



ICG-9 Meeting, Prague, Session 3, 11<sup>th</sup> Nov. 2014

# Spectrum Monitoring applied to the Detection and Geolocation of GPS Jammers



System  
Integration



Radio Monitoring



Spectrum  
Management Systems



Strategic  
Consulting



Training Academy

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Radio Engineering



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Measurement



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**Subsidiaries:**

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**Representative Offices:**

Hungary, Oman

**LS telcom Partner Office:**

Argentina

# Markets We Serve



**Broadcast**



**Spectrum  
Regulation**



**Military**



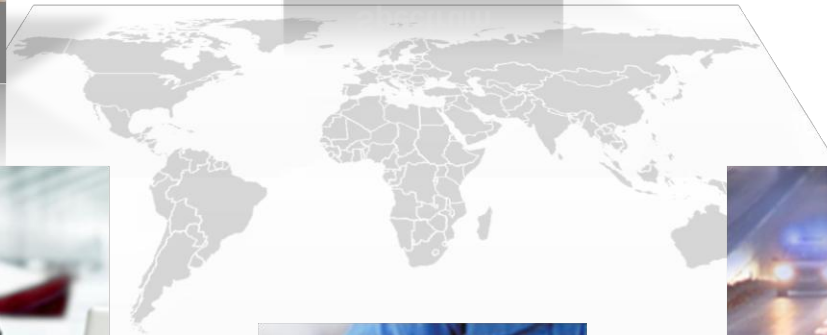
**Telecommunications**



**Utilities**



**Security**



# Detection & Geolocation of GPS Jammers



# LS OBSERVER



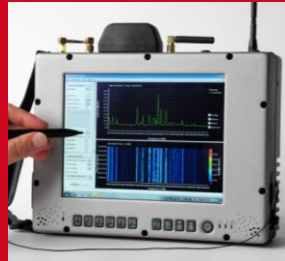
## Monitoring Hardware



Fixed



Portable



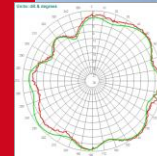
Transportable



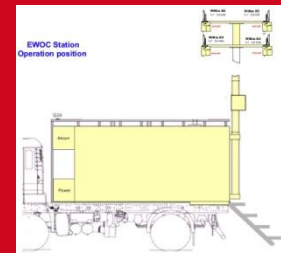
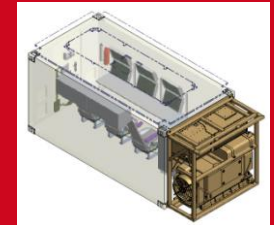
Mobile



Flying



Custom

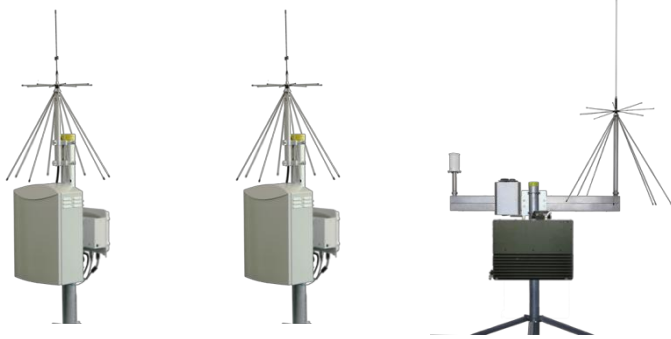


# LS OBSERVER

## Typical System Configuration



### Continuous Monitoring



### Portable Monitoring



### Mobile Monitoring



### Control & Operating Centre



Ethernet, LTE /UMTS, WiMax

3G-UMTS, 4G-LTE

WiMax, 3G-UMTS, 4G-LTE



LS Observer CCU

File View RMU Configuration Tools Window Help

RMU Archive

Name	Coordinate
PMU_8	007.99770021 ° ; 48.71939850 °
R-PMU8	000.00000000 ° ; 00.00000000 °
R-PMU9	007.90677977 ° ; 48.72389984 °
R_B5_Canteen	007.99770021 ° ; 48.71939850 °
R_BS_Shelter	007.99770021 ° ; 48.71939850 °
R_G3_EMF	007.99770021 ° ; 48.71939850 °

Map 1:200T Germany

Long./Lat. 007.85767147 ° ; 48.78850612 ° Longitude - Latitude -WGS 84- Topo height: 121 m Morpho T

FFM Results

Name	Location	Frequency, BW	Date & Time
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Record 5 of 6

