

CERTIFICATE

P3 communications GmbH
hereby certifies

TELEKOM ROMANIA

in the Mobile Benchmark Romania 10/2018.

Score 852 of 1000 in Total

Score 327 of 400 in Voice Services

Score 525 of 600 in Data Services



Hakan Ekmen
CEO



Telekom
Romania

MEASUREMENT OVERVIEW

MEASUREMENT SETUP

Drivetest	Voice	Data
Device	Samsung Galaxy S8	Samsung Galaxy S8
Test Cases	Mobile-to-Mobile (M2M) Side1 (4G preferred: Volte) to Side2 (4G preferred: Volte) 115 sec call window 70 sec call duration 15 sec call setup timeout Multi-RAB traffic injection on both sides	Data 4G preferred CA HTTP DL datastream 7s HTTP UL datastream 7s HTTP 3MB DL fixed file transfer HTTP 1MB UL fixed file transfer Web Browsing - Kepler ETSI Ref. Page 10 Live web pages (5 http / 5 https) 2 YouTube HD video ~ 45s 1 YouTube live stream ~ 45s
Mobility and Route Types	100% Drive test 52% in Cities, 14% in Towns and 34% on Roads Cities, towns and roads	
Samples	~ 3450 per Operator	~ 2980 per Operator
Dates	17 measurement days 10.10.2018 – 29.10.2018.	

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tested and measured the performance of its voice and data services on smartphones in comparison to other LTE/UMTS/GSM mobile radio networks in metropolitan and rural areas of Romania.

The audit was done as a performance benchmark performed by P3 communications between 10.10.2018 and 29.10.2018. in cities and towns as well as on connection roads.

Measurements have been executed as drive tests outdoors using a Samsung Galaxy S8 cat16 Smartphone 1000 Mbit/s Download / 105 Mbit/s Upload.

All data measurements have been performed in 4G preferred mode. Voice measurements have been done in 4G/4G preferred mode on both sides, while call origin has been alternated.

The following pages provide a comparative overview about the performance results observed for the different tested service types.

