



A presentation for the IEEE based on a report by:



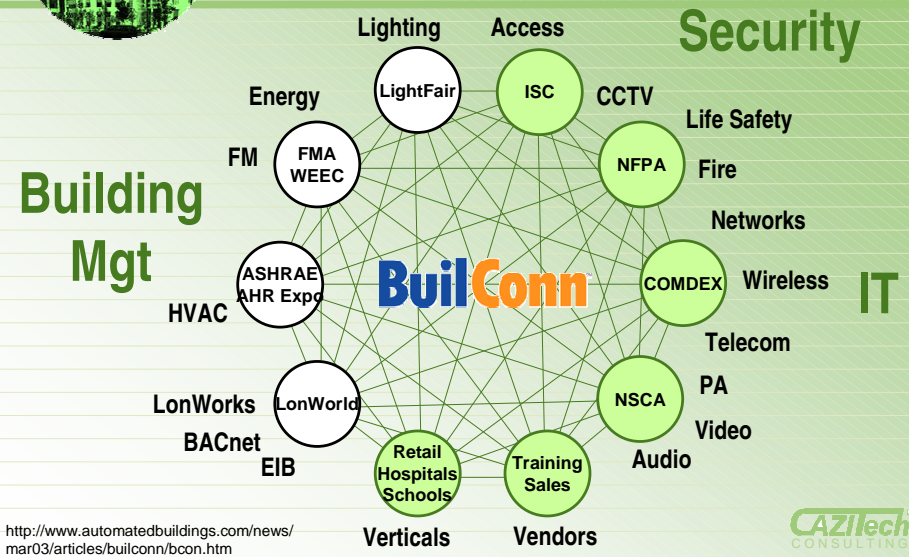
Home & Building Automation & Controls

Finally ready for the Mass Market?

by **Wayne Caswell**
wcaswell@CAZITech.com



Building Systems Sub-industries



<http://www.automatedbuildings.com/news/mar03/articles/builconn/bcon.htm>



Digital Home Applications

Comfort, Convenience, Security



IBM Solutions Experience Lab

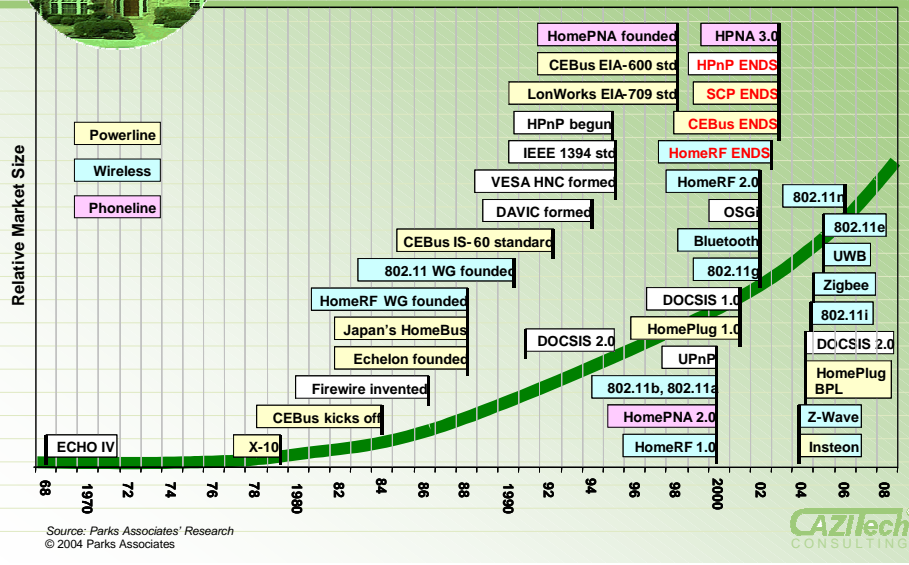
- Hotel / Living Room
- Kitchen
- Garage / Car
- Hospital Room
- Retail Café
- NW Operations Ctr

IPTV, WebSphere, RFID, Speech, Embedded, Location Tracking, RSS, Pen-based, Mobile Devices



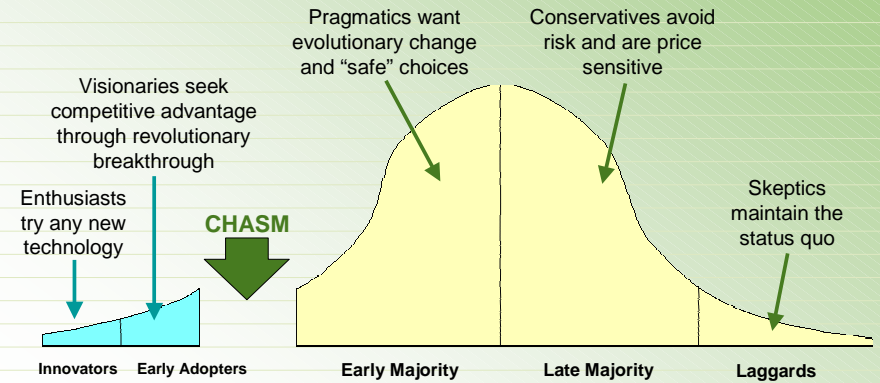


30-year Digital Home Technology Timeline



Mass Market Households vs. High-end New Homes

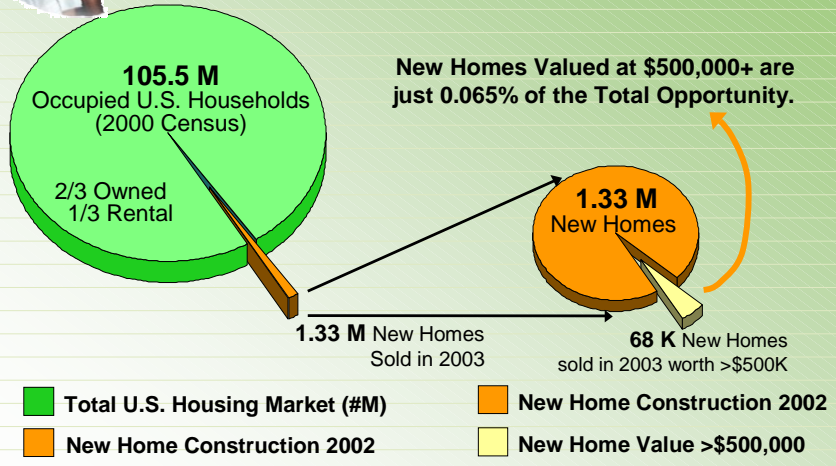
A Wide CHASM separates Today's Home Controls Niche from Mass Market Growth



