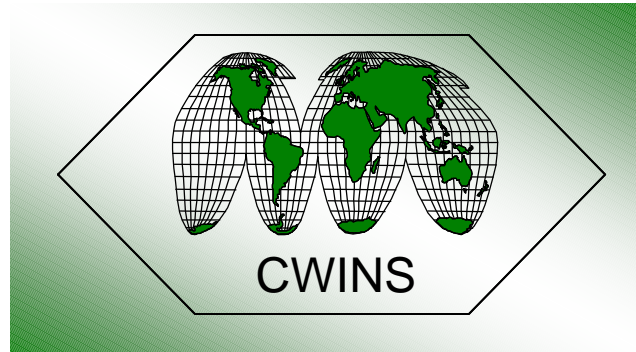


Center for Wireless Information Network Studies



Future Directions in Home Networking

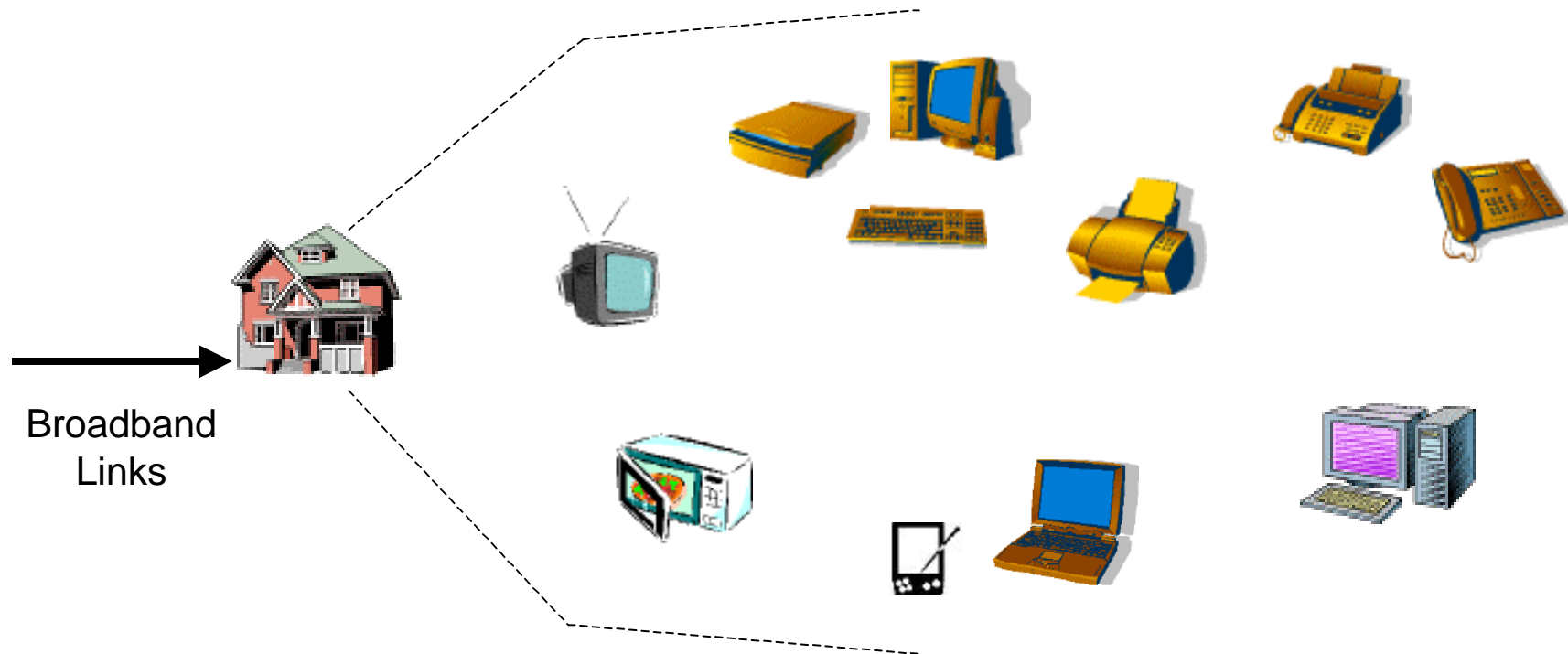
K. Pahlavan, X. Li, and J. Beneat

Outline

- What is a home network ?
- Existing wired and wireless alternatives
- Direction and challenges



What is Home Network?

