

Programming Ubiquitous Things 2024/25 - Spring 2025 - UiO

Introduction to Mobile and Ubiquitous Computing

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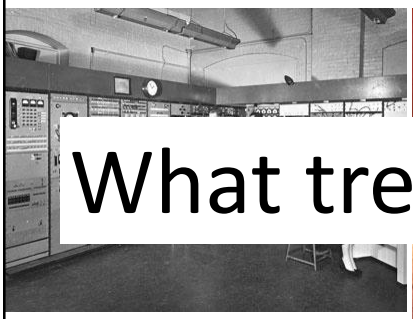
Making the Future a Better Place

Ubiquitous Computing, a Promise to Fulfill ?

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A Glimpse of the Past…



The Whirlwind computer, the large-scale computer of the 1950s and 1960s developed for automated strategic air defense applications. It could display real time video. The last Whirlwind computer was shut down in 1983.



The console and a few peripheral units from an IBM System/360 model 30



The PDP-8, a popular minicomputer in the late 1960s and early 1970s.

What trend do we see here ?

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A Glimpse of Today…





From

“1 computer to many”

To

“many computers to 1”

While

“being connected to all others”



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A Glimpse of Today…



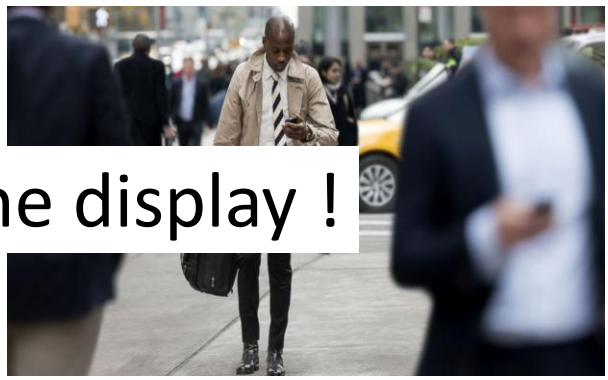


What trend do we see here ?

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A Glimpse of Today…





A focus on the display !



And here ?

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A Glimpse of Today…

https://www.youtube.com/watch?v=4EvNxWhskf8&t=4s (google glasses)

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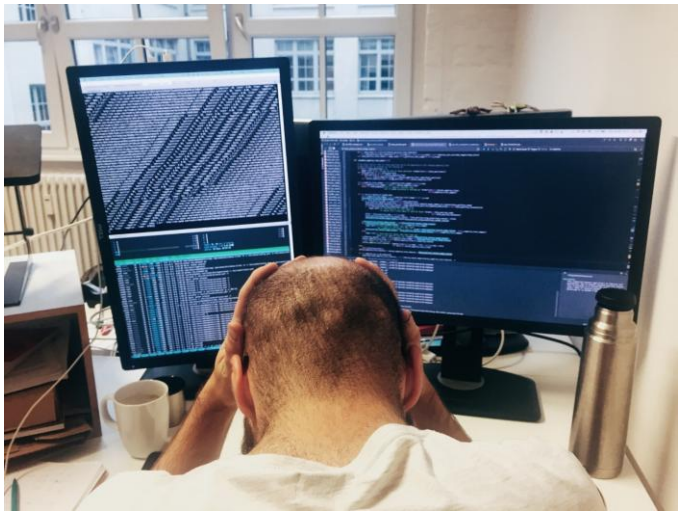
A Glimpse of The Near Future…



- Users will be unhappy
- Users just want the job to get done !

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A Glimpse of The Near Future…



- Programmers will be unhappy !
- Programmers just want the job to get done !

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A Glimpse of the (would like to be) Future…

http://www.youtube.com/watch?v=JSnB06um5r4 (google glasses)



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A Glimpse of the (would like to be) Future…

Not existent anymore in youtube (ubi odissey)



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A Glimpse of the (would like to be) Future…

http://www.youtube.com/watch?v=pq4Ep85MSPU (ring)

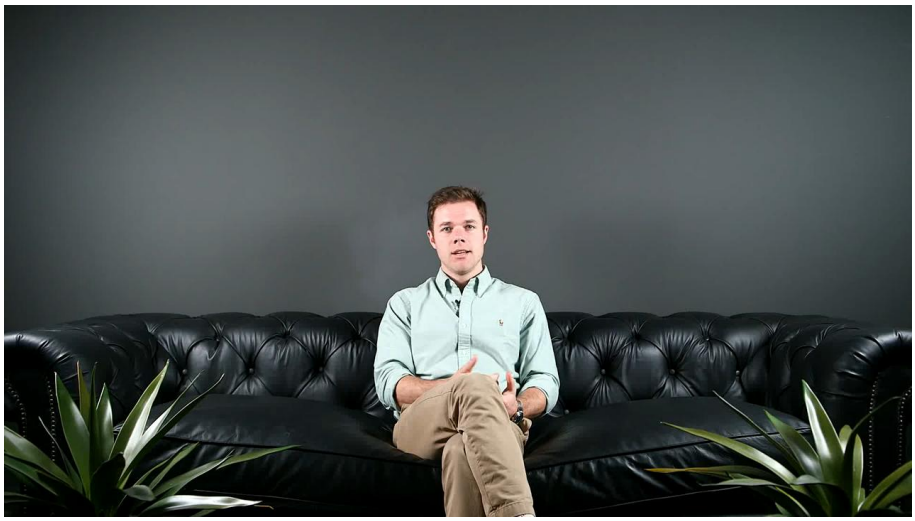


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A Glimpse of Today… akward app !