Source: Crossing the Chasm, by Geoffrey Moore



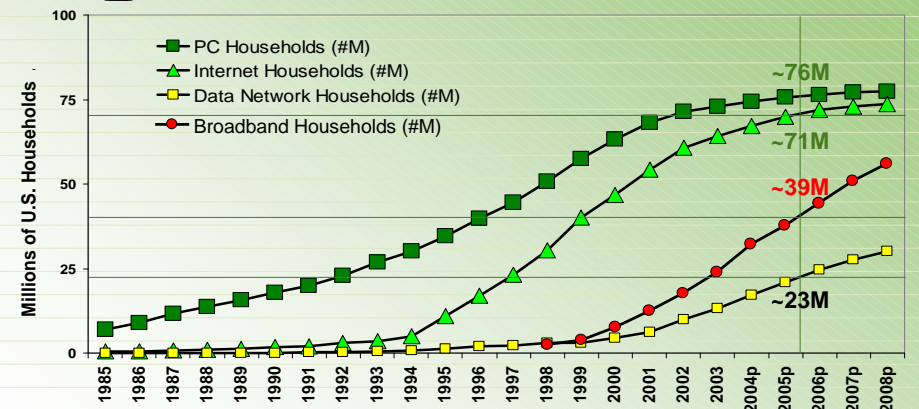
Mass Market Households vs. High-end New Homes



Source: U.S. Department of Commerce, National Association of Home Builders

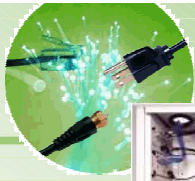


PC, Internet & Home Network Penetration (Millions of U.S. Households)



Source: Parks Associates' Research and Forecasts
© 2004 Parks Associates





Structured Wiring

(for Satellite TV, Telephone, Ethernet, 1394)



Distribution Hub / Panel

- Demarcation point for telecommunications and video services.
- Often includes Ethernet routers and video amplifiers.
- Cost: about ¼ of the entire system

Category 5 UTP cables

- Cat.5 unshielded twisted pairs support voice/data transmission up to 100 Mbps. Cat.5e supports 1 Gbps Ethernet.
- Cost: ~\$100 per 1,000 feet versus \$80 for older Cat.2 cable.

RG-6 Coax Cables

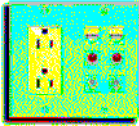
- Quad-shielded and most effective media for video distribution of hundreds of channels (satellite).
- Cost: ~\$350 per 1,000 feet

Optical Fiber (optional)

- One pair has more capacity than 1,400 pairs of copper.
- Cost: about \$150 per foot

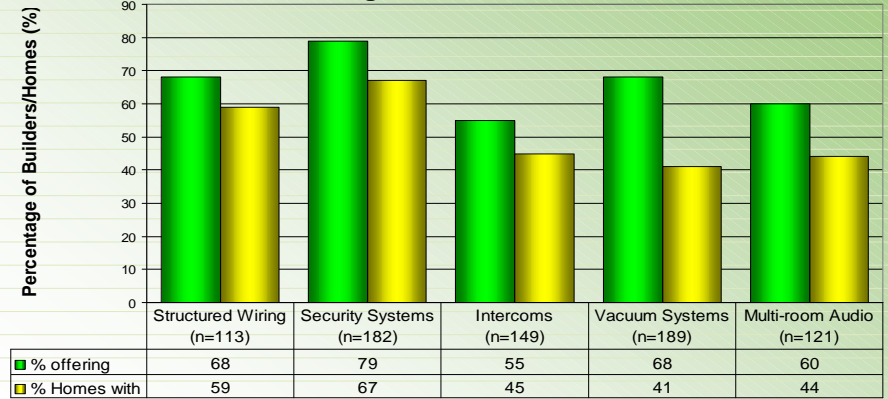
Wall Outlets

- Can accommodate multiple services (data, voice, and video)



Technology Amenities Offered & Installed

Percentage of Home Builders Offering Products; % of Homes being Installed with Amenities in 2003

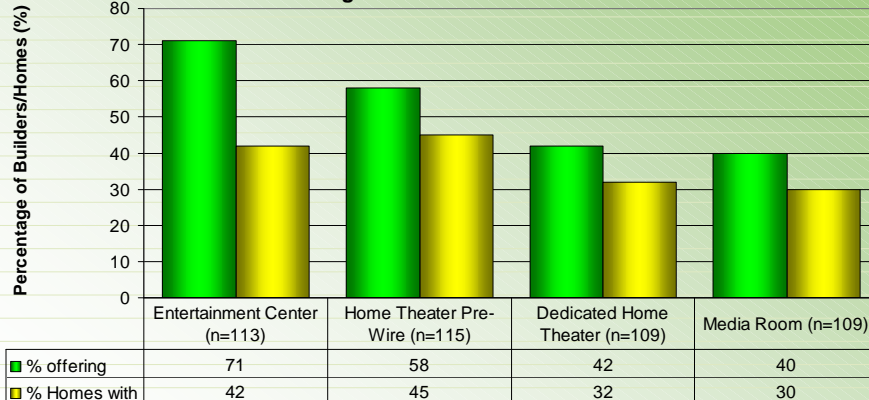


Source: Parks Associates 2004 Builder Survey
© Parks Associates



Entertainment Amenities Offered & Installed

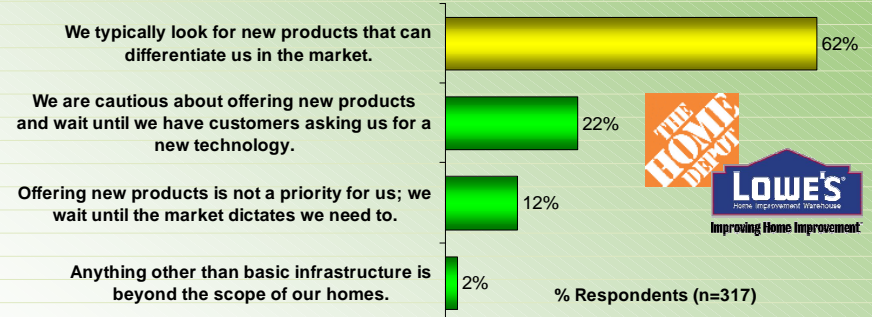
Percentage of Home Builders Offering Products; % of Homes Being Installed with Amenities in 2003



