

Introduction

Mobility

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Mobility: a broad concept

- (1) moving between devices - hot-desking
- (2) moving within an instrumented environment - intelligent buildings and intelligent appliances
- (3) devices within moving vehicles - computers in cars
- (4) small devices that move with you - smartphones, watches

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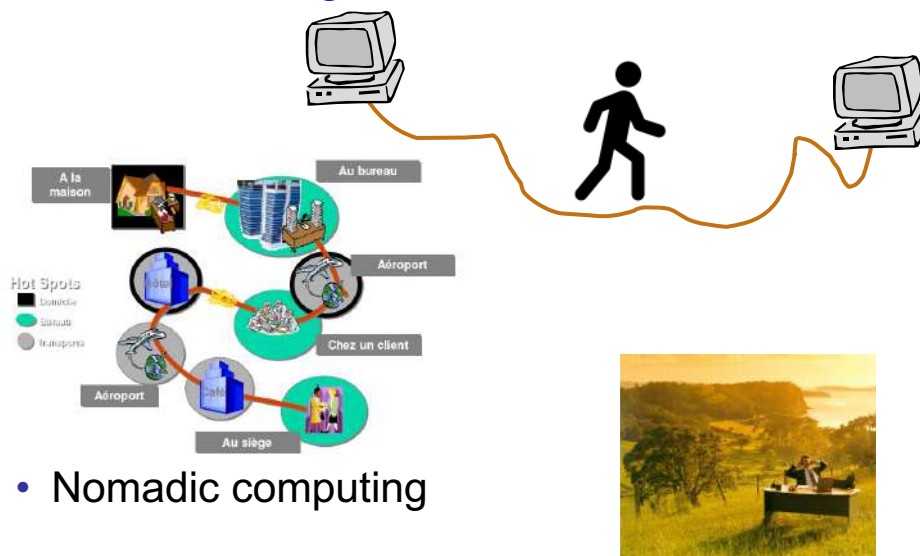
Mobility: a broad concept

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Mobility: moving between devices



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Mobility: a broad concept

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Moving within an instrumented environment

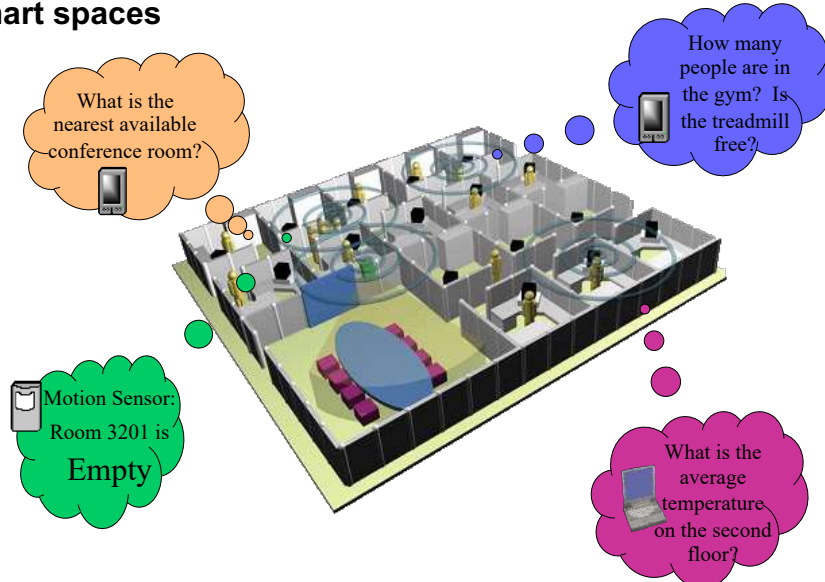


- Examples:
 - Smart spaces
 - Augmented classroom / museum / supermarket

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Moving within an instrumented environment

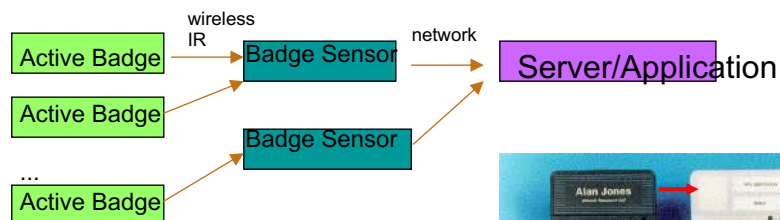
Smart spaces



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Moving within an instrumented environment

- Olivetti Research Laboratory in Cambridge, UK, in 1990-92
- Active Badge: location-aware systems



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Moving within an instrumented environment

- Active Badge
 - Experimented with 32 staffs in ORL company in 2 weeks
 - All staff wearing badge that emits IR signal every 15 seconds
 - Intended to aid telephone receptionist
 - FIND(name)
 - Provides current location of the named badge
 - WITH(name)
 - Locates a named badge and other badges around the badge
 - LOOK(location)
 - Provides badges near the specified location
 - HISTORY(name)
 - Generates report of the location history for the named badge

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Moving within an instrumented environment

- Server
 - Network Control
 - Polling all sensors on the network
 - Representation
 - Builds linked list of (ID, location, time) in time order
 - Data Processing
 - Process large amount of data from the active badge network
 - Display Interface
 - Showing textual information

ORL/STL Active Badge Project

Name	Location	Prob.	Name	Location
P Ainsworth	X343 Accs	100%	J Martin	X310 Mc Rm
T Blackie	X222 DVI Rm.	80%	O Mason	X307 Lab
M Chopping	X410 R302	TUE.	D Millway	X307 Drill
D Clarke	X316 R321	10:30	B Miners	X202 DVI Rm.
V Falcao	X218 R435	AWAY	P Mital	X213 PM
D Garnett	X232 R310	100%	J Porter	X308 Lib.

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Moving within an instrumented environment

- ATT Lab Cambridge: Active Bat 2001
 - Sentient Computing: a form of ubiquitous computing which uses sensors to perceive its environment
 - A "follow-me phone" which would cause the telephone nearest the recipient to ring.
 - Teleporting desktops via VNC just by clicking their Active Bat near the computer.



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Moving within an instrumented environment

- ParcTab (Rank Xerox)1995



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Moving within an instrumented environment

Projet
EasyLiving
Microsoft 2001



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Moving within an instrumented environment

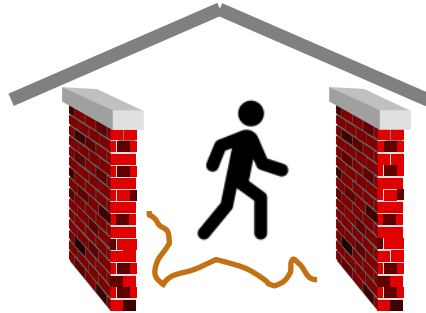
- Location-aware system (within a building)
- Context-triggered actions are simple IF-THEN rules used to specify how context-aware systems should adapt

Like living in a rule-based expert system

```
Coffee   Kitchen  arriving  "play -v 50 ~/sounds/rooster.au"  
schilit *      attention  "emacs -display $NEARESTHOST:0.0"
```

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Moving within an instrumented environment



- Examples:
 - Smart spaces
 - **Augmented** classroom / museum / **supermarket**

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Wireless supermarket concepts

- The Shopping Buddy wireless touch-screen device attached to a shopping cart
 - scans in items placed in the cart by shoppers
 - delivers personalized services and incentives when activated with a frequent-shopper card
 - RFID which triggers certain offers and can help shoppers find anything in the store and draw a path to find it.



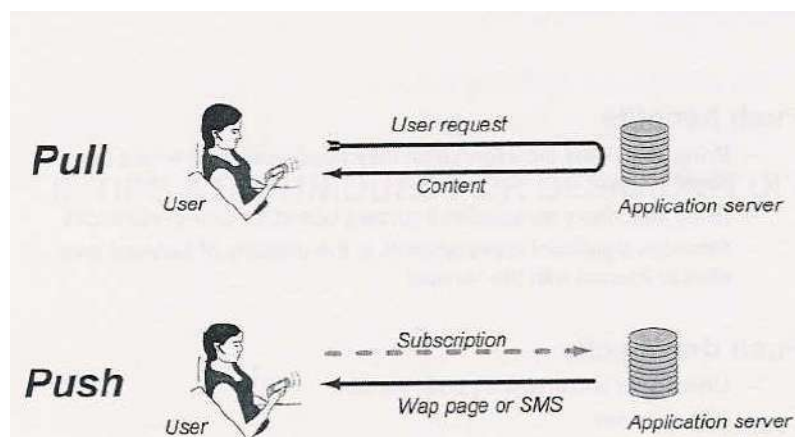
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Wireless supermarket Operation

- As you shop, you can scan in each item
 - keeps a running total of how much you are spending
 - eliminates the need to wait in line at the check-out
 - you can also check the price of each item before you buy
- As you walk down the aisles
 - promotions and paperless coupons “pop-up” on the screen
 - Reminders of articles you search
 - Directions to articles
- You can place an order at the deli (ex. Half a kilo of ham) from anywhere
 - notification to pick it up (No more taking a number and standing in line)

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Wireless supermarket Operation



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Wireless supermarket Operation

- The Everywhere Display (IBM)
- Beamed from the supermarket ceiling
- transforms any surface into an interactive computer
 - On the floor
 - On the items



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Wireless supermarket Operation

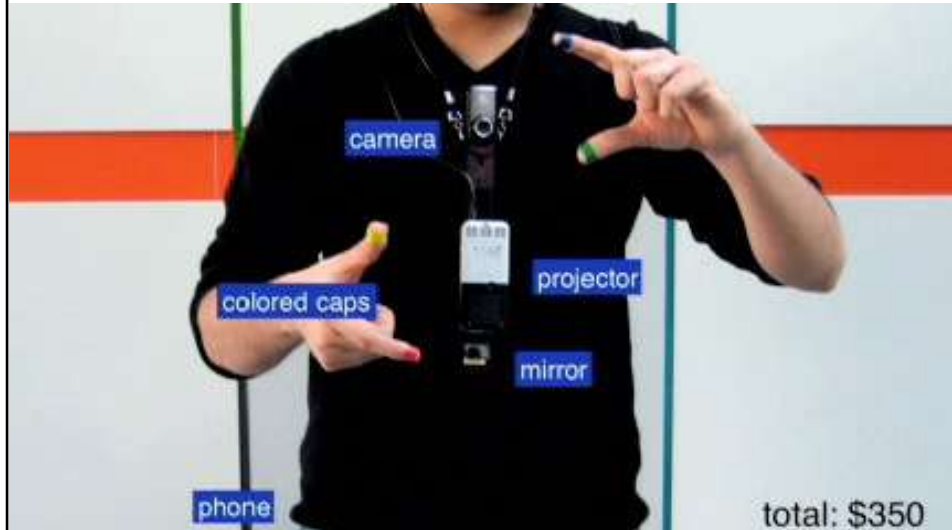
- The Everywhere Display (IBM) transforms any surface into an interactive computer
- A MIT project: Sixthsense 2010
 - wearable gestural interface that augments the physical world around us with digital infor
 - Video SixthSense.mp4



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Wireless supermarket Operation

- Sixthsense 2010



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Moving within an instrumented environment

- Technological approach
 - 1. Augment the user
 - The user wears or carries a device to obtain information about physical objects.
 - => similar to the case 4 « small devices that move with you »
 - 2. Augment the physical object
 - The physical object is changed by embedding input, output or computational devices on or within it.
 - 3. Augment the environment surrounding the user

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Devices within moving vehicles



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Devices within moving vehicles



- AutomotiveUI 2017
- Scrolling a list of songs
- Touch / Pressure
- Haptic feedback



