

Audit Report

4 cities report — Denmark, 2023





Foreword



For the inhabitants of Denmark, it is particularly interesting to see how the operators perform in metropolitan areas. Therefore, we have performed individual analyses for Copenhagen, Aalborg,

Aarhus and Odense, the most populated cities of Denmark.

Telia shows the highest overall performance.



Intro

The leader in mobile benchmarking, umlaut, has analyzed the mobile networks in Copenhagen, Aalborg, Aarhus and Odense with regards to mobile network performance. We measure smartphone voice and data performance based on extensive drivetests. This report has been requested by Telia. City test area has been provided by third party, Methodology, drive routes and times have been independently selected by umlaut. As the de-facto industry standard, our benchmarking methodology focuses on customer-perceived network quality and covers a wide range of mobile services.

Today, more than 200 mobile networks in more than 120 countries are being evaluated by our unique methodology. It allows a technical analysis that is unprecedented in its level of detail and enables comparisons between the network performance and capability of each mobile network. Our benchmarks help network operators to demonstrate how well they are delivering wireless connections to consumers, business users and enterprises and reveals the areas of improvement.

Drivetest	Voice	Data
Device	Samsung Galaxy S21+	Samsung Galaxy S22+
Test Cases	Mobile-to-Mobile Side1 (VoLTE) to Side2 (VoLTE) 105 sec call window 70 sec call duration 15 sec call setup timeout Multi-RAB traffic injection on both sides Generic OTT Voice Channel	Data 5G preferred CA HTTP DL datastream 7s HTTP UL datastream 7s HTTP 10MB DL fixed file transfer HTTP 5MB UL fixed file transfer 9 Live web pages YouTube v16 Interactivity testing (eGaming)
Mobility and Route Types	100% Drivetest Small Country Approach	
Samples	7819	135406
Dates	12 measurement days 05.12.2022. - 17.12.2022	



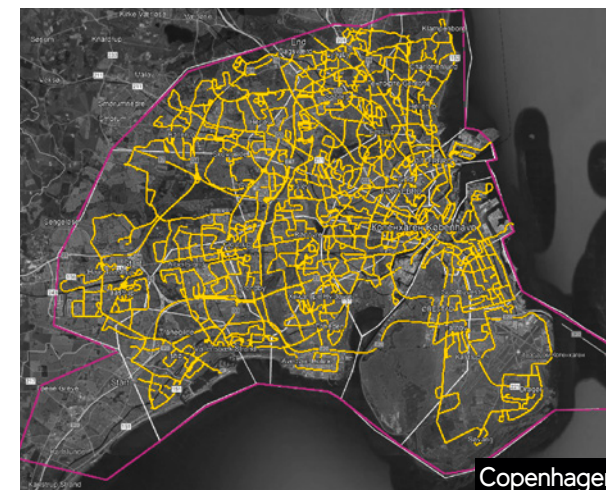
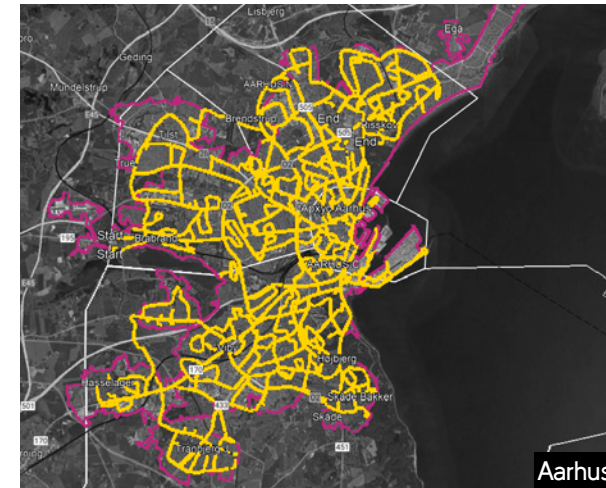
Testing area



