Technische Universität Braunschweig

Institut für Nachrichtentechnik

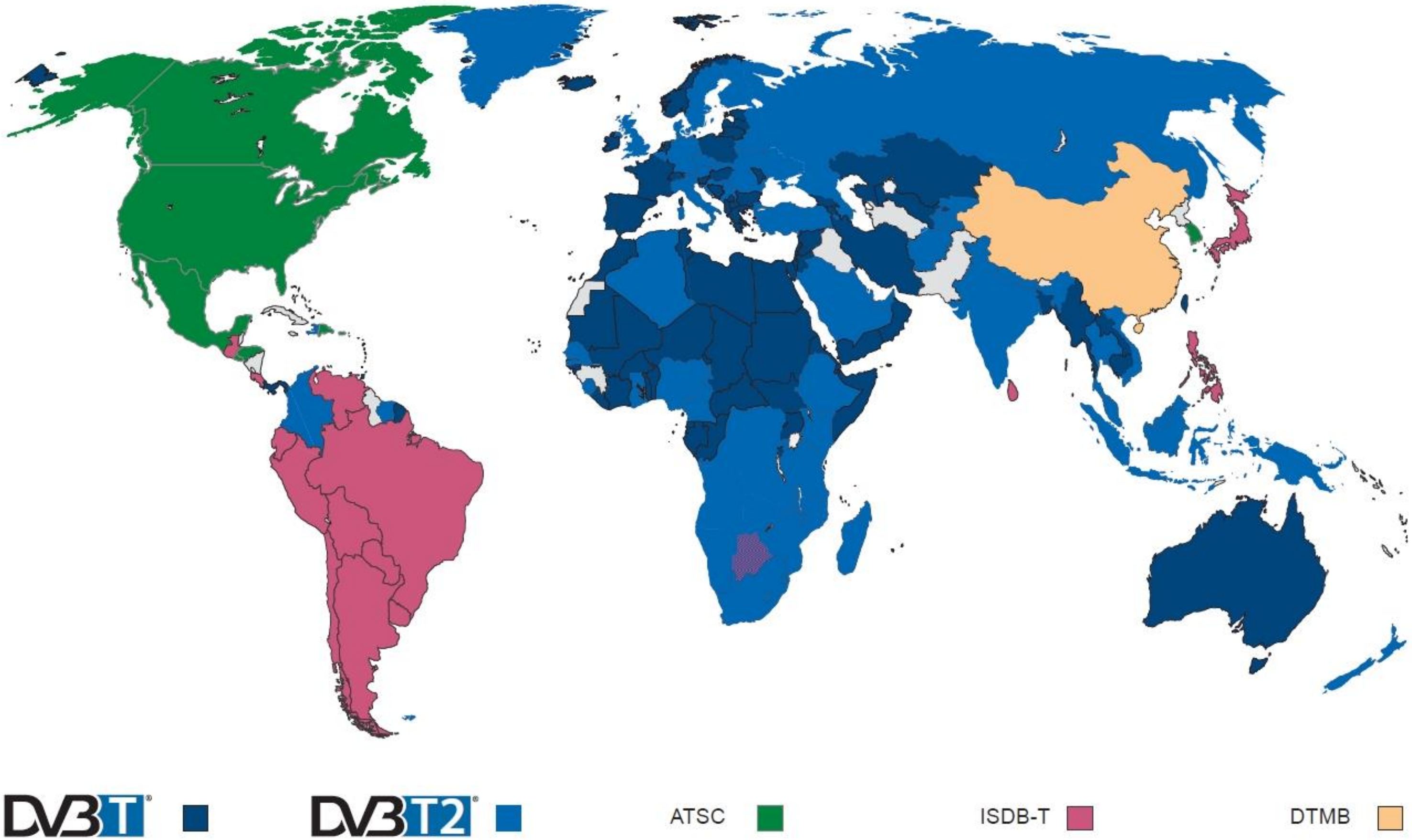
The future role of broadcast in a world of wireless broadband

Ulrich Reimers, 18 June 2015

Structure of my presentation

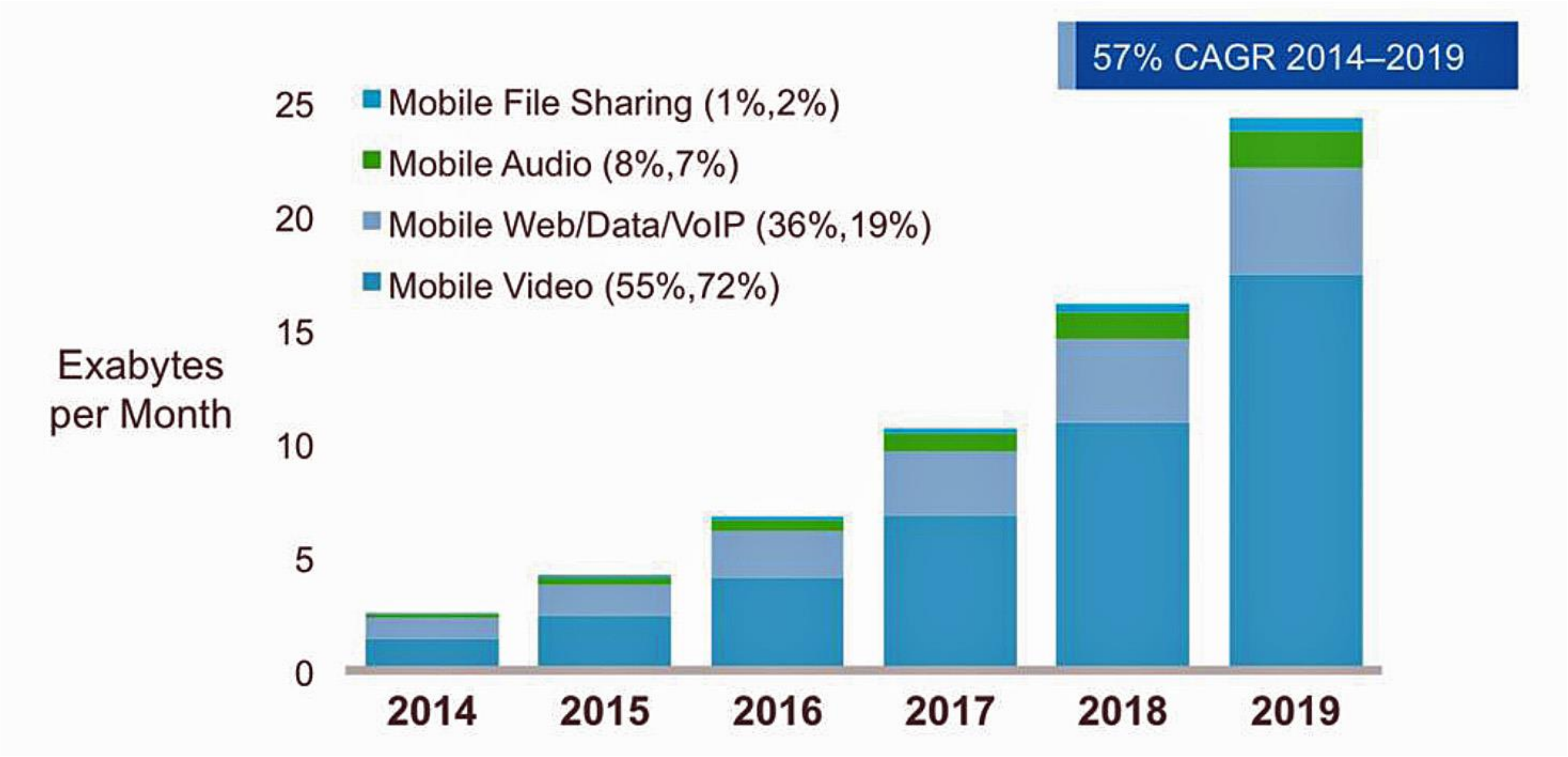
1. (Terrestrial) Broadcast and wireless broadband today – some observations
2. Our approaches to „bridging solutions“
3. Redundancy on Demand (RoD)
4. Dynamic Broadcast
5. Tower Overlay over LTE-A+ (TOoL+)
6. Conclusion

