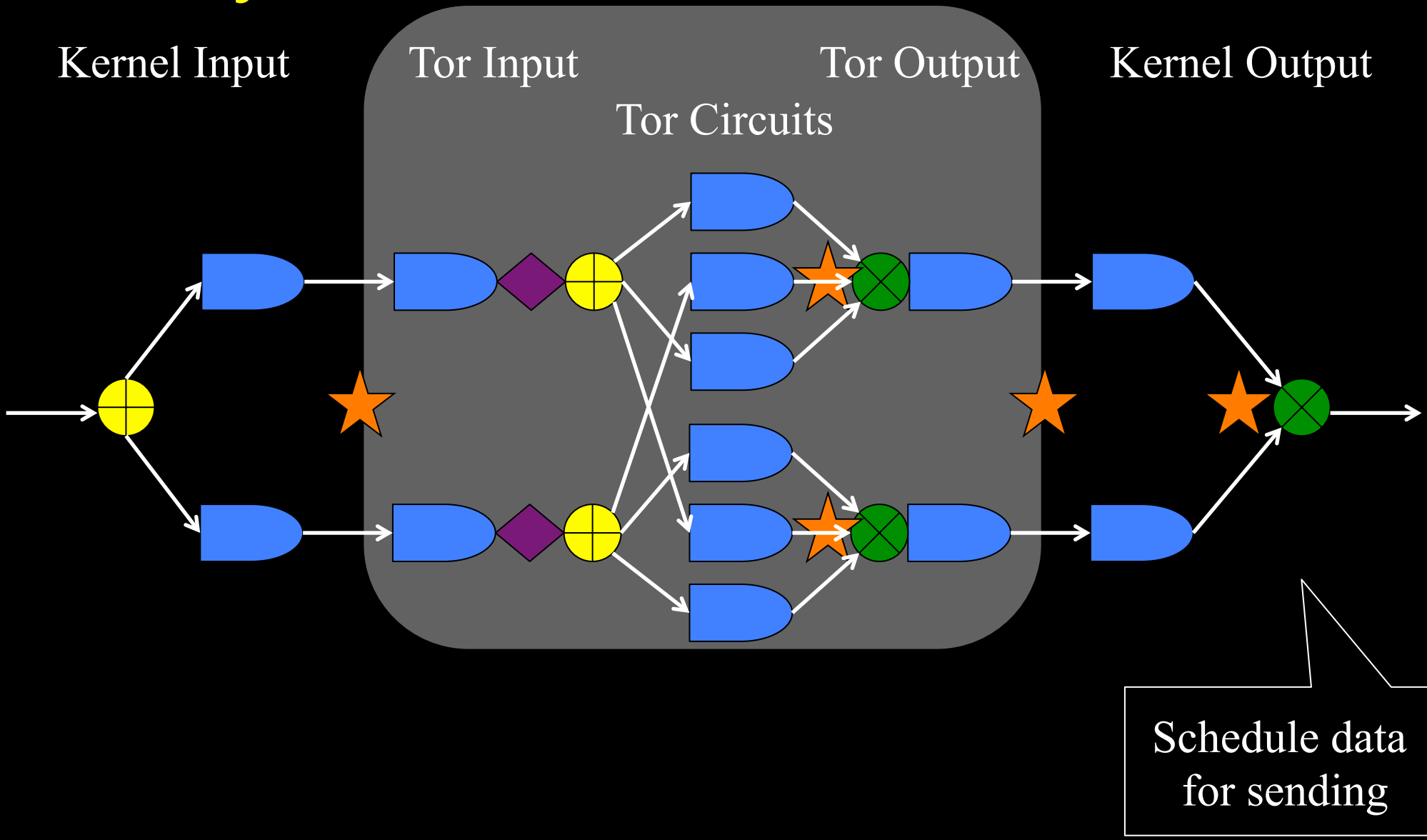


Write data from Tor into sockets

Relay Internals



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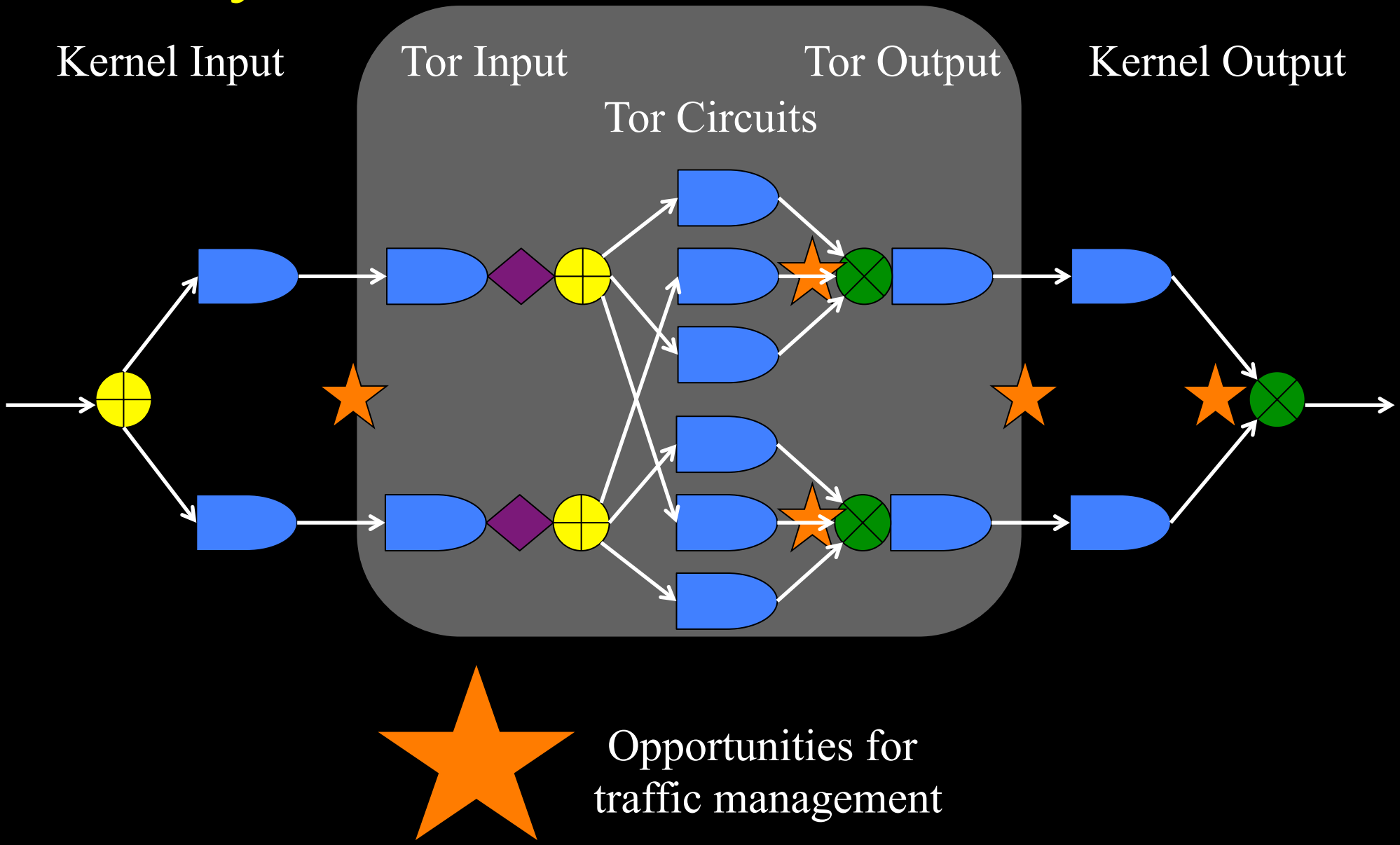

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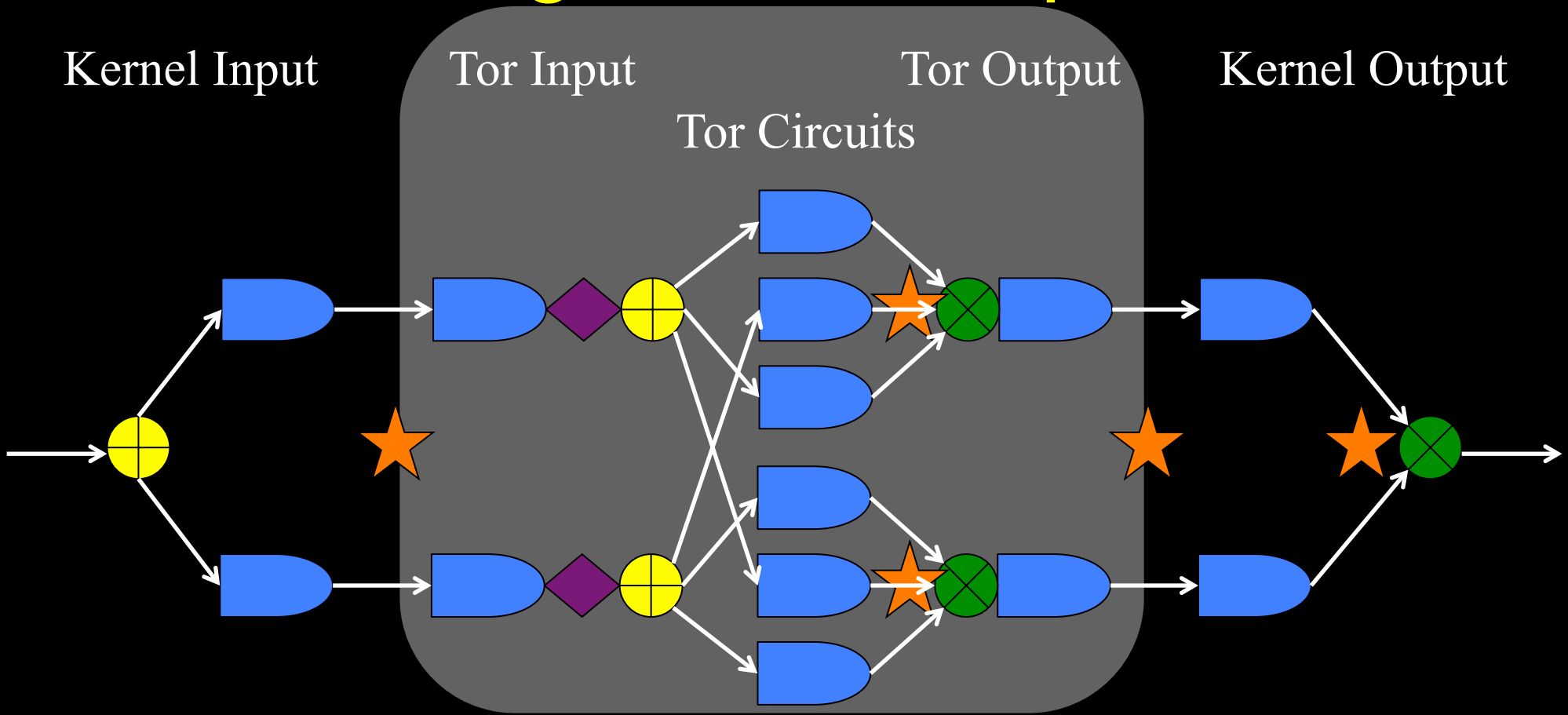
Kernel Congestion: libkqtime



