

Radio Network Design and Convergence between Mobile and Broadcast for Next Generation Networks



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Networks and Fixed Mobile Convergence for CEE, CIS and Baltic States
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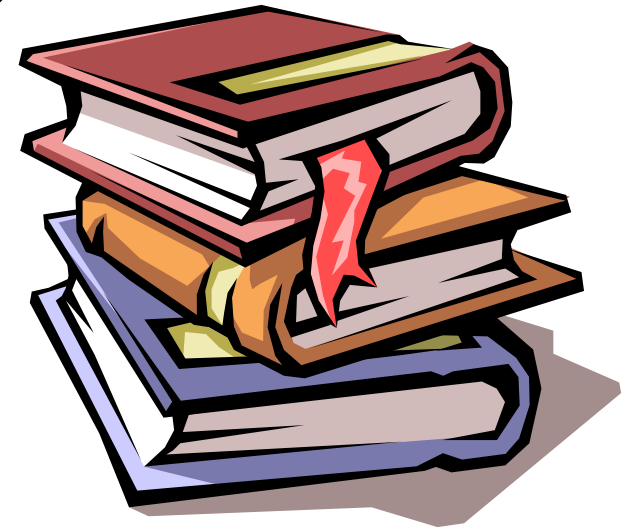
Next generation networks (NGNs) must meet the demands of the next generation users.

A “network everywhere” offering a broad range of different data services, multimedia support, security, personalization and mobility have to be provided by the operators of future networks. But the users do not want to worry about technical details like the access technology; they are only interested in the offered services and the quality and costs thereof.

It will be the task of the network operator to choose the “best” technology, or better the best mix of technologies for their next generation network meeting the customer’s expectations in a cost-effective way.

The presentation will, based on the requirements towards next generation networks, compare the situation of mobile and broadcast and demonstrate the convergence between this. Network design challenges coming up with the next generation networks, will be outlined by having a closer look to tasks and methods of 3G mobile network planning compared to the well-understood procedures for recent 2G networks.

- **Wireless Networks – From the Beginning to the 3rd Generation**
- **Next Generation Networks**
 - ▶ Requirements
 - ▶ User's View
- **Design Challenges of 3G Mobile Networks**
- **Mobile and Broadcast Convergence**
 - ▶ Why?
 - ▶ New Opportunities
 - ▶ Benefits
- **Conclusion**



Wireless Networks – From the Beginning to the 3rd Generation

1G Systems: When it all started

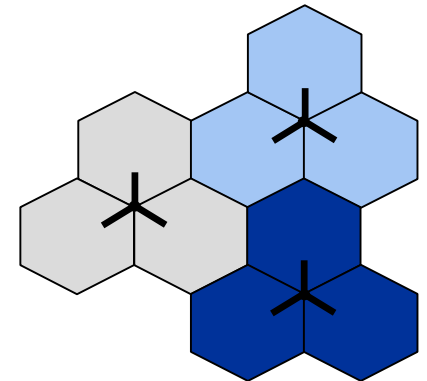
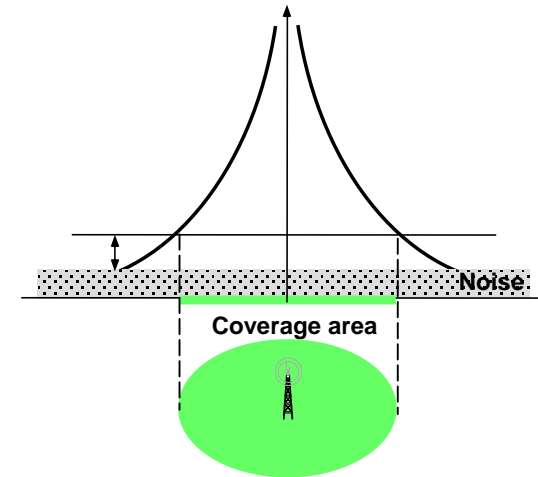
- ▶ Beginning of mobile networks in the early 1960s
- ▶ Main target: to offer voice conversation

2G Systems: Digital Technology

- ▶ 2nd Generation systems ignited the ultimate success story of mobile networks in the late 1980s
- ▶ Year 2000: in some countries the number of mobile subscribers topped the number of fixed phone sets
- ▶ Voice focus, but first data service support

2.5G Systems: Half Step instead of One

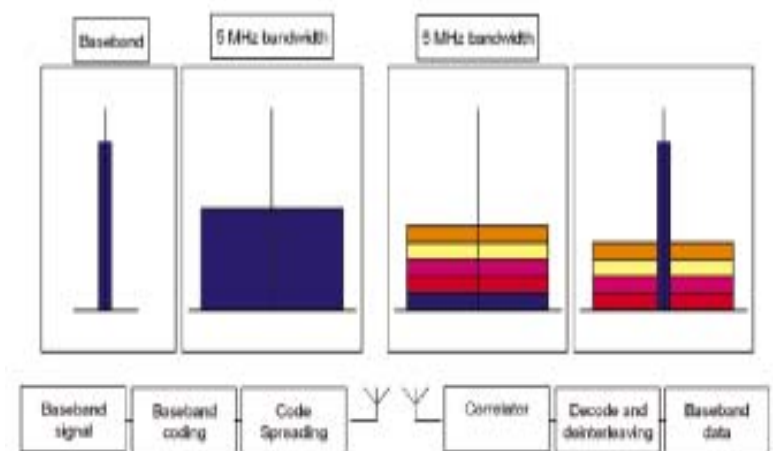
- ▶ In the late 1990s it was realized once again that the air interface would soon become a bottle neck
- ▶ this time not due to the number of *voice* users, but by the growing demand for *data* services
- ▶ Data & voice services, Circuit & packet switched traffic



