Smart Objects

Introduction

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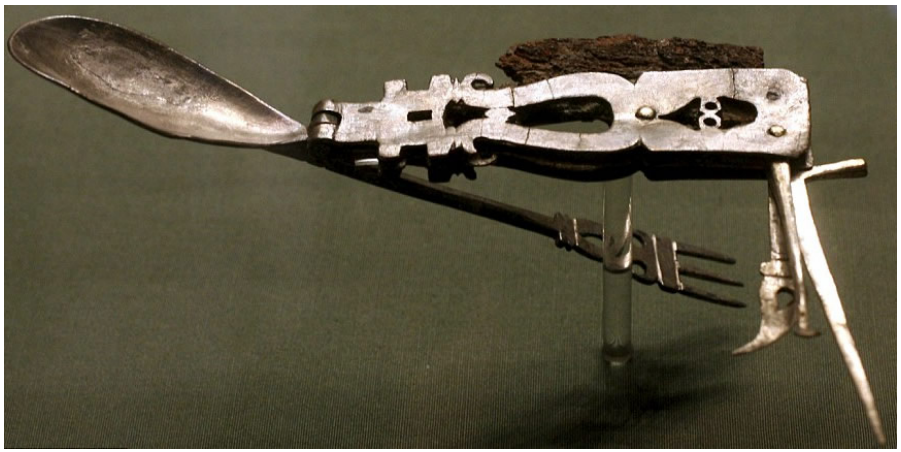
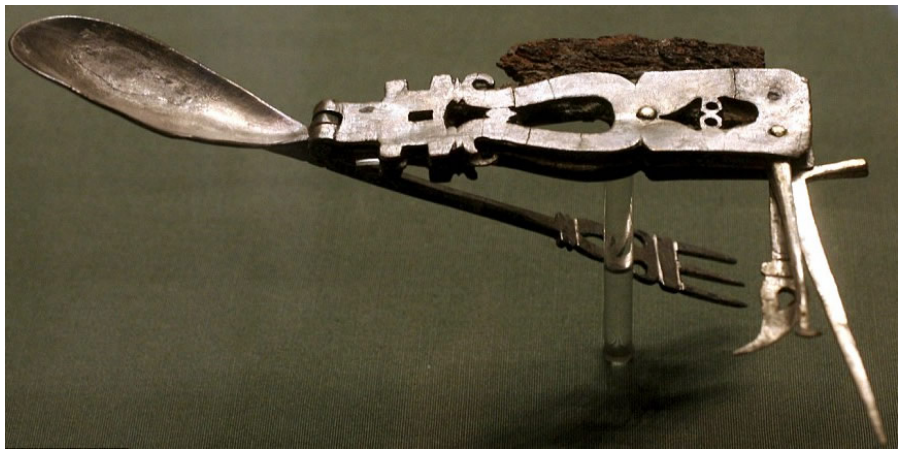
Lecture 1

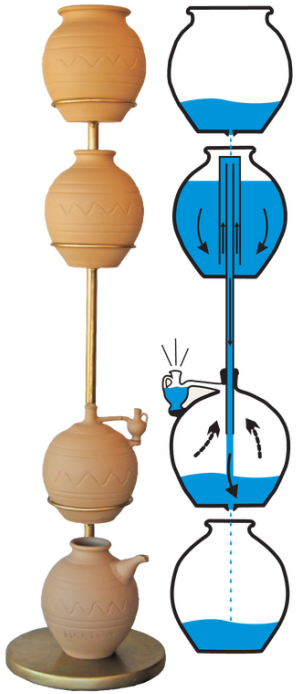
What is a smart object?

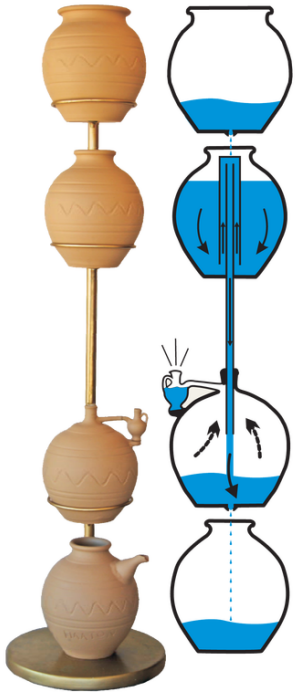




200 A.D. . . . 300 A.D.

280 BC . . . 220 BC





427 BC . . . 347 BC

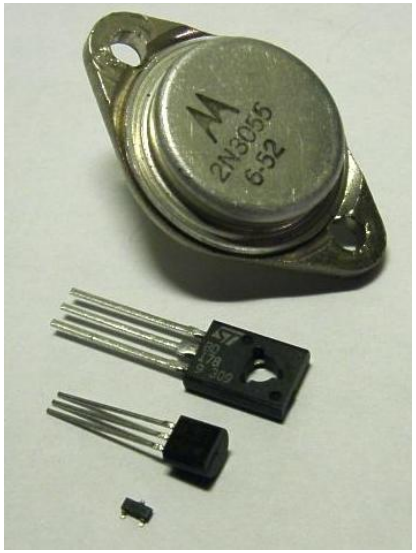
1770 AC

1958 – Braun T3

From Vacuum Tubes . . .

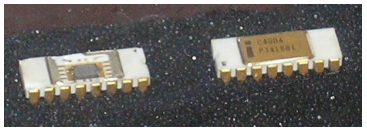
First half of the 1900s

. . . to transistors . . .

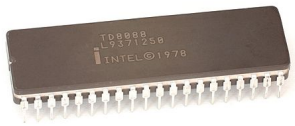


1950s

. . . to microprocessors . . .

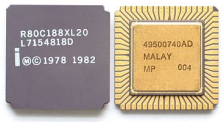


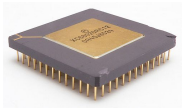
On November 15, 1971, Intel released the world's first commercial microprocessor, the 4004 operating at 740 kHz.



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

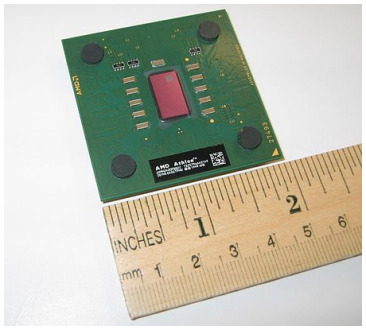
In the 1980s quick progress





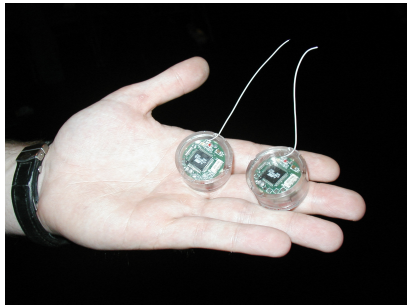
. . . to multi-chip processors . . .

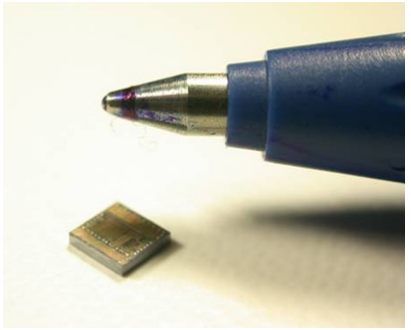
In the 1990s: new designs, new developers, . . .



