

From Mobile Software Language Engineering to Mobile for Social Good

Engineer Bainomugisha

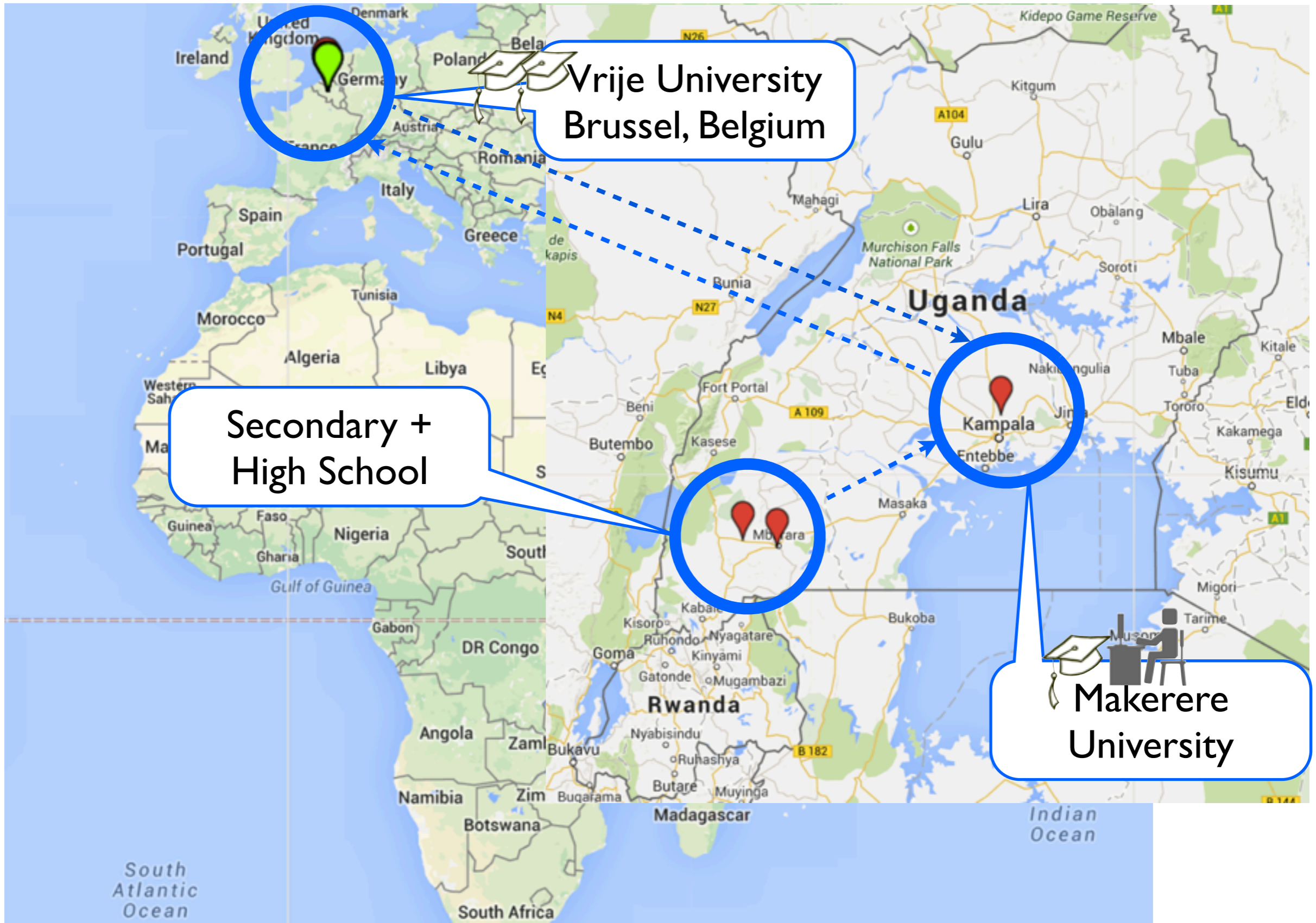
Associate Professor / Head, Department of Computer Science



School of Computing & IT,
Makerere University

Distinguished Guest Lecture at Carnegie Mellon University in Rwanda
17th March 2015

About Me



About Makerere University



- Established in 1922
- About 40,000 students (36,000 undergraduate and 4,000 graduate)
- About 1,500 academic staff/faculty
- 9 Colleges (College of Agriculture and Environmental Sciences

- College of Business and Management Sciences
- **College of Computing & Information Sciences**
- College of Education and External Studies
- College of Engineering, Design, Art and Technology
- College of Health Sciences
- College of Humanities and Social Sciences
- College of Natural Sciences
- College of Veterinary Medicine, Animal resources and BioSecurity
- School of Law

