Personal Clouds: Sharing and Integrating Networked Resources to Enhance End User Experiences

MINSUNG JANG, KARSTEN SCHWAN, KETAN BHARDWAJ, AND ADA GAVRILOVSKA
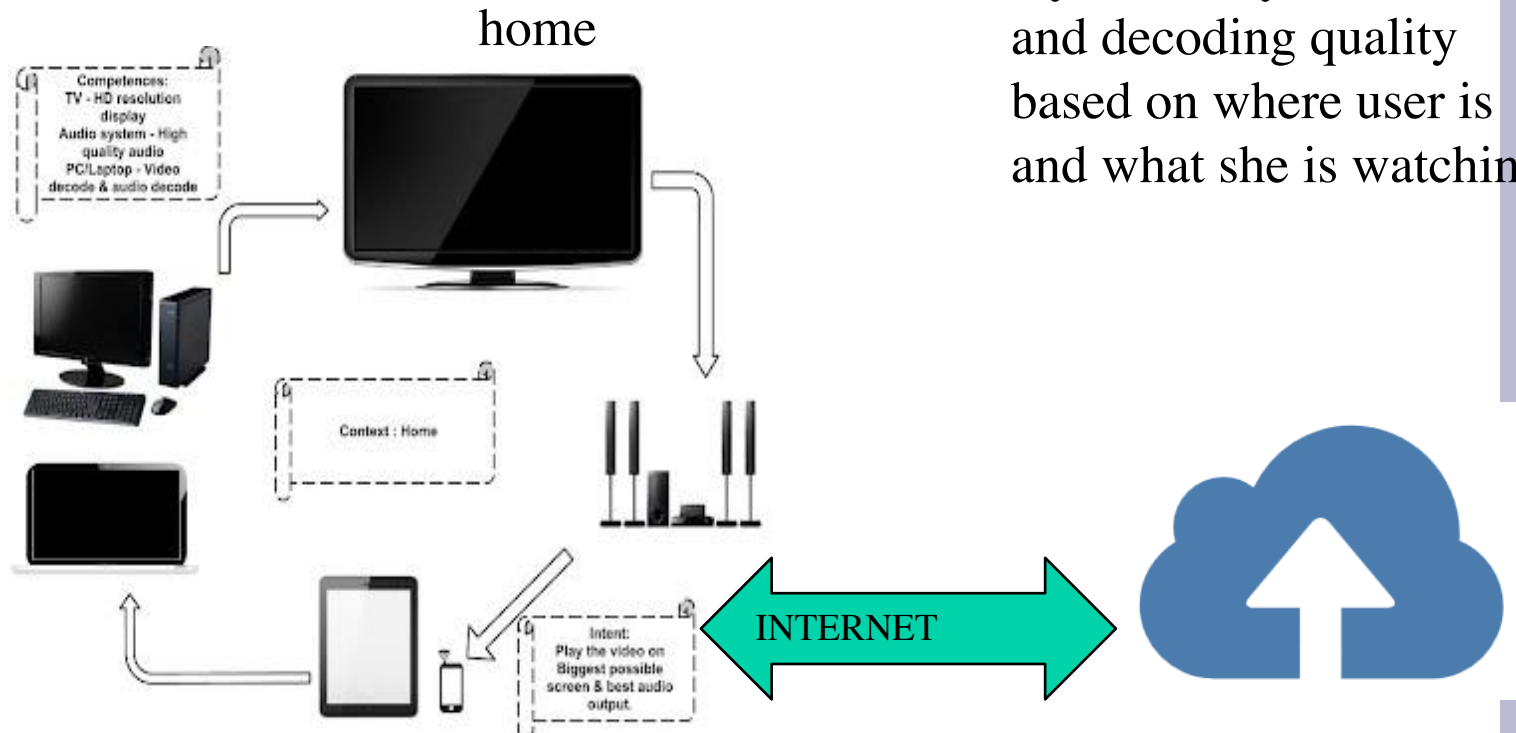GEORGIA INSTITUTE OF TECHNOLOGY

ADHYAS AVASTHI
CISCO SYSTEMS

(PRESENTED FOR INFOCOM 2014)

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Motivation

Watching a movie, @bus → @Home;

Dynamic changes of environment

home

Dynamically select screen and decoding quality based on where user is and what she is watching

INTERNET

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CHALLENGES

Challenges: The status quo

- High overhead for management & use of increased devices
    - App installations for a multiple-device owner

