

SCTP: An innovative transport layer protocol for the web

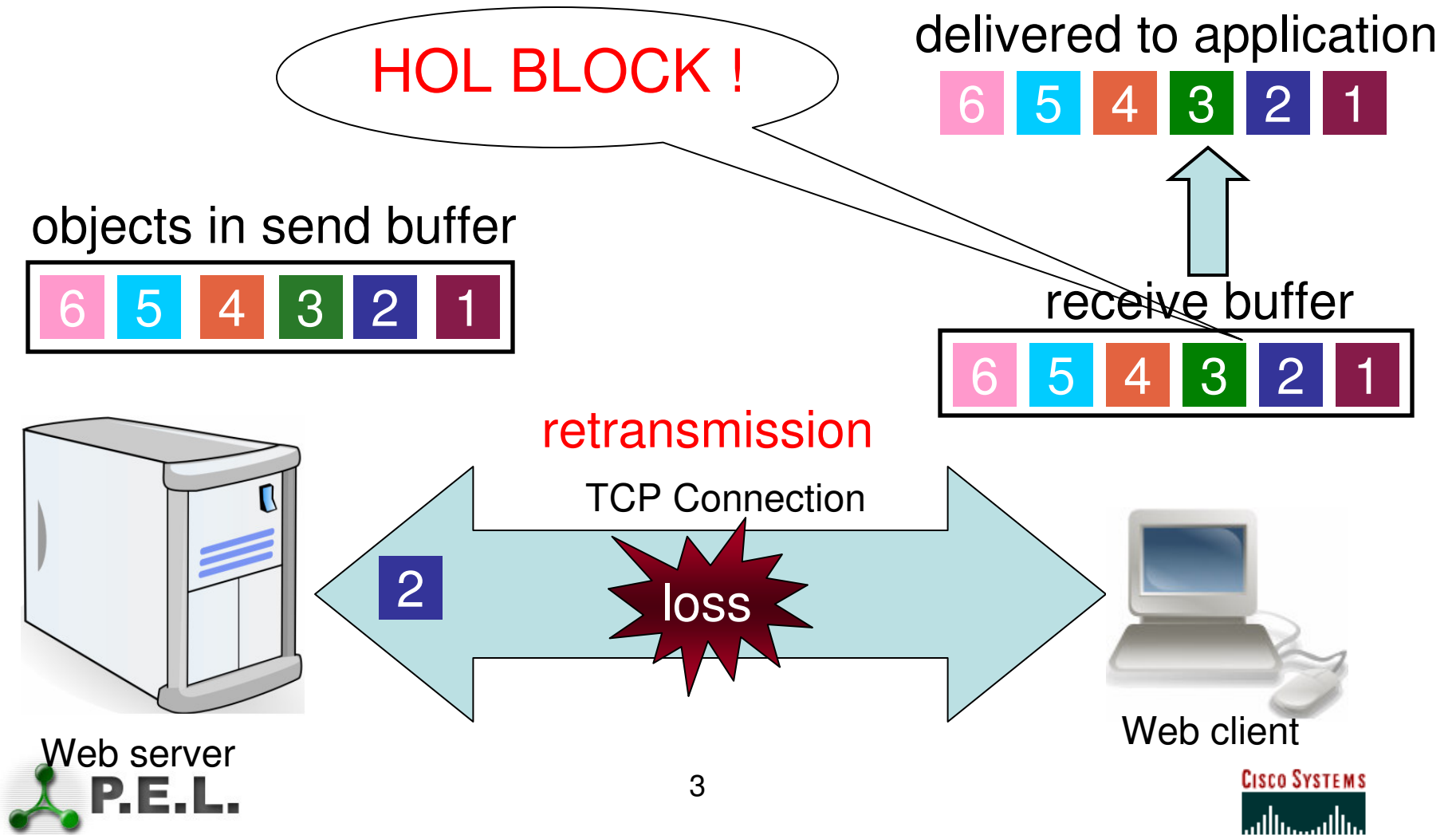
(Position paper)

