# Networking: IPv4 - AF_INET

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*Slides adapted from Dr. B. Fraser*

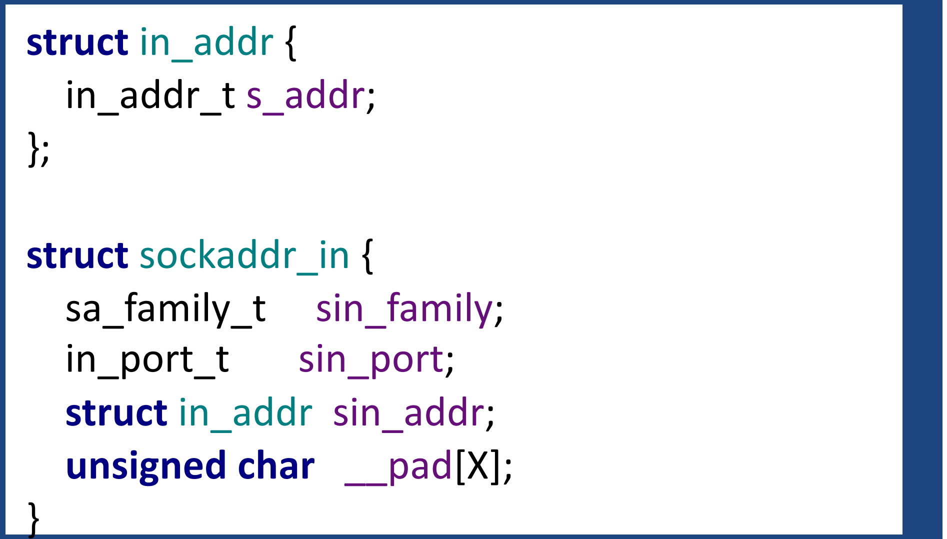
# Topics

- How can we use sockets on a network (AF_INET)?
- How do different computer architectures agree on a data format?

# AF_INET
# Data Structure

# AF_INET and AF_INET6

- IP Addresses
  - IPv4: AF_INET uses 4 bytes for IP addresses:
    e.g., 192.168.7.2
  - IPv6: AF_INET6 uses 16 bytes for IP addresses.
    e.g., 2F10:C203:A135:DC3F:35:6F2:1:F603
  - More info:
    man 7 ip
    man 7 ipv6
  - We’ll focus on AF_INET.
- AF_INET addresses use struct sockaddr_in
  - .. “in” means Internet



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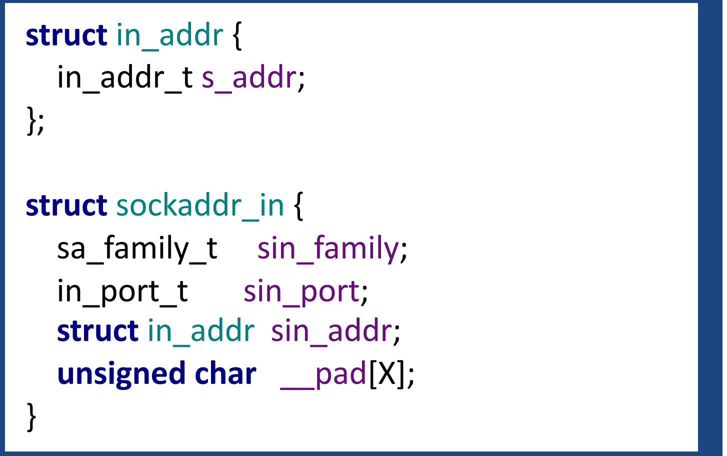
struct in_addr {
   in_addr_t s_addr;
};

