JOINT INSTITUTE
交大密西根学院

Capstone Project: VMware#1-AR in Data Centers

Design Review #3

Group 21
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Instructor
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Sponsor & Mentor
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Team Introduction

Leader

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Senior
ECE

Member

Chenyun Tao
Senior
ECE

Member

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ECE

Member

Yaxin Chen
Senior
ECE

Member

Jinglei Xie
Senior
ECE

Contents

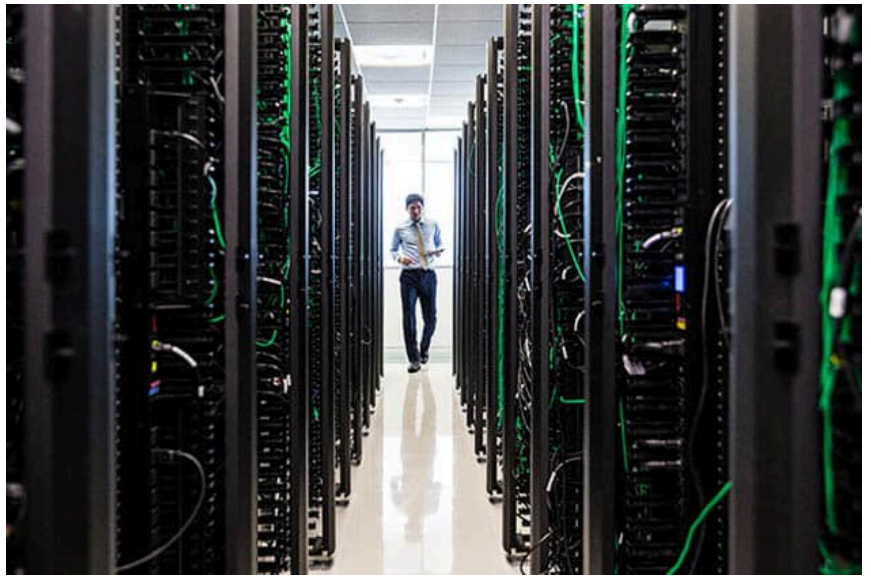
- Introduction
- Engineering Design Analysis
- Final Design Description
- Implementation & Current Progress
- Demonstration & Plan

Contents

Problems & Needs in Data Centers (DC)

Maintenance and audits

- Do not have **integrated** information system
  - Need an **integrated system** that involves all the information together
- Lack **user-friendly** instructions
  - Need a more **user-friendly** tool for instructions and information access

