



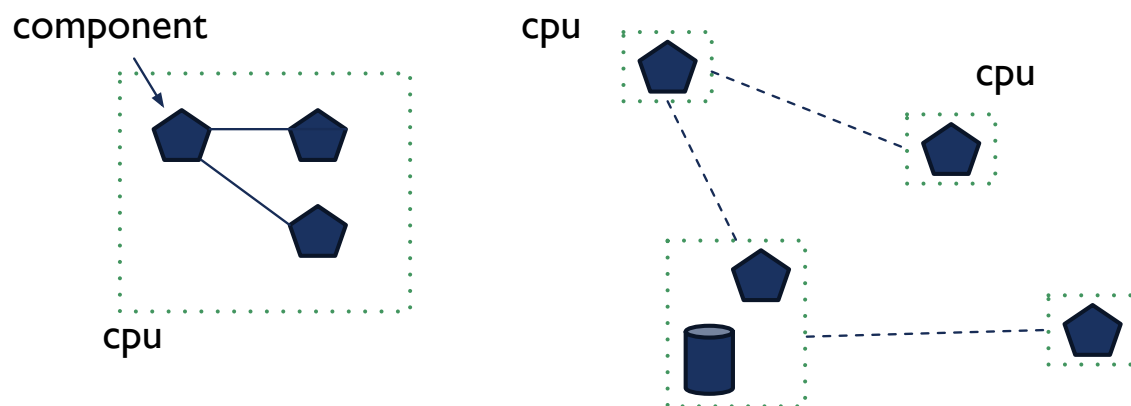
BASIC INTERACTION PATTERNS

WITH (SOME) EXAMPLE



INTRODUCTION

- A software is made of several 'components'
- The interaction among components can be either **synchronous** or **asynchronous**
- Interacting components can run on the **same** CPU or on **different** CPUs
- A component can be **stateless** or stateful



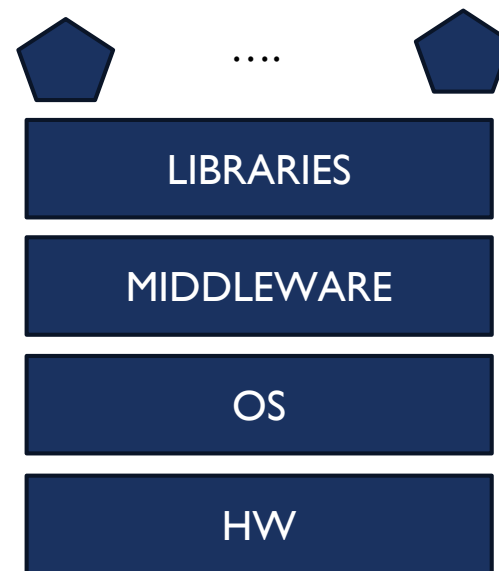
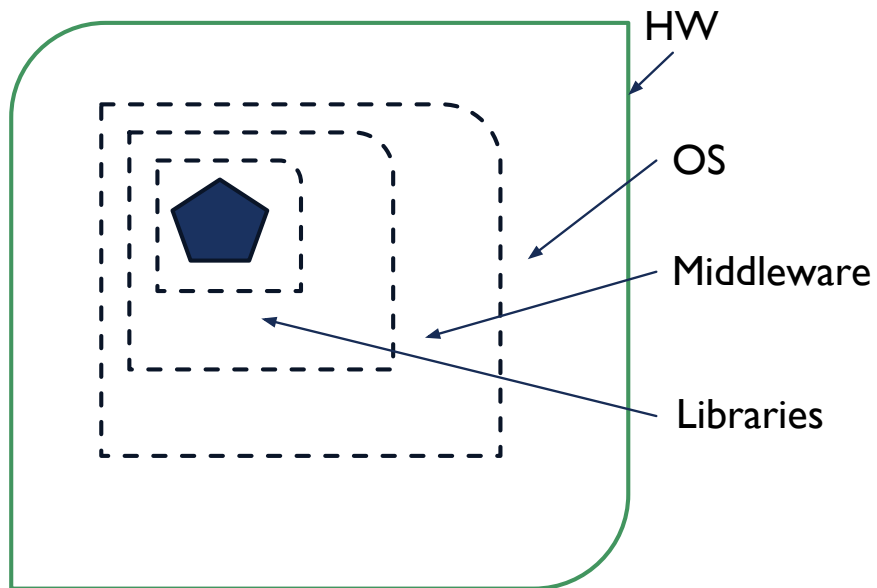
If components run on different CPU they

1. can make progress in parallel (true)
2. can only interact via messages (no shared memory)
3. Do not have a global clock

Then the system is distributed
(network can be Partitioned, component can become not Available, data can be not Consistent \square CAP theorem applies)

MORE ON COMPONENTS

- Any component needs some surrounding support, both hardware or sw, in order to run
- Nevertheless, for now focus on components

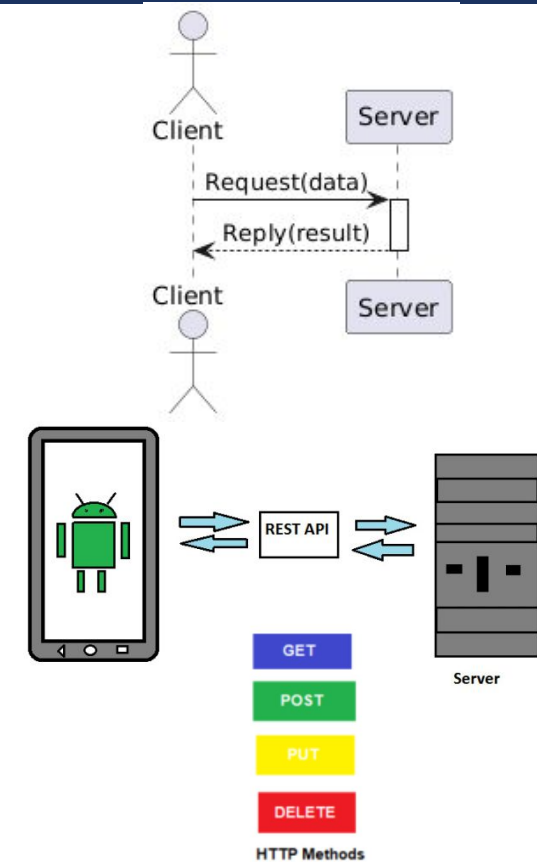
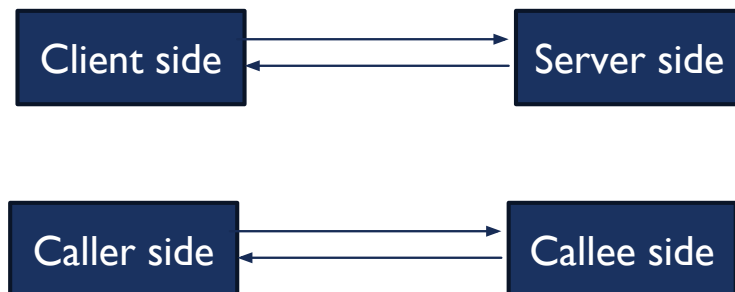


