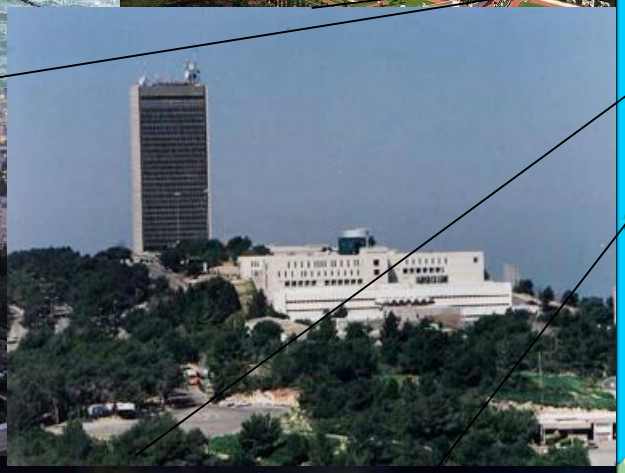
PREFACE



Cyprus is about 50% of the size of Israel, in area, but about 1/6 the population

ADVANCED TECHNOLOGIES FOR SMART (CH) SPACES

A case study in cultural heritage: Novel technology at the fingertips of the visitors

Tsvi Kuflik and the PIL team

Agenda:

- **Ubiquitous computing – a brief introduction**
- The technological infrastructure of an instrumented museum and beyond
- The (smart) museum as a living research lab

What is "smart environment"?

- Nowadays there is a plethora of publications about "smart environments"
- We intuitively get the idea
- Let us try to define what smart environments are

Let us look at some definitions

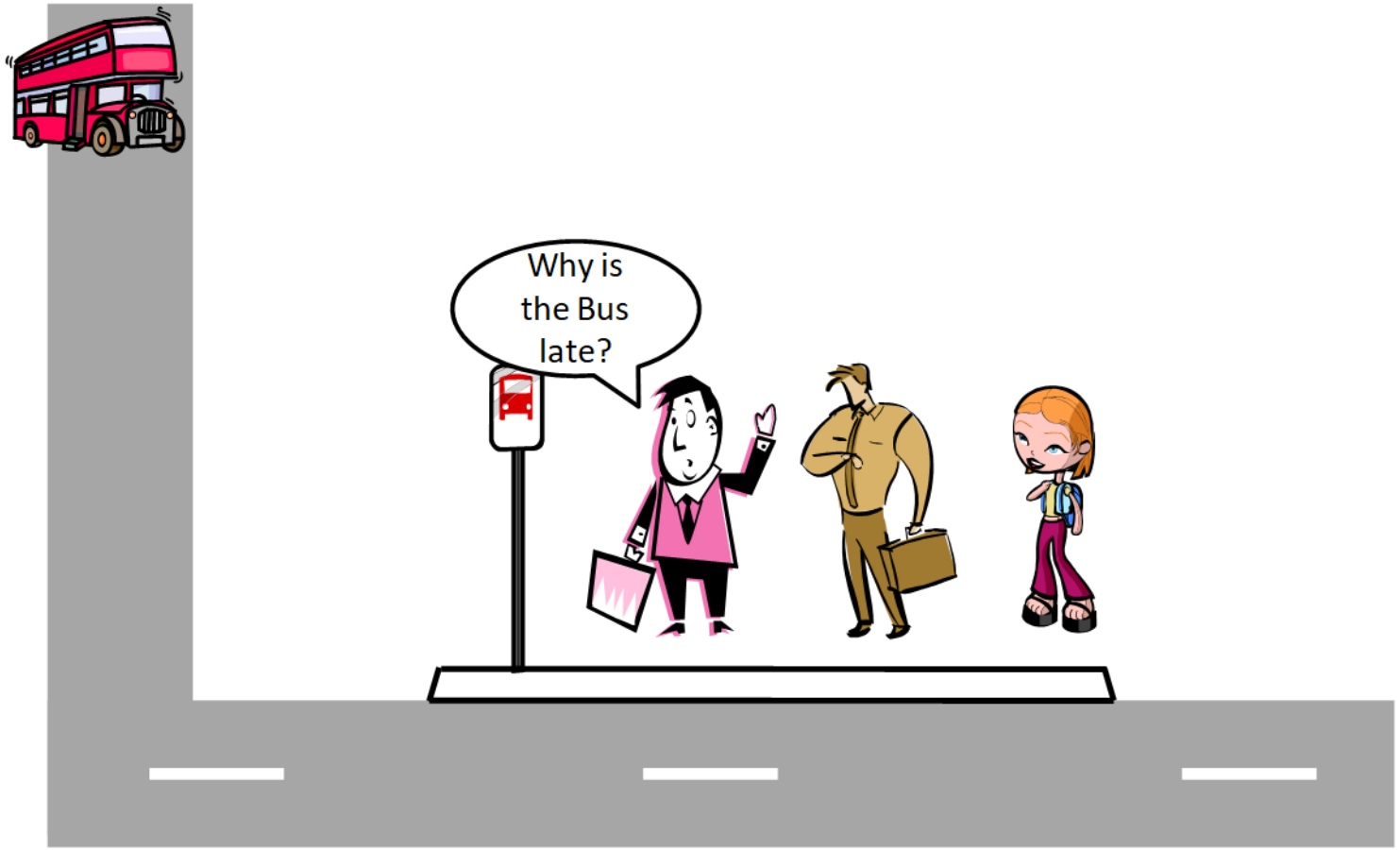
- Smart environments have the potential to allow users to engage and interact seamlessly with their immediate surroundings.
- Nugent, C. D., McClean, S. I., Cleland, I., & Burns, W. (2014). Sensor Technology for a Safe and Smart Living Environment for the Aged and Infirm at Home.
- The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it.
- Weiser, M. (1991). The Computer for the 21 st Century. Scientific american, 265(3), 94-105.

What characterizes smart spaces?

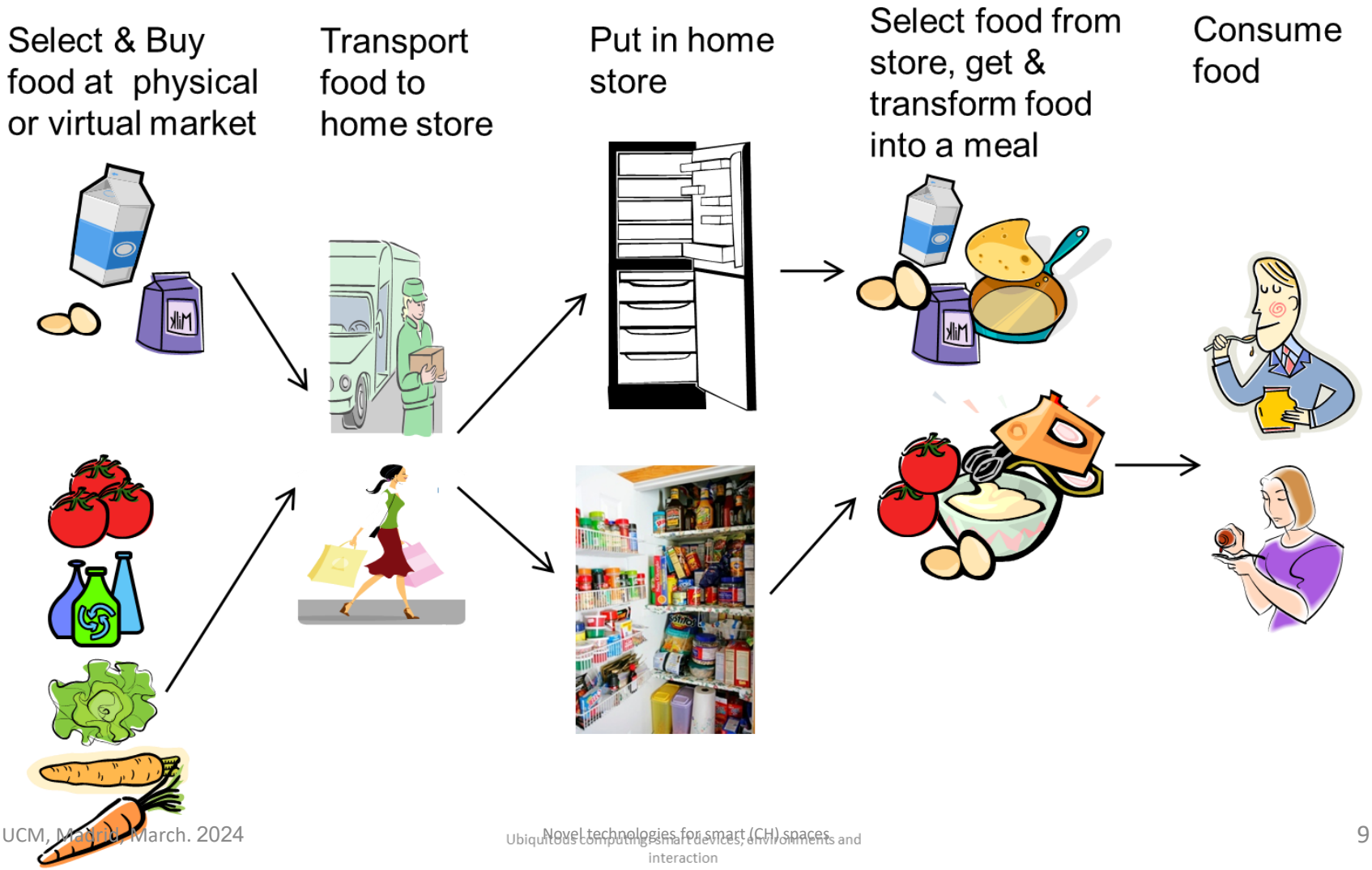
- We inhabit an increasingly digital world, populated by a profusion of digital devices designed to assist and automate more human tasks and activities, to enrich human social interaction and enhance physical world interaction.[1]

[1] Stefan Poslad, Ubiquitous Computing

21st Century Scheduled Transport Service Scenario



Foodstuff Management Scenario



"Smart environment" is a buzzword…

- We make gradual progress towards integrating technology into our daily lives
  - Automation
  - Proactiveness
  - Personalization
  - Context awareness
  - Autonomy

(smart) Devices

- These may be
  - Mobile phones
  - Wearables devices
    - Smart watches
    - Other sport/health-related devices
    - Headsets
    - Smart glasses
    - …

(smart) Devices

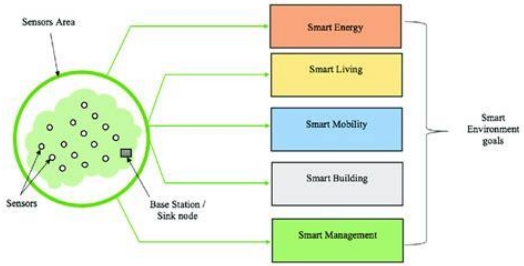
- Devices may be carried
  - Smartphone
- Devices may be attached / worn
  - RFID tag (+sensors)
  - Smart watch
  - Smart glasses
  - …
- Devices may be embedded/implanted
  - Sensors within a 3D printed objet
  - Engine control microcontroller
  - …

(smart) Devices

- Devices may sense
  - Heart rate
  - Temperature
  - Light
  - …
- Devices may communicate
  - BLE
  - Wifi
  - …
- Devices may deliver a service
  - Payment
  - Information
  - …

Environment

- The environment (whatever it is) may contain
  - Sensors
    - Sensing “signals in the environments
    - Understanding the “state” of the environment
  - Actuators
    - Provide a service
    - Change the current “state” to a desired one



Interaction

- Explicit
  - The user explicitly expresses a need for a service
  - The user is in control – reactive system
- Implicit
  - The service is delivered by the environment as a result of a reasoning process
  - The user may be in control – reactive or proactive system
- Some examples
  - Temperature adjustment
  - Collision avoidance
  - Asking Siri/Cortana for a service
  - …

Context awareness

- We start with a very broad definition:

Context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves.

- Abowd, G. D., Dey, A. K., Brown, P. J., Davies, N., Smith, M., & Steggles, P. (1999, September). Towards a better understanding of context and context-awareness. In International symposium on handheld and ubiquitous computing (pp. 304-307). Springer, Berlin, Heidelberg.

