Designing Interactive Systems 2

Lecture 4: The X Window System, Smalltalk

Prof. Dr. Jan Borchers
Media Computing Group
RWTH Aachen University

hci.rwth-aachen.de/dis2

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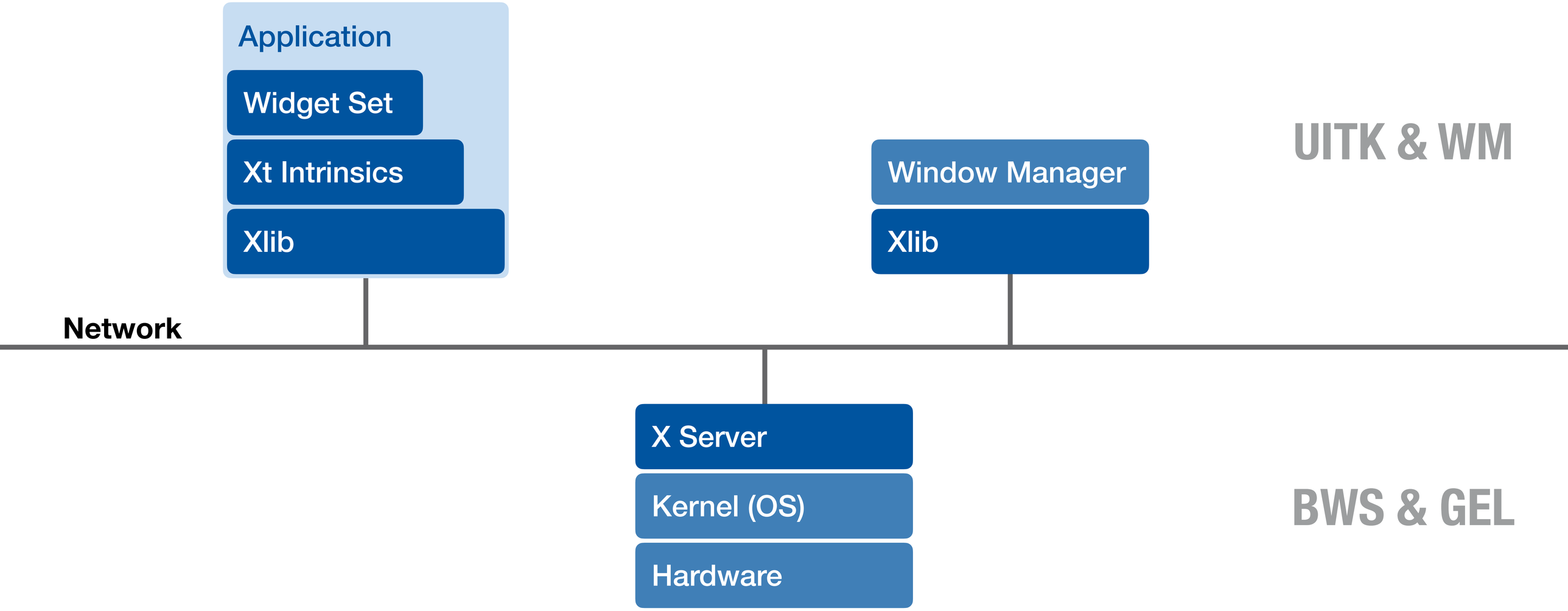
CHAPTER 8

