STM32 Seminar
STM32 Wireless

COMPEL/STM Seminar

November 2010

Seminar Agenda

- Overview of ST Microcontroller Portfolio
- Introduction to Cortex-M Core
- STM32 General Purpose Lines
  - Product-Line Overview (F100/F101/F103)
  - Walk through the main peripherals
  - ST Standard Peripheral Library
  - Live demonstration of the STM32 Value Discovery Kit
- STM32 Low-Power Line
  - Product-Line Overview (L15x)
  - Low-Power modes and consumption
  - Specific Peripherals
- STM32 Connectivity Line
  - Product-Line Overview (F105/7 & next)
  - Ethernet & USB Host Peripherals
  - Third Party Stacks
  - Audio Support
- STM32 Wireless
  - Product-Line Overview (W108)
  - RF Performances
  - Wireless Stacks (Zigbee, RF4CE, proprietary)
- STM32 Tools
  - Third Party Compiler & IDE
  - Boards and Debuger
  - ST Libraries

STM32W - an open architecture for wireless sensor networks

Wireless sensor network domains

Security

Shock sensor, anti theft, anti intrusion

Healthcare, assisted living

Rehabilitation, balance control

Sport and fitness

Sport monitoring, pedometer, fall detection

Infrastructure monitoring

Buildings, bridges

In-network distributed computation

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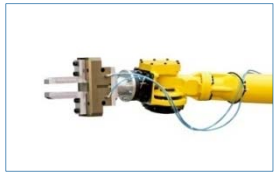
Reduce data transmission

↓

Increase network lifetime



Industrial

Vibration and tilt remote measurement

Games and remote control

Consumer control

Energy management

Smart metering

Open flexible reconfigurable platform

Home and building automation

6LowPAN

Smart energy

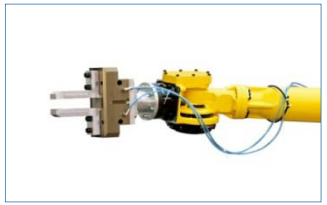
MAC interface

Kernel

STM32

SoC IEEE 802.15.4

Industrial



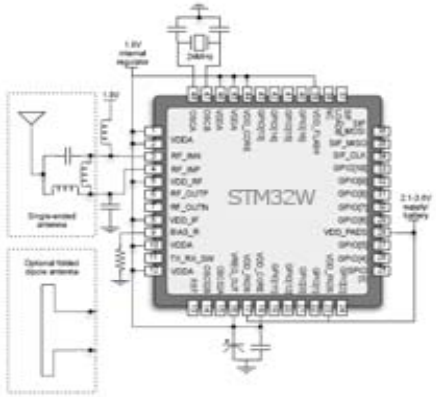
Consumer

- Remote control
- Home automation

Proprietary

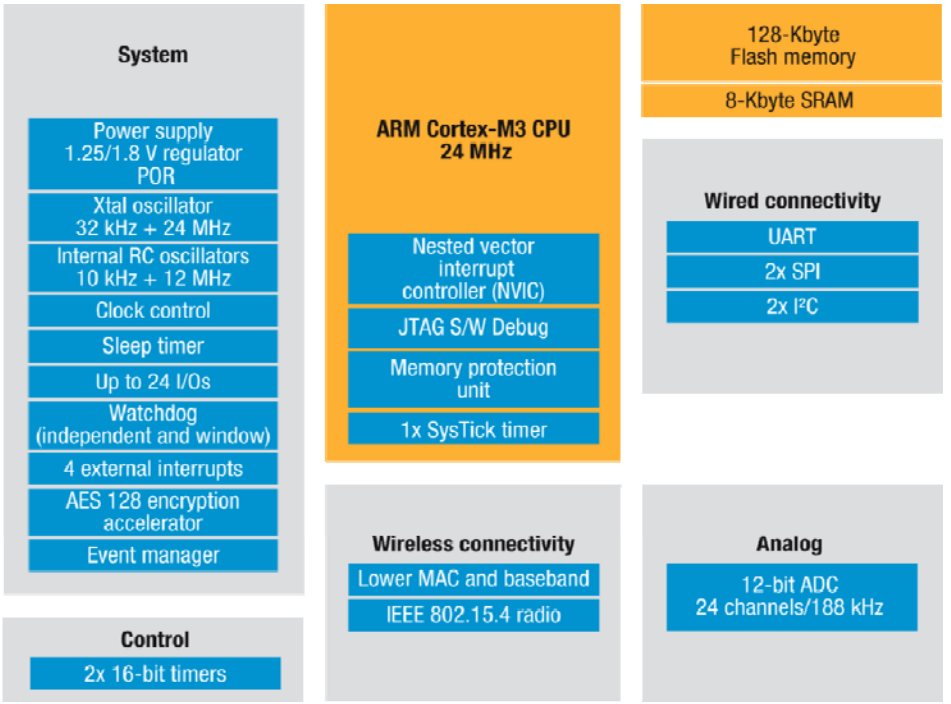
STM32W – IEEE 802.15.4 radio

- Microcontroller
  - ARM Cortex-M3 core architecture
  - Embedded memory (eFlash 16kx64, SRAM 4kx16)
- IEEE 802.15.4 2.4 GHz radio
  - Transmitter: 2-point direct synthesizer modulation
  - Receiver: low IF super heterodyne architecture
  - Digital baseband DSP and MAC support
  - -100 dBm sensitivity and up to 7 dBm output power
- Networking
  - ZigBee compliant PRO and RF4CE stacks
  - 128-Kbyte Flash for stack and apps codes
  - IEEE 802.15.4 simple MAC library
- Peripherals
  - AES encryption HW accelerator
  - Debug channel via JTAG
  - USART, SPI, I²C, 24 GPIOs
- Other
  - Compatible with SN2xx series
  - QFN48 and QFN40 packages available