P. Natarajan, J. Iyengar, P. Amer,
& R. Stewart

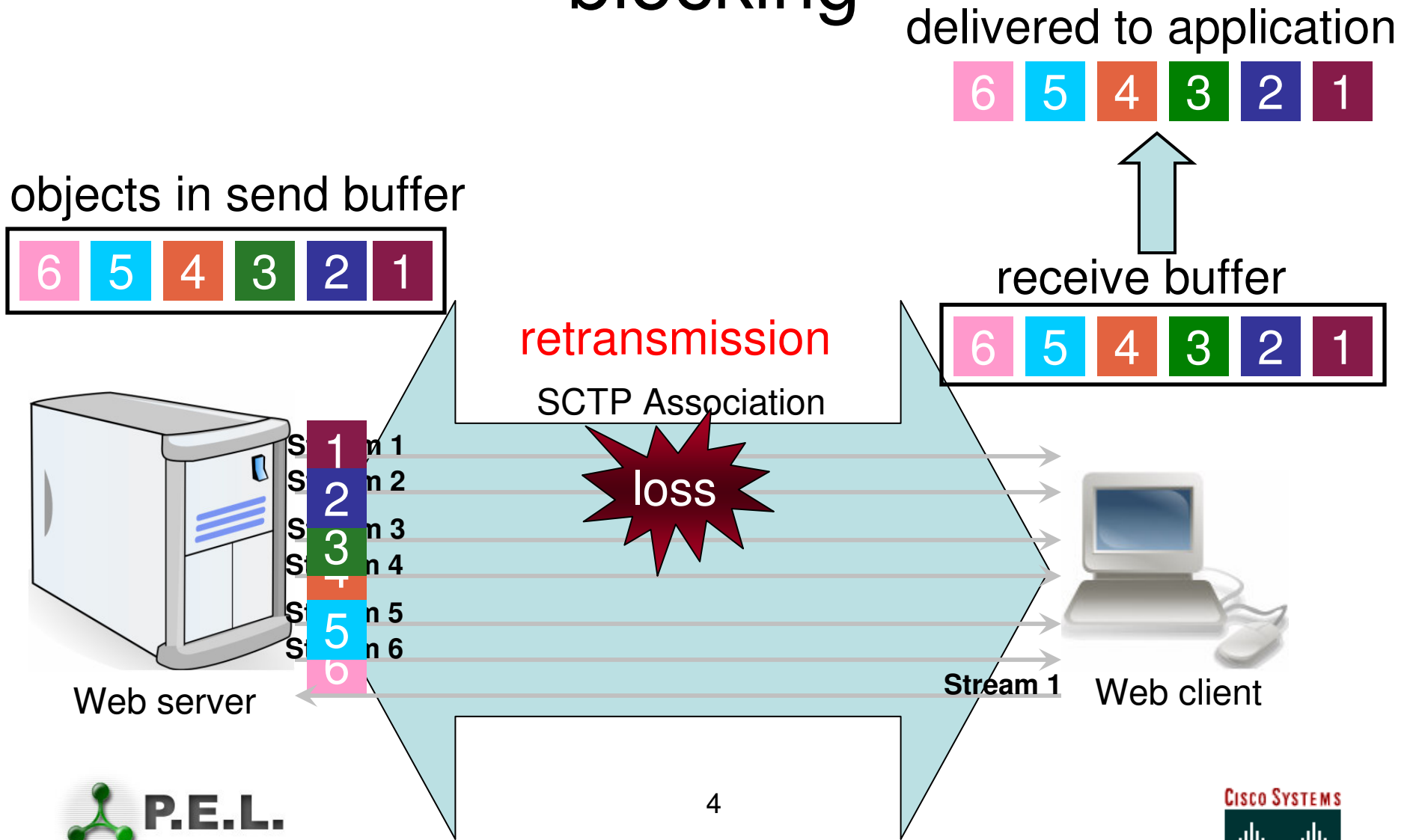
HTTP over TCP

- Transmission Control Protocol (TCP) has been the default transport for HTTP.
- HTTP/TCP Concerns
 - Head-of-line (HOL) blocking
 - Vulnerability to network failures
 - Vulnerability to SYN DoS attacks