The X Window System

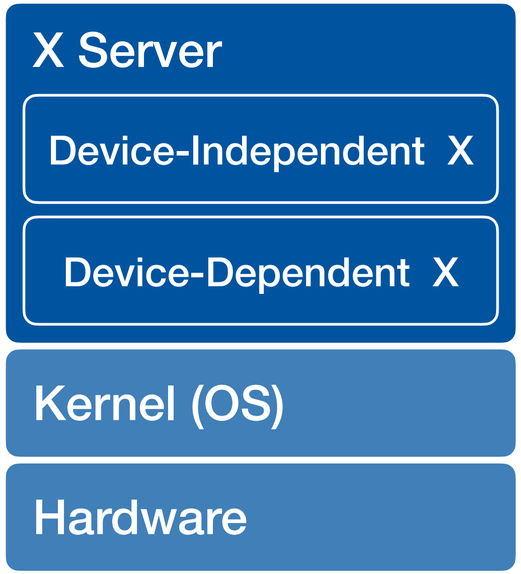
The X Window System

- 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

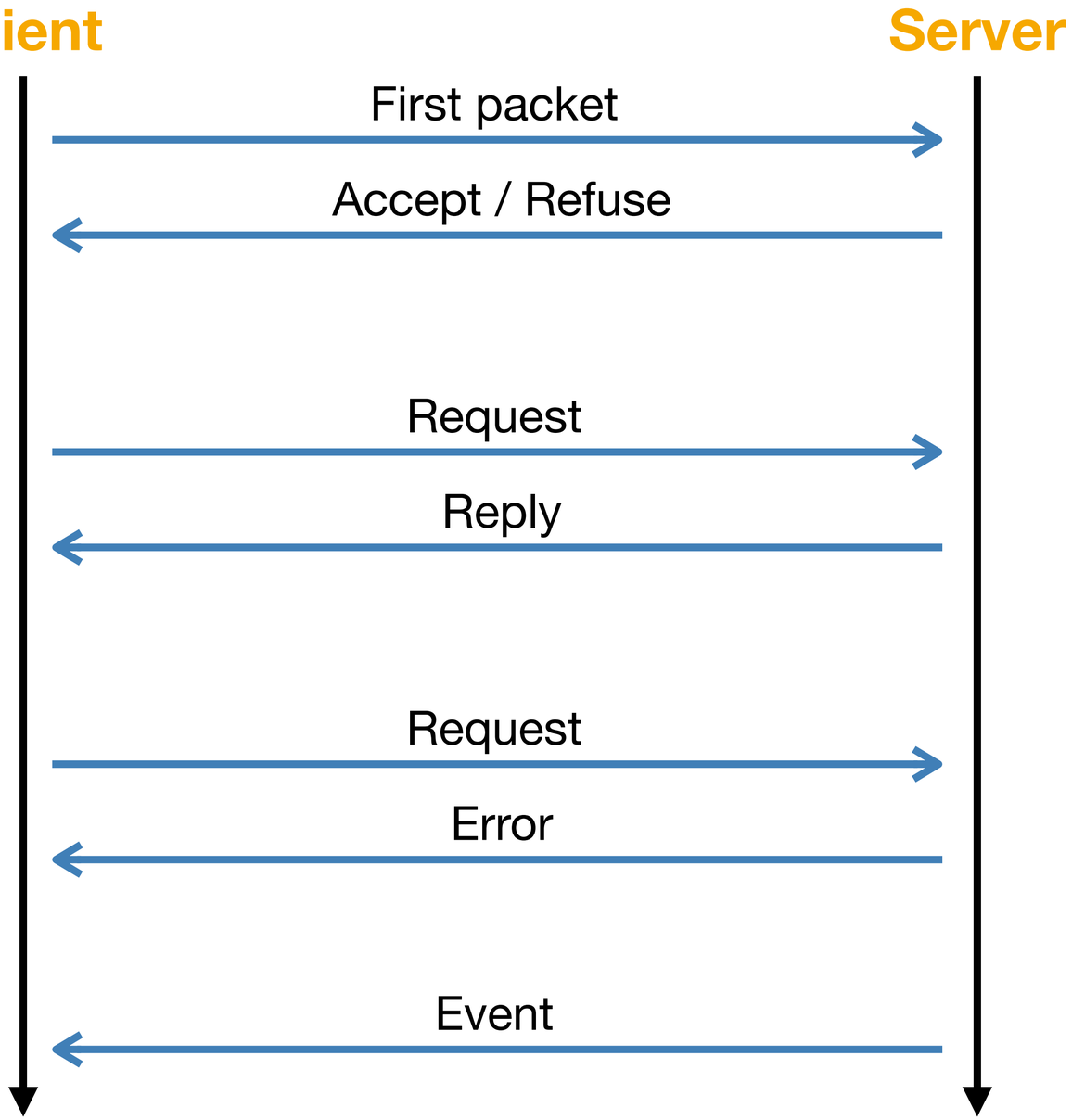


X Server

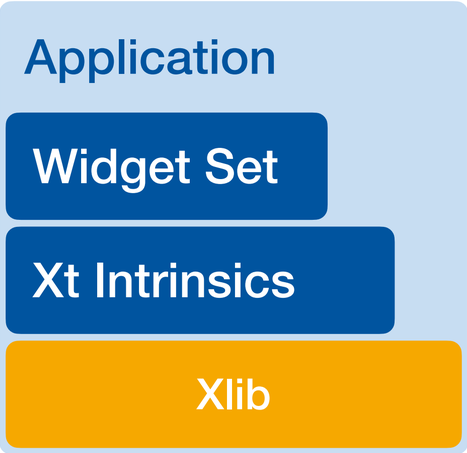


- Responsible for one keyboard (one EL)
- Can manage multiple physical screens (GLs)
- Provides base windows as canvas for clients (BWS)

X: Protocol



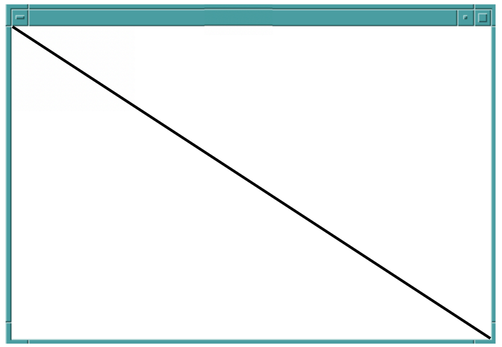
Xlib



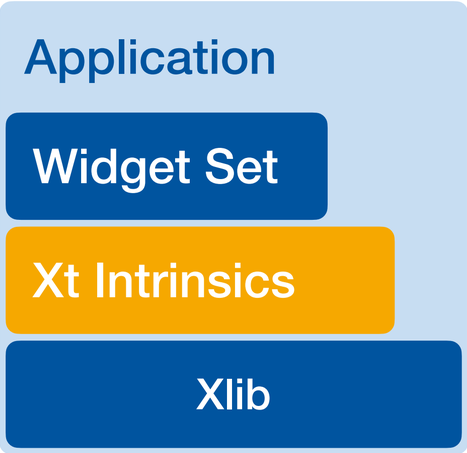
- Implements X protocol client
- Checks for events from server & creates queue on client
- Xlib offers functions to create, delete, and modify server resources

