SMART HOMES

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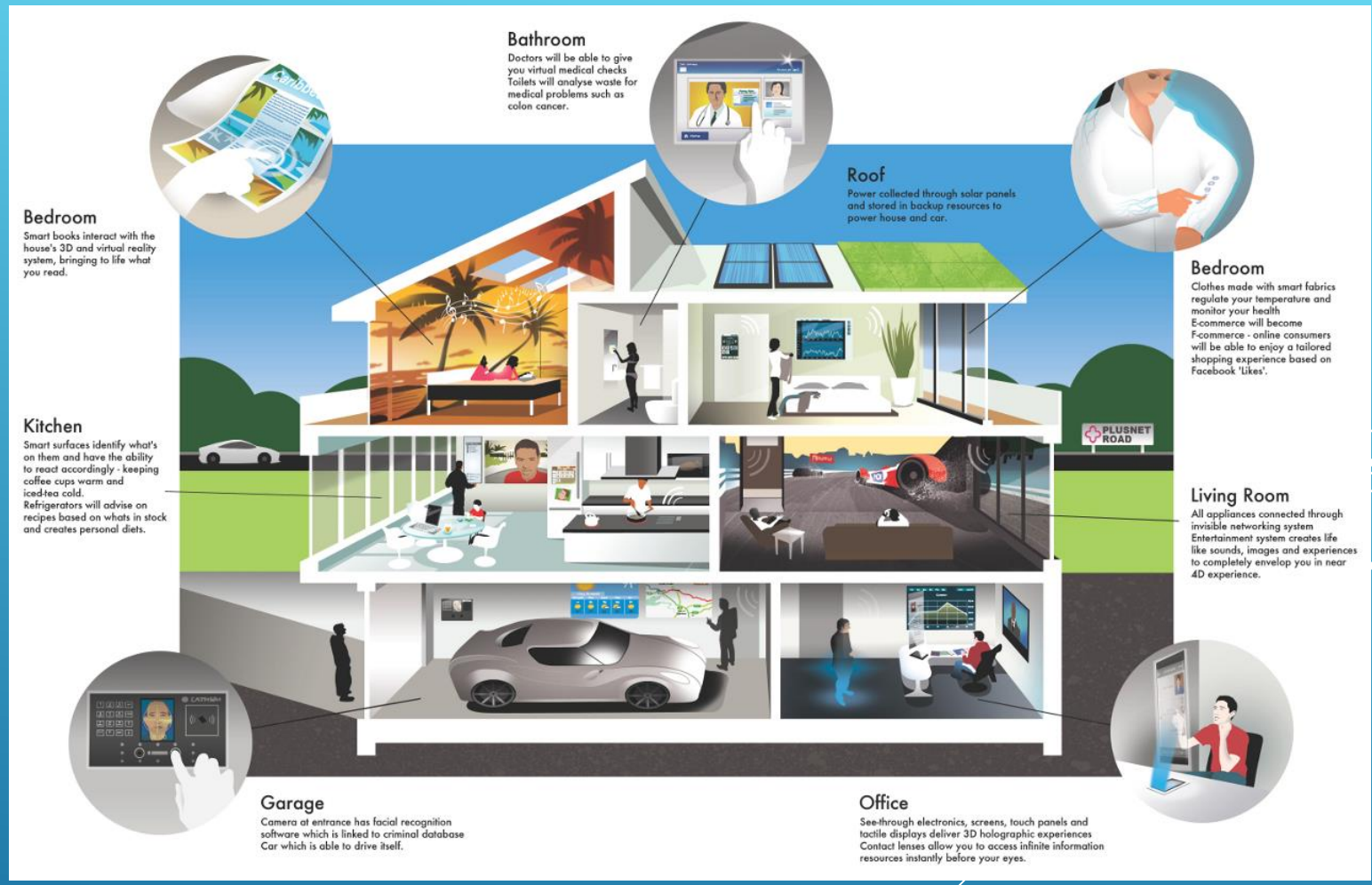
AGENDA

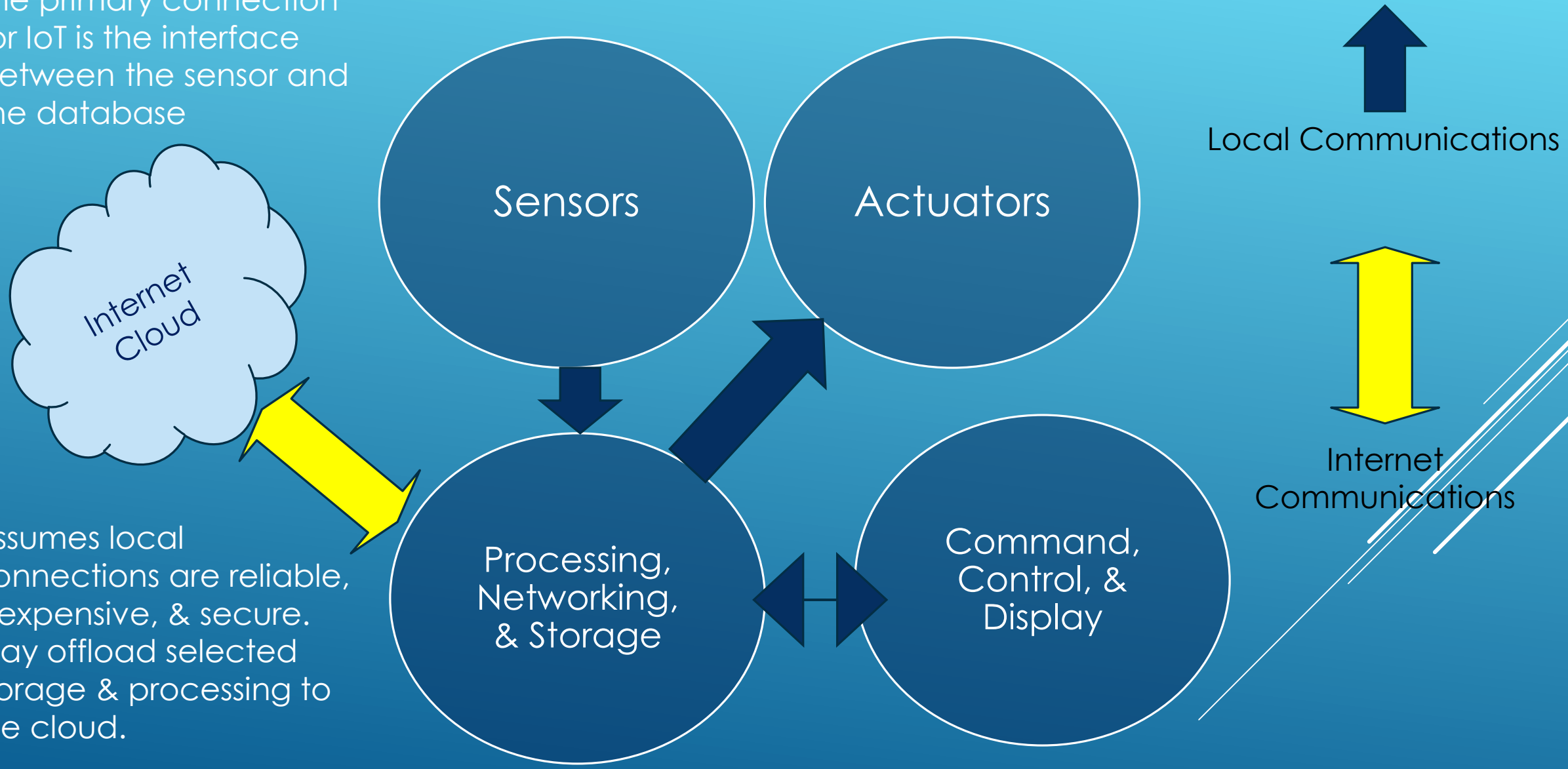


SMART HOME DEFINITION(S)

