# The influence of current Developments in Spectrum Management on Monitoring

Georg Schöne, Chief Technical Officer, LS telcom AG

ITU Regional Seminar for CIS and Europe, Kiev, 10-12.07.2013

Overview

- **Trends in Spectrum Management and -usage**
  - Technology Neutral Licenses
  - Spectrum Trading
  - Dynamic Spectrum Access
  - Mixing of multiple Technologies
  - Terrestric use of extremely high Frequencies

- **Requirements for the Monitoring**

- **Modern Monitoring Solutions**

- **Integrated Future Scenarios**

Technology and Service Neutral Licenses

- Method to overcome technology blocking of granted licenses

- Frequencies and whole Spectrum are granted for arbitrary technology as long as band masks are obeyed

Frequency Separation from the Center Frequency in Percent of Carrier Width

Legend:
- BS FDD 43 dBm
- BS FDD 40 dBm
- BS FDD 30 dBm
- BS TDD 7.68 MChip/s
- BS TDD 3.84 MChip/s
- BS TDD 1.28 Mchip/s
- TDAB uncritical
- TDAB Sensitive
- DVBTsensitive
- DVBTuncritical
- GSMBTS 43dBm
- GSMBTS 33 dBm
- TETRABS <700
- TETRABS >700 low power
- TETRABS >700 high POWER
- TDSCDMA_DL
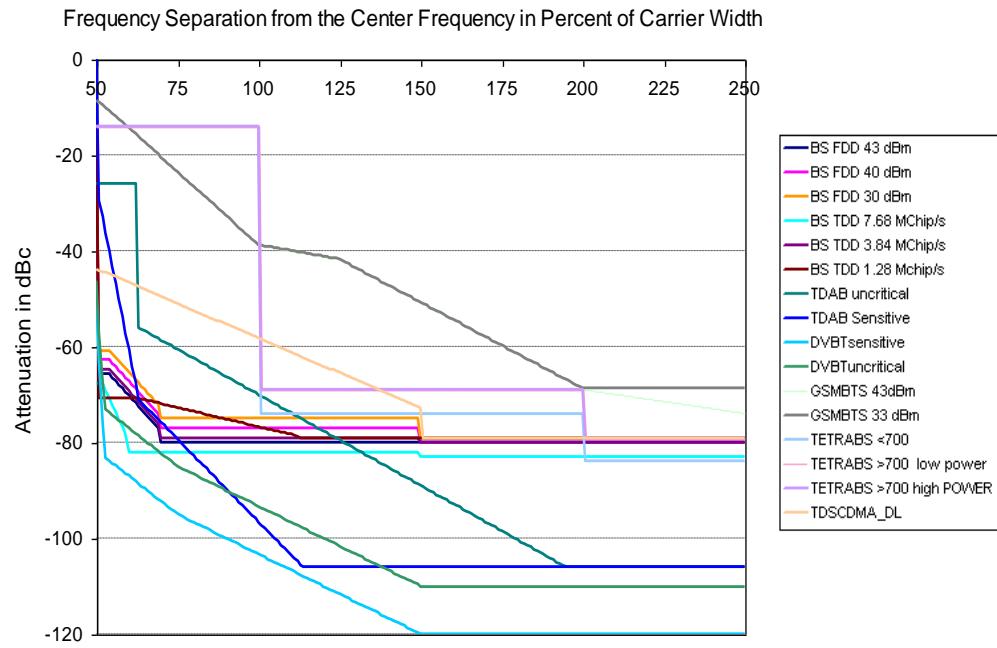
Better Analysis and Measurement coverage may be required to avoid interference in adjacent bands and regions

Trading and Secondary Usage

- Re-Sale of granted frequency space is taking on in many places (US, Australia, UK)

Drawing: Courtesy from ACMA/Australia
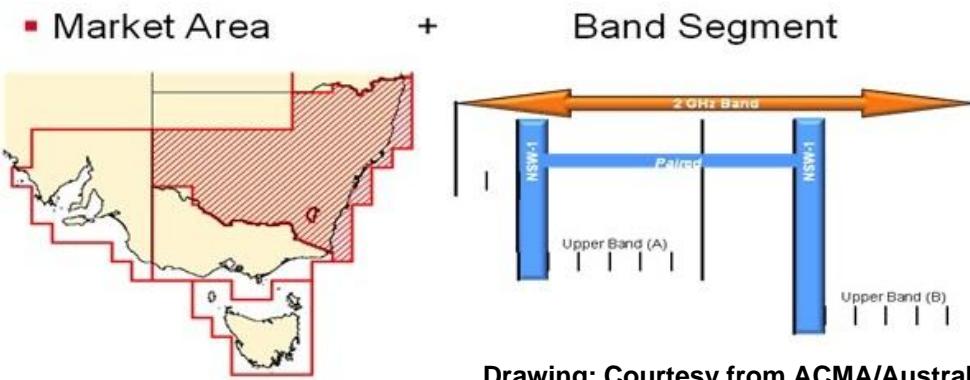
- Allowing Re-Use of assigned Spectrum when business models do not pay out or demand is gone

- Various trade models in use:

  ▪ Simple trade of complete frequency or spectrum block

  ▪ Sub-Use of residual Spectrum (not for high availability services)