https://www.youtube.com/watch?v=e9kNLqOEphI(tickle)

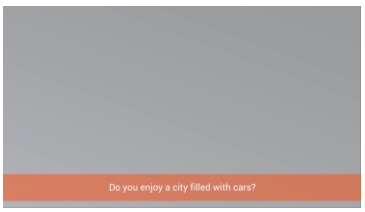


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A Glimpse of the (would like to be) Future…

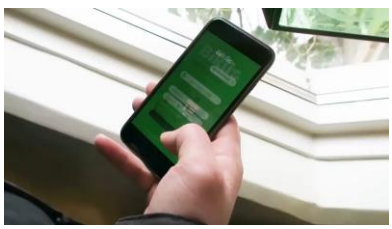
https://www.youtube.com/watch?v=ggSUQFn0QqY

- Bilkio from TRACE



https://www.youtube.com/watch?v=ggSUQFn0QqY

- Bilkio from Sweden



https://www.youtube.com/watch?v=mtVZrHqJTUM

- Bilkio from Italy



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A Glimpse of the (would like to be) Future…

https://www.youtube.com/watch?v=CmnP7WheA9E



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A Glimpse of the (would like to be) Future…

fic American, September 1991

The most … s are those that … disappear. T… … into the fabric of everyday lif… …tinguishable from it. Today´s mul… … the computer screen into a demar… …rather than allowing it to fade into t…

Invisibility

Mark Weiser



Mark Weiser

Born	July 23, 1952 Harvey, Illinois, U.S.
Died	April 27, 1999 (aged 46)
Alma mater	University of Michigan
Known for	Ubiquitous computing

Calm Computing

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Today



- Where do we stand ?
- Where we do not want to go !
- How far away are we ?
- Are we going in the right direction ?
- What are the challenges ?

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Where do we stand ?



- Good feeling that comes mostly:
  - gadgets such as smartphones and tablets (and wearables such as Google glasses) that we routinely carry around us
- Thanks to cellular connections and Wi-Fi networks:
  - we have near-constant access to computing power and online data,
  - giving us what might be called *near-ubiquitous computing*
- Is it not quite the ambient intelligence that was envisioned:
  - is it a step in the right direction ?

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Where are we going to ?
Where we do not want to go !

- A fundamental desired characteristic is calm computing, i.e., the system:
  - remains in the background
  - does exactly what we want it to do
- However, today´s technology is more likely *jittery technology*:
  - constant beeping for messages, posts, updates, news, etc….
  - prevalence of phantom vibration, i.e., the perception of a phone´s vibration in the absence of an event (incoming call or notification)
  - even watching TV is no longer as it used to be due to second screening and chatterboxing

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Where are we going to ?
Where we do not want to go !

- We create new technology but technology changes us also !
- Plus:
  - having so much information fingertip ready
  - Increases productivity
- Minus:
  - still too many and possibly growing !!!

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Where are we going to ?
Where we do not want to go !

- *Digital Hectivity leads to FOMO*:
  - fear of missing something interesting or fun (leading to obsessive checking for social networks)
- *Polyattentiveness / Continuous Partial Attention:*
  - focused on some task but a chunk of our attention is waiting for something more important to pop up
- *Nomophobia:*
  - fear of being without a mobile phone/network
- *Fauxductive*:
  - focus on the trivial
- *Social Notworking:*
  - our brains are engaged but not always in a good way
- *Busy Brain*:
  - mental state that includes racing thoughts, anxiety, lack of focus, …
- *Binge Thinking*:
  - overthink problems or think obsessively but fruitless over a short period of time
- *STST (short time-slice syndrome):*
  - not enough continuous time to think about a subject

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Smart Devices such as the Smartphone became Weapons of Mass **Distraction**

So, what is the most valuable resource in the room ?

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User Attention
is the Most Valuable Resource

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Goal

By Mark Weiser, Scientific American, September 1991

The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it… Today´s multimedia machine makes the computer screen into a demanding focus of attention rather than allowing it to fade into the background.

Invisibility

Calm Computing

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Just get the job done !

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Challenges

- Context-awareness
- Adaptabilty
- Cyberforaging
- Resource Discovery
- Offloading
- Replication
- Battery Usage
- Operating System
- Networking
- Speech Recognition
- Etc.

