

Wireless

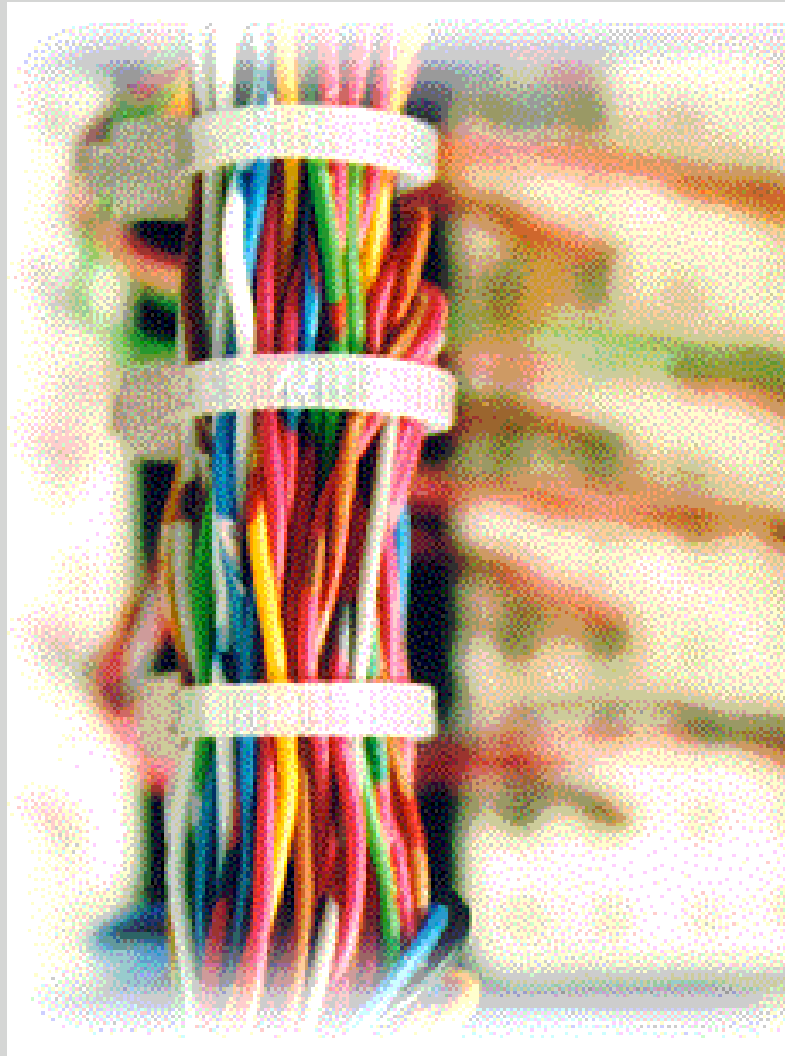
Exit the beige box

- Till now, computing has been about computers, boxes big or little
- Next, computing will be about connectivity
- Boxes will metamorphose or disappear entirely

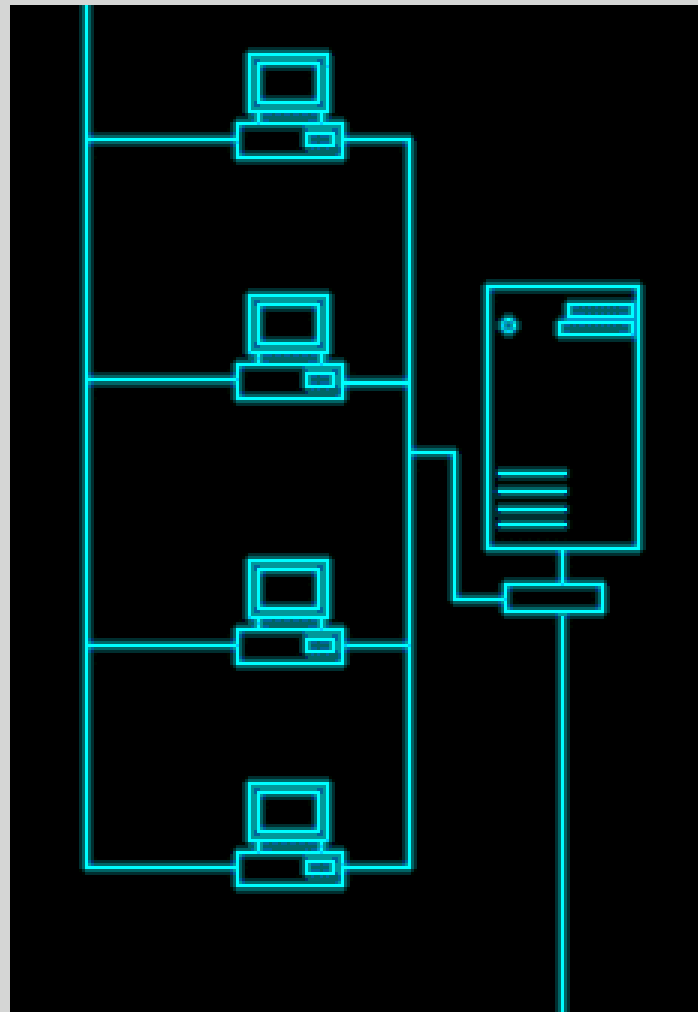


Connectivity, but mostly not fiber

- Over 90% of fiber now in place is “dark.”