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,width,height,
          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,width,height); break;
                case ButtonPress: exit(0);
        }
    }
}
```

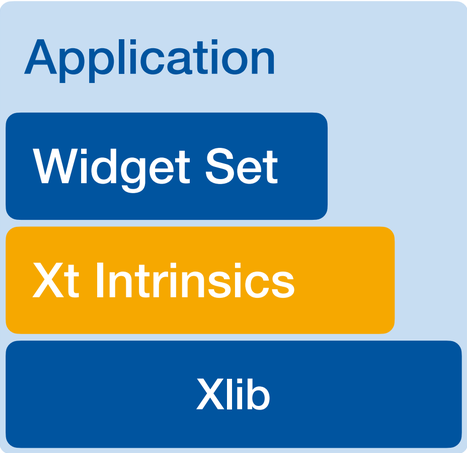


X Toolkit Intrinsics



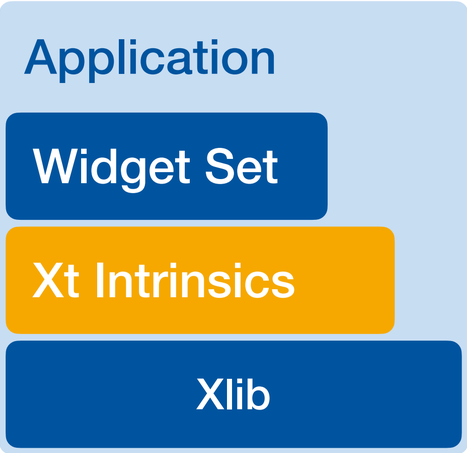
- Xt Functions are generic to work with all widget classes

