Convergence of Mobile Communications and Broadcasting: A long term perspective

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Overview

Convergence of Mobile Communications and Broadcasting

- Introduction
- Terrestrial Broadcasting Infrastructure in Germany
- Mobile Communications Infrastructure in Germany
- Convergence: A long term perspective
- Unified Infrastructure: Benefits and Regulatory Issues

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Convergence Broadcasting / Communications

Introduction and Research Targets

Current Situation

- Broadcasting and communication infrastructure exist in parallel
- Increasing cooperation between MNOs due to high infrastructure costs
- Increasing demand for mobile Internet
- Low market penetration of terrestrial television broadcasting

Regulatory Challenges in Germany

- Spectrum is an economic good, to be used efficiently
- Basic law (*Grundgesetz*) gives broadcasting special role, separate from telecommunications
- Federalist structure of broadcasting in Germany

Aspects of Convergence

1. Efficient use of spectrum: Potential benefits of a unified broadcasting and mobile communications infrastructure
2. Regulatory challenges

Source: TKG, Grundgesetz

Spectrum regulation

Use of spectrum is regulated due to its shared medium characteristics

Technological Regulation

Parameters

- Transmit power
- Frequency ranges
- Standard

Spectrum assignment

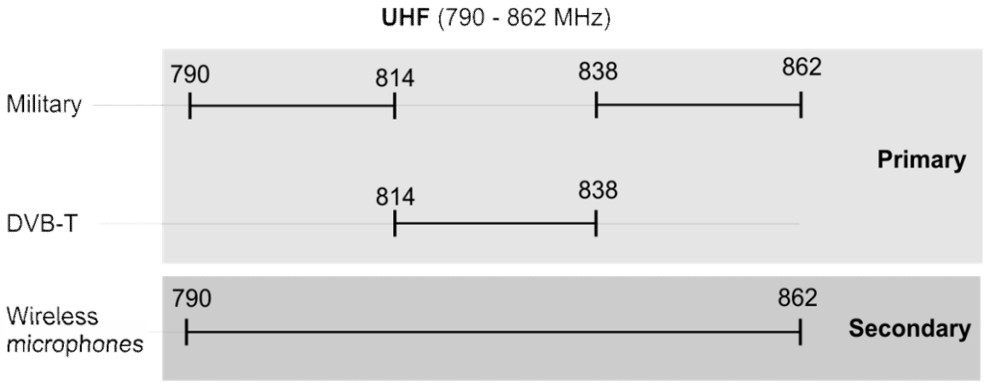
- Duration > 10 years
- Explicit assignment of frequency ranges

Goal of technological regulation

- Minimizing interference
- Efficient use of spectrum

Regulatory Measures

- Individual assignment or general authorization
- Regulation leads to spectrum scarcity and creates the economic good „spectrum”



Example: Current assignment of frequencies between 790 MHz and 862 MHz („Digital Dividend“)

Source: Bundesnetzagentur, Frequenzbereichszuweisungsplan (2008), TKG

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Terrestrial Broadcasting in Germany

DVB-T / Terrestrial television is major spectrum user

Terrestrial broadcasting

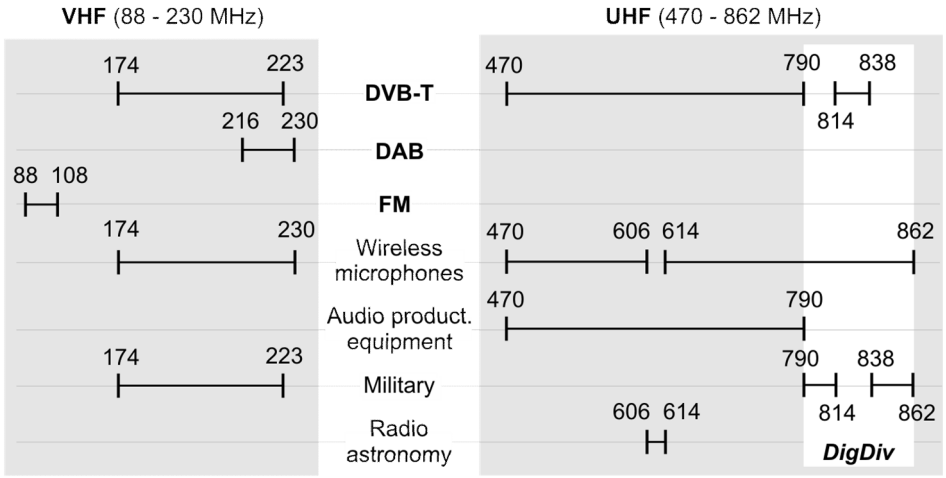
- Audio and television broadcasting
- Broadcasting services offered in the
  - VHF (30 MHz – 300 MHz) and
  - UHF (300 MHz – 3000 MHz) bands
- Spectrum is shared with secondary users