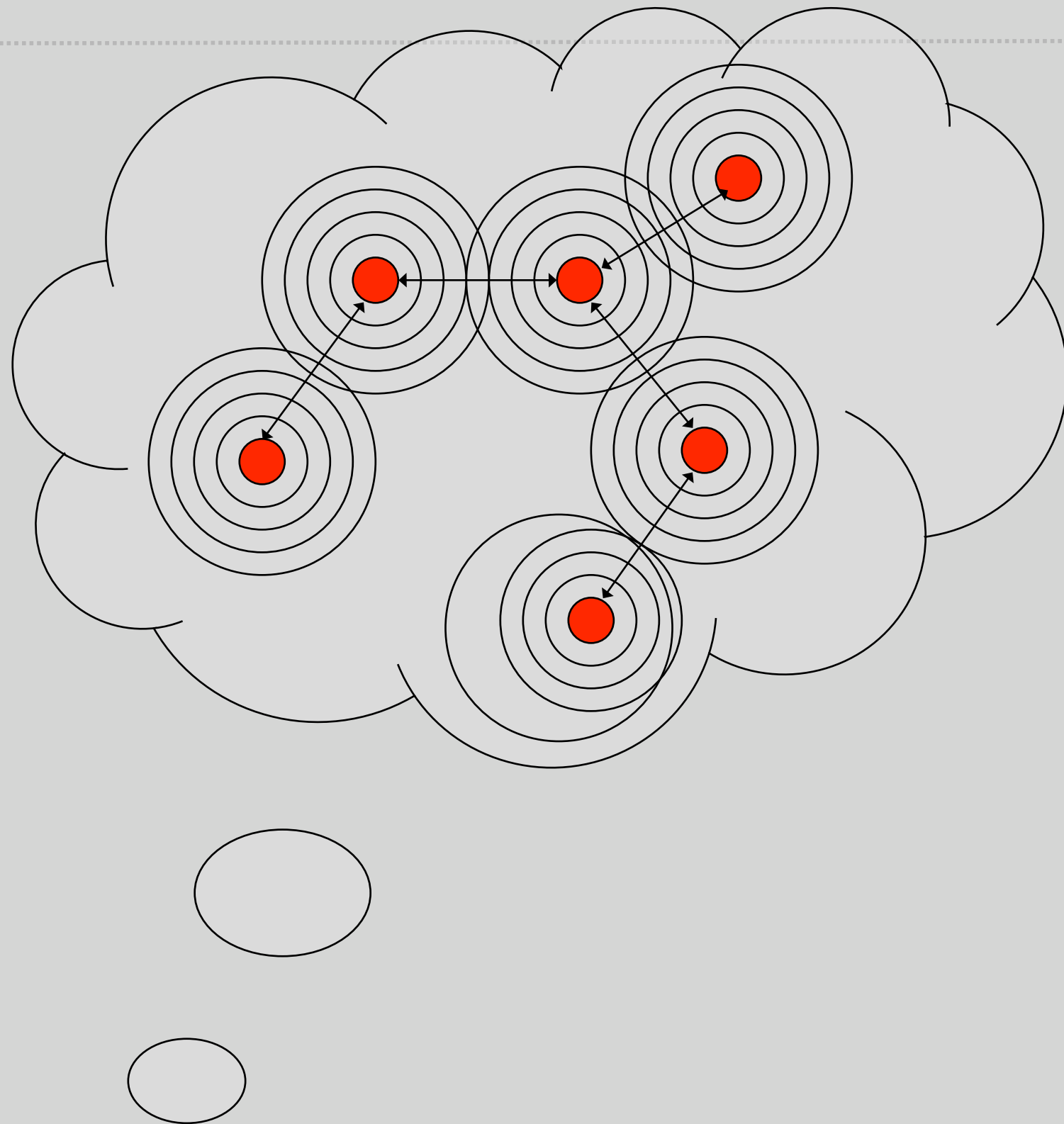


From this...



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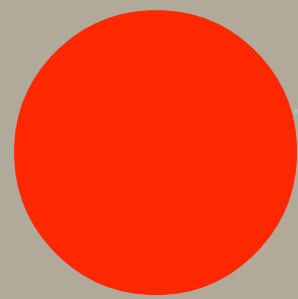
...to this



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Implications

- Technology
- Spectrum
- Transformation of manufacturing enterprises
- Public Policy
- Global coordination and standards
- Pervasive landscape of smart object
- New paradigm of integrating technology into lived experience
- New forms of social interaction



4G

- **1G [1981]: First-generation mobile offered voice-only handsets the size of small suitcases**



- **2G [1991]: SMS Messaging**



- **3G [coming now]:
Wireless communication
with voice and
multimedia on a compact
handset...still only
1Mbps**



Hi4™

NO WIRES. NO LIMITS.

Large, high-resolution LCD screen displays at 240 x 160 with 16 shades of gray.

Quality speaker plays MIDI ringtones for phone and alerts.

Glowing Push Wheel displays multi-color visual alerts and rotates for easy navigation.



ADDRESS BOOK: Make phone calls and send messages directly from your contact list.



TO DO: Track to-do items easily and stay organized.



CALENDAR: Manage your life with a rich calendar application.



DIGITAL CAMERA (Optional): Snap color photos and email them to family and friends.



Jump Button allows quick navigation and multi-tasking.

QWERTY keyboard with dedicated number keys and directional pad.

Accessory Port enables handsfree phone headset and camera accessory.



TELEPHONE: Full-featured mobile phone.



WEB BROWSER: Surf the Internet with native HTML browsing.



INSTANT MESSAGING: Chat and keep track of friends.



EMAIL: Send and receive email with PDF, Word and image attachments from up to three external accounts.

GET AWAY WITH IT!



Hi4™

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- 
- 4G [Latter part of the 1st decade]
-

- Fully wireless, networked, always-on, broadband multimedia interconnectivity, with mobile, wearable devices

First step: Bluetooth

- The original blue tooth



First step: Bluetooth

- Expect over a billion units by 2005
- Short-range radio links intended to replace the cables connecting electronic devices, or to allow communication between devices up to 30' to 40'
- Small, inexpensive embedded chips
- Ad hoc networks called piconets...each unit can communicate with seven other units per piconet
- Up to 10 piconets in 10 meter area...units connect and disconnect based on proximity
- Datarates fairly slow

Now: WiFi [802.11]

- Initially conceived to replace coaxial cables and remove the need to drill holes and string wires
- 802.11b Apple's Airport: typically 4 to 11Mbps going out 100' from the base station
- 802.11g: 54Mbps, more roaming, back compatible with "b"
- Hotspot: access point to WiFi service—fee or free
- Base station: connects individual units with LAN
- Bridge: connects two LANs
- Ad hoc mode: client setting that provides independent peer-to-peer connectivity

- "There's something just plain wrong about a city where you can find 100 open wireless networks in a half hour and not one public bathroom."



