

Native IP over Broadcast Bearers

- 5G Broadcast

Copenhagen | May 25th 2022

By Kenneth Wenzel, Open Channel

DIGITAL TV & RADIO

Anywhere

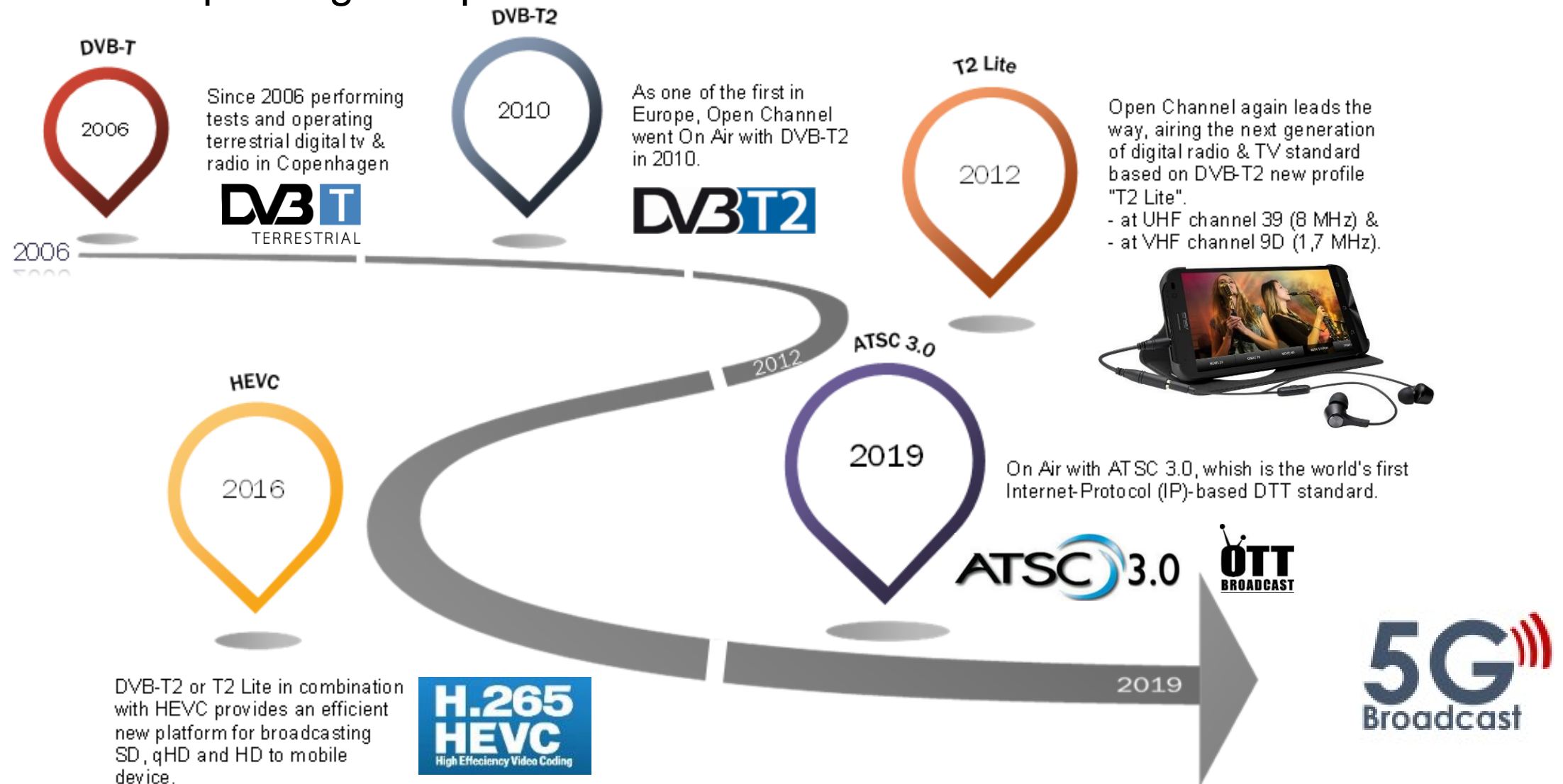
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About | Open Channel

- An independent Danish DTT network operator and
- has since 2006 been performing tests and operating terrestrial digital TV & radio in Copenhagen. Specialists in DVB-T2 and ATSC 3.0



About | Copenhagen Testbed

- In 2010, **Open Channel** was among the first movers to launch and operate a DVB-T2 platform. Now, partnering with another Danish company, **mediathand**, we are the first in Europe in 2019 to go on air with **ATSC 3.0**, in a 6 MHz channel at 587 MHz in Copenhagen.
- This OTT Broadcast trial is designed to explore the opportunities for service operators to define requirements for carrying OTT-type audiovisual services, using IP over broadcast bearer technologies as **DVB-T2, DVB-S2, CBRS, BFWA and 5G**, complementing existing delivery using the internet.
- Along with our partners, we demonstrate how players from both the web and broadcast world can realize some of the many technical and business opportunities emerging from the convergence happening in the global broadcast industry today.

