2nd Seminar on Service Quality Evaluation in Wireless Networks

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# Hybrid Cellular and Broadcasting Networks

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Stadt der Wissenschaft 2007
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# Outline

1. Introduction and Motivation
2. Digital Video Broadcasting – Handheld (DVB-H)
3. Hybrid DVB-H / UMTS – Networks
4. Simulation Results
5. Conclusion

# Services of mobile communication

- **Speech telephony and SMS (2G)**
- **Data communications (2.5G and 3G)**
  - GPRS, EDGE, UMTS, HSPA, MBMS,…
  - Web-Browsing, e-mail, File-Download, …
- **Mobile-TV (3G and e.g. DVB-H)**
  - Mobile broadcast becomes increasingly important (e.g. in Italy, Finland, Germany,…)

→ **One step further**

– Interactive data services with high data rates to mobile terminals

# Why do we need hybrid networks ?

- Mobile networks offer point-to-point connections
- Especially at Hot-Spots network will be not able to serve all users
- Cost efficient system needed for mass delivery
- Solution: additional broadcasting network

→ Hybrid network

**Mobile network**
**(UMTS)**

**Broadcast network**
**(DVB-H)**

# Parts of a hybrid network

- **Combination of two existing and currently deployed networks**

- **In this case it is composed of UMTS and DVB-H:**
  - UMTS (Universal Mobile Telecommunications System):
    - Cellular mobile network of 3. Generation
    - Bi-directional point-to-point connections with 384 kbit/s

      → User-dependent system

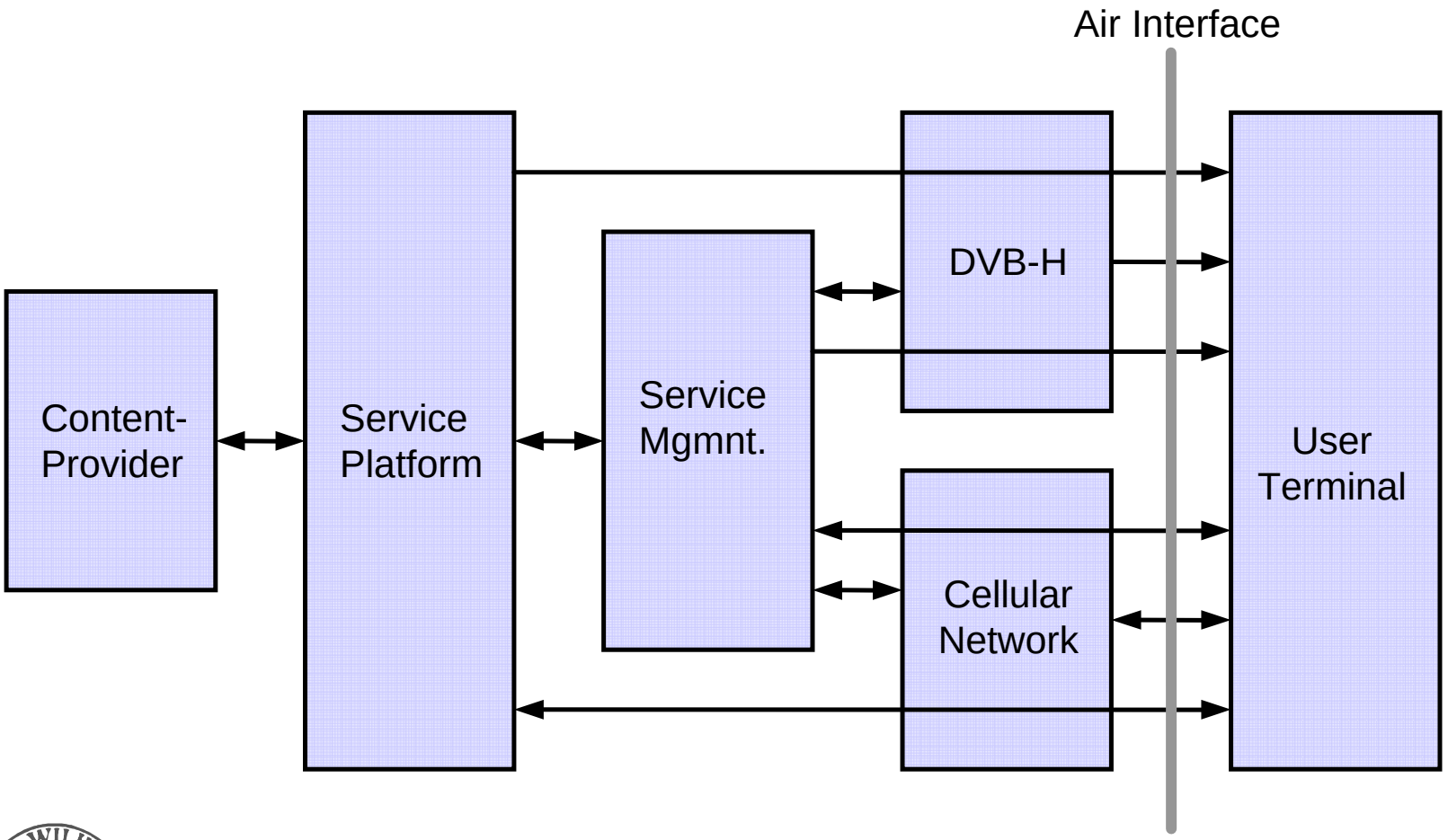
  - DVB-H (Digital Video Broadcasting – Handhelds):
    - Based on and fully compatible to DVB-T
    - Unidirectional point-to-multipoint connections with up to 10 MBit/s