Spectrum allocation

- Spectrum allocation to broadcasting: 427 MHz
- FM: Analog audio broadcasting (5%)
- DAB: Digital audio broadcasting (3 %)
- DVB-T: Digital television broadcasting (92%)

DVB-T

- 512 broadcasting stations cover 90% of Germany outdoors, 30% indoors/mobile
- Transmitters are high power, 50 kW mean
  - Coverage area: several dozen kilometers radius
- Modulation OFDM-based, allows for single frequency networks (SFNs)
- Data rate per TV channel: 3,5 MBit/s



Source: Task Force DVB-T (2009), Bundesnetzagentur, Frequenzbereichszuweisungsplan (2008)

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Mobile Communications Infrastructure 1/2

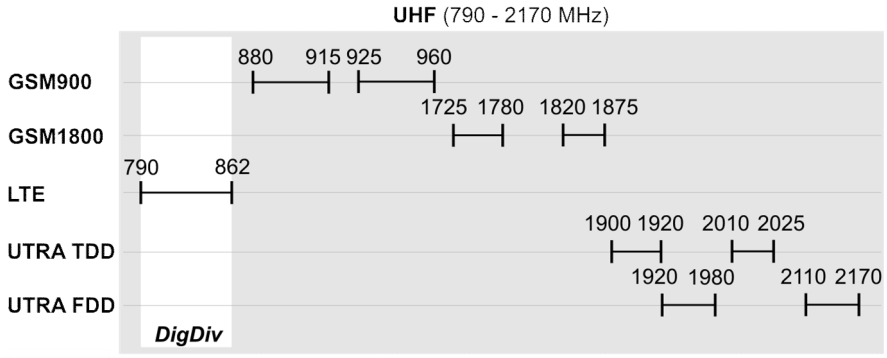
In Germany: Four MNOs and 3 mobile standards

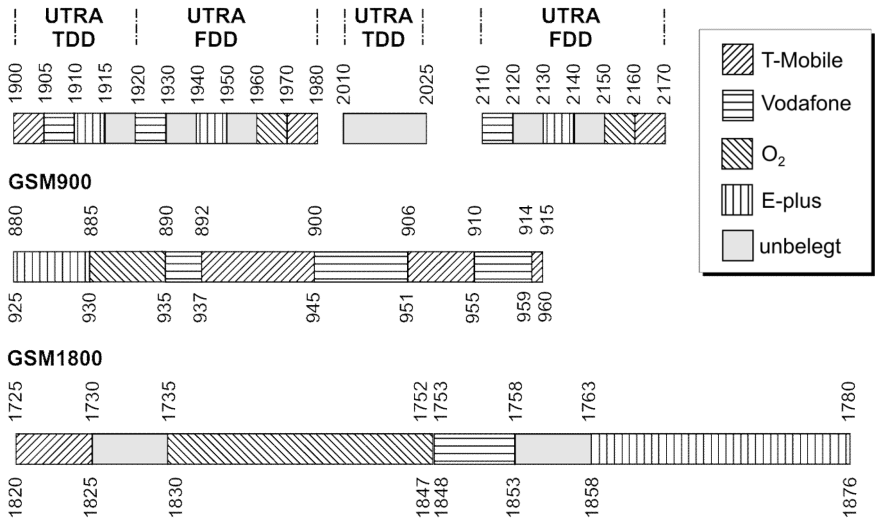
Mobile communications

- Voice and data services offered
- GSM and UMTS operate in
  - Lower UHF (880 MHz – 960 MHz)
  - Higher UHF (1800 MHz, 2000 MHz)
- Spectrum is assigned exclusively to operators

Spectrum allocation

- In total 407 MHz assigned to MNOs (including Digital Dividend frequencies)
- Uneven distribution among operators (auction/assignment outcome)
- No possibility to trade spectrum