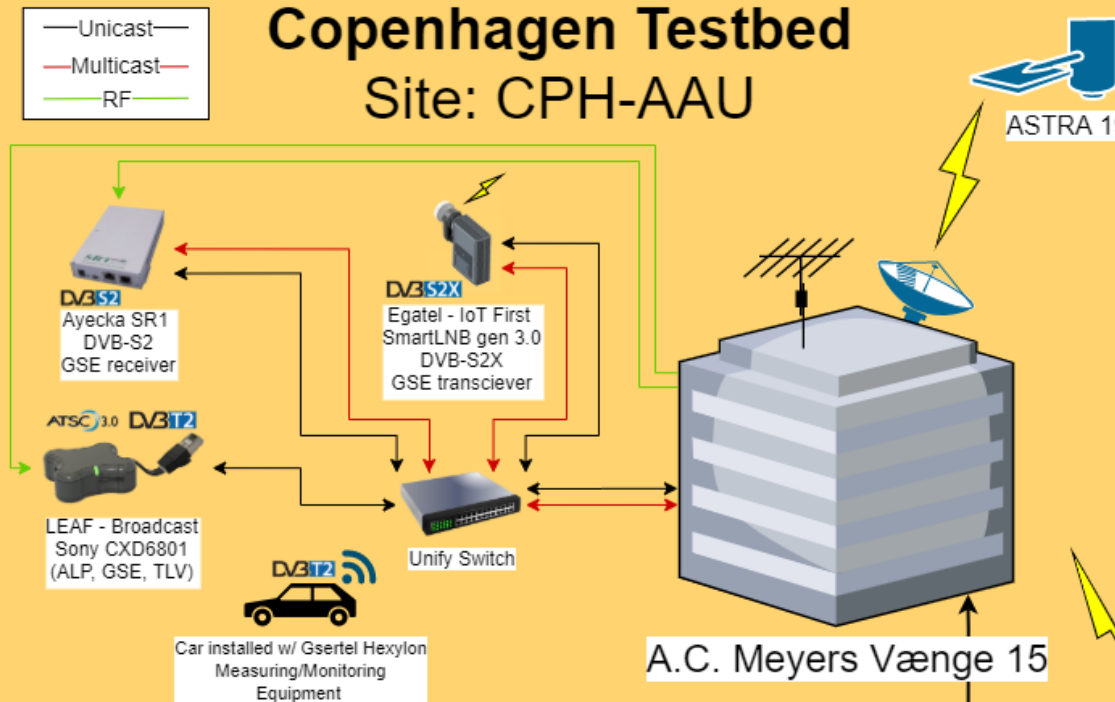


Frederikskaj 12

A.C. Meyers Vænge 15

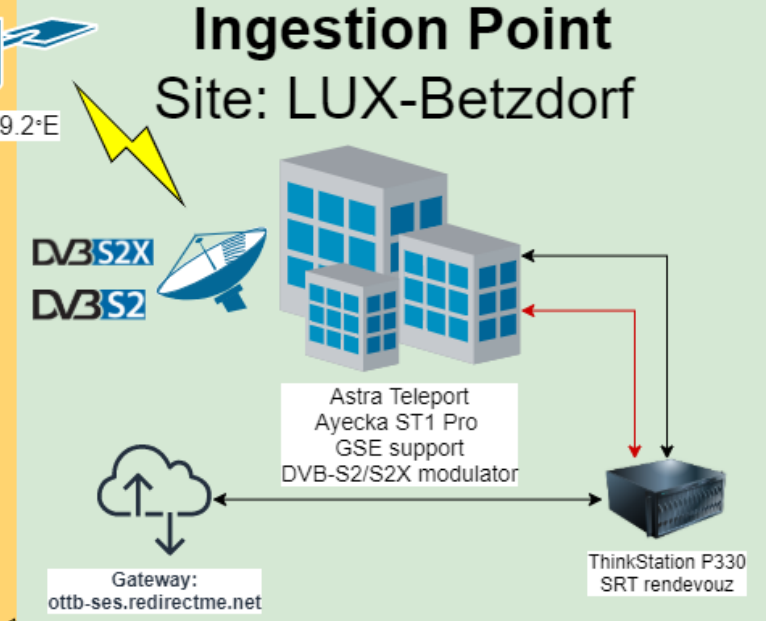
Copenhagen Testbed

Site: CPH-AAU



