

# Smartphone Cities

## December 2016

Charts included in the report

## Figure 1: Scorecard

	4G Web browsing speed						4G Download speed		Voice call
	Average speed			Successful loading			Average speed	Speeds over 2Mbit/s	Success rate
	BBC	Amazon	YouTube	BBC	Amazon	YouTube			
EE	4 seconds	2 seconds	1 second	99%	99%	100%	32Mbit/s	99%	98%
O2	5 seconds	2 seconds	1 second	97%	98%	99%	13Mbit/s	90%	97%
Three	4 seconds	2 seconds	1 second	98%	98%	99%	18Mbit/s	93%	99%
Vodafone	4 seconds	2 seconds	1 second	98%	98%	99%	18Mbit/s	95%	99%

Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

Note: Average (mean for download speed and median for web browsing speed) of all tests gathered with 4G as the best bearer.

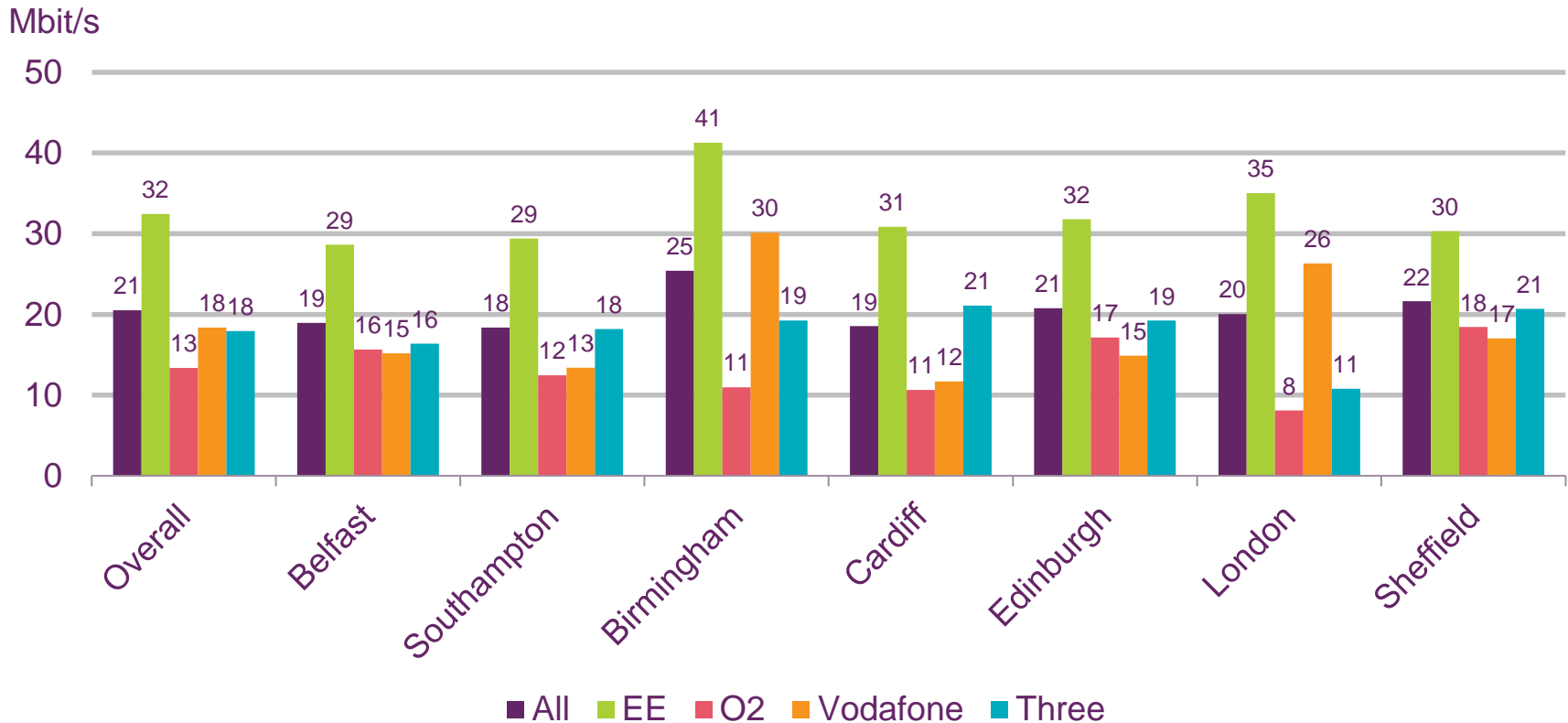
**Figure 2: MVNO network use**

Mobile Network Operators	Examples of MVNOs
EE	BT Mobile, Virgin Mobile
O2	Tesco Mobile, Lyca Mobile
Three	Shebang, iD
Vodafone	Lebara Mobile, Age UK My Phone

	2016	2015
<b>Coverage of mobile data services</b>		
All mobile data: geographic coverage, % landmass	52%	38%
All mobile data: indoor coverage, % of premises	80%	77%
4G: geographic coverage, % landmass	40%	8%
4G: indoor coverage, % of premises	72%	29%
<b>Coverage of mobile voice services</b>		
Geographic coverage, % landmass	66%	58%
Indoor coverage, % of premises	89%	85%

Ofcom Connected Nations 2016

### Figure 3: Average 4G download speed, by city



Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

Note: Average (mean) of all tests gathered with 4G as the best bearer.

**Figure 4: Average 4G download speed: significant differences**

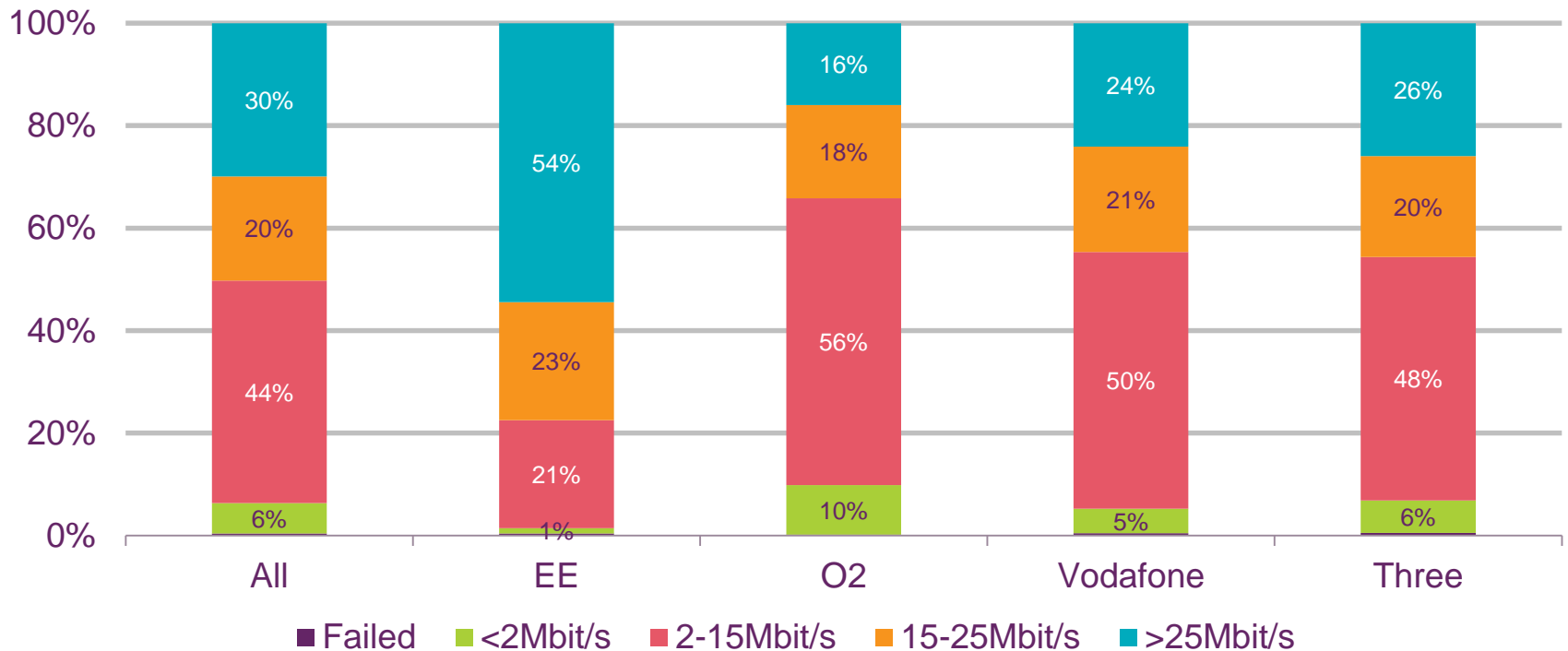
	Fastest	2 <sup>nd</sup> Fastest	3 <sup>rd</sup> Fastest	4 <sup>th</sup> Fastest
Overall	EE	Vodafone, Three (=)	-	O2
Belfast	EE	Three, O2 (=)	-	Vodafone, O2 (=)
Southampton	EE	Three	Vodafone	O2
Birmingham	EE	Vodafone	Three	O2
Cardiff	EE	Three	Vodafone	O2
Edinburgh	EE	Three	O2	Vodafone
London	EE	Vodafone	Three	O2
Sheffield	EE	Three	O2	Vodafone

Source: Ofcom

Note: Differences are significant to a 95% confidence level.

## Figure 5: Distribution of 4G download results; by operator

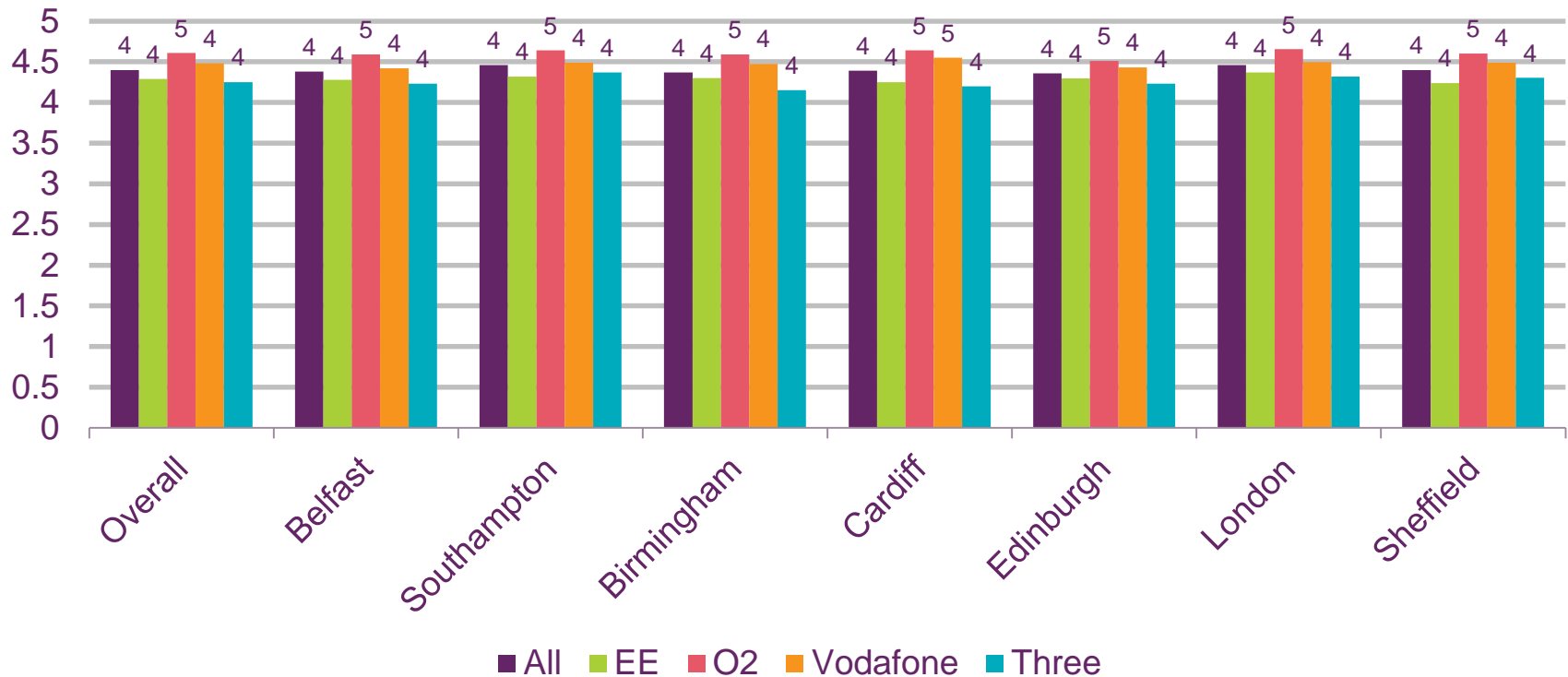
Proportion of samples



Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

## Figure 7: Average 4G BBC homepage load time, by city

seconds



Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

Note: Average (median) of all tests gathered with 4G as the best bearer.



**Figure 8: Average 4G BBC homepage load time: significant differences**

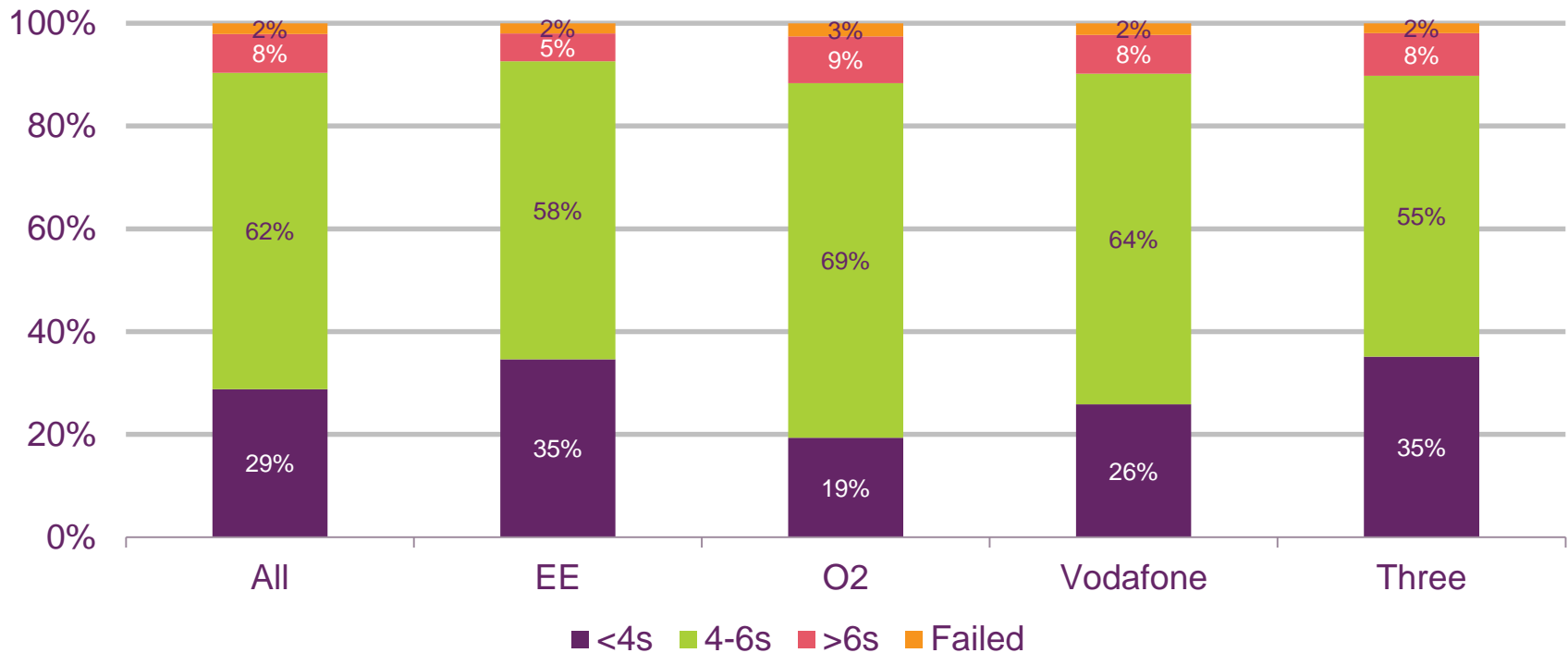
	Fastest	2 <sup>nd</sup> Fastest	3 <sup>rd</sup> Fastest	4 <sup>th</sup> Fastest
Overall	Three	EE	Vodafone	O2
Belfast	EE, Three (=)	-	Vodafone	O2
Southampton	EE, Three (=)	-	Vodafone	O2
Birmingham	Three	EE	Vodafone	O2
Cardiff	EE, Three (=)	-	Vodafone	O2
Edinburgh	EE, Three (=)	-	Vodafone, O2 (=)	-
London	EE, Three (=)	-	Vodafone	O2
Sheffield	EE, Three (=)	-	Vodafone	O2

Source: Ofcom

Note: Differences are significant to a 95% confidence level.

