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Abstract: [MAC attributes should include interference avoidance as well as device discovery]

Purpose: [To be considered in 15.3c Usage Model Document]

MAC attributes break down indicating interference avoidance

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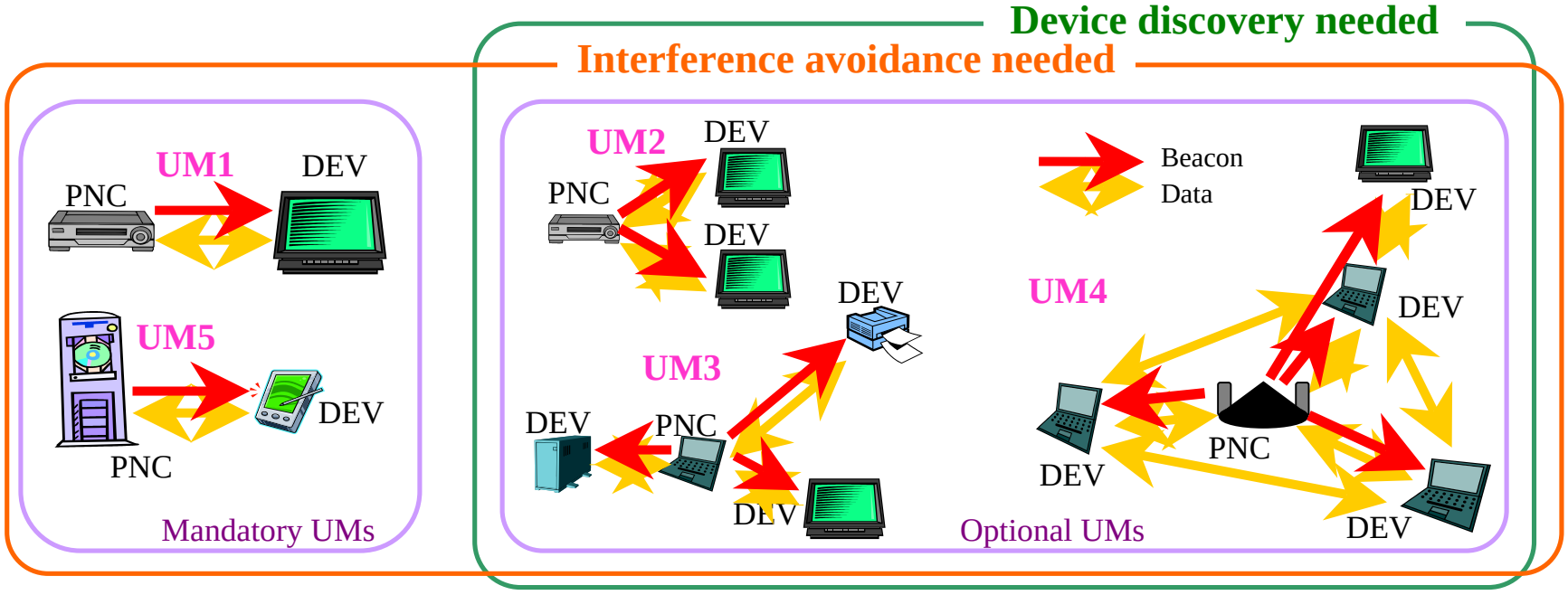
Summary

- Antenna directivity in the current MAC related attributes has been further broken down into interference avoidance and device discovery, and the importance of interference avoidance is shown.
- Interference avoidance management should be introduced under following situations.
  - Situation1: Outer nodes are using same frequency channel.
    - Sensing between different PNs is used for interference avoidance
  - Situation2: New DEV are requiring association.
    - Association permission is considered for interference avoidance
- MAC attributes are classified by usage models.

Current MAC attributes should be broken down

- Antenna directivity in the current MAC attributes could be interpreted as interference avoidance and device discovery.
  - **Interference avoidance**: coping with interference from neighboring PN nodes or newly associating nodes.
    - Needed for every UM case.
  - **Device discovery**: finding communication partner(s).
    - Needed for UM2, 3, and 4



MAC attribute break down example #1 (UM1 case)

- UM1 needs interference avoidance as well as other UMs.

