EEE P802.11
Wireless LANs

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| TGax Simulation Scenarios |
| Date: May 13, 2014 |
| Authors and Contributors |
| Name | Company | Address | Phone | Email |
| Simone Merlin | Qualcomm | 5775 Morehouse DrSan Diego, CA |  | smerlin@qti.qualcomm.com |
| Gwen Barriac | Qualcomm |  |  |  |
| Hemanth Sampath | Qualcomm |  |  |  |
| Laurent Cariou | Orange |  |  |  |
| Thomas Derham | Orange |  |  |  |
| Jean-Pierre Le Rouzic | Orange |  |  |  |
| Robert Stacey  | Intel |  |  |  |
| Minyoung Park | Intel |  |  |  |
| Ron Porat | Broadcom |  |  |  |
| Yasuhiko Inoue | NTT |  |  |  |
| Yusuke Asai | NTT |  |  |  |
| Yasushi Takatori | NTT |  |  |  |
| Akira Kishida | NTT |  |  |  |
| Akira Yamada | NTT Docomo |  |  |  |
| Reza Hedayat | Cisco |  |  |  |
| Sayantan Choudhury | Nokia |  |  |  |
| Klaus Doppler | Nokia |  |  |  |
| Jarkko Kneckt | Nokia |  |  |  |
| David Xun Yang | Huawei |  |  |  |
| Yujian (Ross)  | Huawei |  |  |  |
| Wookbong Lee  | LGE |  |  |  |
| HanGyu Cho | LGE |  |  |  |
| Suhwook Kim | LGE |  |  |  |
| Joseph Levy | InterDigital |  |  |  |
| Frank La Sita | InterDigital |  |  |  |
| Jinjing Jiang | Marvell |  |  |  |
| Liwen Chu | Marvell |  |  |  |
| Yakun Sun | Marvell |  |  |  |
| Ross Jian Yu | Huawei |  |  |  |
| Filip Mestanov | Ericsson |  |  |  |
| Guoqing Li | Intel |  |  |  |
| Scott Marin | Nokia Solutions and Networks |  |  |  |
| Eisuke Sakai  | Sony |  |  |  |
| William Carney | Sony |  |  |  |

# Abstract

This document describes the simulation scenarios for the 11ax TG.

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# Revisions

|  |
| --- |
| **Revisions of document 13/1001** |
| **Revision** | **Comments** | **Date** |
| *R0* | Initial draft template | Aug 28th |
| *R1* |  | Sept 15th 2013 |
| *R2* | Made it consistent with document 1000r2 | Sept 16th 2013 |
| *R3* | Included Scenario 1 from 1081r0 Included Scenario 2 from 722r2Included Scenario 3 and 4 from 1248r0; scenario 3 likely compatible with documents 722 and 1079. Included concept from 1176r0Added ReferencesUpdated co-authors | Oct 4th 2013 |
| *R4* | Minor corrections | Oct 4th 2013 |
| *R5* | Added description for scenario 4a (Simone (Qualcomm), Ron (Broadcom))Tentative addition of contributions related to traffic models; more discussion is needed: * Added video traffic models from #1335 (Guoqing Li, Intel)
* Table for traffic models (Bill, Sony)
* Management Traffic profile and % of unassociated users (Reza, Cisco)
* Application activity intervals (Huai-Rong, Samsung)