- Apps on mobile devices control household devices
- Home that minimizes chores by using connected technology devices
- Home that minimizes energy usage and water consumption
- All of the Above
- Giant companies monetizing information collected from "*your*" technology devices
  - With or without your explicit consent
- A Smart Home is an ecosystem made up of device-to-device or device-to-service interactions wherein devices generate information, share it, and take actions based on the information. The devices and services essentially speak the same language and give and receive instructions. For example, a smart security system motion detector, when it senses movement could trigger the smart lighting to turn on the light in the room or thermostat to adjust the climate controls. *(from Open Connectivity Foundation)*
- Industry has many competing vendors, but has very few globally accepted industry standards and the smart home market is heavily fragmented. Manufacturers typically prevent interoperability by withholding access to the device, grossly inadequate documentation, patents, and by litigation.

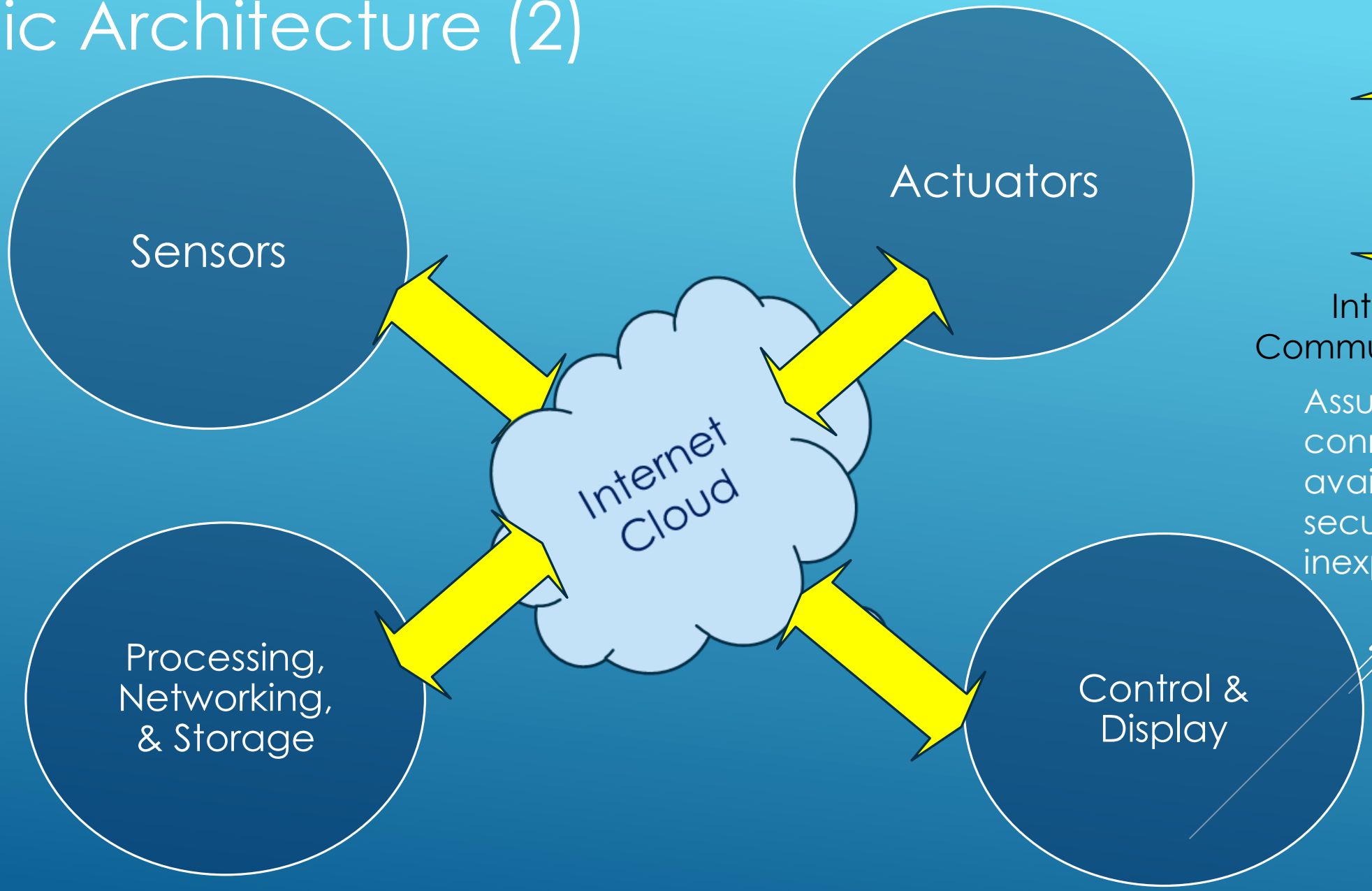
BASIC ARCHITECTURE (1)

The primary connection for IoT is the interface between the sensor and the database



Assumes local connections are reliable, inexpensive, & secure. May offload selected storage & processing to the cloud.

Basic Architecture (2)



Assumes remote connections are available, reliable, secure, and inexpensive.

IOT DATA ISSUES

- IoT today is a post-Babel world, where each disparate group started *again* to build its own vertical tower, each solution striving to be the first or the best, with data collected in a plethora of proprietary formats, and with huge variations in how the meaning of the data is defined and exchanged.
- Simply transporting the data or using the Cloud via Internet Protocol over 3G, 5G, broadband WLAN or fiber is not the problem.
- The problem is giving or selling the data to the recipient, if it is unclear what the information means, how it was collected, when, where, with what quality, under what license, etc.

Genesis 11:1-9

- Each IoT supplier should point or link to the definitions and licensing etc. used in their data. This makes the metadata details within the original "vertical silo" of the collecting organization accessible to third parties thus making for reliable sharing of the information.
- **ETSI ISG CIM** is developing an API (NGSI-LD) to exchange the definitions/metadata/context, for IoT information, and for Linked Data from numerous repositories, for input from various devices, plus handling of requests from users (or their Apps) to access the data and to check the provenance (source, licensing, "freshness" etc.) of information.