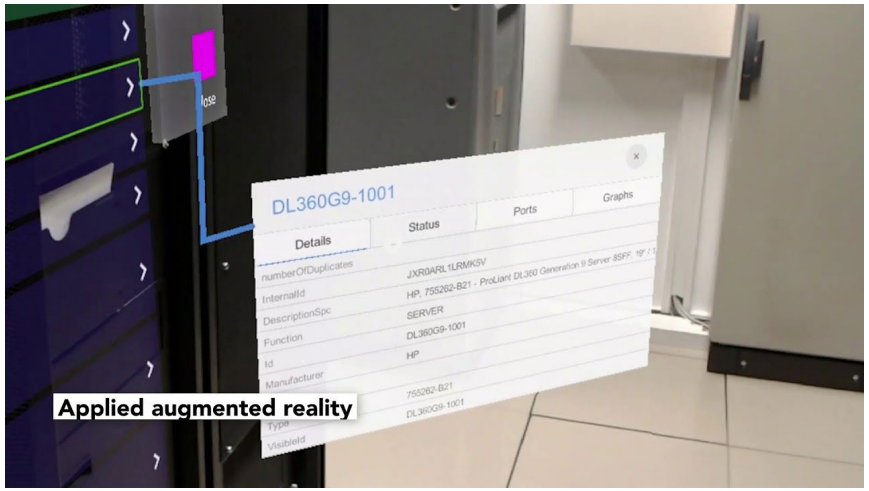


www.cisco.com

Project Goal

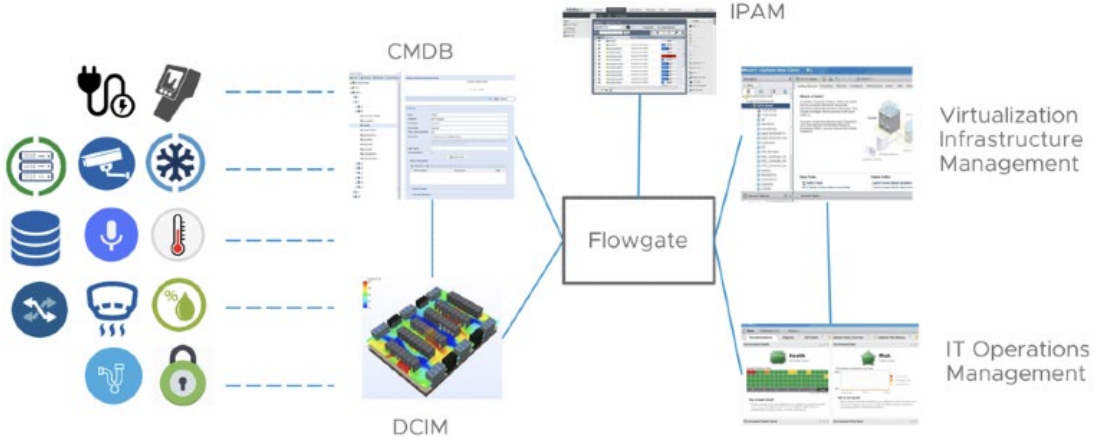
An Augmented Reality (AR) App
for aiding on-site DC maintenance & audit

- **Front-end: AR**
  - A user interface to display the information vividly



www.youtube.com/watch?v=1Pe028PjQhs

- **Back-end: Flowgate**
  - An integrated system containing all necessary information of DC



https://github.com/vmware/flowgate

Customer Requirements (CR) & Engineering Specifications (ES)

CR: Short Reaction Time

ES:

- Barcode localization & identification: < 0.55s [1]
- Database query complexity: O(log(n))
- AR image generation: < 0.1s [2]

CR: Portable Device

ES:

- Platform: Android 7.0+ / iOS 11.0+ [3]
- Light: >= 40lx [4]
- Software package size: < 110MB for Android / < 940MB for iOS [5]

[1] E. Ohbuchi, H. Hanaizumi and L. A. Hock, "Barcode readers using the camera device in mobile phones," *2004 International Conference on Cyberworlds*, Tokyo, Japan, 2004, pp. 260-265, doi: 10.1109/CW.2004.23.
[2] A. Baek, K. Lee, and H. Choi, "CPU and GPU parallel processing for mobile Augmented Reality." 2013.
[3] https://developers.google.com/ar/discover/supported-devices & https://developer.apple.com/documentation/arkit
[4] L. Blom, "Impact of light on augmented reality." Diva Portal. 2018.
[5] https://play.google.com/store/apps & https://www.apple.com/app-store

Customer Requirements (CR) & Engineering Specifications (ES)

CR: Information Correctness
ES:

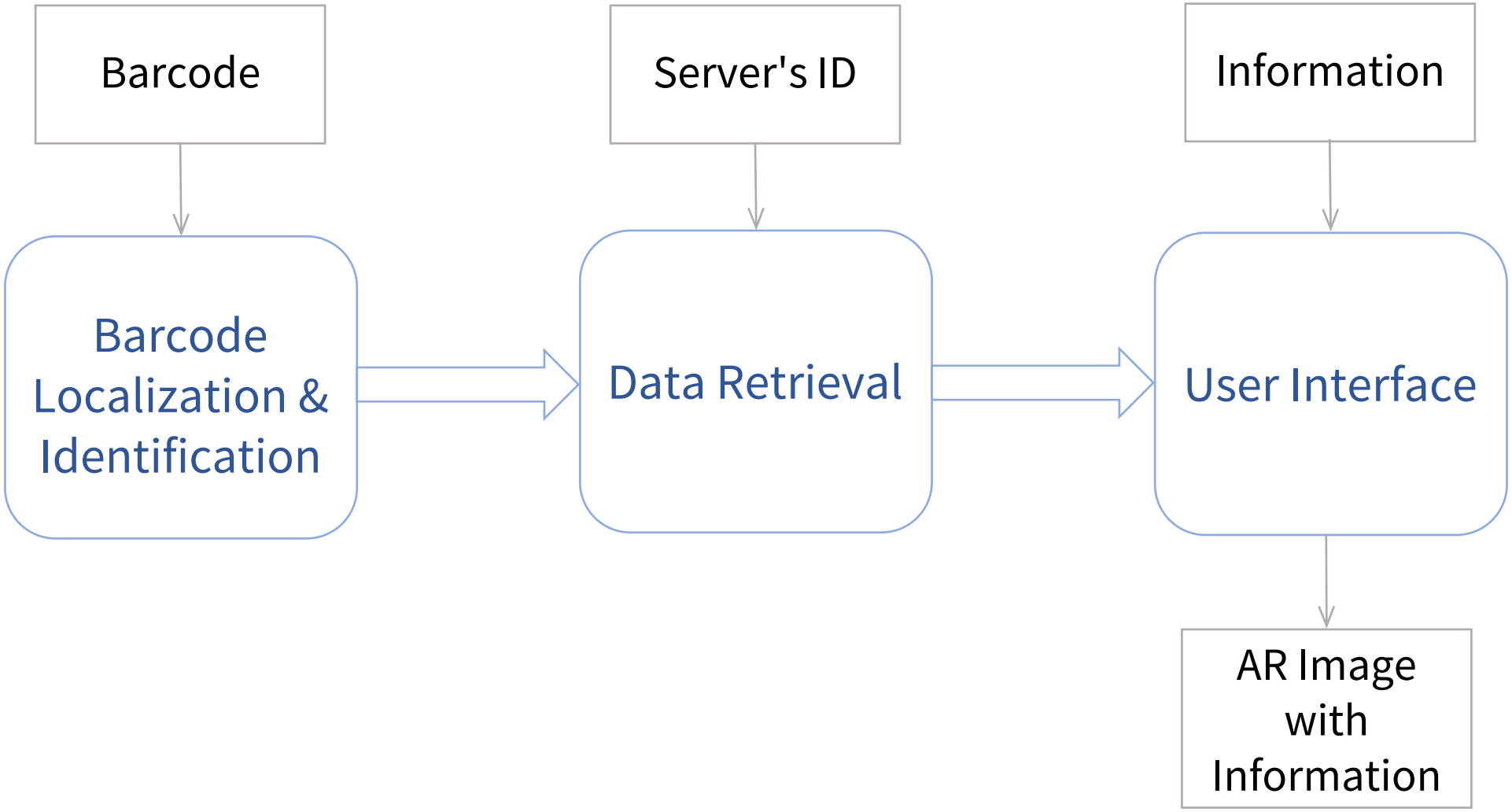
- Barcode localization correctness: > 90% [1]
- Data retrieval accuracy: > 99% [2]

CR: Comfortable Display
ES:

- Frame rate: > 15 frames/s [3]
- Sensible temperature of device: < 40 °C [4]

[1] O. Oktay et al., "Stratified Decision Forests for Accurate Anatomical Landmark Localization in Cardiac Images," in IEEE Transactions on Medical Imaging, vol. 36, no. 1, pp. 332-342, Jan. 2017, doi: 10.1109/TMI.2016.2597270.
[2] https://www.labce.com/spg650115_barcode_reading_and_accuracy.aspx
[3] A. Craig. Augmented Reality Hardware, pp. 69-124. 2013.
[4] https://support.apple.com/en-us/HT201678 & https://support.google.com/pixelphone/answer/9134668?hl=en

Concept Diagram



Contents

Barcode Localization & Identification

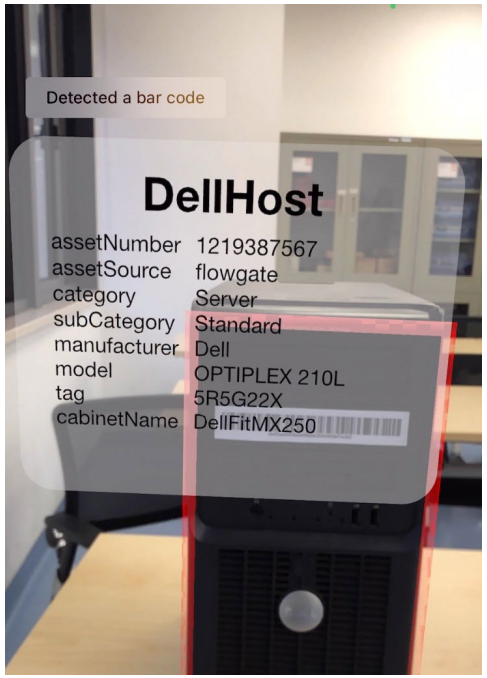
- **Barcode Localization & Identification**
  - Generated from ES & difficulty in implementation
- **How to choose software development kit?**