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Devices within moving vehicles



micro

Tactile Surface

Keyboard



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Devices within moving vehicles

- FutureLab of Ars Electronica (Austria)
- Augmented Reality
 - *Instar.mov* video



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Devices within moving vehicles

- DGA project
- Augmented cockpit (Rafale)



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Devices within moving vehicles: microgestures



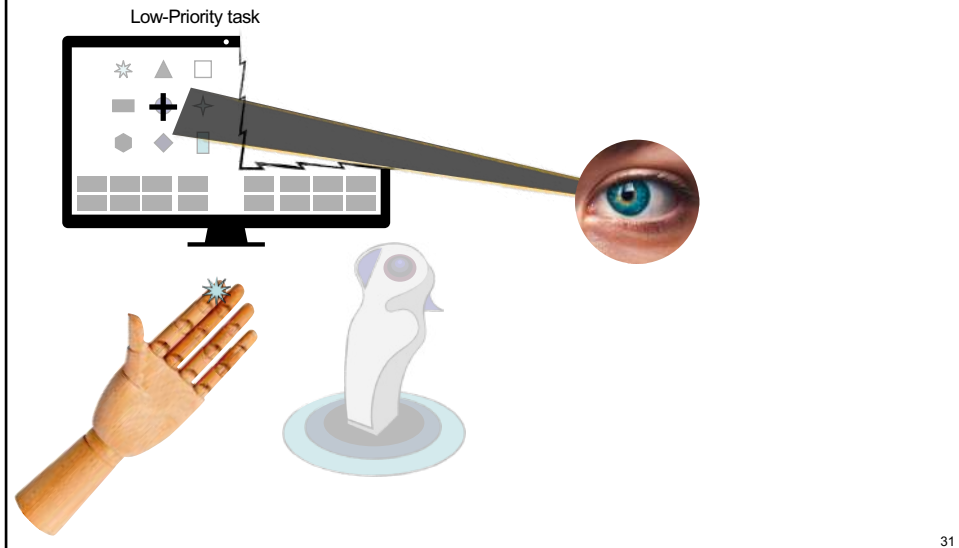
29

M[eye]cro for Low-Priority task



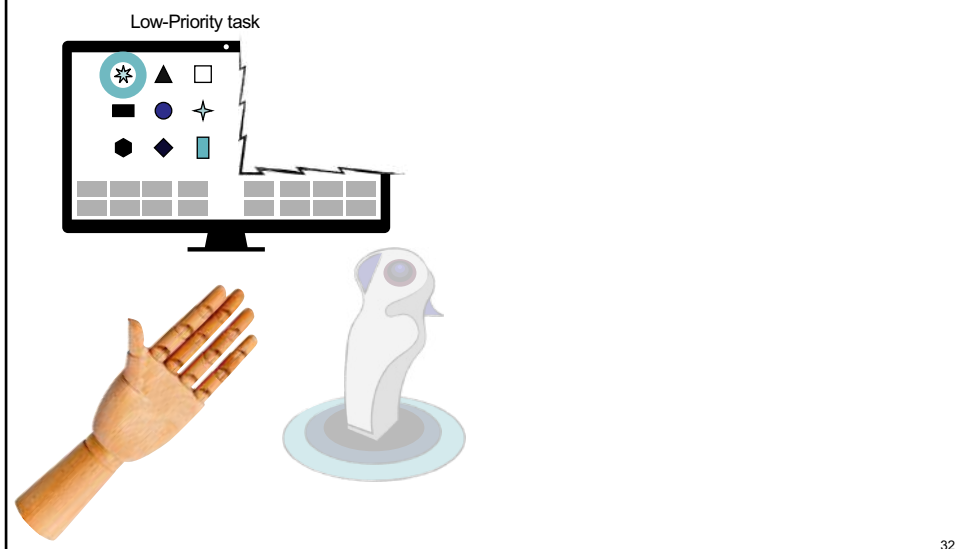
30

M[eye]cro for Low-Priority task



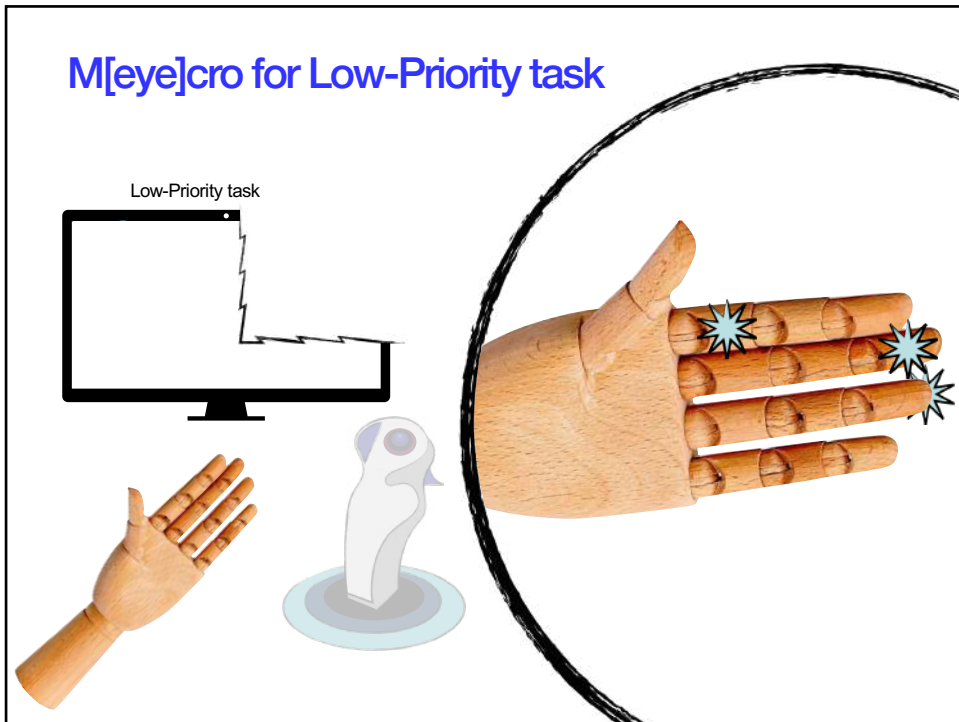
31

M[eye]cro for Low-Priority task

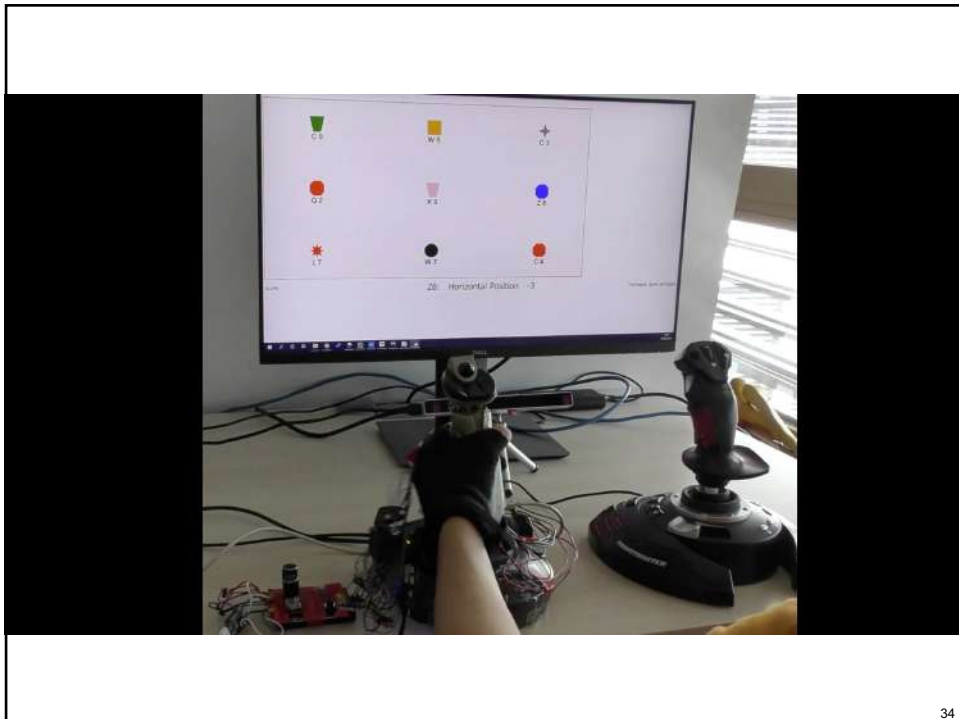


32

M[eye]cro for Low-Priority task



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De plus en plus de dispositifs mobiles utilisés

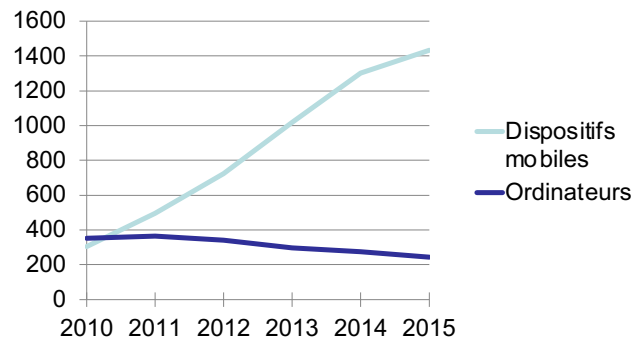


Image : <http://mshmentor.net>

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De plus en plus de dispositifs mobiles utilisés

Vente mondiale de dispositifs en million d'unités



Données : <http://ZDNet.fr/chiffres-cles>

=> Marché important pour les concepteurs d'applications

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Evolution des dispositifs mobiles



Motorola DynaTAC
– 1973⁽¹⁾

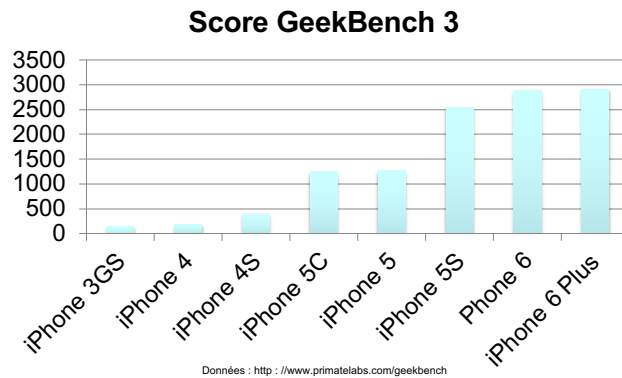


Samsung Galaxy S7 –
2016⁽²⁾

Images :
(1) <http://www.agencecofin.com>
(2) <http://fortune.com>

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Dispositifs mobiles de plus en plus puissants



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Dispositifs mobiles dotés de plus en plus de capteurs



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Vitesses de connexion de plus en plus rapides

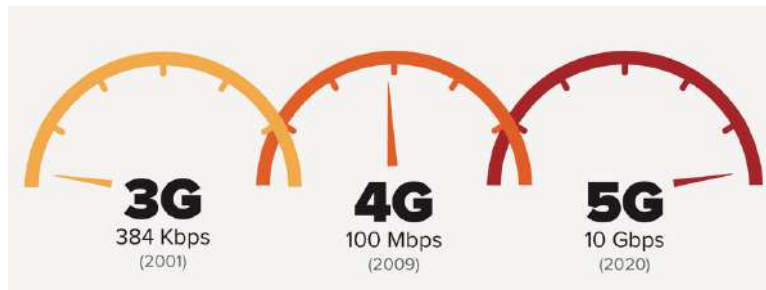
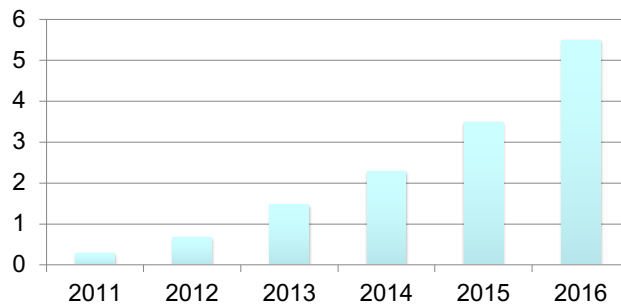


