Introduction to Ubiquitous Computing

Mobile Computing

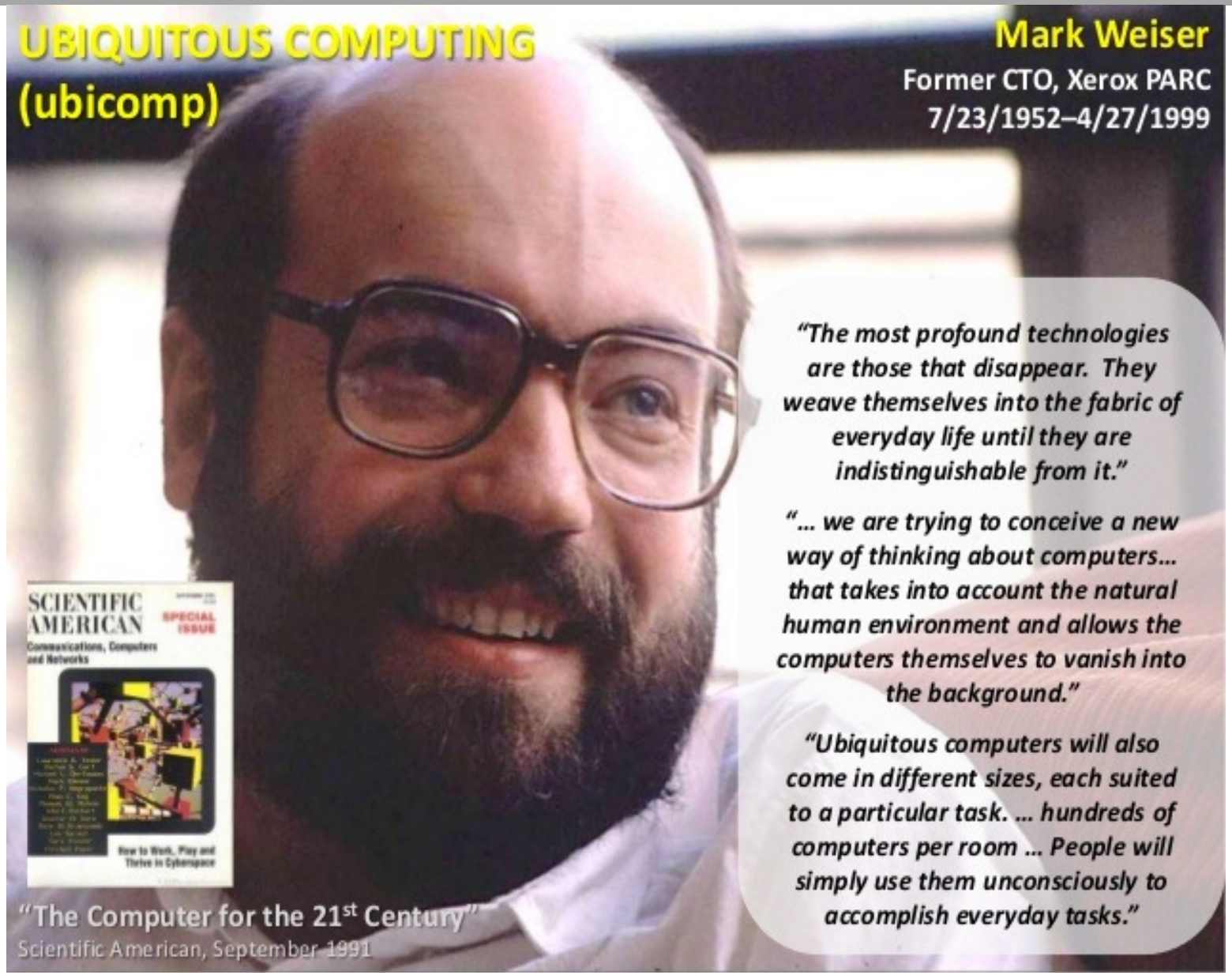
Disseminated Computing

Ubiquitous

- The word “ubiquitous” comes from the Latin “ubiquu” and means “it is everywhere” or “at the same time in several places”