TESTING ROUTE



7200 km
measuring distance



23 %
of population measured

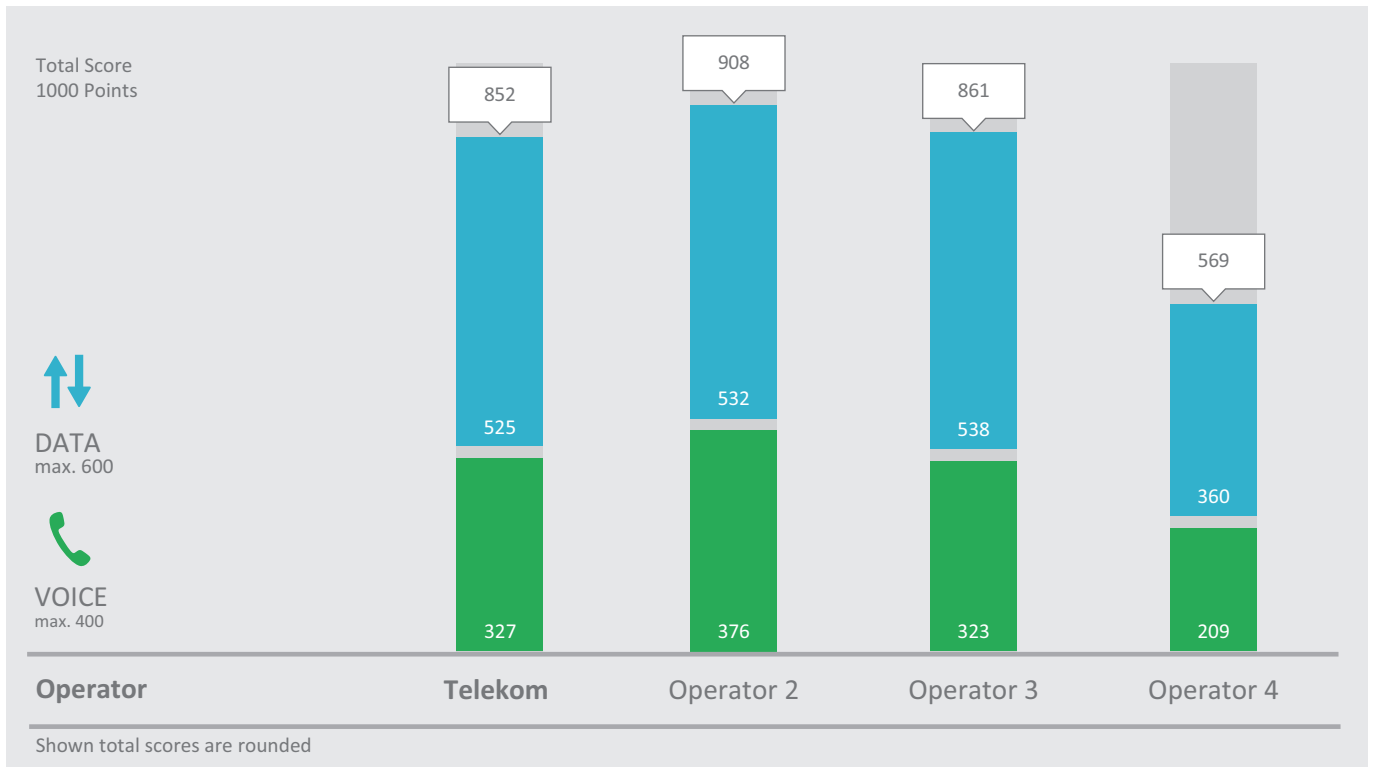
SCORE POINTS AND BREAKDOWN

The following table indicates the score points achieved by the networks under test in the modules “Voice” and “Data Services” as well as the breakdown of achieved points in the geographical categories “Cities”, “Towns” and “Roads”.

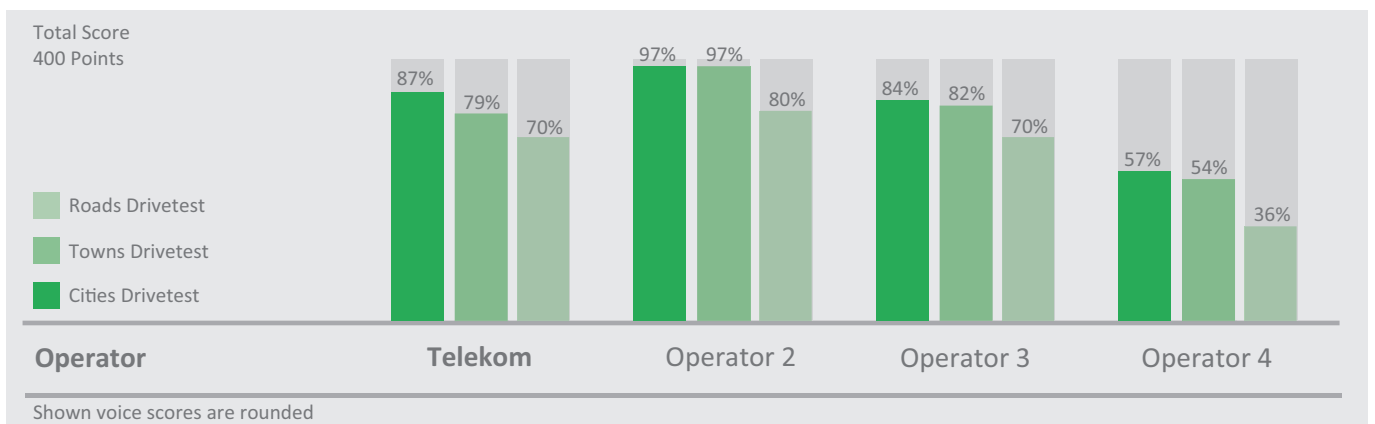
TOTAL SCORE

		Telekom	Operator 2	Operator 3	Operator 4
Voice	max. 400	327	376	323	209
Cities Drivetest	240	87%	97%	84%	57%
Towns Drivetest	80	79%	97%	82%	54%
Roads Drivetest	80	70%	80%	70%	36%
Data	max. 600	525	532	538	360
Cities Drivetest	360	92%	94%	95%	66%
Towns Drivetest	120	90%	81%	87%	55%
Roads Drivetest	120	72%	79%	75%	47%
Total	1000	852	908	861	569