BASIC INTERACTION PATTERNS AMONG SW COMPONENTS

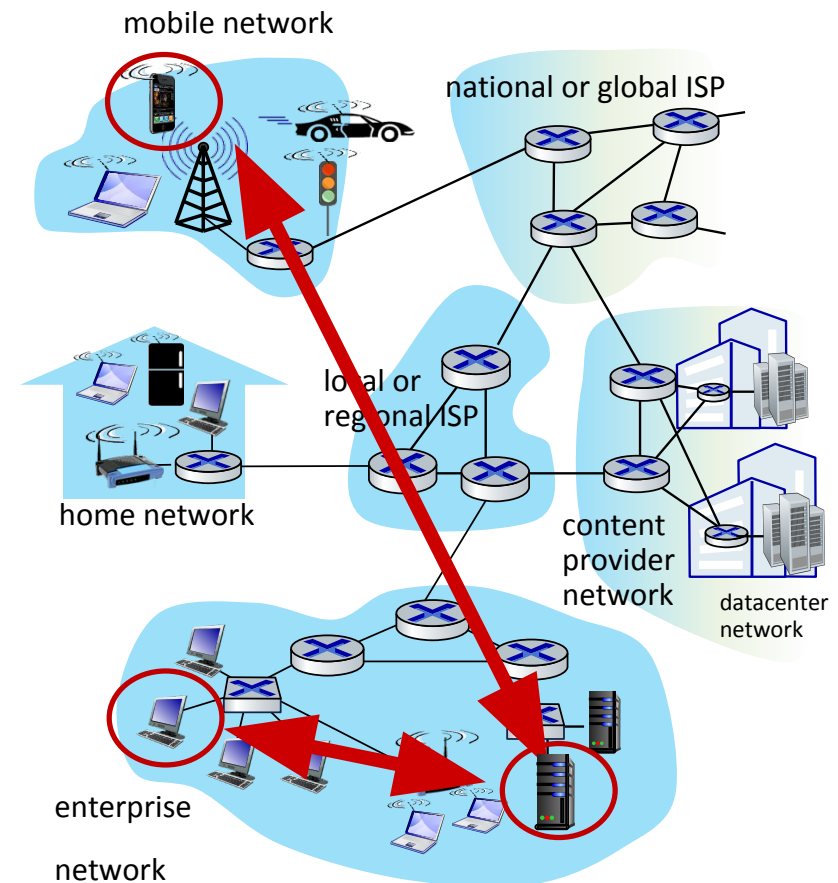
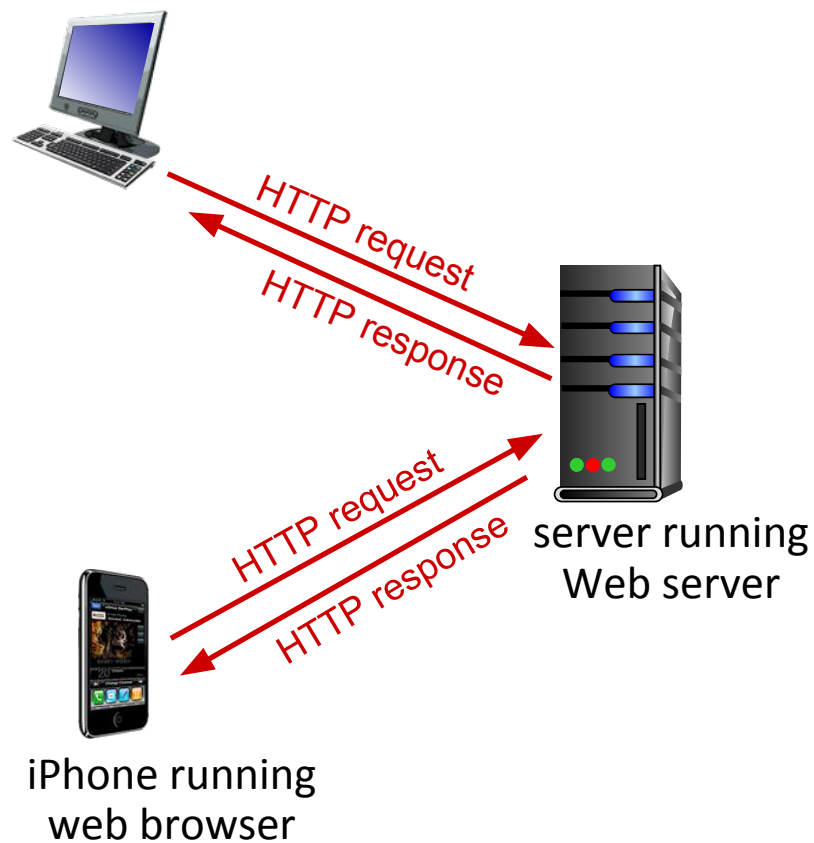
- Short review of the basic interaction patterns (ways) among components in abstract way and providing some technological mapping. We assume no failures
- Interaction patterns:
 - Request/Response
 - One-Way Message (Fire and Forget)
 - Publish/Subscribe
 - Event Notification
- Computational Graphs

REQUEST/RESPONSE

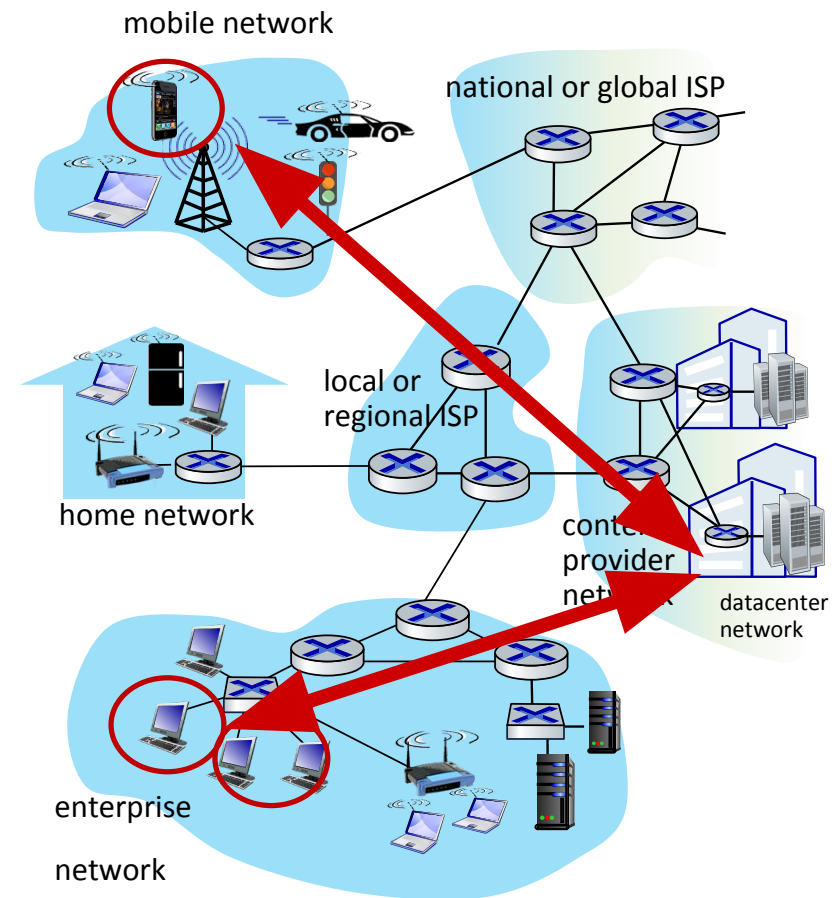
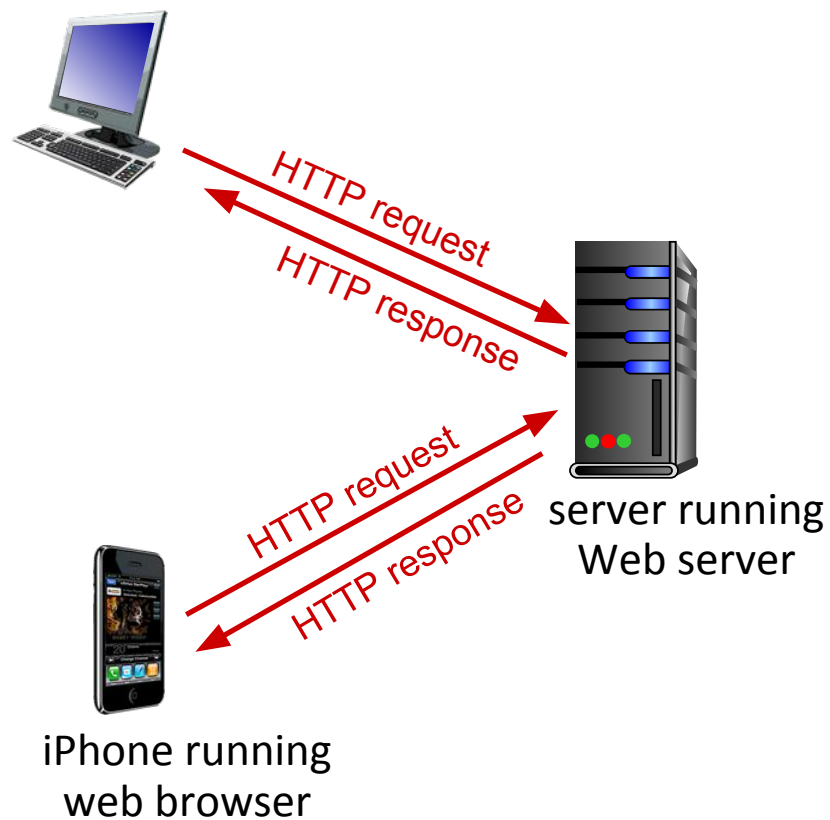
- Perhaps the most common pattern
- Synchronous: caller makes a request and then waits for response
- Examples:
 - A function that calls another function inside the same progra,
 - An app that sends sensor data to REST API
 - A frontend microservice queries backend DB via API



