




Advanced Development in RFID Technology to Provide Solutions for Structural Health Monitoring Operations

Joël van Cranenbroeck, Business Development Manager for Geodetic Monitoring
Leica Geosystems AG, GSR EMEA
CH-9435 Heerbrugg, Switzerland

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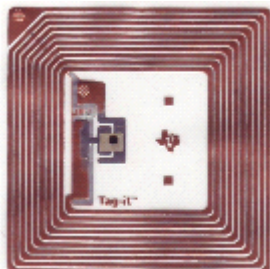
For What Stands RFID ?

Some background ...

Radio-Frequency IDentification (RFID) is the use of an object (typically referred to as an RFID tag) applied to or incorporated into a product, animal, or person for the purpose of identification and tracking using **radio waves**.

Radio-frequency identification comprises **interrogators** (also known as readers), and **tags** (also known as labels).

Some tags can be read from several meters away and beyond the line of sight of the reader.

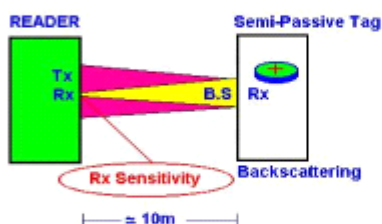


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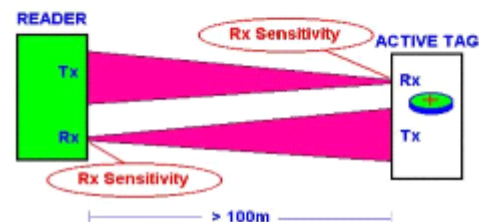
Range is limited by the voltage level received in the tag.

There are generally three types of RFID tags



Range is limited by the sensitivity of the reader receiver

Passive RFID tags, which have no battery and require an external source to provoke signal transmission, and

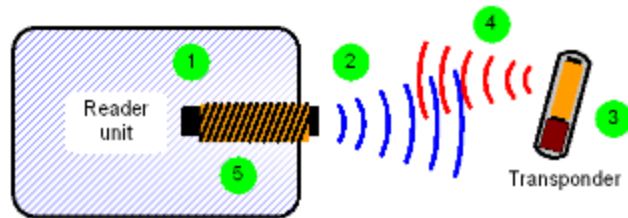


Battery assisted passive (BAP) RFID tags, which require an external source to wake up but have significant higher forward link capability providing greater range.

Active RFID tags, which contain a battery and can transmit signals autonomously,

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How Does RFID Work ?



1. A processor controls the RFID sender / receiver controller;
2. An antenna sends high frequency energy with optional encoded information to the transponder.
3. In the transponder, the high frequency energy is being converted to an electrical charge, which is saved.
4. This makes the transponder answer with its own, unique encoded information;
5. The reader unit receives the transponder's answer. This information can be processed depending on the application.

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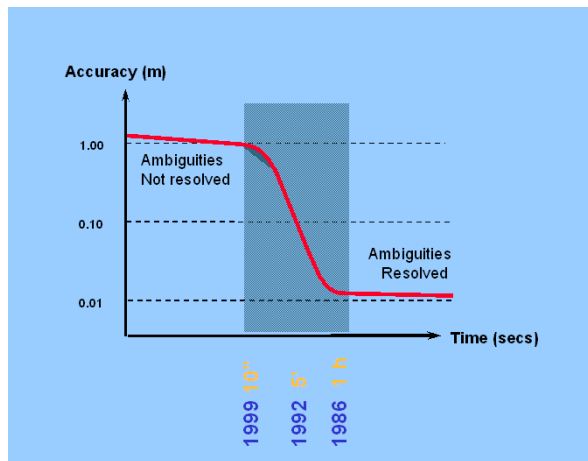
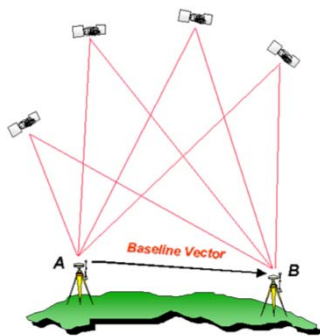
The screenshot shows the NOAA Photo Library website. The header includes the NOAA logo and the text 'NOAA Photo Library'. Below the header is a navigation menu with links: HOME, About, Contacts, Help, Credits, Collections, Search, and Links. The main content area features a photograph of a person operating a tellurometer on a rocky shore next to a glacier. Below the photo is the caption 'Tellurometer traverse at Columbia Glacier' and the following metadata:

Image ID: theb1684, NOAA's Historic Coast & Geodetic Survey (C&GS) Collection
Location: Prince William Sound, Alaska
Credit: NOAA National Geodetic Survey
Category: Geodesy/Triangulation/Baseline/Electronic/

Since 1985, most of the Geodetic Institutes adopted Transit then GPS for the maintenance of their Networks ... Already 25 years !



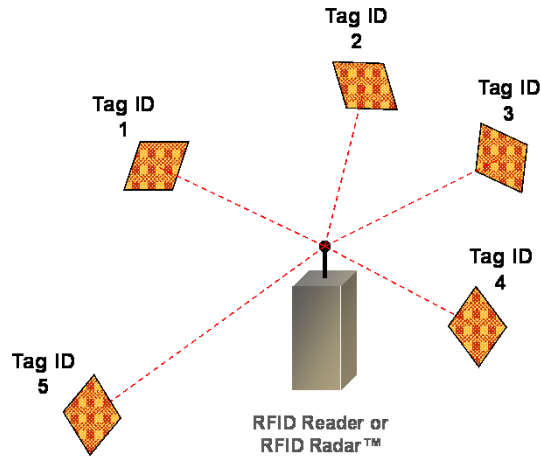
« Differential » GPS was the key for precise relative positioning



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What Next ? What's about RFID ? Elaborating a vision ...



Estimated cost for a such system is about 3.000 €

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RFID Radar™ gives precision long range measurement

Late 2005, a technology has been developed which would allow an RFID system not only to measure the identity of the tags, **but also the distance of the tag from the reader (radar).**

What was unique with this new technology was that it had the ability to measure the distance travelled by the radio signal with a **relative accuracy of 1 mm !**

The system could also measure the location of multiple tags simultaneously and used the same low cost passive and battery assisted tags used in normal RFID readers.

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RFID Radar™ gives precision long range measurement

The system currently has two levels of accuracy – namely absolute accuracy which is about 0.5 meters instantaneously, **and relative accuracy where it is about 1 millimetre.**

In relative mode the system measures the changes in distance very accurately between the reader and the tag.

In that relative mode, the system would allow small movements to be measured at long ranges (up to 100 m) distances.

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RFID for Structural Health Monitoring Applications

That new development could be used to monitor :

- Movement of a bridge with traffic flow or temperature variation,
- The bulging of storage tanks with variations in storage content,
- Bulging of a dam wall,
- Slippage of a structure on a mountain with rainfall
- Movement of a structure in wind and similar situations.

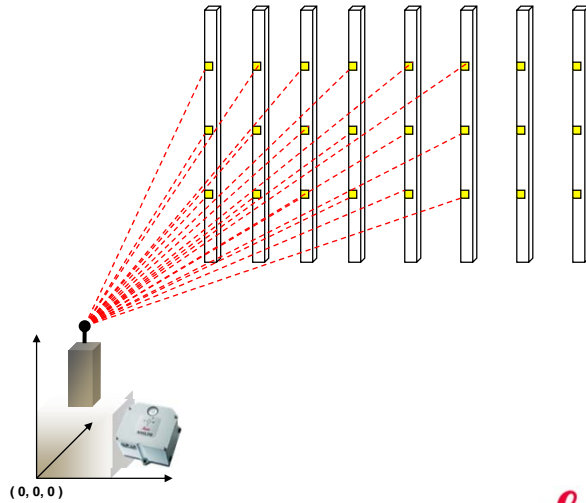
A series of tags would be attached to the structure, and the RFID-radar set up at a monitoring point at a distance. The radar would continuously measure the distance from all the tags to the radar, reporting all the measurements once per second and giving millimetre accuracy 24 hours per day.

