



We simply care

5G Benchmarking Report 2020

Warszawa, Łódź, Wrocław



MADE IN
POLAND



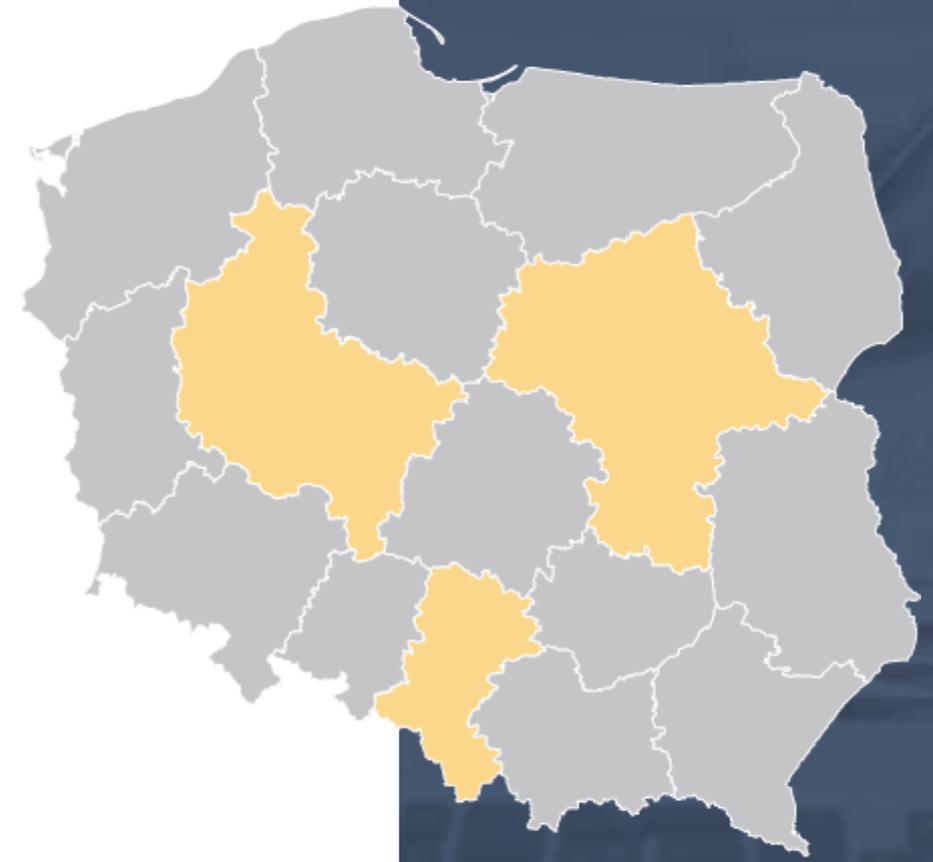
Engineering company with **15+ years** of successful mobile networks' & IT projects. Located in Warsaw(HQ) with distributed offices



Increasing market position and high experience proven with Customers Satisfaction



Offering latest leading-edge technologies to achieve impressive results





Foreword

5G is the fifth generation of cellular networks that aims at bringing entirely new capabilities for people, industry and society

What does it mean to us, the regular users?

Connected vehicles sharing their data to prevent collisions, emergency services being faster deployed, production lines autonomously controlled by sophisticated algorithms, new IoT solutions for medical care, stable connectivity of almost no delay, full-length HD movies on your phone in no time...

5G has enormous potential and is a huge step to a completely new level, the step that many operators has already made even though it is still in teething phase

5G alone is not enough though, it does need new services alongside, the new wireless technology has to be combined with AI & Cloud Computing to build up a sustainable platform for the service providers

Foreword



5G landscape is **constantly shifting** and will continue to do so over the next few months

Even if you can already see 5G icon on your mobile, you're most likely connected to 5G over LTE by its NSA(non-standalone) version

Yet, even though **5G is far from a mature project**, it is truly already there
How does it actually perform with its limited version **deployed in Poland?**

Having driven **3 major polish cities**: Warsaw, Wrocław and Łódź, analyzed **hundreds of measurement hours** we are able to draw a comprehensive **5G picture here**

Notel will detail a bit more and help you understand what **5G ready truly means**



Hardware Specification

A lot of discussions have been held about 5G surrounding smartphones especially when new 5G iPhones have arrived

Not all of them do suit well current 5G implementation operating within certain LTE+NR bands combinations

Following devices were used by **Notel** to be able to properly test the 5G configuration offered by domestic operators: **Orange**, **T-Mobile**, **Play**, **Plus**

Xiaomi Mi 10 5G
M20012J2G



Motorola edge 5G
XT2603-4



5G Benchmarking VOICE

Voice over 5G NR? Sounds tempting, doesn't it?

Alas, for its complexity and requirement of 5G SA (standalone) + 5GC the VoNR can't really be used as of now and is waiting for 5G deployment option 2

How are we going to handle the voice calls on 5G then?

Widely deployed **VoLTE based on IMS** service comes here to help. No IMS changes are necessary here.

In fact the IMS itself is not even aware of EUTRAN support for **EN-DC mobiles**

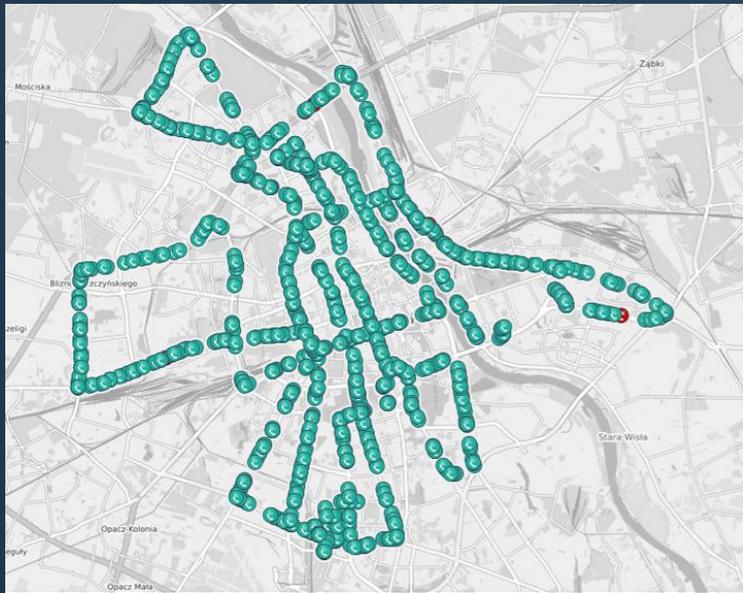
All **VoLTE principles** remain valid here including **SRVCC** as well as **CS fallback to legacy** when needed

Notel will show that the voice support for **5G NSA** should not result in any significant quality deterioration

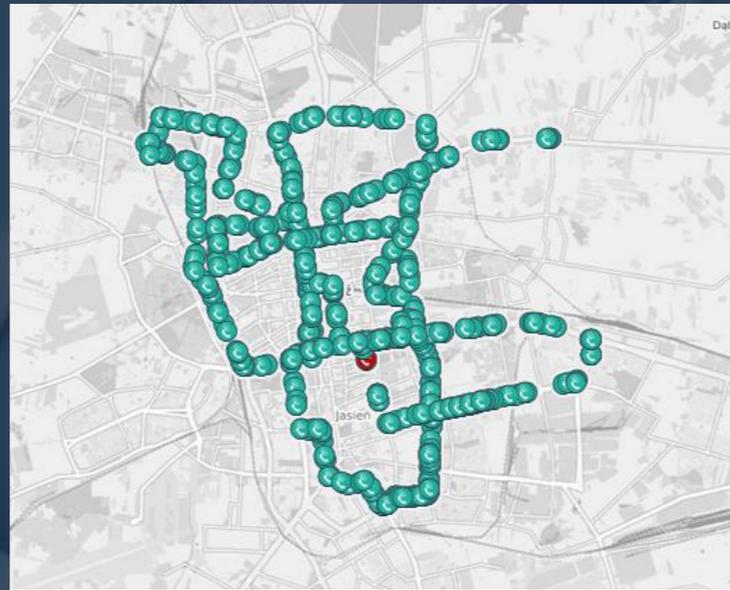
5G Benchmarking VOICE



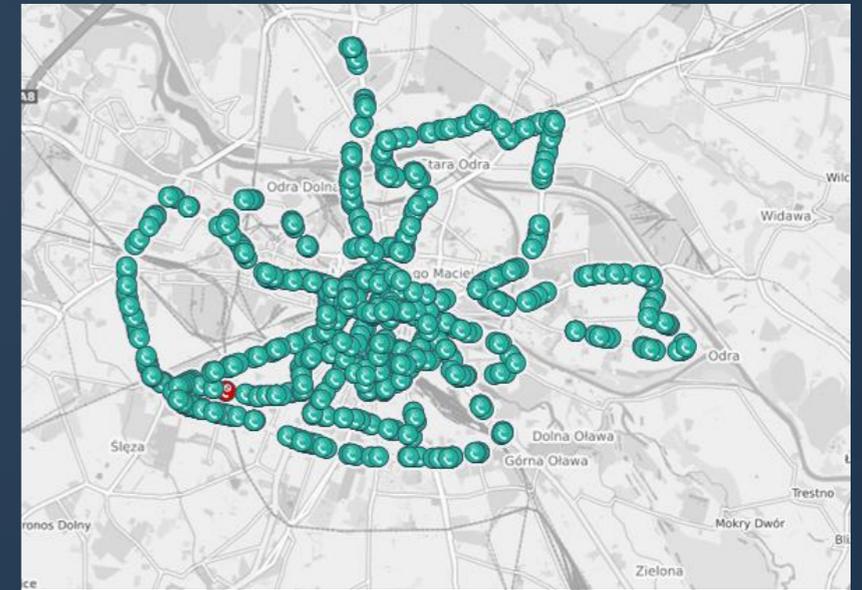
~ 1000 Voice Calls per operator in 5G freemode to test Call Setup Time and Call Setup Success Ratio