 **2600 km**
measuring distance



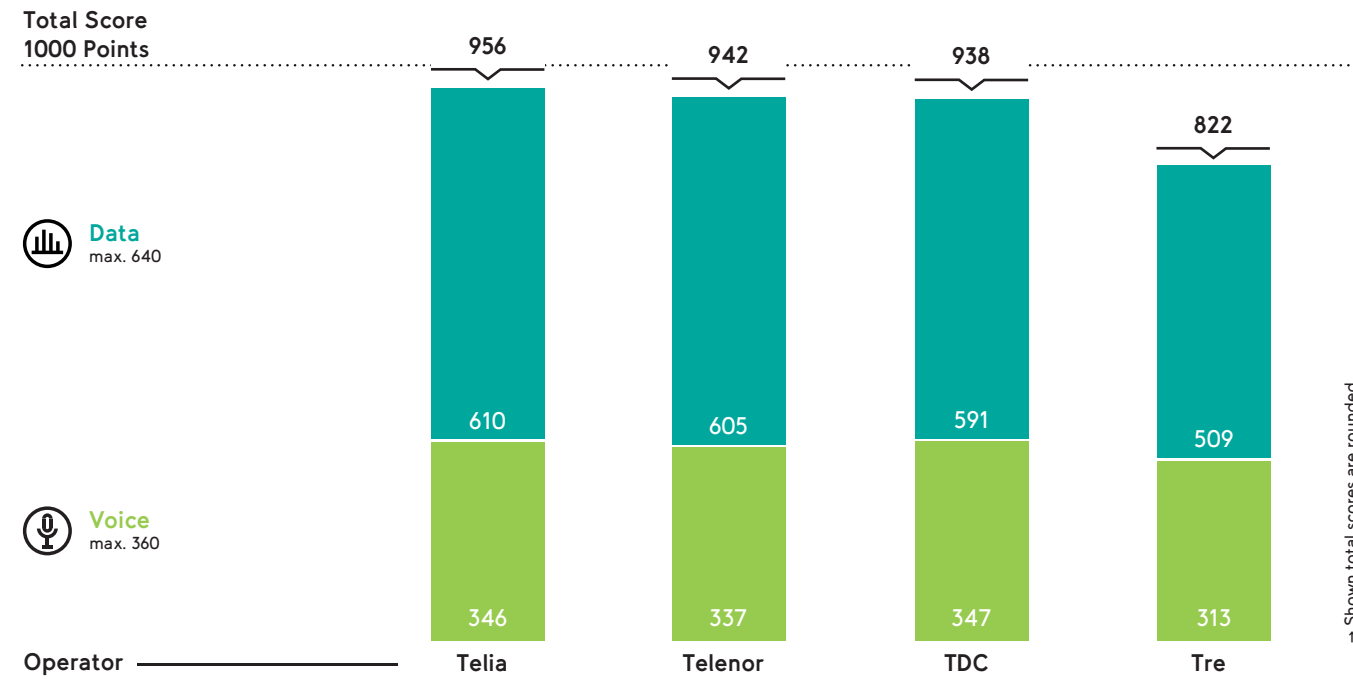
City test areas





Total Score — all 4 cities

Overall results



Overall score considering Voice and Data.

