

# Smartphone Cities

Charts included in the report

**Figure 1: Scorecard**

	Web browsing speed		Download speed	
	Average speed	Successful loading	Average speed	Speeds over 2Mbit/s
EE	5 seconds	98%	20Mbit/s	92%
O2	6 seconds	89%	10Mbit/s	69%
Three	6 seconds	95%	15Mbit/s	87%
Vodafone	6 seconds	91%	12Mbit/s	82%

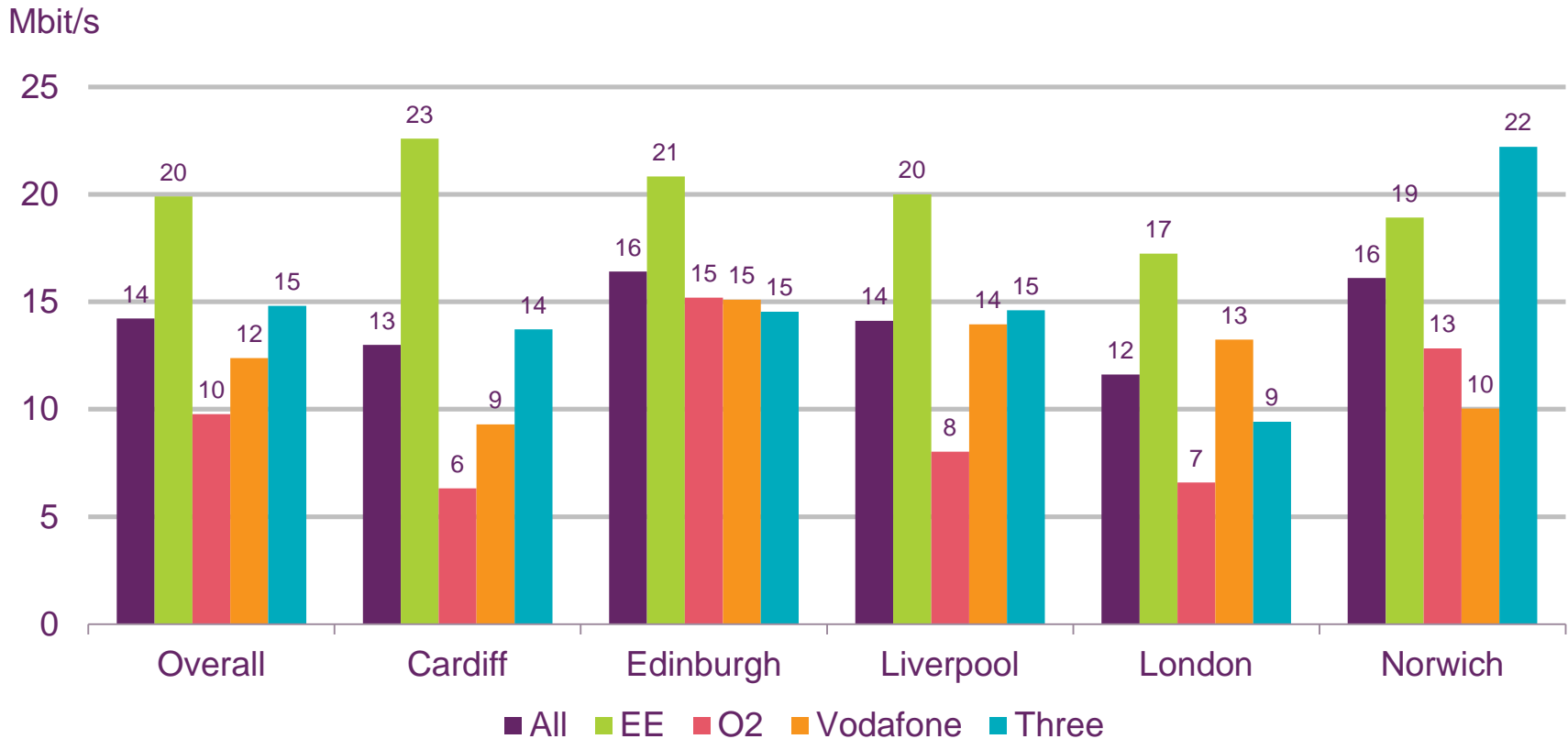
Source: Ofcom mobile broadband measurements, fieldwork November and December 2015.

Note: Average (mean) 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	TalkTalk, Lebara Mobile

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



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

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

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

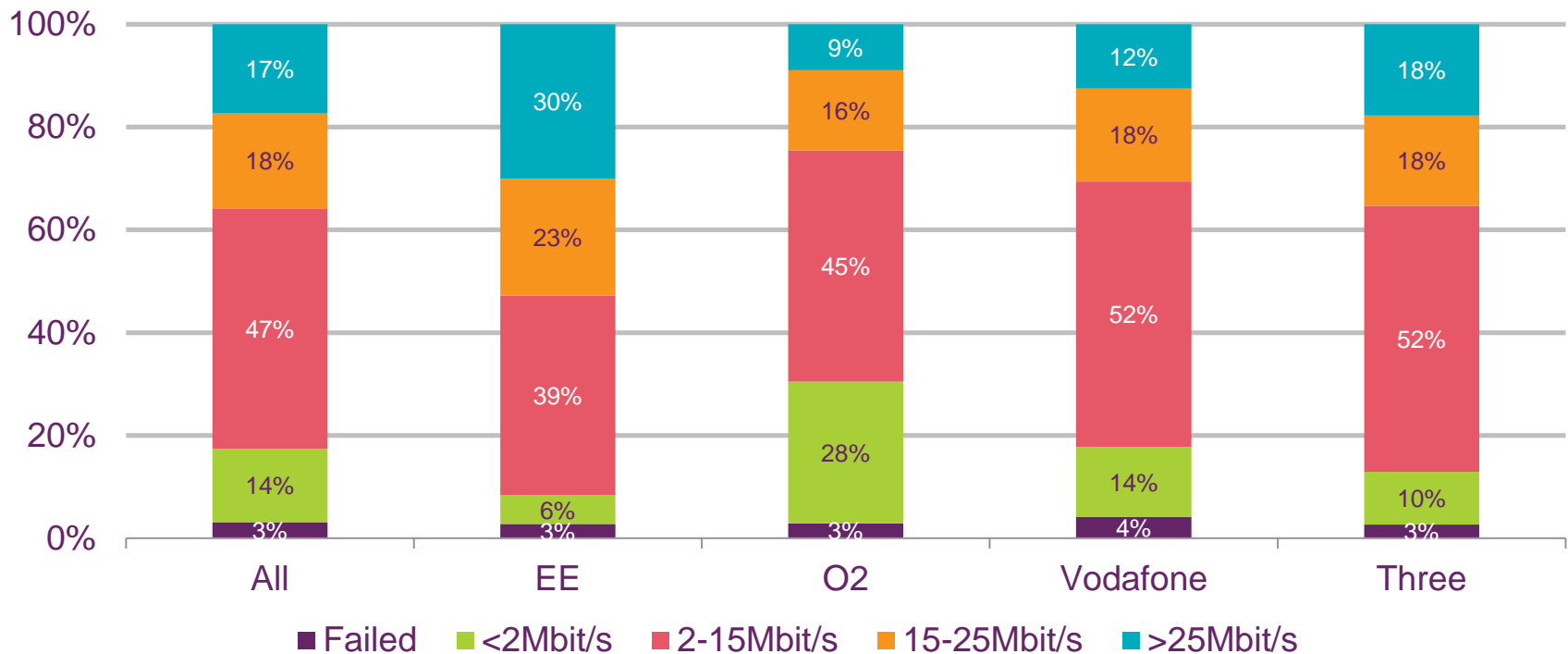
	Fastest	2 <sup>nd</sup> Fastest	3 <sup>rd</sup> Fastest	4 <sup>th</sup> Fastest
Overall	EE	Three	Vodafone	O2
Cardiff	EE	Three	Vodafone	O2
Edinburgh	EE	O2, Three, Vodafone (=)	-	-
Liverpool	EE	Three, Vodafone (=)	-	O2
London	EE	Vodafone	Three	O2
Norwich	Three	EE	O2	Vodafone

Source: Ofcom

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

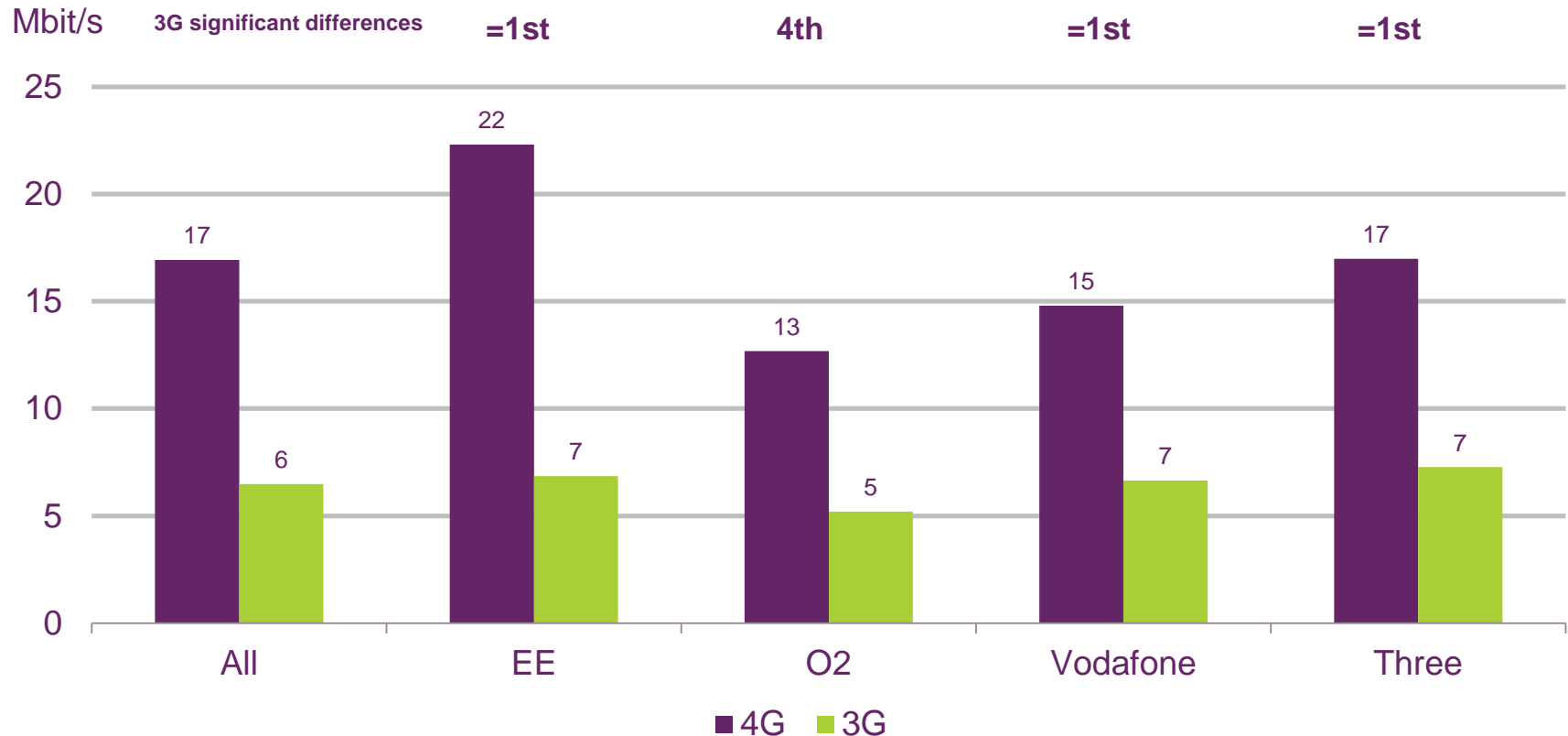
## Figure 5: Distribution of 4G tariff download results; by operator

Proportion of samples



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

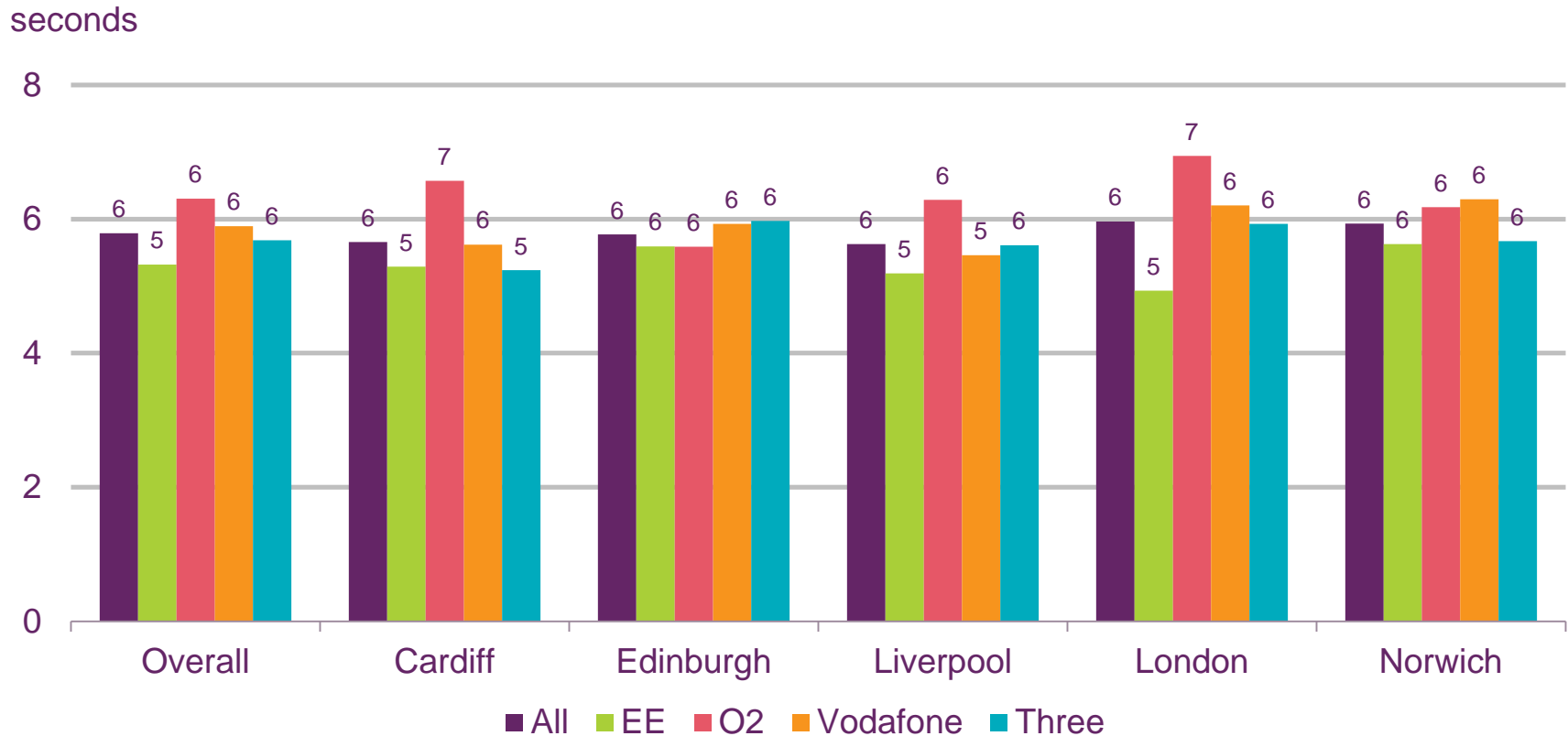
## Figure 6: Average download speed - 4G v 3G, by operator



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

Note: Average (mean) of all tests gathered on 4G only and 3G only.

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



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

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



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

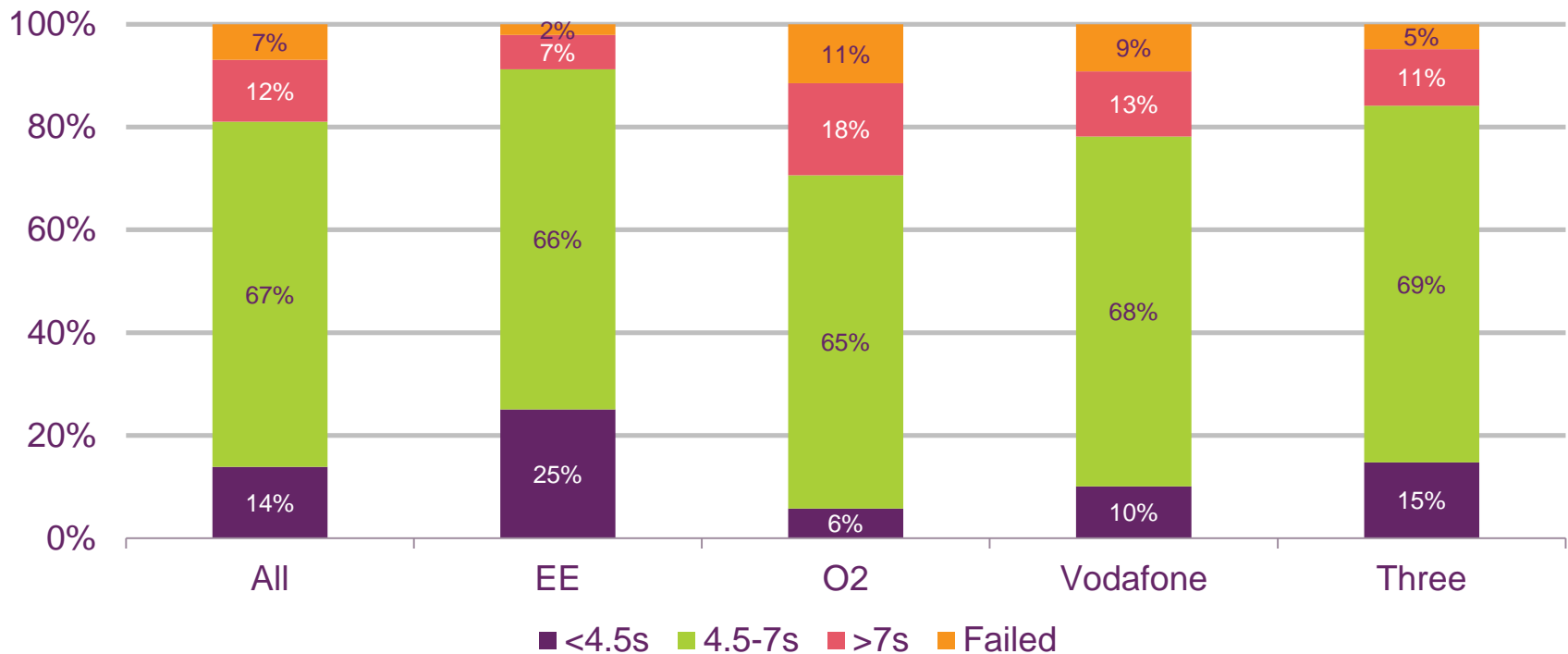
	Fastest	2 <sup>nd</sup> Fastest	3 <sup>rd</sup> Fastest	4 <sup>th</sup> Fastest
Overall	EE	Three	Vodafone	O2
Cardiff	EE, Three (=)	-	Vodafone	O2
Edinburgh	EE, O2 (=)	-	Three, Vodafone (=)	-
Liverpool	EE	Three, Vodafone (=)	-	O2
London	EE	Three	Vodafone	O2
Norwich	EE, Three (=)	-	O2, Vodafone (=)	-

