Designing Interactive Systems 2

Lecture 2: Window System Architecture

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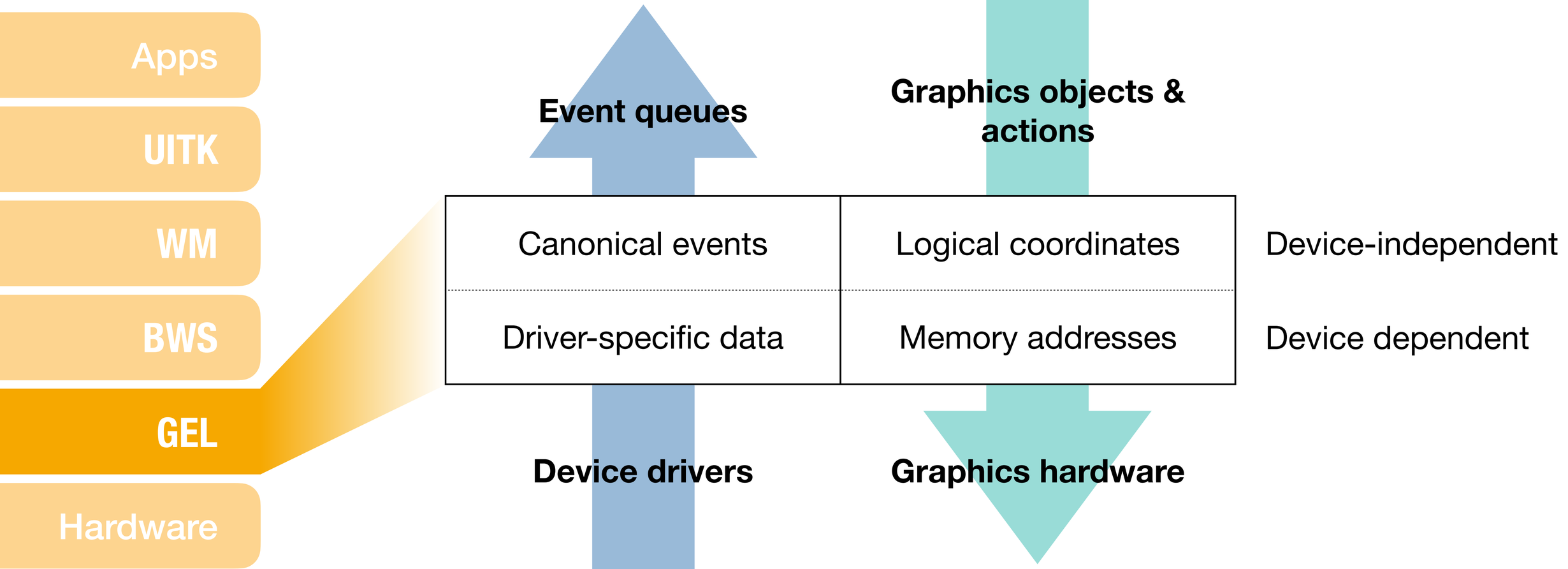
CHAPTER 4

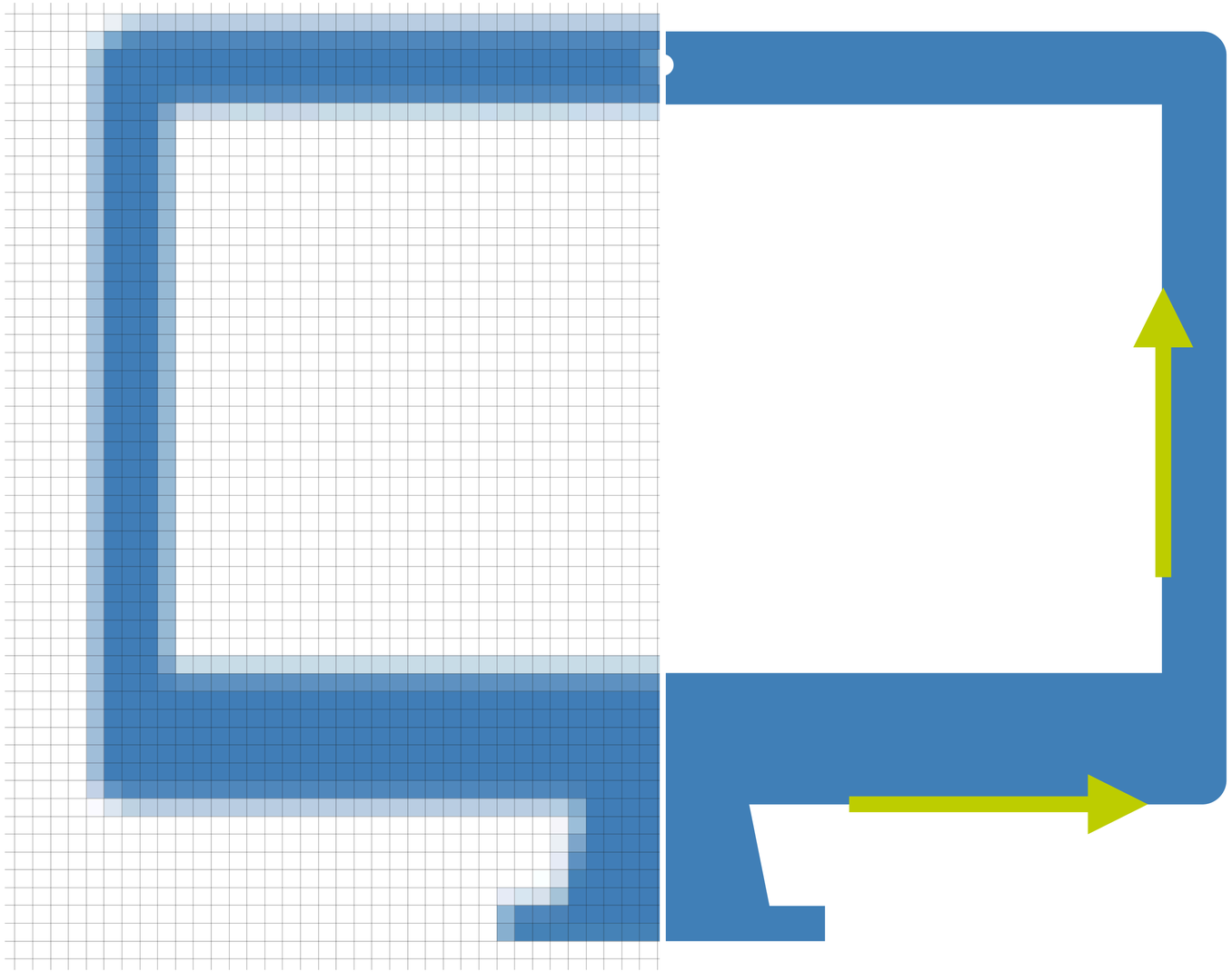
Graphics & Event Library

Graphics & Event Library



Graphics Models

RasterOp Model

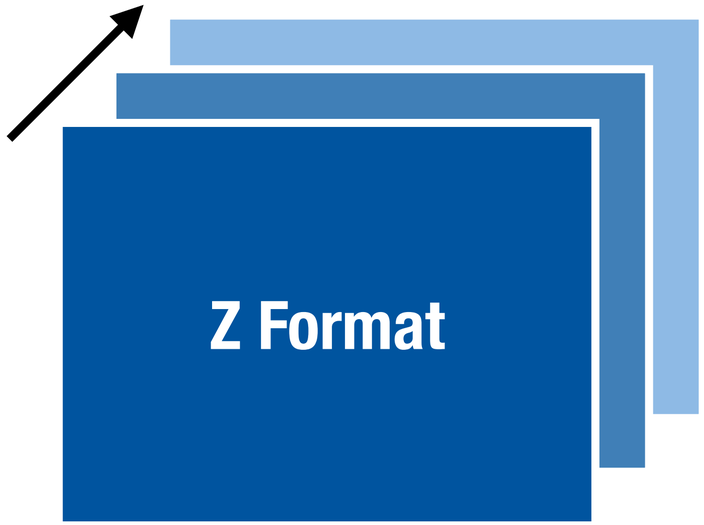


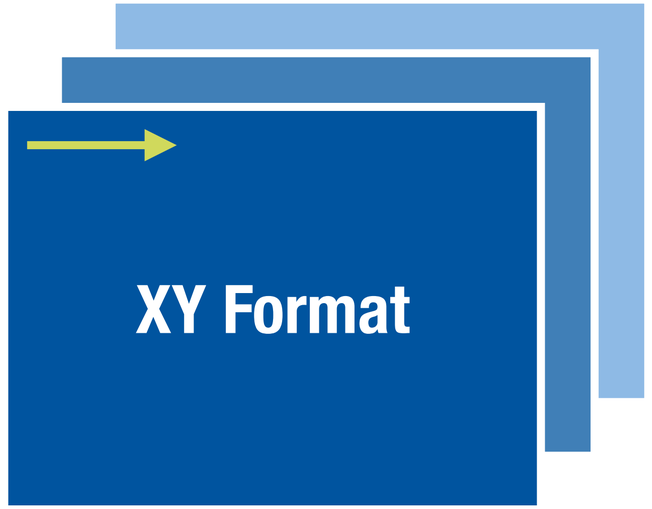
Vector Model

Graphics Library Objects: Canvas

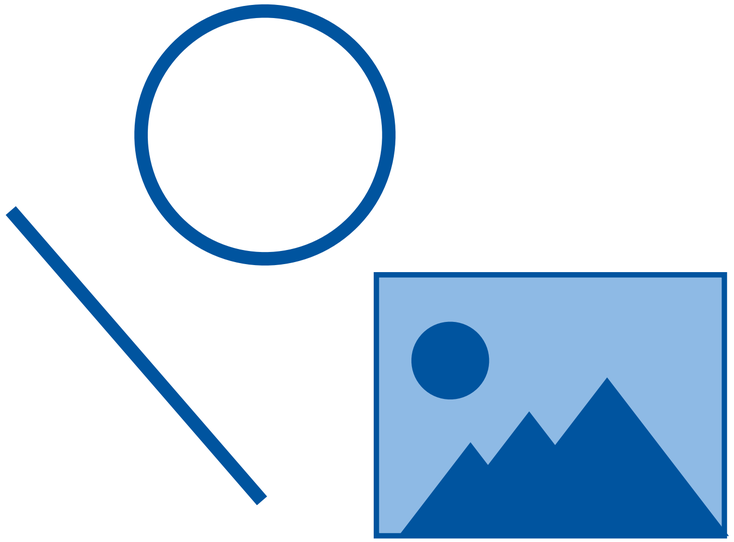
- A canvas is a
  memory area with a coordinate system and memory-to-pixel mapping

- Different formats





Graphics Library Objects: Output Objects



Elementary Objects

Complex Objects

Graphics Library Objects: Graphics Context

- State of the (virtual) graphics processor

- Goal: **reduce parameters** to pass when calling graphics operations

Attribute	Value
Font	Gill Sans
Font size	24 pt
Font color	(0,0,0)
Line width	2 px
...	...

```
drawString(x, y, “Turtle”);
```

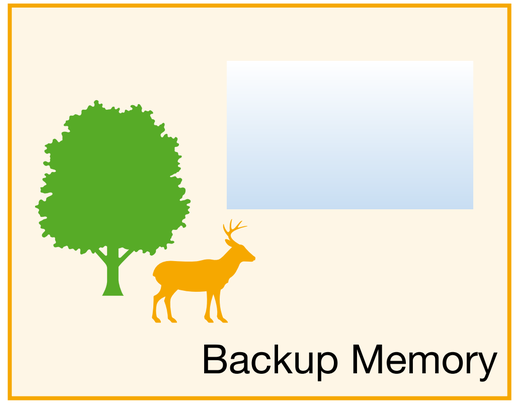
Graphics Library: Drawing

Command-Buffered Drawing

Direct Drawing

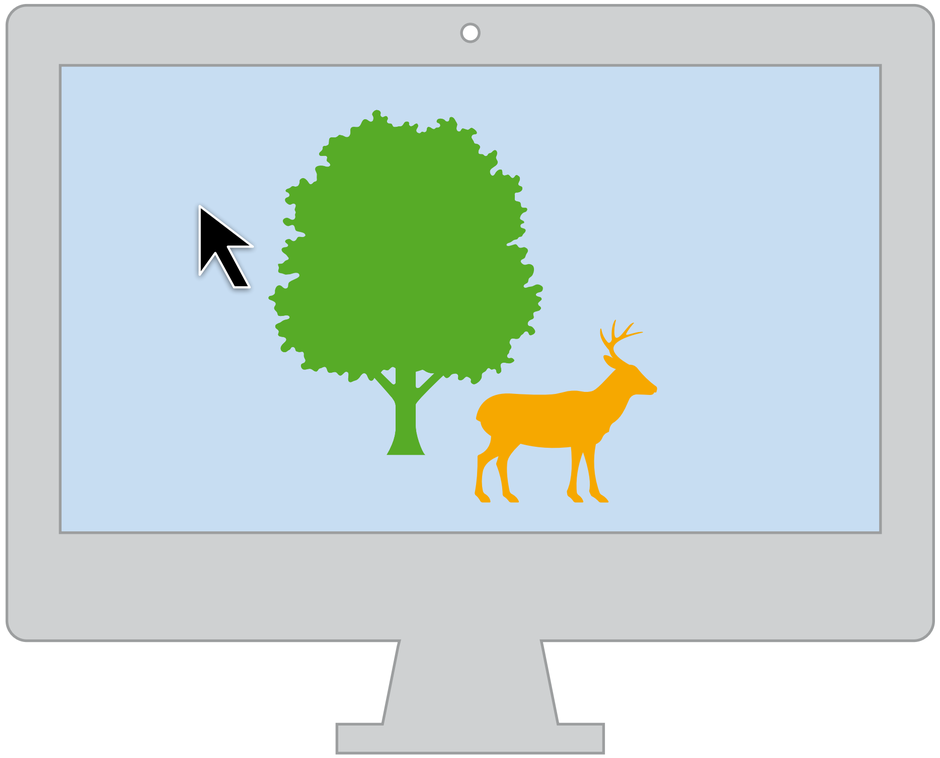
Data-Buffered Drawing


```
setFillColor(green);
fillPath(treePath);
setFillColor(orange);
fillPath(deerPath);
```



Damage Repair

- Mouse cursor is always drawn by GEL (performance)
- Restoring contents that were occluded by mouse cursor needed