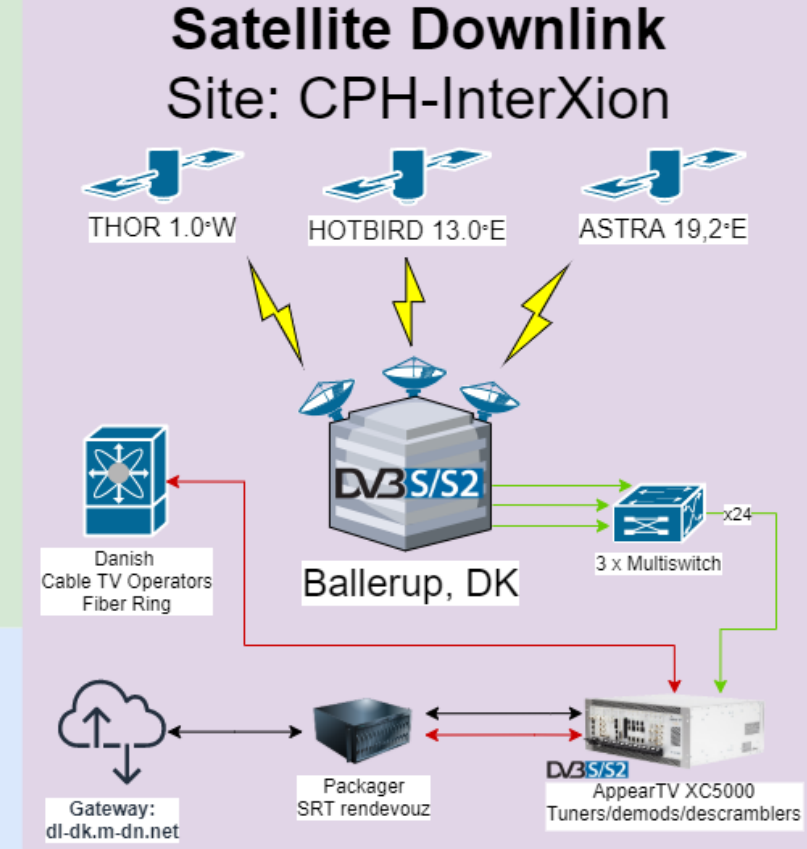
Ingestion Point

Site: LUX-Betzdorf



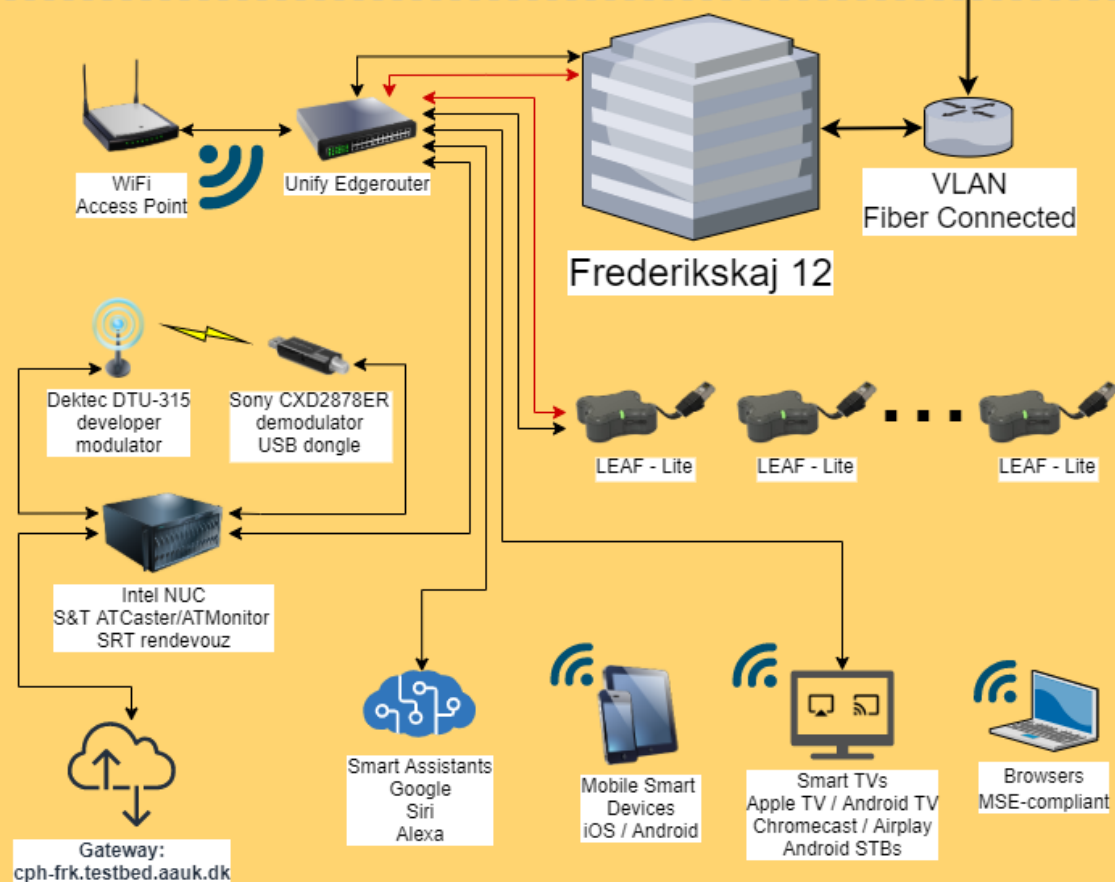
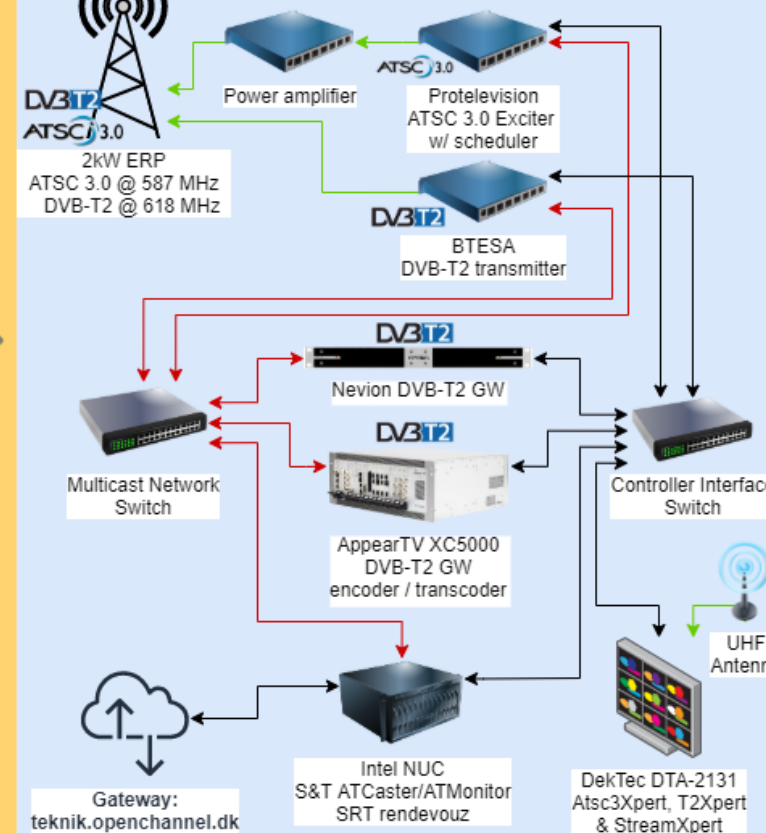
Satellite Downlink

