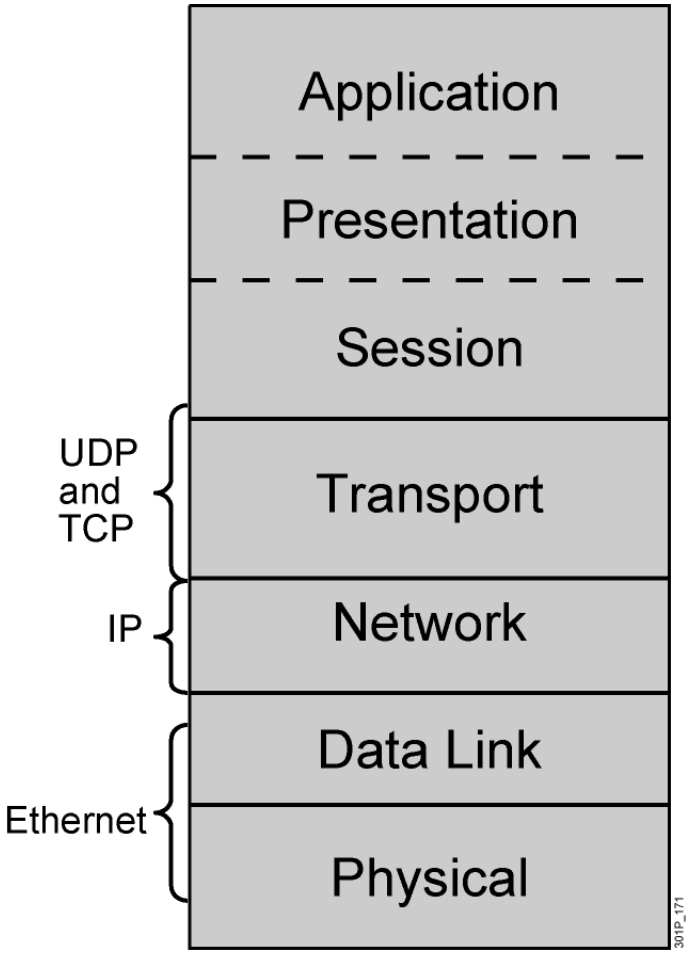
Understanding the TCP/IP Transport Layer

Building a Simple Network

Transport Layer



- Segmentation
- Flow control (when required)
- Connection-oriented (when required)
- Reliability (when required)

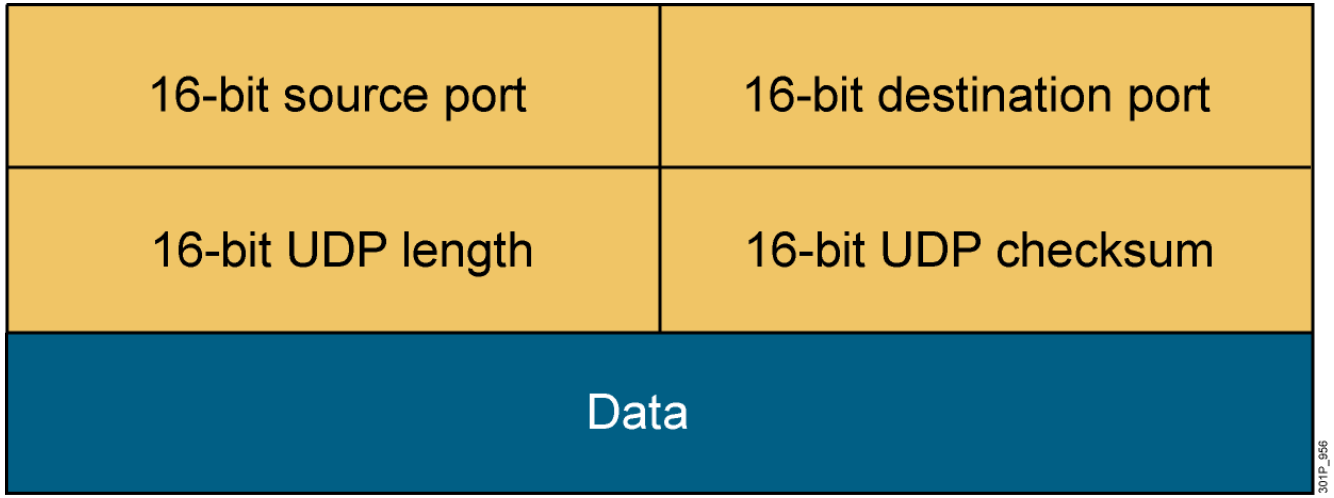
Reliable vs. Best-Effort Comparison

	Reliable	Best-Effort
Connection Type	Connection-oriented	Connectionless
Protocol	TCP	UDP
Sequencing	Yes	No
Uses	▪ E-mail ▪ File sharing ▪ Downloading	▪ Voice streaming ▪ Video streaming

UDP Characteristics

- Operates at transport layer of OSI and TCP/IP models
- Provides applications with access to the network layer without the overhead of reliability mechanisms
- Is a connectionless protocol
- Provides limited error checking
- Provides best-effort delivery
- Has no data-recovery features

