Comparison between LTE and Rival Wireless Technologies (using Opnet 16)

Team 10:
Josh Ancill  jja48@sfu.ca
Kim Izmaylov  kvi@sfu.ca
Anton Khomutskiy  aka78@sfu.ca

http://www.mempf.com/427project/
- “Long Term Evolution”
- 4G (4\textsuperscript{th} Generation 3GPP standard)
- Successor to UMTS/HSPA+ (3G)
- Uses OFDMA on DL (Orthogonal frequency-division multiple access) and Single Channel FDMA on UL
- Higher capacity, lower latency, simplified architecture and higher data transfer rate
- 100 Mbit/s DL and 50 Mbit/s UL (1x1)
- Up to 300 Mbit/s DL and 70 Mbit/s UL (4x4 MIMO)
Rival Technologies

- Worldwide Interoperability for Microwave Access (WiMAX)
  - 802.16-2009: Up to 80 Mbit/s DL and 40 Mbit/s UL (1x1)

- 802.11g (highest supported in Opnet 16.0): up to 54 Mbit/s
- 802.11n (current version): up to 150 Mbit/s (1x1)
Choosing a modulation scheme
## Wi-Fi Scenario Setup

### Key setup parameters (defaults not mentioned)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Application</td>
<td>Modified Video Conference. Custom incoming frame size (increasing linearly with time) defined in a FSI (frame size index) file. Small outgoing frame size.</td>
</tr>
<tr>
<td>Wi-Fi version</td>
<td>802.11g with 54 Mbps (latest in Opnet)</td>
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<tr>
<td>AP Transmit Power</td>
<td>1.0 W</td>
</tr>
<tr>
<td>AP Buffer Size</td>
<td>1024 Kbits</td>
</tr>
<tr>
<td>Mobile Node Transmit Power</td>
<td>0.1 W</td>
</tr>
<tr>
<td>Mobile Node Buffer Size</td>
<td>1024 Kbits</td>
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WiMAX Network Setup

SS: Subscriber Station
# WiMAX Scenario Setup

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<td><strong>Efficiency mode</strong></td>
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<tr>
<td><strong>Service class</strong></td>
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<tr>
<td><strong>SS and BS Classifier definition</strong></td>
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<tr>
<td><strong>SS (DL and UL) service flow service class</strong></td>
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<tr>
<td><strong>SS DL Modulation</strong></td>
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<td><strong>SS UL Modulation</strong></td>
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<tr>
<td><strong>SS ARQ</strong></td>
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<tr>
<td><strong>BS Maximum Transmit Power</strong></td>
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LTE Network Setup

- UE: User Equipment
- eNodeB: Evolved Node B (base station)
- EPC: Evolved Packet Core
**LTE Scenario Setup**

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<td><strong>EPS Bearer</strong></td>
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<td><strong>TFT Packet Filters</strong></td>
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<td><strong>UE Modulation</strong></td>
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<td><strong>eNB Maximum Transmit Power</strong></td>
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<td><strong>UE Maximum Transmit Power</strong></td>
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Generating the traffic

This script generates a Frame Size Index (.csv) file that defines linearly increasing traffic flows.

```
num_nodes=$1
max_bitrate=$2
duration=$3
file_name=$4
frame_size=1
counter='expr $duration \* 30'
echo "Counter: $counter"
max_frame_size='expr $max_bitrate \* 1000000 / 240'
echo "Max Frame Size: $max_frame_size"
increment='expr $max_frame_size / $counter'
echo "Increment $increment"
if (($increment == 0))
then
  echo "Max Bit Rate too small for given duration"
  exit 1
fi
for ((i=0; i < $counter; i++))
do
  for ((j=0; j < $num_nodes; j++))
do
    echo "$frame_size" | tee -a
    frame_size='expr $frame_size + $increment'
done
$frame_size='expr $frame_size + $increment'
done
```
Wi-Fi Results

Traffic flows per mobile node (total of 5 mobile nodes):

Blue: 0 to 3 Mbit/s
Red: 0 to 10 Mbit/s
Green: 0 to 25 Mbit/s

- Wi-Fi starts to become congested at about 28 Mbit/s
- The 3 Mbit/s video stream did not fully utilize Wi-Fi downlink bandwidth
WiMAX Results

Traffic flows per SS (total of 5 SSs):
- Blue: 0 to 3 Mbit/s
- Red: 0 to 10 Mbit/s
- Green: 0 to 25 Mbit/s

- WiMAX starts to become congested at about 63 Mbit/s
- The 3 Mbit/s and 10 Mbit/s video stream did not fully utilize WiMAX downlink bandwidth
LTE Results

Traffic flows per UE (total of 5 UEs):
- Blue: 0 to 3 Mbit/s
- Red: 0 to 10 Mbit/s
- Green: 0 to 25 Mbit/s

- LTE achieves its maximum global throughput at about 92 Mbit/s
- The 3 Mbit/s and 10 Mbit/s video streams did not fully utilize LTE downlink bandwidth
Comparison of Cross Technology Results

Results produced using 0 - 25 Mbit/s

- LTE maintains its throughput for much longer than the other technologies
- WiMAX video throughput drops to ~0 Kbit/s
- Wi-Fi has the smallest delay throughout the simulation until WiMAX throughput drops to ~0
Comparison of Cross Technology Results

Results produced using 0 - 10 Mbit/s

- LTE and WiMAX maintain its throughput throughout the simulation as opposed to WiFi
- Wi-Fi and WiMAX have lower latency at low throughput but LTE wins at higher throughputs
Conclusions

- LTE’s maximum throughput seen in simulation is 92 Mbit/s DL, which is near theoretical values (100 Mbit/s)
- Given that all technologies in our simulation use 20 MHz channels, LTE has the highest spectrum efficiency based on the simulation results showing higher sustained data rates
- LTE has lower latency than WiMAX, comparable to WiFi
- Based on the above LTE is superior to other technologies
References