Event Library

Canonical Mouse Event Queue

Event	
Type	Movement
Value	(0,2)
Timestamp	13:37:12.203

Event	
Type	Mouse Down
Value	Left
Timestamp	13:37:12.271

Event	
Type	Mouse Up
Value	Left
Timestamp	13:37:12.289

Event	
Type	Movement
Value	(12,2)
Timestamp	13:37:12.416

Mouse Driver Event Queue

Event	
Button 1	0
Button 2	0
Button 3	0
X	0
Y	**1**
Wheel	0
Timestamp	31267

Event	
Button 1	**1**
Button 2	0
Button 3	0
X	0
Y	0
Wheel	0
Timestamp	31335

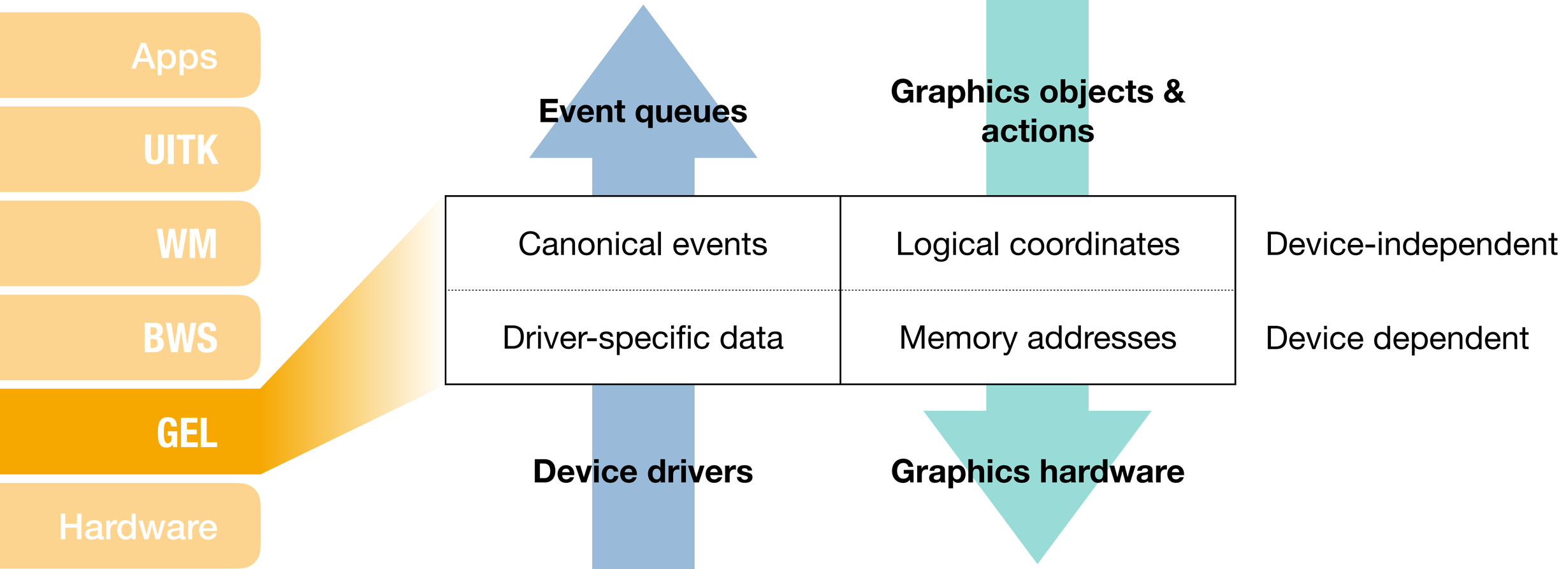
Event	
Button 1	0
Button 2	0
Button 3	0
X	0
Y	0
Wheel	0
Timestamp	31421

Event	
Button 1	0
Button 2	0
Button 3	0
X	**6**
Y	**1**
Wheel	0
Timestamp	31634

How Extensible is the GEL?

- Most systems: Not accessible to application developer
- GEL **as library**: extensible only with access to source code (X11)
- GEL access **via interpreted language**: extensible at runtime (NeWS)
  - NeWS example: Download PostScript code into GEL to draw triangles, gridlines, patterns,...

Graphics & Event Library



CHAPTER 5

Base Window System

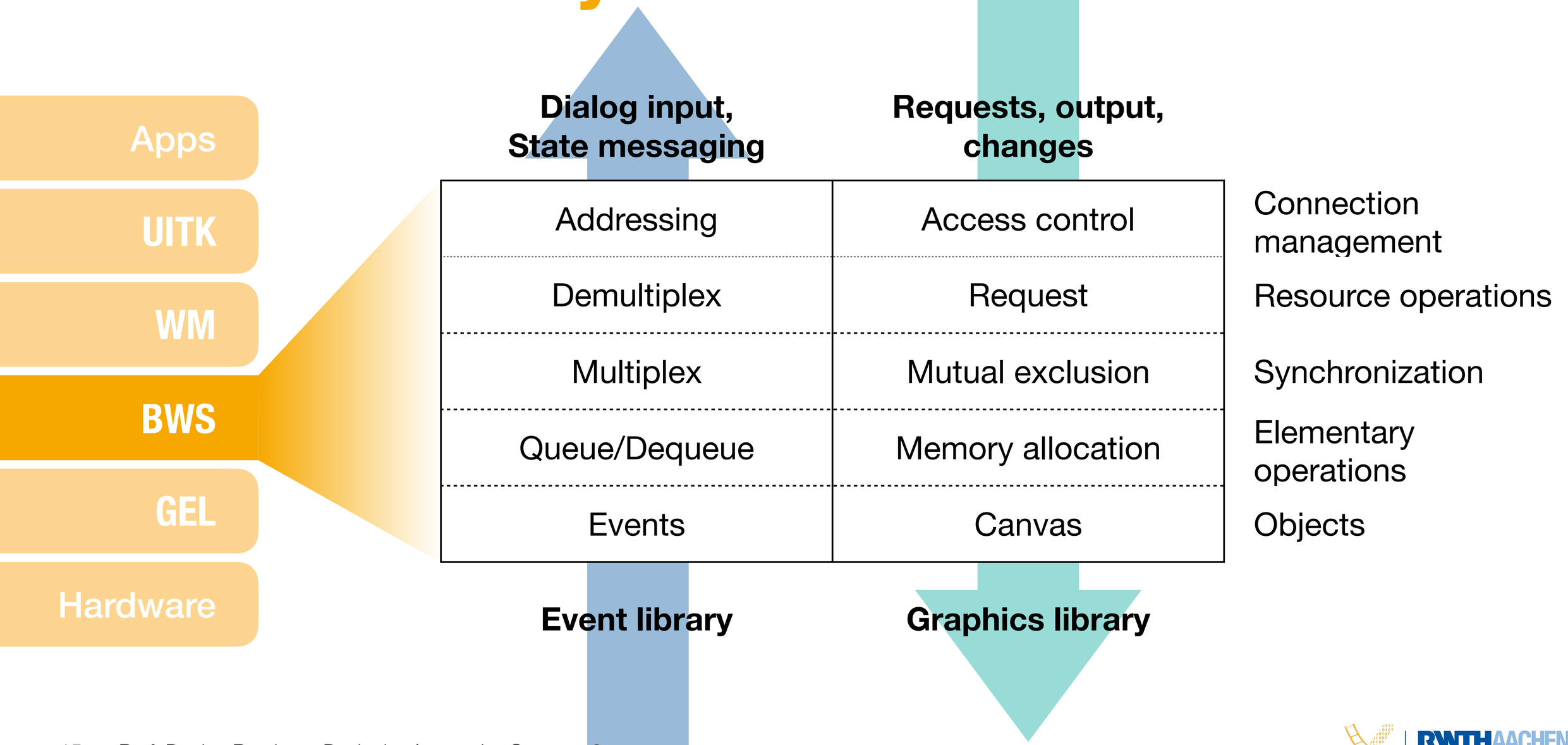
Base Window System

- **Core** of the Window System
  - Provides **WS-wide data structures** and operations
  - Manages **shared resources** to ensure consistency

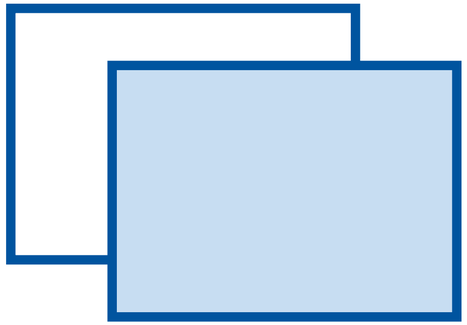
- **Base window**: logical canvases that include the on-screen windows and / or widgets

- In general:
  1 WS — k terminals, m applications, n objects per application (windows, fonts)

Base Window System

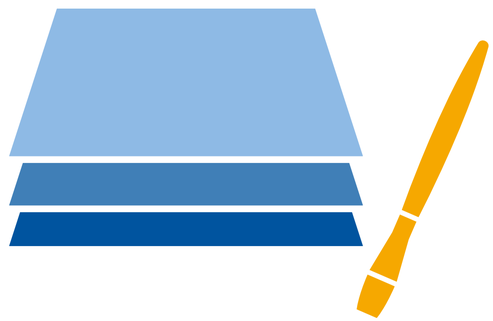


Base Window System: Objects

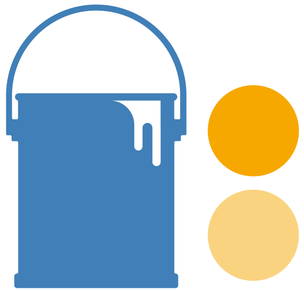


Window & Canvas

Events



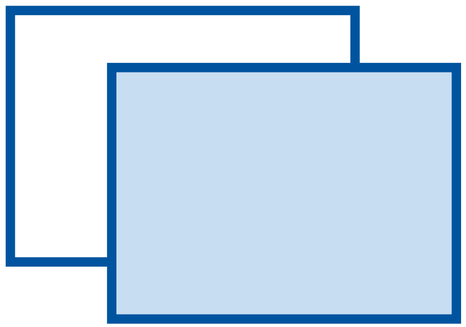
Graphics Context



Color Tables

Fonts

Base Window System: Objects



Window & Canvas

Components

- Owning application
- Using applications
- Size, depth, border, origin
- State variables (only for windows)

Operations

- Drawing in local coordinate system
- State changes

Base Window System: Objects

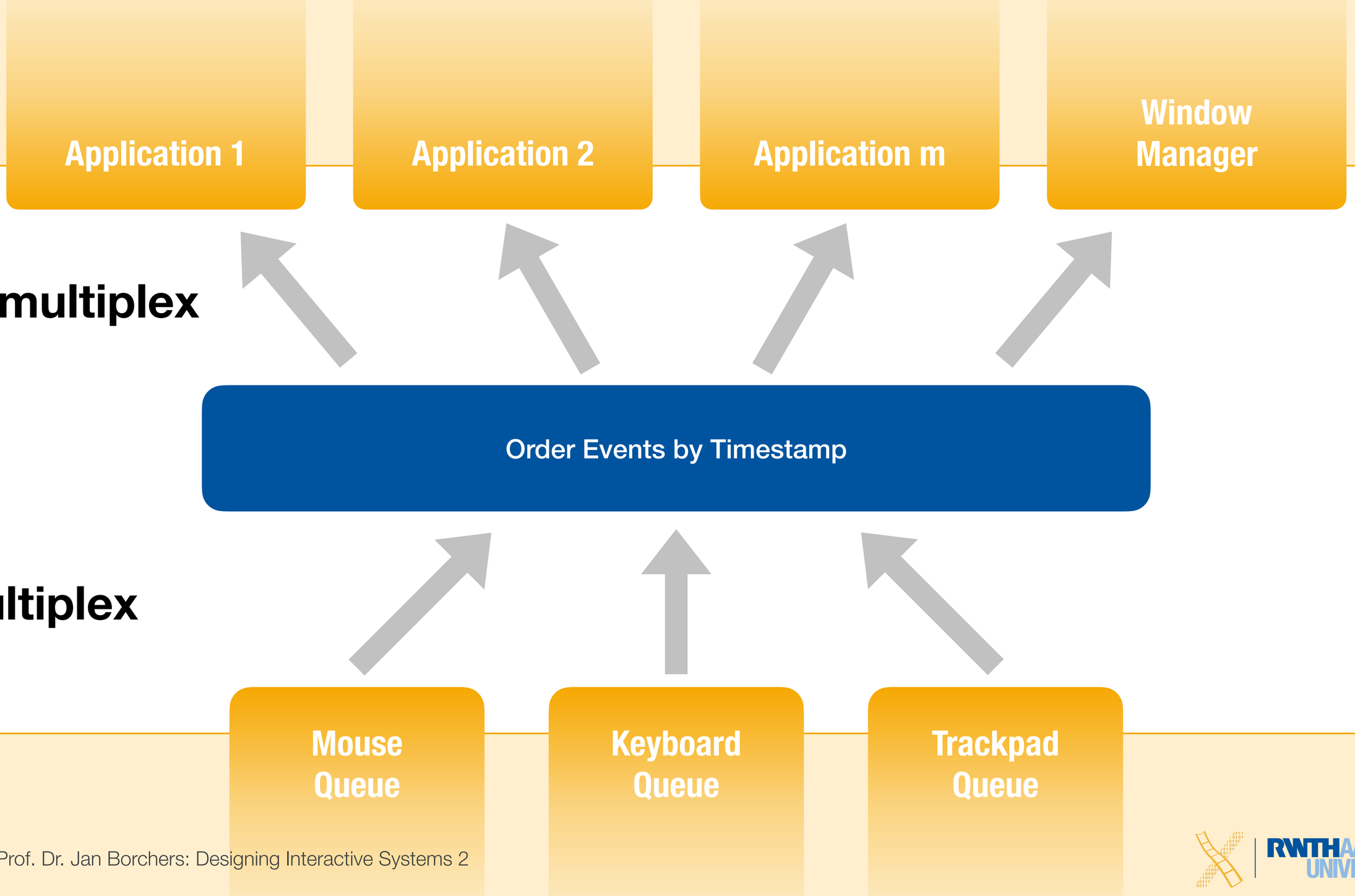
Events

Components

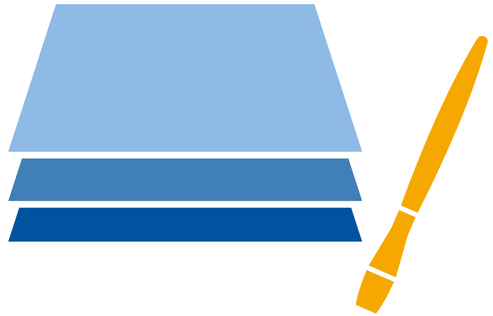
- Event type
- Timestamp
- Type-specific data
- Location
- Window
- Application

Operations

- Read, write and filter events



Base Window System: Objects

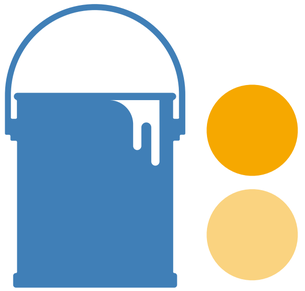


Graphics Context

Components

- Owner app, user apps
- Graphics attributes (line thickness, color index, copy function,...)
- Text attributes (color, skew, direction, copy function,...)
- Color table reference

Base Window System: Objects



Color Tables

Components

- Owner app, user apps
- Data fields for each color entry
- RGB, HSV, YIQ,…

Operations

- Provide default color
- Find close replacements of colors (fault tolerance)