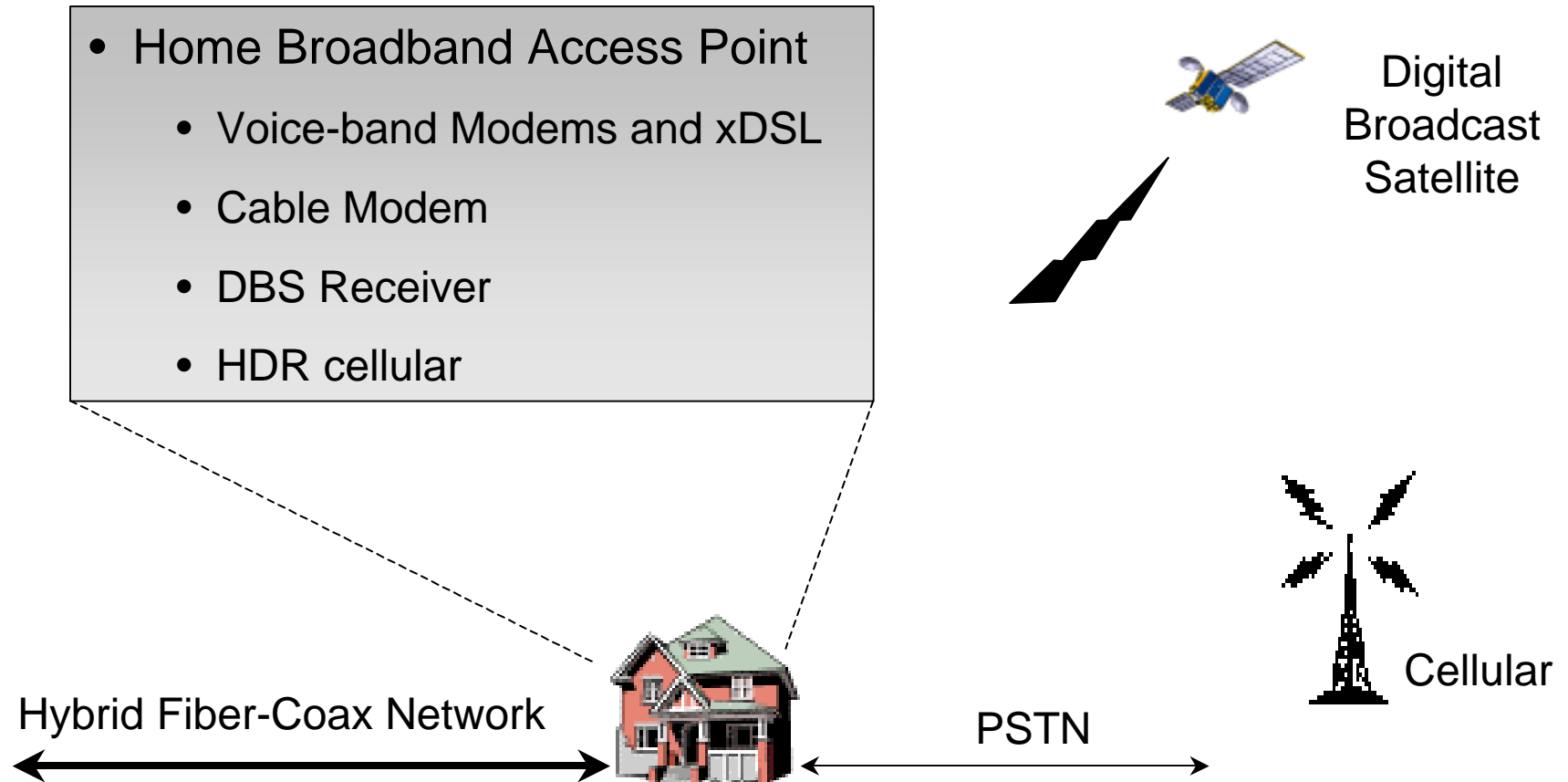


- Home networking enables intercommunication and sharing of multimedia content and broadband services among a variety of devices anywhere in and around the home.



Broadband Home Access Alternatives

- Home Broadband Access Point
 - Voice-band Modems and xDSL
 - Cable Modem
 - DBS Receiver
 - HDR cellular



Why do I need home networks ?

- I want to share my home broadband access between the PC's in the home and my laptop.
- I hate to connect all those wires in the back of my stereo system.
- I want video/audio streaming from web.
- I would like to be able to manage some of my home works from outside (office, car, etc)
- I want utility companies to check the fault in my appliances and read.

