

Ad Hoc Cloud Computing using Mobile Devices

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MCS Workshop @ MobiSys
2010

Agenda

- Smart Phones are not just phones
- Desire versus reality
- Why using mobile devices to create an ad hoc cloud?
- Considerations and Architecture
- Current implementation and evaluations
- Summary and Future Work

Smart Phones are not just phones

- Mobile phones/terminals are becoming more powerful and used for personal information processing
- They have become a central point of ubiquitous information processing
- Mobile phones are considered new portable sensors and expected to be a main driver of smart applications

Smart Phones are not just phones

- Eric Schmit, CEO of Google said
 - “you'll see things you can't even imagine now. As examples of what's being done with Android mobile phones, application that can take pictures of barcodes, identify the corresponding product, and compare prices online. An application that can take a picture of a menu in a foreign language and translate it.”

InformationWeek, 10/28/09

(<http://www.informationweek.com/story/showArticle.jhtml?articleID=220900806>)

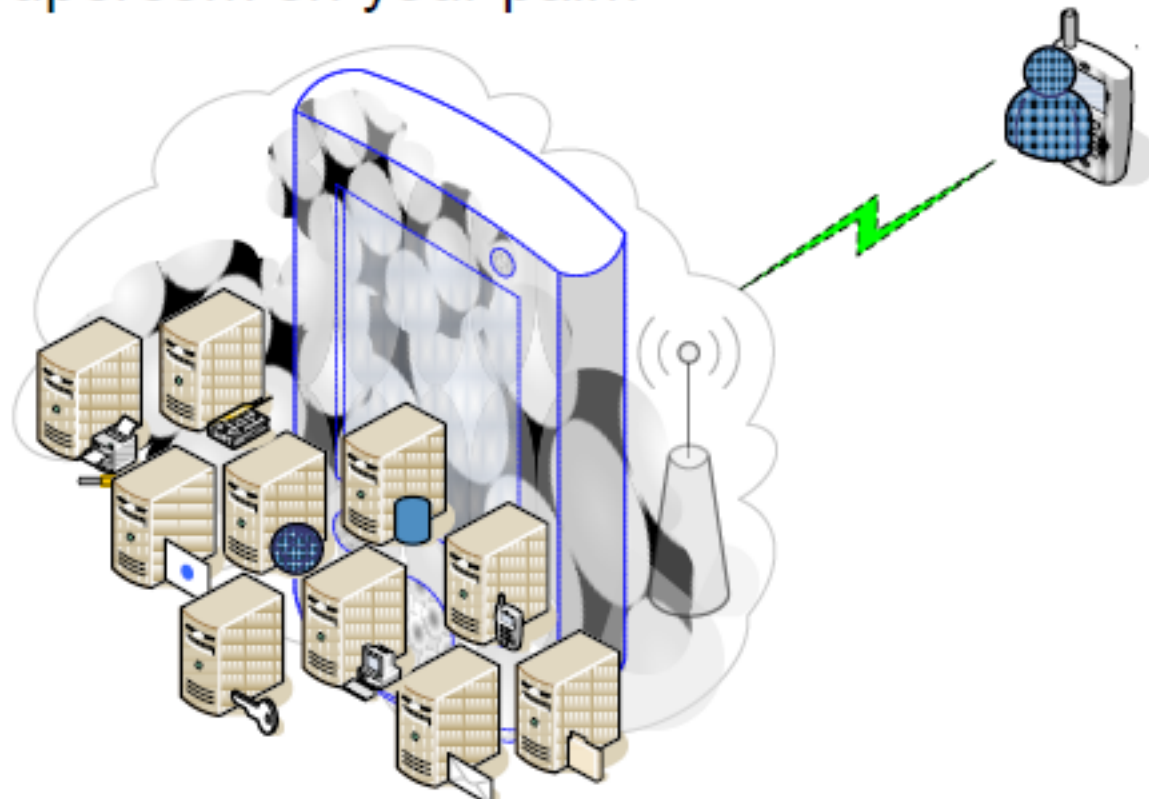
Today's Smart Phone is not enough

- People cannot do their intelligent information management only with Smart phone due to its limitations
 - CPU (~ 10 MIPs) \rightarrow no 1TB knowledge processing
 - GPU (~ 30 MT/s) \rightarrow no real-time 3D information visualization
 - Networks (~ 10 Mbps, single hop) \rightarrow not enough for multimedia transmission
 - Storage (~ 150 GB) \rightarrow no anywhere/anytime personal data storage
 - Display ($\sim 4''/800 \times 400$) \rightarrow no UHD
 - Interface (keypad & touch) \rightarrow no natural human-friendly interface
 - Battery-dependency \rightarrow limited lifetime

Mobile Super Computing

- Large amount of computing & networking resources are allocated to a user's smart phone