Base Window System: Objects

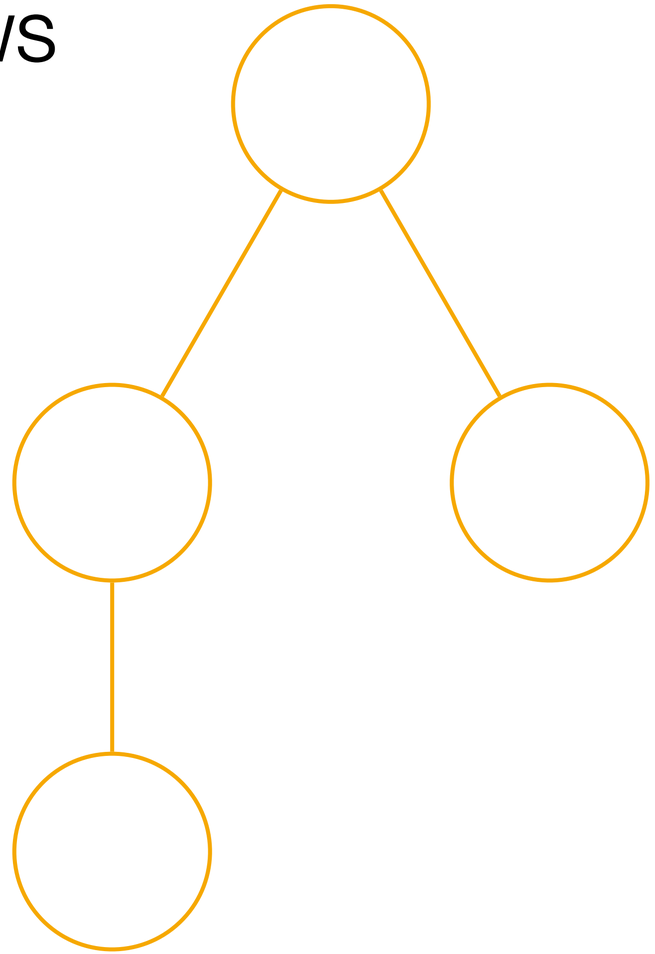
Fonts

Components

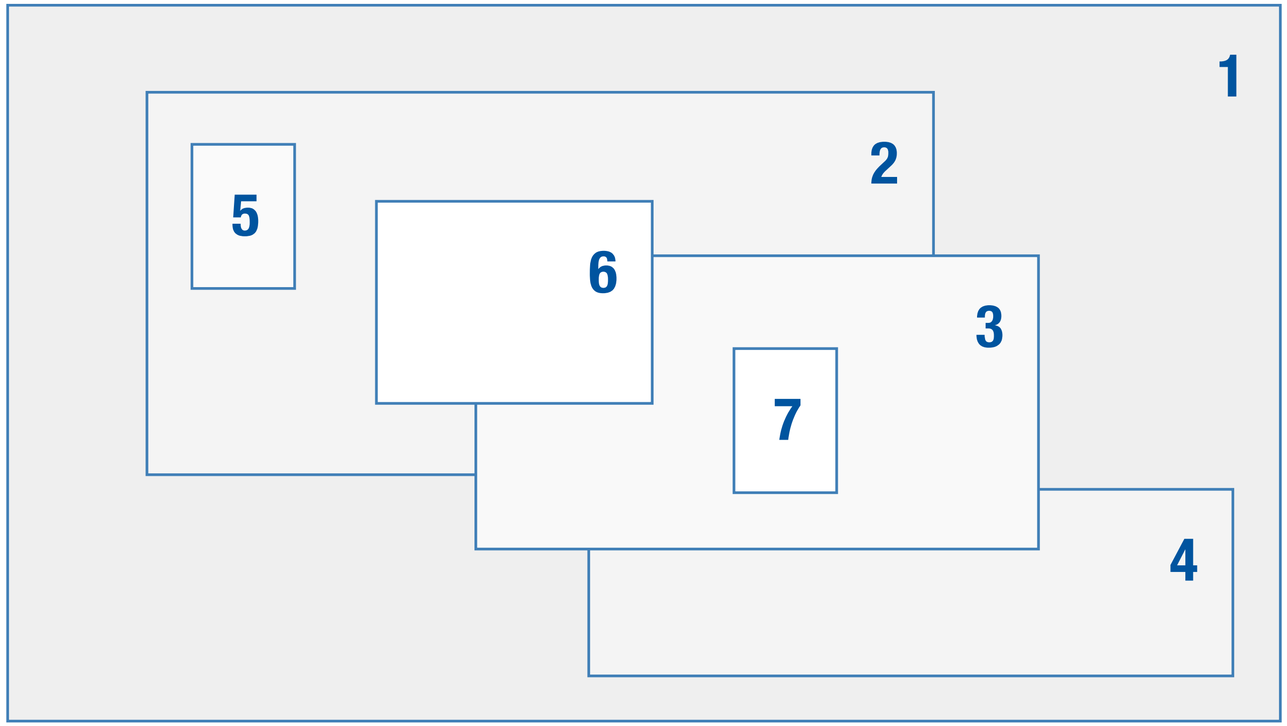
- Owner app, user apps
- Name, measurements
  (font size, kerning, ligatures,...)
- One data field per character

Base Window Management

- Trees are used to manage the window collection in the BWS
  - All child windows are inside their parent window
  - Simplifies event routing or setting visibility



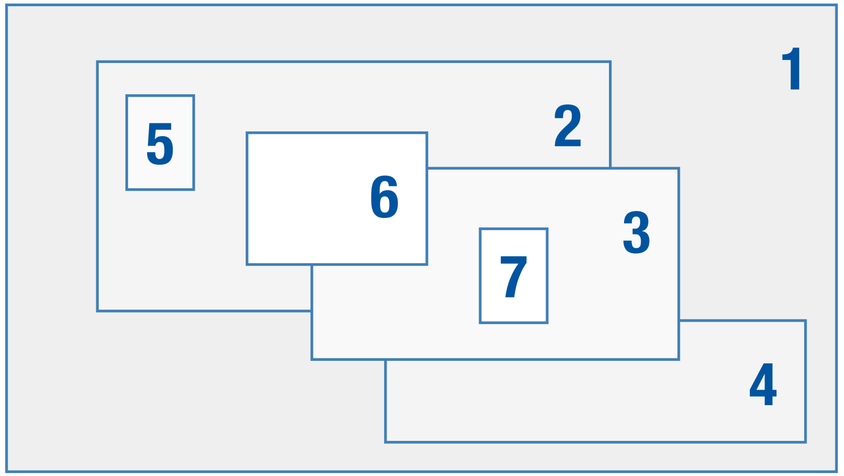
Base Window Management



Exercise

Determine a valid tree structure for the window arrangement shown above.

Base Window Management



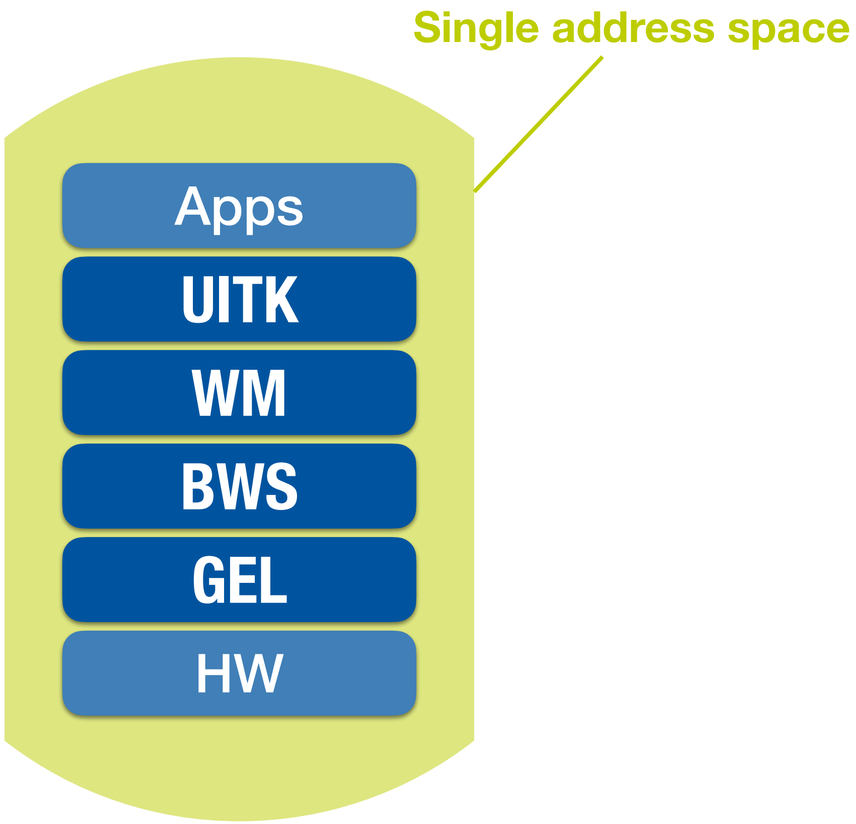
Base Window System: Shared Resources

- Reasons for sharing resources: Scarcity, collaboration
- **Problems**: Competition, consistency

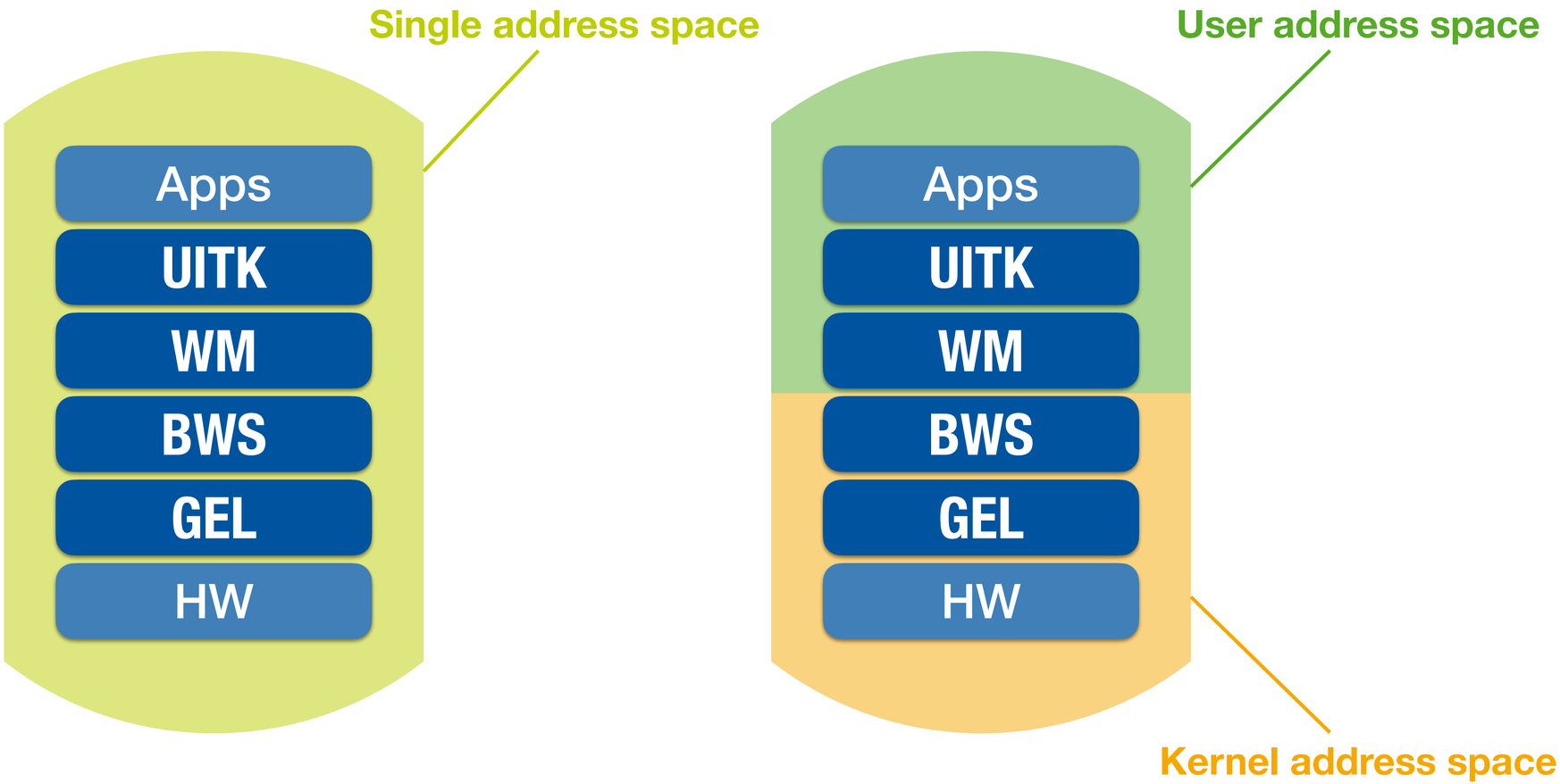
Base Window System: Shared Resources

- Reasons for sharing resources: Scarcity, collaboration
- **Problems**: Competition, consistency
- **Synchronization** needed
  - At BWS entrance
  - Or on individual objects