- Smooth and seamless user experience
    - Watching video clips

- Sharing resources
    - Family reunion

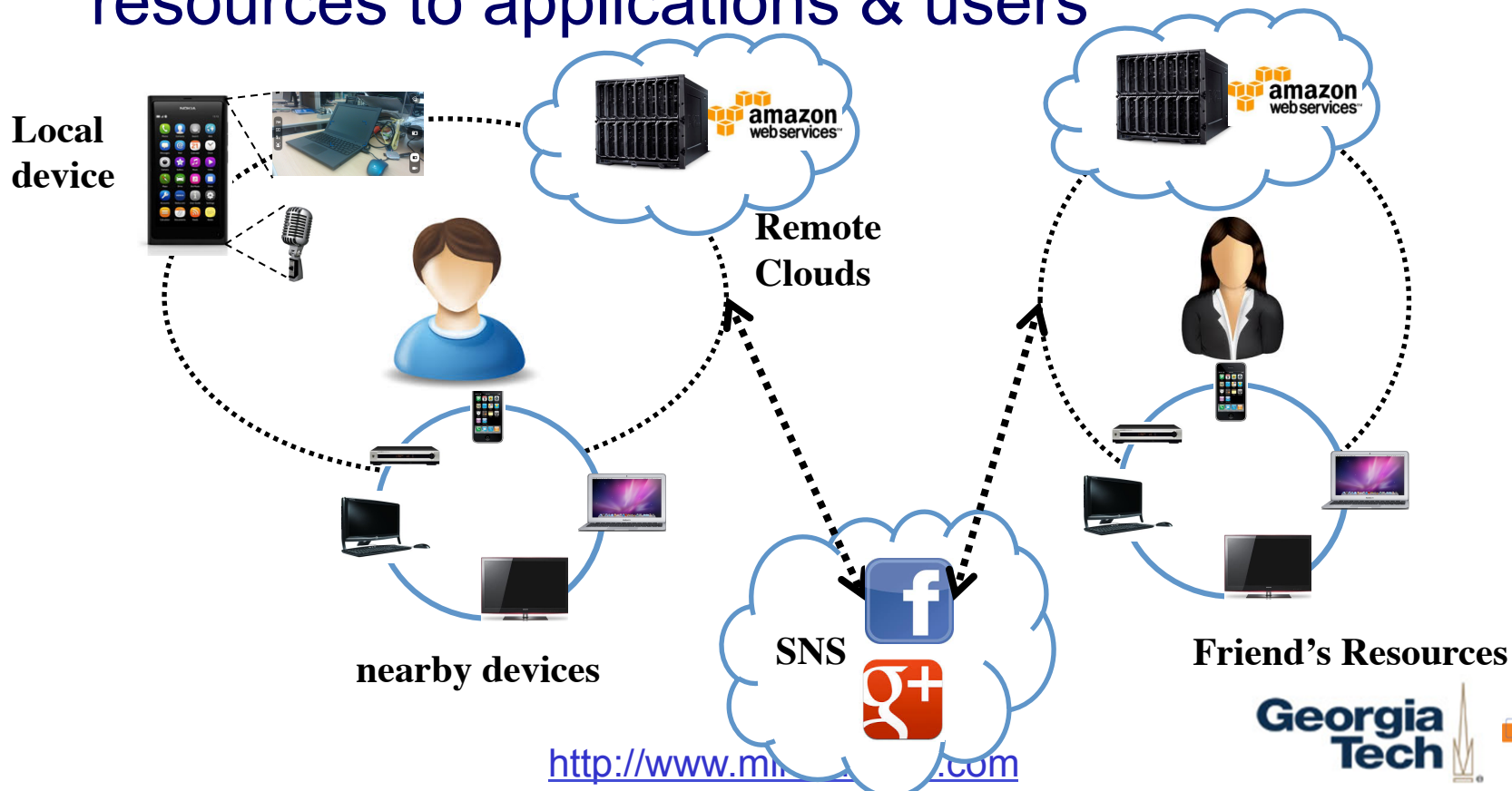**Limitation of a individual
and isolated single device**

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Challenges: Main causes

- Extreme heterogeneity of networked resources
  - From wearable devices to home servers
  - Management of distributed resources

- Inter-operability
  - Vendor-specific (Vertical) or peer-to-peer (Horizontal) manners
    - Sometimes, closed ecosystem (e.g., Contol4Home)
    - pre-determined roles for each device: Not flexible
    - Composing Capabilities

- Permission and access control
  - Who (or what application) is allowed to use my resources?
  - What kind of resources can they use?

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PERSONAL CLOUDS INFRASTRUCTURE

Approach

- Provide a new system-level abstract (Virtual platform) composed of user-accessible resources to applications & users

Local device

Remote Clouds

nearby devices

SNS

Friend's Resources

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Design Considerations for System-level Infrastructure

- ***Providing Mechanism and Control*** to manage a resource pool and construct a virtual platform per application needs

- ***Using system virtualization*** to logically decouple resources from a device

- Instantiating ***an abstract looking like a single device*** from application's point of view

