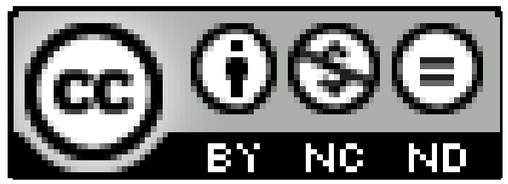
Мрежова сигурност I

http://training.iseca.org/

TCP 1/3



Boyan Krosnov

Преговор и план на курса

- Увод в мрежовата сигурност
- Криптография
- Увод в мрежите
- Ethernet
- Wi-Fi
- IP
- UDP, DHCP, ARP, Атаки върху IP
- IP routing protocols, IPv6

→ **TCP**

- Лекция преговор – 16-ти Ноември
- Тест – 18-ти Ноември
- Демо
- …

План

- История и Стандарт
- Предназначение и употреба
- Интерфейси
- Енкапсулация
- TCP Протокола
  - отваряне и затваряне на сесии
  - flow control
  - congestion avoidance & control
  - други
- Атаки върху TCP

TCP стандарт и история

- 1981 - RFC793 / STD7 – Transmission Control Protocol
- 1983 - Berkley Sockets API
- 1988 – имплементация на Congestion control
- По-големи upgrades - RFC1323, RFC2018, RFC3168
- И други - RFC editor search “TCP”

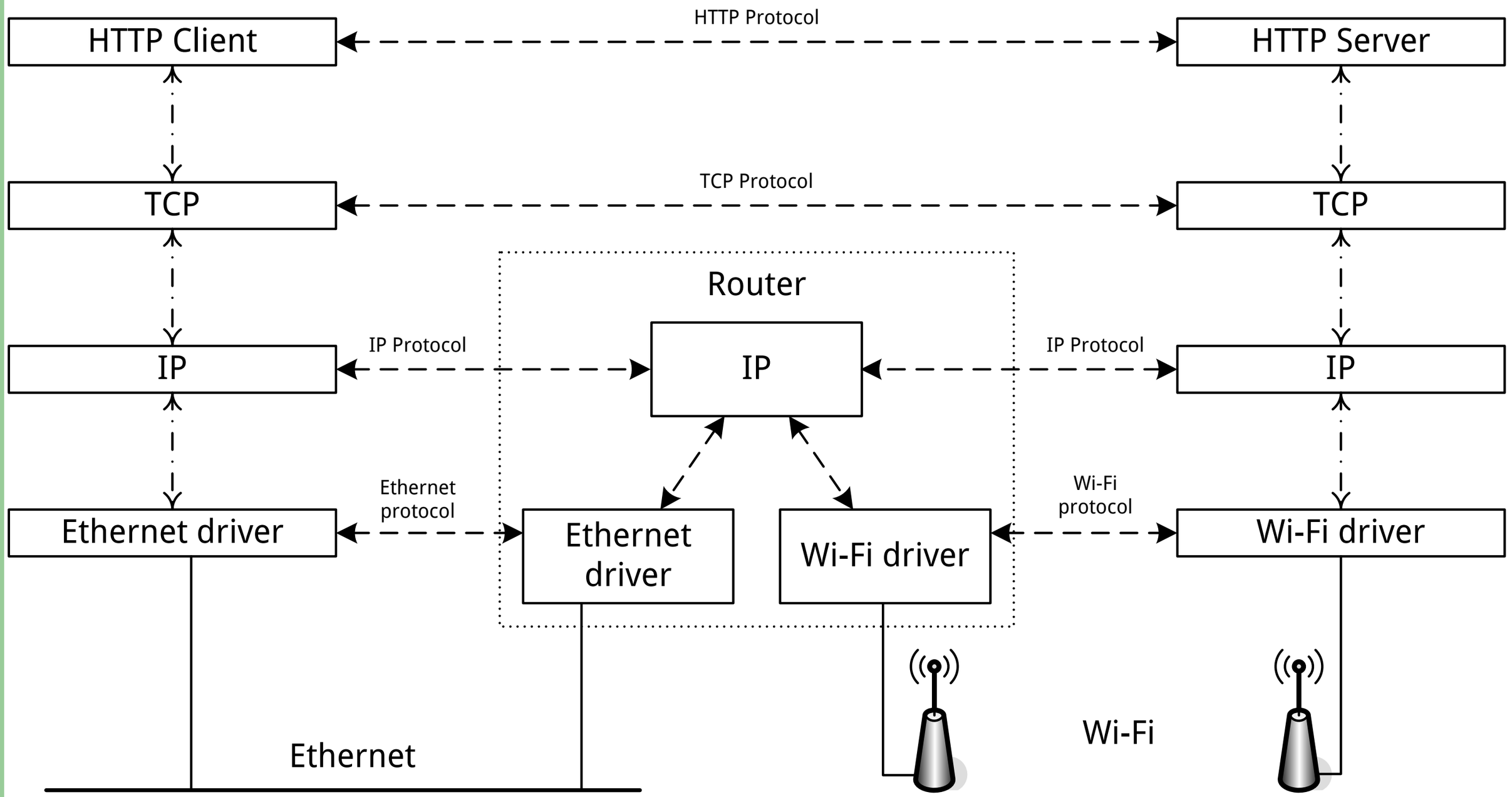
TCP - предназначение

Предназначението на TCP е да предоставя надеждна комуникация от процес до процес в среда на много взаимно-свързани мрежи.

TCP - предоставя

- Поточен трансфер на данни
- Надеждност / Отказоустойчивост
- Flow Control
- Мултиплексиране
- Сесии

Слоевете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HTTP Client
HTTP Server
TCP Protocol
TCP
TCP
Router
IP Protocol
IP Protocol
IP
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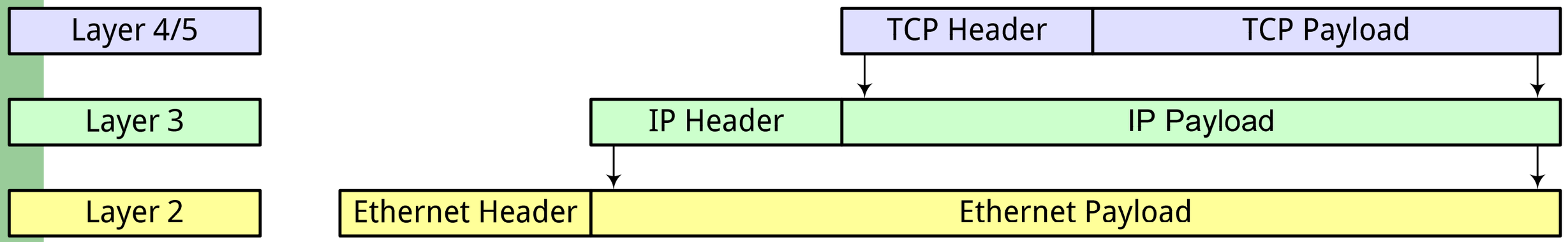
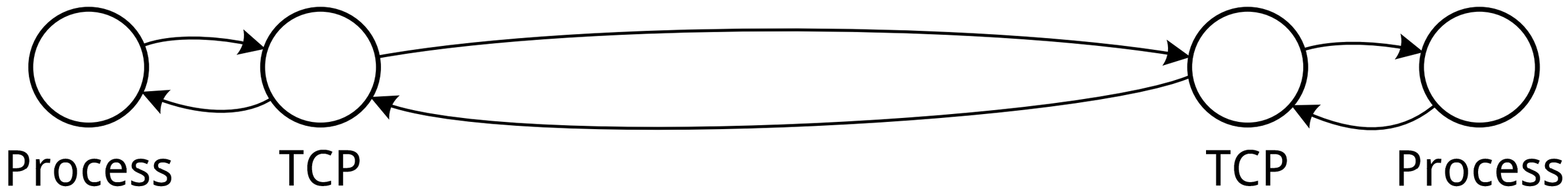
Ethernet driver
Ethernet
driver
Wi-Fi driver
Wi-Fi driver
Ethernet
Wi-Fi

TCP encapsulation



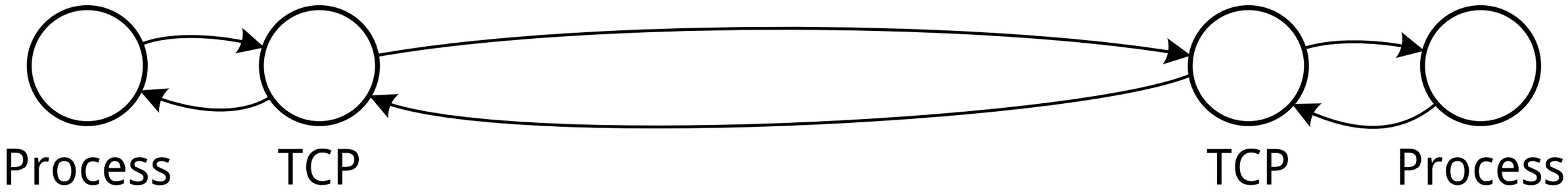
TCP - употреба

- Web – HTTP, HTTPS
- Поща – SMTP, POP, IMAP
- Сваляне на файлове – Bittorrent, FTP, etc.
- и т.н.



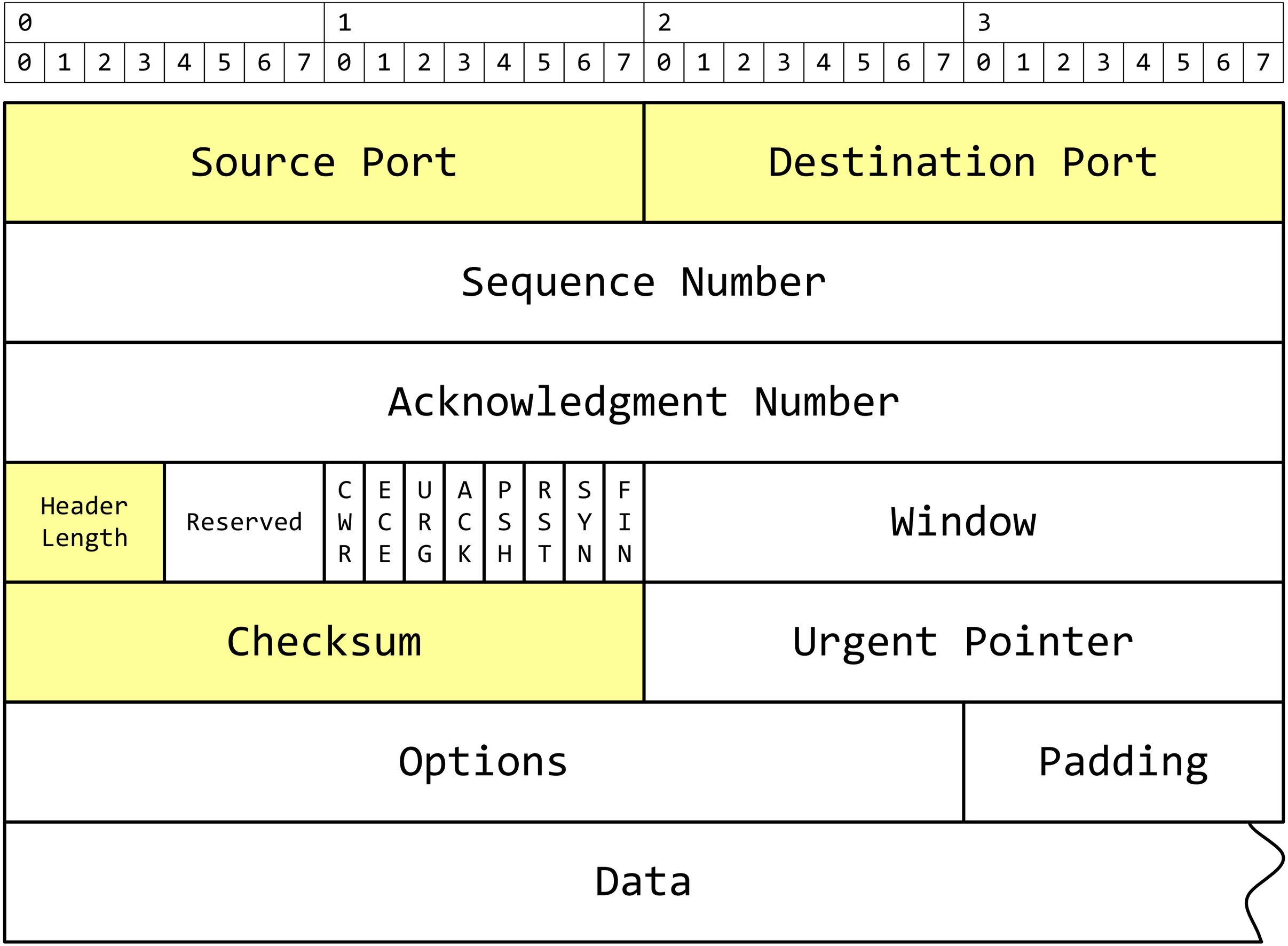
TCP интерфейси

- TCP/user interface
  - OPEN passive - listen
  - OPEN active - connect
  - SEND
    - push
    - urgent
  - RECEIVE
  - CLOSE, ABORT, STATUS