      → Content-dependent system

# More DVB-H Details

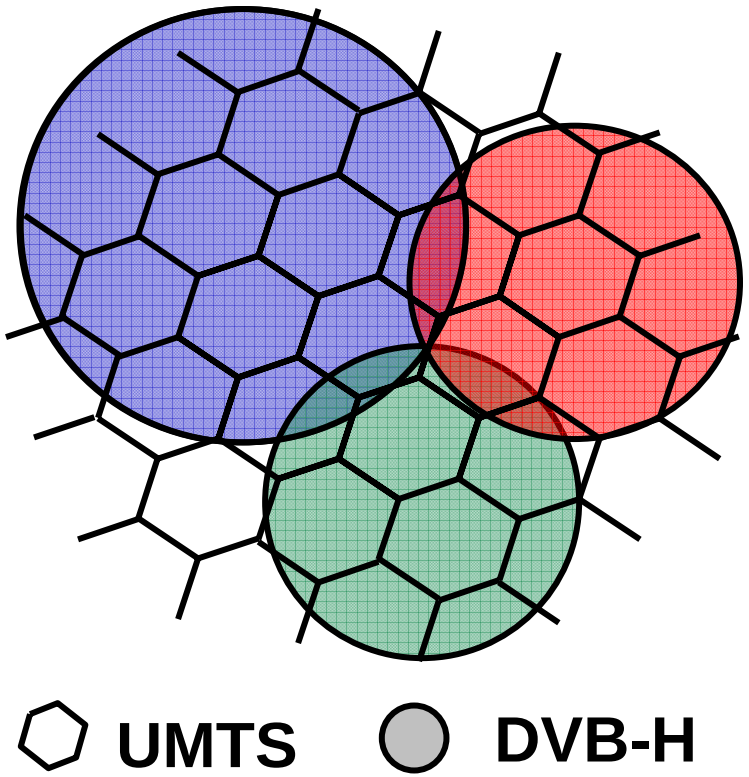
- **Power Reduction**
  - Optimized for battery driven, mobile equipment with small antennas
  - Time Slicing is used for power saving
- **Adaptation to mobile environment**
  - Additional error correction MPE-FEC
  - Maximum speed between 200 km/h and 1000 km/h
- **Network planning**
  - Channel bandwidths 5 MHz, 6 MHz, 7 MHz and 8 MHz
  - Enables loss-free handover using time slicing
  - Enables Signal Frequency Networks (SFN's), also with localized content
  - Additional OFDM-mode 4K for more flexible network planning
- **IP Datacast standard**
  - Transmission of IP-based data with up to 10 Mbit/s
  - End-to-End system with the possibility to include cellular networks
  - Video-Codec: H.264 (highly recommended), Audio-Codec: HE-AAC+ v2