REQUEST/RESPONSE (SOME MORE IMPLEMENTATION DETAILS)



REQUEST/RESPONSE (SOME MORE IMPLEMENTATION DETAILS)

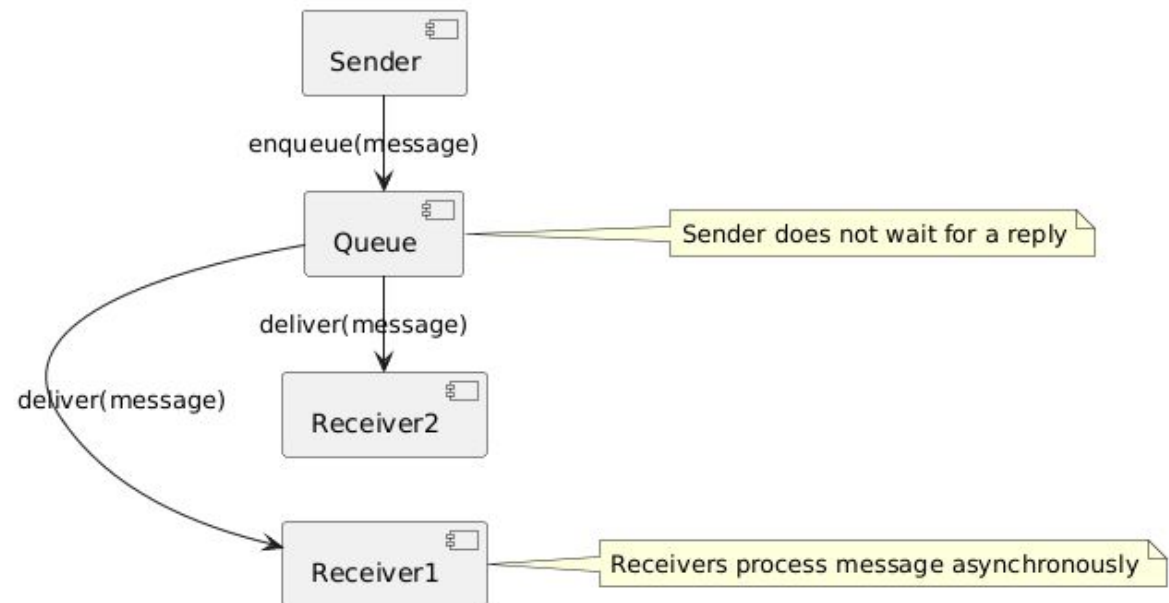
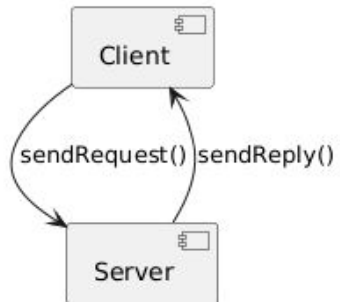


ONE-WAY MESSAGE (FIRE AND FORGET)

- **Fire-and-forget**
- Component sends an asynchronous message (to a queue or intermediary) without waiting for response
- Android: app sends logs or sensor readings to a remote queue without waiting for the reply, e.g. elaboration

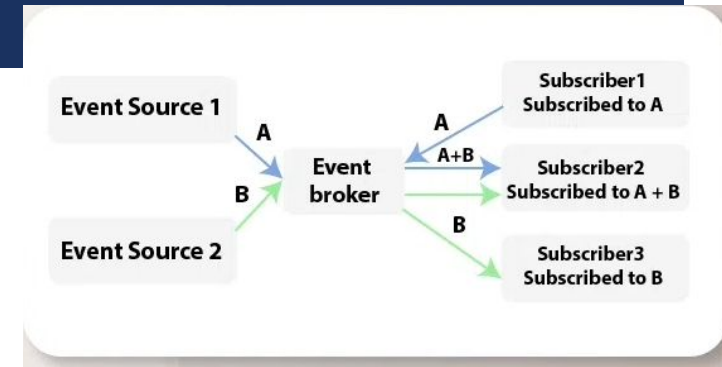


ONE-WAY MESSAGE (FIRE AND FORGET)

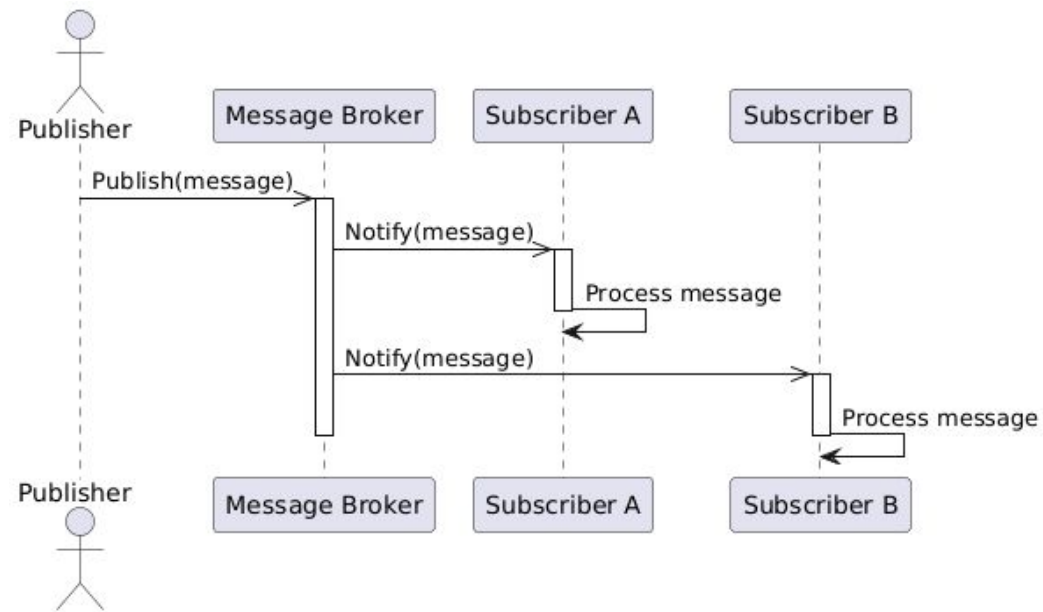


PUBLISH/SUBSCRIBE

- **Publisher** sends events to a **broker** on a specific **topic**
- **Subscribers** receive notifications without direct knowledge of publisher
- Example, Android: push information on topics (e.g., weather alerts) using firebase
- Function that subscribes (register) to sensor events (event handler)