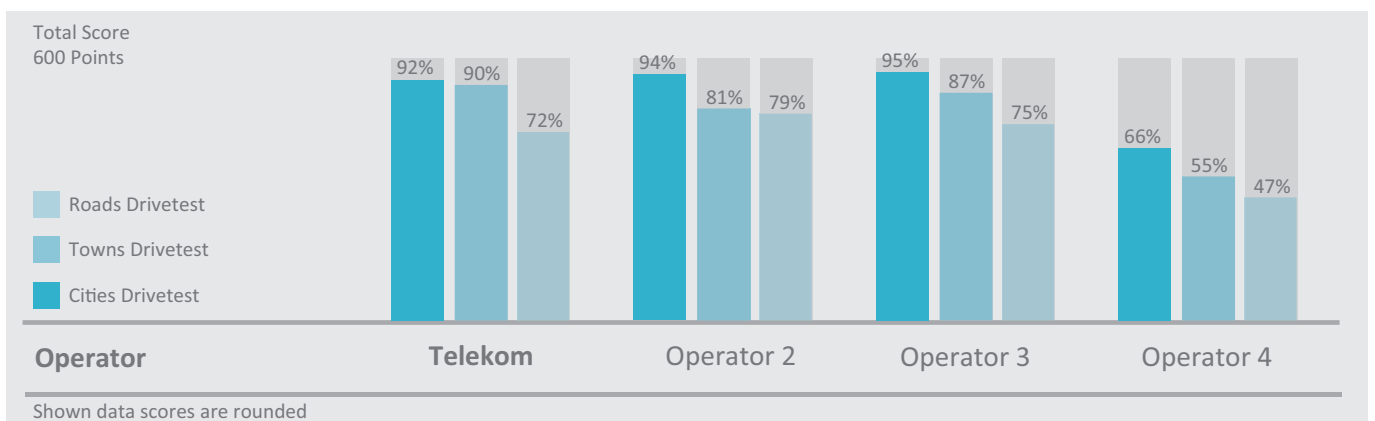
Shown scores are rounded.



TOTAL SCORE The graphic indicates the score points achieved by the networks under test in the modules “Voice” and “Data Services”



VOICE SCORE The graphic indicates the achieved values of all networks for the geographical categories “Cities”, “Towns” and “Roads” in voice services.



DATA SCORE The graphic indicates the achieved values of all networks for the geographical categories “Cities”, “Towns” and “Roads” in data services.

The following table indicates the achieved percentage of the maximum score in each of the different data services.

Data	Service Group	max.	Telekom	Operator 2	Operator 3	Operator 4
Cities	Web Browsing	80,0	92%	94%	97%	69%
	File Download	100,0	83%	90%	89%	61%
	File Upload	100,0	97%	98%	98%	51%
	YouTube	80,0	96%	95%	99%	89%
Towns	Web Browsing	26,7	94%	86%	96%	56%
	File Download	33,3	83%	79%	79%	55%
	File Upload	33,3	92%	90%	89%	37%
	YouTube	26,7	93%	68%	84%	75%
Roads	Web Browsing	26,7	78%	84%	81%	42%
	File Download	33,3	71%	80%	77%	49%
	File Upload	33,3	70%	83%	70%	34%
	YouTube	26,7	69%	69%	72%	66%

VOICE KPI OVERVIEW

The following table indicates the achieved values of all networks under test in each of the relevant Voice Key Performance Indicators (KPIs) for the geographical categories “Cities”, “Towns” and “Roads”.