  ▪ Time Slot defined use

Dynamic Spectrum Access

- Better usage of existing Spectrum resource

- Simple returning of Spectrum to the resource pool when not needed

- Reconfiguration /re-farming on Bands in literally no time

- Attracting owners of a spectrum resource to share it with other users

Whitespace database application window
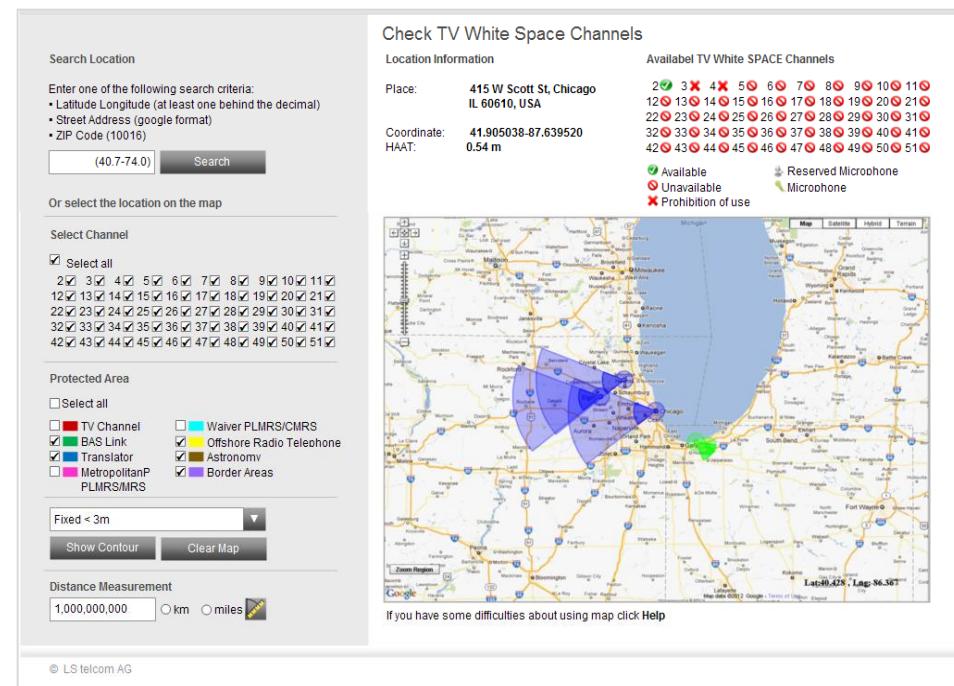
Mixing of multiple Technologies

- Filling in add on services in free time slots or free locations
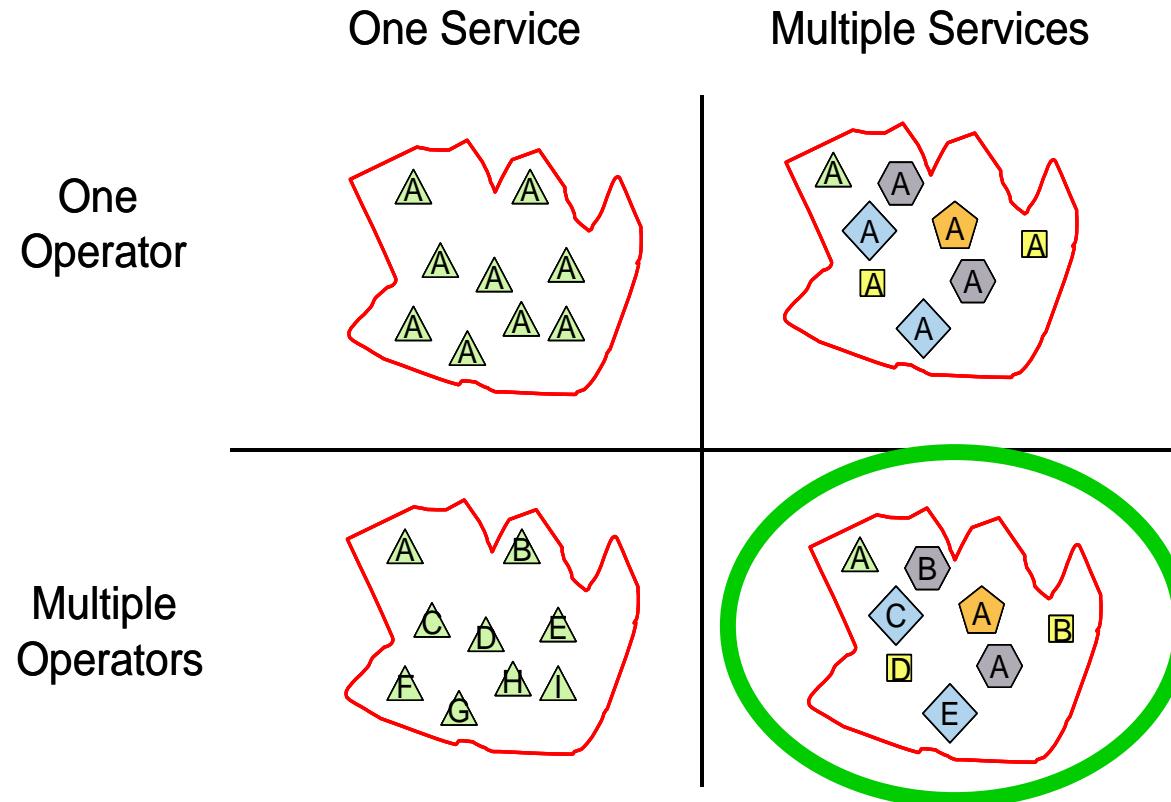
Mixing of Services increases the potential for interference dramatically!

