

PROJECT INFORMATIONAL PRIMER  
for



GENERATION 4  
HARDWARE

## INTRODUCTION

Time Of Arrival lightning locating, or more correctly, Time Difference Of Arrival (TOA from now on) is a method of lightning detection that yields much more accurate strike positions than similar methods such as direction finding (DF) where mainly triangulation is used to find positions of lightning. The lightning locating accuracy of a pure DF network, e.g. StrikeStar, is often affected by site errors such as, for example, terrain obstructing signal reception or terrain and coastal reflection/refraction that bends or modifies the signal path. Another common problem with DF networks is misaligned antennas. Each single sensor in a DF network must be accurately aligned to a common reference direction which in the Boltek case is True North. Even a single degree of misalignment can cause massive locating errors when the strike falls at a considerable distance away from a station. All this put together will contribute to making the final strike position incorrect by sometimes several tens of kilometers in a DF lightning locating network.

In contrast, the TOA locating method does not use any directional information from the lightning detector. Instead each detected lightning strike obtains a timestamp as soon as it is detected by a station. Using this information and at least four detectors that all have detected this same strike, a position can be computed by comparing the capture time differences between the four detectors. This is the core principle of TOA locating.

For TOA locating to work, the timestamping mechanism must be very precise. Electromagnetic signals emitted by a strike discharge travel at the speed of light, approximately 1000 meters/3300 feet in 3.3 microseconds. Consequently, in order to obtain a lightning locating precision of 1000 meters the timestamps must be accurate to at least within 3.3 microseconds. This cannot be achieved without wiring a very precise timing mechanism directly into the lightning detection hardware.

Several years ago we began researching how to achieve this kind of timestamping accuracy while keeping the equipment cost at a minimum and within reach of most hobbyists. Boltek had at the time already a high quality precision timestamp kit available on the market but at 1330 Euros/\$1499 USD for the kit alone with no detector, the cost was prohibitive for most hobby level users.

## THE NETWORK

This document discusses a new TOA lightning locating network project by the name of Microsferics Lightning Detection Network - or simply **MicroLDN**.

During summer of 2015 the first five stations in the Benelux area, Europe, came online and shortly thereafter two additional stations in the United Kingdom signed up. At the time of this writing 20+ stations are online and submitting lightning data. With more inquiries from Europe we expect further expansion shortly.

Expansion into North America and Canada begun in mid 2016 with 23 stations currently online. We are presently experiencing expansion in both Europe and North America/Canada and expect in the 2018 season to expand further again. This document is for informational purposes and intended for Boltek users in Europe, USA and Canada who may be interested in participating.



Lightning over the Netherlands and western Germany August 30 2015, detected by MicroLDN stations in Benelux and UK

## TOA KIT ELECTRONICS AND SOFTWARE

Our research resulted in a GPS disciplined timestamp kit that captured and timestamped its first signals during spring of 2015. Since 2015 there has been advancements in hardware design which brings us to the current generation 4 hardware.



*Microsferics Generation 4 hardware sitting on top of a Boltek LD-250 Detector*

The unit is housed in an alloy enclosure with dimensions of 130 x 80 x 50 mm/5 x 3 x 2 inches (L x W x H) which sits nicely on top of your current hardware.

No external AC adapter is required. An OLED screen indicates the current operating status of the unit. It is also equipped with a self test (BITS) function to test the hardware to ensure it is operating correctly.