Source: Ofcom

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

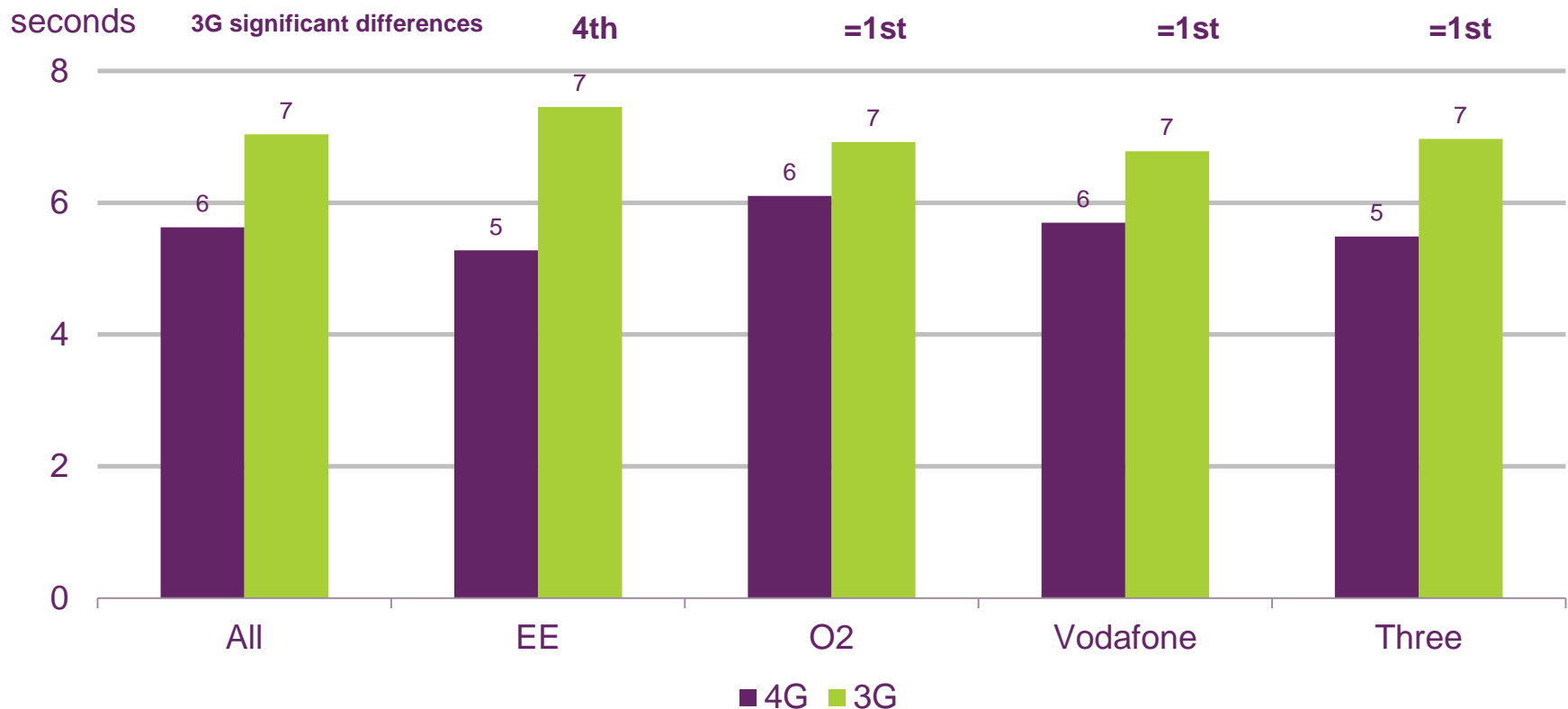
## Figure 9: Distribution of 4G tariff BBC homepage loading time results

Proportion of samples



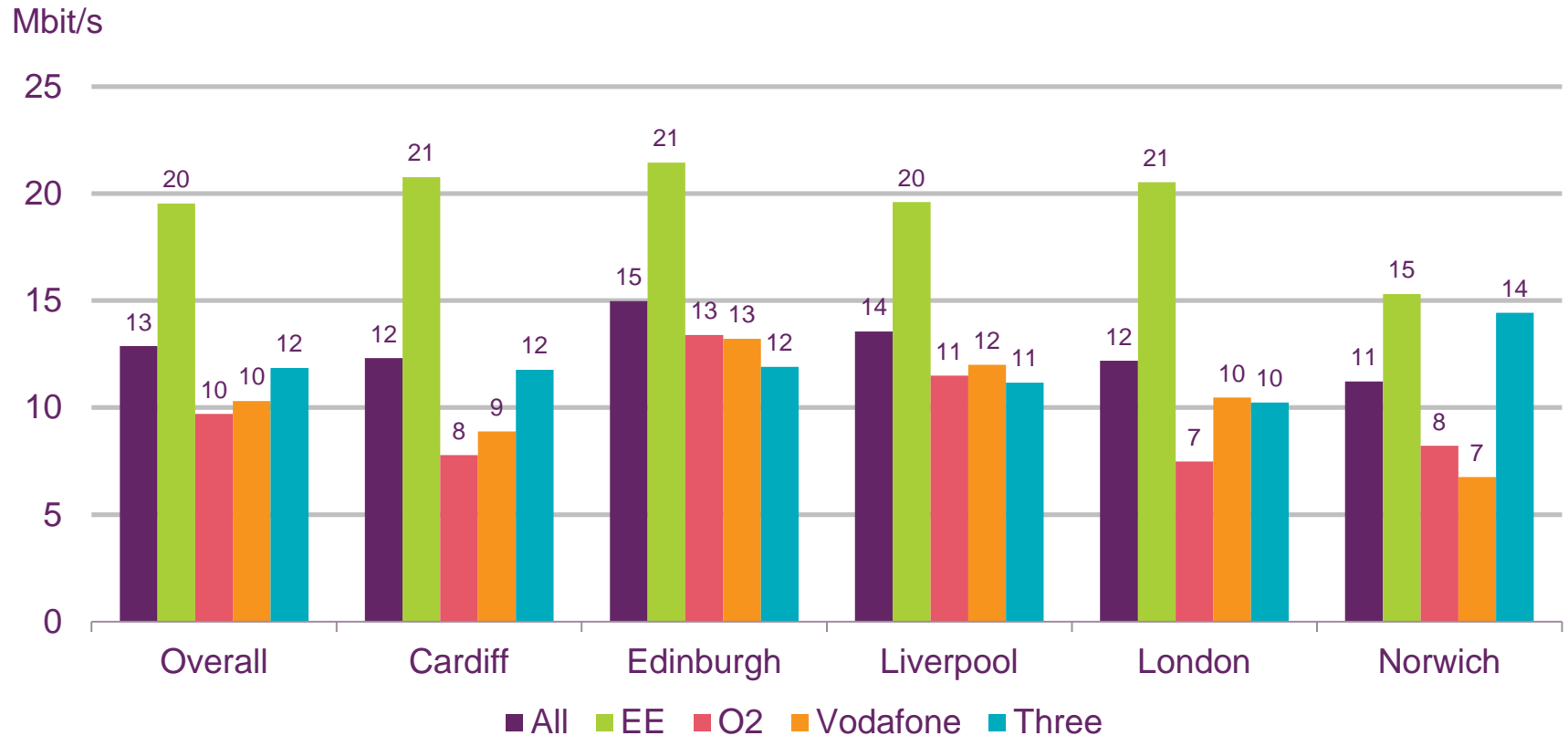
Source: Ofcom mobile broadband measurements, fieldwork November and December 2015.

**Figure 10: Average BBC home page load time, 3G versus 4G**



Source: Ofcom mobile broadband measurements, fieldwork November and December 2015.  
 Note: Average (mean) of all tests gathered on 4G only and 3G only.

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



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

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

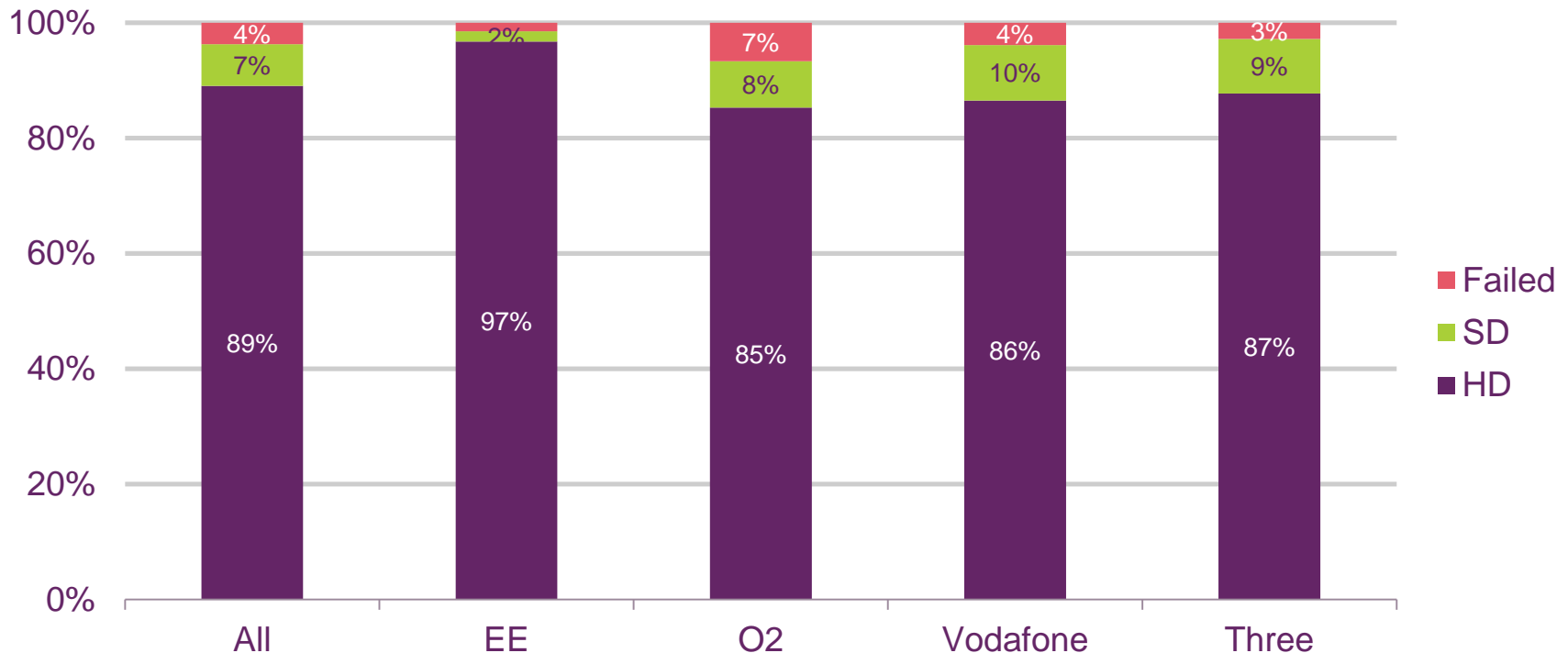
**Figure 12: Average 4G tariff upload speed: significant differences**

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

Source: Ofcom

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

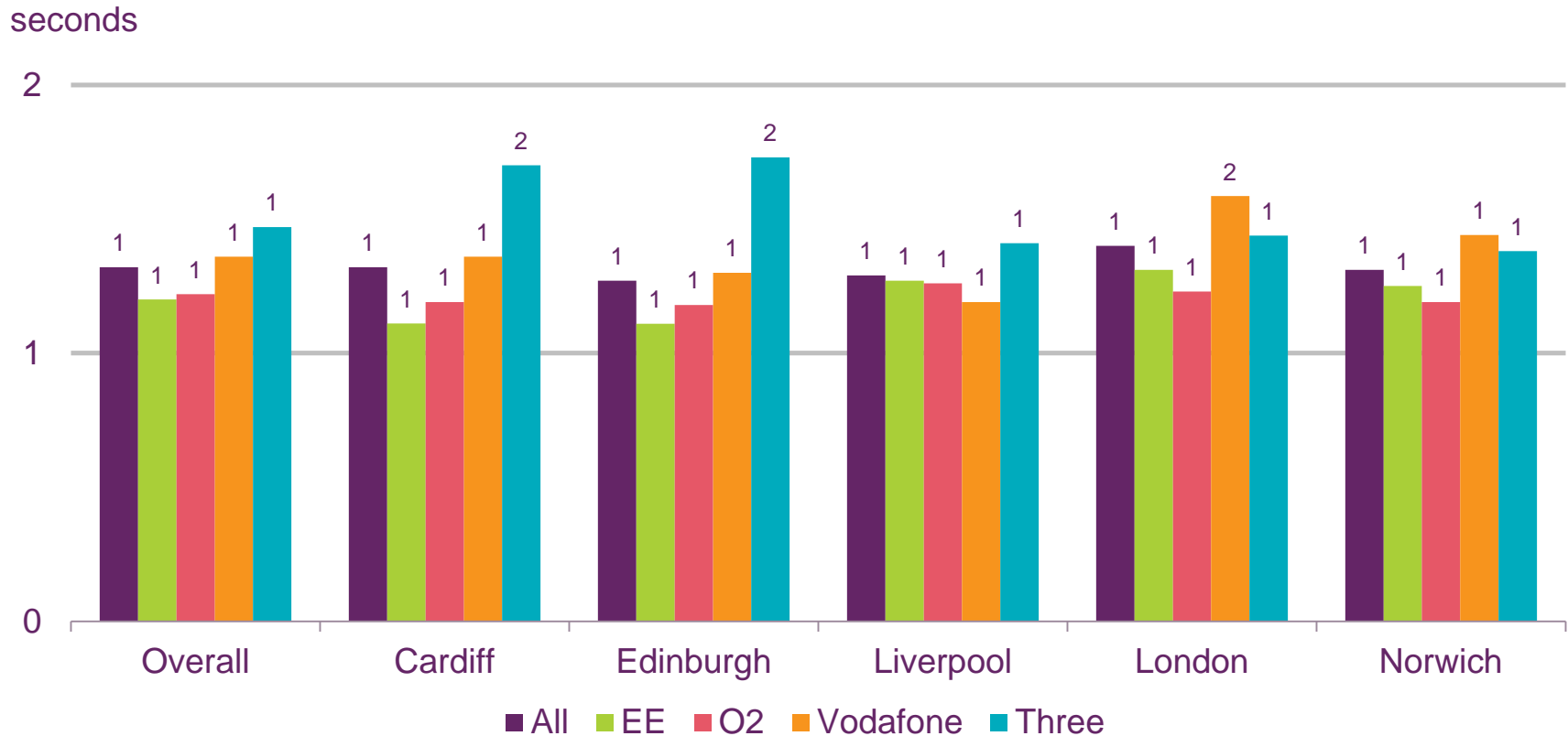
**Figure 13: Video streaming resolution on a 4G tariff**



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

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 tariff standard web page load time



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

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

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

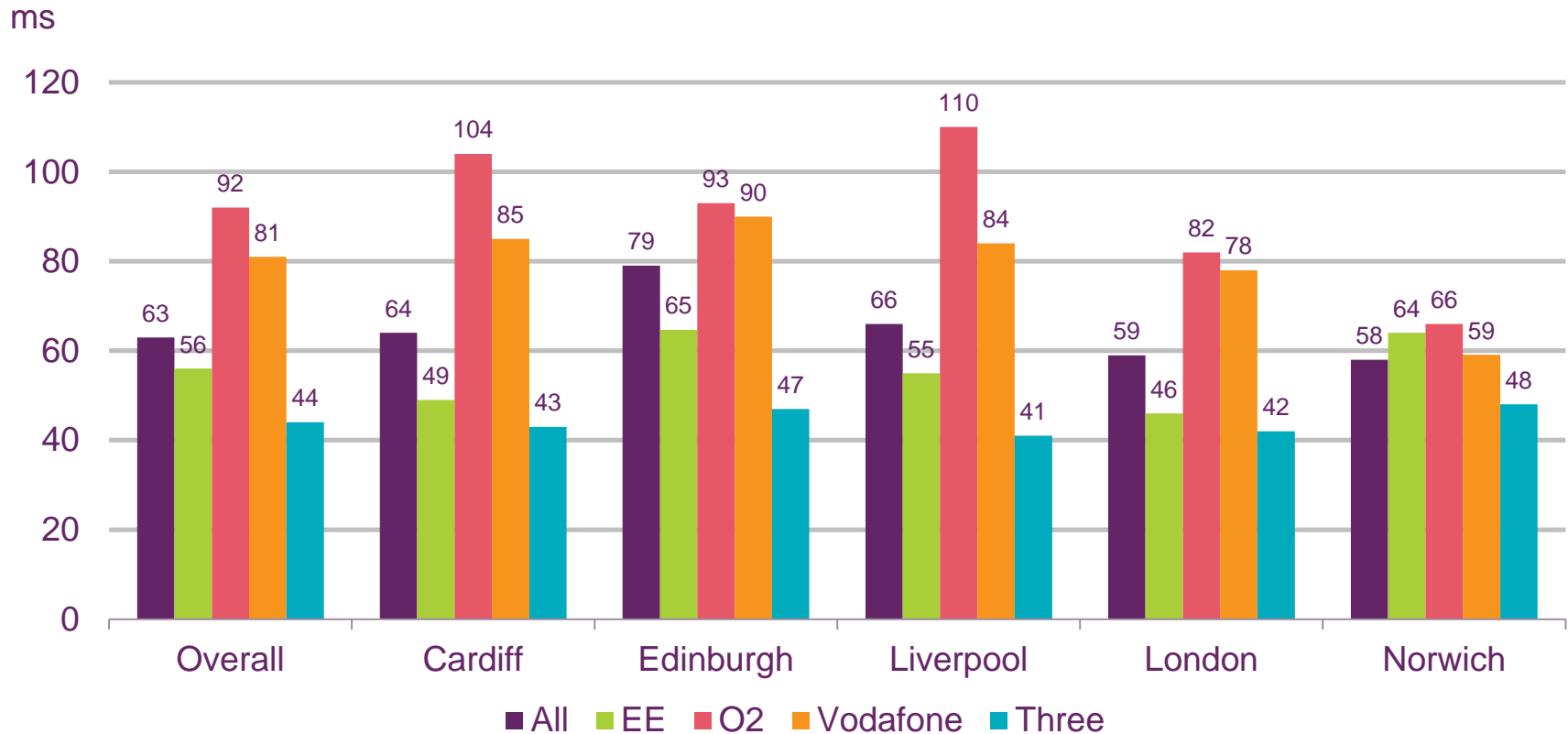
	Fastest	2 <sup>nd</sup> Fastest	3 <sup>rd</sup> Fastest	4 <sup>th</sup> Fastest
Overall	EE, O2 (=)	-	Vodafone	Three
Cardiff	EE	O2	Vodafone	Three
Edinburgh	EE	O2	Vodafone	Three
Liverpool	Vodafone	EE, O2 (=)	-	Three
London	O2	EE	Three	Vodafone
Norwich	O2	EE	Three	Vodafone

Source: Ofcom

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



## Figure 16: Average 4G tariff response time



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

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

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

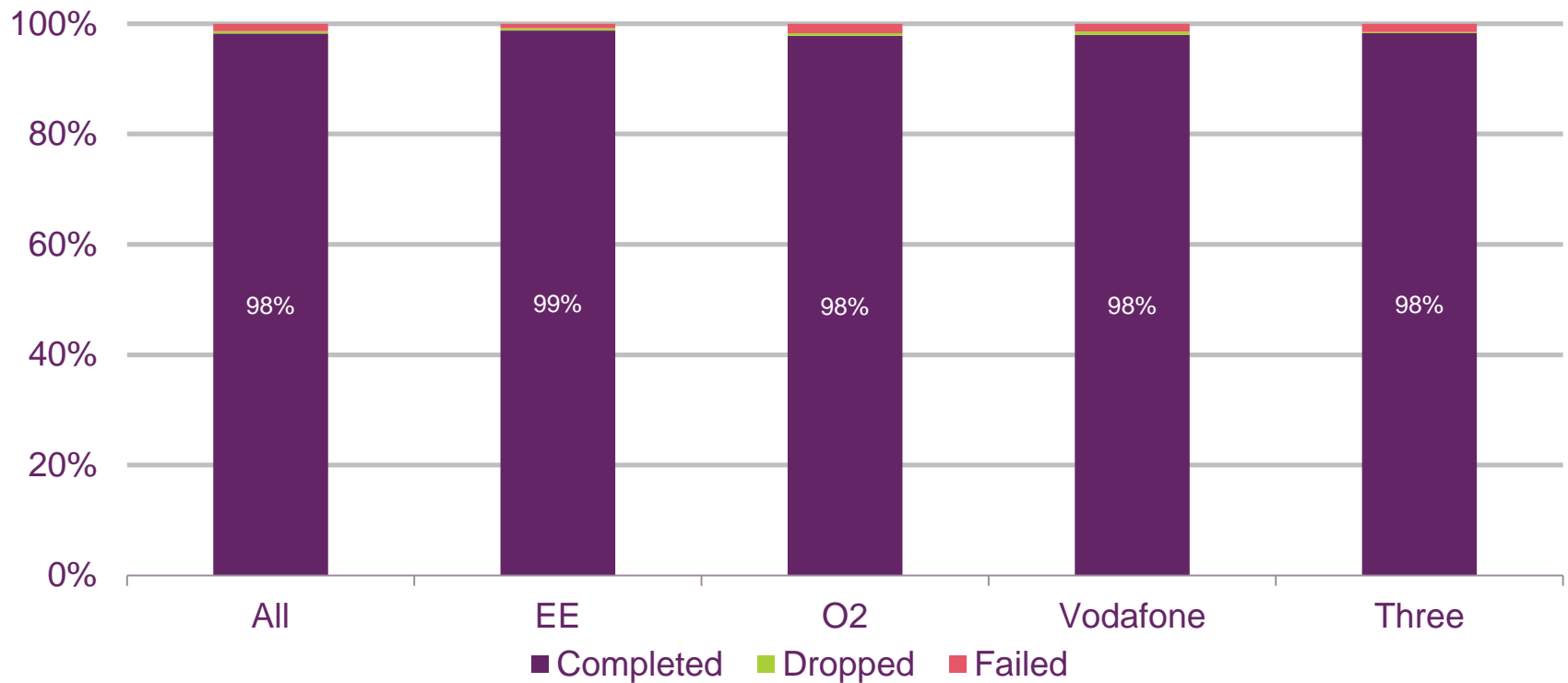
	Fastest	2 <sup>nd</sup> Fastest	3 <sup>rd</sup> Fastest	4 <sup>th</sup> Fastest
Overall	Three	EE	Vodafone	O2
Cardiff	Three	EE	Vodafone	O2
Edinburgh	Three	EE	Vodafone	O2
Liverpool	Three	EE	Vodafone	O2
London	Three	EE	Vodafone	O2
Norwich	Three	Vodafone	EE	O2

