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

Submission Title: [Proposal for IEEE802.15.3e – General Introduction]
Date Submitted: [10 September 2015]
Source: [Ko Togashi(1), Ken Hiraga, Jae Seung Lee, Itaru Maekawa, Makoto Noda, (representative contributors), all contributors are listed in "Contributors" slide]
Company: [ETRI, JRC, NTT, Sony, Toshiba1]
Address1: [1-1-1 Shibaura, Minato-ku, Tokyo 105-8001]
E-Mail1: [ko.togashi@toshiba.co.jp (all contributors are listed in "Contributors" slide)]

Abstract: This document presents an overview of the full MAC/PHY proposal for HRCP.

Purpose: To propose a full set of specifications for TG 3e.

Contributors

In alphabetical order

Name	Affiliation	Email
Jae Seung Lee	ETRI	jasonlee@etri.re.kr
Moon-Sik Lee	ETRI	moonsiklee@etri.re.kr
Itaru Maekawa	Japan Radio Corporation	maekawa.itaru@jrc.co.jp
Lee Doohwan	NTT Corporation	lee.doohwan@lab.ntt.co.jp
Ken Hiraga	NTT Corporation	hiraga.ken@lab.ntt.co.jp
Masashi Shimizu	NTT Corporation	masashi.shimizu@upr-net.co.jp
Keitarou Kondou	Sony Corporation	Keitarou.Kondou@jp.sony.com
Hiroyuki Matsumura	Sony Corporation	Hiroyuki.Matsumura@jp.sony.com
Makoto Noda	Sony Corporation	MakotoB.Noda at jp.sony.com
Masashi Shinagawa	Sony Corporation	Masashi.Shinagawa@jp.sony.com
Ko Togashi	Toshiba Corporation	ko.togashi@toshiba.co.jp
Kiyoshi Toshimitsu	Toshiba Corporation	kiyoshi.toshimitsu@toshiba.co.jp

Proposal for IEEE802.15.3e High-Rate Close Proximity System

September 15, 2015

Joint Proposal

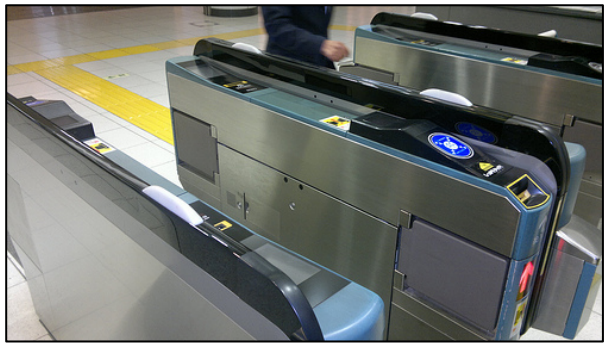
After numerous discussions among the participant companies, a structure of the proposal acceptable to all parties was arrived at, and it was decided that working on a single, unified proposal was the best way forward to develop the 3e standard in the most effective, efficient and comprehensive manner.

The MAC section is derived from 802.15.3/b/c and contains various modifications and simplifications to optimize operation to the new HRCP (High Rate Close Proximity) mode of communications.

The PHY section is divided into two major co-optional solutions, based on single-carrier modulation and OOK modulation. These two PHY solutions cater to various different usage models but they both share and rely on a single common MAC protocol.

Merits of Close Proximity (Review)

- P2P (Point-to-Point) connectivity is easily implemented
- Touch-based connectivity is easily achieved
  - Quick, simple and intuitive operation for everyone
  - No setup procedures needed to establish connection



Short connection time made possible by:

→ quick link setup
→ quick link release
→ data integrity at MAC level

- Low latency using simple MAC
  - Removal of unnecessary processes not essential for P2P connectivity
  - Required processes are streamlined for dedicated P2P operation
- Robustness against errors and fluctuations
  - No serious throughput degradation nor stability problems

