*Available online a*t www.scientiaresearchlibrary.com

Scientia Research Library

ISSN 2348-0424
USA CODEN: JETRB4

Journal of Engineering And Techonology Research, 2014, 2 (1):17-24

(*http://www.scientiaresearchlibrary.com/arhcive.php*)

A Novel Method for Analysis of Synchronization of GPS and Geosynchronous Satellite Signals Using Solar Braking and Intrinsic Velocity Rectification

Maurya Avadhesh Kumar[1], Maurya Vishwa Nath[2], Singh R.K[3]

[1]*Department of Electronics & Communication Engineering, Lucknow Institute of Technology, G.B. Technical University, India*

[2]*Department of Mathematics, School of Science & Technology, University of Fiji, Fiji*

[3]*Department of Electronics & Communication Engineering, Kumaun Institute of Technology, Uttaranchal Technical University, India*

ABSTARCT

Present paper envisages an efficient method for synchronization of GPS and geosynchronous satellite signals with Earth using solar braking. A transformation in the velocity of an inertial frame can account for relativistic shifts in the timing of events, termed 'intrinsic velocity'. Here, the synchronization of GPS and geosynchronous satellite signals has been analyzed by rectifying the intrinsic velocity. To serve our proposed aim in this paper, the relativistic Lorentz transformation has been applied. In its several sections, the first section focuses to summarize work done by previous researchers in a little attempt. Second section of the paper presents terminology and notations used under analysis. The methodology employed to analyze the synchronization of GPS and geosynchronous satellite signals have been demonstrated in third section. Moreover, descriptions of the global positioning and geosynchronous satellites have been presented in sub- sections 3.1 and 3.2 respectively. However, significant results have been found and discussed in the fourth section. Finally, conclusive analysis based on observations has been done exhaustively in the fifth section.

Keywords: Synchronization, GPS and geosynchronous satellite signals, Lorentz factor, relativistic Lorentz transformation, intrinsic velocity, coordinate speed, coordinate time, and coordinate velocity, solar braking

INTRODUCTION

Rigorous study of Literature reveals that analysis of synchronization of GPS and geosynchronous satellite signals has received considerable attention by a number of previous noteworthy researchers and it has occupied a prominent place in emerging fields of Electronics and Communication Engineering, Physical Sciences and Earth Sciences. Noticeable textbooks by several authors e. g. Born [3], Einstein et al [6] and Essen [7] are recognized as main sources to explore and analyze problems on the subject. Recent experimental tests by Adam et al [1] confined their attention in this direction and demonstrated doubt upon the principal postulate of relativity, that is, the constancy of the speed of light and the associated maximum speed of physical bodies, for more details we refer [3, 6 & 14]. In this context, research works done by [10-12] are also relevant up to some extent. Controversy over the validity of relativity has been established in research work of earlier noteworthy researchers e. g. Dingle [5], Essen [7], and Mueller and Kneckebrodt [15] in the twentieth century. Moreover, this controversy continues into the twenty-first century, documented by remarkable researcher Mueller and Kneckebrodt [15] and references therein.

Can a model for inertial frame motion be constructed as an alternative to relativity? A model for inertial frame motion could utilize Newtonian physics and the mathematical framework of absolute time and Euclidean space. Absolute time means that the timing of events in a moving inertial frame is identical to that of a stationary frame. The relativistic Lorentz transformation would also be employed.

. MATERIALS AND METHODS

Terminology and Notations Used

The following terms with notations are defined for the purpose of analyse the synchronization of GPS and geosynchronous satellite signals:

- *Intrinsic velocity*, v_0, is defined as the measured velocity of a body having magnitude and direction.
- *Intrinsic speed*, $|v_0|$, is defined as the magnitude of the intrinsic velocity of a body in motion.
- *Coordinate velocity*, v, is defined as the Newtonian velocity having magnitude and direction in a stationary reference frame.
- *Coordinate speed*, $|v|$, is defined as the magnitude of coordinate velocity of a body in motion.
- *Intrinsic Time*, T_0, is defined as the measured time for an event.
- *Coordinate time*, T, is defined as the classically anticipated Newtonian time for an event for a stationary reference frame.
- *Lorentz factor*: $\Gamma = \dfrac{1}{\sqrt{1-\dfrac{v^2}{c^2}}}$

In this context, formulae for constant one-dimension inertial frame motion provide following facts;

- Intrinsic Velocity, v_0, is transformed with respect to classical expectation for an inertial frame in constant motion:

$$v_0 = v\Gamma$$

where v_0 is the intrinsic velocity in a moving frame and v is coordinate velocity.