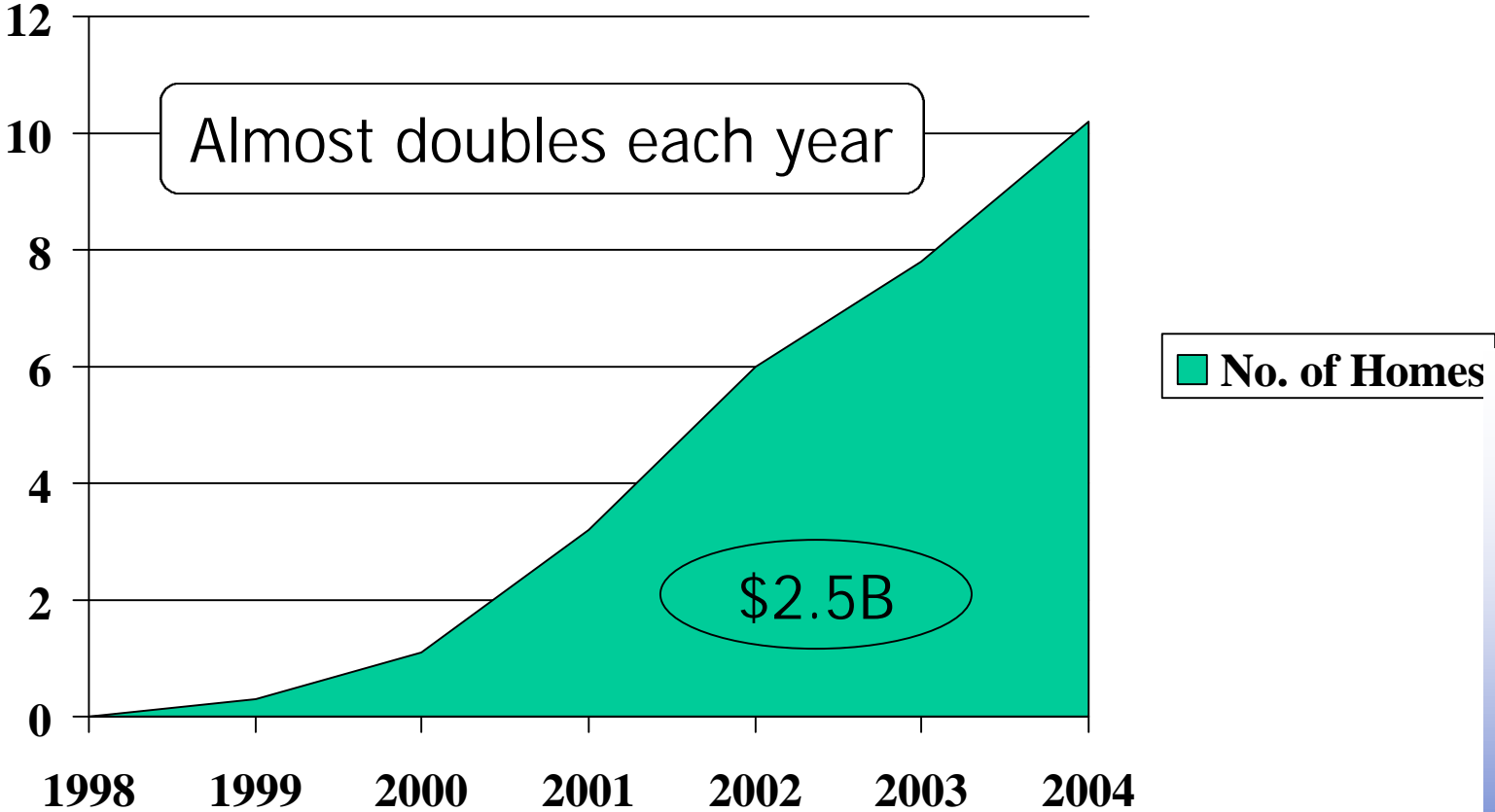


Why companies want to get into home networks ?

- 80% of US house holds will have a broadband data access by the year 2002
- More “information appliances” will be sold than PCs by the year 2002
- To interconnect PC’s and information appliances to the broadband services, 10 million home networks will be installed by the year 2004



Networked Homes (M)

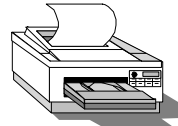


Home Networking Applications



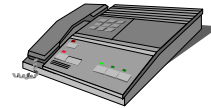
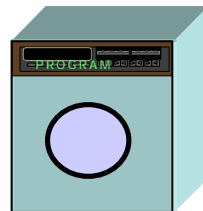
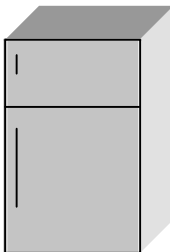
Home Computing

Desktop computer
Laptop
Printer
Scanner
QuickCam



Smart appliances

Oven(s)
Fridge(s)
Washing machine(s)



Phone appliances

Standard phone
Inter Comm
Cordless phone



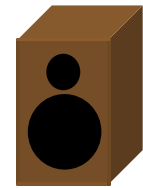
Security Systems

Motion detectors
Door pins
System control unit
Camera
Alarm



Entertainment Audio/Visual appliances

Analog/Digital TV
VCR / DVD
Camcorder
Stereo system
Speakers / Headphones



Utility metering

Electricity
Gas
Fuel
Water



Location / Navigation

locating children
fencing pets
navigating handicaps



As Compared with Offices

- Expected market for service providers is much larger
- Number of devices are much larger
- Bandwidth requirements are more diversified (from multi-channel video up to monthly meter reading)
- Includes new applications such as positioning/navigation and audio/video broadcasting
- It must be plug-and-play, no net-manager
- Number of users of the network are much smaller
- Coverage area is smaller
- Building infrastructure for network planning is different



Criteria for Home Networks

- Consumer Requirement
 - Low cost
 - Plug-and-Play
 - Avoid new wiring
 - Easy to install and upgrade
 - Easy to manage/maintain
- Performance Requirement
 - Comprehensive coverage
 - Support of high speed multimedia applications
 - Accommodation of legacy Voice/Video/Data services
- Network Requirement
 - Flexible to accommodate variety of bandwidth and priorities
 - Scalable to support the growth of the network
 - Easy to reconfigure to accommodate relocations
 - Secure and private to avoid neighbor access.



Existing Solutions

- Wired LANs (different versions of Ethernet)
 - Have inexpensive cards
 - Support high speeds upto Gbps
 - Support thick cable, thin cable and TP wirings
- Wireless LANs (802.11, Bluetooth, etc)
 - Chip sets are available at reasonable costs
 - Supports reasonable data rates
 - Ideal to support relocations and mobile applications



Problems with Ethernet at Home

- If the existing TPs are used with existing Ethernet cards it interferes with analog voice and xDSL.
- If existing cables for TV are used with existing Ethernet cards it will interfere with TV.
- If broadband technology is used with the cable for TV the cost of the modem is very high and coverage is not good.
- Installation of new TP or cable is expensive and not desirable for consumer.
- *Therefore, we need another alternatives.*



No-New Wiring Alternatives

- *Phoneline using HPNA* (1 – 10 Mbps)
- *Power Lines* (10 Mbps)
- Coaxial Cable (10 Mbps)