Wireless Networks – From the Beginning to the 3rd Generation

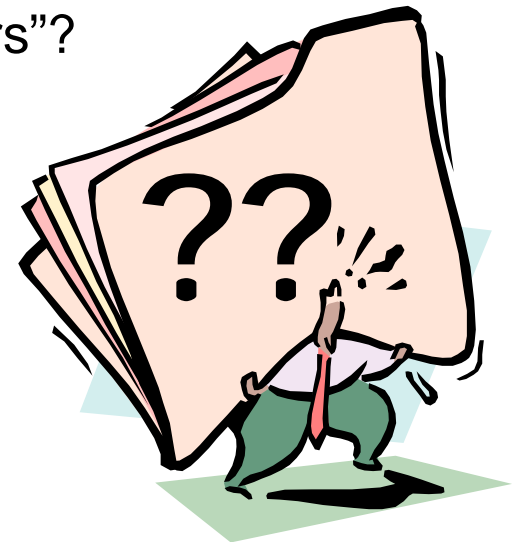
3G Systems: From “Evolution“ to „Revolution“

- 3G systems do not simply extend existing 2G, they are completely new
- This forces network planners to use new algorithms and planning processes to create and engineer these systems
- Key characteristics of 3G Systems:
 - ▶ Mainly data services
 - ▶ Broad range of different data services, multi media support
 - ▶ Mainly packet switched data
 - ▶ Enhanced multiple access schemes
 - ▶ International standardization
 - ▶ All-in-one planning, coverage & QoS
 - ▶ Co-existence with 2G Systems

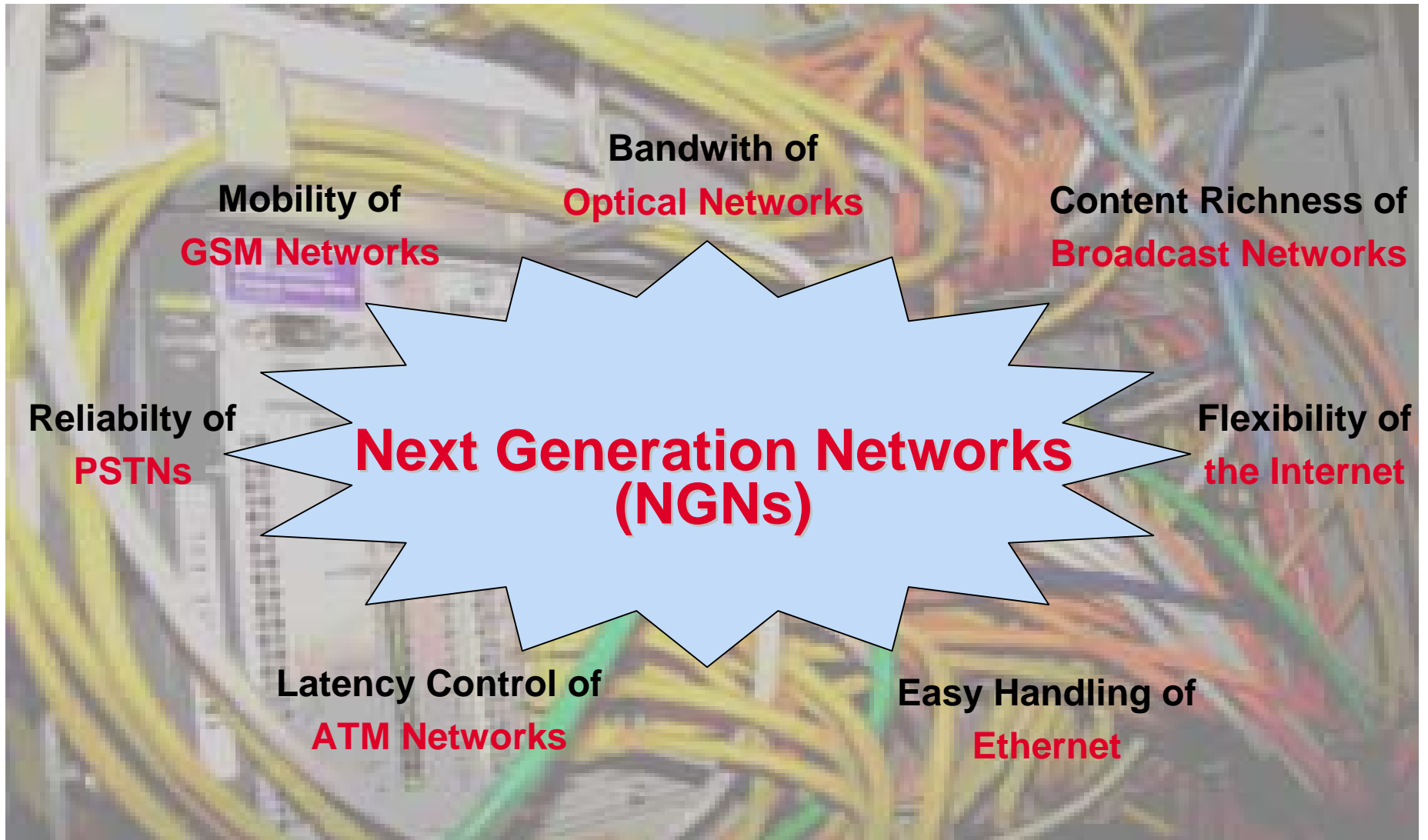


Looking at the Evolution of Wireless Networks during the last years, the following questions could be asked:

- What will be the next steps of evolution?
- What are the demands of the “Next Generation Users”?
- What are the requirements on the “Next Generation Networks”?
- Could one of the “traditional” networks fulfill this requirements?



Next Generation Networks: Requirements



Next Generation Networks: User's View

Users are **not** interested in

- Network technologies
- Comparing different access technologies
- Selecting the best fitting access technology

Users are interested in **SERVICES**, that the end user/consumer can access

- User friendly
- Affordable
- Everywhere available

Users want to

- Control cost
- Browse and find new services without added costs



Next Generation Network: EverNet - Network Everywhere

- **My Network is located, where I am located**
- **No matter via which access technology**
 - **I am located in my network**



... like Electricity?