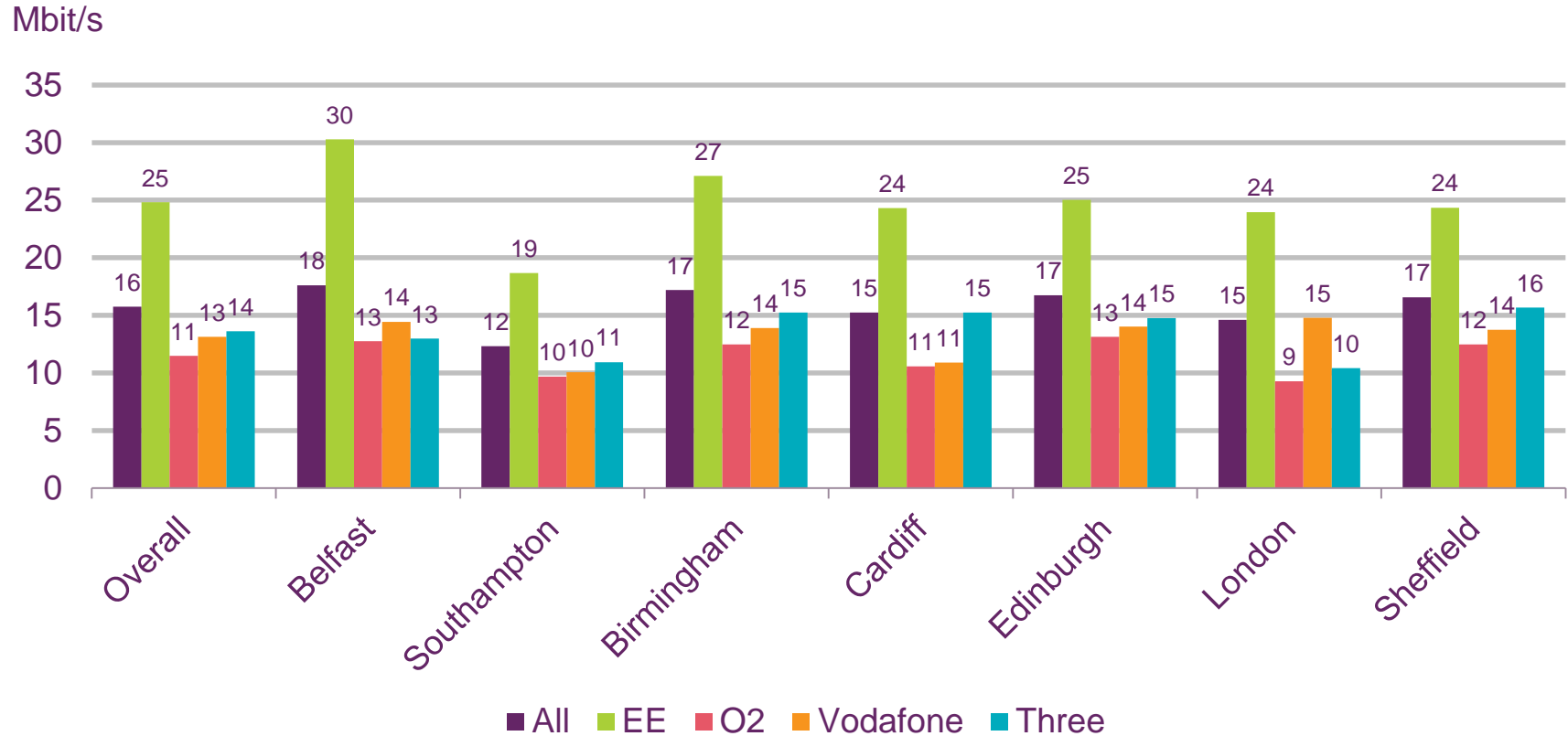
## Figure 9: Distribution of 4G BBC homepage loading time results

Proportion of samples



Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

## Figure 11: Average 4G upload speed, by city



Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

Note: Average (mean) of all tests gathered with 4G as the best bearer.

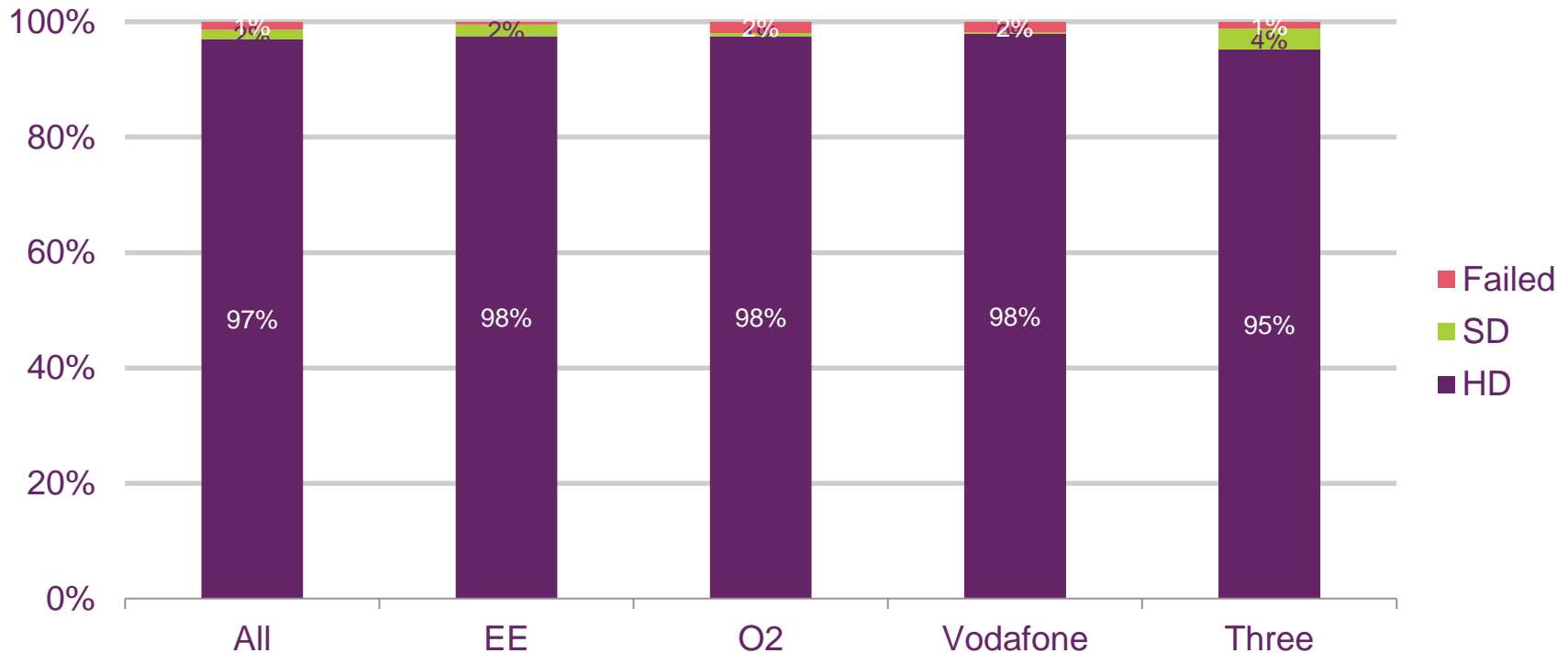
**Figure 12: Average 4G upload speed: significant differences**

	Fastest	2 <sup>nd</sup> Fastest	3 <sup>rd</sup> Fastest	4 <sup>th</sup> Fastest
Overall	EE	Three	Vodafone	O2
Belfast	EE	Vodafone	Three, O2 (=)	-
Southampton	EE	Three	O2, Vodafone (=)	-
Birmingham	EE	Three	Vodafone	O2
Cardiff	EE	Three	O2, Vodafone (=)	-
Edinburgh	EE	Three	Vodafone	O2
London	EE	Vodafone	Three	O2
Sheffield	EE	Three	Vodafone	O2

Source: Ofcom

Note: Differences are significant to a 95% confidence level.

## Figure 13: Video streaming resolution on 4G

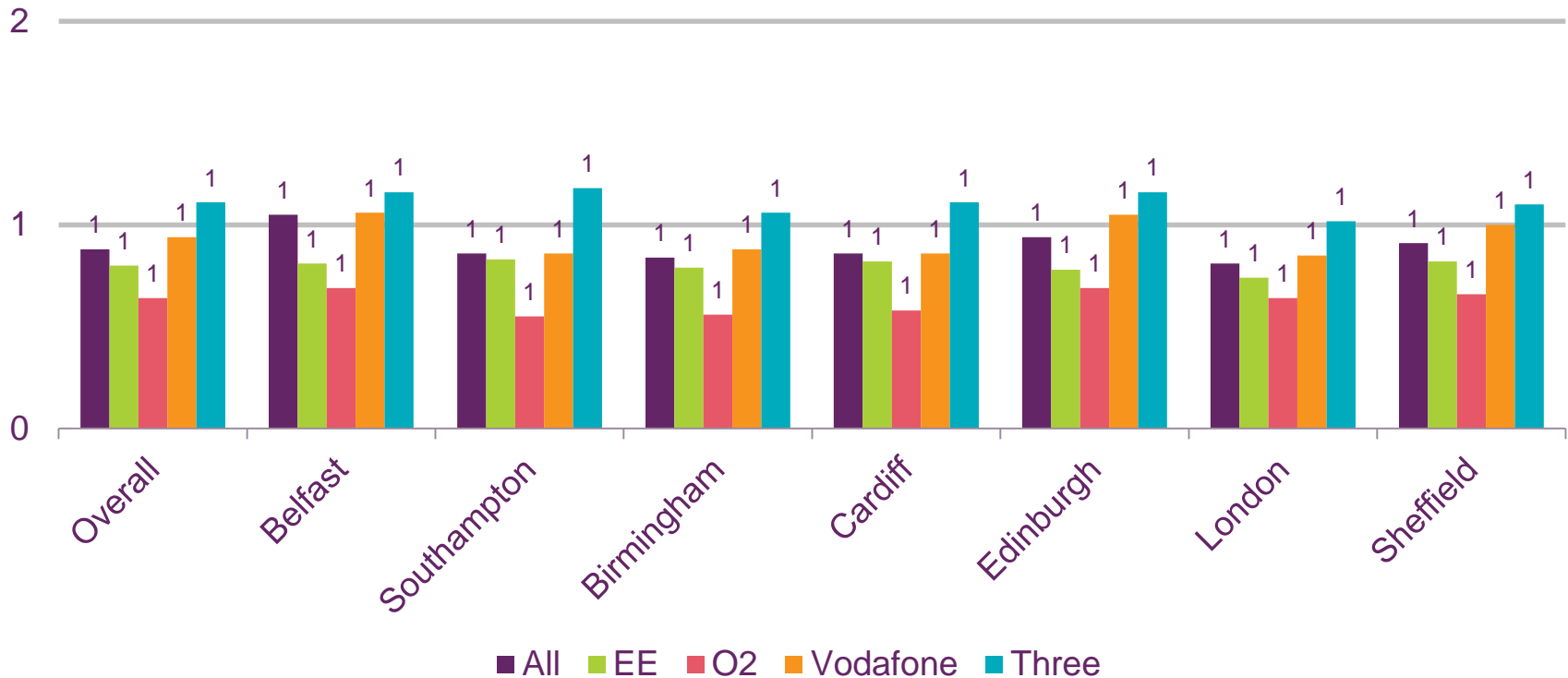


Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

Note: Proportion of all tests gathered with 4G as the best bearer. HD videos here have a resolution of 720p and SD videos have a resolution of 360p.

## Figure 14: Average 4G standard web page load time

seconds



Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

Note: Average (median) of all tests gathered with 4G as the best bearer.

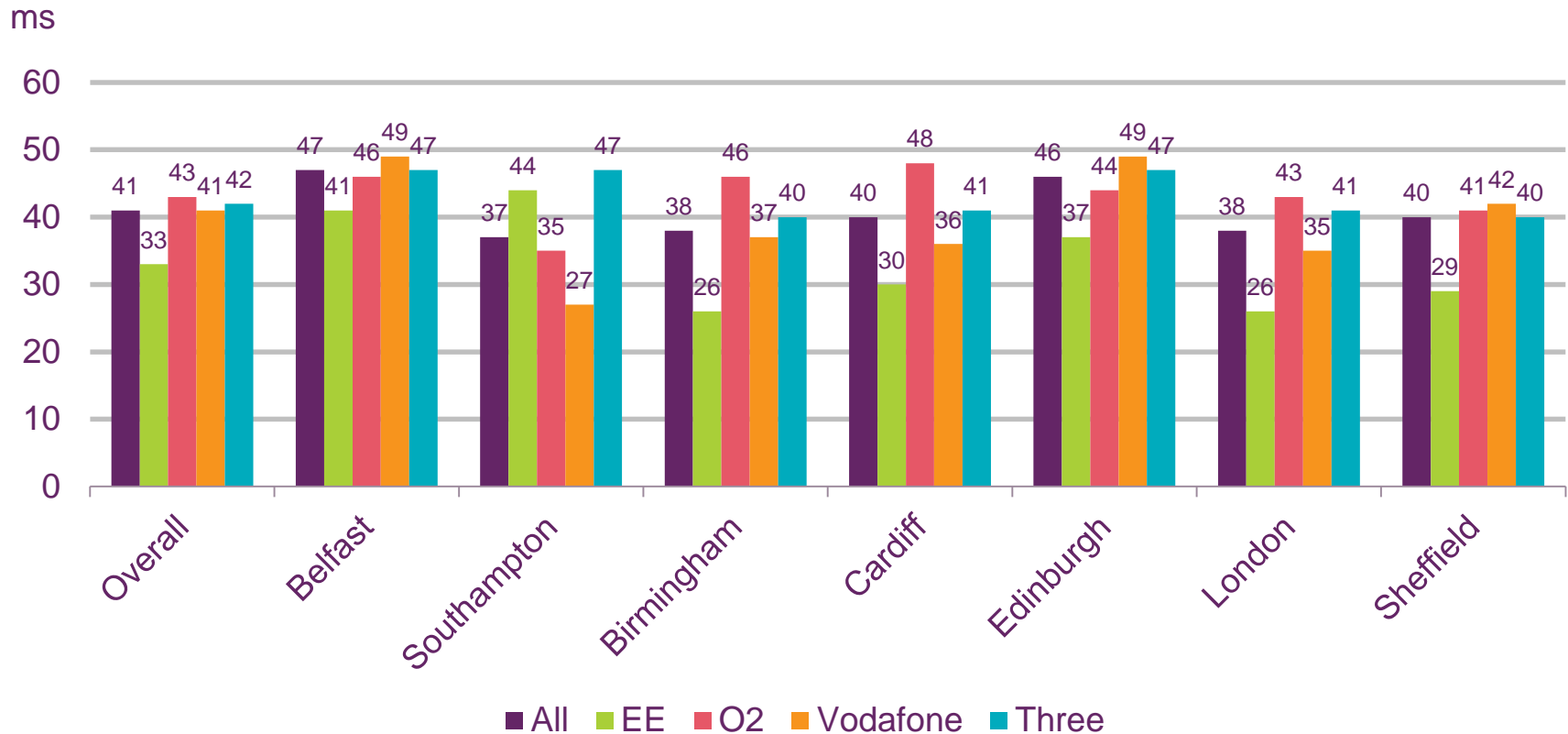
**Figure 15: Average 4G standard web page load time: significant differences**

	Fastest	2 <sup>nd</sup> Fastest	3 <sup>rd</sup> Fastest	4 <sup>th</sup> Fastest
Overall	O2	EE	Vodafone	Three
Belfast	O2	EE	Vodafone	Three
Southampton	O2	EE	Vodafone	Three
Birmingham	O2	EE	Vodafone	Three
Cardiff	O2	EE	Vodafone	Three
Edinburgh	O2	EE	Vodafone	Three
London	O2	EE	Vodafone	Three
Sheffield	O2	EE	Vodafone	Three

Source: Ofcom

Note: Differences are significant to a 95% confidence level.

## Figure 16: Average 4G response time



Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

Note: Average (median) of all 32 byte ping tests gathered with 4G as the best bearer.



**Figure 17: Average 4G response time: significant differences**

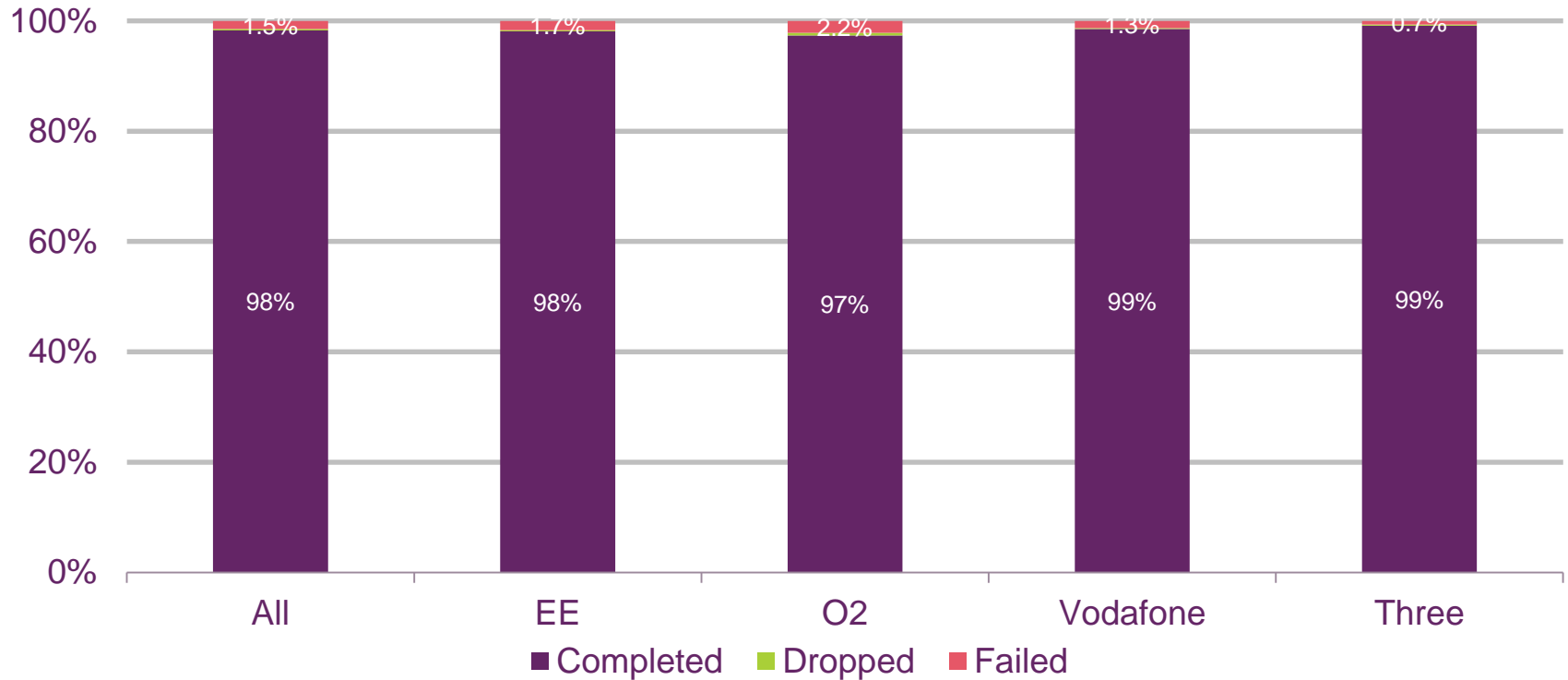
	Fastest	2 <sup>nd</sup> Fastest	3 <sup>rd</sup> Fastest	4 <sup>th</sup> Fastest
Overall	EE	Vodafone	Three	O2
Belfast	EE	O2	Three	Vodafone
Southampton	Vodafone	O2	EE	Three
Birmingham	EE	Vodafone	Three	O2
Cardiff	EE	Vodafone	Three	O2
Edinburgh	EE	O2	Three	Vodafone
London	EE	Vodafone	Three	O2
Sheffield	EE	Three	O2	Vodafone

Source: Ofcom

Note: Differences are significant to a 95% confidence level.