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RFID for Structural Monitoring Applications

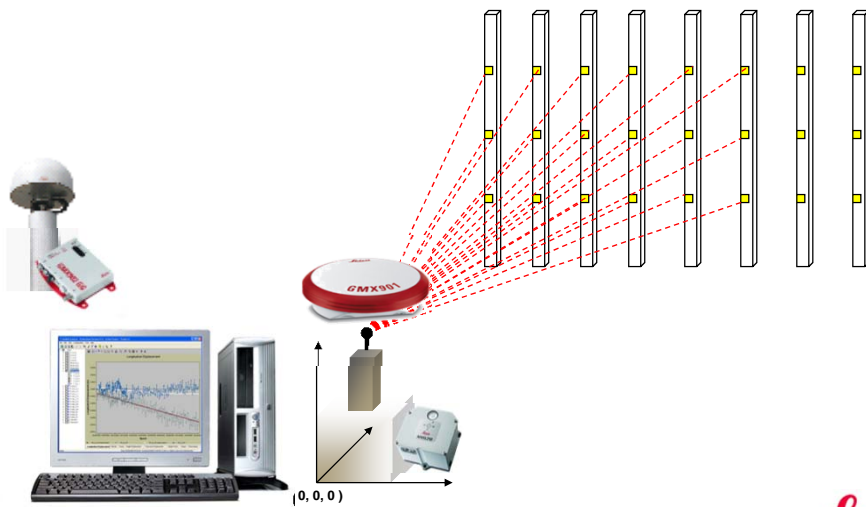


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RFID for Structural Monitoring Applications

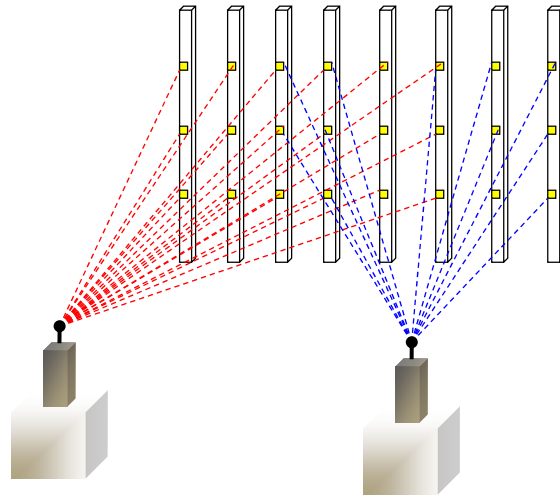


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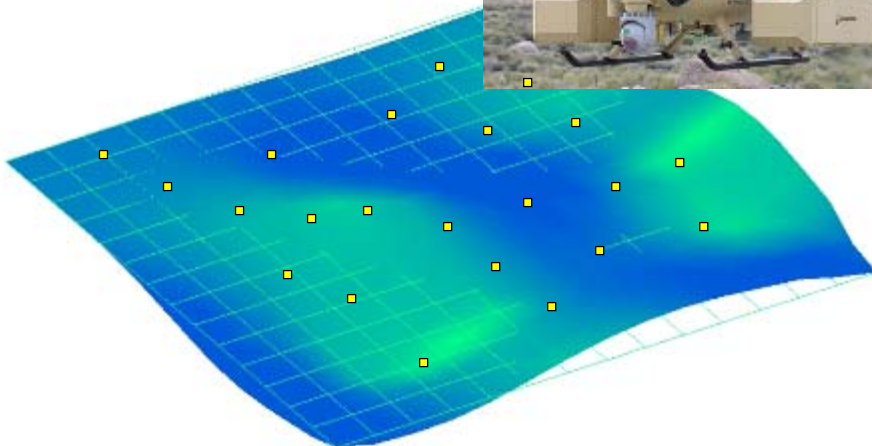
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RFID for Structural Monitoring Applications



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Pre-validation of the System Accuracy in the “relative” mode ...