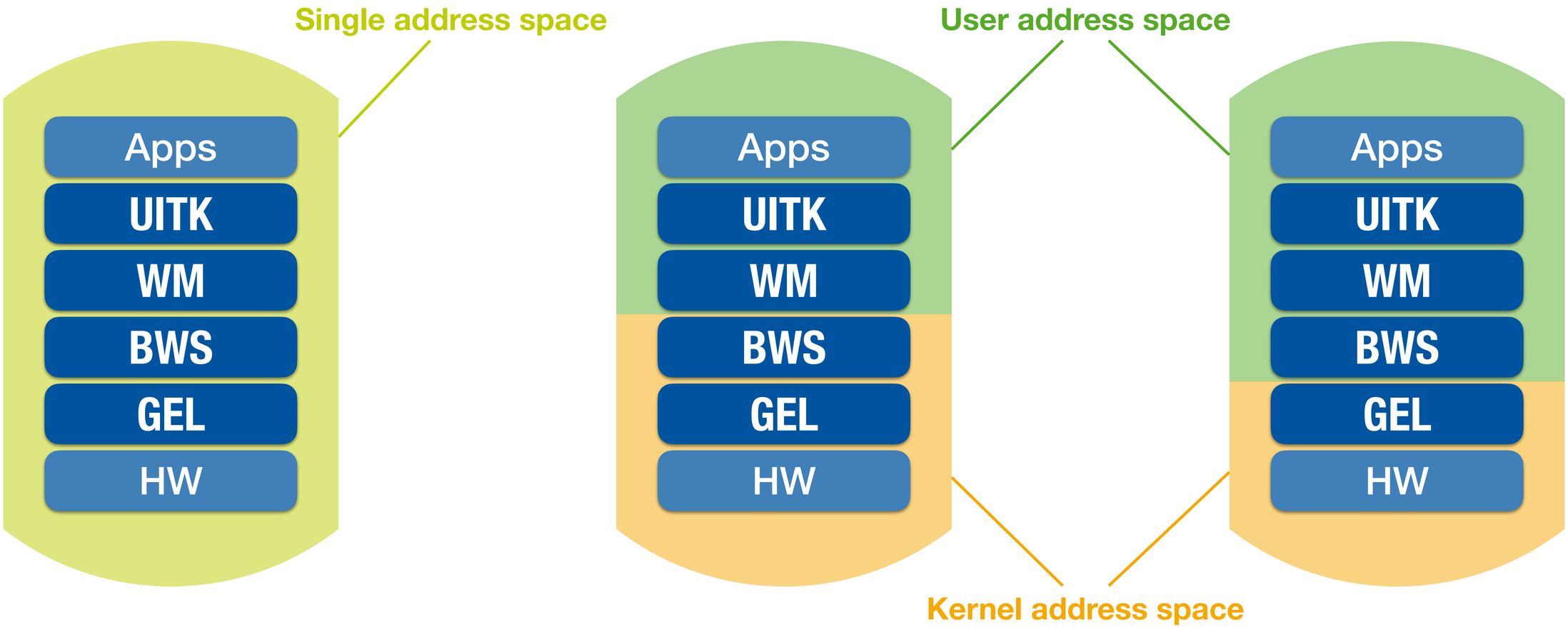
Base Window System: OS Integration



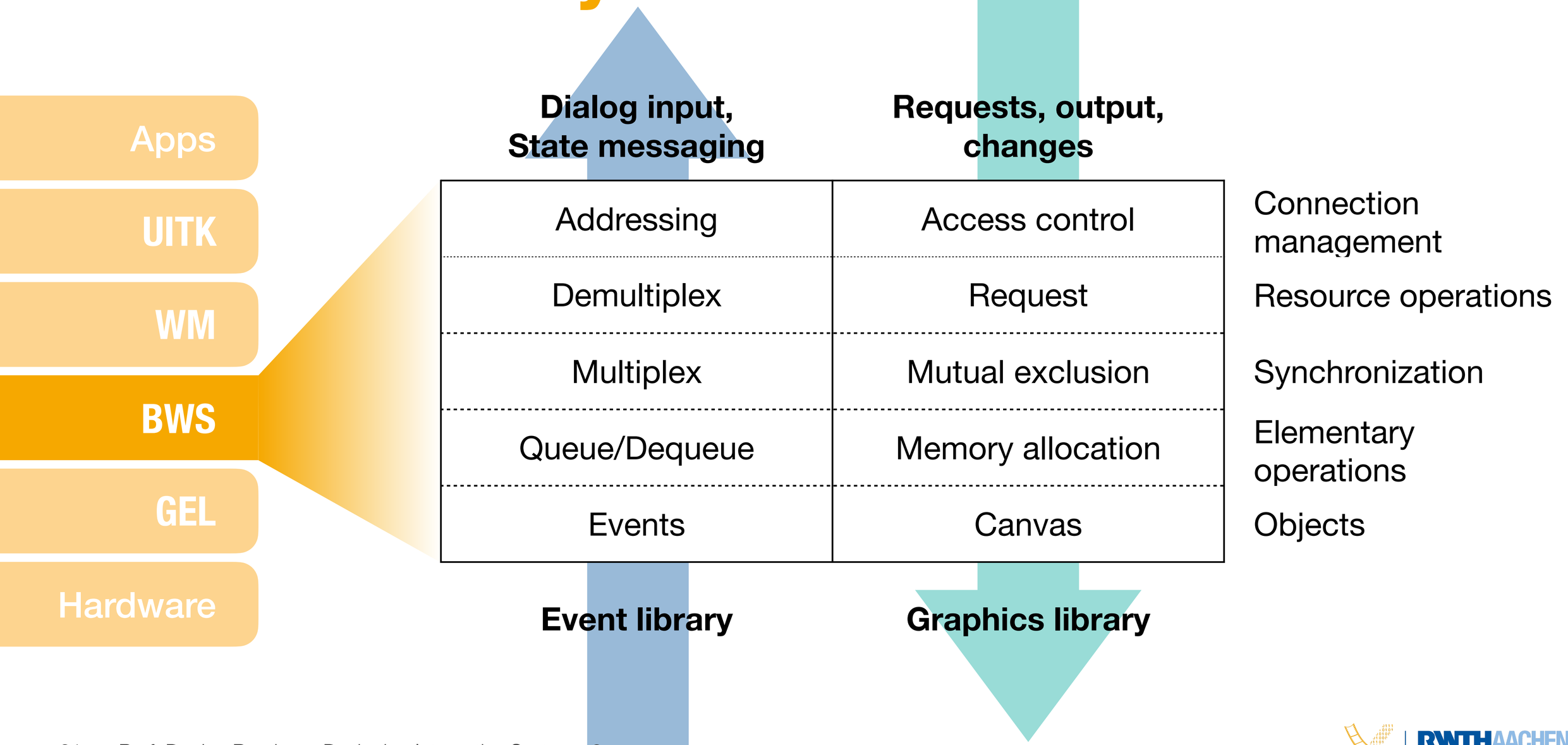
Base Window System: OS Integration



Base Window System: OS Integration



Base Window System



Designing Interactive Systems 2

Lecture 3: Window System Architecture

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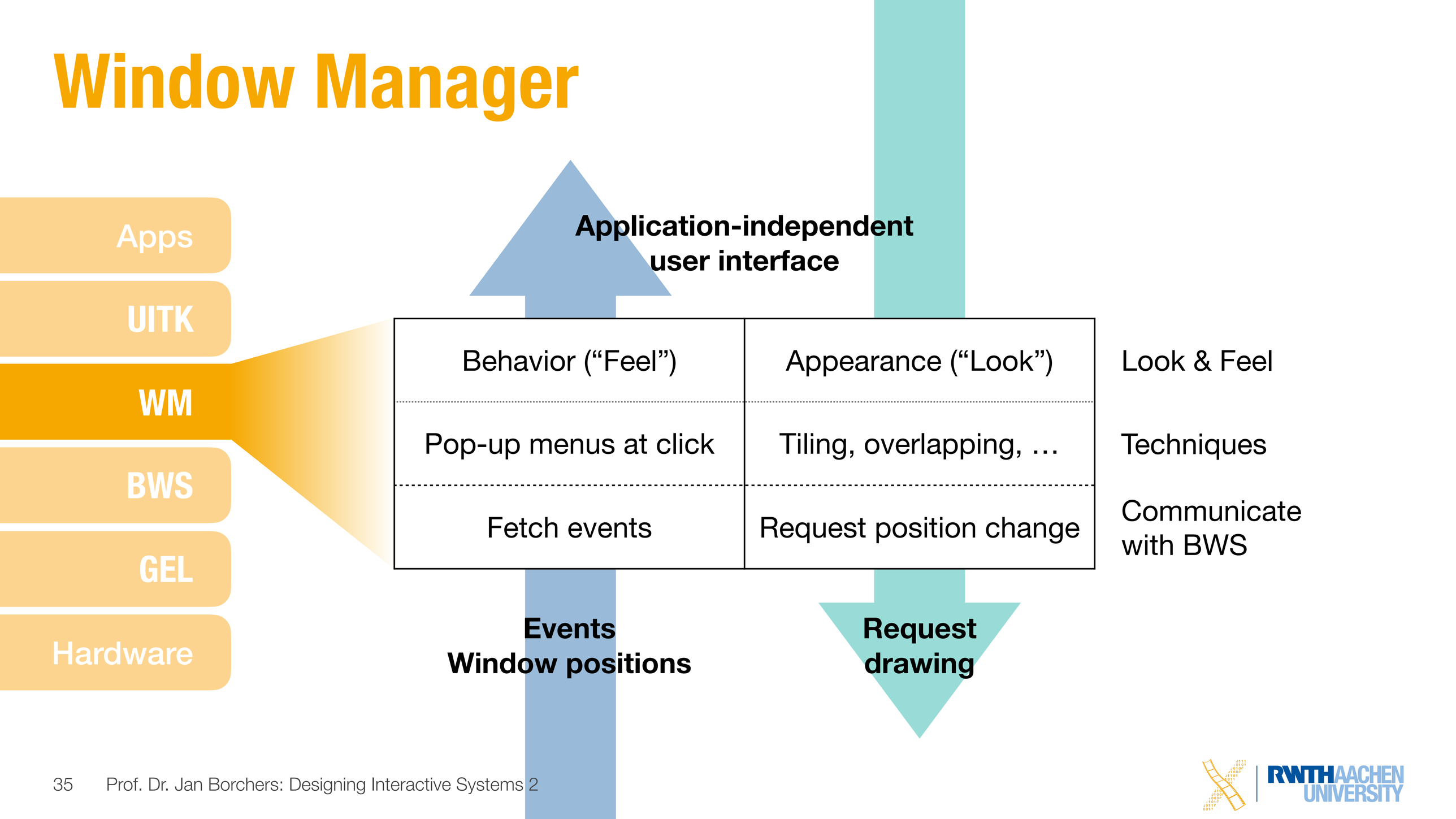
CHAPTER 6

Window Manager

Window Manager

- Allow users to control windows
- Provide Look & Feel for interaction with the WS

Window Manager



Window Manager

Screen Management

- What is rendered where on screen?
- Where is empty space? Which apps are iconified?

Window Manager

Screen Management

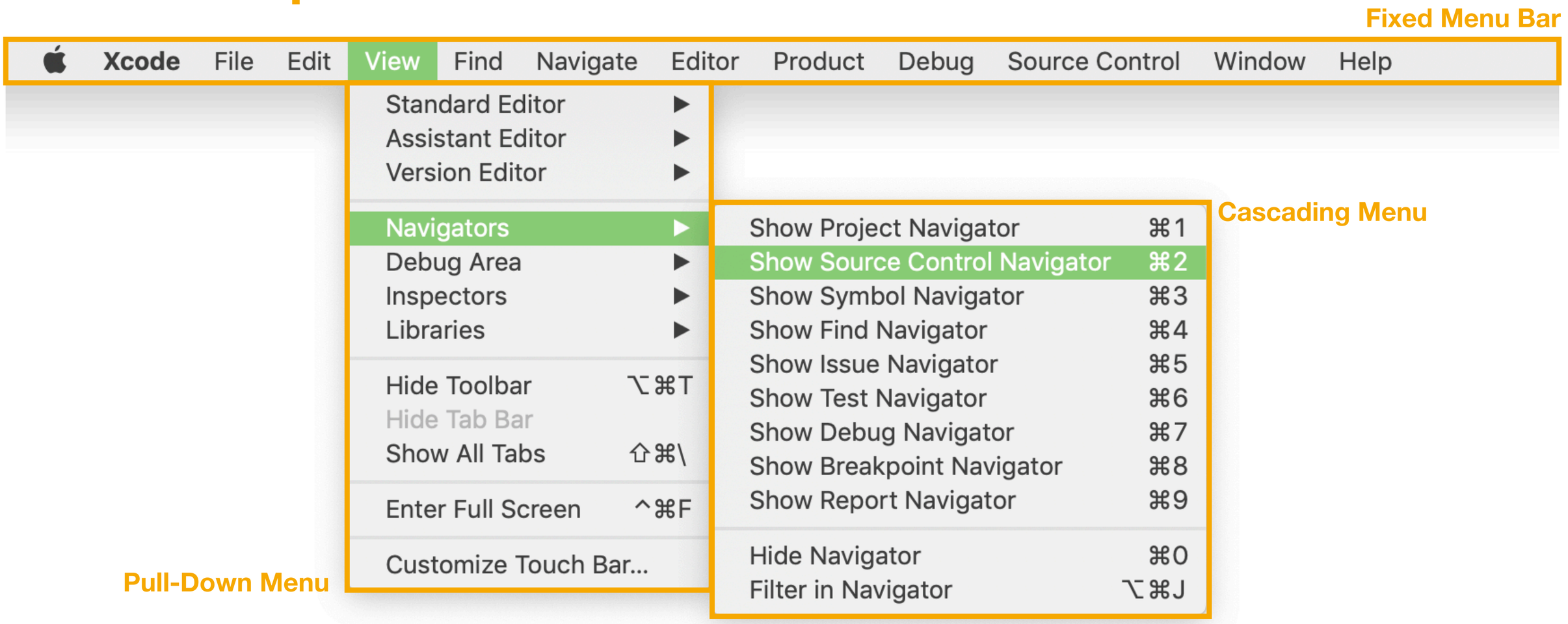
- What is rendered where on screen?
- Where is empty space? Which apps are iconified?

Session Management

- Provide consistent ways to perform standard tasks
- Move window, start app, iconify window

