Home Automation

Essentials for transforming your home into a Smart Home

Home Automation

Domotics

Intelligent Home

Connected Home

Smart Home

Internet of Things

Home Control

Have You Ever…

- Wondered if your garage door was really closed?
- Paid too much for home security?
- Wished you came home to a lighted home?
- Wanted to make your home “lived-in” while you were away?
- Wanted to know when you had water leaks in the basement?
- Had your smoke alarm batteries die at 2:15 am?
- Wanted to know who was at your front door?
- Wished you knew what your pet was doing when you were away?

Well, Then You Need Home Automation…

- And you need to bring in a professional installer…
- And you need to spend thousands of dollars to get it done right…
- And you need to spend $50 to $115 a month for service

Or you can watch this presentation!

You can do this on your own! - DIY

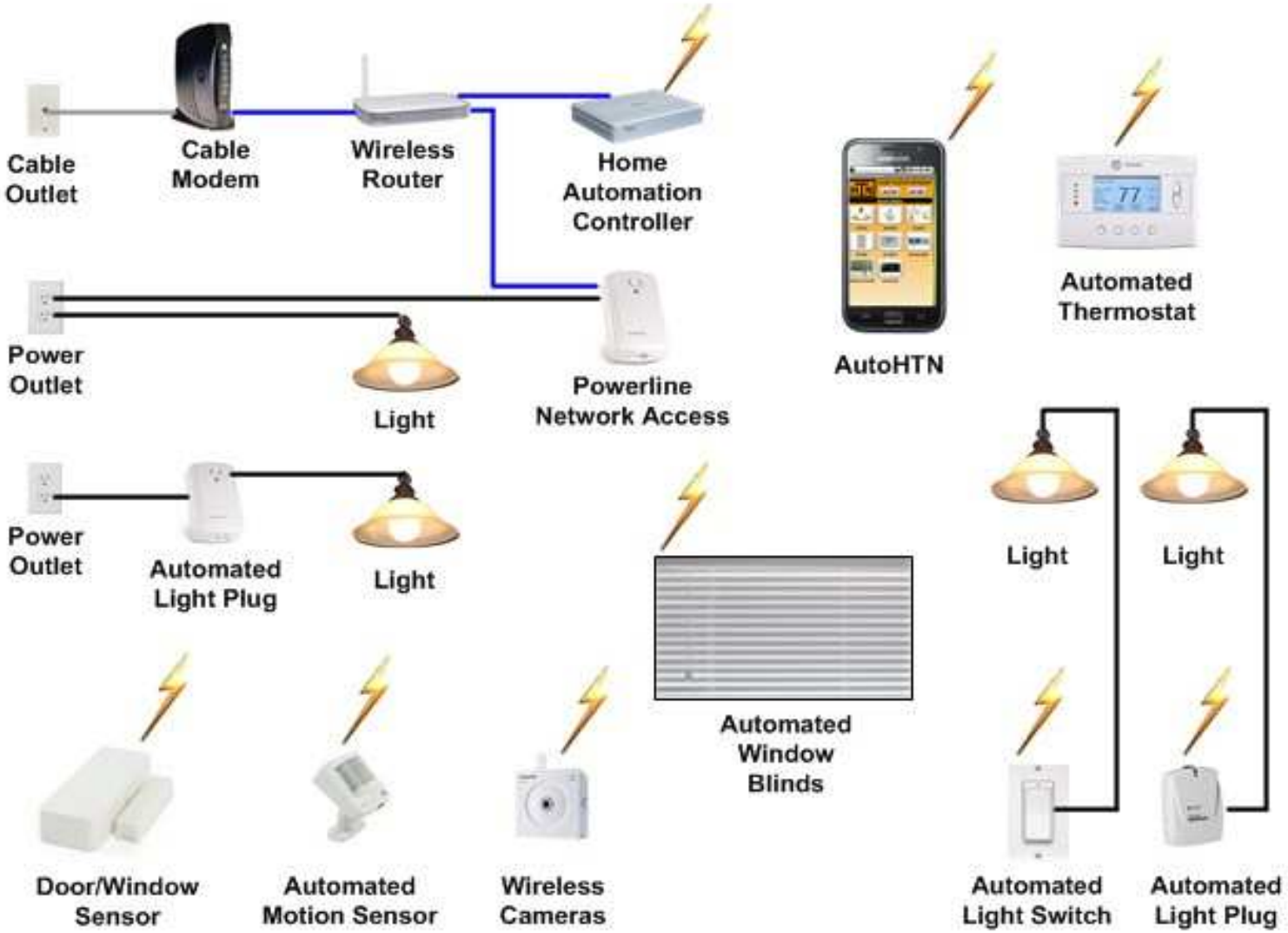
BLUF (Bottom Line Up Front)