College of Computing & Information Sciences

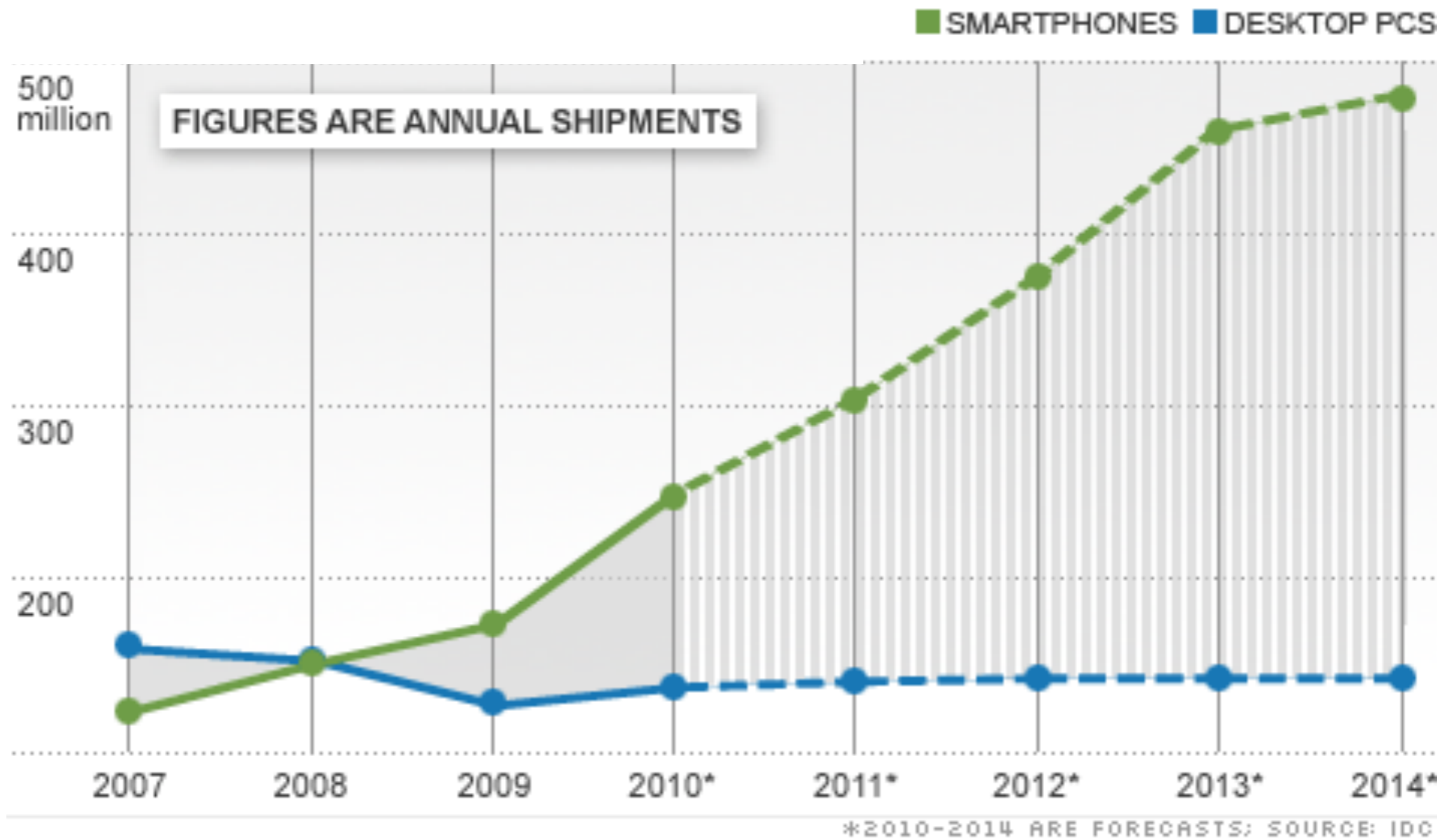


- School of Computing & IT
 - About 5,000 students
 - 4 academic departments
 - 4 masters programmes; 4 undergraduate programmes & 4 PhD programmes

From Mobile Software Language Engineering to Mobile for Social Good

1. Mobile Software Language Engineering
2. Mobile for Social Good

Inexorable Revolution of Smartphones



Source: International Data Corporation (IDC).

Evolution of Mobile Devices and Networks

Difficult to Program &
No Embedded Sensors



2000-2005



2007-

Programmable & Come With
Cheap Powerful Sensors



GPS



Compass



Camera



Accelerometer



Wireless communication

Evolution of Mobile Software Applications



2007-

Programmable & Come With Cheap Powerful Sensors



GPS



Compass



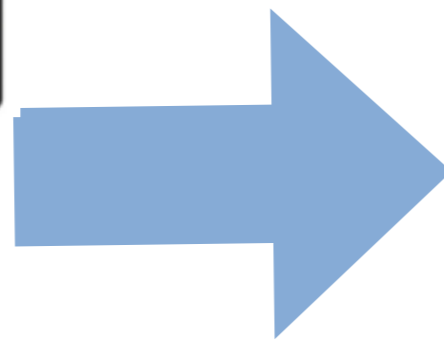
Camera



Accelerometer



Wireless communication



- Peer-to-peer mobile applications
- Context-aware applications

Evolution of Mobile Software Applications



- Peer-to-peer mobile applications



Zero Infrastructure



Mobile Ad hoc Networks
= Volatile Connections

- Context-aware applications



Continuous context changes



Dynamic behavioral adaptations

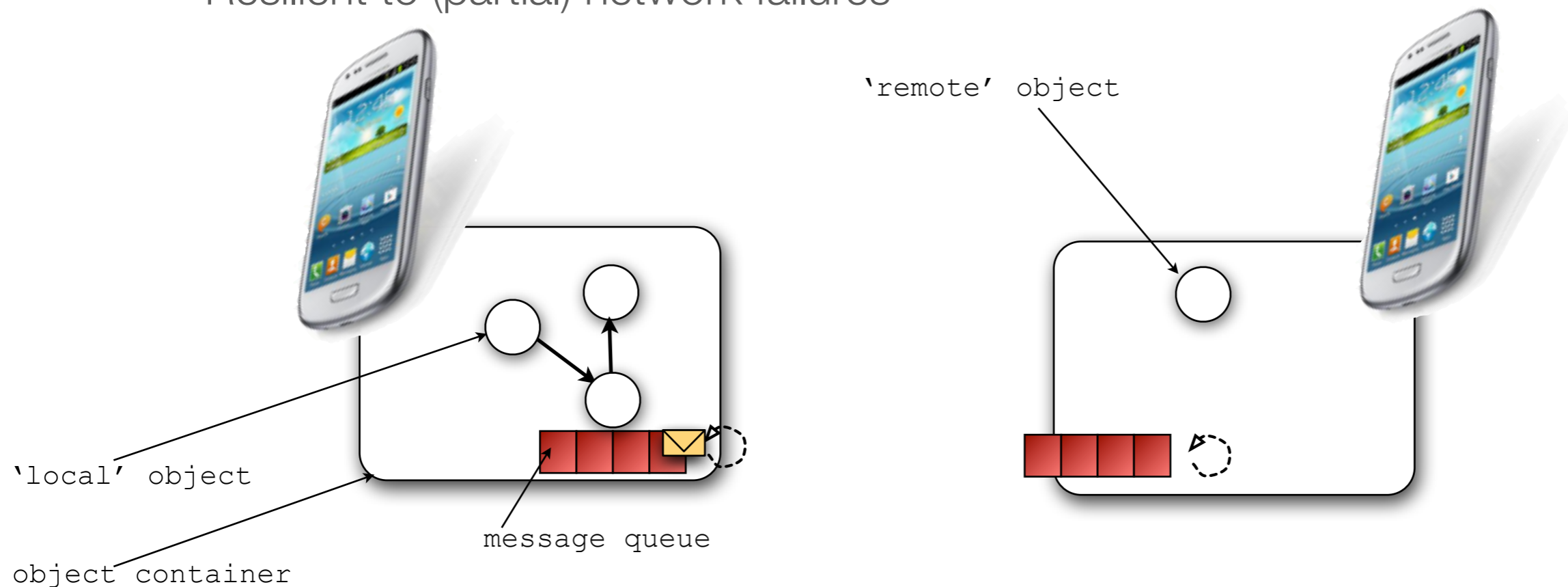
Programming Language Support for Peer-to-Peer Mobile Applications

iScheme - *an instantiation of ambient-oriented programming (AmoP)*

Peer-to-peer (decentralized) service discovery

Asynchronous communication

Resilient to (partial) network failures



Bainomugisha, E. *et.al.* (2012). Bringing Scheme Programming to the iPhone - Experience. *Journal of Software: Practice and Experience*, 42(3):331–356.