# System architecture of hybrid networks



# Network structure of hybrid networks

- Cellular structure of DVB-H network
- **Full coverage** by the UMTS network
- Full coverage for DVB-H not necessary due to hybrid approach
- **Overlaying** DVB-H cells expected to be larger than UMTS cells



# Advantages of hybrid networks

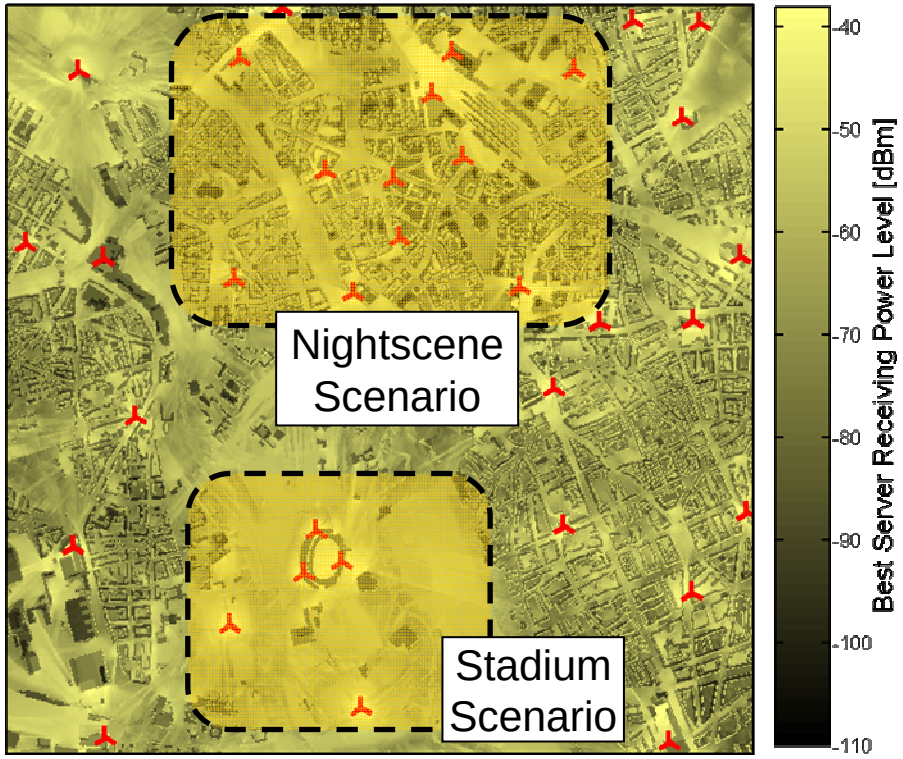
- **Comparison between single UMTS network and hybrid network**

- **Advantages of hybrid networks are:**
  - Reducing of necessary data rate
  - Reducing of mean response time
  - → These criteria depend on load balancing and network structure

- **Further advantages:**
  - Unloading UMTS network
  - Minimizing electromagnetic Radiation
  - Reducing infrastructure costs
  - → Additional criteria for optimized network planning

