JOINT INSTITUTE
交大密西根学院

Capstone Project: VMware#1-AR in Data Centers

Design Review #1

Group 21
Shuyi Zhou Liying Han Jinglei Xie
Chenyun Tao Yaxin Chen

Instructor
Mingjian Li
Sponsor & Mentor
Gavin Lu Yixing Jia

Team Introduction

Leader

Shuyi Zhou
Senior
ECE

Member

Chenyun Tao
Senior
ECE

Member

Liying Han
Senior
ECE

Member

Yaxin Chen
Senior
ECE

Member

Jinglei Xie
Senior
ECE

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Maintenance of Data Center (DC)

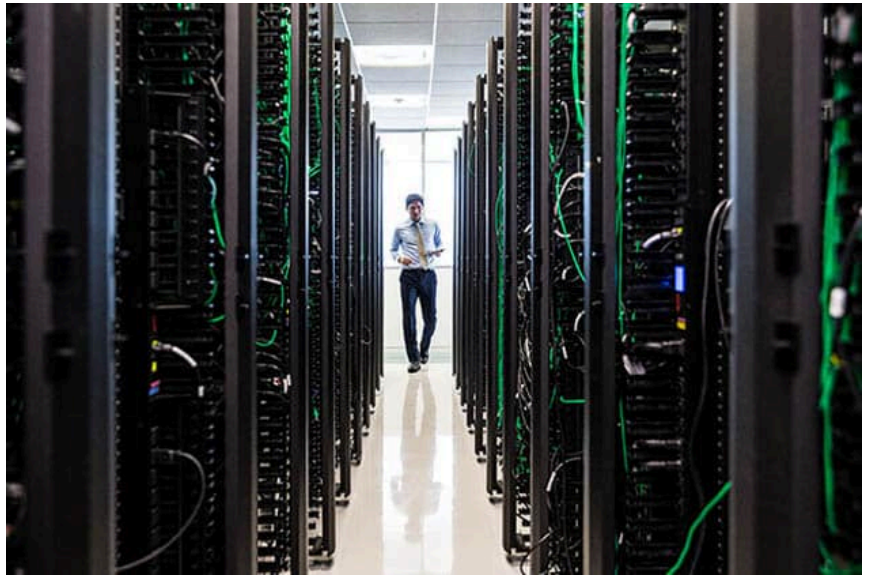
Data centers (DCs) :
requires reliability & availability

<u>Systems for DC maintenance [1]:</u>

- Monitor and control the energy usage of IT devices
- Monitor status of devices
- Store models and parameters of devices

<u>On-site operations:</u>

- Fix the problematic devices manually inside DC



www.cisco.com

[1] M. F. Abadi, F. Haghighat, and F. Nasiri, “Data center maintenance: applications and future research directions,” *Facilities*, vol. 38, no. 9/10, pp. 691–714, 2020.

Problems & Needs of On-stie Maintenance

- Do not have integrated information system
  - Structure of data center
  - Device model & parameters
  - Device status
  - Environment & power

- Lack user-friendly instructions
  - Complicated literal descriptions in manuals or documents