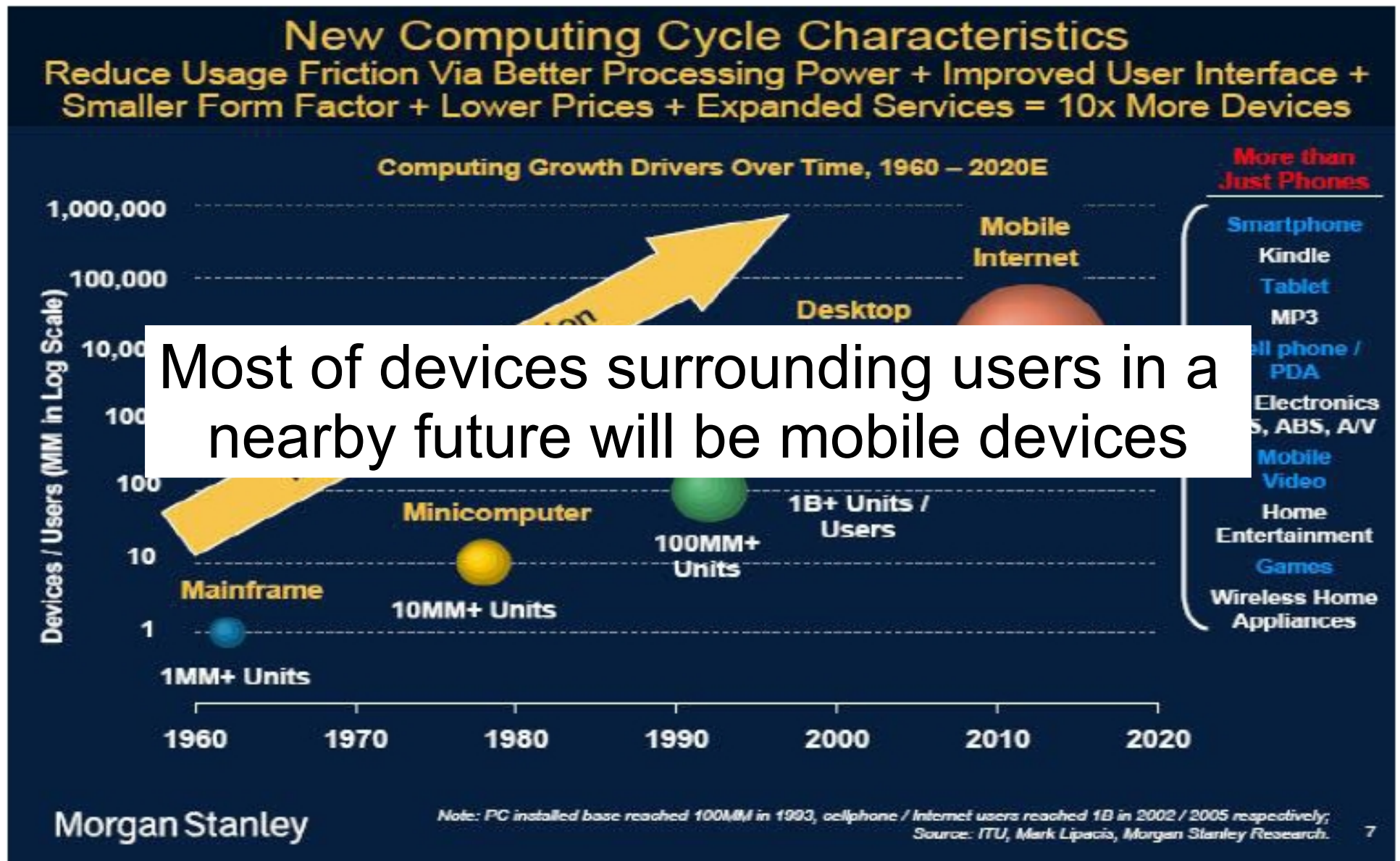
Supercom on your palm



Mobile Super Computing is not always 'the' solution

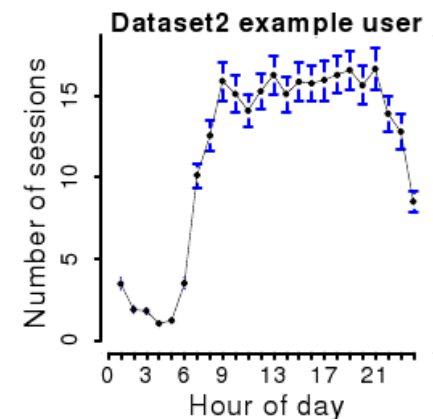
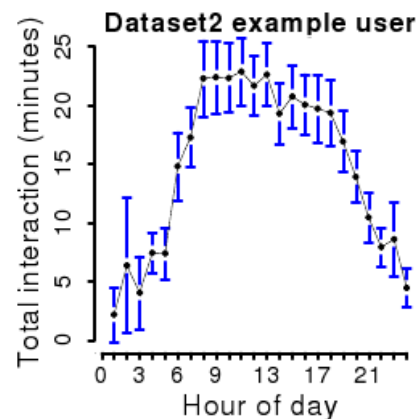
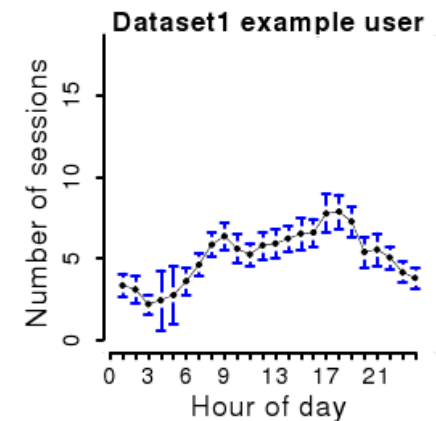
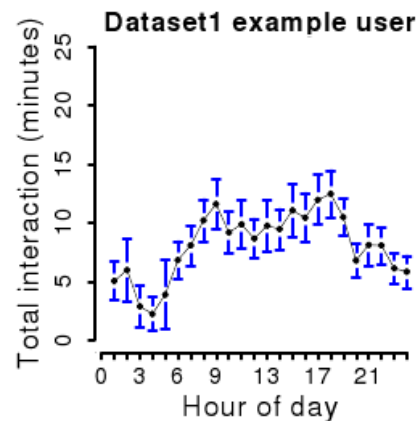
- Cost of 3G
 - In South Korea the subscription plans for the iPhone 3GS (32GB) are near 70 USD per month, and if the user wants to download 1 GB of data he
- Therefore, an initial solution will be to use resources from nearby devices connecting via a wireless radio
- WIFI connectivity is not always present
 - Less than 20% in US cities (Balasubramanian et al, 2010)

Ubiquitousness of Mobile Devices



Mobile phones are a source of idle resources...