- You don’t need to do it all at once
- Automate those items first that matter most to you
- Have a coherent strategy for your desired objective (end) state
- Understand the compatibilities and incompatibilities of products
- Be aware of emerging technologies
- Do some research; watch some YouTube videos
- Perform a cost benefit analysis, if that’s important to you
- Don’t be afraid to experiment

Automation Opportunities

- Lighting control
- HVAC – smart sensing, remote control, money savings
- Security
- Smoke and and CO alarms
- Lawn and garden sprinkler system control
- Front door bell and controlled access
- CCTV
- Garage door sensor and opener
- Music

Typical Home Automation Diagram



Home Automation Dichotomies

- Professionally installed and supported systems vs DIY
- 3d Party security monitoring vs DIY
- Control Hub vs Internet
- Control Hub vs Smart Phone
- Established protocols and products vs Emerging Technologies
- Apple vs Google vs Samsung vs Amazon vs Others
- Industry standard protocols and interoperability

My Personal Recommendation

- For now, go cheap until the battle over ascendency and technology plays out
- For home security, you absolutely need to be hub-centered
- Buy standard protocol equipment – Z-Wave, ZigBee, Insteon, Wi-Fi
- You don’t want to be a slave to your smart phone
- Z-Wave light switches can be reprogrammed to work with a new hub and system

Protocols

Home Automation Protocols

- **ZigBee**
- **Z-Wave**
- **Insteon**
- **HomePlug**
- **X10**
- **Wavenis**
- **6LoWPAN**
- **WiFi**
- **BLE**

X10

X10, developed in the 1970s, is the oldest home automation protocol. X10 is a simple system that uses power lines in your home to allow communication between devices and appliances. It is fairly reliable but subject to interference from other electrical devices in the circuit. Special noise filters can mitigate this interference. X10 is a primitive system and can only perform about 16 commands, sent one at a time.

X10 Details

- Powerline networking
- Designed in the 1970s
- Max 256 devices
- 16 Command codes
- 60 bps
- No acknowledgments
- No security

Insteon

Insteon combines wired and wireless communication into a single system that offers greater reliability and flexibility. The powerline is used as a backup to the RF frequency used by the system. This allows commands to reach the proper destination with little interference. Insteon supports over 65,000 different commands and is one of the best options for upgrading the light switches in your home.

INSTEON®

Insteon

- Dual mesh network
  - Powerlines
  - RF
- Advantage of using home's existing powerline infrastructure
- Powerline phase issue
- ISM frequency at 904 MHz
- RF issues:
  - Interference from other wireless devices
  - Interference from walls and objects

Z-Wave

Z-Wave is the golden standard of wireless smart house systems. Z-Wave uses the same mesh networking strategy as ZigBee. Z-Wave devices are universally compatible with one another. Z-Wave is available for nearly every type of device that you would want in a smart home. It is not as fast or powerful as ZigBee, but makes up for this by being more efficient – therefore it doesn't need to be as fast or powerful.

