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ZigBee Remote Control 2.0:
Updated Standard for Radio Frequency-Based Remote Controls

October 1, 2014
11:00 PST – 20:00 CET

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Agenda & Speakers

- Introduction of ZigBee RF4CE
  - Cees Links, Marketing Working Group Chair & CEO, *GreenPeak Technologies*
- ZigBee Remote Control 2.0 explained
  - Ted Grauch, Vice President, Video Premise Equipment, *Comcast Cable*
- New Features of ZigBee Remote Control 2.0
  - Joseph Reddy, Texas Instruments
  - Arsham Hatambeiki, Vice President, Corporate Product Strategy, *Universal Electronics*
- Question & Answers
  - Ryan Maley, *ZigBee Alliance*

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Introduction of ZigBee RF4CE
ZigBee Remote Control 2.0

Cees Links

Marketing Working Group Chair &
CEO, GreenPeak Technologies

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What is ZigBee RF4CE?

- ZigBee
  - Is the only open, low power networking communication standard
  - It is based on IEEE 802.15.4 standard
  - Networks the widest range of low-power devices to work together
  - Helps consumers and businesses to sense and control their world
- ZigBee RF4CE
  - Is a networking layer that is a full member of the ZigBee family
  - It features simplicity, low cost, robustness against interference and very low latency, especially suitable for human input devices
- ZigBee RF4CE ZigBee Remote Control 2.0
  - Is the new application standard succeeding ZigBee Remote Control 1.x
  - Standardizes multi-vendor remote controls and input devices for consumer electronics and home entertainment equipment

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What is the Design Criteria?

- Connecting consumer electronic devices: remote controls, keyboards, mice, pointers, etc.
- Multi-vendor interoperability between end-devices and host-devices (targets): HD-TV, DVR, Set-top box, Blu-ray player, computers, etc.
- Ease of use: simple pairing/commissioning
- Single worldwide standard, one frequency band (2.4 GHz)
- Robust against interference of WiFi and Bluetooth
- Low latency (<10 ms)
- Secure
- Small software footprint (<32 KB)
- Low-cost

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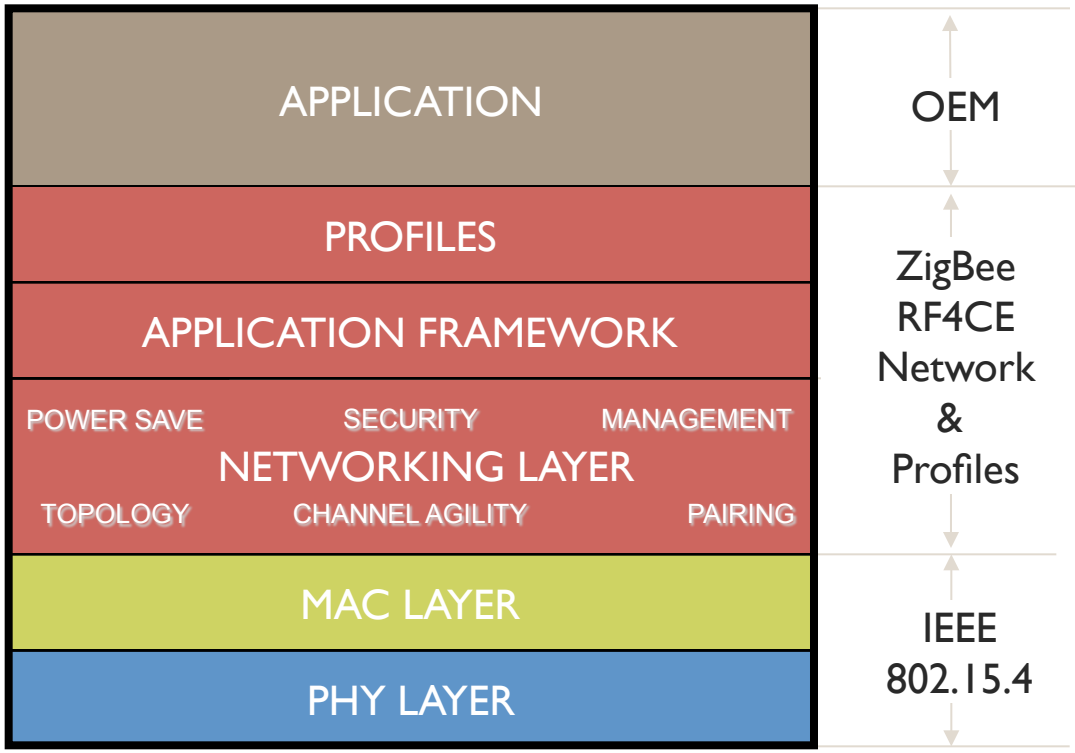
What is defined by ZigBee RF4CE?