Terrestric use of extremely high Frequencies

LS telcom

- Sharing efficiency increases substantially with decrease of cell radius
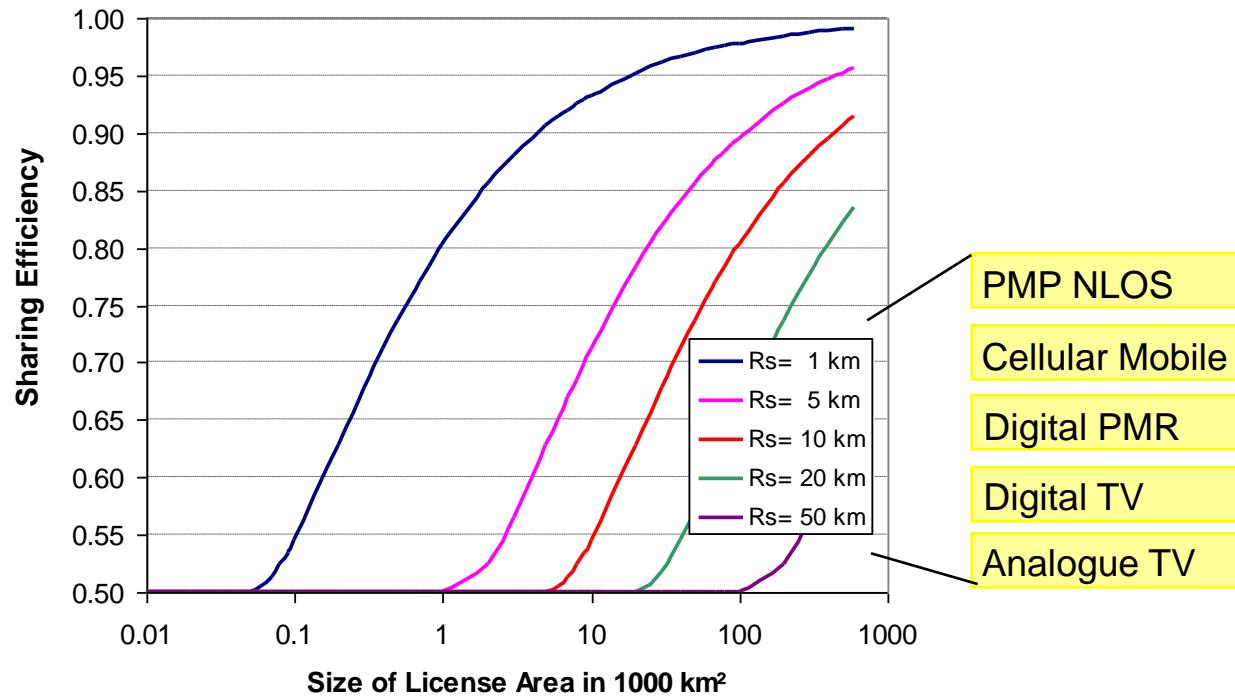
➔ **Microcells go along with lower power and higher frequencies to decrease the cell radius and gain of additional bandwidth**

Results from Change in Spectrum Use

Lack of usable Monitoring sites	Small sensors network instead of big monitoring sites
Upper Frequency limit reaches 6 GHz with low transmitting power	Portable monitoring, small sensors network
Cognitive radio, dynamic spectrum usage	Continuous, automatic analysis of signals inside the sensors
Temporary spectrum usage, white spaces	Continuous monitoring 24 / 7 / 365

New operational requests

Lack of Personal and Budget	Semi or fully Automated Systems
Never know Where and When to Monitor	Continuous Monitoring of all Frequencies by 24 / 7 / 365
Spectrum usage quickly changes	Continuous Spectrum Inventory and Spectrum Cleansing
Web-Licencing requires immediate results	Results availaible 24 / 7 / 365

Limits of traditional monitoring

LS telcom

- Systems are getting older
- Spectrum is getting full
- Locating traditional monitoring sites getting more difficult.

Problem Complexity (vertical axis, Low to High)

Probability (horizontal axis, Low to High)

- System Selection
- Modulation scheme
- Spectrum Policy
- (Lack of) Funding availability
- Workforce Skill
- Release of Spectrum
- Frequency range
- Age of existing equipment
- Spectrum availability