Limiting operation to Close Proximity

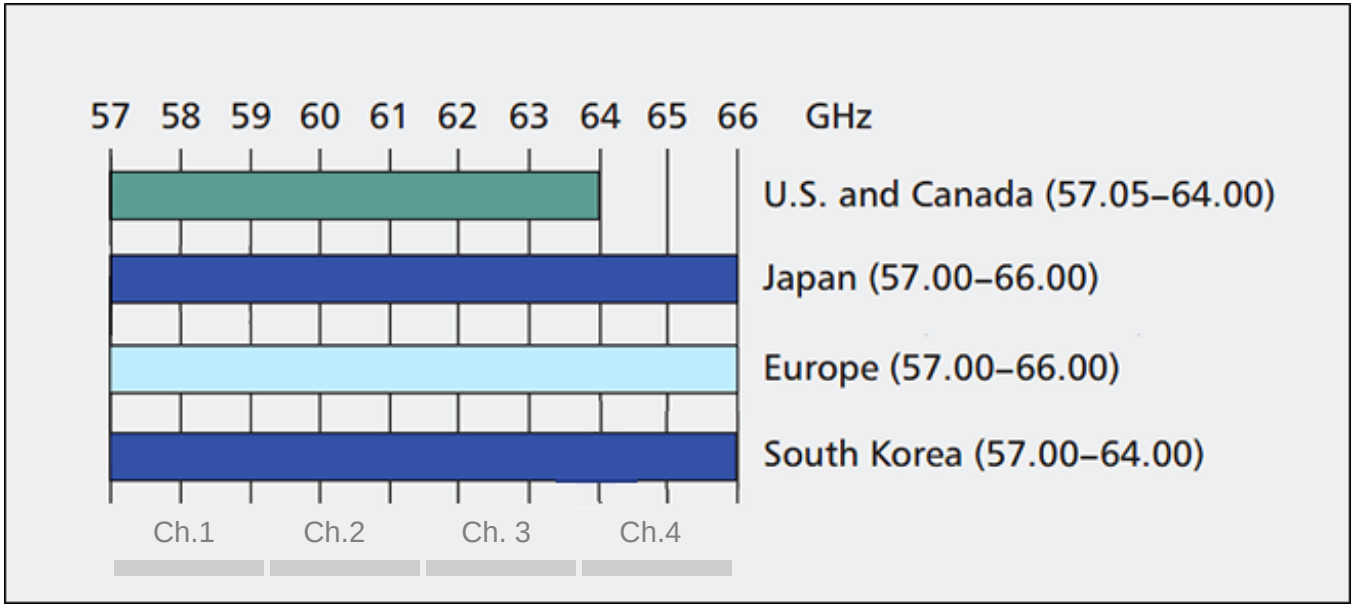
- Establish nominal operational coverage
  - Implementation dependent
  - Distance coverage of 10 cm at minimum rate
  - Automatic system switch-on function based on fast setup time under 2 msec.
- Data rate and connection time
  - Maximum PHY SAP rate per 2.16GHz bandwidth shall exceed that of 15.3c (ie., more than 5.775 Gbps using 64 QAM)
  - Must satisfy the conditions for maximum connection time while also capable of achieving 100 Gbps using at least one mode.

- No interference or co-existence issues
  - Because of the close proximity nature of the wireless propagation, there are no interference or co-existence issues.

60 GHz frequency band

- Out of the four channels defined for the 60GHz ISM band, channels 1, 2 and 3 should be used for HRCP, either individually, bonded or aggregated (ie., channels 1+3), as these three base channels are allowed by the major regulatory domains (US, Japan, Europe, South Korea).

