

## *Lecture 9*

# Regulation by Licensing

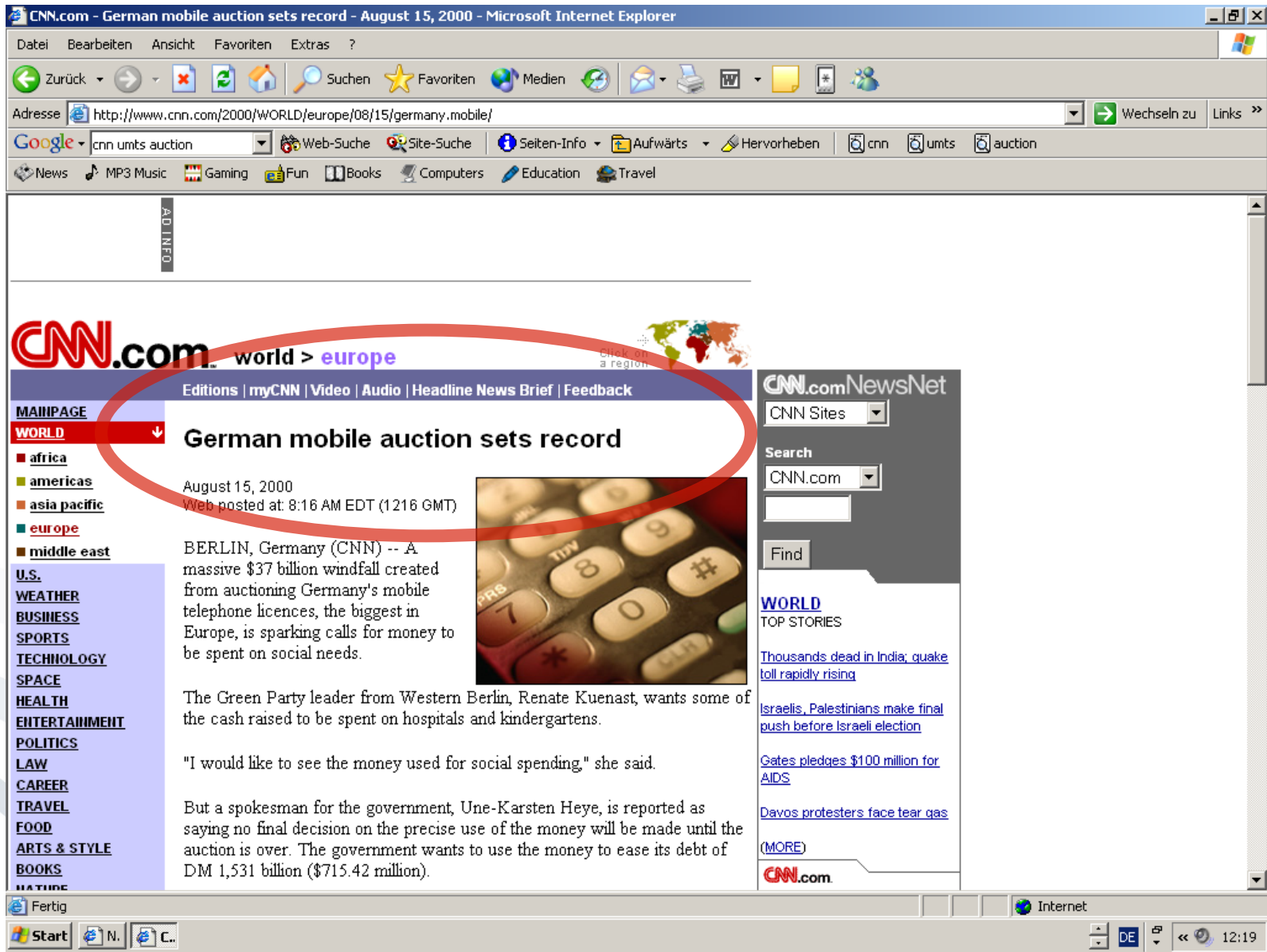
Mobile Business II (SS 2016)

Prof. Dr. Kai Rannenberg

Deutsche Telekom Chair of Mobile Business & Multilateral Security  
Goethe University Frankfurt a. M.



- General Information
- UMTS Auction in Germany (2000)
  - Process
  - Admittance to the Auction
  - Licence
    - Liabilities
    - Validity
  - Result of the Auction
  - Auction of the Auction's Clock
  - International UMTS Licensing
- Frequency auction for wireless access (2010)
- Frequency auction for wireless access (2015)
- Conclusions and Outlook



The screenshot shows a Microsoft Internet Explorer browser window. The address bar displays the URL: <http://zdnet.com.com/2100-1105-530774.html>. The browser's menu bar includes 'Datei', 'Bearbeiten', 'Ansicht', 'Favoriten', 'Extras', and '?'. The toolbar contains various icons for navigation and actions. Below the toolbar, there are search engines (Google, Web-Suche, Site-Suche) and a list of categories (News, MP3 Music, Gaming, Fun, Books, Computers, Education, Travel). The main content area displays the ZDNet News website. The article title 'UK 3G operators 'destined for bankruptcy'' is highlighted with a red oval. The article is by Graeme Wearden, dated September 25, 2001, 5:00 PM PT. The text of the article discusses the mobile industry's warning that two of the UK's 3G licence holders could go bust by 2004 due to slow m-commerce growth. An advertisement for IBM eServer iSeries 890 is visible at the bottom of the article. The right sidebar contains a search bar, a 'Tech Update' section with links to 'Securing cyberspace: The national plan', 'InfiniBand--old before its time?', and 'Take steps to minimize laptop loss', and a 'News in Brief' section with headlines like 'Site makes room for unknown musicians' and 'Barksdale sells \$1 million in AOL stock'. The bottom status bar shows the current page and the time 12:21.

**News: UK 3G operators 'destined for bankruptcy' - Microsoft Internet Explorer**

Datei Bearbeiten Ansicht Favoriten Extras ?

Zurück Suchen Favoriten Medien

Adresse <http://zdnet.com.com/2100-1105-530774.html> Wechseln zu Links

Google umts auction 2000 Web-Suche Site-Suche Seiten-Info Aufwärts Hervorheben umts auction 2000

News MP3 Music Gaming Fun Books Computers Education Travel

**ZDNet News**  
technology News Now

Page One Applications **Networking** Hardware Commentary

**Networking**

**UK 3G operators 'destined for bankruptcy'**

By Graeme Wearden  
ZDNet (UK)  
September 25, 2001, 5:00 PM PT

**The mobile industry was warned on Tuesday that two of the UK's 3G licence holders could go bust by 2004 because of the slow growth of m-commerce.**

The grim prediction was made by the keynote speaker at London's Mobile Commerce World Europe, Ken Blakeslee--senior executive at Wireless Works, a venture capitalist group. Blakeslee fears that the slow growth in the popularity of m-commerce revenues will be fatal for some operators, some of whom have spent tens of billions of pounds winning licences to roll out next-generation mobile services.

"Some network operators paid dearly for their 3G licences. I think as many as two of them could be bankrupt by 2004, just in time for the other 3G operators to buy up their licences," said Blakeslee.

Blakeslee would not say which of the UK's five operators he thought were most likely to fail, but hinted that Hutchison 3G, which owns a British 3G licence but does not already operate

advertisement

**@server** IBM

**The new IBM eServer iSeries 890**

**High-performance IBM servers provide advanced security and**

Search

ZDNet News GO

**Tech Update**

Securing cyberspace: The national plan  
InfiniBand--old before its time?  
Take steps to minimize laptop loss  
**More networking analysis...**

**News in Brief**

Site makes room for unknown musicians 04:46PM  
Barksdale sells \$1 million in AOL stock 03:02PM  
U.K. mobile firms eye "electronic Post-Its" 01:35PM  
Xerox makes management changes 12:03PM  
Corel CFO departs; new COO named 10:50AM  
**More...**

**Commentary**

RASH

(Noch 1 Element) Bild [http://zdnet.com.com/i/zdnn/nav/4\\_off.gif](http://zdnet.com.com/i/zdnn/nav/4_off.gif) wird geladen

Start W M 1. P. C. M. D. a. L. v. G. S. A. R. m. P. C. N. 3. DE 12:21

# UMTS Emotion Curve



Almost all information accessible at:



Bundesnetzagentur

[www.bundesnetzagentur.de](http://www.bundesnetzagentur.de)

Caution: Many pages! 😊



- General Information
- UMTS Auction in Germany (2000)
  - Process
    - Admittance to the Auction
    - Licence
      - Liabilities
      - Validity
    - Result of the Auction
    - Auction of the Auction's Clock
    - International UMTS Licensing
  - Frequency auction for wireless access (2010)
  - Frequency auction for wireless access (2015)
  - Conclusions and Outlook

# Process of the Auction (1)

- 31.07.-18.08.2000
  - Office building of the RegTP [now Bundesnetzagentur], Canisiusstraße 21, 55122 Mainz
  - on weekdays, 8-18 o'clock, 1 h lunchtime between 12 and 14 o'clock [without leaving the bidder rooms]
  - Every bidding party is represented by two authorized persons
- Every bidding party is provided with a separate room with an auction PC, telephone and fax (just connection to the company)





