INVENIUM
DATA INSIGHTS

Research & Development

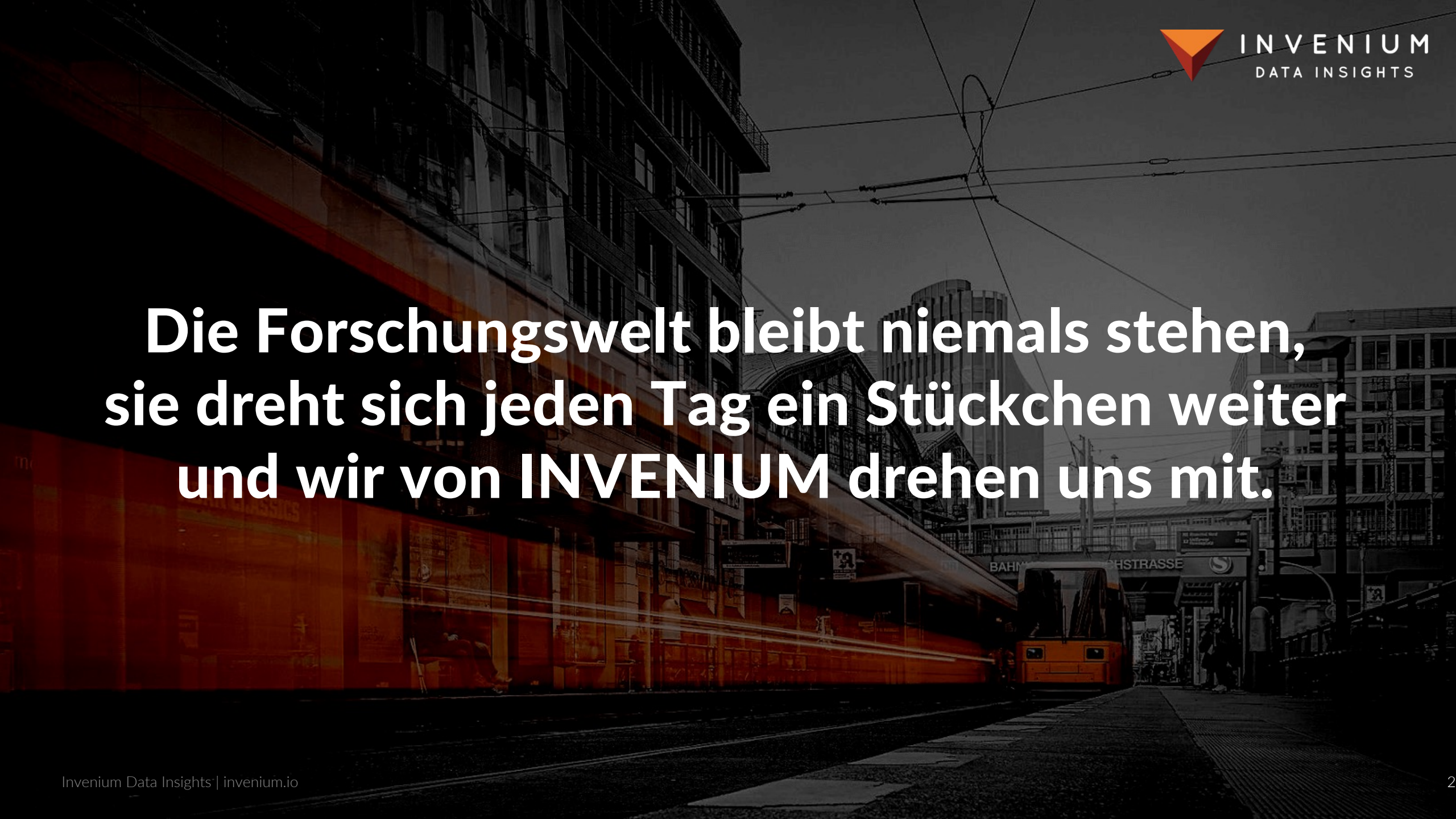
Mobilfunkbasierte Mobilitätsanalysen nach Maß

Webinar: Research & Development

Michael Haberl – INVENIUM
Business Development

supported by

A1 Telekom Austria Group



Die Forschungswelt bleibt niemals stehen, sie dreht sich jeden Tag ein Stückchen weiter und wir von INVENIUM drehen uns mit.

Agenda

1. Einleitung – 5G Faktencheck
2. Quintessenz **5G-Mobis**
   i. Key-Findings RSA FG
   ii. Key-Findings ANDATA
3. Quintessenz **5G-Libra**
   i. Werkstattbericht TU Graz
4. Wrap-Up und Q&A
5. 5G – Ausblick, Chance & Herausforderungen

Vortragende

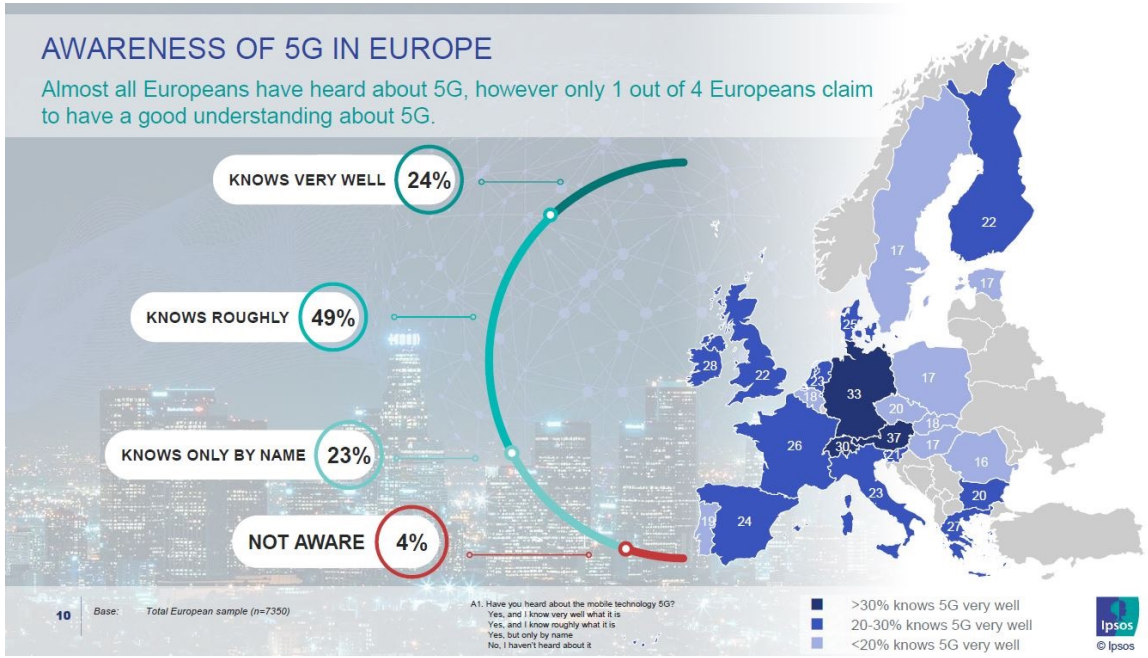
Florian Schöpflin - RSA FG
iSpace Researcher

José Carmona - ANDATA
Entwicklungsingenieur

Michael Cik – TU GRAZ
Verkehrswissenschaftler & Co-Founder von INVENIUM

Michael Haberl – INVENIUM
Business Development

5G in aller Munde

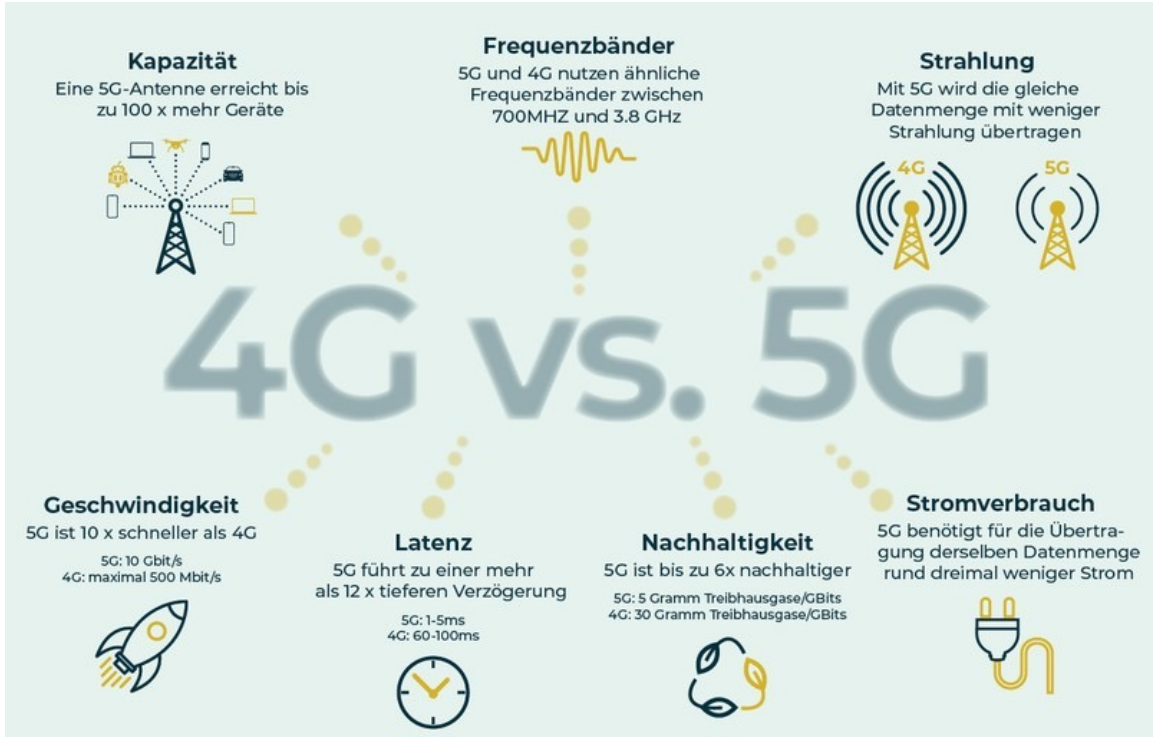


https://www.coit.es/noticias/que-saben-y-que-piensan-los-europeos-sobre-el-5g-0

https://www.digi.com/blog/post/lte-vs-5g

Evolution oder Revolution?