struct sockaddr_in {
   sa_family_t     sin_family;
   in_port_t       sin_port;
   struct in_addr  sin_addr;
   unsigned char   __pad[X];
}
```

# sockaddr_in Field: sin_addr

- Binary Format
  - Humans write IPv4 addresses as “192.168.7.1”
    - ‥Computer represents as 4-byte value
- Convert address
  - inet_pton()                    “192.168.0.1” --> binary
    - ‥presentation to network
  - inet_ntop()                    binary --> “192.168.0.1”
    - .. network to presentation
  - These handle both IPv4 and IPv6
- Presentation String Lengths
  - Max string length defined in <netinet/in.h>
  - IPv4: INET_ADDRSTRLEN
    IPv6: INET6_ADDRSTRLEN



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# sin_addr - Two special addresses

- loopback address: 127.0.0.1

sin_addr.s_addr = INADDR_LOOPBACK;

–Local communication, similar to UNIX domain sockets.

–.. Data sent/received locally

i.e., nothing onto network.

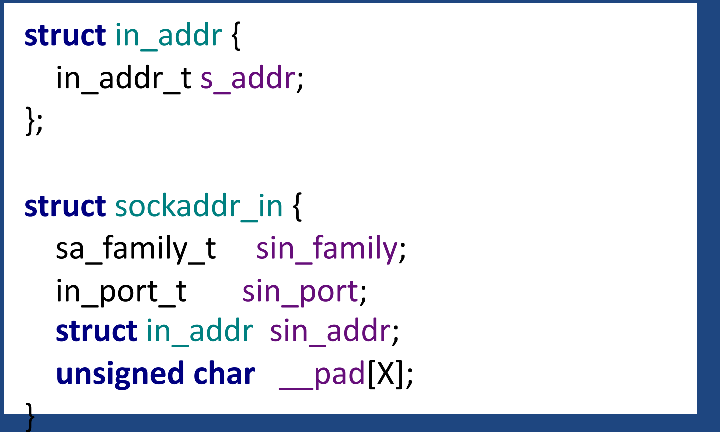
- Wildcard address

sin_addr.s_addr = INADDR_ANY;

–A machine can have multiple network cards,

–e.g., wireless & wiret (Ethernet) card: each with an IP address.

–.. bind() to socket with wildcard address listens to any address.



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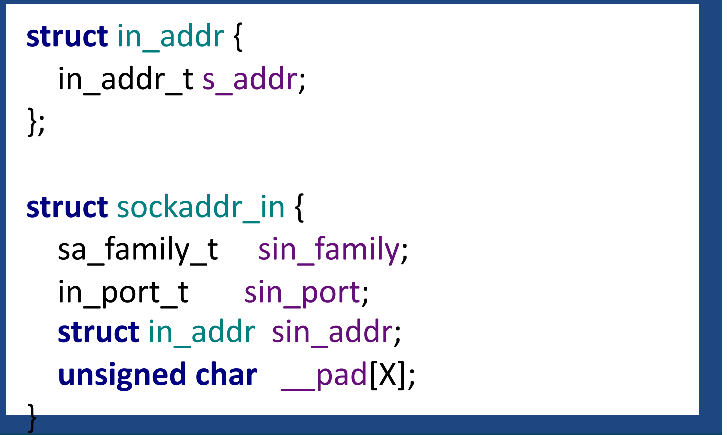
# sockaddr_in Field: sin_port

- bind() needs IP address and port
- ..Port number identifies a specific socket on the machine.
- Some ports are well known, such as:
- SSH: 22
- HTTP: 80
- Clients know to look at these ports.
- .. Ephemeral Port
- If we don't bind() our socket to a specific port, then TCP or UDP picks an unused "random" port.



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# Byte Order
# &
# Hosts

# Byte Order

- Different computer architectures use different byte orders:
  - e.g., consider the number 12345 = 0x3039
  - Little Endian:
    - Store the little part (least-significant byte=LSB) first (at lower address).
  - Big Endian:
    Store the big part (MSB) first (at lower address).
- Network Byte Order
  - Different computers communicate,
    so network must have established byte order.
  - Network Byte Order is Big Endian
  - E.g., port number and the IP address are multi byte,
    so they are sent MSB first.

# Network Byte Order

- Byte-order translation functions

man byteorder