## Process of the Auction (2)

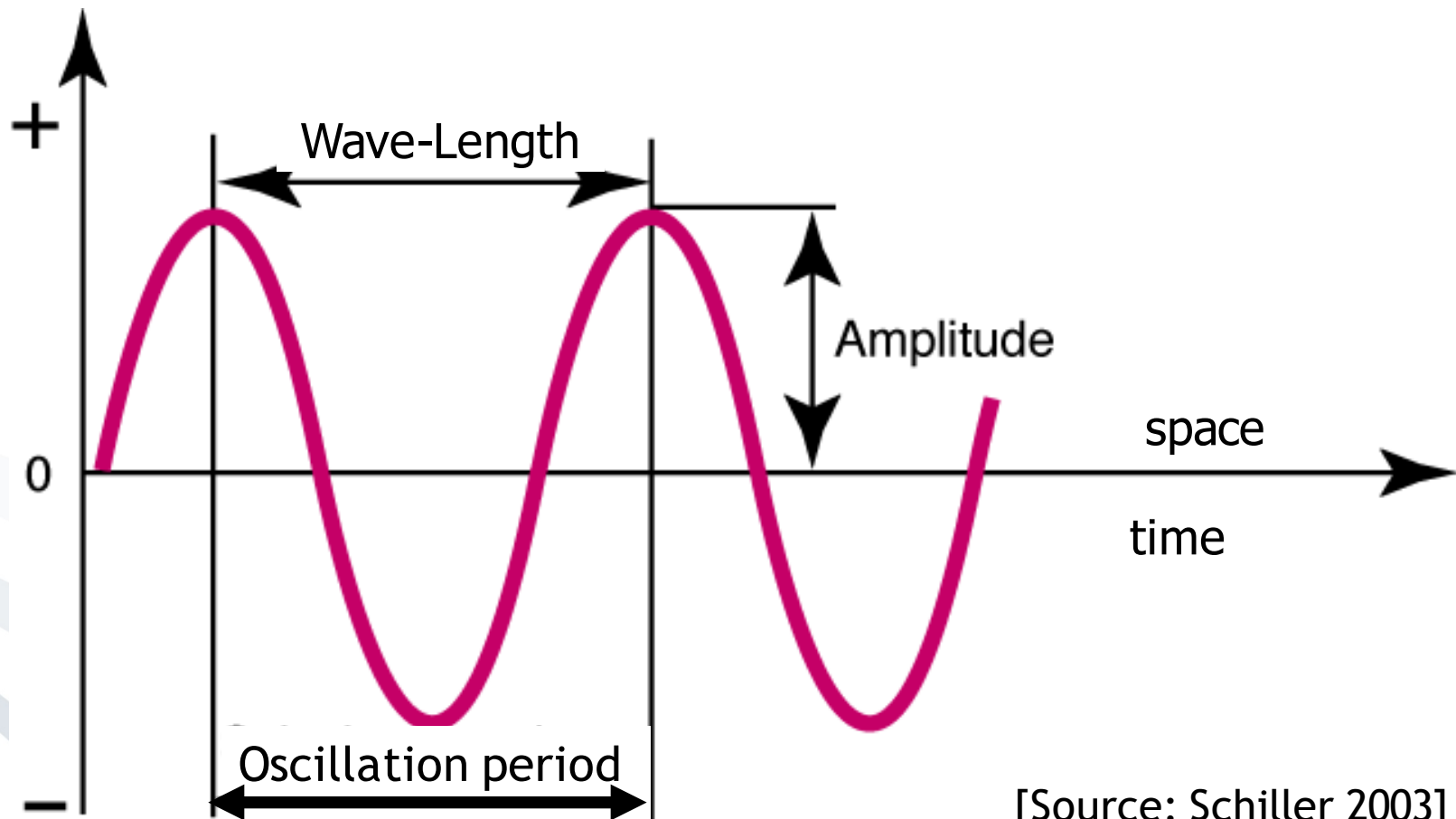
- Bidder tutorial
  - Separated for every bidder
    - Instruction to the process
    - Prerequisite for auction!
    - [The telephone and fax numbers have to be brought to the bidder tutorial.]
- Mobile telephones not admitted!
- All the time an employee of the RegTP is present in the rooms.



## Process of the Auction (3)

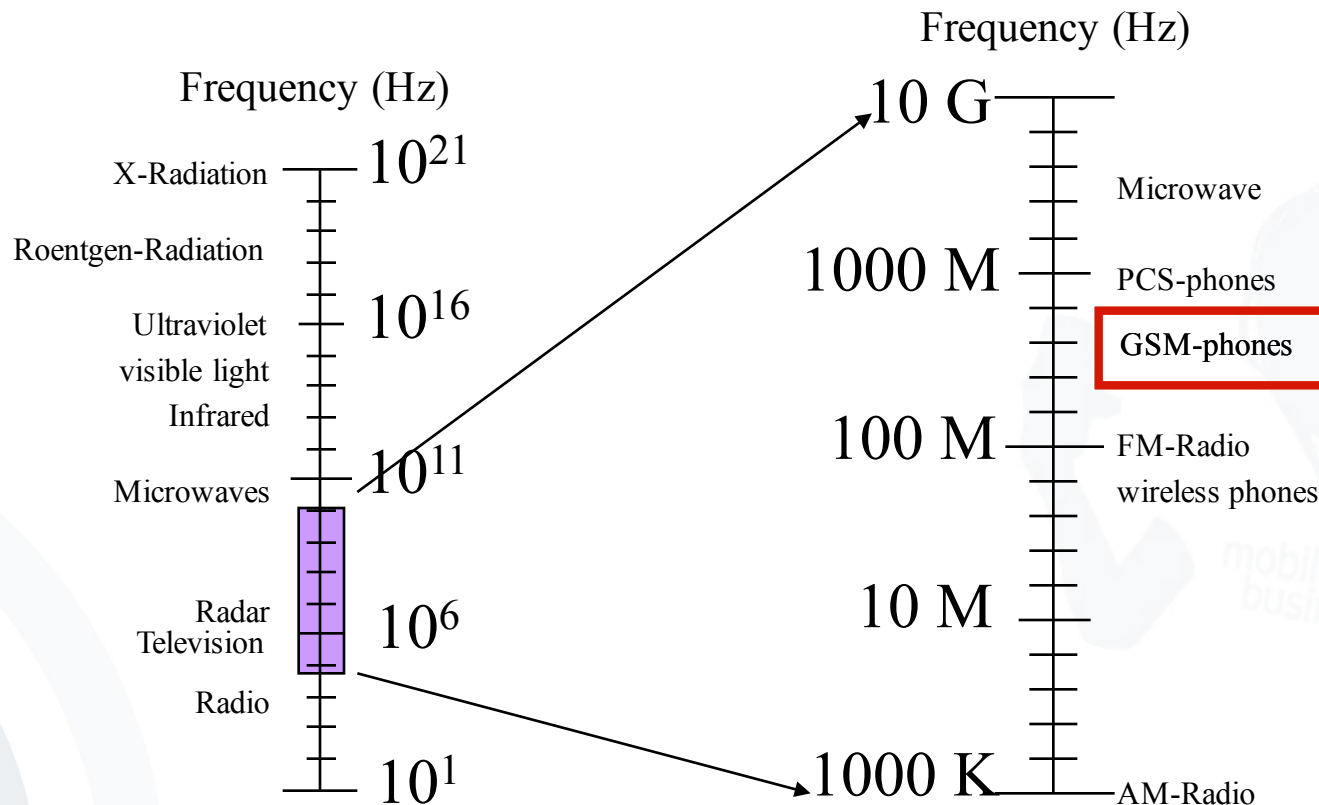
- Simultaneous multiple round auction in two stages
- No communication among the bidders
- At the start of each round, each bidder will only be notified of the numerical value of the current highest bids and the identity of the current highest bidders. This ensures utmost transparency.

- Electromagnetic Waves and Frequencies



[Source: Schiller 2003]

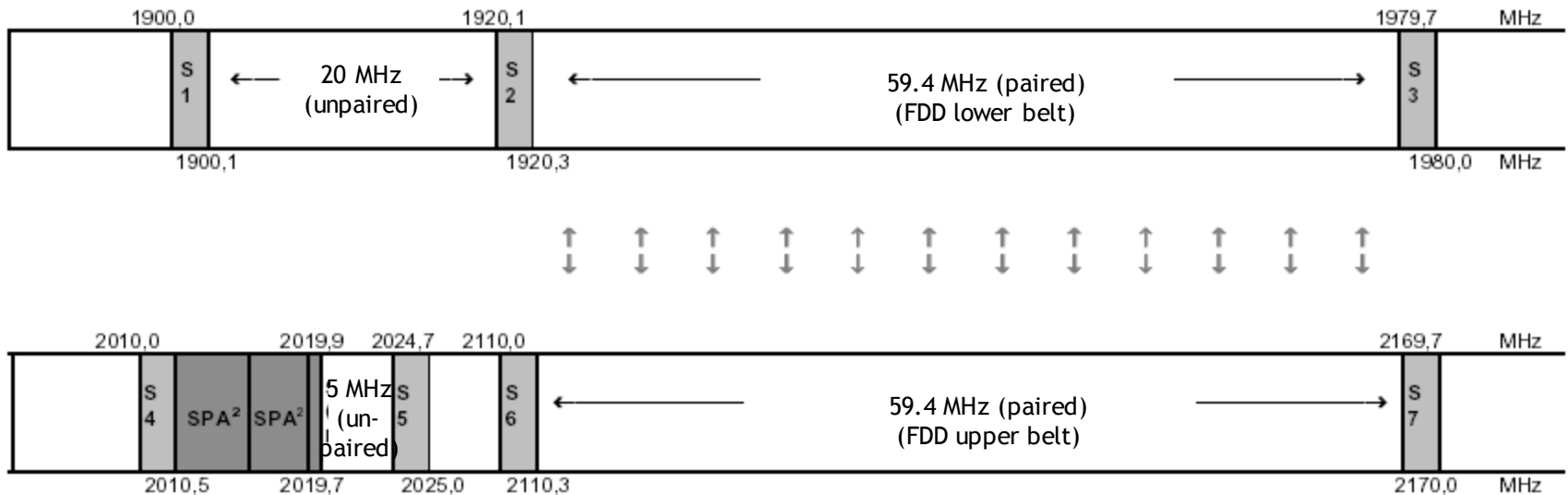
- Frequency range of entertainment and communication electronics



# Excursion: Frequencies & Co (3)

UMTS/IMT-2000 channel plan for the frequency areas 1920 - 1980 MHz, 2010 - 2025 MHz and 2110 - 2170 MHz (in accordance to ERC/DEC(99)25)