STM32W architecture overview

- 32-bit ARM Cortex-M3 core running @ 24 MHz
- 128-Kbyte Flash, 8-Kbyte RAM
- Fully IEEE 802.15.4 compliant radio @ 2.4 GHz
- Power management
  - Deep sleep mode <1 µA with RAM retention
- On-chip debug support
  - ARM JTAG/SWD
  - Packet trace interface enables remote monitoring of radio messages
- ARM memory protection unit
  - To detect erroneous software accesses
- Sleep timer, watchdog timer and GP timers
- AES 128 encryption acceleration
- Serial communication (UART/SPI/I²C)
- GPIO
- ADC (6 channels, first order 12 bits sigma delta)



Power management modes

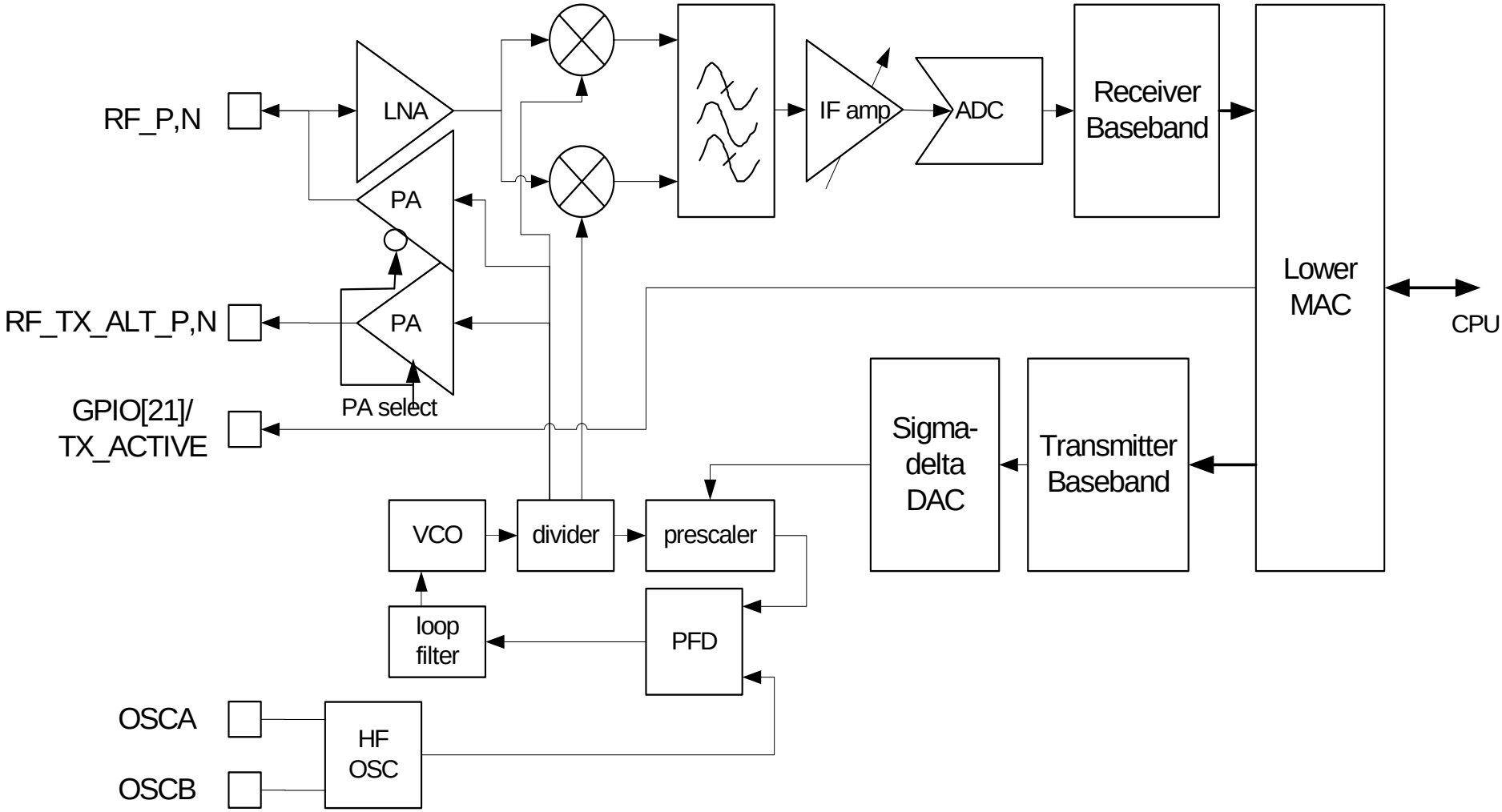
Native Cortex-M3 sleep mode is a perfect foundation to implement several STM32W system low-power modes