- Essentially the whole stack from PHY/MAC Layer up to the (Application) Profiles, including the Application Frameworks and Networking
- IEEE 802.15.4 (2.4 GHz)
- Thin, flexible and future -proof networking layer
- Coexistence with other 2.4 GHz technologies
- Interoperability
- Secure communications
- Power saving mechanisms in network layer
- Simple and intuitive pairing

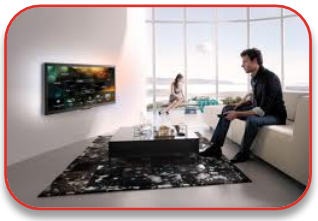


Where is ZigBee RF4CE being adopted?

- A strong ecosystem of technology providers, product developers and (cable) operators have shipped millions of ZigBee RF4CE TV's, set-top boxes, gateways and remote controls

What is the ZigBee RF4CE experience?

- Goes through walls and into cupboards/furniture
  - Set-top-box (STB) can be placed in furniture or another room
  - Multiple room support
- Does not require line-of-sight
  - Not bothered by someone/something “in the way”
  - No pointing at devices required
- Is not sensitive for background light interference
  - Sunlight, LED, fluorescent lights
- Is standardized and selective
  - Supports multiple devices without complex programming
  - Does not unintentionally control unpaired boxes
- Allows for an improved keyboard experience
  - Tactile feedback/triple tap entry/discrete commands
- Supports a long battery life
  - Ultra-low power consumption



Even more benefits with ZigBee RF4CE!

- Bi-directional communication brings unique experiences that were not possible in the IR-era
- Receive and display messages on remotes
  - Program information
  - News highlights
  - Sport results
  - Stock info
- Find the Lost Remote feature
  - Ping a lost remote control with a button on the TV or STB
- Supports new applications
  - Casual gaming (multi-user)
  - Arm-chair payments
  - Ambience control (lighting, air conditioning, curtains, etc.) this is a new feature of ZigBee Remote Control 2.0 that is integrated with ZigBee Home Automation 1.2

And beyond remote controls!

- ZigBee Input Device standardizes communication with other devices
  - Keyboards
  - Touchpads – standardizing touch sense
  - Pointing devices – standardizing motion sense
  - Air mice
  - Wands
- ZigBee Input Device moves ZigBee RF4CE beyond "the remote"
  - Standardizing Internet-TV capabilities
  - Allowing interactive applications, data entry
  - Enabling control of advanced menu structures

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ZigBee Remote Control 2.0 explained

Ted Grauch
Vice President, Video Premise Equipment
Comcast Cable

ZigBee - ZigBee Remote Control 2.0 - Explained

- ZigBee Remote Control 2.0 Represents a very exciting jump forward in global standardization of CE device control
  - Natural Progression from ZigBee Remote Control 1.1
- ZigBee Remote Control 2.0 is the culmination of 2 years of work
  - World's largest Silicon, CE, RC & Service Operators
  - Involved directly or with feedback & commentary
- ZigBee Remote Control completes a full Application – MAC/PHY layer standardization of RF remote control technology
  - All major functions needed in service delivery
  - All major functions required by the CE industry
  - Retail use cases
  - Interoperability at all levels of the stack
  - Test plans & Test houses preparing to certify