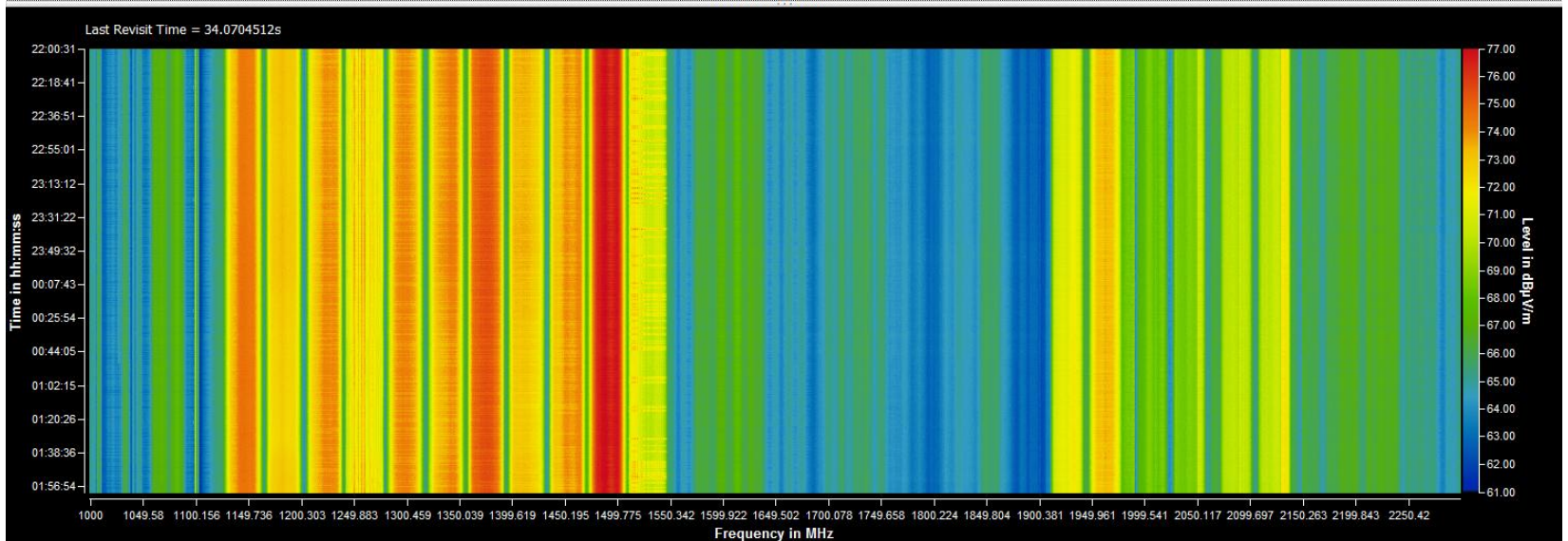
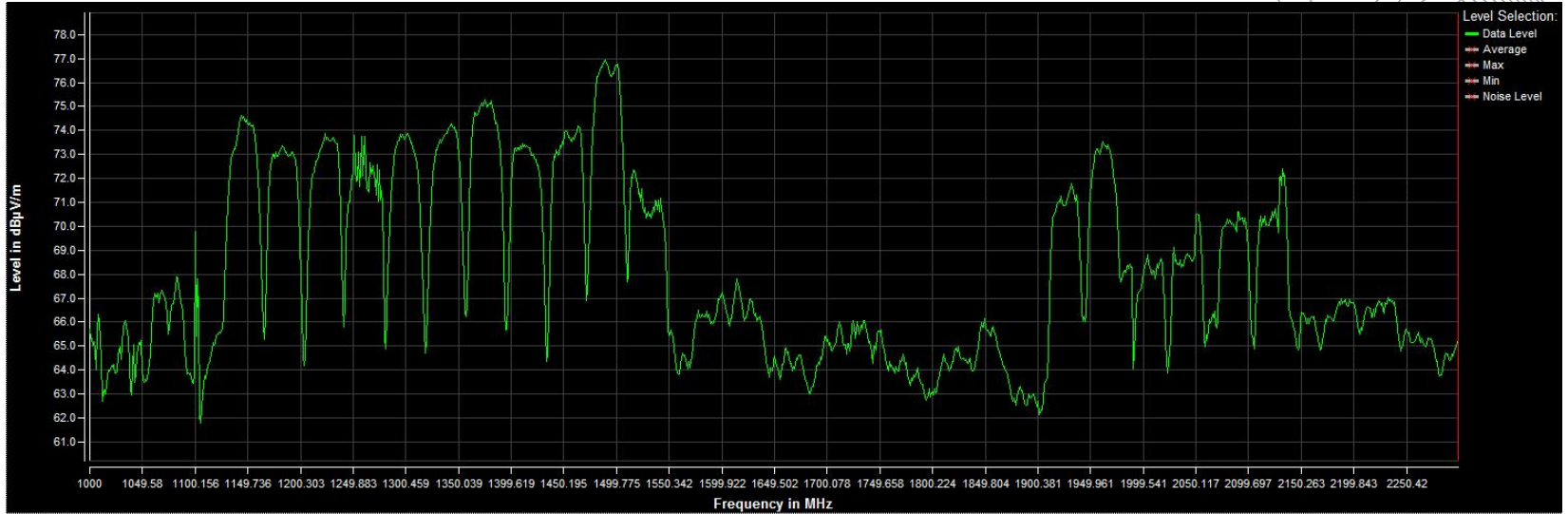
Record 0 of 0