Mode	Regulators	Low-frequency 10 kHz RC oscillator	32 kHz crystal oscillator	High-frequency 12 MHz RC oscillator	24 MHz crystal oscillator	Power consumption
Deep sleep 2	off	off	off	off	off	0.4 µA
Deep sleep 1	off	off	optional	off	off	0.8 µA
Standby	on	on	optional	off	off	2 mA
Active at 12 MHz	on	on	optional	off	on	6 mA

Active mode	Sensitivity	Rx current	Tx current	Tx current
Radio peripheral	dBm	mA	mA at 0 dBm	mA at -32 dBm
	-100	20	24	15

STM32W RF peripheral

Radio block diagram



Analog receiver features

- Low IF super heterodyne receiver
- Input RF signal is mixed down to the IF frequency of 4MHz by I and Q mixers.
- Output of the mixers is then filtered and combined by a polyphase bandpass filter
- Sampling by a 12 Msps dedicated ADC.

Analog transmitter features

- Synthesizer using a 2 point modulation scheme.
- It modulates the division ratio using sigma-delta fractional N technique and the VCO directly using a varactor.
- The 4.8GHz VCO signal is then divided by 2 and amplified by the on chip PA.
- 2 on-chip PAs:
  - One is used to combine the transmitter output with the receiver input pins.
  - The other is support using an external high power PA.

Baseband

- The receiver is a conventional coherent PSK architecture. It generates a coherent reference at the IF frequency, locked in frequency and phase to the incoming signal. The preamble period of the 802.15.4 signal is used to achieve frequency, phase and chip timing and symbol timing lock with the received signal.
- The receiver demodulates at the chip level making hard decisions before despreading.
- The receiver DSP operates down to a signal to noise level of 1 dB out of the ADC.
- Tx baseband spreads the 4-bit symbol into its 802.15.4 defined 32-chip sequence.
- It also provides the interface for software to calibrate the Tx module to reduce silicon process, temperature, and voltage variations.