www.google.com/about/datacenters/gallery/

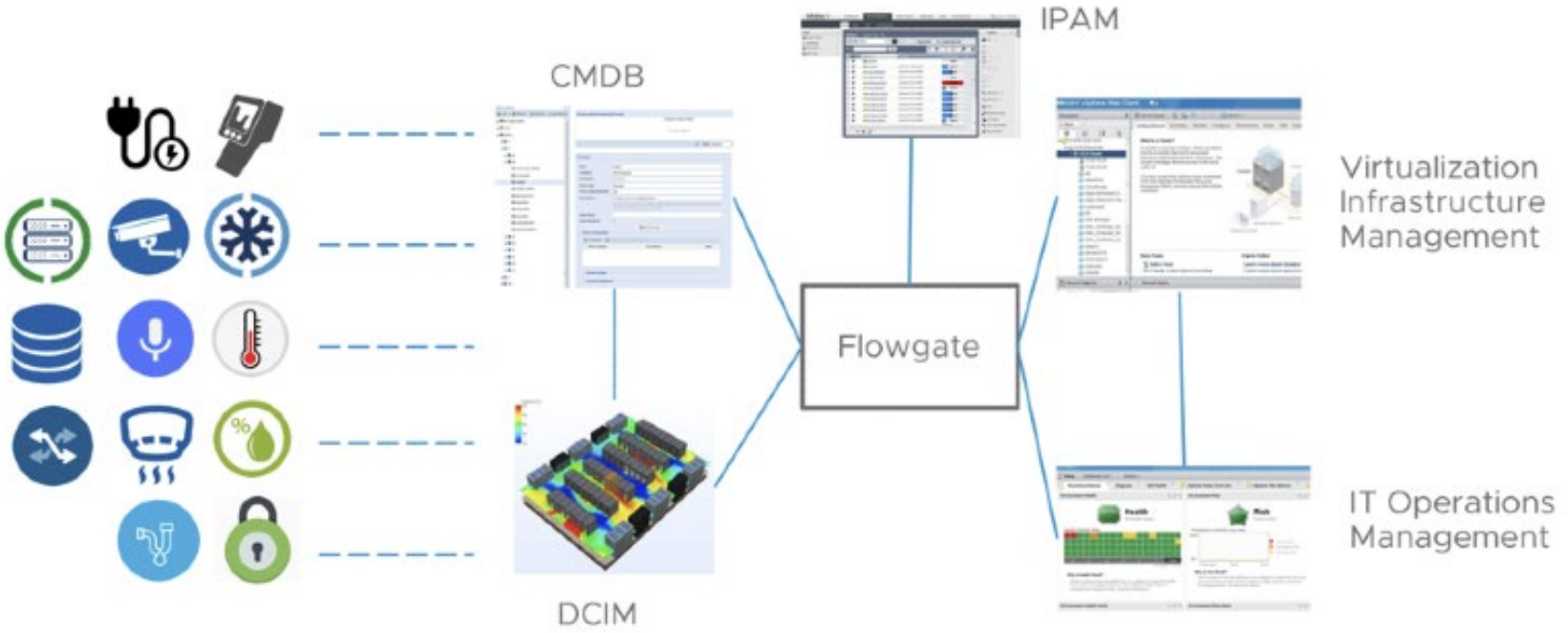
Problems & Needs of On-stie Maintenance

- Do not have integrated information system
  - Structure of data center
  - Device model & parameters
  - Device status
  - Environment & power
- Lack user-friendly instructions
  - Complicated literal descriptions in manuals or documents

- An integrated system that involves all the information together
- A more user-friendly tool to aid and instruct on-site maintenance work

