Designing Interactive Systems 2

Lecture 4: The X Window System, Smalltalk

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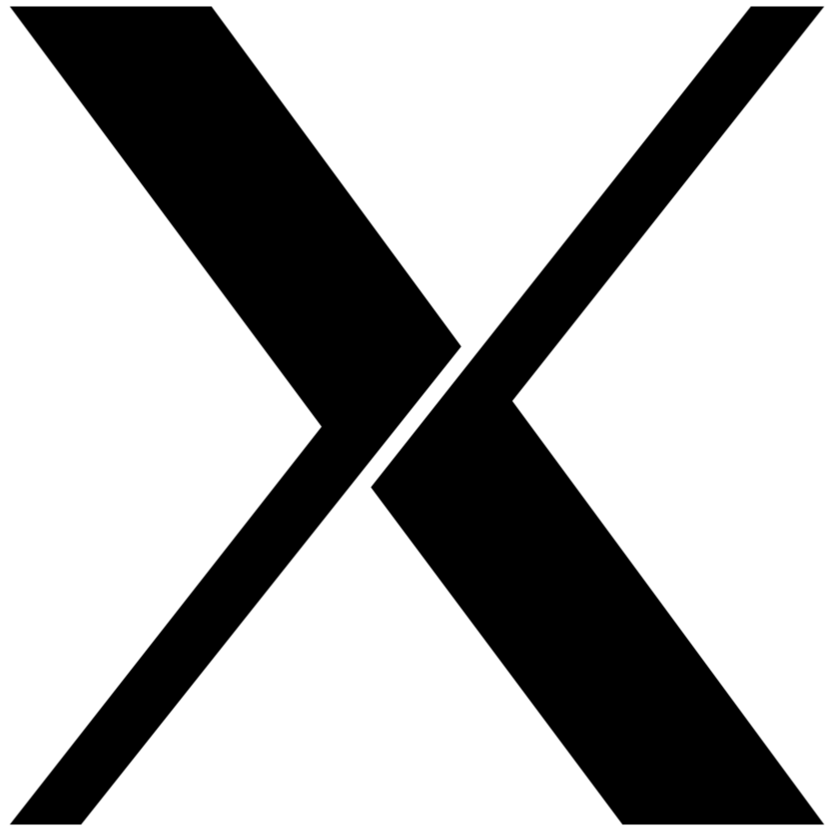
CHAPTER 8

The X Window System

The X Window System



- Origin: **W** window system for **V** OS
  - **W** moved BWS&GEL to remote machine
  - Simplified porting to new architectures, but slow under Unix
- MIT: **X** improvement over **W**
  - Asynchronous calls: much-improved performance
  - Application = client

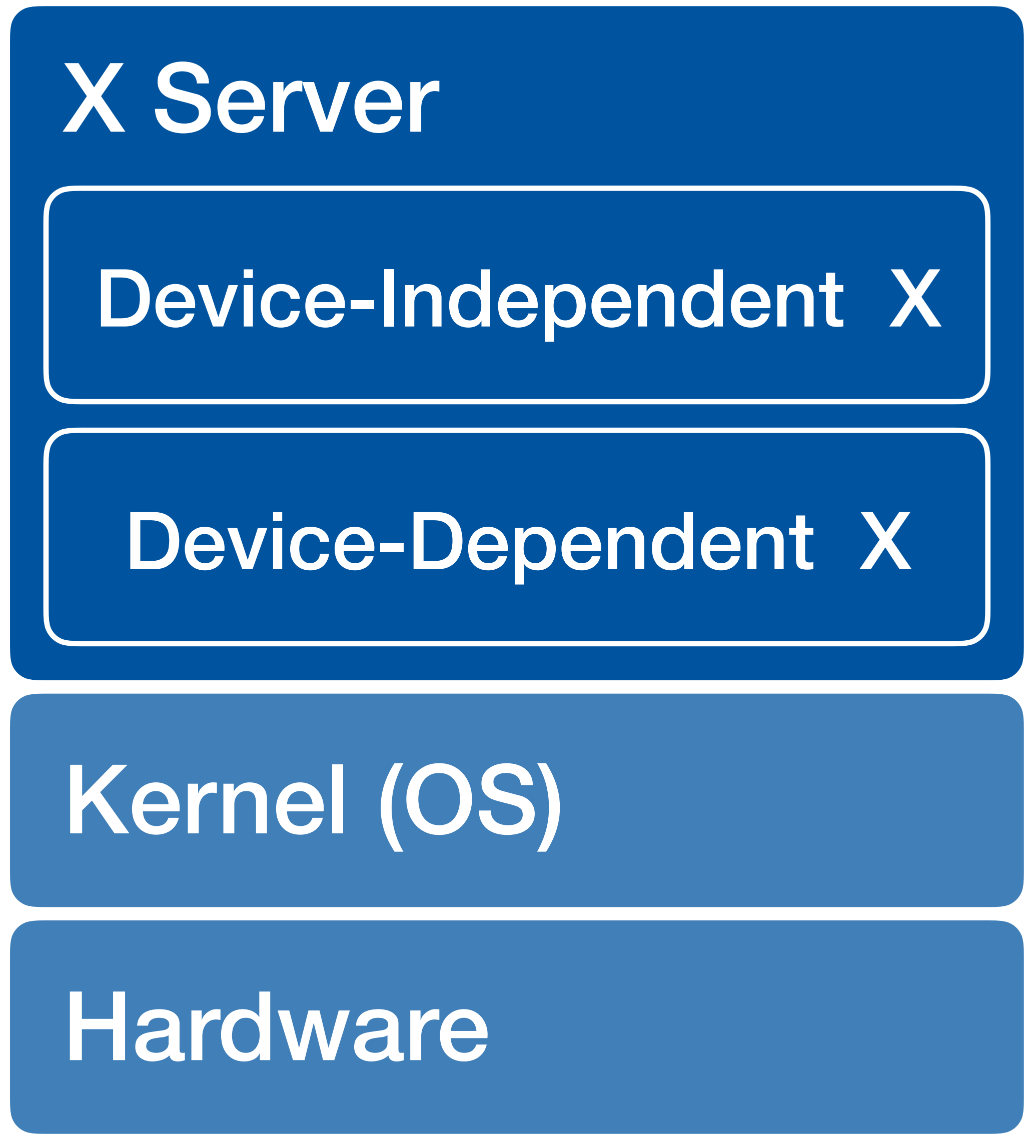
X: Architecture

Application
Widget Set
Xt Intrinsics
Xlib
Network
Window Manager
Xlib
X Server
Kernel (OS)
Hardware

