MIRACLE:
Mixed Reality Applications for City-based Leisure and Experience

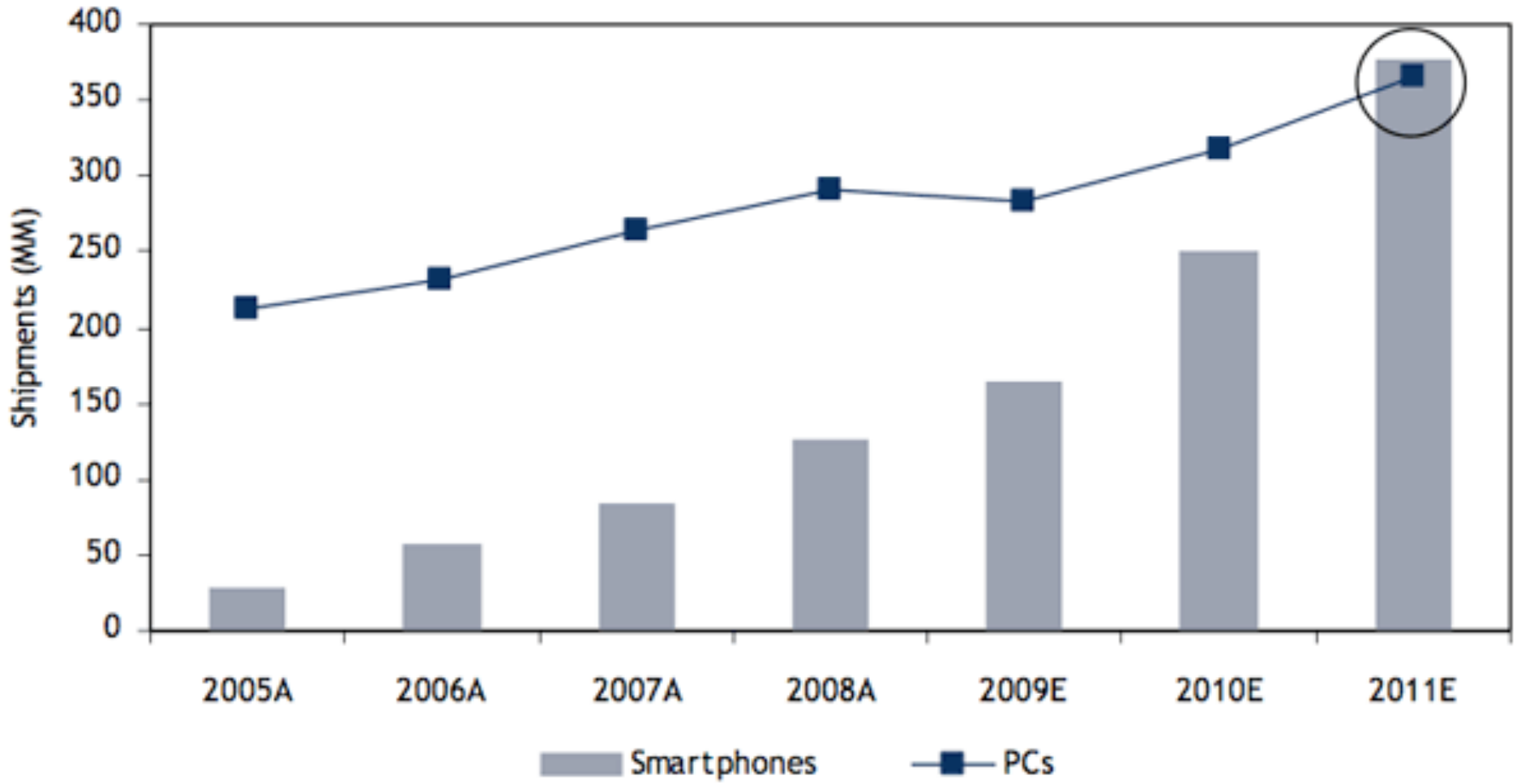
Mark Billinghurst
HIT Lab NZ
October 2009

PEPSI
ECLIPSE OF THE SUN IN GHANA
29 MARCH 2006

cingular
NEXTEL
Messages

Silicon Alley Insider Chart of the Day

Smartphone Sales To Beat PC Sales By 2011



Source: RBC Capital Markets estimates

vimeo
eskobo
Zimbra
FireAnt
standpoint
SHOUTWIRE
vSocial
blogbeat
FeedBurner
Yub.com
ajchat
jambo
ROLLYO
ClipShack
looklater
Noodly
diigo
box
writely
pegasus
SQUIDOO
pictureCloud
ShoZu
Technorati
Gmail
feedmarker
MusicSearch
Meet With Approval
Spin
Gcast
chatsum
WebJay
digg
TRUVEO
Clipfire
FXNG
magnolia
Jobs
Simpy
Gtalkr
squishy
ourmedia
Alimydata.com
NewsAlloy
FOTOLOG
CASTPOST
zoominfo
Feedster
PODZINGER
Ning
Oskles
Strangespace
Fruitcast
Publub
wink
iKarma
gOFFICE
Findory
buddymedia
pando
zigtag
oyogi
dabble
Renkoo
YEDDA
Tail
Tailrank
Trumba
Zimbra
favoor
ODDPOST
simplyhired
Feedster
PodDaler
groupby
Blogniscient
nuvvo
TagWorld
blish
flogr
meebo
last.fm
newsgator
smugmug
Pageflakes
shutterfly
greenee
skobee
Finder
Tail
Talkr
R
caligreg
oyogi
dabble
Findory
Zigtag
pando
Zoho
Zimbra
Zumbo
Ziggs
Feedster
Flickr
Ning
Oskles
Strangespace
FeedBurner
Bloglines
Yub.com
ajchat
Gcast
chatsum
looklater
Noodly
WebJay
digg
TRUVEO
Clipfire
FXNG
MusicSearch
Meet With Approval
Spin
jambo
ROLLYO
ClipShack
diigo
box
Jobs
writely
Simpy
Gtalkr
pegasus
SQUIDOO
pictureCloud
ShoZu
Technorati
Gmail
feedmarker
magnolia
Tagyu
AlmondRocks
squishy
ourmedia
Alimydata.com
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Oskles
Strangespace
Fruitcast
Publub
wink
iKarma
gOFFICE
Findory
buddymedia
pando
zigtag
oyogi
dabble
Renkoo
YEDDA
Tail
Tailrank
Trumba
Zimbra
favoor
ODDPOST
simplyhired
FireAnt
standpoint
SHOUTWIRE
vSocial
blogbeat
FeedBurner
Yub.com
ajchat
jambo
ROLLYO
ClipShack
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Noodly
diigo
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SQUIDOO
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buddymedia
pando
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oyogi
dabble
Renkoo
YEDDA
Tail
Tailrank
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vSocial
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Yub.com
ajchat
jambo
ROLLYO
ClipShack
looklater
Noodly
diigo
box
writely
pegasus
SQUIDOO
pictureCloud
ShoZu
Technorati
Gmail
feedmarker
MusicSearch
Meet With Approval
Spin

US User-Generated Content Creators, 2007-2012 (millions and % of Internet users)

Note: individuals who create and share any of the following online at least once per month-video, audio, photos, personal blogs, personal Web sites, online bulletin board postings, personal profiles in social networks or virtual worlds and/or customer reviews
Source: eMarketer, April 2008

MIRACLE Project

- Goal: Explore *User Generated Content* in context of *Mobile Mixed Reality*

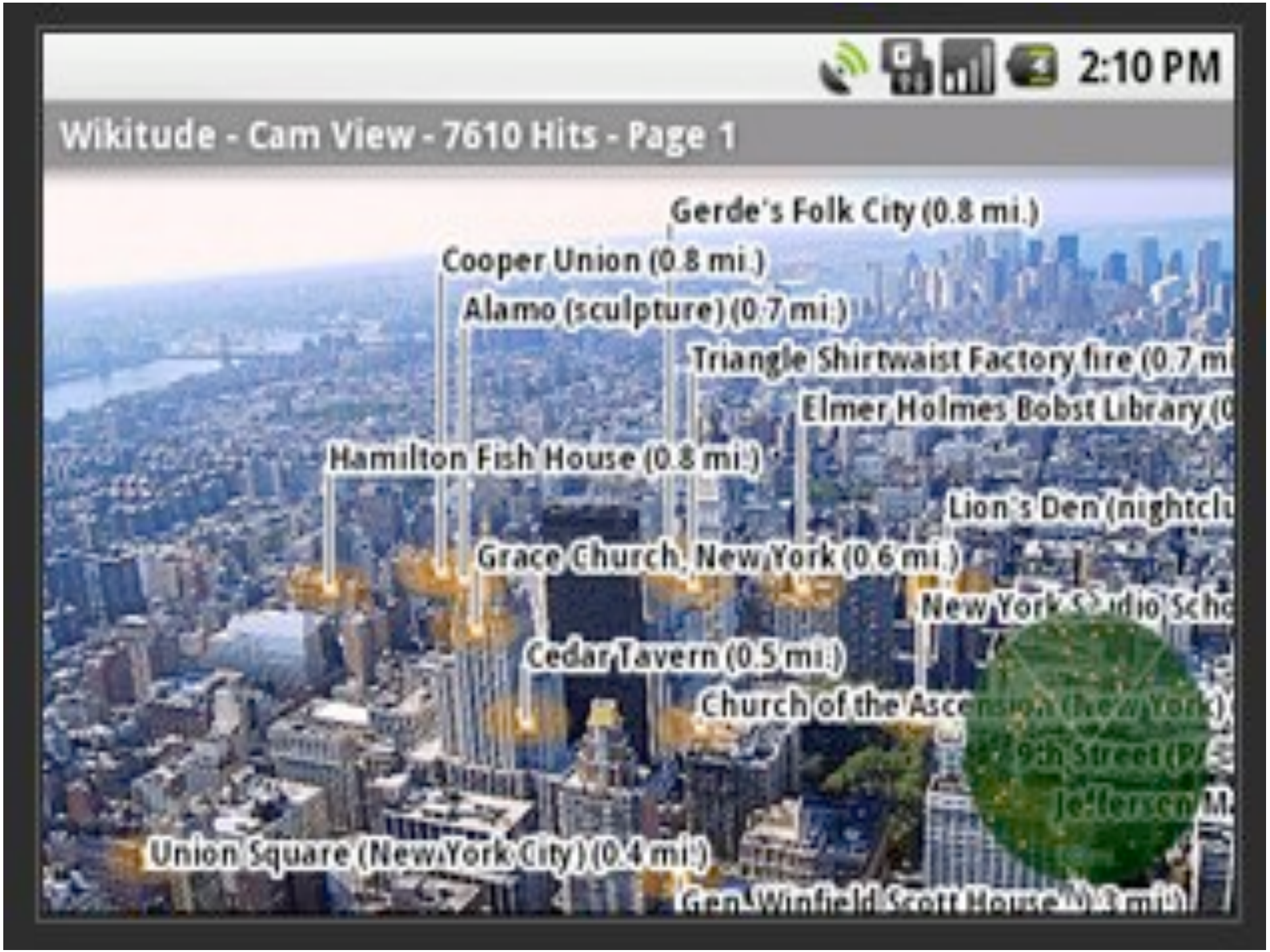
  UGC + Mobile + AR + Urban

- Main Challenge: Provision of tools and interfaces to allowing users to experience and create their own geo-based Mixed Reality content

TAPAS
SALUD
PALVELU
SUUTARI
mawana

17:32 30-08-07
1853
1929
Burgers in Räpis are awful Avoid at all cost!
Ordered
bukra
KIRJAKAUPPA
Juzmo
Train to Turku
18:09
€4.80
STELLA ARTOIS
May Lin
Pekka
PERSONAL VIEW

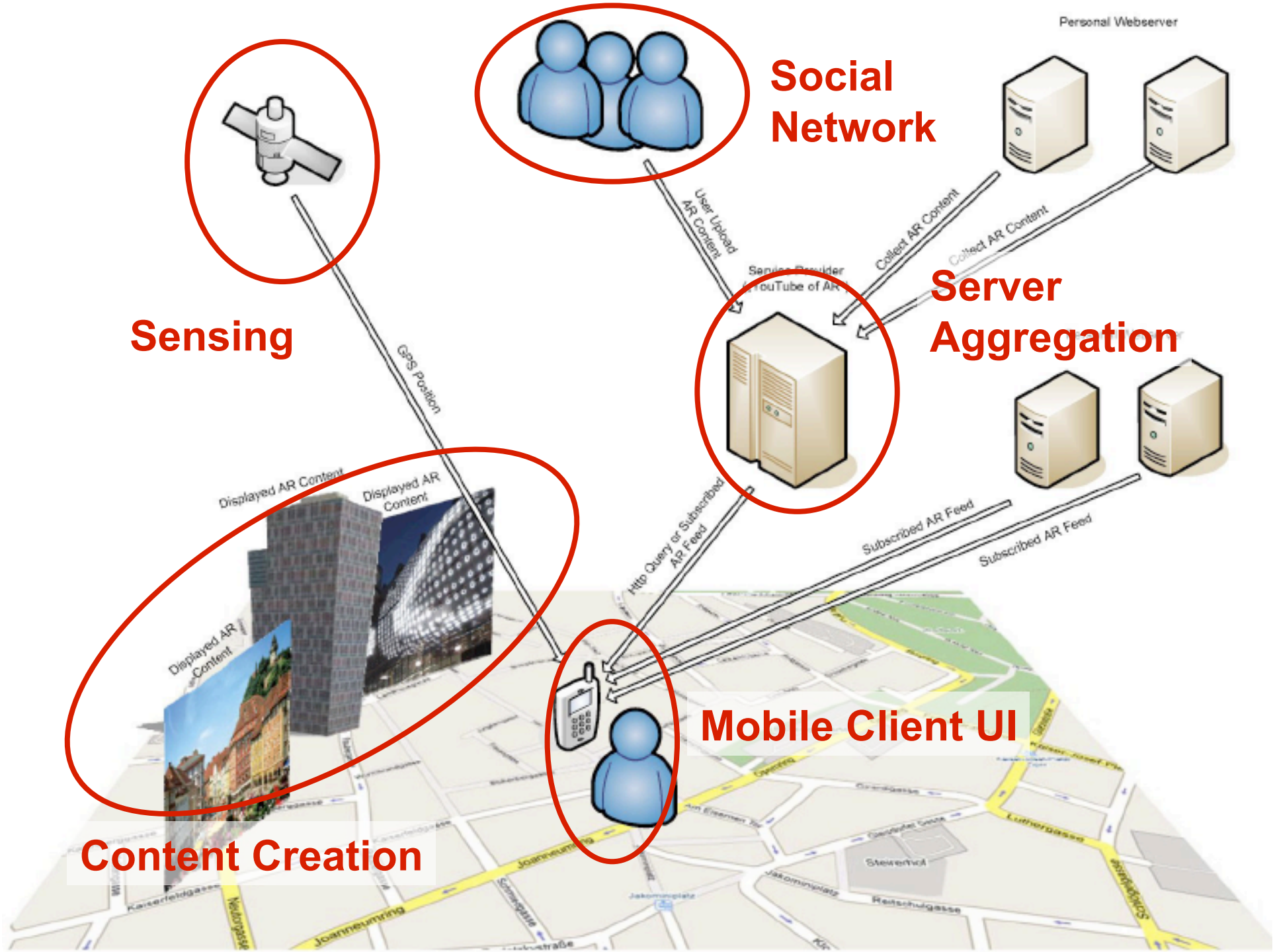
vodafone
Soundwalk
Saint Germain Des Près
0.3
CAFÉ DE FLORE
www.cafe-de-flore.com
172 Boulevard Saint Germain
75006 Paris
Tel : 33 1 45 48 55 26
Every day 7.30 am - 1.30 am
06
07
menu