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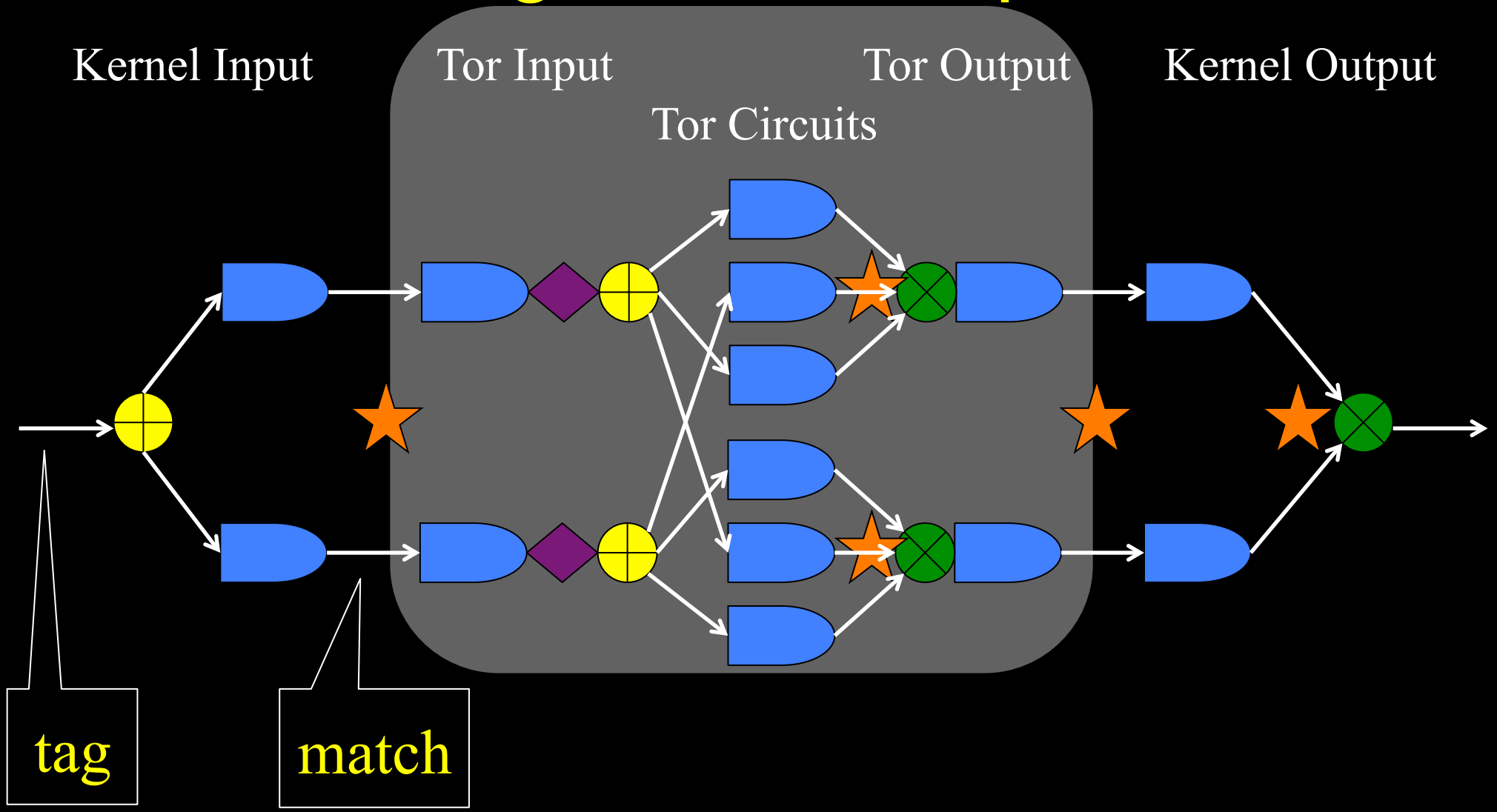

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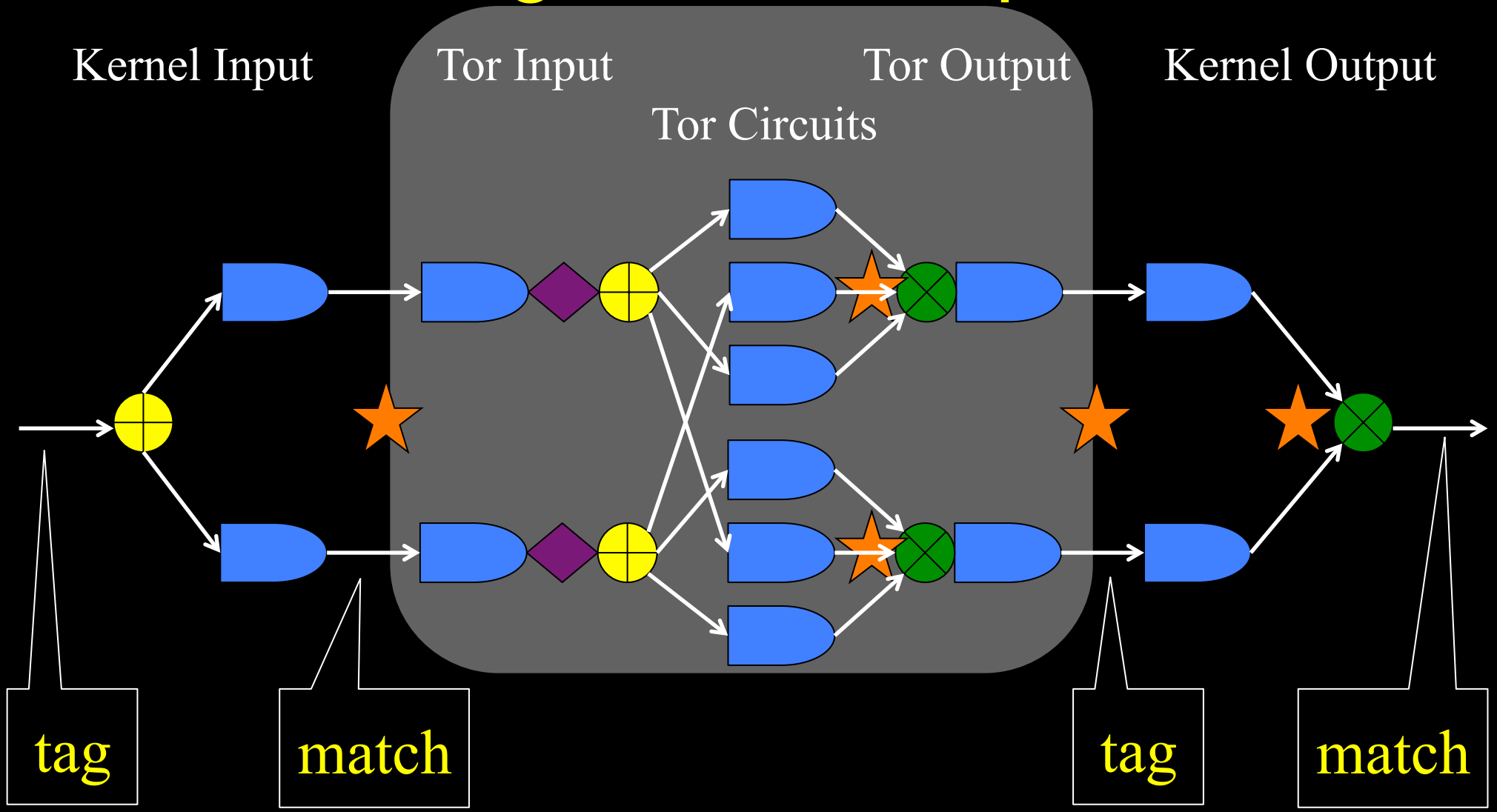