Site: CPH-InterXion

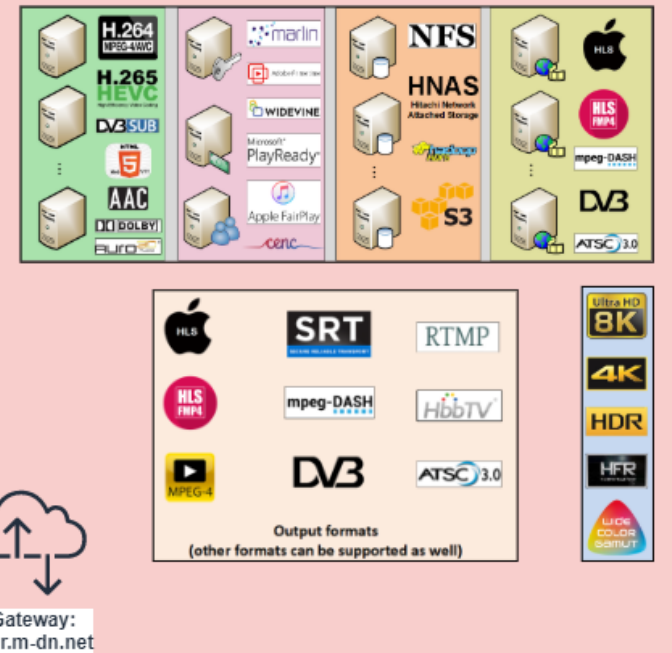


Copenhagen Testbed

Site: CPH-BOA

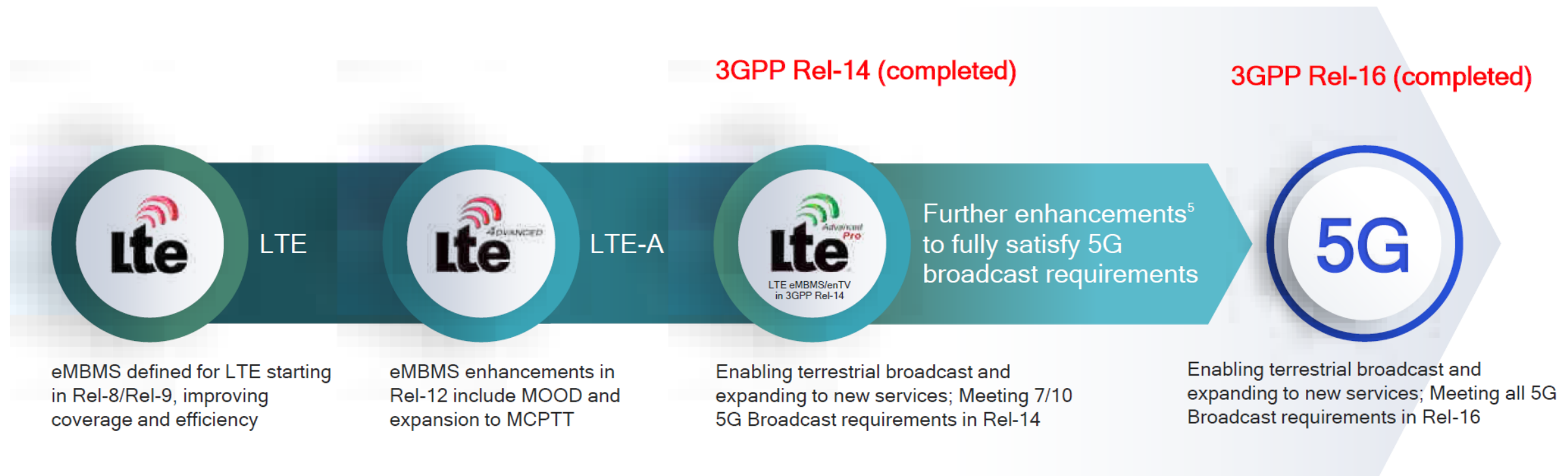


Cloud Platform



5G Broadcast | The future of media delivery?

- LTE-based 5G Terrestrial Broadcast is a broadcasting standard defined by 3GPP (Release 16/14)
- The main design target of 5G broadcast is to enable operation of a broadcast network where the receivers are hardware-compatible with cellular modems.
- 5G broadcast is a set of features that allow standalone operation of a broadcasting network without the need of supporting a unicast network.



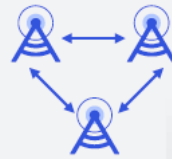
5G Broadcast | LTE-based 5G Terrestrial Broadcast

- “enTV” or Enhanced Television services, it is designed to make delivering digital TV over the existing mobile networks a reality.
- 3GPP R16/14 enTV — meets 5G terrestrial broadcast requirements

Radio access enhancements

Longer range & high mobility

New numerology with 100/200/300us CP² for up to 100km radius and 250km/h speed



More broadcast capacity

Supports dedicated broadcast network with 100% eMBMS carrier allocation



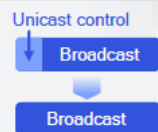
More deployment flexibility

Single network for mobile and fixed devices with enhanced support for rooftop reception



