Traffic models comments on IEEE 802.16j-06/013

Document Number: [IEEE S802.16j-06/093r3]
Date Submitted: [2006-09-26]
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Venue: IEEE 802.16 #45
Base Document: IEEE 802.16j-06/013
Purpose: Improve the traffic models in IEEE 802.16j-06/013

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Summary of contribution

• We propose to replace the traffic models in Section 3 and Appendix C of IEEE 802.16j-06/013 with our traffic models in IEEE 802.16j-06/093.

• Based on 3GPP2 traffic models (3GPP2/TSG-C.R1002, “1xEV-DV Evaluation Methodology (V14)”), we re-organized models and added missing gaming model to the original traffic modes in IEEE 802.16j-06/013.

• The following traffic models will be included
  – HTTP [1][2][7]
  – FTP [1][2]
  – NRT video streaming [1][2]
  – VoIP [1][3][4][5]
  – Gaming [1][6]
Bursty traffic generation model

- All traffic model can be generated using a bursty traffic generation model.
Bursty traffic generation model-2

• Parameter of interests are:
  – Session inter-arrival time and session duration
  – Packet call inter-arrival time and duration
  – Datagram inter-arrival time and datagram size
Traffic models - HTTP

- Interactive and self-similar
Traffic models – HTTP parameter description

• Session arrival is poisson with rate
• Session duration distribution is indirectly determined by other parameters, i.e., # of pages/session, size of objects, and reading time
• Within a packet call, the following parameters are important:
  – $S_M$: size of the main object in a packet call
  – $S_E$: size of an embedded object in a packet call
  – $N_d$: number of embedded objects in a packet call
  – $D_{pc}$: reading time
  – $T_p$: parsing time for main page
# Traffic models – HTTP parameters

<table>
<thead>
<tr>
<th>Component</th>
<th>Distribution</th>
<th>DL Parameters</th>
<th>UL Parameters</th>
<th>PDF</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Pages/Session</td>
<td>Lognormal</td>
<td>Mean = 17, Std. Dev = 22</td>
<td>Mean = 17, Std. Dev = 22</td>
<td></td>
</tr>
<tr>
<td>Main object size ( (S_m) )</td>
<td>Truncated Lognormal</td>
<td>Mean = 10710 bytes, Std. dev. = 25032 bytes, Minimum = 100 bytes, Maximum = 2 Mbytes, 1.37, =8.35</td>
<td>Mean = 9055 bytes, Std. dev. = 13265 bytes, Minimum = 100 bytes, Maximum = 100 Kbytes, 1.37, =8.35</td>
<td>( f_x = \frac{1}{\sqrt{2\pi s_x}} \exp\left(-\frac{(\ln x - m)^2}{2s_x^2}\right), )</td>
</tr>
<tr>
<td>Embedded object size ( (S_e) )</td>
<td>Truncated Lognormal</td>
<td>Mean = 7758 bytes, Std. dev. = 126168 bytes, Minimum = 50 bytes, Maximum = 2 Mbytes, 2.36, =6.17</td>
<td>Mean = 5958 bytes, Std. dev. = 11376 bytes, Minimum = 50 bytes, Maximum = 100 Kbytes, 1.69, =7.53</td>
<td></td>
</tr>
<tr>
<td>Number of Embedded objects per page ( (N_d) )</td>
<td>Truncated Pareto</td>
<td>Mean = 5.64, Max. = 53</td>
<td>Mean = 4.229, Max. = 53</td>
<td>( f_x = \frac{a}{k+1} \cdot \frac{a}{x}, x &lt; m ) ( f_x = \frac{a}{m}, x = m ) ( a = 1.1, k = 2, m = 55 ) Note: Subtract k from the generated random value to obtain ( N_d )</td>
</tr>
<tr>
<td>Reading time ( (D_{pc}) )</td>
<td>Exponential</td>
<td>Mean = 30 sec</td>
<td>Mean = 30 sec</td>
<td></td>
</tr>
<tr>
<td>Parsing time ( (T_p) )</td>
<td>Exponential</td>
<td>Mean = 0.13 sec</td>
<td>Mean = 0.13 sec</td>
<td></td>
</tr>
</tbody>
</table>

11/08/06
Traffic models – FTP

• DL FTP user session

• For UL FTP traffic, each packet call refers to the transfer of one file only.
Traffic models – FTP parameter description

• For DL FTP session
  – Session arrival has Poisson with rate $\lambda$.
  – Session duration distribution is TBD (It can be modeled indirectly by # files transferred per session, file size, and reading time)
  – Packet calls are made up of file transfer with parameter of interests:
    • $S$: size of file to be transferred
    • $D_{pc}$: reading time