Network Services like Internet and www, that previously had been experienced for some hours a day and principally at the desk as a media space which is separated from the reality, will be integrated in our daily life and are rarely perceptible as independent part.

As little as nowadays you use electricity in a conscious way – you switch on the light, listen to the radio, use the vacuum cleaner.

As little you 'go into' the Internet under the conditions of omnipresent wideband network:
The separation of off- and online disappears more and more.

Therefore, the EverNet makes the access network “disappear” in the same way as a working supply network the electricity.

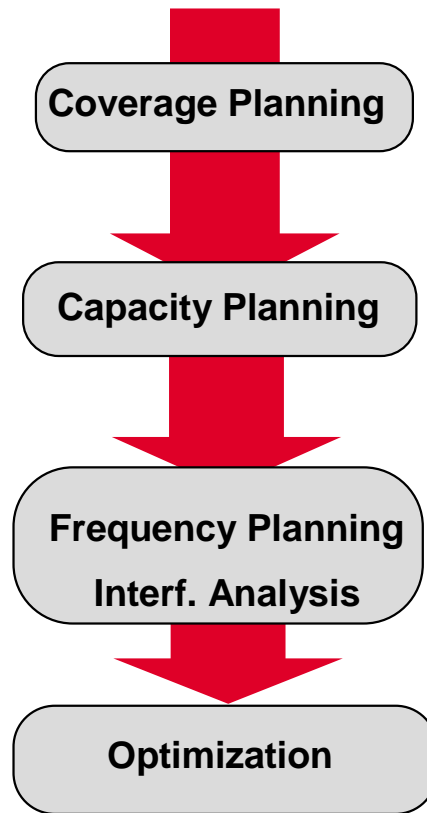


What are the network design challenges coming up with the next generation networks?

Let's have a closer look to tasks and methods of 3G cellular networked planning compared to the well-understood procedures for recent 2G networks

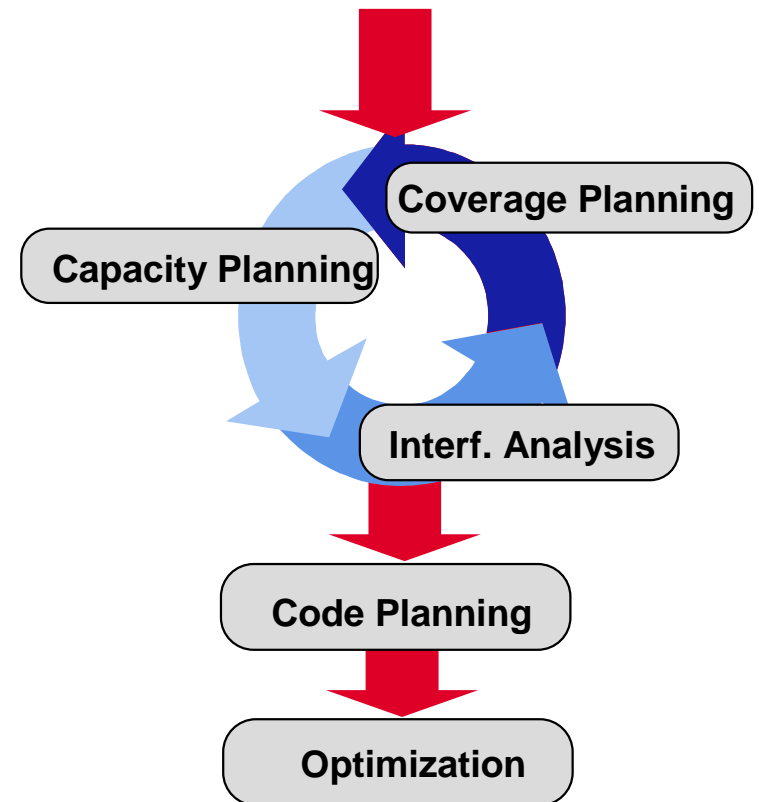


2G Network Planning



Steps are **independent** from each other.
If the traffic load exceeds a cell's capacity, an other transceiver can be added to the cell.

3G Network Planning



Coverage -, capacity planning and interference analysis are **not independent**.
-> Dynamic Cell Areas

