IEEE P802.11  
Wireless LANs

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| --- | --- | --- | --- | --- |
| HEW SG Simulation Scenarios  Proposed contribution for Indoor small BSS hotspot and for Outdoor large BSS hotspot based on Doc 1153r0 | | | | |
| Date: September 26, 2013 | | | | |
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# Revisions

|  |  |  |
| --- | --- | --- |
| **Revision** | **Comments** | **Date** |
| *R0* | Initial draft template | Aug 28th |
| *R1* |  | Sept 15th |
| *R2* | Made it consistent with document 1000r2 | Sept 16th |
|  | Proposition for section 3 and 4 based on contribution 1153 | Sept 26th |

# Introduction

This document defines simulation scenarios to be used for

* Evaluation of perfrormance of fetures proposed in HEW
* Generation of reults for simulators calibratton purpose.

Each scenario is defiend by specifying

* Topology: AP/STAs positions, P2P STAs pair positions, obstructions , layout, propagation model
* Traffic model
  + STA - AP traffic
  + P2P traffic (tethering, Soft-APs, TDLS)
  + ‘Idle’ devices (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 optioally 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 included in curly brackets {} are mandatory and shall be adopted for any simulation.

Values included in square brackets [] are default values and can be used as reference for calibration

* They shall be used for generating results for calibration purposes
* They may be changed for simulations for performance evaluation; in case theya are changed, the simulation results shall be accompained by a list of the paramters and the corresponding values used in the simulation.

**Scenarios summary**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Scenario Name** | **Topology** | **Management** | **Channel Model** | **Homogeneity** | **~Traffic Model** |
| **1** | Residential | A - Apartment bldg.  e.g. ~10m x 10m apts in a multi-floor bldg  ~10s of STAs/AP, P2P pairs | Unmanaged | Indoor | Flat | Home |
| **2** | Enterprise | B - Dense small BSSs with clusters  e.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, uniform  e.g. ~10-20m inter AP distance  ~100s of STAs/AP, P2P pairs |
| Mobile |
| **4** | Outdoor Large BSS Hotspot | D - Large BSSs, uniform  e.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 |

1. **Residential Scenario [Example Template]**

The Residential scenario consists of one apartment building with multiple apartments; Multiple STAs and one AP are located inside each apartment; STAs within an apartment are associated with the AP in the same apartment. APs are independently operated. The traffic model is derived from the Home profile.

*Add picture [TBD]*

|  |  |
| --- | --- |
| **Parameter** | **Value** |
|  | |
| **Topology (A)** | |
| Environment description | 1 Apartment building   * Number of floors {N} * Floors hight: {3 m} * Apartments in each floor {2xN} * Apartment size:{10m x 10m x 3m} |
| APs location | {1 per room, randomly located inside the room} |
| STAs location | {N per AP, randomly located inside the room} |
| Channel Model | {Indoor, TBD} |
| Penetration Losses | Apartment-to-apartment wall penetration {XdB @ 2.4GHz, YdB at 5GHz}  External wall penetration {XdB @ 2.4GHz, YdB at 5GHz} |
|  | |
| **PHY paramters** | |
| BW: | [up to X MHz] |
| MCS: | [BCC up to MCS X] |
| GI: | [long] |
| Data Premble: | [11ac] |
| STA TX power | [Xdbm/Antenna] |
| AP TX Power | [Ydbm/Antenna] |
| AP #of TX antennas | {N} |
| AP #of RX antennas | {N} |
| STA #of TX antennas | {N} |
| STA #of RX antennas | {N} |
|  | |
| **MAC paramters** | |
| Acess protocol parameters: | [EDCA with default EDCA Parameters set] |
| Primary channels | [all BSSs on same primary channel] |
| Aggregation: | [A-MPDU / max aggregation size / BA window size, No A-MSDU, with immediate BA] |
| Max # of retries | [10] |
| RTS/CTS | [off] |
| Rate adaptation method | [genie, TBD in Evaluation Methodology] |
|  |  |
| Association | Each STA associated with the AP in same apartment |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Traffic model (Per each apartment) - TBD** | | | | | | | | | |
| **#** | **Source/Sink** | **Name** | **Transport Protocol** | **Average rate [Mbps]** | **MSDU size [B]** | **Max. Delay [ms]** | **Max. PLR** | **PKT arrival distribution** | **AC** |
| **Dowlink** | | | | | | | | | |
| D1 | AP/STA1 | 4k Video | … |  |  |  |  |  |  |
| D2 | AP/STA2 | Broswing | … |  |  |  |  |  |  |
| 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 |  |  | X Bytes |  |  | 1/Xms |  |
| M2 | STA2 | Probe Req. |  |  | X Bytes |  |  | 1/Xs |  |
| M3 | STA3 |  |  |  |  |  |  |  |  |
| … | … |  |  |  |  |  |  |  |  |
| MN | STAN |  |  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Traffic model (Per each apartment) - TBD** | | | | | | | | |
| **#** | **Source/Sink** | **Transport Protocol** | **Average rate [Mbps]** | **MSDU size [B]** | **Max. Delay [ms]** | **Max. PLR** | **PKT arrival distribution** | **AC** |
| **Dowlink** | | | | | | | | |
| D1 | AP/STA1 |  |  |  |  |  |  |  |
| D2 | AP/STA2 |  |  |  |  |  |  |  |
| 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 | STA1 |  |  |  |  |  |  |  |
| M2 | STA2 |  |  |  |  |  |  |  |
| M3 | STA3 |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| MN | STAN |  |  |  |  |  |  |  |

