Designing Interactive Systems 2

Lecture 9: Post-Desktop Window Systems

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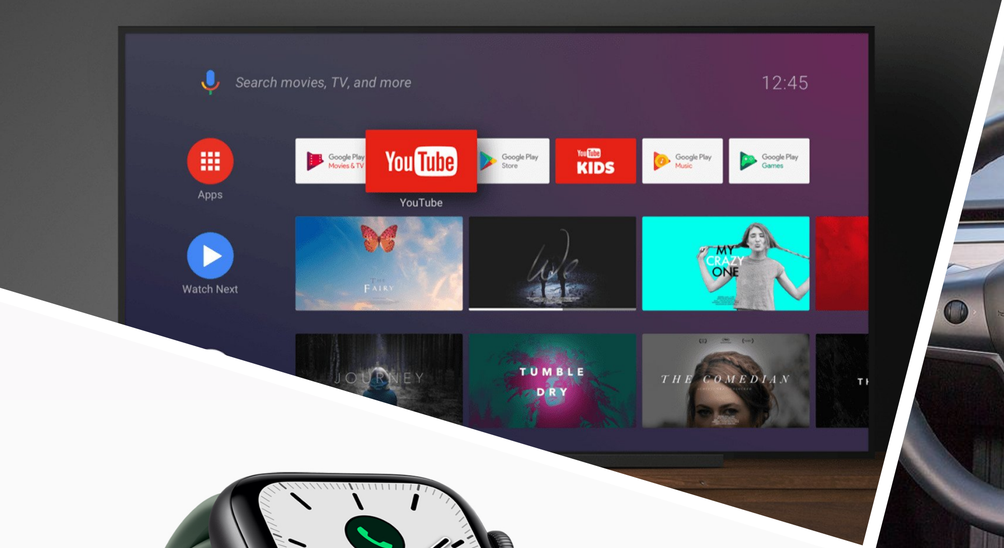
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Apps
YouTube
Watch Next
KIDS
TUMBLE DRY
THE COMEDIAN


SAMSUNG


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IBM Simon

1994

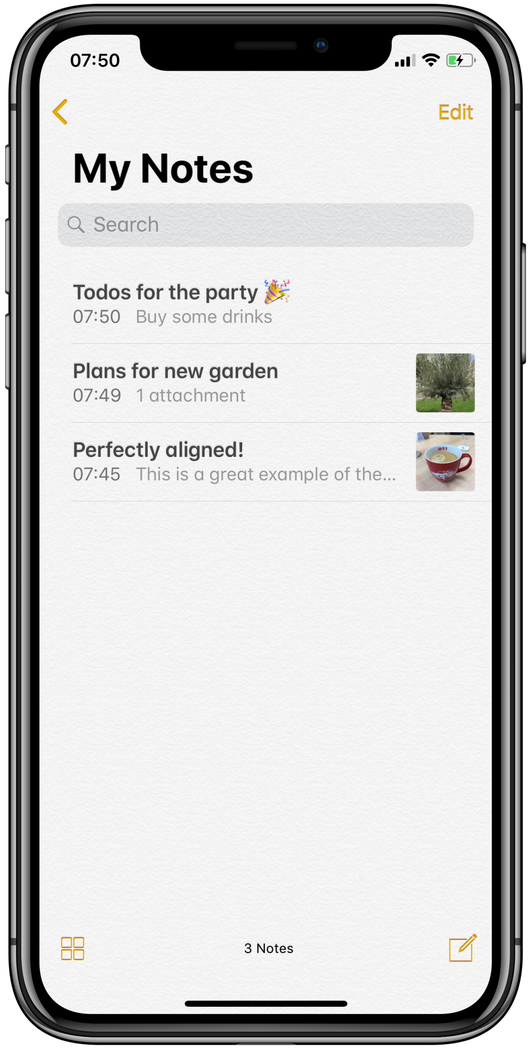
CHAPTER 27

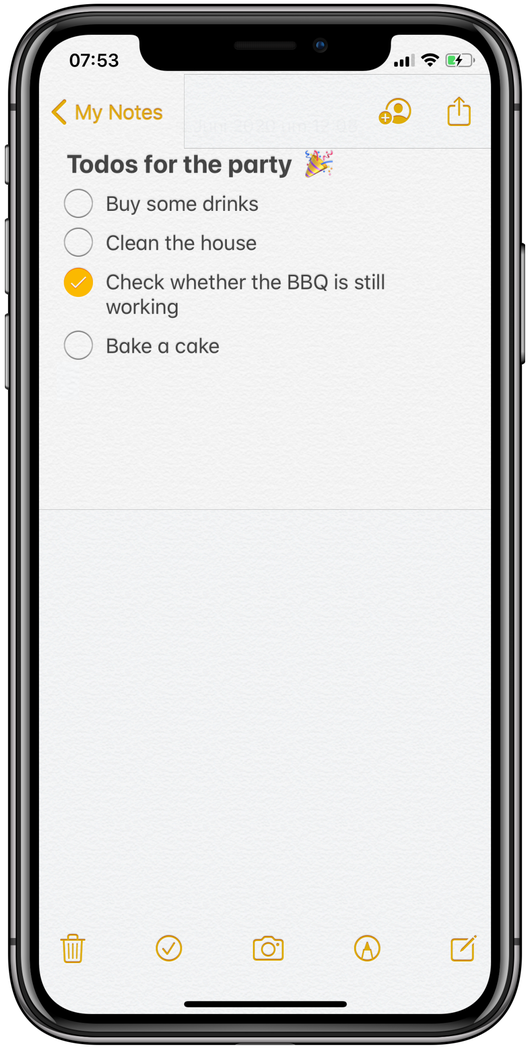
Mobile Devices

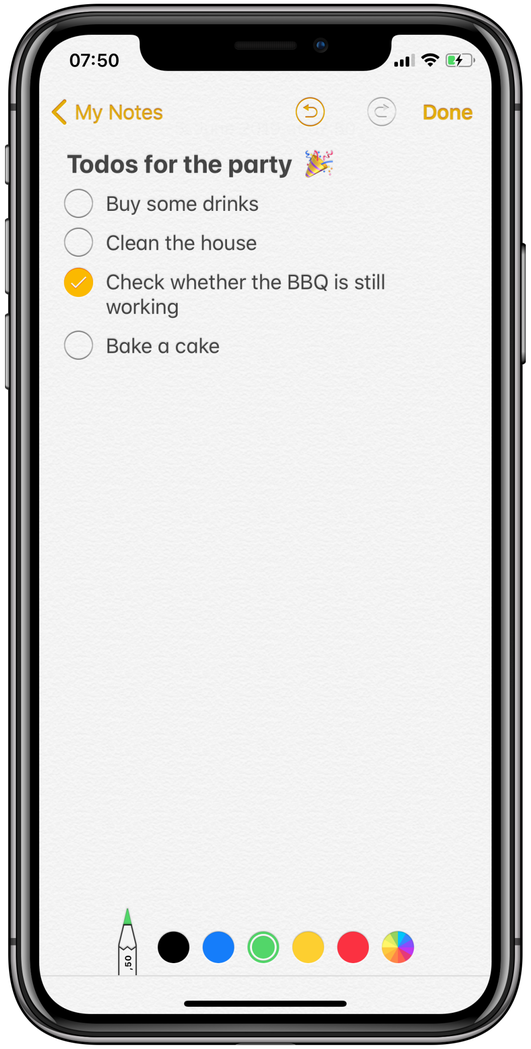
Mobile Device Characteristics

- Small screens
  - Users interact with one **app** at a time
  - Users interact with one **screen** at a time
  - Onscreen help is minimal

Mobile Device Characteristics

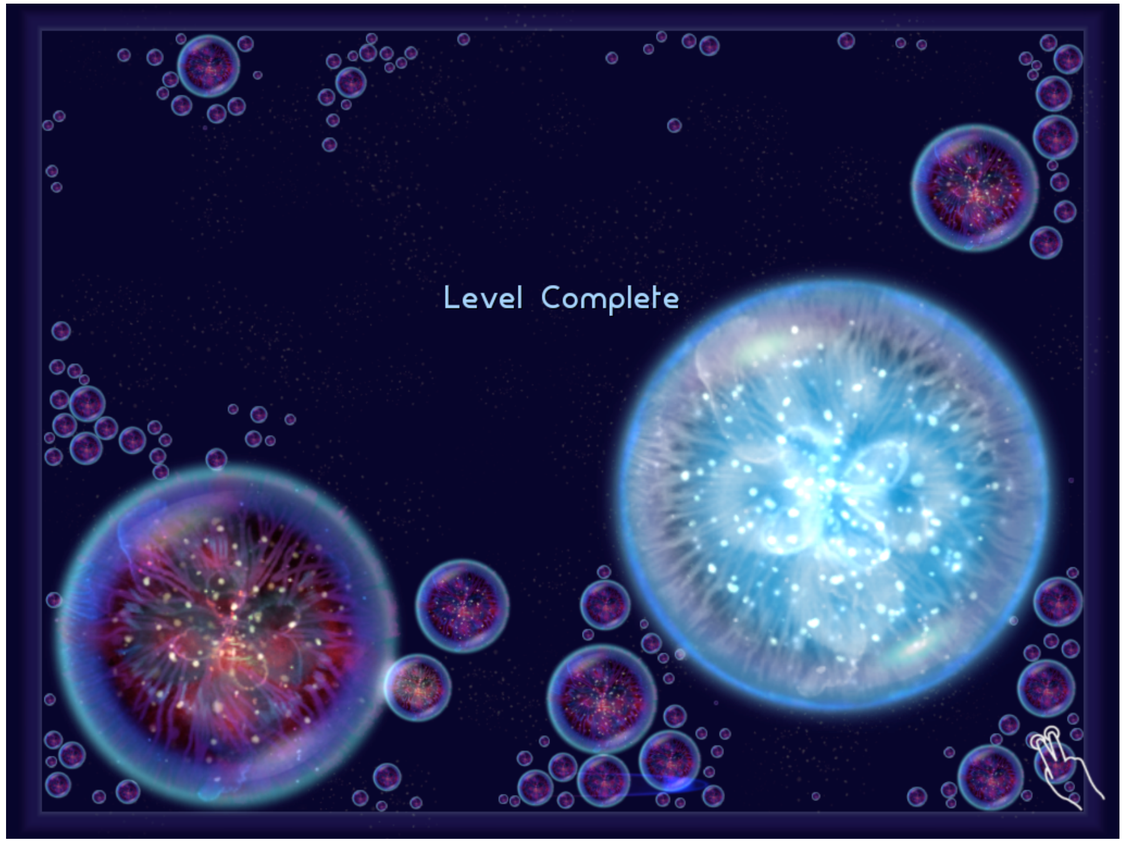






Mobile Device Characteristics

Osmos HD



Pulse

Mobile Device Characteristics

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  - Onscreen help is minimal
- Limited memory ⇒ Restrictive memory management
- Limited power ⇒ Efficient code crucial for battery life
- New input and sensor technologies

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- New input and sensor technologies
- **Context is key ⇒ (task focus, peripheral use)**

Context is Key

Context is Key

10 Golden Rules of Interface Design (see DIS 1)

1. Keep the interface simple!
2. Speak the user's language!
3. Be consistent and predictable!
4. Provide feedback!
5. Minimize memory load!
6. Avoid errors, help to recover, offer undo!
7. Design clear exits and closed dialogs!
8. Include help and documentation!
9. Offer shortcuts for experts!
10. Hire a graphics designer!

Life as an App

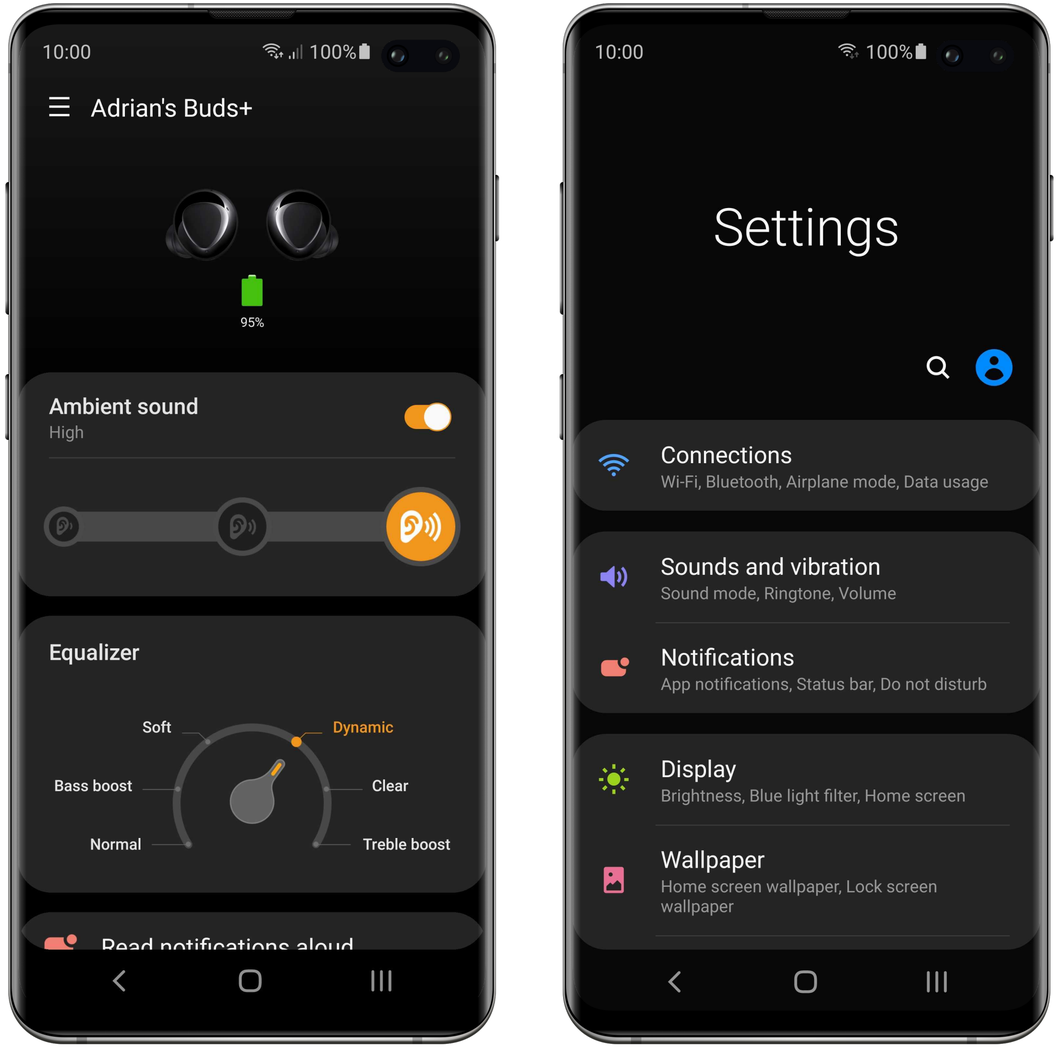
- A mobile OS is an **app-centric environment**
- **One app per task**
  - Hence, do one thing but do it well
- **Sandboxing**
  - Data is typically stored per app and not visible to others
- Data exchange between apps difficult
- Define the task that users want to accomplish with your app