ZigBee Remote Control 2.0 - Background

- ZigBee Remote Control 2.0 completes a process begun by ZigBee Remote Control 1.1
  - ZigBee Remote Control 1.1 has seen massive adoption by Service Operators in North America & Europe, and beginning major traction in S.America & Asia
  - 95% of that business is new in the last 36 months
  - Remains Lowest Cost, Lowest Power protocol for Command & Control
  - Ultra high reliability of C&C, High QoS even in high noise environments
- ZigBee Remote Control 1.1 provided all the major building blocks for CE device control in 2011
  - Framework in place under 1.1 specifications
  - But Service operators needed gaps filled
- Great success but needed improvement
  - Operators needed customization
  - Equipment suppliers filled in the application level gaps in the 1.1 specifications with needed implementations
  - US Cable under CableLabs defined the 'MSO Profile' in 2012 to attempt to standardize a portion of application functions for completeness

ZigBee Remote Control 2.0 - Content

- Simplified RF Binding/Pairing Options
- Group Binding/Pairing
- Framework for transferring IR Control Databases and other use-case specific metadata
  - Device to Remote Control and vice-versa
  - Extends to Binary Object transfers such as Firmware
- Find My Remote feature framework
  - Low power implementation
- Firmware Update Trigger methods framework
- Device bridging framework
  - ZigBee Remote Control 2.0 is NOT a mesh network standard
  - Methods standardized to support a bridging of commands onto ZigBee Pro Mesh Networks
- HID Command bank for Pointers/Keyboards
- Enhanced Security

ZigBee Remote Control 2.0 - Next

- ZigBee Remote Control 2.0 Interoperability and Certification Focus
- Service Operator Deployments
  - Expected to ramp in 1H of 2015
- ZigBee Remote Control 2.0 Foundational for a Retail Market
- ZigBee Remote Control 2.0 as a platform for Innovation
  - Frameworks in place for a number of data transfer use cases
  - Interesting new feature and function combinations

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New Features of ZigBee RF4CE
ZigBee Remote Control 2.0

Joseph Reddy
Systems Architect
Texas Instruments

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Binding

- ZigBee Remote Control 2.0 builds on the ZigBee Remote Control 1.x “push button”
  - Enable single-sided pairing (user action only on Controller)
  - Adds explicit user validation to confirm binding
  - Fully backwards-compatible with ZigBee Remote Control1 devices
  - Proxy binding feature
    - Enables out-of-band binding (e.g. NFC etc.)
    - Multi set top box setup

