

Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: 802.15.4 Refresher

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Source: Phil Beecher, Beecher Communications Consultants Ltd / PGE

Contact: Phil Beecher, Beecher Communications Consultants Ltd

Voice: +44 7765 400948, E-Mail: pbeecher@ieee.org

Re: TG4g PHY Amendment

Abstract: Refresher on 802.15.4 operation

Purpose: 802.15.4 operation considerations

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802.15.4 Refresher

Overview

802.15.4 context

- 802.15.4 defines a simple MAC and multiple PHYs for use as components in communications protocol stacks
- Target applications characteristics:
 - low throughput data, small packet sizes, high degree of coexistence, very low maintenance
 - devices that are simple, low cost, low energy (long-term battery operation), nearly autonomous setup
- Currently 802.15.4 is used by
 - Zigbee, ISA100.11a, 6LoWPAN and many proprietary systems

802.15.4 context

- Guiding concepts are:
 - MAC and PHY include only those mandatory declarations required for interoperability
 - Implementation considerations are out of scope
 - MAC and PHY provide “tools” or “mechanisms” for link operation but rely upon higher layers to control how and when these tools are used
 - e.g. when to perform CCA – CCA is controlled by the MAC based on parameters set by a higher layer.
 - The criteria used to determine which devices are allowed into the network are determined by the higher layer, but use MAC primitives and MAC layer command frames
 - Performance factors are traded off for simplicity
 - e.g. no QoS, no fragmentation/reassembly, no duplicate packet recognition, etc.

802.15.4 Refresher

Part 1

Channels and Channel Pages

802.15.4-2003 Channels

Channel number(s)	Channel number description
0	Channel 0 is in 868 MHz band using BPSK
1 - 10	Channels 1 to 10 are in 915 MHz band using BPSK
11 – 26	Channels 11 to 26 are in 2.4 GHz band using O-QPSK
27 - 31	Reserved

802.15.4-2006 introduces Channel Pages

Channel Page	Channel number(s)	Channel number description
0	0	Channel 0 is in 868 MHz band using BPSK
	1 - 10	Channels 1 to 10 are in 915 MHz band using BPSK
	11 - 26	Channels 11 to 26 are in 2.4 GHz band using O-QPSK
1	0	Channel 0 is in 868 MHz band using ASK
	1 - 10	Channels 1 to 10 are in 915 MHz band using ASK
	11 - 26	Reserved
2	0	Channel 0 is in 868 MHz band using O-QPSK
	1 - 10	Channels 1 to 10 are in 915 MHz band using O-QPSK
	11 - 26	Reserved
3-31	Reserved	Reserved

802.15.4-2009 Additional Channel Pages

Channel Page	Channel number(s)	Channel number description
3	0 – 13	Channels 0 to 13 are in 2.4GHz band using CSSS
4	0	Channel 0 is sub-gigahertz band for UWB
	1 – 4	Channels 1 to 4 are low band for UWB
	5 – 15	Channels 5 to 15 are high band for UWB
5	0 - 3	Channels 0 to 3 are in 780MHz band using O-QPSK
	4 - 7	Channels 4 to 7 are in 780MHz band using MPSK
6	0 - 9	Channels 0 to 9 are in 950MHz band using BPSK
	1 - 10	Channels 10 to 21 are in 950MHz band using GFSK
7 - 31	Reserved	Reserved