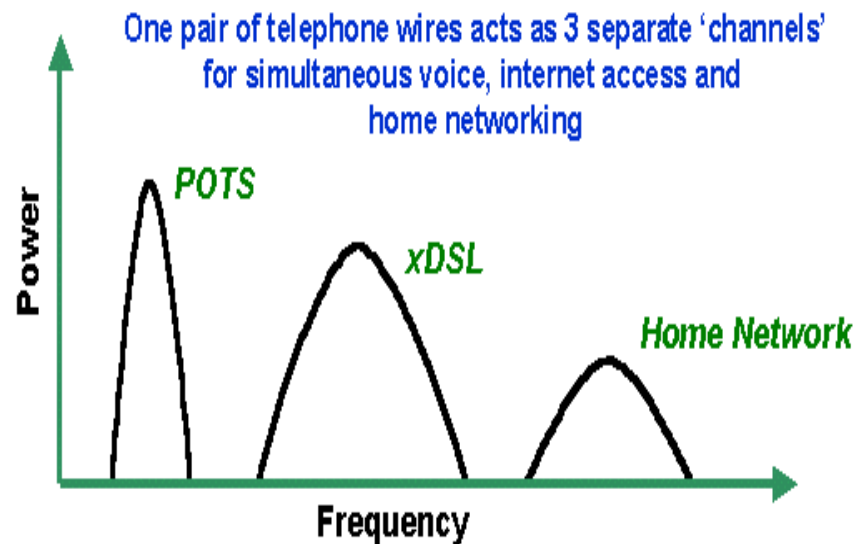
HomePNA

- Why HPNA instead of IEEE 802.3?
 - To tolerate random and unspecified wiring topology at home.
 - To coexist with POTS and xDSL services.
 - To cope with high-noise condition over home phonline.
- What is HPNA ?
 - An Ethernet-compatible LAN over random-tree Phonline
 - Uses a stand-alone adapter to connect any device having an Ethernet 10Base-T interface directly to the in-home telephone jack.
 - Uses IEEE 802.3 CSMA/CD in MAC Layer to accommodate existing Ethernet software and hardware.
 - Uses a patented physical layer to accommodate the requirements



Spectral Compatibility of HomePNA

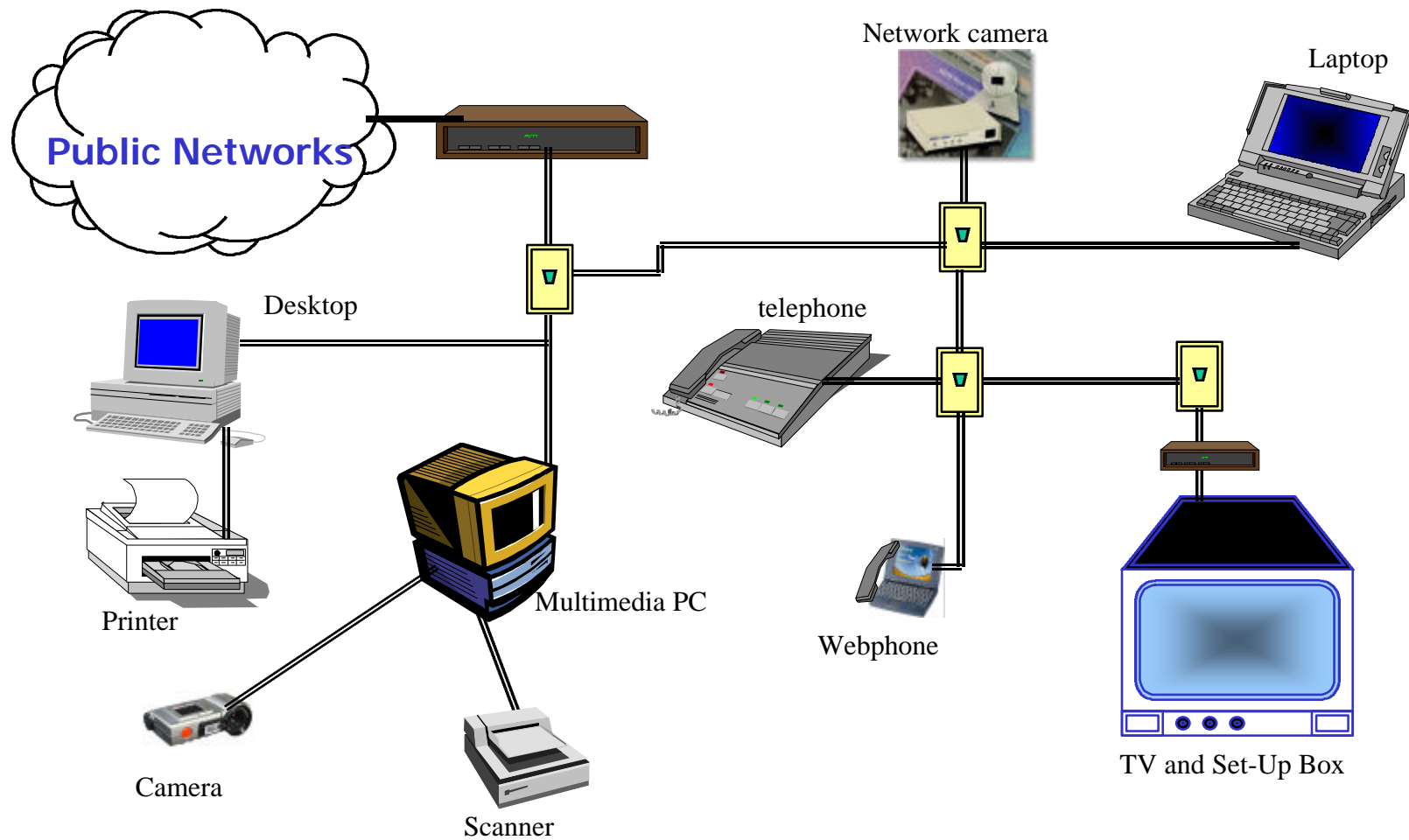
Compatible with Voice and xDSL



- POTS: 20 Hz – 3.4 kHz
- xDSL: 25 kHz – 1.1 MHz
- HomePNA: 2 MHz – 30 MHz



Home PNA



Power Lines

- Why Power Lines ?

