IEEE P802.11  
Wireless LANs

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| --- | --- | --- | --- | --- |
| TGbb Simulation Scenarios | | | | |
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Abstract

This document describes the simulation scenarios for IEEE802.11bb.

# Glossary of acronyms

1. Glossary of acronyms

|  |  |
| --- | --- |
| **Acronym** | **Defination** |
| A-MPDU | Aggregated MAC Protocol Data Unit |
| A-MSDU | Aggregated MAC Service Data Units |
| ACK | Acknowledge |
| AP | Access Point |
| BSS | Basic Service Sets |
| BW | Bandwidth |
| CTS | Clear To Send |
| DL | Down Link |
| FOV | Filed Of View |
| FTP | File Transfer Protocol |
| FWHM | Full Width At Half Maximum |
| GI | Guard Interval |
| HCF | Hybrid Coordination Function |
| IP | Internet Protocol |
| IR | Infrared |
| LED | Lighting Emitting Diode |
| MAC | Media Access Control |
| P2P | Peer-To-Peer |
| PD | Photodiode |
| PHY | Physical Layer |
| PIN | P-Type, Intrinsic And N-Type |
| RTS | Request To Send |
| RX | Receiver |
| STA | Station |
| TCP | Transmission Control Protocol |
| TDLS | Tunneled Direct Link Setup |
| TX | Transmiter |
| UL | Up Link |

# Introduction

This document defines simulation scenarios to be used for

* Evaluation of performance of features proposed in TGbb.
* 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

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

The Monte Carlo simulations necessary to show the statistical performance of the system should use the analytical channel model provided in doc. 11-17/0479r0 for stations at various locations and movement in the environment. Random blockages should be considered in the simulations as a break in the LoS between the AP and the STA.

The implementation of the blockages should be modelled by introducing an object in the space that models the spatial consistency of the blocking. A document describing the blockage model will be provided in doc. 11-18-2037r0.

The channel model for STA per time instance within a given environment should be simulated as follows:

* Distribute the APs
* Distribute the STAs
* Determine LoS channel model:
  + For stational scenarios use the CIR provided in doc. 11-18/1582r3
  + For mobile scenarios use the analytical model provided in doc. 11-17/0479r0
* Determine random blockages of the LoS channel model using doc. 11-18-2037r0

The movement of an STA should constitute multiple time instances where the location and orientation of the STA is spatially correlated.

**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 for performance evaluation.**

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

Evaluation Metrics for all scenarios should include:

* System: Goodput, Delay and Packet Loss rate
* MAC: Throughput, Latency and Frame Loss Rate
* PHY: BER (coded/uncoded) VS SNR/SINR, Link throughput

# Scenarios summary

This document reports the initial agreement according to document 11-18/1422r0.

1. Scenarios summary

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Scenario Name | Topology | Management | Channel Model | Traffic profile  [tentative] |
| 1 | Industrial wireless | A - Industrial Robotic work cell  e.g. ~8m x 10m x 7m size  2 STAs/AP, P2P pairs | Managed | Indoor- Manufacturing Cell | Industrial |
| 2 | Hospital ward | B - Dense small BSSs  e.g. ~8 m × 8 m × 3 m size,  ~1-3m inter AP distance,  4 STAs/light, P2P pairs | Managed | Indoor- Office | Enterprise |
| 3 | Enterprise | C - Dense small BSSs  e.g. ~ 6.8 m × 4.7 m × 3 m size  ~1-3m inter AP distance  5 STAs/light, P2P pairs |
| Enterprise |
| 4 | Residential | D - Apartment bldg.  e.g. ~6m x 6m x 3m size,  ~0.5-2 m inter AP distance  5 STAs/light, P2P pairs | Managed | Indoor-Home | Home |