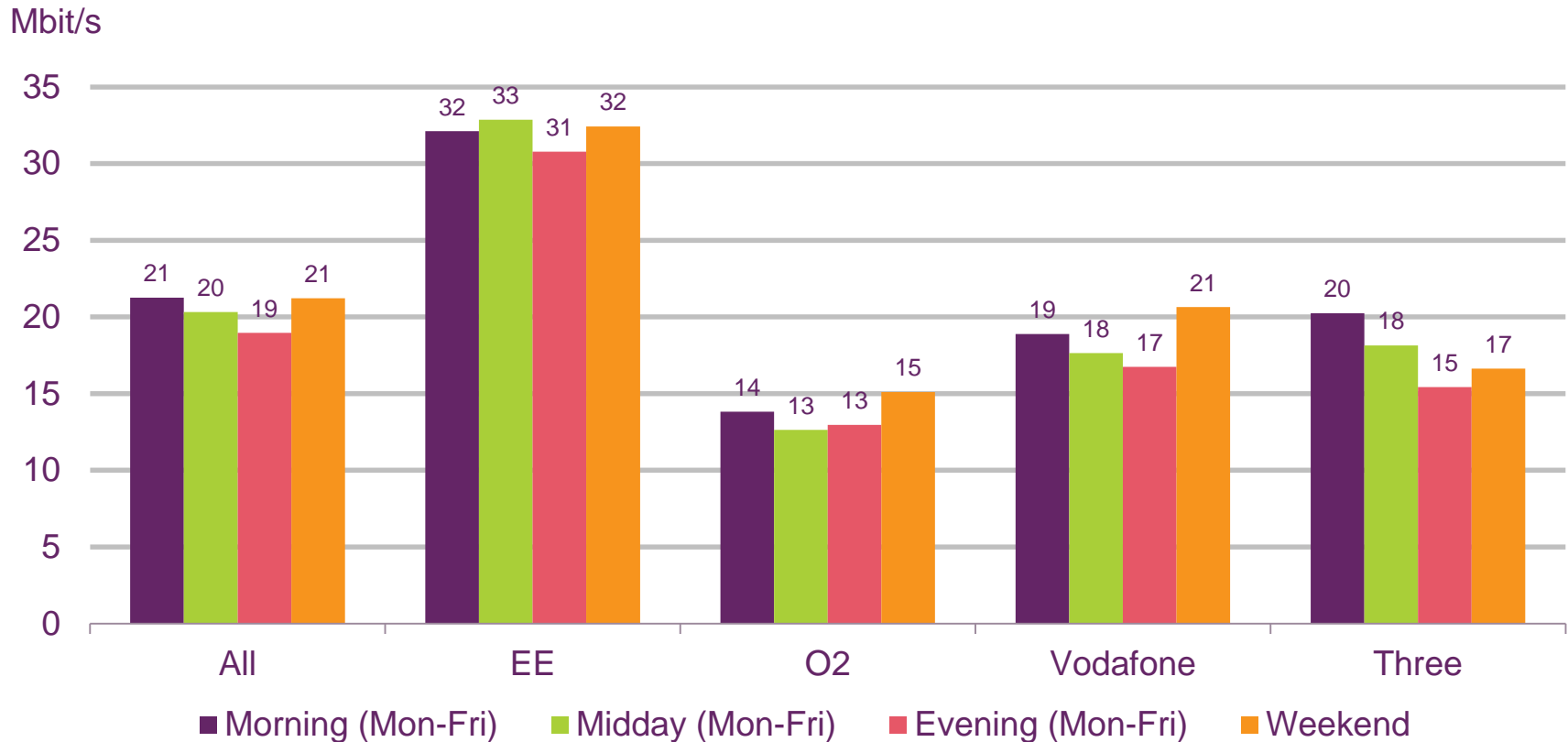
## Figure 18: Call success rate

Proportion of samples



Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

**Figure 19: Average 4G download speed, by MNO and time of day**



Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

Note: Average (mean) of all tests gathered with 4G as the best bearer. Morning is 7am to 10am, midday is 10am to 4.30pm and evening is 4.30pm to 8pm.

**Figure 20: Average 4G download speed, by MNO and time of day: significant differences**

	Fastest	2 <sup>nd</sup> Fastest	3 <sup>rd</sup> Fastest	4 <sup>th</sup> Fastest
Overall	Weekend, Morning (=)	-	Midday	Evening
EE	Weekend, Morning, Midday (=)	-	Evening, Morning (=)	-
O2	Weekend	Morning, Evening (=)	-	Midday
Vodafone	Weekend	Morning	Midday, Evening (=)	-
Three	Morning	Midday	Weekend	Evening

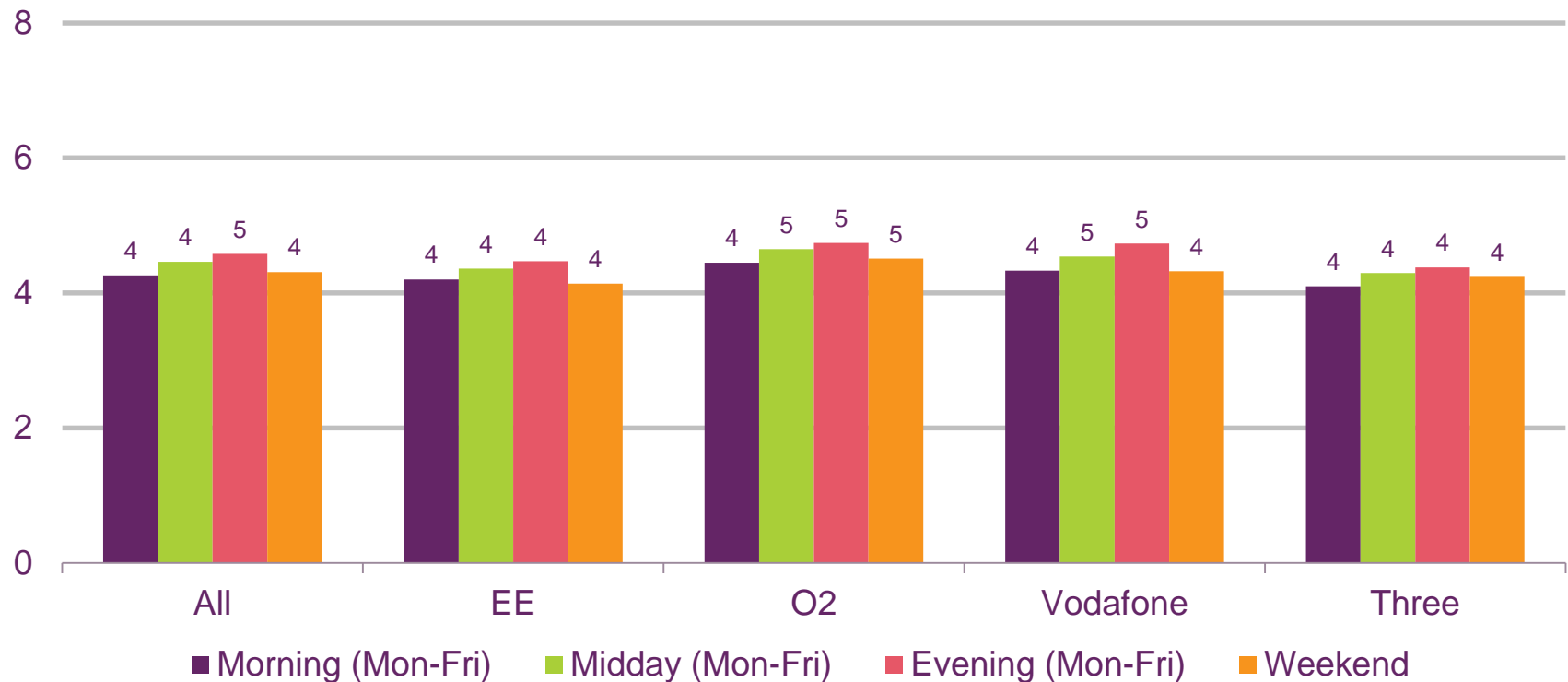
Source: Ofcom

Note: Differences are significant to a 95% confidence level. Morning is 7am to 10am, midday is 10am to 4.30pm and evening is 4.30pm to 8pm (all Monday to Friday).

Note: For EE, Weekends, Mornings and Midday are all similar, but while Weekends and Midday are significantly higher than Evenings, Mornings are not.

**Figure 21: Average 4G BBC homepage load time, by MNO and time of day**

seconds



Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

Note: Average (mean) of all tests gathered with 4G as the best bearer. Morning is 7am to 10am, midday is 10am to 4.30pm and evening is 4.30pm to 8pm.

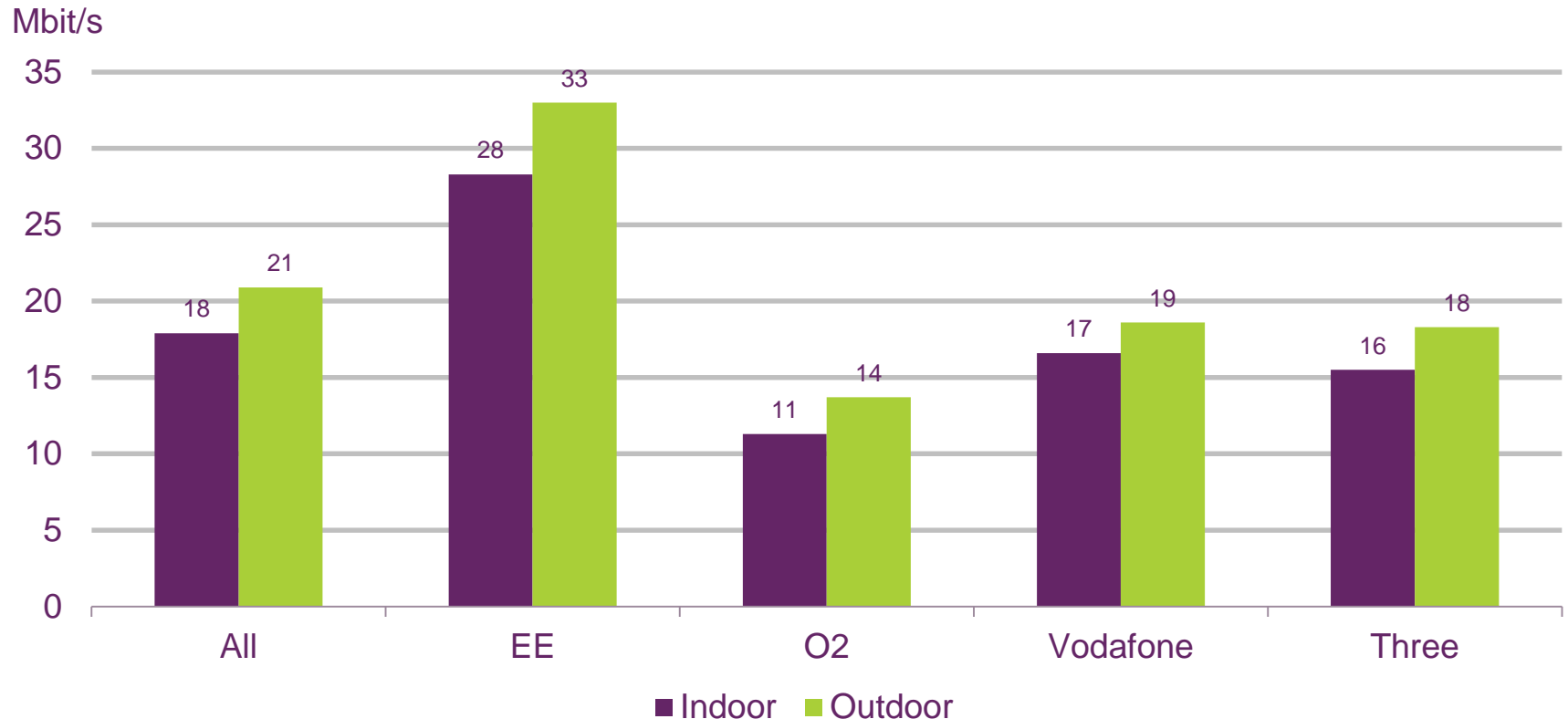
**Figure 22: Average 4G BBC homepage load time, by MNO and time of day: significant differences**

	Fastest	2 <sup>nd</sup> Fastest	3 <sup>rd</sup> Fastest	4 <sup>th</sup> Fastest
Overall	Morning	Weekend	Midday	Evening
EE	Weekend	Morning	Midday	Evening
O2	Morning, Weekend (=)	-	Midday	Evening
Vodafone	Morning, Weekend (=)	-	Midday	Evening
Three	Morning	Weekend	Midday, Evening (=)	-

Source: Ofcom

Note: Differences are significant to a 95% confidence level. Morning is 7am to 10am, midday is 10am to 4.30pm and evening is 4.30pm to 8pm (all Monday to Friday).

**Figure 23: Average 4G download speed, by MNO, indoor vs. outdoor**

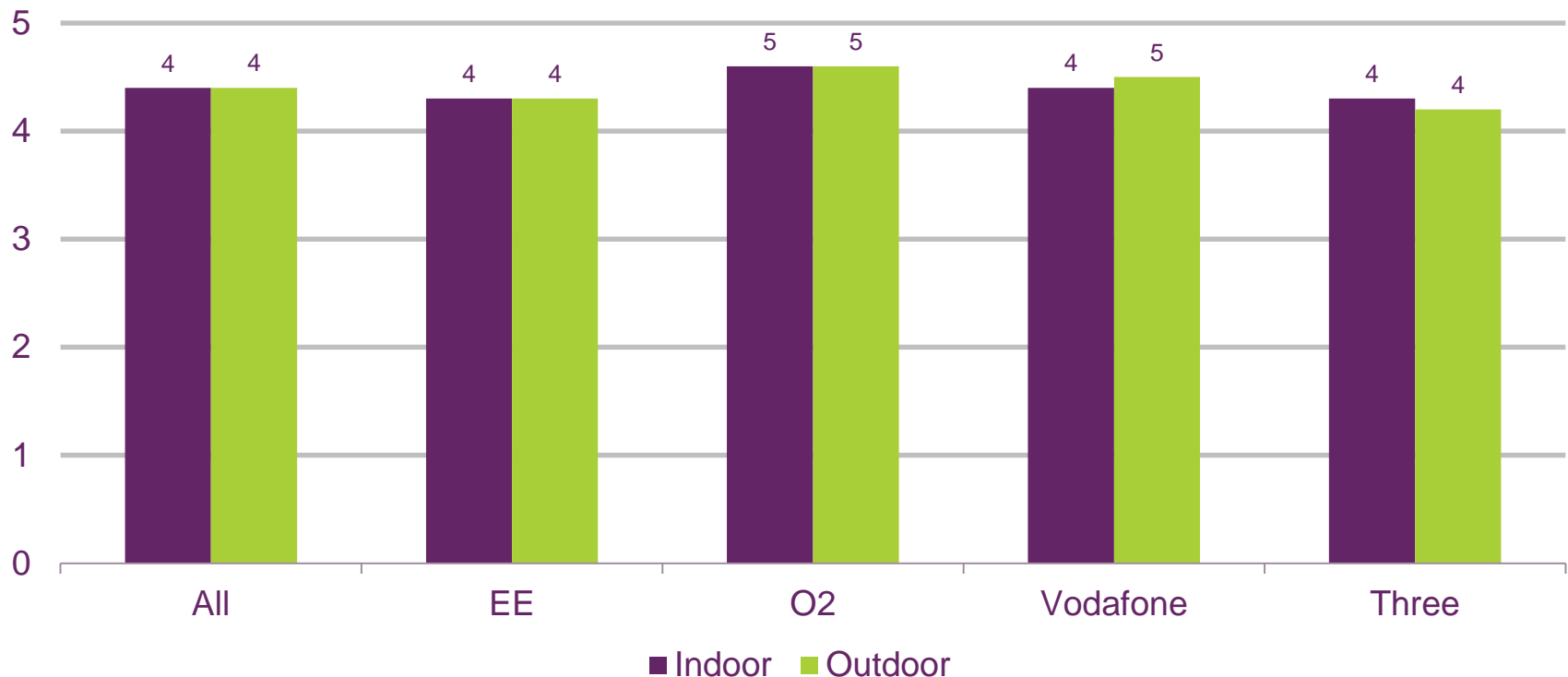


Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

Note: Average (mean) of all tests gathered with 4G as the best bearer.

**Figure 24: Average 4G BBC homepage load time, by MNO: indoor vs outdoor**

Seconds

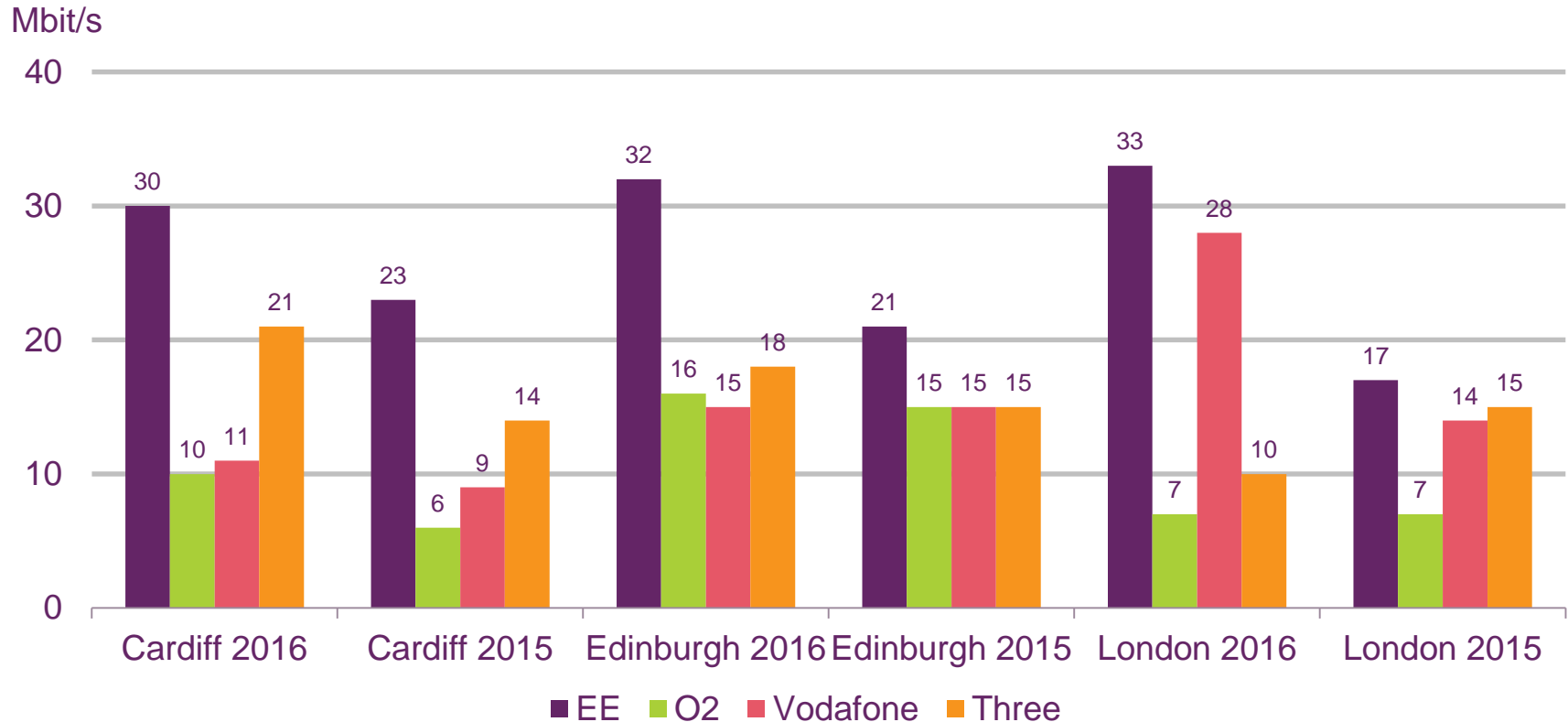


Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

Note: Average (mean) of all tests gathered with 4G as the best bearer.