802.15.4 Refresher

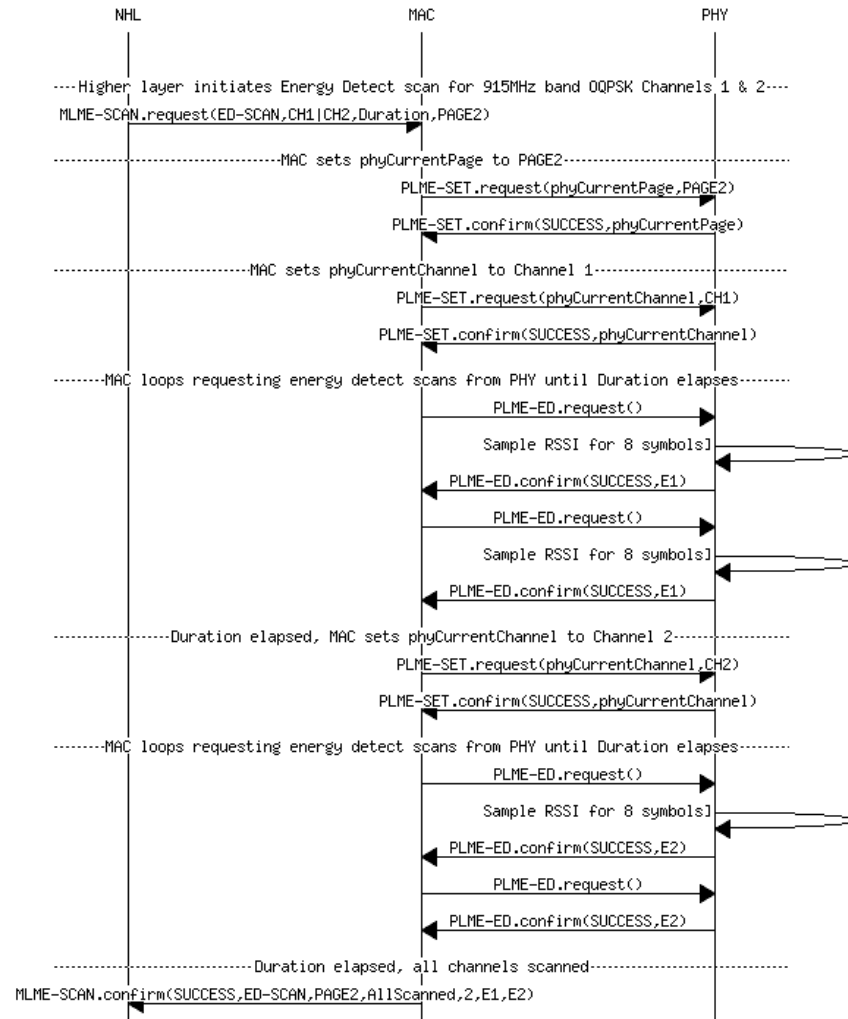
Part 2

Scanning for channels and existing networks

Scanning for 802.15.4 Networks operating in 915MHz band

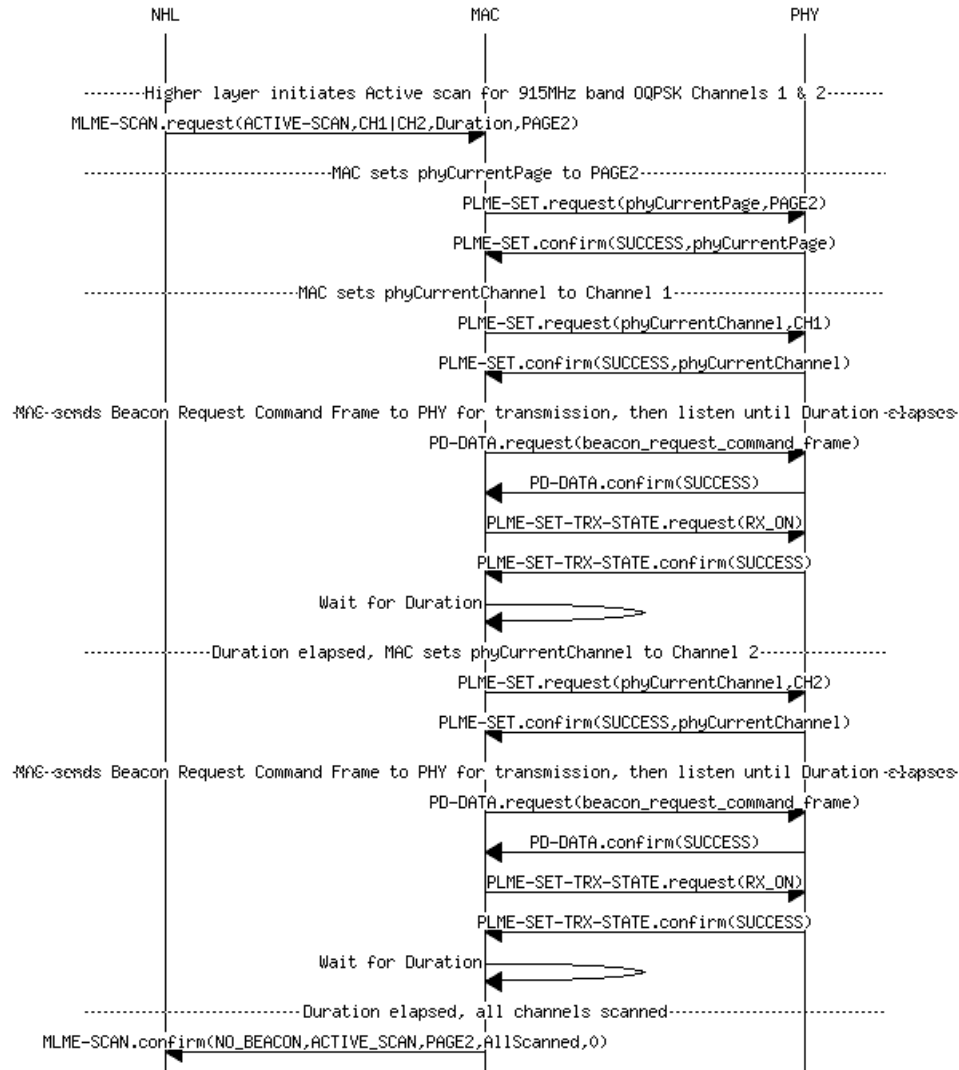
- A Higher Layer in the Protocol stack (above the MAC) performs the following tasks:
 - Check which channel pages are supported by the radio by reading the PHY PIB
 - Initiate Energy Detect Scan on channels of each channel page of interest, e.g.
Channel Page 2, Channels 1-10 (O-QPSK @915MHz)
 - Initiate Active Scan on channels of each channel page of interest, e.g.
Channel Page 2, Channels 1-10 (O-QPSK @915MHz) and
Channel Page 0, Channels 1-10 (BPSK@915MHz)