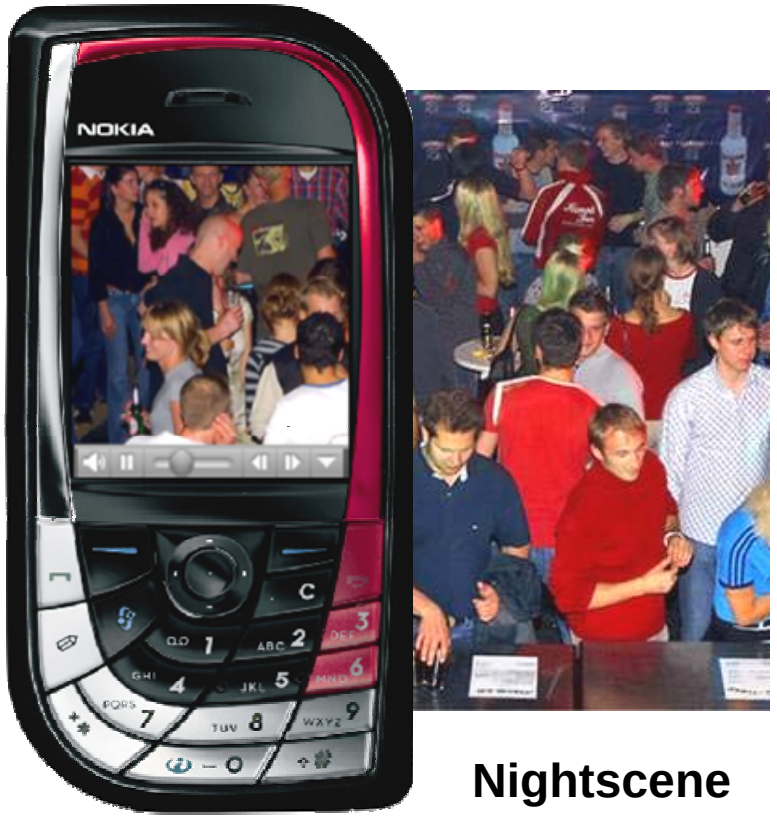
# Simulation of hybrid networks

- **Scenario based on realistic user and environment data**
  - City of Hannover with building data used for propagation simulation
  - Population data for service assumptions of 8 different services (Voice, Web-Browsing, File-Download, …)
- **Realistic UMTS network with 34 Node-Bs for 8 typical services**
- **Video transmission with 384 kbit/s in hot-spot areas**
- **Snapshot analysis based on Monte-Carlo simulation**