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

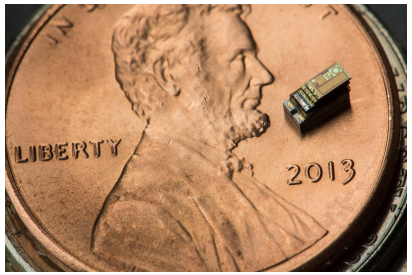
- Typically include a CPU, memory and secondary storage,
- digital and analog Input-Output ports,
- radio frequency signal processing functions,
- networking technologies

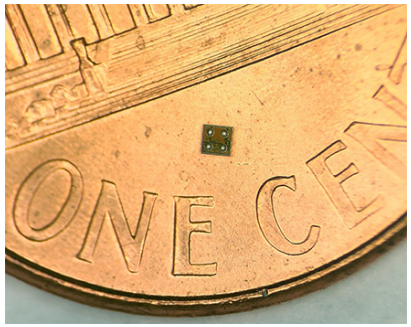


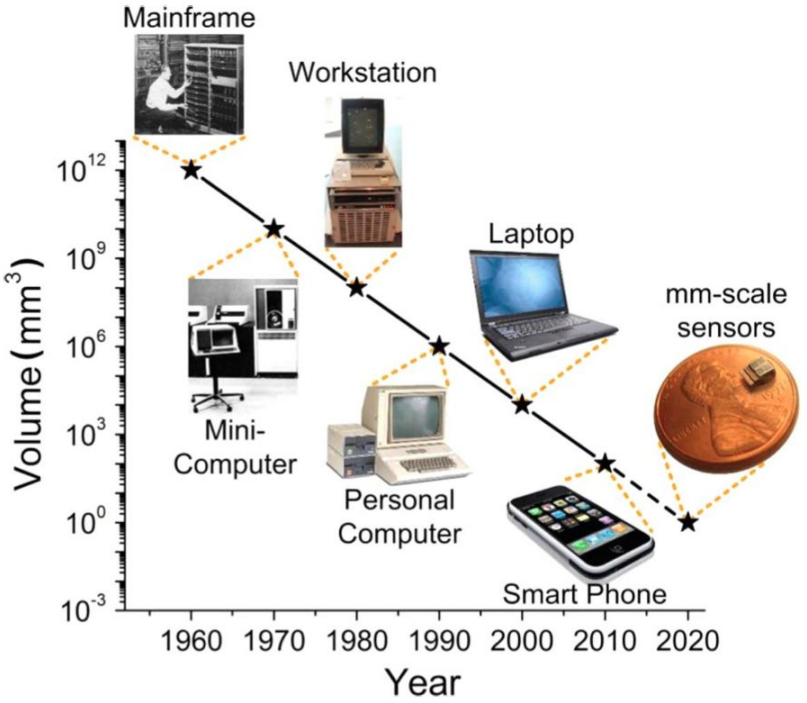


. . . to millimeter-scale micro motes

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

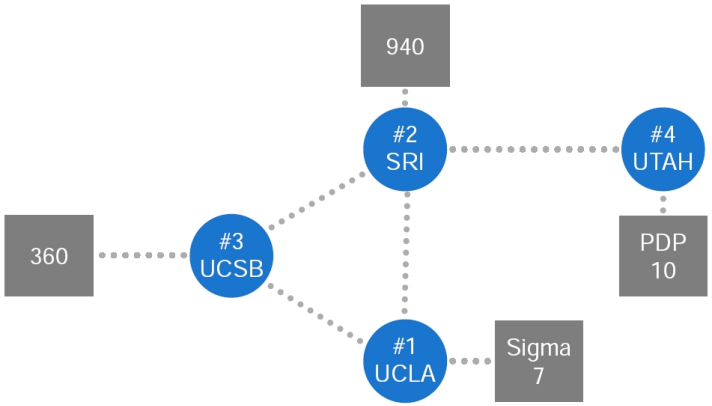




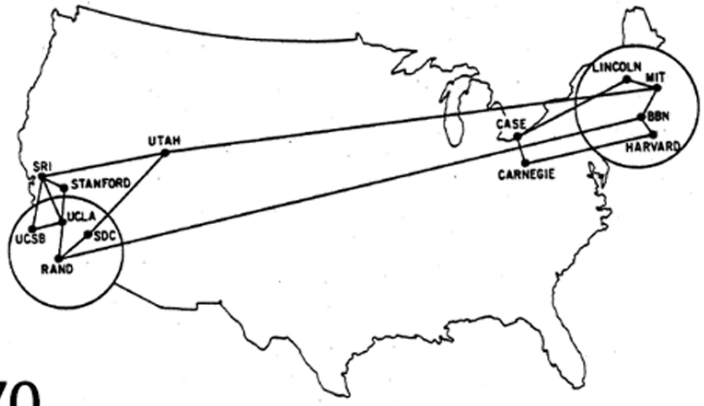


The beginning of Internet (ArpaNet)

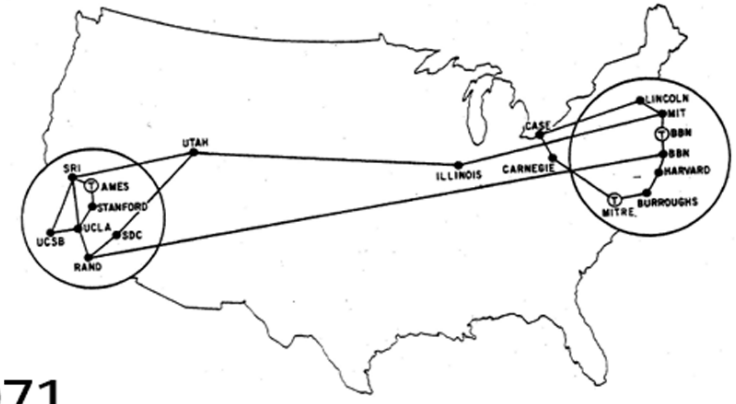
- The initial topology of the network on December, 1969
- 4 computers connected via a simple packet switching network