Warszawa



Łódź

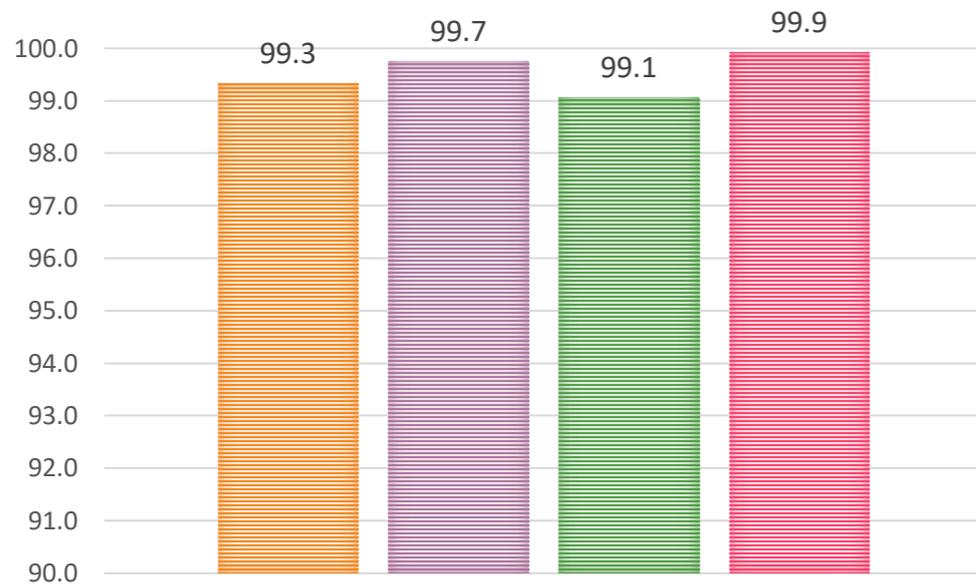


Wrocław

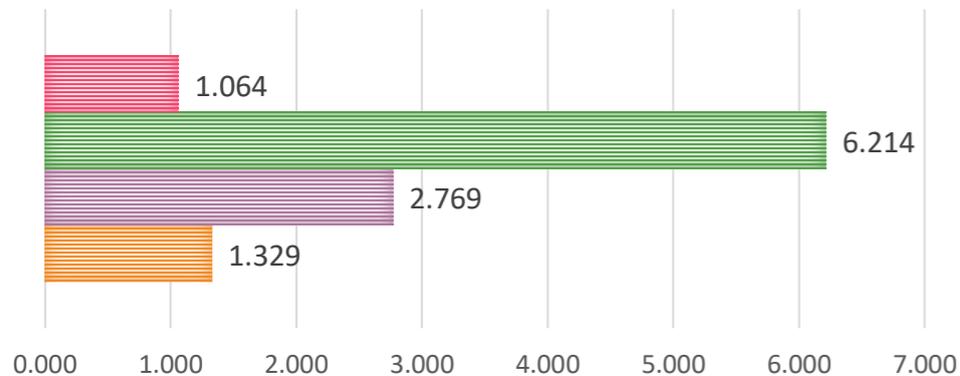
5G Benchmarking Voice



Call Setup Success rate [%]



Call Setup Time (MO) [s]



The freemode voice call scenario for 5G handset results in fallback to VoLTE

EN-DC capable mobiles may be ordered to release the NR leg if network requires so (vendor implementation dependent)

Call Setup Time not affected by the implementation of 5G NSA mode

The longer CST for **Plus** comes as a cost of no VoLTE support for all EN-DC handsets which entails CS legacy procedures to be involved

5G Benchmarking DATA



Drivetest

The mmWave 5G (20-60 Ghz) implementation is still a matter of **months** from now

5G signal widely available now is not the Ultra Wideband yet

The most common realisation of 5G operates in lower-band, often with dynamic spectrum sharing (DSS) - technology that **repurposes** LTE for 5G coverage

How can it be of our advantage then to stick to 5G data with its **current NSA Option 3** implementation?

Notel will answer this question in the next few slides where the benchmarking results for data services are presented

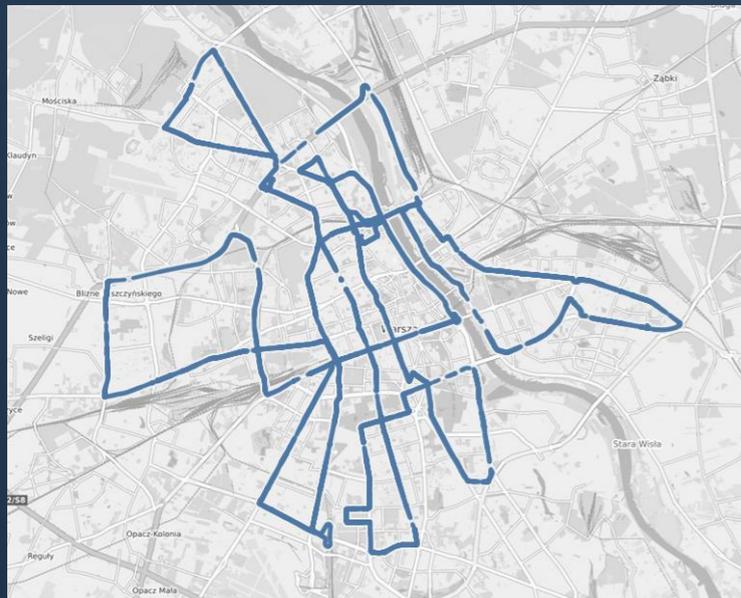
5G Benchmarking DATA



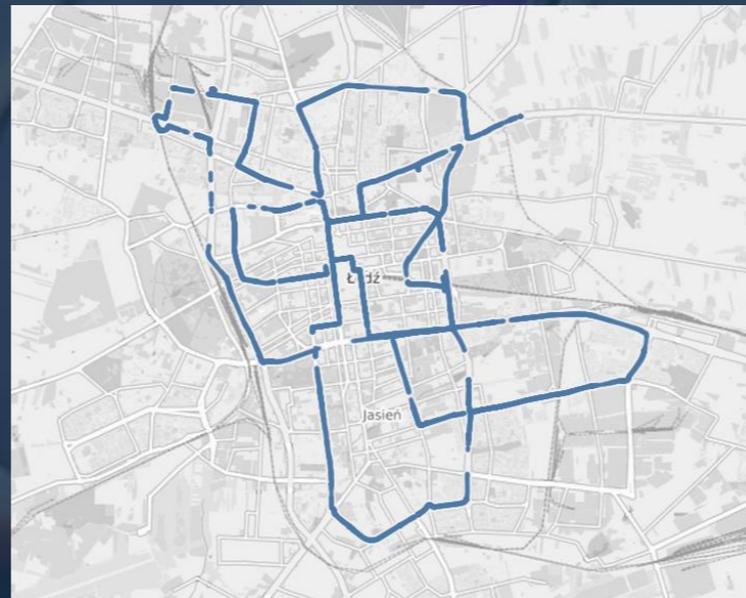
Drivetest

~2500 Packet Data Tests per operator including:

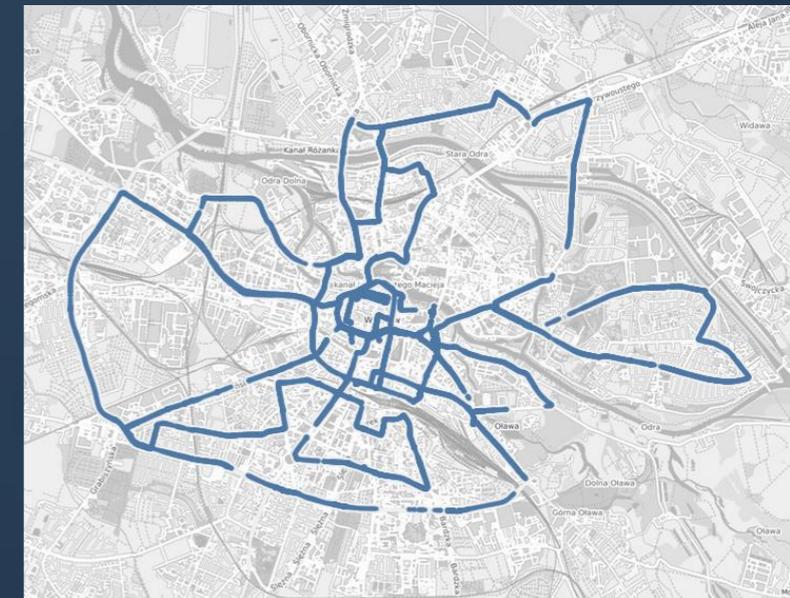
- HTTP small file upload+download sessions
- HTTP large file upload+download sessions
- FTP upload+download multisessions
- Latency Tests