HOL blocking in TCP



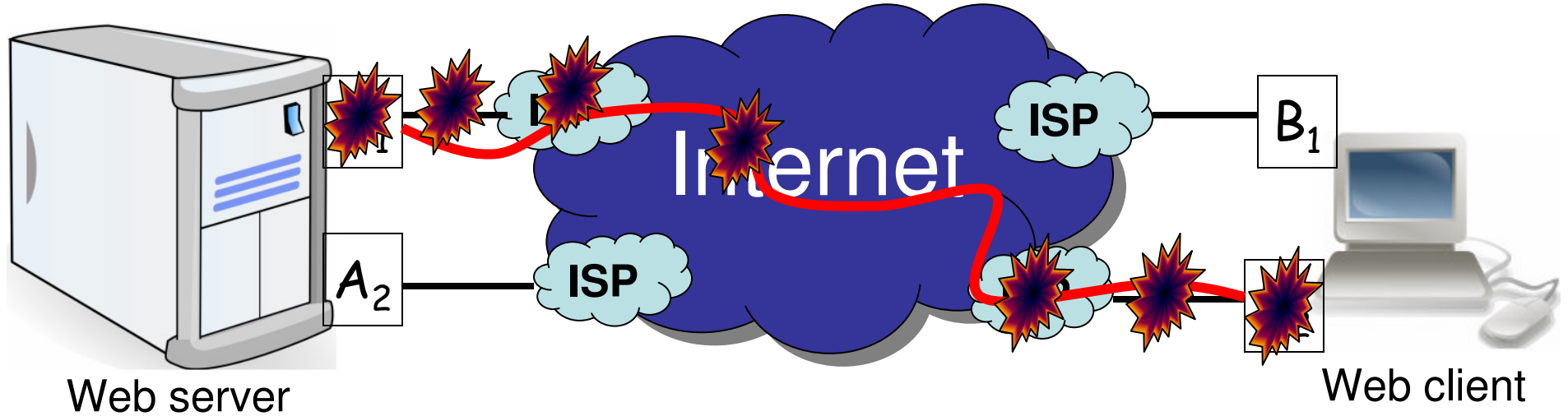
SCTP multistreaming avoid HOL blocking



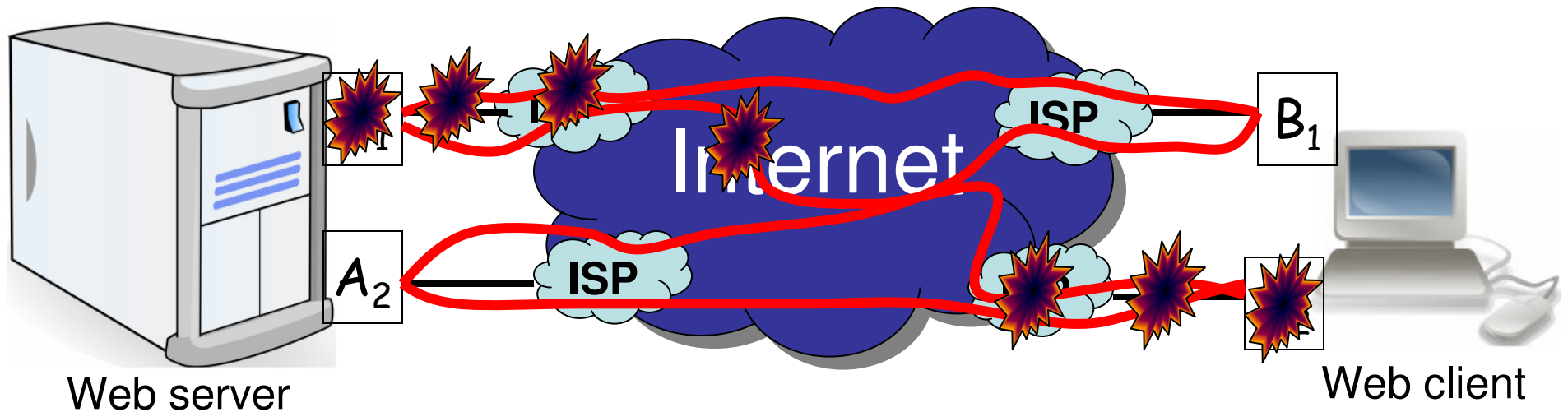
TCP work-around to mitigate HOL blocking

- How?
 - Multiple persistent TCP connections to transfer independent web objects
- Problems
 - Possible HOL blocking within one TCP connection
 - No shared sequence space => Less robust to loss detection and recovery
 - Increased load on web server
 - Increased connection establishment latency during SYN losses.
 - Aggressive behavior during congestion