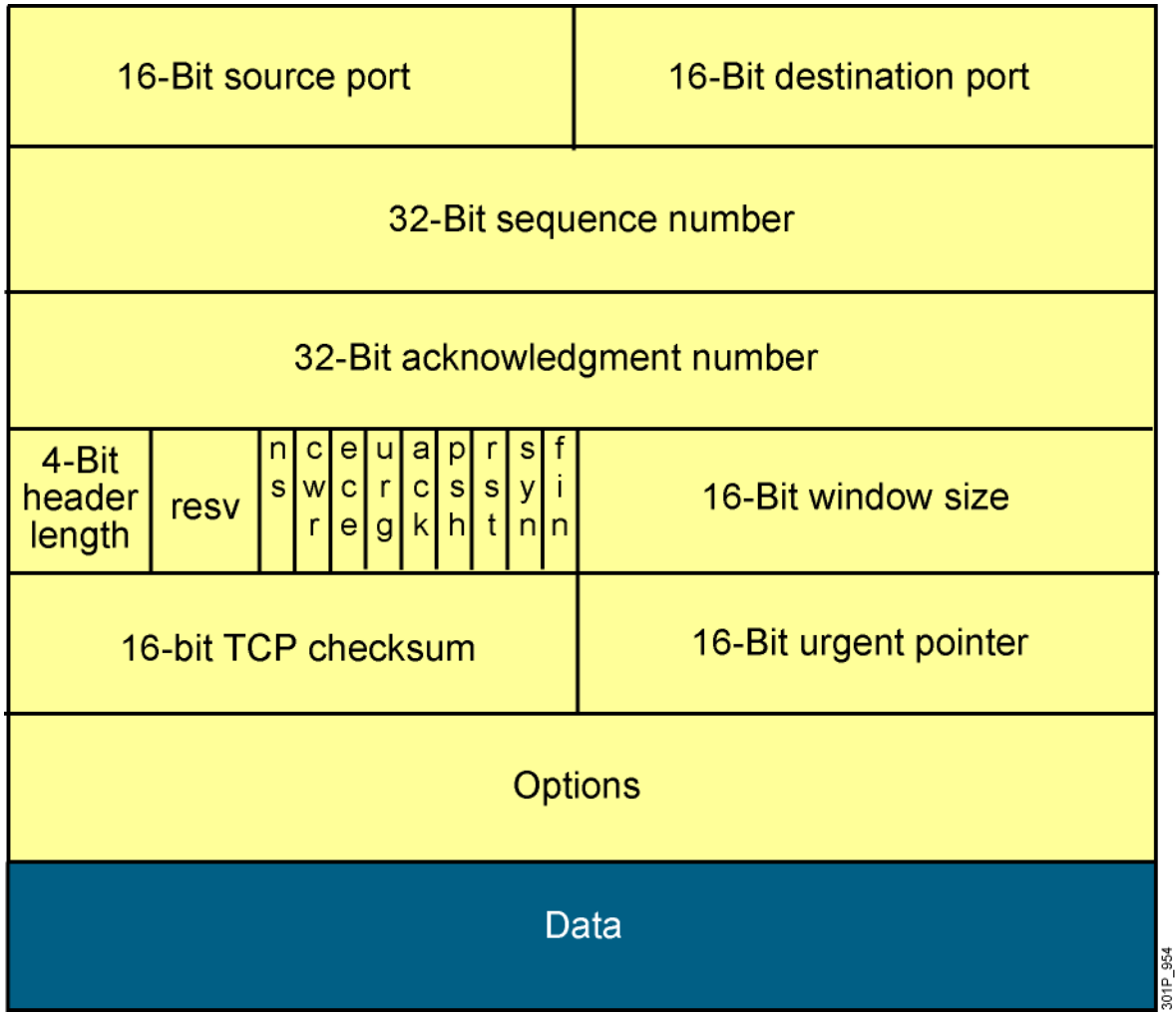
UDP Header



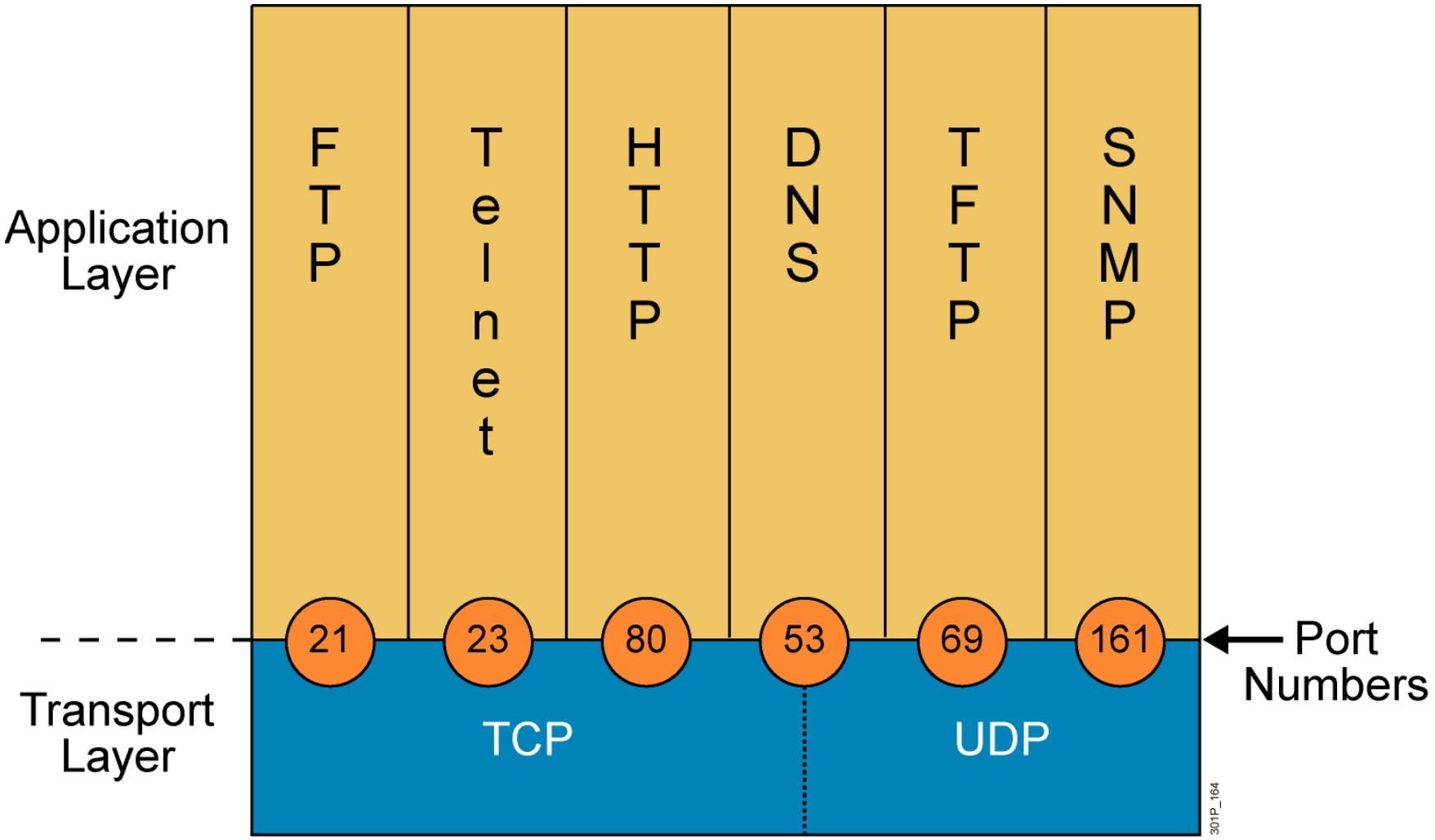
TCP Characteristics

- Transport layer of the TCP/IP stack
- Connection-oriented protocol
- Error checking
- Sequencing of data packets
- Acknowledgement of receipt
- Data-recovery features