X Toolkit Intrinsics



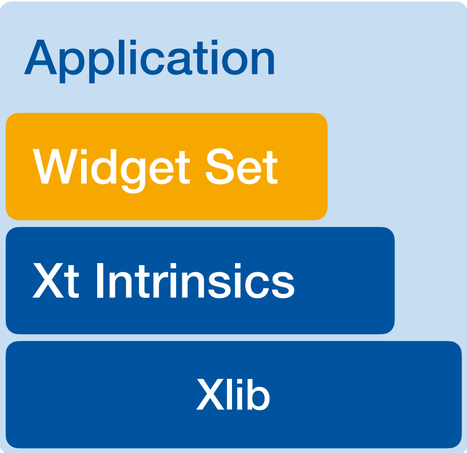
- Xt Functions are generic to work with all widget classes
- At runtime widgets have four states:
  Created, managed, realized, mapped

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



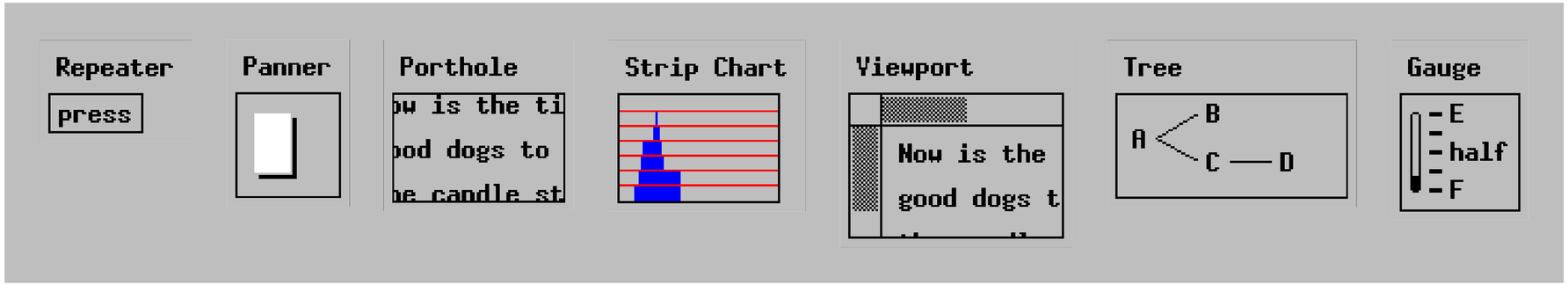
- Programming model already given in intrinsics
- Collection of several different user interface components