Von 4G zu 5G



https://chance5g.ch/de/storys/5g-ist-die-effizienteste-aller-mobilfunkgenerationen/

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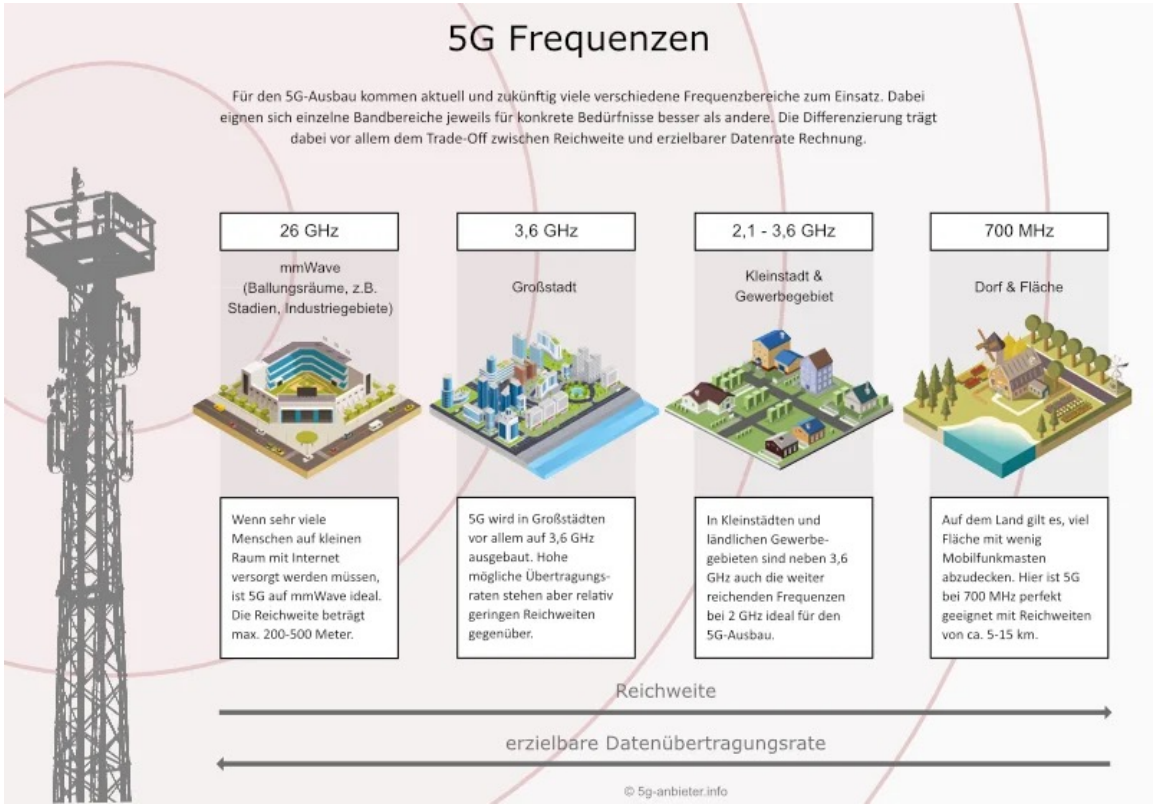
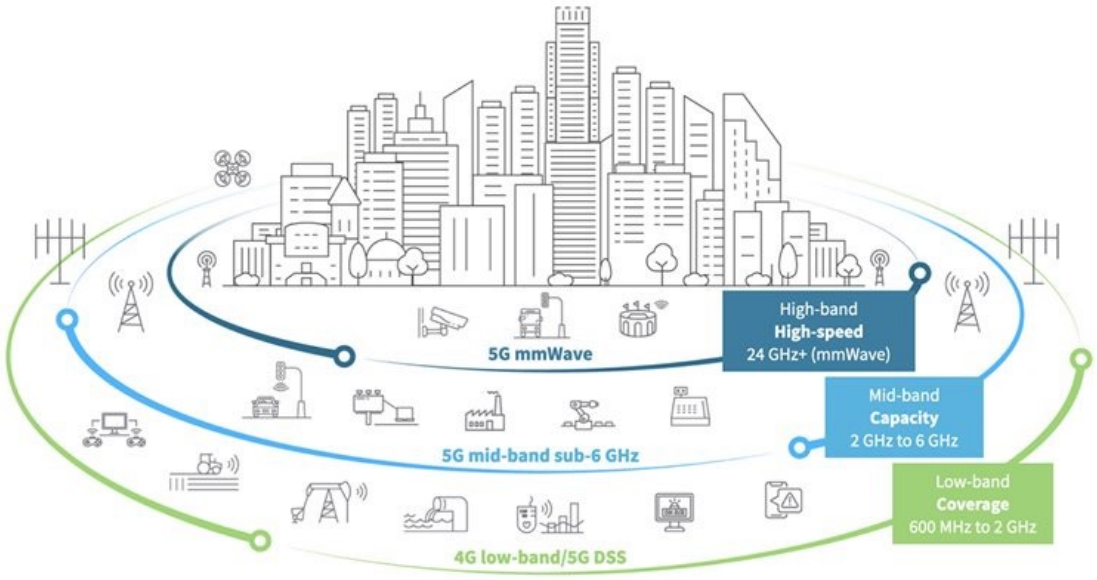


https://www.5g-anbieter.info/technik/5g-frequenzen.html

https://www.digi.com/blog/post/lte-vs-5g

Evolution oder Revolution?