Comprehensive wiring coverage in all homes

Historically used for low data rate (< 100 kbps) control and security networks operating below 500 KHz (X-10, CEBus/CAL and Lonworks).

Smart appliances have emerged in the market that have some built-in intelligence, can sense other appliances on the power lines, and can be accessed through the Internet

High data rate (> 1 Mbps) products have emerged in the market that operates above 1 MHz for home computing (no clear standard initiative)

- Problems to overcome

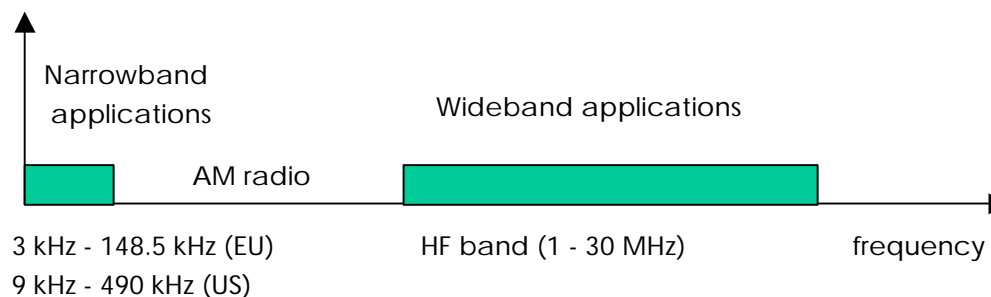
Integration of the various power lines networks at different frequencies

Tremendous interference from electrical appliances, high attenuation, varying input impedance and multipath phenomena

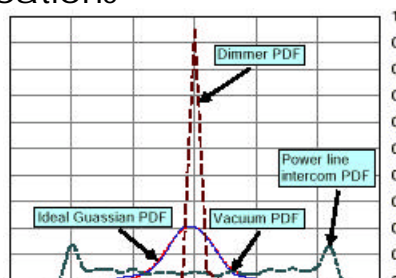
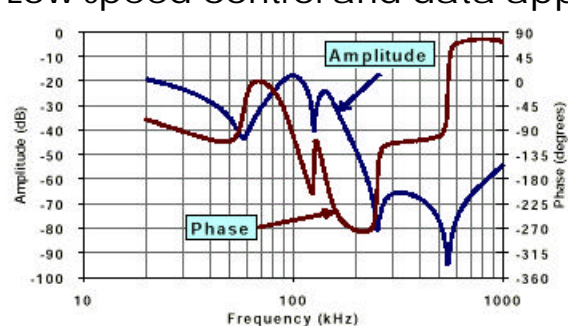




Power Lines Technology

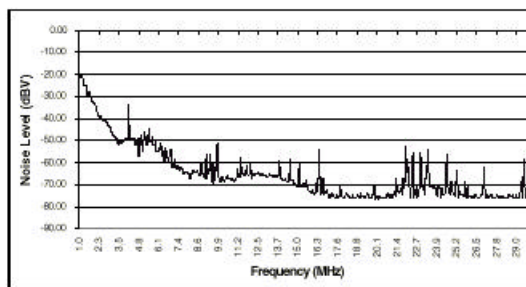
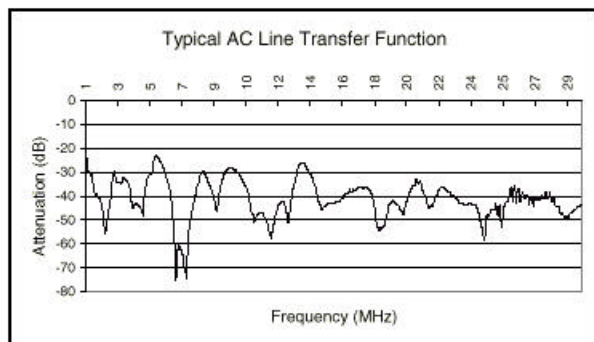


Low speed control and data applications



Transmission Techniques:
 FSK, QPSK, Dual carrier BPSK
 Spread Spectrum: DSSS, HFSS, Chirp
 Access Methods:
 CSMA

