



5G QoE Benchmark in Europe

MedUX Insights: Detailed report, February 2025

Measurement campaign: Q4 2024
FINAL REPORT [CONFIDENTIAL]

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5G



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Executive Summary

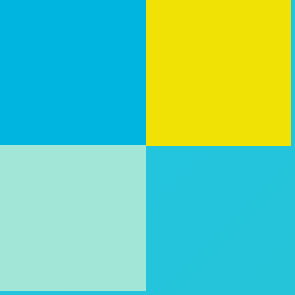
5G QoE Benchmark in Europe

**MedUX Insights:
Report Release at MWC25**
Mar. 3, 2025

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5G





MedUX

The Internet **Quality of Experience
Testing and Monitoring Company**



After 10 successful years in the industry...

The Internet Quality of Experience Testing and Monitoring Company

10 years empowering
QoE Everywhere

... we decided to give back...

#MedUXImpact



Discover more about [MedUX Impact](#)

5G

transformative enabler:
**Fourth Industrial
Revolution**

Smart Communities

Digital Health

Digital Industries

Efficient Mobility

... and beyond

... and transform how we perceive Connectivity.

5G Connectivity Benchmark in Europe

**The Time To Transform Connectivity
is Now**

Quality of Experience Everywhere in the digital Era

MedUX

3rd Edition

5G QoE Benchmark in Europe

With TRUE QoE KPIs



Best QoE

5G Speed

Best Reliability

5G Coverage

Streaming

Responsiveness

Web Browsing

5G Gaming

Data & OTT

...and more

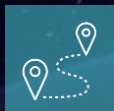
Empowering 5G customer-centric use cases with real field data

Quality of experience everywhere in the Digital Era



Stats and Scope of 5G QoE Benchmark

MedUX



>5,500 Km

Distance driven
within cities



11 countries

DE ES FR GB IT PT
BE NO SE DK PL



>45 days

of measurements



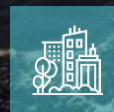
>175K

Performance
tests



>1,700 Km²

Surface covered



15 cities

BER MUN BCN MAD PAR
LON MIL ROM LIS POR
BRU OS STH CPH WAW



>60 MM

inhabitants
in urban areas



>5 MM

Radio samples

In Europe



39 Operators



bouygues

free

SFR

orange

O₂

T

vodafone

vodafone

TIM

iliad

WINDTRE

MEO

NOS

vodafone

M

orange

vodafone

O₂

E

vodafone

3

3

3

3

TELE2

3

3

3

youSee

3

ice

3

orange

T

PLAY

plus

orange

3

3

5G QoE Benchmark in Europe

Did you know?

Best Mobile Quality of Experience
in Europe



FASTEST 5G DL SPEED

1.9 Gbps

Achieved in Lisbon



FASTEST 5G UL SPEED

386 Mbps

Achieved in Madrid



TOP 5G DL AVG SPEED

579 Mbps

Achieved in
Stockholm



TOP 5G AVAILABILITY

87 %

Achieved in
Copenhagen



RELIABILITY

99.6%

Most consistent
Experience in Lisbon



**MedUX
5G QoE
Benchmark**

**Best
Reliability in
European
cities**

**Top experience in a
major European city**

Lisbon



Portugal

Leveraging true QoE KPIs

Did you know?

**Most consistent
Network Experience
recorded in Lisbon**

**99.6 %
successful
Internet Sessions**

**Lisboetas also enjoy
the best Value for
Speed Experience**

**Best Social Media
thanks to a low
average session
duration**



**MedUX
5G QoE
Benchmark**

**Best
Reliability in
European
cities**

**Top experience in a
major European city**

Lisbon



Portugal

CONGRATULATIONS



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**The Internet QoE Testing and Monitoring
Company**

www.medux.com



**MedUX
5G QoE
Benchmark**

**Best QoE in
European
cities**

**Top experience in a
major European city**

Porto



Portugal

Leveraging true QoE KPIs

Did you know?

**Speed matters but a
Consistent
Experience across
services is king**

**Porto enjoy the best
Data & OTT experience**



**Best Median DL Speed
with 565 Mbps**

**One of the most stable
gaming connections,
with the lowest average
jitter at just 10 ms)**

**MedUX
5G QoE
Benchmark**

**Best QoE in
European
cities**

**Top experience in a
major European city**

Stockholm



Sweden

Leveraging true QoE KPIs

Did you know?

Speed matters but a
Consistent
Experience across
services is king

Stockholmers enjoy
the best 5G UL average
speed

Best Web Browsing
Experience thanks to a
web browsing time
below 1 second

Best Streaming
Experience thanks to a
top time-to-content
(1.6s time to play)



**MedUX
5G QoE
Benchmark**

**Best QoE in
European
cities**

**Top experience in a
major European city**

**Porto &
Stockholm**



**Portugal &
Sweden**

CONGRATULATIONS



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MedUX 5G QoE Benchmark

Mobile Experience Awards

Awarded Cities

Best QoE
Ranking

- Stockholm
- Porto
- Lisbon
- Copenhagen
- Paris
- Munich

MedUX QoE Awards

Top Awards	Experience & 5G Awards
  #1 QOE	STREAMING, DATA & OTT, 5G UL SPEED
  #1 QOE	DATA & OTT, VALUE FOR SPEED, 5G DL SPEED, 5G AVAILABILITY
  RELIABILITY	VALUE FOR SPEED, 5G DL SPEED
	NETWORK RESPONSIVENESS, STREAMING, 5G AVAILABILITY
	
	5G GAMING

LEADER
CO-LEADER

MedUX



QoE Everywhere in the Digital Era

MedUX

Powered by:

resillon

Assure. Secure. Innovate.

Learn more about our 5G QoE Benchmark [here](#)



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Content

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Detailed Report

5G Benchmark in Europe

with TRUE QoE KPIs



MedUX Insights:

5G QoE Research Study

At MedUX we have conducted a first of its kind **5G Quality of Experience (QoE) Benchmark in Europe**. The study unveils two outstanding winners ('*ex aequo*') in Europe, followed closely by two very strong competitors.

We have leveraged our autonomous and cost-effective 'light' drive testing solution to benchmark, monitor and improve mobile networks. It aims at improving customer satisfaction by delivering an honest, **independent review that enhances service quality** from the viewpoint of the people who matter most – the users.





5G Campaign Overview

The measurement campaign consisted of drive tests conducted during Q4 2024 in 15 major cities across Europe, covering more than 60 million inhabitants.

Our drive test cars covered more than 5,500 kilometers and 1,700km2 to understand how mobile operators cover the most important European capitals.



Measurement Scope



Technology: Up to 5G SA

- Unforced mode



Devices: 8 MedUX Mobile

- 5G SA-Ready Smartphones



Dedicated Vehicles: 1 car per city

- Up to 8 devices per vehicle



Robust Testing Sampling:

- Tests: min 5K samples per city
- Radio: min 150K samples per city



Internet QoE Testing Protocol

- OTT and services (Streaming, Gaming, Web Browsing, Speed Test DL/UL), destination servers and parameters



5G Unlimited SIM cards



Planned route: 2-5 Driving Days per city



Timing: Q4 2024



Key findings

Our 5G QoE benchmark, conducted in Europe during Q42024, shows two outstanding winners ('ex aequo') in Europe, followed closely by two very strong competitors.

Porto and Stockholm share the first overall position in the 5G QoE Benchmarking campaign (less than 0.05% difference).



Stockholm offers the best Global QoE, leading in Streaming, and co-leading in Data&OTT experience

- Wins the [Top Award of Best QoE](#) and shows the best performance in two main categories
- Ranks as the third city with the highest 5G availability and shows outstanding consistency across all services.
- Also leads 5G Upload (UL) Speed and Web Browsing experience, and co-leads the File Transferring and Social Media experience .

QoE scoring: 4.787 out of 5

85.8% of 5G Availability



Porto is co-Best in the Global QoE ranking, leading in Data&OTT experience and Value for Speed

- Co-leads the [Top Award of Best QoE](#) and shows the best performance in two main categories.
- Ranks as the second city with the highest 5G availability overall, showing a 100% registration rate in mid-band (n78).
- Co-leads 5G Download (DL) Speed experience, showcasing the best median DL Speed both in overall and 5G, and also the Social Media and Dropbox Experience.

QoE scoring: 4.785 out of 5

95.0% of Data&OTT Score



Lisbon provides the most reliable service and third-best Global QoE

- Portugal's Capital wins the [Top Award of Best Reliability](#) and best consistency across all services.
- Co-leads the Value for Speed, and Social Media Experience, both in overall and 5G-only.
- Furthermore, Lisboa enjoys the best 5G Download (DL) Speed experience as well.

99.63% of successful sessions

98.8% of 5G Value for Speed Score



Benchmarking Methodology

With the goal of providing an independent and international benchmarking tool, MedUX developed its own QoE ScoreCard to determine and certify the best provider or operator with respect of the services accessed via mobile networks.

This goal is achieved by executing benchmarking tests that represent a major part of the services used by final customers of mobile networks. The results collected are individually and collectively weighted and aggregated into an overall score.

The service category scoring model and its drill-down capabilities makes it exploitable by different stakeholders, from executive management (CxOs) to more technical departments (engineering and optimization). Thus, providers or operators can improve their networks and services offering a better experience to their customers.

To give transparency and a clear interpretation of the benchmarking results, MedUX publishes a description of the scoring methodology, in line with the current state of the ETSI TR 103 559 V1.2.1

In this context we introduce the following terms, Quality of Service (QoS) and Quality of Experience (QoE):

- QoS: "Totality of characteristics of a telecommunications service that bear on its ability to satisfy stated and implied needs of the user of the service."
- QoE: "Degree of delight of the user of a service. In the context of communication services, it is influenced by content, network, device, application, user expectations and goals, and context of use."

MedUX propose a model where technical measurements are transformed into perceptive indicators taking into account the human response to mobile service's events, improvements and degradations.

For further details about the methodology used please visit our blog ["Assessing customer experiences with an advanced mobile broadband benchmarking methodology"](#)

Tests suite

MedUX evaluates mobile networks experience by ranking the performance of typical consumer use cases such as web browsing popular websites, downloading/uploading content, visiting social networks, accessing gaming servers and streaming video content, among other.

	Service Availability	Connectivity based on radio technology samples.
	Cloud DL	Multi-thread download speed test based on public CDNs.
	Cloud UL	Multi-thread upload speed test based on dedicated servers.
	HTTP DL	File download test based on dedicated servers (7 seconds Burst)
	HTTP UL	File upload test based on dedicated servers (7 seconds Burst)
	Dropbox	Single-thread download from a file (10MB) hosted in Dropbox.

	Latency	Echo request to a specific URL based on ICMP.
	Social Media	Social media sessions based on Chrome browser
	Streaming	Youtube Video playback based on a Android multimedia player.
	Gaming	Echo request to gaming servers based on ICMP.
	Web Browsing	Navigation of any website based on Chrome browser.

5G Campaign Setup – Tests performed

Probes configuration

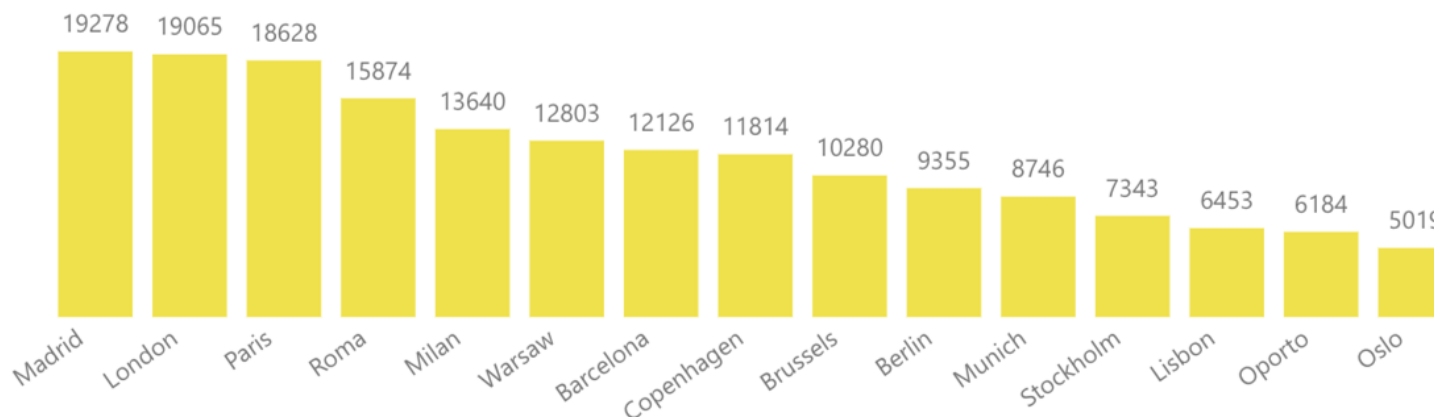
25
Networks

10
Task types

5.354.608
#Radio Samples

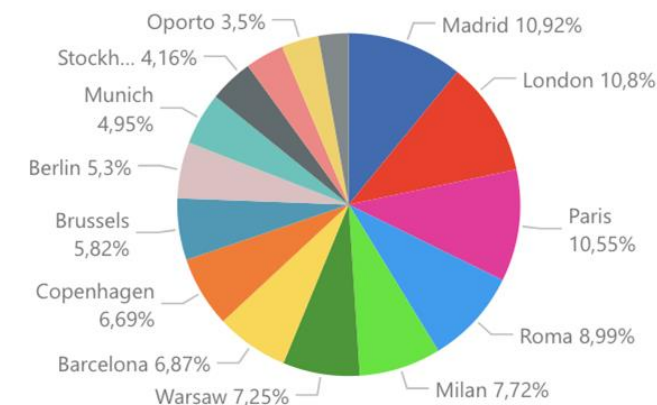
176.608
#Test performed

Number of test performed by city



For further details about the test cases covered in the campaign scope please see "Tests Suite" above or "Testing and KPI details" below.

ServiceType	Barcelona	Berlin	Brussels	Copenhagen	Lisbon	London	Madrid	Milan	Munich	Oslo	Paris	Porto	Rome	Stockholm	Warsaw	Total
DATA & OTT	8325	6354	6783	8047	4386	13004	13214	9253	5943	3415	12702	4204	10789	4840	8716	119975
Dropbox	558	432	449	549	290	781	876	640	407	245	869	281	738	319	589	8023
GamingTest	2223	1722	1790	2195	1152	3529	3507	2556	1616	971	3391	1118	2946	1281	2336	32333
HTTP-DL	557	441	470	549	306	892	889	649	428	235	895	292	749	321	598	8271
HTTP-UL	521	411	359	514	254	846	820	605	387	203	730	248	706	298	548	7450
Social Media	2223	1667	1854	2093	1189	3386	3565	2389	1540	879	3403	1125	2805	1319	2294	31731
Web Browsing	2243	1681	1861	2147	1195	3570	3557	2414	1565	882	3414	1140	2845	1302	2351	32167
Network Responsiveness	2241	1750	2262	2178	1205	3632	3557	2585	1662	953	3473	1147	3006	1557	2359	33567
Ping	2241	1750	2262	2178	1205	3632	3557	2585	1662	953	3473	1147	3006	1557	2359	33567
Streaming	554	429	456	531	294	888	888	611	387	231	865	287	719	333	580	8053
YouTube	554	429	456	531	294	888	888	611	387	231	865	287	719	333	580	8053
Value for Speed	1006	822	779	1058	568	1541	1619	1191	754	420	1588	546	1360	613	1148	15013
Cloud-DL	562	439	473	546	310	901	894	654	422	236	905	290	753	319	616	8320
Cloud-UL	444	383	306	512	258	640	725	537	332	184	683	256	607	294	532	6693
Total	12126	9355	10280	11814	6453	19065	19278	13640	8746	5019	18628	6184	15874	7343	12803	176608



Radio Samples	301149	292123	305941	365312	194685	589688	471398	431445	277926	163296	600282	186756	485696	231277	457634	5354608
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Quality of Experience – Ranking approach

MedUX mobile benchmarking approach, based on our own MOS (MedUX Opinion Score) and QoE Scorecard, assesses network performance and end-user experience in the 5G Era. We revisit criteria and thresholds once a year to consider best practices but also to reflect technology and industry development.

At MedUX we use the concept of Mean opinion score (MOS) for most of the rankings, which ratings are algorithmically estimated based on test results and KPIs, in line with the current state of the ETSI TR 103 559 V1.2.1 and ITU Recommendation ITU-T P.800.1.

•Top Awards:

- **Overall QoE Score** – a combination of availability, accessibility, speed, streaming, and data and OTT experience results.
- **Reliability** – assesses network consistency across all service categories, focusing on 5G stability by considering the success rate (%) of all tests and services described above. A test is considered as not successful if it fails or if does not meet minimum service thresholds.

•Experience Awards:

- **Accessibility** (responsiveness) – how long it takes to access the network. Particularly in 5G it measures how long takes to access the 5G network across all testing categories while taking latency and network responsiveness results into account.
- **Value for Speed** (throughput) - how much data can be transferred. Particularly in 5G it measures how is the network capacity when stressing the line (multi-thread and multi-server stress test with our patented Cloud Speed Test).
 - DL Speed
 - UL Speed
- **Video Streaming experience** - it measures the average video experience for each operator while considering video resolution, video loading time, and stall ratio.
- **Data and OTT experience** - a combination of gaming, web browsing, social networks, file transfer experiences.

