

Smart Objects

Introduction

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Lecture 1



What is a smart object?

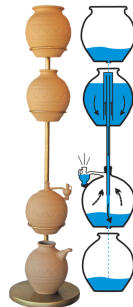
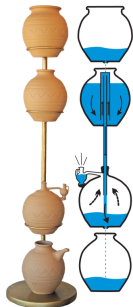


200 A.D. . . . 300 A.D.





280 BC ... 220 BC



427 BC ... 347 BC



SI OBJECT



SI OBJECT

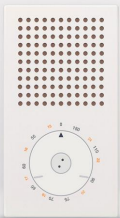


SI OBJECT



1770 AC





1958 – Braun T3

From Vacuum Tubes ...



First half of the 1900s



... to transistors ...



1950s



... to microprocessors ...



On November 15, 1971, Intel released the world's first commercial microprocessor, the 4004 operating at 740 kHz.



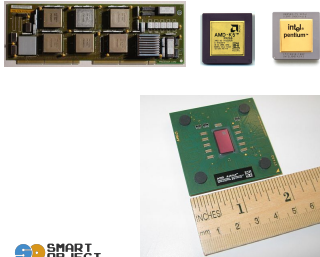
The Intel 8088 introduced on July 1, 1979, an 8-bit processor operating at 5 MHz.

In the 1980s quick progress



... to multi-chip processors ...

In the 1990s: new designs, new developers, ...

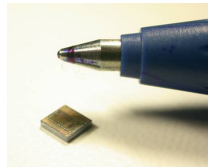
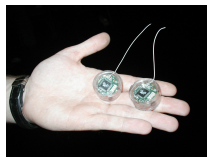


SMART OBJECT



... to systems-on-chip ...

- Typically include a CPU, memory and secondary storage,
- digital and analog Input-Output ports,
- radio frequency signal processing functions,
- networking technologies

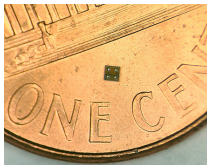


SMART OBJECT

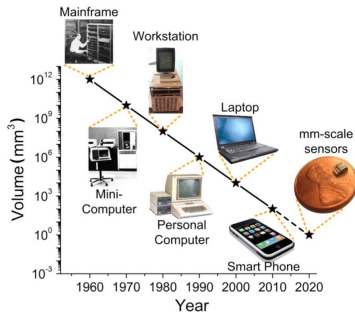


... to millimeter-scale micro notes

- Combining CPU, memory, I/O, battery, sensors, networking ...



SMART OBJECT

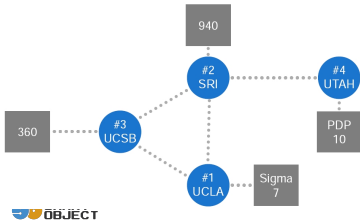


SMART OBJECT

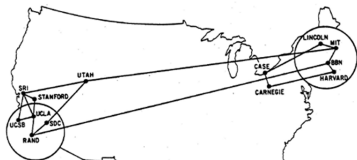


The beginning of Internet (ArpaNet)

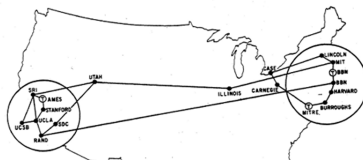
- The initial topology of the network on December, 1969
- 4 computers connected via a simple packet switching network