# 1-Industrial wireless

1. Topology for industrial wireless scenario

|  |  |
| --- | --- |
| **Topology (A)** | |
| (a)  Transmitters Receivers  **C:\Users\CTTLab\Desktop\Manufacturing Cell.PNG C:\Users\CTTLab\Desktop\Manufacturing Cell-2.PNG**  (b) (c)   1. Topology for industrial wireless scenario | |
| **Parameter** | **Value** |
| Environment description | 1 Industrial Robotic work cell   * Floors hight: 7 m * Work cell size:8m x 10m x 7m |
| APs location | 1 per work cell, located on the top of the work cell boundary looking in the direction of the robots |
| STAs location | 2 per AP, one installed at the head of each robot, with multiple transceivers facing different directions |
| Channel Model | Industrial [1] |
| 1. PHY parameters for industrial wireless scenario | |
| **PHY parameters** | |
| BW: | [up to 250 MHz] [5] |
| Wavelength: | IR (780 - 5000nm) for Downlink, IR (780 - 5000nm) for Uplink |
| GI: | to be specified by proposer |
| Data Preamble: | to be specified by proposer |
| STA TX power | 1 W optical / LED |
| AP TX Power | 1 W optical / LED |
| Modualtion depth | to be specified by proposer |
| Photodiode model | Hamamatsu S6968 |
| LED model | SFH 4716AS OSRAM Opto Semiconductors |
| Luminaire specifications | See channel model document [1] |
| Receiver specifications | See channel model document [1] |
| Noise floor | -70dBm [-174 dBm/Hz] [6] |
| 1. MAC parameters for industrial wireless scenario | |
| **MAC parameters** | |
| Access protocol parameters: | [HCF and provide any detail on any changes] |
| Aggregation: | [A-MPDU / A-MSDU] |
| Max # of retries | [5] |
| RTS/CTS | [on/off] |
| Rate adaptation method | to be specified by proposer |
| Association | Each STA shall try to associate with the observed AP having highest SNR/SINR |

1. Traffic model for industrial wireless scenario

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Traffic model** | | | | | | | | | |
| **#** | **Source/Sink** | **Name** | **Transport Protocol** | **Average rate [Mbps]** | **MSDU size [B]** | **Max. Delay [ms]** | **Max. PLR** | **PKT arrival distribution** | **AC** |
| **Dowlink** | | | | | | | | | |
| D0 | AP/STA1 | Local file transfer |  | max rate |  |  |  |  |  |
| D1 | AP/STA1 | 4k Video | … |  |  |  |  |  |  |
| D2 | AP/STA2 | Browsing | … |  |  |  |  |  |  |
| D3 | AP/STA3 | … |  |  |  |  |  |  |  |
| … | … |  |  |  |  |  |  |  |  |
| DN | AP/STAN |  |  |  |  |  |  |  |  |
| **Uplink** | | | | | | | | | |
| U1 | STA1/AP |  |  |  |  |  |  |  |  |
| U2 | STA2/AP |  |  |  |  |  |  |  |  |
| U3 | STA3/AP |  |  |  |  |  |  |  |  |
| … | … |  |  |  |  |  |  |  |  |
| UN | STAN/AP |  |  |  |  |  |  |  |  |
| **P2P** | | | | | | | | | |
| P1 | STA1/STA2 |  |  |  |  |  |  |  |  |
| P2 | STA3/STA4 |  |  |  |  |  |  |  |  |
| P3 | STA5/STA6 |  |  |  |  |  |  |  |  |
| … | … |  |  |  |  |  |  |  |  |
| PN/2 | STAN-1/ STAN |  |  |  |  |  |  |  |  |
| **Idle Management** | | | | | | | | | |
| M1 | AP1 | Beacon |  |  | X Bytes |  |  | 1/Xms |  |
| M2 | STA2 | Probe Req. |  |  | X Bytes |  |  | 1/Xs |  |
| M3 | STA3 |  |  |  |  |  |  |  |  |
| … | … |  |  |  |  |  |  |  |  |
| MN | STAN |  |  |  |  |  |  |  |  |

# 2 - Hospital ward

1. Topology for hospital ward scenario

|  |  |
| --- | --- |
| **Topology (A)** | |
| (a)    (b) (c)   1. Topology for hospital ward scenario | |
| **Parameter** | **Value** |
| Environment description | 1 hospital ward   * Floors height: 3 m * Ward size:8m x 8m x 3m |
| AP location | 16 lights per ward, installed on the ceiling  See channel model document [1] |
| STAs location | See channel model document [1] |
| Channel Model | hospital ward [1] |
| 1. PHY parameters for hospital ward scenario | |
| **PHY parameters** | |
| BW: | [up to 250 MHz] [5] |
| Frequency: | Visible Light for Downlink, IR for Uplink |
| GI: | to be specified by proposer |
| Data Preamble: | to be specified by proposer |
| Modualtion depth | to be specified by proposer |
| STA TX power | 200 mW optical / LED |
| AP TX Power | 10 W optical / LED (380 -790 nm) |
| TX beam angle of AP | 90 degrees |
| Photosensitive area | 1 cm2 PIN PD |
| Photodiode model | Hamamatsu S6968 |
| Luminaire specifications | See channel model document [1] |
| Receiver specifications | See channel model document [1] |
| Noise floor | -70 dBm [6] |
| Number of TX light sources per AP | to be specified by proposer |
| Number of APs | to be specified by proposer |
| Number of RX photoreceivers per AP | to be specified by proposer |
| Number of TX light sources per STA | to be specified by proposer |
| Number of STAs | to be specified by proposer |
| Number of RX photoreceivers per STA | to be specified by proposer |
| 1. MAC parameters for hospital ward scenario | |
| **MAC parameters** | |
| Access protocol parameters: | [HCF and provide any detail on any changes] |
| Aggregation: | [A-MPDU / A-MSDU] |
| Max # of retries | [5] |
| RTS/CTS | [on/off] |
| Rate adaptation method | to be specified by proposer |
| Association | Each STA shall try to associate with the observed AP having highest SNR/SINR |