Quality of Experience – Ranking approach

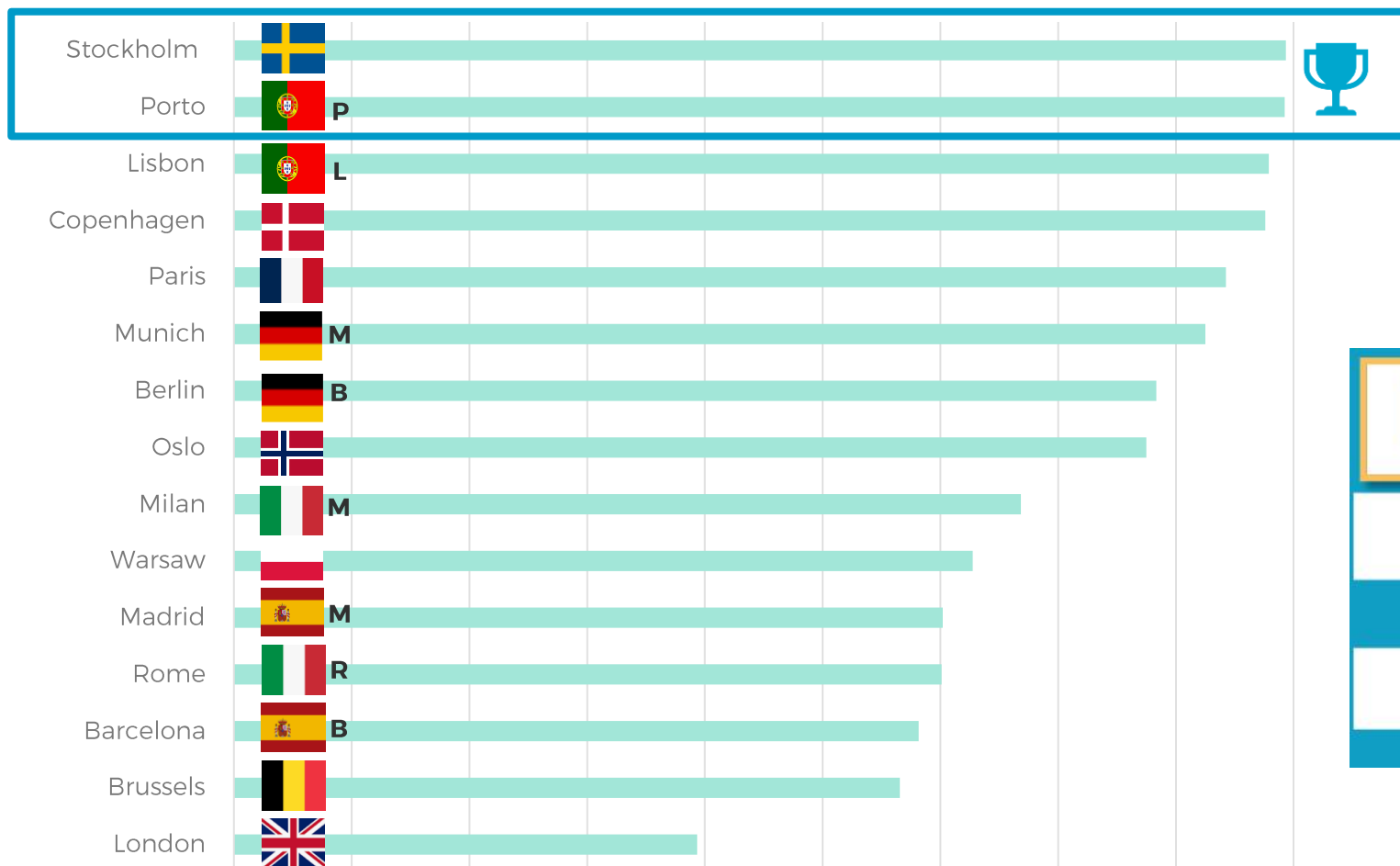
•5G Awards

- **5G Availability** – the percentage of 5G network registration, a proxy of 5G coverage available during the measurements.
- **5G DL Speed** (throughput) – how much data can be transferred in 5G downlink channel, how is the network capacity when stressing the line (multi-thread and multi-server stress test with our patented Cloud Speed Test),
- **5G UL Speed** (throughput) – how much data can be transferred in 5G uplink channel, how is the network capacity when stressing the line (multi-thread and multi-server stress test with our patented Cloud Speed Test),
- **5G Gaming**, it measures the average 5G gaming experience rating different key parameters against gaming servers.

For further details about the methodology used please visit our blog [“Assessing customer experiences with an advanced mobile broadband benchmarking methodology”](#)

Quality of Experience: Mobile Experience Ranking

Our 5G QoE measurement campaigns aim to test and shape the future of 5G experience. The study unveils two outstanding winners ('ex aequo' with less than 0.05% difference), Stockholm and Porto, followed closely by two very strong competitors: Lisbon and Copenhagen.



CONGRATULATIONS



Mobile Experience Awards

Awards are granted to the best performing operators in each attribute or category we test. If two or more operators record statistically indistinguishable results, each operator earns an Experience Award while sharing the highest rank in that category.

Stockholm and Porto co-lead the European 5G QoE Benchmarking campaign, sharing the Video Streaming and the Data and OTT with other European cities.

	Top Awards	Experience Awards					5G Awards			
	Best Experience	Reliability	Data & OTT	Streaming Experience	Value for Speed	Network Responsiveness	5G Availability	5G DL Speed	5G UL Speed	5G Gaming
Europe Winners										
	S P	L	P S	S C	L P	C B	C P	L P	S	B M

- Porto, Lisbon, Stockholm and Copenhagen lead most of the rankings across all mobile experience categories
- Porto and Stockholm share the most important award for Best QoE while showing outstanding stability across most mobile experience categories and KPIs.
- Lisbon leads the second most important award for Best Reliability, as well as other specific awards on Value for Speed and 5G DL Speed.
- Copenhagen wins Network Responsiveness and 5G Availability awards.
- Portuguese cities, Lisbon and Porto, lead the 5G DL Speed, whereas German cities, Berlin and Munich, lead the Gaming Experience in 5G.

NOTE*: Co-leaders or Co-best (less than 0.5% difference)

Benchmarking Experience - Best QoE (MOS)

Many cities have excellent or even outstanding performance, but Stockholm, Porto and Lisbon scored the highest among all cities. Porto and Stockholm share the first overall position in the European 5G QoE Benchmarking campaign.

Services MOS (Max MOS)	Barcelona	Berlin	Brussels	Copenhagen	Lisbon	London	Madrid	Milan	Munich	Oslo	Paris	Porto	Rome	Stockholm	Warsaw
DATA & OTT (2.625)	2,108	2,370	2,203	2,449	2,458	1,937	2,177	2,262	2,418	2,353	2,424	2,494	2,185	2,490	2,175
MOS Dropbox (0.25)	0,195	0,213	0,200	0,241	0,226	0,203	0,194	0,214	0,222	0,193	0,245	0,242	0,212	0,226	0,214
MOS Gaming (0.375)	0,293	0,373	0,331	0,349	0,353	0,319	0,328	0,353	0,374	0,315	0,371	0,357	0,308	0,345	0,324
MOS HttpDL (0.25)	0,218	0,231	0,187	0,237	0,249	0,177	0,212	0,218	0,245	0,247	0,232	0,250	0,209	0,250	0,236
MOS HttpUL (0.25)	0,211	0,228	0,205	0,250	0,238	0,148	0,225	0,208	0,232	0,239	0,235	0,240	0,182	0,250	0,227
MOS SocialMedia (0.5)	0,375	0,379	0,421	0,425	0,451	0,356	0,388	0,390	0,398	0,446	0,411	0,450	0,428	0,450	0,370
MOS WebBrowsing (1)	0,817	0,947	0,859	0,947	0,940	0,734	0,830	0,879	0,947	0,913	0,930	0,955	0,846	0,969	0,805
Network Responsiveness (0.375)	0,306	0,371	0,336	0,372	0,368	0,330	0,331	0,360	0,370	0,364	0,367	0,370	0,339	0,368	0,344
MOS Ping (0.375)	0,306	0,371	0,336	0,372	0,368	0,330	0,331	0,360	0,370	0,364	0,367	0,370	0,339	0,368	0,344
Streaming (1.25)	1,079	1,119	1,007	1,194	1,191	0,917	1,033	1,058	1,146	1,137	1,178	1,182	1,029	1,199	1,052
MOS YouTube (1.25)	1,079	1,119	1,007	1,194	1,191	0,917	1,033	1,058	1,146	1,137	1,178	1,182	1,029	1,199	1,052
Value for Speed (0.75)	0,669	0,706	0,584	0,736	0,741	0,602	0,664	0,658	0,716	0,696	0,716	0,739	0,649	0,730	0,685
MOS CloudDL (0.5)	0,444	0,471	0,393	0,488	0,498	0,404	0,434	0,439	0,485	0,456	0,483	0,498	0,443	0,481	0,458
MOS CloudUL (0.25)	0,225	0,235	0,191	0,248	0,243	0,198	0,230	0,219	0,231	0,240	0,233	0,242	0,206	0,249	0,226
Total MOS (5)	4,163	4,567	4,131	4,752	4,758	3,787	4,204	4,337	4,650	4,550	4,685	4,785	4,202	4,787	4,255

Services MOS (Max MOS)	Barcelona	Berlin	Brussels	Copenhagen	Lisbon	London	Madrid	Milan	Munich	Oslo	Paris	Porto	Rome	Stockholm	Warsaw
Reliability (2.75)															
MOS Reliability (2.75)	2,510	2,594	2,541	2,615	2,663	2,334	2,556	2,586	2,649	2,647	2,590	2,639	2,601	2,634	2,490

NOTE*: Co-leaders or Co-best (less than 0.5% difference)

Benchmarking Experience - Best QoE (% out of max. score)

Many cities have excellent or even outstanding performance, but Stockholm, Porto and Lisbon scored the highest among all cities. Porto and Stockholm share the first overall position in the European 5G QoE Benchmarking campaign.

Services MOS (Max MOS)	Barcelona	Berlin	Brussels	Copenhagen	Lisbon	London	Madrid	Milan	Munich	Oslo	Paris	Porto	Rome	Stockholm	Warsaw
DATA & OTT (2.625)	80,32 %	90,29 %	83,94 %	93,30 %	93,62 %	73,79 %	82,94 %	86,18 %	92,11 %	89,63 %	92,36 %	95,00 %	83,22 %	94,85 %	82,87 %
MOS Dropbox (0.25)	78,16 %	85,37 %	80,04 %	96,28 %	90,58 %	81,39 %	77,46 %	85,50 %	88,72 %	77,22 %	98,07 %	96,76 %	84,68 %	90,28 %	85,61 %
MOS Gaming (0.375)	78,00 %	99,45 %	88,34 %	93,07 %	94,17 %	85,06 %	87,54 %	94,08 %	99,66 %	83,90 %	98,86 %	95,26 %	82,09 %	92,07 %	86,32 %
MOS HttpDL (0.25)	87,22 %	92,32 %	74,61 %	94,94 %	99,74 %	70,68 %	84,64 %	87,37 %	98,00 %	98,87 %	92,77 %	99,93 %	83,66 %	100,00 %	94,30 %
MOS HttpUL (0.25)	84,22 %	91,09 %	81,85 %	100,00 %	95,04 %	59,01 %	90,00 %	83,14 %	92,96 %	95,40 %	94,12 %	96,02 %	72,85 %	100,00 %	90,70 %
MOS SocialMedia (0.5)	75,08 %	75,75 %	84,27 %	85,04 %	90,13 %	71,19 %	77,66 %	78,03 %	79,60 %	89,19 %	82,28 %	89,96 %	85,58 %	90,00 %	74,08 %
MOS WebBrowsing (1)	81,66 %	94,66 %	85,94 %	94,69 %	94,04 %	73,44 %	83,02 %	87,92 %	94,70 %	91,34 %	92,99 %	95,50 %	84,58 %	96,88 %	80,48 %
Network Responsiveness (0.375)	81,69 %	99,06 %	89,66 %	99,24 %	98,17 %	88,07 %	88,18 %	95,91 %	98,77 %	97,11 %	97,76 %	98,56 %	90,38 %	98,23 %	91,62 %
MOS Ping (0.375)	81,69 %	99,06 %	89,66 %	99,24 %	98,17 %	88,07 %	88,18 %	95,91 %	98,77 %	97,11 %	97,76 %	98,56 %	90,38 %	98,23 %	91,62 %
Streaming (1.25)	86,35 %	89,55 %	80,59 %	95,54 %	95,30 %	73,39 %	82,62 %	84,60 %	91,67 %	90,94 %	94,22 %	94,55 %	82,32 %	95,89 %	84,12 %
MOS YouTube (1.25)	86,35 %	89,55 %	80,59 %	95,54 %	95,30 %	73,39 %	82,62 %	84,60 %	91,67 %	90,94 %	94,22 %	94,55 %	82,32 %	95,89 %	84,12 %
Value for Speed (0.75)	89,25 %	94,12 %	77,88 %	98,15 %	98,80 %	80,27 %	88,52 %	87,70 %	95,48 %	92,80 %	95,46 %	98,59 %	86,58 %	97,34 %	91,31 %
MOS CloudDL (0.5)	88,81 %	94,28 %	78,61 %	97,62 %	99,56 %	80,88 %	86,87 %	87,82 %	97,10 %	91,29 %	96,53 %	99,53 %	88,66 %	96,13 %	91,70 %
MOS CloudUL (0.25)	90,11 %	93,80 %	76,41 %	99,21 %	97,27 %	79,06 %	91,81 %	87,45 %	92,26 %	95,84 %	93,32 %	96,71 %	82,41 %	99,77 %	90,53 %
Total MOS (5)	83,27 %	91,34 %	82,62 %	95,03 %	95,16 %	75,73 %	84,09 %	86,74 %	93,00 %	90,99 %	93,70 %	95,69 %	84,04 %	95,74 %	85,11 %

Services MOS (Max MOS)	Barcelona	Berlin	Brussels	Copenhagen	Lisbon	London	Madrid	Milan	Munich	Oslo	Paris	Porto	Rome	Stockholm	Warsaw
Reliability (2.75)															
MOS Reliability (2.75)	91,29 %	94,32 %	92,41 %	95,11 %	96,84 %	84,88 %	92,94 %	94,05 %	96,34 %	96,26 %	94,17 %	95,98 %	94,58 %	95,79 %	90,56 %

NOTE*: Co-leaders or Co-best (less than 0.5% difference)

Benchmarking Reliability – Consistent performance

Most cities have excellent or even outstanding performance, but Lisbon shows the Best Reliability in the European 5G QoE Benchmarking campaign.

Services MOS (Max MOS)	Barcelona	Berlin	Brussels	Copenhagen	Lisbon	London	Madrid	Milan	Munich	Oslo	Paris	Porto	Rome	Stockholm	Warsaw
Reliability (2.75)															
MOS Reliability (2.75)	2,510	2,594	2,541	2,615	2,663	2,334	2,556	2,586	2,649	2,647	2,590	2,639	2,601	2,634	2,490



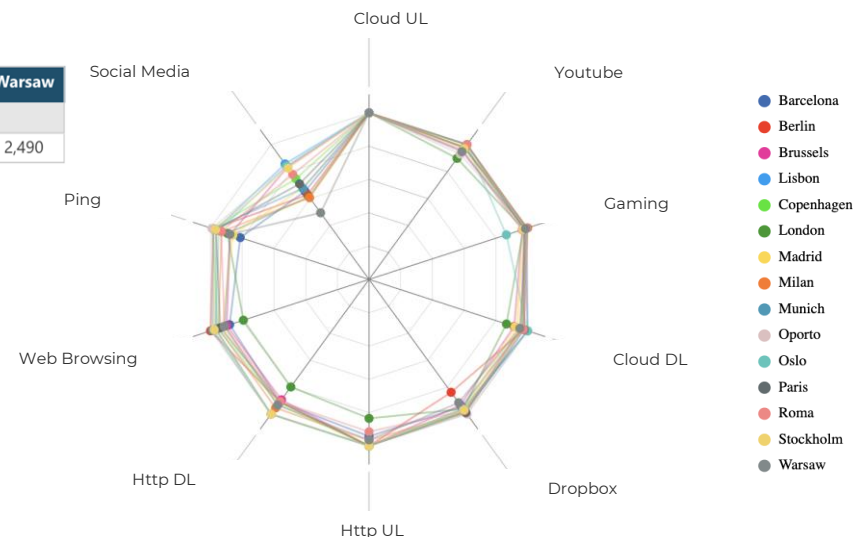
Best Experience:

- 7.5% - Accessibility
- 15% - Value for speed
- 25% - Streaming
- 52.5% - Data & OTT

Reliability (part of QoE Scorecard):

- 0.206p - Accessibility*
- 0.412p - Value for speed*
- 0.687p - Streaming Experience*
- 1.445p - Data & OTT*