Context awareness

- Some specific aspects
  - Physical
    - Location
    - Temperature
    - Light
    - …
  - Social
    - Alone
    - With friends
    - …
  - Temporal
    - Time of day (and its impact)
    - Season
    - …

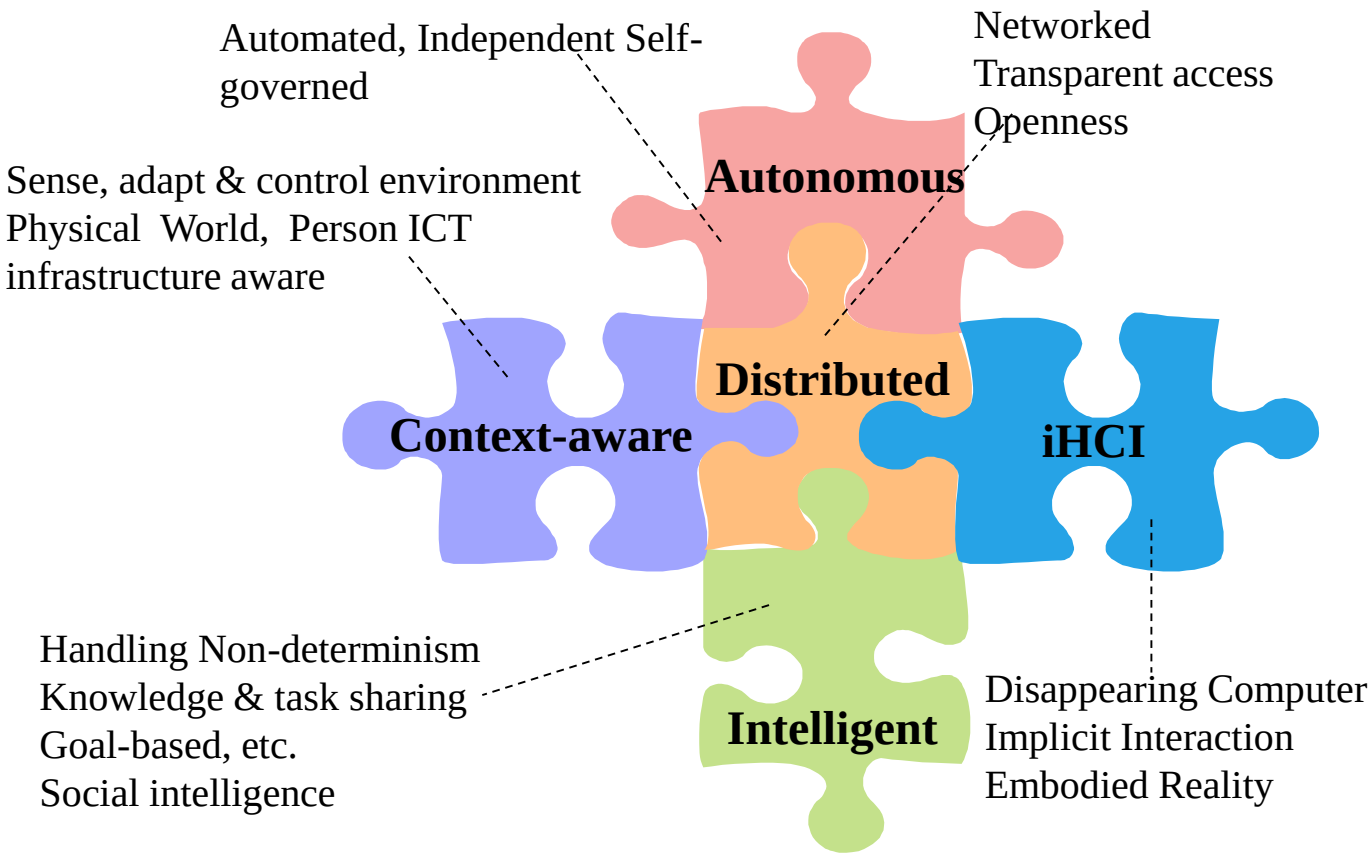
Context awareness

- Context aware service delivery
  - Providing users with a service while taking into account contextual aspects
    - Next PoI recommendation, outdoors while considering the weather
    - Recommendation to stop for lunch at noon…
    - Changing the phone to silent mode when faced down
    - Turning the screen off when the phone is held next to the ear
    - Reminding an event (outlook reminder)
    - Turning the light on when the room gets too dark
    - …

Personalization

- Providing users with services tailored to their characteristics and preferences
  - Providing information to the user in the users' language
  - Recommending/suggesting items/services that meet the user's preferences
  - Learning the user's driving behavior and acting accordingly
    - Acceleration etc
  - Online language course – adapting to the user's level of knowledge
  - …

5 Main Types of Property for UbiCom



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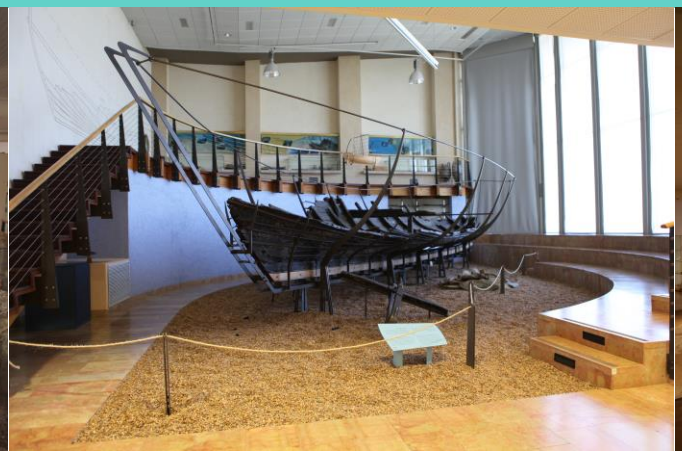
Ubiquitous computing challenges of CH

- Invisible technological infrastructure
  - CH sites are carefully designed and preserved
- Users' awareness of the availability of services
  - Hints:
    - Visual cues
    - Prior knowledge
- The environment is quiet (especially indoors)
- We need to know where the visitor is
- We need to know where the visitor was and where the visitor is going
- We need to know what the visitor is interested in
- We need to know the social context
- …

The Hecht Museum (Movie)

The Phoenicians



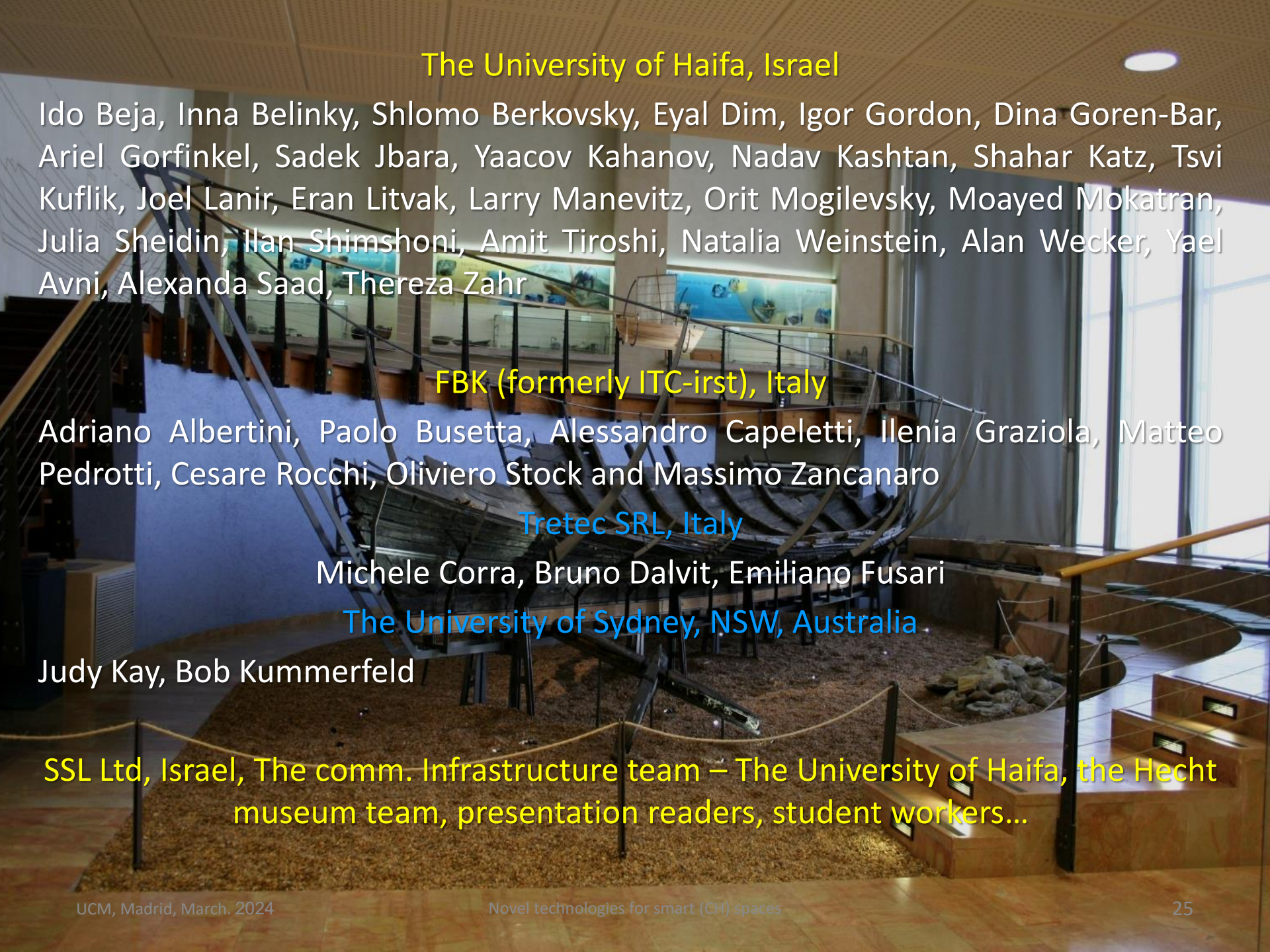
The Ma’agan Michael Ship

Ancient arts and crafts

Second floor coins

First floor - archeology

Museum’s floor plan



The University of Haifa, Israel

Ido Beja, Inna Belinky, Shlomo Berkovsky, Eyal Dim, Igor Gordon, Dina Goren-Bar, Ariel Gorfinkel, Sadek Jbara, Yaacov Kahanov, Nadav Kashtan, Shahar Katz, Tsvi Kuflik, Joel Lanir, Eran Litvak, Larry Manevitz, Orit Mogilevsky, Moayed Mokatran, Julia Sheidin, Ilan Shimshoni, Amit Tiroshi, Natalia Weinstein, Alan Wecker, Yael Avni, Alexanda Saad, Thereza Zahr

FBK (formerly ITC-irst), Italy

Adriano Albertini, Paolo Busetta, Alessandro Capeletti, Ilenia Graziola, Matteo Pedrotti, Cesare Rocchi, Oliviero Stock and Massimo Zancanaro

Tretec SRL, Italy

Michele Corra, Bruno Dalvit, Emiliano Fusari

The University of Sydney, NSW, Australia

Judy Kay, Bob Kummerfeld

SSL Ltd, Israel, The comm. Infrastructure team – The University of Haifa, the Hecht museum team, presentation readers, student workers…

Research goal

- Our overall research goal is to explore the potential of state of the art technology to enrich the cultural heritage visit experience
  - Mobile technology
  - Indoor and outdoor positioning
  - Machine vision
  - Social signal processing
- We did that through series of research projects over 20 years (and going on).

Challenges

- Knowing where the visitor is
  - Indoor positioning system
- What about the museum constraints?
  - Invisible technology…
- What amount of information is needed?
- How can we let the visitors know that information is available?

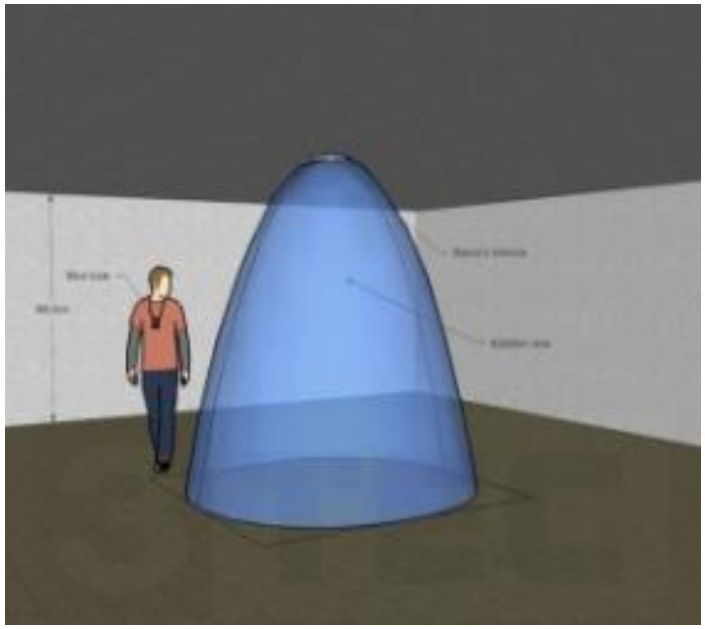
So what did we do?