Current MAC attributes **Revised MAC attributes**

	UM	Use Case	Usage	MAC-SAP	Equivalent 'Usage' in current description [Usage #]	Current attributes (for reference)	Edited MAC Related Systems Attributes
Mandatory	1	U1/U3	Uncompressed video streaming 1080i, 24, 60	1.75Gbps (1.49Gbps w/o Blk.)	Uncompressed HDTV Video/Audio streaming [DVD players and other power-line operated devices] [1]	a) Isochronous b) High throughput efficiency c) Point-to-Point d) Support for high gain antennas for Data Transmission e) Device discovery f) Moderate latency g) Minimum reserved bandwidth	a) Isochronous b) High throughput efficiency c) Point-to-point d) Support for high gain antenna for data transmission d-1) Interference avoidance ~~e) Device discovery~~ e) Moderate latency f) Minimum reserved bandwidth

MAC attribute break down

MAC attribute break down example #2 (UM2 case)

- UM2 as well as UM3 and 4 needs device discovery.

Current MAC attributes **Revised MAC attributes**

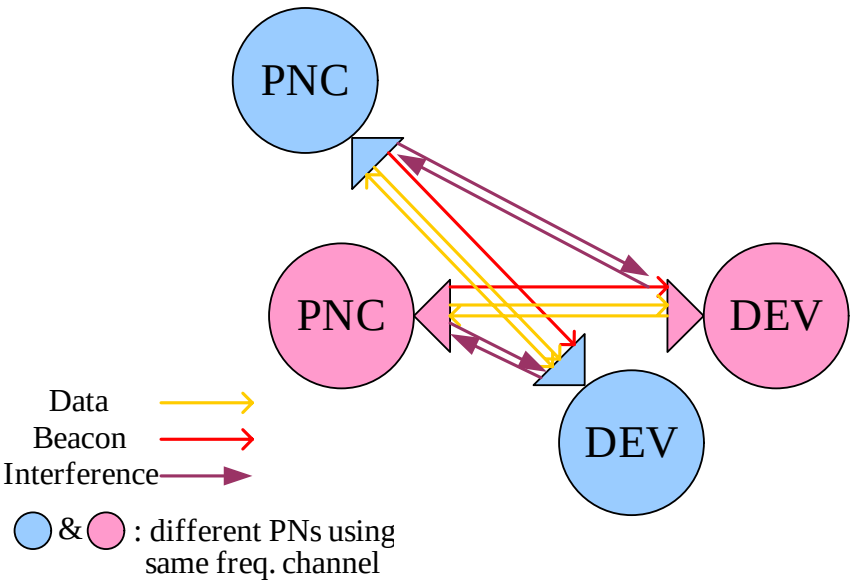
	UM	Use Case	Usage	MAC-SAP	Equivalent 'Usage' in current description [Usage #]	Current attributes (for reference)	Edited MAC Related Systems Attributes
Optional	2	U1/U3	Uncompressed video streaming 1080i, 24, 60	0.62Gbps (0.497Gbps w/o Blk.)	Uncompressed HDTV Video/Audio streaming [DVD players and other power-line operated devices] [1]	a) Isochronous b) High throughput efficiency c) Point-to-Point d) Support for high gain antennas for Data Transmission e) Device discovery f) Moderate latency g) Minimum reserved bandwidth	a) Isochronous b) High throughput efficiency c) Point-to-point d) Support for high gain antenna for data transmission d-1) Interference avoidance d-2) Device discovery e) Moderate latency f) Minimum reserved bandwidth

MAC attribute break down

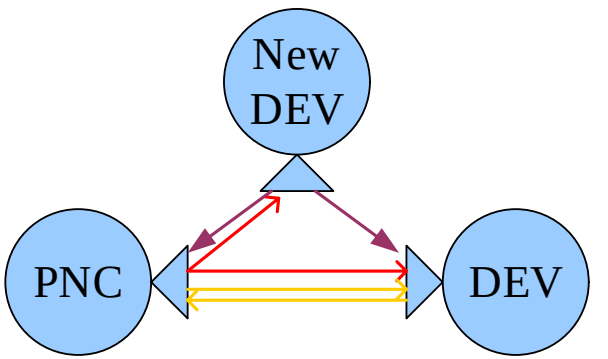
Interference situation definitions

- Interference situations are defined as follows.
  - Situation1: Different PNs are using same frequency channel.
  - Situation2: New DEV are requiring association in a PN.

