IEEE P802.11
Wireless LANs

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| Mixed traffic configurations on simulation scenarios |
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# Abstract

This document provides a mixed traffic model for each simulation scenario in Simulation Scenarios Document IEEE 802.11-14/0980r6

# Problem 1

The underlying dot11ax Traffic Models are presented in [IEEE 802.11-14/0571r7 Evaluation Methodology](https://mentor.ieee.org/802.11/dcn/14/11-14-0571-07-00ax-evaluation-methodology.docx).

Traffic Model relevancy (Per each apartment/cubicle/BSS) to specific Simulation Scenarios are TBD for scenario 1~4 in the [Simulation Scenarios Document IEEE 802.11-14/0980r6](https://mentor.ieee.org/802.11/dcn/14/11-14-0980-06-00ax-simulation-scenarios.docx).

Currently the reserved location for the TBD information in the Simulation Scenario document only conveys the potential presence and characterstics of the traffic models.

For simulation purposes it is also necessary to know the specific traffic types that are present for a given Simulation Scenario, and at what frequency of presence among STA in the BSS: Traffic Mix.

Add Traffic Mix to each Simulation Scenario to complete the Simulation Scenario process and document.

# Remedy 1

[Add the descriptions of traffic mix onfigurations in scenario 1~4 as:]

# 1 - Residential Scenario

(Initial version from documents 11-13/1081r0**,** 786)

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| --- |
| **Topology** |
| Figure 1 - Residential building layout |
| **Parameter** | **Value** |
| Environment description | Multi-floor building* 5 floors, 3 m height in each floor
* 2x10 apartments in each floor
* Apartment size:10m x 10m x 3m
 |
| APs location | In each apartment, place AP in random xy-locations (uniform distribution) at z = 1.5 m above the floor level of the apartment. |
| AP Type | M APs in the buildingAP\_1 to AP\_M1: HEWAP\_{M1+1} to AP\_M: non-HEWM = Number of Apartments = 100M1 = [100]Non-HEW = 11b/g/n in 2.4GHzNon-HEW = 11ac in 5GHz  |
| STAs location | In each apartment, place STAs in random xy-locations (uniform distribution) at z = 1.5m above the floor level of the apartment |
| Number of STA and STAs type | N STAs in each apartmentSTA\_1 to STA\_N1: HEWSTA\_{N1 +1} to STA\_N: non-HEWN = [2] or N = 10 N1 = [N]Non-HEW = 11b/g (TBD) in 2.4GHzNon-HEW = 11ac (TBD) in 5GHz |
| Channel ModelAnd Penetration Losses | Fading modelTGac channel model D NLOS for all the links. |
| Pathloss modelPL(d) = 40.05 + 20\*log10(fc/2.4) + 20\*log10(min(d,5)) + (d>5) \* 35\*log10(d/5) + 18.3\*F^((F+2)/(F+1)-0.46) + 5\*Wd = max(3D distance [m], 1)fc = frequency [GHz]F = number of floors traversedW = number of walls traversed in x-direction plus number of walls traversed in y-direction |
| ShadowingLog-normal with 5 dB standard deviation, iid across all links |
|  |
| **PHY parameters** |
| MCS | [use MCS0 for all transmissions] or[use MCS7 for all transmissions] |
| GI | Short |
| AP #of TX antennas  | All HEW APs with [2] or all with 4 |
| AP #of RX antennas  | All HEW APs with [2] or all with 4 |
| STA #of TX antennas | All HEW STAs with [1] or all with 2 |
| STA #of RX antennas | All HEW STAs with [1] or all with 2 |
|  |
| **MAC parameters** |
| Access protocol parameters  | [EDCA with default parameters according to traffic class] |
| Center frequency, BSS BW and primary channels | Operating channel: 2.4GHz: random assignment of 3 20MHz non-overlapping channels 5GHz: random assignment of [3] or 5 80MHz non-overlapping channels, with random selection of primary channel per operating channel  |
| Aggregation  | [A-MPDU / 64 MPDU aggregation size / BA window size, No A-MSDU, with immediate BA] |
| Max # of retries  | Max retries: 10 |
| RTS/CTS Threshold | [No RTS/CTS] |
| Association | X% of STAs in an apartment are associated to the AP in the apartment; 100-X% of the STAs are not associated[X=100] |
| Management | Each AP is independently managed |

