Futures

- X Consortium “Low Bandwidth X” standard
- Layering over other transports
  - PPP (more common now)
  - Allows access to other services (e.g. printing, SNMP, XDM)
- Make helper more of a peer
  - Caching of fonts, properties, keymaps
  - Authorization
  - Delayed sending of data (e.g. property contents)
- Other compression techniques
  - Replace LZW, smarter deltas, bitmap-oriented compression

Application and User Impact

- Text Performance
    - Good (xmh used heavily from home by NCD Engineering)
- Pixmap Performance
    - Depends on amount of data (size and depth)
    - Compression helps on sparse images
- Demonstrates any application inefficiencies
    - Extra Repaints
    - Unnecessary round trips (esp. redundant QueryFonts, AllocColor)
    - Benefit of reusing window hierarchies
- Local window manager is **VERY** useful

Host Implementation Issues

- Network connections to clients
  - Whatever the host provides (display doesn't care)
  - Host side should snoop protocol and handle authorization
- Getting session started
  - Login, xinit
  - XDM (terminal servers)
- Tty issues
  - Getting a true raw 8 bit stream
  - Avoiding lots of reads (e.g. VMS QIO to wait for entire frame)
  - Terminal server implementation

X Server Implementation Issues

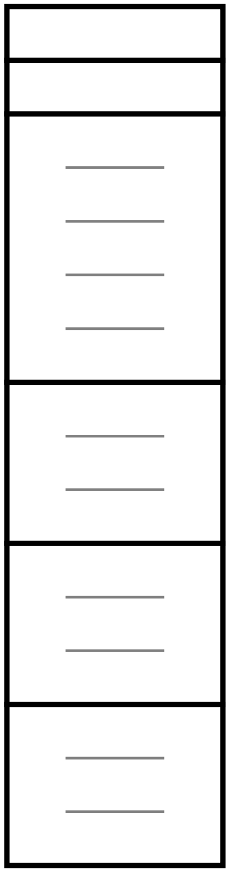
- Which layer to change?
  - Kernel (provide sockets for each client)?
  - OS layer of the X server?
- What modules got touched? OS
  - IO: Deal with delta replacement, compression, etc.
  - WaitFor: combine all remote clients into one socket
- Font and RGB access
  - Add file retrieval to XRemote protocol
  - Suspends X activity during file access

XRemote Physical Line Packet Framing

- Similar to IETF-PPP
- Minimal overhead (3 bytes)
- 16 bit CRC
- Escapes modem-control characters

XRemote Reliable Datagram Protocol

- 16 bit header
- Non-routing
  - No net address
- Simple, fast



Startup/shutdown packet
Packet compressed

unused

Packet Sequence Number

Window (# of packets)

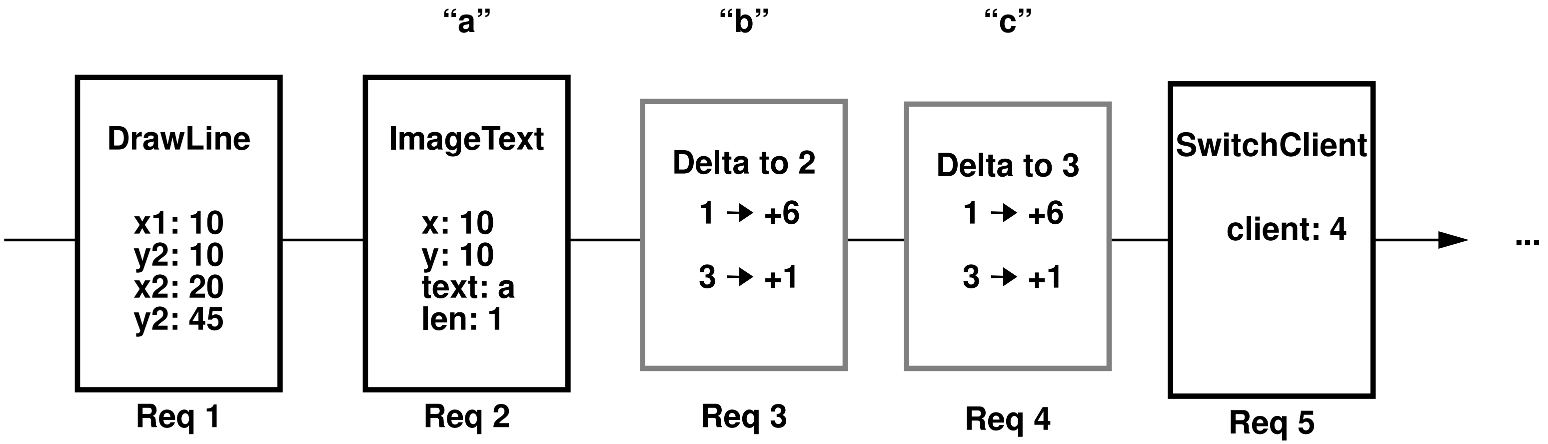
Ack of last received packet

Host vs. Modem Compression

- Compression in host and display
  - Compression gets data at memory bus speeds
  - Fewer bytes sent over serial interface (latency, interrupts)
- Don't want to depend on modem error correction
  - Not all modems have features
  - Still need to protect against host dropping (e.g. silo overflows)
- Allows modems to concentrate on transmission
  - Doing compression in modem adds latency
- LZW esp. well-suited to compressing Deltas

