The Internet of Things…

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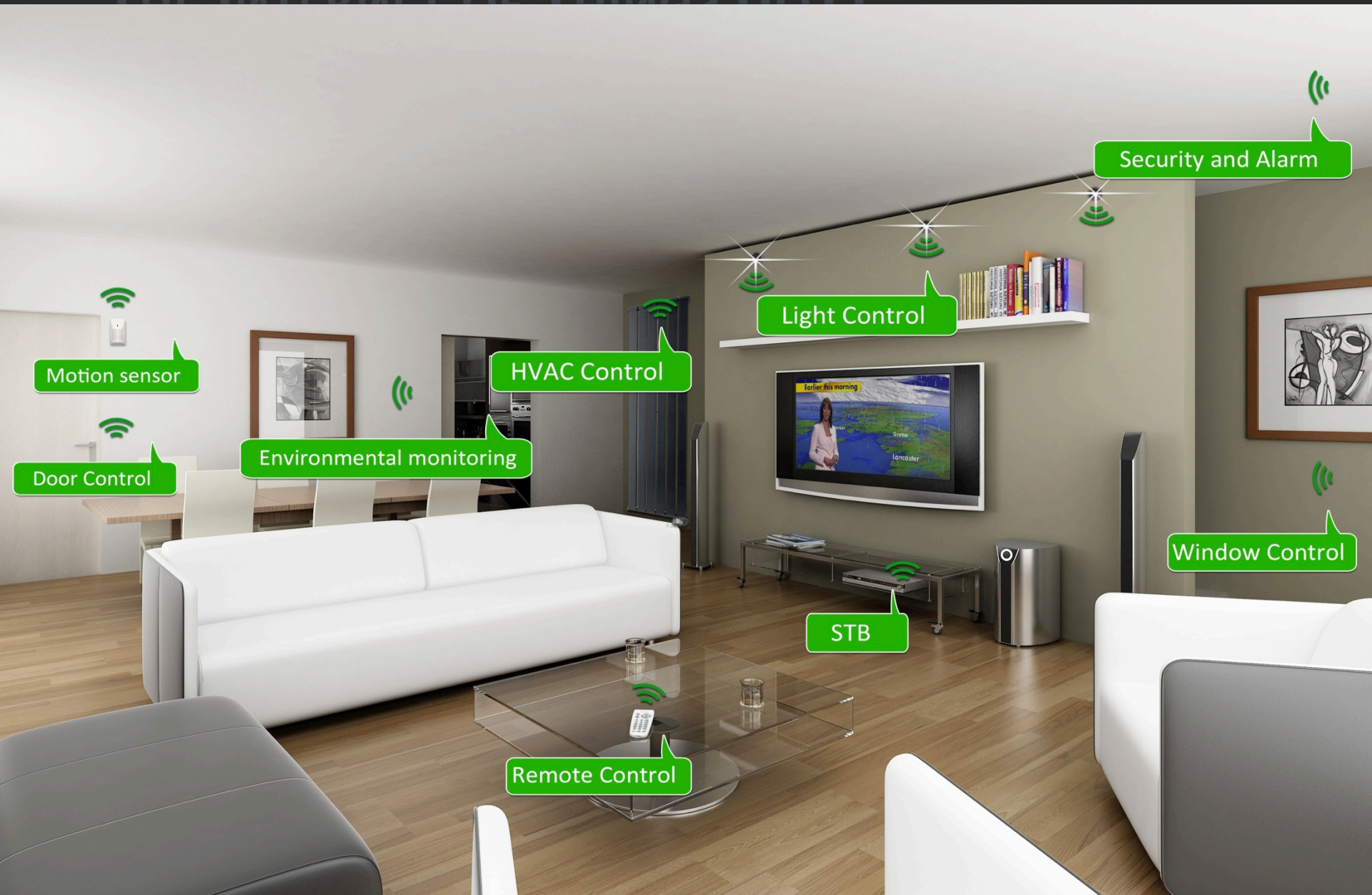
The Internet of Things (IoT)



What is The Internet of Things (IoT)

- **Internet of Things (IoT)** – An Internet like structure of uniquely identified objects
  - What is an Object (or Thing)?
    - **Devices** – Software or firmware that represents a physical piece of hardware
    - **Services** – A software service (e.g., SOAP and RESTful Web Services, EJB, Corba Object)
    - **Data Objects** – Related data bundled into a single Object or Entity
      - Cannot perform direct action, but can be acted upon by services and devices
  - **Identity**
    - The characteristic of an Object that distinguishes it from all other Objects
    - Identity does **NOT** indicate locality or accessibility
      - Where an Object is and if it can be accessed
    - Identity does not describe functionality (but some of the functionality can be inferred)
  - The **Internet of Things (IoT)** is a Conceptual extension of the Internet
    - Numerous implementations, using many technologies
    - Internet Protocol may be used, but is only one small facet