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Operations
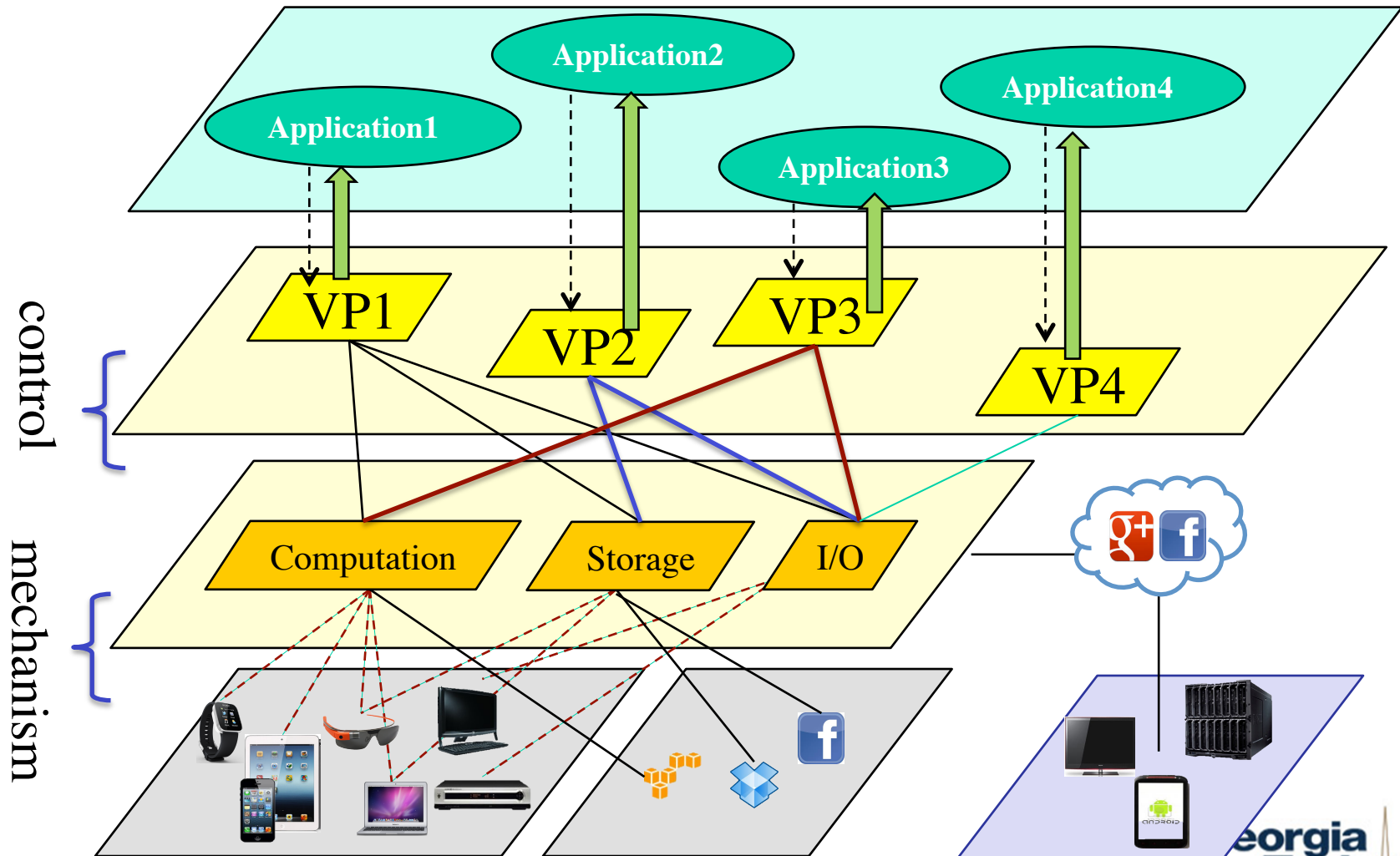
ARCHITECTURE