Source: Ofcom

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

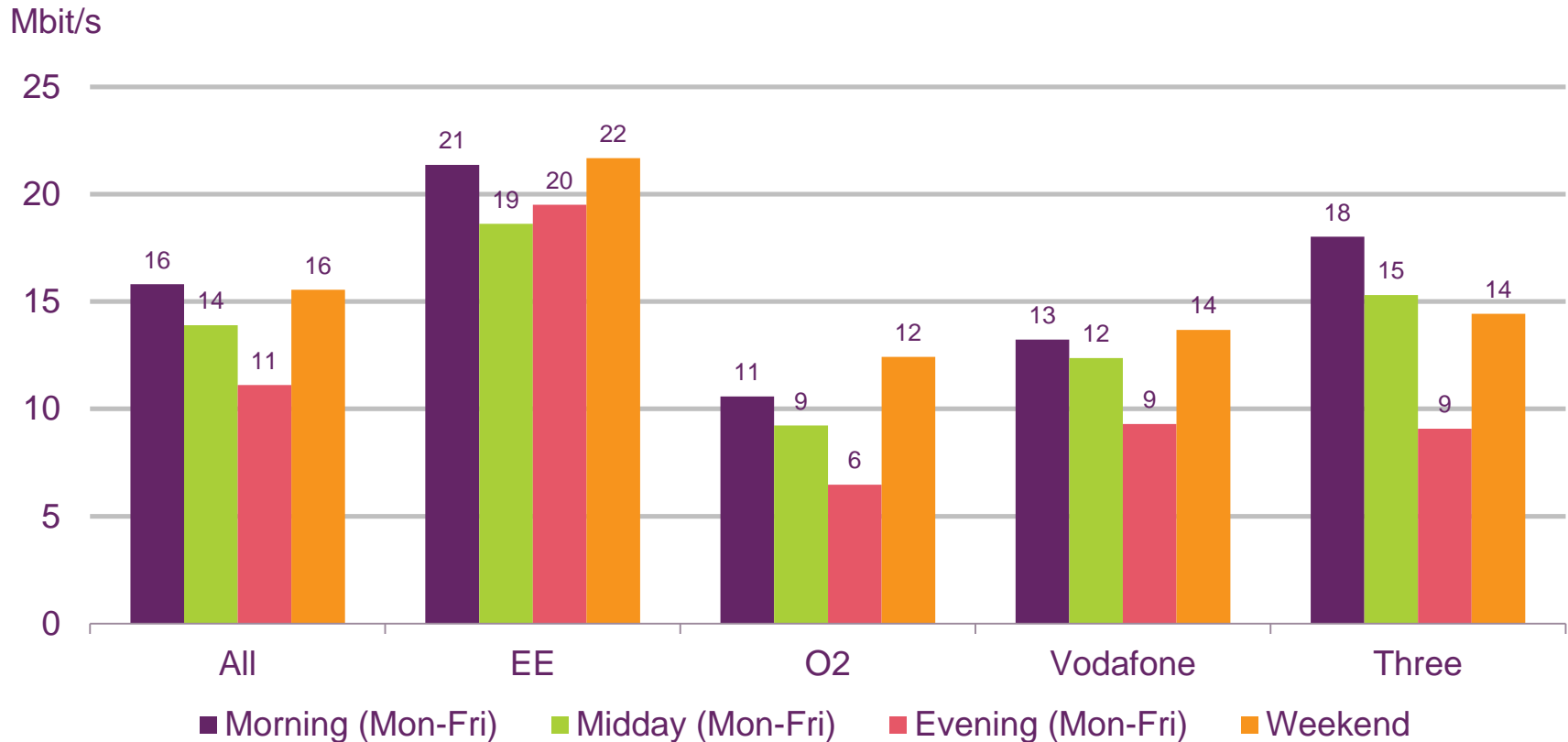
## Figure 18: Call success rate

Proportion of samples



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

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



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

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 tariff download speed, by MNO and time of day: significant differences**

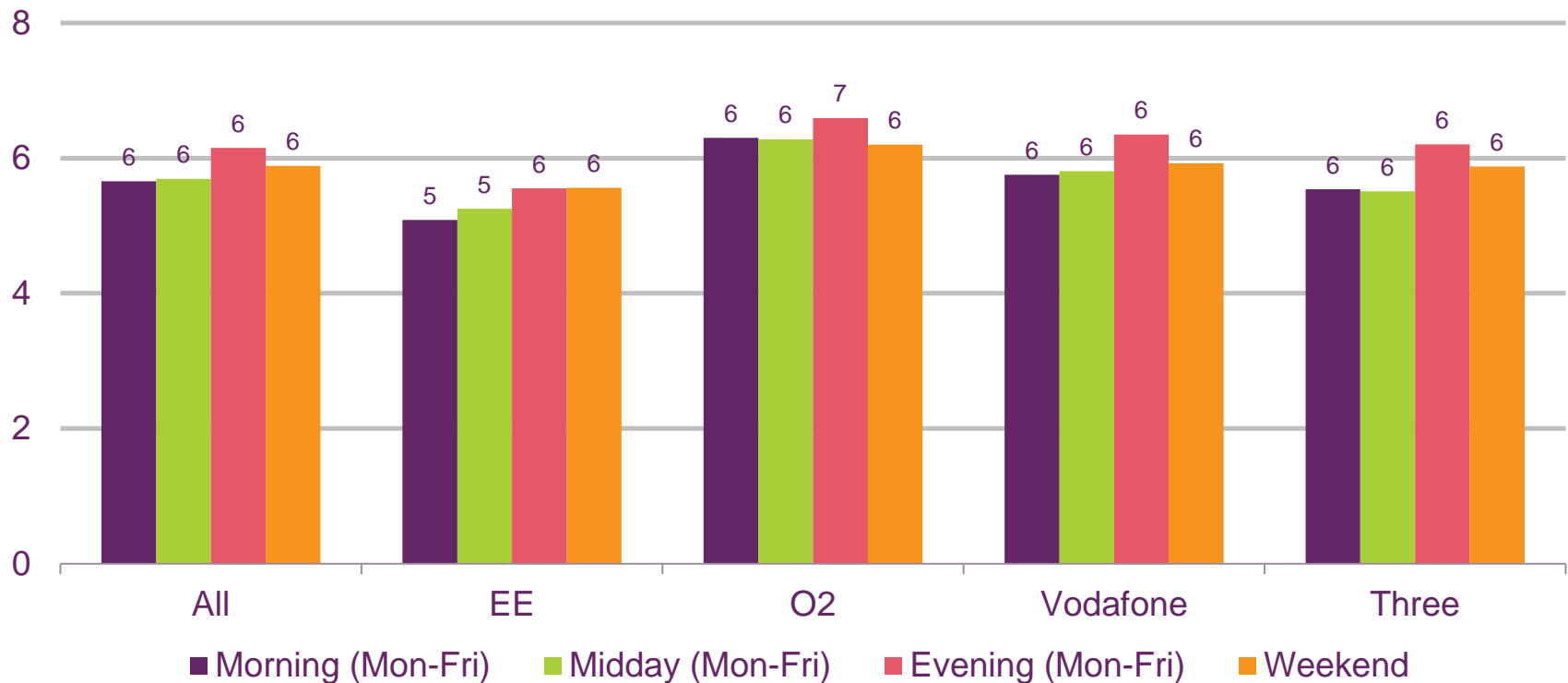
	<b>Fastest</b>	<b>2<sup>nd</sup> Fastest</b>	<b>3<sup>rd</sup> Fastest</b>	<b>4<sup>th</sup> Fastest</b>
Overall	Morning, Weekends (=)	-	Midday	Evening
EE	Morning, Weekends (=)	-	Midday, Evening (=)	-
O2	Weekends	Morning, Midday (=)	-	Evening
Vodafone	Afternoon, Morning, Weekends (=)	-	-	Evening
Three	Morning	Midday, Weekends (=)	-	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 21: Average 4G tariff BBC homepage load time, by MNO and time of day**

seconds



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

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 tariff 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, Midday (=)	-	Weekend	Evening
EE	Morning	Midday	Weekend, Evening (=)	-
O2	Morning, Midday, Weekend (=)	-	-	Evening
Vodafone	Morning, Midday, Weekend (=)	-	-	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).

## Figure 23: Metric Summary



	Cardiff				Edinburgh			
Metric	EE	O2	Three	Vodafone	EE	O2	Three	Vodafone
<b>Download Speed</b>								
Average speed	23 Mbit/s	6 Mbit/s	14 Mbit/s	9 Mbit/s	21Mbit/s	15Mbit/s	15Mbit/s	15Mbit/s
% over 2Mbit/s	95%	54%	92%	74%	92%	96%	87%	94%
<b>Web browsing</b>								
BBC homepage load time: average	5s	7s	5s	6s	6s	6s	6s	6s
BBC homepage success rate	99%	88%	97%	89%	96%	92%	96%	92%
Standard webpage load time: average	1s	1s	2s	1s	1s	1s	2s	1s
Standard webpage success rate	99%	95%	98%	90%	96%	96%	95%	96%
<b>Upload speed: average</b>	21Mbit/s	8Mbit/s	12Mbit/s	9Mbit/s	21Mbit/s	13Mbit/s	12Mbit/s	13Mbit/s
<b>YouTube</b>								
% of HD streams	98%	83%	94%	88%	96%	96%	72%	91%
Time to first picture: average	2s	4s	2s	3s	2s	3s	2s	3s
Video Quality: average MOS	4	4	4	4	4	4	4	4
<b>Response time: average</b>	49ms	104ms	43ms	85ms	65ms	93ms	47ms	90ms
<b>Voice calls</b>								
Mobile to fixed call success rate	99%	97%	99%	98%	98%	97%	98%	98%
Mobile to mobile call quality: average MOS	4	4	4	4	4	4	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).



# Figure 24: Metric Summary



	Liverpool				London				Norwich			
Metric	EE	O2	Three	Vodafone	EE	O2	Three	Vodafone	EE	O2	Three	Vodafone
<b>Download Speed</b>												
Average speed	20Mbit/s	8Mbit/s	15Mbit/s	14Mbit/s	17Mbit/s	7Mbit/s	9Mbit/s	13Mbit/s	19Mbit/s	13Mbit/s	22Mbit/s	10Mbit/s
% over 2Mbit/s	91%	73%	89%	93%	92%	59%	81%	80%	89%	67%	88%	70%
<b>Web browsing</b>												
BBC homepage load time: average	5s	6s	6s	5s	5s	7s	6s	6s	6s	6s	6s	6s
BBC homepage success rate	99%	92%	97%	97%	99%	87%	96%	87%	96%	85%	90%	90%
Standard webpage load time: average	1s	1s	1s	1s	1s	1s	1s	2s	1s	1s	1s	1s
Standard webpage success rate	99%	97%	95%	99%	99%	97%	98%	92%	99%	91%	93%	95%
<b>Upload speed: average</b>	20Mbit/s	11Mbit/s	11Mbit/s	12Mbit/s	21Mbit/s	7Mbit/s	10Mbit/s	10Mbit/s	15Mbit/s	8Mbit/s	14Mbit/s	7Mbit/s
<b>YouTube</b>												
% of HD streams	97%	95%	92%	96%	99%	75%	94%	83%	94%	77%	86%	74%
Time to first picture: average	2s	4s	3s	3s	2s	3s	3s	3s	2s	4s	2s	3s
Video Quality: average MOS	4	4	4	4	4	4	4	4	4	4	4	4
<b>Response time: average</b>	55ms	110ms	41ms	84ms	46ms	82ms	42ms	78ms	64ms	66ms	48ms	59ms
<b>Voice calls</b>												
Mobile to fixed call success rate	99%	99%	99%	99%	99%	97%	99%	98%	99%	98%	97%	96%
Mobile to mobile call quality: average MOS	4	4	4	4	4	4	4	4	4	4	4	4

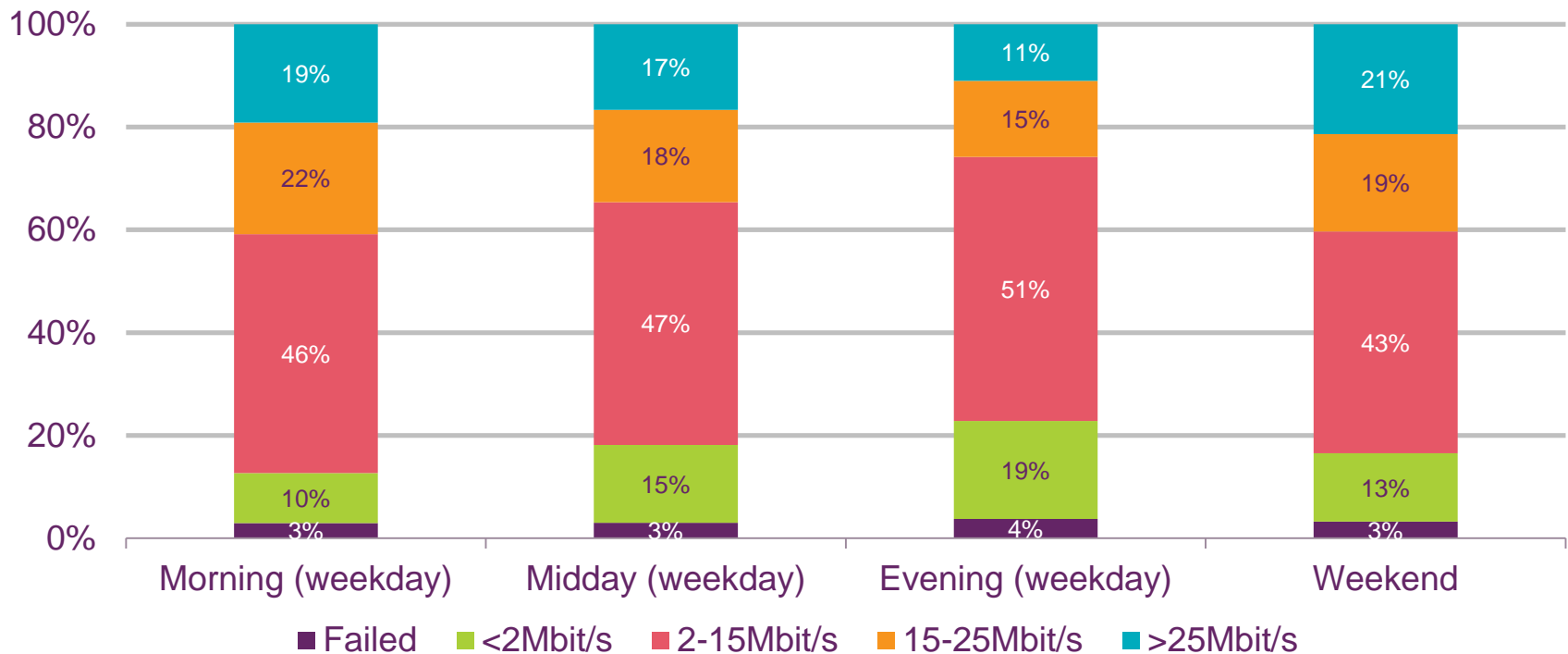
Source: Ofcom. Note: 's' is seconds and 'ms' is milliseconds. 'MOS' stands for mean opinion score and scores range from 1 (bad) to 5 (excellent).

# Smartphone Cities

Additional analysis – download speeds

## Figure 25: Distribution of 4G tariff download speeds, by daypart

Proportion of test samples

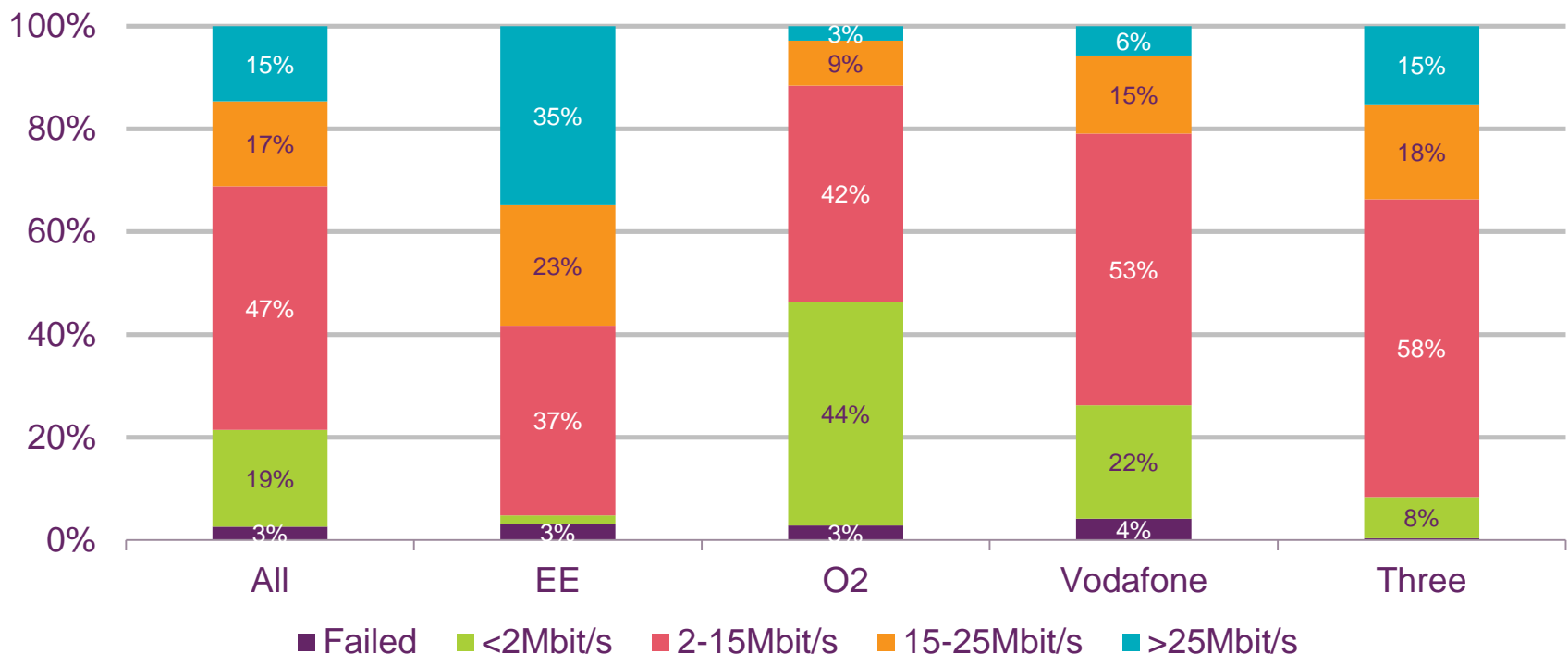


Source: Ofcom mobile broadband measurements, fieldwork November and December 2015.

Note: Morning is 7am to 10am, midday is 10am to 4.30pm and evening is 4.30pm to 8pm.