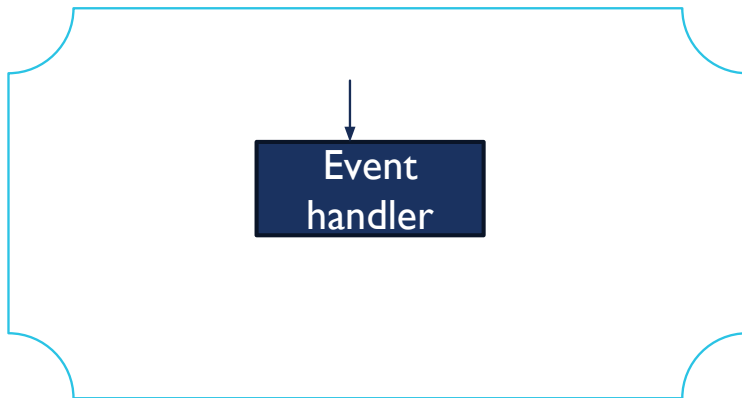


PUBLISH/SUBSCRIBE

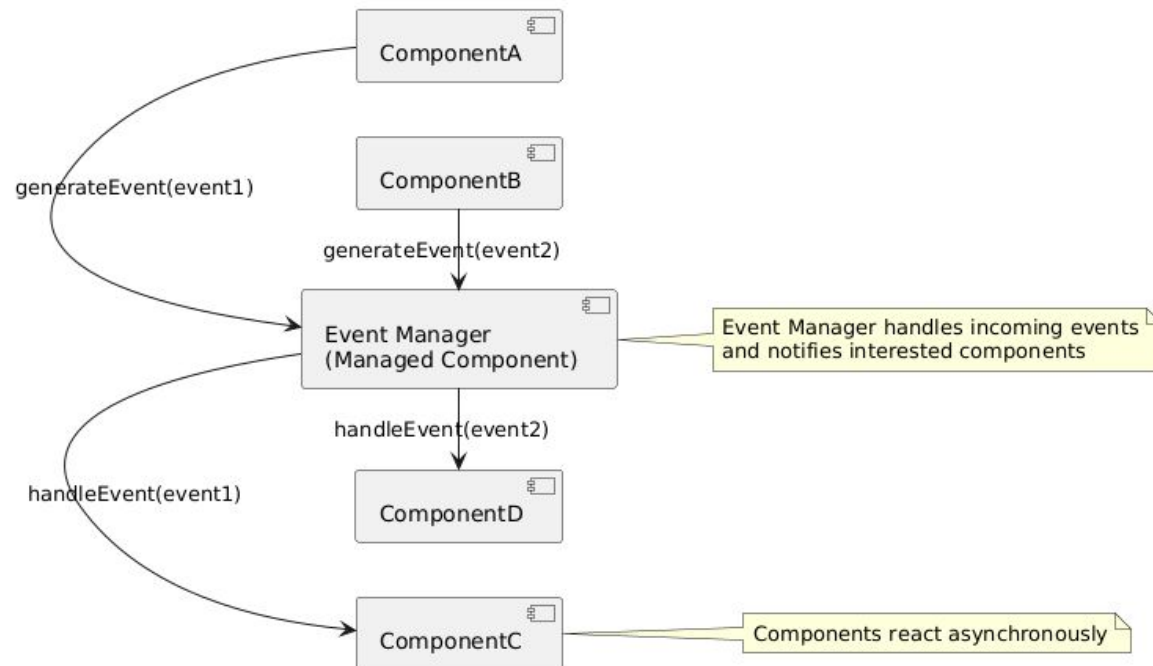


EVENT NOTIFICATION

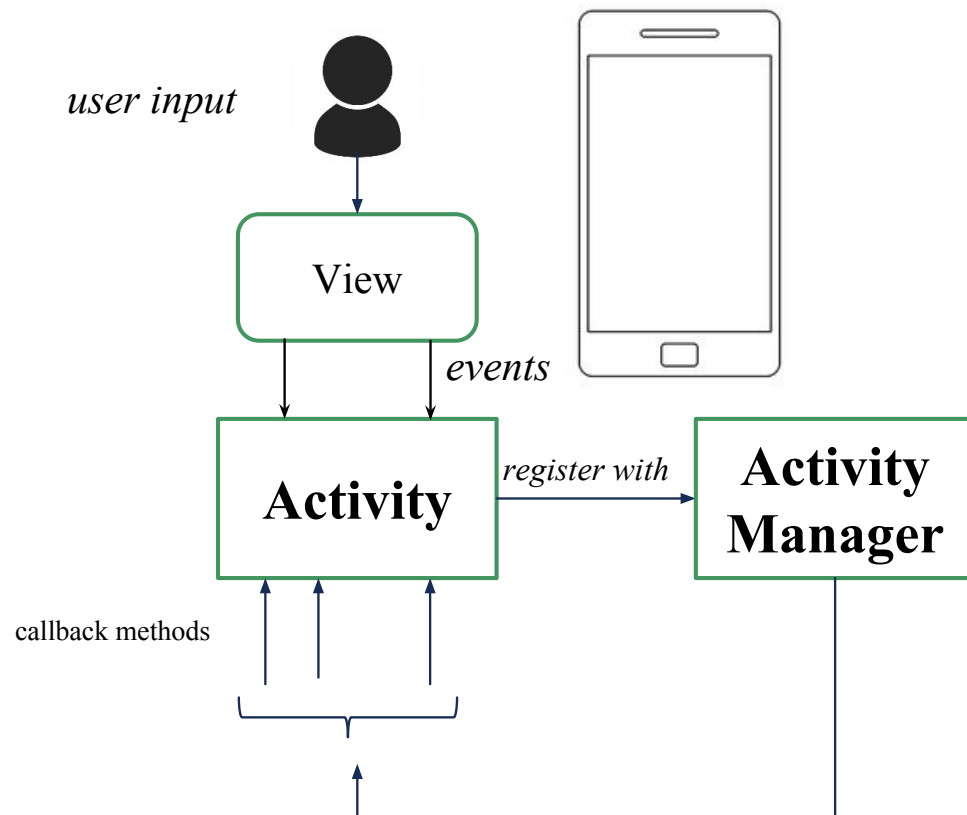
- Passive component that reacts only to events (sometimes called event-handler)
- Foundation of event-driven programming
- The component is dormant until the event occurs (we say it is a **managed** component)
- Needs for a surrounding software
- Android: All android sw is event-driven
 - UI sw that updates visual components when events (e.g, touch)



EVENT NOTIFICATION



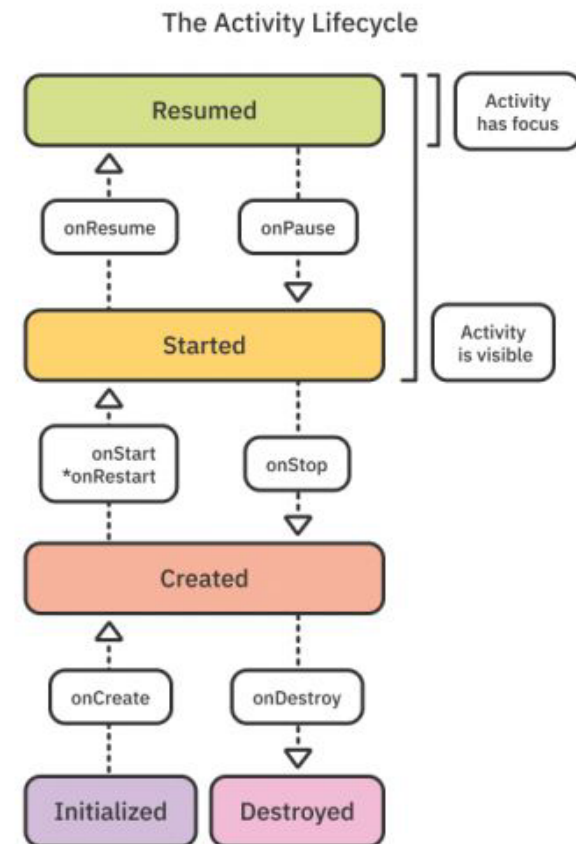
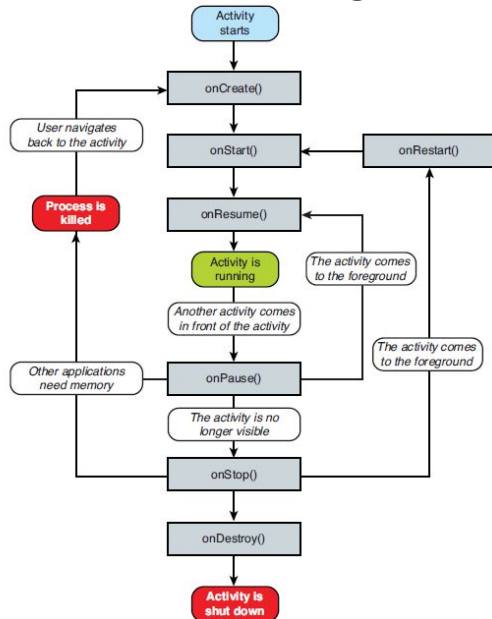
EXAMPLE OF COMPONENT IN ANDROID