Better efficiency

New subframe design reduces overhead in dedicated broadcast transmissions



System layer enhancements

Receive only mode

Delivery of free-to-air content to devices without SIM/service subscription



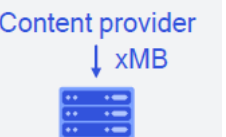
Unified protocol stack

CMAF packaging - compatible with unicast and broadcast stacks



Standardized interface

Content providers can deliver media over LTE with a unified framework



Shared broadcast

Multiple operators can serve users on a common broadcast carrier



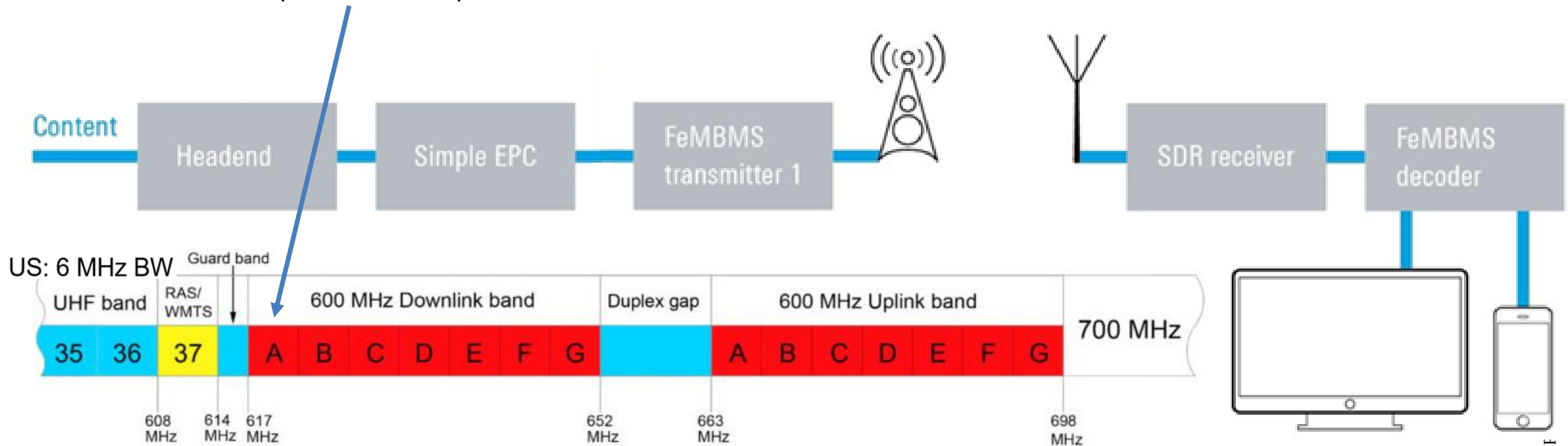
Rel-16
enTV
is 5G
Broadcast

5G Broadcast | 3GPP MBMS Supported content formats

- A 5G Broadcast TV/Radio Service Application can make use of different 5G Broadcast User Services as defined in ETSI TS 103 720 V1.1.1 (2020-12) clause 5.3.2:
 - Transport-only Proxy Mode (UDP Proxy), i.e. layer 4 gateway operation with UDP/IP header restamping in the BM-SC
 - Transport-only Forward -only Mode, i.e. layer 3 gateway operation, also known as IP packet routing
 - File Delivery, supported by the download delivery mode and non-real-time file delivery in order to distribute files on a scheduled basis or in carousels.
 - Segment Streaming, supported by the download delivery mode and real-time segment delivery in order to distribute segment streaming services such as DASH, HLS and hybrid DASH/HLS.
- Delivery system is agnostic to codecs, formats and TV service metadata
- IP-based TV Services can be run on top, for example DVB-I, ATSC3.0

5G Broadcast | Upcoming 5G Broadcast trial

- The combination of high-resolution smartphones, 5G cellular networks and an overlay model effectively emulating digital terrestrial TV (DTT) networks will finally usher in mobile TV services at large scale.
- Open Channel has a DTT broadcast permit on UHF channel 39 (614 - 622 MHz | 8 MHz BW), which is suitable for a 5G Broadcast trial with LTE-based 5G Terrestrial Broadcast Release 16 and 17 in LTE band 71 at **A: 617 – 622 MHz** (5MHz BW).



5G Broadcast | Trial Licence

- Trial licence: April 6th 2022 – April 5th 2023 / 2025
- Antenna Position: BOA (TDC Tower)
- Address: Borups Allé 43, 2200 Copenhagen, DK

- Coordinates: Longitude (WGS 84) 012E32 23
Latitude (WGS 84) 55N41 30

- Antenna Height: 97 meters
- Elevation: 8 meters

- Polarization: Vertical polarization
- Transmission power: 2 kWatt ERP omni-directional

- Frequency: LTE band 71
1st phase at 617 – 622 MHz | 5MHz BW
2nd phase at 614 – 622 MHz | 8MHz BW

UHF 39

UHF 35



5G EVENT

VIDSTE DU, AT 5G VIL BLIVE BRUGT I FORBINDELSE MED **TOUR DE FRANCE** I DANMARK

SDFI, TV2 og DI inviterer til 5G event for at vise hvad 5G kan bruges til i erhvervslivet. Ikke bare til Tour de France – men i alle brancher

ONSDAG DEN 29. JUNI 2022 FRA KL. 11.00

I INDUSTRIENS HUS I KØBENHAVN – LIGE UDEN FOR MÅLSTREGEN PÅ RÅDHUSPLADSEN

Dagen vil blandt andet byde på:

- I. Demonstration af 5G udstyr og mulighed for afprøvning heraf
- II. Lancering af Sekretariat for Anvendelse af Nye Teknologier
- III. Hvor står vi med 5G i Danmark samt industriens og erhvervslivets behov for og anvendelse af 5G
- IV. Hvordan anvendes 5G i forbindelse med tv-produktion af Tour de France, andre sport-events og den grønne omstilling (engelsk session)

Nærmere detaljer for dagen og invitation vil blive fremsendt, når det endelige program foreligger.