Delta Replacement

- Previous 16 requests < 64 bytes cached on both sides
- If byte delta against previous request is smaller, send that instead



Req 1
DrawLine
x1: 10
y2: 10
x2: 20
y2: 45

Req 2 “a”
ImageText
x: 10
y: 10
text: a
len: 1

Req 3 “b”
Delta to 2
1 → +6
3 → +1

Req 4 “c”
Delta to 3
1 → +6
3 → +1

Req 5
SwitchClient
client: 4

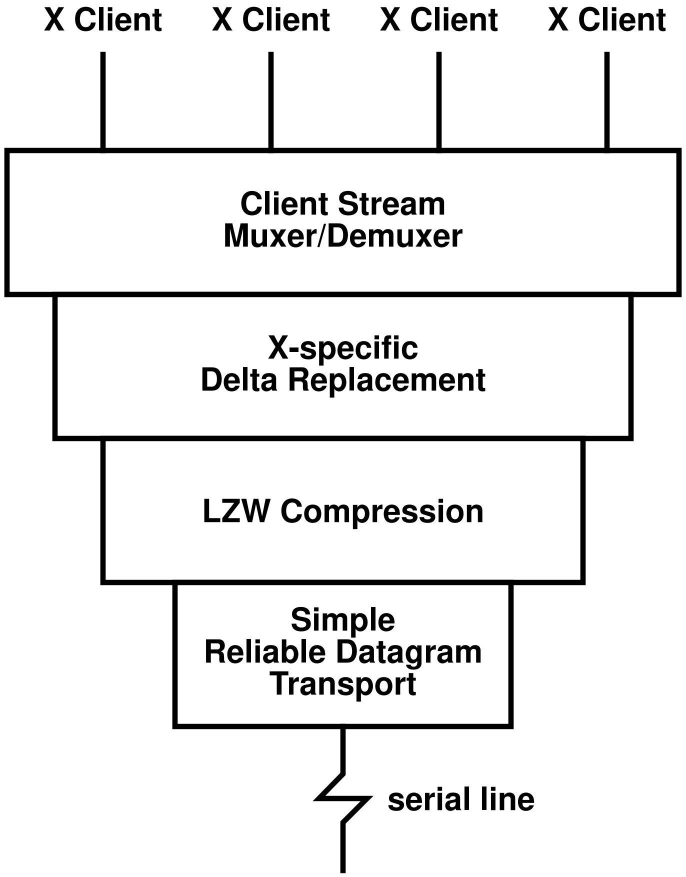
...

Client Stream Muxing

- Client streams merged on X request boundaries
- X-style pseudo-requests inserted as delimiters
  - Create new client
  - Switch subsequent requests to given client
  - Kill a given client
- Host side watches for GrabServer/UngrabServer
  - Blocks other clients during grab
  - Decreases buffering needed in display
  - Avoids wasting time transmitting other client requests
  - Grab and Ungrab still transmitted