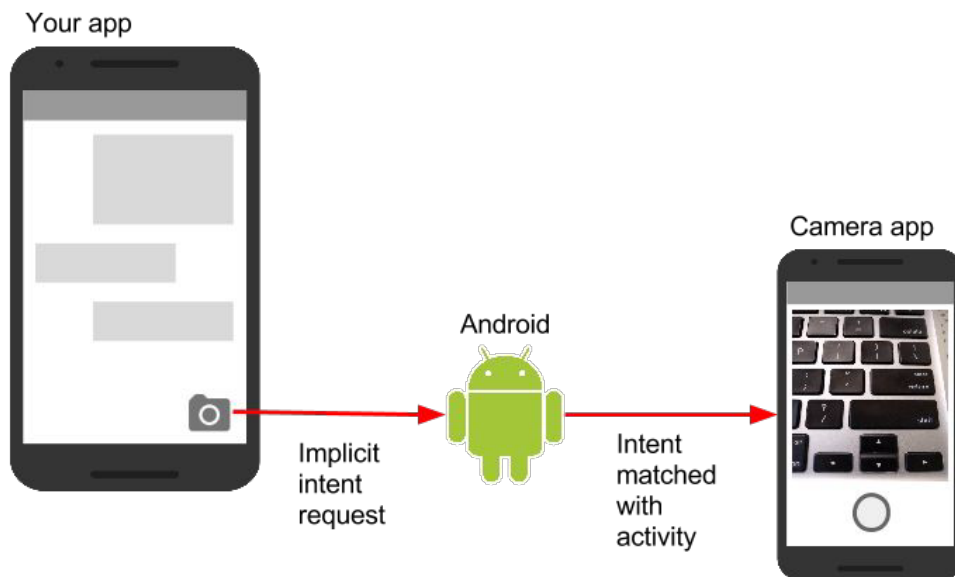
- An **Activity** is a fundamental software component in any Android application that reacts to events, either generated by the Android framework or by other components.
- Each Activity responds to a set of predefined events (inherited from its base class) by implementing **callback** methods (*onCreate()*, *onResume()*...).
- In addition, it registers itself with a system manager and declares which system-wide events it can handle.
- These events are communicated through special messages called **Intents**.

EXAMPLE: ACTIVITY LIFECYCLE

- A managed component in general has a state and reacts differently based on the current state
- The state may change when an event occurs
- The state diagram describes the lifecycle of the component

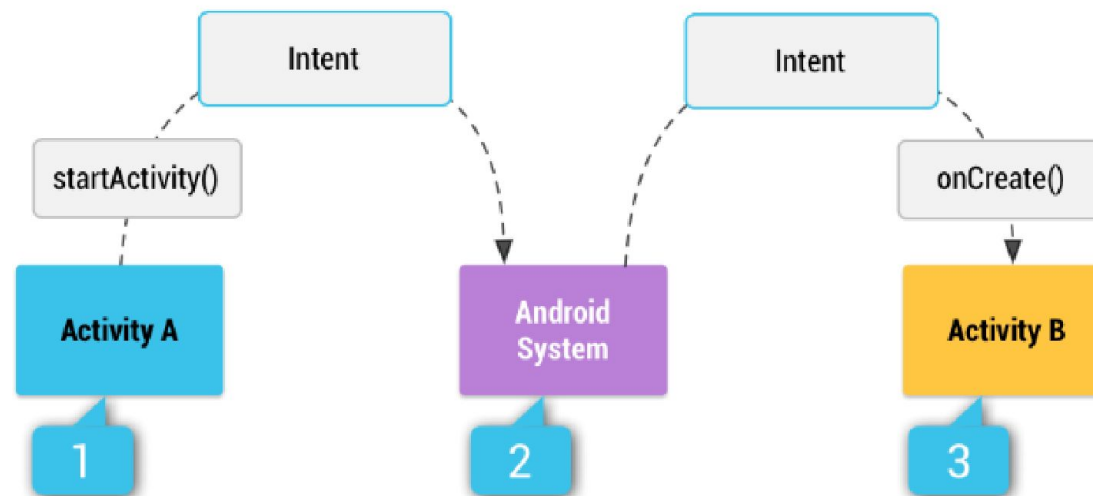


EXAMPLE: INTENTS IN ANDROID



- Implicit Intents are asynchronous messages without a specific destination, carrying a description of the action that the receiving component should perform when process the Intent.
- At registration time, an Activity declares its capabilities to perform specific actions (into the manifest file) and can therefore become eligible for Intents that require those capabilities.
- Intents are not confined to a single application but are system-wide, so other applications can also respond to them.
- They are the glue that integrate another application in the normal navigation flow of the current one

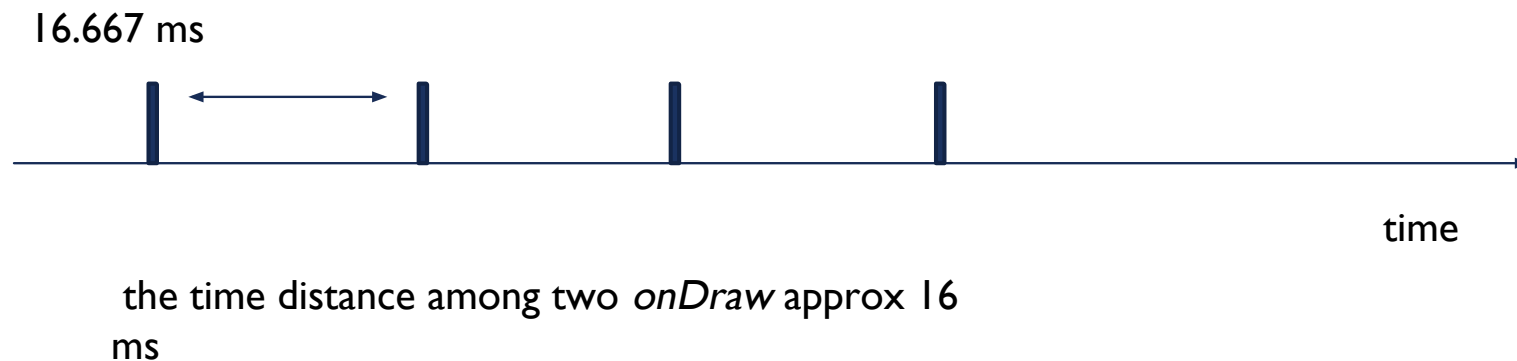
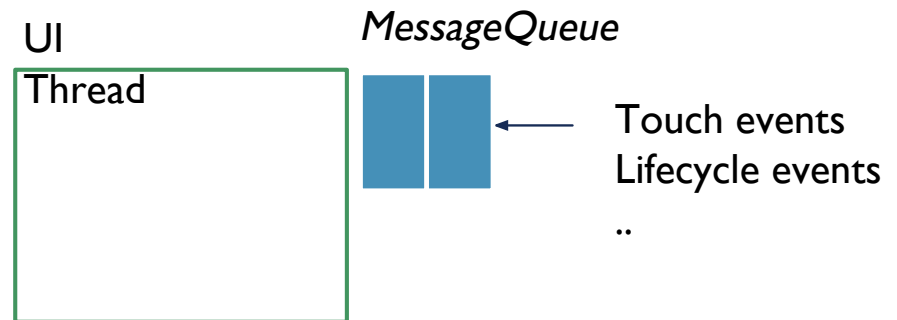
INTENT: BASE CASE