TCP: Network fault-(In)tolerance

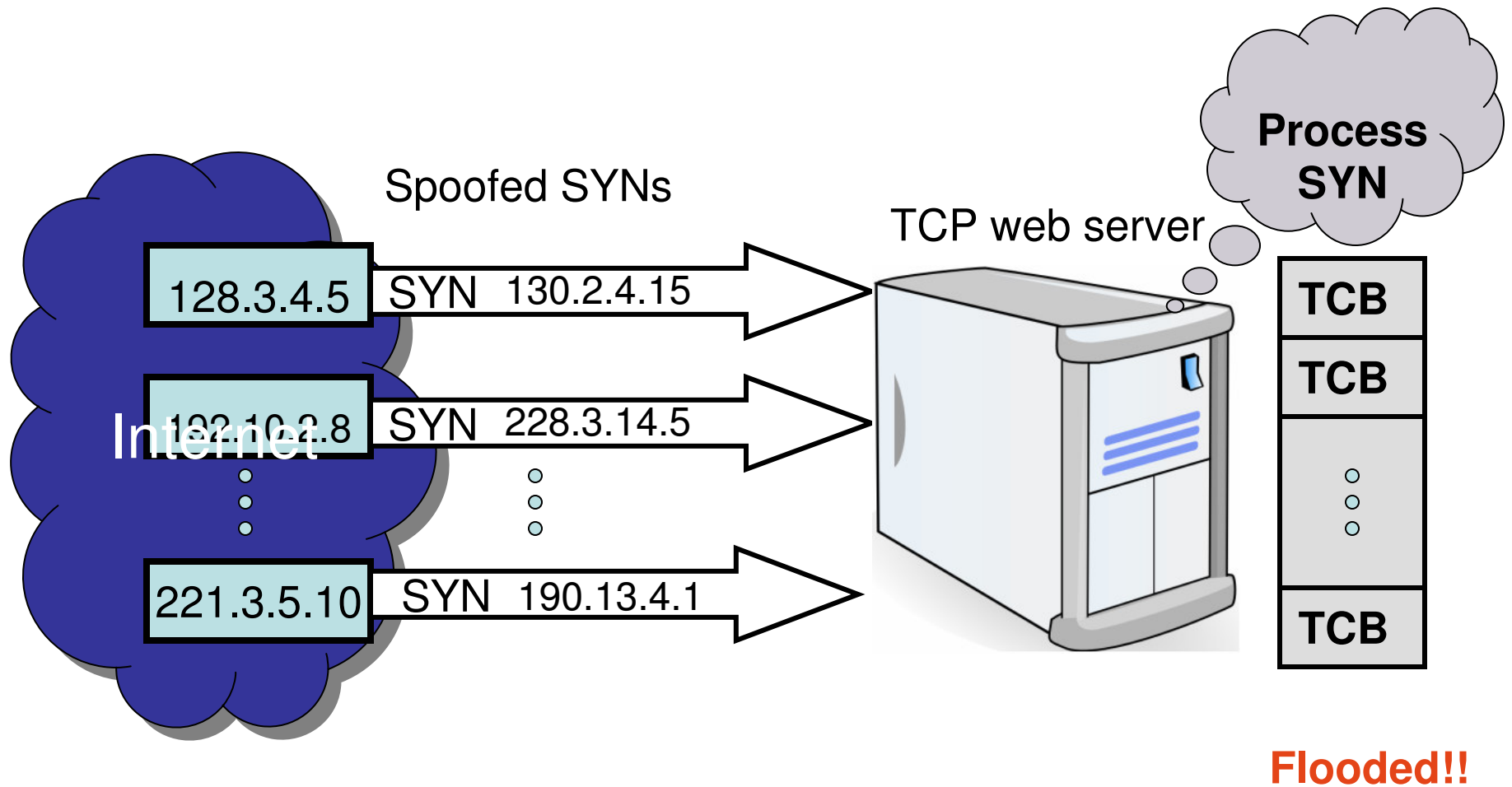


SCTP: Transport layer multihoming

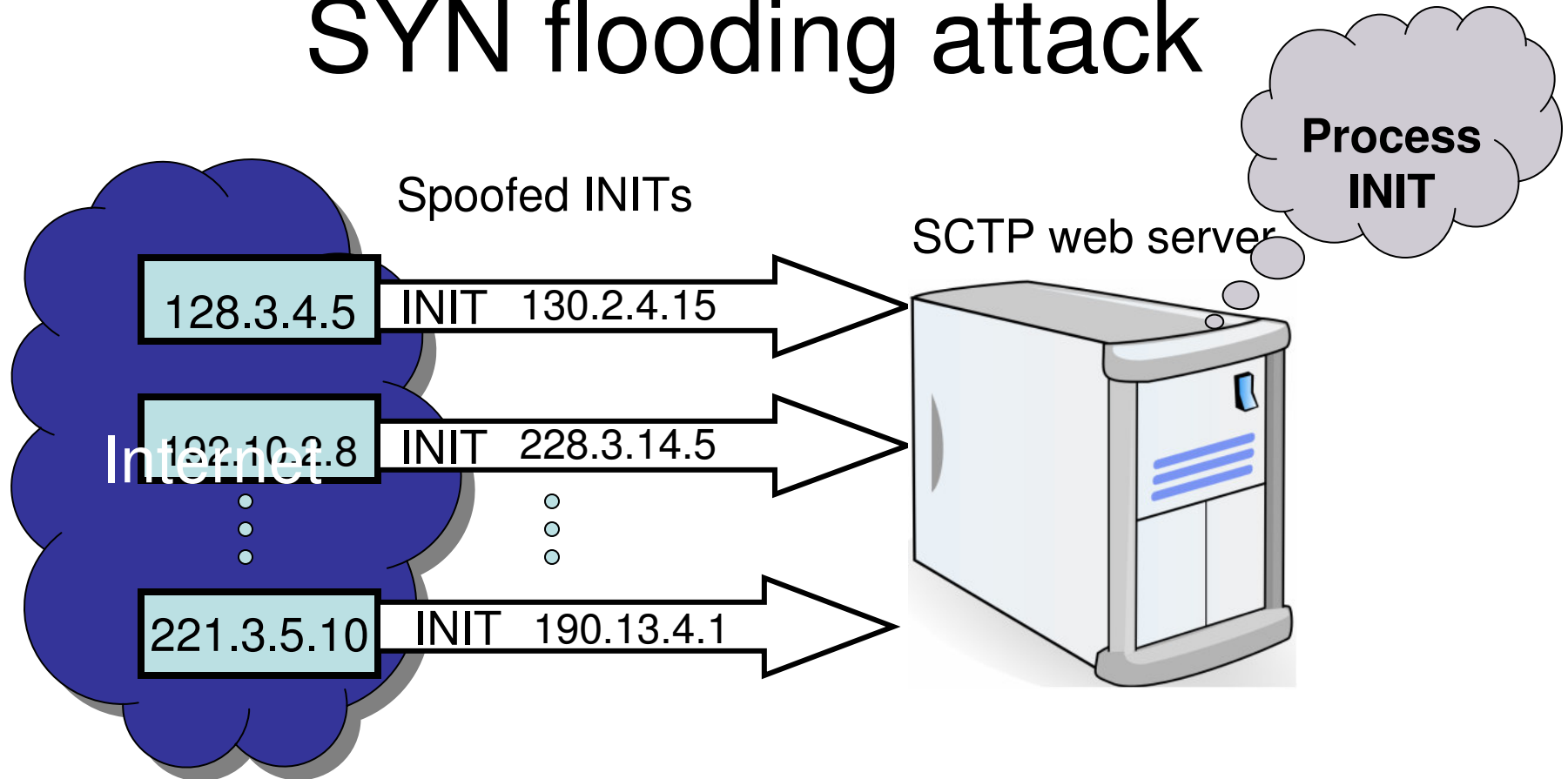


SCTP Association: $(\{A_1, A_2\}, \{B_1, B_2\})$
SCTP Failure Detection & Failover