**Traffic model**

**For Calibration:**

* Use full buffer traffic
* Downlink only or Uplink only
* BE class

**For performance tests:**

|  |
| --- |
| **Traffic model (Per each apartment) - TBD** |
| **#** | **Source/Sink** | **Name** | **Traffic definition** | **Flow specific parameters**  | **AC** |
| **Downlink** |
| D1 | AP/STA1 | Buffered video streaming |  | 200Mbps/N (4k video 20Mbps for N=10); | VI |
| … |  |  |  |  | VI |
| DN | AP/STA\_N | Buffered video streaming |  |  200Mbps/N (4k video 20Mbps for N=10); | VI |
| **Uplink** |
| U1 | STA1/AP |  |  | 1.5Mpbs |  |
|  |  |  |  |  |  |
| UN | STA\_N/AP |  |  | 1.5Mpbs |  |
| **P2P (optional)** |
| P1 | STA\_{N1+1}/STA\_{N1+2} | Buffered video streaming  |  | 10Mbps | VI |
|  |  |  |  |  |  |
|  | STA\_{N-1}/STA\_{N} | Buffered video streaming  |  | 10Mbps |  |
|  **Idle Management (optional**  |
| M1 | AP1 | Beacon | TX | 80 octets long Beacon frame is transmitted every 100ms  |  |
| M2-M | All unassociated STAs | Probe Req |  | TBD |  |

Traffic model for each apartment:

|  |
| --- |
| Downlink |
| Traffic type  | Percent of STAs in Test Population (%) |
| T1 Local file transfer | 10 |
| T3 Internet streaming video/audio  | 10 |
| T4 Buffered Streaming Video (lightly compressed VHD/4K)  | 50 |
| T8 Gaming  | 30 |
| T9 VoIP  | 10 |
| Webbrowsing/HTTP  | 50 |

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| --- |
| Uplink |
| Traffic type  | Percent of STAs in Test Population (%) |
| T1 Local file transfer | 10 |
| T3 Internet streaming video/audio  | 10 |
| T8 Gaming  | 30 |
| T9 VoIP  | 10 |
| Webbrowsing/HTTP  | 50 |

# 2 – Enterprise Scenario

(Initial version form the Wireless Office scenario in 11/722r2)

|  |  |
| --- | --- |
| **Parameter** | **Value** |
|  |
| **Topology** |
| Figure 2 - BSSs within the building floor |
|  |
| Toplogy_dense.pngFigure 3 - STAs clusters (cubicle) and AP positions within a BSSFigure 4 - STAs within a cluster |
| Topology Description  | Office floor configuration * 1. 8 offices (see Figure 2)
	2. 64 cubicles per office (see Figure 3)
	3. Each cubicle has 4 STAs (see Figure 4)

STA1: laptopSTA2: monitorSTA3: smartphone or tabletSTA4: Hard disk |
| APs location | 4 APs per officeInstalled on the ceiling at:AP1: (x=5,y=5,z=3)AP2: (x=15,y=5,z=3)AP3: (x=5,y=15,z=3)AP4: (x=15,y=15,z=3)From the left-bottom of each office location. |
| AP Type | HEW |
| STAs location | Placed randomly in a cubicle (x,y) z=1 |
| Number of STAsand STAs type | N STAs in each cubicle. STA\_1 to STA\_{N1}: HEWSTA\_{N1+1} to STA\_{N} : non-HEWN = 4N1 = [4]Non-HEW = 11b/g/n (TBD) in 2.4GHzNon-HEW = 11ac (TBD) in 5GHz |
| Channel ModelAnd Penetration Losses | Fading modelTGac channel model D NLOS for all the links. |
| Pathloss modelPL(d) = 40.05 + 20\*log10(fc/2.4) + 20\*log10(min(d,10)) + (d>10) \* 35\*log10(d/10) + 7\*Wd = max(3D-distance [m], 1)fc = frequency [GHz]W = number of office walls traversed in x-direction plus number of office walls traversed in y-directionShadowingLog-normal with 5 dB standard deviation, iid across all links  |
|  |  |
|  |
| **PHY parameters** |
| MCS | [use MCS0 for all transmissions] or[use MCS7 for all transmissions] |
| GI | Short |
| AP #of TX antennas  | 4 |
| AP #of RX antennas  | 4 |
| STA #of TX antennas | All STAs with [1], or all STAs with 2 |
| STA #of RX antennas | All STAs with [1], or all STAs with 2 |
|  |
| **MAC parameters** |
| Access protocol parameters | [EDCA with default EDCA Parameters set] |
| Center frequency, BSS BW and primary channels | Channel allocation5GHz: Four 80 MHz channels (Ch1, Ch2, Ch3, Ch4) The channel distribution can be:Ch1: BSS 4k-3Ch2: BSS 4k-2Ch3: BSS 4k-1Ch4: BSS 4kk=1~8, is the office index.APs on same 80MHz channel uses the same primary channel2.4GHz: Ch1: BSS 1Ch2: BSS 2Ch3: BSS 3 and 4Repeat same allocation for all offices |
| Aggregation  | [A-MPDU / max aggregation size / BA window size, No A-MSDU, with immediate BA] |
| Max # of retries  | 10 |
| RTS/CTS Threshold | [no RTS/CTS] |
| Association | X% of STAs associate with the AP based on highest RSSI in the same office; 100-X% of STAs are not associated. [X=100] |
| Management | It is allowed to assume that all APs belong to the same management entity |
| **Parameters for P2P (if different from above)** |
| Primary channels | Channel allocation5 GHzAll P2P group use one 80 MHz channel which is Channel 1 of HEW’s parameter with random selection of primary channel per operating channel2.4 GHzRandom assignment in 4 channels of HEW’s parameter |