10 <http://soft.vub.ac.be/amop/ischeme/ischeme>

Programming Language Support for Peer-to-Peer Mobile Applications

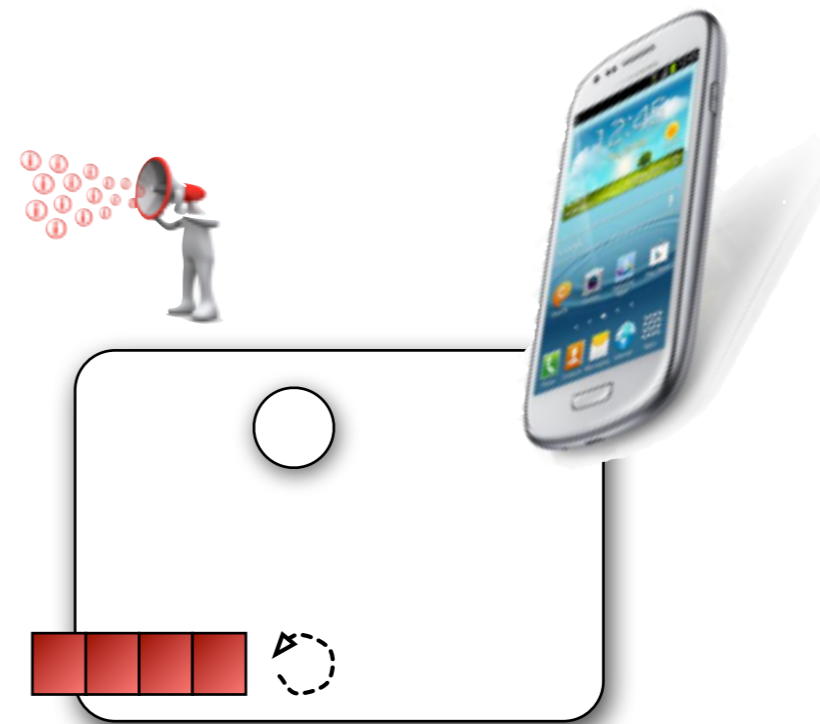
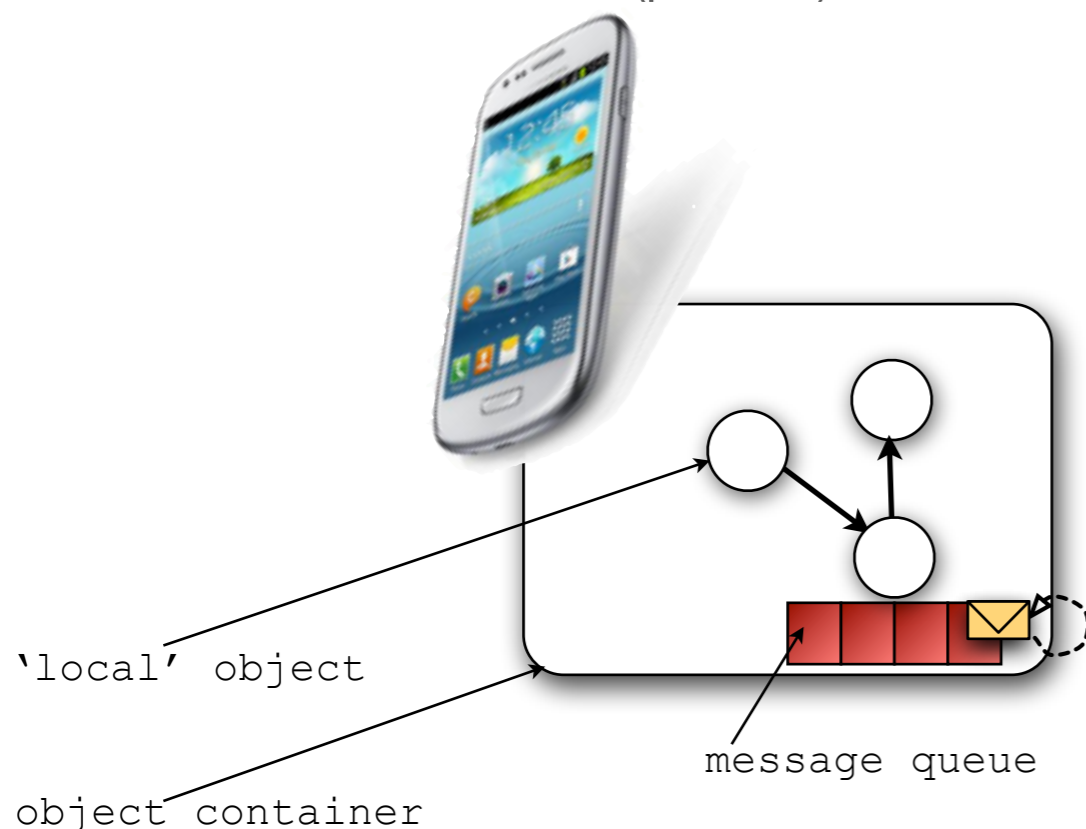
iScheme - *an instantiation of ambient-oriented programming (AmoP)*

Peer-to-peer (decentralized) service discovery

Asynchronous communication

Resilient to (partial) network failures

`(define service-type)`
`(export object service-type)`



Bainomugisha, E. *et.al.* (2012). Bringing Scheme Programming to the iPhone - Experience. *Journal of Software: Practice and Experience*, 42(3):331–356.

|| <http://soft.vub.ac.be/amop/ischeme/ischeme>

Programming Language Support for Peer-to-Peer Mobile Applications

iScheme - *an instantiation of ambient-oriented programming (AmoP)*

Peer-to-peer (decentralized) service discovery

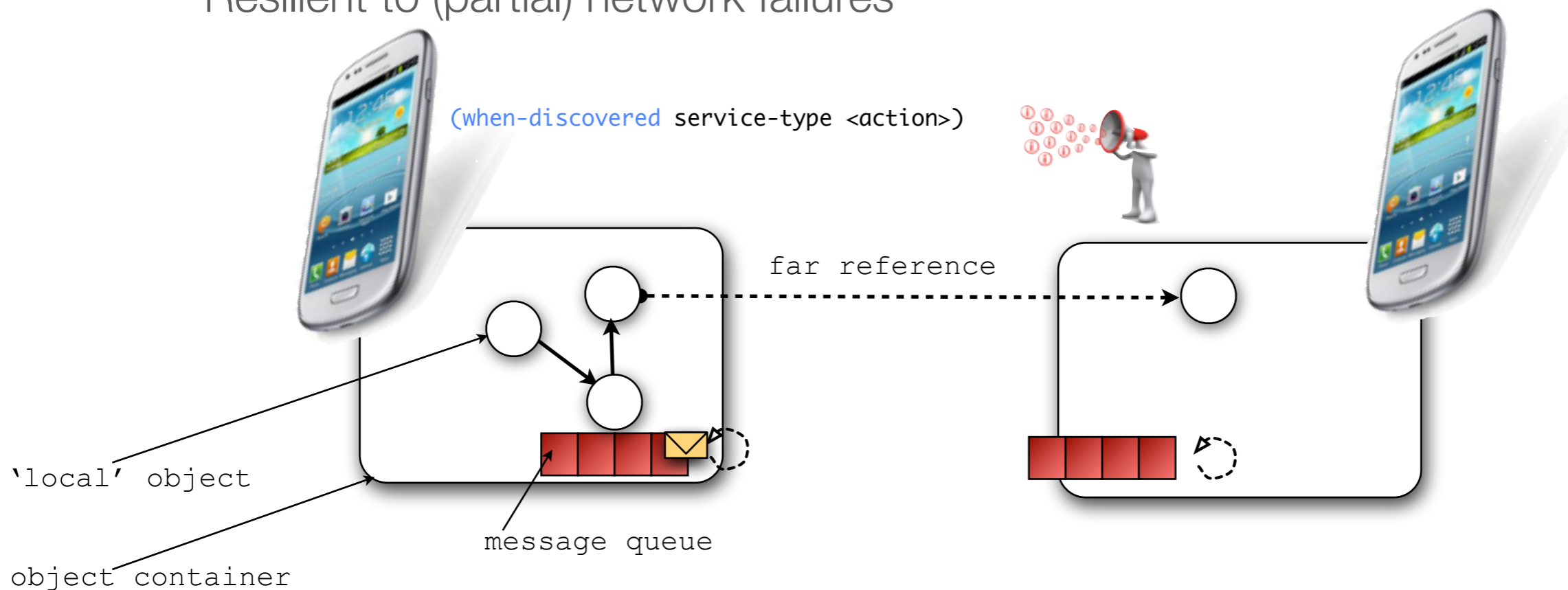
Asynchronous communication

Resilient to (partial) network failures

`(define service-type)`

`(export object service-type)`

`(when-discovered service-type <action>)`



Bainomugisha, E. *et.al.* (2012). Bringing Scheme Programming to the iPhone - Experience. *Journal of Software: Practice and Experience*, 42(3):331–356.