Software Components

- **Applications** is a set of services running on a PCloud instance (e.g., a media player)
- **PCloud Instance** presents an illusion of a single machine. (i.e. implementation of a VP)
- **PCloud Runtime** brings up a PCloud instance complied with application's needs
- **Cirrostratus** is the extension of the Stratus framework
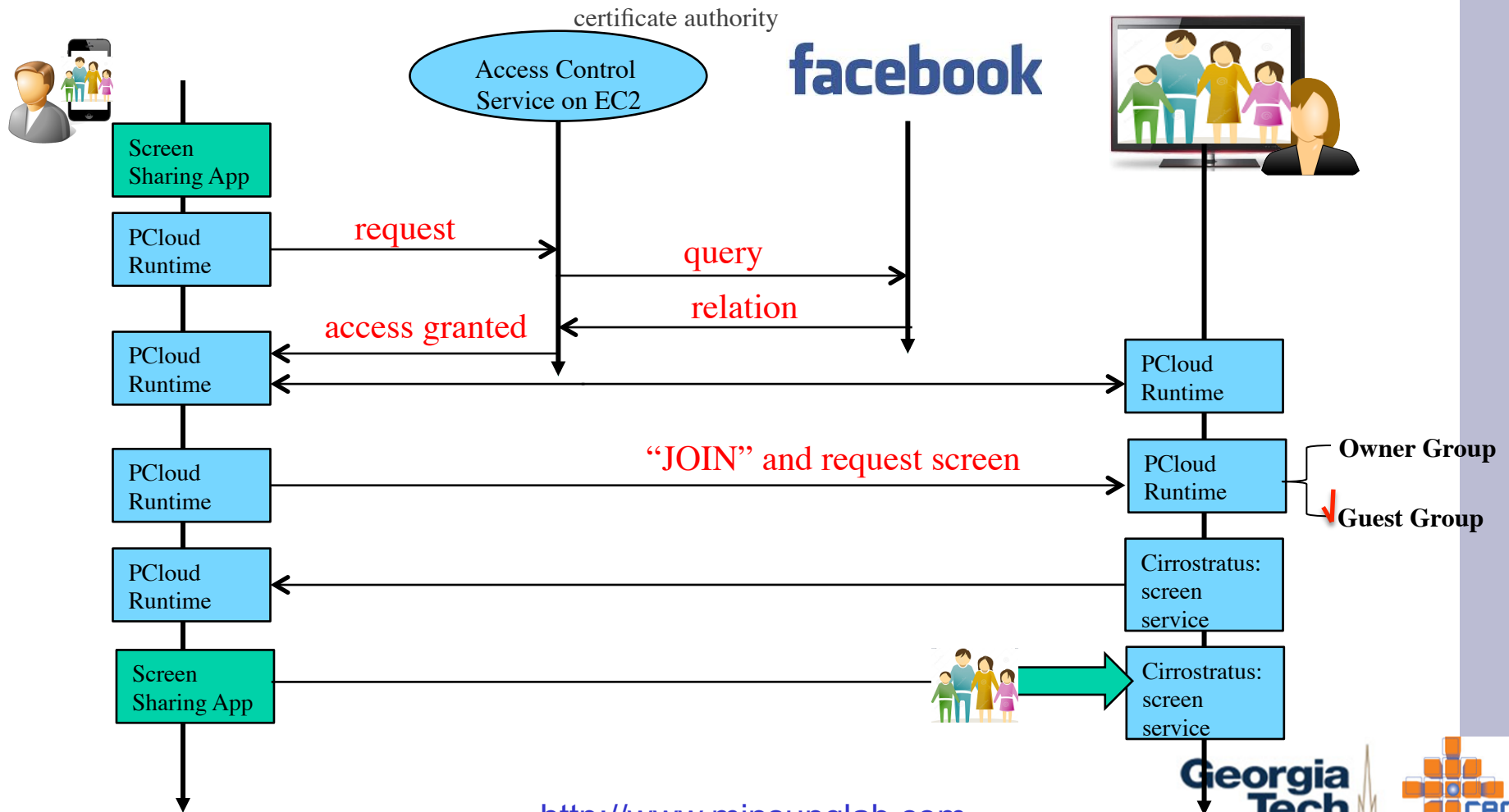- **System Services** are used to authorize applications to run and to access a data storage with global scope

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Implementations
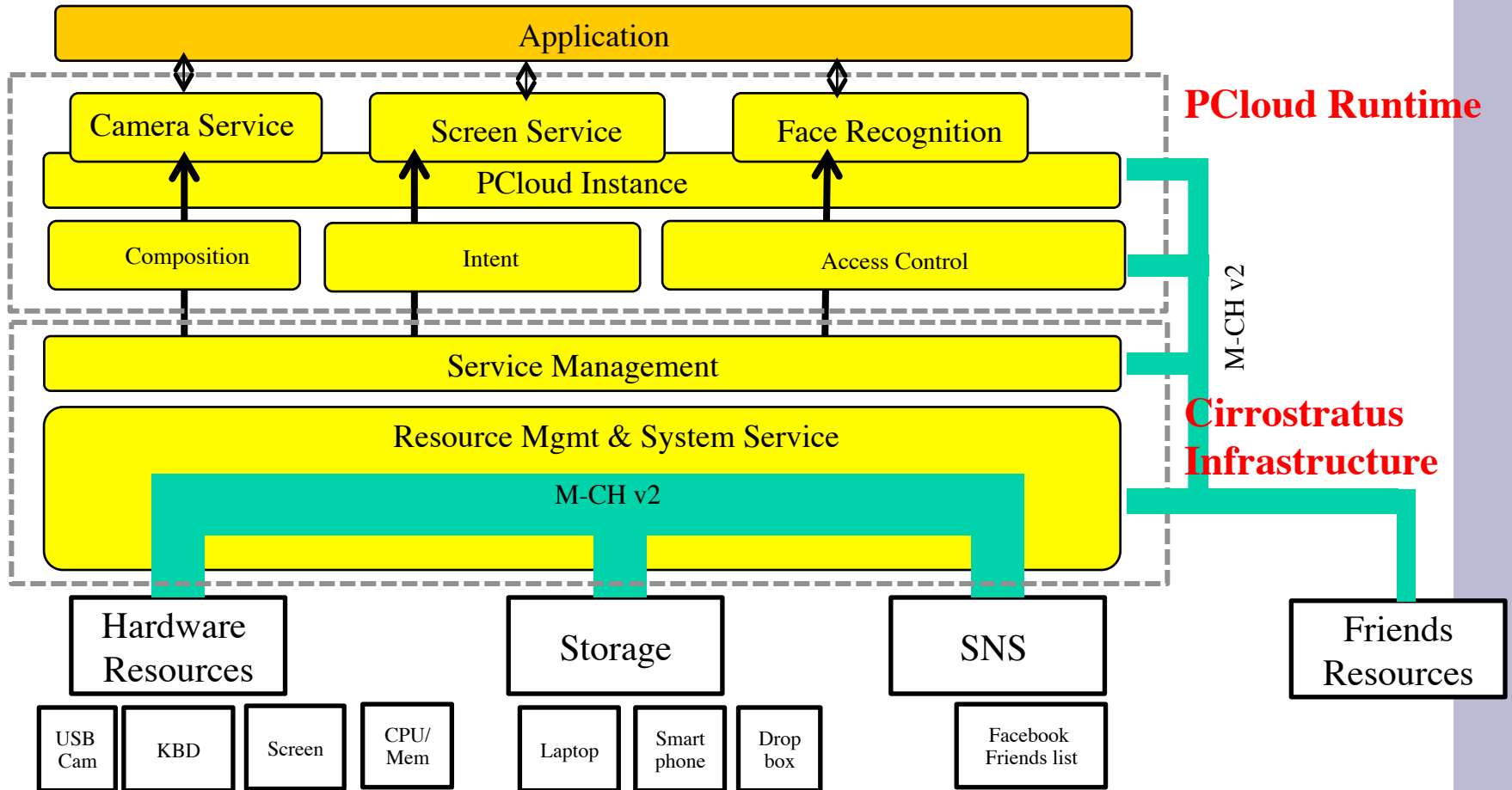
Contributions