UITK & WM

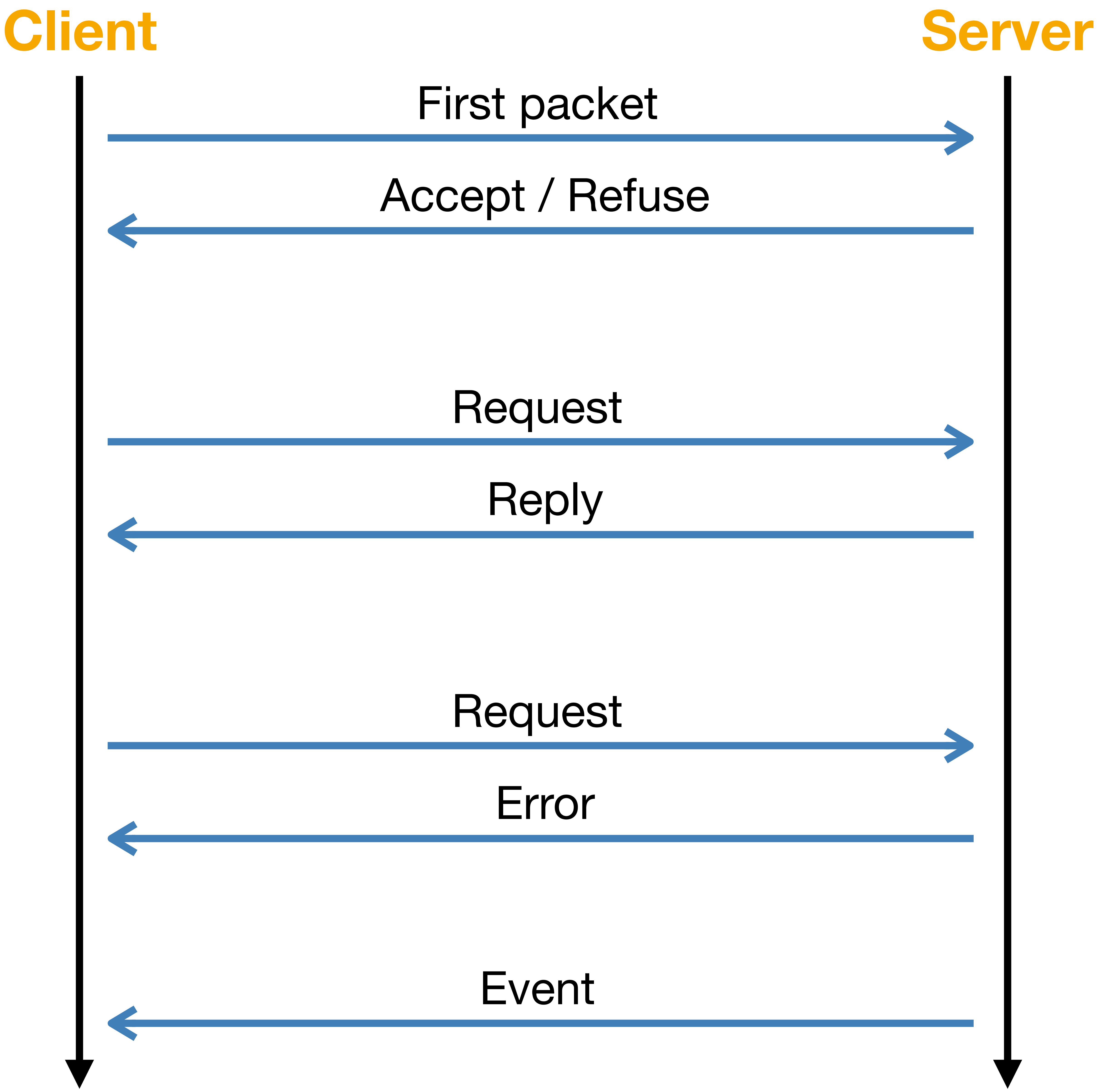
BWS & GEL

X Server

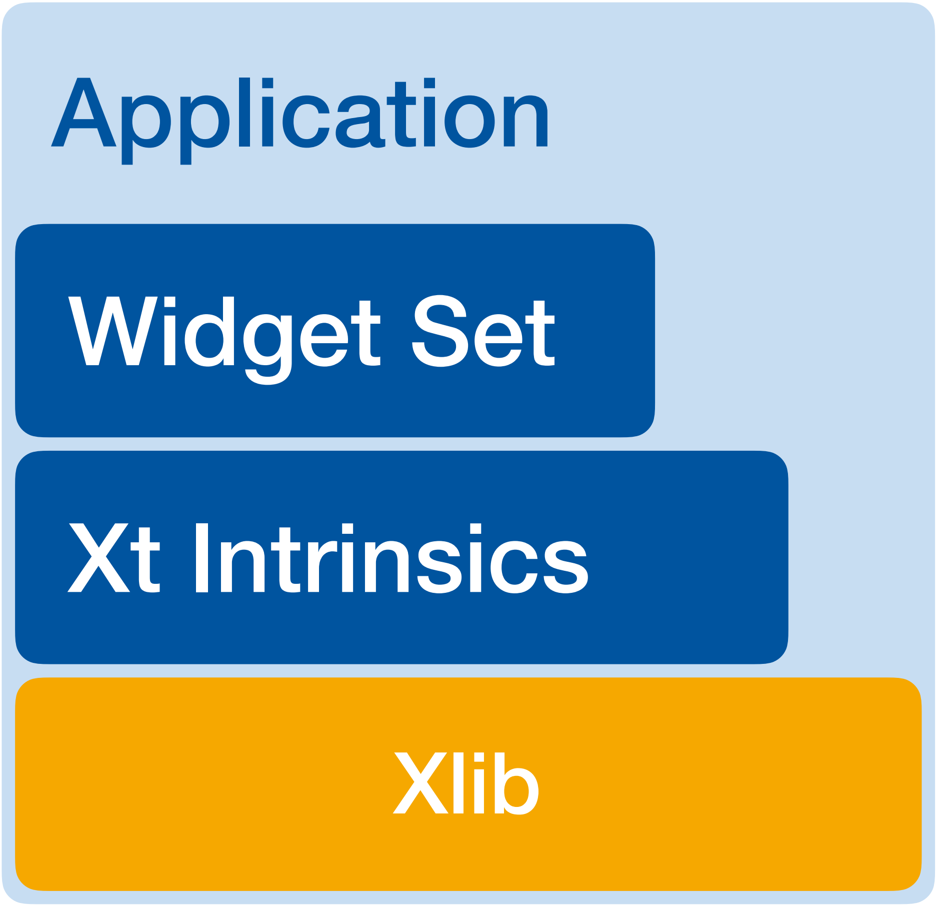


- Responsible for one keyboard (one EL)
- Can manage multiple physical screens (GLs)
- Provides base windows as canvas for clients (BWS)

X: Protocol


Client
Server
First packet
Accept / Refuse
Request
Reply
Request
Error
Event

Xlib

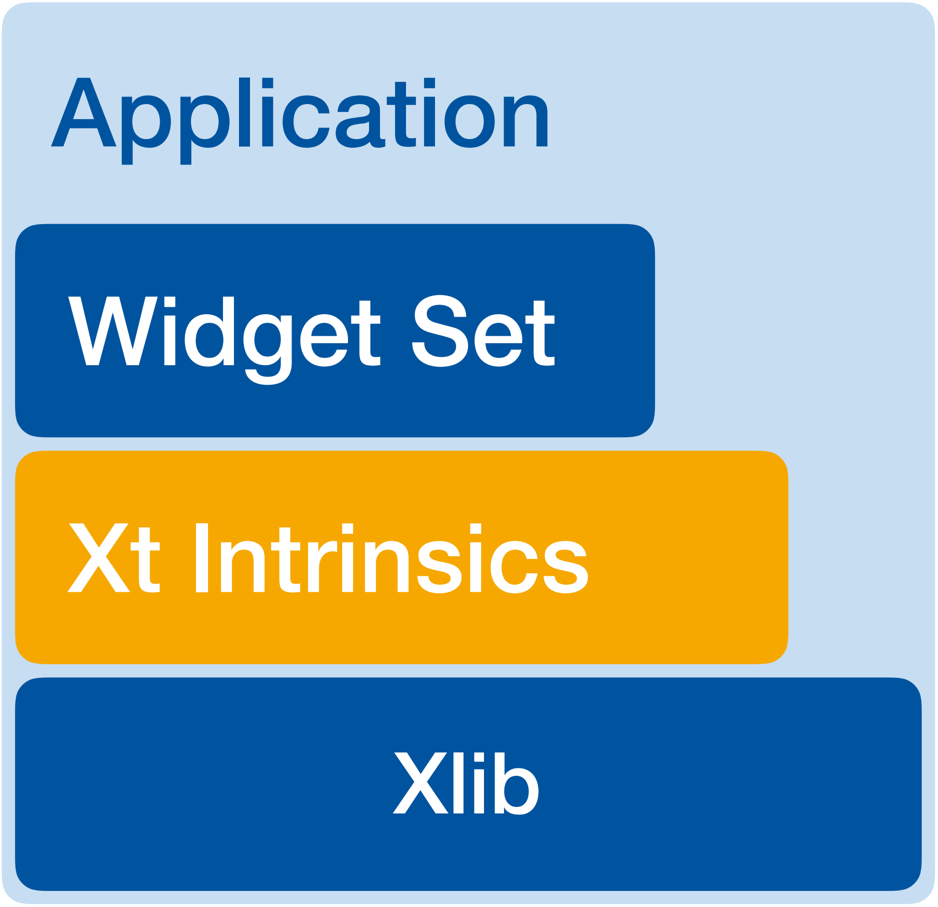


- Implements X protocol client
- Checks for events from server & creates queue on client
- Xlib offers functions to create, delete, and modify server resources

Typical Xlib application

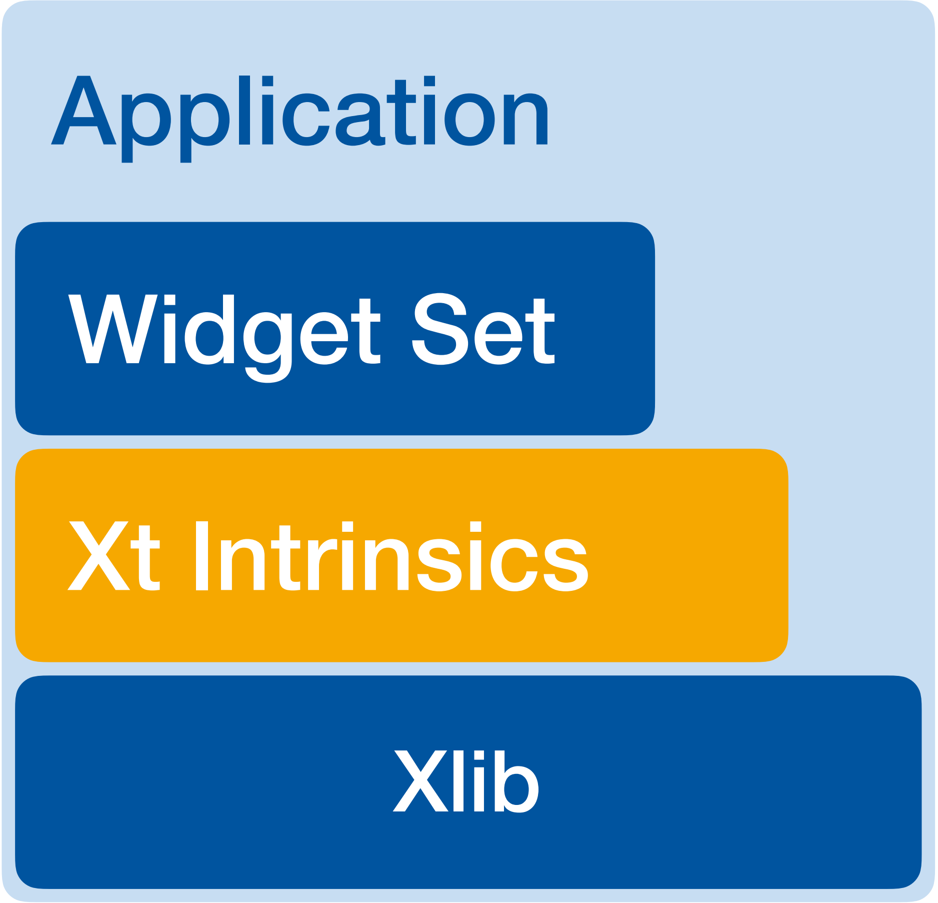
```
#include Xlib.h, Xutil.h
Display *d; int screen; GC gc; Window w; XEvent e;
main () {
    d = XOpenDisplay(171.64.77.1:0);
    screen = DefaultScreen(d);
    w = XCreateSimpleWindow(d, DefaultRootWindow(d), x,y,w,h,
          border, BlackPixel(d), WhitePixel(d)); //fore- & background
    XMapWindow(d, w);
    // Graphics Context setup left out here
    gc = XCreateGC(d, w, mask, attributes);
    XSelectInput(d, w, ExposureMask|ButtonPressMask);
    while (TRUE) {
        XNextEvent(d, &e);
            switch (e.type) {
                case Expose: XDrawLine (d, w, gc, x,y, w,h); break;
                case ButtonPress: exit(0);
        }
    }
}
```

