# ZigBee RF4CE Standard

## The Remote Control Standard For Consumer Electronics

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# Need for Standardization

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# Home Entertainment Control

| Today with IR | Today with RF |
|---|---|
| • Line of sight transmission<br>– Decades-old technology<br>– Short transmission distance<br>– Many consumers want devices hidden<br>• Field of vision limitations<br>– Remote needs to be pointed at IR receiver | • No line-of-sight or field of vision limitations<br>– Control components behind walls or in cabinets<br>– Control over extended ranges |
| • Unidirectional unacknowledged transfers<br>– Unreliable communication<br>– Cannot send information to remote control or between components (DTV, set top box, etc.) | • Bi-directional capability<br>– Reliable communications<br>– Send program guides, playlists stock quotes, etc to remote/components<br>– Allows for communications between devices<br>– Over-the-air firmware updates possible<br>– Remote locator |
| • Technology Challenge<br>– Plasma DTV contains high frequency inverter that obstructs IR signals<br>– LCD back lighting saturates DTV IR receiver | • Faster more reliable communications<br>– Transmit commands until received<br>– Many times faster response than IR<br>– Enables enhanced user interfaces<br>– Touchpad or pointing capability |
| • Power consumption<br>– Multiple redundant transmissions for each command<br>– Higher TX power required to avoid interference created by plasma/LCD screens | • 802.15.4 RF consumes 25% of the power used by IR solutions |
| • Requires manufacturer-specific IR databases<br>– Each product has its own commands<br>– Requires larger memory for storing lookup tables | • Allows for true interoperability between vendors products |

# ZigBee RF4CE Use Cases

- One step theater experience
  - Simply insert a DVD into player
    - TV automatically selects correct input for viewing DVD
    - Surround sound system automatically switches to DVD listening mode
    - Remote control automatically switches modes to control DVD
    - Set top box and other components not needed switch off
    - Lights dim to desired setting
    - Curtains/shades close
- Media Center Control
  - Hardware typically in different room from entertainment center
  - Contains content like music, photos and movies that is streamed to or from entertainment center
  - Advanced remote control with LCD or DTV/STB GUI overlay capability allows for remote navigation of content
- In System Remote Control Programming
  - Remotes can ship without code and learn supported product features on initial power up
  - Send firmware updates that add features or fix bugs after product ships

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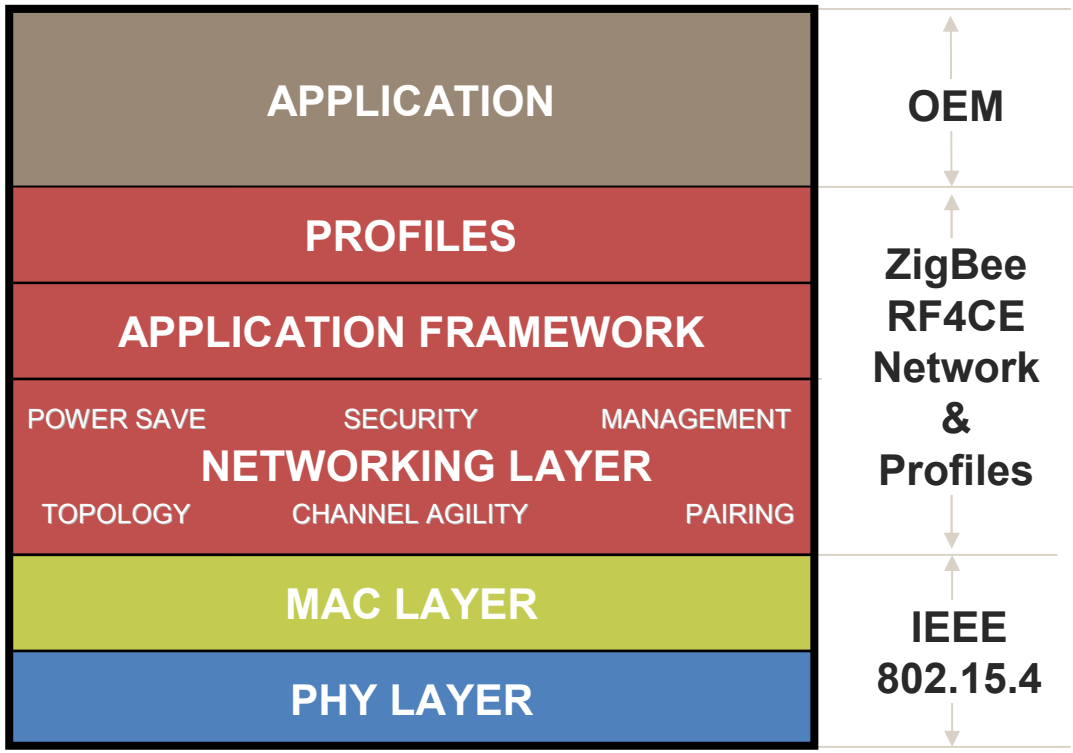
# ZigBee RF4CE
# Technical Overview