Binding

Bedroom / neighbor

Living room

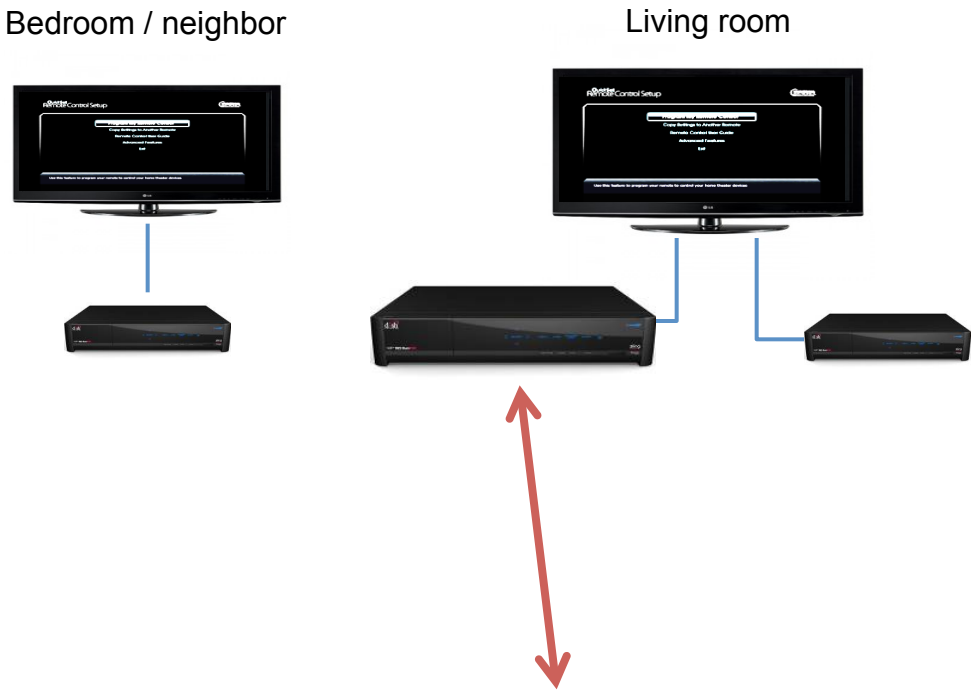
Binding

1. **User pushes button on Controller leading to RF4CE device discovery**

Binding

1. User pushes button on Controller leading to RF4CE device discovery
2. Receives responses from all RF4CE devices

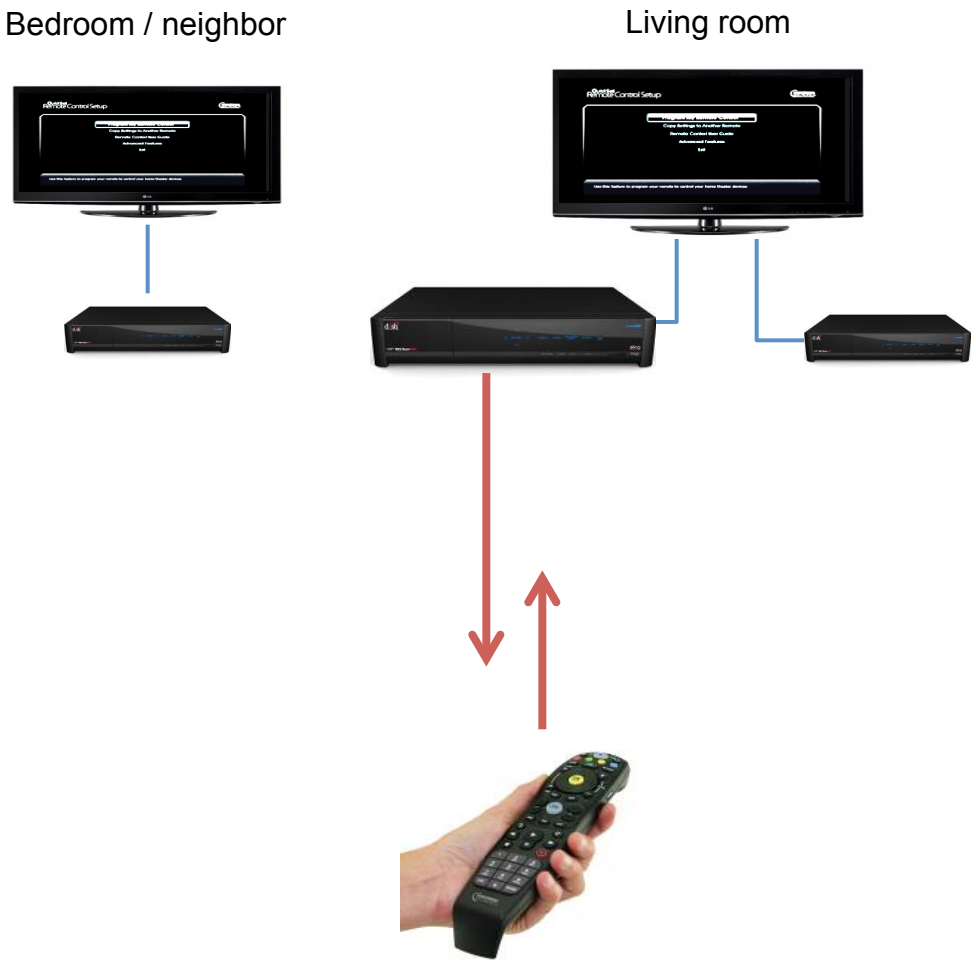
Binding



1. User pushes button on Controller leading to RF4CE device discovery
2. Receives responses from all RF4CE devices
3. Rank devices, make a temporary pairing incl. security with highest rank

