



Radio Monitoring

Direction Finding System

LS OBSERVER AOA 1xx
DF Time Travel®

Next Generation Direction Finding

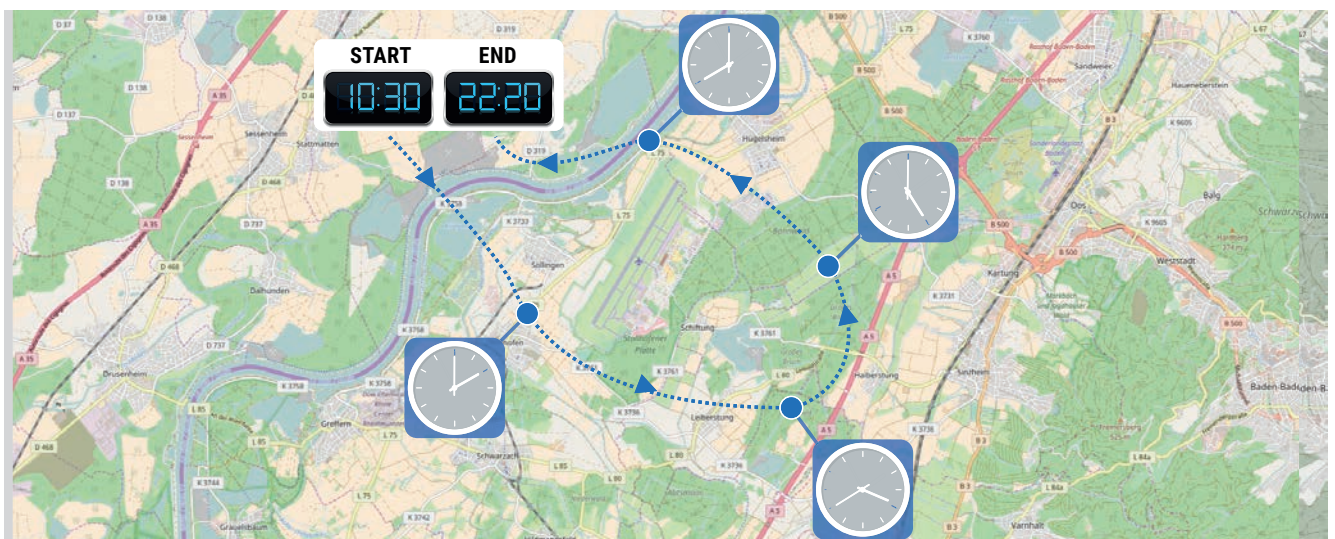
The LS OBSERVER Angle of Arrival (AOA) 1xx antenna system is the innovation in the sector of direction finding. With the DF Time Travel® technology, it is able to perform DF not only live as usual, but also retrospectively based on recorded data. With its advanced DF method, the system is even able to resolve multiple co-channel signals by their angle of arrival. Where normally, multiple antennas are needed, the AOA 1xx captures an ultra-wide frequency range (see page 4) with only one module and this even for both vertically as well as horizontally polarized signals. The module includes multiple layers of circular arranged directional antennas, as well as an omni-directional antenna set in the middle (only applicable for AOA 1xxm series). Based on this architecture, the system is not only able to perform DF, but also

omni-directional and directional monitoring. With the directional monitoring functionality each directional antenna element can be chosen individually for a measurement to monitor a specific azimuth. The AOA 1xx consists of a robust design able to cope with extreme weather and shock conditions, suitable for 24/7 or temporary operation at fixed sites and mobile applications when mounted on a vehicle. The antenna system is connected to a LS OBSERVER RMU (FMU, TMU or PPU) controlled by the LS OBSERVER CMS software. Via the CMS, the user can calculate and display bearings, perform triangulation, calculate heatmaps, analyze recorded measurements and much more.

DF Time Travel®

With the AOA 1xx antenna system, LS telcom introduces a brand new DF technology, called DF Time Travel®. This technology allows customers to perform direction finding not only live as usual, but also retrospectively based on recorded 360° spectrum measurements. Unlike conventional systems on the market, this technology does not simply store calculated bearings, but can perform the bearing calculation itself, based on the record of an ultra-wide frequency range (e.g. 9 kHz-6 GHz). Within this record, the user can choose every signal of interest, without any DF bandwidth limitation, and calculate a line of