Frequency dependency of fixed site coverage
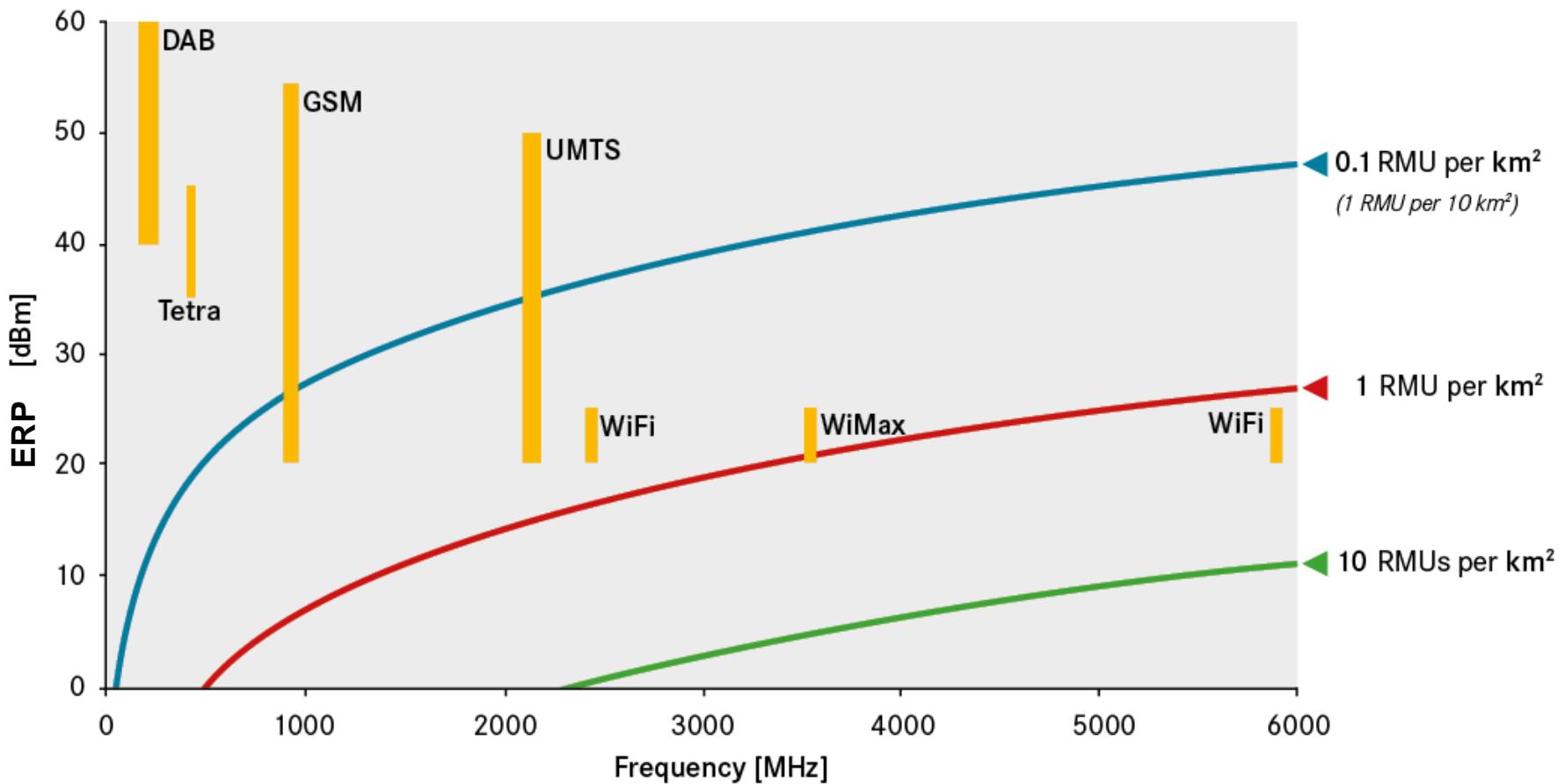
Further Needs

- Scalable remote sensors, stand-alone or networked

- Ability to integrate existing Monitoring equipment, also from 3rd parties

- ITU compliance

- Interface to spectrum management system

- Automated Spectrum Analysis

Available technologies

|	
Small Footprint Sensor Networks	Formfactor and price allow for cheap role-out of huge networks and contiuous monitoring
Mobile recording sensors	Low cost drive testing with arbitrary carriers like taxi, bus, train
Portable homing Sensors	EMF and Interference may often only be identified on the spot
Airborne Measurement Platforms	Optical and RF Site Inspection for Towers and Satellite Ground Stations

LS telcom

- **Distributed Spectrum Monitoring Systems**

  - Small, IP based units with Omni, Directed or DF Antennas and/or TDOA technology

  - Units are usually programmable, often based on an embedded Windows or Linux System

  - Reduces the effort of mobile campaigns and is permanently available

  - Costs usually substantially lower than for standard equipment

 - Provides permanent sensing capabilities with a narrow mesh

Classic Scenario

Meshed Scenario

- Measurement Location
- TX Location
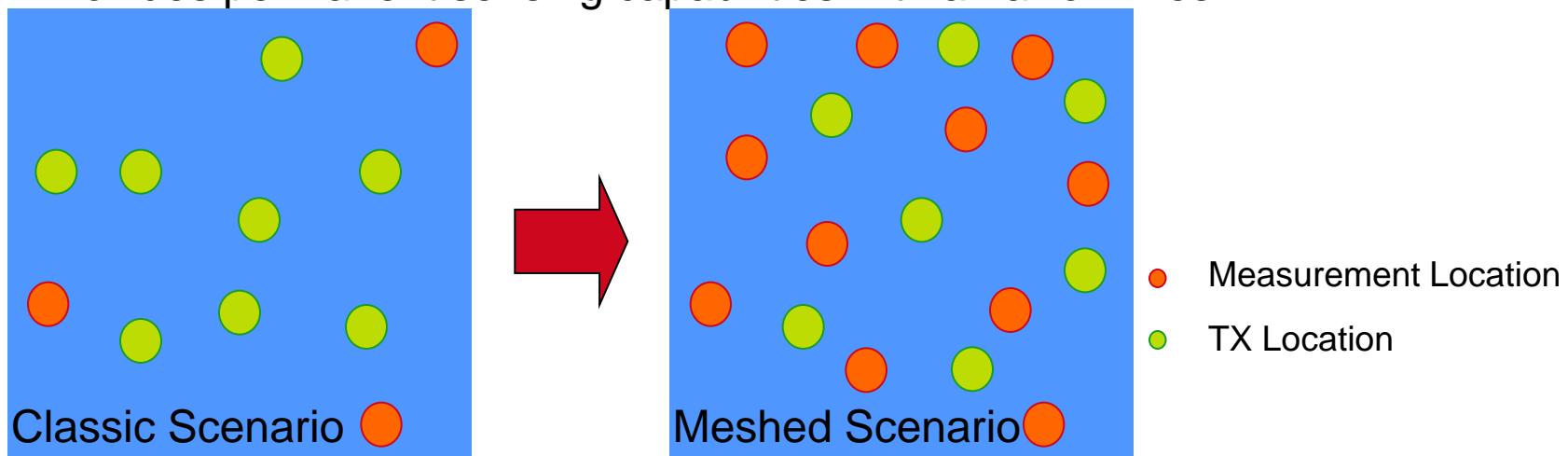
Small Footprint Sensor Networks