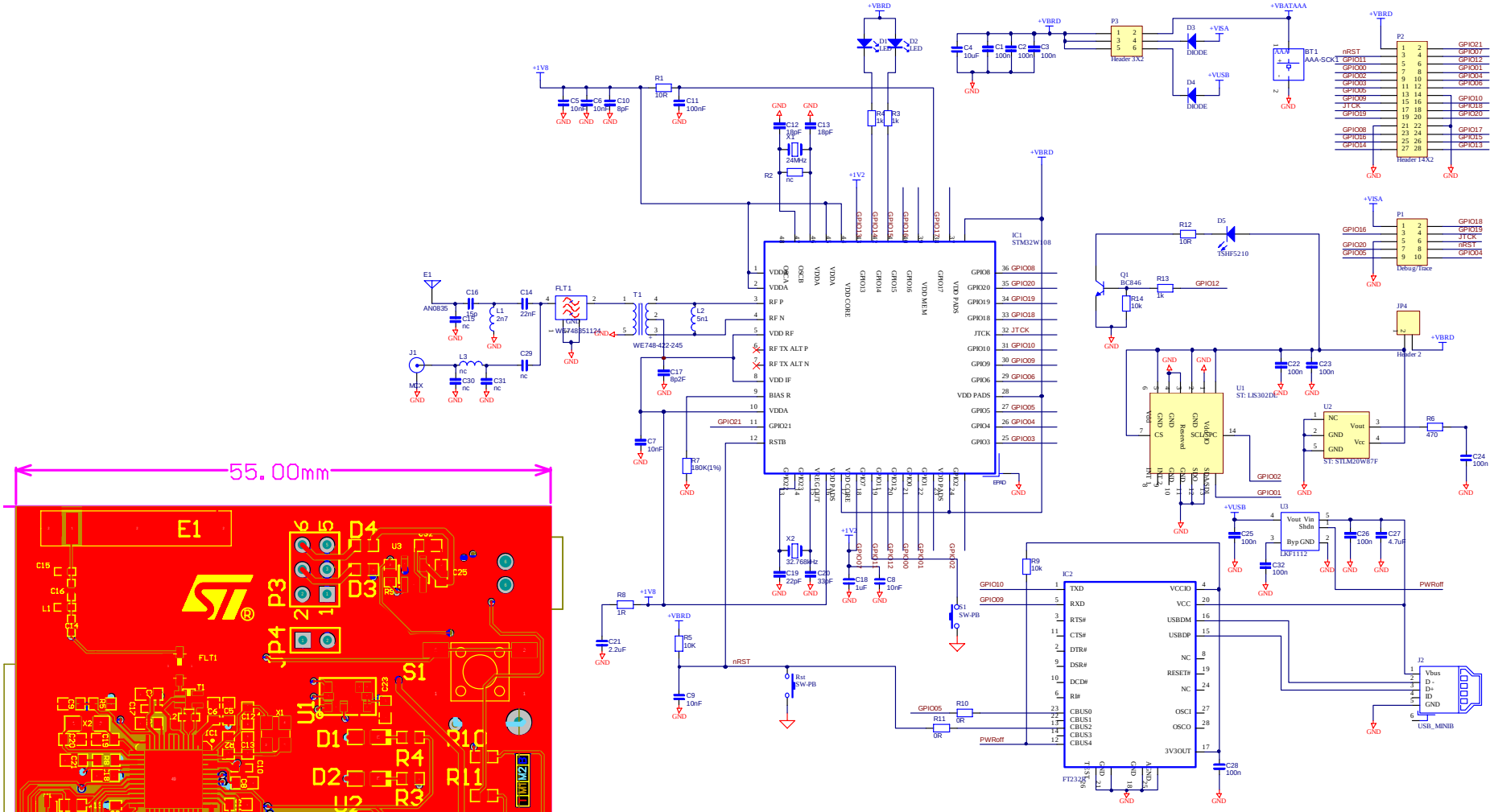
Lower MAC

- CRC generation, appending and checking
- Hardware timers and interrupts
- DMA memory control
- Preamble, sync word and length generation and prepending
- Address recognition and packet filtering
- Automatic acknowledgement transmission
- Automatic transmission of packet from memory
- Automatic transmission after backoff time if CSMA clear
- Automatic acknowledgement checking
- Time stamping of receive and transmit messages
- Attaching packet information to receive packets
- Pseudo random number generator for backoff slots
- 15.4 timing and slotted/unslotted timing

Radio other features

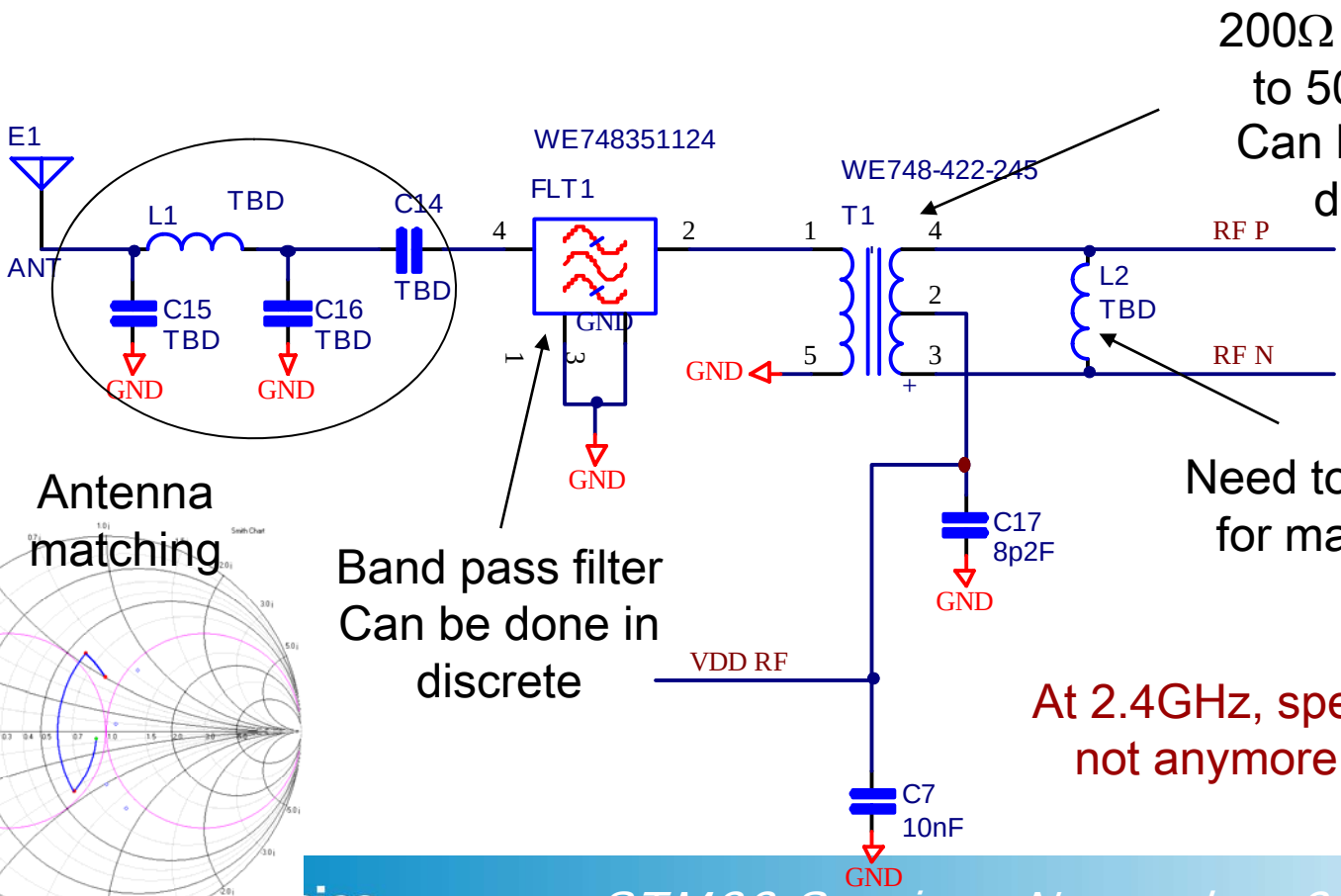
- Dedicated ADC for calibration
- Hardware packet trace interface
- Hardware AES128 block
- True random number generator based on thermal noise in the analog circuitry