2:10 PM
Wikitude - Cam View - 7610 Hits - Page 1
Gerde's Folk City (0.8 mi.)
Cooper Union (0.8 mi.)
Alamo (sculpture) (0.7 mi.)
Triangle Shirtwaist Factory fire (0.7 mi
Elmer Holmes Bobst Library (0
Hamilton Fish House (0.8 mi.)
Lion's Den (nightclu
Grace Church, New York (0.6 mi.)
Cedar Tavern (0.5 mi.)
Union Square (New York City) (0.4 mi.)

MIRACLE Objectives

- Develop new types of mobile Mixed Reality systems based on mobile devices
- Providing tools for easy creation of mobile Mixed Reality applications
- Allow people to access new rich media anywhere, anytime, augmenting their current environment
- Enabling people to create their own rich content for leisure, learning, information, and other purposes
- Developing methods for evaluating the Mobile MR experience and measuring the Presence aspects.

Harvard University
Brattle St,
Cambridge, MA
(617) 495-402
Out of Town News-Hudson News
Harvard Sq
Cambridge, MA 02138
(617) 354-7777
Menu
0.2 Miles then turn right on Cambridge St.
5.1 miles left


Social Network
Personal Webserver
Sensing
Server Aggregation
User Upload AR Content
Collect AR Content
Collect AR Content
GPS Position
Displayed AR Content
Displayed AR Content
Displayed AR Content
Http Query or Subscribed AR Feed
Subscribed AR Feed
Subscribed AR Feed
Mobile Client UI
Content Creation

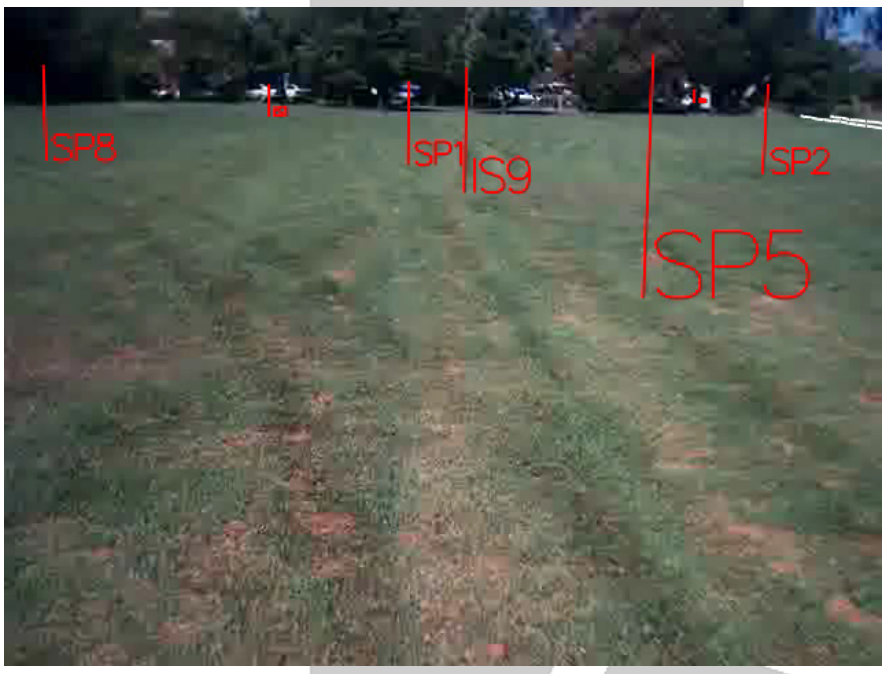
HIT Lab NZ Research

- Earlier Work
  - Backpack AR
  - Mobile Phone AR (Interaction, Advertising)
- Mobile Tracking, Interaction
  - SSTT
- Mobile AR Content Authoring
  - ComposAR, Python AR
- Android Platform
  - 3D model viewing
- Social Networking
  - Otasizzle (TKK)

Mobile Outdoor AR: Trimble

- Highly accurate outdoor AR tracking system
  - GPS, Inertial, RTK system
- First prototype complete
  - Laptop based
  - 2-3 cm accuracy

Image Registration



AR Stakeout Application

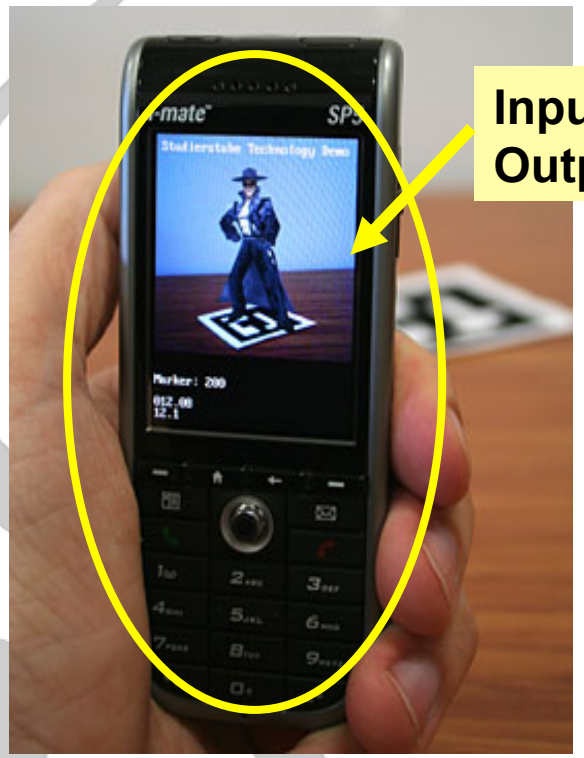
Mobile Phone AR

- Mobile Phones
  - camera
  - processor
  - display
- AR on Mobile Phones
  - Simple graphics
  - Optimized computer vision
  - Collaborative Interaction

HMD vs Handheld AR Interface

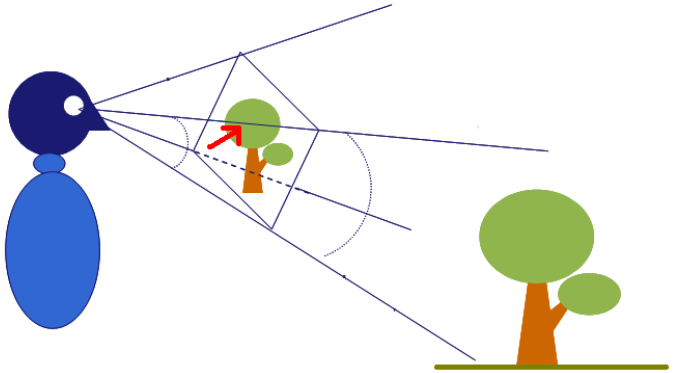
Wearable AR

HandHeld AR

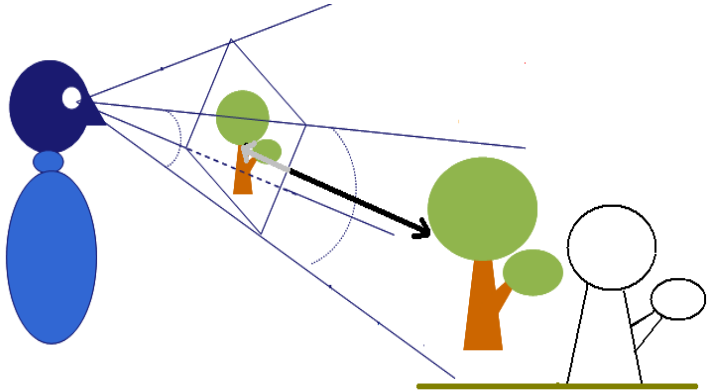


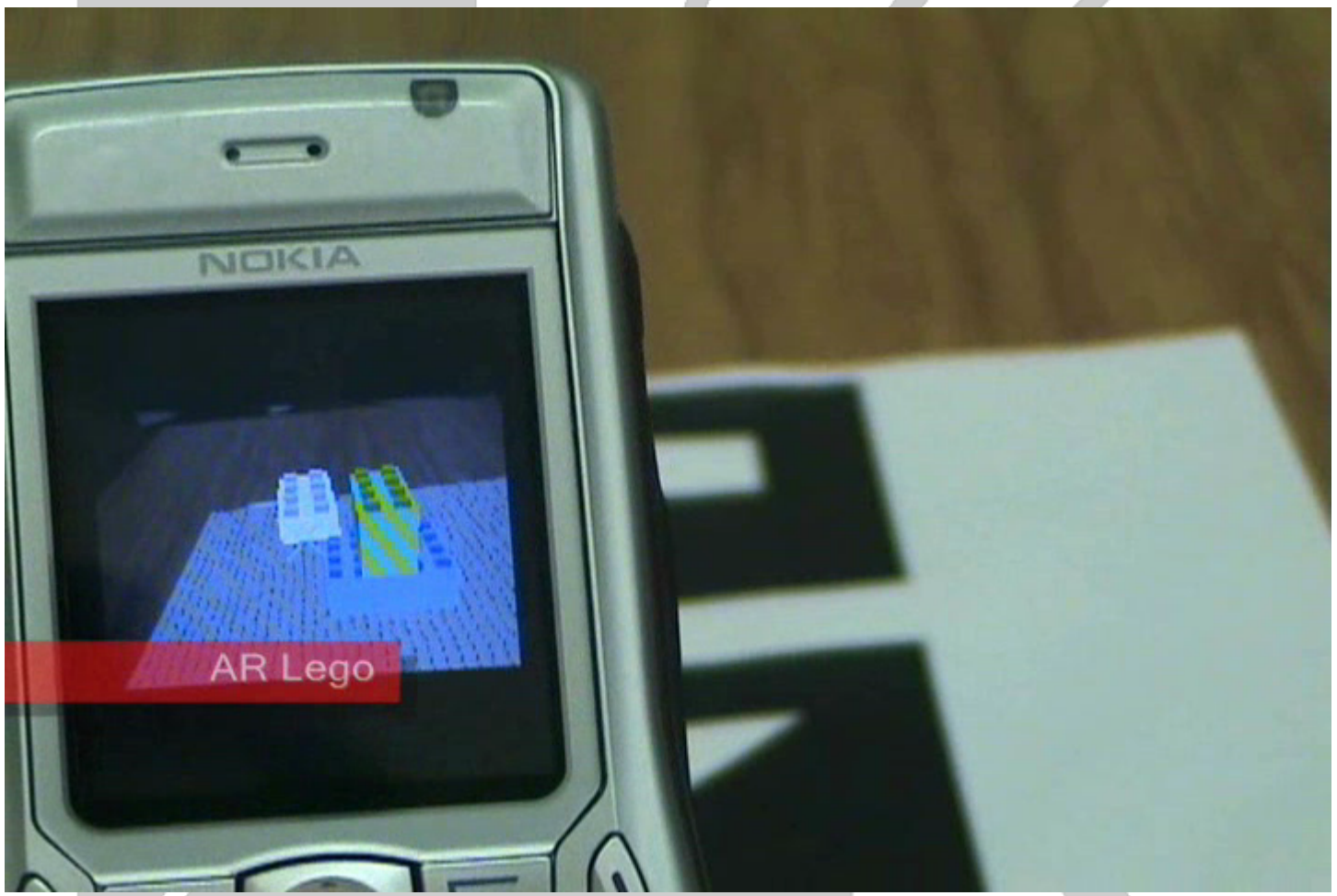
Handheld Interface Metaphors

- **Tangible AR Lens Viewing**
  - Look through screen into AR scene
  - Interact with screen to interact with AR content
    - Eg Invisible Train