Warszawa

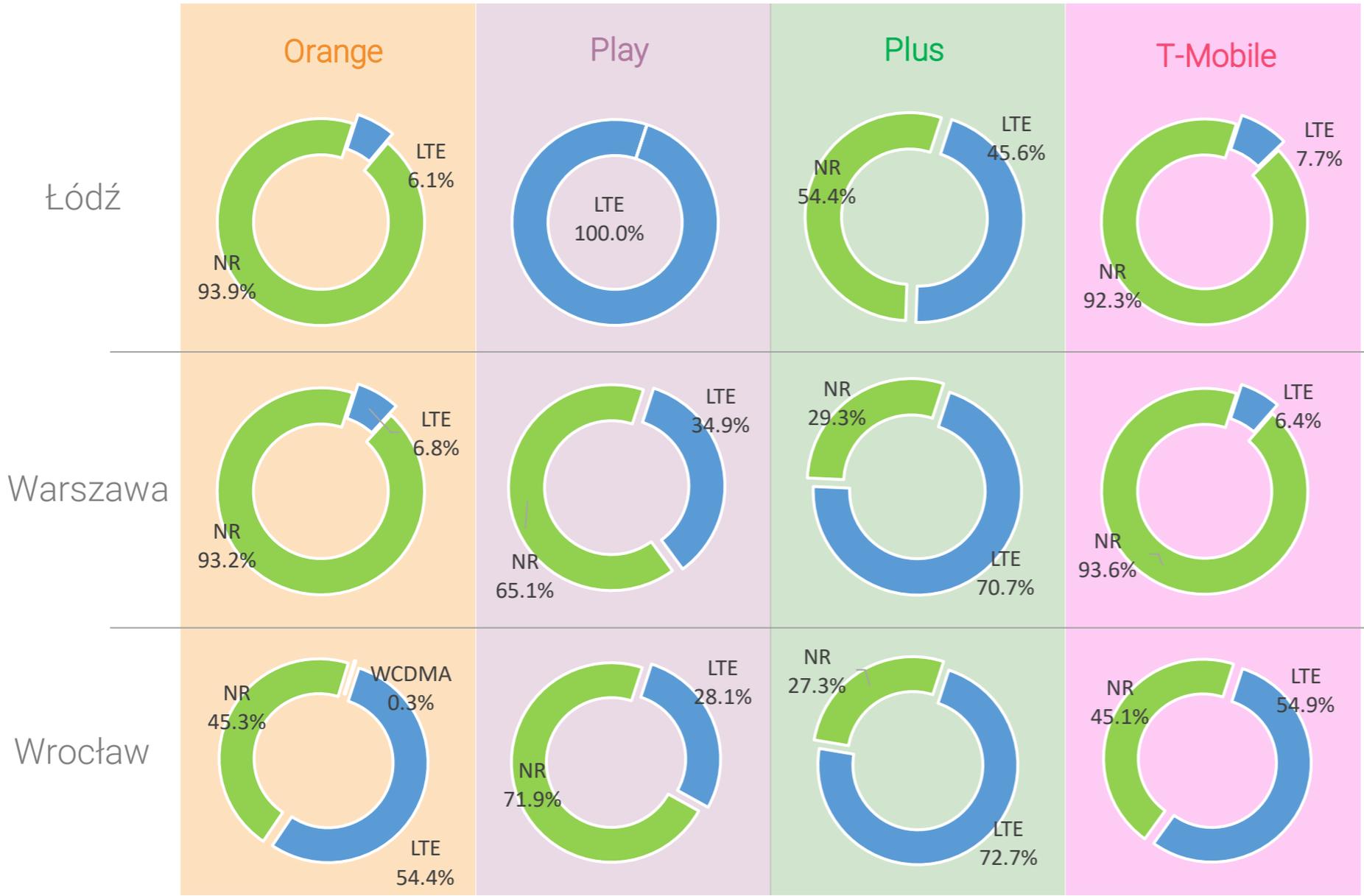


Łódź



Wrocław

5G Benchmarking DATA (RAT usage)



NR + LTE resources utilisation visibly differs between the operators

Orange, T-Mobile, Play make use FDD 2100 DSS band implementation 10MHz wide

Plus on the other hand offers NR in TDD 2600 (n41) band that is 40MHz wide

Play does not look to have any 5G services in Łódź area



5G Benchmarking DATA (LTE+NR split)



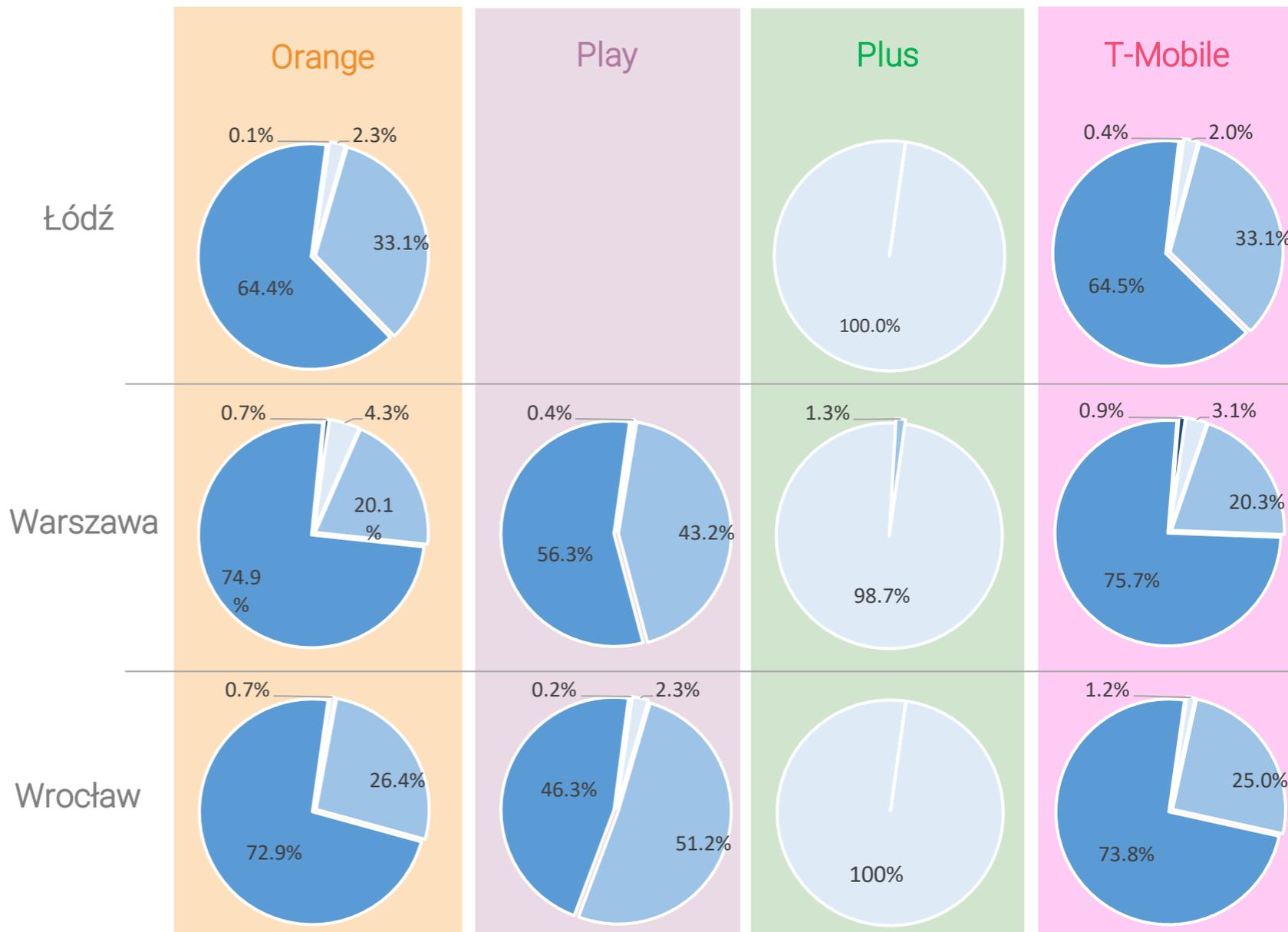
Drivetest

Majority of data sessions for **T-Mobile**, **Play**, **Orange** were served in configuration of: 2-3 LTE cells (CA) + 1 NR cell

Different strategy is represented for **Plus** whereby: 1 LTE cell + 1 NR cell is of use