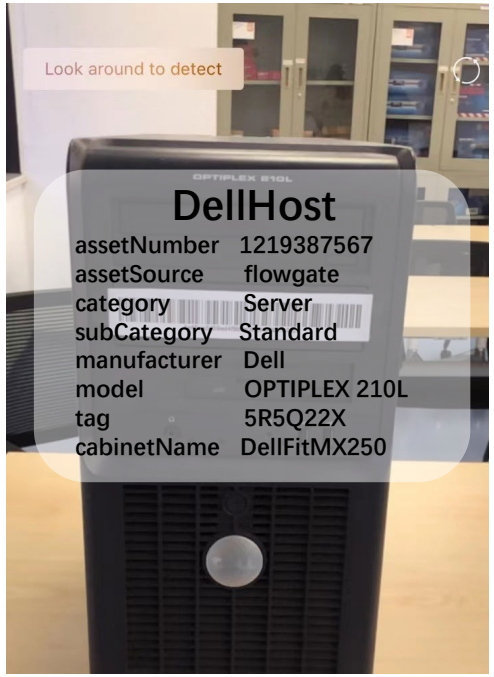
- **ZXing [1]**
  - Open source
  - Slow identification
  - Low accuracy
- **ML Kit**
  - Open source (Google)
  - Moderate speed
  - Moderate accuracy
- **Scandit**
  - Close source
  - Fast identification
  - High accuracy

[1] http://www.discoversdk.com/compare/scandit-_-barcode-scanner-sdk-vs-zxing

User Interface

- **User Interface**
- Generated from CR & survey about existing similar softwares
- **How to display information?**
  - Display in AR (3-D coordinate)
  - Display on screen (2-D coordinate)





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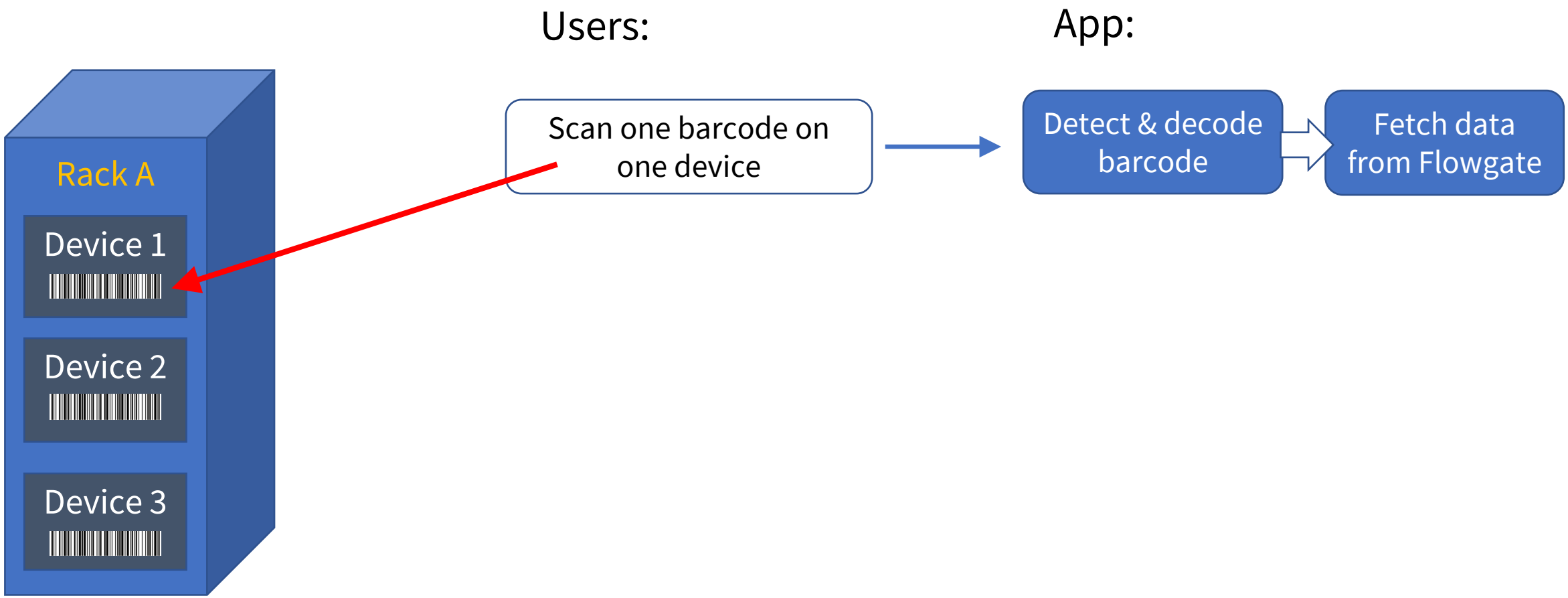
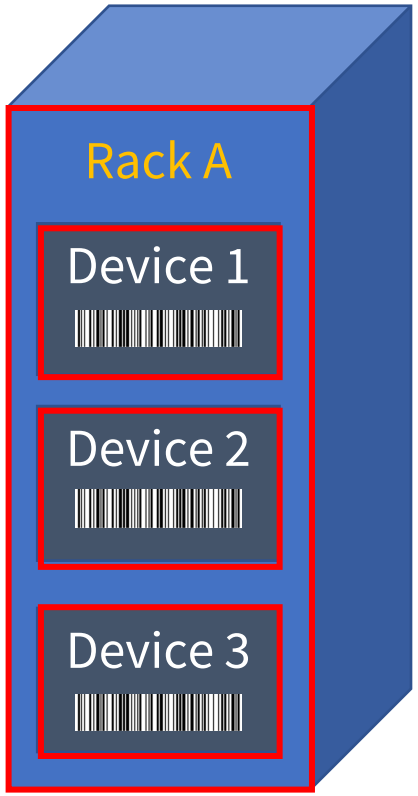
Final Design Workflow