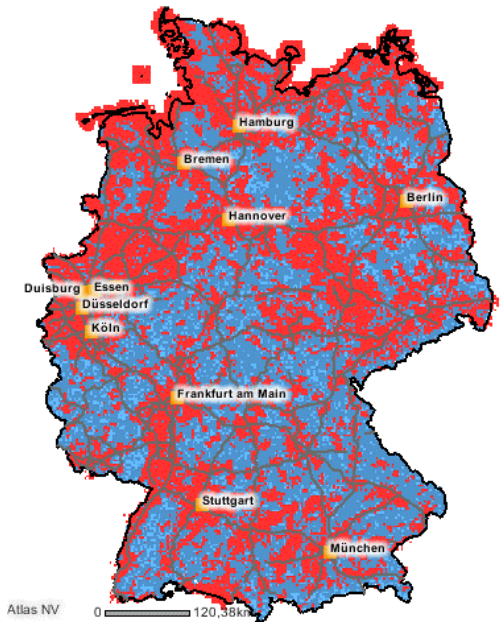
Source: Bundesnetzagentur, Frequenzbereichszuweisungsplan (2008)

Mobile Communications Infrastructure 2/2

In Germany: Four MNOs and 3 mobile standards

GSM/UMTS Coverage

Example: Vodafone



GSM GSM +UMTS

Parallel Infrastructures

- Parallel Voice and Data networks
  - GSM with 473 kBit/s
  - UMTS with 384 – 7.2 Mbit/s
- Parallel Infrastructures by 4 operators

T-Mobile vodafone O2 e-plus

Next Step: LTE

- LTE with 20 – 100 Mbit/s
- Hence, LTE will be the first standard with high enough data rates to allow video streaming comparable to DVB-T
- New infrastructure (investments) required by each of the operators

Source: MNOs (2009); 3GPP (2009)

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Cost Reasons: Mobile Communications

High infrastructure costs force MNOs to cooperate

Cost Impacts

Spectrum Use

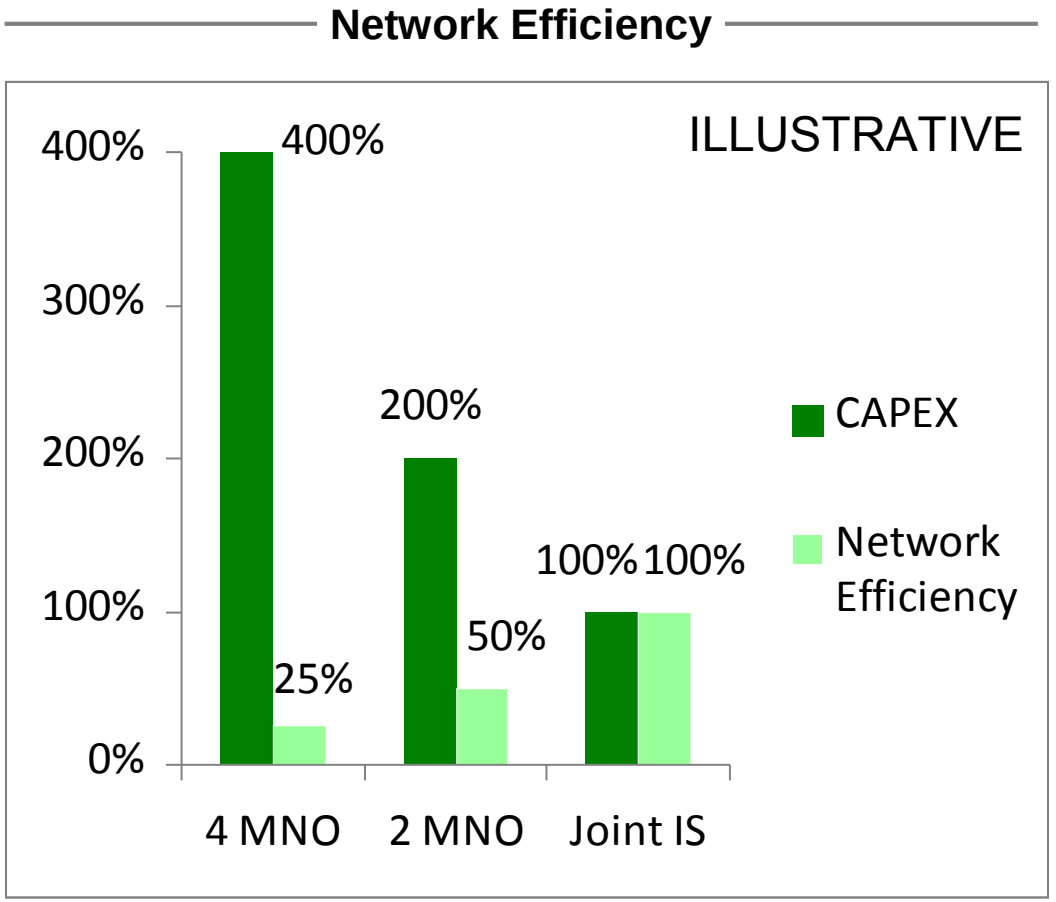
- "Efficient use of spectrum" required by law (TKG §52)
- Fixed assignment to operators

