LINET Lightning Detection

Unique, independent, ultra-precise and reliable system

LINET lightning detection system is developed and manufactured by Nowcast company from Germany and is working as an independent system consisting of the network of sensors, central server and analysing and visualizating tools. The system is able to detect both CG and IC strokes, identify thunderstorm cells, track them and provide nowcasting of their movement.

- Efficient coverage of large areas
- Continuos operation in real-time
- Thunder cells and sub cells detections and nowcasting
- Distinction between lightning strokes types and IC emission height in km

Lightning detection principles

Two frequency ranges are typically used for lightning detection: LF / VLF and VHF. VLF / LF (3 – 300 kHz) attenuates more slowly as in VHF frequency range and is used for networks covering larger areas such as a complete country or a complete transmission or railway network. Source of the magnetic radiation is the flow of electric current in conducting lightning channels. Second type of range is VHF (30 - 300 MHz), which propagates only over short distances (~100 m -10 km) and is typically used for scientific purposes. Radiation source is the air breakdown processes (so called "leader steps"). LINET system is using VLF / LF range (3 to 300 kHz).

How LINET works

LINET system is detecting CG (cloud-to-ground) and IC (cloud-to-cloud or intracloud) strokes by measuring the electromagnetic radiation emitted by lightning strokes with very high accuracy (75 m in ideal conditions) with highly sensitive lightning sensors. As the electromagnetic radiation spreads almost at the speed of light, it reaches the sensors at slightly varying times. Even though this difference is a matter of mere microseconds (µs), it enables precisely calculating the location where the lightning stroke originates. To this end

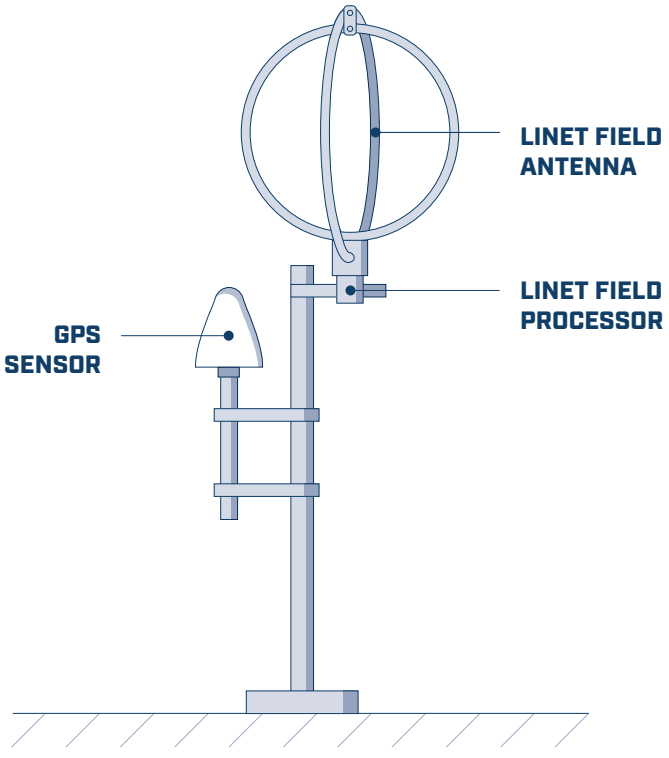
cloud-to-ground (CG)

cloud-to-cloud or intracloud (IC)

all data recorded by each lightning sensor is transmitted to a central server via the internet. The server then calculates the exact geographical position for all the lightning strokes measured (the so-called "location") and stores them in a database. The results are then made available to the customer in real time. This measurement method is also referred to as the Time-of-Arrival (TOA) method. LINET, however, does not only measure the position of the lightning stroke. LINET also captures the strength and polarity of the lightning strokes, and the height of intra-cloud strokes, in particular, expanding the lightning information to include a third dimension. This feature is unique around the world for low-frequency networks (VLF / LF) used for large areas. LINET systems essentially comprises two modules: several lightning sensors and a central server.

LINET sensor

LINET is working as a network of cooperating sensors. At least 5 sensors are used to triangulate a stroke location, in order to result in the unrivaled nowcast accuracy. The lightning sensors consist of one magnetic field antenna, a GPS module and a field processors and are set up at distance of app. 150 to 250 km (recommended). The position of the LINET Field Processor is of little importance as long as sufficient and stable internet connection is available. The redundant number of sensors constitutes a great advantage given that only the best signals will be included in the calculation. The sensor can be installed indoors or outdoors, however the Antenna is normally installed outdoors and only the Processor is often placed indoors. The LINET Field Processor receives the signals from the LINET Field Antenna and the GPS antenna, processes them and transfers them to the Central Processing Unit(s). The LINET Field antenna is sensitive to the electro-magnetic waves emitted by lightning strokes. VLF range is between approx. 5 kHz and 100 kHz (after signal processing). The GPS Antenna receives the signals from GPS satellites. GPS serves as an accurate time source. Accuracy is in the nanosecond range.