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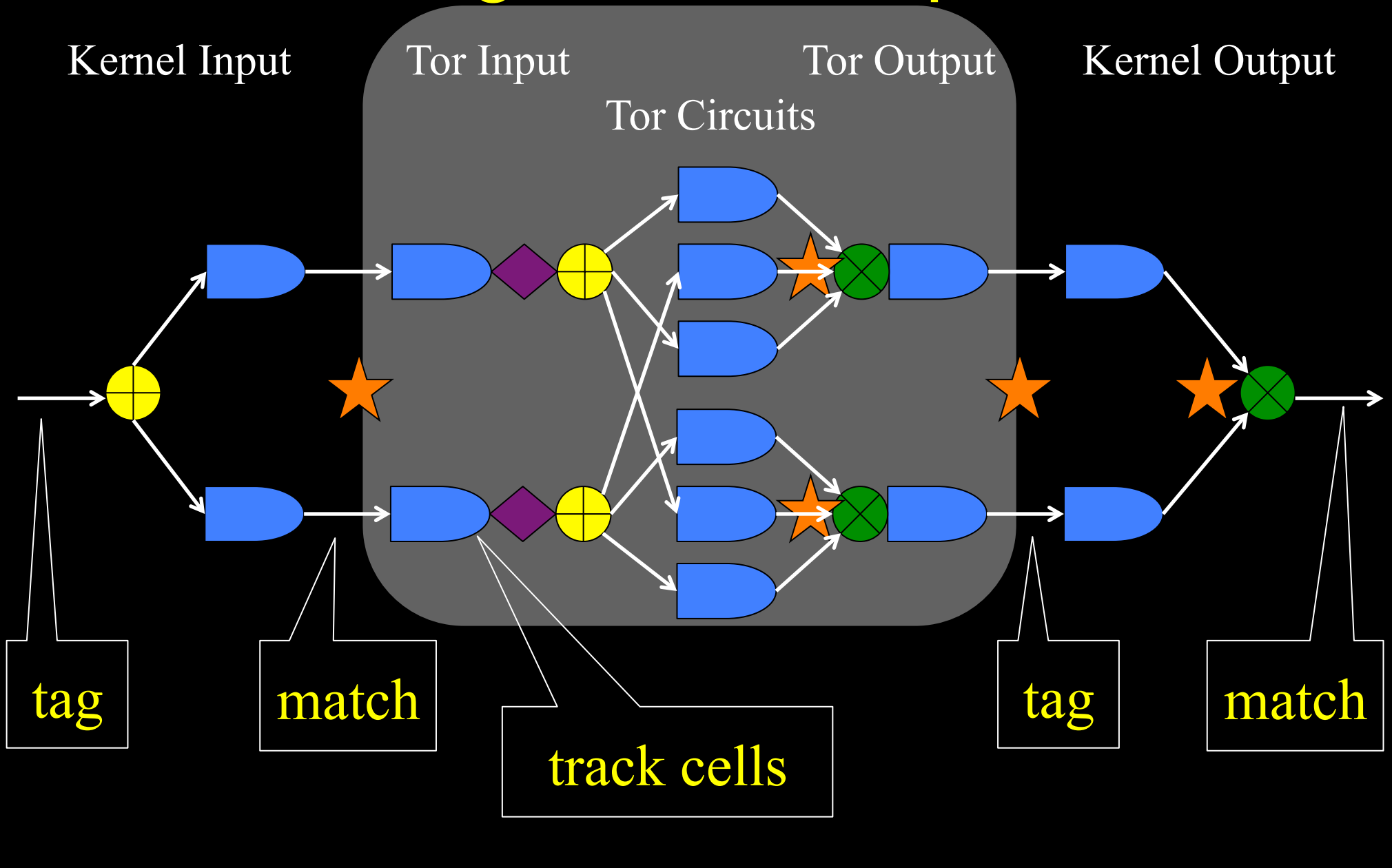
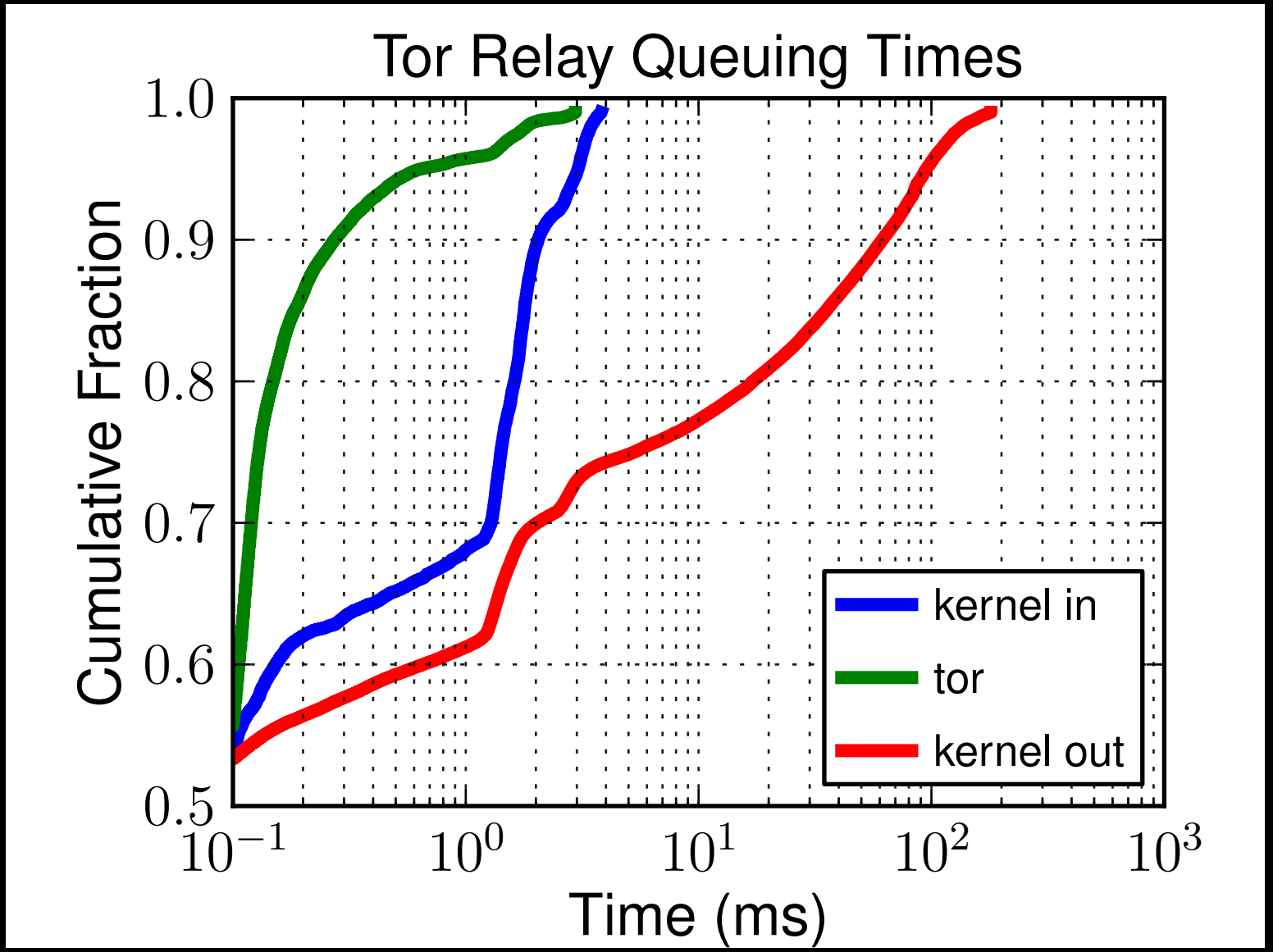


Congestion Analysis



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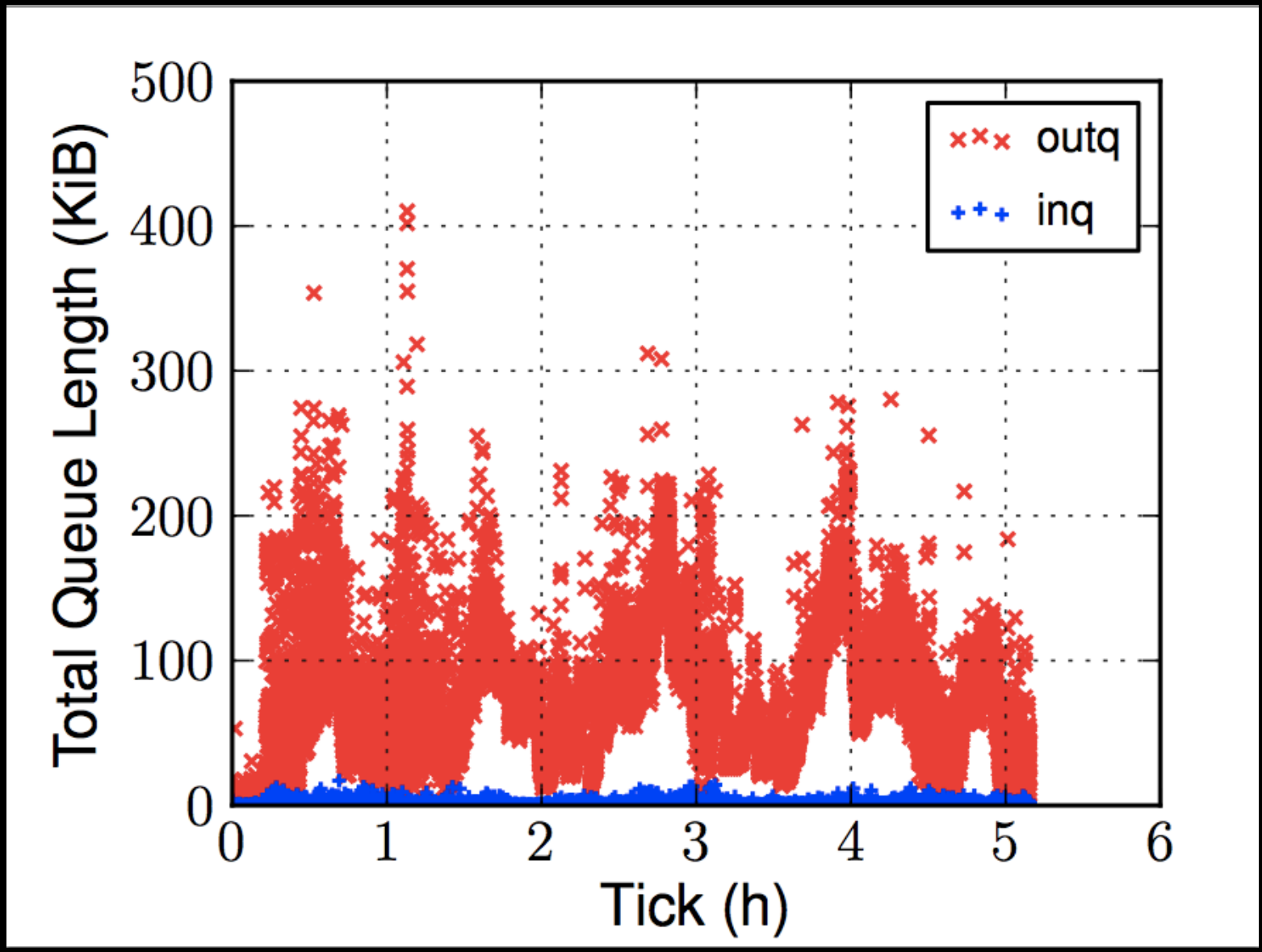
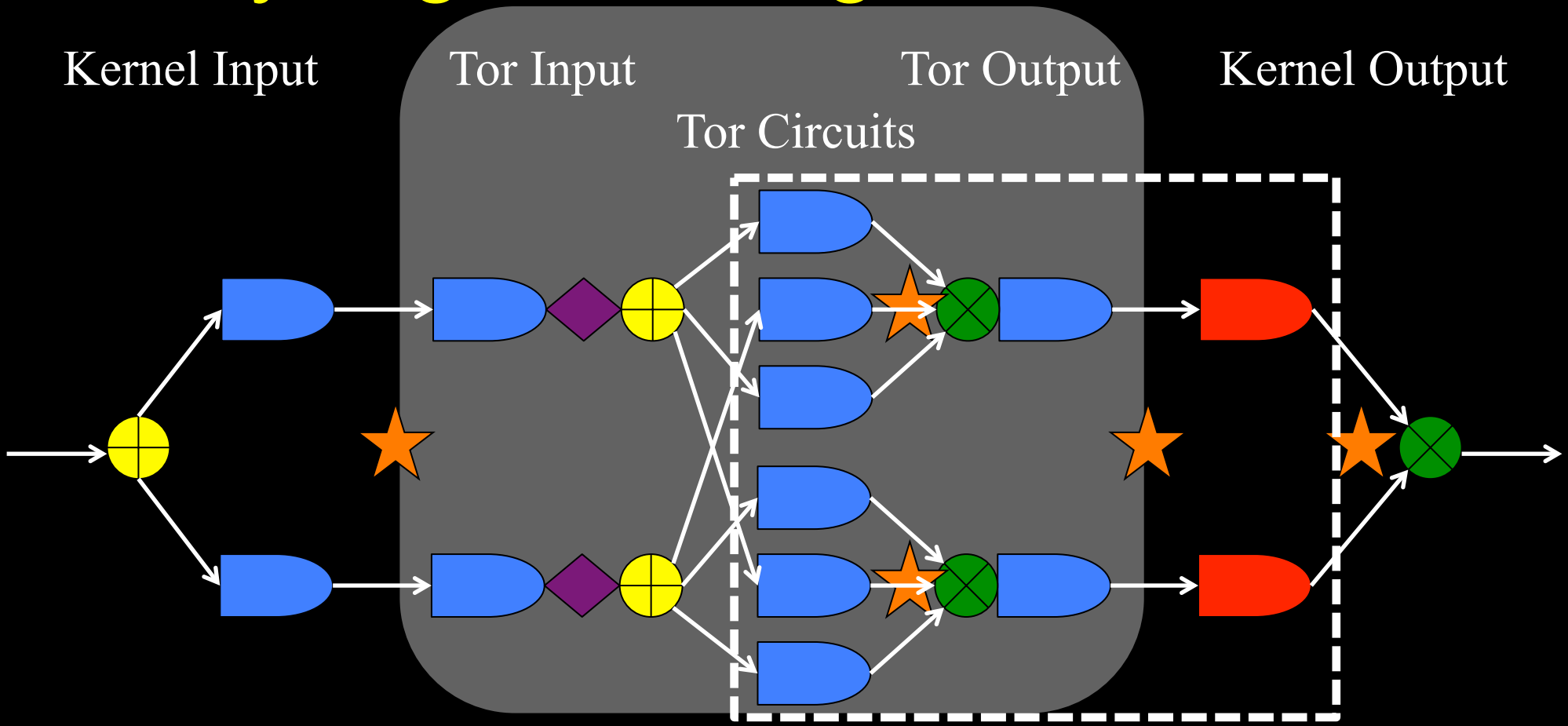