```
#include <arpa/inet.h>
uint32_t htonl(uint32_t hostlong);
uint16_t htons(uint16_t hostshort);
uint32_t ntohl(uint32_t netlong);
uint16_t ntohs(uint16_t netshort);
```

"Host To Network Long", etc.

– ..

- Only for multi-byte values

– single byte data (chars) just sent one at a time.

# Host Names

- Can use a host name instead of an IP address
  - Host name is the computer name.
  - getaddrinfo()

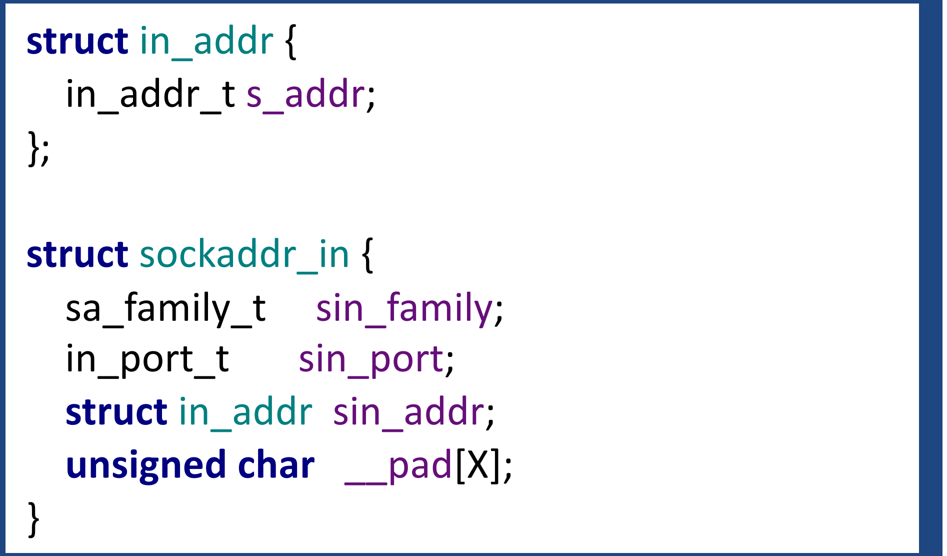
Converts host name (string) to set of all possible options (structs containing an IP and a port number)

- getnameinfo()

performs reverse---IP to host name.

# Activity

- Create two programs, server and client.
  - Implement the socket sequence (TCP stream) using AF_INET
  - Send messages from the client and print them out from the server.
  - Use port 8000 on the server.
- Recall
  - AF_INET uses sockaddr_in



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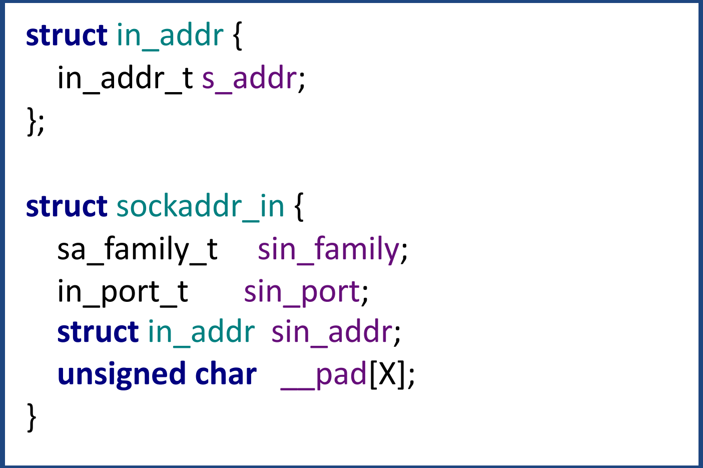
See inet_tcp_server.c, inet_tcp_client.c

# recv() and send()

- ssize_t recv(int sockfd, void *buf, size_t len, int flags);
  - Similar to read() but socket specific.
  - Provides more control, e.g.:
    - MSG_DONTWAIT: Non-blocking
    - MSG_PEEK: read but don't remove
- ssize_t send(int sockfd, const void *buf, size_t len, int flags);
  - Similar to write() but socket specific.
  - Provides more control
    e.g.: MSG_DONTWAIT: Non-blocking

# Summary

- Use AF_INET for IPv4



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```

- Network Byte Order
  - Big-Endian: Biggest byte is first.