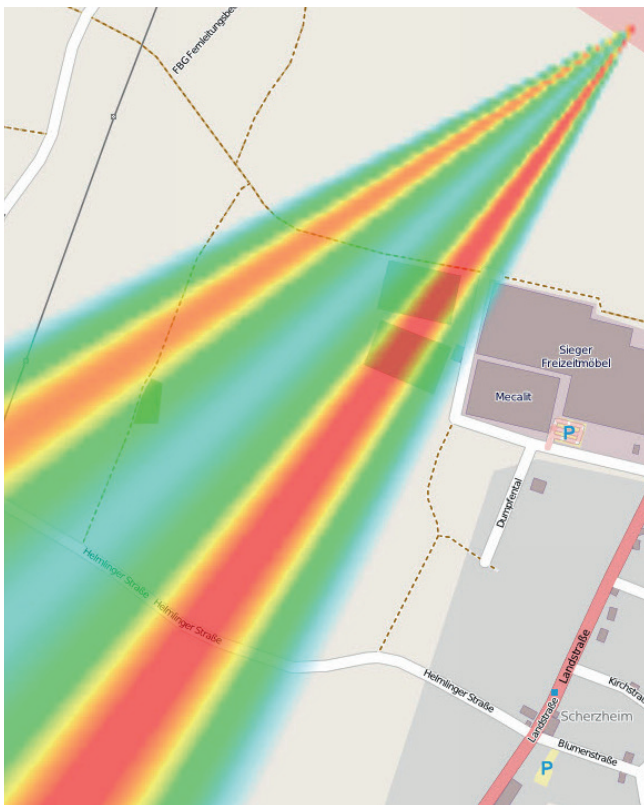
bearing for it. Was there interference reported a few days ago? You will never find the source with conventional systems if it is not on air anymore. With DF Time Travel®, you can simply access the record around the reported time and frequency range and calculate the angle of arrival of the interference, even if the interferer is currently not transmitting. If you have further measurements from different locations you can triangulate both measurements in the CMS software and visualize the result as a heatmap indicating the most likely location of the interferer.



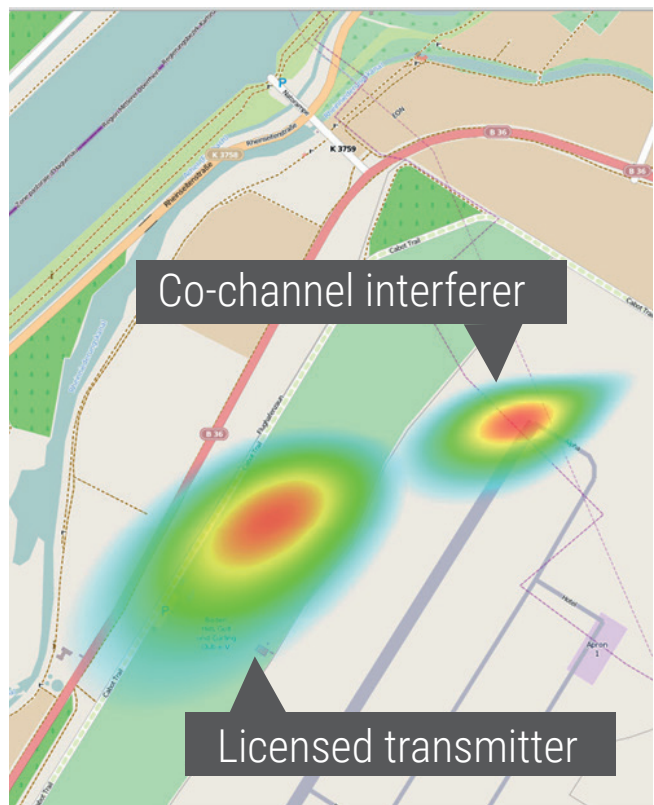
Co-channel emission resolution

In the event of multiple co-channel emissions, e.g. a wanted signal and a co-channel interferer, the AOA 1xx DF technology is able to separate those signals by their angle of arrival (requires that the co-channel emissions are received from different directions). This is achieved by not only considering the global maximum of a 360° scan, but also further peaks. Those peaks can be caused by reflections or further same channel emitters. If this

is the case the user is presented with multiple lines of bearing. To evaluate which signal is received with the highest level, an additional heatmap visualization can be displayed. In order to locate each of the co-channel emission sources, multiple DF results from different locations can be combined to a multi-spot heatmap.