Infrastructure Sharing

- Outsourcing of network operation (e.g. E-Plus → Alcatel Lucent)
- Joint frequency use not allowed in DE
- Joint Planning for LTE started (discussion by Swiss regulator)

Spectrum / Resource Trading

- Joint frequency use on joint infrastructure in the future?



Source: TKG § 52, Furrer (2009), and according to Krämer (2009), Forge/Blackman/Bohlin (2007), p. 9.

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Regulatory Reasons: Spectral Area Efficiency

Spectrum is more efficiently used in small cells with low power transmitters

Efficient use of spectrum

- "Efficient use of spectrum" required by law (TKG §52)
- Efficiency not clearly defined
- Technological efficiency can be measured in spectral area efficiency

EM wave propagation: High attenuation

- Signal strength decays fast from transmitter (inverse power law)
- Assume received power at coverage cell edge P_C
- α = 2..5, for broadcasting $\alpha = 4$

Lower power, higher efficiency

- For α = 4 the power to cover the same area is reduced by a factor of n; data rate is increased by factor of n
- Gain is reduced due to frequency planning, but general relationship holds

$$P_C \propto \frac{1}{r_0^{\alpha}} P_0$$

$$P_n = n^{-\frac{1}{r_0^{\alpha}}+1} P_0 \cdot P_0$$

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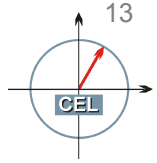


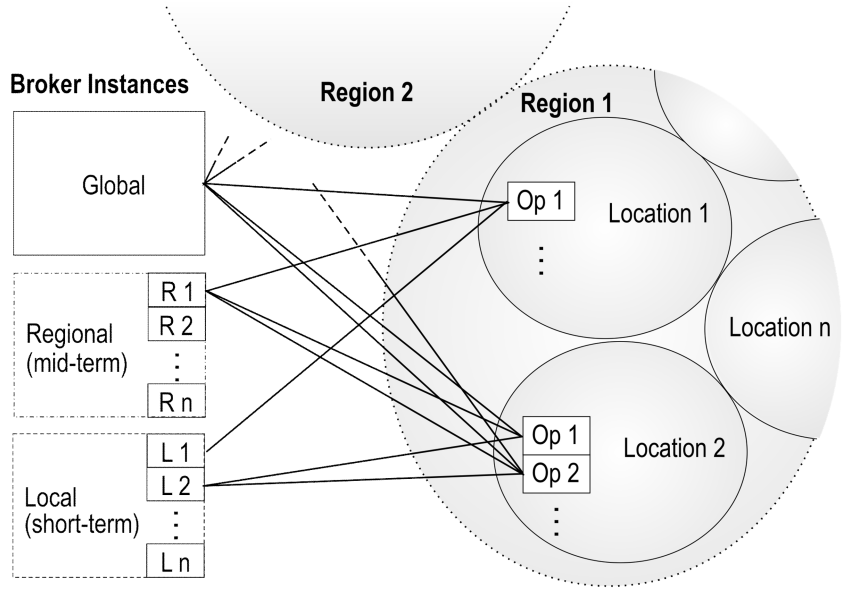
Regulatory Reasons: Efficient Spectrum Allocation

A very long term perspective: Unified Infrastructure can support Online Spectrum Auctions

Online Spectrum Auctions

- Model: Several service providers (former MNOs) share unified infrastructure
- MNOs facing high traffic demand may bid for additional channels/spectrum, low demand operators may offer parts of allocated channels/spectrum
- Double auctions similar to stock exchange within a trading period
- Prerequisite: Goods need to be interchangeable: equivalent cell coverage
  - Unified infrastructure provides for this

Hierarchical Spectrum Trading



Source: Burgkhardt (2009), Yamada (2008), Cave (2006)