1969

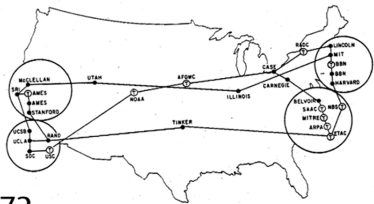


1970

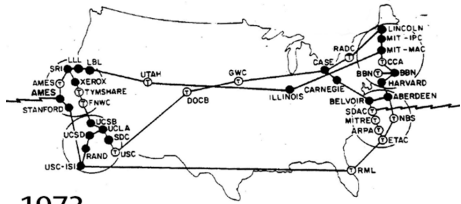


1971

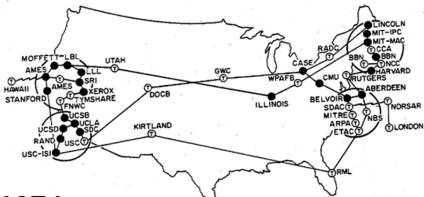




1972



1973

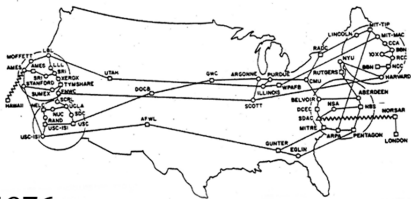


1974

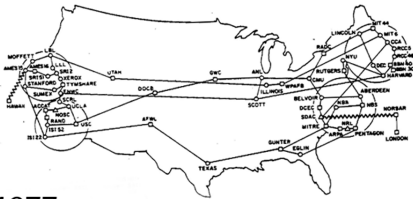


1975

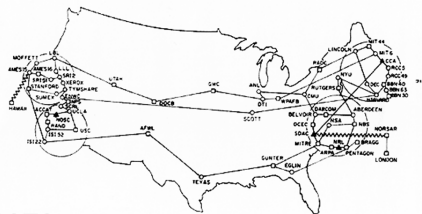




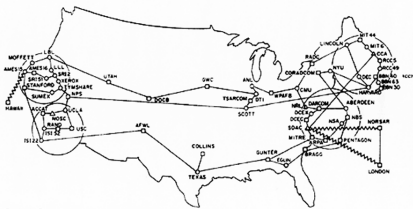
1976



1977



1978



1979

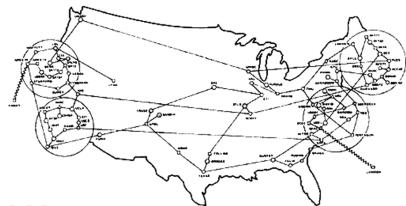




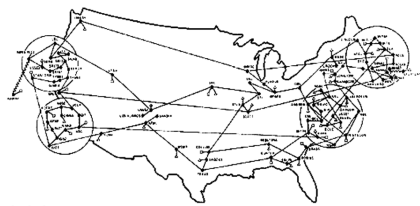
1980



1981

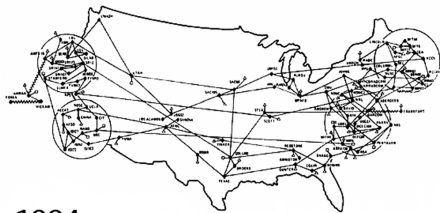


1982

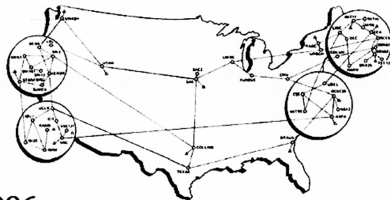


1983

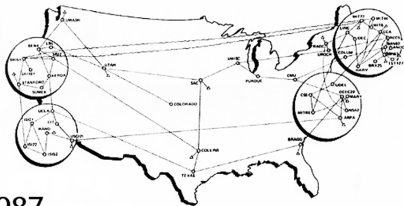




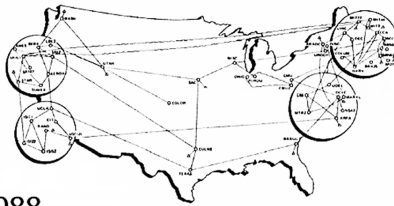
1984



1986

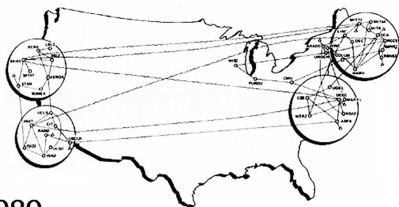


1987

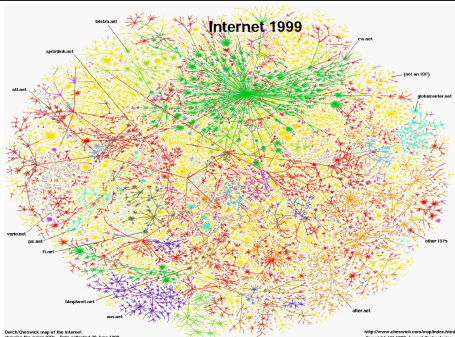


1988





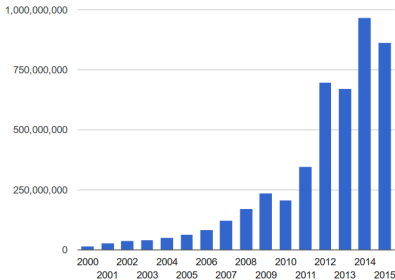
1989



Dark Orange: core of the Internet
Showing the major ISPs. Data collected 28 Jan 1999

http://www.stanford.edu/group/infocore.html
Copyright (C) 1999, Lucent Technologies