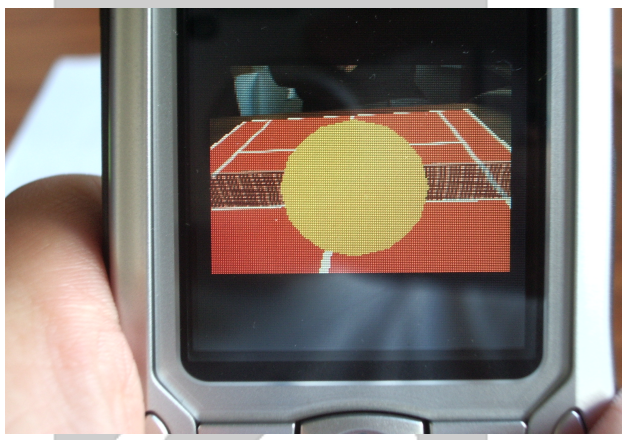


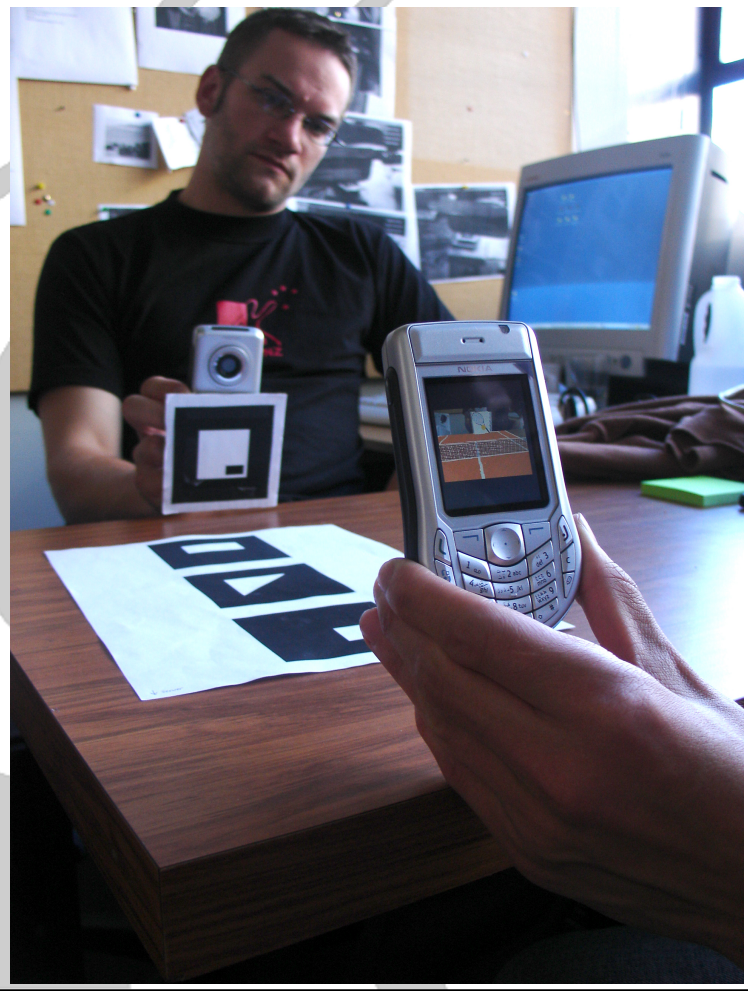
- **Tangible AR Lens Manipulation**
  - Select AR object and attach to device
  - Use the motion of the device as input
    - Eg AR Lego




NOKIA
AR Lego

Collaborative AR

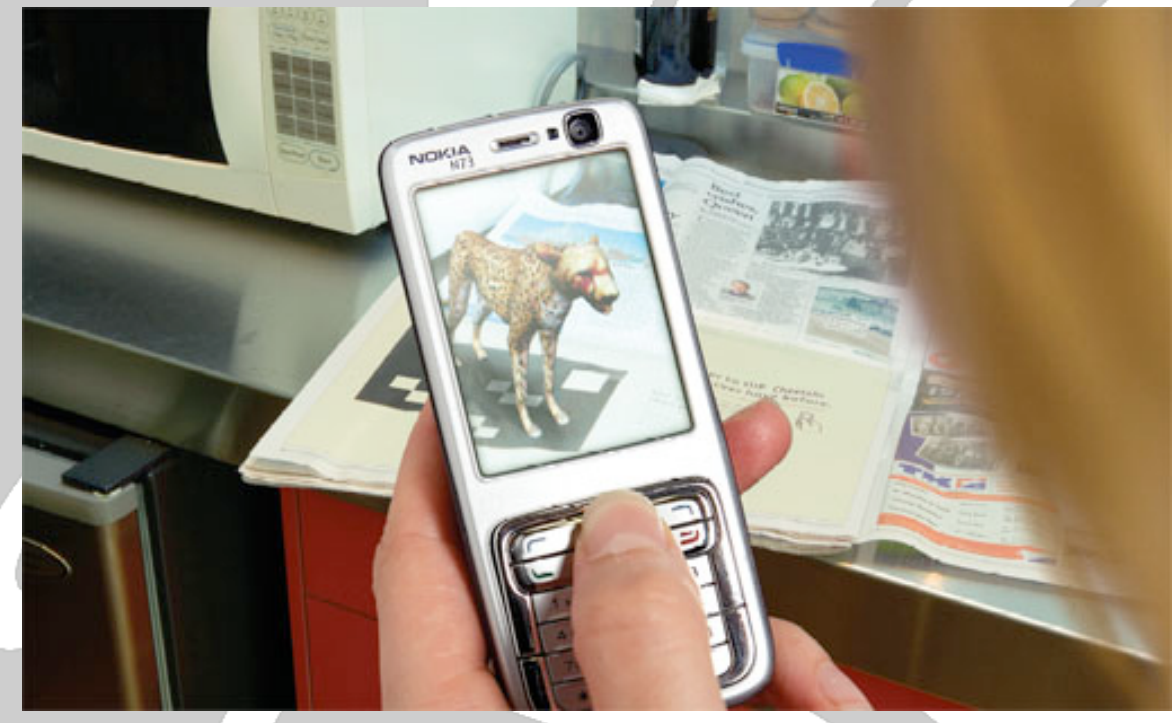




- AR Tennis
  - Virtual tennis court
  - Two user game
  - Audio + haptic feedback
  - Bluetooth messaging

Collaborative AR

AR Advertising



- Txt message to download AR application (200K)
- See virtual content popping out of real paper advert
- Tested May 2007 by Saatchi and Saatchi

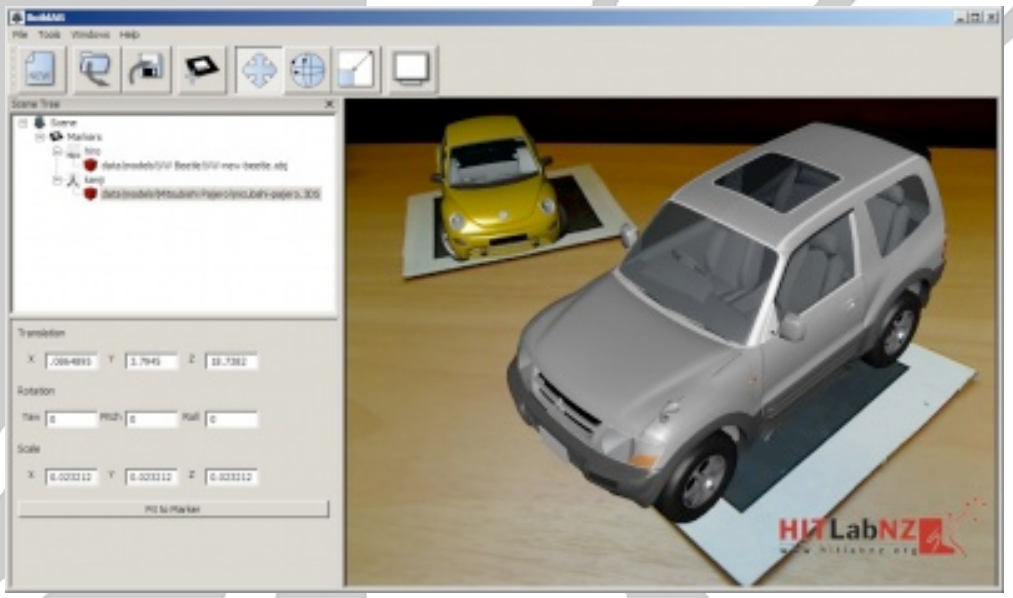
Rapid Prototyping

- Speed development time by using quick hardware mockups
  - handheld device connected to PC
  - LCD screen
  - USB phone keypad
  - Camera

Authoring

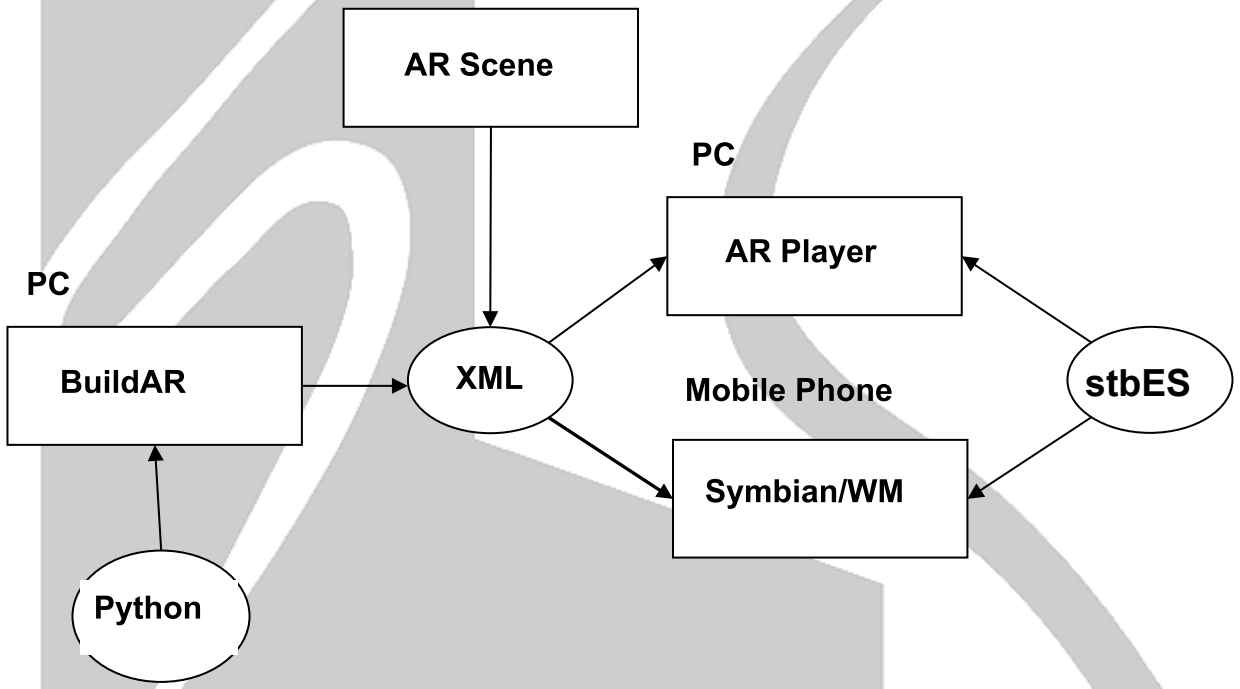
- Destop Authoring
  - Most AR authoring to date on desktop
  - Efficient for complex content preparation
  - Efficient for large-scale overview
  - Not efficient for spontaneous authoring
- In-situ authoring:
  - Tracking requires model or online modeling
  - Annotation on phone: limited

BuildAR

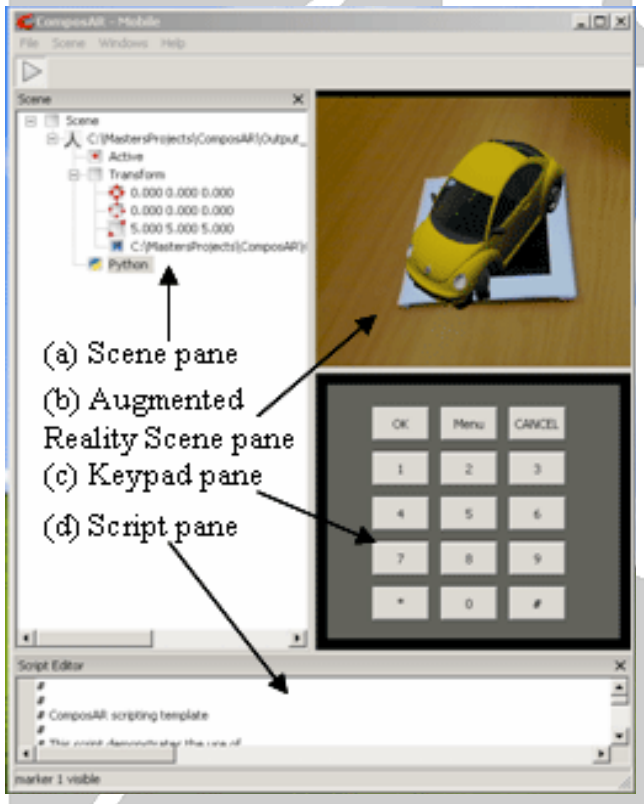


- http://www.hitlabnz.org/wiki/BuildAR
- Stand alone application
- Visual interface for AR model viewing application
- Enables non-programmers to build AR scenes