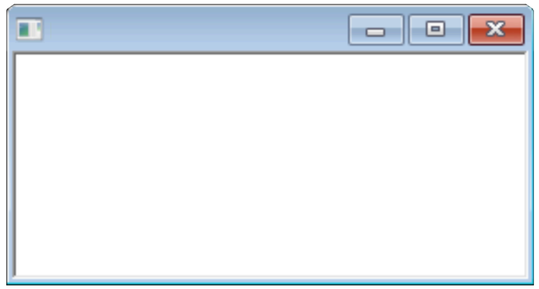
Session Management

Menu Techniques

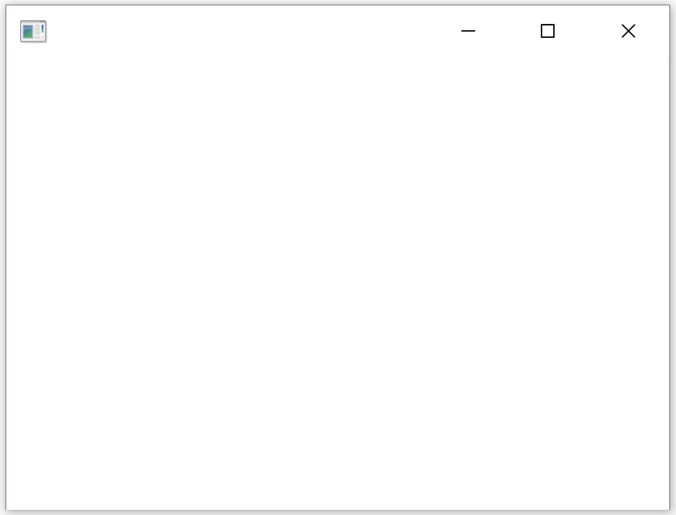


Session Management

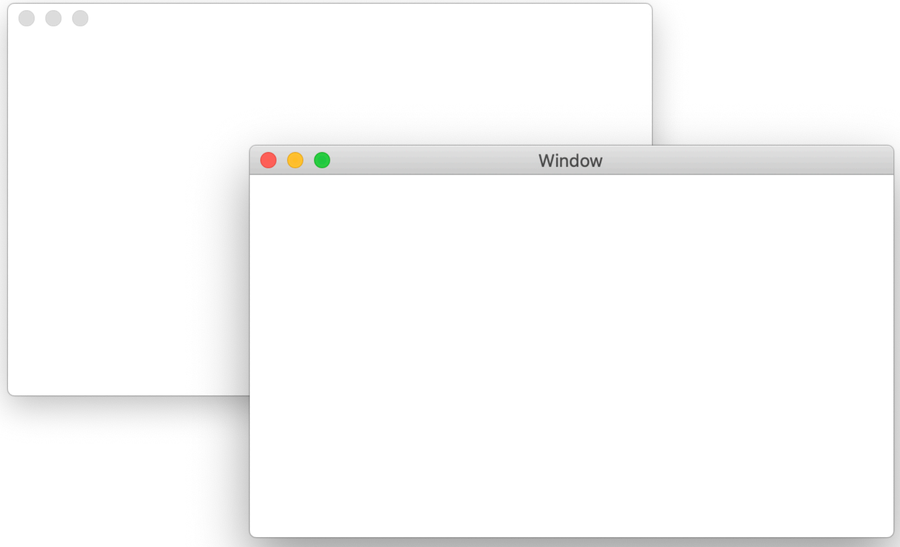
Window Decorations



Windows 7



Windows 10



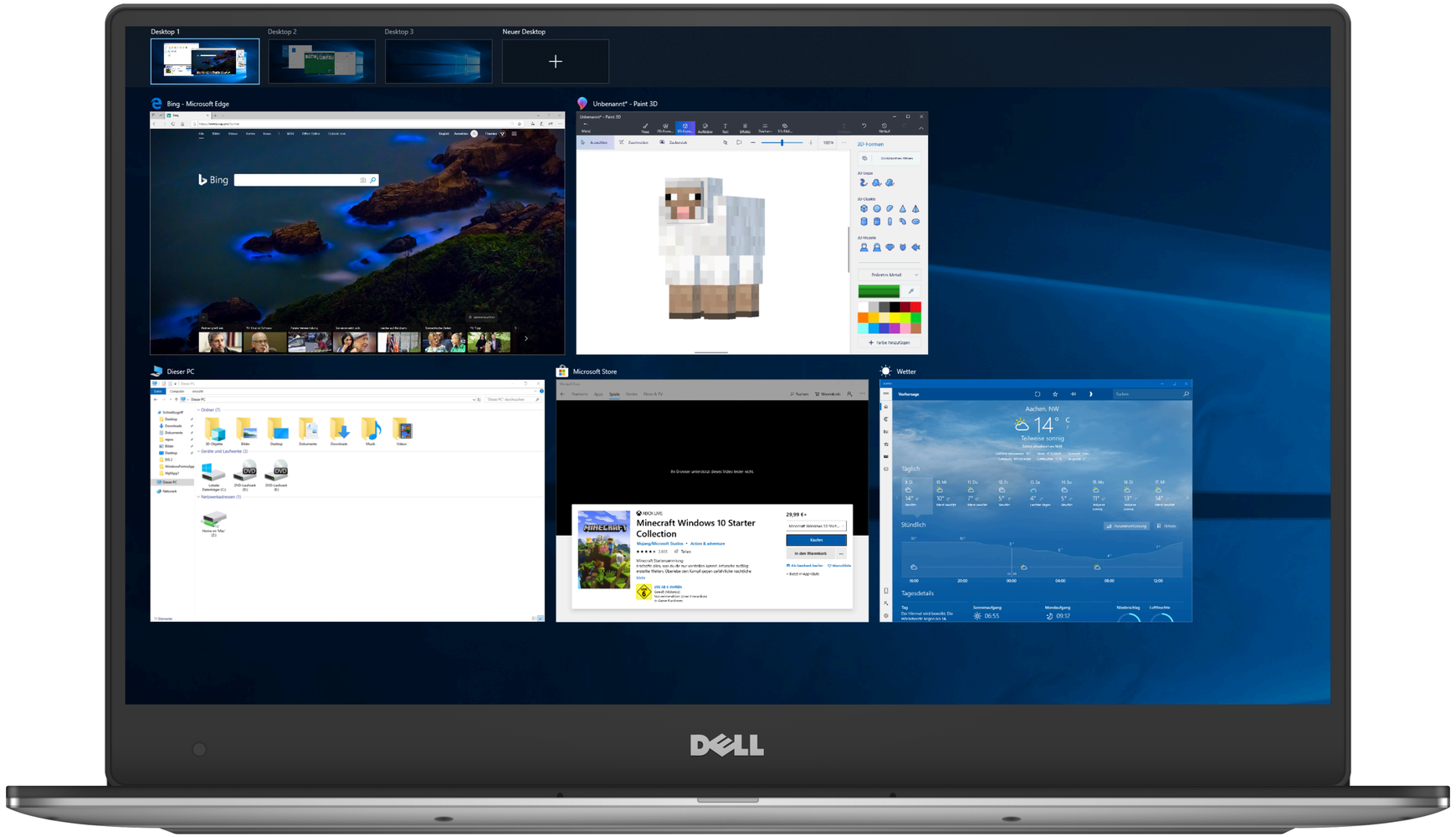
macOS

Session Management

Layout Policy

Session Management

Virtual Desktops



Session Management

Direct manipulation

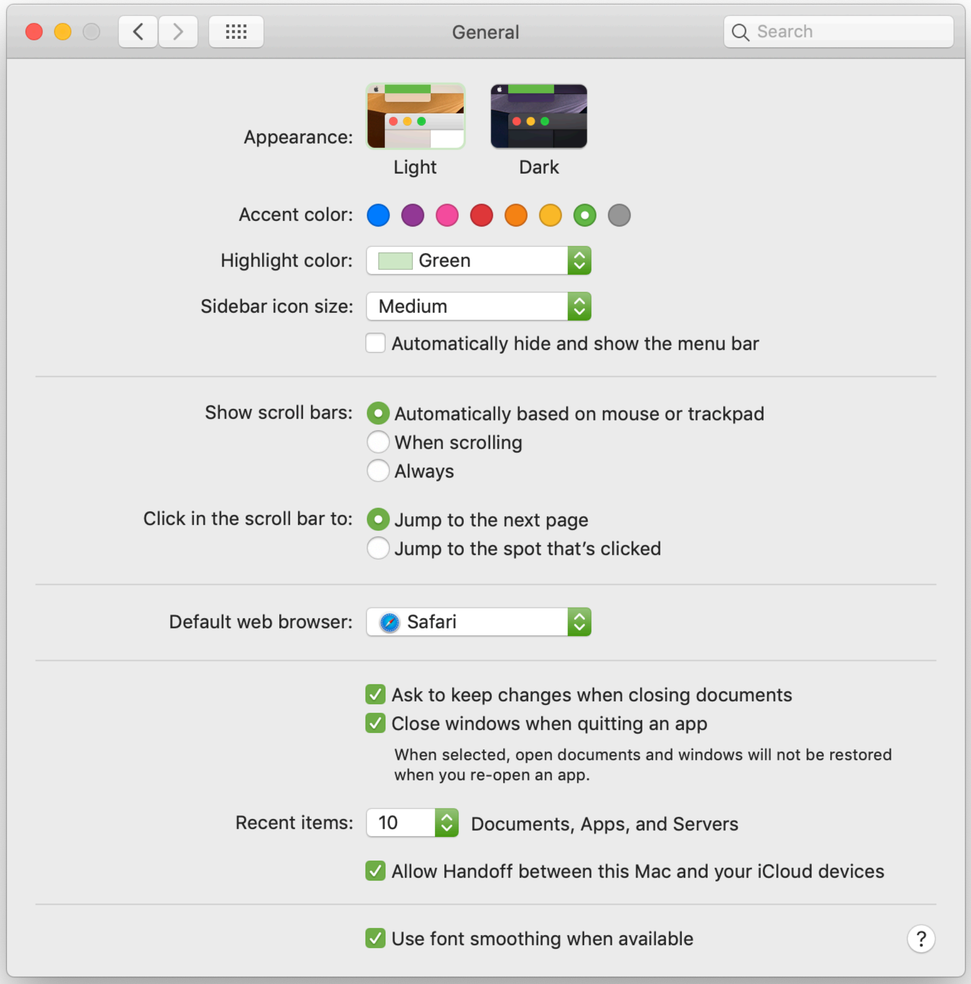
Icon technique

Input focus

Look & Feel

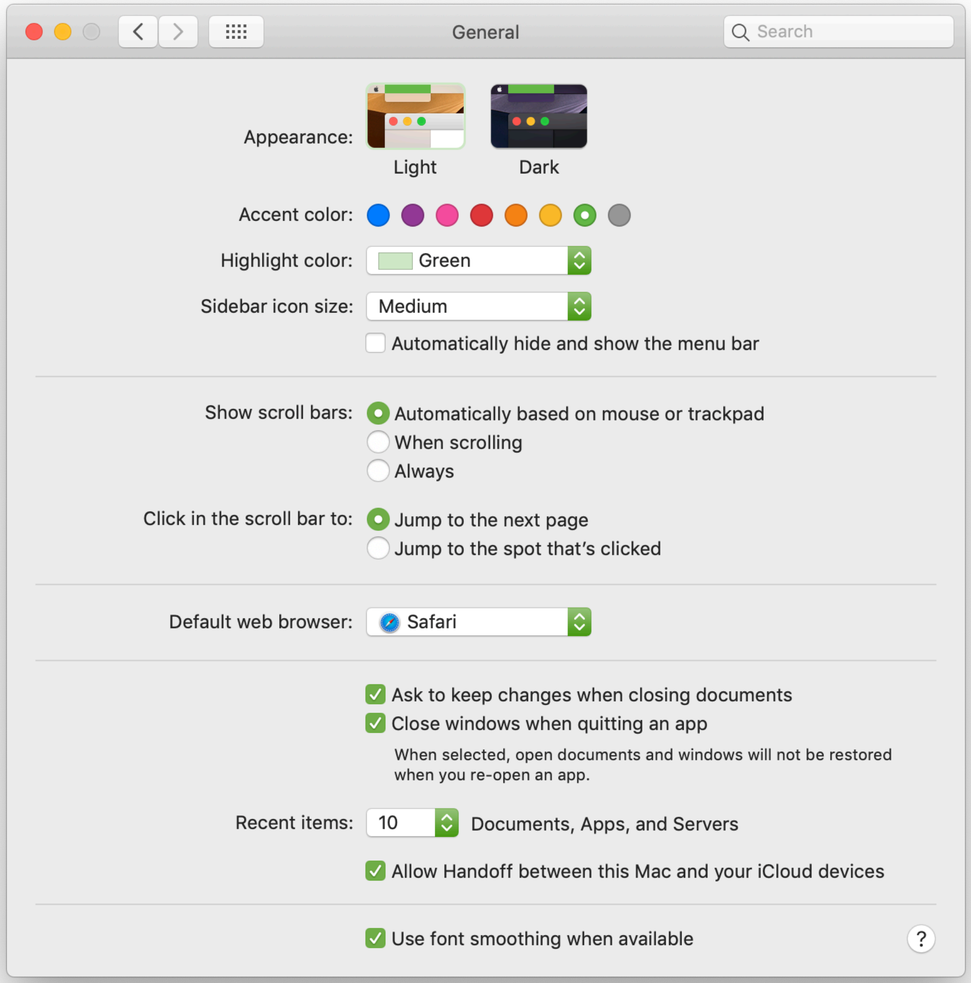
Late Refinement

- WM accompanies the session
  - changing window positions
  - changing app appearance



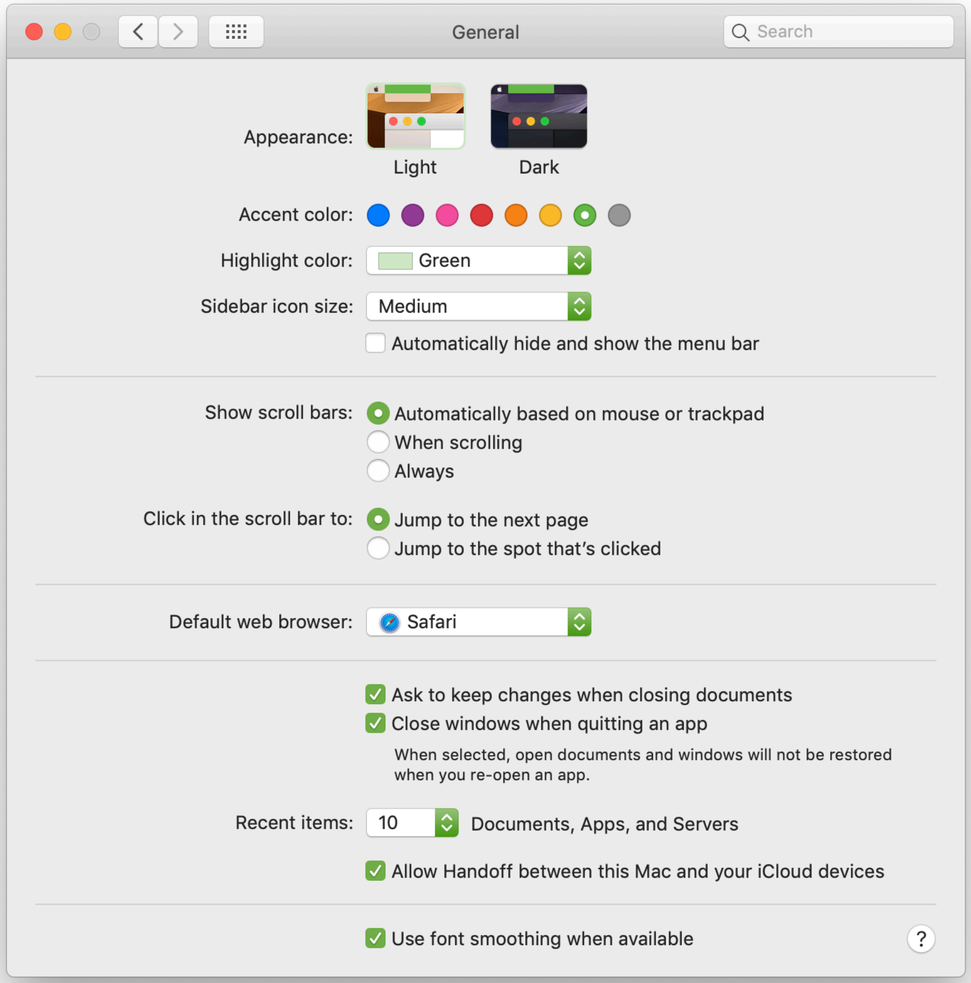
Late Refinement

- WM accompanies the session
  - changing window positions
  - changing app appearance
- Levels of late refinement
  - Per session or application
  - Per launch, user or for all users



Late Refinement

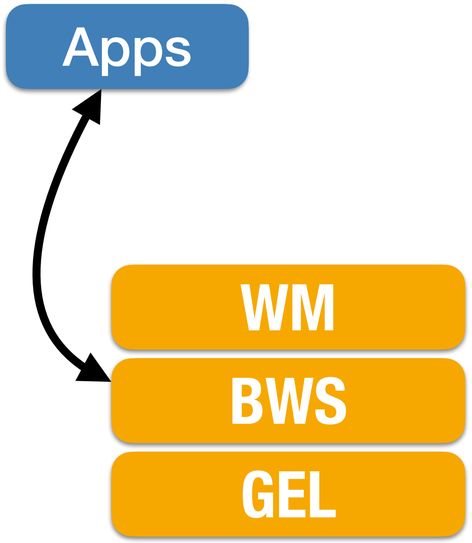
- WM accompanies the session
  - changing window positions
  - changing app appearance
- Levels of late refinement
  - Per session or application
  - Per launch, user or for all users
- Implementation with table files, internal database, or delta technique