SÆT KRYDS I KALENDEREN ALLEREDE NU



Styrelsen for Dataforsyning
og Infrastruktur



Dansk Industri

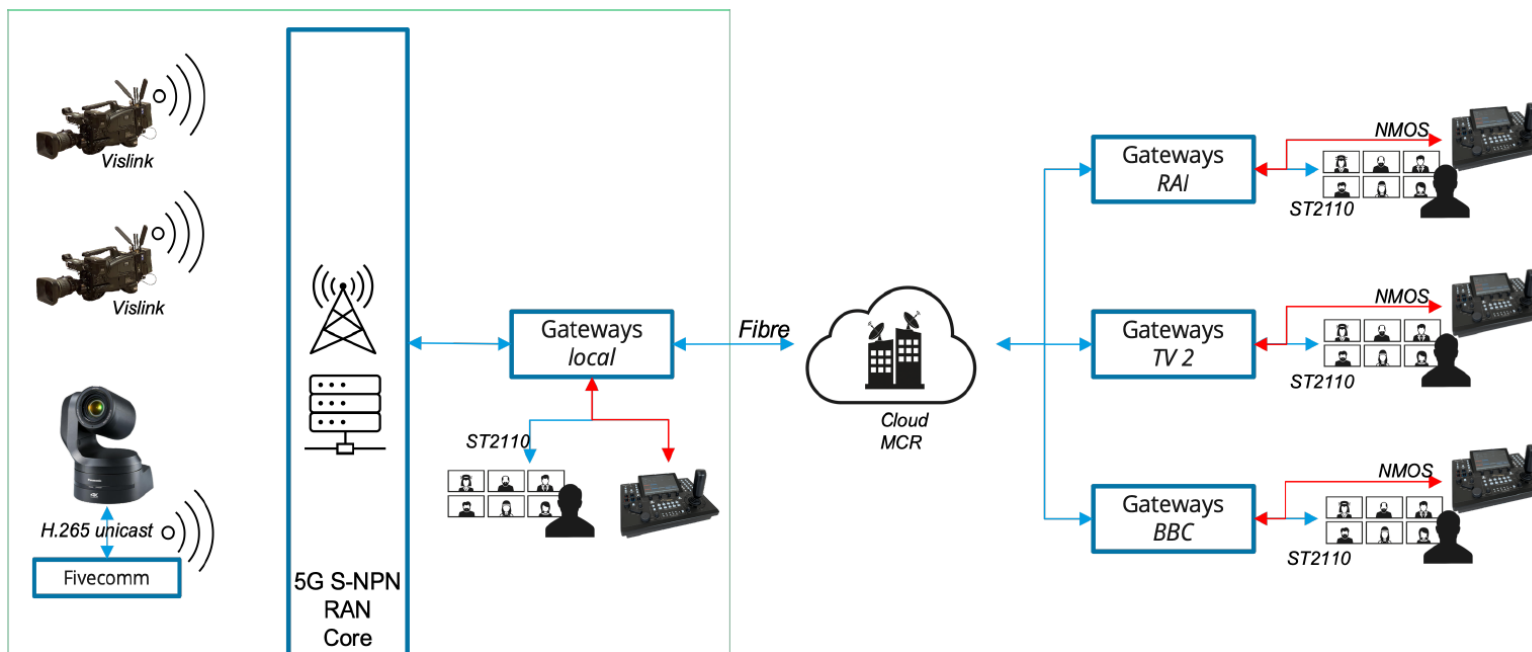
5G Week | Copenhagen

		5G NPN		5G Production		
Monday 27 th June	Tuesday 28 th June	Wednesday 29 th June	Thursday 30 th June	Friday 1 st July	Saturday 2 nd July	Sunday 3 rd July
		Presentation of the 2022 Tour de France teams at the Tivoli Gardens		Stage 1 Copenhagen > Copenhagen Individual time trial	Stage 2 Roskilde > Nyborg	Stage 3 Vejle > Sønderborg
5G-RECORDS Plenary meeting at TV 2	5G-RECORDS Plenary meeting at TV 2	5G remote production PoC in TIVOLI.				
	5G networking – grab a beer at <i>BlackSwan</i>	5G SEMINAR at DI			Festivelo Fælledparken	
				5 mobile TV2DK live team International media in town	+75.000 spectators in Roskilde	

5G Week | 5G Production



- PoC distribution – “broadcasting” – a popup channel
- TV2 Denmark to provide a dedicated 5G showcase stream – content: studio output from TIVOLI, camera via mmW, Festivelo from Fælledparken



5G Week | 5G Broadcast Demo

- Date: Monday 27th June – Friday 1st 2022
- Equipment: Rohde & Schwarz
- Receiving equipment: Qualcomm QRDs smartphones
- Transmission power: 4 (or maybe 8) kWatt ERP



CIBICOM



5G Week | 5G Broadcast Demo – Indoor Reception

FeMBMS System Parameters

System		OFDM		C/N	
Channel bandwidth (MHz):	5	Carrier spacing (kHz):	15.00	Gauss raw (dB):	0.70
MCS index:	6	Subcarriers/resourceblocks:	12	Rice raw 1 rx (dB):	3.6
OFDM variant:	2	Useful symbol time (μ s):	66.7	Rice raw 2 rx (dB):	-2.10
Rx diversity:	Yes	TU samples:	2045	Rayleigh raw (dB):	5.1
System bandwidth (MHz):	4.50	Guard interval (μ s):	16.7	Rayleigh TU6 120km/h (dB):	5.40
Modulation:	QPSK	GI samples:	512	CDD transmitter diversity (dB):	0.50
Code rate:	0.433	Guard interval fraction:	0.25	CAS	
Elementary clock (MHz):	30.72	Total symbol length (μ s):	83.40	Rice (dB):	-6.60
Elementary period (μ s):	0.03255			Rayleigh (dB):	-4.80
Pilot pattern		Data		Doppler Performance	
Dx:	1	Resource blocks:	25	Max Doppler (fd) - FFT-leakage 3dB	
Dy:	4	Bits per constellation:	2	FFT leakage (Hz):	6095.4
GI-Equalisation		Net bit rate (MBit/s):	2.535	Vmax (m/s, km/h):	3047.7 10971.7
Nyquist factor:	1.00	CAS OFDM		Max Doppler (fd) - Channel estimation	
Nyquist limit (μ s):	66.70	CAS OFDM Mode:	2	Channel estimation (Hz):	1874.1
Equalisation factor:	0.89	Guard time (μ s):	16.7	Vmax (m/s, km/h):	937.0 3373.2
Interval of correct equalisation, Tf (μ s):	59.4	Symbol time (μ s):	66.7	Limiting values for Doppler	
		Total symbol time (μ s):	83.4	Max Doppler frequency (Hz):	1874.1
				Vmax (m/s, km/h):	937.0 3373.3