**Traffic model**

|  |
| --- |
| **Traffic model (Per each cubicle)**  |
| **#** | **Source/Sink** | **Name** | **Traffic definition** | **Flow specific parameters**  | **AC** |
| **Downlink** |
| D1 | AP/STA1 | Web browsing, Local file transfer | T1 |  | VI |
| D2 | AP/STA3 | Web browsing, Local file transfer | T3 |  | BE |
| **Uplink** |
| U1 | STA1/AP | Web browsing, Local file transfer |  |  |  |
| U2 | STA3/AP | Web browsing, Local file transfer |  |  |  |
| **P2P** |
| P1 | STA1/STA2 | Lightly compressed video |  |  |  |
| P2 | STA1/STA4 | Hard disk file transfer |  |  |  |
|  **Idle / Management** |
| M1 | AP | Beacon  |  |  |  |
| M2 | STAs | Probes  |  |  |  |

Traffic model for each cubicle:

|  |
| --- |
| Downlink |
| Traffic type  | Percent of STAs in Test Population (%) |
| T3 Internet streaming video/audio  | 10 |
| T4 Buffered Streaming Video | 5 |
| T8 VDI | 100 |
| T9 VoIP | 15 |

|  |
| --- |
| Uplink |
| Traffic type  | Percent of STAs in Test Population (%) |
| T3 Internet streaming video/audio | 10 |
| T8 VDI | 100 |
| T9 VoIP | 15 |

## Interfering scenario for scenario 2

All surveys and observations so far have led to the same conclusion that most enterprises in the world are made up of micro, small or medium sizes. The results of the surveys also indicate that small enterprises consist of a single office/room whereby medium enterprises consist of 2 to 4 offices. Hence, a mixed office scenario that contains multiple BSSs belonging to different ESSs is proposed. These ESSs are managed independently. (Reference: 14/0051r0).

**Interference models:**

Based on the mixed enterprise topology, two kinds of interferences are considered either in a combined or separate way:

* Interference between APs belonging to different managed ESS due to the presence of multiple operators (multiple small and medium enterprises).
* Interference with unmanaged networks (P2P links).
1. Interference between APs belonging to different managed ESS due to the presence of multiple operators (multiple small and medium enterprises). Use the model of scenario 2 with the following differences.

Different offices can be managed by a different entities, as indicated in Figure 5, where each color represents a management entity (note that office 1 (BSS1-4) and office 2 (BSS5-8) have same management entity)

BSS 9-12

BSS13-16

BSS 5-8

BSS 1-4

20 m

20 m

BSS 25-28

BSS 29-32

BSS 21-24

BSS 17-20

1

2

4

3

Figure 5- Scenario 2 with different management entities

1. Interference with unmanaged networks (P2P links). Use the model of scenario 3 with the following differences.

A number of additional P2P STAs

|  |  |
| --- | --- |
| STAs location | (NP2P /2) P2P pairs with STAs placed 0.5m apart. The P2P pairs are placed in a random location within an office. |
| Number of STAsand STAs type | P2P STAs: NP2P STAs in an office, with MP2P STAs HEW.STA\_{64N+1} to STA\_{64N+MP2P}: HEWSTA\_{64N+ MP2P+1} to STA\_{64N+NP2P}: non-HEW (NP2P = TBD, MP2P = TBD) ,with N STAs in a cubic as described in scenario 2, and 64 cubics per office.Non-HEW = 11b/g/n (TBD) in 2.4GHz Non-HEW = 11n/ac (TBD) in 5GHz  |



