

# R E P O R T T O T A L

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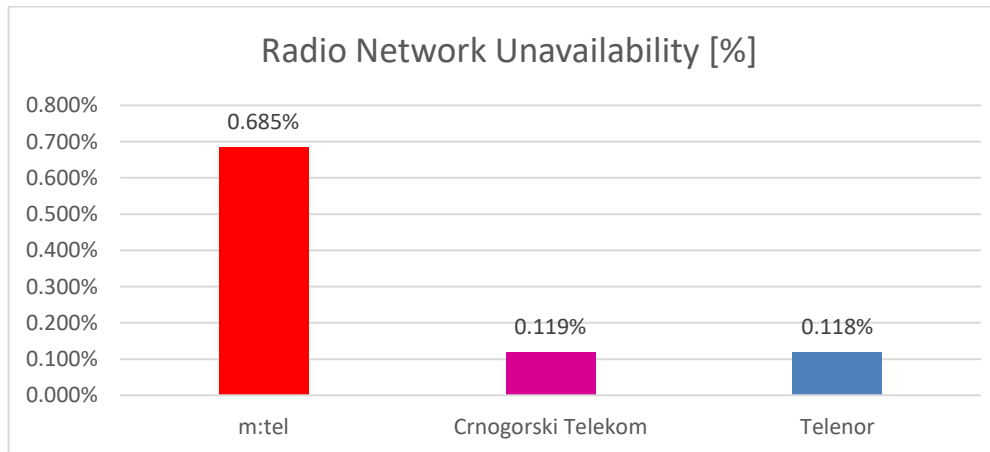
## TELEPHONY SERVICE

For Telephony Service 4 parameters have been measured: Radio Network Unavailability, Telephony Service Non-Accessibility, Telephony Setup Time and Telephony Cut-off Call.

**Radio Network Unavailability [%]** - probability that the end user has not been provided with mobile services.

$$\text{Radio Network Unavailability [\%]} = \frac{\text{number of unsuccessful attempts in providing services, i.e. attempts to access mobile network}}{\text{total number of attempts}} * 100$$

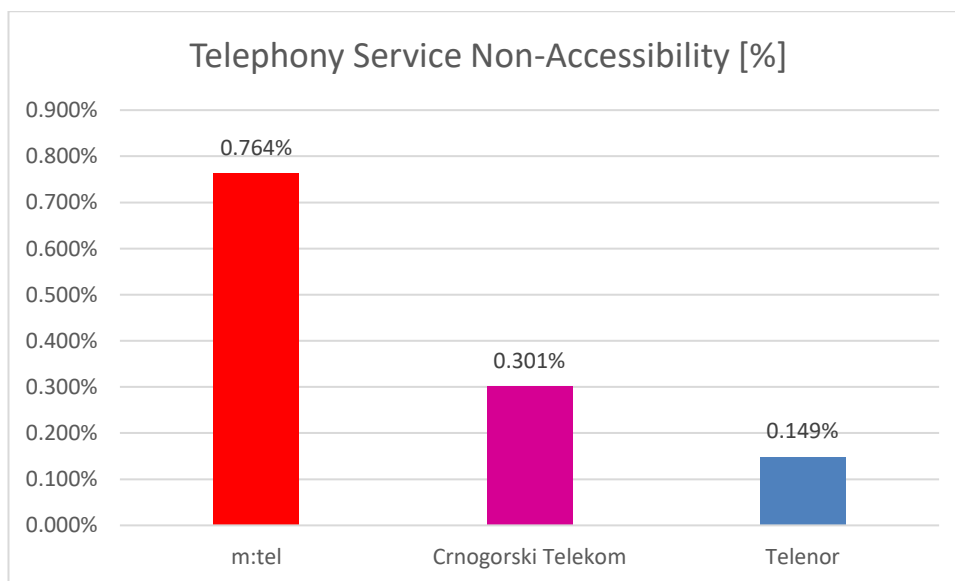
Operator	m:tel	Crnogorski Telekom	Telenor
Successful	3334	3353	3365
Unsuccessful	23	4	4
Total of samples	3357	3358	3369
Failure rate [%]	0,685	0,119	0,118
Interval of reliability of results [%] with confidence level of 99 %	0,37 - 1,14	0,02 - 0,37	0,02 - 0,37



**Telephony Service Non-Accessibility [%]** - probability that the end user cannot setup a call, although there is an indication on the mobile device that telephony service is accessible.

$$\text{Telephony Service Non-Accessibility [\%]} = \frac{\text{number of unsuccessful attempts to setup a call}}{\text{total number of attempts to setup a call}} * 100$$

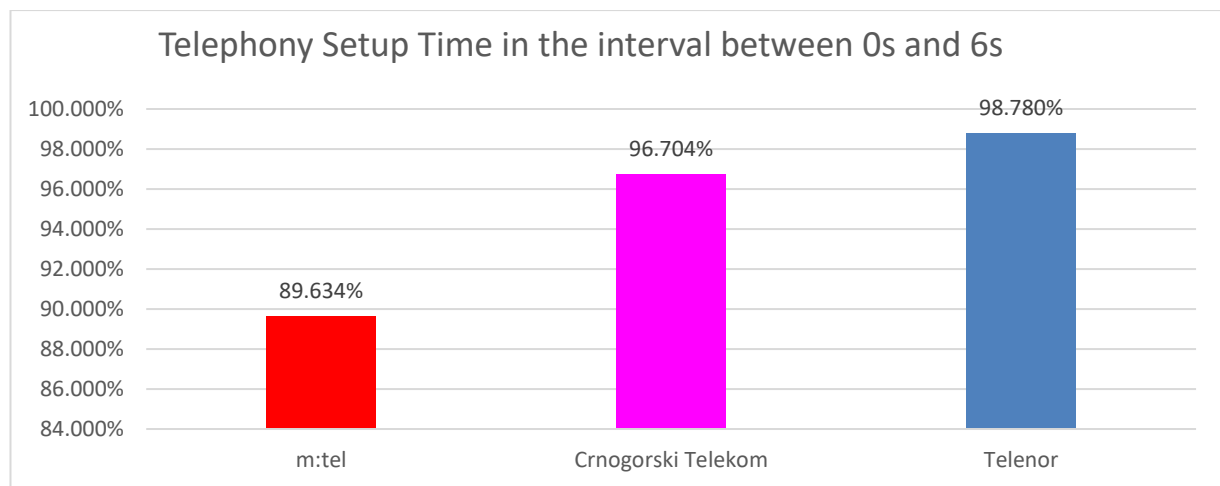
Operator	m:tel	Crnogorski Telekom	Telenor
Successful	3243	3311	3343
Unsuccessful	25	10	5
Total of samples	3268	3321	3348
Failure rate [%]	0,764	0,301	0,149
Interval of reliability of results [%] with confidence level of 99 %	0,43 – 1,25	0,14 – 0,66	0,03 – 0,37



**Telephony Setup Time [s]** – time after the request to setup a call has been sent and the signal on setting up the call is received.

Telephony Setup Time [s] = (time for setting up a call – time for sending request to setup a call) [s]