**Figure 25: Average 4G tariff download speed: July-October 2016 vs November-December 2015**



Source: Ofcom mobile broadband measurements, fieldwork July to October 2016 and November to December 2015.

Note: Average (mean) of all tests gathered with 4G as the best bearer.

**Figure 26: Average 4G download consistency**

	2016			2015		
	Cardiff	London	Edinburgh	Cardiff	London	Edinburgh
EE	99%	96%	99%	95%	92%	92%
Vodafone	91%	93%	99%	74%	80%	94%
O2	85%	67%	97%	54%	59%	96%
Three	94%	82%	98%	92%	81%	87%

Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

**Figure 27: Average 4G web browsing success**

	2016			2015		
	Cardiff	London	Edinburgh	Cardiff	London	Edinburgh
EE	98%	97%	99%	99%	99%	96%
Vodafone	98%	95%	100%	89%	87%	92%
O2	97%	90%	100%	88%	87%	92%
Three	98%	97%	99%	97%	96%	96%

Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

# Figure 28: Metric Summary for 10km radius



0-10km	Belfast				Southampton			
Metric	EE	O2	Vodafone	Three	EE	O2	Vodafone	Three
<b>Download Speed:</b>								
Average speed	29 Mbit/s	16 Mbit/s	15 Mbit/s	16 Mbit/s	29Mbit/s	12Mbit/s	13Mbit/s	18Mbit/s
% over 2Mbit/s	99%	94%	96%	93%	99%	95%	95%	93%
<b>Web browsing</b>								
BBC homepage load time: average	4s	5s	4s	4s	4s	5s	4s	4s
BBC homepage success rate	99%	99%	98%	99%	99%	98%	98%	97%
Amazon homepage load time: average	2s	3s	2.5s	2.6s	1.9s	2s	1.9s	2.2s
Amazon homepage success rate	99%	99%	99%	99%	100%	99%	98%	98%
YouTube homepage load time: average	1s	1.1s	1s	1s	1s	1s	1s	1.1s
YouTube homepage success rate	100%	99%	99%	100%	100%	99%	99%	99%
Standard webpage load time: average	0.8s	0.7s	1.1s	1.2s	0.8s	0.6s	0.9s	1.2s
Standard webpage success rate	99%	99%	99%	99%	99%	100%	99%	99%
<b>Upload speed: average</b>	30Mbit/s	13Mbit/s	14Mbit/s	13Mbit/s	19Mbit/s	10Mbit/s	10Mbit/s	11Mbit/s
<b>YouTube</b>								
% of HD streams	86%	98%	98%	100%	99%	98%	99%	81%
Time to first picture: average	1.9s	-	2.5s	2.3s	2.2s	-	2.4s	2.2s
Video Quality: average MOS	4	-	4	4	4	-	4	4
<b>Response time: average</b>	41ms	46ms	49ms	47ms	44ms	35ms	27ms	47ms
<b>Voice calls</b>								
Mobile to mobile call success rate	98%	97%	99%	100%	96%	97%	97%	99%
Mobile to mobile call quality: average MOS	4	4	4	4	4	3	4	4

Source: Ofcom. Note: 's' is seconds and 'ms' is milliseconds. 'MOS' stands for mean opinion score and scores range from 1 (bad) to 5 (excellent). Note: There is no O2 data for YouTube 'time to first picture' and Video quality as there was an unknown error which has not been resolved.

# Figure 29: Metric Summary for 10km radius

0-10km	Birmingham				Cardiff			
Metric	EE	O2	Vodafone	Three	EE	O2	Vodafone	Three
<b>Download Speed:</b>								
Average speed	41 Mbit/s	11 Mbit/s	30 Mbit/s	19 Mbit/s	31Mbit/s	11Mbit/s	12Mbit/s	21Mbit/s
% over 2Mbit/s	99%	91%	97%	95%	98%	85%	90%	92%
<b>Web browsing</b>								
BBC homepage load time: average	4.3s	4.6s	4.5s	4.2s	4.3s	4.6s	4.6s	4.2s
BBC homepage success rate	98%	99%	99%	99%	98%	96%	97%	97%
Amazon homepage load time: average	1.9s	2.3s	2s	2s	2s	2.4s	2.1s	2.2s
Amazon homepage success rate	99%	100%	99%	99%	98%	97%	98%	98%
YouTube homepage load time: average	0.9s	1.1s	1s	1s	1s	1.1s	1s	1s
YouTube homepage success rate	100%	99%	99%	99%	99%	98%	98%	98%
Standard webpage load time: average	0.8s	0.6s	0.9s	1.1s	0.8s	0.6s	0.9s	1.1s
Standard webpage success rate	99%	100%	100%	99%	99%	98%	98%	98%
<b>Upload speed: average</b>	27Mbit/s	12Mbit/s	14Mbit/s	15Mbit/s	24Mbit/s	11Mbit/s	11Mbit/s	15Mbit/s
<b>YouTube</b>								
% of HD streams	100%	99%	99%	99%	99%	95%	97%	96%
Time to first picture: average	1.9s	-	2.2s	2.1s	2.2s	-	2.4s	2.1s
Video Quality: average MOS	4	-	4	4	4	-	4	4
<b>Response time: average</b>	26ms	46ms	37ms	40ms	30ms	48ms	36ms	41ms
<b>Voice calls</b>								
Mobile to mobile call success rate	100%	98%	99%	98%	98%	98%	97%	100%
Mobile to mobile call quality: average MOS	4	3	3	4	4	3	4	4

Source: Ofcom. Note: 's' is seconds and 'ms' is milliseconds. 'MOS' stands for mean opinion score and scores range from 1 (bad) to 5 (excellent). Note: There is no O2 data for YouTube 'time to first picture' and Video quality as there was an unknown error which has not been resolved.

# Figure 30: Metric Summary for 10km radius



0-10km	Edinburgh				London				Sheffield			
Metric	EE	O2	Vodafone	Three	EE	O2	Vodafone	Three	EE	O2	Vodafone	Three
<b>Download Speed</b>												
Average speed	32Mbit/s	17Mbit/s	15Mbit/s	19Mbit/s	35Mbit/s	8Mbit/s	26Mbit/s	11Mbit/s	30Mbit/s	18Mbit/s	27Mbit/s	21Mbit/s
% over 2Mbit/s	99%	98%	95%	98%	96%	71%	91%	82%	99%	97%	98%	98%
<b>Web browsing</b>												
BBC homepage load time: average	4.3s	4.5s	4.4s	4.2s	4.4s	4.7s	4.5s	4.3s	4.2s	4.6s	4.5s	4.3s
BBC homepage success rate	99%	100%	97%	99%	97%	92%	95%	95%	99%	99%	100%	99%
Amazon homepage load time: average	2.2s	2.3s	2.3s	2.3s	2.2s	2.7s	2.2s	2.5s	2s	2.2s	2.1s	2.2s
Amazon homepage success rate	98%	99%	96%	99%	98%	93%	96%	95%	100%	99%	99%	99%
YouTube homepage load time: average	1s	1s	1.1s	1s	1s	1.1s	0.9s	1s	1s	1s	1.1s	1s
YouTube homepage success rate	100%	100%	97%	100%	99%	96%	97%	98%	100%	99%	100%	99%
Standard webpage load time: average	0.8s	0.7s	1.1s	1.2s	0.7s	0.6s	0.9s	1s	0.8s	0.7s	1s	1.1s
Standard webpage success rate	99%	100%	97%	99%	98%	97%	98%	98%	100%	99%	100%	100%
<b>Upload speed: average</b>	25Mbit/s	13Mbit/s	14Mbit/s	15Mbit/s	24Mbit/s	9Mbit/s	15Mbit/s	10Mbit/s	24Mbit/s	12Mbit/s	14Mbit/s	16Mbit/s
<b>YouTube</b>												
% of HD streams	100%	100%	97%	100%	99%	94%	96%	97%	99%	99%	99%	94%
Time to first picture: average	2.2s	-	2.6s	2.0s	2.1s	-	2.1s	2.3s	2.2s	-	2.6s	2.3s
Video Quality: average MOS	4	-	4	4	4	-	4	4	4	-	4	4
<b>Response time: average</b>	37ms	44ms	49ms	47ms	26ms	43ms	35ms	41ms	29ms	41ms	42ms	40ms
<b>Voice calls</b>												
Mobile to Mobile call success rate	99%	99%	99%	99%	-	-	-	-	99%	95%	99%	99%
Mobile to mobile call quality: average MOS	4	3	4	4	-	-	-	-	4	3	3	4

Source: Ofcom. Note: 's' is seconds and 'ms' is milliseconds. 'MOS' stands for mean opinion score and scores range from 1 (bad) to 5 (excellent). Note: There is no O2 data for YouTube 'time to first picture' and Video quality as there was an unknown error which has not been resolved.

# Smartphone Cities

Additional analysis – 0-4km, 4-10km

# Figure 31: Metric Summary for 0-4km radius



0-4km	Belfast				Southampton			
Metric	EE	O2	Vodafone	Three	EE	O2	Vodafone	Three
<b>Download Speed:</b>								
Average speed	28 Mbit/s	16 Mbit/s	15 Mbit/s	16 Mbit/s	29Mbit/s	12Mbit/s	13Mbit/s	18Mbit/s
% over 2Mbit/s	100%	94%	97%	93%	100%	95%	96%	94%
<b>Web browsing</b>								
BBC homepage load time: average	4.3s	4.7s	4.4s	4.3s	4.4s	4.6s	4.6s	4.3s
BBC homepage success rate	99%	99%	98%	100%	99%	99%	100%	98%
Amazon homepage load time: average	2.5s	2.6s	2.5s	2.5s	1.9s	2.1s	1.9s	2.2s
Amazon homepage success rate	99%	98%	98%	100%	100%	100%	100%	98%
YouTube homepage load time: average	1s	1.1s	1s	1s	1s	1s	1s	1.1s
YouTube homepage success rate	100%	99%	99%	100%	100%	100%	100%	99%
Standard webpage load time: average	0.8s	0.7s	1.1s	1.2s	0.9s	0.6s	0.9s	1.2s
Standard webpage success rate	99%	99%	99%	100%	99%	100%	100%	99%
<b>Upload speed: average</b>	31Mbit/s	13Mbit/s	15Mbit/s	13Mbit/s	18Mbit/s	10Mbit/s	10Mbit/s	11Mbit/s
<b>YouTube</b>								
% of HD streams	96%	100%	100%	100%	99%	100%	100%	87%
Time to first picture: average	2.1s	-	2.8s	2.7s	2.4s	-	2.7s	2.9s
Video Quality: average MOS	4	-	4	4	4	-	4	4
<b>Response time: average</b>	41ms	46ms	49ms	46ms	42ms	34ms	27ms	46ms
<b>Voice calls</b>								
Mobile to mobile call success rate	99%	99%	100%	100%	95%	97%	98%	99%
Mobile to mobile call quality: average MOS	4	4	4	4	4	3	4	4

Source: Ofcom. Note: 's' is seconds and 'ms' is milliseconds. 'MOS' stands for mean opinion score and scores range from 1 (bad) to 5 (excellent). Note: There is no O2 data for YouTube 'time to first picture' and Video quality as there was an unknown error which has not been resolved.



# Figure 32: Metric Summary for 0-4km radius



0-4km	Birmingham				Cardiff			
Metric	EE	O2	Vodafone	Three	EE	O2	Vodafone	Three
<b>Download Speed:</b>								
Average speed	40 Mbit/s	10 Mbit/s	29 Mbit/s	17 Mbit/s	30Mbit/s	10Mbit/s	11Mbit/s	21Mbit/s
% over 2Mbit/s	100%	90%	99%	94%	99%	85%	91%	94%
<b>Web browsing</b>								
BBC homepage load time: average	4.7s	4.7s	4.5s	4.2s	4.3s	4.6s	4.4s	4.3s
BBC homepage success rate	99%	99%	99%	99%	98%	97%	98%	98%
Amazon homepage load time: average	1.9s	2.4s	2s	2s	2s	2.4s	2.1s	2.2s
Amazon homepage success rate	99%	100%	100%	99%	98%	98%	99%	98%
YouTube homepage load time: average	0.9s	1.1s	1s	1s	1s	1.2s	1.1s	1s
YouTube homepage success rate	100%	100%	100%	99%	99%	99%	99%	98%
Standard webpage load time: average	0.8s	0.6s	0.9s	1.1s	0.9s	0.6s	0.9s	11.S
Standard webpage success rate	99%	100%	100%	99%	99%	99%	99%	98%
<b>Upload speed:</b> average	27Mbit/s	13Mbit/s	14Mbit/s	14Mbit/s	25Mbit/s	11Mbit/s	11Mbit/s	16Mbit/s
<b>YouTube</b>								
% of HD streams	100%	100%	100%	100%	100%	99%	99%	99%
Time to first picture: average	2.1s	-	2.5s	2.6s	2.4s	-	3s	2.4s
Video Quality: average MOS	4	-	4	4	4	-	4	4
<b>Response time:</b> average	26ms	49ms	37ms	40ms	32ms	49ms	36ms	41ms
<b>Voice calls</b>								
Mobile to mobile call success rate	100%	98%	99%	99%	98%	98%	98%	100%
Mobile to mobile call quality: average MOS	4	3	3	4	4	3	3	4

Source: Ofcom. Note: 's' is seconds and 'ms' is milliseconds. 'MOS' stands for mean opinion score and scores range from 1 (bad) to 5 (excellent). Note: There is no O2 data for YouTube 'time to first picture' and Video quality as there was an unknown error which has not been resolved.

# Figure 33: Metric Summary for 0-4km radius



0-10km	Edinburgh				London				Sheffield			
Metric	EE	O2	Vodafone	Three	EE	O2	Vodafone	Three	EE	O2	Vodafone	Three
<b>Download Speed</b>												
Average speed	32Mbit/s	16Mbit/s	15Mbit/s	18Mbit/s	33Mbit/s	7Mbit/s	28Mbit/s	10Mbit/s	28Mbit/s	18Mbit/s	27Mbit/s	21Mbit/s
% over 2Mbit/s	99%	97%	99%	98%	96%	67%	93%	82%	100%	98%	98%	99%
<b>Web browsing</b>												
BBC homepage load time: average	4.2s	4.9s	4.7s	4.1s	4s	4.3s	4.1s	4.1s	4.7s	4.6s	4.7s	4.6s
BBC homepage success rate	99%	100%	100%	99%	97%	90%	95%	97%	100%	99%	100%	100%
Amazon homepage load time: average	2.1s	2.3s	2.3s	2.3s	2.2s	2.7s	2.2s	2.5s	2s	2.2s	2.1s	2.2s
Amazon homepage success rate	97%	99%	98%	98%	98%	92%	96%	97%	100%	99%	99%	99%
YouTube homepage load time: average	1s	1.1s	1.1s	1s	1s	1.2s	0.9s	1s	1s	1s	1.1s	1s
YouTube homepage success rate	99%	100%	100%	100%	99%	95%	97%	99%	100%	99%	100%	99%
Standard webpage load time: average	0.8s	0.7s	1.1s	1.2s	0.8s	0.7s	0.9s	1.1s	0.8s	0.7s	1s	1.1s
Standard webpage success rate	99%	100%	100%	99%	98%	96%	97%	98%	100%	99%	100%	100%
<b>Upload speed: average</b>	23Mbit/s	13Mbit/s	14Mbit/s	14Mbit/s	23Mbit/s	9Mbit/s	15Mbit/s	10Mbit/s	24Mbit/s	12Mbit/s	14Mbit/s	16Mbit/s
<b>YouTube</b>												
% of HD streams	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	98%
Time to first picture: average	2.4s	-	2.7s	2.5s	2.6s	-	2.7s	3.1s	2.5s	-	2.9s	2.5s
Video Quality: average MOS	4	-	4	4	4	-	4	-	4	-	4	4
<b>Response time: average</b>	37ms	46ms	49ms	47ms	28ms	45ms	34ms	42ms	29ms	42ms	42ms	40ms
<b>Voice calls</b>												
Mobile to Mobile call success rate	99%	98%	99%	98%	-	-	-	-	98%	97%	98%	99%
Mobile to mobile call quality: average MOS	4	4	4	4	-	-	-	-	4	3	3	4

Source: Ofcom. Note: 's' is seconds and 'ms' is milliseconds. 'MOS' stands for mean opinion score and scores range from 1 (bad) to 5 (excellent). Note: There is no O2 data for YouTube 'time to first picture' and Video quality as there was an unknown error which has not been resolved.

