

# SCTP: An innovative transport layer protocol for the web

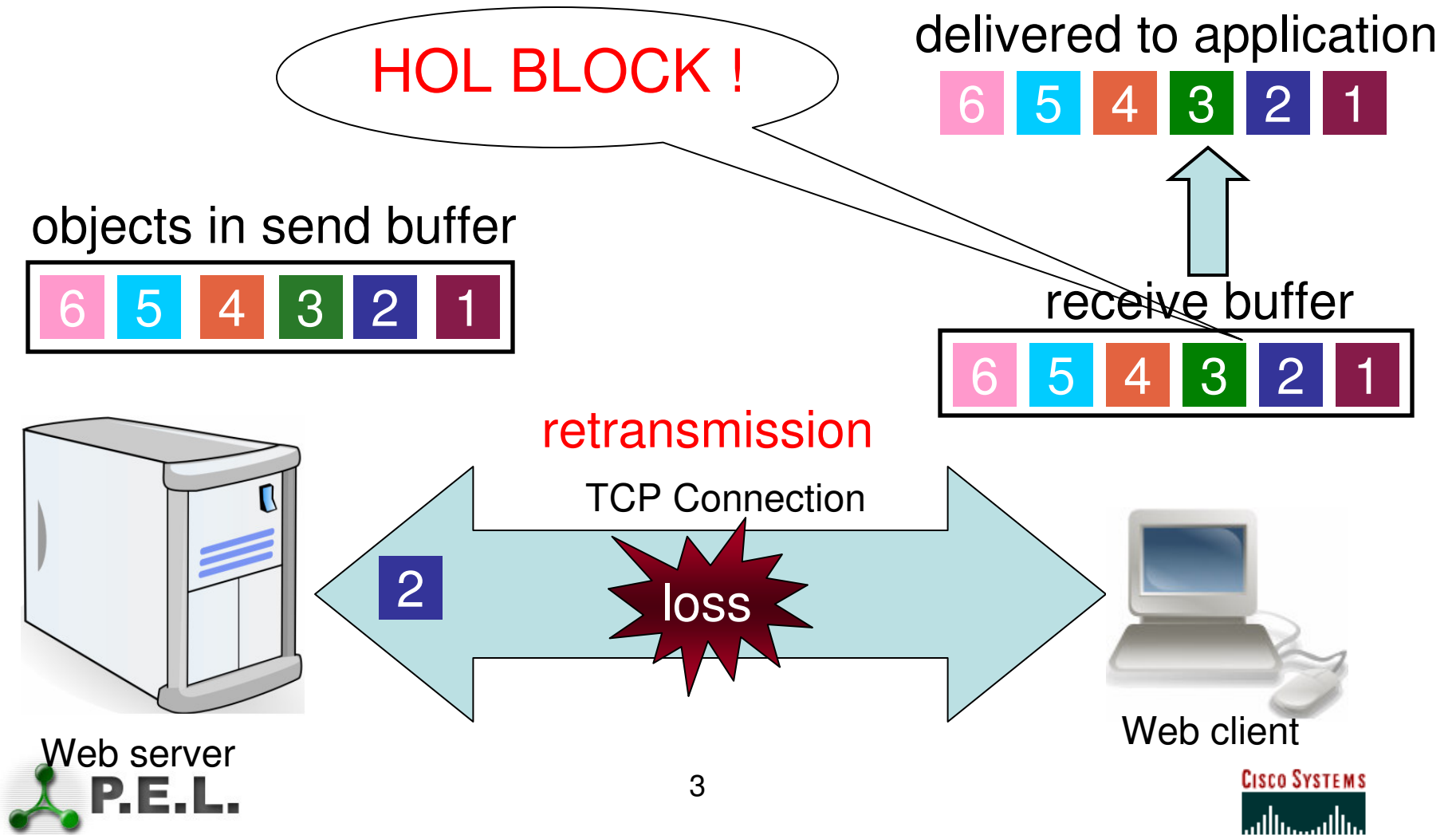
(Position paper)