This will have significant impact on the final results as we shall see later on

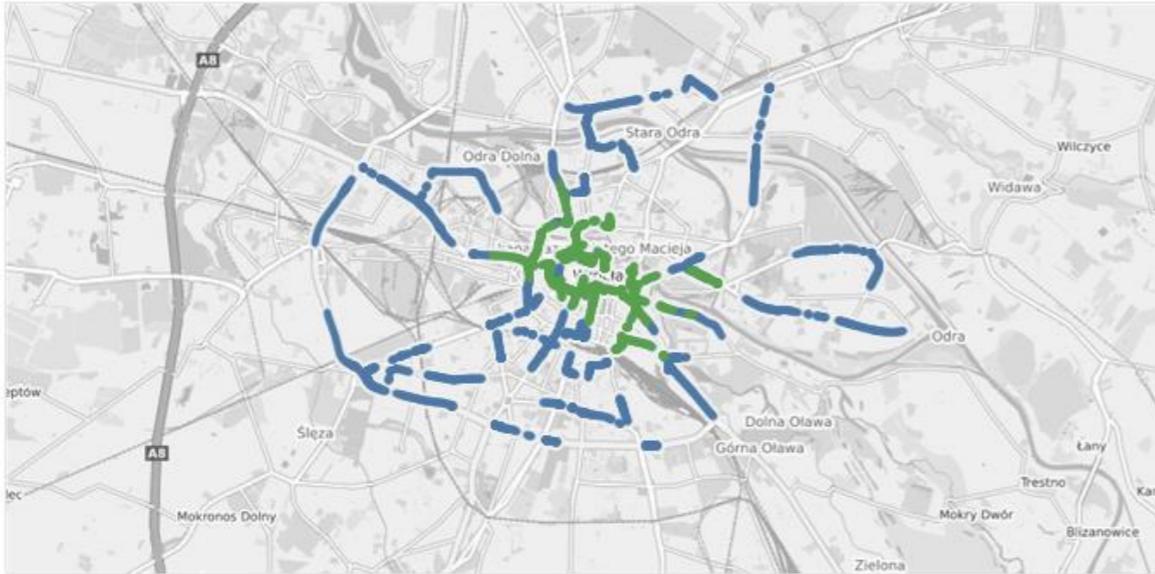
- LTE cells: 1 NR cells: 1
- LTE cells: 2 NR cells: 1
- LTE cells: 3 NR cells: 1
- LTE cells: 4 NR cells: 1



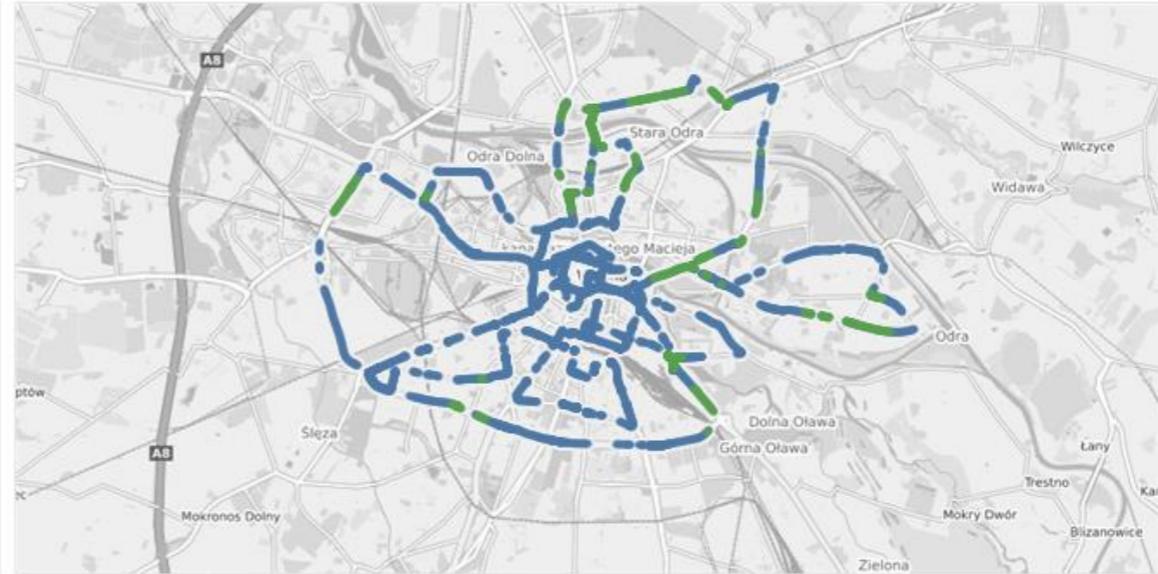
5G Benchmarking DATA (RAT usage): Wrocław



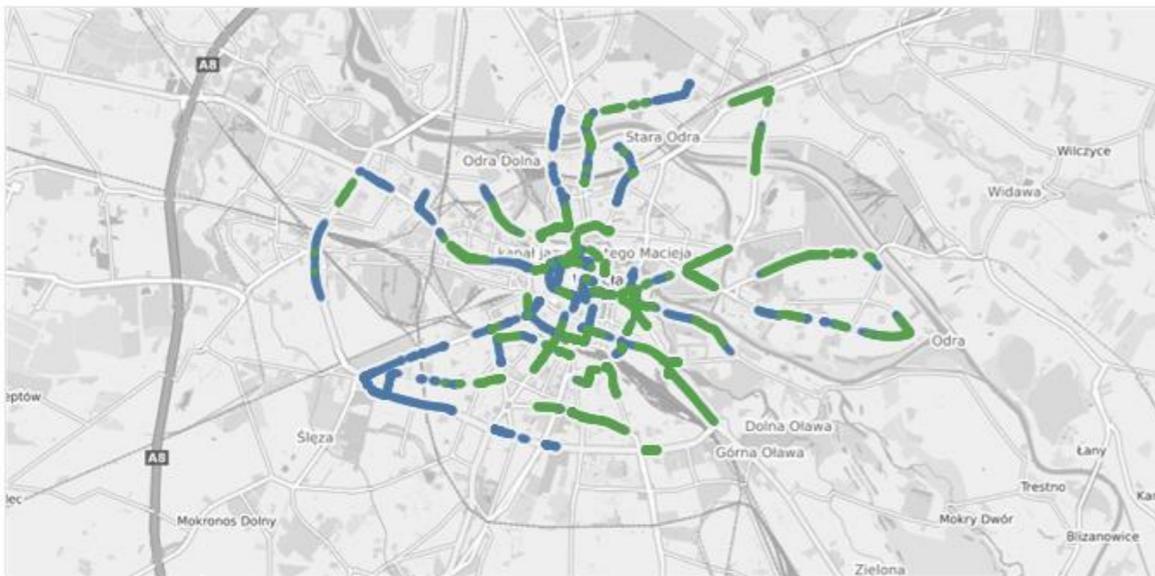
RAT Usage (Phone) Data Sessions for Orange