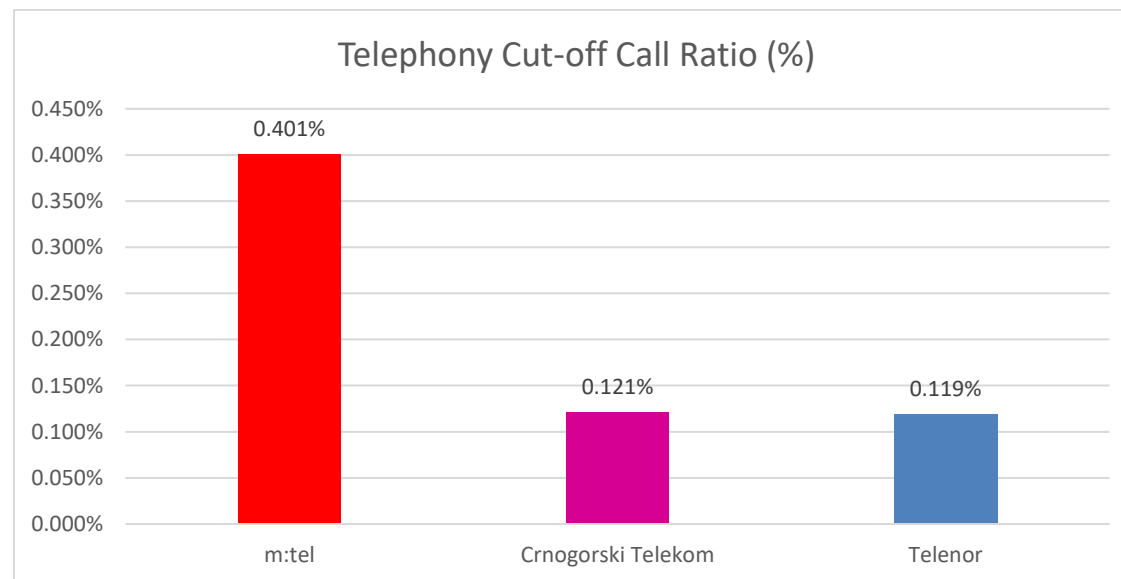
Operator	m:tel	Crnogorski Telekom	Telenor
<b>Telephony Setup Time in the interval between 0s and 6s</b>	2603	3140	3240
<b>Telephony Setup Time longer than 6s</b>	301	107	40
<b>Total of samples</b>	2904	3247	3280
<b>Rate of the calls setup in the interval between 0s and 6s [%]</b>	89,634	96,704	98,78
<b>Interval of reliability of results [%] with confidence level of 99 %</b>	88,10 – 91,04	95,81 – 97,46	98,20 – 99,22



**Telephony Cut-off Call [%]** – probability that a successful attempt in setting up a call is cut-off, when the cut-off has not been initiated neither by the user who made a call and/nor by the user who received a call.

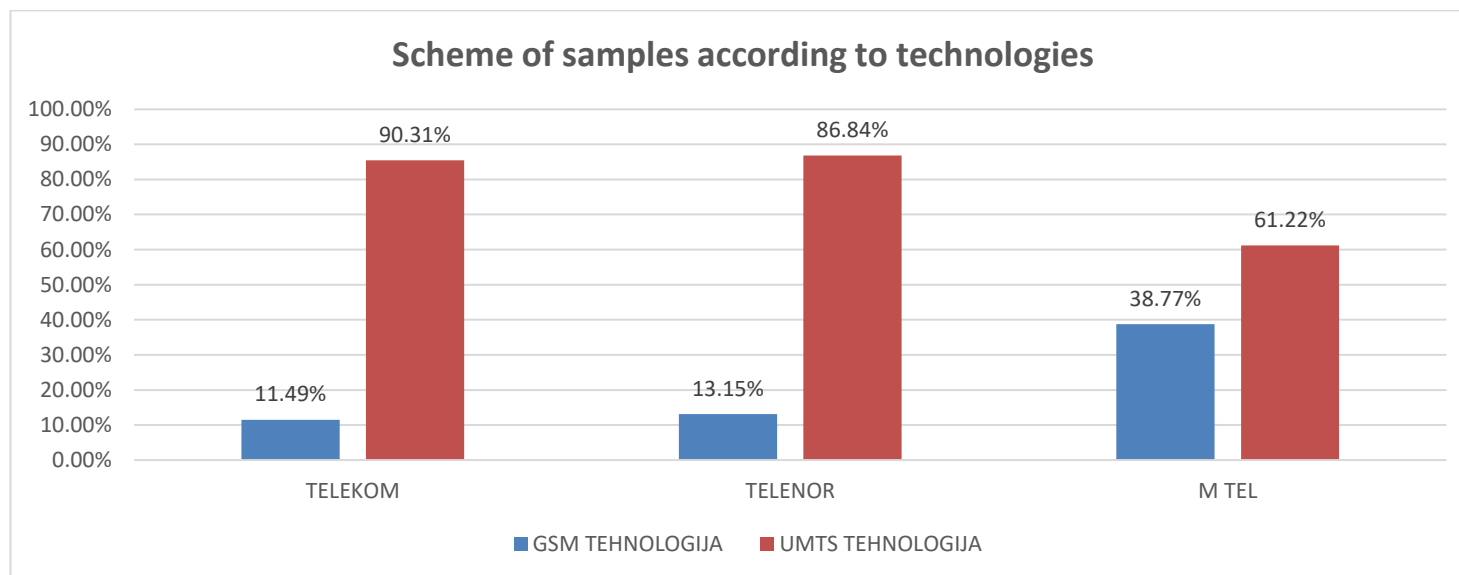
$$\text{Telephony Cut-off Call Ratio [\%]} = \frac{\text{number of calls unintentionally cut-off}}{\text{number of calls successfully setup}} * 100$$

Operator	m:tel	Crnogorski Telekom	Telenor
<b>Successful</b>	3222	3300	3335
<b>Unsuccessful</b>	13	4	4
<b>Total of samples</b>	3235	3304	3339
<b>Failure rate [%]</b>	0,401	0,121	0,119
<b>Interval of results reliability [%] with confidence level of 99 %</b>	0,17 – 0,79	0,02 – 0,38	0,02 – 0,38



Figures showing technologies deployed in telephony service.

OPERATOR	GSM TECHNOLOGY (%)	UMTS TECHNOLOGY (%)
<b>Crnogorski Telekom</b>	11,49	90,31
<b>Telenor</b>	13,57	86,84
<b>m:tel</b>	38,77	61,22



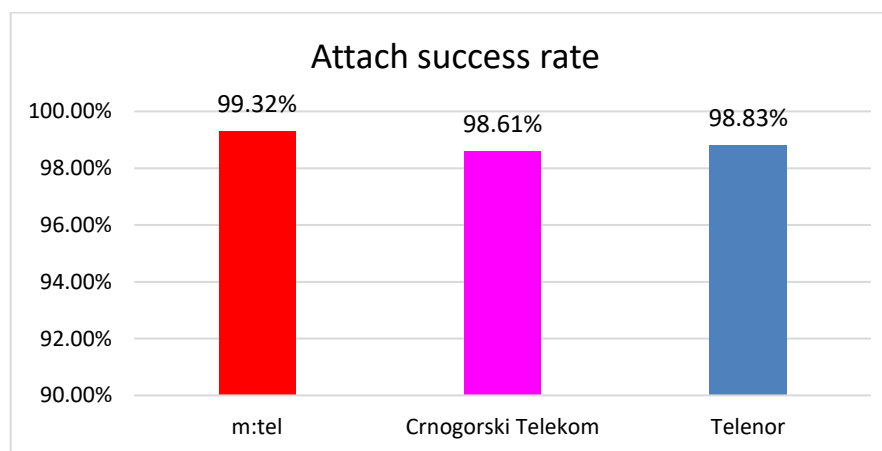
## DATA SERVICE

For data service 12 parameters have been measured: Attach Success Ratio, PDP Context Activation Success Ratio , PDP Context Cut-off Ratio, EPS bearer allocation success ratio, FTP IP-Service Access Success Ratio, FTP {Download|Upload} Data Transfer Cut-off Ratio, HTTP browsing IP-Service Access Success Ratio, HTTP browsing Data Transfer Cut-off Ratio, FTP data rate download, FTP mean data rate download per session, FTP data rate upload, FTP mean data rate upload per session.