Въпроси

TCP Header Format



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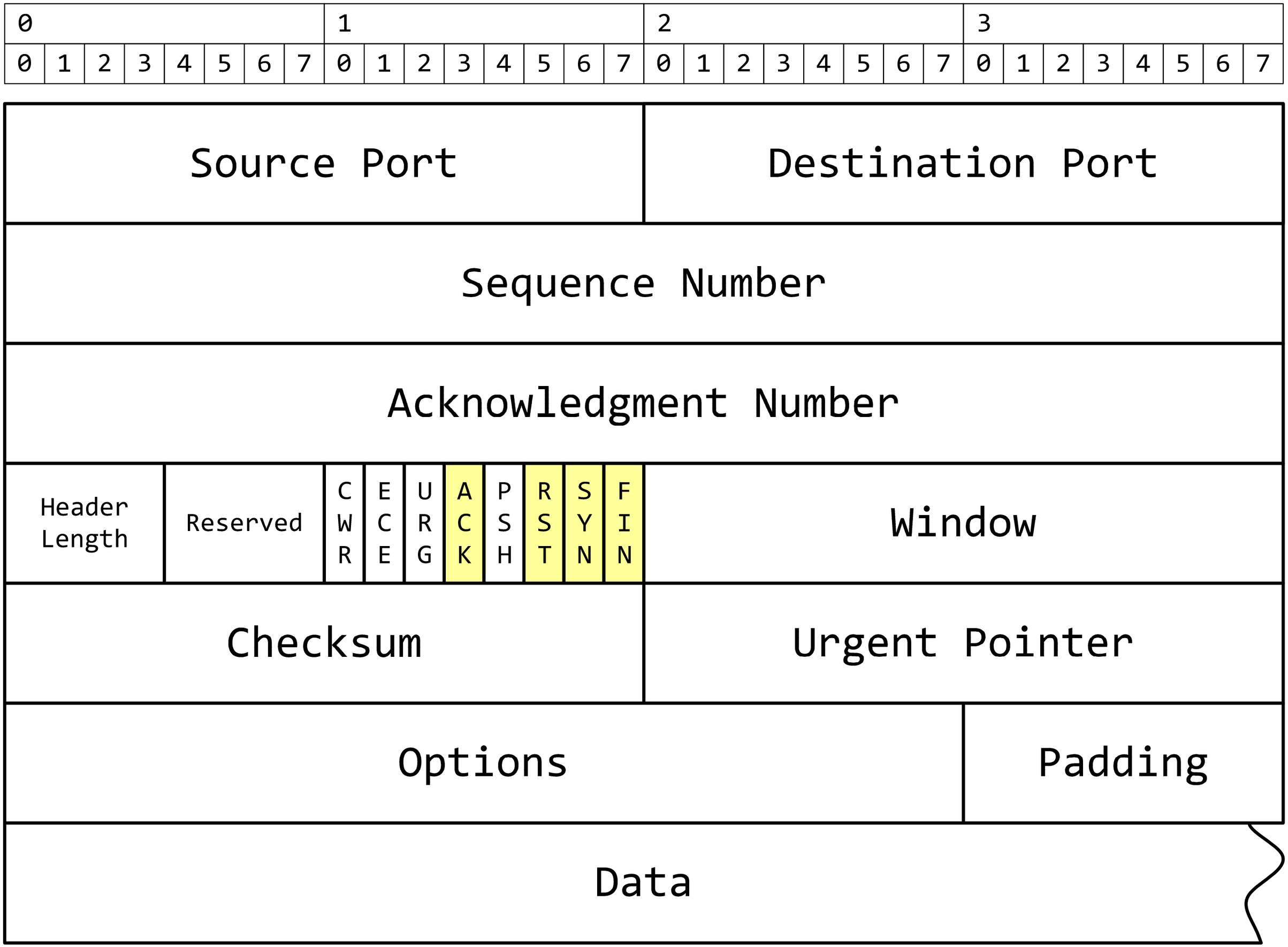

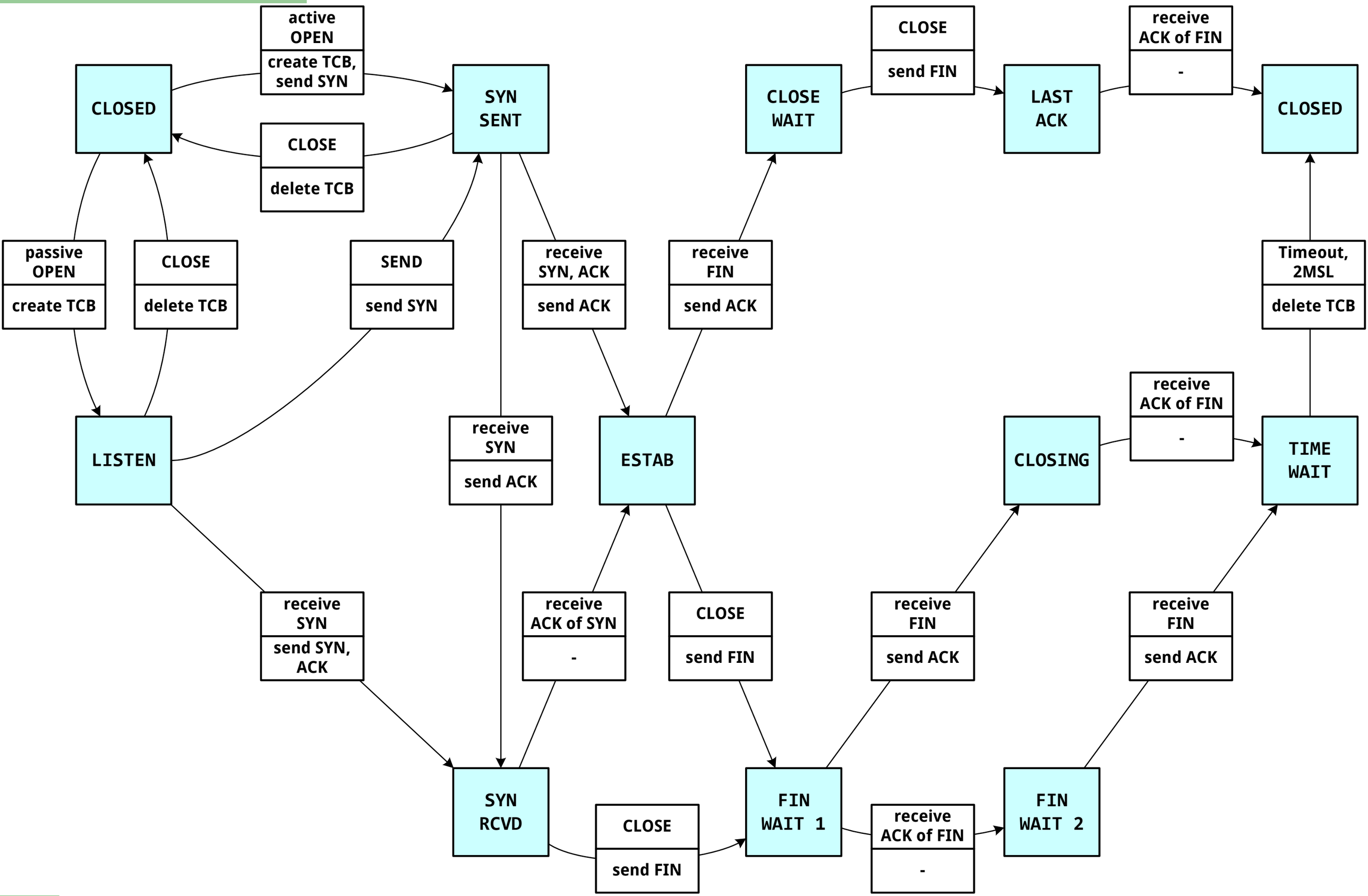
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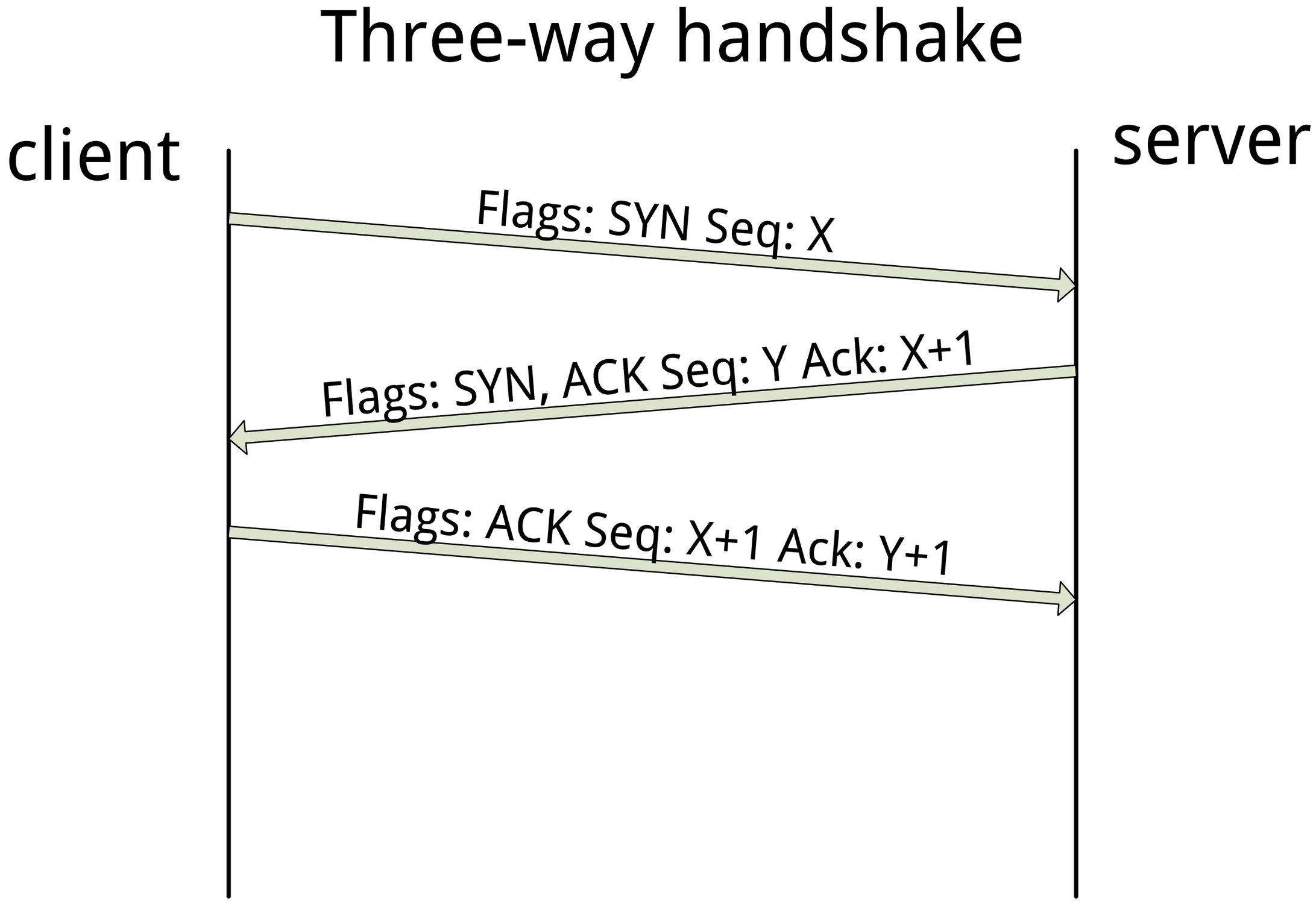
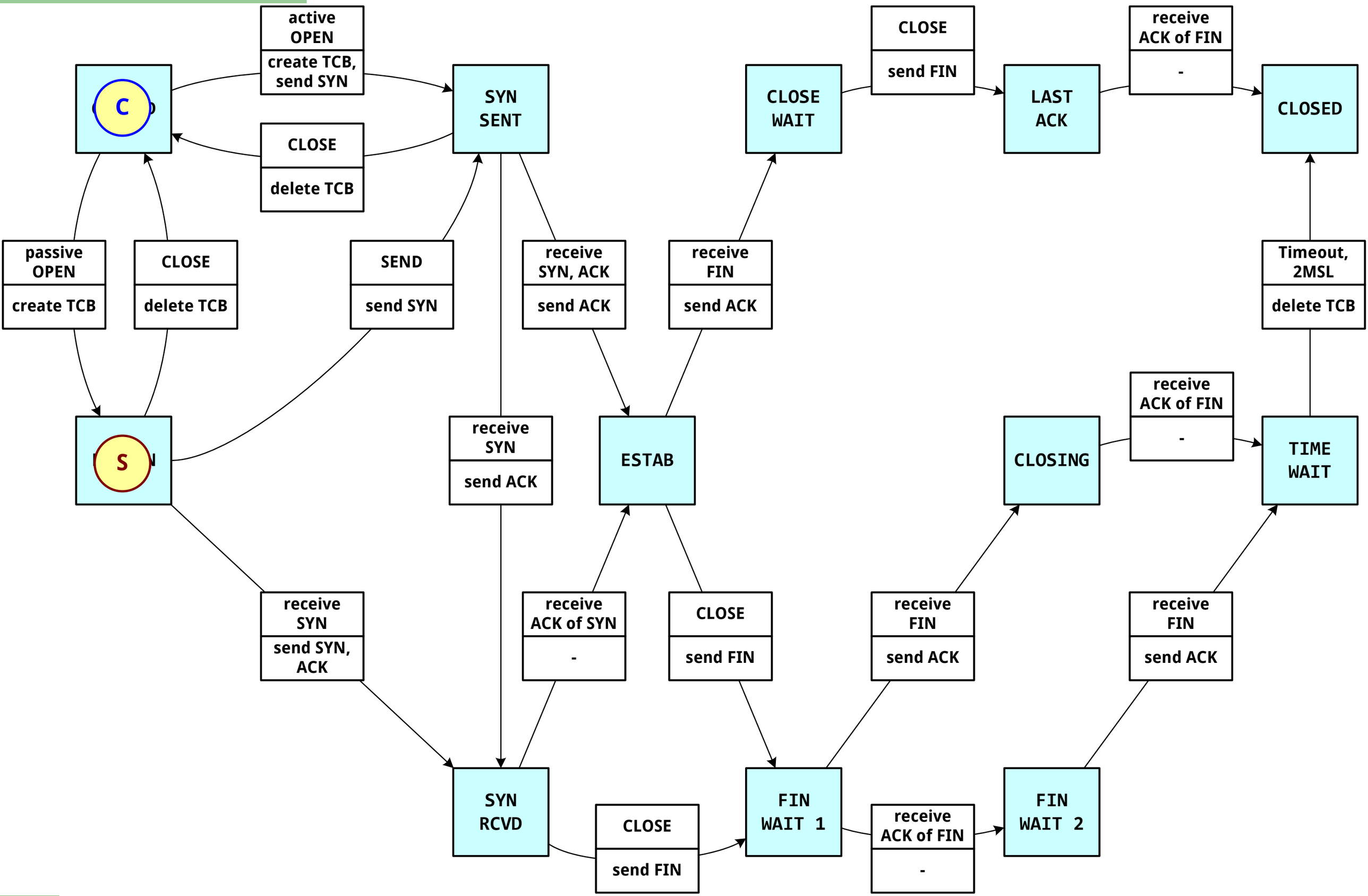
Отваряна на сесия