# Figure 34: Metric Summary for 4-10km radius



4-10km	Belfast				Southampton			
Metric	EE	O2	Vodafone	Three	EE	O2	Vodafone	Three
<b>Download Speed:</b>								
Average speed	31 Mbit/s	14 Mbit/s	15 Mbit/s	18 Mbit/s	30Mbit/s	12Mbit/s	13Mbit/s	17Mbit/s
% over 2Mbit/s	100%	92%	96%	94%	99%	93%	95%	91%
<b>Web browsing</b>								
BBC homepage load time: average	4.3s	4.6`s	4.5s	4.3s	4s	4.3s	4.0s	4.5s
BBC homepage success rate	99%	99%	99%	98%	97%	96%	95%	96%
Amazon homepage load time: average	2.4s	2.7s	2.6s	2.7s	1.8s	2s	1.8s	2.3s
Amazon homepage success rate	100%	99%	100%	97%	99%	98%	97%	99%
YouTube homepage load time: average	1s	1.1s	1s	1.1s	0.9s	1s	0.9s	1.2s
YouTube homepage success rate	100%	99%	99%	99%	99%	97%	97%	99%
Standard webpage load time: average	0.8s	0.7s	1.1s	1.2s	0.9s	0.6s	0.9s	1.2s
Standard webpage success rate	99%	99%	99%	100%	99%	100%	100%	99%
<b>Upload speed: average</b>	27Mbit/s	13Mbit/s	14Mbit/s	12Mbit/s	21Mbit/s	9Mbit/s	10Mbit/s	10Mbit/s
<b>YouTube</b>								
% of HD streams	59%	100%	100%	100%	98%	97%	98%	66%
Time to first picture: average	1.8s	-	2.5s	2.4s	2s	-	2.3s	2.3s
Video Quality: average MOS	4	-	4	4	4	-	4	4
<b>Response time: average</b>	45ms	54ms	53ms	54ms	46ms	43ms	34ms	76ms
<b>Voice calls</b>								
Mobile to mobile call success rate	99%	99%	100%	100%	95%	97%	98%	99%
Mobile to mobile call quality: average MOS	4	3	3	4	4	3	3	4

Source: Ofcom. Note: 's' is seconds and 'ms' is milliseconds. 'MOS' stands for mean opinion score and scores range from 1 (bad) to 5 (excellent). Note: There is no O2 data for YouTube 'time to first picture' and Video quality as there was an unknown error which has not been resolved.

# Figure 35: Metric Summary 4-10km radius



4-10km	Birmingham				Cardiff			
Metric	EE	O2	Vodafone	Three	EE	O2	Vodafone	Three
<b>Download Speed:</b>								
Average speed	44 Mbit/s	13 Mbit/s	32 Mbit/s	24 Mbit/s	32Mbit/s	14Mbit/s	14Mbit/s	23Mbit/s
% over 2Mbit/s	100%	93%	94%	99%	99%	89%	91%	94%
<b>Web browsing</b>								
BBC homepage load time: average	4.2s	4.7s	4.9s	4.2s	4.1s	4.5s	4.4s	4.4s
BBC homepage success rate	98%	98%	99%	100%	99%	89%	91%	94%
Amazon homepage load time: average	1.9s	2.2s	2s	2s	2s	2.3s	2.1s	2.3s
Amazon homepage success rate	99%	100%	99%	100%	99%	95%	97%	97%
YouTube homepage load time: average	0.9s	1s	1s	1s	1s	1.1s	1s	1s
YouTube homepage success rate	99%	99%	99%	100%	99%	96%	97%	98%
Standard webpage load time: average	0.8s	0.5s	0.9s	1.1s	0.8s	0.6s	0.9s	1.1s
Standard webpage success rate	99%	99%	99%	100%	99%	96%	97%	98%
<b>Upload speed: average</b>	29Mbit/s	12Mbit/s	13Mbit/s	17Mbit/s	24Mbit/s	11Mbit/s	11Mbit/s	13Mbit/s
<b>YouTube</b>								
% of HD streams	100%	100%	100%	100%	100%	97%	98%	96%
Time to first picture: average	1.8s	-	2.2s	2.1s	2.1s	-	2.4s	2.0s
Video Quality: average MOS	4	-	4	4	4	-	4	4
<b>Response time: average</b>	26ms	46ms	37ms	40ms	30ms	48ms	36ms	41ms
<b>Voice calls</b>								
Mobile to mobile call success rate	100%	98%	99%	98%	98%	98%	97%	100%
Mobile to mobile call quality: average MOS	4	3	3	4	4	3	3	4

Source: Ofcom. Note: 's' is seconds and 'ms' is milliseconds. 'MOS' stands for mean opinion score and scores range from 1 (bad) to 5 (excellent). Note: There is no O2 data for YouTube 'time to first picture' and Video quality as there was an unknown error which has not been resolved.

# Figure 36: Metric Summary for 4-10km radius



4-10km	Edinburgh				London				Sheffield			
Metric	EE	O2	Vodafone	Three	EE	O2	Vodafone	Three	EE	O2	Vodafone	Three
<b>Download Speed</b>												
Average speed	31Mbit/s	20Mbit/s	16Mbit/s	20Mbit/s	40Mbit/s	11Mbit/s	23Mbit/s	13Mbit/s	35Mbit/s	20Mbit/s	18Mbit/s	21Mbit/s
% over 2Mbit/s	100%	98%	98%	99%	97%	82%	92%	85%	98%	96%	98%	97%
<b>Web browsing</b>												
BBC homepage load time: average	4.5s	4.7s	4.9s	4.1s	3.7s	4.3s	3.9s	4s	4.6s	4.3s	4.4s	4.4s
BBC homepage success rate	100%	100%	98%	100%	98%	97%	97%	91%	99%	99%	99%	97%
Amazon homepage load time: average	2.2s	2.2s	2.2s	2.3s	2.1s	2.6s	2.3s	2.4s	2s	2.1s	2.1s	2.2s
Amazon homepage success rate	99%	100%	100%	99%	97%	90%	95%	97%	100%	99%	100%	100%
YouTube homepage load time: average	1s	1s	1s	1.1s	0.9s	1.1s	1s	1s	1s	1s	1.1s	1s
YouTube homepage success rate	99%	100%	98%	100%	100%	98%	99%	96%	99%	99%	100%	99%
Standard webpage load time: average	0.8s	0.7s	1.1s	1.2s	0.7s	0.6s	0.8s	0.9s	0.8s	0.7s	1s	1.1s
Standard webpage success rate	99%	100%	99%	99%	99%	99%	99%	98%	99%	99%	99%	98%
<b>Upload speed: average</b>	29Mbit/s	15Mbit/s	16Mbit/s	15Mbit/s	26Mbit/s	11Mbit/s	13Mbit/s	13Mbit/s	26Mbit/s	14Mbit/s	14Mbit/s	15Mbit/s
<b>YouTube</b>												
% of HD streams	100%	100%	100%	100%	100%	100%	100%	100%	100%	99%	99%	86%
Time to first picture: average	2.3s	-	2.6s	2.1s	2s	-	2.2s	2.2s	2s	-	2.5s	2.2s
Video Quality: average MOS	4	-	4	4	4	-	4	4	4	-	4	4
<b>Response time: average</b>	42ms	44ms	58ms	53ms	31ms	44ms	39ms	53ms	34ms	43ms	46ms	47ms
<b>Voice calls</b>												
Mobile to Mobile call success rate	99%	98%	99%	98%	-	-	-	-	98%	97%	98%	99%
Mobile to mobile call quality: average MOS	4	3	4	4	-	-	-	-	4	3	3	4

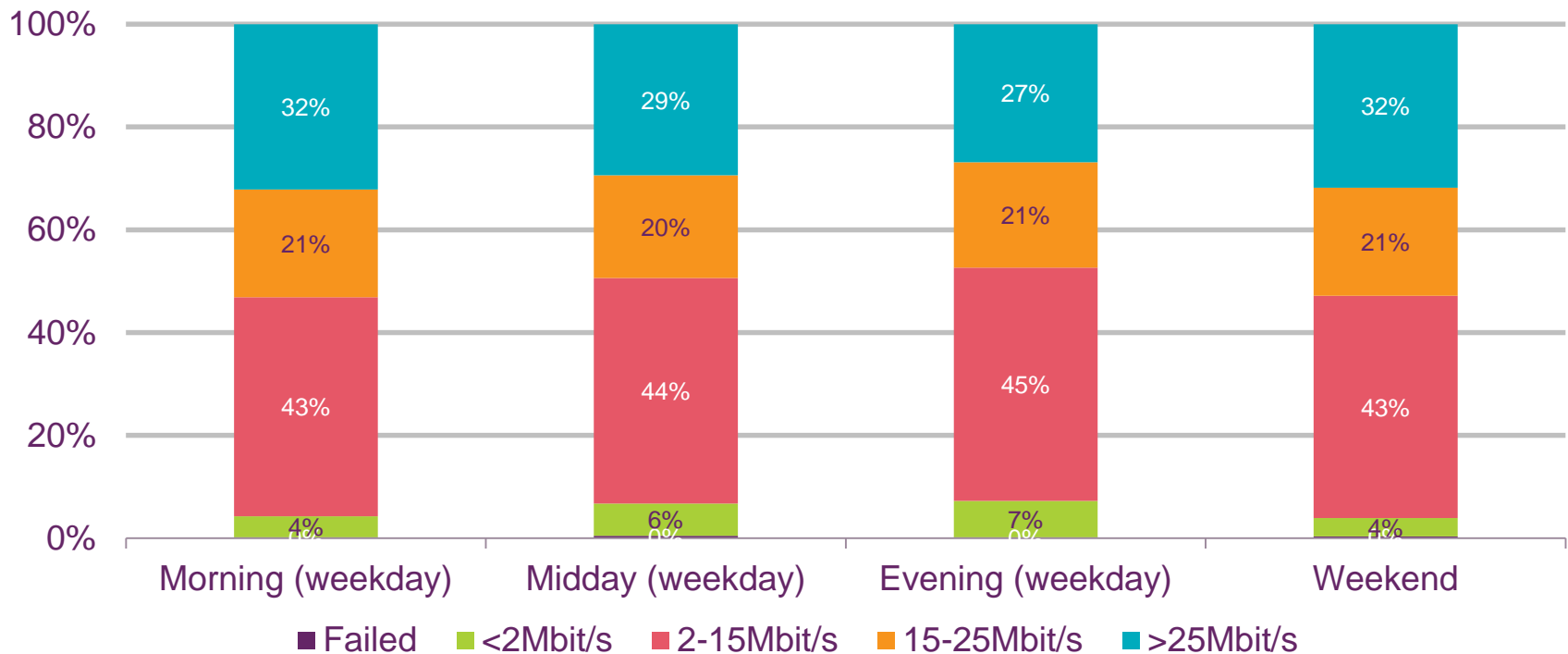
Source: Ofcom. Note: 's' is seconds and 'ms' is milliseconds. 'MOS' stands for mean opinion score and scores range from 1 (bad) to 5 (excellent). Note: There is no O2 data for YouTube 'time to first picture' and Video quality as there was an unknown error which has not been resolved.

# Smartphone Cities

Additional analysis – download speeds

## Figure 37: Distribution of 4G tariff download speeds, by daypart

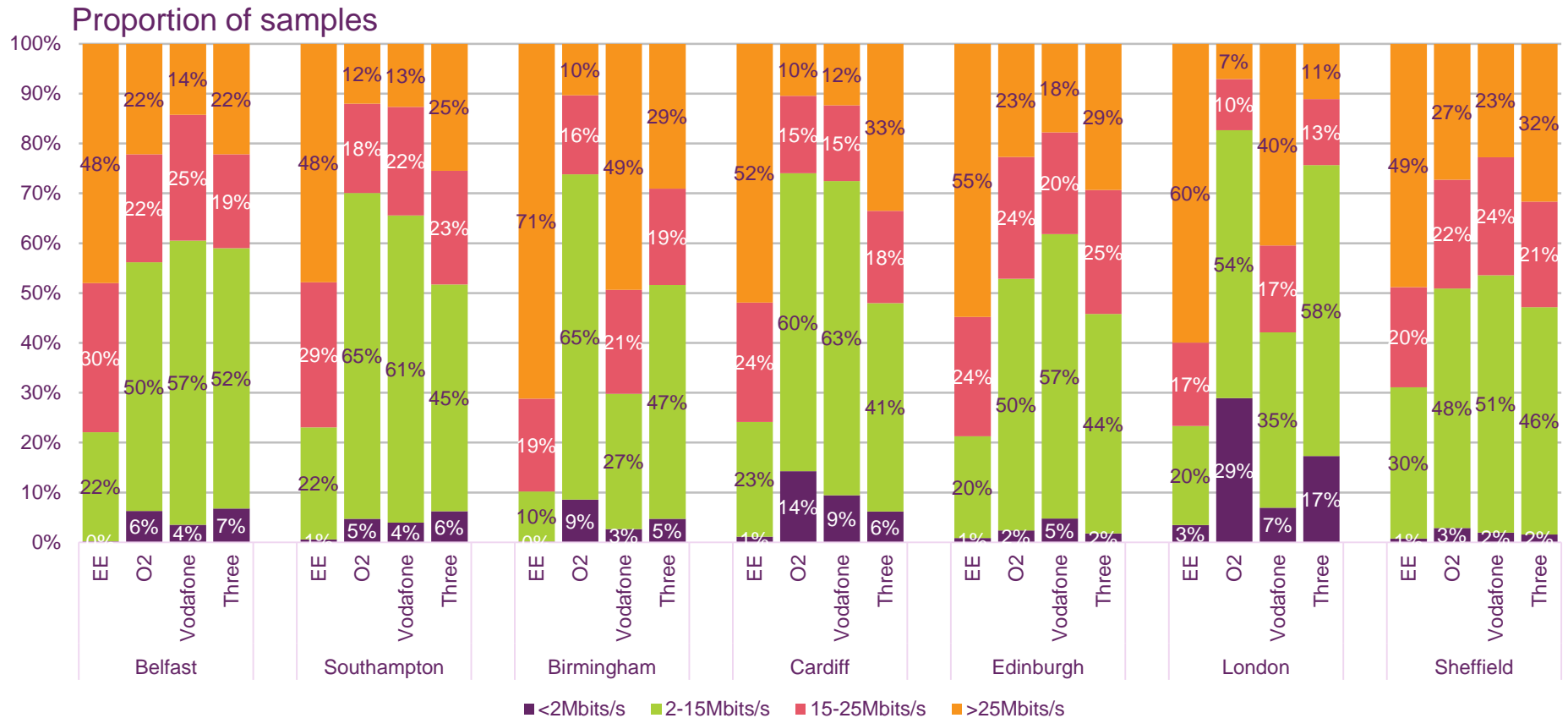
Proportion of test samples



Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

Note: Morning is 7am to 10am, midday is 10am to 4.30pm and evening is 4.30pm to 7pm.