Aiding On-site DC Maintenance: Back-end

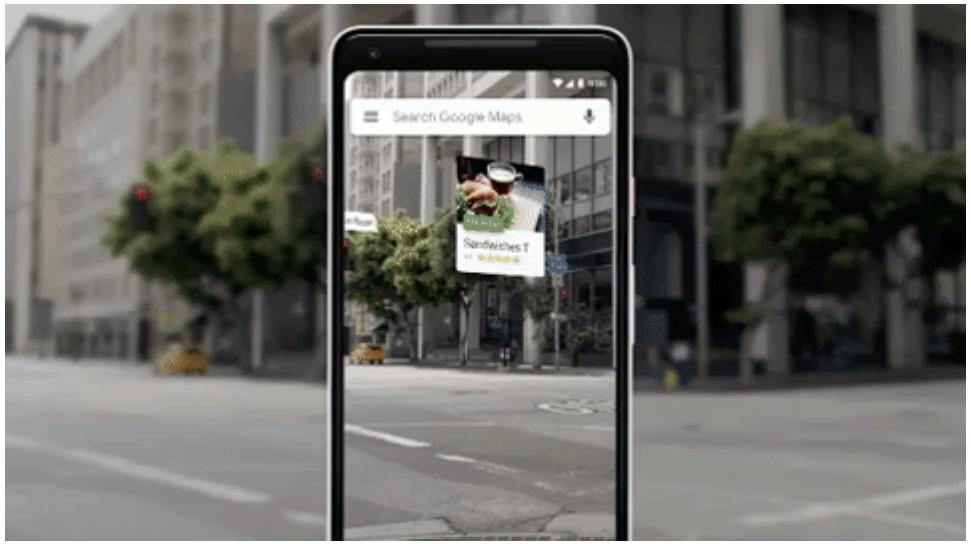
Data → Various data systems → FlowGate

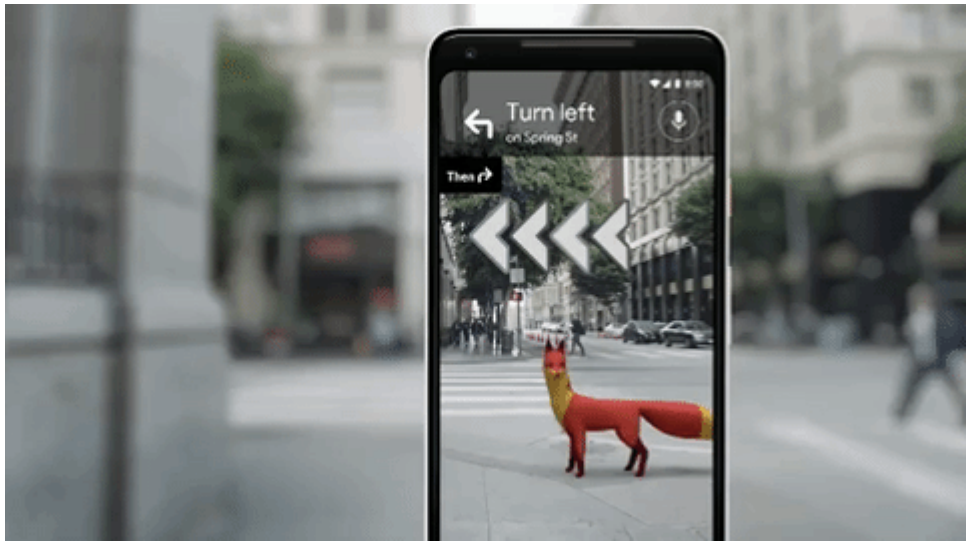


[1] Vmware. "Flowgate." GitHub. [Online]. Available: https://github.com/vmware/flowgate. Accessed: Sept. 27, 2020.

Aiding On-site DC Maintenance: Front-end

Augmented Reality (AR) = Information Generated By Computers + Real-World Scenarios



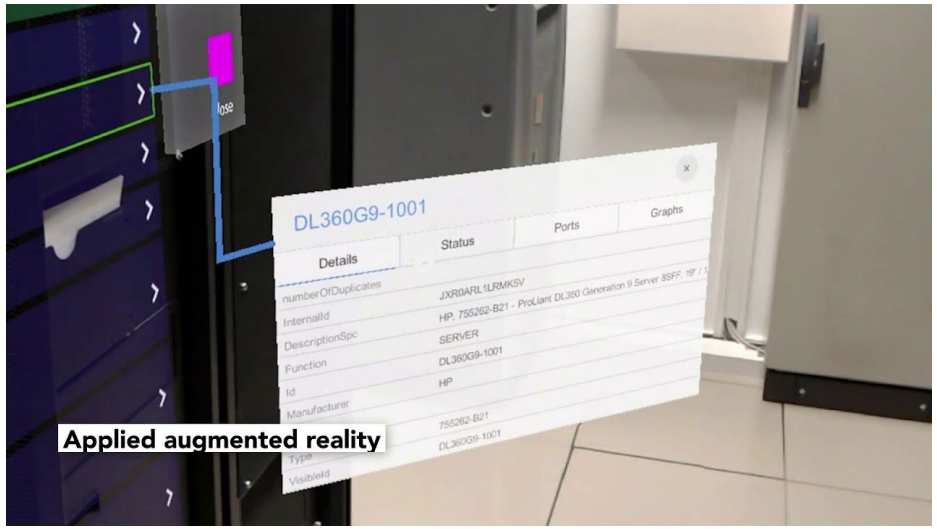


mini.eastday.com/

Aiding On-site DC Maintenance: Front-end

Augmented Reality (AR)
for aiding on-site DC maintenance

- Advantages [1]:
  - Provide easier access to information: avoid unnecessary visits to different information systems
  - Provide convenient and vivid instructions for on-site technicians



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

[1] H. Jalo, H. Pirkkalainen, O. Torro, H. Kärkkäinen, J. Puhto, and T. Kankaanpää, "How Can Collaborative Augmented Reality Support Operative Work in the Facility Management Industry?" *KMIS*, vol. 3, pp. 41-51, Sept. 2018, doi: 10.5220/0006889800410051