### Interfering Scenario

None

# 2- Enterprise

# 3- (Indoor) small BSS Hotspot (dense)

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 []:

* In such environments, the infrastructure network (ESS) is planned. For simulation complexity simplifications, an hexagonal cell 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 network (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*
    - *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, [Cisco]:
  + Existence of unassociated clients, with regular probe request broadcasts.

*(Note that sticky clients issue is currently captured in the outdoor large BSS scenario)*

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.*

|  |  |
| --- | --- |
| **Parameter** | **Value** |
|  | |
| **Topology (A)** | |
| Environment description | **Cell layout configuration**   * The frequency reuse pattern is set to 3 (80 MHz channel bandwidth at 5GHz, 20MHz channels at2.4GHz)   .    Cell layout when simulating all channels.  Cell layout when simulating only one channel.  For simulation simplification, it is proposed to simulate only one channel (out of the 3 channels).  In such case, ICDOBSS is equal to 3R (21m TBD).  **Each cell has the following configuration :**  Cell radius: R meters (7m TBD)  Inter-cell distance (ICD): 2\*h meters  h=sqrt(R2-R2/4)  Planned frequency allocation:   * Frequency reuse 3 (3 80 MHz channel bandwidth at 5GHz) * Frequency reuse 3 (3 20 MHz channel bandwidth at 2.4GHz) |
| APs location | AP is placed at the center of the cell. |
| STAs location | “30-50” STAs are placed randomly in a cell meters. |
| Channel Model | {Indoor, TGn F for instance} |
| Penetration Losses | None |
|  | |
| **PHY parameters** | |
| BW: | {20MHz at 2.4GHz, 80 MHz at 5GHz} |
| MCS: | {BCC up to MCS 9} |
| GI: | [long] |
| Data Premble: | [11ac] |
| STA TX power | [max 15dBm] |
| AP TX Power | [max 17dBm] |
| AP #of TX antennas | {2, 4} |
| AP #of RX antennas | {2, 4} |
| STA #of TX antennas | {1, 2} |
| STA #of RX antennas | {1, 2} |
|  | |
| **MAC parameters** | |
| Acess protocol parameters: | [EDCA with default EDCA Parameters set] |
| Primary channels | [all OBSSs on same primary channel] |
| Aggregation: | [A-MPDU / max aggregation size / BA window size, No A-MSDU, with immediate BA] |
| Max # of retries | [10] |
| RTS/CTS | [off] |
| Rate adaptation method | [realistic rate adaptation, based on ACK statistics for instance] |
|  |  |
| Association | STAs associate with the AP based on lowest pathloss, (potential errors can be added to model sticky clients)  When simulating only one channel, STAs in cell coverage associate with the AP at the center of the cell. |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Traffic model (per each cell) - TBD** | | | | | |
| **#** | **Source/Sink** | **Name** | **Traffic definition** | **Flow specific paramters** | **AC** |
| **Dowlink** | | | | | |
| 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 |  |  |  |  |

### Interfering Scenario 1a (overlay of unmanaged P2P networks)

Soft APs used for tethering to upload content.

Overlay of 10 to 50 (TBD) unmanaged BSSs dropped randomly in

* the area occupied by other channels (white part in the figure)
* or the whole simulation area.

Each of these unmanaged BSSs is made of an AP and a STA separated by 0.5m.

Traffic is made of local file transfer (10MB TBD) in uplink.

### Interfering Scenario 1b (overlay of unmanaged P2P networks and overlay of unassociated clients)

1 Soft APs used for tethering to upload content.

Overlay of 10 to 50 (TBD) unmanaged BSSs dropped randomly in the area occupied by other channels (white part in the figure).

Each of these unmanaged BSSs is made of an AP and a STA separated by 0.5m.

Traffic is made of local file transfer (10MB) in uplink.

2 Overlay of X (TBD) unassociated STAs, randomly dropped on the whole simulation area, sending probe requests every X (TBD) ms.

Those probe requests have to be answered by probe responses by the reachable APs in the simulation zone (both the P2P unmanaged APs and the infrastructure APs).

**Mix of HEW STAs and legacy STAs**

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

# 4- Outdoor large BSS hotspot

This scenario has the objective to capture the issues (and be representative of) real-world outdoor deployments with a high separation between APs (cell 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, an hexagonal cell 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 network (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 dense hotspot scenario*
  + Interference with unmanaged stand-alone APs: *this OBSS interference is currently not captured in this scenario, but in the hierarchical indoor/outdoor scenario 3b*
  + 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*

The frequency reuse pattern, used by each operator is fixed to 3.