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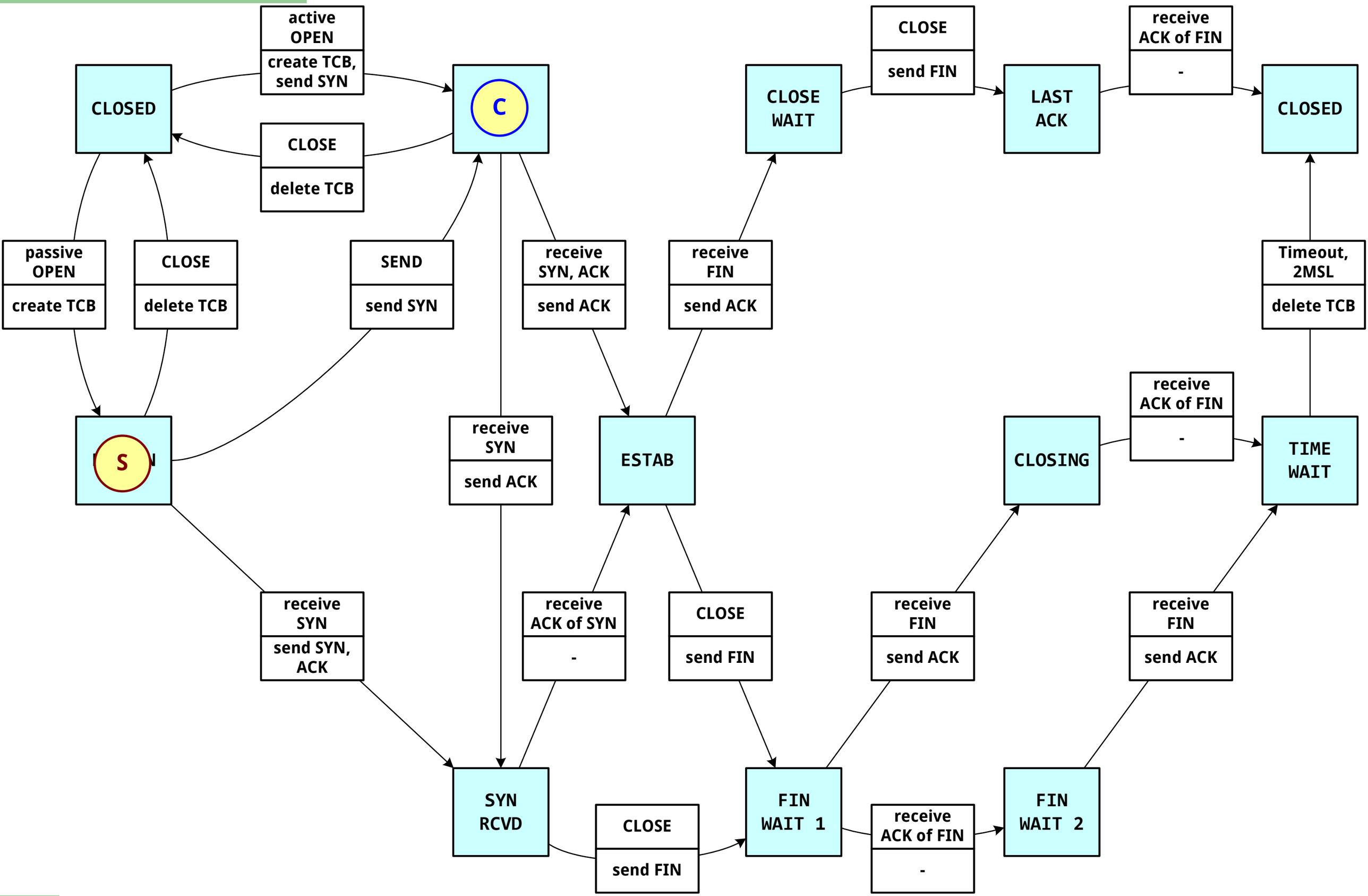
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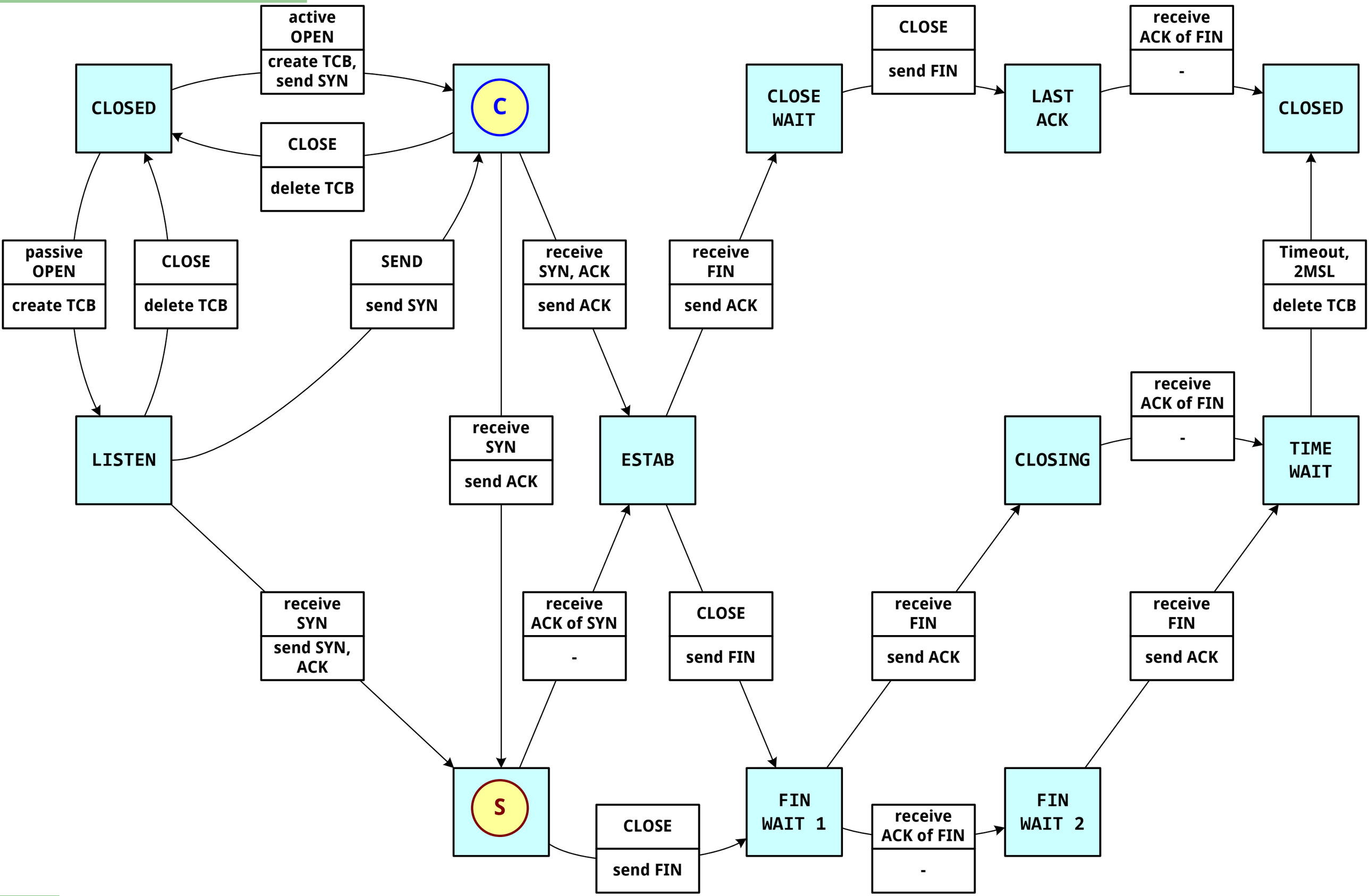
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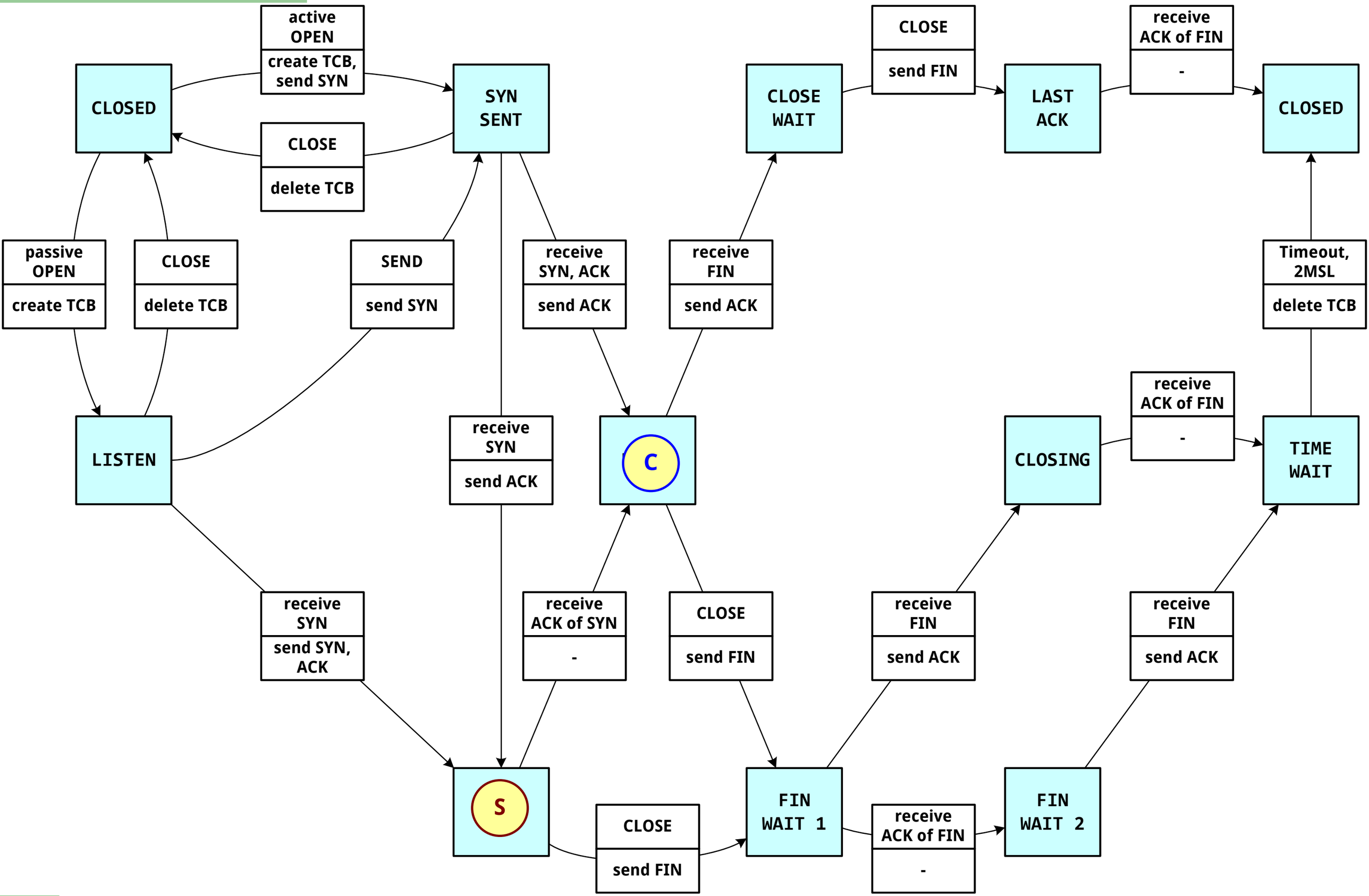
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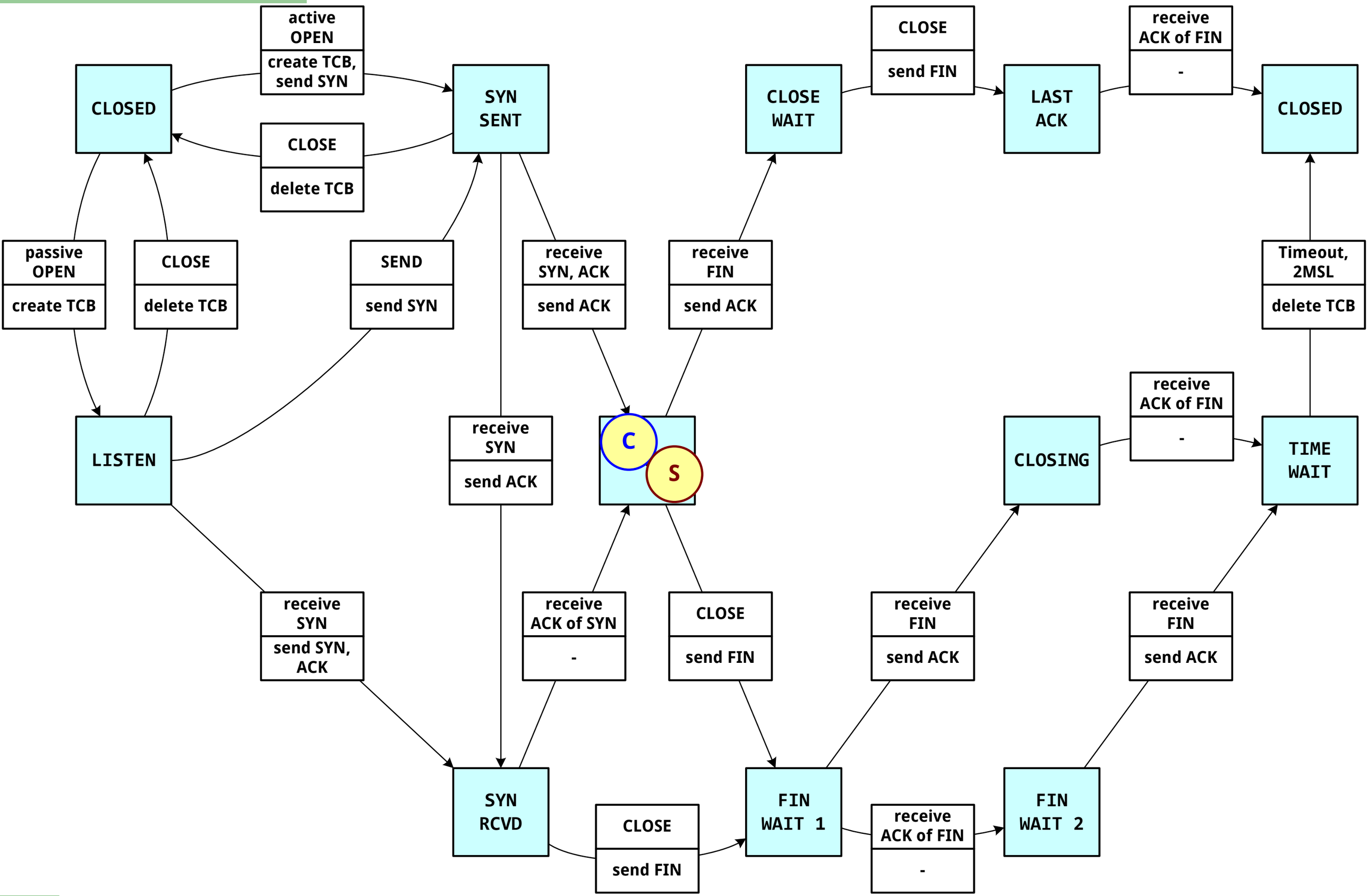
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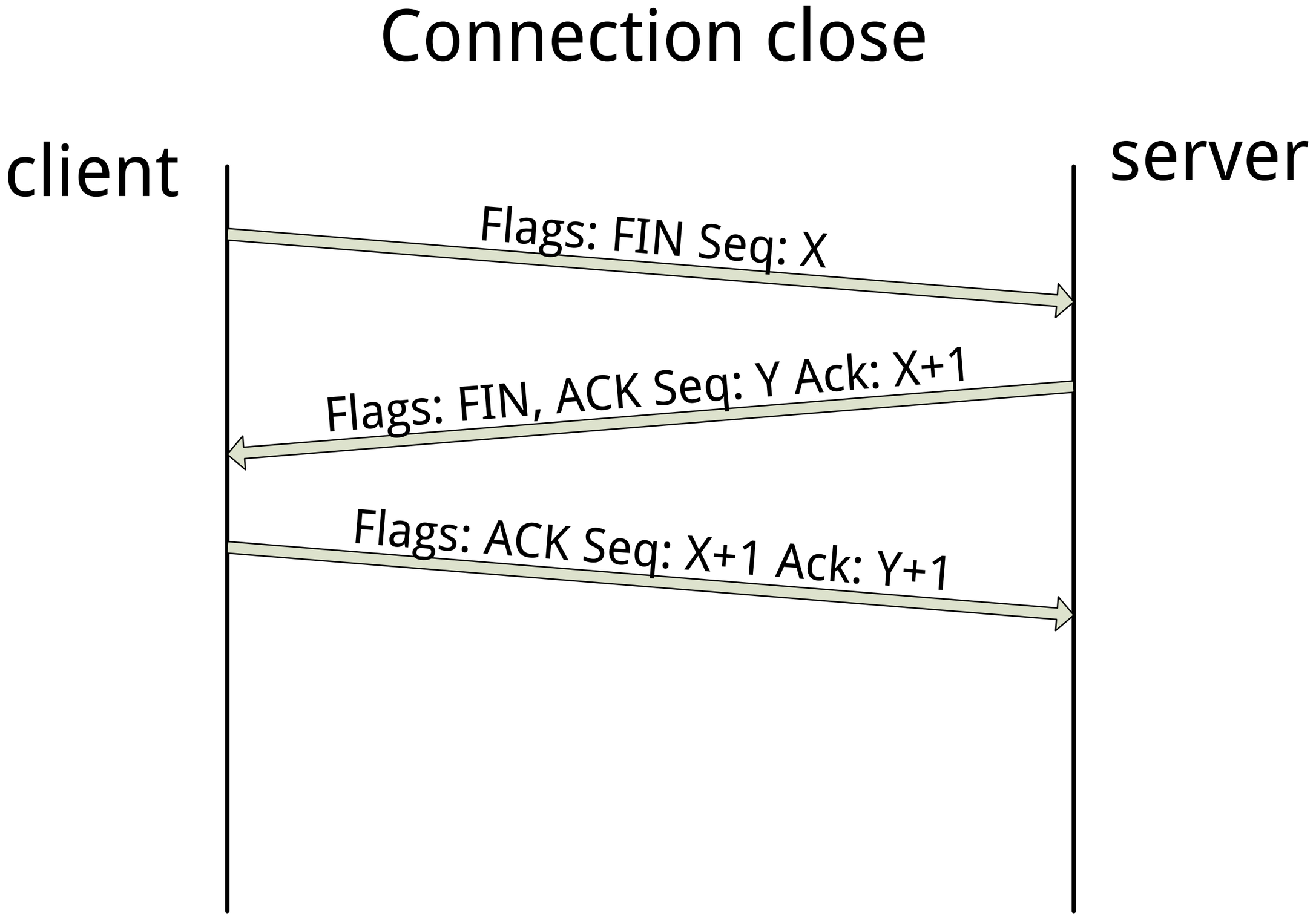
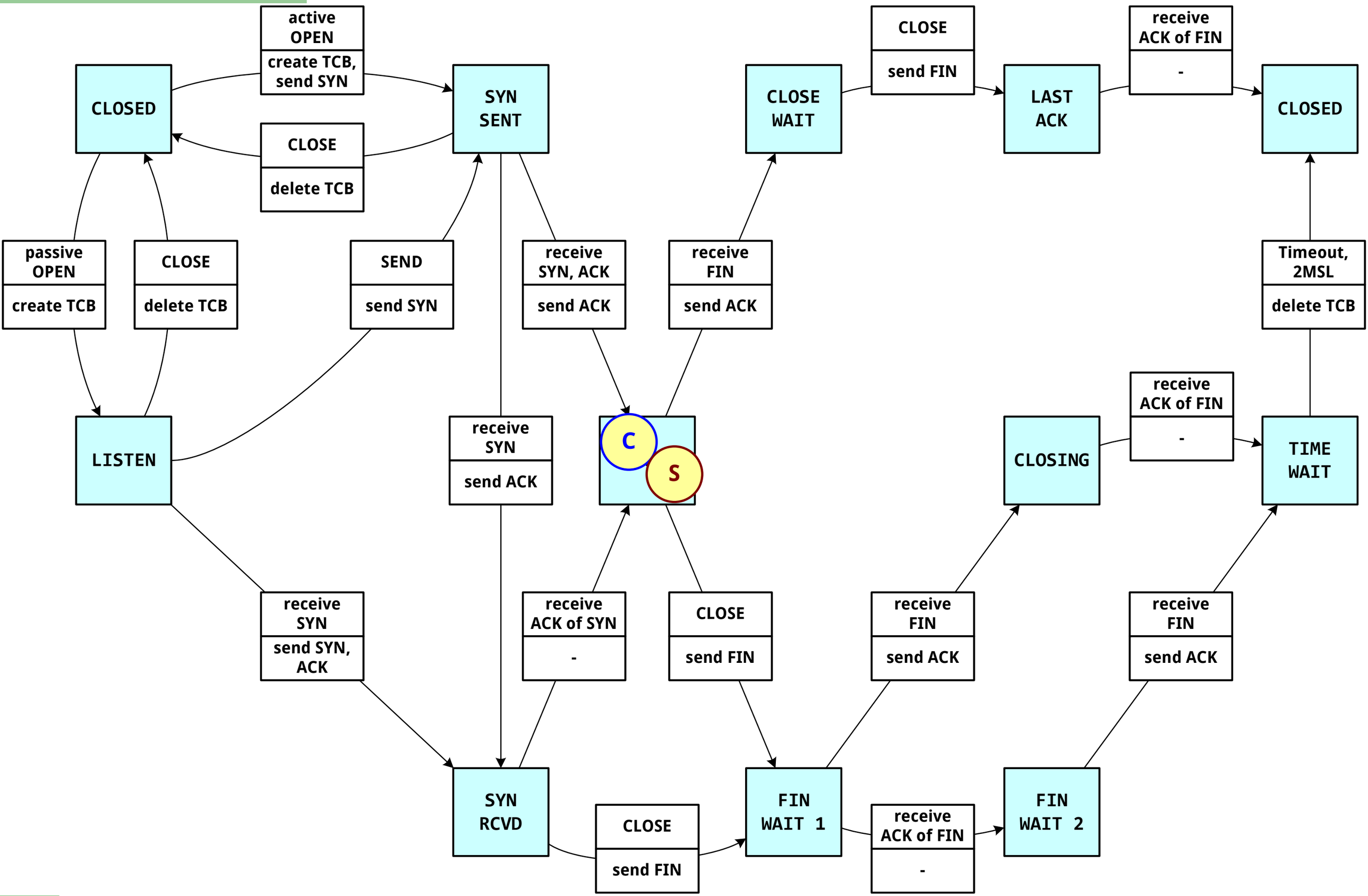
Въпроси