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

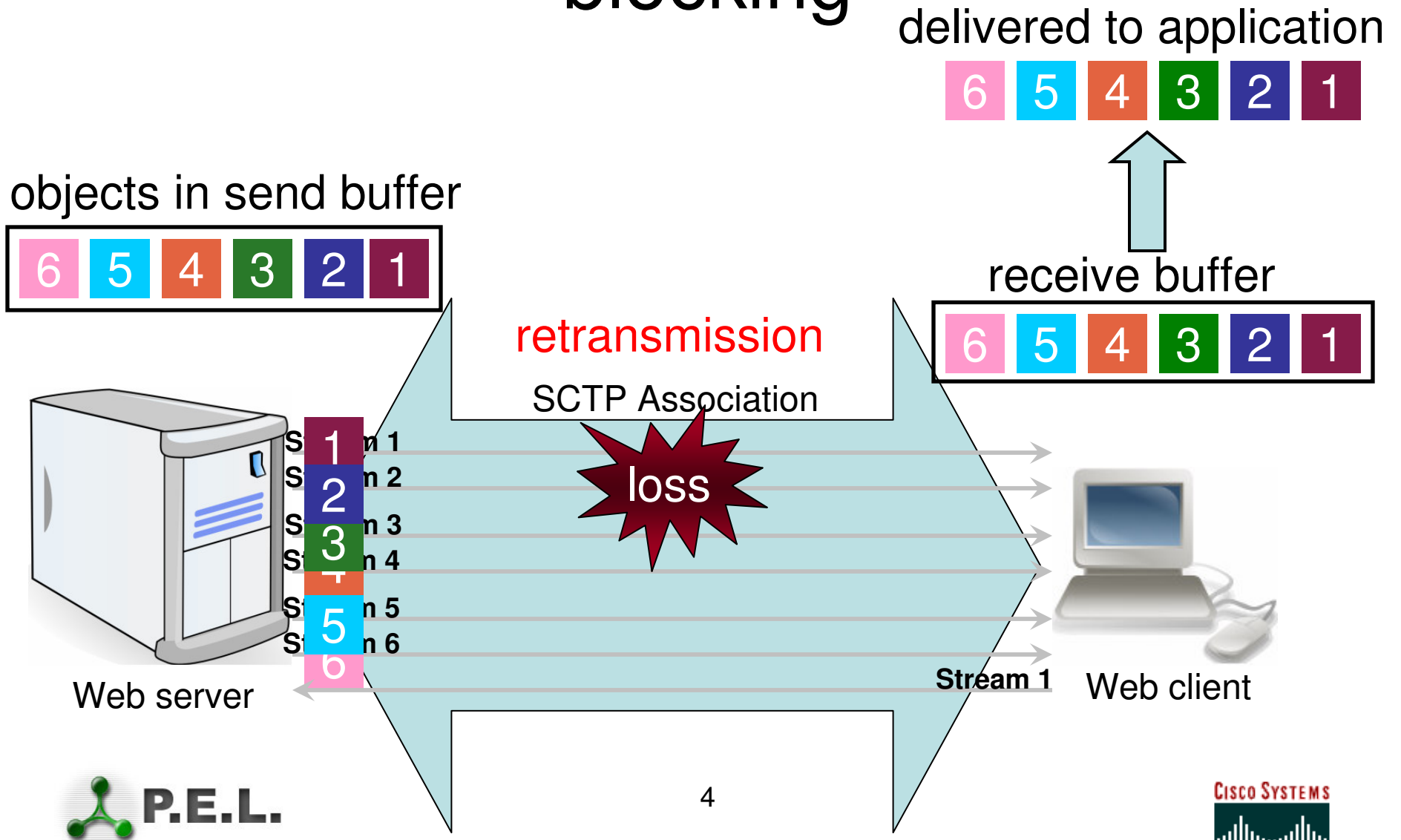
# HTTP over TCP

- 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



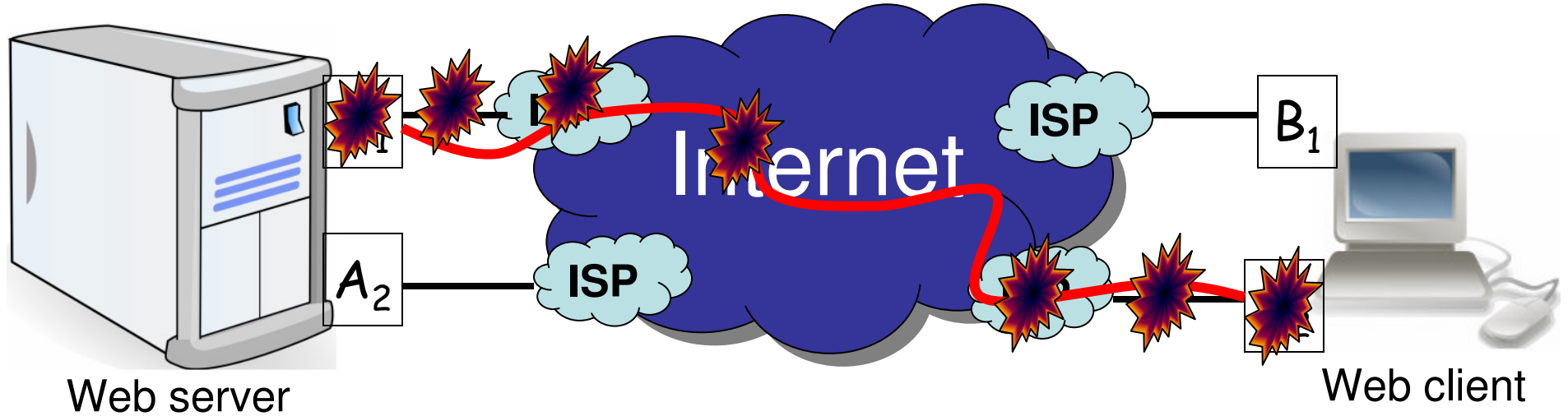
# SCTP multistreaming avoid HOL blocking