X Toolkit Intrinsics



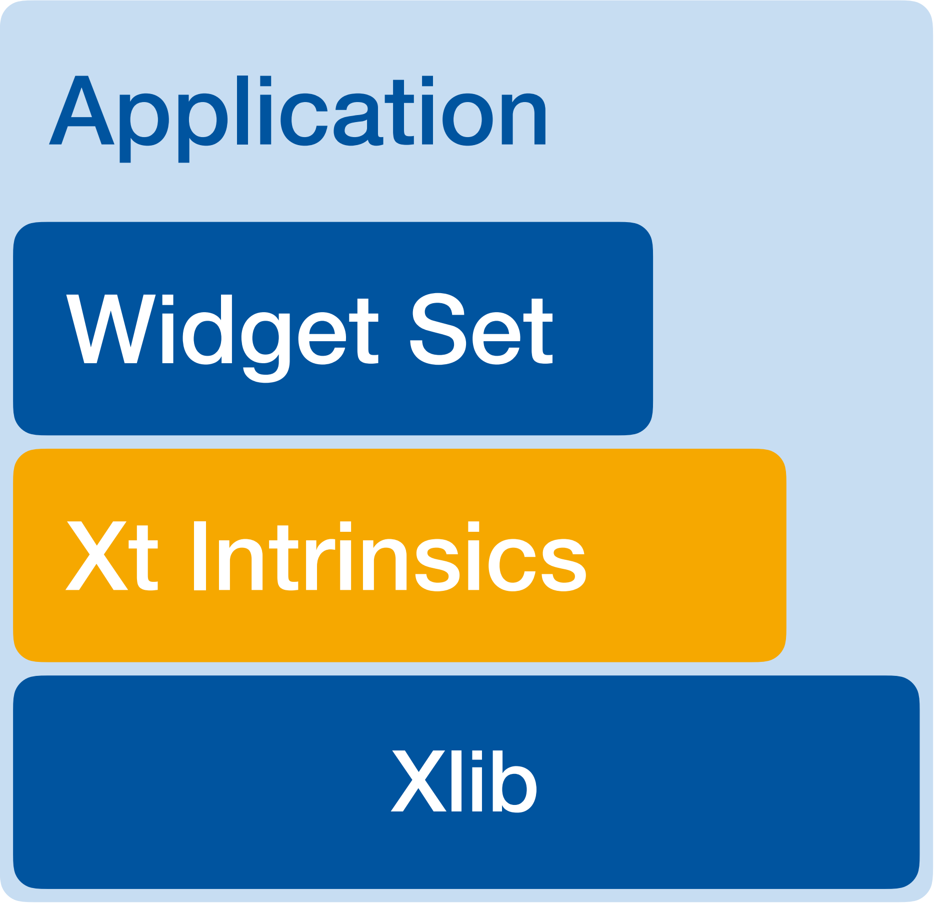
- Xt Functions are generic to work with all widget classes

X Toolkit Intrinsics



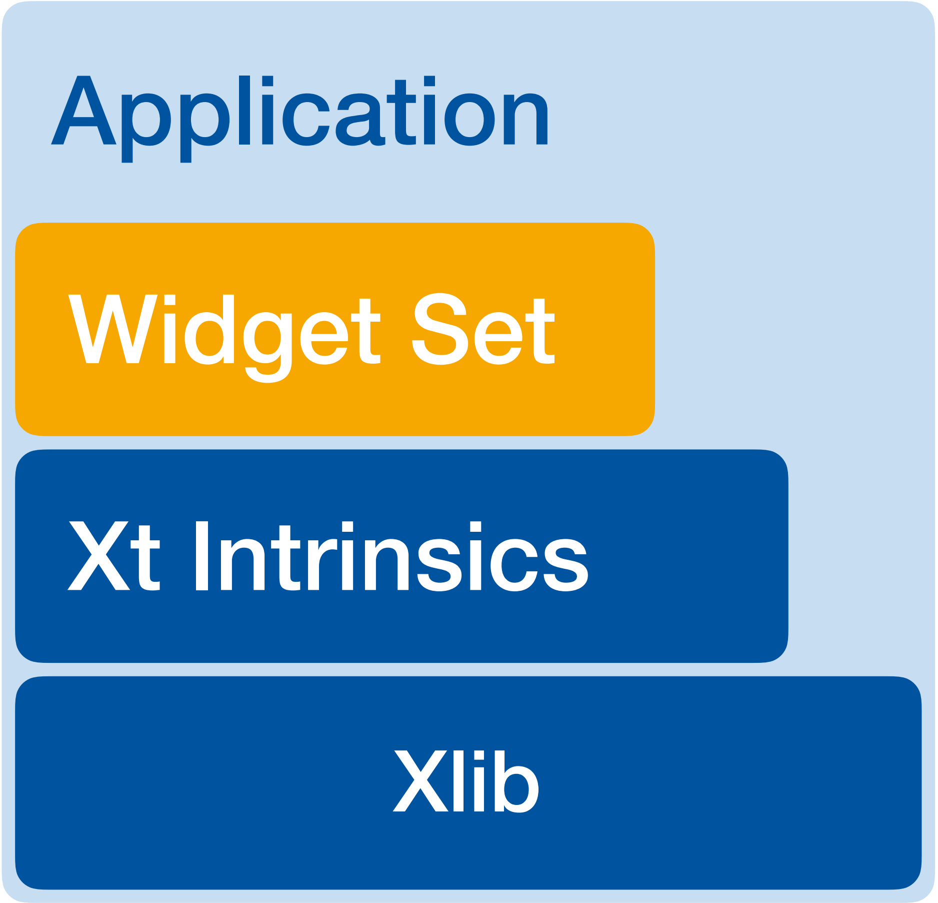
- Xt Functions are generic to work with all widget classes
- At runtime widgets have four states:
  Created, managed, realized, mapped

X Toolkit Intrinsics



- Xt Functions are generic to work with all widget classes
- At runtime widgets have four states:
  Created, managed, realized, mapped
- Dispatches events

Widget Set

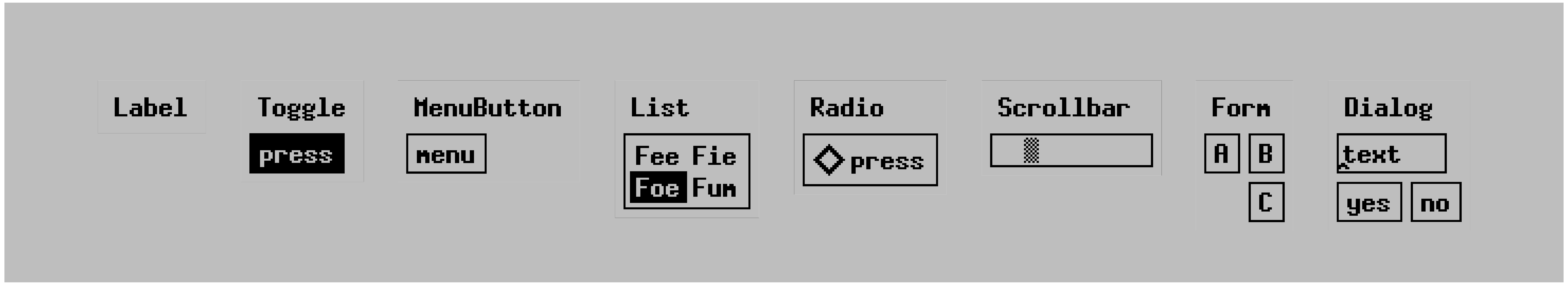


- Programming model already given in intrinsics
- Collection of several different user interface components
- Defines the look & feel of the system together with the WM

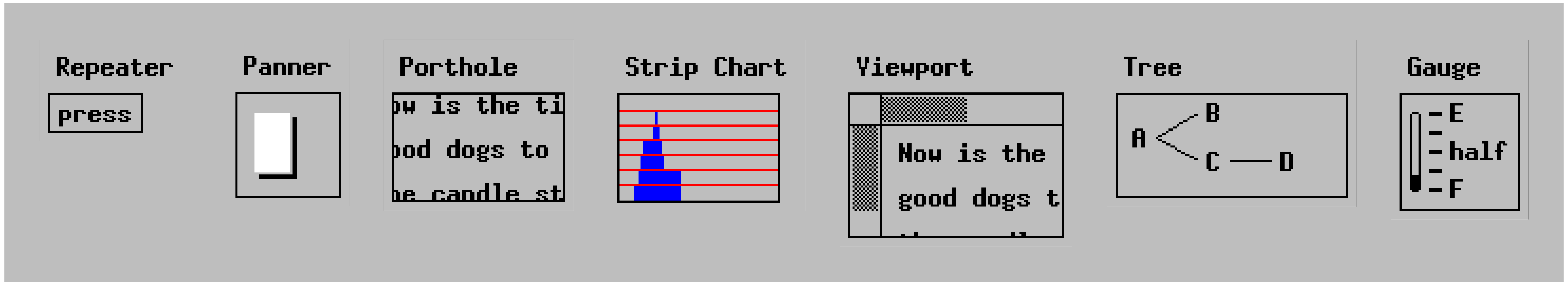
Athena Widget Set

- *Simple* — Base class for all other Athena widgets
  - Does nothing, but adds new resources such as cursor and border pixmap