What the Internet of Things (IoT) is Lacking

- **Basket of Remotes** – Many Objects, how do we control them all?
- **Object Discovery** – The Automatic Discovery of Objects over the Network
  - DNS Based Service Discovery (DNS-SD) [IETF ZeroConf & Apple's Bonjour]
  - Simple Service Discovery Protocol (SSDP) [UPnP]
  - Proprietary Protocols using Broadcast or Multicast (Too common, usually poorly done)
- **Object Self Description** – A form of Introspection
  - Provides a means by which an Object can describe its Features to others
  - **Feature Discovery**
    - Uniquely Identified Features

Who is Involved with the Internet of Things (IoT)

- **Eclipse .org** – Eclipse Smart Home (Open Source)
  - One of the first players in the space with Eclipse Smart Home
  - Is a Gateway and Rules Engine for Devices Integration
- **Google** – The Physical Web (Open Source), Nest, Thread (Standard)
  - Leverage Internet Standards & Open Source
  - Thread – A New Open Wireless Protocol Standard
  - Integration
- **Apple** – HomeKit & Home Automation Protocol (Proprietary)
  - Included in iOS 8 and OS X Yosemite
  - Device Profiles
  - iOS and OS X Devices become Gateways and Integration Points

Who is Involved with the Internet of Things (IoT)

- **Microsoft** – Windows
  - Windows for Micro PCs
  - Universal Plug-n-Play (UPnP)
  - Seems to be Treating the IoT as Solutions and not as a Network
- **SMPTE** – ST2071 (Standard)
  - Open Standard for Media & Device Control over IP Networks
- **Home Gateway Initiative**
  - A Consortium of Vendors to Create Standards & a Common Vision
- **Thread Group**
  - A Consortium of led by Google and Samsung
- Many, Many, More

So What is the Internet of Things, Really?

- The Internet of Things is the extension of Device and Network Technologies into the Real World.
  - **Wearable Devices** (Watches, Glasses, Media Players, …)
  - **Appliances**
  - **Cars**
  - **Media & Entertainment Centers**
    - Tactile Feedback (The next 3D)
  - **Sensors**
  - **Home Controllers** (Thermostats, Security Systems, etc…)
  - **Robots**
  - **Connected Everything!**

So What is the Internet of Things, Really?

- Many Implementations
  - Way too Protocols!
    - Z-wave, KNX, Thread, The list goes on and on.
  - Everyone is Working on their own Solutions; Few are Collaborating
    - Re-Inventing the Wheel, over and over and over
- **Commonalities Across All Implementations**
  - **Identity** - Uniquely Identified Objects/Things
  - **Network** Interconnection
  - **Discovery**
    - Objects/Things, Devices, Services
    - Object Self-Description (Not Always Implemented)
      - **Features Discovery** (What the Identified Object/Thing Does)

The Society of Motion Picture and Television Engineers (SMPTE)

SMPTE's Contribution to the Internet of Things

SMPTE ST2071 Media & Device Control

- SMPTE ST2071 Document 1 - Framework
  - A Platform & Protocol Agnostic Framework for the Control of Media & Devices
  - Defines a Hierarchical Structure for Media, Connecting Media to Real World Events
  - Defines a Common Format for Identity
    - **Device Identity**
    - **Service Identity**
    - **Media Identity**
    - **Feature Identity (Capabilities)**
- SMPTE ST2071 Document 2 - Protocol
  - An Open Protocol, SOAP & RESTful Web Services
- SMPTE ST2071 Document 3 - Discovery
  - Device, Service, Feature Discovery (Scalable from the Local Network to the Internet)
- SMPTE ST2071 Document 4 – Interface Repository
  - Federated Repository for the Search and Registration of Documentation & Artifacts

Capability-based Design/Programming

- **Feature Discovery** and Object **Self-Description**
  - Provides a means by which Objects can describe their behavior (Introspection)
- A Capability is a **Uniquely Identified Feature**
- Most Powerful when defined as **small concise features** (e.g., Play, Stop, Pause)
  - Allows Object behavior to be described using well-known, predefined interfaces
    - **Lego™ blocks for Programming** (Object definition, Interface definitions & SOA)
    - Implementers may define their own Capabilities
- New Capabilities can be added statically or dynamically
  - Without affecting interoperability
  - **Clients work with Capabilities they understand, ignoring the ones they don't**
- Why?
  - Object inheritance in strongly typed OOD environments breaks network compatibility
    - Changes the binary / network signature of the Object, requiring client update (Corba, Java)

Capability-based Design/Programming

Develop to the Object Behavior,
NOT the Object Type

Resource Identity (in Practice)

- Resource Identifiers
  - Uniquely Identifies Resources and Groups of Resources
  - Contains a **Type**, **Namespace**, and **Name Value Pairs** defined by underlying system
  - **Device Identity**
  - **Service Identity**
  - **Media Identity**
    - Media Asset, Material, Container, Bundle, Instance, File
  - **Capability Identity** (Feature & Interface Identity)
  - Examples:
    - urn:smpte:**udn**:**com.example**:uuid=12345-12345-12345
    - urn:smpte:**umn**:**com.example**:type=media_asset;mid=12345
    - urn:smpte:**umn**:**com.example**:type=material_asset;mid=12345;umid=0x123…
    - urn:smpte:ucn:org.smpte:device_v1.0