## Figure 26: Distribution of 4G tariff download speeds, by operator; Cardiff

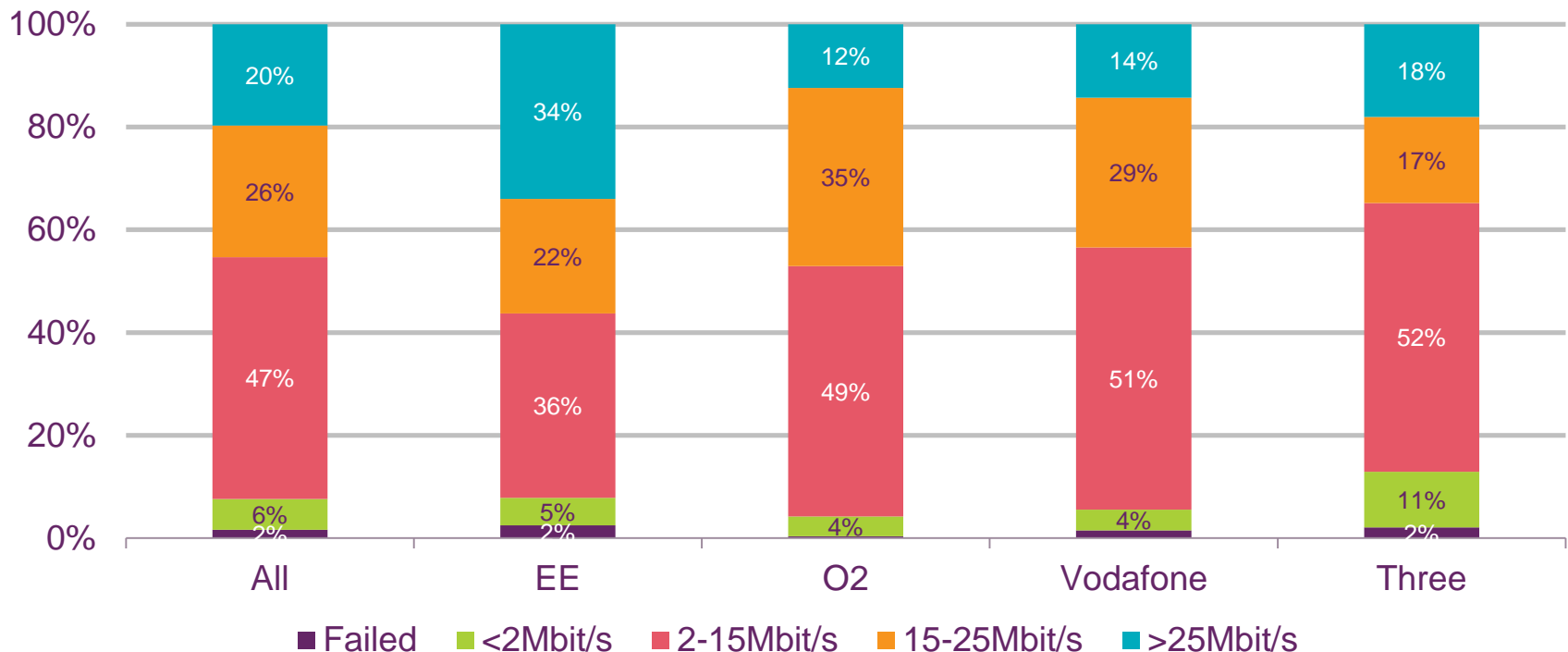
Proportion of samples



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

## Figure 27: Distribution of 4G tariff download speeds, by operator; Edinburgh

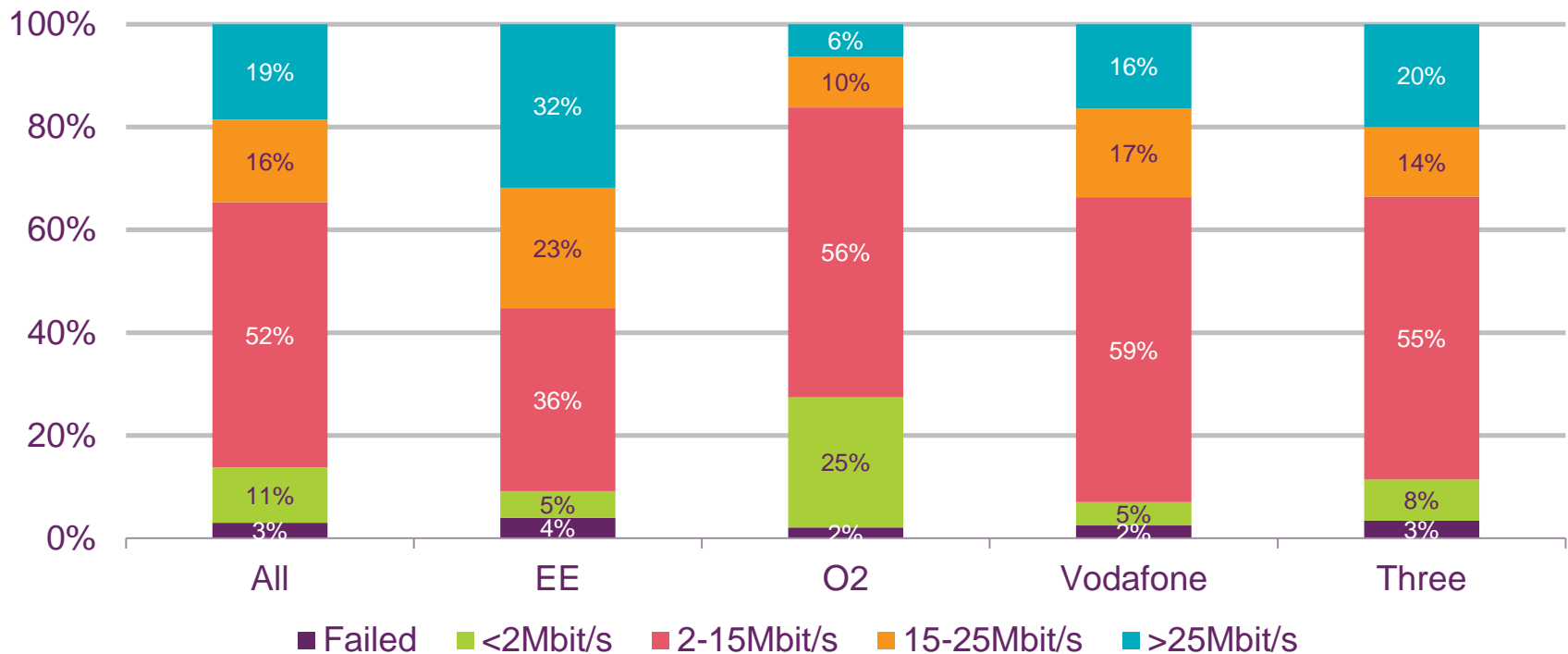
Proportion of samples



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

## Figure 28: Distribution of 4G tariff download speeds, by operator; Liverpool

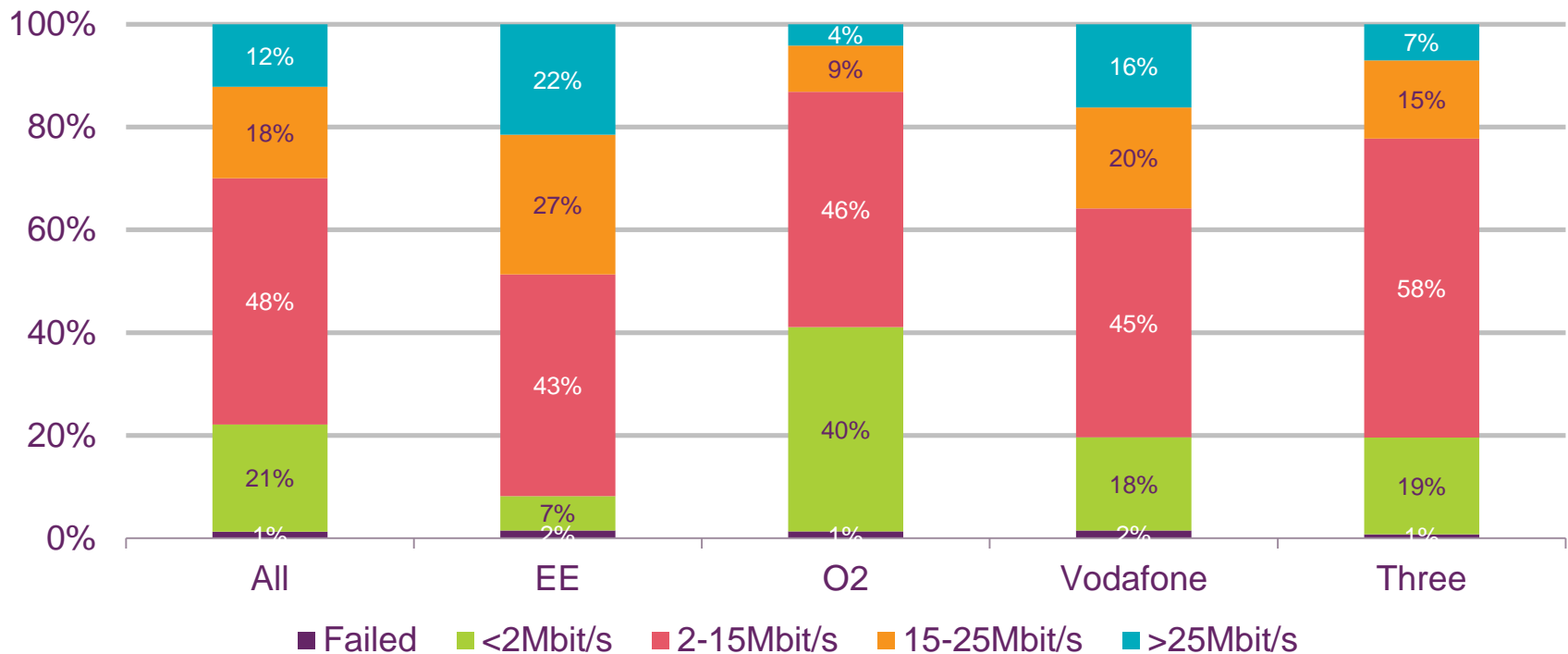
Proportion of samples



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

## Figure 29: Distribution of 4G tariff download speeds, by operator; London

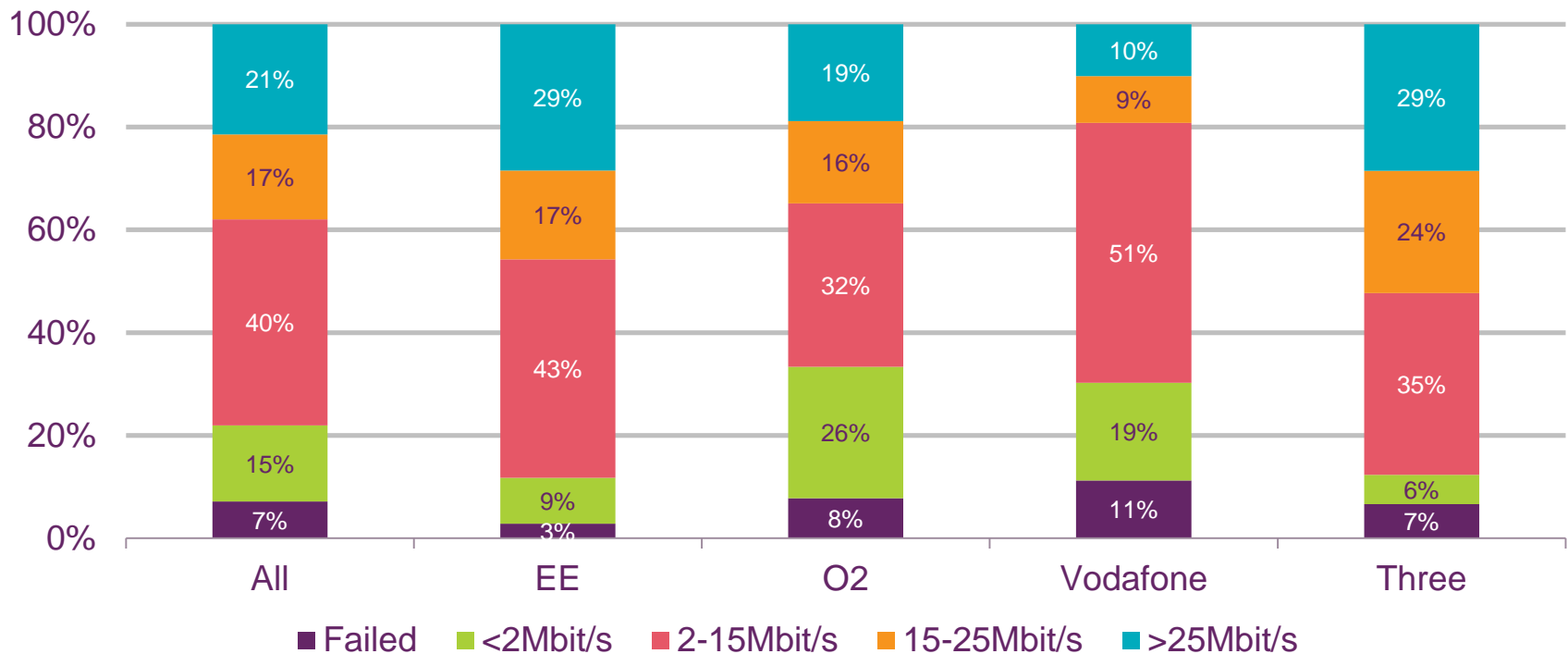
Proportion of samples



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

## Figure 30: Distribution of 4G tariff download speeds, by operator; Norwich

Proportion of samples



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

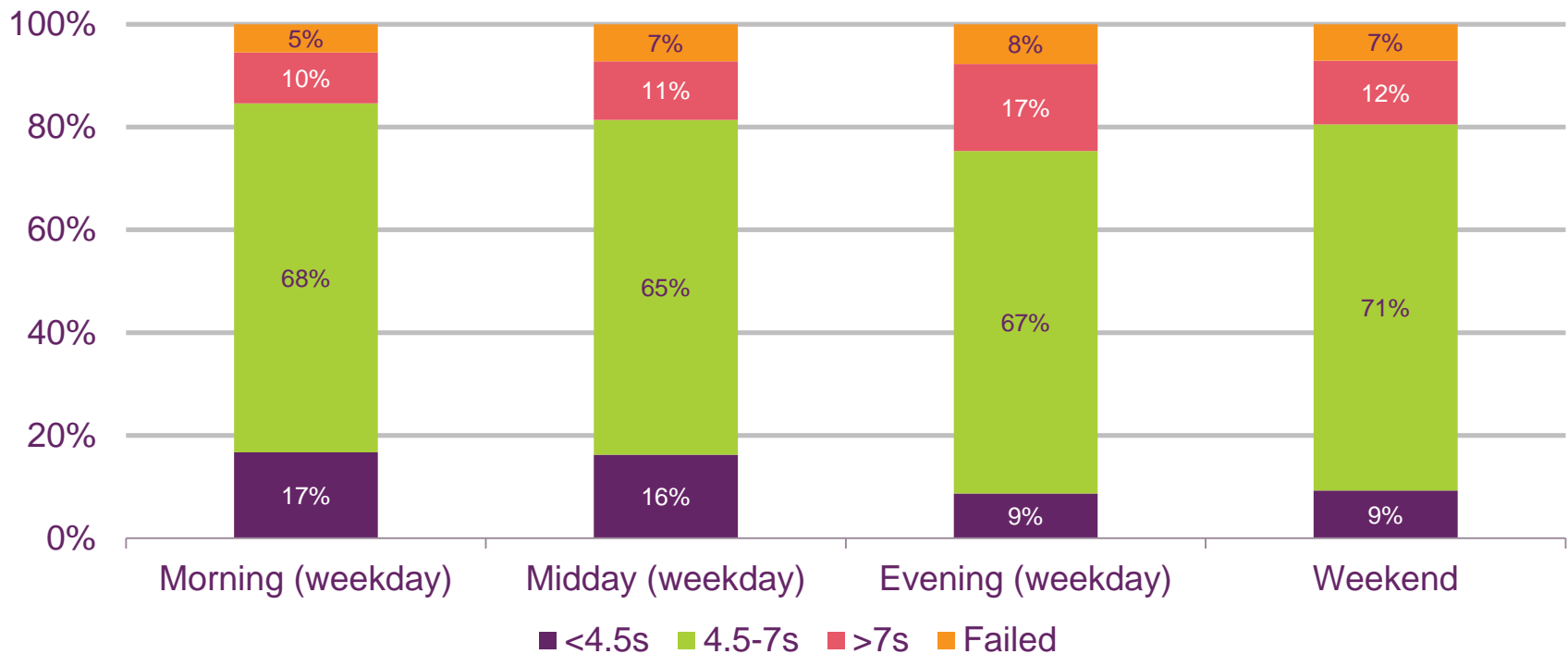


# Smartphone Cities

Additional analysis – BBC homepage web browsing

## Figure 31: Distribution of 4G tariff BBC homepage load time, by daypart

Proportion of test samples

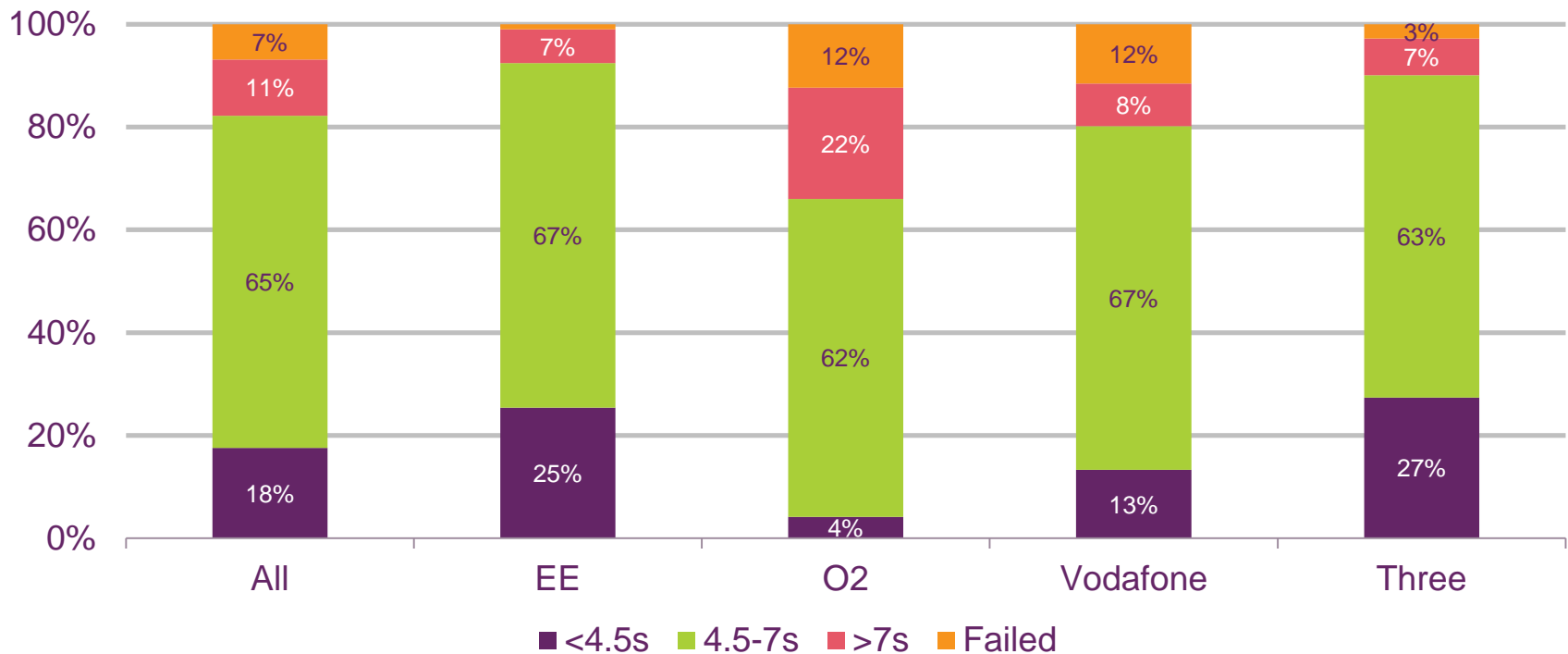


Source: Ofcom mobile broadband measurements, fieldwork November and December 2015.

Note: Morning is 7am to 10am, midday is 10am to 4.30pm and evening is 4.30pm to 8pm.