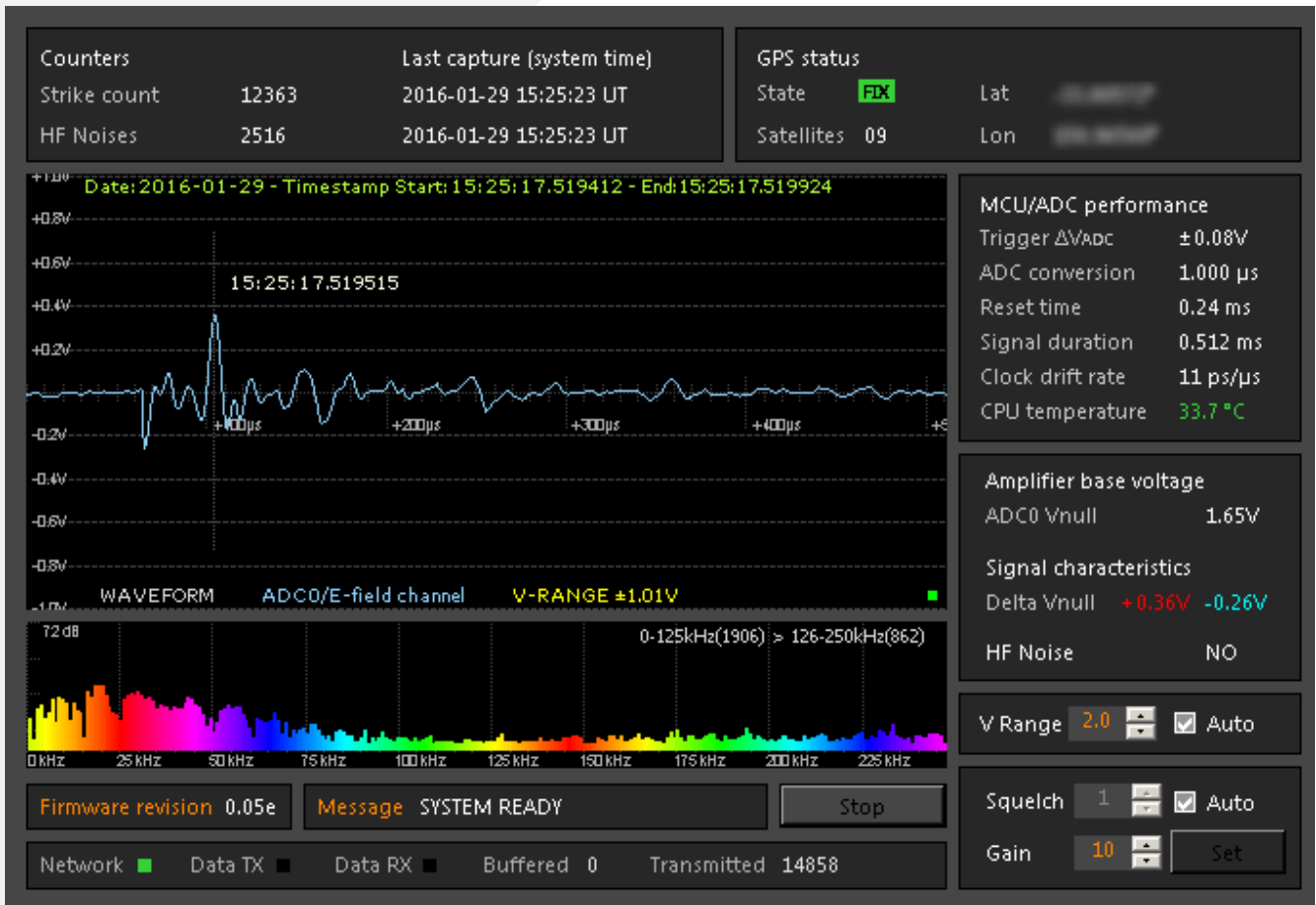
*Side is 130 mm/5 inches*



*Backside is 80 mm/3 inches*

The Plug and Play hardware collates signal data from the lightning detector, timestamps the signal precisely by using an integrated GPS, and then sends the data to a PC client application for further processing.

The entire TOA kit attaches to the Boltek system by connecting between the antenna unit and PC (StormTracker PCI) or detector box (LD-250/LD-350) using an extra Ethernet CAT6 cable, causing no interference with normal single point lightning detector operations.



MicroLDN client software for Windows with a timestamped stroke waveform

The Microsferics unit is also connected to a PC via USB cable where a special client software performs some cursory signal analysis to identify noises and then transmits the signal data to a central processing server where strike locations are computed.

The client software is autonomous and will continuously adjust squelch to suppress noise as well as ensure that the client at all times is connected to the TOA server.