12 <http://soft.vub.ac.be/amop/ischeme/ischeme>

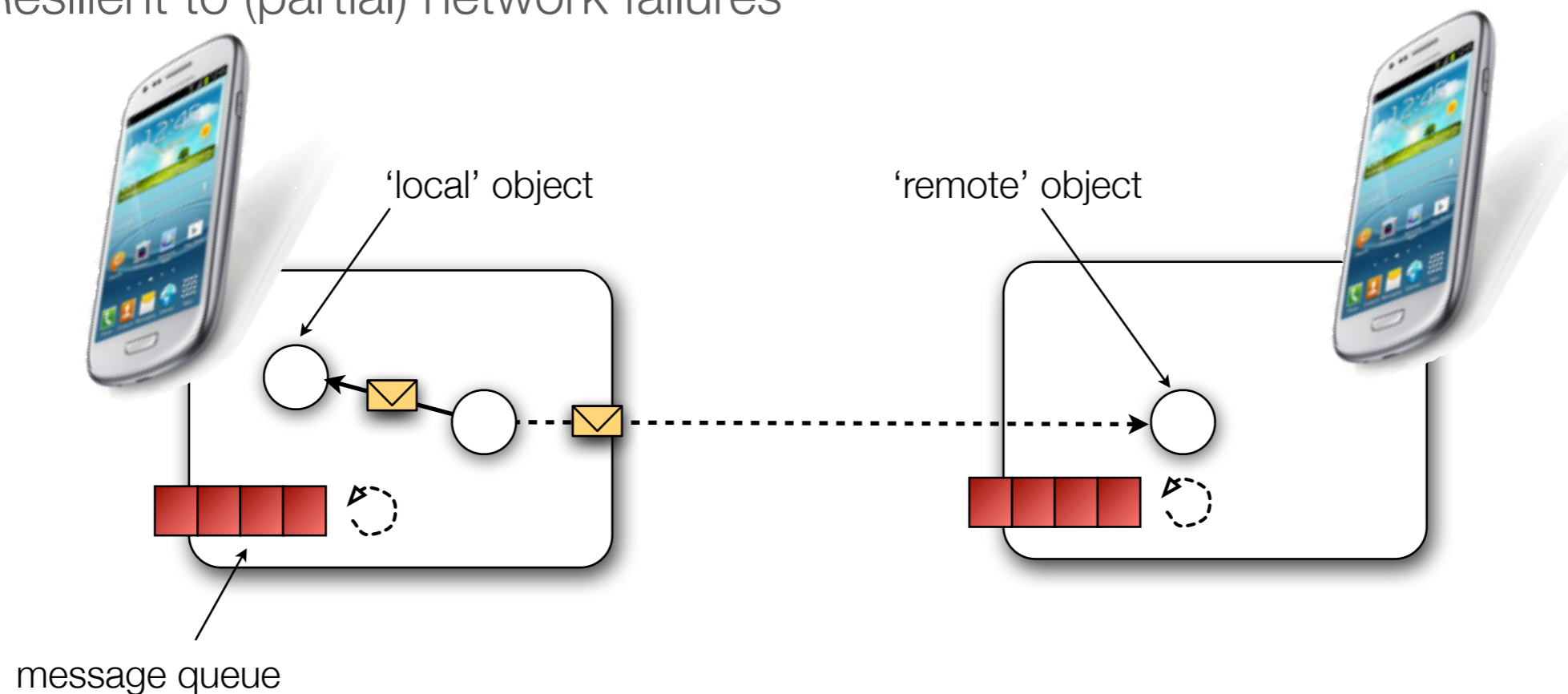
Programming Language Support for Peer-to-Peer Mobile Applications

iScheme - *an instantiation of ambient-oriented programming (AmoP)*

Peer-to-peer (decentralized) service discovery

Asynchronous communication

Resilient to (partial) network failures



Bainomugisha, E. *et.al.* (2012). Bringing Scheme Programming to the iPhone - Experience. *Journal of Software: Practice and Experience*, 42(3):331–356.

13 <http://soft.vub.ac.be/amop/ischeme/ischeme>

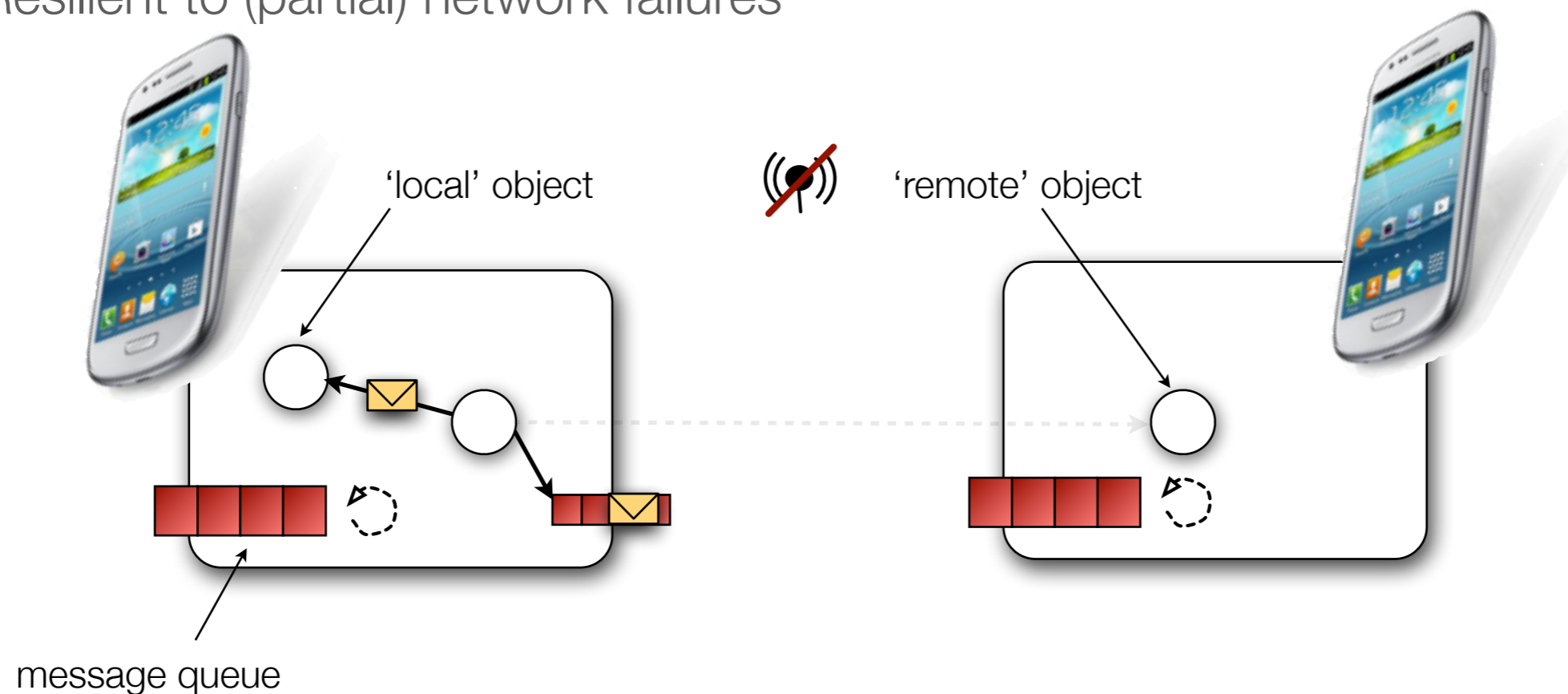
Programming Language Support for Peer-to-Peer Mobile Applications

iScheme - *an instantiation of ambient-oriented programming (AmoP)*

Peer-to-peer (decentralized) service discovery

Asynchronous communication

Resilient to (partial) network failures



Bainomugisha, E. *et.al.* (2012). Bringing Scheme Programming to the iPhone - Experience. *Journal of Software: Practice and Experience*, 42(3):331–356.