Voice	Service Group	Unit	Telekom	Operator 2	Operator 3	Operator 4
Cities	Qualifier	[%]	99,5	99,8	99,1	97,1
	Call Setup Time	[s]	4,7	2,0	4,5	8,3
	Call Setup Time P90	[s]	6,0	2,4	6,4	10,3
	AVG Speech Quality	[MOS-LQO]	3,5	4,0	3,4	2,3
Towns	Qualifier	[%]	98,0	99,8	99,0	96,4
	Call Setup Time	[s]	4,9	2,0	5,2	8,1
	Call Setup Time P90	[s]	6,2	2,4	6,7	9,4
	AVG Speech Quality	[MOS-LQO]	3,5	4,0	3,5	2,4
Roads	Qualifier	[%]	95,0	95,0	95,4	89,3
	Call Setup Time	[s]	5,2	2,3	5,7	8,4
	Call Setup Time P90	[s]	6,8	3,4	7,2	10,6
	AVG Speech Quality	[MOS-LQO]	3,5	3,9	3,4	2,4

DATA KPI OVERVIEW

The following table indicates the achieved values of all networks under test in each of the relevant Data Key Performance Indicators (KPIs) for the geographical categorie "Cities".

Data Cities	KPI Name	Unit	Telekom	Operator 2	Operator 3	Operator 4
HTTP Live Page DL	Qualifier	[%]	98,6	99,3	99,2	95,1
	Time to first Byte	[ms]	393	447	321	493
	KBytes first second	[KB]	845	950	985	584
HTTP Static Page DL	Qualifier	[%]	99,7	100,0	99,9	98,1
	AVG Session Time	[s]	1,3	1,1	0,9	1,9
HTTP file DL 3MB	Qualifier	[%]	99,2	99,8	100,0	98,7
	AVG Session Time	[s]	2,0	1,7	1,0	2,9
	90% faster than	[kbit/s]	9615	13522	13901	6022
	10% faster than	[kbit/s]	49793	76288	66207	28235
HTTP file UL 1MB	Qualifier	[%]	99,8	100,0	99,9	98,1
	AVG Session Time	[s]	0,7	0,6	0,5	2,7
	90% faster than	[kbit/s]	8757	12112	13841	1761
	10% faster than	[kbit/s]	27972	25974	29740	7672
HTTP DL FDTT 7s	Qualifier	[%]	99,7	100,0	100,0	93,8
	AVG throughput	[kbit/s]	42783	62324	49877	21504
	90% faster than	[kbit/s]	12593	17517	14669	7585
	10% faster than	[kbit/s]	76676	121796	95023	38297
HTTP UL FDTT 7s	Qualifier	[%]	99,8	100,0	99,9	91,8
	AVG throughput	[kbit/s]	36997	40237	40034	5673
	90% faster than	[kbit/s]	14320	16830	18569	1984
	10% faster than	[kbit/s]	56681	58404	55882	8369
YouTube	Qualifier	[%]	99,4	99,5	99,9	98,3
	Start Time	[s]	1,5	1,5	1,3	1,9
	Playouts w/o interruptions	[%]	99,8	99,6	99,9	99,4
	AVG Resolution	[p]	1067	1075	1078	1058
YouTube Live	Qualifier	[%]	99,5	99,5	99,8	98,4
	Start Time	[s]	2,2	2,4	1,9	2,5
	Playouts w/o interruptions	[%]	99,9	98,8	99,7	98,5
	AVG Resolution	[p]	1071	1083	1087	1053

DATA KPI OVERVIEW

The following table indicates the achieved values of all networks under test in each of the relevant Data Key Performance Indicators (KPIs) for the geographical categorie “Towns”.

