

AUDIT REPORT

P3 communications GmbH

Am Kraftversorgungsturm 3, D-52070 Aachen, Germany

Has been tasked by



TDC Group, Sletvej 30 10-184, 8310 Tranbjerg J, Denmark

to independently audit the

performance of its voice and data services on smartphones

in comparison to other GSM/UMTS/LTE mobile radio networks in metropolitan and rural areas of the islands Zealand, Lolland and Falster in Denmark.

The audit was done as an independent performance benchmark performed by P3 communications between December 12th and December 18th, 2014 in Copenhagen and 10 further cities and towns as well as on connection roads. Measurements have been executed as drive tests outdoors using a Samsung Galaxy S4 LTE+ Smartphone (150 Mbit/s Download / 50 Mbit/s Upload). All data measurements have been performed in LTE/3G/2G mode (LTE preferred). Voice measurements have been done in LTE preferred mode on one side and 3G preferred mode on other side, while call origin has been alternated.

The following pages provide a comparative overview about the performance results observed for the different tested service types. Unless otherwise stated the shown bar graphs present the average value of the respective KPI and the error bars indicate the 95% confidence interval.

Smartphone Voice – mobile-to-mobile communication
Smartphone Data – HTTP Web Browsing, HTTP File Transfer and YouTube Video



Maziar Kianzad
Head of International Benchmarking

Audit Result Summary

Smartphone Data Service													
Service Type	Requirement	KPI Name and Description	Result										
Smartphone Data – Static Web Browsing ,Kepler‘ reference page	In order to offer a good HTTP Static Web Browsing service the content must be transferred quickly and reliably. Further the content must not be compressed in a way that lossy compression affects the user perception.	Static Web Page Session Time including DNS resolution time, IP Service Access Time and Transfer Time.	<p>Overall Session Duration [seconds]</p> <table border="1"> <thead> <tr> <th>Operator</th> <th>Duration [seconds]</th> </tr> </thead> <tbody> <tr> <td>TDC</td> <td>0,59</td> </tr> <tr> <td>Operator1</td> <td>0,96</td> </tr> <tr> <td>Operator2</td> <td>0,88</td> </tr> <tr> <td>Operator3</td> <td>1,29</td> </tr> </tbody> </table>	Operator	Duration [seconds]	TDC	0,59	Operator1	0,96	Operator2	0,88	Operator3	1,29
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Static Web Page Session Success Ratio including DNS Resolution Success, IP Service Access Success.	<p>Overall Session Success Ratio [%]</p> <table border="1"> <thead> <tr> <th>Operator</th> <th>Success Ratio [%]</th> </tr> </thead> <tbody> <tr> <td>TDC</td> <td>99,93</td> </tr> <tr> <td>Operator1</td> <td>100,00</td> </tr> <tr> <td>Operator2</td> <td>99,33</td> </tr> <tr> <td>Operator3</td> <td>99,79</td> </tr> </tbody> </table>	Operator	Success Ratio [%]	TDC	99,93	Operator1	100,00	Operator2	99,33	Operator3	99,79		
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Audit Result Summary