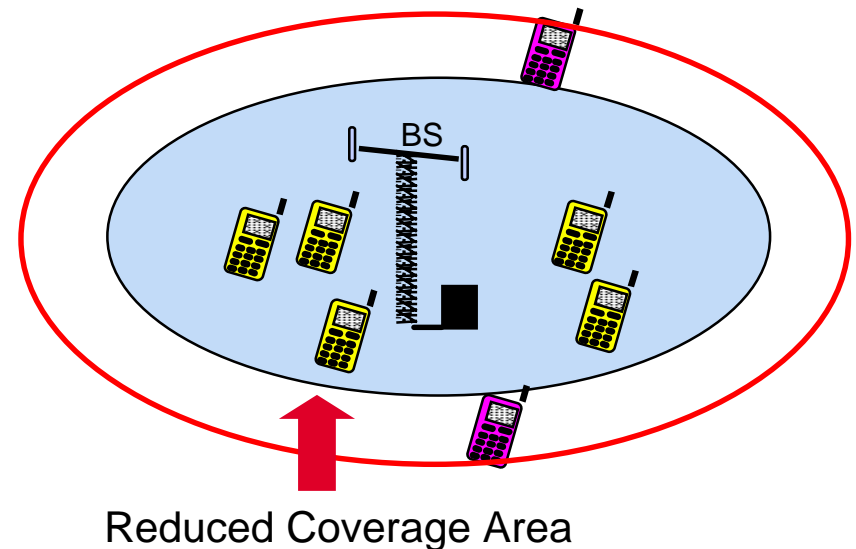
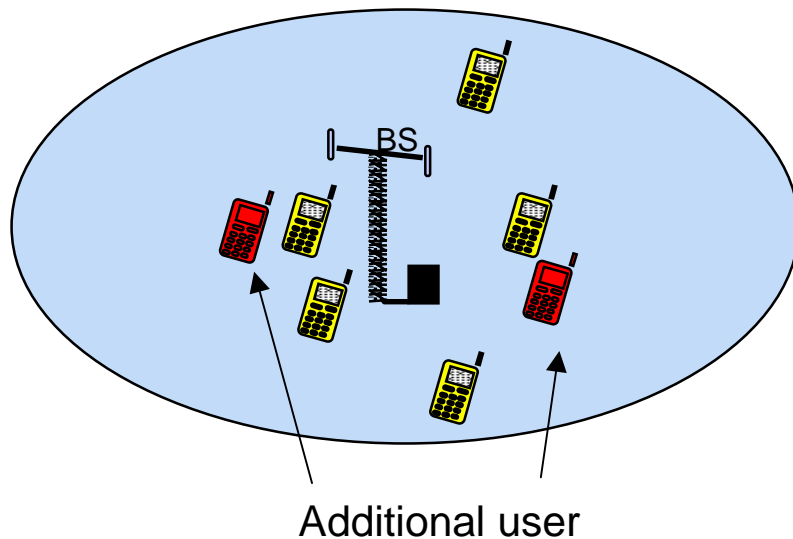
- Especially for GSM-dominant countries 3G/UMTS is a completely new technology
- There are major differences like
 - ▶ cell breathing effects (compared to GSM networks)
 - ▶ mixed traffic scenarios (packet and circuit switched)
 - ▶ mix of services (bit rates, etc.)
- There is a dependency between load and coverage area of a cell
- The separation of coverage planning, capacity planning and interference analysis will no longer work in 3G systems



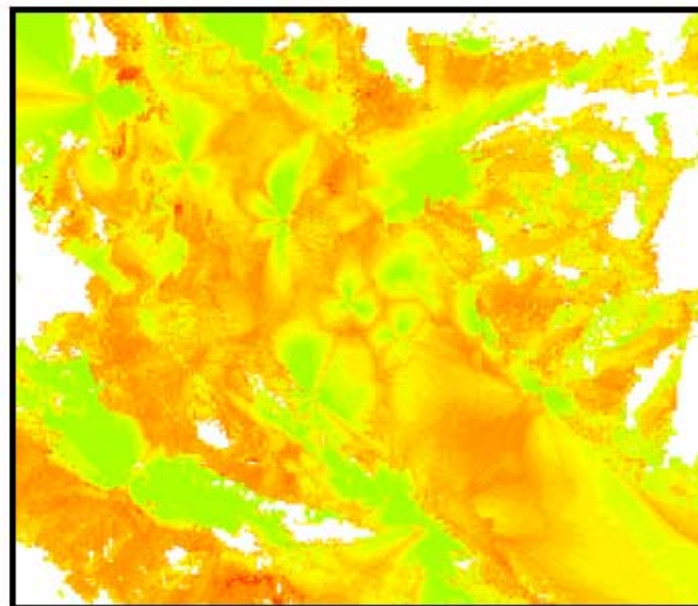
New Challenges for Radio Network Planning Engineers

Design of 3G Mobile Networks: Cell Breathing

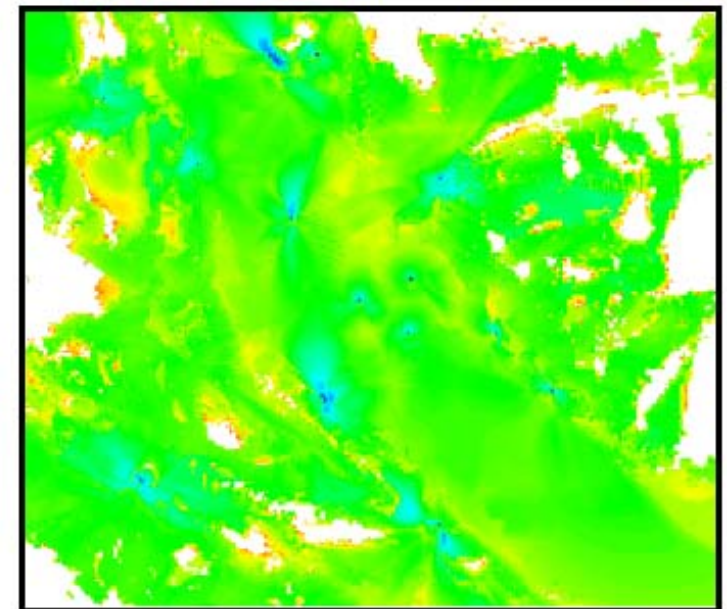
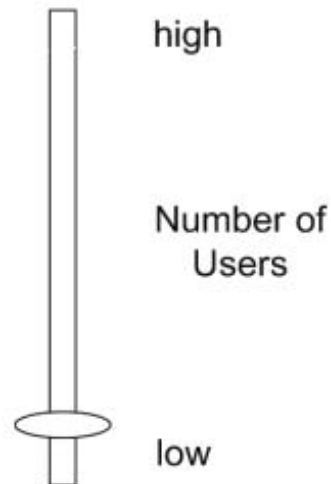
- More users inside a cell increase interference signal (noise)
- Power control has to increase the transmit power to fulfill the E_b/N_0 requirements
- Users far apart from the BS who cannot increase their power anymore
- Their connection will be lost
- When the cell load increases the coverage area shrinks and vice versa
- The cell is breathing