- Falaki et. Al, 2010
 - Less than 25% per hour of usage



(a) Interaction time

(b) Number of sessions

... and will be able to handle
stronger computations

- Qualcomm's dual-core ARM CPUs clocked at up to 1.2 GHz presented at Computex 2010

(<http://www.dailytech.com/ARM+Readies+Dual+Core+CPU+Onslaught+With+12+GHz+Snapdragon/article18575.htm>)

- Samsung is planning to release a quad-core ARM processor for mobile phones in 2012

(<http://www.mydigitallife.info/2010/05/03/samsung-plans-quad-core-arm-cortex-a9-processor-due-by-20122013/>)

Scenario

• Task aware collaboration



鬼面瓦は鬼の顔を表現したもので、
主に建築物や工芸品に使われて悪いものを追い払う象徴となった。

瓦にこの文様が使われたのは三国時代からで、
鬼の顔の表現された姿により世相が分かったりもする。

This design was used on roof tile from the Three Kingdoms period.
The expressions shown on the design indicate the time of its production.

統一新羅時代に至っては、鬼面文軒丸瓦と鬼面文軒半瓦が絶えず製作される中、
て建物の下がり棟と軒床の端に付着する鬼面瓦が本格的に作られ始めた。

From the Unified Silla dynasty, roof-end tiles and concave roof tiles with the monster-mask design were steadily produced.

統一新羅時代の鬼面瓦は、大量生産されただけでなく、
形態と構図が完璧で高い水準を見せている。

Also, roof tiles attached to the eaves ridge and the slanting ridge of buildings began to be actively produced.

During the Unified Silla dynasty, roof tiles with a monster-mask design were mass-produced with perfect design and arrangement of the design.

特に7世紀後半から8世紀前半にかけての時期に作られた鬼面瓦は、
鬼の顔の表現が非常に力強く、悪鬼の顔の表情が非常に生々しく表現されている。

Monster-mask roof tiles manufactured from the late 7th century through the early 8th century are at the peak of their quality.

As for roof tiles produced for the slanting ridge, they have big faces which seem ready to burst out with forceful power and energy.

Monster-mask roof tiles from the late Unified Silla dynasty lack this lavish energy and elegance of design.

今にもその雄姿を現している点も特徴である。
このような鬼面瓦は、統一新羅後期には次第に量感が弱くなり、
文様表現の繊細さも落ち、全般的に無気力な傾向に流れるようになる



monster mask, this design was used on buildings and crafts, in the belief that it repels evils.

鬼面瓦は鬼の顔を表現したもので、
主に建築物や工芸品に使われて悪いものを追い払う象徴となった。

This design was used on roof tile from the Three Kingdoms period.