13 <http://soft.vub.ac.be/amop/ischeme/ischeme>

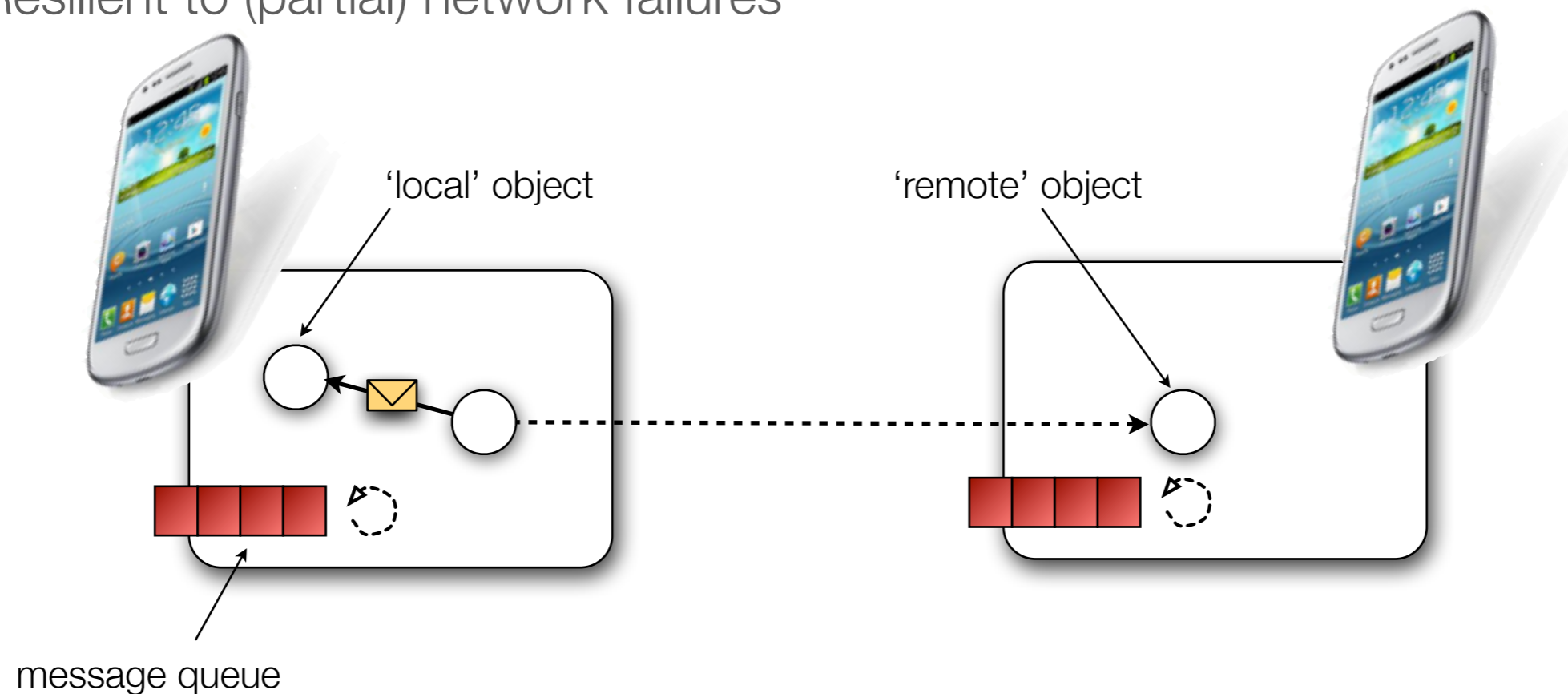
Programming Language Support for Peer-to-Peer Mobile Applications

iScheme - *an instantiation of ambient-oriented programming (AmoP)*

Peer-to-peer (decentralized) service discovery

Asynchronous communication

Resilient to (partial) network failures



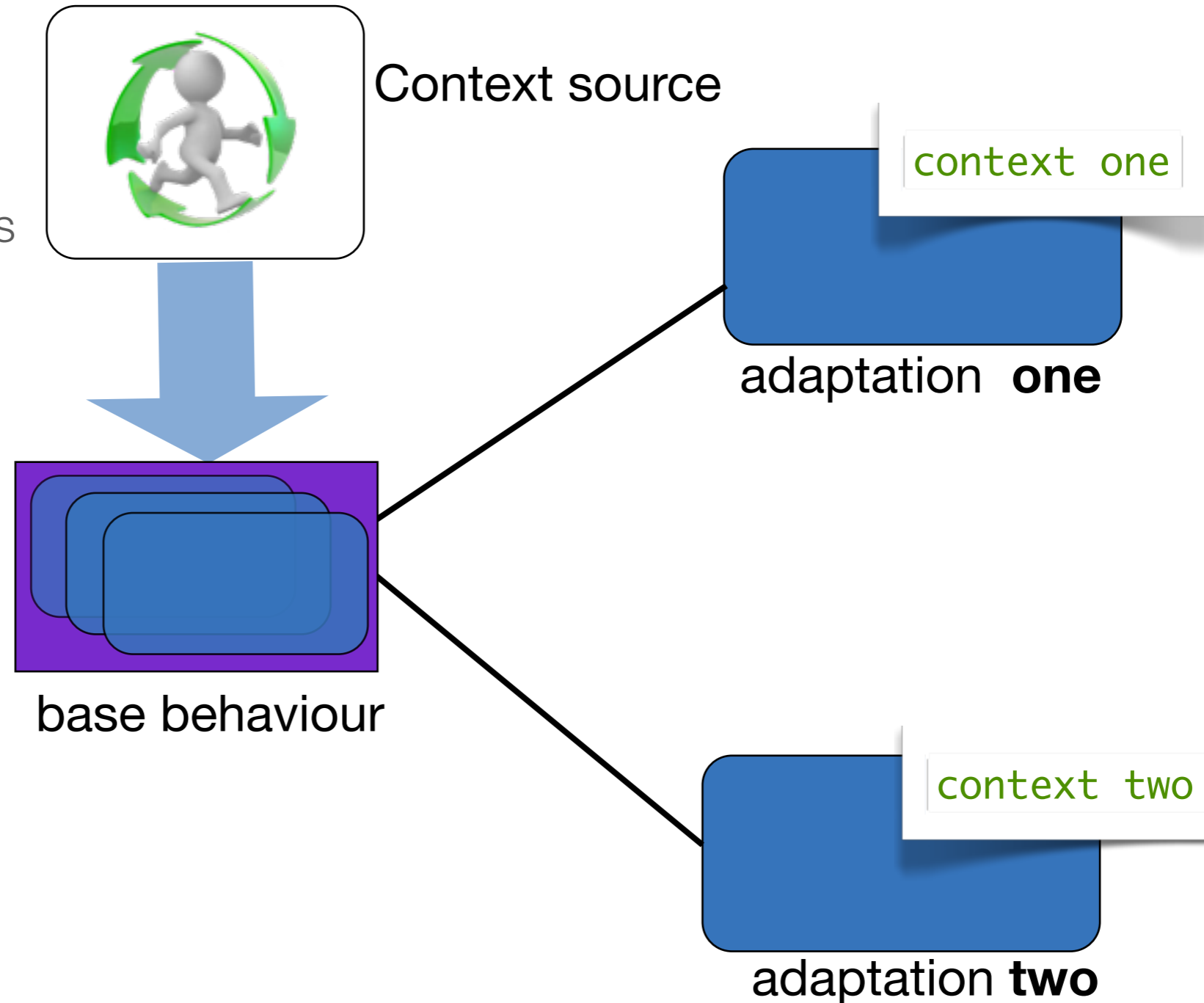
Bainomugisha, E. *et.al.* (2012). Bringing Scheme Programming to the iPhone - Experience. *Journal of Software: Practice and Experience*, 42(3):331–356.