Lines of bearing for two co-channel emissions



Mutli-spot heatmap for two co-channel emission sources

Directional monitoring

With the directional monitoring mode, an specific directional antenna element of the AOA 1xx can be selected to perform monitoring. The AOA 1xx includes seven circularly arranged directional antenna elements per layer which capture a total angle of 360°. By choosing one specific element for monitoring, incoming emissions from other directions are suppressed due to its selectivity. This enables the user to monitor only a specific azimuth instead of the full 360° picture provided by an omni-directional element. Typical use-cases for this are

the monitoring of emissions coming from outside a national border or a restricted area.

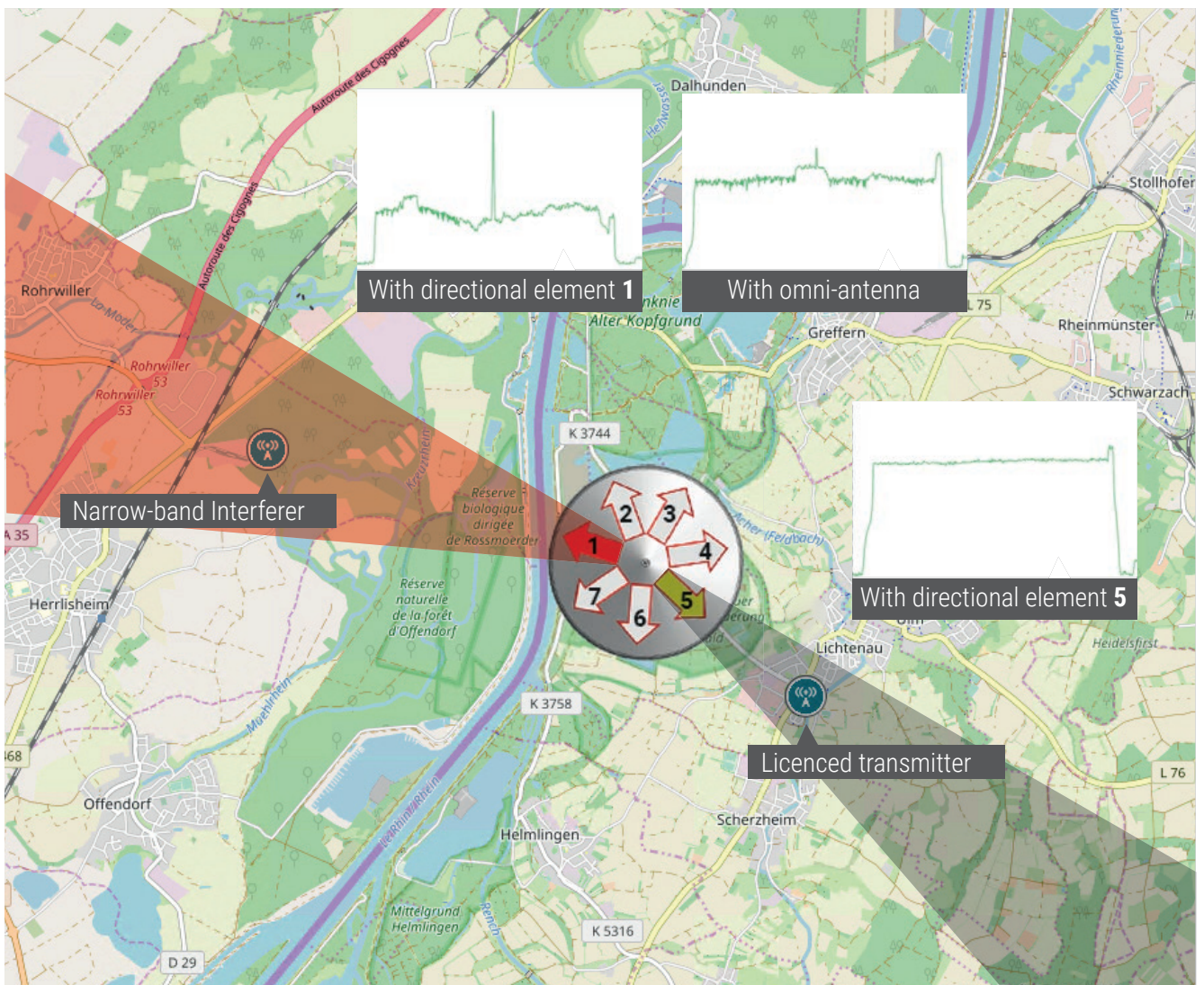
In the scenario of multiple overlapping emissions (e.g. co-channel interference, reflections), an omni-directional antenna will receive only a mixture of all emissions. With the directional monitoring mode the user is able to suppress the interfering emissions by selecting the antenna element which is directed to the signal source of interest. Thus, the user is able to analyze

each signal separately, e.g. only the interfering signal or only the wanted signal. In scenarios where a signal interferes with its own reflections the user is able to suppress the reflections by selecting the antenna element which has line of sight to the searched signal.