Situation1

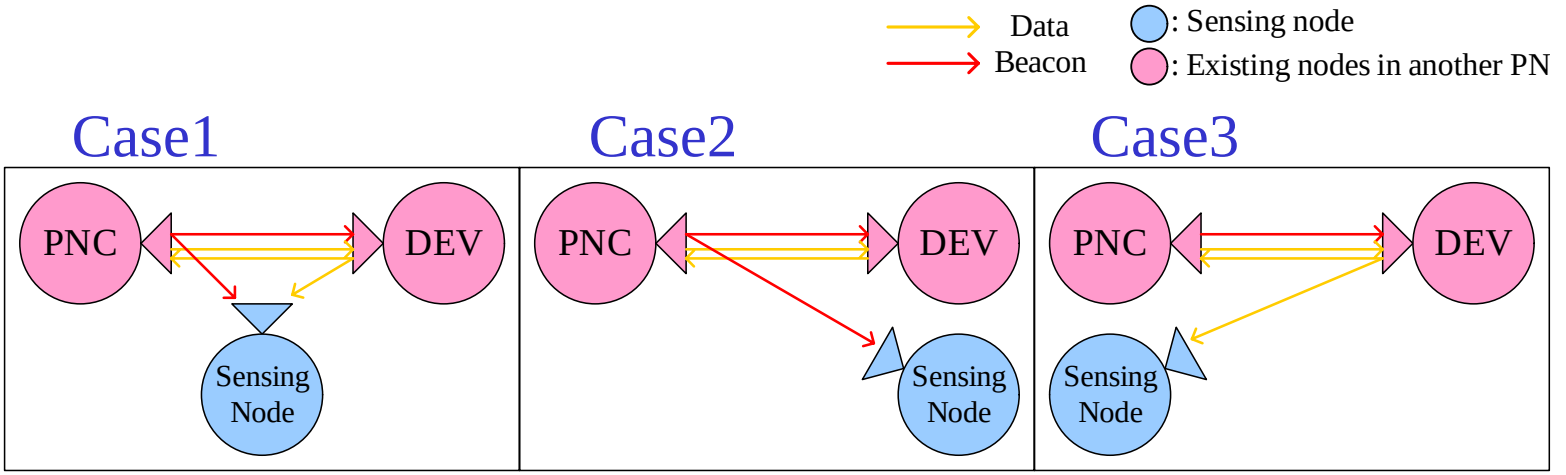


Situation2



Necessary managements in situation1

- A PN should allocate a channel after confirming every node in the PN is NOT under 'interference cases' with that channel.
- Possible 3 interference cases should be watched out, when outer PNC or DEV in another PN are existing.
  - Case1: Beacons from PNC and Frames from DEV are heard.
  - Case2: Beacons from PNC but not Frames from DEV are heard.
  - Case3: Frames from DEV but not Beacons from PNC are heard.



Necessary managements in situation1(cont.)

- Each of interference case should be sensed and avoided as follows
  - For case 1 and 2,
    - The outer PNC sends beacons including the channel occupation information that reaches to the testing node.
    - Then, the sensing node nodes receiving the beacons shall not transmit any frame on the PNC's channel.
  - For case 3
    - A sensing node that hears existing DEV's frame shall not transmit any frame on that channel.
    - ATP(Association Timeout Period) value, for example, should be designed so that DEV sends a frame in suitable intervals.

Necessary managements in situation2

- Association requirement from New DEV could be rejected to maintain current PNC-DEV communication.
  - PNC could reject the requirement due to PN or PNC policy if necessary.
  - Moreover, DEV itself could reject such a new association to maintain the current communication link.
    - The DEV can sense this new association event by directly receiving association requirement.
    - The DEV might be informed from the PNC the event.

Conclusions

- Antenna directivity in the current MAC related attributes has been further broken down into interference avoidance and device discovery, and the importance of interference avoidance is shown.
- Interference avoidance management should be introduced under following situations.
  - Situation1: Outer nodes are using same frequency channel.
    - Sensing between different PNs is used for interference avoidance
  - Situation2: New DEV are requiring association.
    - Association permission is considered for interference avoidance
- MAC attributes are classified by usage models.