# ZigBee RF4CE Overview

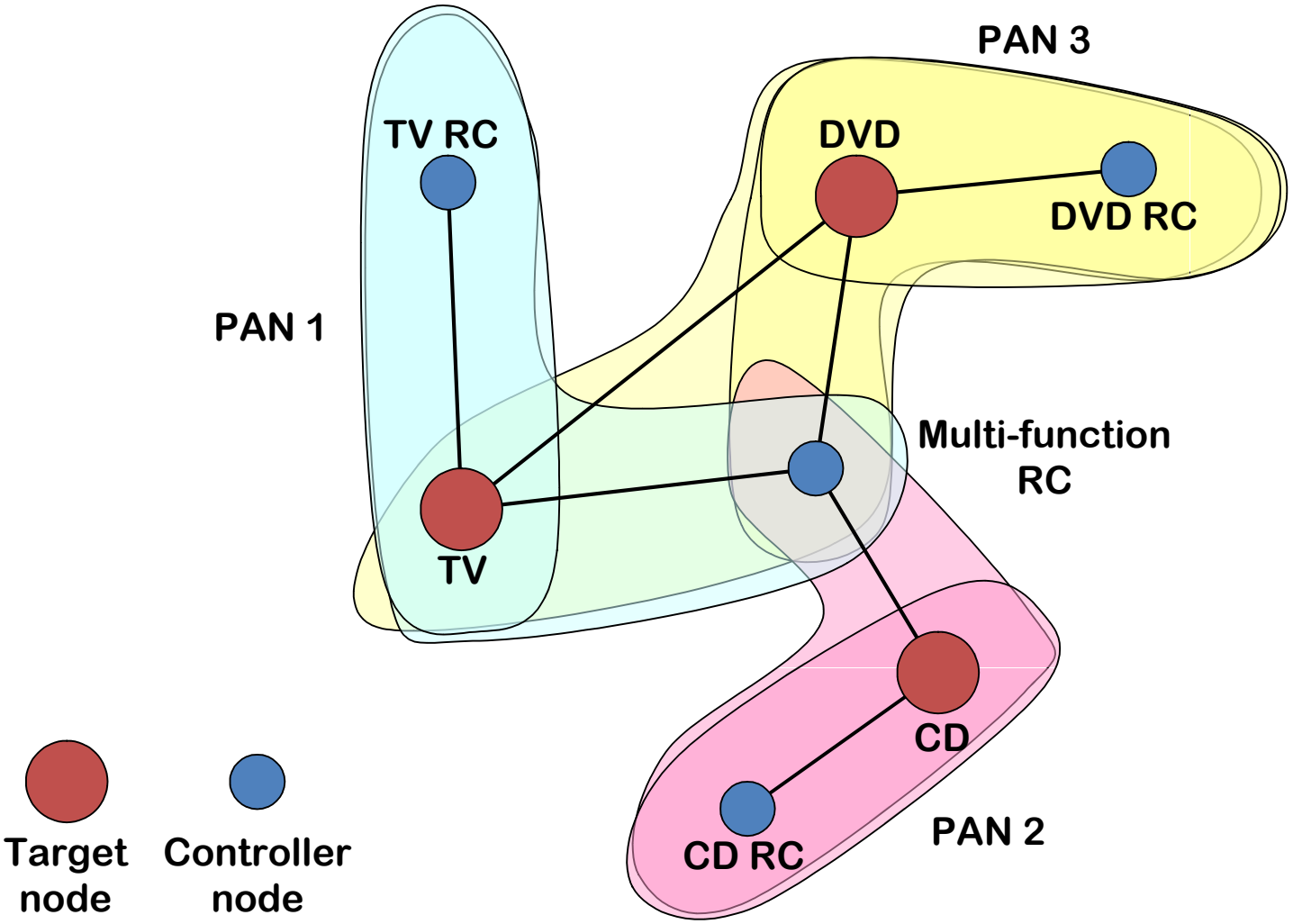
- Based on 2.4 GHz MAC/PHY IEEE 802.15.4 standard
- Networking layer is thin, flexible and future-proof
- Co-exists with other 2.4 GHz technologies
- Support for interoperability
- Support for secure communications
- Power save mechanisms implemented in network layer
- Simple and intuitive pairing mechanism
- Allow for vendor specific applications and transactions
- Support for many different applications