RAT Usage (Phone) Data Sessions for Plus



RAT Usage (Phone) Data Sessions for Play

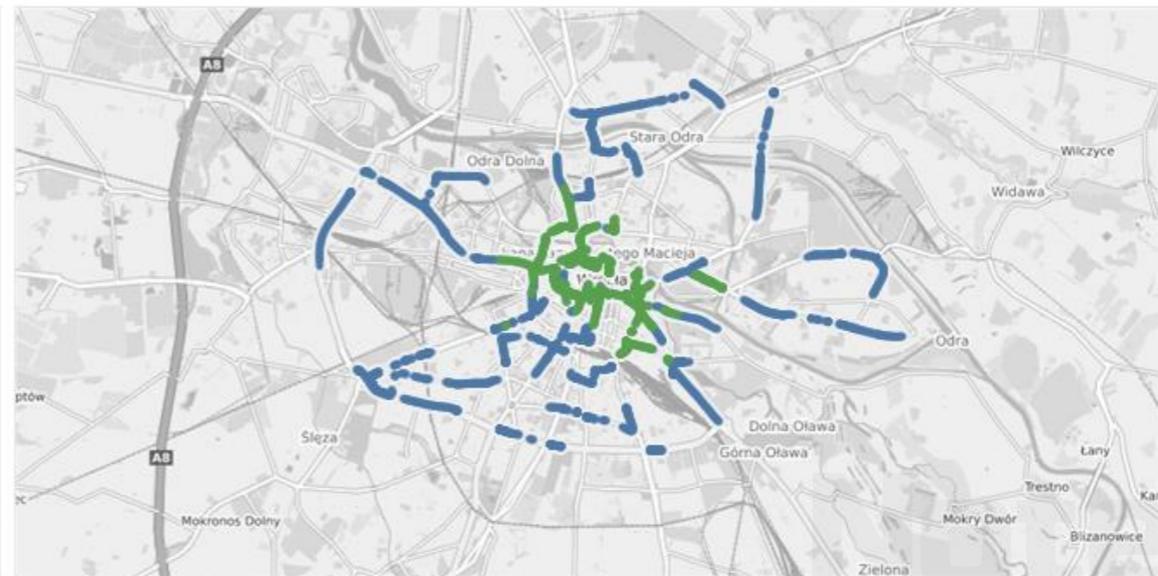


■ NR

■ LTE

■ WCDMA

RAT Usage (Phone) Data Sessions for T-Mobile



5G Benchmarking DATA (RAT usage): Warszawa

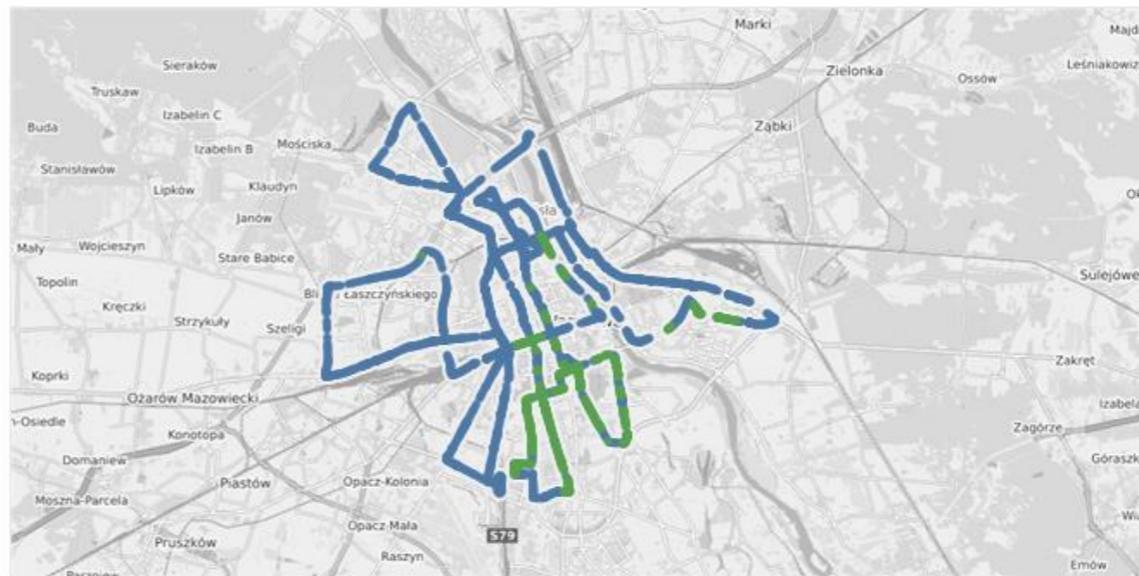


Drivetest

RAT Usage (Phone) Data Sessions for Orange



RAT Usage (Phone) Data Sessions for Plus

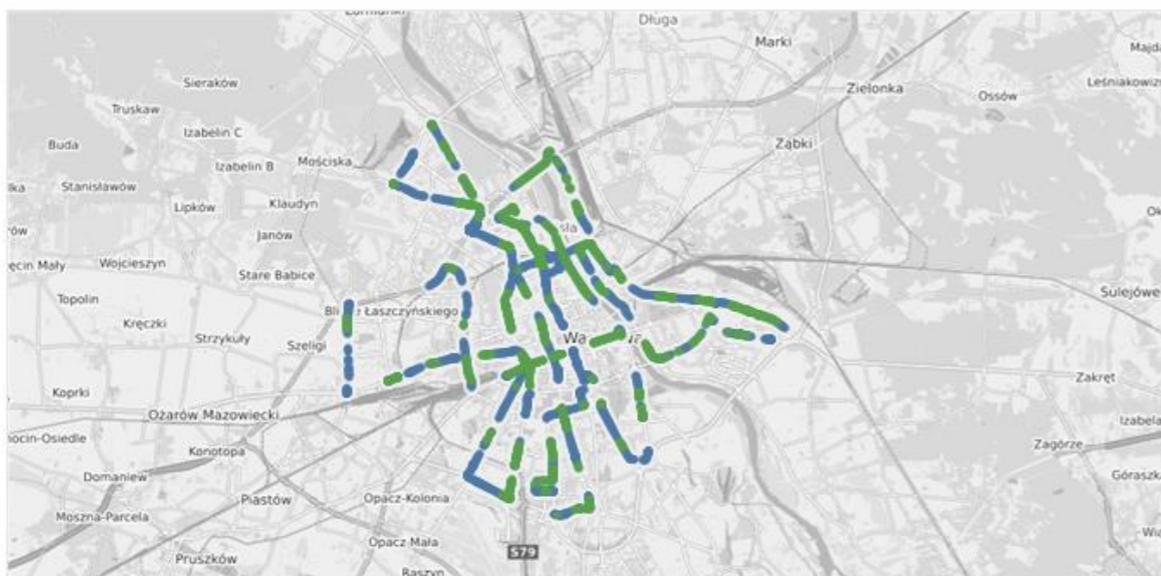


RAT Usage (Phone) Data Sessions for Play

■ NR

■ LTE

■ WCDMA



RAT Usage (Phone) Data Sessions for T-Mobile

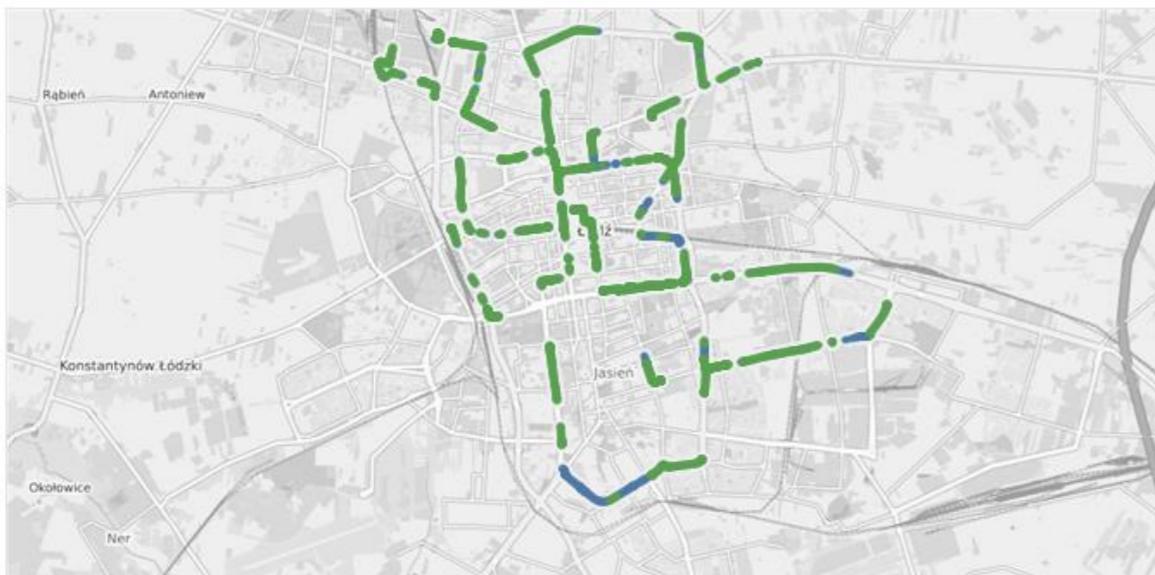


5G Benchmarking DATA (RAT usage): Łódź

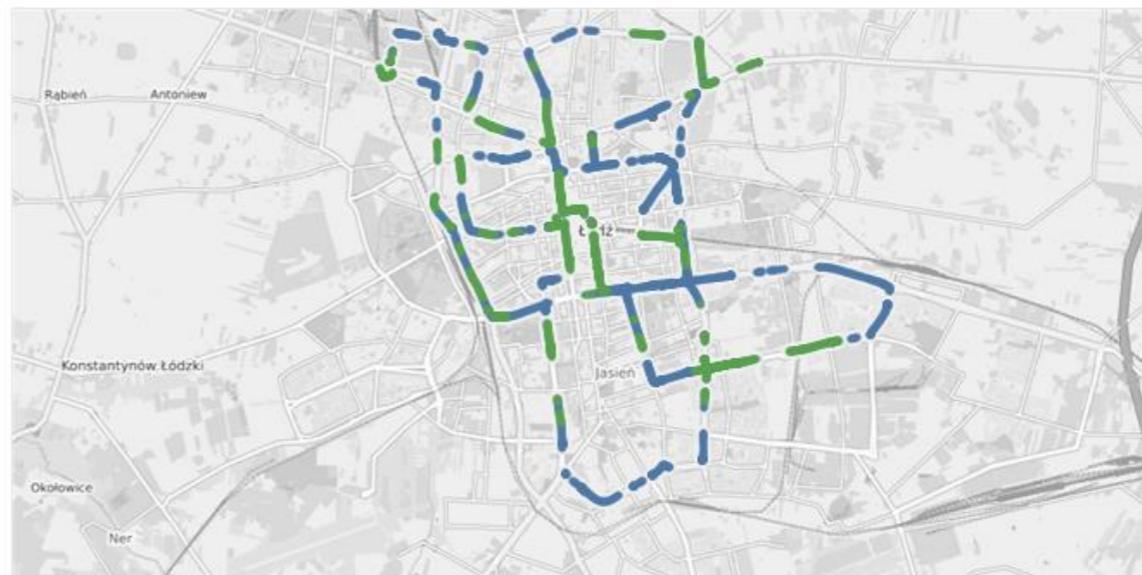


Drivetest

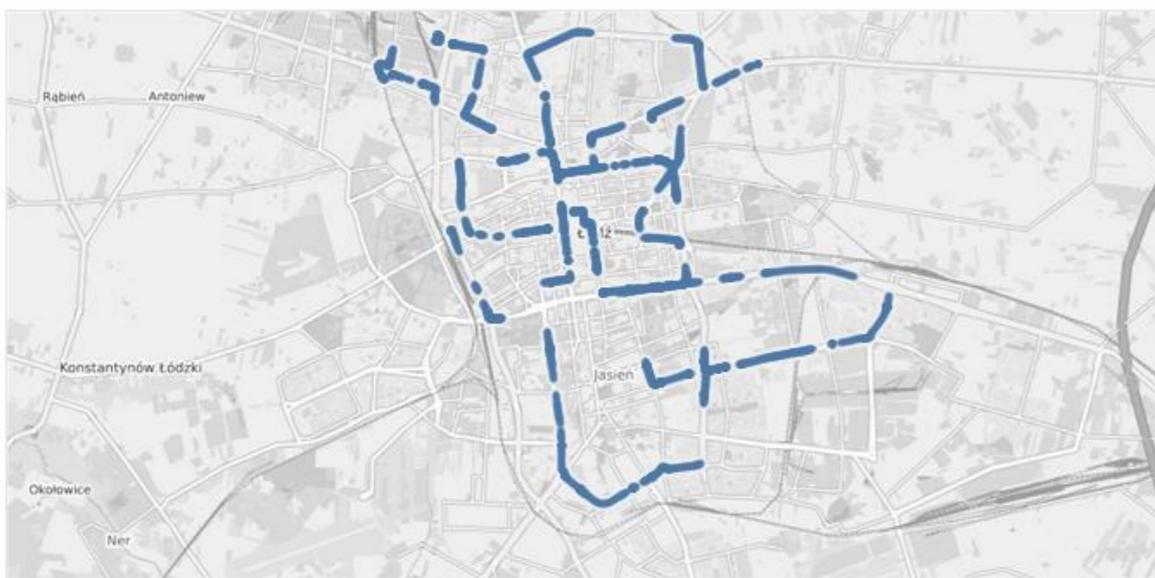
RAT Usage (Phone) Data Sessions for Orange