Затваряне на сесия

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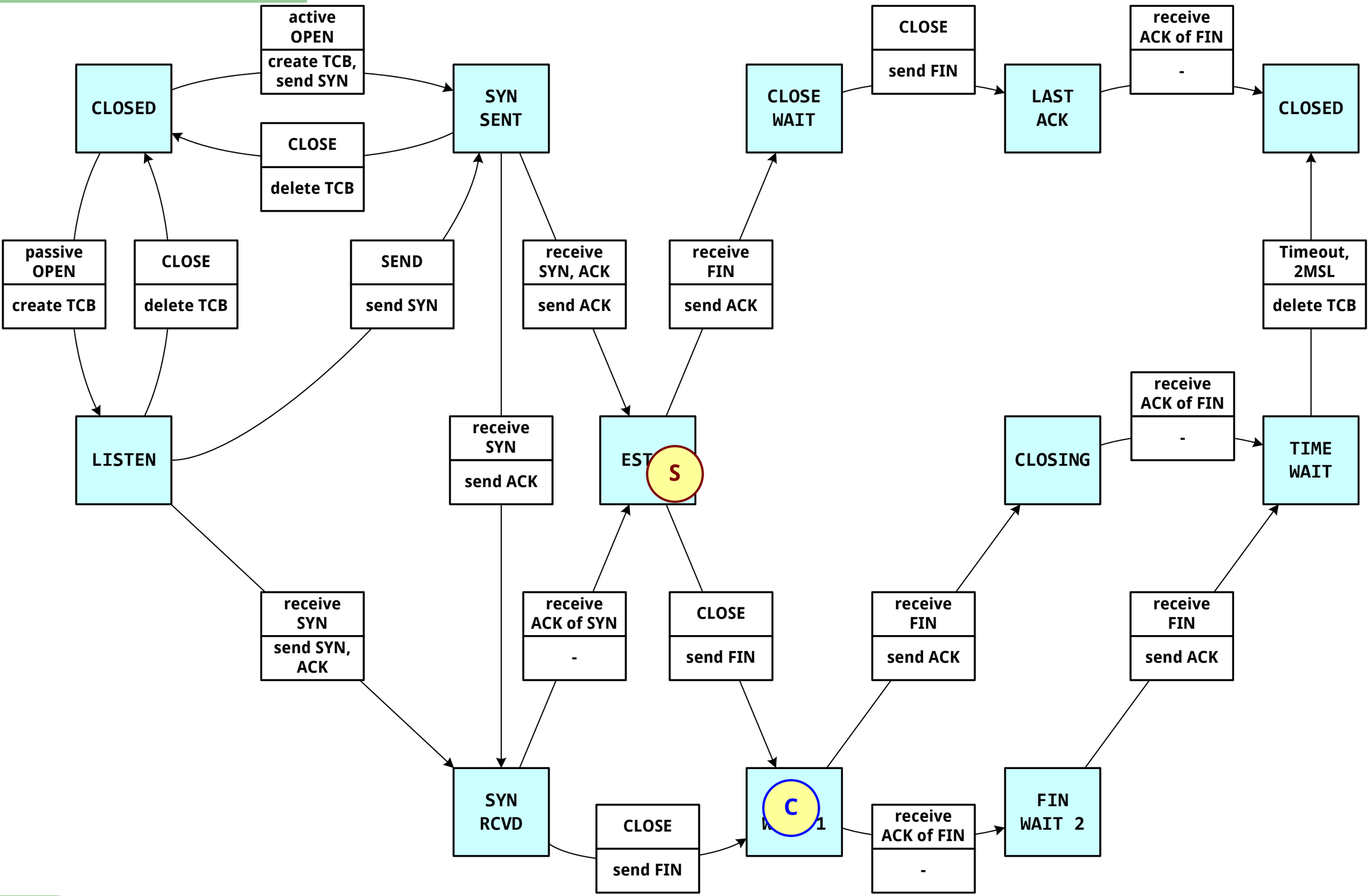
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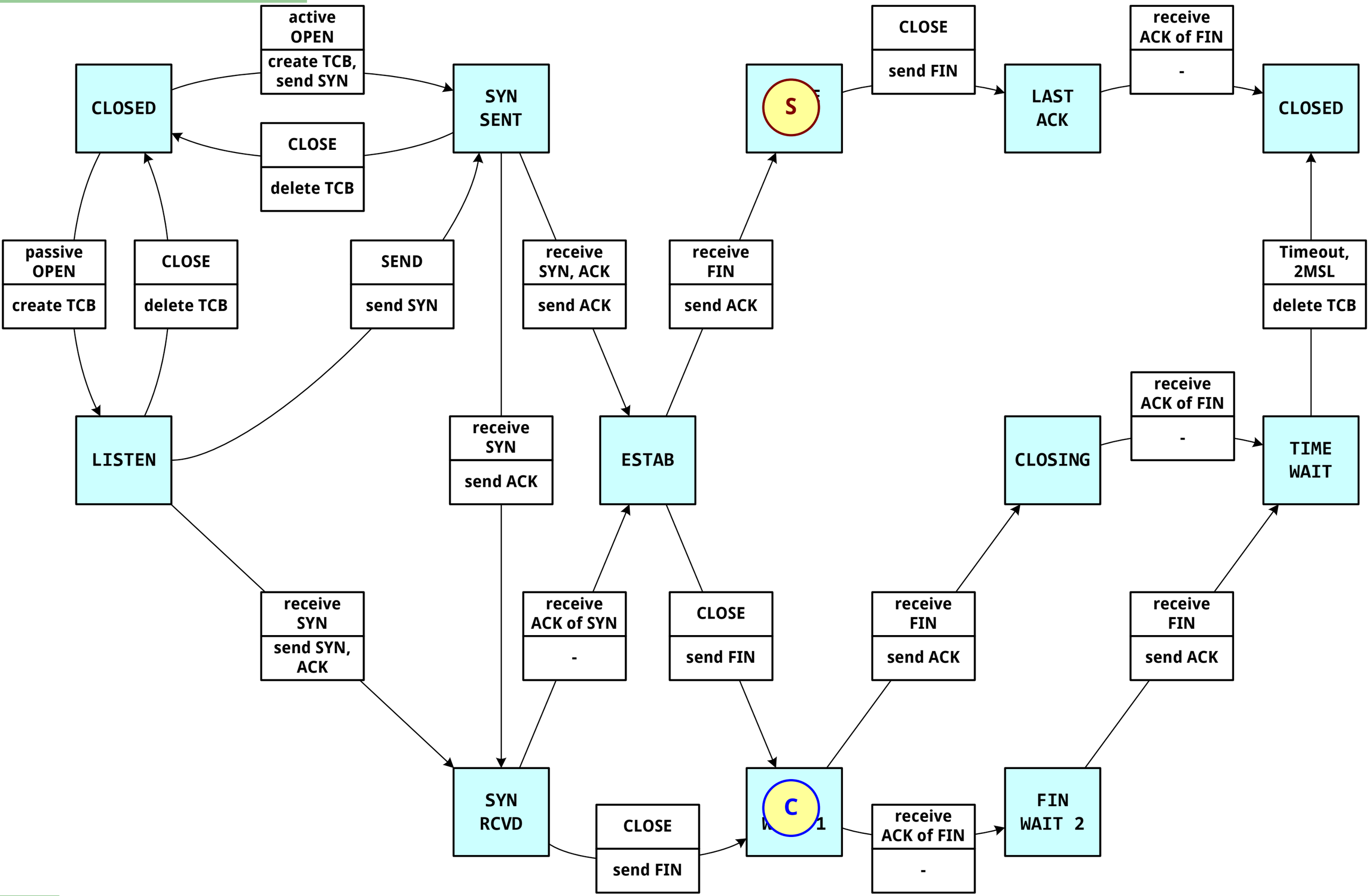
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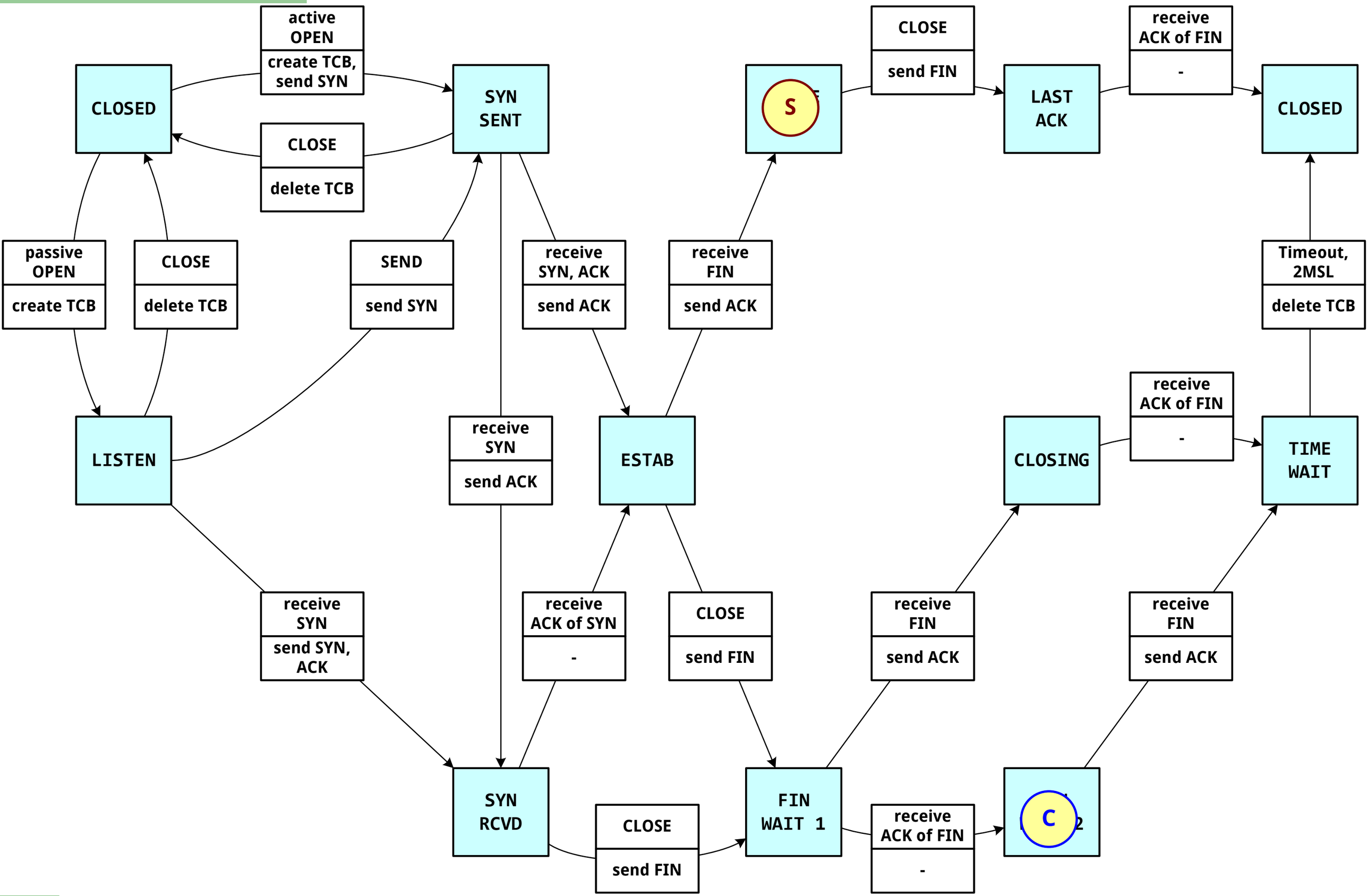
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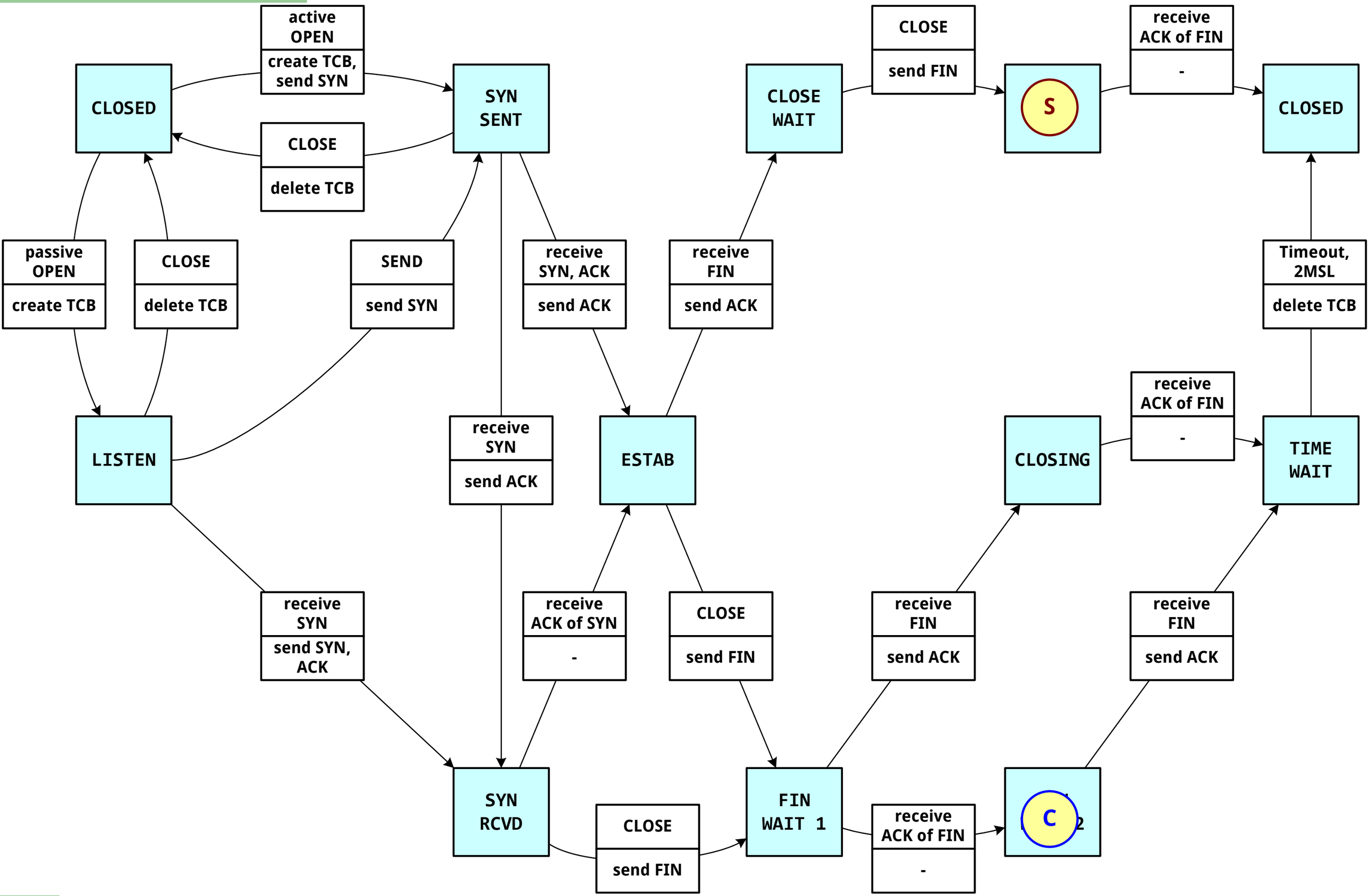