Attach Success Ratio) [%] – probability that the user can be attached to the Packet Service Network (PS Network).

$$\text{Attach Success Ratio [\%]} = \frac{\text{number of successful attaches to the PS Network}}{\text{total number of attempts to attach to the PS Network}} * 100$$

Operator	m:tel	Crnogorski Telekom	Telenor
Successful	3057	3057	2949
Unsuccessful	21	43	35
Total of samples	3078	3100	2984
Success rate [%]	99,32	98,61	98,83
Interval of results reliability [%] with confidence level of 95 %	98,96-99,58	98,14-98,99	98,37-99,18

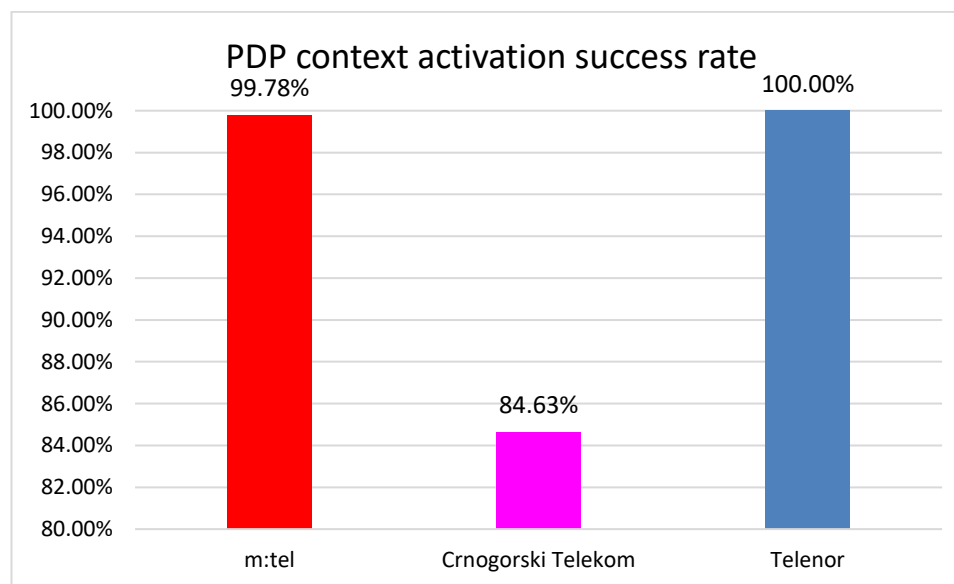




**PDP Context Activation Success [%]** – probability that the PDP (packet data protocol) context can be activated successfully. It refers to GSM and UMTS technologies.

$$\text{PDP Context Activation Success Ratio [\%]} = \frac{\text{number of PDP contexts successfully activated}}{\text{number of attempts to activate PDP contexts}} * 100$$

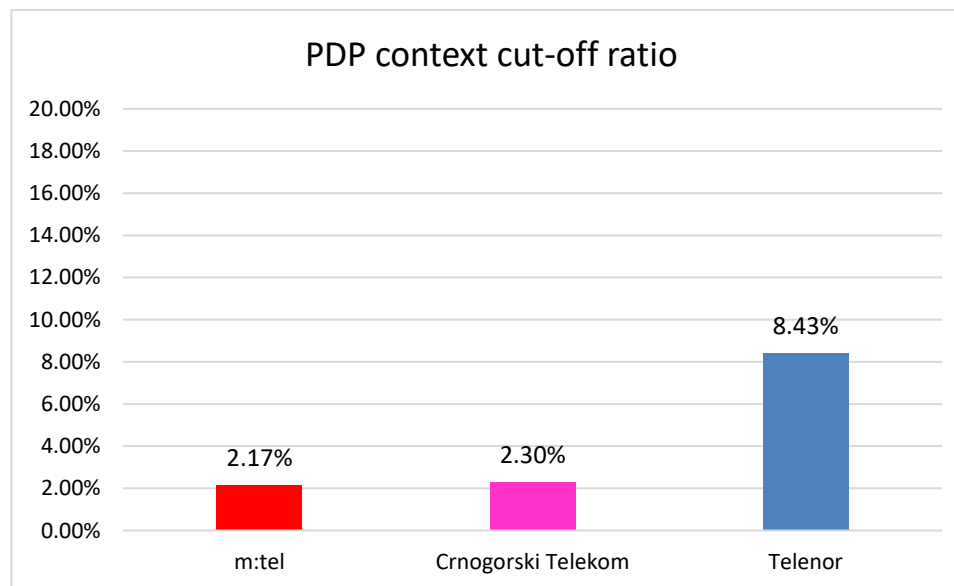
Operator	m:tel	Crnogorski Telekom	Telenor
Successful	461	435	178
Unsuccessful	0	79	0
Total of samples	462	514	178
Success rate [%]	99,78	84,63	100,00
Interval of results reliability [%] with confidence level of 95 %	98,80-99,99	81,22-87,64	97,95-100



PDP Context Cut-off) [%] – probability that the PDP context has been deactivated while the user hasn't started the procedure of deactivation. It refers to GSM and UMTS technologies.

$$\text{PDP Context Cut-off Ratio Ratio [\%]} = \frac{\text{number of PDP context cut-offs}}{\text{number of PDP contexts successfully setup}} * 100$$

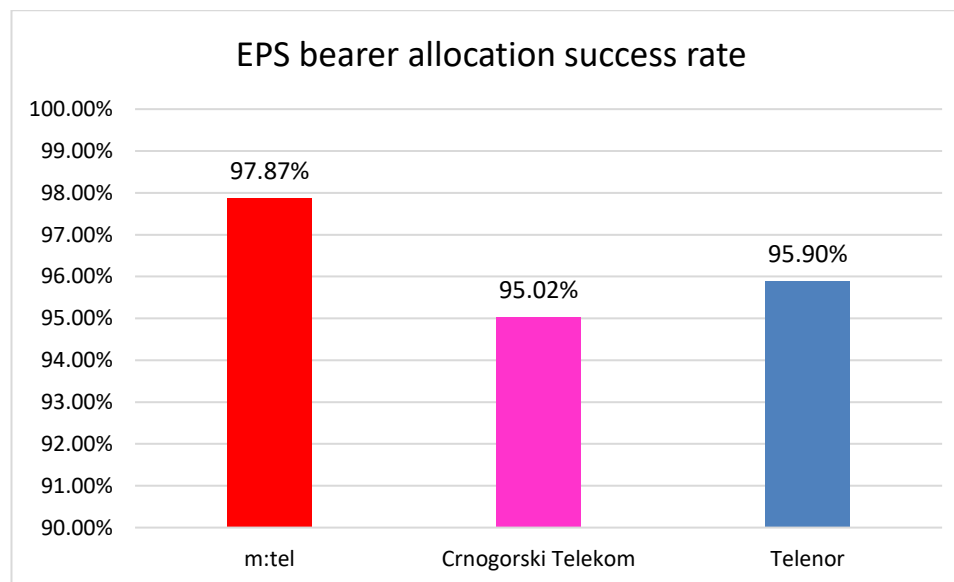
Operator	m:tel	Crnogorski Telekom	Telenor
Successful	461	435	178
Unsuccessful	10	10	15
Failure rate [%]	2,17	2,30	8,43
Interval of results reliability [%] with confidence level of 95 %	1,04-3,95	1,11-4,19	4,79-13,52



EPS bearer allocation success [%] – success in establishing default and dedicated EPS bearers. This parameter refers only to LTE technology.

$$\text{EPS bearer allocation success rate [\%]} = \frac{\text{number of successfully established EPS bearers}}{\text{number of attempts in establishing EPS bearers}} * 100$$

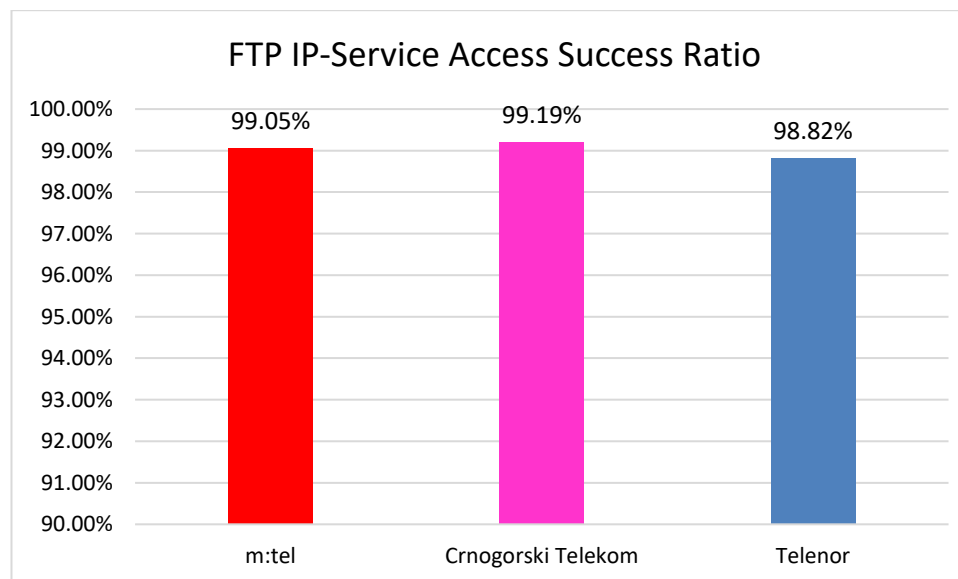
Operator	m:tel	Crnogorski Telekom	Telenor
Successful	2615	2653	2808
Unsuccessful	57	139	120
Total of samples	2672	2792	2928
Success rate [%]	97,87	95,02	95,90
Interval of reliability of results [%] with confidence level of 95 %	97,24-98,38	94,15-95,80	95,12-96,59