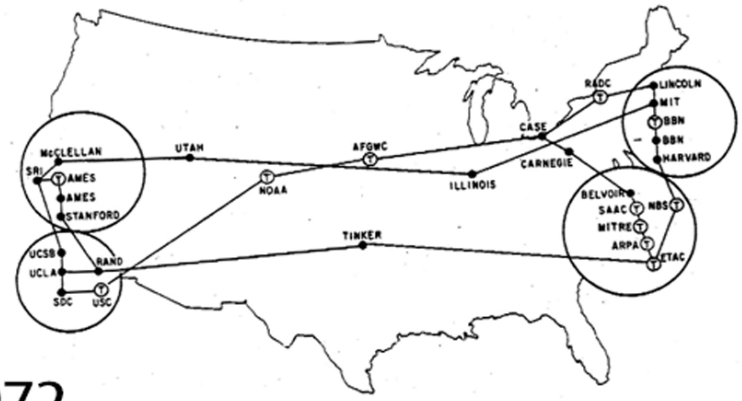
1969



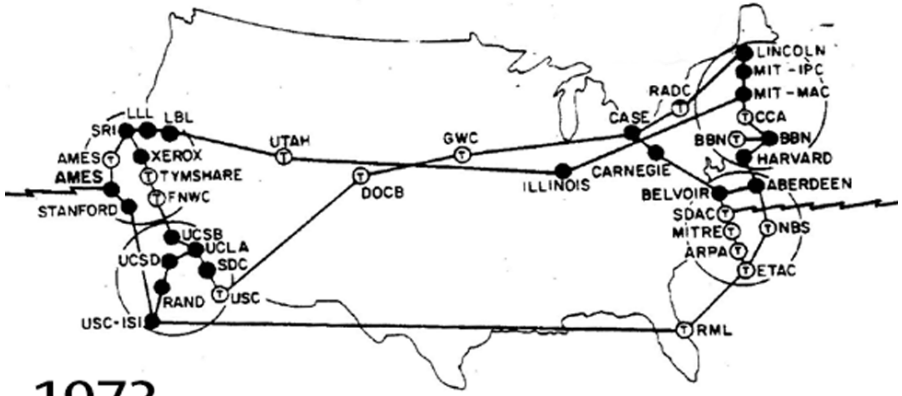
1970



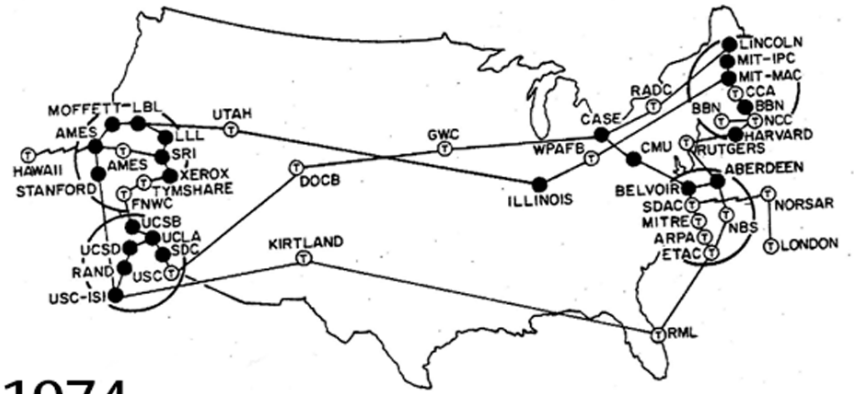
1971



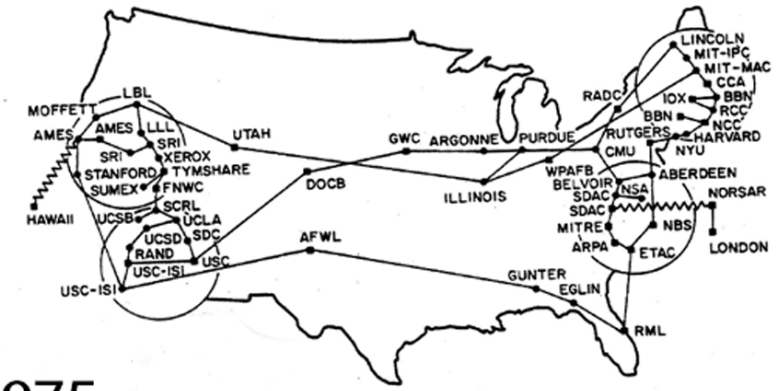
1972



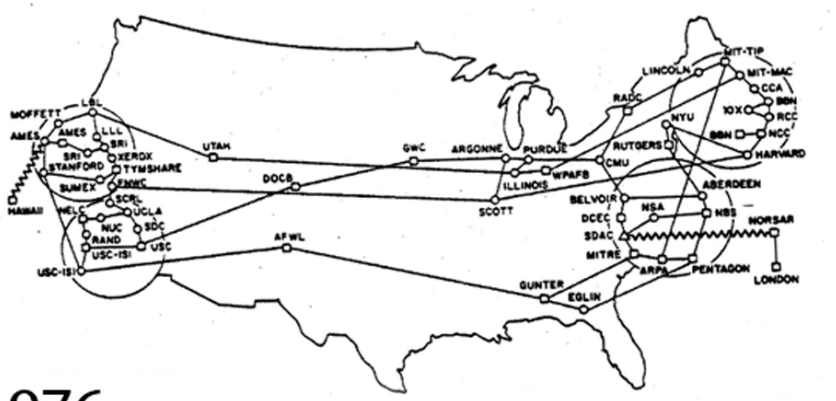
1973



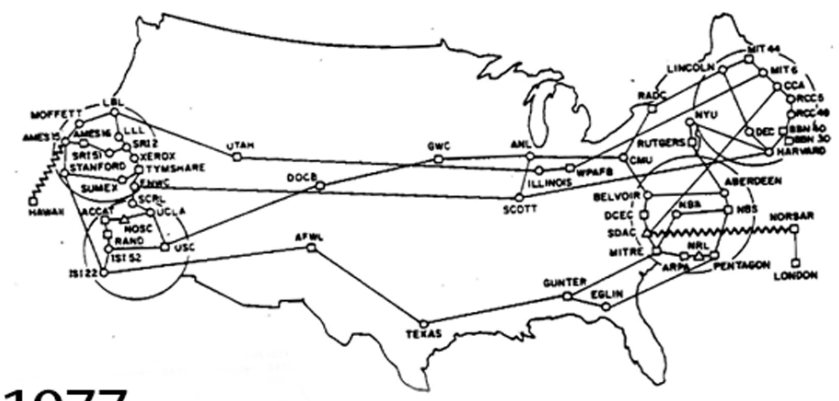
1974



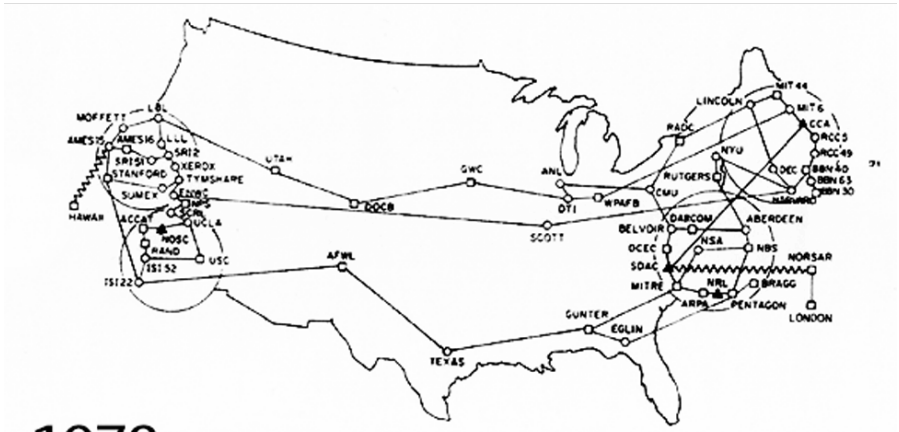