# Figure 38: Distribution of 4G tariff download speeds, by city and operator



Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

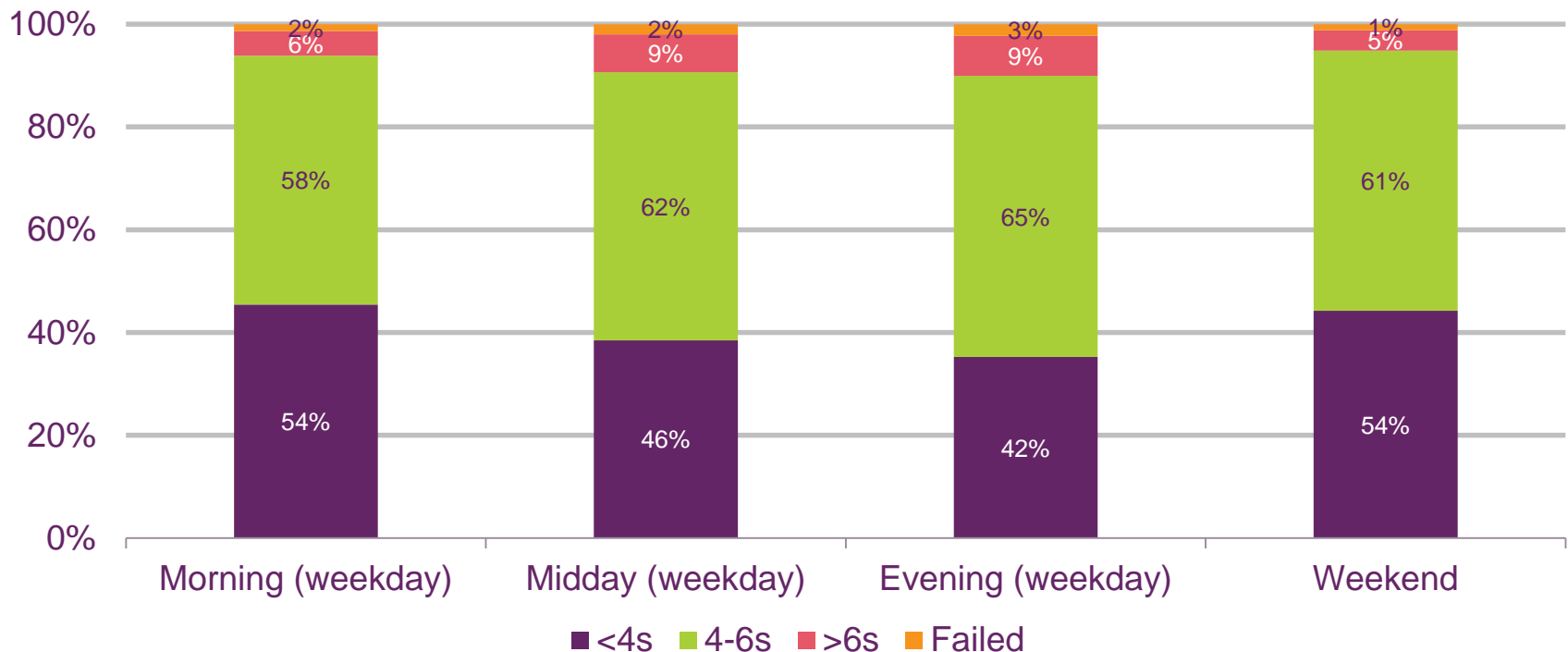


# Smartphone Cities

Additional analysis – BBC homepage web browsing

## Figure 39: Distribution of 4G tariff BBC homepage load time, by daypart

Proportion of test samples

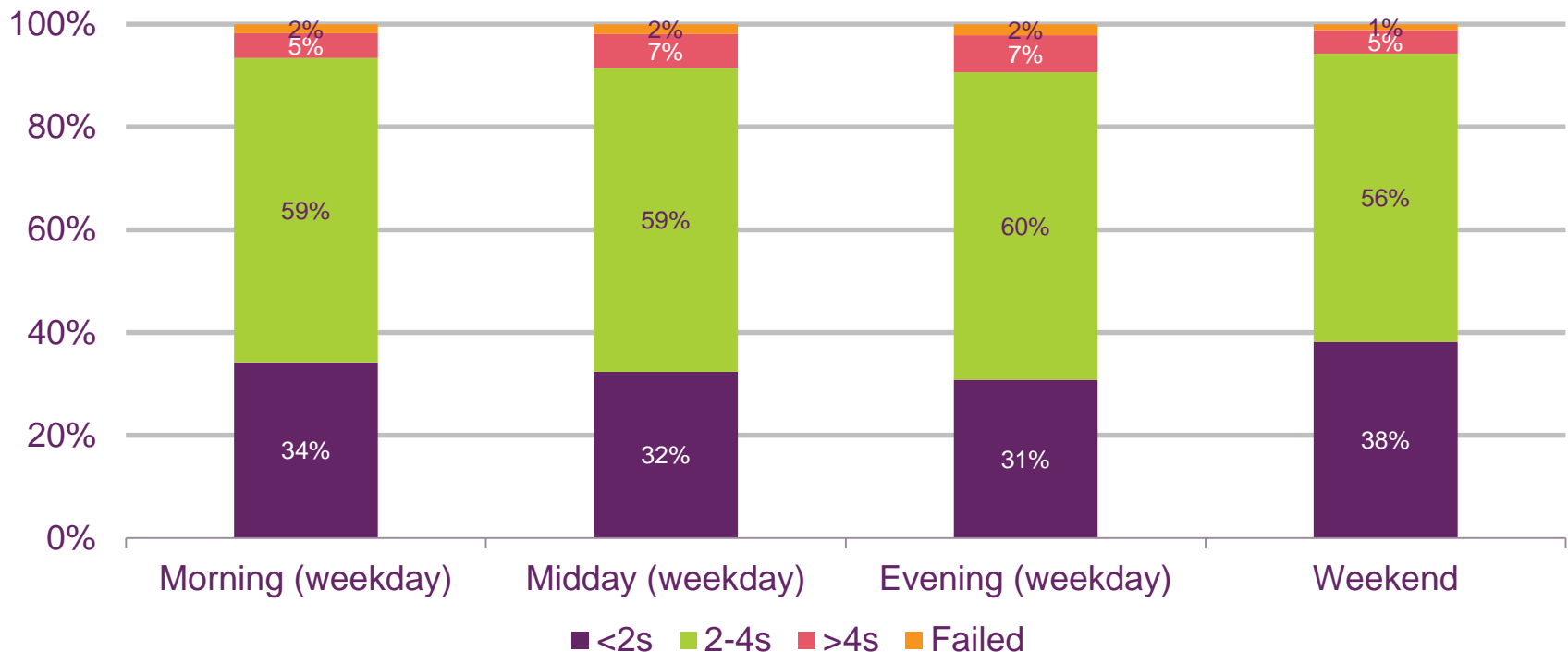


Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

Note: Morning is 7am to 10am, midday is 10am to 4.30pm and evening is 4.30pm to 7pm.

## Figure 40: Distribution of 4G tariff Amazon homepage load time, by daypart

Proportion of test samples

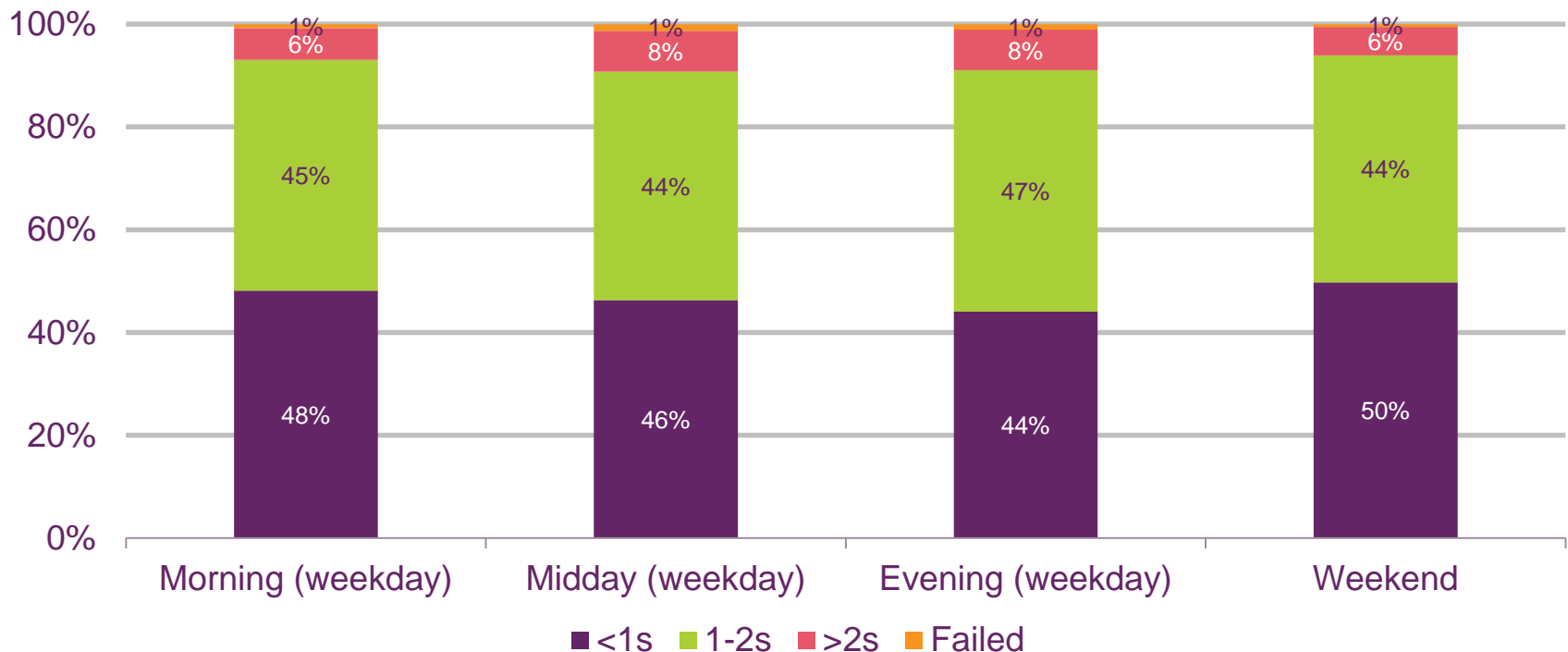


Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

Note: Morning is 7am to 10am, midday is 10am to 4.30pm and evening is 4.30pm to 7pm.

## Figure 41: Distribution of 4G tariff YouTube homepage load time, by daypart

Proportion of test samples

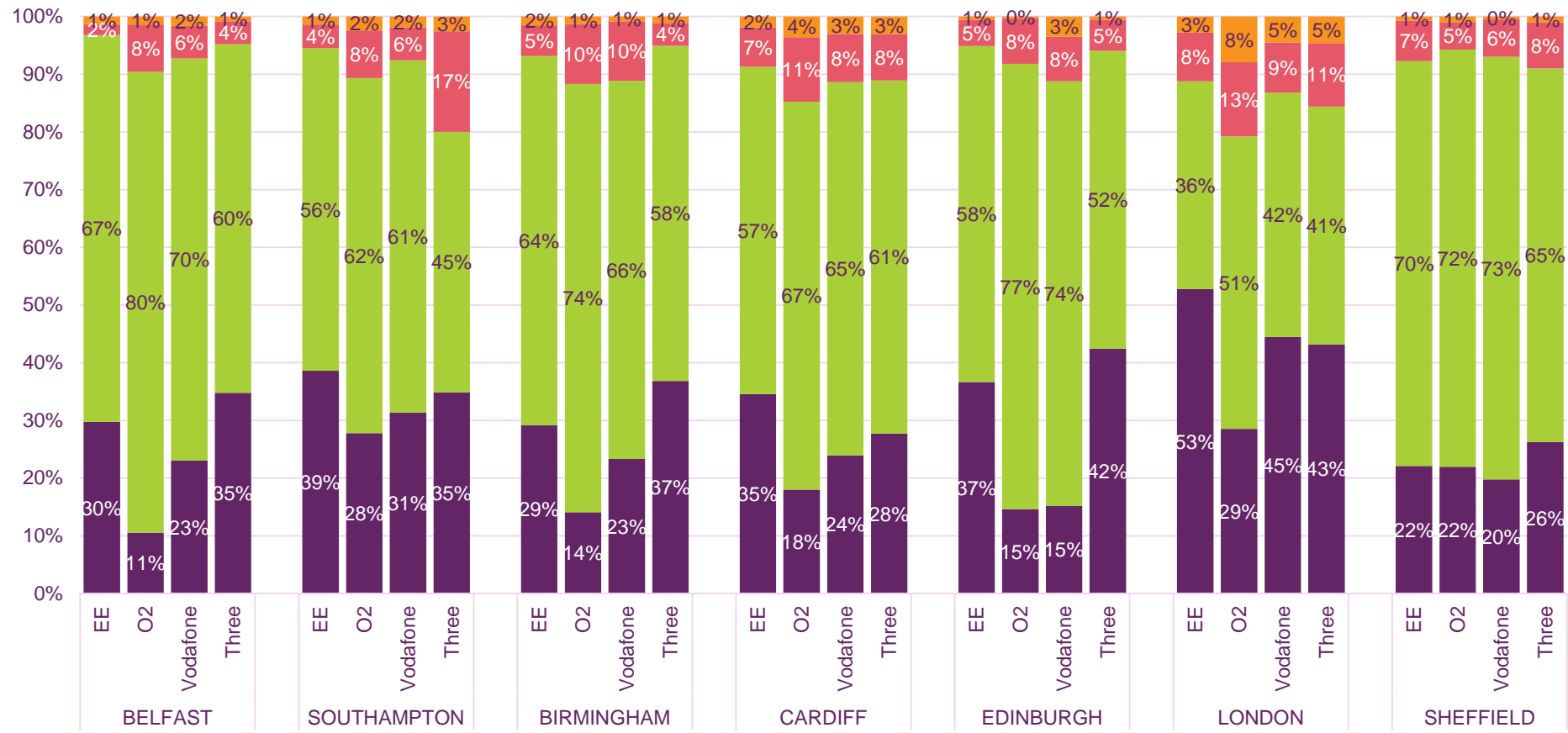


Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

Note: Morning is 7am to 10am, midday is 10am to 4.30pm and evening is 4.30pm to 7pm.