Indicated that legacy STAs can be present (Various)Indicated that legacy APs can be present in scenario 1(Liwen, Marvell)Indication of antenna height (Wookbong, LG)RTS Thresholds (Liwen, Marvell)Primary channel location (Liwen (Marvell), Klaus (Nokia))Clarified that all BSSs are either all at 2.4GHz, or all at 5GHz (Liwen, Marvell)Some changes on traffic model for Residential Scenario (Klaus, Nokia)Initial indications of channel model (various, Joseph, (InterDigital), Wookbong (LG); needs more discussion)Clarification on non-HEW definition.Other comments from Jason, David, Wookbong, Thomas | Nov 14th 2013 |
| *R6* | Modified the number of APs in scenario 2 (Filip (Ericsson))Add description of the interference scenario for Scenario 2 (David (Huawei))Added considerations on feedback from WFA |  |
| *R7* | Editorials corrections and accepted all track changes to ease identification of future changes (Wookbong) | Mar 2014 |
| *R8* | Update on the management traffic parameters (Reza)Various updates (Yakun)Addition of multicast traffic on Scenario 3 (Eisuke)Updated Scenarion 1 with pathloss model and calibration parameters (Simone, 14/355r0)Updates on Residential Scenario parameters (Jarkko, Klaus) | Mar 2014 |
| R9 | Updated Interfering scenario for scenario 2 which I missed in previous version (from Ross) | April 2014 |

|  |
| --- |
| **Revisions of document 14/0621** |
| **Revision** | **Comments** | **Date** |
| R0 | Cleanup, removal of old comments, resolution of (hopefully) non-controversial TBDs. To see all the comments, please refer to r9Included comments from Jarkko: added a tentative set of common parameters upfront; removed several comments.Included comments from Suhwook on the allocation of channels from 14/0625Included VDI and Gaming in the traffic profiles from doc 14/0594, 14/0595.Included calibrations scenarios from 14/0600r0Removed Annex 2, which is now part of Evaluation Methodology document | May 2014 |
| R1 | Modified the pathloss for Scenario 1, based on 14/577r0  | May 2014 |
| R2 | Removed section on calibration scenarios: people need more time to reviewCorrected pathloss formula for Scenario 1Accepted all the changes to have a clean baseline  | May 2014 |
| **R2 was accepted as baseline for the TG Simulation Scenario document on 5/14/14** |
|  |  |  |

# Introduction

This document defines simulation scenarios to be used for

* Evaluation of performance of features proposed in HEW
* Generation of results for simulators calibration purpose.

Each scenario is defined by specifying

* Topology: AP/STAs positions, P2P STAs pair positions, obstructions , layout, propagation model
* Traffic model
	+ UL: STA - AP traffic
	+ DL: AP – STA traffic
	+ P2P traffic (tethering, Soft-APs, TDLS)
	+ ‘Idle’ management (generating management traffic such as probes/beacons)
* List of PHY, MAC, Management parameters
	+ We may want to fix the value of some parameters to limit the degrees of freedom, and for calibration
	+ Optionally, some STAs may use legacy (11n/ac) operation parameters, if required to prove effectiveness of selected HEW solutions
* An interfering scenario (its performance optionally tracked)
	+ Not managed or managed by a different entity than the one of the main scenario
	+ Defined by its own Topology, Traffic model and parameters

Per each of above items, the scenario description defines a detailed list of parameters and corresponding values.

**Values not specified can be set to any value.**

**Values included in square brackets [] are default values to be used for calibration.**

**All other parameters values not included in [], are to be considered mandatory.**

Simulation results should be presented together with the specification of the value used per each of the parameters in the tables.

# Notes on this version

This document builds on document 13/1001r9, which was developed during the HEW SG phase.

The document consolidates contributions on scenarios details from various authors and reflects the comments/submissions received. It is not a final version by any means and is subject to changes based on further discussion and feedback.

Major TBDs

* Traffic models
* Channel models an penetration losses per scenario
	+ Not clear agreement on which channel models to be used in each scenario; some tentative included in the document
* Calibration scenarios;
* Some other topics under discussion refer to simulation methodology/parameters that can be common and fixed across all scenarios, hence they may be directly included in the Evaluation Methodology document or in an appendix of this documents
	+ Rate adaptation model
	+ Use of wrap around for scenarios 3 and 4?
		- Discussion is needed; Use of wrap around with CSMA may create artefacts
	+ Is the ‘random’ position of STAs randomly generated by each simulation run, or are we going to have a file with common positions?
	+ Several channel model and RF related parameters that are likely to be common and fixed across scenarios see #1383