Intel a wireless driver, among others

- Intel's Banias line of chips have built-in Wi-Fi function and are to be installed in more than 20 million laptop computers shipped next year. 60 million computers with radio chips worldwide by the end of 2004.



War Driving



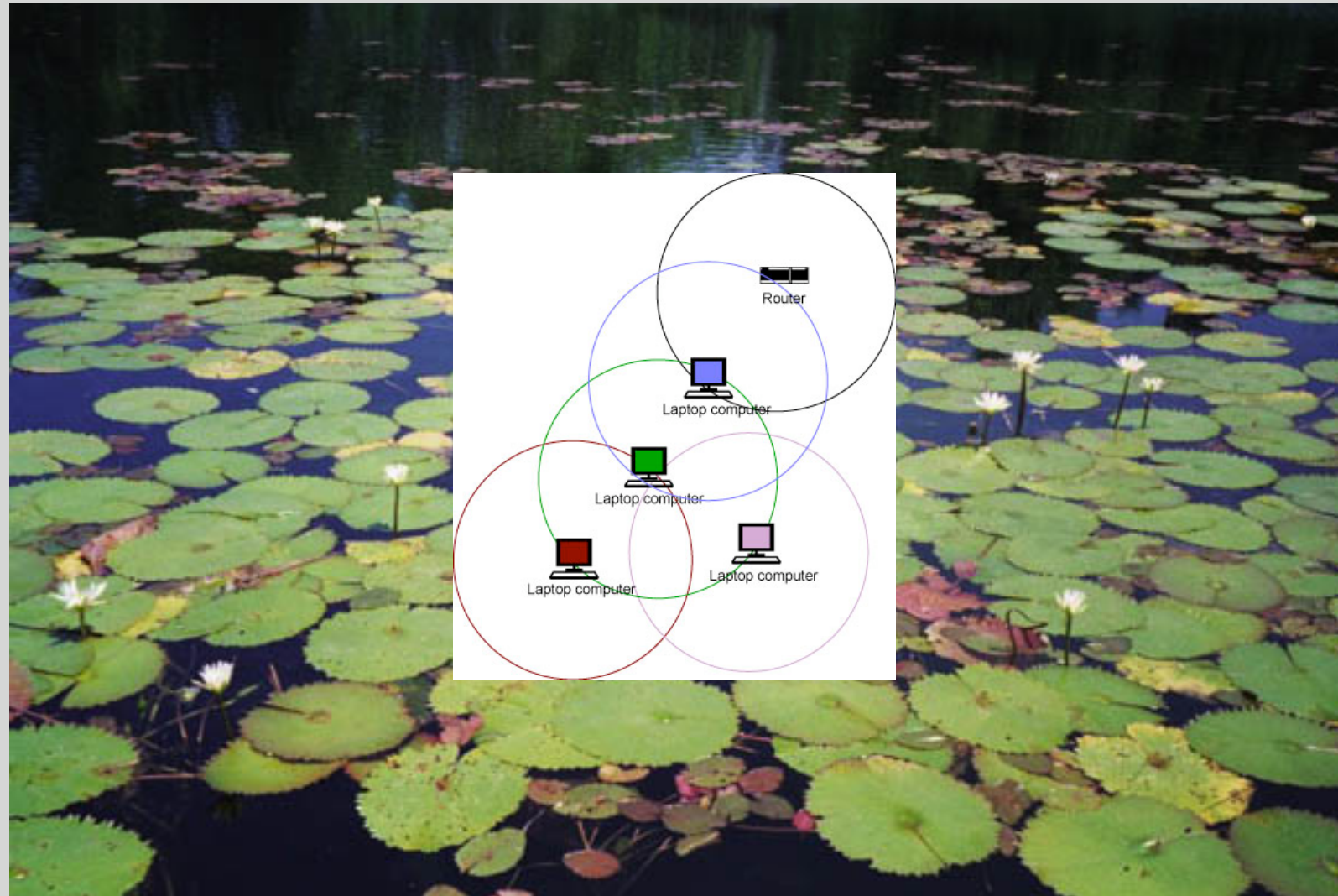
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Coming: UWB [Ultrawideband]

