Chapter 13

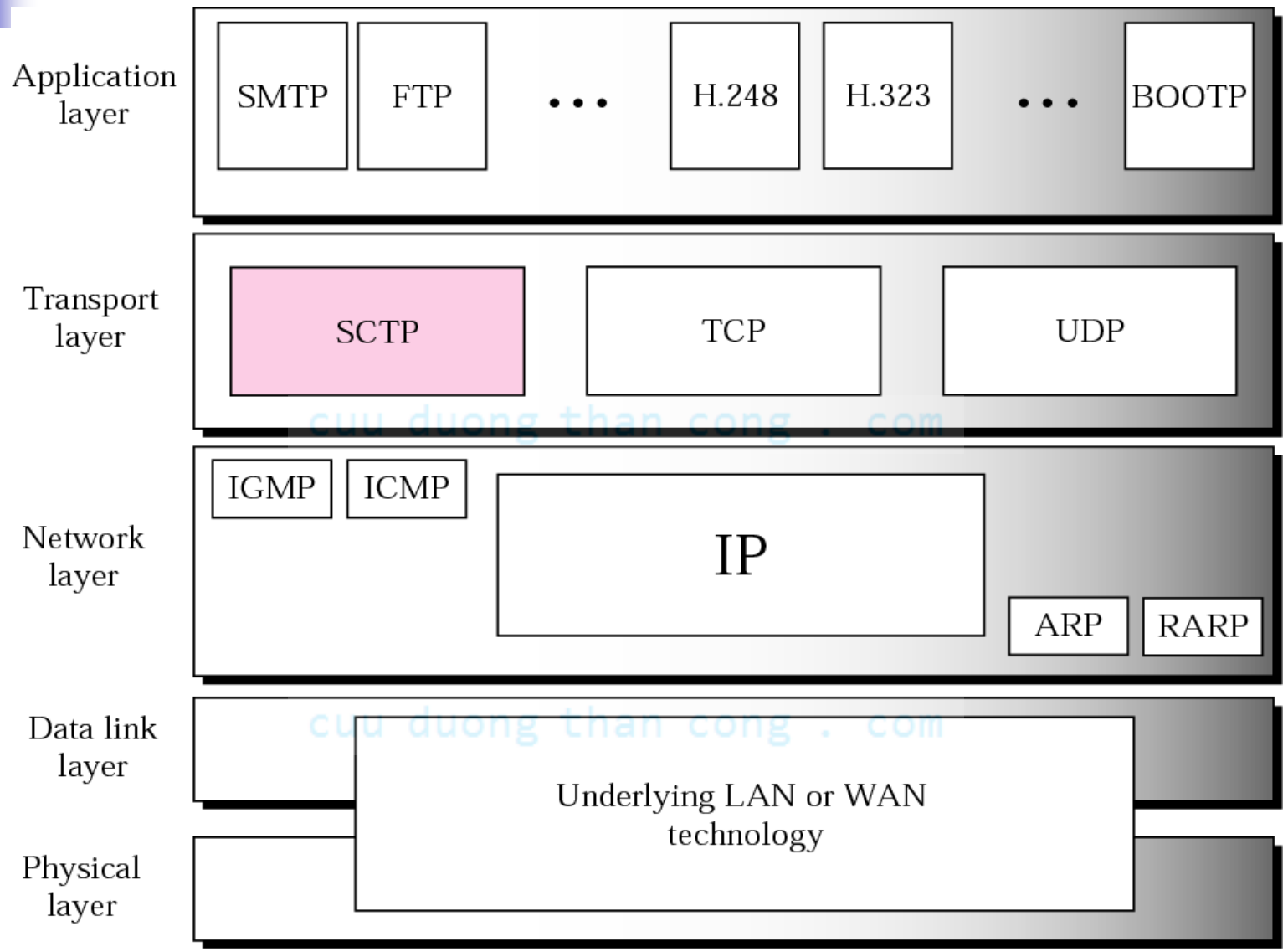
Stream Control Transmission Protocol

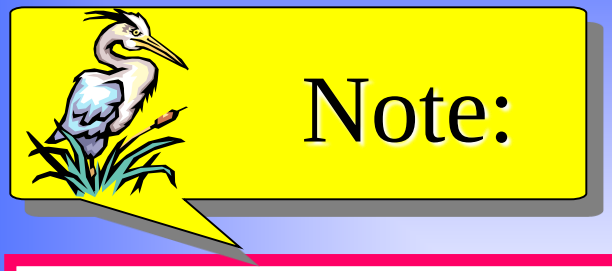
Objectives

Upon completion you will be able to:

- *Be able to name and understand the services offered by SCTP*
- *Understand SCTP's flow and error control and congestion control*
- *Be familiar with the fields in a SCTP segment*
- *Understand the phases in an SCTP association*
- *Understand the SCTP state transition diagram*

Figure 13.1 *TCP/IP protocol suite*





SCTP is a message-oriented, reliable protocol that combines the good features of UDP and TCP.

13.1 SCTP SERVICES

We explain the services offered by SCTP to the application layer processes.

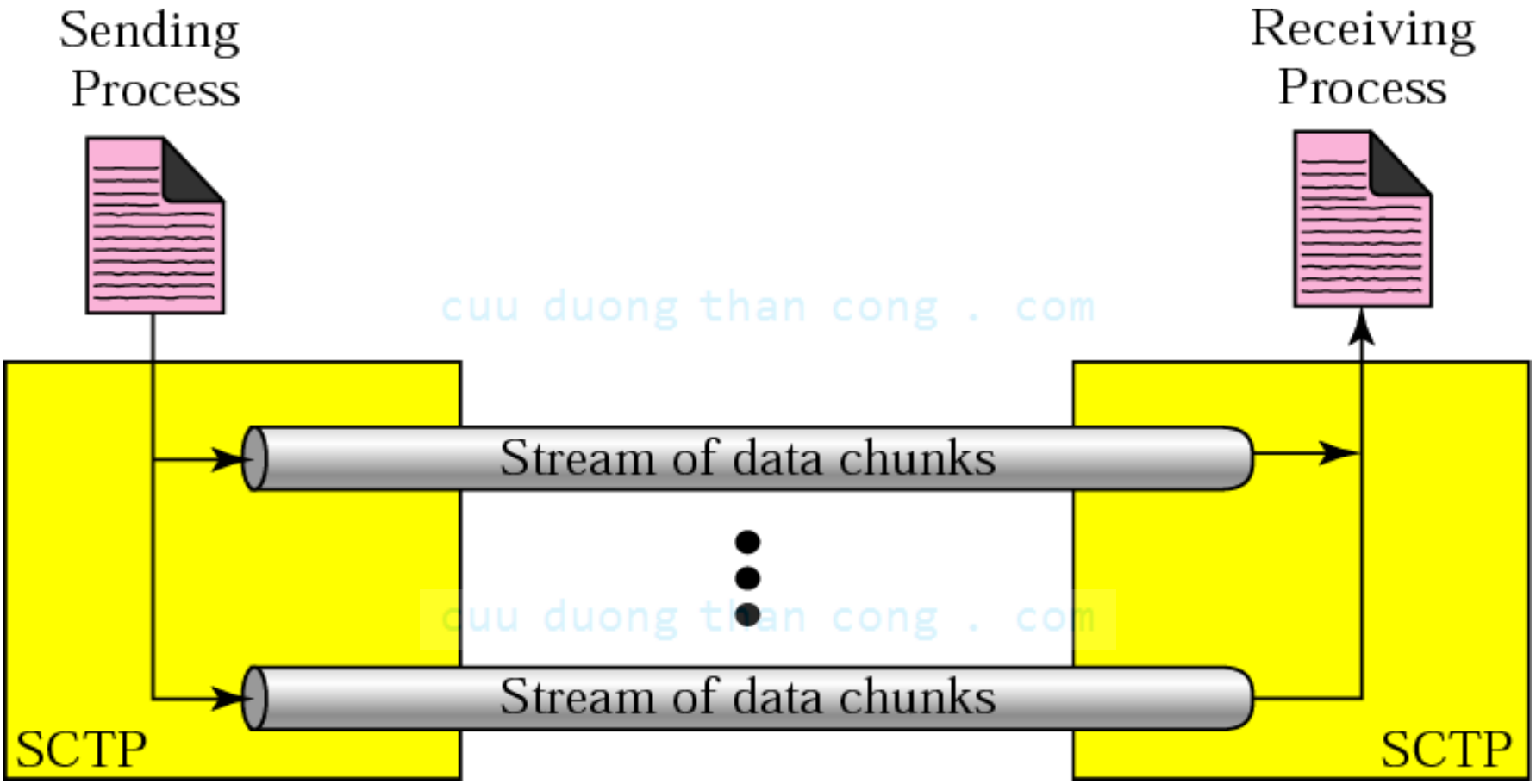
The topics discussed in this section include:

Process-to-Process Communication
Multiple Streams
Multihoming
Full-Duplex Communication
Connection-Oriented Service
Reliable Service

Table 13.1 Some SCTP applications

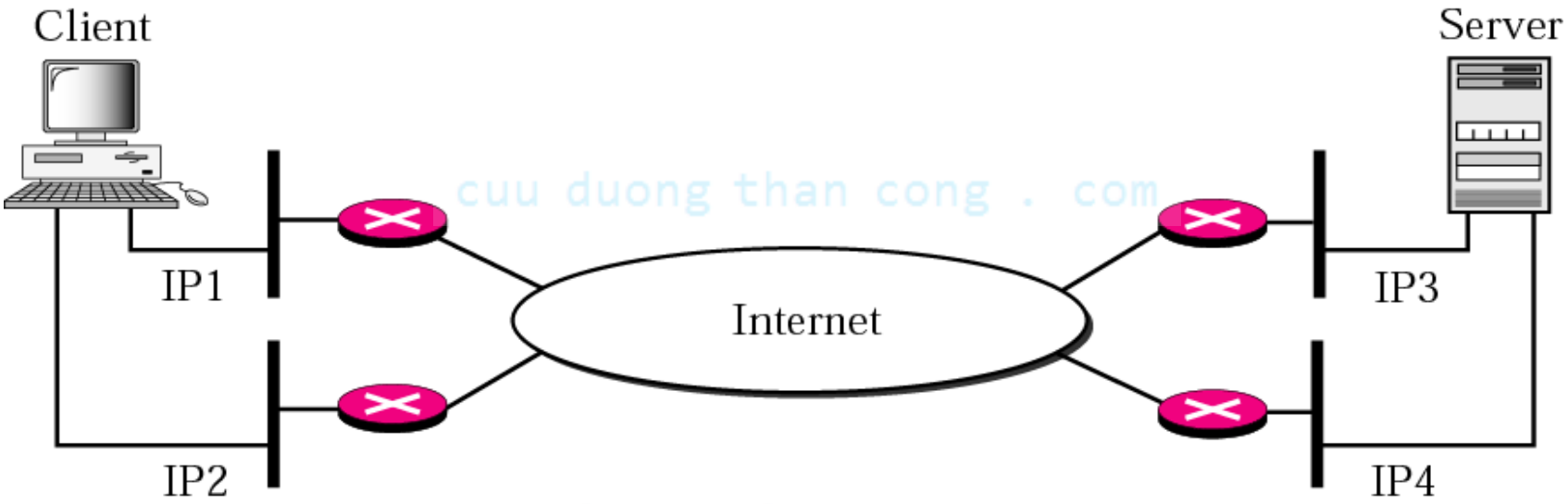
Protocol	*Port Number*	*Description*
IUA	9990	ISDN over IP
M2UA	2904	SS7 telephony signalling
M3UA	2905	SS7 telephony signalling
H.248	2945	Media gateway control
H.323	1718, 1719, 1720, 11720	IP telephony
SIP	5060	IP telephony

Figure 13.2 *Multiple-stream concept*



An association in SCTP can involve multiple streams.

Figure 13.3 *Multihoming concept*



SCTP association allows multiple IP addresses for each end.

13.2 SCTP FEATURES

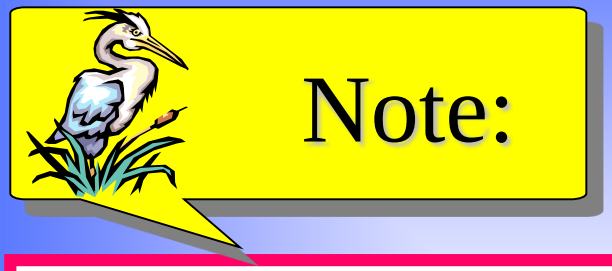
We discuss the general features of SCTP and then compare them with those of TCP.

The topics discussed in this section include:

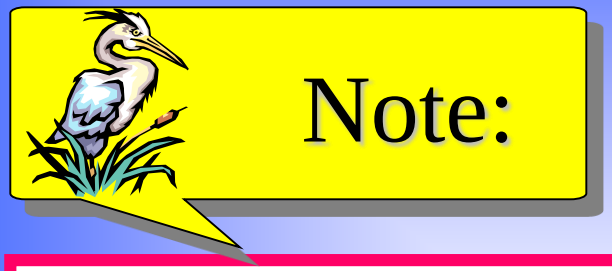
Transmission Sequence Number (TSN)
Stream Identifier (SI)
Stream Sequence Number (SSN)
Packets
Acknowledgment Number
Flow Control
Error Control
Congestion Control

Note:

In SCTP, a data chunk is numbered using a TSN.