This is the world of terrestrial (TV) broadcast today – it is colourful (Source: www.dvb.org)



Digital Terrestrial Television Systems. Blue indicates countries that have adopted or deployed DVB-T and DVB-T2. April 2015

In 2019 mobile video will be responsible for 72% of all mobile data traffic?



Source: http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white_paper_c11-520862.html

Mobile Network Operators (MNOs) are spectrum hungry and will try to push terrestrial broadcast out of the UHF band?

Rundenergebnis der Runde 134

Frequenzbereich	Block	Ausstattung	Höchstbieter	Höchstgebot (€ in Tsd.)
700 MHz (gepaart)	700 A	2x5 MHz konkret	TEF DE	75.050
	700 B	2x5 MHz abstrakt	TEF DE	75.050
	700 C	2x5 MHz abstrakt	Vodafone	75.020
	700 D	2x5 MHz abstrakt	Vodafone	75.020
	700 E	2x5 MHz abstrakt	Telekom	75.000
	700 F	2x5 MHz abstrakt	Telekom	75.000
900 MHz (gepaart)	900 A	2x5 MHz konkret	TEF DE	116.668
	900 B	2x5 MHz abstrakt	Telekom	140.865
	900 C	2x5 MHz abstrakt	Vodafone	134.348
	900 D	2x5 MHz abstrakt	Telekom	134.389
	900 E	2x5 MHz abstrakt	TEF DE	140.246
	900 F	2x5 MHz abstrakt	Telekom	139.832
	900 G	2x5 MHz abstrakt	Vodafone	134.290
1,8 GHz (gepaart)	1800 A	2x5 MHz abstrakt	Telekom	205.158
	1800 B	2x5 MHz abstrakt	Telekom	224.993
	1800 C	2x5 MHz abstrakt	TEF DE	192.710
	1800 D	2x5 MHz abstrakt	TEF DE	195.204
	1800 E	2x5 MHz abstrakt	Telekom	214.320
	1800 F	2x5 MHz abstrakt	Telekom	232.171

In Germany, a spectrum auction is currently under way. It includes the 700 MHz band

On 12 June, after 134 rounds of auction the three MNOs allowed to participate have shown no particular interest in the 700 MHz band

The amount of money they offer is exactly the minimum sum that the regulator had defined before the auction started

The crystal ball: Video coding in 2016

- Using HEVC, in 2016 the following data rates should be realistic (aggressively defined, but the numbers are supported by colleagues at Fraunhofer HHI)

- For HDTV receivers of the „living room" type 5 Mbit/s video plus 0.8 Mbit/s for audio etc. are required
  - => 222 min. TV viewing per day leads to: 9.6 GByte/day, 290 GByte/month

- For Tablet PCs with a „retina display", 1 Mbit/s video plus 0.4 Mbit/s for audio etc. are required
  - It is unclear how long people will watch video on tablets in the future
  - => 1 hour requires 630 MByte
  - => 1 hour per day every day requires 18.9 GByte/month

- With a view to the fact that true flat rate tariffs are a dying species: What will be cost implications for the user if (wireless) broadband will have to deliver these amounts of data?

Another question arises: Will people really watch „Live" video on portable devices? If classical terrestrial broadcast should no longer be available, the answer is: „Yes"

If „Live“ video on Tablet PCs and other portable devices is required, then:

- One or more of the following network technologies will have to do the job:
  - WiFi – for all of us, this is an extremely important delivery network technology based on a fixed Internet connection. WiFi experiences congestion in many built-up areas
  - Long Term Evolution (LTE) in unicast mode
  - LTE with eMBMS (evolved Multimedia Broadcast Multicast Service)
  - A „bridging solution “ combining the best of the (terrestrial) broadcast and the wireless broadband worlds

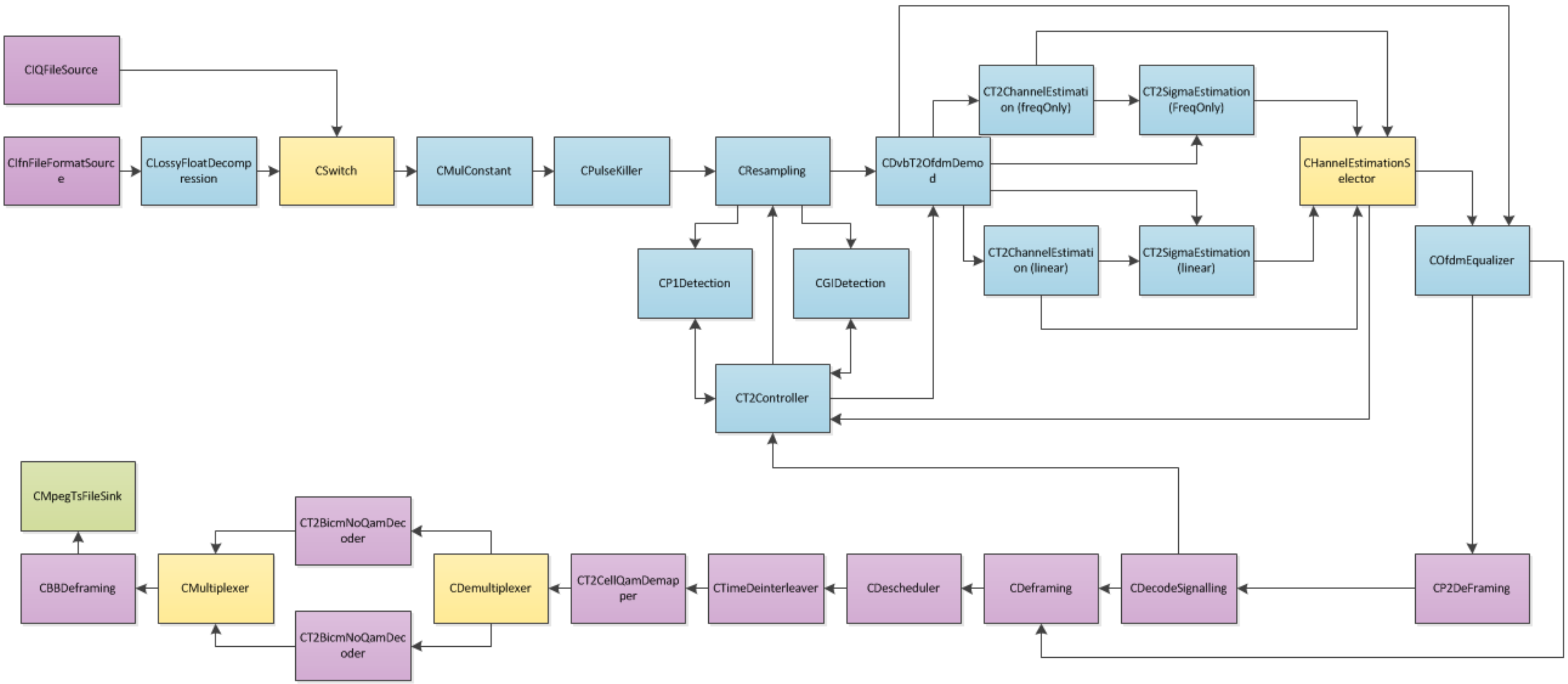
- Is the following scenario completely unrealistic?
  - Olympic Games 2020 in Tokyo
  - In Germany, eight parallel „Live“ video streams @ 1.4 Mbit/s each are requested by viewers in 2/3 of the 30.000 network cells of each of the 3 mobile network operators