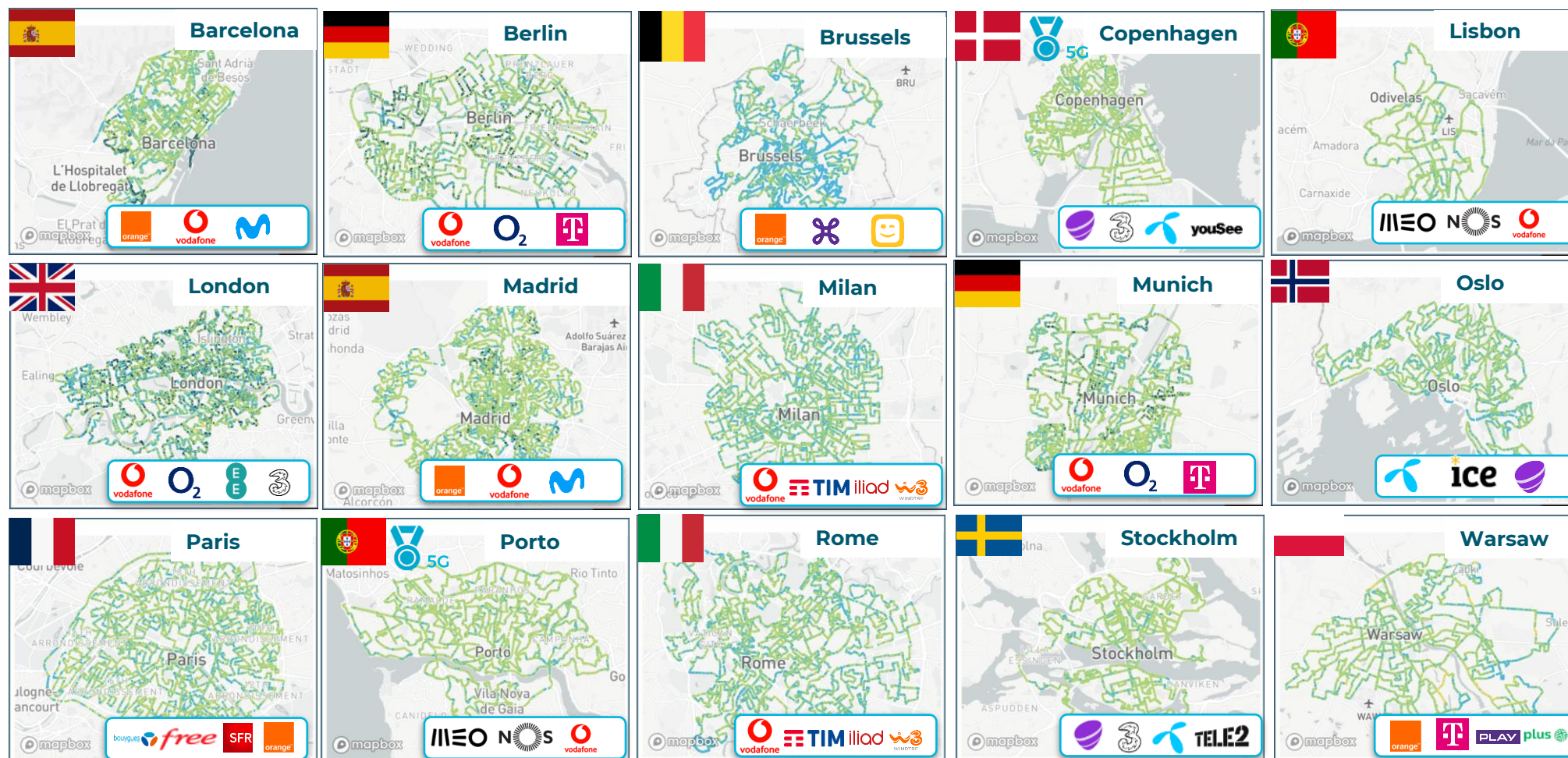
*MOS Reliability is based on 2.75p max



	Barcelona	Berlin	Brussels	Copenhagen	Lisbon	London	Madrid	Milan	Munich	Oslo	Paris	Porto	Rome	Stockholm	Warsaw
CloudDLComplete (%)	100,00 %	100,00 %	100,00 %	99,63 %	100,00 %	99,89 %	99,89 %	99,85 %	100,00 %	100,00 %	99,78 %	100,00 %	100,00 %	99,69 %	99,84 %
CloudULComplete (%)	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %
DropboxComplete (%)	99,82 %	98,38 %	99,33 %	99,82 %	98,97 %	99,74 %	99,89 %	99,84 %	99,26 %	99,18 %	100,00 %	100,00 %	99,86 %	99,69 %	99,49 %
GamingComplete (%)	99,78 %	100,00 %	99,66 %	99,95 %	99,83 %	99,74 %	99,89 %	99,96 %	99,94 %	98,66 %	99,79 %	99,82 %	99,93 %	99,69 %	99,87 %
HttpDLComplete (%)	100,00 %	99,32 %	100,00 %	99,64 %	100,00 %	99,55 %	100,00 %	99,69 %	100,00 %	100,00 %	99,11 %	100,00 %	99,33 %	100,00 %	100,00 %
HttpULComplete (%)	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %	99,76 %	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %
PingComplete (%)	99,33 %	100,00 %	99,56 %	99,91 %	99,92 %	99,67 %	99,66 %	99,50 %	100,00 %	99,48 %	99,74 %	99,83 %	99,90 %	99,74 %	99,53 %
SocialMediaComplete (%)	97,66 %	96,94 %	98,71 %	97,61 %	98,74 %	97,87 %	98,37 %	97,11 %	97,53 %	98,75 %	97,15 %	98,58 %	98,72 %	98,26 %	97,65 %
WebBrowsingComplete (%)	99,02 %	100,00 %	99,19 %	99,58 %	99,75 %	98,54 %	99,58 %	99,59 %	99,94 %	99,89 %	99,41 %	99,74 %	99,44 %	99,77 %	99,36 %
YouTubeComplete (%)	100,00 %	99,77 %	99,56 %	99,81 %	100,00 %	98,99 %	100,00 %	100,00 %	100,00 %	100,00 %	99,77 %	99,30 %	100,00 %	99,70 %	99,48 %
Global Test Success (%)	99,22 %	99,34 %	99,42 %	99,42 %	99,63 %	99,15 %	99,53 %	99,29 %	99,51 %	99,36 %	99,22 %	99,60 %	99,60 %	99,50 %	99,30 %

Benchmarking Coverage – Best 5G Availability

3G 4G 5G-NSA 5G-SA NoService

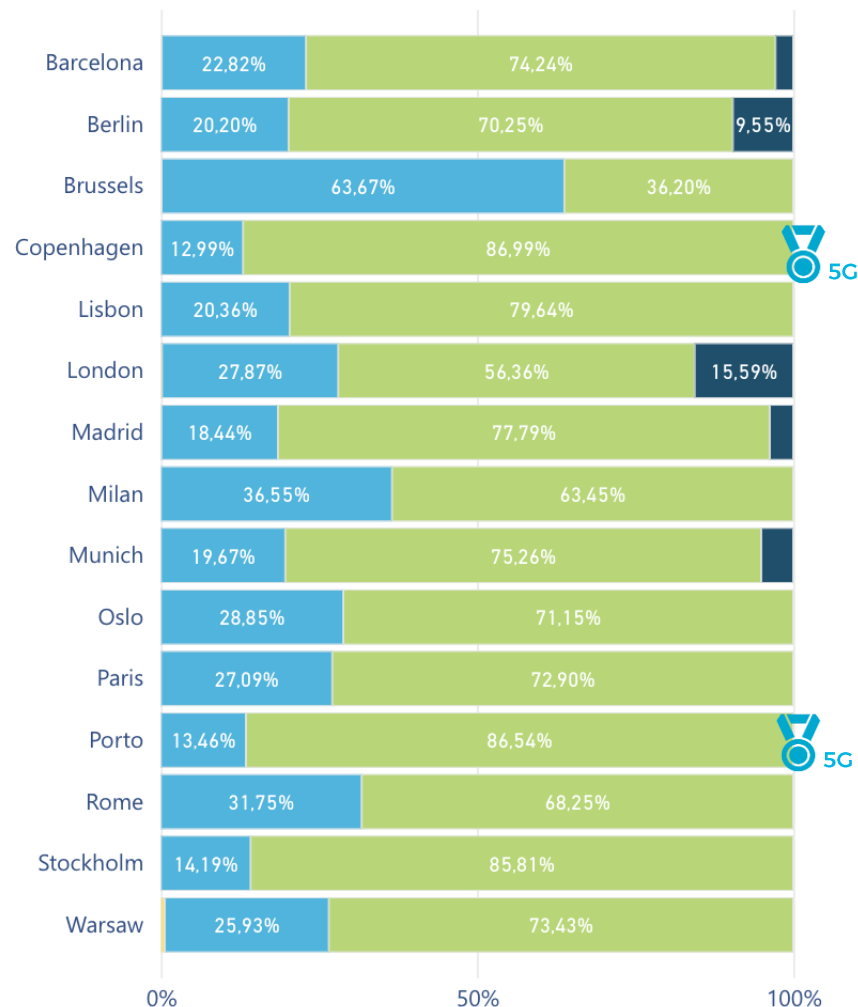


Copenhagen has the best 5G availability (coverage) with 87% technology registration. Closely followed by **Porto**, co-leading with 86.54%



Benchmarking Coverage – Best 5G availability (Registration Rate)

● 3G ● 4G ● 5G-NSA ● 5G-SA



SubTech	Barcelona	Berlin	Brussels	Copenhagen	Lisbon	London	Madrid	Milan	Munich	Oslo	Paris	Porto	Rome	Stockholm	Warsaw	Total
NR_NSA	74,25%	70,25%	36,20%	86,99%	79,64%	56,38%	77,79%	63,59%	75,26%	71,15%	72,90%	86,54%	68,25%	85,81%	73,46%	70,53%
LTE	17,69%	19,93%	18,74%	12,99%	11,04%	20,75%	13,99%	12,98%	17,22%	24,01%	20,20%	7,26%	13,75%	10,59%	12,24%	15,90%
LTE_CA	5,13%	0,27%	44,93%	0,00%	9,33%	7,13%	4,45%	23,43%	2,46%	4,85%	6,89%	6,19%	18,00%	3,60%	13,70%	10,49%
NR_SA	2,81%	9,55%				15,60%	3,70%		5,06%	0,00%					0,00%	2,99%
HSPA+	0,10%		0,12%	0,01%		0,15%	0,06%				0,01%				0,55%	0,08%
UMTS	0,02%		0,01%	0,00%		0,00%	0,01%				0,00%				0,05%	0,01%

NR Bands Distribution [%]

NR Band	Barcelona	Berlin	Brussels	Copenhagen	Lisbon	London	Madrid	Milan	Munich	Oslo	Paris	Porto	Rome	Stockholm	Warsaw	Total
1	1,45%		11,54%	0,18%		1,25%	0,44%			55,67%	0,26%			0,06%	7,35%	2,94%
28	5,25%	6,40%	10,30%				2,35%	1,71%	0,63%	2,55%			6,93%			2,24%
78	93,30%	93,60%	78,16%	99,82%	100,00%	98,75%	97,20%	98,29%	99,37%	41,78%	99,74%	100,00%	93,07%	99,94%	92,65%	94,81%

Copenhagen has the best 5G availability (technology registration rate) with 87.00% technology registration, closely followed by Porto, co-leading with 86.54%.

Apart from having high 5G availability, both Portuguese cities, **Lisbon and Porto**, have 100% of registration in 5G Mid-Band n78, which is a proxy of high-quality 5G.



Benchmarking “5G only” Experience (MOS)

Portuguese cities, Lisbon and Porto, lead the 5G DL Speed category, whereas German cities, Berlin and Munich, lead the Gaming Experience in 5G. Stockholm leads the 5G UL Speed category.

Porto, Lisbon and Stockholm achieved the best overall 5G ranking result, followed closely by three strong competitors: Copenhagen, Paris and Munich.

Services MOS (Max MOS)	Barcelona	Berlin	Brussels	Copenhagen	Lisbon	London	Madrid	Milan	Munich	Oslo	Paris	Porto	Rome	Stockholm	Warsaw
DATA & OTT (2.625)	2,185	2,382	2,298	2,473	2,491	2,061	2,224	2,319	2,453	2,346	2,454	2,512	2,264	2,497	2,257
MOS Dropbox (0.25)	0,202	0,211	0,220	0,243	0,234	0,212	0,196	0,222	0,237	0,186	0,247	0,242	0,219	0,228	0,232
MOS Gaming (0.375)	0,301	0,373	0,287	0,350	0,360	0,312	0,332	0,350	0,373	0,313	0,372	0,360	0,305	0,348	0,324
MOS HttpDL (0.25)	0,233	0,229	0,236	0,240	0,250	0,203	0,224	0,235	0,245	0,248	0,230	0,250	0,222	0,250	0,243
MOS HttpUL (0.25)	0,213	0,230	0,221	0,250	0,249	0,164	0,227	0,220	0,240	0,247	0,243	0,248	0,203	0,250	0,239
MOS SocialMedia (0.5)	0,388	0,387	0,435	0,433	0,450	0,379	0,391	0,393	0,405	0,438	0,422	0,448	0,436	0,449	0,385
MOS WebBrowsing (1)	0,847	0,951	0,898	0,957	0,949	0,791	0,854	0,901	0,952	0,915	0,939	0,963	0,879	0,971	0,835
Network Responsiveness (0.375)	0,320	0,371	0,313	0,373	0,371	0,332	0,334	0,363	0,371	0,361	0,365	0,371	0,339	0,369	0,344
MOS Ping (0.375)	0,320	0,371	0,313	0,373	0,371	0,332	0,334	0,363	0,371	0,361	0,365	0,371	0,339	0,369	0,344
Streaming (1.25)	1,113	1,124	1,118	1,209	1,199	1,041	1,054	1,099	1,167	1,134	1,181	1,181	1,099	1,201	1,125
MOS YouTube (1.25)	1,113	1,124	1,118	1,209	1,199	1,041	1,054	1,099	1,167	1,134	1,181	1,181	1,099	1,201	1,125
Value for Speed (0.75)	0,694	0,708	0,697	0,736	0,746	0,655	0,688	0,702	0,727	0,712	0,724	0,743	0,678	0,740	0,721
MOS CloudDL (0.5)	0,465	0,474	0,471	0,488	0,498	0,443	0,454	0,475	0,491	0,465	0,484	0,498	0,468	0,490	0,484
MOS CloudUL (0.25)	0,229	0,234	0,226	0,248	0,247	0,212	0,234	0,227	0,235	0,247	0,239	0,244	0,210	0,250	0,236
Total MOS (5)	4,311	4,585	4,426	4,791	4,806	4,090	4,301	4,483	4,718	4,552	4,722	4,806	4,379	4,808	4,446



Services MOS (Max MOS)	Barcelona	Berlin	Brussels	Copenhagen	Lisbon	London	Madrid	Milan	Munich	Oslo	Paris	Porto	Rome	Stockholm	Warsaw
Reliability (2.75)															
MOS Reliability (2.75)	2,554	2,592	2,628	2,632	2,680	2,455	2,584	2,590	2,668	2,626	2,598	2,642	2,639	2,636	2,576



Benchmarking “5G only” Experience (% out of max. score)

Portuguese cities, Lisbon and Porto, lead the 5G DL Speed category, whereas German cities, Berlin and Munich, lead the Gaming Experience in 5G. Stockholm leads the 5G UL Speed category.

Porto, Lisbon and Stockholm achieved the best overall 5G ranking result, followed closely by three strong competitors: Copenhagen, Paris and Munich.

Services MOS (Max MOS)	Barcelona	Berlin	Brussels	Copenhagen	Lisbon	London	Madrid	Milan	Munich	Oslo	Paris	Porto	Rome	Stockholm	Warsaw
DATA & OTT (2.625)	83,24 %	90,74 %	87,54 %	94,22 %	94,89 %	78,51 %	84,72 %	88,34 %	93,45 %	89,38 %	93,47 %	95,68 %	86,25 %	95,13 %	85,97 %
MOS Dropbox (0.25)	80,97 %	84,22 %	88,19 %	97,25 %	93,80 %	84,93 %	78,27 %	88,61 %	94,97 %	74,23 %	98,92 %	96,81 %	87,58 %	91,18 %	92,87 %
MOS Gaming (0.375)	80,39 %	99,57 %	76,41 %	93,43 %	95,87 %	83,12 %	88,50 %	93,31 %	99,60 %	83,43 %	99,10 %	96,02 %	81,20 %	92,93 %	86,29 %
MOS HttpDL (0.25)	93,12 %	91,78 %	94,26 %	95,81 %	99,84 %	81,32 %	89,75 %	93,81 %	98,17 %	99,32 %	92,15 %	99,96 %	88,97 %	100,00 %	97,25 %
MOS HttpUL (0.25)	85,35 %	92,11 %	88,55 %	100,00 %	99,49 %	65,44 %	90,72 %	87,80 %	96,18 %	98,63 %	97,20 %	99,39 %	81,08 %	100,00 %	95,47 %
MOS SocialMedia (0.5)	77,52 %	77,50 %	87,08 %	86,66 %	89,96 %	75,71 %	78,23 %	78,57 %	80,92 %	87,53 %	84,39 %	89,63 %	87,29 %	89,87 %	76,94 %
MOS WebBrowsing (1)	84,74 %	95,09 %	89,83 %	95,69 %	94,88 %	79,14 %	85,40 %	90,05 %	95,17 %	91,52 %	93,93 %	96,30 %	87,89 %	97,15 %	83,46 %
Network Responsiveness (0.375)	85,40 %	98,91 %	83,40 %	99,46 %	98,85 %	88,63 %	89,18 %	96,85 %	99,05 %	96,18 %	97,22 %	98,90 %	90,33 %	98,40 %	91,68 %
MOS Ping (0.375)	85,40 %	98,91 %	83,40 %	99,46 %	98,85 %	88,63 %	89,18 %	96,85 %	99,05 %	96,18 %	97,22 %	98,90 %	90,33 %	98,40 %	91,68 %
Streaming (1.25)	89,00 %	89,94 %	89,44 %	96,68 %	95,88 %	83,31 %	84,36 %	87,93 %	93,32 %	90,71 %	94,45 %	94,45 %	87,91 %	96,10 %	89,98 %
MOS YouTube (1.25)	89,00 %	89,94 %	89,44 %	96,68 %	95,88 %	83,31 %	84,36 %	87,93 %	93,32 %	90,71 %	94,45 %	94,45 %	87,91 %	96,10 %	89,98 %
Value for Speed (0.75)	92,49 %	94,39 %	92,93 %	98,12 %	99,42 %	87,34 %	91,74 %	93,54 %	96,87 %	94,88 %	96,50 %	99,01 %	90,38 %	98,73 %	96,09 %
MOS CloudDL (0.5)	92,98 %	94,86 %	94,13 %	97,59 %	99,68 %	88,63 %	90,78 %	94,92 %	98,23 %	92,96 %	96,87 %	99,64 %	93,58 %	98,09 %	96,88 %
MOS CloudUL (0.25)	91,51 %	93,44 %	90,54 %	99,18 %	98,92 %	84,74 %	93,65 %	90,78 %	94,16 %	98,70 %	95,76 %	97,75 %	83,98 %	100,00 %	94,51 %
Total MOS (5)	86,23 %	91,70 %	88,51 %	95,81 %	96,12 %	81,79 %	86,02 %	89,65 %	94,35 %	91,05 %	94,45 %	96,11 %	87,59 %	96,16 %	88,92 %

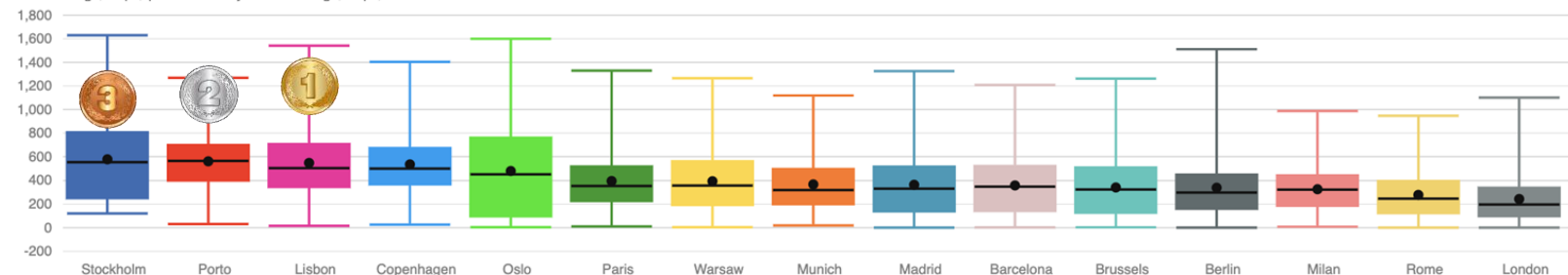


Services MOS (Max MOS)	Barcelona	Berlin	Brussels	Copenhagen	Lisbon	London	Madrid	Milan	Munich	Oslo	Paris	Porto	Rome	Stockholm	Warsaw
Reliability (2.75)															
MOS Reliability (2.75)	92,88 %	94,27 %	95,55 %	95,72 %	97,45 %	89,27 %	93,96 %	94,18 %	97,02 %	95,48 %	94,48 %	96,08 %	95,97 %	95,87 %	93,68 %