Z-Wave and Z-Wave Plus

- Z-Wave Alliance
- 9.6 to 200 kbps
- 908 MHz in U.S.
- 868 MHz in Europe
- New 2.4 GHz
- 90’ to 300’ range
- 232 nodes max
- Master and slave architecture
- Uses mesh networking
- BPSK
- Collision Avoidance
- Random back off times

Z-Wave Device Types

- Controllers:
  - Host routing tables for mesh network
    - Used to calculate best route for a signal to get to a slave
  - Routes retransmitted by slave nodes
  - Only one primary controller
    - Can include/exclude devices
    - Manage allocation of Node Ids
  - Secondary controllers get copies of routing tables
- Slave Devices
  - Do not compute routing tables
  - Can store routing tables
  - Act as a repeater

ZigBee

A type of wireless mesh network where every device acts as a relay to send and receive information. ZigBee networks become larger, stronger, and more reliable with each additional device added.

ZigBee devices from one manufacturer often are unable to communicate with those from another because devices use different methods of programming to accomplish the same tasks. For this reason, manufacturers use ZigBee as a way to limit third-party devices in closed systems.

ZigBee

- ZigBee Alliance
- Based on IEEE 802.15.4
- Design goals:
  - Wireless networks
  - Low data rates
  - Self organizing mesh networks
  - Low power
- Released in 2005

ZigBee Details

- IEEE 802.15.4
- 915 MHz and 2.4 GHz in U.S.
- 868 MHz and 2.4 GHz in Europe
- Supports up to 64,000 nodes
- Mesh networking
- 128 Bytes packet size
- 20/40/250 kbps data rate
- 10 to 100 meter range
- Uses CSMA/CA
- 128 bit encryption keys

UPB (Universal Powerline Bus)

UPB is a wired system developed in the late 1990s as an improvement to the technology that undergirds X10. UPB reduces the interference that sometimes plagues X10 by using high-power pulses to send its commands over power line circuits. UPB sends commands faster and can handle greater voltage loads than X10, enabling a broader range of applications. UPB is fully programmable beyond the simple commands of X10.

Wi-Fi

Wi-Fi is a great choice to connect your computer or smartphone to the home automation controller or system, but it should ideally only be used for that purpose. NFC is a decent choice for home automation but requires close proximity to work properly. This requirement makes it a great choice for door locks and security system access, but not much else.

BLE

Bluetooth low energy (**Bluetooth LE**, **BLE**, marketed as **Bluetooth Smart**) is a wireless personal area network technology designed and marketed by the Bluetooth Special Interest Group aimed at novel applications in the healthcare, fitness, beacons, security, and home entertainment industries. Compared to Classic Bluetooth, Bluetooth Smart is intended to provide considerably reduced power consumption and cost while maintaining a similar communication range.

[Wikipedia]

6LoWPAN

- IPv6 over Low power Wireless Personal Area Network
- Use existing internet network infrastructure
- IPv6 packets on top of IEEE 802.15.4 network
- Issues:
  - IPv6 not designed for sensor networks
  - 1280 byte IPv6 packets
  - 127 byte IEEE 802.15.4 frames
  - 40 byte IPv6 header

Protocol Comparison Chart

PHY Technology	Power	Range	Cost	Data Rate	Location	Protocol	Multi-Vendor
Zigbee	Low	Home - -	Medium, but could be low	low	No	SEP	Modest
Zwave	Low	Home	Medium	low	No	Proprietary	No
24 GHz WiFi	Medium	Home	Medium descending to low	High	Yes, indoor	IP	Large
900MHz WiFi (80211ah)	Low	Home + +	Low	Medium	Yes, indoor	IP	Large
Home Plug Green PHY (HPGP)	Medium	Home + +	Medium	Medium	No	IP	Modest
Cellular	Medium	Long	Medium to High	Medium	Yes, outdoor	IP	Modest
BT LE	Low	Personal	Low	low	Under discussion	BT	Large