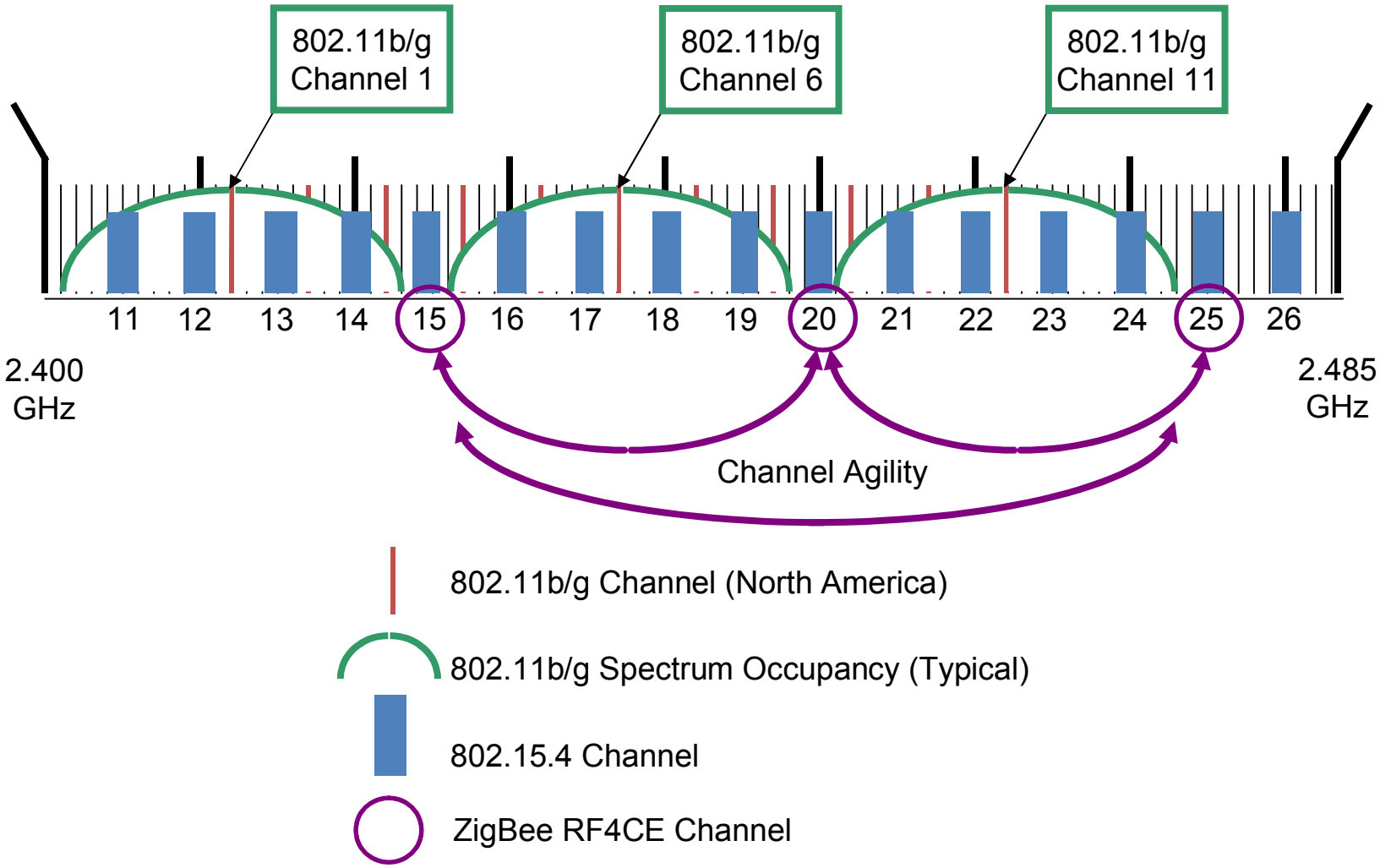
# ZigBee RF4CE Node Types

- Two Nodes Types
  - Target Node
    - Network Startup
    - Full PAN Capability
    - Accepts or declines a pairing request
    - Makes decision on operating channel (frequency agility)
  - Controller Node
    - Initiates pairing and discovery process to Target Nodes
    - Implements frequency agility
    - On-demand communication
- ZigBee RF4CE Network Supports
  - Multiple PANs
  - Participation in multiple networks
  - Low power “Power Save” mechanism built into network stack
  - Supports multiple transmission options
  - Support for multiple application profiles