瓦にこの文様が使われたのは三国時代からで、

It is not always useful

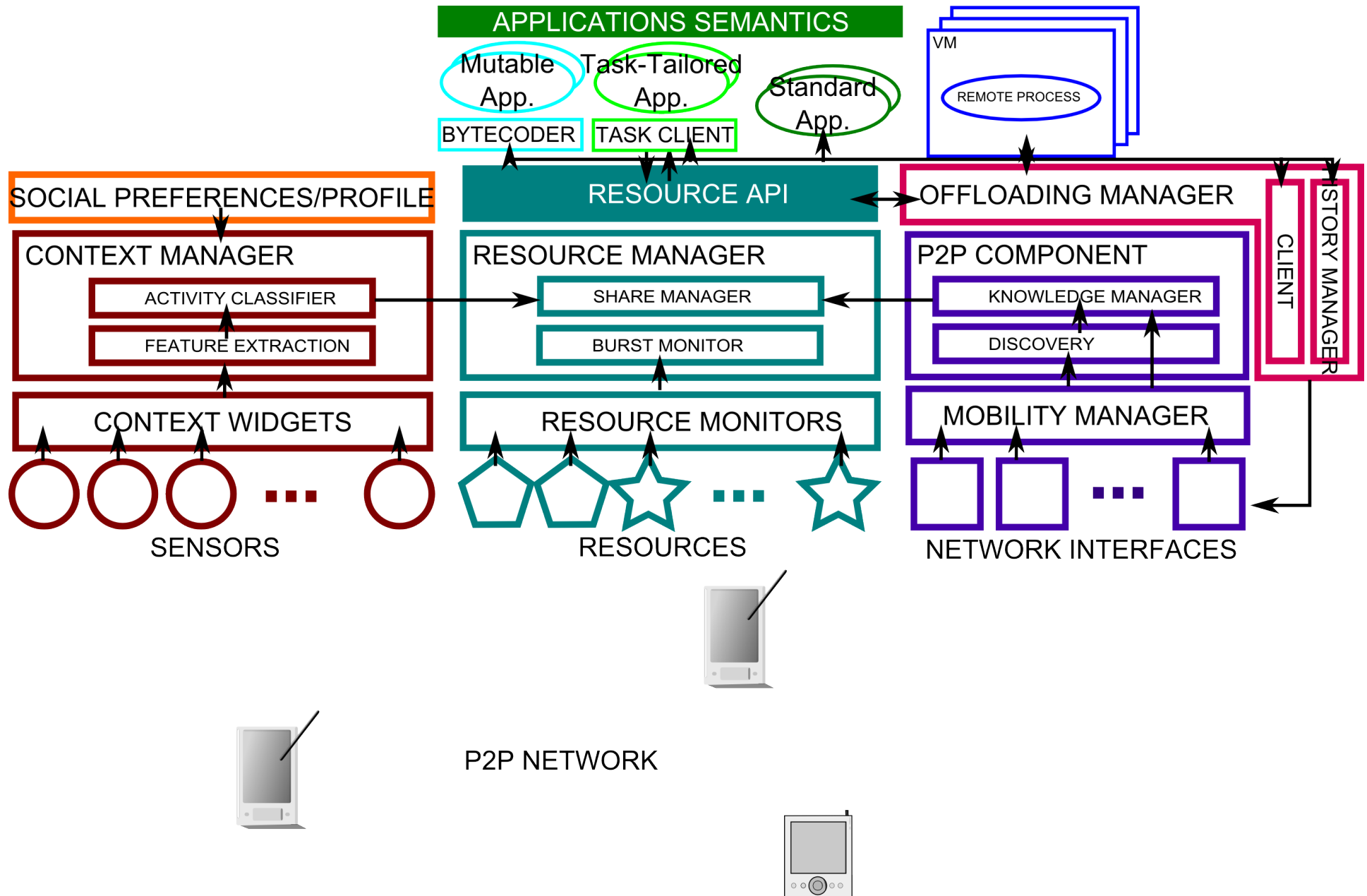
- Cost of accessing or limited connectivity to networks
- Number of surrounding devices is high enough
- Tasks can run on a single device or can be divided into smaller tasks
- Users are willing to share resources (usually to save theirs)

→ It is a complement to current mobile cloud solutions not a complete alternative

Design Considerations

- Size of tasks
- Future mobile activities of users
- Activity/Task awareness
- Application behavior
- Mobility

Architecture



Current Implementation

- Mobile cloud computing client and an ad hoc cloud computing peer
 - Both are developed based on Hadoop
- Java as programming language
 - JamVM used on iPhones to run the framework
 - Bytecoding done with javassist
 - Communication between mobile phones based on Yaja!, an XMPP middleware (Added: RPC and Serverless messaging)

Preliminary Evaluations

- Based on translation scenario
- Cloud computing cluster based using Hadoop
 - Five servers
- Three iPhone clients
 - But only one selected as potential surrogate
- WiFi used as communication medium
- We simulate mobility
 - Creation of ad hoc cloud happens only when mobile nodes are at stable places

Preliminary Evaluations

- Ad Hoc cloud computing versus local execution
 - Performance-wise is not harmed