Final Design Workflow



Users:

App:

Scan one barcode on one device

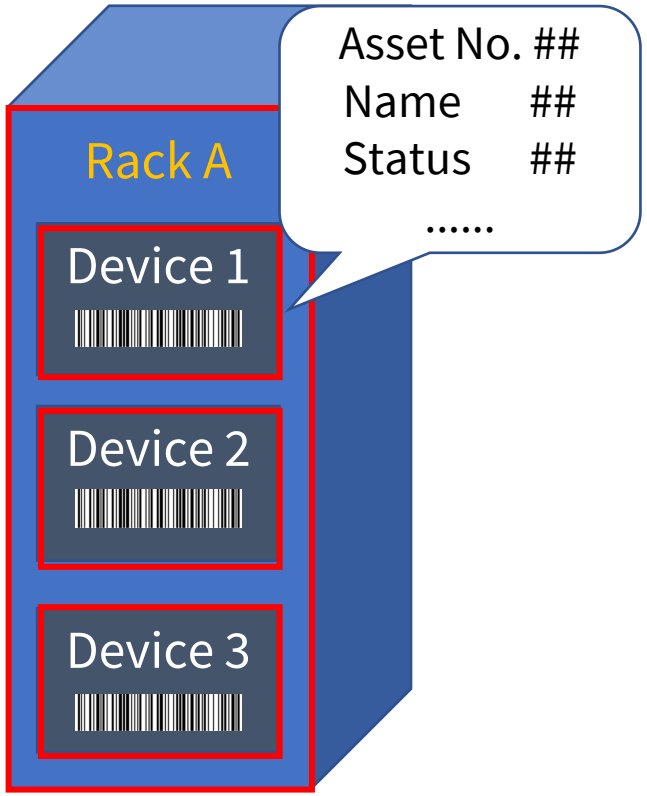
Step back to catch the whole view of rack

Detect & decode barcode

Fetch data from Flowgate

Show location of rack & device

Final Design Workflow



Users:

App:

Scan one barcode on one device

Step back to catch the whole view of rack

Step closer to maintain device with given info.