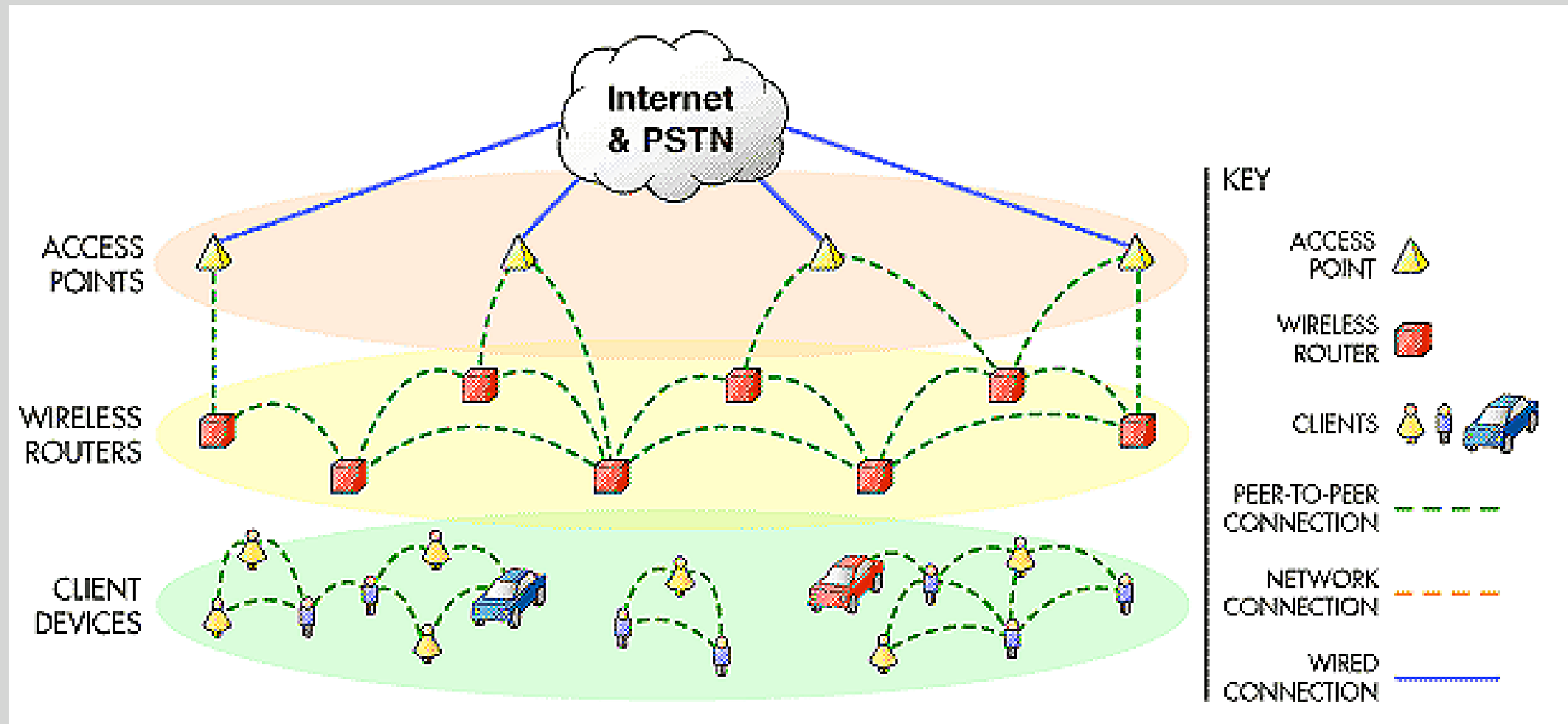
- Each Wi-Fi system will also act like a small router, relaying to its nearest neighbors. Messages can hop peer-to-peer, leaping from lily to lily like frogs — the stems are not required.
- P2P networks use direct connections between autonomous nodes at the edges. Data flows from one user to another, rather than through a central server

- 
-
- “Everything you assumed about telecommunications is about to change. Large wired and wireless telephone companies will be replaced by micro-operators, millions of which can be woven into a global fabric of broadband connectivity.” Nicholas Negroponte
- 

Frogs & Lillipads: P2P



Mesh Networks



Mesh Networks

- Does not use base stations to transmit with large numbers of end-users — the "point to multipoint" system. Instead, the nodes relay signals between each other, which means much fewer base stations are required
- Achieves nearly 100 per cent cover by turning each home into a mini base station. A stubby unit on the roof hides four directional antennas with motors that automatically align them with other antennas on other houses.

Mesh Networks

- Doesn't depend on a central authority to manage connections and store necessary data. It grows with each new node. Those nodes gain from the connection to a large network, but the network gains as well from what each node brings to the collective.
- By pushing intelligence and decision making to the edge of the network, highly mobile and scalable broadband networks can be built at very low cost
- Usually more use means poorer service; here the more the better

Mesh Networks

- Philadelphia will put hundreds [or thousands] of nodes on lamp-posts, making the entire city wireless.
- Boingo Wireless and Surf and Sip that are attempting to assemble networks of individual Wi-Fi "hot spots" around a region or around the country.
- Vivato's new antennas have a range of 7k outdoors, less inside indoors...new antenna/processor technology...directional beams of radio waves rather than large spherical coverage, so that it can follow a user walking with their laptop.

WiMAX [802.16]

- Promises 20 times speed of current Wi-Fi
- Hi-def TV signals throughout the home
- Installed in TV, mobile phone, handheld devices

Add in...Grid Computing

- An extension of the P2P idea, where networks link computers to create virtual supercomputers available to any contributor
- SETI: millions of users contribute unused cycles to help monitor space

UWB [Ultrawideband]

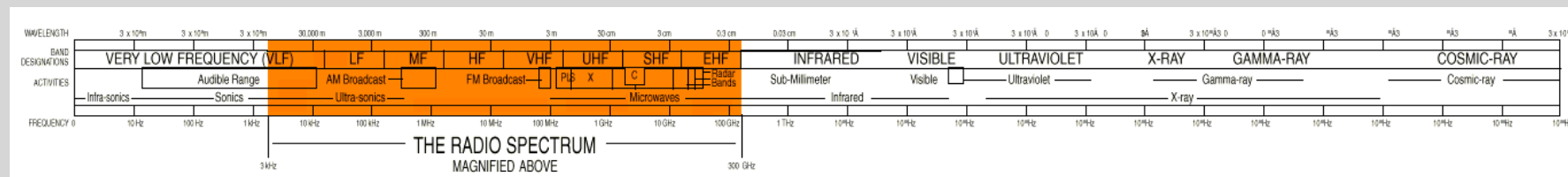
- More secure than the .11's
- Sends “pulses” within existing frequencies at so low energies that they should not interfere with other signals
- Can transmit vast amounts of data at high speeds
- Used for voice communications, “through the wall capability”, and ground penetration radar devices
- Approved in February 2001 by FCC for limited use
- Devices could operate on 1/1000th the power of devices that use radio waves – “making a wireless communicator the size of a quarter”

**“Spectrum is
the gold of the
early 21st
century.”**

Electromagnetic Spectrum

- The set of all possible frequencies (an infinite number) is called the "electromagnetic spectrum"
- The subset of frequencies from 3,000 cycles per second to 300 billion cycles per second is known as the "radio spectrum"