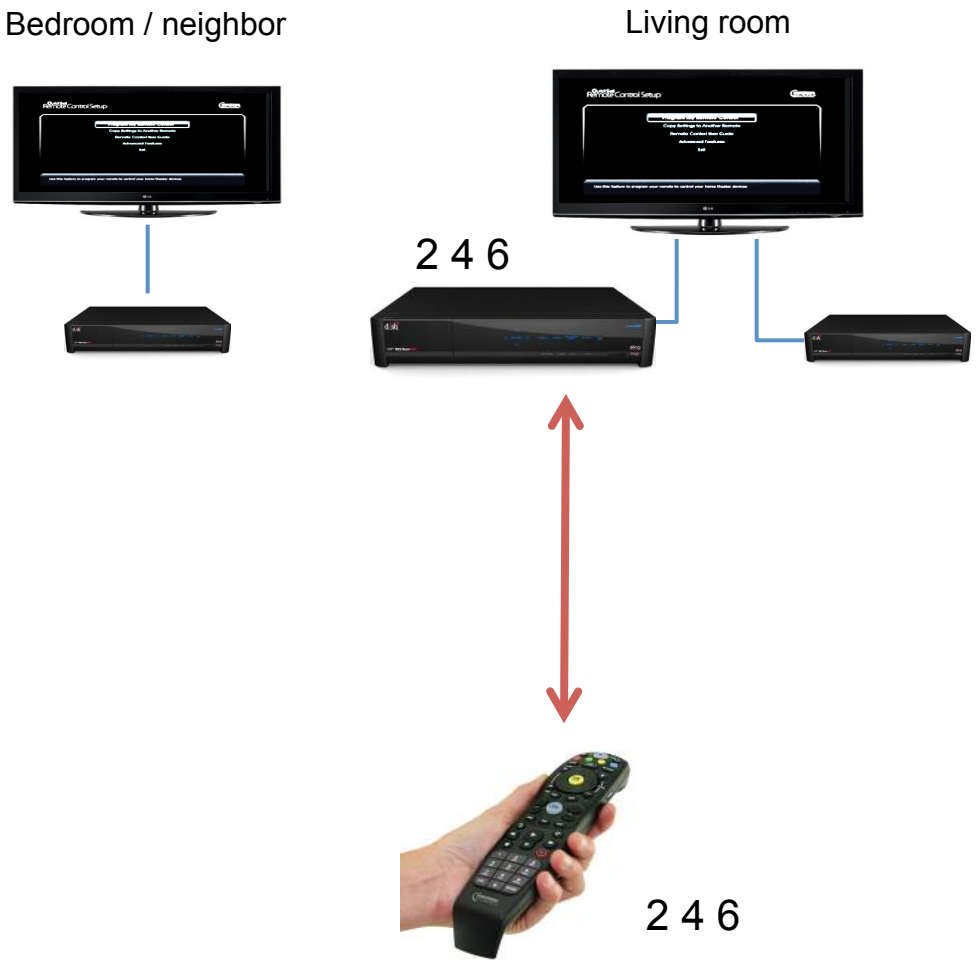
Rank:
1. STB #2
2. TV #2
3. STB #1

Binding



1. User pushes button on Controller leading to RF4CE device discovery
2. Receives responses from all RF4CE devices
3. Rank devices, make a temporary pairing incl. security with highest rank
4. Configure device attributes

Binding



1. User pushes button on Controller leading to RF4CE device discovery
2. Receives responses from all RF4CE devices
3. Rank devices, make a temporary pairing incl. security with highest rank
4. Configure device attributes
5. Validate binding (PIN)