My team and I in Braunschweig…

- … continue doing research on traditional broadcast systems such as DVB-T2 (specializing on the reception in high speed environments such as cars and trains) and ATSC 3.0
- But our main focus is on „bridging solutions“ – bridging the gap between wireless broadband and broadcast systems
- Our first proposal is „Dynamic Broadcast“
- Our second proposal is the „Tower Overlay over LTE-A+ (TOoL+)“
- Our third proposal is „Redundancy on Demand (RoD)“

- Why „bridging solutions“? We are aware of:
  - The rather dramatic increase of video consumption in mobile data networks
  - The increasing pressure on terrestrial broadcast spectrum (really?)
  - The growing popularity of mobile devices such as Tablet PCs
  - The loss of importance of classical terrestrial broadcast (at least in Germany)

We are able to realise our systems via Software Defined Radio and meanwhile we are able to achieve „live quality“



Example: An in-car receiver for DVB-T2

Approach No. 1: Dynamic Broadcast

- Dynamic Broadcast assumes that classical terrestrial broadcast is maintained and that the viewers continue to enjoy the traditional viewing comfort
- Dynamic Broadcast retains the dominant role of broadcasters in defining their program schedules
- Despite accepting these two boundary conditions, Dynamic Broadcast makes spectrum availabe for wireless broadband
- The fundamental concept behind Dynamic Broadcast is the time-multiplexed allocation of spectrum

- One positive effect of Dynamic Broadcast is the fact, that TV White Spaces now are managed actively

Approach No. 2: Tower Overlay over LTE-A+ (TOoL+)

- TOoL+ enables a joint and and co-timed use of spectrum by both classical terrestrial broadcast and wireless broadband networks – without being tied to the existence of classical terrestrial broadcast since that may disappear over time
- At the same time we assume that mobile devices with high-quality displays (e.g. Tablet PCs) will be able to present „live-HQ-video“. We are convinced that cellular technologies will not be able to offer these services in an economically acceptable way – where „acceptable“ relates to both the cost for network operators and for the end customers.
- And we assume that broadcast tuners will not be implemented in Smartphones and Tablets in a large scale. One reason? The plurality of broadcast standards (Sorry! DVB-H, DVB-SH, DVB-NGH, and MediaFLO told us a lesson)

Approach No. 3: Redundancy on Demand

- With this approach we support classical terrestrial broadcast networks in times of ever tighter spectrum ressources and of increasing interference
- The coverage area of a classical terrestrial broadcast network is extended (for instance for deep indoor reception). If the signal quality of the terrestrial broadcast signal is insufficient, the receiver pulls some redundancy information via (wireles or fixed) broadband network.
- This approach was jointly developed by Sony and TUBS

- By the way: Our systems have been introduced in the DVB-Project

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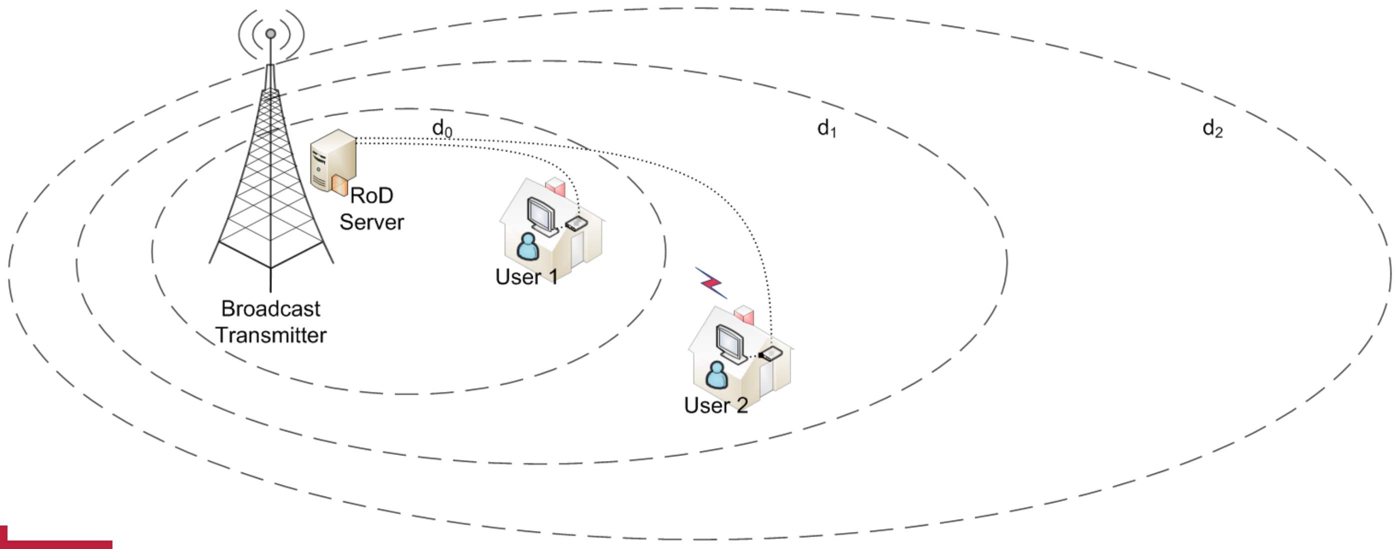
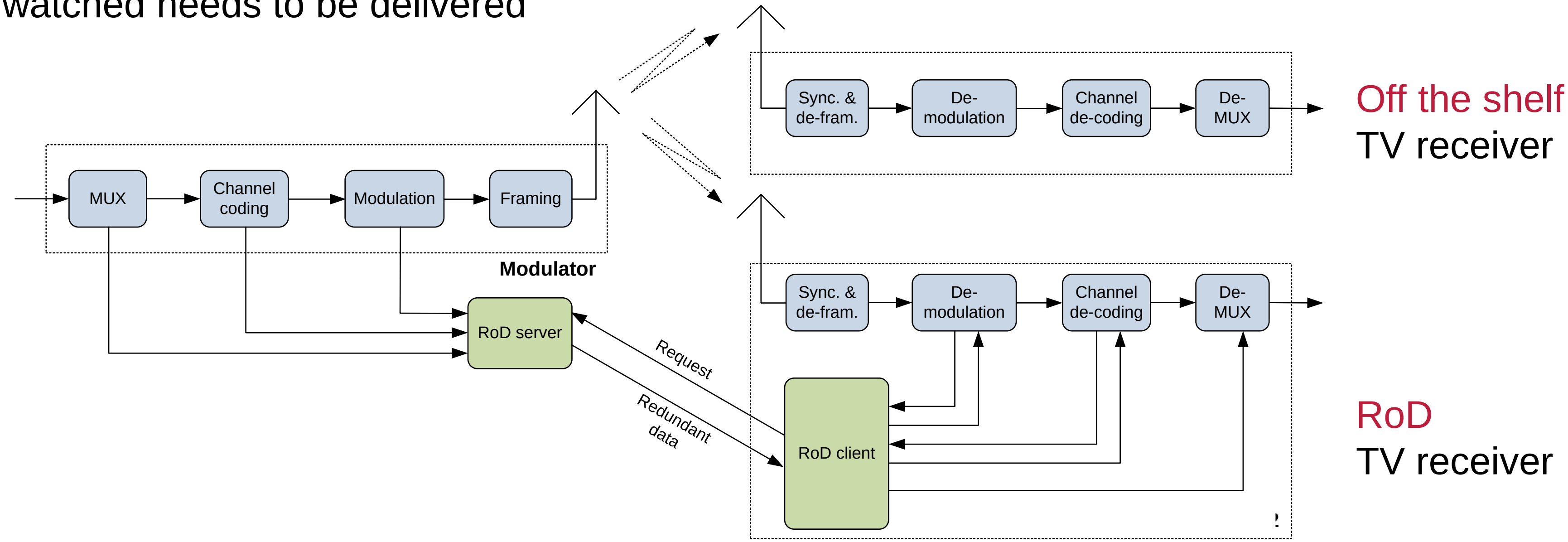
Redundancy on Demand (RoD)