- **TDO Requirements**
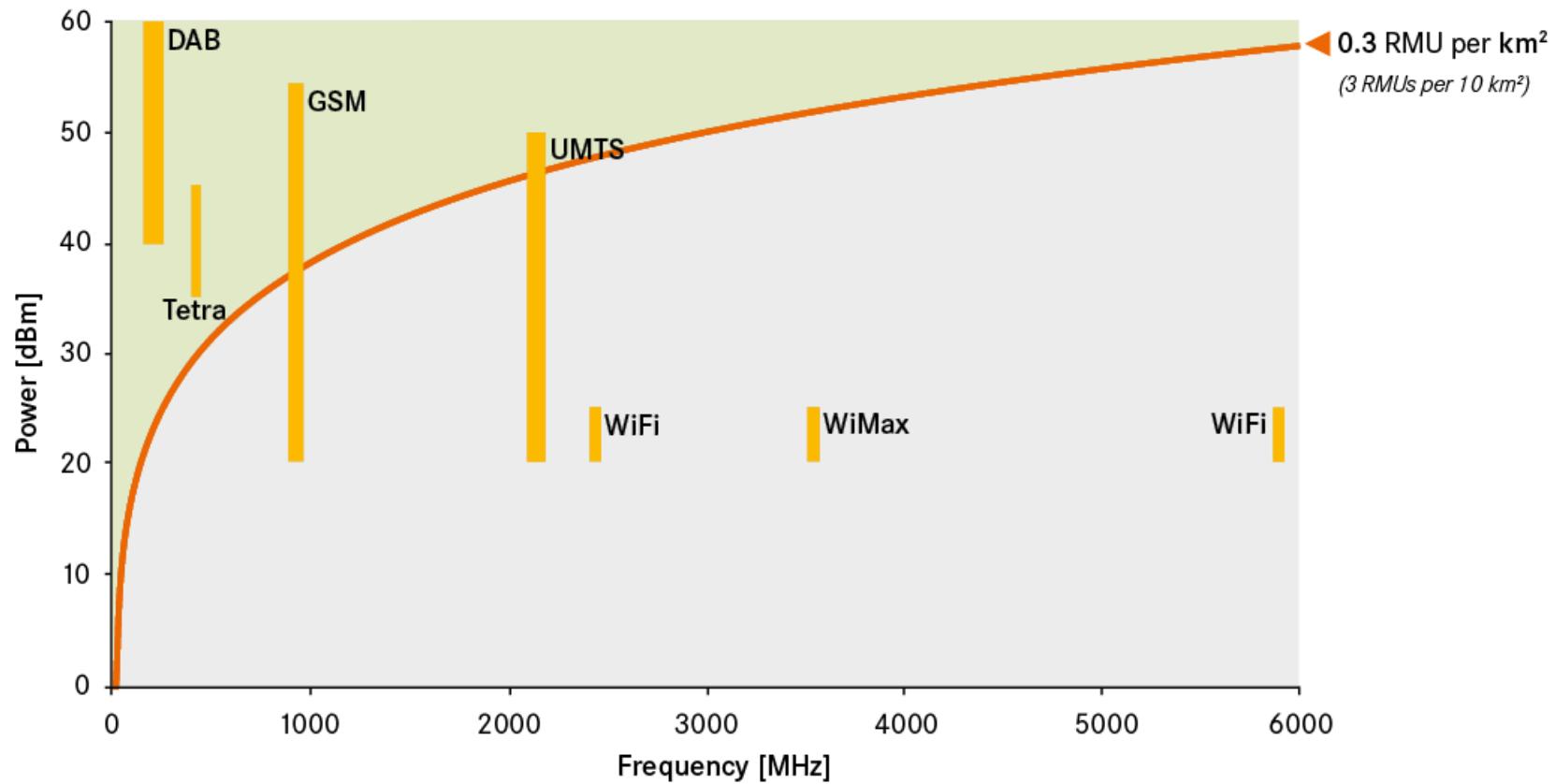
These diagrams are based on semi-rural topography and are diagrammatic only.