List of Remote Monitoring Units

Position of the units shown on the map



# Wideband Spectrum Monitoring

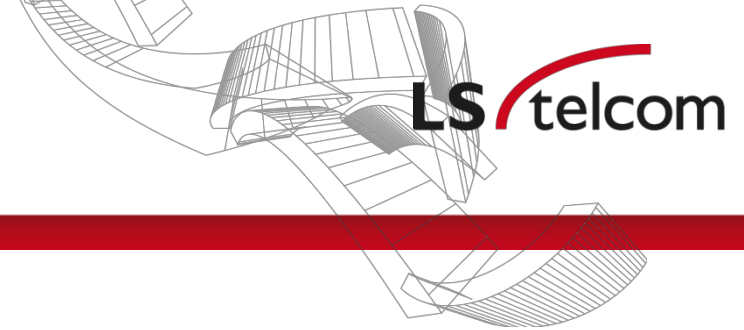




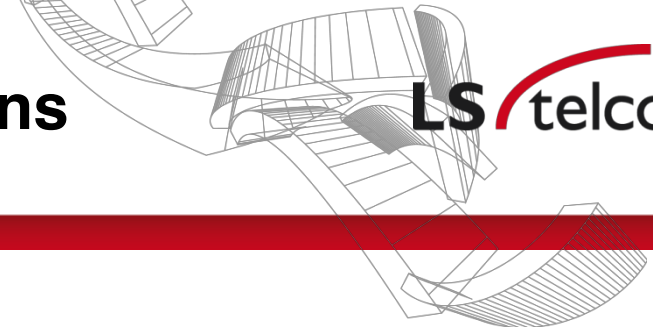
- Principles of operation
  - Wideband monitoring
  - Monitor radio-frequencies 24/7
  - Record measurement results
  
- Benefits
  - Monitor several frequency bands
  - Quick identification of anomalies
  - Allow quick geolocation
  - Automated monitoring system
  - Look back in the past



# Fixed Monitoring Stations



- Installed at fixed sites
- Remotely controlled
- Wideband MHz – GHz ranges
- Measuring RF continuously
- Automatically looking for unwanted emissions
- Raising alerts



- Same features as FMS
- Easily transportable
- Installation within minutes
- Temporary measurements



- Mainly handheld usage for in field measurements but also applicable as mobile and portable unit
- Manual or remote controlled operations
- Display of measurement result files
- Geolocation of using PDoA
- Direction Finding: sequential AoA/LoB
- 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