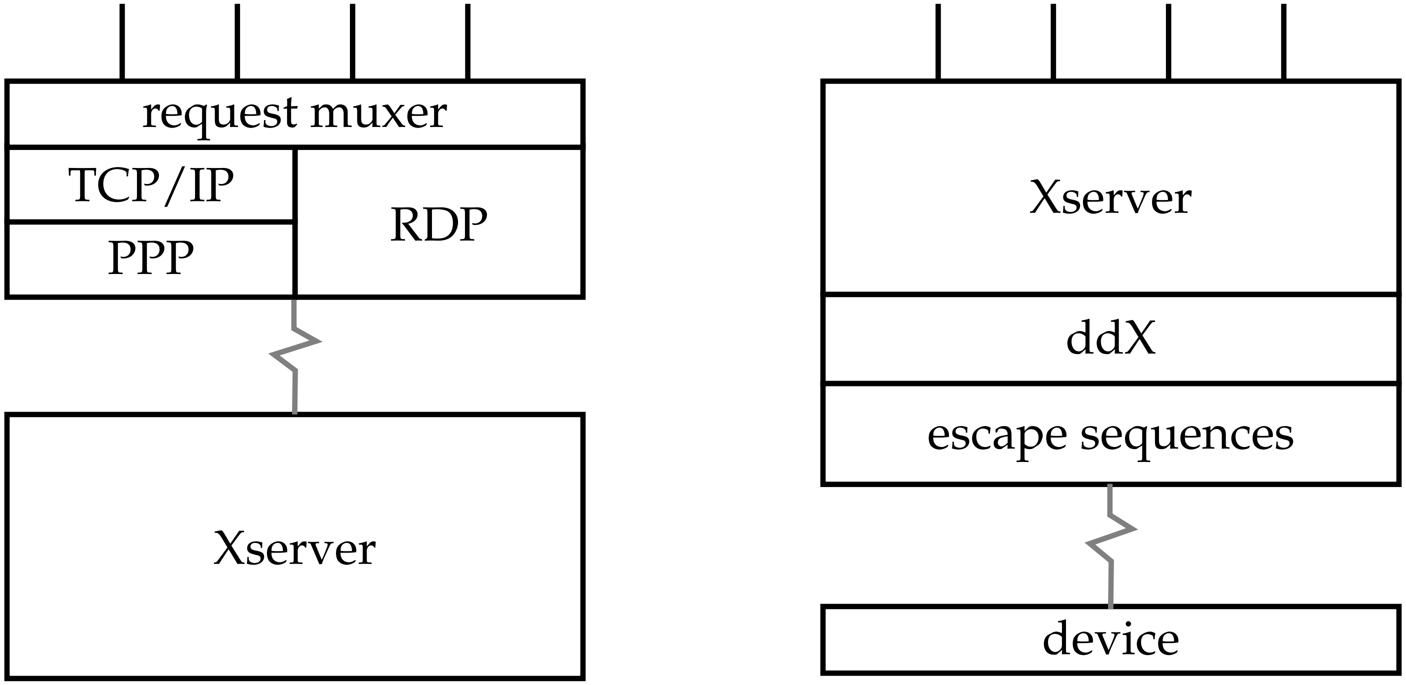
XRemote Architecture

- Host-side Pseudo X Server
  - muxes communication
  - delta and compression
  - simple transport
  - portable
- Terminal-side OS
  - does reverse of above
  - new network type
  - still have local clients (eg. wm)



Where to Split?

- X Server in display vs. X Server on host



request muxer

TCP/IP

PPP

RDP

Xserver

Xserver

ddX

escape sequences

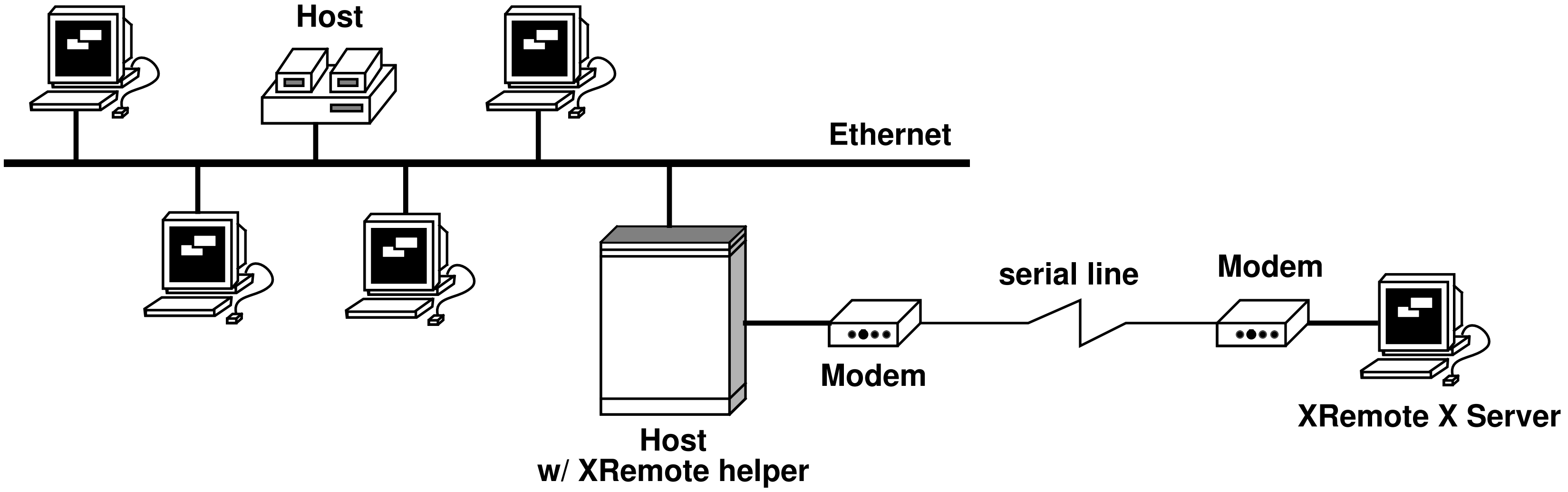
device

Approaches

- Raw X over SLIP, CSLIP, or PPP
  - Very easy to implement,
  - Allows access to other services
  - Too slow to be useful
  - Requires network address
  - Not widely enough available (at the time)
- Host-side pseudo server which manages serial line
  - Works better in ASCII terminal replacement environments
  - More portable
  - More efficient use of serial line
  - Issue: How much functionality runs on host?

What is XRemote?

- Protocol for running X over serial lines
- Transparent to users and applications



XRemote:^{TM} A Serial Line Protocol for X

Dave Cornelius
Network Computing Devices, Inc.