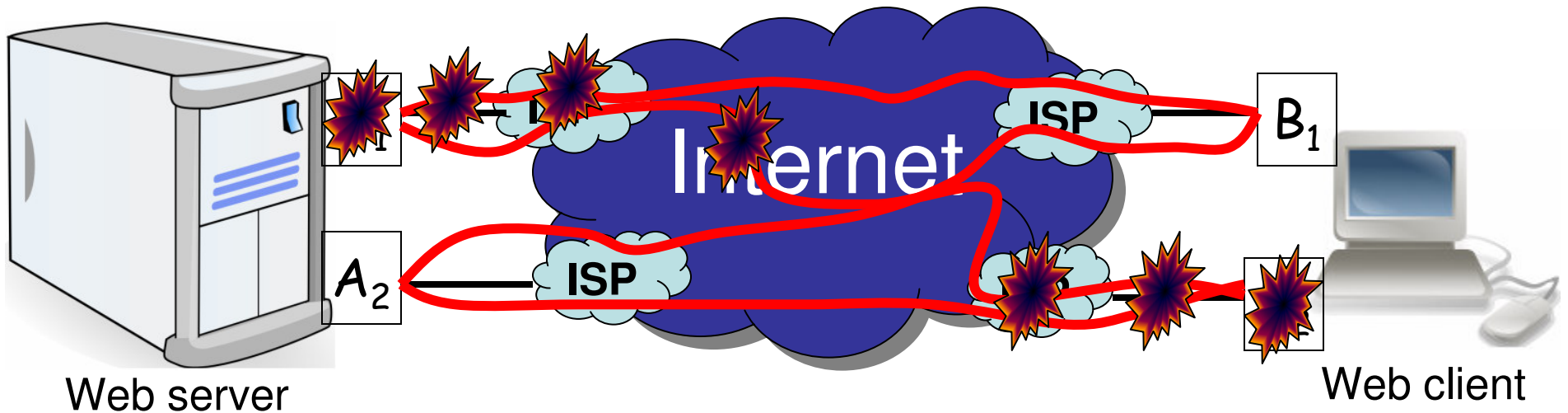
# TCP work-around to mitigate HOL blocking