### Frequency range

12.4 GHz

4.4 GHz

100 kHz

9 kHz

### Storage

up to 2 years monitoring data

Environmental parameters

Ruggedised

### Geolocation

PDoA

Direction Finding Software

### Connectivity

3G-UMTS

WiFi

Bluetooth

Ethernet

Remote Control

### Accessories

Monitoring Antenna

Battery

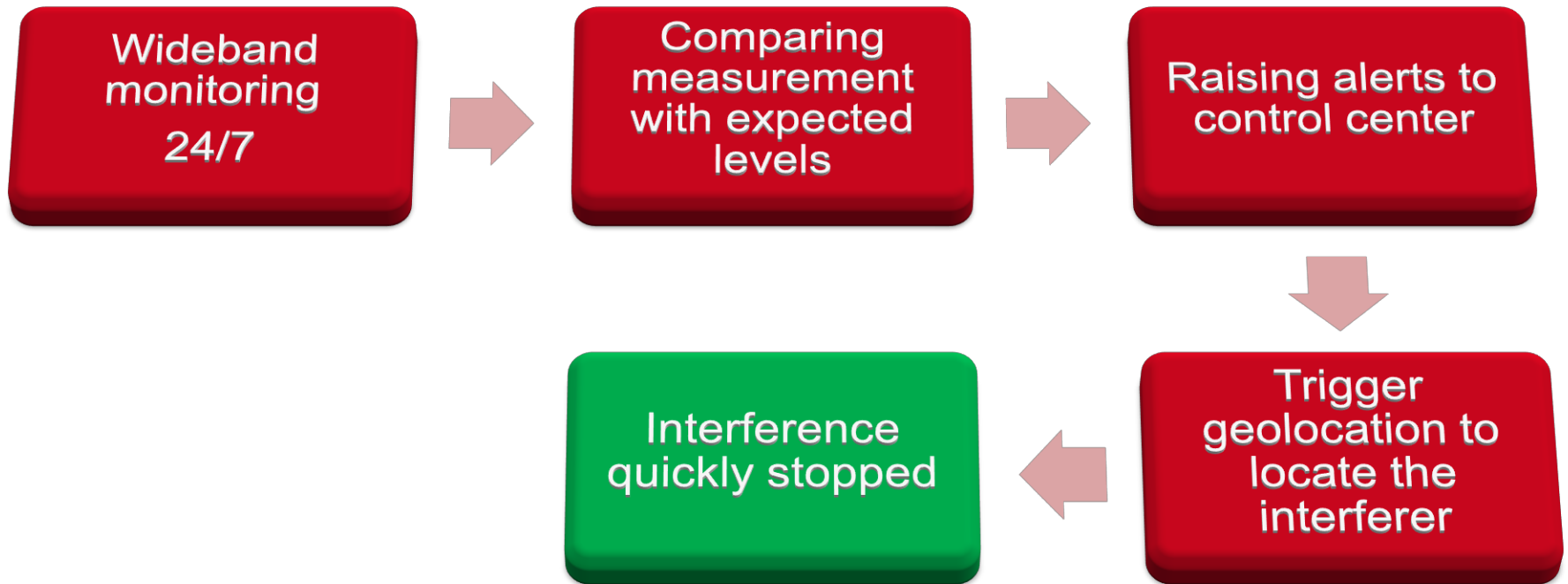
Directional -Antenna Bag Case

...