- **FDD Spectrum:** Sending frequencies for mobile stations in FDD mode (1920 - 1980 MHz),  
Sending frequencies for basis stations in FDD mode (2110 - 2170 MHz),
- **TDD Spectrum:** Sending frequencies for mobile and basis stations in TDD mode (1900 - 1920 MHz, 2010 - 2025 MHz), the lowest two TDD frequency blocks of the area 2010 - 2025 MHz are reserved for public domain applications (SPA)<sup>1</sup> according to ERC/DEC(99)25

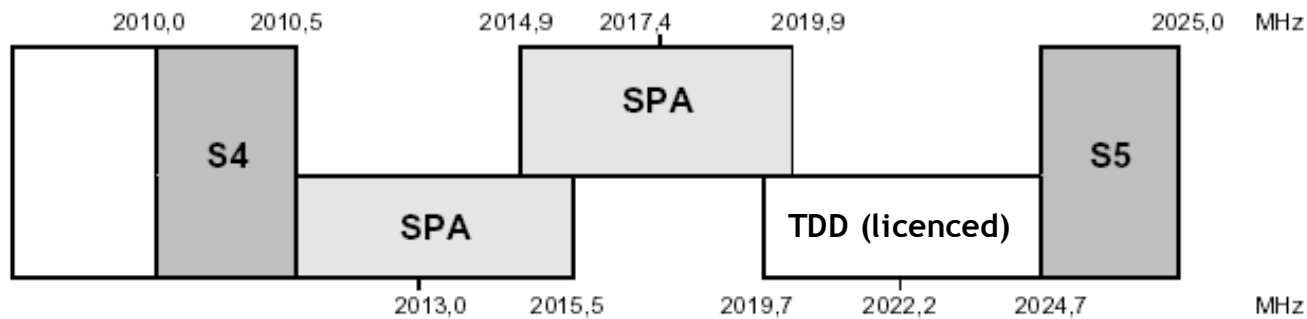


<sup>1</sup> Public domain applications (SPA = Self provided applications operating in a self coordinated environment).

<sup>2</sup> Reserved for public domain applications (SPA) according to ERC/DEC(99)25.

# Excursion: Frequencies & Co (4)

detailed fragmentation of the frequency range between 2010 MHz and 2025 MHz





## Process of the Auction (4)

- 2 \* 60 MHz (paired) and 1 \* 25 MHz (unpaired) available.
- Two auction stages
- 1st Stage:
  - Licenses are offered whose frequency equipment amounts at least 2 x 10 MHz (paired) and at most 2 x 15 MHz (paired).
  - Hence the **amount of the licences** which are up for auction in the first stage amounts **between four and six** depending on the demand of frequency blocks and the actual bidding behaviour of the candidates.
  - The spectrum of 2 x 60 MHz (paired) is offered in 12 abstract blocks, each per 2 x 5 MHz (paired).

## Process of the Auction (5)

- 2nd Stage:
- **Five blocks** of 1 x 5 MHz unpaired spectrum and any blocks of 2 x 5 MHz paired spectrum not bought in the first stage shall be auctioned.
  - Block one to four: 1 x 5 MHz unpaired spectrum shall be offered as abstract frequency blocks, i.e. with no defined spectral position.
  - Fifth block shall be offered with a defined spectral position.
- If, at the close of the bidding proceedings, there is no valid bid for a frequency block or if a bidder is the highest bidder for one frequency block only, the block shall not be awarded in the first stage. The unbought spectrum shall be auctioned in the second stage in blocks of 2 x 5 MHz among the successful bidders from the first stage, together with the other auctionable (unpaired) spectrum.
- Only those bidders are admitted to the participation in the second stage who have purchased licences by auction in the first stage.

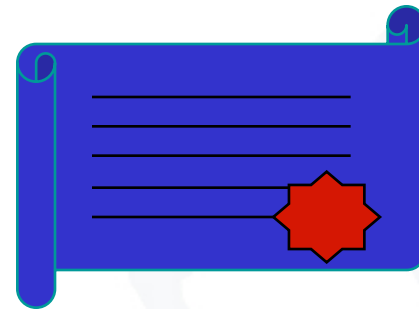
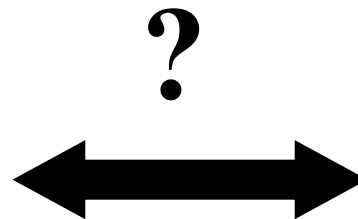
## Process of the Auction (6)

- The bidding rights in the first stage are limited to at least  $2 \times 10$  MHz (paired) and at most  $2 \times 15$  MHz (paired).
- Unpaired frequencies can be purchased by auction (in the second stage) without limitation.
- **Minimum bidding in the 1st stage**
  - For one licence with a basis equipment of  $2 \times 10$  MHz (paired) 200 million DM/102,258 million EUR,
  - For one licence with an equipment of  $2 \times 15$  MHz (paired) 300 million DM/153,387 million EUR.
- **Minimum bidding in the 2nd stage**
  - 50 million DM/25,565 million EUR per  $1 \times 5$  MHz frequency block unpaired
  - As far as a paired frequency spectrum is auctioned in the second stage the minimum bidding per  $2 \times 5$  MHz frequency block (paired) amounts 100 million DM/51,129 million EUR.

- General Information
- UMTS Auction in Germany (2000)
  - Process
  - Admittance to the Auction
  - Licence
    - Liabilities
    - Validity
  - Result of the Auction
  - Auction of the Auction's Clock
  - International UMTS Licensing
- Frequency auction for wireless access (2010)
- Frequency auction for wireless access (2015)
- Conclusions and Outlook

# Admittance to the Auction (1)

- Would Kai Rannenberg have been able to purchase a licence by auction?



## Admittance to the Auction (2)

- Four requirements have to be fulfilled:

Proposition

Notification of the RegTP

Deposit

Bank guarantee





- Requirement 1: Proposition
  - In German language
  - Original proposition and 15 copies
  - Till 28th April 2000
  - Legal prerequisites for the admittance to the auction process have to be fulfilled (Section 8(3) sentence 2 subparas 1 to 3 of the Telecommunications Act).

## ■ Requirement 1: Proposition

- a) Statements to the requestor
- b) Statements to reliability
- c) Statements to efficiency
- d) Statements to competence
- e) Participation structure of the requestor /  
innocuousness certificate of the Federal  
Cartel Office

## TKG § 8, Abs. 3 (Nr. 1-3)

- “ An ordered licence is to deny if:
1. the regulation office does not possess useful frequencies which can be allocated to the requester who wants to conduct radio connections or
  2. facts justify the supposition that
    - a) the requester does not possess the reliability, efficiency and competence which are required for the exertion of the requested licence rights and it is to expect that these licence rights will not be executed enduring or
    - b) the public safety or order would be endangered through the issue of the licence.
- ”

- Requirement 2: Notification of the RegTP
  - Approval of the statements to reliability, productivity, competence, ...
  
- Requirement 3: Deposit
  - 14 days before the auction
  - 20 Million DM (10,226 Million EUR)

## Admittance to the Auction (7)

- Requirement 4: Bank guarantee (1)
  - Indefinite, unconditional, irrevocable, directly enforceable
  - Amounting to 400 million DM (204,517 million EUR) for the purchase by auction of a licence with a frequency equipment of 2 x 10 MHz (paired) in the first stage of the auction
  - Amounting to 600 million DM (306,775 million EUR) for the purchase by auction of a licence with a frequency equipment of 2 x 15 MHz (paired) in the first stage of the auction

- Requirement 4: Bank guarantee (2)
  - amounting to 100 million DM (51,129 million EUR) per occupied bidding right for unpaired frequencies in the second stage of the auction
  - amounting to 200 million DM (102,258 million EUR) for one bidding right for paired frequencies in the second stage of the auction



- General Information
- UMTS Auction in Germany (2000)
  - Process
  - Admittance to the Auction
  - Licence
    - Liabilities
    - Validity
  - Result of the Auction
  - Auction of the Auction's Clock
  - International UMTS Licensing
- Frequency auction for wireless access (2010)
- Frequency auction for wireless access (2015)
- Conclusions and Outlook

## **Licence Template**

**Licence for operating of transmission paths**

**For the supply of mobile radio services of the third generation  
(UMTS/IMT-2000) for the public in the area of the Federal Republic of Germany**

**(UMTS/IMT-2000 licence)**

Hereby the regulation authority for telecommunication and post (LICENSER) issues a licence for  
operating of transfer routes for the supply of mobile radio services of the third generation  
(UMTS/IMT-2000) for the publicity (licence class 1; mobile radio licence)

**to ..... (LICENSEE)**

based on the auction from ..... and on the application for admission of the LICENSEE to the  
auction process from ..... according to § 6 paragraph 1 No. 1, paragraph 2 No. 1 letter a) in  
connection with § § 11 paragraph 4, 8 paragraph 1 sentence 1 as well as paragraph 4 and 5 and  
50 paragraph 2 of the telecommunication law.

1. Part A
2. Part B
3. Part C
4. Part D

## Index of contents

- Part A
  - 1 Scope of Licence
  - 2 Right to Operate Transmission Paths
  - 3 Usage of Mobile Radio Frequencies
  - 4 Use of Public Ways
  - 5 Numbering
  - 6 Fees and Contributions

- Part B

- 1 Licence Term

- 2 Revocation of Licence and Accompanying Rights

- 3 Attachment of Collateral Clauses after Licence Award

- 4 Roll-Out and Coverage Obligations

- 5 Frequency Usage Conditions

- 6 Open Network Provision and Interconnection

- 7 Extract from the Commercial Register

- 8 Technical Protection Measures

- Part C
  - 1 Market Dominance
  - 2 Competitive Independence of Licensee
  - 3 Connection of Terminal Equipment
  - 4 Telecommunications Secrecy and Telecommunications Systems Security
  - 5 Restriction of Telecommunications Secrecy
  - 6 Data Protection and Information Requests from Security Authorities
  - 7 Civil Protection
  - 8 Influence on Other Legal Relationships



- 9 Transfer of Licence and Accompanying Rights, Change in Ownership of Licensee, and Merger Prohibition
- 10 Fixed Link Frequencies
- 11 Notification and Reporting Requirements
- 12 Separation of Corporate Structures and Separate Accounting
- 13 Submission of General Terms and Conditions
- 14 Customer Protection
- 15 Offerings for Service Providers
- 16 Choice of Operator
- 17 Information Requirements

## ■ 1 Scope of Licence

This licence applies to the operation of transmission paths for the offer of publicly available 3G mobile radio (UMTS/IMT-2000) services on the territory of the Federal Republic of Germany by the LICENSEE or by other parties.