1975



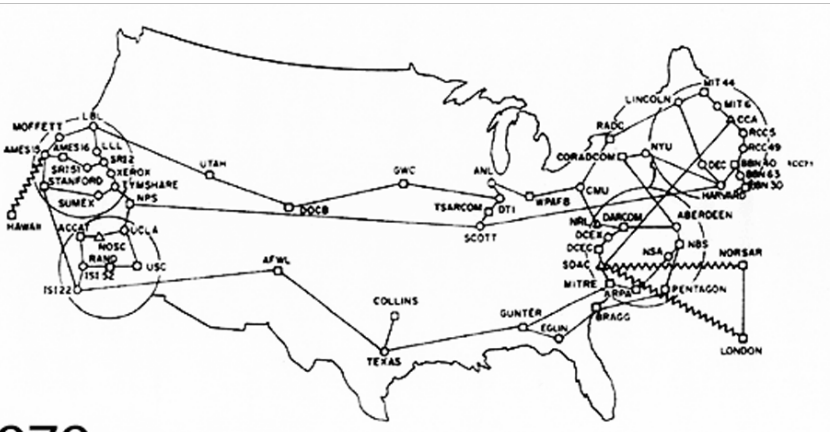
1976



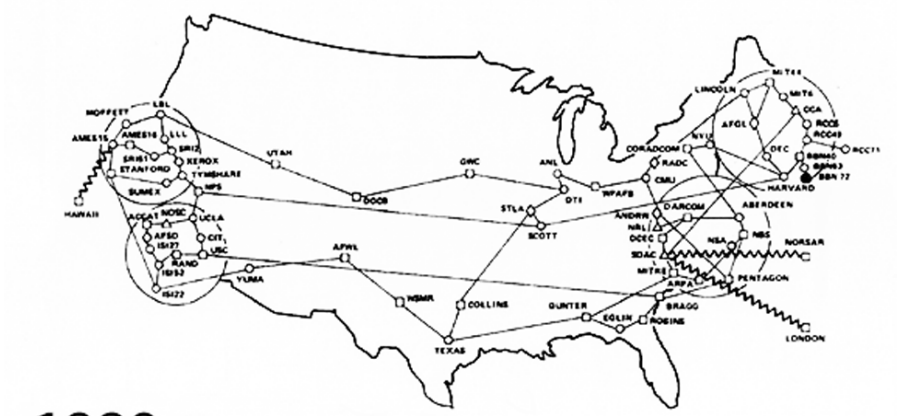
1977



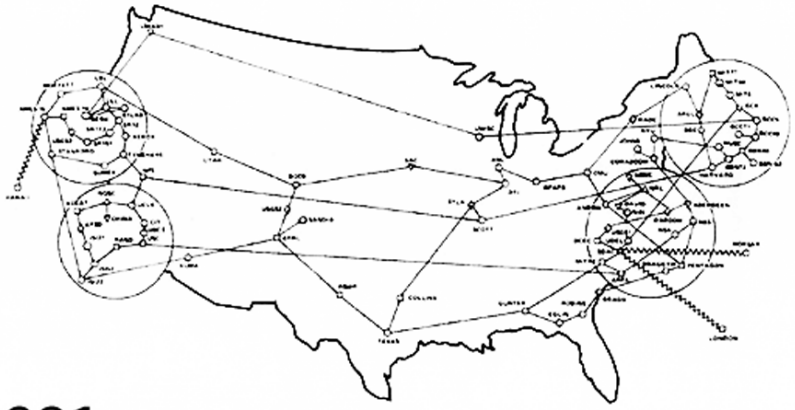
1978



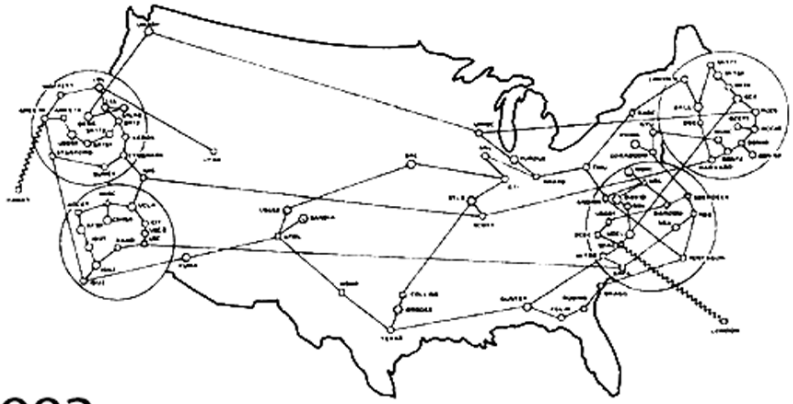
1979



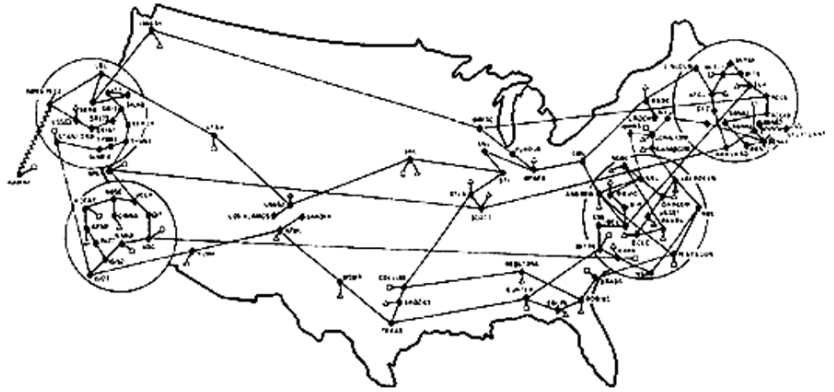
1980



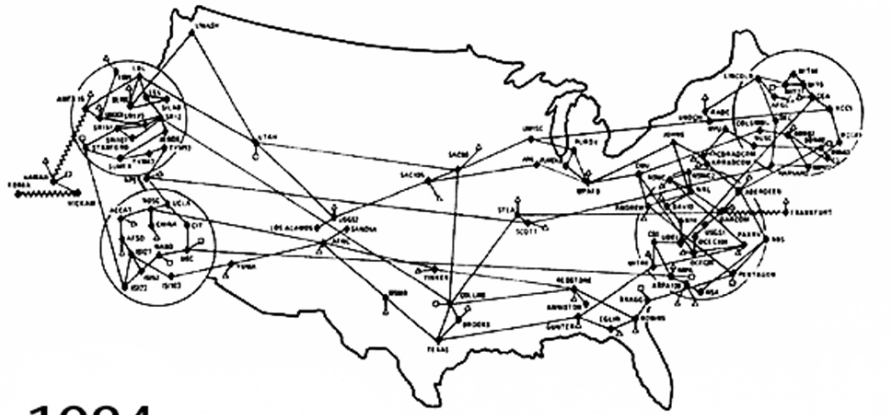
1981



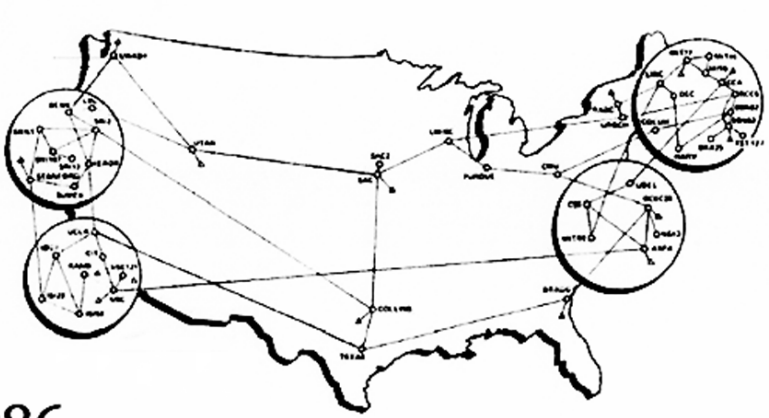