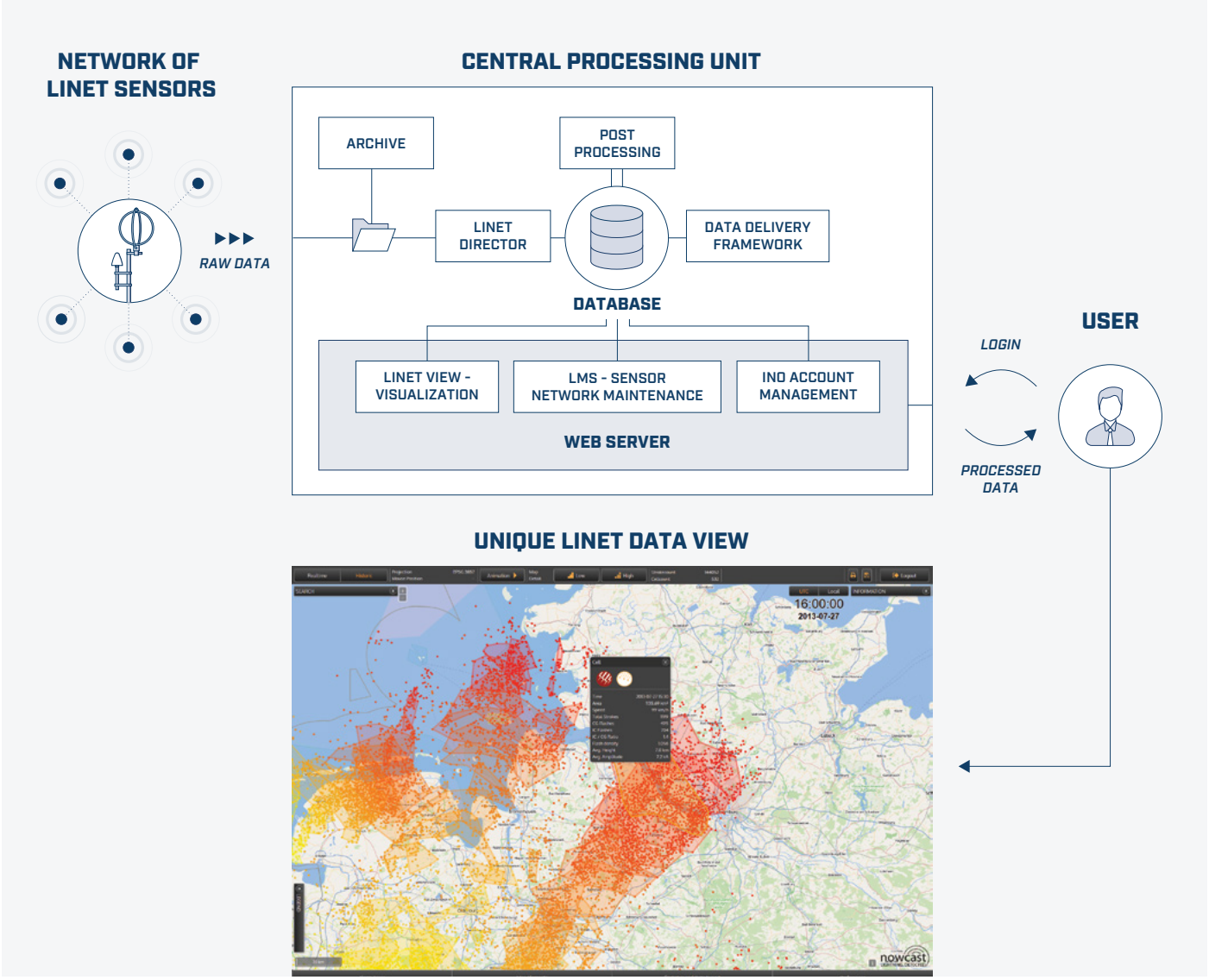
LINET server

LINET server is provided as industry standard, Intel-based servers and rack-mountable. Specified according to customer requirements such as number of LINET sensors or number of users. Central processing software is based on Ubuntu LTS Operating System and PostgreSQL Database. PostgreSQL is used as the central datastore in the LINET systems environment. It contains all strokes, cells, nowcasting as well as user data and network configuration data. It is provided together with the PostGIS extensions which enable geospatial querying directly on the database. It is the data backend for all data retrieval utilities and web applications.