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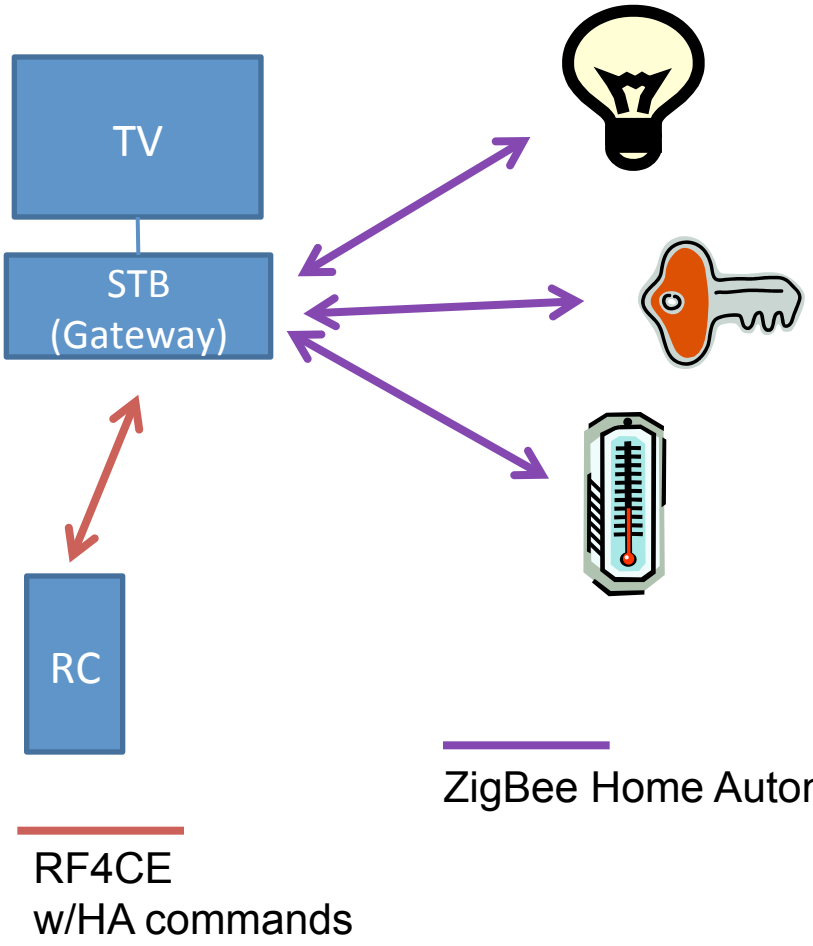
Home Control

- ZigBee PRO is widely deployed for Home Control (Lighting, Security, Energy etc.)
- RF4CE remotes and STB enable a natural way for user to control these devices
- Key benefits
  - Use Remote and STB/TV as the “UI” for command and control of home networking devices

ZigBee PRO Bridging



- Gateway device (STB) joins both ZigBee PRO and RF4CE networks
- RC sends ZigBee Remote Control 2.0 HA commands to GW to e.g. “turn on light X”
- GW converts message to corresponding ZigBee PRO message and relays it to the ZigBee PRO device, e.g. the light bulb

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Security

- ZigBee Remote Control1 has solid frame security
  - Encryption, Authentication and Replay protection
  - AES-128-CCM algorithm
- ZigBee Remote Control2 adds additional enhancements
  - Periodic “re-key” of security material
  - Allows option of vendor-specific secrets
  - Continues to use proven, standard algorithms
    - AES-128-CCM, AES-CMAC hash

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New Features of ZigBee RF4CE
ZigBee Remote Control 2.0

Arsham Hatambeiki
Vice President, Corporate Product Strategy
Universal Electronics

Consumer Home Study Results

“I watch TV to relax but.. my remote makes me feel bad..”

“Our universal remote isn’t programmed to all of our hardware because we couldn’t figure out how to do it.” - Lauren

“I just want one remote. I wish I could just click, click, click to turn everything on or off. ” - Janel

“It sucks having so many remotes. Technology should evolve so that you don’t have to have all these remotes. I’m sure that others could figure it all out, but I can’t.” - Steve

UEI Ethnographic Study; March 2013

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Design Goal

- ZigBee Remote Control 2.0 provides the underlying foundation to enable a true plug & play experience for the user
- Vendor application running in audio & video devices; e.g. STB or TV, can now automatically & intelligently configure controller behaviors to provide a pleasant out of the box experience
- Dynamic configuration of controller behavior also allows simpler remote designs, removing the clutter of keys