Growth of web sites connected to the Internet



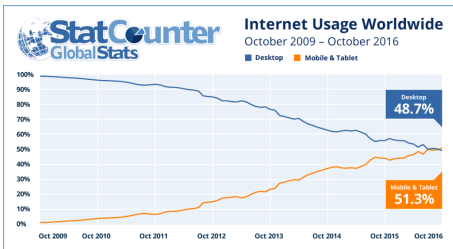
Today: 1.75 billion websites

Worldwide Internet Users

| | 2005 | 2010 | 2013 | 2016 | 2020 |
|-------------------------------|-------|-------|-------|-------|-------|
| World population | 6.5 b | 6.9 b | 7.1 b | 7.5 b | 7.8 b |
| Not using the Internet | 84% | 70% | 61% | 54% | 48% |
| Using the Internet | 16% | 30% | 39% | 46% | 62% |
| Users in the developing world | 8% | 21% | 31% | 34% | 42% |
| Users in the developed world | 51% | 67% | 77% | 79% | 89% |

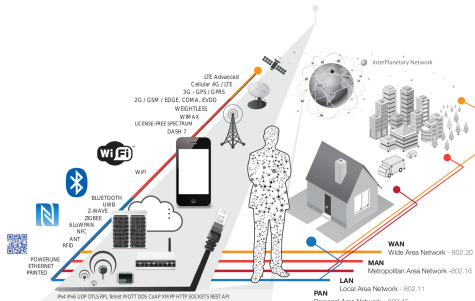
Source: International Telecommunication Union official website

Mobile vs Static Internet Usage



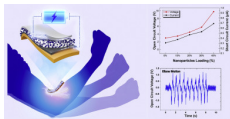
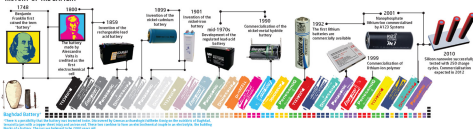
Today: 4.18 billion mobile Internet users

Broad range of options for connectivity

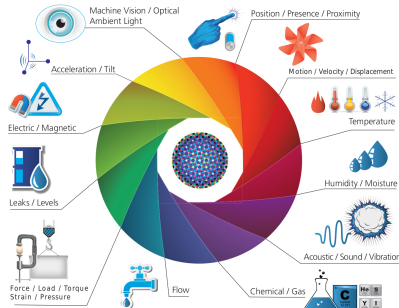


From batteries to energy harvesting, to nanogenerators

HISTORY OF THE BATTERY

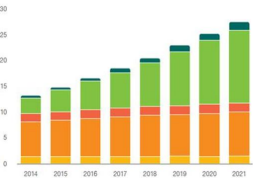


Sensors & Actuators: a digital nervous system



Things, People & Processes are becoming connected

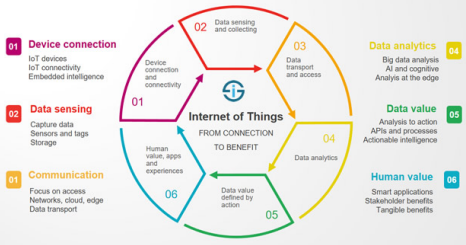
Connected devices (billions)



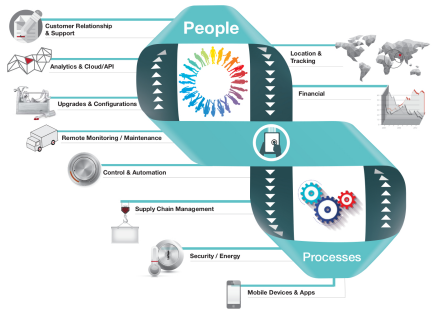
| | 15 billion | 28 billion | CAGR 2015-2021 |
|------------------|------------|------------|----------------|
| Cellular IoT | 0.4 | 1.5 | 27% |
| Non-cellular IoT | 4.2 | 14.2 | 22% |
| PC/laptop/tablet | 1.7 | 1.8 | 1% |
| Mobile phones | 7.1 | 8.6 | 3% |
| Fixed phones | 1.3 | 1.4 | 0% |

The Internet of Things

From connecting devices to human value



People & Processes: bi-directional systems

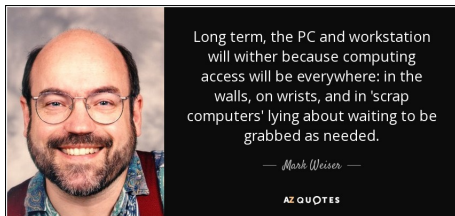


The interactions between these entities are creating new types of smart applications and services.