- 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

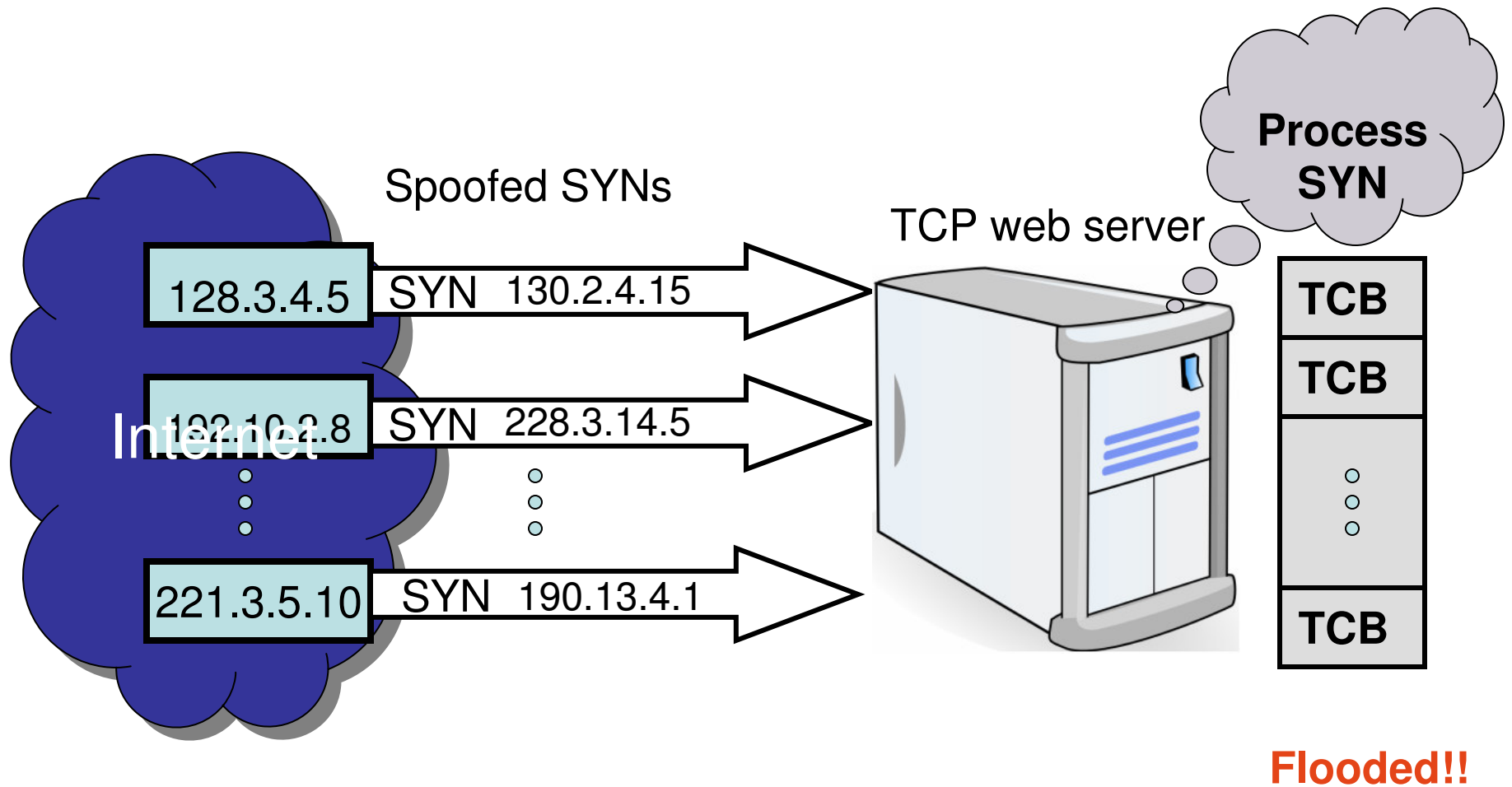


# SCTP: Transport layer multihoming



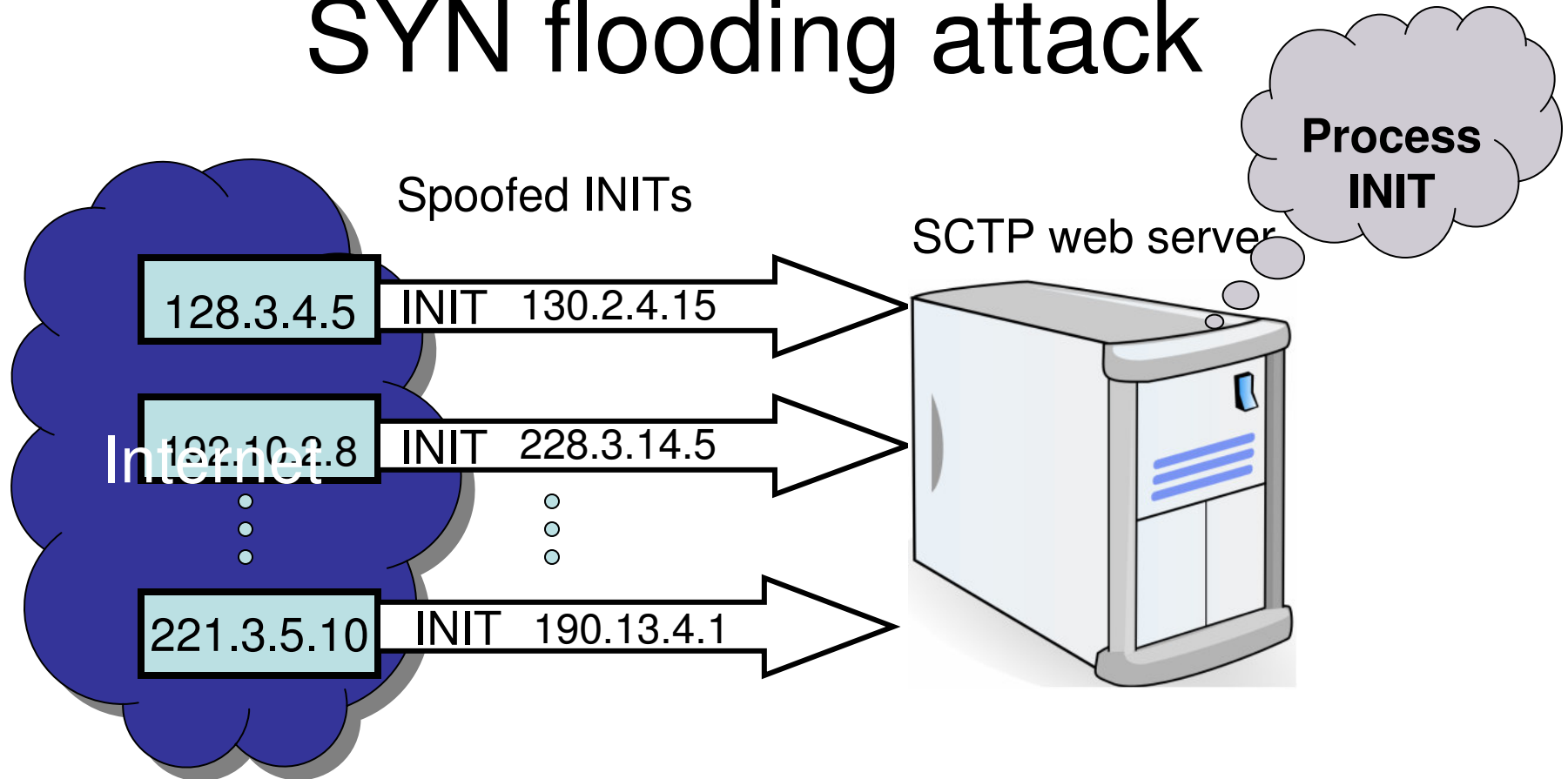
SCTP Association:  $(\{A_1, A_2\}, \{B_1, B_2\})$   
SCTP Failure Detection & Failover