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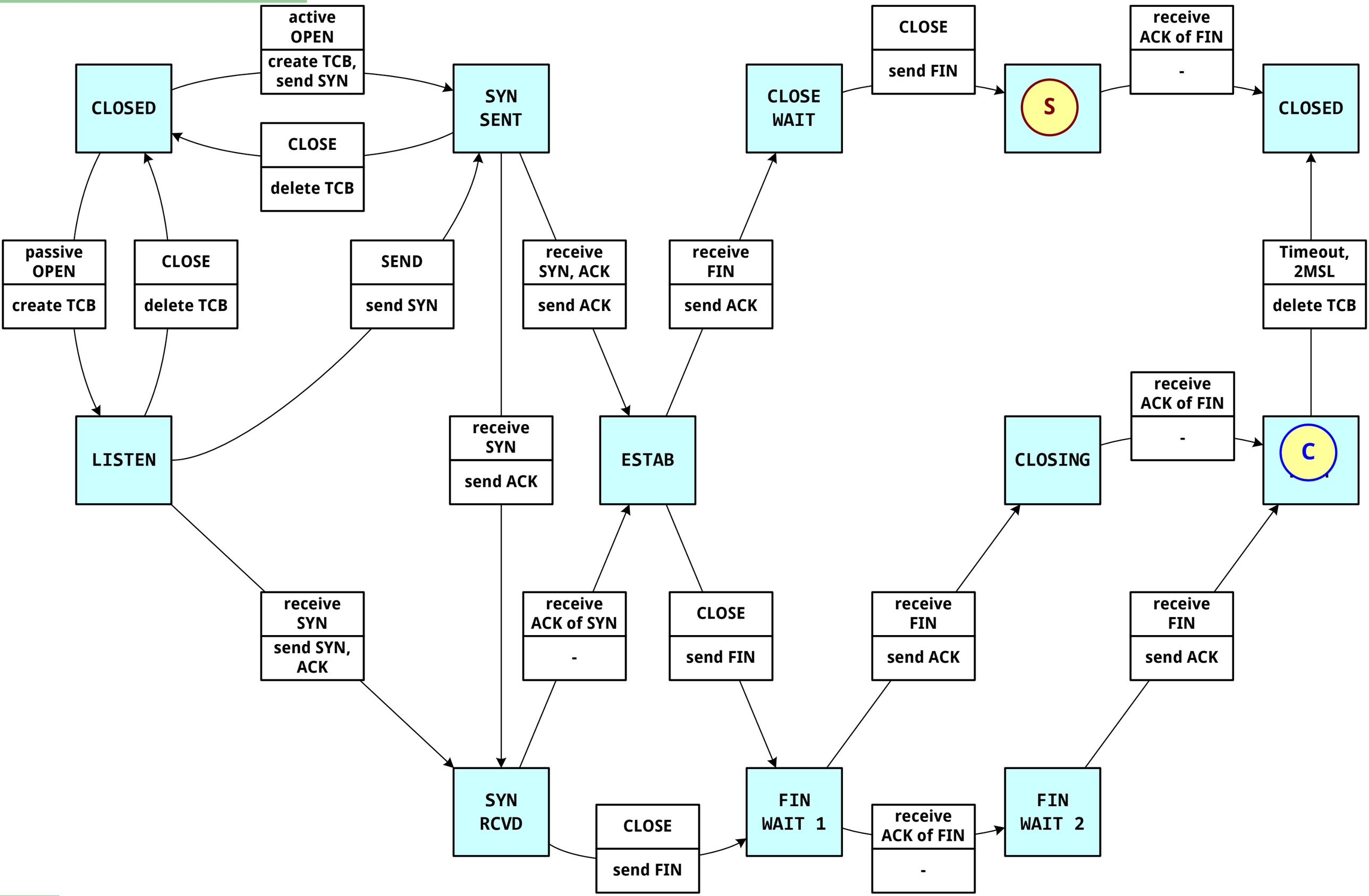
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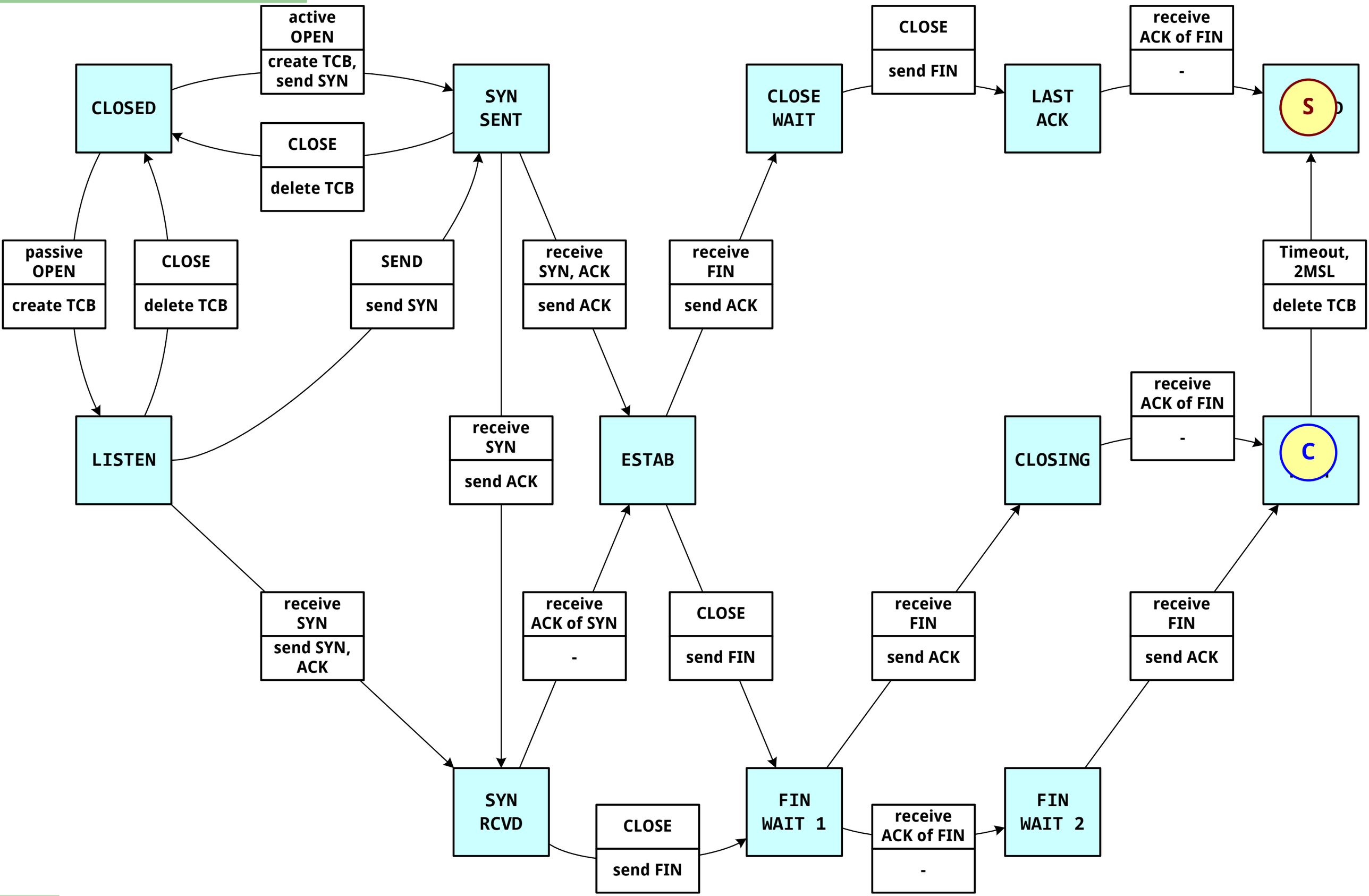
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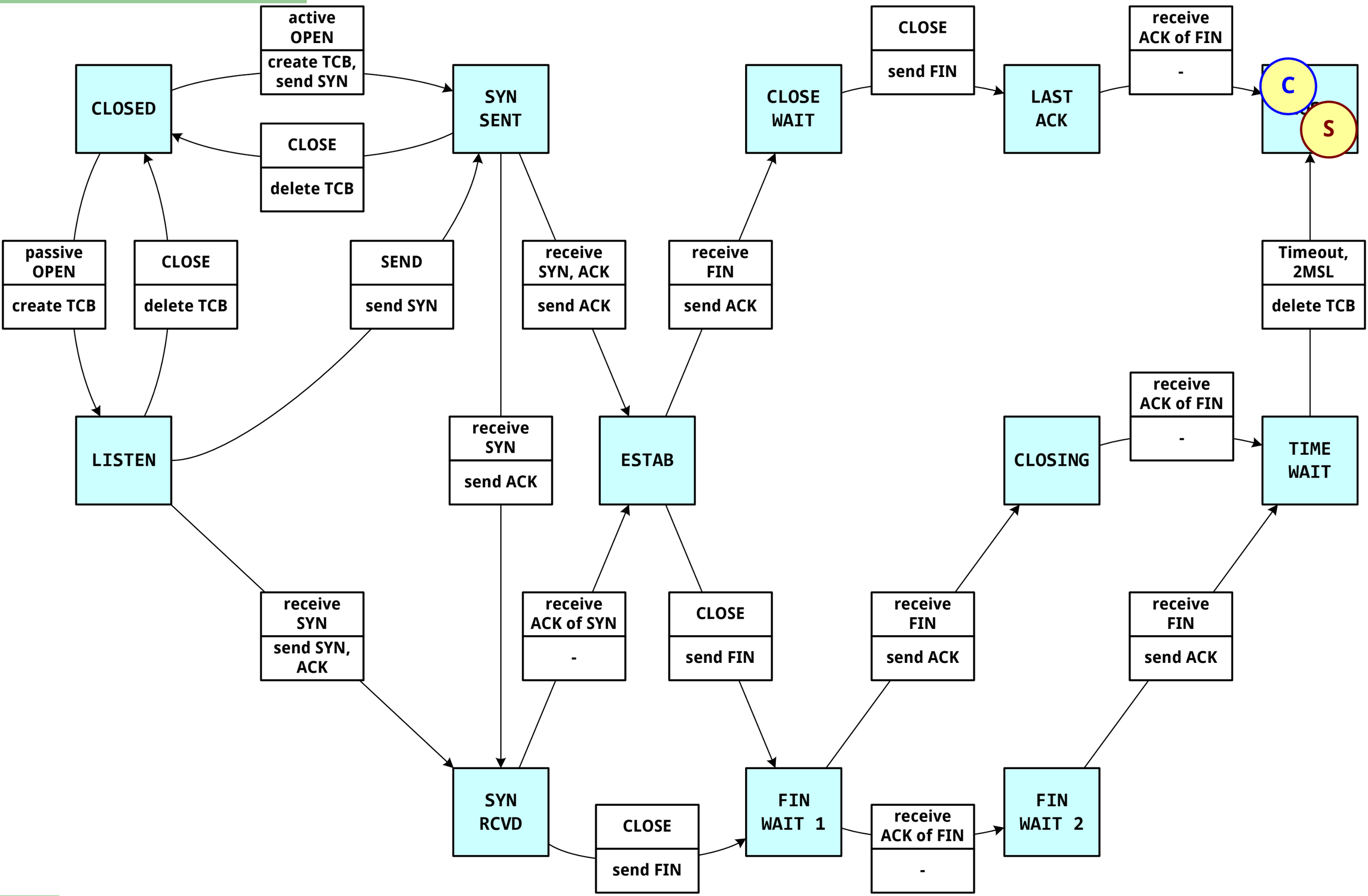
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Особености

