Software Architecture — Project Assignment

杨磊 sely@scut.edu.cn
洪翊翔 550291063@qq.com

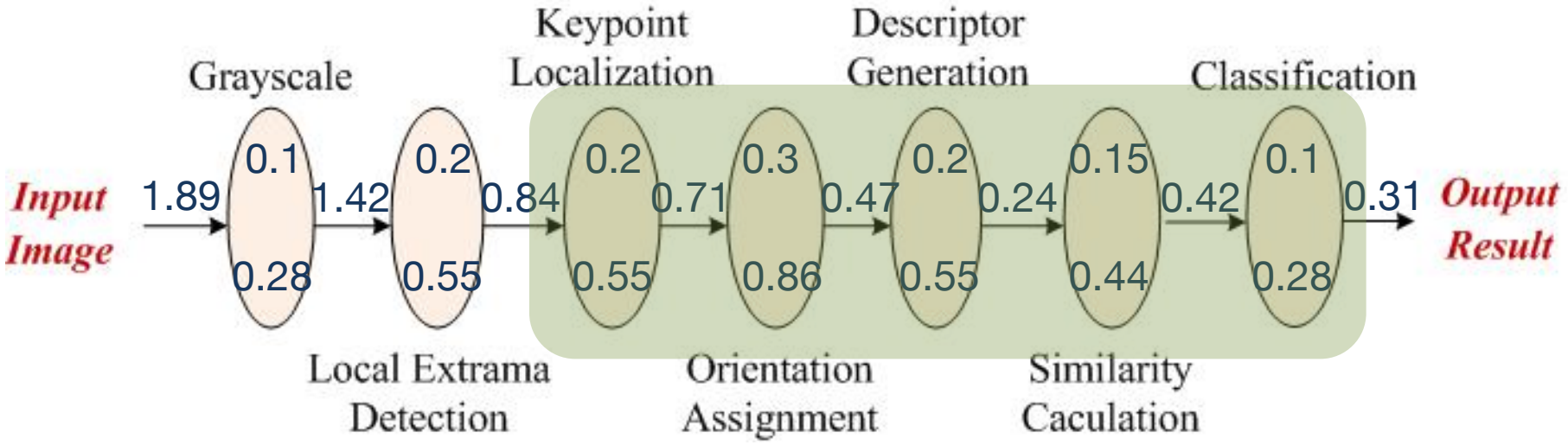
Background

- **Performance**
  - **Scheduling**
- **Allocation Structure**
  - **Module to file**
  - **Module to hardware resource**
  - **Module to human resources**

Computation Partitioning

- **Computation partitioning decomposes application software into a set of modules, and decides which modules are executed locally, and which parts are offloaded onto the remote server or cloud**

