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5G-MAG REFERENCE TOOLS FOR 5G BROADCAST

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5G BROADCAST GOALS

- Let broadcast network operators **directly reach mobile phones** (and also in-car receivers and fixed rooftop antennas) **within the broadcast spectrum**
- Stay **hardware-compatible** with existing 4G/5G modems in cell phones: no new silicon needed

Two Way
Short Distance
Phone TX is limit

One Way
Long Distance
Tower TX is limit

Cellular tech standards:
LTE, 5G

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5G BROADCAST IS DEFINED BY 3GPP

- **eMBMS** (Rel 9) as a basis: multicast & SFN subframes shared between cells in LTE
- Addition of **new numerologies** (subcarrier spacing / CP length) suitable for broadcast (HPHT, MPMT, LPLT): Inter-site distances ~ **100km / 60mi**, mobility up to **250km/h / 155mph**.
- **Receive-only** mode
- Stays compatible with existing modems (framing, channels, coding, …)
- Inherits existing **flexible allocation of bandwidth** for transport of video, audio and data: codec-agnostic and IP-based.
- LTE physical layer, hence a.k.a. **LTE-based terrestrial broadcast**

It's a **broadcast standard**, and not meant for MNOs.

It's NOT a 5G or LTE cell base station, or meant to be integrated into one.
It's existing broadcast towers transmitting in a format that cell phones understand.

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Stationary reception
Application
Middleware
Modem (HW)

Reception on mobile
Application
Middleware (Android)
Baseband (HW)

Content Provider

xMB: ctrl & data

Broadcast Core

BM-SC

MBMS-GW (Sync)

MME

MCE

M1 (data)

M2 & S1 (ctrl)

Modulator / eNodeB

digital I/Q data

Exciter

RF

Amplifier

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OPEN SOURCE REFERENCE TOOLS

Stationary reception

rt-wui / VLC / dash.js / …

rt-mbms-mw (with rt-libflute)

rt-mbms-modem (using srsLTE)

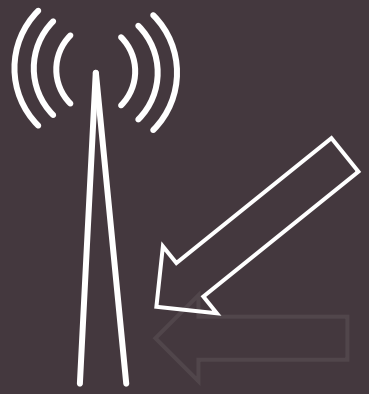
SDR

Qualcomm QRD or CRD

rt-mbms-mw-android

QC MBMS MW

Baseband (HW) – with QC SW to enable SIM-less rec'v only



Content Provider **ffmpeg**

xMB: ctrl & data

RTP MPEG-TS

or **HLS/DASH** via **rt-libflute**

Broadcast Core

MBMS-GW (Sync)

MME

srsRAN mbms-gw

MCE

M1 (data)

M2 & S1 (ctrl)

Modulator / eNodeB

rt-mbms-tx

digital I/Q data

Exciter

SDR (BladeRF, Lime, Ettus, …)