OK Close

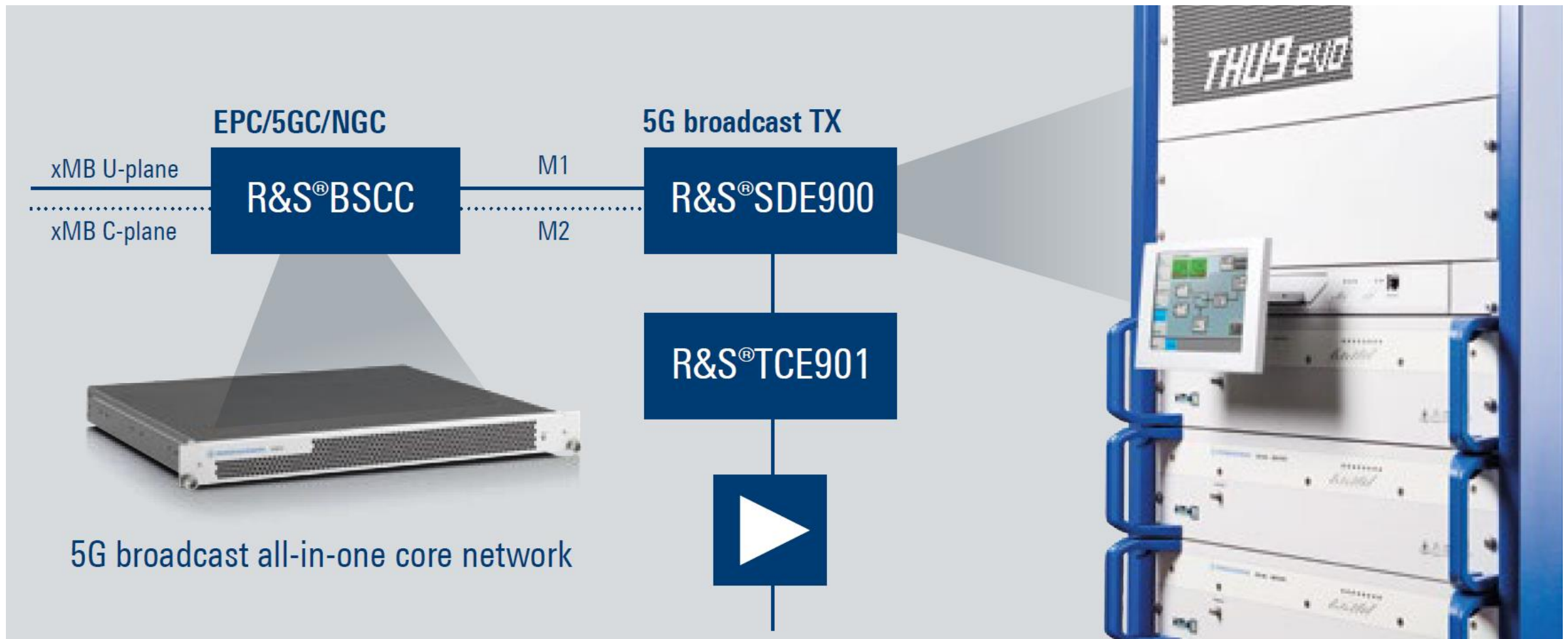
Borups Alle
5G Trial
+ Borups Alle
5G Trial 4kW

5G Event



Equipment | HPHT/MPMT Overlay solution

- Rohde & Schwarz R&S SDE900 server unit & TCE901 Exciter.