Designing the UI

- Make it obvious how to use your app
- Sort information from top to bottom
- Use alignment to ease scanning and communicate groupings

Designing the UI

- Make it obvious how to use your app
- Sort information from top to bottom
- Use alignment to ease scanning and communicate groupings
- Minimize text input
- Provide fingertip-size targets
- Touch is always in focus



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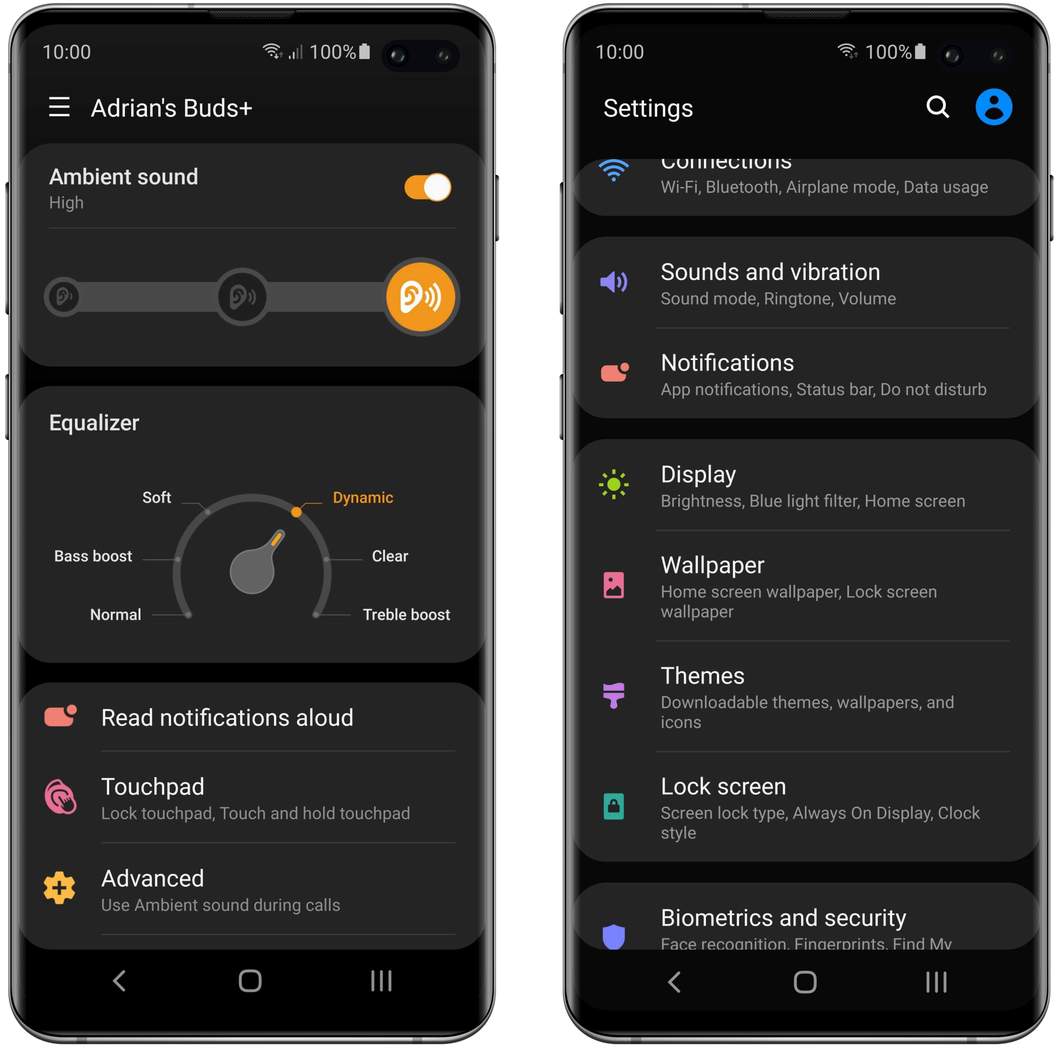
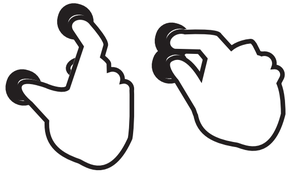
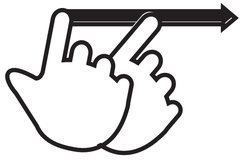


Interaction Design

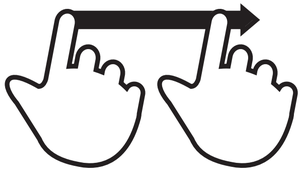
- There are no on-screen signifiers how and where to perform multitouch gestures
- On some targets pressure input possible
- Interaction patterns vary between different platforms: Follow the respective guidelines for intuitive operation
- If you use complex gestures, help the user





Gestures

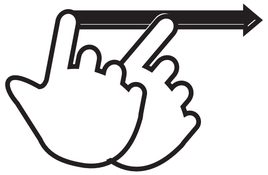
Tap



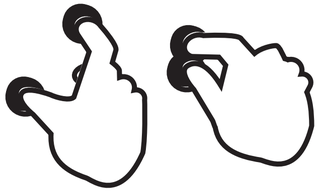
Drag

Pinch open

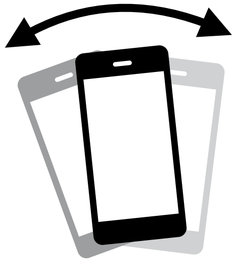
Double tap



Flick

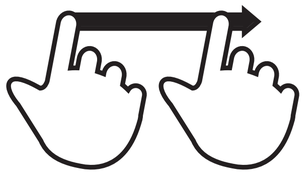


Pinch close

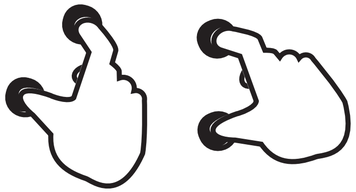


Shake

Touch and hold



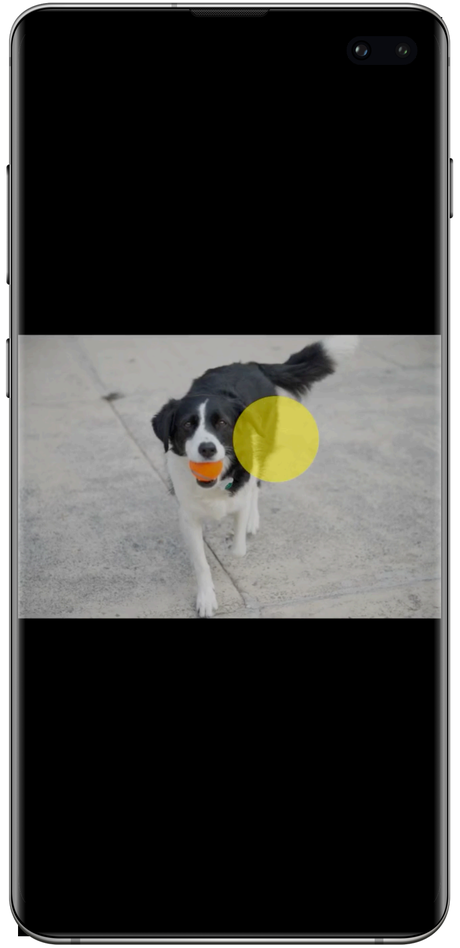
Swipe



Rotate

Platform-Independent Gestures

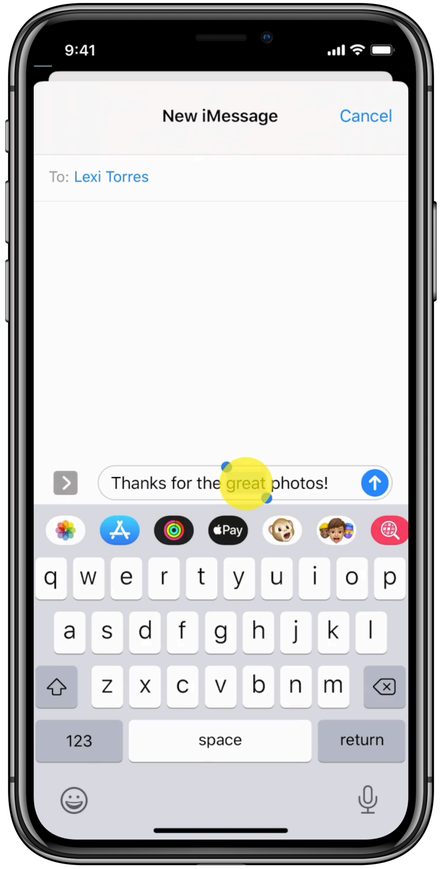
Pinch
for zooming
in and out



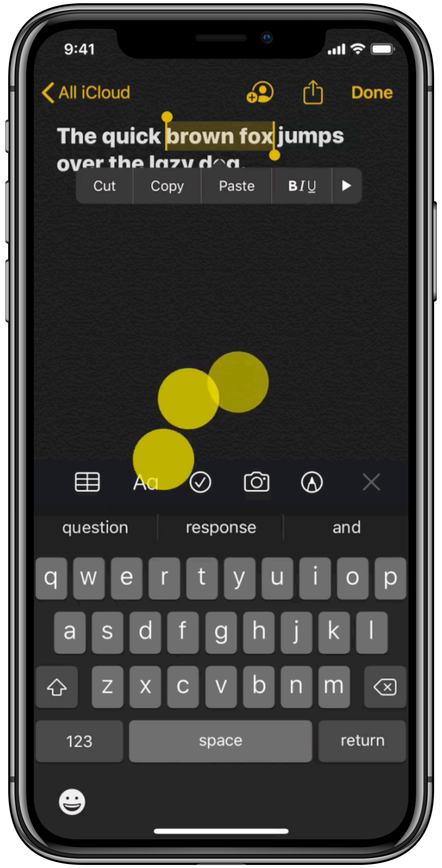
Double Tap
zooms into content,
or toggles between
zoom levels

iOS Gestures

Swipe
reveals actions in tables or return to previous screen

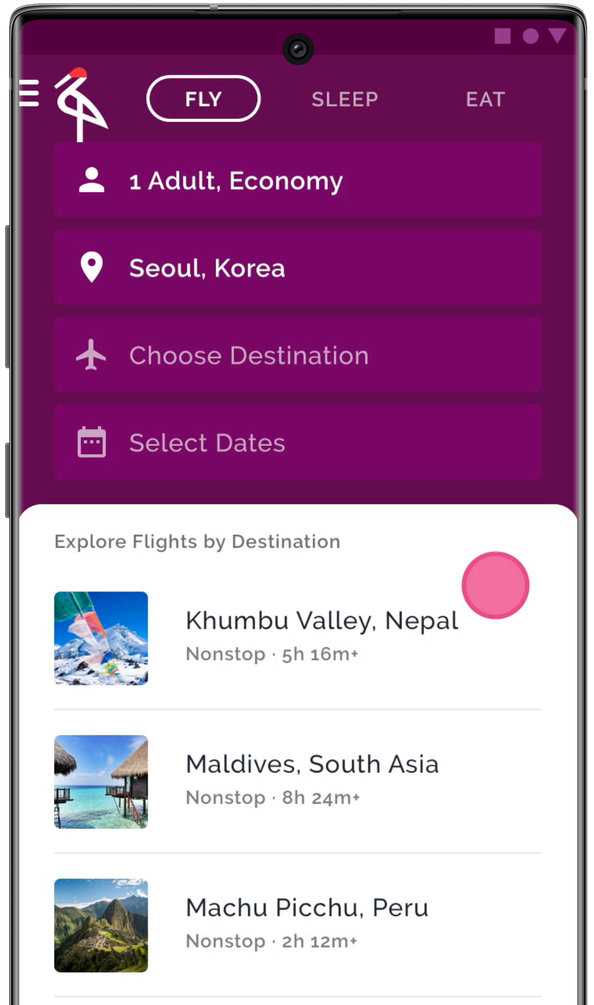


Touch and hold
selects a word when performed inside editable text



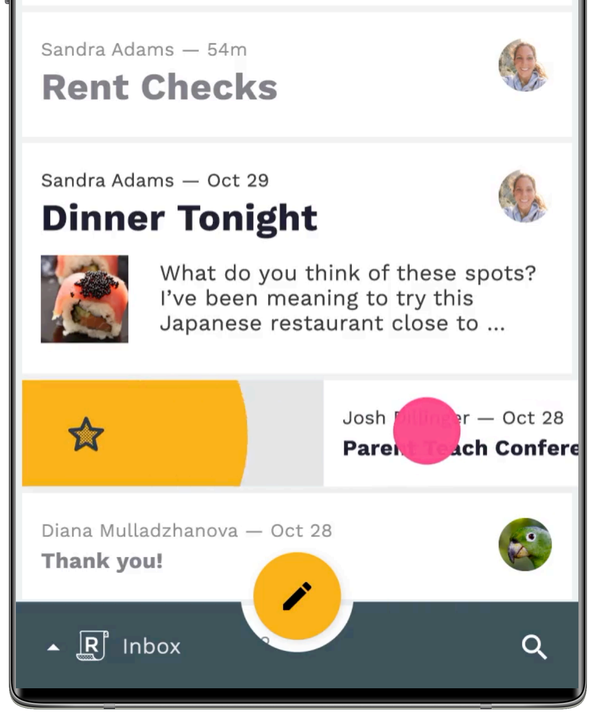
Three Finger Pinch
to copy and paste text