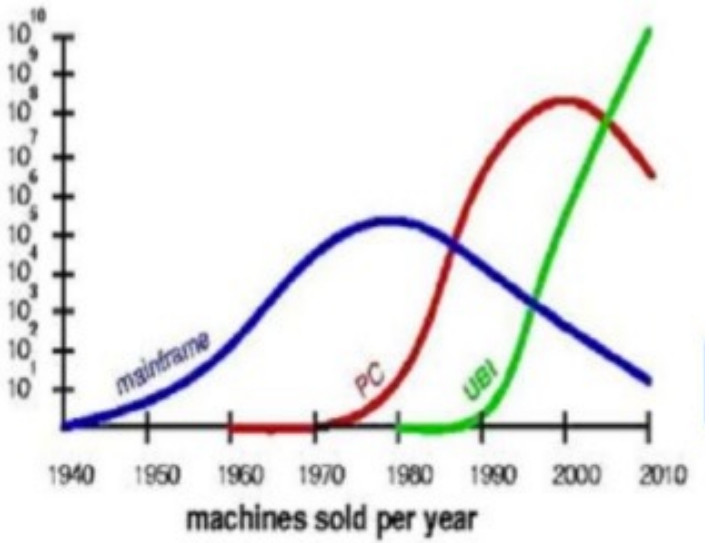
- Ubiquitous computing
  - It involves auxiliary equipment and systems that allow it to act appropriately regardless of the location

Ubiquitous/Omnipresent Systems



Computing evolution

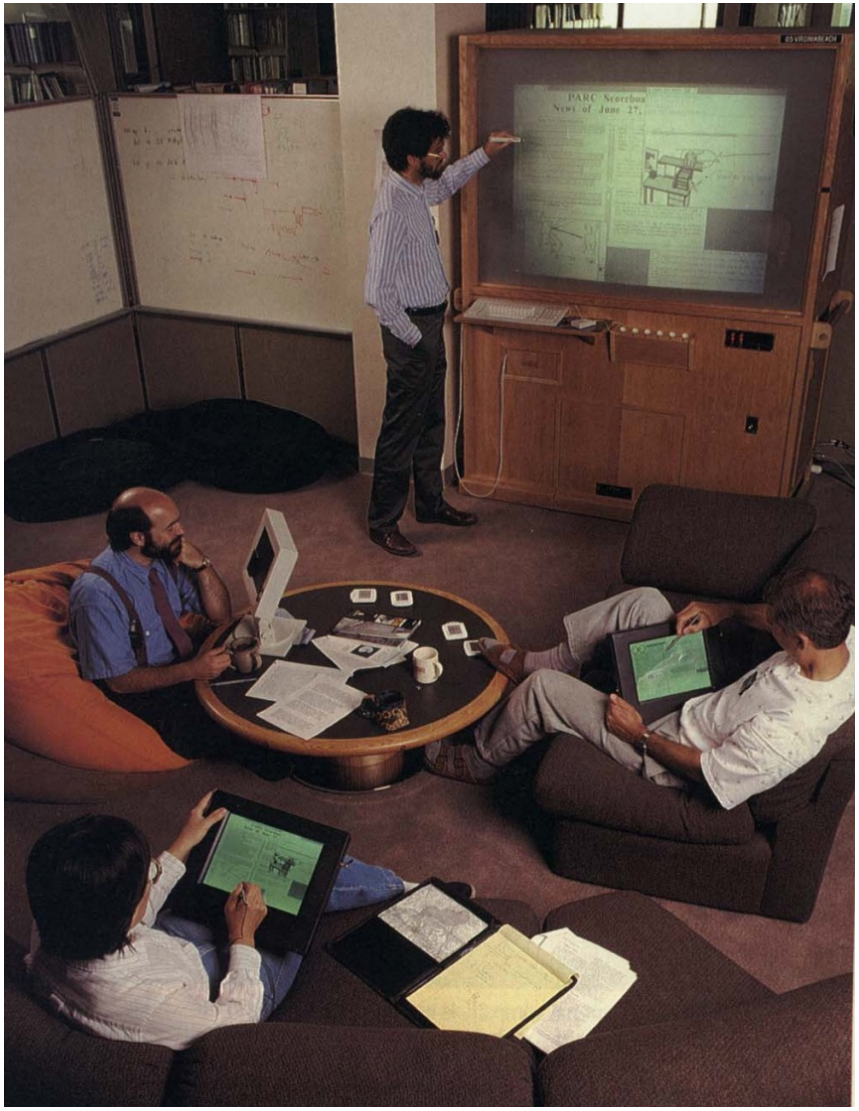
- Mainframes
  - One computer
  - Multiple users
- Personal computer
  - One computer
  - One person
- Ubiquitous computing
  - One person
  - Multiple computers/equipments
  - *Evolution: Multiple people, multiple equipment*