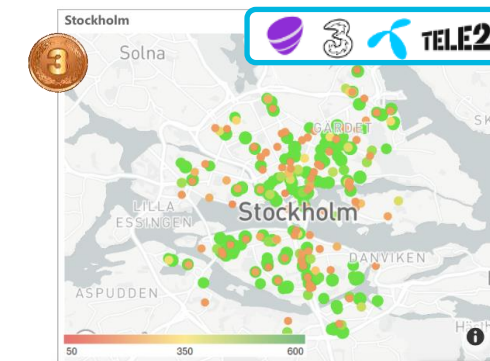
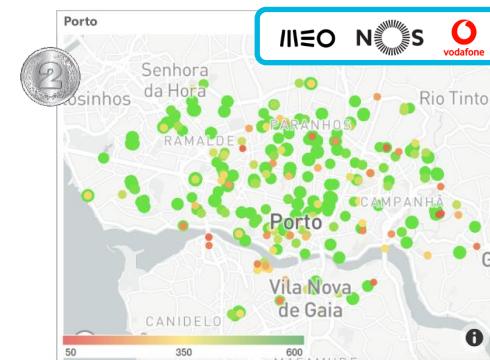
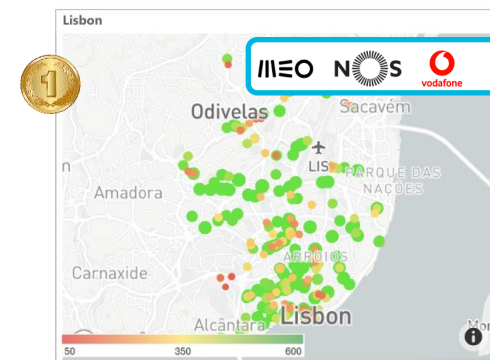


Benchmarking 5G DL Speed - Cloud Speed Test (multi-thread)

CloudDLAvg (Mbps) por Location y CloudDLAvg (Mbps)

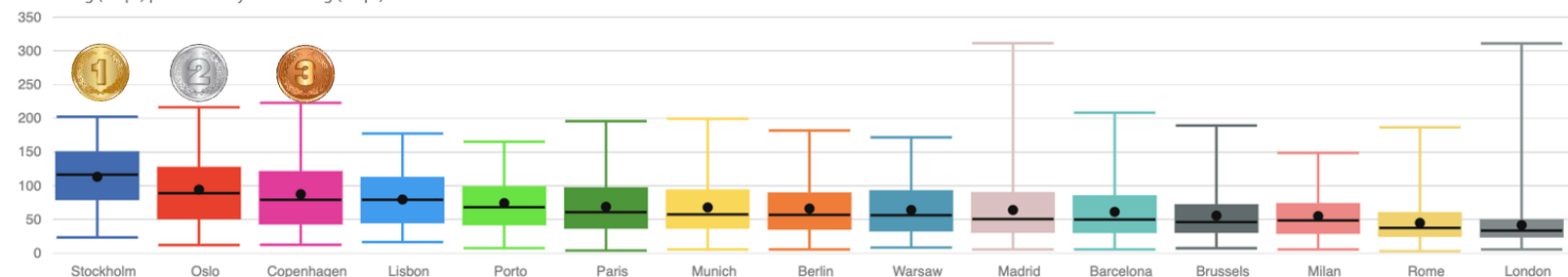


Location	CloudDLCompleteQ (%)	CloudDL>20Mbps (%)	CloudDL>100Mbps (%)	CloudDLAvg (Mbps)	CloudDLp50	CloudDLp90	CloudDLMax
Stockholm	99,65 %	100,00 %	100,00 %	579,04	554,68	1.034,46	1.863,51
Porto	100,00 %	100,00 %	98,52 %	562,18	565,60	845,38	1.541,48
Lisbon	100,00 %	99,28 %	97,12 %	548,47	504,52	930,85	1.955,47
Copenhagen	99,60 %	100,00 %	98,59 %	536,00	500,40	867,31	1.619,02
Oslo	100,00 %	95,77 %	67,20 %	480,08	451,85	1.031,76	1.908,59
Paris	99,72 %	99,58 %	94,58 %	395,03	352,95	696,39	1.625,30
Warsaw	99,79 %	98,96 %	88,82 %	393,50	356,69	718,98	1.640,38
Munich	100,00 %	99,71 %	91,55 %	366,73	318,59	667,67	1.637,04
Madrid	99,36 %	94,44 %	80,72 %	363,48	330,47	740,24	1.665,06
Barcelona	99,79 %	95,30 %	79,91 %	357,71	347,41	690,48	1.479,34
Brussels	100,00 %	96,59 %	77,84 %	340,53	323,49	672,89	1.443,68
Berlin	99,74 %	98,68 %	85,45 %	338,19	297,36	615,23	1.845,64
Milan	99,78 %	98,03 %	88,38 %	325,73	322,16	551,40	1.260,69
Rome	99,82 %	98,58 %	80,96 %	277,67	246,09	535,26	1.234,59
London	99,44 %	95,60 %	74,43 %	243,05	196,29	534,75	1.333,91

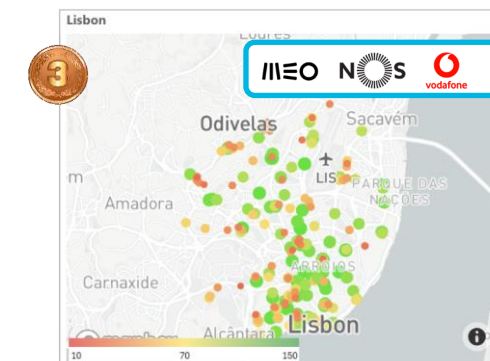
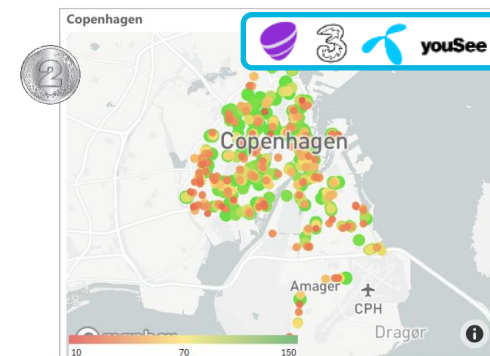
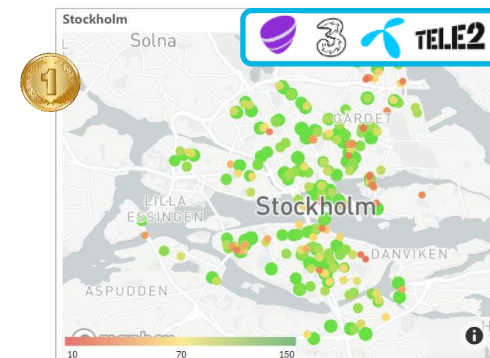


Benchmarking 5G UL Speed - Cloud Speed Test (multi-thread)

CloudULAvg (Mbps) por Location y CloudULAvg (Mbps)



Location	CloudULCompleteQ (%)	CloudUL>10Mbps (%)	CloudUL>20Mbps (%)	CloudULAvg (Mbps)	CloudULp50	CloudULp90	CloudULMax
Stockholm	100,00 %	100,00 %	100,00 %	113,36	116,53	168,65	343,24
Oslo	100,00 %	100,00 %	98,08 %	94,24	89,01	173,51	361,72
Copenhagen	100,00 %	100,00 %	98,78 %	87,35	78,64	158,82	363,36
Lisbon	100,00 %	100,00 %	99,15 %	79,74	79,35	130,15	295,73
Porto	100,00 %	99,59 %	98,77 %	74,25	68,04	130,40	299,01
Paris	100,00 %	99,66 %	96,57 %	68,85	60,85	118,51	337,17
Munich	100,00 %	98,67 %	97,01 %	67,58	56,92	124,19	285,08
Berlin	100,00 %	98,87 %	95,21 %	65,48	56,81	124,90	311,30
Warsaw	100,00 %	99,78 %	94,18 %	64,12	56,06	119,70	287,54
Madrid	100,00 %	99,09 %	94,70 %	63,56	49,79	126,08	386,28
Barcelona	100,00 %	98,49 %	94,46 %	60,83	48,31	115,04	372,74
Brussels	100,00 %	98,84 %	93,06 %	55,71	46,28	101,78	367,45
Milan	100,00 %	98,82 %	93,60 %	54,77	48,44	100,89	238,39
Rome	100,00 %	98,11 %	88,03 %	44,64	37,86	81,41	226,10
London	100,00 %	98,28 %	89,69 %	41,43	34,18	73,15	310,99



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2. Detailed Report
3. **Challenging context with global ambitions**
4. Annexes: KPIs and Category Results
5. MedUX, a trusted partner



Challenging context with global ambitions



Time for action

- **Insufficient progress** in reaching targets
- High quality coverage, particularly a Meaningful Connectivity, still **requiring +200 EUR bln investment**
- Variety of **types and methods for Gigabit broadband** rollout reveals differences in Quality of Experience
- **Need for specific quality metrics** beyond coverage for properly monitoring and reporting progress

Competitiveness

Economic Recovery

Prosperity

Resilience



The role of 5G in Achieving Europe's Digital Decade 2030 Goals

Unlocking the Power of Connectivity for a More Innovative and Inclusive Europe



Digital Infrastructure

5G enables faster, reliable and high-quality connectivity for all urban and rural regions, reducing digital divides.



Digital Transformation

5G supports cutting-edge tech (AI, IoT) by delivering the infrastructure for real-time data processing and innovation in industries.



Digital Skills

5G accelerates access to online learning platforms and digital services, improving access to education and job opportunities



Digital Public Services

5G enhances the delivery of smart cities and governments, remote healthcare, and accessibility to public services.



2030 DIGITAL DECADE



Ambitious targets to enable a Gigabit Society

Skills

20 million employed **ICT specialists**, more
graduates + gender balance
80% of adults can **use tech** for everyday tasks

Government

Key Public Services - 100% online
Everyone can **access health records** online
Everyone can use **eID**



Infrastructure

Gigabit connectivity for everyone, **high-speed mobile coverage** (at least 5G) everywhere
EU produces 20% of world's **semiconductors**
10 000 **cloud edge nodes** = fast data access
EU **quantum computing** by 2025

Business

75% of companies using **Cloud, AI or Big Data**
Double the number of **unicorn startups**
90% of **SMEs** taking up tech

**Future-proof Fixed and Mobile connectivity as an enabler
for digital transformation and digital public services**

100% 5G Coverage

***100% 3.4-3.8 GHz 5G Coverage**

100% FTTP Coverage

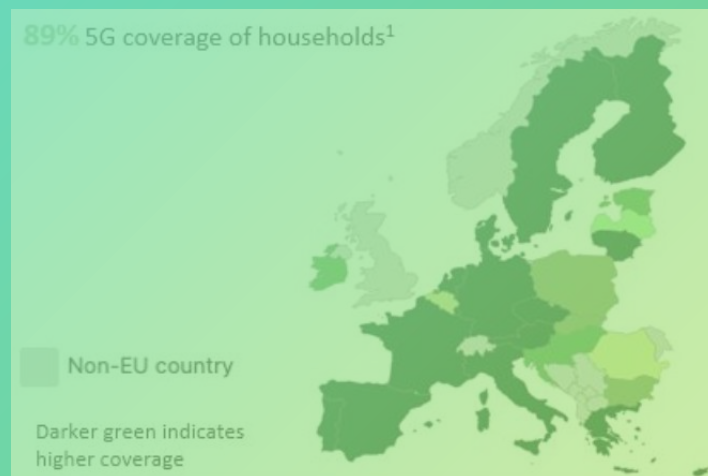
100% Fixed VHCN

... and beyond



5G Observatory Report

5G developments towards Digital Decade targets



As per 2024 5G Observatory Reports:

460.000 5G Base Stations

89% 5G Coverage

51% 3.4-3.8 GHz 5G Coverage

Most-common type is basic 5G, SA lagging behind

Insufficient developments in the deployment of 5G



The Time to Transform 5G Connectivity is NOW!

Together, we can build a High-Quality Digital World to drive Societal Progress and Digital Transformation and to ensure citizens and businesses benefit from 5G full capabilities EVERYWHERE



Going beyond coverage for a meaningful connectivity

Ambitioning **top-notch quality and service experience** as pivotal elements to transform basic connectivity into an impactful tool for long-term societal development.



Anticipating a potential 5G Divide among and within States

Considering quality of experience **differences among major cities** in Europe as a “wake-up call” to ensure citizens and businesses benefit from the full capabilities offered by 5G everywhere.



Understanding the devil of 5G potential is in the details

Grasping the details about **5G flavors and use cases requirements** is key. Most-common 5G type is DSS, only 51% of 3.4-3.8 GHz 5G Coverage and NR SA lagging behind.



Catching up with world-class 5G technology leaders

Setting more ambitious National Digital Decade Strategy Roadmaps and accelerating **high-quality 5G investments** and deployment pace.





Rolling Campaign 2025

Ensure your city is included in Europe's most comprehensive 5G QoE Benchmarking research study.

Public entities can join our not-for-profit benchmarking and connectivity initiative to gain valuable insights into the true performance of 5G.

Contact Us.

Q42024 Scope

2025 Candidates

Join Us



5G Benchmarking Initiative



Up to 5G



5G SA-Ready Smartphones



Dedicated Vehicles



Robust Testing Sampling



Internet QoE Testing protocol



Several Driving Days per City



2025 (TBC)

Join Us



Q42024 reports available on-demand



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4. **Annexes: KPIs and Category Results**
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Annex: Detailed Benchmarking Results

Category Results

Quality of Experience – Ranking approach

MedUX mobile benchmarking approach, based on our own MOS (MedUX Opinion Score) and QoE Scorecard, assesses network performance and end-user experience in the 5G Era. We revisit criteria and thresholds once a year to consider best practices but also to reflect technology and industry development.

At MedUX we use the concept of Mean opinion score (MOS) for most of the rankings, which ratings are algorithmically estimated based on test results and KPIs, in line with the current state of the ETSI TR 103 559 V1.2.1 and ITU Recommendation ITU-T P.800.1.

•Top Awards:

- **Overall QoE Score** – a combination of availability, accessibility, speed, streaming, and data and OTT experience results.
- **Reliability** – assesses network consistency across all service categories, focusing on 5G stability by considering the success rate (%) of all tests and services described above. A test is considered as not successful if it fails or if does not meet minimum service thresholds.

•Experience Awards:

- **Accessibility** (responsiveness) – how long it takes to access the network. Particularly in 5G it measures how long takes to access the 5G network across all testing categories while taking latency and network responsiveness results into account.
- **Value for Speed** (throughput) - how much data can be transferred. Particularly in 5G it measures how is the network capacity when stressing the line (multi-thread and multi-server stress test with our patented Cloud Speed Test).
 - DL Speed
 - UL Speed
- **Video Streaming experience** - it measures the average video experience for each operator while considering video resolution, video loading time, and stall ratio.
- **Data and OTT experience** - a combination of gaming, web browsing, social networks, file transfer experiences.

Quality of Experience – Ranking approach

•5G Awards

- **5G Availability** – the percentage of 5G network registration, a proxy of 5G coverage available during the measurements.
- **5G DL Speed** (throughput) – how much data can be transferred in 5G downlink channel, how is the network capacity when stressing the line (multi-thread and multi-server stress test with our patented Cloud Speed Test),
- **5G UL Speed** (throughput) – how much data can be transferred in 5G uplink channel, how is the network capacity when stressing the line (multi-thread and multi-server stress test with our patented Cloud Speed Test),
- **5G Gaming**, it measures the average 5G gaming experience rating different key parameters against gaming servers.

For further details about the methodology used please visit our blog [“Assessing customer experiences with an advanced mobile broadband benchmarking methodology”](#)

Mobile Experience Awards

Awards are granted to the best performing operators in each attribute or category we test. If two or more operators record statistically indistinguishable results, each operator earns an Experience Award while sharing the highest rank in that category.

Stockholm and Porto co-lead the European 5G QoE Benchmarking campaign, sharing the Video Streaming and the Data and OTT with other European cities.

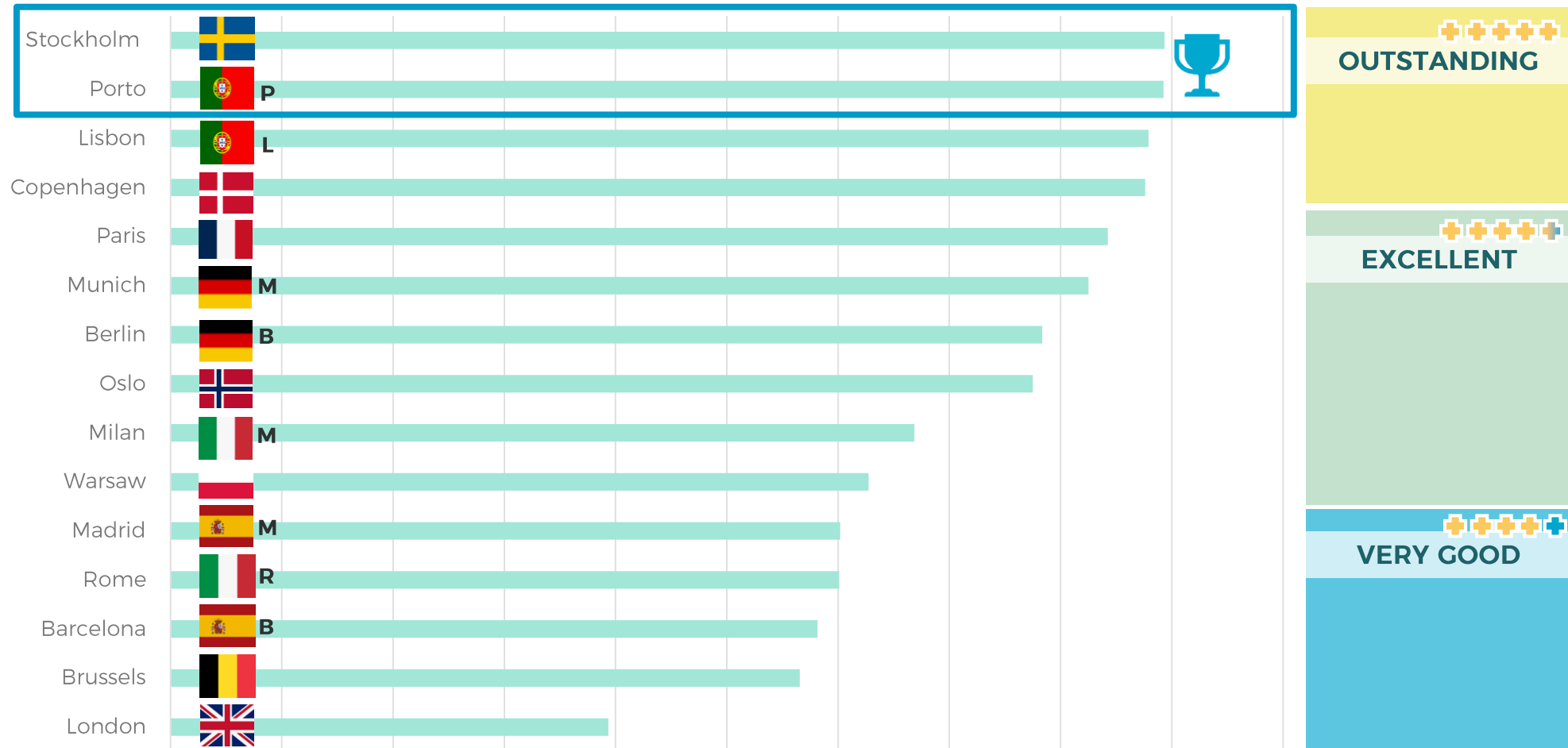
	Top Awards	Experience Awards					5G Awards			
	Best Experience	Reliability	Data & OTT	Streaming Experience	Value for Speed	Network Responsiveness	5G Availability	5G DL Speed	5G UL Speed	5G Gaming
Europe Winners										
	S P	L	P S	S C	L P	C B	C P	L P	S	B M

- Porto, Lisbon, Stockholm and Copenhagen lead most of the rankings across all mobile experience categories
- Porto and Stockholm share the most important award for Best QoE while showing outstanding stability across most mobile experience categories and KPIs.
- Lisbon leads the second most important award for Best Reliability, as well as other specific awards on Value for Speed and 5G DL Speed.
- Copenhagen wins Network Responsiveness and 5G Availability awards.
- Portuguese cities, Lisbon and Porto, lead the 5G DL Speed, whereas German cities, Berlin and Munich, lead the Gaming Experience in 5G.