The LICENSEE shall be free to apply any standard from the IMT-2000 concept.

The system used by the LICENSEE shall fulfil the following minimum requirements according to Decision No 128/1999/EC of the European Parliament and of the Council of 14 December 1998 on the coordinated introduction of a third-generation mobile and wireless communications system (UMTS) in the Community (EC Official Journal of 22 January 1999):

- Multimedia capability, full mobility and low mobility applications in different geographical environments beyond the capability of the second generation systems such as GSM;
- Efficient access to the Internet, Intranets and other Internet Protocol (IP) based services.
- High quality speech transmission commensurate with that of fixed networks.
- Service portability across distinct UMTS/IMT-2000 environments, where appropriate (e.g. public/private/business; fixed/mobile).

- Operation in one seamless environment, including full roaming with GSM and between the terrestrial and satellite components of UMTS/IMT-2000 networks.
- New terrestrial air interface for access to all services (including packet data based services, supporting asymmetric traffic and allowing for bandwidth/data rate on demand in harmonised frequency bands).
- Call handling, service control, and location and mobility management, including full roaming functionality based on an evolution of existing core network systems, for example on an evolved GSM core network, taking the convergence between mobile/fixed networks into account.

## 2 Right To Operate Transmission Paths

- This licence authorises the LICENSEE to operate transmission paths for public 3G mobile radio (UMTS/IMT-2000) service offerings on the territory of the Federal Republic of Germany.

## Part B

### 1 Licence Term

The licence and accompanying rights shall expire on 31 December 2020.

- That means 20 years runtime
- GSM licences for originally 20 years, too
  - Licences D-Networks until 2009
  - Licence E1 until 2012
  - Licence E2 until 2016
- In 2006, all GSM licence agreements were extended until end of 2016 [Bundesnetzagentur 2006].
- Bundesnetzagentur confirmed that the GSM licences will be subject of a new auction [Bundesnetzagentur 2013]

### **4 Roll-Out and Coverage Obligations**

- 4.1 The LICENSEE shall ensure the offer of UMTS/IMT-2000 mobile radio services to at least 25% of the population by no later than 31 December 2003 and to at least 50% of the population by no later than 31 December 2005.

- After 31 December 2005, the LICENSER may increase the coverage obligation in connection with the award of additional spectrum, where necessary for regulatory reasons in order to ensure the regulatory aims as set out in Section 2(2) of the Act (Section 8(2) of the Act).



- 4.3 The coverage obligation according to Paragraph 4.1 shall apply on condition that the relevant specifications of the UMTS/IMT-2000 standard chosen by the LICENSEE are available in sufficiently stable form in good time before startup of service and that the relevant technical systems are on the market.

## **6 Data Protection and Information Requests from Security Authorities**

- 6.1 The LICENSEE shall be subject to the provisions on personal data protection of the Telecommunications Act, the Telecommunications Carriers Data Protection Ordinance, and the Federal Data Protection Act.
- 6.2 Attention is drawn to the obligation to furnish information in accordance with Sections 89(6) and 90 of the Act.

## Shared use of infrastructure

- To what extent and under which technical conditions is a shared use of infrastructure in line with the UMTS licensing conditions [decision of the presidents chamber from 18.02.2000 on the determinations and rules for the licensing for UMTS/IMT-2000; RegTP official gazette from 23.02.2000, Vfg 13/2000]
- Thesis paper of the RegTP [available from [www.bundesnetzagentur.de](http://www.bundesnetzagentur.de) in German and in English]

## Infrastructure Sharing

### Interpretation of the UMTS Award Conditions in Light of More Recent Technological Advance

- Shared use of sites, masts, antennas, cables and combiners is permitted under the Award Conditions.
- Shared use of Site Support Cabinets, or SSCs (= more than one Node B in a single SSC) has no further implications for functions control (full legal control of the operator's network) and the independence of the licence holders as competitors and is thus compatible with the Award Conditions.

- Use of logically distinct Node Bs in one and the same unit instead of physically distinct Node Bs at the same site is covered by the Award Conditions if the individual cooperation agreements guarantee that each licence holder will retain functions control and competitive independence. The preconditions are:
  1. each licence holder has independent control of his own logical Node Bs so that he can operate his assigned frequencies only (no spectrum pool);
  2. no exchange of any data relating to competition beyond that required for technical operations takes place (eg customer data);
  3. separation of the Operation and Maintenance Centres;
  4. operation of additional own Node Bs (to guarantee the operator's planning autonomy);
  5. no regional splitting up of coverage areas that rules out network and coverage area overlap.

- Use of logically distinct RNCs in one and the same unit instead of physically distinct RNCs is covered by the Award Conditions if the individual cooperation agreements guarantee that each licence holder will retain functions control and competitive independence. The preconditions are:
  1. each licence holder has independent control of his own logical RNC, particularly of the usage-sensitive cell load and power;
  2. no exchange of any data relating to competition beyond that required for technical operations takes place (eg customer data);
  3. separation of the Operation and Maintenance Centres;
  4. possibility of operating additional own RNCs (to guarantee the operator's planning independence);
  5. connection of the operator's own Node Bs, operated solely by himself, to his own logical RNC.

- Shared use of the core network, i.e. of the MSC, would lead to a spectrum pool and is thus incompatible with the requirement of functions control as set out in the Telecommunications Act and the UMTS Award Conditions.
- Transitional arrangements on the shared use of MSCs are ruled out in light of principle 5.

### **9 Transfer of Licence and Accompanying Rights, Change in Ownership of LICENSEE, and Merger Prohibition**

- 9.1** Transfer of licence shall be in written form and shall require prior written approval by the LICENSER (Section 9(1) sentence 1 of the Act).
- 9.2** The LICENSER shall be given notice without undue delay of any other transfer of licence to a new holder, change in ownership of the LICENSEE, or permission for another party to use the licence (Section 9(2) of the Act).
- 9.3** If the LICENSEE holds a dominant position according to Section 19 of the Restraints of Competition Act in the relevant market, he may be required by the LICENSER as a condition of his licence to refrain from any linkage with another company within the meaning of Section 37 of the Restraints of Competition Act if there is a limitation of the number of licences in accordance with Section 10 of the Telecommunications Act and if the other company is or will be operating in a telecommunications market deemed to be the same product and geographical market as the LICENSEE's sphere of activity (Section 32 of the Telecommunications Act).

→ In July 2014, after Telefónica Deutschland Holding AG's acquisition of control of E-Plus Mobilfunk GmbH & Co. KG, BNetzA granted both companies the right to use the frequency spectrum of both (previously separated) companies (Decision BK 1-13/002).

[Bundesnetzagentur 2014a]



- General Information
- UMTS Auction in Germany (2000)
  - Process
  - Admittance to the Auction
  - Licence
    - Liabilities
    - Validity
  - Result of the Auction
    - Auction of the Auction's Clock
    - International UMTS Licensing
- Frequency auction for wireless access (2010)
- Frequency auction for wireless access (2015)
- Conclusions and Outlook

## Agenda of the allocation of the UMTS/IMT-2000 frequency blocks

### FDD frequency blocks

(MHz)	1920,3	1930,2	1940,1	1950,0	1959,9	1969,8	1979,7
	FDD 1: Mannesmann Mobilfunk (9,9 MHz)	FDD 2: Group 3G (9,9 MHz)	FDD 3: E-Plus 3G Lux (9,9 MHz)	FDD 4: MobilCom Multimedia (9,9 MHz)	FDD 5: VIAG (9,9 MHz)	FDD 6: T-Mobil (9,9 MHz)	

(MHz)	2110,3	2120,2	2130,1	2140,0	2149,9	2159,8	2169,7
	FDD 1: Mannesmann Mobilfunk (9,9 MHz)	FDD 2: Group 3G (9,9 MHz)	FDD 3: E-Plus 3G Lux (9,9 MHz)	FDD 4: MobilCom Multimedia (9,9 MHz)	FDD 5: VIAG (9,9 MHz)	FDD 6: T-Mobil (9,9 MHz)	

### TDD frequency blocks

(MHz)	1900,1	1905,1	1910,1	1915,1	1920,1	2019,7	2024,7
	TDD Block 1: Group 3G (5 MHz)	TDD Block 2: MobilCom Multimedia (5 MHz)	TDD Block 3: T-Mobil (5 MHz)	TDD Block 4: Mannesmann Mobilfunk (5 MHz)			E-Plus 3G Lux (5 MHz)

# Result of the Auction (2)

## Final result of the UMTS licence auction

Licensee	acquired frequency spectrum	DM	License valid until
E-Plus Hutchison	2x 10 MHz (paired) 1x 5 MHz (unpaired)	16.491.800.000	31 Dec 2020
Group 3G	2x 10 MHz (paired) 1x 5 MHz (unpaired)	16.568.700.000	
Mannesmann Mobilfunk	2x 10 MHz (paired) 1x 5 MHz (unpaired)	16.594.800.000	
MobilCom Multimedia	2x 10 MHz (paired) 1x 5 MHz (unpaired)	16.491.000.000	
T-Mobil	2x 10 MHz (paired) 1x 5 MHz (unpaired)	16.704.900.000	
VIAG Interkom	2x 10 MHz (paired)	16.517.000.000	
<b>Total</b>	<b>145 MHz</b>	<b>99.368.200.000</b>	

- General Information
- UMTS Auction in Germany (2000)
  - Process
  - Admittance to the Auction
  - Licence
    - Liabilities
    - Validity
  - Result of the Auction
  - Auction of the Auction's Clock
  - International UMTS Licensing
- Frequency auction for wireless access (2010)
- Frequency auction for wireless access (2015)
- Conclusions and Outlook

# Auction of the Auction's Clock

- From 28.08.2000 till 15.09.2000, 15 o'clock the auction's clock (costs: about 200 DM) was offered for a start bidding of 250 DM.
- The Pfeleiderer AG in Neumarkt/Oberpfalz issued a bid of 30.000 DM.
- The money benefited charitable institutions.