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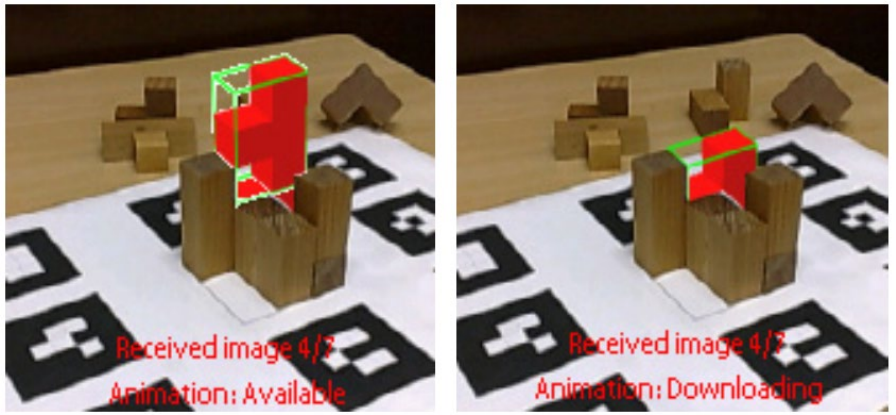
Competitive & Related Products

Mobile Augmented Assembly [1]

- PC server software + phone client software:
  - PC: complex AR model information
  - Phone: an AR view and control
  - Transfer: WLAN/Bluetooth

- guidance for real world assembly task:
  - Animated images



Step by step guidance of a 3D puzzle on a mobile phone [1]

[1] M. Hakkarainen, C. Woodward and M. Billinghurst, "Augmented assembly using a mobile phone," 2008 7th IEEE/ACM International Symposium on Mixed and Augmented Reality, Cambridge, 2008, pp. 167-168, doi: 10.1109/ISMAR.2008.4637349.

- Augmented Assembly Software

➢ Advantages

- Be instructive and intuitional
- Require less computing resources for AR on mobile phones

➢ Disadvantages

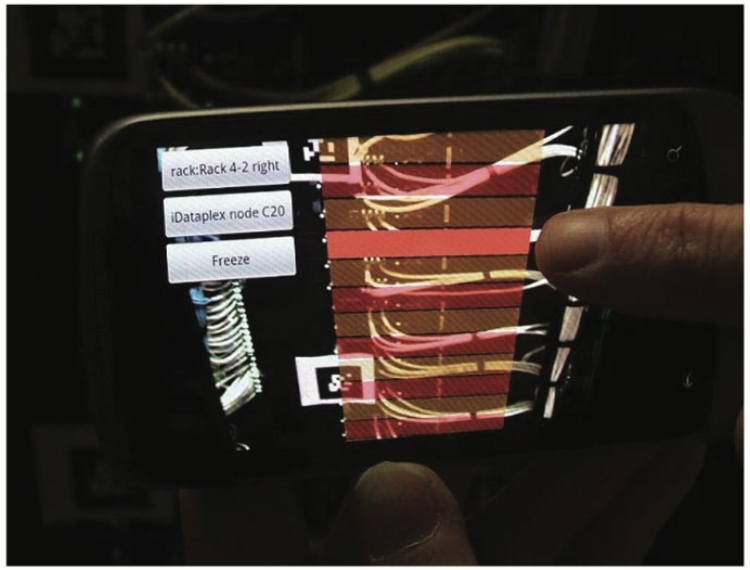
- Long data transmission times between the phone and PC server (19.13/3.44 sec for Bluetooth/WLAN)
- Lack Data Base for real-time information

Competitive & Related Products

Mobile Augmented Reality in Data Center (IBM) [2]

- Tivoli MEO server + phone client software:
  - Server: provide data by scan QR code
  - Phone: Interact with AR, changes be sent to the server

- Visual overlay:
  - IDs, locations of several devices on a rack
  - Button to freeze the video capture



Visual overlay of data center assets on top of assets in an IBM rack [1]

[1] S. Deffeyes, "Mobile augmented reality in the data center," in IBM Journal of Research and Development, vol. 55, no. 5, pp. 51-55, Sept.-Oct. 2011, doi: 10.1147/JRD.2011.2163278.