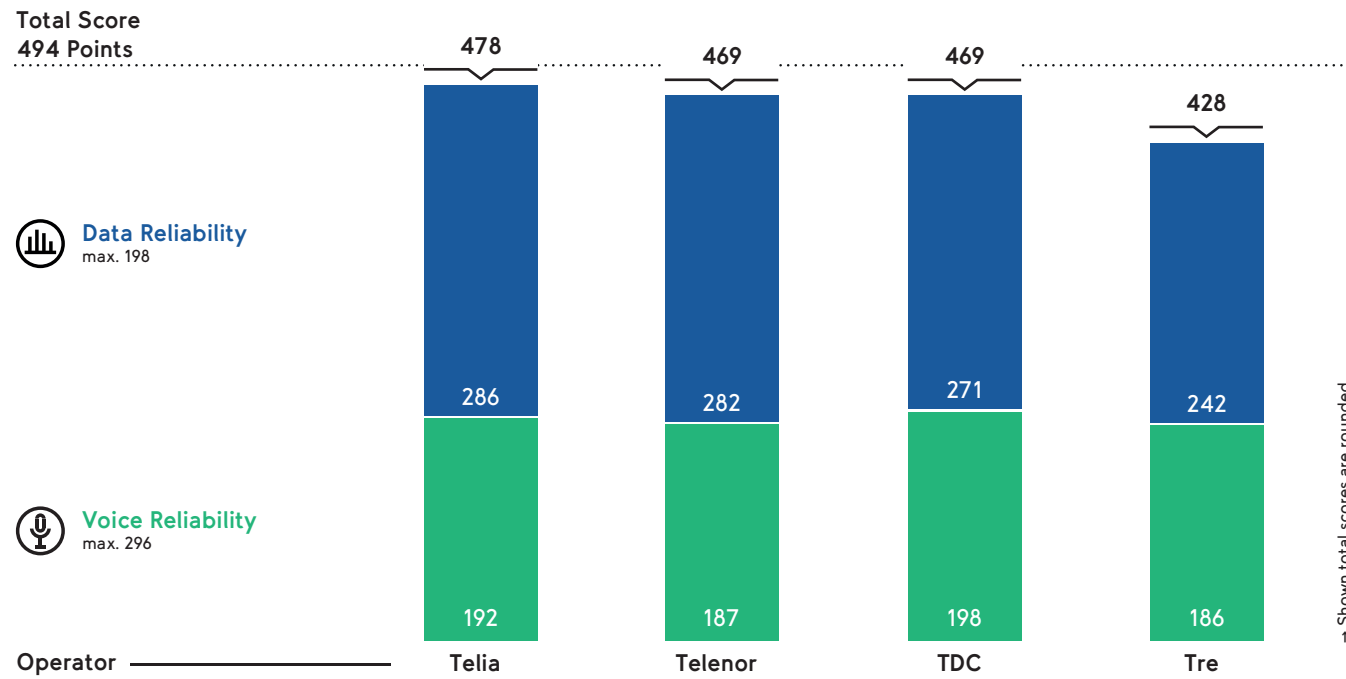
Total score

	Telia	Telenor	TDC	Tre	
Voice	max. 360	346	337	347	313
Cities Drivetest		96%	93%	97%	87%
Data	max. 640	610	605	591	509
Cities Drivetest		95%	94%	92%	80%
Total	1000	956	942	938	822

Shown scores are rounded.



Reliability Score — all 4 cities



Reliability score considering Voice Reliability and Data Reliability.

Total score

	Service Group	max	Telia	Telenor	TDC	Tre
Reliability	Voice Reliability	198	97%	94%	100%	94%
	Data Reliability	296	97%	95%	92%	82%

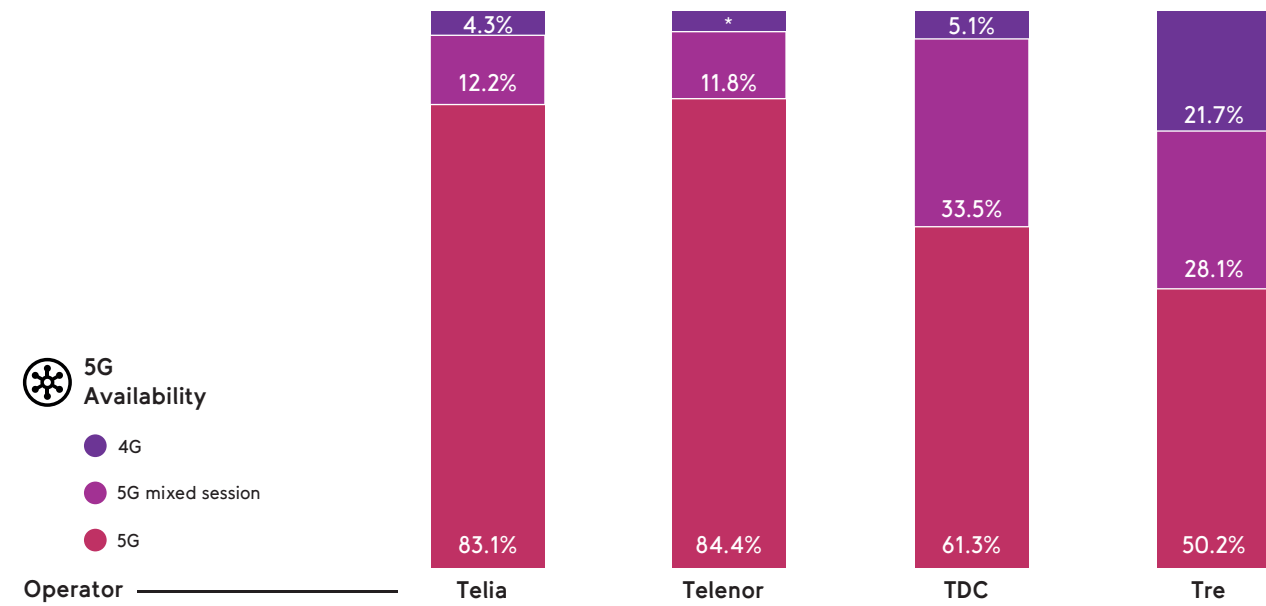
Score achievement in school grades:
 outstanding (≥95%), very good (≥85% and <95%), good (≥75% and ≤85%), satisfactory (≤65% and <75%), sufficient (≤55% and <65%).