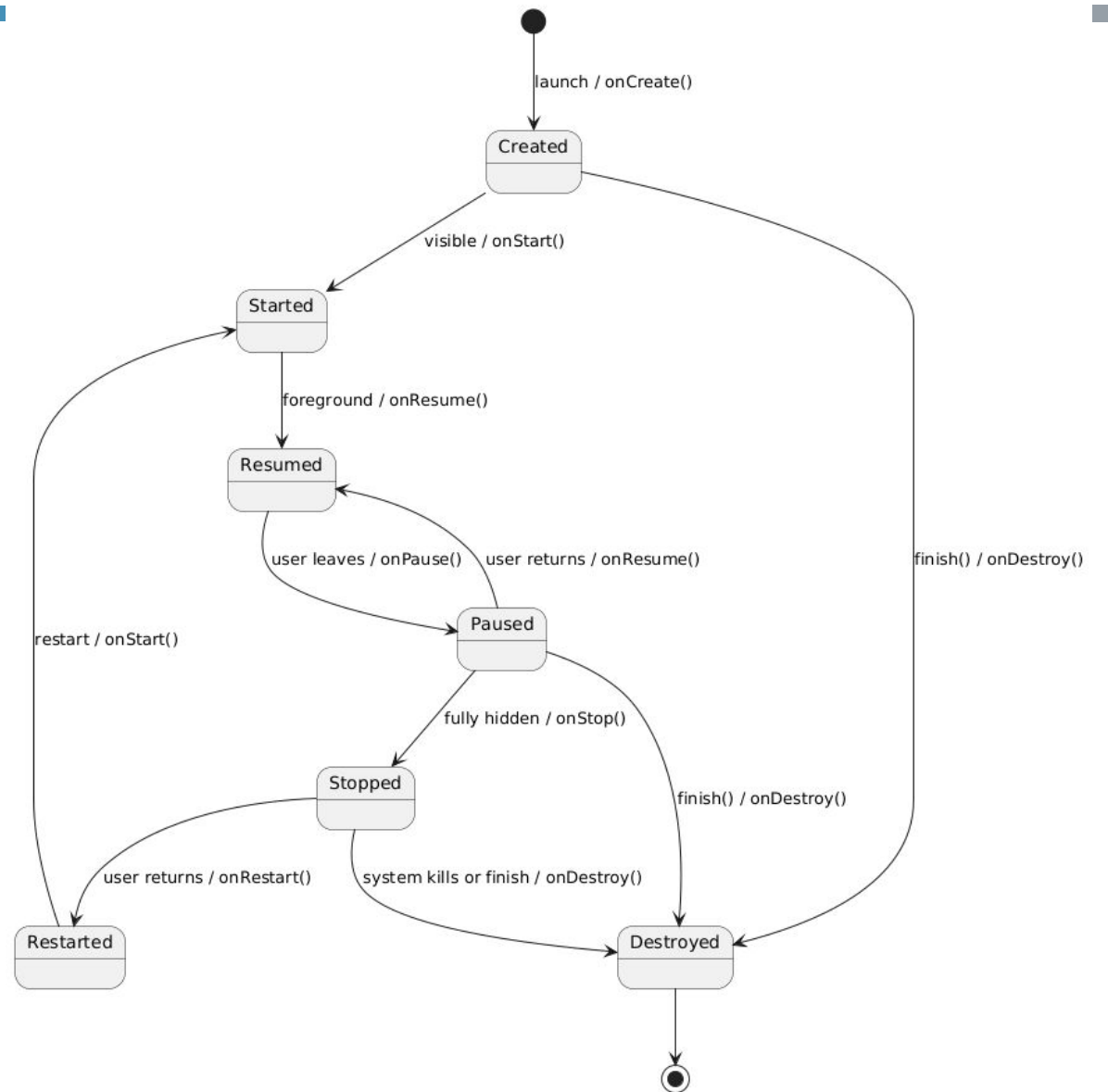
1. A Creates the intent and calls `startActivity` with a reference to B
2. The 'android system' checks if such an Activity is installed
3. The 'android system' calls the B's `onCreate` method

EXAMPLE: VIEW UPDATES

- The software inside an activity runs on a thread, called **UI thread** or **main thread**
- This software includes handlers of touch events, that are dispatched through a message queue
- View updates is done by an *onDraw* method called every approx. 16.7 ms, which provides a refresh rate of 60 Frame per Second (FPS)



Android Activity Lifecycle (State diagram)



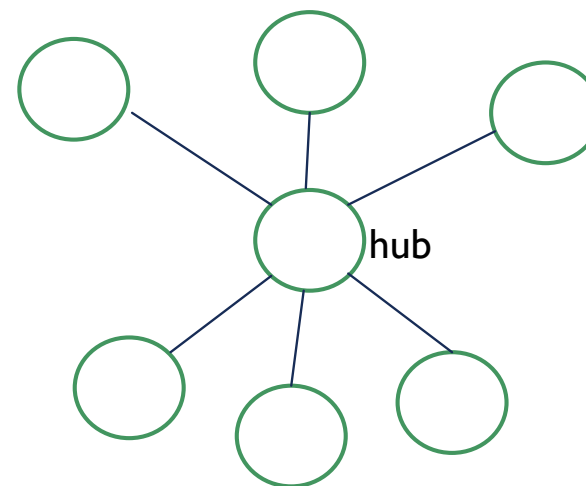
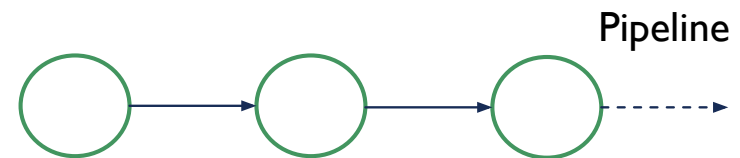
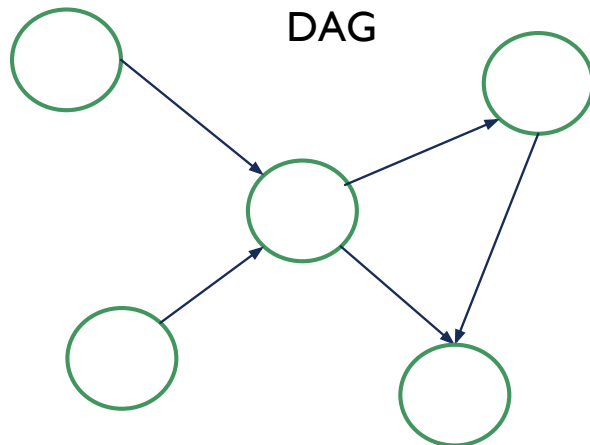
COMPUTATIONAL GRAPH

- Basic interaction patterns can be composed into **computational graphs**
- Nodes = components
- Edges = interactions
- Graph types:
 - Linear pipeline
 - Hub
 - DAG (with branches and joins)