Analyzing the Design



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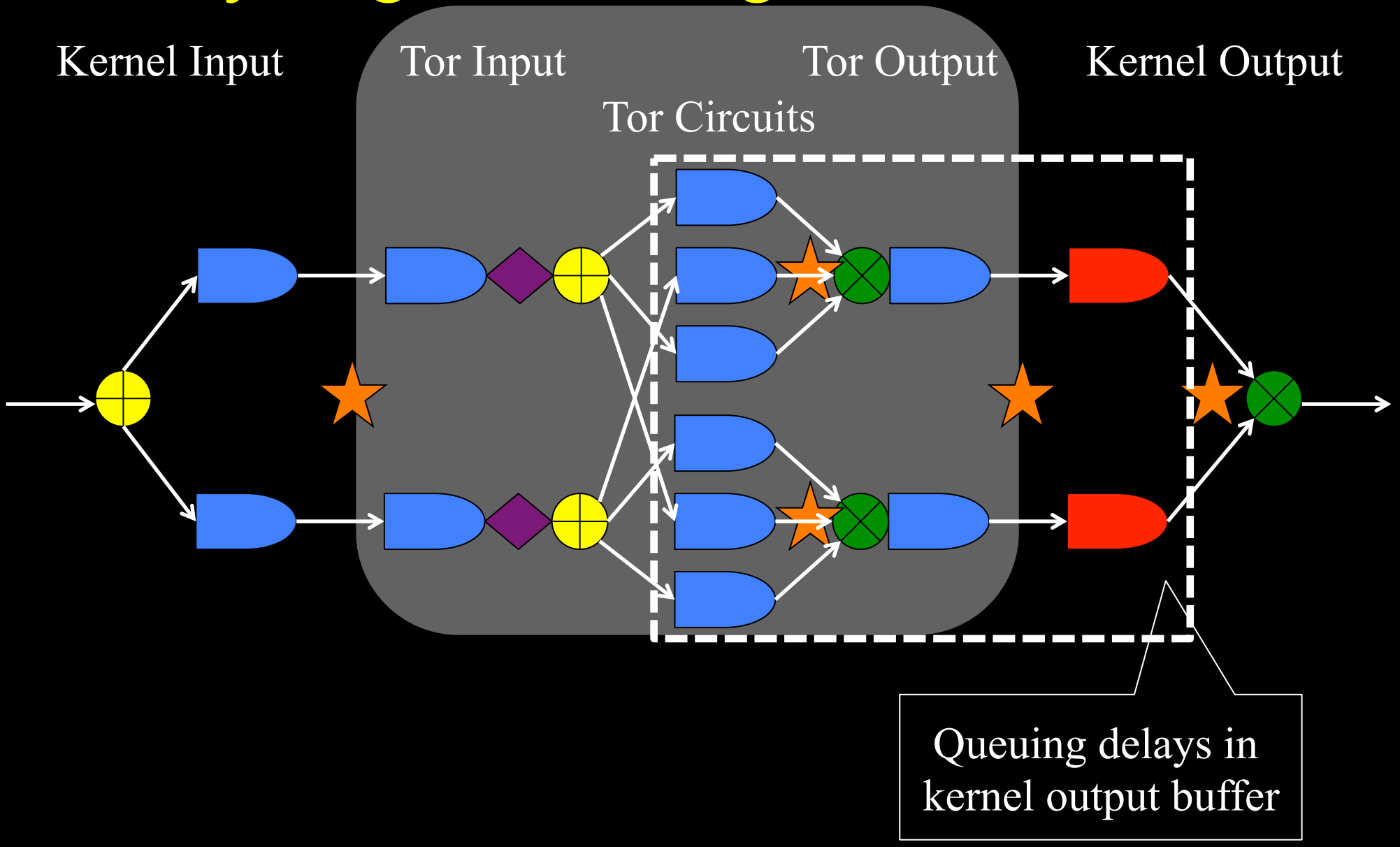

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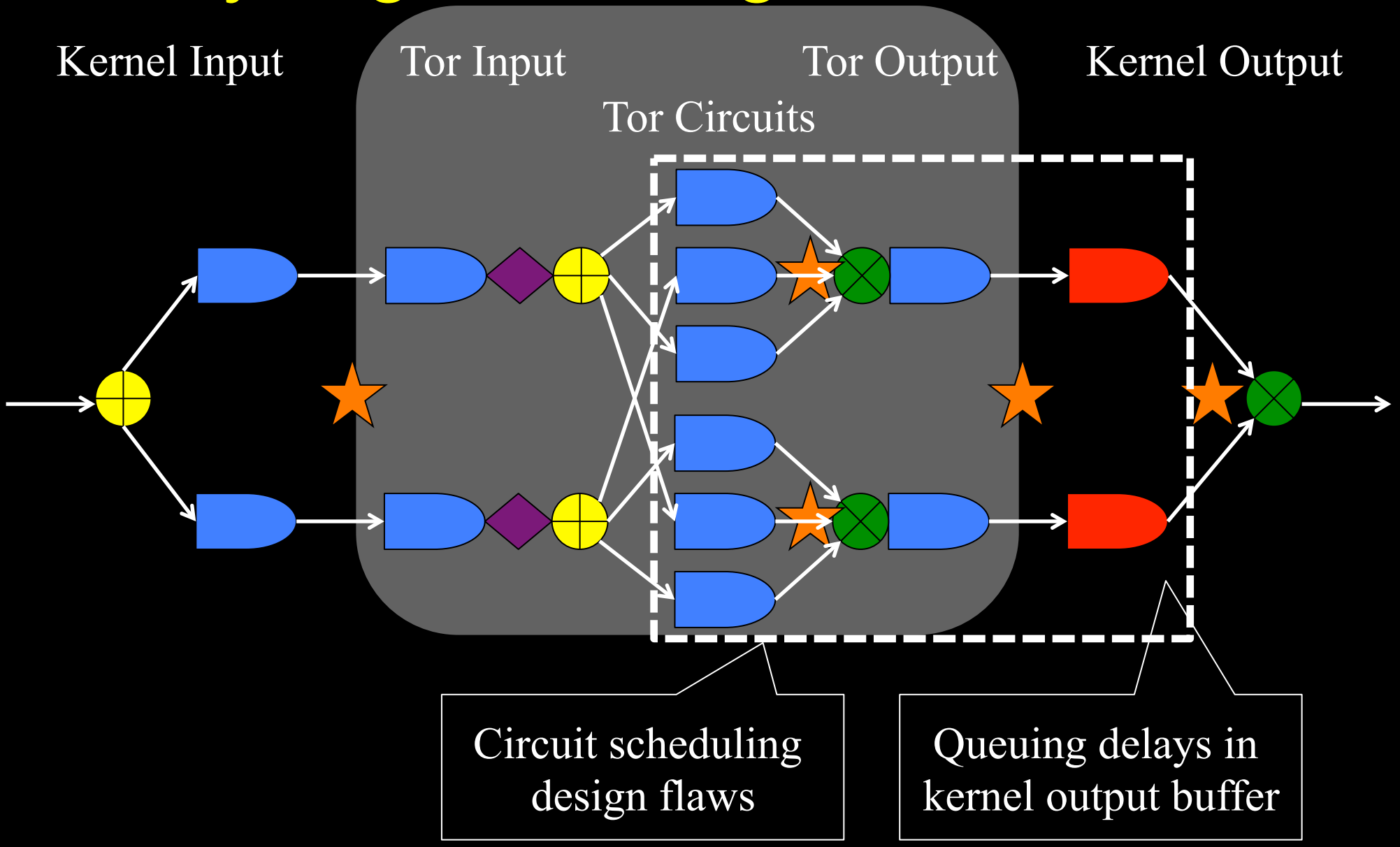