5G Availability — all 4 cities

Technology share overall

Technology share
100%



5G Availability

- 4G
- 5G mixed session
- 5G

Operator

→ Shown total scores are rounded.

Overall share of technology used for conveying data traffic per aggregation.

* Share of technology is lower than 4%.





Voice KPI overview

Achieved values of all networks under test in each of the relevant Voice Key Performance Indicators (KPIs) for the geographical category "Cities".

Voice	Service Group	Unit	Telia	Telenor	TDC	Tre
Cities overall	Qualifier	[%]	99,7	99,4	100,0	99,4
	Call Setup Time (P90)	[s]	1,5	2,4	2,2	3,5
	Speech Quality (P10)	[MOS-LQO]	4,2	4,2	4,0	3,9
	Multirab connectivity	[%]	99,4	99,6	100,0	100,0



Data Services KPI overview

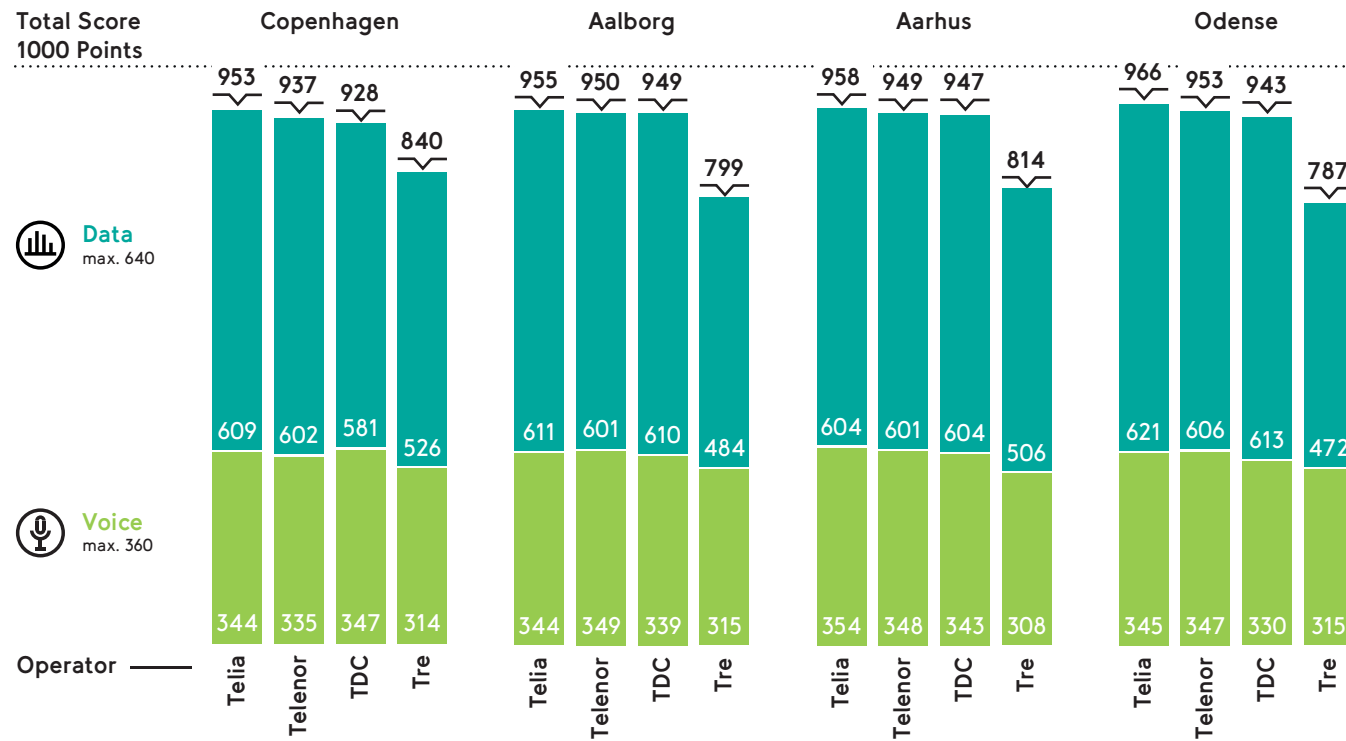
Achieved values of all networks under test in each of the relevant Data Key Performance Indicators (KPIs) for the geographical category "Cities".