<p>Smartphone Data – Live Web Browsing. 3 Top live web pages in Denmark have been measured: m.ekstrabladet.dk m.youtube.com en.m.wikipedia.org</p>	<p>In order to offer a good HTTP Live Web Browsing service the content of 3 Top Live pages must be transferred quickly and reliably. Further the content must not be compressed in a way that lossy compression affects the user perception.</p>	<p>Live Web Page Session Time including DNS Resolution Time, IP Service Access Time and Transfer Time.</p>	<p>Overall Session Duration [seconds]</p> <table border="1"> <thead> <tr> <th>Operator</th> <th>Session Duration [seconds]</th> </tr> </thead> <tbody> <tr> <td>TDC</td> <td>5,9</td> </tr> <tr> <td>Operator1</td> <td>6,5</td> </tr> <tr> <td>Operator2</td> <td>6,3</td> </tr> <tr> <td>Operator3</td> <td>7,8</td> </tr> </tbody> </table>	Operator	Session Duration [seconds]	TDC	5,9	Operator1	6,5	Operator2	6,3	Operator3	7,8	<p style="text-align: center;">Better</p>
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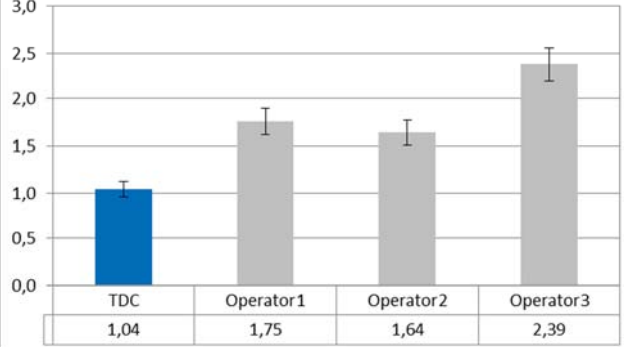
Audit Result Summary

Smartphone Data - Data Transfer in uplink and downlink direction	In order to offer a good HTTP Data Transfer downlink or uplink service the uncompressible content must be transferred quickly and reliably.	<p>Average Mean User Data Rate based on a 10 second HTTP file download. An infinite file is downloaded for 10 seconds. The transferred amount of data is divided by 10 seconds to calculate the mean user data rate.</p>	<p>Downlink Mean User Data Rate [kbit/s]</p> <table border="1"> <thead> <tr> <th>Operator</th> <th>Mean User Data Rate [kbit/s]</th> </tr> </thead> <tbody> <tr> <td>TDC</td> <td>36177</td> </tr> <tr> <td>Operator1</td> <td>20147</td> </tr> <tr> <td>Operator2</td> <td>23097</td> </tr> <tr> <td>Operator3</td> <td>15457</td> </tr> </tbody> </table>	Operator	Mean User Data Rate [kbit/s]	TDC	36177	Operator1	20147	Operator2	23097	Operator3	15457	Better
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TDC	36177													
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<p>Average Mean User Data Rate based on a 10 second HTTP file upload. An infinite file is uploaded for 10 seconds. The transferred amount of data is divided by 10 seconds to calculate the mean user data rate.</p>	<p>Uplink Mean User Data Rate [kbit/s]</p> <table border="1"> <thead> <tr> <th>Operator</th> <th>Mean User Data Rate [kbit/s]</th> </tr> </thead> <tbody> <tr> <td>TDC</td> <td>36431</td> </tr> <tr> <td>Operator1</td> <td>14356</td> </tr> <tr> <td>Operator2</td> <td>15580</td> </tr> <tr> <td>Operator3</td> <td>11357</td> </tr> </tbody> </table>	Operator	Mean User Data Rate [kbit/s]	TDC	36431	Operator1	14356	Operator2	15580	Operator3	11357			
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TDC	36431													
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Audit Result Summary