**FTP IP-Service Access Success, Method B (Server connection setup success rate) [%]** – probability that the user has successfully setup TCP/IP session with the server. It is measured jointly for upload and download.

$$\text{FTP IP-Service Access Success Ratio [\%]} = \frac{\text{number of sessions successfully setup}}{\text{number of attempts in setting up sessions}} * 100$$

Operator	m:tel	Crnogorski Telekom	Telenor
Successful	5837	5913	5851
Unsuccessful	56	48	69
Total of samples	5893	5961	5921
Success rate [%]	99,05	99,19	98,82
Interval of reliability of results [%] with confidence level of 95 %	98,77-99,28	98,93-99,41	98,51-99,08

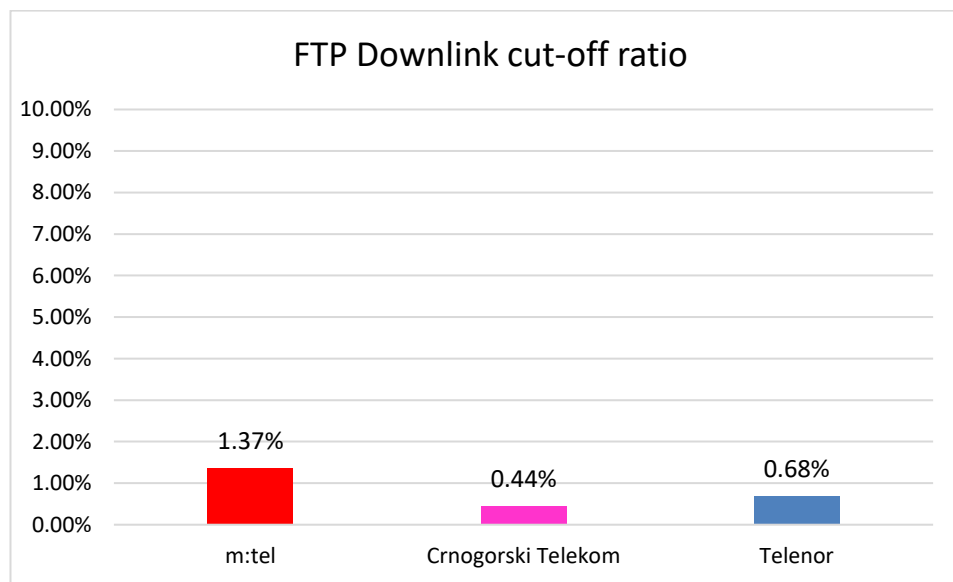


FTP {Download|Upload} Data Transfer Cut-off) [%] – probability that downlink/uplink data transfer is cut-off without intention of the user to do so. Measuring the parameter starts with the first request for sending data, after the connection with the server has been established. Measuring the parameter is completed upon receiving the last data packet.

$$\text{FTP \{Download|Upload\} Data Transfer Cut-off Ratio [\%]} = \frac{\text{number of data transfers completed unsuccessfully}}{\text{number of data transfers successfully setup}} * 100$$

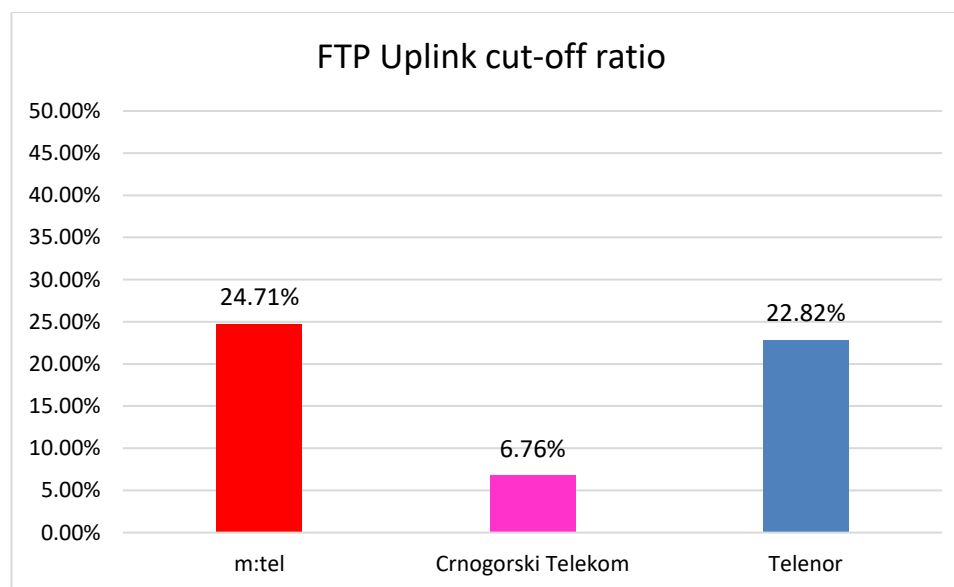
**FTP Download:**

Operator	m:tel	Crnogorski Telekom	Telenor
Successful	2852	2925	2922
Unsuccessful	39	13	20
Failure rate [%]	1,37	0,44	0,68
Interval of reliability of results [%] with confidence level of 95 %	0,97-1,86	0,24-0,76	0,42-1,06



## FTP Upload:

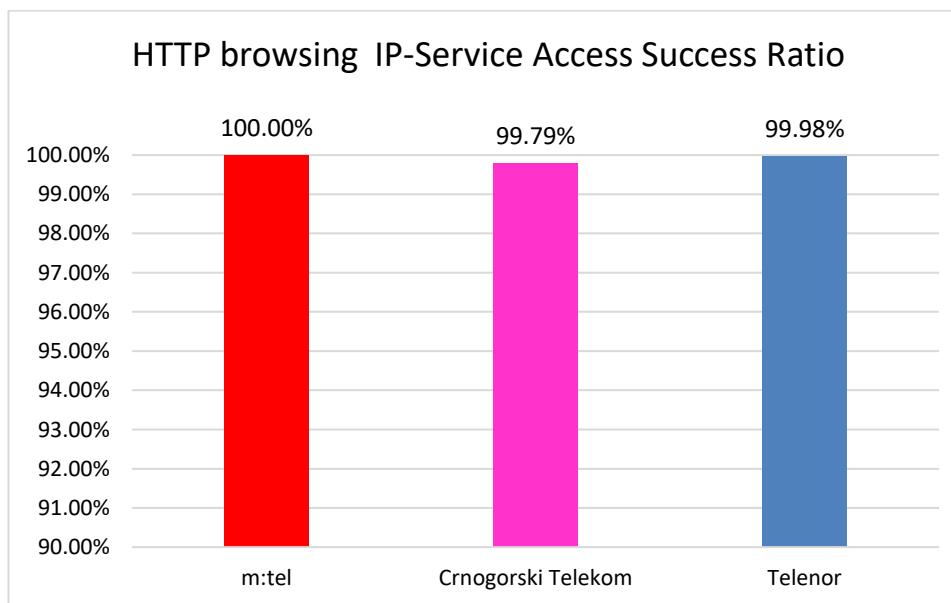
Operator	m:tel	Crnogorski Telekom	Telenor
Successful	2983	2988	2927
Unsuccessful	737	202	668
Failure rate [%]	24,71	6,76	22,82
Interval of reliability of results [%] with confidence level of 95 %	23,17-26,30	5,89-7,72	21,31-24,39



HTTP browsing IP-Service Access Success (Server connection setup success rate) [%] – probability that the user has successfully setup TCP/IP session with the server. It is measured jointly for upload and download.

$$\text{HTTP browsing IP-Service Access Success Ratio [\%]} = \frac{\text{number of sessions successfully setup}}{\text{number of attempts in setting up sessions}} * 100$$

