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INSIDE

Innovative VLF Navigation Solution for Indoor/Underground and Difficult Environment

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The objective of the INSIDE project is to define the most appropriate localization technique, which could enable better accuracy and positioning in all possible conditions, especially indoor and underground.

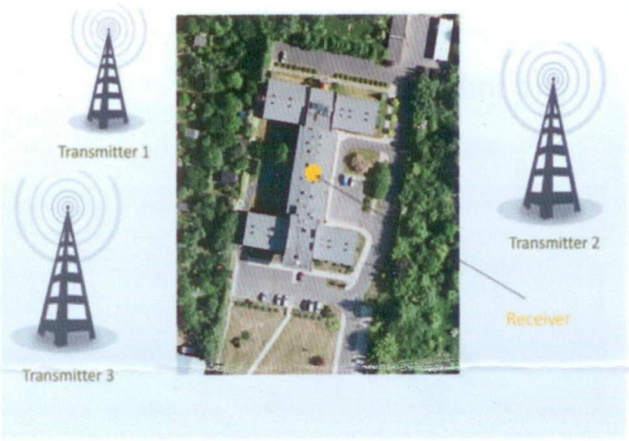
Main Assumptions:

-the developed technology will break through the constraints of GNSS methodology

- the localization technique will be based on The Low Frequency principle, which is not explored yet methodology for that purposes

- the indoor positioning in the project will be based on the usage of 3 or 4 transmitter modules (the angle of arrival method), arranged around the building, which will enable the localization of the receiver at the intersection of the line of sight of each module

- the technology was not yet used in the position determination



Very Low Frequency (VLF) is frequency of electromagnetic field ranging from **3 to 30 kHz.** It causes that the EM wave length is from **100km down to 10km**. These ranges could be very useful for **indoor navigation**. The buildings have much smaller dimensions than the wavelengths, so the **effects of multipath, diffraction and reflection are omitted**.

ADVANTAGES OF USING VLF IN INSIDE	DISADVANTAGES OF USING VLF IN INSIDE
Effective **indoor location** Expected **best accuracy** among indoor radio location technologies **No multipath** signal **Cost-effective** transmitters – low frequency devices have been long known and standard electronic elements will be used **Independence** from GNSS can be acquired (in special conditions) Can be used both **indoor and outdoor**	**Large** transmitter antennas The accuracy of the system **depends of the accuracy of the positioning of the transmitter**, i.e. if the transmitter measures its coordinates with GPS, its error will influence the error of the system Relatively **large receiver antennas**

Position Determination in INSIDE project

The position of each EMF source is known as: Pi = [Xi, Yi, Zi]

There is accuracy of each source position knowledge: ΔPi = [ΔXi, ΔYi, ΔZi]

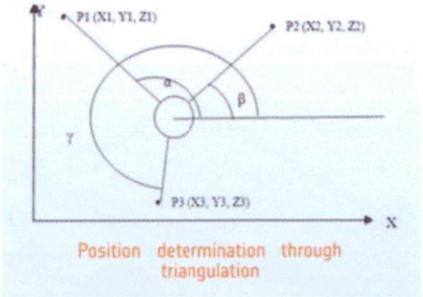
The method consists of measurement of Angle of Arrival of EM field. When the angle of sight of each source is known, the position of the object can be achieved.
For simplification of calculations, it will be assumed that all the objects are on one plain, which implies that: Z1=Z2=Z3=0

Also the orientation of the X axis of the object is parallel to X axis describing the EMF sources positions. The absolute position of object A (x, y, z=0) can be calculated.

For two EMF sources, the solution of equations $y = tg\alpha\, x + b1$ and $y = tg\, x + b2$, where b1 and b2 are offsets, is as follows:

$$x = \frac{b_2 - b_1}{tg\alpha - tg\beta}$$

$$y = tg\beta\, x + b_2$$



Position determination through triangulation