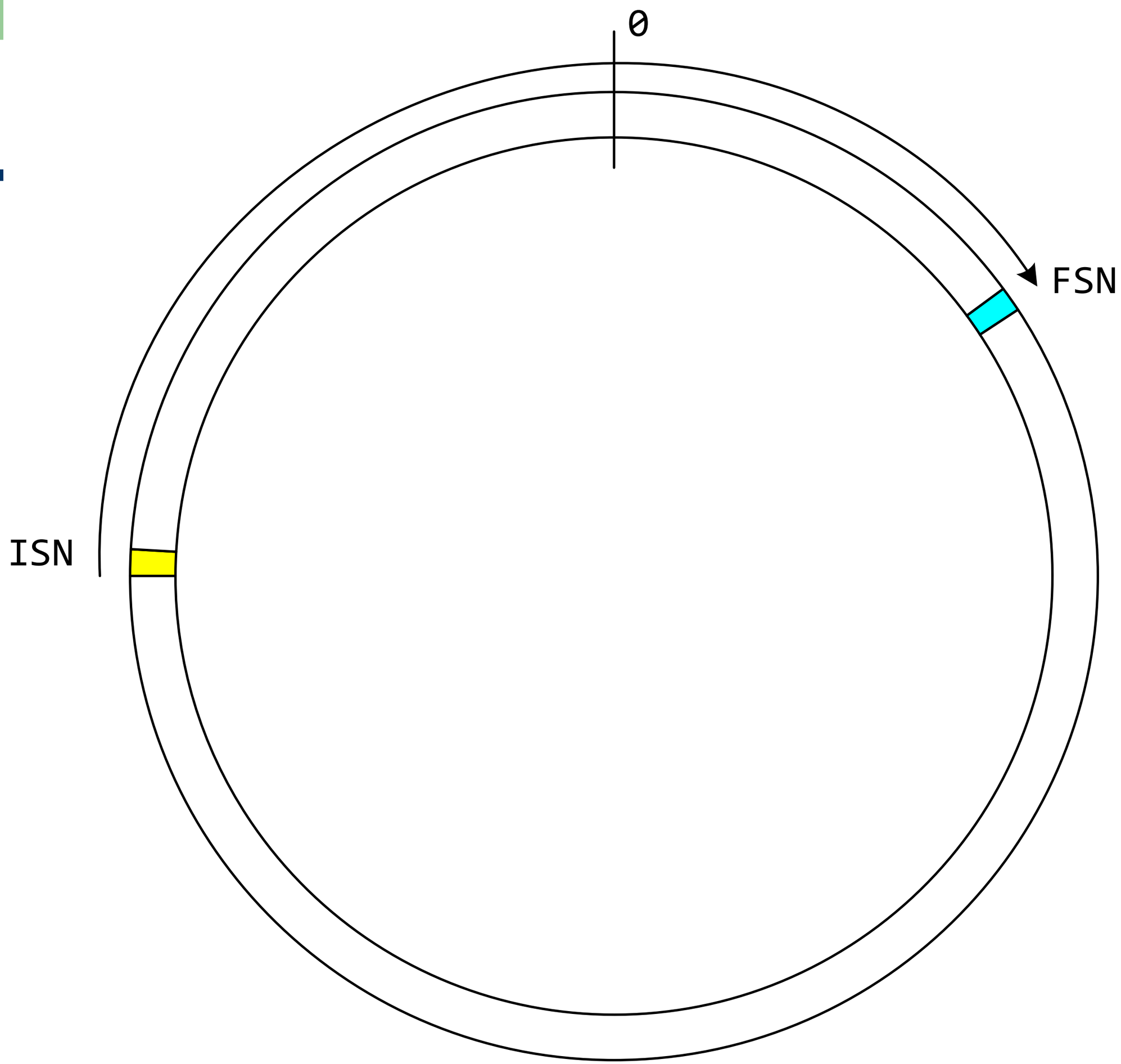
- Едновременно отваряне
- Едностранно затваряне
- Time Wait състояние
- RST

