

TRedess

5G BROADCAST POCKET SIREN PROJECT

INFRASTRUCTURE DEVELOPMENT

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2 Pocket Siren Network Infrastructure
Current network implmentation, Nakolos core, TRedess transmitters

3 Possible next steps / phases on this project
New 3GPP release 19 features, extension of the network, etc

4 Conclusions

BRIEF INTRODUCTION TO TREDESS

1

1) TRedess > Company overview

TRedess is a Spanish company **specialized in air cooled TV, DAB+ and 5G Broadcast Transmitters and Gap Fillers**, counting with

- **more than 30.000 TV transmitting devices** operating worldwide in **70 countries**
- **more than 1.000 DAB+ transmitting devices** operating worldwide in more than **25 countries**
- Long term collaboration with Levira in
  - **DVB-T/T2 network**
  - **DAB+ network**
  - **Synchronization solutions for SFNs**



- TRedess was also selected as **Levira´s partner for the implementation of the Pocket siren 5G BC network**.

1) TRedess > Company overview

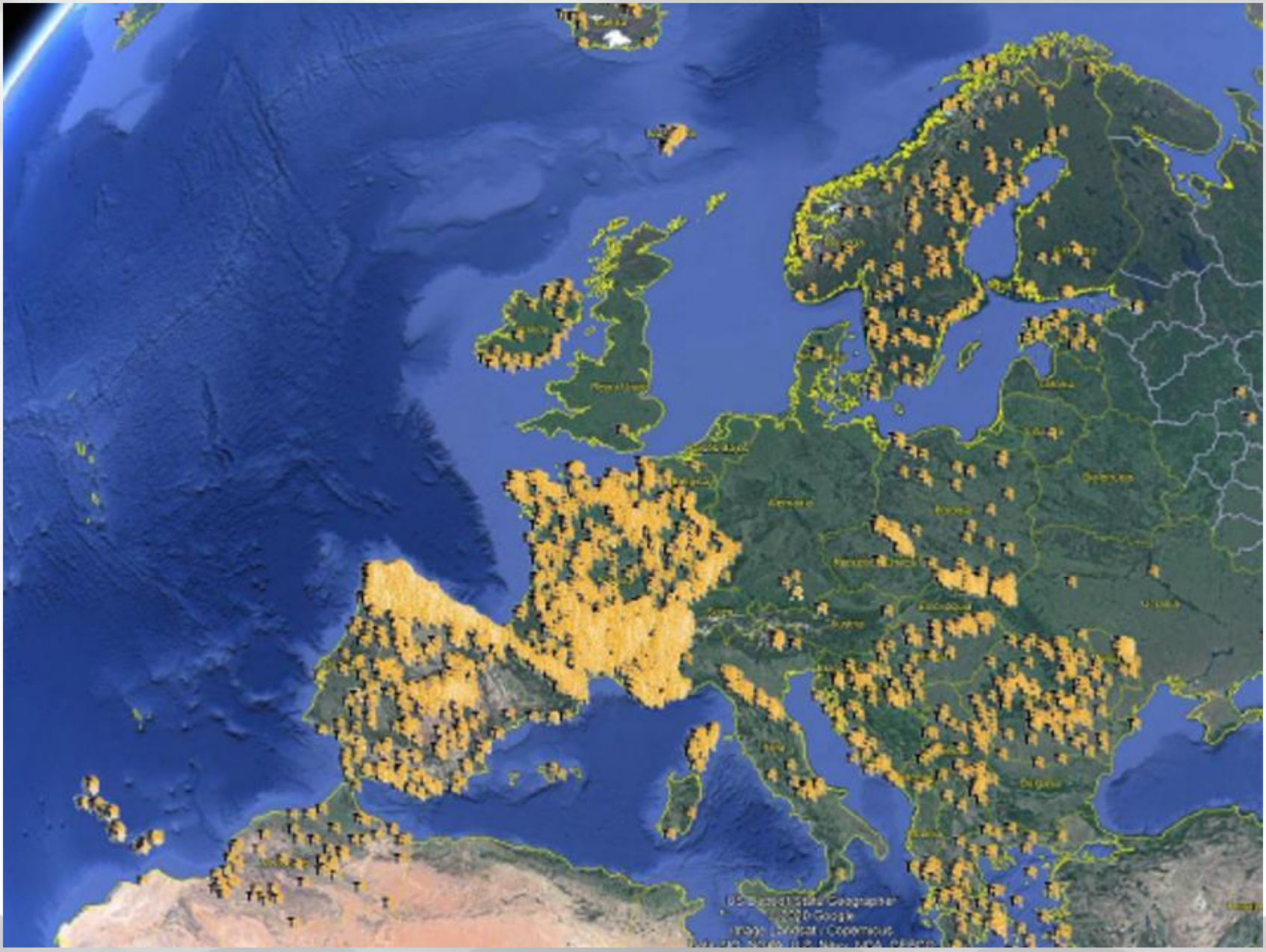
TV / DAB+/ 5G Broadcast solutions from very low powers up to 6KW.



1) TRedess > Company overview



1) TRedess > Company overview















Tallin Tower (Estonia):

TX TRedess 5G Broadcast de 3KW & TX DAB+ 600W

Levira’s Pocket Siren 5G Broadcast Project

4. 5G PROJECT WITH TERACOM IN SWEDEN

We have been also selected by **Teracom in Sweden** for implementing a 5G Broadcast network with 3 sites of 2500W, 100W and 50W (January 2026).

TERACOM

5. 5G PROJECT WITH CELLNEX NETHERLANDS

We have been also selected by **Cellnex Netherlands** for implementing a 5G Broadcast network with 3 sites of 1200W, 1200W and 400W (January 2026).

broadcast partners
a company of cellnex

7. TRIAL PROJECT WITH OIV IN CROATIA

We have been also selected by **OiV in Croatia** for implementing a trial of 5G Broadcast technology in the country (March 2025).

OIV Digitalni signali i mreže

8. 5G TRIAL PROJECT WITH TELECENTRAS IN LITHUANIA

We have been also selected by **Telecentras in Lithuania** for implementing a trial of 5G Broadcast technology in the country.

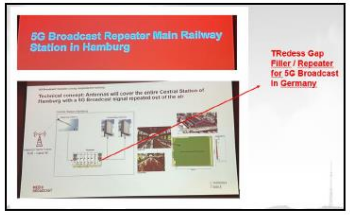
The trial started in October 2025, and tests were conducted on highways to evaluate system performance. The results exceeded expectations and initial link budget calculations, particularly in terms of coverage, which was quite impressive considering the terrain and urban landscape of the test locations.

TELECENTRAS

5G Broadcast

9. 5G PROJECT IN GERMANY – 5G BROADCAST GAP FILLER IN TRAIN STATION

Also, a **TRedess 5G Broadcast Gap Filler** has been also implemented in the Train / metro station in **Hamburg**.



2. 5G PROJECTS IN THE US

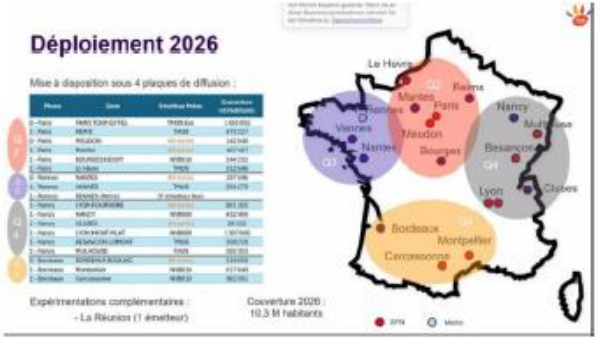
Some TRedess 5G Broadcast transmitters are **in operation in the US**, with a case for example in the Gillette Stadium in Massachusetts (see photos attached).



6. 5G PROJECT IN FRANCE

We have been also selected by **TDF** for implementing a 5G Broadcast network in France. Plan for 2026 is to build around 20 sites around the country.

tdf



3. 5G PROJECT IN THE US WITH CASTANET

In collaboration with CASTANET, TRedess has deployed in the US several transmitting stations (Santa Cruz, Las Vegas) where **both standards (ATSC 3.0 and 5G Broadcast) coexist using Time Division Multiplexing** (TDM).