1982



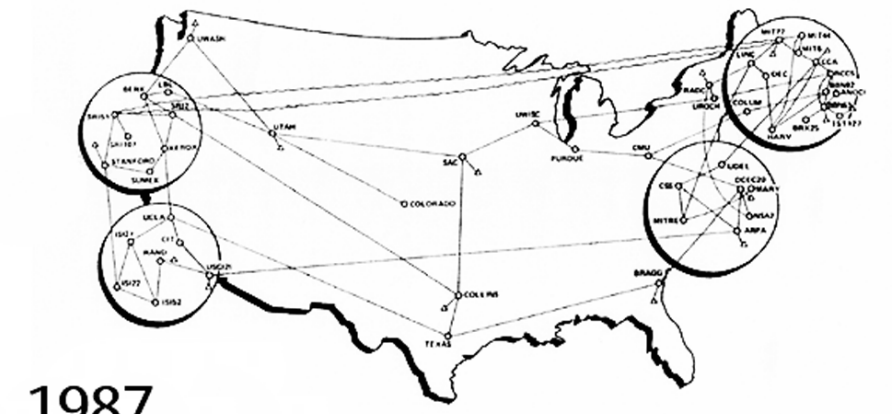
1983



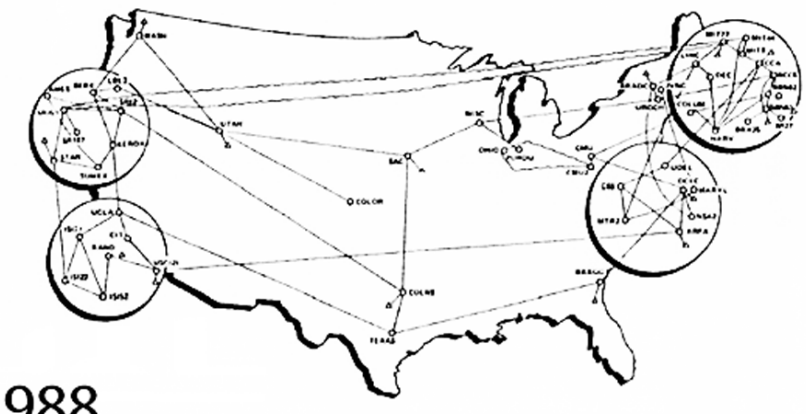
1984



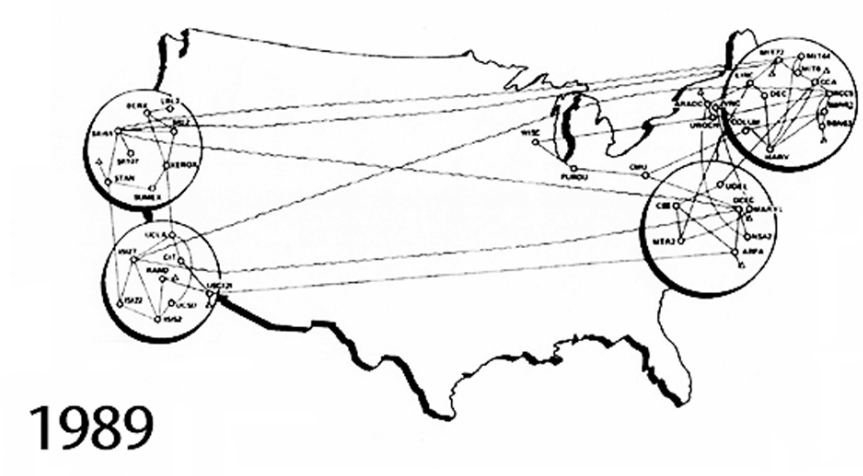
1986

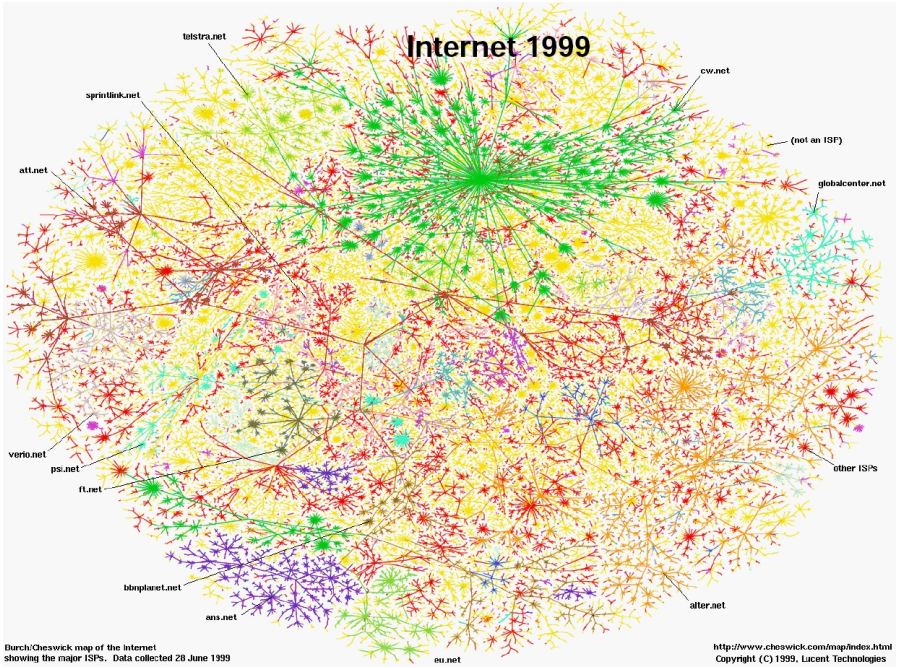


1987

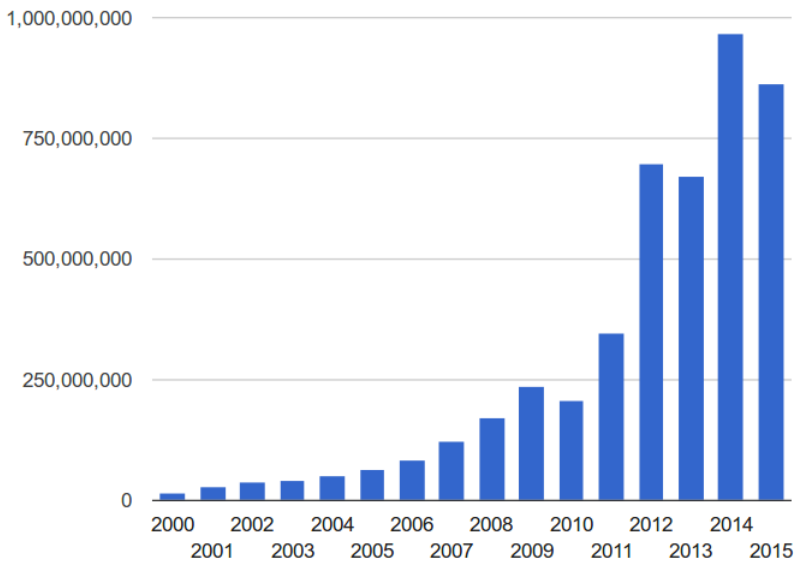


1988





Growth of web sites connected to the Internet