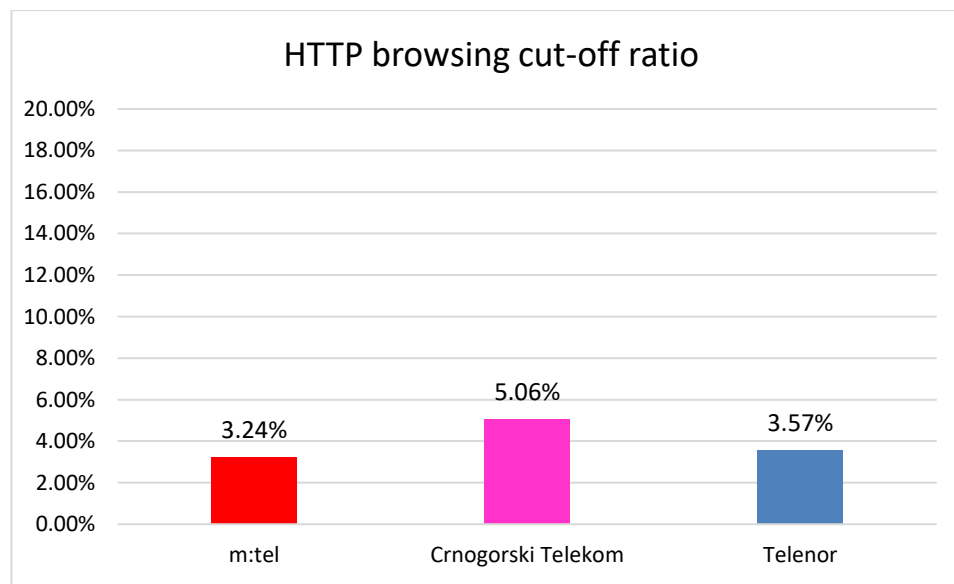
Operator	m:tel	Crnogorski Telekom	Telenor
Successful	4262	4210	4263
Unsuccessful	0	9	1
Total of samples	4262	4219	4264
Success rate [%]	100,00	99,79	99,98
Interval of reliability of results [%] with confidence level of 95 %	99,91-100	99,6-99,9	99,87-100



**HTTP browsing Data Transfer Cut-off [%]** – probability that data transfer is cut-off without intention of the user to do so. Measuring the parameter starts with the first request for sending data, after the connection with the server has been established. Measuring the parameter is completed upon receiving the last data packet.

$$\text{HTTP browsing Data Transfer Cut-off Ratio [\%]} = \frac{\text{number of data transfers completed unsuccessfully}}{\text{number of data transfers successfully commenced}} * 100$$

Operator	m:tel	Crnogorski Telekom	Telenor
Successful	4262	4210	4263
Unsuccessful	138	213	152
Failure rate [%]	3,24	5,06	3,57
Interval of reliability of results [%] with confidence level of 95 %	2,73-3,81	4,42-5,77	3,03-4,17





**FTP data rate download** [Mb/s] – speed of data transfer according to the sample measured within 1 second in the process of file transfer download.

Data given in percentiles\*:

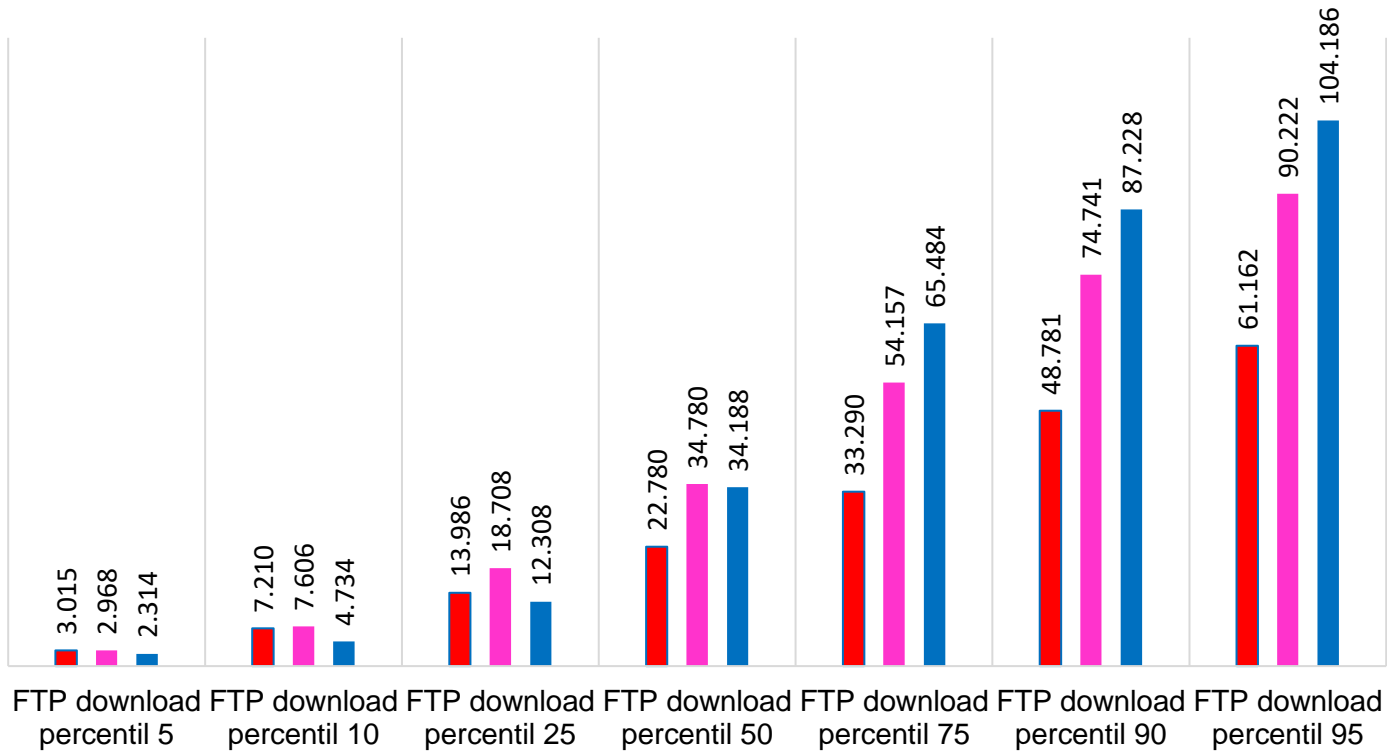
<b>Operator</b>	<b>m:tel [Mb/s]</b>	<b>Crnogorski Telekom [Mb/s]</b>	<b>Telenor [Mb/s]</b>
<b>percentile 5</b>	3.015	2.968	2.314
<b>percentile 10</b>	7.210	7.606	4.734
<b>percentile 25</b>	13.986	18.708	12.308
<b>percentile 50</b>	22.780	34.780	34.188
<b>percentile 75</b>	33.290	54.157	65.484
<b>percentile 90</b>	48.781	74.741	87.228
<b>percentile 95</b>	61.162	90.222	104.186
<b>Total of samples</b>	41 657	42 861	42 739