NOTE*: Co-leaders or Co-best (less than 0.5% difference)

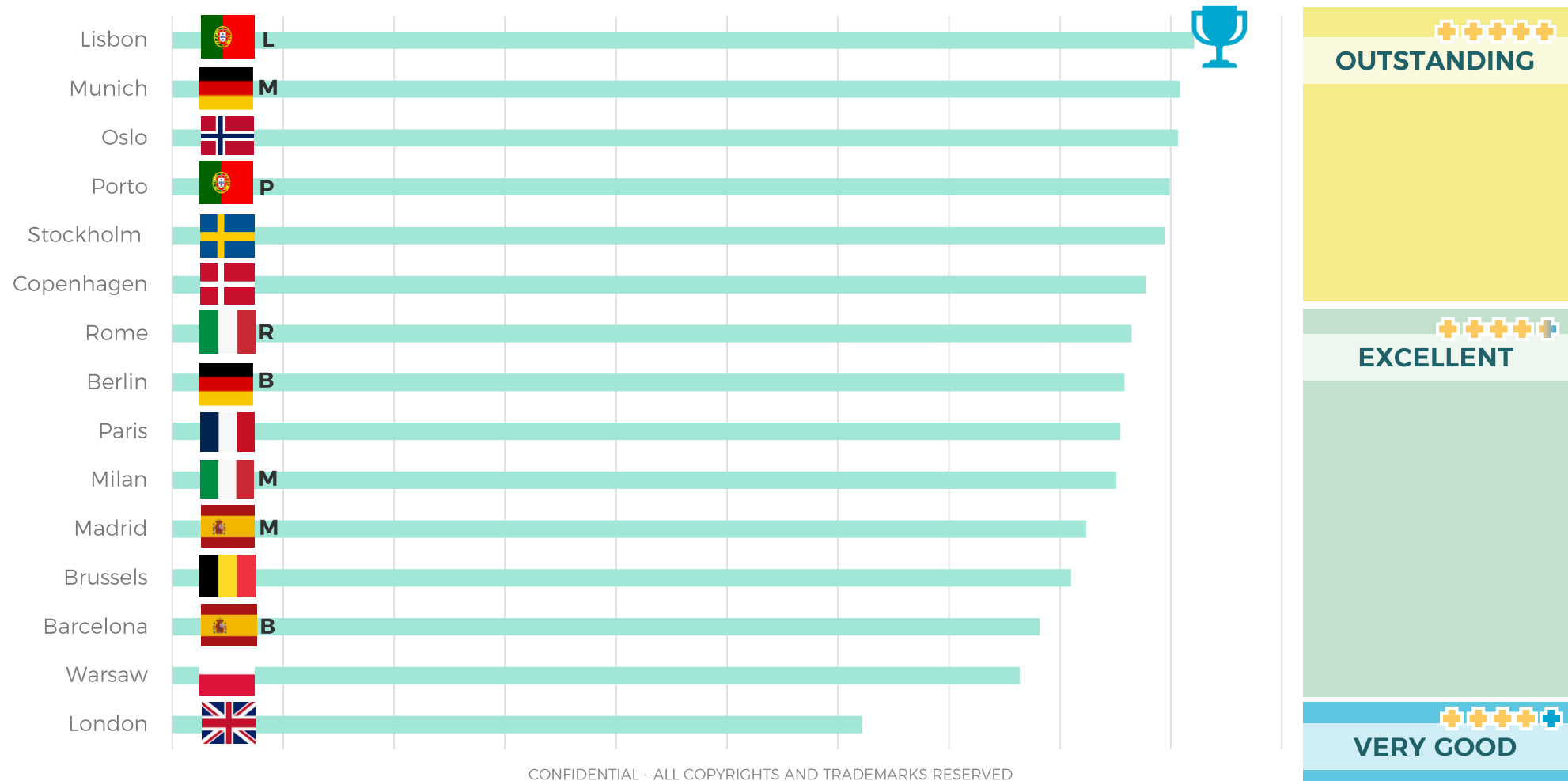
Quality of Experience: Overall QoE Ranking

Our 5G QoE measurement campaigns aim to test and shape the future of 5G experience. The study unveils two outstanding winners ('ex aequo' with less than 0.05% difference), Stockholm and Porto, followed closely by two very strong competitors: Lisbon and Copenhagen.



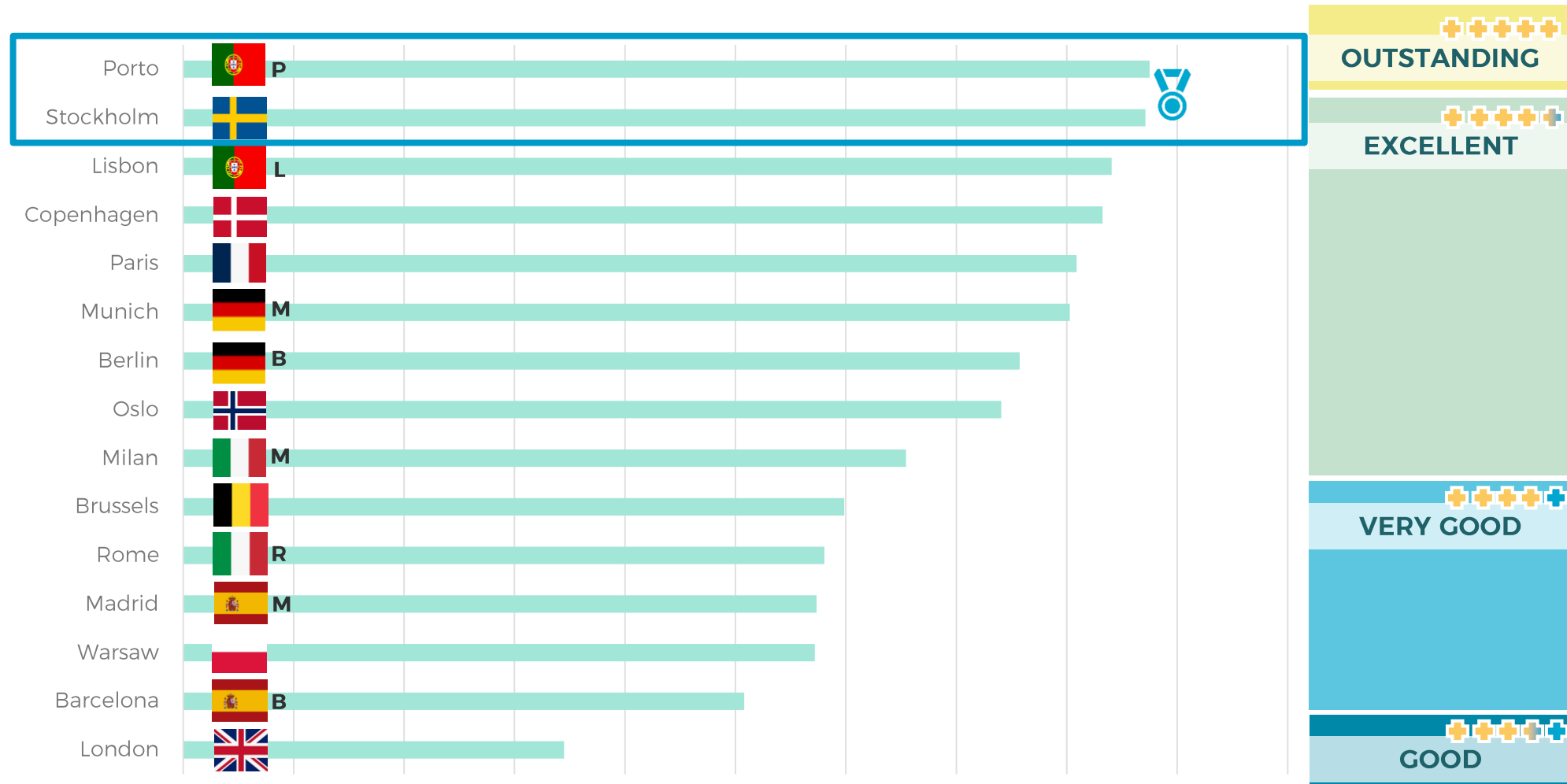
Quality of Experience: Reliability Ranking

The study unveils an outstanding winner, Lisbon, followed closely by two strong competitors: Munich and Oslo. Reliability assesses network consistency across all service categories, focusing on service stability by considering the success rate (%) of all tests described above.



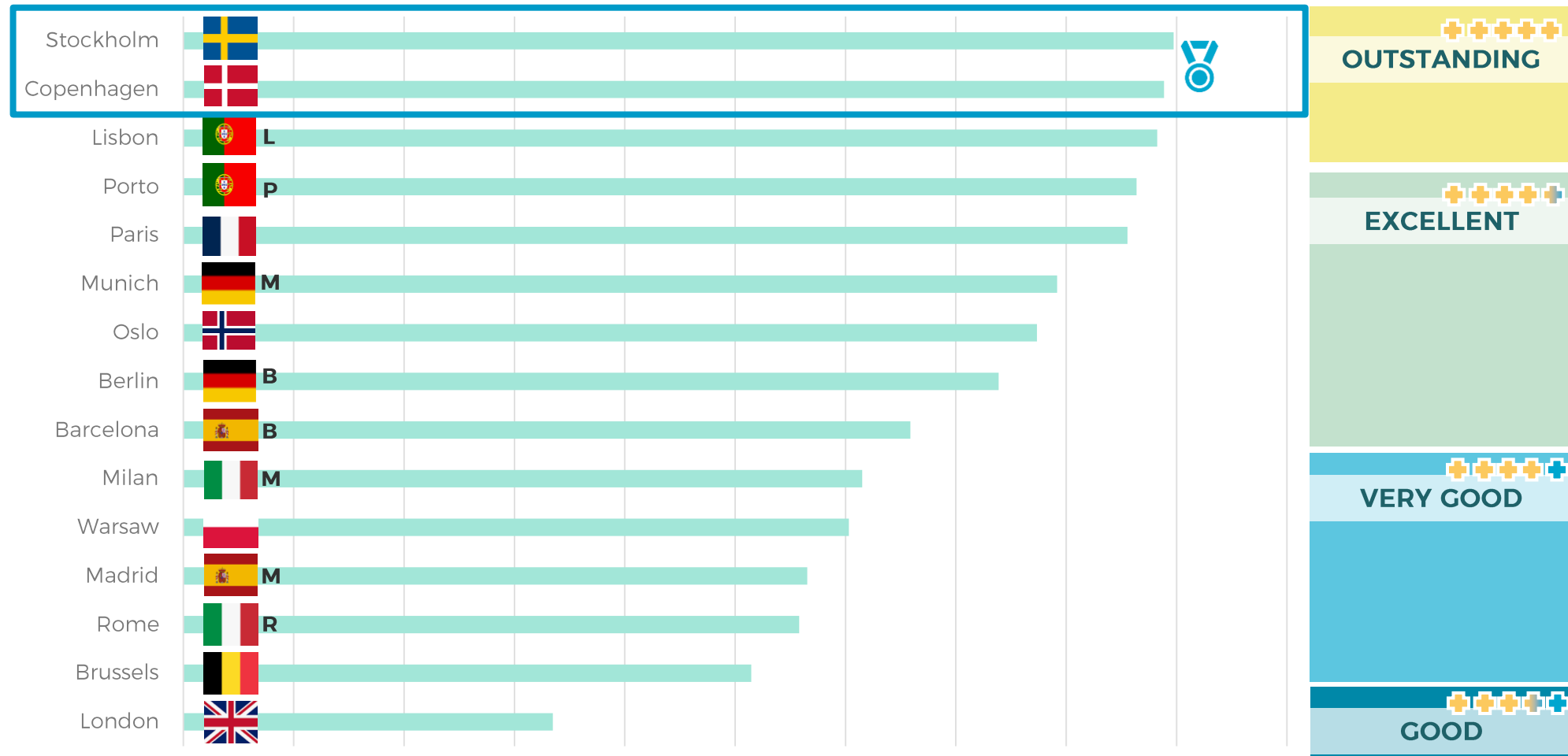
Quality of Experience: Data & OTT Experience Ranking

The study unveils two outstanding winners, Porto and Stockholm, followed closely by two strong competitors: Lisbon and Copenhagen. Data & OTT Experience assesses a combination of gaming, web browsing, social networks, file transfer experiences.



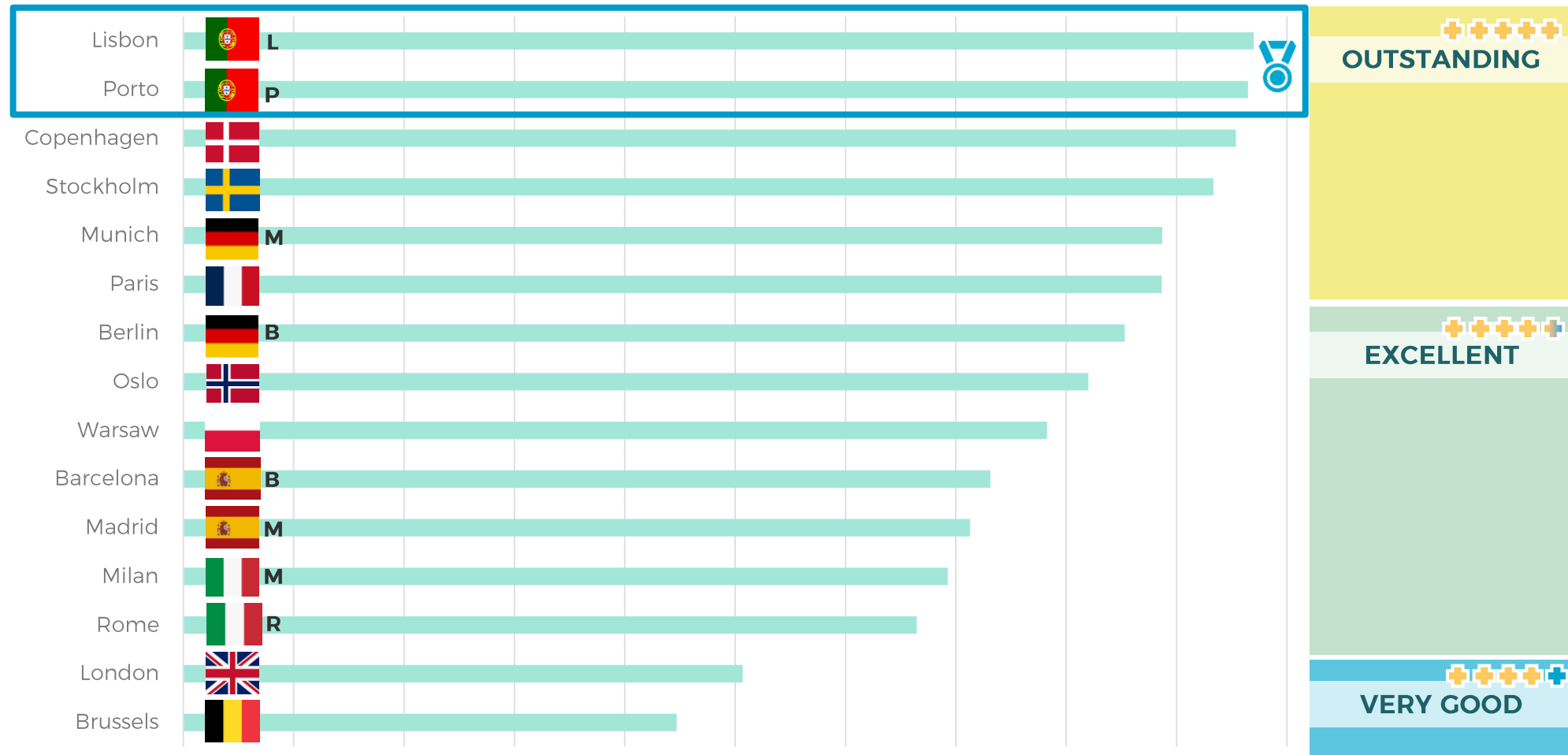
Quality of Experience: Streaming Experience Ranking

The study unveils two outstanding winners, Stockholm and Copenhagen, followed closely by three strong competitors: Lisbon, Porto and Paris. Streaming Experience assesses the average video experience while considering video resolution, video loading time, and stall ratio.