- Standard widgets



- Special widgets



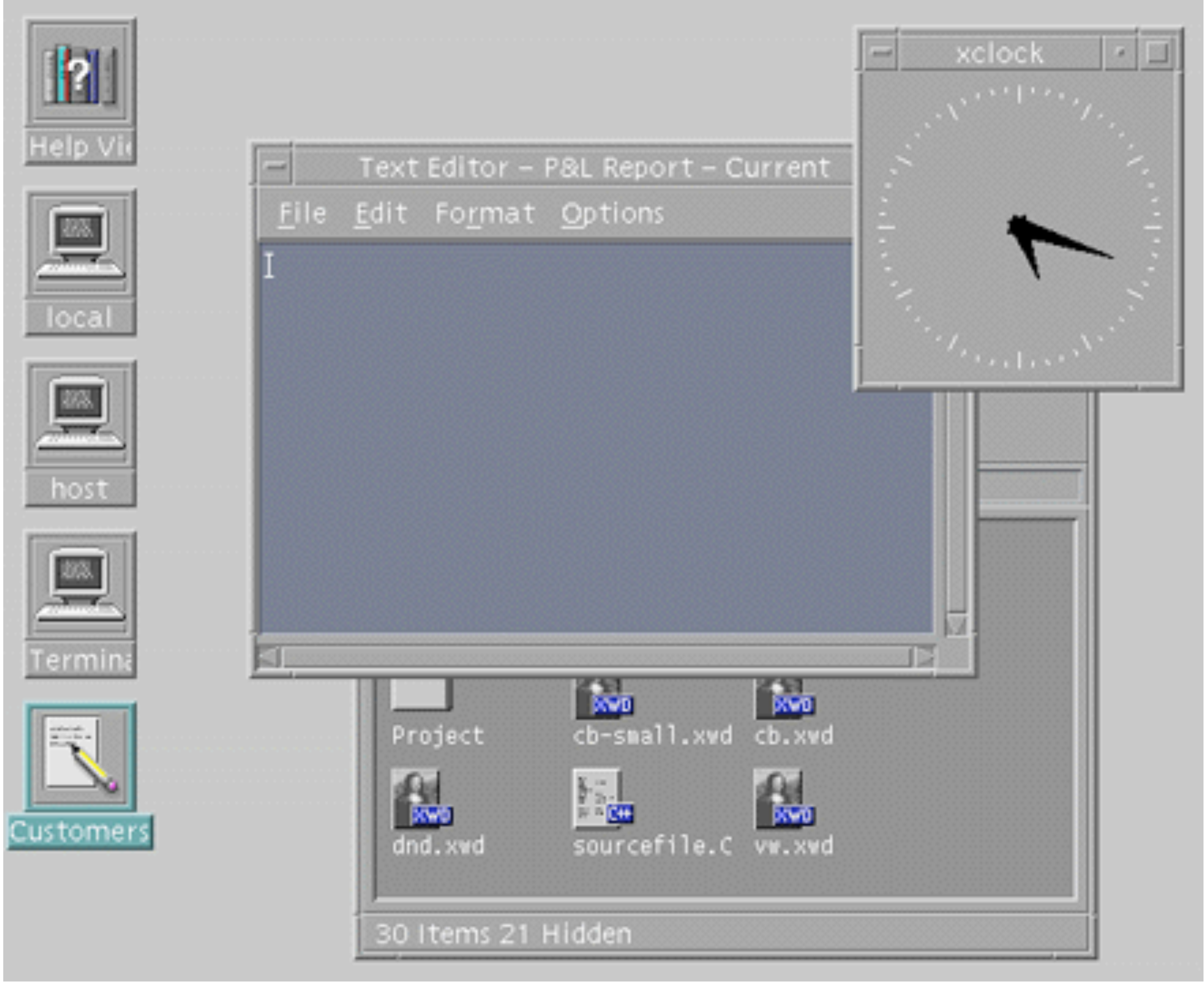
Motif: More than a Widget Set

- **Style Guide** (book)
  for application developer

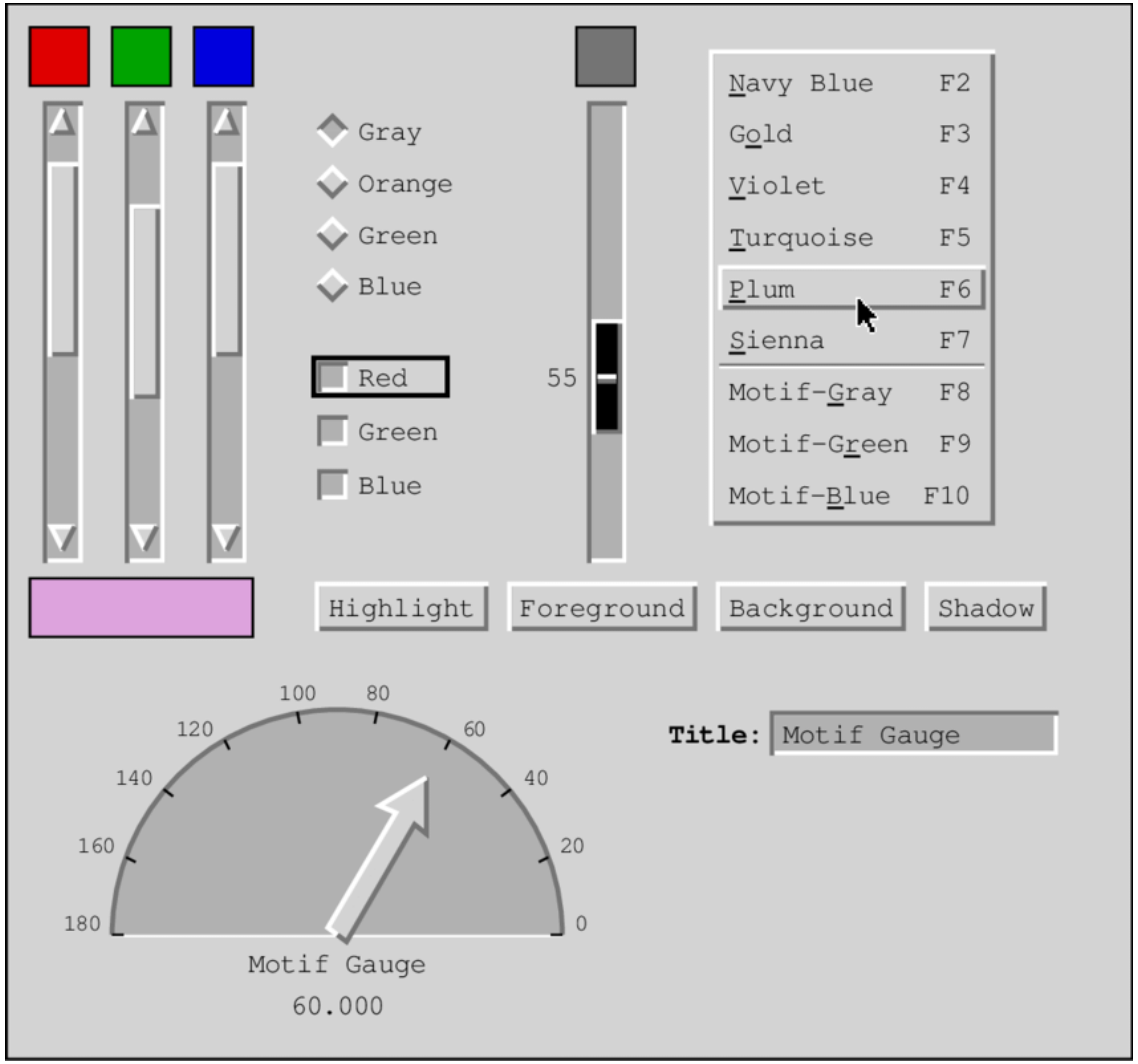
- **Widget set**
  implementing style guide

- **Window Manager** (mwm)

- **UIDL**



Motif: Widget Set



Programming in X

```
#include <X11/Intrinsic.h>
#include <X11/StringDefs.h>
#include <X11/Xlib.h>
#include <Xm/Xm.h>
#include <Xm/PushB.h>

void ExitCB (Widget w, caddr_t client_data, XmAnyCallbackStruct *call_data)
{
  XtCloseDisplay (XtDisplay (w));
  exit (0);
}

void main(int argc, char *argv[])
{
  Widget toplevel, pushbutton;

  toplevel = XtInitialize (argv [0], "Hello", NULL, 0, &argc, argv);

  pushbutton = XmCreatePushButton (toplevel, "pushbutton", NULL, 0);
  XtManageChild (pushbutton);

  XtAddCallback (pushbutton, XmNactivateCallback, (void *) ExitCB, NULL);

  XtRealizeWidget (toplevel);

  XtMainLoop ();
}
```

X: Window Manager

- Ordinary client to the BWS
- Communicates with apps via hints in X Server
- Look&Feel mechanisms are separated from Look&Feel policy
- Late refinement
- Exchangeable at runtime