Popular Wireless Command and Control Technologies

	Z-WAVE	ZigBee HA 900MHz	ZigBee HA 2.4GHz	DECT ULE	KNX - RF	WiFi 802.11xx	BlueTooth ULE	EnOcean 315MHz	EnOcean 900MHz	Insteon
Year first launched in Market	**2003**	2003	2003	2013	2005	1997	2010	2004	2004	2004
Complete interoperable HA ecosystem?	**Yes**	No	No	No	No	No	No	No	No	No
Number of interoperable HA products US	**>700**	0	78	0	0	<50	0	323	23	170
Number of interoperable HA products EU	**>500**	0	78	0	<50	<50	0	323	1129	30
Number of Suppliers of HA Products	**over 100**	<10	30	0	<10	Many	0	30	77	2
Number of suppliers of Stack	**1**	Many	Many	1	1	Many	Many	1	1	1
Number of suppliers of Transceiver	**2**	18	18	Many	Many	Many	Many	1	1	1
Cost effective for mid-market HA application	**Yes**	Yes	Yes	Yes	No	Yes	Yes	No	No	Yes
DIY options for consumers?	**Yes**	Yes	Yes	No	No	Yes	No	No	No	Yes
HA Security Panel options?	**Yes**	No	No	No	No	No	No	No	No	No
Used by Service Providers?	**Yes**	No	Yes	No	No	No	No	No	No	No
SDO PHY/MAC Standard	**ITU-T G.9959**	IEEE 802.15.4	IEEE 802.15.4	EN300 175	ISO/IEC 14543-3	IEEE 802.11.1	IEEE 802.15.1	ISO/IEC 14543-3-10	ISO/IEC 14543-3-10	none
RF Band used for HA	**900MHz**	900MHz	2.4Ghz	1.9GHz	868.3MHz	2.4GHz	2.4GHz	315MHz	900MHz	900MHz
Topology	**Mesh**	Mesh	Mesh	Star	Star	Star	Scatternet	Peer to Peer	Peer to Peer	Peer to Peer
Support by commercial HA Gateways?	**>100**	<10	<50	<10	<10	1,000's	1,000's	12	39	30

Every effort was made to be accurate in this information regarding residential command and control application. Data was taken from multiple public sources in February 2014
For questions, comments or concerns please contact mark@z-wavealliance.org

Z-WAVE ALLIANCE

www.z-wavealliance.org

Mesh Networking

- Ad-Hoc network
- Independent devices
- Self-routing
- Healing properties
- Increased reliability