- Ideal authoring tool
  - Develop on PC, deploy on handheld



- Desktop PC authoring tool



Desktop PC

Mobile Phone

Python AR

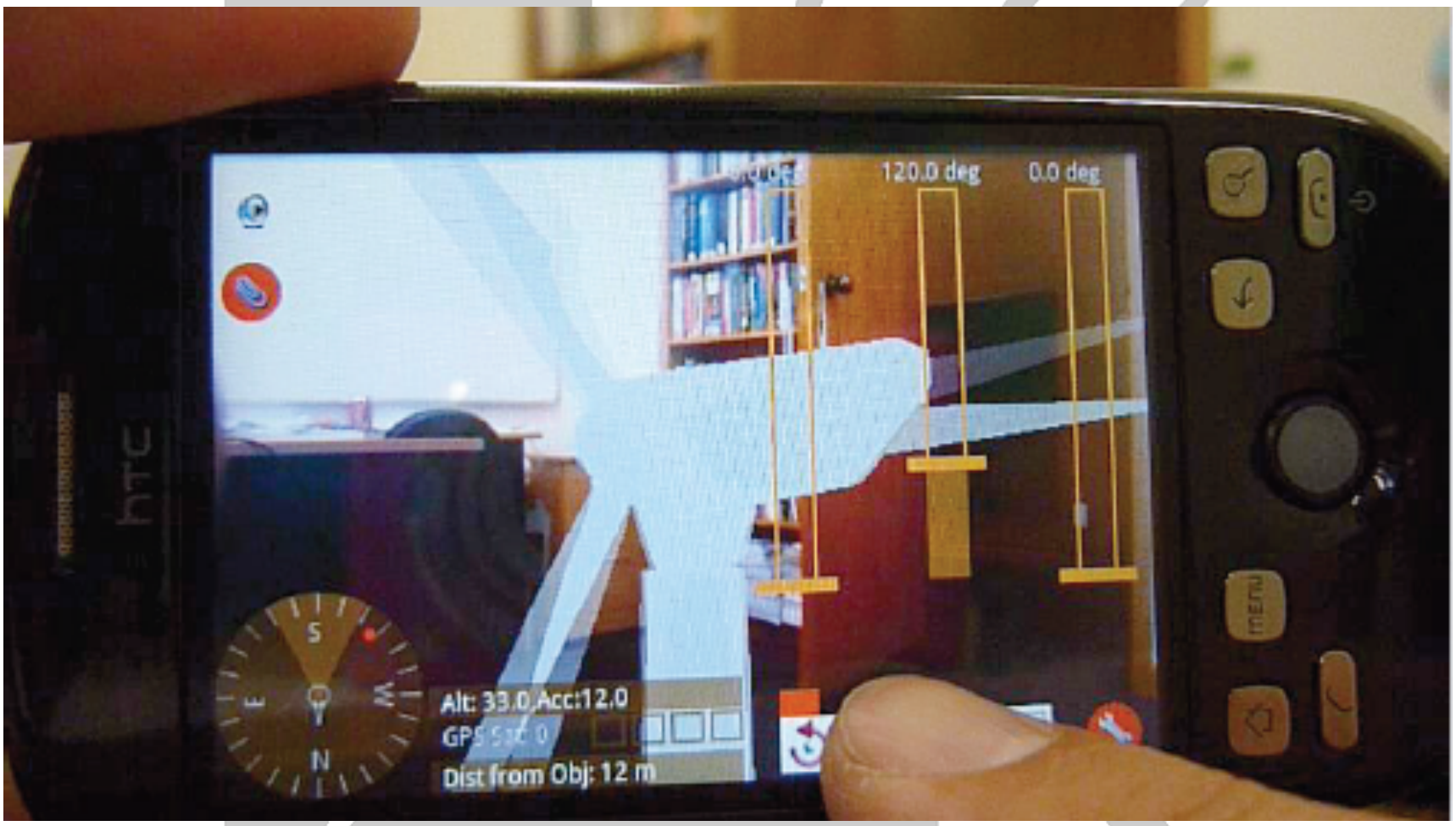
- Python rapid prototyping tool
- Symbian Series 60 Python
  - Mature python platform
  - Support for SMS, 2D/3D UI, Bluetooth etc
- Wrapper around stbTracker tracking
  - 20 fps marker based tracking

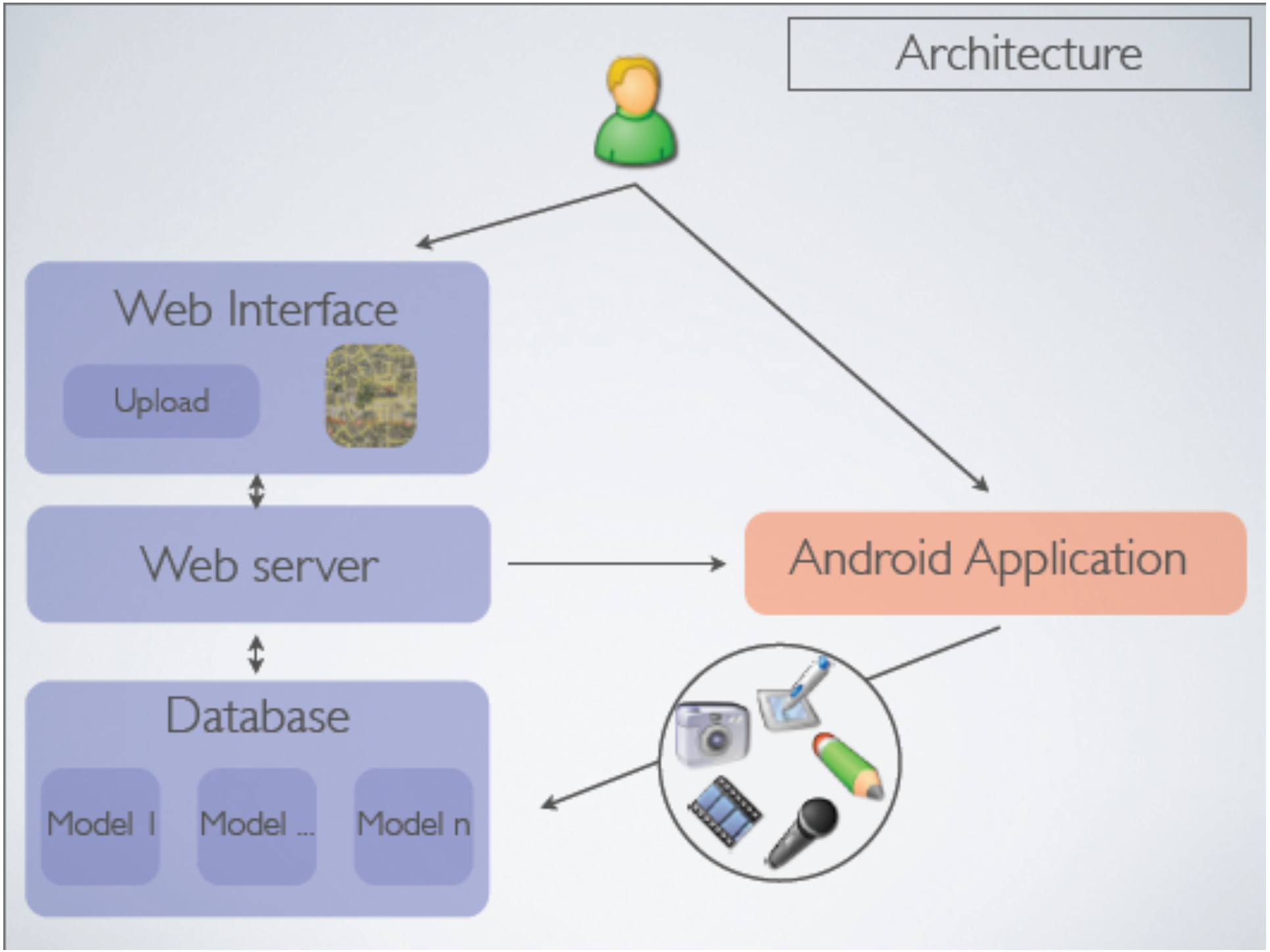
```
import e32
import appuifw
from gles import *

# 1 - Import Magnet library
if e32.s60_version_info>=(3,0):
    import imp
 magnet=imp.load_dynamic('Magnet', 'c:\\sys\\bin\\Magnet.pyd')

# 2 - Define model – OpenGL ES Commands

# 3 - Define callback
def frameback(num_markers):
        if (num_markers > -1):
        .. draw Model

# 4 - Main code
appuifw.app.orientation = 'landscape'          # Use full frame
SetCameraCallback(frameback)                   # Register callback
createCamera()                                 # Define camera
InitGLES()                                     # Start Open GL
TrackerInit()                                  # Start tracker
InitCamera()                                   # Start camera
```

```
#----- Get transform matrix for each model
glMatrixMode(GL_MODELVIEW)
T = getTn(marker_counter)
glLoadMatrixf(T)

#----- Calculate distance between the two markers
if (marker_counter == 0):
        T0 = T    # save matrix for distance calculations
elif (marker_counter == 1) and (getMarkerCode(marker_counter) == MY_MARKER):
        d = sqrt((T[12]-T0[12])*(T[12]-T0[12]) + \
                 (T[13]-T0[13])*(T[13]-T0[13]) + \
                 (T[14]-T0[14])*(T[14]-T0[14]))
        if (d < NEAR):       # Use model depending on distance
                 model_index = CONE
        elif (d > FAR):
                 model_index = CUBE
        else:
                 model_index = CYLINDER
model = models[model_index]
```

Android Model Loader

- Android G1 phone
- Outdoor AR model viewer
- Toolkit to modify the model
- Displays of 3D model
  - a OBJ/MTL Loader
- User interface
  - Model Manipulation
- Gyroscope manager


120.0 deg
0.0 deg
S
W
N
Alt: 33.0,Acc:12.0
Dist from Obj: 12 m
htc
menu


Architecture
Web Interface
Upload
Web server
Android Application
Database
Model 1
Model ...
Model n

CROWD MODE ACTIVE
James West, 37
1ST CONNECTION
FRIEND
Looking forward to hearing @solar's talk on sustainability in dev environments. Right now I'm dying for a good cup of coffee.
25 MINS AGO
MORE>
Nancy Duate, 26
2ND CONNECTION
VIA WORK
this conference is just what I need!
5 MINS AGO
MORE>
Francois Robillard, 35
2ND CONNECTION
VIA Catherine Daniels
check out the latest in my series on HTML6 - www.robillard.com/html6/
YESTERDAY 3:45pm
MORE>
Cecelia Declan, 42
1ST CONNECTION
COLLEAGUE
went to the most fabulous restaurant last night - Pasta Factory off Kloof Street. We made our own pizzas and pastas then ...
SATURDAY 11:22am
MORE>
Not Attending
John Smith
Gabriel Rutledge
Charles Thompson
On their way
Elliot Randall
12 MINS
Marc Legget
35 MINS
Amy Wallace
59 MINS
Design and Development Conference
29 Sep - 1 Oct
9am - Web Design for the Mobile Age
11am - Agile Development Workshop
12pm - Lunch @ Ecco
MORE>
20FOURLABS
Future of Social Networking with Augmented Reality
Concept investigation by Matthew Buckland (matthewbuckland.com) and Philip Langley (@royalalien) of 20fourlabs.com

The Social AR Experience

- Yesterday
  - Viewing
- Today
  - Content Creation
- Tomorrow
  - Information filtering
  - Platform integration
  - Ubiquitous AR
  - Social analysis tools
  - New social experiences

OtaSizzle (TKK)

- Mobile social interaction platform for Aalto students and teachers
- Study issues related to service adoption and use, by intensive data collection and analysis
- Platform for application development
- 1200 users, 100 N97 clients

Ossi

"Made it to the morning lecture, after all."

How are your friends?

friends

Where are your friends?

"Is heading home-home tomorrow!"

What are they doing?

"When are we going for lunch?"

groups

What are they discussing?

How about playing poker tomorrow at our place?"

OSSI *beta*

sizzle

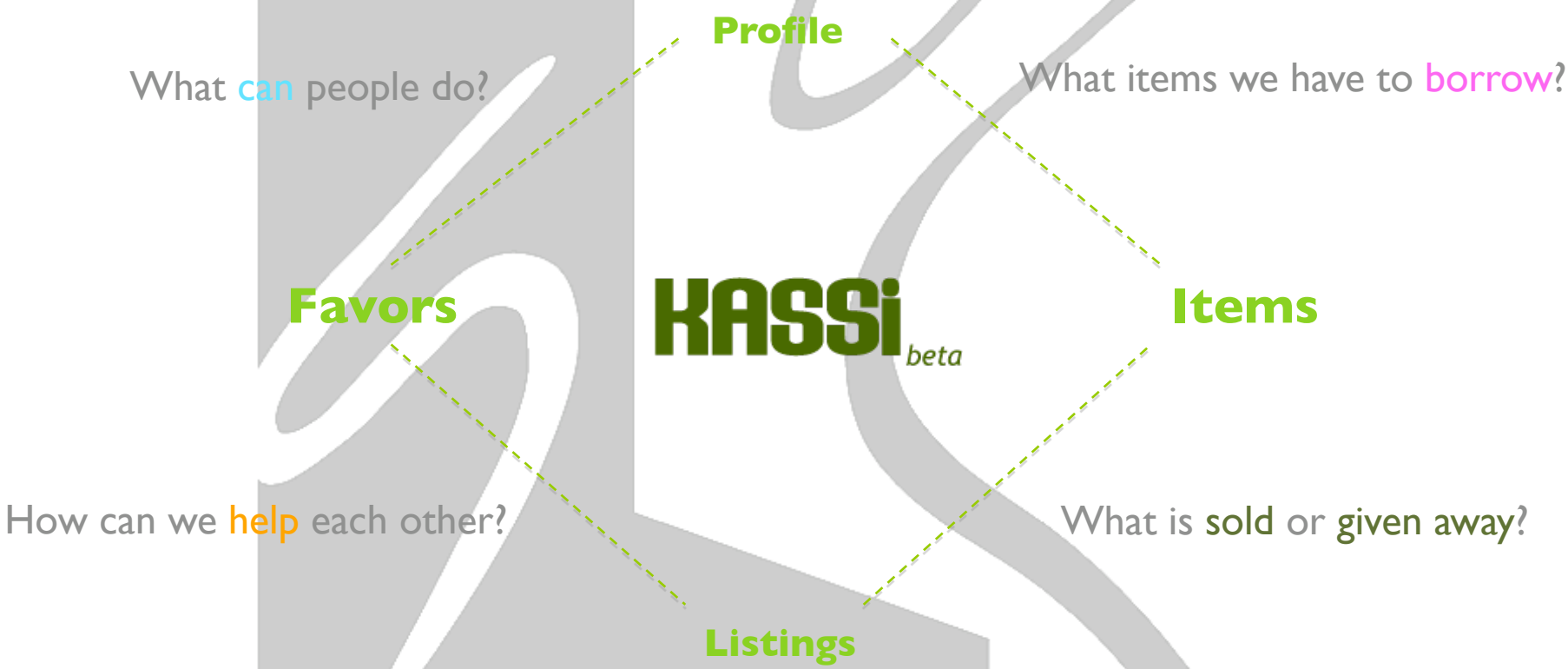
"Recycling center in Otaniemi is now open"