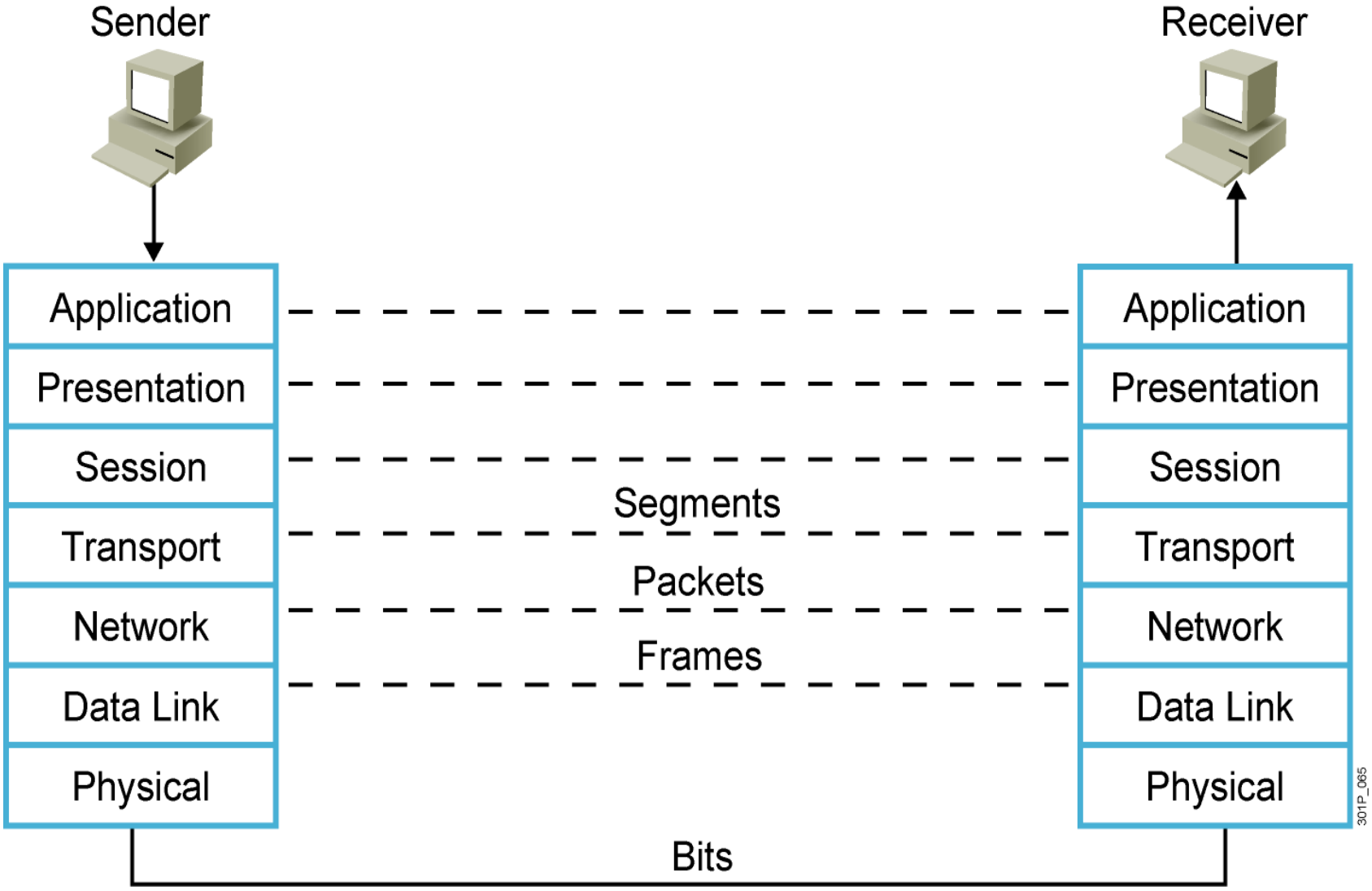
TCP Header



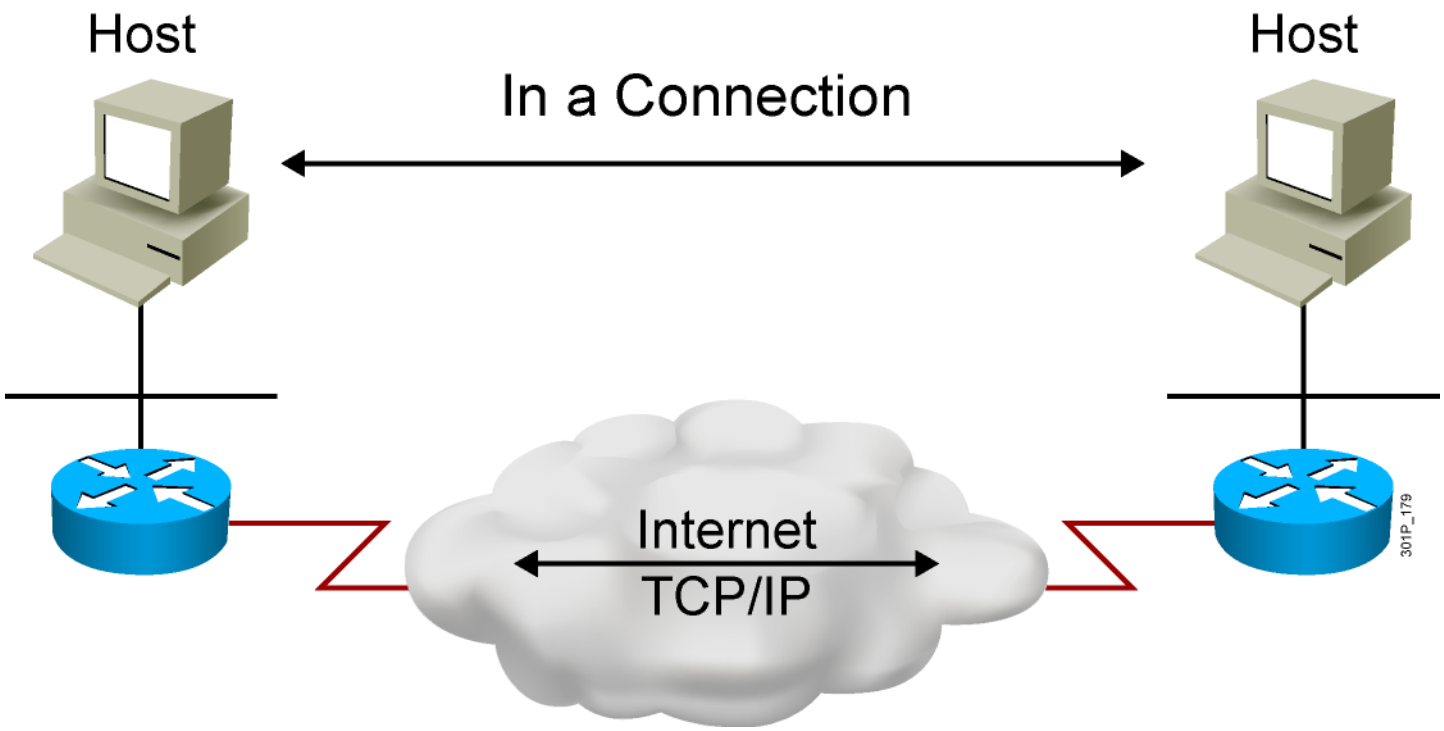
Mapping Layer 4 to Applications



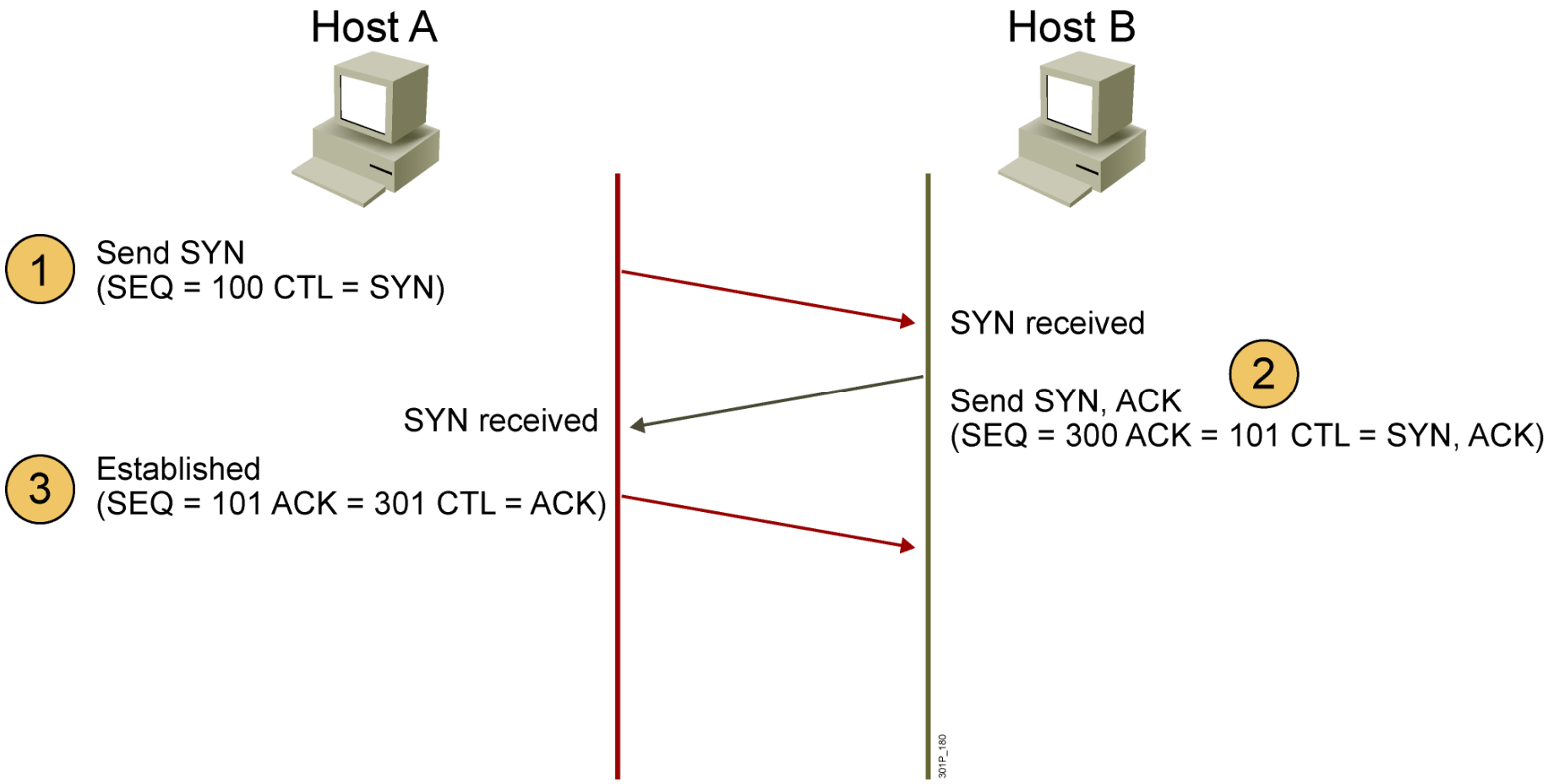
Peer-to-Peer Communication



Establishing a Connection

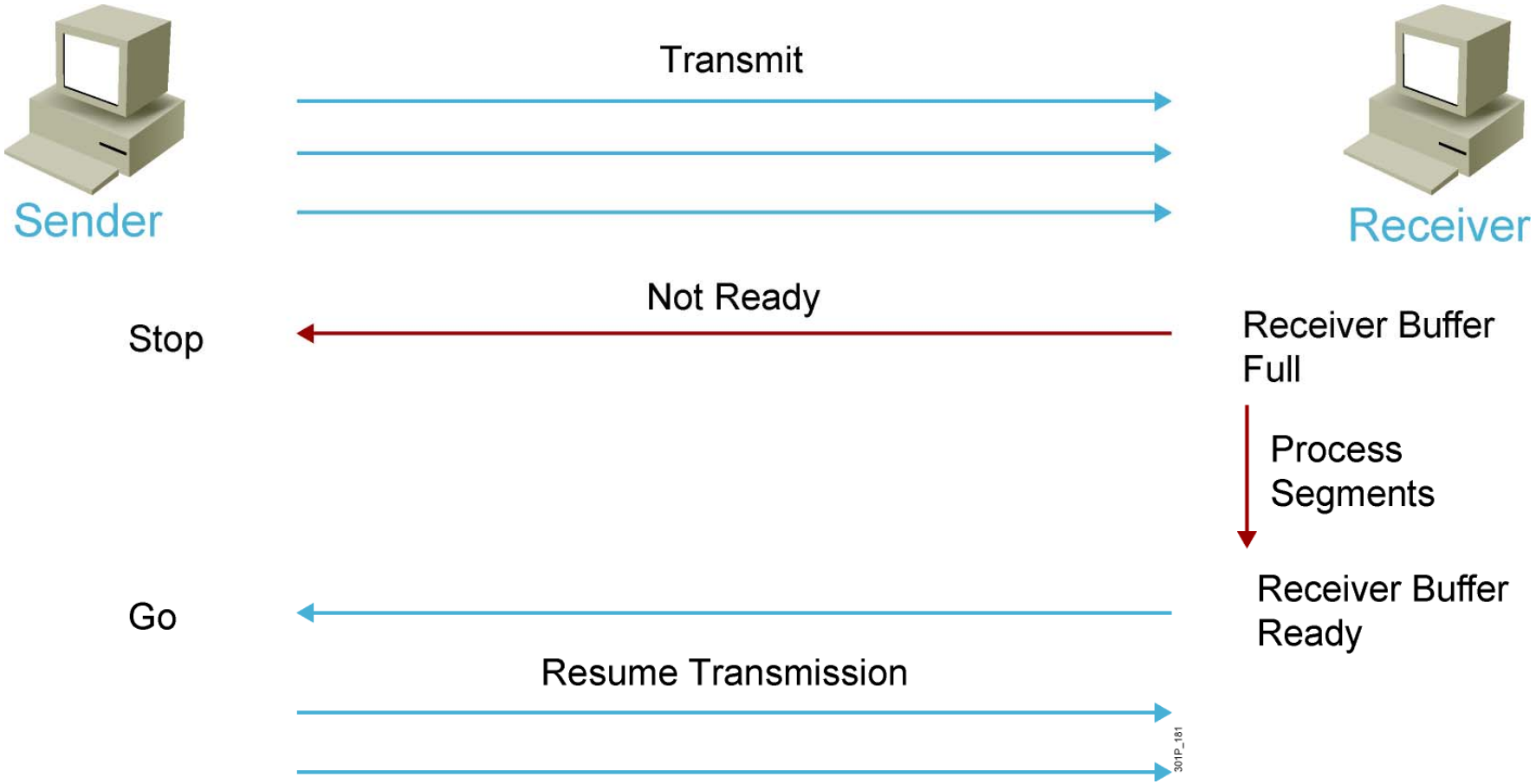


Three-Way Handshake

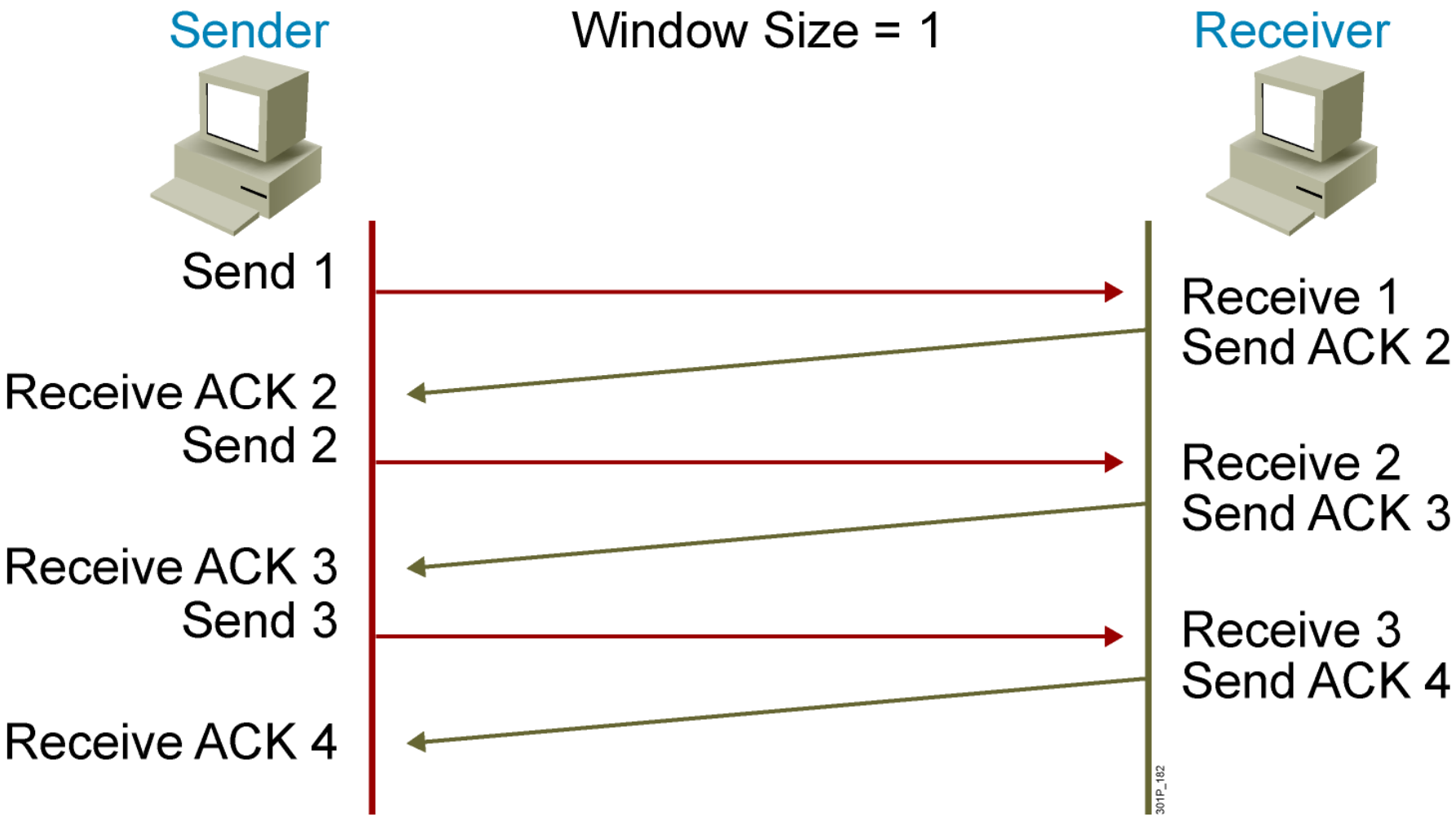


CTL = Which control bits in the TCP header are set to 1

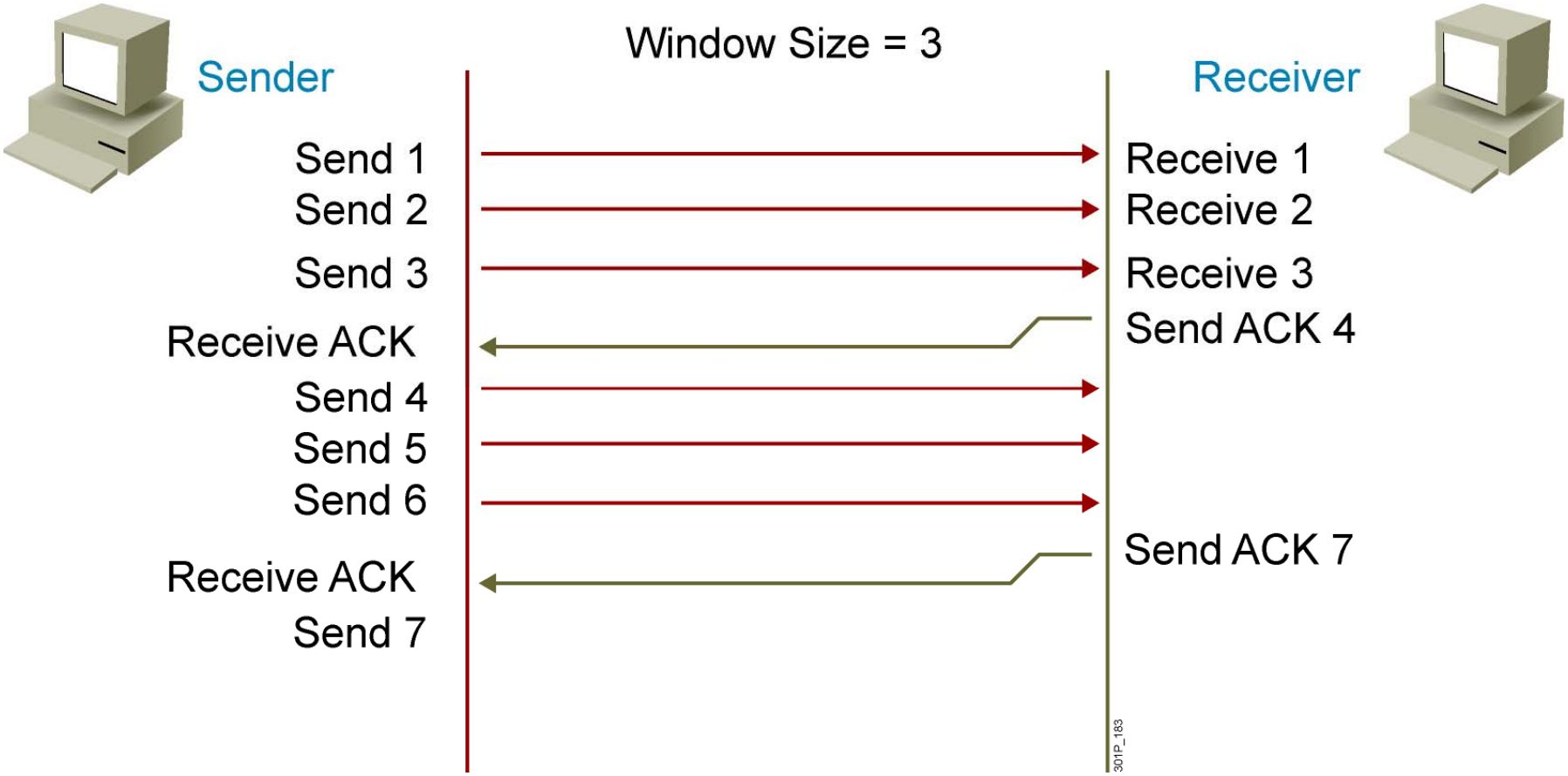
Flow Control



TCP Acknowledgment



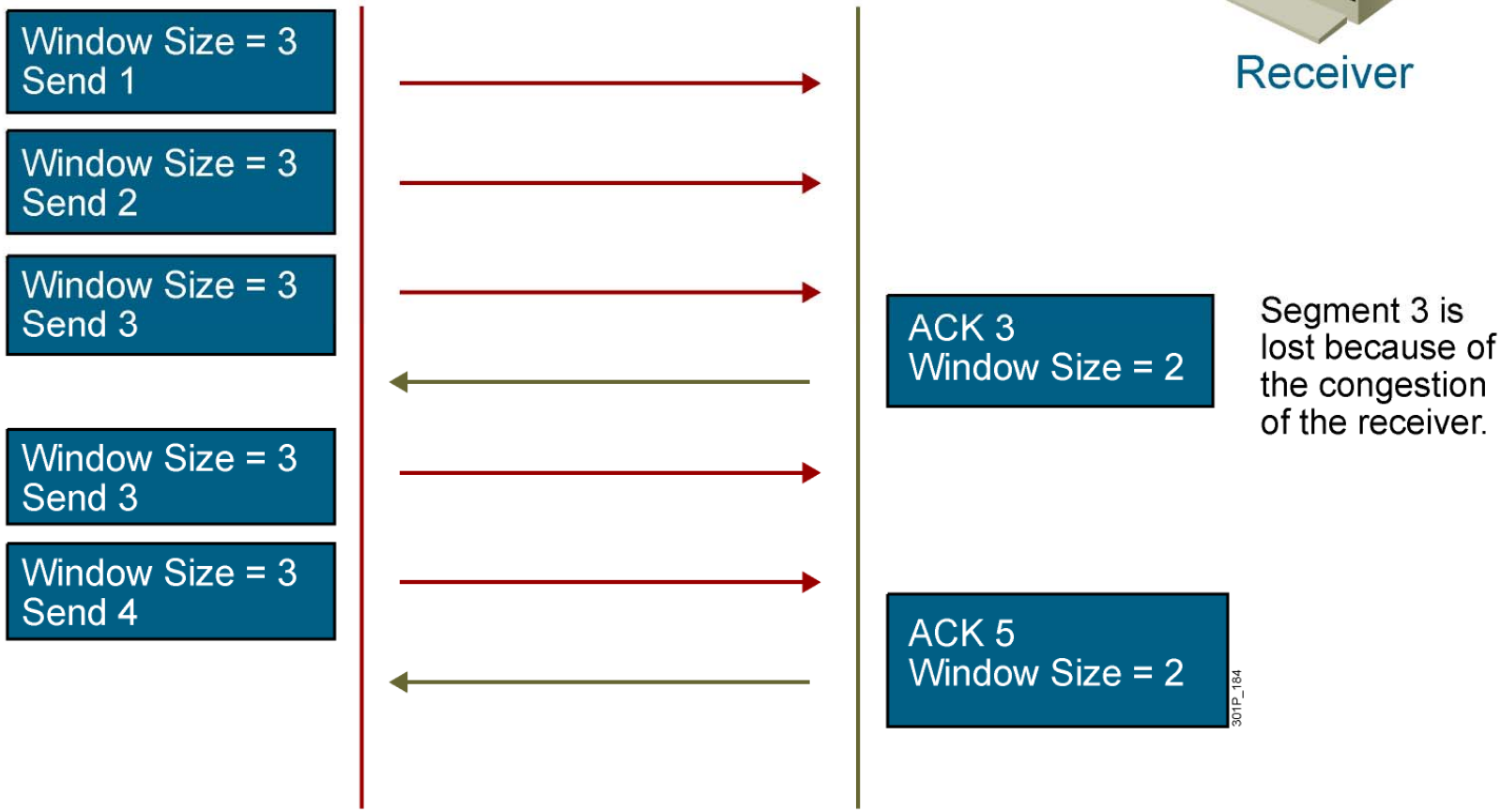
Fixed Windowing



TCP Sliding Windowing

Sender

Receiver



Summary