Data Cities	KPI Name	Unit	Telia	Telenor	TDC	Tre
HTTP Web Page DL Smartphone	Qualifier	[%]	99,8	99,5	99,4	96,7
	Overall Session Time	[s]	1,3	1,2	1,4	3,3
HTTP 10MB DL Smartphone	Qualifier	[%]	99,8	99,7	99,9	99,6
	Overall Session Time	[s]	0,9	0,9	1,4	2,9
	90% faster than	[Mbit/s]	68,5	90,6	38,6	24,1
	10% faster than	[Mbit/s]	306,5	280,7	344,8	354,0
HTTP 5MB UL Smartphone	Qualifier	[%]	99,8	99,7	99,8	99,8
	Average Session Time	[s]	2,0	1,9	2,1	3,9
	90% faster than	[Mbit/s]	15,7	15,5	10,0	9,5
	10% faster than	[Mbit/s]	77,9	65,6	82,2	49,5
HTTP DL FDTT	Qualifier	[%]	99,8	99,9	99,0	99,1
	10% faster than	[Mbit/s]	639,4	843,6	803,3	858,2
	faster than 20 Mbit/s	[%]	98,9	99,2	97,8	93,5
	faster than 100 Mbit/s	[%]	93,8	93,9	83,4	75,4
HTTP UL FDTT	Qualifier	[%]	99,5	99,1	99,2	98,9
	10% faster than	[Mbit/s]	107,4	104,3	124,5	120,2
	faster than 2 Mbit/s	[%]	99,8	99,4	99,6	98,6
	faster than 5 Mbit/s	[%]	97,8	97,9	97,6	96,3
YouTube	Qualifier	[%]	99,3	99,0	98,6	98,4
	Start Time	[s]	1,9	1,8	1,9	2,4
	AVG Resolution	[p]	8,9	9,2	9,3	9,2
YouTube Live Smartphone	Qualifier	[%]	99,6	99,6	97,9	96,0
	Start Time	[s]	3,7	3,6	3,7	3,7
	AVG Resolution	[p]	7,8	7,8	8,0	7,8
YouTube 4K Smartphone	Qualifier	[%]	99,1	99,7	96,9	95,9
	Start Time	[s]	2,4	2,2	2,3	2,6
	AVG Resolution	[p]	8,5	8,6	8,6	8,9
Interactivity	Interactivity egaming	[%]	76,1	75,3	71,6	71,8
Conversational App	Qualifier	[%]	100,0	100,0	100,0	99,9
	Speech Quality (P10)	[MOS-LQO]	2,6	2,6	3,3	3,4