# TCP SYN Flooding Attack

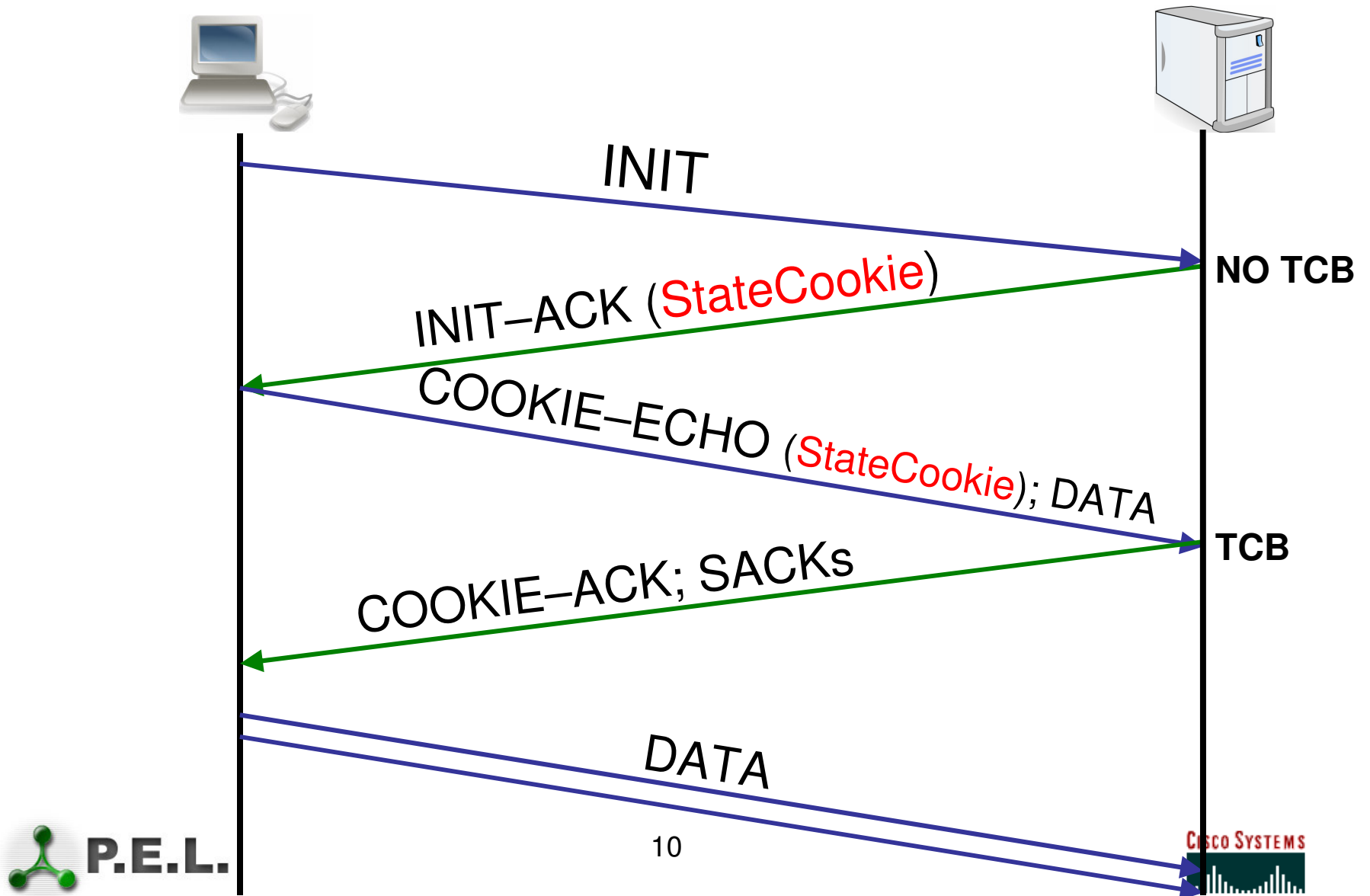




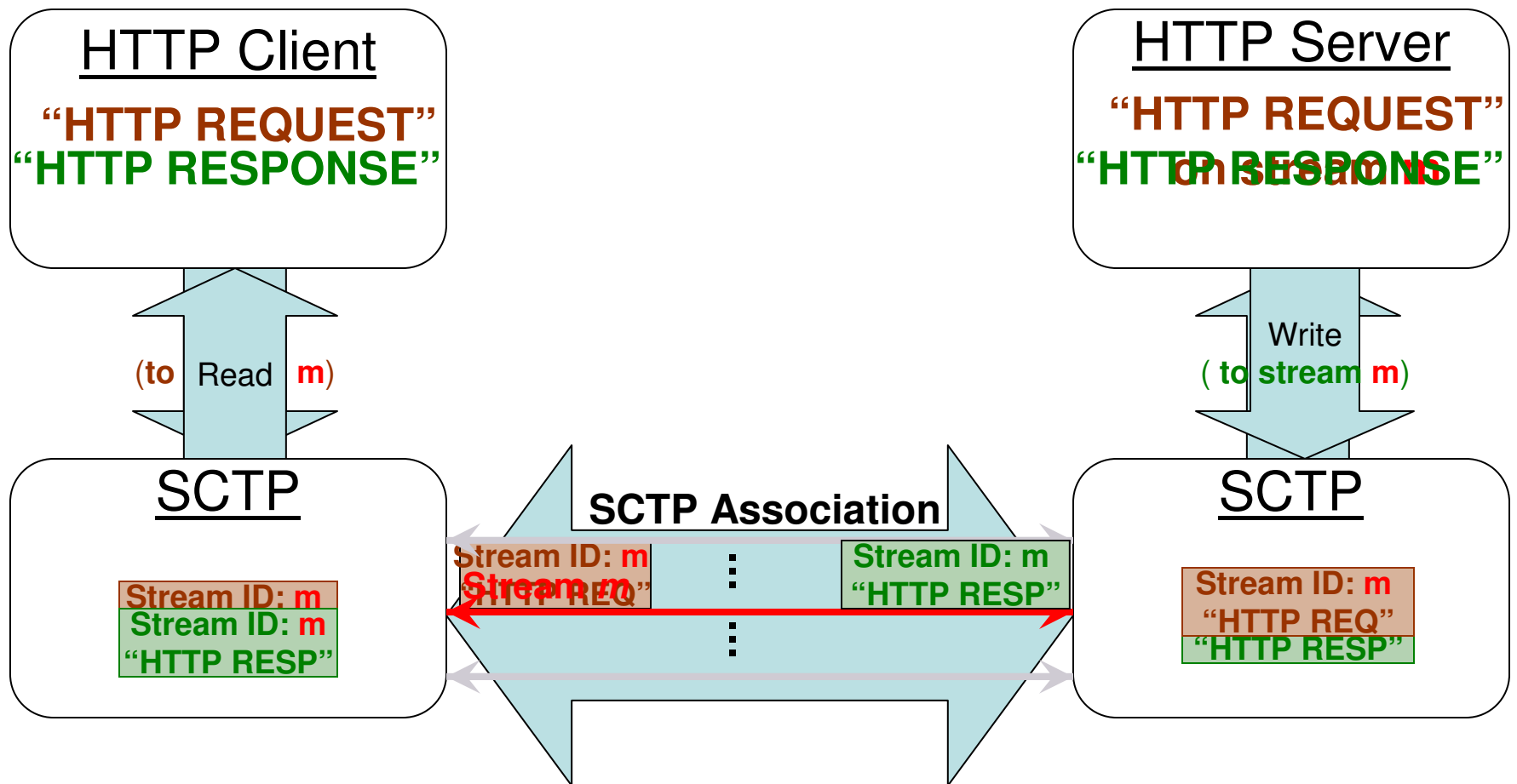
# SCTP Association setup avoids SYN flooding attack