User Flow

① Upon initial power up, vendor application notifies the user about discovered devices

② Vendor application identifies control codes for the discovered devices, either locally or through the cloud

③ Control codes are downloaded and mapped to controller keys over 2-way link

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Design Overview

Vendor Application	Vendor specific application capable of automatic or user assisted discovery of AV devices and control codes to configure the controller with the appropriate commands (IR or RF)
ZigBee Remote Control	Action Mapping Server & Client which provide standardized messaging to configure controller action mappings using vendor application in target
GDP	Notification Server & Client allow the flexibility to update action mappings throughout the lifetime of the product upon any change
	Poll Server & Client as the basic foundation of the messaging between a powered and a battery operated device

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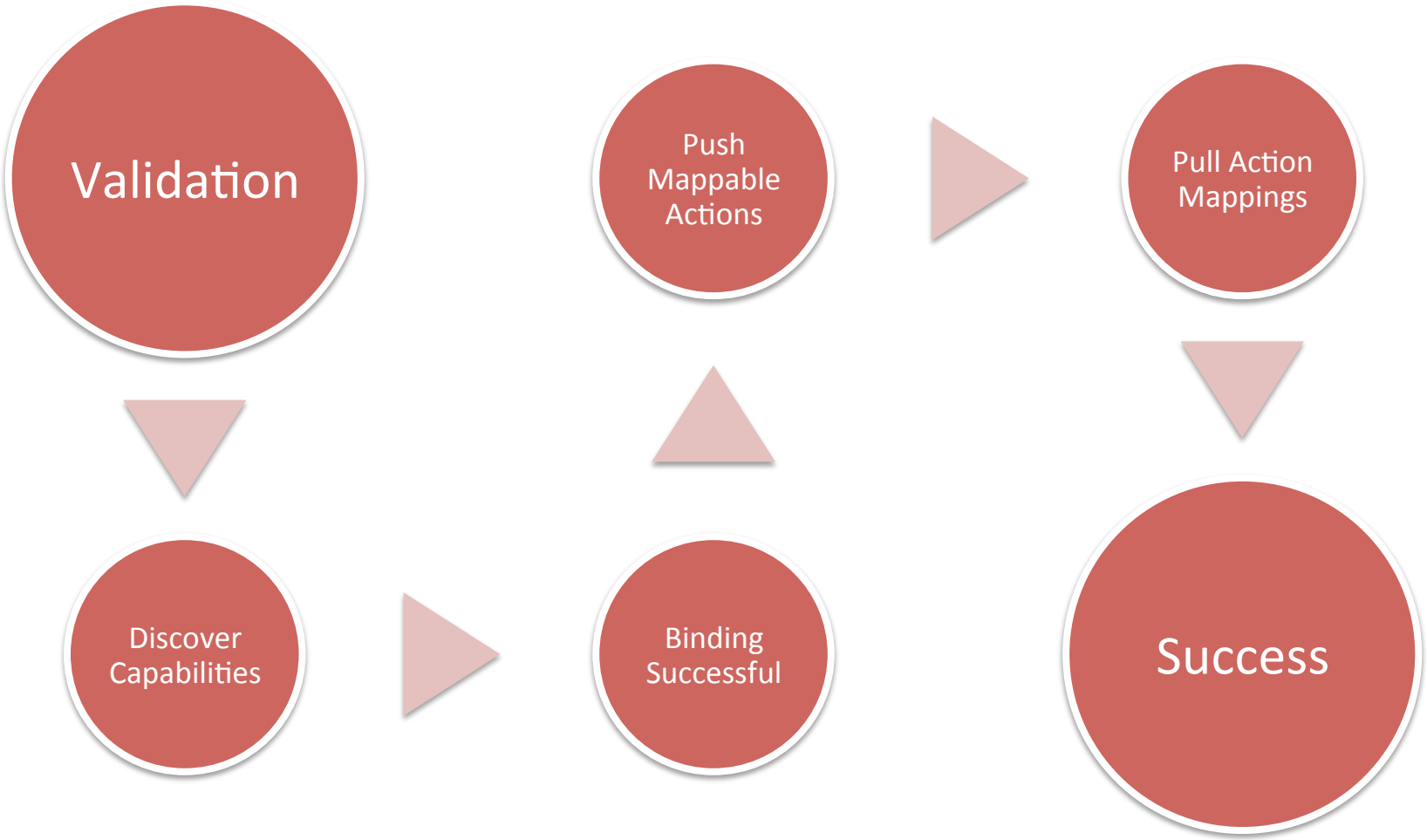
Under the hood