Late Refinement: macOS Login Window

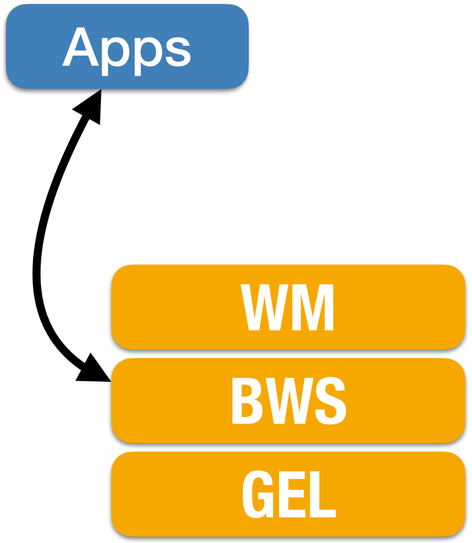
```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE plist PUBLIC "-//Apple/DTD PLIST 1.0//EN"
"http://www.apple.com/DTDs/PropertyList-1.0.dtd">
<plist version="1.0">
<dict>
    <key>GuestEnabled</key>
    <false/>
    <key>lastUser</key>
    <string>loggedIn</string>
    <key>lastUserName</key>
    <string>borchers</string>
    <key>retriesUntilHint</key>
    <integer>3</integer>
</dict>
</plist>
```

Window Manager: Location

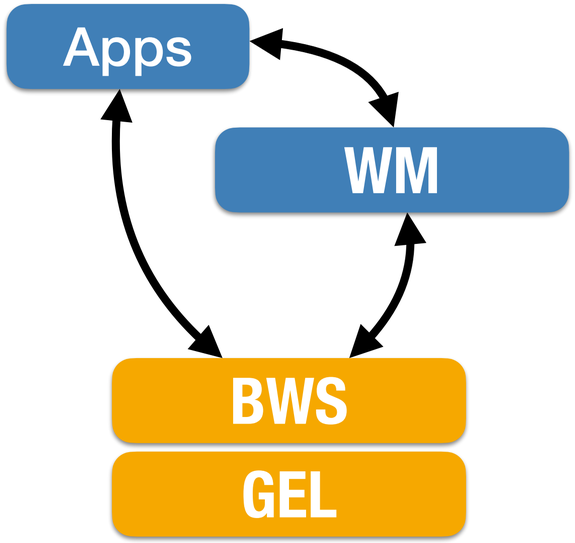


Upper part of BWS

Window Manager: Location

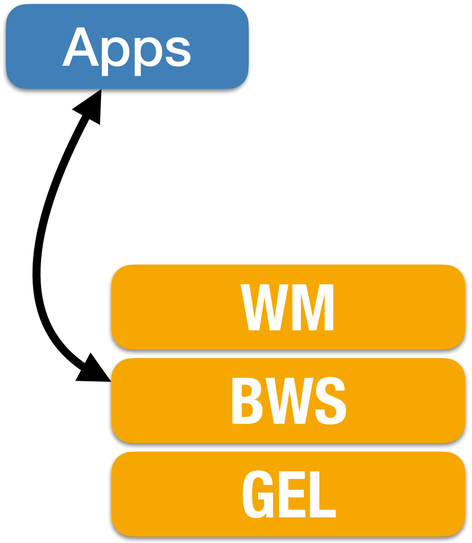


Upper part of BWS

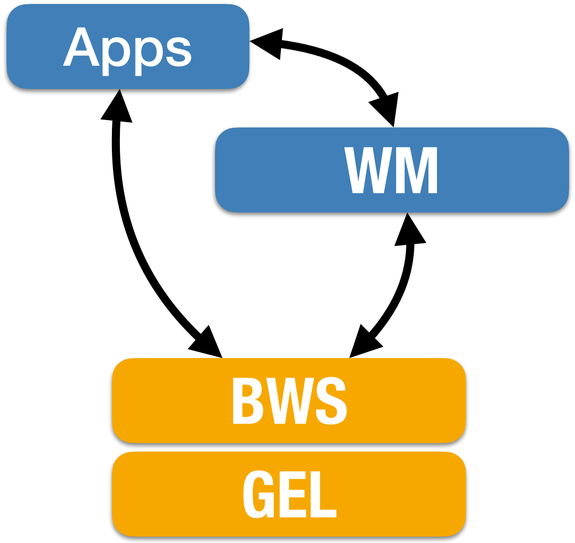


Separate server

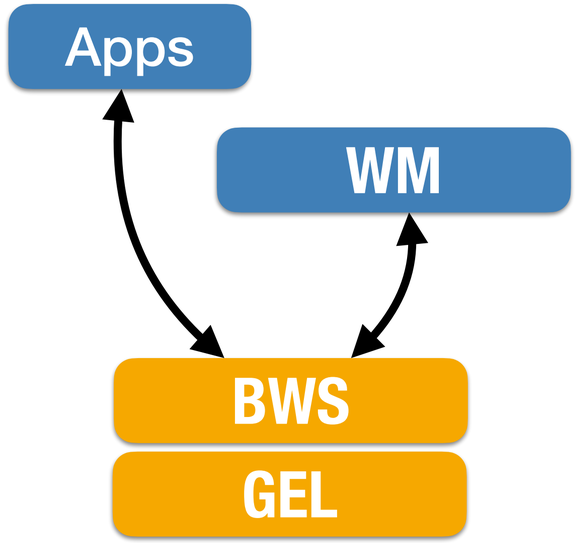
Window Manager: Location



Upper part of BWS



Separate server

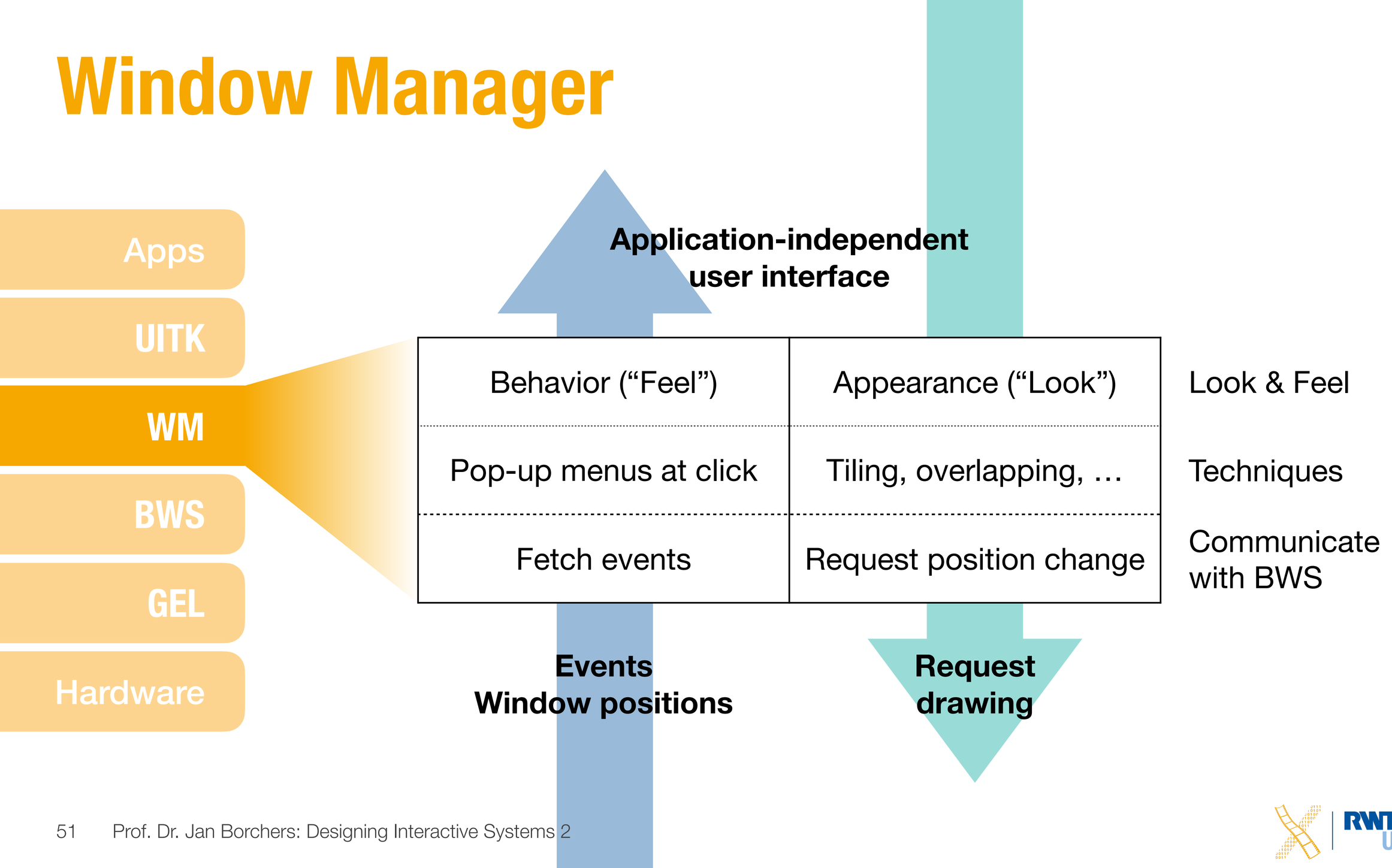


Separate user process

Window Manager: Conclusions

- WM leads from system- to **user-centered view** of WS
- Provide different levels of **consistency**
- Accompanies user during **session**
- Potentially **exchangeable**
- WM requires UI Toolkit to implement same **Look & Feel** across applications

