GEO3 principles

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DESCRIPTION

The Geocube system is a deformation monitoring system.

It is based on GPS and provides millimetric deformation information.

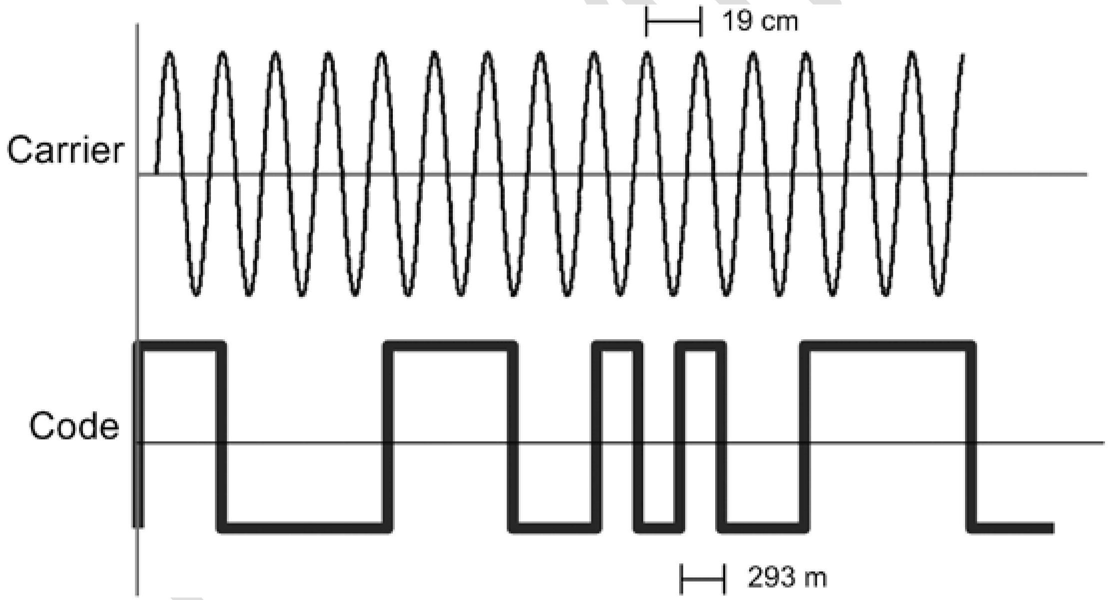
It works in network of several devices all connected by radio to a computing unit: the coordinator.

INTRODUCTION

Many GNSS precise positioning devices are available on the market. However none of them are dedicated to small move monitoring. And none of them have been designed to work in a network mode. When we decided to launch the geocube, we decided to benefit from those two features to build a low-cost but precise device.

PRINCIPLE

The key of precise GPS positioning is the exploitation not of the code, but of the phase of the GPS carrier signal :



But the carrier phase measurement contains uncertainly which is the number of cycles between the satellite and the receiver. It is called ambiguity.

Many ways exist to compute this uncertainty, but they almost all use the exploitation of a second wavelength launched by the satellite, which is expensive

The geocube receiver uses only one wavelength (L1) from the satellites.

Then using the network aspect of the network, and the fact that the geocubes do not move much the coordinator makes a Coarse calculation, that give not the position of each device, but their relative position between each other.

But this calculus has to start from a point that would not be too far from the real solution. this point is given by the navigated position issued from the code analysis of the GPS signal. (5-10m)

Then the coarse calculation computes the approximate distance between geocubes with a -+10cm precision.

The problem with this first approach is that we have to wait very long between each measurement (15minutes) the closest from the real distances we start the fastest the process. It last between 3hours and 10 hours depending on the starting point precision and the quality of the signal.

Then, once the ambiguities are solved, a fast process can start where the phase are carefully tracked, and where each point is supposed to remain close to the older position. “Masses” are attached to point enabling them to move more or less. This leads to a millimetric precision

ALMANACS

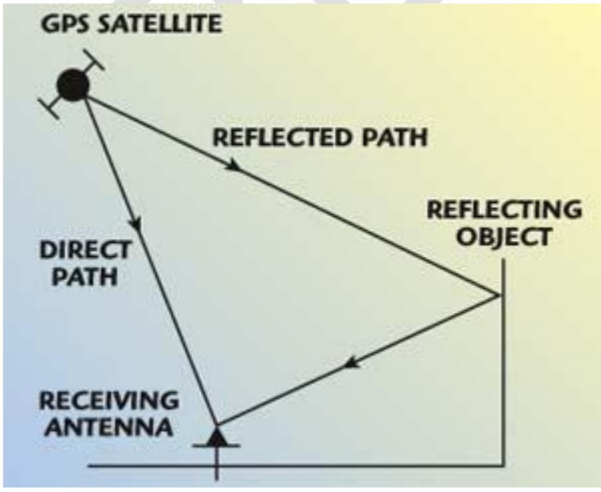
For all those calculations it is really important to know the exact position of the satellite at a given time. This information is given by almanacs. The almanacs cannot be computed very long in advance. For best precision it is important to get the latest data set available. The coordinator downloads it every hour from a server. This requires the coordinator to be connected to internet.

When an internet connection is not possible the post processing is still possible. Data are not processed immediately. but is done when an internet connection is available.

MULTI-PATHS & RESIDUALS

When the signal reaches the receiver’s antenna the coordinator assumes a direct line between the satellite and the receiver. But this is not always true and this leads to errors in positioning.

The main source of errors is called multi path:



The multipaths can be avoided with a very expensive antenna called Choke-ring. But another way to get rid of them is to know that they are quasi cyclic if the environment does not change too much : since the satellites come to the same position every 23:56 (sidereal day) the multipath have the same cyclic aspect. Then performing an average on 23h56min will erase their effect. Alternatively a post processing that would take a “reference no-move day” and subtract it to the data will enable real time move detection.

Other errors come from ionospheric and tropospheric distorsions that cause delay and diffraction of waves coming from satellites. Those will impair the results from wide area geocube networks (10km)