1. Computation Partitioning
a simple example

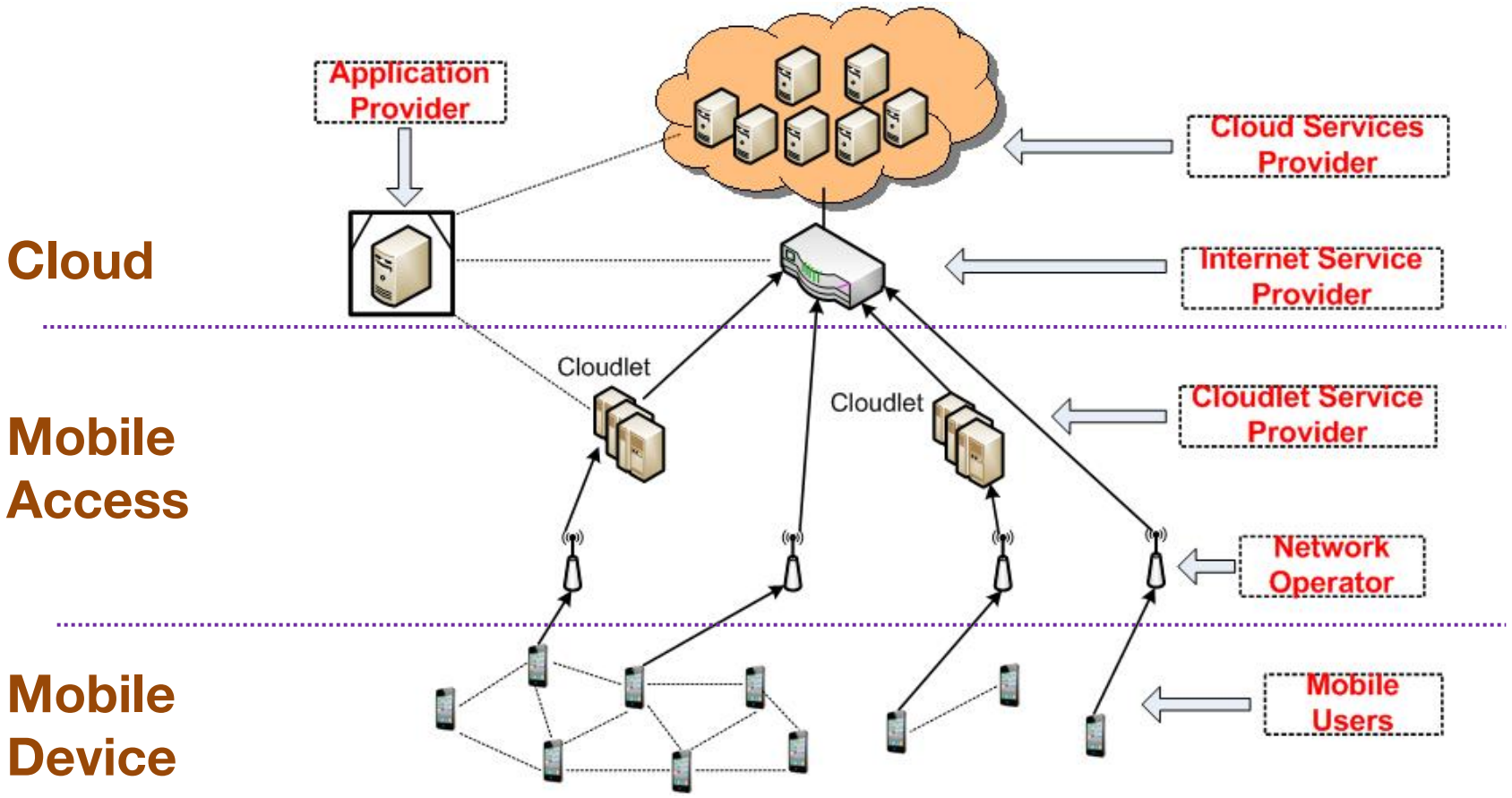


Optimal Partitioning 0.28 + 0.55 + 0.84 + 0.2 + 0.3 + 0.2 + 0.15 + 0.1 + 0.31 = 2.93