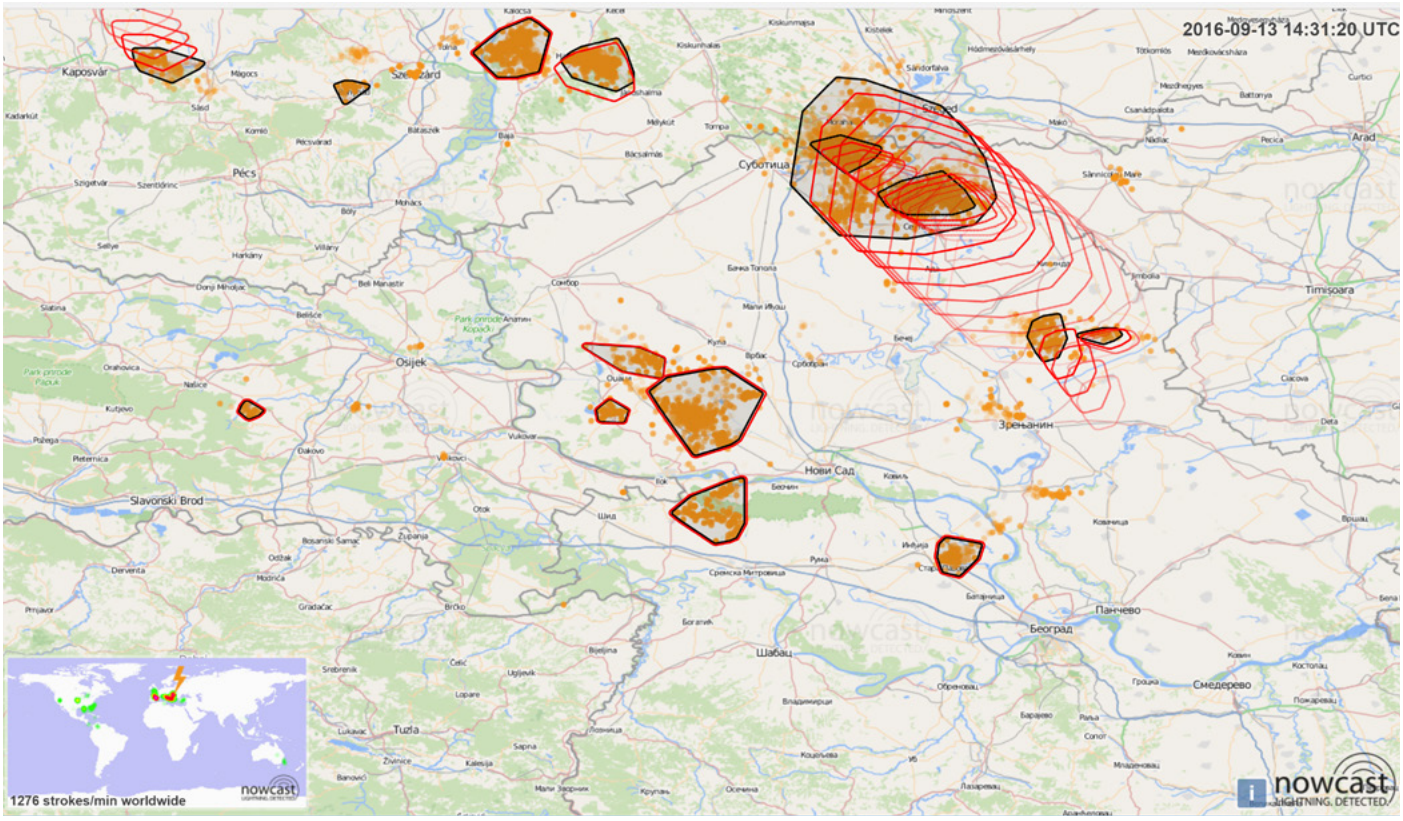
LINET software

LINET Director is the main lightning detection software. It processes the arriving raw sensor data and outputs lightning strokes to the database. System is providing post processing:

- Strokes to Flashes - one „flash" consists of several strokes;
- The Cell recognition and tracking algorithm determines lightning cells by calculating and updating contours in real time around groups of flashes;
- Tracking / Nowcasting-algorithm calculates a reliable short-term prediction (up to 1 hour) of the cell's future path.



