Housekeeping

• Defer discussion of performance to next week
• Questions?
• Lecture Slides on class web site – now PDF format
• EECS accounts: mail info to jding1@eecs.wsu.edu
• Need the access code for ETRL 301? See the EECS systems staff in Sloan 358
• Agenda for today:
  – Implementation structure for protocol end-nodes
  – Feedback/Assessment

Lab Info

• Lab machines are: nif-c10 to nif-c25, nif-c6, nif-c7, nif-c33, nif-c39
• Need ssh version 2 to access remotely
  – www.ssh.com, www.openssh.org,
    www.appgate.com/products/mindterm/
• Or .. Use ssh v1 to connect to nif-s3 and then use the ssh version 2 installed there to get to the other machines

Elements of a Protocol Implementation

Outline
  Service Interface
  Process Model
  Common Subroutines
  Example Protocol

OSI Architecture
Interfaces

 Socket API

- Creating a socket
  ```
  int socket(int domain, int type, int protocol)
  ```
  • domain = PF_INET, PF_UNIX
  • type = SOCK_STREAM, SOCK_DGRAM

- Passive Open (on server)
  ```
  int bind(int socket, struct sockaddr *addr, int addr_len)
  ```
  ```
  int listen(int socket, int backlog)
  ```
  ```
  int accept(int socket, struct sockaddr *addr, int addr_len)
  ```

Sockets (cont)

- Active Open (on client)
  ```
  int connect(int socket, struct sockaddr *addr, int addr_len)
  ```

- Sending/Receiving Messages
  ```
  int send(int socket, char *msg, int mlen, int flags)
  ```
  ```
  int recv(int socket, char *buf, int blen, int flags)
  ```

Protocol-to-Protocol Interface

- Configure multiple layers
  – static versus extensible

- Process Model
  – avoid context switches

- Buffer Model
  – avoid data copies
**PPI Configuration**

```
name=tulip;
name=eth llp=tulip;
name=arp llp=eth;
name=ip llp=eth,arp;
name=icmp llp=ip;
name=udp llp=ip;
name=tcp llp=ip;
```

**PPI Process Model**

- **Process-per-Protocol**
  - Send
  - Rcv
  - Deliver

- **Process-per-Message**
  - Send
  - Rcv

**PPI Machinery**

- Multiplexing and Demultiplexing (demux key)
- Encapsulation (header/body)

**Message Library**

- **Add header**
  ```
  bcopy("xyz", hdr, 3);
  msgAddHdr(m, hdr, 3);
  ```

- **Strip header**
  ```
  hdr = msgStripHdr(m, 3);
  ```
Message Library (cont)

• Fragment message
  \[ \text{msgFragment}(m, \text{new}, 3); \]

• Reassemble messages
  \[ \text{msgReassemble}(\text{new}, m_1, m_2); \]

Message Library Discussion

• Data Structures for messages
• Memory management
• Concurrency

Map Library

• Demultiplex Packets
• Operations

  \[
  \begin{align*}
  \text{Map} & \quad \text{mapCreate} \left( \text{int number}, \text{int size} \right) \\
  \text{Binding} & \quad \text{mapBind} \left( \text{Map map}, \\
  & \quad \quad \quad \text{void *key}, \\
  & \quad \quad \quad \text{void *id} \right) \\
  \text{XkReturn} & \quad \text{mapResolve} \left( \text{Map map}, \\
  & \quad \quad \quad \text{void *key}, \text{void **id} \right)
  \end{align*}
  \]

Map Library Discussion

• Data structures
• Memory management
• Concurrency
Event Library

• Scheduling Timeouts & Book-keeping activity

• Operations

    Event evSchedule(EvFunc function,
                     void *argument,
                     int time)

    EvCancelReturn evCancel(Event event)