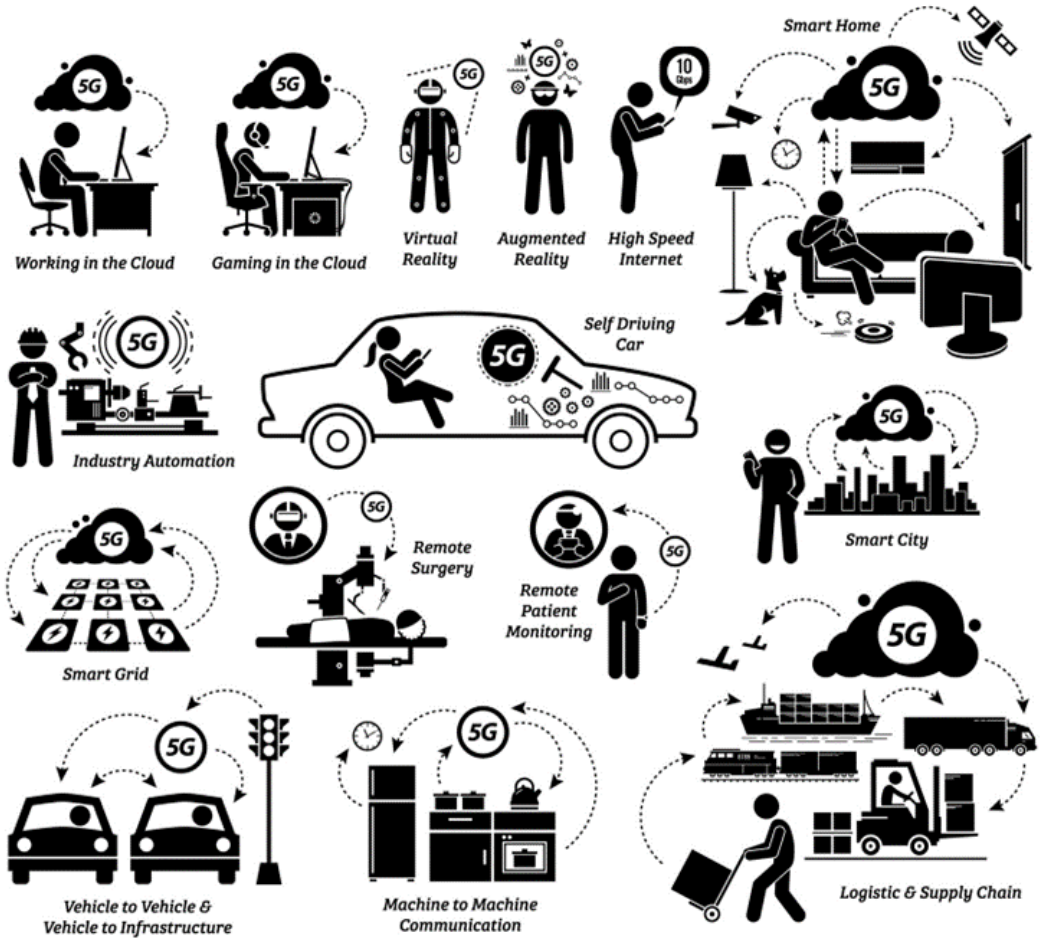
Von 4G zu 5G



https://de.digi.com/blog/post/lte-vs-5g

https://www.digi.com/blog/post/lte-vs-5g

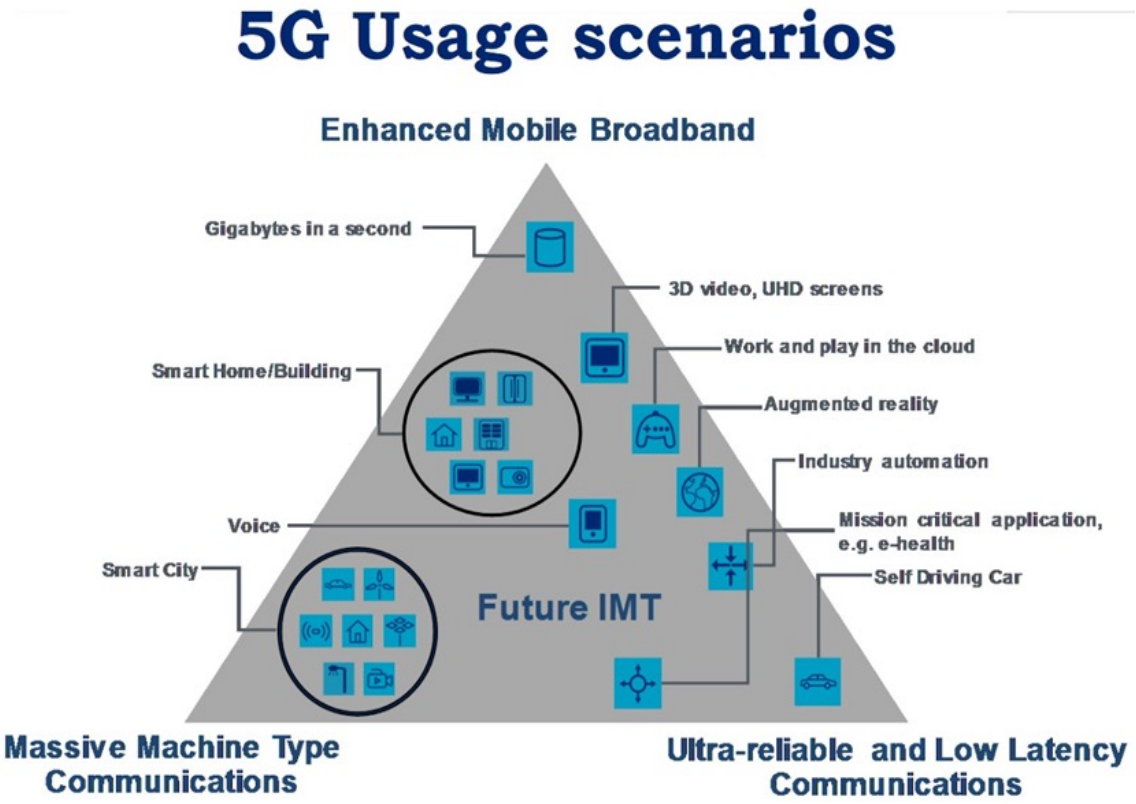
5G UseCases



https://www.etsy.com/de/listing/811863058/5g-nutzungen-internet-dinge-mogliche

https://www.digi.com/blog/post/lte-vs-5g

5G UseCases



https://salepeaket.live/product_details/49116742.html

https://www.digi.com/blog/post/lte-vs-5g

5G Shines Bright

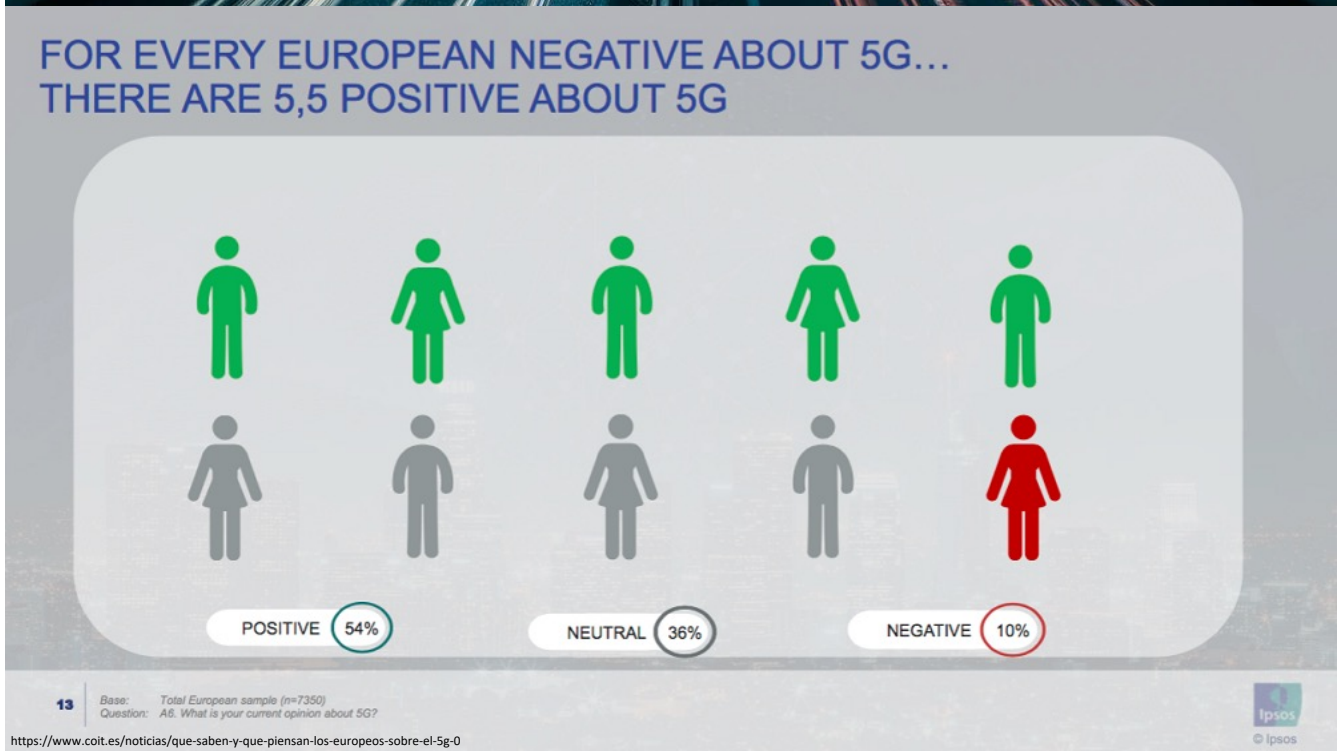
1. Speed
2. Latency
3. Energy efficiency
4. Connectivity
5. Reliability
6. Media on demand
7. Mobility
8. Autonomous vehicle control
9. Security

https://www.digi.com/blog/post/lte-vs-5g

The Dark Side of 5G

Ist das 5G-Netz gesundheitsschädlich?

- Mit 5G ändert sich an der Strahlenbelastung zunächst wenig.
- Die für 5G genutzten Mobilfunkfrequenzen sind größtenteils dieselben wie für 4G und wurden vorher bereits für andere Zwecke eingesetzt.



https://www.coit.es/noticias/que-saben-y-que-piensan-los-europeos-sobre-el-5g-0

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Forschungsprojekt – 5G-Mobis

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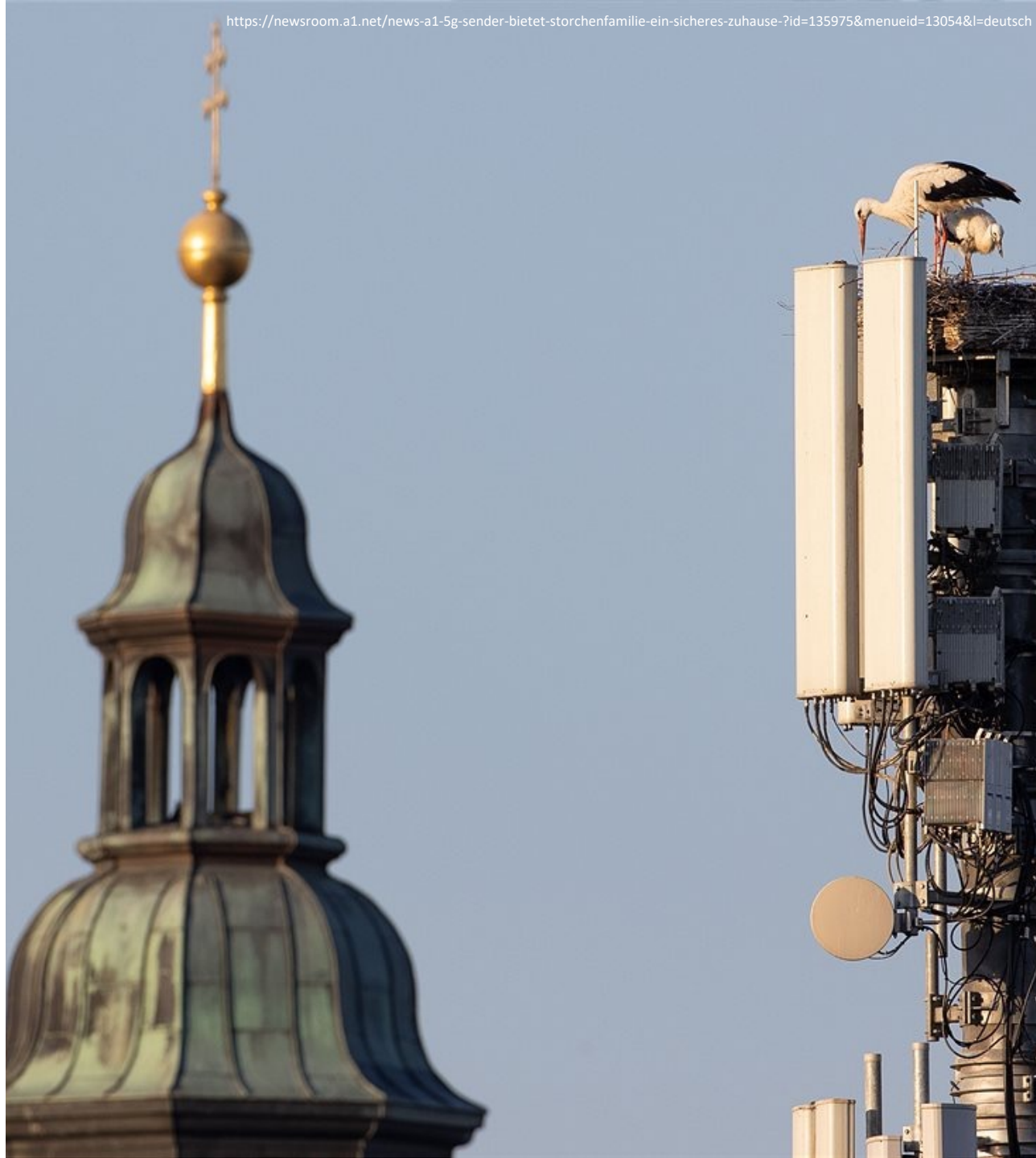
https://www.digi.com/blog/post/lte-vs-5g

Zentrale Forschungsfrage des Forschungsprojektes – 5G-Mobis

„Welche Chancen entstehen durch die Verbesserung der Breitband-Infrastruktur und werden dadurch auch neue Use-Cases für Mobilitätsanalysen realisierbar?“


https://newsroom.a1.net/news-a1-5g-sender-bietet-storchenfamilie-ein-sicheres-zuhause-?id=135975&menueid=13054&l=deutsch

https://www.digi.com/blog/post/lte-vs-5g

RSAFG

Research Studio **iSPACE**

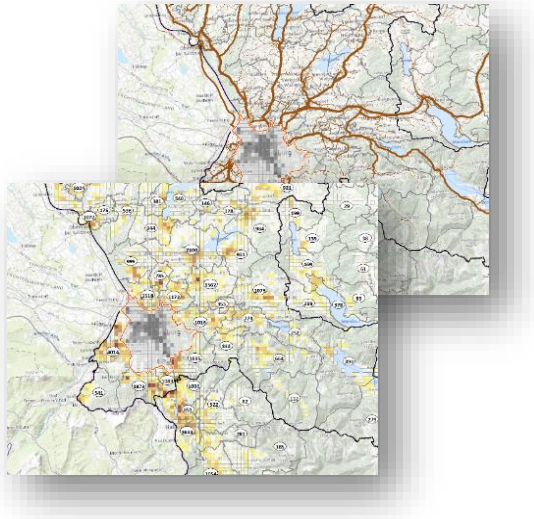
Mehrwert kombinierter 5G-Daten in der Mobilitätsplanung

Florian Schöpflin
florian.schoepflin@researchstudio.at

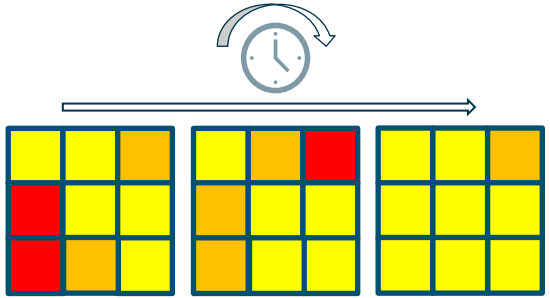
researchstudio.at

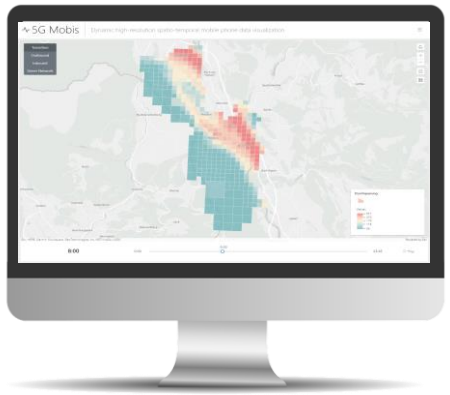
10.04.2024
Salzburg

Technische Neuerungen 5G-Technologie



„statische“ Datengrundlagen





Zeitlich-dynamische Analysemodelle

https://pixabay.com/de/illustrations/monitor-bildschirm-rechner-7437819/

5G MOBiS

LAND SALZBURG

INNOVATION SALZBURG

RSAFG Research Studio iSPACE

ANDATA

INVENIUM DATA INSIGHTS

- Statische Daten/Analysen
- Adaptive Verkehrsregelung und Bewegungsmuster
- Um 5G erweiterbare Lösungen
- GIS-Methoden und Analysen
- Vorarbeiten/Synergien
- Datenanforderungskatalog

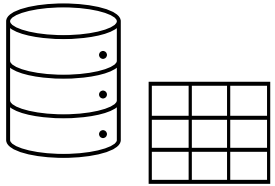
Laufzeit

01.05.2021 – 31.03.2024

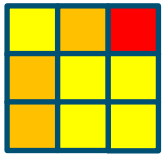
Forschungsfrage

Wie können raum-zeitlich **hochauflösenden Mobilfunkdaten datenschutzkonform** für verschiedene **Raumtypen** und **Uhrzeiten** aufbereitet werden?