Source: Parks Associates 2004 Builder Survey
© Parks Associates



Home Builders' Attitudes about offering NEW Products



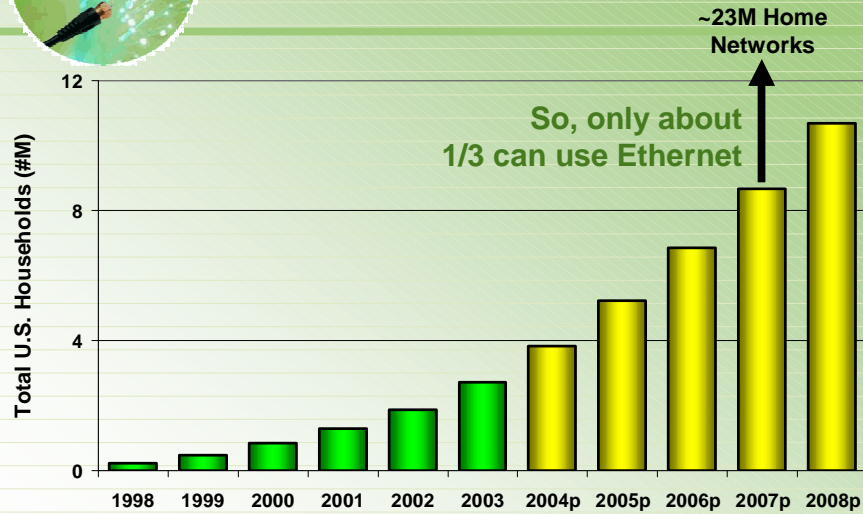
- They sold \$11 Billion in technology products in 2004 (est. \$12.2B in 2005)
- They represent a Formidable Channel, but only for NEW homes
- 26% have dedicated resource for New Product Development

Source: Parks Associates 2004 Builder Survey
© Parks Associates





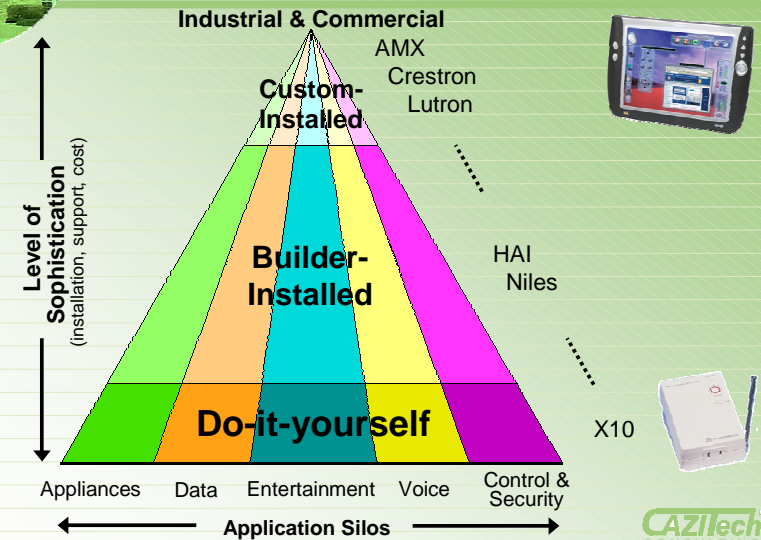
Households w/ Structured Wiring



Source: Parks Associates' Research
© 2004 Parks Associates



Home Controls & Automation Market Segmentation

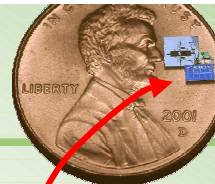


Source: CAZiTech & Parks Associates



Home Controls & Automation Market Drivers

1. **Embedded Processors**, Sensors & Actuators
2. **Digital Convergence**: Media, Devices & Disciplines
3. **Standards** that Scale & attract Big Players



1. Embedded Processors, Sensors & Actuators

- **Average Car**: 110 embedded processors and capacity of Cray-III supercomputer
- **A Trillion** smart devices by 2010 (interconnected by Standard Protocols)
- **4G Computers**: Processor, Network, Power
 - Berkeley's Golem Dust (11.7 mm³)
 - Berkeley's Deputy Dust (6.6 mm³)
- **Inside the Home**: Since you can't anticipate future wiring, Wireless Mesh to the rescue.
- **Outside the Home**: Always-on Broadband, BIG Broadband



Cybernetic Age: embedded Processors, Sensors & Actuators

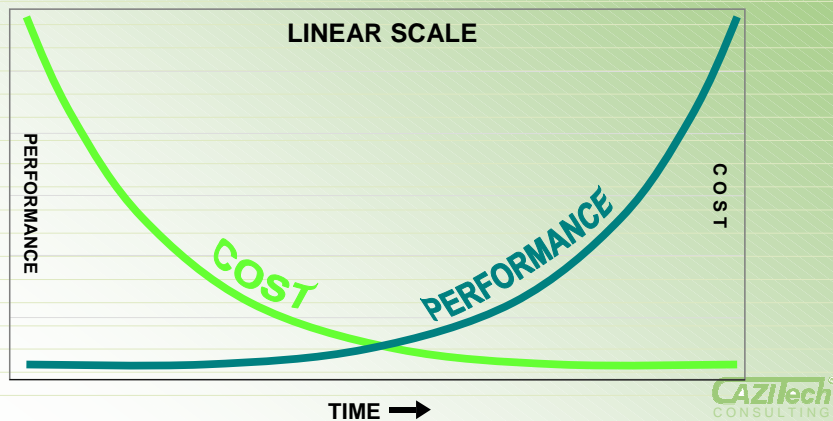




1. Embedded Processors, Sensors & Actuators

More Computing Performance at Less Cost

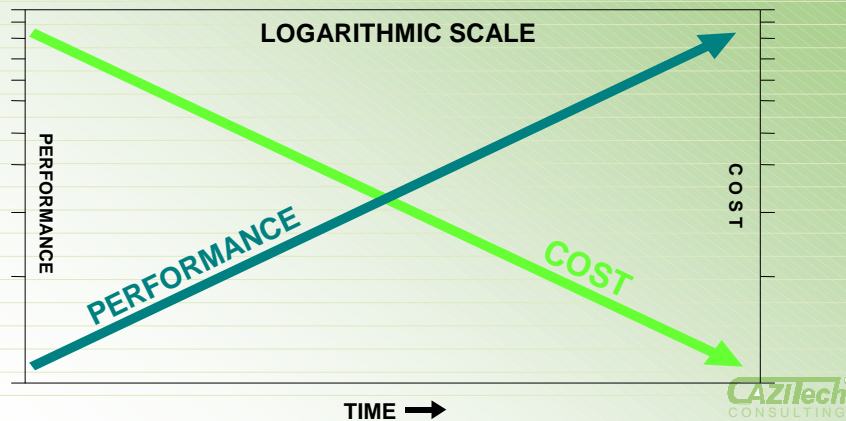
(Embedded processors in Everything with a Digital Heartbeat)