Small Footprint Sensor Networks

LS telcom

- **Examples from various vendors**

Agilent N6841

Thales TRC 6200

LS telcom Observer

CRFS RFeye

R&S UMS120

Small Footprint Sensor Networks

- Monitoring 24 hours / 365 days

- Recording Raw Data for later processing

- Keep track of all permanent and occasional RF emissions

- To keep network traffic manageable download only the portion of raw data that you really need

  and keep the rest in the sensor
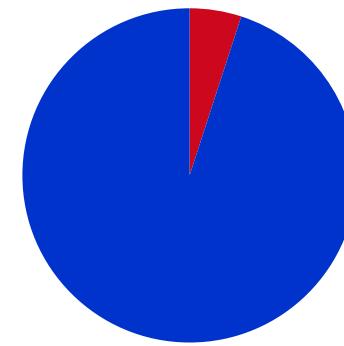
Portable Monitoring Units in details

- Handheld usage for in field measurements

- Geolocation of interference source or pirate sender

- Useful in dense populated areas, like big towns, where fixed stations can't hear between the buildings

- Like fixed stations, recording Raw Data for later processing

- Geolocation:

    - Direction finding: sequential AoA/LOB

    - TDoA, when combined to fixed stations

Airborne Monitoring Platforms

- Supported technologies:
  - FM & digital Radio
  - Analogue & digital TV
  - Mobile telephone stations
  - PMR

- Perform measurements in unapproachable areas
- Measuring in proximity of the tx antenna system
- Small and Lightweight: accesses areas where classical devices can't access e.g. in cites
- Antenna measurements to control Antenna Pattern and EMF radiation limits
- Identifying of faulty VSAT sites
- Visual inspection of sites
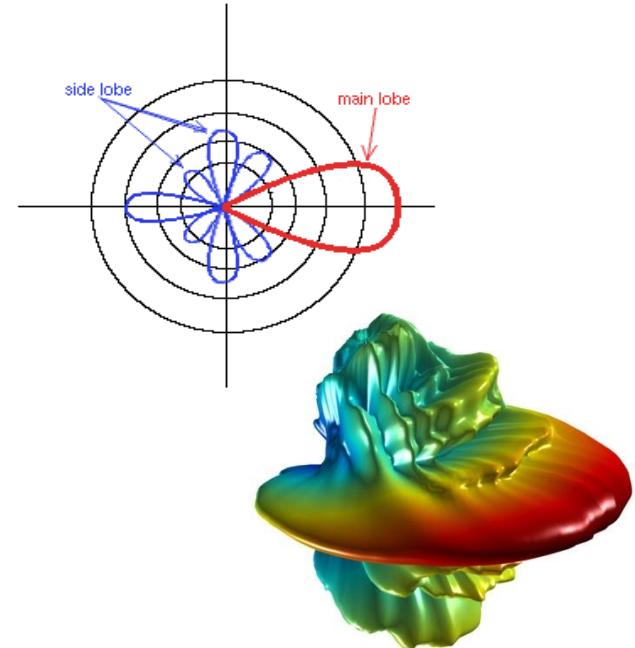
Airborne Platforms Measurement Concept

UAV
- GPS & IMU Sensors
- RF Measurement Device
- On-board Computer
- Radio Link

Typically
700m Dia.

GCS
- Radio Link
- Real-time Processing
- Data Logging

Mesh Network
Repeater

Mesh Network
Repeater

Mesh Network
Repeater
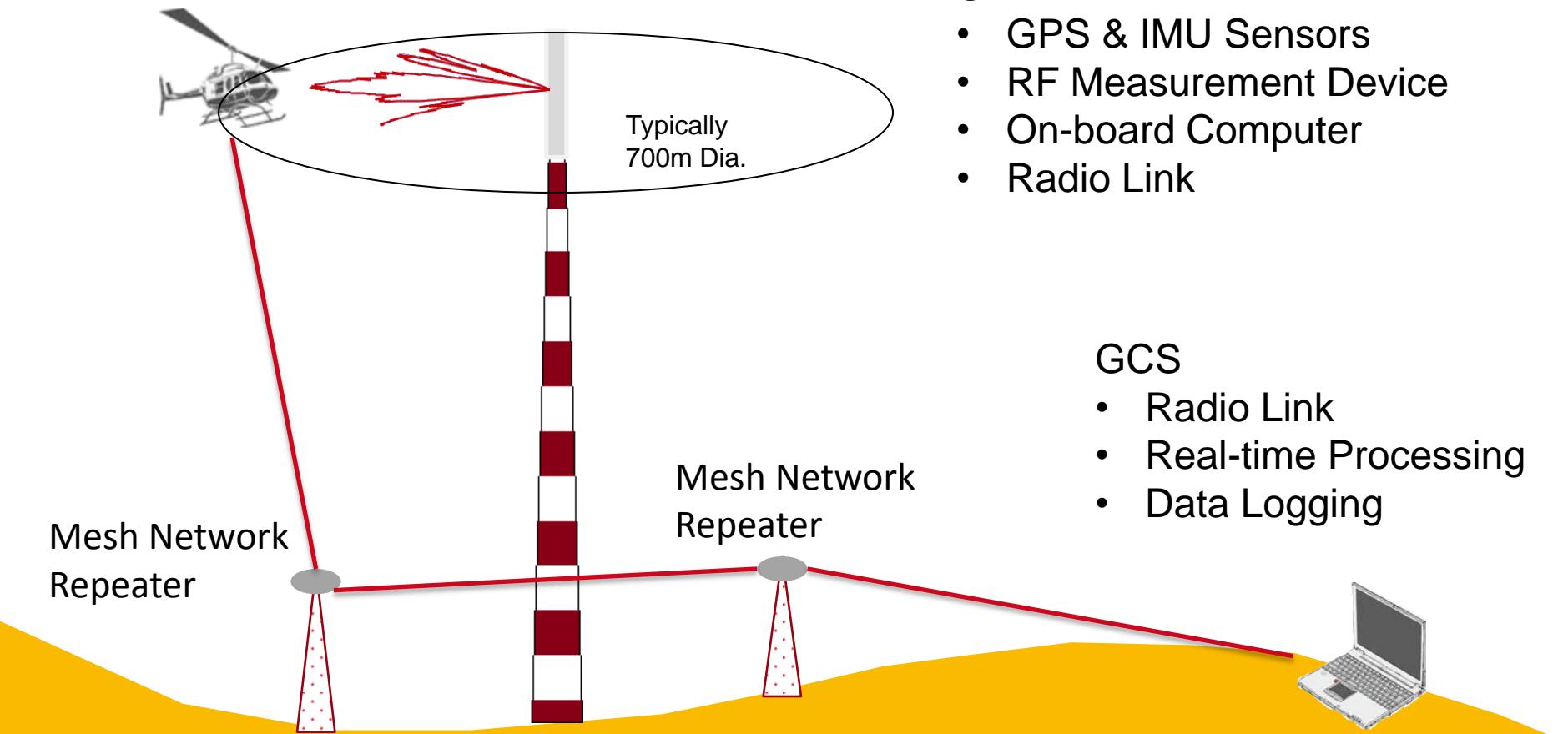
Comparison of Capabilities

