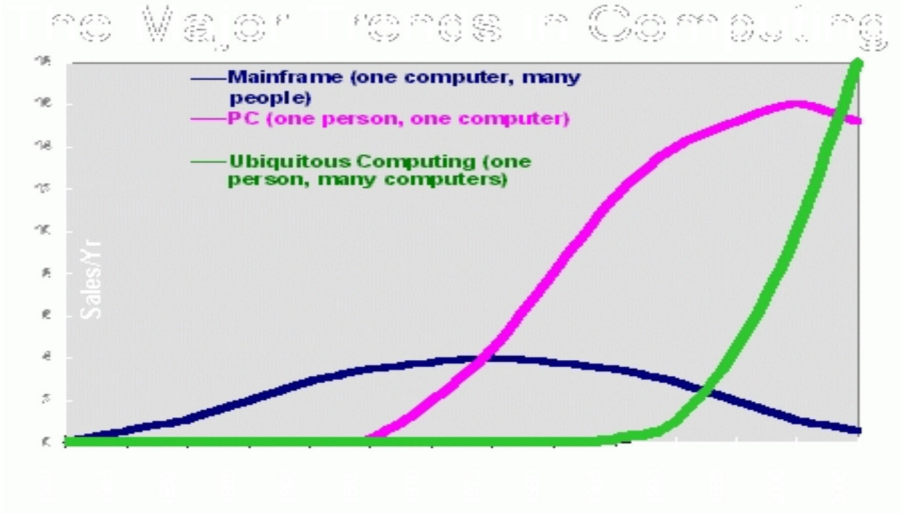
Ubiquitous Computing

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. Alan Kay of Apple calls this "Third Paradigm" computing.



Mark Weiser is the father of ubiquitous computing; his web page contains links to many papers on the topic.

Two recent papers express elements of the ubiquitous computing philosophy: "Open House" (also in a MS Word version) , and "Designing Calm Technology" .

What Ubiquitous Computing Isn't

Ubiquitous computing is roughly the opposite of virtual reality. Where virtual reality puts people inside a computer-generated world, ubiquitous computing forces the computer to live out here in the world with people. Virtual reality is primarily a horse power problem; ubiquitous computing is a very difficult integration of human factors, computer science, engineering, and social sciences.

Early work in Ubiquitous Computing

The initial incarnation of ubiquitous computing was in the form of "tabs", "pads", and "boards" built at Xerox PARC, 1988-1994. Several papers describe this work, and there are web pages for the Tabs and for the Boards (which are a commercial product now):

Ubicomp helped kick off the recent boom in mobile computing research, although it is not the same thing as mobile computing, nor a superset nor a subset.

Ubiquitous Computing has roots in many aspects of computing. In its current form, it was first articulated by Mark Weiser in 1988 at the Computer Science Lab at Xerox PARC. He describes it like this:

Ubiquitous Computing #1	Ubiquitous Computing #2
Inspired by the social scientists, philosophers, and anthropologists at PARC, we have been trying to take a radical look at what computing and networking ought to be like. We believe	For thirty years most interface design, and most computer design, has been headed down the path of the "dramatic" machine. Its highest ideal is to make a computer so exciting, so wonderful, so

that people live through their practices and tacit knowledge so that the most powerful things are those that are effectively invisible in use. This is a challenge that affects all of computer science. Our preliminary approach: Activate the world. Provide hundreds of wireless computing devices per person per office, of all scales (from 1" displays to wall sized). This has required new work in operating systems, user interfaces, networks, wireless, displays, and many other areas. We call our work "ubiquitous computing". This is different from PDA's, dynabooks, or information at your fingertips. It is invisible, everywhere computing that does not live on a personal device of any sort, but is in the woodwork everywhere.	interesting, that we never want to be without it. A less-traveled path I call the "invisible"; its highest ideal is to make a computer so imbedded, so fitting, so natural, that we use it without even thinking about it. (I have also called this notion "Ubiquitous Computing", and have placed its origins in post-modernism.) I believe that in the next twenty years the second path will come to dominate. But this will not be easy; very little of our current systems infrastructure will survive. We have been building versions of the infrastructure-to-come at PARC for the past four years, in the form of inch-, foot-, and yard-sized computers we call Tabs, Pads, and Boards. Our prototypes have sometimes succeeded, but more often failed to be invisible. From what we have learned, we are now explorting some new directions for ubicomp, including the famous "dangling string" display.

Slides

In March 1996 Weiser spoke at the Nomadic '96 conference. Here are the slides.

You can access the postscript for Weiser's 35mm color slides for the keynote talk entitled "Building Invisible Interfaces" given at the *User Interface, Systems, and Technologies (UIST)* conference, November, 1994.

Dr. Doug Terry gave a talk at Stanford University on systems problems of mobile computing. Here are his slides.

Slides from the invited talk by Weiser: "Does Ubiquitous Computing Need Interface Agents? No." given at Mit Media Lab Symposium on User Interface Agents, October 1992.

Cartoons

Virtual Reality vs. Ubiquitous Computing, in cartoons.

Phenomenological post-modernism explained and related to computer science, in cartoons.

Papers

Other writeups by Weiser on different aspects of Ubicomp can be found in the following references:

- Mark Weiser. "The world is not a desktop". *Interactions*; January 1994; pp. 7-8.
- Mark Weiser, "Hot Topics: Ubiquitous Computing" *IEEE Computer*, October 1993.
- Mark Weiser, "Some Computer Science Problems in Ubiquitous Computing,"

Communications of the ACM, July 1993. (reprinted as "Ubiquitous Computing". *Nikkei Electronics*; December 6, 1993; pp. 137-143.)
- Mark Weiser, "The Computer for the Twenty-First Century," *Scientific American,* pp. 94-10, September 1991

Press

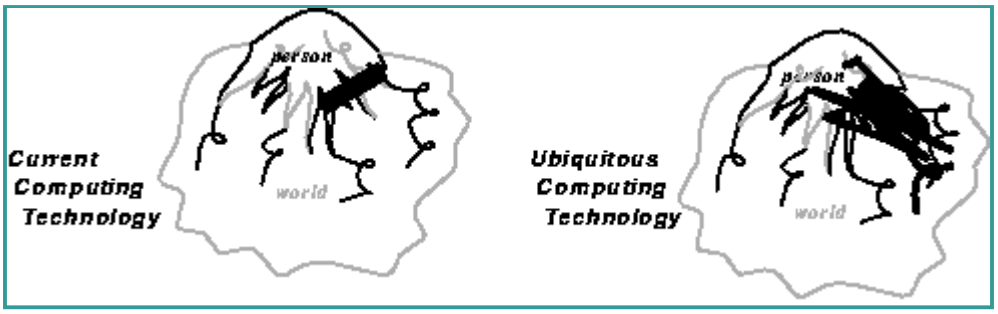
There have been popular press articles about ubicomp. Some of the recent ones are cited below:

- "The Chips Are Coming". *Smithsonian Magazine*, September 1994.
- "Hot Chips". Australian ABC TV. (Includes Mark and daughter Corinne using computer at home.) May 17, 1994.
- "The power to invent the future." London Financial Times, March 24, 1994. (3 pp.)
- "PARC is back". *WIRED*; February 1994; pp. 91-95.
- "Xerox PARC". *Nikkei Electronics*; November 22, 1993; pp. 115-124.

Other

Here are some other press references. (Weiser's CV has still more press and paper references.)

There are some quicktime movies of some of the ubiquitous computing devices.



Ubiquitous computing work at PARC was funded by Xerox and ARPA; funding does not mean endorsement.

Weiser, 03/17/96 8:00:04 PM