Въпроси

Flow Control

Sequence number space

- Аритметика по модул 2^{32}
- Initial Sequence Number (ISN)
- sequence числа на носения поток
- “Final Sequence Number”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FSN
ISN

Flow Control

- (Send) Sequence number
  - първия изпратен байт в текущия сегмент
- (Receive) Acknowledgment number
  - първия свободен байт от sequence-а
- (Receive) Window Size
  - колко байта да получим на веднъж

0								1								2								3							
0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7

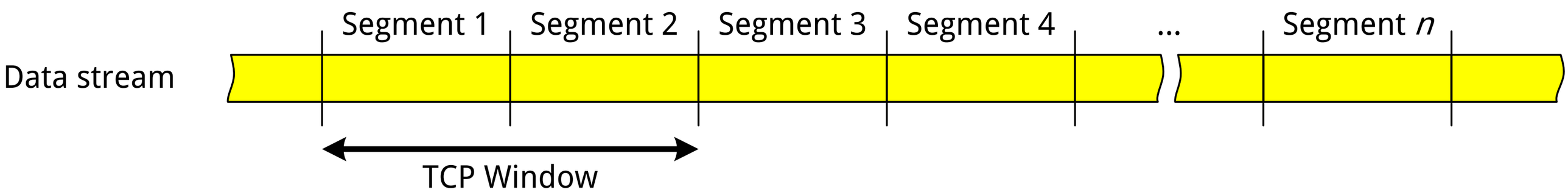
Source Port																Destination Port															
Sequence Number																															
Acknowledgment Number																															
Header Length				Reserved				C W R	E C E	U R G	A C K	P S H	R S T	S Y N	F I N	Window																
Checksum																Urgent Pointer															
Options																								Padding							
Data																															

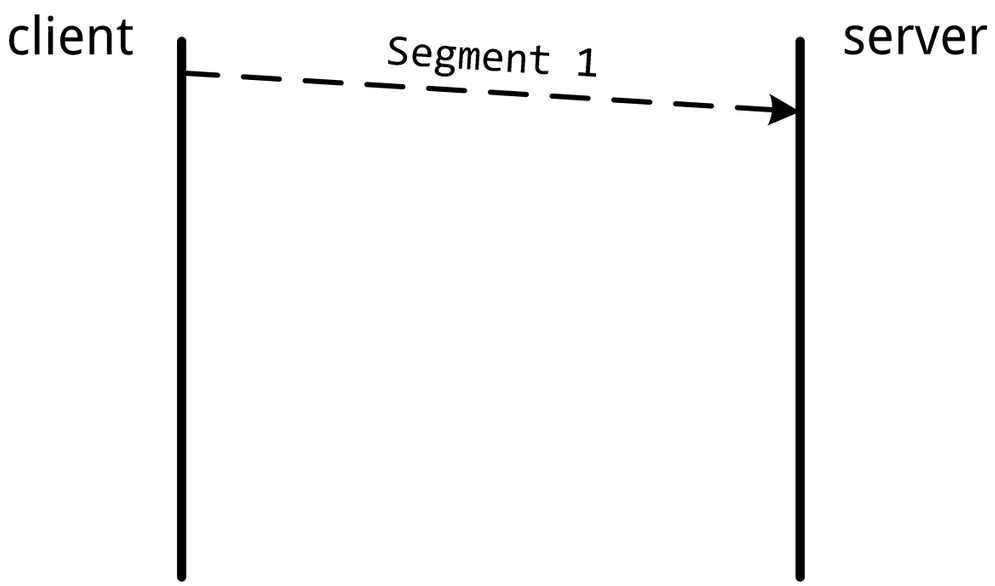
Въпроси

client

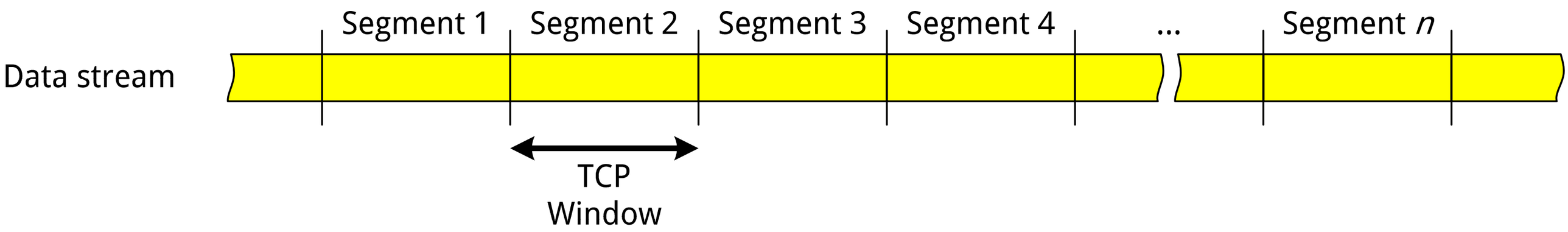
server

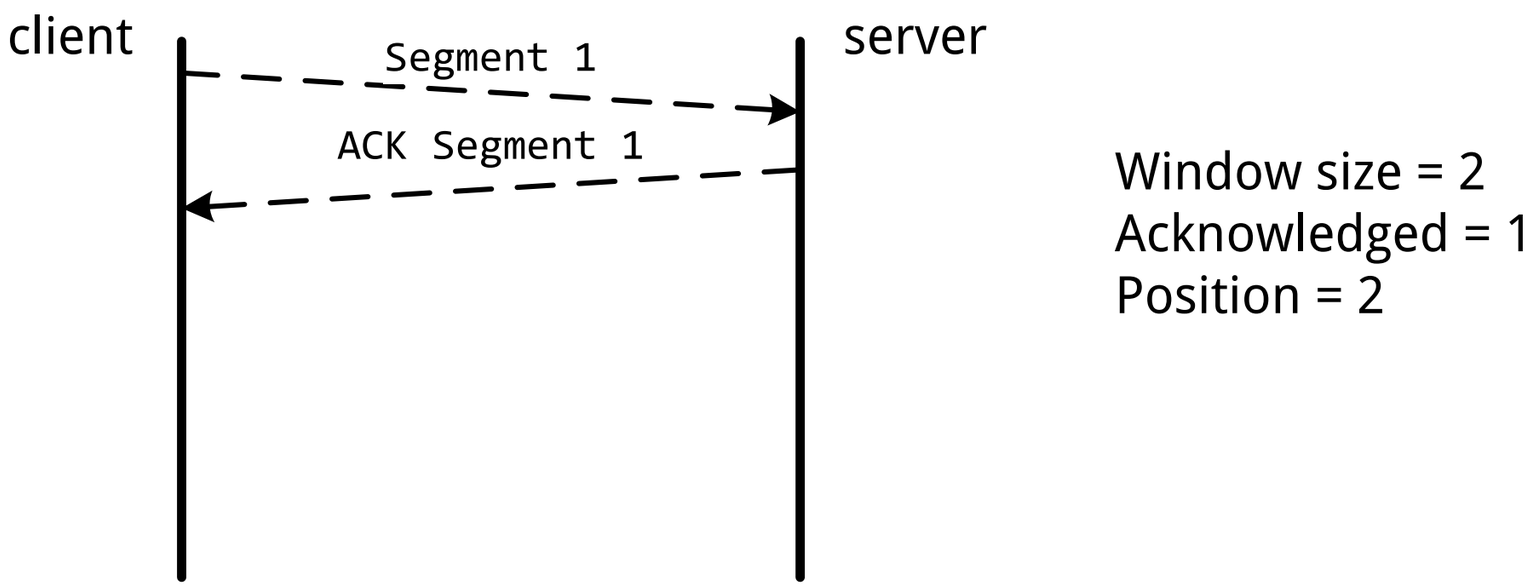
Window size = 2
Acknowledged = 0
Position = 1



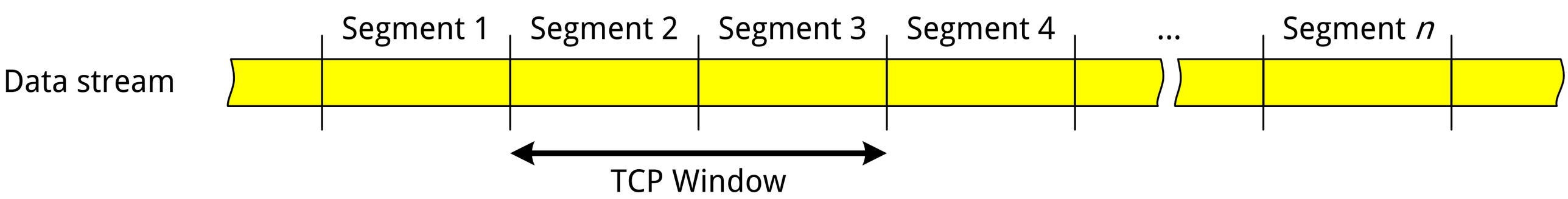


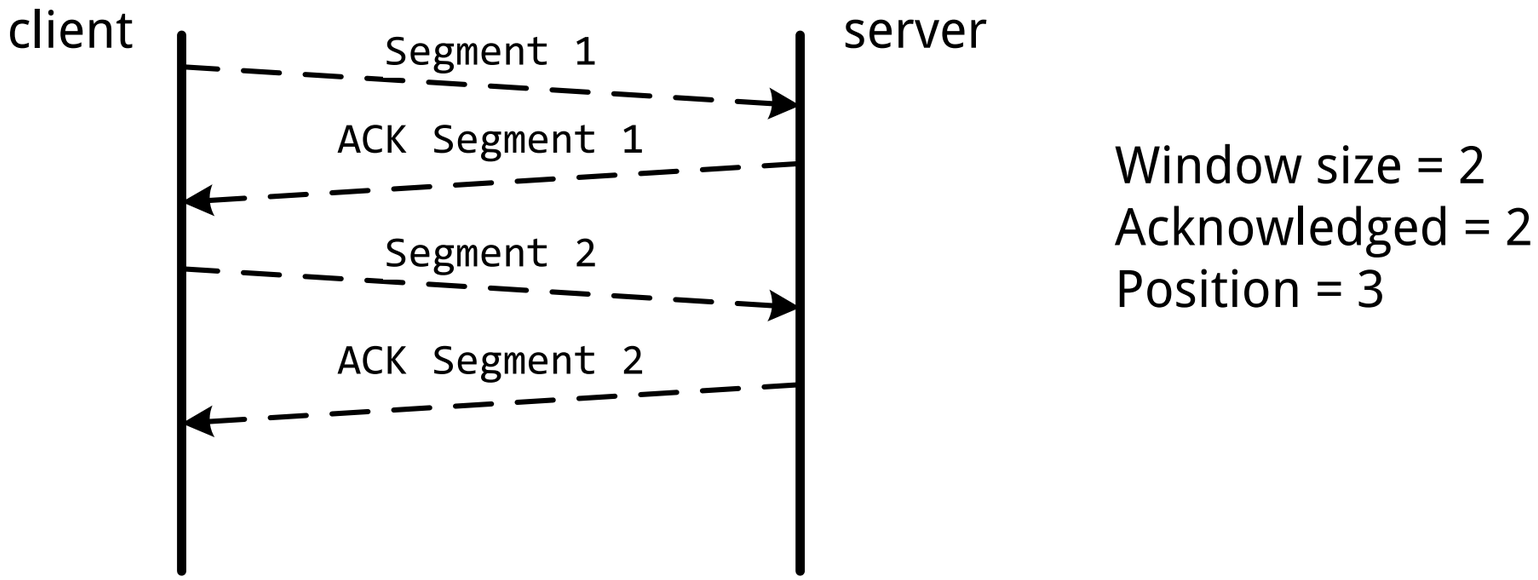
Window size = 1
Acknowledged = 0
Position = 2