Electromagnetic Spectrum



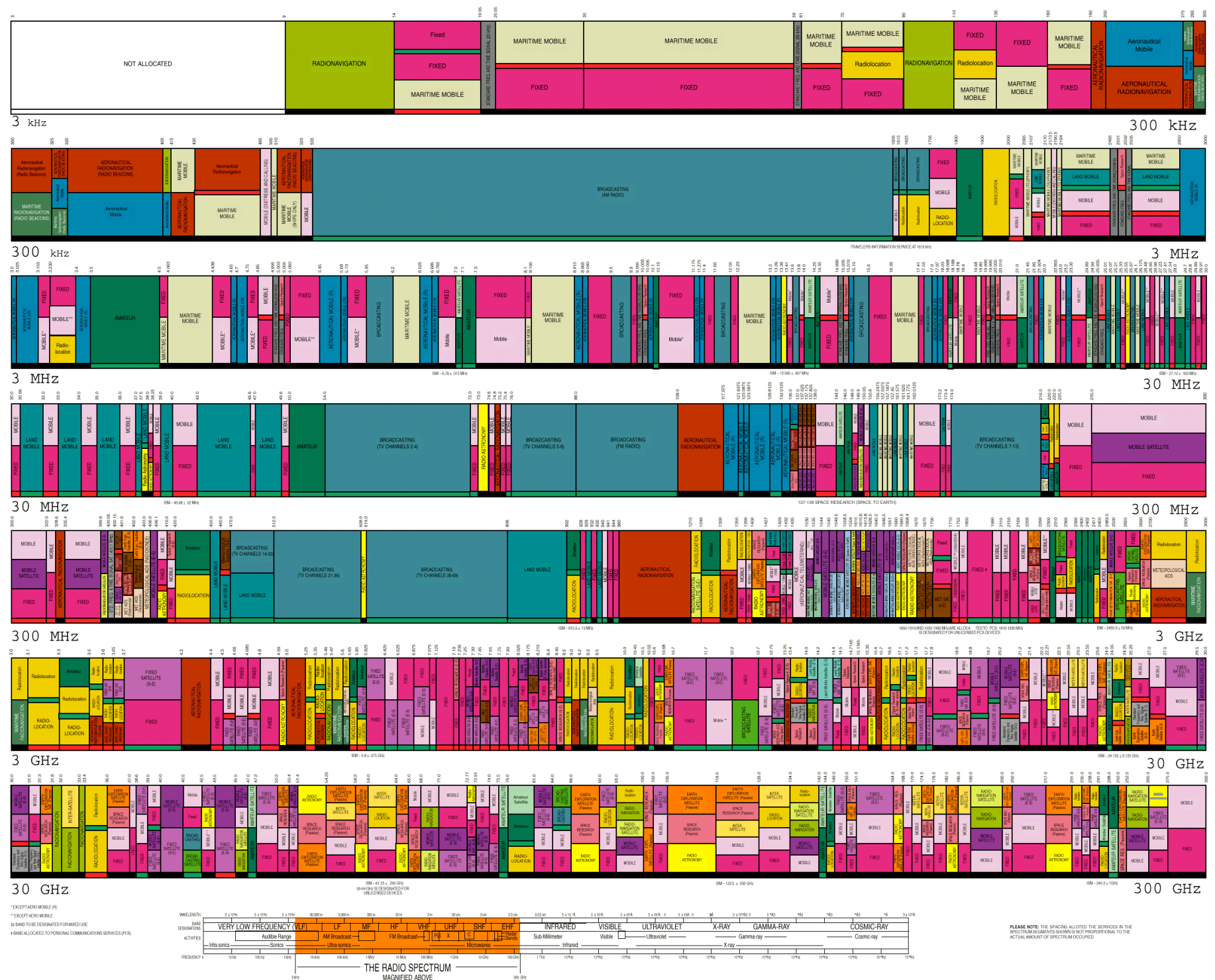
RADIO SERVICES COLOR LEGEND

 AERONAUTICAL MOBILE	 INTER-SATELLITE	 RADIO ASTRONOMY
 AERONAUTICAL MOBILE SATELLITE	 LAND MOBILE	 RADIO DETERMINATION SATELLITE
 AERONAUTICAL RADIONAVIGATION	 LAND MOBILE SATELLITE	 RADIOLOCATION
 AMATEUR	 MARITIME MOBILE	 RADIOLOCATION SATELLITE
 AMATEUR SATELLITE	 MARITIME MOBILE SATELLITE	 RADIONAVIGATION
 BROADCASTING	 MARITIME RADIONAVIGATION	 RADIONAVIGATION SATELLITE
 BROADCASTING SATELLITE	 METEOROLOGICAL AIDS	 SPACE OPERATION
 EARTH EXPLORATION SATELLITE	 METEOROLOGICAL SATELLITE	 SPACE RESEARCH
 FIXED	 MOBILE	 STANDARD FREQUENCY AND TIME SIGNAL
 FIXED SATELLITE	 MOBILE SATELLITE	 STANDARD FREQUENCY AND TIME SIGNAL SATELLITE