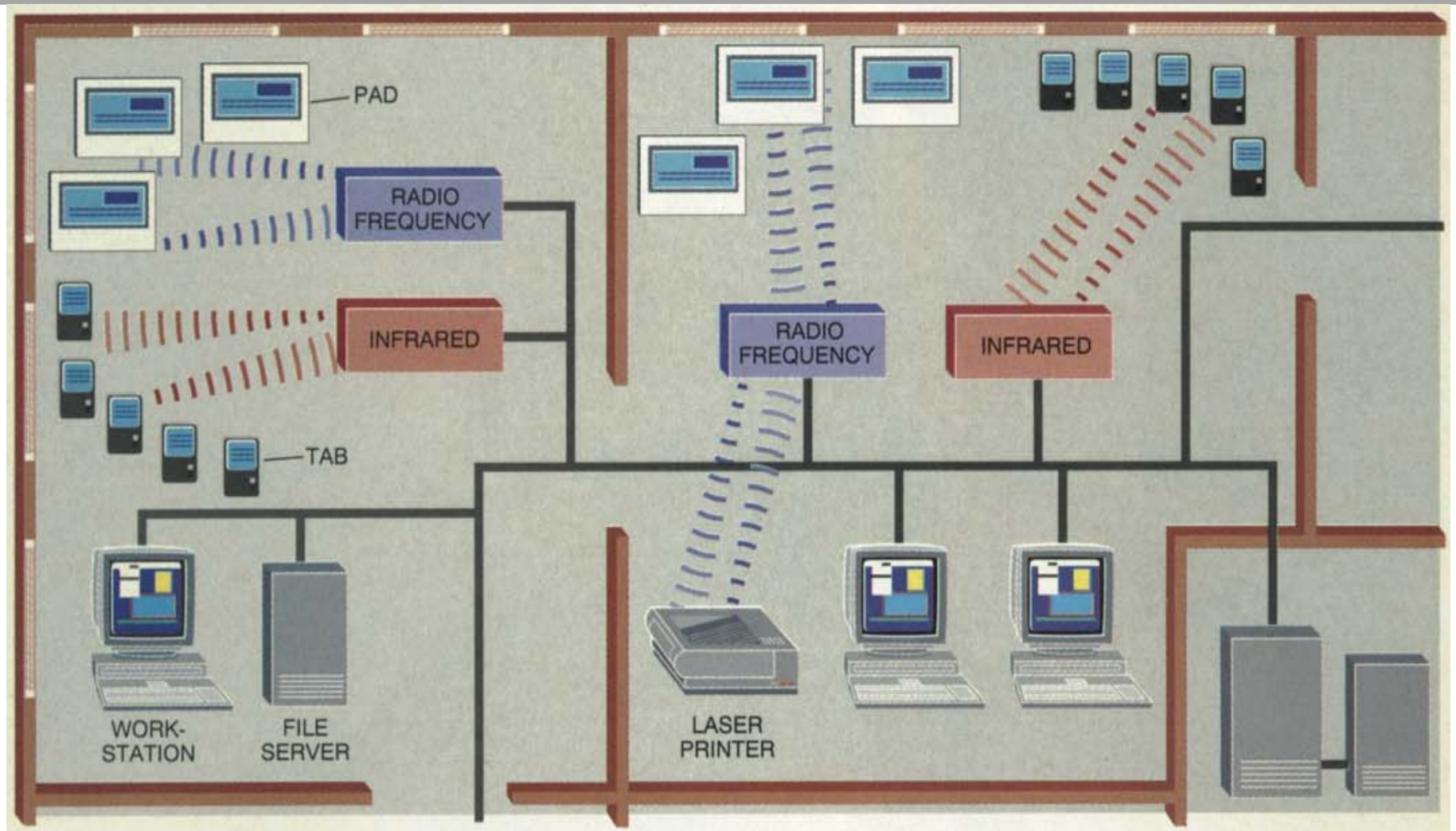
The Major trends in Computing
(Source : *Image © Mark Weiser/PARC*)