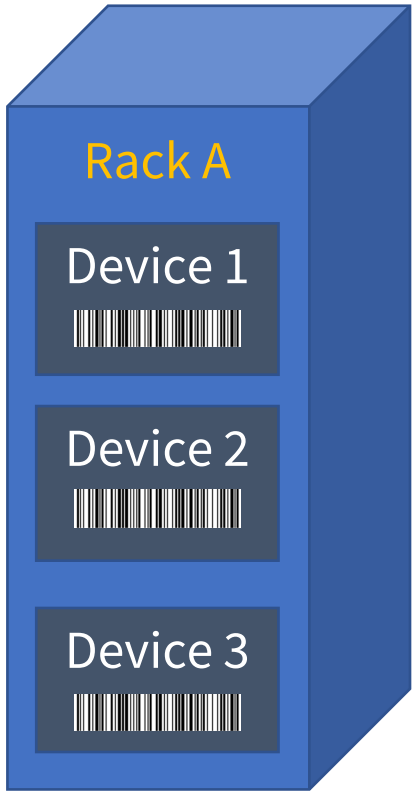
Detect & decode barcode

Fetch data from Flowgate

Show location of rack & device

Show data of device

Final Design Workflow



Users:

App:

Scan one barcode on one device

Step back to catch the whole view of rack

Step closer to maintain device with given info.