This approach leverages the "min_time_to_next" field within the ATSC 3.0 bootstrap, **enabling both services (ATSC 3.0 & 5G Broadcast) to be transmitted from a single transmitter**, optimizing spectrum and accelerating next-gen deployments.

https://www.lightreading.com/5g/castanet-tees-up-5g-broadcast-market-trials

CASTANET



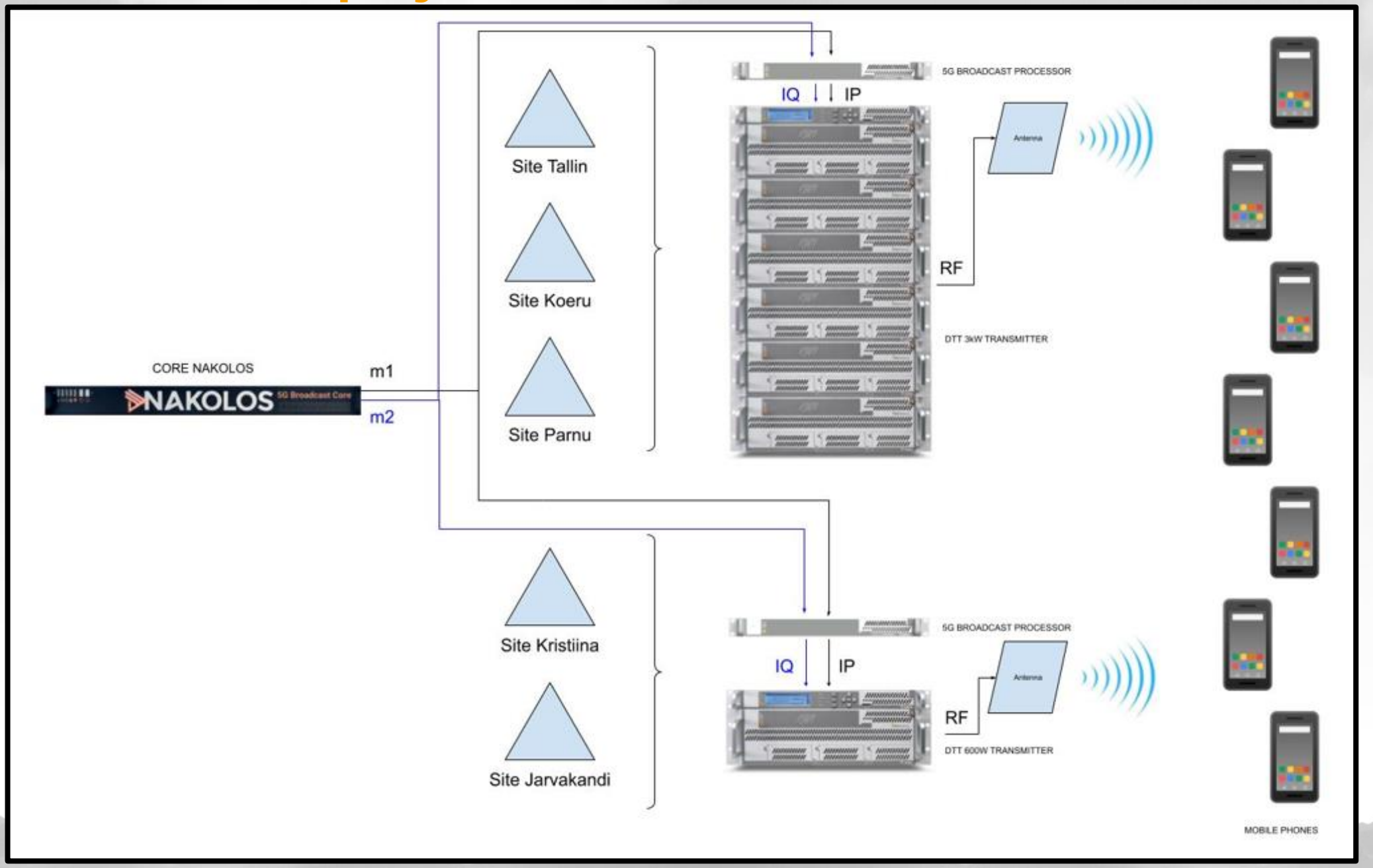
Las Vegas – 3KW – TRedess ATSC 3.0 & 5G Broadcast transmitter

POCKET SIREN NETWORK INFRASTRUCTURE

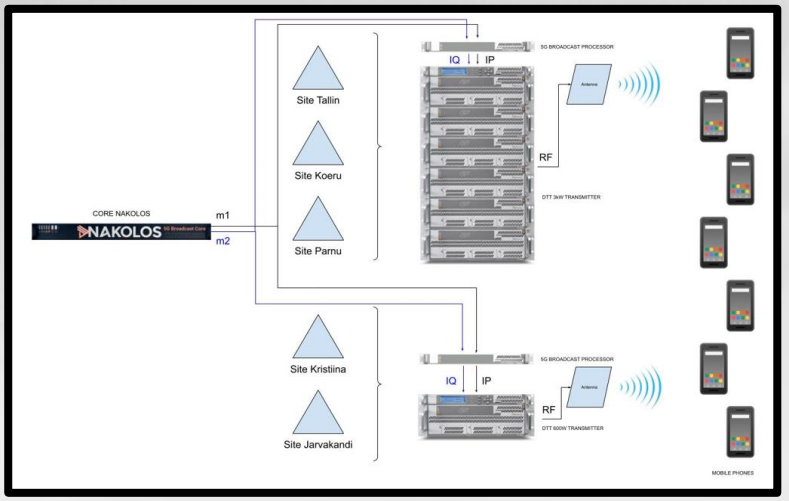
2

Current network implementation: Nakolos core & TRedess 5G Broadcast transmitters

Pocket Siren project – Network infrastructure

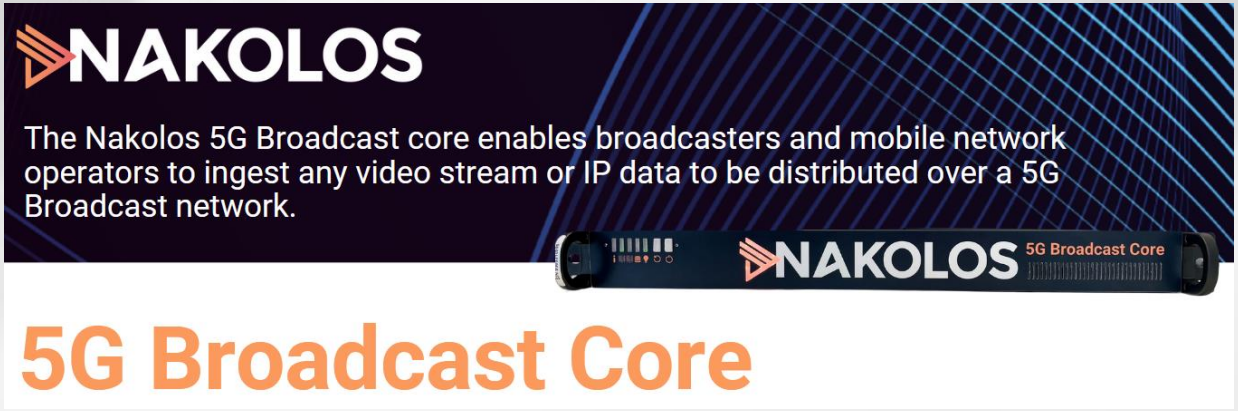


End to End flow



- The NAKOLOS Core receives two inputs:
  - Live TV & radio streams with video, audio and data.
  - EE-Alarm (Alerts in CAP)
- The National warning system sends an EE-Alarm in a CAP message with area polygon, category and languages.
- The EE-Alert is received by the Nakolos Core in CAP (the international standard format for exchanging warnings between systems).
- The Nakolos Core packages and schedules the content for broadcast. For alerts, translates CAP into CMAS, the alert format phones understand natively, and sets the alert level.
- Everything goes to the TRedess transmitters over standard 3GPP interfaces (M1/M2).
- The transmitters modulate the signal and broadcast it as RF from Levira's high towers.
- Any 5G Broadcast-capable phone in range receives it, with no SIM or mobile network needed. Alerts appear with sound and vibration, and TV / Audio content is played in the App

PART 1: NAKOLOS CORE



5G Broadcast Core

BIG BLUE MARBLE
5G BROADCAST PORTFOLIO

End-to-end 5G Broadcast solutions from Big Blue Marble — from the 3GPP core to the app on the phone.