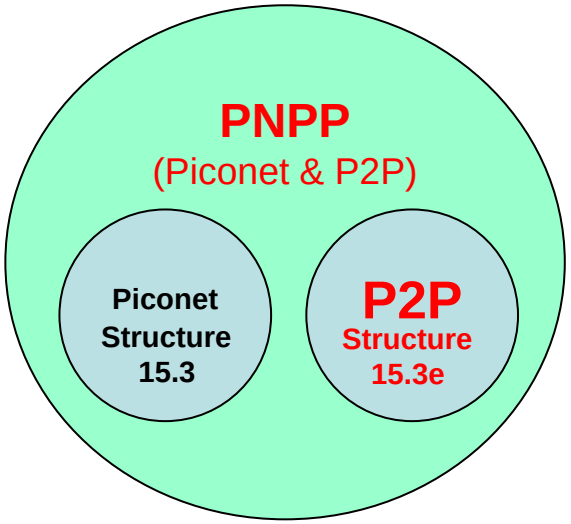
As of September 2015



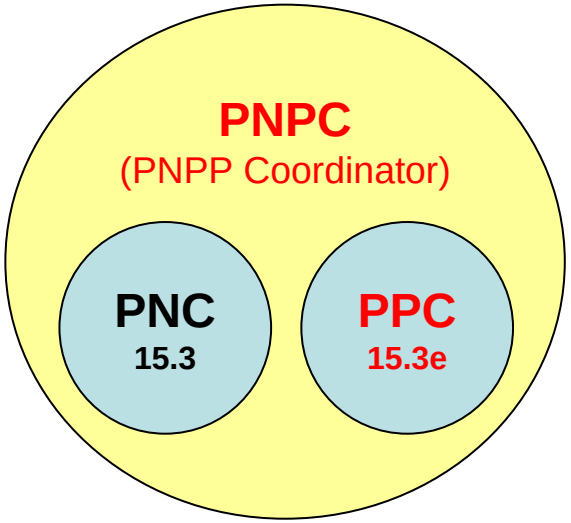
Coordination

- Since the topology is limited to P2P, the system is not a “piconet” but just a P2P structure with just two devices. The coordinator is:
  - Not a PNC but a PPC (P2P Coordinator)
- Redundant processes can be removed to optimize for P2P connectivity:
  - No coordinator handover
  - No child piconet
  - No neighbor piconet
  - No parent piconet
  - No PNC shutdown
  - No parameter changes in system
  - No periodic exchange of management frames

System structure definition



Coordinator definition



Superframe

- No Beacons are sent once connection is established
  - No handover or transfer of the coordinator
  - No new DEV will join (always two)
  - No system parameter modifications
  - Full bandwidth available (at all times)
- No CAP or CTA
  - PPAP (P2P Access Period) only
  - Access to full bandwidth since the communications is P2P and there is no need to assign any time division

Other management aspects

PPC DEV

- No information discovery after connection is established
  - Data transfer starts immediately.
- No dynamic channel selection
  - Default channel is preset to achieve short connection setup.
- No peer information retrieval and no channel status request
  - Fixed P2P connection reduces connection time.
- No information announcement to peers and no remote scan
  - No need to transmit since the single peer device remains constant.
- No stream management
  - Short connection time is optimized for a single, unique transaction.
- No second exchange in Association procedure
  - Capability negotiation limited to a single exchange to achieve short setup time
- Short Setup time
  - Time from first successful reception of all necessary information from the management frame(s) to completion of association by both devices.
- No Piconet identifiers
  - No exchange of PNID for each session

Data exchange

PPC DEV

- No Carrier Sense (no CSMA)
  - Close proximity P2P will always have full access to entire bandwidth
- No Delayed or Implied ACK
  - Derived from throughput and data integrity considerations
    - Upper layer throughput will be degraded since TX will have to wait for a response
    - Applicable only for isochronous data streams (which are not supported)
- No selective repeat (No Block ACK)
  - Derived from throughput and data integrity considerations
- Data throughput
  - Shall be calculated at the MAC SAP.

	PHY criteria	Location
1	**Communication distance:** Must demonstrate link budget values at a distance of 10 cm based on simulation.	Section 12a
2	**Frequency**: Shall operate within the 60GHz unlicensed band	Section 12a
3	**Interference**: Shall be able to operate in dense environments without mutual interference among 3e devices	Section 12a
4	**Coexistence**: Shall be able to coexist with other systems in the same band when operating without any beamforming technology	Section 5
5	**Data Rate:** Calculated at the PHY SAP: At least one mode shall be capable of achieving 100 Gbps satisfying the common frequency regulations of US, EU, Korea, and Japan	Section 12a
6	**Antenna form factor:** The antenna used for satisfying the other PHY criteria shall be small enough for placement and operation inside a mobile device, including smartphones.	Section 12a

	MAC criteria	Location
1	**Connection setup time:** less than 2 ms	Section 5
2	**Definition of "Connection setup time"**: time from first successful reception of all necessary information from the management frame(s) to completion of association by both devices.	Section 5
3	**P2P**: Operation shall be limited to point-to-point connection between two devices only	Section 5
4	**No identifiers**: Connection setup shall be performed without exchanging network identifiers (PNID) for each session	Section 6
5	**NO CSMA:** No Listen before Talk (or CSMA) shall be used prior to transmission	Section 5
6	**Management frames:** No periodic management frames shall be transmitted after completion of association	Section 7
7	**Data throughput**: Shall be calculated at the MAC SAP	Section 7
8	**Error detection and correction**: In the presence of random and burst errors, there shall not be serious throughput degradation nor falling into unstable states	Section 7

	System criteria	Location
1	**Touch action**: Bringing the antennas to within about 1 cm shall trigger the two devices to establish connection. Accurate spatial alignment shall not be required.	Section 12a
2	**Disconnection**: Shall be able to disconnect promptly when devices draw apart beyond 10 cm	Section 12a
3	**Efficient design**: System shall achieve high throughput and low latency using simple design.	Section 12a
4	**Mobile** devices should be energy-efficient.	Section 12a