- State of the art TV receivers are equiped with both broadcast (terrestrial, cable, satellite) frontends AND broadband network interfaces (Ethernet, WiFi …)
- So far, the media content is either received via the broadcast OR via the broadband interface
- RoD extends the coverage of terrestrial TV broadcast by use of the broadband network
- The RoD receiver requests „redundancy“ via the broadband network if the transinformation on the broadcast network is insufficient. Redundancy may be single FEC packets
  - A primary target of RoD is optimizing indoor reception in metropolitan areas
  - Convergence of broadcast and broadband happens on the physical layer



The RoD system

- A RoD server generates the required redundancy data
- A RoD receiver requests redundancy if required and decodes the broadcast signal with support by the RoD data
- As shown in the diagram, RoD is backwards compatible
- Yes, buffering is required in the RoD receiver in order to compensate for the request cycle (for typically 200 ms)
- Since DVB-T2 uses Physical Layer Pipes (PLPs) only the redundancy for the PLP actually watched needs to be delivered



The RoD system – already **field tested** in the DVB-T2 network in Berlin in 2015

RoD server GUI

RoD receiver GUI

RoD server + DVB-T2 gateway

DVB-T2 modulator

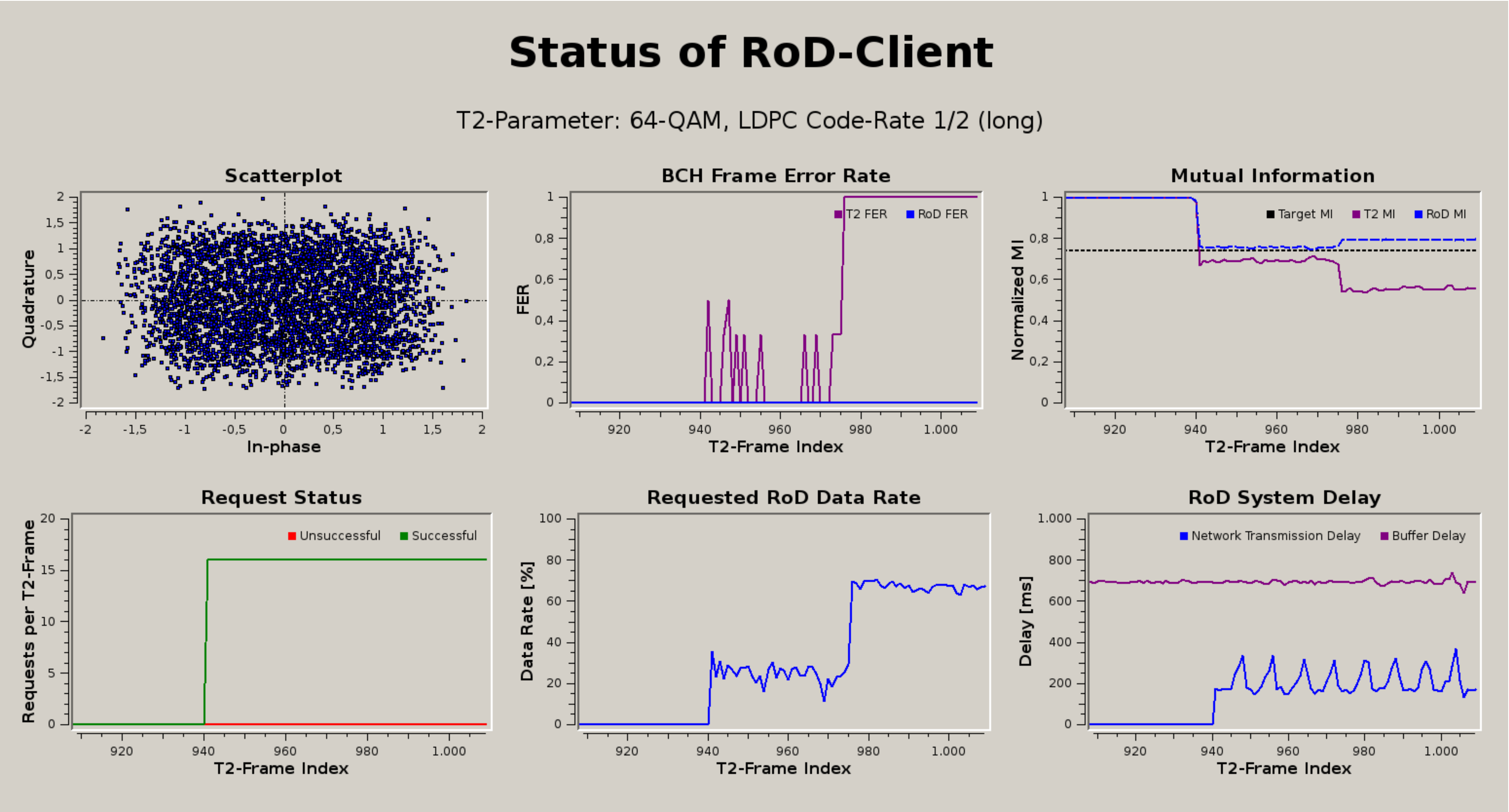
DVB-T2 receiver (off the shelf)