Equipment classification

- Categorization (*Mark Weiser*)
  - *Tabs*
    - Inch-scale devices
    - Interconnected
  - *Pads*
    - Foot-scale devices or decimeter level
    - "*Pads are intended to be 'scrap computers' (analogous to scrap paper) that can be grabbed and used anywhere; they have no individualized identity or importance*"
  - *Boards*
    - Interactive whiteboards
    - Scales at meter/yard level



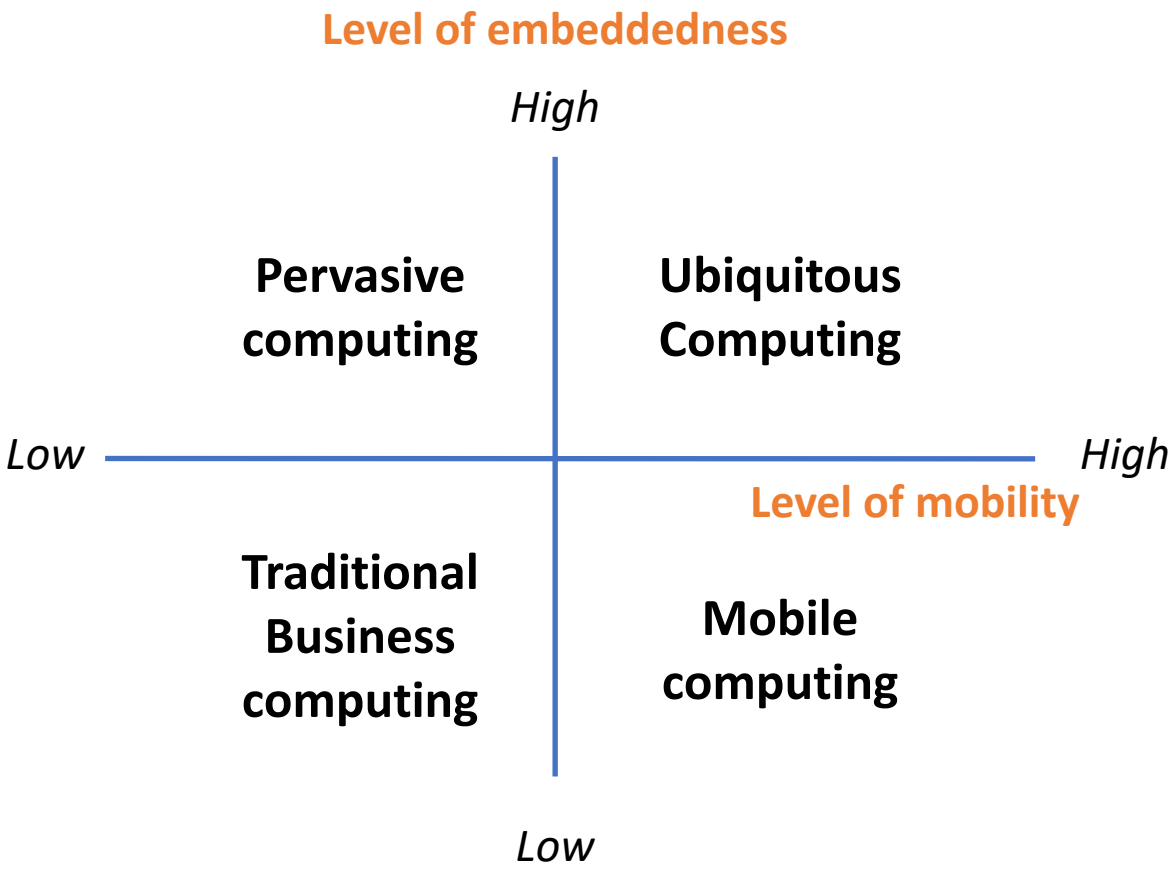
“21st century network”



WIRED AND WIRELESS NETWORKS link computers and allow their users to share programs and data. The computers pictured here include conventional terminals and file servers, pocket-size machines known as tabs and page-size ones known as pads. Future networks must be capable of supporting hundreds of devices in a single room and must also cope with devices—ranging from tabs to laser printers or large-screen displays—that move from one place to another.