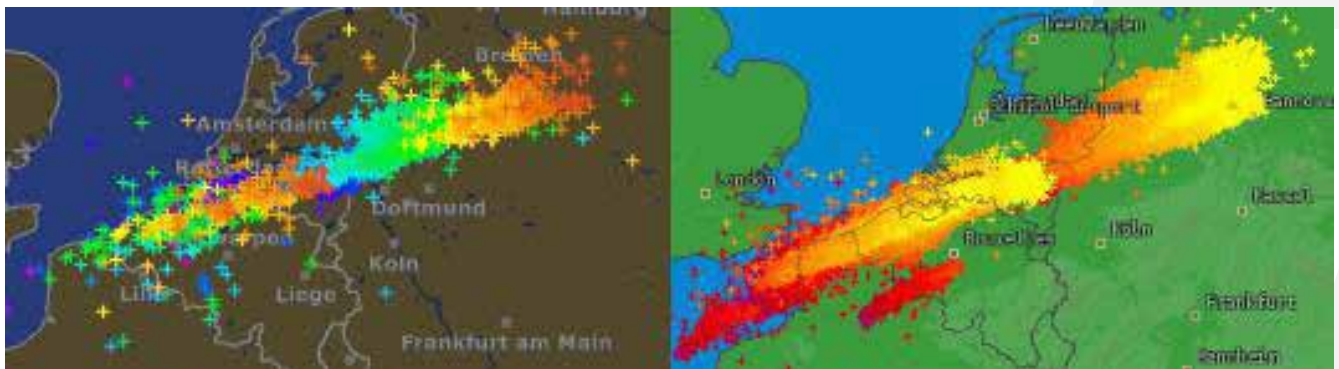
## Q & A - POSSIBLY FREQUENTLY ASKED QUESTIONS



Clear storm paths can be seen in this 1-hour cumulative plot of lightning activity over and to the west of the Netherlands. White strike plots are recent, dark orange are oldest.

**Q: How is the MicroLDN accuracy compared to StrikeStar?**

**A:** It is not comparable. MicroLDN accuracy is orders of magnitude better.



MicroLDN on left (6 detectors) comparison with Blitzortung for the same area and time frame. Blitzortung has well over 50 times the number of stations covering the shown area.

**Q: How is the MicroLDN accuracy compared to Blitzortung?**

**A:** It is on the same approximate level. Because of the larger number of participating stations, Blitzortung has the option of using a minimum of 11 stations for each strike detection. With a significantly lower number of detectors online we are seeing very good locating accuracy with only 4, 5 and 6 station detections.

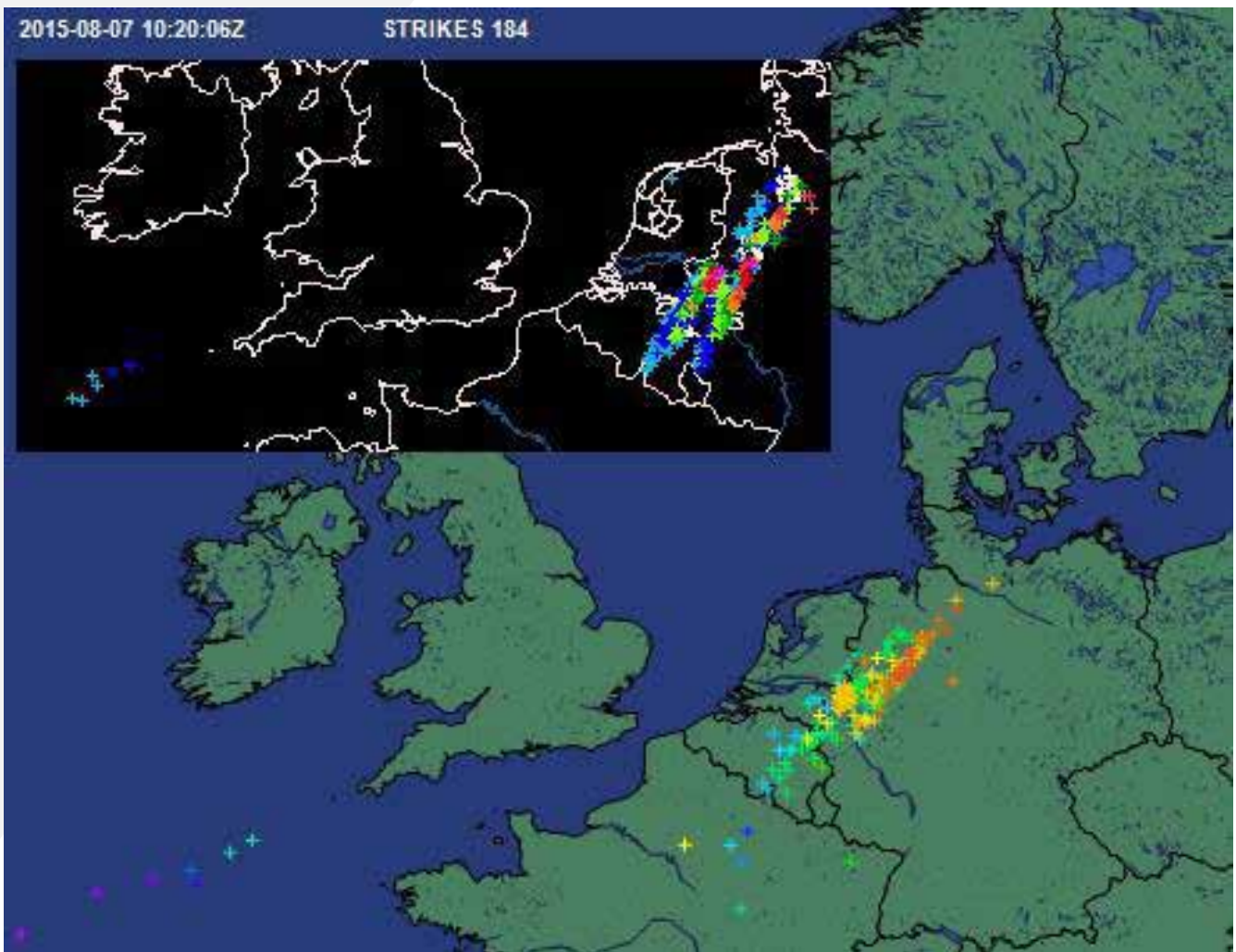
Currently the main differences between the networks are a) because of the small number of participating stations in MicroLDN, the detection efficiency is lower in comparison. We are in other words detecting a lesser number of lightning strikes overall; and b) With a lower number of participating stations we are obviously not matching the Blitzortung level of geographical coverage.