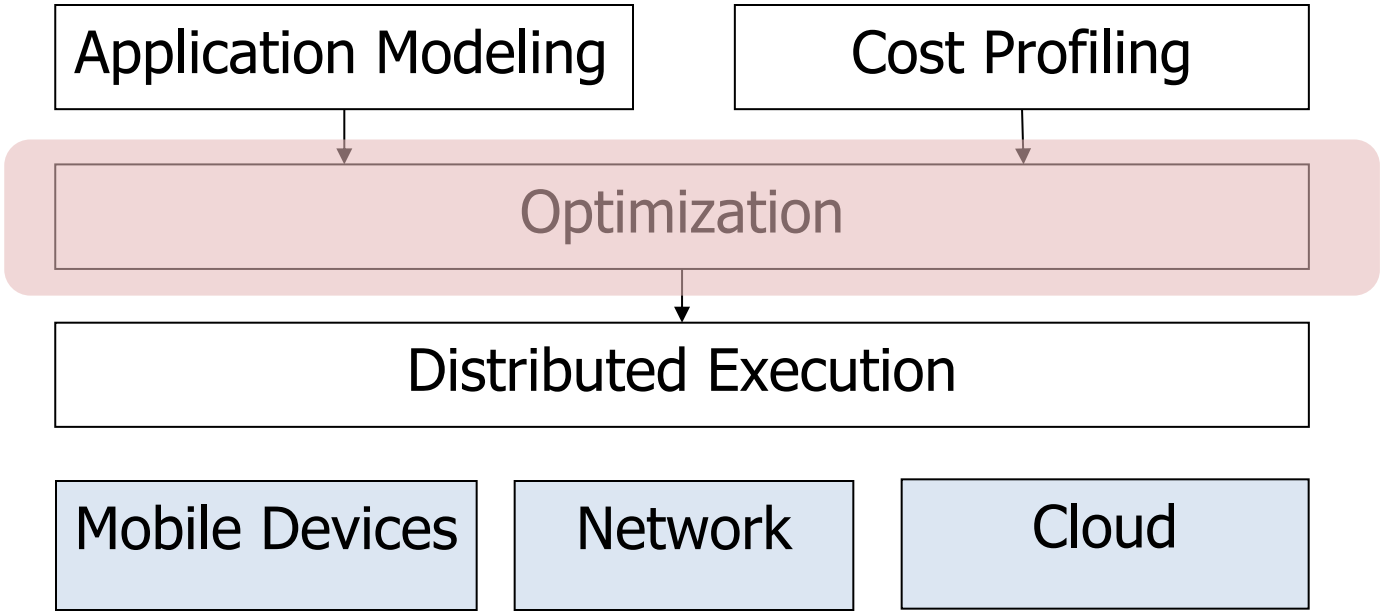
Local Execution: 0.28 + 0.55 + 0.55 + 0.86 + 0.55 + 0.44 + 0.28 = 3.51

Remote Execution: 1.89 + 0.1 + 0.2 + 0.2 + 0.3 + 0.2 + 0.15 + 0.1 + 0.31 = 3.45

MCC System Model

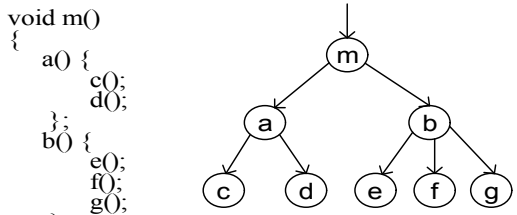


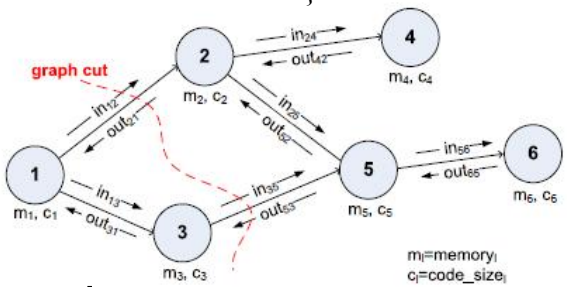
Issues in Computation Partitioning

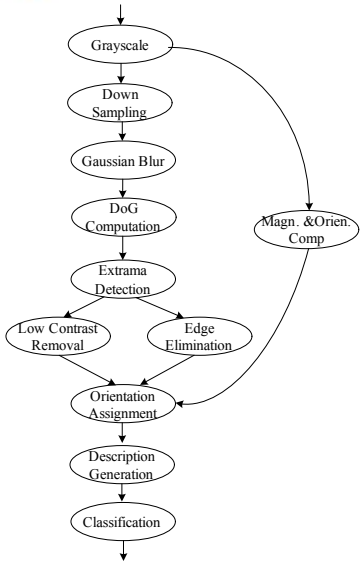


Application Modeling

- How to represent the structure of application: 3 major approaches
  - Procedure calls
    - Application: a set of procedures
    - Function-centric & synchronous
  - Service invocation
    - Application: a service invocation graph
    - Message-centric & asynchronous
  - Dataflow
    - Application: a directed acyclic graph
    - Edge represents the flow of data; Node is the processing function onto the data







Cost Modeling

- Estimate the execution cost of each component in the application and weigh the cost of offloading against the potential gain
  - Execution cost can be measured by one or the weighted summation of the following metrics:
    - execution time (local and remote)
    - energy consumption
    - data transferred over the network
- Profiling is an approach to collecting and estimating the cost of application components
  - Prediction-based profiling
  - Model-based profiling