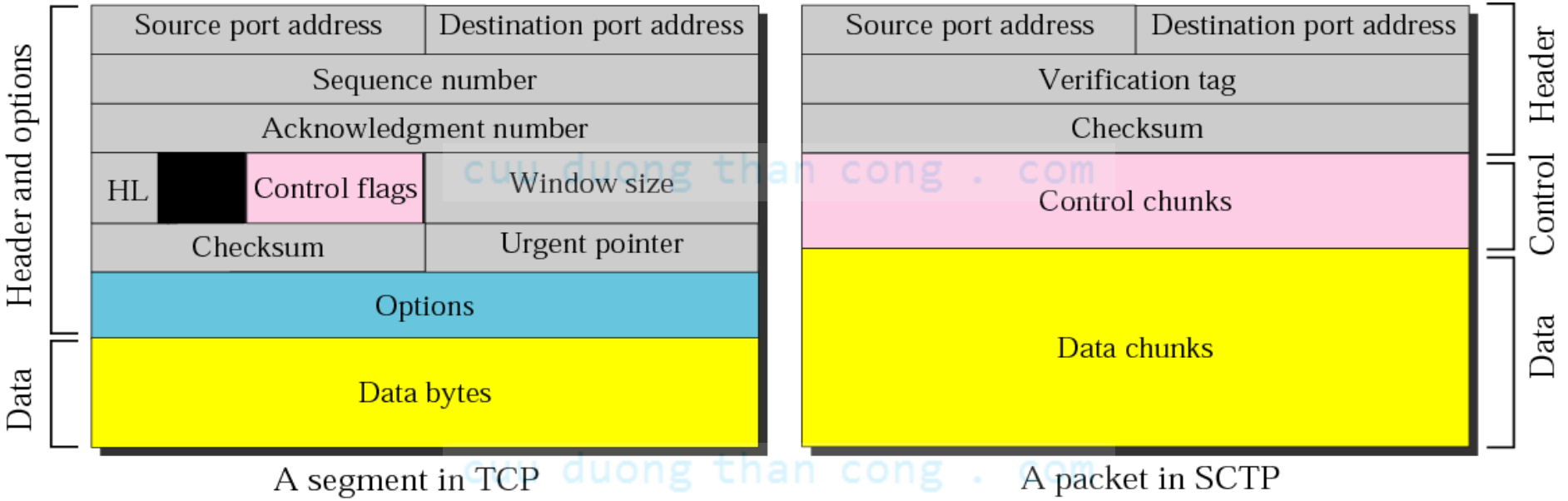


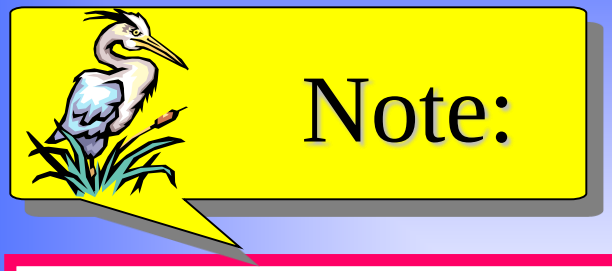
To distinguish between different streams, SCTP uses a SI.



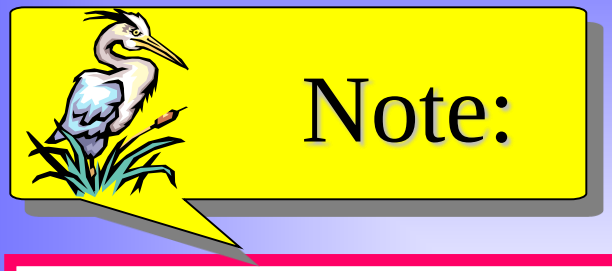
To distinguish between different data chunks belonging to the same stream, SCTP uses SSNs.

Figure 13.4 *Comparison between a TCP segment and an SCTP packet*



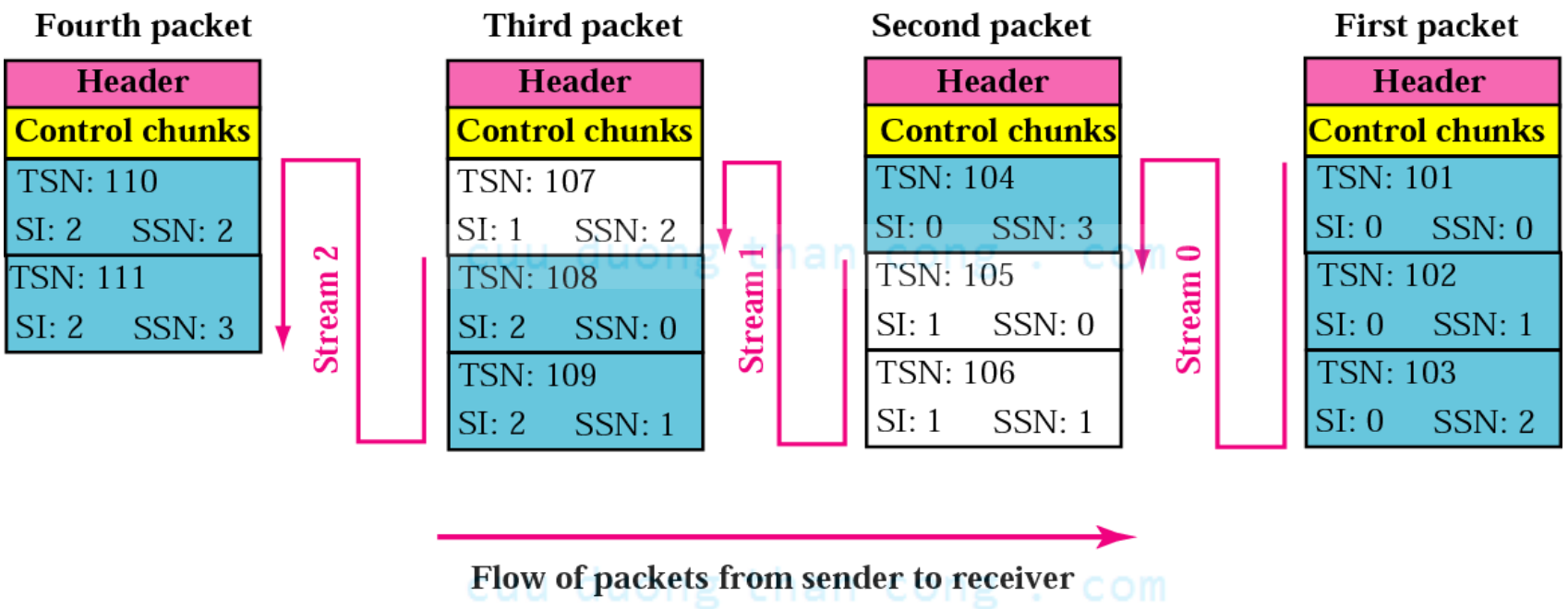


TCP has segments;
SCTP has packets.



In SCTP, control information and data information are carried in separate chunks.

Figure 13.5 *Packet, data chunks, and streams*



Note:

Data chunks are identified by three identifiers: TSN, SI, and SSN.

TSN is a cumulative number identifying the association; SI defines the stream; SSN defines the chunk in a stream.

Note:

In SCTP, acknowledgment numbers are used to acknowledge only data chunks; control chunks are acknowledged by other control chunks if necessary.

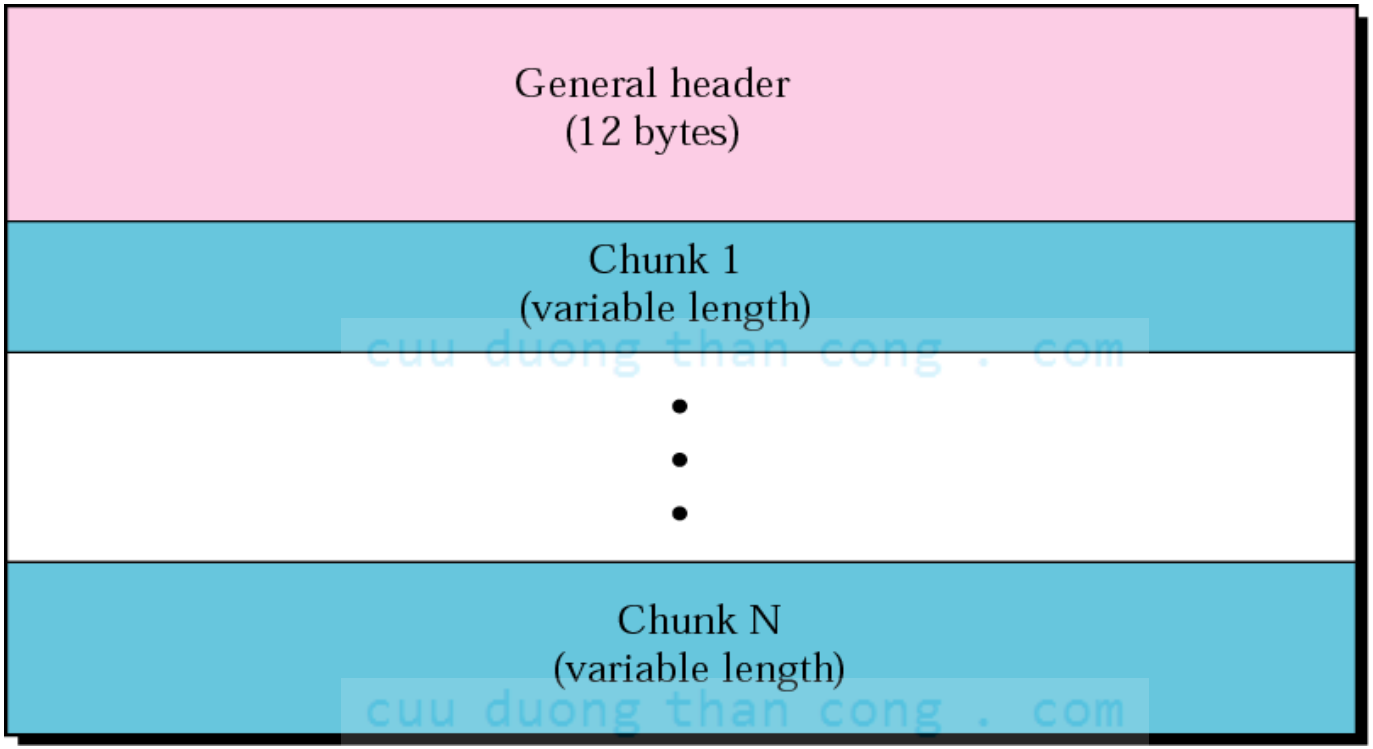
13.3 PACKET FORMAT

We show the format of a packet and different types of chunks. An SCTP packet has a mandatory general header and a set of blocks called chunks. There are two types of chunks: control chunks and data chunks.

The topics discussed in this section include:

General Header
Chunks

Figure 13.6 *SCTP packet format*



In an SCTP packet, control chunks come before data chunks.

Figure 13.7 *General header*

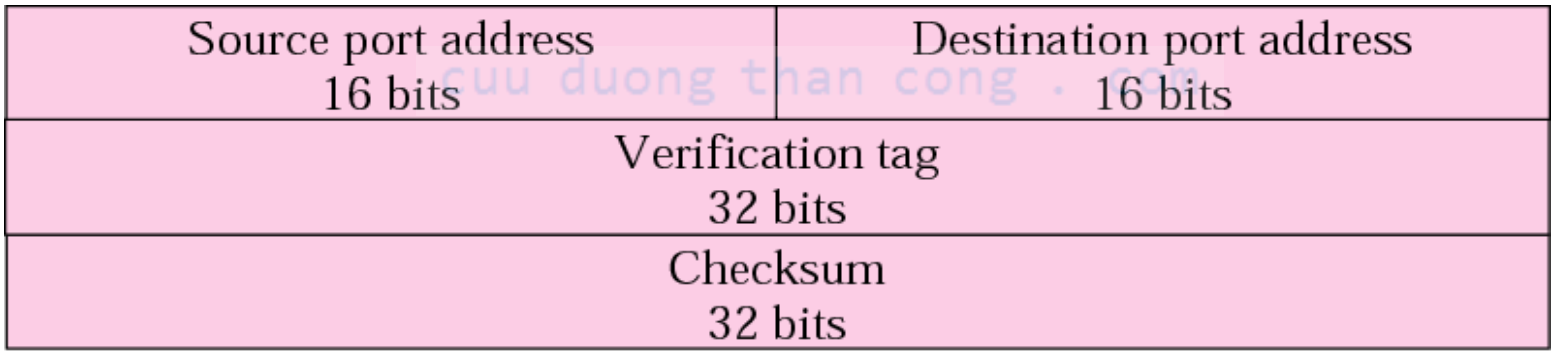
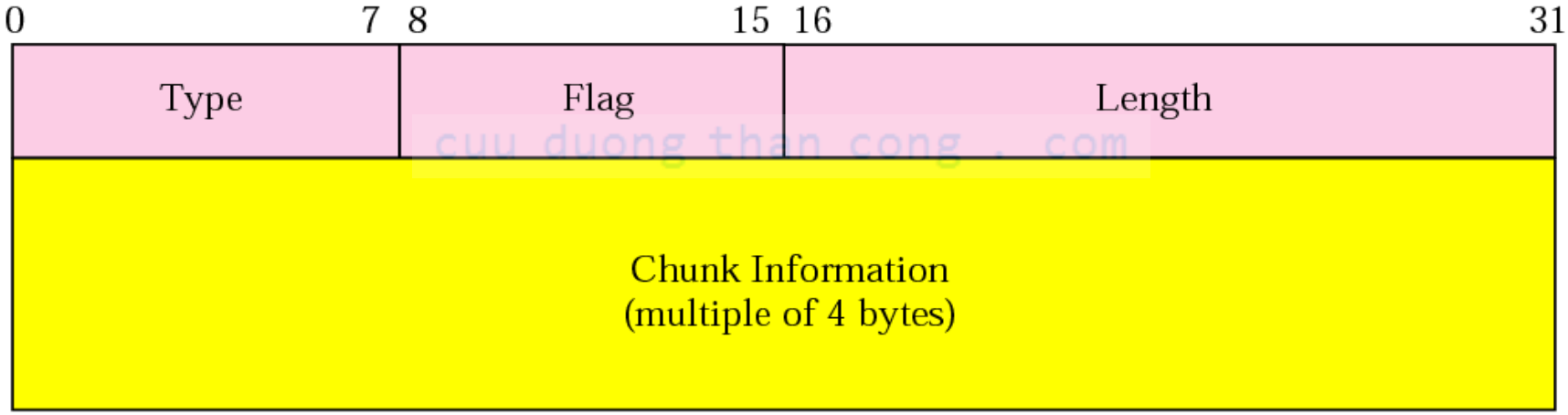


