

GEOLOCATION USING MULTIPLE REFERENCE

NovaGrid S.A.S.

INTRODUCTION

In this paper, we describe some results of our new algorithm called « multi-reference geolocation » which allows carrier geolocation with a great accuracy even using public ephemeris (NORAD TLEs).

EPHEMERIS ACCURACY PROBLEM FOR GEOLOCATION

The ephemeris accuracy impacts on the accuracy of target geolocation. The following figure shows an example of a target located using operators ephemeris (several hundreds of meters accuracy on satellite location).

In this example, the ellipse size (about 150 km) is mainly due to the ephemeris accuracy and the distance between the known signal and the target (80 degrees in longitude and 40 degrees in latitude between the known carrier and the target in this case).



Locating a target using public ephemeris gives not accurate target locations since the accuracy of the location of each satellite is about 30 km. The same target as before is located using public ephemeris and the result is shown in the following figure. The ellipse size is about 1400 km !!



ellipse with public TLEs

ellipse with operator ephemeris

USING THE MULTI-REFERENCE GEOLOCATION ALGORITHM

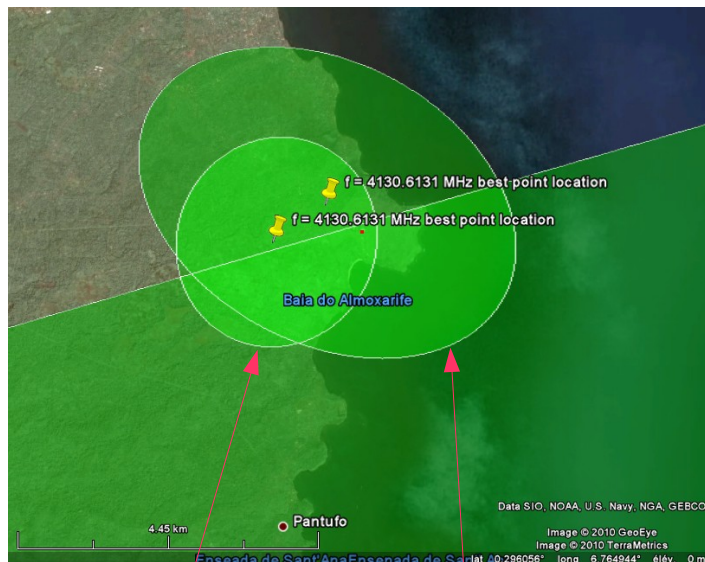
Now, if several known carriers are used (3 more known carriers), the multi-reference geolocation algorithm is able to give a very small ellipse. The same example as before is shown in the following figure. The ellipse size in this case, using public TLEs, is about 8 km !! (this increases the accuracy by a factor of 200).



ellipse with operator ephemeris

ellipse with public TLEs and multi-reference

If accurate ephemeris are known, the ellipse size due to ephemeris accuracy can be reduced. The following figure shows an example for the same target but using operator ephemeris and multi-reference algorithm. The ellipse size is about 1 km.



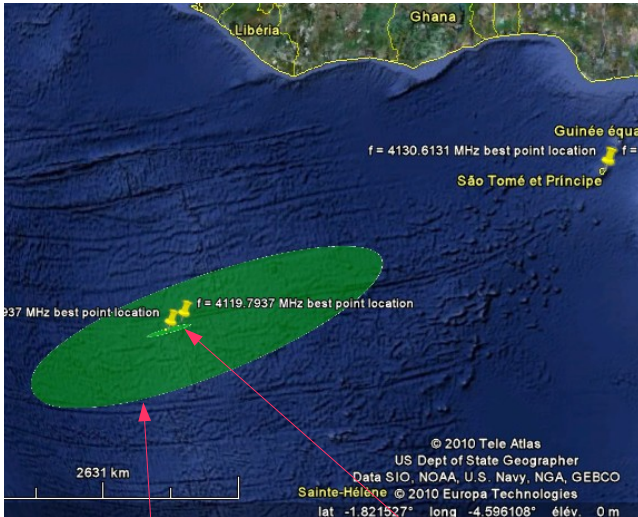
ellipse with operator ephemeris and multi-reference

ellipse with public TLEs and multi-reference

A SECOND EXAMPLE

A second example is given below. We show 4 ellipse computations :

- using public TLEs (1200 km)
- using operator ephemeris (150 km)
- using public TLEs and multi-reference (8 km)
- using operator ephemeris and multi-reference (1 km)



ellipse with public TLEs

ellipse with operator ephemeris



ellipse with public TLEs and multi-reference

ellipse with operator ephemeris



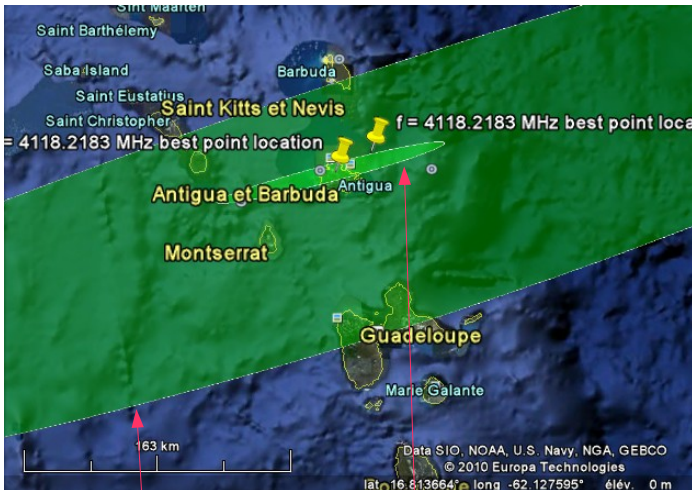
ellipse with public TLEs and multi-reference

ellipse with operator ephemeris and multi-reference

A THIRD EXAMPLE

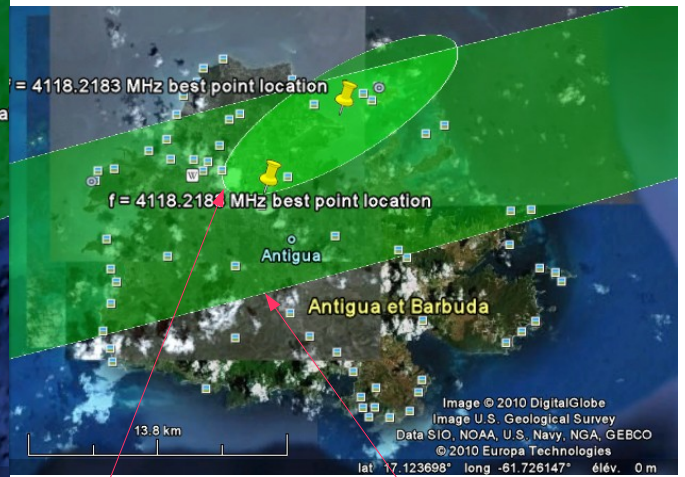
A second example is given below. We show 4 ellipse computations :

- using public TLEs (500 km)
- using operator ephemeris (70 km)
- using public TLEs and multi-reference (7 km)
- using operator ephemeris and multi-reference (1 km)



ellipse with public TLEs

ellipse with operator ephemeris



ellipse with public TLEs and multi-reference

ellipse with operator ephemeris



ellipse with public TLEs and multi-reference

ellipse with operator ephemeris and multi-reference