- Augmented Assembly Software

➢ Advantages

- Provide Real-time data
- Be user-friendly

➢ Disadvantages

- limited information stored in Tivoli MEO server
- Physical status of device not detected; only rely on QR code

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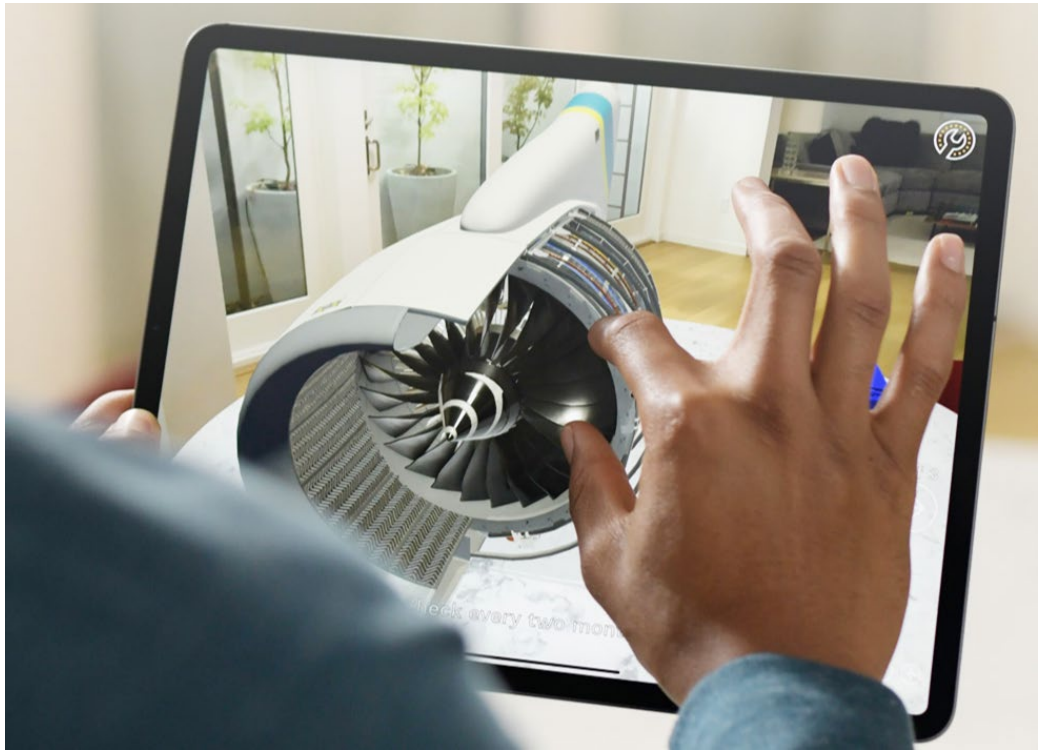
Customer Requirements (CR)

- **Display real-time information of data center with AR**
  - Short Reaction Time [1]
  - Information Correctness
  - Comfortable Display
  - Portable Device

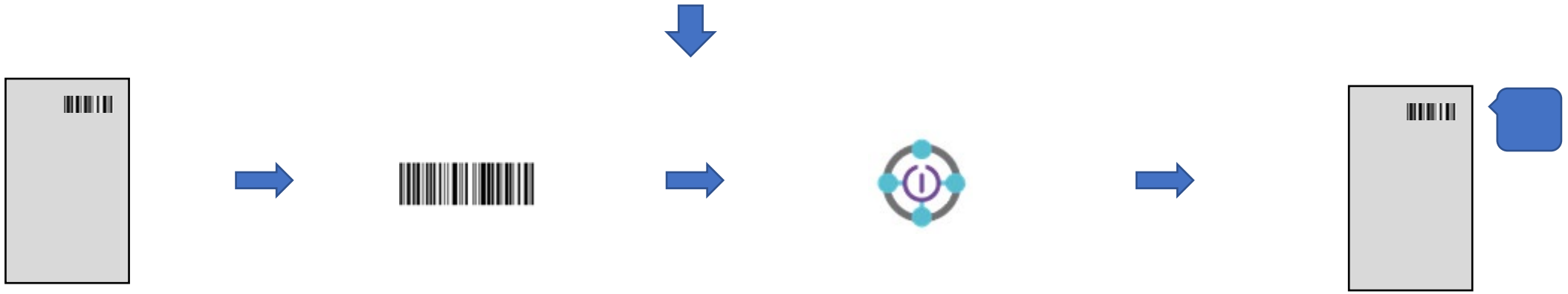


www.apple.com/augmented-reality/

[1] N. Fiona, "A Study on Tolerable Waiting Time: How Long Are Web Users Willing to Wait?", Behaviour & Information Technology - Behaviour & IT, 2003, pp. 285, doi: 10.1080/01449290410001669914.