Example Energy Detect Scan Channel Page 2 – O-QPSK in 915MHz band



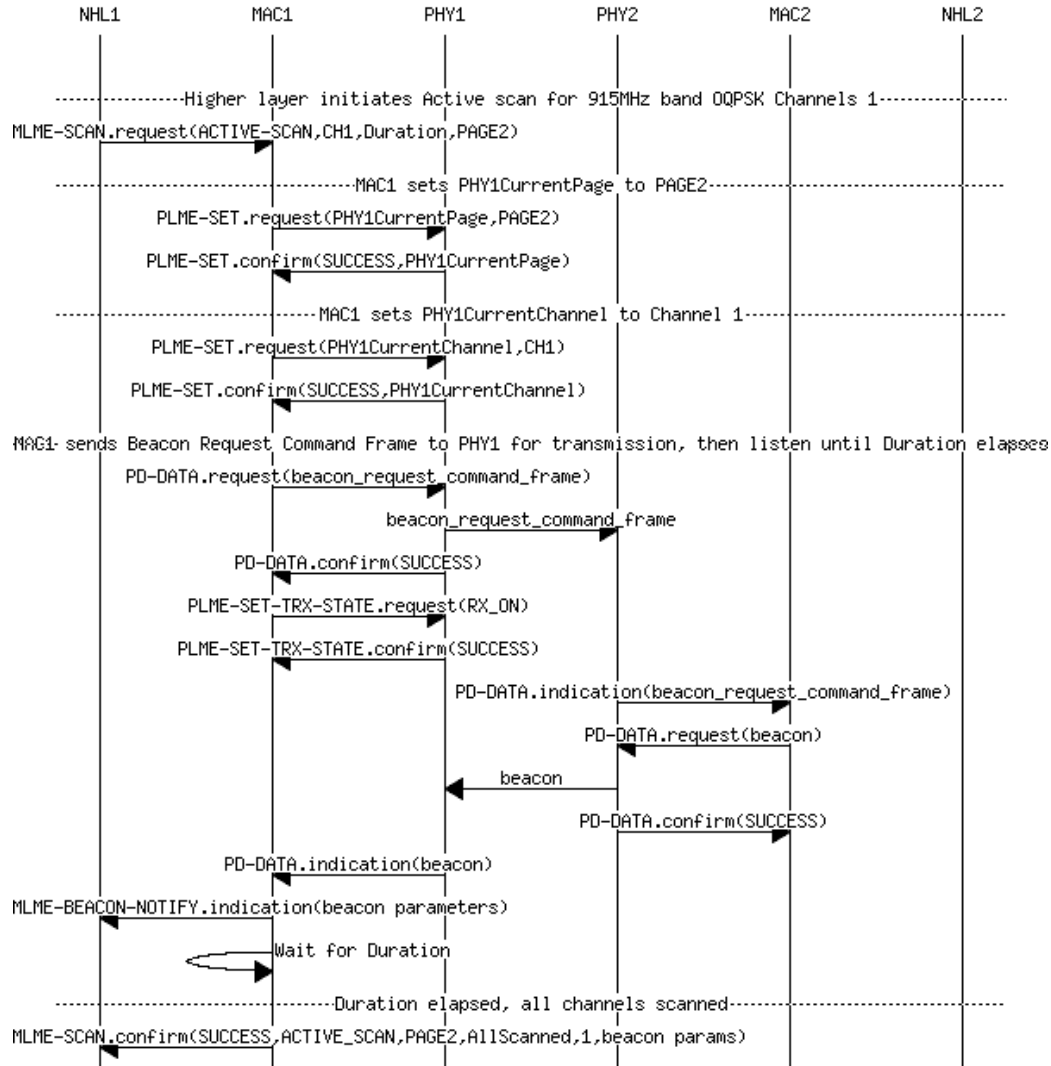
Example Active Scan (no response)