Revised MAC related system attributes

Red letters mean major revisions due to this break down.
Blue letters mean minor revisions.

	UM	Use Case	Usage	MAC-SAP	Equivalent 'Usage' in current description [Usage #]	Current attributes (for reference)	Edited MAC Related Systems Attributes
Mandatory	1	U1/U3	Uncompressed video streaming 1080i, 24, 60	1.75Gbps (1.49Gbps w/o Blk.)	Uncompressed HDTV Video/Audio streaming [DVD players and other power-line operated devices] [1]	a) Isochronous b) High throughput efficiency c) Point-to-Point d) Support for high gain antennas for Data Transmission e) Device discovery f) Moderate latency g) Minimum reserved bandwidth	a) Isochronous b) High throughput efficiency c) Point-to-point d) Support for high gain antenna for data transmission d-1) Interference avoidance ~~e) Device discovery~~ e) Moderate latency f) Minimum reserved bandwidth
			Uncompressed video streaming 1080p, 24, 60	3.56Gbps (2.98Gbps w/o Blk.)	Uncompressed HDTV Video/Audio streaming [DVD players and other power-line operated devices] [1]	a) Isochronous b) High throughput efficiency c) Point-to-Point d) Support for high gain antennas for Data Transmission e) Device discovery f) Moderate latency g) Minimum reserved bandwidth	a) Isochronous b) High throughput efficiency c) Point-to-point d) Support for high gain antenna for data transmission d-1) Interference avoidance ~~e) Device discovery~~ e) Moderate latency f) Minimum reserved bandwidth

	UM	Use Case	Usage	MAC-SAP	Equivalent 'Usage' in current description [Usage #]	Current attributes (for reference)	Edited MAC Related Systems Attributes
Mandatory	5	U7/U9	File Transfer (and synch)	1.5Gbps burst	Internet bulky music and video downloading [mobile devices] [4]	a) Asynchronous b) High throughput efficiency c) Point-to-Point d) Support for moderate gain antennas for data transmission e) Device discovery (Automatic preferred) f) Multiple nearby data transmissions g) Power saving mode	a) Asynchronous b) Reasonably low error rate c) Point-to-point d) Support for moderate gain antennas for data transmission d-1) Interference avoidance ~~e) Device discovery (Automatic preferred)~~ ~~f) Multiple nearby data transmissions~~ e) Latency tolerated f) Power saving mode
			File Transfer (and synch)	2.25Gbps burst	Internet bulky music and video downloading [mobile devices] [4]	a) Asynchronous b) High throughput efficiency c) Point-to-Point d) Support for moderate gain antennas for Data transmission e) Device discovery (Automatic preferred) f) Multiple nearby data transmissions g) Power saving mode	a) Asynchronous b) Reasonably low error rate c) Point-to-point d) Support for moderate gain antennas for data transmission d-1) Interference avoidance ~~e) Device discovery (Automatic preferred)~~ ~~f) Multiple nearby data transmissions~~ e) Latency tolerated f) Power saving mode

	UM	Use Case	Usage	MAC-SAP	Equivalent 'Usage' in current description [Usage #]	Current attributes (for reference)	Edited MAC Related Systems Attributes
Optional	2	U1/U3	Uncompressed video streaming 1080i, 24, 60	0.62Gbps (0.497Gbps w/o Blk.)	Uncompressed HDTV Video/Audio streaming [DVD players and other power-line operated devices] [1]	a) Isochronous b) High throughput efficiency c) Point-to-Point d) Support for high gain antennas for Data Transmission e) Device discovery f) Moderate latency g) Minimum reserved bandwidth	a) Isochronous b) High throughput efficiency c) Point-to-point d) Support for high gain antenna for data transmission d-1) Interference avoidance d-2) Device discovery e) Moderate latency f) Minimum reserved bandwidth
			Uncompressed video streaming 720x480p, 24,60	1.75Gbps (1.49Gbps w/o Blk.)	Uncompressed HDTV Video/Audio streaming [DVD players and other power-line operated devices] [1]	a) Isochronous B) High throughput efficiency c) Point-to-Point d) Support for high gain antennas for Data Transmission e) Device discovery f) Moderate latency g) Minimum reserved bandwidth	a) Isochronous b) High throughput efficiency c) Point-to-point d) Support for high gain antenna for data transmission d-1) Interference avoidance d-2) Device discovery e) Moderate latency f) Minimum reserved bandwidth

