**Computation of the Emission Time**

**and**

**Computation of Satellite Coordinates**

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**Computation of the Emission Time and Computation of Satellite Coordinates:** In this project the two Computation of the Emission Time and Computation of Satellite Coordinates are given as follows.

# 1 Computation of the Emission Time

There are two seperated algorithm for computing the satellite transmission time from receiver time. First method uses pseudorange measurement and second is pure geometric algorithm which is based on satellite coordinate and approximate position of receiver. The two method are given as follows :

## 1.1 A Pseudorange-Based Algorithm :

The emission time can be directly evlauated from the reception time. Since the pseudorange R is a distance between two celestial and terrestrial stations and pluse some errors. From pure formula (without noise and errors) the emission time is :

$$t^{sat}[emission] = t_{reception} - \Delta t - \delta^{sat}$$
$$\text{where} \rightarrow \Delta t = R/c$$

The advantage of this method :

- without itrerative calculations
- the accuracy is very high

## 1.2 A Purely Geometric Algorithm :

This algorithm is based on receiver clock($t_{rcv}$) :

$$t_{rcv}[emission] = t_{rcv}[reception] - \Delta t$$

where $\Delta$ t is now calculated by iteration assuming that an approximate receptor position r0rcv is known. The algorithm is given as follows :

1- Calculate the position $r^{sat}$ of the satellite at signal reception time $t_{rcv}$.

2- Calculate the geometric distance between the satellite coordinates obtained previously and the receiver's position.

$$\Delta t = \frac{||r^{sat} - r_{0rcv}||}{c}$$

3- Calculate the satellite's position at the time $t = t_{rcv} - \Delta t \rightarrow r^{sat}$.
4- Compare the new position rsat with the former position. If they differ by more than a certain threshold value,iterate algorithm again.

Finally the emission time is :

$$T[emission] = t_{rcv}[emission] - \delta t_{rcv}$$

where $\delta t_{rcv}$ is the receiver clock offset that can be claculated from a navigation file.

$$\tilde{\delta t}^{sat} = a_0 + a1(t - t_0) + a_2(t - t_0)^2$$

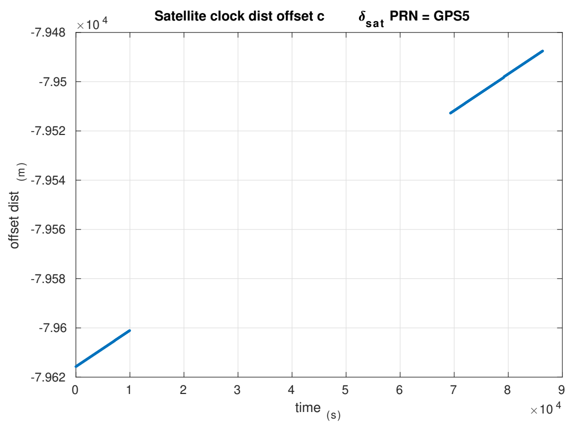


Figure 2: Dist clock offset.

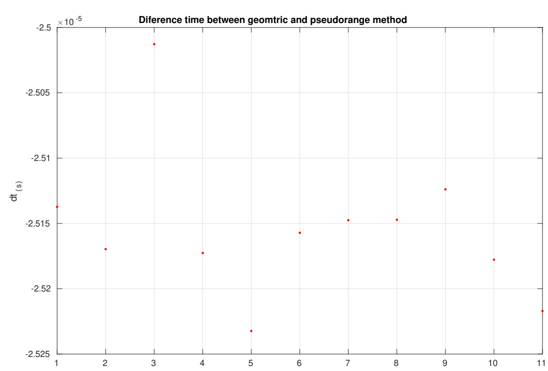


Figure 3: Difference between Geometric algorithm and pseudorange algoeithm.