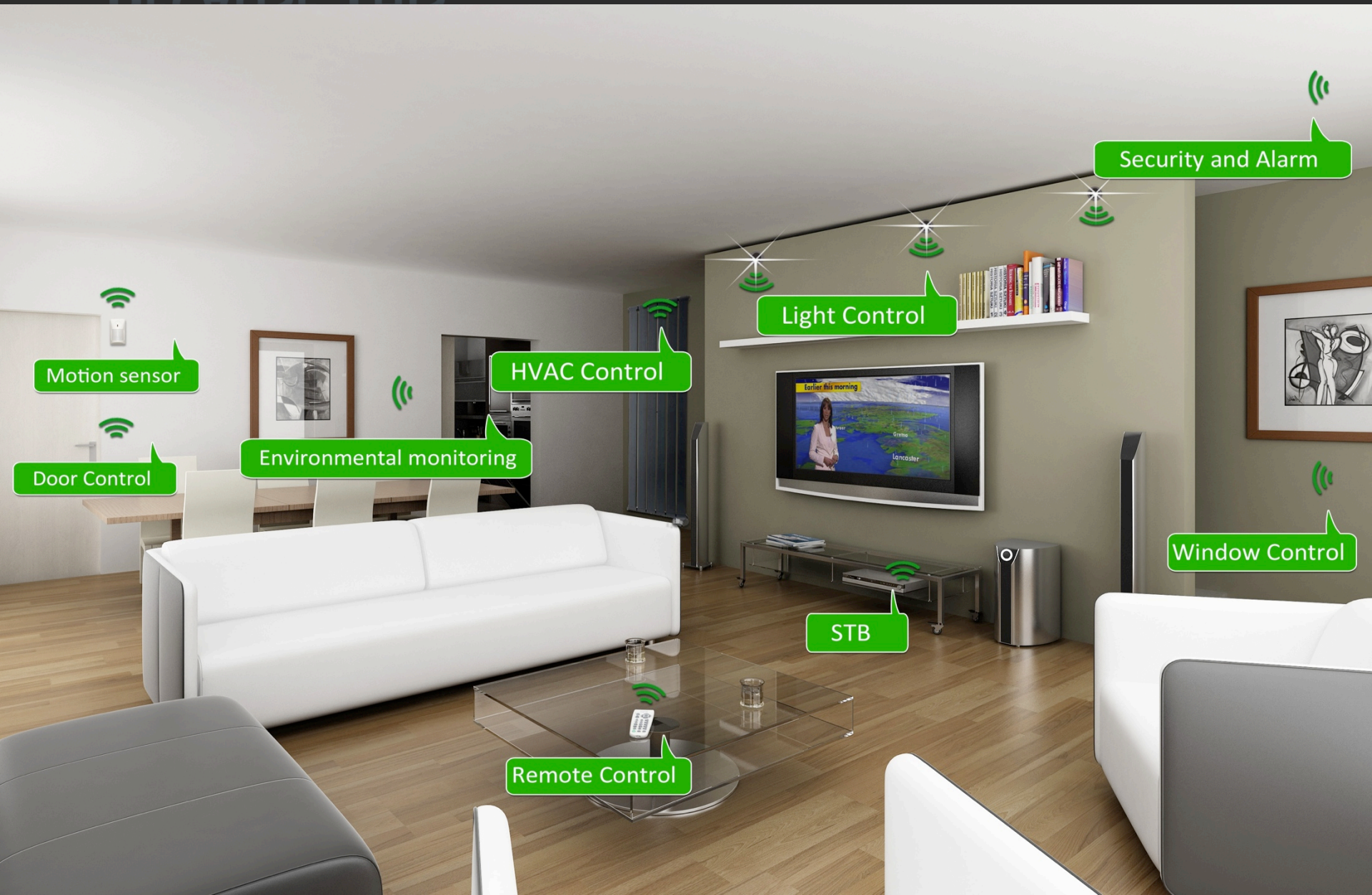
Capability Interface Repository

- Capability Interface Repository
  - DNS for Software Interfaces
    - Requires **Unique Identity and Namespace for each Interface**
    - Supports **SDO**, **Vendor Specific**, and **3rd Party Repositories**
  - Allows Plug & Play for Development
    - Use Service **Discovery** to find devices and services to develop for
    - **Interrogate** device or service for its Capabilities
    - **Use** Capability Repository to get programmatic artifacts for each Capability
      - Documentation
      - WSDL, WSDL Equivalent, and / or Binary Artifacts
      - WADL, YAML

Why is SMPTE & ESPN Interested?

So Why is SMPTE & ESPN Interested in the Internet of Things?

Because This...



Is the Same Problem as This!