Datenbasis

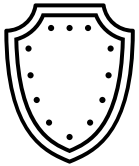


Rasterbasierte Mobilfunkdaten
Trips im Pilotgebiet Hallein
(Durchreise, Quell-Ziel)



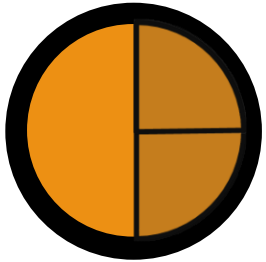
1.000m / 500m / 250m

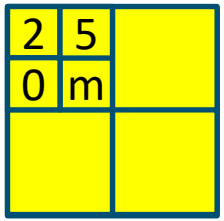
24h / 12h / 6h / 2h / 1h /
30min / 15 min / 2 min / 1 min



Datenschutz: Werte < 20

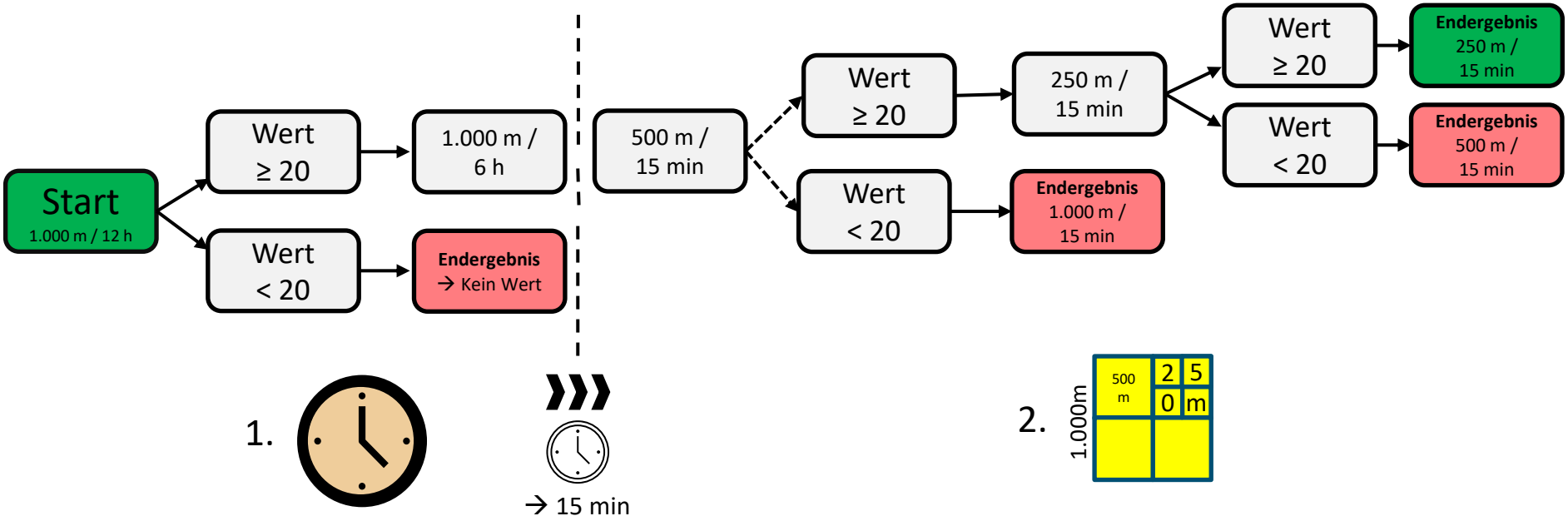
Datenschutzkonforme Aufbereitung der Mobilfunkdaten





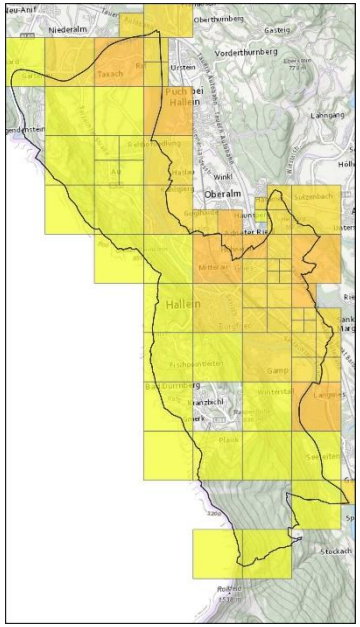
1. Reduktion der **Zeitkomponente** (12h → 6 h → … → **15 min**)
2. Reduktion der **räumlichen Komponente** (1.000m → 500m → **250 Meter)**

Datenschutzkonforme Aufbereitung der Mobilfunkdaten

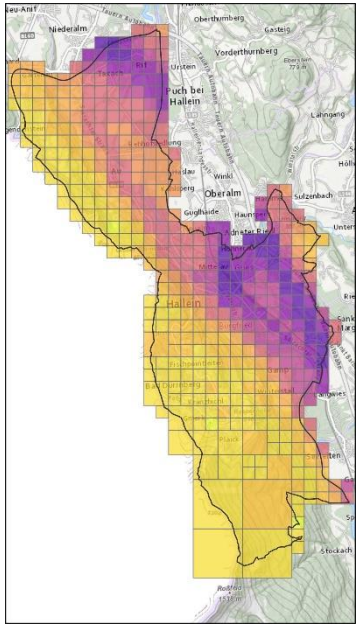


Raum-zeitliche Auflösung

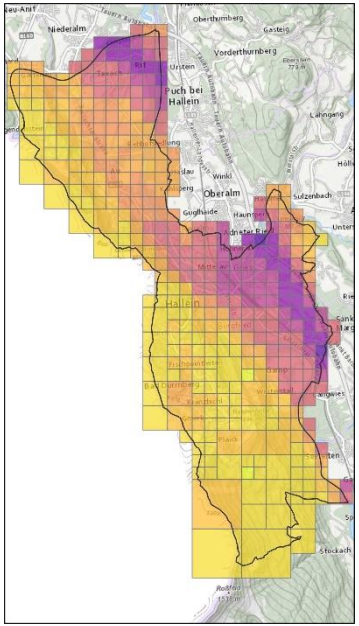
02:00 Uhr



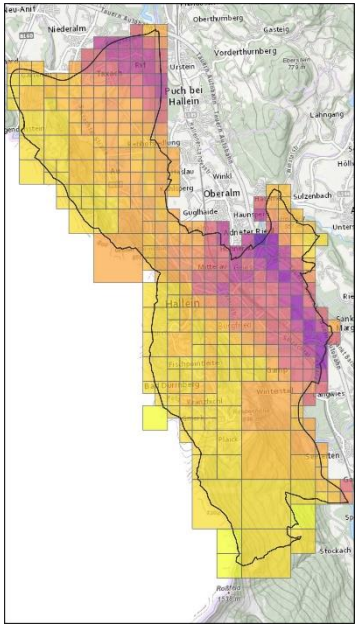
07:15 Uhr



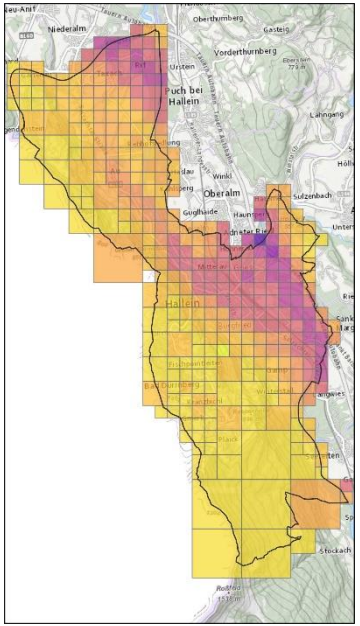
08:15 Uhr



09:15 Uhr



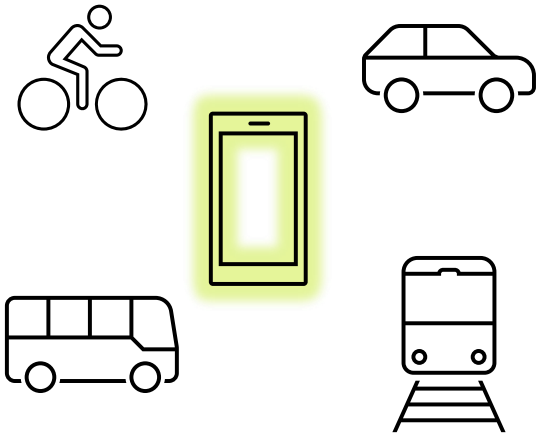
10:45 Uhr



Forschungsfrage

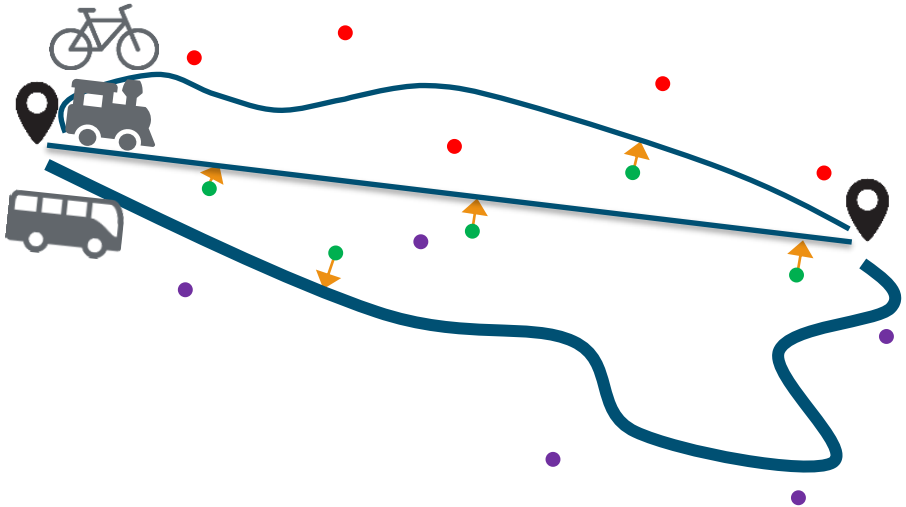
Kann der **Modi** von raum-zeitlich hochauflösenden **Mobilfunkdaten abgeleitet** werden?

Datenbasis

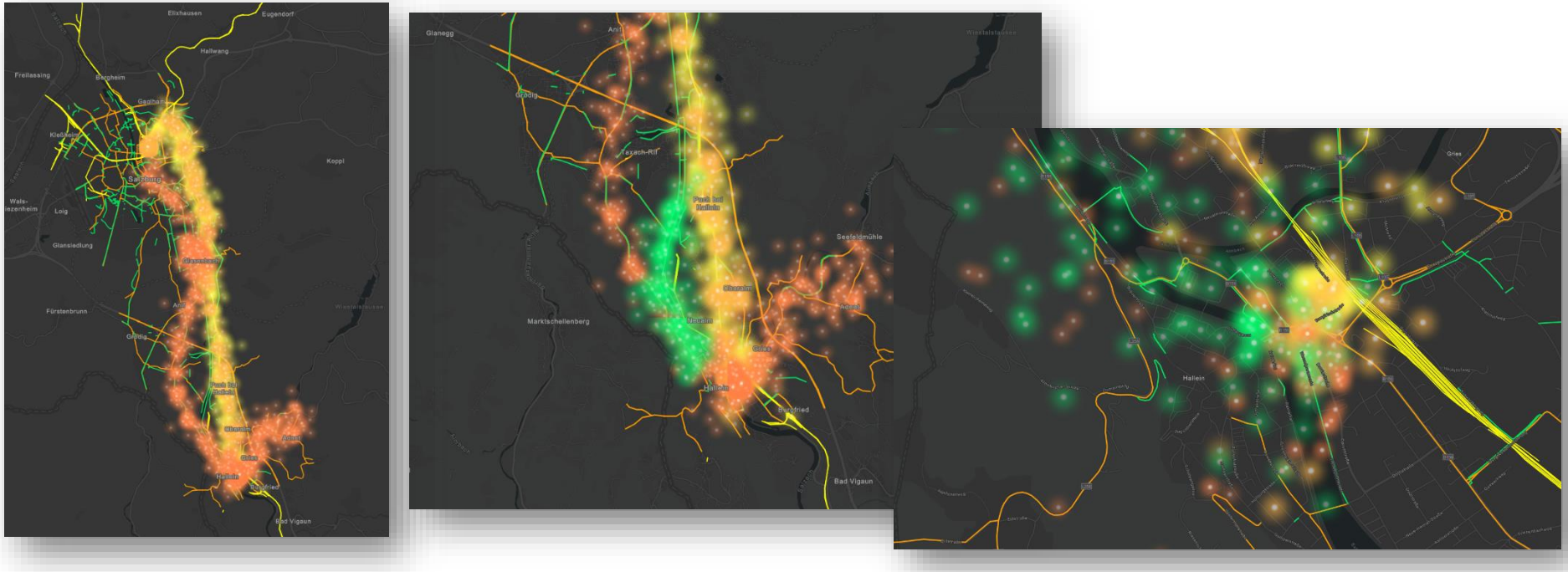


Erhobene Testdaten

Automatisierte Zuweisung von Mobilfunkdaten zu Verkehrsmitteln



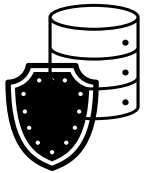
Automatisierte Zuweisung verwendeter Modi zu Mobilfunktrajektorien