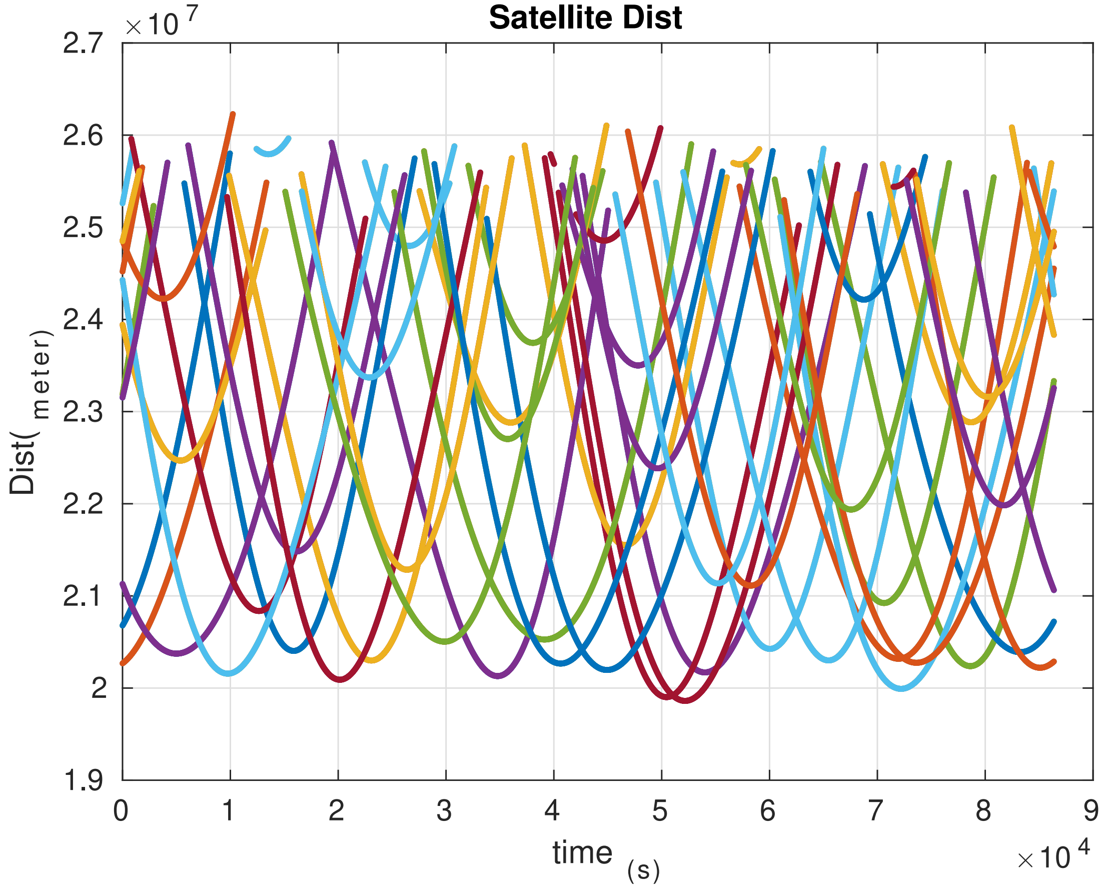


Figure 4: Satellite Distance from reciver in time.

# 2 Computation of Satellite Coordinates :

Once the signal transmission time is known, the satellite coordinate can easily be calculated at the epoch. An algorithm for computing satellite coordinates at transmission time, but referred to the ECEF tied to Earth at reception time, is as follows:

1- Calculate the satellite coordinates at emission time in the associated ECEF reference frame

2- consider Earth's rotation during the time interval $\Delta t$ that the signal takes to propagate from the satellite to the receiver:

$$r^{sat} = R_3(\omega_E \Delta t)\tilde{r}^{sat}.$$

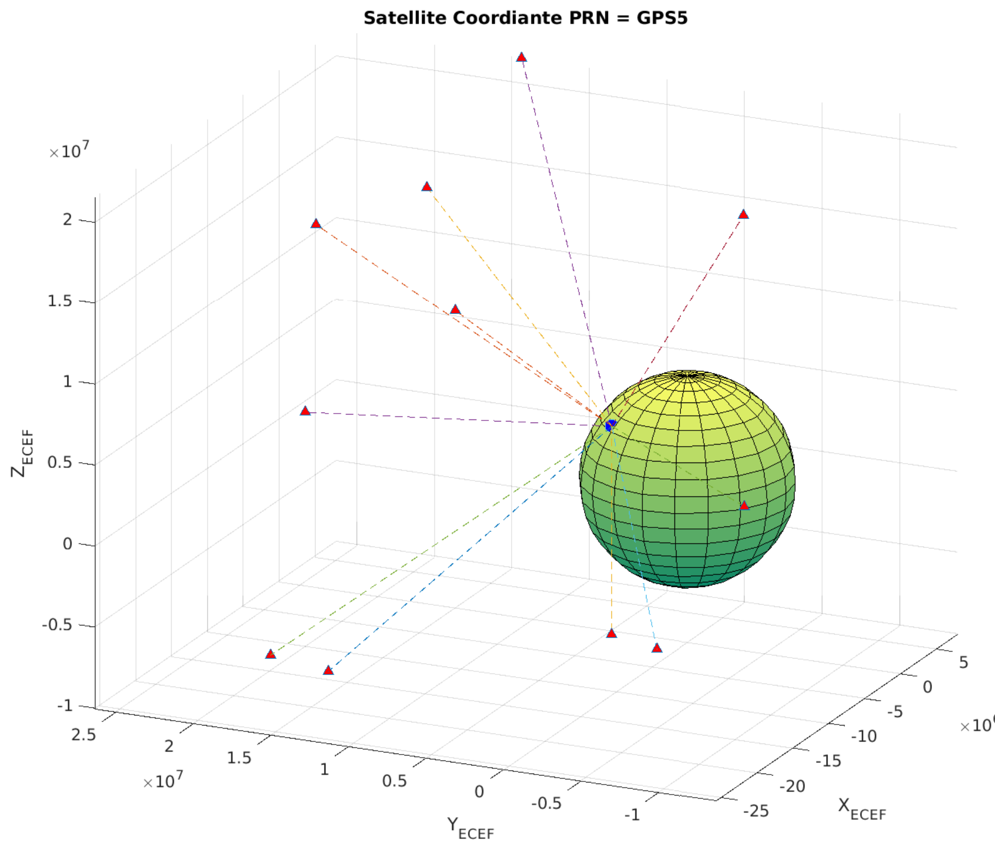


Figure 5: Satellite Coordiante epoch 1.