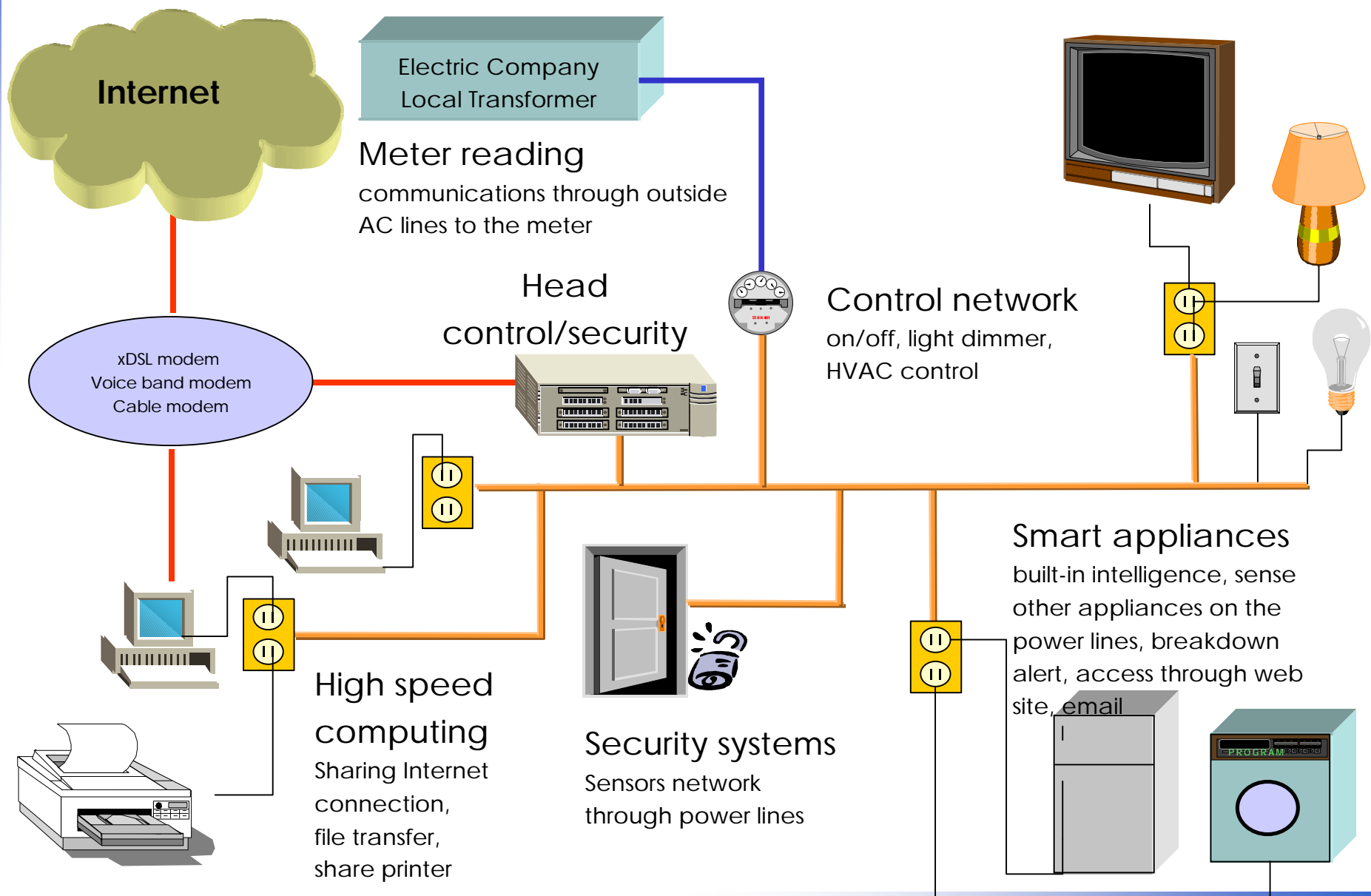
Evolving high speed data applications



Transmission Techniques:
 FSK (Intellogis)
 OFDM (Intellon)
 Access Methods:
 DSMA/CTP (Intellogis)
 CSMA/CDCR (Intellon)



Power Lines Potential Applications



Limitations of Wired Approach

- Common Drawbacks:
 - No mobility support.
 - Limited coverage due to high attenuation in signal.
- Power-line Home Networking
 - Proprietary technologies, not standardized.
 - Suffers from electrical noise (almost anything with an electrical motor can cause problems).
- Phone-line Home Networking
 - Limited number of phone jacks per home.
 - Inappropriate location of phone jack for home networking.
- Cable Home Networking
 - Limited number of connecting point per home



Wireless LAN Standards

Parameters	IEEE 802.11	IEEE 802.11b	IEEE 802.11a	HIPERLAN/2	HIPERLAN/1
Status	Approved, Products	Final ballot, Nov'99, Products	In preparation In preparation		Approved, No products
Freq. Band	2.4 GHz	2.4 GHz	5 GHz		5 GHz
PHY, modulation	DSSS: BPSK, QPSK FHSS: GFSK	DSSS: BPSK, QPSK, CCK	OFDM		GMSK
Delayspread robustness	1, 2 Mbps: 200-400 ns 11 Mbps: 20-60ns Fallback mechanism		12 Mbps: 350 ns 36 Mbps: 125 ns		unknown
Datarate	1, 2 Mbps	1, 2, 5.5, 11 Mbps	6, 9, 12, 18, 24, 36, 54 Mbps		23.5 Mbps
Access method	Distributed control, CSMA/CA Or RTS/CTS			Central control. Reservation based access, scheduled by Access Point	Active contention resolution, Priority signalling