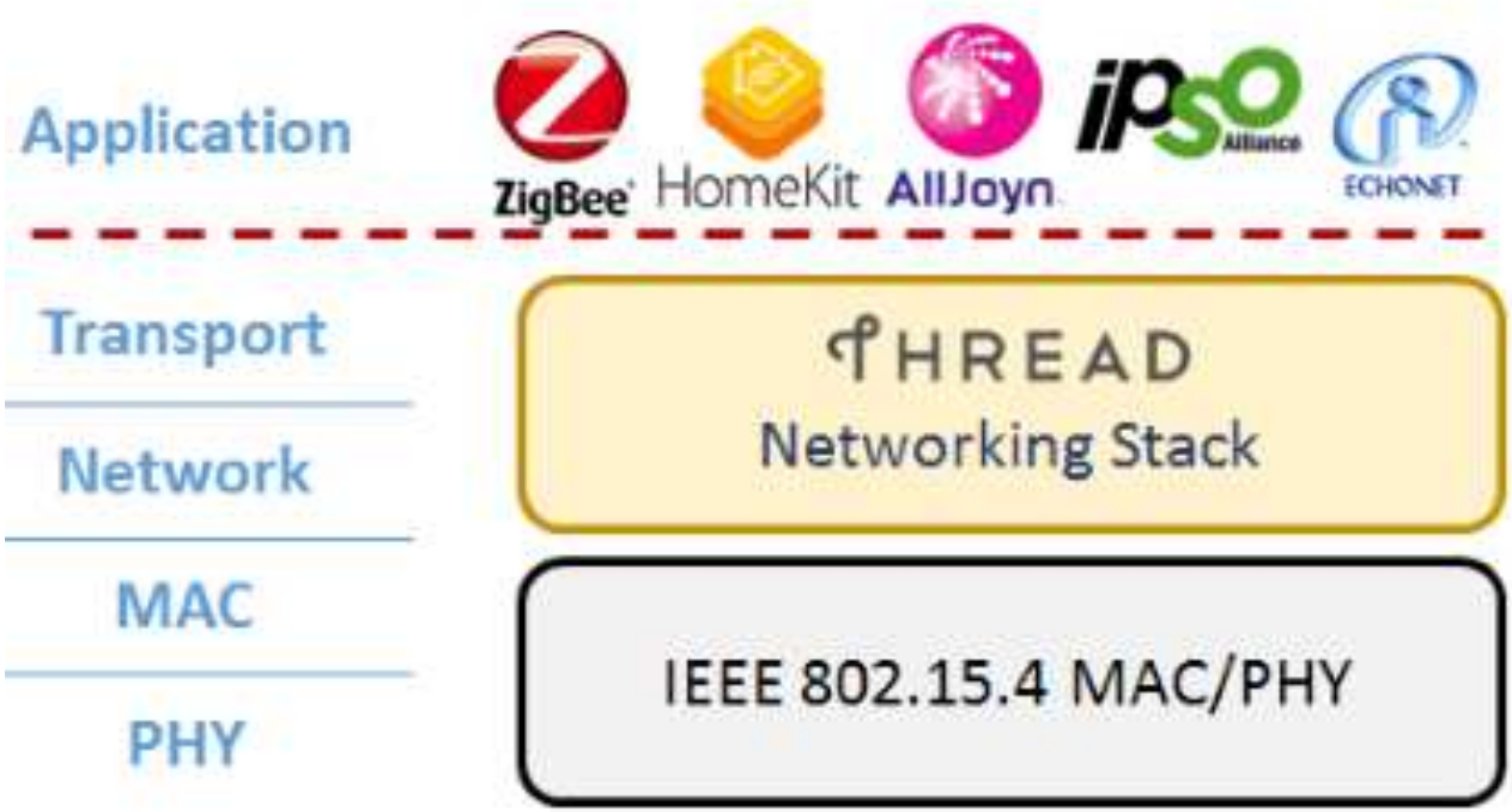
Google vs Apple

HomeKit

Thread

- Being developed by Google
- **Thread** is an IPv6-based,royalty-free protocol for smart household devices to communicate on a network
- Nest Labs announced a working group with the companies Samsung, ARM Holdings, Freescale, Silicon Labs, Big Ass Fans and the lock company Yale in an attempt to have Thread become the industry standard by providing Thread certification for products. Other protocols currently in use include ZigBee and Bluetooth Smart
- Thread uses 6LoWPAN, which in turn uses the IEEE 802.15.4 wireless protocol with mesh communication, as does ZigBee and other systems. Thread however is IP-addressable, with cloud access and AES encryption. It supports over 250 devices on a network

Where Thread Lives



Commercially Available Products

Large Corporations Jumping Into HA

- **Google:** Bought Nest (which bought Revolv)
  - Developing Thread and Brillo protocols

- **Apple:** Developed HomeKit
- **Amazon:** Created Echo (Alexa)

- **Samsung:** Bought SmartThings
- **Microsoft:** MIA, although Cortana is interesting. Insteon focused
- **Facebook:** Mark Zuckerberg: I'm building an AI for my home that's 'kind of like Jarvis in Iron Man'
- **Belkin:** Bought WeMo

Big Box Stores and Their Systems & Products

- Lowes: Iris

- **The Good** The Iris Home Management System is compatible with a larger variety of sensors than most of the competition, making it an intriguing option for smart home multitaskers.
- **The Bad** For certain uses, like home security, Iris lags behind its competitors. Also, the website you'll use to control your system isn't as well-designed or easy to use as it should be. The smartphone app isn't much better.
- **The Bottom Line** Iris charges $10 per month for full system functionality, making it difficult to recommend over fee-free competitors like SmartThings, iSmartAlarm, or Insteon.

- Home Depot: Wink

- **The Good** Wink's $80 hub works with a lot of different protocols and brands and costs less than the competition.
- **The Bad** Pairing products with the hub can be complicated and the app isn't as accessible as some of its partners' standalone designs.
- **The Bottom Line** While the Wink Hub has some design and usability kinks to work out, its affordability and versatility make it a very desirable option for whole-home automation.