# Figure 42: Distribution of 4G tariff BBC homepage load time, by operator

Proportion of samples

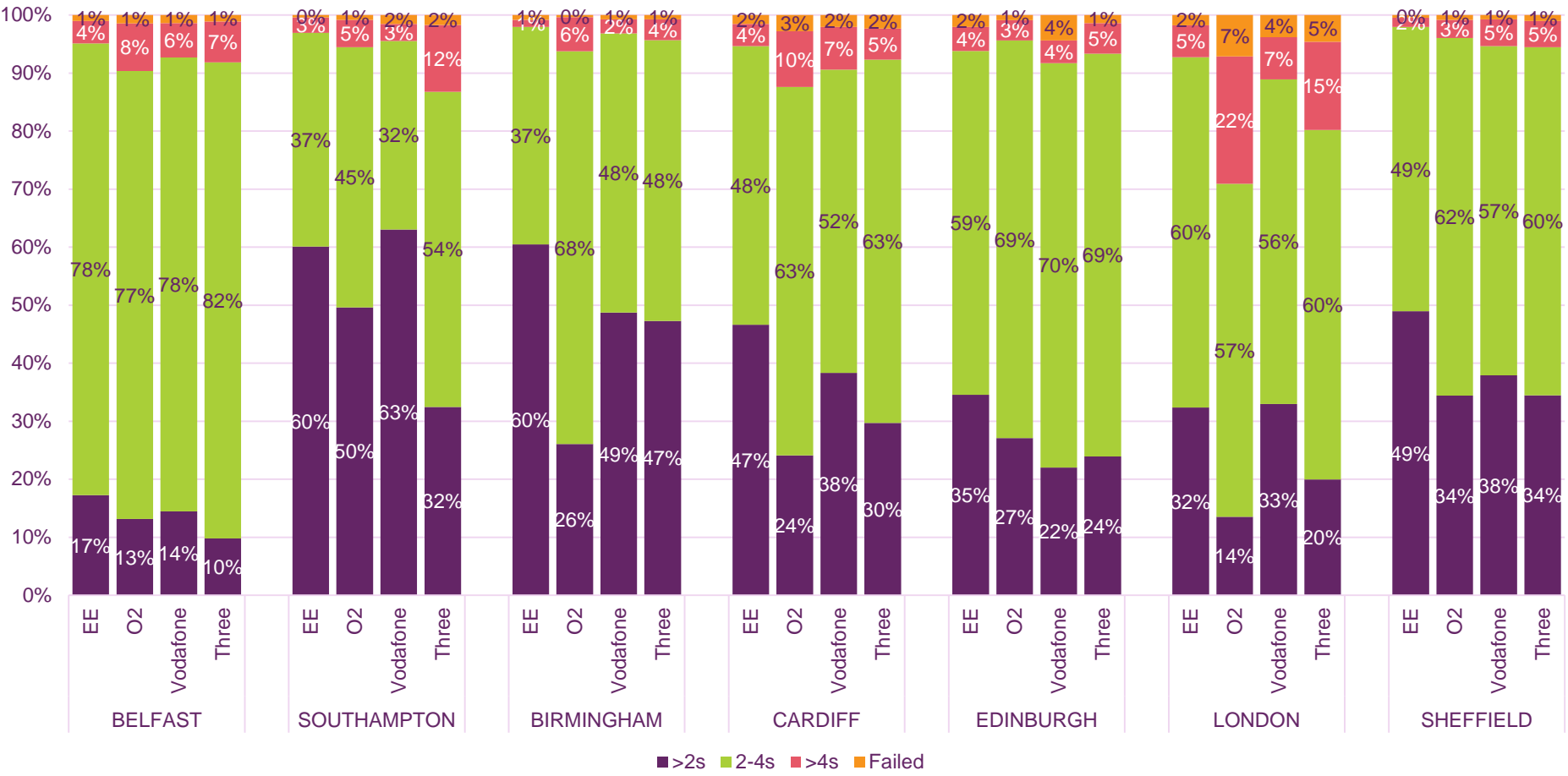


■ <4s ■ 4-6s ■ >6 ■ Failed

Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

# Figure 43: Distribution of 4G tariff Amazon homepage load time

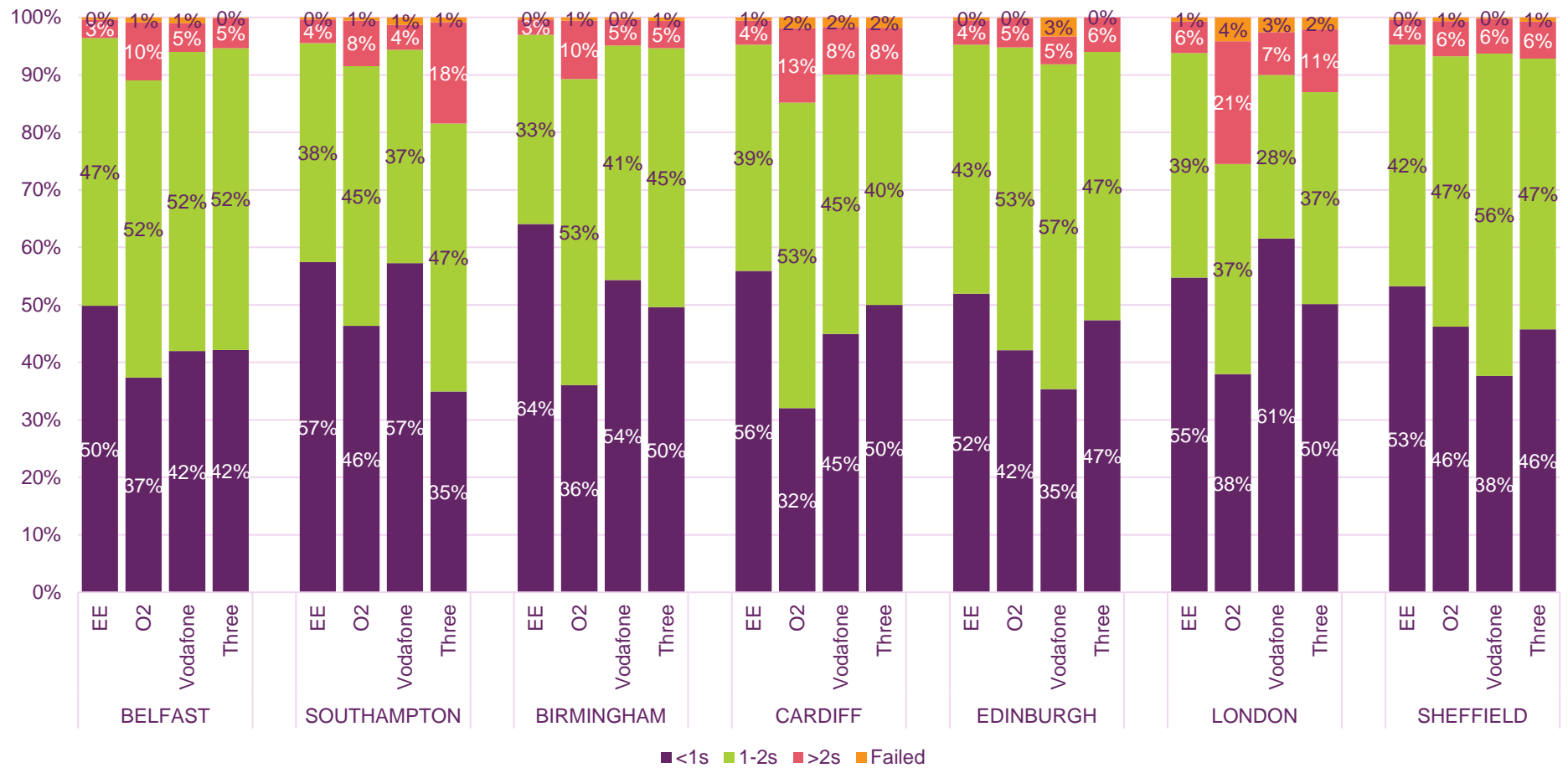
Proportion of samples



Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

# Figure 44: Distribution of 4G tariff YouTube homepage load time

Proportion of samples



Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

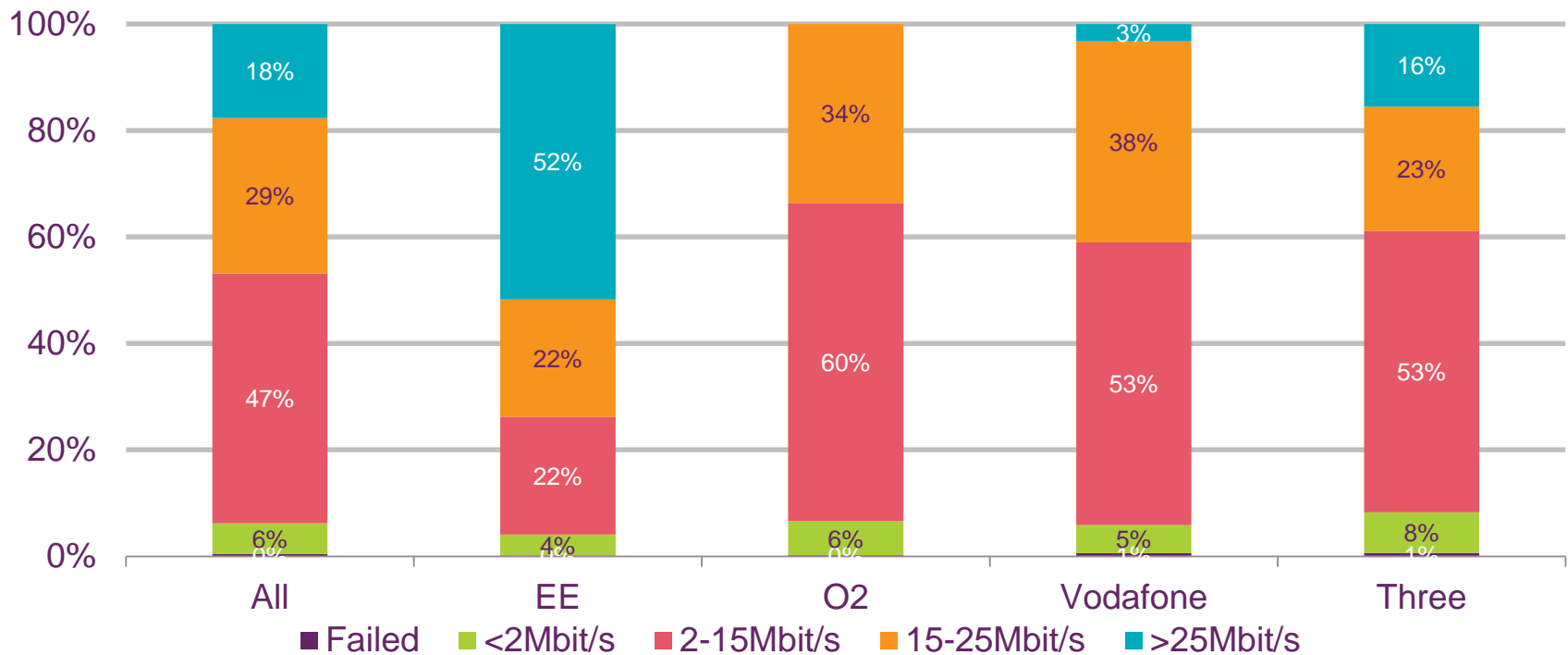
# Smartphone Cities

Additional analysis – internet activities



## Figure 45: Distribution of 4G upload speeds, by operator

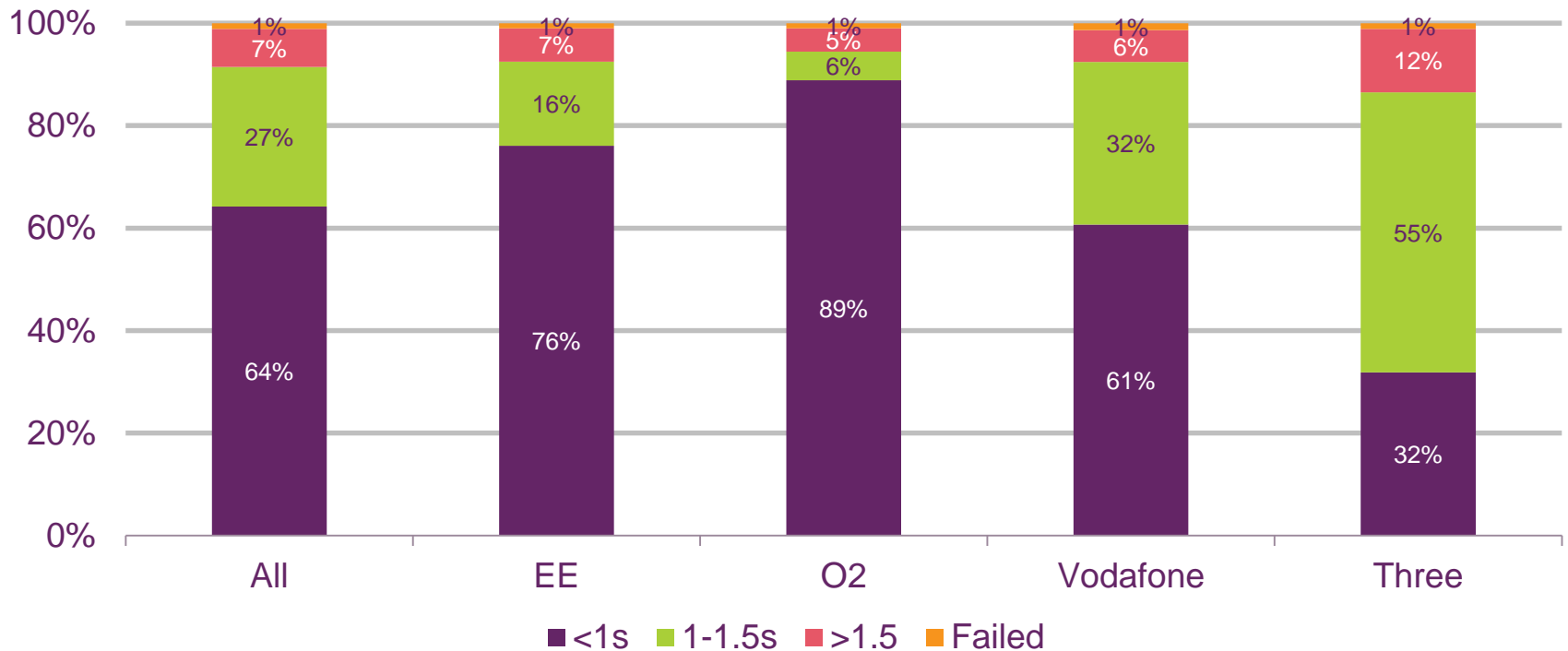
Proportion of samples



Source: Ofcom mobile broadband measurements, fieldwork November and December 2015.

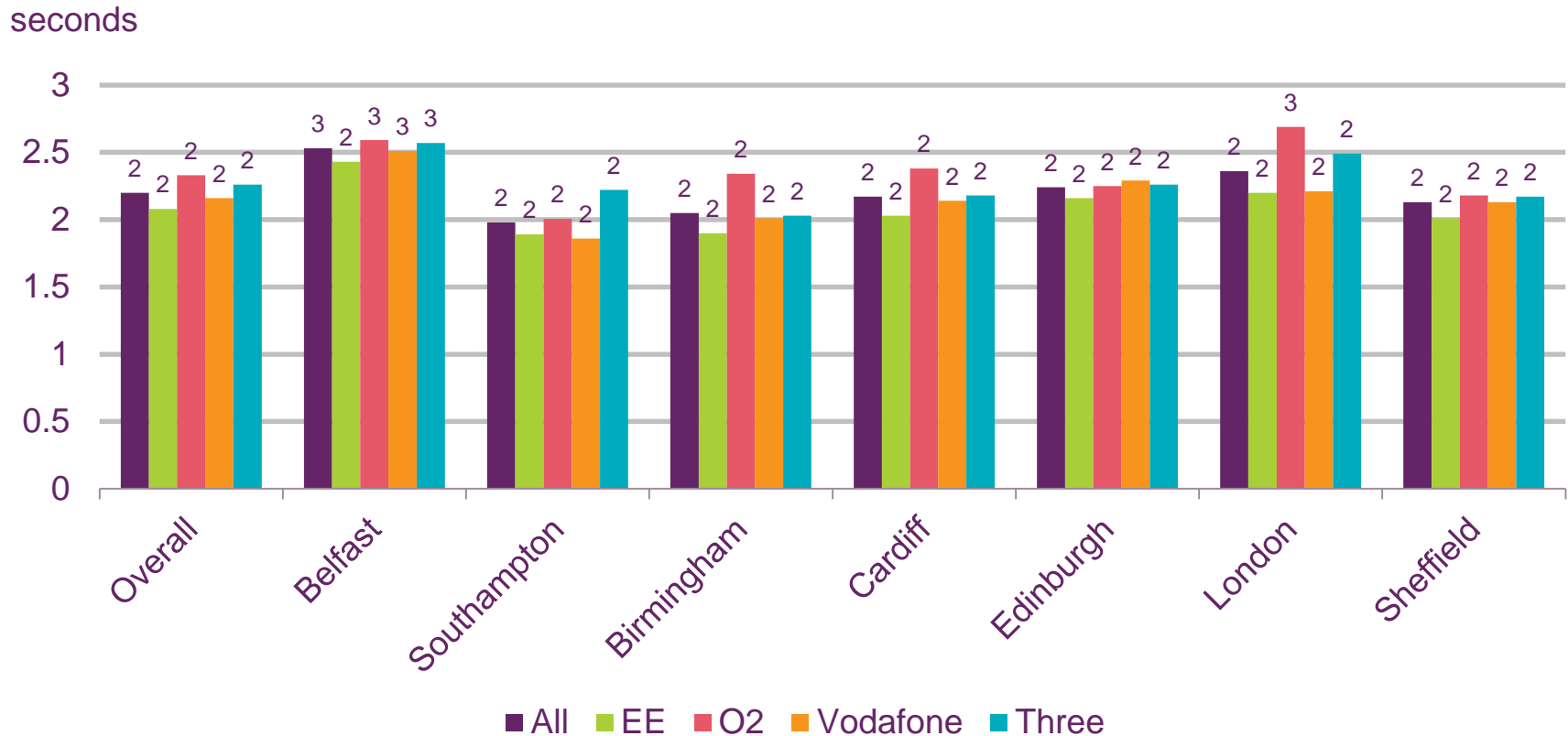
## Figure 46: Distribution of 4G tariff standard web page load time; by operator

Proportion of samples



Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

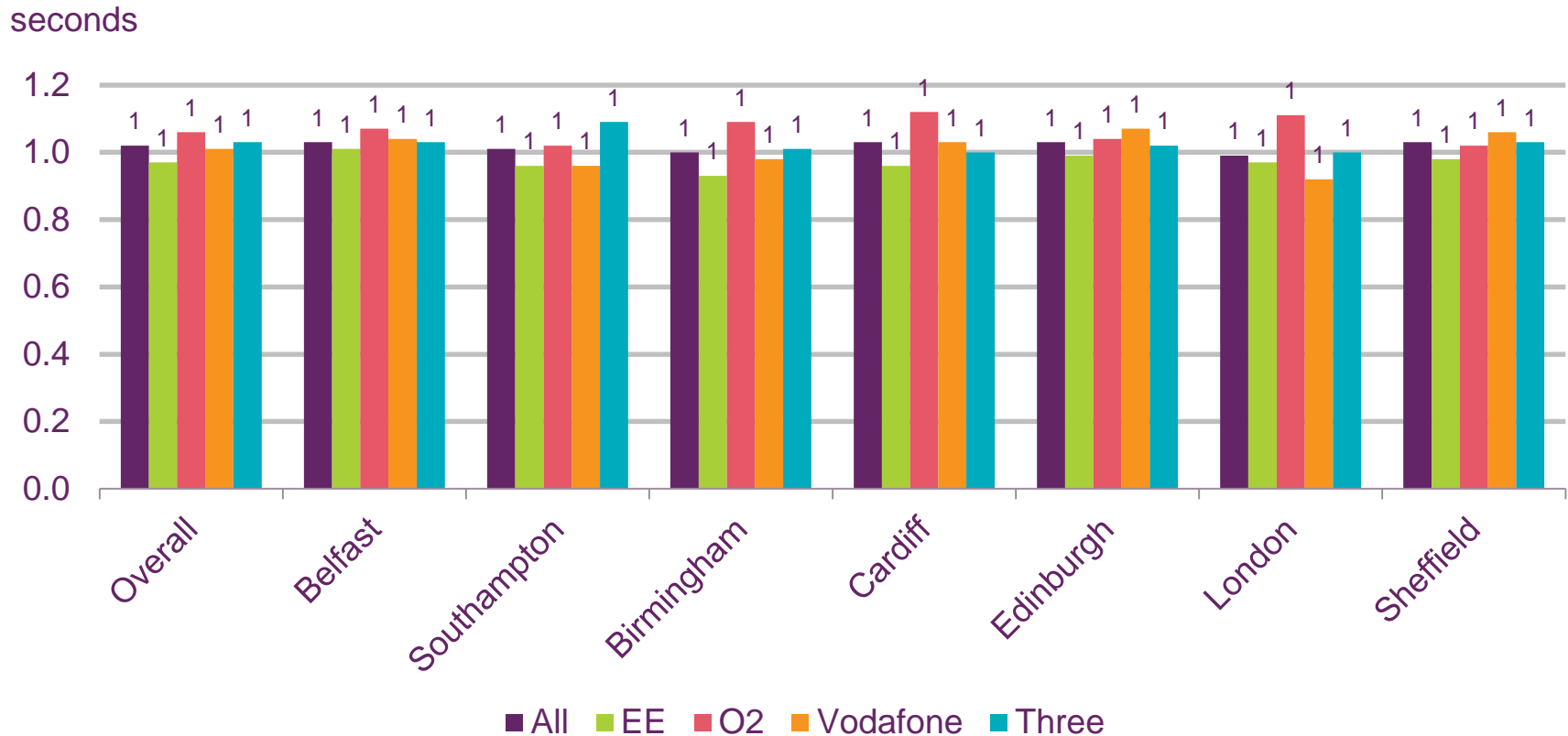
**Figure 47: Average 4G tariff Amazon homepage load time, by city**



Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

Note: Average (median) of all tests gathered with 4G as the best bearer.

**Figure 7: Average 4G tariff YouTube homepage load time, by city**

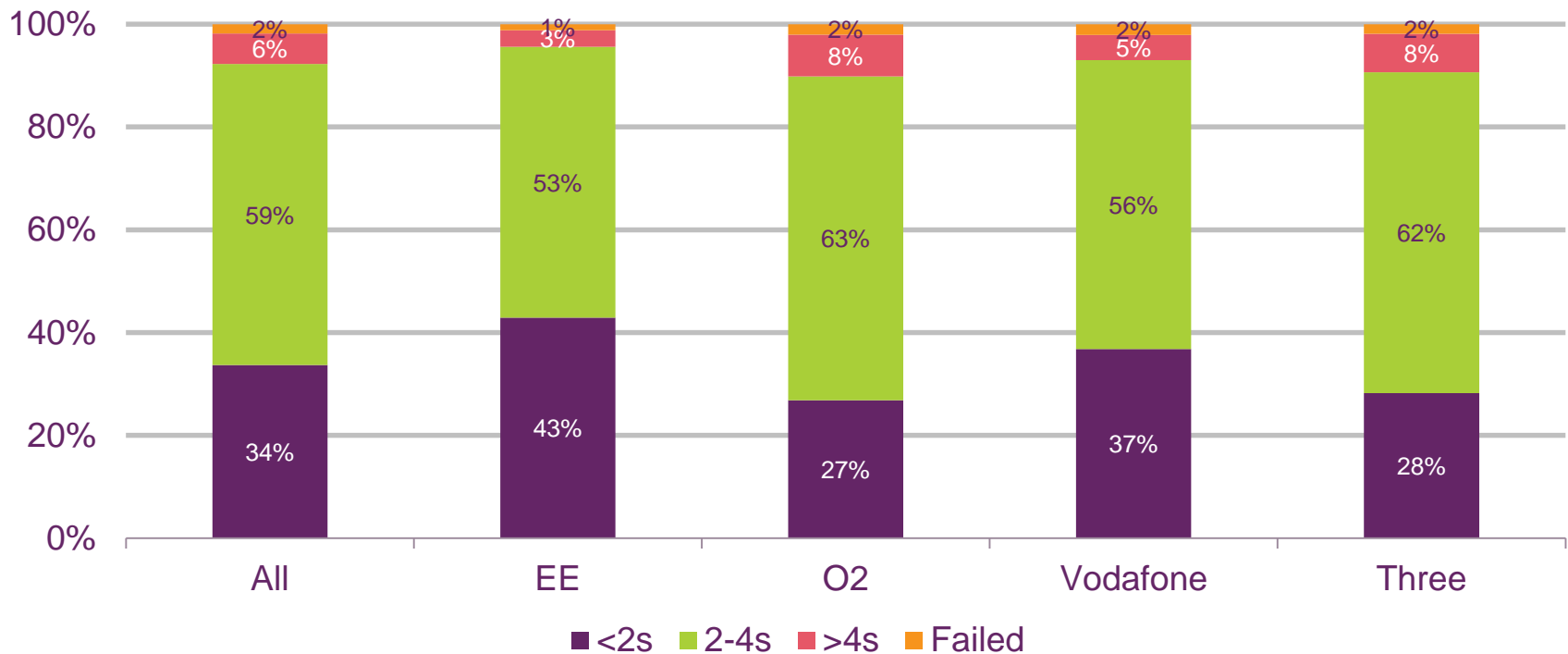


Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

Note: Average (median) of all tests gathered with 4G as the best bearer.