8+
countries in Europe running Nakolos

Rel. 19
world's first end-to-end implementation

USE CASES OF THE NAKOLOS PLATFORM

01 5G Broadcast standalone

02 Seamless switching

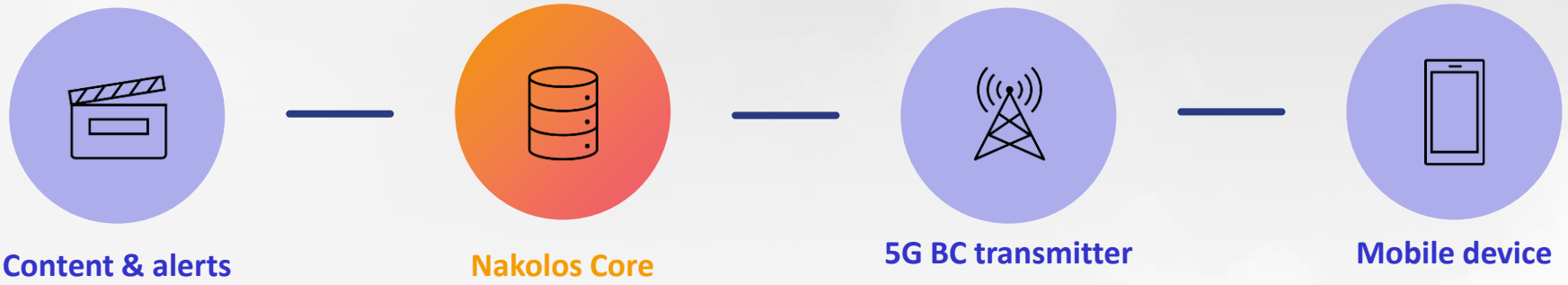
03 Broadcast on demand

04 Low latency for live events

05 Emergency warning

NAKOLOS

Nakolos 5G Broadcast Core



3GPP-native

FeMBMS / 5G Terrestrial Broadcast, Rel. 14–19, plus mixed-mode eMBMS

Ingest & orchestration

Real-time ingest, smart scheduling, analytics, broadcast on demand

Interoperable

Standard xMB, M1, M2, M3 and CAP interfaces incl. emergency alerts

Flexible deployment

Cloud-native or on-premise, high availability and redundancy

TRedess

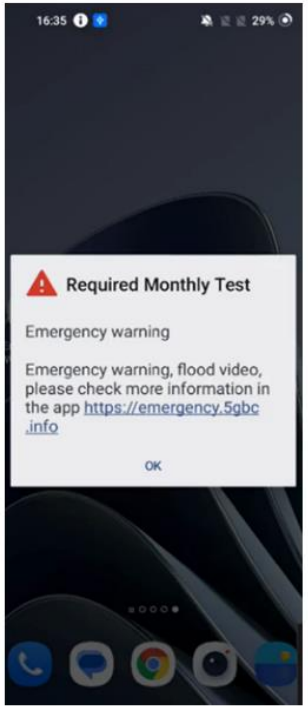
5G Broadcast for mobiles

For the Pocket Siren project, **Nakolos delivered also the test app used to receive the 5G Broadcast streams on the phone**

Additionally, Nakolos provides **a developer-friendly SDK** that brings 5G Broadcast into commercial Android apps with very little code

The **SDK also supports seamless switching between 5G Broadcast, 4G/5G mobile and Wi-Fi** so playback continues wherever you are

Nakolos has also added **new use case functionality**: A cell broadcast alert with a link opens the emergency app, which then shows live text, images and video delivered

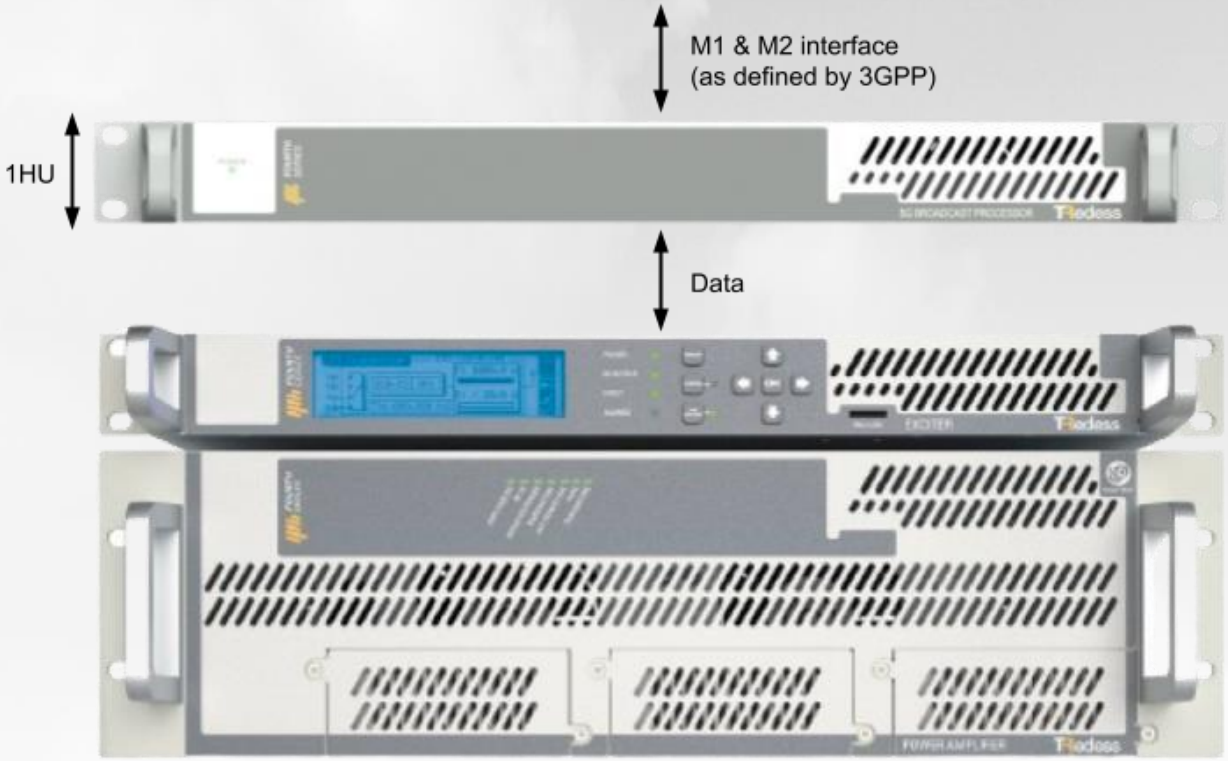




Cell Broadcast alert → emergency app with live video

PART 2: TREDESS 5G BROADCAST TRANSMITTERS





UWB Doherty

The Pocket Siren project made use of the most efficient Ultra-WideBand Doherty technology → So, also the **energy optimization** has been taken into account for the benefit of the project

5G Broadcasting

is easier with TRedess

TRedess has completed its portfolio with the new **TRedess 5G Broadcast modulator** that, together with the top-class efficiency TRedess Doherty amplifiers, bring to the market **the most optimum and efficient air cooled 5G Broadcast transmitters**.

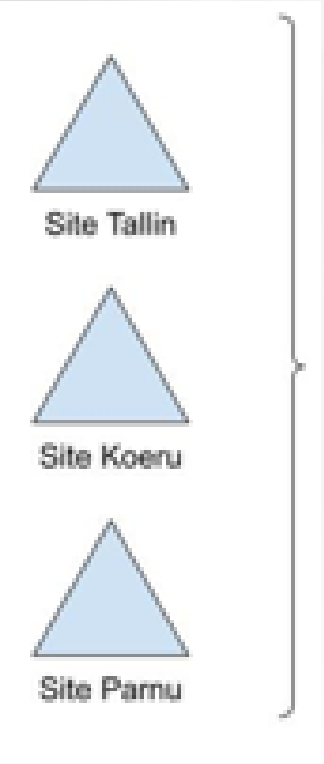
This new solution will allow TRedess new and existing customers to count with an **easy path to add the new possibilities of 5G Broadcast technology to their current DTT infrastructure**, enabling viewers to watch the action of live in real time on their mobiles at large events, implementing emergency warning systems, etc…



Key features:

- Supports FeMBMS (up to 3GPP Release 19) and eMBMS (Release 9/12 mixed mode for Android prototype handsets CRD/QRD).
  - CAS muting (enabling DVB-T2 / ATSC3.0 + 5G BC)
  - Time and Frequency Interleaving
  - Higher MCS order
  - Multiplel PMCH
  - SFN operation
- Channel bandwidths 1.4,3,5,6,7,8 and 10MHz.
- Subcarrier spacings (Δf) 0.37, 1.25, 2.5, 7.5 and 15KHz.
- Data and control input through standardized M1 and M2 interfaces compatible with 3GPP-compliant 5G BC cores.
- Emergency warning system support through standardized S1 interface.