standard

SW Option

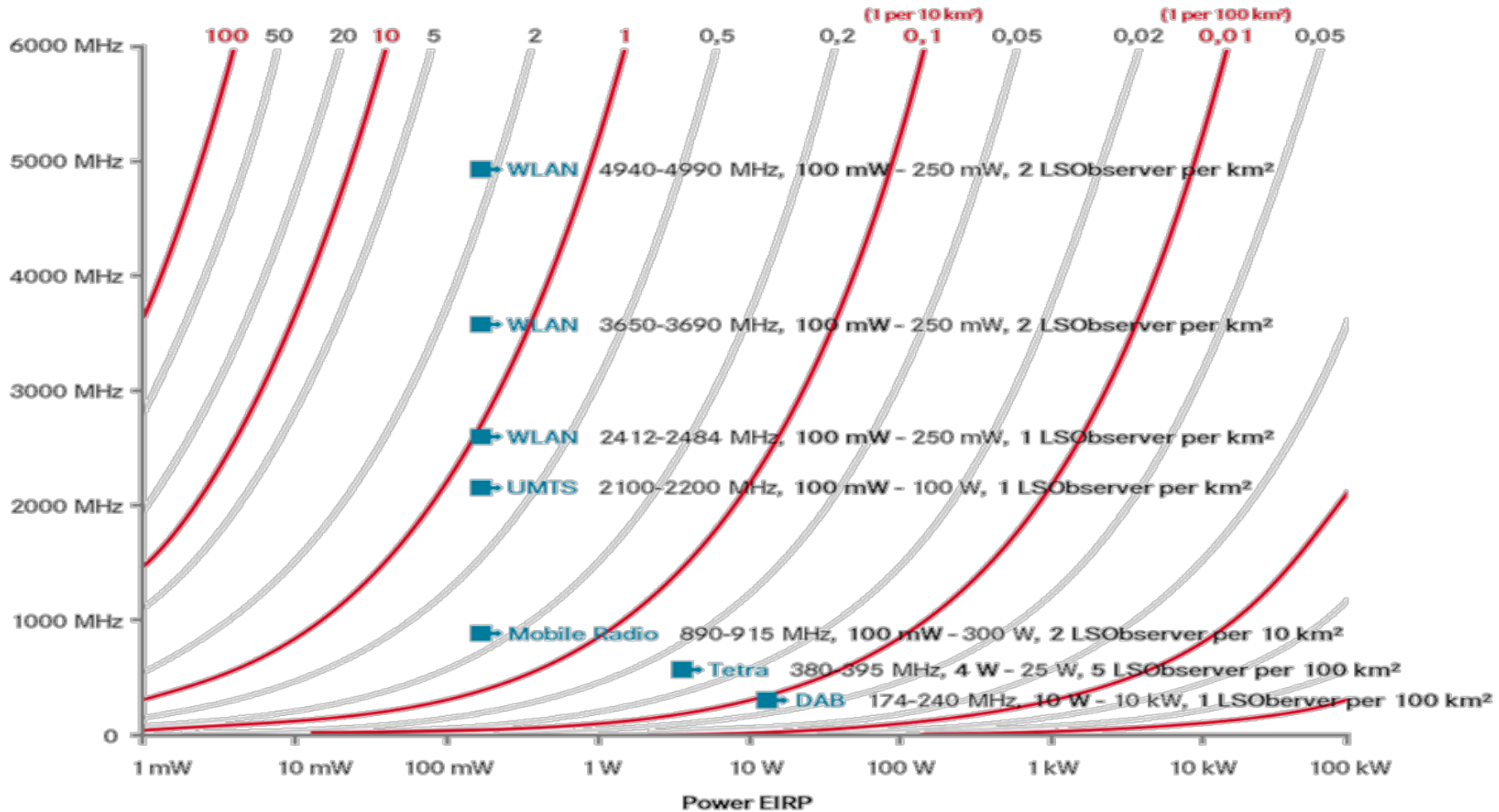
HW Option



# LS OBSERVER

## How many Monitoring Units?

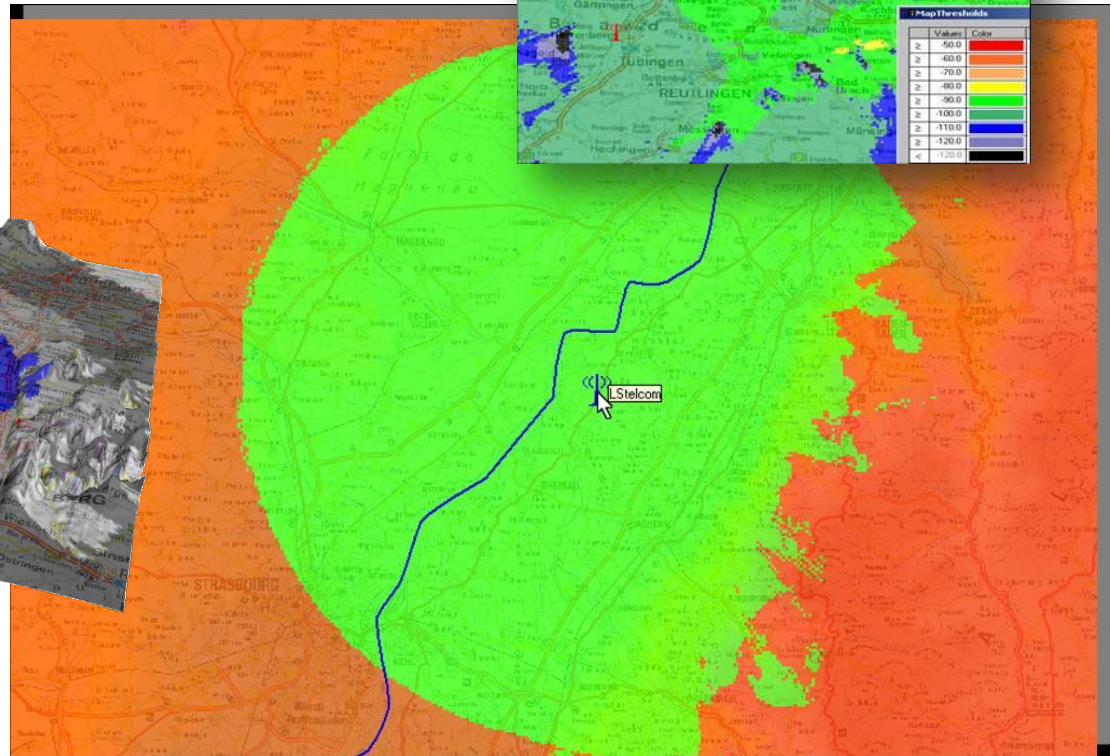
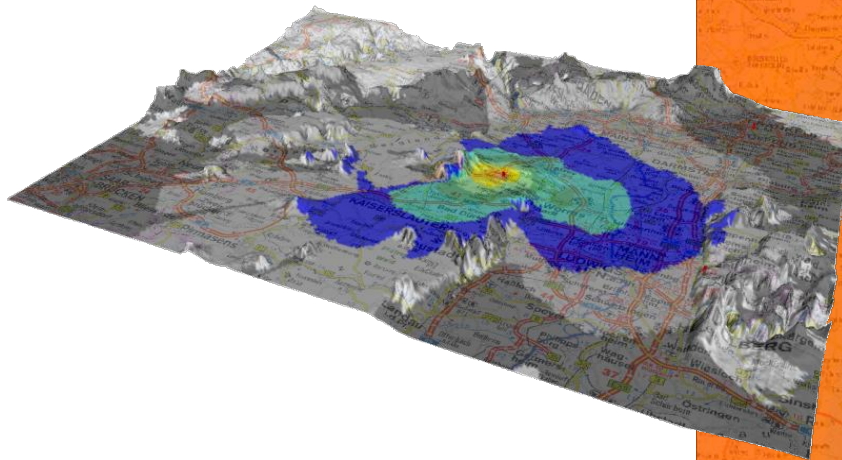
Number of LSObserver per km<sup>2</sup>