Mode of operation



Red area: thunderstorm cell with lightning activity
Red outlines: nowcasting of thunderstorm cell in 10-minute-steps
Black outlines: core-cells with strong lightning activity and convectivity within the thunderstorm cell

LINET data

With LINET data small as well as large private and public companies get detailed numerical lightning information in real time. The user can access the data files in real time in various formats and on various devices via the internet. In addition to standard information pertaining to the location, time and stroke current, LINET reliably differentiates between intra-cloud strokes and cloud-to-ground strokes, and even ascertains the height of intra-cloud strokes. The data packages provide you with the following information:

- date & time;
- geo-coordinates;
- lightning amperage;
- lightning type: cloud-to-ground or intra-cloud;
- emission height of intra-cloud strokes
- polarity.

LINET view

LINET view visualizes and analyzes the current or any historical thunderstorm situation in your web-browser. Strokes, thunder cells and nowcasting are displayed on the map, as well as any customer-specific elements (e.g. points of interest, transmission-grids, stations, airports, power lines, wind farms, pipelines, oil rigs, or industrial facilities) and individual alarm areas. The application is easy to use and provides many tools for the management of thunderstorm related risks. LINET view provides the user with a reliable estimated time of arrival (ETA and ETD) of the thunderstorm based on the nowcasting of the storm development. Main features of linet view:

- Web Application;
- All data layers;
- Real-time data;
- Historical Data;
- Alarm Areas;
- Warning / Alert included;
- Statistics;
- Integration of additional data layers possible.

Nowcasting

The LINET lightning detection system analyses the position and spatial patterns as well as further thunderstorm parameters. It enables the grouping of flashes to the lightning cells. Continual mapping of occurrence of new flashes enables to determine the trajectory of storm cells and create the prediction, nowcasting, of cell movement for following 1 hour in 10 minutes time steps. This prediction is visualized via contours on map. Nowcasting is updated with every single detected flash. It enables the system to provide the best and the most actual prediction based on the actual state of meteorological situation.

Technical parameters

Detection	cloud-to-cloud cloud-to-ground intra-cloud lightning discharges
Type of measurement	detector network and server
Output	unique LINET view, Ethernet or serial data
Detection efficiency	98% for strokes > 4 kA even strokes down to < 3 kA are detected
Optimal sensor distance	150 - 250 km
Location accuracy	average 75 m in a well deployed network
False alarm rate	smaller than 0.1 %
Maximum flash rate	no limitation
Time of flash	microseconds accuracy
Measurement principle	detection via TOA principle
Frequency range	VLF / LF

Nowcasting parameters

Updating frequency	< 1 min possible
Prediction advance	1 hour
Nowcasting method	cell detection and tracking

Outputs and reports

Update rate	real-time
Message content	timestamp (date + time) coordinates type of Stroke (CG / IC) IC-height current Amplitude (kA) polarity

Power requirements

Sensor power requirements	120 V AC or 230 V AC (+/- 10%)
Sensor power consumption	< 40 Watt

Environmental parameters

Operating temperature	-40 °C (-40 °F) to 65 °C (149 °F)
Relative humidity	0 - 100 % condensing
Protection rating	housing with IP67 possible
Wind	up to 250 km/h

Physical parameters - field antenna

Material	sealed copper and aluminum
Weight	8 kg
Size	crossed Loops 40 cm (15.75 in) diameter height 50 cm (19.69 in)
Lifetime	> 10 years (standard warranty 1 year)

Physical parameters - field processor

Housing material	coated aluminum
Weight	1.5 kg
Size	15 x 20 x 30 cm
Lifetime	> 10 years (standard warranty 1 year)

Physical parameters - GPS antenna

Weight	0.5 kg
Size	height 15 cm (5.91 in) diameter 10 cm (3.94 in)
Lifetime	> 10 years (standard warranty 1 year)

Maintenance

Self-test capability	Sensor is maintenance free. All operational parameters are continuously monitored via central processing.
Visual inspection	Not necessary, all operational parameters are continuously monitored via remote central processing.

Certification and compliance

Nowcast is certified according to EN ISO 9001 (Quality Management) and EN ISO 14001 (Environmental Management).

LINET Field Processor (Model LFP Rev. C3) is in conformity with:

EN 55022:2010 - Information technology equipment, Radio disturbance characteristics, Limits and methods of measurement (CISPR 22:2008, modified)

EN 55024:2010 - Information technology equipment, Immunity characteristics, Limits and methods of measurement (CISPR 24:2010)

following the provisions of the directives 2004/108/EC (electromagnetic compatibility) and 93/68/EEC (CE marking) and its amendmants.