Engineering Specifications

CR: Short Reaction Time



Object localization: time < 0.5s [1]

Barcode identification: time < 0.05s [2]

Database query: complexity = O(log(n))

AR image generation: time < 0.1s [3]

[1] Q. Peng and Y. Song, "Object recognition and localization based on Mask R-CNN," *Journal of Tsinghua University (Science and Technology)*, 2019, vol. 59, no. 2, pp. 135-141.

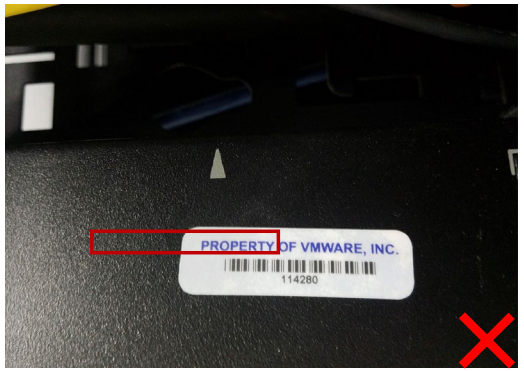
[2] E. Ohbuchi, H. Hanaizumi and L. A. Hock, "Barcode readers using the camera device in mobile phones," *2004 International Conference on Cyberworlds*, Tokyo, Japan, 2004, pp. 260-265, doi: 10.1109/CW.2004.23.

[3] A. Baek, K. Lee, and H. Choi, "CPU and GPU parallel processing for mobile Augmented Reality." 2013.

Engineering Specifications

CR: Information Correctness

- **Localization:**
  - Error rate < 10% [1]



- **Data retrieval:**
  - Error rate < 0.01% [2]

Barcode of Device 1

Database query

Device 1	Device 2
Temperature: ...	Temperature: ...
Humidity: ...	Humidity: ...

[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

Engineering Specifications

CR: Comfortable Display

- **Frame rate > 15 frames per second [1]**
- **Sensible temperature of device < 40 °C [2]**

www.apple.com/augmented-reality/

[1] A. Craig. Augmented Reality Hardware, pp. 69-124. 2013.
[2] https://support.apple.com/en-us/HT201678 & https://support.google.com/pixelphone/answer/9134668?hl=en

Engineering Specifications

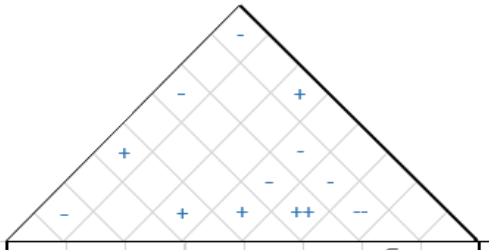
CR: Portable Device

- **Product environment**
  - Platform: Android 7.0+ / iOS 11.0+ [1]
  - Light: >= 40lx [2]

- **Applications**
  - Size of software package < 110MB for Android, < 940MB for iOS [3]

[1] https://developers.google.com/ar/discover/supported-devices & https://developer.apple.com/documentation/arkit
[2] L. Blom, "Impact of light on augmented reality." Diva Portal. 2018.
[3] https://play.google.com/store/apps & https://www.apple.com/app-store

Quality Function Deployment



++ strongly positive + medium positive - medium negative -- strongly negative Blank totally unrelated	Weights (1 - 10)	Object Localization Correctness	Object Localization Time	Barcode Identification	Database Query	AR Image Generation	Frame Rate	Device Temperature in Operation	Size of Software Package	Mobile Augmented Assembly	IBM
Short Reaction Time	6		9	3	9	3	3		1	4	5
Information Correctness	10	3			9	1		1		8	8
Comfortable Display	7	1				3	9	3	1	7	4
Portable Device	5							3	9	1	4
Measurement Units		%	s	s	s	s	fps	℃	MB		
Target Value		90	0.5	0.05	1	0.1	15	40	110		
Absolute Importance		90	70	53	92	60	41	39	31		
Relative Importance %		19.8	15.4	11.7	20.3	13.2	9.03	8.59	6.83		
Rank Order of Ecs		2	3	4	1	5	6	7	8		
Mobile Augmented Assembly											
IBM											

