Socket
and
Network Programming

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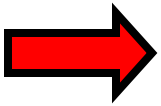
Contents



- Network Concepts
- Socket
- Related Data Structures
- Related System Calls and Commands

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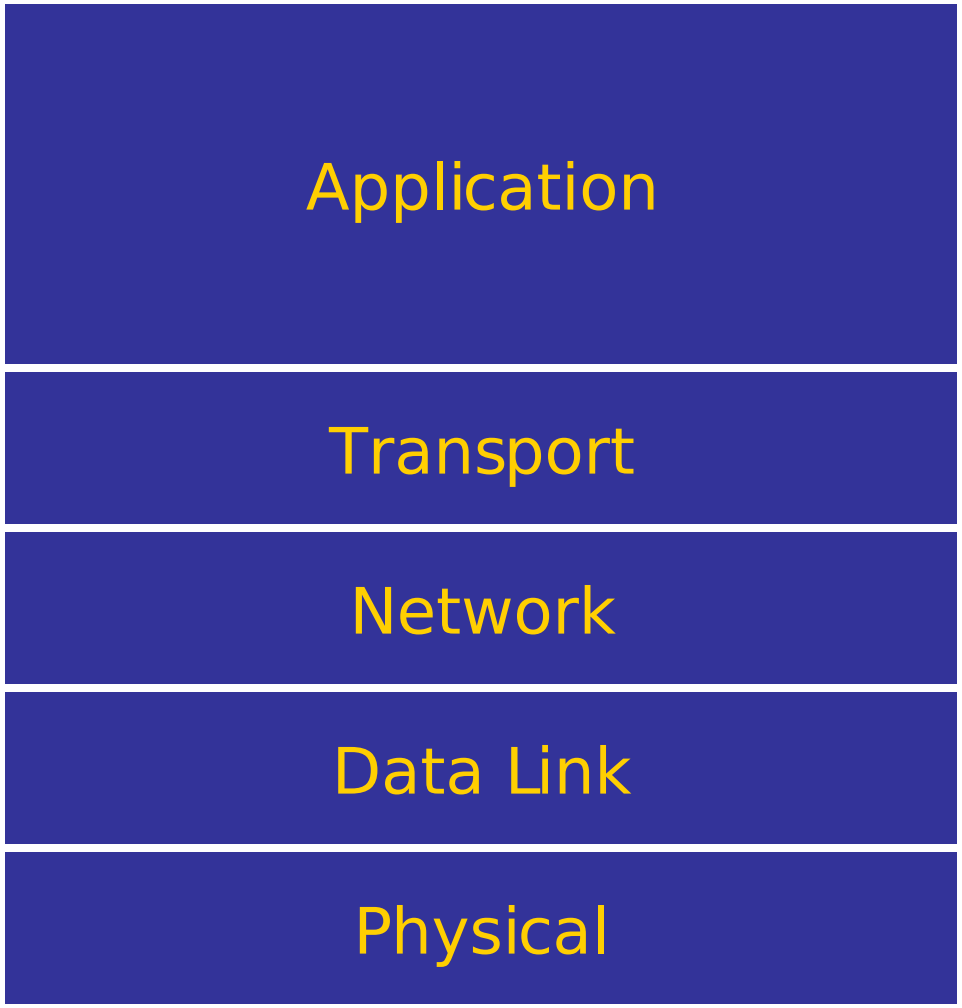
Network Layers



End-to-End Connection

Routing

Framing

Physical topology

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Physical Layer

- It sends bits and receives bits.

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Data Link Layer

- It ensures that messages are delivered to the proper device.
- It translates messages from the Network layer into bits for physical layer to transmit.
  - It formats the message into data frames.
  - It adds a header containing the hardware destination and source address.