Conclusio

Potenzial für nachfrageorientierte Mobilitätsplanung (in Kombination mit anderen Daten)

Optimierung bestehender GIS-Methoden möglich



Datenschutz als limitierender Faktor

RSAFG

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Mehrwert kombinierter 5G-Daten in der Mobilitätsplanung

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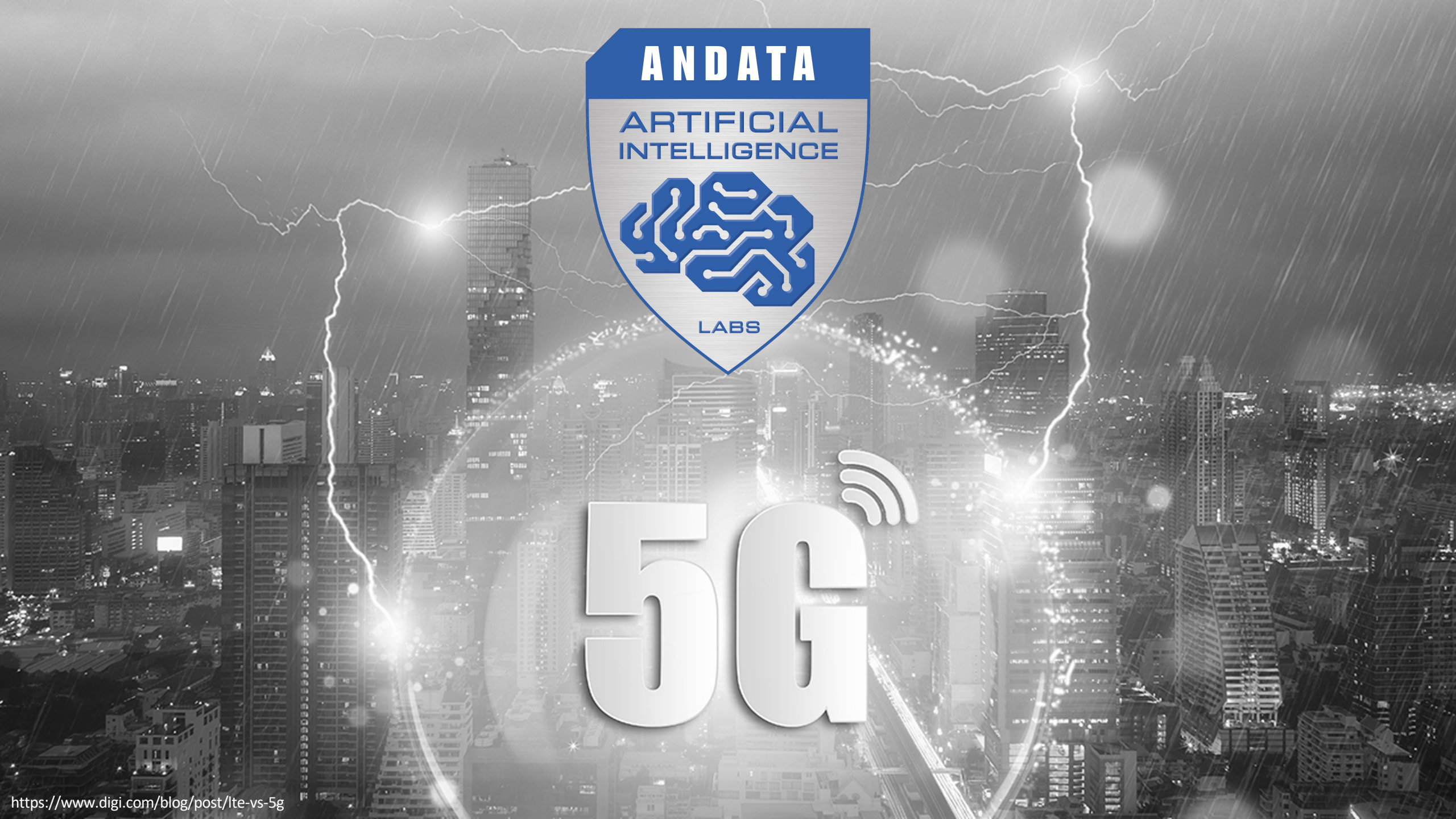


https://www.digi.com/blog/post/lte-vs-5g

Evaluation of 5G-based positioning for intelligent intersection control

Dr. José Carmona

ANDATA

2024-04-10

Fields of Competence

- Artificial Intelligence
- Data Mining
- Big Data Analytics
- Modeling and simulation
- Predictive Model based Control
- Distributed Control
- Signal Classification
- Swarm Intelligence
- (Embedded) Software
- Decision Support Systems
- Robustness and Complexity Management

ANDATA ARTIFICIAL INTELLIGENCE LABS

MathWorks Partner

since 2004

Big Data Analytics & AI & Simulation

Data driven development process

Failure Prediction

Anomalies and Incident Detection

Industry 4.0, Digitalization

(Mobile) Robotics *Automated Guided Vehicle*

Traffic Control and Automation

ADAS and vehicle automation

Automotive safety

Contact: A-5400 Hallein, Hallburgstraße 5, +43 6245 74063, office@andata.at, www.andata.at
A-1040 Vienna, Große Neugasse 16

Project Goals 5G MOBIS

- Can **5G** be used for **more precise identification of the traffic situation** wrt time and space?
  - only from perspective of the provider and without usage of dedicated apps
  - following traces of mobile phones locally and anonymously
- What are the required data and processing steps to retrieve the relevant information

for **„intelligent traffic control“?**

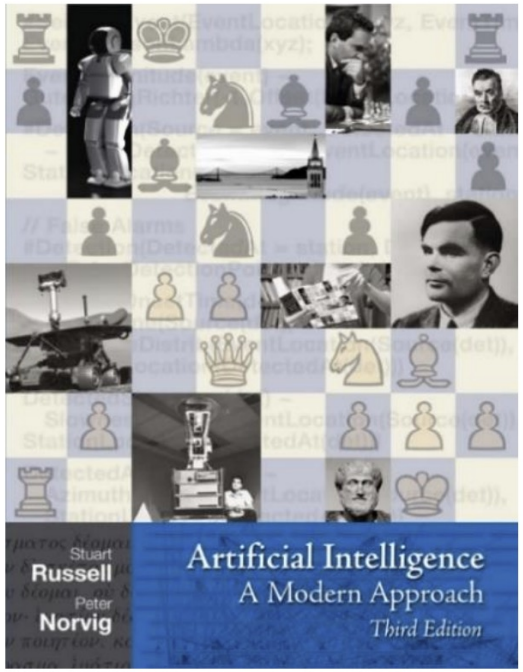
➢ Enabling precise Floating Car/Pedestrian/Bike Data (FCD) without the big players like Google, HERE, etc.

„Intelligent (AI-based) Traffic Control“: What is „intelligence“?

Criteria for Intelligence (according *Russel, Norvig: Artificial Intelligence, A Modern Approach, Chapter 2)*

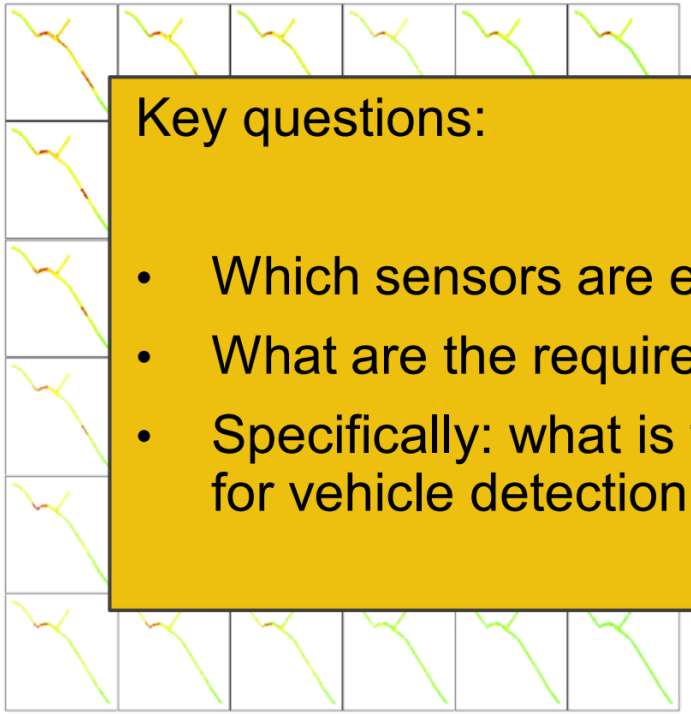
- Detection and interpretation of the situation → 5G-MOBIS
- Judgement and pondering upon different action alternatives
- Adaption to changing environments and new situations
- Goal-oriented procedures

➢ „Intelligent Systems“:
ALL those criteria are in place in common



Situation Detection and Interpretation

- The available set of sensors captures the traffic situation for further detection and interpretation



Key questions:

- Which sensors are enough to obtain a given control quality?
- What are the requirements to the sensors?
- Specifically: what is the necessary QoS when if we use 5G for vehicle detection and location?