Coverage for the 144kbps service



Downlink coverage

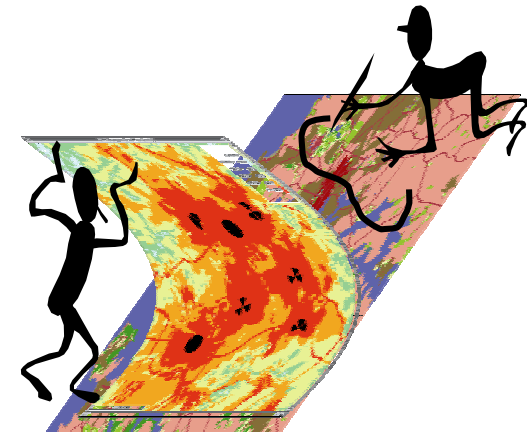


Uplink coverage

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Design of 3G Mobile Networks: Cell Breathing

- Capacity enhancements have to be considered from the beginning
- It won't be possible to add another frequency /TRX
- That means at the beginning:
 - ▶ smaller cell sizes than necessary
 - ▶ More base stations than necessary
 - ▶ Higher invest
- If the traffic estimation was too low
 - ▶ Cell areas will shrink
 - ▶ Coverage holes in the network will appear



**This could only be solved by adding
additional base stations**

Design of 3G Mobile Networks: Uplink and Downlink Planning

- Asymmetric traffic -> different data rates in uplink and downlink
- coverage areas and capacities are different for both directions

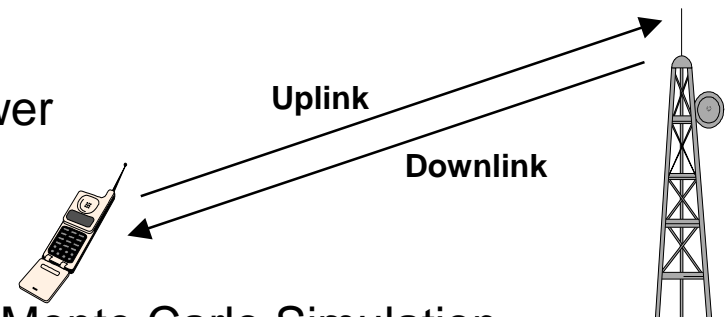


Up- and downlink have to be planned separately

In GSM network typically only the downlink is simulated in tools

A planning procedure based on a planning tool can consist of the following steps:

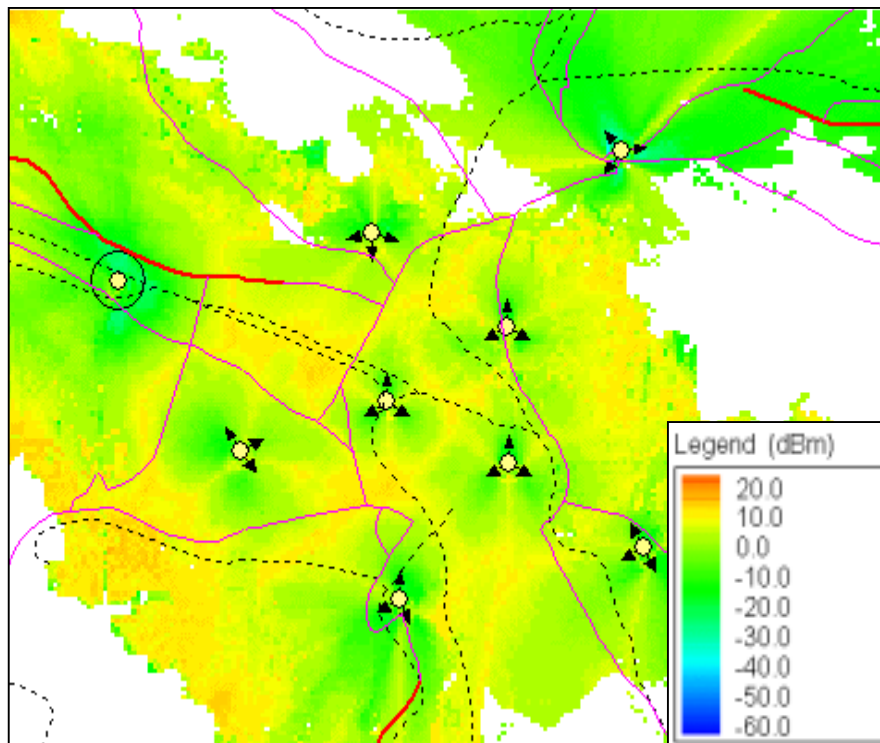
- Considering only Downlink:
 - ▶ planning of cell areas based on Pilot Power
 - ▶ establishing of handover area
- Considering Up- and Downlink:
 - ▶ Verification of the coverage areas with a Monte Carlo Simulation
 - ▶ traffic scenarios have to be known



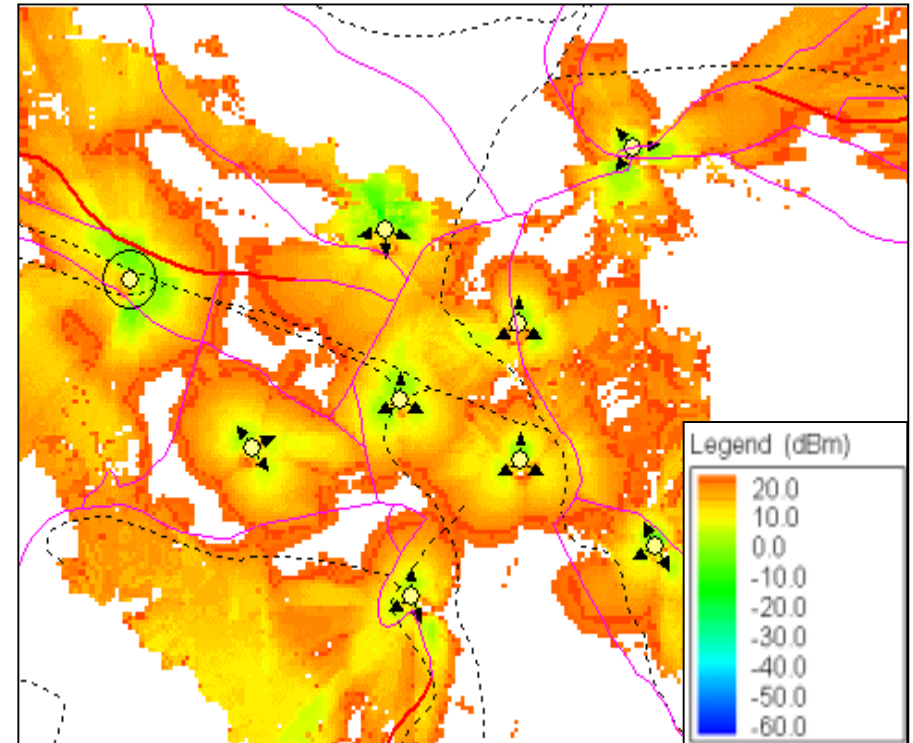
Design of 3G Mobile Networks: Uplink and Downlink Planning