## Figure 48: Distribution of 4G tariff Amazon homepage loading time results

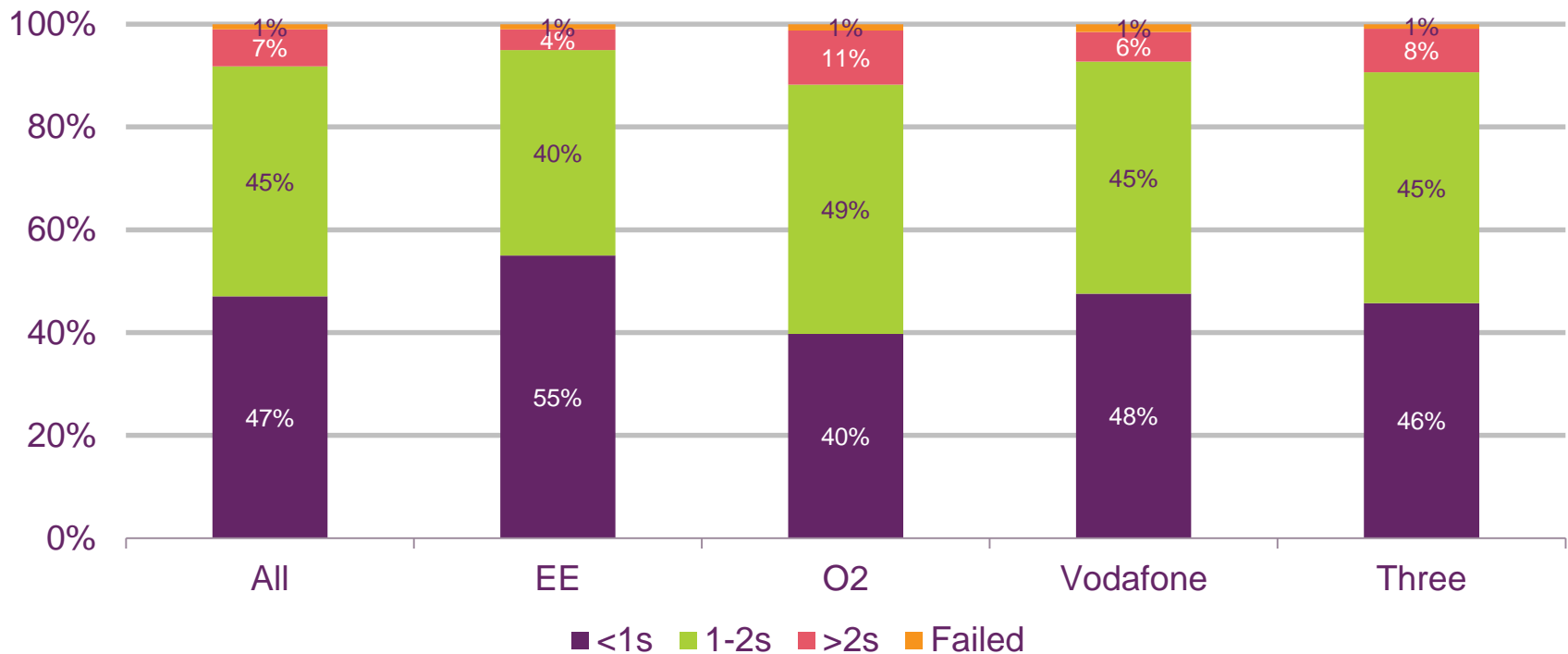
Proportion of samples



Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

## Figure 49: Distribution of 4G tariff YouTube homepage loading time results

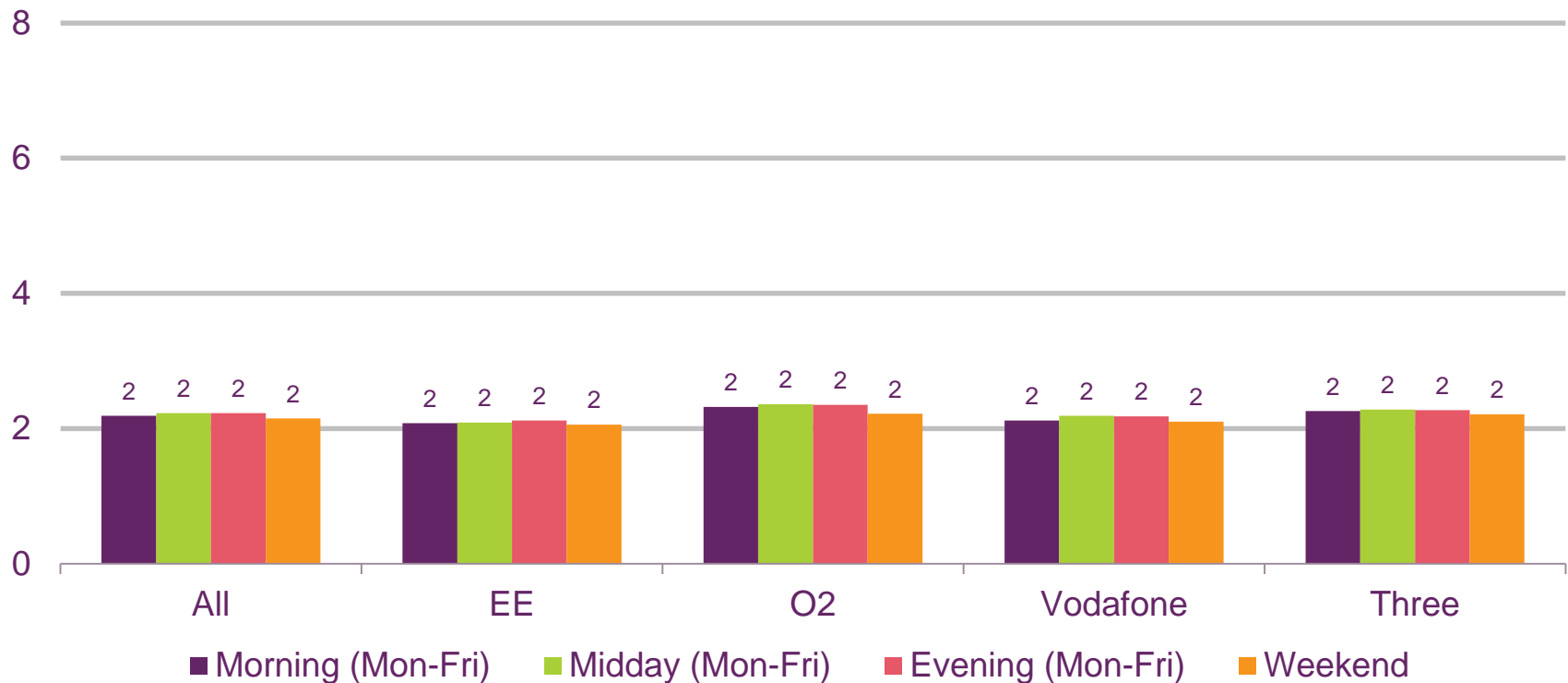
Proportion of samples



Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

**Figure 50: Average 4G tariff Amazon homepage load time, by MNO and time of day**

seconds

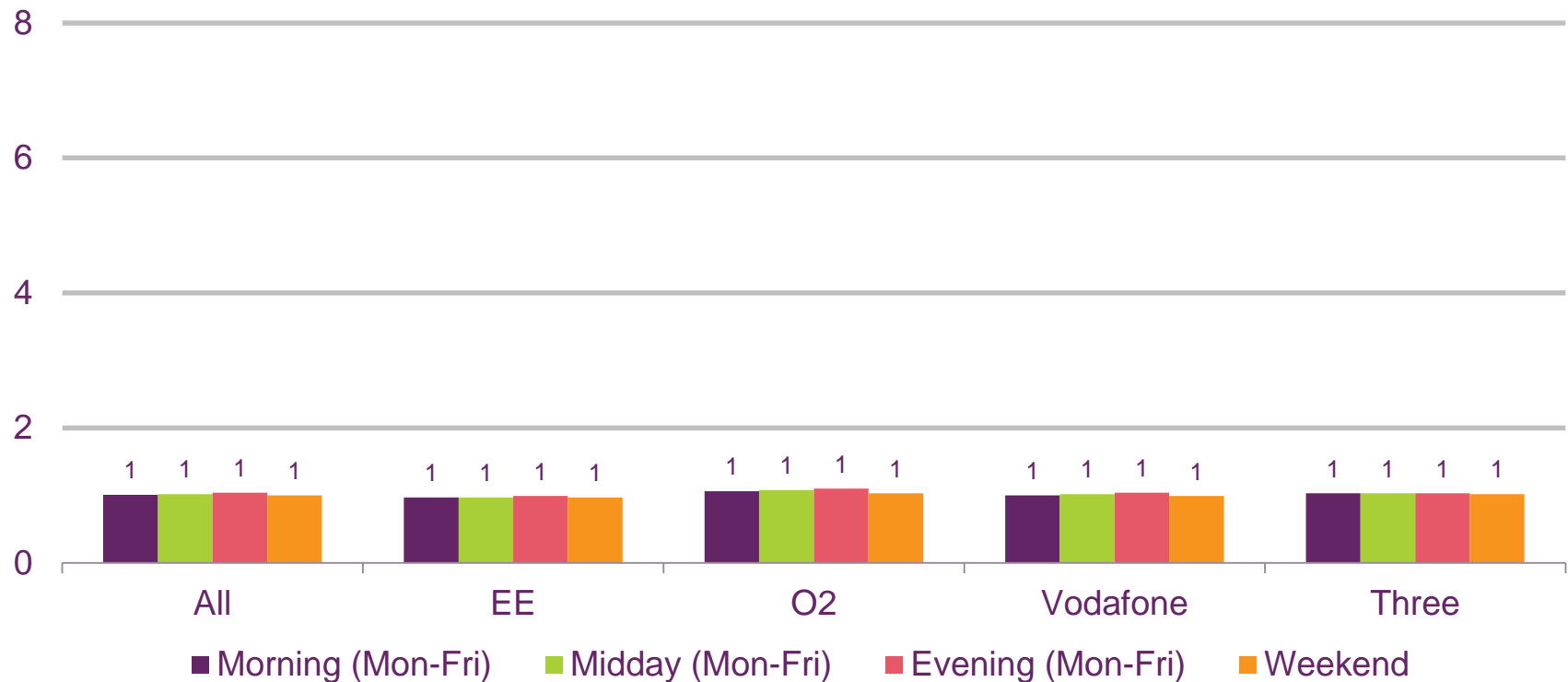


Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

Note: Average (median) of all tests gathered with 4G as the best bearer. Morning is 7am to 10am, midday is 10am to 4.30pm and evening is 4.30pm to 8pm.

## Figure 51: Average 4G tariff YouTube homepage load time, by MNO and time of day

seconds



Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

Note: Average (median) of all tests gathered with 4G as the best bearer. Morning is 7am to 10am, midday is 10am to 4.30pm and evening is 4.30pm to 8pm.

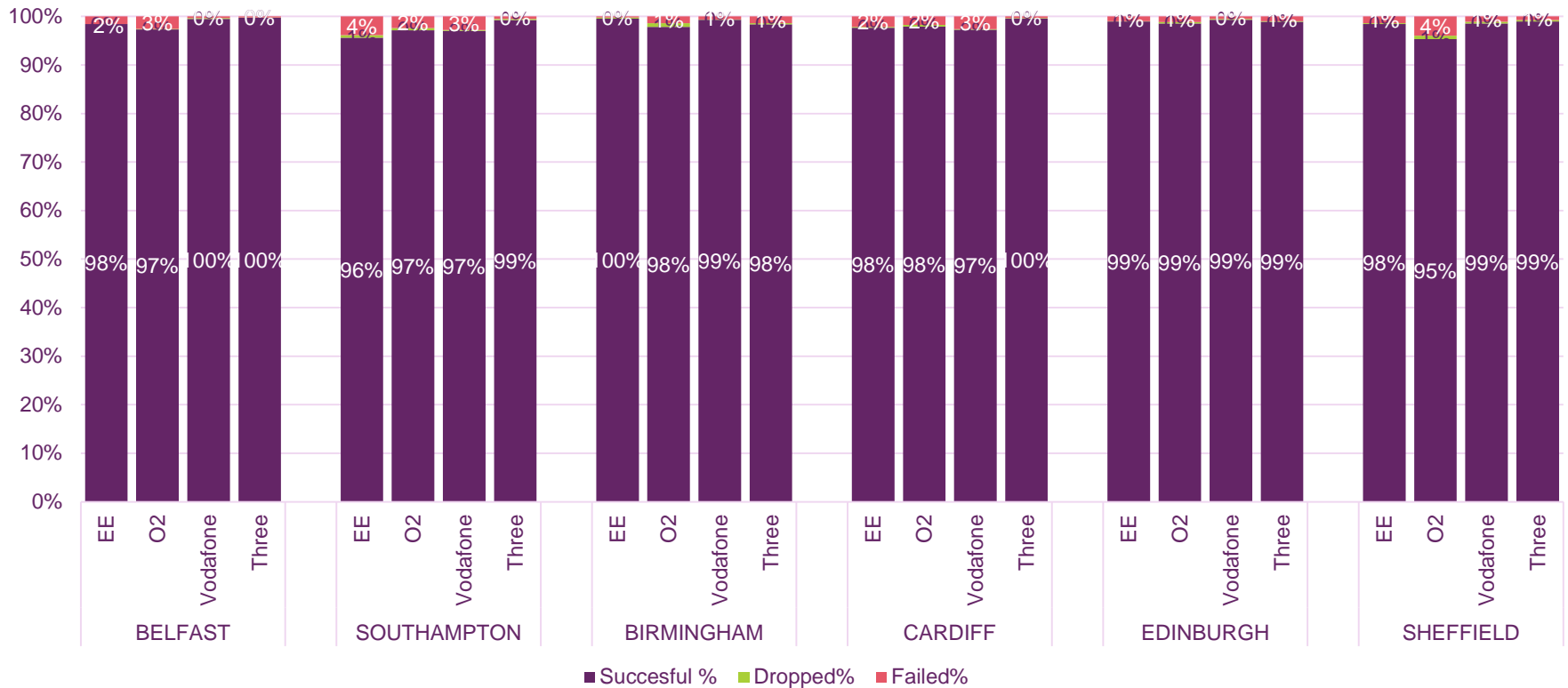


# Smartphone Cities

Additional analysis – voice call performance

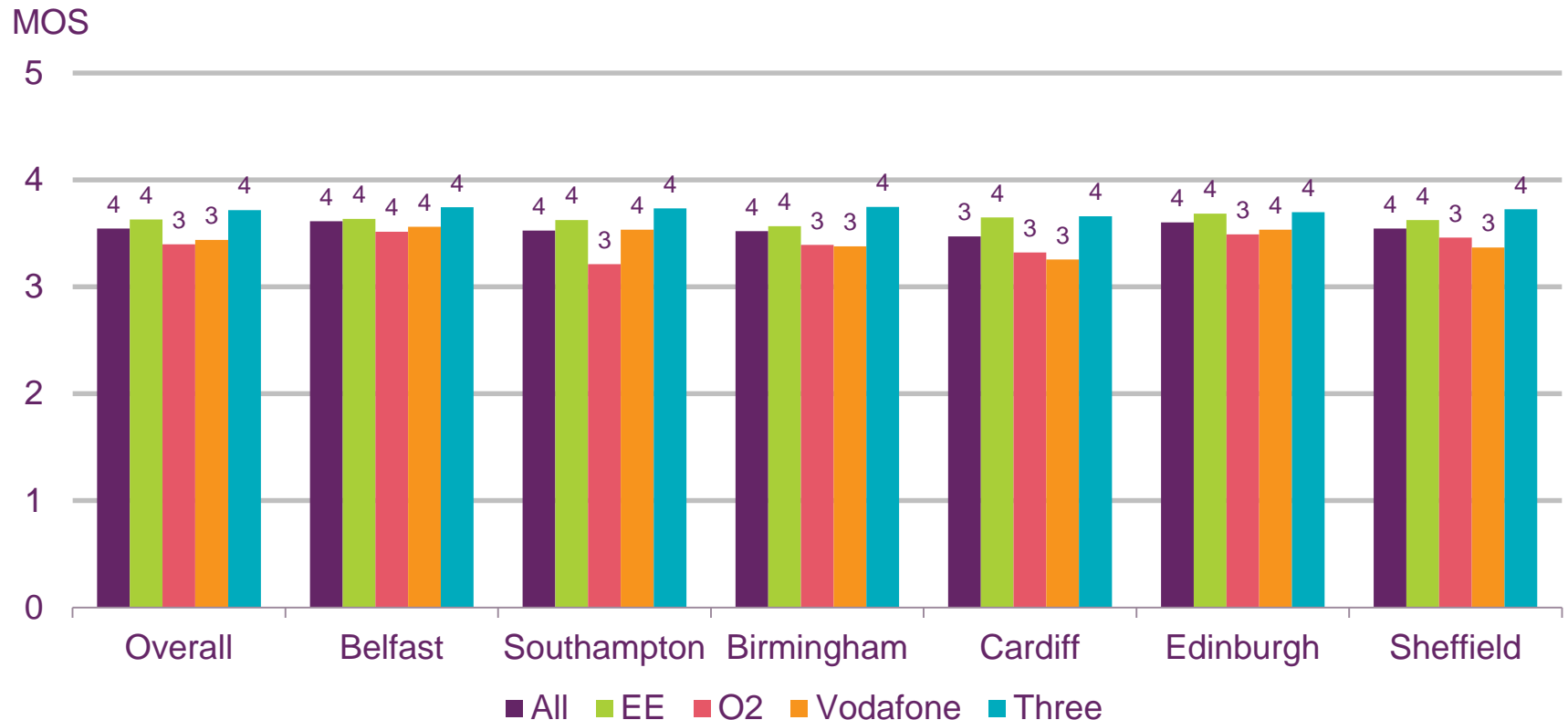
## Figure 52: Call success rates, by operator and city

Proportion of samples



Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

### Figure 53: Average mobile call voice quality; by city



Source: Ofcom mobile broadband measurements, fieldwork July to October 2016.

Note: Average (mean) of all tests gathered with 4G as the best bearer. 'MOS' stands for mean opinion score and scores range from 1 (bad) to 5 (excellent).

**Figure 54: Average mobile call voice quality on a 4G tariff; significant differences**

	Highest score	2 <sup>nd</sup> highest score	3 <sup>rd</sup> highest score	4 <sup>th</sup> highest score
Overall	Three	EE	Vodafone	O2
Belfast	Three	EE	Vodafone	O2
Southampton	Three	EE	Vodafone	O2
Birmingham	Three	EE	O2	Vodafone
Cardiff	Three	EE	O2	Vodafone
Edinburgh	Three	EE	Vodafone	O2
Sheffield	Three	EE	O2	Vodafone

Source: Ofcom

Note: Differences are significant to a 95% confidence level.