Channel Page 2 – O-QPSK in 915MHz band



Example Active Scan (response)

Channel Page 2, channel 1 – O-QPSK in 915MHz band



Starting an 802.15.4 Network in 915MHz band

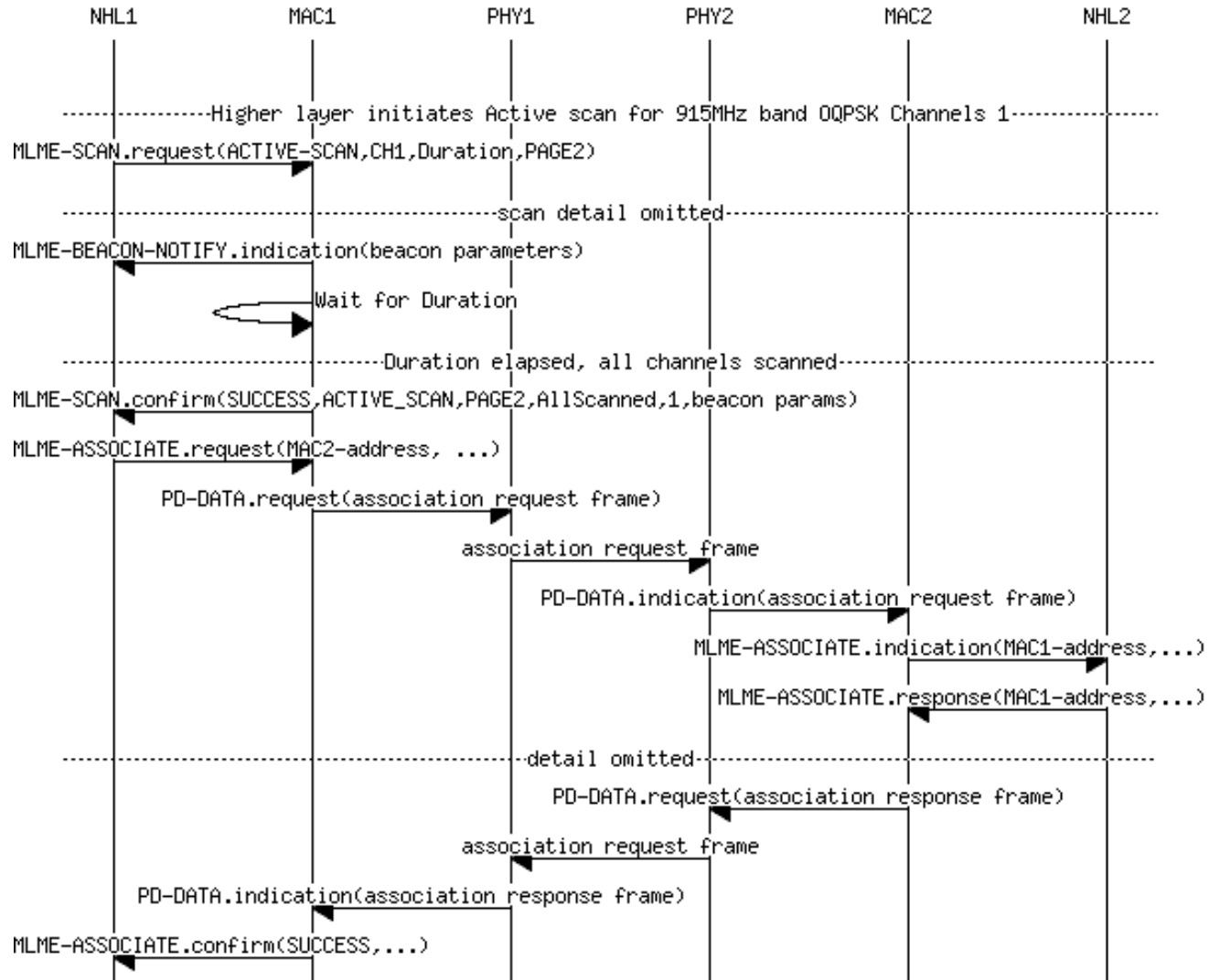
- A Higher Layer in the Protocol stack (above the MAC) performs the following tasks:
 - Check which channel pages are supported by the radio by reading the PHY PIB
 - Performs Energy Detect Scan and Active Scan on channels of each channel page of interest
 - Picks a channel based on radio capability and scan result
 - Chooses a PAN-ID and maybe a Short Address
 - Issues MLME-START.request to MAC, specifying channel page, channel, PAN-ID and PAN characteristics.