- Intrinsic time, T_0, is transformed with respect to classical expectation for an inertial frame in constant motion:

$$T_0 = \frac{T}{\Gamma}$$

where T_0 is the time for an event in a moving frame and T is anticipated coordinate time for an event.

Furthermore, it is also remarkable that there is no relativistic change in time between inertial frames due to relative motion when a shift in velocity occurs. A transformation in the velocity of an inertial frame has caused an apparent shift in the timing of an event.

Methodology Used Under Analysis

The high precision of the Global Positioning Satellite system for satellite communication, accurate to approximately one metre on Earth, has become a scientific fact in the twenty first century; we refer Ashby [2]. The accuracy of positioning at the surface of the earth has been proclaimed as a proof of Special and General Relativity, as a clock time rate correction is employed on-board GPS satellites Flandern [8].

It will be shown, however, that a transformation from coordinate to intrinsic velocity can account for the clock correction due to special relativity on board GPS satellites. This velocity transformation takes place in absolute time and exactly accounts for the relativistic time correction.

An analysis of the intrinsic velocity transformations will be given in the context of a constant speed inertial frame of GPS and GEO satellites in orbit; see figure 1 for illustration. Furthermore, an alternative method of 'time' correction for GPS satellites will be suggested.

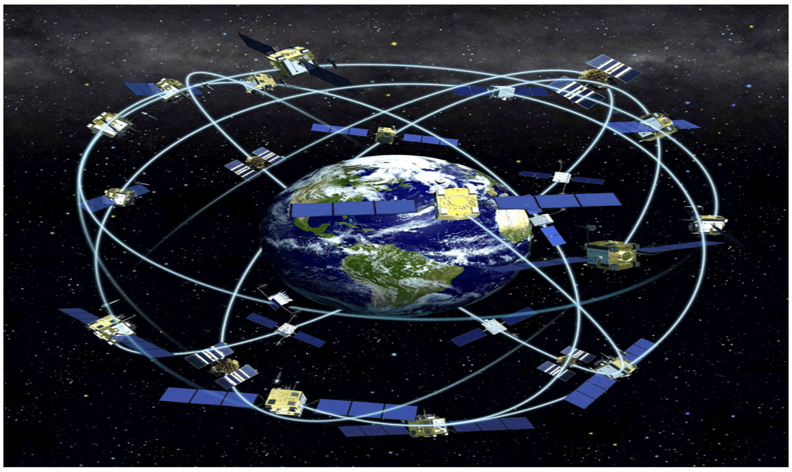

Figure 1. GPS satellites orbiting the Earth

The Global Positioning Satellite (GPS)

Classical physics calculates the coordinate velocity of bodies in a stationary inertial frame reference. A Lorentz factor correction yields a slight increase in the intrinsic speed as satellite travel with constant speed. Over a period of time the shift in the intrinsic speed of the satellite will lead to synchronisation problems with the earth base station and the drift in the satellite position would therefore need to be corrected.

A global positioning satellite orbits at an altitude of approximately 20, 200 kilometres above the earth and makes two complete sidereal orbits per day. The GPS satellite obeys Newtonian mechanics given by the sum of the kinetic and potential energy, for further details we refer, Flandern [8]:

$$\frac{1}{2}\mathrm{mv}^2 - \frac{GmM_E}{R} = \frac{1}{2}\frac{GmM_E}{R}$$

The technical data for GPS:

R = Radius earth + height = 6.4 x 10^6 + 20.2 x10^6 = 26.6 x10^6 metres,
Time for sidereal day = 23 hours, 56 minutes and 4 seconds = 86,164 seconds
GPS orbital period = ½ sidereal day = 43,082 seconds
Angular speed, $|\omega| = 1.4584247033980749 \times 10^{-4}$ rad.s^{-1}
Coordinate speed, $|v| = \omega R = 3879.4097110388793530$ m.s^{-1}
$\Gamma = 1.0000000000837217$