- Connection-oriented transport provides reliable transport; connectionless transport provides best-effort transport.
- UDP is a protocol that operates at the transport layer and provides applications with access to the network layer without the overhead of the reliability mechanisms of TCP. UDP is a connectionless, best-effort delivery protocol.
- TCP is a protocol that operates at the transport layer and provides applications with access to the network layer. TCP is connection-oriented, provides error checking, delivers data reliably, operates in full-duplex mode, and provides some data recovery functions.

Summary (Cont.)

- TCP/IP supports a number of applications, including FTP, TFTP (transfers configuration files and Cisco IOS images), and Telnet (provides capability to remotely access another computer).

- Port numbers are used to map Layer 4 to an application.

Summary (Cont.)

- Flow control avoids the problem of a transmitting host overflowing the buffers in the receiving host and slowing network performance.
- TCP provides sequencing of segments with a forward reference acknowledgment. When a single segment is sent, receipt is acknowledged and the next segment is then sent.

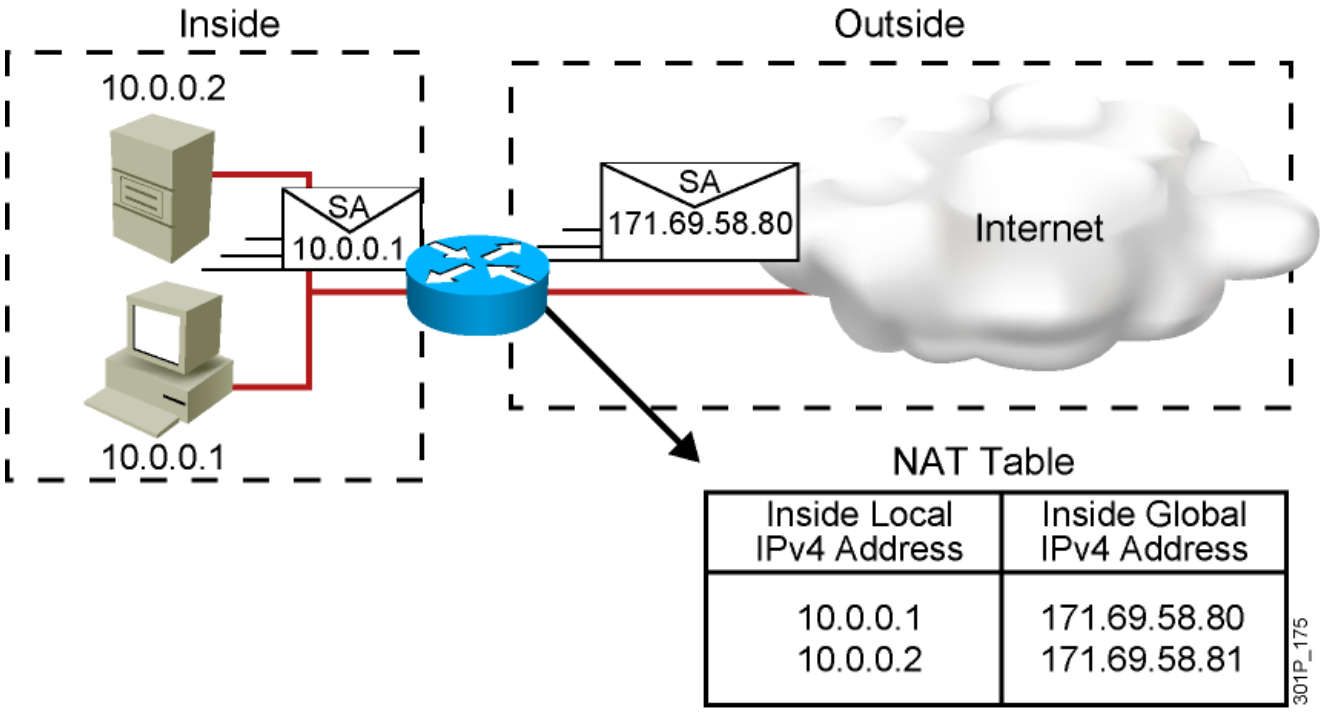
Summary (Cont.)