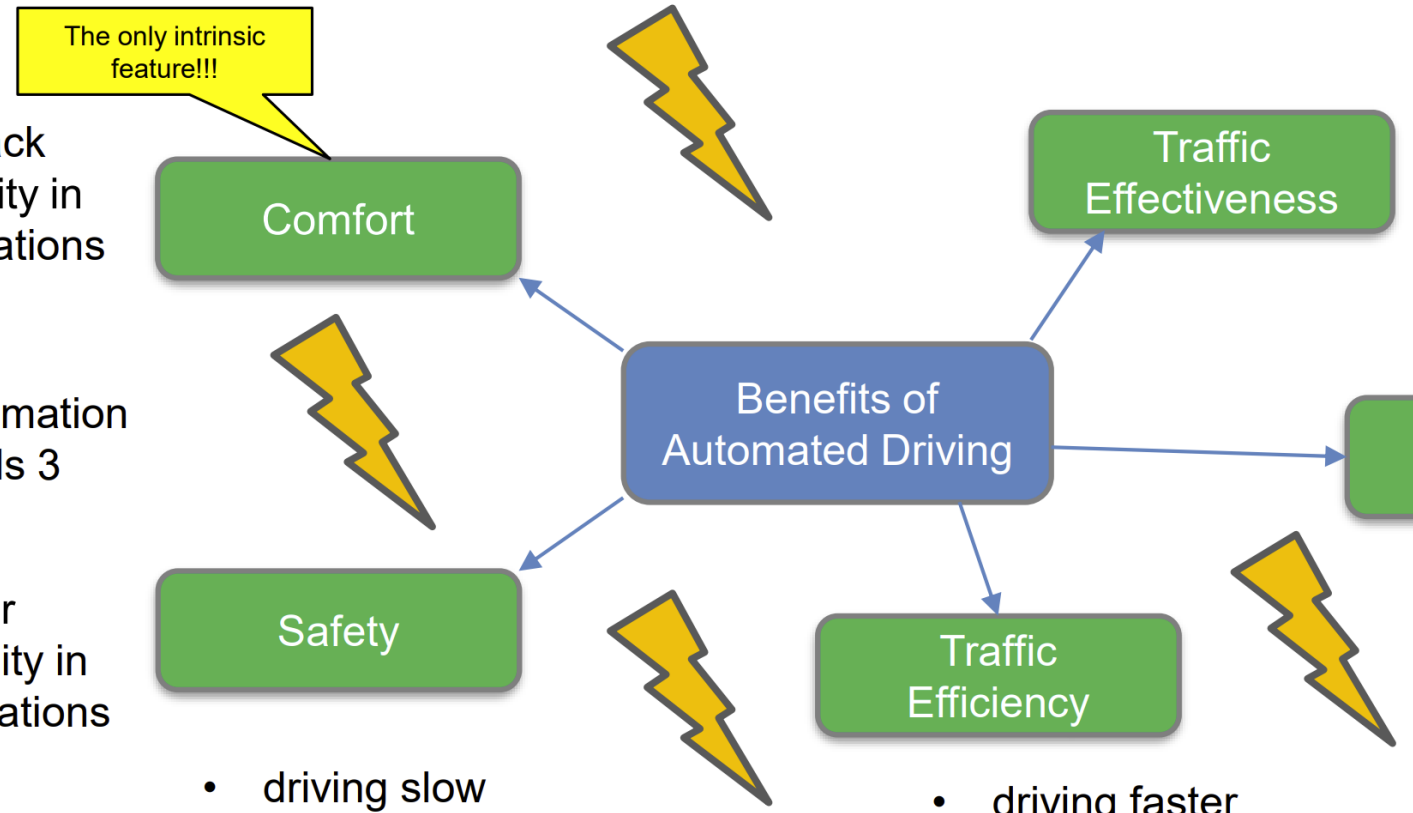
VERONET

TRAFFIC PREDICTION

INCIDENT DETECTION

➢ Poor or insufficient sensorics hinder a good situation interpretation and therefore results in a worse performance

Expected Benefits from Cooperative, Connected, Automated Mobility



- Passing back responsibility in critical situations
  - e.g. automation levels 3
- Taking over responsibility in critical situations

- changing traffic modes
- choosing the right traffic mode according the given situation

- less responsive
- driving slow
- high density for wind shadow

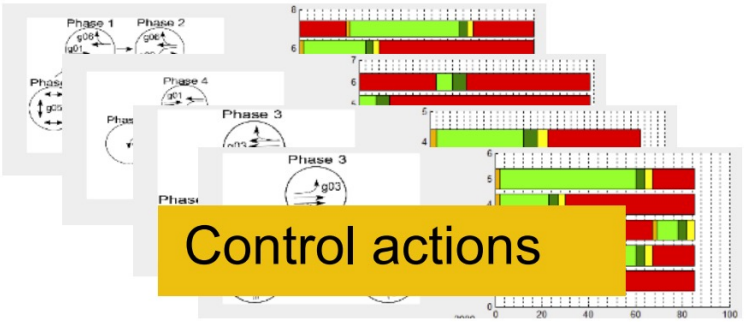
- driving slow
- with low density

- driving faster
- with high density
- more responsive

Accumulation of conflicting interests!

➢ Finding the Pareto front is crucial for balancing the interests.

Scenario Management (as a Service) smaas.andata.at



1. Scenario Definition including Car2X
   - “Galsterer” intersection in Hallein and
   - Alpenstraße/B159 in Anif
   - numerous general intersections
2. Simulation based optimization and development of according actions
3. Sensor set specification, effectivity rating
4. Control development and execution

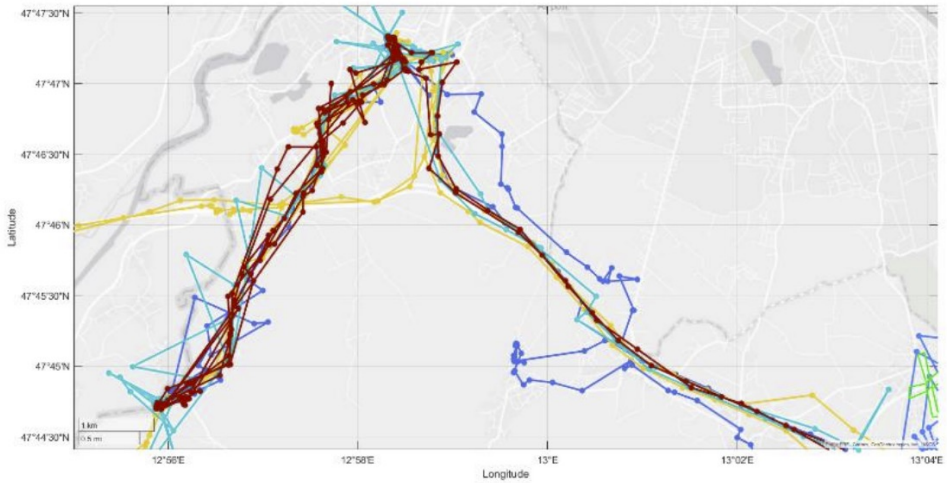
VERONET

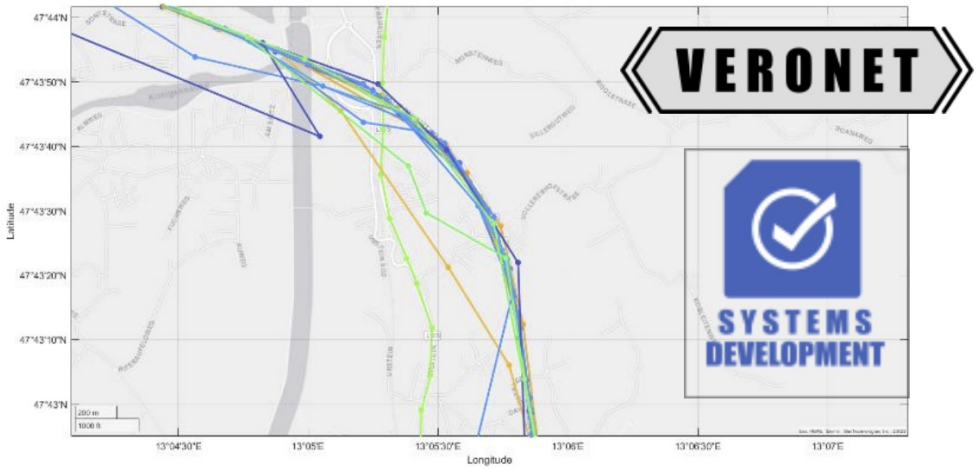
NODE CONTROL

SCENARIO MANAGEMENT

Modelling 5G as a sensor

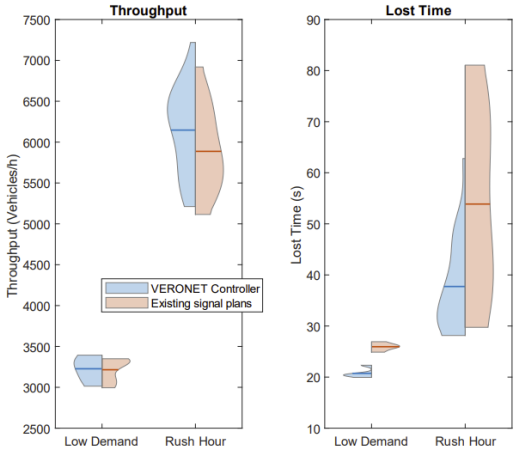
- Parametrizable models of 5G-based locations were developed. Relevant parameters:
  - Penetration (proportion of traffic participants with a 5G device)
  - Temporal resolution (how often is the location for each participant updated)
  - Spatial deviation (how accurate are the obtained locations)
- 16 different quality-of-service levels of 5G-based positioning were considered (4 deviation levels * 4 sampling levels)
- Validation with the help of real 5G data collected using several devices as ground truth

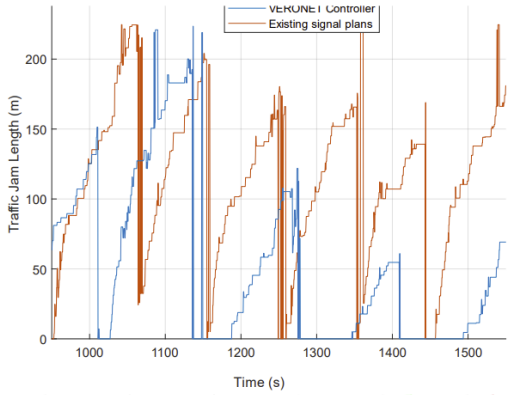


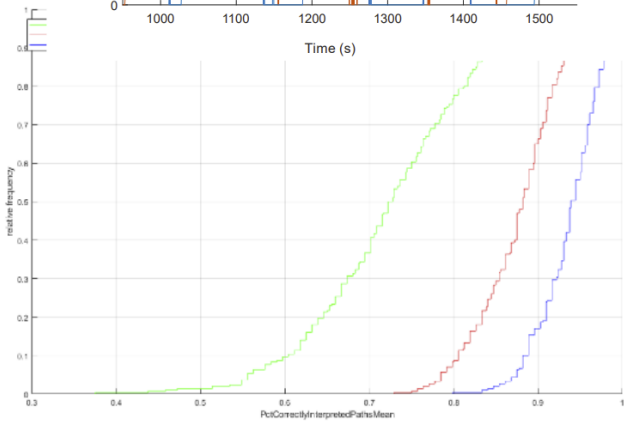


Performance Assessment

- The presented assessment framework makes it possible to quantify the performance resulting from different 5G quality-of-service levels
- As a consequence, it is possible to formulate requirements to the sensors in order to achieve a given performance
- The effect of the different parameters (penetration, resolution, deviation) on the KPIs can be measured
- Currently 5G alone is *not yet* adequate to successfully detect the traffic situation
  - Main reason: Deviation too large (streets / routes cannot be differentiated)
- It can nevertheless be helpful to support other systems (e.g. GPS, specially in regions with poor satellite reception







Summary and Conclusion

- 5G-based positioning for intelligent traffic control: research questions
  - How good do different Quality-of-Service configurations perform for traffic control?
  - What are the requirements regarding penetration, resolution and positioning accuracy?
- Framework to answer this questions based on Scenario Manament (as a Service)
  - Simulation of traffic situations and control actions
  - Sensor modelling
- 5G alone is not yet accurate enough to identify traffic situations, but it can support other sensors to improve the accuracy of traffic situation identification

Thanks, for listening!

The singularity is near, let‘s be prepared!