- Resource management and dynamic composition of distributed networked resources
    - Local, Nearby, and Cloud resources
- Runtime environment for applications to seamlessly access such resources
- SNS guides permissions for resource sharing

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EVALUATION

Screen Sharing

certificate authority

Access Control Service on EC2

facebook

Screen Sharing App

PCloud Runtime

request

query

PCloud Runtime

access granted

relation

PCloud Runtime

PCloud Runtime

"JOIN" and request screen

PCloud Runtime

Owner Group

Guest Group

PCloud Runtime

Cirrostratus: screen service

Screen Sharing App

Cirrostratus: screen service

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Results: Quick Deployment

TABLE II.   ELAPSED TIME FOR DISPLAY SHARING

Task (message)	From	To	Time taken	Dev.
Initiate a certificate	MO	S	88.2	27.6
Return the certificate and key pairs	S	MO	213	35.3
Authentication	All	All	405	41
Send a display sharing request	MO	SM	140	66.3
Return a list of available capabilities	SM	MO	293	117.3
Notify a selection of a display that wants to use	MO	SM	179	55.8
Initiate a VNC connection	SM	MO	153.3	80
Total Elapsed time			1471.5 ms	

MO: a mobile device, S: the authentication service, SM: a Cirrostratus master

The unit for time is milliseconds

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Neighborhood Watch

Camera Service → Face Service → Face Database

Local storage

Face Service

Public Clouds — amazon web services

Home Devices

Aggregated storage

Friends' albums (faces, tag)

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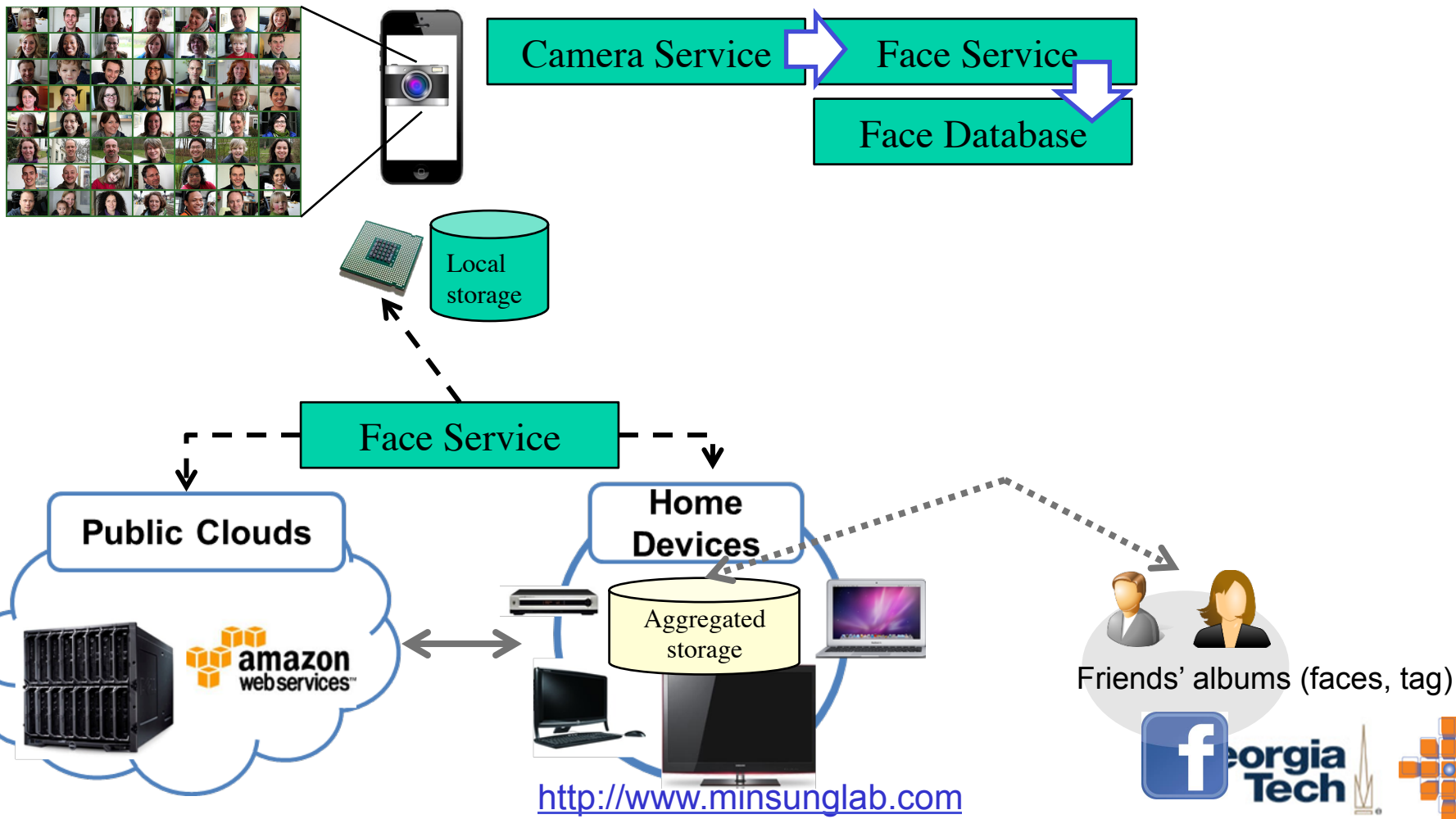
Results: Impact on Response Time and Battery Life

