TFO(TCP Fast Open)

- TCP Fast Open (TFO) is a real protocol, and it is an extension to the traditional TCP (Transmission Control Protocol). TFO is designed to reduce latency in the establishment of a TCP connection.

- Normally, a TCP connection requires a three-way handshake (SYN, SYN-ACK, ACK) to establish a connection before any data can be exchanged.

Demonstration of TCP:

•The TCP Fast Open the sender sends data to the receiver along with the initial SYN. This allows for data transfer to begin immediately instead of waiting for the entire handshake process to take place.

•TFO works only for repeat connections because of the requirement of TFO cookie.

Demonstration of TFO:

4 0.000209	192.168.1.175	192.168.1.176	TCP	66	50000 → 36702 [ACK] Seq=3950198196
5 10.001508	192.168.1.176	192.168.1.175	TCP	66	36702 → 50000 [FIN, ACK] Seq=369293
6 10.041269	192.168.1.175	192.168.1.176	TCP	66	50000 → 36702 [ACK] Seq=3950198196
7 11.074242	192.168.1.175	192.168.1.176	TCP	66	50000 → 36702 [FIN, ACK] Seq=395019
8 11.074547	192.168.1.176	192.168.1.175	TCP	66	36702 → 50000 [ACK] Seq=3692933010
9 16.788916	192.168.1.176	192.168.1.175	TCP	94	36704 → 50000 [SYN] Seq=2112094440
10 16.788952	192.168.1.175	192.168.1.176	TCP	74	50000 → 36704 [SYN, ACK] Seq=562309
11 16.789649	192.168.1.176	192.168.1.175	TCP	66	36704 → 50000 [ACK] Seq=2112094449

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▷ Flags: 0x002 (SYN)
  Window size value: 29200
  [Calculated window size: 29200]
  Checksum: 0xf0f7 [unverified]
  [Checksum Status: Unverified]
  Urgent pointer: 0
◢ Options: (32 bytes), Maximum segment size, SACK permitted, Timestamps, No-Operation (NOP), Window scale, TCP
  ▷ TCP Option - Maximum segment size: 1460 bytes
  ▷ TCP Option - SACK permitted
  ▷ TCP Option - Timestamps: TSval 2106150, TSecr 0
  ▷ TCP Option - No-Operation (NOP)
  ▷ TCP Option - Window scale: 7 (multiply by 128)
  ◢ TCP Option - TCP Fast Open
      Kind: TCP Fast Open Cookie (34)
      Length: 10
    ▷ Fast Open Cookie: 03e5344d684532f1
  ▷ TCP Option - No-Operation (NOP)
  ▷ TCP Option - No-Operation (NOP)
```

•When a client sends the SYN packet to the server then it sets the Kind = 34 in the options field. When the server sees the kind value equal to 34 it understands that client supports TFO and requests for cookies. The server generates a unique cookie and encrypts it using the IP address of the client so that each client has a unique cookie.
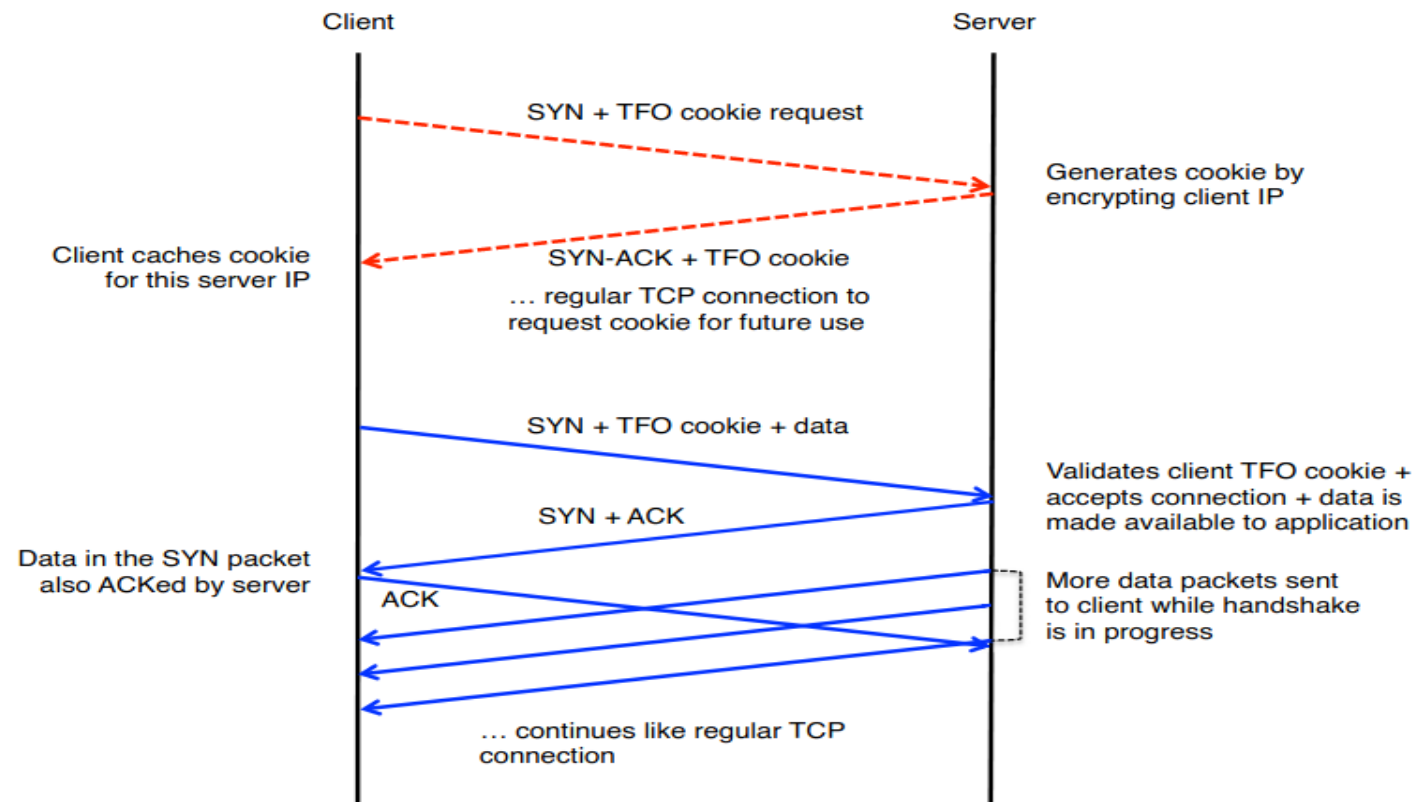
Performance of TFO over TCP

Page	RTT(ms)	PLT : non-TFO (s)	PLT : TFO (s)	Improv.
amazon.com	20	1.54	1.48	4%
	100	2.60	2.34	10%
	200	4.10	3.66	11%
nytimes.com	20	3.70	3.56	4%
	100	4.59	4.30	6%
	200	6.73	5.55	18%
wsj.com	20	5.74	5.48	5%
	100	7.08	6.60	7%
	200	9.46	8.47	11%
TCP wikipedia page	20	2.10	1.95	7%
	100	3.49	2.92	16%
	200	5.15	3.03	41%