Optimization

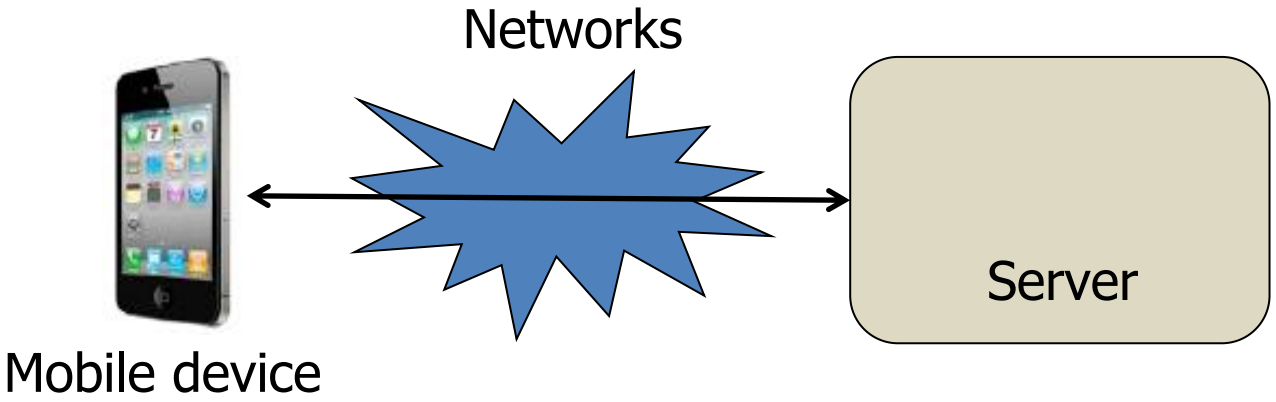
- Obtain optimal partition of the computation - can be solved either *online* or *offline*
  - Online optimization solves the optimization on the fly for each execution of an application.
  - Offline optimization calculates the optimal partitions under different device and network status in offline phase
    - Search the most matched partition given the measurements of the device and network status
    - Avoid the overhead of solving optimization, but need abundant offline test cases
- Optimization can be solved at the *mobile side* or *cloud side*

Distributed Execution

- Execute the partitioned computation components over mobile devices and cloud fabric.
- **Two execution approaches**
  - Client server communication method
  - Virtual machine/container migration

Client Server Communication

- RPC and RMI
- Require pre-installation on servers, and prone to network disconnection

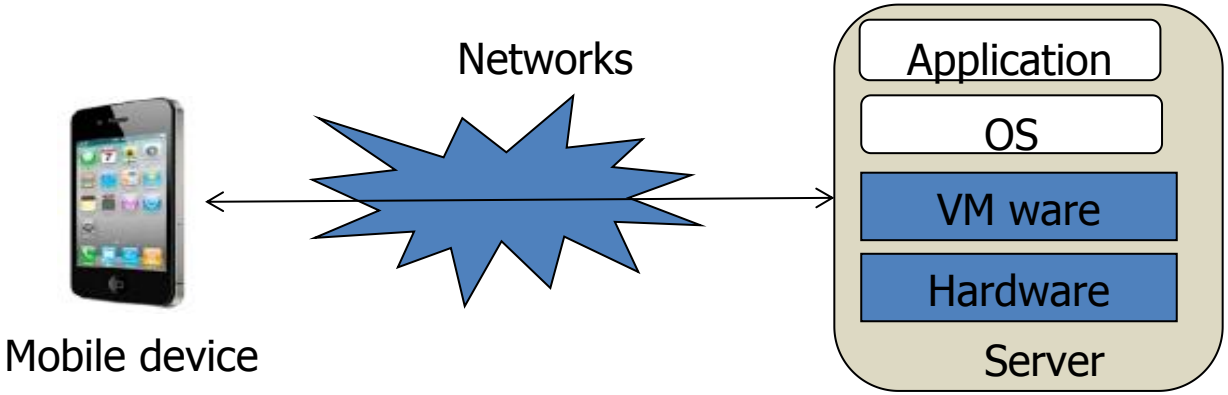


- **e.g., Spectra [1], Chroma[2]**

[1] J.Flinn. Balancing performance, energy, and quality in pervasive computing. ICDCS'02
[2] R. Balan. Tactics-based remote execution for mobile computing. Mobisys'03