Image : <http://www.khichdionline.com>

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Vitesses de connexion de plus en plus rapides

Données consommées mensuellement sur dispositifs mobiles (en Go)



Données : <http://www.ericsson.com>

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Evolution des dispositifs mobiles

- Nombreuses possibilités d'interaction
- Capacités matérielles proches de celles des ordinateurs de bureau ou portables
- Facilité de récupération des données

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De plus en plus de commandes sur dispositifs mobiles sur des écrans ayant toujours une taille réduite

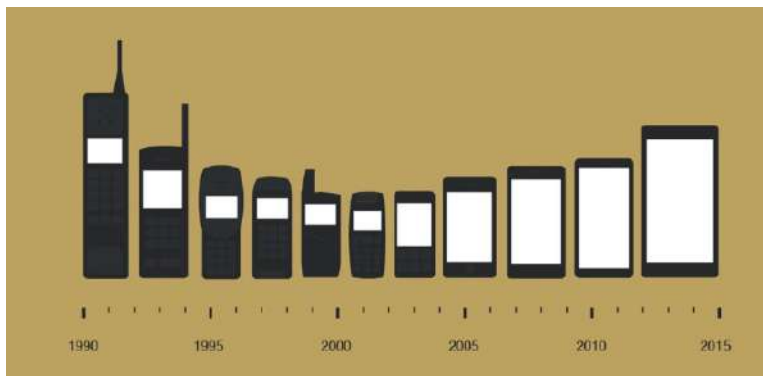
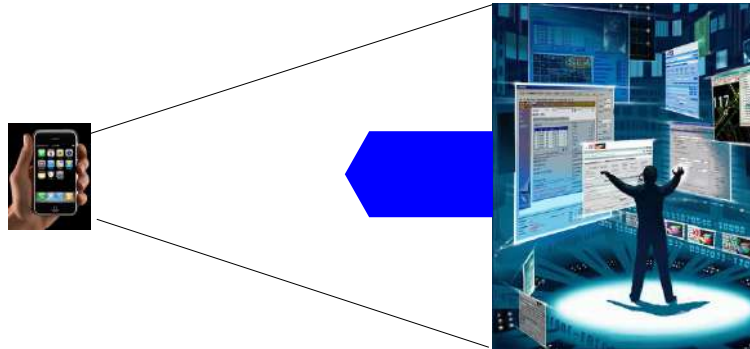


Image : <https://edutalk.entersocio.com>

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Input/Output Interaction



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Mobile devices

- Touch screen
- Few buttons
- Finger occlusion problem
- Long lists of items



 **We need menus ...**



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Menu techniques

➔ We need menus which are well adapted for:

- Touch screen mobile devices
- Long list of items
- Mobile situations



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Menu techniques

- Shall we reasonably copy/paste linear menus from the PC world?
 - Limited screen space
 - Small items
 - No shortcuts
 - No eyes-free selection



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Menu techniques

- Shall we reasonably copy/paste linear menus from the PC world?
 - Limited screen space
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Menu techniques

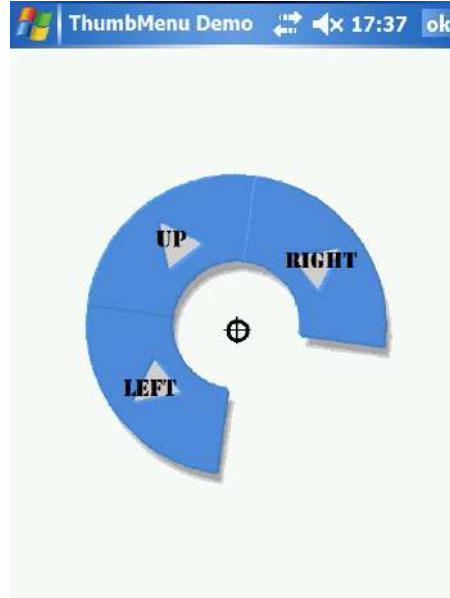
- Shall we reasonably copy/paste linear menus from the PC world?
 - Limited screen space
 - Small items
 - No shortcuts
 - No eyes-free selection

➡ We need new menu techniques

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Menu techniques

- Arch and Thumb menus



ArchMenu and ThumbMenu, Huot et al., IHM 2007

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Menu techniques

- Arch and Thumb menus



- ✓ No thumb occlusion
- ✓ Previsualization (browsing submenus)
- ✓ Easy to learn

- ✗ Menu breadth limitation
- ✗ No expert mode

ArchMenu and ThumbMenu, Huot et al., IHM 2007

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Menu techniques

- earPod: Auditory menu



earPod, Zhao et al., CHI 2007

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Menu techniques

- earPod



- ✓ Eyes-free selection
- ✓ Expert mode
- ✓ Easy to learn

- ✗ Menu breadth limitation
- ✗ No previsualization

earPod, Zhao et al., CHI 2007

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Menu techniques

- Leaf menu
- Video leaf_01.mov

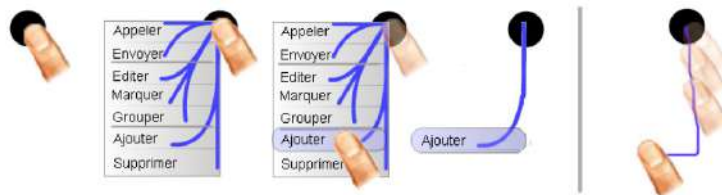


Leaf menu, Roudaut et al., INTERACT 2009

55

Menu techniques

- Leaf menu



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Leaf menu, Roudaut et al., INTERACT 2009

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Menu techniques

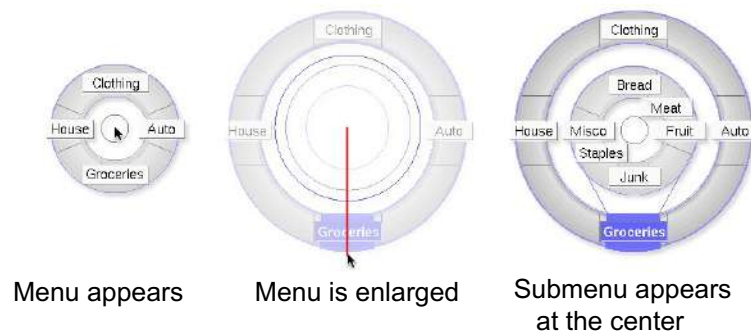
- Wavelet menu



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Wavelet menu: Novice mode

- An adaptation of the Wave menu
 - Inverted concentric layout
 - Parent menus surround submenus



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Wavelet menu: Novice mode

- **Efficient screen space management**
- Focus of attention = Last opened submenu displayed at the center
- Interaction still possible even if the parent menus are outside the screen



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Wavelet menu: Novice mode

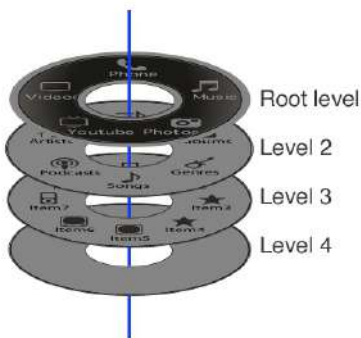
- **Stacking metaphor** to better understand the inverted concentric layout
 - To reinforce the perception of the hierarchy
 - To hide the strokes behind a stack handling



60

Wavelet menu: Novice mode

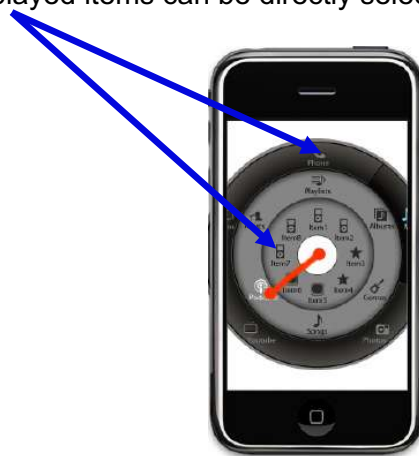
- **Stacking metaphor** to better understand the inverted concentric layout
 - To reinforce the perception of the hierarchy
 - To hide the strokes behind a stack handling



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Wavelet menu: Novice mode

- **Direct manipulation**
- All displayed items can be directly selected



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Wavelet menu: Novice mode

- Submenus previsualization
- Exploration of the menu tree:
Rapid scan of submenus

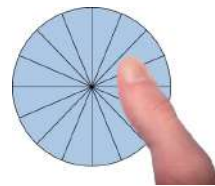


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Wavelet menu: Novice mode

- Breadth and depth of the menu system

- Circular layout:
 - Limited number of items



- Hybrid layout:
 - Linear menus integration for handling long lists



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Evolution des dispositifs mobiles

- Nombreuses possibilités d'interaction
- Capacités matérielles proches de celles des ordinateurs de bureau ou portables
- Facilité de récupération des données

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De plus en plus **de données** à appréhender sur dispositifs mobiles sur des écrans ayant toujours une taille réduite

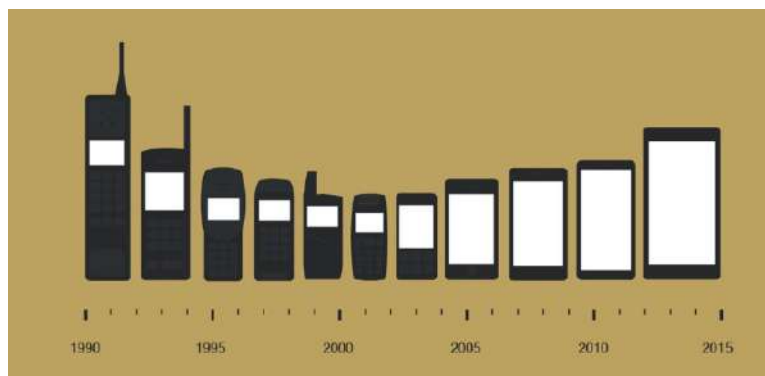


Image : <https://edutalk.entersocio.com>

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De plus en plus de données à
appréhender sur dispositifs mobiles
sur des écrans ayant toujours une taille
réduite



Image :
<http://epon.infocom-nancy.fr>

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Double problématique



- 1) Visualisation
- 2) Navigation

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Données à une dimension et/ou temporelles

- Données fréquemment utilisées sur dispositifs mobiles
- Techniques de visualisation actuellement utilisées non optimales



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Données à une dimension et/ou temporelles

Données à une dimension



Séquence d'éléments

Données temporelles



Séquence d'éléments ordonnés selon le temps

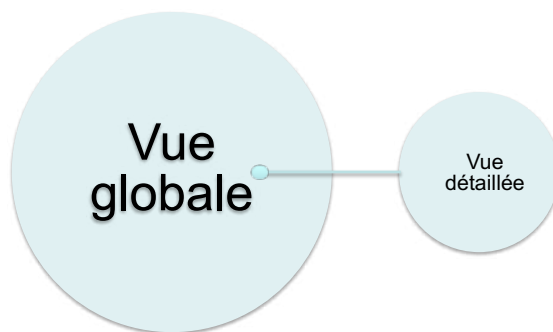
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Besoin