Figure 13.8 *Common layout of a chunk*



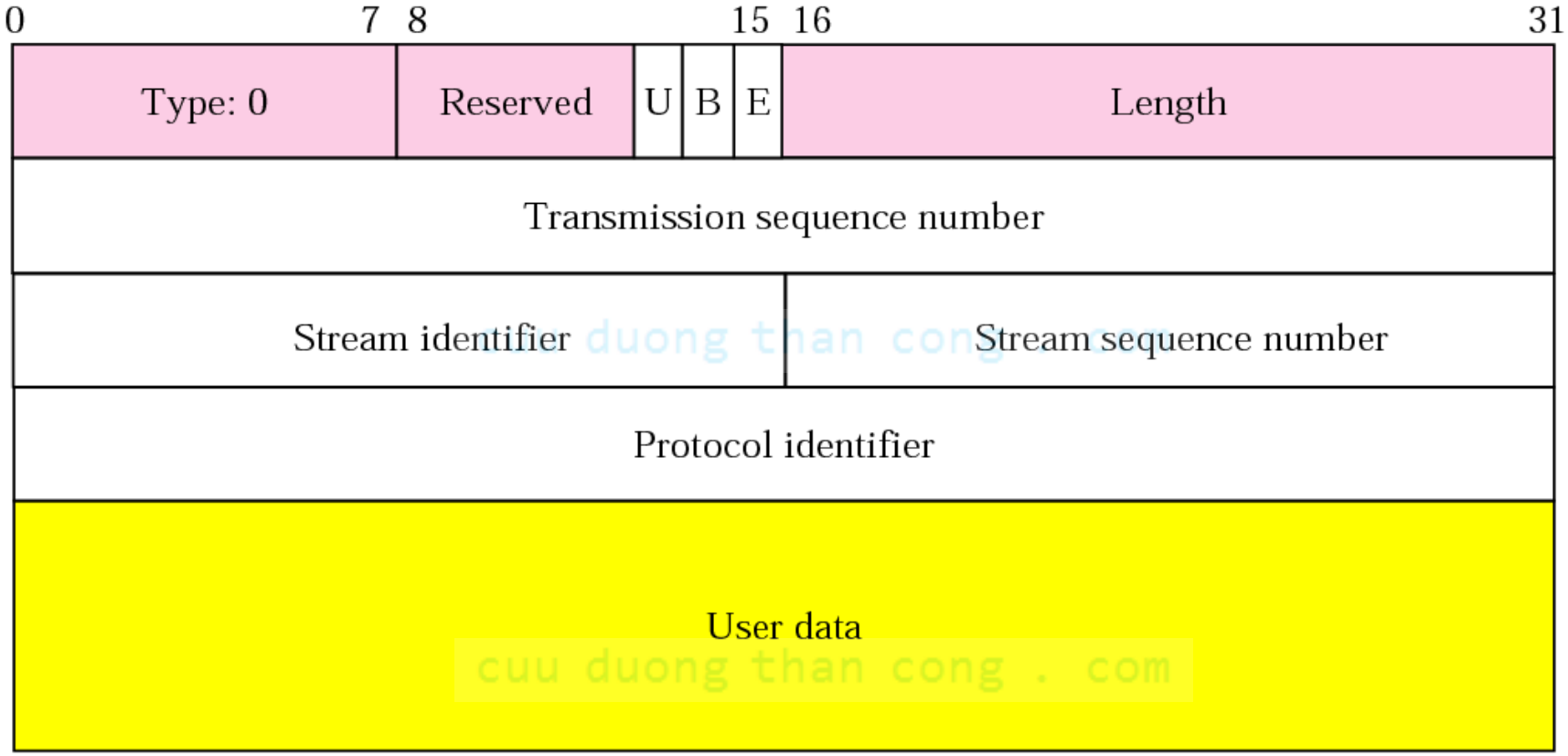
Chunks need to terminate on a 32-bit (4 byte) boundary.

Table 13.2 Chunks

Type	Chunk	Description
0	DATA	User data
1	INIT	Sets up an association
2	INIT ACK	Acknowledges INIT chunk
3	SACK	Selective acknowledgment
4	HEARTBEAT	Probes the peer for liveliness
5	HEARTBEAT ACK	Acknowledges HEARTBEAT chunk
6	ABORT	Abort an association
7	SHUTDOWN	Terminates an association
8	SHUTDOWN ACK	Acknowledges SHUTDOWN chunk
9	ERROR	Reports errors without shutting down
10	COOKIE ECHO	Third packet in association establishment
11	COOKIE ACK	Acknowledges COOKIE ECHO chunk
14	SHUTDOWN COMPLETE	Third packet in association termination
192	FORWARD TSN	For adjusting cummulating TSN

The number of padding bytes are not included in the value of the length field.

Figure 13.9 *DATA chunk*

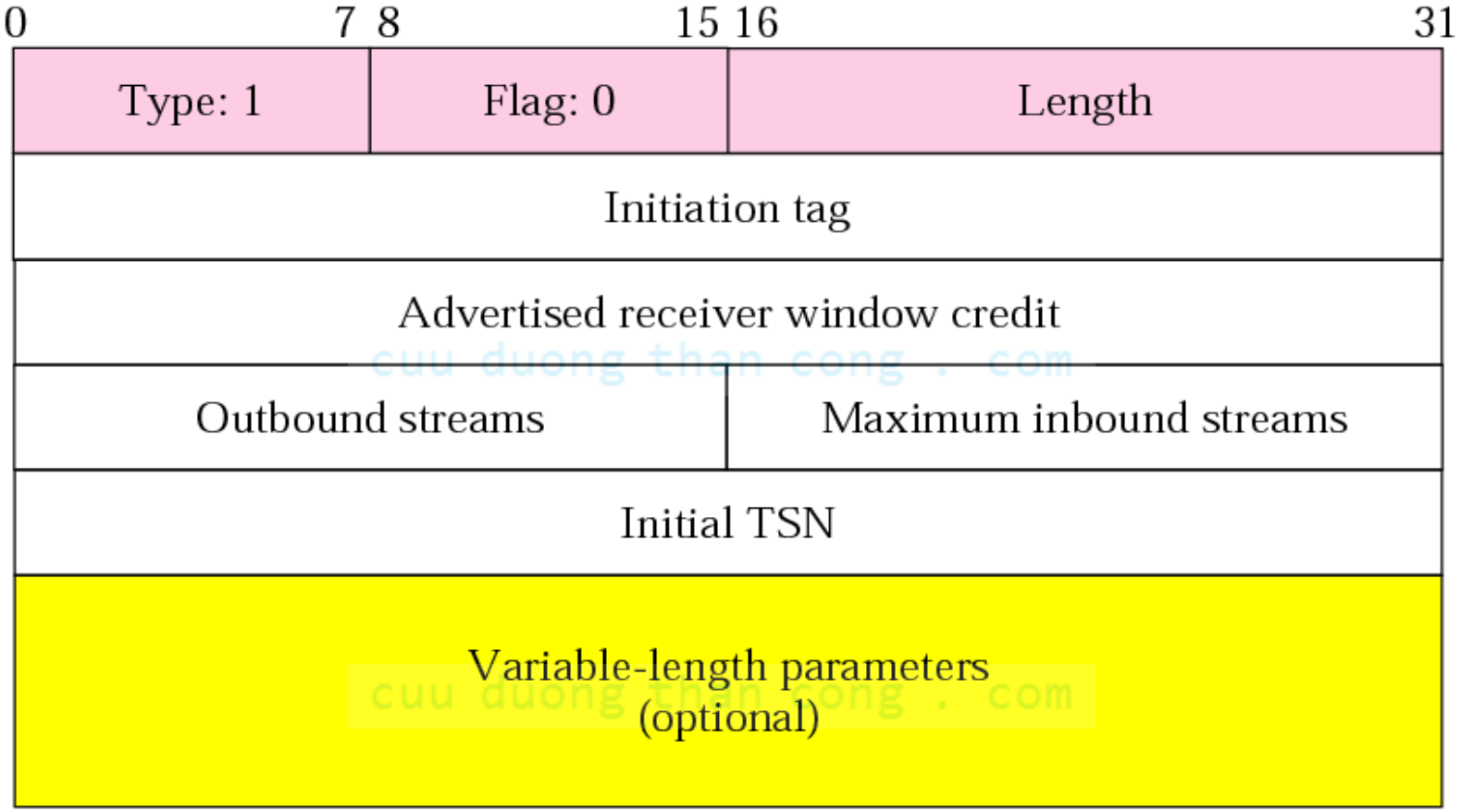


Note:

A DATA chunk cannot carry data belonging to more than one message, but a message can be split into several chunks.

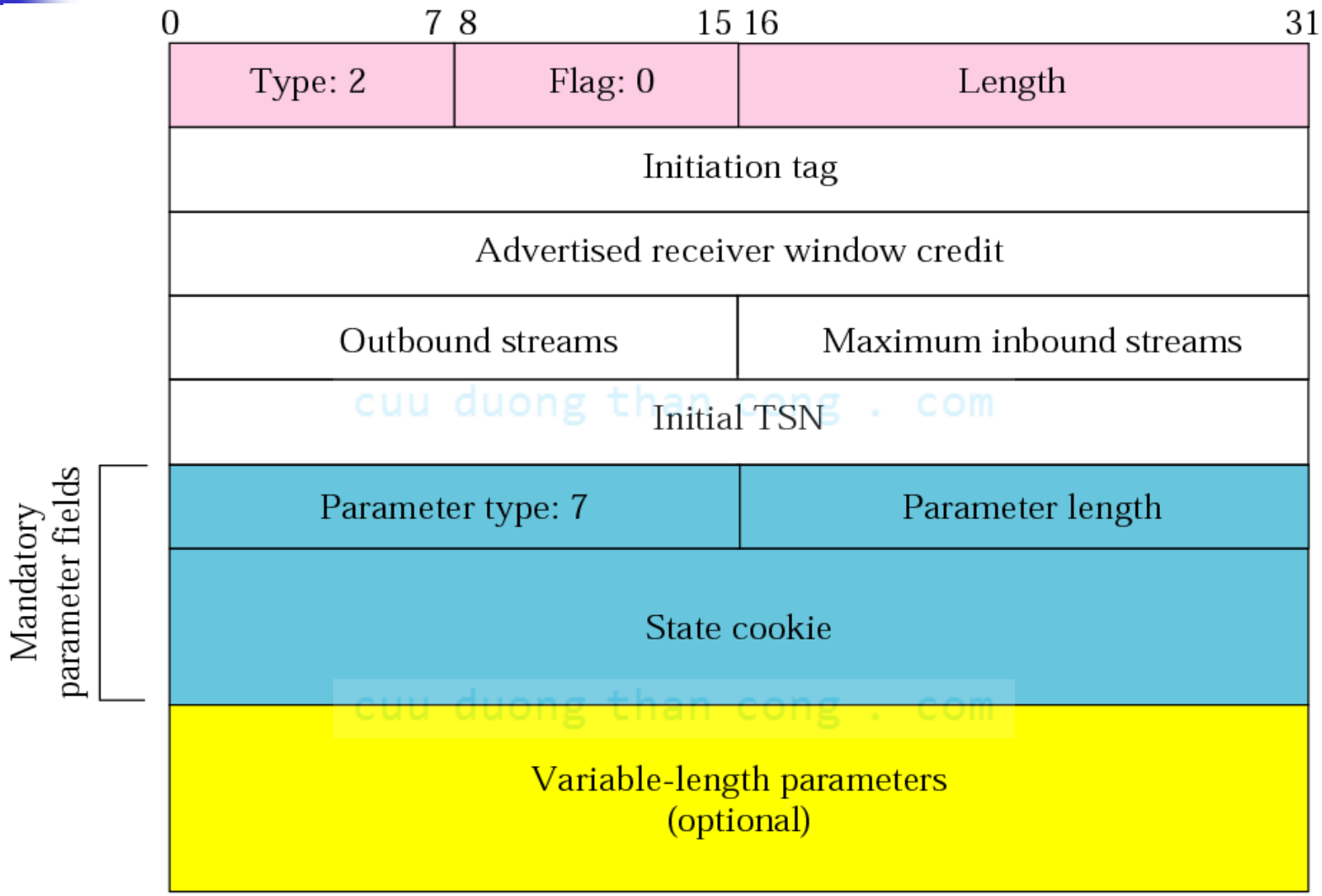
The data field of the DATA chunk must carry at least one byte of data, which means the value of length field cannot be less than 17.

Figure 13.10 *INIT chunk*



No other chunk can be carried in a packet that carries an INIT chunk.