EMERGING STANDARDS

- **IEEE 1888** Ubiquitous Green Community Control Network Protocol for measurement and control networks for home and residential quarters so that they can achieve green, smarter functions. It specifies the interactive data format between devices and systems as well as the standardized definitions of the sensor, actuator, and equipment, together with the data communication processes. It also includes the data format definition for configuration and management-oriented functions; the data format definition for deployment and control-oriented functions; and the method definition for conformance and interoperability tests.
- **OASIS** (Organization for the Advancement of Structured Information Standards) - OASIS Message Queuing Telemetry Transport (MQTT) Technical Committee (TC): The MQTT TC is developing an open publish/subscribe protocol for telemetry messaging designed to be simple, lightweight, and suited for use in constrained networks and multi-platform environments

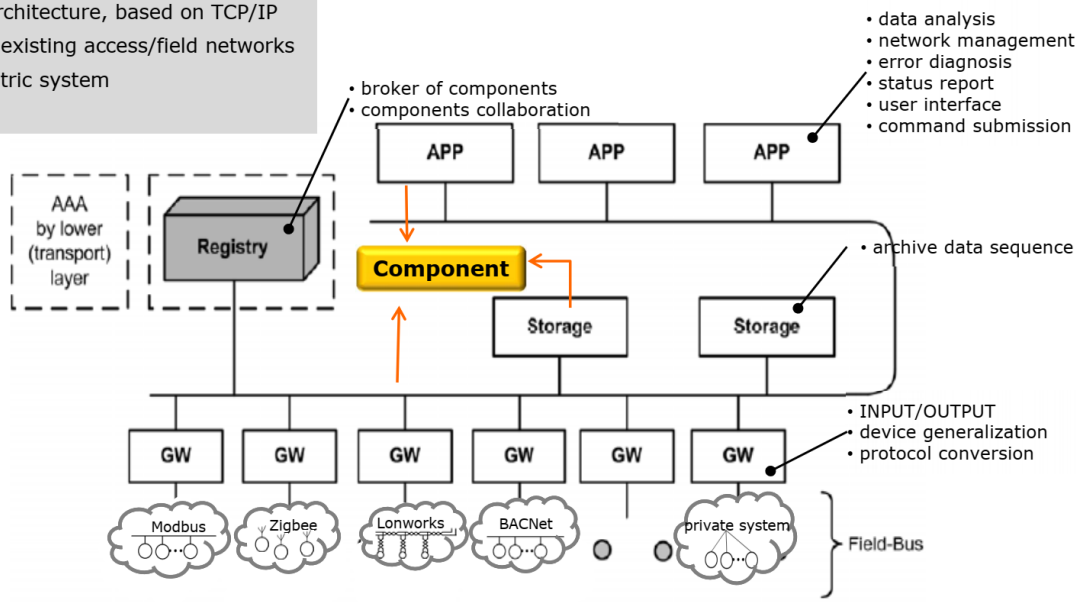
- The **Thread Group** started by Google (NEST), Apple, ARM, Haiku Home, NXP, Samsung Electronics, SiliconLabs, and Yale Security currently has over 230 member organizations and has developed the Thread Stack for connecting products in the home. Thread is built on open standards and IPv6 technology with 6LoWPAN as its foundation. It leverages a wireless mesh network to connect devices to each other, the internet and cloud services.
- The **Open Connectivity Foundation** (OCF) - A non-profit organization that defines connectivity requirements for interoperability between IoT devices. OCF develops specifications, open source implementations and a certification for Smart Home Devices program for diverse markets. OCF supports the IoTivity2 open source effort, which is a reference implementation of OCF specifications
- **Object Management Group** - Data-Distribution Service (DDS) Platform Special Interest Group: DDS defines a virtual Global Data Space where applications can share information by reading and writing data-objects addressed by means of an application-defined name and a key. DDS features fine and extensive control of quality of service (QoS) parameters, including reliability, bandwidth, delivery deadlines, and resource limits. DDS also supports the construction of local object models on top of the Global Data Space.
  CORBA is OMGs most well-known standard.

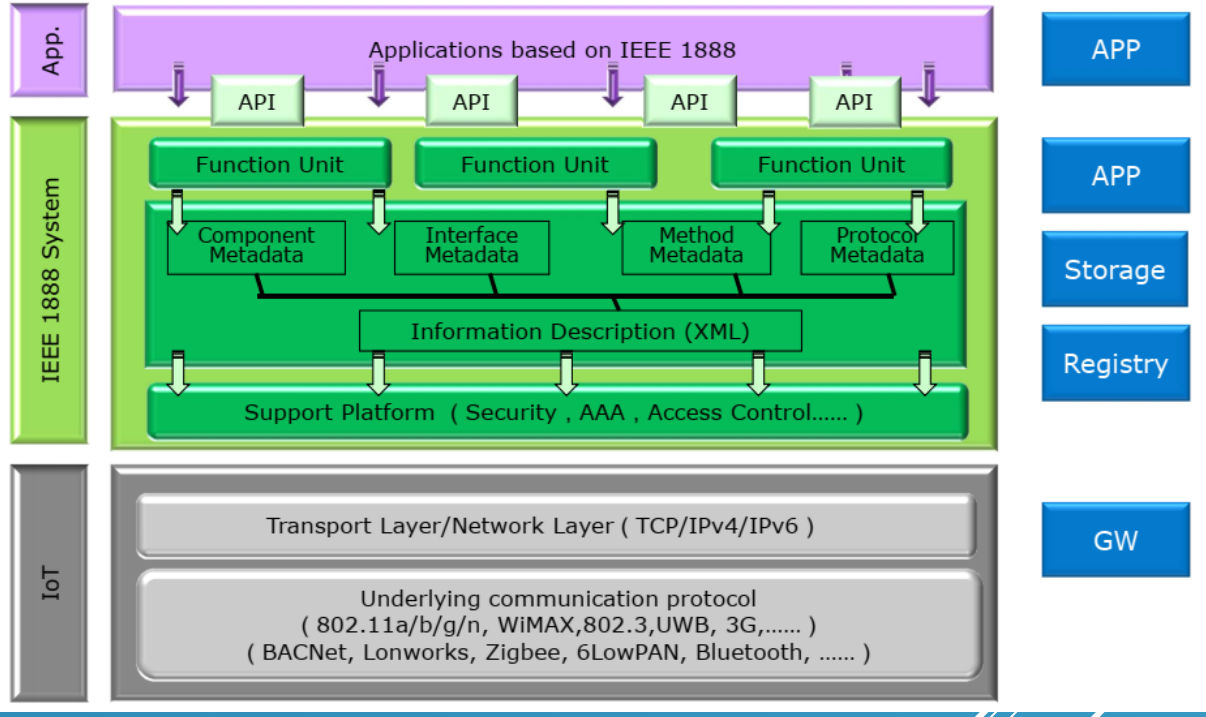
MIPI

- **MIPI I3C** is a bus interface implemented on a standard CMOS I/O that uses a two-wire interface for connecting sensors to an application processor.
- MIPI I3C can integrate mechanical, motion, biometric, environmental, and any other type of sensor.
- MIPI I3C supports a minimum data rate of 10 Mbps with options for higher performance high data rate modes.
- Additional technical highlights include multi-master support, dynamic addressing, command-code compatibility, and a uniform approach for advanced power management features, such as sleep mode.
- It provides synchronous and asynchronous time-stamping to improve the accuracy of applications that use signals from various sensors. It can also batch and transmit data quickly to minimize energy consumption of the host processor.
- I3C was initially intended for mobile applications as a single interface used for all digitally interfaced sensors. It is now intended for all mid-speed embedded applications across sensors, actuators, power regulators, MCUs, FPGAs, etc.
- The interface is useful for other applications, as it offers high-speed data transfer at very low power levels while allowing multi-drop, which is highly desirable for any embedded system.