- We examined the museum and selected 43 most interesting positions
- We Installed almost invisible indoor positioning system
- We prepared over 300 presentations * three languages
- We introduced additional capabilities
  - Navigation support
  - Recommendations
  - Messaging service

The Hecht Museum Layout

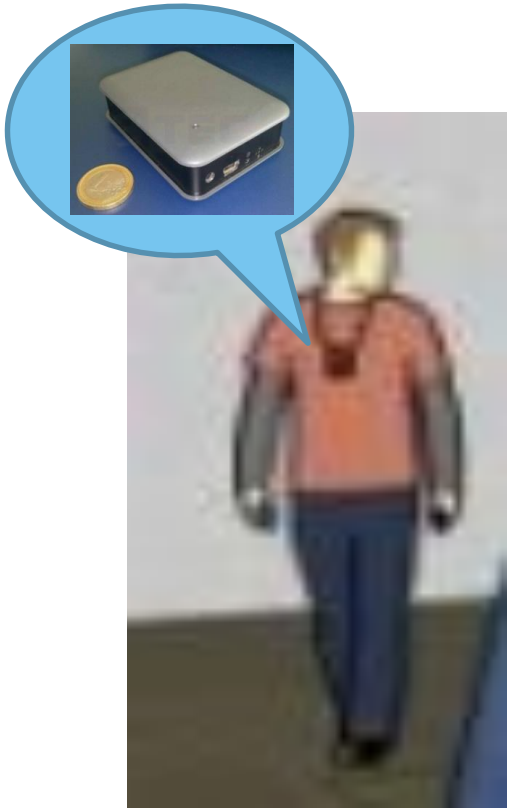
Instrumentation - Beacon

- Stationed in a selected points of interest
- Transmits an ID using radio frequency
- Detectable within a radius of 2m

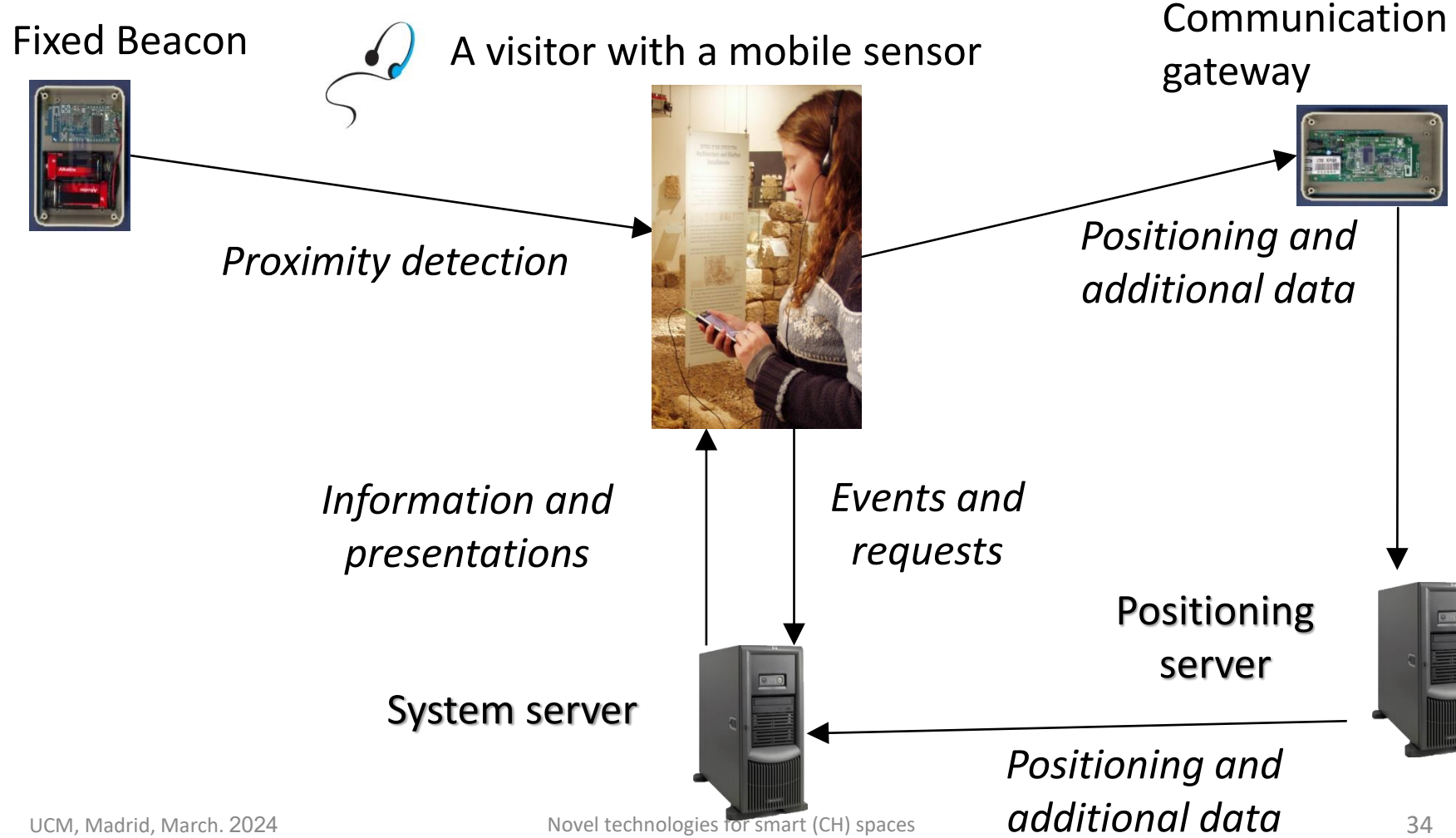


Instrumentation - Blinds

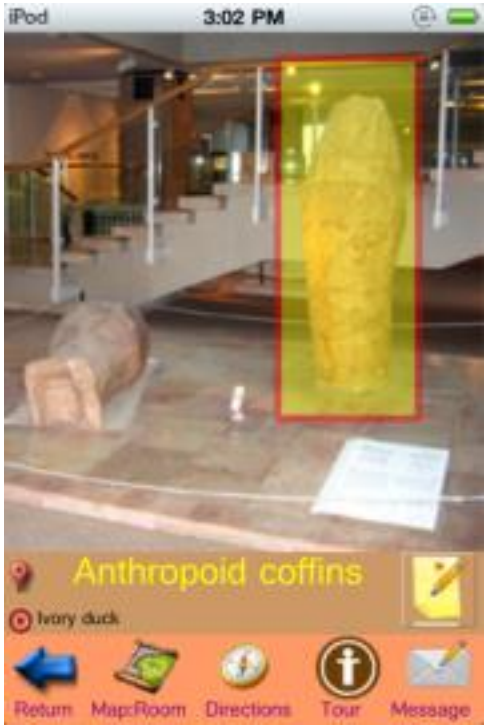
- Transfers data to the central server through a gateway
- Reports:
  - Blind ID
  - Detection time
  - Proximity to a Beacon , within 2m, and its ID
  - Proximity to other Blinds (people), within 2m
  - Compass data
  - Acceleration
  - Voice ativity

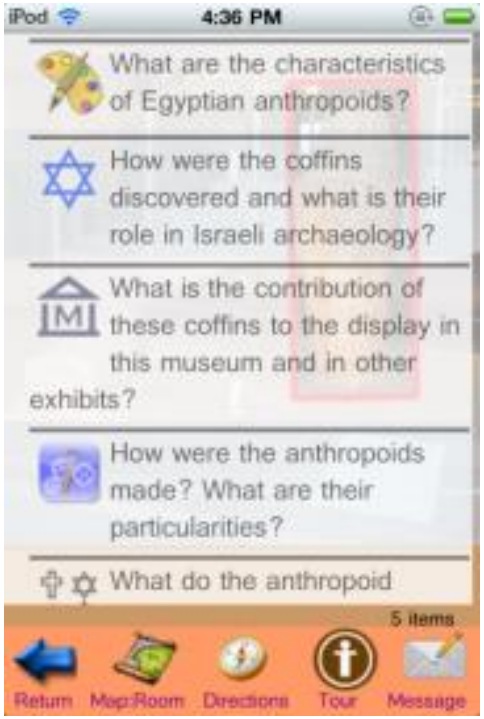


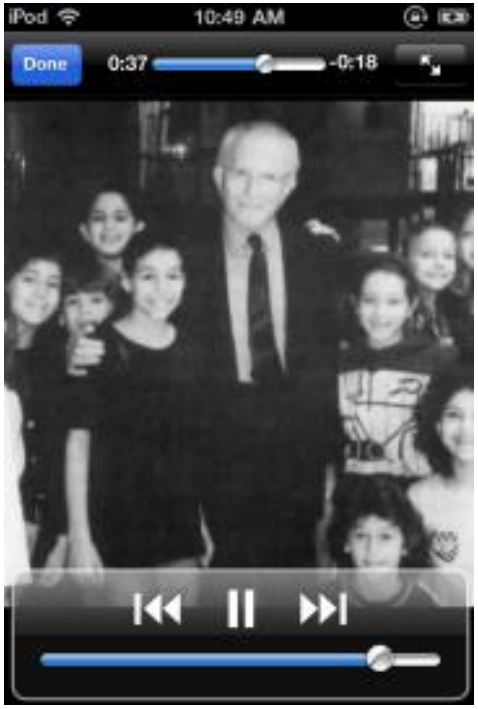
How does the system work?