Display of the RoD receiver

SDR-Frontend

RoD receiver

The graphical user interface of the RoD receiver tells the whole story



By the way: in the field trial in Berlin we used LTE for delivering RoD data to an in-car RoD receiver

Now let us create a more radical approach: Broadcast and broadband networks cooperate above the physical layer

- Why does all content have to be broadcasted – even if only few people watch it? Let us deliver „the long tail“ over broadband and save cost on the broadcast network

- With a view to the storage capacity available in the receivers, not all content needs to be transmitted in „real time“ since some of it can be pre-transmitted and (securely) stored for presentation at the on-air time decided by the broadcaster. And: content that will be repeated will not have be transmitted again

- This is where Dynamic Broadcast comes into the picture

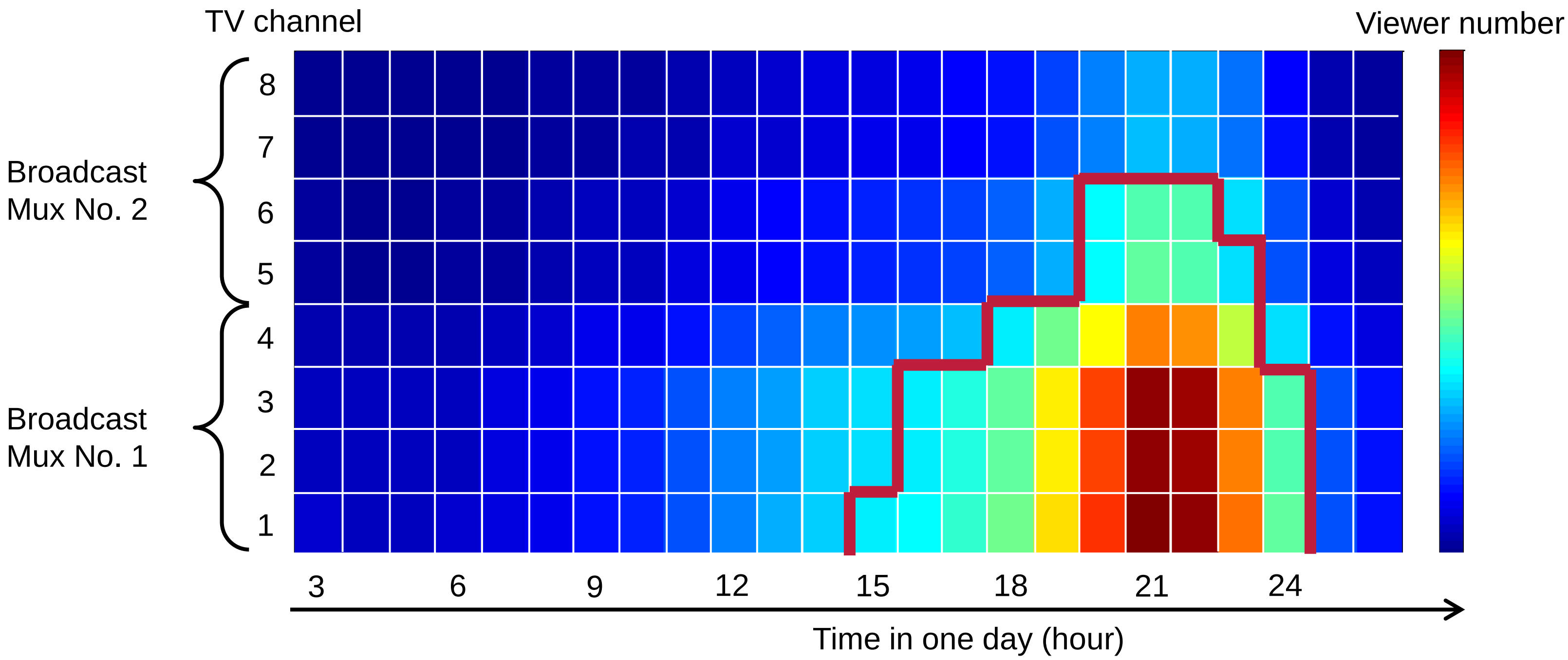
- Dynamic Broadcast frees capacity on the broadcast channels and thus gives broadcasters the chance to distribute additional virtual channels

- Dynamic Broadcast enables a dynamic use of TV spectrum and thereby supports the use of White Space devices in spectrum managed by the broadcaster

- At least in certain countries broadcast network operators can make „dual use“ of the TV spectrum by operating wireless broadband networks inside „their own spectrum“

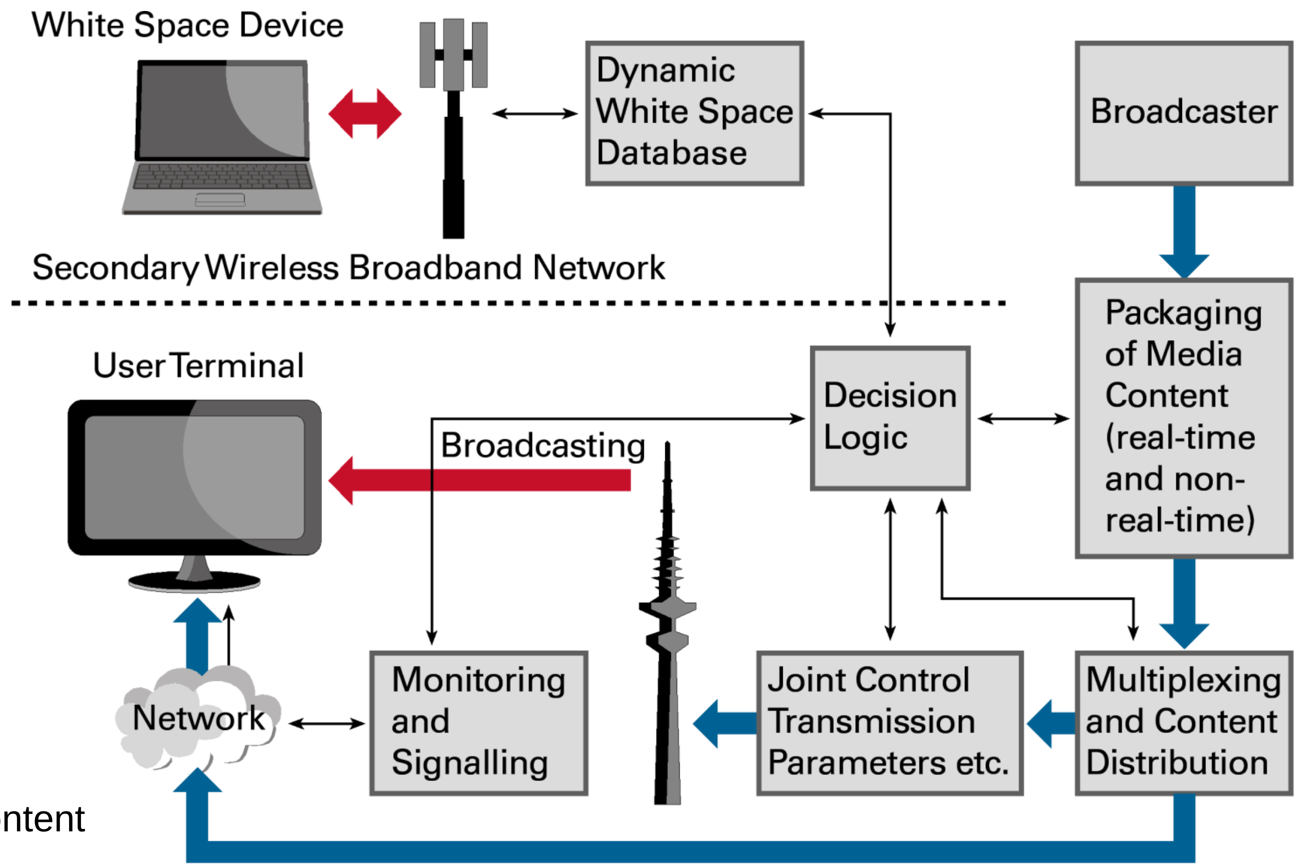
Popularity distribution of TV events – an example