ANDATA GmbH

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Email: office@andata.at

Web: www.andata.at

www.veronet.eu

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DATA INSIGHTS

Forschungsprojekt – 5G-Libra

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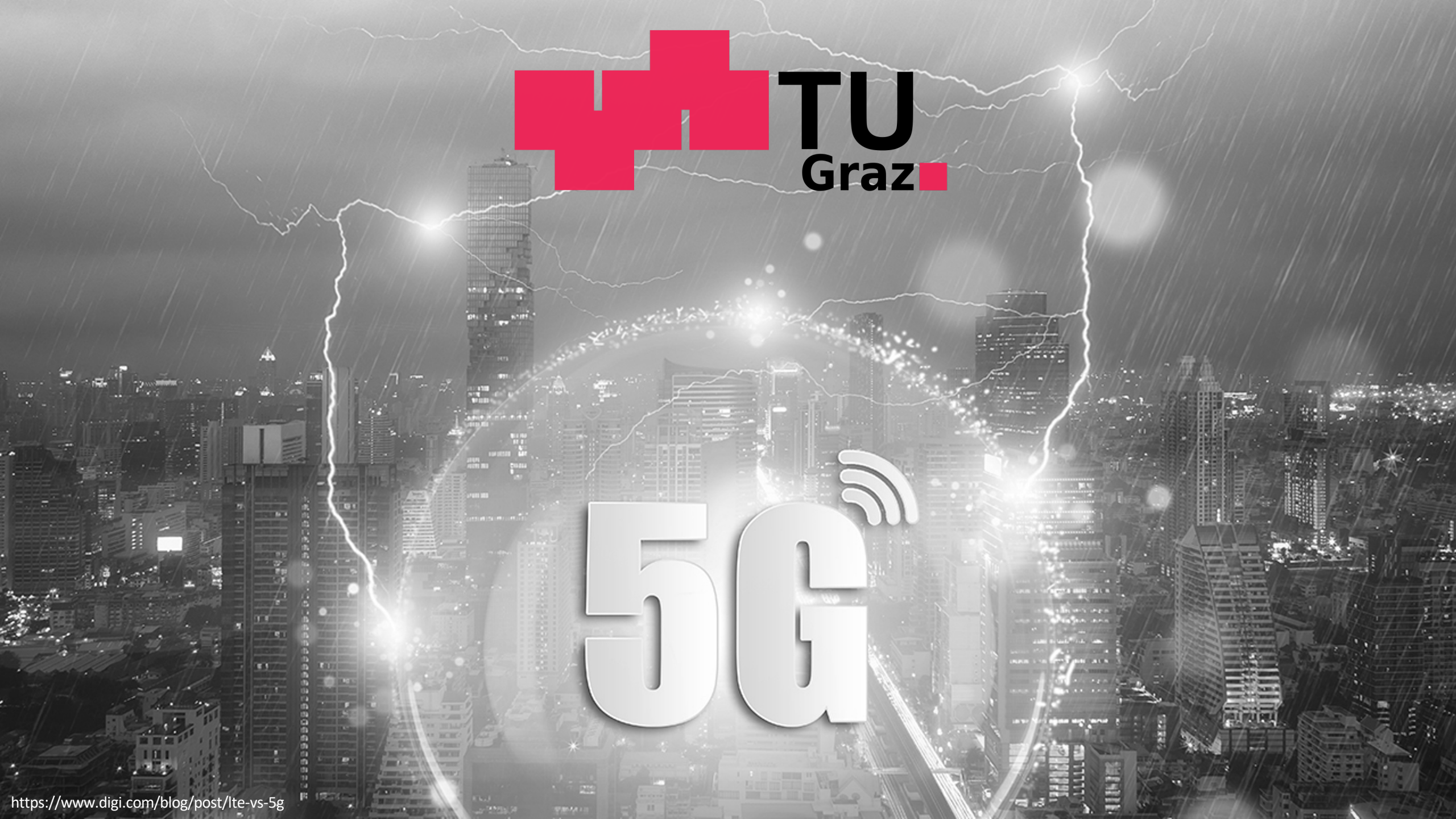
https://www.digi.com/blog/post/lte-vs-5g

Zentrale Forschungsfrage des Forschungsprojektes– 5G-Libra

„Welche Potentiale birgt die Aufwertung des Mobilfunknetzes, von 4G auf 5G, und welche neuen Anwendungsfälle lassen sich dadurch entwickeln?“

Bild: https://newsroom.a1.net/news-a1-setzt-meilenstein-fuer-die-5-mobilfunkgeneration?id=67833&menueid=13051&l=deutsch

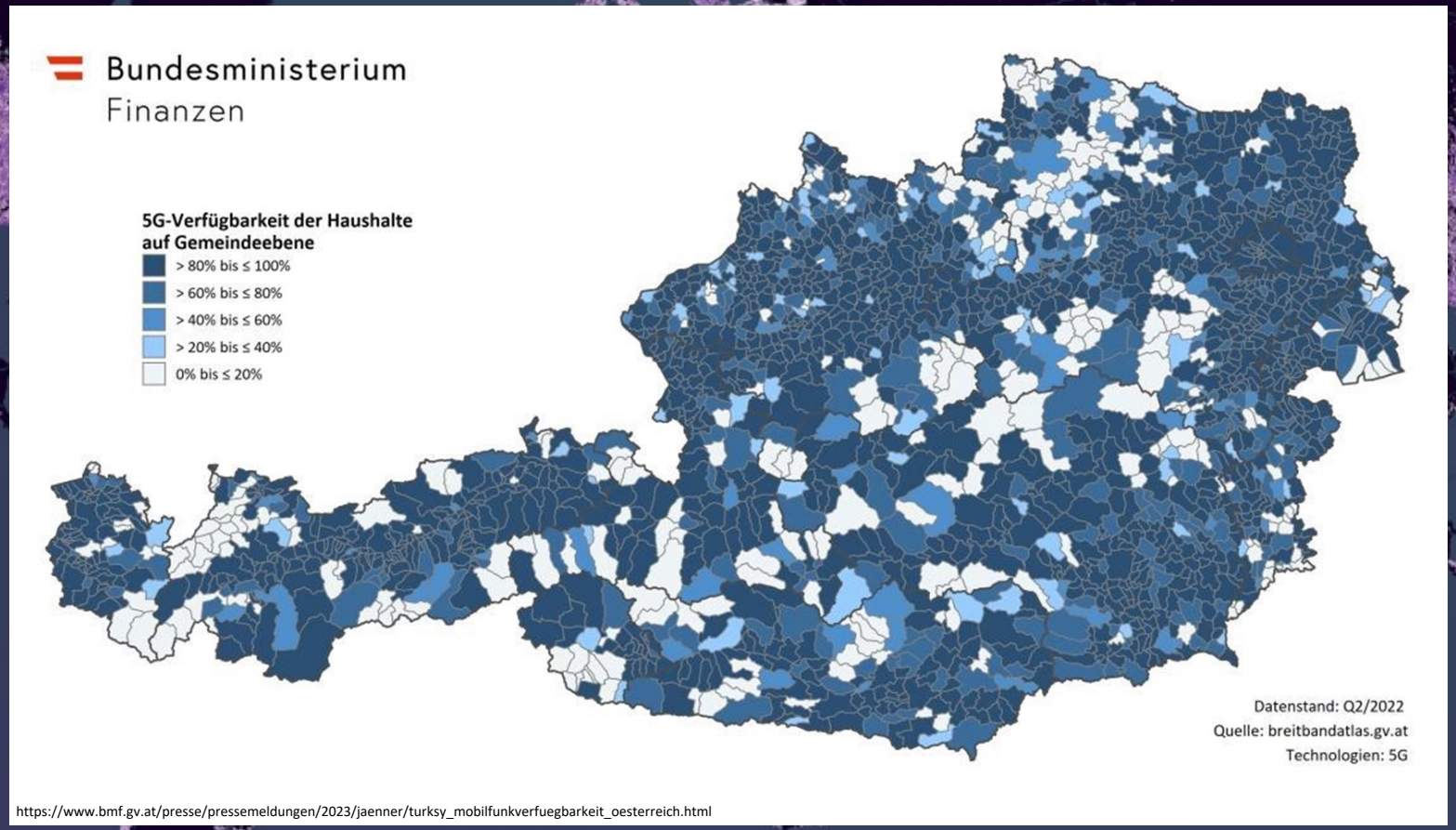


https://www.digi.com/blog/post/lte-vs-5g

Allgemeines 4G vs. 5G

5G Verfügbarkeit in Österreich - Unterschiede:

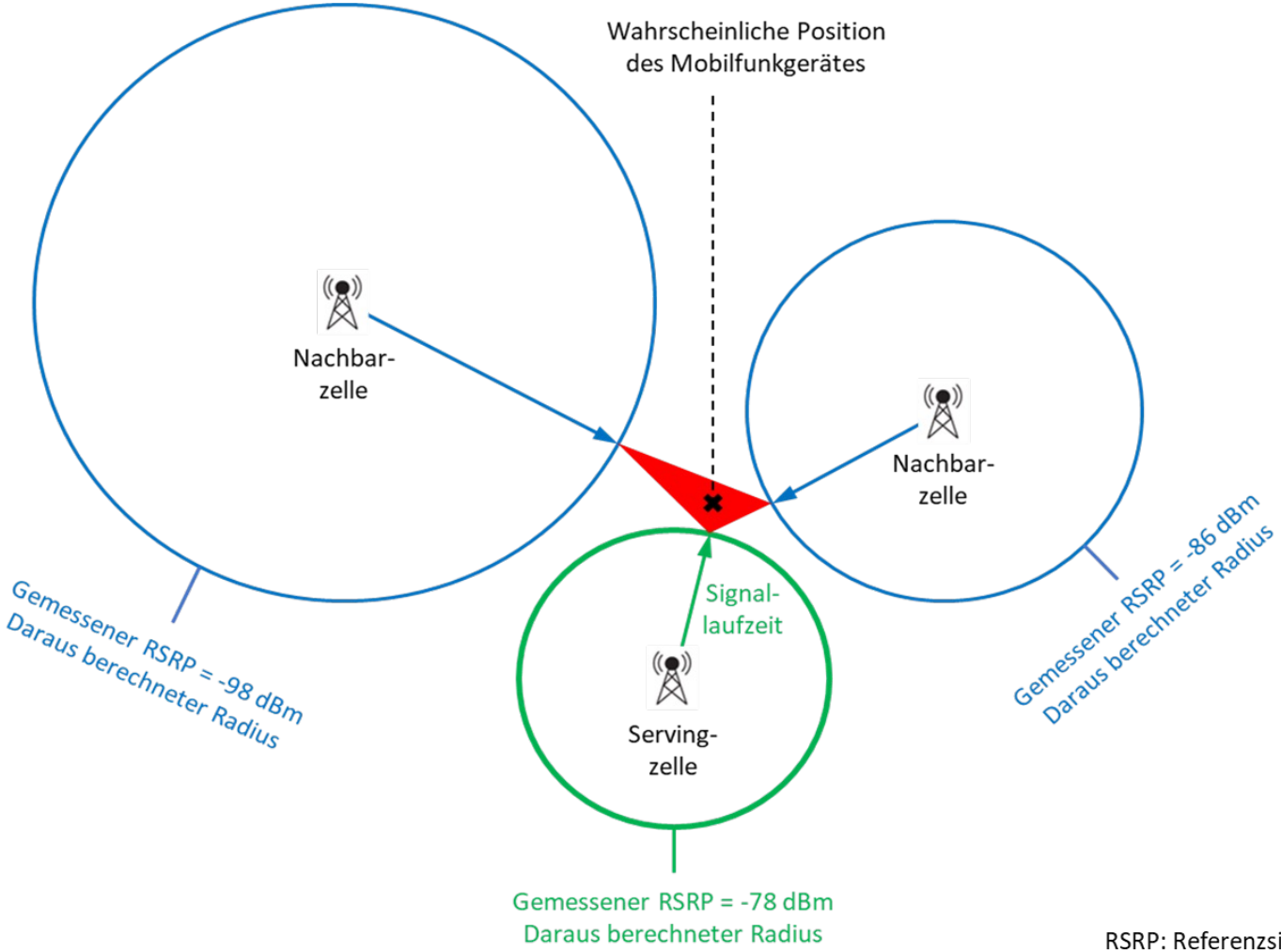
- **Backend** des 5G-Mobilfunknetzes
- 5G **„beim Kunden“**
- **Mobilfunkmonitoringsystem** – Basis für Mobilitätsanwendungen