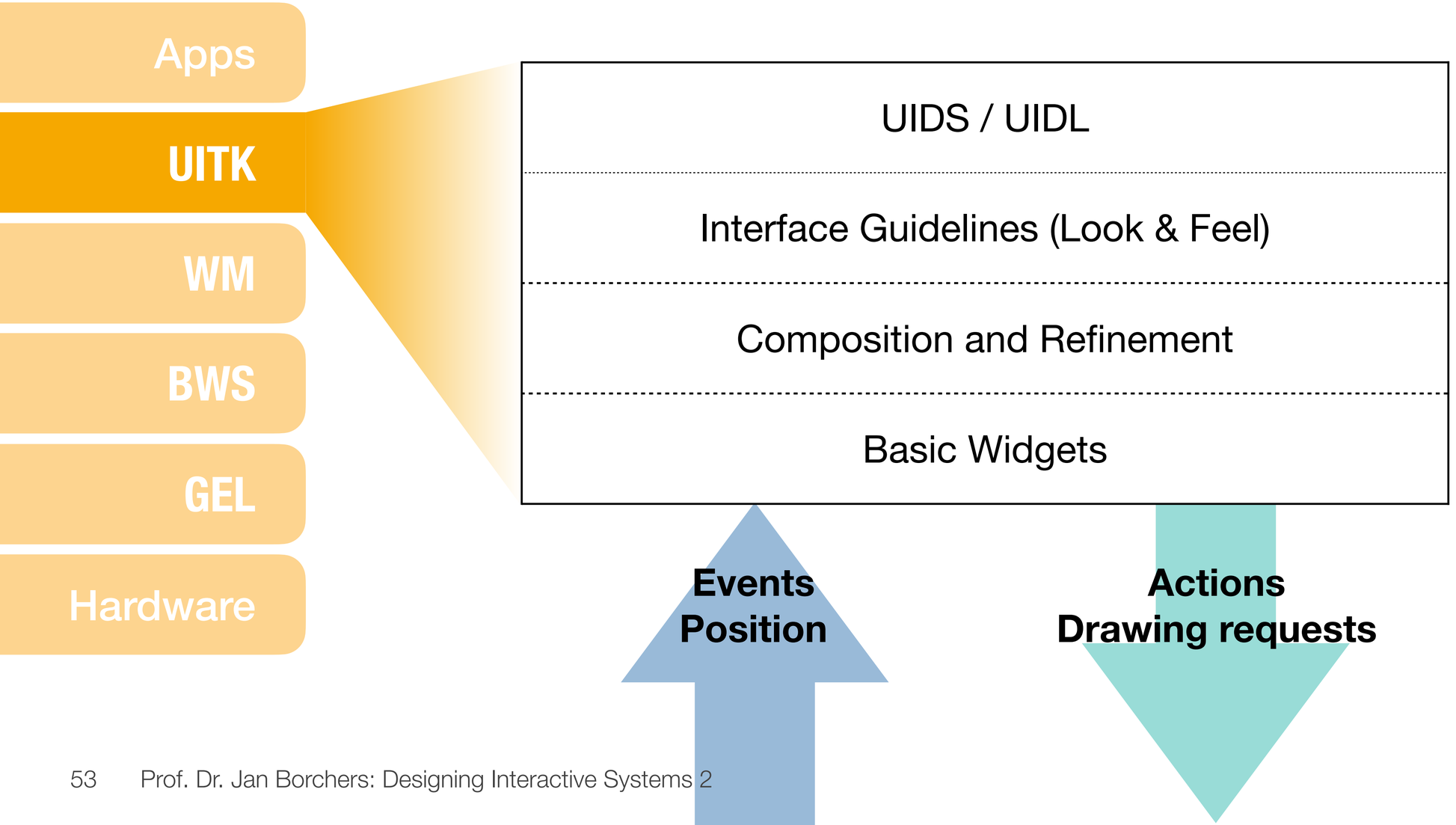
Window Manager



CHAPTER 7

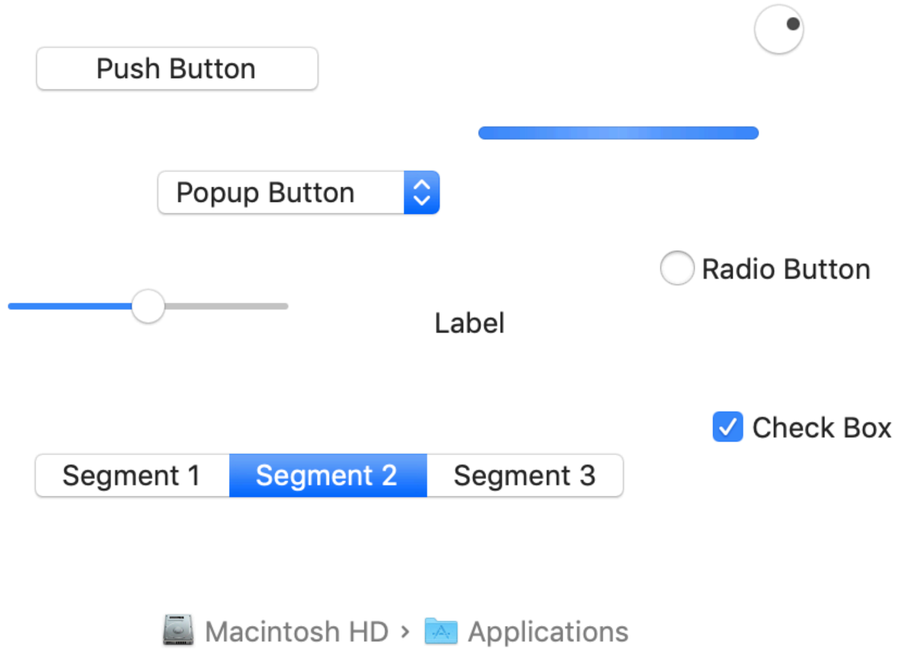
User Interface Toolkit

User Interface Toolkit

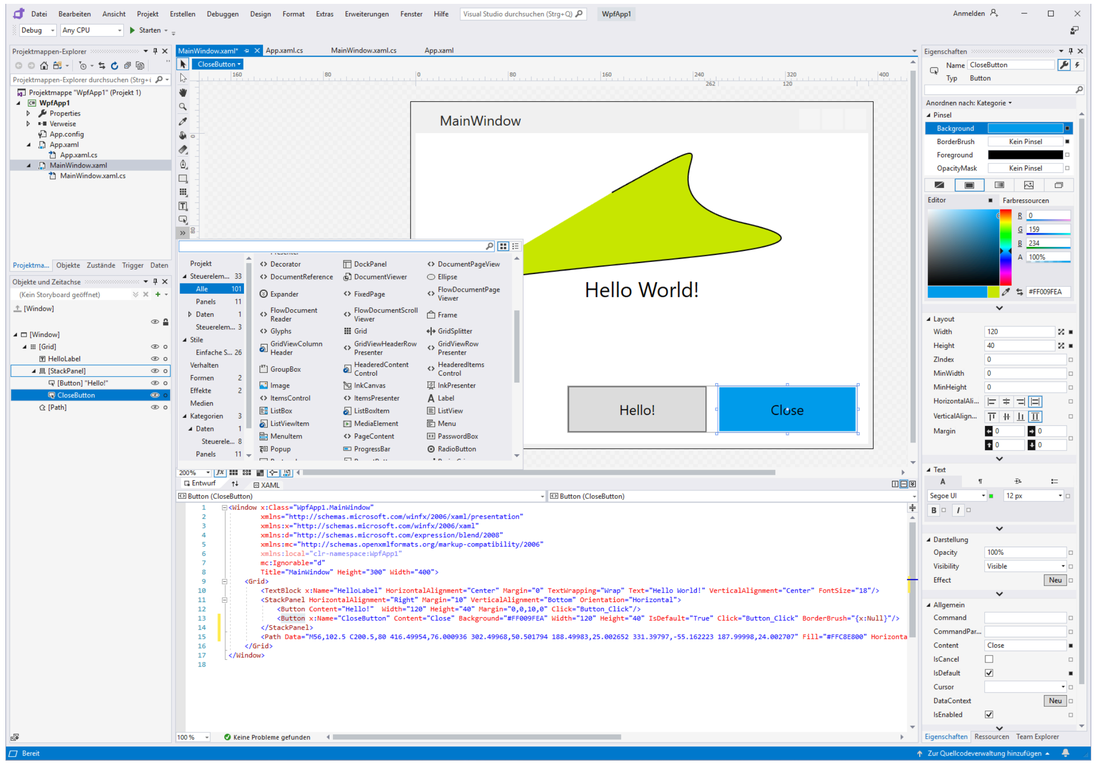


UITK: Components

Widget Set



User Interface Design System



Visual Studio Blend

UITK: Requirements

- Composition
- Reusability
- Communication
- Separation from app logic

UITK: Defining Widgets

Widget :=

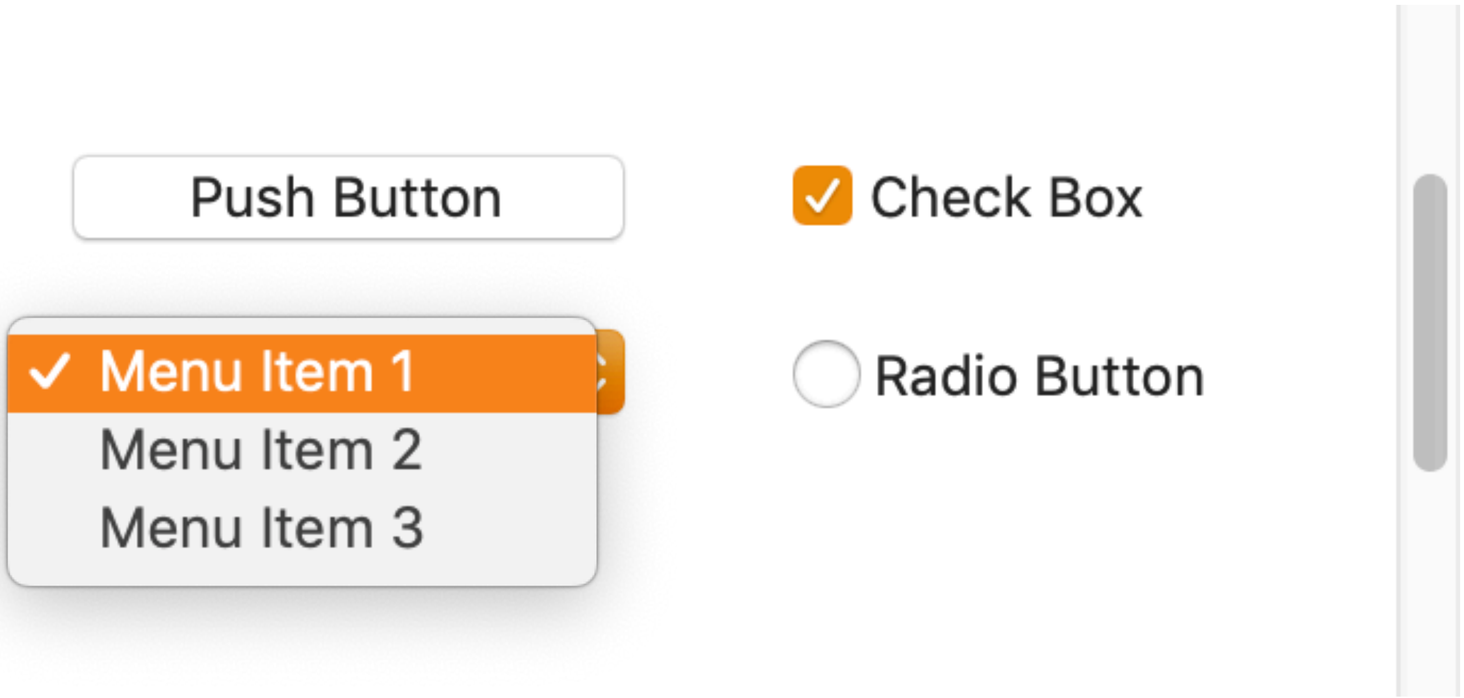
$$<\boldsymbol{W}=(w_1 \ldots w_k),\ \boldsymbol{G}=(g_1 \ldots g_l),\ \boldsymbol{A}=(a_1 \ldots a_m),\ \boldsymbol{I}=(i_1 \ldots i_n)>$$

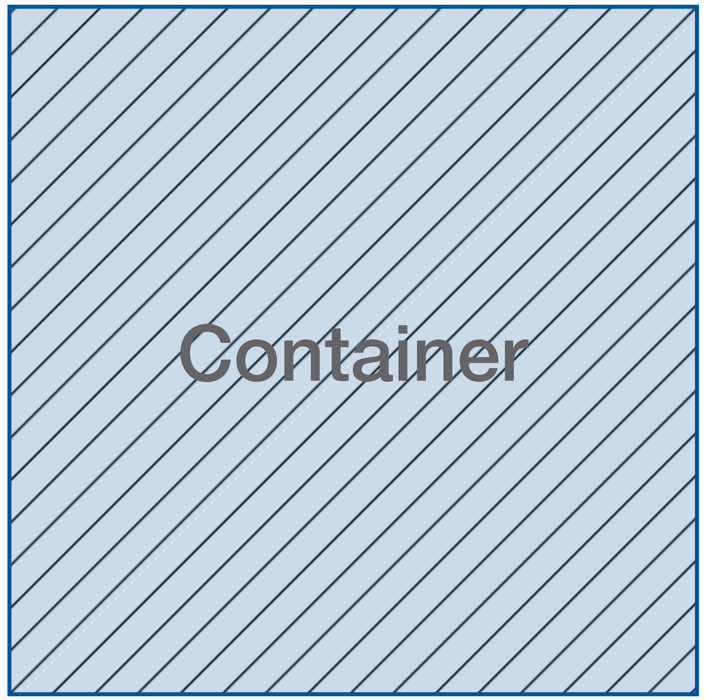
UITK: Defining Widgets

Exercise

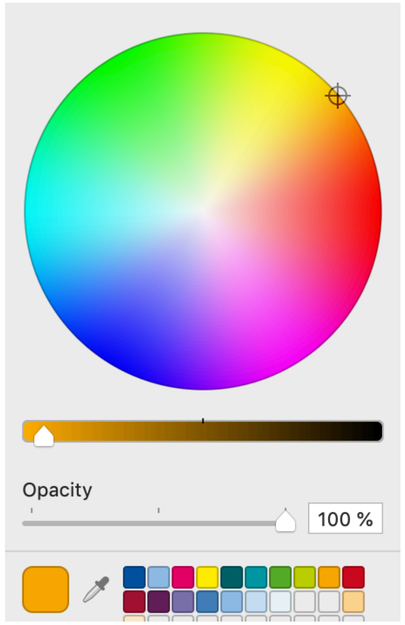
What are the typical components <W, G, A, I> of a button?