RF

Amplifier

Rohde & Schwarz BSCC, SDE

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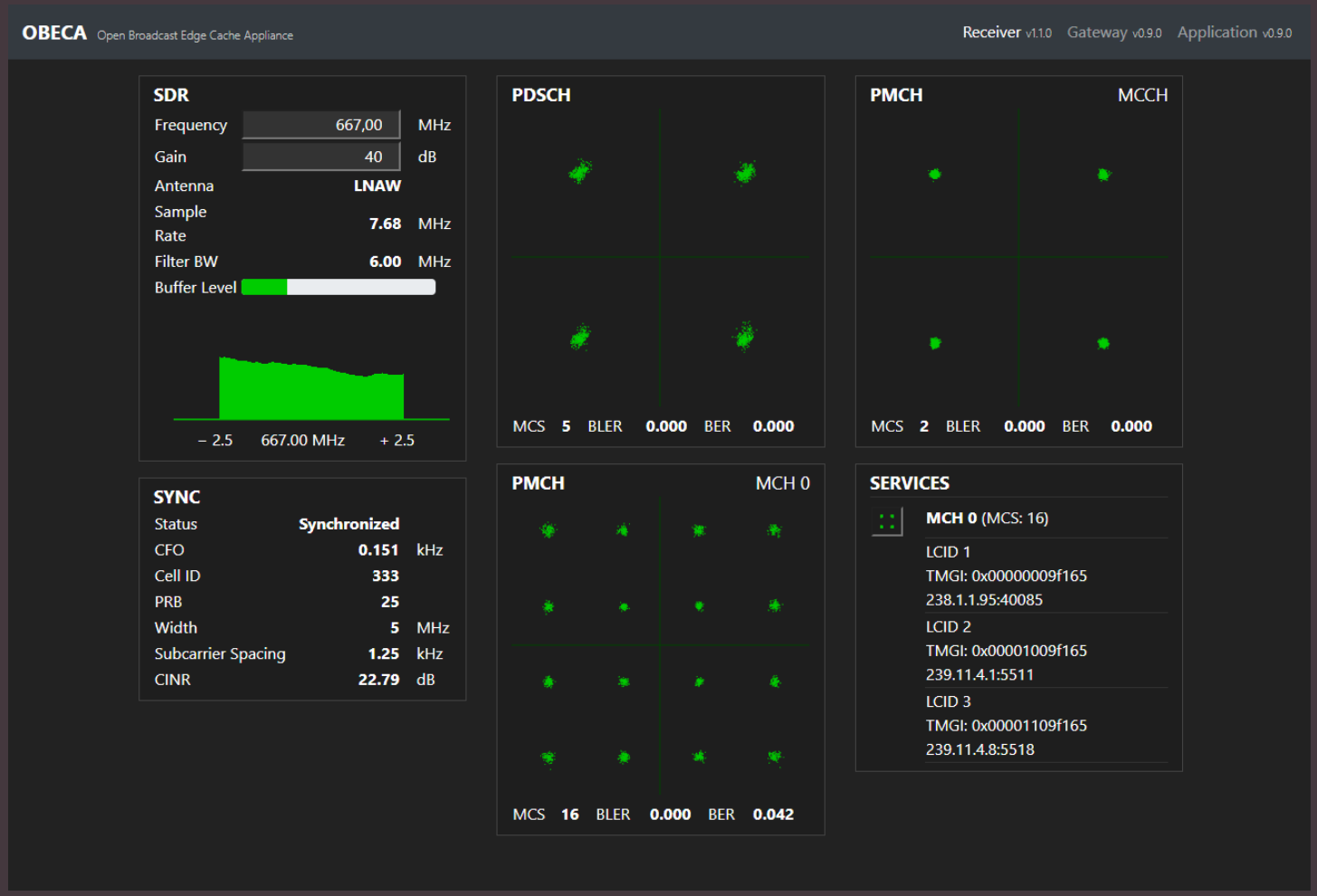
RT-WUI

Web User Interface

- Interfaces via RESTful API to rt-mbms-modem and rt-mbms-mw
- Useful for checking basic reception parameters
- Middleware file list and service announcement
- Contains HLS and DASH players



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SERVICE CONTINUITY

- Seamless switching between broadcast and OTT/unicast content delivery
- Enables flexible usage of bandwidth
  - Broadcast on demand: services can be dynamically provisioned when the demand is there, otherwise viewers are on OTT / using CDN download
  - Off-peak times are freed for e.g. content prepositioning / data services
  - Any mix is possible, e.g.
    - 24/7 radio channels with robust coding and SCS 2.5kHz for high mobility
    - 4 TV channels at 1080p / 3 Mbps during the day, but only one at UHD / 12 Mbps for a sports game in the evening
- Mobility scenarios between MBSFN areas: can carry same MBMS service