Quality of Experience: Value for Speed Ranking

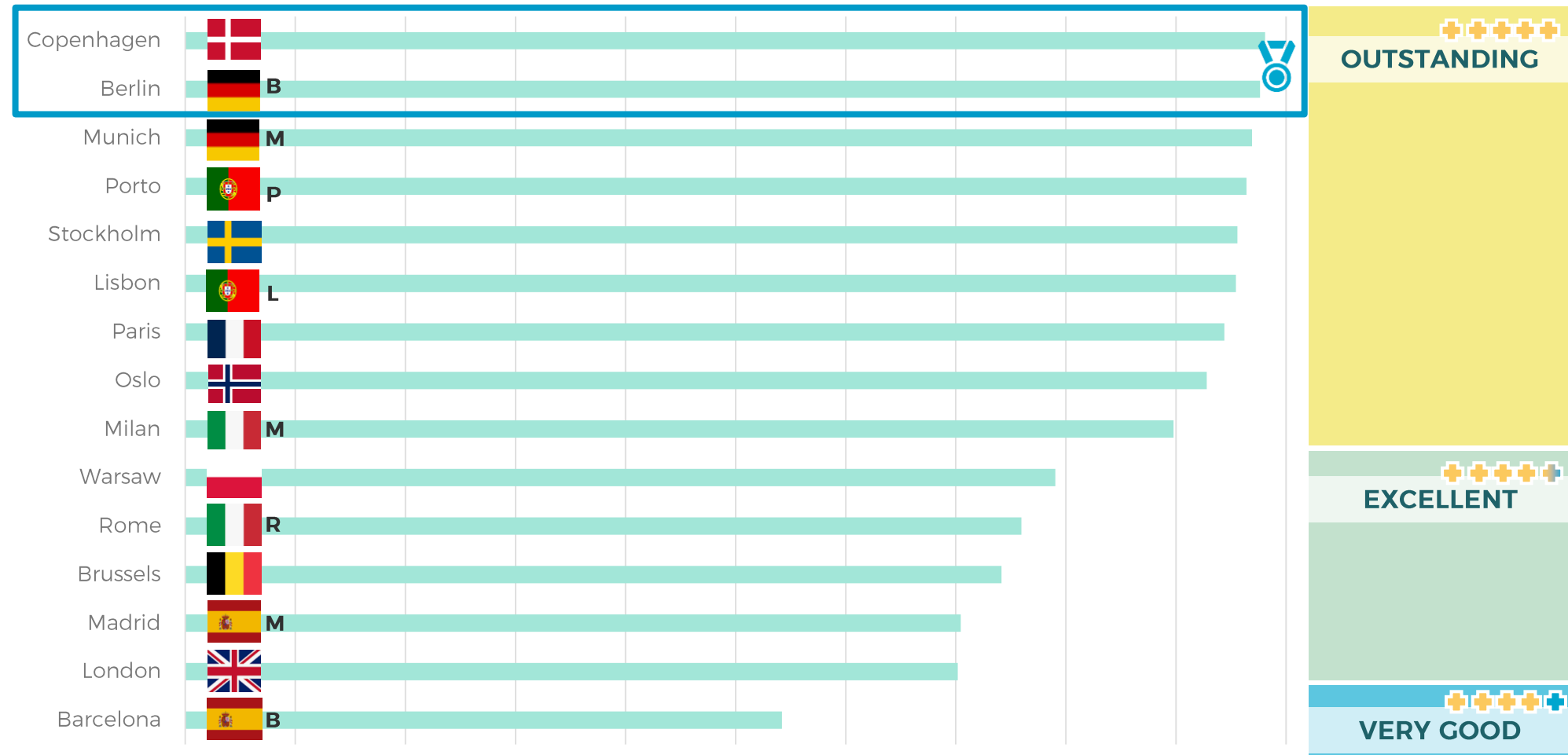
The study unveils two outstanding winners, Lisbon and Porto, followed closely by two strong competitors: Copenhagen and Stockholm. Value for Speed assesses how much data can be transferred. Particularly, it measures how is the network capacity when stressing the line.





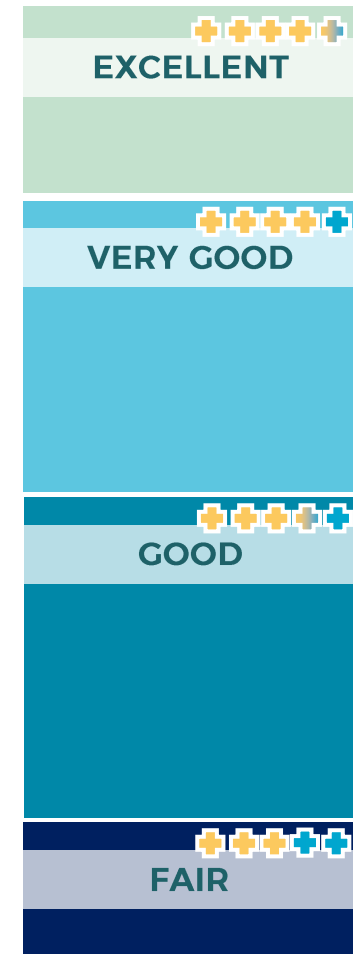
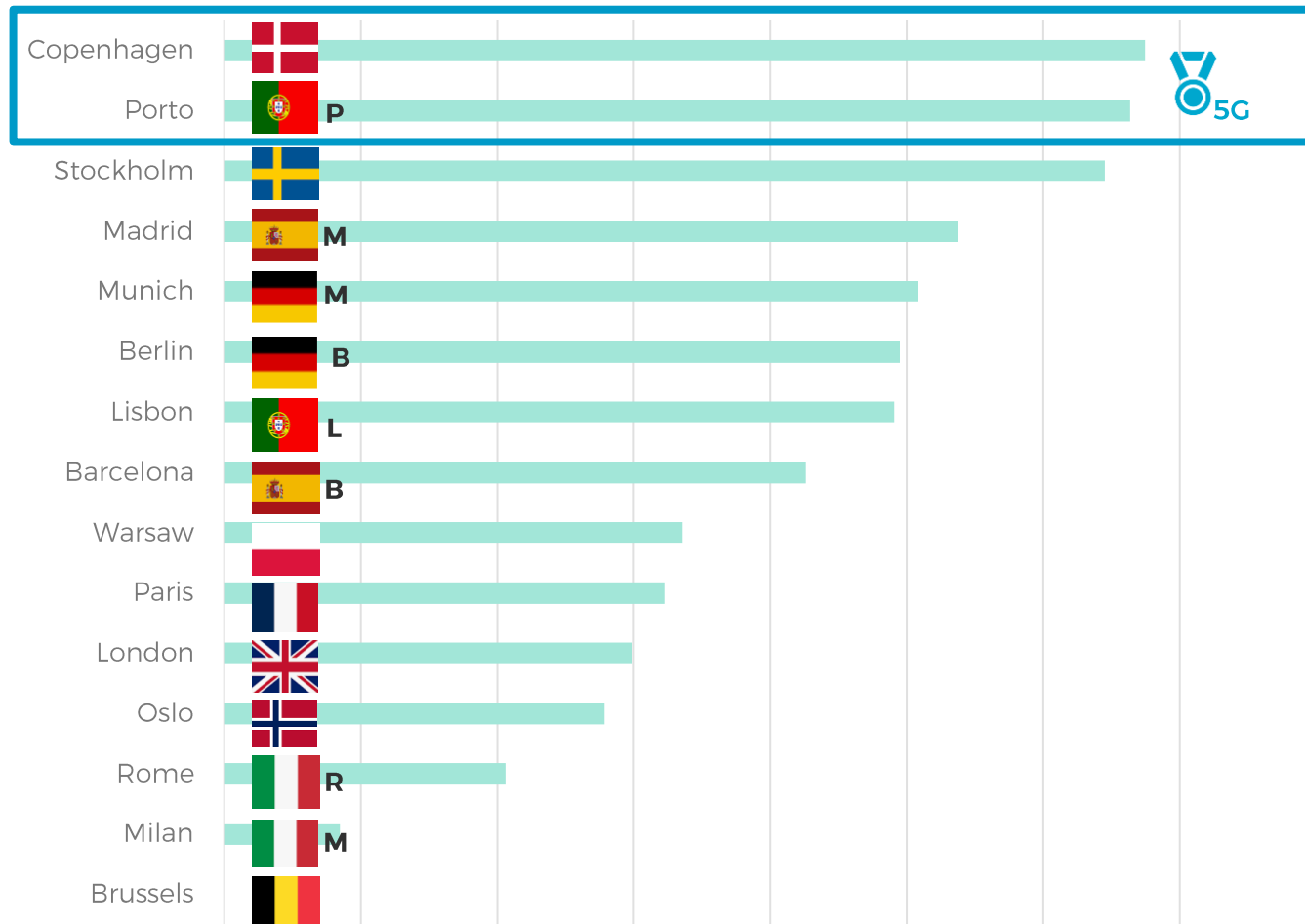
Quality of Experience: Network Responsiveness Ranking

The study unveils two outstanding winners, Copenhagen and Berlin, followed closely by two strong competitors: Munich and Porto. Network Responsiveness (Accessibility) assesses how long it takes to access the network.



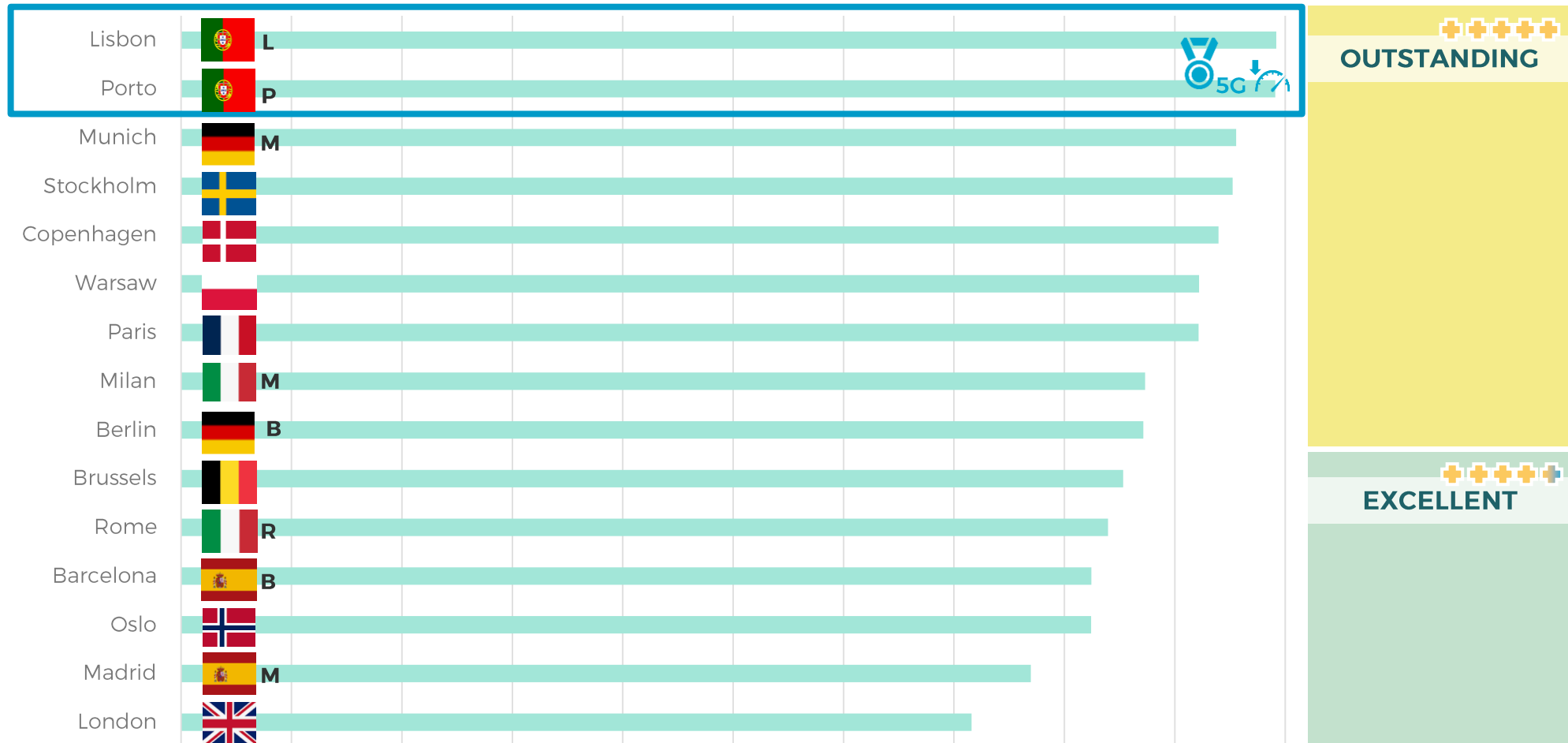
Quality of Experience: 5G Availability Ranking

The study unveils two outstanding winners, Porto and Copenhagen, followed closely by one strong competitor: Stockholm. 5G Availability assesses the percentage of 5G network registration (% of time connected 5G), a proxy of 5G coverage available during the measurements.



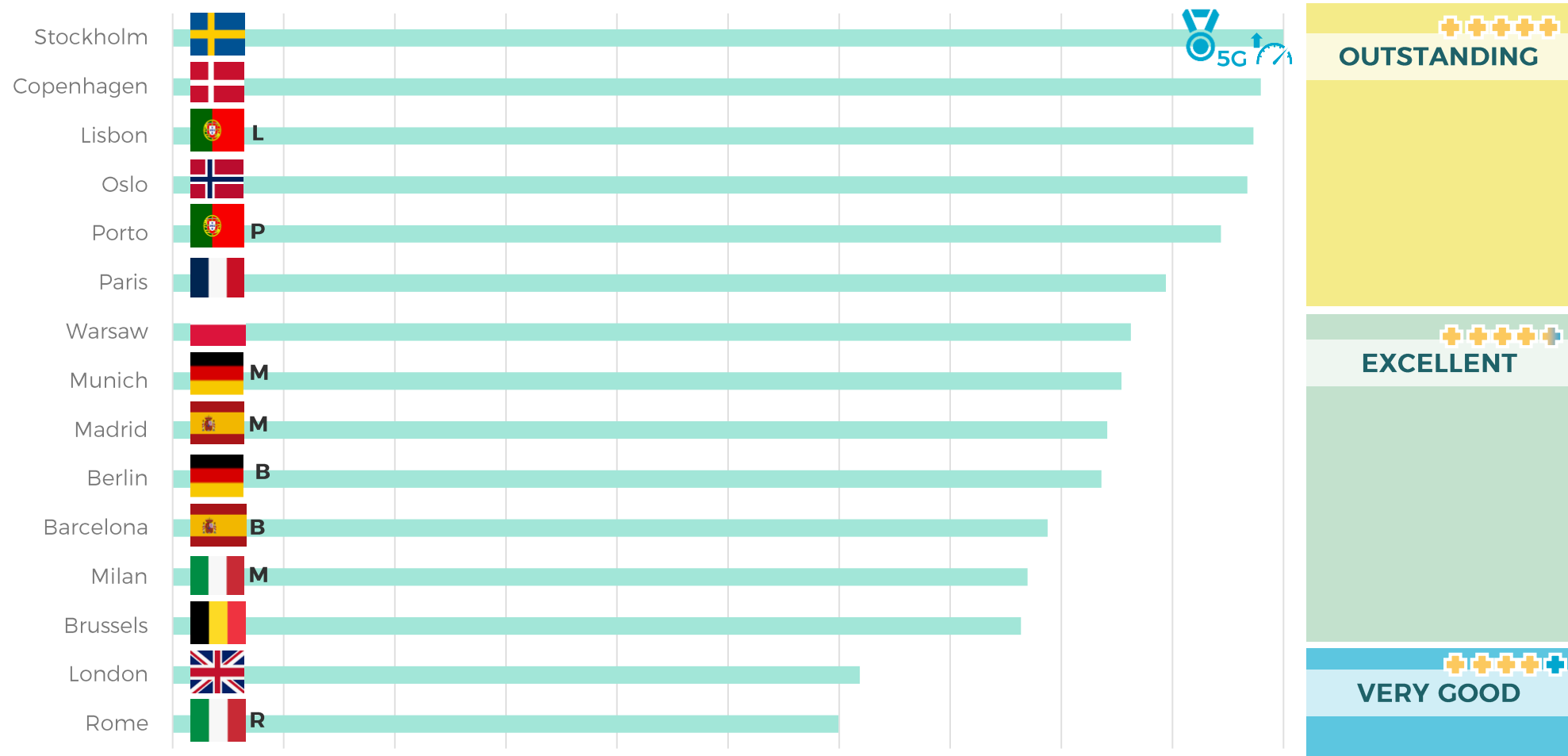
Quality of Experience: 5G DL Speed Ranking

The study unveils two outstanding winners, Lisbon and Porto, followed closely by two strong competitors: Munich and Stockholm. 5G DL Speed assesses how much data can be transferred in 5G downlink channel, how is the network capacity when stressing the line.



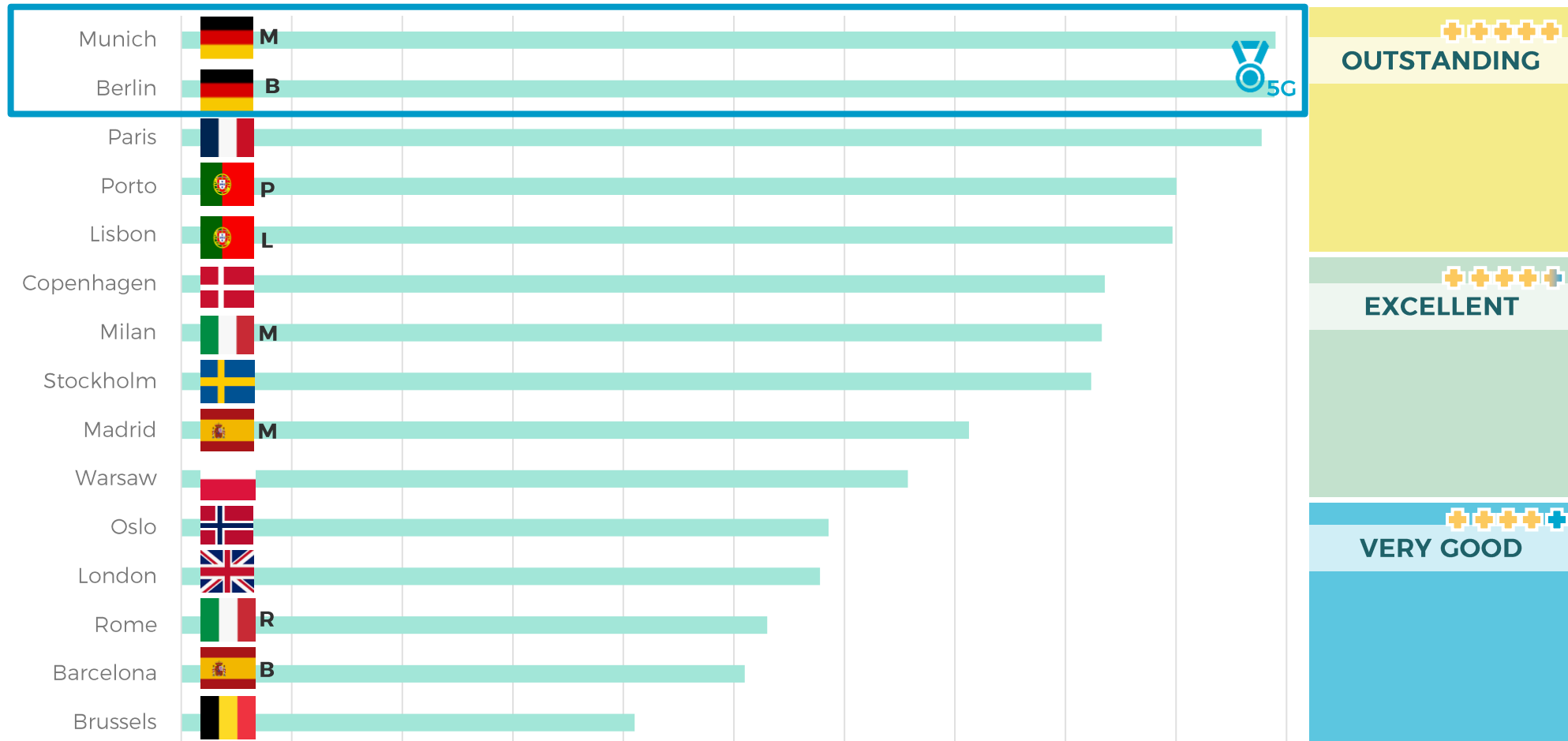
Quality of Experience: 5G UL Speed Ranking

The study unveils an outstanding winners, Stockholm, followed closely by three strong competitors: Copenhagen, Lisbon and Oslo. 5G UL Speed assesses how much data can be transferred in 5G uplink channel, how is the network capacity when stressing the line.