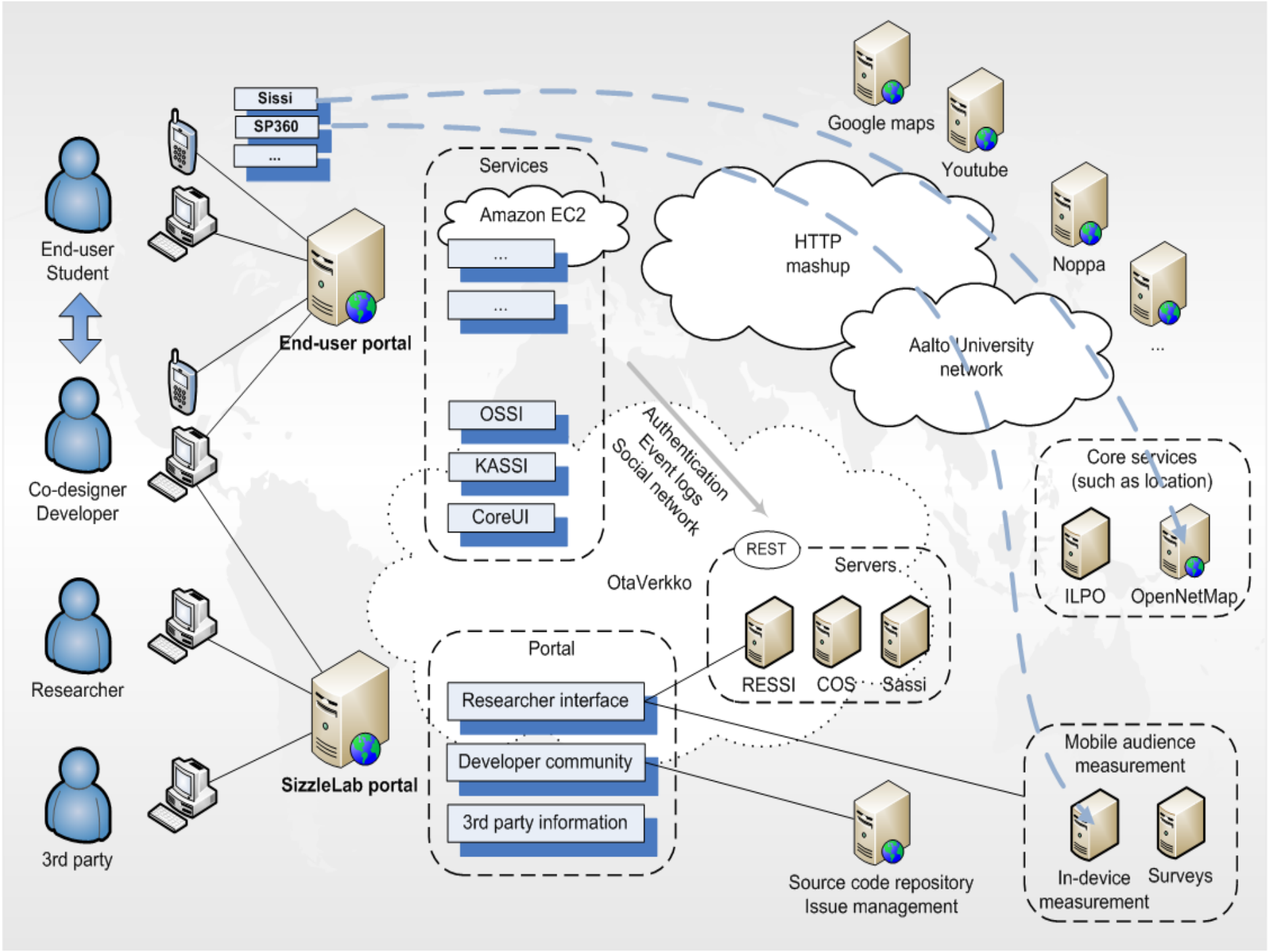
What is happening on campus?

"Views on new course arrangements?"

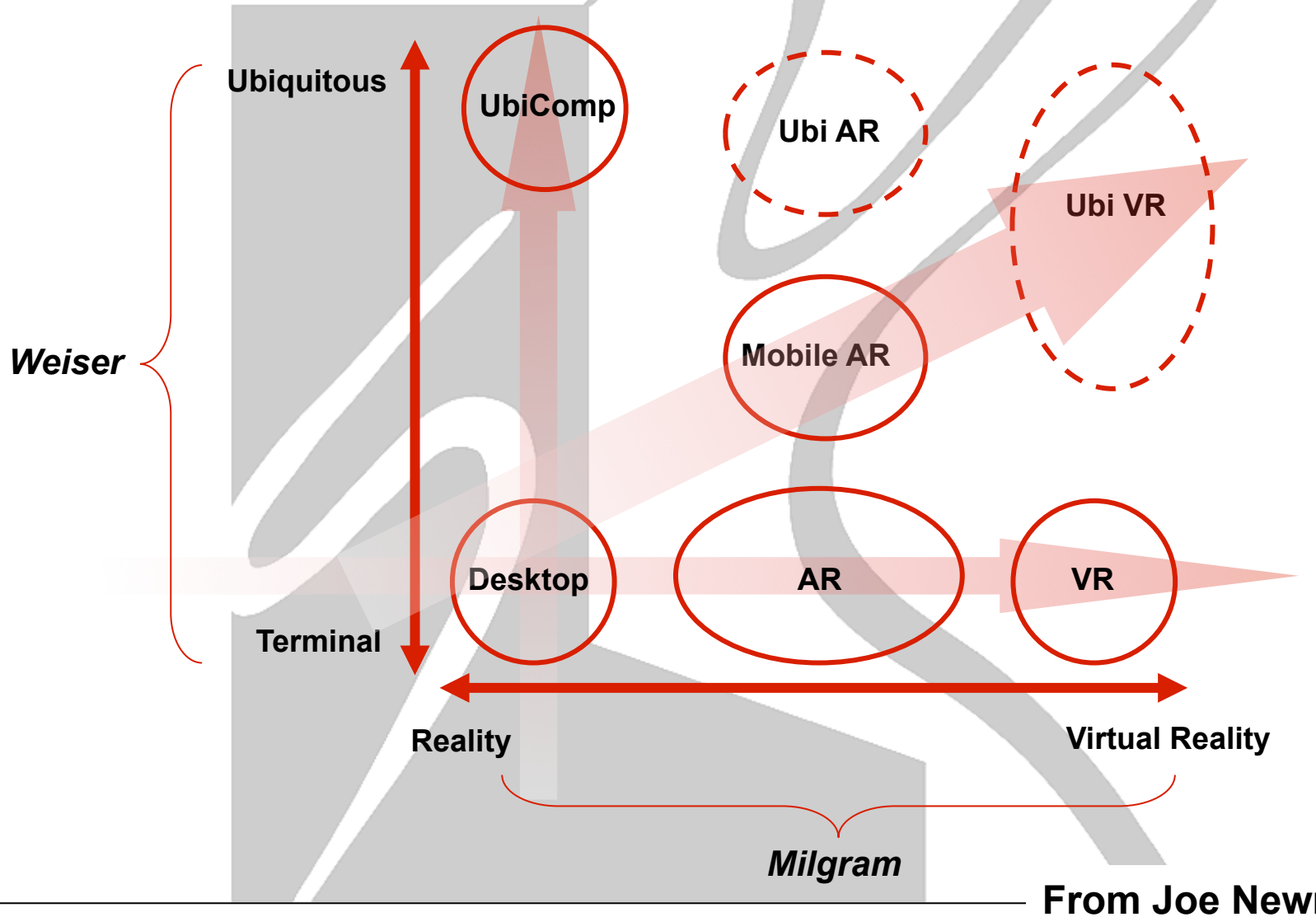
What is the talk of campus?

Kassi


Profile
What can people do?
What items we have to borrow?
Favors
KASSi beta
Items
How can we help each other?
What is sold or given away?
Listings

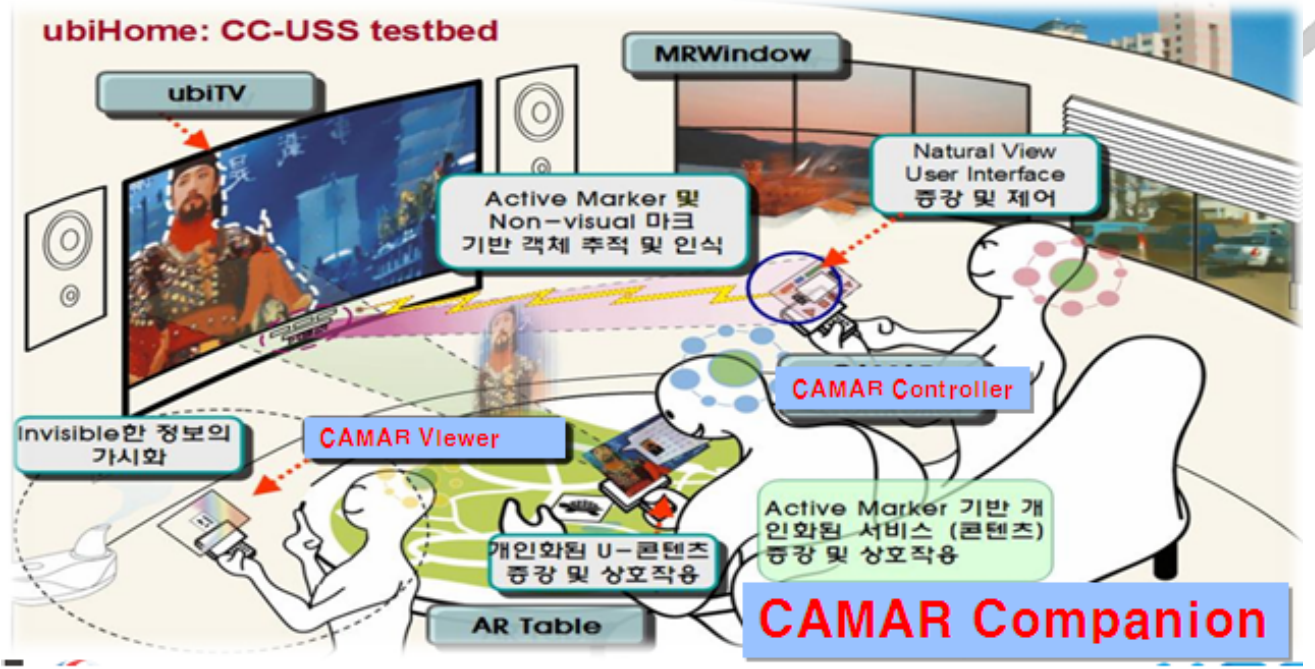

Sissi
SP360
...
Google maps
Youtube
Services
Amazon EC2
...
...
HTTP
mashup
Noppa
...
Aalto University
network
End-user
Student
End-user portal
OSSI
KASSI
CoreUI
Authentication
Event logs
Social network
Co-designer
Developer
Core services
(such as location)
ILPO
OpenNetMap
REST
Servers
OtaVerkko
RESSI
COS
Sassi
Researcher
Portal
Researcher interface
Developer community
3rd party information
SizzleLab portal
3rd party
Source code repository
Issue management
Mobile audience
measurement
In-device
measurement
Surveys