# 3 - Enterprise

1. Topology for enterprise scenario

|  |  |
| --- | --- |
| **Topology (A)** | |
| (a)    (b) (c)    (d)   1. Topology for enterprise scenario | |
| **Parameter** | **Value** |
| Environment description | 1 office with/without cubicles   * Floors hight: 3 m * Office size: 6.8 m × 4.7 m × 3 m |
| APs location | 10 lights per office, installed on the ceiling |
| STAs location | See channel model document [1] |
| Channel Model | Office [1] |
| 1. PHY parameters for enterprise scenario | |
| **PHY parameters** | |
| BW: | [up to 300 MHz] [5] |
| Frequency: | Visible light (DL) and IR (UL) |
| Wavelength: | Visible Light (380 -780 nm) for Downlink, IR (780 - 5000nm) for Uplink |
| GI: | to be specified by proposer |
| Data Preamble: | to be specified by proposer |
| STA TX power | 200 mW optical |
| Modualtion depth | to be specified by proposer |
| Luminaire specifications | See channel model document [1] |
| Receiver specifications | See channel model document [1] |
| Noise floor | -70 dBm [6] |
| Number of TX light sources per AP | to be specified by proposer |
| Number of APs | to be specified by proposer |
| Number of RX photoreceivers per AP | to be specified by proposer |
| Number of TX light sources per STA | to be specified by proposer |
| Number of STAs | to be specified by proposer |
| Number of RX photoreceivers per STA | to be specified by proposer |
| 1. MAC parameters for enterprise scenario | |
| **MAC parameters** | |
| Access protocol parameters: | [HCF and provide any detail on any changes] |
| Aggregation: | [A-MPDU / A-MSDU] |
| Max # of retries | [5] |
| RTS/CTS | [on/off] |
| Rate adaptation method | to be specified by proposer |
| Association | Each STA shall try to associate with the observed AP having highest SNR/SINR |

# 4 – Residential

1. Topology for residential scenario

|  |  |
| --- | --- |
| **Topology (A)** | |
| (a)  living room Arrangement of luminaries  **D:\OZYEGIN UNIVERSITY\S005827\Ph.D. Works\ISTKA Project\OKATEM Poster\Home.PNGC:\Users\CTTLab\Desktop\Capture.PNG**  (b) (c)   1. Topology for enterprise scenario | |
| **Parameter** | **Value** |
| Environment description | A living room with table, chairs, couch, coffee table and human bodies   * Floors hight: 3 m * Room size:6m x 6m x 3m |
| APs location | 9 lights per office, installed on the ceiling |
| STAs location | See channel model document [1] |
| Channel Model | Home [1] |
| 1. PHY parameters for residential scenario | |
| **PHY parameters** | |
| BW: | [up to 300 MHz] [5] |
| Frequency: | Visible light (DL) and IR (UL) |
| Wavelength: | Visible Light (380 -780 nm) for Downlink, IR (780 - 5000nm) for Uplink |
| GI: | to be specified by proposer |
| Data Preamble: | to be specified by proposer |
| STA TX power | 200 mW optical |
| Modualtion depth | to be specified by proposer |
| Luminaire specifications | See channel model document [1] |
| Receiver specifications | See channel model document [1] |
| Noise floor | -70 dBm [6] |
| Number of TX light sources per AP | to be specified by proposer |
| Number of APs | to be specified by proposer |
| Number of RX photoreceivers per AP | to be specified by proposer |
| Number of TX light sources per STA | to be specified by proposer |
| Number of STAs | to be specified by proposer |
| Number of RX photoreceivers per STA | to be specified by proposer |
| 1. MAC parameters for residential scenario | |
| **MAC parameters** | |
| Access protocol parameters: | [HCF and provide any detail on any changes] |
| Aggregation: | [A-MPDU / A-MSDU] |
| Max # of retries | [5] |
| RTS/CTS | [on/off] |
| Rate adaptation method | to be specified by proposer |
| Association | Each STA shall try to associate with the observed AP having highest SNR/SINR |

# Annex 1 - Reference traffic profiles per scenario

A more realistic traffic model may be used based on [ref] to better represent traffic in specific scenarios. Specific parameters are to be given by the proposers.