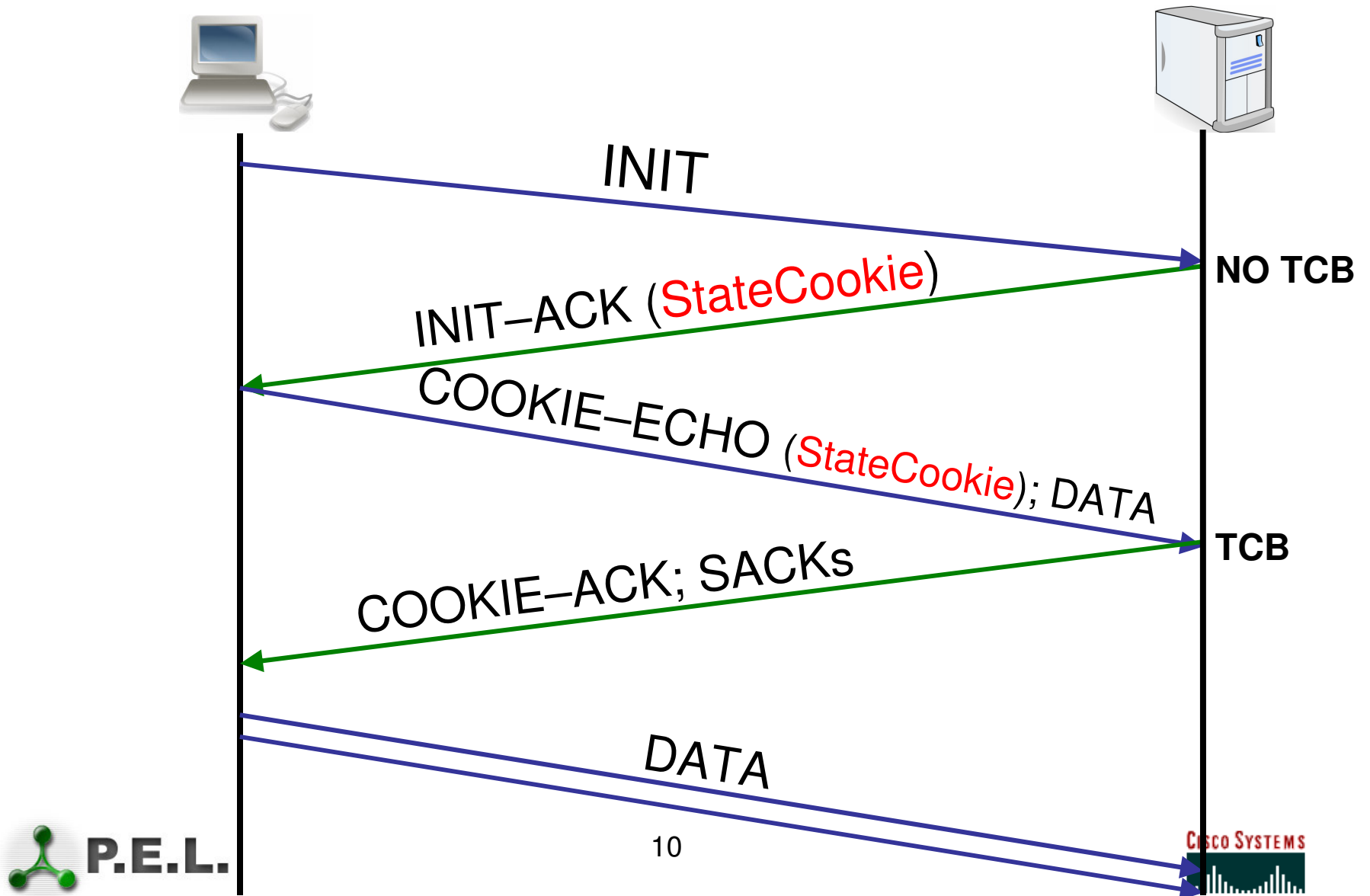
TCP SYN Flooding Attack



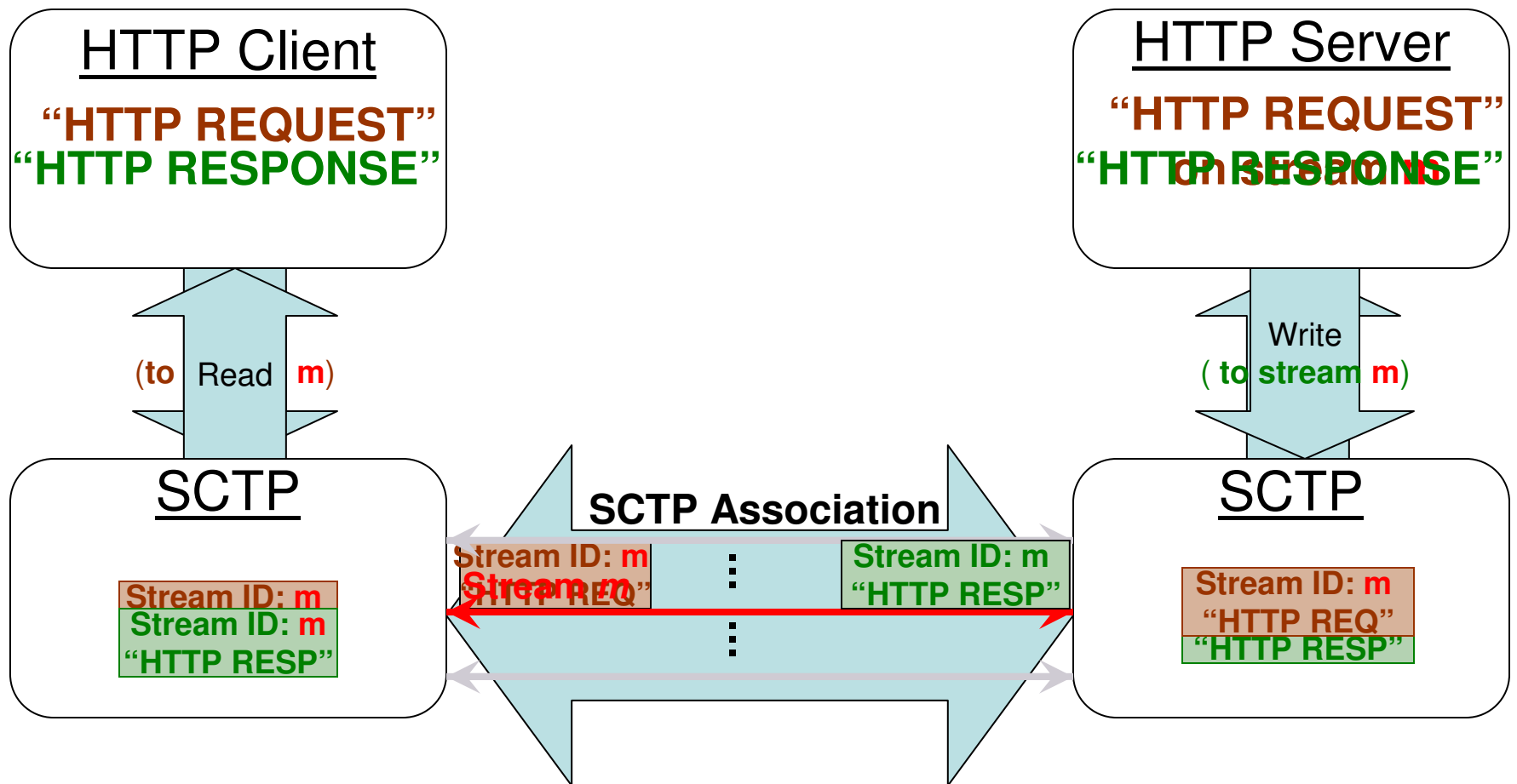
SCTP Association setup avoids SYN flooding attack