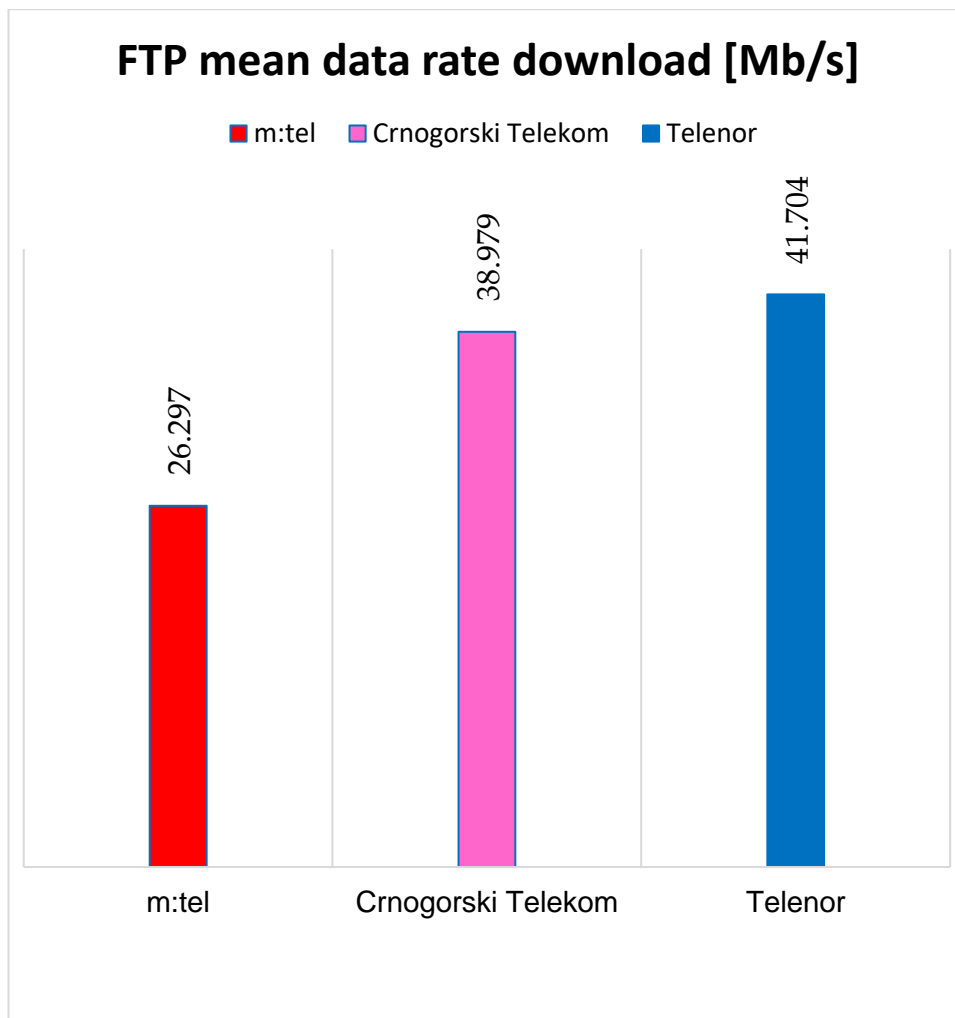
	<b>m:tel</b>	<b>Crnogorski Telekom</b>	<b>Telenor</b>
<b>Mean data rate [Mb/s]</b>	26.297	38.979	41.704

\*The term percentile 10 means that 10% of the samples have their values lower than or equal to the speed given in the Table (in Mb/s).

# FTP data rate download [Mb/s]

m:tel Crnogorski Telekom Telenor





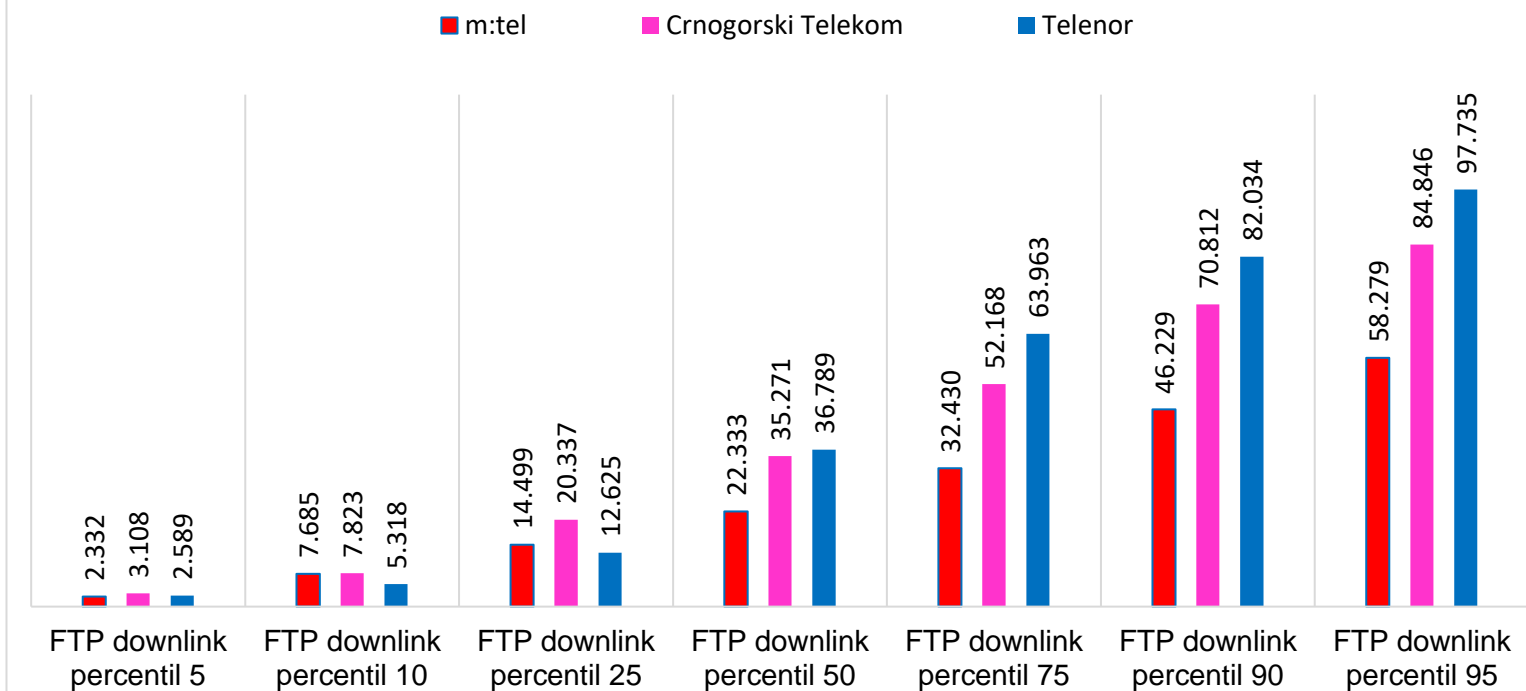
FTP mean data rate download per session) [Mb/s] – mean speed of data transfer measured within one session i.e. of the test file download.

$$\text{FTP mean data rate download [Mb/s]} = \frac{\text{size of downloaded data (of the test file)}}{\text{(time of completion of the file download - time of commencement of the file download) [s]}}$$

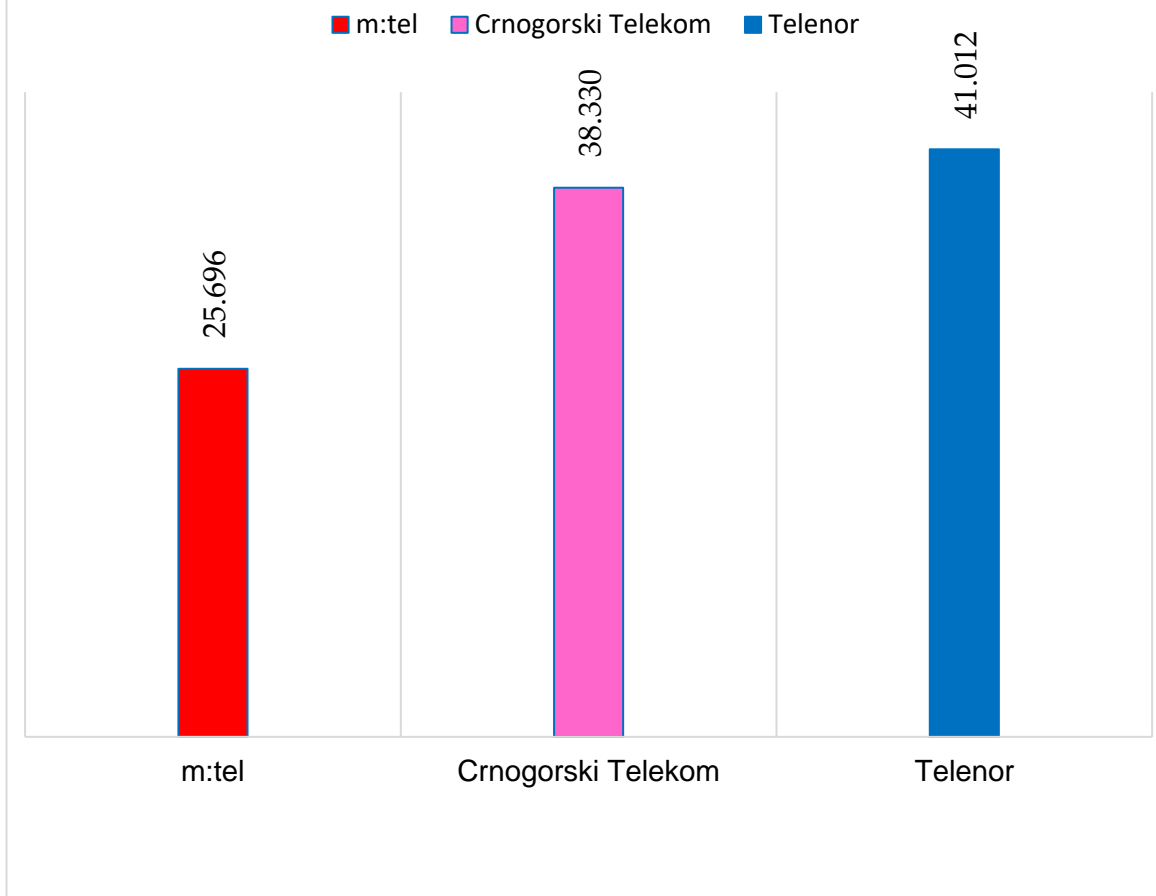
Operator	m:tel [Mb/s]	Crnogorski Telekom [Mb/s]	Telenor [Mb/s]
percentile 5	2.332	3.108	2.589
percentile 10	7.685	7.823	5.318
percentile 25	14.499	20.337	12.625
percentile 50	22.333	35.271	36.789
percentile 75	32.430	52.168	63.963
percentile 90	46.229	70.812	82.034
percentile 95	58.279	84.846	97.735
Total of samples	2820	2892	2884