• For UL FTP session
  – FTP users arrive according to Poisson again.
  – Parameter of interest is upload file size.
Traffic models – FTP parameters

- **DL FTP model**

<table>
<thead>
<tr>
<th>Component</th>
<th>Distribution</th>
<th>Parameters</th>
<th>PDF</th>
</tr>
</thead>
<tbody>
<tr>
<td>File size (S)</td>
<td>Truncated Lognormal</td>
<td>Mean = 2Mbytes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Std. Dev. = 0.722 Mbytes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Minimum = TBD</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maximum = 5 Mbytes</td>
<td></td>
</tr>
<tr>
<td>Reading time (D_{pe})</td>
<td>Exponential</td>
<td>Mean = 180 sec.</td>
<td></td>
</tr>
</tbody>
</table>

\[ f_X = \frac{1}{\sqrt{2 \pi s_x}} \exp\left(-\frac{(\ln x - m)^2}{2s^2}\right), x \geq 0 \]

\[ s = 0.35, m = 14.45 \]

- **UL FTP model**

<table>
<thead>
<tr>
<th>Component</th>
<th>Distribution</th>
<th>Parameters</th>
<th>PDF</th>
</tr>
</thead>
<tbody>
<tr>
<td>File size (S)</td>
<td>Truncated Lognormal</td>
<td>Mean = 19.5kbytes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Std. Dev. = 46.7kbytes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Minimum = 0.5kbytes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maximum = 500 kbytes</td>
<td></td>
</tr>
</tbody>
</table>

\[ f_X = \frac{1}{\sqrt{2 \pi s_x}} \exp\left(-\frac{(\ln x - m)^2}{2s^2}\right), x \geq 0 \]

\[ s = 2.0899, m = 0.9385 \]
Traffic models – Near real time video streaming for DL

- Video session is assumed to last the whole simulation.
- Packet call arrives regularly every frame. There is zero OFF period in a video session.
Traffic models – Near real time video streaming for DL parameter

- Each video frame arrives at a regular interval $T$
- Each frame is a packet call
- Within each frame (packet call), datagrams arrive randomly with randomly distributed packet sizes.

<table>
<thead>
<tr>
<th>Information types</th>
<th>Inter-arrival time between the beginning of each frame</th>
<th>Number of packets (slices) in a frame</th>
<th>Packet (slice) size</th>
<th>Inter-arrival time between packets (slices) in a frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution</td>
<td>Deterministic (Based on 10fps)</td>
<td>Deterministic</td>
<td>Truncated Pareto (Mean= 50bytes, Max= 125bytes)</td>
<td>Truncated Pareto (Mean= 6ms, Max= 12.5ms)</td>
</tr>
<tr>
<td>Distribution</td>
<td>100ms</td>
<td>8</td>
<td>$K=20$bytes $= 1.2$</td>
<td>$K=2.5$ms $= 1.2$</td>
</tr>
</tbody>
</table>
Traffic model - VoIP

Exponential distribution with average duration of \(1/b\)

Packet calls

Exponential distribution with average duration of \(1/b\)

Active State
Packet size
79 or 41 bytes

Inactive State
Packet size
51 or 15 bytes
Traffic model – VoIP parameters

• VoIP users arrives with Poisson distribution with rate $\lambda$.
• Session duration is TBD distribution.
• Use simplified AMR model with active state and inactive state generating packets of different constant size depending on with or without header compression and using IPv4 or IPv6
  – Active state: 33 bytes of AMR payload for every 20msec
  – Inactive state: 7 bytes of AMR payload for every 160msec
# VoIP Packet Size Calculation