- General Information
- UMTS Auction in Germany (2000)
  - Process
  - Admittance to the Auction
  - Licence
    - Liabilities
    - Validity
  - Result of the Auction
  - Auction of the Auction's Clock
  - International UMTS Licensing
- Frequency auction for wireless access (2010)
- Frequency auction for wireless access (2015)
- Conclusions and Outlook

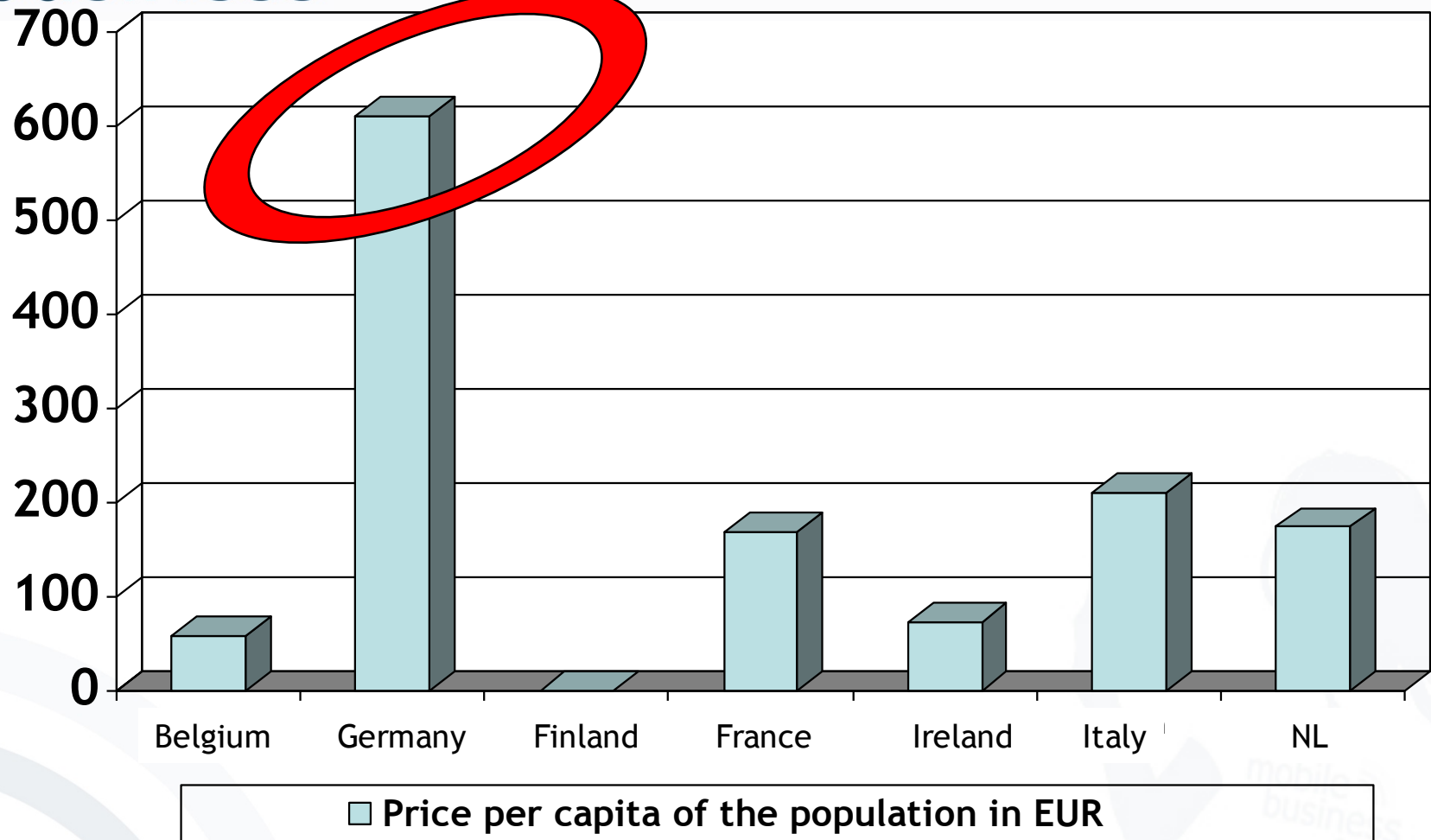
# International UMTS Licensing (1)

- Australia (A)
- Austria (A)
- Belgium (A)
- Czech Republic (A)
- Denmark (A)
- Estonia (Sealed bid)
- Finland (BC)
- France (BC + fee)
- Germany (A)
- Greece (A)
- Hong Kong (Revenue Share)
- Ireland (BC)
- Isle of Man (Award)
- Israel (A)
- Italy (A)
- Japan (BC)
- Latvia (A)
- Liechtenstein (Award)
- Luxembourg (BC)
- Malaysia (BC)
- Monaco (Award)
- Netherlands (A)
- New Zealand (A)
- Norway (BC)
- Poland (BC)
- Portugal (BC)
- Singapore (Award)
- Slovakia (BC)
- Slovenia (A)
- South Korea (BC)
- Spain (BC)
- Sweden (combination A & BC)
- Switzerland (A)
- Taiwan (A)
- UK (A)

A = Auction, BC = Beauty Contest

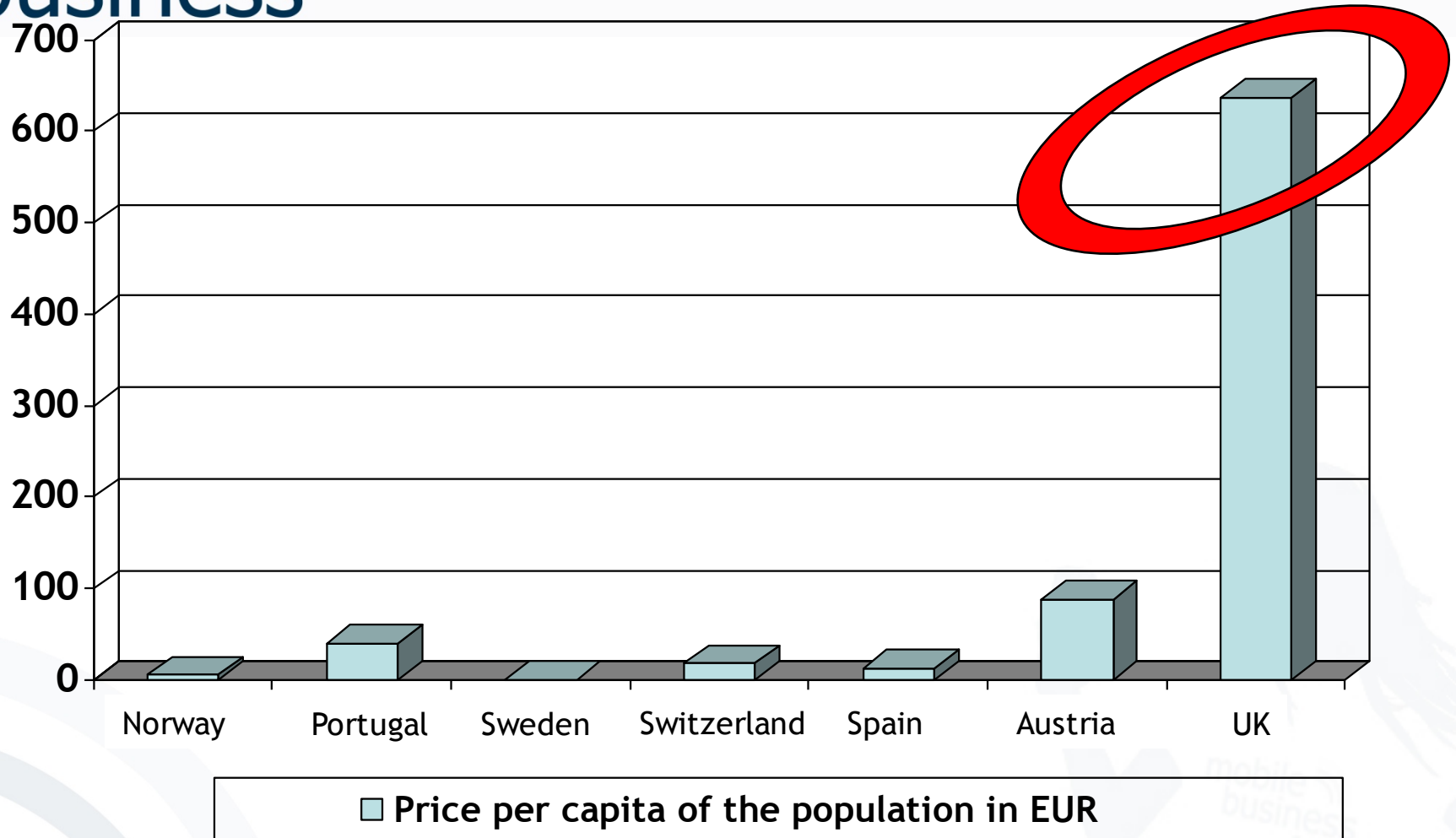
[[www.gsmworld.com/gsm europe/faq/3g.shtml](http://www.gsmworld.com/gsm europe/faq/3g.shtml);  
[www.umtsworld.com/industry/licenses.htm](http://www.umtsworld.com/industry/licenses.htm)]