# 3 - Indoor Small BSSs Scenario

(From document 1248r0)

This scenario has the objective to capture the issues and be representative of real-world deployments with high density of APs and STAs that are highlighted by the first category of usage models described in [5]:

* In such environments, the infrastructure network (ESS) is planned. For simulation complexity simplifications, a hexagonal BSS layout is considered with a frequency reuse pattern.
* In such environments, the “traffic condition” described in the usage model document mentions:
	+ interference between APs belonging to the same managed ESS due to high density deployment: *this OBSS interference is captured in this scenario*
		- *note that this OBSS interference is touching STAs in high SNR conditions (close to their serving APs, while in outdoor large BSS scenario, the OBSS interference will be touching STAs in low SNR conditions (for from their serving APs)*
	+ Interference with unmanaged networks (P2P links): *this OBSS interference is captured in this scenario by the definition of interfering networks, defined here as random unmanaged short-range P2P links, representative of Soft APs and tethering*
	+ Interference with unmanaged stand-alone APs: *this OBSS interference is currently not captured in this scenario, but in the hierarchical indoor/outdoor scenario*
	+ Interference between APs belonging to different managed ESS due to the presence of multiple operators: *this OBSS interference is currently not captured in this scenario, but in the outdoor large BSS scenario*
* Other important real-world conditions representative of such environments are captured in this scenario, [20]:
	+ Existence of unassociated clients, with regular probe request broadcasts.

Different frequency reuse pattern can be defined (1, 3 and/or more).

Frequency reuse 3 is more realistic in a scenario with such high density of AP and we should use it as the default setting.

It is representative of the majority of planned deployments which apply frequency reuse higher than 1 and where STAs are located closer from their serving APs (good SNR conditions) than from neighboring APs on the same channel.

It is regular

Reuse 1 should however also be considered, to capture the fact that some regions have very low available bandwidth and are forced to apply frequency reuse 1 deployments. (But this reuse 1 case is very difficult seeing the huge overlap between neighboring APs due to high density of APs).

Note that frequency reuse 1 is more suited to scenario 4 either to represent:

 A single operator deployment in a region where available bandwidth is low (the lower density of APs in large outdoor makes it more realistic)

 An overlap between 3 operators, each applying a frequency reuse 3: this is equivalent to a single deployment with reuse 1.

In order to focus this scenario on the issues related to high density, the channel model is considered as a large indoor model (TGn F). *Note that robustness to outdoor channel models, which is also a requirement for some usage models in category 1 (like outdoor stadiums), is captured in the outdoor large BSS scenario.*

It is important to define a proportion (TBD %) of legacy devices in the scenario that won’t implement the proposed solution under evaluationto ensure that the solution will keep its efficiency in real deployments (some solutions may be sensitive to the presence of legacy devices while other won’t).

These legacy devices shall simply keep the baseline default parameters and shall not implement the proposed solution under evaluation. Those devices can be:

* STAs connected to the planned network
* APs and STAs part of the interfering network