This is how it looks







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- We can enable online visit planning
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- We can study interrupt management
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- We can track visitors' gaze
- We can provide information via smart glasses
- We can provide feedback to the curator
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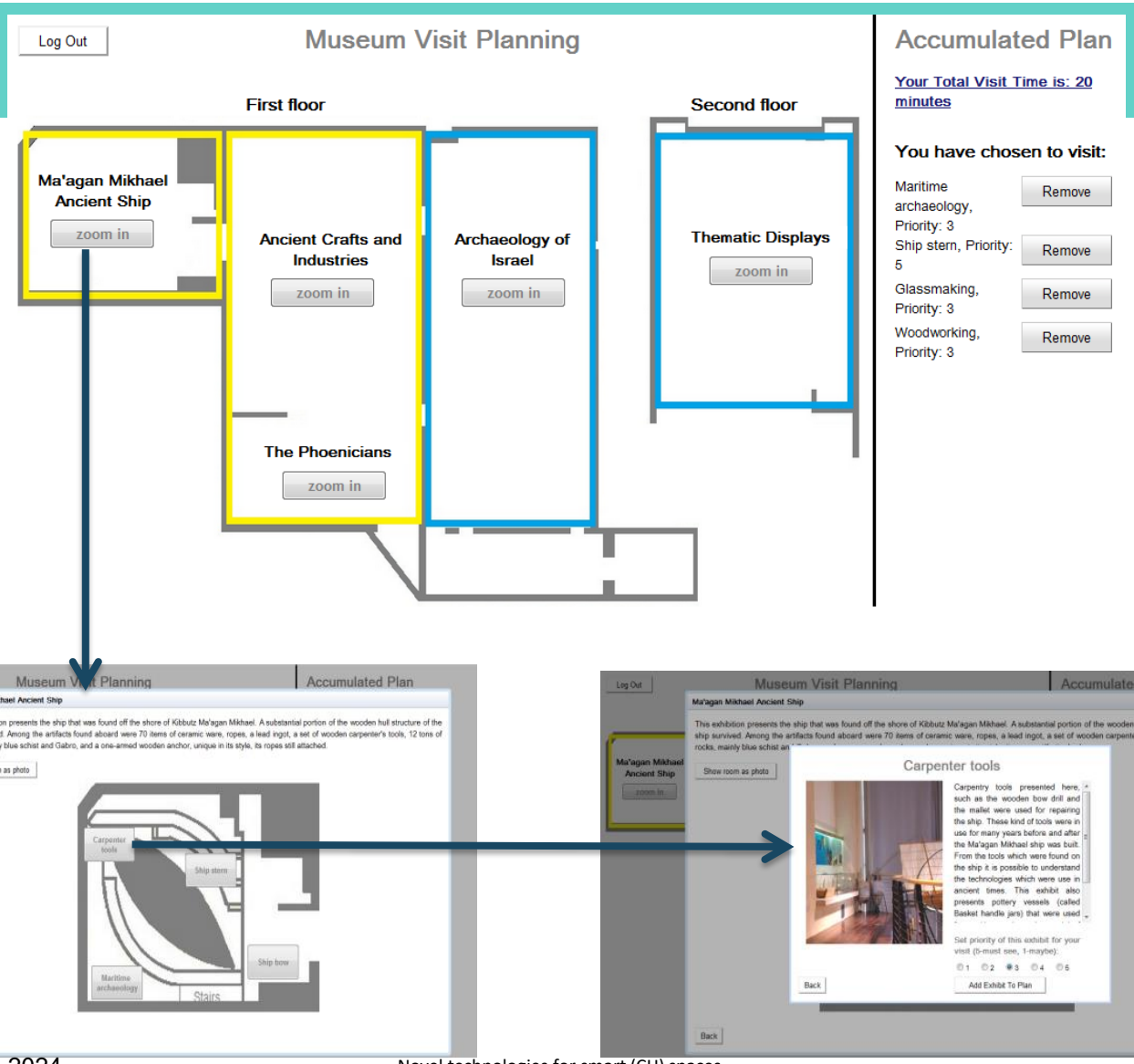
Log Out
Museum Visit Planning
First floor
Second floor
Ma'agan Mikhael Ancient Ship
zoom in
Ancient Crafts and Industries
zoom in
Archaeology of Israel
zoom in
Thematic Displays
zoom in
The Phoenicians
zoom in
Accumulated Plan
Your Total Visit Time is: 20 minutes
You have chosen to visit:
Maritime archaeology, Priority: 3
Remove
Ship stern, Priority: 5
Remove
Glassmaking, Priority: 3
Remove
Woodworking, Priority: 3
Remove
Museum Visit Planning
Accumulated Plan
Ma'agan Mikhael Ancient Ship
This exhibition presents the ship that was found off the shore of Kibbutz Ma'agan Mikhael. A substantial portion of the wooden hull structure of the ship survived. Among the artifacts found aboard were 70 items of ceramic ware, ropes, a lead ingot, a set of wooden carpenter's tools, 12 tons of rocks, mainly blue schist and Gabro, and a one-armed wooden anchor, unique in its style, its ropes still attached.
Show room as photo
Carpenter tools
Ship stern
Ship bow
Maritime archaeology
Stairs
Back
Carpenter tools
Carpentry tools presented here, such as the wooden bow drill and the mallet were used for repairing the ship. These kind of tools were in use for many years before and after the Ma'agan Mikhael ship was built. From the tools which were found on the ship it is possible to understand the technologies which were use in ancient times. This exhibit also presents pottery vessels (called Basket handle jars) that were used
Set priority of this exhibit for your visit (5-must see, 1-maybe):
1 2 3 4 5
Add Exhibit To Plan

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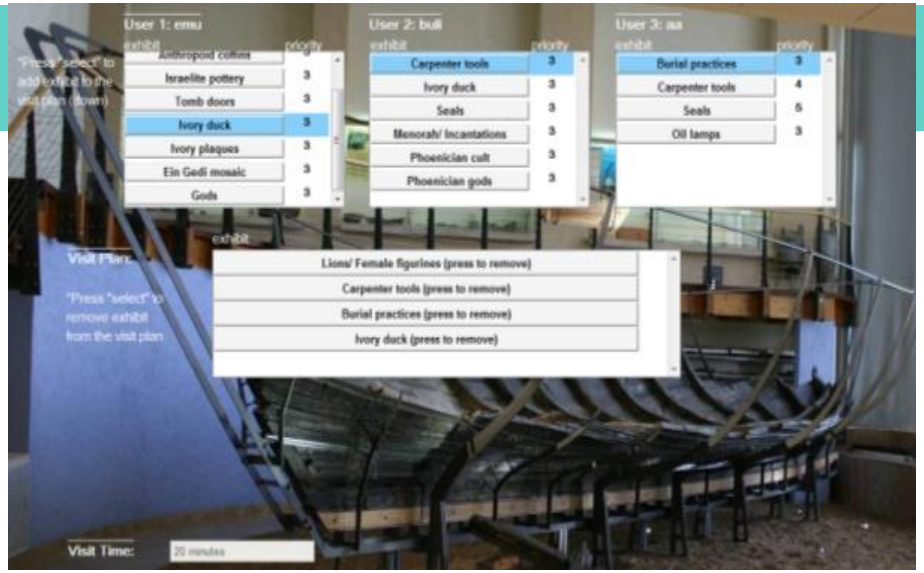
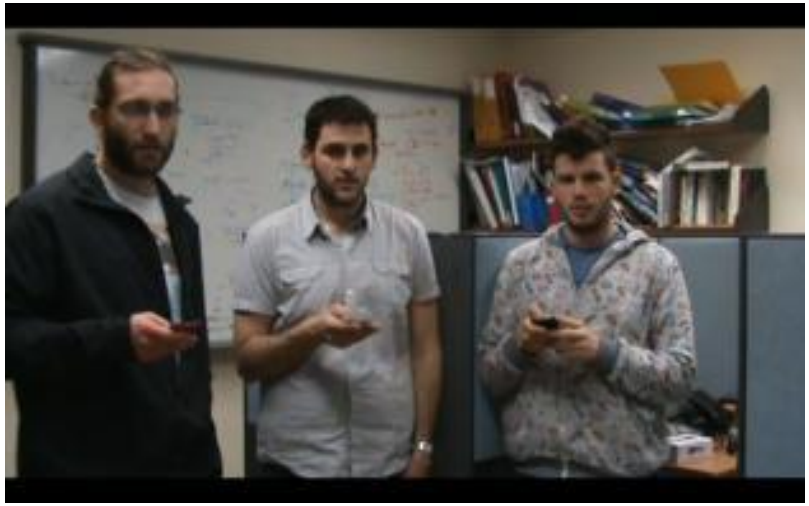
-

Shared setting

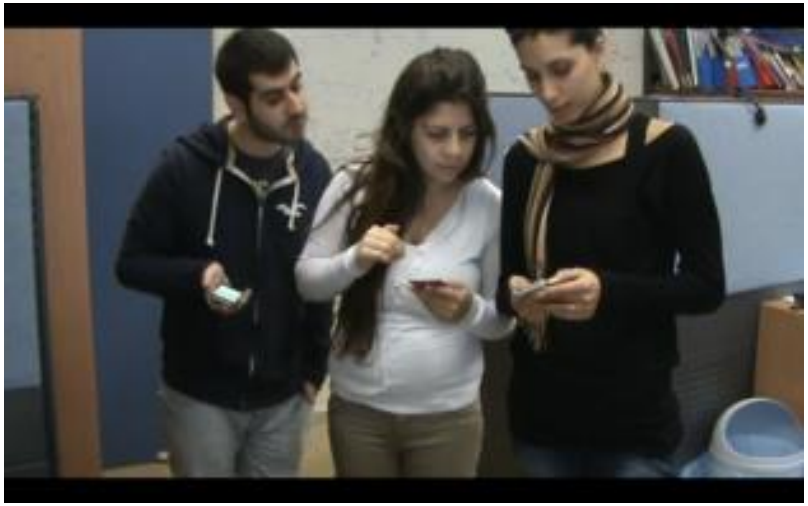


Private setting

Results



Shared setting



Private setting

- Speaking time was longer in the private setting.
- Private setting was perceived to stimulate more discussion.

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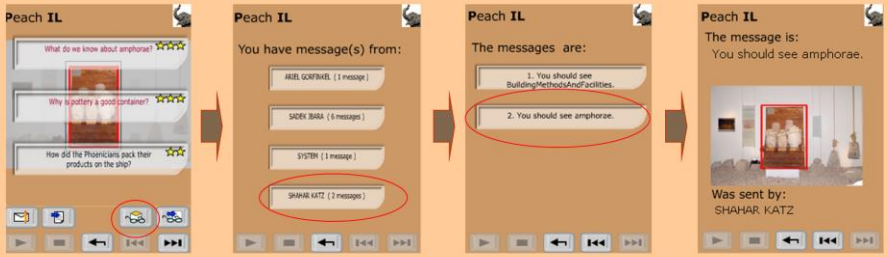
-

Context aware communication

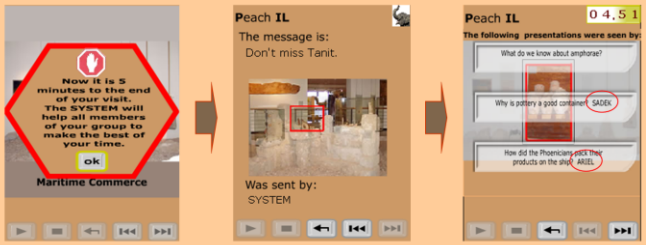
During the visit, while the visitors are following on individual paths, the system allows them to communicate with other members of their group. They can send predefined messages about exhibits they find especially interesting, or leave post-its on some exhibit that they would like the others to notice.

Inter-Group communication



When a visitor gets a message, a relevant button becomes enabled. The system uses the contextual position information for translating it by giving the exact name of the exhibit and attaching the relevant picture.

System- Group communication



When the system enters into the “little time available” modality, it actively ensures that visitors see "crucial exhibits for a visitor." In this scenario the system also addresses a social context. It sends "don't miss messages" to the visitors. Messages are sent to visitors regarding the nearest "must see exhibit", that seems to be of interest to him/her and that he/she has not seen yet. When the visitor approaches the “must see exhibit”, the presentations recommended by the system for that exhibit are those that seem of interest but not yet presented to any other group member, instead of being those recommended only according to her/his specific user model.

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Visit summary and recommendations

Caro [nome], 06 settembre 2004

Hai appena terminato la tua visita a Torre Aquila nel castello del Buonconsiglio, dove hai visitato l'affresco del Ciclo dei Mesi raffigurante la vita a Trento nel Medioevo. In particolare ti sei soffermato sugli affreschi di inverno e di primavera.

Hai iniziato la tua visita con il mese di Gennaio, che rappresenta tre scene principali: una battaglia a palle di neve, il castello di Stenico e una scena di caccia. Sei sembrato particolarmente interessato alla scena di caccia, dove ci sono due cacciatori alla ricerca di conigli e volpi che non vanno in letargo durante il rigido inverno.

Da qui sei passato al mese di Febbraio, dove le due scene principali sono un torneo in cui si scontrano due gruppi di cavalieri, che è un'attività aristocratica, e un fabbro, che svolge invece un'attività plebea.

Poi hai visto il mese di Aprile, che rappresenta principalmente attività agricole primaverili come la semina e l'aratura, che sono state anch'esse di tuo interesse. Ad esempio, hai visto i contadini che usano gli animali per preparare il terreno ai confini di un villaggio.

Quindi sei passato al mese di Luglio che presenta attività agricole estive quali il rastrellamento, la falciatura e la fienagione. Oltre alle scene plebee c'è una scena aristocratica nella quale un nobile offre un falco ad una dama.

Sembra che tu sia molto interessato alla stagione invernale di Trento nel Medioevo visto che ha passato quasi tutto il tempo guardando gli affreschi che mostrano le attività invernali di svago.

Ulteriori attività primaverili di svago appaiono nei mesi di Maggio e Giugno, che non hai visitato, ognuna con le sue specifiche caratteristiche.

Altre attività di lavoro a Trento nel Medioevo si possono trovare nella maggior parte dei mesi che non hai visitato.

In base alle preferenze che hai mostrato durante la visita potresti andare a visitare Castel Ivano, dove puoi trovare diversi affreschi sul tema dell'inverno.