# ZigBee RF4CE Network Topology



# ZigBee RF4CE Frequency Agility

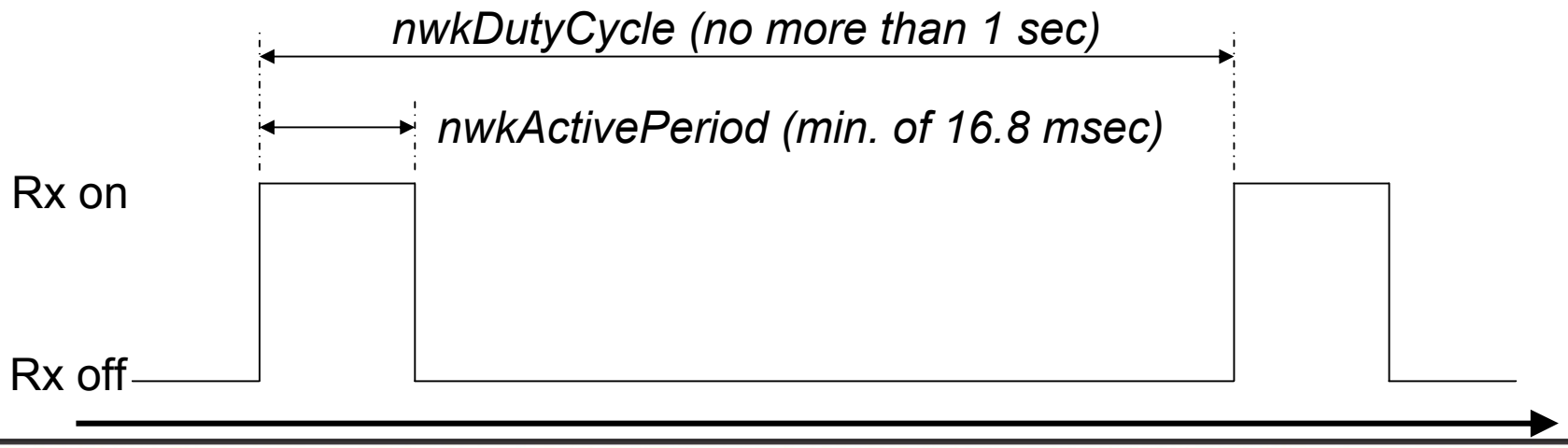


# ZigBee RF4CE Security

- Security is established during pairing process
- Utilizes AES-128
  - Security mode: ENC-MIC-32
    - Data confidentiality (via payload encryption)
    - Data authentication (via Message Integrity Code)
    - Replay protection (via frame counter)
- Nodes use 128-bit link keys
  - Keys are generated automatically, if security is supported
  - Keys are stored in the pairing table
- Application can decide which transmissions require the use of security

# ZigBee RF4CE Power Save Mechanism

- Two states for Power Save: Active & Standby
- Defined in network stack
- Controllers simply turn off when no buttons are being pressed
- Targets must also use power save when in standby
  - But must ensure a (human) reasonable reaction time
- Power saving utilizes
  - Active period during which the device wakes
  - Duty cycle at which device repeats active period
- Power saving mechanism is aligned with frequency agility



# ZigBee RF4CE Application Profiles

- Defines pairing and discovery procedures
- Standardizes commands
- Ensures interoperability between devices

- First Applications Profile - Consumer Electronics Remote Control (CERC)
  - Defines push button pairing process between controller and targer
    - The mechanism works in conjunction with the existing ZigBee RF4CE discovery and pairing mechanisms.
    - Discovery, pairing and security (as necessary) all take place via a single button push.
  - Defines commands for basic CE device control
    - User control pressed
    - User control repeated
    - User control released
  - User control pressed command carries HDMI CEC commands
  - Support for manufacture specific commands

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