IEEE IOT STANDARDS

- Innovations
  - All-IP open architecture, based on TCP/IP
  - federation of existing access/field networks
  - database-centric system
  - unified AAA





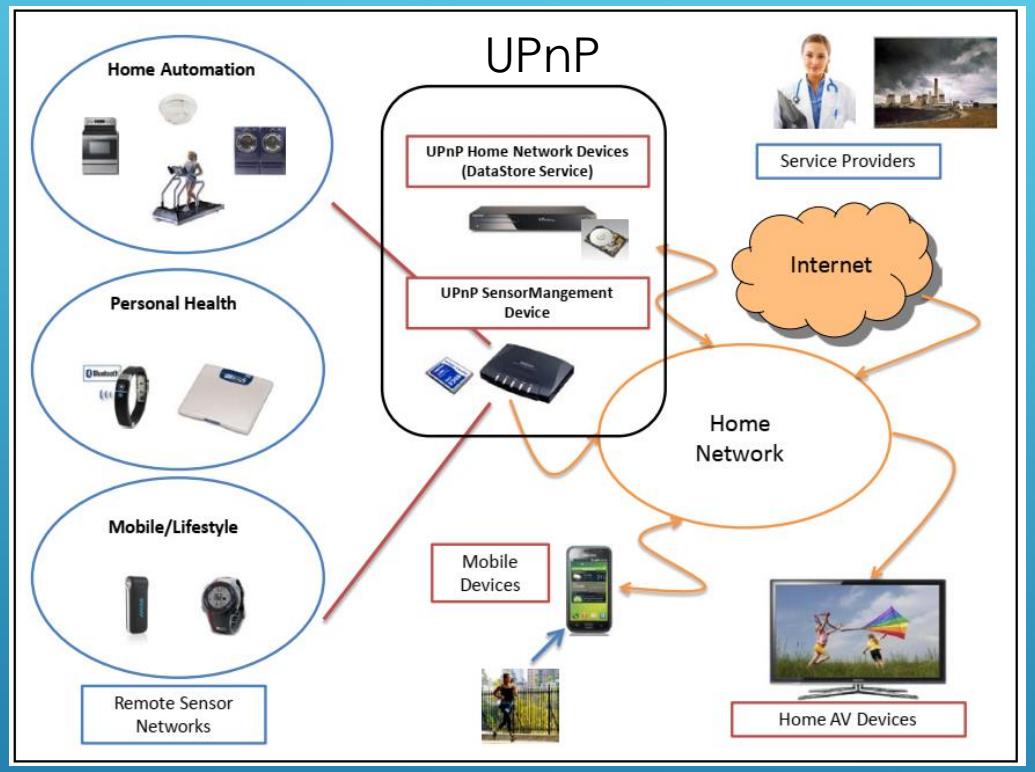
1888 Ubiquitous Green Community Control Network Protocol

IEEE 1451.0™-2007 - IEEE Standard for a Smart Transducer Interface for Sensors and Actuators - Common Functions, Communication Protocols, and Transducer Electronic Data Sheet (TEDS) Formats
IEEE P2413 - Standard for an Architectural Framework for the Internet of Things (IoT) that defines relationships among various IoT verticals (e.g., transportation, healthcare, etc.) and common architecture elements. It also provides a blueprint for data abstraction and the quality "quadruple" trust that includes protection, security, privacy, and safety."

OASIS

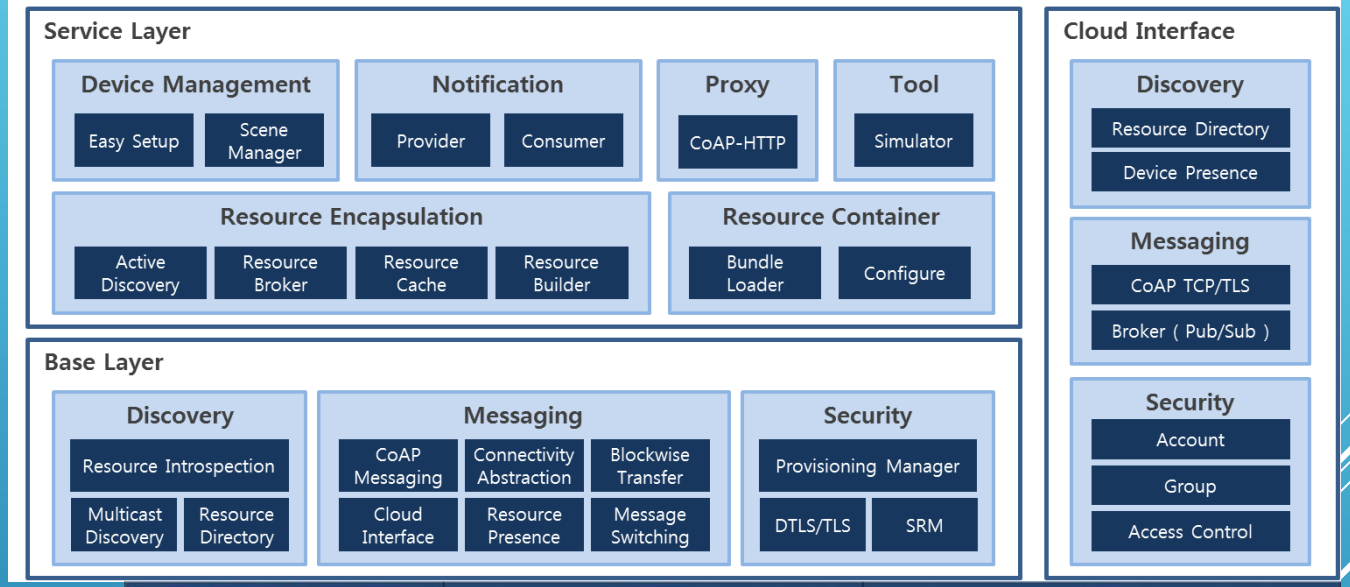
- Oasis sponsors the Message Queuing Telemetry Transport Protocol MQTT V3.1, together with enhancements, documented usage examples, best practices, and guidance for use of commonly available registry and discovery mechanisms. The standard supports:
  - bi-directional messaging to handle both signals and commands,
  - deterministic message delivery,
  - basic QoS levels,
  - always/sometimes-connected scenarios,
  - loose coupling, and
  - scalability to support large numbers of devices.
- Enhancements include:
  - message priority and expiry,
  - message payload typing,
  - request/reply, and
  - subscription expiry.
- As an M2M/Internet of Things (IoT) connectivity protocol, MQTT is designed to support messaging transport from remote locations/devices involving small code footprints (e.g., 8-bit, 256KB ram controllers), low power, low bandwidth, high-cost links, high latency, variable availability, and negotiated delivery guarantees.
- For example, MQTT is being used in sensors communicating to a broker via satellite links, and in a range of home automation and small device scenarios. MQTT is also used for mobile applications because of its small size, minimized data packets, and efficient distribution of information to one or many subscriber receivers.

OPEN CONNECTIVITY FORUM



- IoT Management and Control Architecture Overview
- IoT Management and Control Device
- IoT Management And Control DataModel Service
- IoT Management And Control Transport Generic Service
- DataStore
- Schema Files
- Industry is seeking open-source software for low levels of the software stack so that their resources may be focused on developing higher-level applications.