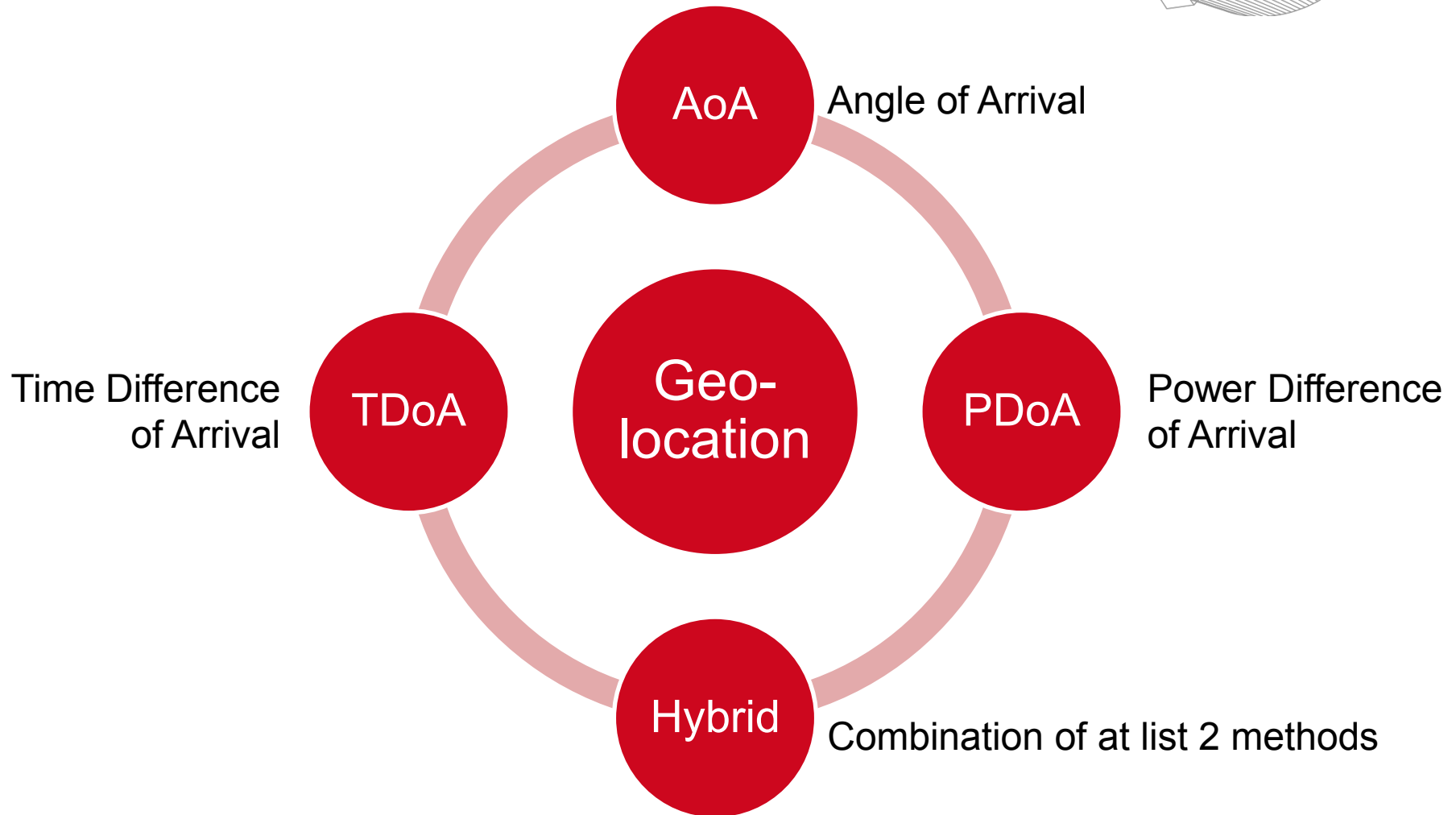




# Where to place the monitoring units? Simulation & Planning

- LS telcom's Software to
  - calculate the coverage of a monitoring unit
  - find the best place for new installations





# Geo-location with AoA



The screenshot shows the I S Observer CCIJ software interface. At the top, there is a menu bar with 'File', 'View', 'RMU Configuration', 'Tools', 'Window', and 'Help'. Below the menu bar is a toolbar with various icons. The main area displays a satellite map of a rural area with a red line pointing to a specific location. A circular inset shows a zoomed-in view of the antenna array. On the left, there is a table with columns 'Name' and 'Coordinate'. The first row is circled in black and contains 'R-PMU11' and '007,99714994'. At the bottom, there is a table titled 'FFM Results' with columns 'Name', 'Location', 'Frequency, BW', and 'Date & Time'. The first row is circled in black and contains 'R-PMU11', '007,99594567 ° ; 48,71932700', '950,238095238095 MHz, 150000 Hz', and '10.04.2014 11:44:42'. An arrow points from the circled row in the 'FFM Results' table to the circled row in the 'Name' table.

Name	Coordinate
R-PMU11	007,99714994

Name	Location	Frequency, BW	Date & Time
<input type="checkbox"/>	R-PMU11 007,99594567 ° ; 48,71932700	950,238095238095 MHz, 150000 Hz	10.04.2014 11:44:42
<input type="checkbox"/>	R-PMU11 007,99529950 ° ; 48,72014150	950,238095238095 MHz, 150000 Hz	10.04.2014 11:39:10
<input type="checkbox"/>	R-PMU11 007,99597450 ° ; 48,71984367	950,238095238095 MHz, 150000 Hz	10.04.2014 11:24:14
<input type="checkbox"/>	R-PMU11 007,99739617 ° ; 48,71847950	950,238095238095 MHz, 150000 Hz	10.04.2014 11:19:10
<input checked="" type="checkbox"/>	R-PMU11 007,99730650 ° ; 48,71896017	950,238095238095 MHz, 150000 Hz	10.04.2014 11:16:25