(a)
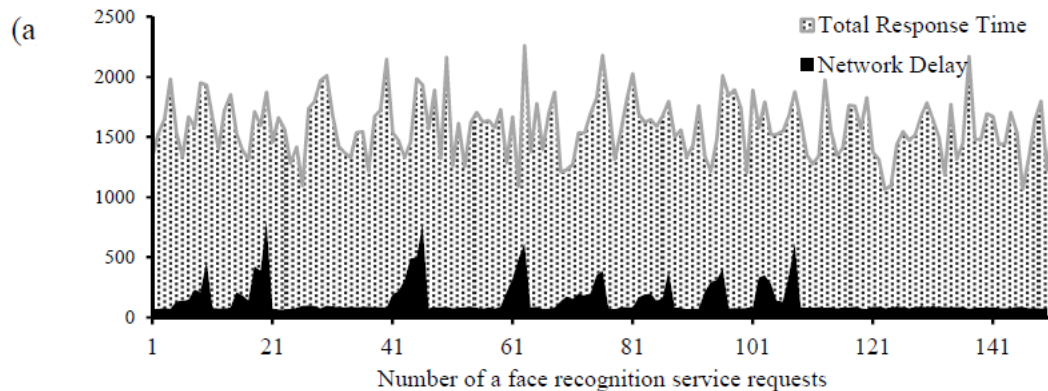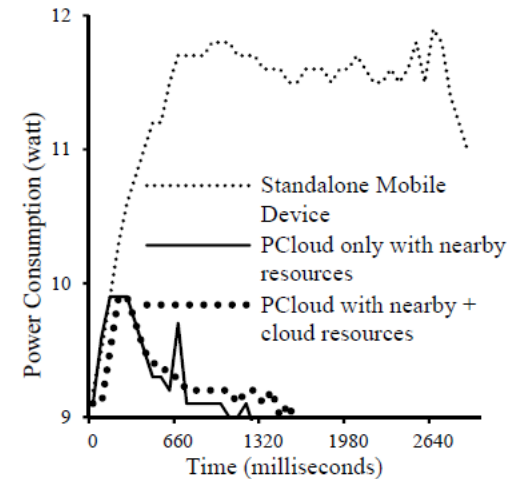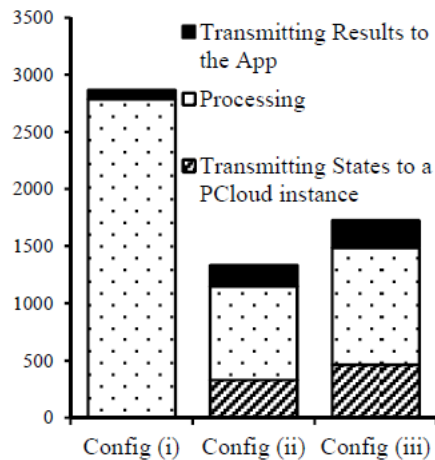
(b) Power consumption

Figure 4.   User-experienced total response times in milliseconds for face recognition requests sent every 3 seconds for a 5 minute duration.

face service: Config. (i) local, Config.(ii) nearby@Home, Config.(iii) EC2

ADDITIONAL USE CASES

Basic Operations- Discovery

PCloud Discovery Service

Query
with the current location

Available PCloud Maste

PCloud
Agent
for Android

slide to unlock

List of available

PCloud Master loca

oPsai
Screen – 1
Screen – 2
Screen – 3

PCloud
Master
Node

Home
Devices

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Use cases (1)

- P

Use cases (2)