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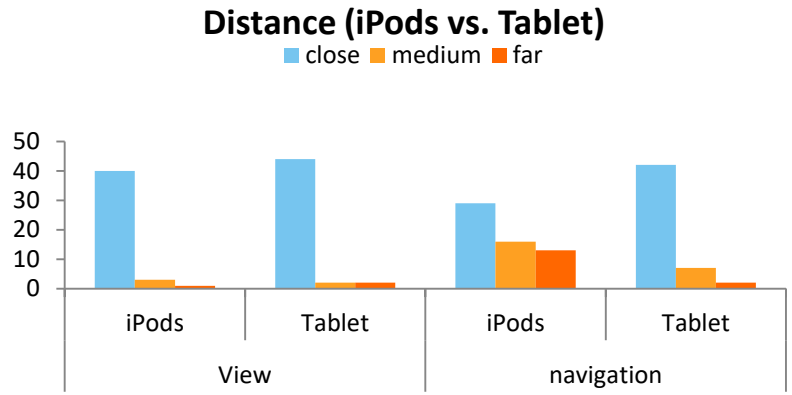
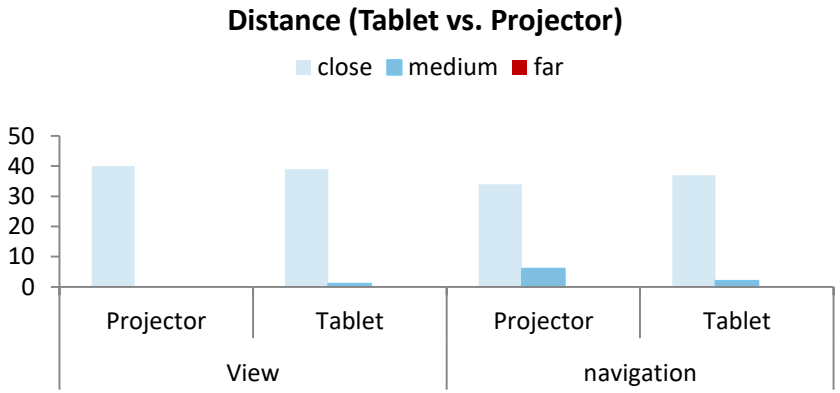
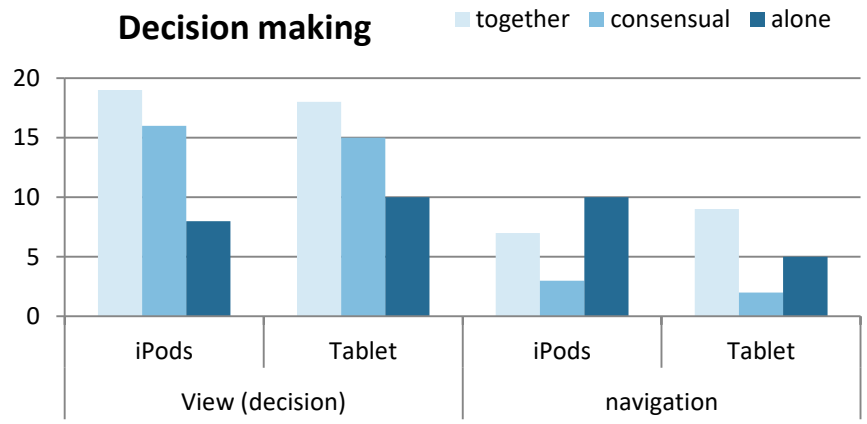
Landmark-based navigation

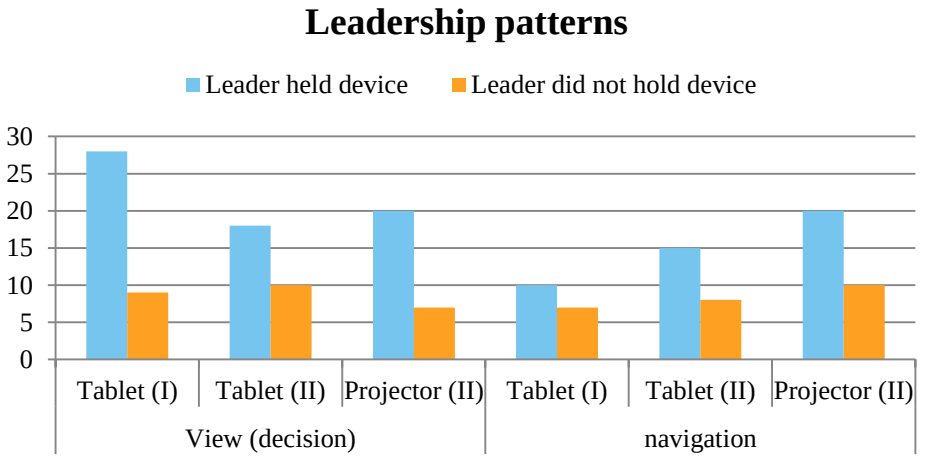
Shared displays study

Shared displays study









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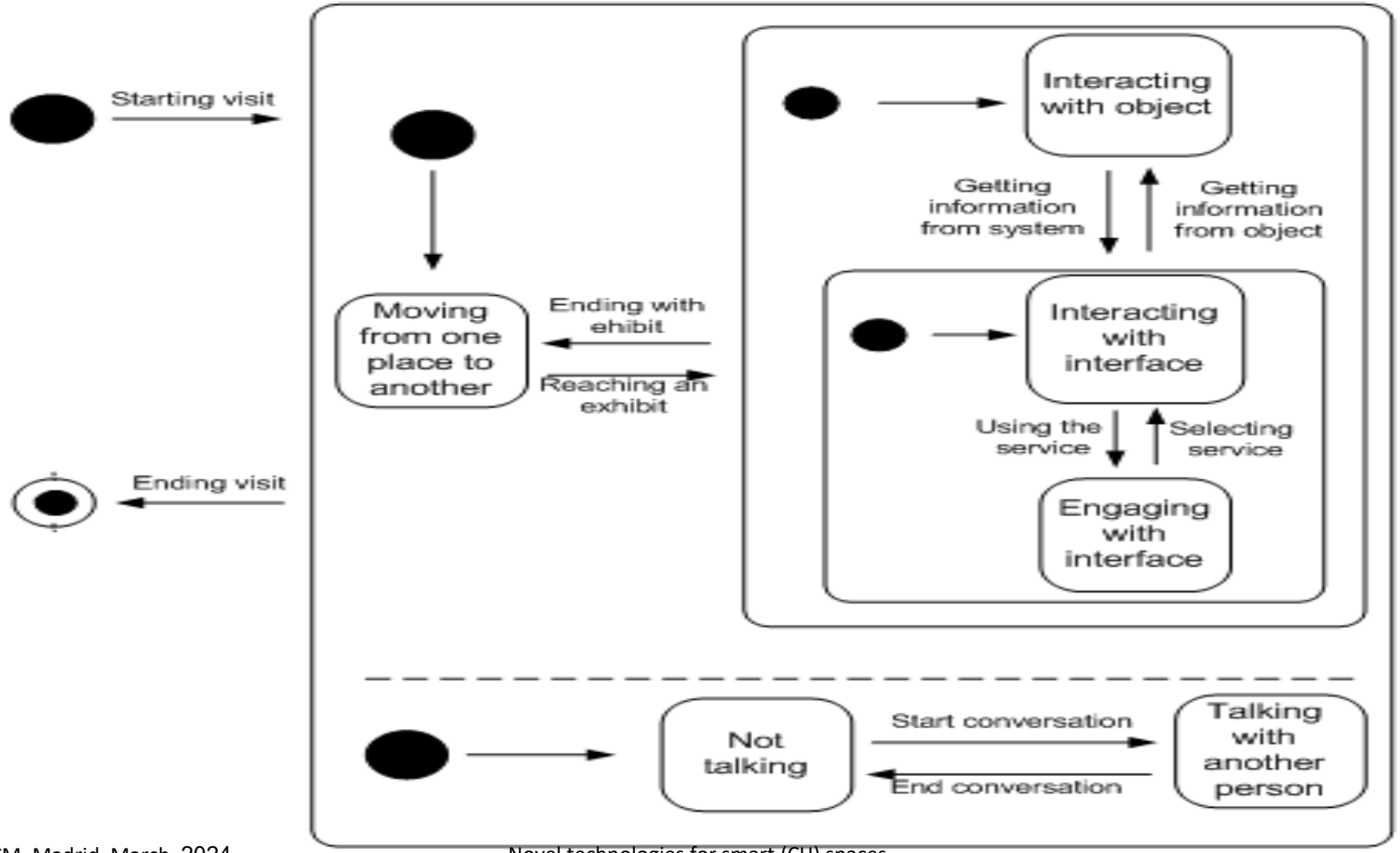
Motivation

- Proactiveness allows systems to provide their users with relevant information (or service) at the right time
- Proactive museum visitors guide is one example for such system
- However, when considering proactiveness, two questions pop up:
  - When to provide information to the users?
    - We do not want to interfere
  - How to notify the users about the availability of a service ?
    - We would like to make sure that the user will get the message

Pilot study A – defining situations



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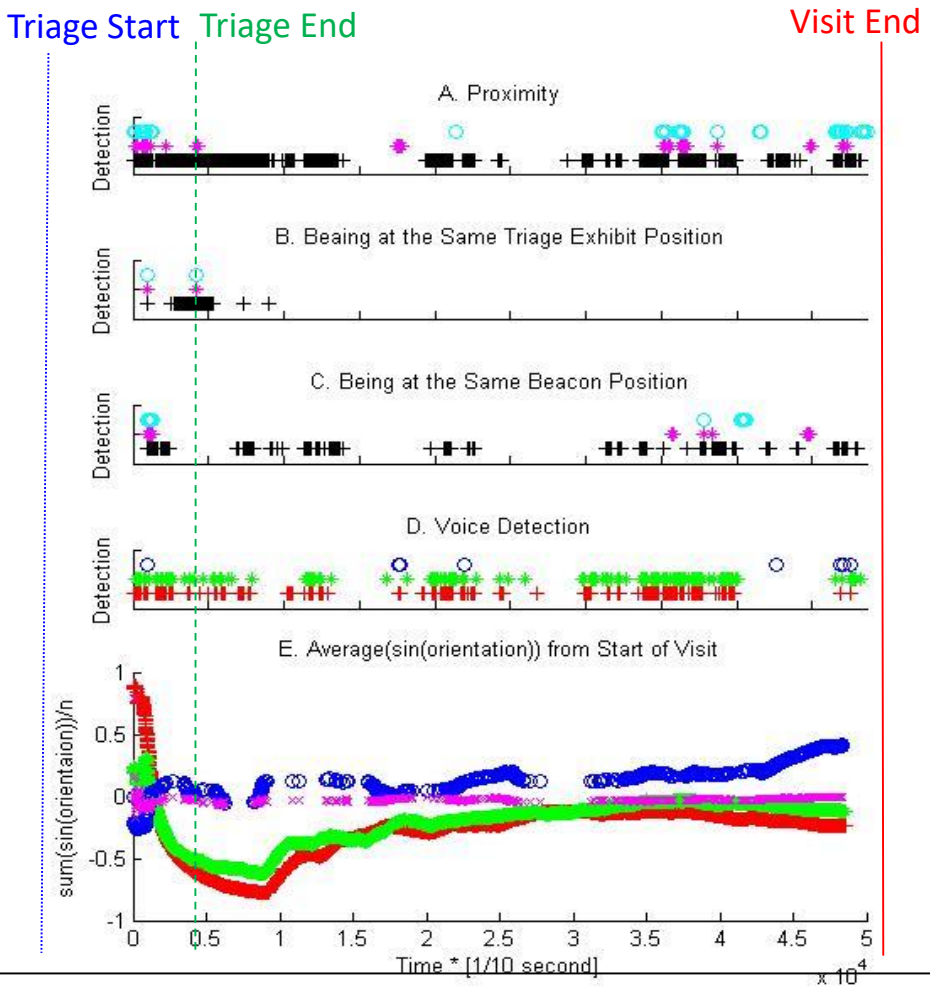
An illustrative example



Legend: Top three plots: '+': visitor 1&2; '*': visitor 1&3; 'o': visitor 2&3
Two bottom plots: '+': visitor 1; '*': visitor 2; 'o': visitor 3; 'x': random