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COMING UP…

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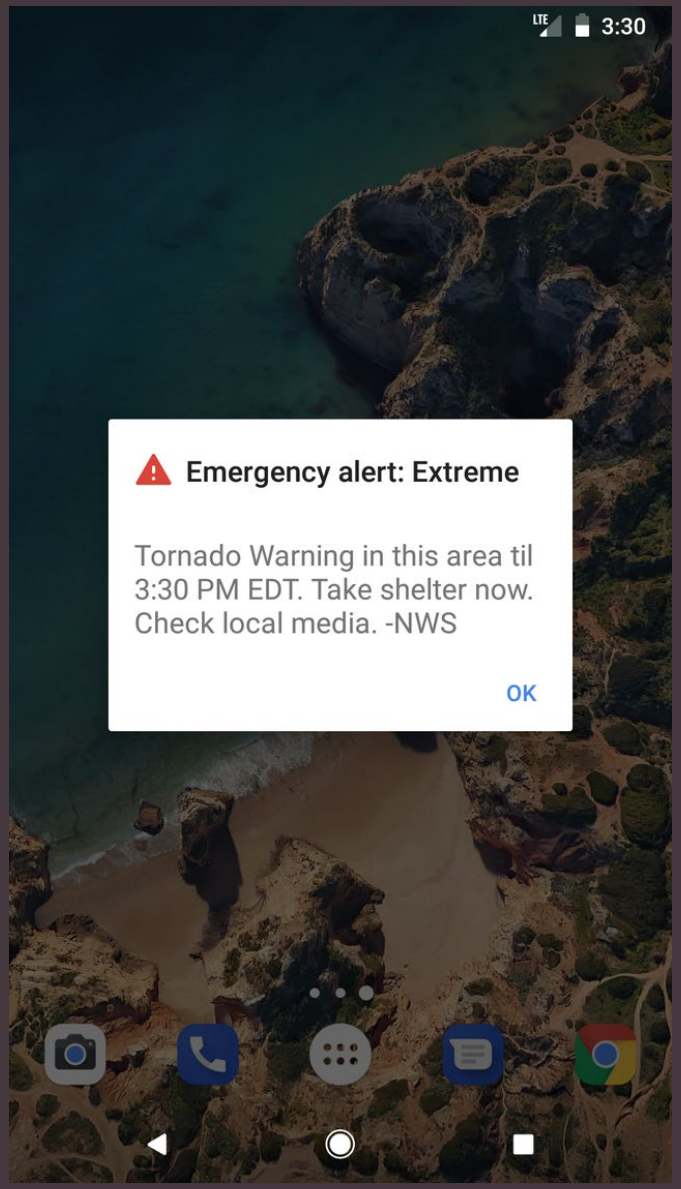
EMERGENCY WARNINGS

- 5G Broadcast enables BNOs to reach cell phones through cell broadcast / ETWS
- Beneficial in power outages: generator-backed HPHT transmitters up even when MNO networks are down

.. and many other new usecases.

https://github.com/5G-MAG/Getting-Started/wiki/Emergency-Alerts-5G-Broadcast



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TIME AND FREQUENCY INTERLEAVING

Increases robustness of signal

- **Report** just completed: https://www.5g-mag.com/post/time-and-frequency-interleaving-for-broadcast-services-in-3gpp-systems
- To be added to **rt-mbms-modem**