802.15.4 Refresher

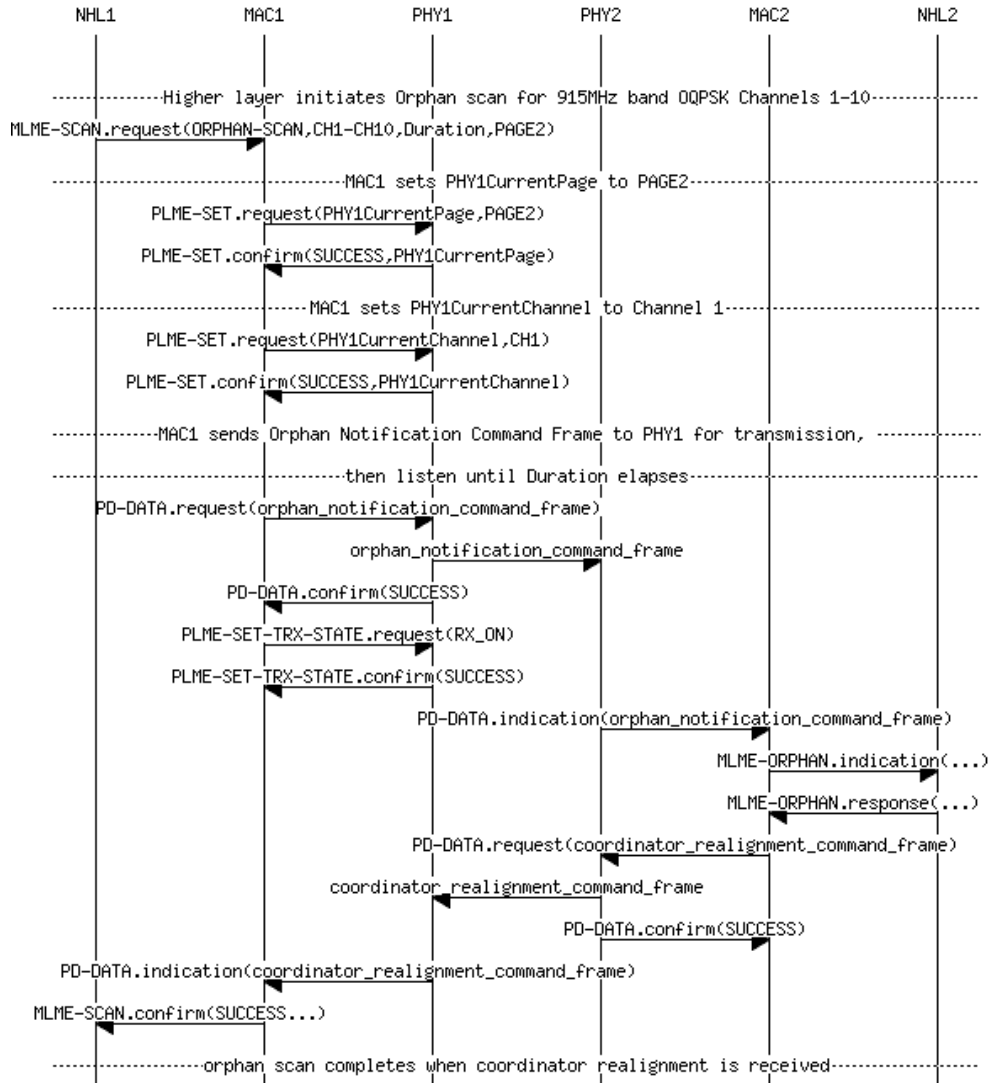
Part 3

Association and Orphaning

Association



Orphan Scan



802.15.4 Refresher

Part 4

Coordinated Channel Change Example

Coordinated Channel Change