Ongoing Research



From Joe Newmann

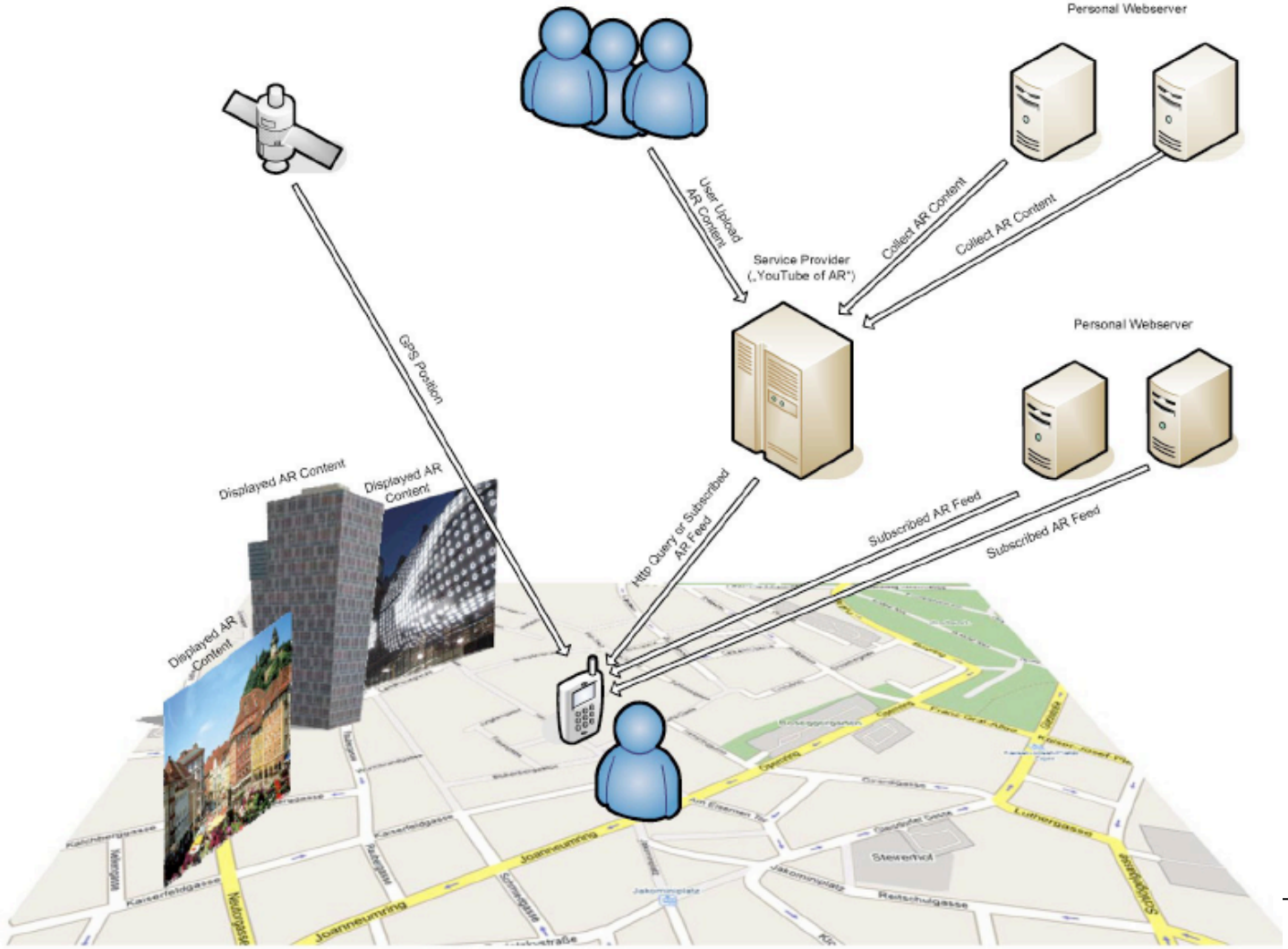
Ubiquitous VR/AR (5+ years)

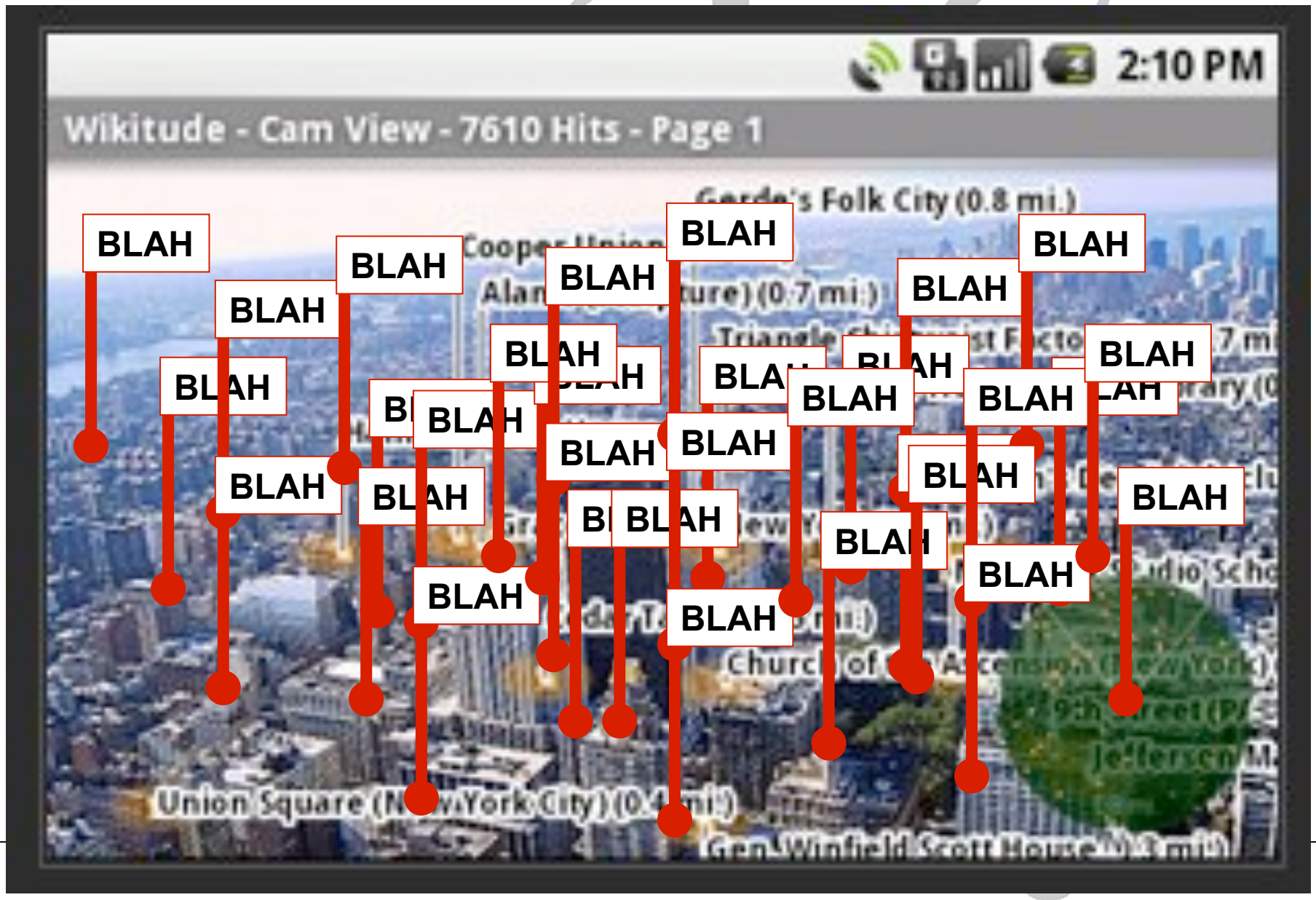


UbiVR
GIST (Korea)

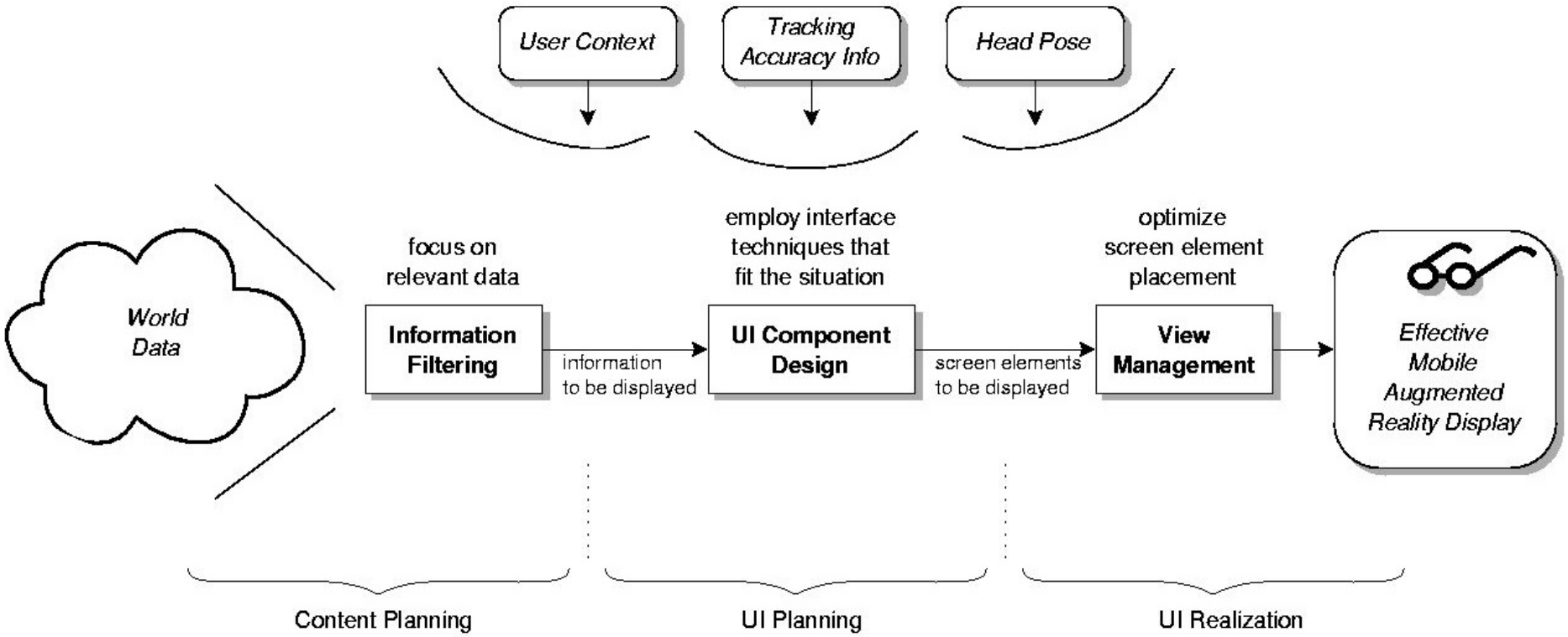
- How does you AR device work with other devices?
- How is content delivered?

AR 2.0 Infrastructure



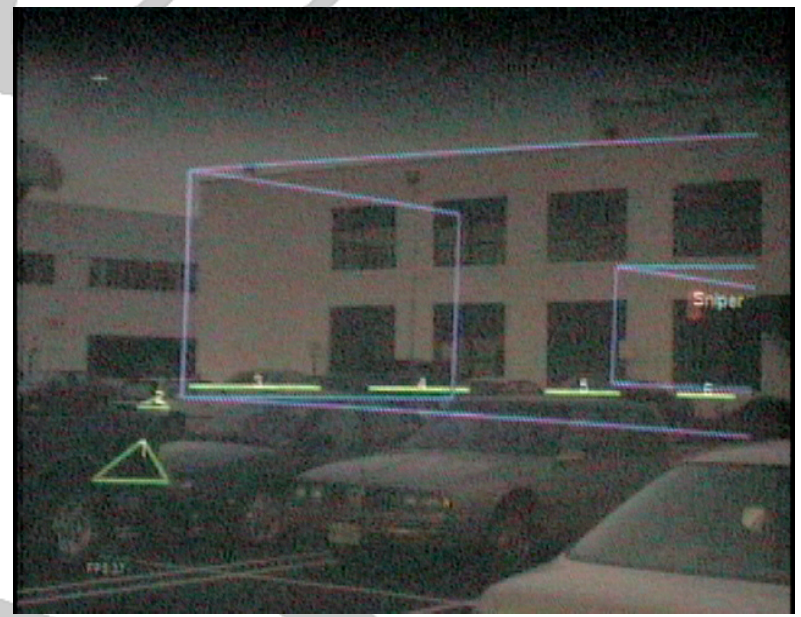

2:10 PM
Wikitude - Cam View - 7610 Hits - Page 1
BLAH
BLAH
BLAH

Information Filtering



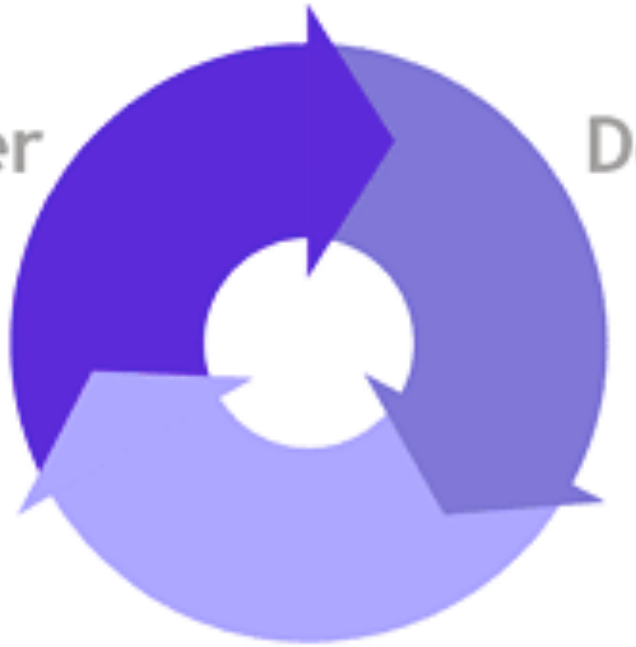
Information Filtering

- Information Filtering (Julier et al. '00)



- Remove clutter by goal- and distance based filtering
- User's task is route finding: Sniper and relevant buildings are displayed; objects, which are determined to be unnecessary, removed