|  |  |
| --- | --- |
| **Parameter** | **Value** |
|  |
| **Topology (A)** |
| Figure 6 - BSSs layoutBSSBSSBSSBSSBSSBSSBSSBSSBSSBSSBSSBSBSSBSSBSSBSSBSSBSSBSSFigure 7 - Layout of BSSs using the same channel in case frequency reuse 3 is used |
| Environment description | BSSs are placed in a regular and symmetric grid as in Figure 6 for frequency reuse 1 and Figure 7 for frequency reuse 3.Each hexagon in Figures 6 and 7 has the following configuration:Radius (R): 10 meters Inter BSS distance (ICD): 2\*h meters h=sqrt(R2-R2/4) |
| APs location | AP is placed at the center of the hexagon, with 3m antenna height |
| AP Type | HEW |
| STAs location | STA antenna height 1.5m.Reuse 1:STAs are placed randomly (uniform distribution) within the 19 cell area. STA identifies AP from which it receives the highest power (based on distance-based pathloss and shadowing). STA associates to corresponding AP if the AP does not yet have N1 STAs associated to it; if AP already has N1 STAs associated to it then this STA is removed from the simulation. This process is repeated, with iid dropping of STAs within the 19 cell area, until each of the 19 APs has exactly N1 STAs associated to it.Reuse 3:STAs are placed randomly (uniform distribution) within the 61 cell area that covers the reuse 3 pattern in Figure 7. STA identifies which (of the 61) APs from which it receives the highest power (based on distance-based pathloss and shadowing). If the corresponding AP is one of the 19 co-channel APs shown in Figure 7 and if the AP does not yet have N1 STAs associated to it, then STA associates to it; else STA is removed from the simulation. This process is repeated until each of the 19 co-channel APs has exactly N1 STAs associated to it.If Y >0 or Z> 0, where Y and Z are the percentage of STAs that associate with the 2nd /3rd strongest AP’s respectively (see below for specification of Y, Z, and X; percentage of STAs that associate with strongest AP), then the above procedure should be performed three times: first to load each AP with N1\*X/100 STAs that have associated with the strongest AP, then to load with N1\*Y/100 STA’s that have associated to the 2n d strongest AP, and a third time to load with N1\*Z/100 STA’s that have associated to the 3rd strongest AP. This procedure guarantees each AP has the same number of associated STAs that have identified it as the strongest, 2nd strongest, and 3rd strongest AP (e.g., if X = 50, Y = 25, Z =25, then each AP will have 20/10/10 associated STAs for which that AP is the 1st/2nd/3rd strongest respectively.). |
| Number of STA and STAs type | N STAs per AP.STA\_1 to STA\_{N1}: HEWSTA\_{N1+1} to STA\_{N} : non-HEWN = [30] or 40 N1 = [N] Non-HEW = 11b/g/n (TBD) in 2.4GHzNon-HEW = 11ac (TBD) in 5GHz |
| Channel Model | Fading modelTGac channel model D NLOS for all the links. |
| Pathloss modelPL(d) = 40.05 + 20\*log10(fc/2.4) + 20\*log10(min(d,10)) + (d>10) \* 35\*log10(d/10) d = max(3D-distance [m], 1)fc = frequency [GHz]ShadowingLog-normal with 5 dB standard deviation, iid across all links  |
|  |  |
|  |
| **PHY parameters** |
| MCS | [use MCS0 for all transmissions] or[use MCS7 for all transmissions] |
| GI | Short |
| AP #of TX antennas  | All APs with [2] or all APs with 4 |
| AP #of RX antennas  | All APs with [2] or all APs with 4 |
| STA #of TX antennas | All STAs with [1] or all STAs with 2 |
| STA #of RX antennas | All STAs with [1] or all STAs with 2 |
|  |
| **MAC parameters** |
| Access protocol parameters  | [EDCA with default EDCA Parameters set] |
| Primary channels  | All BSSs either all at 2.4GHz, or all at 5GHz2.4GHz:20MHz BSS with reuse 35GHz:80 MHz BSS [Reuse 3] or reuse 1Per each 80MHz use same primary channel across BSSs |
| Aggregation | [A-MPDU / max aggregation size / BA window size, No A-MSDU, with immediate BA] |
| Max # of retries  | 10 |
| RTS/CTS Threshold | [no RTS/CTS] |
| Association | X% of STAs are associated with the strongest AP, Y% of STAs are associated with the second-strongest AP, and Z% of STAs associate with the third-strongest AP. Z% of STAs are not associated. Association is based on RSSI, i.e., received power as determined by path loss, shadowing, and any penetration loss (but not multipath). Detailed distribution to be decided.[X=100,Y=0,Z=0] |
| Management | It is allowed to assume that all APs belong to the same management entity |

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| **Traffic model (per each BSS) - TBD** |
| **#** | **Source/Sink** | **Name** | **Traffic definition** | **Flow specific parameters**  | **AC** |
| **Downlink** |
| D1 | AP/STA1 to AP/STA10 | Highly compressed video (streaming) | T2 |  |  |
| D2 | AP/STA11 to AP/STA20 | Web browsing | T4 |  |  |
| D3 | AP/STA21 to AP/STA30 | Local file transfer | T3 |  |  |
| D4 | AP/STA31 toAP/STA 70 | Multicast Video Streaming | T8 |  |  |
|  |  |  |  |  |  |
| **Uplink** |
| U1 | STA1/AP to STA10/AP | Highly compressed video (streaming) – UL TCP ACKs… |  |  |  |
| U2 | STA11/AP to STA20/AP | Web browsing: – UL TCP ACKs… |  |  |  |
| U3 | STA21/AP to STA30/AP | Local file transfer | T3 |  |  |
| U4 | STA/AP31 toSTA/AP 70 | - |  - |  |  |
|  |  |  |  |  |  |
| **P2P** |
| P1 | NONE (see interfering scenarios) |  |  |  |  |
|  **Idle / Management** |
| M1 | AP | Beacon  | TX |  |  |
| M2 | STA36 to STA TBD | Probe Req. | TY |  |  |