1. Embedded Processors, Sensors & Actuators

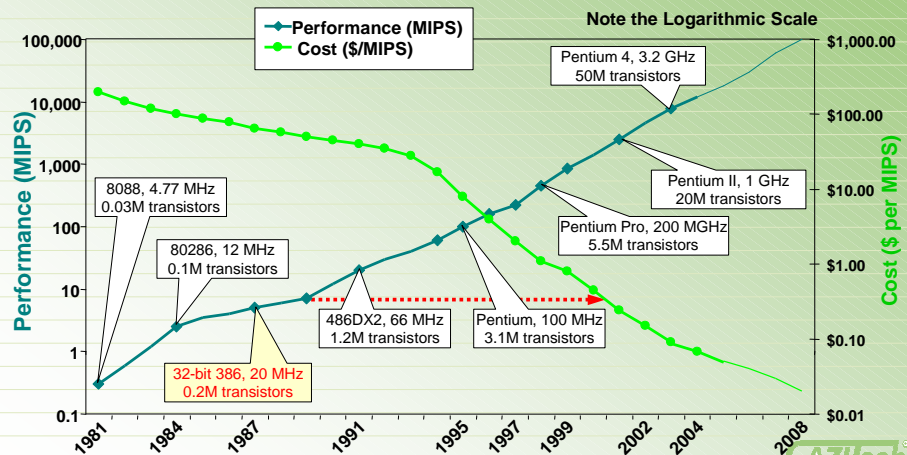
More Computing Performance at Less Cost

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1. Embedded Processors, Sensors & Actuators

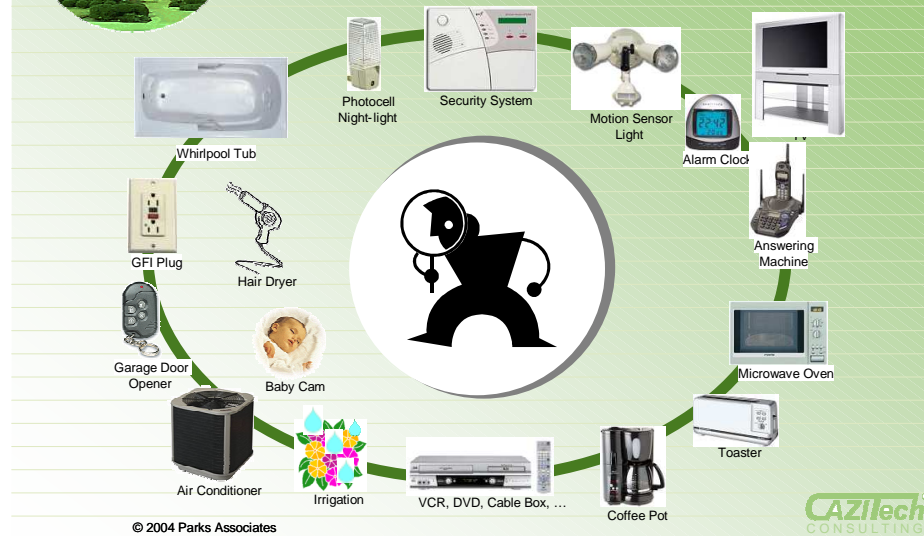
Intel processors over Time, showing the effect of Moore's Law



Source: Intel



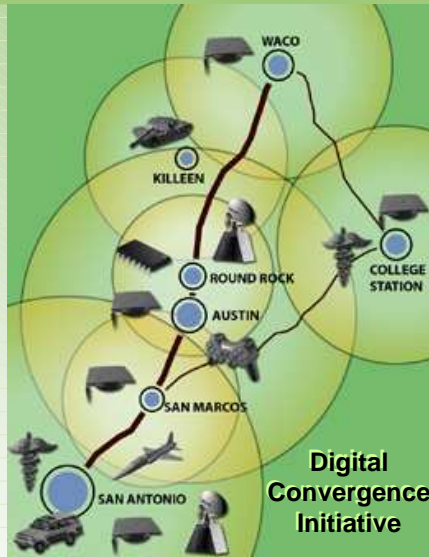
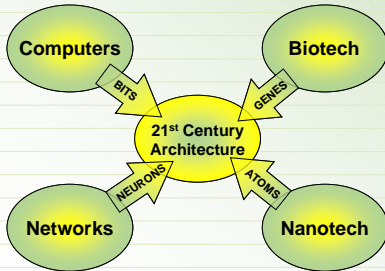
1. Embedded Processors, Sensors & Actuators





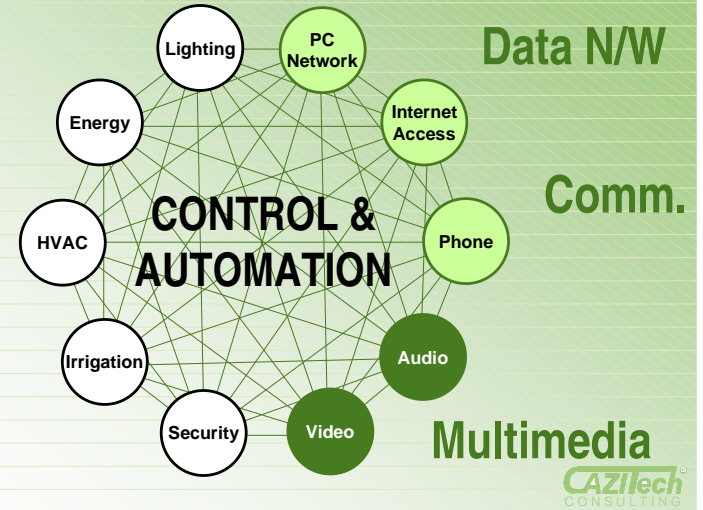
2. Digital Convergence: Media, Devices & Disciplines

- DCI Started by IC2 Institute at U.Texas
- Connecting the Greater Waco – Austin –San Antonio Corridor
- Extends UTOPIA concept (Utah Telecomm. Open Infrastructure Agency)



2. Digital Convergence: In the Home

Home Mgt.



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3. Standards that Scale blur Market Segmentation

IP-based Standards
(reliable, scalable, affordable)

Ethernet
10/100/1000-base-T

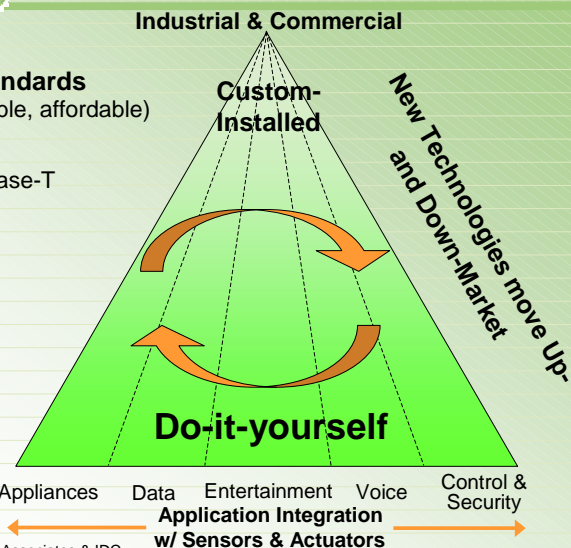
HomePlug

Insteon

Wi-Fi
BOM = \$14
(2006 MIMO)

ZigBee

Z-Wave



Source: CAZiTech, Parks Associates & IDC

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3. Standards that Scale attract Big Players