13 <http://soft.vub.ac.be/amop/ischeme/ischeme>

Programming Language Support for Context-Oriented Programming

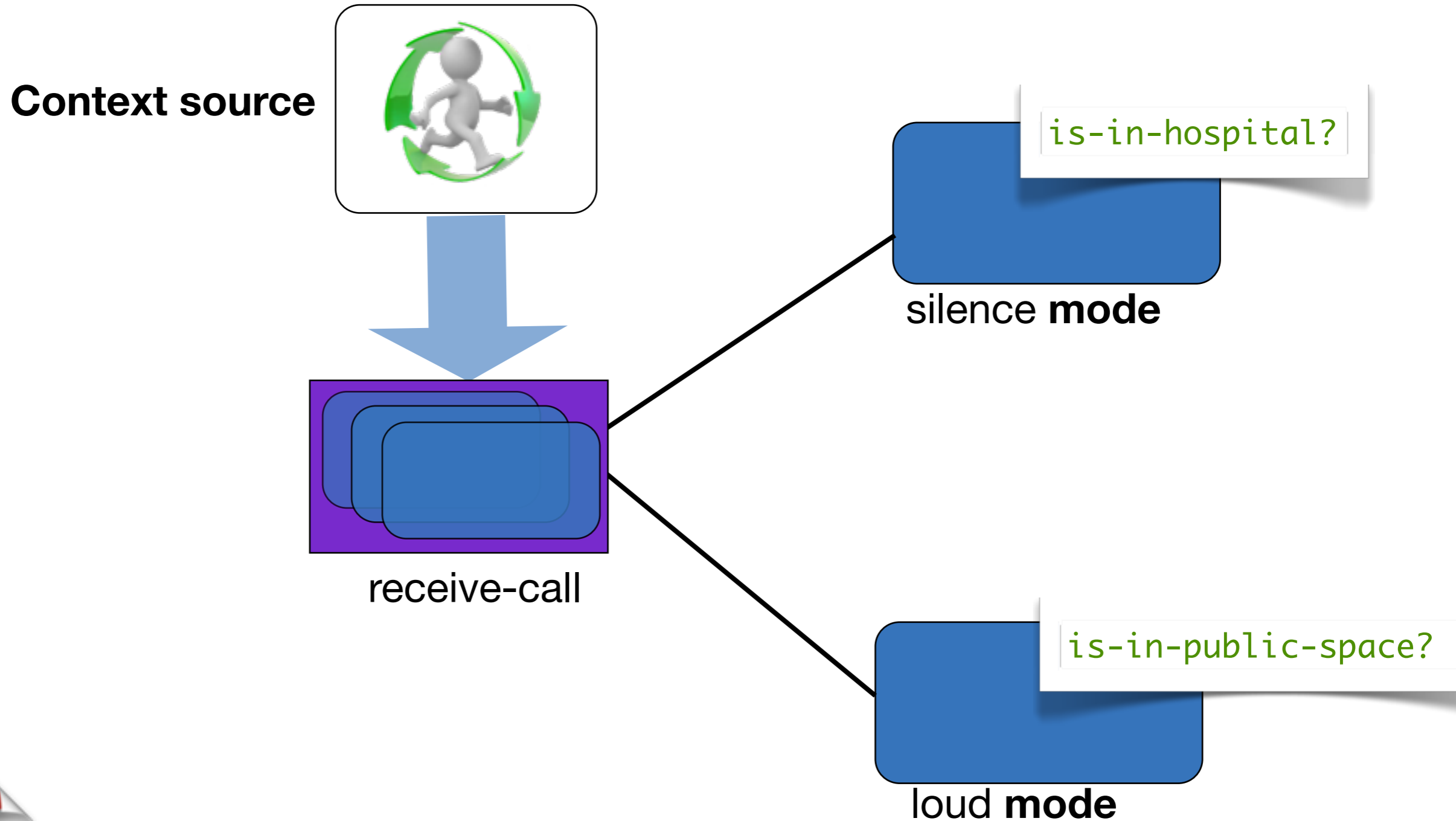
Flute Language

Reactive context sources
Contextual dispatch



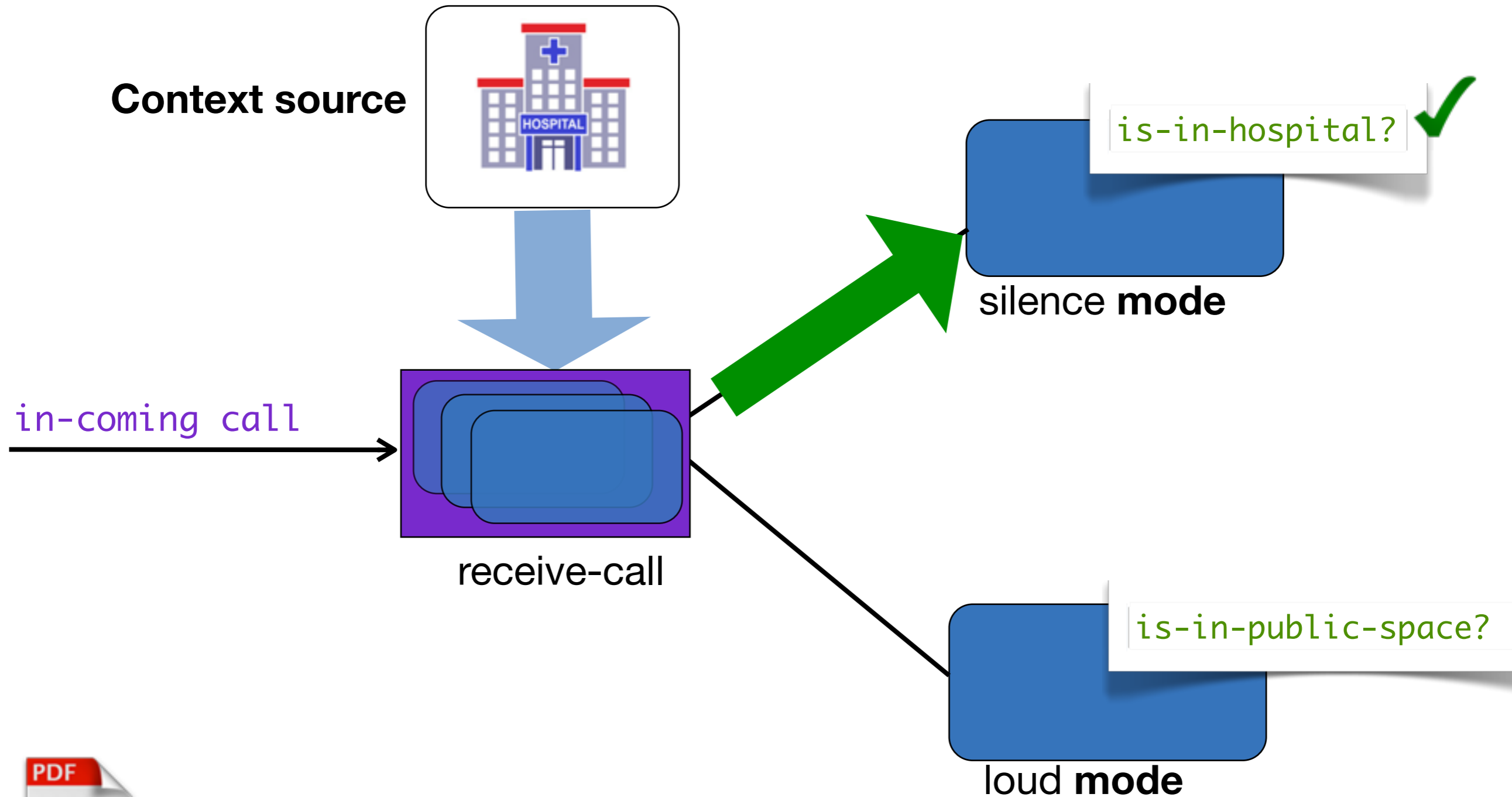
Bainomugisha, E. *et.al.* (2012). Interruptible Context-dependent Executions: A Fresh Look at Programming Context-aware Applications. *SPLASH/OnWard! 2012*, Arizona, USA