Traffic models are described in appendix 2

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Traffic** | **Subtype** | **Description** | **Rate, Mbps (Average/Peak)** | **Packet Error Rate** | **Jitter, ms** | **Delay, ms** |
| **Video** | **Video Lightly Compressed**† | **HD, 1920x1080 pixels, Motion JPEG2000[3]** | **150** | **1.00E-07** | **20** | **20** |
| **VHD, 4k\*2k, Motion JPEG2000** | **600** | **1.00E-07** | **20** | **20** |
| **UHD, 8k\*4k, Motion JPEG2000** | **2400** | **1.00E-07** | **20** | **20** |
| **3D VHD, 4kp, Motion JPEG2000** | **900** | **1.00E-07** | **20** | **20** |
| **3D UHD, 8kp, Motion JPEG2000** | **3600** | **1.00E-07** | **20** | **20** |
| **Outdoor backhaul** |  |  | **20000** | **3.00E-07** | **30** | **30** |
| **Productivity docking** | **Monitor 4K lightly compressed** |  | **300/1500** |  | **10** | **10** |
| **Monitor 5K lightly compressed** |  | **500/2700** |  | **10** | **10** |
| **Monitor 8K lightly compressed** |  | **1600/8000** |  | **10** | **10** |
| **USB HID** |  | **100** |  | **10** | **10** |
| **USB total** |  | **8000** |  | **NA** | **NA** |
| **Ethernet** |  | **2000** |  | **NA** | **NA** |
| **Mobile to mobile** |  | **8000** |  | **NA** | **NA** |
| **combined wireless link** | **2 monitors+USB+Ethernet** | **13200** |  | **10** | **10** |
| **Gaming** | **First-person Shooter** | **Like CS and games in Xbox 360** | **20** | **1.00E-03** | **10** | **10** |
| **Real-time strategy** |  | **0.08** | **1.00E-02** | **40** | **40** |
| **Turn based games** |  | **0.005** | **1.00E-02** | **400** | **400** |
| **Interactive real-time gaming (assumption)** |  | **100** | **1.00E-03** | **100** | **100** |
| **Internet Access** | **FTP** |  | **200** | **1.00E-03** | **100** | **100** |
| **Internet Browsing** |  | **0.2** | **1.00E-03** | **50** | **50** |
| **Twitter & Facebook** |  | **20** | **1.00E-03** | **50** | **50** |
| **IM** |  | **0.2** | **1.00E-03** | **50** | **50** |
| **VoIP** |  | **0.02** | **1.00E-03** | **50** | **50** |
| **High-def audio** |  | **0.05** | **1.00E-02** | **10** | **10** |
| **Online Videos** |  | **20** | **1.00E-03** | **20** | **20** |

# Annex 2 - Traffic models

1. **lightly compressed video (assuming H.264 I-frame only)**
   1. Requirements
      1. Application PLR: 1e-8
      2. Delay: 10 ms
   2. Parameters
      1. Slice inter-arrival time (IAT) = 1/4080 seconds (1/8100 and 1/16200 seconds for 4K and 8K respectively)
      2. µ = 15.798 Kbytes
      3. σ = 1.350 Kbytes
   3. b = 515, 1023, 2047 Mbps (for 1080p, 2160p and 4320p respectively Algorithm for each video source – Input: target bit rate in Mbps (p); Output: slice size in Kbytes (L)
      1. At each IAT, generate a slice size L with the following distribution: Normal(µ\*(p/b), σ\*(p/b))
         * If L > 92.160 Kbytes, set L = 92.160 Kbytes (1080p)
         * If L > 180 Kbytes, set L  = 180 Kbytes (2160p aka 4K)
         * if L > 360 Kbytes, set L = 360 Kbytes (4320p aka 8K)
2. **Video Conferencing (e.g., Lync) Traffic Model**

Unlike video streaming where video traffic is unidirectional, video conferencing is two-way video traffic. The video traffic is generated at each station, send to AP, transverse the internet and reach another AP and then send to the destination.