RAT Usage (Phone) Data Sessions for Plus



RAT Usage (Phone) Data Sessions for Play

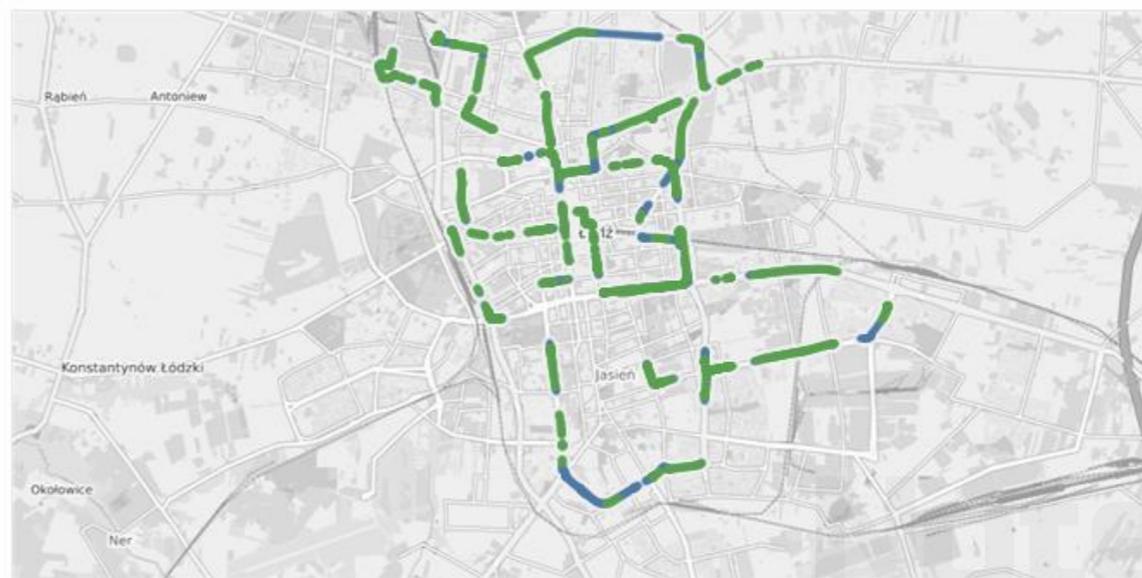


■ NR

■ LTE

■ WCDMA

RAT Usage (Phone) Data Sessions for T-Mobile



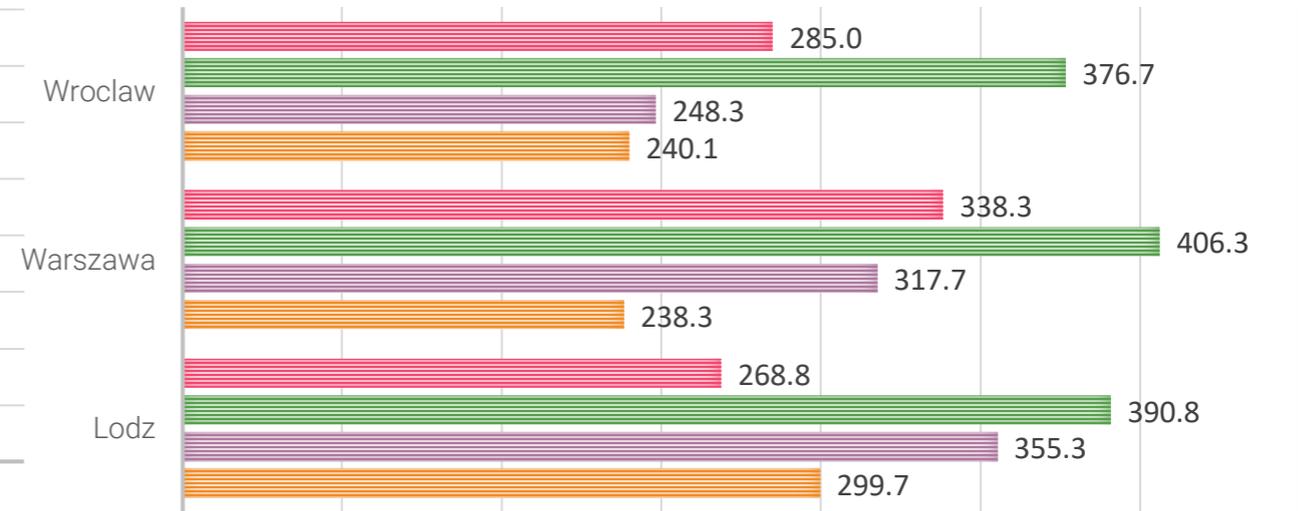
5G Benchmarking DATA (Throughput) – large files



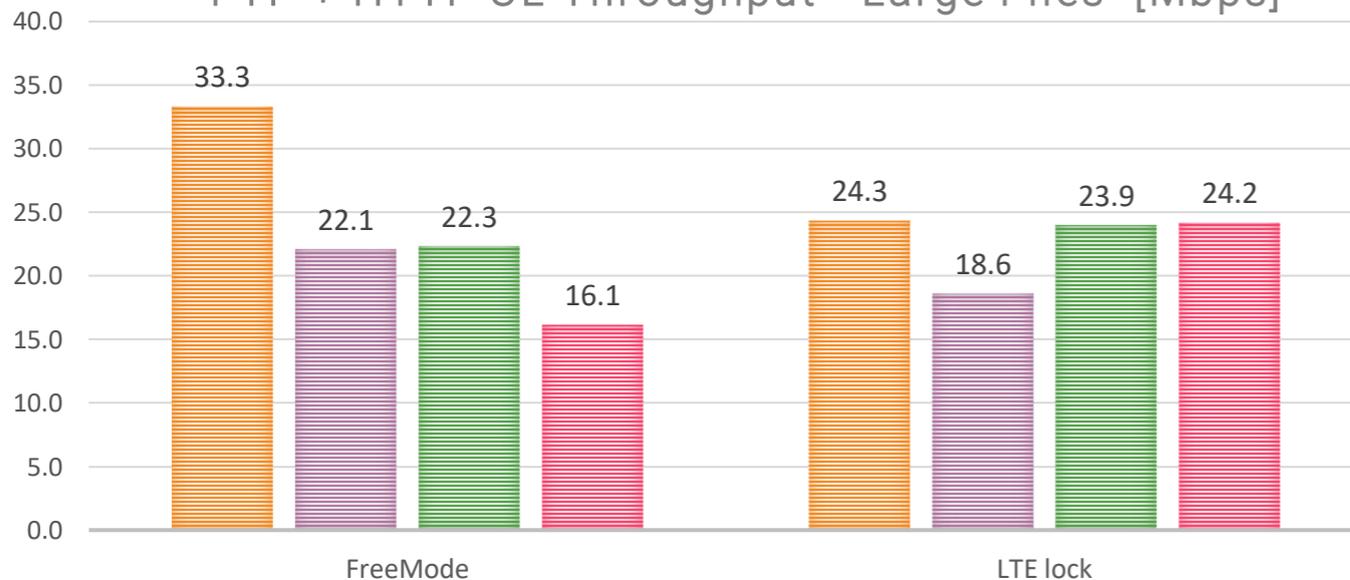
FTP + HTTP DL Throughput - Large Files [Mbps]



Max application downlink throughput [Mbps]



FTP + HTTP UL Throughput - Large Files [Mbps]



The freemode configuration (NR+LTE) proves to show that with its current NSA implementation can still be outperformed by LTE only usage (LTE lock) which comes of no surprise though

The difference is to be noticed here for Plus as its configuration of 1LTE+1NR highly profits from NR technology in use especially when max throughput is regarded



5G Benchmarking DATA (Throughput) – small files



HTTP DL Throughput - Small Files [Mbps]