# Scenarios summary

This document reports the initial agreement according to document 11-13/1000r2.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Scenario Name** | **Topology** | **Management** | **Channel Model** | **Homogeneity** | **~Traffic Model** |
| **1** | Residential | A - Apartment building e.g. ~10m x 10m apartments in a multi-floor building~10s of STAs/AP, P2P pairs | Unmanaged | Indoor | Flat | Home |
| **2** | Enterprise | B - Dense small BSSs with clusterse.g. ~10-20m inter AP distance,  ~100s of STAs/AP, P2P pairs | Managed | Indoor | Flat | Enterprise  |
| **3** | Indoor Small BSS Hotspot | C - Dense small BSSs, uniforme.g. ~10-20m inter AP distance ~100s of STAs/AP, P2P pairs | Mobile  |
| **4** | Outdoor Large BSS Hotspot | D - Large BSSs, uniforme.g. 100-200m inter AP distance ~100s of STAs/AP, P2P pairs | Managed | Outdoor | Flat | Mobile |
| **4a** | Outdoor Large BSS Hotspot+ Residential | D+A | Managed + Unmanaged | Hierarchical | Mobile + Home |

## Considerations on the feedback from WFA

Document 11-13/1443 includes feedback from WFA regarding prioritization of usage models.

Document 11-13/1456r1 shows a mapping between the prioritized usage models and the simulation scenarios in this document (as of r5).

The summary is copied here:

* **Mapping**
	+ 1b Airport / train station 🡪 Scenario 3
	+ 1e E-education 🡪 Scenario 2
	+ 3a Dense apartment building 🡪 Scenario 1
	+ 4b Pico-cell street deployment 🡪 Scenario 4
	+ 2b Public transportation 🡪 ??
		- No good match with existing scenarios
* **Is usage model 2b relevant for HEW, in the opinion of the SG?**
	+ Usage model 2b is essentially ‘single cell’, which is a departure from ‘Dense scenarios’ scope of HEW
		- High density of STAs but likely just 1 or few APs
	+ Goal of simulation scenarios is to capture key issues, and for proof of solutions
	+ If considered not relevant: our current simulation scenarios are enough
	+ If considered relevant: we need to either add one more scenario, or fit it into an existing one (preferred)
		- E.g. can it fit as a special case of Scenario 2 or 3?

## Common Parameters for all simulation Scenarios

[Tentative. If there is agreement, the corresponding rows per scenario will be removed]

Each simulation scenario shall use the PHY and MAC parameters as defined below. If a scenario changes any value of these parameters, then the changed value is listed in the simulation scenario.

|  |
| --- |
| **PHY parameters** |
| BW | All BSSs either all at 2.4GHz, or all at 5GHz[20MHz BSS at 2.4GHz, or 80 MHz BSS at 5GHz]  |
| Data Preamble Type | [2.4GHz, 11n; 5GHz, 11ac] |
| STA TX Power  | 18 dBm per antenna |
| AP TX Power  | 21 dBm per antenna |
| P2P TX Power | 15 dBm per antenna |
| AP Number of TX antennas  | All APs with [2] or all with 4 antennas |
| AP Number of RX antennas  | All APs with [2] or all with 4 antennas |
| STA Number of TX antennas | All STAs with [1] or all with 2 antennas |
| STA Number of RX antennas | All HEW STAs with [1] or all with 2 antennas |
| AP antenna gain | +2dBi |
| STA antenna gain | -4dBi |
| Noise Figure | 7dB |

|  |
| --- |
| **MAC parameters** |
| Access protocol parameters  | [EDCA with default parameters] |
| Aggregation  | [A-MPDU / max aggregation size / BA window size, No A-MSDU, with immediate BA] |
| Max number of retries  | Max retries: 10 |
| RTS/CTS Threshold | [no RTS/CTS] |