SCTP: Four-way Association setup

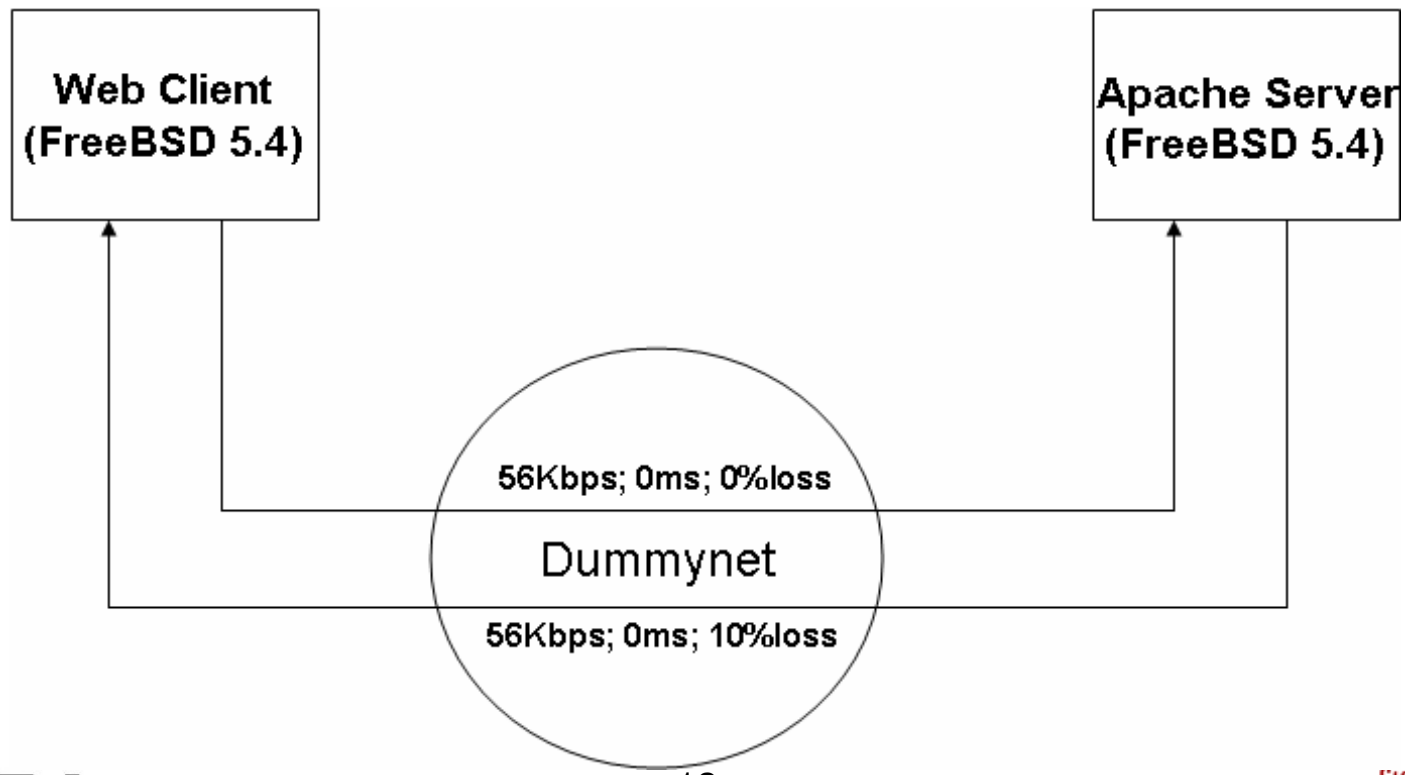


HTTP/SCTP streams: Design

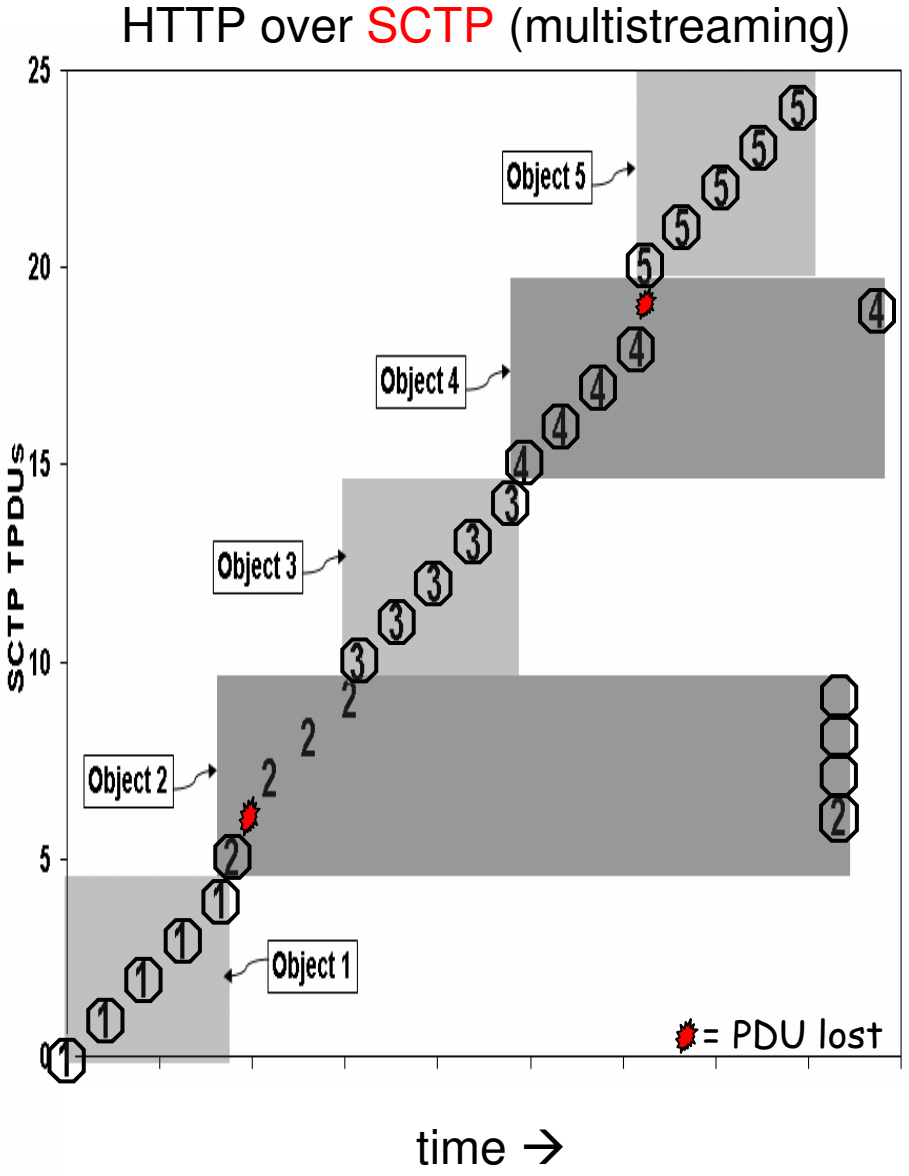