In single frequency networks like for DVB-T, multiple adjacent transmitters work on the same frequency. With the directional monitoring mode the user is able to perform monitoring only for one specific transmitter of this single frequency network instead of having a mixture of the signals from multiple transmitters.

In case the reception level for a signal of interest is low when using a standard omni-directional antenna, the

directional monitoring mode can be used to increase the sensitivity of the system. The CMS software is able to automatically choose the directional antenna element which provides the highest reception level for the emission of interest. Due to the selectivity and higher gain of the directional elements, signals which may be hidden behind the noise floor, when measuring with an omni-directional antenna, are clearly visible with the directional monitoring mode. In contrast to omni-directional monitoring, this mode provides a higher SNR for the signal of interest in order to perform automatic signal parameter analysis or demodulation, which would not be possible with a low SNR.



Narrow-band interferer hidden behind wanted signal

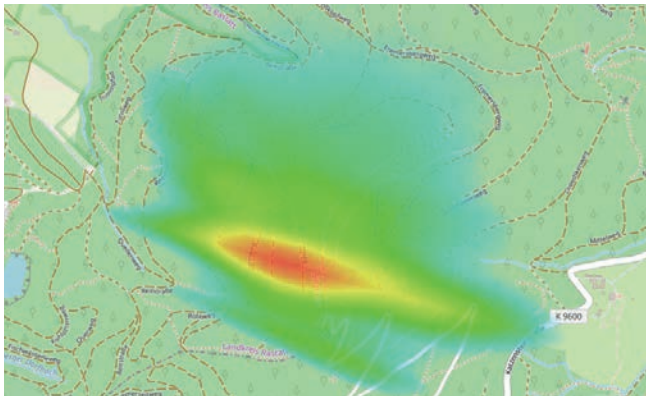
Vehicle-based operations

If the AOA 1xx is used for applications based on a vehicle, the CMS software provides powerful features to quickly locate any emission source. While driving, the system permanently scans the frequency range of interest. If there is a signal the operator wants to locate, he



AOA 1xx mounted on a vehicle

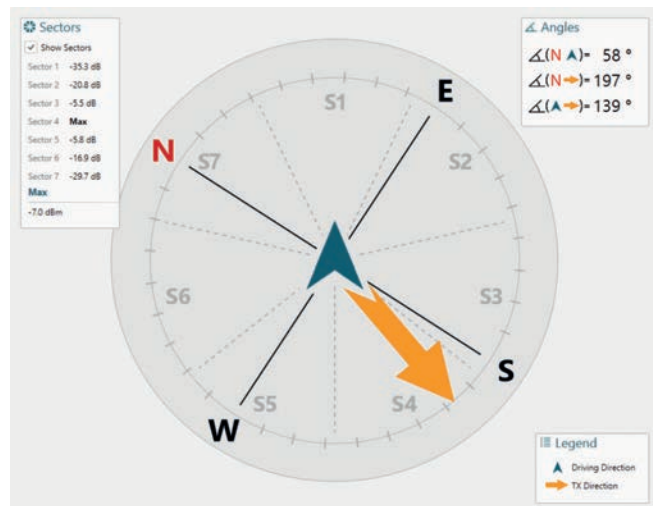
simply double-clicks on it and the software displays the live, permanently recalculated line of bearing on the map starting from the current GPS position of the vehicle.



Heatmap visualization

To locate an emission source, the user can either choose multiple lines of bearing captured at different points along the driving route and visualize them on a map to make a visual triangulation, or he can display a heatmap. The more bearings you have, the more complex the visual triangulation becomes. In contrast to this, with the heatmap visualization, the user is able to directly identify the most likely location for the searched emitter.

For emitter homing, the CMS software includes a compass view with the calculated bearing direction and the current driving direction. Thanks to this clear and user-friendly view, the driver of the vehicle is able to easily follow the calculated direction to the searched emitter.



Compass view for emitter homing

Highlights AoA 1xx

- Retrospective DF based on stored frequency range scans
- Ultra-large frequency range with only one antenna
- Co-channel emission resolution
- Monitoring of a specific azimuth
- Omni-directional monitoring and DF in parallel (Only for AoA 1xxm series)

Related LS OBSERVER components

CMS* (Central Monitoring Software)

The CMS is a modern and user-friendly software to control either a single LSO device or a whole network of devices. It provides a wide range of powerful features like DF, geolocation, automatic violation detection, ITU signal parameter analysis, demodulation, occupancy analysis and much more. When using CMS with the AOA 1xx, the "AOA - Direction Finding AddOn" is required.