**Station layer model**



1. Station layer model for video conferencing

STA layering model is shown in Figure A2.1. Because the traffic from AP to station has experienced network jitter, it can be modelled the same way as the traffic model of video streaming.

For the traffic sent from Station to AP, since the traffic has not experienced network jitter, it is a periodic traffic generation as the first two steps described in video streaming.

**Video traffic generation**

Traffic model from AP to station: use the same model as video streaming.

Traffic model from station to AP: use the first two steps in video streaming traffic model

**Application event models**

Application event model is used to specify the patterns of the application events, i.e., when to start the applications and how long for each application in the simulation. Different use scenarios may choose different application event models in the simulation.

* Poisson model

Poisson model can be used for random application event pattern where there are many users, each generating a little bit of traffic and requesting network access randomly.

Parameters: TBD

* Hyper-exponential model

Hyper-exponential model can be used for peak event pattern where users requesting network access in big spikes from the mean.

Parameters: TBD

1. **Local file transfer**
   1. protocol: TCP (Reno)
   2. offered load: infinite
   3. MSDU sizes: 64 bytes for TCP connection establishment (3-way handshake) and 1500 bytes for payload data.
   4. Algorithm: at the start of simulation, generate a TCP connection establishment with the following TCP parameter configuration (as appropriate for the simulation platform):

|  |  |
| --- | --- |
| **TCP Model Parameters** | |
| MSS | Ethernet (1500) |
| Receive Buffer (bytes) | 65535 |
| Receive Buffer Adjustment | None |
| Delayed ACK Mechanism | Segment/Clock based |
| Maximum ACK Delay (sec) | 0.05 |
| Slow-Start Initial Count (MSS) | 1 |
| Fast Retransmit | Enabled |
| Duplicate ACK Threshold | 3 |
| Fast Recovery | Reno |
| Window Scaling | Enabled |
| Selective ACK (SACK) | Disabled |
| ECN Capability | Disabled |
| Segment Send Threshold | Byte Boundary |
| Active Connection Threshold | Unlimited |
| Karn's Algorithm | Enabled |
| Nagle Algorithm | Disabled |
| Initial Sequence Number | Auto Complete |
| Initial RTO (sec) | 3.0 |
| Min RTO (sec) | 1.0 |
| Max RTO (sec) | 64.0 |
| RTT Gain | 0.125 |
| Deviation gain | 0.25 |
| RTT Deviation Coefficient | 4.0 |
| Timer Granularity | 0.5 |

1. **Web browsing** 
   1. Protocol: HTTP (version 1.0 or above)
   2. MSDU sizes: 350 bytes for HTTP requests and 1500 bytes for payload data
   3. Algorithm: After each reading time the new requests for pages are generated by the user (mean of 31 seconds), generate a HTTP request with the following parameters enlisted below. The parsing time is the time taken by the HTTP page to fill in all subpage requests which appear from the master page. After going through few of the subpages the user quits the session which is indicated by the last packet of the session. This is shown inFigure A2.2.

Reading Time

First Packet of Session

Last Packet of Session

Reading Time

Parsing Time

1. HTTP traffic pattern

|  |  |  |  |
| --- | --- | --- | --- |
| **Component** | **Distribution** | **Parameters** | **PDF** |
| Main  object  size (SM) | Truncated Lognormal | Mean = 10710 bytes  SD = 25032 bytes  Min = 100 bytes  Max = 2 Mbytes (before truncation) | if x>max or x<min, discard and generate a new value for x |
| Embedded object size (SE) | Truncated Lognormal | Mean = 7758 bytes  SD = 126168 bytes  Min = 50 bytes  Max = 2 Mbytes (before truncation) | f x>max or x<min, discard and generate a new value for x |
| Number of embedded objects per page (Nd) | Truncated Pareto | Mean = 5.64  Max. = 53 (before truncation) | Subtract k from the generated random value to obtain Nd  if x>max, discard and regenerate a new value for x |
| Reading time (Dpc) | Exponential | Mean = 30 sec | λ = 0.033 |
| Parsing time (Tp) | Exponential | Mean = 0.13 sec |  |

1. **Full buffer traffic model**

Unlike wireless display, video streaming is generated from a video server, and traverses multiple hops in the internet before arriving at AP for transmission to STA. It is a unidirectional traffic from the video server to the station.