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Configuration Procedure

Exchange Version & Capability Info

- PushAttribute (aplZRCProfileVersion, aplZRCProfileCapabilities, aplZRCActionBanksVersion)
- GetAttributes (aplZRCProfileVersion, aplZRCProfileCapabilities, aplZRCActionBanksVersion)

Action Banks Discovery

- GetAttributes (aplActionBanksSupportedRx)
- PushAttributes (aplActionBanksSupportedTx)

Action Codes Discovery per Bank by Recipient [Rx]

- GetAttributes (aplActionCodesSupportedRx,BankA-BankB) ….
- GetAttributes (aplActionCodesSupportedRx,...-BankZ)

Action Codes Discovery per Bank [Tx]

- PushAttributes (aplActionCodesSupportedTx,...-BankZ)

ZigBee Remote Control Capabilities

- *aplZRCProfileCapabilities exchanged in configuration procedure defines all next steps*
  - *supportActionsOriginator*
  - *supportActionsRecipient*
  - If *"InformAboutSupportedActions"* then Action Bank Exchange
  - If "*supportVendorSpecificIRDBFormats"* then IRDB Vendor Support Announcement procedure (before Action Mapping Procedure)
  - If *"supportHAActionsOriginator" and "supportHAActionsRecipient"* then Home Automation Supported Announcement procedure (before Action Mapping Procedure)
  - If *"supportActionMappingClient " and "supportActionMappingServer"* then Action Mapping Procedure

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Action Mapping Procedure

- Action Mapping allows an Action Mapping Client to advertise triggers that can mapped to different Actions defined by the Action Mapping Server.
- The action mapping Client may push a full or partial list of its mappable actions at any time. The action Mapping Server shall update its list of existing mappable actions for this Client accordingly.
- The action mapping Client can invalidate one of the existing mappable actions on the Server by pushing the entry with the corresponding index and setting the action device type for this entry to 0xff..
- Action Mapping Server can cause the Action Mapping client to update at any moment in time, by sending a Client Notification command frame with:
  - "Request Action Mapping Negotiation" sub type for a full update
  - "Request Selective Action Mapping Update".

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Action Mapping Client to Server

Binding Successful

PushAttributes (aplMappableActions)
…

PullAttributes (aplActionMappings, CommandA) …

PullAttributes (aplActionMappings, CommandZ)

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Action Mapping Attributes

- ***aplMappableActions***
  - Each attribute includes:
    - Action device type
    - Action bank
    - Action code

- ***aplActionMappings***
  - Each attribute includes:
    - Mapping Flags, RF Descriptor and IR Descriptor

Bits: 0	1	2	3-5	6	7
RF Specified	IR Specified	RF Descriptor First	Reserved	Use Default	Permanent

Client Notification sub-type

- **Request Action Mapping Negotiation Sub Type**
  - no Client Notification payload
- **Request Selective Action Mapping Update Sub Type**
  - Payload: Indices for Action Mapping Client to inform Action Mapping Server about.

Bits: 8	16	…	16
MappableActionIndexListLength	aplMappableAction Index *0*	…	aplMappableAction Index *MappableActionIndexListLength - 1*

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Questions & Answers

Please submit your questions using Chat function

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Thank you!

- Webinar will be available for on-demand viewing
- Email with link to presentation slides will be sent to everyone viewing the live presentation

- Learn more about ZigBee RF4CE at www.ZigBee.org/RF4CE
- Learn more about ZigBee Remote Control at www.ZigBee.org/RemoteControl
- Read the RF4CE white paper at www.ZigBee.org/LearnMore/WhitePapers.aspx

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