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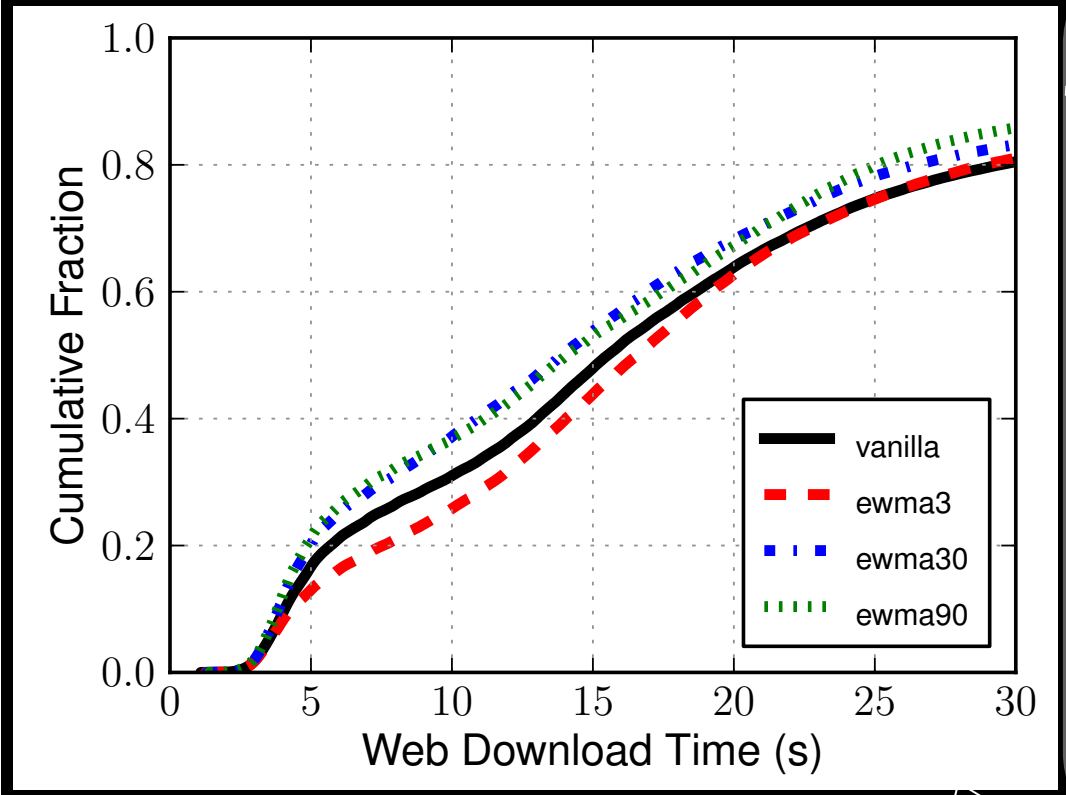
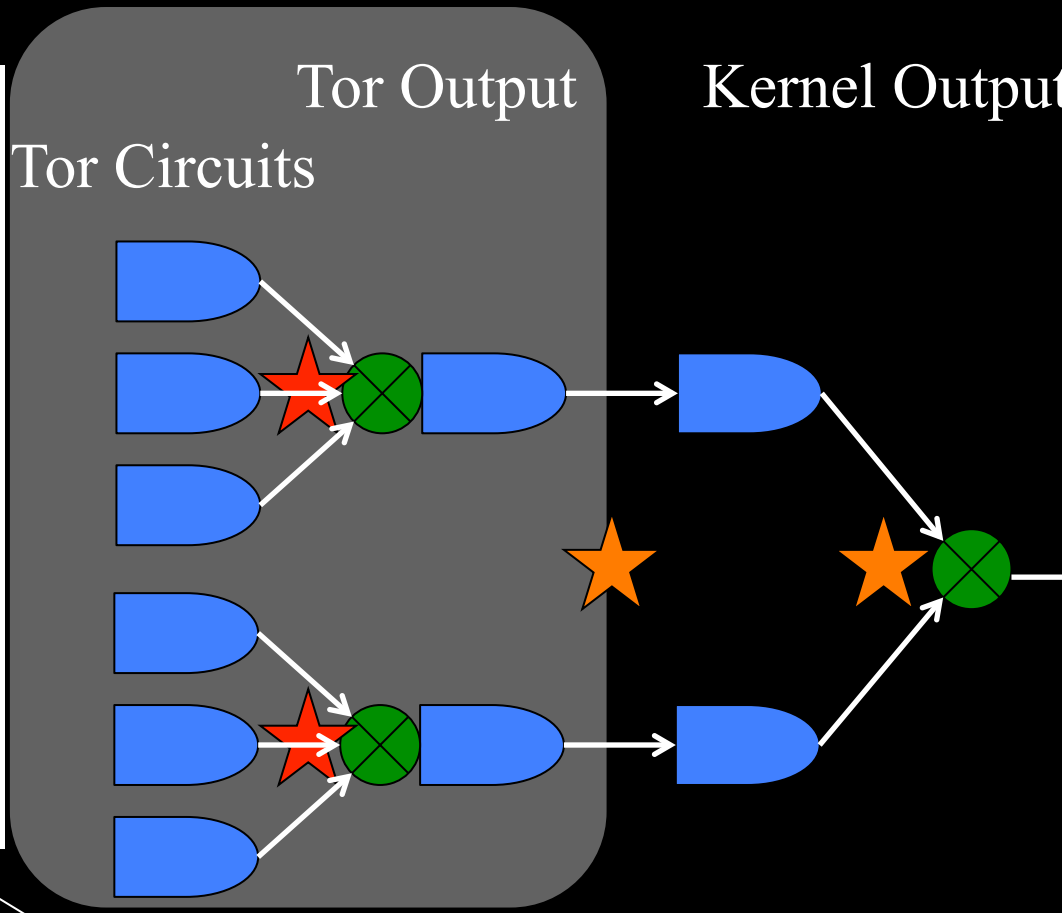
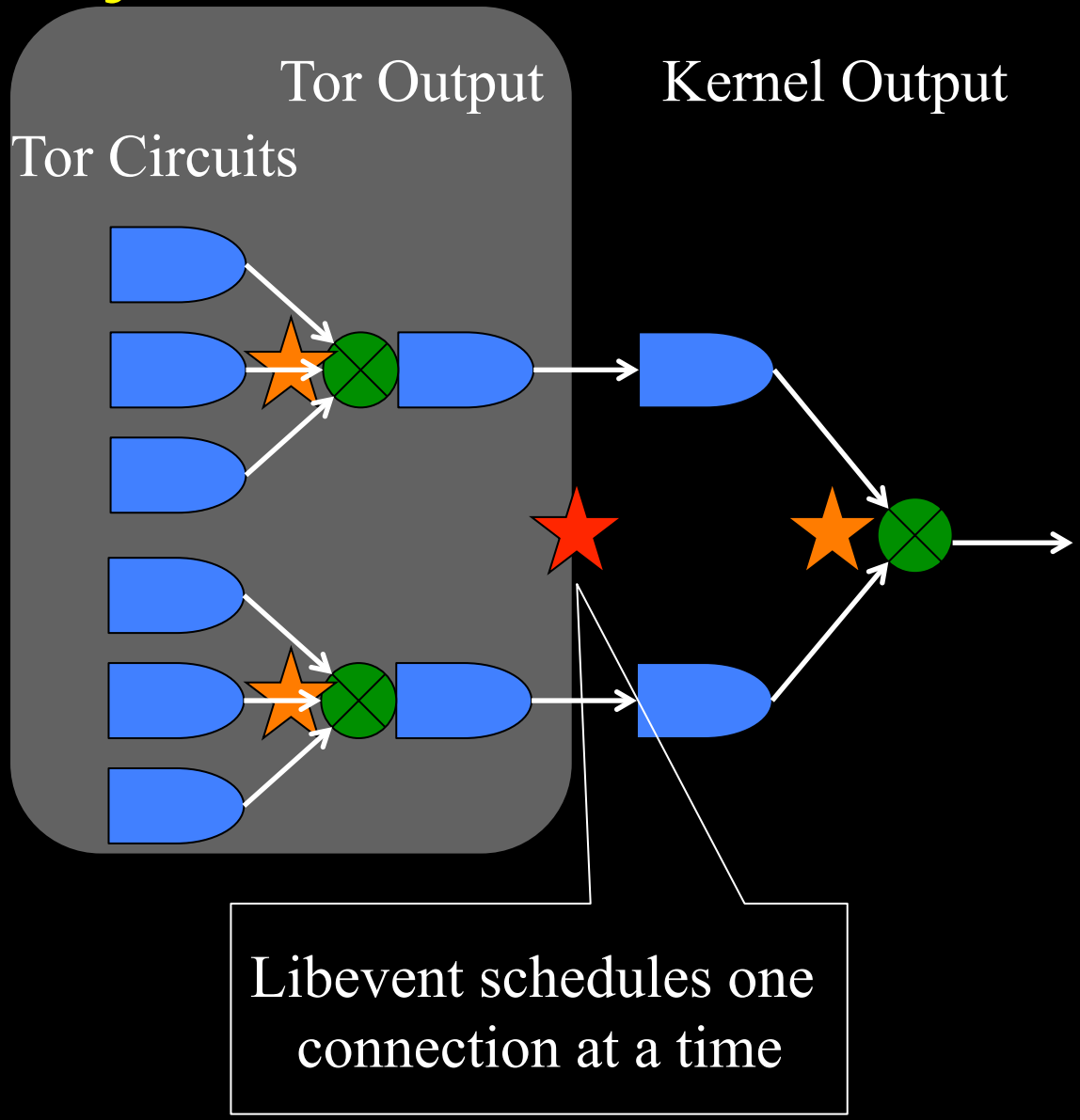