Figure 13.11 *INIT ACK chunk*



No other chunk can be carried in a packet that carries an INIT ACK chunk.

Figure 13.12 *COOKIE ECHO chunk*

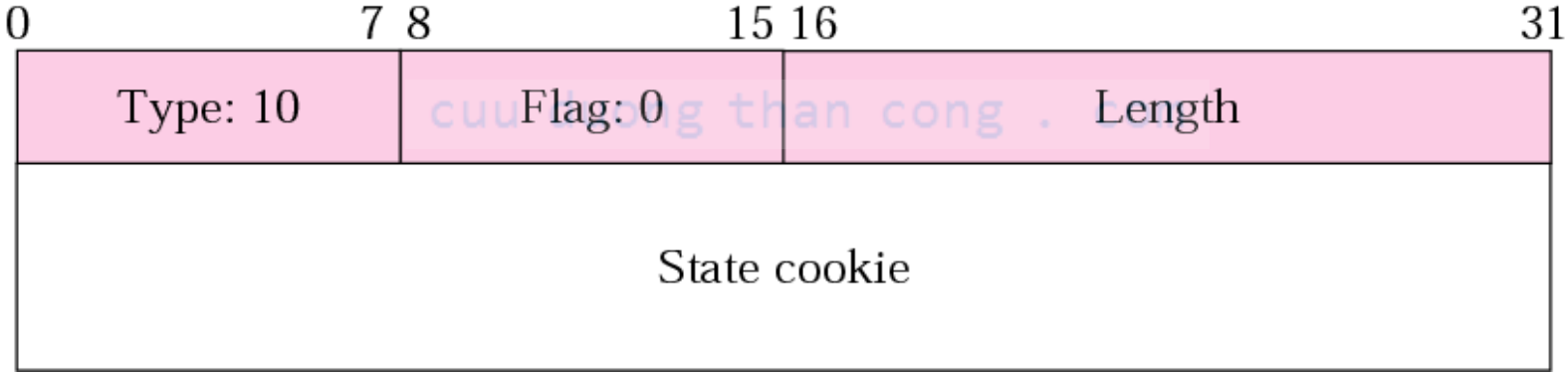


Figure 13.13 *COOKIE ACK*

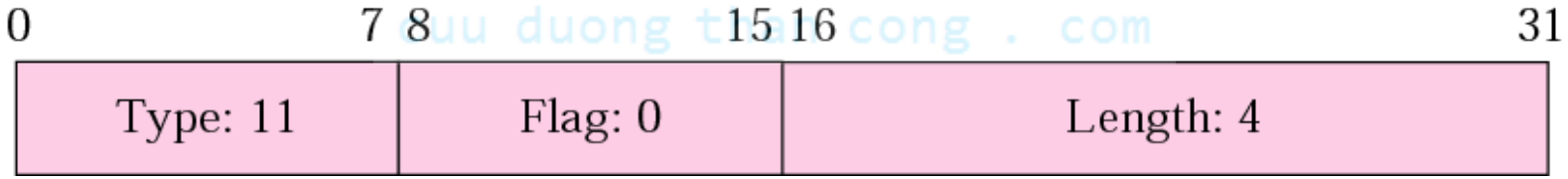


Figure 13.14 *SACK chunk*

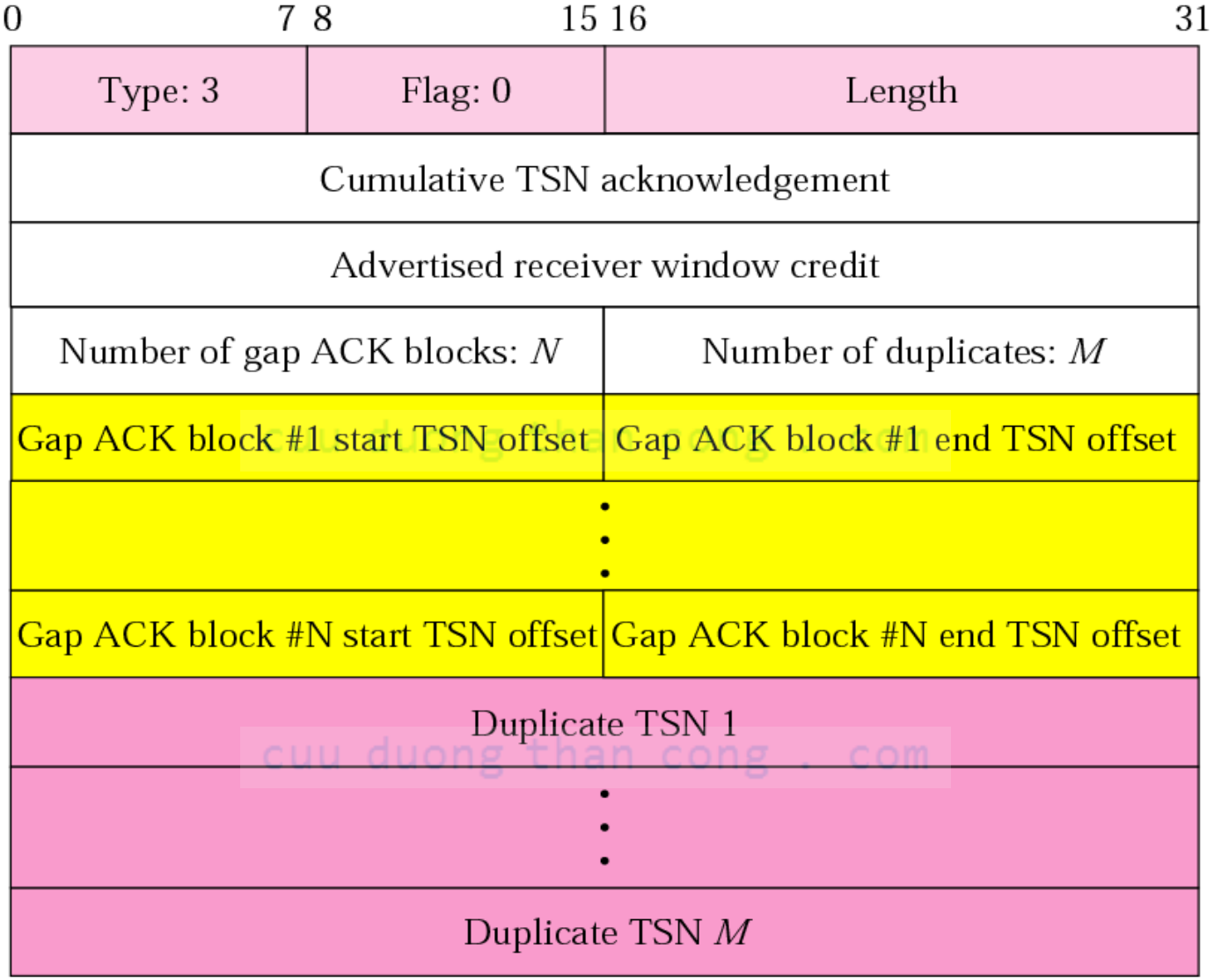


Figure 13.15 *HEARTBEAT and HEARTBEAT ACK chunks*

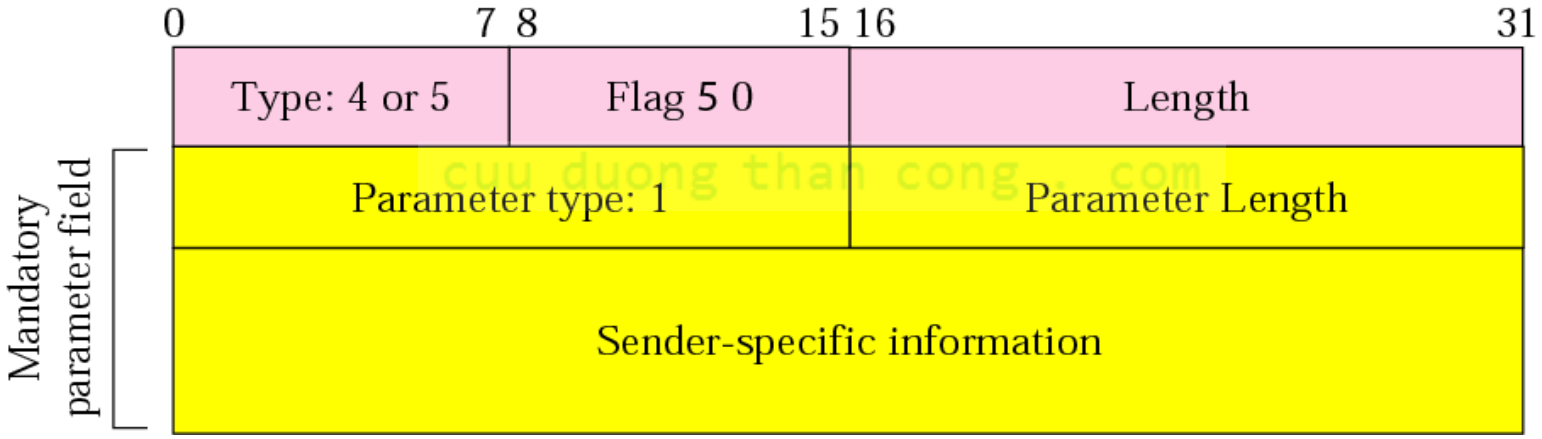


Figure 13.16 *SHUTDOWN, SHUTDOWN ACK, and SHUTDOWN COMPLETE chunks*

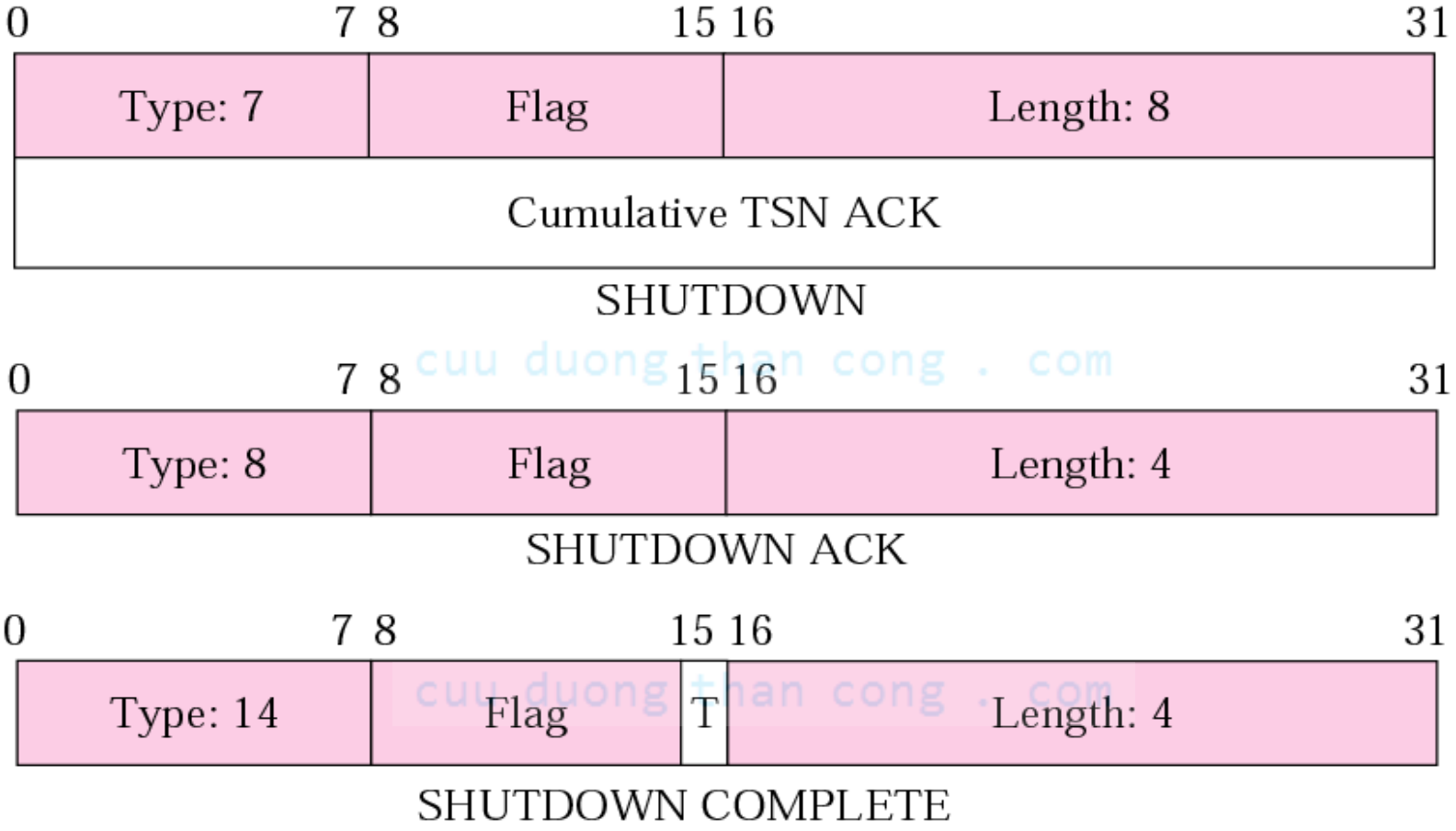


Figure 13.17 *ERROR chunk*

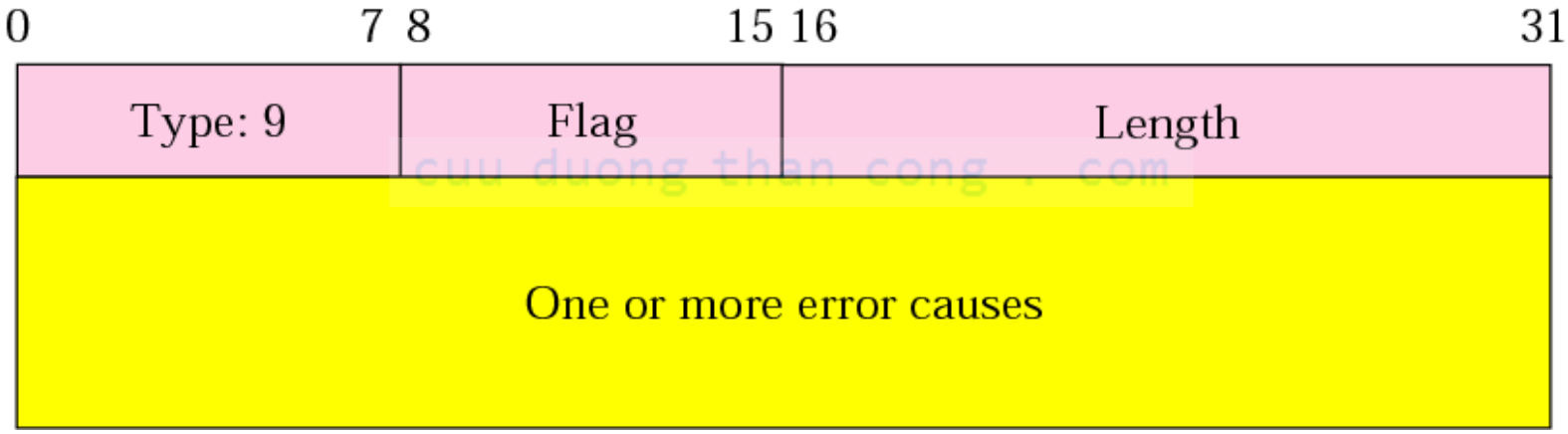
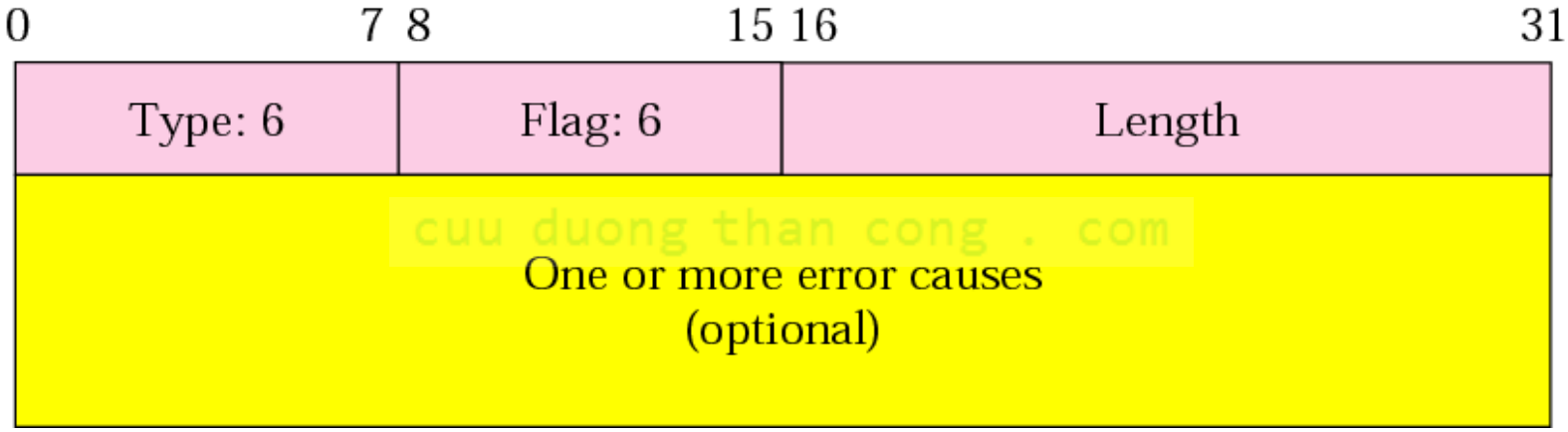


Table 13.3 Errors

Code	*Description*
1	Invalid stream identifier
2	Missing mandatory parameter
3	State cookie error
4	Out of resource
5	Unresolvable address
6	Unrecognized chunk type
7	Invalid mandatory parameters
8	Unrecognized parameter
9	No user data
10	Cookie received while shutting down