Experience Design Process



Discover

User Needs Assessment

Field Observation
Contextual Inquiry
User Profiling
Requirement Gathering

Design

User Interface Design

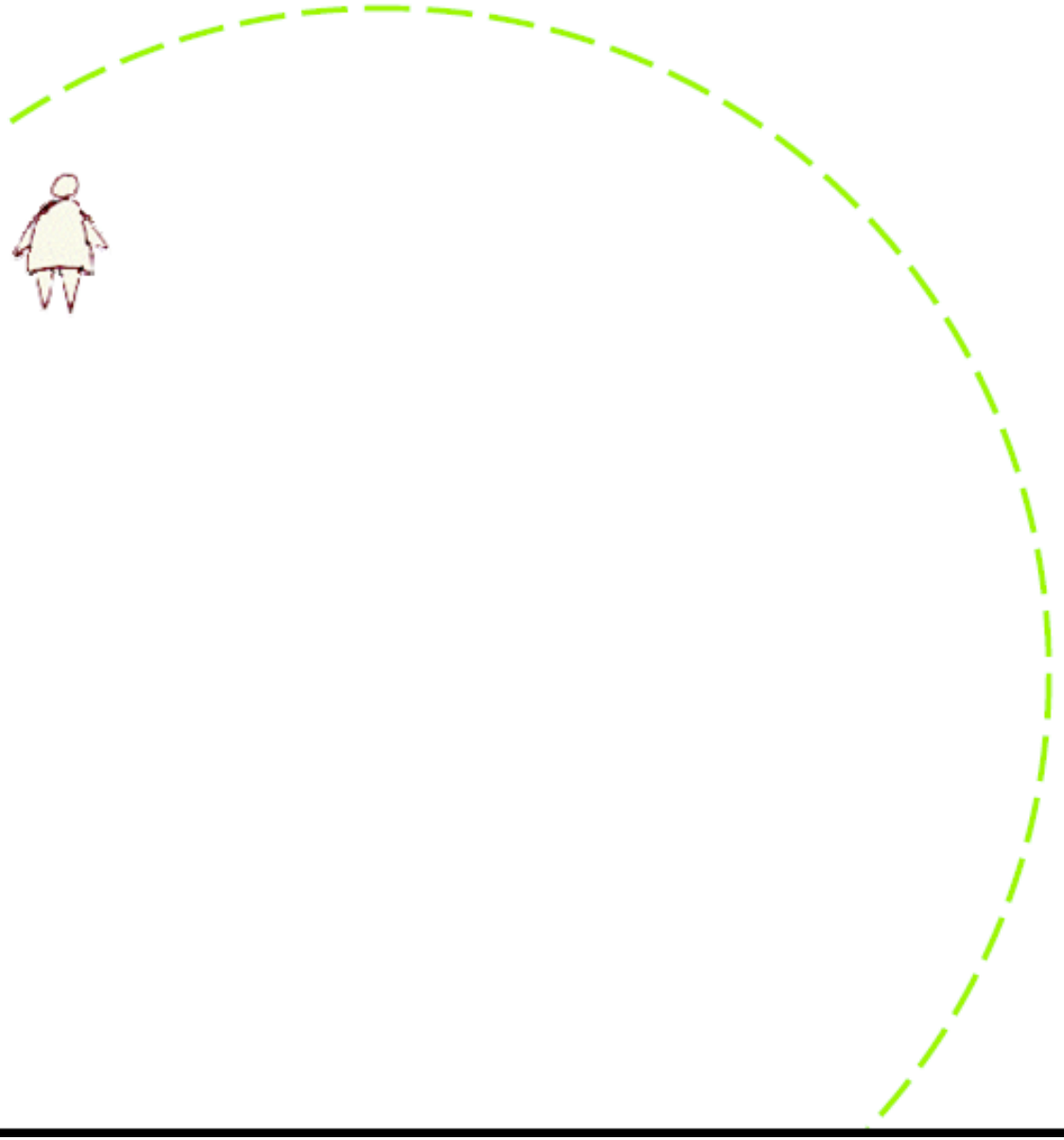
Task Analysis/Use Cases
UI Specification
Application Graphics
Prototyping

Evaluate

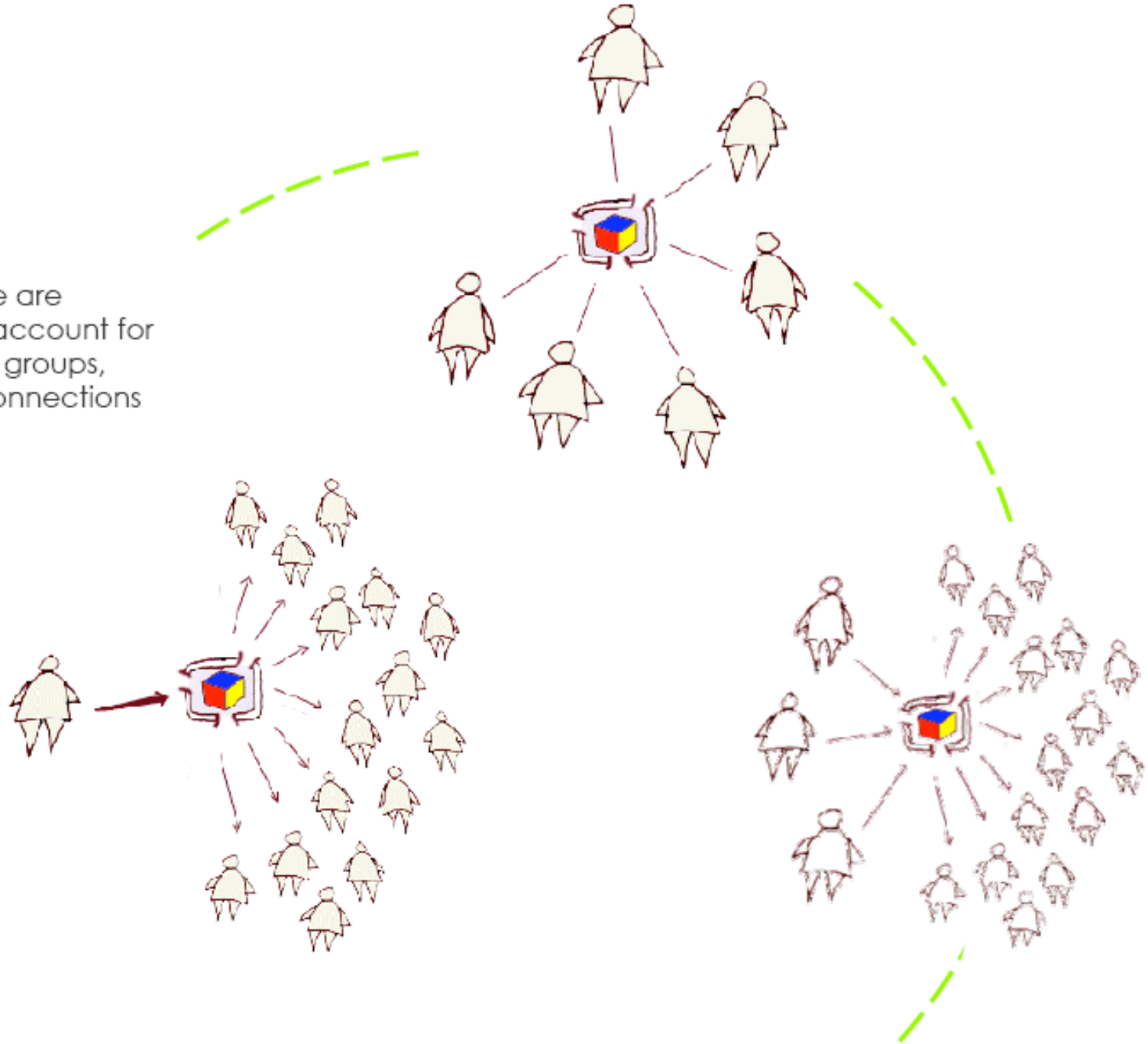
Usability Evaluation

Demonstration
Heuristic Evaluation
Task-Specific Evaluation

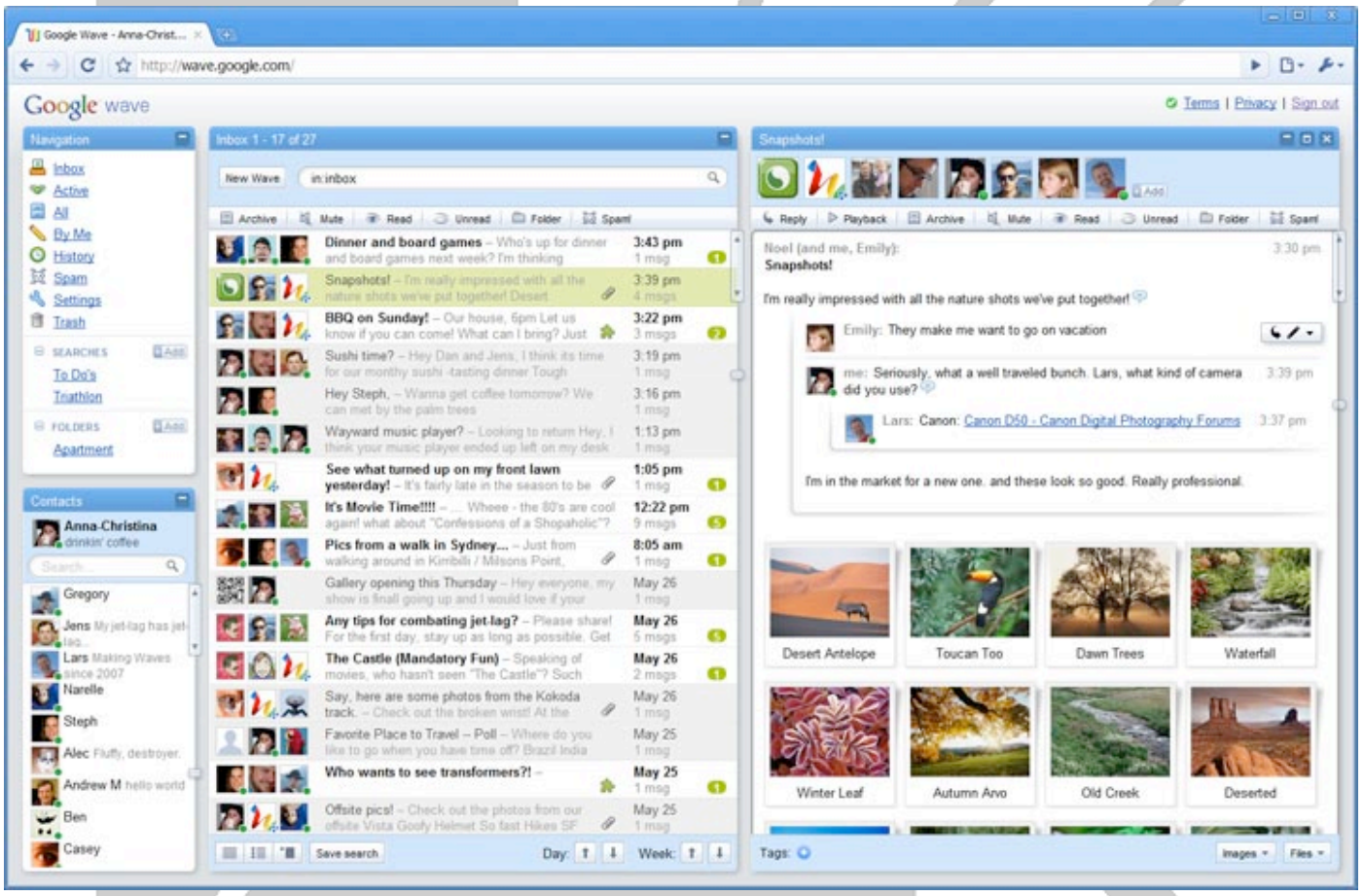
we are used to
designing for individuals



and now we are
learning to account for
variations in groups,
genres of connections



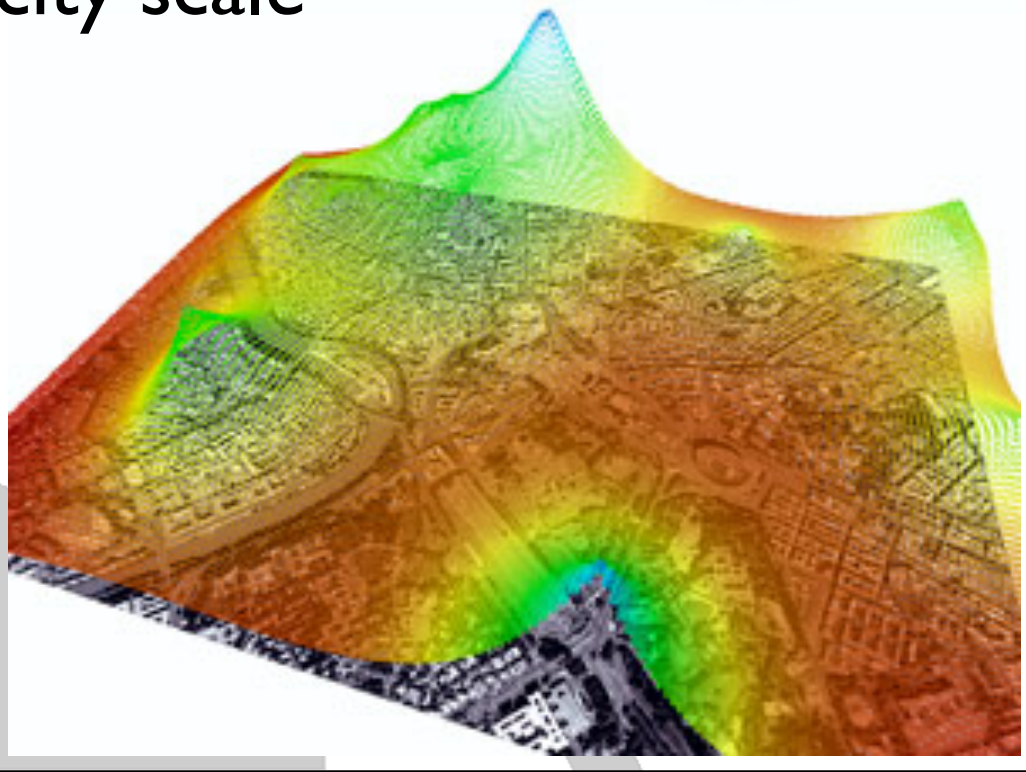
New Social Experiences: Google Wave

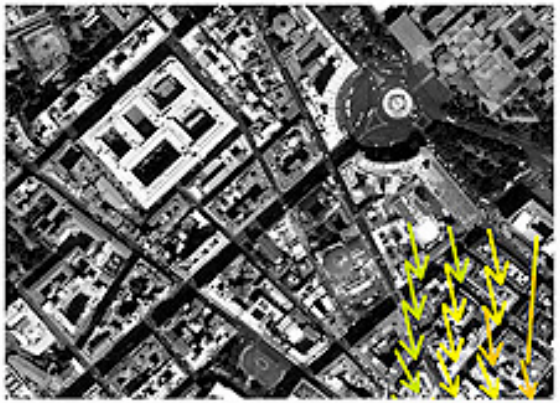


- Asynch -> Synch -> Multimodal

Social AR On a City Scale

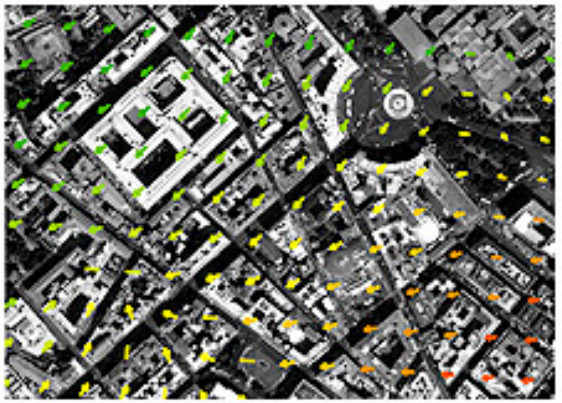
- Carlo Ratti (MIT CitySense)
- Track devices over city scale
  - "Real Time Rome"