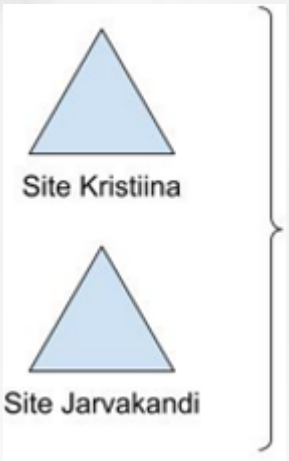



Site Tallin
Site Koeru
Site Parnu


Tedess 5G Broadcast


Tedess 5G Broadcast


Tedess 5G Broadcast


Site Kristiina
Site Jarvakandi

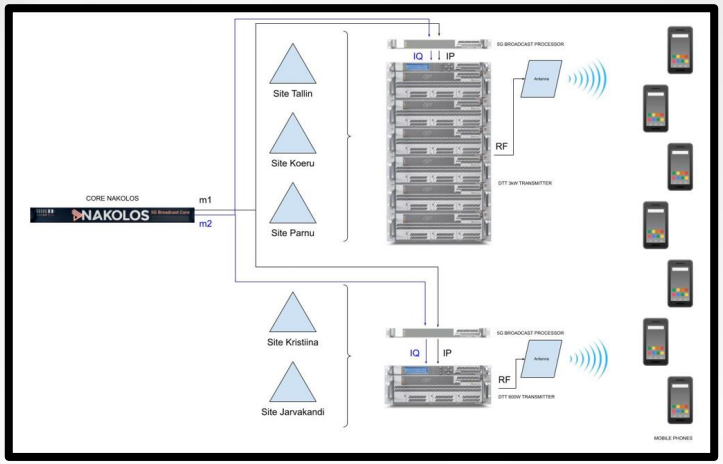

Tredess 5G
Broadcast
Tredess 5G
Broadcast

OFFICIAL LAUCHING DATE AT TALLINN TV TOWER (APRIL 2025)