Typically, Video streaming application runs over TCP/IP protocol, and video frames will be fragmented at TCP layer before leaving the video server. Since these TCP/IP packets experiences different processing and queuing delay at routers, the inter-arrival time between these TCP/IP packets are not a constant despite the fact that video frames are generated at constant interval at the video application layer.

**STA Layering Model**

STA layering model is shown in Figure A2.2. Both AP and STA generate video frames at application layer. The video traffic goes through TCP/IP layer and then to MAC layer. The TCP protocol used for video streaming simulation is the same as other traffic model.



1. Station layer model for buffered video streaming

**Video traffic generation**

The video traffic from source and receiver is generated as follows.

**Step 1**: At application layer, generate video frame size (bytes) according to Weibull distribution with the following PDF.


f(x;\lambda,k) =
\begin{cases}
\frac{k}{\lambda}\left(\frac{x}{\lambda}\right)^{k-1}e^{-(x/\lambda)^{k}} & x\geq0 ,\\
0 & x<0,
\end{cases} (A2-1)

Depending on the video bit rate, the parameters to use are specified in Table A2.1.

1. Lambda and k parameters with different video bit rates for buffered video streaming

|  |  |  |  |
| --- | --- | --- | --- |
| **Traffic Model Class Identifier** | **Video bit rate** | **λ** | **k** |
| BVS1 | 10Mbps | 34750 | 0.8099 |
| BVS2 | 8Mbps | 27800 | 0.8099 |
| BVS3 | 6Mbps | 20850 | 0.8099 |
| BVS4 | 4Mbps | 13900 | 0.8099 |
| BVS6 | 2Mbps | 6950 | 0.8099 |

**Step 2**: AT TCP layer, set TCP segment as 1500 bytes and fragment video packet into TCP segments.

**Step 3**: Add network latency to TCP/IP packets when these segments arrive at AP for transmission. The network latency is generated according to Gamma distribution whose PDF is shown below

f(x;k,\theta) =  \frac{x^{k-1}e^{-\frac{x}{\theta}}}{\theta^k\Gamma(k)} \quad \text{ for } x > 0 \text{ and } k, \theta > 0. (A2-2)

Where

* + k=0.2463
  + θ=60.227

The mean of the latency with the above parameters is 14.834ms. To simulate longer or shorter network latency, scaleθlinearly since mean of Gamma distribution is k\*θ

If network latency value is such that the packet arrives at MAC layer after the end of the simulation time, then re-generate another network latency value until the packet arrives at MAC within the simulation window.

1. Gaming traffic model
2. Algorithm ：Gaming traffic can be modelled by the Largest Extreme Value distribution. The starting time of a network gaming mobile is uniformly distributed between 0 and 20 ms to simulate the random timing relationship between client traffic packet arrival and reverse link frame boundary[1][2][3]
3. Parameter ：initial packet arrival time, the packet inter arrival time, and the packet sizes are illustrated

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Component** | **Distribution** | | **Parameters** | | **PDF** |
| **DL** | **UL** | **DL** | **UL** |
| Initial packet arrival (ms) | Uniform | Uniform | a=0,  b=20 | a=0,  b=20 |  |
| Packet arrival time (ms) | Largest Extreme Value | Largest Extreme Value | a=15,  b=7 | a=23.5,  b=10.5 |  |
| Packet size (Byte) | Largest Extreme Value | Largest Extreme Value | a=390,  b=89 | a=158,  b=26.2 |  |

1. **Multicast Video Streaming Traffic Model**

Multicast Video Streaming is one-way video traffic from AP to multiple STAs

The video traffic is generated from a video server, and traverses multiple hops in the internet before arriving at AP for transmission to STAs.

**Station layer model**



1. Station layer model for multicast video streaming

STA layering model is shown inFigure A2.3. AP generates video frames at application layer.

Because the traffic from AP to stations has experienced network jitter,

it can be modelled the same way as the traffic model of video streaming.

The video traffic goes through UDP/IP layer and then to MAC layer.

**Video traffic generation**

Traffic model from AP to station: use the same steps in video streaming traffic model.

We assume bit rate for video streaming 6 Mbps (1080/30p AVC) and 3 Mbps (1080/30p HEVC).

Depending on the video bit rate, the parameters to use are specified in Table A2.2.

1. Lambda and k parameters with different video bit rates for multicast video streaming

|  |  |  |  |
| --- | --- | --- | --- |
| **Traffic Model Class Identifier** | **Video bit rate** | **λ** | **k** |
| MC1 | 6Mbps | 20850 | 0.8099 |
| MC2 | 3Mbps | 10425 | 0.8099 |

**References for traffic models**

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