Needed transmit power

achieve a connection for a defined service by a given network load.



Needed transmit power in **Downlink**
for speech service



Needed transmit power in **Uplink**
for speech service

Design of 3G Mobile Networks: The Impact of Service Mixes

- One of the key features of 3G Systems is its inherent flexibility regarding data rates and service types
- there exist lots of services and they are very different from each other
 - ▶ in their data rates
 - ▶ in their traffic types
 - ▶ in their and QoS demands
- In 2G there was only one service, therefore **co-interference** caused by other services simply did not exist.
- 3G networks cannot be optimized per service but only per service mix as a 3G base station serve all users and their specific services within its cell simultaneously



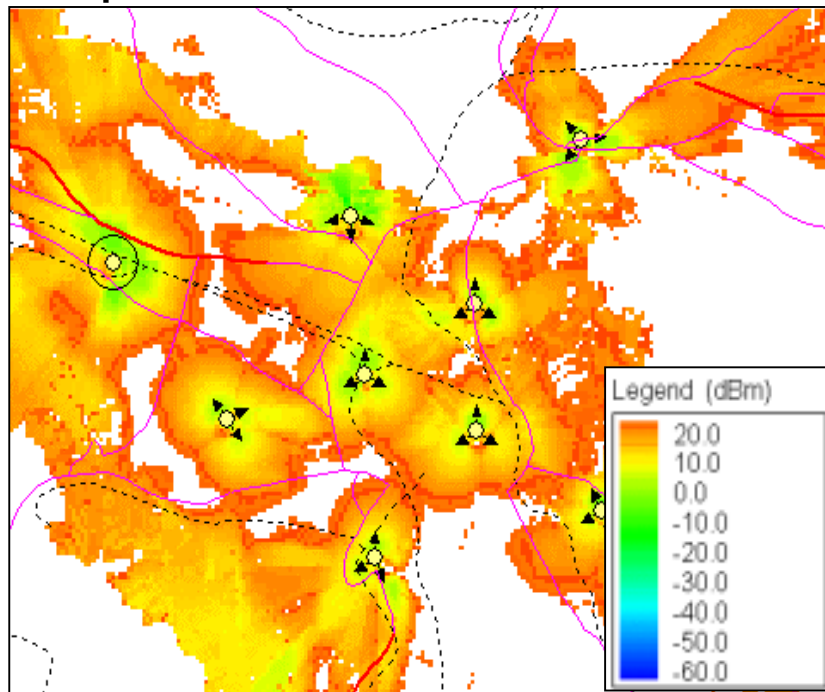
**A cell will no longer have one coverage area,
a cell will have one coverage area for each service**

Based on which service/coverage area should the network be dimensioned?

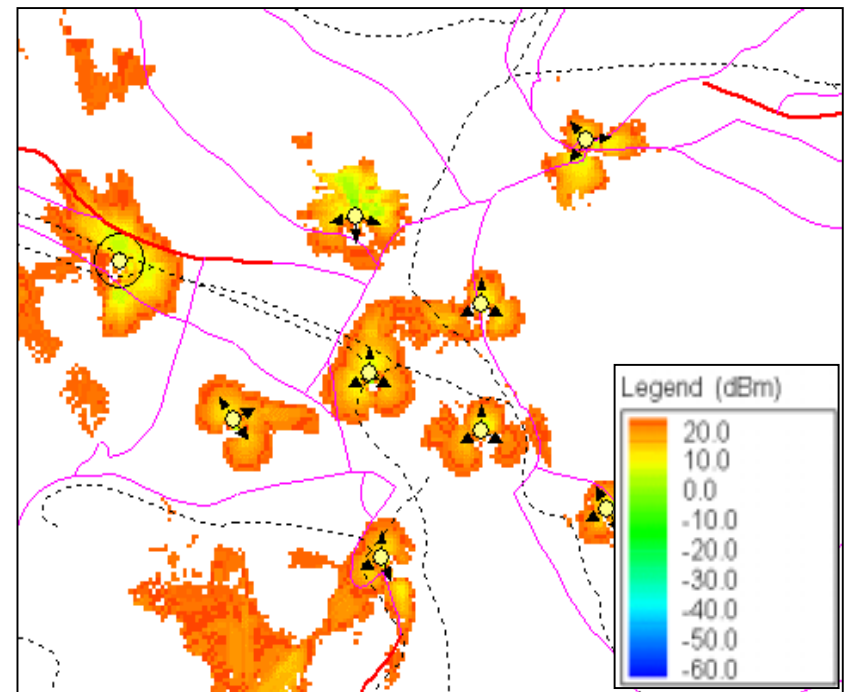
Design of 3G Mobile Networks: Coverage Areas for Different Services