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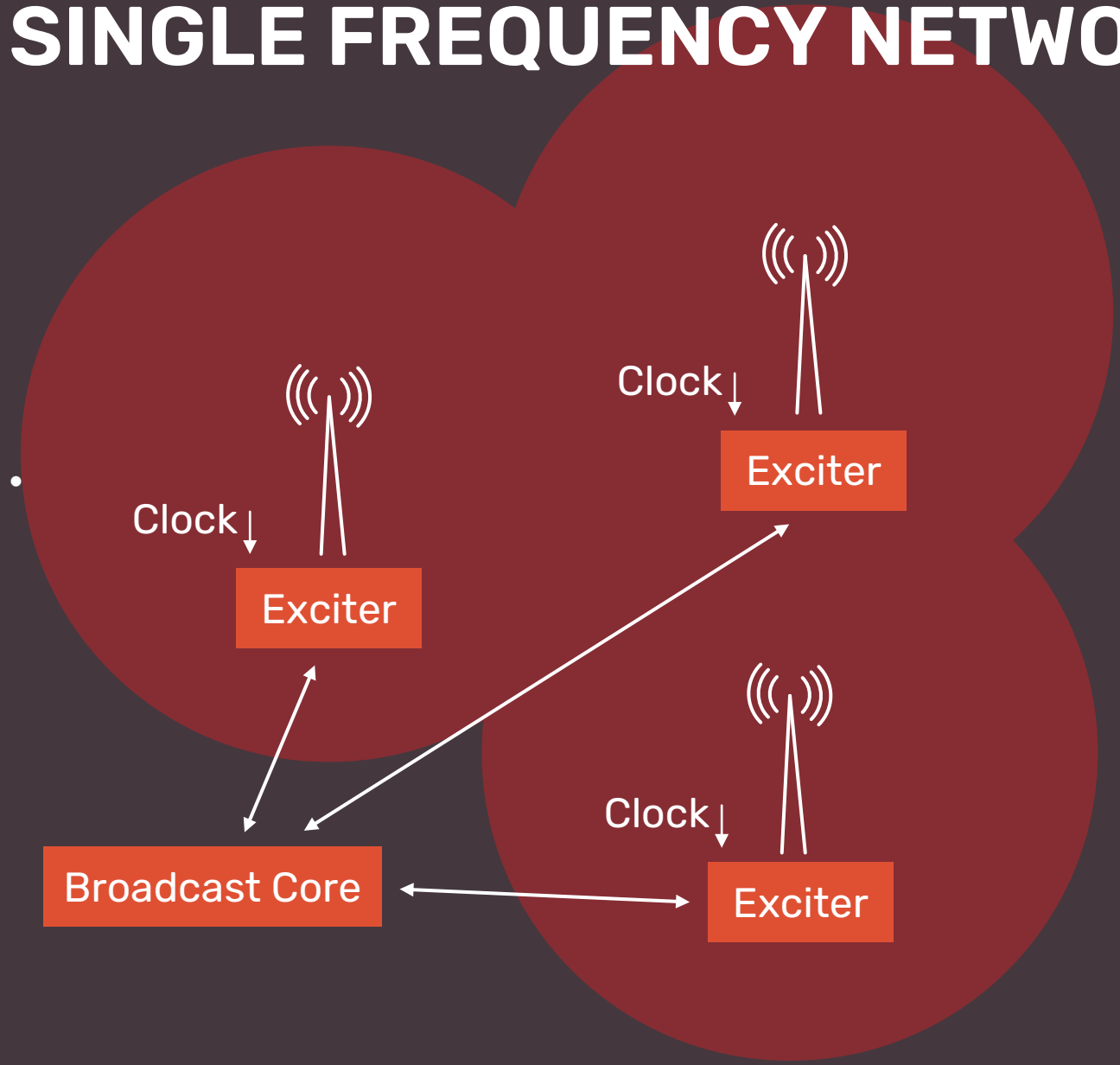
SINGLE FREQUENCY NETWORK / POSITIONING



- Broadcast Core provides sync (in control + as header on data)
- Local timing source (GPS-disciplined oscillator, Rubidium, Network, etc)

Additional Use: Positioning

- CAS subframes are different
- Enables localization of UE
- ESA trial in Vienna with R&S based on rt-mbms-modem receiver
- Will work when GPS is down

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LINKS & REPOS

- **Getting Started**
  https://github.com/5G-MAG/Getting-Started/wiki/MBMS-&-LTE-based-5G-Broadcast
- **Transmission**
  - **mbms-gw** from **srsRAN_4G** (which is also the basis for the physical layer of rt-mbms-tx and rt-mbms-modem)
  - **rt-mbms-tx**
    or **rt-mbms-tx-for-qrd-and-crd** for CRD / QRD
- **Reception**
  - **rt-mbms-modem**
  - **rt-mbms-mw**
  - Optionally: **rt-wui**
  - **On Android: rt-mbms-mw-android**
- **Where to get a CRD** (eMBMS-enabled mobile)
  https://www.ors.at/5g-broadcast/innovation-ors-group/

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THANK YOU!