- **PC:** Cisco/Linksys, HP, IBM, Microsoft, Sony
- **CE:** LG, Panasonic, Sanyo, Samsung, Sharp, Sony
- **Semiconductor:** Intel, Motorola, Philips, TI
- **Appliance:** LG, Panasonic, Samsung, Sanyo, Sharp, Whirlpool
- **Retail:** BestBuy, Circuit City, CompUSA, Home Depot, Lowe's, Radio Shack, Sears, Smarhome, Tweeter, Ultimate Electronics, Wal-Mart



Finding Nemo, by Disney & Pixar Animation Studios

Working together in Trade Associations

- 1394 Trade Assn (1394TA.org)
- Assn.of Home Appliance Mfgs. (AHAM.org)
- Continental Automated Buildings Assn. (CABA.org)
- Consumer Electronics Assn. (CE.org)
- Digital Living Network Assn. (DLNA.org)
- Fiber-to-the-Home Council (FTTHCouncil.org)
- HomePlug Powerline Alliance (HomePlug.org)
- Internet Home Alliance (InternetHomeAlliance.org)
- Multimedia over Coax Alliance (MoCAAlliance.org)
- Open Service Gateway Alliance (OSGi.org)
- Universal Plug and Play Forum (UPnP.org)
- Wi-Fi Alliance (wi-fi.org)
- ZigBee Alliance (zigbee.org)

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3. Standards that Scale attract Big Players

COMPANIES	Promote an INDUSTRY					Promote Specific STANDARDS							
	AHAM	CABA	CEA	DLNA	IHA	1394	HomePlug	LonMark	MoCA	OSGI	UPnP	Wi-Fi	ZigBee
AMX		X	X		X								
Cisco/Linksys		B	X	X	P		X		X		X	X	
Crestron Electronics		X	X								X		
Echelon		B	X				P		P	X			
Hewlett-Packard			B	P	P	B				B	X	X	
Honeywell		B	X				P			X			P
IBM		X	X	P	P				P	X	X		
Intel		X	X	P		X				B	X		
Leviton		B	X							X			X
LG Electronics	X		X	X	X	X				B	X	P	
Lutron		X	X							X			
Microsoft		B	X	P	X	X				B	X		
Motorola		X	X	X	X	X	X	X	P	X	X	P	
Panasonic	X	X	B	P	P	B	P	X	X	B	X		
Philips Semicon.		X	B	P		X			P	B	X	P	
Samsung	X			P		B	X	P	P	B	X	P	
Sanyo	X		B	X		X	X			X	X		
Sharp	B			P		X	P		X	X	X		
Smarthome		X	X							X			
Sony			X	P		X	X			B	X		
Sun Microsystems		X				X			P	X			
Texas Instruments			X	P		B			X	X	X	X	
Ucentric Systems			X	X						X			
Vantage Controls		X	X							X			
Whirlpool	B	X			P					X			



Standards & Technologies that impact Home Control

NAME	BRIEF DESCRIPTION	CLASS	TYPE	URL
PHONELINE, COAX – Uses existing phone lines and coaxial cables for high-speed data networking				
HomePNA™	High-speed network using phone outlets	Data	Consortia	HomePNA.org
HomeRAN™	High-speed network using coax outlets	Data	Proprietary	TMT3.com
MoCA	High-speed network from Multimedia over Coax Alliance	Data	Consortia	MoCAAlliance.com
STRUCTURED WIRING – Nets that rely on specialized Structured Wiring (RG-6 coax and Cat.5/6/7 TTP)				
Ethernet	IEEE 802.3 high-speed network, 10/100/1000 Mbps	Data	Standard	groupes.ieee.org/groups/802/3/
HAVI	Home Audio Video interoperability in entertainment cluster	Data	Consortia	HAVI.org
IEEE 1394	Very high-speed connection (AKA Firewire, iLink)	Data	Standard	1394ta.org
TIA/EIA-570-A	Telecommunications Cabling Standard (specs the wire)	Media	Standard	TiaOnline.org
DEVICE/NETWORK MANAGEMENT – Device Discovery, Network Management, and Upper Layer Stds				
CableHome™	Extend cable-based services over home network	Data	CableLabs	cablelabs.com
DOCSIS™	Data Over Cable Service Interface Specification		® Consortia	/projects/cablehome/
OpenCable™	Plug-and-Play retail TV receivers			
Jini	Sun's Java based open software architecture	Discovery	Consortia	Jini.org
OSGi™	Open Service Gateway initiative – development platform	Gateways	Consortia	OSGi.org
UPnP™	Microsoft's Universal Plug and Play collection of standards	Various	Consortia	UPnP.org
INTERNET PROTOCOLS – Increasingly used in home control applications, especially for remote access				
TCP/IP	Transmission Control Protocol/Internet Protocol	Data	Standard	W3.org
UDP	User Datagram Protocol – simpler than TCP, runs on IP	Data	Standard	W3.org
HTML	Hypertext Markup Language – for graphical user interface	GUI	Standard	W3.org
HTTP	Hypertext Transfer Protocol – messaging format & transfer	Data	Standard	W3.org
XML	Extensible Markup Language – creates customized tags	Data	Standard	W3.org
SSL	Secure Sockets Layer – private key encryption	Data	Standard	W3.org