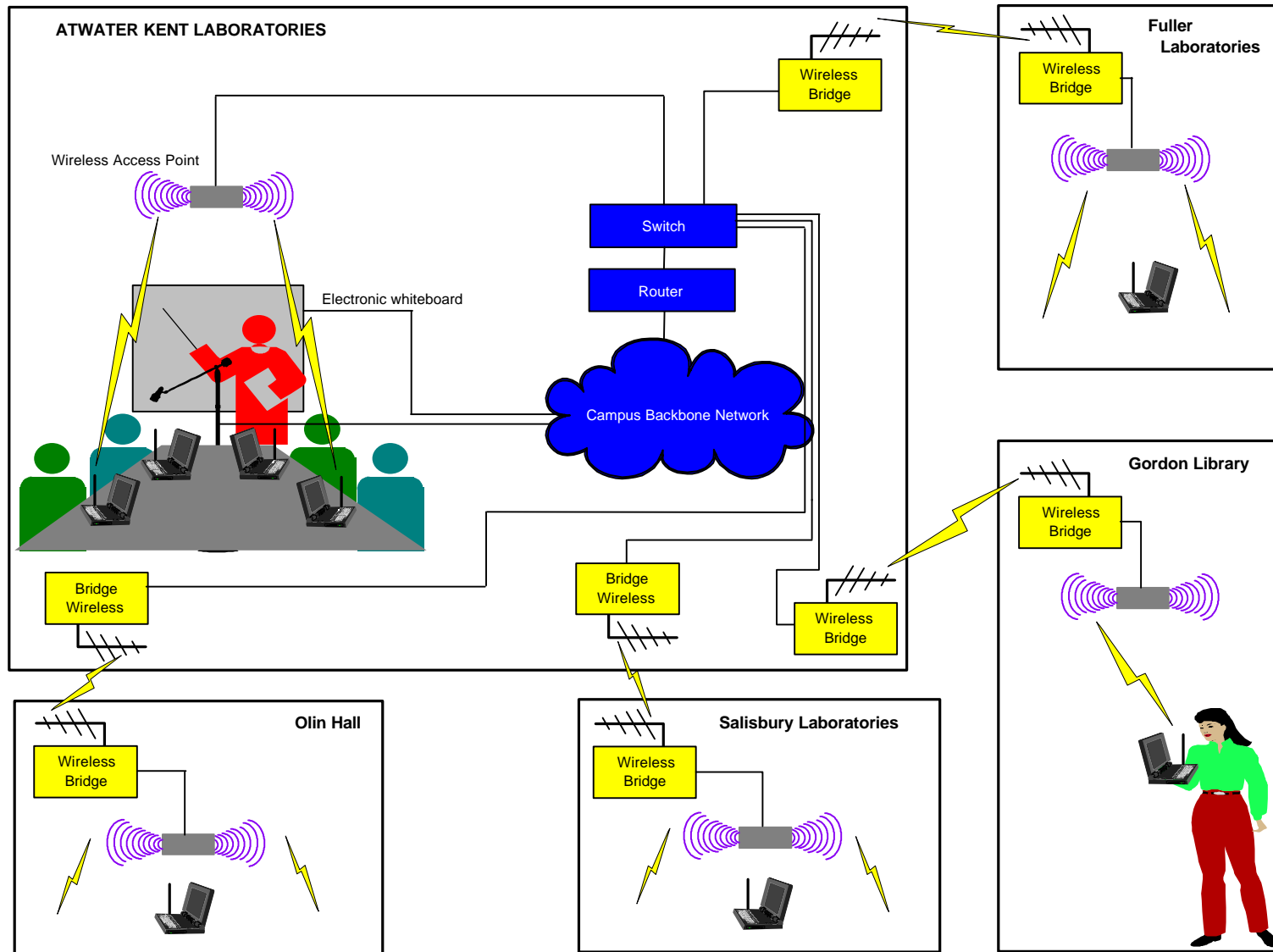


Wireless Alternatives

- IEEE 802.11/HIPERLAN (2-54Mbps)
- Bluetooth (1 Mbps)
- IEEE 802.15 WPAN (1, 20 Mbps)
- HomeRF (1 Mbps, 2 Mbps)
- Proprietary Home Networking Systems
 - Proxim (1.6 Mbps)
 - Sharewave chip sets



Wireless Campus Area Network (W-CAN)