Circuit schedulers are ineffective at prioritization

Ineffective Priority



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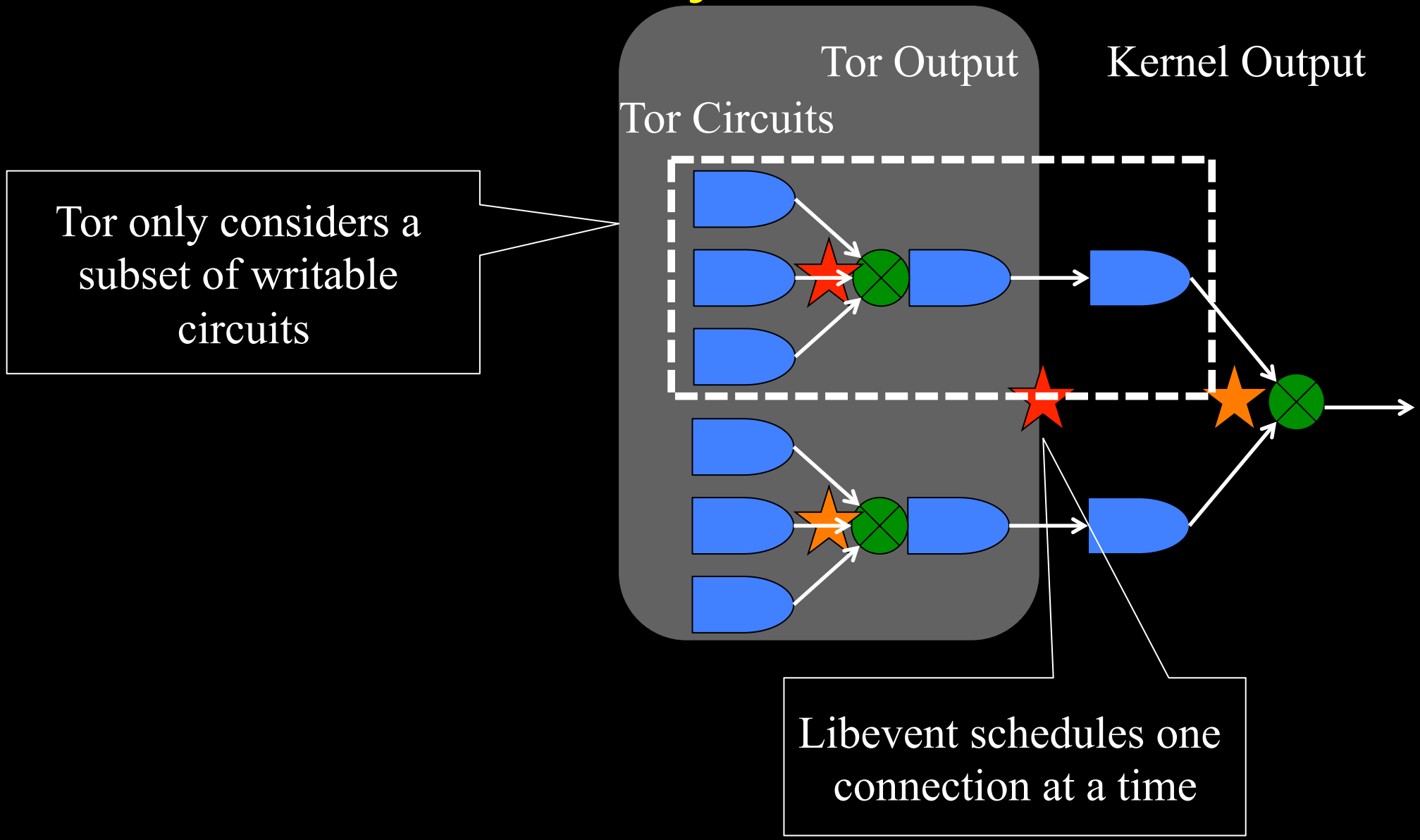

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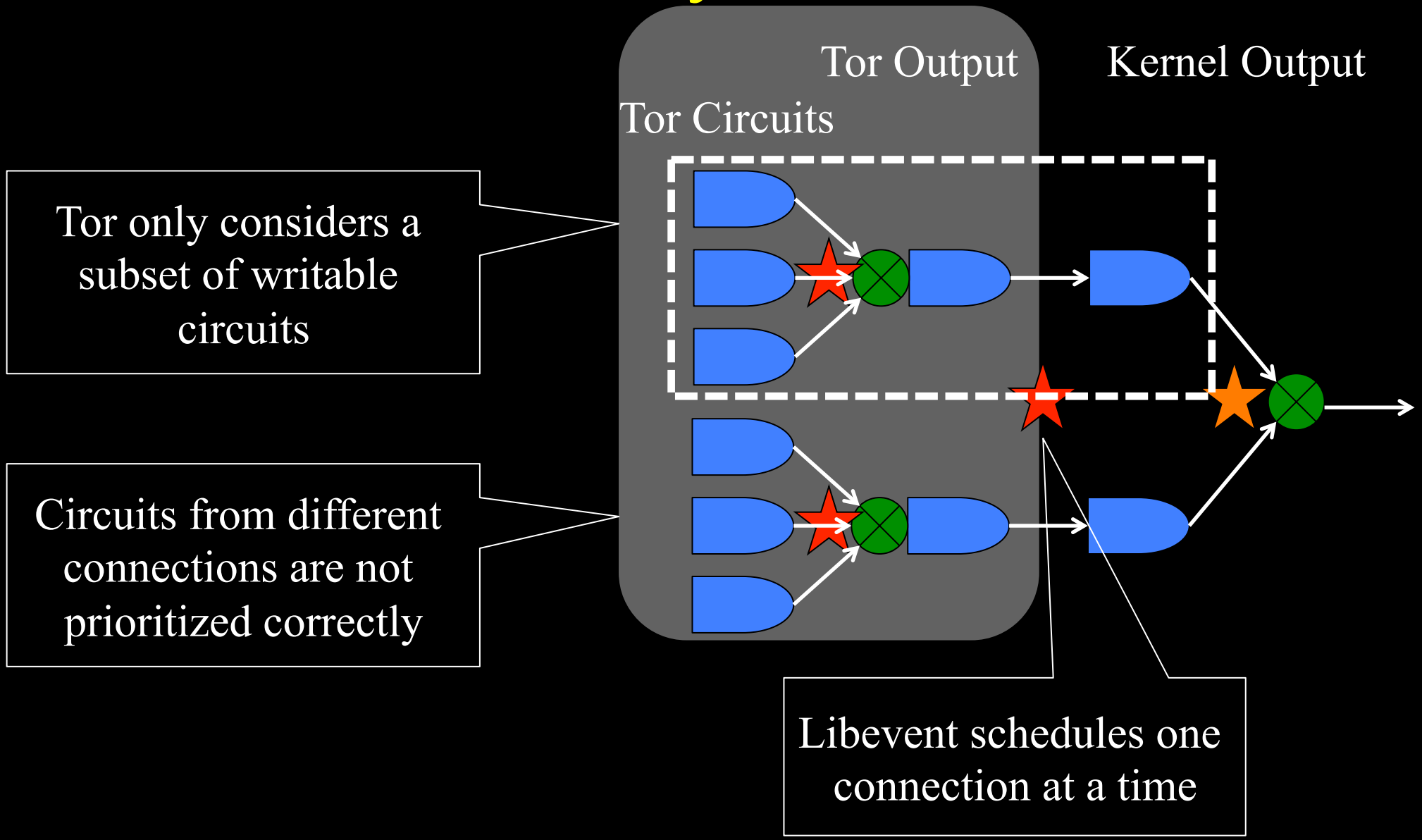
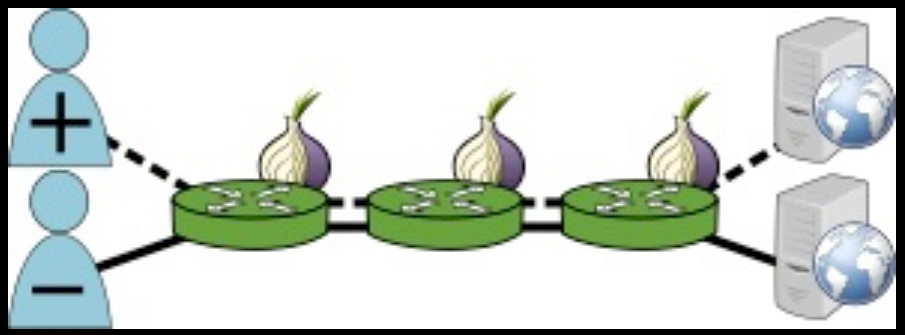