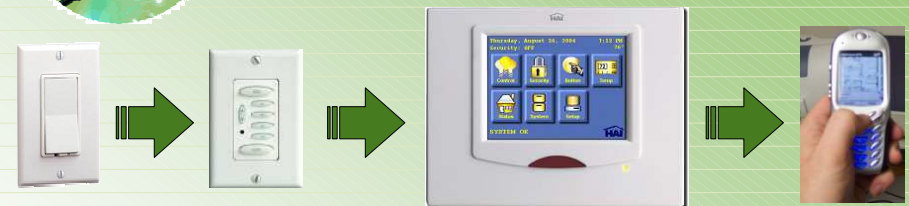


Standards & Technologies that impact Home Control

NAME	BRIEF DESCRIPTION	CLASS	TYPE	URL
OBSOLETE – Development has stopped on these standards, although some products still use them.				
CEBus®	ANSI standard (EIA-600, -721, -776)	Control	Standard	CEBus.org
Home Plug & Play™	CIC branded CEBus network using CAL (EIA-721) protocol	Control	Standard	CEBus.org
HomeRF™	2.4 GHz wireless network merging voice, data & streaming	Data	Consortia	HomeRF.org
SCP	Simple Control Protocol using CEBus, Home Plug & Play	Control	Consortia	N/A
WIRELESS – Uses radio transmissions in unlicensed bands such as 900MHZ, 2.4 GHz and 5 GHz				
Bluetooth®	IEEE 802.15.1 – short range wireless cable replacement	WPAN	Standard	Bluetooth.com
IrDA®	Infrared Data Association – line of sight control & data	Control	Consortia	IrDA.org
RadioRA™	Lutron's proprietary wireless control protocol	Control	Proprietary	Lutron.com/radiora
Ultra-Wideband	IEEE 802.15.3a – high-speed, short range wireless	WPAN	Standard	UWB.org
Wi-Fi®	IEEE 802.11a/b/g... – high-speed wireless LAN	WLAN	Standard	Wi-Fi.org
WIMAX	IEEE 802.16 – High-speed wireless MAN	WMAN	Standard	WiMaxForum.org
ZigBee	IEEE 802.15.4 – low power, low cost mesh network	Control	Standard	ZigBee.org
Z-Wave™	Low power, low cost mesh network	Control	Proprietary	Zen-sys.com
POWERLINE – Uses A/C power mains or electric utility's power grid				
BACnet	Amer.Soc.of Heating, Refrig. & A/C Engineers (ASHRAE)	Control	Consortia	BACnet.org
Echonet	Japanese Energy Conservation & Homecare NETWORK	Control	Consortia	echonet.gr.jp/english/
HomePlug™	High-speed network using OFDM technology	Data	Consortia	HomePlug.org
Insteon™	Smarthome's Dual band (RF + powerline) control network	Control	Proprietary	insteon.net
LonWorks™	EIA-709 powerline control based on Echelon's Lon Talk	Control	Standard	Echelon.com
UPB™	Universal Powerline Bus from Powerline Control Systems	Control	Proprietary	pcslighting.com
X10	De facto standard for low-speed powerline control	Control	Proprietary	X10.com

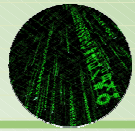


Powerline Standards for Home Networking & Controls



FEATURE	X-10	UPB	LonWorks	HomePlug AV	Insteon
Devices	256	>62K	>32K		>16M
Cost (lamp mod.)	\$12 lamp	\$75 lamp	\$35		\$30 lamp
Reliability	1-way	2-way	2-way		2-way
Speed	1-3 sec.	0.3 sec.		85-200 Mbps	0.04 sec.
Range	150'	75'	4,000'		n*150'
Compatibility	de facto	Proprietary	ANSI/EIA709		X-10
Function					

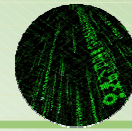
See also: http://en.wikipedia.org/wiki/Power_line_communication



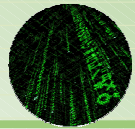
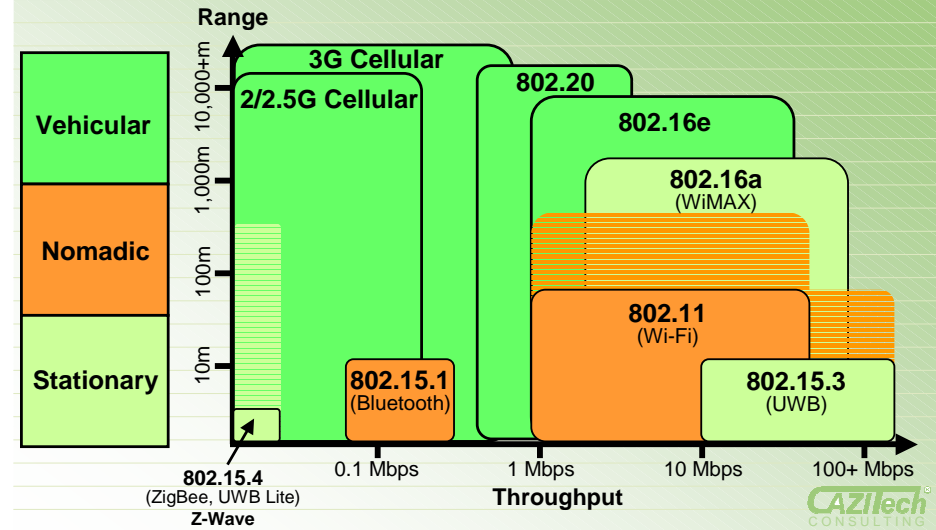
Wireless Standards for Home Networking & Controls

Tradeoffs

- Cost
- Battery Life
- Compatibility
- Ease of Setup & Use
- Reliability
- Security
- Range
- Speed



Wireless Positioning (Relative Measures on Logarithmic Scale)



Wireless Standards for Home Networking & Controls



Remote Control of A/V Equipment or Media Center PC



Remote Control of Surveillance Equipment



Wireless Standards for Home Networking & Controls



Crestron



AMX Modero



Sony VAIO VGN-U50



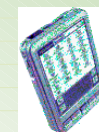
Niles TS1 (~\$500)