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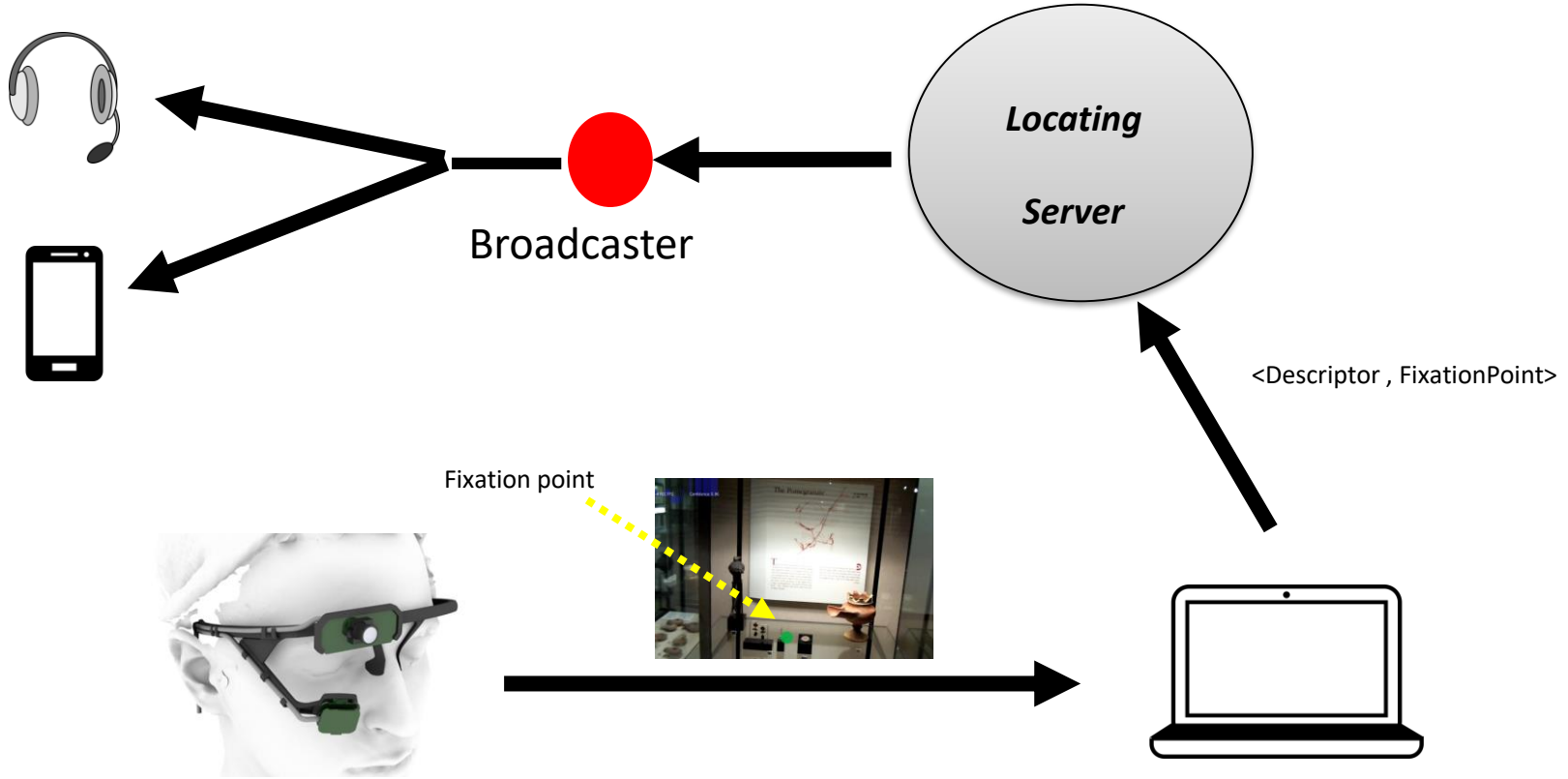
So we have an instrumented museum, so what?

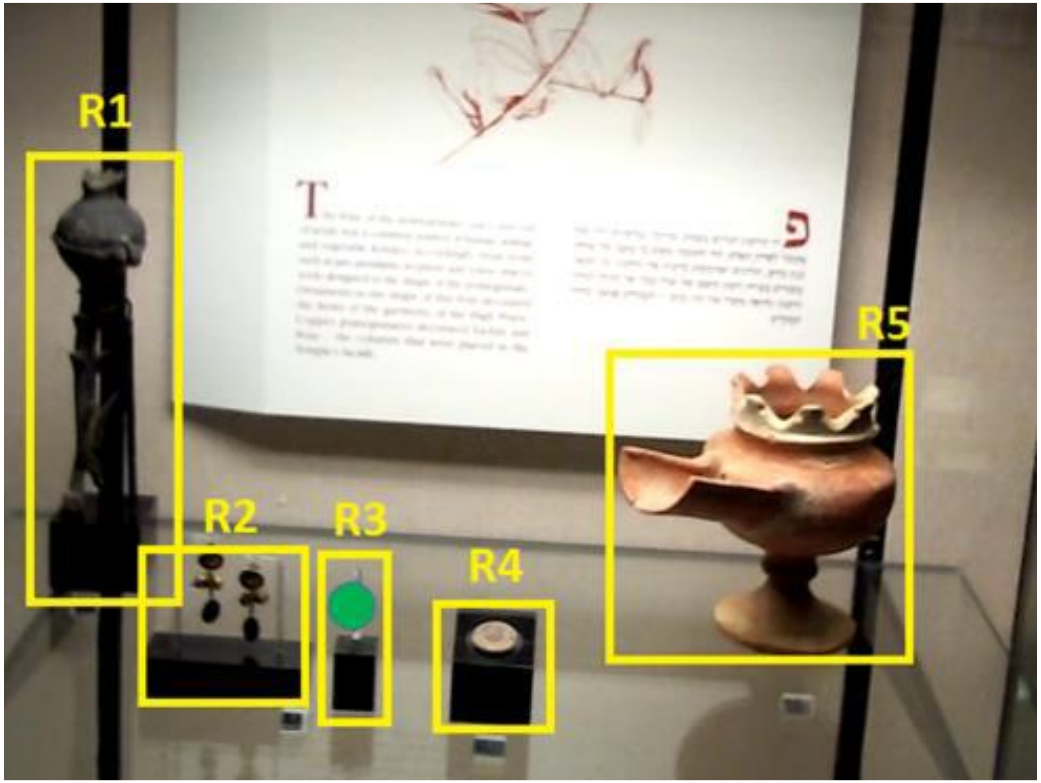
Our research question:

How can we use mobile eye tracker to identify location and object of interest?

Architecture



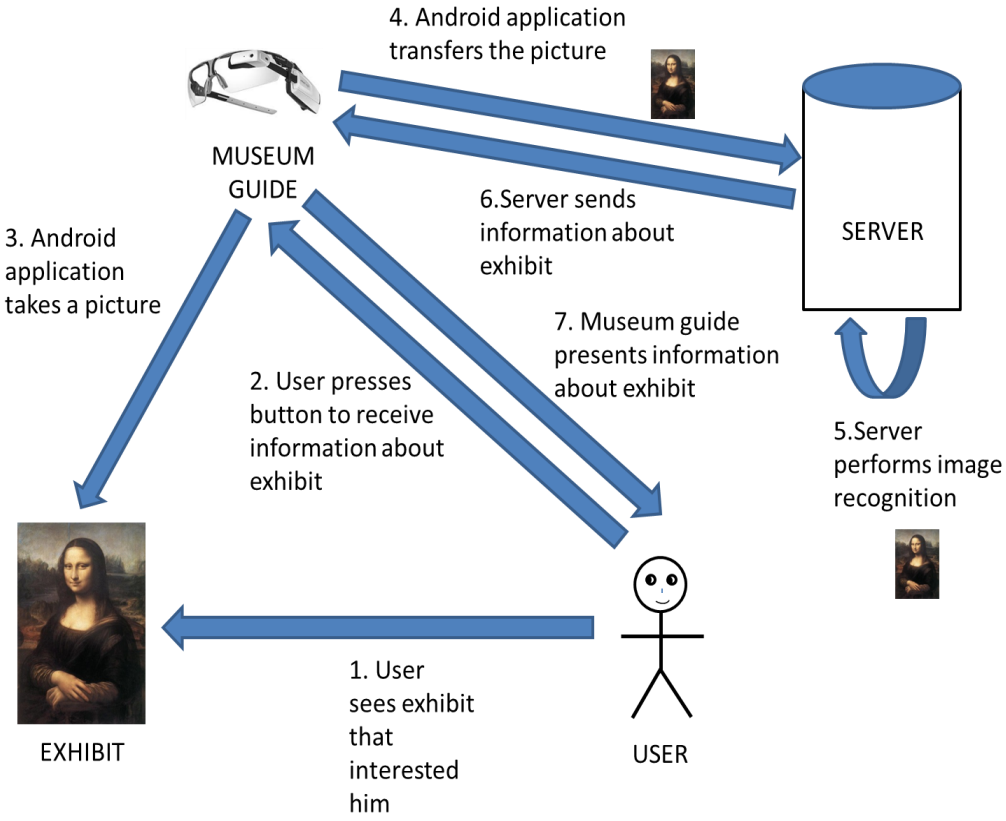
The use of an eye tracker as a pointing device



So we have an instrumented museum, so what?

- We can enable online visit planning
- We can enable onsite re-planning
- We can enable onsite interaction
- We can create a personalized visit summary
- We can study indoor navigation
- We can study interrupt management
- We can monitor visitors' behavior
- We can track visitors' gaze
- **We can provide information via smart glasses**
- We can provide feedback to the curator
-

System Architecture



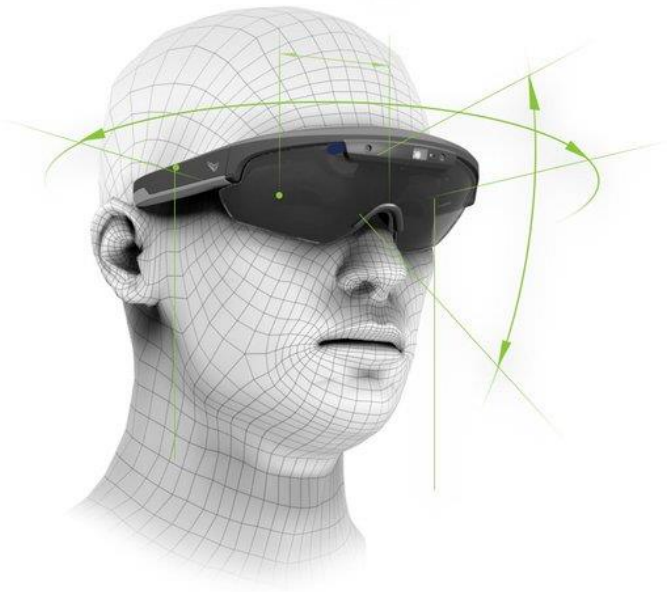
Enhancing Cultural Heritage Outdoor Experience with Augmented-Reality Smart Glasses

- Our objective was to explore the potential of augmented-reality smart glasses to enhance visitor experience at outdoor cultural heritage sites
  - Reveal usability problems
  - Identify technology acceptance factors

ARSG-based Mobile Guide – System Requirements

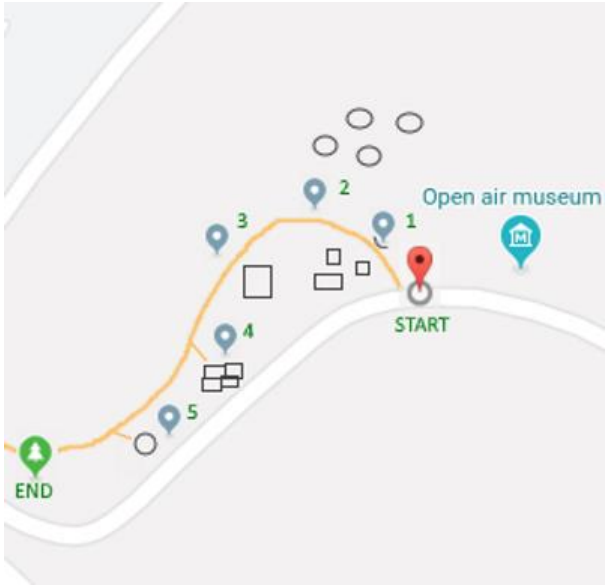
- **User interfaces** – intuitive interaction techniques for controlling the content
- **Content presentation -** clear and useful content as complementary information to better understand the objects on display
- **Context awareness** - respond to user requests based on information about their environment or the context of operations
- **Navigation** - navigation is a critical design issue for a meaningful visitor experience
- **Outdoor environment conditions -** lighting conditions, background noises

Everysight Raptor - AR smart glasses designed for cycling



Experimentation - Field study

- Data Collection
  - Visitors walked along the trail and visited 5 POIs along the way
  - The guide logged data in a file for post-visit analysis
  - Participants filled out a System Usability Scale (SUS) questionnaire
  - They then filled out an additional questionnaire about the smart glasses only
  - We also conducted a short semi-structured interview