- ## Slide sharing in a classroom or coffee shop
    - Use case for Multiple devices participation
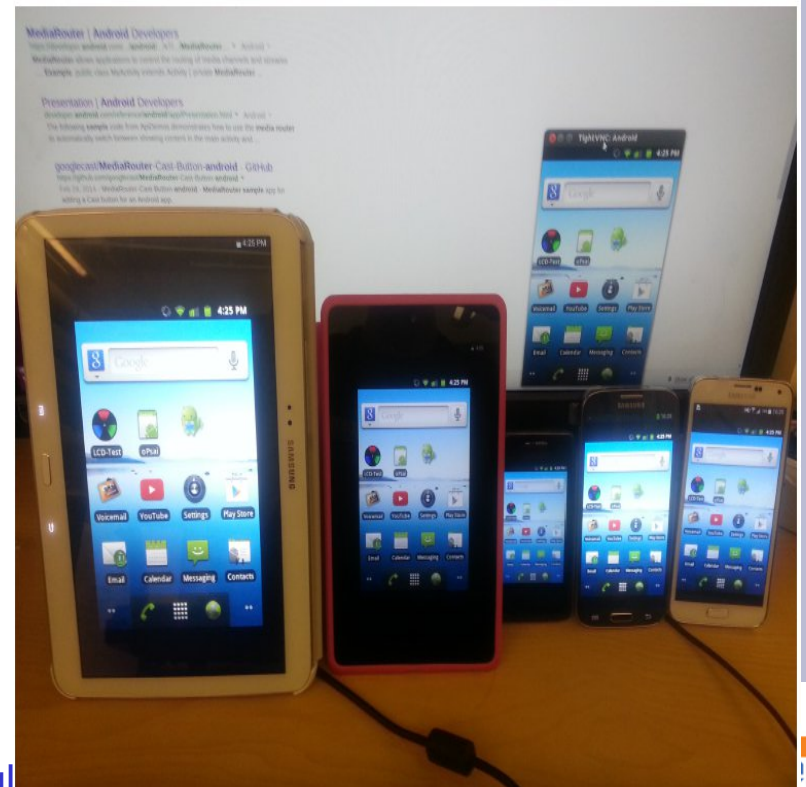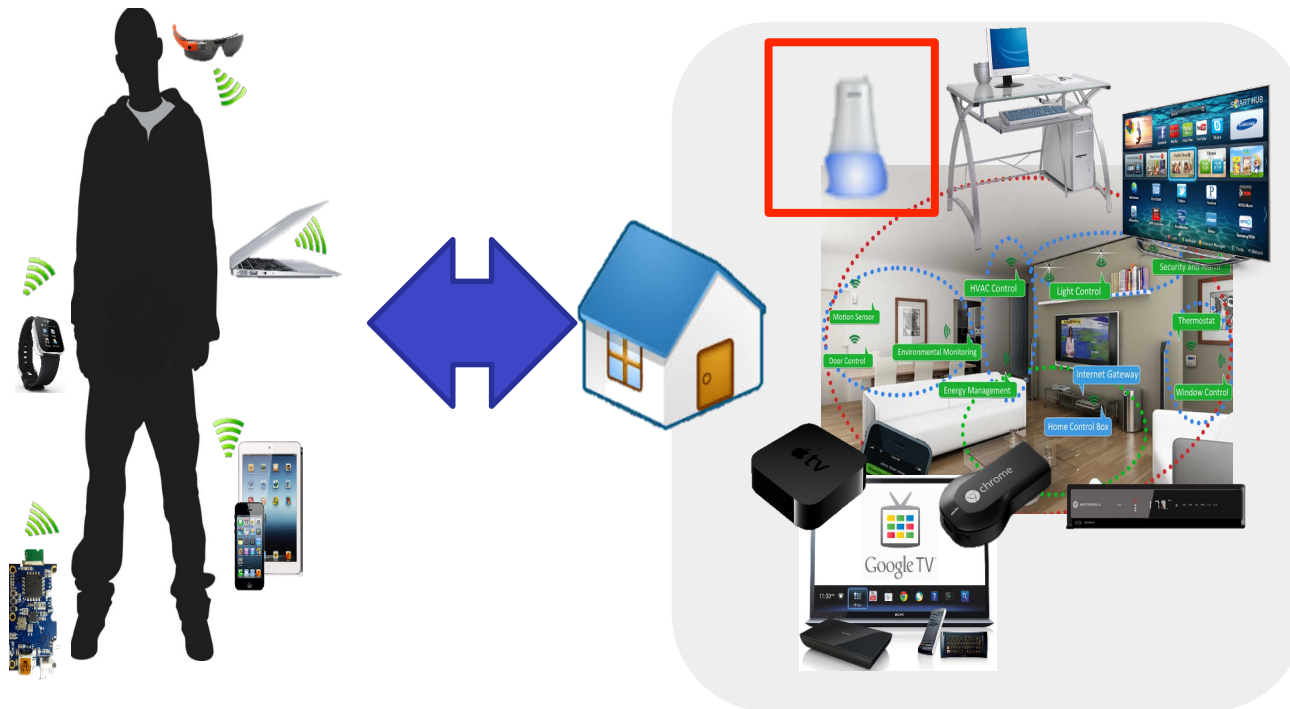
Use cases (3)

- Collaboration
  - Use case for Multiple devices participation with a virtual white board
  - A (large) touch screen monitor turns into a tool to exchange opinions and record all ideas during a meeting
  - It also updates all participants' device screen.