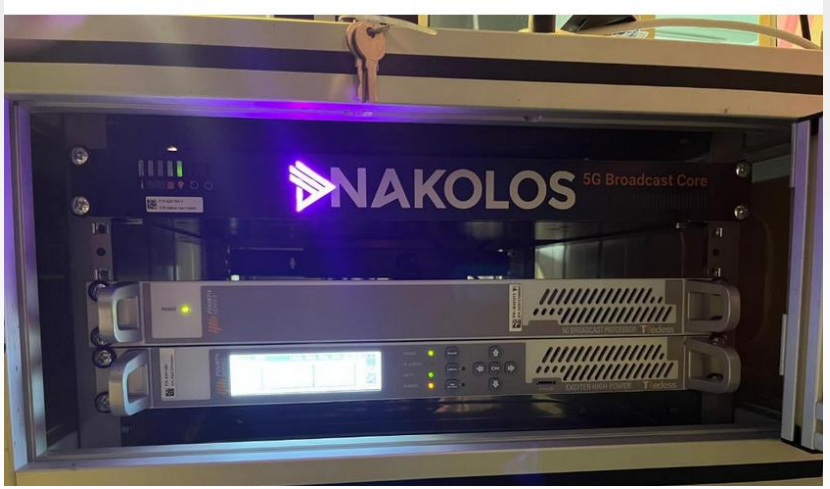




First demo system of the Pocket Siren project









Hexilon Monitoring unit



OnePlus

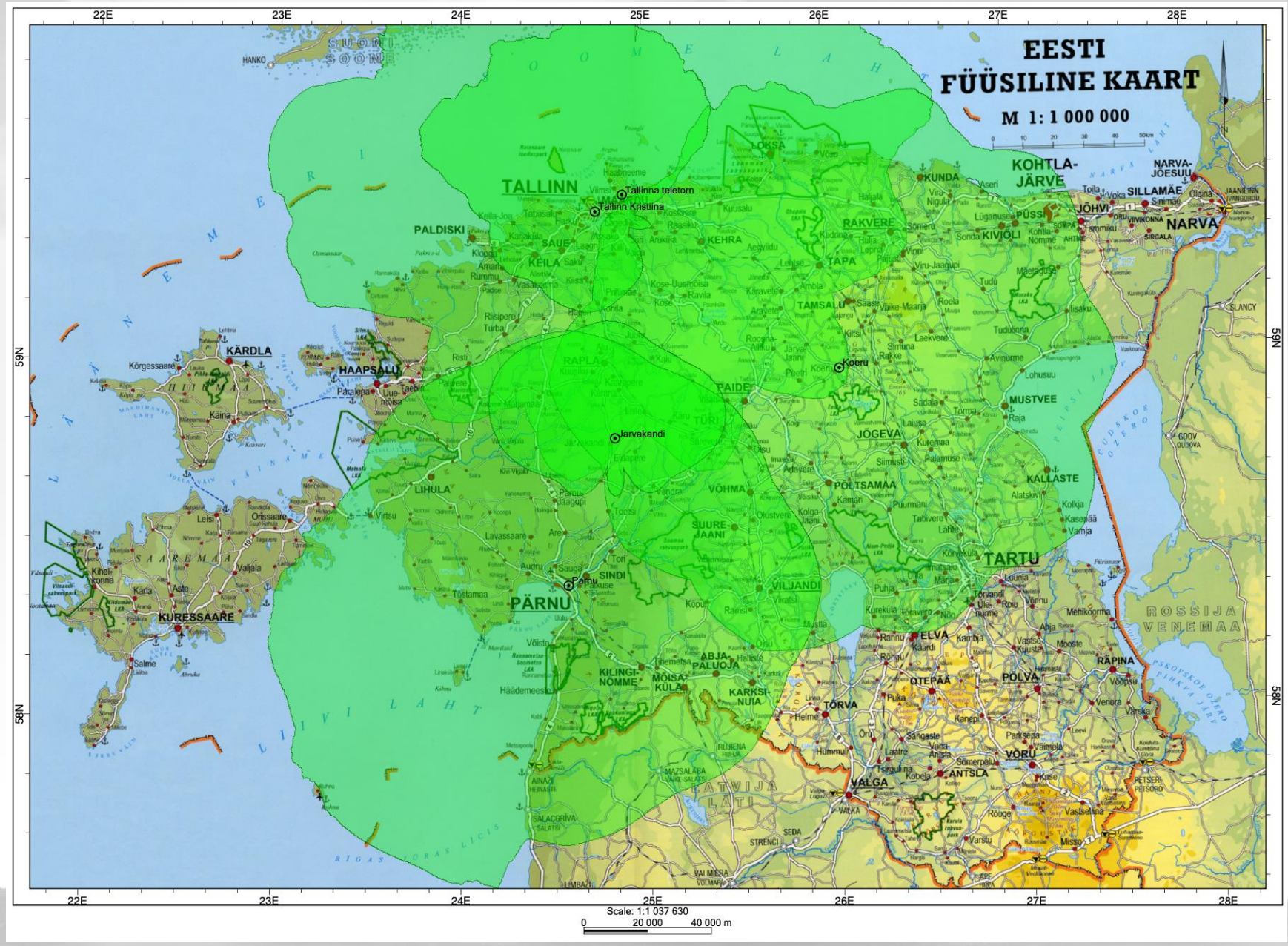


Xiaomi



Motorola

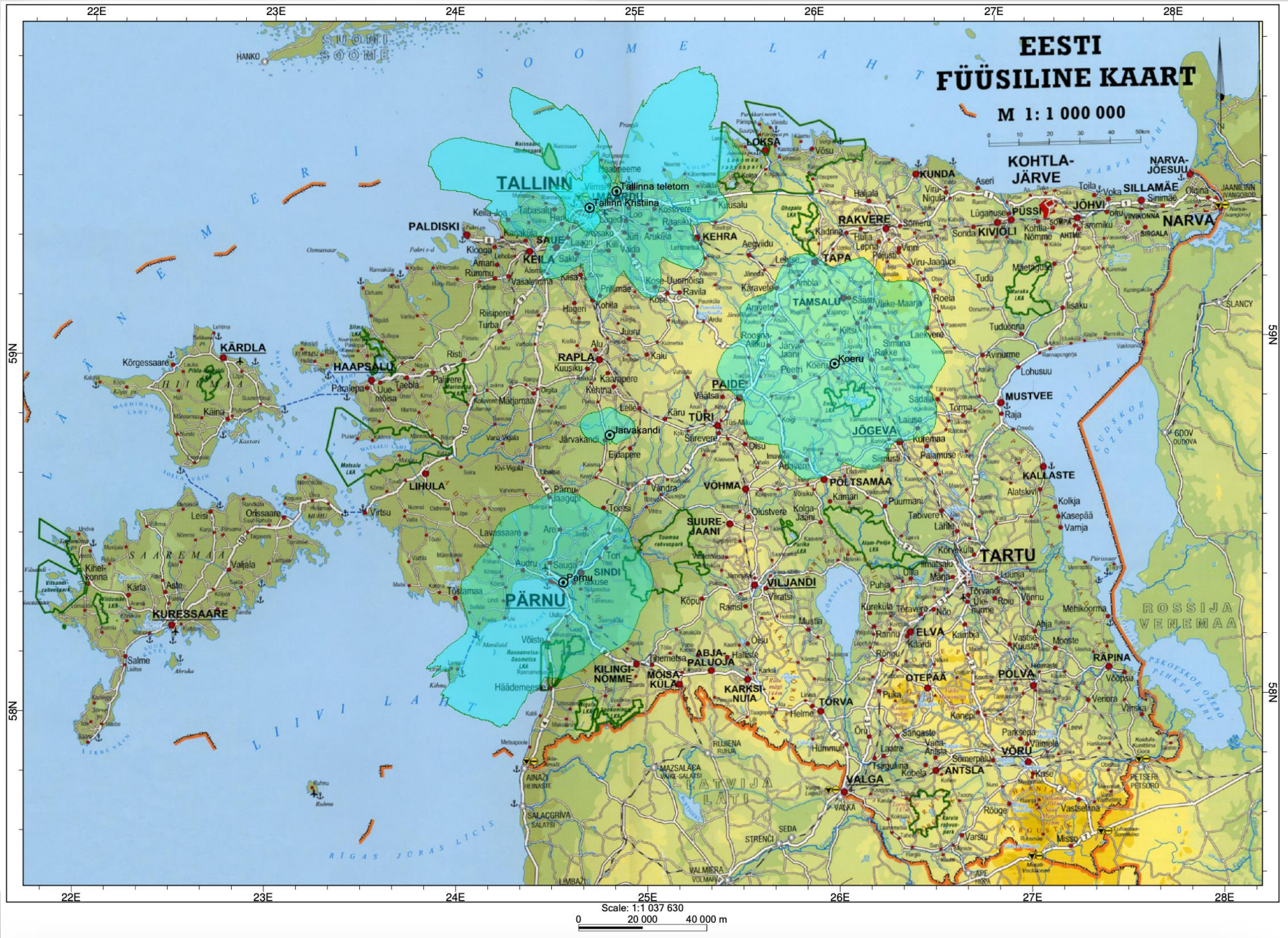
ESTIMATED COVERAGE: SCENARIO 1 (Coverage from a directional antenna at 10 meters height)



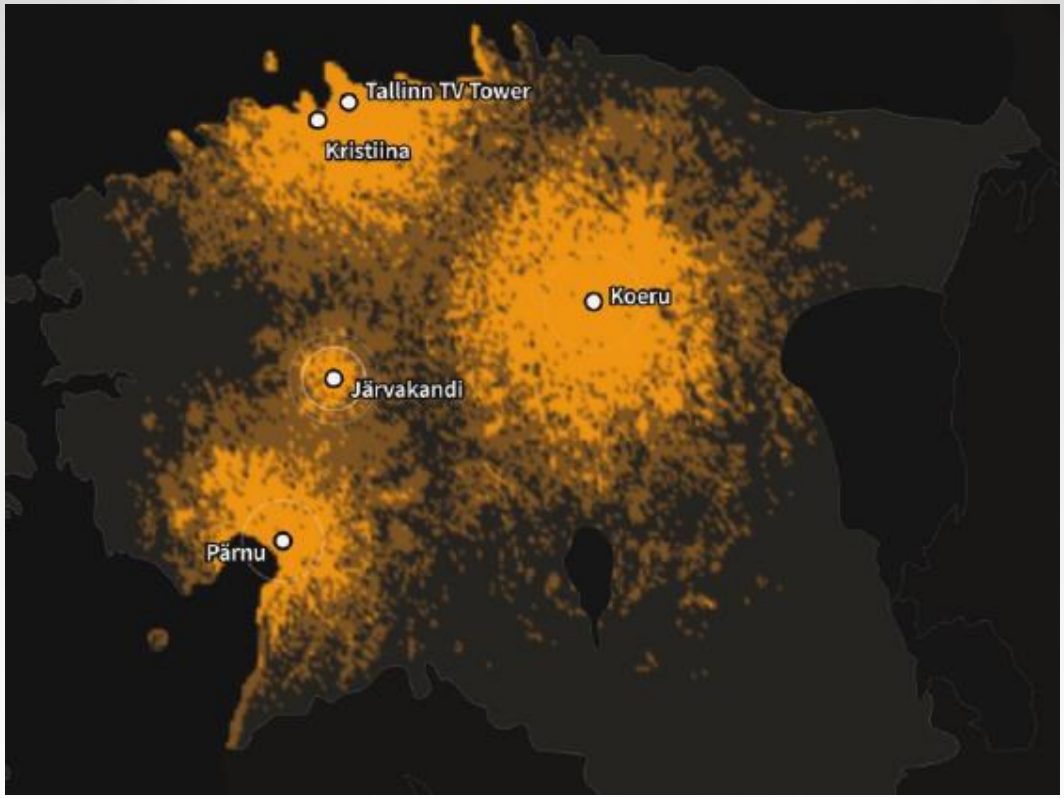
ESTIMATED COVERAGE: SCENARIO 2 (from a directional antenna located at the top of a car)



ESTIMATED COVERAGE: SCENARIO 2 (Coverage from inside a pocket)



SFN IMPLEMENTATION BETWEEN TALLINN & KRISTINA SITES



Site	Type	Mast	Ch.	TX
Tallinn TV Tower	HPHT	270 m	E40	3 kW
Koeru	HPHT	337 m	E41	3 kW
Pärnu	HPHT	187 m	E41	3 kW
Kristiina	LPLT	97 m	E40	600 W
Järvakandi	LPLT	78 m	E41	600 W

Tallinn & Kristiina run both in SFN on channel E40 (626 MHz)
Bandwidth 5 MHz – band 71.

SFN IMPLEMENTATION BETWEEN TALLINN & KRISTINA SITES

- Tallinn & Kristiina sites had and overlapping coverage zone & both transmitters operating ins same UHF channel – SFN

- But the distance between the two TX is larger than the GI (Guard Interval) used: Note that the Guard Interval used is forced by the available Mobile phones (only supporting certain GI)

- As expected, due to the above situation, in the overlapping zones, the reception of the Broadcast Services (audio & video) was not ideal and some interferences were found.

- BUT, very interesting, the Emergency Warning system (that is not transmitted in the broadcast frames) was perfectly working with the emergency signals being perfectly decodable and displayed on the telephones.

- Release 9 / 12 used → forces to use a SCS (Subcarrier Spacing of around 15KHz) → This limits the ISD (Inter Site Distance) to be approximately 5Km

- Using newer releases in future phases of the project: Using lower SCS → SFN sizes would become bigger → the problems observed in audio / video services would disappear

SCS	CP	ISD	Mobility
15KHz	16.7us	5km / 3.1mi	>250Km/h / >155mph
7.5KHz	33.3us	10km / 6.2mi	>250Km/h / >155mph
2.5KHz	100us	30km / 18.6mi	~250Km/h / ~155mph
1.25KHz	200us	60km / 37.3mi	~120Km/h / ~75mph
0.37KHz	300us	90km / 55.9mi	<120Km/h / <75mph

PART 3: MOBILE PHONE MODELS USED IN THE PROJECT SO FAR

1. **OnePlus 13R** (Android 15, Snapdragon 8 Gen 3)
2. **Xiaomi 13** (Android 14, Snapdragon 8 Gen 2)
3. **OnePlus 10T 5G** (Android 12, Snapdragon 8+ Gen 1)
4. **OnePlus 10 Pro 5G** (Android 12, Snapdragon 8 Gen 1)
5. **Motorola Edge 50 Ultra** (Android 14, Snapdragon 8s Gen 3)
6. **Motorola Razr 50 Ultra** (Android 14, Snapdragon 8s Gen 3)
7. **Motorola Razr+ 2023** (Android 14, Snapdragon 8+ Gen 1)
8. **NothingPhone 3** (Android 15, Snapdragon 8s Gen 4)
9. **NothingPhone 2**
10. **Motorola Razr 60 Ultra**