# SCTP: Four-way Association setup

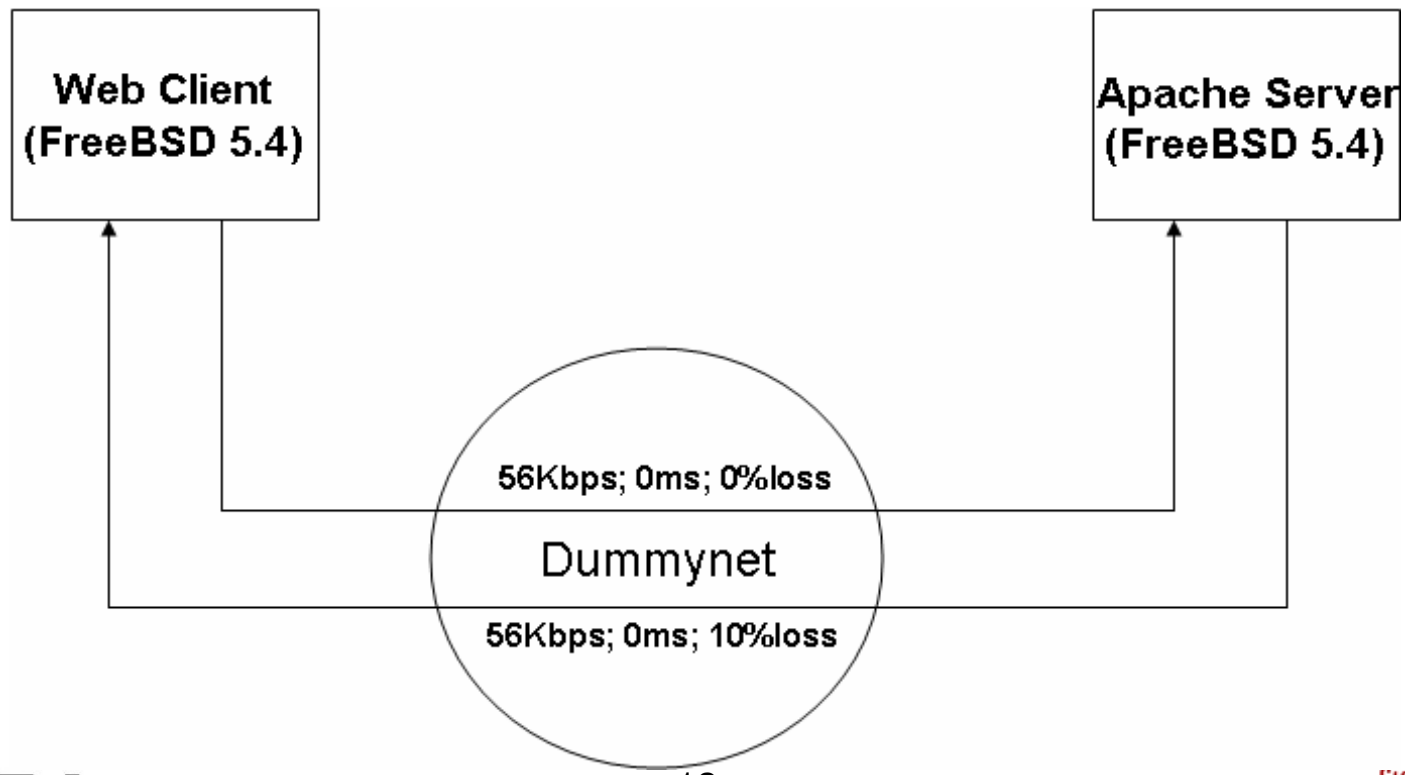


# HTTP/SCTP streams: Design

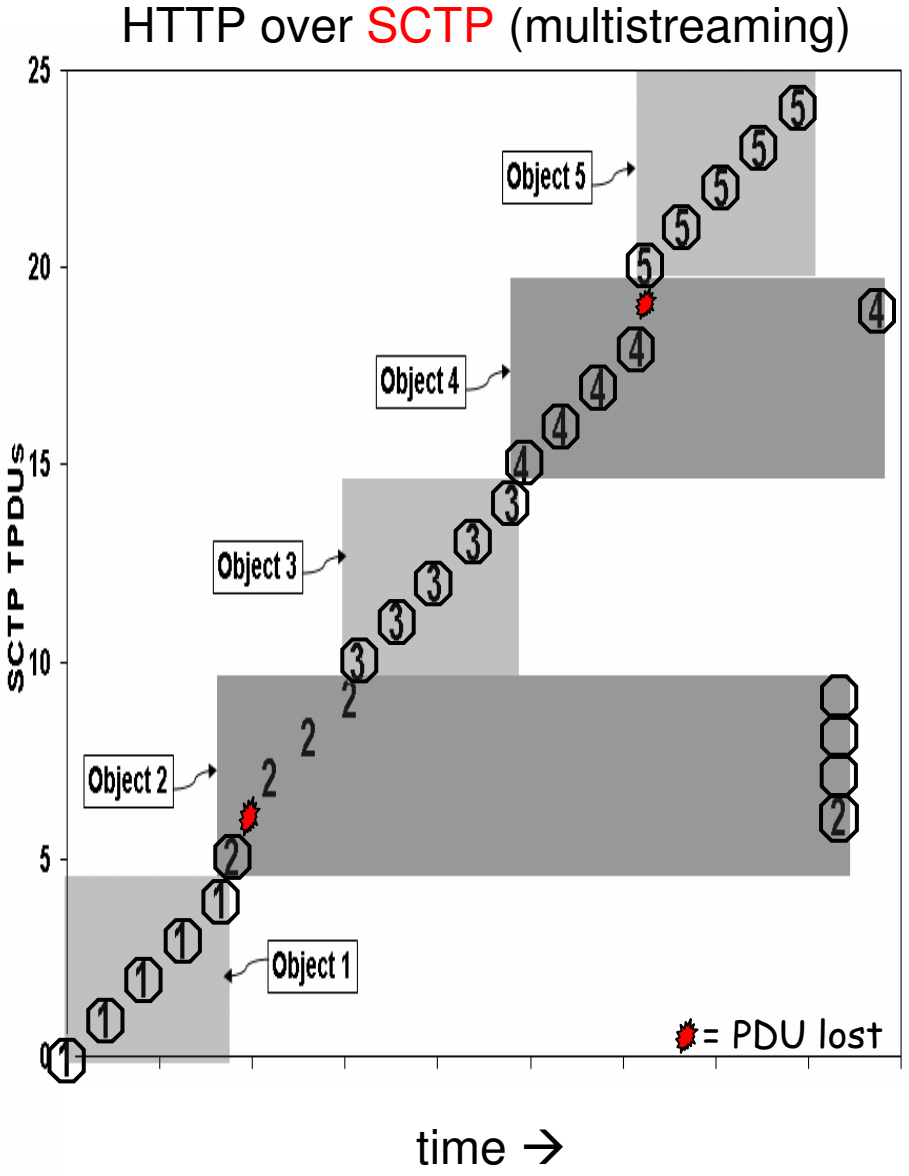
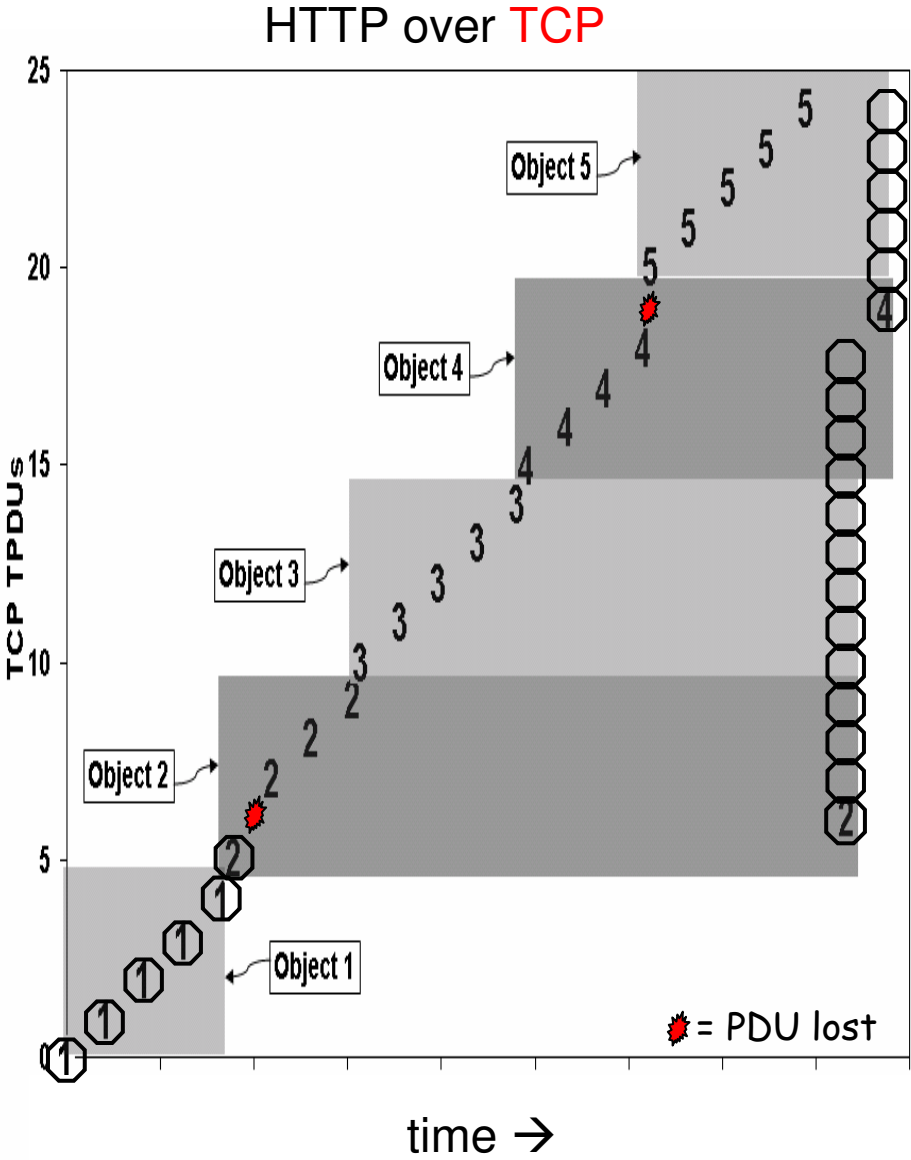