 GOVERNMENT EXCLUSIVE
  GOVERNMENT/ NON-GOVERNMENT SHARED

 NON-GOVERNMENT EXCLUSIVE

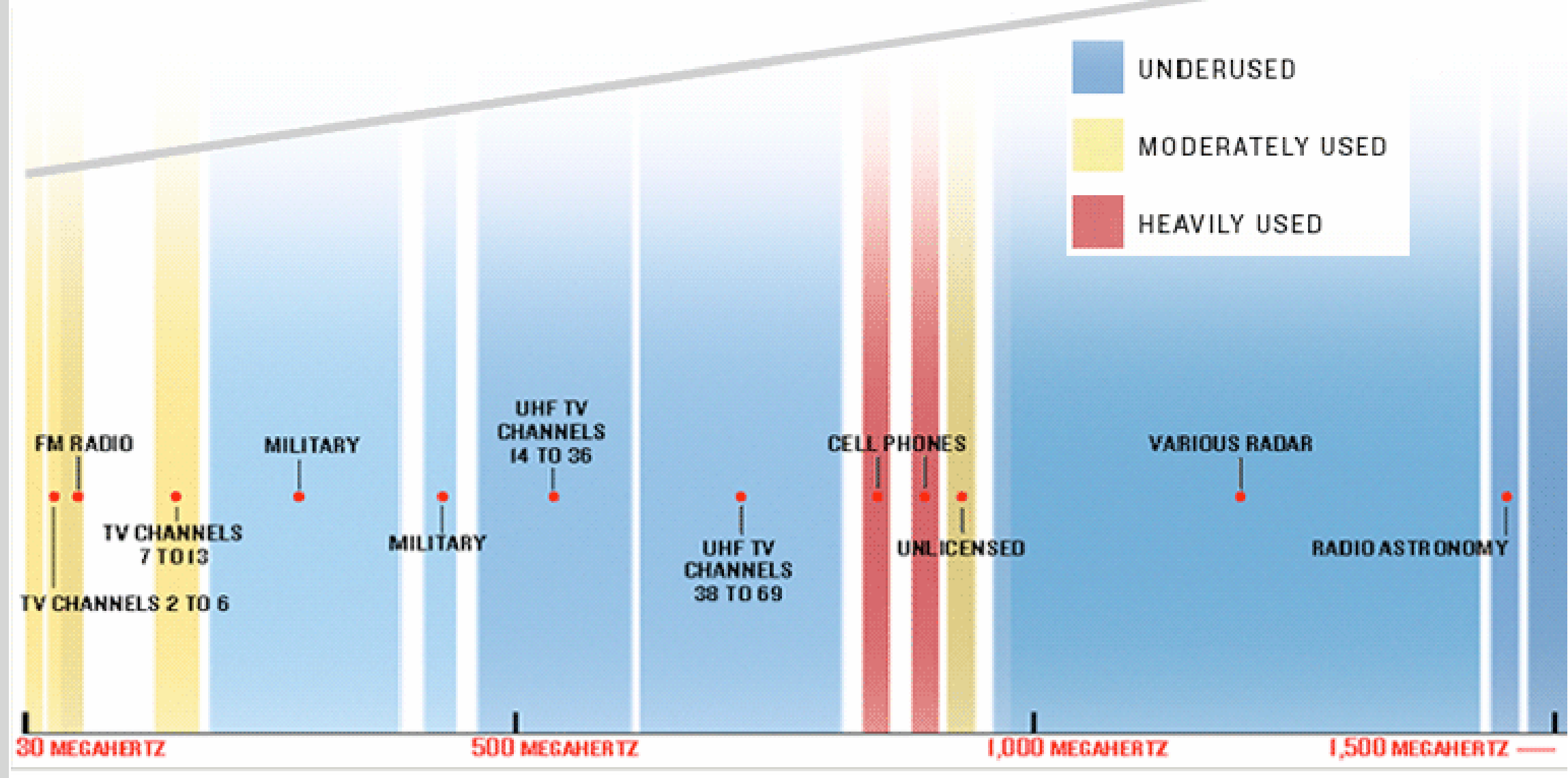
SERVICE	EXAMPLE	DESCRIPTION
Primary	FIXED	Capital Letters
Secondary	Mobile	1st Capital with lower case letters
Permitted	/BROADCASTING/	Capital Letters between oblique strokes



PLEASE NOTE: THE SPACING ALLOTTED THE SERVICES IN THE SPECTRUM SEGMENTS SHOWN IS NOT PROPORTIONAL TO THE ACTUAL AMOUNT OF SPECTRUM OCCUPIED.

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Only certain radio signals have the ability to easily penetrate walls and travel long distances at low power—together these frequencies are comprised in a precious—and limited—natural resource known as the prime radio spectrum. The prime spectrum is divided up between FM radio, TV, cell phones, radio telescopes and dozens of other uses. Yet most spectrum is empty most of the time. UHF television retains a frequency band big enough for 55 channels, though few cities have more than a couple, and those are rarely watched. Meanwhile, cell phones and unlicensed bands are packed to the bursting. The prime spectrum is on the low end of the larger electromagnetic spectrum. Higher frequency signals are also valuable, but typically confined to uses where signals travel in a straight, unobstructed line—like satellite TV.