X: Demo

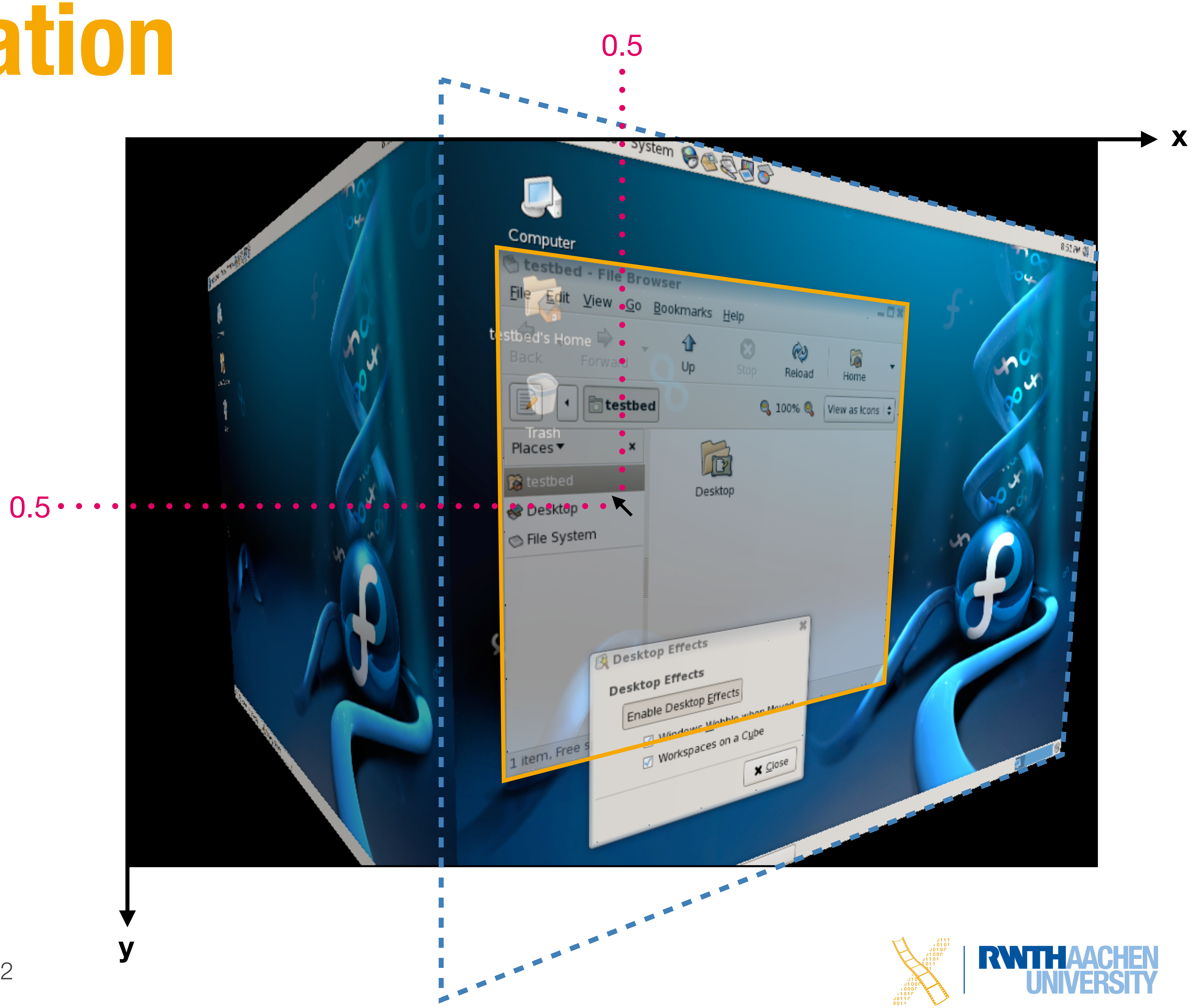
CHAPTER 9

Wayland

Wayland: Motivation

- X rendering pipeline designed in the 1980s
- Modern clients use libraries instead of referring to X
  - Hence, the X Server has lost one of its core functionalities
- Communication overhead
  - X was designed as a distributed system
  - 3D effects

Wayland: Motivation

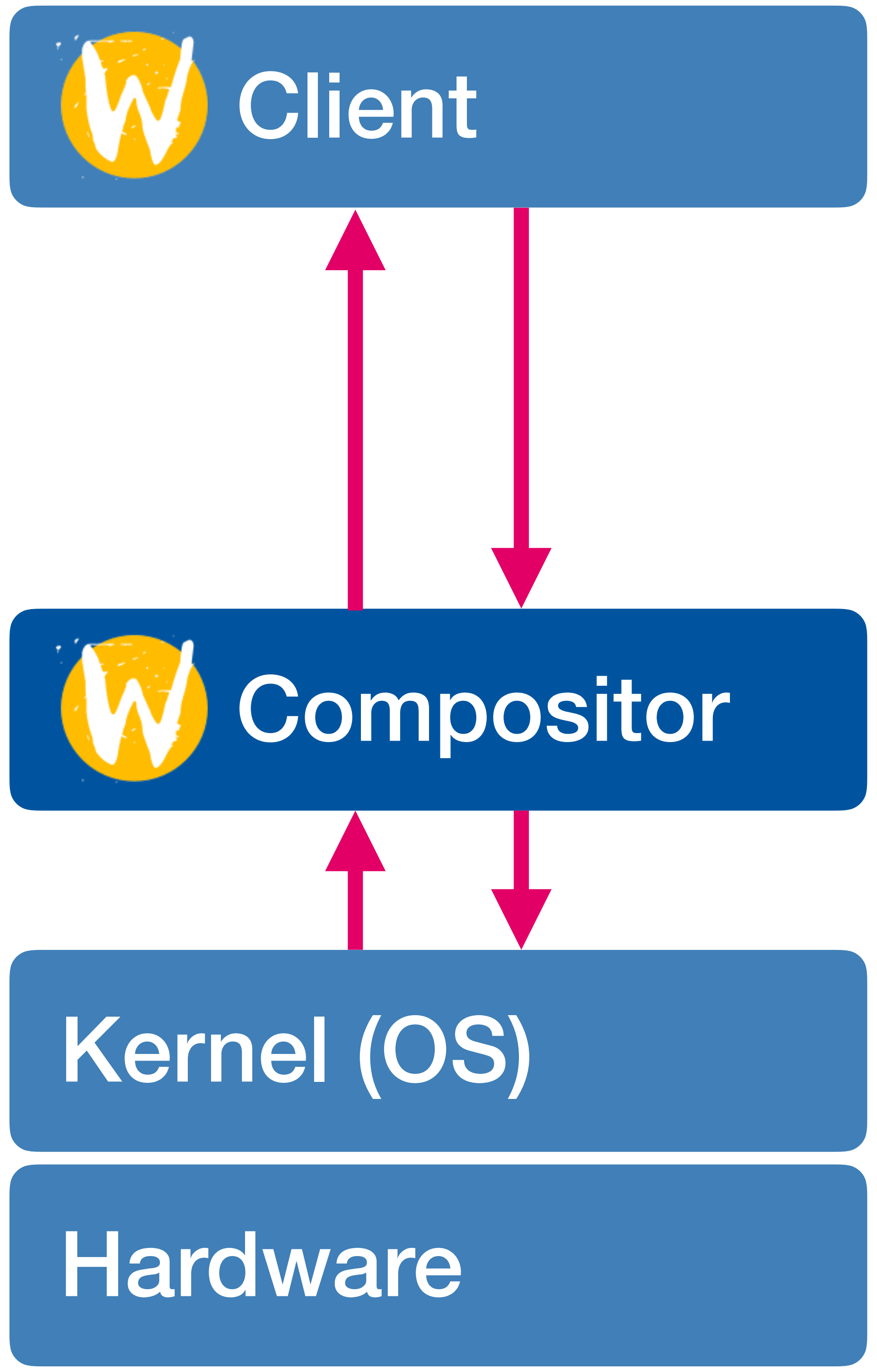


X: Communication

App (X Client)
WM (Compositor)
Network
X Server
Kernel (OS)
Hardware

Wayland

- Wayland is…
  - A communication protocol between the compositor and its clients (similar to Xlib)
  - An implementation of that protocol as a C library
- No network transparency
  Clients and compositor talk to each other via IPC



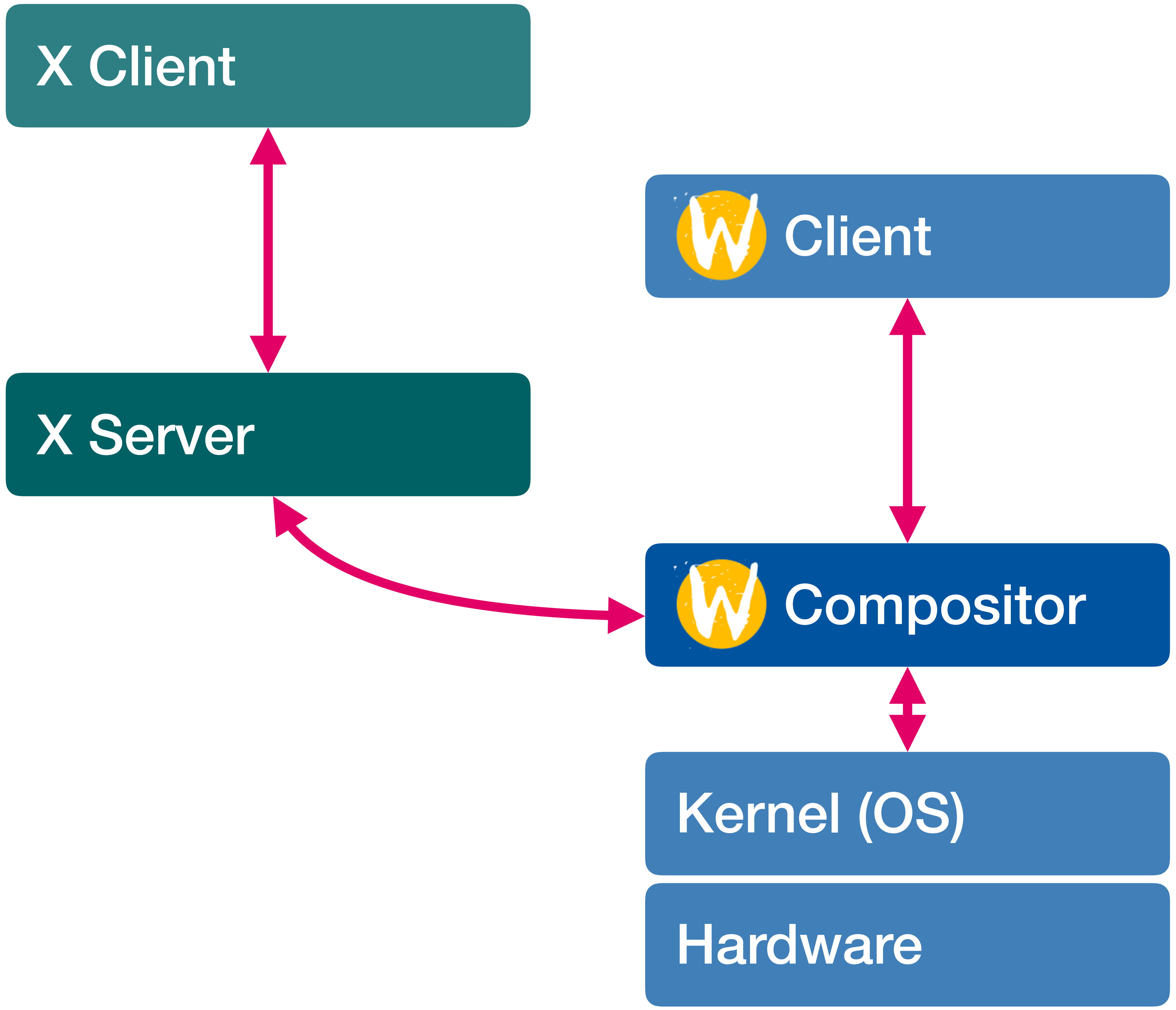
Wayland: Direct Rendering

- Graphics memory shared between clients and compositor
- Applications render directly into a memory buffer
- Compositor uses buffers from all clients and recomposites the screen
- Saves communication overhead