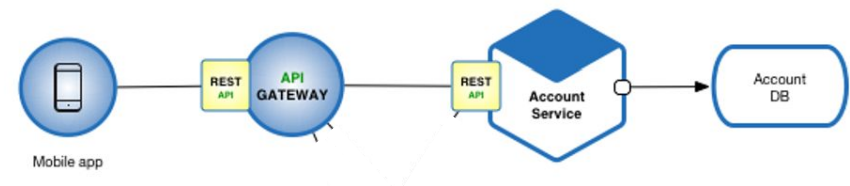
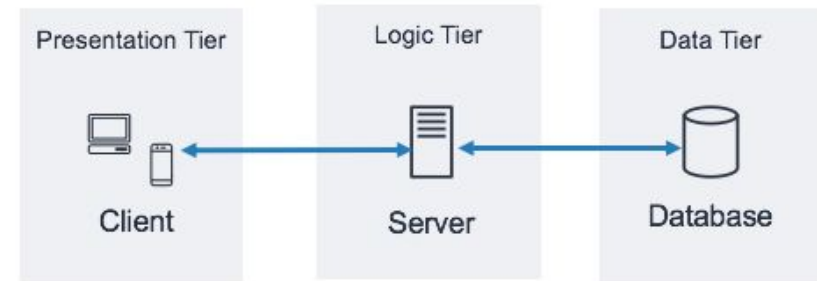
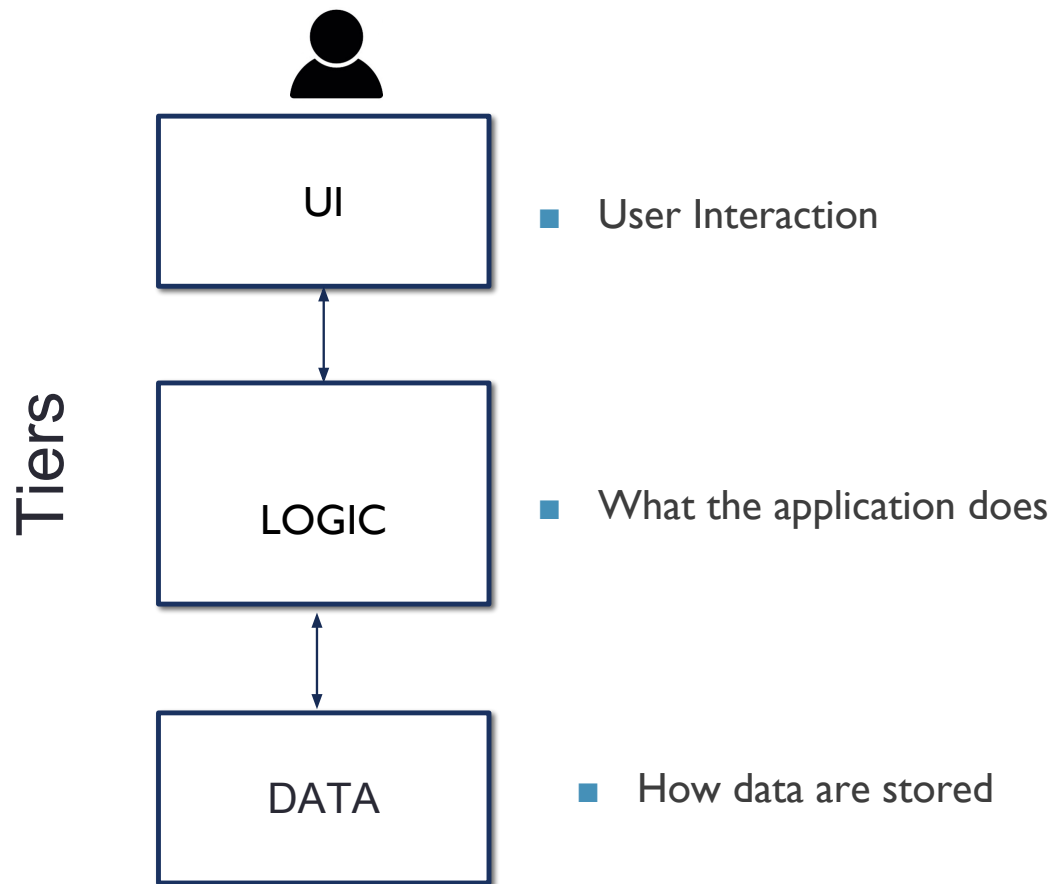
COMPUTATIONAL GRAPH

- Graph types:

- Linear pipeline
- Hub (star topology)
- DAG with branches and joins

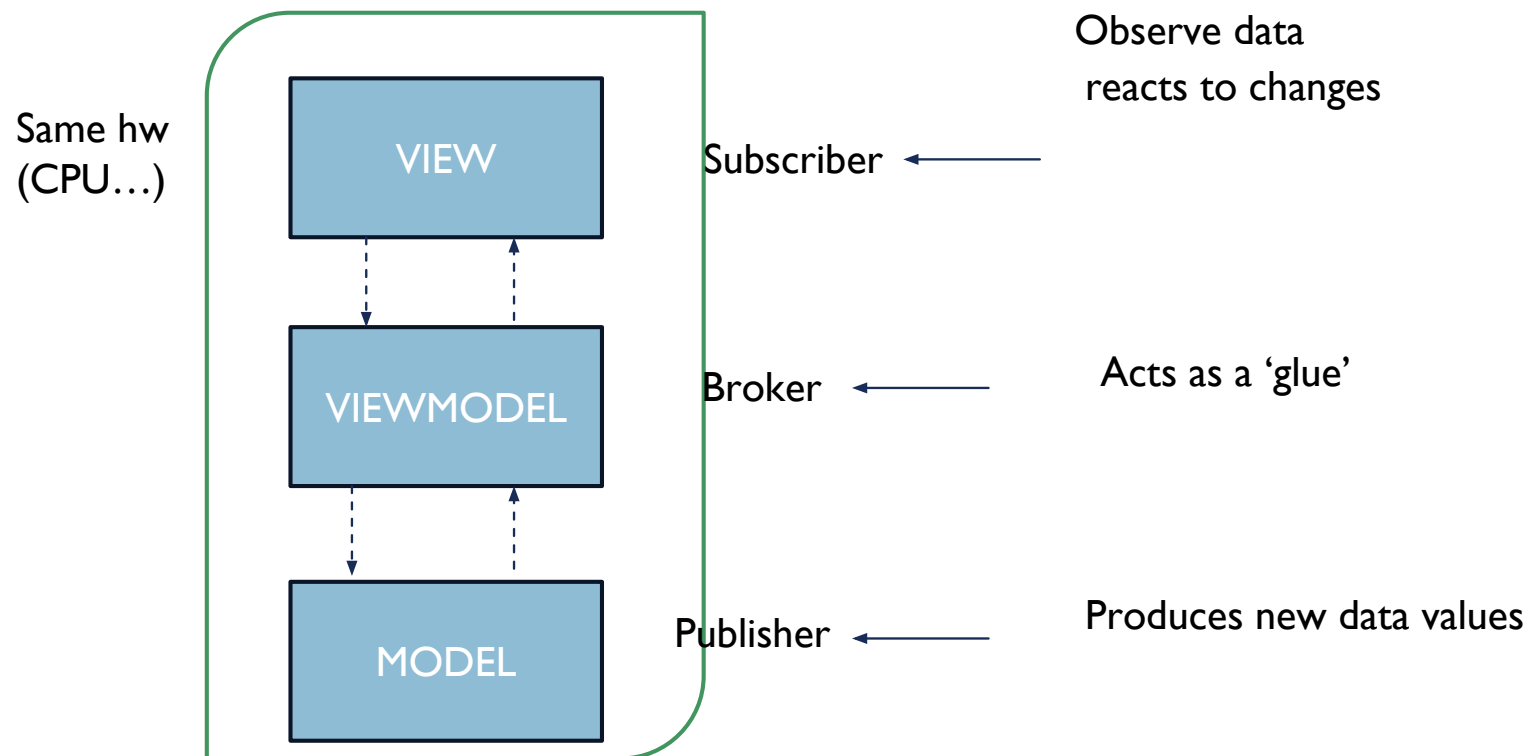


EXAMPLE OF LINEAR COMPUTATION GRAPH

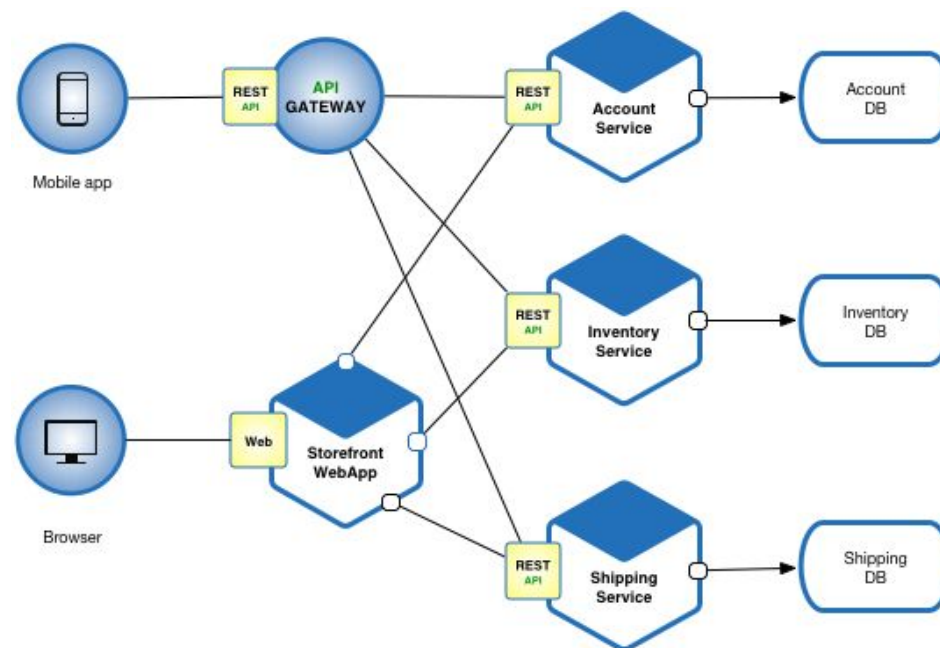


EXAMPLE: MODEL-VIEW-VIEWMODEL (MVVM)