	UM	Use Case	Usage	MAC-SAP	Equivalent 'Usage' in current description (Usage #)	Current attributes (for reference)	Edited MAC Related Systems Attributes
Optional	3	U1/U2	Uncompressed video streaming 1080p, 24, 60	1.75Gbps (1.49Gbps w/o Blk.)	Uncompressed HDTV Video/Audio streaming [DVD players and other power-line operated devices] [1]	a) Isochronous b) High throughput efficiency c) Point-to-Point d) Support for high gain antennas for Data Transmission e) Device discovery f) Moderate latency g) Minimum reserved bandwidth	a) Isochronous b) High throughput efficiency c) Point-to-point d) Support for high gain antenna for data transmission d-1) Interference avoidance d-2) Device discovery e) Moderate latency f) Minimum reserved bandwidth
			Uncompressed video streaming 1080i, 24, 60	3.56Gbps (2.98Gbps w/o Blk.)	Uncompressed HDTV Video/Audio streaming [DVD players and other power-line operated devices] [1]	a) Isochronous b) High throughput efficiency c) Point-to-Point d) Support for high gain antennas for Data Transmission e) Device discovery f) Moderate latency g) Minimum reserved bandwidth	a) Isochronous b) High throughput efficiency c) Point-to-point d) Support for high gain antenna for data transmission d-1) Interference avoidance d-2) Device discovery e) Moderate latency f) Minimum reserved bandwidth

	UM	Use Case	Usage	MAC-SAP	Equivalent 'Usage' in current description [Usage #]	Current attributes (for reference)	Edited MAC Related Systems Attributes
Optional	3	U5	File Transfer and synch. PC-HDD	0.25Gbps	Local file transfer for printing, document and small size file [6]	a) Asynchronous b) Point-to-Point c) Support for moderate gain antennas for data transmission d) Device discovery (Automatic preferred) e) Multiple nearby data transmissions f) Power saving mode	a) Asynchronous b) Reasonably low error rate c) Point-to-point d) Support for moderate gain antennas for data transmission d-1) Interference avoidance d-2) Device discovery ~~e) Multiple nearby data transmissions~~ e) Latency tolerated f) Power saving mode
		U9	File Transfer PC-Printer	0.5Gbps	Local file transfer for printing, document and small size file [6]	a) Asynchronous b) Point-to-Point c) Support for moderate gain antennas for data transmission d) Device discovery (Automatic preferred) e) Multiple nearby data transmissions f) Power saving mode	a) Asynchronous b) Reasonably low error rate c) Point-to-point d) Support for moderate gain antennas for data transmission d-1) Interference avoidance d-2) Device discovery ~~e) Multiple nearby data transmissions~~ e) Latency tolerated f) Power saving mode

	UM	Use Case	Usage	MAC-SAP	Equivalent 'Usage' in current description [Usage #]	Current attributes (for reference)	Edited MAC Related Systems Attributes
Optional	4	U2	Uncompressed video streaming 1080i, 24, 60	1.75Gbps (1.49Gbps w/o Blk.)	Uncompressed HDTV Video/Audio streaming [DVD players and other power-line operated devices] [1]	a) Isochronous b) High throughput efficiency c) Point-to-Point d) Support for high gain antennas for Data Transmission e) Device discovery f) Moderate latency g) Minimum reserved bandwidth	a) Isochronous b) High throughput efficiency c) Point-to-point d) Support for high gain antenna for data transmission d-1) Interference avoidance d-2) Device discovery e) Moderate latency f) Minimum reserved bandwidth
		U16	Ad-hoc	0.0416Gbps	Ad hoc information distribution system [16]		a) Asynchronous b) Reasonably low error rate c) Point-to-point d) Support for high gain antenna for data transmission d-1) Interference avoidance d-2) Device discovery e) latency tolerated
		U17	Gigabit Ethernet	0.125Gbps	1Gigabit Ethernet link - LOS [13]		a) Asynchronous b) Reasonably low error rate c) Point-to-point d) Support for high gain antenna for data transmission d-1) Interference avoidance d-2) Device discovery e) latency tolerated