## Figure 32: Distribution of 4G tariff BBC homepage load time, by operator; Cardiff

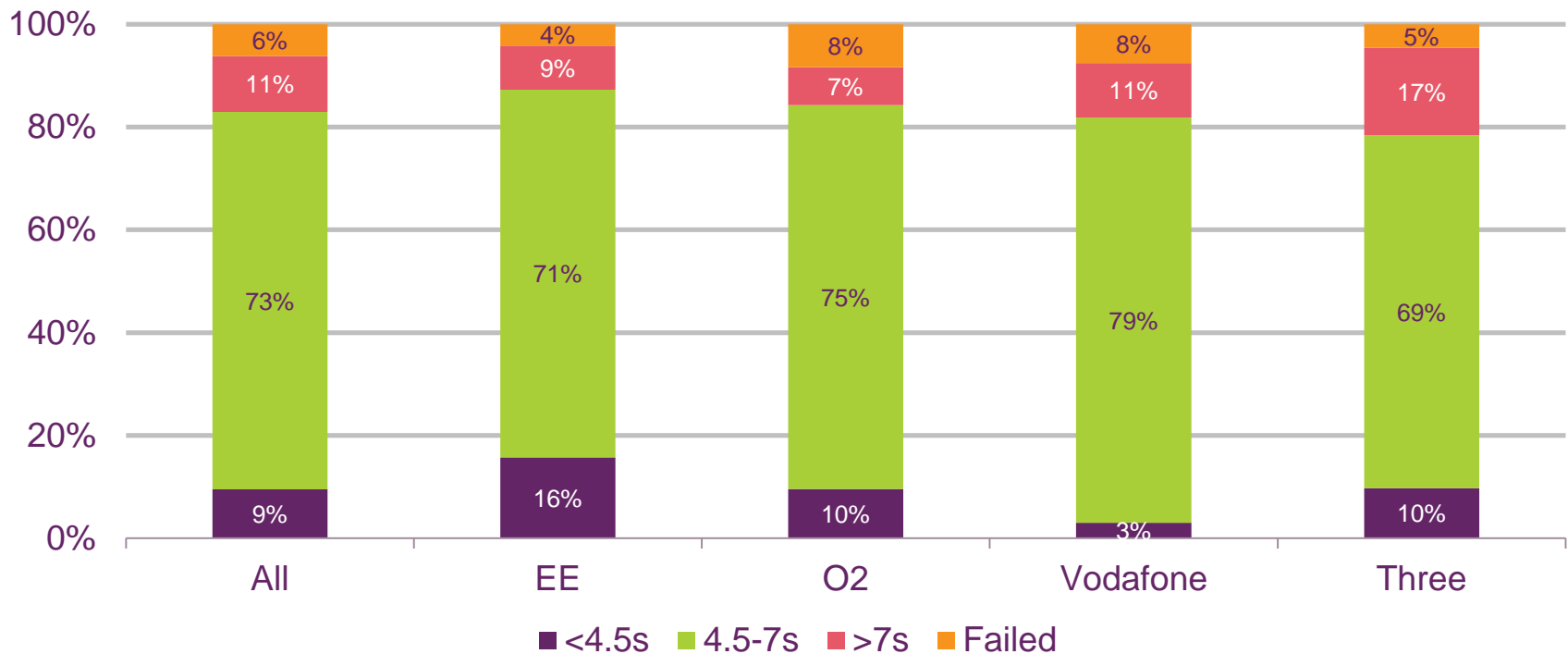
Proportion of samples



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

## Figure 33: Distribution of 4G tariff BBC homepage load time, by operator; Edinburgh

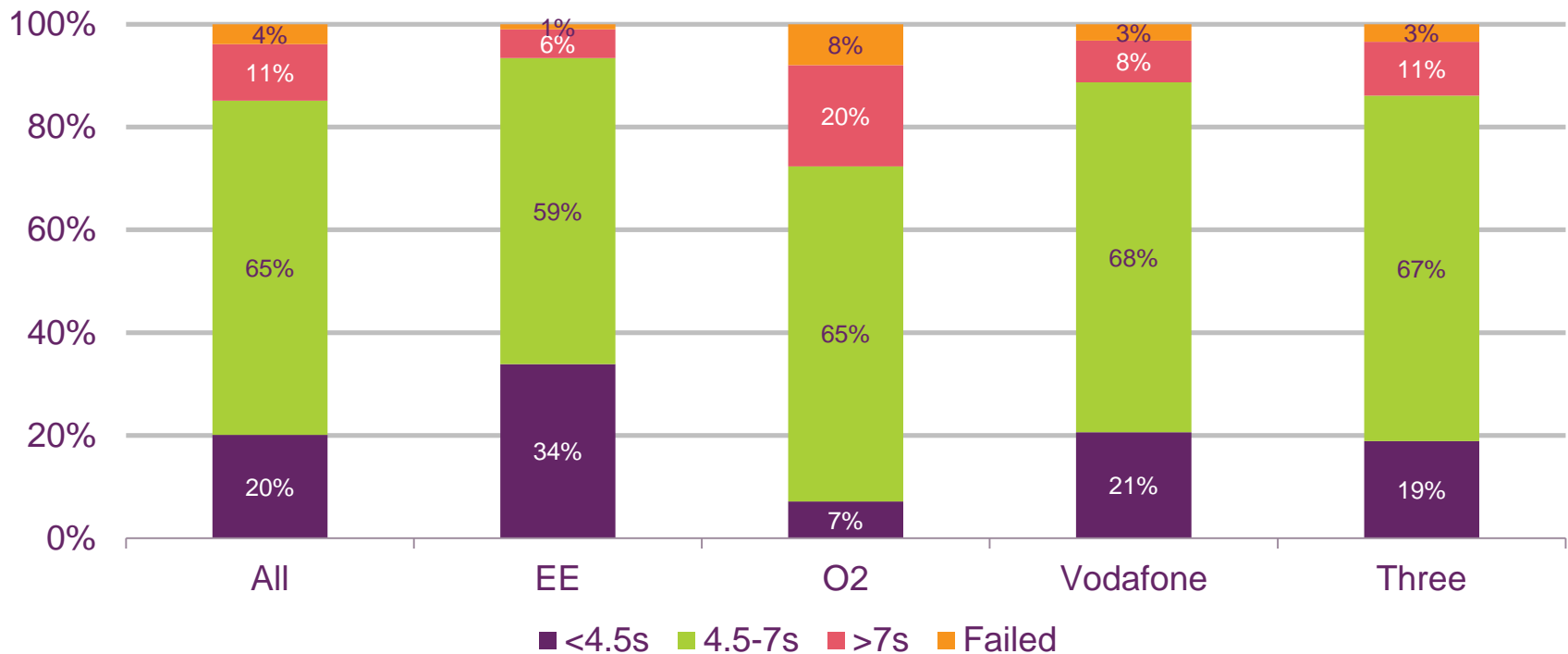
Proportion of samples



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

## Figure 34: Distribution of 4G tariff BBC homepage load time, by operator; Liverpool

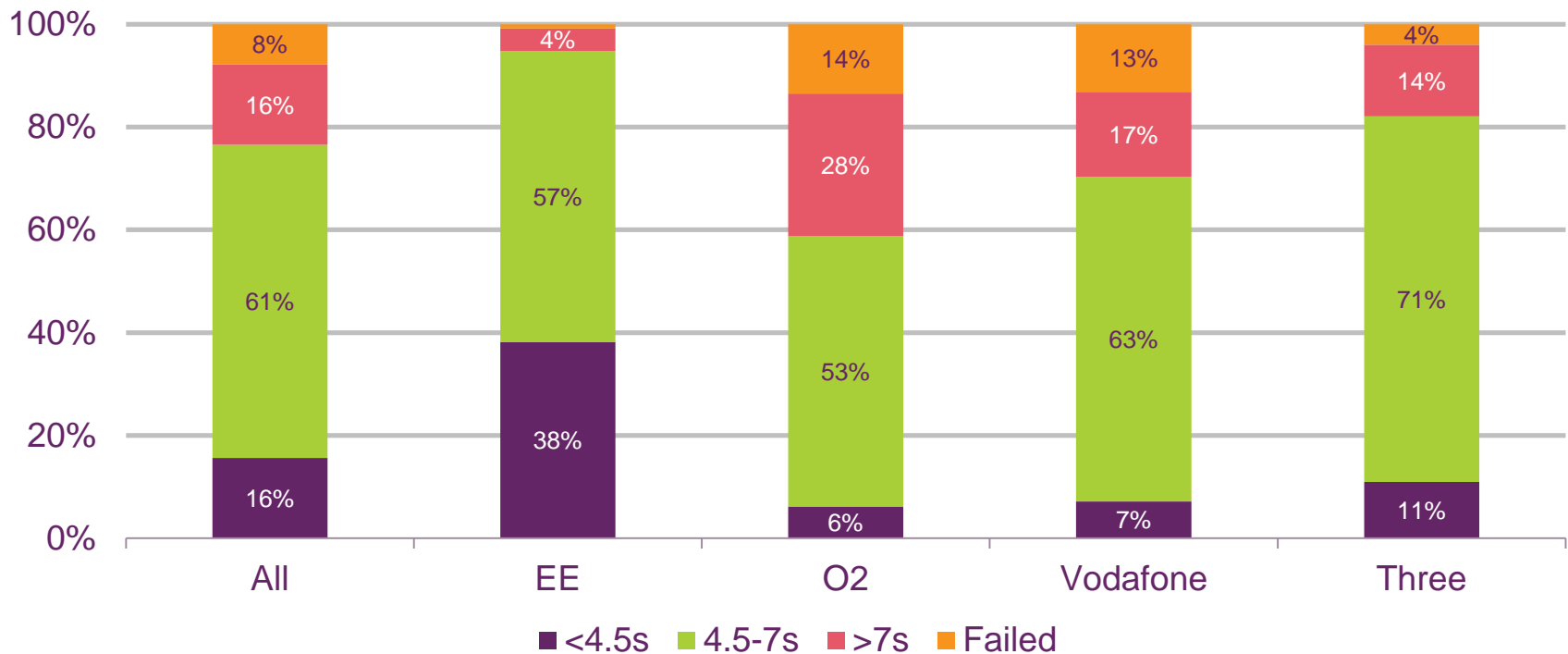
Proportion of samples



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

## Figure 35: Distribution of 4G tariff BBC homepage load time, by operator; London

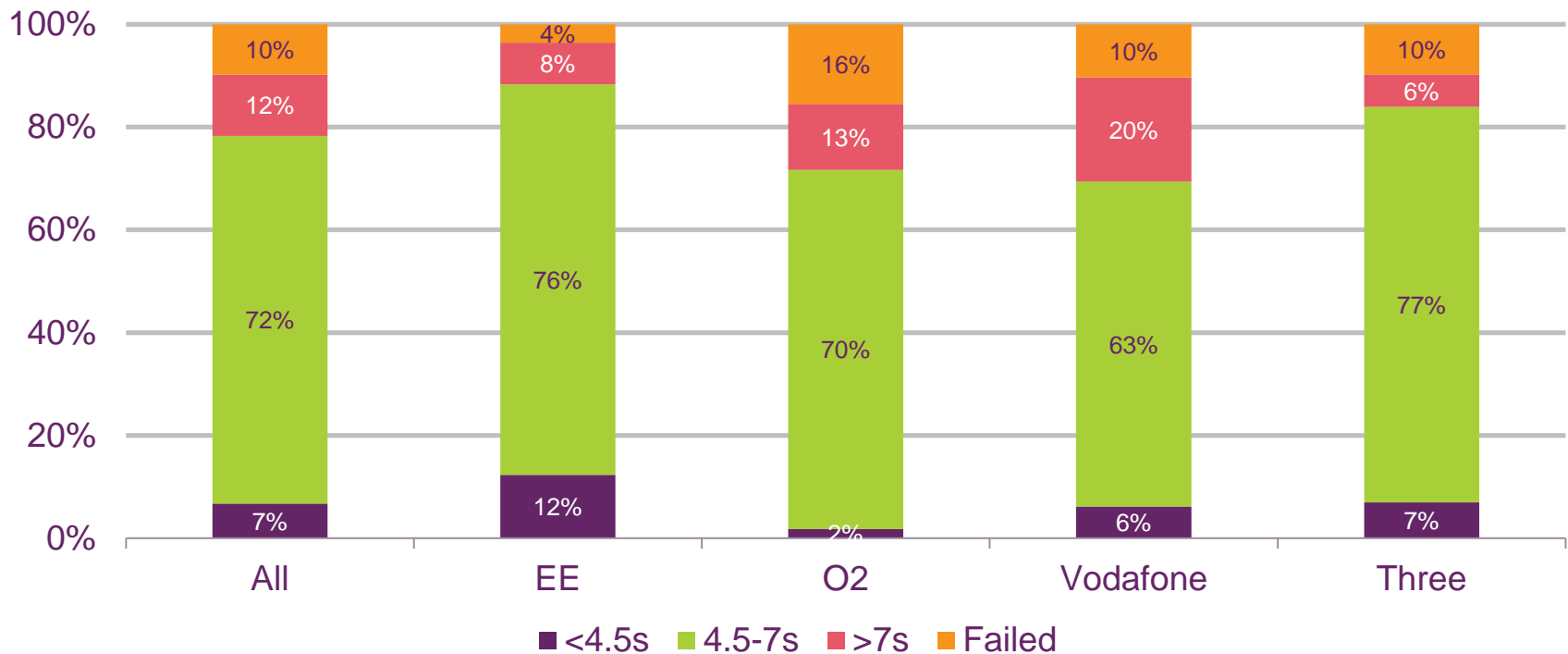
Proportion of samples



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

## Figure 36: Distribution of 4G tariff BBC homepage load time, by operator; Norwich

Proportion of samples



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

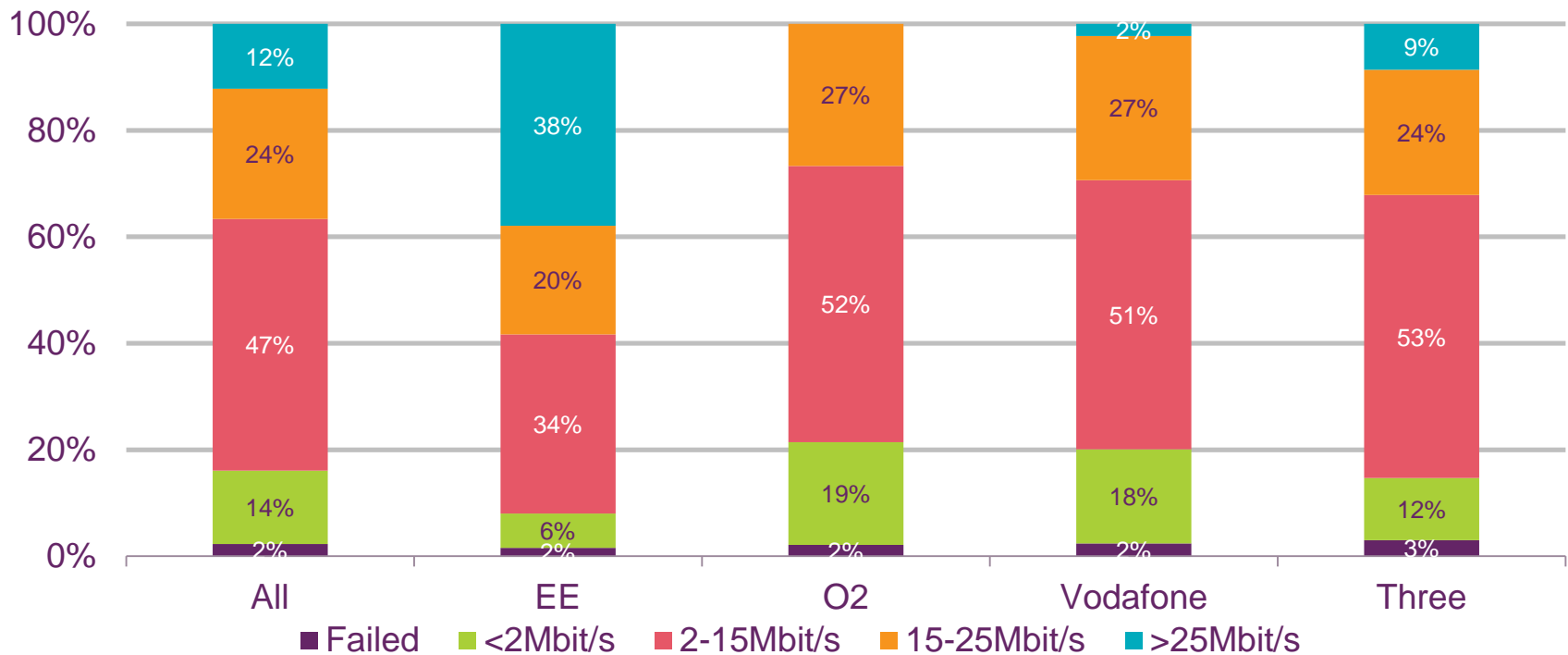
# Smartphone Cities

Additional analysis – internet activities



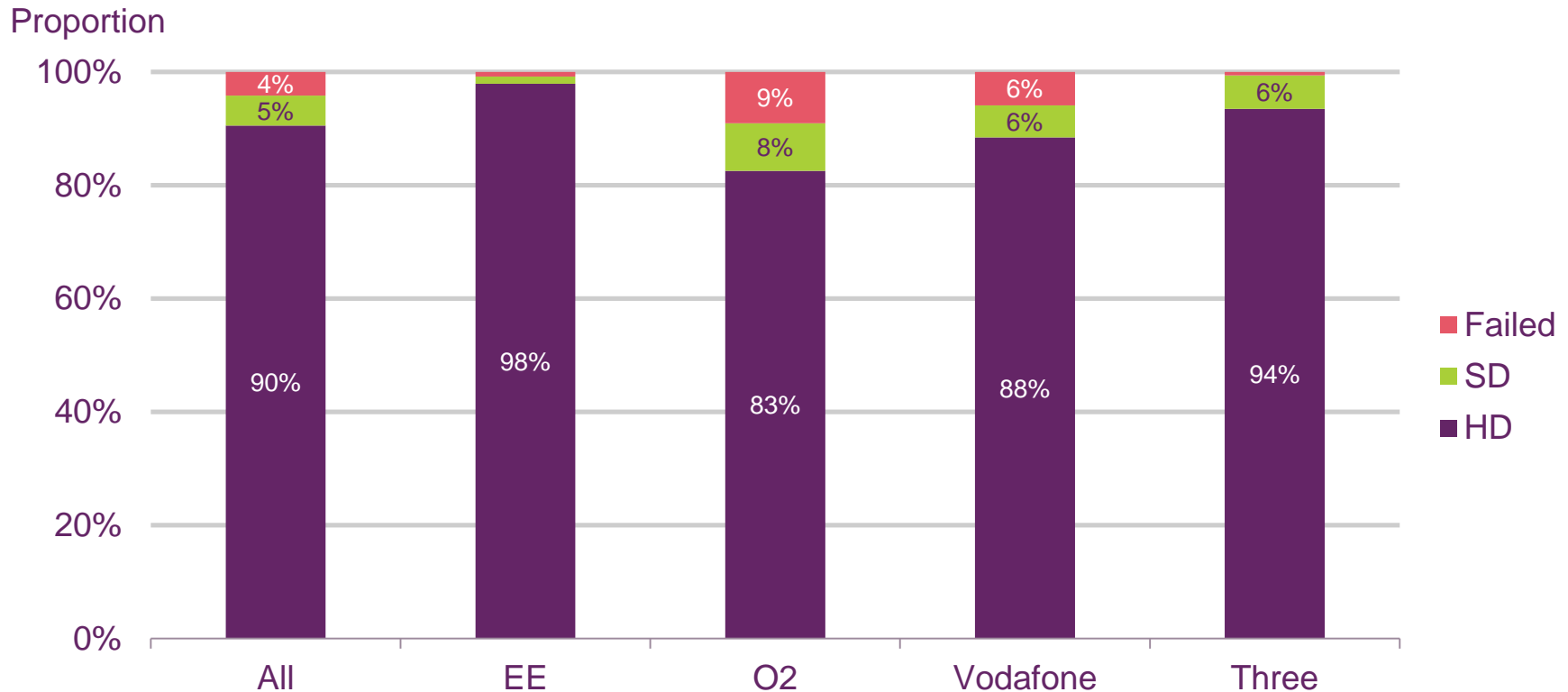
## Figure 37: Distribution of 4G tariff upload speeds, by operator

Proportion of samples



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

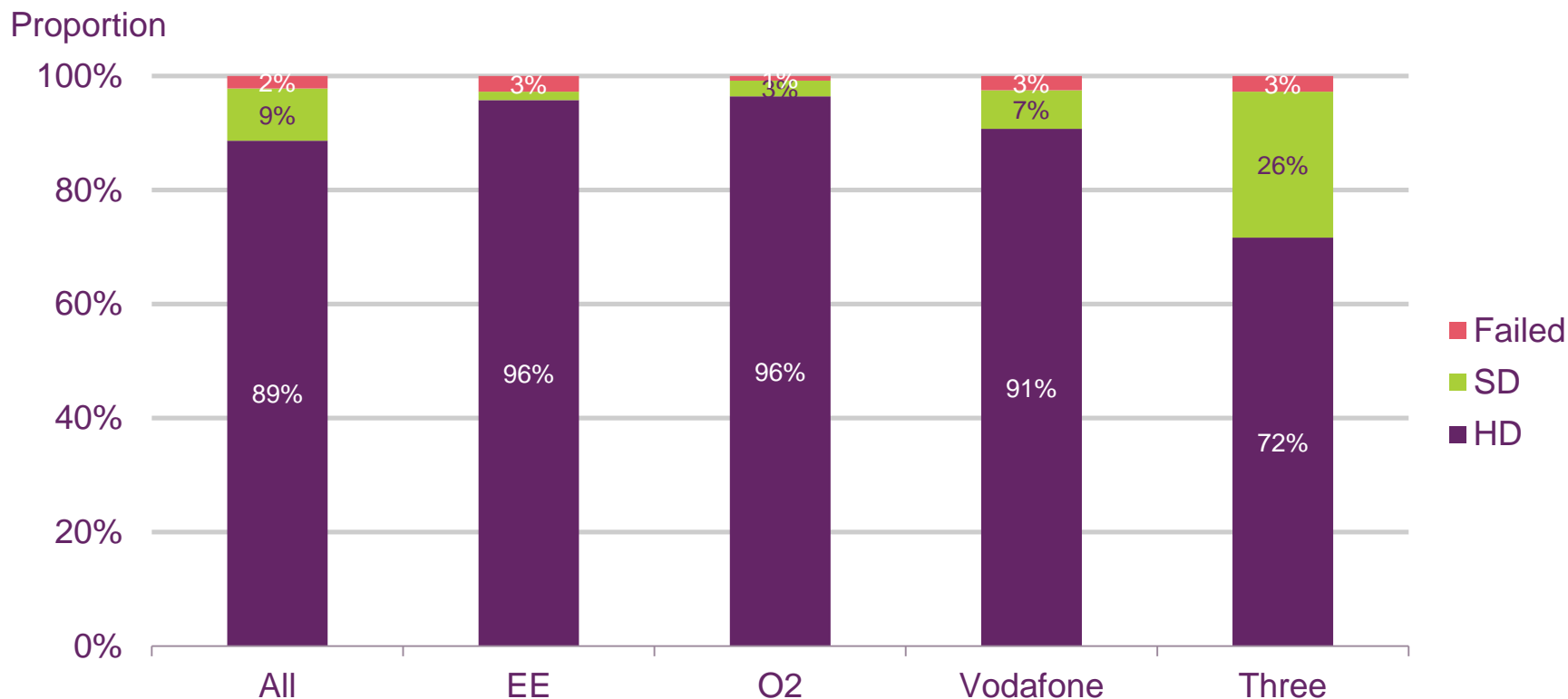
**Figure 38: YouTube streaming resolution on a 4G tariff; Cardiff**



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

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.