Results – A Semi-Structured Interview

- 63.3% of participants thought that the smartphone guide was easier to operate
  - Participants felt more comfortable with operating a “familiar” device (14)
  - The colors of the smartphone’s display are “more vivid and pleasant to the eye” (15)

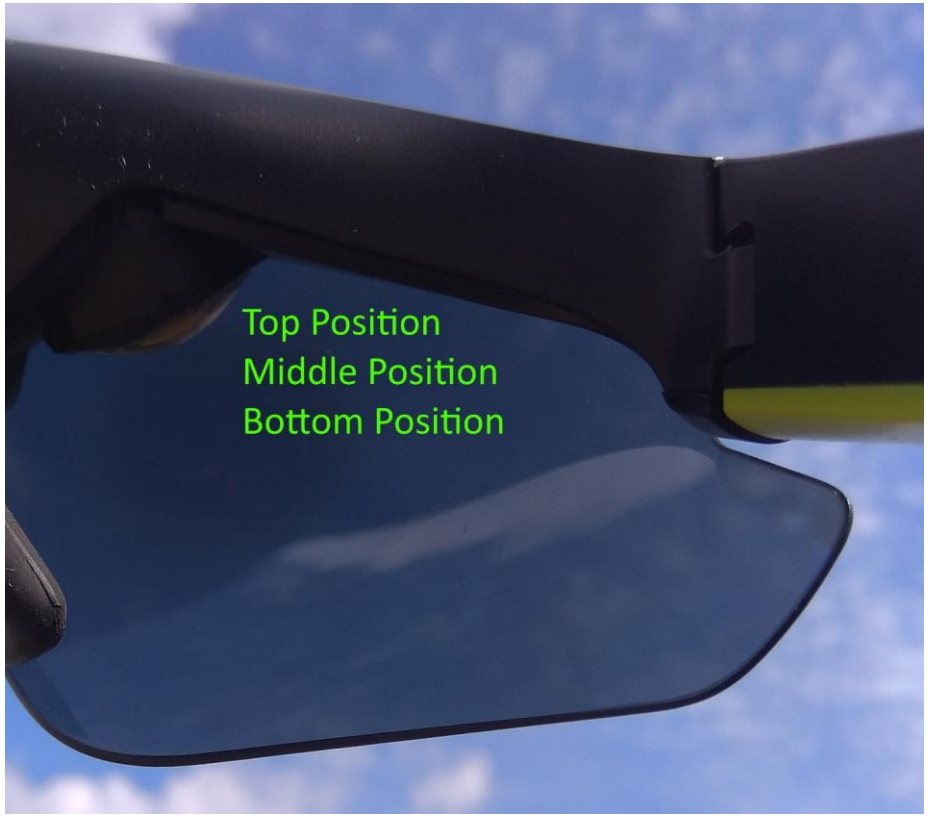
  Disadvantages:
  - The smartphone “disconnects” them from the objects ahead (11)
  - The smartphone was “too heavy” to hold while looking for nearby POIs (5)

- 80.0% of participants selected the smart glasses guide as their preferred guide for museum use in the future
  - Elevated experience and “cool” technology (9)
  - Walking around “hands-free” (8)
  - Always “looking ahead” while consuming content (10)

  Disadvantages:
  - Participants found the smart glasses to be “bulky” (2)
  - Participants experienced some challenges “focusing on the display” (3)

Lab Experiment – ARSG Text Color

Lab Experiment – Text Position Selection



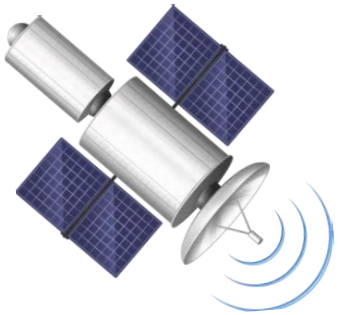
Conclusions

- We confirmed the perceived usefulness, ease of use and enjoyment of our visitor guide on both smartphone and smart glasses
- The smartphone is still perceived as more natural and more intuitive than the smart glasses.
- However, the smart glasses are more appealing to visitors of CH venues than the smartphone.
- The comfort and balanced weight of the smart glasses contribute to a seamless and enjoyable wearing experience for museum visitors.
- AR displays in outdoor environments must work across a wide variety of lighting conditions.
- The smart glasses create a more private and intimate visitor guide experience, as opposed to the smartphone's exposed display, which alternatively offers an opportunity for information sharing.

Context Aware Mobile Guide Using JiNS MEME

"WHAT YOU LOOK AT IS WHAT YOU GET"

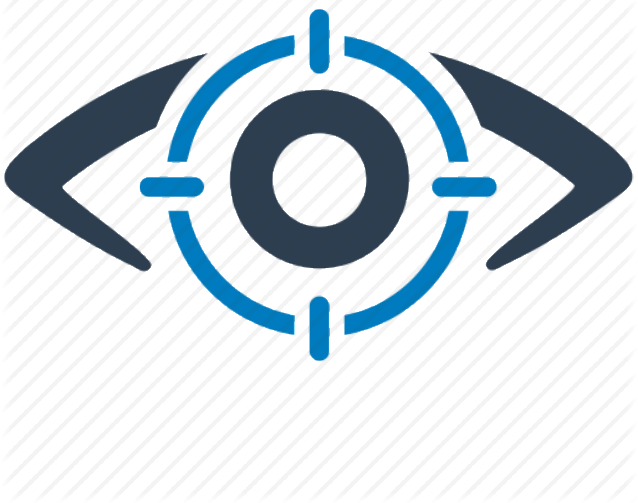
GPS + compass for positioning



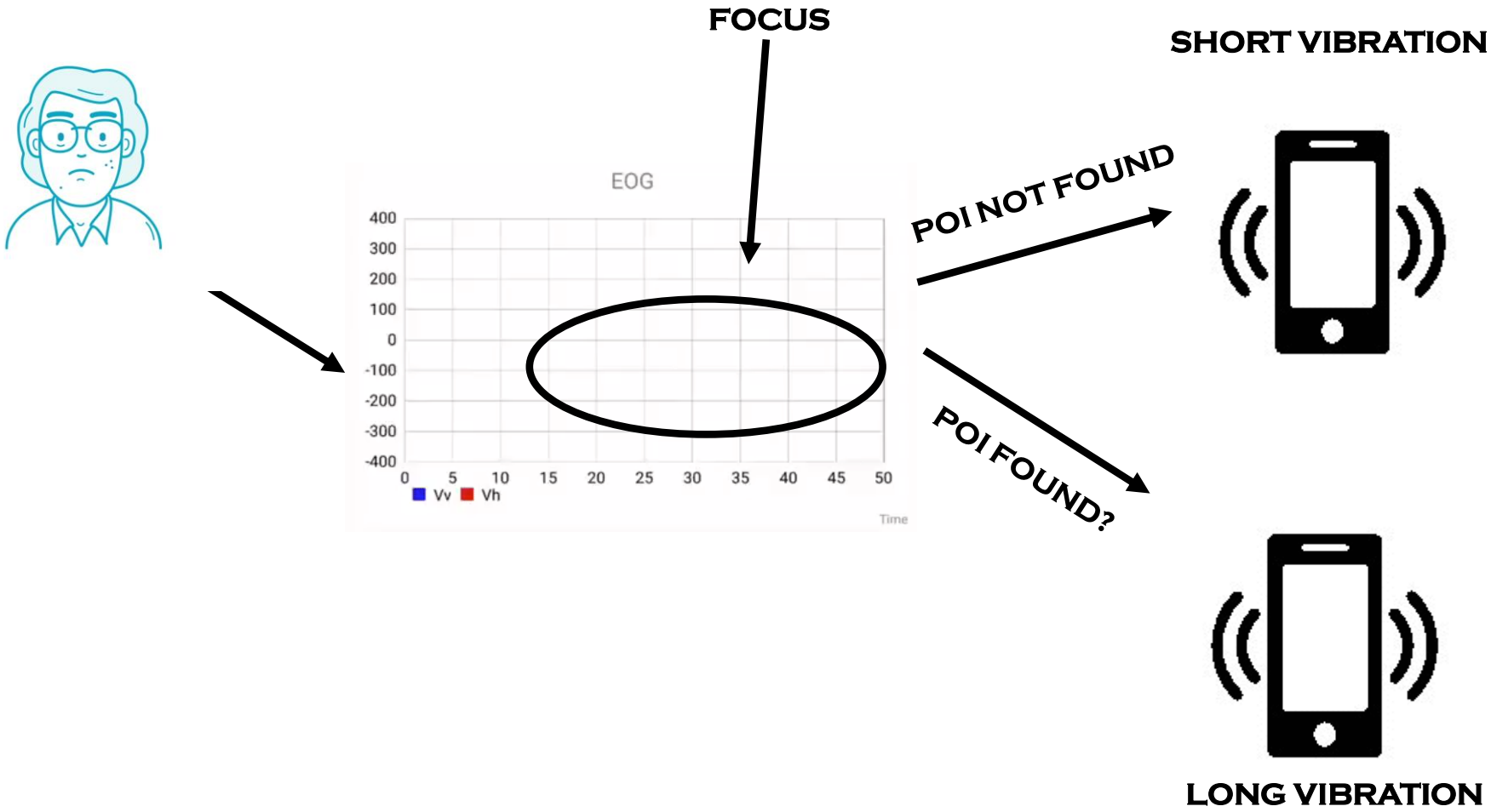
The device

EOG for detecting eye

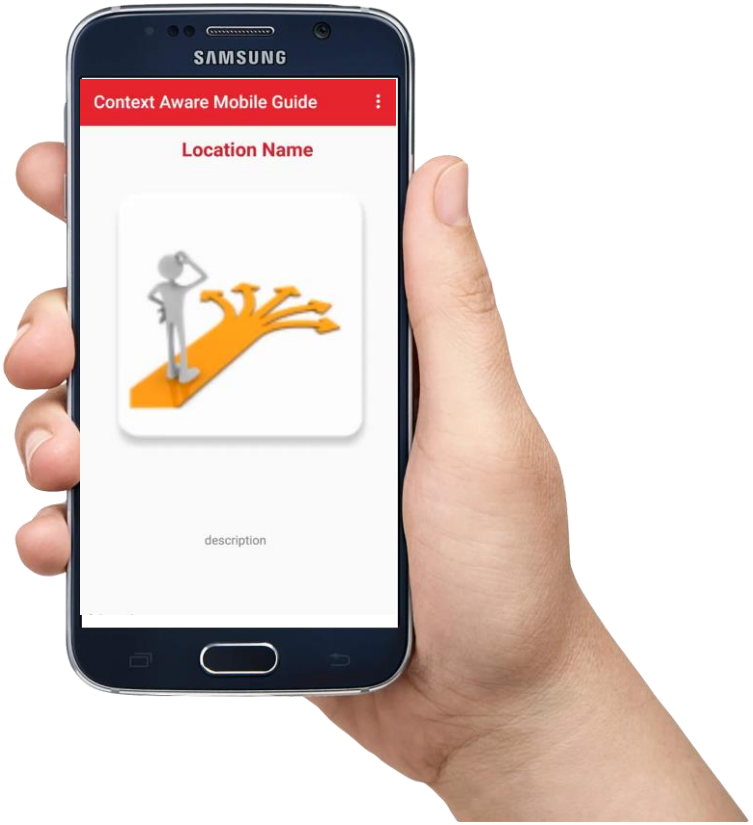
fixations

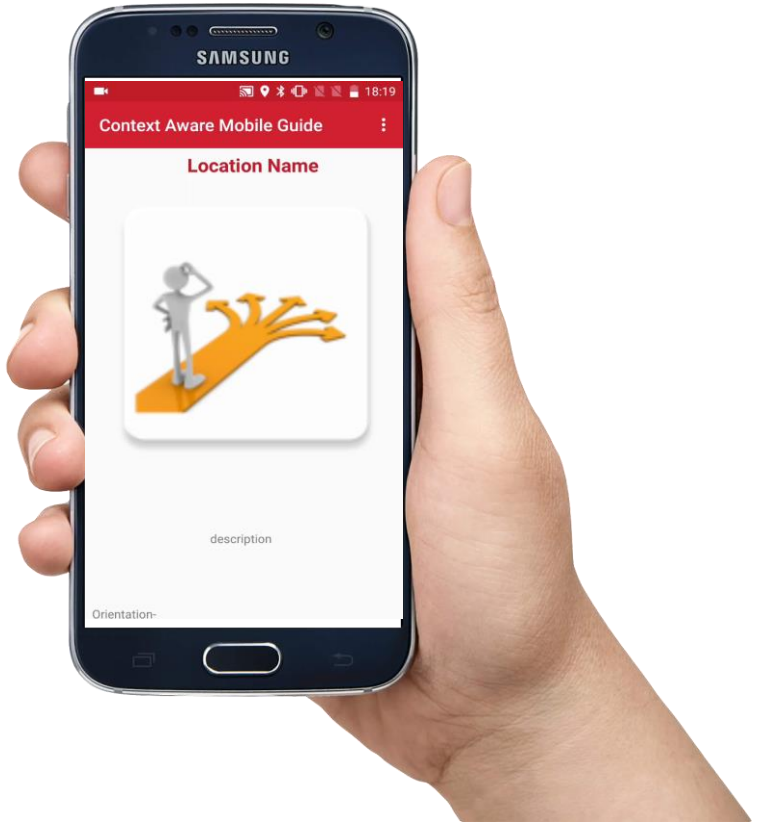


Interaction



Interaction




SAMSUNG
18:19
Context Aware Mobile Guide
Location Name
description
Orientation-

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- **We can provide feedback to the curator**
-