# 1 - Residential Scenario

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

|  |
| --- |
| **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/2.4e9) + 20\*log10(min(d,5)) + (d>5) \* 35\*log10(d/5) + 18.3\*F^((F+2)/(F+1)-0.46) + 5\*Wd = distance [m]fc = frequency [GHz]F = number of floors traversedW = number of walls traversed  |
|  |
| **PHY parameters** |
|  |  |
| MCS | [use MCS0 for all transmissions] or[use MCS7 for all transmissions] |
| GI | Short |
| Data Preamble  | [5GHz: 11ac, 2.4GHz: 11n] |
| STA max TX power  | 18dBm per antenna |
| AP max TX Power  | 21dBm per antenna |
| 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 |
| AP antenna gain | +2dBi |
| STA antenna gain | -4dBi |
| Noise Figure | 7dB |
|  |
| **MAC parameters** |
| Access protocol parameters  | [EDCA with default parameters according to traffic class] |
| Center frequency, BSS BW and primary channels | BSSs operate either all at 2.4GHz, or all at 5GHzOperating BW: 5GHz: all BSSs operate in 80 MHz 2.4GHz: all BSSs operate in 20MHzOperating channel: 2.4GHz: random assignment of 3 20MHz non-overlapping channels 5GHz: all BSSs on same [3] 5 80MHz channel, 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 |  |

# 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 Model | Option 1.AP-AP: TGac channel model DAP-STA: TGac channel model DSTA-STA: TGac channel model DOption 2.STA/STA: TGac channel model  B[Option 1, Pathloss >= PL(d=1m)] |
| Penetration Losses | 7 dB per wall between offices (no cubicle wall is considered) |
|  |
| **PHY parameters** |
|  |  |
| MCS | [use MCS0 for all transmissions] or[use MCS7 for all transmissions] |
| GI | Short |
| Data Preamble | [2.4GHz, 11n; 5GHz, 11ac] |
| STA TX power  | 21 dBm |
| AP TX Power  | 24 dB total  |
| 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 |
| AP antenna gain | +2dBi |
| STA antenna gain | -4dBi |
| Noise Figure | 7dB |
| **Parameters for P2P (if different from above)** |
| P2P STAs TX power | 21 dBm |
|  |
| **MAC parameters** |
| Access protocol parameters | [EDCA with default EDCA Parameters set] |
| Center frequency, BSS BW and primary channels | All BSSs either all at 2.4GHz, or all at 5GHz5GHz: all BSSs operating in 80MHz; 2.4GHz: all BSSs operating in 20MHz.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  |  |  |  |

## 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 | STAs are placed randomly within each hexagon, at a minimum distance of 1m from the AP in X-Y plane  |
| Number of STA and STAs type | N STAs in each hexagon.STA\_1 to STA\_{N1}: HEWSTA\_{N1+1} to STA\_{N} : non-HEWN = 40 N1 = [40] Non-HEW = 11b/g/n (TBD) in 2.4GHzNon-HEW = 11ac (TBD) in 5GHz |
| Channel Model | AP-AP: TBDSTA-STA: TGac channel model BOption 1.AP-STA: TGac channel model DOption2.AP-STA: ITU InH model w/3D [AP-AP: TGac channel model DAP-STA: TGac channel model DSTA-STA: TG channel model BPathloss >= PL(d=1m)] |
| Penetration Losses | None |
|  |
| **PHY parameters** |
|  |  |
| MCS | [use MCS0 for all transmissions] or[use MCS7 for all transmissions] |
| GI | Short |
| Data Preamble | [2.4GHz, 11n; 5GHz, 11ac] |
| STA TX power  | 15dBm |
| AP TX Power  | 17dBm |
| 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 |
| AP antenna gain | +2dBi |
| STA antenna gain | -4dBi |
| Noise Figure | 7dB |
|  |
| **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. 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 |