Intrinsic time, $T_0 = \frac{T}{\Gamma} = 86163.9999927862034418$ seconds
Intrinsic speed, $|v_0| = 3879.4097113636701290$ m.s^{-1}
Error in time, $\Delta t = T - T_0$ = 7.213 x 10^{-6} seconds per day
GPS resynchronisation rate = 7.213 x 10^{-6} seconds per day or 83.62 picoseconds per sidereal day

The Geosynchronous Satellite

Science fiction writer, Arthur C. Clarke, first suggested the concept of using geostationary orbit for communications satellites. Geosynchronous orbit occurs when a satellite's centripetal force exactly balances the gravitational force. As a result, a geostationary orbit is fixed in position and height synchronously orbiting around the Earth.

A special case of geosynchronous orbit is the geostat ionary orbit. Thi s i s a circular geosynchronous orbit at zero inclination, directly above the equator. A satellite in a geostationary orbit appears stationary to ground observers. Communications sat ellites are often given geostationary orbits, or close to geostationary, so that the satellite antennas that communicate with them do not have to move.

As it is stationary with respect to the earth, the geosynchronous satellite orbits at constant speed once per day at a fixed height, termed geosynchronous earth orbit (GEO). The orbital height of the GEO above the earth is approximately at 35,800 Kilometres. The coordinate speed of the geosynchronous satellite can be calculated by bal ancing the centripetal and Newtonian gravitational forces:

$$v^2 = \frac{GM}{R}$$

For central force motion assuming a circular orbit, coordinate speed: $v = \omega R$

$$\therefore \quad \omega^2 R^2 = \frac{GM}{R}$$

$$\Rightarrow R^3 = \frac{GM}{\omega^2}$$

$$\Rightarrow R = \sqrt[3]{\frac{GM}{\omega^2}}$$

The technical data for GEO:

$G = 6.67 \times 10^{-11}$, $M = 5.99 \times 10^{24}$ kg, sidereal day, $T = 86164$ seconds,

Angular speed, $|\omega| = 7.2921235169903747 \times 10^{-5}$ rad.s^{-1}

Radius of GEO orbit, $R = 4.227329 \times 10^{7}$ m

Coordinate speed of GEO, $|V| = 3082.6650034489940103$ m.s^{-1}

Intrinsic speed, $|v_0| = v\Gamma = 3082.66500361195578419$ m.s^{-1}

Error in speed, $|\Delta v| = 1.6296177389404182$ m.s^{-1}

Advance in satellite position per revolution, $\Delta s = 14.0414382858062194$ mm

Intrinsic time, $T_0 = 86163.9999954450349206$ seconds

Error in time, $\Delta t = T - T_0 = 4.554 \times 10^{-6}$ per day

GEO resynchronization rate = 4.554 x 10^{-6} seconds per day or 52.8 x10^{-12} seconds per earth day. According to USNO, the time correction rate for constant motion of the GEO satellite orbit 52. 8 pico- seconds per second, see for more details, Flandern [8]. Simil arly, the intrinsic time correction for the GEO satellite is identical to the Relativistic time dilation correction.

According to theoretical contributions from Special and General Relativity synchronization with UTC is achieved by adjusting the satellite clock. Satellite atomic clock frequency is reduced to 10.22999999543 MHz instead of 10.23 MHz compared to stationary ground clocks, Ashby[2].

In this view, adjustment of the clock rate for the synchronization of the GPS and geosynchronous satellite is not sourced in relativistic time dilation or contraction, rather it has been suggested that the adjustment of the clock rate of satellites is sourced in t he dif ference between the calculated coordinate and intrinsic speeds.

RESULT AND DISCUSSION

As the velocity of a satellite is increased in t ravel, resynchronisation of a GPS signal with earth can be achieved by reducing the intri nsic speed of travel to the Newtonian speed. In orbit an atmospheric vacuum with a solar wind at heights above 20,000 kilometres will be assumed. By the use of adjustable flaps or solar sails exterior to the satellite, velocity braking could be achieved against the solar wind enveloping the orbit. This is shown in Figure 2 below.