|	Sensor Networks	Portable devices	Airborne Platforms
Continuous Monitoring	yes	possible	no
Storage of raw data	yes	yes	yes
Mobility	possible	yes	yes
Antenna measurement	indicative	partially	yes
Geo-location	yes	yes	partially

Modular Sensor Network

Local Processing

- RAW Data: 30 Days Rolling
- Compressed Data: 2 Years Rolling

Central Management Unit

- Network Management
- Access Control
- Profile Management
- Storage of Previous Data Requests (can be Back up of RMU)

Client

- Spectrum Analysis Display

Local or Remote Access

Optional

Optional
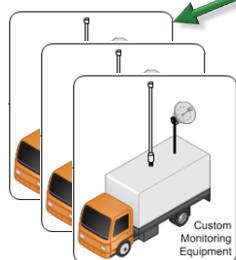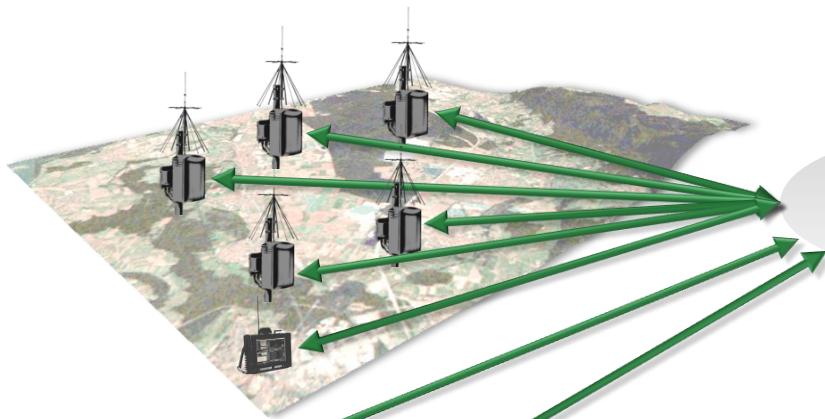
Mobile Units

Portable Monitoring

Portable Units

Fixed classical Monitoring/DF Units

Custom Monitoring Equipment
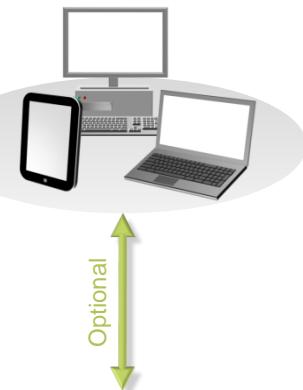
Analysis Servers and Tools

- Spectrum Analysis, Reporting and Display
- Geo-location: TDOA/POA Geo-location and GIS
- Other: EMC Analysis Server/Base Station Data Server