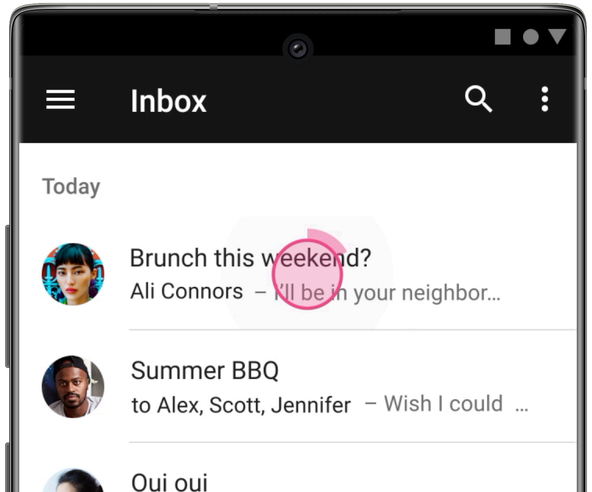
Android Gestures



Swipe
to switch between content tabs

Swipe
to complete actions upon passing a threshold





Long Press
reveals additional features, e.g. the edit mode of a table

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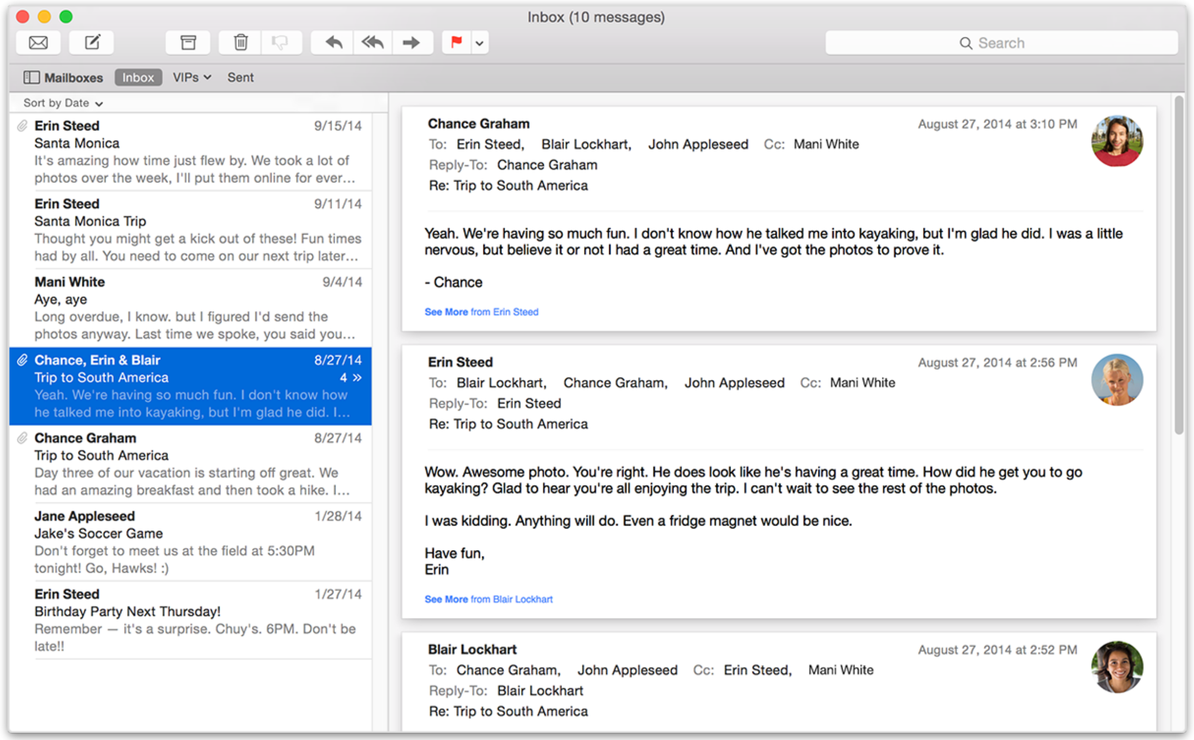
Designing the User Interface

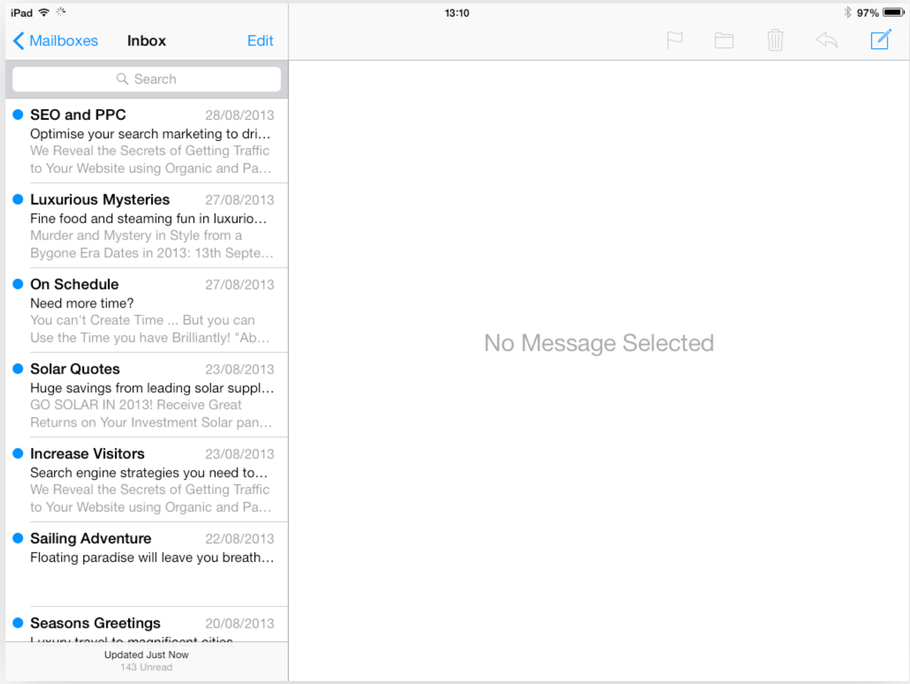
- Different resolutions and aspect ratios:

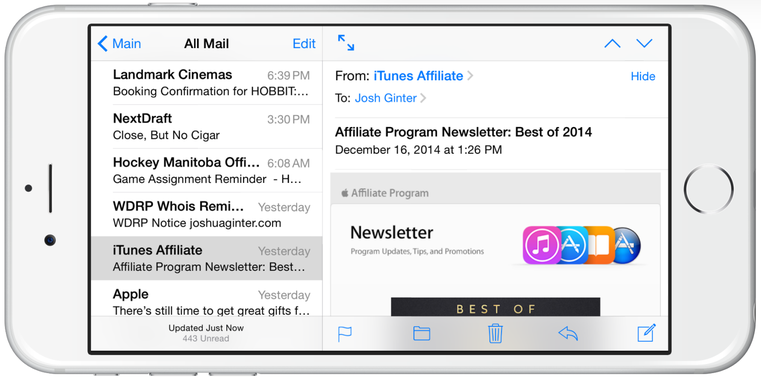
	Resolution	
	Classic	Retina
iPhone	480 x 320	960 x 640
iPhone 5 (C,S), SE	1136 x 640	
iPhone 6/S	1334 x 750	
iPhone 6/S Plus	1920 x 1080	
iPad, iPad mini	1024 x 768	2048 x 1536
iPad Pro 9.7”	2048 x 1536	
iPad Pro 12.9”	2732 x 2048	

- Device orientation:
  - Portrait or landscape
  - Designing for the iPad requires more than increasing the resolution

Example: Mail





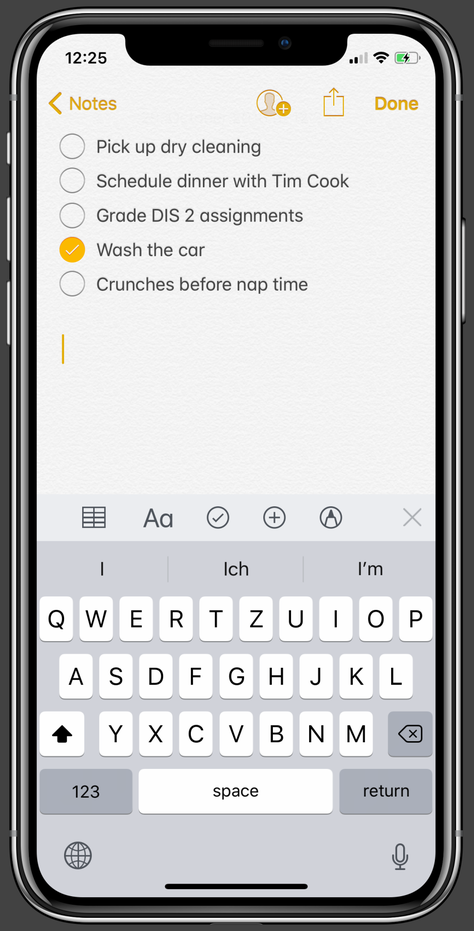


CHAPTER 28

Mobile Application Styles

Productivity Applications

Calendar



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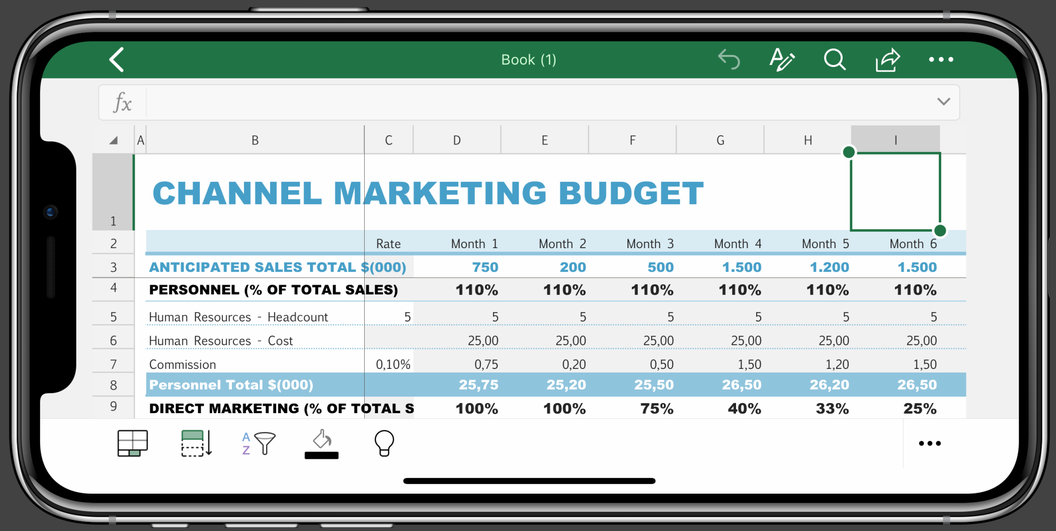
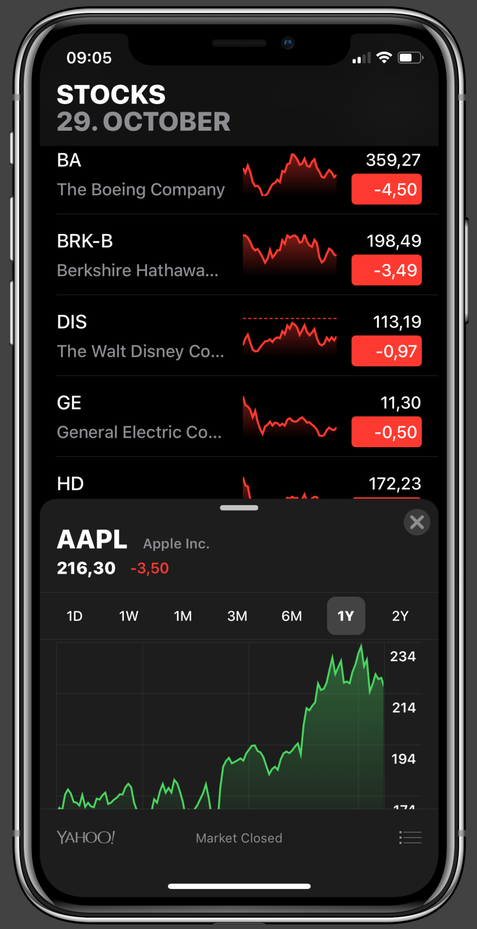