Quality of Experience: 5G Gaming Ranking

The study unveils two outstanding winners, Munich and Berlin, followed closely by a strong competitors: Paris. 5G Gaming assesses the average gaming experience in 5G rating different key parameters against gaming servers.



Annex: Detailed Benchmarking Results

KPIs

Testing and KPI details (1/2)

	Test Name	KPI Name	KPI Details
	Network Availability	% Registered network time	% of time that the MedUX device has an active connection
	Latency-Ping	- Average Latency (ms) - Completed Tests (%) - Jitter (ms) - Packet Loss (%)	- Average latency obtained during the test execution % of total tests performed that have successfully completed - Variance in time delay between data packets over the network % of packet loss during test execution
	HTTP Down (Burst)	- Average DL Speed (Mbps) - Completed Tests (%) - P10 DL Speed (Mbps) - P90 DL Speed (Mbps)	- Download Speed (Mbps) % of total tests performed that have successfully completed - P10 of the values obtained in the test - P90 of the partial values obtained in the test
	HTTP Up (Burst)	- Average UL Speed (Mbps) - Completed Tests (%) - P10 UL Speed (Mbps) - P90 UL Speed (Mbps)	- Upload Speed (Mbps) % of total tests performed that have successfully completed - P10 of the values obtained in the test - P90 of the values obtained in the test
	Cloud Speed test DL	- Average DL Speed (Mbps) - Completed Tests (%) - P10 DL Speed (Mbps) - P90 DL Speed (Mbps)	- Download Speed (Mbps) % of total tests performed that have successfully completed - P10 of the values obtained in the test - P90 of the partial values obtained in test
	Cloud Speed test UL	- Average UL Speed (Mbps) - Completed Tests (%) - P10 UL Speed (Mbps) - P90 UL Speed (Mbps)	- Upload Speed (Mbps) % of total tests performed that have successfully completed - P10 of the values obtained in test - P90 of the values obtained in test

Testing and KPI details (2/2)

	Test Name	KPI Name	KPI Details
	Web Browsing	- Average DNS Lookup Time (ms) - Completed tests (%) - Loading time (ms)	- Average DNS lookup by resource % of total tests performed that have completely loaded requested URL - Time to completely browse the website
	Streaming (YouTube)	- Average Full resolution time (%) - Startup Time (ms) - Completed Tests (%)	- Percentage of time that the video was played in full resolution - Time to begin playing the video (Player Loading Time + Time to Play) % of total tests performed that have successfully played requested video
	Gaming	- Average Latency (ms) - Completed Tests (%) - Jitter (ms)	- Average latency obtained during the test execution % of total tests performed that have successfully completed - Variance in time delay between data packets over the network
	Social Media	- Average Session duration(ms) - Completed Tests (%) - Average Time to first byte (ms)	- Time to complete a navigation session through the platform % of total tests performed that have successfully completed - Time to receive the first byte from the social media server
	Dropbox	- Average DL Time (ms) - Completed Tests (%) - P10 DL Speed (Mbps) - P90 DL Speed (Mbps)	- Time to download the file % of total tests performed that have successfully completed - P10 of the partial values obtained in the test - P90 of the partial values obtained in the test
	All tests	- CompleteQ (%) - KPI < X (%) - KPI > X (%)	% of total tests successfully completed that fulfils the qualifier thresholds. % of total tests which value is below the threshold. % of total tests which value is above the threshold.

Detailed Benchmarking Results

KPIs Value for Speed

Location	CloudDLComplete (%)	CloudDLCompleteQ (%)	CloudDL>100Mbps (%)	CloudDL>20Mbps (%)	CloudDLp90	CloudDLAvg (Mbps)	CloudDLp10	CloudULComplete (%)	CloudULCompleteQ (%)	CloudUL>20Mbps (%)	CloudUL>10Mbps (%)	CloudULp90	CloudULAvg (Mbps)	CloudULp10
Barcelona	100,00 %	99,64 %	72,86 %	91,79 %	663,32	318,94	23,95	100,00 %	100,00 %	93,02 %	98,42 %	110,43	57,66	22,65
Berlin	100,00 %	99,77 %	84,25 %	97,95 %	594,54	325,13	67,44	100,00 %	100,00 %	95,56 %	98,96 %	123,75	64,58	25,84
Brussels	100,00 %	99,15 %	49,47 %	89,77 %	509,90	183,27	17,96	100,00 %	100,00 %	81,37 %	96,73 %	81,61	41,84	15,54
Copenhagen	99,63 %	99,63 %	97,61 %	99,82 %	856,30	523,66	213,62	100,00 %	100,00 %	98,83 %	100,00 %	157,90	86,59	31,80
Lisbon	100,00 %	100,00 %	95,48 %	99,03 %	925,08	528,37	206,05	100,00 %	100,00 %	98,06 %	99,61 %	129,39	76,79	27,97
London	99,89 %	98,67 %	67,38 %	92,01 %	499,50	216,08	23,77	100,00 %	100,00 %	85,63 %	97,34 %	65,55	38,46	18,30
Madrid	99,89 %	99,22 %	73,39 %	91,54 %	714,86	331,36	23,53	100,00 %	100,00 %	92,83 %	98,90 %	123,59	60,70	22,03
Milan	99,85 %	99,54 %	71,89 %	94,01 %	523,38	261,62	30,27	100,00 %	100,00 %	89,20 %	98,88 %	93,53	49,18	19,38
Munich	100,00 %	100,00 %	86,73 %	99,29 %	641,95	341,61	82,79	100,00 %	100,00 %	95,78 %	98,19 %	124,17	65,88	25,50
Oslo	100,00 %	100,00 %	60,59 %	95,34 %	1.005,27	426,31	74,98	100,00 %	100,00 %	95,65 %	99,46 %	167,43	85,67	24,78
Paris	99,78 %	99,78 %	89,81 %	98,78 %	665,16	355,53	98,62	100,00 %	100,00 %	93,56 %	99,56 %	115,18	63,38	22,04
Porto	100,00 %	100,00 %	98,28 %	99,66 %	852,51	552,66	238,52	100,00 %	100,00 %	97,27 %	99,61 %	128,96	72,21	27,55
Rome	100,00 %	99,73 %	68,97 %	95,21 %	512,03	234,21	32,76	100,00 %	100,00 %	86,00 %	98,19 %	77,15	41,06	17,86
Stockholm	99,69 %	99,37 %	97,48 %	99,05 %	1.015,15	558,16	239,96	100,00 %	100,00 %	99,66 %	100,00 %	167,85	110,95	41,49
Warsaw	99,84 %	99,51 %	79,45 %	96,41 %	668,60	341,87	46,01	100,00 %	100,00 %	90,98 %	99,06 %	116,49	59,72	20,60

KPIs DL & UL File Transferring

Location	HttpDLComplete (%)	HTTPDLCompleteQ (%)	HttpDLSpeedAvg (Mbps)	HttpDLP10	HttpDLP90	HttpULComplete (%)	HttpULCompleteQ (%)	HttpULSpeedAvg (Mbps)	HttpULP10	HttpULP90
Barcelona	100,00 %	99,10 %	304,32	25,55	629,44	100,00 %	99,42 %	46,14	7,26	102,96
Berlin	99,32 %	99,09 %	313,88	51,83	620,40	100,00 %	100,00 %	53,46	9,41	109,22
Brussels	100,00 %	98,94 %	167,61	18,53	438,88	100,00 %	100,00 %	33,61	7,87	77,86
Copenhagen	99,64 %	99,27 %	497,93	235,22	778,55	100,00 %	100,00 %	79,29	26,61	136,99
Lisbon	100,00 %	100,00 %	512,98	186,97	869,14	100,00 %	100,00 %	59,75	13,79	111,47
London	99,55 %	97,98 %	195,68	17,37	462,01	99,76 %	98,35 %	24,91	4,08	52,28
Madrid	100,00 %	99,10 %	319,25	19,15	662,34	100,00 %	100,00 %	49,29	8,66	107,11
Milan	99,69 %	99,54 %	244,06	28,97	508,85	100,00 %	99,67 %	39,11	9,08	79,05
Munich	100,00 %	100,00 %	349,72	97,14	682,43	100,00 %	100,00 %	54,60	11,40	109,84
Oslo	100,00 %	100,00 %	372,93	63,50	770,06	100,00 %	100,00 %	73,47	13,39	154,30
Paris	99,11 %	99,11 %	359,81	107,18	653,96	100,00 %	100,00 %	56,98	13,58	102,55
Porto	100,00 %	100,00 %	549,09	231,65	891,68	100,00 %	100,00 %	60,15	14,98	112,48
Rome	99,33 %	99,07 %	227,69	28,04	503,88	100,00 %	99,15 %	31,94	6,06	68,23
Stockholm	100,00 %	100,00 %	442,98	184,09	949,01	100,00 %	100,00 %	103,49	36,40	153,32
Warsaw	100,00 %	99,33 %	325,70	41,81	680,79	100,00 %	99,64 %	54,57	11,08	110,16

Detailed Benchmarking Results

KPIs Network Responsiveness

Location	PingComplete (%)	PingCompleteQ (%)	PingJitter<50ms (%)	PingLatencyAvg (ms)	PingJitterAvg (ms)
Barcelona	99,33 %	98,13 %	88,08 %	51,40	34,53
Berlin	100,00 %	99,83 %	95,71 %	30,42	14,28
Brussels	99,56 %	98,76 %	87,25 %	41,90	24,67
Copenhagen	99,91 %	99,86 %	94,99 %	30,47	15,09
Lisbon	99,92 %	99,67 %	97,50 %	28,73	11,64
London	99,67 %	98,93 %	87,60 %	47,12	29,98
Madrid	99,66 %	98,59 %	88,92 %	44,13	31,33
Milan	99,50 %	99,30 %	94,22 %	31,10	17,03
Munich	100,00 %	99,82 %	94,27 %	25,17	14,56
Oslo	99,48 %	99,48 %	97,27 %	34,49	14,69
Paris	99,74 %	99,65 %	93,98 %	32,57	15,63
Porto	99,83 %	99,74 %	96,68 %	32,62	12,41
Rome	99,90 %	99,33 %	87,51 %	46,93	26,23
Stockholm	99,74 %	99,68 %	98,46 %	32,99	10,08
Warsaw	99,53 %	98,77 %	97,14 %	43,24	19,81

KPIs Gaming

Location	GamingComplete (%)	GamingCompleteQ (%)	GamingJitter<20ms (%)	GamingLatencyAvg (ms)	GamingJitterAvg (ms)
Barcelona	99,78 %	99,78 %	72,27 %	64,59	35,57
Berlin	100,00 %	100,00 %	84,44 %	40,73	13,96
Brussels	99,66 %	99,66 %	70,85 %	49,43	23,10
Copenhagen	99,95 %	99,95 %	78,90 %	48,47	18,39
Lisbon	99,83 %	99,83 %	93,39 %	46,49	17,04
London	99,74 %	99,74 %	65,80 %	52,37	27,46
Madrid	99,89 %	99,89 %	74,14 %	53,43	32,10
Milan	99,96 %	99,96 %	78,32 %	46,94	17,94
Munich	99,94 %	99,94 %	87,18 %	37,70	15,85
Oslo	98,66 %	98,66 %	83,61 %	51,64	15,04
Paris	99,79 %	99,79 %	82,30 %	39,99	15,99
Porto	99,82 %	99,82 %	91,31 %	45,01	10,76
Rome	99,93 %	99,93 %	73,17 %	60,65	28,52
Stockholm	99,69 %	99,69 %	92,25 %	48,28	12,18
Warsaw	99,87 %	99,87 %	89,24 %	57,30	18,70

Detailed Benchmarking Results



KPIs Web Browsing

Location	WebBrowsingComplete (%)	WebBrowsingCompleteQ (%)	WebBrowsingDnsLess 50ms (%)	WebBrowsingTTFB < 200 ms (%)	WebBrowsingDnsDelay Avg (ms)	WebBrowsingWBT Avg (ms)
Barcelona	99,02 %	98,62 %	90,61 %	92,21 %	34,73	1304,78
Berlin	100,00 %	99,94 %	93,39 %	97,56 %	26,02	1123,35
Brussels	99,19 %	98,98 %	87,41 %	95,89 %	38,68	1159,29
Copenhagen	99,58 %	99,49 %	97,48 %	98,27 %	17,98	980,76
Lisbon	99,75 %	99,58 %	98,33 %	97,57 %	19,34	1195,75
London	98,54 %	97,48 %	88,67 %	91,42 %	36,97	1469,09
Madrid	99,58 %	99,04 %	90,13 %	91,50 %	34,47	1370,33
Milan	99,59 %	99,42 %	90,46 %	94,82 %	30,12	1315,53
Munich	99,94 %	99,81 %	93,99 %	98,66 %	25,01	1183,12
Oslo	99,89 %	99,66 %	88,41 %	97,96 %	50,57	1213,40
Paris	99,41 %	99,38 %	95,75 %	97,98 %	23,70	1057,72
Porto	99,74 %	99,74 %	97,37 %	97,72 %	18,85	1006,98
Rome	99,44 %	99,05 %	87,55 %	95,01 %	33,37	1427,28
Stockholm	99,77 %	99,77 %	98,46 %	98,77 %	16,69	995,58
Warsaw	99,36 %	98,94 %	77,11 %	96,54 %	163,70	1682,10



KPIs Social Media

Location	SocialMediaComplete (%)	SocialMediaCompleteQ (%)	SocialMediaSession < 6s (%)	SocialMediaSDAvg (ms)	SocialMediaTTFB Avg (ms)
Barcelona	97,66 %	96,99 %	96,52 %	2972,77	174,57
Berlin	96,94 %	96,64 %	96,20 %	2888,59	145,40
Brussels	98,71 %	98,44 %	98,92 %	2597,48	160,73
Copenhagen	97,61 %	97,56 %	98,52 %	2357,91	97,62
Lisbon	98,74 %	98,57 %	99,49 %	2595,99	102,75
London	97,87 %	96,81 %	96,30 %	2942,69	207,69
Madrid	98,37 %	97,39 %	95,41 %	3071,02	170,55
Milan	97,11 %	96,69 %	94,90 %	3072,36	122,81
Munich	97,53 %	97,27 %	95,11 %	3002,61	141,21
Oslo	98,75 %	98,75 %	94,77 %	2707,23	124,55
Paris	97,15 %	97,12 %	97,29 %	2516,22	101,36
Porto	98,58 %	98,58 %	99,64 %	2362,78	105,19
Rome	98,72 %	98,32 %	95,31 %	3133,96	139,02
Stockholm	98,26 %	98,26 %	99,70 %	2270,89	84,68
Warsaw	97,65 %	96,43 %	90,63 %	3616,86	150,97



KPIs Cloud Storage

Location	DropboxComplete (%)	DropboxCompleteQ (%)	DropboxTimeDL (ms)	DropboxP10	DropboxP90	DropboxSpeed (Mbps)
Barcelona	99,82 %	99,46 %	2529	15,00	147,69	77,57
Berlin	98,38 %	98,38 %	1232	40,22	192,07	104,50
Brussels	99,33 %	99,33 %	2325	16,36	189,57	84,29
Copenhagen	99,82 %	99,82 %	1000	56,95	192,20	104,82
Lisbon	98,97 %	98,97 %	1037	58,82	164,65	104,86
London	99,74 %	99,62 %	2366	17,31	174,37	83,65
Madrid	99,89 %	99,66 %	3038	11,64	179,04	87,36
Milan	99,84 %	99,84 %	2013	20,67	194,11	100,87
Munich	99,26 %	99,26 %	1302	35,52	189,66	120,21
Oslo	99,18 %	99,18 %	2447	29,36	80,91	58,22
Paris	100,00 %	99,88 %	960	57,50	244,02	141,04
Porto	100,00 %	100,00 %	837	61,38	176,06	116,09
Rome	99,86 %	99,73 %	1904	19,34	194,39	99,83
Stockholm	99,69 %	99,69 %	1421	51,06	101,91	74,76
Warsaw	99,49 %	99,15 %	1480	31,21	165,70	103,20



KPIs Streaming

Location	YouTubeComplete (%)	YouTubeCompleteQ (%)	YouTubePlayStartTimeAvg (ms)	YouTubeStalls < 1 (%)	YouTubeFullResTime (%)
Barcelona	100,00 %	99,64 %	2.135,16	100,00 %	84,60 %
Berlin	99,77 %	99,07 %	2.160,49	100,00 %	89,76 %
Brussels	99,56 %	99,12 %	1.946,56	99,78 %	80,56 %
Copenhagen	99,81 %	99,25 %	1.851,33	100,00 %	93,83 %
Lisbon	100,00 %	99,66 %	2.082,18	100,00 %	94,14 %
London	98,99 %	96,96 %	2.324,11	99,77 %	78,96 %
Madrid	100,00 %	99,44 %	2.171,74	99,66 %	82,42 %
Milan	100,00 %	99,18 %	2.380,75	100,00 %	84,50 %
Munich	100,00 %	99,74 %	2.270,35	100,00 %	91,52 %
Oslo	100,00 %	100,00 %	2.100,86	100,00 %	89,44 %
Paris	99,77 %	99,19 %	1.918,24	100,00 %	93,13 %
Porto	99,30 %	99,30 %	1.739,51	100,00 %	95,49 %
Rome	100,00 %	99,03 %	2.316,94	99,72 %	82,87 %
Stockholm	99,70 %	99,70 %	1.606,55	99,70 %	94,57 %
Warsaw	99,48 %	98,28 %	2.632,48	100,00 %	89,01 %