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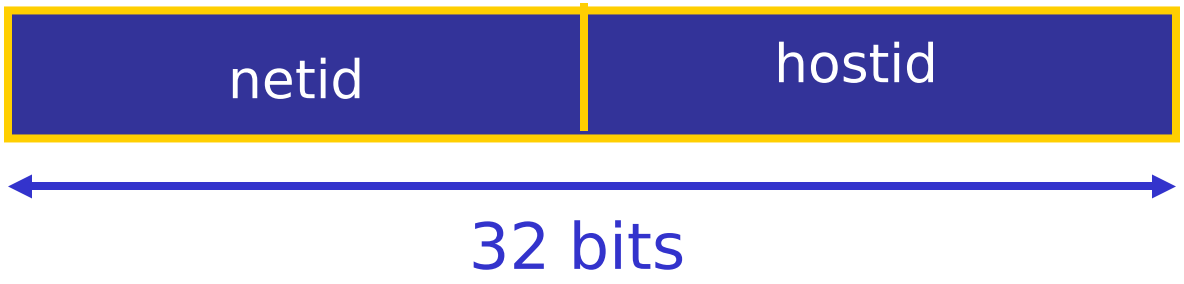
Network Layer

- It is responsible for routing through an internetwork and for network addressing.
  - It is responsible for transporting traffic between devices that are not locally attached.
- It uses software address.



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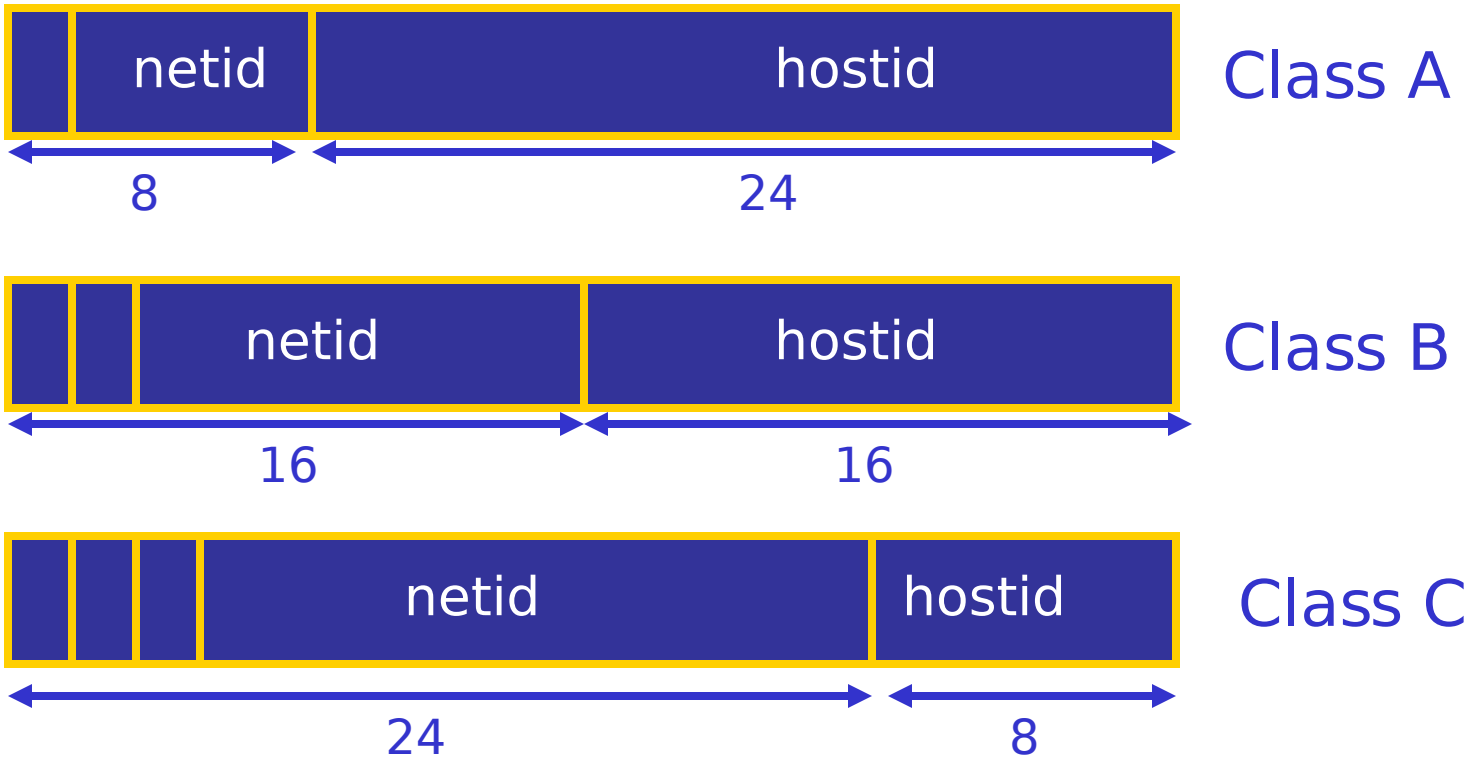
IP Addresses