- The example used here are two DVB-T multiplexes in operation in Germany: Each carries four TV channels (programmes)



Overview of the Dynamic Broadcast system

Important: The viewers will not notice any difference in comparison to traditional TV broadcast



- Broadcast media content
- RF transmission
- Control channel

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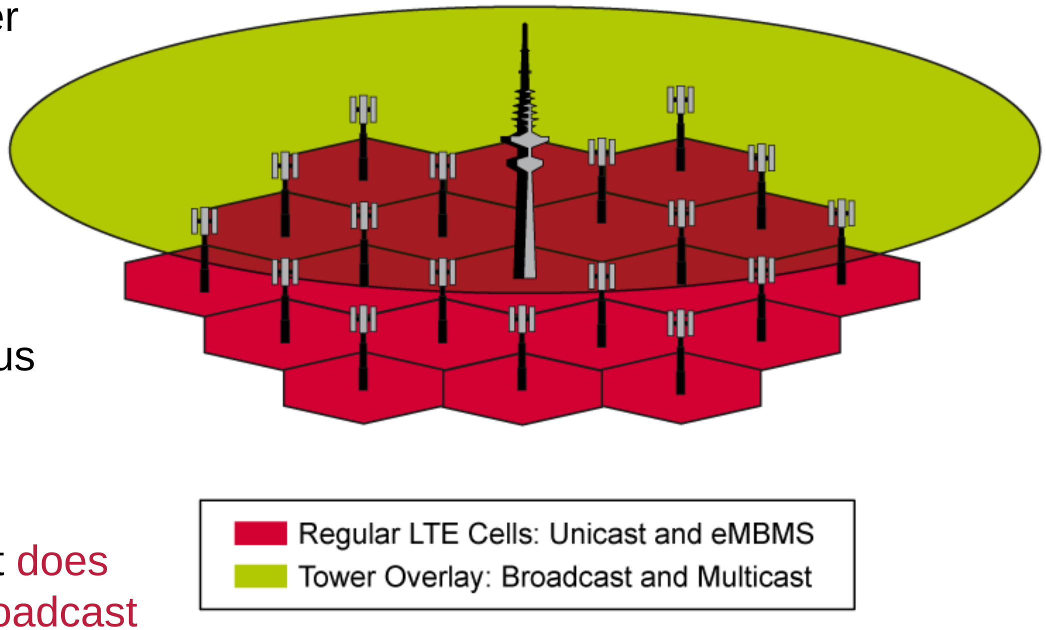
Dynamic Broadcast requires/offers new degrees of freedom

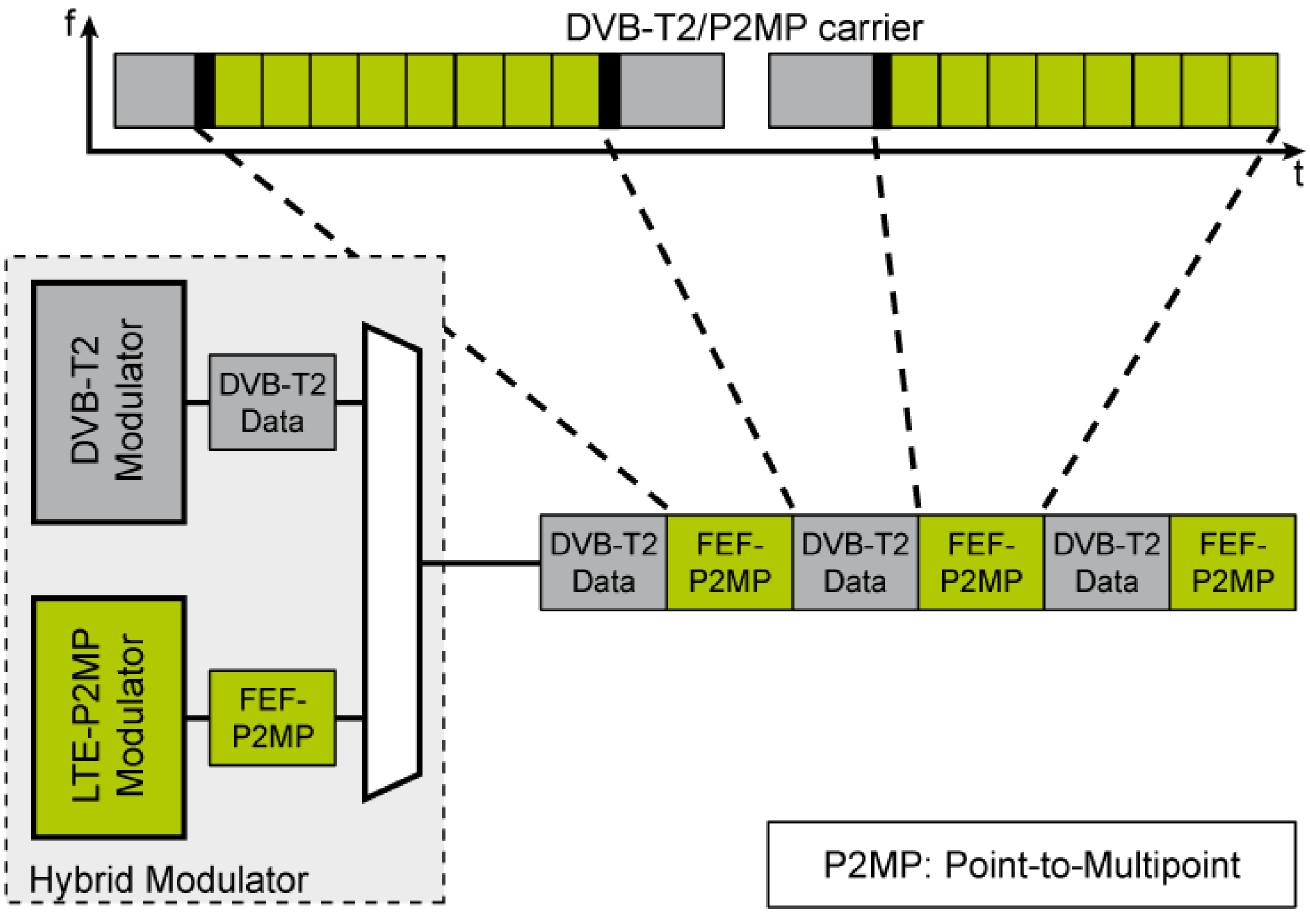
- In order to make broadcast network structures „dynamic“ some or all of the following degrees of freedom will be exploited – dynamically over time:
  - Choice of live broadcast or of content pre-download or of local replay of repeat content
  - Choice of delivery network (broadcast or broadband)
  - Multiplex configurations of the broadcast network
  - Channel allocations in the broadcast network
  - Transmission parameters of the broadcast network
- We first demonstrated the system live at IFA Berlin 2012
- (May be, this approach is a bit too radical?)