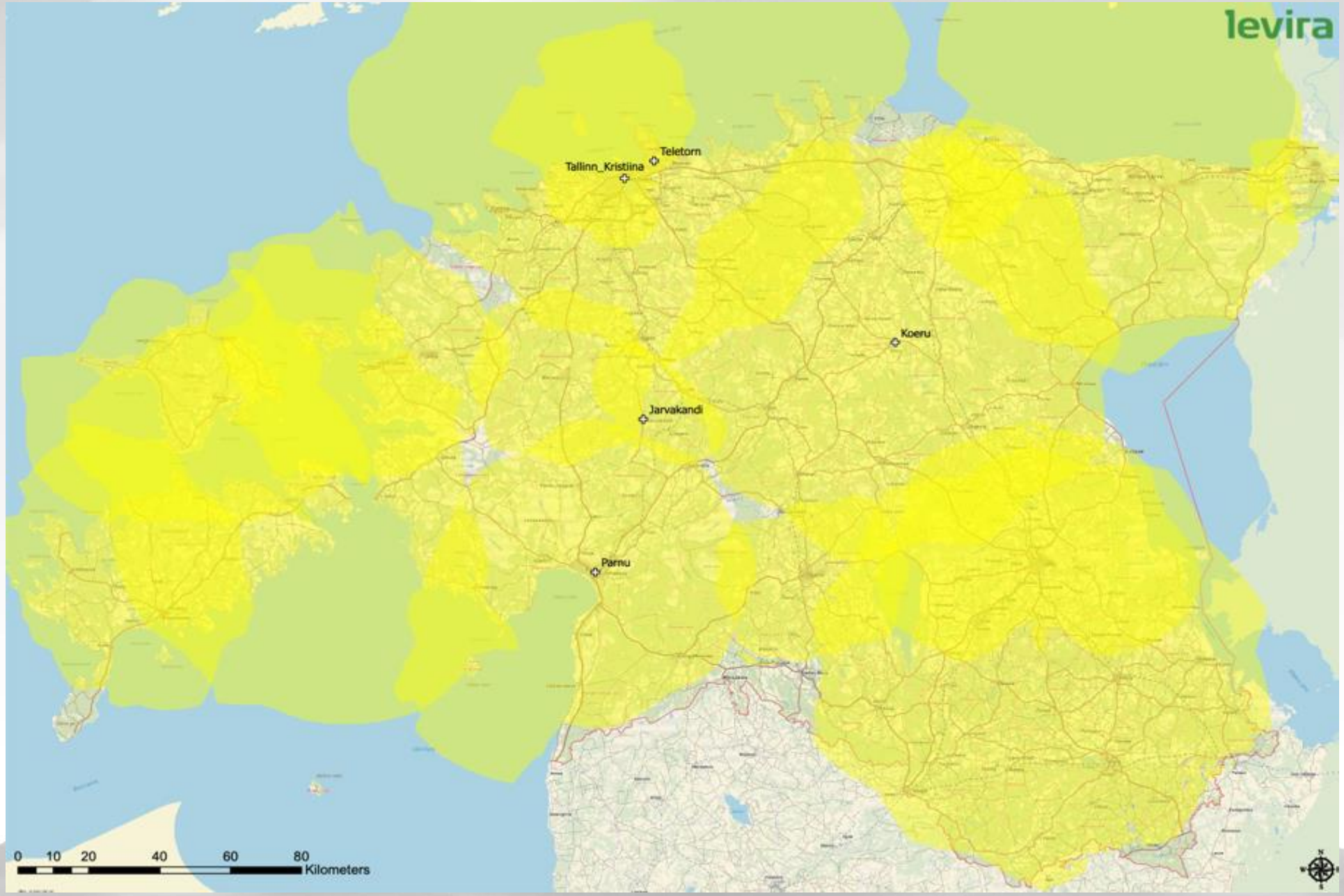
POSSIBLE NEXT STEPS / PHASES ON THIS PROJECT

3

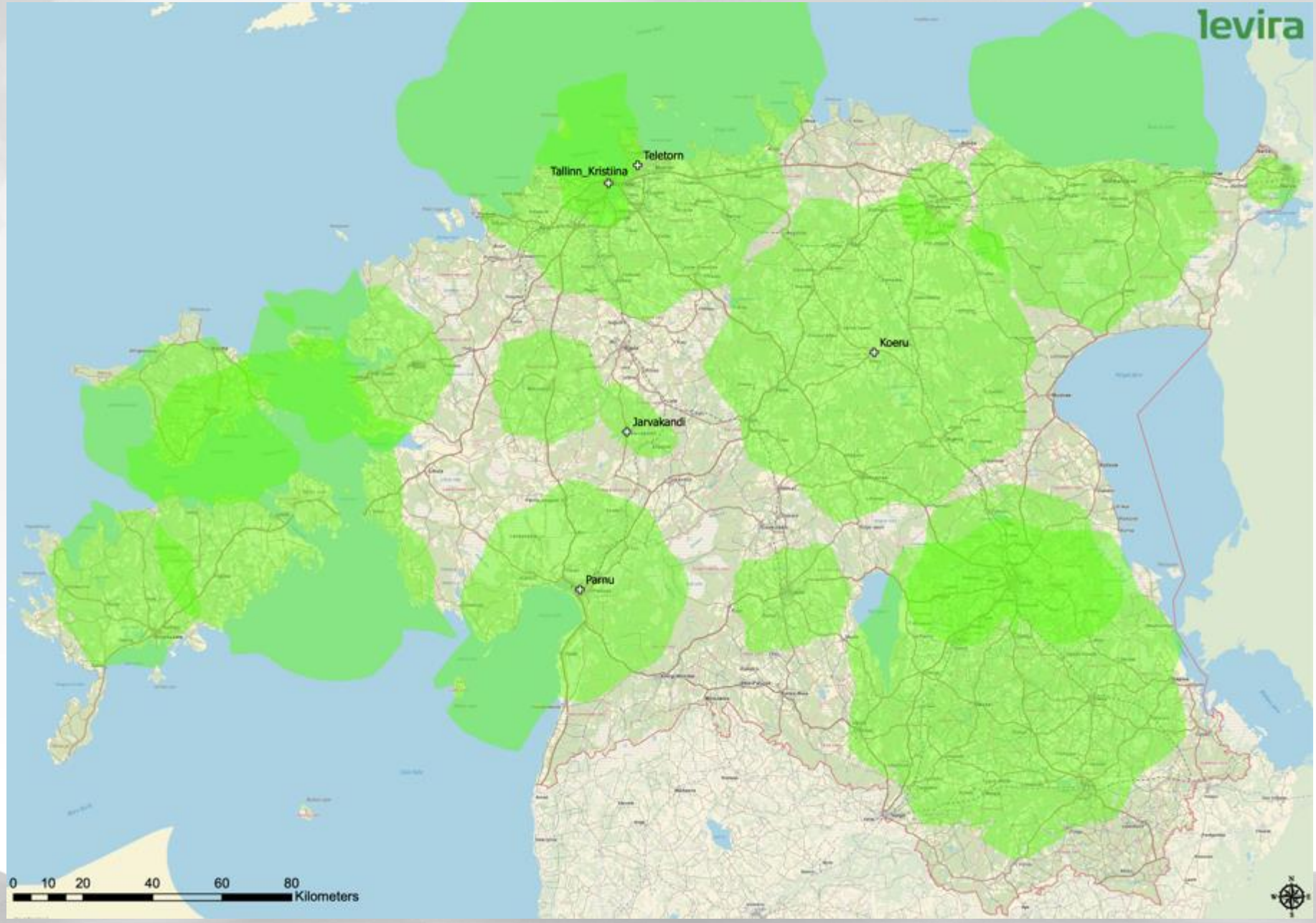
Extension of the network with new sites

New 3GPP release 19 features

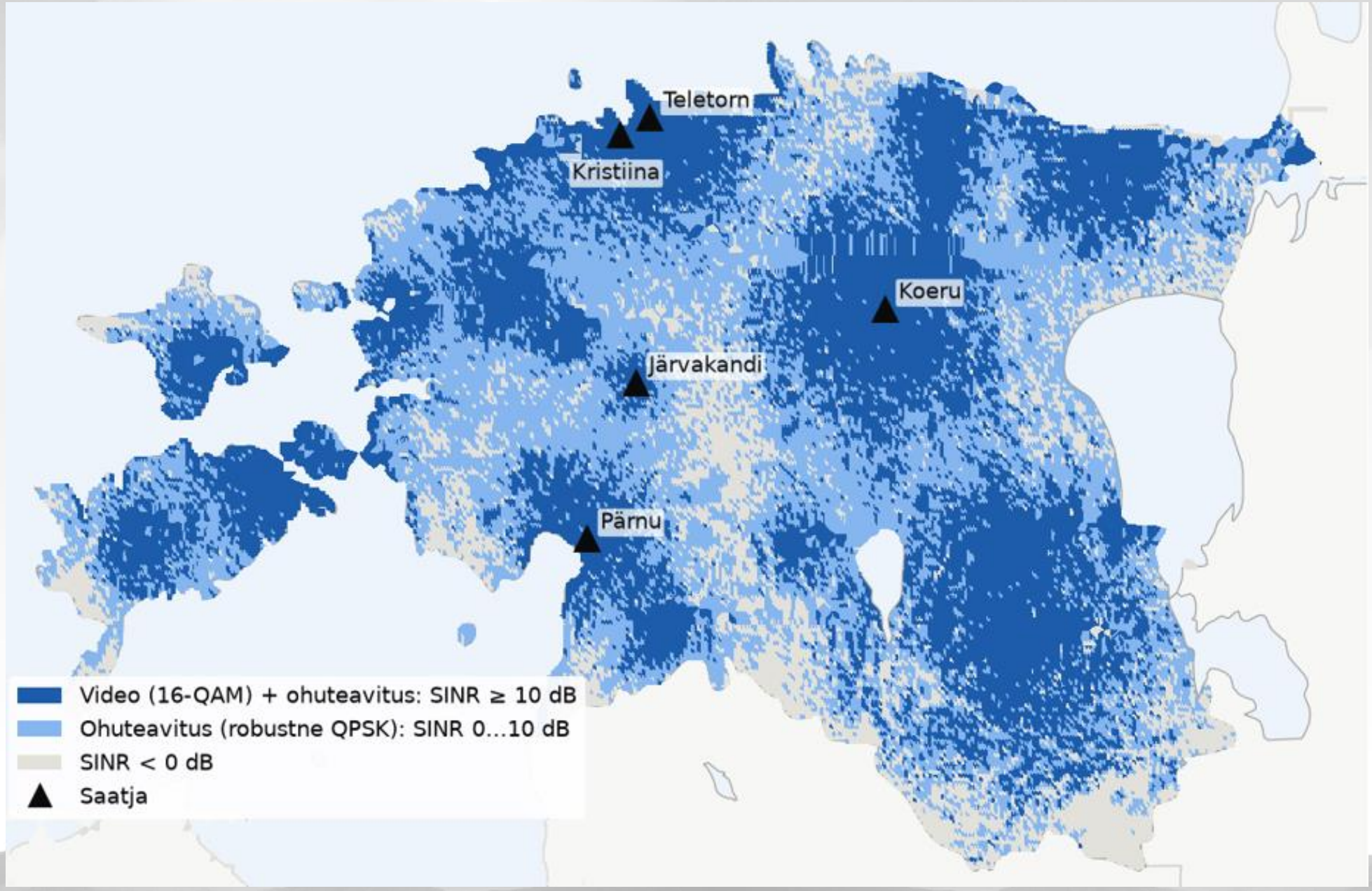
EXTENSION OF THE PROJECT WITH NEW SITES: (QPSK – 16 SITES – EMERGENCY WARNING)



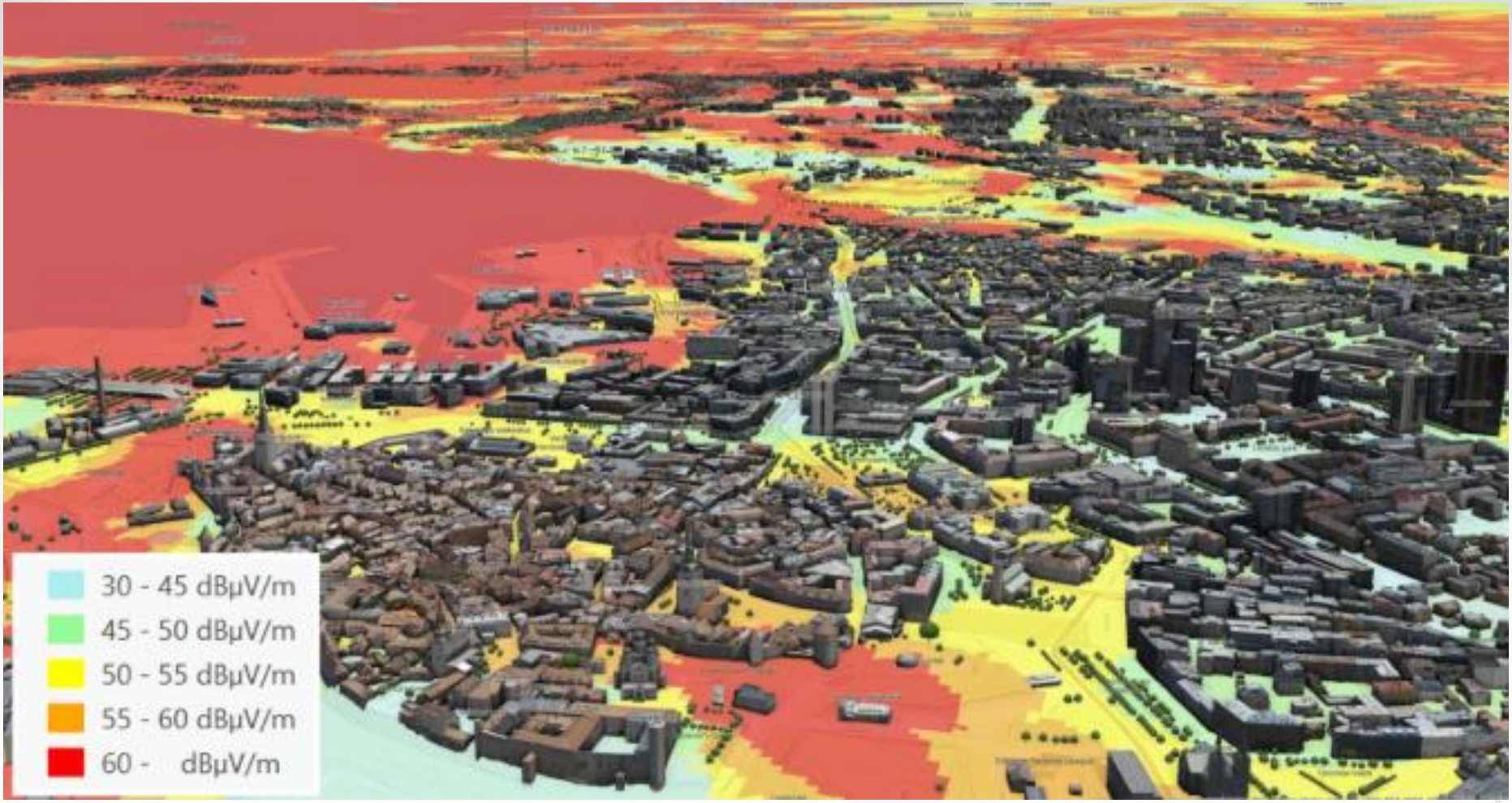
EXTENSION OF THE PROJECT WITH NEW SITES: (16 QAM – 16 SITES)



20 SITES (16 SITES + 4 GAP FILLERS) – VIDEO / EMERGENCY WARNING



TALLINN CITY AREA COVERAGE – EFFECT OF THE BUILDINGS (16 sites simulation)



EVOLUTION OF THE PROJECT NEW FEATURES OF THE RELEASE 19

Key features:

- Supports FeMBMS (up to 3GPP Release 19) and eMBMS (Release 9/12 mixed mode for Android prototype handsets CRD/QRD).
  - CAS muting (enabling DVB-T2 / ATSC3.0 + 5G BC)
  - Time and Frequency Interleaving
  - Higher MCS order
  - Multiplel PMCH
  - SFN operation
- Channel bandwidths 1.4,3,5,6,7,8 and 10MHz.
- Subcarrier spacings (Δf) 0.37, 1.25, 2.5, 7.5 and 15KHz.
- Data and control input through standardized M1 and M2 interfaces compatible with 3GPP-compliant 5G BC cores.
- Emergency warning system support through standardized S1 interface.



Release 19 standardization closed at the end of 2025 → **Release 19** capabilities have not been explored during the project.