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Besoin



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Approche par multiplexage

- Multiplexage temporel
- Multiplexage spatial
- Multiplexage en profondeur



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Approche par multiplexage

- Multiplexage temporel
- Multiplexage spatial
- Multiplexage en profondeur



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Approche par multiplexage

- Multiplexage temporel
- Multiplexage spatial
- Multiplexage en profondeur



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Approche par multiplexage

- Multiplexage temporel
- Multiplexage spatial
- Multiplexage en profondeur



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Approche par multiplexage

Multiplexage temporel



Pas d'affichage simultané des deux vues

Multiplexage spatial



Partage de l'espace à l'écran

Multiplexage en profondeur



Surcharge d'informations à l'écran

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Multiplexage spatial

Indices contextuels



[Baudisch & Rosenholtz, 2003]



- Informations sur la vue globale limitées
- Bords de l'écran surchargés si beaucoup d'informations

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Multiplexage spatial

Vue globale + Détails



[Burigat & Chittaro, 2013]

- Compromis sur les tailles des deux vues difficile
- Effort mental pour faire le lien entre les deux vues

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Multiplexage spatial

Focus + Contexte



[Wang & Chi, 2011]

- Compromis sur les tailles des deux espaces difficile
- Transition entre focus et contexte difficile à appréhender si la déformation est trop importante

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Multiplexage spatial & Focus + Contexte

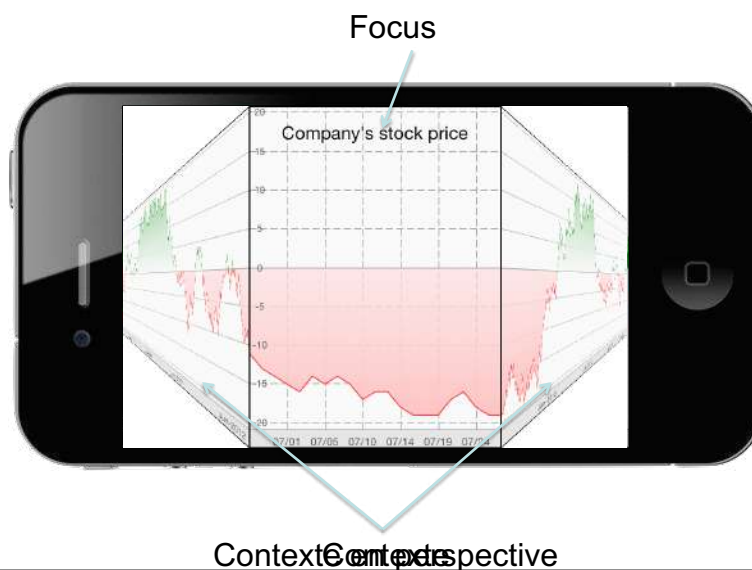
- Indices contextuels
 - Peu d'information sur les données du contexte
- Vue globale + Détails
 - Pas d'optimisation de l'espace à l'écran à cause des deux vues

⇒ Focus + Contexte

- Choix de la taille du focus et du contexte

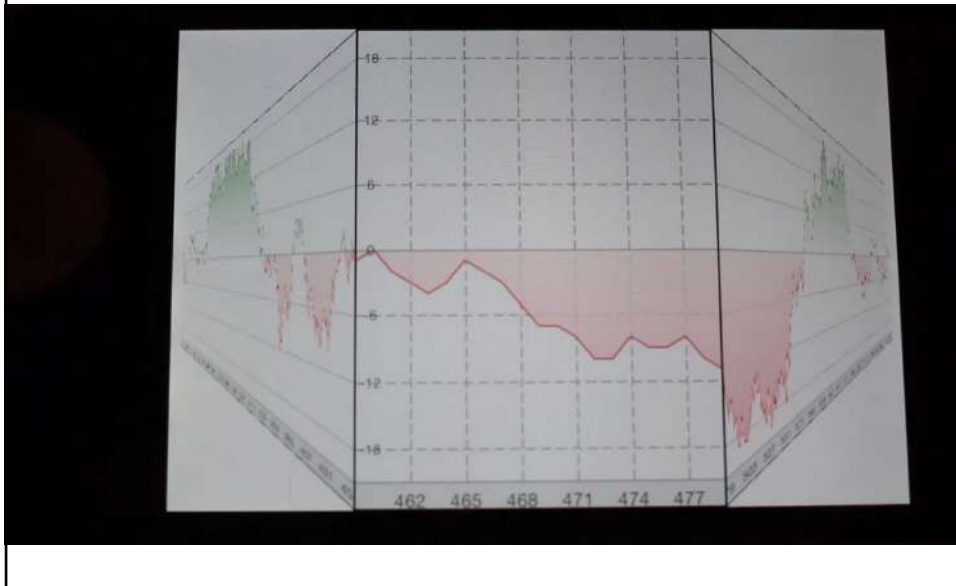
81

Implémentation d'une vue bifocale



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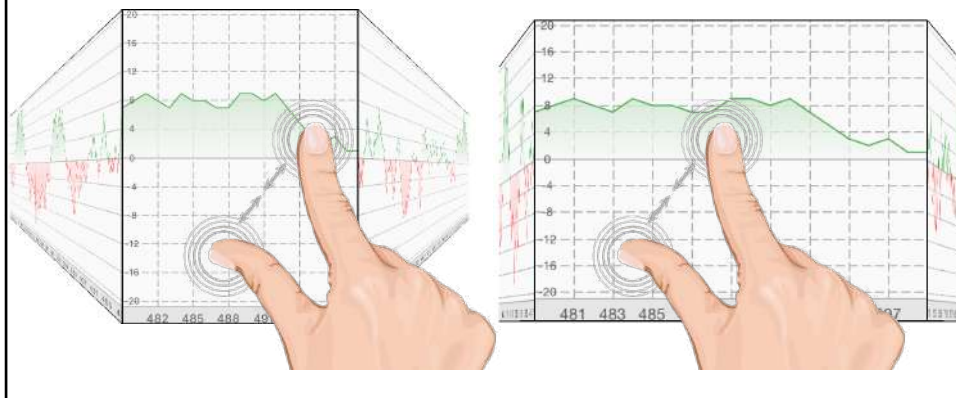
Implémentation d'une vue bifocale



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Implémentation d'une vue bifocale

- Possibilité de redimensionnement par un geste de *Pinch*



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Double problématique

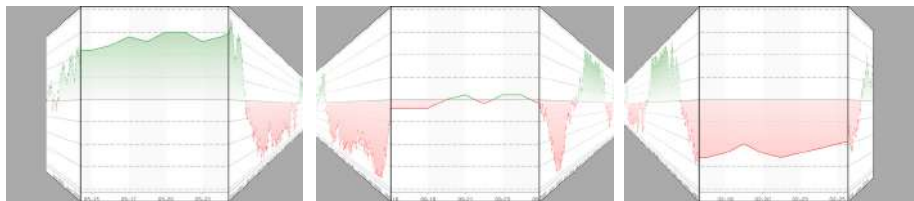


- 1) Visualisation
- 2) Navigation

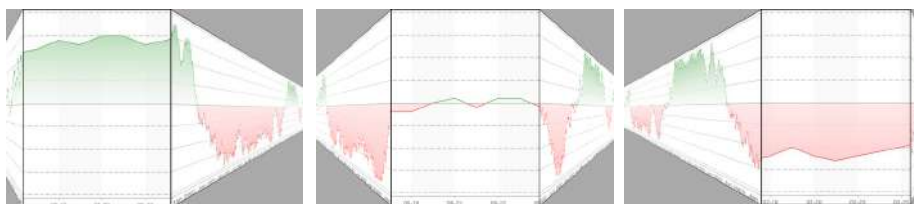
85

Deux métaphores d'interaction

- Métaphore d'interaction du ruban



- Métaphore d'interaction de la loupe



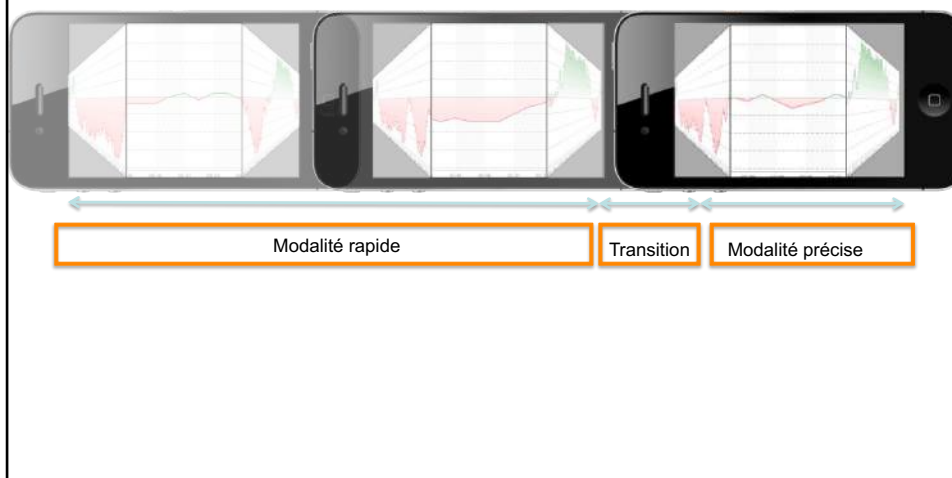
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Navigation dans une vue bifocale

- Accès rapide aux données dans la zone de contexte
- Interaction précise dans la zone de focus
- Deux échelles de navigation :
 - Celle du contexte
 - Celle du focus

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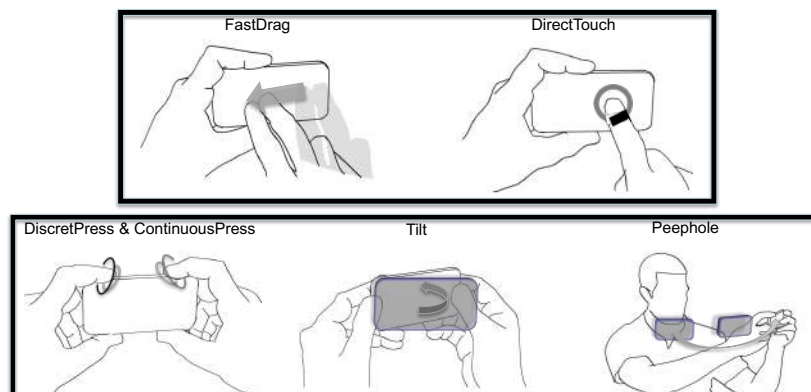
Modèle de navigation en trois phases



88

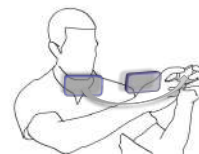
Conception de techniques de navigation multimodale

- Phase de navigation précise : modalité Flick
- Phase de navigation rapide :



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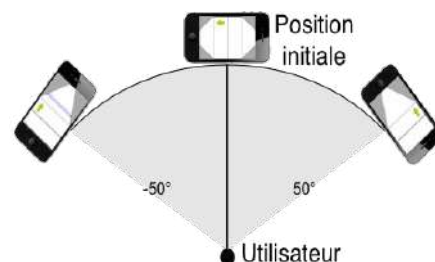
Technique Peephole



Utilisation du magnétomètre

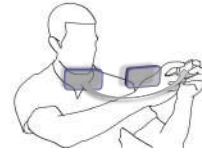
Déplacement du dispositif de manière sphérique