X as Wayland Client

- Provide backwards compatibility to X clients

- XWayland is an X Server implementation with changes that allow to run X on Wayland



CHAPTER 10

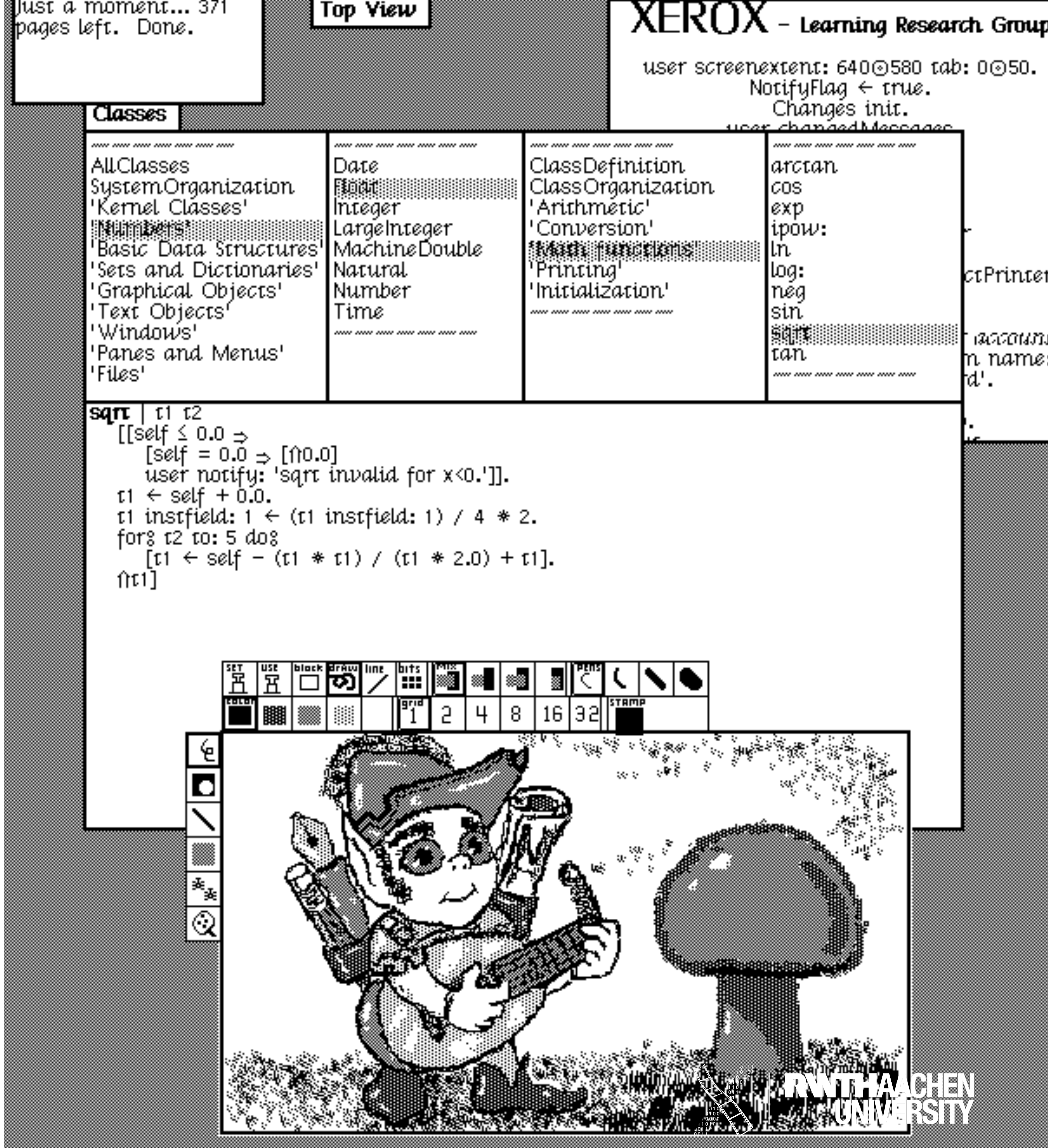
Smalltalk

Smalltalk

- The common ancestor of all window systems

- Operating system,
  window system,
  OO programming language

- Introduced the MVC Pattern



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pages left. Done.

Top View

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user screenextent: 640⊙580 tab: 0⊙50.
NotifyFlag ← true.
Changes init.

Classes

AllClasses
SystemOrganization
'Kernel Classes'
'Numbers'
'Basic Data Structures'
'Sets and Dictionaries'
'Graphical Objects'
'Text Objects'
'Windows'
'Panes and Menus'
'Files'

Date
Float
Integer
LargeInteger
MachineDouble
Natural
Number
Time

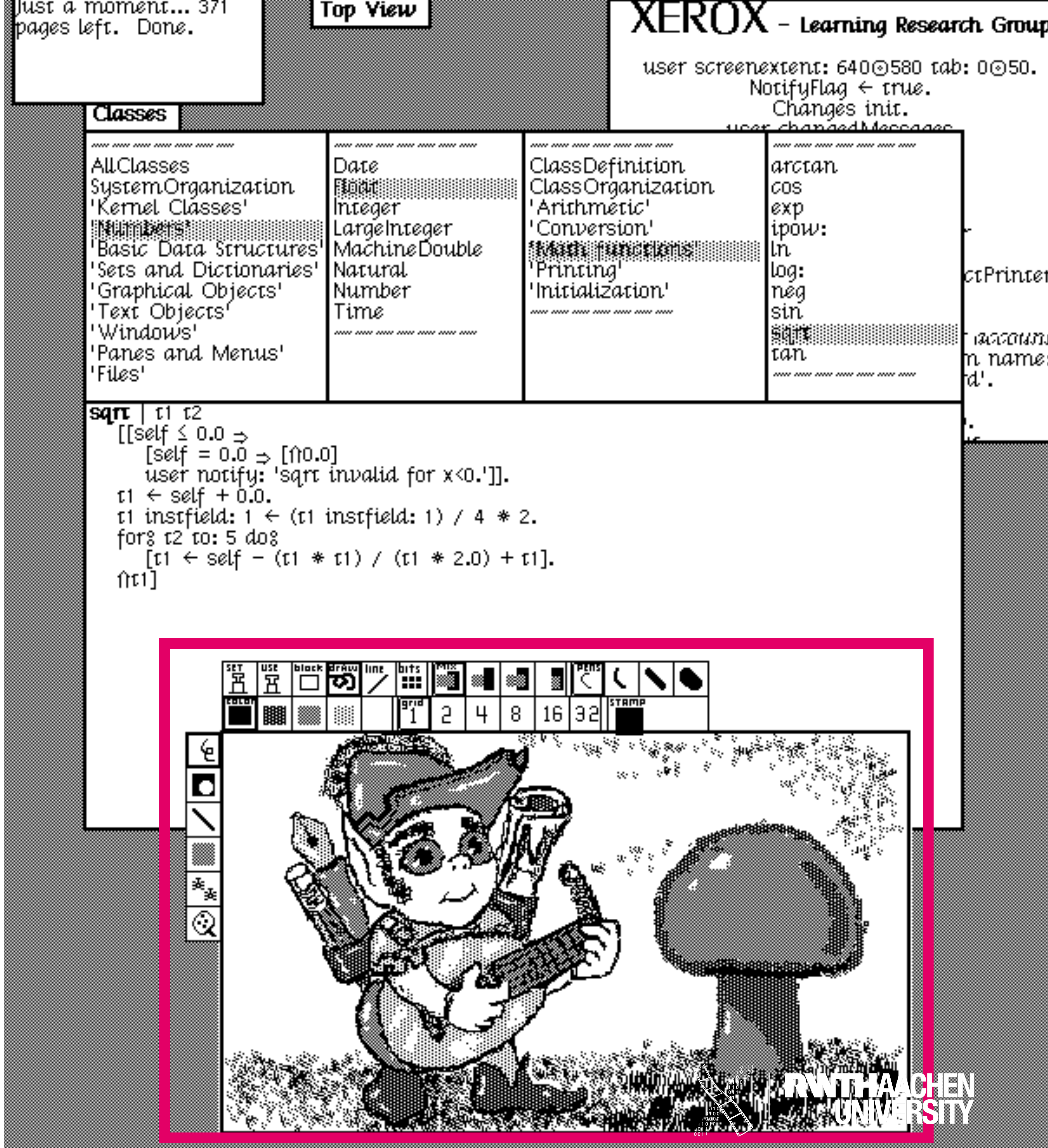
ClassDefinition
ClassOrganization
'Arithmetic'
'Conversion'
'Math functions'
'Printing'
'Initialization'

arctan
cos
exp
ipow:
ln
log:
neg
sin
sqrt
tan

```
sqrt | t1 t2
   [[self ≤ 0.0 ⇒
      [self = 0.0 ⇒ [⇑0.0]
      user notify: 'sqrt invalid for x<0.']].
   t1 ← self + 0.0.
   t1 instfield: 1 ← (t1 instfield: 1) / 4 * 2.
   for⦂ t2 to: 5 do⦂
      [t1 ← self - (t1 * t1) / (t1 * 2.0) + t1].
   ⇑t1]
```

Smalltalk

- The common ancestor of all window systems
- Operating system,
  window system,
  OO programming language
- Introduced the MVC Pattern
- UITK with modeless editor