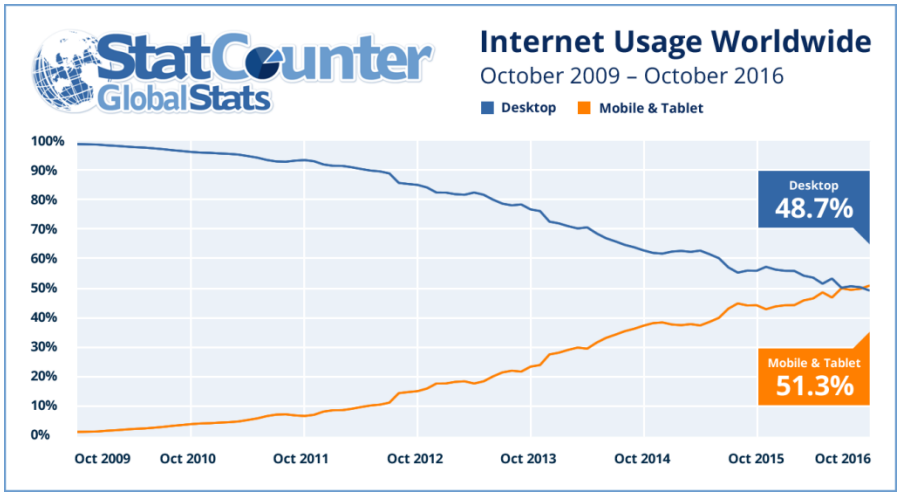


Worldwide Internet Users

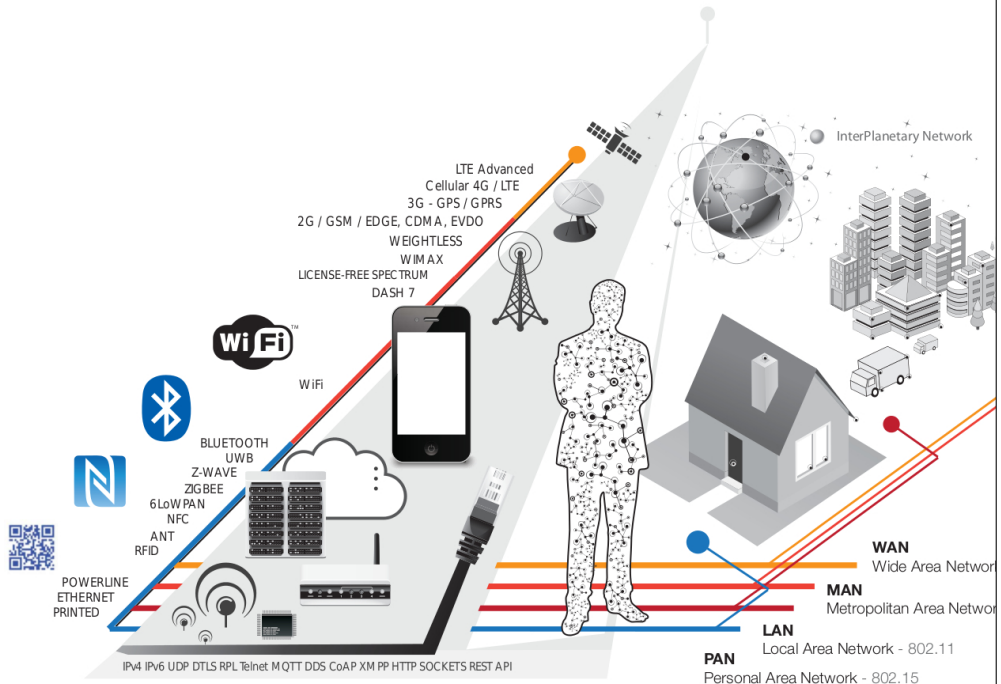
	2005	2010	2013	2016
World population	6.5 b	6.9 b	7.1 b	7.5 b
Not using the Internet	84%	70%	61%	54%
Using the Internet	16%	30%	39%	46%
Users in the developing world	8%	21%	31%	34%
Users in the developed world	51%	67%	77%	79%