- Amplitude de $[-50^\circ, 50^\circ]$
- Activé grâce à un des capteurs



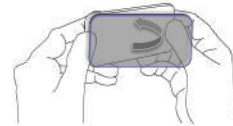
90

Technique Peephole



91

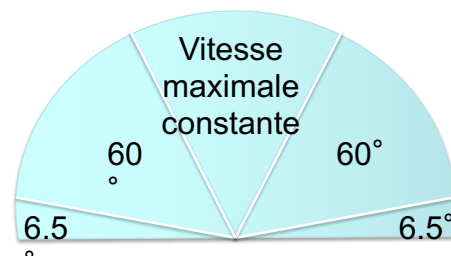
Technique Tilt



Conversion linéaire de l'angle en vitesse

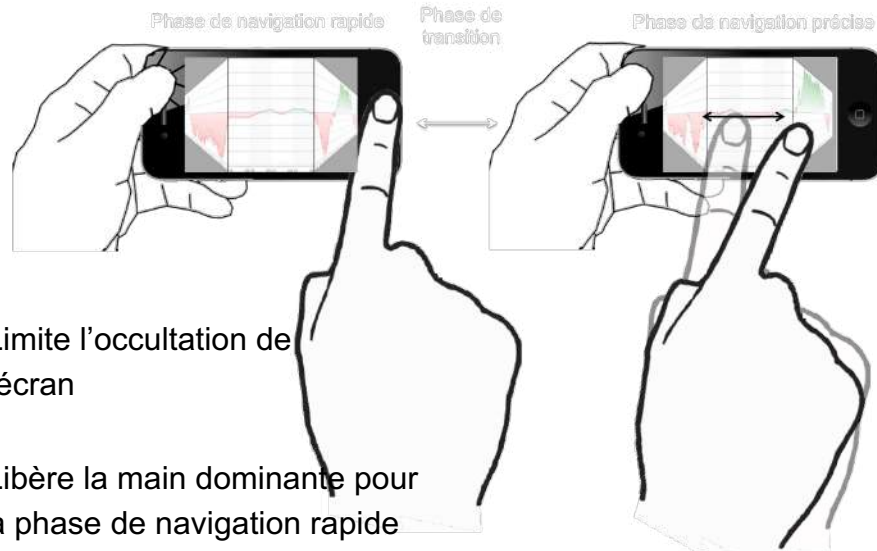
Zone stable de 13°

Amplitude de $[-60^\circ, 60^\circ]$



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Technique basée sur la pression



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Evolution des dispositifs mobiles

- Nombreuses possibilités d'interaction
- Capacités matérielles proches de celles des ordinateurs de bureau ou portables
- Facilité de récupération des données

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Réalité Augmentée interactive sur dispositifs mobiles



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Pointing in handheld AR



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Pointing in handheld AR



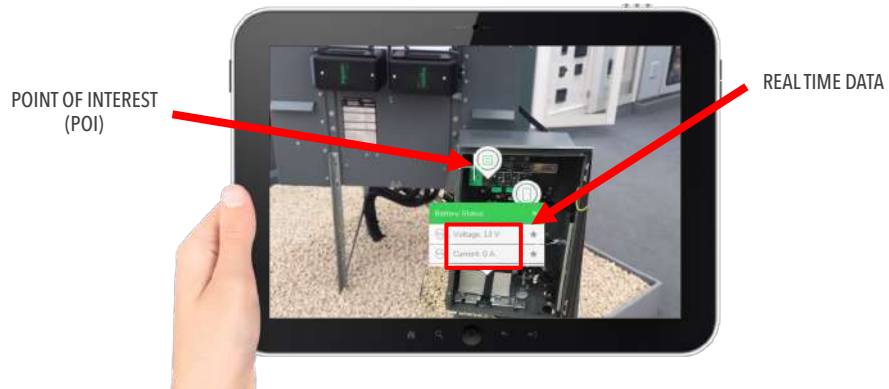
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Pointing in handheld AR



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Pointing in handheld AR



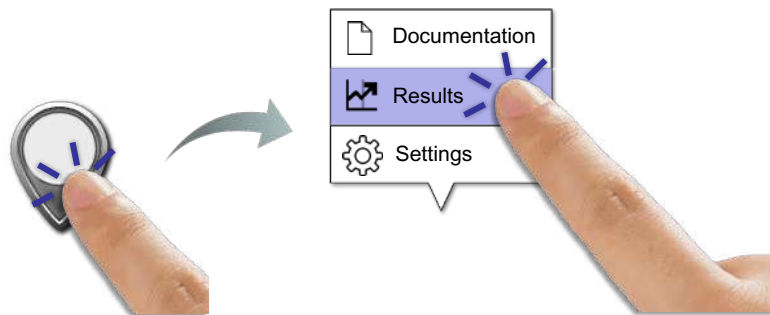
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Pointing in handheld AR



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Pointing in handheld AR



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Pointage : Loi de Fitts

– $T = I \cdot \log 2D/L$

avec D : distance à parcourir, L : largeur de la cible, $I = 0,1$ sec

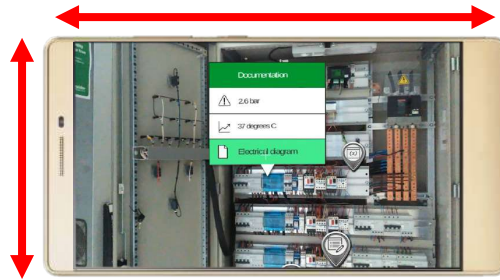
- Temps proportionnel à la distance à parcourir pour atteindre la cible et inversement proportionnel à la taille de la cible



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Pointing in handheld AR

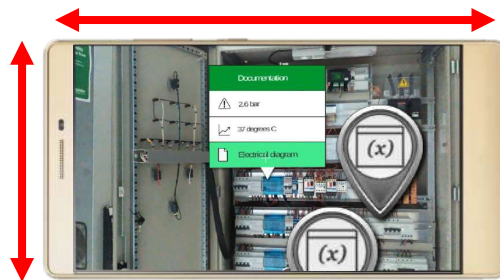
- 1 Limited screen' size
- 2 Digital targets anchored to physical world
- 3 Information contained inside digital targets



103

Pointing in handheld AR

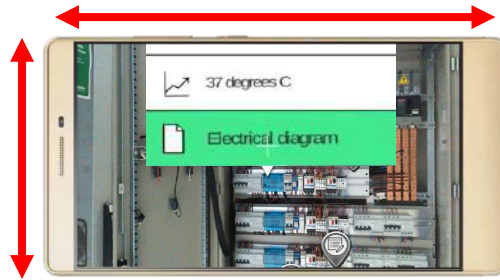
- 1 Limited screen' size
- 2 Digital targets anchored to physical world
- 3 Information contained inside digital targets



104

Pointing in handheld AR

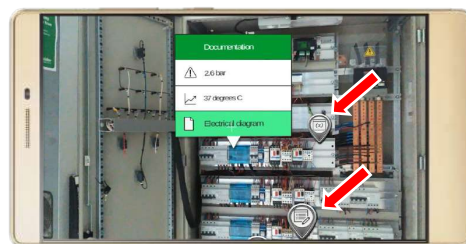
- 1 Limited screen' size
- 2 Digital targets anchored to physical world
- 3 Information contained inside digital targets



105

Pointing in handheld AR

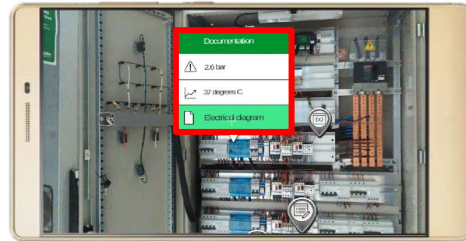
- 1 Limited screen' size
- 2 Digital targets anchored to physical world
- 3 Information contained inside digital targets



106

Pointing in handheld AR

- 1 Limited screen' size
- 2 Digital targets anchored to physical world
- 3 Information contained inside digital targets



107

Pointing in handheld AR



Limited intrusion on screen



Digital - physical link



Access AR information

108

Types of pointing

Direct pointing



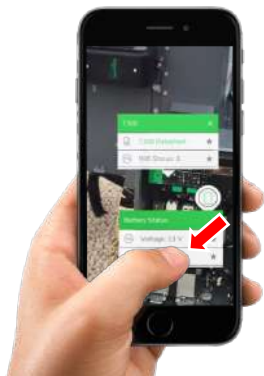
Indirect pointing



109

Types of pointing

Direct pointing



Indirect pointing

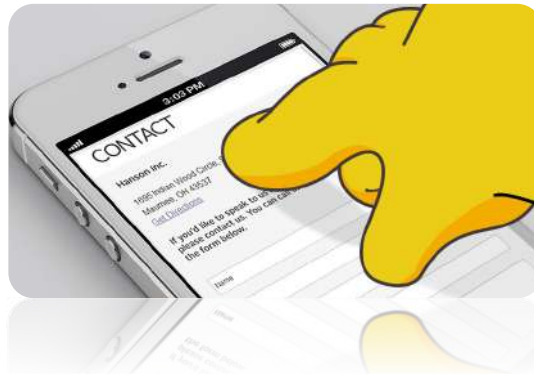


110

Problems with direct pointing

- **Target occultation**

- Ambiguous selection area
- Unreachable screen areas
- Instability



111

Problems with direct pointing

- **Target occultation**

- Ambiguous selection area
- Unreachable screen areas
- Instability



112

Problems with direct pointing

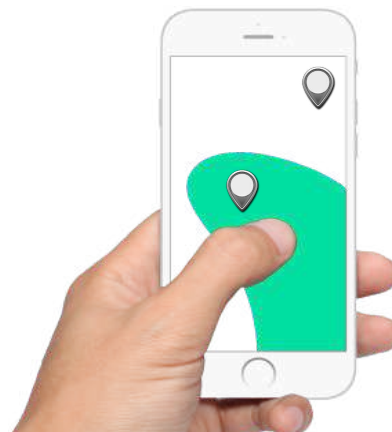
- Target occultation
- **Ambiguous selection area**
- Unreachable screen areas
- Instability



113

Problems with direct pointing

- Target occultation
- Ambiguous selection area
- **Unreachable screen areas**
- Instability



114

Problems with direct pointing

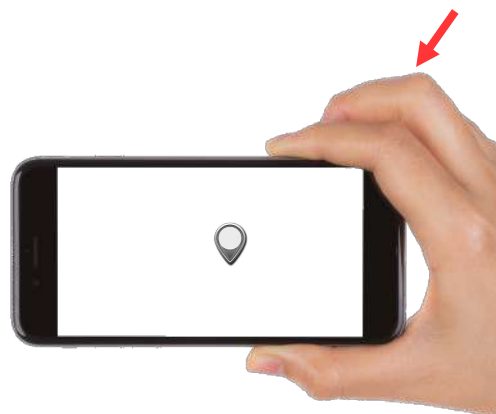
- Target occultation
- Ambiguous selection area
- Unreachable screen areas**
- Instability



115

Problems with direct pointing

- Target occultation
- Ambiguous selection area
- Unreachable screen areas
- Instability**



116

Problems with direct pointing

- Target occultation
- Ambiguous selection area
- Unreachable screen areas
- **Instability**