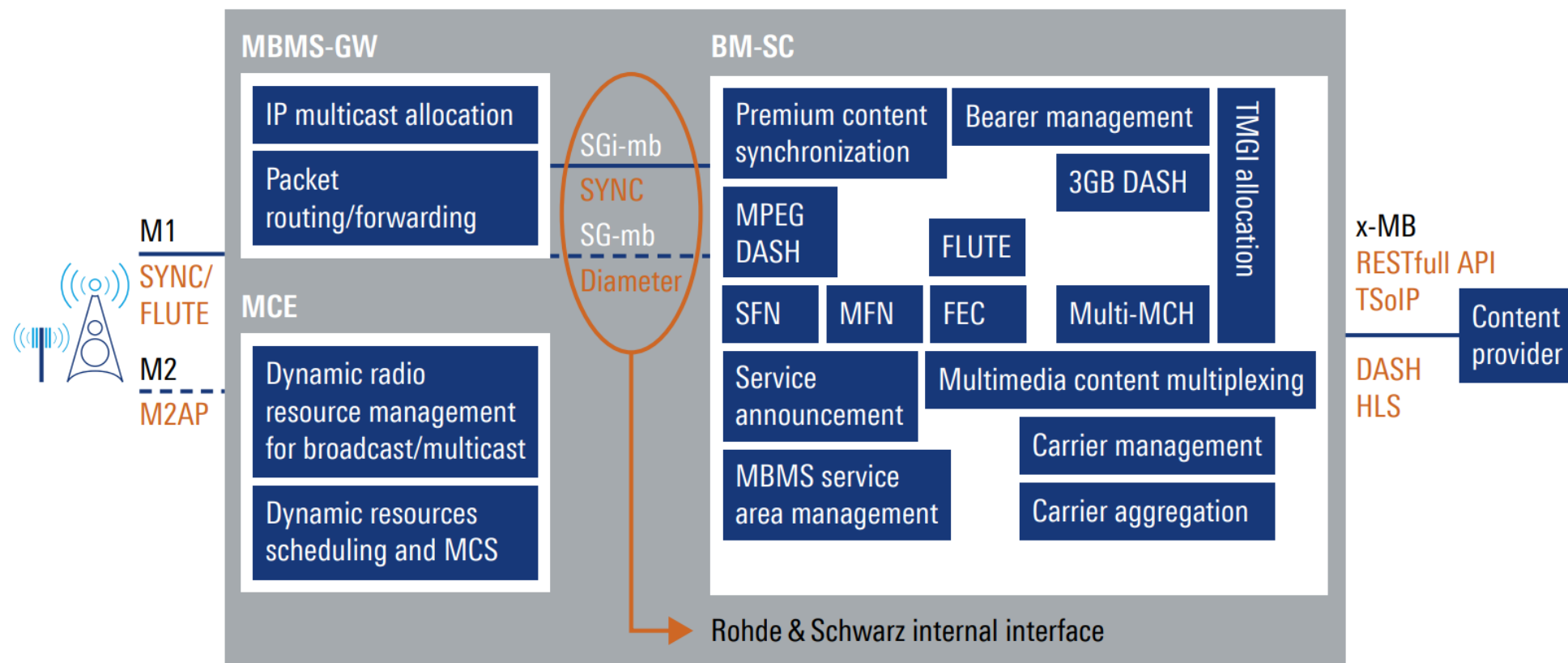


Equipment | 3GPP MBMS System architecture

- **BM-SC** Broadcast multicast service center is a 3GPP instance that provides membership and session control. One of the main tasks is ensuring content synchronization, service announcements and security. The BM-SC sets up the eMBMS session and initiates delivery of the content by pulling it from the content server.
- **MBMS-GW** Multimedia broadcast multicast service gateway distributes eMBMS user plane data to the transmitters using IP multicast and performs eMBMS session control signaling. It acts as a mobility anchor and provides service continuity.
- **MCE** Multicell/multicast coordination entity can be a separate entity or a part of eNodeB/transmitter. The main role of the MCE is to manage the broadcast/multicast-related radio resources such as the modulation and coding scheme (MCS).

Equipment | R&S BSCC2.0 internal architecture

- MBMS-GW, BM-SC and MCE are implemented in the R&S®BSCC2.0
- 3GPP Release 16 support
- Transport stream over IP (TSoIP)
- File delivery over unidirectional transport stream (FLUTE)
- MPEG-DASH, 3GP-DASH and HLS & Common media application format (CMAF)



Equipment | Rohde & Schwarz SDE900 server unit

- The LTE-based 5G Terrestrial Broadcast MBMS physical layer is implemented by the server based exciter solution, consisting of the SDE900 server unit and the TCE901 exciter.
- The SDE900 software defined encoder generates the I/Q modulation data. The TCE901 exciter generates the COFDM waveform based on the I/Q data.

Equipment | Transmitter

- Rohde & Schwarz THU9evo, TMU9evo & TLU9 transmitter



R&S® THU9evo high-power transmitter

The high-power transmitter family comes with the market-leading liquid cooling system and ensures trouble-free operation during its lifetime.

- ▶ Liquid-cooled
- ▶ Up to 106 kW in the UHF band
- ▶ Unique Rohde & Schwarz Doherty technology – up to 43% energy efficiency



R&S® TMU9evo medium-power transmitter

The medium-power transmitter stands for simplicity and endurance. Transmission has never been as effortless and cost-efficient.

- ▶ Air-cooled
- ▶ Up to 3 kW
- ▶ Unique Rohde & Schwarz Doherty technology – up to 40% energy efficiency



R&S® TLU9 low-power transmitter

The unique low-power transmitter/gap filler offers maximum reliability, ensuring trouble-free operation during its lifetime with minimum footprint.

- ▶ Air-cooled
- ▶ Single-box design
- ▶ 1 W to 200 W

Thanks!

@WenzelKenneth

#DVBT2 #T2Lite #ATSC3.0

#5GBroadcast

#Digitalradio #DRM+

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Kenneth Wenzel

About | Kenneth Wenzel

Kenneth Wenzel is an independent consultant who provide advice and training worldwide to a wide range of Network operators, Broadcasters and Public authorities - Covering DVB-T2, ATSC 3.0, 5G Broadcast & DRM standards, Network planning, Network design, Network architecture and Measurements, Acquisition and Installation.

In addition, Kenneth Wenzel is also the senior project manager and director of Open Channel, which is an independent Danish DTT network operator, where he and his team are performing tests and operating terrestrial digital radio & TV in Greater Copenhagen since 2006 in collaboration with the broadcast industry.

Kenneth Wenzel is the editor/manager of the DVB-T2, ATSC 3.0 & 5G Broadcast group on LinkedIn.

He is an innovator and entrepreneur in the digital radio & TV space, working with new technologies. Testing, developing and operating on the forefront of DRM+, DVB-T2 as well as related platforms such as ATSC 3.0, WiMAX and LTE/5G/5G broadcast.

Kenneth Wenzel holds a Master of Science in Engineering (M.Sc. Eng.) from The Technical University of Denmark (DTU). He has also studied in France. One-year high school and a year at the Ecole Centrale Paris, a French grand école in engineering and science.