Data Towns	KPI Name	Unit	Telekom	Operator 2	Operator 3	Operator 4
HTTP Live Page DL	Qualifier	[%]	98,8	97,3	99,3	92,6
	Time to first Byte	[ms]	357	430	326	461
	KBytes first second	[KB]	872	805	831	513
HTTP Static Page DL	Qualifier	[%]	99,9	98,9	100,0	96,0
	AVG Session Time	[s]	1,1	1,4	1,2	2,3
HTTP file DL 3MB	Qualifier	[%]	99,6	99,8	99,1	97,1
	AVG Session Time	[s]	2,2	3,1	2,2	3,9
	90% faster than	[kbit/s]	7347	3850	5528	3374
	10% faster than	[kbit/s]	51971	59172	54674	28269
HTTP file UL 1MB	Qualifier	[%]	99,6	99,8	99,8	93,8
	AVG Session Time	[s]	0,8	0,9	1,0	2,7
	90% faster than	[kbit/s]	7522	5703	4653	1428
	10% faster than	[kbit/s]	26846	24111	28051	15285
HTTP DL FDTT 7s	Qualifier	[%]	100,0	99,6	99,8	94,4
	AVG throughput	[kbit/s]	39965	40759	34104	19089
	90% faster than	[kbit/s]	8788	3442	4261	3949
	10% faster than	[kbit/s]	76541	90464	76685	36705
HTTP UL FDTT 7s	Qualifier	[%]	99,6	99,8	100,0	89,1
	AVG throughput	[kbit/s]	34559	27256	27382	8984
	90% faster than	[kbit/s]	8105	7869	5267	1519
	10% faster than	[kbit/s]	59077	51472	56312	19343
YouTube	Qualifier	[%]	99,0	95,3	98,1	96,7
	Start Time	[s]	1,4	1,9	1,7	2,0
	Playouts w/o interruptions	[%]	99,6	98,2	98,5	99,1
	AVG Resolution	[p]	1055	1047	1034	922
YouTube Live	Qualifier	[%]	99,0	92,6	97,5	94,9
	Start Time	[s]	2,1	2,6	2,2	2,5
	Playouts w/o interruptions	[%]	99,5	96,8	98,0	97,8
	AVG Resolution	[p]	1043	1038	1008	922

DATA KPI OVERVIEW

The following table indicates the achieved values of all networks under test in each of the relevant Data Key Performance Indicators (KPIs) for the geographical categorie “Roads”.

Data Roads	KPI Name	Unit	Telekom	Operator 2	Operator 3	Operator 4
HTTP Live Page DL	Qualifier	[%]	94,4	96,5	95,6	85,9
	Time to first Byte	[ms]	399	464	387	585
	KBytes first second	[KB]	686	696	652	421
HTTP Static Page DL	Qualifier	[%]	94,8	97,8	97,0	89,5
	AVG Session Time	[s]	1,5	1,6	1,7	3,1
HTTP file DL 3MB	Qualifier	[%]	95,7	98,5	97,4	94,0
	AVG Session Time	[s]	4,4	4,4	4,0	5,9
	90% faster than	[kbit/s]	2643	2768	3215	2188
	10% faster than	[kbit/s]	45438	52971	48271	28846
HTTP file UL 1MB	Qualifier	[%]	94,5	98,7	96,7	87,4
	AVG Session Time	[s]	1,8	1,6	2,5	4,0
	90% faster than	[kbit/s]	2397	2397	1552	1096
	10% faster than	[kbit/s]	24922	23081	22472	14925
HTTP DL FDTT 7s	Qualifier	[%]	95,4	98,4	98,4	86,6
	AVG throughput	[kbit/s]	25923	27196	21387	14530
	90% faster than	[kbit/s]	3191	3005	2637	2089
	10% faster than	[kbit/s]	62261	63179	57253	34877
HTTP UL FDTT 7s	Qualifier	[%]	93,6	97,7	94,3	83,2
	AVG throughput	[kbit/s]	18246	19082	14852	7090
	90% faster than	[kbit/s]	2604	3391	1407	1153
	10% faster than	[kbit/s]	50669	40669	36767	18300
YouTube	Qualifier	[%]	92,1	92,9	93,1	94,1
	Start Time	[s]	2,0	2,1	1,9	2,2
	Playouts w/o interruptions	[%]	97,1	96,8	98,2	98,6
	AVG Resolution	[p]	973	993	871	700
YouTube Live	Qualifier	[%]	90,8	90,1	95,1	89,3
	Start Time	[s]	2,6	2,8	2,6	2,8
	Playouts w/o interruptions	[%]	95,8	94,8	94,8	97,7
	AVG Resolution	[p]	950	984	837	706

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