Comparison Uplink Coverage Speech / 64 kBit/s

Needed transmit power in Uplink
for **speech service**



Needed transmit power in Uplink
for **64 kBit/s data**

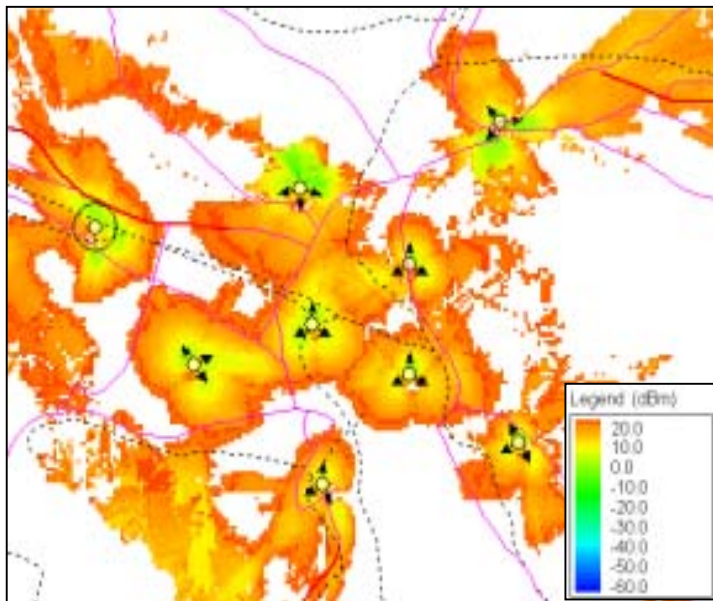


Services with a high data rate use a lower spreading factor. Therefore they operate with a small processing gain, and need in general a higher transmit power to achieve the required E_b/N_0 . This will lead to smaller service areas compared to speech service

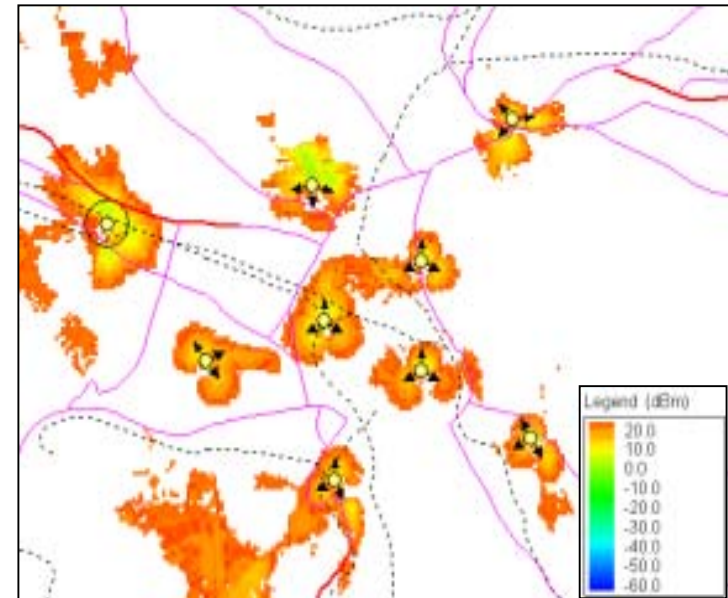
Design of 3G Mobile Networks: Coverage Area for one Service

- Coverage area for a specific service is not constant
- Even then, when the load on this specific service is constant
- The coverage area is also dependant on the traffic of other services in the cell

Comparison Coverage 64 kBit with and without speech subscribers



Needed transmit power for data service 64 kBit/s
No additional speech users are in the network



Needed transmit power for data service 64 kBit/s
Additional speech users are in the network

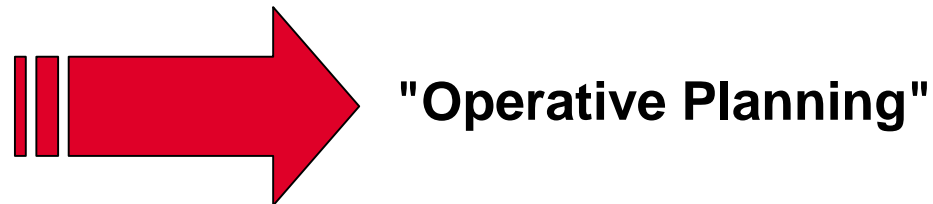
Design of 3G Mobile Networks: What needs to be considered with 3G?

Many planning jobs from 2G networks re-appear in 3G networks also, but often more complicated (e.g. neighbor planning) or simultaneously (e.g. coverage and capacity analysis)

New problems (like service mix or re-use of existing 2G sites) add to this, rendering the network design a very challenging process.

Consequences:

- forecasting of traffic and user behaviour is more important
- reaction times from operations to planning need to be optimised



**Operators who can support the required services
with the demanded quality of service,
will have a clear advantage in the 3G race.**

Mobile & Broadcasting - Benefits of Convergence

One network per application?

- Telephony network for one-to-one talking application
- Data communication networks for data transmission
- Broadcasting networks for radio and television services

One network can be used for multiple applications and services

- 2G mobile mainly for voice – but also for messaging and data
- 3G mobile also for fast-internet

Hybrid usage of networks

- One network for downlink, another for uplink
- Parallel usage of broadcast and one-to-one networks

Towards shared usage of

- Spectrum
- Network Resources



Mobile & Broadcasting - Current Situation



Mobile Networks

- 2G, 2.5G, 3G
- One-to-one
- Full Mobility
- Bi-directional
- On-demand
- Personalized
- Pay per use



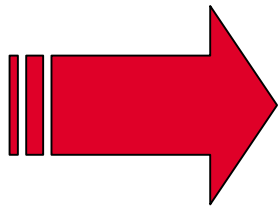
Broadcast Networks

- analog, DAB, DVB
- One-to-many
- Uni-directional
- restricted mobility
- capability of broadband transmission

Convergence: Why? Cooperating: a Must?