• SENSORS + CONNECTIVITY + PEOPLE + PROCESSES

A interesting era

- The **Internet** gave us the opportunity to connect in ways we could never have dreamed possible.
- The **Internet of Things** will take us beyond connection to become part of a living, moving, **global nervous system**.
- Whether you are an individual, technology developer, or adopter of these technologies, the Internet of Things will stretch the boundaries of today's systems.
- **Are you prepared for the changes in the way we learn, work and innovate?**



Long term, the PC and workstation will wither because computing access will be everywhere: in the walls, on wrists, and in 'scrap computers' lying about waiting to be grabbed as needed.

— Mark Weiser —

AZ QUOTES



"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

<https://web.archive.org/web/20141022035044/http://www.ubiq.com/hypertext/weiser/SciAmDraft3.html>



"A good tool is an invisible tool. By invisible, I mean that the tool does not intrude on your consciousness; you focus on the task, not the tool."

Mark Weiser, 1993

<https://web.archive.org/web/20141109145219/http://www.ubiq.com/hypertext/weiser/ACMInteractions2.html>



"Ubiquitous computing names the third wave in computing, just now beginning. First were mainframes, each shared by lots of people. Now we are in the personal computing era, person and machine staring uneasily at each other across the desktop. Next comes ubiquitous computing, or the age of calm technology, when technology recedes into the background of our lives"

Mark Weiser, 1988



"A future in which we - individuals, neighbors, friends, and relatives - can use the technology around us to observe, discover, and act on the patterns that shape our lives. Whether your passion is personal or global, whether your interest is in health or the environment, whether you act alone or in a group, Urban Sensing is a new approach that empowers all of us to illuminate and change the world around us"

D. Estrin, M. Srivastava

Senseable City Lab (MIT)



Names, names, names . . .

Lots of names and approaches have been proposed and adapted by the research community, e.g.:

- ambient intelligence
- pervasive computing
- ubiquitous computing
- disappearing computer
- wireless sensor networks
- physical computing
- internet of things
- semantic reality
- urban sensing
- . . .

Also given various contexts and interpretations (always according to what fits your research agenda)



What is a smart object?



An object becomes smart when thanks to the technology it can do something better than its non-smart original version.



An object becomes smart when thanks to the technology it can do something completely new than its non-smart original version.



Maass and Janzen – 2007

Three core requirements:

- 1 adaptation to situational contexts,
- 2 adaptation to actors that interact with products or product bundles,
- 3 adaptation to underlying business constraints

In more details:

- 1 Situated: recognition of situational and community contexts
- 2 Personalized: tailoring of products according to buyer's and consumer's needs and affects
- 3 Adaptive: change product behavior according to buyer's and consumer's responses and tasks
- 4 Pro-active: anticipation of user's plans and intentions
- 5 Business-aware: consideration of business and legal constraints
- 6 Network capable: ability to communicate and bundle with other

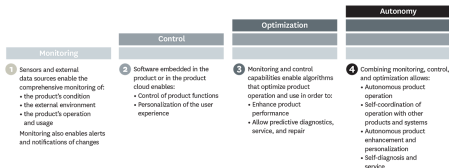


Mühlhäuser – 2008

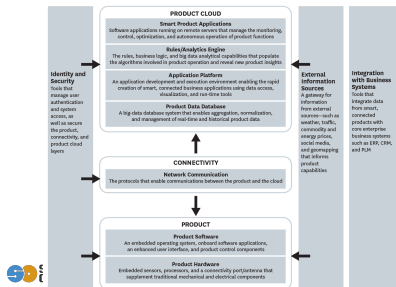
"A Smart Product is an entity (tangible object, software, or service) designed and made for self-organized embedding into different (smart) environments in the course of its lifecycle, providing improved simplicity and openness through improved p2u and p2p interaction by means of context-awareness, semantic self-description, proactive behavior, multimodal natural interfaces, AI planning, and machine learning."



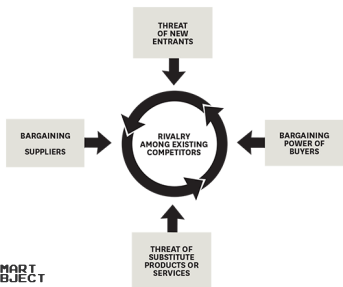
Capabilities of Smart, Connected Products



The New Technology Stack



The Five Forces That Shape Industry Competition



Redefining Industry Boundaries