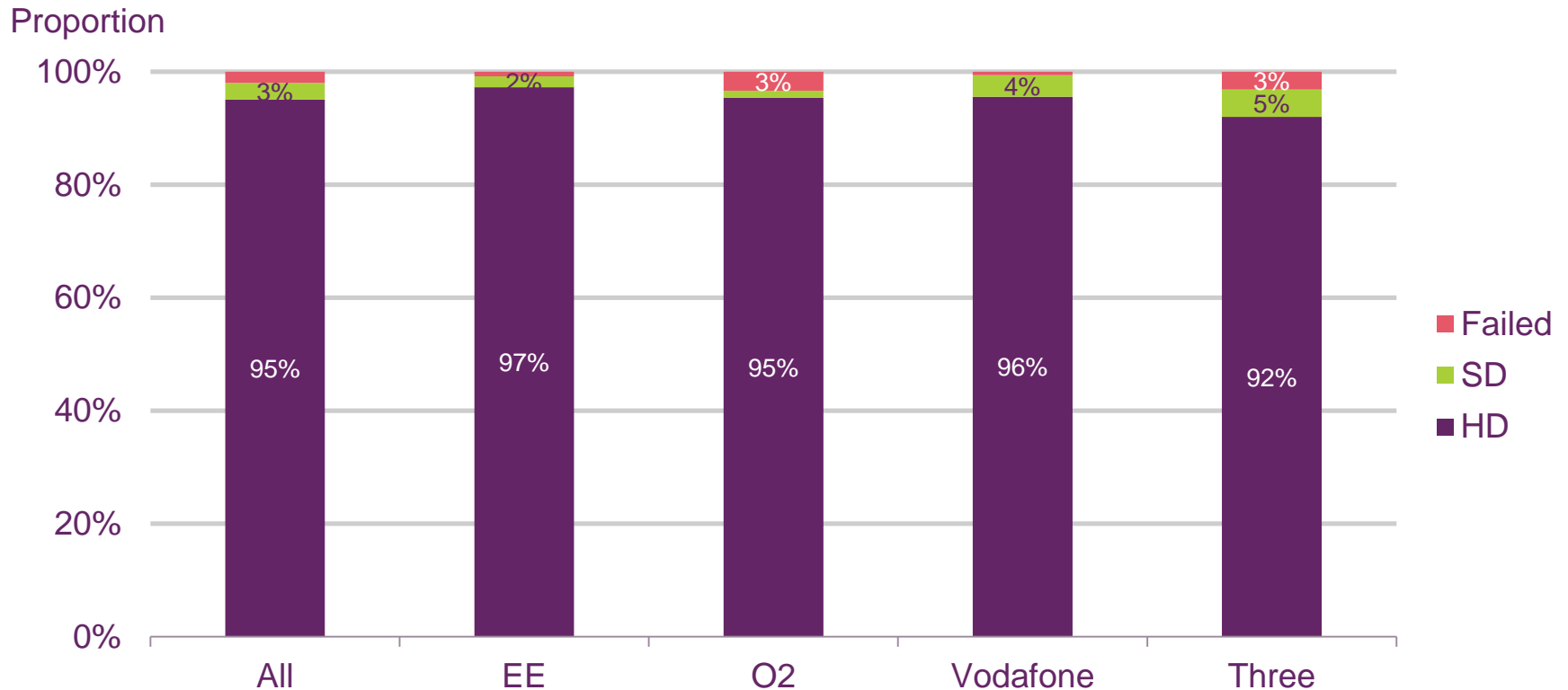
### Figure 39: YouTube streaming resolution on a 4G tariff; Edinburgh



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

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.

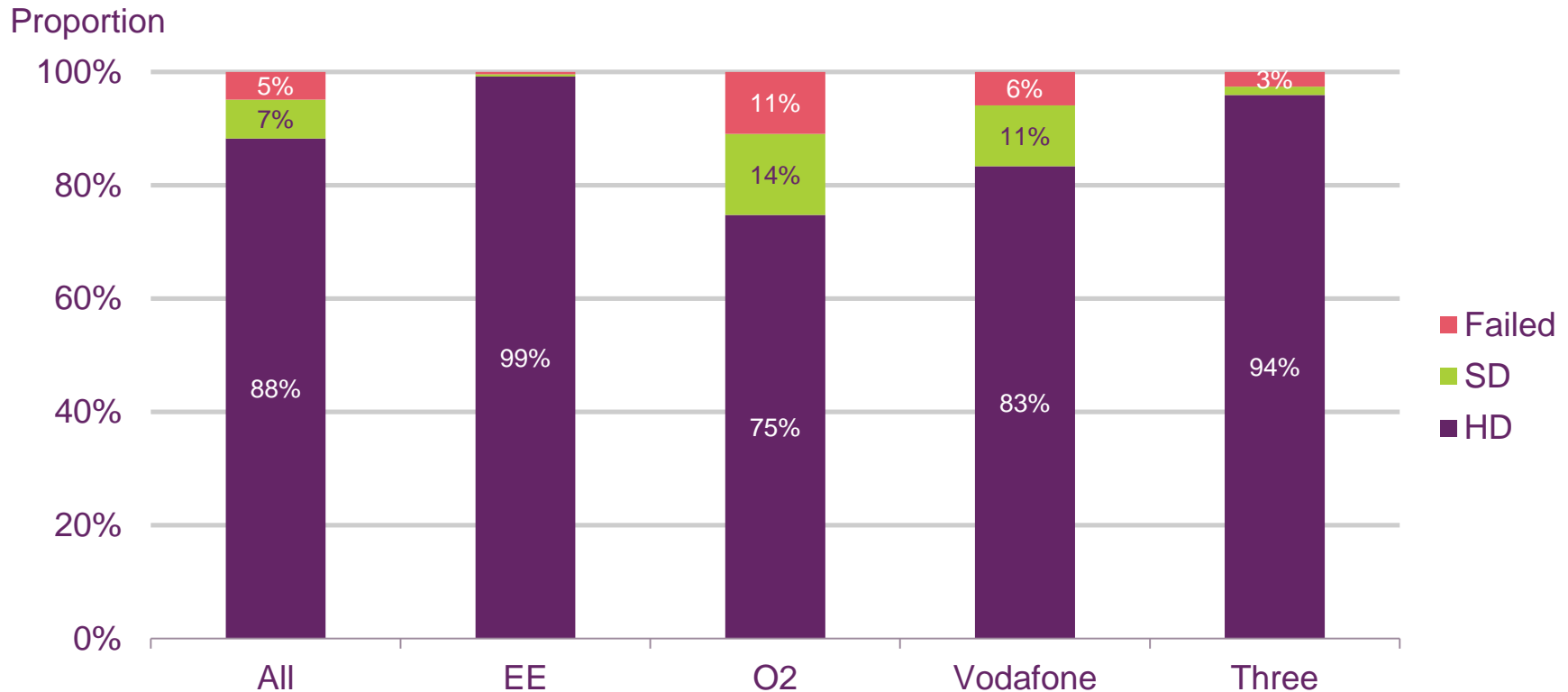
## Figure 40: YouTube streaming resolution on a 4G tariff; Liverpool



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

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.

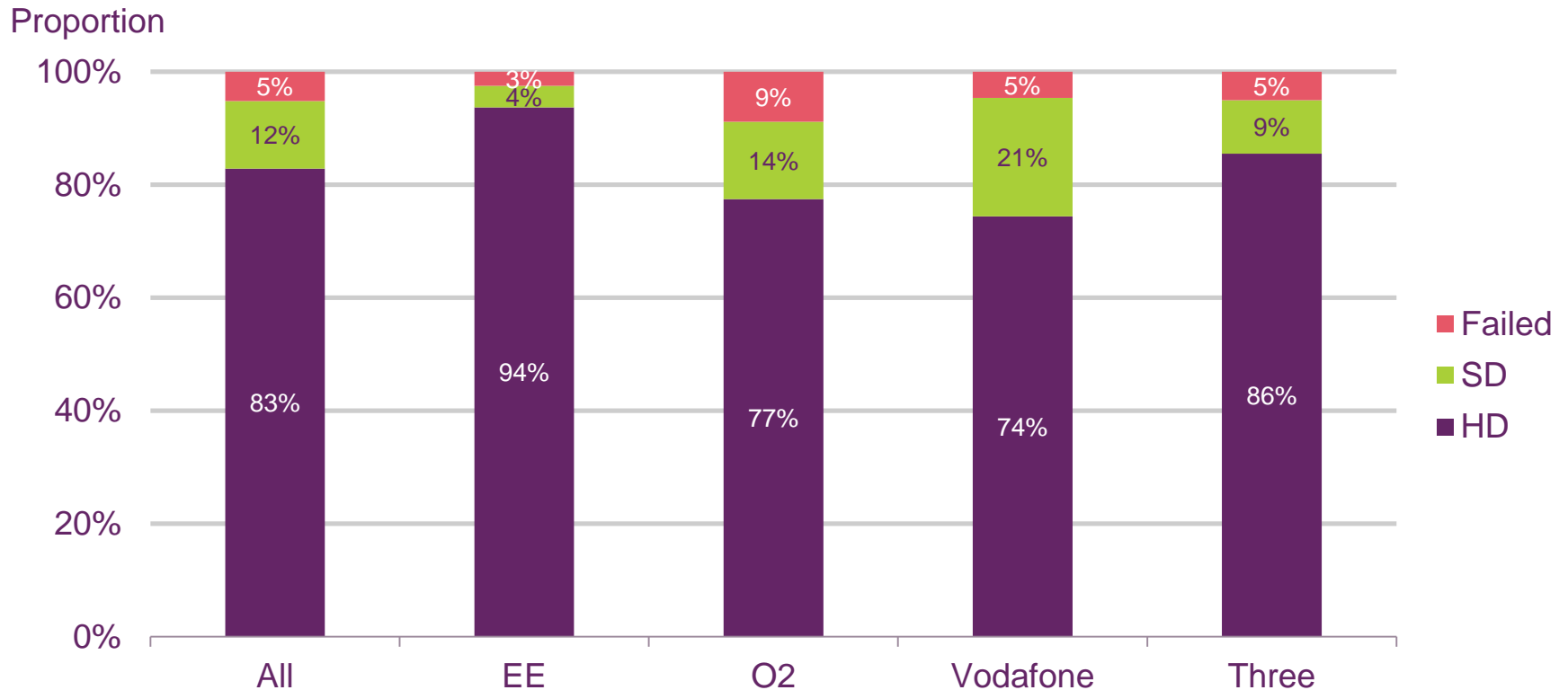
**Figure 41: YouTube streaming resolution on a 4G tariff; London**



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

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.

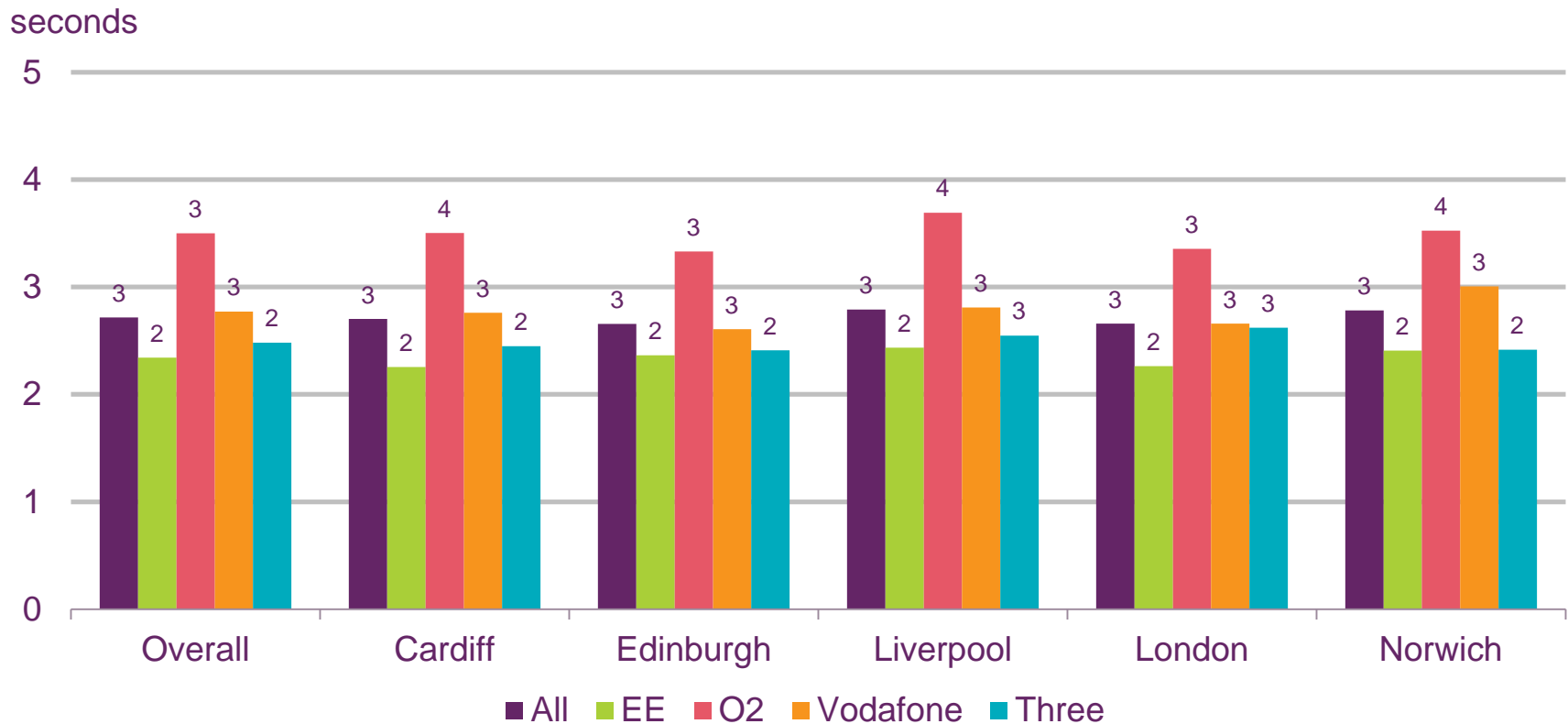
## Figure 42: YouTube streaming resolution on a 4G tariff; Norwich



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

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 43: Average YouTube time to first picture on a 4G tariff, by city**



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

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

## Figure 44: Average YouTube time to first picture on a 4G tariff: significant differences

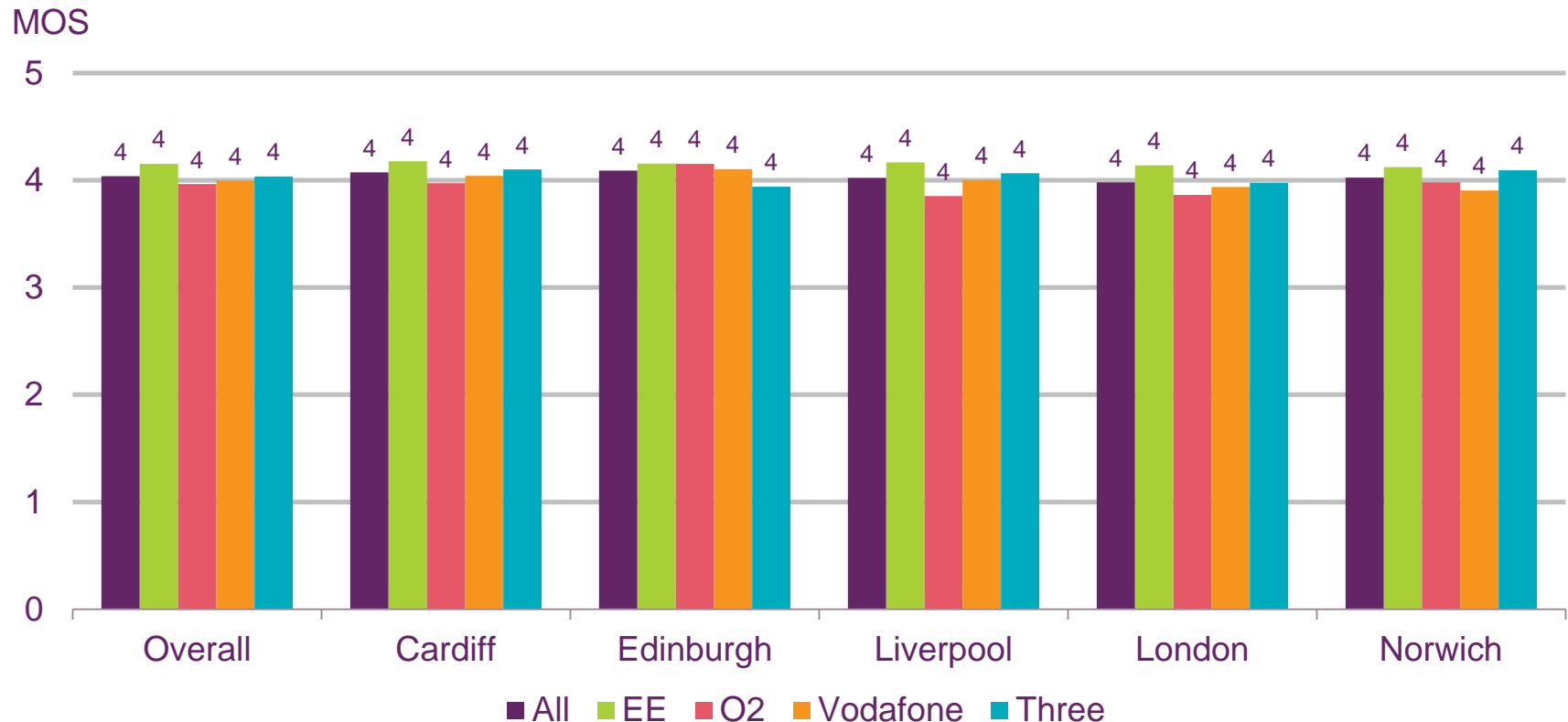
	Fastest	2 <sup>nd</sup> Fastest	3 <sup>rd</sup> Fastest	4 <sup>th</sup> Fastest
Overall	EE	Three	Vodafone	O2
Cardiff	EE	Three	Vodafone	O2
Edinburgh	EE, Three (=)	-	Vodafone	O2
Liverpool	EE	Three	Vodafone	O2
London	EE	Three, Vodafone (=)	-	O2
Norwich	EE, Three (=)	-	Vodafone	O2