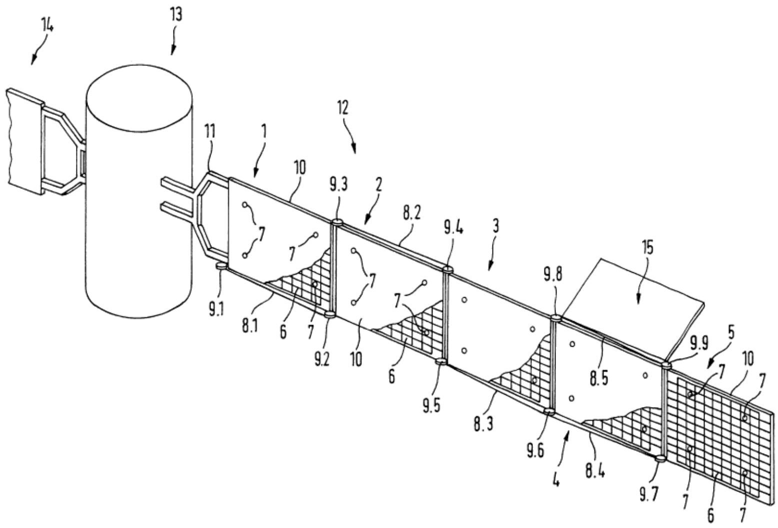

Figure :2 GPS Satellite with Sails or Brakes attached to the Solar Panels

The adjustable satellite sail, or flap, could be raised during a solar head-wind for half the orbit to slow travel speed. For the other half of the orbit, when a solar tail wind is in place, the satellite sails would be lowered and gas jets employed to slow the speed of travel. Precision computer control systems would be needed to achieve this end.

As the satellite orbit height tends to wane over time, the sail could also be used to reposition the orbit in a solar tail-wind. The reduction of the satellite speed to the calculated Newtonian orbital speed, being closer to true orbital speed, is anticipated to cause increased orbital stability. The added bonus of 'solar braking' is that the time of day on the satellite can be exactly synchronized with Earth time.

It can be observed that adjustable sails, gas jets and computer-controlled speed on board a satellite involves precision and complex engineering. An efficient method of re-synchronization would merely adjust the rate of the on board satellite clock. Synchronization of satellite to earth signals is thereby achieved by making intrinsic satellite time equivalent to the coordinate time.

The method employed of synchronization for the GPS by the U.S. Naval Observatory (USNO) is that the time rate on the satellite is adjusted to Universal Coordinated Time (UTC) [8]. GPS satellites

orbit the earth twice per day with Lorentz factor correction of $\Delta f/f = v^2/2c^2 = 83.7 \times 10^{-12}$ producing

a delay of 7.2 μs per day, refer Ashby [2]. The time correction for the GPS satellite is therefore identical to the relativistic time dilation correction.

CONCLUSION

In this paper, we have shown that a transformation of the intrinsic velocity of an inertial frame can exactly account for relativistic timing effects. Due to this point of view, relativistic time dilation or contraction of moving inertial frames would be merely apparent. Here, we succeeded to explore that by adjusting the speed of travel of a GPS satellite against the solar wind, uniform braking to the Newtonian coordinate velocity could be achieved. In addition to this, we propose that this method has the advantages of improved orbital stability and adjusted clock rates on satellites would not be necessary.

It is noted that the most efficacious method for synchronisation of signals is simply to adjust the satellite atomic clock frequency according to relativistic formula. This is the method of synchronisation of signals presently employed by USNO.

Intrinsic velocity shifts can exactly account for relativistic time corrections required for the resynchronisation of GPS satellite signal s. In this view there is no relativistic time difference between moving inertial frames and the synchronisation of the time of day between the Earth and the satellite requires that t here be no adjustment of the satellite clock rate. Finally we conclude following facts based on significant observations;

- Synchronization timing rectifications for satellites and the earth station are calculated from the special and general relativity corrections.
-These relativistic corrections for GPS provide an accuracy at the earth of +/- 1 meter.
-This result is cited as a proof of relativistic time and relativity.
-It was shown that the timing can be attributable to a shift in known velocity of the satellite.
-A method of solar braking is suggested as a means of resynchronization of satellite and ground signals.
-This result is cited as evidence for absolute time in inertial frames.
-The relativistic time shifts between inertial frames remains controversial and this research shows that the debate is ongoing.