**Q: Why don't I just join Blitzortung instead?**

**A:** Because you are special and we like you more. Of course you could do that but if you are using your Boltek equipment anyway, why not take this opportunity and make it TOA network capable and also participate in a new and exciting project with a bright future? The Boltek detector is a higher quality piece of equipment and not as sensitive to electromagnetic interference as the Blitzortung hardware. The entire TOA kit does not require any assembly and is more user friendly to operate than comparable kits. And as a bonus, your single point lightning detector remains unaffected and will work just as before.

**Q: Is this a contest between you and Blitzortung?**

**A:** No, we are simply trying to provide an equivalent service to existing Boltek users.



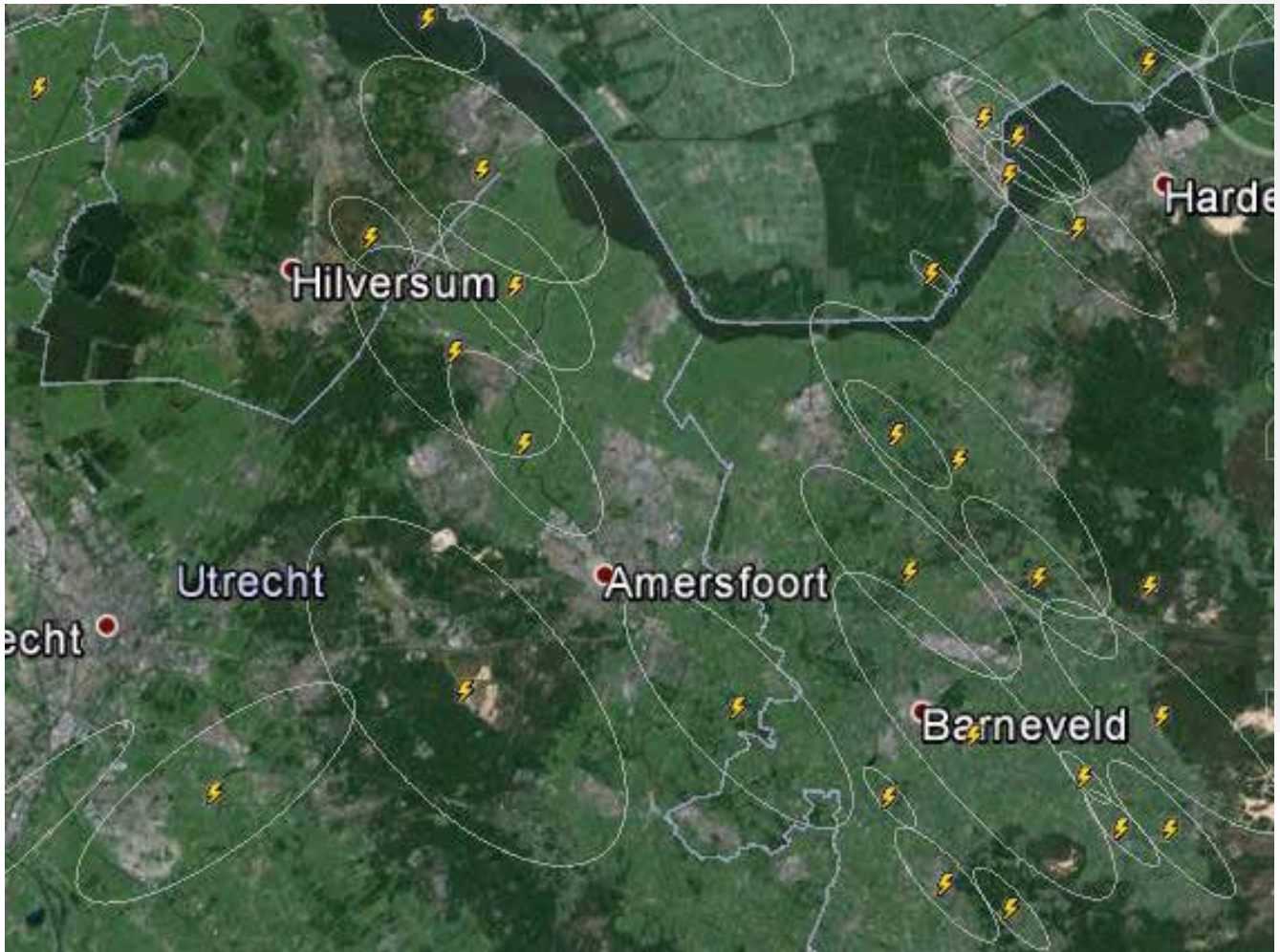
Comparison with ATD commercial network (black inset map) of lightning moving at the edge of network coverage. ATD map shows 3 hours of data whereas the MicroLDN map shows around 11 hours in total with most of the activity occurring in the 3 hour time window shown by ATD.