|  |
| --- |
| **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 |  |  |

## 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 |

|  |
| --- |
| **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 | STAs are placed randomly in each hexagon, at a minimum distance of 10 m from the AP, in the X-Y plane.STA antenna height 1.5 m. |
| Number of STA and STAs type | N STAs within each hexagon. 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 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 |
| Data Preamble | [2.4GHz, 11n; 5GHz, 11ac] |
| STA TX power  | 15dBm |
| AP TX Power  | 30dBm |
| 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 |
| AP antenna gain | +2dBi |
| STA antenna gain | -4dBi |
| Noise Figure | 7dB |
|  |
| **MAC parameters** |
| Access protocol parameters  | [EDCA with default EDCA Parameters set] |
| Center frequency, BW and primary channels  | All BSSs either all at 2.4GHz, or all at 5GHzFrequency 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 |

|  |
| --- |
| **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 |  |  |  |  |

# 4a- Outdoor Large BSS + Residential Scenario

|  |  |
| --- | --- |
| **Parameter** | **Value** |
|  |
| **Topology (A)** |
| Figure 10 –Layout of large BSSs with residential buildings  |
| Environment description | This scenario consists of an overlay of the following* Scenario 4, with the exception that only 7 cells are included out of the 19
* A Residential building per each BSS, which center is placed in a random uniform position within a radius of ICD/2 around the AP; the Residential building topology is as defined in Scenario 1, with the exception that the number of floors is set to 1.
 |
| APs location | See Scenario 1 and 4. |
| AP Type | See Scenario 1 and 4. |
| STAs location | See Scenario 1 and 4. |
| Number of STA and STAs type | See Scenario 1 and 4. |
| Channel Model | See Scenario 1 and 4{indoor/outdoor??} |
| Penetration Losses | See Scenario 1 and 4. |
|  |
| **PHY parameters** |
| Same parameters as defined for the STAs in Scenario 1 and Scenario 4.  |
|  |
| **MAC parameters** |
| All parameters except the ones listed in this table are same as in Scenario 1 and Scenario 4 |
| Association | STAs defined by Scenario 1, associate as defined by Scenario 1STAs defined by Scenario 4: 80% associate as defined by Scenario 420% associate with strongest AP from a Residential building |
| Management | It is allowed to assume that all outdoor APs belong to the same management entity. Each indoor AP belongs to a different management entity |

|  |
| --- |
| **Traffic model (Per each BSS) - TBD** |
| **#** | **Source/Sink** | **Name** | **Traffic definition** | **Flow specific parameters**  | **AC** |
| **Downlink** |
| Traffic model for STAs defined by Scenario 1, is defined by Scenario 1 |
| Traffic model for STAs defined by Scenario 2, is defined by Scenario 2 |

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# Annex 1 - Reference traffic profiles per scenario

**Reference traffic profile for Scenario 1**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Traffic Model #**  | **Traffic model name**  | **Description**  | **Application traffic** **(Forward / Backward)**  |  **Application Load (Mbps)** **(Forward / Backward)**  | **A-MPDU Size (B)** **(Forward / Backward)**  |
| T1  | Local file transfer  | FTP/TCP transfer of large file within local network  | FTP file transfer / FTP TCP ACK  | Full buffer / 0.1  | Max A-MPDU / 64  |
| T2 | Lightly compressed video |  |  |  |  |
| T3 | Internet streaming video/audio |  |  |  |  |
| T4 | 4k video streaming |  |  |  |  |
| T5 | Online game server |  |  |  |  |
| T6 | Management: Beacon  |  |  |  |  |
| T7 | Management: Probe requests |  |  |  |  |
| T8 | Gaming |  |  |  |  |

**Reference traffic profile for Scenario 2**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Traffic Model #**  | **Traffic model name**  | **Description**  | **Application traffic** **(Forward / Backward)**  |  **Application Load (Mbps)** **(Forward / Backward)**  | **A-MPDU Size (B)** **(Forward / Backward)**  |
| T1  | Local file transfer  | FTP/TCP transfer of large file within local network  | FTP file transfer / FTP TCP ACK  | Full buffer / 0.1  | Max A-MPDU / 64  |
| T2 | Lightly compressed video |  |  |  |  |
| T3 | Internet streaming video/audio |  |  |  |  |
| T4 | 4k video streaming |  |  |  |  |
| T5 | Online game server |  |  |  |  |
| T6 | Management: Beacon  |  |  |  |  |
| T7 | Management: Probe requests |  |  |  |  |
| T8 | Virtual desktop infrastructure |  |  |  |  |