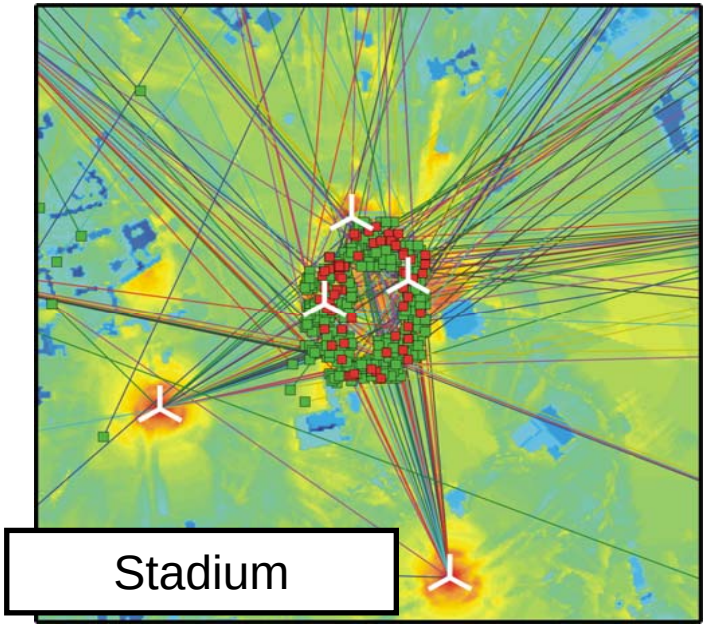
# Hot-Spot scenarios at Hannover

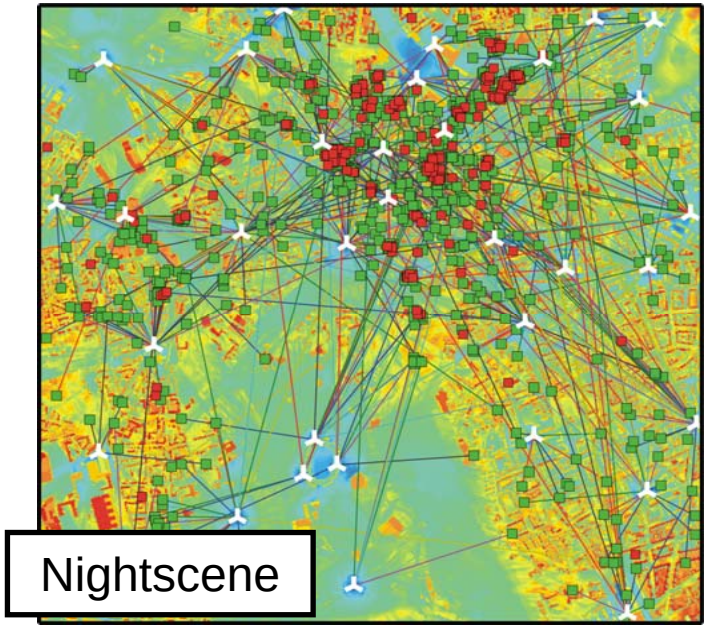

**Stadium Scenario**




**Nightscene Scenario**

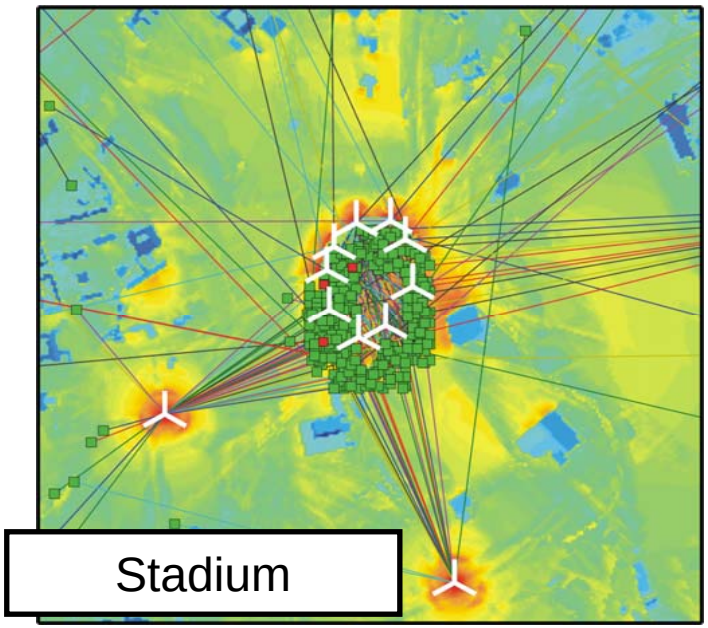
# Additional Video Service

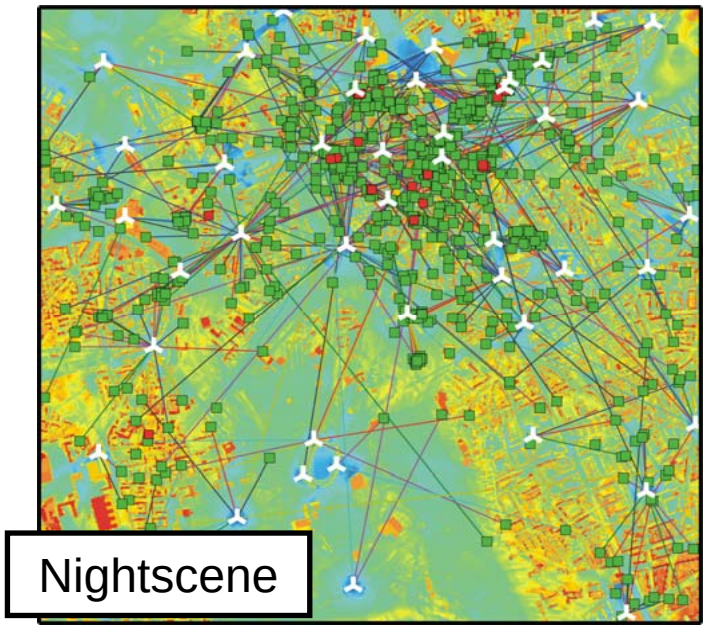



- **Video-On-Demand service with 384 kbit/s at the downlink**
- **Overloaded UMTS network → Rejection of video users**