## International UMTS Licensing (2)

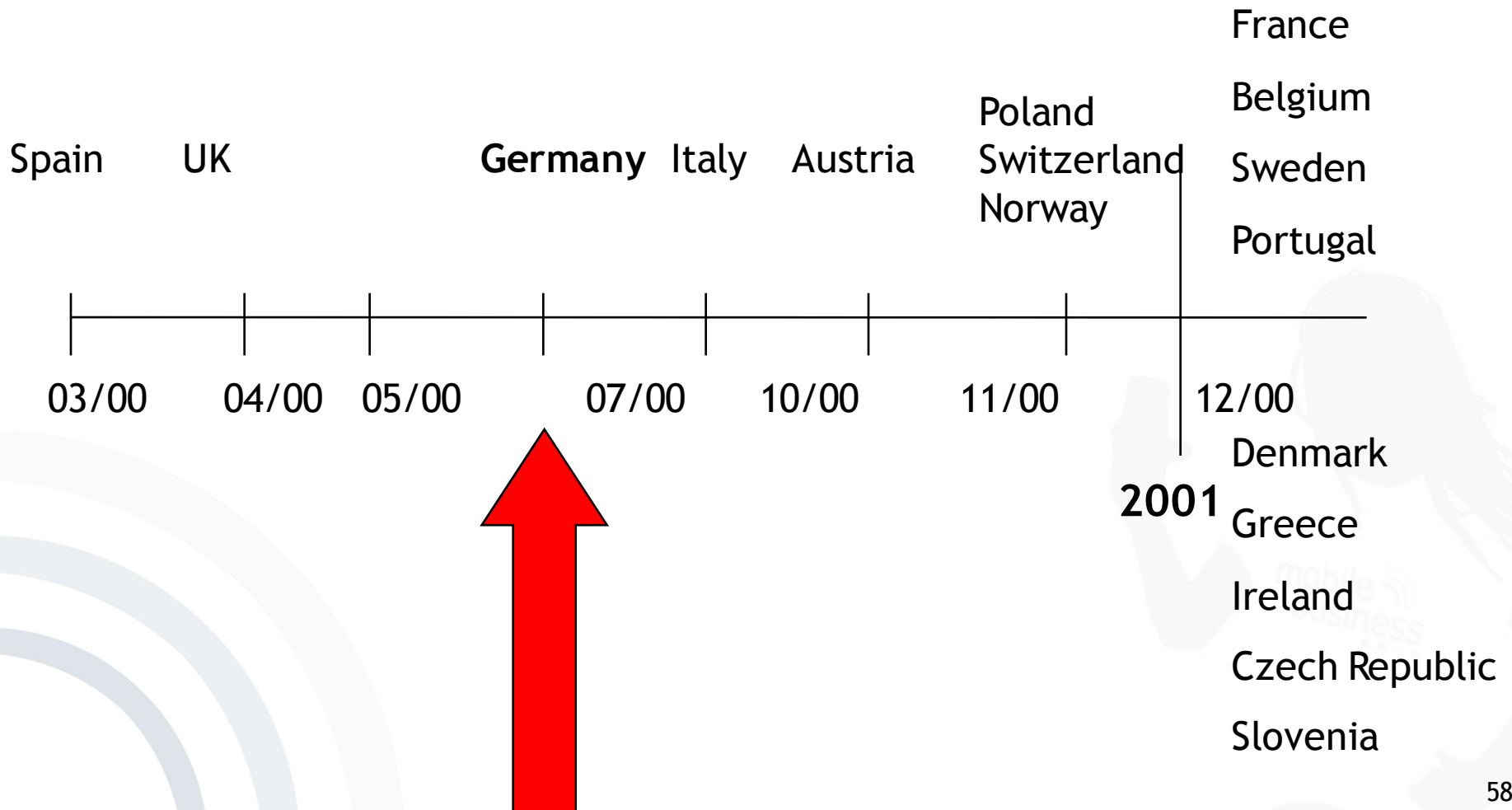




## International UMTS Licensing (3)



# International UMTS Licensing (4)



- Actually it does not matter which frequency blocks one gets.
- **BUT:** If one operates several UMTS networks (beyond the frontiers) it can be interesting to get frequency blocks in the same “range”.

- General Information
- UMTS Auction in Germany (2000)
  - Process
  - Admittance to the Auction
  - Licence
    - Liabilities
    - Validity
  - Result of the Auction
  - Auction of the Auction's Clock
  - International UMTS Licensing
- Frequency auction for wireless access (2010)
- Frequency auction for wireless access (2015)
- Conclusions and Outlook

Based on Broadband strategy within the German economic stimulus package (Konjunkturpaket II)

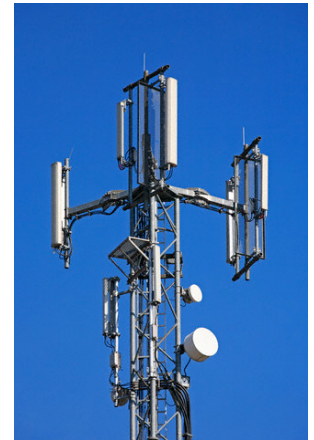
- Usage of digital dividend as soon as possible
- Provisioning of innovative mobile telephony and broadband internet in rural environments

The expression „digital dividend" refers to the **increase in transmission capacity** that is achieved by changing over to digital technology.

In the course of digitizing TV and radio broadcasts (DVB-T), signals will be transmitted in future over one frequency or one channel. This will **free up valuable frequency bands** (frequency range 790-862 MHz) - used to date solely for the transmission of analog signals - for the broadband Internet service.

# Frequency auction for wireless access (2010)

- Frequency auctions for wireless network access for the provision of telecommunication services in the ranges:
- **800 MHz (paired)**
  - Used in 4G networks
  - Bound to network expansion obligations in rural environments (90% of the population of all states from 2016)
- **1.8 GHz (paired)**
  - Mainly used for 4G and some GSM services (for transitional period only)
- **2.0 GHz (paired & unpaired)**
  - UMTS spectrum
  - Allocated in 2000 to Group 3G and Mobilcom, but never used
- **2.6 GHz (paired & unpaired)**
  - Used in 4G networks for local hotspots, e.g. at large arenas or airports.
- Almost similar auction process as UMTS auction 2000 (Simultaneous multiple round auction)



# Ende der Auktion

Frequenzbereich	Block	Ausstattung	Höchstbieter	Höchstgebot (€ in Tsd)
-----------------	-------	-------------	--------------	------------------------

0,8 GHz (gepaart)	0,8 GHz A	2x5 MHz konkret	To2 GER	616.595
	0,8 GHz B	2x5 MHz abstrakt	To2 GER	595.760
	0,8 GHz C	2x5 MHz abstrakt	Telekom D	570.849
	0,8 GHz D	2x5 MHz abstrakt	Telekom D	582.949
	0,8 GHz E	2x5 MHz abstrakt	Vodafone	583.005
	0,8 GHz F	2x5 MHz abstrakt	Vodafone	627.317

1,8 GHz (gepaart)	1,8 GHz A	2x5 MHz abstrakt	Telekom D	20.700
	1,8 GHz B	2x5 MHz abstrakt	Telekom D	20.700
	1,8 GHz C	2x5 MHz abstrakt	Telekom D	19.869
	1,8 GHz D	2x5 MHz konkret	E-Plus Grp	21.550
	1,8 GHz E	2x5 MHz konkret	E-Plus Grp	21.536

2,0 GHz (gepaart)	2,0 GHz A	2x4,95 MHz konkret	Vodafone	93.757
	2,0 GHz B	2x4,95 MHz konkret	E-Plus Grp	103.323
	2,0 GHz C	2x4,95 MHz konkret	E-Plus Grp	84.064
	2,0 GHz D	2x4,95 MHz konkret	To2 GER	66.931

2,0 GHz (ungepaart)	2,0 GHz E	1x5 MHz konkret	To2 GER	5.731
	2,0 GHz F	1x14,2 MHz konkret	To2 GER	5.715

Ausgeschiedene Bieter:

Frequenzbereich	Block	Ausstattung	Höchstbieter	Höchstgebot (€ in Tsd)
-----------------	-------	-------------	--------------	------------------------

2,6 GHz (gepaart)	2,6 GHz A	2x5 MHz abstrakt	Telekom D	19.096
	2,6 GHz B	2x5 MHz abstrakt	Telekom D	19.025
	2,6 GHz C	2x5 MHz abstrakt	To2 GER	17.364
	2,6 GHz D	2x5 MHz abstrakt	To2 GER	17.364
	2,6 GHz E	2x5 MHz abstrakt	Vodafone	18.948
	2,6 GHz F	2x5 MHz abstrakt	Vodafone	19.025
	2,6 GHz G	2x5 MHz abstrakt	Telekom D	19.069
	2,6 GHz H	2x5 MHz abstrakt	Telekom D	19.038
	2,6 GHz I	2x5 MHz abstrakt	To2 GER	18.948
	2,6 GHz J	2x5 MHz abstrakt	E-Plus Grp	18.931
	2,6 GHz K	2x5 MHz abstrakt	E-Plus Grp	17.739
	2,6 GHz L	2x5 MHz abstrakt	To2 GER	17.739
	2,6 GHz M	2x5 MHz abstrakt	Vodafone	17.739
	2,6 GHz N	2x5 MHz abstrakt	Vodafone	17.752

2,6 GHz (ungepaart)	2,6 GHz O	1x5 MHz abstrakt	Vodafone	9.130
	2,6 GHz P	1x5 MHz abstrakt	Vodafone	9.130
	2,6 GHz Q	1x5 MHz abstrakt	Telekom D	8.598
	2,6 GHz R	1x5 MHz abstrakt	Vodafone	8.598
	2,6 GHz S	1x5 MHz abstrakt	Vodafone	9.051
	2,6 GHz T	1x5 MHz abstrakt	Vodafone	9.051
	2,6 GHz U	1x5 MHz abstrakt	E-Plus Grp	8.273
	2,6 GHz V	1x5 MHz abstrakt	To2 GER	8.229
	2,6 GHz W	1x5 MHz abstrakt	To2 GER	8.229
	2,6 GHz X	1x5 MHz abstrakt	E-Plus Grp	8.229

Summe aller gehaltenen Höchstgebote (€ in Tsd)	4.384.646
Zahlungsverpflichtung aufgrund zurückgenommener Höchstgebote (€ in Tsd)	0
Summe	4.384.646