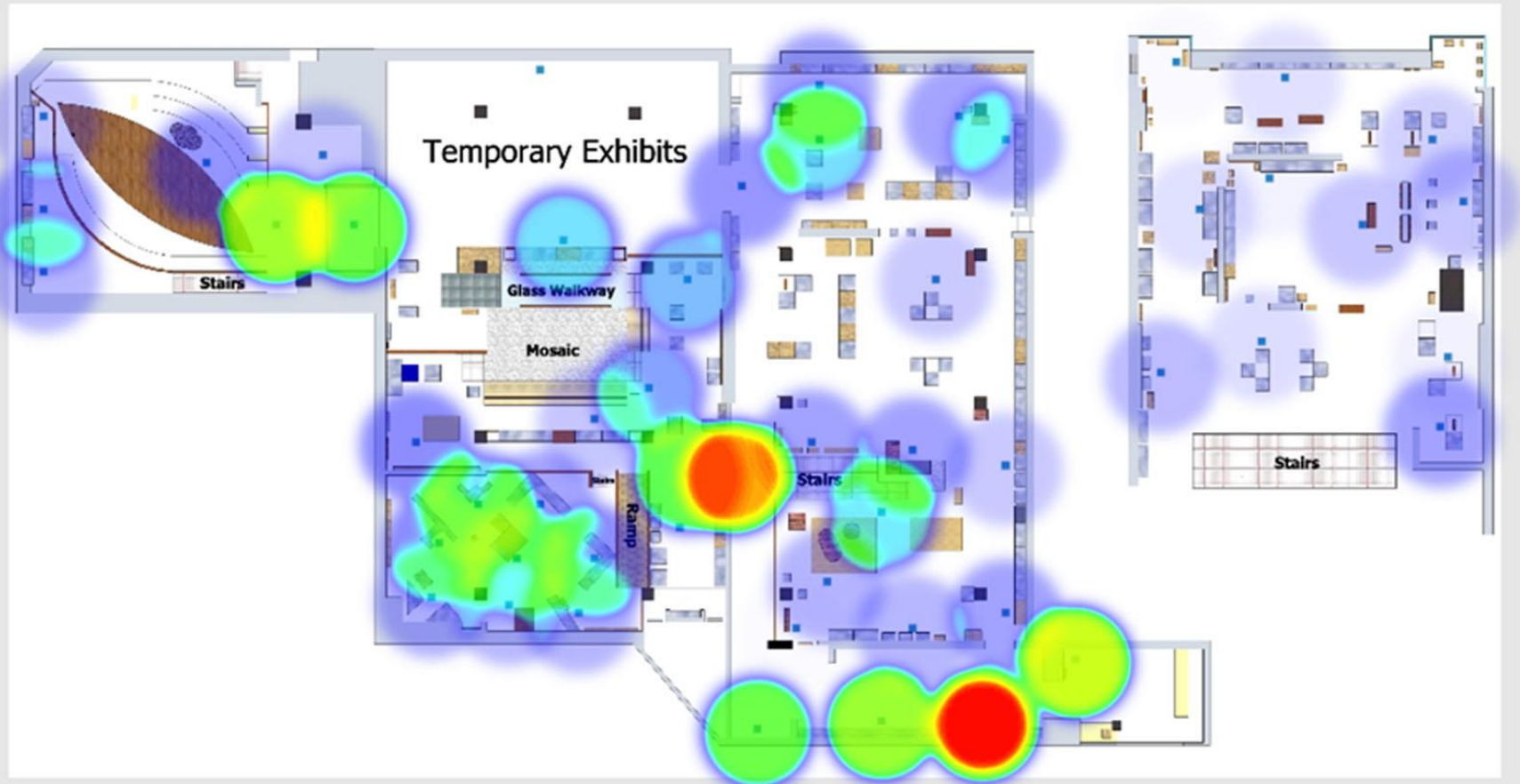
Attracting and holding power

AMVBAS | Individual Visitor | Small Groups | Aggregation | Mobile Guide

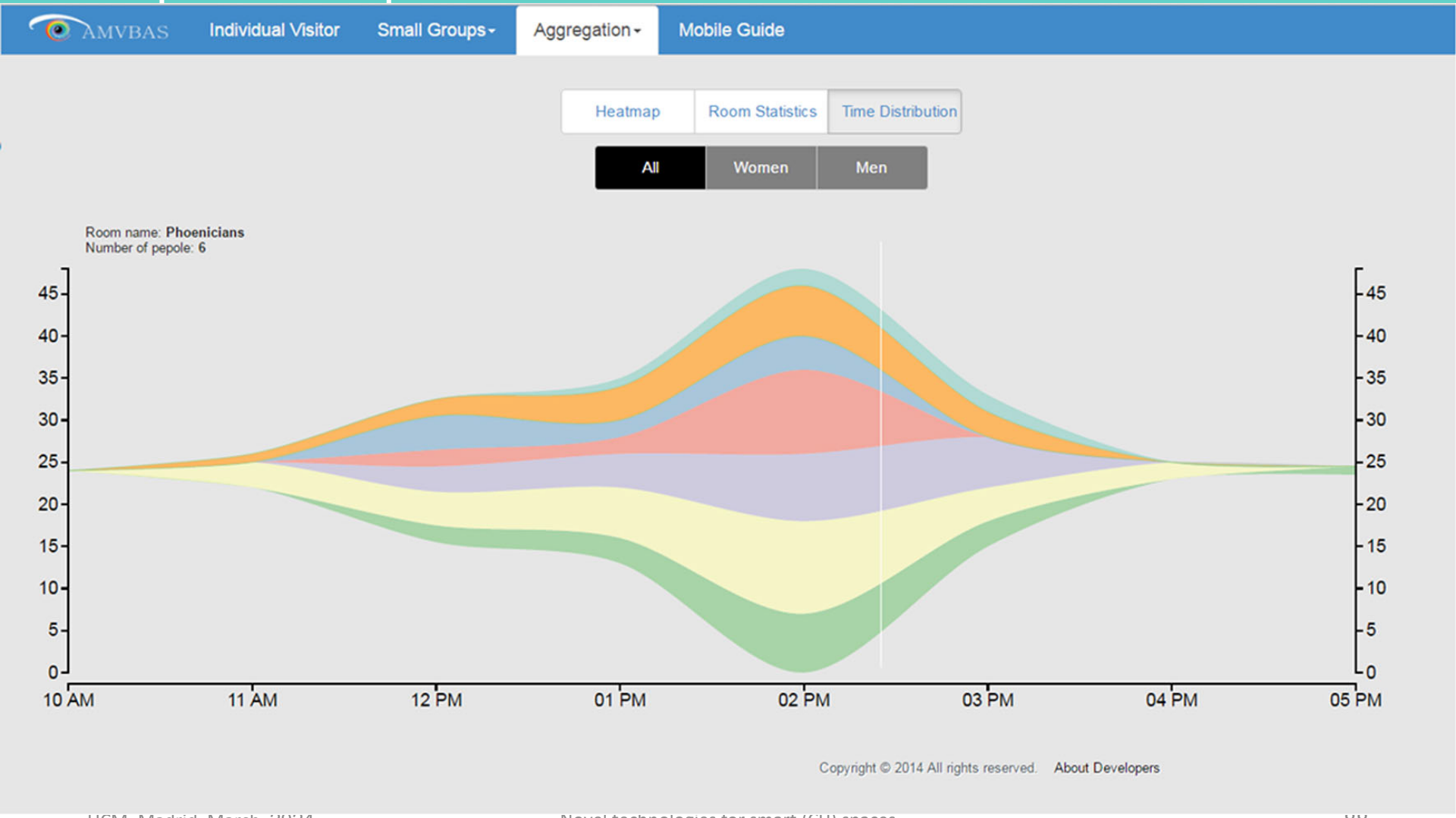
Heatmap | Room Statistics | Time Distribution

Age Range: 1 — 100

All | Men | Women | Language



A spatio-temporal view



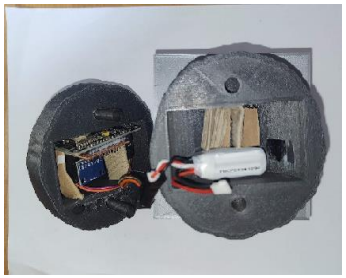
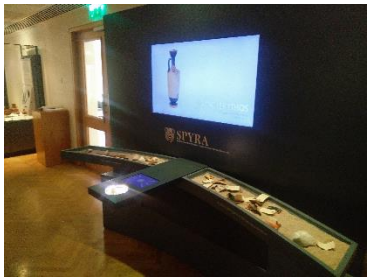
The effects of a mobile visitors guide on visitors' behavior

- We compared visit logs in a 10-month study
  - 252 regular visitors that used a mobile guide
  - 152 regular visitors that did not use it

- We found out that
  - Using a mobile guide increased visit time
  - The mobile guide monopolized visitor's time
    - Both holding power and attraction power increased
  - The use of the guide disrupted the social interaction of visitors coming in a group (less talking, separating)

So we have an instrumented museum, so what?

- Recent studies
  - Using tangible user interfaces
    - Augmenting real objects
    - Instrumenting 3D replicas


Enhancing the visit experience for people with visual impairment

- Exhibitions are nicely designed, but not for visually impaired / blind people
- Everything is protected
- It is impossible to touch objects



Enhancing the visit experience for people with visual impairment

- As part of a one-semester graduate course we developed exhibitions for visually impaired visitors
  - With the help of the museum staff several themes were selected
  - Objects were selected
    - 3D scanned
    - 3D printed
  - 3 different interaction techniques were designed

Enhancing the visit experience for people with visual impairment

- An example for a thematic set – burial tradition
  - Interaction based on RFID scanning
    - The objects have a specific place and they are equipped with an RFID tag

Enhancing the visit experience for people with visual impairment

- Two more examples for a thematic sets – mythology and ancient weapons
- Interaction is based on microswitches (left) and push buttons (right)

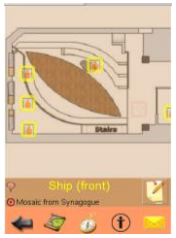
So what did we get

- We cover major aspects of the museum visit and we will cover more

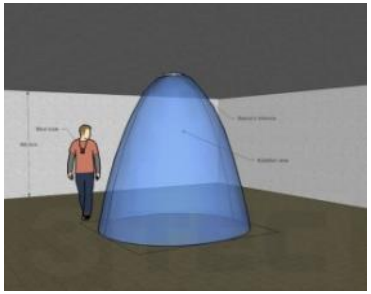
Web-based visit planning (at home)

Onsite individual visit

Group interaction with large displays



Post visit summary



SSP and Interrupt management

Individual and group navigation and communication support

And if we connect everything

The visit becomes a link in a lifelong chain of cultural heritage experience

Planning

Onsite visit

Summary

Planning

Summary


Questions?


thank you
gracias
danke
merci
obrigado
謝謝
teşekkür ederim
ngiyabonga
go raibh maith agat
mochchakkeram
dziękuję
bedankt
sukriya
kop khun krap
terima kasih
grazie
arigatô
dakujem
спасибо
мерси
감사합니다
tapadh leat
dank je
mauruuru
hvala
sagolun
takk
taiku
ευχαριστώ