Source: Ofcom

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



Figure 45: Average YouTube streaming quality on a 4G tariff, by city



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

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

**Figure 46: Average YouTube streaming quality on a 4G tariff; significant differences**

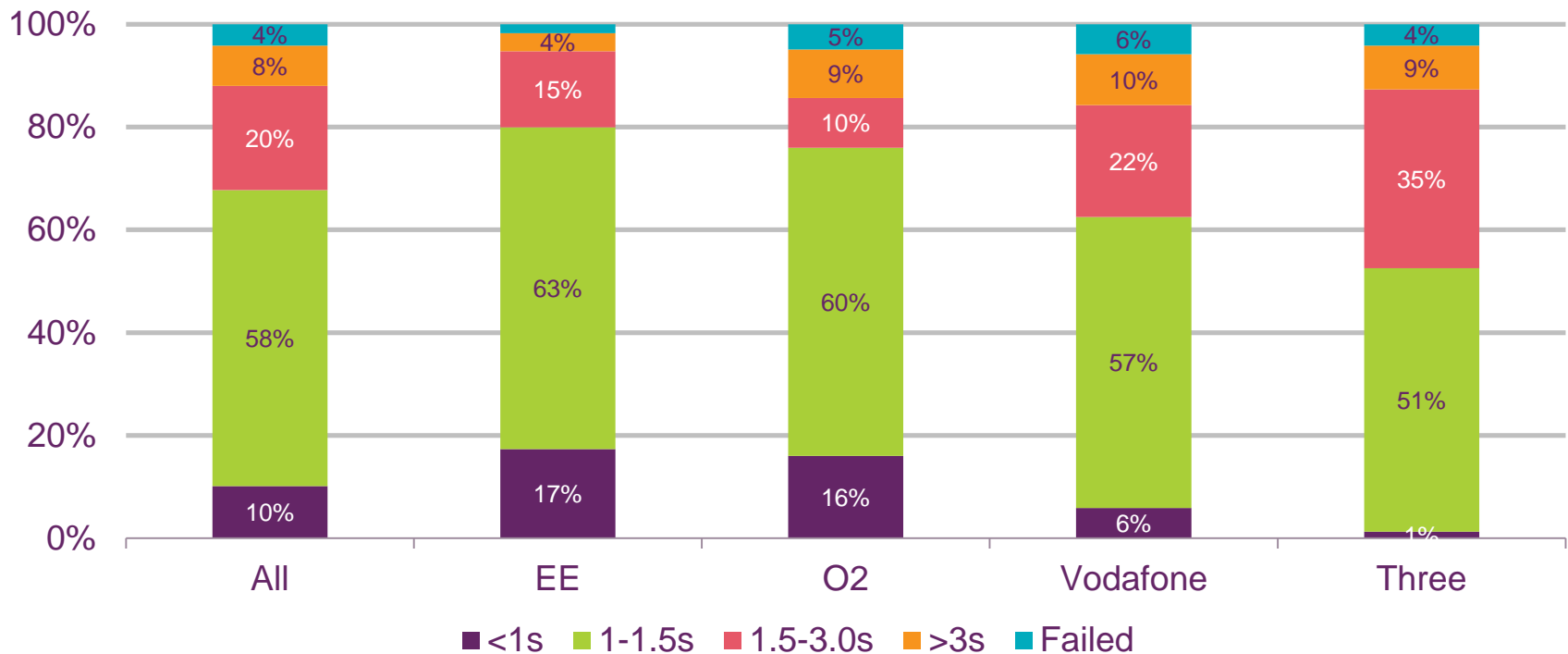
	Highest score	2 <sup>nd</sup> highest score	3 <sup>rd</sup> highest score	4 <sup>th</sup> highest score
Overall	EE	Three	Vodafone	O2
Cardiff	EE	Three	Vodafone	O2
Edinburgh	EE, O2 (=)	-	Vodafone	Three
Liverpool	EE	Three	Vodafone	O2
London	EE	Three, Vodafone (=)	O2, Vodafone (=)	-
Norwich	EE, Three (=)	-	O2	Vodafone

Source: Ofcom

Note: Differences are significant to a 95% confidence level. Note that in London there is no significant difference in the average MOS figures between Three and Vodafone but Three has a higher average score than O2 while there is no significant difference between the scores of Vodafone and O2.