**Q: How is the MicroLDN accuracy compared to ATD/NLDN/USPLN/other commercial networks?**

**A:** It is close but not at the same level of accuracy as commercial networks, nor can this be expected given the low cost electronics used. With that said, it is still good enough to match these networks on a slightly larger scale and the network does provide useful information on positions of individual lightning impacts. We are working continuously on improving the system in various ways so this answer might not be relevant at some point in the future.

**Q: What is the actual measured accuracy?**

**A:** This will depend greatly on how many sensors are co-detecting a strike and the position of the strike in relation to the detecting sensors. The more sensors that are involved in the TOA computation, the better the accuracy will be. Likewise, if a strike occurs somewhere within the network perimeter, that is to say near the center point of a set of detecting sensors, the locating accuracy will be higher. Theoretically the system provides for sub-kilometer accuracy under ideal conditions. In real world scenarios we are seeing variations in accuracy between 0.5 and 6 kilometers



Selection of strikes detected by at least 5 stations with their respective confidence ellipses. The largest error ellipse in this image, near the Utrecht label, has a major/minor axis of 7.5/5.5 km.



**Q: Can anyone join?**

**A:** Yes. You currently need to be operating a Boltek Lightning detector as the hardware we supply is an add-on to the Boktek detectors. You will need a PC running Windows 7 or newer for the client software.

**Q: Is the TOA kit free?**

**A:** This is self sponsored equipment that nobody is making money off. TOA kits are basically sold at cost price so the answer is sorry, but no.

The prices are available here: <http://microsferics.com/index.php/Pricing>

**Q: I want to know more, whom do I contact?**

**A:** You can either direct your questions to the person you received this document from or send an e-mail to [info@microsferics.com](mailto:info@microsferics.com). This contact address is for English speaking persons but questions in Dutch and German languages can also be directed to [info@weerstation-assen.nl](mailto:info@weerstation-assen.nl) who is a MicroLDN participating station in Europe. Please try to keep your questions brief and to the point.

**Q: I am 65 - 98 % certain that I will be interested to take part in this. What do I do?**

**A:** Make sure to tell this to the person you received this document from so that we are made aware of your potential interest.

**Q: I am 100 % certain that I want to take part in this right away. How do I obtain a TOA kit?**

**A:** Send your application to [join@microsferics.com](mailto:join@microsferics.com) including your location coordinates.

**Q: May I distribute this document to others who might be interested?**

**A:** Yes.

WE LOOK FORWARD TO HEARING FROM YOU!



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