- The TCP window size decreases the transmission rate to a level at which congestion and data loss do not occur. The TCP window size allows a specified number of unacknowledged segments to be sent.
- A fixed window is a window with an unchanging size that can accommodate a specific flow of segments.
- A TCP sliding window is a window that can change size dynamically to accommodate the flow of segments.
- TCP provides the sequencing of segments by providing sequence numbers and acknowledgment numbers in TCP headers.

Scaling the Network with NAT and PAT

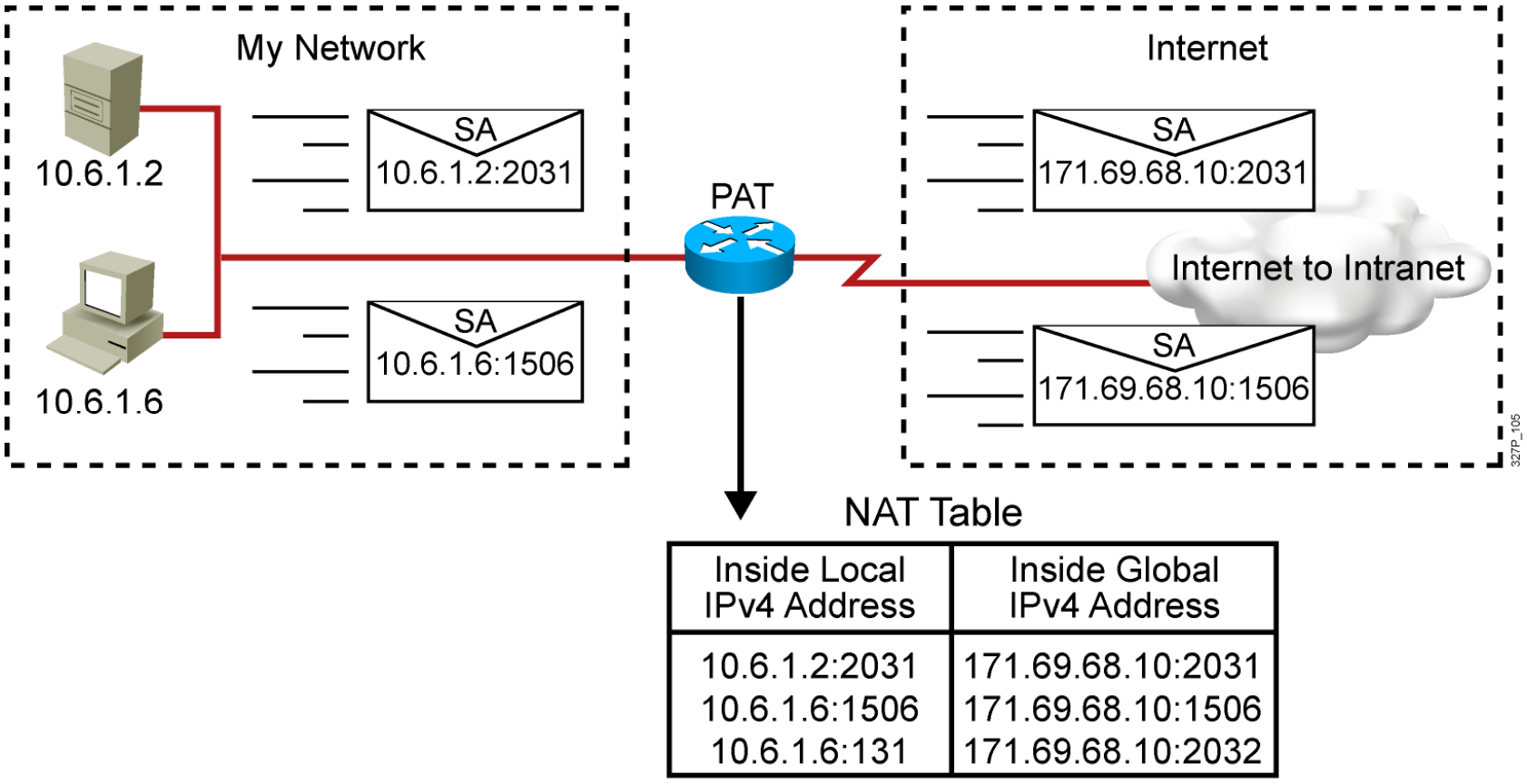
Address Space Management

Network Address Translation



- **An IP address is either local or global.**
- **Local IPv4 addresses are seen in the inside network.**
- **Global IPv4 addresses are seen in the outside network.**

Port Address Translation



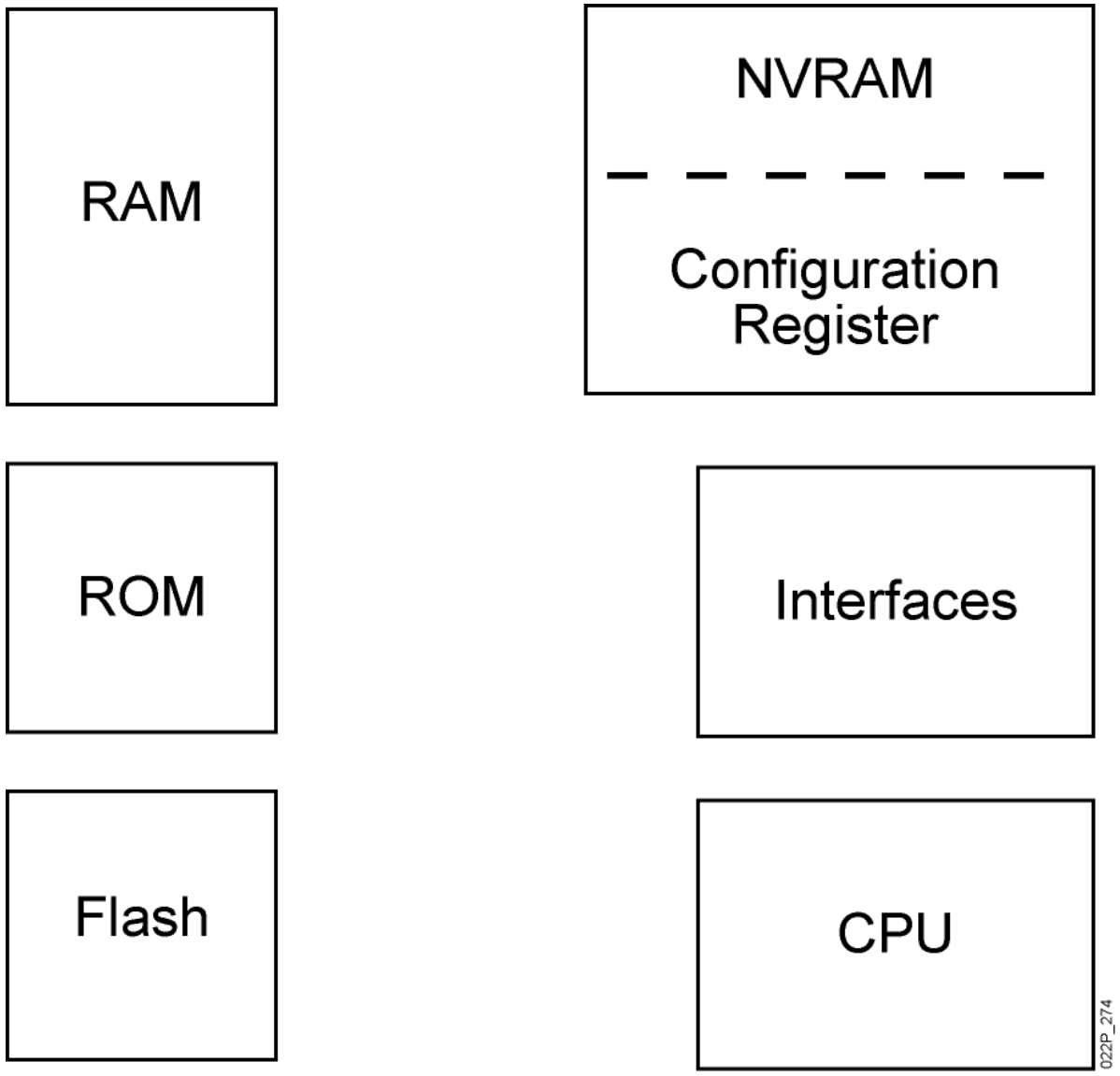
Managing Router Startup and Configuration