Microsoft Excel

Utility Applications

Compass



Stocks

The Elements

Immersive Applications

Monument Valley 2

Pokémon GO

Google Earth

CHAPTER 29

iOS

iOS History: Interaction Milestones

2007
Multitouch

2010
iPad

2014
Apple
Watch

2015
3D Touch

2017
ARKit

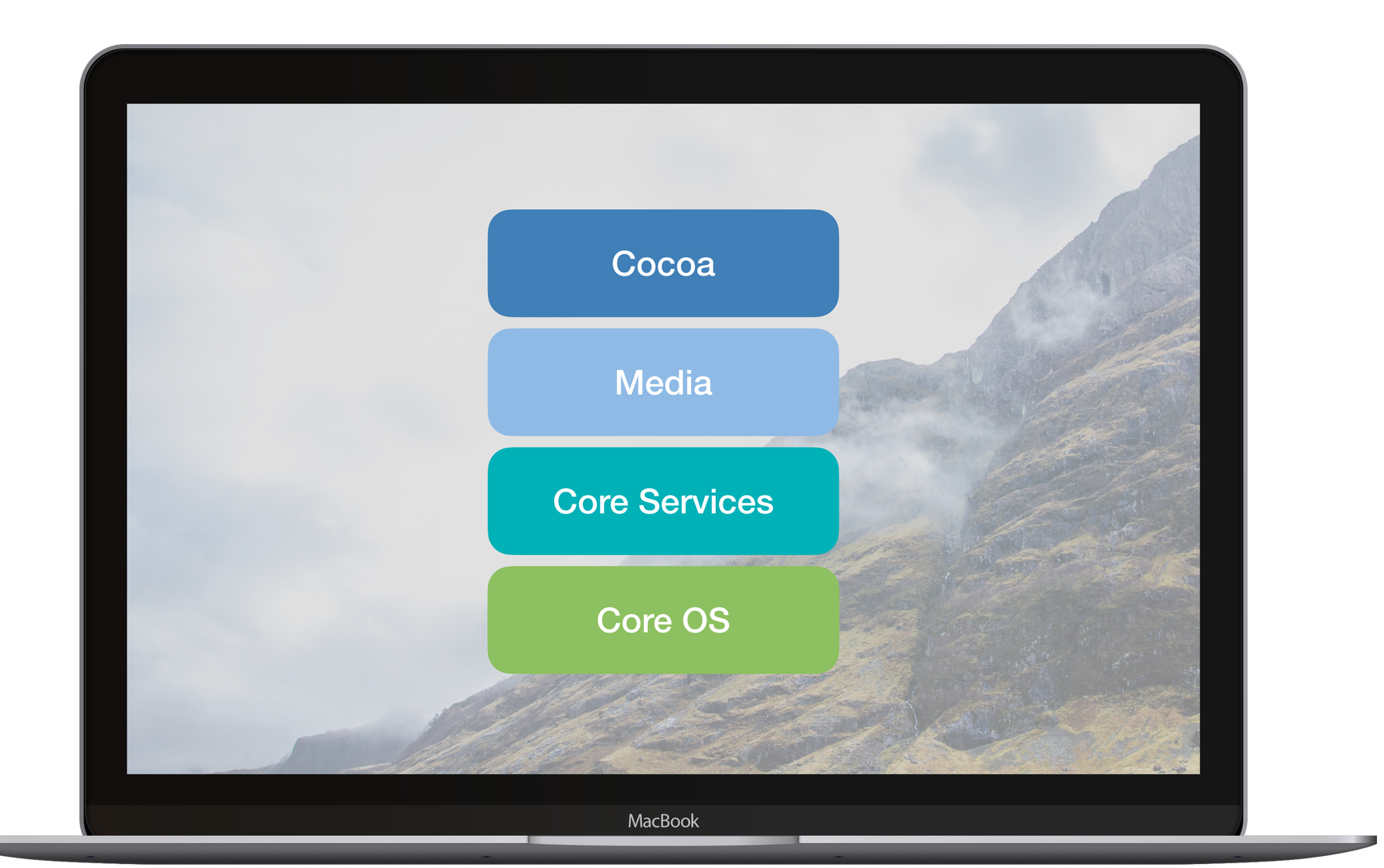
2008
App Store

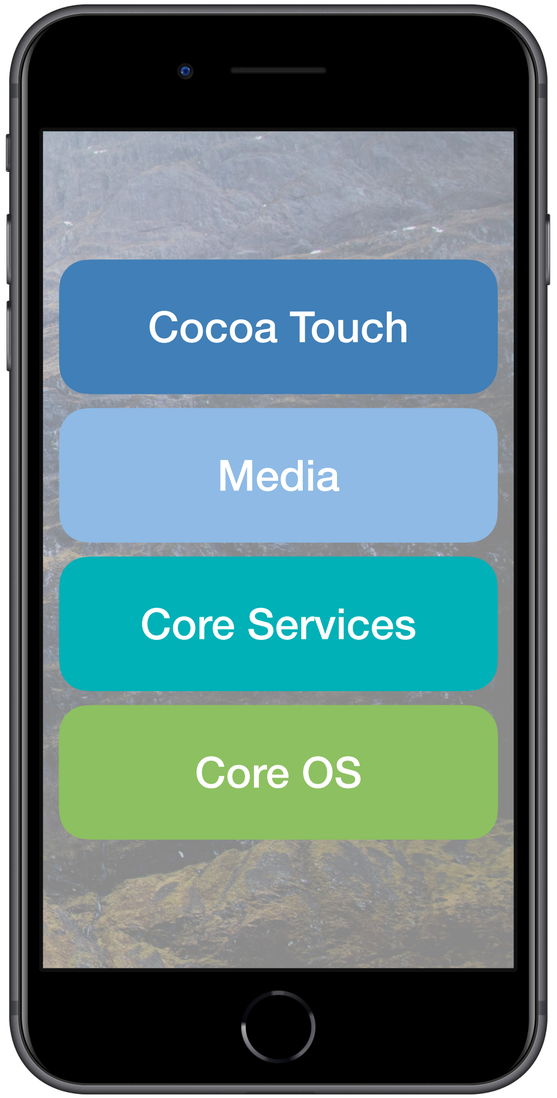
2011
Siri

2015
iPad Pro & Pencil
Split-Screen Mode

2019
iPadOS, SwiftUI

iOS Architecture





iOS Development: Similar to macOS Development

- **From AppKit to UIKit**
  - Redesigned Views for limited screen space, no menu bar
  - Different event handling (multiple touch input events instead of 1 mouse click; no hover menus)
  - More modern framework, e.g. target-action is no longer 1:1 but 1:n
  - Originally only RGB color space
- **Changes in Foundation**
  - No Cocoa bindings
  - No distributed objects
  - No garbage collection*
- **New & adapted Frameworks** to interact with phone hardware

iOS: Handling Touch Input

- Override **touch methods**

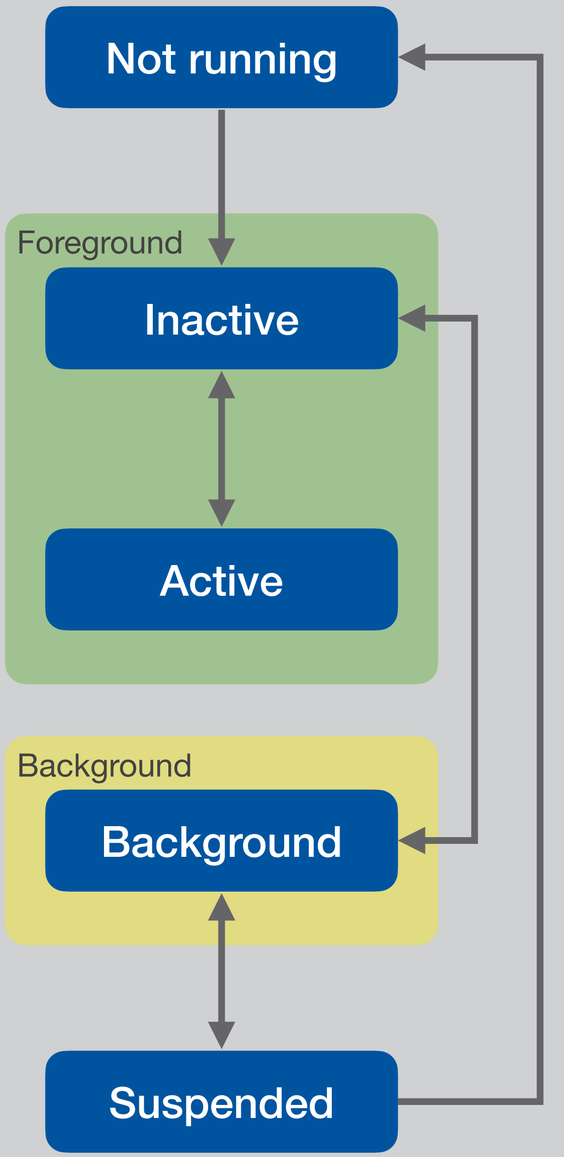
```
override func touchesBegan(_ touches: Set<UITouch>,
                           with event: UIEvent?) {
    if let touch = touches.first {
        print(touch.location(in: self))
    }
}
```

- Use a **gesture recognizer**

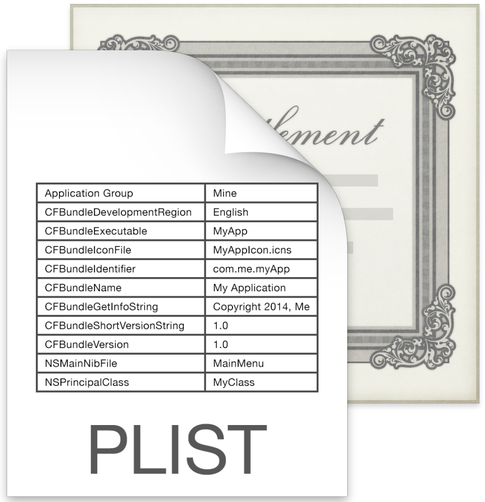
```
self.recognizer = UIPinchGestureRecognizer(target: self,
                        action: #selector(action(_:)))
self.view.addGestureRecognizer(recognizer)
```

iOS App Lifecycle

- Lifecycle delegate methods allow apps to react to state changes
- Explicit termination only by user in task switcher, only in case of problems
- The OS decides when to terminate an app, mostly depending on memory footprint, and the app may not be aware of the termination



iOS Apps: Components



App Specification

Code

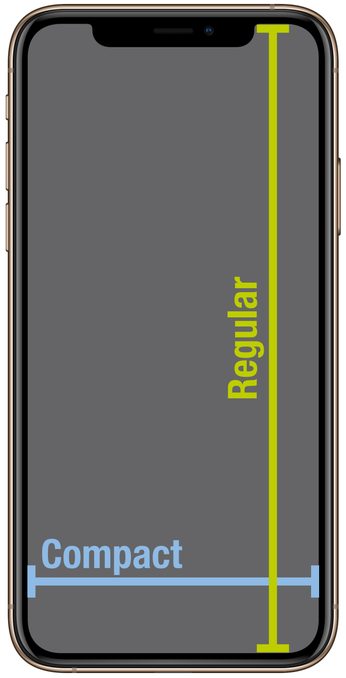
User Interface

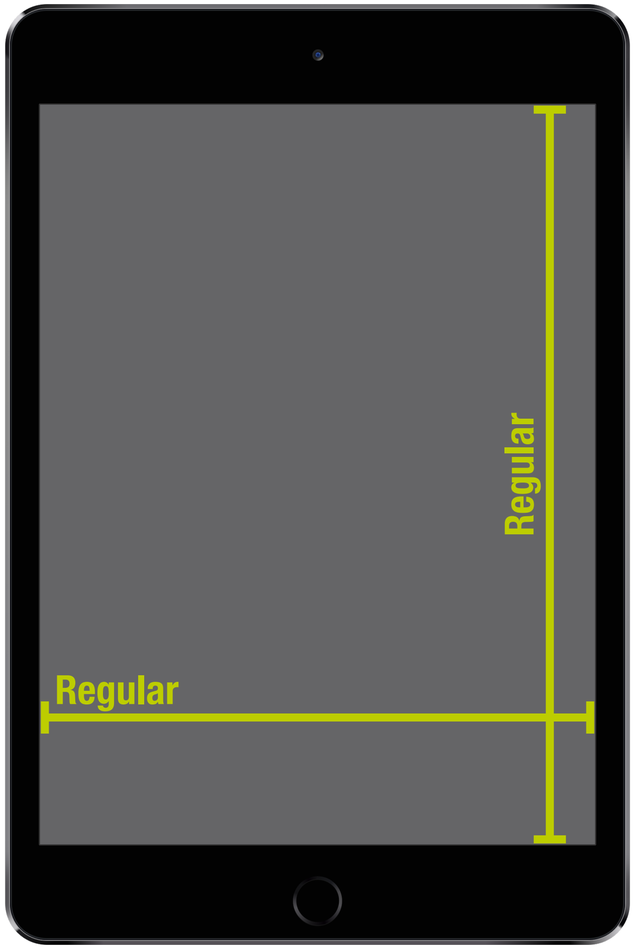
Assets

Adapting to Different Devices

- How to create an interface that works well on different aspect ratios?
- Storing pixel coordinates is not flexible, requires values for every different screen size
- Solution: **AutoLayout** (2011) describes relationships between widgets instead
- Key addition to AutoLayout in iOS: Declare variations in UI depending on **size classes**

iOS: Trait Variations





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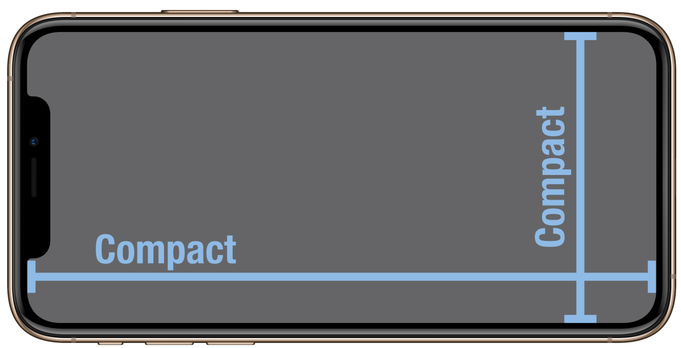
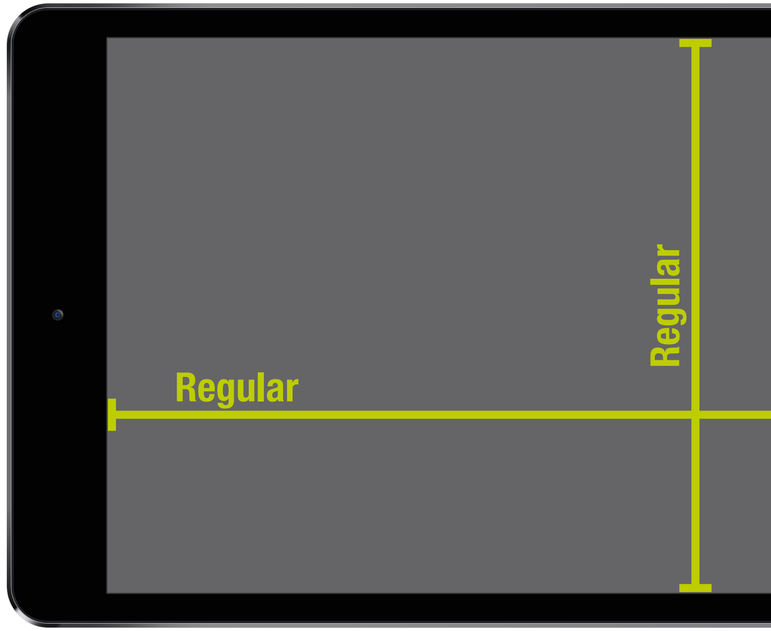