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Transport Layer

- Flow control
  - It prevents a sending host on one side of connection from overflowing the buffers in the receiving host.
- Acknowledgment
  - It guarantees the data won't be duplicated or lost.
- Windowing
  - It controls how much information is transferred from one end to the other.

Network Connections

- The Transport layer provide two types of connection:
- Connection-less (UDP)
  - It is an unreliable connection.
- Connection-oriented (TCP)
  - It handshakes before transfers information.

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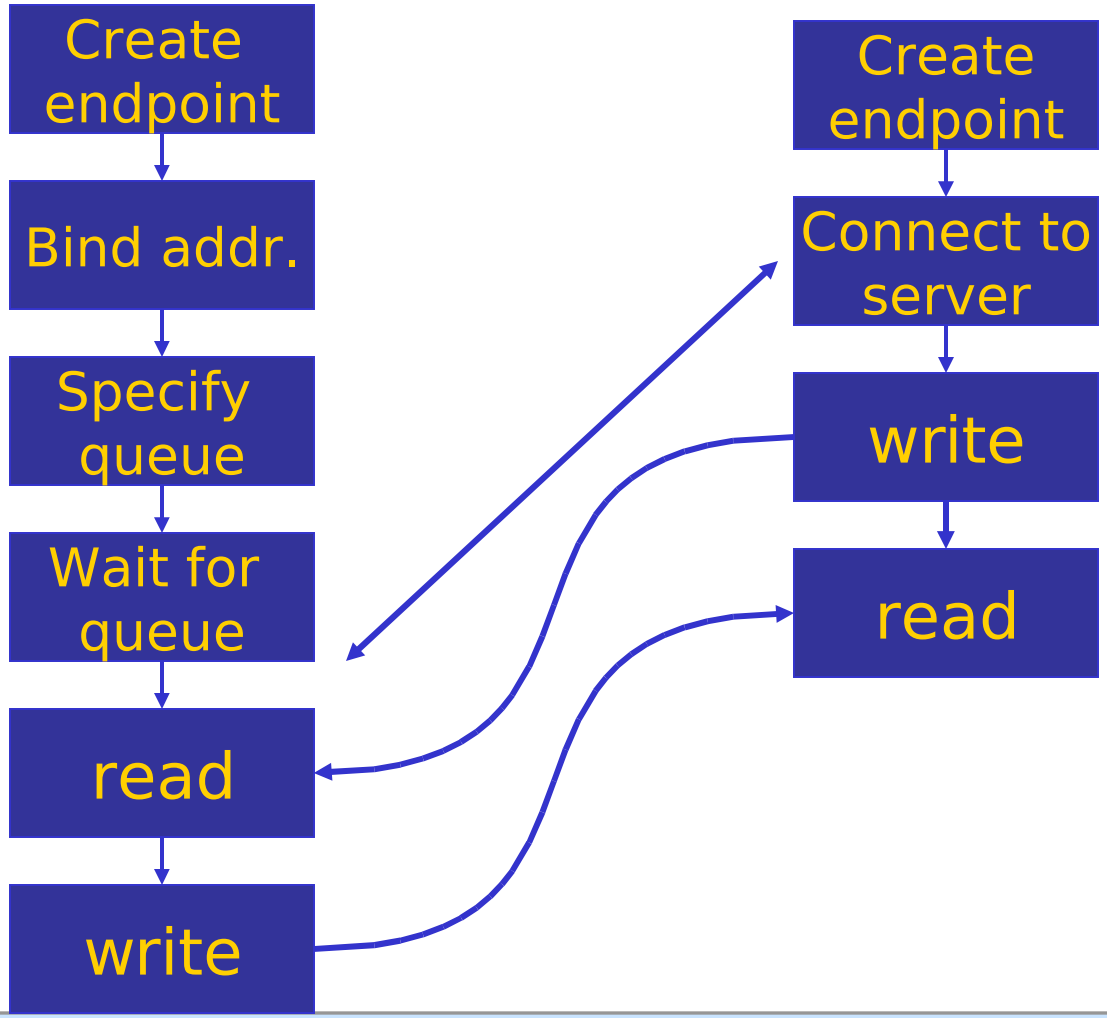
Connection-oriented