Network Environment Management

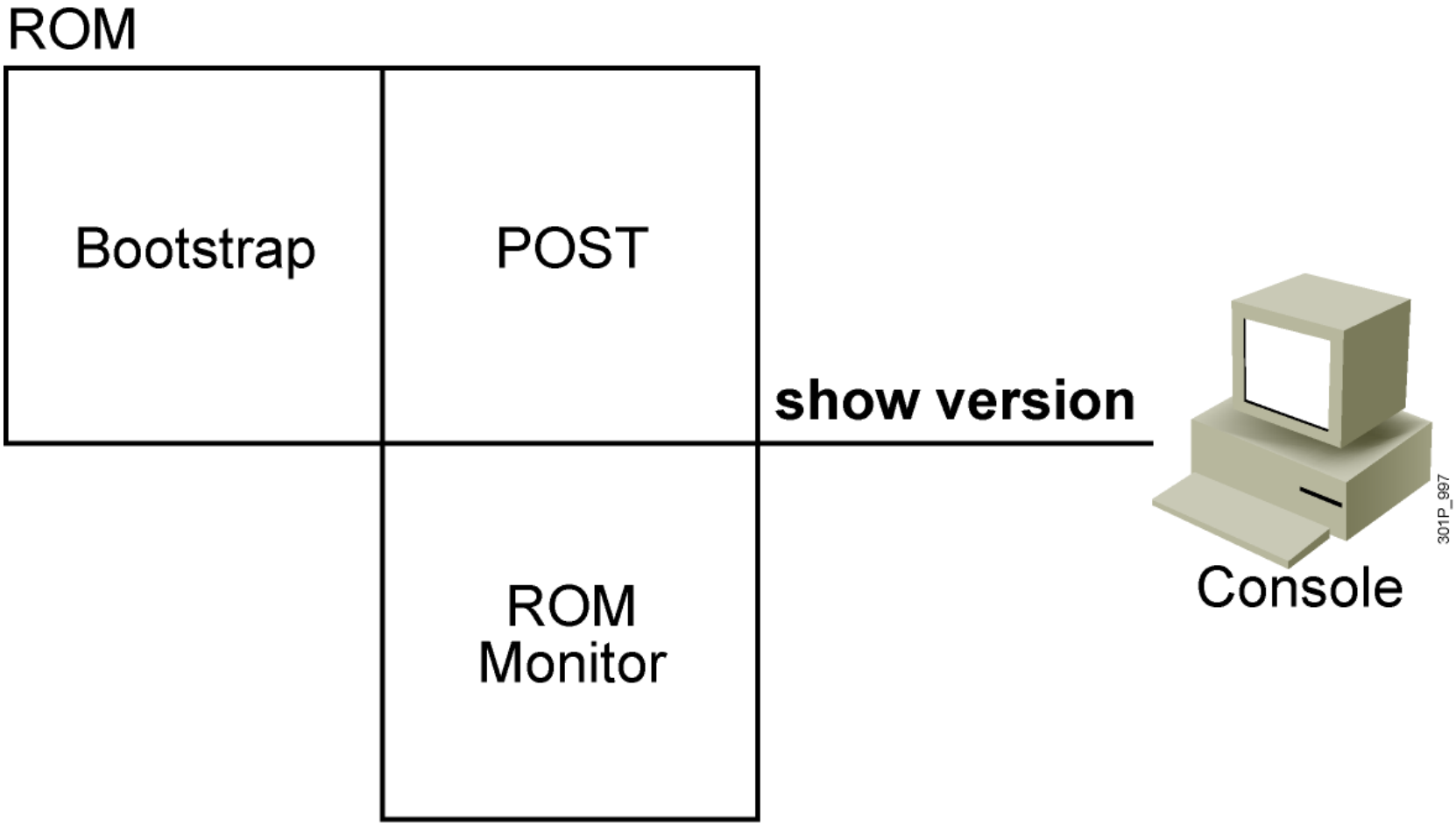
Router Power-On Boot Sequence

1. Perform power-on self-test (POST).
2. Load and run bootstrap code.
3. Find the Cisco IOS Software.
4. Load the Cisco IOS Software.
5. Find the configuration.
6. Load the configuration.
7. Run the configured Cisco IOS Software.