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Next Step

- ## Sensors/Cameras
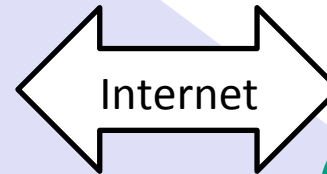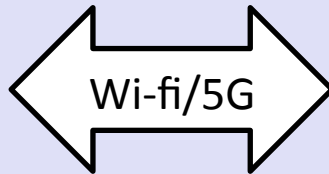 - Use case in consideration: Home surveillance and security

THE ROLE OF THE MIDDLE TIER

Current state of device ecosystem

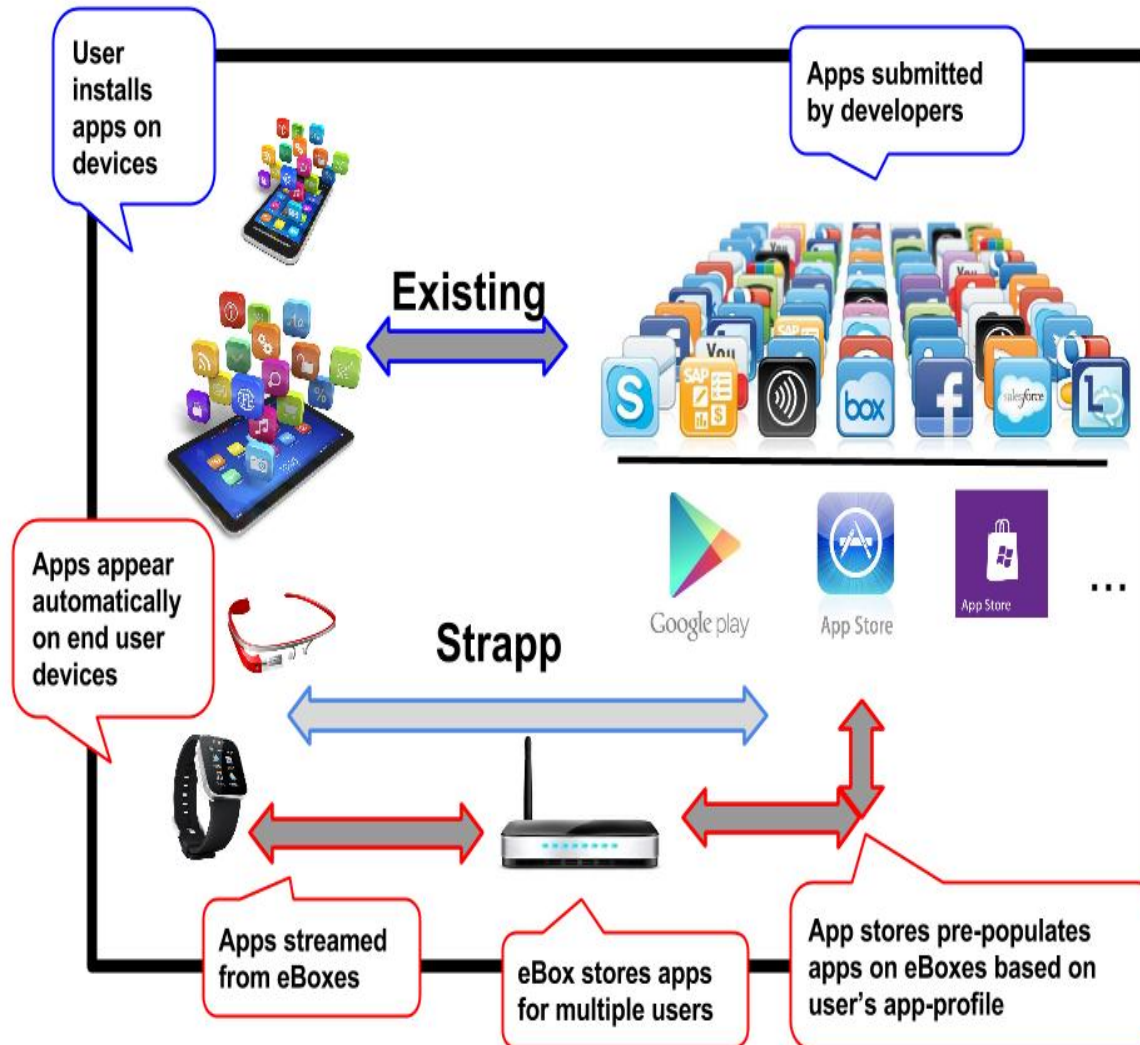Better support **and** leverage richness of services, device types, users and data…

Maintain focus on dynamic, decentralized nature of the environment, and on importance of service quality

Wi-fi/5G

Internet

Offer additional capabilities through increased flexibility of middle-tier infrastructure

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Strapp: App streaming from eBoxes

Benefits and Next Steps

- Benefits -> performance, resource usage (including battery), richer services

- Ability to integrate virtualized and non-virtualized devices (Android and Meego support)

- Increased importance of edgeBox role – context cache, last-mile content distribution, to-cloud bandwidth…

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