

aka “Ubiquitous Computing”
“Internet of Things” (IoT)



Mobile and Pervasive Computing

15-821/18-843

Fall 2024

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Available for purchase Feb 2024 (US)

Introducing Apple Vision Pro: Apple's first spatial computer

What are the challenges in creating such a system?

How do you overcome them?

What have we learned about building such systems?

How does it fit into the existing cyberworld?

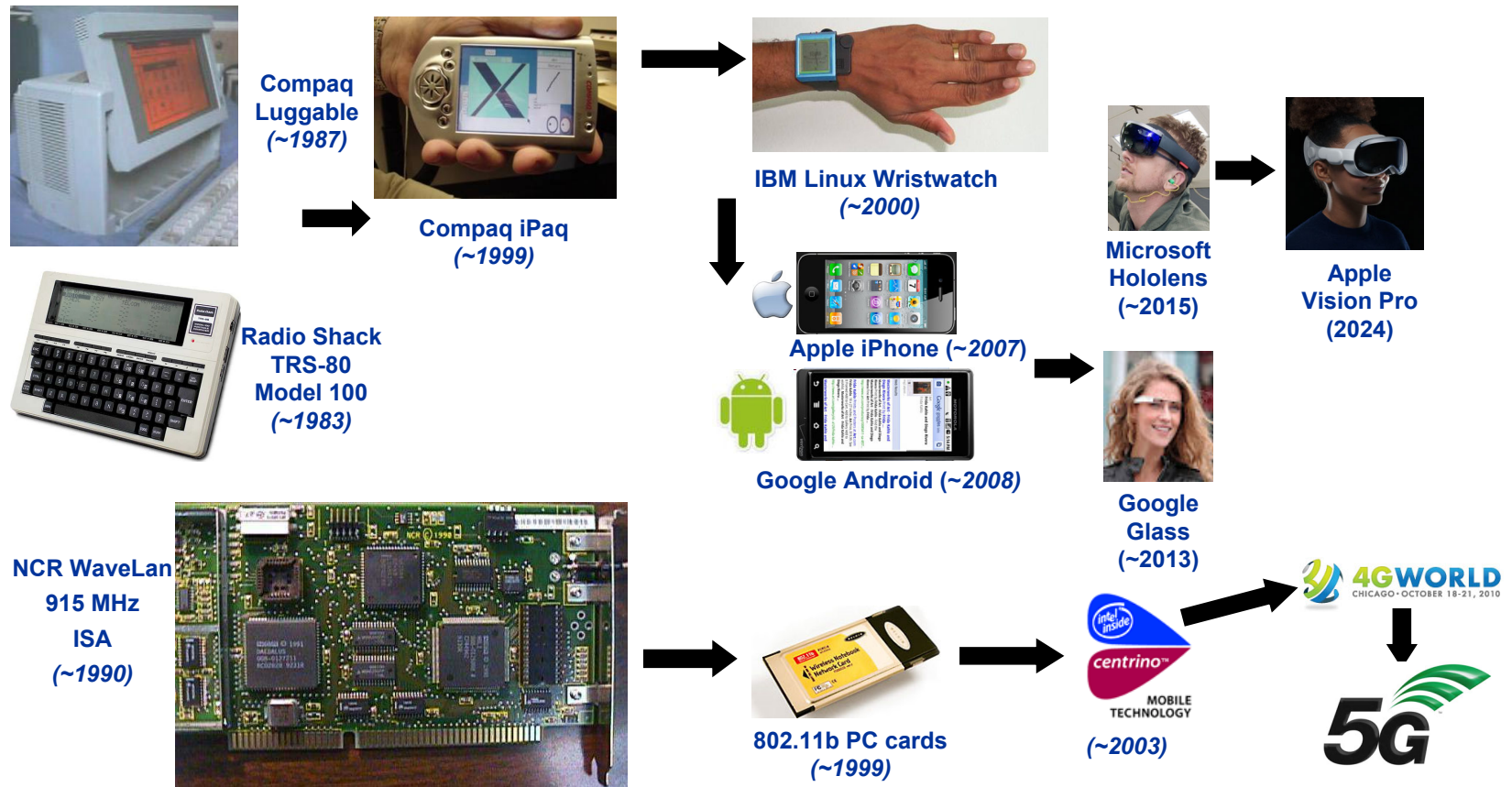
How did we get here?

...