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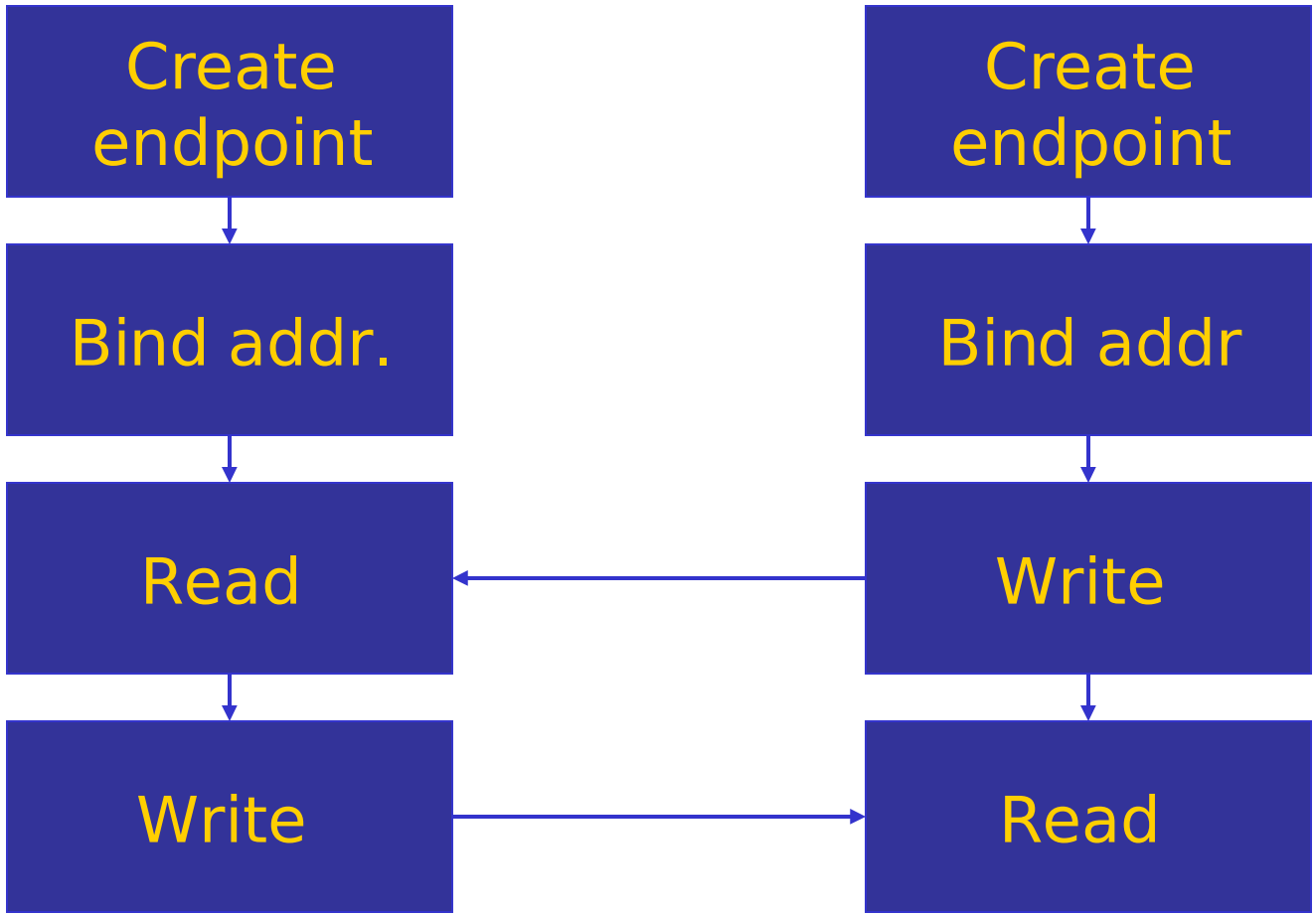
Connection-less