UITK: Basic Widgets





UITK: Creating Complex Widgets

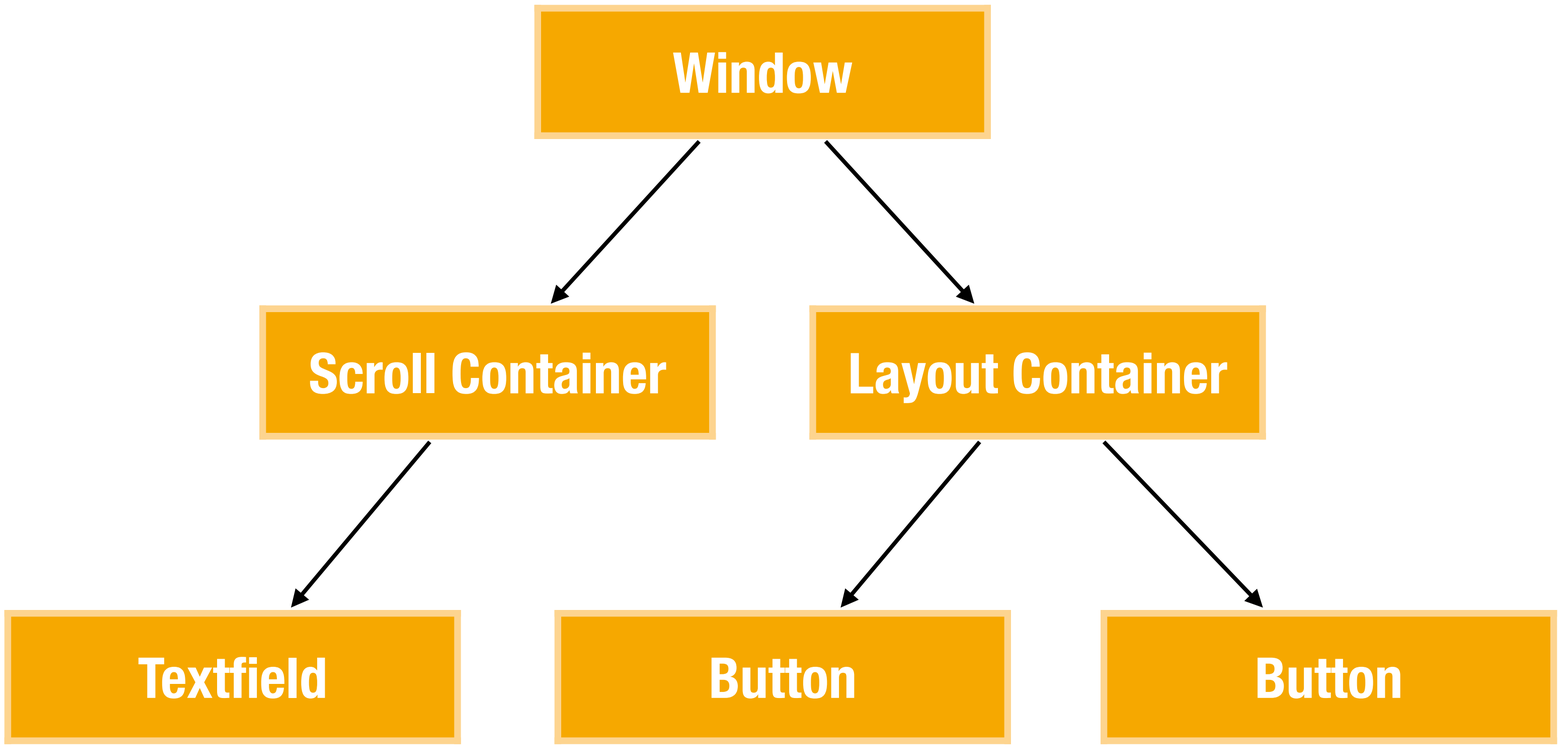


Composition

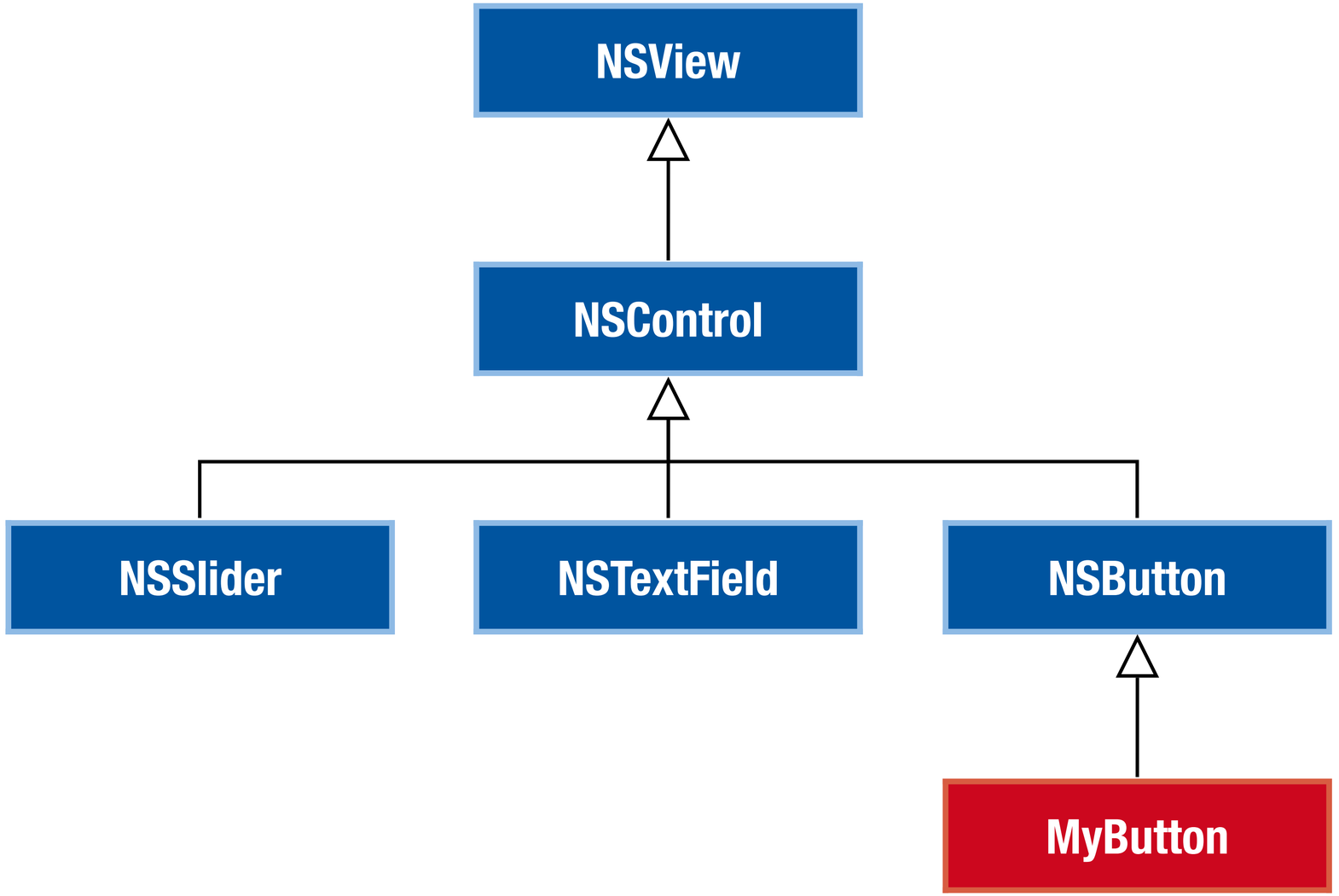
Minimal Button

Refinement

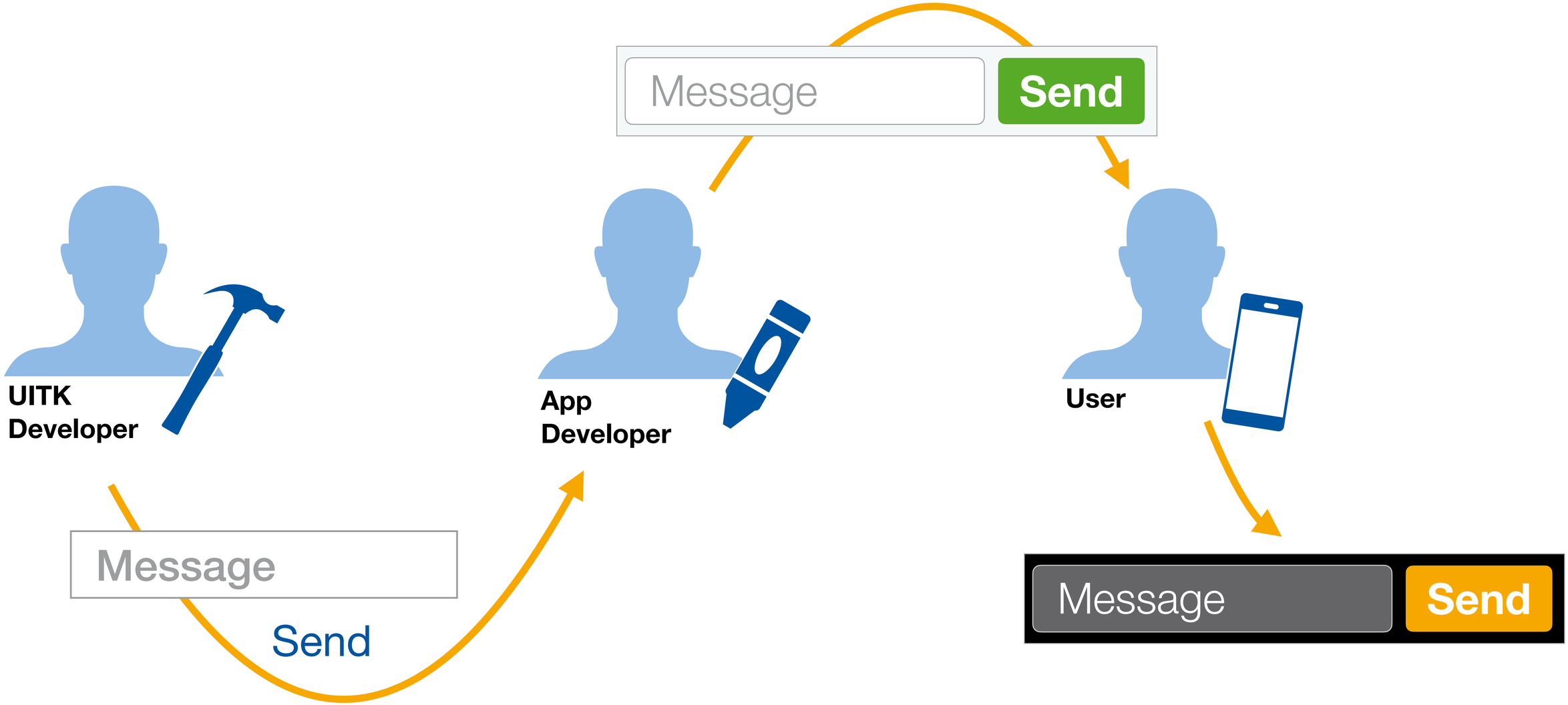
Dynamic Widget Hierarchy



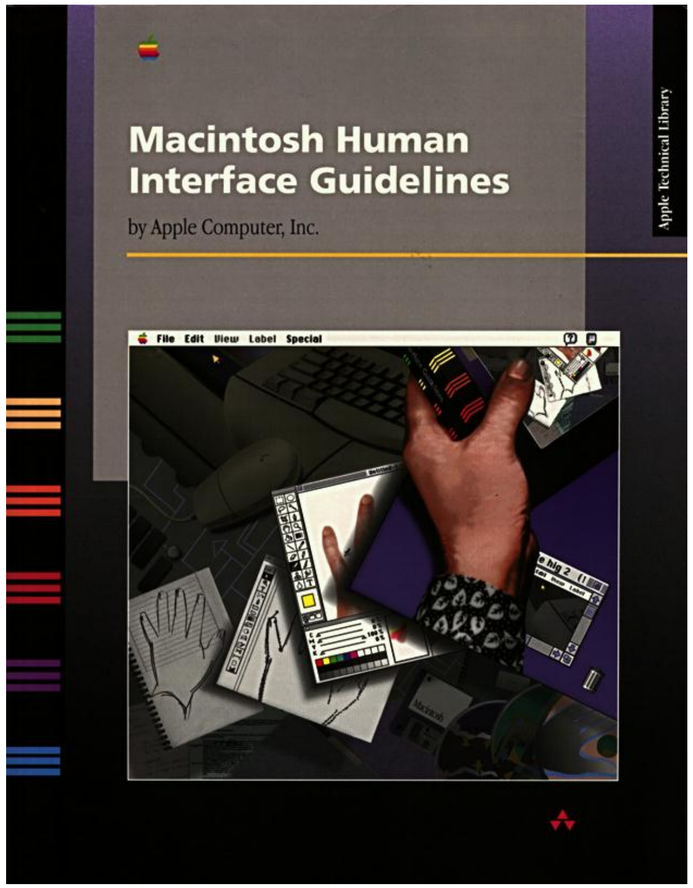
Static Widget Hierarchy

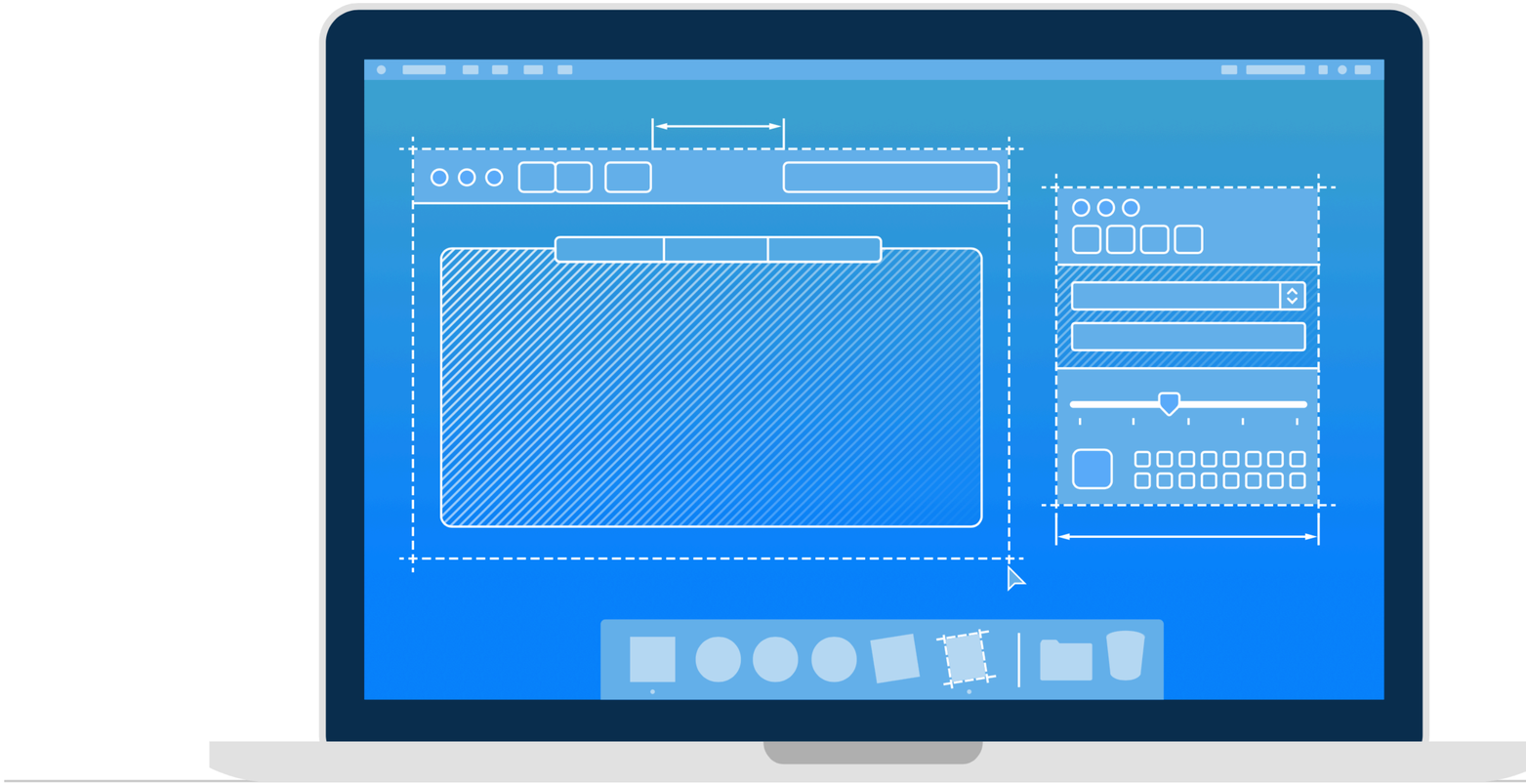


Late Refinement of Widgets



Style Guidelines





Types of UIDS

Language oriented (UIDL)

- Compiler implements style guidelines by checking constructs

Interactive

- Complex drawing programs to define look of UI
- Via lines connecting user input (*I*) to actions (*A*) (allowed by style guide)

Automatic

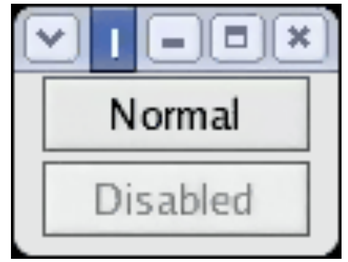
- Create UI automatically from spec of app logic (research)

User Interface Description Languages

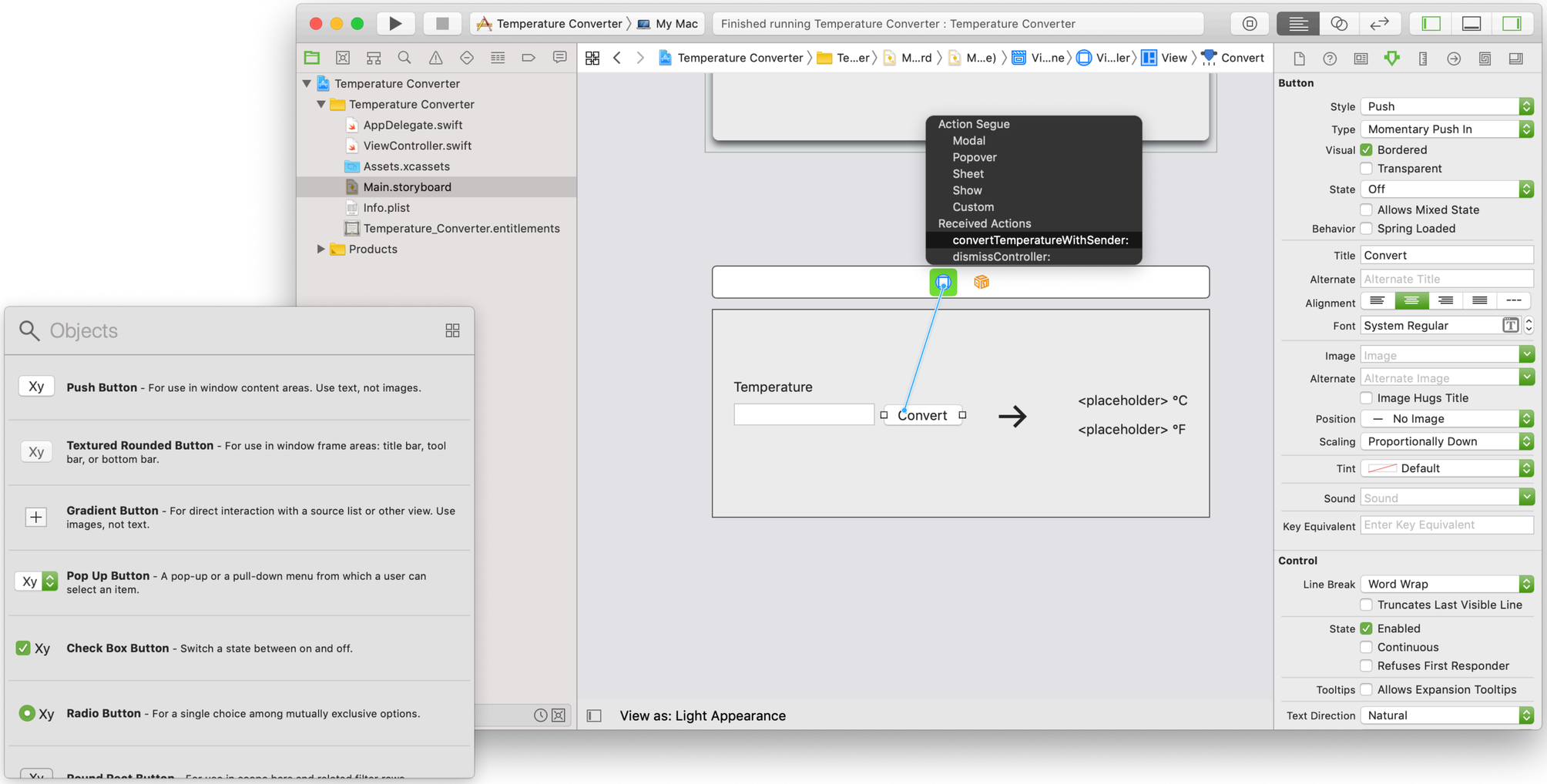
```
<?xml version="1.0"?>
<?xml-stylesheet href="chrome://global/skin/" type="text/css"?>
<window id="findfile-window"
        title="Find Files"
        orient="horizontal"
        xmlns="http://www.mozilla.org/keymaster/gatekeeper/
there.is.only.xul">

    <button label="Normal"/>
    <button label="Disabled" disabled="true"/>

</window>
```



User Interface Design Systems



User Interface Toolkit