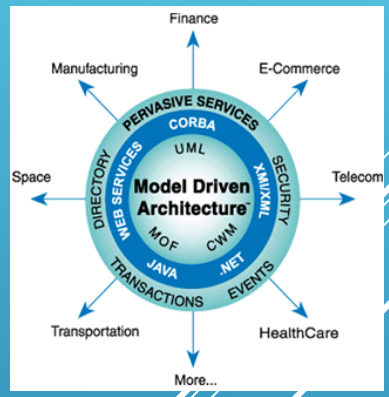
- **IoTivity v1.2**



Component (Base Layer)	Feature	설명
Discovery	Multicast Discovery, Device Presence	Discover Resource, check device presence
	Resource Introspection	Resource type/property management
	Resource Directory	DNS service for Resource
Messaging	CoAP Messaging	Transmit messages between devices
	Block-wise Transfer	Block data transfer (more than 1KB data)
	Connectivity Abstraction	Wi-Fi, BLE, BT abstraction with CoAP
	Cloud Interface	CoAP/TCP, OAuth, Account, Pub/Sub
	Message switching	Routing thru hetero-connectivity devices
	Connection management	Automatic connection management (BLE)
Security	DTLS/TLS	Secure data channel with encryption
	Security Resource Manager	Access control(CRUD), Key Management
	Security Provisioning Manager	Transmit credential for authentication

OBJECT MANAGEMENT GROUP

- **Common Object Request Broker Architecture (CORBA)**
- OMG created the Common Object Request Broker Architecture standard in 1991. CORBA enables software written in multiple computer languages and running on multiple computers to interoperate. Data Distribution Service (DDS) is publish/subscribe middleware for distributed systems that augment CORBA with a data-centric publish-subscribe specification.
- **Model-driven architecture (MDA)**
- OMG evolved towards modeling standards by creating Unified Modeling Language (UML) followed by related standards for: Meta-Object Facility (MOF), XML Metadata Interchange (XMI), MOF Query/Views/Transformation (QVT) and Model to text transformation language (MOFM2T).



- Systems Modeling Language (SysML), a modeling language based on UML has been standardized in collaboration with INCOSE.
- UML modeling and the Semantic Web adopted the *Ontology Definition Metamodel* which relates UML models in a standard way with RDF and Web Ontology Language (OWL).
- Semantics of Business Vocabulary and Business Rules (SBVR) incorporates the formal use of natural language in modeling and provides a formal language model. Based on a fusion of linguistics, logic, and computer science, SBVR captures specifications in natural language and represents them in formal logic so they can be machine-processed.

IETF STANDARDS

- **Home Networking Architecture** RFC7368
- This RFC describes evolving networking technology within residential home networks with increasing numbers of devices and a trend towards increased internal routing. This document defines a general architecture for IPv6-based home networking, describing the associated principles, considerations, and requirements. It highlights specific implications of IPv6 for home networking, discusses the elements of the architecture, and suggests how standard IPv6 mechanisms and addressing can be employed in home networking. The architecture describes the need for specific protocol extensions for certain additional functionality. It assumes that the IPv6 home network is not actively managed.
- **Architectural Considerations in Smart Object Networking** RFC7452
- Smart objects are devices with constraints on energy, bandwidth, memory, size, cost, etc. An increasing number of products put the Internet Protocol Suite on smaller and smaller devices and offer the ability to process, visualize, and gain insight from the collected sensor data. The network synergy can be increased if the data collected from many different devices can be combined. This RFC provides high-level guidance on the use of Internet technology for the development of smart objects, and connected systems in general.
- **Authentication and Authorization for Constrained Environments** RFC 7744 The ACE working group aims to produce a standardized solution for authentication and authorization to enable authorized access in constrained IoT environments where nodes are limited in CPU, memory and power.
- **Home Networking Control Protocol** RFC7788
- This RFC describes the Home Networking Control Protocol (HNCP), an extensible configuration protocol, and a set of requirements for home network devices. HNCP is described as a profile of and extension to the Distributed Node Consensus Protocol (DNCP – RFC7787). HNCP enables discovery of network borders, automated configuration of addresses, name resolution, service discovery, and the use of any routing protocol that supports routing based on both the source and destination address.

RETAIL STANDARDS

- **Walmart** is asking companies that want to sell smart home products to make sure those products work with **Google Home**. The retailer has instructed potential suppliers to ensure that their products support Google Home, and if they also support Amazon Alexa, that they make such certification visible on the packaging.
- Walmart suggested that it would prefer if providers didn't host their services on Amazon Web Services, and that the ideal smart home products shouldn't require a hub.
- Amazon is Walmart's arch-rival in the retail space; meanwhile, Walmart has clearly indicated its discomfort with Amazon's reach in cloud computing and logistics. In June of last year, The Wall Street Journal reported that Walmart had told its tech vendors to move off of Amazon's cloud.
- Also last year, Walmart signed a deal with Google to provide hundreds of thousands of products that Google Home customers could order by voice using their Google Home and Google Express service.
- Walmart offered impressive discounts on Google Minis during Amazon's "Prime Day" discounting event in July, and expect similar deals in the smart home arena bundling Google Home devices with other smart home products for this year's holiday season.
- Most device makers try to support Alexa first, Google second, and in many cases, weigh the benefits of HomeKit (Apple).
- **IKEA** has built its own line of connected products with a focus on low prices and easy installation.
- **Lowe's** has its own smart home hub and Iris-branded products to match the hub, though it also sells a wide range of other connected products.
- **Home Depot** and **Best Buy** both sell products from a variety of vendors.
- **Amazon's Alexa** is currently the team to beat when it comes to building a better smart home, It doesn't seem like Walmart is penalizing companies that work with Amazon, which would be a step too far.

SECURITY

- **NIST Cybersecurity Framework**
- The NIST Cybersecurity Framework is a 3 part risk-based approach to managing cybersecurity risk:
  - **Framework Core** - The Framework Core is a set of cybersecurity activities, desired outcomes, and applicable references that are common across critical infrastructure sectors. The Core presents industry standards, guidelines, and practices in a manner that allows for communication of cybersecurity activities and outcomes across an organization from the executive level to the implementation and operations level.
  - **Framework Implementation Tiers** - Framework Implementation Tiers ("Tiers") provide context on how an organization views cybersecurity risk and the processes in place to manage that risk.
  - **Framework Profiles** - The Profile can be characterized as the alignment of standards, guidelines, and practices to the Framework Core in a particular implementation scenario. Profiles can be used to identify opportunities for improving cybersecurity by comparing a *Current* Profile (the "as is" state) with a *Target* Profile (the "to be" state).
  - "I can think of no industry in the past 100 years that has improved its safety and security without being compelled to do so by government" – Bruce Schneier, 2018
- **NIST SP800-53** covers the steps in the Risk Management Framework that address security control selection for information systems in accordance with the security requirements in Federal Information Processing Standard (FIPS) 200. This includes selecting an initial set of baseline security controls based on a FIPS 199 worst-case impact analysis, tailoring the baseline security controls, and supplementing the security controls based on an assessment of risk. The security rules cover 19 areas including access control, incident response, business continuity, and disaster recoverability.
- **NIST SP800-183** examines the trust concerns of NoTs using the notion of primitives. They are: Sensor, Aggregator (software), Communications Channel, External Utility, and Decision Trigger.