# HTTP/SCTP Implementation

- Apache 2.0.55
- Firefox 1.6a



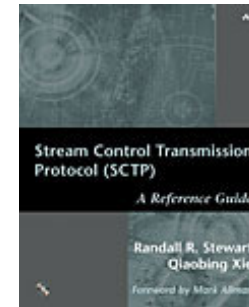
# It Works !



# 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

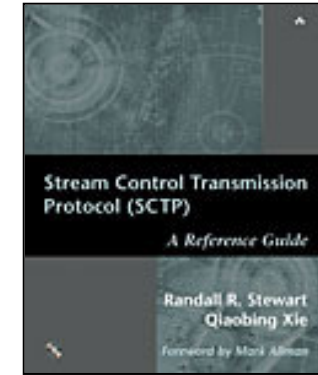


# References – Internet Drafts

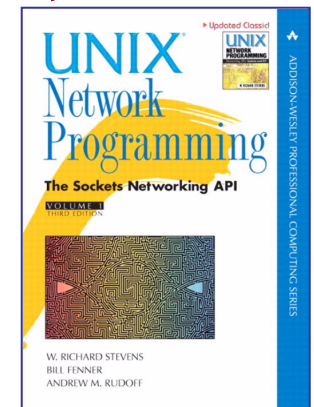
- SCTP (BIS)
  - draft-ietf-tsvwg-2960bis-01.txt
- Sockets API Extensions for SCTP
  - draft-ietf-tsvwg-sctpsocket-12.txt
- SCTP Dynamic Address Reconfiguration ([Add-IP](#))
  - draft-ietf-tsvwg-addip-sctp-14.txt
- SCTP Packet Drop Reporting ([Pkt-Drop](#))
  - draft-stewart-sctp-pktdrprep-04.txt
-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

# References - Books

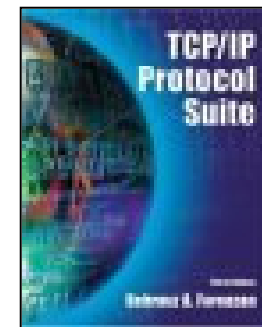
- **Stream Control Transmission Protocol (SCTP); A Reference Guide**, Randall R. Stewart, Qiaobing Xie, Addison Wesley, 2002, ISBN 0-201-72186-4



- **UNIX Network Programming; The Sockets Networking API, Vol. 1, 3<sup>rd</sup> 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, 3<sup>rd</sup> 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](mailto:mailer.cisco.com)
  - Note for Cisco audience: this is an external list

# Questions