Finally with passing above remarks and conclusions, we highly expect that our present contribution for analysis the synchronization of GPS and geosynchronous satellite signals will be useful for researchers, scientist s, statisticians and mathematicians for their future research and development in this direction.

ACKNOWLEDGEMENTS

The first author of the present paper would like to express his heartiest gratitude to Prof. (Dr.) R.B. Misra, Hon'ble Ex Vice Chancellor, Dr. Ram Manohar Lohia Avadh University, Faizabad, U.P., India; Prof. (Dr.) R.K. Singh, Professor & Head, Department of Electronics & Communication Engineering, Kumaun Institute of Technology, Uttarakhand Technical University, Dehradun, India and Prof. (Dr.) V.N. Maurya, Department of Mathematics, School of Science & Technology, University of Fiji, Saweni/Suva & Ex-Director, Vision Institute of Technology, Aligarh (G.B. Technical University Lucknow, India) for their continuous encouragement, enlightening and sincere guidance to prepare the present paper.

REFERENCES

[1] Adam T. et al, 2011. Measurement of neutrino velocity with the opera detector in the CNGS beam, *CERN Research Report*, Sept. **2011**.
[2] Ashby N., **2003**. Relat ivity in the global positioning system, *Living Rev. Relativity*, Vol. 6, No.1.
[3] Born M., **1962**. Einstein's Theory of Relativity, *Dover*, New York, USA, pp. 57
[4] Brown G.B., **1967**. What is wrong with relativity?, *Bulletin of the Institute of Physics*, Vol. 18, pp. 71-77.
[5] Dingle H., **1972**. Science at the Crossroads, Martin Brian & O'Keeffe, London, UK
[6] Einstein A., Lorentz H.A., Minkowski H., Weyl H., 1952. The Principle of Relativity, *Dover*, New York, USA
[7] Essen L., **1971**. The special theory of relativity, A critical analysis, *Oxford Science Research Papers* 5, Clarendon Press, Oxford.

[8] Flandern T.V., **1998**. What the global positioning system t ells us about relativity, Open questions in relativistic Physics, *Apeiron*, pp. 81-90.
[9] Gift S.J., **2010**. Doppler shift reveals light speed variation", *Apeiron*, Vol. 17, No. 1.
[10] Maurya A.K. and Maurya V.N., **2013**. A novel algorithm for optimum balancing energy consumption LEACH protocol using numerical simulation technique, *International Journal of Electronics Communication and Electrical Engineering*, Algeria, Vol. 3, Issue 4, pp. 1-19, ISSN: 2277-7040
[11] Maurya A.K., Maurya V.N. and Arora D. K., **2013**. Linear regression and coverage rate performance analysis for optimization of received signal strength in antenna beam-tilt cellular mobile environment, *International Journal of Electronics Communication and Electrical Engineering*, Algeria, Vol. 3, Issue 7, pp. 1-14, ISSN: 2277-7040
[12] Maurya V.N., Arora D.K., Maurya A.K. and Gautam R. A., **2013**. Numerical simulation and design parameters in solar photovoltaic water pumping systems, *American Journal of Engineering Technology*, Academic & Scientific Publishing, New York, USA, Vol. 1, No. 1, pp. 1-09
[13] Meyl K., **2001**. Scalar Waves: Theory and Experiment s, *Journal of Scientific Exploration*, Vol. 15, No. 2, pp. 199–205.
[14] Michelson A., Morley A., **1887**. Anthers drag interferometer experiment, *American Journal of Science*, Vol. 34, pp. 333.
[15] Mueller G.O., Kneckebrodt K., **2006**. 95 Years of criticism of the special theory of relativity (1908-2003), *The G.O. Mueller Research Project*, Germany.