Figure 13.18 *ABORT chunk*



13.4 AN SCTP ASSOCIATION

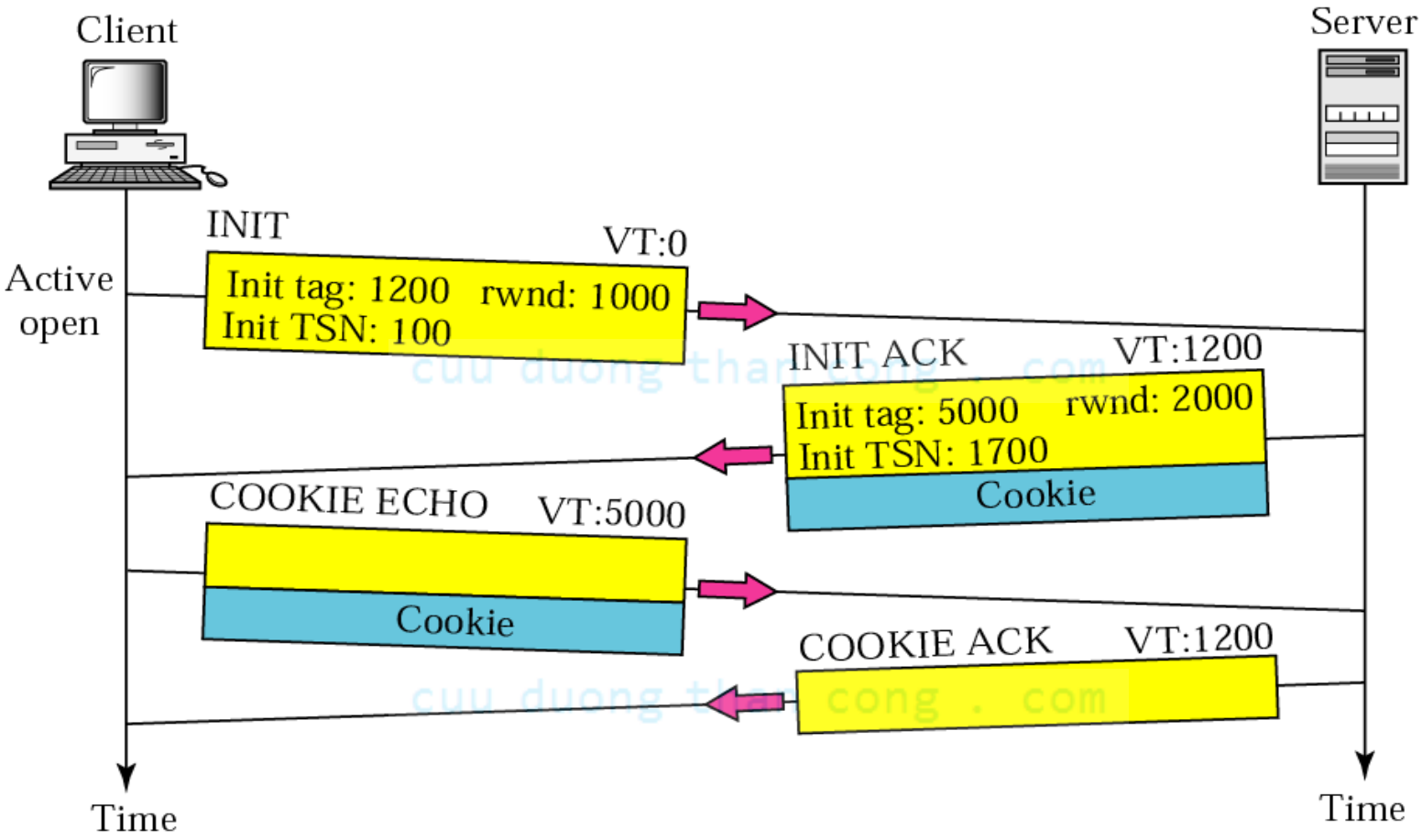
SCTP, like TCP, is a connection-oriented protocol. However, a connection in SCTP is called an association to emphasize multihoming

The topics discussed in this section include:

Association Establishment
Data Transfer
Association Termination
Association Abortion

A connection in SCTP is called an association.

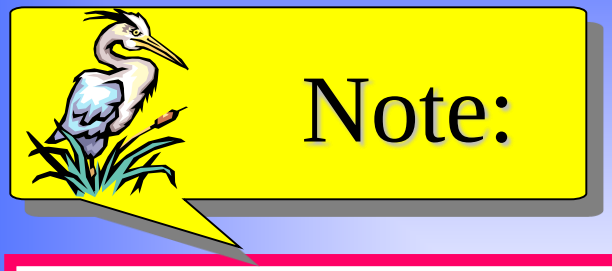
Figure 13.19 *Four-way handshaking*



Note:

No other chunk is allowed in a packet carrying an INIT or INIT ACK chunk.

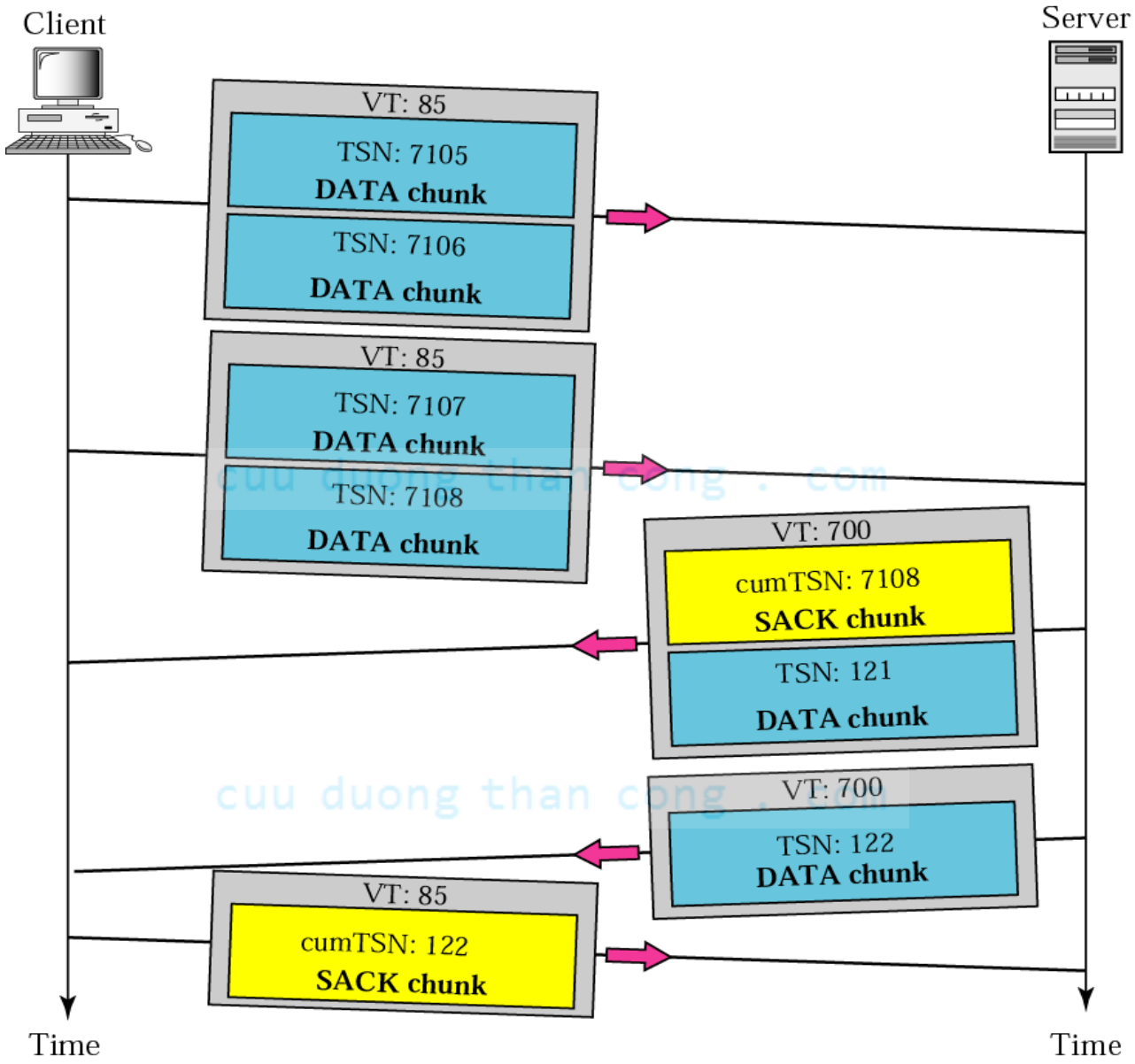
A COOKIE ECHO or a COOKIE ACK chunk can carry DATA chunks.



In SCTP, only DATA chunks consume TSNs;

DATA chunks are the only chunks that are acknowledged.

Figure 13.20 *Simple data transfer*



Note:

The acknowledgment in SCTP defines the cumulative TSN, the TSN of the last DATA chunk received in order.