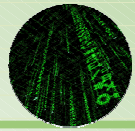
CorAccess Amigo



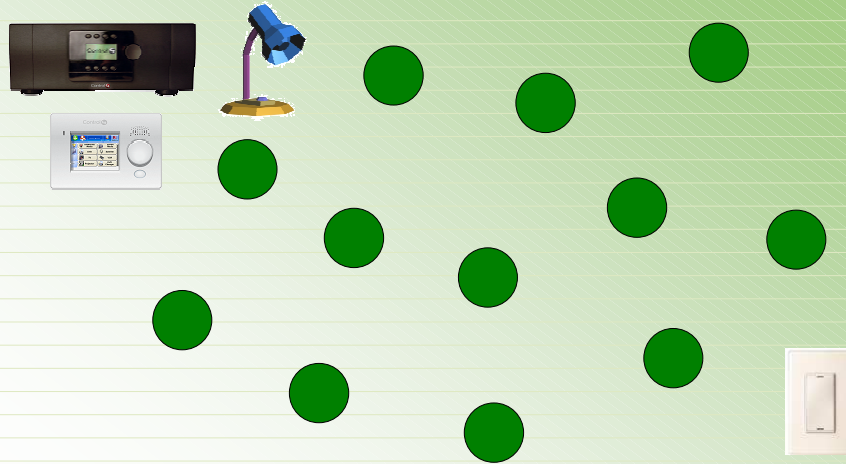
Philips Pronto



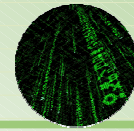
Remote Control S/W for existing PDA



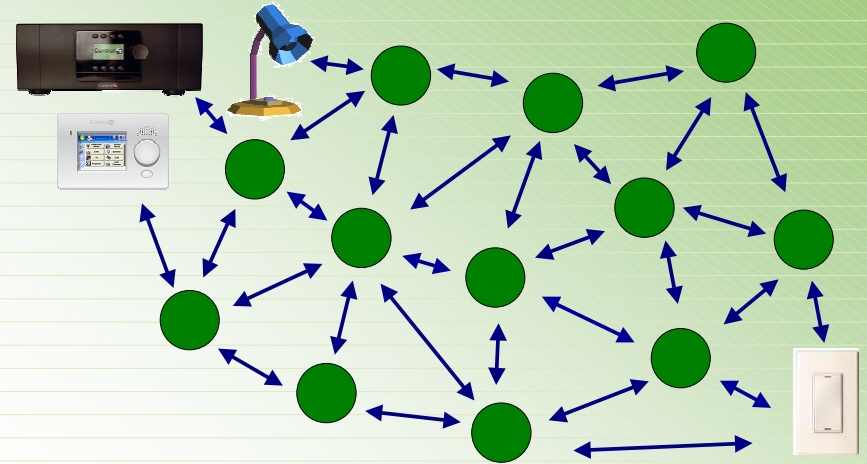
Mesh Networking



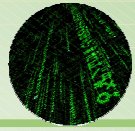
Source: Control+



Mesh Networking

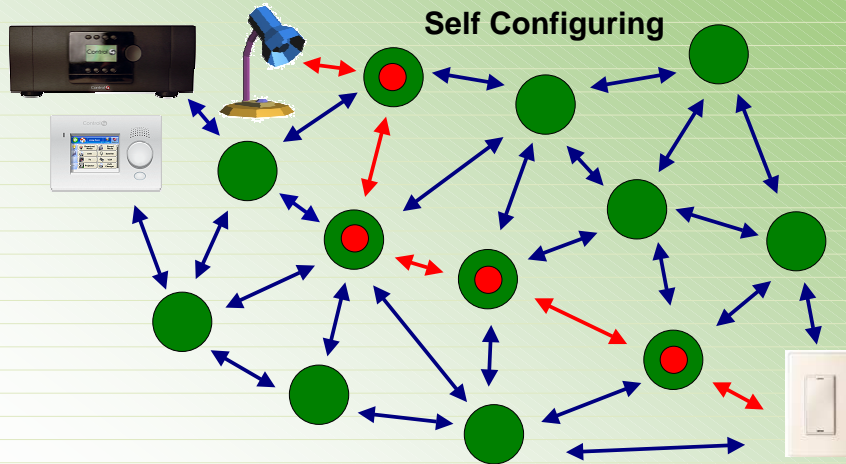


Source: Control+

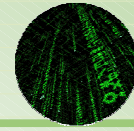


Mesh Networking

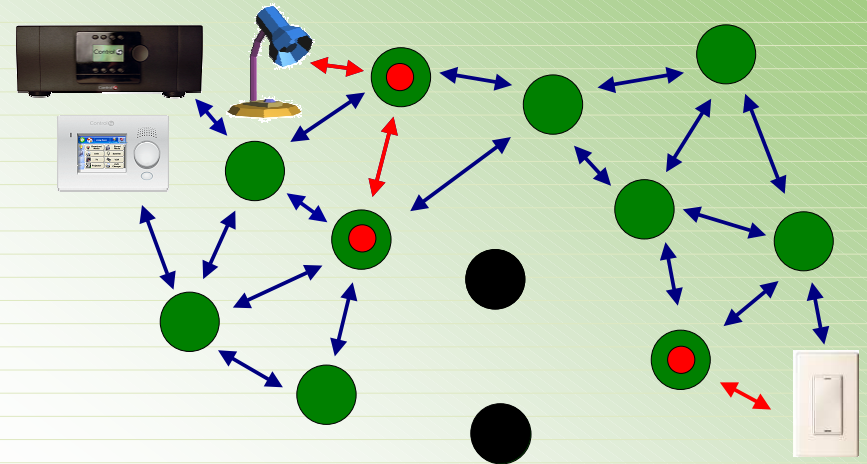
Self Configuring



Source: Control+

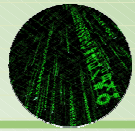


Mesh Networking

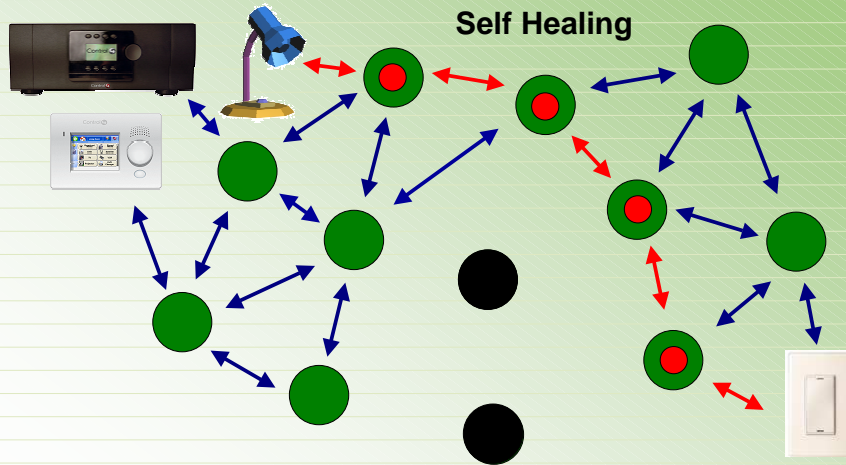


Source: Control+

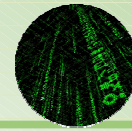




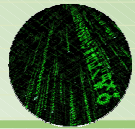
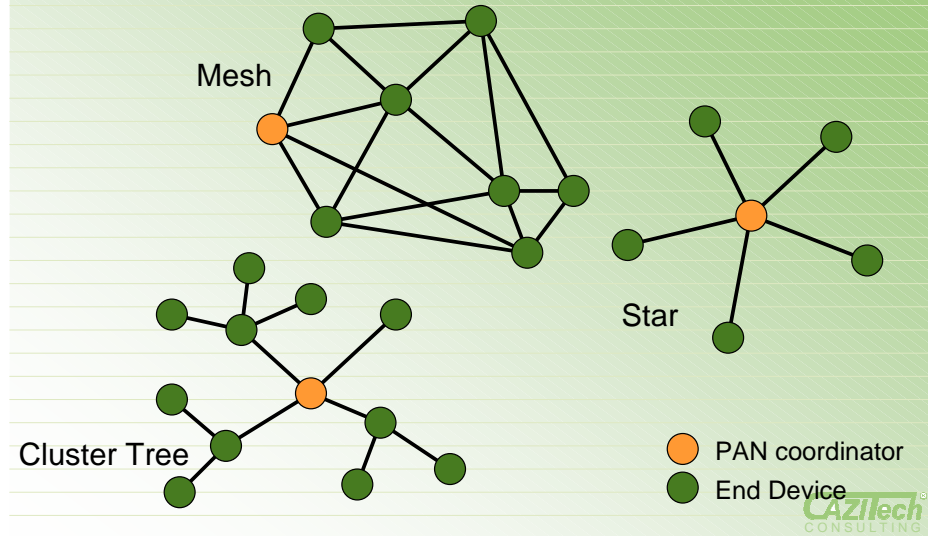
Mesh Networking