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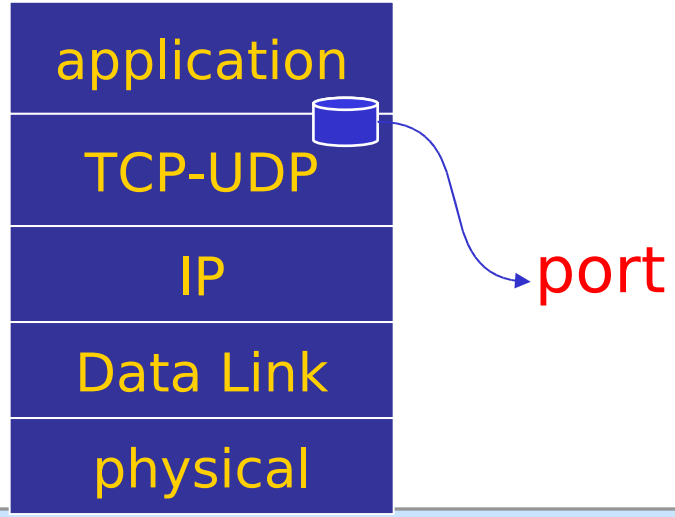
Port Numbers

- It is possible for more than one user process at a time to be using either TCP or UDP.
- This requires some method for identifying the data associated with each user process.



5-Tuple Association

{ protocol, src port, src addr, dst port, dst addr }

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Socket

- It is an interface between the application layer and other layers.

```
main()
{
   FILE *fd;
   fd = fopen (...);
   process (fd);
   fclose (fd);
}
```

```
main()
{
   int sockfd;
   sockfd = socket (...);
   process (sockfd);
   close (sockfd);
}
```

Type of Sockets

- Stream Socket
  - Provide a reliable, sequenced, two-way connection.
  - This is use TCP Socket.
- Datagram Socket
  - A connection-less and unreliable connection.
  - This is use UDP Socket.
- Raw Socket
  - Used for internal network protocols.

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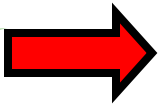

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Data Structures

```
struct sockaddr {
    unsigned short    sa_family;    // address family, AF_xxx
    char              sa_data[14];  // 14 bytes of protocol address
};
```

```
struct sockaddr_in {
    short int          sin_family;  // Address family
    unsigned short int sin_port;    // Port number
    struct in_addr     sin_addr;    // Internet address
    unsigned char      sin_zero[8]; // Same size as struct sockaddr
};
```

```
struct in_addr {
    unsigned long s_addr; // that's a 32-bit long, or 4 bytes
};
```

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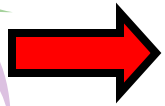

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Byte Ordering Routines

- htons() // "Host to Network Short"
- htonl() // "Host to Network Long"
- ntohs() // "Network to Host Short"
- ntohl() // "Network to Host Long"

Address Conversion Routines

- inet_addr_t inet_addr (char *cp);
  - Converts the Internet host address cp from numbers-and-dots notation into binary data in network byte order.
- int inet_aton (char *cp, struct in_addr *inp);
  - Converts the Internet host address cp from numbers-and-dots notation into binary data.
- char *inet_ntoa (struct in_addr in);
  - Converts the Internet host address given in network byte order to a string in standard numbers-and-dots notation.

socket System Call

- int socket (int family, int type, int protocol);
- It creates the end point.
- Family:
  - AF_INET, AF_UNIX, ...
- Type:
  - SOCK_STREAM
  - SOCK_DGRAM
  - SOCK_RAW

bind System Call

- int bind (int sockfd, struct sockaddr *addr, int addrlen);
- It assigns a name to an unnamed socket.

connect System Call

- int connect (int sockfd, struct sockaddr *addr, int addrlen);
- A client use it to establish a connection with a server.

listen System Call

- int listen (int sockfd, int backlog);
- This system call is used by connection-oriented to indicate that it is willing to receive connections.