Programming Language Support for Context-Oriented Programming



Bainomugisha, E. *et.al.* (2012). Interruptible Context-dependent Executions: A Fresh Look at Programming Context-aware Applications. *SPLASH/OnWard! 2012*, Arizona, USA

Programming Language Support for Context-Oriented Programming



Bainomugisha, E. *et.al.* (2012). Interruptible Context-dependent Executions: A Fresh Look at Programming Context-aware Applications. *SPLASH/OnWard! 2012*, Arizona, USA

Mobile for Social Good

How does mobile software language engineering improve people's lives?

Opportunities

- > 6 billion mobile phones + >7 billion people
- Hardware capabilities (sensors, multitouch screens, connectivity...)
- Growing use of smartphones and mobile internet access

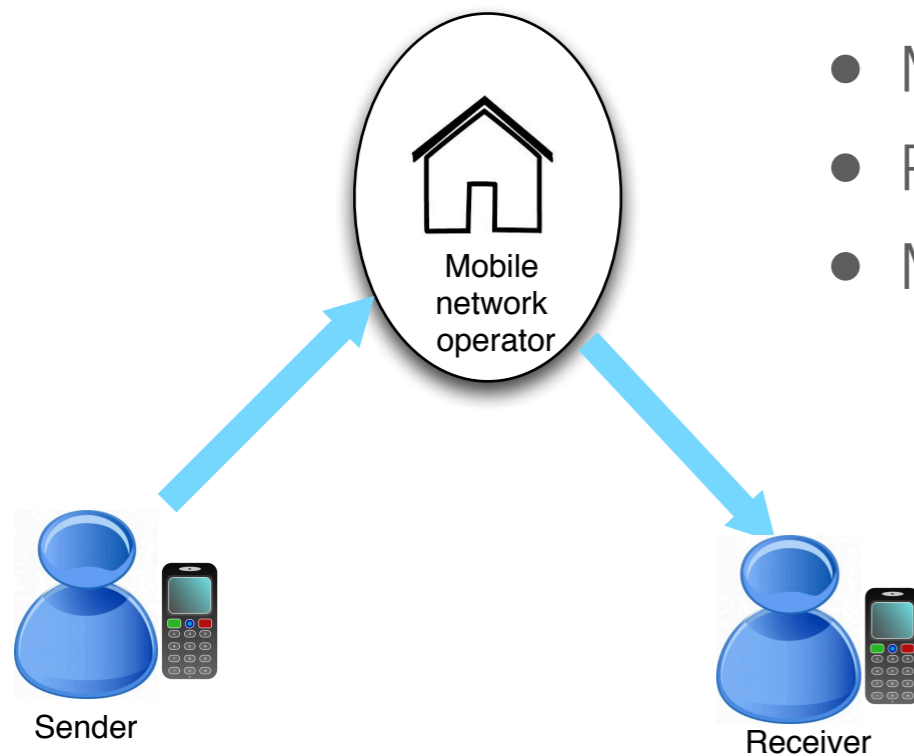
Application Areas

- Healthcare
- Transportation
- Energy
- Education
- Financial services
- Agriculture

Mobile for Social Good

Project #1: Peer-to-Peer Mobile Money Transactions

- Middleware for secure P2P mobile money transactions
- P2P service discovery of digital wallets
- Monetary object representation and secure exchange



a) Client-server mobile money transaction



b) P2P mobile money transaction



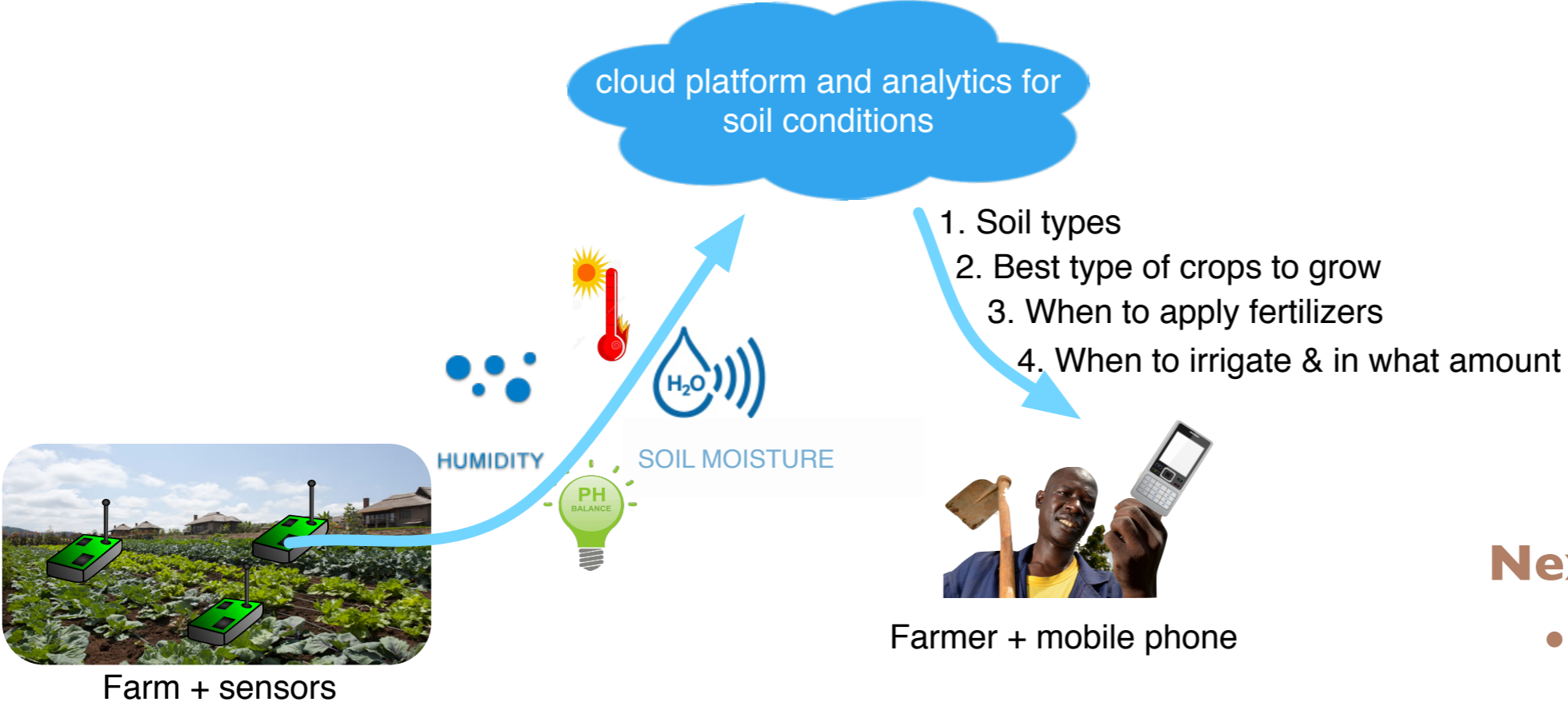
Tadeo, J. & Bainomugisha, E. *et.al.* (2015). *P2PMoMo: A Middleware for Secure Peer-to-Peer Mobile Money Transactions.* (Draft Manuscript)