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GET INVOLVED

http://tinyurl.com/join5gmagslack
Public calls on Fridays (monthly): 13:00–14:30 CEST

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APPENDIX

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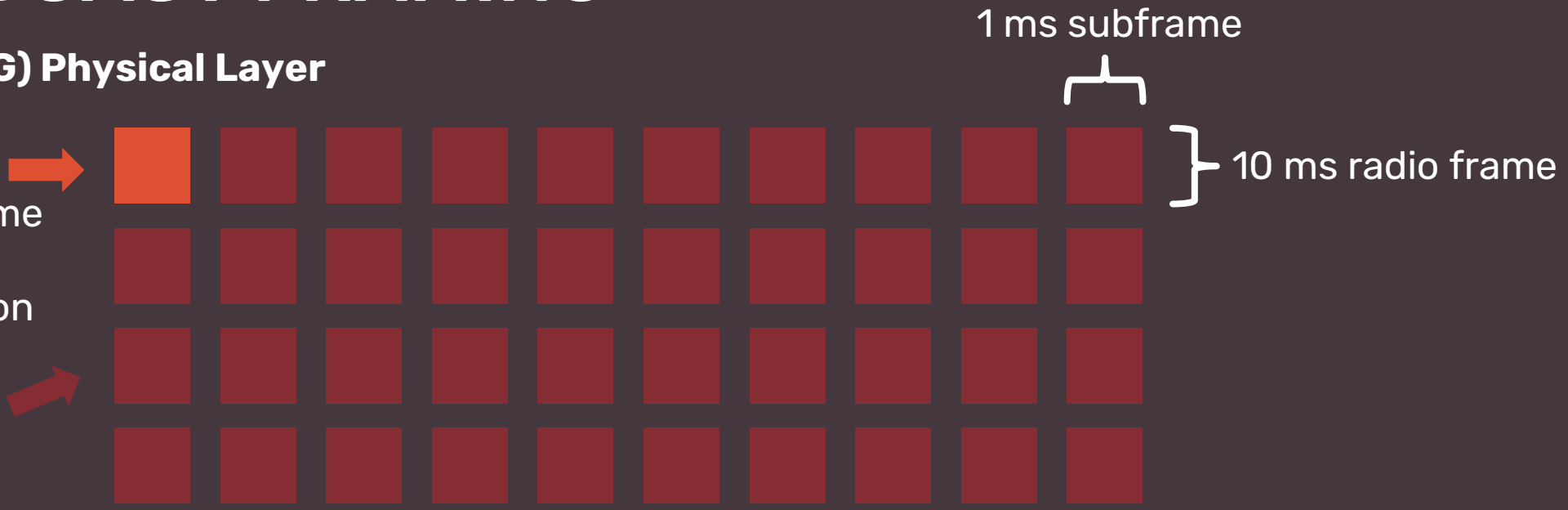
5G BROADCAST FRAMING

- **Based on LTE (4G) Physical Layer**



- **OFDM Modulation:** QPSK, 16QAM or 64QAM
- **Requirements:** need time base (e.g. 1pps & 10Mhz) for operation in SFN. Amplifier stages must deal with OFDM PAPR (but PAPR reduction techniques possible)

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CELL ACQUISITION SUBFRAME (CAS)

- Synchronisation signals and all parameters needed to decode MBSFN subframes
- Enhancements in 3GPP Release 16 for robustness
- Cell-specific reference signals and scrambling sequences based on PCI (physical cell identifier)
- Structured like a ‘normal’ LTE subframe with extended CP (cyclic prefix a.k.a. guard period)
- Frequency domain: always 15kHz subcarrier spacing
- 1 PRB (physical resource block) = 180kHz. CAS has LTE bandwidths, i.e.
  5MHz bandwidth = 25 PRBs = 4.5 MHz occupied, 250kHz guard bands each side
- Time domain: 12 modulation symbols of 66.67µs each with 16.67µs CP = 1ms

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MBSFN SUBFRAMES

- “Multimedia Broadcast Single Frequency Network”
- Transmission of payload data
- Since 3GPP Rel-9 (for MNO operation), adapted in Rel-14 for BNO operation, new numerologies in Rel-16, 6/7/8 MHz channel bandwidth in Rel-17, UHF band 108 in Rel-18
- Same scrambling, same reference signals within SFN area
- Several numerologies possible (CP and SCS combinations)

SCS	CP	ISD	Mobility
15 kHz	16.7 µs	5 km	> 250 km/h
7.5 kHz	33.3 µs	10km	> 250 km/h
2.5 kHz	100 µs	30km	~ 250 km/h
1.25 kHz	200 µs	60km	~ 120 km/h
0.37 kHz	300 µs	90km	< 120 km/h

- Numerologies can be mixed: multiple MBSFN areas can be defined.