Applications
Middleware
Operating System



Multidisciplinary

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Context-Awareness

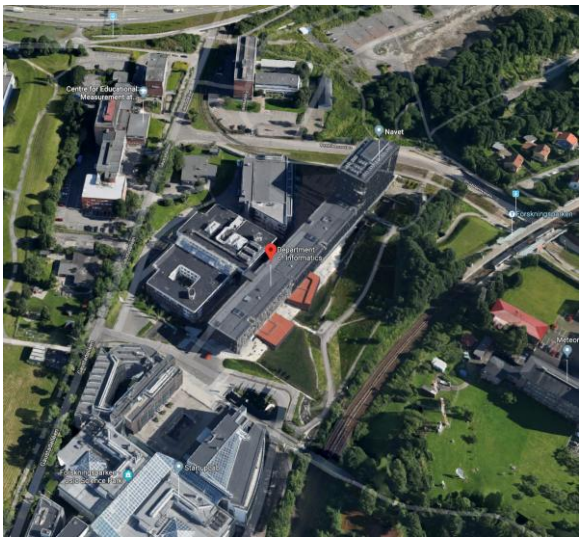
- Invisibility implies no configuration, no interaction, *no-nothing*; the system simply makes what the user wants
- This requires the system to be pro-active; and it must be correct
- The system must get all the context information to predict what the user wants and act accordingly
- Context information includes many aspects; since the most obvious which is location to many others as user´s agenda, temperature, presence, etc.
- Basically, based on context, the system captures the user intent



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Location

- Triangulation:
  - lateration, which uses multiple distance measurements between known points
  - angulation, which measures angles or bearing relative to points with known separation
- Proximity:
  - measures nearness to a known set of points
- Scene analysis:
  - examines a view from a particular point
- Privacy, Symbolic, Scale, Cost, Absolute, Accuracy and Precision



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Adaptability

- The system must be capable of dealing with the variability of the environments
- Such variability ranges all aspects:
  - network on/off/faster/etc., memory available or not, CPU available or not, etc., all resources may vary with time and location
- Capable to automatically adapt to the environment, once again, while remaining invisible



- Ubiquitous (invisible) systems must be able to handle all the spectrum of resource variability, thus including fault-tolerance aspects (when resources are unavailable)
- Balancing pro-activity and invisibility

It is not the strongest of the species that survives, nor the most intelligent. It is the one that is most adaptable to change.

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Cyberforaging

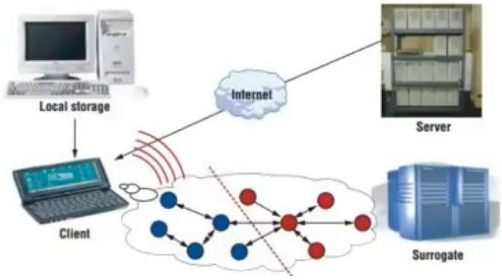
- Dealing with variable, uncertain or unavailable resources can be done by taking advantage of other equivalent resources in the surroundings
- E.g., lack of network availability may be solved with a shared hotspot
- Invisibility implies:
  - discovering available resources
  - use such resources
  - automatically, without bothering the user
- Opportunities provided by cyberforaging:
  - take advantage of any resource available (e.g., network, printer, CPU, storage, display, etc.)



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Offloading

- Offload CPU from the mobile device to a more powerful CPU
- Implies deciding if it is really adavantageous:
  - time to compute
  - time to send and receive
  - time it takes to decide what to offload (static and/or dynamic)
  - run-time code changes to support offloading



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Resource Discovery

- Protocols to discover the resources nearby
- Use such resources if that is needed or advantageous
- Examples:
  - use a printer at the hotel where I have just arrived
  - use a more powerful CPU from a nearby laptop
  - use a higher quality display (HD, bigger, etc.)
  - use a storage available from a server or from the cloud
- Scalable and correct discovery protocols (flooding, false positives, completeness, etc.)



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Replication



- Accessing data and code anywhere
- Data staging on untrusted surrogates
- File hoarding
- Object replication







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Battery Usage

- Find where battery is being mostly used
- Minimize what consumes most energy:
  - reduce/aggregate messages
  - redesign communication protocols (e.g., minimize wait-state)
  - better match between messages sending and communication protocol



App	Run-time	#Routine calls (#Threads)	% Battery	3rd-Party Modules Used	*Where is the energy spent inside an app?*
browser	30s	1M (34)	0.35%	-	38% HTTP; 5% GUI; 16% user tracking; 25% TCP cond.
angrybirds	28s	200K (47)	0.37%	Flurry[7],Khronos[41]	20% game rendering; 45% user tracking; 28% TCP cond.
fchess	33s	742K (37)	0.60%	AdWhirl[42]	50% advertisement; 20% GUI; 20% AI; 2% screen touch
nytimes	41s	7.4M (29)	0.75%	Flurry[7],JSON[43]	65% database building; 15% user tracking; 18% TCP cond.
mapquest	29s	6M (43)	0.60%	SHW[44],AOL,JSON[43]	28% map tracking; 20% map download; 27% rendering

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Security

- Less than 5% of lost or stolen laptops ever recovered
- How to secure relevant information in a lost/stolen mobile device
- Repeated authentication mechanism
- When, how, for what purpose location information may be accessed
- Securely use the mobile device for special purposes
- Effects of the GPDR (General Data Protection Regulation)



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Conclusions

- Hardware Evolution
- Ubiquity of Devices
- Ubiquity Nightmare
- Vision: Invisible Computing
- Challenges to Make Invisible Computing a Reality

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