	m:tel	Crnogorski Telekom	Telenor
Mean data rate per session [Mb/s]	25.696	38.330	41.012

## FTP mean data rate download per session [Mb/s]



## FTP mean data rate download per session [Mb/s]



**FTP data rate upload** [Mb/s] – Speed of data transfer according to the sample measured within 1 second in the process of the file transfer upload.

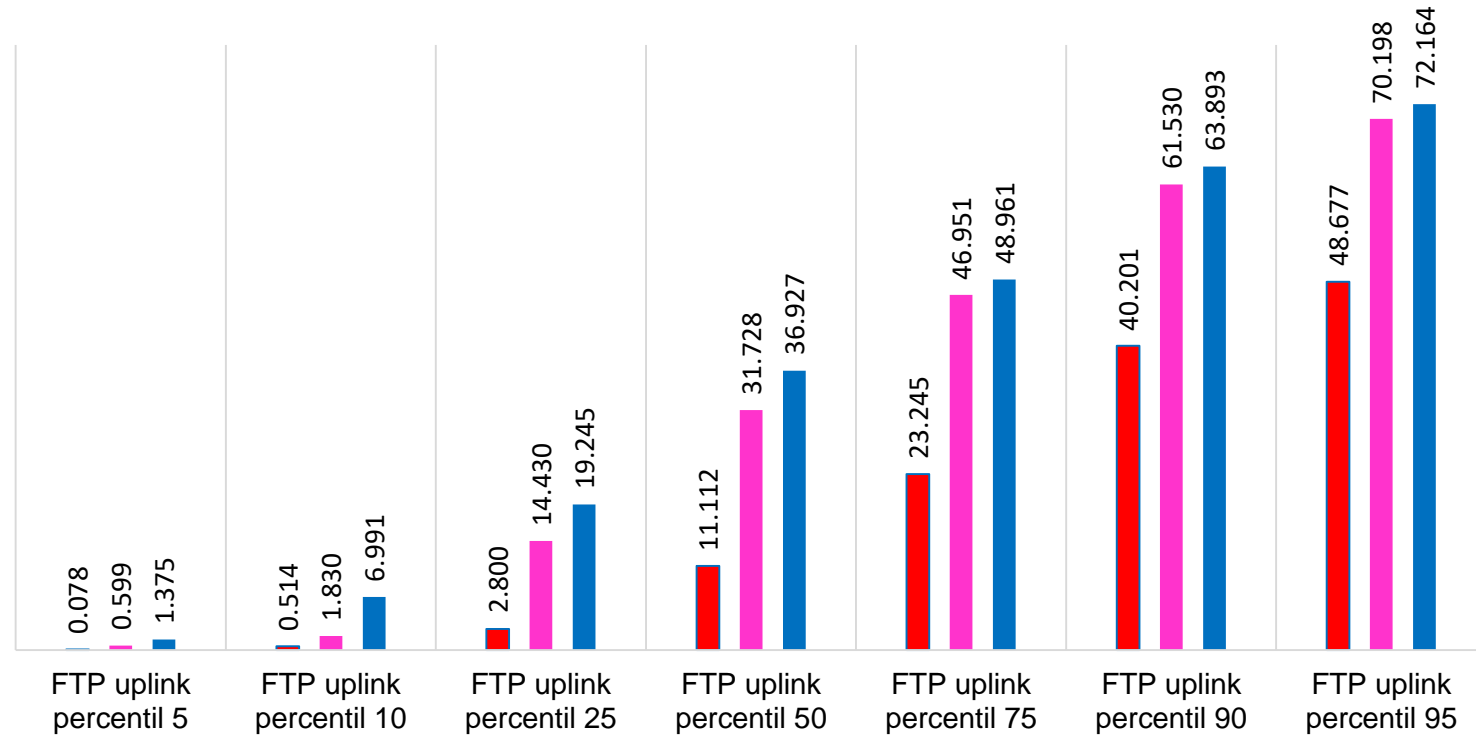
-Data given in percentiles:

<b>Operator</b>	<b>m:tel [Mb/s]</b>	<b>Crnogorski Telekom [Mb/s]</b>	<b>Telenor [Mb/s]</b>
<b>percentile 5</b>	0.078	0.599	1.375
<b>percentile 10</b>	0.514	1.830	6.991
<b>percentile 25</b>	2.800	14.430	19.245
<b>percentile 50</b>	11.112	31.728	36.927
<b>percentile 75</b>	23.245	46.951	48.961
<b>percentile 90</b>	40.201	61.530	63.893
<b>percentile 95</b>	48.677	70.198	72.164
<b>Total of samples</b>	20100	33218	25816

	<b>m:tel</b>	<b>Crnogorski Telekom</b>	<b>Telenor</b>
<b>Mean data rate upload [Mb/s]</b>	15.793	31.820	35.755

## FTP data rate upload [Mb/s]

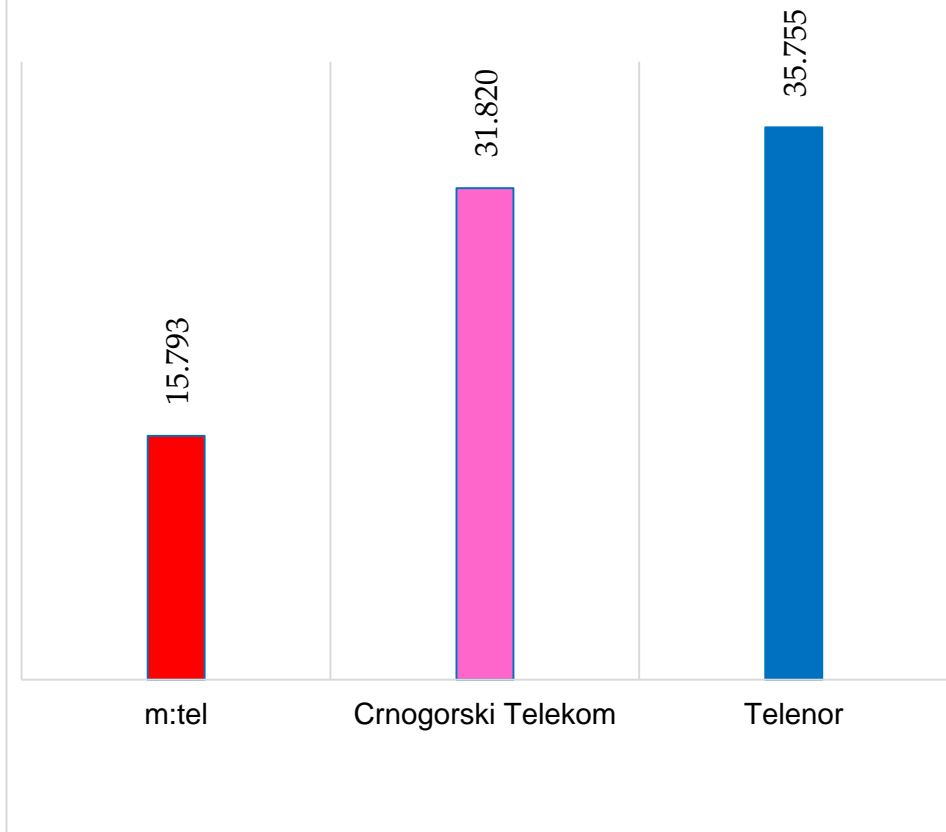
■ m:tel ■ Crnogorski Telekom ■ Telenor





## FTP mean data rate upload [Mb/s]

■ m:tel ■ Crnogorski Telekom ■ Telenor



FTP mean data rate upload per session [Mb/s] – mean speed of data transfer measured within one session i.e. of the test file upload.