Total Score — Cities

Overall results in Copenhagen, Aalborg, Aarhus and Odense



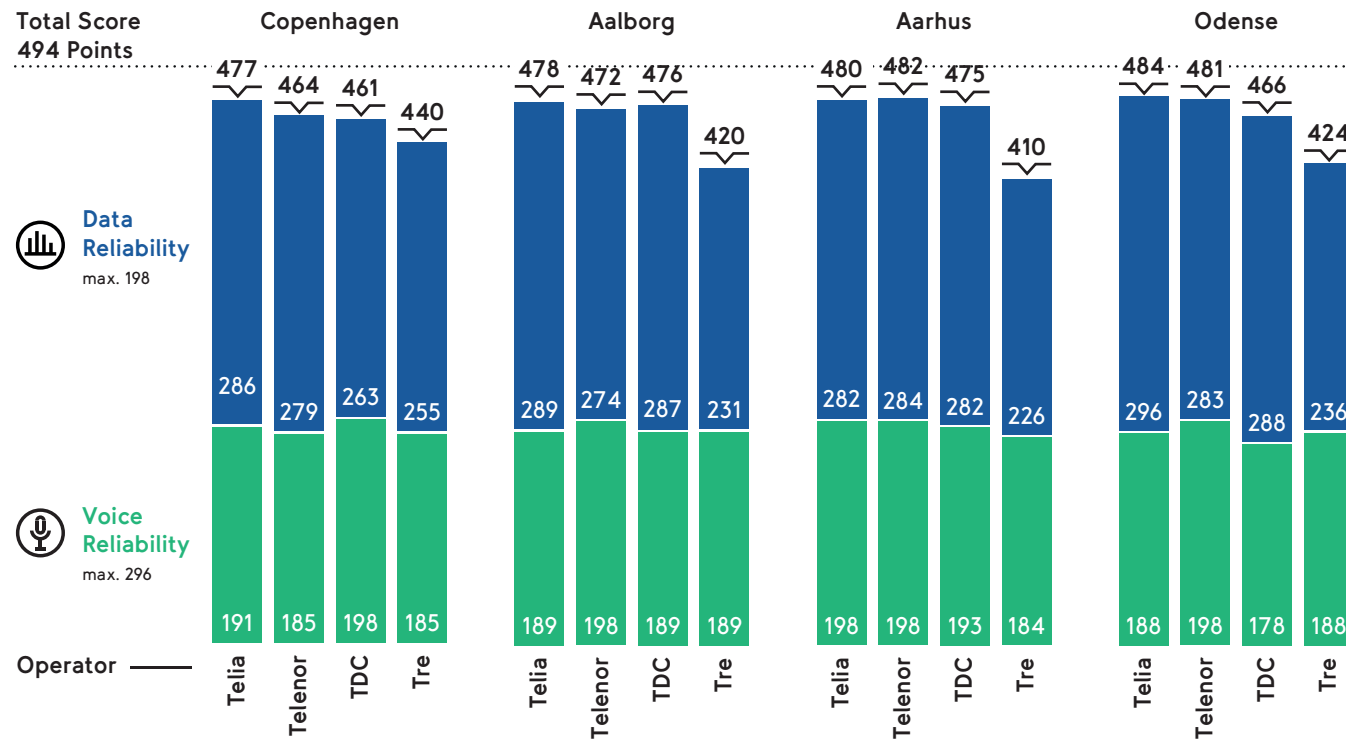
Overall score considering Voice and Data in Copenhagen, Aalborg, Aarhus and Odense.