117

Solution

Indirect pointing

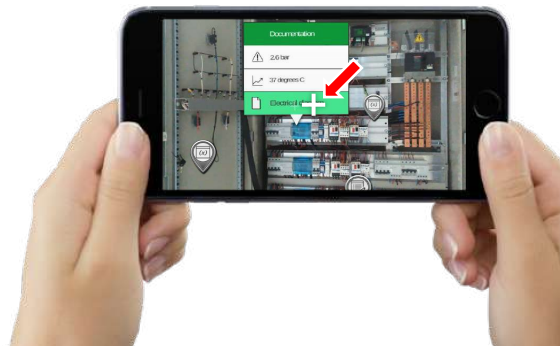


118

Solution

Indirect pointing

- ✓ No target occultation

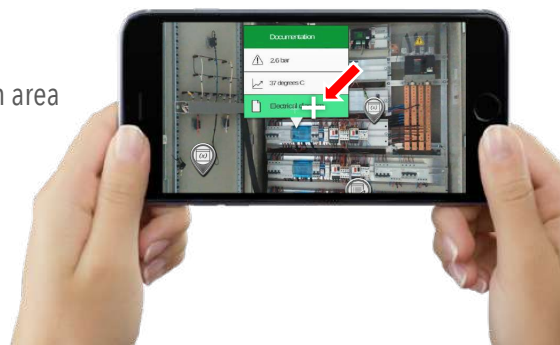


119

Solution

Indirect pointing

- ✓ No target occultation
- ✓ No ambiguous selection area



120

Solution

Indirect pointing

- ✓ No target occultation
- ✓ No ambiguous selection area
- ✓ No unreachable screen areas

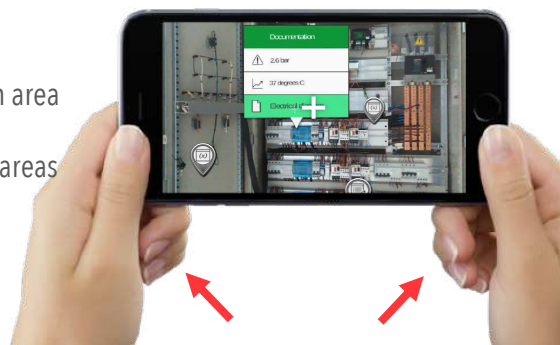


121

Solution

Indirect pointing

- ✓ No target occultation
- ✓ No ambiguous selection area
- ✓ No unreachable screen areas
- ✓ No instability

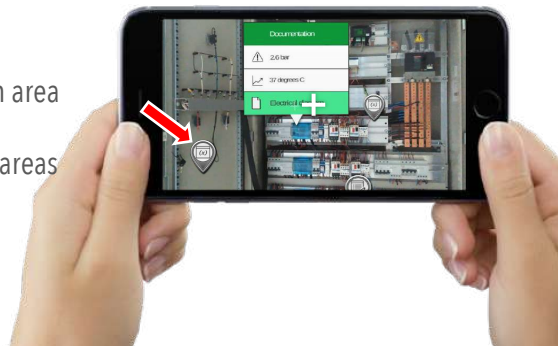


122

Solution

Indirect pointing

- ✓ No target occultation
- ✓ No ambiguous selection area
- ✓ No unreachable screen areas
- ✓ No instability



123

Solution

Indirect pointing

- ✓ No target occultation
- ✓ No ambiguous selection area
- ✓ No unreachable screen areas
- ✓ No instability



124

Solution

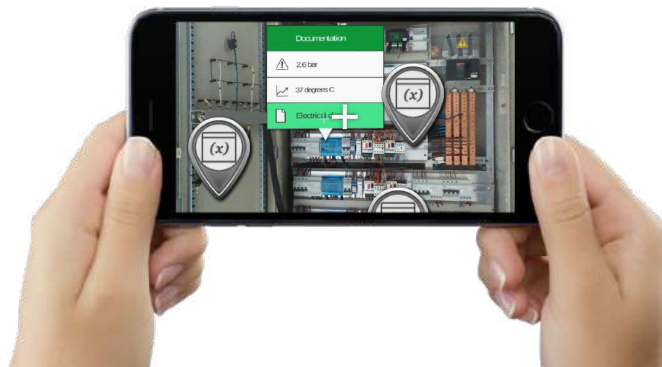
- ✓ No target occlusion
- ✓ No ambiguous selection areas
- ✓ No unreachable screen areas
- ✓ No instability

Indirect pointing



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Increasing the size of targets