Broadcast Networks

- Go digital (DAB, DVB)
- Need a return channel to enable interactive services
- Need arguments to keep their spectrum
- Suffer erosion of advertisement revenues & audience
- Need to create new business models to get infotainment revenue



Any telecom access useable as return channel

Interactivity adds value

Mobility is an opportunity

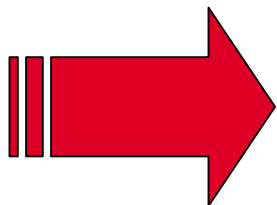
Potential for new revenue streams



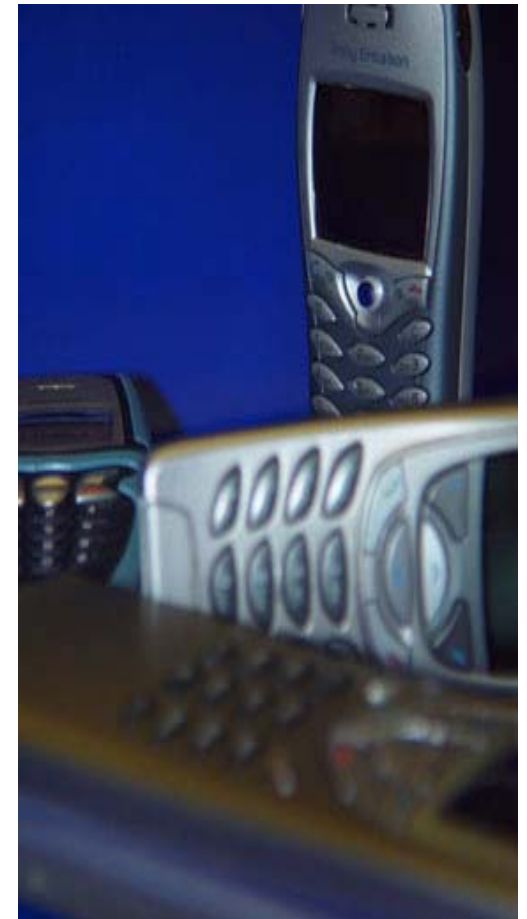
Convergence: Why? Cooperating: a Must?

Mobile Networks

- Telephony is limited by the number of people
- want to sell high value services
- need low cost data distribution and more bandwidth
- must keep UMTS promise
- video content over handset is a must



„cheap“ downlink bandwidth is helpful
television content is welcome
new revenue streams from non voice services



Convergence: Why? Cooperating: a Must?

Cooperating a Must?

...the DVB-H Scenario:

- DVB-T allows mobile reception, but with high power consumption
- DVB-H is based on DVB-T, backwards fully compatible and gives additional features to support Handheld portable and mobile reception
 - ▶ Battery saving
 - ▶ Mobility with high data rates
 - ▶ Increased general robustness
 - ▶ Support for seamless handover
- DVB-H is meant for IP-based services via MPE insertion
- DVB-H can share DVB-T multiplex with MPEG2 services



To transmit Videostreaming via „point-to-point“ networks like GSM or UMTS is much more expensive and capacity situation is much more critical

Convergence: Why? Cooperating: a Must?

Remember:

- Mobile operators are trying to sell expensive MMS-Services, allowing to see a 10s Videoclip in a bad resolution
- Broadcast operators using DVB-H will be able to transmit television programs in high quality and possibly for free to the handhelds

User's view:

- Making phone calls via the mobile is fine!
- But why paying for a low quality 10s Videoclip, if I can watch TV on my mobile for free?

A Horror Scenario for mobile operators?

- Billions spend for UMTS licences
- Already in trouble with WLAN-Hype
- And finally overtaken by old traditional broadcast?



Mobile & Broadcasting - New opportunities together



Benefits for both by using „Hybrid Networks“ taking the advantages of mobile and broadcast networks

Mobile & Broadcasting - Benefits of Convergence

Benefits for Broadcasters:

- Increased attractiveness of broadcasting services
 - More interactiviveness
 - More mobility
- Allowing attractive new, combined services
 - Request programme / data
 - Feedback on acceptance, user requirements
 - Offering a portal to the internet
- High number of (mobile receivers) are available
- Customer relations and billing could be „outsourced“ to mobile operator
- Most of their network infrastructure could be used
- New business



Mobile & Broadcasting - Benefits of Convergence

Benefits for mobile operators:

- Increased attractiveness of mobile services
 - More bandwidth
 - „low cost“ downstream
 - Content (television)
- Allowing attractive new, combined services
 - Wide range of new broadband multi-media services
- Interaction is initiated via mass medium
 - Volume of individual traffic will increase
- Infrastructure investments could be minimised
- Enhanced business

**Mobile operators which co-operate with broadcasters
will easily compete with single mobile operators!**



Mobile & Broadcasting Convergence Conclusions

Conclusions:

- Life goes mobile, TV goes mobile as well
- There are opportunities for broadcast and telecommunication to work together
- Several scenarios for practical cooperation are possible
- Synergy of the two platforms can strengthen both and enable new services
- Joint development and market activities are a the basis for new business opportunities
- The fusion of mobile and broadcast networks can develop a powerful next generation mobile-broadband-Internet



Broadcasting and telecoms will benefit from closer interworking and synergies



Thank you for your attention !

For more information:

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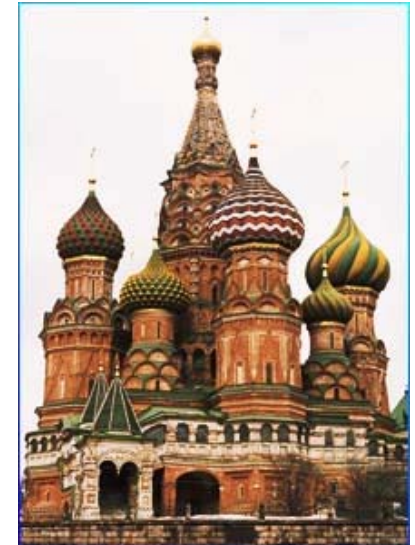
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All presented network simulation results have been performed by using
LS telcom's Radio Network Planning Tool **xG-Planner**