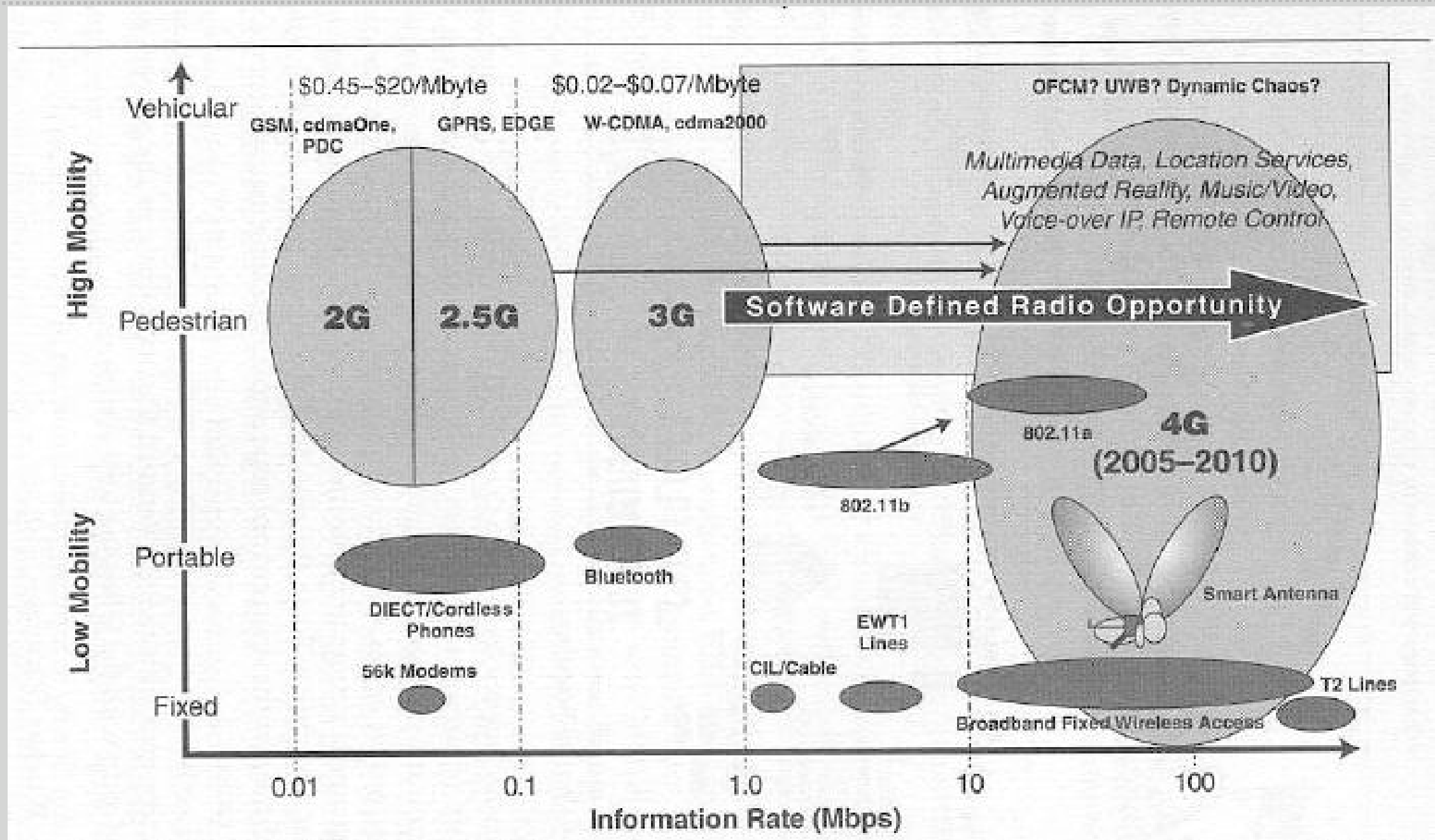
- Open Spectrum

Open Spectrum

- “In an open spectrum world, wireless transmitters would be as ubiquitous as microprocessors: in televisions, cars, public spaces, handheld devices, everywhere. They would tune themselves to free spectrum and self-assemble into networks. Anyone could become a radio broadcaster reaching millions. Phone calls would rarely need to pass through central networks; they would be handed off and relayed across devices, for free or nearly so. Businesses would track far-flung assets in real time via embedded sensors. Big TV networks and cable operators would lose their hammerlock control over media distribution. Entrepreneurs would develop as yet undreamed of applications that we can't live without.” Kevin Werbach

Add to that: Software Defined Radio

- Replaces analog radio circuitry with digitally generated samples of radio waveforms—digitally generated samples of radio waveforms.
- Smart radio receivers that can determine instantaneously when and where a bit of spectrum is going unused and switch their communications accordingly to avoid interference