The most relevant Rel. 19 features for this use case would be:

- **TFI (Time Frequency Interleaving)**, time and frequency interleaving of the PMCH
- **CAS Muting:**

EVOLUTION OF THE PROJECT NEW FEATURES OF THE RELEASE 19

Time and Frequency interleaving: enhance the robustness of the 5G Broadcast signal against challenging propagation conditions



The result is a direct improvement in signal robustness and in indoor reception of the service



coverage gained through configuration rather than network investment.

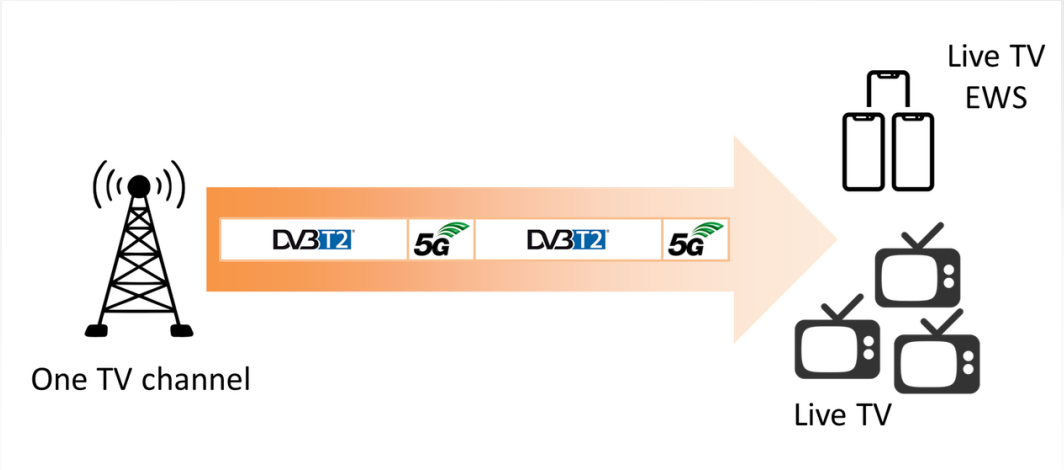


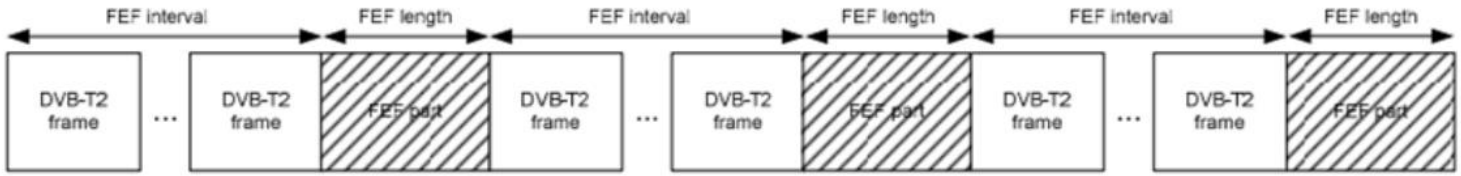
Real final outoor & indoor coverage can be increased by just using TFI without the need to add some additional sites

EVOLUTION OF THE PROJECT NEW FEATURES OF THE RELEASE 19

Release 19 also brings another interesting feature:

CAS muting: Making use of the FEF (future Extension Frames of the DVB-T2 standard), CAS muting allows the capability to combine the transmission of DVB-T2 and 5G Boadcast → allowing to reuse existing DVB-T2 infrastructure → lowering rollout cost





EVOLUTION OF THE PROJECT NEW FEATURES OF THE RELEASE 19



First 5G Broadcast PlugFest by 5G-MAG brings developers together in Berlin

NAKOLOS & TREDESS showed
in May 2026 (5G-MAG PLUG FEST) and during IBC 2026
the first end-to-end solution supporting
the full Release 19 feature set

so, it would be possible to continue improving the Pocket Siren project with those additional Rel. 19 functionalities.

CONCLUSIONS 4

The 2 years period allowed to move this project from an initial proof of concept to a mature system: results obtained & measured coverage figures → 5G Broadcast is a clear complementary fit together with the other existing alerting systems → But some further steps for improving the system could be implemented in new project phases

20 towers → 96% of the population (with no dependence on the mobile network)

Indoor result: measurements help to also resolve the classic doubt about HTHP penetration

Location-based alerts: Tests performed helped also to dismantle the objection that broadcast means that you cannot target a specific area.

Efficiency: cost and energy per citizen covered:

- **Reuse of the existing DTT infrastructure**: towers, civil works, power feeds and permits already existing
- **Transmitters with high-efficiency Doherty amplifiers**, reducing OPEX and power consumption compared with covering the same territory over the cellular network.
- **Order of magnitude**: estimation that with just around 20 x 5G Broadacst sites versus thousands of base stations for equivalent national coverage.

Resilience: Pocket Siren does not depend on the cellular network. No SIM, no mobile data, no app, no network registration. One transmitter serves every device in its area, so the network does not the moment everyone is using their phone at once

In a network outage, a congestion event, a fiber cut or an attack on critical infrastructure, the broadcast tower keeps transmitting

Complementary system: not competing with other alerting systems

Layer	Depends on	Strength	Where it fails
Sirens	Mains power and loudspeakers	Immediate outdoor reach	Does not reach indoors or say what to do
SMS / app	Cellular network and handset registration	Universal installed base	Congests; some messages end up in spam
Cell broadcast (2027)	Cellular network	No app needed, full screen	Falls with the network; needs Apple and Google updates on the handset
5G Broadcast (Pocket Siren)	HTHP broadcast towers	Independent of the mobile network, no congestion, rich content	Handset support still limited
Radio and TV	Broadcast	Coverage and public trust	Requires the receiver to be switched on

5G Broadcast brings along enriched functionality and inclusiveness

- **Multiple languages**: different spoken languages, tourists, foreign workers. In Estonia this is a real scenario, not a theoretical one.
- **Images, video and instructions**: an alert that says what to do, not only what is happening. And visual support for deaf and hard-of-hearing people and for anyone who does not read the language well.
- **Audible even in silent mode**, with a full-screen message.
- **Academic backing**: TalTech's behavioural research on message design, with the finding that traditional alerts not always imply a response from a relevant part of the population → rich content (audio / video) more than jut a technical embellishment it is probably the difference between just warning people and getting them to react.

GALERY 5


levira







… the story behind the photo of this puzzle hanging on a wall at Levira´s kitchen ..

… on 25th April 2025, just few minutes the first demo day event was finished …





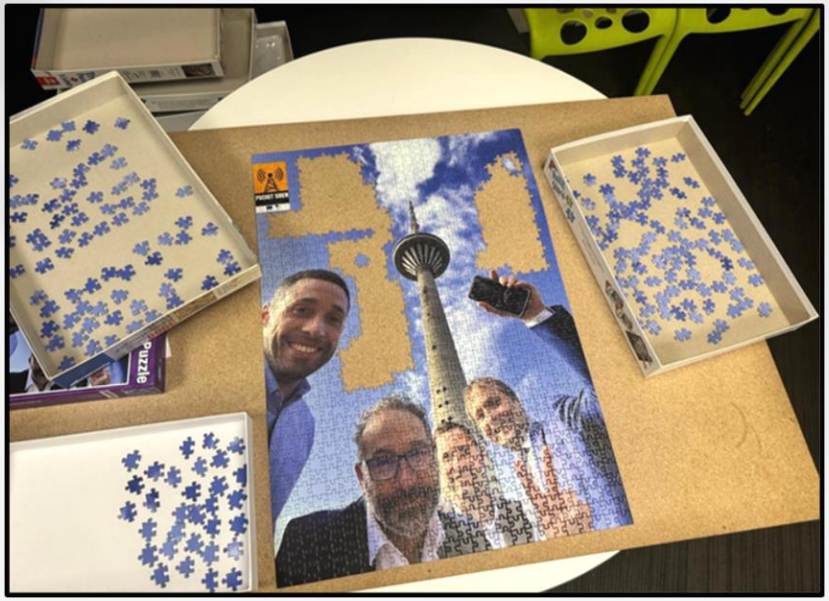







1000
Pocket Siren Puzzle







Like any other Puzzle, the Pocket Siren is a successful story because it is the result of putting together many different small pieces coming from different people / partners / entities / countries.

Pieces that have been carefully put together with technical knowledge, patience, but specially with enthusiasm and with the clear aim that the Estonian population can in the end benefit from all the advantages the 5G Broadcast system can bring to their safety

Thank you

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