24.500 measurements performed within 1 hour time

Id number	Type	Range (meters)
BBBFK0898	Credit card passive	14,3
BCBBB0002	Stick tag (BAT)	9,0
BCBBB5025	Claymore (BAT)	19,3
BCBBB5026	Claymore(BAT)	36
BCBBB0026	Claymore(BAT)	36,15
BCBBB0003	Stick tag with reflector	37,95
BCBBB0004	Stick tag with reflector	35,40

Table showing different types of tags used. Note BAT means battery assisted tag.

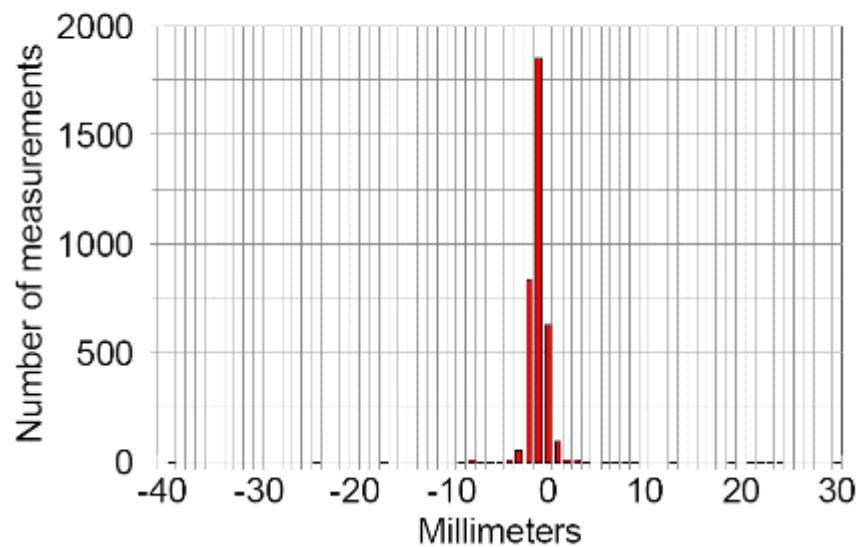
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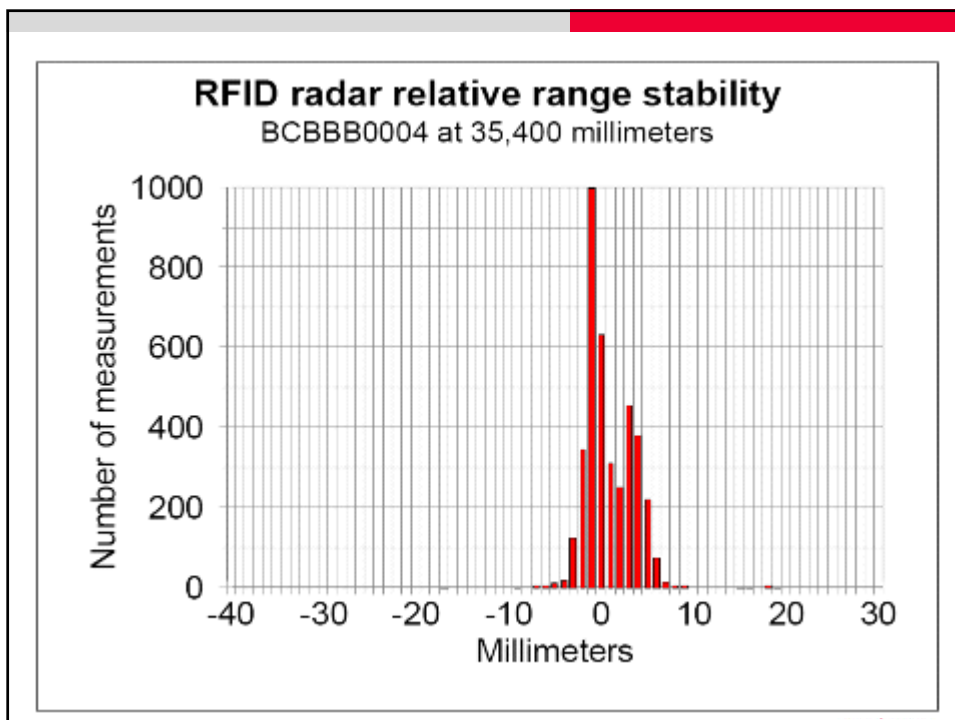
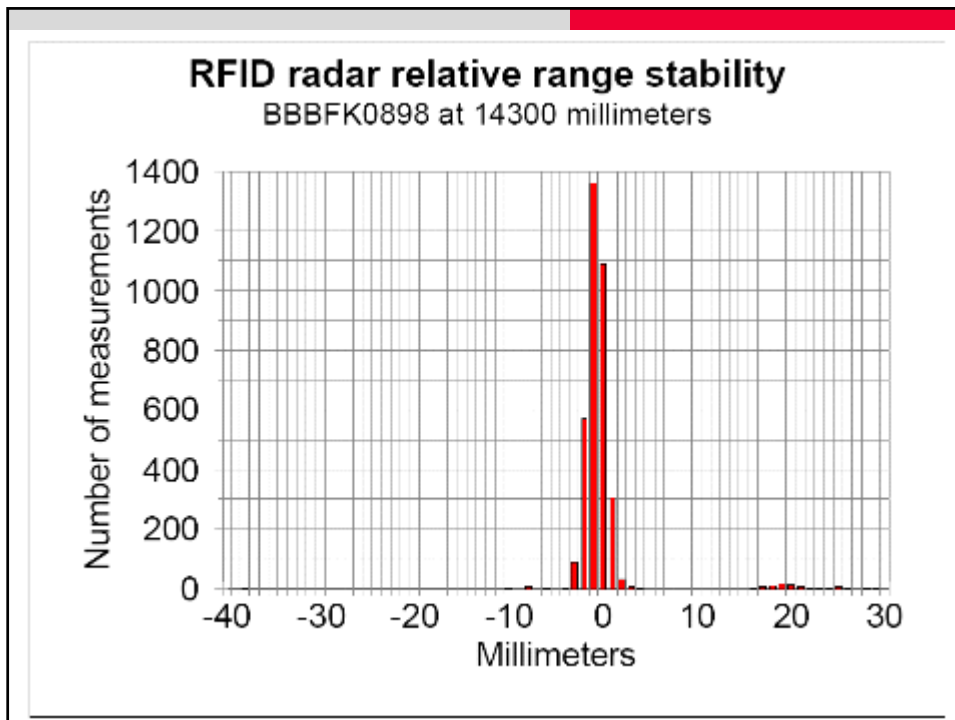
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RFID radar relative range stability

BCBBB0002 at 9,000 millimeters





Conclusions and Prospective ...

1. The RFID technology is actually engaged in hundred of applications !
2. The cost of the tag is very low due to the mass market consumption ...
3. The “cost” per points versus other technologies like TPS, GNSS and HDS is unbeatable and would make let us consider them as consumable ...
4. But there is “no free lunch” and proper and scientific investigations must be leaded to insure the validity of that vision :
 - The effective range and the influence of the tag orientation versus the reader as well as the environment (metal reflection).
 - At that present stage the system is providing 2D range measurements ... while the developers has already envision a 3D range measurement mode.
 - Typical “use” cases should be elaborated,
 - Influence of weather conditions on the measurements ...
 - Etc, ...

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We will do it again ...

From Syledis, Transit, GPS, Locata etc, ...

There is no reason to believe that RFID technology would not be able to deliver millimetre accuracy as well ...

That needs to mobilize scientific researches and to narrow the field of investigation with the associated (new) business model.

We do believe that when a signal can be received ... it could be demodulated and the measurement (geometry) can be extracted and processed to deliver positioning information.

We do believe that such new technology must be engaged also in new applications that we are even not considering today !

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Surveying and Surveyors in 2020 ...
Many thanks for your attention and reaction !