MB851 Application Board / Ref Design

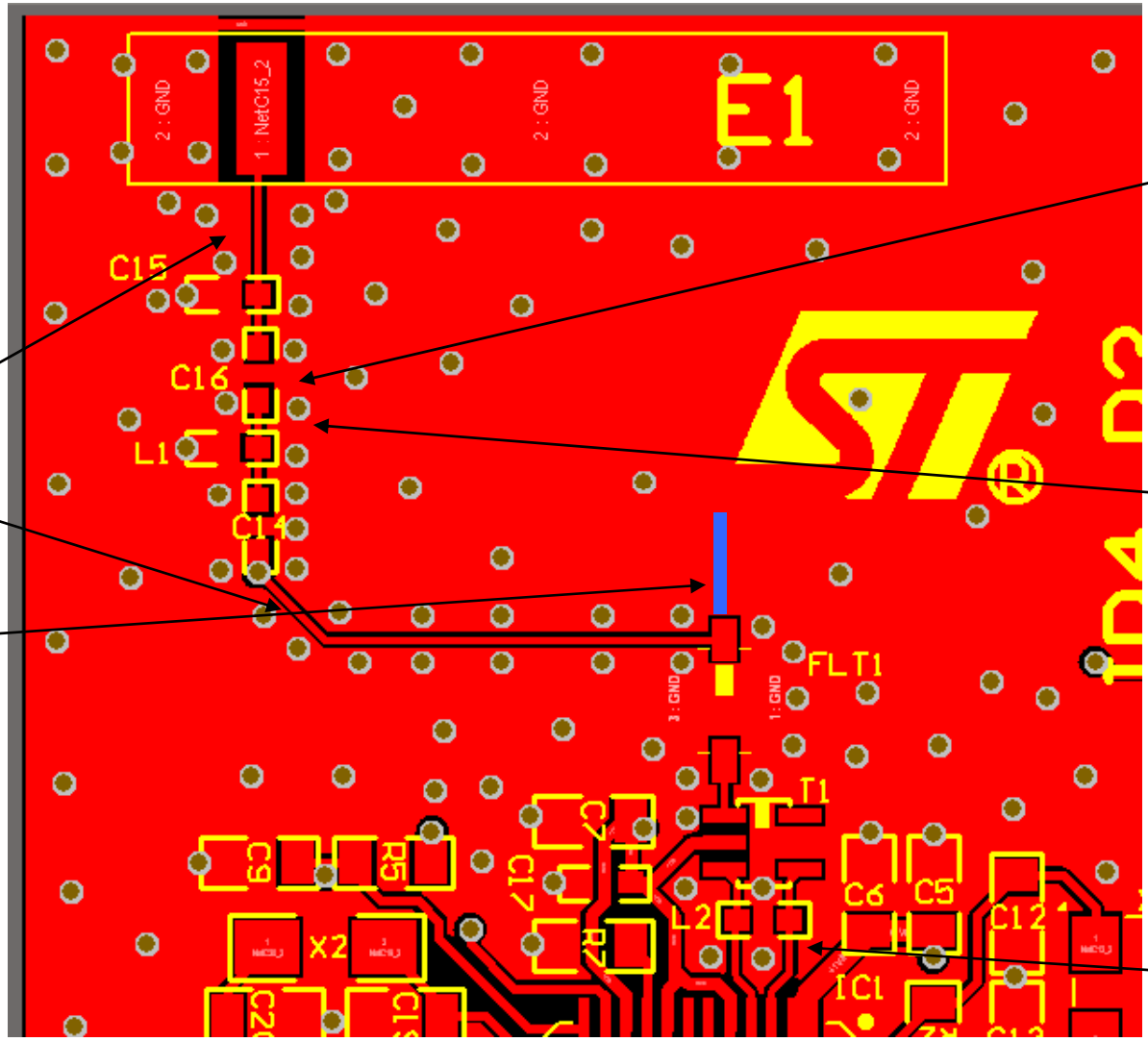


Product specificities: RF design

Antenna matching is very dependant on PCB substrate
- Copy paste only valid if same material is used (even manufacturer)
- Specific equipments needed Spectrum Analyzer, RF Network Analyzer



Gerber RF part topview



50Ω trace

Best Would be straight here. In our design we had not the space to do it.