Traffic model for each BSS:

|  |
| --- |
| Downlink |
| Traffic type  | Percent of STAs in Test Population (%) |
| T1 Local file transfer | 10 |
| T3 Internet streaming video/audio  | 10 |
| T4 Buffered Streaming Video (lightly compressed VHD/4K)  | 40 |
| T8 Gaming  | 40 |
| T9 VoIP  | 20 |
| Webbrowsing/HTTP  | 30 |

|  |
| --- |
| Uplink |
| Traffic type  | Percent of STAs in Test Population (%) |
| T1 Local file transfer | 10 |
| T3 Internet streaming video/audio  | 10 |
| T8 Gaming  | 40 |
| T9 VoIP  | 20 |
| Webbrowsing/HTTP  | 30 |

## Interfering Scenario for Scenario 3

This scenario introduces and overlay of unmanaged P2P networks on top of Scenario 3.

|  |  |
| --- | --- |
| **Parameter** | **Value** |
|  |
| **Topology** |
| BSSBSSBSSBSSBSSBSSBSSFigure 8 - BSSs layout, with interfering P2P links |
| Topology Description | Starting from Scenario 3 topology, add K P2P pairs of STAs within each hexagon |
| APs location |  |
| AP Type | HEW |
| STAs location | STAs pairs randomly placed in the simulation areaPer each pair, STAs are placed 0.5m apart |
| Number of STA and STAs type | STA\_1 to STA\_{K1}: HEWSTA\_{K1+1} to STA\_{K} : non-HEWK = 4K1 = [4] |
| Channel Model | TBD |
| Penetration Losses | None  |
|  |
| **PHY parameters: Same as main scenario****Except for the following ones** |
| STA TX Power | 15dBm |
|  |
| **MAC parameters: same as main scenario****Except for the following ones** |
| Primary channels | P2P on same channel as the BSS corresponding to the same hexagon |

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| --- |
| **Traffic model for interfering scenario**  |
| **#** | **Source/Sink** | **Name** | **Traffic definition** | **Flow specific parameters**  | **AC** |
| **Downlink** |
| 1 | STA\_1 to STA\_2 | Highly compressed video (streaming) | T2 |  |  |
| 2 |  |  |  |  |  |
| 3 | STA\_n to STA\_{n+1} | Local file transfer | T3 |  |  |
|  **Idle / Management** |
| M1 | STA\_{2n} | Beacon  | TX |  |  |

# 4 - Outdoor Large BSS Scenario

This scenario has the objective to capture the issues (and be representative of) real-world outdoor deployments with a high separation between APs (BSS edge with low SNR) with high density of STAs that are highlighted by the forth category of usage models described in []:

* In such environments, the infrastructure network (ESS) is planned. For simulation complexity simplifications, a hexagonal BSS layout is considered with a frequency reuse pattern. This frequency reuse pattern is defined and fixed, as part of the parameters that can’t be modified in this scenario. *(Note that BSS channel allocation can be evaluated in simulation scenarios where there are not planned networks (ESS), as in the residential one.)*
* In such environments, the “traffic condition” described in the usage model document mentions:
	+ interference between APs belonging to the same managed ESS due to high density deployment: *this OBSS interference is captured in this scenario even if it is low as the distance between APs is high*
	+ Interference with unmanaged networks (P2P links): *this OBSS interference is currently not captured in this scenario, but in the scenario 3.*
	+ Interference with unmanaged stand-alone APs: *this OBSS interference is currently not captured in this scenario, but in the hierarchical indoor/outdoor scenario 4a*
	+ Interference between APs belonging to different managed ESS due to the presence of multiple operators: *this OBSS interference is captured in this scenario, by an overlap of 3 operators, using relatively similar grid but channel selection offset*

Reuse factor, TBD

We should consider a hexagonal deployment using frequency reuse 1.