## Figure 47: Distribution of 4G tariff standard web page load time; by operator

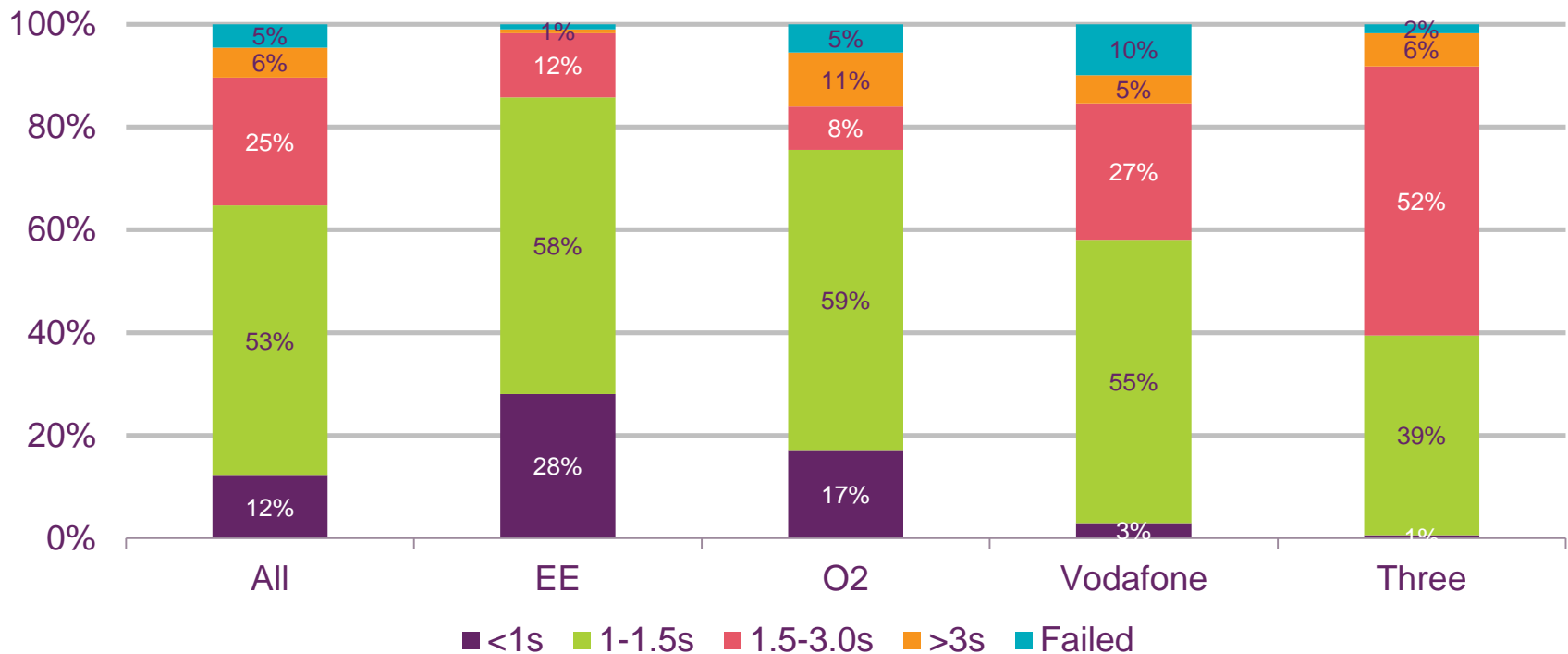
Proportion of samples



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

## Figure 48: Distribution of 4G tariff standard web page load time, by operator; Cardiff

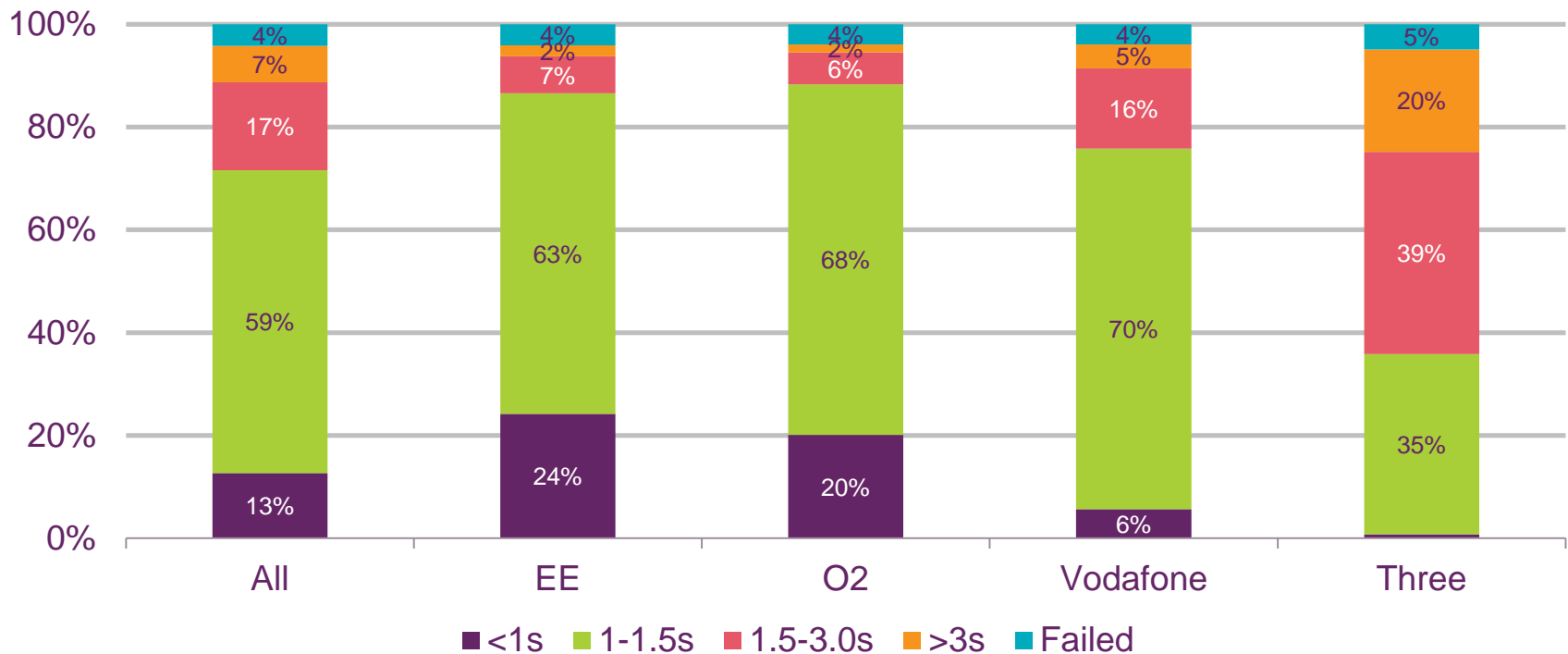
Proportion of samples



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

## Figure 49: Distribution of 4G tariff standard web page load time, by operator; Edinburgh

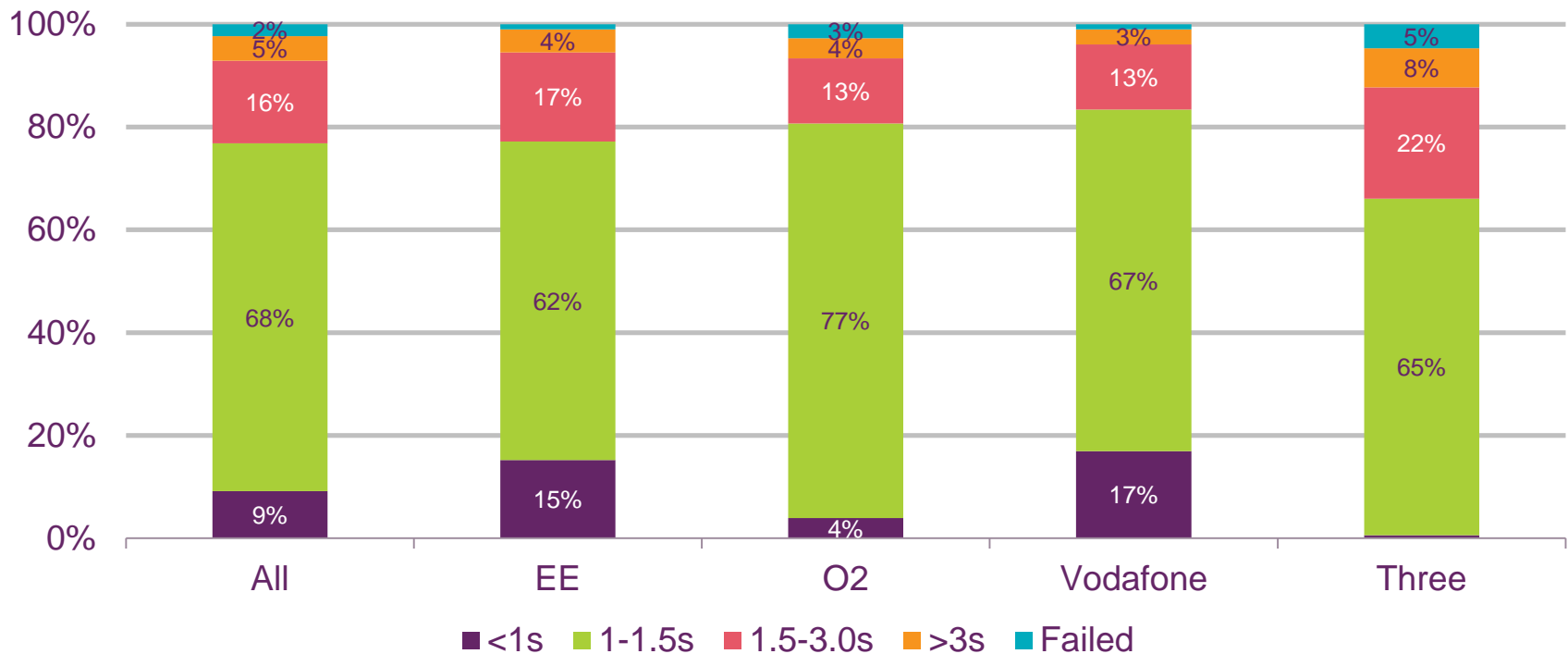
Proportion of samples



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

## Figure 50: Distribution of 4G tariff standard web page load time, by operator; Liverpool

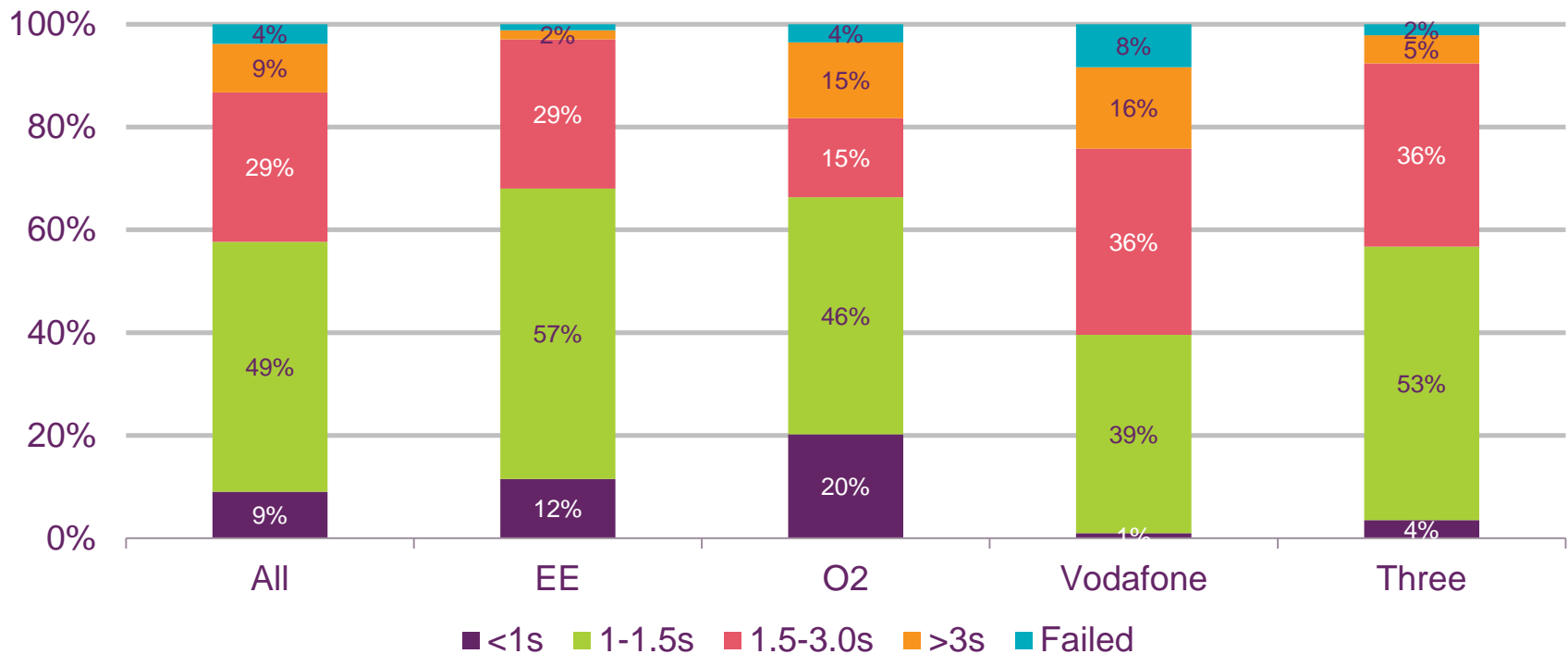
Proportion of samples



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

## Figure 51: Distribution of 4G tariff standard web page load time, by operator; London

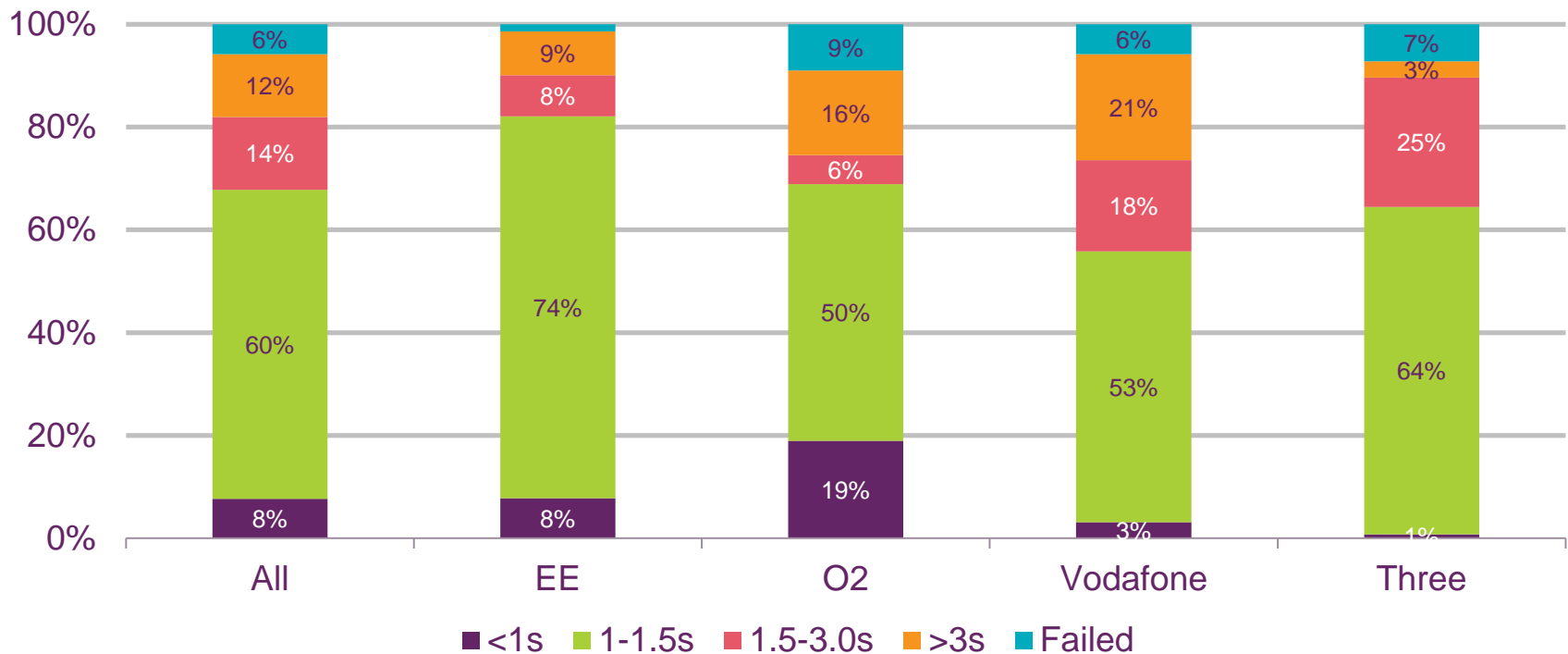
Proportion of samples



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

## Figure 52: Distribution of 4G tariff standard web page load time, by operator; Norwich

Proportion of samples



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

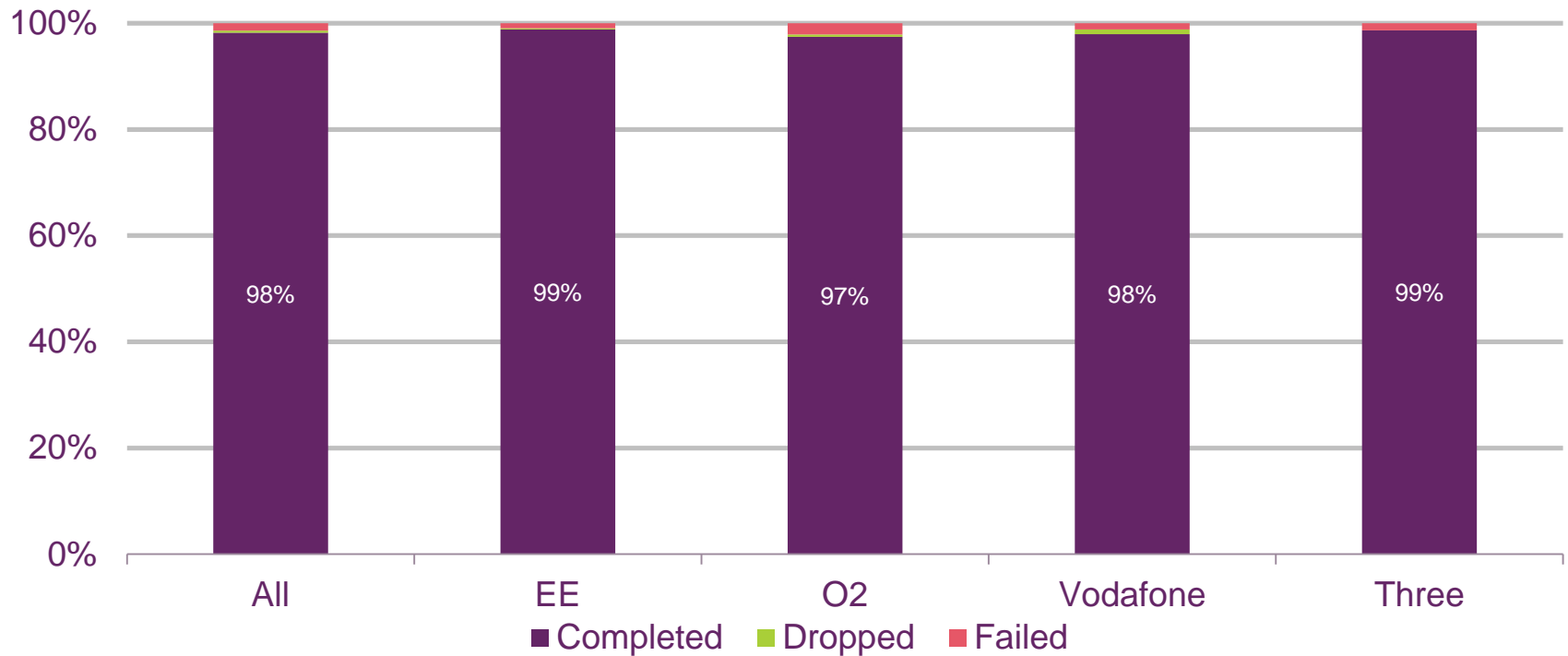


# Smartphone Cities

Additional analysis – voice call performance

## Figure 53: Call success rates, by operator; Cardiff

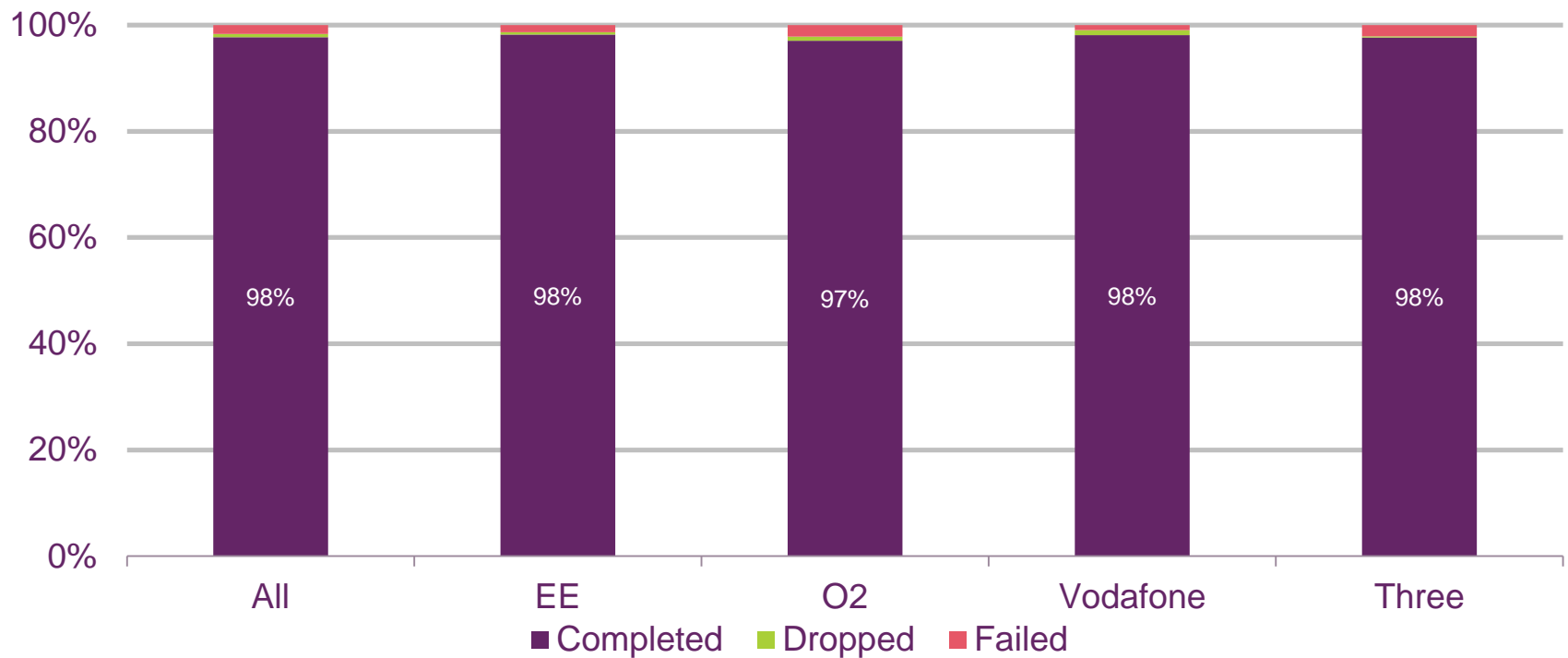
Proportion of samples



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

## Figure 54: Call success rates, by operator; Edinburgh

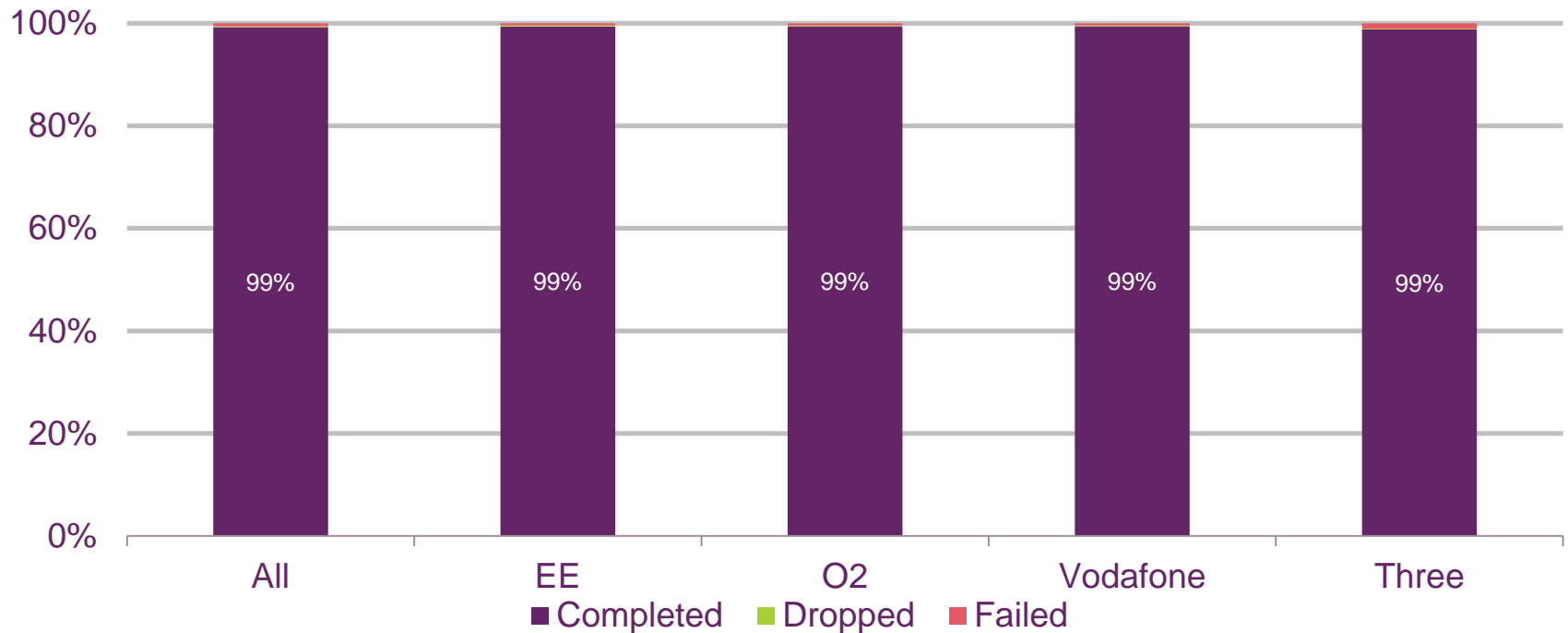
Proportion of samples



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

## Figure 55: Call success rates, by operator; Liverpool

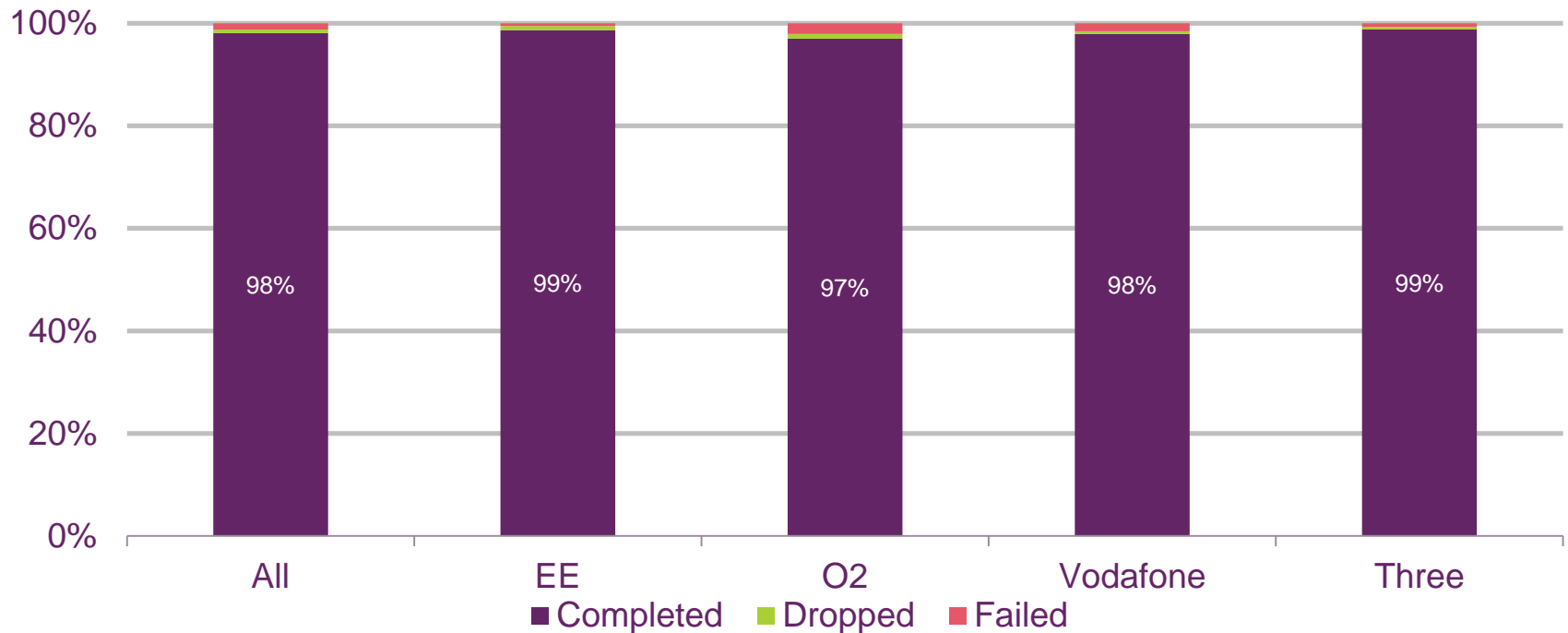
Proportion of samples



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

## Figure 56: Call success rates, by operator; London

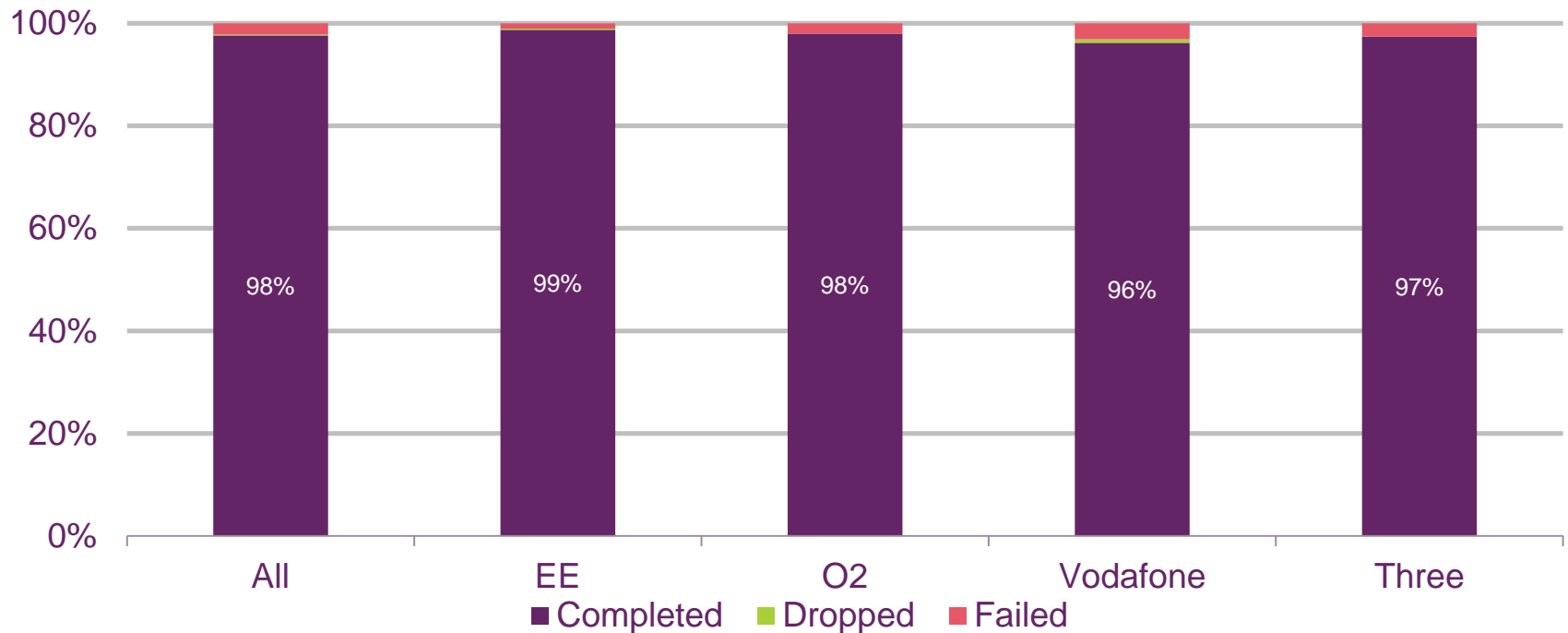
Proportion of samples



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

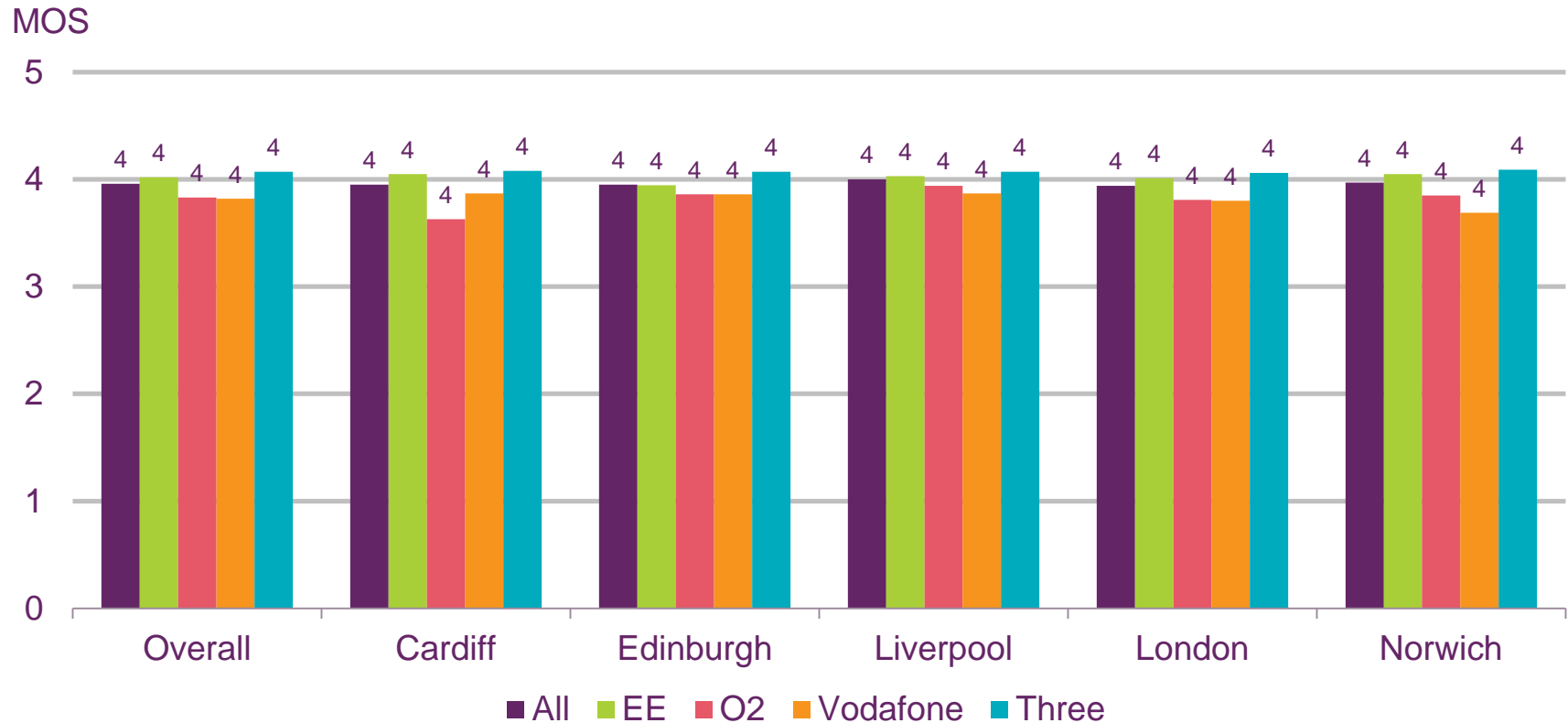
## Figure 57: Call success rates, by operator; Norwich

Proportion of samples



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

**Figure 58: Average mobile call voice quality; by city**



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

Note: Average (median) 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 59: 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	O2, Vodafone (=)	-
Cardiff	Three	EE	Vodafone	O2
Edinburgh	Three	EE	O2, Vodafone (=)	-
Liverpool	Three	EE	O2	Vodafone
London	Three	EE	O2, Vodafone (=)	-
Norwich	Three	EE	O2	Vodafone

Source: Ofcom

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