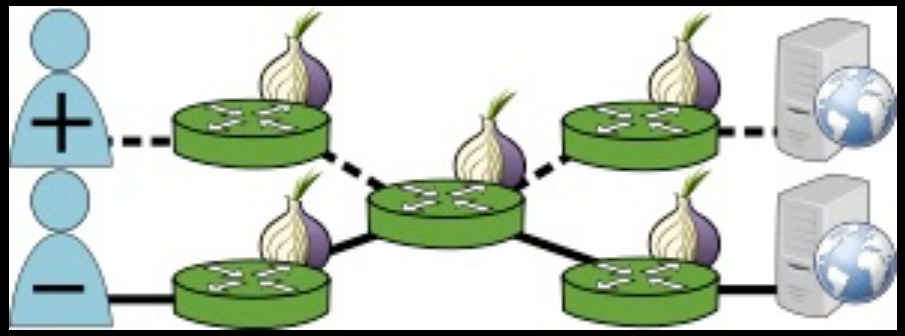
Scheduling Problems

Scenario A



Shared Connection

Scenario B



No Shared Connection

Scheduling Problems

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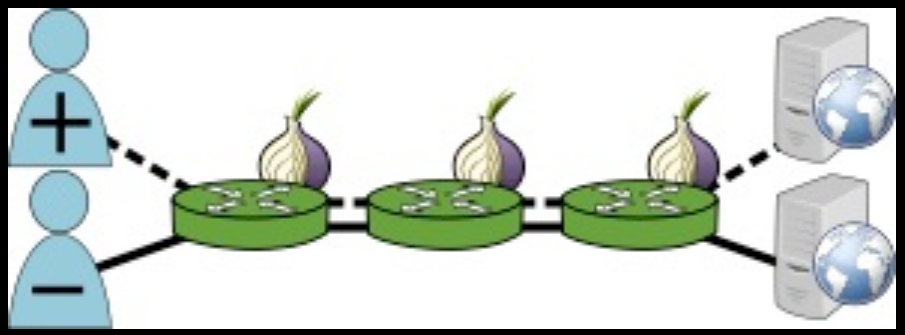

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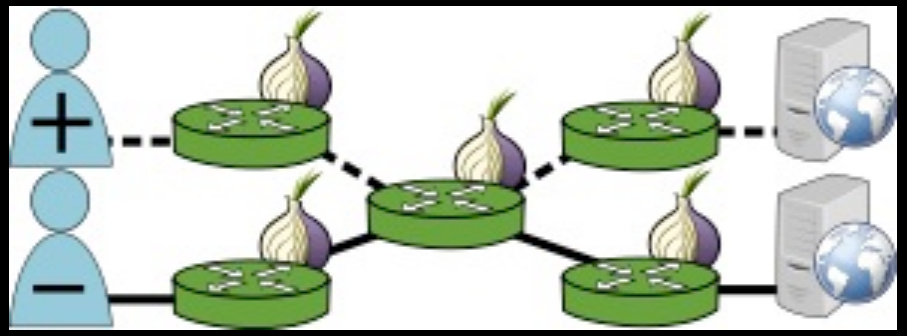
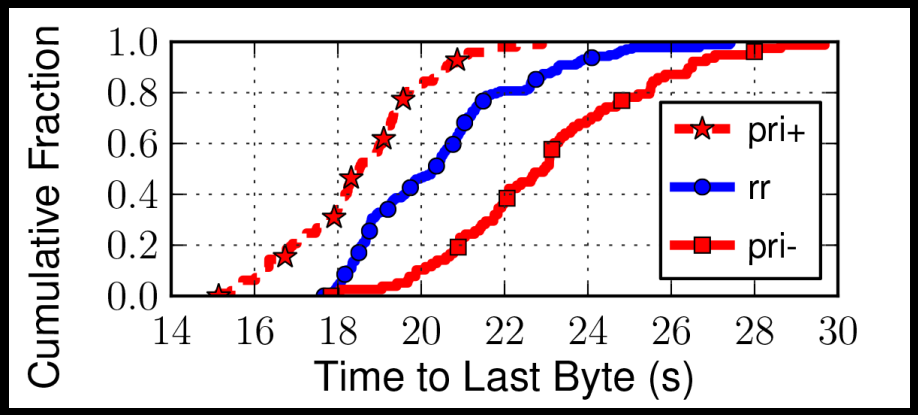
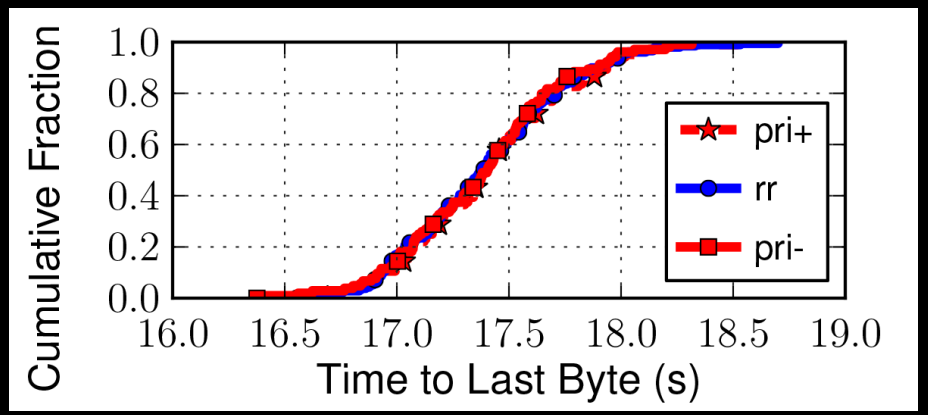
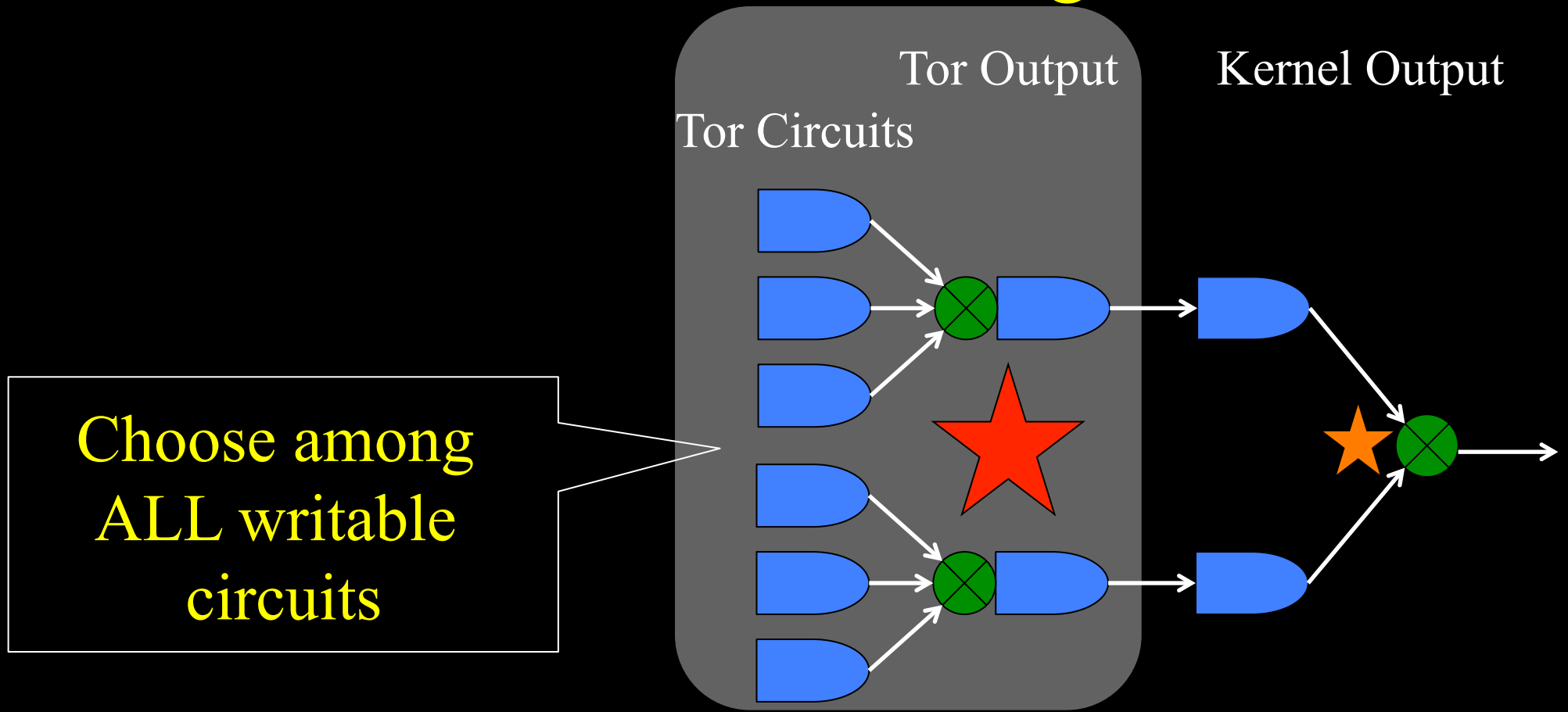