  - At Stadium scenario approx. 20 %,
  - At Nightscene scenario approx. 43%
- **Furthermore influence on other typical UMTS services e.g. voice**

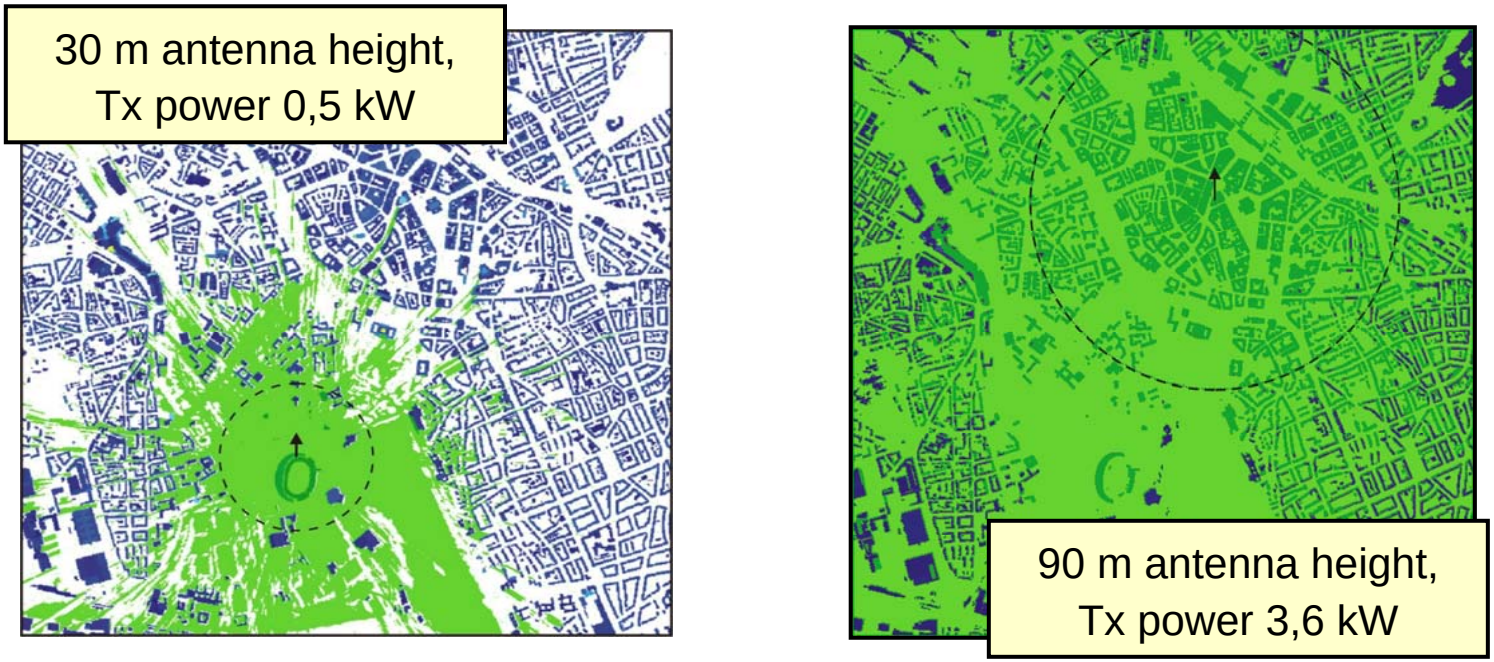
# Enhanced UMTS network




- **Additional UMTS base station to solve the problem**
  - Stadium: 6 additional Node-Bs (18 cells)
  - Nightscene: 11 additional Node-Bs + second UMTS frequency
- **Alternative approach needed**