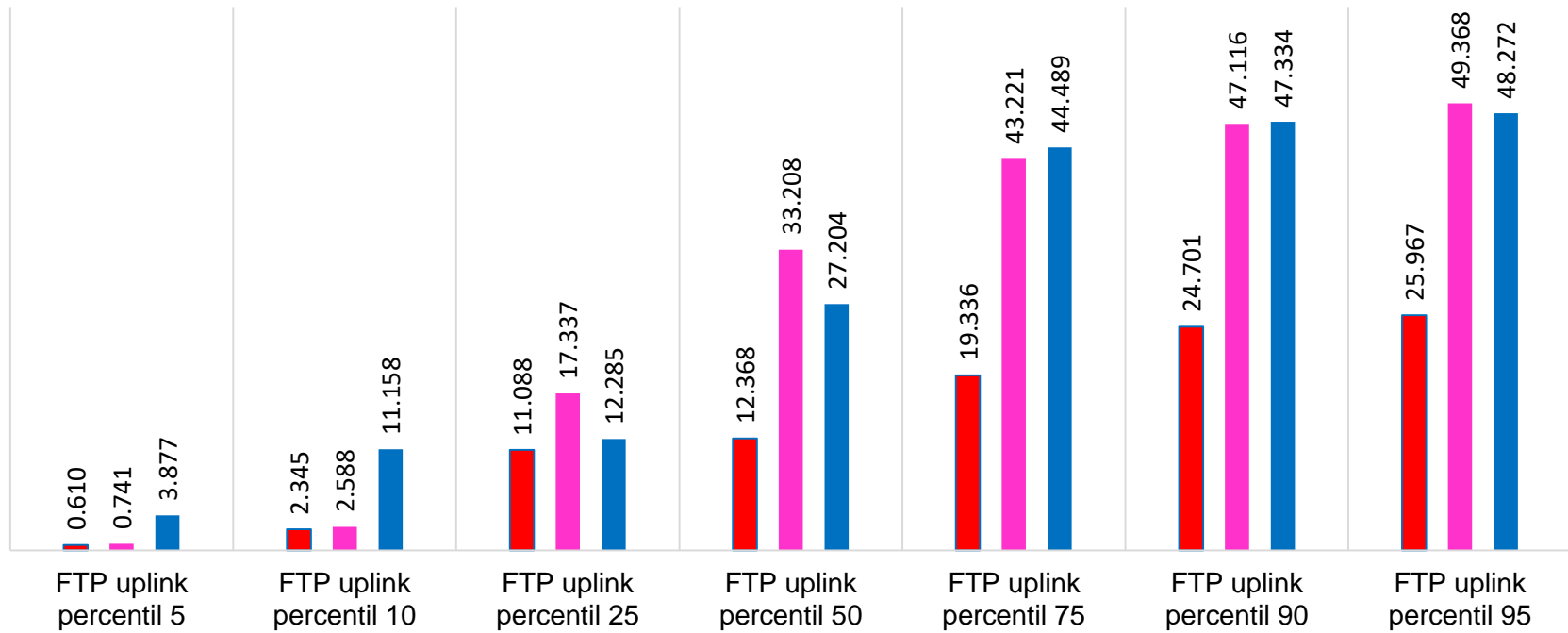
$$\text{FTP Mean Data Rate upload [Mb/s]} = \frac{\text{size of uploaded data (of test file)}}{\text{(time of completion of the file upload – time of commencement of the file upload)}}$$

Operator	m:tel [Mb/s]	Crnogorski Telekom [Mb/s]	Telenor [Mb/s]
percentile 5	0.610	0.741	3.877
percentile 10	2.345	2.588	11.158
percentile 25	11.088	17.337	12.285
percentile 50	12.368	33.208	27.204
percentile 75	19.336	43.221	44.489
percentile 90	24.701	47.116	47.334
percentile 95	25.967	49.368	48.272
Total of samples	2947	2956	2890

	m:tel	Crnogorski Telekom	Telenor
Mean data rate upload per session [Mb/s]	14.521	29.579	28.279

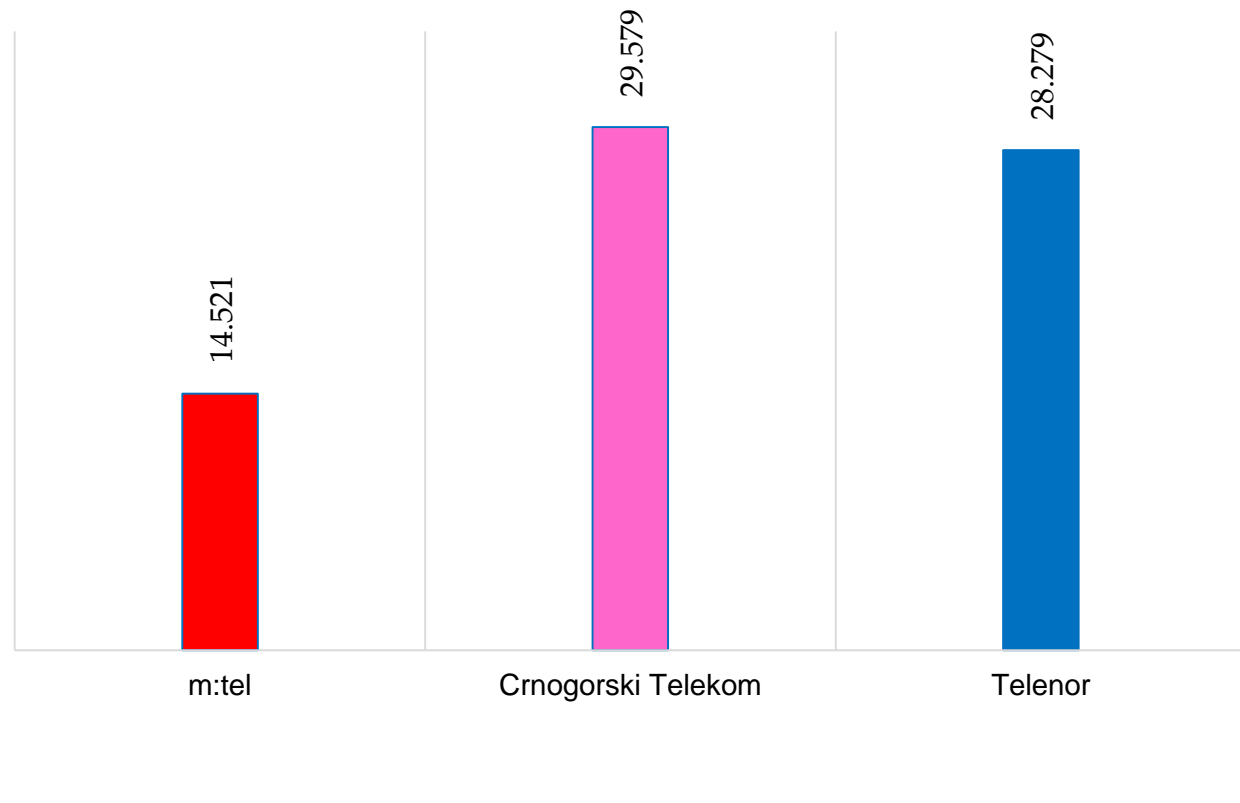
## FTP mean data rate upload per session[Mb/s]

m:tel Crnogorski Telekom Telenor



## FTP mean data rate upload per session [Mb/s]

■ m:tel ■ Crnogorski Telekom ■ Telenor



Figures showing technologies deployed for data transfer.

Deployment of technologies	m:tel	Crnogorski Telekom	Telenor
2G (%)	2.6	3.76	1.26
3G (%)	12.25	10.61	5.25
4G (%)	85.14	85.63	93.49