- Staples: Connect

- **The Good** The new D-Link version of the Staples Connect hub sports a better design than the original. Automations will work even when the Internet is down, and you don't need to keep the hub plugged into your router. New, built-in radios for ZigBee and Bluetooth help it work with more devices than before.
- **The Bad** Staples Connect still doesn't work directly with Nest, WeMo, Insteon or IFTTT; and camera support is minimal at best. We also noticed a bit of lag when automating unsupported devices.
- **The Bottom Line** Staples Connect is a reliable, easy-to-use platform, and the new D-Link hub is undeniably better than the original. If you already own devices that'll work with it, the new hub makes a lot of sense, but if you're starting your smart home from scratch, consider waiting to see what happens with Apple HomeKit and SmartThings 2.0.

Examples of Available Systems

Nest

- Smart thermostat
- Nest Protect – smart smoke and CO sensor that interfaces with Nest thermostat and the Internet
- Has other sensors that detect movement within the home (used for Away Mode)
- Alarms are sounded and sent via e-mail and text to your smartphone

WeMo by Belkin

- Smartphone controlled
- Inexpensive
- IFTTT integration
- No hub
- Some integration with other systems
- Wi-Fi and Star Network infrastructure

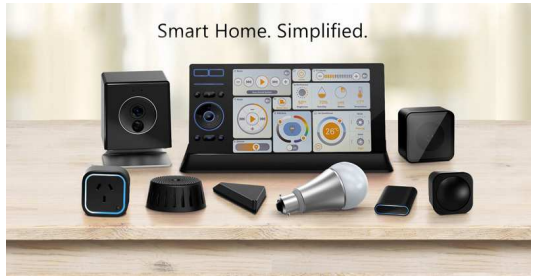
HomeKit

- HomeKit is a database similar to HealthKit and PassKit that allows developers to make software that discovers, configures, communicates with, and controls devices for home automation. Actions can be initiated using Siri either from home or Apple TV
- Option for manufacturers of existing equipment to make *gateways* that connect equipment using their protocols to HomeKit, which includes equipment manufactured by Insteon.
- Wi-Fi and BLE centric
- Establishes security framework and encryption standards needed

Wink

- Integrates with Amazon Alexa
- Holding company, Quirky, went bankrupt and spun Wink off
- Price is ~$20 at Home Depot when purchased with two products
- Performance is improving; firmware continually updated
- Lags behind other major hub-based products
- Works with Z-Wave, ZigBee, WiFi, and BLE – four radios in hub

Oomi



- New, hub-based system – still vaporware
- Not smartphone centric
- Largest crowd-funded campaign
- In addition to its plethora of sensors, the Oomi Cube also has radios for Wi-Fi networking, Bluetooth Low Energy, and Z-Wave. The system relies on NFC (near-field communication) for pairing, and the company boasts that the entire system can be set up in less than five minutes by simply touching the Oomi Touch to each device that you want to add to the system

Irrigation Controls

- Smart irrigation systems are becoming popular
  - Rachio Iro
  - Eve
  - Lono
  - Skydrop
  - Toro
- Works with Nest
- Uses local met data to control irrigation

IFTTT

- **IFTTT** is a web-based service that allows users to create chains of simple conditional statements, called "recipes", which are triggered based on changes to other web services such as Gmail, Facebook, Instagram, and Pinterest. IFTTT is an abbreviation of "If This Then That”
- Integrates with many home automation systems to trigger events within a home or between web services
- Can supplement hub-controlled automation systems
- Zapier is another web-based service but focused more on businesses and not on homeowners

Final Thoughts

- Good time to jump in
- Security concerns is a major consideration. Getting better, HomeKit resolving much of it for limited amount of systems
- Wi-Fi, especially using IPv4, is an issue
- Industry consolidation happening now
- Look at CES 2016 products starting this week
- Smartphones are important for some things (e.g., geo fencing) but you don’t want to be trapped into having it as your central hub