- Defines the look & feel of the system together with the WM

Athena Widget Set

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

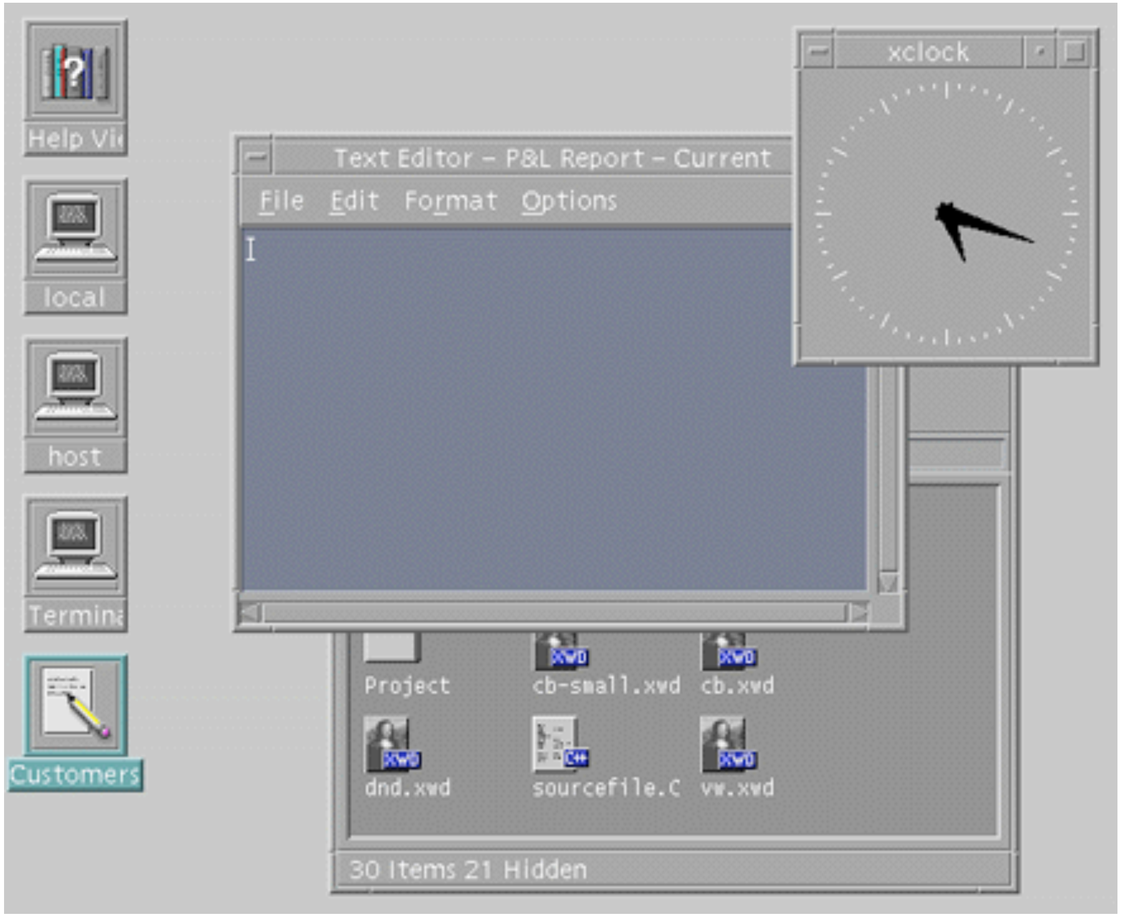
- Standard widgets

- Special widgets

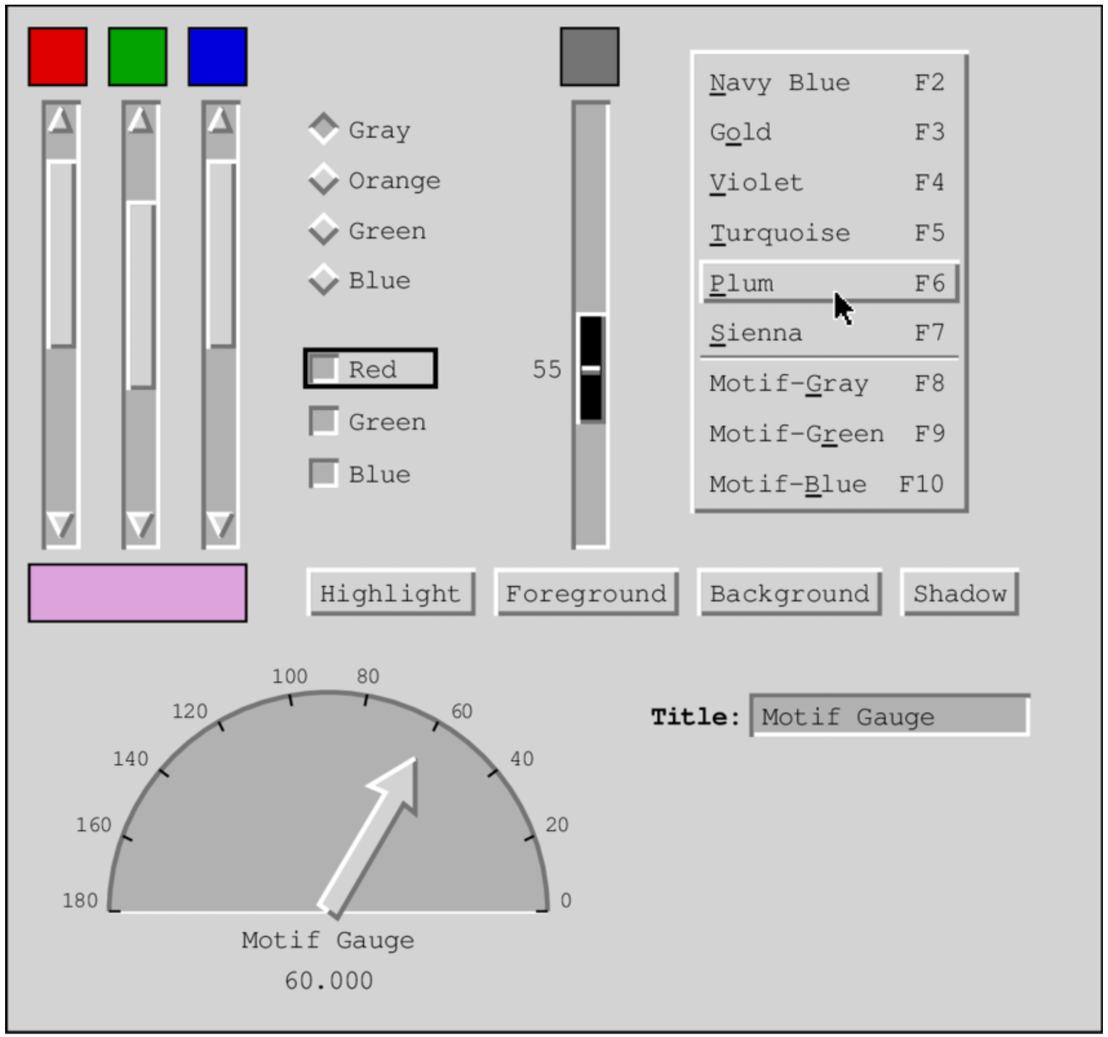


Motif: More than a Widget Set

- **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

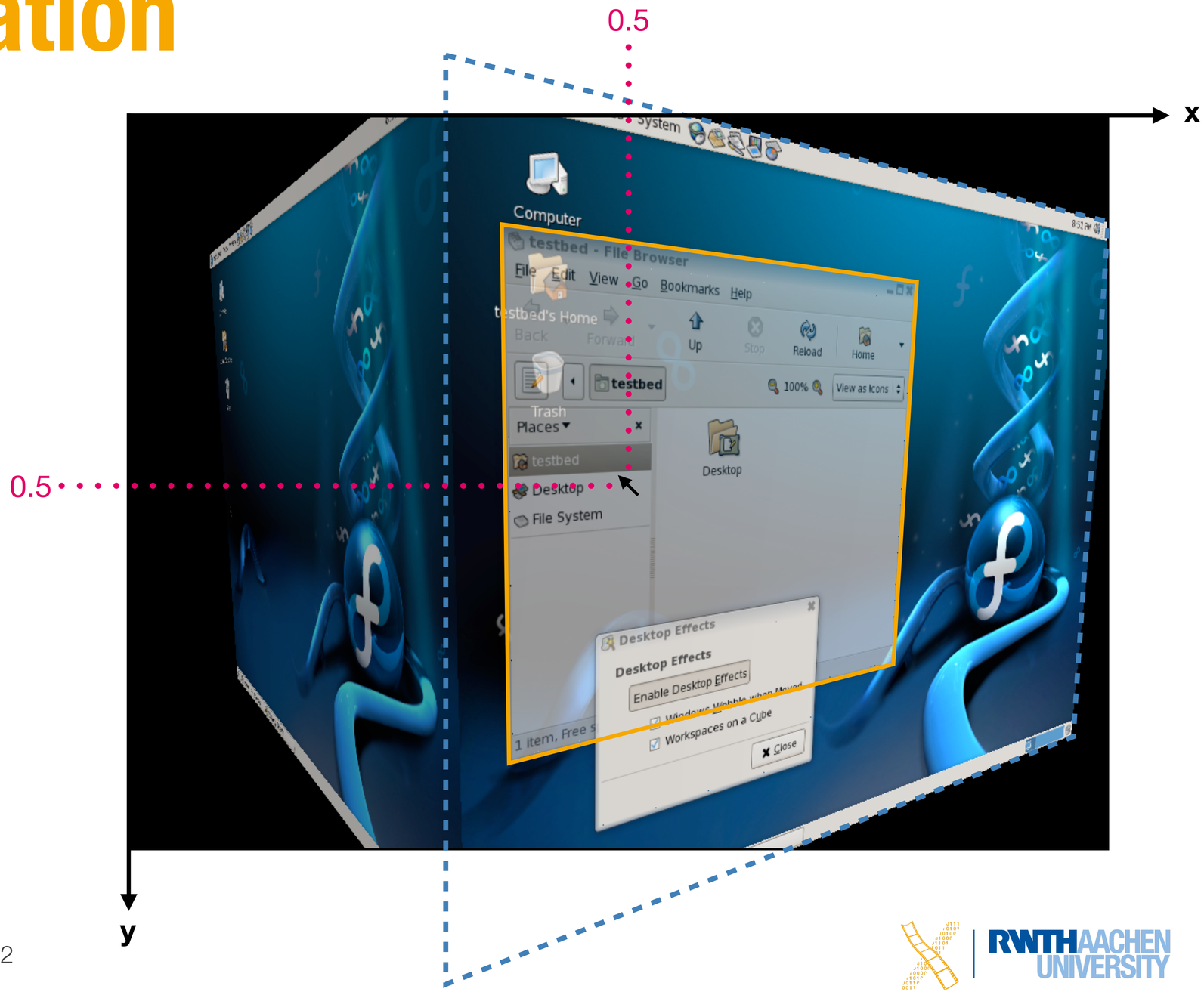
CHAPTER 9