Finish.
Maintain another device

Detect & decode barcode

Fetch data from Flowgate

Show location of rack & device

Show data of device

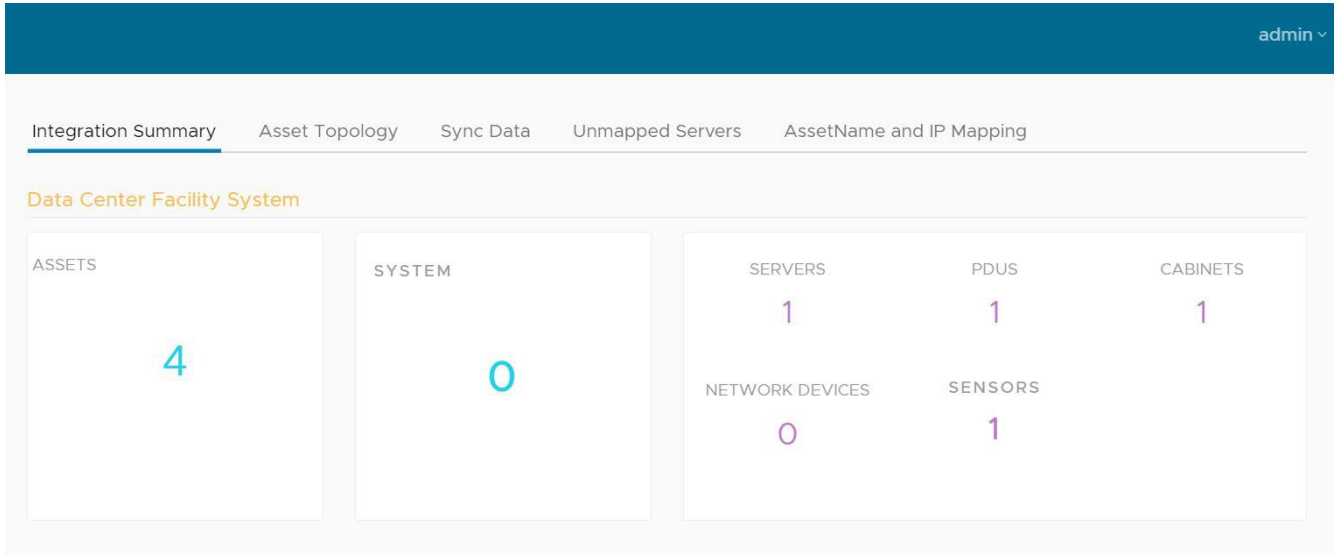
Initialize the app state

Contents

Steps of Implementation

Step 1
Configure backend server

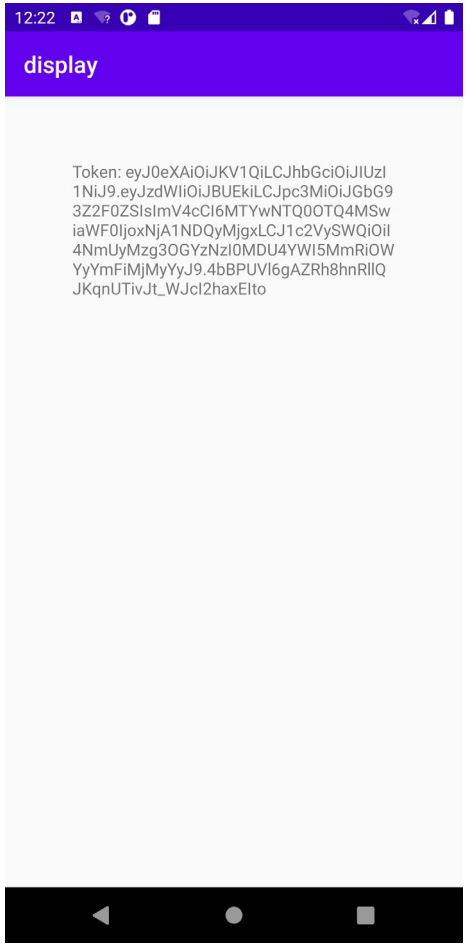
- Install flowgate server
- Create informations sets for data center assets



Steps of Implementation

Step 2-1
Implement data management functions using API

- Python (testing and asset mapping)
- Java (raw data retrieval in Android)
- Swift (raw data retrieval in IOS)



Steps of Implementation

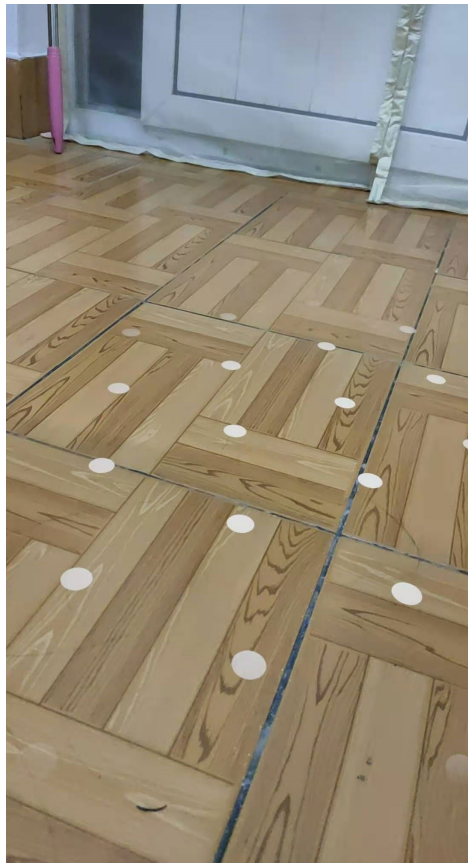
Step 2-2
Implement bar code scanning

- Read data strings from the bar codes

Steps of Implementation

Step 2-3
Implement simple AR apps (for testing)

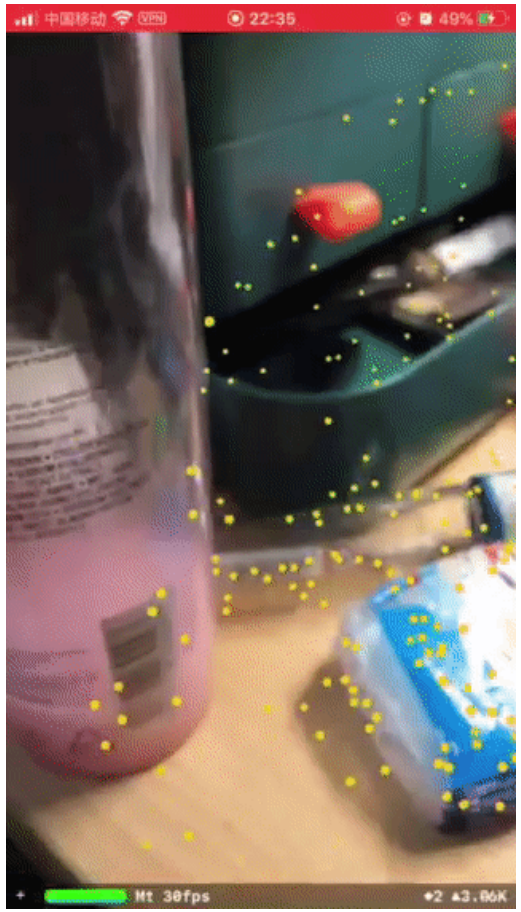
- Find a plane in the environment and place a textbox on it