Figure 13.21 *Association termination*

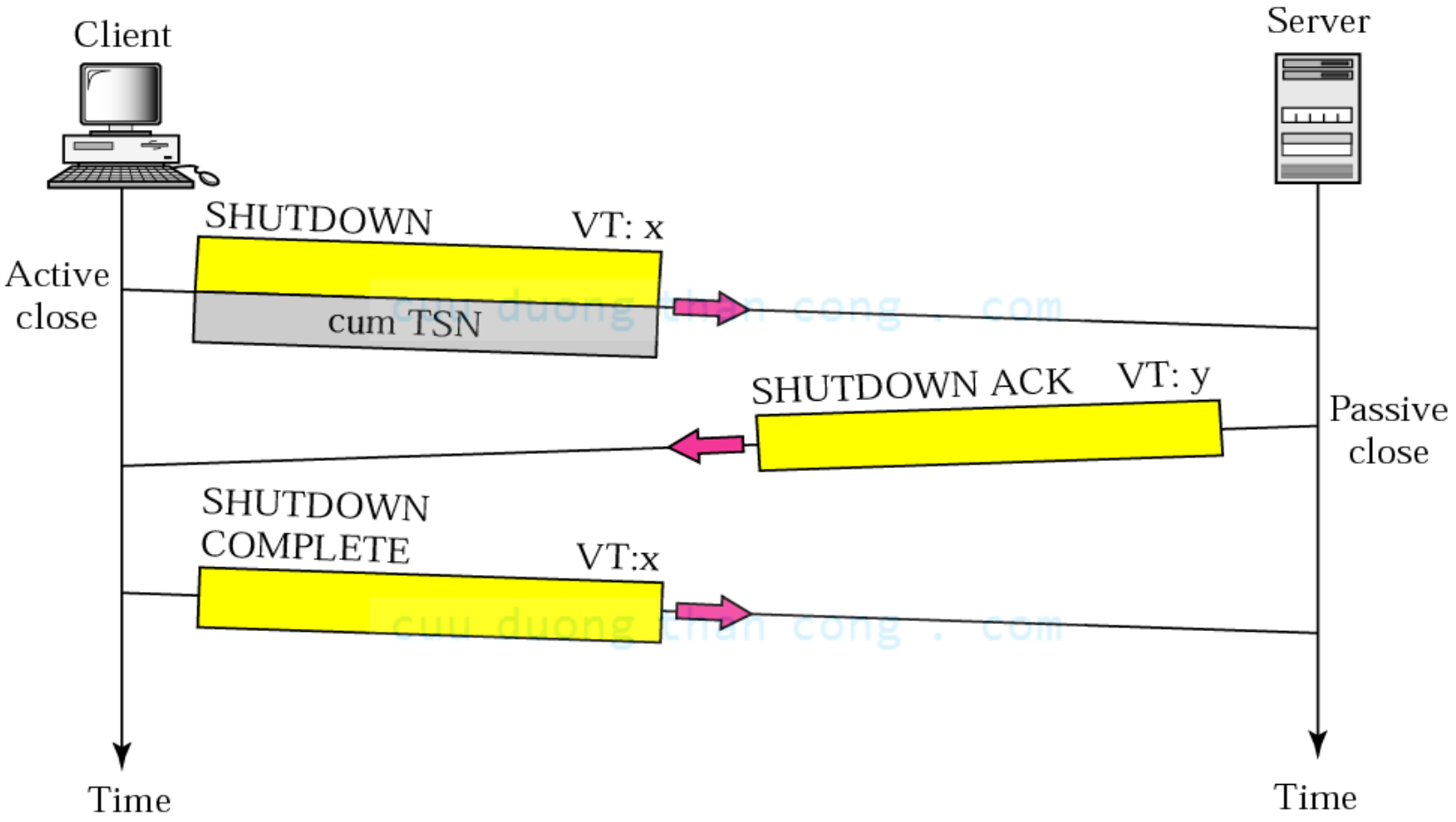
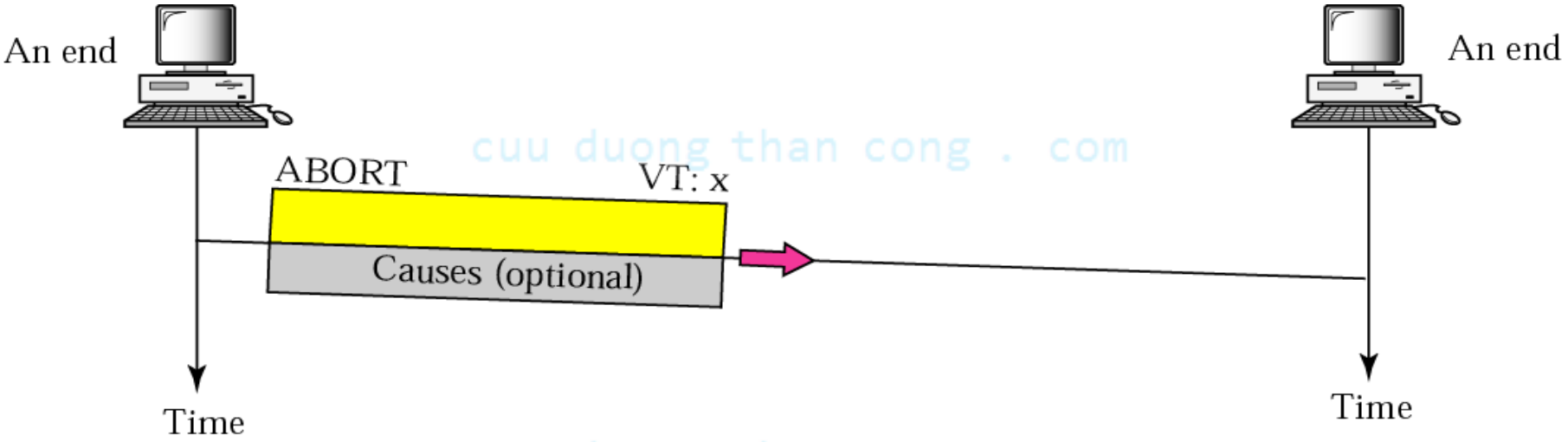


Figure 13.22 *Association abortion*



13.5 STATE TRANSITION DIAGRAM

To keep track of all the different events happening during association establishment, association termination, and data transfer, the SCTP software, like TCP, is implemented as a finite state machine.

The topics discussed in this section include:

Scenarios
Simultaneous Close

Figure 13.23 *State transition diagram*

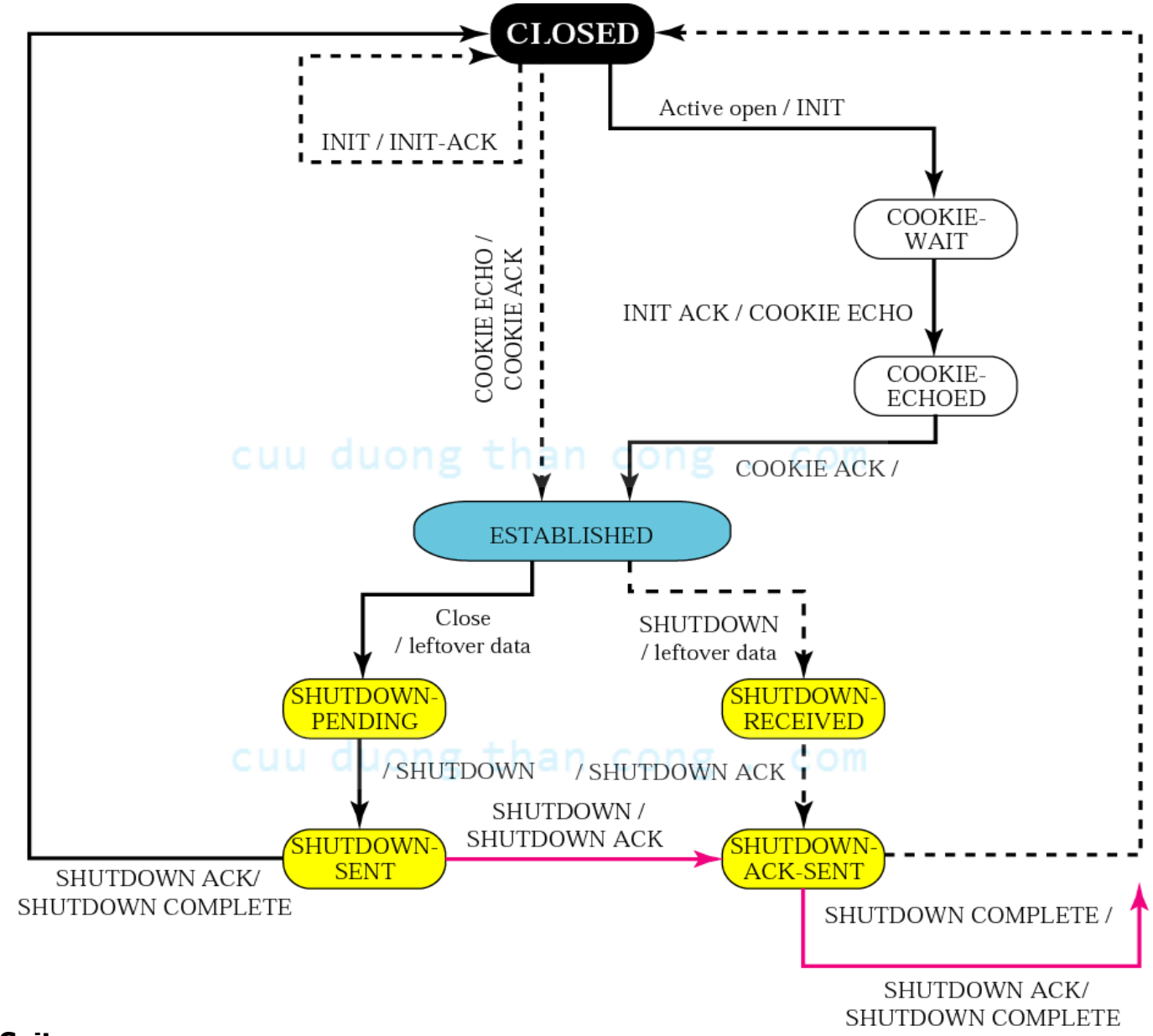


Table 13.4 States for SCTP

State	*Description*
CLOSED	No connection
COOKIE-WAIT	Waiting for a cookie
COOKIE-ECHOED	Waiting for cookie acknowledgment
ESTABLISHED	Connection is established; data are being transferred
SHUTDOWN-PENDING	Sending data after receiving *close*.
SHUTDOWN-SENT	Waiting for SHUTDOWN acknowledgment
SHUTDOWN-RECEIVED	Sending data after receiving SHUTDOWN
SHUTDOWN-ACK-SENT	Waiting for termination completion.