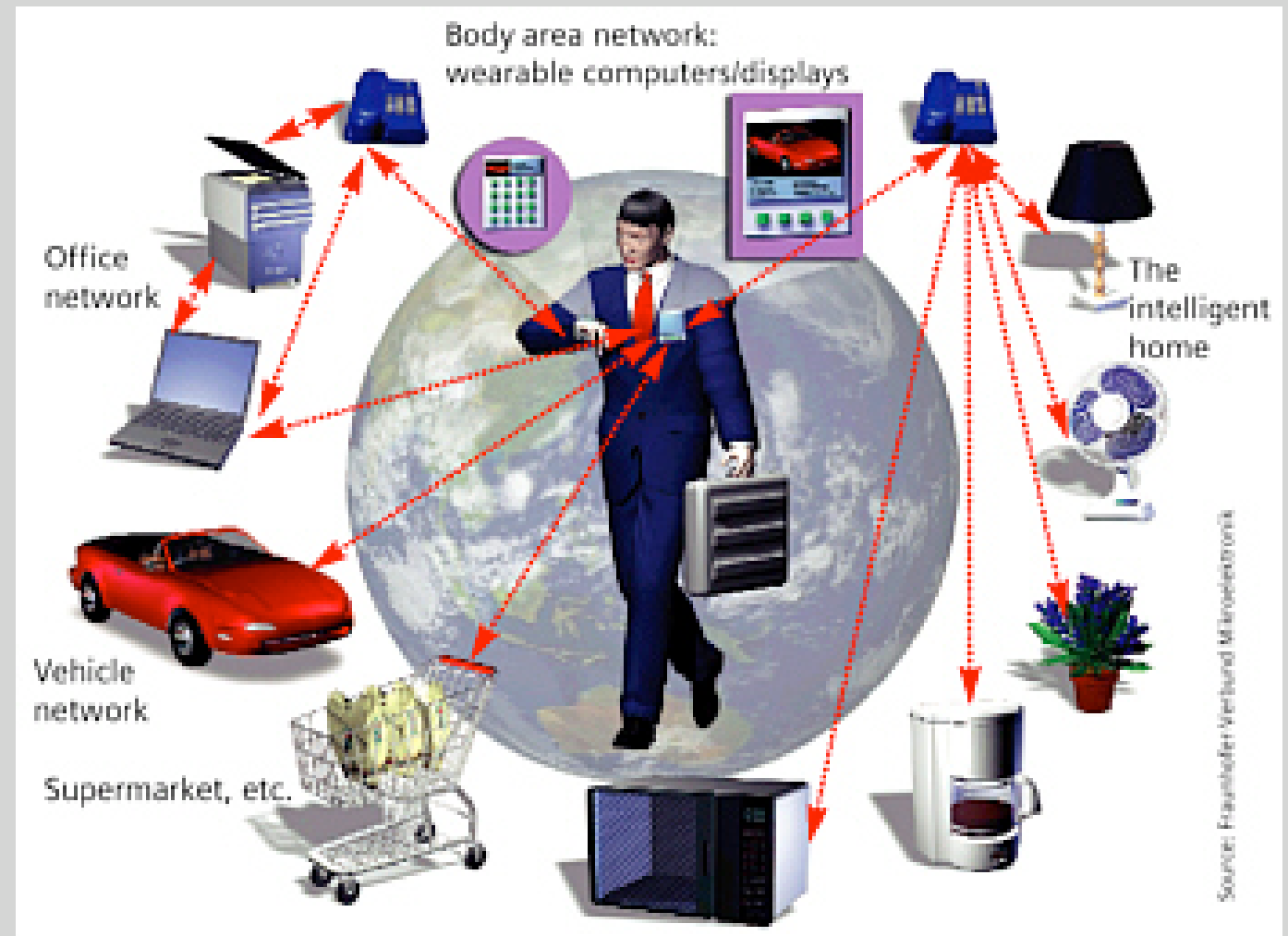


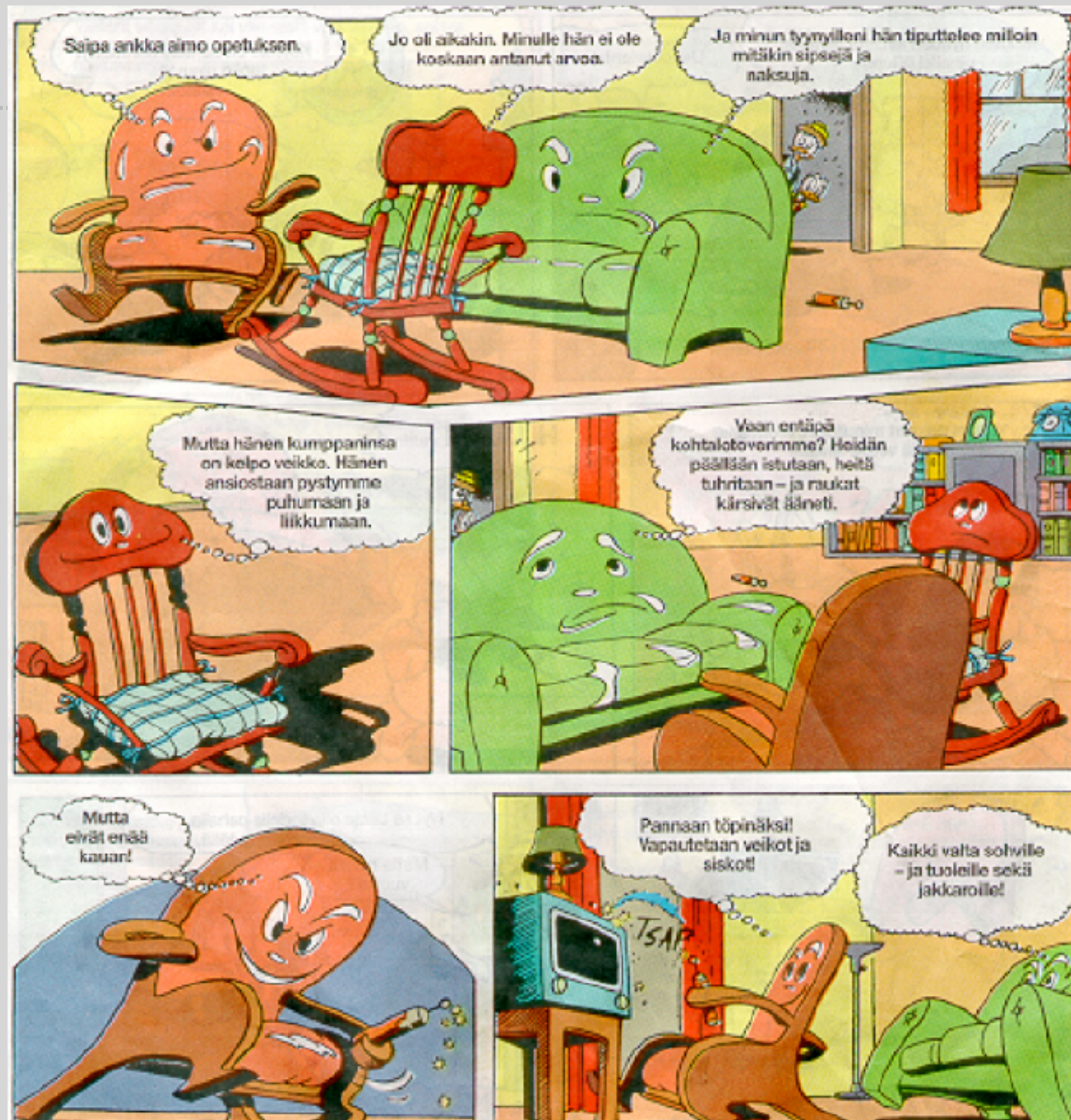
And then: Ubiquitous computing

- Coined by Weiser early 90's. Computers as we know them will disappear, giving way to many small computing devices embedded in everyday objects, all networked together
- Unconscious interface
- Smart objects
- Tech-u-wear

Three eras

- Mainframe: one computer, many people
- PC: one computer, one person
- Ubiquitous computing: one person, many computers





Wireless will mean wearable: VR





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Discussion

- It's the "wires" stupid: from computers to connectivity
- Always on, anywhere
- Smart objects
- Interoperability
- Ad hoc networks
- Environment becomes a computational/communicative field
- Context awareness



Discussion

- Control revolution: micro-sensors
- Transformation [disappearance] of the "interface"—but don't write off the screen just yet
- Changing patterns of social organization and power—distributed, edge cultures vs centralized centers?
- Going inside computers and multiplying computers around us



Discussion

- Being able to find anything...and always able to be found
- Two centers of gravity: center [.net] and edge [P2P]
- Spectrum scarcity or spectrum plenty
- Technological, sensing grid superimposed over (and mostly superceding) the natural world
- Mediated sociability

Discuss



- Personalized micro-networks
- Macro-network: "All your base are belong to our..." global grid
- Changing patterns of geo-regional technological development [stragglers, evolvers, leapers]
- Digital convergence > medium convergence > appliance convergence
- Industrial shock—can current enterprise organization accommodate such change?



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