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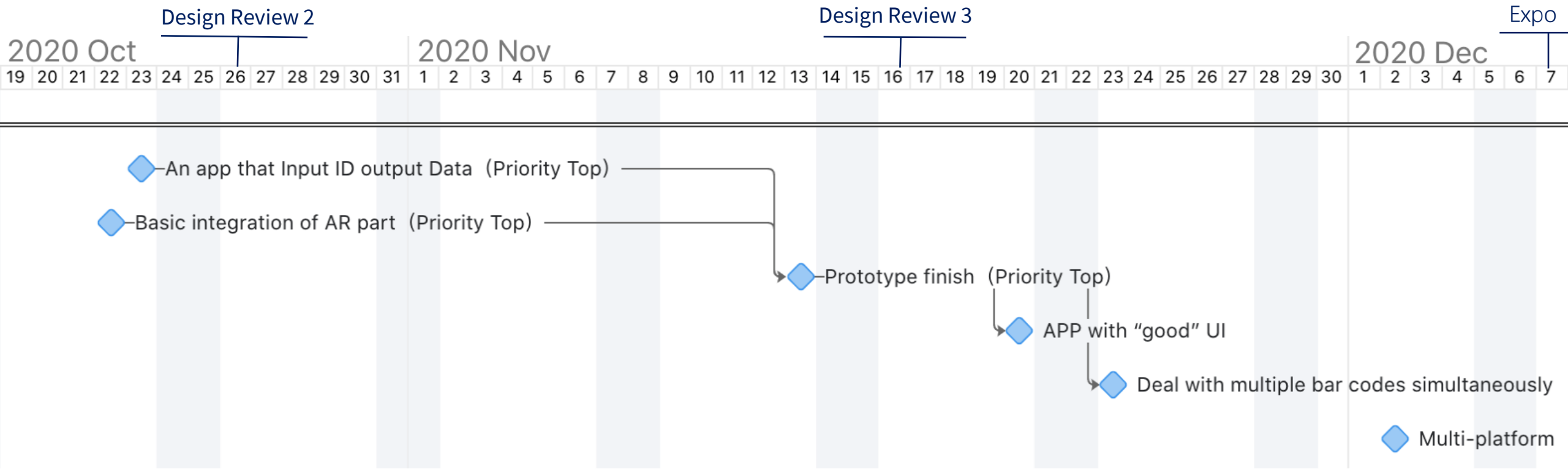
Project Plan: Milestones



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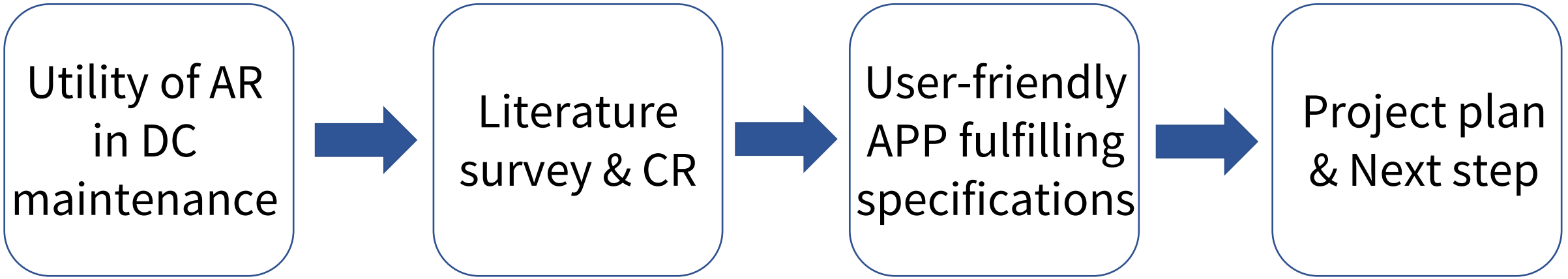
Conclusion


Utility of AR in DC maintenance
Literature survey & CR
User-friendly APP fulfilling specifications
Project plan & Next step


Joint Institute
Q & A