Figure 13.24 *A common scenario of states*

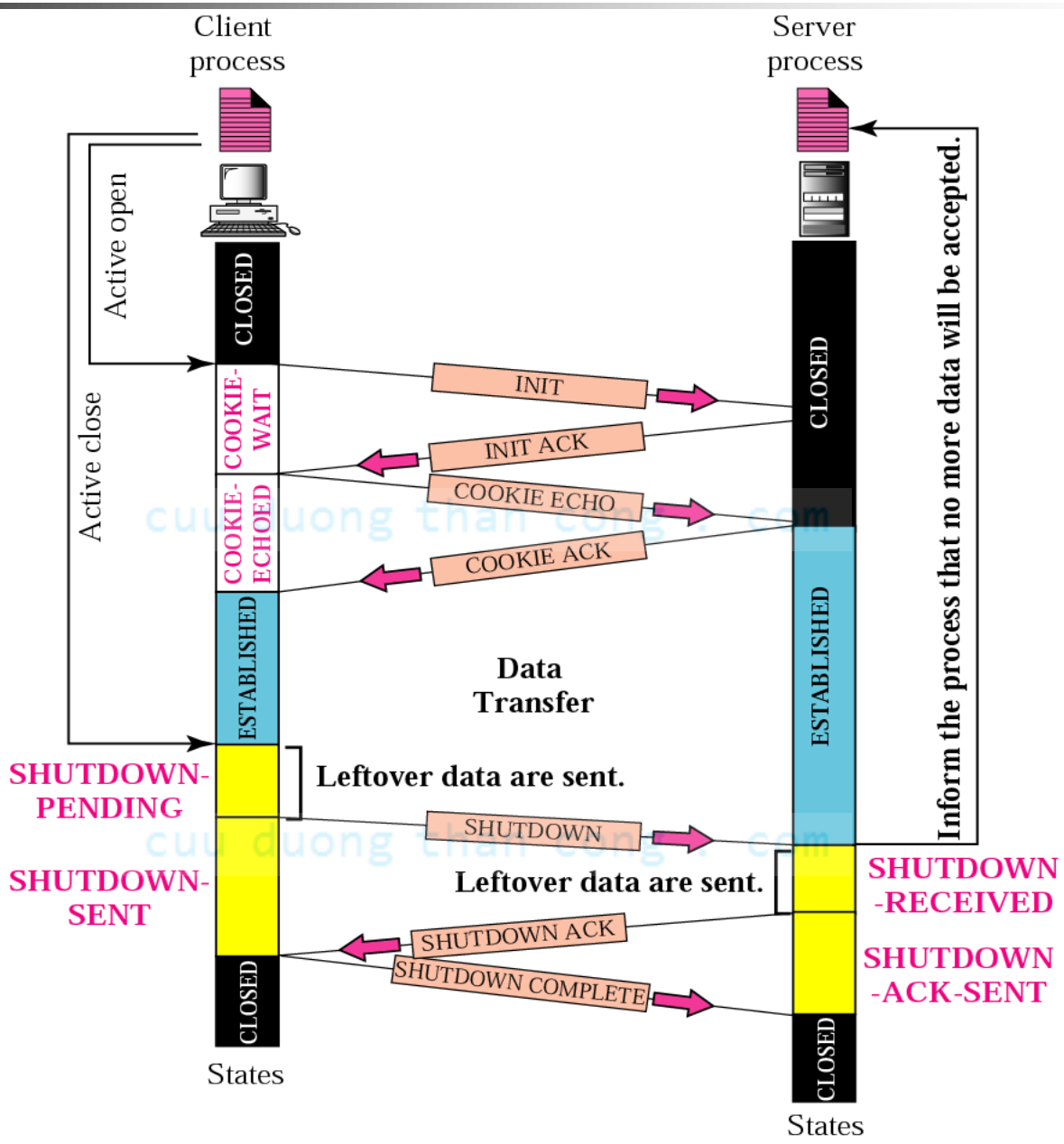


Figure 13.25 *Simultaneous open*

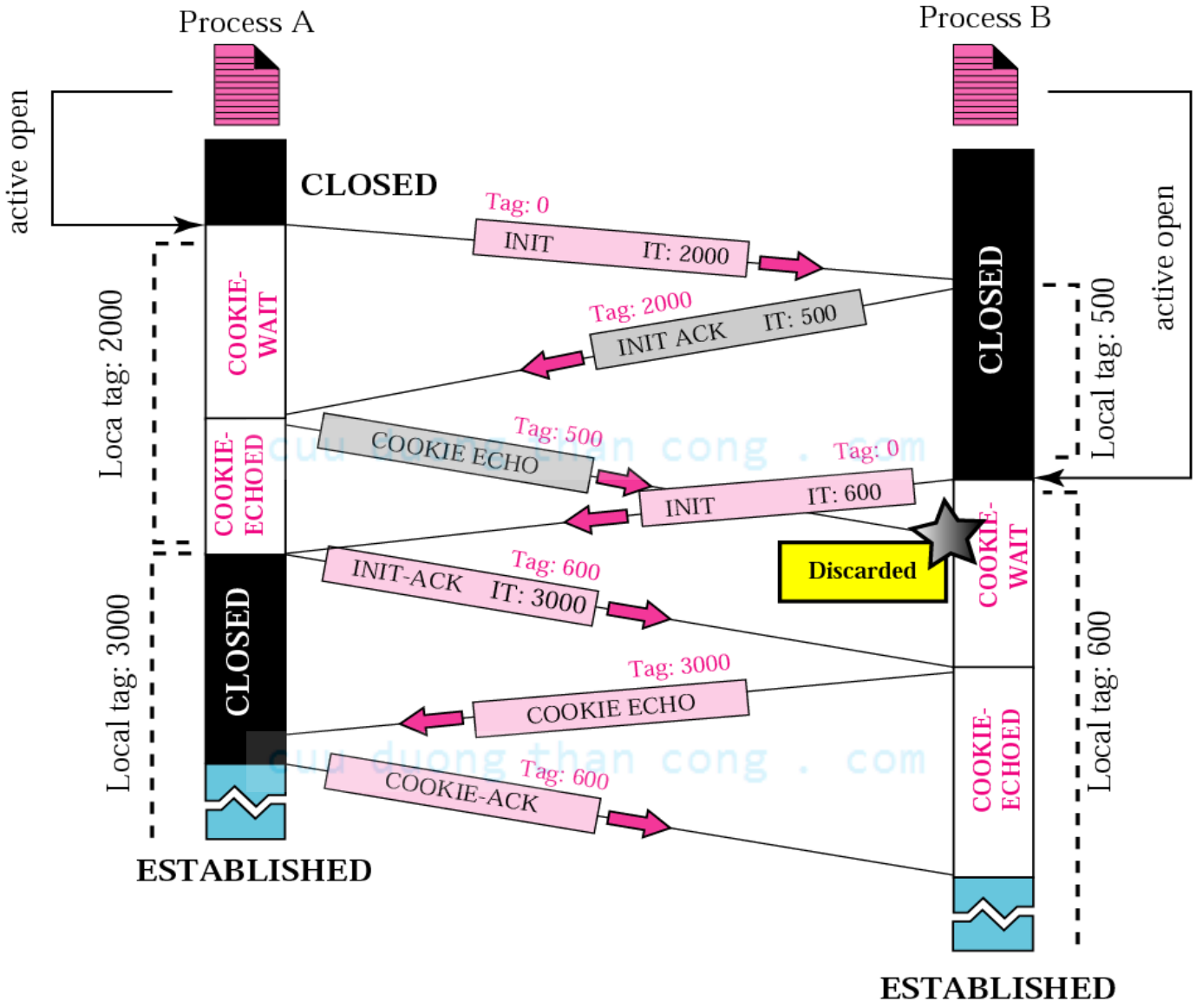
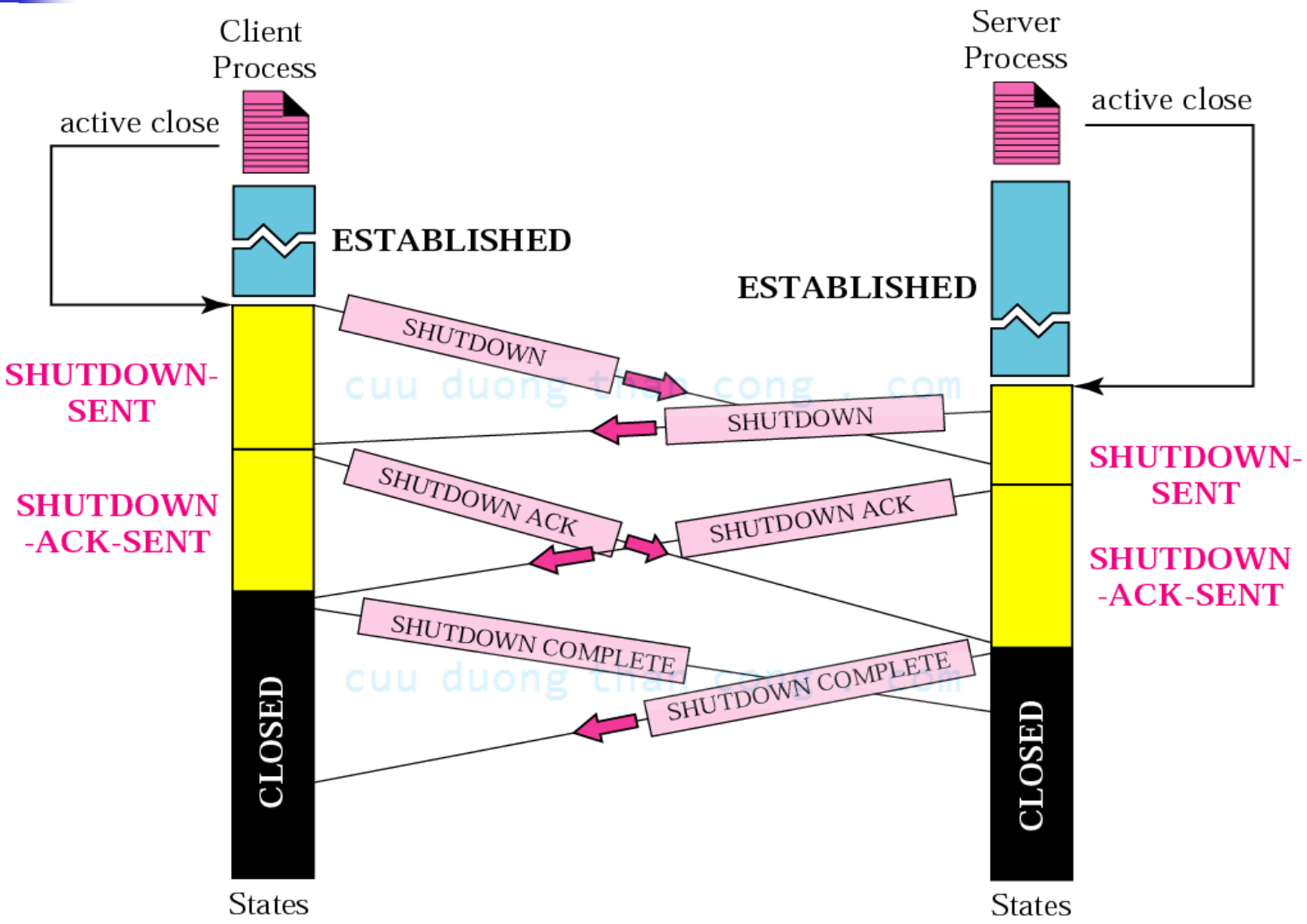


Figure 13.26 *Simultaneous close*



13.6 FLOW CONTROL

Flow control in SCTP is similar to that in TCP. In SCTP, we need to handle two units of data, the byte and the chunk.

The topics discussed in this section include:

Receiver Site
Sender Site
A Scenario

Figure 13.27 *Flow control, receiver site*

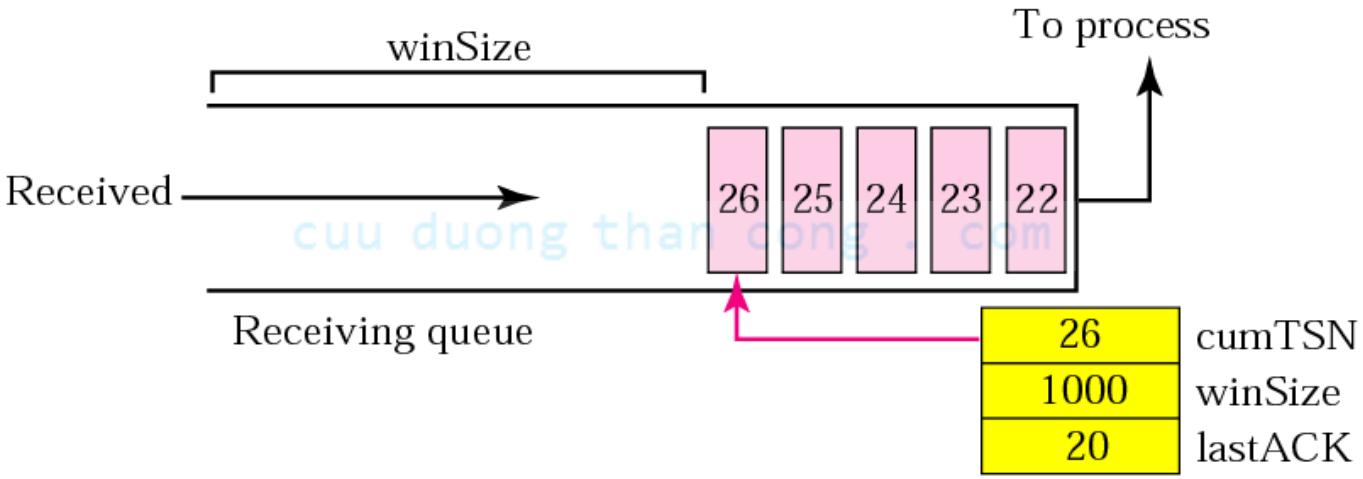


Figure 13.28 *Flow control, sender site*

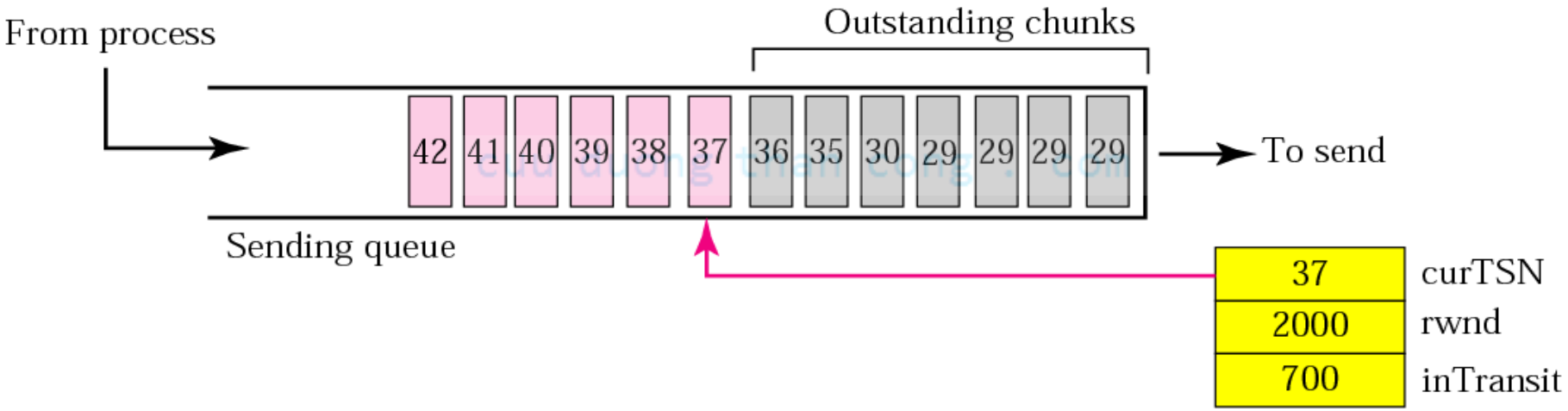
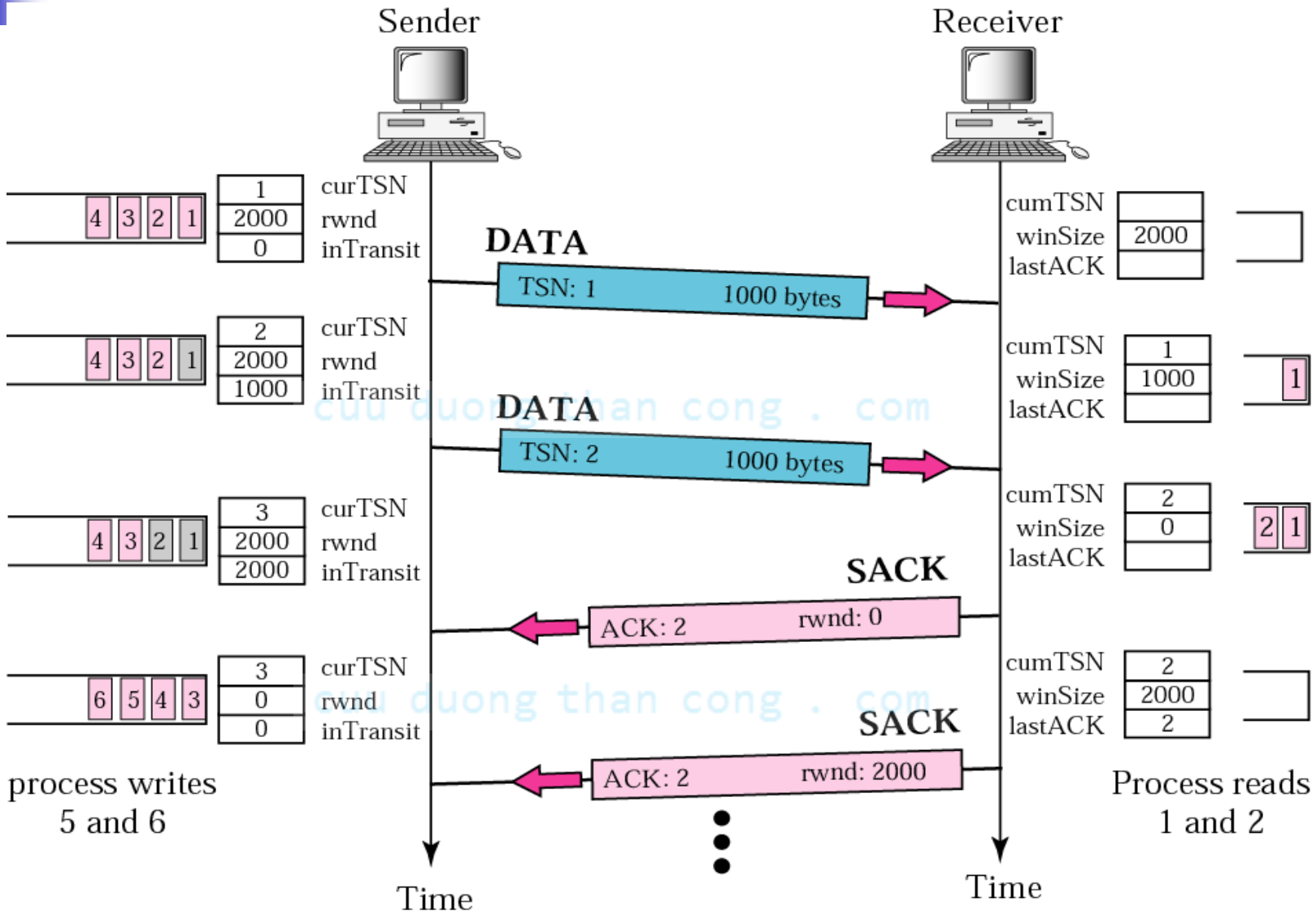


Figure 13.29 *Flow control scenario*



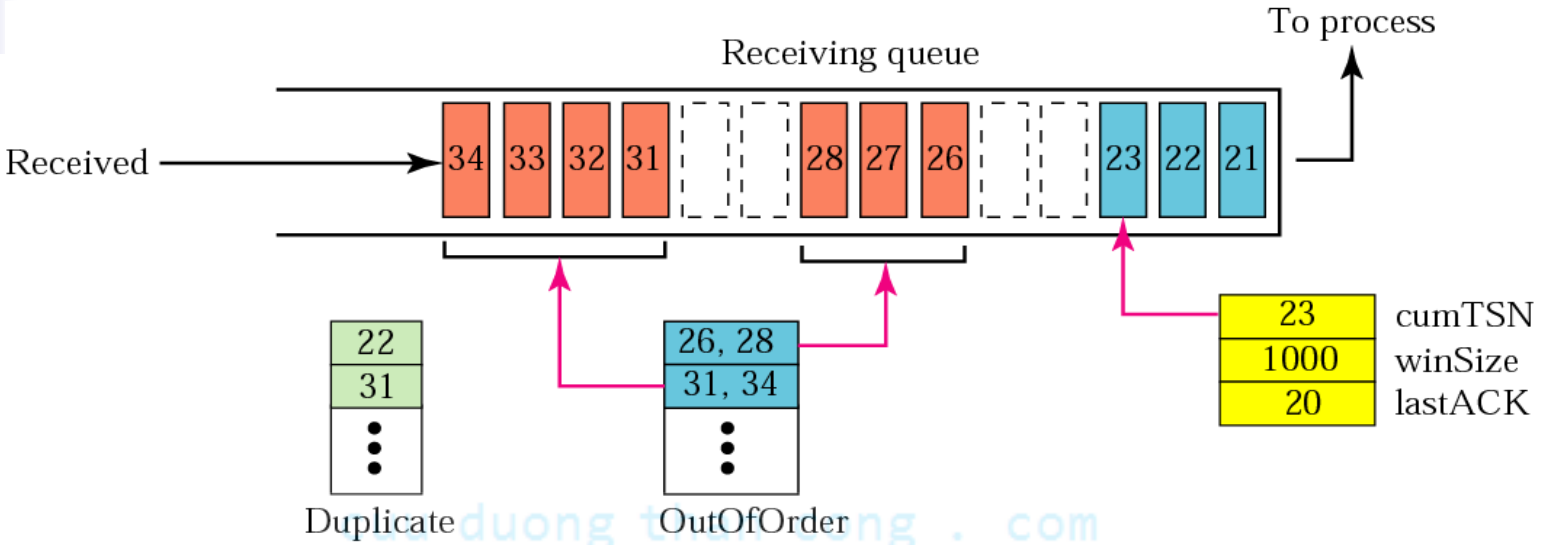
13.7 ERROR CONTROL

SCTP uses a SACK chunk to report the state of the receiver buffer to the sender. Each implementation uses a different set of entities and timers for the receiver and sender sites.

The topics discussed in this section include:

Receiver Site
Sender Site
Sending Data Chunks
Generating SACK Chunks

Figure 13.30 *Error control, receiver site*



SACK chunk

Type: 3	Flag: 0	Length: 32
Cumulative TSN: 23		
Advertised receiver window credit: 1000		
Number of gap ACK blocks: 2	Number of duplicates: 2	
Gap ACK block #1 start: 3	Gap ACK block #1 end: 5	
Gap ACK block #2 start: 8	Gap ACK block #2 end: 12	
Duplicate TSN: 22		
Duplicate TSN: 31		

Numbers are relative to cumTSN

Figure 13.31 *Error control, sender site*

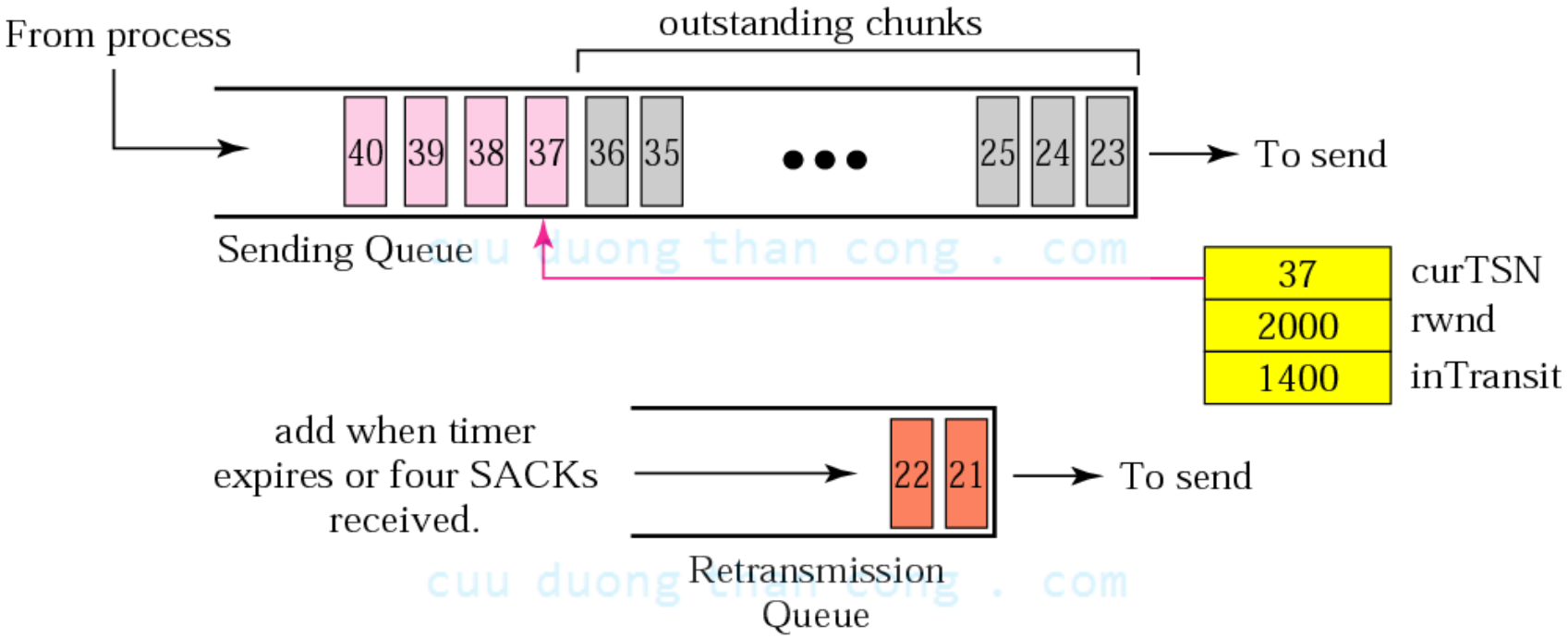
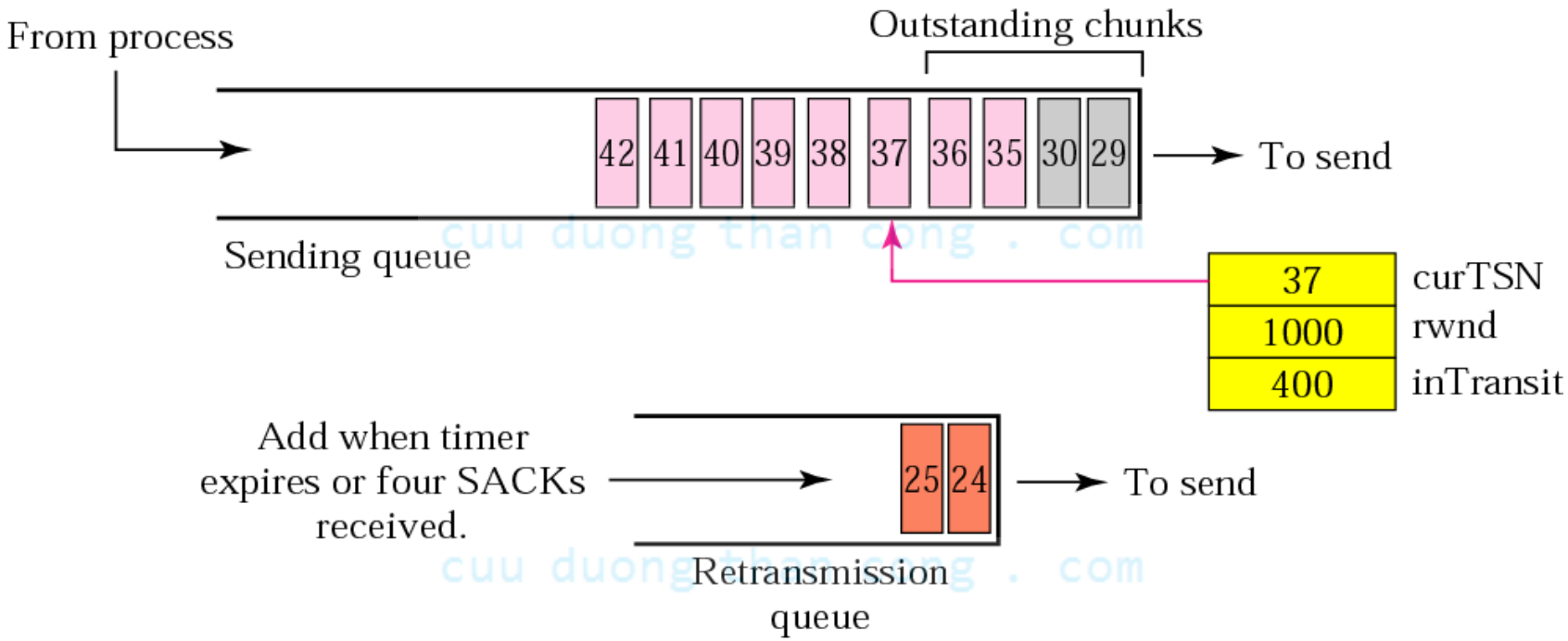


Figure 13.32 *New state at the sender site after receiving a SACK chunk*



13.8 CONGESTION CONTROL

SCTP uses the same strategies for congestion control as TCP. SCTP uses slow start, congestion avoidance, and congestion detection phases. SCTP also uses fast retransmission and fast recovery.

The topics discussed in this section include:

Congestion Control and Multihoming
Explicit Congestion Notification