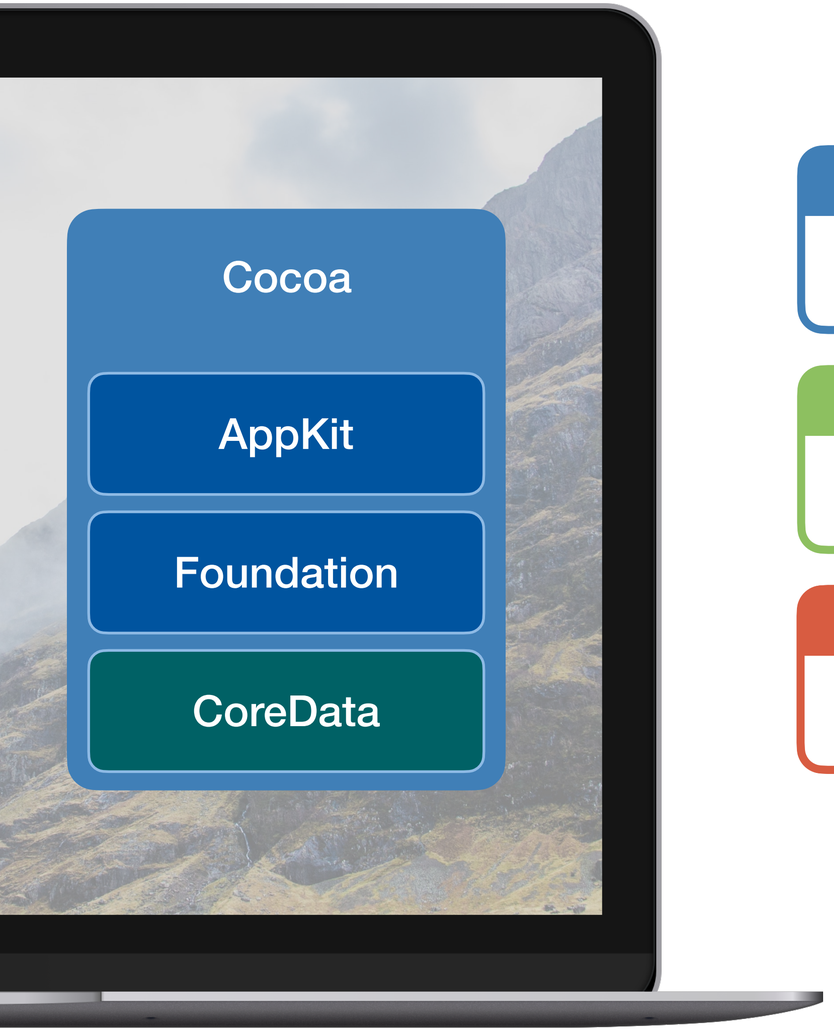
Some iOS SDKs

App Frameworks	 App Extensions	 Handoff	 Multitasking	 Notifications
Media & Web	 AirPlay	 MapKit	 MusicKit	 WebKit
App Services	 CloudKit	 HealthKit	 Machine Learning	 SiriKit
Graphics & Games	 GameCenter	 Metal	 SceneKit	 SpriteKit

iOS Design Themes

- **Clarity**
  - Subtle decorations
  - Sharpened focus on functionality
  - Use negative space, colors, fonts to highlight important content
  - Direct manipulation to support understanding
- **Deference**
  - UI does not compete with content
  - Content fills entire screen
  - Fluid motion
  - Typically no bezels
  - Translucency hints at more content
- **Depth**
  - Distinct visual layers
  - Realistic motion
  - Navigational transitions provide sense of depth

iOS Architecture Recap



View	View
AppKit	UIKit
Controller	**Controller**
AppKit	UIKit
Model	
Foundation, CoreData	

IOS GOES DECLARATIVE

SwiftUI

SwiftUI (2019)

- **Designed for Swift** as successor to ObjC-based AppKit (Mac) and UIKit (iOS, etc.)
- **Unified** framework across Apple's devices (on macOS, iOS, watchOS, tvOS)
  - Generates code using native widgets and technologies on each device
- **Declarative** instead of imperative programming paradigm
  - Declare UI and link to model code (with declarative **Combine** framework)
  - SwiftUI derives appropriate widgets and layout for each device class
  - Very compact code for standard UIs, supporting many features automatically (Dark Mode,…)
  - Fewer opportunities for fine-tuning your UI
  - Major rethinking from imperative OO UI design paradigm needed for complex apps
- Still in its early stages

SwiftUI: How it works

- **One language** for UI and code, using Swift's language features (closures,..)
  - Like Motif's UIDL, very compact, but here it's the actual source code
- **Views** are structs (lightweight classes), discarded and generated frequently
- **Closures** (lambda functions) enable Views, e.g., to contain executable subviews
- Views are a function of their state (program state), not a result of a sequence of events
- **Editable live preview** in Xcode, synchronizing UIDS and code (⇒ Morphic)
  - Using Swift's dynamic code replacement for live updates
  - Simultaneous previews for multiple device classes

SwiftUI: Demo

SwiftUI: Layout

`VStack`

`HStack`

`ZStack`

View Modifiers

A view modifier can change attributes of its input

```
Text("Label")
    .foregroundColor(Color.red)
```

Label

It can also work recursively on all child views

```
VStack {
            Text("Label 1")
            Text("Label 2")
}.foregroundColor(Color.red)
```

Label 1
Label 2

```
Text("Label")
    .padding()
    .background(Color.red)
```

Padding inside

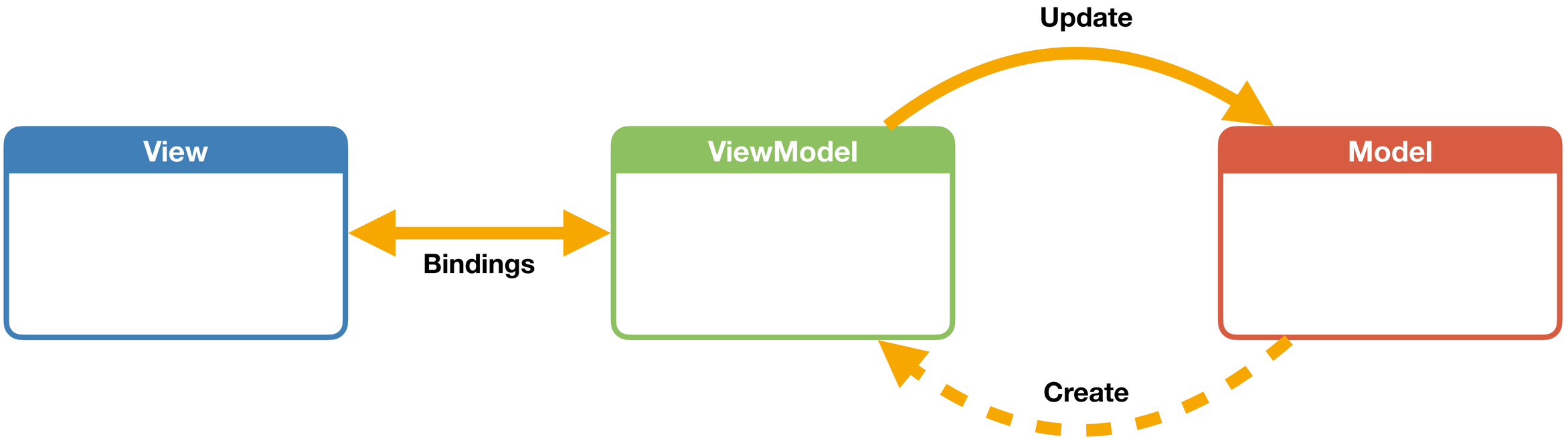
Label

```
Text("Label")
    .background(Color.red)
    .padding()
```

Padding outside

Label

MVVM Paradigm



SwiftUI: Trends

- From imperative to declarative programming
- From event-based programming to Publish/Subscribe mechanism linking to model
- Still in its early steps
  - API still evolving (similar to Swift in 2014)
  - Until provided natively, integrating legacy ObjC-style UIKit frameworks is unelegant (similar to Carbon apps in 2001)
- Watch demo at https://developer.apple.com/videos/play/wwdc2019/204/

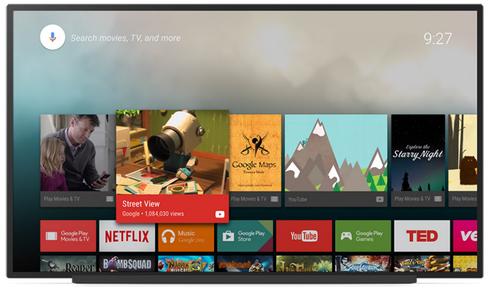
CHAPTER 30

Android

Android History

2007
Roots of Android

2009
Android Market



2014
Support for TVs and watches

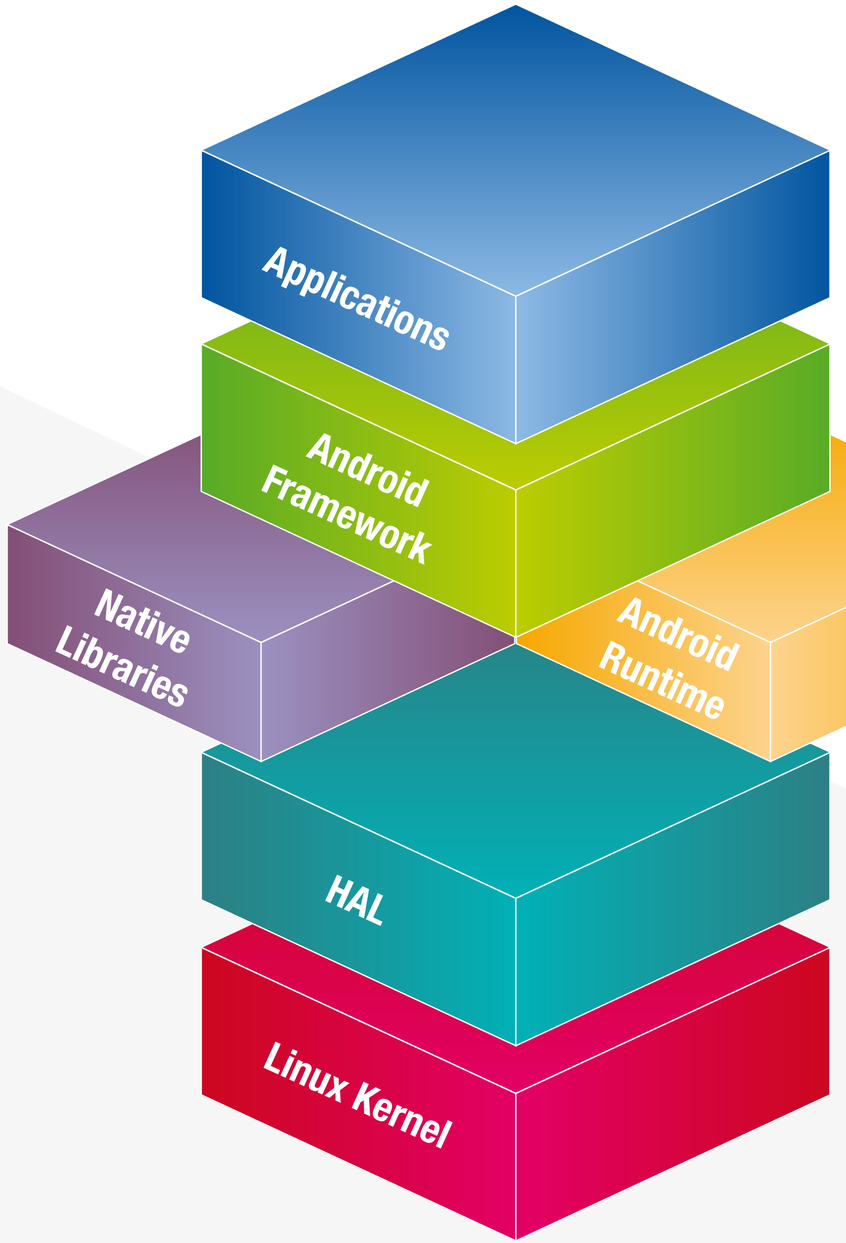
2008
First Android device

2011
Support for tablets

2013
“OK Google”

2015
Fingerprint gestures

Android Stack



Alarm, Browser, Calendar, Photo Album, SMS, ...