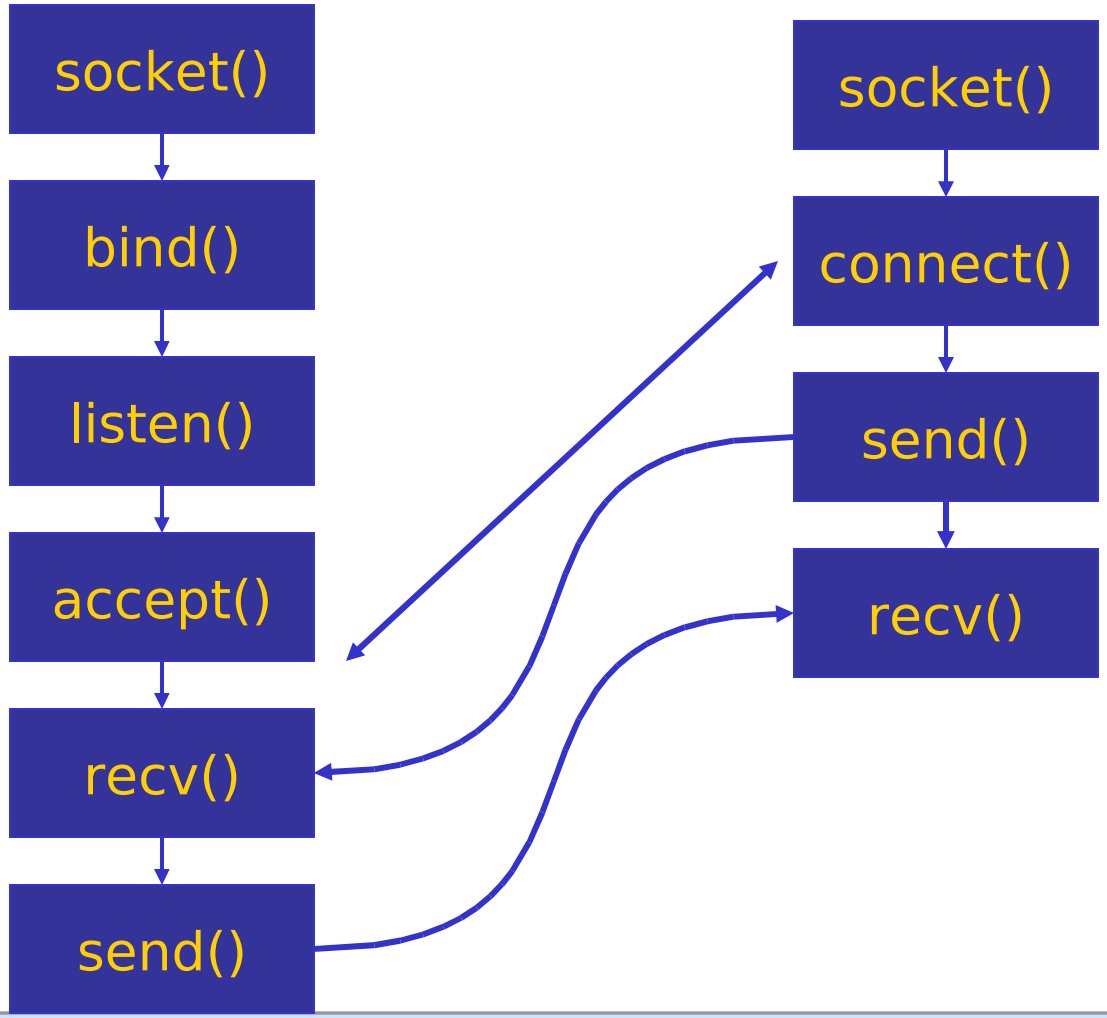
accept System Call

- int accept (int sockfd, struct sockaddr *addr, int *len);
- An incoming calls arrive at a listening socket, they will be queued until the server program ready to process them.

send and recv System Calls

- int send (int sockfd, char *buff, int len., int flag);
- int sendto (int sockfd, char *buff, int len., int flag, struct sockaddr *to, int addrlen);
- int recv (int sockfd, char *buff, int len., int flag);
- int recvfrom (int sockfd, char *buff, int len., int flag, struct sockaddr *from, int *addrlen);