FMU** (Fixed Monitoring Unit)

For 24/7 outdoor measurements from a fixed site. Includes an embedded receiver, computer, storage and network communication modem. Thanks to its compact form factor, it can be directly installed on a mast next to the AOA 1xx antenna to minimize cable losses. Different versions available, for further information see our product brochure.



PPU** (Protected Portable Unit)

For mobile, portable or temporary fixed applications. Includes an embedded receiver, computer, storage, network communication modem and batteries (hot swappable) for up to 4 hours (subject to receiver type and setting) runtime. Different versions available, for further information see our product brochure.



TMU** (Transportable Monitoring Unit)

For mobile vehicle-based or temporary fixed applications. Includes an embedded receiver, computer, storage, network communication modem and batteries for up to 8 hours runtime. Different versions available, for further information see our product brochure.



* Mandatory

** Only 1 item is mandatory

Optional items

Dual receiver option

Integration of a second receiver into FMU, PPU or TMU for parallel monitoring and direction finding.

Accessories set for fixed applications

Consisting of:

- Mast mount for AOA 1xx antenna
- Lightning rod which is screwed onto the antenna radome
- 5 m cable set (customized lengths available)

Accessories set for vehicle based applications

Consisting of:

- Vehicle adapter to fix the AOA 1xx to a standard roof rack
- Compass which can be attached to the vehicle adapter
- 5 m cable set (customized lengths available)

Accessories set for temporary fixed measurements

Consisting of:

- Mobile framework construction to carry the AOA 1xx antenna. Retractable and demountable for transport. Also suitable for carrying the AOA 1xx on a pick-up truck.
- 5 m cable set (customized lengths available)

BAS 218 monitoring antenna

The BAS 218 combines two omni-directional monitoring antennas for the frequency range from 9 kHz – 18 GHz under one radome.

TECHNICAL DETAILS **AOA 1xx**

	AOA 106m	AOA 108m	AOA 112m	AOA 118
RF Characteristics – Direction Finding Antenna Set				
Set-Up	Multi-layer – Multi directional – Array			
Frequency Range	300 MHz - 6 GHz	20 MHz - 8.5 GHz	8 kHz - 12 GHz	8 kHz - 18 GHz
Impedance Nominal	50 Ohm			
Location Methode	DF TimeTravel®			
Polarisation	Horizontal and vertical			

RF Characteristics – Monitoring Antenna Set				
Set-Up	Array of monopole and discone			Directional monitoring mode with DF antenna set
Frequency Range	8 kHz - 6/8/12 GHz***	8 kHz - 8 GHz	8 kHz - 18 GHz	
Impedance Nominal	50 Ohm			
Directivity	Omni-directional			
Polarization	Vertical			
Gain	Typical 0 to -20 dBi above 1 MHz dependent on frequency			

Connectivity				
RF	2 x N connector female or 1 x N with switch			1x N connector female
Control	Multi-purpose serial connector			
Power	5/12 VDC			
Mechanical	Flange adapter with 8xM8			

Mechanical Characteristics				
Diameter	1790 mm			
Height	590 mm	890 mm	890 mm	890 mm
Mass	39 kg	46 kg	49 kg	55 kg

Environmental Characteristics				
Wind Speed Operational	100 km/h			
Wind Speed Survival	180 km/h			
Operation Temperature	-20 to 55 °C			
Storage Temperature	-40 to 70 °C			
Humidity	0 to 100 %			
Protection Class	IP55/65/67, dependent on version			

Upgrades

AOA106m VHF1	Extends DF frequency range of AoA 106m down to 88 MHz **
AOA106m VHF2	Extends DF frequency range of AoA 106m down to 20 MHz **
AOA106m HF	Extends DF frequency range of AoA 106m down to 500 kHz **
AOA106m LF	Extends DF frequency range of AoA 106m down to 8 kHz **
AOA106m SHF1	Extends DF frequency range of AoA 106m up to 8.5 GHz*
AOA106m SHF2	Extends DF frequency range of AoA 106m up to 12 GHz*
AOA106 SHF3	Extends DF frequency range of AoA 106m up to 18 GHz*+****

* Weight may be increased

** Weight and height may be increased

*** Dependent on AoA upgrade

**** No monitoring antenna set included for this option

For further information, please visit our website www.LStelcom.com or contact Info@LStelcom.com.