Wayland

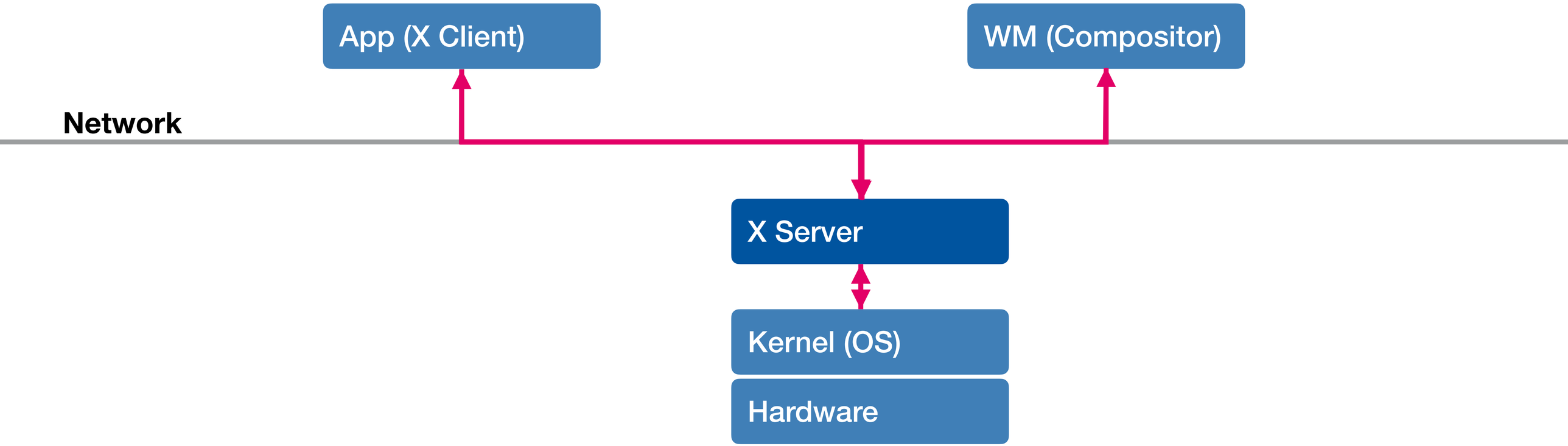
Wayland: Motivation

- 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

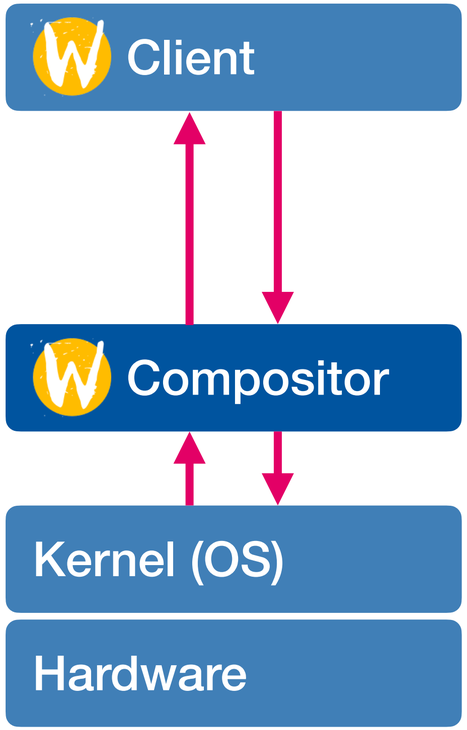


X: Communication



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

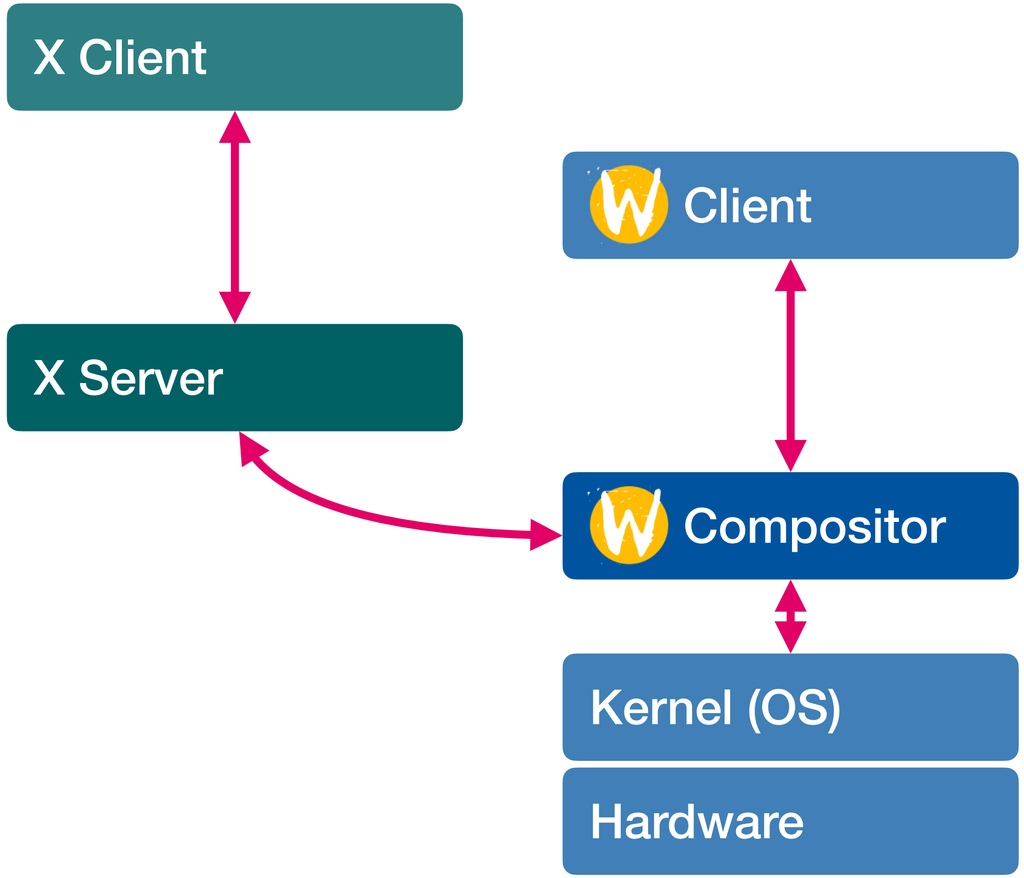


Wayland: Direct Rendering

- 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

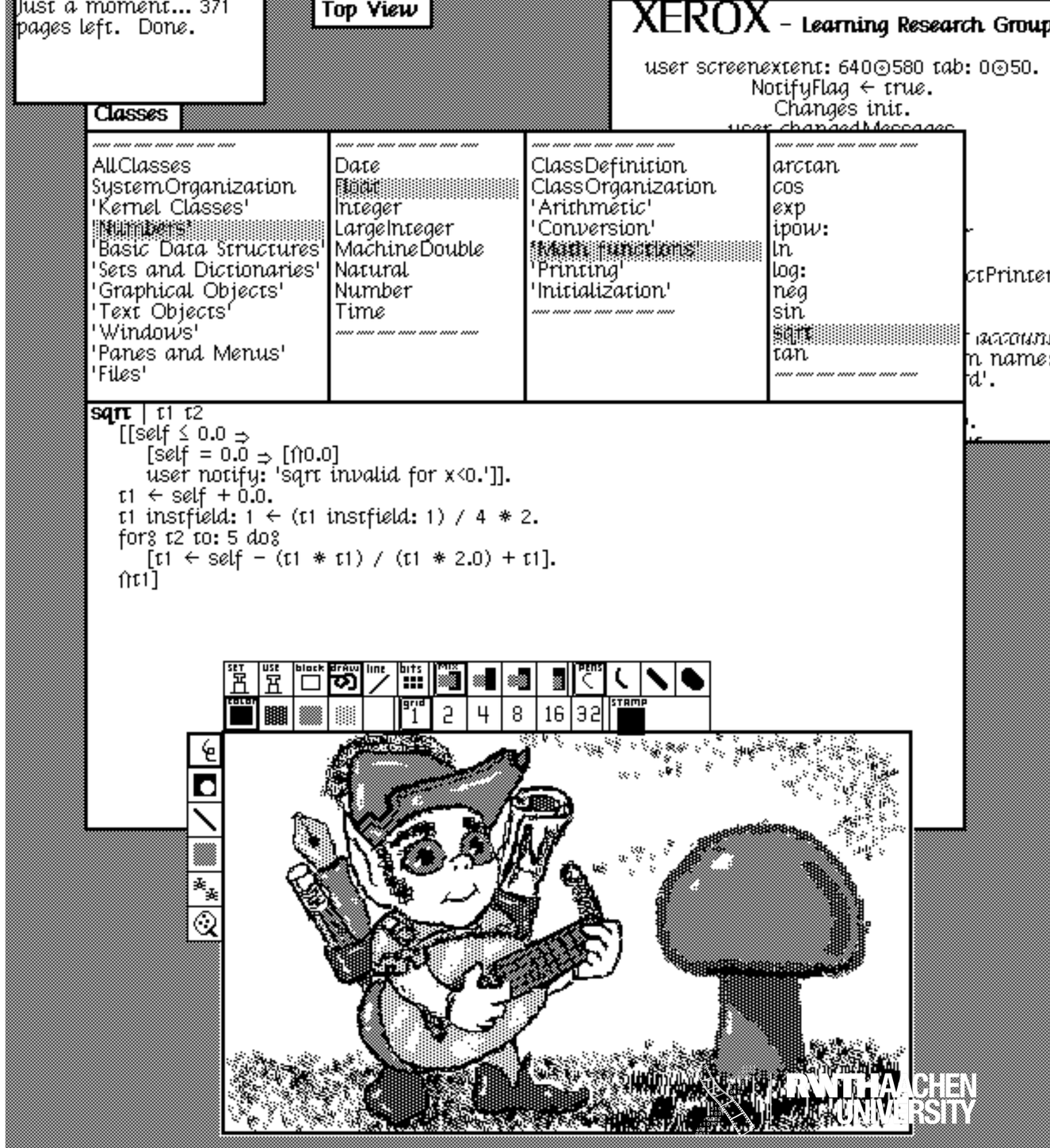