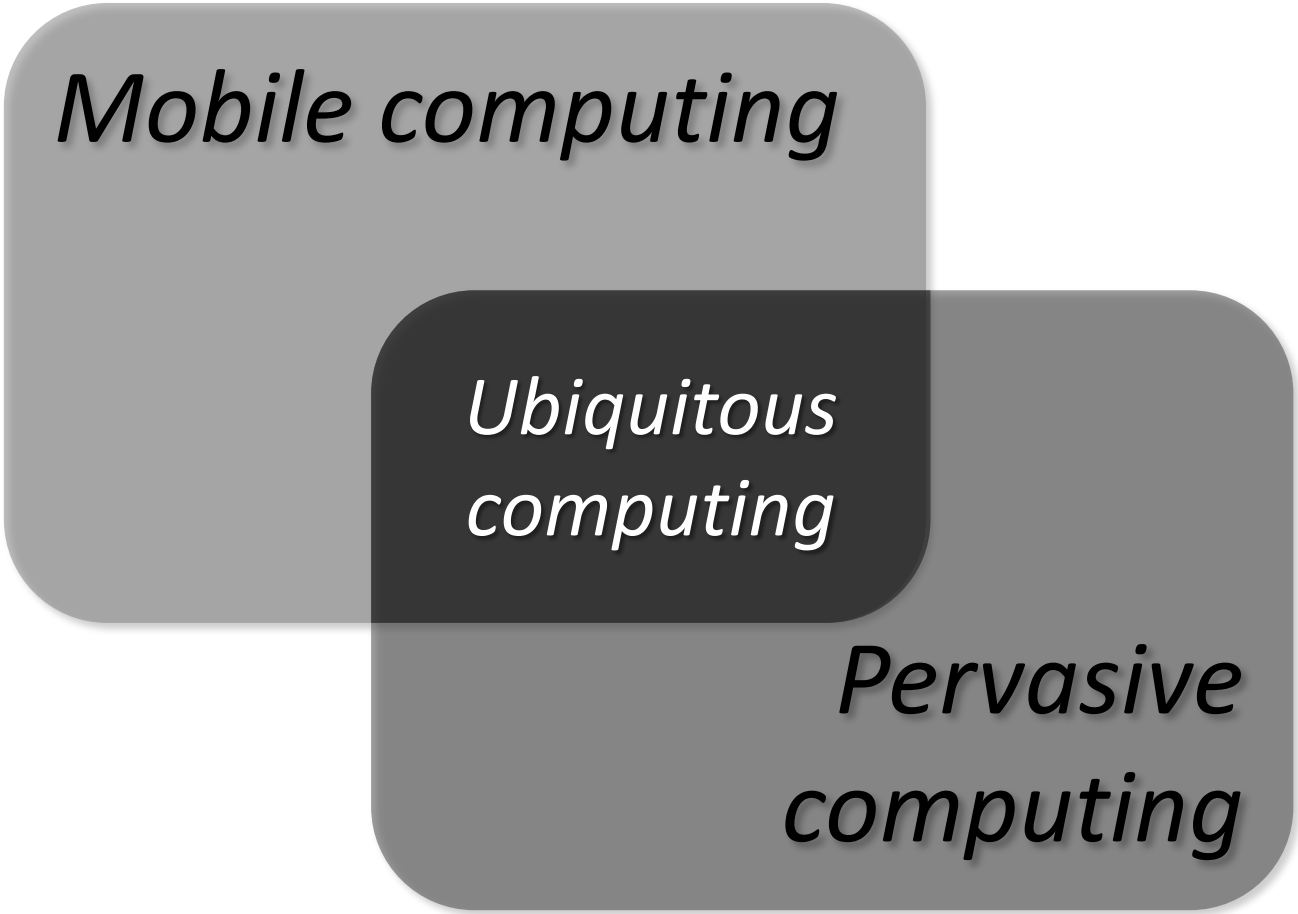
Mark Weiser , 1991

Ubiquitous computing



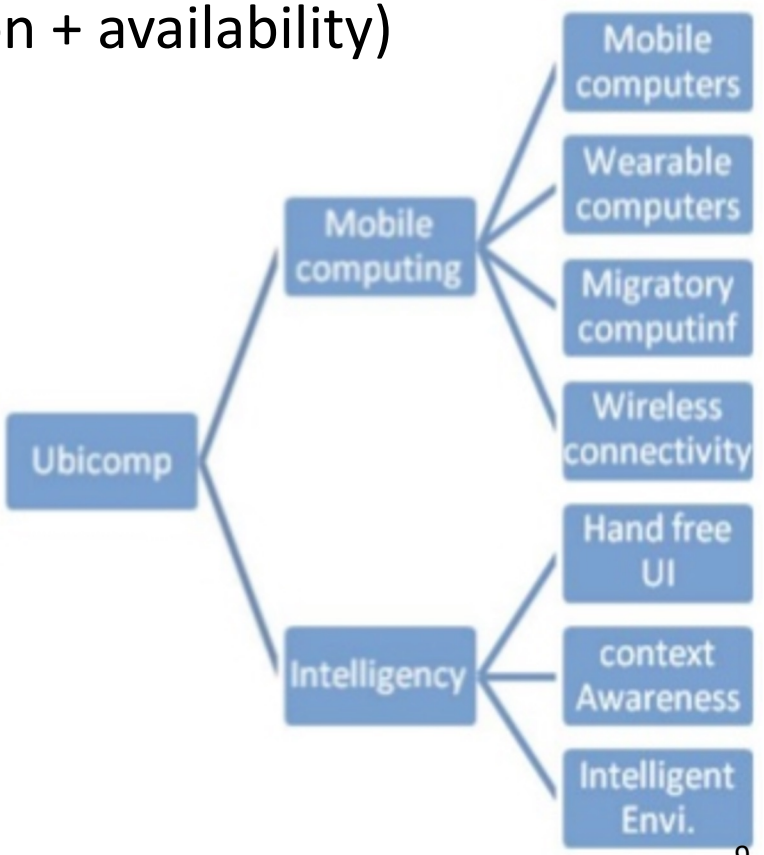
Source : Bob Hardian , 2011 (based on Lyytinen , 2002)

Ubiquitous computing



Ubiquitous computing

- Is the result of the evolution in other fundamental areas
  - Mobile computing
    - Provision of services regardless of location
  - Pervasive computing (disseminated computing) or Ambient intelligence (integration + dissimulation + availability)
    - Integration (embedded systems)
    - Contextualization
    - Customization
    - Adaptation to the environment
    - Anticipation/proactivity



Ubiquitous systems

- Needs in terms of supporting technologies:
  - Hardware
    - Miniaturization
    - Nanotechnology
    - Sensors (motion, temperature, proximity, …)
    - Biometric systems
    - Embedded systems
    - *smart devices*

Ubiquitous systems

- Needs in terms of supporting technologies:
  - Communication systems
    - Streaming
      - WLAN (Wi-Fi)
      - WMAN (WiMax)
      - WWAN (GSM, GPRS, UMTS, LTE, 5G,…)
      - Others (Bluetooth, IrDA , RFID, NFC, ZigBee , LoRaWAN ...)
    - Support Services
      - Protocols
      - Addressing
      - Name resolution
      - Searching for other devices