# Result of the Auction 2010

Licensee	acquired frequency spectrum	Euro	License valid until
Vodafone D2 GmbH	800 MHz: 2x 10 MHz (paired) 2000 MHz: 2x 5 MHz (paired) 2600 MHz: 2x 20 MHz (paired) 2600 MHz: 1x 25 MHz (unpaired)	1,422,503,000	31 Dec 2025
Telefónica O2 Germany GmbH & Co. OHG	800 MHz: 2x 10 MHz (paired) 2000 MHz: 2x 5 MHz (paired) 2000 MHz: 1x 10 MHz (unpaired) 2600 MHz: 2x 20 MHz (paired) 2600 MHz: 1x 10 MHz (unpaired)	1,378,605,000	
Telekom Deutschland GmbH	800 MHz: 2x 10 MHz (paired) 1800 MHz: 2x 15 MHz (paired) 2600 MHz: 2x 20 MHz (paired) 2600 MHz: 1x 5 MHz (unpaired)	1,299,893,000	
Erste MVV Mobilfunk Vermögensverwaltungs-gesellschaft mbH (E-Plus)	1800 MHz: 2x 10 MHz (paired) 2000 MHz: 2x 10 MHz (paired) 2600 MHz: 2x 10 MHz (paired) 2600 MHz: 1x 10 MHz (unpaired)	283,645,000	
<b>Total</b>	<b>360 MHz</b>	<b>4,384,646,000</b>	

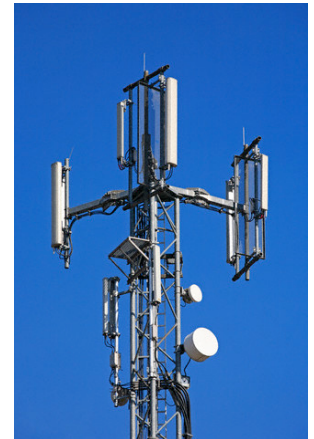
- General Information
- UMTS Auction in Germany (2000)
  - Process
  - Admittance to the Auction
  - Licence
    - Liabilities
    - Validity
  - Result of the Auction
  - Auction of the Auction's Clock
  - International UMTS Licensing
- Frequency auction for wireless access (2010)
- Frequency auction for wireless access (2015)
- Conclusions and Outlook

Based on Broadband strategy of federal government.

- ➔ Preparation of ground for usage of digital dividend II without undue delay (as soon as spectrum will be cleared of TV broadcasts: By 2017, probably later)
- ➔ Further improvement of innovative mobile telephony and broadband internet in rural environments (stricter coverage obligations than in 2010)

# Frequency auction for wireless access (2015)

- Frequency auctions for wireless network access for the provision of telecommunication services in the ranges:
- **700 MHz (paired)**
  - Digital dividend II
  - Available for use after switchover from DVB-T to DVB-T2 has completed (by 2017, probably later)
- **900 MHz (paired)**
  - Basis for today's mobile networks (since start of GSM „D-Netze“)
- **1800 MHz (paired)**
  - Basis for today's mobile networks (since start of GSM „E-Netze“)
- **1500 MHz (unpaired)**
  - New spectrum for wireless access, e.g. for increase of download bandwidth (future use).
- Allocation of frequency spectrum now **technologically neutral**
- Only very few restrictions (cf. „concrete blocks“ in the auction: Blocks with usage limitations)
- Almost similar auction process as 2000 and 2010 (Simultaneous multiple round auction)
- Licenses valid until 31 December 2033



# Coverage and bandwidth obligations (2015 auction)

Coverage and Bandwidth Obligations in accordance with Digital Agenda of the Federal Government of Germany:

- Aiming at (almost) nationwide broadband internet coverage: **98 percent of households** and
  - min. 95 percent of h. per federal state
  - min. 99 percent of h. in city states (Stadtstaaten)
- As a general rule: Provide at least 10 Mbit/s per customer → but no guarantee: Shared Medium!
- All autobahns and ICE railway tracks are to be covered (as extensively as technically and legally possible)
- 700 MHz to be preferred, but other existing infrastructure, no matter which frequency spectrum, will be included in assessment process.
- Obligations hold for every single operator (thus not for all operators collectively, as in 2010 auction)
- Time frame: Within 3 years (counting from frequency assignment onwards) → implementation by summer 2018.



To ensure:

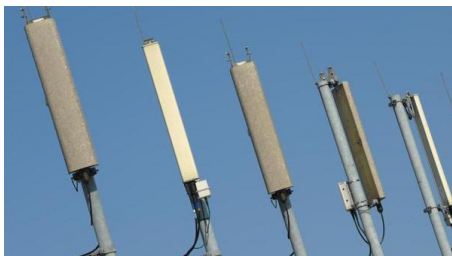
- **Timely start** of network roll-out, **sustained effort** of operators
- **Efficient use of new frequency spectrum** as quick as possible
- Implementation of regulation goals in accordance with the federal **infrastructure guaranteeing mandate** in the area of telecommunication (Basic Law of the Federal Republic of Germany, Art. 87f GG)
- **Safeguard interests of users**, notably consumer interests, in the area of telecommunications ( § 2 Abs. 2 Nr. 1 TKG)
- **Foster mature and competitive** telecommunication and telecommunication service markets ( § 2 Abs. 2 Nr. 2 TKG)
- **Encourage efficient investment** in infrastructure in accordance with § 2 Abs. 3 TKG
- **Overall speed-up** of network roll-out of high-performance next generation public telecommunication networks ( § 2 Abs. 2 Nr. 5 TKG)
- **Safeguard efficient, interference-free use of frequencies** ( § 52 i.V.m. § 2 Abs. 2 Nr. 7 TKG)



Bundesnetzagentur



Start:  
27 May 2015



Rundenergebnis der Runde 1				
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	75.050
	900 B	2x5 MHz abstrakt	TEF DE	75.050
	900 C	2x5 MHz abstrakt		
	900 D	2x5 MHz abstrakt	Vodafone	75.020
	900 E	2x5 MHz abstrakt	Vodafone	75.020
	900 F	2x5 MHz abstrakt	Vodafone	75.020
	900 G	2x5 MHz abstrakt	Telekom	75.000
1,8 GHz (gepaart)	1800 A	2x5 MHz abstrakt	Telekom	37.500
	1800 B	2x5 MHz abstrakt	TEF DE	37.550
	1800 C	2x5 MHz abstrakt	TEF DE	37.550
	1800 D	2x5 MHz abstrakt	TEF DE	37.550
	1800 E	2x5 MHz abstrakt	TEF DE	37.550
	1800 F	2x5 MHz abstrakt	TEF DE	37.550
	1800 G	2x5 MHz abstrakt		
	1800 H	2x5 MHz abstrakt		
	1800 I	2x5 MHz abstrakt		
	1800 J	2x5 MHz konkret		
1,5 GHz (ungepaart)	1500 A	1x5 MHz abstrakt	Telekom	18.750
	1500 B	1x5 MHz abstrakt	Telekom	18.750
	1500 C	1x5 MHz abstrakt	Telekom	18.750
	1500 D	1x5 MHz abstrakt	Telekom	18.750
	1500 E	1x5 MHz abstrakt	Vodafone	18.770
	1500 F	1x5 MHz abstrakt	Vodafone	18.770
	1500 G	1x5 MHz abstrakt	Vodafone	18.770
	1500 H	1x5 MHz abstrakt	Vodafone	18.770
Summe aller gehaltenen Höchstgebote (€ in Tsd.)				1.275.630
Zahlungsverpflichtung aufgrund zurückgenommener Höchstgebote (€ in Tsd.)				0
Summe (€ in Tsd.)				1.275.630



News-Meldung vom 08.06.2015 19:11

# «Vorge... Frequenzauktion: Bieterwettstreit im 1800-MHz-Band

UPDATE

vorlesen / MP3-Download



(Bild: dpa, Carsten Rehder)

**Bei der Versteigerung zahlreicher Mobilfunkfrequenzen zeichnet sich ein starkes Interesse der Netzbetreiber am 1800-MHz-Band ab. Das eignet sich prima für LTE in Ballungsgebieten.**

Bei der laufenden Frequenzauktion der Bundesnetzagentur steht nach 80 Runden das Spektrum im 1800-MHz-Band besonders hoch im Kurs, direkt gefolgt von den 900-MHz-Frequenzen. In den etablierten GSM-Bändern versuchen die Netzbetreiber, ihr bisher genutztes Spektrum zu sichern und auszubauen. Die Gebote stehen derzeit bei insgesamt rund 2,7 Milliarden Euro, davon eine gute Milliarde für die Frequenzen im 1800-MHz-Band.

...desnetzagentur 2x50 MHz Spektrum. Die ...ten Frequenzen laufen Ende ...neu vergeben. Die neuen ...zu Beginn der

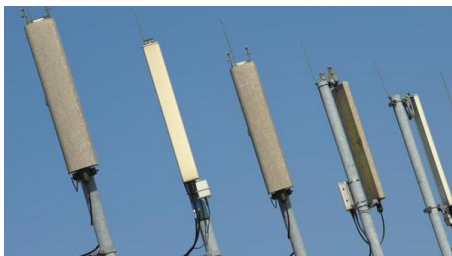
Focus on 1800 MHz  
spectrum

[Heise 2015]



Result:

19 June 2015  
(after 16 working days)



Rundenergebnis der Runde 181				
Frequenzbereich	Block	Ausstattung	Höchstbieter	Höchstgebot ( € in Tsd. )
700 MHz (gepaart)	700 A	2x5 MHz konkret	TEF DE	166.397
	700 B	2x5 MHz abstrakt	Vodafone	165.509
	700 C	2x5 MHz abstrakt	TEF DE	166.847
	700 D	2x5 MHz abstrakt	Telekom	166.567
	700 E	2x5 MHz abstrakt	Telekom	171.649
	700 F	2x5 MHz abstrakt	Vodafone	163.476
900 MHz (gepaart)	900 A	2x5 MHz konkret	TEF DE	195.520
	900 B	2x5 MHz abstrakt	Vodafone	211.807
	900 C	2x5 MHz abstrakt	Vodafone	203.298
	900 D	2x5 MHz abstrakt	Telekom	183.671
	900 E	2x5 MHz abstrakt	Telekom	180.968
	900 F	2x5 MHz abstrakt	Telekom	180.465
	900 G	2x5 MHz abstrakt	TEF DE	189.958
1,8 GHz (gepaart)	1800 A	2x5 MHz abstrakt	Vodafone	237.494
	1800 B	2x5 MHz abstrakt	Telekom	248.054
	1800 C	2x5 MHz abstrakt	Vodafone	258.247
	1800 D	2x5 MHz abstrakt	Vodafone	249.133
	1800 E	2x5 MHz abstrakt	Telekom	248.101
	1800 F	2x5 MHz abstrakt	Vodafone	255.967
	1800 G	2x5 MHz abstrakt	TEF DE	239.228
	1800 H	2x5 MHz abstrakt	Telekom	248.784
	1800 I	2x5 MHz abstrakt	TEF DE	240.288
	1800 J	2x5 MHz konkret	Vodafone	180.153
1,5 GHz (ungepaart)	1500 A	1x5 MHz abstrakt	Vodafone	40.939
	1500 B	1x5 MHz abstrakt	Vodafone	40.939
	1500 C	1x5 MHz abstrakt	Vodafone	40.919
	1500 D	1x5 MHz abstrakt	Telekom	42.964
	1500 E	1x5 MHz abstrakt	Vodafone	42.961
	1500 F	1x5 MHz abstrakt	Telekom	39.011
	1500 G	1x5 MHz abstrakt	Telekom	40.961
	1500 H	1x5 MHz abstrakt	Telekom	40.961
Summe aller gehaltenen Höchstgebote (€ in Tsd.)				5.081.236
Zahlungsverpflichtung aufgrund zurückgenommener Höchstgebote (€ in Tsd.)				0
Summe (€ in Tsd.)				5.081.236

# Result of the Auction 2015

Licensee	acquired frequency spectrum	Euro	License valid until
Telefónica Deutschland GmbH & Co. OHG	700 MHz: 2x 10 MHz (paired) 900 MHz: 2x 10 MHz (paired) 1800 MHz: 2x 10 MHz (paired)	1,198,238,000	31 Dec 2033
Telekom Deutschland GmbH	700 MHz: 2x 10 MHz (paired) 900 MHz: 2x 15 MHz (paired) 1800 MHz: 2x 15 MHz (paired) 1500 MHz: 1x 20 MHz (unpaired)	1,792,156,000	
Vodafone GmbH	700 MHz: 2x 10 MHz (paired) 900 MHz: 2x 10 MHz (paired) 1800 MHz: 2x 25 MHz (paired) 1500 MHz: 1x 20 MHz (unpaired)	2,090,842,000	
<b>Total</b>	<b>270 MHz</b>	<b>5,081,236,000</b>	

# Comparison of auctions

## UMTS (2000)

- Participants 6
- Altogether 145 MHz
- Duration 19 days
- 173 rounds
- Time per round 40 Min.

→ 50bn €

## Wireless Access (2010)

- Participants 4
- Altogether 360 MHz
- Duration 27 days
- 224 rounds
- Time per round 90 Min.

→ 4.4bn €

## Wireless Access (2015)

- Participants 3
- Altogether 270 MHz
- Duration 16 days
- 181 rounds
- Time per round 60 Min.

→ 5.1bn €

- General Information
- UMTS Auction in Germany (2000)
  - Process
  - Admittance to the Auction
  - Licence
    - Liabilities
    - Validity
  - Result of the Auction
  - Auction of the Auction's Clock
  - International UMTS Licensing
- Frequency auction for wireless access (2010)
- Frequency auction for wireless access (2015)
- Conclusions and Outlook

- Historic event  
... and you were around!
- UMTS licence payments were initially excessive
- Network expansion obligations of 800 MHz auctions in 2010 have already increased network coverage in rural areas.
- Digital Agenda of the Federal Government has led to stricter coverage and bandwidth obligations for operators in 2015 auction.

- Discussion on
  - Shared use of infrastructure
  - Licence transfer
  - Economic viability of network investments, e.g. required fiber network roll-out into rural areas in order to hook up base stations.
  - Use of 3G and/or LTE in (parts of) the frequency spectrum currently used exclusively for GSM

continues.

## “Kartellamt nimmt Mobilfunkanbieter unter die Lupe”

*“Die Mobilfunkbetreiber T-Mobile, Vodafone, E-Plus und O2 steuern möglicherweise auf einen Konflikt mit dem Kartellamt zu. [...] Darin äußern die Wettbewerbshüter den Verdacht, das Mobilfunkquartett könnte im Vorfeld der anstehenden Lizenzverlängerung von milliardenschweren Funkfrequenzen sensible Geschäftsinformationen ausgetauscht haben, um ein für sie teures Versteigerungsverfahren zu vermeiden.[...] In den Fragebögen haben die vier Mobilfunkler das Frequenzspektrum brüderlich untereinander aufgeteilt und kommen sich gegenseitig nicht in die Quere.”*

<http://www.spiegel.de/spiegel/vorab/kartellamt-nimmt-mobilfunkanbieter-unter-die-lupe-a-898094.html>

- [Bundesnetzagentur 2000]: Licence Template; Schedule 1 to “Ruling of 18 February 2000 by the President's Chamber on the Determinations and Rules for the Award of Licences for the Universal Mobile Telecommunications System (UMTS) / International Mobile Telecommunications-2000 (IMT-2000); Third Generation Mobile Communications“; [www.bundesnetzagentur.de/media/archive/2163.pdf](http://www.bundesnetzagentur.de/media/archive/2163.pdf)
- [Bundesnetzagentur 2006]: Konzept zur Vergabe weiteren Spektrums für den digitalen öffentlichen zellularen Mobilfunk unterhalb von 1,9 GHz (GSM-Konzept);  
Umsetzung des Handlungskomplexes II (Angleichung der Restlaufzeiten), [http://www.bundesnetzagentur.de/enid/Oeffentlicher\\_Mobilfunk/GSM-Konzept\\_-\\_Angleichung\\_der\\_Restlaufzeiten\\_4bu.html](http://www.bundesnetzagentur.de/enid/Oeffentlicher_Mobilfunk/GSM-Konzept_-_Angleichung_der_Restlaufzeiten_4bu.html)
- [Bundesnetzagentur 2010] Frequenzvergabeverfahren 2010;  
[http://www.bundesnetzagentur.de/DE/Sachgebiete/Telekommunikation/Unternehmen\\_Institutionen/Frequenzen/OeffentlicheNetze/Mobilfunknetze/Z\\_VergabeverfDrahtloserNetzzugang2010.html](http://www.bundesnetzagentur.de/DE/Sachgebiete/Telekommunikation/Unternehmen_Institutionen/Frequenzen/OeffentlicheNetze/Mobilfunknetze/Z_VergabeverfDrahtloserNetzzugang2010.html), accessed 2015-06-22.
- [Bundesnetzagentur 2013] Frequenzen für mobiles Breitband;  
[http://www.bundesnetzagentur.de/SharedDocs/Pressemitteilungen/DE/2013/130624\\_MobilesBreitband.html](http://www.bundesnetzagentur.de/SharedDocs/Pressemitteilungen/DE/2013/130624_MobilesBreitband.html), accessed 2016-03-16.



- [Bundesnetzagentur 2014a] Verwaltungsverfahren wegen frequenz-regulatorischer Aspekte des Zusammenschlussvorhabens der Telefónica Deutschland Holding AG und der E-Plus Mobilfunk GmbH & Co. KG;  
[http://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Telekommunikation/Unternehmen\\_Institutionen/Frequenzen/OffentlicheNetze/Mobilfunk/FusionEntscheidung.pdf?\\_\\_blob=publicationFile&v=1](http://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Telekommunikation/Unternehmen_Institutionen/Frequenzen/OffentlicheNetze/Mobilfunk/FusionEntscheidung.pdf?__blob=publicationFile&v=1)
- [Bundesnetzagentur 2014b] Entscheidung zur Anordnung und Wahl des Verfahrens sowie über die Festlegungen und Regeln im Einzelnen (Vergaberegeln) und über die Festlegungen und Regelungen für die Durchführung des Verfahrens (Auktionsregeln) zur Vergabe von Frequenzen in den Bereichen 700 MHz, 900 MHz, 1800 MHz sowie weiterer Frequenzen im Bereich 1452 - 1492 MHz für den drahtlosen Netzzugang zum Angebot von Telekommunikationsdiensten (Aktenzeichen: BK1-11/003),  
[http://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Telekommunikation/Unternehmen\\_Institutionen/Frequenzen/OffentlicheNetze/Mobilfunk/DrahtloserNetzzugang/Projekt2016/EntscheidungsentwurfProjekt2016\\_pdf.pdf?\\_\\_blob=publicationFile](http://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Telekommunikation/Unternehmen_Institutionen/Frequenzen/OffentlicheNetze/Mobilfunk/DrahtloserNetzzugang/Projekt2016/EntscheidungsentwurfProjekt2016_pdf.pdf?__blob=publicationFile)

- [Bundesnetzagentur 2015] Mobiles Breitband - Projekt 2016, [http://www.bundesnetzagentur.de/DE/Sachgebiete/Telekommunikation/Unternehmen\\_Institutionen/Frequenzen/Projekt2016\\_Frequenzauktion/projekt2016-node.html](http://www.bundesnetzagentur.de/DE/Sachgebiete/Telekommunikation/Unternehmen_Institutionen/Frequenzen/Projekt2016_Frequenzauktion/projekt2016-node.html), accessed 2015-06-22.
- [European Commission 2012]: ERTMS - European Rail Traffic Management System; [http://ec.europa.eu/transport/rail/interoperability/ertms/ertms\\_en.htm](http://ec.europa.eu/transport/rail/interoperability/ertms/ertms_en.htm), accessed 2012-04-23
- [Heise 2015] Frequenzauktion: Bieterwettstreit im 1800-MHz-Band. Heise Online, <http://www.heise.de/netze/meldung/Frequenzauktion-Bieterwettstreit-im-1800-MHz-Band-2682209.html>, accessed 2015-06-22.