- License Database and Spectrum Management

Symbiosis of Management and Monitoring

LS telcom

Networked systems improve speed and quality

SUMMARY
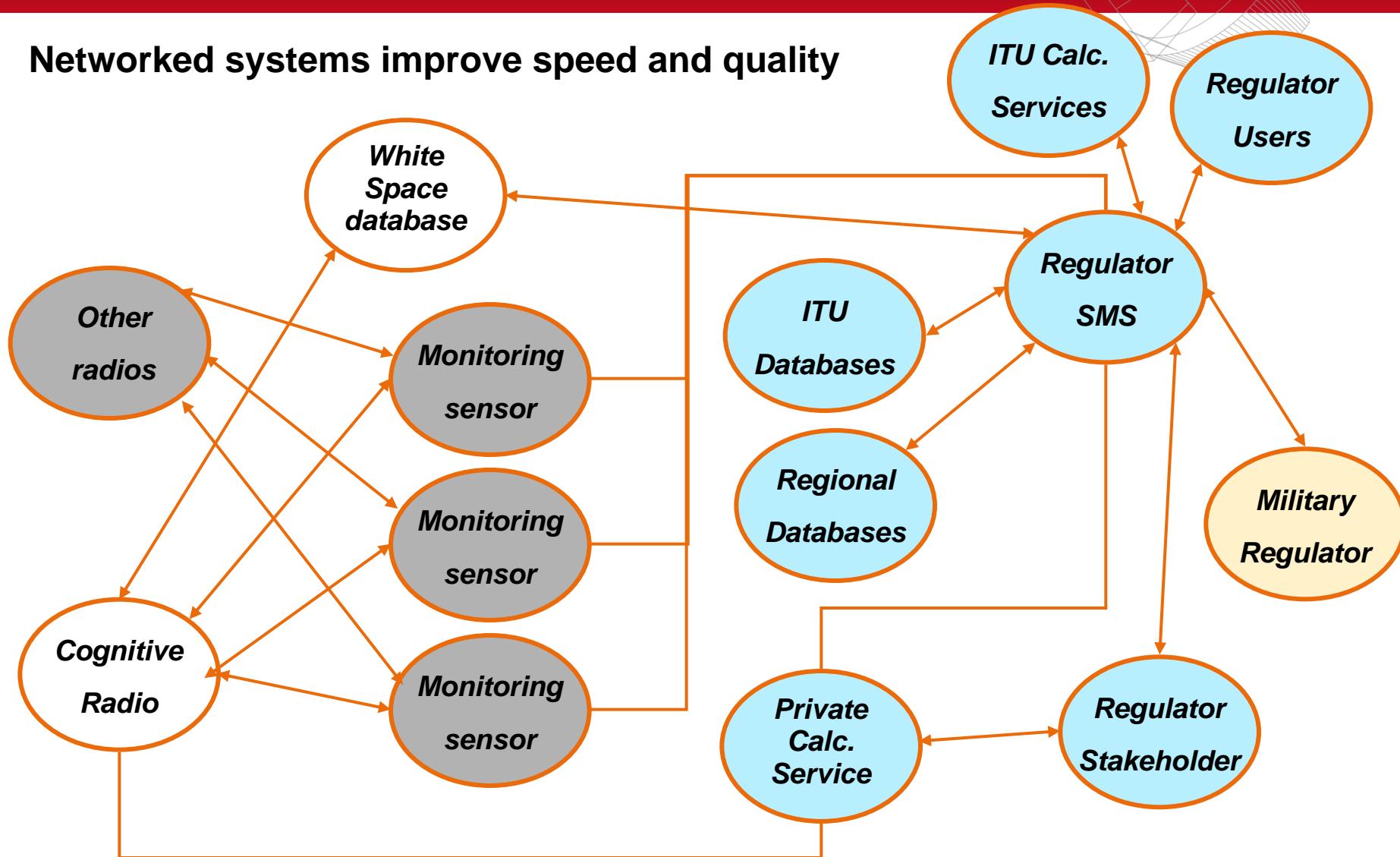
- Monitoring is important! But only if you make proper use of the data!

- The volumes created can be vast.... You need mechanisms to automatically analyse and compress it to the essence.

- Well conceived and implemented monitoring systems can provide very good value for money

- The need for effective monitoring is going to increase as the bands become highly congested

Thank you for your attention!

Im Gewerbegebiet 31-33
D-77839 Lichtenau
GERMANY
gschoene@LStelcom.com
Tel. +49 (0)7227 9535 600
www.LStelcom.com

Disclaimer

LS telcom

Copyright (c) 2013 by LS telcom AG

This document must neither be copied wholly or partly, nor published or re-sold without prior written permission of LS telcom. The information contained in this document is proprietary to LS telcom. The information shall only serve for documentation purposes or as support for education and training purposes and for the operation and maintenance of LS telcom products. It must be treated strictly confidential and must neither be disclosed to any third party nor be used for other purposes, e.g. software development, without the written consent of LS telcom.
This document may contain product names, e. g. MS Windows, MS Word, MS Excel and MS Access, which are protected by copyright or registered trademarks / brand names in favour of their respective owners.
LS telcom make no warranty or representation relating to this document and the information contained herein. LS telcom are not responsible for any costs incurred as a result of the use of this document and the information contained herein, including but not limited to, lost profits or revenue, loss of data, costs of recreating data, the cost of any substitute equipment or program, or claims by any third party.

Urheberrecht der LS telcom AG

Dieses Dokument darf ohne ausdrückliche Zustimmung der LS telcom AG weder insgesamt noch teilweise kopiert, veröffentlicht oder weitergegeben werden. Die Information in diesem Dokument Ist intellektuelles Eigentum von LS telcom. Die Information ist nur für Dokumentationszwecke oder die Nutzung für Ausbildung und Training bestimmt, sowie für die Nutzung und Wartung von LS telcom Produkten. Die Information ist streng vertraulich zu behandeln und darf ohne ausdrückliche Zustimmung der LS telcom AG weder Dritten Parteien offenbart, noch für andere Zwecke genutzt werden, beispielsweise für Softwareentwicklung.
Dieses Dokument kann Produkt- und Markennamen enthalten, beispielsweise MS Windows, MS Word, MS Excel und MS Access, die durch Urheberrecht, Markenrecht oder Namensrecht der jeweiligen Rechteinhaber geschützt sind.
LS telcom gibt keinerlei Garantie oder Zusicherung im Zusammenhang und aus diesem Dokument und der darin enthaltenen Information. LS telcom übernimmt keinerlei Haftung für Schäden, Kosten und Aufwendungen, die aus der Nutzung dieses Dokuments und der darin enthaltenen Information entstehen, inklusive, aber nicht nur, für entgangener Gewinne oder Umsätze, Datenverlust, Kosten der Datenwiederherstellung, Aufwendungen für die Ersatzbeschaffung von Hardware oder Software, oder für Ansprüche dritter Parteien.