Detailed Benchmarking Results (5G only)

KPIs Value for Speed

Location	CloudDLComplete (%)	CloudDLCompleteQ (%)	CloudDL>100Mbps (%)	CloudDL>20Mbps (%)	CloudDLp90 (Mbps)	CloudDLAvg (Mbps)	CloudDLp10 (Mbps)	CloudULComplete (%)	CloudULCompleteQ (%)	CloudUL>20Mbps (%)	CloudUL>10Mbps (%)	CloudULp90 (Mbps)	CloudULAvg (Mbps)	CloudULp10 (Mbps)
Barcelona	100,00 %	99,79 %	79,91 %	95,30 %	690,48	357,71	40,96	100,00 %	100,00 %	94,46 %	98,49 %	115,04	60,83	24,29
Berlin	100,00 %	99,74 %	85,45 %	98,68 %	615,23	338,19	72,87	100,00 %	100,00 %	95,21 %	98,87 %	124,90	65,48	25,97
Brussels	100,00 %	100,00 %	77,84 %	96,59 %	672,89	340,53	57,41	100,00 %	100,00 %	93,06 %	98,84 %	101,78	55,71	23,97
Copenhagen	99,60 %	99,60 %	98,59 %	100,00 %	867,31	536,00	231,57	100,00 %	100,00 %	98,78 %	100,00 %	158,82	87,35	32,64
Lisbon	100,00 %	100,00 %	97,12 %	99,28 %	930,85	548,47	247,11	100,00 %	100,00 %	99,15 %	100,00 %	130,15	79,74	30,67
London	99,86 %	99,44 %	74,43 %	95,60 %	534,75	243,05	38,65	100,00 %	100,00 %	89,69 %	98,28 %	73,15	41,43	19,93
Madrid	99,87 %	99,36 %	80,72 %	94,44 %	740,24	363,48	33,80	100,00 %	100,00 %	94,70 %	99,09 %	126,08	63,56	23,88
Milan	99,78 %	99,78 %	88,38 %	98,03 %	551,40	325,73	91,71	100,00 %	100,00 %	93,60 %	98,82 %	100,89	54,77	22,47
Munich	100,00 %	100,00 %	91,55 %	99,71 %	667,67	366,73	115,55	100,00 %	100,00 %	97,01 %	98,67 %	124,19	67,58	27,73
Oslo	100,00 %	100,00 %	67,20 %	95,77 %	1.031,76	480,08	92,03	100,00 %	100,00 %	98,08 %	100,00 %	173,51	94,24	36,07
Paris	99,72 %	99,72 %	94,58 %	99,58 %	696,39	395,03	136,93	100,00 %	100,00 %	96,57 %	99,66 %	118,51	68,85	25,94
Porto	100,00 %	100,00 %	98,52 %	100,00 %	845,38	562,18	262,83	100,00 %	100,00 %	98,77 %	99,59 %	130,40	74,25	30,15
Rome	100,00 %	99,82 %	80,96 %	98,58 %	535,26	277,67	56,81	100,00 %	100,00 %	88,03 %	98,11 %	81,41	44,64	18,83
Stockholm	99,65 %	99,65 %	100,00 %	100,00 %	1.034,46	579,04	241,23	100,00 %	100,00 %	100,00 %	100,00 %	168,65	113,36	47,89
Warsaw	99,79 %	99,79 %	88,82 %	98,96 %	718,98	393,50	92,80	100,00 %	100,00 %	94,18 %	99,78 %	119,70	64,12	23,86

KPIs DL & UL File Transferring

Location	HttpDLComplete (%)	HTTPDLCompleteQ (%)	HttpDLSpeedAvg (Mbps)	HttpDLP10	HttpDLP90	HttpULComplete (%)	HttpULCompleteQ (%)	HttpULSpeedAvg (Mbps)	HttpULP10	HttpULP90
Barcelona	100,00 %	99,17 %	337,55	41,76	655,54	100,00 %	99,35 %	49,43	7,74	105,48
Berlin	99,18 %	98,91 %	330,62	66,61	660,25	100,00 %	100,00 %	54,39	10,51	109,03
Brussels	100,00 %	99,44 %	303,21	46,52	620,99	100,00 %	100,00 %	45,87	9,65	89,85
Copenhagen	99,61 %	99,41 %	502,79	237,81	789,69	100,00 %	100,00 %	80,30	28,77	138,60
Lisbon	100,00 %	100,00 %	530,62	213,32	880,05	100,00 %	100,00 %	69,40	26,26	113,34
London	99,43 %	98,44 %	222,67	31,68	498,99	99,70 %	98,95 %	27,89	5,08	57,12
Madrid	100,00 %	99,36 %	349,82	26,66	691,48	100,00 %	100,00 %	51,52	9,04	109,13
Milan	99,56 %	99,56 %	302,60	69,55	536,92	100,00 %	99,78 %	44,52	11,00	85,95
Munich	100,00 %	100,00 %	378,65	116,49	698,74	100,00 %	100,00 %	58,38	14,91	115,10
Oslo	100,00 %	100,00 %	412,11	69,65	819,61	100,00 %	100,00 %	82,63	17,87	160,83
Paris	98,94 %	98,94 %	382,57	129,24	679,74	100,00 %	100,00 %	62,52	17,51	105,24
Porto	100,00 %	100,00 %	562,91	265,03	895,47	100,00 %	100,00 %	64,99	19,92	112,84
Rome	99,10 %	98,92 %	265,72	46,90	526,69	100,00 %	100,00 %	35,70	7,23	72,95
Stockholm	100,00 %	100,00 %	474,28	198,69	970,75	100,00 %	100,00 %	105,95	48,29	154,13
Warsaw	100,00 %	99,79 %	374,82	81,29	724,20	100,00 %	100,00 %	59,62	14,20	112,81

Detailed Benchmarking Results (5G only)

KPIs Network Responsiveness

Location	PingComplete (%)	PingCompleteQ (%)	PingJitter<50ms (%)	PingLatencyAvg (ms)	PingJitterAvg (ms)
Barcelona	99,41 %	98,50 %	88,11 %	48,12	29,30
Berlin	100,00 %	99,80 %	95,74 %	30,26	14,41
Brussels	99,45 %	98,78 %	74,64 %	46,20	32,20
Copenhagen	99,90 %	99,90 %	95,14 %	30,02	14,49
Lisbon	100,00 %	99,79 %	97,59 %	28,34	12,16
London	99,71 %	99,10 %	87,27 %	47,71	29,43
Madrid	99,65 %	98,66 %	89,21 %	42,99	29,52
Milan	99,71 %	99,53 %	93,24 %	29,59	18,72
Munich	100,00 %	99,86 %	94,50 %	24,57	13,65
Oslo	99,31 %	99,31 %	97,50 %	33,44	13,09
Paris	99,69 %	99,61 %	93,07 %	31,78	15,79
Porto	99,90 %	99,80 %	96,88 %	32,24	12,49
Rome	99,90 %	99,47 %	85,37 %	47,09	27,63
Stockholm	99,78 %	99,71 %	98,40 %	32,66	9,90
Warsaw	99,57 %	98,86 %	97,37 %	44,08	20,47

KPIs Gaming

Location	GamingComplete (%)	GamingCompleteQ (%)	GamingJitter<20ms (%)	GamingLatencyAvg (ms)	GamingJitterAvg (ms)
Barcelona	99,94 %	99,94 %	70,58 %	61,97	32,17
Berlin	100,00 %	100,00 %	84,34 %	40,58	14,14
Brussels	99,59 %	99,59 %	50,35 %	56,56	32,69
Copenhagen	100,00 %	100,00 %	78,99 %	48,36	18,56
Lisbon	99,89 %	99,89 %	92,30 %	44,67	16,54
London	99,74 %	99,74 %	63,30 %	53,93	28,59
Madrid	99,87 %	99,87 %	73,98 %	51,95	30,30
Milan	99,94 %	99,94 %	74,31 %	46,21	19,52
Munich	99,93 %	99,93 %	87,83 %	37,25	15,22
Oslo	98,34 %	98,34 %	83,38 %	49,91	13,63
Paris	99,84 %	99,84 %	80,38 %	38,72	16,41
Porto	99,89 %	99,89 %	91,07 %	44,51	10,24
Rome	99,90 %	99,90 %	70,40 %	60,52	29,42
Stockholm	99,74 %	99,74 %	92,69 %	47,52	11,41
Warsaw	99,84 %	99,84 %	89,39 %	57,09	16,96

Detailed Benchmarking Results (5G only)



KPIs Web Browsing

Location	WebBrowsingComplete (%)	WebBrowsingCompleteQ (%)	WebBrowsingDnsLess 50ms (%)	WebBrowsingTTFB < 200 ms (%)	WebBrowsingDnsDelay Avg (ms)	WebBrowsingWBT Avg (ms)
Barcelona	99,25 %	98,99 %	91,44 %	92,91 %	33,90	1246,22
Berlin	100,00 %	100,00 %	93,59 %	97,49 %	25,04	1102,21
Brussels	99,44 %	99,44 %	87,46 %	97,18 %	37,85	1068,05
Copenhagen	99,64 %	99,59 %	97,66 %	98,68 %	17,57	967,34
Lisbon	99,72 %	99,72 %	98,52 %	97,50 %	18,81	1184,89
London	98,84 %	98,22 %	89,74 %	92,49 %	35,00	1364,08
Madrid	99,74 %	99,39 %	90,36 %	91,77 %	33,72	1319,13
Milan	99,47 %	99,35 %	93,77 %	96,30 %	27,65	1254,57
Munich	99,92 %	99,85 %	94,58 %	98,72 %	23,94	1183,96
Oslo	99,85 %	99,56 %	88,92 %	98,53 %	53,36	1182,34
Paris	99,50 %	99,50 %	96,26 %	98,07 %	22,94	1039,73
Porto	99,81 %	99,81 %	97,49 %	98,14 %	18,66	1002,31
Rome	99,63 %	99,36 %	88,61 %	96,14 %	31,02	1329,63
Stockholm	99,74 %	99,74 %	98,96 %	99,05 %	15,86	982,25
Warsaw	99,62 %	99,29 %	77,81 %	97,28 %	169,26	1629,57



KPIs Social Media

Location	SocialMediaComplete (%)	SocialMediaCompleteQ (%)	SocialMediaSession < 6s (%)	SocialMediaSDAvg (ms)	SocialMediaTTFB Avg (ms)
Barcelona	97,85 %	97,25 %	96,50 %	2917,09	163,57
Berlin	97,05 %	96,83 %	96,53 %	2845,74	137,57
Brussels	98,47 %	98,47 %	99,11 %	2478,72	131,10
Copenhagen	97,84 %	97,79 %	98,45 %	2350,14	93,19
Lisbon	98,59 %	98,49 %	99,62 %	2568,28	99,84
London	97,99 %	97,14 %	96,63 %	2820,08	177,01
Madrid	98,41 %	97,39 %	95,51 %	3055,12	164,15
Milan	96,83 %	96,54 %	95,48 %	2927,69	107,10
Munich	97,64 %	97,48 %	95,57 %	2958,52	139,51
Oslo	98,44 %	98,44 %	95,45 %	2691,46	123,88
Paris	97,42 %	97,38 %	96,89 %	2505,67	93,87
Porto	98,49 %	98,49 %	99,72 %	2360,30	103,22
Rome	98,76 %	98,43 %	96,74 %	2996,13	126,36
Stockholm	98,16 %	98,16 %	99,66 %	2254,35	79,69
Warsaw	97,64 %	96,62 %	91,09 %	3510,44	130,93



KPIs Cloud Storage

Location	DropboxComplete (%)	DropboxCompleteQ (%)	DropboxTimeDL (ms)	DropboxP10	DropboxP90	DropboxSpeed (Mbps)
Barcelona	100,00 %	99,54 %	2252	18,35	154,10	83,90
Berlin	98,18 %	98,18 %	1231	39,76	193,92	104,86
Brussels	99,42 %	99,42 %	1377	29,44	208,52	116,76
Copenhagen	100,00 %	100,00 %	993	56,80	191,15	103,33
Lisbon	99,51 %	99,51 %	934	61,15	168,59	111,94
London	99,66 %	99,66 %	2090	23,60	182,21	92,30
Madrid	100,00 %	99,73 %	2962	11,91	181,55	91,46
Milan	99,76 %	99,76 %	1616	26,82	207,50	115,25
Munich	100,00 %	100,00 %	1063	40,90	194,01	126,60
Oslo	99,38 %	99,38 %	2797	19,92	81,42	57,88
Paris	100,00 %	100,00 %	740	72,73	252,46	160,62
Porto	100,00 %	100,00 %	787	64,63	177,65	121,26
Rome	100,00 %	100,00 %	1622	20,49	201,97	112,19
Stockholm	99,63 %	99,63 %	1213	55,47	110,49	78,34
Warsaw	99,52 %	99,52 %	1025	46,03	168,48	110,72



KPIs Streaming

Location	YouTubeComplete (%)	YouTubeCompleteQ (%)	YouTubePlayStartTimeAvg (ms)	YouTubeStalls < 1 (%)	YouTubeFullResTime (%)
Barcelona	100,00 %	99,79 %	2.122,90	100,00 %	87,45 %
Berlin	99,72 %	99,72 %	2.160,75	100,00 %	90,49 %
Brussels	100,00 %	100,00 %	1.875,68	100,00 %	86,09 %
Copenhagen	99,80 %	99,61 %	1.784,46	100,00 %	94,64 %
Lisbon	100,00 %	99,62 %	2.074,95	100,00 %	94,73 %
London	99,44 %	98,59 %	2.079,60	99,86 %	84,95 %
Madrid	100,00 %	99,50 %	2.162,75	99,62 %	84,48 %
Milan	100,00 %	99,13 %	2.316,20	100,00 %	87,71 %
Munich	100,00 %	100,00 %	2.151,85	100,00 %	92,47 %
Oslo	100,00 %	100,00 %	2.085,10	100,00 %	89,07 %
Paris	99,73 %	99,45 %	1.898,29	100,00 %	93,49 %
Porto	99,28 %	99,28 %	1.734,48	100,00 %	95,84 %
Rome	100,00 %	99,48 %	2.055,83	99,83 %	86,60 %
Stockholm	99,67 %	99,67 %	1.593,40	99,67 %	95,89 %
Warsaw	100,00 %	98,94 %	2.597,97	100,00 %	92,10 %



Content

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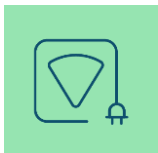
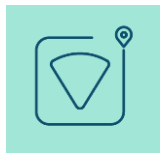


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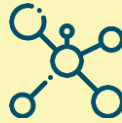
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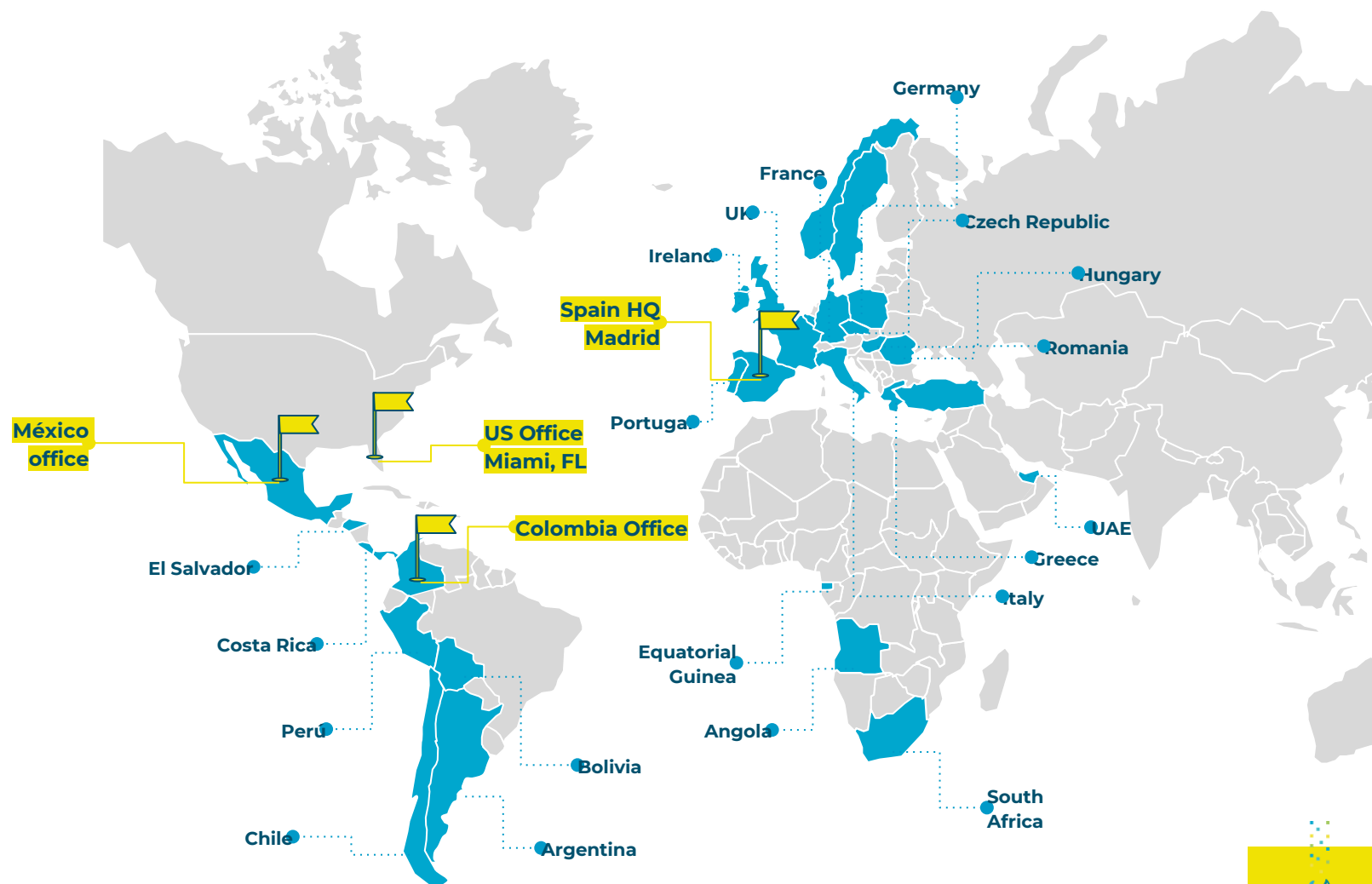
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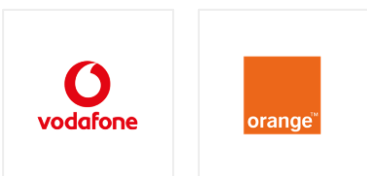
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