Such a frequency reuse 1 scenario is representative of:

 A single operator deployment in a region where available bandwidth is low and forces frequency reuse 1 deployments (the lower density of APs in large outdoor makes it more realistic)

 An overlap between 3 operators, each applying a frequency reuse 3: in case of close location of this is equivalent to a single operator deployment with reuse 1.

As the inter-site distance is high, the overlap between neighboring cells is close to minimum sensitivity (low SNR)

* *this enables to capture the issue of outdoor performance in low SNR conditions*
* *this enables to capture the issue of fairness between users spread on the full coverage of each AP*
* *this enables to capture OBSS interference touching STAs in low SNR conditions (far from their serving APs), while in dense hotspot scenario, the OBSS interference is touching STAs in high SNR conditions (close to their serving APs)*

It is important to define a proportion (TBD %) of legacy devices in the scenario that won’t implement the proposed solution under evaluationto ensure that the solution will keep its efficiency in real deployments (some solutions may be sensitive to the presence of legacy devices while other won’t).

These legacy devices shall simply keep the baseline default parameters and shall not implement the proposed solution under evaluation. Those devices can be:

* STAs connected to the planned network
* APs and STAs part of the interfering network

|  |  |
| --- | --- |
| **Parameter** | **Value** |
|  |
| **Topology (A)** |
| Figure 9 – BSSs layout  |
| Environment description | Outdoor street deploymentBSS layout configurationDefine a 19 hexagonal grid as in Figure 9With ICD = 130m h=sqrt(R2-R2/4)/2 |
| APs location | Place APs on the center of each hexagonAntenna height 10 m. |
| AP Type | HEW |
| STAs location | .STA antenna height 1.5 m.STAs are placed randomly (uniform distribution) within the 19 cell area, at a minimum X-Y distance of 10 m from every AP. STA identifies AP from which it receives the highest power (based on distance-based pathloss and shadowing). STA associates to corresponding AP if the AP does not yet have N1 STAs associated to it; if AP already has N1 STAs associated to it then this STA is removed from the simulation. This process is repeated until each of the 19 APs has exactly N1 STAs associated to it.If Y >0 or Z> 0, where Y and Z are the percentage of STAs that associate with the 2nd /3rd strongest AP’s respectively (see below for specification of Y, Z, and X; percentage of STAs that associate with strongest AP), then the above procedure should be performed three times: first to load each AP with N1\*X/100 STAs that have associated with the strongest AP, then to load with N1\*Y/100 STA’s that have associated to the 2n d strongest AP, and a third time to load with N1\*Z/100 STA’s that have associated to the 3rd strongest AP. This procedure guarantees each AP has the same number of associated STAs that have identified it as the strongest, 2nd strongest, and 3rd strongest AP (e.g., if X = 50, Y = 25, Z =25, then each AP will have 20/10/10 associated STAs for which that AP is the 1st/2nd/3rd strongest respectively.). |
| Number of STA and STAs type | N STAs per AP. STA\_1 to STA\_{N1}: HEWSTA\_{N1+1} to STA\_{N} : non-HEW(N= 50 - 100 TBD, N1 = TBD) Non-HEW = 11b/g/n (TBD) in 2.4GHzNon-HEW = 11ac (TBD) in 5GHzN=50[N1=50] |
| Channel Model | [UMi] or UMa The following equations from ITU-UMi model [4] are to be used for computing the path loss for each drop in an outdoor scenarioLOS Links $$PL\_{ITU-LOS}(d(m) < d\_{BP})=22.0log\_{10}d +28+20log\_{10}f\_{c}(GHz)$$$$PL\_{ITU-LOS}\left(d\left(m\right)>d\_{BP}\right)=40log\_{10}(d>d\_{BP})+7.8 -18log\_{10}\left(h\_{BS}^{'}\right)-18log\_{10}\left(h\_{MS}^{'}\right)+2log\_{10}f\_{c}(GHz)$$ where the effective antenna height parameters are given by $h\_{BS}^{'}=h\_{BS}-1.0$ and $h\_{MS}^{'}=h\_{MS}-1.0$ and $d\_{BP}=\frac{4h\_{BS}^{'}h\_{MS}^{'}f\left(Hz\right)}{c(=3×10^{8})}$NLOS Links$$PL\_{ITU-NLOS}\left(d(m)\right)=36.7log\_{10}(d)+22.7+26.0log\_{10}f\_{c}(GHz)$$Modify height parameters as follows depending on the link* + $h\_{MS}$ = 1.5m for the STA; $h\_{BS}$ = 10m for AP in the AP🡨🡪 STA links
	+ $h\_{MS}=h\_{BS}$ = 1.5m for STA🡨🡪 STA links
	+ $h\_{MS}=h\_{BS}=10$m for AP 🡨🡪 AP links

