Elements of a Protocol Implementation

Outline
- Service Interface
- Process Model
- Common Subroutines
- Example Protocol

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)

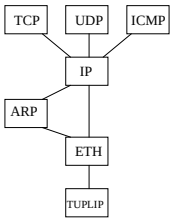
Sockets (cont)

- 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

Configuration




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


Protocol Objects

- Active Open

```
Sessn xOpen(Protl hlp, Protl llp,
            Part *participants)
```

- Passive Open

```
XkReturn xOpenEnable(Protl hlp,Protl llp,
                     Part *participant)

XkReturn xOpenDone(Protl hlp,
                   Protl llp,Sessn session,
                   Part *participants)
```

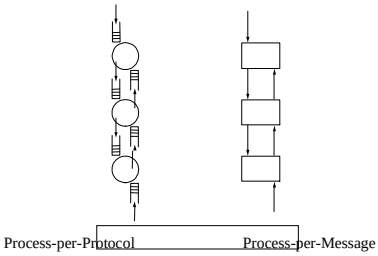
- Demultiplexing

```
XkReturn xDemux(Protl hlp, Sessn lls,
                Msg *message)
```

Session Objects

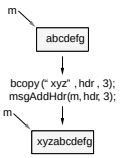
- Local end-point of a channel
- Interpret messages and maintain channel state
- Export operations for sending and receiving messages
- Operations
  - send a message
    ```
    XkReturn xPush(Sessn lls,Msg *message)
    ```
  - deliver a message
    ```
    XkReturn xPop(Sessn hls, Sessn lls,
                  Msg *message,void *hdr)
    ```


Process Model

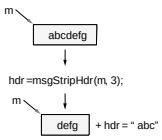


Message Library

- Add header

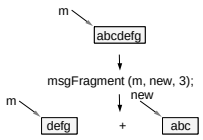


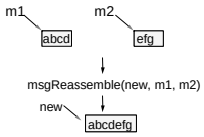
- Strip header



Message Library (cont)

- Fragment message
- Reassemble messages





Event Library

- Scheduling Timeouts & Book-keeping activity
- Operations

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

EvCancelReturn evCancel(Event event)
```


Map Library

- Demultiplex Packets
- Operations

```
Map mapCreate(int number,int size)

Binding mapBind(Map map,
                void *key,
                void *id)

XkReturn mapResolve(Map map,
                    void *key,void **id)
```

Example

```
static Sessn
aspOpen(Protl self, Protl hlp, Part *p)
{
   Sessn     asp_s;
   Sessn     lls;
   ActiveId  key;
   ProtlState  *pstate = (ProtlState *)self->state;

   bzero((char *)&key, sizeof(key));

   /* High level protocol must specify both */
   /* local and remote ASP port */
   key.localport = *((AspPort *) partPop(p[0]));
   key.remoteport = *((AspPort *) partPop(p[1]));
   /* Assume failure until proven otherwise */
   asp_s = XK_FAILURE;
```



```
   /* Open session on low-level protocol */
   lls = xOpen(self, xGetDown(self, 0), p);
   if ( lls != XK_FAILURE )
   {
      key.lls = lls;
      /* Check for session in active map */
      if (mapResolve(pstate->activemap, &key,
         (void **)&asp_s) == XK_FAILURE)
      {
      /* Session not in map; initialize it */
         asp_s = asp_init_sessn(self, hlp, &key);
         if ( asp_s != XK_FAILURE )
         {
            /* A successful open */
            return asp_s;
         }
      }

      /* Error has occurred */
      xClose(lls);
   }
   return asp_s;
}
```



```
static XkReturn aspPush(Sessn s, Msg *msg)
{
   SessnState *sstate;
   AspHdr     hdr;
   void       *buf;

   /* create a header */
   sstate = (SessnState *) s->state;
   hdr = sstate->hdr;
   hdr.ulen = msgLen(msg) + HLEN;

   /* attach header and send */
   buf = msgAddrHdr(msg, HLEN);
   aspHdrStore(&hdr, buf, HLEN, msg);
   return xPush(xGetDown(s, 0), msg);
}
```

```
static XkReturn aspDemux(Protl self, Sessn lls, Msg *msg)
{
   AspHdr       h;
   Sessn        s;
   ActiveId     activeid;
   PassiveId    passiveid;
   ProtlState   *pstate;
   Enable       *e;
   void         *buf;

   pstate = (ProtlState *)self->state;

   /* extract the header from the message */
   buf = msgStripHdr(msg, HLEN);
   aspHdrLoad(&h, buf, HLEN, msg);

   /* construct a demux key from the header */
   bzero((char *)&activeid, sizeof(activeid));
   activeid.localport = h.dport;
   activeid.remoteport = h.sport;
   activeid.lls = lls;
```



```
   /* see if demux key is in the active map */
   if (mapResolve(pstate->activemap, &activeid,
       (void **)&s) == XK_FAILURE)
   {
       /* didn't find an active session, */
       /* so check passive map */
       passiveid = h.dport;
       if (mapResolve(pstate->passivemap, &passiveid,
           (void **)&e) == XK_FAILURE)
       {
           /* drop the message */
           return XK_SUCCESS;
       }

       /* port was enabled, so create a new */
       /* session and inform hlp */
       s = asp_init_sessn(self, e->hlp, &activeid);
       xOpenDone(e->hlp, s, self);
   }
   /* pop the message to the session */
   return xPop(s, lls, msg, &h);
}
```



```
static XkReturn
aspPop(Sessn s, Sessn ds, Msg *msg, void *inHdr)
{
   AspHdr    *h = (AspHdr *) inHdr;

   /* truncate message to length shown in header */
   if ((h->ulen - HLEN) < msgLen(msg))
        msgTruncate(msg, (int) h->ulen);

   /* pass message up the protocol stack */
   return xDemux(xGetUp(s), s, msg);
}
```