Steps of Implementation

Step 3
Integrate AR with bar code scanning

- Scan the bar code and place the readings onto a 3D window



Steps of Implementation

Step 4
Integrate AR, bar code scanning and data retrieval

- Scan the bar code, retrive corresponding data from the backend server, and display the information onto a 3D window

Steps of Implementation

Step 5
Recognize devices in AR

- Recognize a device and mark it with a red rectangle in the AR interface

Steps of Implementation

Step 6
Recognize racks / cabinets in AR

Still in progress

- Recognize a rack / cabinet, mark it with a blue rectangle and display its corresponding information in the AR interface

Current performance

	Current performance	Requirement
Barcode localization & identification	≈ 1.5s (may occasionally have wrong reading in Android)	< 0.55s
Barcode localization correctness	≈ 98%	> 90%
AR image generation	< 0.1s	< 0.1s
Data retrieval accuracy	100%	> 99%
Frame rate	≈ 60 fps	> 15 fps
temperature	≈ 47 °C	< 40 °C

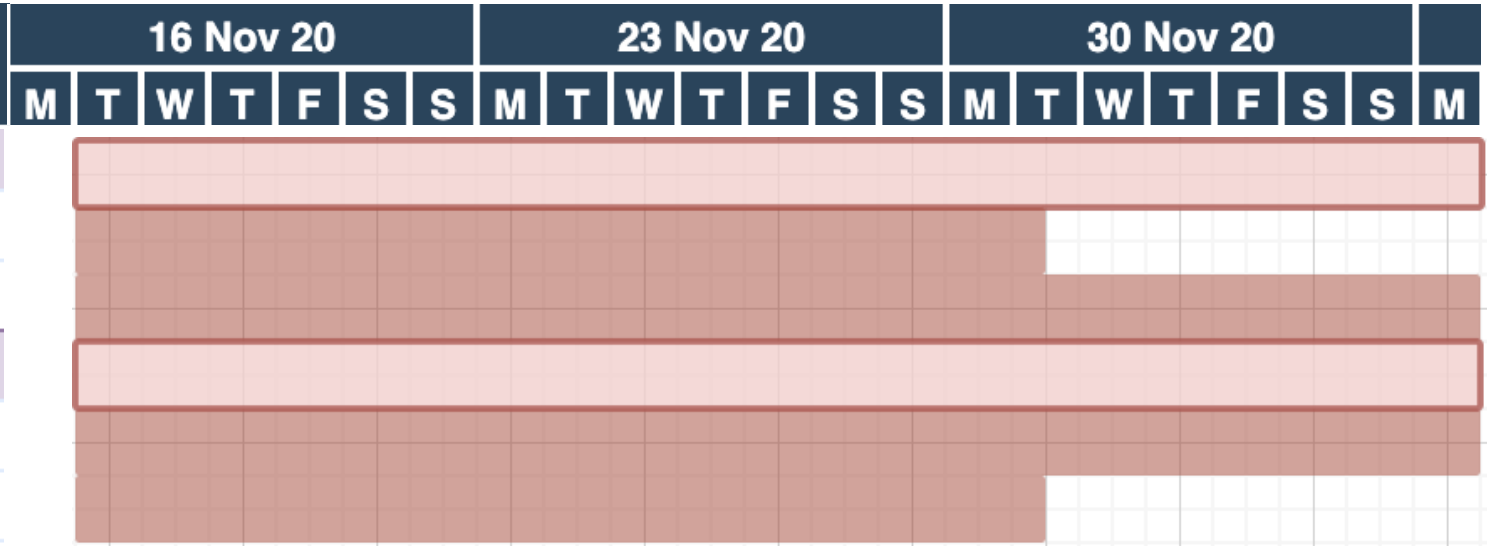
- CPU usgae: 116-134%
- Memory usage: ≈ 245MB

Contents

Future Plan

- **Manufacturing plan**

	Task Name
1.4	Good UX
1.4.1	Adjust the workflow
1.4.2	Be able to freeze the screen
1.5	Improve algorithm
1.5.1	Pause session to save CPU
1.5.2	Multiple cabinets/bar codes



Future Plan

- **Validation plan**
  - **test our program in real data center**
  - **multiple cabinets and multiple server bar code**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Q & A