Tower Overlay over LTE-A+ (TOoL+): The concept

- Both LTE and LTE eMBMS are based on a more or less dense cellular infrastructure which we believe is too costly for the delivery of popular media content
- In our system, popular video services are provided on a dedicated carrier via a Tower Overlay over the cellular network
- The overlay becomes part of the LTE-A^{+} network by means of LTE-A^{+} carrier aggregation to ensure simultaneous provision of unicast, eMBMS, and broadcast services
- The LTE-A+ Smartphone or Tablet does not have to be equipped with a broadcast frontend to receive the signal

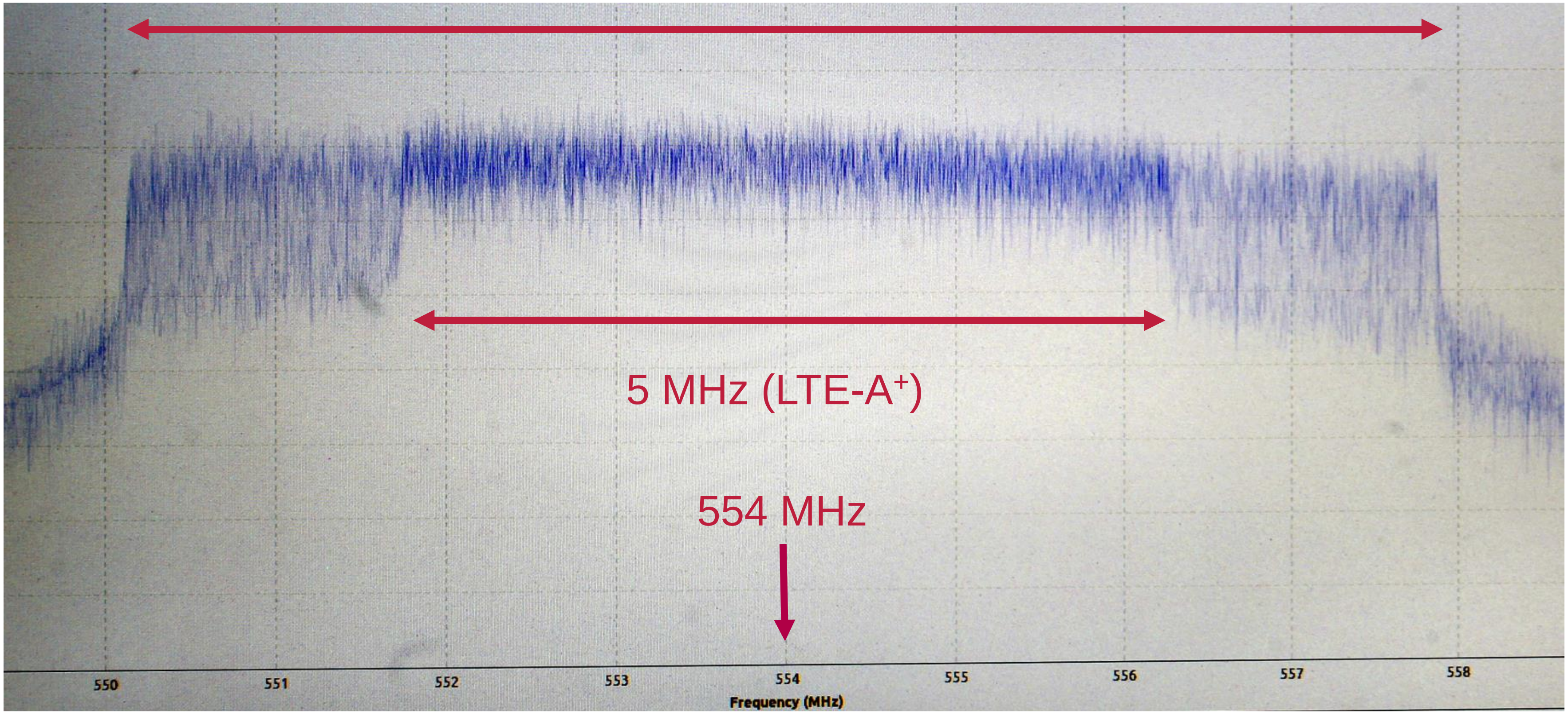


The LTE-A+ signals are embedded in Future Extension Frames provided by DVB-T2 (and by ATSC 3.0)