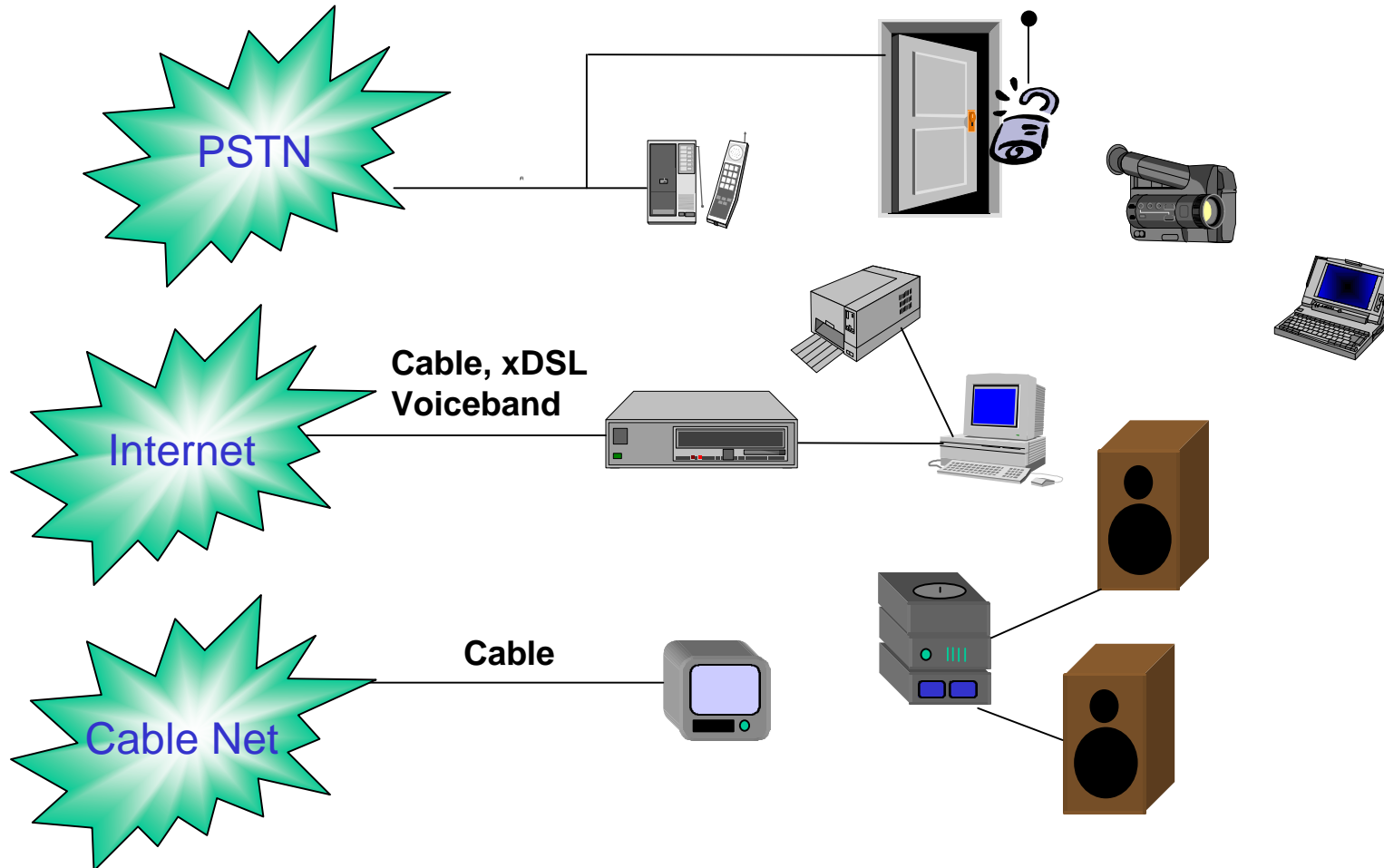


Wireless at Home

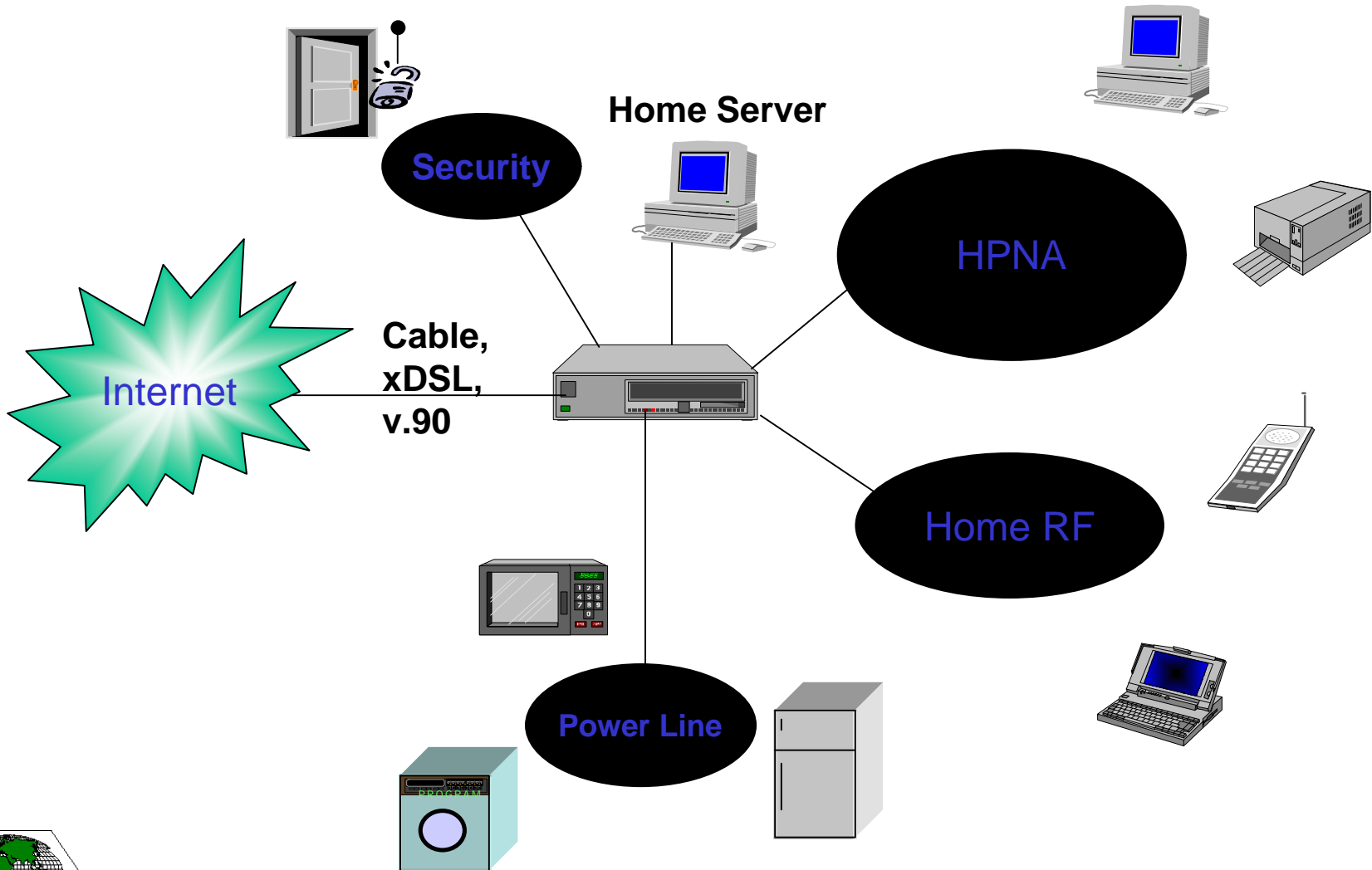
- Incentives for wireless solution:
 - Wireless networking is the natural solution for portable appliances (laptops, video/digital camera, cordless phones, remote control, etc)
 - Wireless provides a plug-and-play-”anywhere” solution
- Challenges for wireless solution:
 - Data rate
 - Coverage
 - Interference
 - Cost



Today's Fragmented Home Networks



Evolving HAN (Home Area Network) Products



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