Smartphone Data - YouTube Video HD	In order to provide a good quality regarding the YouTube service, a smooth Payout of the reference video without any interruptions is required.	Percentage of uninterrupted Playouts without any interruptions. This KPI aims at fixed line YouTube Experience without any interruptions.	<p>Uninterrupted Playouts [%]</p> <table border="1"> <thead> <tr> <th>Operator</th> <th>Value [%]</th> </tr> </thead> <tbody> <tr> <td>TDC</td> <td>98,2</td> </tr> <tr> <td>Operator1</td> <td>97,7</td> </tr> <tr> <td>Operator2</td> <td>98,4</td> </tr> <tr> <td>Operator3</td> <td>95,2</td> </tr> </tbody> </table>	Operator	Value [%]	TDC	98,2	Operator1	97,7	Operator2	98,4	Operator3	95,2	Better
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Operator3	95,2													
In order to provide a good quality regarding the YouTube service, a smooth Payout of the reference video without major interruptions is required.	Percentage of successful downloads including minor interruptions. Single interruptions up to 8 seconds and a total interruption length of 15 seconds are accepted.	<p>Playout Success Ratio [%]</p> <table border="1"> <thead> <tr> <th>Operator</th> <th>Value [%]</th> </tr> </thead> <tbody> <tr> <td>TDC</td> <td>98,56</td> </tr> <tr> <td>Operator1</td> <td>99,00</td> </tr> <tr> <td>Operator2</td> <td>99,33</td> </tr> <tr> <td>Operator3</td> <td>97,24</td> </tr> </tbody> </table>	Operator	Value [%]	TDC	98,56	Operator1	99,00	Operator2	99,33	Operator3	97,24	Better	
Operator	Value [%]													
TDC	98,56													
Operator1	99,00													
Operator2	99,33													
Operator3	97,24													

Audit Result Summary

	<p>In order to offer a good quality regarding the YouTube service a short waiting time before the video starts playing is required.</p>	<p>The Playout Waiting Time includes video Catalogue Service Access and Download time, video IP Service Access and video buffering time.</p>	<p>Playout Waiting Time [seconds]</p>  <table border="1"><thead><tr><th>Category</th><th>Value</th></tr></thead><tbody><tr><td>TDC</td><td>1,04</td></tr><tr><td>Operator1</td><td>1,75</td></tr><tr><td>Operator2</td><td>1,64</td></tr><tr><td>Operator3</td><td>2,39</td></tr></tbody></table>	Category	Value	TDC	1,04	Operator1	1,75	Operator2	1,64	Operator3	2,39	<p>Better</p>
Category	Value													
TDC	1,04													
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Operator2	1,64													
Operator3	2,39													

Audit Result Summary

LTE/3G preferred Smartphone Voice Service

Service Type	Requirement	KPI Name and Description	Result										
Voice mobile-to-mobile service measured with two independent devices and systems at different locations. One party was set to LTE preferred, the other to 3G preferred mode.	<p>In order to offer a good Voice Service a network has to provide reliable service access and stable voice calls.</p> <p>Call Success Ratio values around 97% indicate a sufficient, values around 98% a good and values around 99% an excellent quality.</p>	The Call Success Ratio includes the Call Setup Success Ratio and the composite Dropped Call Ratio.	<p>Call Success Ratio [%]</p> <table border="1"> <thead> <tr> <th>Entity</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>TDC</td> <td>97,38</td> </tr> <tr> <td>Operator1</td> <td>96,21</td> </tr> <tr> <td>Operator2</td> <td>97,86</td> </tr> <tr> <td>Operator3</td> <td>97,95</td> </tr> </tbody> </table>	Entity	Value	TDC	97,38	Operator1	96,21	Operator2	97,86	Operator3	97,95
	Entity	Value											
TDC	97,38												
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Operator2	97,86												
Operator3	97,95												
<p>In order to offer a good Voice Service a network has to provide reasonable speech quality. Offered speech codecs, share of low and empty speech samples and general network performance impact the mean speech quality score.</p>	Average Speech Quality on Call Basis is adapted from POLQA wideband evaluation. Each recorded speech sample is compared with a German wideband reference sample. The POLQA algorithm determines a value between 1.0 and 4.5 where 4.5 is the best value.	<p>Call Speech Quality on call basis [POLQA MOS]</p> <table border="1"> <thead> <tr> <th>Entity</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>TDC</td> <td>3,51</td> </tr> <tr> <td>Operator1</td> <td>3,24</td> </tr> <tr> <td>Operator2</td> <td>3,23</td> </tr> <tr> <td>Operator3</td> <td>3,48</td> </tr> </tbody> </table>	Entity	Value	TDC	3,51	Operator1	3,24	Operator2	3,23	Operator3	3,48	
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