COMMON THEMES

- Syslogd - as defined in RFC 5424
- Time Stamp – EVERY SENSOR & ACTUATOR, COMMAND, Response (use NTP RFC 5905)
  - The pool.ntp.org project is a big virtual cluster of timeservers providing reliable easy to use NTP service.
  - The pool is being used by tens of millions of systems around the world. It's the default "time server" for most of the major Linux distributions and many networked appliances.
- Sensors – provide awareness of the environment.
- Actuators – respond to the environment
- Sensors & actuators should use “Get”, “Set”, and “Trap” routines similar to those used in SNMP
  - Get – enables the event recorder to retrieve information from the sensor or actuator
  - Set – Enables applications that use the event recorder database to set the value of objects at the sensor or actuator
  - Trap – Enables a sensor or actuator to notify the event recorder of significant (or abnormal) events
- Utilities – usage tracking, normality checks, projections, cost minimization routines
- HVAC – temperature humidity controls, occupancy activation, outside anticipation
- Local vs Cloud – “who” owns the data? Monetization, processing power, architecture decision
- Command & Control – useful displays, dashboard, web browser, utility billing management
- Security - pervasive but unobtrusive, upgradeable to respond to future threats
- The greatest Smart Home benefit comes from many devices working together

EVENT RECORDER

- The Smart Homes event recorder is a specialized database conceptually based on *Syslogd*
- Every sensor and actuator must contribute to the event recorder
- Available to user and readily expandable and updated as sensors are changed
- Conceptually similar to a flight data recorder, the smart home event recorder collects the outputs of each sensor, timestamps them, and provides a text based *summary* of the event, as well as links to more data from the sensors if required
- Event data loggers detect when something happened, how long it happened, and how many times it happened.
- Event data loggers monitor discrete (on/off) signals for changes in state in various ways, and those changes are logged along with the date and time of occurrence.
- Continuously changing variables, such as voltage, current, temperature, pressure, and flow are polled "as required" and time stamped in the event recorder.
- This is the "reflex action enabler" of the smart home. Scripts and Programs (apps) fuse the outputs of different sensors together to determine the response of the smart home to different conditions
- Dare we say: "Stream of Consciousness"

DIAGNOSTICS & TESTING

- How do you know if your smart house is properly functioning?
- Connectivity tests
- Sensor calibration
- Initialization routines
- Error messages
- Trend reporting
- Comparison with external environment
  - neighbors' smart houses
  - smart grid
  - smart cities
  - Internet data (such as weather reports)

SOME SMART HOME APPLICATIONS

- **Heating, ventilation and air conditioning** (HVAC): it is possible to have remote control of all home energy monitors over the internet incorporating a simple and friendly user interface. A true Smart Grid is not possible without a smart home. The smart home is a necessary ingredient in a smart grid.
- **Lighting control system**: a "smart" network that incorporates communication between various lighting system inputs and outputs, using one or more central computing devices.
- **Occupancy-aware control system**: it is possible to sense the occupancy of the home using smart meters and environmental sensors like CO_2 sensors, which can be integrated into the building automation system to trigger automatic responses for energy efficiency and building comfort applications.
- **Appliance control** and integration with the smart grid and a smart meter, taking advantage, for instance, of high solar panel output in the middle of the day to run laundry machines and dishwashers.
- **Home security**: a household security system integrated with a home automation system can provide additional services such as remote surveillance of security cameras over the Internet, or access control and central locking of all perimeter doors and windows.
- **Robotics**: Elder care robots, cleaning devices, robotic lawnmowers, pets
- **Safety**: Leak detection, smoke and CO detectors, fire suppression, extinguishers, alarms to public safety orgs
- **Indoor positioning systems** (IPS) (find your keys, the remote, etc.).
- **Special needs**: Home automation for the elderly and disabled, blind, deaf, mobility
- **Pet And Baby Care**, for example tracking the pets and babies and controlling pet access rights
- **Air quality control**. monitor the air quality and pollution level in each home in the area and create a pollution map in smart cities initiative
- **Wearables** – Smart homes will recognize personal wearable devices and send/receive useful information monitor our heart condition and our vital signs, and based on this information in real time create alerts to medical professionals.
- **Health Care** - smart homes may monitor our daily patterns: when we get up, when we go to the bathroom, how long we spend having breakfast, in the bathroom, or take showers. The home can notice the signs of something that is treatable and manageable today but tomorrow could become a huge problem. Include the ability to monitor pollutant levels around us, humidity, temperature, and UV levels and overlay that with personal data like allergies tied to local and regional Smart Cities efforts.

VIDEO SURVEILLANCE

- Key to sensor fusion and integration
- Recognition - people, objects, actions
  - Action recognition is in its infancy; can this be on site or must this be processed within the cloud?
  - Recognition should be a mix of local data and external data (ie, faces on the FBI's most wanted list)
  - Recognition results should be searchable simple text messages in syslog format
    - Name of person, name of object, verb describing observed action
- Authorization – based on recognition after system training
- Pervasive coverage assured by proper camera placement – minimize blind spots
- PTZ upon command (automatic return to initial position)
- Include outdoor areas
  - Night time lighting

AUDIO SURVEILLANCE

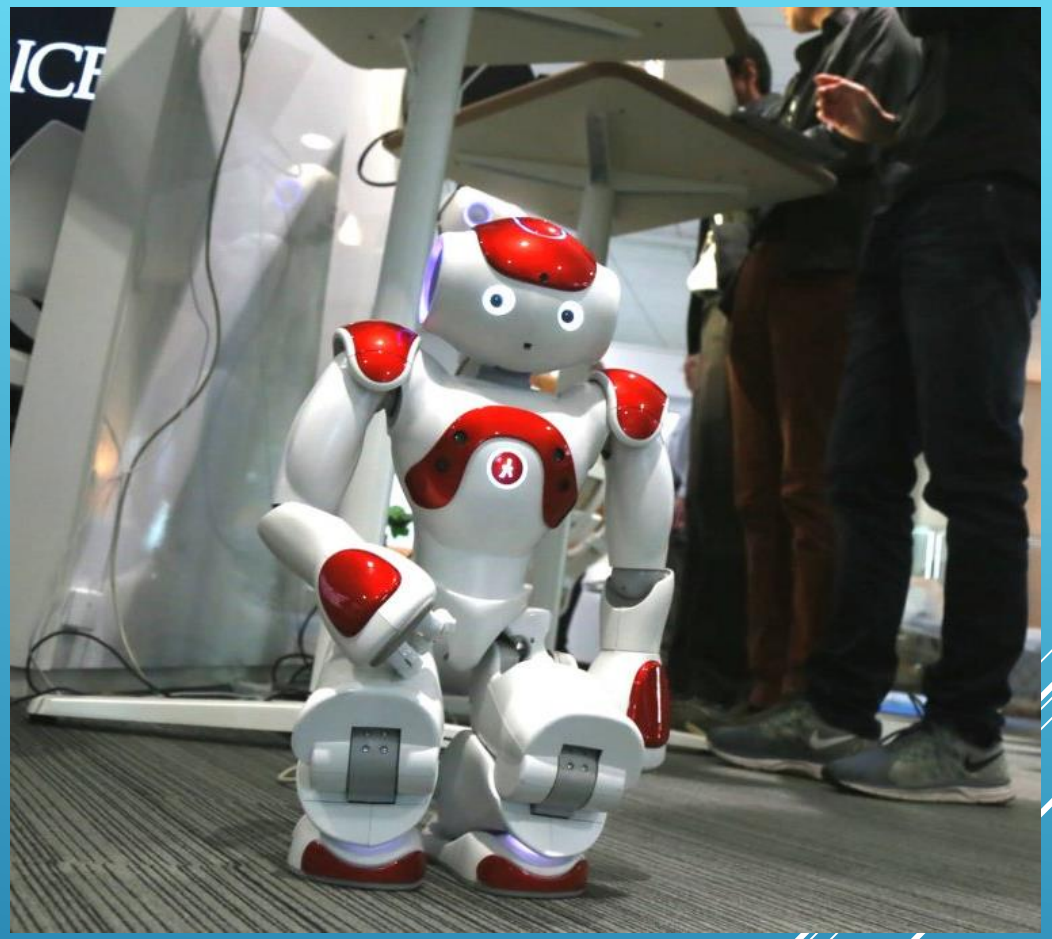
- "Hey Alexa, …"
- Speech recognition,
- Speaker identification
- Object and animal recognition (bugs, birds, and vehicles)
- Speech to text, keywords in event recorder
- Audio triangulation for location
- Integration with home entertainment system(s) and phones
- Call up surveillance cameras based on auditory positional cues
- Current offerings often have weak or non-existent privacy safeguards