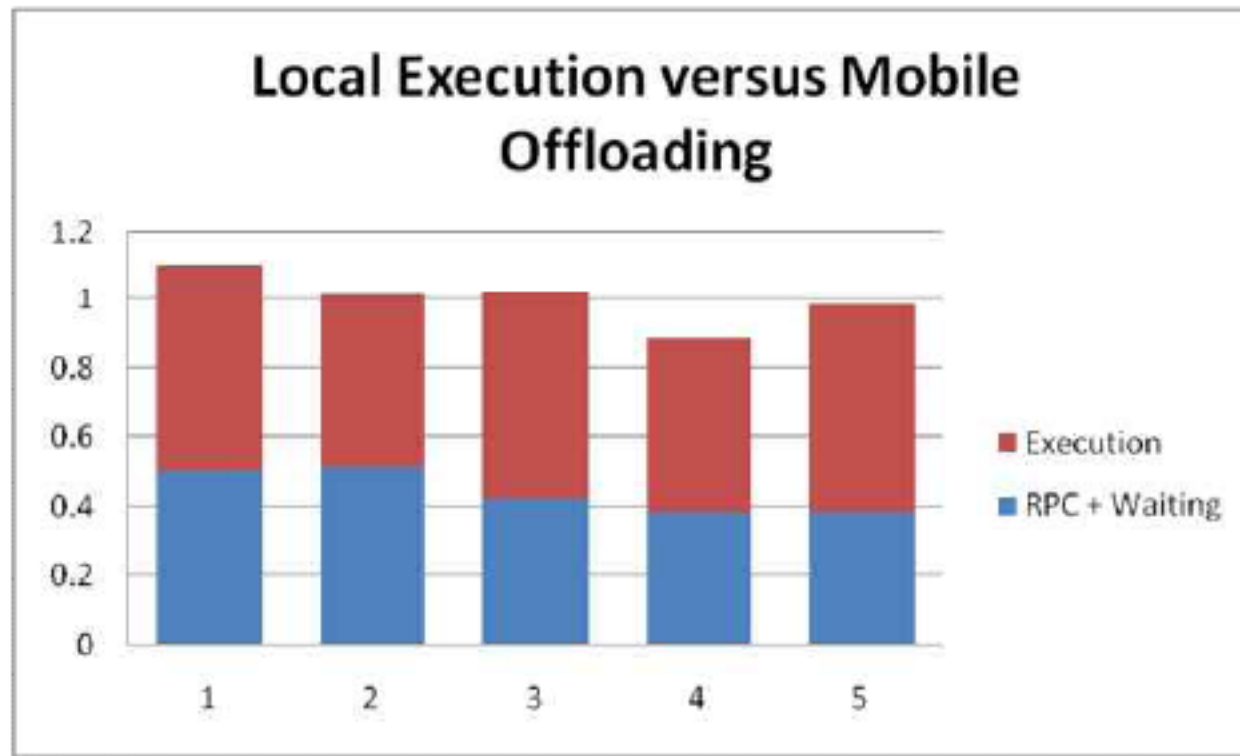


Figure Performance of Mobile Offloading compared to local execution. Results are normalized to local execution (value 1).

Preliminary Evaluations

- Hadoop suffers from low performance with small files
 - We modify this behavior configuring with an infinite number of reuse.
- The gain was of 2% for the average performance and of 3% for the best one.
 - Must tailor hadoop to mobile devices!!!
- There is one more problem with small files that we found during our test: During start up, each DataNode scans its file system and provides the NameNode with the information which files it is storing. The more files there are, the longer this takes in scanning and networking.

Summary

- Mobile phones are becoming the ubiquitous companion for users
 - But they are still resource constrained and battery dependent
 - The usage of remote surrogates is a way to overcome this deficiency
- Limited communication and cost is a barrier for mobile service computing
- A complementary solution is to take advantage of nearby mobile devices
- Main usage: collaborative or 'same time' tasks
- Requires to incorporate context and task awareness

Future Work

- The usage of mobility traces will be considered to create stable communities and not only places
- Considerations related to the usage of context awareness for fault tolerance will be introduced
 - Event-based alerts
- Implement a partitioning scheme for offloading between mobile phones

Questions?