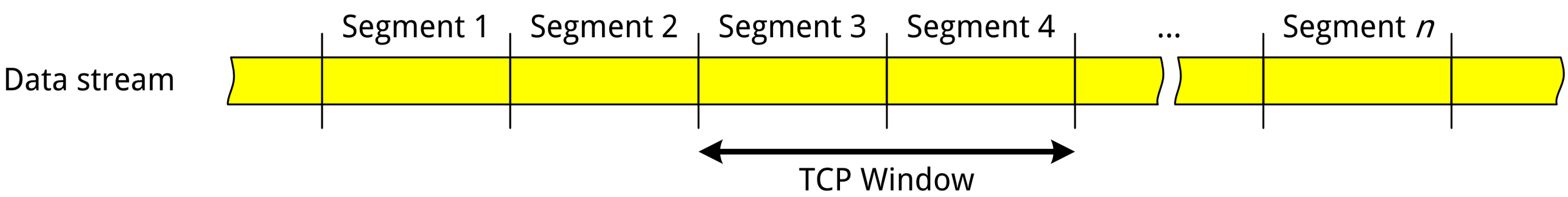


Window size = 2
Acknowledged = 1
Position = 2





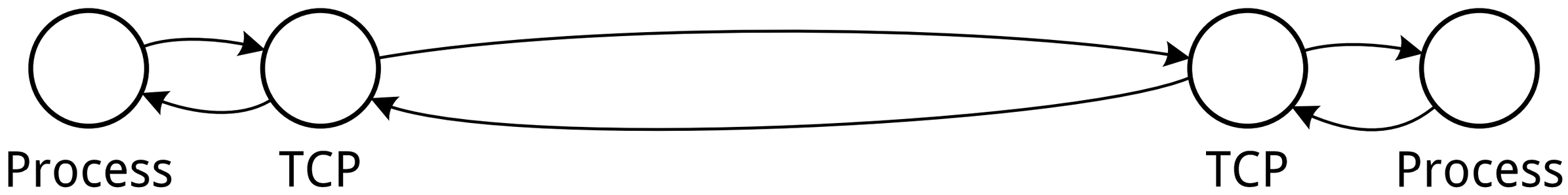
Window size = 2
Acknowledged = 2
Position = 3



Push

- Инструктира получаващото TCP да извести процеса че има данни за незабавно получаване

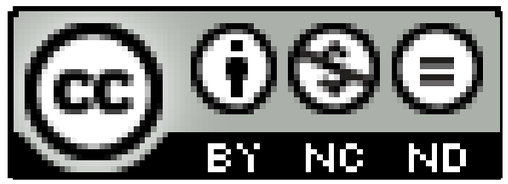
- Примерно
  - в края на HTTP request хедъра
  - на всеки пакет при интерактивни протоколи



Мрежова сигурност I

http://training.iseca.org/

TCP 2/3

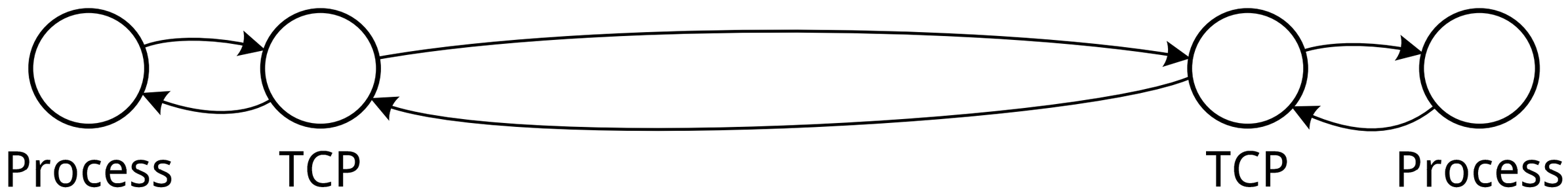


Boyan Krosnov

Push

- Инструктира получаващото TCP да извести процеса че има данни за незабавно получаване

- Примерно
  - в края на HTTP request хедъра
  - на всеки пакет при интерактивни протоколи

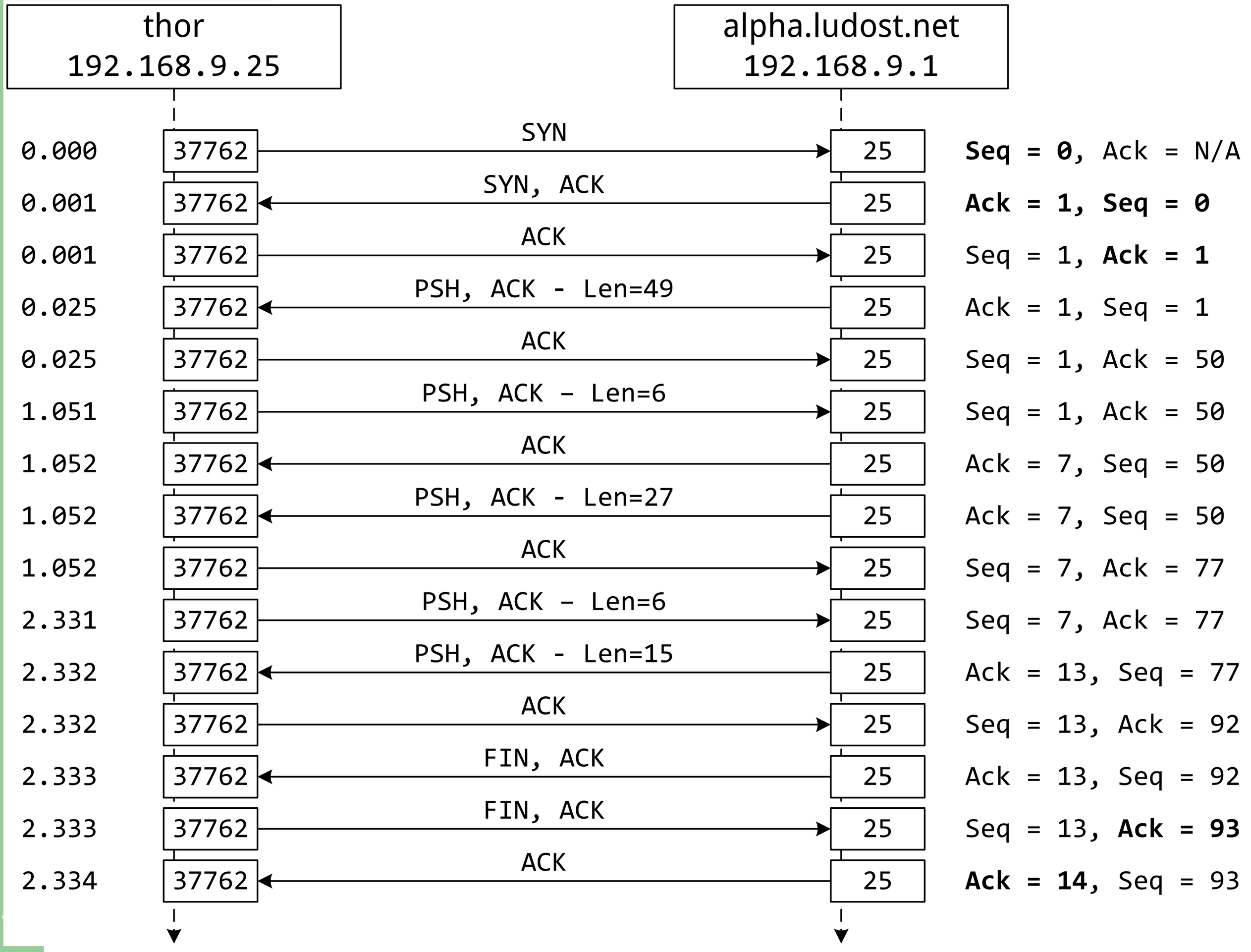


0								1								2								3							
0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7

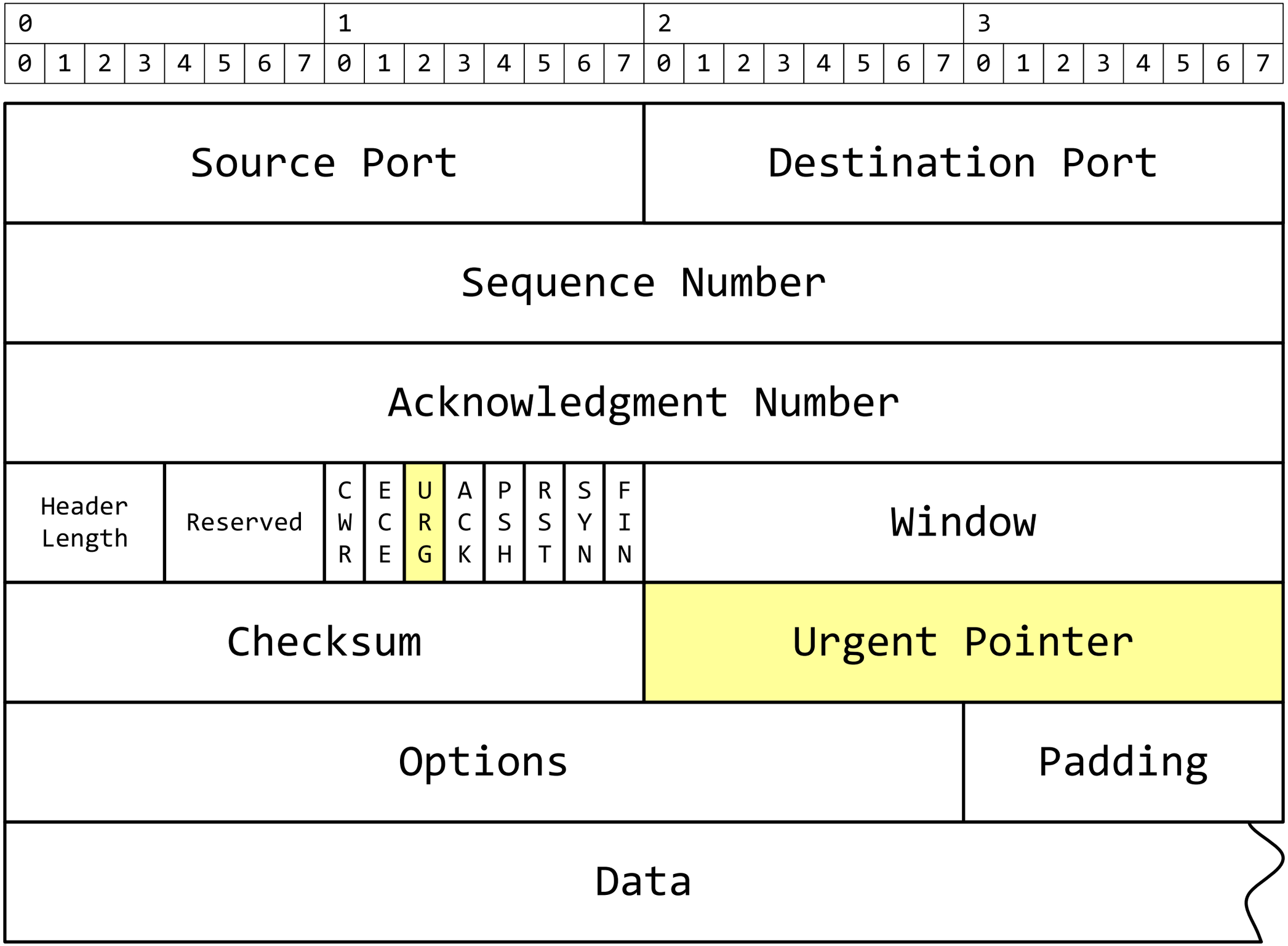
Source Port																Destination Port
Sequence Number																
Acknowledgment Number																
Header Length	Reserved				CWR	ECE	URG	ACK	PSH	RST	SYN	FIN	Window			
Checksum																Urgent Pointer
Options																Padding
Data																

Пример за TCP сесия

- Отваряне
- Данни в едната посока
- Данни в другата посока
- Затваряне


thor
192.168.9.25
alpha.ludost.net
192.168.9.1
0.000 37762 SYN 25 Seq = 0, Ack = N/A
0.001 37762 SYN, ACK 25 Ack = 1, Seq = 0
0.001 37762 ACK 25 Seq = 1, Ack = 1
0.025 37762 PSH, ACK - Len=49 25 Ack = 1, Seq = 1
0.025 37762 ACK 25 Seq = 1, Ack = 50
1.051 37762 PSH, ACK – Len=6 25 Seq = 1, Ack = 50
1.052 37762 ACK 25 Ack = 7, Seq = 50
1.052 37762 PSH, ACK - Len=27 25 Ack = 7, Seq = 50
1.052 37762 ACK 25 Seq = 7, Ack = 77
2.331 37762 PSH, ACK – Len=6 25 Seq = 7, Ack = 77
2.332 37762 PSH, ACK - Len=15 25 Ack = 13, Seq = 77
2.332 37762 ACK 25 Seq = 13, Ack = 92
2.333 37762 FIN, ACK 25 Ack = 13, Seq = 92
2.333 37762 FIN, ACK 25 Seq = 13, Ack = 93
2.334 37762 ACK 25 Ack = 14, Seq = 93

URG


0 1 2 3
0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7
Source Port
Destination Port
Sequence Number
Acknowledgment Number
Header Length
Reserved
CWR
ECE
URG
ACK
PSH
RST
SYN
FIN
Window
Checksum
Urgent Pointer
Options
Padding
Data

Въпроси

TCP Throughput

- Throughput
  - Функция на пропусквателната способност на мрежата
  - … и Round-trip time RTT
- Receive Window
  - Трябва да е поне Bandwidth * RTT
  - Иначе не може да се използва пълноценно мрежата

Congestion Control

- История
  - John Nagle – 1984 - RFC 896
  - Congestive Collapse – 1986
  - Van Jacobson et al.
    - имплементира Congestion avoidance/control в TCP
    - 4.3BSD и AT&T 1988-
    - Congestion Avoidance & Control paper 1988 (допълнителен материал)

- RFC5681 – Последната версия
- RFC5783 – История на промените

Congestion Control

- Congestion Window (cwnd) е различно от Receive Window (rwnd)

- Slow start
- Exponential back-off

- Fast retransmit
- Fast recovery

Explicit congestion notification

- Механизъм за експлицитно нотифициране на TCP за задръстване в мрежата

- Традиционно TCP измерва само загубени пакети и закъснения като наблюдава потока от Acknowledgment числа

Въпроси

Опции

- MSS
  - PMTU-D
- WScale
- Timestamps
- SACK
- MD5, TCP-AO

Въпроси