Source: International Telecommunication Union official website

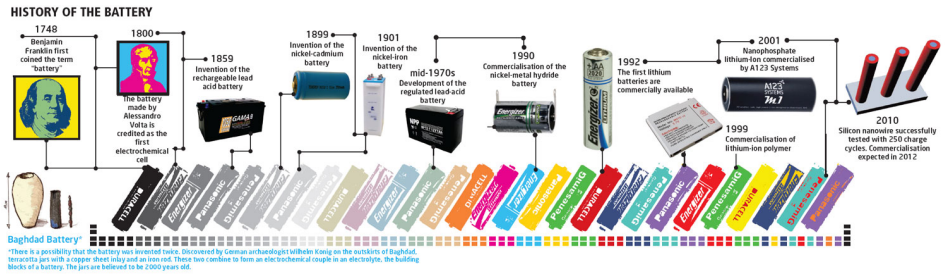
Mobile vs Static Internet Usage

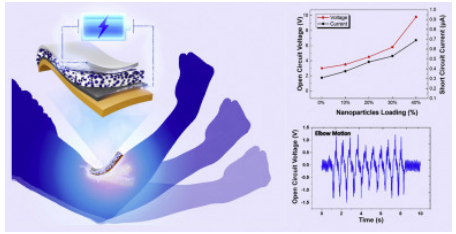


Broad range of options for connectivity

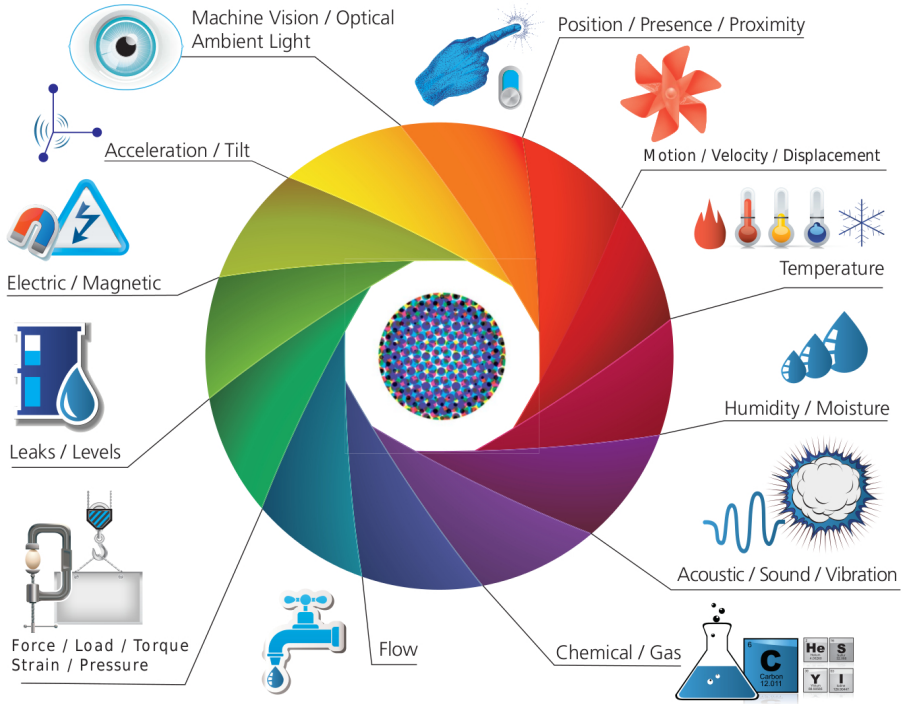


From batteries to energy harvesting, to nanogenerators

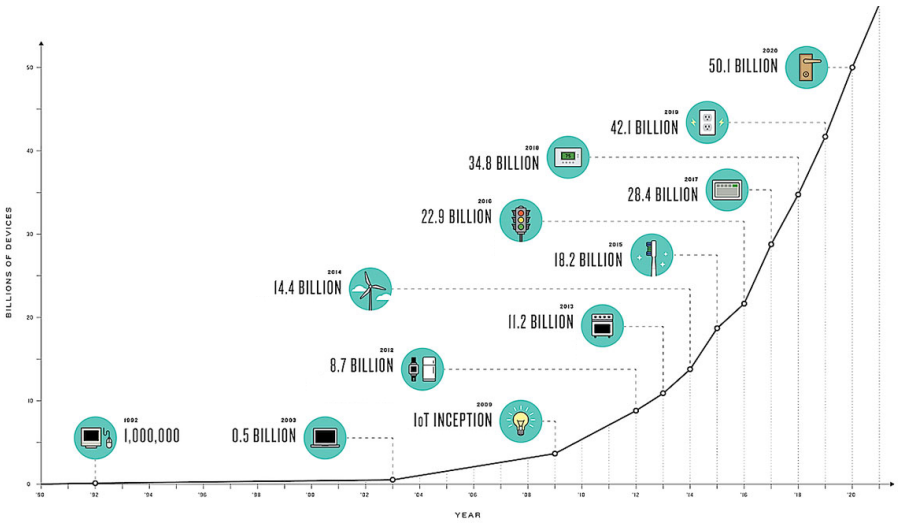




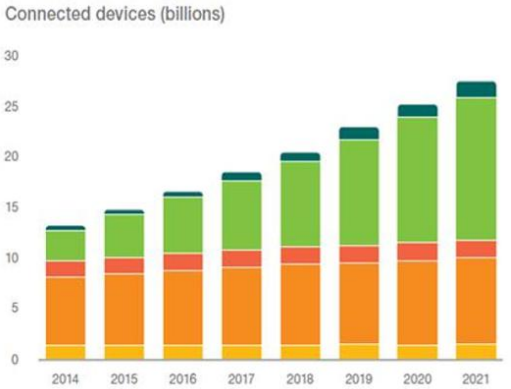
Sensors & Actuators: a digital nervous system



An explosion of connected possibility



Things, People & Processes are becoming connected

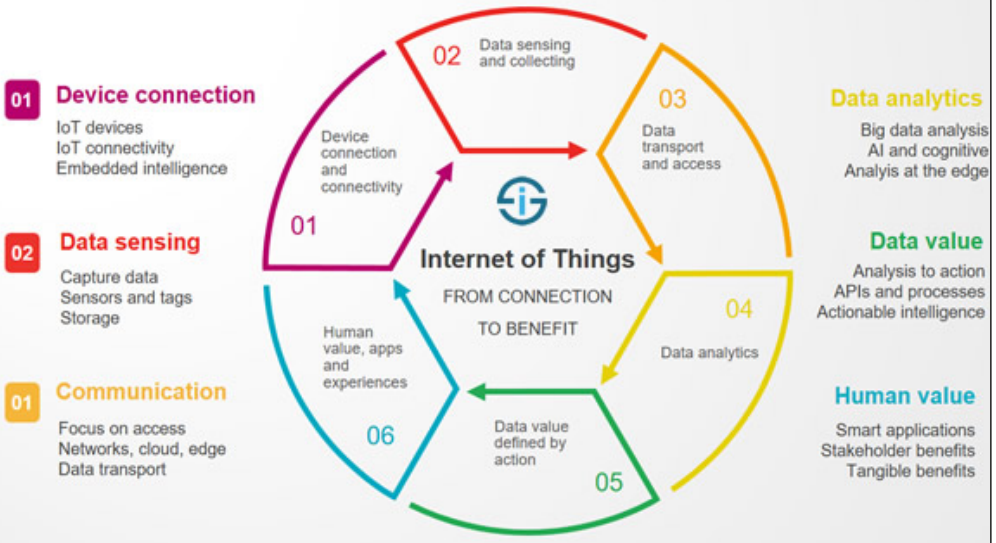


	15 billion	28 billion	CAGR 2015–2021
Cellular IoT	0.4	1.5	27%
Non-cellular IoT	4.2	14.2	22%
PC/laptop/tablet	1.7	1.8	1%
Mobile phones	7.1	8.6	3%
Fixed phones	1.3	1.4	0%