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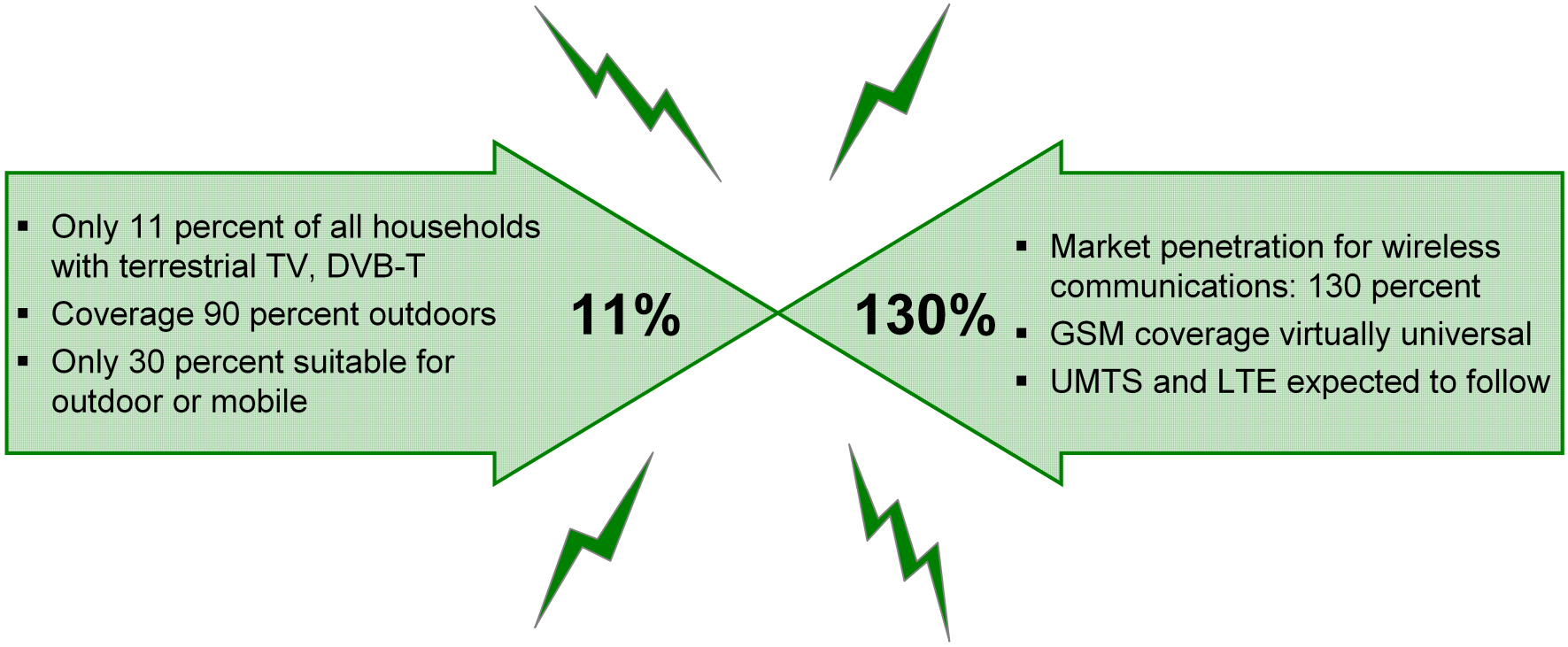
Regulatory Reasons: User Preferences

Rising mobile data demand, low market penetration of DVB-T



Source: BNetzA (2009), Frequenznutzungsplan

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Unified Infrastructure – Benefits and Challenges

Do technological advantages outweigh regulatory challenges? Future research.

Technological Advantages

- Cost savings due to removal of redundant infrastructure
- Higher spectral area efficiency
- More effective MNO frequency planning and better capacity / area coverage
- Simplified international frequency planning due to lower power
- Long run: free, real-time formation of spectrum prices via auctions

Unified joint Infrastructure

Regulatory Concerns

- Infrastructure competition eliminated?
- Competition on a single network, comparable to wired services?
- Special role of broadcasting in German law – need to restructure *Landesmedienanstalten* and redefine basic coverage (*Grundversorgung)*?

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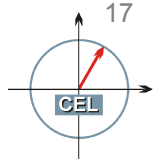

Q&A / Discussion

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Thank you for your attention!