CHAPTER 10

Smalltalk

Smalltalk

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



Smalltalk

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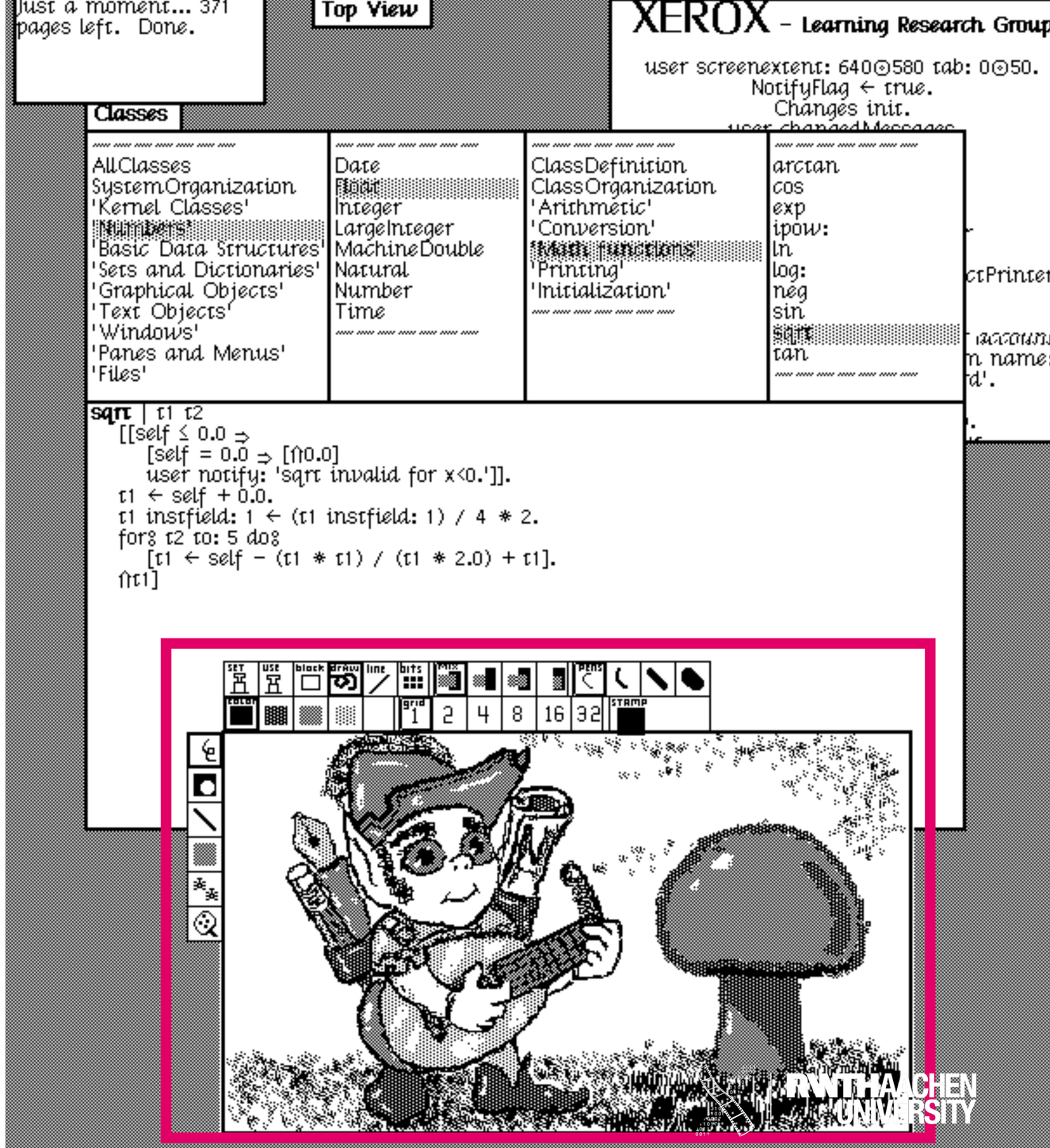
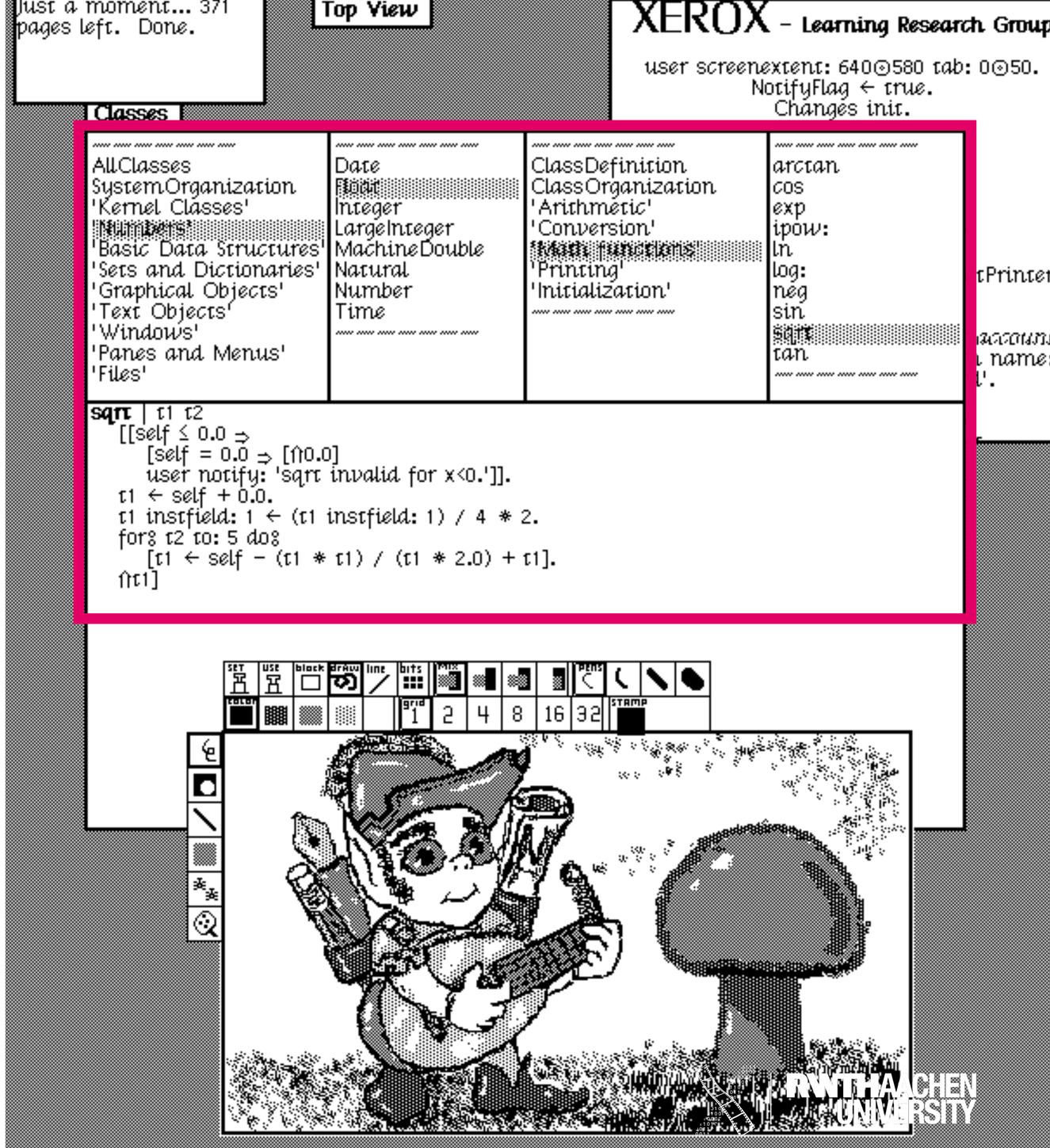
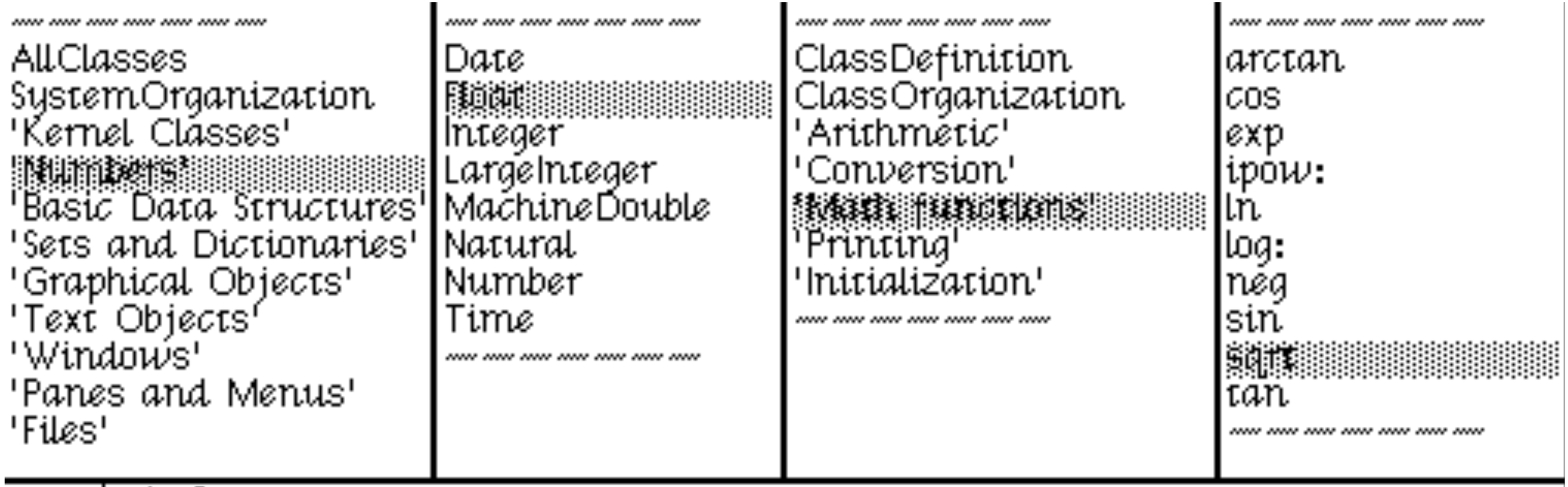
  OO programming language
- Introduced the MVC Pattern
- UITK with modeless editor