LTE-A+ signals? Look at this spectrum

8 MHz (DVB-T2)



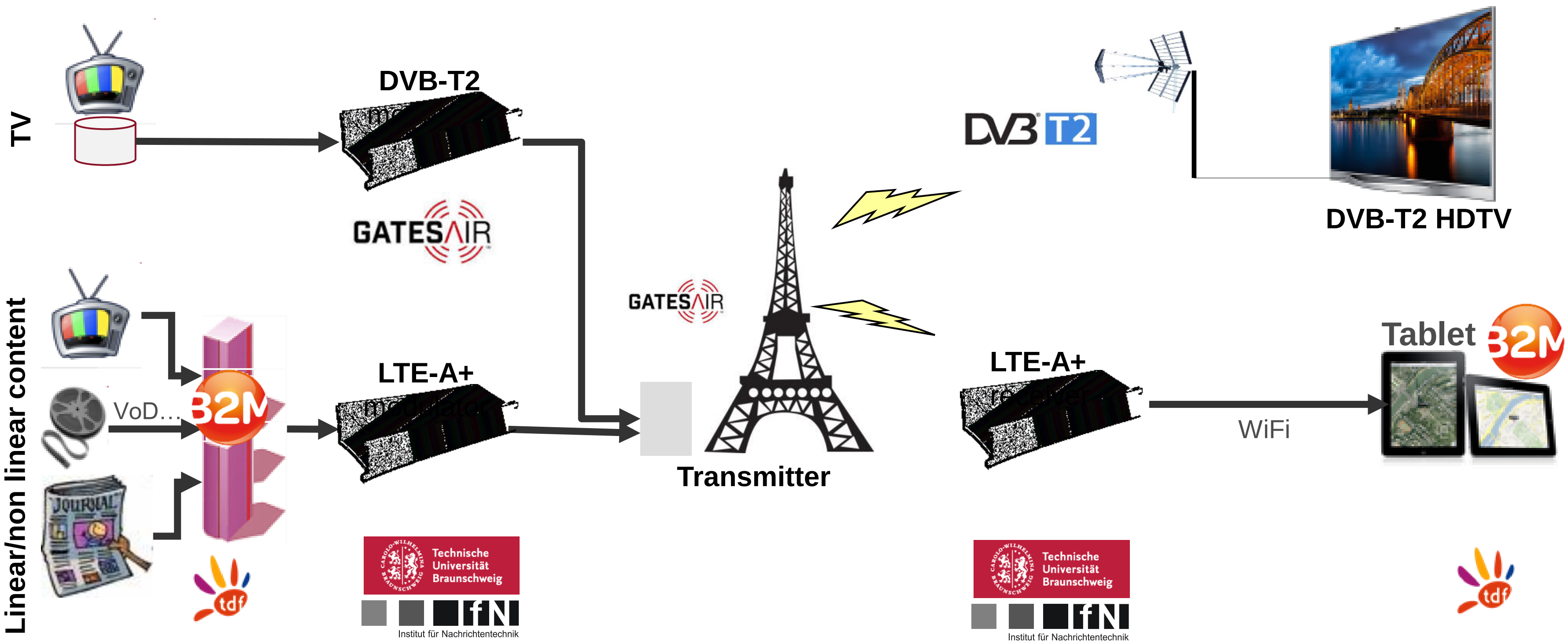
5 MHz (LTE-A+)

554 MHz

This is LTE-A+ at 5 MHz. We can also show LTE-A+ at 8 MHz

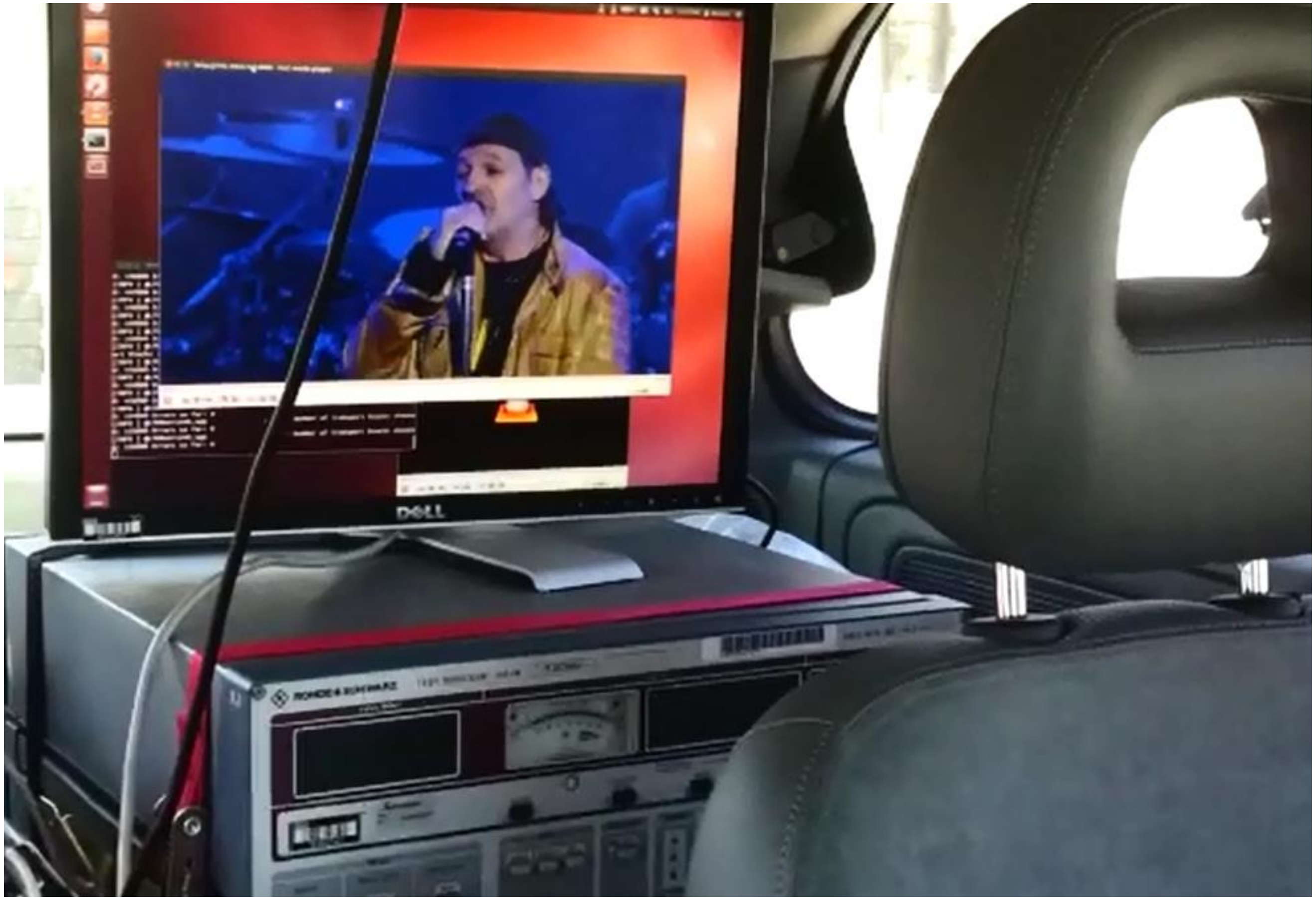
TOoL+ has already been **field-tested** in Paris in 2015 and is on air in the Aosta Valley in Italy (and in Braunschweig)

- Two independent DVB-T2 and LTE-A+ network components, sharing a broadcast frequency



This diagram was designed by Pierre Bretillon, TDF

In-car reception of TOoL+ in the Aosta Valley



Our RAI colleagues receiving the LTE-A+ component in a car moving through Aosta

Conclusion

- With the availability of DVB-T2, terrestrial broadcast networks have reached a fabulous efficiency and performance. ATSC 3.0 promises to provide similar quality
- Despite such excellence, terrestrial broadcast is challenged by a variety of alternative ways to deliver media content and by the ever-growing importance of „media-capable" portable devices such as Smartphones and Tablet PCs
- More than ever before operators of terrestrial broadcast networks need to define long-term strategies in a fast developing media world in which even their right to use spectrum eclusively may no longer be guranteed
- At the same time Mobile Network Operators (MNOs) are facing a video avalanche which may jeopardize their current business models
- This is why my team and I are determined to offer new approaches for terrestrial media distribution – come and join us

Thank you
for your attention!

Prof. Dr.-Ing. Ulrich Reimers

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