<table>
<thead>
<tr>
<th>Description</th>
<th>AMR without Header</th>
<th>AMR with Header</th>
<th>G.729 without Header</th>
<th>G.729 with Header</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IPV4(IPv6)</td>
<td>IPV4(IPv6)</td>
<td>IPV4(IPv6)</td>
<td>IPV4(IPv6)</td>
</tr>
<tr>
<td>Voice Payload</td>
<td>7bytes (inactive)  * 33 bytes (active)</td>
<td>7bytes (inactive) 33 bytes (active)</td>
<td>0 bytes (inactive) 20 bytes (active)</td>
<td>0 bytes (inactive) 20 bytes (active)</td>
</tr>
<tr>
<td>Protocol Headers</td>
<td>40 bytes (60 bytes)</td>
<td>2 bytes (4 bytes)</td>
<td>40 bytes (60 bytes)</td>
<td>2 bytes (4 bytes)</td>
</tr>
<tr>
<td>RTP</td>
<td>12 bytes</td>
<td>12 bytes</td>
<td>12 bytes</td>
<td>12 bytes</td>
</tr>
<tr>
<td>UDP</td>
<td>8 bytes</td>
<td>8 bytes</td>
<td>8 bytes</td>
<td>8 bytes</td>
</tr>
<tr>
<td>IPv4 (IPv6)</td>
<td>20 bytes (40 bytes)</td>
<td>20 bytes (40 bytes)</td>
<td>20 bytes (40 bytes)</td>
<td>20 bytes (40 bytes)</td>
</tr>
<tr>
<td>802.16e GMH</td>
<td>6 bytes</td>
<td>6 bytes</td>
<td>6 bytes</td>
<td>6 bytes</td>
</tr>
<tr>
<td>CRC</td>
<td>4 bytes</td>
<td>4 bytes</td>
<td>4 bytes</td>
<td>4 bytes</td>
</tr>
<tr>
<td>Total VoIP packet size</td>
<td>57 bytes/ 77 bytes (inactive) 83 bytes / 103 bytes (active)</td>
<td>19 bytes/ 21 bytes (inactive) 45 bytes/ 47 bytes (active)</td>
<td>0 bytes (inactive) 70 bytes / 90 bytes (active)</td>
<td>0 bytes (inactive) 32 bytes/ 34 bytes (active)</td>
</tr>
</tbody>
</table>
# Traffic models – VoIP parameters

<table>
<thead>
<tr>
<th>Component</th>
<th>Distribution</th>
<th>Parameters</th>
<th>PDF</th>
</tr>
</thead>
</table>
| Active state duration                          | Exponential  | Mean = 1 second  | $f_x = l e^{-lx}, x \geq 0$  
|                                                |              |                  | $l = 1/\text{Mean}$                          |
| Inactive state duration                        | Exponential  | Mean = 1.5 second | $f_x = l e^{-lx}, x \geq 0$  
|                                                |              |                  | $l = 1/\text{Mean}$                          |
| Probability of transition from active to inactive state | N/A          | (=0.6)           |                                               |
| Probability of transition from inactive to active state | N/A          | (=0.4)           |                                               |
Traffic models – Gaming

• Gaming user session arrival with Poisson distribution with arrival rate $\lambda$.
• Gaming user session duration has TBD distribution.

<table>
<thead>
<tr>
<th>Component</th>
<th>Distribution</th>
<th>Parameters</th>
<th>PDF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$f(x) = \frac{1}{b-a}, \ a \ x \ b$</td>
</tr>
<tr>
<td>Initial packet</td>
<td>Uniform</td>
<td>a=0, b=40ms</td>
<td>$f(x) = \frac{1}{b-a}, \ a \ x \ b$</td>
</tr>
<tr>
<td>arrival</td>
<td>Uniform</td>
<td>a=0, b=40ms</td>
<td>$f(x) = \frac{1}{b-a}, \ a \ x \ b$</td>
</tr>
<tr>
<td>Packet</td>
<td>Extreme</td>
<td>a=48ms, b=4.5ms</td>
<td>$f(x) = \frac{1}{b} e^{-\frac{x-a}{b}} e^{-\frac{b}{x-a}}, \ b &gt; 0$</td>
</tr>
<tr>
<td>arrival time</td>
<td>Extreme</td>
<td>a=40ms, b=6ms</td>
<td>$X = a - b \ln(-\ln Y), \ Y \sim U(0,1)$</td>
</tr>
<tr>
<td>Packet size</td>
<td>Extreme</td>
<td>a=330bytes, b=82</td>
<td>$f(x) = \frac{1}{b} e^{-\frac{x-a}{b}} e^{-\frac{b}{x-a}}, \ b &gt; 0$</td>
</tr>
<tr>
<td></td>
<td>Extreme</td>
<td>a=45bytes, b=5.7</td>
<td>$X = a - b \ln(-\ln Y) + 2, \ Y \sim U(0,1)$</td>
</tr>
</tbody>
</table>
## Traffic mix proposal

<table>
<thead>
<tr>
<th></th>
<th>Voice Capacity</th>
<th>FTP</th>
<th>HTTP</th>
<th>n.r.t. video</th>
<th>Gaming</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Voice Capacity</strong></td>
<td>100% #users = Nv</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Data Capacity</strong></td>
<td>0%</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Traffic Mix 1</strong></td>
<td>0.5 Nv</td>
<td>Remaining Data Users</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Traffic Mix 2</strong></td>
<td>0.5 Nv</td>
<td>Remaining Data Users</td>
<td>30%</td>
<td>30%</td>
<td>30%</td>
</tr>
<tr>
<td><strong>Traffic Mix 3</strong></td>
<td>0.75 Nv</td>
<td>Remaining Data Users</td>
<td>30%</td>
<td>30%</td>
<td>30%</td>
</tr>
</tbody>
</table>
References