# DVB-H network coverage

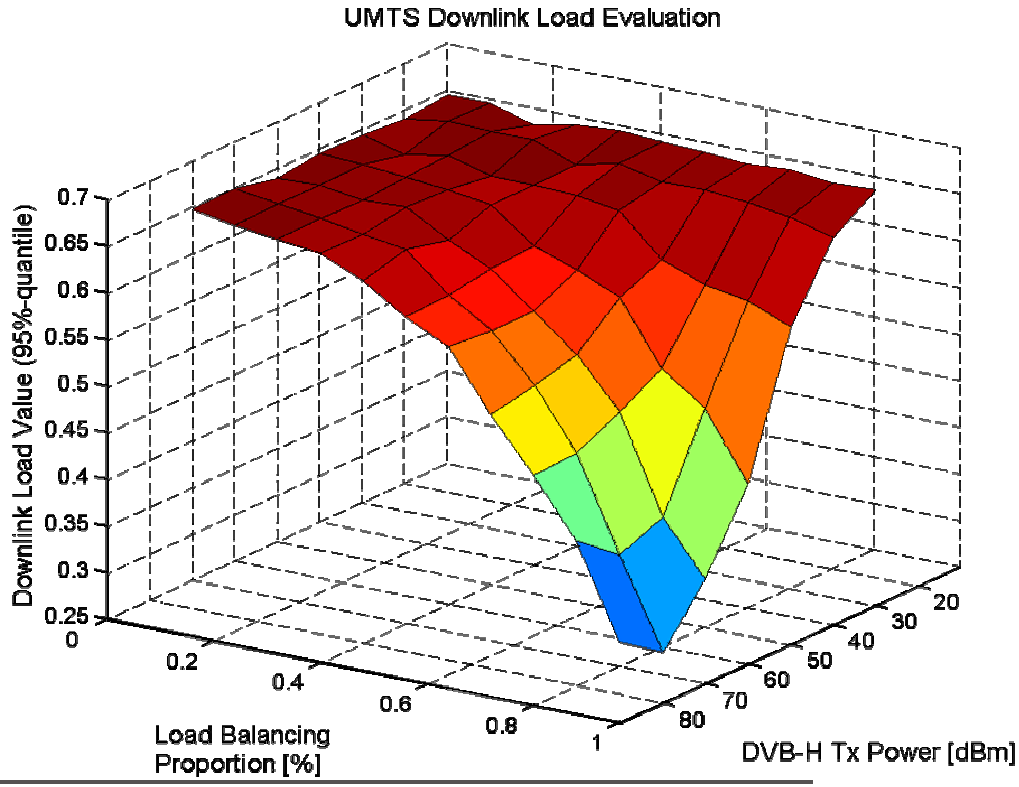



- **Coverage area simulated by ray tracing propagation model**
- **Indoor reception also enabled inside the stadium building and for 99 % of the buildings of the Nightscene scenarios**