126

Target expansion

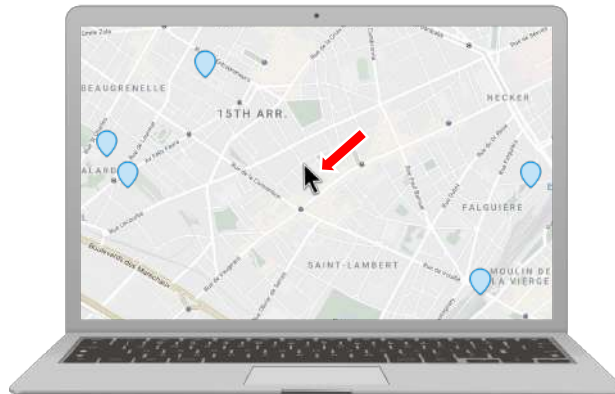
Example



127

Target expansion

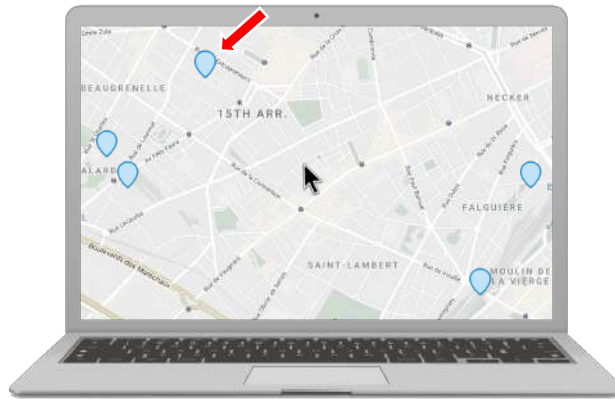
Example



128

Target expansion

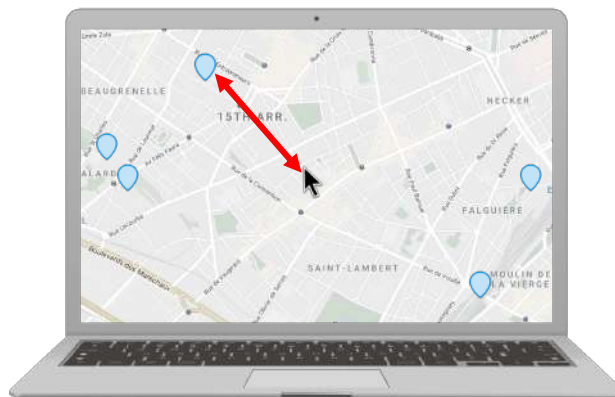
Example



129

Target expansion

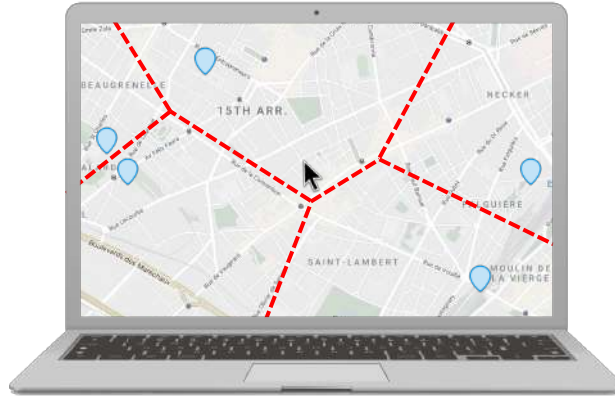
Example



130

Target expansion

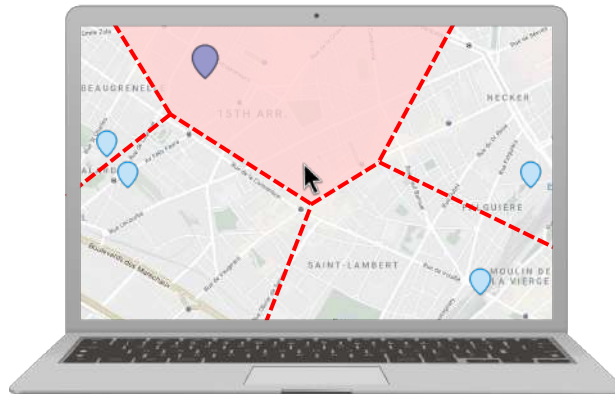
Example



131

Target expansion

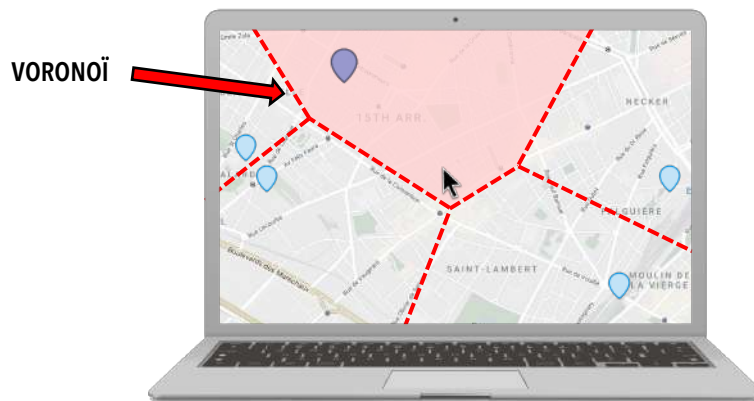
Example



132

Target expansion

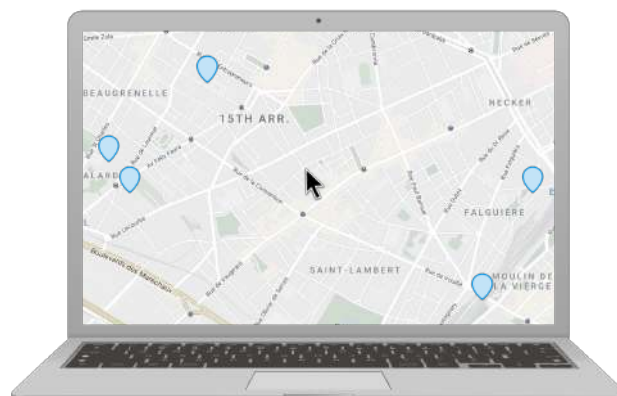
Example



133

Target expansion

Example



134

Target expansion

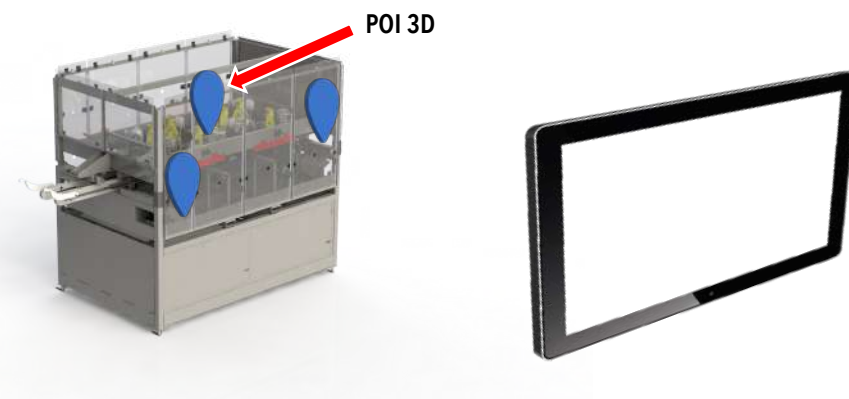
Example



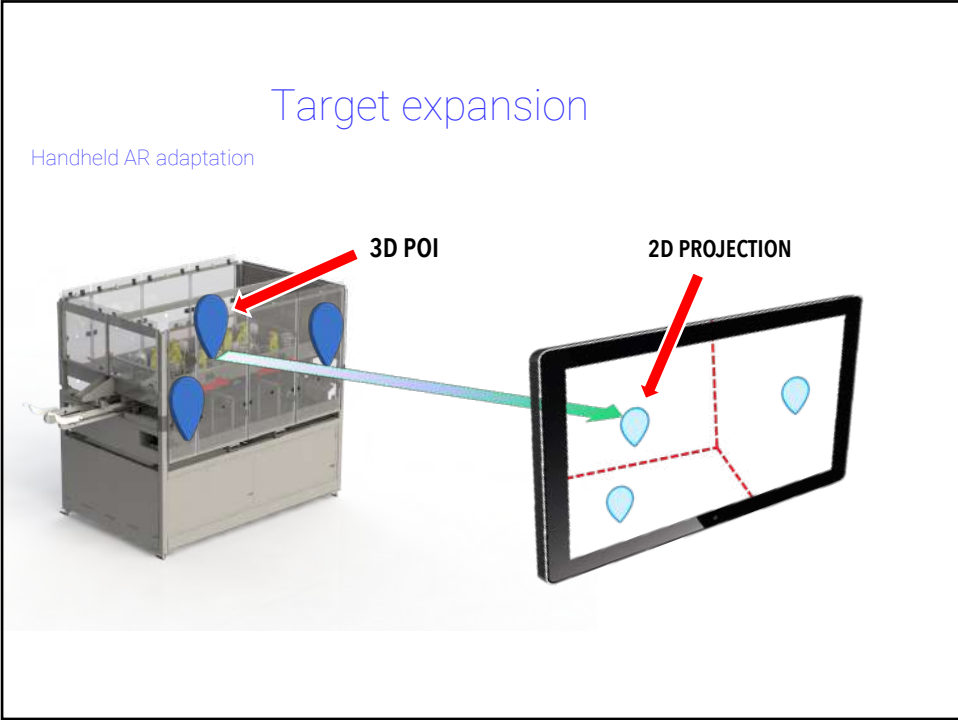
135

Target expansion

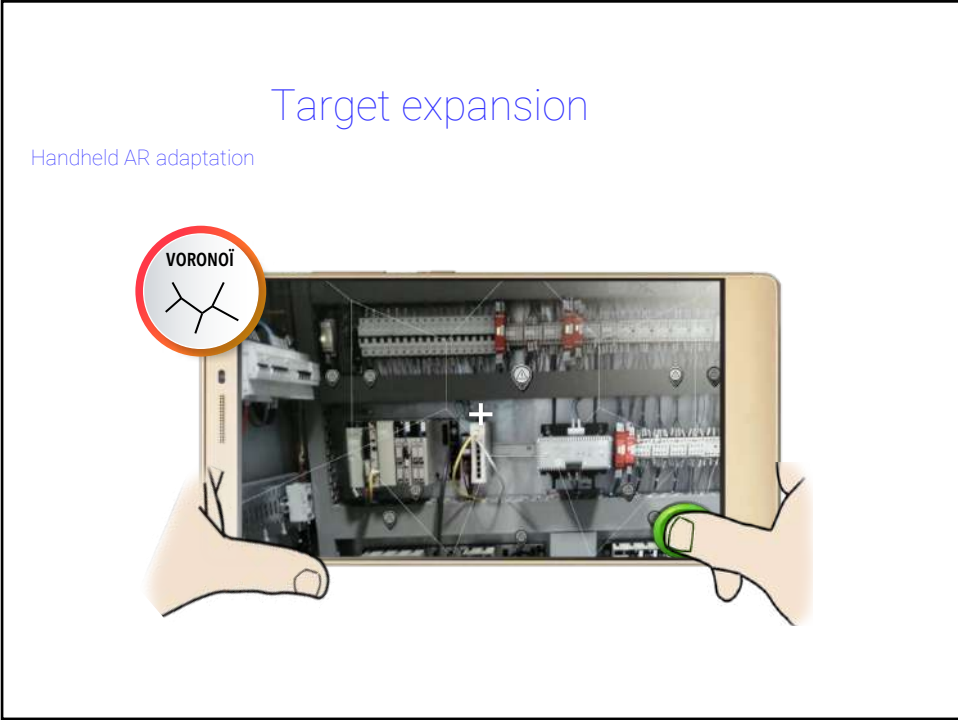
Handheld AR adaptation



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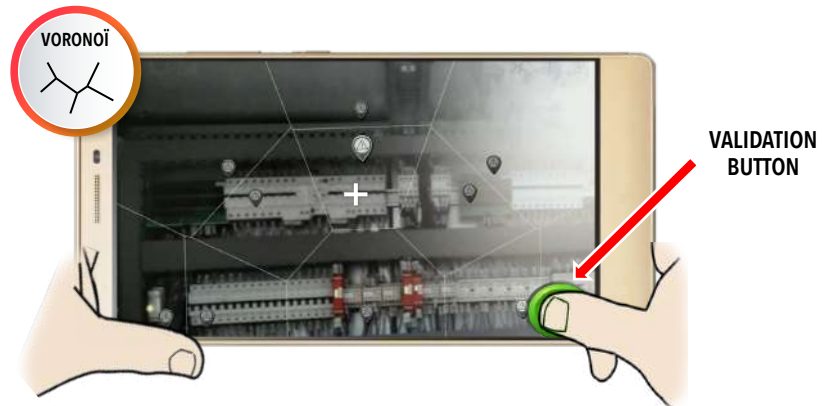
137



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Target expansion

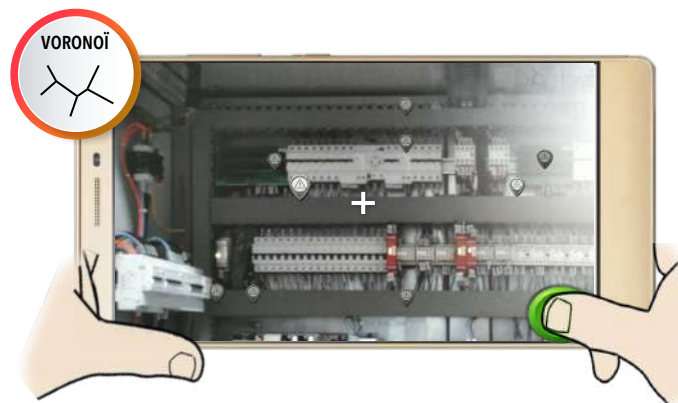
Handheld AR adaptation



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Digital information access

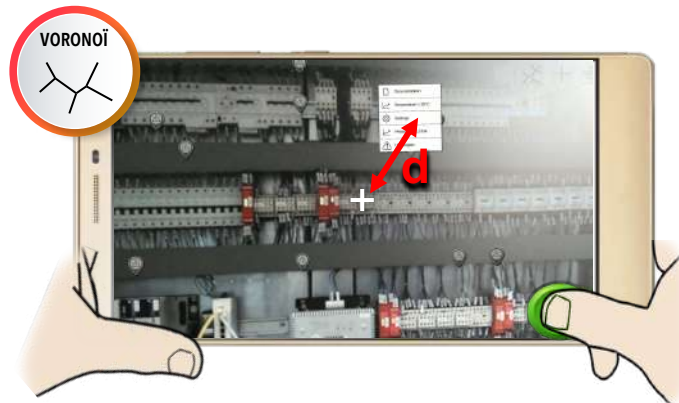
Problem



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Digital information access

Problem

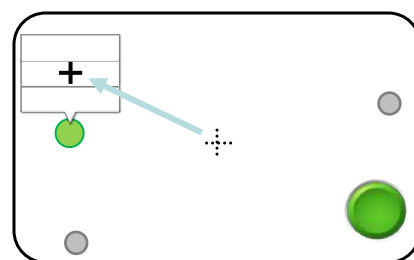


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Digital information access

Different strategies

- 1 How to make the cursor **jump** ?
- 2 How to **manipulate** the cursor?