Connection-oriented



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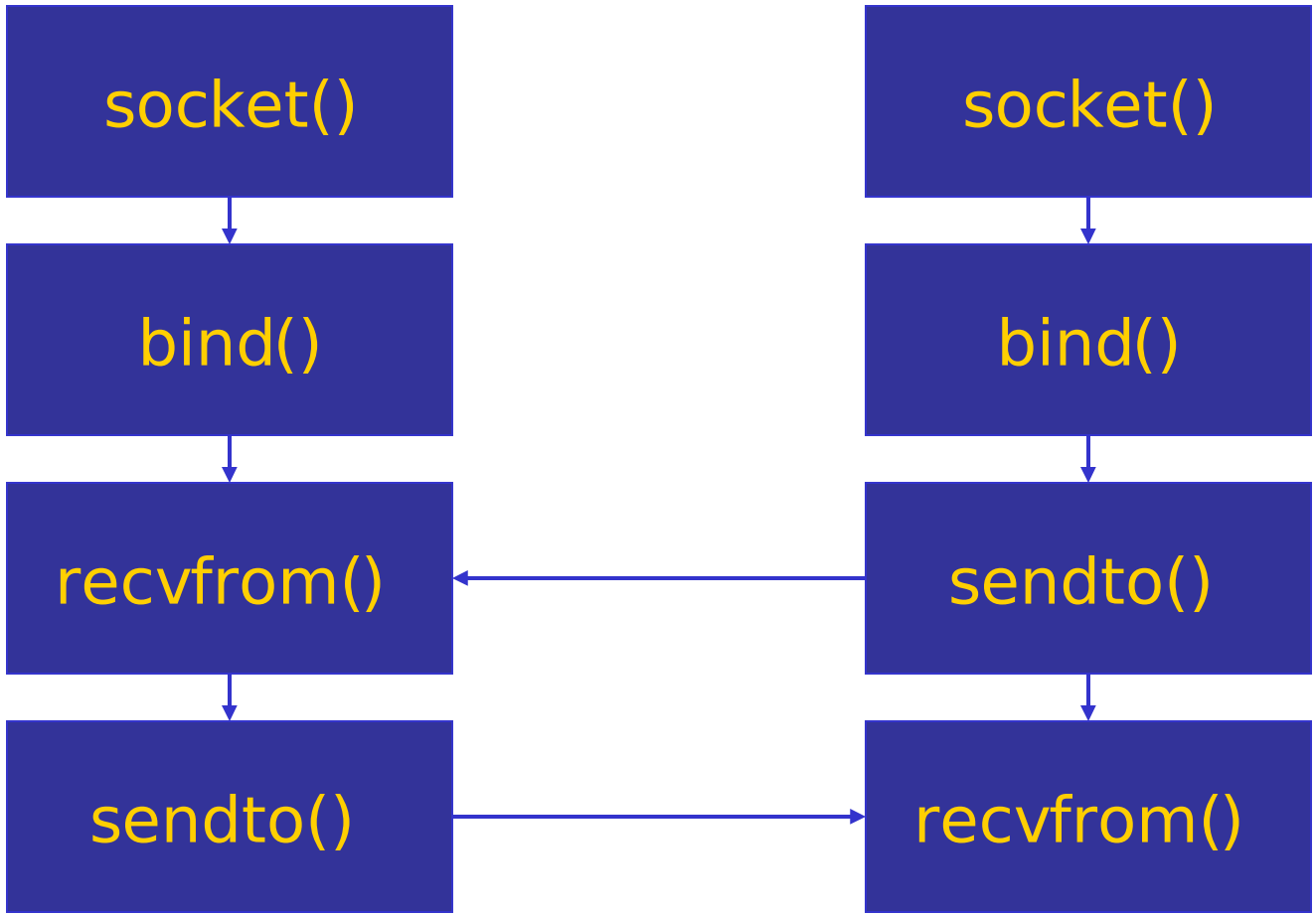
Connection-less



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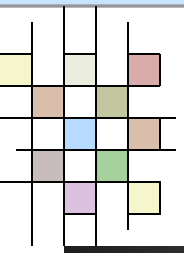

Question?

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