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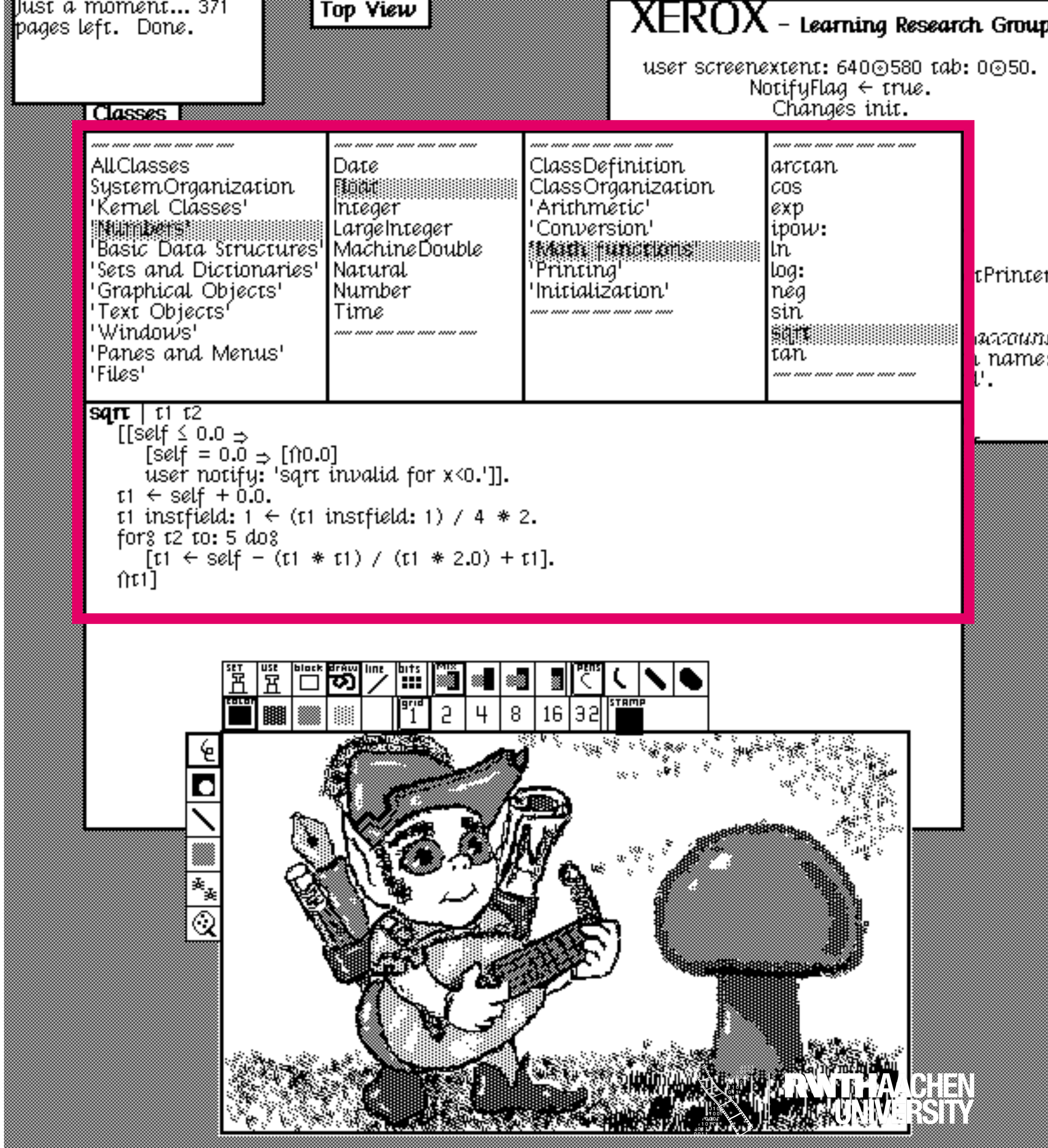
Smalltalk

- The common ancestor of all window systems
- Operating system, window system, OO programming language
- Introduced the MVC Pattern
- UITK with modeless editor
- Inspect and modify the system's code while it is running



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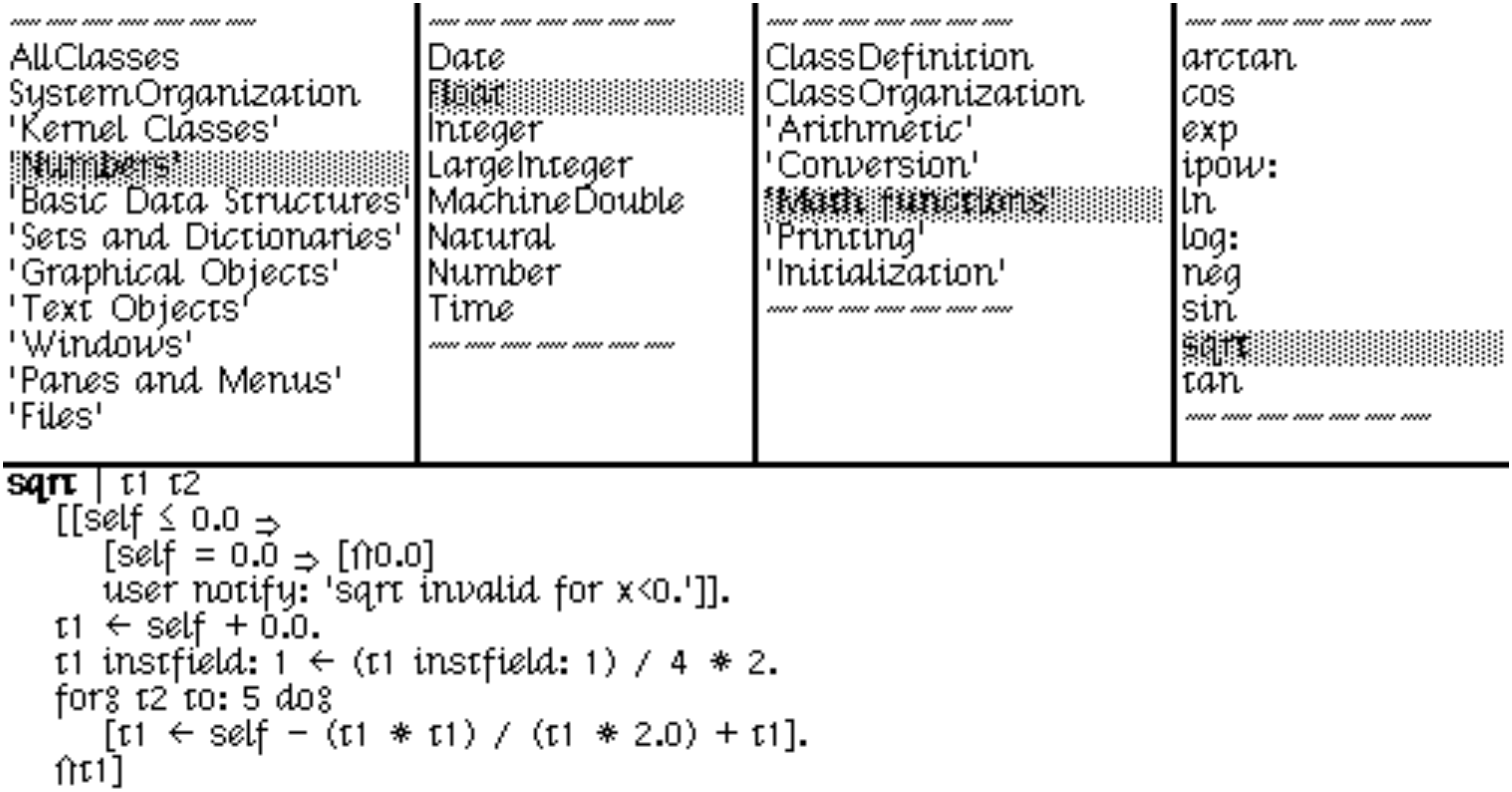

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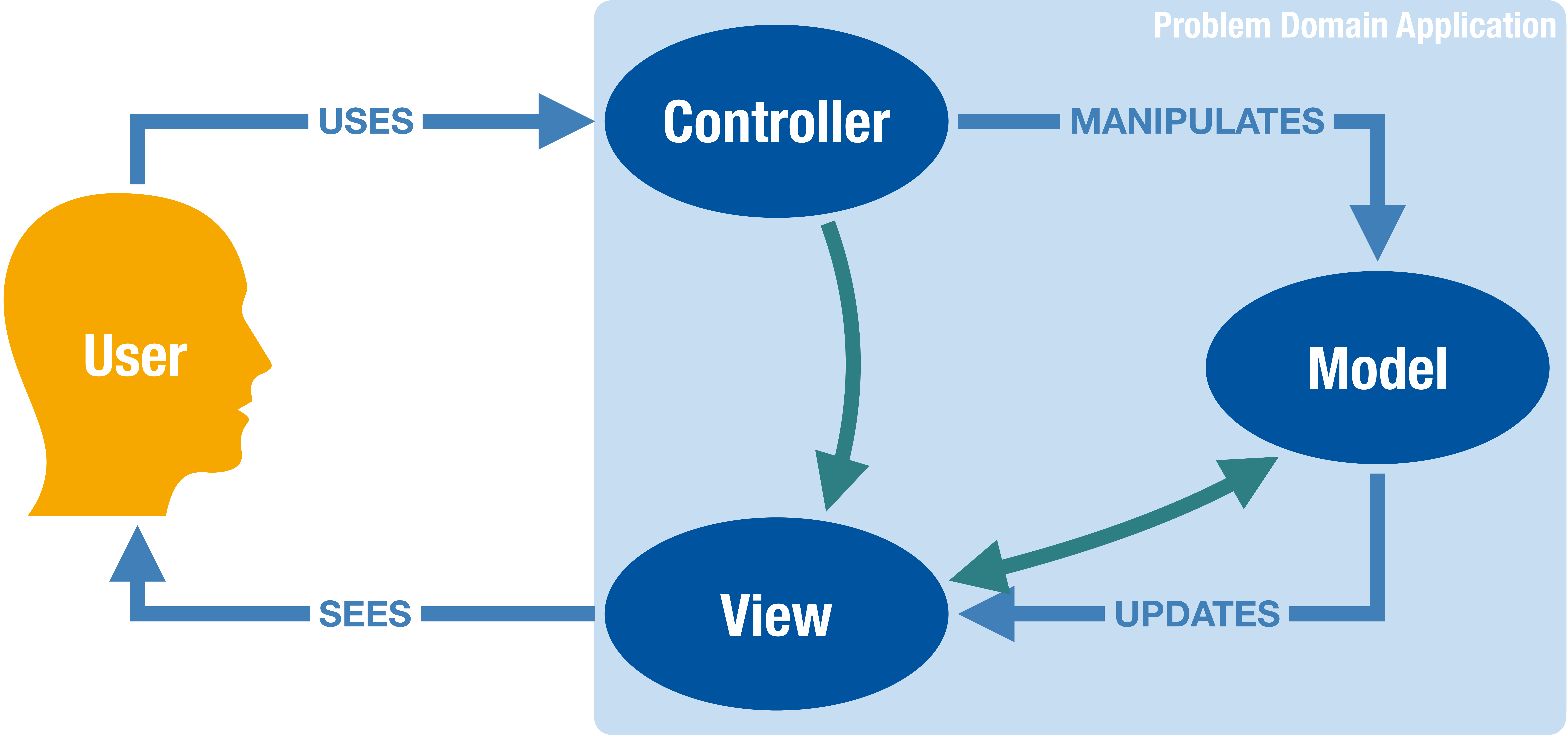
Smalltalk: Architecture