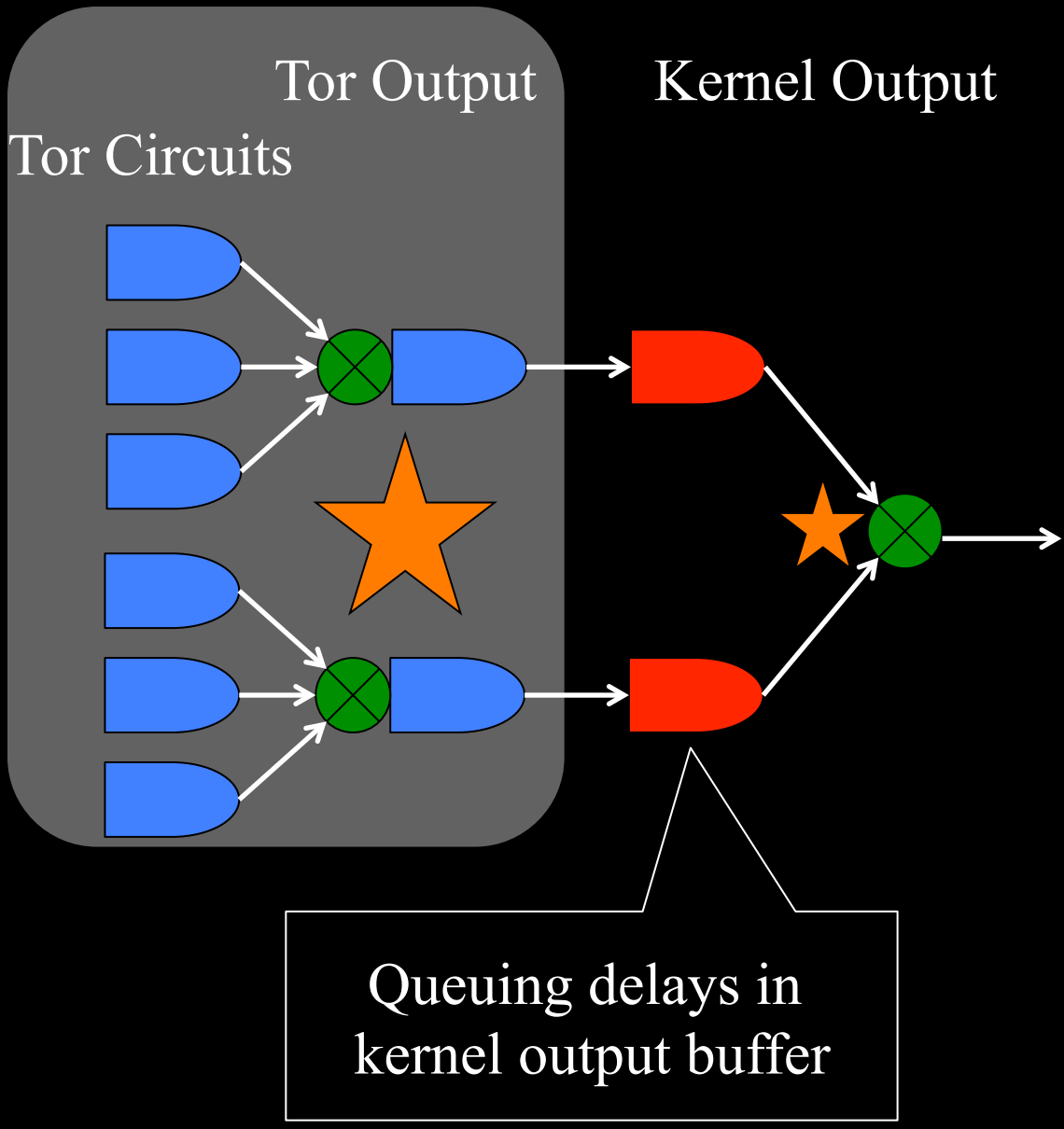




Global Circuit Scheduling

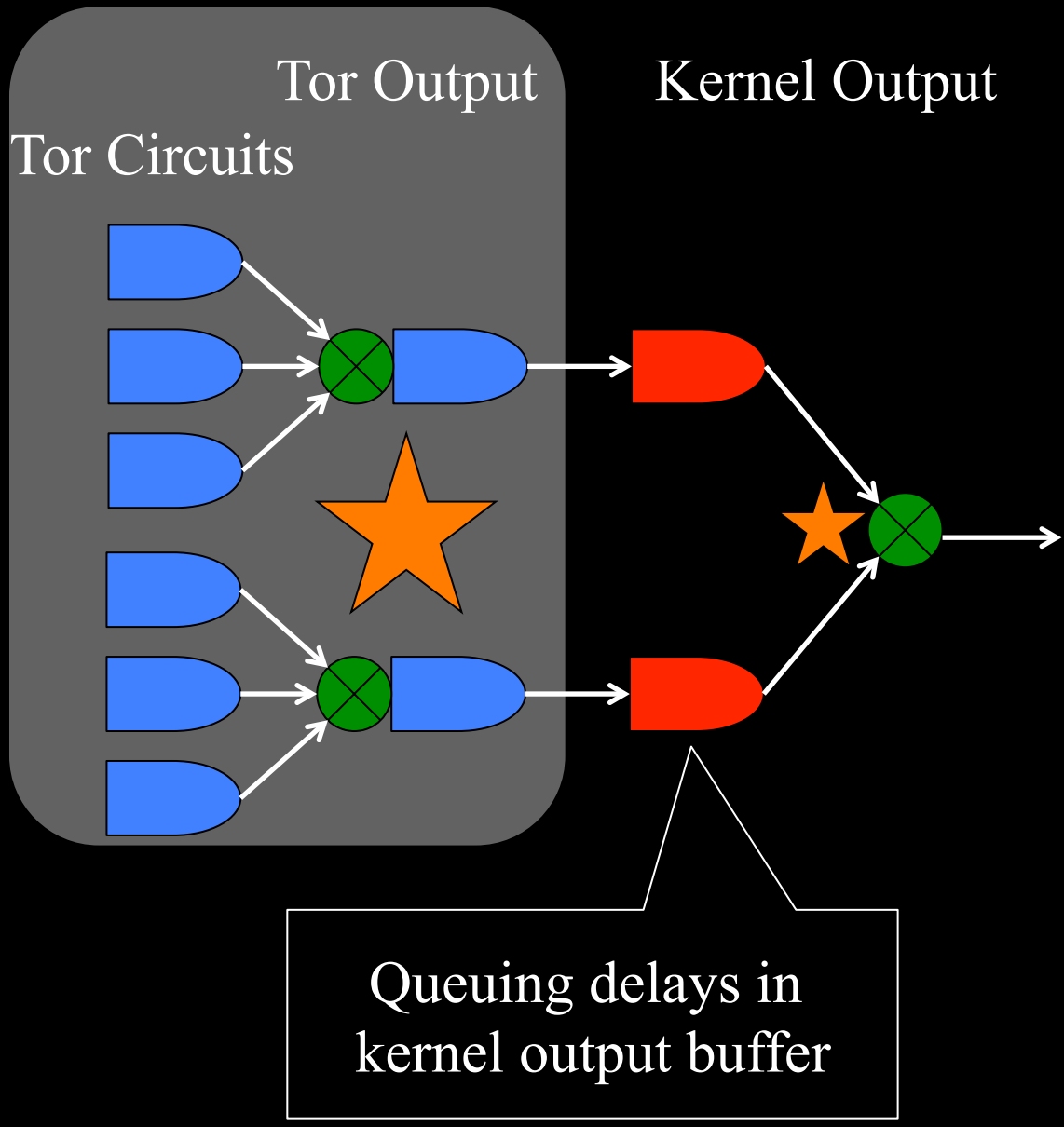


Kernel Buffer Bloat



Kernel Buffer Bloat

- Too many large kernel queues
- More data in kernel than it can send
- Circuit scheduler timing issues



Tor Output Auto-tuning

- Don’t write what the kernel can’t send
- Smartly write to kernel using
  - Socket queue lengths and sizes
  - TCP windows
  - Node bandwidth capacity
- Check again before kernel starvation

Increase effectiveness of circuit scheduler

Questions?

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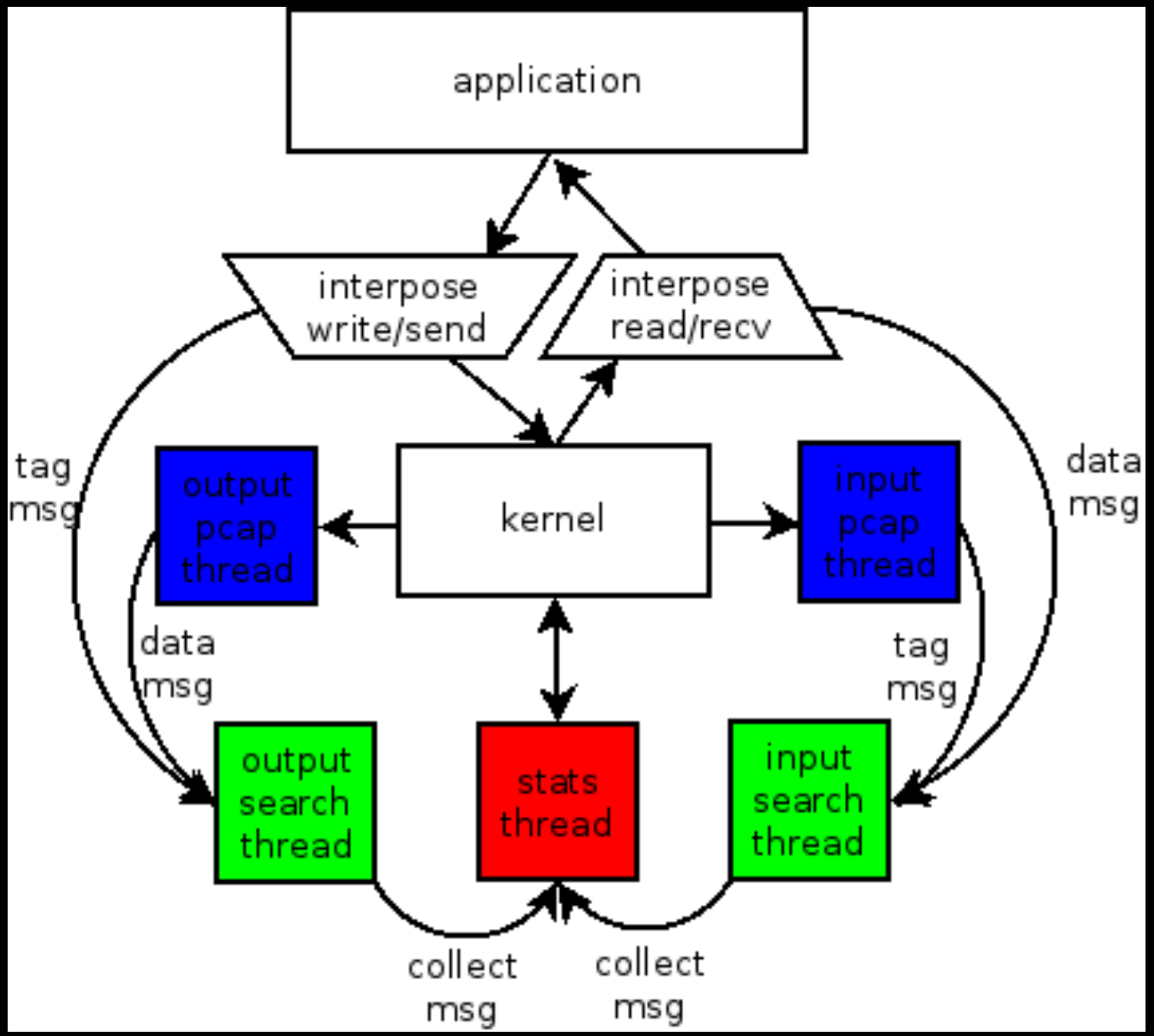
rob.g.jansen@nrl.navy.mil

think like an adversary

libkqtime


application
interpose
write/send
interpose
read/recv
tag
msg
output
pcap
thread
kernel
input
pcap
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data
msg
data
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output
search
thread
stats
thread
input
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thread
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