Reliability Score — Cities

In Copenhagen, Aalborg, Aarhus and Odense



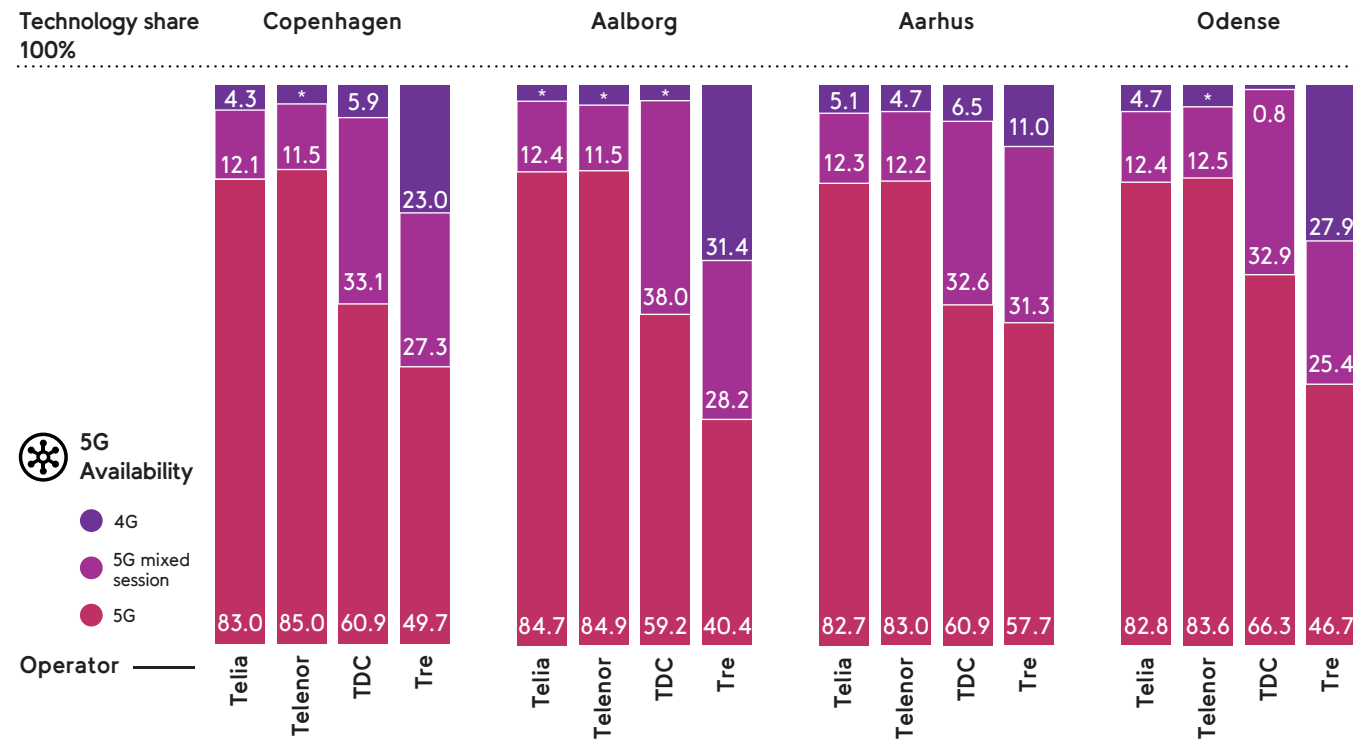
Reliability score considering Voice Reliability and Data Reliability in Copenhagen, Aalborg, Aarhus and Odense.





5G Availability — Cities

Technology share in Copenhagen, Aalborg, Aarhus and Odense



Share of technology used for conveying data traffic per aggregation in Copenhagen, Aalborg, Aarhus and Odense.

* Share of technology is lower than 4%.





Methodology

umlaut score

As the de-facto industry standard, our benchmarking methodology focuses on customer-perceived network quality and covers a wide range of mobile services. Today, more than 200 mobile networks in more than 120 countries are being evaluated by our unique scoring methodology. It allows a technical analysis that is unprecedented in its level of detail – enabling comparisons between the network performance and capability of each mobile network. Our public benchmarks as well as the certificate benchmarks help network operators to demonstrate how well they deliver wireless connections to consumers, business users and enterprises while revealing the areas of improvement.

Various adaptations have been realized in the 2022 User Experience testing methodology to further improve end-user focus, differentiation, robustness and fairness. In the 2022 benchmarking framework new metrics has been included based on YouTube Streaming, Conversational Apps (OTT Voice) and Online eGaming.



Data Test Cases Setup

Voice Test

- Mobile-to-Mobile calls, with controlled background PS data traffic
- Evaluating user experience
- Speech Quality

Web Browsing Test

- Popular live pages download (global and local page selection mix) plus one reference web page
- Evaluating user experience

Data Download/Upload Test

- Data Stream – Fixed duration, multi socket, HTTP download and upload
- File Download – Fixed size, single socket, HTTP/S file download and upload
- Evaluating network capability and User Experience

Interactivity (eGaming) Test

- TWAMP-based test of UDP Latency and Packet Loss for eGaming Traffic
- Traffic pattern representing a real time high activity multiplayer game
- Evaluating network capability

Youtube Test

- YouTube Video download & playout
- Testing Video-on-Demand and Live streaming
- Evaluating user experience – up to 1080p/FHD
- Evaluating network capability – up to 2160p/4K VoD

Conversational Apps

- Generic VoIP Mobile-to-Mobile call, aligned with popular conversational speech apps
- Evaluating user experience