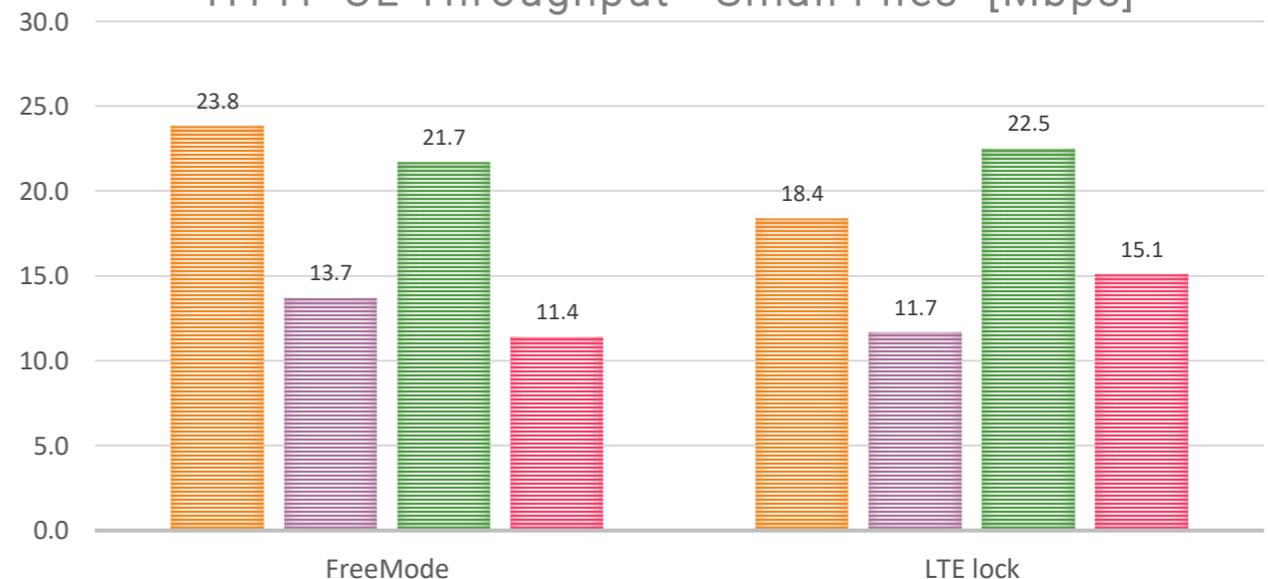


Orange presents outstanding performance for small files download no matter if NR+LTE or pure LTE is regarded

This metric might come to smartphones' users notices as combined with latency reflects the customer experience when working with those kind of devices

The average upload throughput for small files is also clearly better for Orange and Plus being almost x2 better compared to T-Mobile and Play

HTTP UL Throughput - Small Files [Mbps]



5G Benchmarking Data (Latency)



Average ping latency [ms]

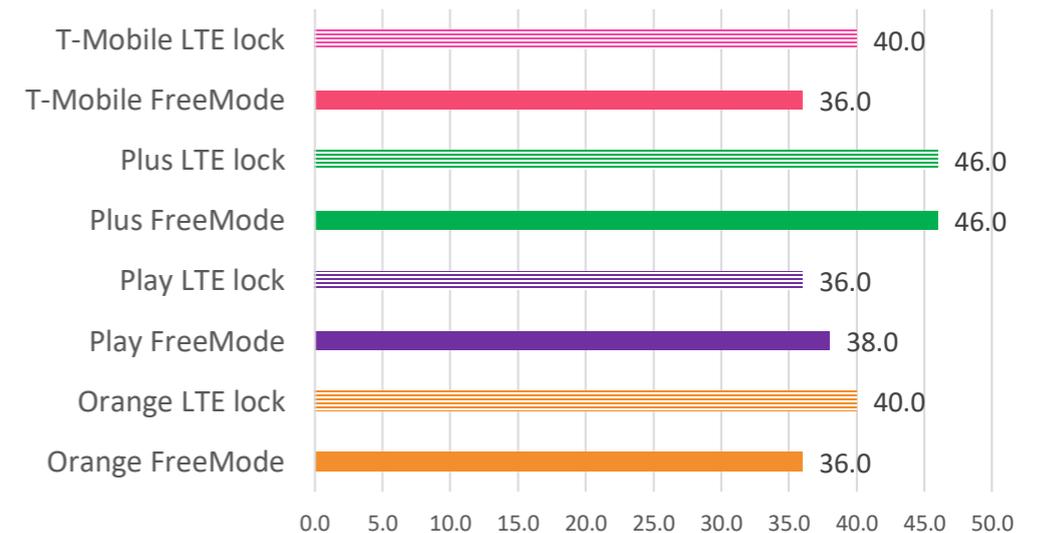


Similar latency level was achieved by all the operators

Slightly better results visible there for freemode (NR+LTE)

No major evolution step was made here when confronted with legacy 4G implementation

Median Ping latency [ms]



5G n78 Throughput & Latency Test (Warsaw)



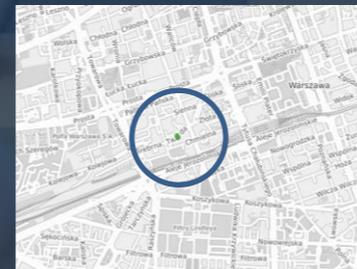
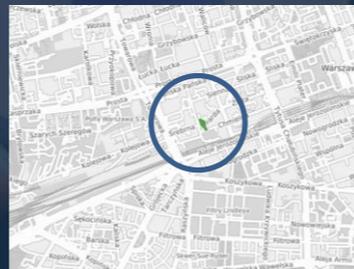
Stationary

As learned in the previous slides the low band 5G implementation, limited to 40 Mhz or sharing 10MHz with LTE (DSS) does not really offer any better throughput & latency when compared with LTE

How does it apply to the other vastly popular 5G C-band range that is likely to be freed up for commercial use?

As 5G C-band is commercially not available in Poland, **Notel** conducted its tests in 3 test locations in Warsaw for n78 band of 80MHz and 40MHz respectively (credits to **Operators** for helping with the 5G SIM cards)

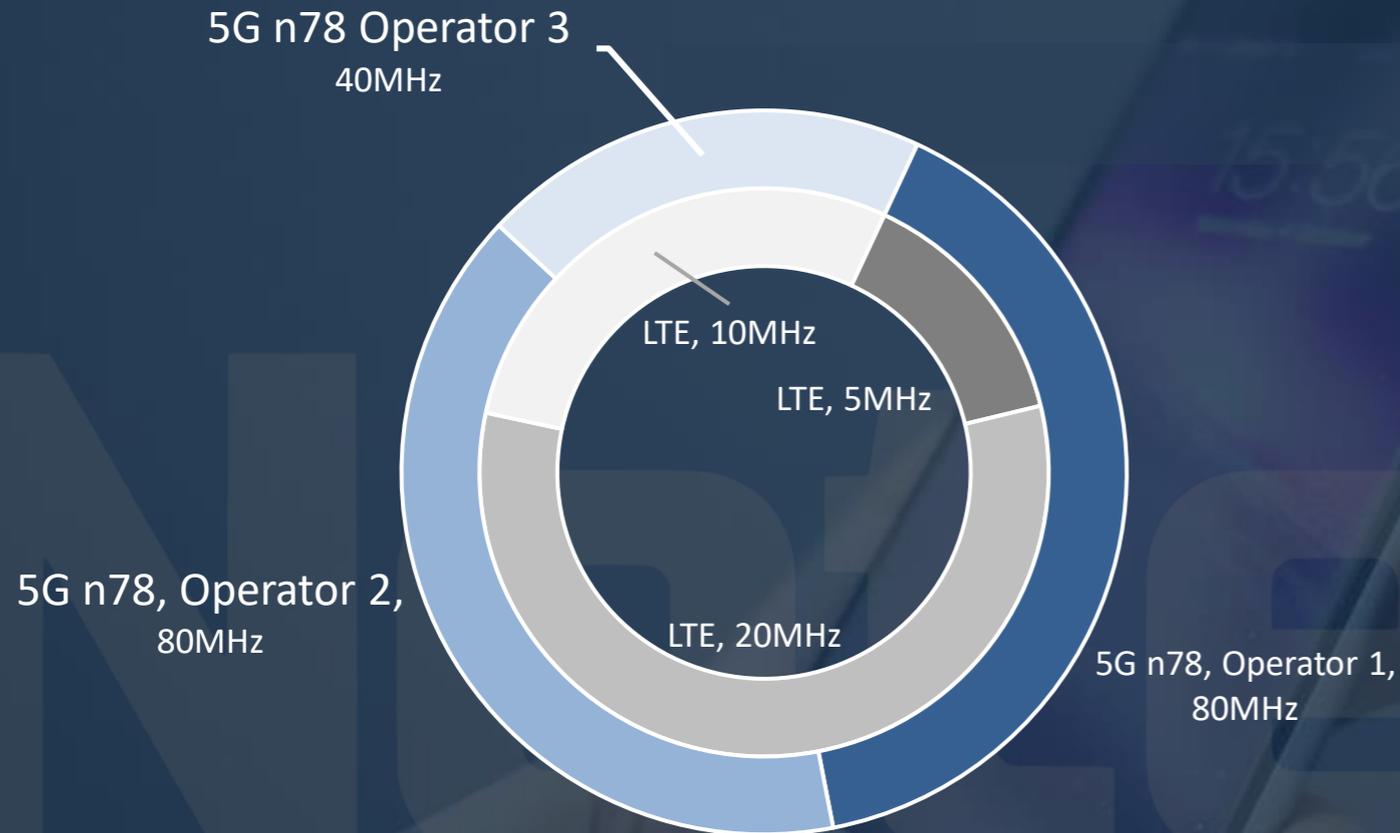
The nature of these tests is no means benchmarking of the operators. We would rather check what range of results the C-band potentially offers



5G n78 Throughput & Latency Test (Warsaw)