UTILITY/ENVIRONMENT SURVEILLANCE

- Power Consumption (kWH), calculate cost, verify utility bill, smart grid parameters
- Voltage, current, power factor (identify devices),
- Water consumption (temperature, pressure, # of gallons, well status) verify utility bill
- Sewage (flow rate, # of gallons, leach field, cesspool status)
- Gas pressure, flow, # of BTUs, verify utility bill, safety monitor cutoff
- Cable, Internet – verify connectivity, utility bills
- Weather – local temperature, wind speed, humidity, rainfall/snow depth
- Report to Owner usage graphs, trends: daily, weekly, monthly, quarterly, annual

HEALTH SURVEILLANCE

- Measure pulse, blood pressure, blood sugar, blood oxygen, hours of sleep, perform stool and urine analysis
- Provide alerts of medical interest
- Integration with wearable technologies
- Record what and how much food is eaten per person
- First Aid Kit help, date codes, re-order supplies, doctor, clinic, emergency room
- Elder Care Robotics
- https://arstechnica.com/gadgets/2018/10/amazon-patents-alexa-tech-to-tell-if-youre-sick-depressed-and-sell-you-meds/



A prototype robot that could assist senior citizens by detecting vital signs.
IBM Research/Flickr

SMART APPLIANCES

- All appliances instrumented
- All events recorded and time stamped (use NTP)
  - For example: Home version of SNMP using "appliance MIB"
    - John Romkey developed a "Toaster MIB" in 1990 for a demonstration at the InterOp trade show
- May be wireless (Wi-Fi) if small portable appliance or
- Wired (Ethernet) for large fixed appliances such as refrigerator, dishwasher, washer/dryer, stove/oven, furnace, water heater
- Provide smart grid compatible operation
- Amazon offers a microwave powered by Alexa, its voice assistant for $60, but it is also selling the chip that gives the device its smarts to other manufacturers, making Alexa connectivity an easy proposition for a wide variety of home appliances, like fans, toasters, and coffee makers.
- Recently both Facebook and Google unveiled their own home "hub" devices that let you watch videos and perform other digital tricks by voice.

SAFETY SYSTEMS

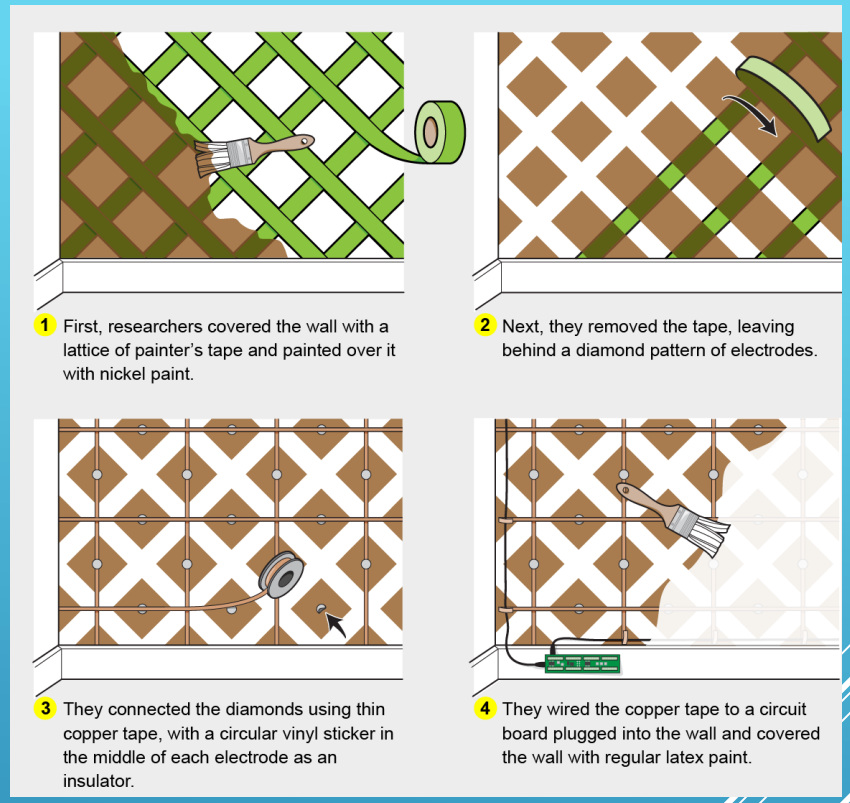
- Smoke Detection
- CO_2 Detection
- Gas Leak Detection
- Fire Suppression Sprinklers
- Flood Detectors
- Intrusion Detection
- Automated Door locks
- Storm Safety (tornado alerts, lightning detection, wind speed, precipitation)

SMART CONTAINERS

- Definition of Container (drawer, shelf, storage bin or box, closet, etc.)
  - A container is any receptacle or enclosure for holding a product used in storage, packaging, or shipping. Things kept inside of a container are protected by being inside of its structure. The term is most frequently applied to devices made from materials that are durable and are usually at least partly rigid.
  - A container can also be considered as a basic tool, consisting of any device creating a partially or fully enclosed space that can be used to contain, store, and transport objects or materials.
  - The characteristics that create utility for a container go beyond just providing shock and moisture protection for the contents. A well-designed container will also exhibit ease of use, so it is easy for the worker to open or close, to insert or extract the contents, and to handle the container in shipment. A good container will have convenient and legible labeling locations, a shape that is conducive to efficient stacking and storing, and easy recycling at the end of its useful life
- Sensors indicate current state, capacity limits, List contents (inventory), Date codes, SKUs , text description, temperature, weight, (derive and indicate $$ value – feed to insurance)
- Who opened, closed container – when, what was put in, taken out
  - Is "who" sensor part of surveillance system?

SMART WALLS

- Convert a Wall into a Giant Touch Screen that tracks people's gestures or monitors appliances
  - By Prachi Patel on June 1, 2018, Scientific American
- To create the high-tech surface, Zhang and his colleagues applied painter's tape in a lattice pattern to a 12-by-eight-foot wall, then coated it with commercially available conductive nickel paint. Removing the tape left a pattern of diamond-shaped electrodes, which the researchers connected using a grid of thin copper tape strips. They affixed a vinyl sticker in the middle of each diamond to insulate the electrodes from one another. Finally, they wired the strips to a custom-built circuit board and covered the wall with standard latex paint.
- In tracking a touch or gesture, the wall functions similarly to a smartphone screen. The circuit board prompts the electrodes to emit an electric field; when a person's body intercepts this field, it triggers a measurable change in current at the nearby electrodes. The user must be within three feet of the wall for it to work, however—a limitation the researchers are working to overcome.
- In the wall's appliance-detection mode, the power is turned off, and the electrodes act as an antenna to passively pick up electromagnetic waves emitted by nearby devices. The researchers detected iPads up to 6.5 feet away from of the wall; fans and floor lamps could be sensed from about 10 feet.



Zhang and his colleagues at Disney Research presented the wall in April at the CHI Conference on Human Factors in Computing Systems in Montreal.