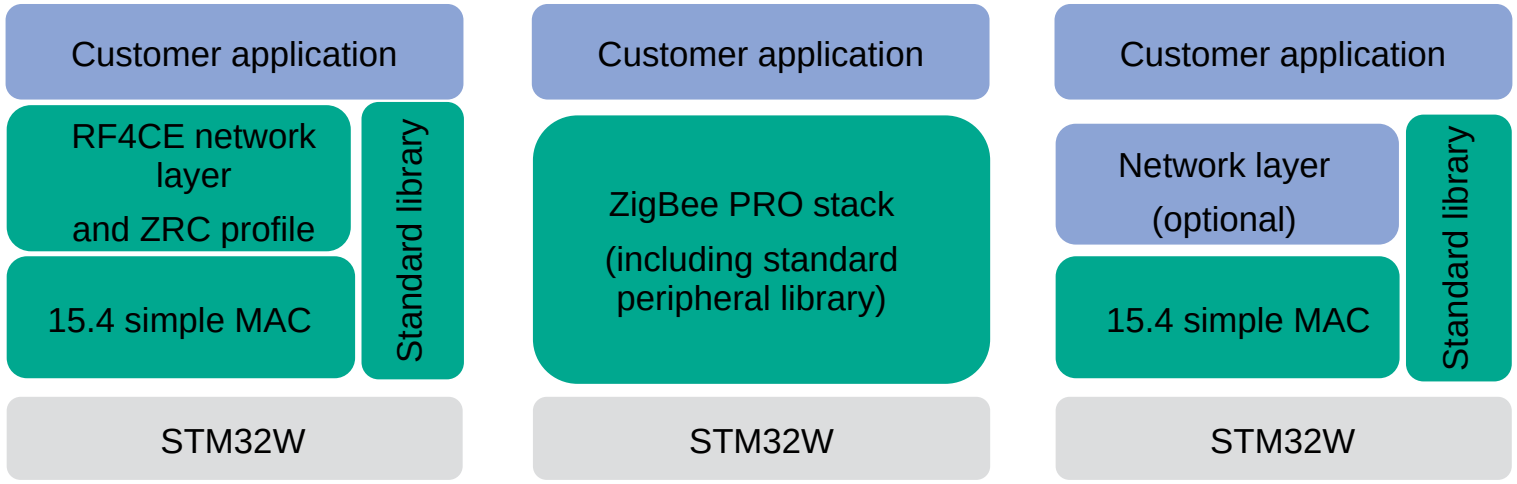
Minimized space between components

Via's a long RF path for "good" ground

200Ω Differential difficult

Stacks and Tools

STM32W software libraries



Application profiles

- Smart energy (SE)
- Home automation (HA)
- Consumer (CERC)

Customer code

Libraries provided by ST

Silicon

ZigBee PRO Stack Features

- The ZigBee PRO stack uses Stochastic Addresses for node addressing and Mesh (next-hop) routing x delivering messages.
- Many-to-One/Source Routing and Asymmetric Link Handling allow setting large networks (up to thousands of nodes)
- Advanced network encryption and device security features allow setting more secure networks.
- Frequency Agility feature allows the entire network to change channels if some interferences occur.
- Fragmentation feature allows handling large messages delivery.

Public Application Profiles

- **Building Automation** – defining devices for large commercial buildings and networks.
- **Smart Energy Management** – defining products that enhance energy management and efficiency for consumers. Consumers will remotely control their homes and manage their energy use.
- **Personal Home Health Care** – Monitoring of personal health in the home environment.
- **Home Automation** – defining devices for typical residential and small commercial installations.
- **Telecom Application** – Wireless applications within the telecom area.

ZigBee Stack Size benchmark

- Current application sizing

	SN250	SN250 New compiler	**STM32W**
Smallest App	78466	70619	**63557**
Base HA App	89100	80190	**72171**
Base HA plus Link Keys	99772	89795	**80815**
Base SE w ECC	13272	101945	**91750**

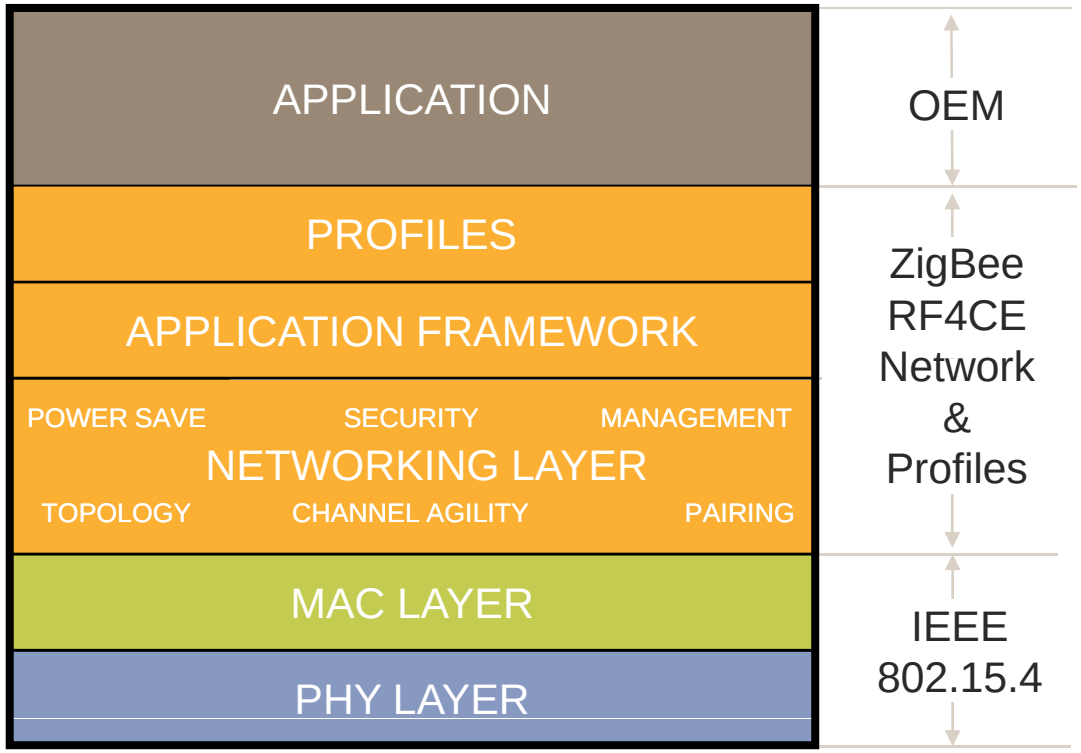
  - **Notes: End device configuration save 7KB**
    ➔ 40 to 60KB free for application SW!
- TI Z-Stack CC2430 (8051)
  - Coordinator/Router - 116 kB Flash, 7 kB RAM
  - End Device - 99kB Flash, 3.8kB RAM