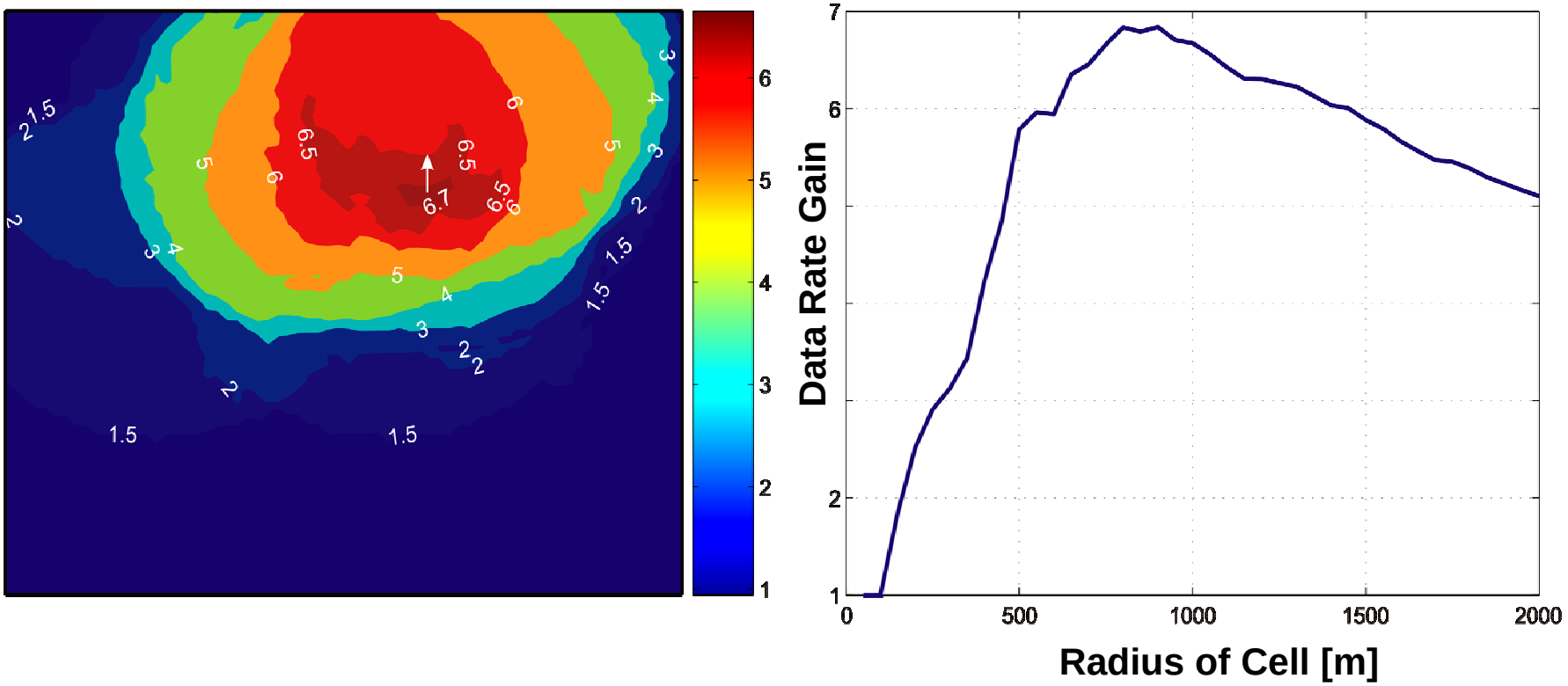
# Unloading UMTS cells

- **Downlink Load Factor describes load of each UMTS cell**
- **Load factor dependent on load balancing and size of the DVB-H cell**
- **Optimization process for load, response time and DVB-H Coverage**

$$\eta_{DL} = \sum_{j=1}^{N_{DL}} \frac{\left(E_b / N_0\right)_j \cdot R_j \cdot \nu_j}{W} \cdot \left(\left(1-\alpha_j\right)+i\right)$$



# Reducing necessary capacity




- Gain of data rate: single UMTS system compared to hybrid case
- Approx. 7 times more capacity needed in p-t-p case

# Conclusion

- **Hybrid networks offers a an efficient way of transmission**

  **→ especially for mass delivery of high data rate services at hot spots, e.g. video services**

- **Both network parts (UMTS and DVB-H) are fully standardized and currently under deployment**

- **Optimization with load balancing and network planning**

# Thank you for your attention !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# Backup-Slides