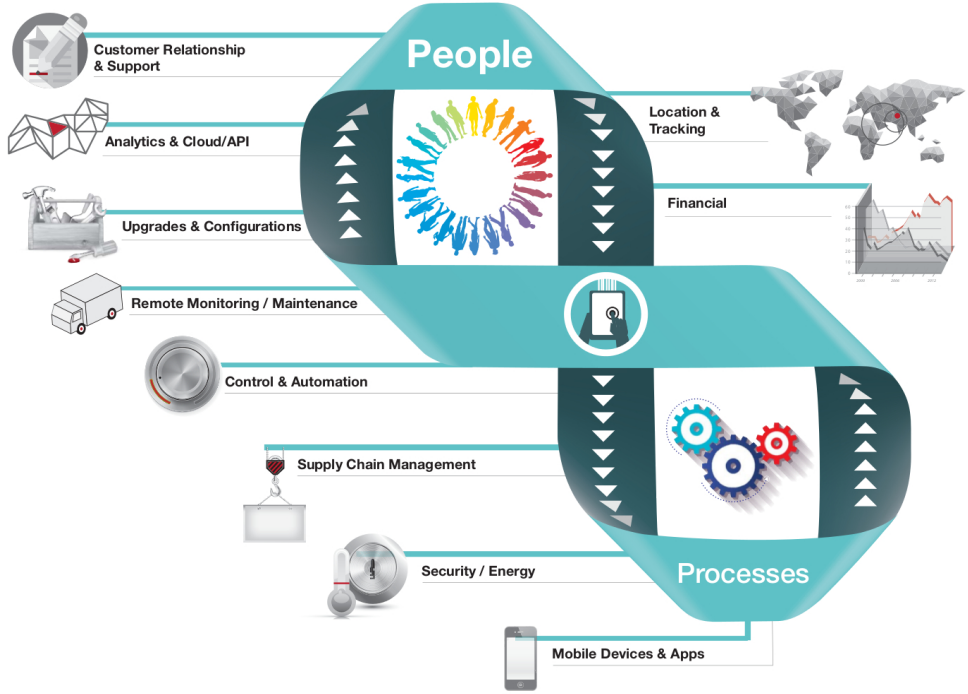
2015 2021

The Internet of Things

From connecting devices to human value



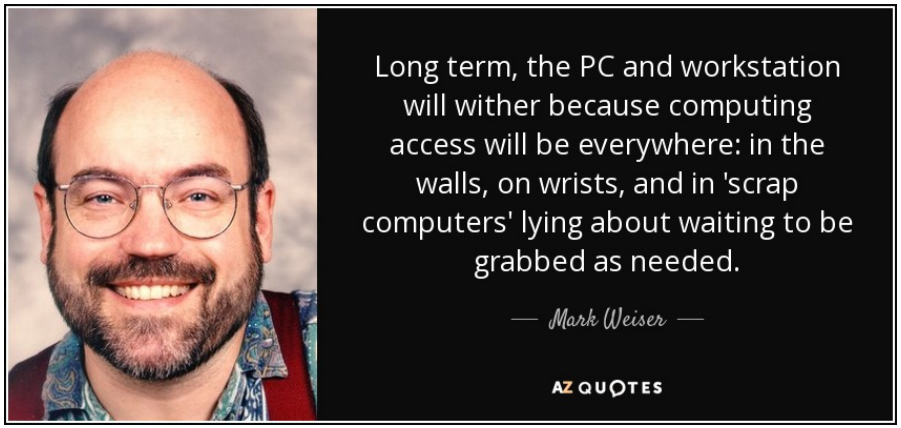
People & Processes: bi-directional systems



The interactions between these SENSORS + CONNECTIVITY + PEOPLE + PROCESSES entities are creating new types of smart applications and services.

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 nerbous system.
- Whether you are an individual, technology developer, or adopter of these technologies, the Internet of Things will strech the boundaries of today's systems.
- Are you prepared for the changes in the way we learn, work and innovate?



"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?

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

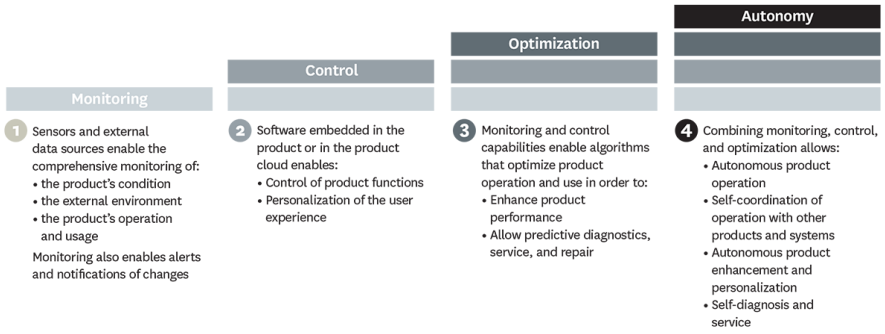
In more details:

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

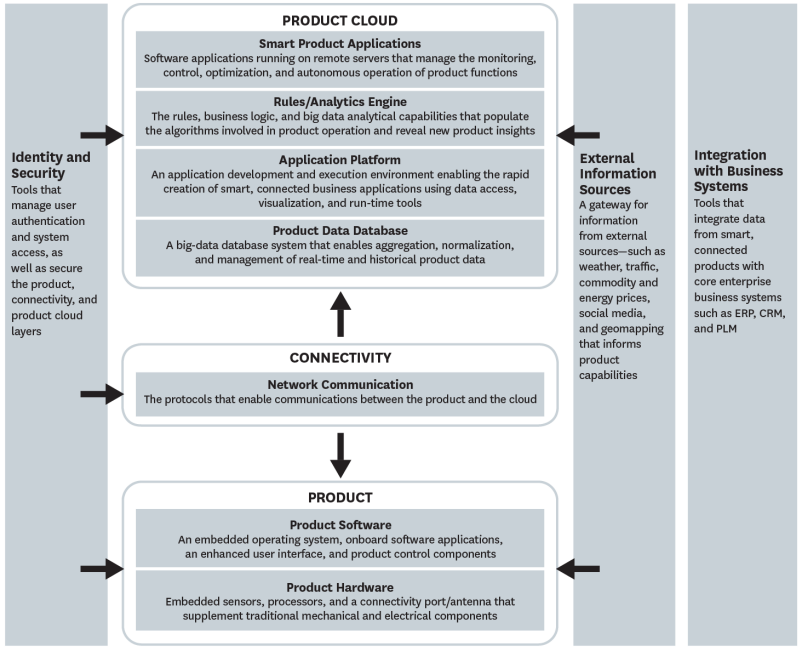
Mühlhäuser – 2008

"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."

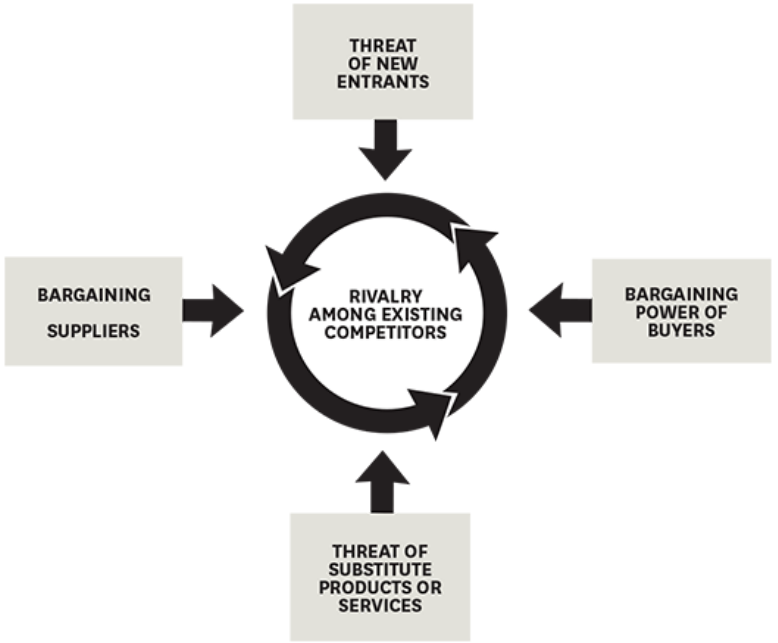
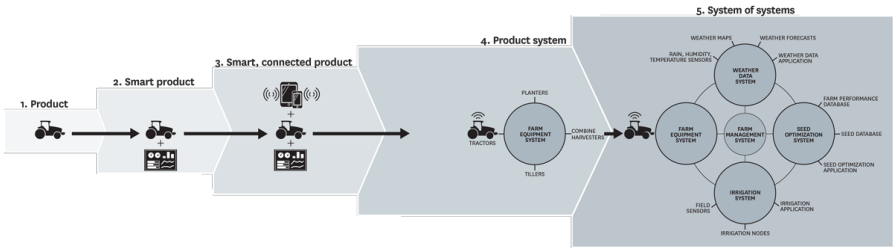
Capabilities of Smart, Connected Products



The New Technology Stack



The Five Forces That Shape Industry Competition



Redefining Industry Boundaries