ROOMS

- Container for People, Furniture, Stuff
- Maintain Comfortable Environment
  - Positive Pressure HVAC, dust filters – HEPA, electrostatic
  - Lighting, - Color, Intensity, Directional Pattern
  - Auditory – Entertainment, Command & Inquiry, Sonic Direction Finding,
  - Visual Display – Art, Video, Surveillance Display
- What does/should "Smart" do?
  - Maintain Inventory, insurance list
  - Personalization
  - Operating Expense Minimization
- Windows
  - open close analog actuator up-down, left-right, position sensors, smart glass
  - window blinds open-close
  - window drapes, curtains open-close
- Doors
  - Lock – Unlock, video camera/microphone, position sensor, environmental response

KITCHEN

- Food Preparation & Cooking –check date codes
- Eating
- Food Storage and Supplies
- Dinner Clean-up
- Dishwasher uses sensors to detect how much grime is on whatever's inside, then adjusts water level and temperature accordingly. It also cools the contents after drying, to avoid steaming-hot cutlery.
- Garbage & Litter
- Pets
- https://www.wired.com/review/hestan-smart-induction-cooktop/

BATHROOM

- Shower
- Bath
- Toilet, Analyze wastes, report, water usage
- Dressing Area
- Makeup and Hair Styling
- Storage of Soaps, Cosmetics, Towels, TP
- GFI Outlets: Hair Dryers, Hair Irons, Shavers (identify powered devices, time stamp usage, safety)
- First Aid Kit (record who accessed, what was used, replenish list)

LAUNDRY

- Washer
- Dryer
- Ironing
- Sewing
- "Folding" Table
- Laundry Sink
- Clothes Line Drying (Solar powered dryer ☺)
- Laundry Soap/Detergent/Bleach Storage

LIVING ROOM

- Family Gatherings
- Conversation & Discussion
  - Fact Checker
- Snacking
- Entertainment
- Art
- Music & Sound

DINING ROOM

- Family Dinners
- Food Distribution
- Dinnerware Storage and Display

BEDROOMS

Sleep

Relationship Enhancement

Reading

Clothes Storage

Dressing Area

Exercise

DEN

- Family Entertainment
- Family Games
- Homework
- Audio Visual
- Home Theatre
- Books (Library)
- Music

HOME OFFICE

- Internet
- Computer
- Printer
- Telephone (office extension)
- Security perimeter

PORCH / DECK / PATIO

- Barbeque
- Porch Swing
- Table & Umbrella sunscreen, rainwater control
- Outdoor Lighting
- Insect Control
- Music & Entertainment

GARAGE

- Door Opener
- Vehicle Detection
- Vehicle mass measurement
- Vehicle up/down loads
- Pits / Lift for maintenance
- Storage
- Tools

SHED

- Lawn Equipment & Supplies Storage
- Bicycles
- Garden Hoses
- Smart sprinklers
- Fertilizer
- Insecticide
- Herbicide

DRIVEWAY

- Vehicle Detection
- Lighting
- Ice/Snow Melt
- Car Wash area prep
- Water Runoff

Context-aware convenience at home will come soon. We all have lots of keys and many of us have garage door openers. But do we really need a physical key at all? Can a system recognize us and let us in without a key? When your car is approaching the driveway, your home senses you as the homeowner returning and automatically opens the garage door. And when you leave the house, it should close the door, lock it automatically because it knows you are gone, and activate your alarm system.

E-HOUSE INITIATIVE

- e-House is located in Stone Ridge, New York Mid-Hudson Valley at the edge of the Catskill Forest Preserve. Its sculptural shape features trapezoidal "View Catcher" and "Light Catcher" rooms that protrude from the building's rectilinear stone-clad passive solar shell. Its plan is based on a traditional great room with get-away rooms and the organizational planning and circulation patterns are uniquely based on the compression and flow as experienced in nature.
- e-House will function as a smart house in which all major functions are distance controlled and monitored from a Website. Architected/designed by Mike McDonough.
- An experimental radiant heating, cooling, and snowmelt system with rainwater thermal storage cisterns and heat exchangers will be the high performance centerpiece of the building. Other emerging technologies include one of the first autoclaved aerated concrete block wall systems in the United States, in conjunction with structural insulated panels, engineered lumber trusses, and a variety of new insulations.
- "Today's home-control systems are often based on a kind of novelty approach to home management," McDonough explains. "People find it cool to open the blinds with a remote control. OK, that's fine, but . . . you end up with a handful of remotes and no real satisfaction or accomplishment. The e-House can do that—however, what it really does is open blinds to warm the kitchen with morning sun, and close blinds when the wind speed or outside ambient temperature results in a significant heat loss. It's remote, automated, energy-conservation management."

E-HOUSE TECHNOLOGIES

- **High Performance Site Planning**
- Aerial digital mapping and photogrammetric surveying
- Complete site resource mapping and minimal site clearing
- Conservation/restoration of native plant species at site
- Recycling of demolition-related materials
- Mature tree preservation
- Strategic re-use of existing site infrastructure
- Site-sourced fill, stone, and lumber
- Community-based micro-agriculture initiatives
- **High Performance Building Envelope**
- Integrated-building planning
- Autoclaved aerated concrete (AAC) and structural Insulated Panels (SIPs) exterior walls systems
- Engineered rubble-trench foundations with slag concrete grade beam system
- Exterior roof decks with slip-resistant porcelain tile, snowmelt, and failure proof substrate
- Self-healing, corrosion resistant stainless steel roofing
- Long lifecycle, moisture-release and vermin-resistant, CFC and HCFC free insulation
- Engineered lumber panels, trusses, studs, plates, beams, and girders
- High-efficiency doors and windows
- Designed-for-deconstruction (DFD) building systems
- **High Performance Interior Finishes Components**
- Engineered bamboo flooring and kitchen cabinetry
- Low toxicity, low VOC primers, finish coats, and vapor barrier paints
- Water-based low VOC floor finishes
- Future-proofed removable wire chase baseboards
- Recycled glass content ceramic tile
- Organic fabric and solid wood furnishings
- Integrated central vacuum cleaner system
- **High Performance Appliances and Equipment**
- Advanced engineering and Energy Star-rated appliances
- Stain proof, computer assisted, low water consumption plumbing fixtures
- Advanced engineering long life-cycle plumbing fittings
- High-efficiency lighting and control systems
- Insulated chimney systems
- **High Performance Mechanical Systems**
- On-site geothermal energy
- Off-site wind power (zero-energy home model)
- Photovoltaic uninterruptable power source (UPS) technologies
- Thermal solar technologies
- Multi-fuel radiant heating, cooling, and snow melt systems
- High efficiency computer monitored domestic hot water
- Centralized displacement ventilation
- Full fresh air dual core ERV-HRV system
- Passive solar high thermal mass floors and roofs
- Computer-controlled rainwater retention
- Thermal reservoir with water-to-water heat exchanger technologies
- **High Performance Smart House Building Controls**
- Demand-response distributed intelligence systems controls
- Supervisory control and data acquisition (SCADA) controls
- Web-based systems monitoring and control
- CAT 5e backbone ELAN with wireless networking
- Cross-platform Mac/PC compatible networking and remote access
- **Alternative Technologies**
- Site-sourced native bluestone exterior walls
- Site-sourced, locally milled lumber
- High-efficiency, wood-fired Rumford fireplace and bake oven
- Integration of local artisans and traditional skills
- Daylighting
- Natural ventilation
- Operable windows

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