ZigBee RF4CE / Home Entertainment Control

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

ZigBee RF4CE Technical Overview

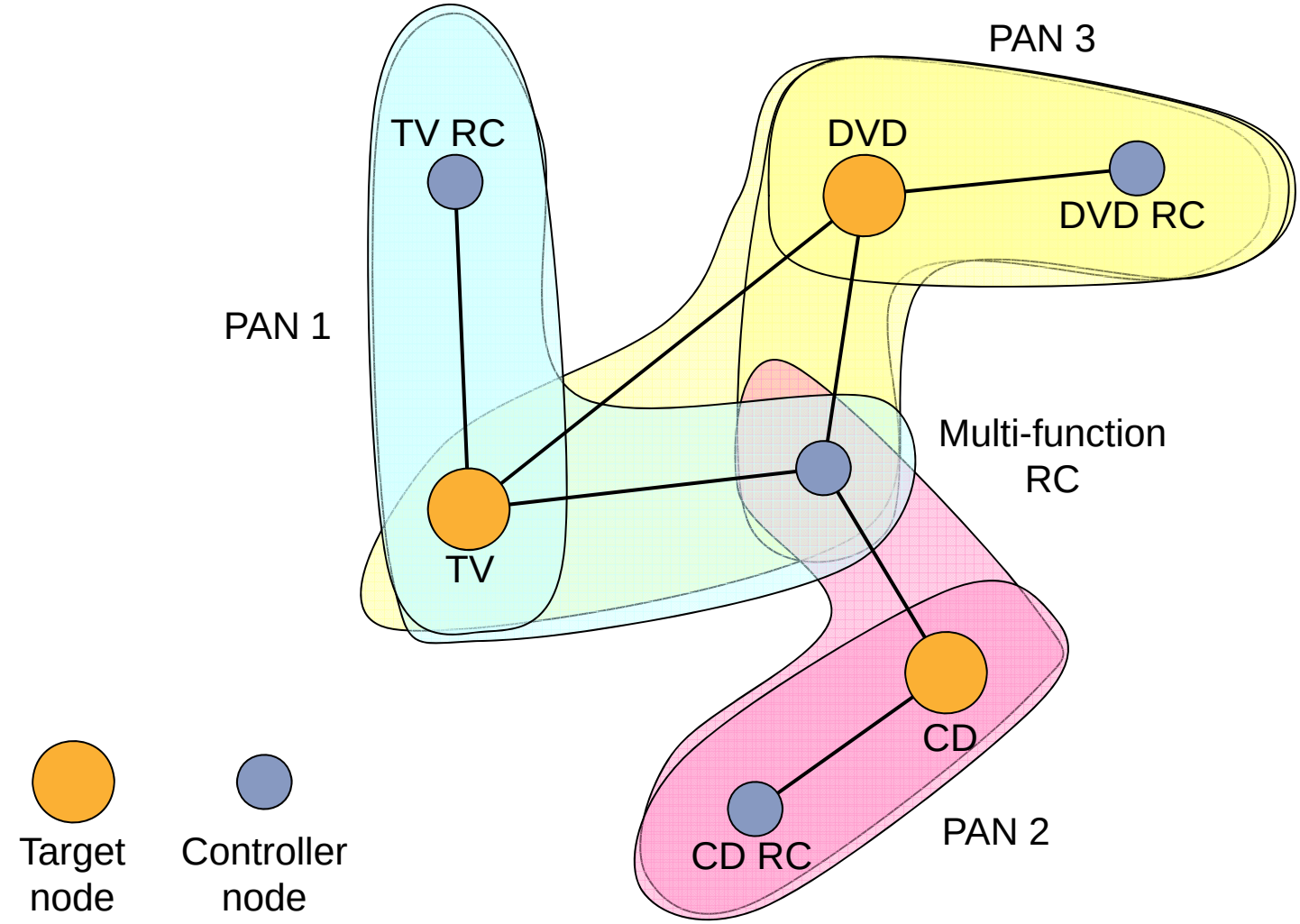
- Based on 2.4 GHz MAC/PHY IEEE 802.15.4 standard
- Networking layer is thin, flexible and future-proof
- Co-exists with other 2.4 GHz technologies
- Support for interoperability
- Support for secure communications
- Power save mechanisms implemented in network layer
- Simple and intuitive pairing mechanism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



