RTCM – rede temática de comunicações móveis
Lisboa, 17 de Fevereiro, 2006

TELE-TRAFFIC SIMULATION FOR MOBILE COMMUNICATION SYSTEMS BEYOND 3G

Simulação de Tele-Tráfego para Sistemas de Comunicações Móveis pós-3G

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Summary

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Introduction

The main objective of this work consisted of producing an event-based simulator to obtain results for:

- blocking and
- handover (HO) failure probabilities

and extracting conclusions about the results and the validation of traffic models, with very simple hypothesis
## Services of the Vehicular scenario (E-UMTS)

<table>
<thead>
<tr>
<th>Applications</th>
<th>Data rate [kb/s]</th>
<th>Usage [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voice (VOI)</td>
<td>12.2 (1ch. of 12.2)</td>
<td>42.0</td>
</tr>
<tr>
<td>Video-telephony (VTE)</td>
<td>144 (12ch. of 12.2)</td>
<td>16.0</td>
</tr>
<tr>
<td>Multimedia Web Browsing (MWB)</td>
<td>384 (32ch. of 12.2)</td>
<td>18.5</td>
</tr>
<tr>
<td>Assistance in Travel (ATR)</td>
<td>1536 (128ch. of 12.2)</td>
<td>23.5</td>
</tr>
</tbody>
</table>

is an outdoor environment, with high mobility
Parameters used in the model

The busy hour call attempt (BHCA) - is the total number of call attempts by all users covered by a radio cell or a part of a cell during a given time duration.

The call holding time - is the call duration if the call is not prematurely dropped.

The sojourn time - is the time that the user stays in a cell.

Session activity/inactivity parameters:

• ON period
• OFF period
Call holding time

The call holding time is assumed to be exponentially distributed with mean $\tau$ where

$$\tau = \frac{1}{\mu}$$

where $\mu$ is the service rate

<table>
<thead>
<tr>
<th>Applications</th>
<th>$\mu$ [min$^{-1}$]</th>
<th>$1/\mu$ [s$^{-1}$]</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOI</td>
<td>0.333</td>
<td>180</td>
<td>Exponential</td>
</tr>
<tr>
<td>VTE</td>
<td>0.333</td>
<td>180</td>
<td>Exponential</td>
</tr>
<tr>
<td>MWB</td>
<td>0.066</td>
<td>900</td>
<td>Exponential</td>
</tr>
<tr>
<td>ATR</td>
<td>0.05</td>
<td>1200</td>
<td>Exponential</td>
</tr>
</tbody>
</table>
Sojourn time

The sojourn time is assumed to be exponentially distributed with mean \( \tau_h \) where

\[
\tau_h = \frac{1}{\eta}
\]

and \( \eta \) is calculated using this formula

\[
\eta = \frac{V_{av}}{2 \times \ln(2)} \times \frac{1}{(2R)}
\]

\( V_{av} = 50 \text{km/h} \)

\( R \) - cell coverage distance
Handover rate

The handover rate $\gamma$ is given by

$$\gamma = \frac{\eta}{\mu}$$

and the channel occupancy time is given by

$$\tau_c^- = \min(\tau, \tau_h^-)$$
Busy hour call attempt

The new calls are generated following a Poisson distribution with rate $\lambda_j = BHCA_j$.

$$BHCA_j[\text{min}^{-1}] = \frac{Usage_j}{\tau_j[\text{min}]} \cdot M_T \cdot \rho$$

So the time between calls will be exponentially distributed, and its average obtained by

$$Time\_between\_calls[s] = \frac{60}{BHCA[\text{min}^{-1}]}$$
Scenario assumptions
## Session activity parameters

<table>
<thead>
<tr>
<th>Applications</th>
<th>Active state (ON)</th>
<th>Inactive state (OFF)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Avg. [s]</td>
<td>Filesize [KB]</td>
</tr>
<tr>
<td>VOI</td>
<td>1.4</td>
<td>2.14</td>
</tr>
<tr>
<td>VTE</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>MWB</td>
<td>5</td>
<td>240</td>
</tr>
<tr>
<td>ATR</td>
<td>60</td>
<td>11520</td>
</tr>
</tbody>
</table>
Simulation language

- NS-2 - is a network simulator
- Build a new simulator in C++
- AweSim V3.2 - is a general purpose simulation system built in C++ and Visual Basic
Why use AweSim V3.2?

• It has lots of tools for simulation processes and the most of the random functions needed
• The models can be built using a graphical language called Visual SLAM
• The time to learn to working with AweSim and run a simple model is very short
• The experience obtained by working with this simulator would help to build a new one in C++ if the complexity of the model overlap the capabilities of AweSim
• The student version is freely distributed
• It can work with discrete event or with continuous simulation approaches
General aspect of AweSim network - One application
QoS Parameters

- The call blocking probability, $P_b$
- The handover failure probability, $P_{hf}$
- The ON-OFF blocking probability, $P_{bONOFF}$
User Model

Applications activation

\[ \Lambda_{\text{VOI}} \quad \Lambda_{\text{VTE}} \]

\[ \text{VOI} \quad \text{Idle} \quad \text{VTE} \]

\[ H_{\text{VOI}} \quad H_{\text{VTE}} \]

Service component activation

Service component \( j \)
(used by application \( k \))

\[ \Lambda_{jk} \]

\[ \text{Idle} \quad \text{Active} \]

\[ H_{jk} \]
Tele-traffic Model Validation/single service, with three cells, VOI ($\rho=0.1$) different handovers rates, $\gamma$

\[\begin{array}{c|c|c|c|c|c|c|c}
\gamma & 0.000 & 0.001 & 0.002 & 0.003 & 0.004 & 0.005 & 0.006 \\
\hline
\rho = 0.1 & Pb & Phf & PbONOFF & THEOR. \\
\end{array}\]
Tele-traffic model validation [VePa04]/single service, with three cells, VOI ($\rho=0.2$) different handovers rates, $\gamma$.

![Graph showing probability vs. $\gamma$.]
Tele-traffic model validation/single service, with three cells, VOI ($\rho=1$) different handovers rates, $\gamma$
Comparison of theoretical results for $P_{b\ ONOFF}$, for different $\rho$, with $\gamma$ as a parameter (VOI, $c=4$)
$P_b$, $P_{hf}$, $P_b^{ONOFF}$ and theoretical $P_b^{ONOFF}$ for VOI in the multi-service case, $c=48$ and $\rho=0.1$
$P_b$, $P_{hf}$, $P_b^{ONOFF}$ and theoretical $P_b^{ONOFF}$ for VTE in the multi-service case, $c=48$ and $\rho=0.1$
Conclusions

- By comparing call blocking and handover failure probabilities we can observe that they have very similar values for the lowest $\gamma_s$
- The validation of the Bernoulli-Poisson-Pascal model to compute $P_{b\ ONOFF}$, was achieved for a single application, and handover rates up to 10
Future work

• The Vehicular scenario is not the only one defined in SEACORN. One of the next steps of this work will be to simulate the Office and Business City Centre scenarios, by changing scenario parameters in the Control and the Network files
• Another step will be to use our simulator to validate the model for the multi-service case
• Build the model of a more complex physical scenario: use other geometry in a more complex scenario
• Develop new characteristics in the simulator, e.g.,
  • accounting for queuing of data sessions in order to obtain results about important parameters like delay
  • Modeling calls/sessions as Bernoulli processes (not Poisson)
Obrigado
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