**Reference traffic profile for Scenario 3**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Traffic Model #**  | **Traffic model name**  | **Description**  | **Application traffic** **(Forward / Backward)**  |  **Application Load (Mbps)** **(Forward / Backward)**  | **A-MPDU Size (B)** **(Forward / Backward)**  |
| T1  | Local file transfer  | FTP/TCP transfer of large file within local network  | FTP file transfer / FTP TCP ACK  | Full buffer / 0.1  | Max A-MPDU / 64  |
| T2 | Lightly compressed video |  |  |  |  |
| T3 | Internet streaming video/audio |  |  |  |  |
| T4 | 4k video streaming |  |  |  |  |
| T5 | Online game server |  |  |  |  |
| T6 | Management: Beacon  |  |  |  |  |
| T7 | Management: Probe requests |  |  |  |  |
| T8 | Multicast Video Streaming | UDP/IP transfer of compressed video streaming | UDP packet transfer/Nothing | 3-6Mbps/Nothing |  |
| T8 | Gaming |  |  |  |  |

**Reference traffic profile for Scenario 4**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Traffic Model #**  | **Traffic model name**  | **Description**  | **Application traffic** **(Forward / Backward)**  |  **Application Load (Mbps)** **(Forward / Backward)**  | **A-MPDU Size (B)** **(Forward / Backward)**  |
| T1  | Local file transfer  | FTP/TCP transfer of large file within local network  | FTP file transfer / FTP TCP ACK  | Full buffer / 0.1  | Max A-MPDU / 64  |
| T2 | Lightly compressed video |  |  |  |  |
| T3 | Internet streaming video/audio |  |  |  |  |
| T4 | 4k video streaming |  |  |  |  |
| T5 | Online game server |  |  |  |  |
| T6 | Management: Beacon  |  |  |  |  |
| T7 | Management: Probe requests |  |  |  |  |

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# Annex 3 - Templates

|  |  |
| --- | --- |
| **Parameter** | **Value** |
|  |
| **Topology** |
| Figures |
| Environment description  |  |
| APs location |  |
| AP Type |  |
| STAs location |  |
| Number of STA and STAs type |  |
| Channel Model |  |
| Penetration Losses |  |
|  |
| **PHY parameters** |
| Center frequency and BW |  |
| MCS |  |
| GI |  |
| Data Preamble:  |  |
| STA TX power  |  |
| AP TX Power  |  |
| AP #of TX antennas  |  |
| AP #of RX antennas  |  |
| STA #of TX antennas |  |
| STA #of RX antennas |  |
|  |
| **MAC parameters** |
| Access protocol parameters |  |
| Primary channels  |  |
| Aggregation |  |
| Max # of retries  |  |
| RTS/CTS Threshold |  |
| Association |  |

**Traffic model**

|  |
| --- |
| **Traffic model (Per each apartment) - TBD** |
| **#** | **Source/Sink** | **Name** | **Traffic definition** | **Flow specific parameters**  | **AC** |
| **Downlink** |
| D1 | AP/STA1 | 4k Video | T1 |  | VI |
| D2 | AP/STA2 | Local file transfer | T3 |  | BE |
| D3 | AP/STA3 | … |  |  |  |
| … | … |  |  |  |  |
| DN | AP/STAN |  |  |  |  |
| **Uplink** |
| U1 | STA1/AP |  |  |  |  |
| U2 | STA2/AP |  |  |  |  |
| U3 | STA3/AP |  |  |  |  |
| … | … |  |  |  |  |
| 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 |  |  |  |  |

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