List of Monitoring Units

Bearing results



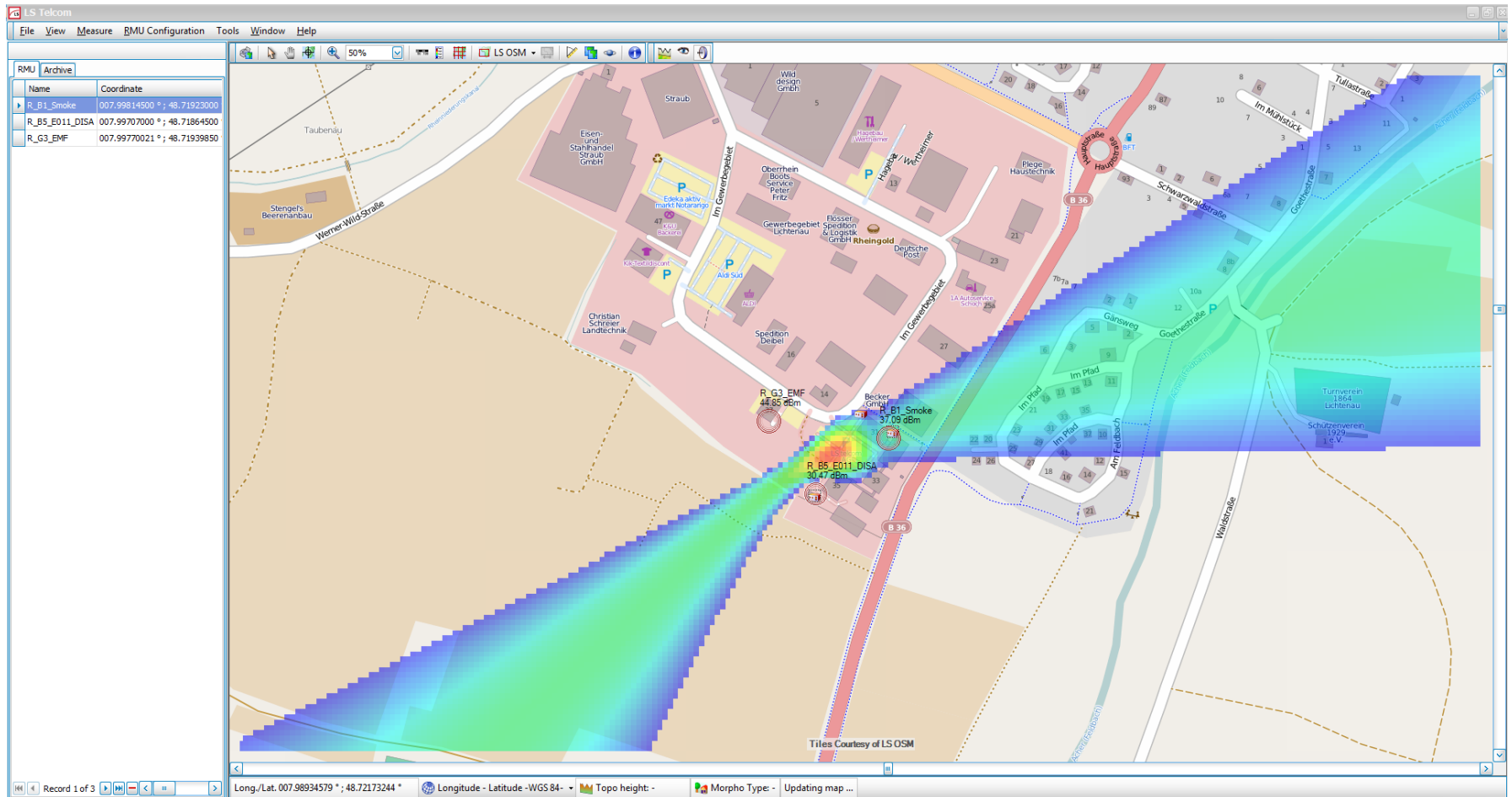
- PDoA is based on measuring the signal strength at different places and then computing the location using the different signal strengths that have been measured at different place
- PDoA can be computed live or at a later time using recorded data
- TDoA, like PDoA, is a computation based on a difference between measurement realised at different places but using time instead of signal strength. Each monitoring unit is equipped with a high precision GPS receiver that allows to exactly know when signals are received. Comparing the time when a same signal has been received by different monitoring stations allows to determine the area where the emitter is located with a good precision
- TDoA must be performed live. It can't be computed backwards