Content Providers, Activities, Resources, Telephony

Audio Manager, Freetype, OpenGL, SQLite, SSL, WebKit

ART, Core Libraries

Audio, Bluetooth, Camera, Storage, Graphics, Sensors

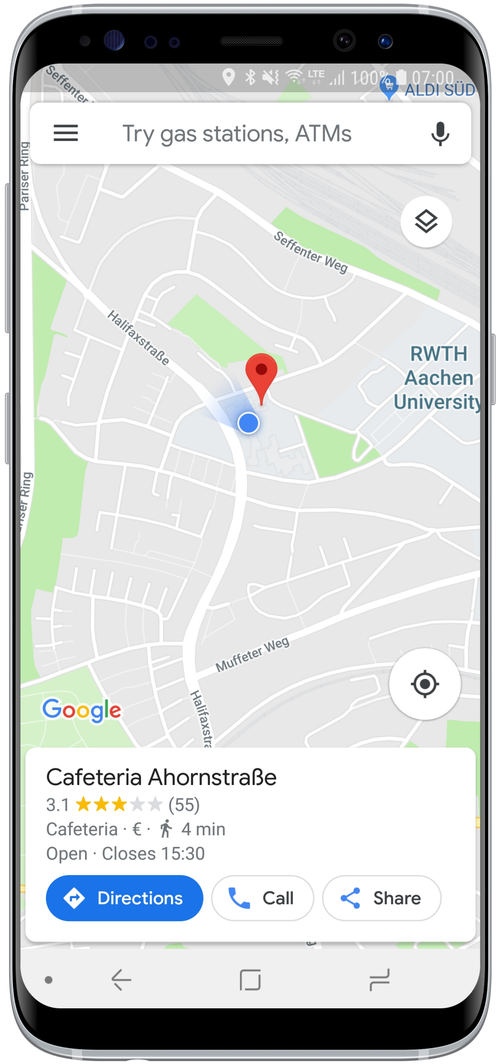
Drivers, Shared Memory, Power Management, USB, WiFi

Application Fundamentals

- Idea: **Share** elements of applications
  - No single entry point
- All of the four different **types of component**s are entry points for the system or user
  - Activities
  - Services
  - Broadcast receivers
  - Content providers

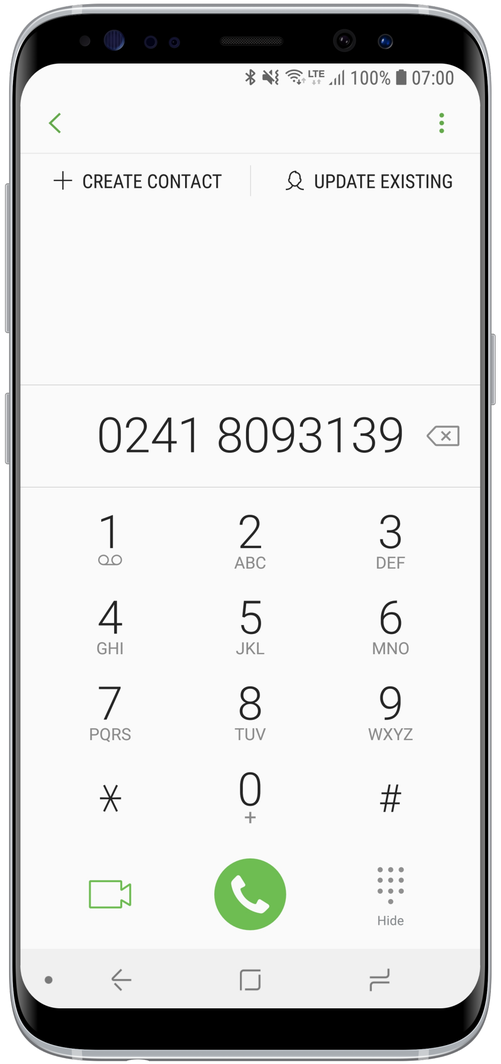
Activity

- Single screen of your application’s UI
  - Contains a tree of views
  - Defines menus
- Starts & stops services
- Calls other activities via intents



Intent

- Messaging object to request an action from another app (component)
- **Explicit intent**
  - Open another activity in the same app
- **Implicit intent**
  - Requesting an abstract “service”
  - Caller does not know callee
- Intent filters expose functionalities to other components



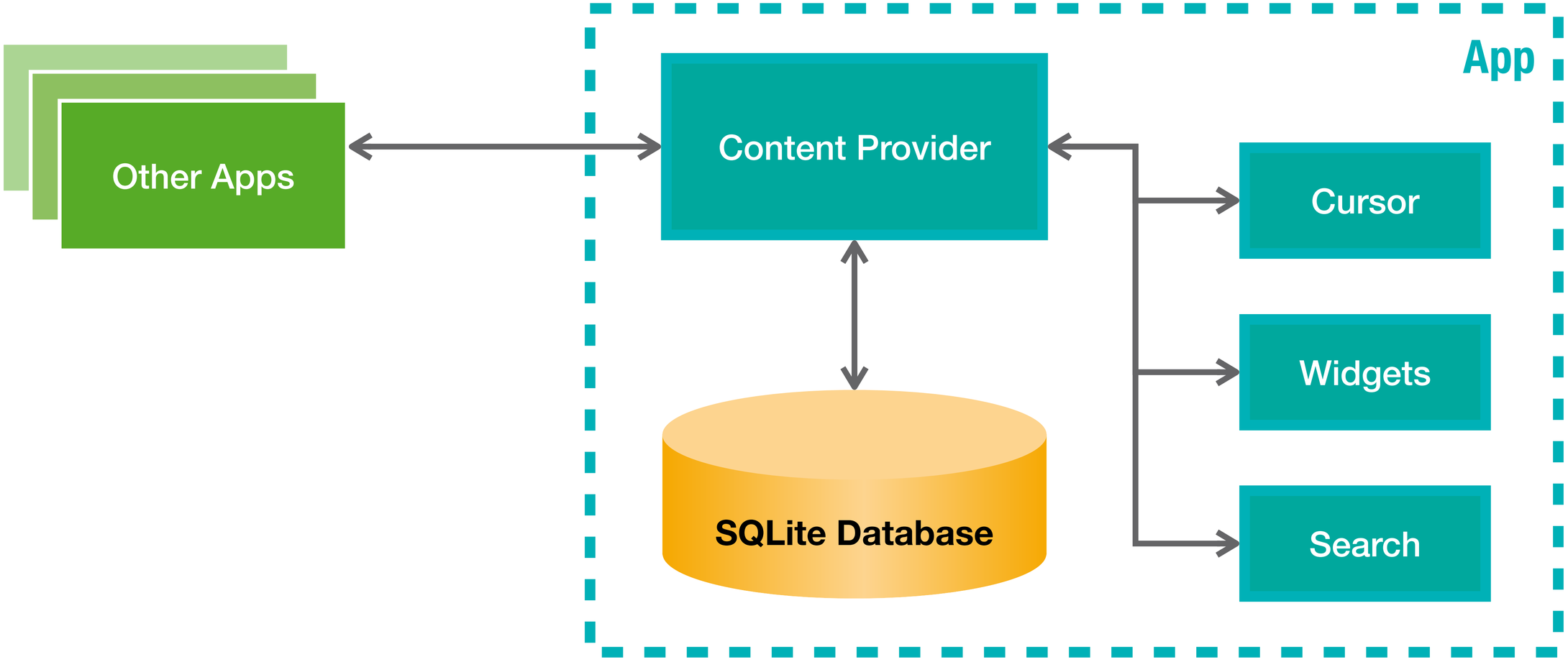
Broadcast Receiver

- Broadcasts are implicit intents
  - e.g. for system events like timezone change, device shutdown, ...
- Broadcast receivers are used to register from system or application events
- Use a **dynamic** broadcast receiver
  to make your app react to changes during runtime
- Use a **static** broadcast receivers
  to start your app on a specific broadcast

Service

- Long-running operation in the background and does not provide a UI
  - e.g., network transactions, play music, perform file I/O
- **(Unbound) service**
  - Is kept alive by the system even if the starting Activity has finished executing
- **Bound service**
  - Components can bind to a service and interact with it through an interface exposed by the Service
  - Client Server architecture
  - When the last client unbinds from the service, the system destroys it

Content Provider



Android Manifest

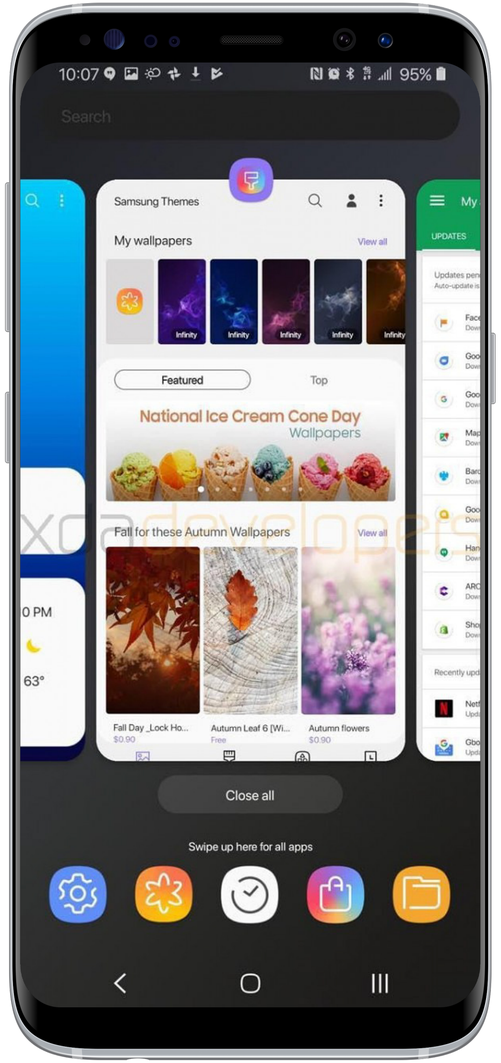
- XML file that defines a black box view of an application
- Interface between the OS and the app
  - Icon
  - Requirements (e.g., minimum API level)
  - Permissions (e.g., making calls)
- Exposes app’s functionality
  - Available activities
  - Intent filters (e.g., entry point)

Tasks and Multitasking

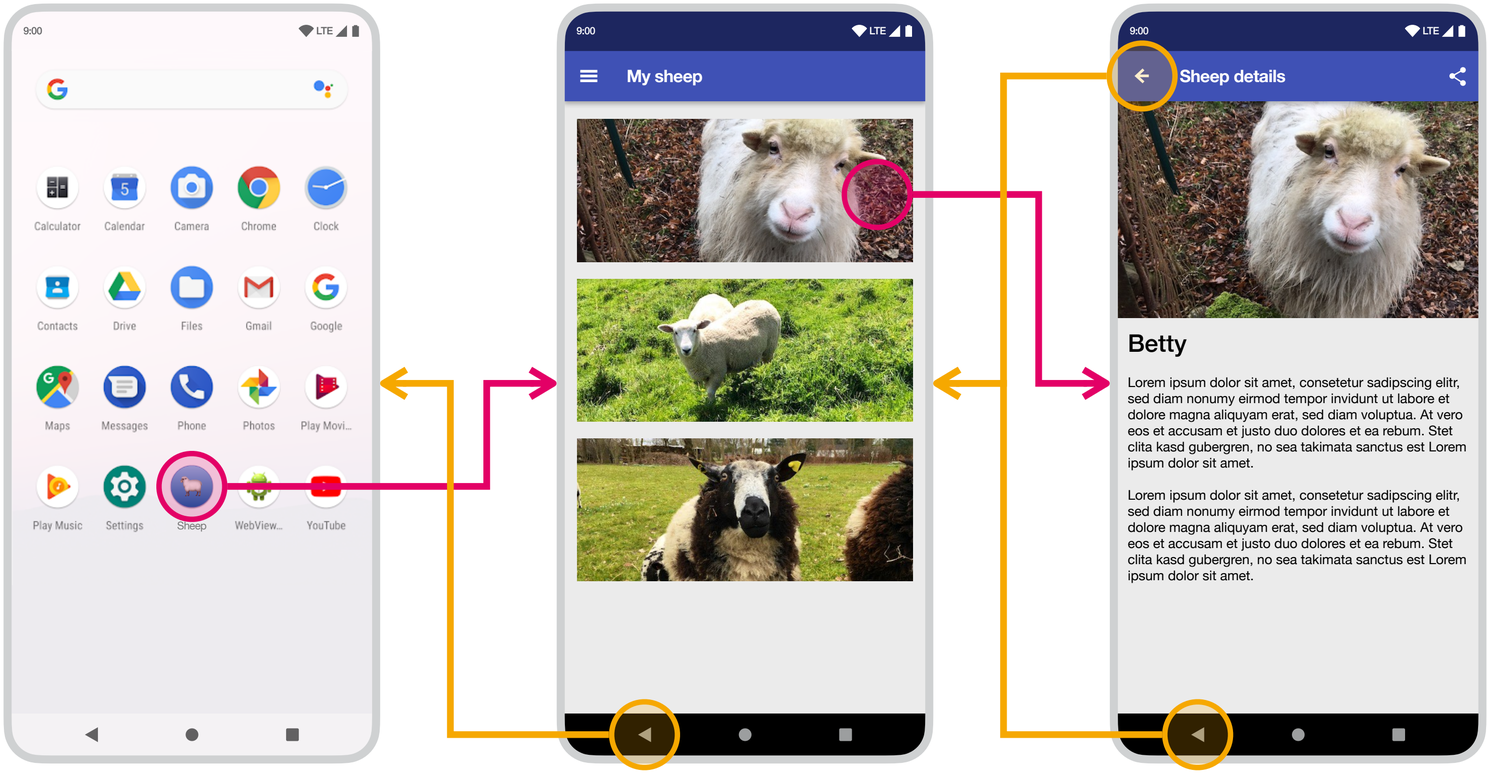
- **Tasks** are a sequence of activities (possibly from different apps)