Mobility: the Journey

continued shrinking of hardware and effects of Moore's Law



Focus of this course

“The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it.”

Mark Weiser, 1991

How do we build *human-centric* systems that

- are saturated with computing and communication,
- yet gracefully integrated with human users?

“IoT” tends to ignore humans — subset of our vision

The World in 1991

No World Wide Web

No smartphones

No cell phones

No Wi-Fi

No flash storage

No USB

No Amazon, Google, Facebook, Twitter, ...

(IBM, Microsoft, Apple existed)

Early-1990s Dream



Enduring Challenges of Mobility

Resource poverty

- weight, power, size constraints
- tiny I/O devices (displays, keys, ...)

Communication uncertainty

- bandwidth / latency / money
- intermittent connectivity
- feast or famine

Finite energy source

- transmission costs energy
- so does computing

Multi-modal interaction

- hands and eyes occupied
- speech/gesture recognition

Scarce user attention

- lower human performance
- more errors
- less patience

Lower privacy, security, robustness

- cameras, location sensing, ...
- more attack vectors
- physical destruction / damage

Goals of this Course

- Gain **broad knowledge** of key issues
- Obtain **hands-on experience** with some aspect of it
- Understand the **commercial landscape** in this space

Course Organization

Course Web site: <http://www.cs.cmu.edu/~15-821>

Components

- **Readings** + quizzes
- Lectures on topics of readings
- Projects (2 checkpoints + final demo/poster)
- Presentation of Commercial Scan for 1 course topic

Typical class

- Online Quiz on readings (~15 min + 10 min answers, **bring laptops**)
- Lecture + Discussion by Asim, Satya or guest (~90 min)
- Break (~10 min)
- Commercial Scan presentation (~40 min + discussion)

Topics

Introduction and Background

- **Ubiquitous Data Access**
- **Exploiting Virtual Machines**
- **Resource-Driven Dynamic Adaptation**
- **Mobile Hardware Technologies**
- **Sensing and Actuation**
- **Novel Wireless Technologies**
- **Security and Privacy**
- **Location and Context Awareness**
- **Design Methodologies and Infrastructure**

Reading List

<http://www.cs.cmu.edu/~15-821/assets/READINGS/reading-list-2024.pdf>

6 papers on each topic (ruthless pruning!)

- organized oldest to newest
- bias towards work by Asim & Satya (+Dan and guest faculty)

Key skill: ability to extract key points quickly from a paper

Tips on Commercial Scan

(not complete!)

- 1. What are major companies that supply products (e.g. software, hardware, etc.) or services (e.g. cloud services like Amazon EC2, training, etc.) relevant to this course topic?**
 - Are these well-established companies or startups?
 - Who are the primary customers: individual users, small business, large enterprises, etc.?
 - Briefly describe these goods and services.
- 2. How is the marketplace segmented?**
 - What is the basis of the segmentation?
 - In each segment, which are the major and minor players?
- 3. What is the business model?**
 - How do the companies make money?
 - What are the major costs involved?
 - Do these business models trigger any significant policy issues (e.g. privacy)?

- 4. What are the major standards in this arena? Are these official standards or informal standards that have evolved?**
- 5. Are there capabilities discussed in the research papers for this topic that are missing from the marketplace? What might be the reasons for this gap?**
- 6. Does commercial practice reveal important unaddressed research topics? Why have these topics not been investigated?**
- 7. Are there significant unmet needs in this space? Why have these needs remained unmet?**

...etc, etc. ...

Schedule

<http://www.cs.cmu.edu/~15-821/assets/schedule2024.html>

Key dates

- **Fri Aug 30** **Submit project preferences**
- **Sep 17** **Project Checkpoint-1 Presentations**
- **Oct 22** **Project Checkpoint-2 Presentations**
- **Nov 26** **Final Project Demonstrations and Posters**
(Just before Thanksgiving)
- **Dec 3** **Last class**

Grading Criteria

- **Project execution & final demo/poster (55%)**
- **Commercial Scan presentation (20%)**
- **Quizzes (20%)**
- **Class participation (5%)**

Multiple CommScans OK

Best score is used

Doing extra, NEVER hurts

Lecture Notes

In AFS (</afs/andrew/course/15/821/classnotes>)

Only accessible to students in class

Not Web-crawable

These are for your personal use only

You are welcome to make personal copies and keep them permanently

Roster

CommScan Signups

Project Selection