3 operators or service providers are deploying an infrastructure network (ESS) using similar grid locations but channel selection offset.

This leads to a simple theoretical frequency reuse 1 deployment with 130m (TBD) ISD between neighboring cells:

* with an overlap between neighboring cell 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 low SNR conditions (close to their serving APs)*
* with neighboring cells not sharing the same management entity
* with constraint on associations: STAs connect only to the APs from a single operator.
  + *this enables to capture the issue of sticky clients*

|  |  |
| --- | --- |
| **Parameter** | **Value** |
|  | |
| **Topology (A)** | |
| Environment descry  ption | Outdoor street deployment  Overlap of 3 operators  Cell layout configuration  Planned deployment: 19 hexagonal cells planned using a regular grid for AP placement, with a standard deviation of 20% (TBD).    Cell layout of the scenario.  Frequency reuse 1 is considered: each cells are using the same channel (80MHz).  **Each cell has the following configuration**  Cell radius: R meters defined as the distance for MCS0 sensitivity.  Inter-cell distance (ICD): 2\*h meters (**130m**) TBD  h=sqrt(R2-R2/4)  standard deviation of 20% on ICD |
| APs location | AP is placed at the center of the cell. |
| STAs location | “50-100” STAs are placed randomly in a cell. |
| Channel Model | {Outdoor, ITU micro} |
| Penetration Losses | None |
|  | |
| **PHY parameters** | |
| BW: - | [up to 80 MHz] |
| MCS: | [BCC up to MCS 9] |
| GI: | [long] |
| Data Premble: | [11ac] |
| STA TX power | [max 15dBm] |
| AP TX Power | [max 30dBm] |
| AP #of TX antennas | {2, 4} |
| AP #of RX antennas | {2, 4} |
| STA #of TX antennas | {1, 2} |
| STA #of RX antennas | {1, 2} |
|  | |
| **MAC parameters** | |
| Acess protocol parameters: | [EDCA with default EDCA Parameters set] |
| Primary channels | [all OBSSs on same primary channel] |
| Aggregation: | [A-MPDU / max aggregation size / BA window size, No A-MSDU, with immediate BA] |
| Max # of retries | [10] |
| RTS/CTS | [off] |
| Rate adaptation method | [realistic rate adaptation, based on ACK statistics for instance] |
|  |  |
| Association | Each cell is made of a drop of one AP at the specific grid point, with associated STAs randomly distributed over the hexagonal zone.  Because of the standard deviation of the ICD (the grid with points to place the APs) is not regular, there will be overlaps between neighboring APs and STAs will not always be associated with the closest AP. |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Traffic model (Per each cell) - TBD** | | | | | |
| **#** | **Source/Sink** | **Name** | **Traffic definition** | **Flow specific paramters** | **AC** |
| **Dowlink** | | | | | |
| 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 |  |  |  |  |

**Mix of HEW STAs and legacy STAs**

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

# 4a- Outdoor large BSS hotspot+residential

Interference with unmanaged stand-alone APs (very high number of private APs in buildings creating interference on outdoor planned deployment): *this OBSS interference is captured in this scenario*

**Annex 1 - Reference traffic profiles [Exmaple template]**

**T1 - Local file transfer**

* Add description
* Mandatory settings
  + E.g. TCP model paramters
* Optional paramters settings that may be specified per traffic flow in the scenario
  + E.g. Offered rate in Mbps or full buffer

**T2 - Lightly compressed video**

Add description

Mandatory paramters settings

Optional paramters settings

**T3 - Internet streaming video/audio (e.g. Youtube)**

Add description

Mandatory settings

Optional paramters settings

**T4 …**

**Annex 2 - Templates**

|  |  |  |
| --- | --- | --- |
| **Parameter** | | **Value** |
|  | | |
| **Topology** | | |
| Topology Description (A)  (AP/STAs positions, P2P STAs pair positions, obstructions , layout, propagation model) |  | |
| Channel Model |  | |
| Penetration Losses |  | |
|  | | |
| **PHY paramters** | | |
|  |  | |
| BW: |  | |
| MCS: |  | |
| GI: |  | |
| Data Premble: |  | |
| STA TX power |  | |
| AP TX Power |  | |
| AP #of TX antennas |  | |
| AP #of RX antennas |  | |
| STA #of TX antennas |  | |
| STA #of RX antennas |  | |
|  | | |
| **MAC paramters** | | |
|  |  | |
| Acess protocol parameters: |  | |
| Primary channels |  | |
| Aggregation: |  | |
| Max # of retries |  | |
| RTS/CTS |  | |
| Rate adaptation method |  | |
|  |  | |
| Association |  | |

**Traffic model**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Traffic model (Per each apartment) - TBD** | | | | | |
| **#** | **Source/Sink** | **Name** | **Traffic definition** | **Flow specific paramters** | **AC** |
| **Dowlink** | | | | | |
| D1 | AP/STA1 | 4k Video | T1 |  | VI |
| D2 | AP/STA2 | Local file transwer | 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 |  |  |  |  |