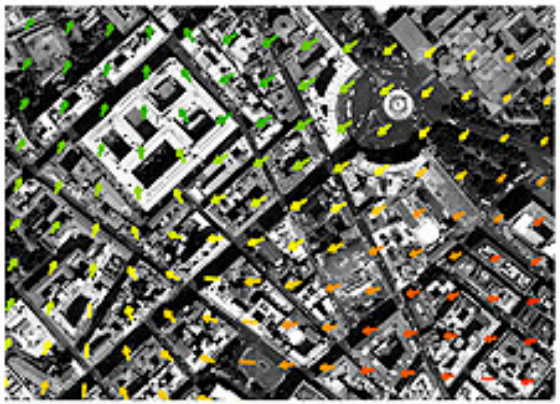


00 - 00 AM

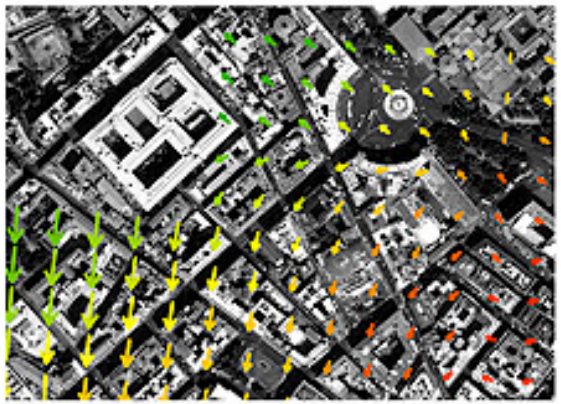
04 - 00 AM



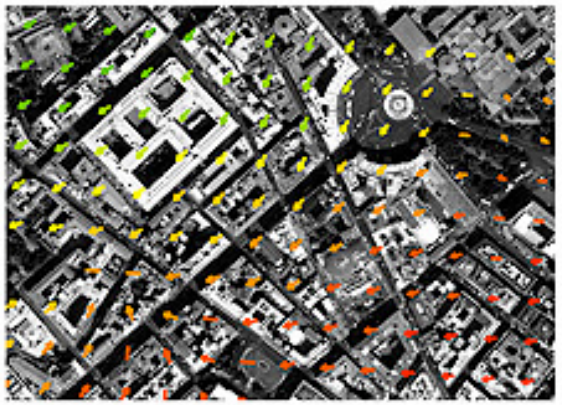
08 - 00 AM



12 - 00 PM



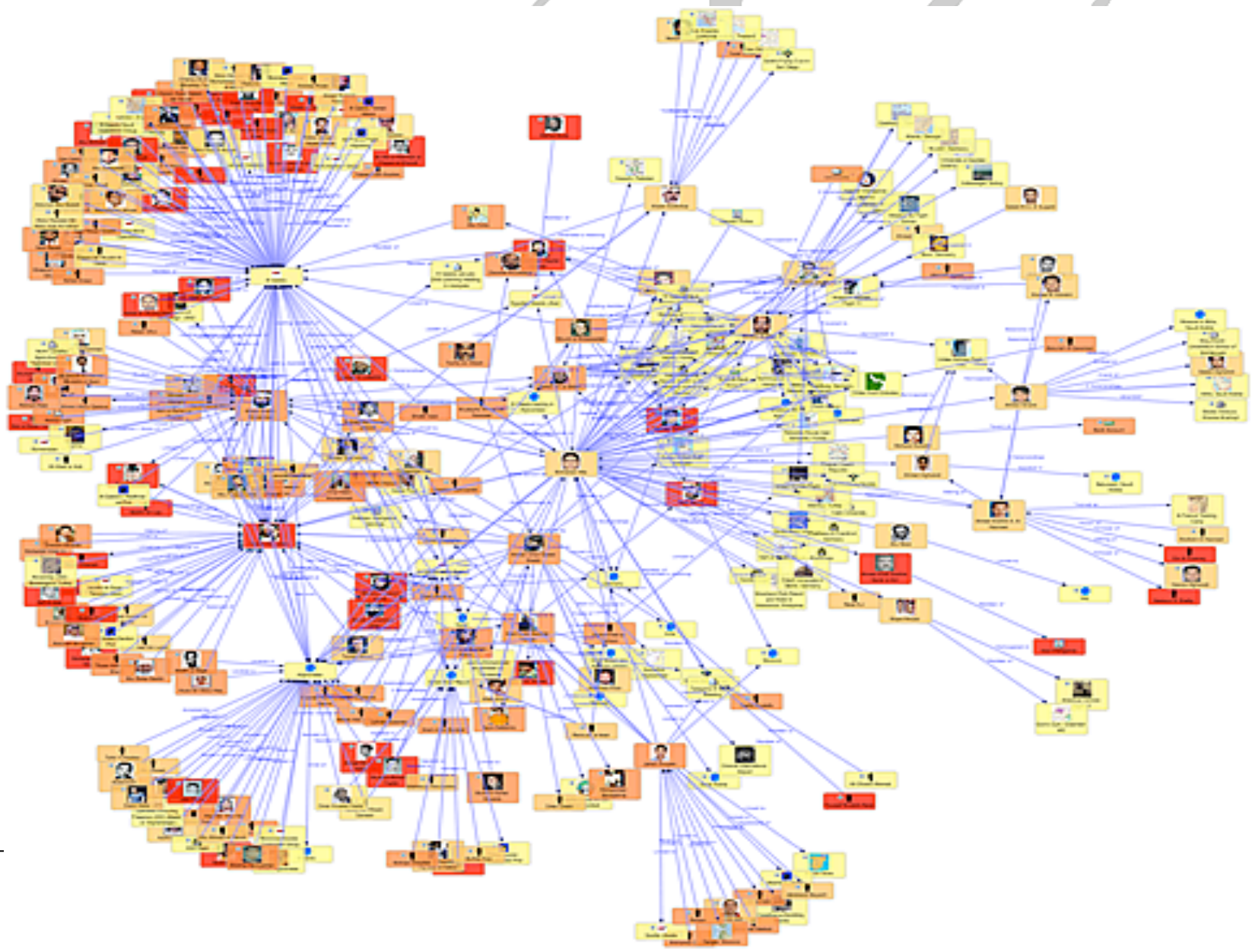
04 - 00 PM

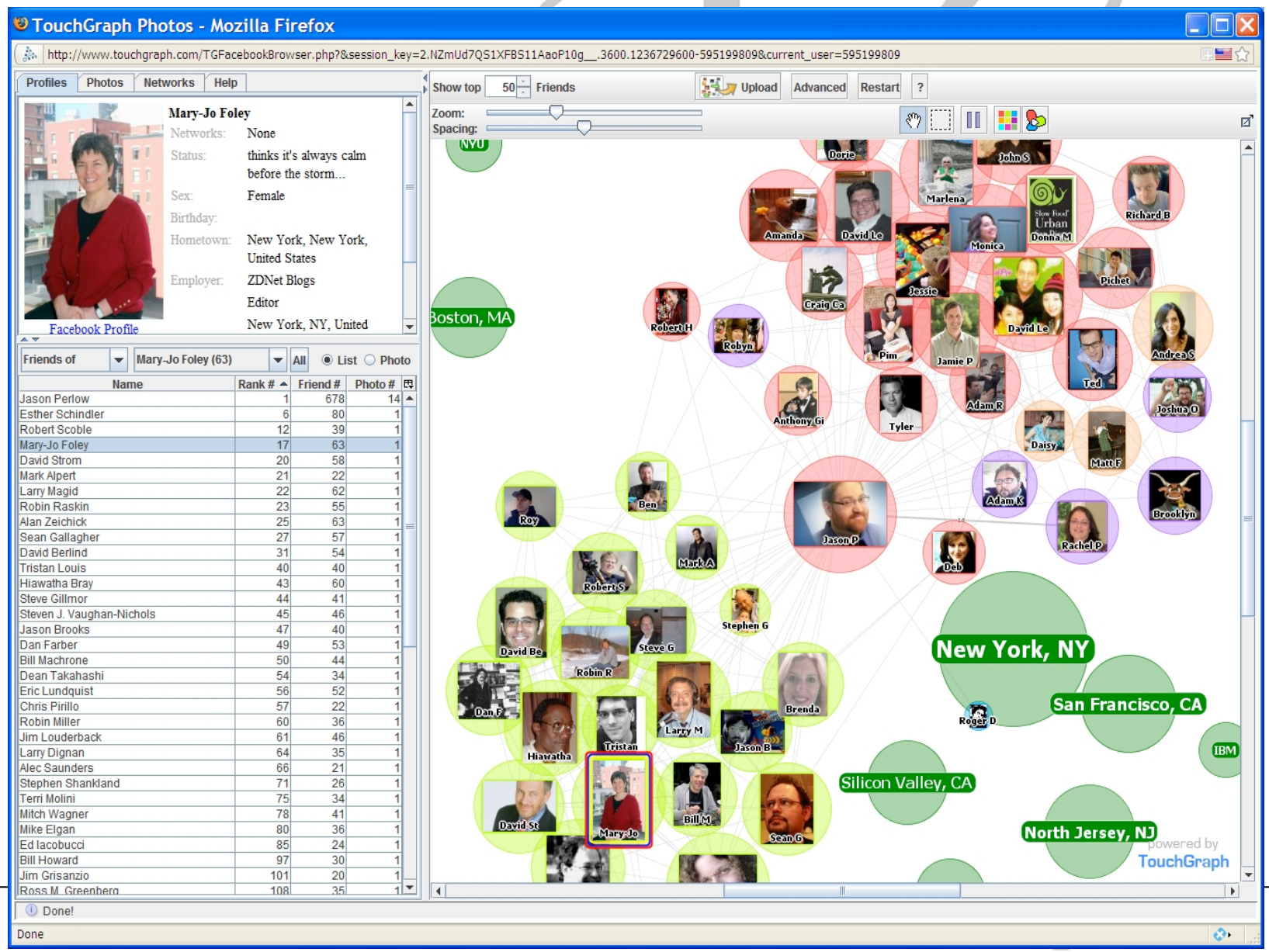


20 - 00 PM

Analysis Tools

- Google Analytics
  - Rich web analysis
  - Visual Informatics
  - Customizable

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Profiles
Photos
Networks
Help
Mary-Jo Foley
Networks: None
Status: thinks it's always calm before the storm...
Sex: Female
Birthday:
Hometown: New York, New York, United States
Employer: ZDNet Blogs
Editor
New York, NY, United
Facebook Profile
Friends of
Mary-Jo Foley (63)
All
List
Photo
Name
Rank #
Friend #
Photo #
Jason Perlow 1 678 14
Esther Schindler 6 80 1
Robert Scoble 12 39 1
Mary-Jo Foley 17 63 1
David Strom 20 58 1
Mark Alpert 21 22 1
Larry Magid 22 62 1
Robin Raskin 23 55 1
Alan Zeichick 25 63 1
Sean Gallagher 27 57 1
David Berlind 31 54 1
Tristan Louis 40 40 1
Hiawatha Bray 43 60 1
Steve Gillmor 44 41 1
Steven J. Vaughan-Nichols 45 46 1
Jason Brooks 47 40 1
Dan Farber 49 53 1
Bill Machrone 50 44 1
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Eric Lundquist 56 52 1
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Robin Miller 60 36 1
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Larry Dignan 64 35 1
Alec Saunders 66 21 1
Stephen Shankland 71 26 1
Terri Molini 75 34 1
Mitch Wagner 78 41 1
Mike Elgan 80 36 1
Ed Iacobucci 85 24 1
Bill Howard 97 30 1
Jim Grisanzio 101 20 1
Ross M. Greenberg 108 35 1
Done!
Done
Show top 50 Friends
Upload
Advanced
Restart
?
Zoom:
Spacing:
NYU
Boston, MA
New York, NY
San Francisco, CA
Silicon Valley, CA
North Jersey, NJ
IBM
Mary-Jo
powered by TouchGraph

Key Questions

- How to evaluate Mobile MR systems?
- How to author Social AR experiences?
- How to filter/customize information?
- How to integrate with other platforms?
- How to evaluate the quality of user experience?
- Etc…

Future Research

- Complete OtaSizzle platform development
  - Prototype AR social networking tools
- User Studies
  - Comparing Layar AR view to map view
  - Mobile social networking
- Tracking
  - NFT, port SSTT other platforms (Nokia N900)
- Add sensor input to Python AR code
  - GPS, compass

More Information

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