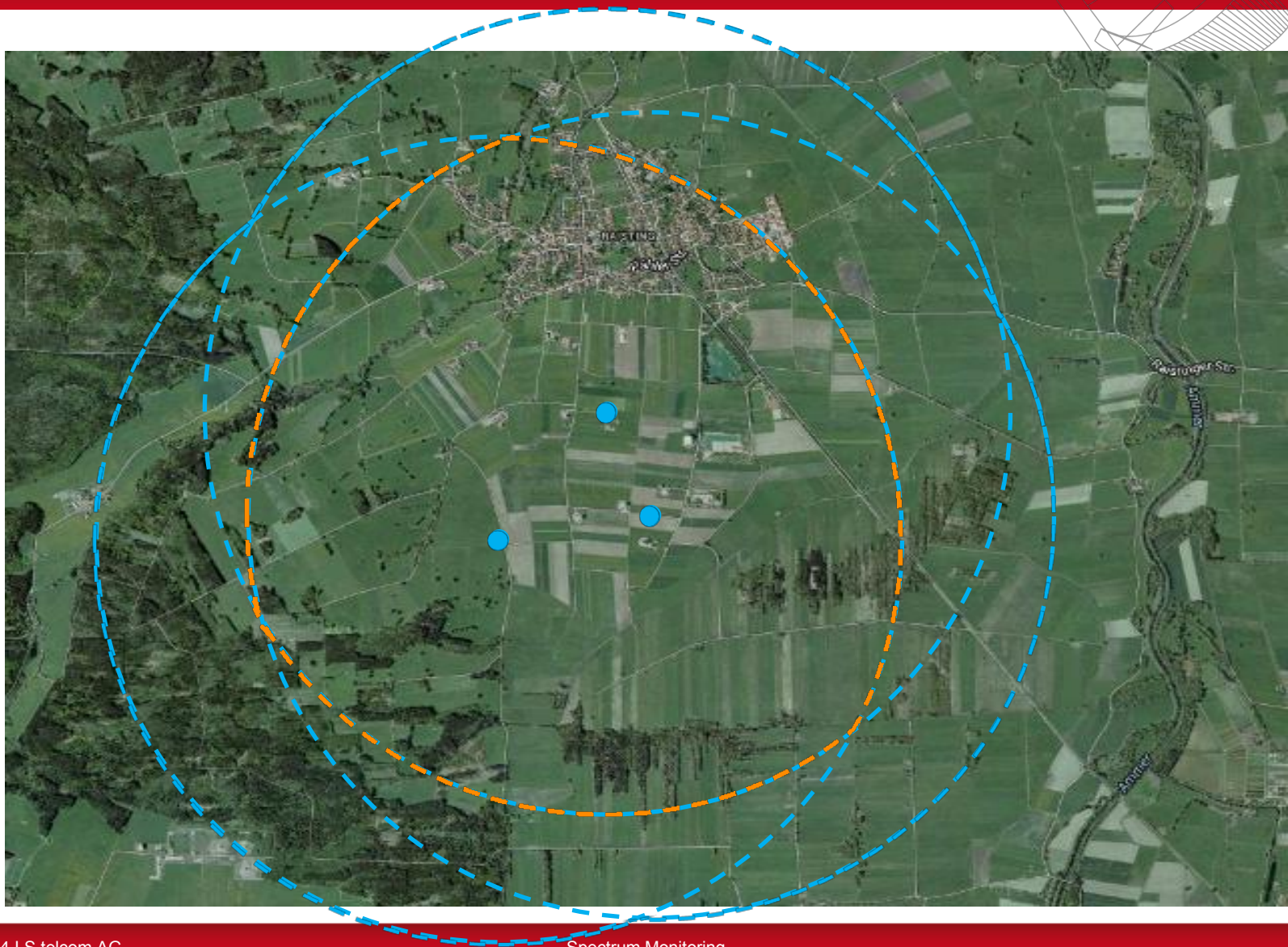
	<b>PDoA</b>	<b>TDoA</b>	<b>Hybrid</b>
Minimum number of units	3	3	3
Typical accuracy	200 m	45 m	45 m
Speed of geo-location	1 s	1 s	1 s
Minimum signal duration*	0.1 s	live signal	live signal
Minimum signal bandwidth	none	200 kHz	200 kHz
Maximum signal bandwidth	20 MHz	20 MHz	20 MHz
Can be computed live	yes	yes	yes
Can be computed on recorded data	yes	no	no

\*: the signal must be in the air until three stations completed one scan

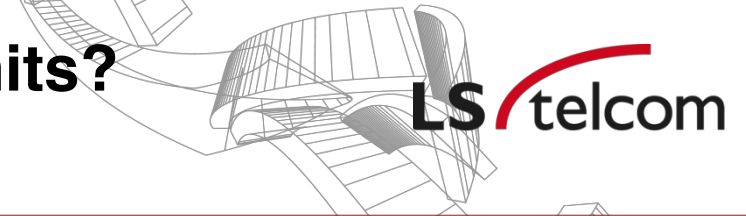
# Geo-location with TDoA / PDoA



# Monitoring of a wide area Coverage for **Detection** and **Geolocation**



# Where to place the monitoring units? Along roads, at „way points“



Copyrights pictures:



# Where to place the monitoring units? Around particular sites



Copyrights pictures:

# Thank you for your attention



## QUESTIONS ?

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    - +49 (0) 7227 9535-490



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