Stationary



Consequently we were able to test the following scenarios in the network

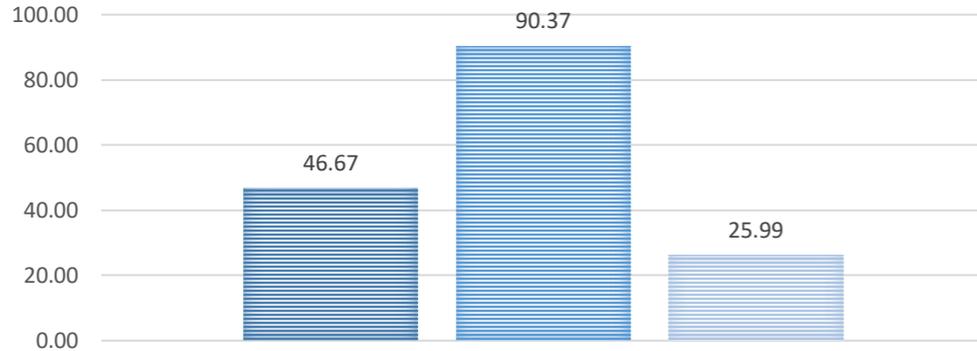
- 5G n78 80MHz + LTE 5MHz
- 5G n78 80MHz + LTE 20MHz
- 5G n78 40MHz + LTE 10MHz

5G n78 Throughput Test (Warsaw)

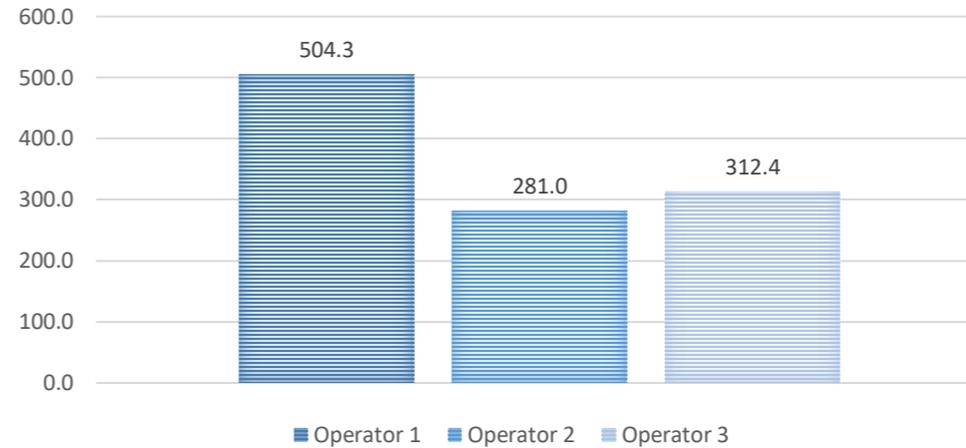


Stationary

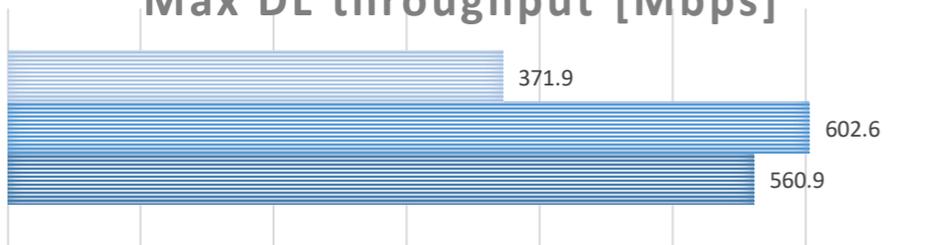
Average FTP UL throughput Large files [Mbps]



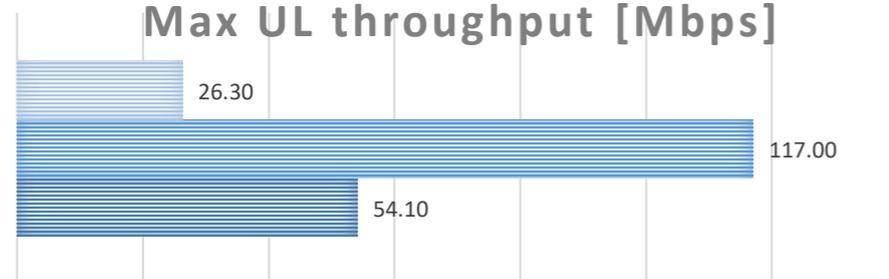
Average FTP DL throughput Large files [Mbps]



Max DL throughput [Mbps]



Max UL throughput [Mbps]



Good average DL throughput measured for **Operator 1** was purely a result of high utilization of NR radio (80% NR + 20% LTE), much lower average of **Operator 2** comes here as a surprise and may need to be investigated further

The maximum DL throughputs **look comparable** between the scenarios where 80 MHz was in use

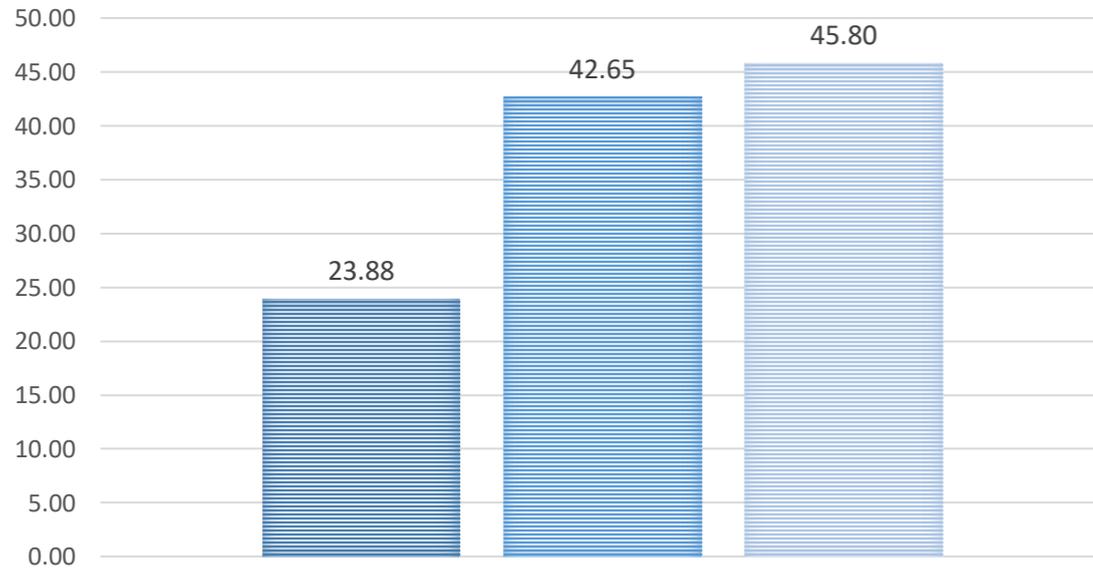
The **UL throughputs** look other way round though and the **Operator 2** look to be performing better here

5G n78 Benchmarking Data (Latency)

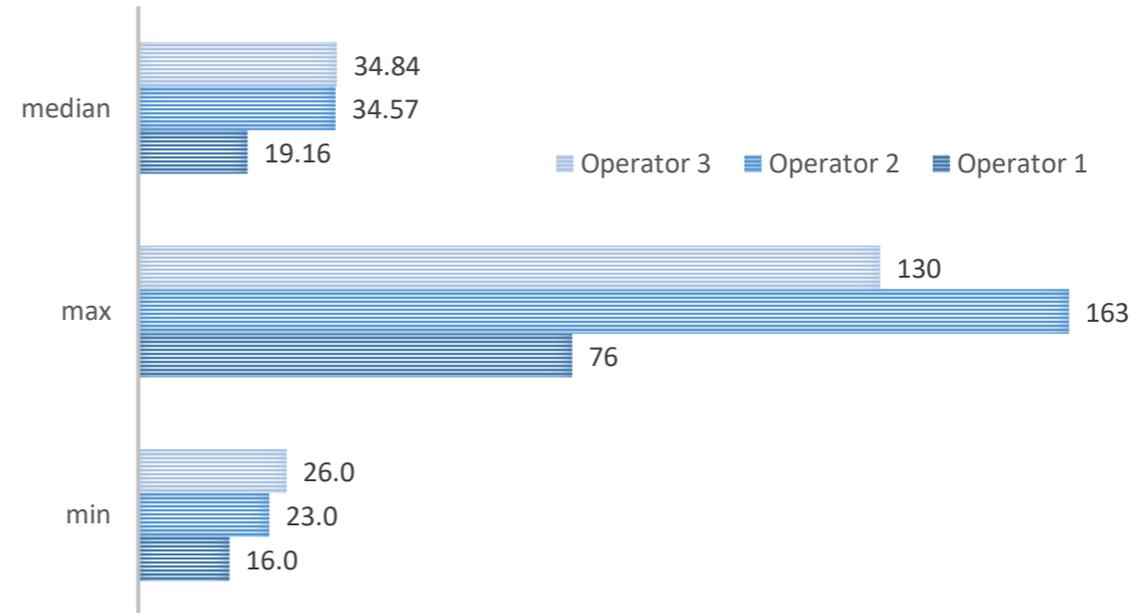


Stationary

Ping average latency [ms]



Ping Latency [ms]



A huge difference can be seen between the operators for the latency. The **Operator 1** completely outperformed the other two ones giving the lowest PING result

Summary

Domestic mobile operators use mainly **low-band spectrum** in order to provide 5G coverage blanket

The low-band solution does not offer any thrilling results in terms of latency and throughput thus true **5G readiness** is here questionable

The **millimeter wave** (high band spectrum) will easily outperform the 4G performance, it will however be limited to the small coverage spots for a while

The **C-band spectrum deployment** looks to be a good compromise for a start here provided that the spectrum will eventually **get freed up**

Rather solid signal propagation along with higher speeds is what benefit from when using proper 5G handsets

It seems the **C-band** is what we should be waiting for the time being before high band deployment properly starts

5G



THANK YOU



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