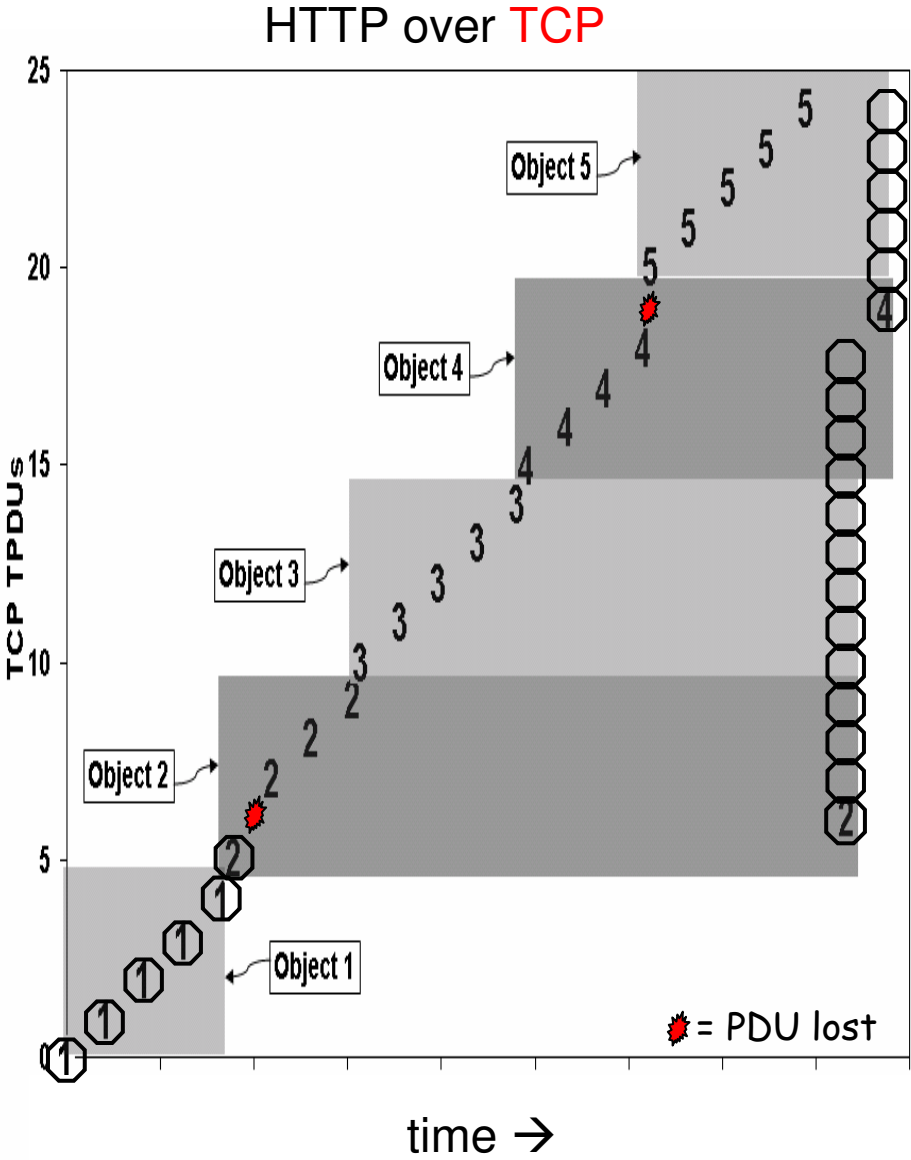


HTTP/SCTP Implementation

- Apache 2.0.55
- Firefox 1.6a



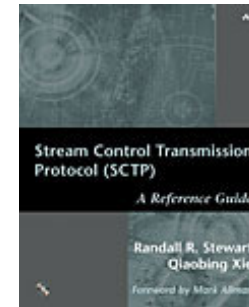
It Works !