      - Security (authentication, access control, integrity, privacy…)

Ubiquitous systems

- Needs in terms of supporting technologies:
  - Location systems
    - Satellite
      - Global
        - GPS (Navstar) [USA]
          - A-GPS
        - Glonass [Russia]
        - Galileo [EU]
        - Beidou-3 [China]
      - Regionals
        - BeiDou , BeiDou-2 [China]
        - NavIC [India]
        - QZSS [Japan]
    - GSM
    - WiFi networks
    - Beacons , Bluetooth BLE, ...

    - "Trilateration" *(not triangulation!)*
      - Coordinates calculation based on information from at least 4 signal/information sources
        - Timestamp , Position of the satellite/GSM antenna, ...

Ubiquitous systems

- Needs in terms of supporting technologies:
  - User interfaces
    - Key point: Usability
    - Intuitive
    - Easy to use
    - Presentation of really important information
    - … *User Experience!!!*
  - Data security and privacy

Ubiquitous systems

- Difficulties (examples)
  - Interfaces
    - Screens with limited dimensions and resolutions
  - Limited resources
    - Storage
    - Processors
    - Energy autonomy
  - Communications
    - Connectivity
  - *Indoor/outdoor* location
  - Device heterogeneity

Mobile Architectures

Mobile computing

Pervasive computing