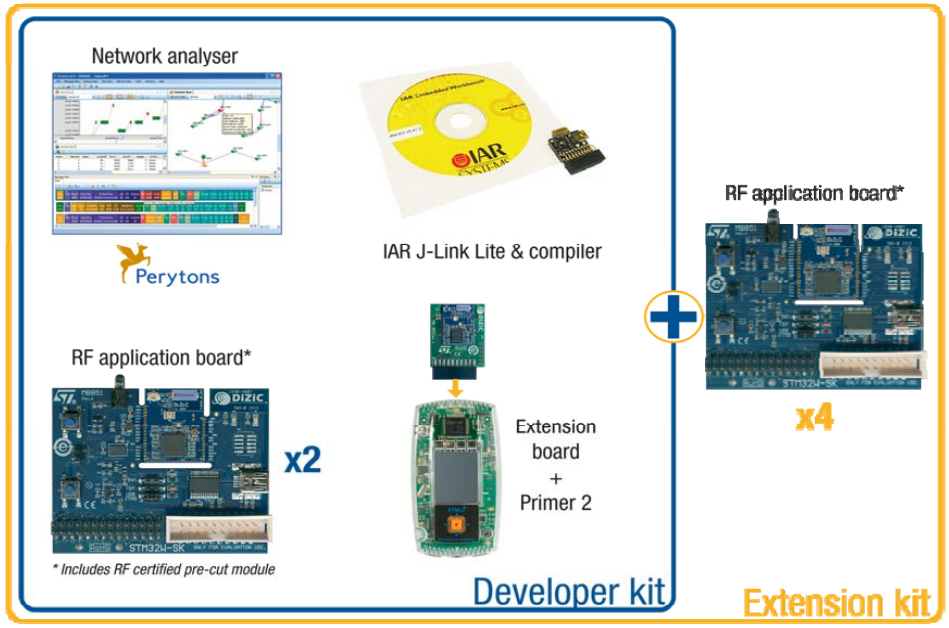
ZigBee RF4CE Node Types

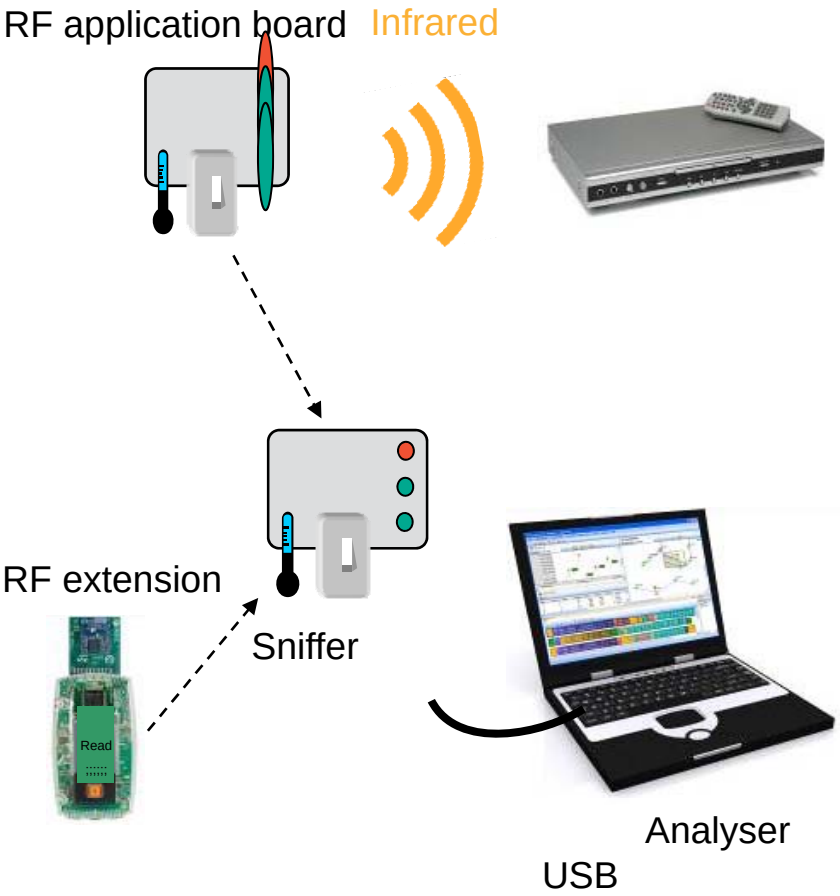
- Two Nodes Types
  - Target Node
    - Network Startup
    - Full PAN Capability
    - Accepts or declines a pairing request
    - Makes decision on operating channel (frequency agility)
  - Controller Node
    - Initiates pairing and discovery process to Target Nodes
    - Implements frequency agility
    - 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



STM32W development tools





STM32W in a nutshell

- Highest performance
  - Industry-leading RF performance
  - Network performance – highest throughput, lowest latency for routing, security computations
  - Enhanced battery life by 25%+
- Application code space
  - ZigBee PRO stack 20%+ smaller than best-in-class previous product generation, plus architecture provides more usable Flash
  - 1.5 times higher code efficiency than 8-bit core based solutions available on the market
- Power consumption
  - 1/3rd less active current than 250/260 series, combined with core efficiencies, results in longest battery life in industry
- Industry-standard, leading core
  - High performance, standard tools, powerful debug capabilities
  - Part of largest ARM Cortex-M3 product family: STM32

Thank you

Integrated 2.4 GHz radio MCU enables efficient and low-cost wireless network implementation

STM32W is a ZigBee certified platform (PRO Stack)

STM32W is a ZigBee RF4CE certified platform

STM32W is an IEEE 802.15.4 certified platform

- Please visit: www.st.com/stm32w

Thank You !