Other SCTP features

- Preservation of Message Boundaries
- Partial Reliability Extension (PR-SCTP)
 - Timed reliability: Attempt for reliable transmission only within a time period.
 - Example: Online game client use PR-SCTP to transmit player's coordinates. Old coordinates discarded when newer ones available.
- Unordered data delivery
 - 1 SCTP association to transmit both ordered and unordered data
 - Vs. UDP: Unordered data transmitted **reliably**.
- SCTP shim layer
 - Between application and transport layer.
 - No code change to app. Transparently converts app's TCP calls to corresponding SCTP calls.

Current status



- **Home: IETF TSVWG (Transport Services Working Group)**

- IETF recognizes broader scope
- Proposed Standard - RFC2960

Interops (8)	Date	#Impl
Munich	6/00	12
Research Triangle Park	10/00	22
Sophia Antipolis	4/01	19
San Jose (Connectathon)	2/02	6
U of Essen (Germany)	9/02	20
U of Delaware	6/03	11
U of Muenster (Germany)	7/04	14
Vancouver	8/06	??

- **Supported by industry:**

- **Participation in Inerops:** ADAX - Cisco - HP/Compaq - Data Connection - DataKinetics - Ericsson - Hughes Software - IBM - Motorola - Netbricks - Nokia - Open SS7 - Performance Technologies - RadiSys - Siemens - Artesan - Sun Microsystems - Telesoft Technologies - Toshiba - Ulticom – Wipro
- **Implementations:** AIX, FreeBSD, NetBSD, DragonFly BSD, Linux, QNX, Solaris, True64, IOS (Cisco Routers), Mac OS, Windows (user space), more...



References - RFCs

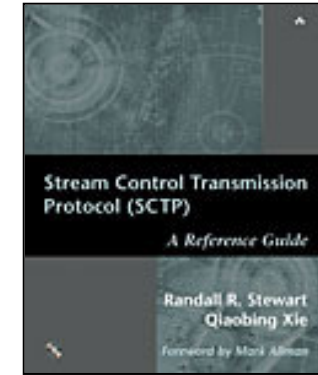
- RFC 2960 – Stream Control Transmission Protocol
- RFC 3257 – SCTP Applicability Statement
- RFC 3286 – An introduction to SCTP
- RFC 3309 – SCTP Checksum Change
- RFC 3436 – Transport Layer Security over SCTP
- RFC 3554 – On the Use of SCTP with IPsec
- RFC 3758 – SCTP Partial Reliability Extension
- RFC 4460 – SCTP Specification Errata and Issues

References – Internet Drafts

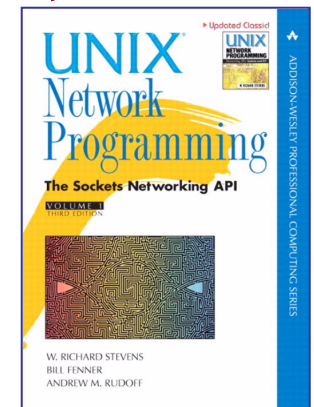
- SCTP (BIS)
 - draft-ietf-tsvwg-2960bis-01.txt
- Sockets API Extensions for SCTP
 - draft-ietf-tsvwg-sctpsocket-12.txt
- SCTP Dynamic Address Reconfiguration ([Add-IP](#))
 - draft-ietf-tsvwg-addip-sctp-14.txt
- SCTP Packet Drop Reporting ([Pkt-Drop](#))
 - draft-stewart-sctp-pktdrprep-04.txt
- Authenticated Chunks for SCTP ([Auth](#))
 - draft-tuexen-sctp-auth-chunk-02.txt

References - Books

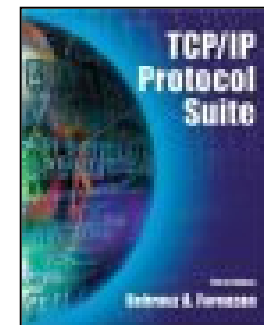
- **Stream Control Transmission Protocol (SCTP); A Reference Guide**, Randall R. Stewart, Qiaobing Xie, Addison Wesley, 2002, ISBN 0-201-72186-4



- **UNIX Network Programming; The Sockets Networking API, Vol. 1, 3rd ed**, W. Richard Stevens, Bill Fenner, Andrew M. Rudoff, Addison-Wesley, 2004, ISBN 0-13-141155-1
 - chapter 2: The Transport Layer: TCP, UDP, and SCTP
 - chapter 9: Elementary SCTP Sockets
 - chapter 10: SCTP Client/Server Example
 - chapter 23: Advanced SCTP Sockets



- **TCP/IP Protocol Suite, 3rd ed**, Behrouz A. Forouzan. McGraw Hill, 2006, ISBN 0-07-296772-2
 - chapter 13: SCTP



References - Papers

- Caro Jr. et al, “[SCTP: A Proposed Standard for Robust Internet Data Transport](#)”, IEEE Computer 36(11), 11/03
- Stewart & Amer, [Internet Society Brief 17](#)
- Univ of Delaware Protocol Engineering Lab ([PEL](#))

References – Online

- <http://www.sctp.org>
 - Also reachable with HTTP over SCTP!
- <http://www.ietf.org/html.charters/tsvwg-charter.html>
 - All current work on SCTP is done in the IETF TSVWG
- [sctp-impl](mailto:sctp-impl@mailer.cisco.com) on mailer.cisco.com
 - Note for Cisco audience: this is an external list

Questions