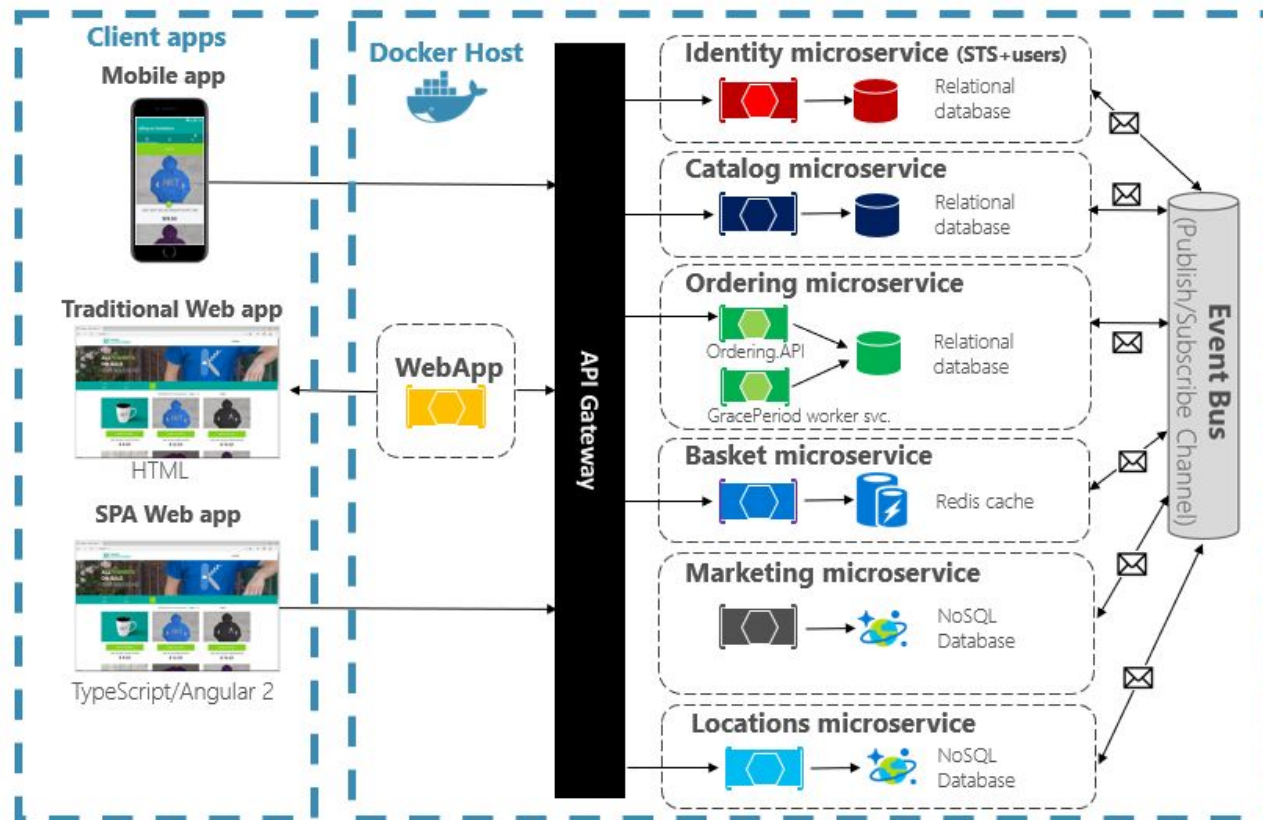
- This is a pattern suggested to organize the software of an android app, which is based on a pub/sub interaction pattern



HUB



GENERAL GRAPH

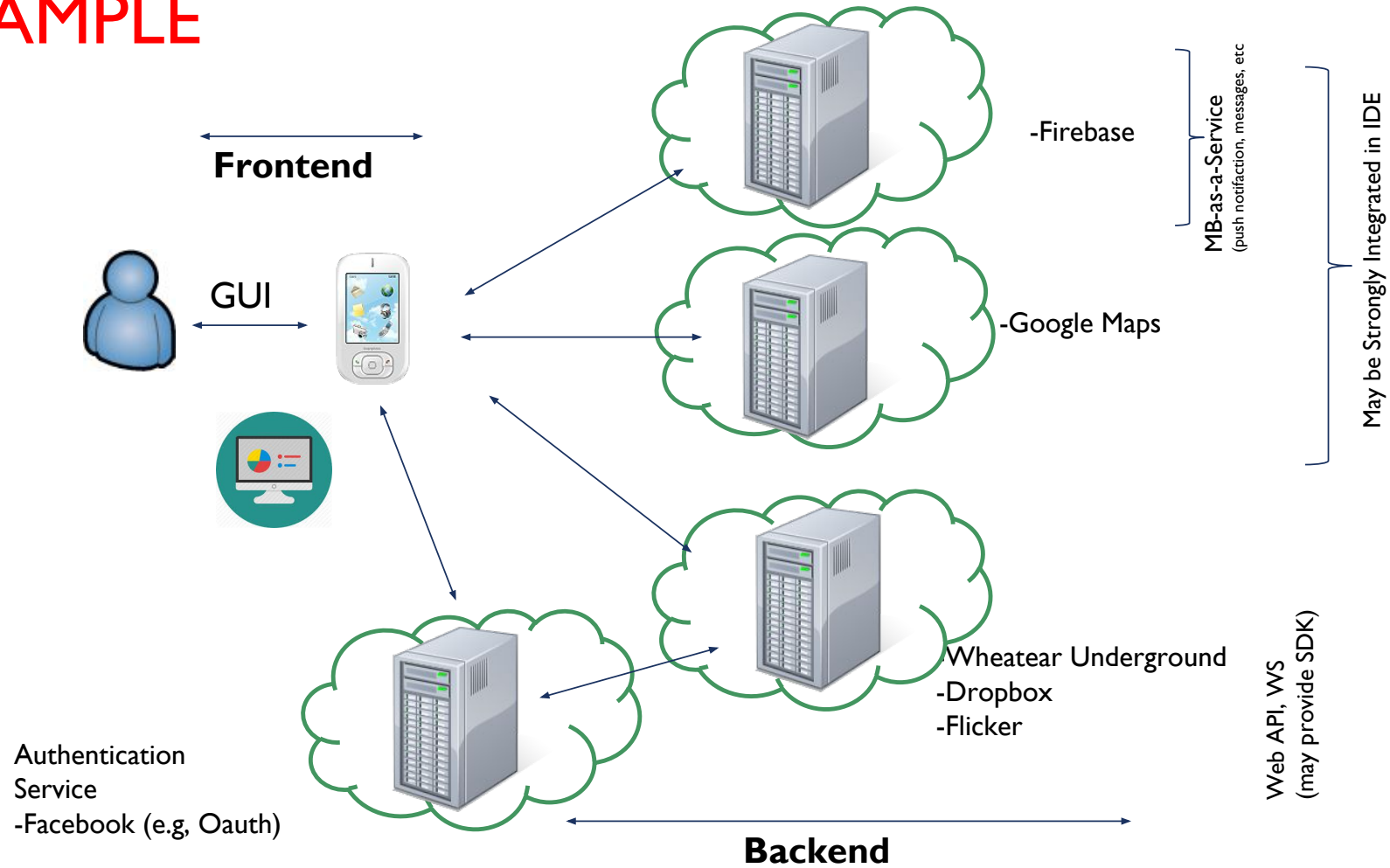


SPA=Single Page Application

SOME TERMINOLOGY

- **Cloud-native applications:** applications where the computational graph run enterally on cloud **and** are made of small loosely coupled components that can easily scale
- **Cloud Backend services:** components that run o cloud as support to applications running elsewhere
 - mobile Backend as a Service (mBaaS)
- **Lift & shift:** An application that usually runs on-premises and it is moved almost unchanged to run on a cloud

AN EXAMPLE



ANOTHER EXAMPLE