- Every time a new activity is started, the previous one is moved to the task's **back stack**
  - The same activity can be instantiated multiple times in one back stack
  - The back button switches to the previous activity in the stack

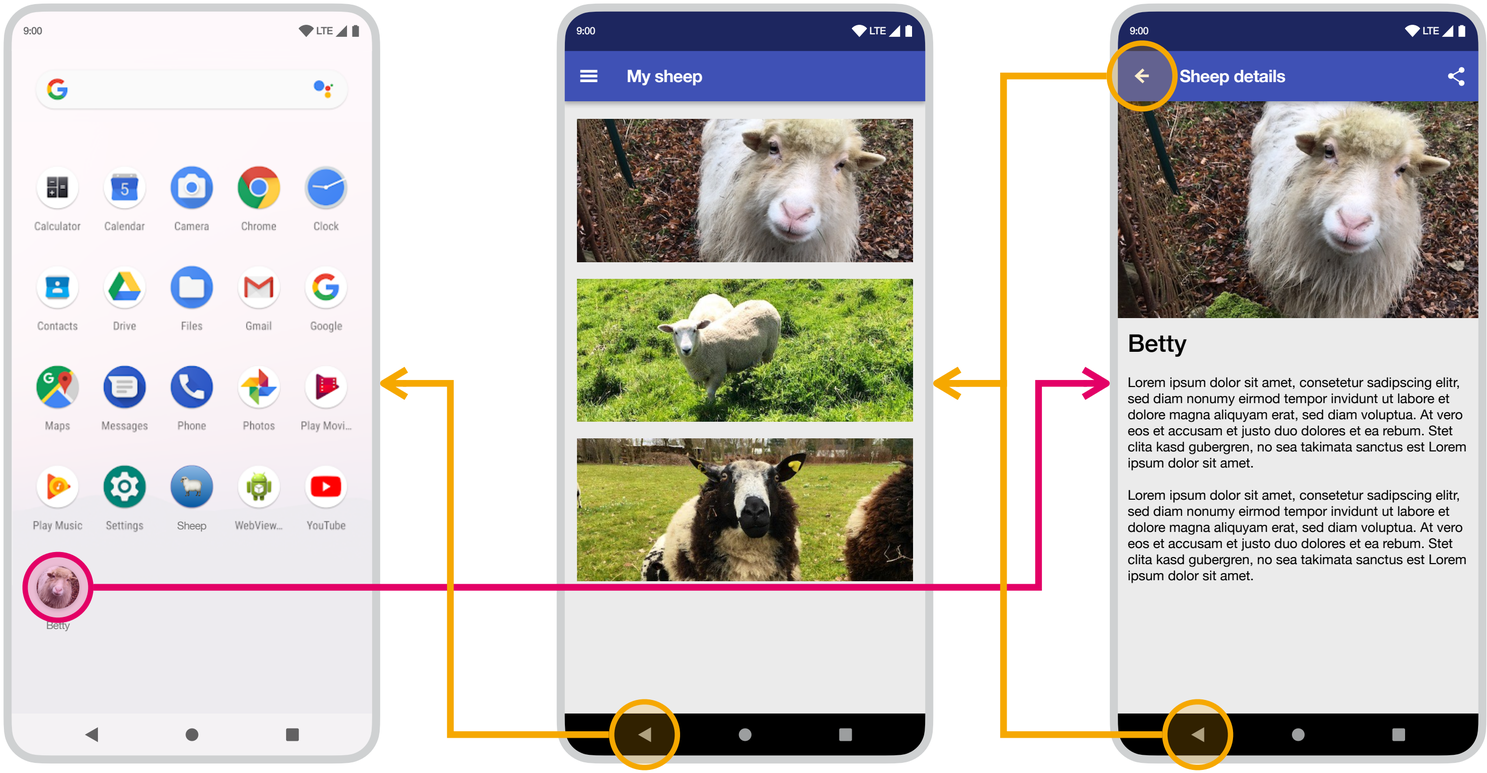
- The home button signals that the user switches to a new task



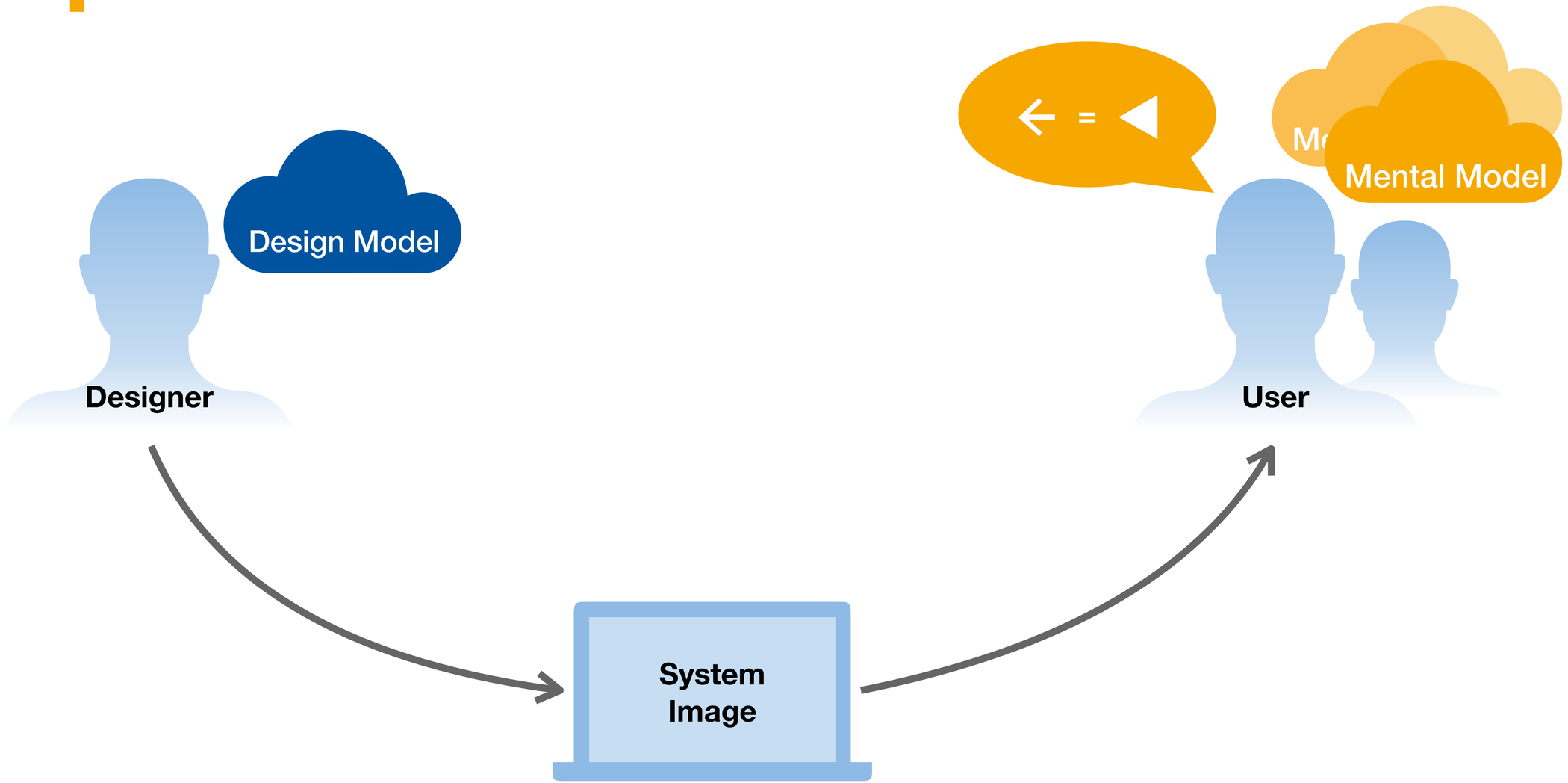
Back Navigation



Deep Links



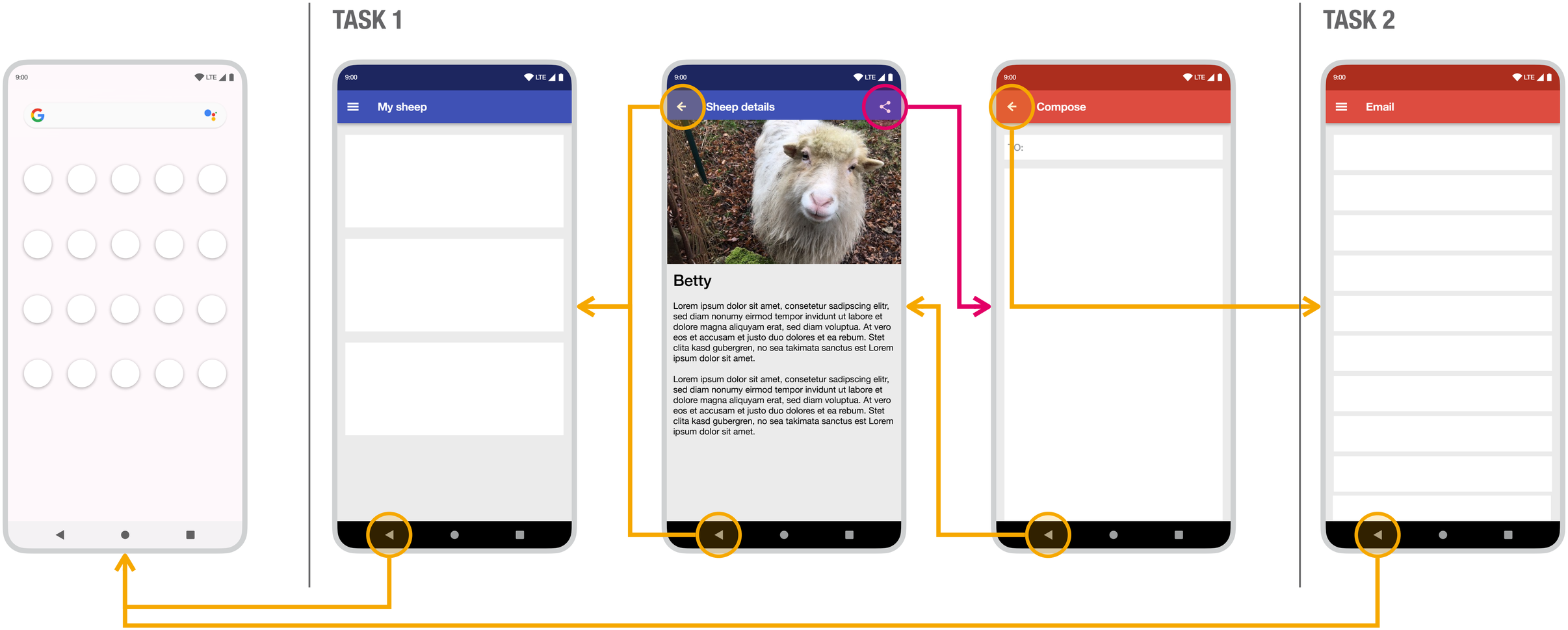
Conceptual Models



The Up Button

- The on-screen up button navigates to a parent activity that is statically defined by the developer
- It never exits the app and hence does not exist on root activity
- For tasks that remain in one app, up and back behave identically
- Pressing the up button creates a new task if the current activity was presented from an activity of a different app
- The up button cannot be used to navigate between sibling contents, e.g. paged contents inside of an activity

Switching Tasks



CHAPTER 31

Designing for TVs

TV UIs: Design Considerations

- **Across the Room**
  - Users sit a few meters away from the screen
  - Resolution and viewing distance make it difficult to process too much information
    - Show ~ as much as on phone
  - “Connect” user with content

TV UIs: Design Considerations

- **Immersion is key**
  - Primary use: entertainment
  - Engulf people in a cinematic experience
  - Exploit canvas with edge-to-edge scenery
  - Use fluid animations, captivating audio and vibrant colors