https://www.bmf.gv.at/presse/pressemeldungen/2023/jaenner/turksy_mobilfunkverfuegbarkeit_oesterreich.html

https://www.ookla.com/articles/5g-global-reach-2024

Mobilfunkmonitoringsystem 4G



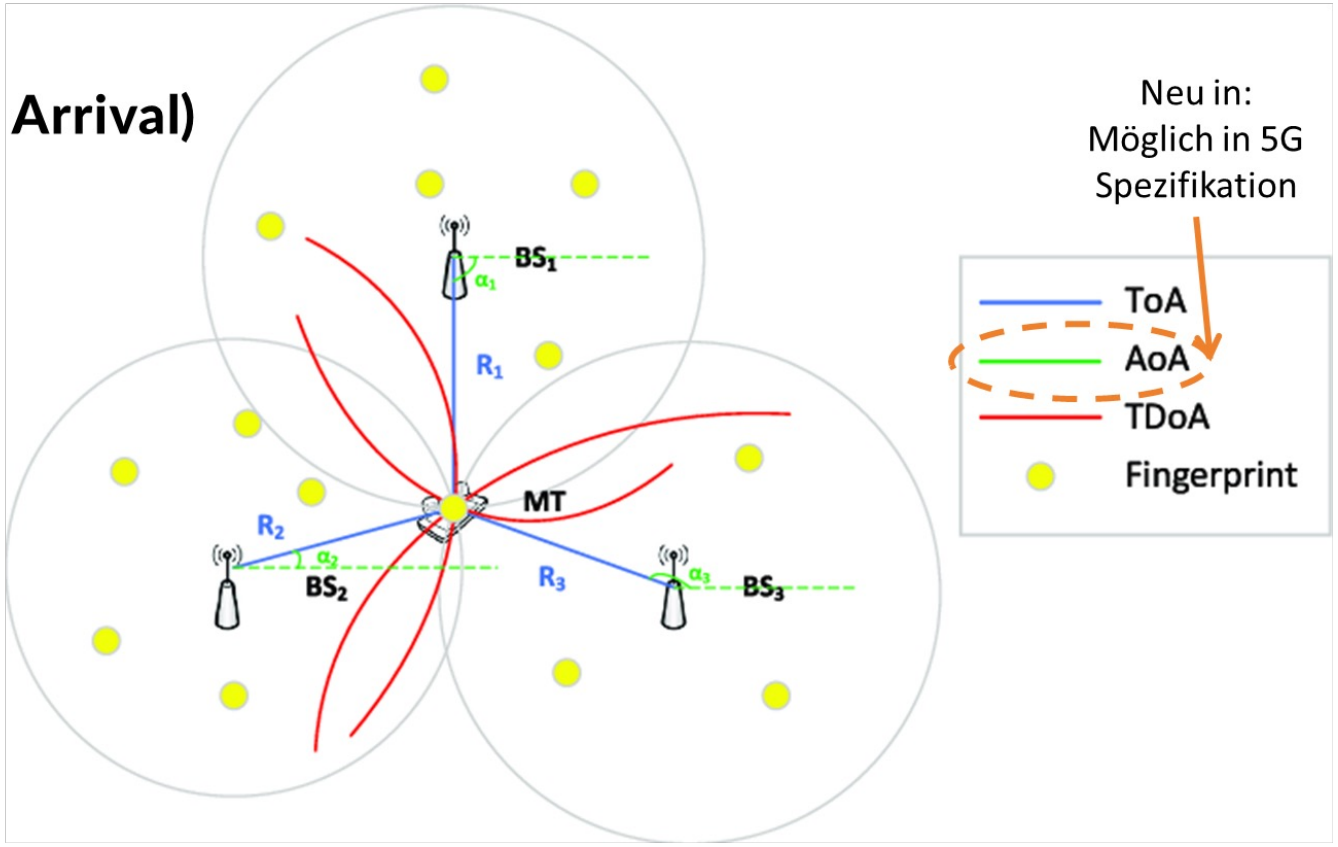
RSRP: Referenzsignal der Empfangsfeldstärke am Endgerät

Mobilfunkmonitoringsystem 5G

ToA (Time of Arrival)

TDoA (Time Difference of Arrival)

AoA (Angle of Arrival)



Anhaltspunkte für Positionierungsgenauigkeit:
https://ieeexplore.ieee.org/document/7177280

Aufbau eines 5G-Synthesizer (MNO-Synthesizer)

- Parametrisierung der 5G-Netzeinflussparameter
- Eingangsgrundlage Trajektorie aus FCD, GPS oder Verkehrsmodell
- Entwicklung eines Modells zu Generierung von 5G-synthetisierten Personenverkehrsströmen:
  - Zeitkriterium
    - Auf Basis der gewählten Samplingrate wird nach Zufallsprinzip eine Maximalzeit bis zum vorherig gewählten Datenpunkt definiert.
  - Distanzkriterium
    - Eine Maximaldistanz zwischen 700 und 1000 Meter bis zum vorherig gewählten Datenpunkt wird nach Zufallsprinzip gewählt.

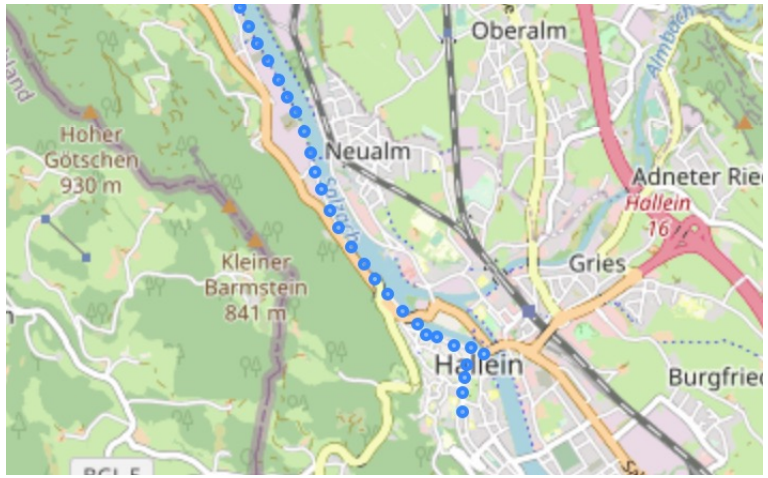
MNO-Synthesizer

Input:

GPS-Trajektorien der Beobachtungsobjekte samt Koordinate und Zeitstmpel

{Obs(x,y | time), Obs(x,y | time),

…., Obs(x,y | time)}

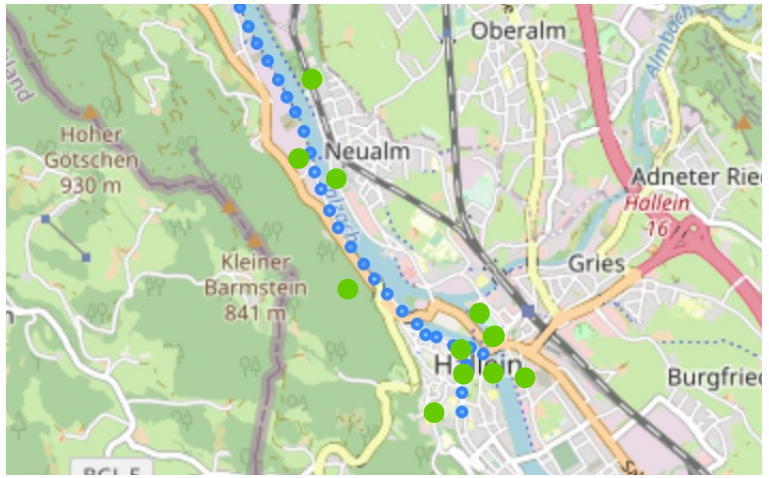


Output:

Pseudo-Cellular-Trajektorie der GPS-Trajektorie samt generierte Koordinate und Zeitstempel

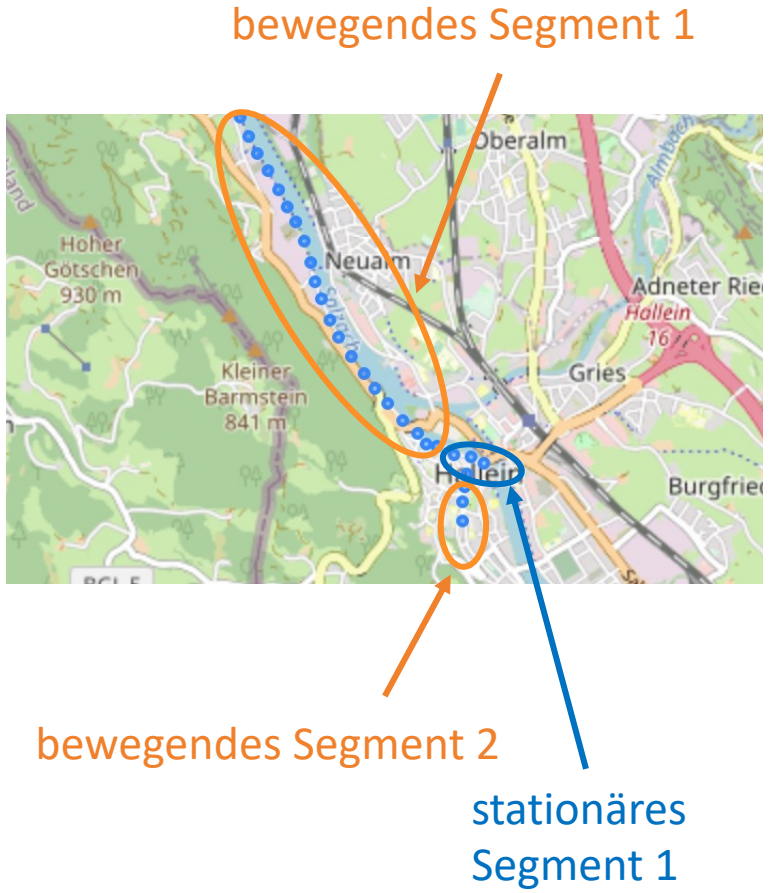
{Obs(x,y | time), Obs(x,y | time),

…., Obs(x,y | time)}



Projektziel 5G-Libra: Analyse 4G vs. 5G

- Vergleich der realen 4G-Trajektorie vs. 5G-synthetische Trajektorie
- Grundlegende Verarbeitung: Segmentierung in “bewegend” und “stationär”
- Verbesserung des Wahrscheinlichkeitsmodell: Wegezweck- und Verkehrsmittelerkennung
- Alle Schritte unter Berücksichtigung des Datenschutzes



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Wrap-Up und Q&A

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