- Single process, single address space
- Machine-dependent **virtual machine** (byte-code interpreter)
- Machine-independent **virtual image** (Smalltalk classes)
- Initially OS & WS merged, later WS on top of OS

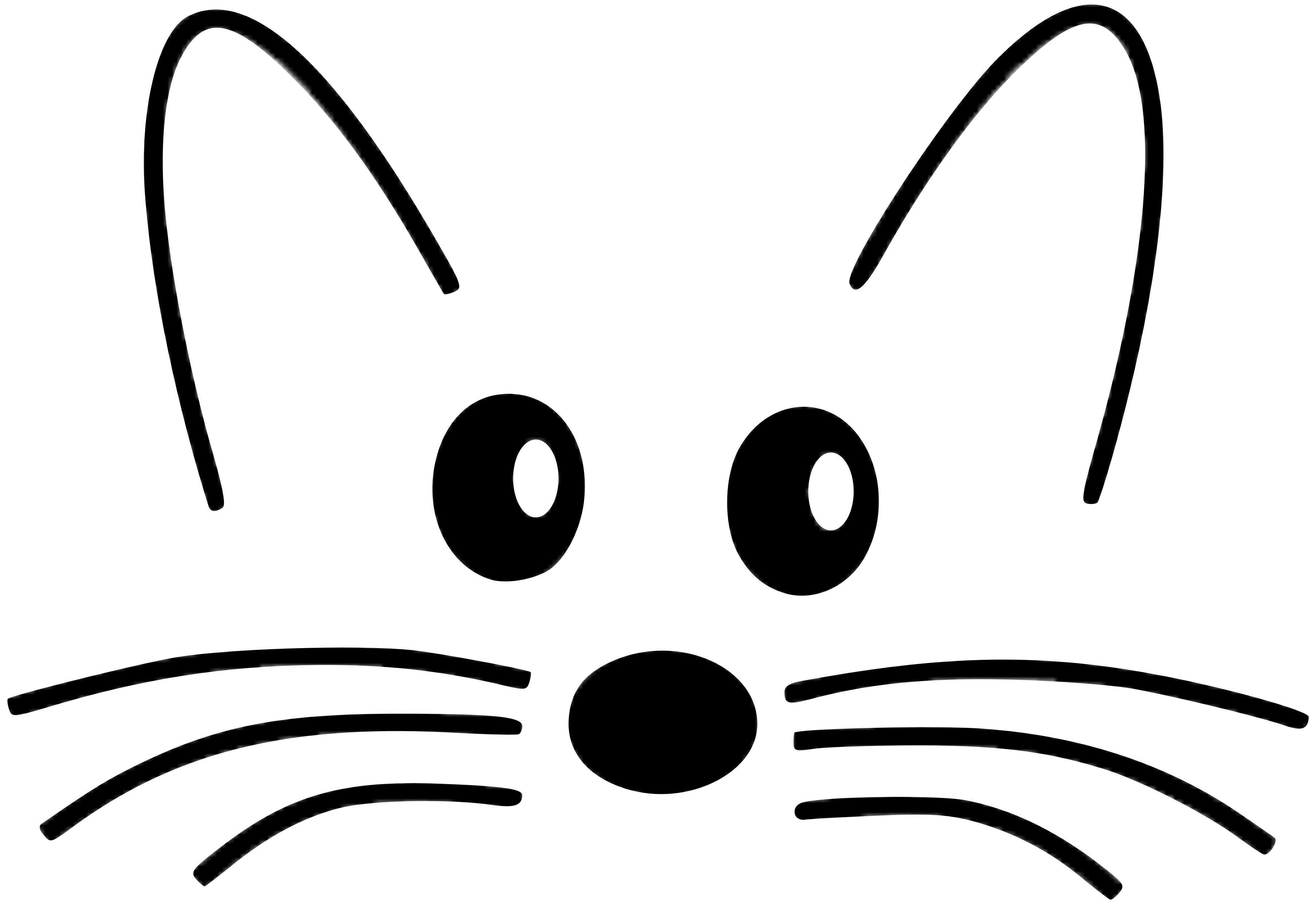
Model-View-Controller



Morphic

- UI construction environment for Smalltalk
- Key concepts:
  Directness and **liveness**
- Widgets are called **morphs**
  - Every morph can be a container for other morphs
  - Used for reification of widget structure and layout
  - Morphs can have autonomous behavior, usually appearing as animation

Squeak: Demo



Morphic: Implementing Layout

Exercise

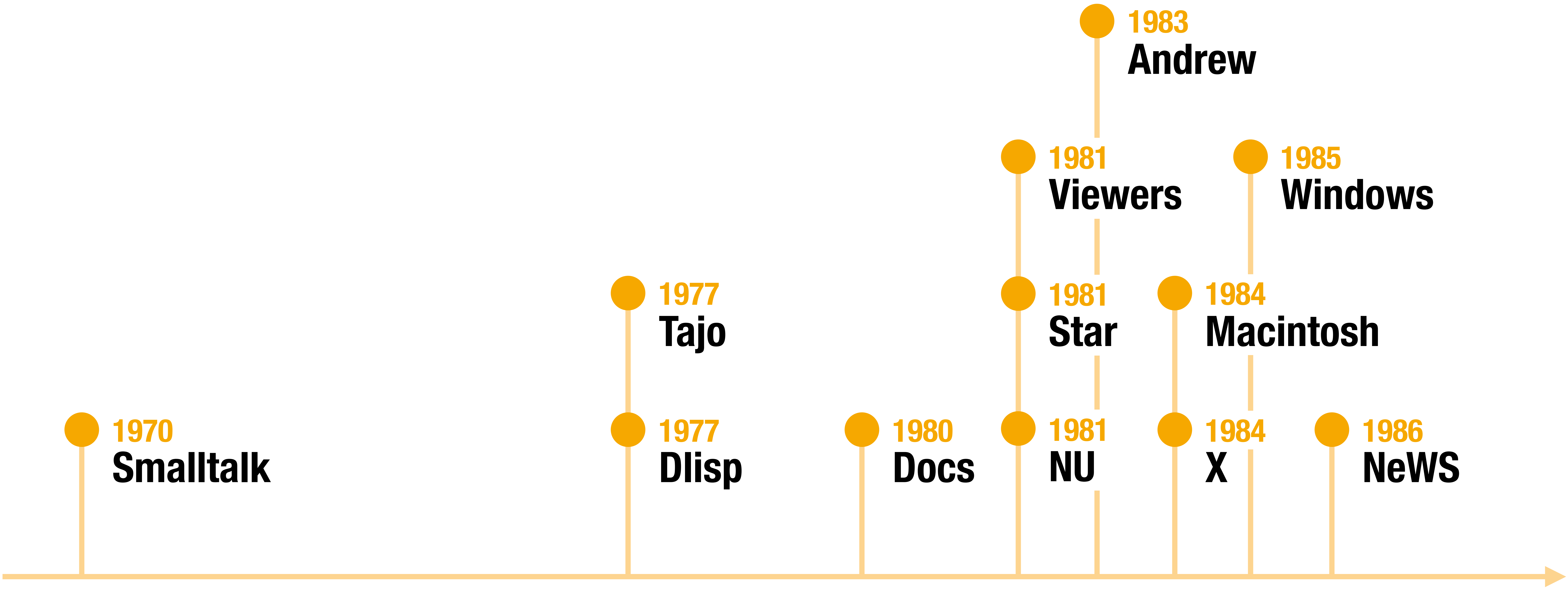
Algorithm to determine the layout of a morph that includes a tree of submorphs?

- **1st pass:** Compute minimum size of all submorphs bottom-up
- **2nd pass:** Distribute available space between submorphs top-down
- Optimizations?
  - Deferred layout
  - Pruning
  - Site selection

Morphic: Managing Redraws

- Damage List
  - Add bounding box of each changed morph to list
  - Each frame, redraw all morphs intersecting each bounding box in damage list
  - Double buffering prevents the user from seeing the construction of an animation
- Improvements?

History



1970 Smalltalk

1977 Dlisp

1977 Tajo

1980 Docs

1981 NU

1981 Star

1981 Viewers

1983 Andrew

1984 X

1984 Macintosh

1985 Windows

1986 NeWS