TV UIs: Design Considerations

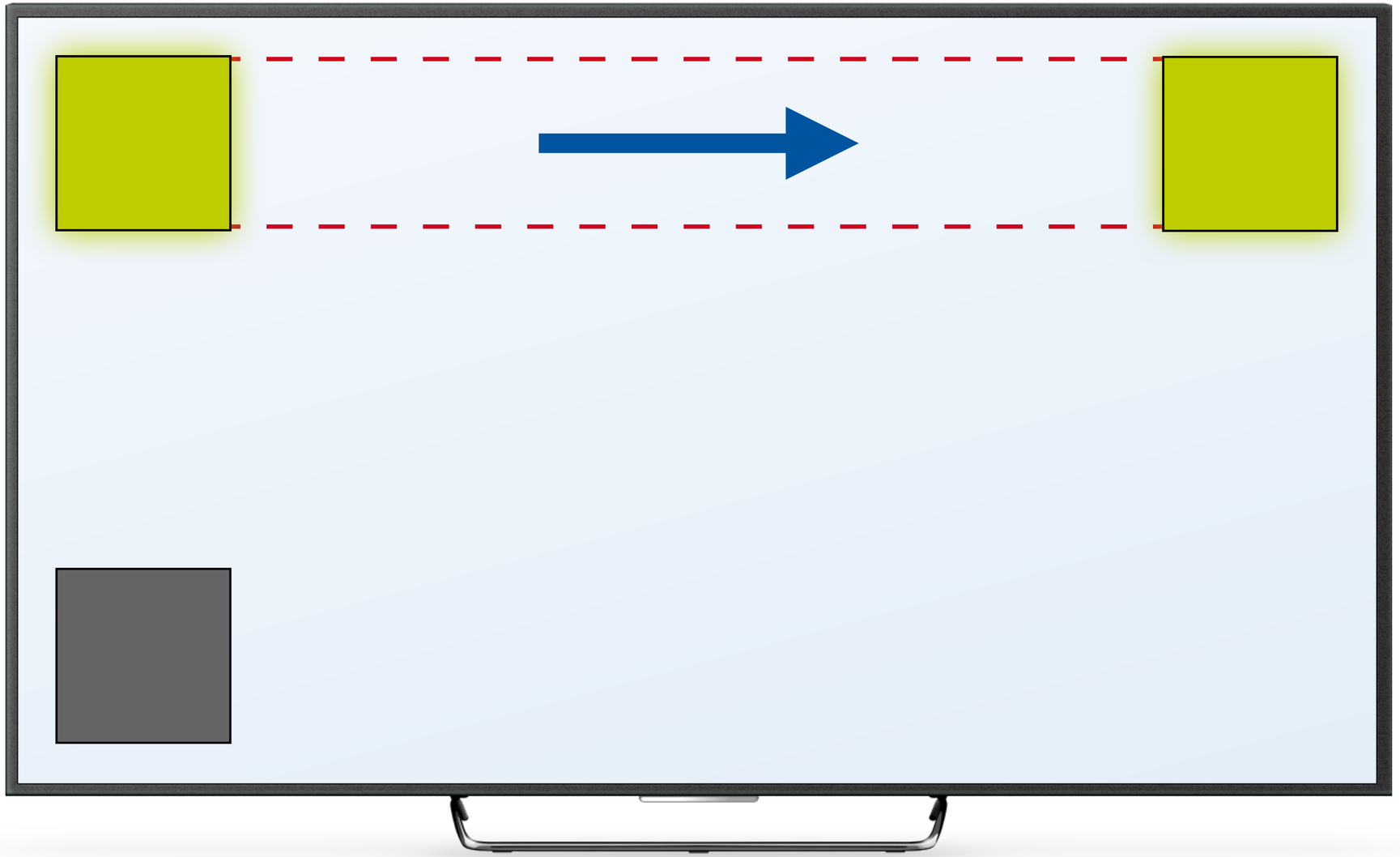
- **Clarity**
  - Use consistent layouts
  - Make the focus clear and unmistakable, even from at distance
  - Movement across space is consistent and predictable

Input?

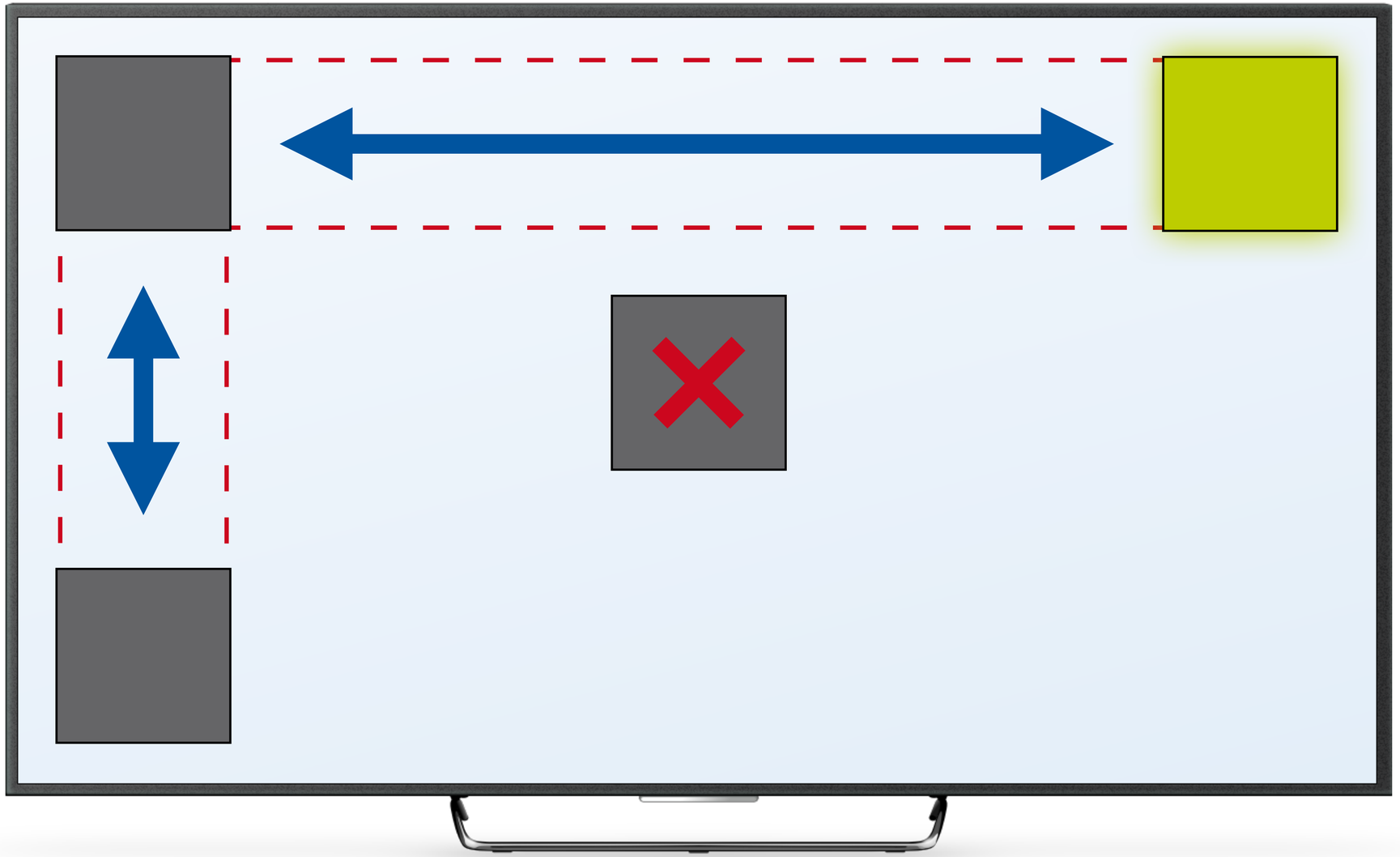
Focus Model

- Fundamental interaction principle for TV UIs
  - Always one element highlighted
- Always move focus in the direction expected
  - Focus moves in the direction of the gesture
    - Content might move in the opposite direction of the focus
  - But: (fullscreen) objects move in the direction of the gesture
- Make the focused item obvious

Focus Model



Focus Model



Overriding the Default Navigation

- Needed if
  - Some UI elements are not accessible by the focus model
  - The semantic order of contents does not fit their physical arrangement (e.g., in two-column designs)
- Possible solutions
  - Statically define item successors (e.g., Xbox)
  - Add dynamic focus guides (e.g., tvOS)

Overriding Default Navigation on Xbox

Overriding Default Navigation on Xbox

```
<StackPanel Orientation="Horizontal" Margin="300,300">
    <UserControl XYFocusRight="{x:Bind ButtonThree}">
        <StackPanel>
            <Button Content="One"/>
            <Button Content="Two"/>
        </StackPanel>
    </UserControl>
    <StackPanel>
        <Button x:Name="ButtonThree" Content="Three"/>
        <Button Content="Four"/>
    </StackPanel>
</StackPanel>
```

Overriding Default Navigation on tvOS: Focus Guides

Overriding Default Navigation on tvOS: Focus Guides

```
var focusGuide: UIFocusGuide = {
    let fg = UIFocusGuide()
    self.view.addLayoutGuide(fg)
    fg.rightAnchor.constraint(equalTo: shopButton.rightAnchor).isActive = true
    fg.bottomAnchor.constraint(equalTo: moreButton.bottomAnchor).isActive = true
    fg.leftAnchor.constraint(equalTo: shopButton.leftAnchor).isActive = true
    fg.topAnchor.constraint(equalTo: moreButton.topAnchor).isActive = true
    return fg
}()

override func didUpdateFocus(in context: UIFocusUpdateContext, with coordinator:
UIFocusAnimationCoordinator) {
    super.didUpdateFocus(in: context, with: coordinator)
    switch context.nextFocusedView {
        case self.moreButton:  focusGuide.preferredFocusEnvironments = [shopButton]
        default:               focusGuide.preferredFocusEnvironments = [moreButton]
    }
}
```

Supporting Focus: Parallax Effect (tvOS)

- An example of the subtleties of UI design
- Focused item elevated
- Sways responding to small remote touches
- Illumination for reflection effect
- After inactivity: grow while other items dim
- Layered images create parallax effect
- Reinforces focus, but in *subtle* ways

Beyond Smartphones: In-Car Interaction

Beyond Smartphones: Wearables

Limitations repeat themselves in history.

APPENDIX

Code Usability

Explicit Parameter Names

Java

```
Person joe = new Person("Joe", "Snuffy", 21);
joe.hi();
```

Objective-C

```
Person *joe = [Person personWithFirstName:@"Joe" lastName:@"Snuffy" andAge:21];
[joe sayHi];
```

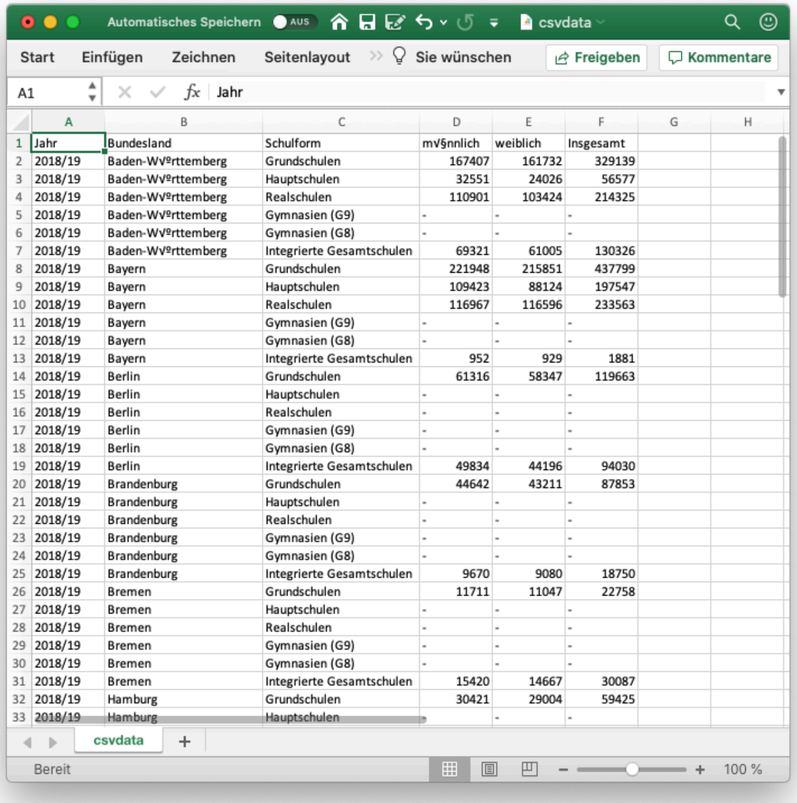
Swift, Python

```
joe = Person(”Joe","Snuffy", age=21)
joe.hi()
```

What Else Do Developers Need?

- A powerful API that lets you do the right thing
- Availability of frameworks
- Easy project management
- A good IDE
- Proficiency in their language of choice

Python: ♥ for File Handling and Data



	A	B	C	D	E	F	G	H
1	Jahr	Bundesland	Schulform	mv§nnlich	weiblich	Insgesamt		
2	2018/19	Baden-WVºrttemberg	Grundschulen	167407	161732	329139		
3	2018/19	Baden-WVºrttemberg	Hauptschulen	32551	24026	56577		
4	2018/19	Baden-WVºrttemberg	Realschulen	110901	103424	214325		
5	2018/19	Baden-WVºrttemberg	Gymnasien (G9)	-	-	-		
6	2018/19	Baden-WVºrttemberg	Gymnasien (G8)	-	-	-		
7	2018/19	Baden-WVºrttemberg	Integrierte Gesamtschulen	69321	61005	130326		
8	2018/19	Bayern	Grundschulen	221948	215851	437799		
9	2018/19	Bayern	Hauptschulen	109423	88124	197547		
10	2018/19	Bayern	Realschulen	116967	116596	233563		
11	2018/19	Bayern	Gymnasien (G9)	-	-	-		
12	2018/19	Bayern	Gymnasien (G8)	-	-	-		
13	2018/19	Bayern	Integrierte Gesamtschulen	952	929	1881		
14	2018/19	Berlin	Grundschulen	61316	58347	119663		
15	2018/19	Berlin	Hauptschulen	-	-	-		
16	2018/19	Berlin	Realschulen	-	-	-		
17	2018/19	Berlin	Gymnasien (G9)	-	-	-		
18	2018/19	Berlin	Gymnasien (G8)	-	-	-		
19	2018/19	Berlin	Integrierte Gesamtschulen	49834	44196	94030		
20	2018/19	Brandenburg	Grundschulen	44642	43211	87853		
21	2018/19	Brandenburg	Hauptschulen	-	-	-		
22	2018/19	Brandenburg	Realschulen	-	-	-		
23	2018/19	Brandenburg	Gymnasien (G9)	-	-	-		
24	2018/19	Brandenburg	Gymnasien (G8)	-	-	-		
25	2018/19	Brandenburg	Integrierte Gesamtschulen	9670	9080	18750		
26	2018/19	Bremen	Grundschulen	11711	11047	22758		
27	2018/19	Bremen	Hauptschulen	-	-	-		
28	2018/19	Bremen	Realschulen	-	-	-		
29	2018/19	Bremen	Gymnasien (G9)	-	-	-		
30	2018/19	Bremen	Gymnasien (G8)	-	-	-		
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33	2018/19	Hamburg	Hauptschulen		-	-