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

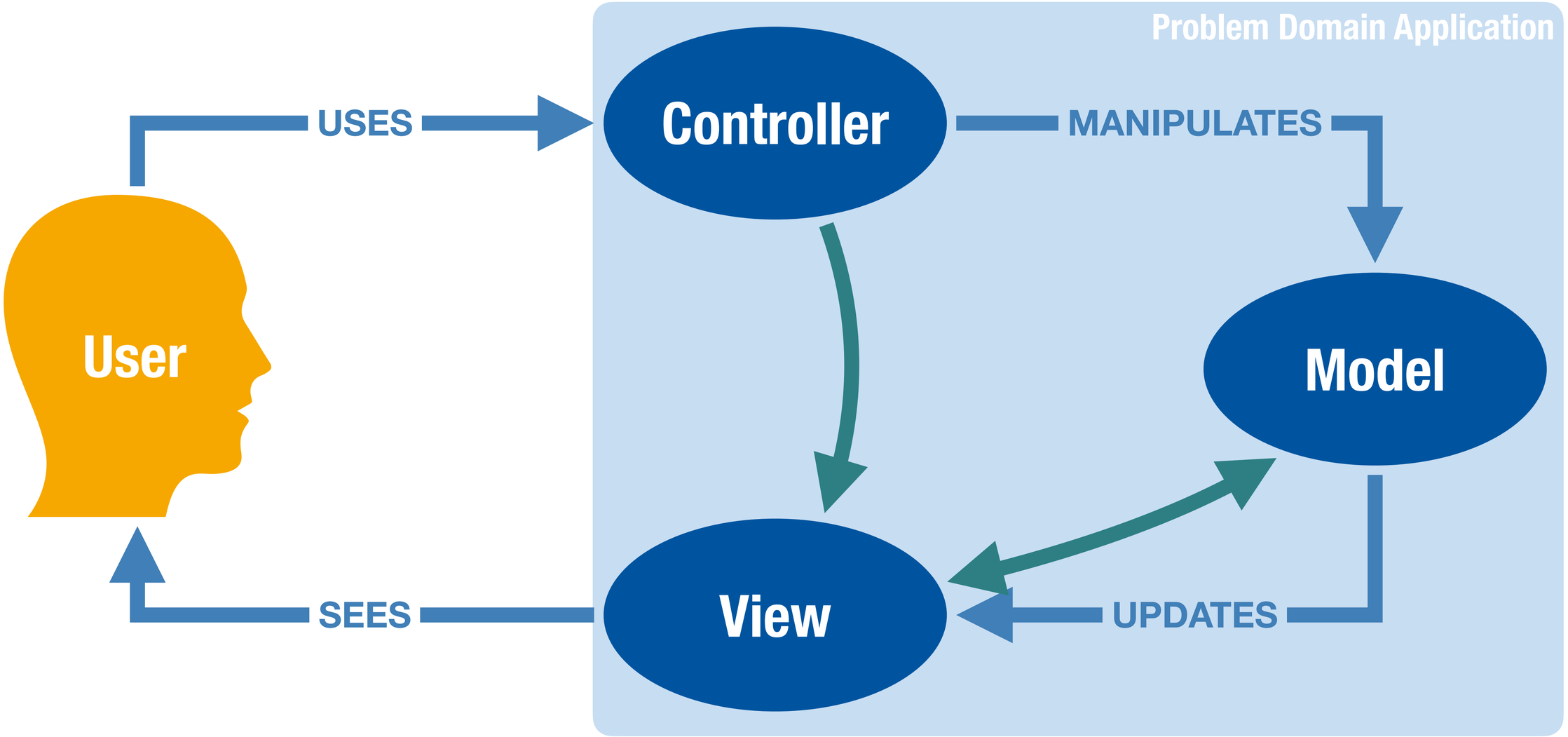




Smalltalk: Architecture

- 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

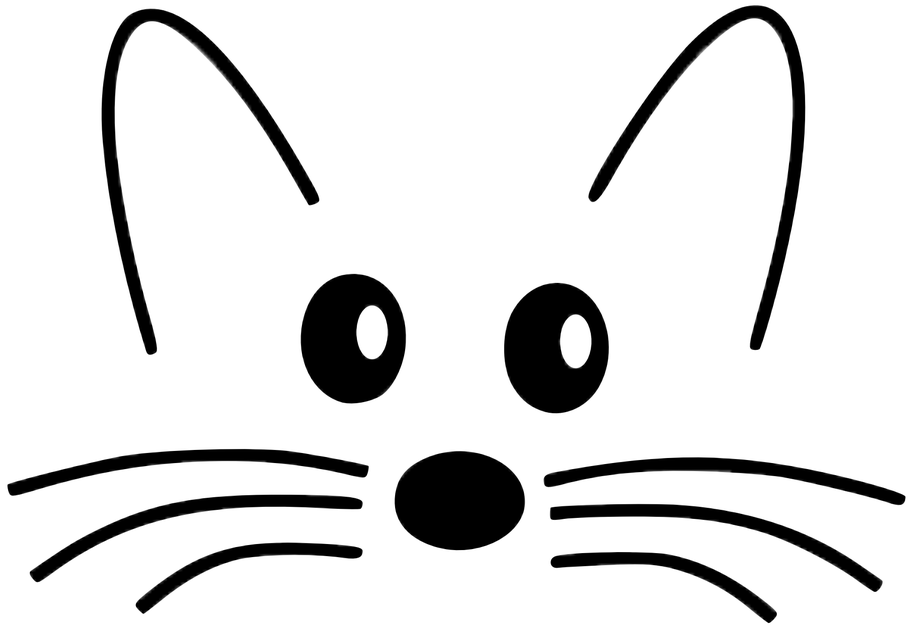
Model-View-Controller



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



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

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