Virtual Machine Migration

- Do not need pre-installation on clouds
- Code changes are not required for execution on clouds
- Using VM Migration is heavyweight
  - **e.g., MAUI [1], Cloudlet [2] , CloneCloud[3], ThinkAir [4]**



[1] Maui: making smartphones last longer with code offload. MobiSys'10
[2] Clonecloud: elastic execution between mobile device and cloud.EuroSys'11
[3] The case for VM-basedcloudlets in mobile computing, IEEE Pervasive Computing 2009.
[4] ThinkAir: Dynamic resource allocation and parallel execution in cloud for mobile code offloading. Infocom'12

References

1. Optimizing the performance of dataflow applications in throughput
   - "A framework for partitioning and execution of data stream applications in mobile cloud computing". *IEEE SIGMETRICS PER 2013*.
2. Optimizing the performance of workflow application in execution time
   - "Run Time Application Repartitioning in Dynamic Mobile Cloud Environments", *IEEE Trans. On Cloud Computing, 2016*

Project Assignment

- **Part A** Select one mobile application to implement and test its performance on the mobile device. The selected application should be compute-intensive and latency sensitive. Examples include but are not limited to:
  - hand gesture recognition,
  - face recognition,
  - image based object recognition,
  - augmented reality,
  - OCR and etc.

Project Assignment

- **Part B** Please analyze the module structure of the application, and try to partition the modules between the mobile device and a remote server (or cloud). Test the performance of the application under various partitioning, and show via experiments what are the factors and how do they impact the performance of application.
- **Part C** Based on the test results above, try to develop a system/component that supports the dynamic partitioning of the application in the run time.

Score Criterias

- Required to finish at least part A and B
  - Part A: 60 points; Part B: 90 points; Part C: 100 points.
- Final deliverables for scoring
  - Final Report (60%)
  - Demonstration (40%)

Final Report

- Content of the final report should include:
  - **Title** 标题
  - **Abstract** 摘要
  - **Introduction** 引言
  - **[Main Body]**: application; performance metric and measurement; computation partitioning; system design, architecture; 正文
  - **Experiments and results**: state the experiment purposes, environment settings, and results with figures or tables 实验
  - **Conclusions** 结论
  - **References** 参考文献

Final Report

- ***The module structure*** of the application should be included in your report
- ***Measure the application performance*** under as many settings as possible, i.e., different partitioning, network connections (WiFi or 4/5G), bandwidth, mobile devices, or input data
- Beyond the experiment results, ***what are the insights*** you want to provide
- If Part C is finished, the ***component-and-connector structure*** the system is required

Demonstrations

- Each group has ***6 minutes*** to demonstrate the system and results
- Design the demonstration procedures, and make sure it ***proceeds smoothly and logically***
  - A checklist indicating what you will demonstrate is required
- Debugging the demonstrations at least ***10 times*** in advance, and make sure ***no failures occur***

两次线下报告

	时间	内容
开题报告 （Confirmation Report）	2025年10月30日 第9周周四，9-12节 地点：B7-133	展示课题的研究背景及意义、选择的应用程序及模块结构
中期报告 （Mid-term Report）	（提交报告文档）	展示应用程序的不同划分方式；以及以不同划分方式执行的性能
终期答辩 （Final Defense）	2025年12月18日 第16周周四，9-12节 地点：B7-238	完成项目内容的汇报以及系统的演示，重点展示计算划分方案对应用程序执行性能的影响以及动态计算划分的实现

Time Schedule

- Send group information to 550291063@qq.com on 20**/Oct/2025**
  - 所有小组成员姓名和学号，组长的**Email**和手机
- Each group submits a *confirmation report to the* email 550291063@qq.com on **29/Oct/2025**. The report shows what application you select to implement, and the module structure of the application source codes.
- Each group submits a *mid-term progress report* by 23**/Nov/2025** via emails
- Each group submits the *Final report* and *source code* via emails by **16/Dec/2025**. (不接受晚交的作业)
- *Demonstration* is arranged on 18**/Dec/2025**.