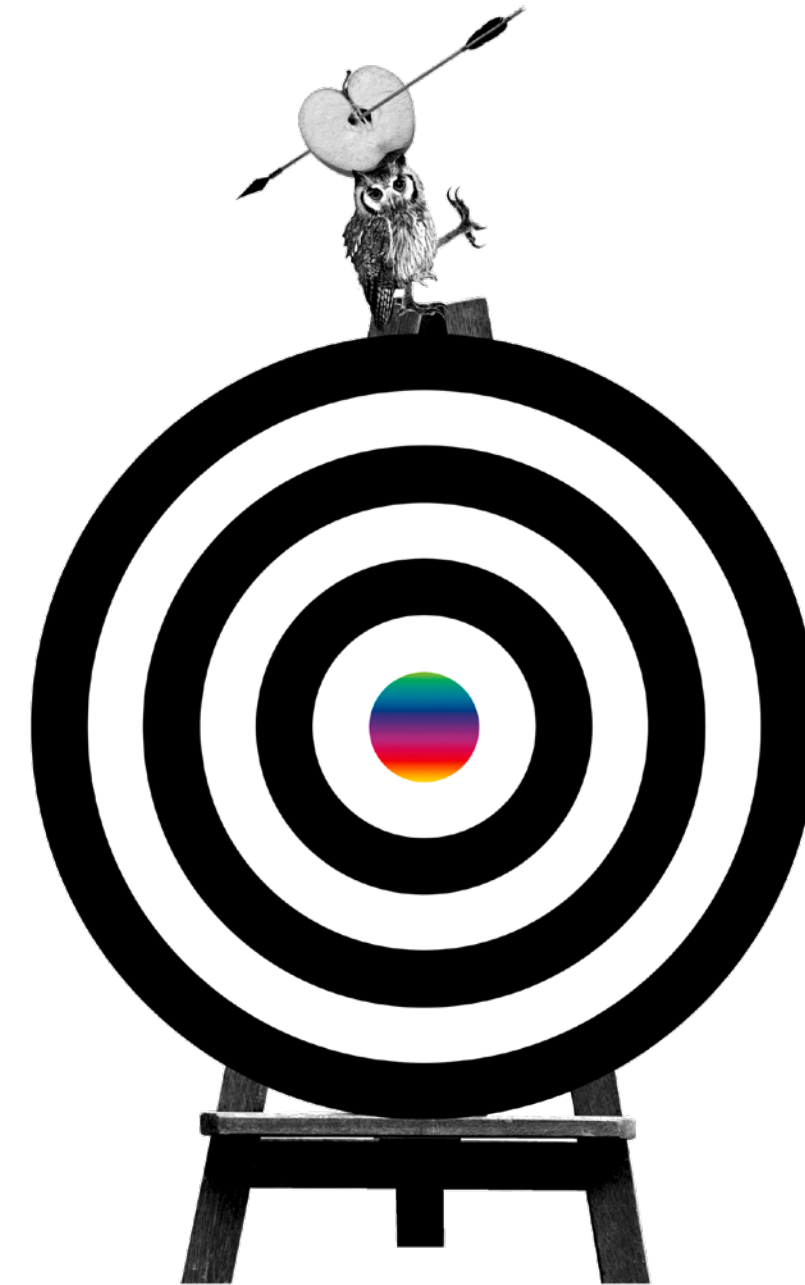
Following our international benchmarking methodology standard the Samsung Galaxy S21+ has been used for voice measurements including Conversational Apps and the Sam-

sung Galaxy S22+ has been used for data measurements. For more details of our Framework please visit: www.umlaut.com/benchmarking



Key takeaways

- ||| Telia achieved the highest overall score with 956 points out of 1000 in the measured city test areas.
- ≡ Telia achieved the highest overall score in the test areas of Copenhagen, Aalborg, Aarhus and Odense.
- ||| Overall, Telia achieved the highest data performance with 610 points.
- ≡ In voice performance, TDC is leading with 347 points followed by Telia with 346 points of 360.
- ||| Telia achieved the highest overall reliability score.
- ≡ In all four cities Telia has shown very high 5G Availability of more than 94% in the measured test areas.





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