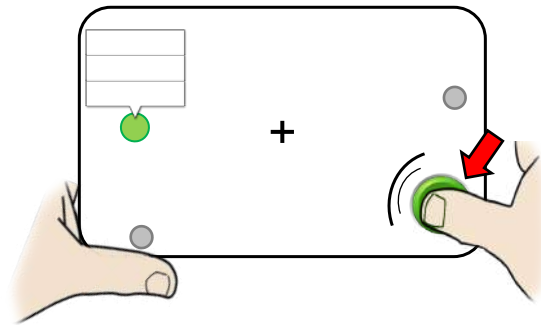


**Jumping
cursor**

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Digital information access

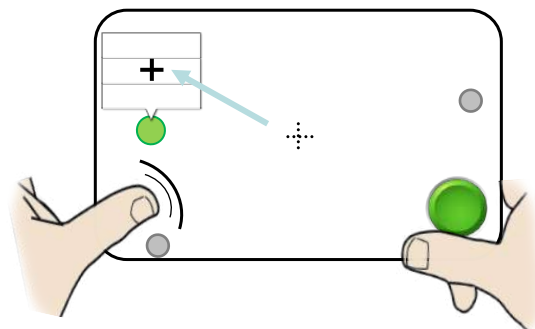
Jumping cursor



143

Digital information access

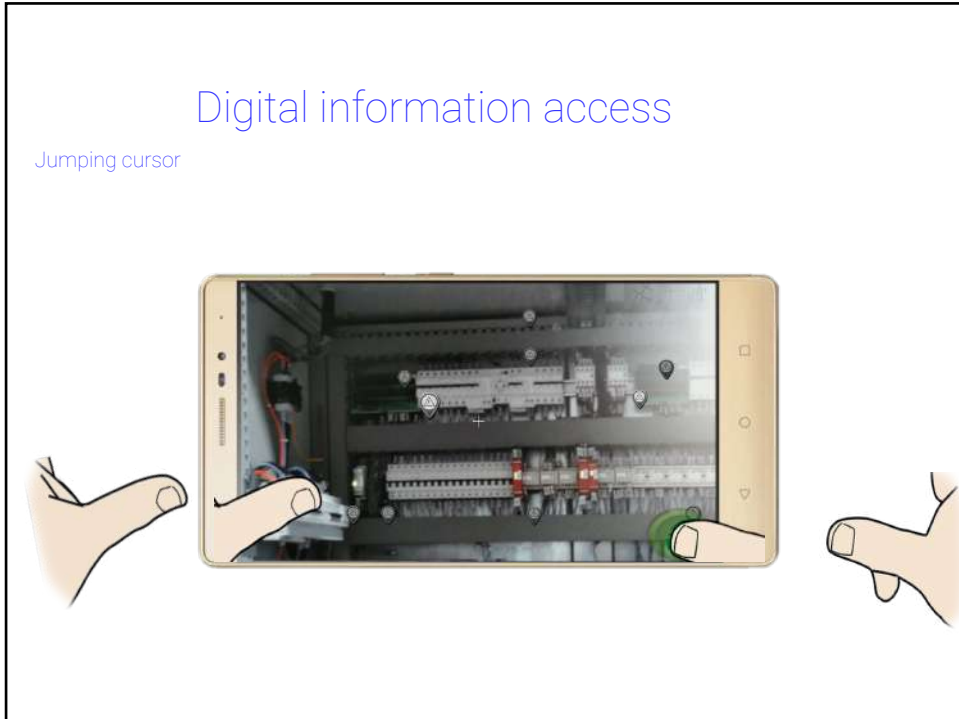
Jumping cursor



144

Digital information access

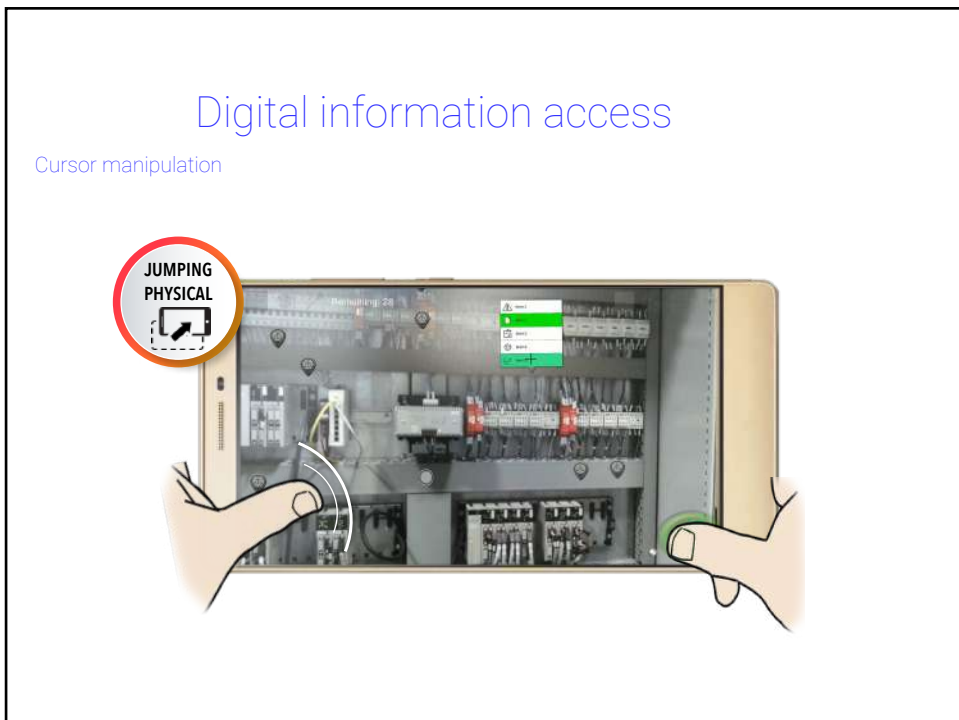
Jumping cursor



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Digital information access

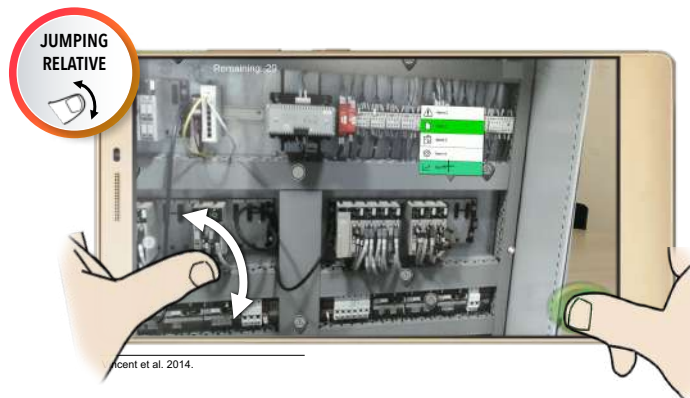
Cursor manipulation



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Digital information access

Cursor manipulation



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Evolution des dispositifs mobiles

- Nombreuses possibilités d'interaction (multimodalité) pour :
- Accès à de nombreuses commandes
- Accès à de grandes quantités de données
- Réalité augmentée interactive mobile

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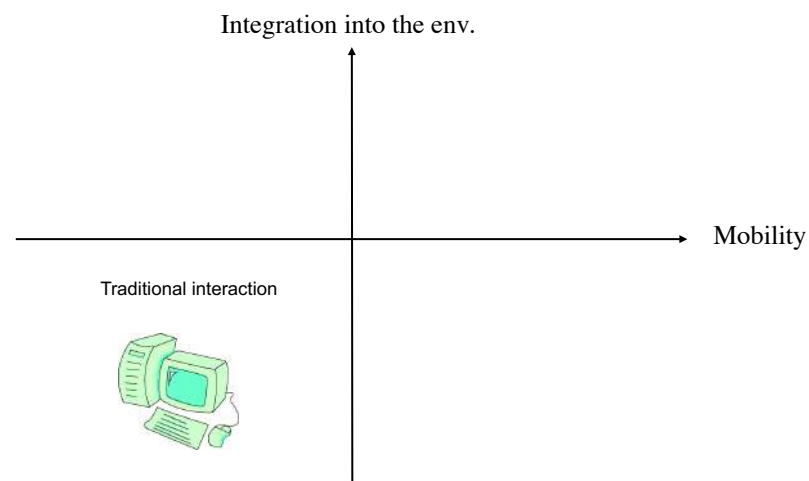
Conclusion

Mobility: a broad concept

- (1) moving between devices - hot-desking
- (2) moving within an instrumented environment - intelligent buildings and intelligent appliances
- (3) devices within moving vehicles - computers in cars
- (4) small devices that move with you - smartphones, watches

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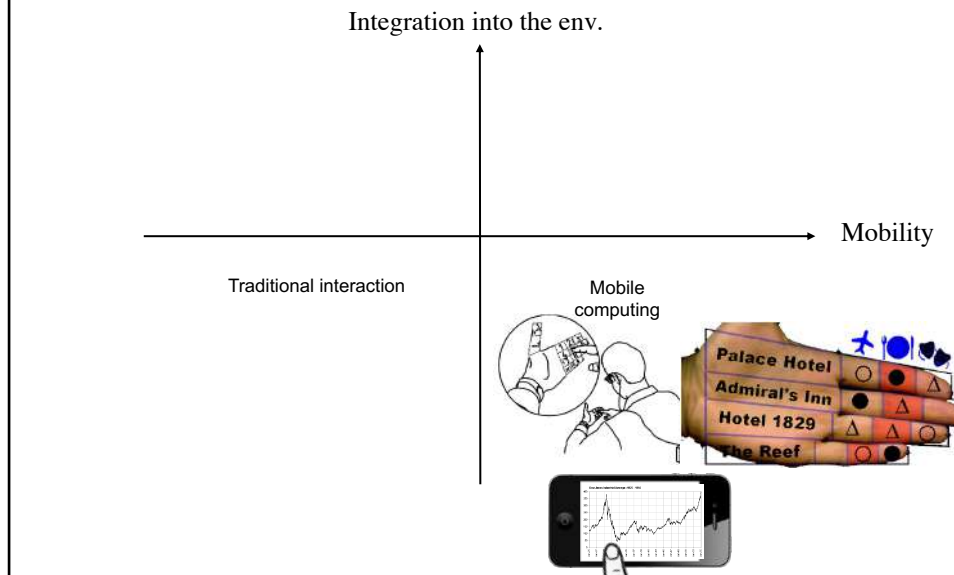
Conclusion: From WIMP to Post-WIMP



[Lyytinen & Yoo 2002]

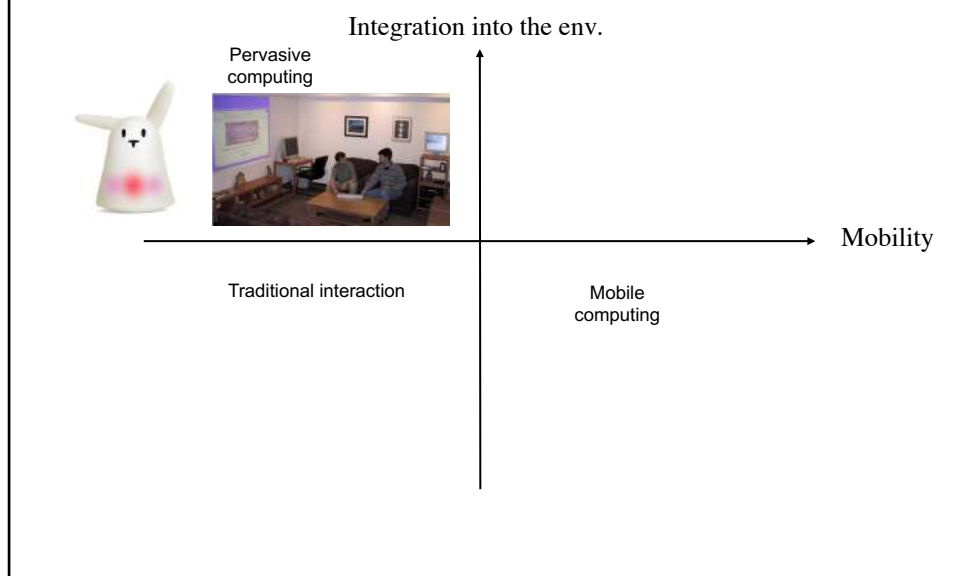
150

Conclusion: From WIMP to Post-WIMP



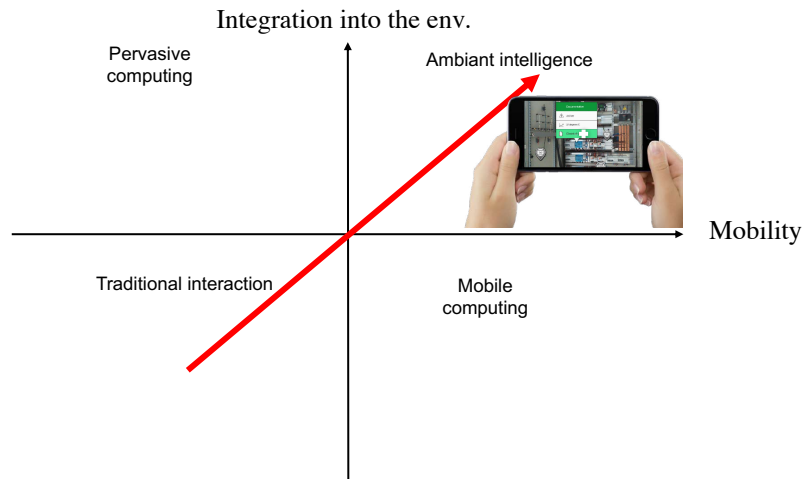
151

Conclusion: From WIMP to Post-WIMP



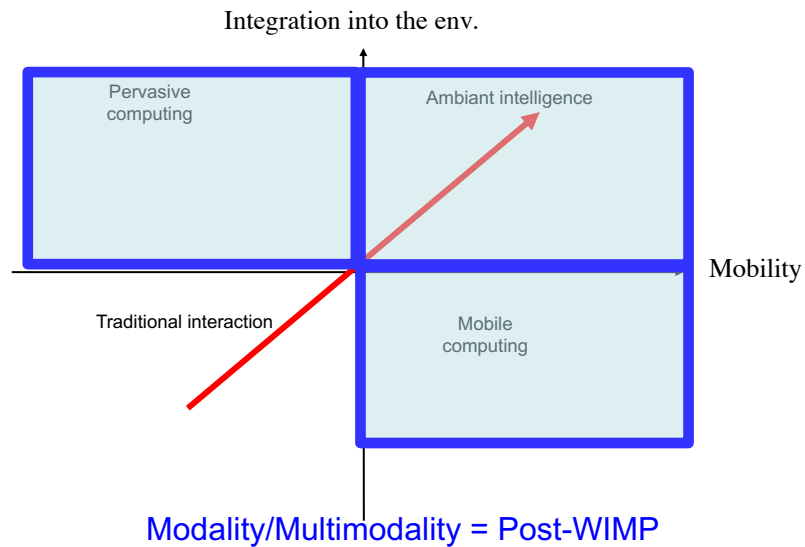
152

Conclusion: From WIMP to Post-WIMP



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Conclusion: From WIMP to Post-WIMP



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