Router Internal Components

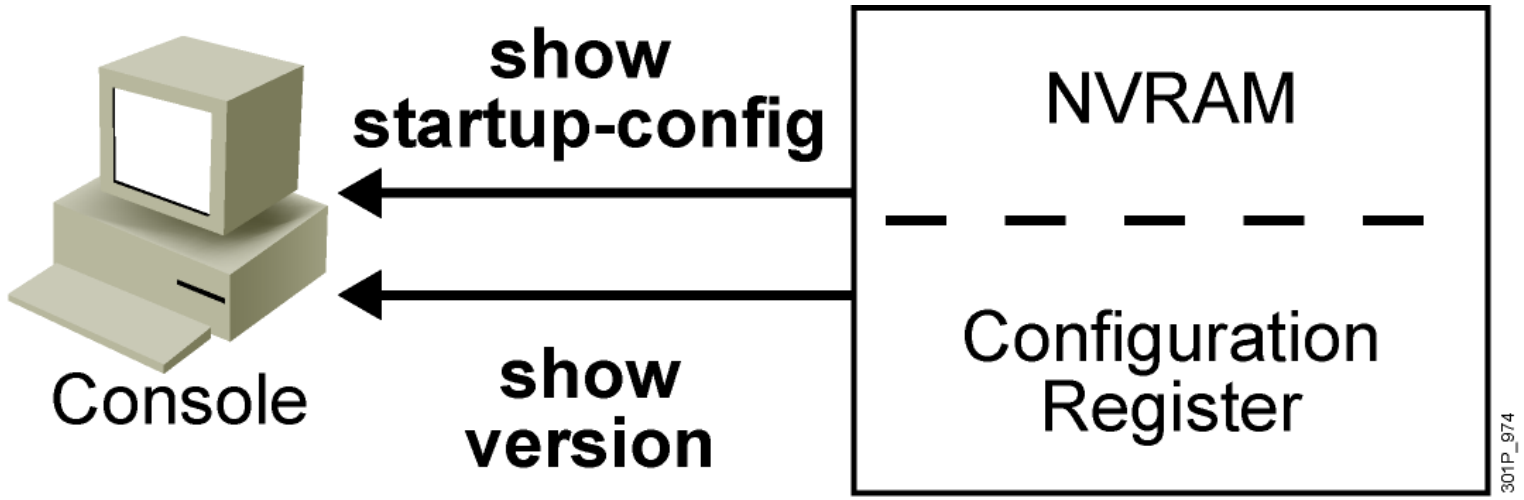


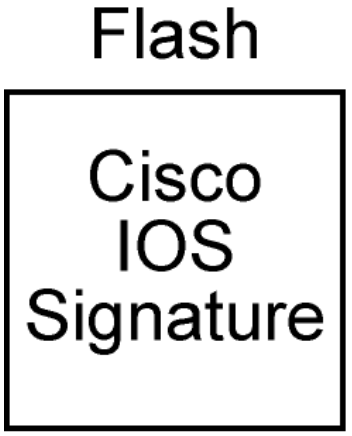
ROM Functions



Contains microcode for basic functions

Finding the Cisco IOS Image

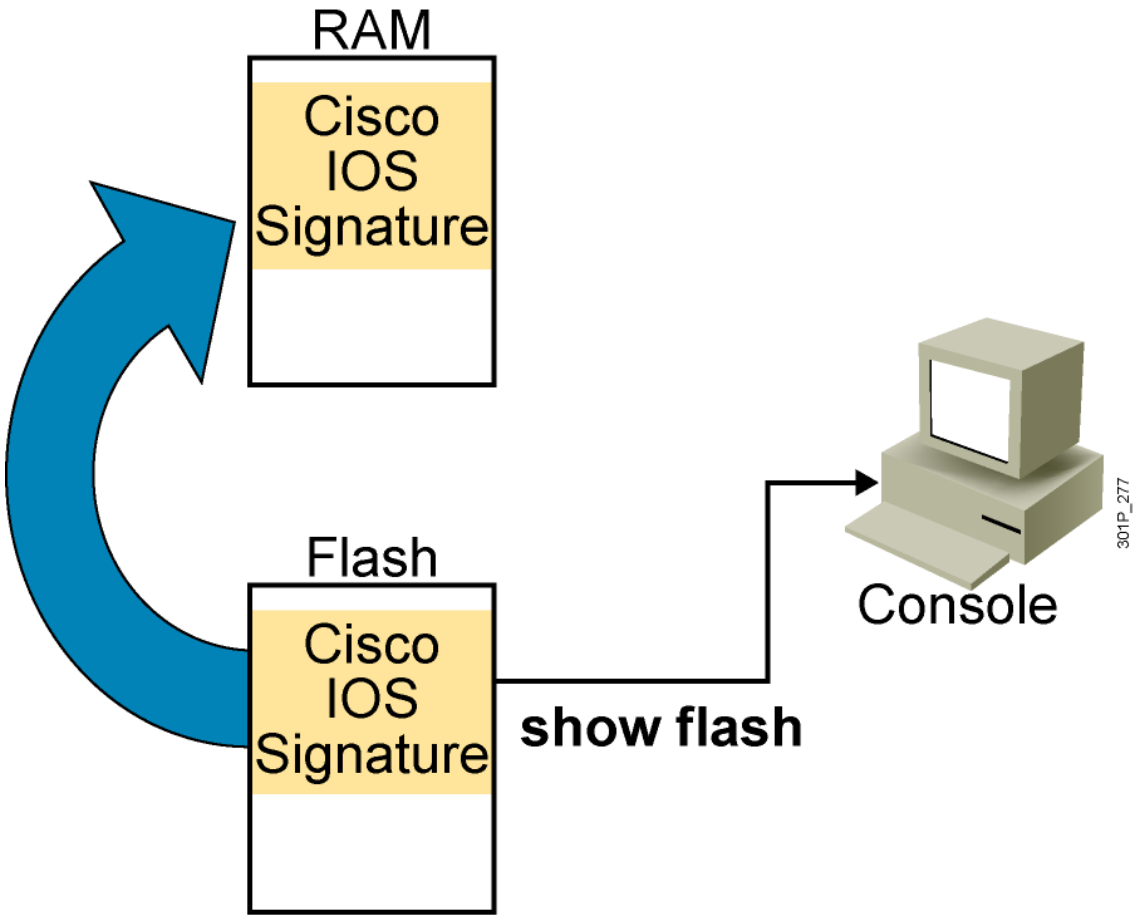




Order of search:

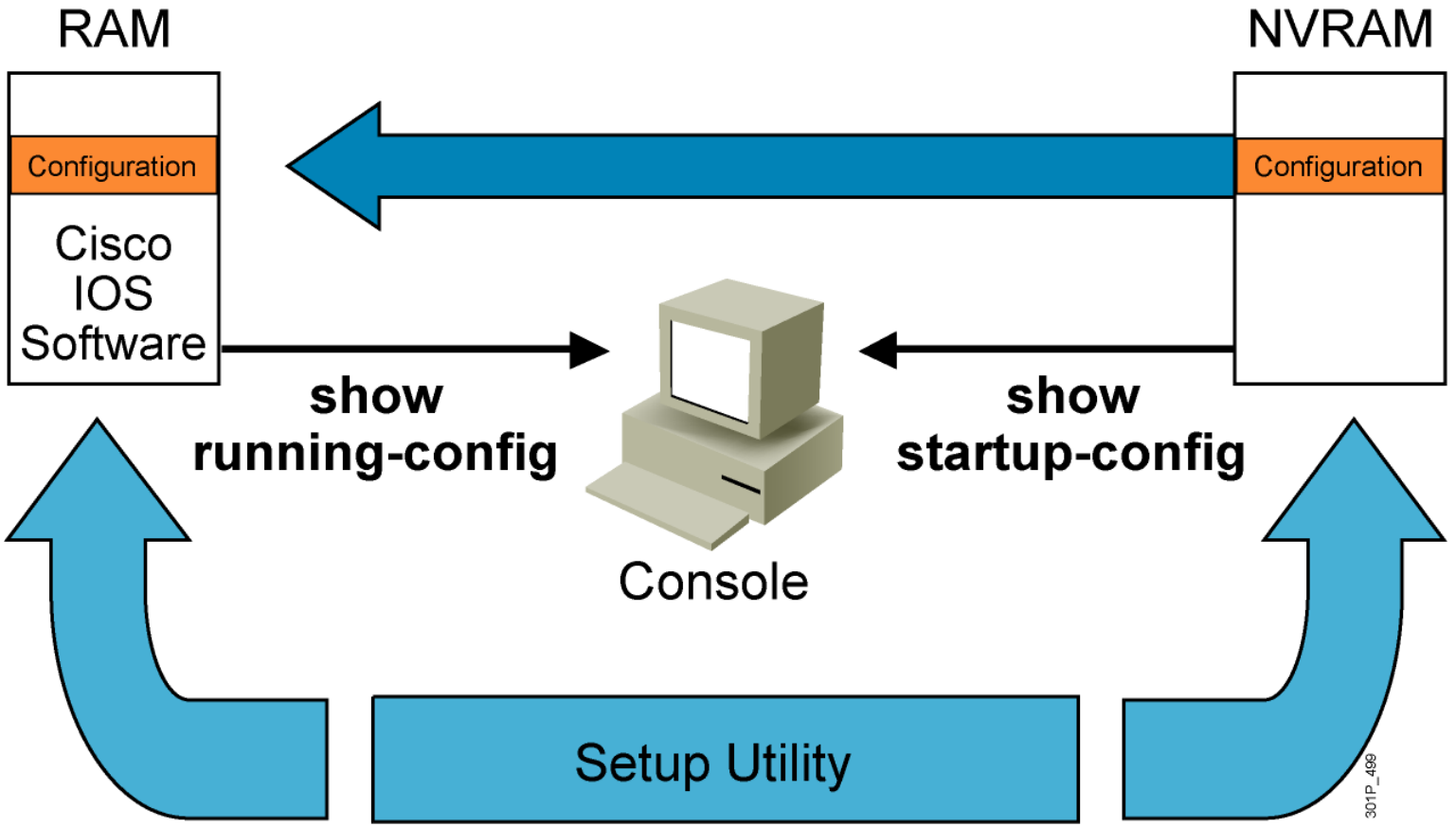
1. Checks configuration register
2. Parses configuration for boot system command
3. Defaults to first file in flash memory

Loading the Cisco IOS Image from Flash Memory



The flash memory file is loaded into RAM.

Loading the Configuration



- Load and execute the configuration from NVRAM
- If no configuration is present in NVRAM, enter setup mode

show running-config **and** show startup-config **Commands**

In RAM

```
RouterX#show running-config
Building configuration...??
Current configuration:?
!?
version 12.2
!
     -- More --
```

In NVRAM

```
RouterX#show startup-config
Using 1359 out of 32762 bytes
!
version 12.2
!
     -- More --
```

Displays the current and saved configuration

show version **Command**

```
Cisco IOS Software, 2800 Software (C2800NM-IPBASE-M), Version
12.4(5a), RELEASE SOFTWARE (fc3)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2006 by Cisco Systems, Inc.
Compiled Sat 14-Jan-06 03:19 by alnguyen

ROM: System Bootstrap, Version 12.4(1r) [hqluong 1r], RELEASE
SOFTWARE (fc1)

RouterX uptime is 1 week, 5 days, 21 hours, 30 minutes
System returned to ROM by reload at 23:04:40 UTC Tue Mar 13 2007
System image file is "flash:c2800nm-ipbase-mz.124-5a.bin"

Cisco 2811 (revision 53.51) with 251904K/10240K bytes of memory.
Processor board ID FTX1013A1DJ
2 FastEthernet interfaces
2 Serial(sync/async) interfaces
DRAM configuration is 64 bits wide with parity enabled.
239K bytes of non-volatile configuration memory.
62720K bytes of ATA CompactFlash (Read/Write)

Configuration register is 0x2102 (will be 2104 at next reload)
```

show flash **Command**

```
RouterX#sh flash
-#- --length-- -----date/time------ path
1     14951648 Feb 22 2007 21:38:56 +00:00 c2800nm-ipbase-mz.124-5a.bin
2         1823 Dec 14 2006 08:24:54 +00:00 sdmconfig-2811.cfg
3      4734464 Dec 14 2006 08:25:24 +00:00 sdm.tar
4       833024 Dec 14 2006 08:25:38 +00:00 es.tar
5      1052160 Dec 14 2006 08:25:54 +00:00 common.tar
6         1038 Dec 14 2006 08:26:08 +00:00 home.shtml
7       102400 Dec 14 2006 08:26:22 +00:00 home.tar
8       491213 Dec 14 2006 08:26:40 +00:00 128MB.sdf

41836544 bytes available (22179840 bytes used)
```

Summary

- When a router boots, it performs tests, finds, and loads software, finds and loads configurations, and finally runs the software.
- The major internal components of a router include RAM, ROM, flash memory, NVRAM, and the configuration register.
- When a router boots, it searches for the Cisco IOS Software image in a specific sequence: location specified in the configuration register, flash memory, a TFTP server, and ROM.
- The configuration register includes boot information specifying where to locate the Cisco IOS Software image. The register can be examined with a **show** command and change the register value with the **config-register** global configuration command.