MSc Student
Judas Tadeo

Mobile for Social Good

Project #2: Soil Metrics: Low-cost soil conditions monitoring

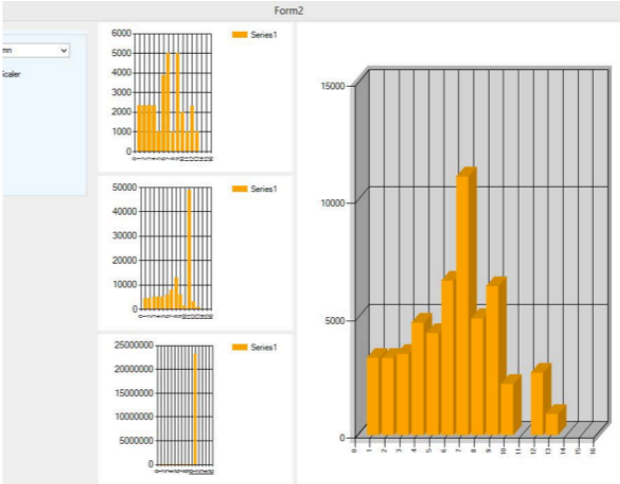


Next steps

- Solar-powered batteries
- Peer-to-peer networks

2014

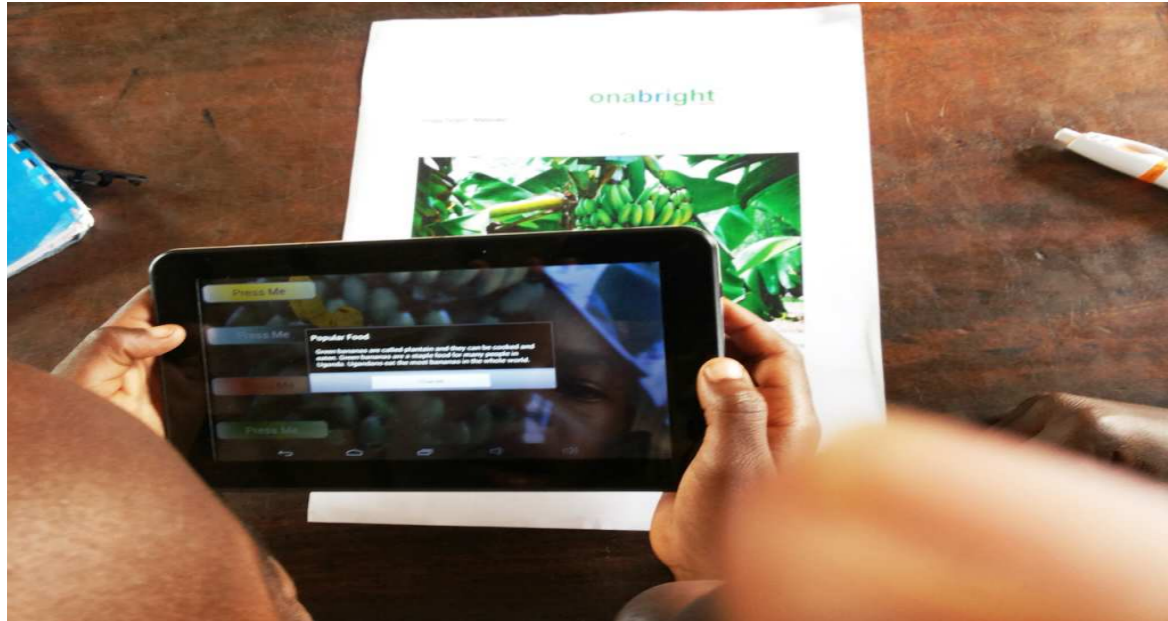
2015



**Undergraduate students
Joel Ssematimba Joel &
Kevin Kiyega**

Mobile for Social Good

Project #3: Using Augmented Reality and Serious Gaming to Enhance Learning: The Case of Primary School Education in Uganda

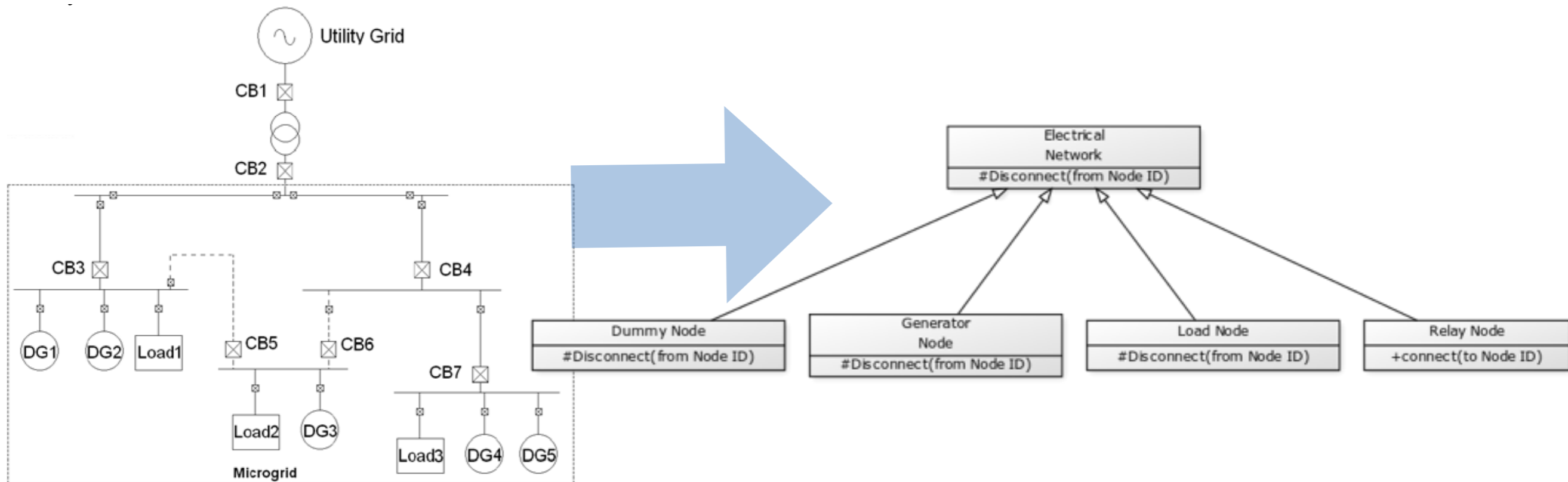


**MSc student
Bright Onapito**

Mobile for Social Good

Project #4: Object Oriented Representation of Electrical Networks

(In Collaboration with Prof. Taha Selim)



- Representation of electrical nodes (relays, generators, and loads) as object-oriented data structures
- Monitoring of changes in the network in *a peer-to-peer fashion without a centralized infrastructure*
- Simulations



MSc student
Milton Kaye

Research Groups at the School of Computing & IT

Artificial Intelligence for Development

Wireless Networks & System Security

Development Informatics

Software & Enterprise Engineering

Thank you