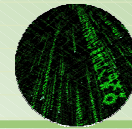
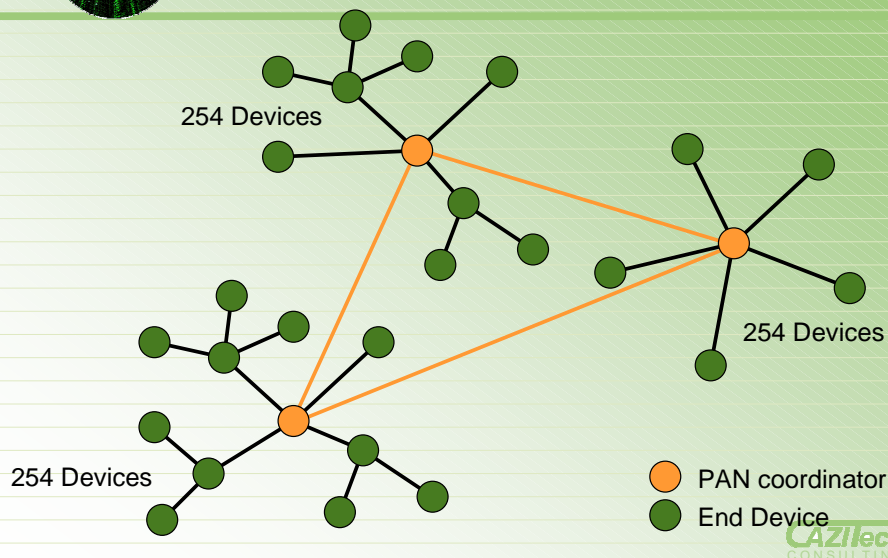
Source: Control4



Network Topologies ZigBee & Z-Wave



Bridging Clusters >10,000 Devices (254 * 255)



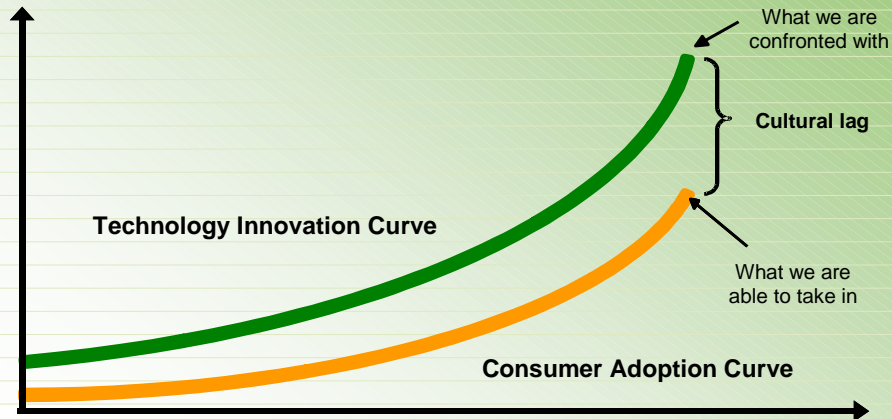
Wireless Standards for Home Control Applications

FEATURE	ZigBee	Z-Wave	INSTEON
Devices	>64K (254*255) <input type="checkbox"/>	255 per controller <input type="checkbox"/>	16.7 M <input type="checkbox"/>
Cost / Availability	None yet <input type="checkbox"/>	Zensys ~\$1 chip set Home Depot, Lowes <input type="checkbox"/>	~\$2 chip set \$35 lamp module <input type="checkbox"/>
Battery Life	Low Power <input type="checkbox"/>	Low Power <input type="checkbox"/>	Low Power <input type="checkbox"/>
Frequency	868/915 MHz (EU/NA) 2.4 GHz (WW) <input type="checkbox"/>	868/908 MHz (EU/NA) <input type="checkbox"/>	868/915 MHz (EU/NA) 131/120 KHz (PLC) <input type="checkbox"/>
Speed	40-250 Kbps <input type="checkbox"/>	9.6-40 Kbps <input type="checkbox"/>	10 messages/sec <input type="checkbox"/>
Range	~150' <input type="checkbox"/>	~150' <input type="checkbox"/>	~150' <input type="checkbox"/>
Compatibility	IEEE 802.15.4 <input type="checkbox"/>	Proprietary <input type="checkbox"/>	Proprietary, X-10 <input type="checkbox"/>
Topology	Routed Mesh/Star Supervised <input type="checkbox"/>	Routed Mesh/Star Supervised <input type="checkbox"/>	Peer-to-Peer Mesh Non-supervised <input type="checkbox"/>





Conclusions The Consumer's Cultural Lag



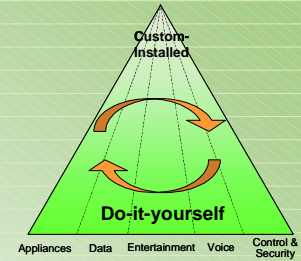
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Conclusions Ready for the Mass Market?

**We FINALLY have Scalability
But TOO Many Standards
Need a DOMINANT Player
Tough MARKETING Challenges**

- Awareness
- Branding
- Partnerships
- Value
- Packaging



X-10 ActiveHome Home Automation Kit with
5-in-1 remote, PC interface, and software \$49.95



Reference Material

- **AutomatedBuildings.com** (Resource: Building Management Systems)
- **CABA.org** (Continental Automated Buildings Association – Residential & Commercial)
- **CAZiTech.com** (CAZiTech Consulting – Speaker's home page)
- **Control4.com** (Good online marketing of ZigBee solution)
- **CortexaTechnology.com** (Flexible and well-architected solution from local firm)
- **DLNA.org** (Digital Living Network Alliance)
- **HomeToys.com** (Resource: Residential Market and Do-it-yourself)
- **InternetHomeAlliance.com** (Collaborative Market Research)
- **MesaHome.com** (Austin's oldest Home Systems installer)
- **ParksAssociates.com** (Premier Home Systems market researcher)
- **SmartHome.com** (INSTEON developer and online Home Systems retailer)
- **Z-WaveAlliance.org** (Z-Wave information)
- **ZigBeeAlliance.org** (ZigBee information)



Wayne Caswell

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Wayne Caswell is a retired IBMer and digital home pioneer with extensive IT experience in development, systems engineering, marketing, and strategy. He helped pioneer the Residential Gateway concept, influenced RG standards, and served as the Marketing Chairman of the HomeRF Working Group, an initiative that converged voice, data and entertainment networks into a single wireless specification that ultimately lost in the market to Wi-Fi.

After IBM, Wayne founded CAZiTech Consulting, an independent practice that helped organizations of all sizes discover and exploit new opportunities in technology convergence within broadband, wireless and home networking markets. He is now exploring new ways to influence the future of these technologies with a resume of experience that includes strategic planning, business development, and market and competitive analysis.

Wayne has a BS degree in Technology Management from American University and is a member of the Austin Wireless Alliance, CABA, the FCC Consumer Advisory Committee, and World Future Society, among other associations.