In the above equations, the variable d is defined as:d = max(3D-distance [m], 1)TBD Note: In case of UMi channel model, M.2135-1 defines that 50% of user are indoor users, but since indoor users can be served by indoor AP, we can change the percentage of users are indoor; need to decide which percentage  |
| Penetration Losses | None |
|  |
| **PHY parameters** |
| MCS | [use MCS0 for all transmissions] or[use MCS7 for all transmissions] |
| GI | Long |
| AP #of TX antennas  | All APs with [2] or all APs with 4 |
| AP #of RX antennas  | All APs with [2] or all APs with 4 |
| STA #of TX antennas | All STAs with [1] or all STAs with 2 |
| STA #of RX antennas | All STAs with [1] or all STAs with 2 |
|  |
| **MAC parameters** |
| Access protocol parameters  | [EDCA with default EDCA Parameters set] |
| Center frequency, BW and primary channels  | Frequency reuse 1 is used. 5GHzall BSSs are using the same 80MHz channel[Same Primary channel]2.4GHzAll BSSs are 20MHz BSS on same channel |
| Aggregation  | [A-MPDU / max aggregation size / BA window size, No A-MSDU, with immediate BA] |
| Max # of retries  | 10 |
| RTS/CTS Threshold | [no RTS/CTS] |
| Association | X% of STAs are associated with the strongest AP, Y% of STAs are associated with the second-strongest AP, and Z% of STAs are associated with the third-strongest AP. Z% of STAs are not associated. Detailed distribution to be decided.[X=100, Y=0,Z=0] |
| Management | It is allowed to assume that all APs belong to the same management entity |

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| **Traffic model (Per each BSS) - TBD** |
| **#** | **Source/Sink** | **Name** | **Traffic definition** | **Flow specific parameters**  | **AC** |
| **Downlink** |
| D1 | AP/STA1 to AP/STA10 | Highly compressed video (streaming) | T2 |  |  |
| D2 | AP/STA11 to AP/STA20 | Web browsing | T4 |  |  |
| D3 | AP/STA21 to AP/STA25 | Local file transfer | T3 |  |  |
| … | … |  |  |  |  |
| DN | AP/STAN |  |  |  |  |
| **Uplink** |
| U1 | AP/STA1 to AP/STA10 | Highly compressed video (streaming) – UL TCP ACKs… |  |  |  |
| U2 | AP/STA11 to AP/STA20 | Web browsing: – UL TCP ACKs… |  |  |  |
| U3 | STA26/AP to STA30/AP | Local file transfer | T3 |  |  |
| … | … |  |  |  |  |
| UN | STAN/AP |  |  |  |  |
| **P2P** |
| P1 | STA1/AP |  |  |  |  |
| P2 | STA2/AP |  |  |  |  |
| P3 | STA3/AP |  |  |  |  |
| … | … |  |  |  |  |
| PN | STAN/AP |  |  |  |  |
|  **Idle Management** |
| M1 | AP1 | Beacon  | TX |  |  |
| M2 | STA2 | Probe Req. | TY |  |  |
| M3 | STA3 |  |  |  |  |
| … | … |  |  |  |  |
| MN | STAN |  |  |  |  |

Traffic model for each BSS:

|  |
| --- |
| Downlink |
| Traffic type  | Percent of STAs in Test Population (%) |
| T1 Local file transfer | 10 |
| T3 Internet streaming video/audio  | 5 |
| T4 Buffered Streaming Video (lightly compressed VHD/4K)  | 20 |
| T8 Gaming  | 20 |
| T9 VoIP  | 30 |
| Webbrowsing/HTTP  | 20 |

|  |
| --- |
| Uplink |
| Traffic type  | Percent of STAs in Test Population (%) |
| T1 Local file transfer | 10 |
| T3 Internet streaming video/audio  | 5 |
| T8 Gaming  | 20 |
| T9 VoIP  | 30 |
| Webbrowsing/HTTP  | 20 |