Experimental Detection of

Preferred or Universal Reference Frame

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Abstract

The dimensional parameters of permittivity ε_0 and permeability μ_0 associated with empty space characterize the velocity of light propagation c in vacuum, thereby implying the notion of an Absolute reference frame with respect to which c is measured. Even before the null result of Michelson-Morley experiment, Physicists had persistently felt the necessity of detecting this Universal or Absolute reference frame. It was the failure of all attempts to detect a Universal reference frame that prompted Albert Einstein to declare the absence of such a frame and propounded his special theory of relativity. In this paper we have shown through a detailed analysis that by making use of modern advancements in technology, we can determine the absolute velocity of an object with respect to a Preferred or Universal reference frame in real time, with an accuracy of a few meters per second. It involves a precise measurement of propagation time of a few signal pulses. That means we can experimentally detect and establish an Absolute reference frame, which had been postulated to be non-existent in SR. With the experimental establishment of an Absolute reference frame, the hitherto discredited notion of Aether again comes into focus of scientific investigation.

Key words : Aether; vacuum; preferred reference frame; absolute reference frame; experimental detection; universal reference frame; telecommunication

1. Notion of Preferred or Universal Reference Frame

The Preferred or Universal or an Absolute reference frame may be defined as an inertial reference frame fixed with respect to the 'Centre of Mass' of the Universe. The speed of light is an isotropic constant **c** and the measures of distance and time are absolute in this frame. Such an absolute reference frame may be considered to be fixed in relation to the 'aether', which is assumed to be an elastic medium or continuum pervading the entire physical space. The notion of aether was necessitated to explain the propagation of transverse waves of light through the vacuum. However, the notion of aether was discarded as a consequence of the null result of Michelson-Morley experiment [1], even though our understanding of the nature of light was too inadequate at that time. Even today we do not know much about the shape, size, mutual interaction and momentum exchange characteristics of photons.

A thorough review of the notions of aether and the matter free empty space or vacuum, reveals that possibly they may be one and the same entity. Fundamental properties of this vacuum or empty space are characterised by,

- ε_0 the Permittivity of free space
- μ_0 the Permeability of free space
- $Z_0 = \text{sqrt}(\mu_0/\varepsilon_0)$ the intrinsic impedance of vacuum or free space

These three parameters are dimensional constants and hence represent the fundamental properties of vacuum or empty space. (This issue has been extensively discussed in the science.physics.research forum of the usenet)[2] The velocity of light propagation through the vacuum is intimately related to these fundamental parameters through an important relation, $c = 1/\text{sqrt}(\mu_0.\varepsilon_0) = Z_0/\mu_0 = 1/(Z_0.\varepsilon_0)$. Once we associate the velocity of light propagation with the empty space or vacuum or aether through this relation, the notion of an Absolute reference frame gets automatically implied. Let us imagine a vast extent of empty space or vacuum in which a single photon wave packet is propagating at a uniform velocity c. This notion of 'uniform velocity c' is physically meaningless unless the notion of an Absolute reference frame with respect to which c is measured, is implied as well.

2. Necessity of Detection of Universal Reference Frame

Even before the null result of Michelson-Morley experiment, the Physicists had persistently felt the necessity of detecting the Universal or Absolute reference frame in order to validate the notion of aether. In fact it was the failure of all attempts to detect a Universal reference frame by the end of 19th century that prompted Albert Einstein to declare the absence of such a frame and propounded his Special theory of Relativity (SR). As per one of the two postulates of SR, the velocity of light is supposed to be an isotropic constant **c**, in all inertial reference frames in relative motion. This postulate leads to two peculiar kinematical consequences. These are the notions of '**relative** time dilation' and '**relative** length contraction' in inertial reference frames in relative motion. [3, 4] These kinematical consequences are quite distinct from the dynamic formulations of SR concerning mass, momentum and total energy transformations. The dynamic formulations of SR are essentially based on the crucial property of inertia associated with all forms of energy, including electromagnetic and kinetic energy and these are not dependent on the non-existence of the preferred or universal reference frame.

However, the scientific opinion has remained divided over the validity of the kinematical consequences of the above-mentioned postulate throughout the 20th century.

With the current advancements in space and telecommunication technologies we have apparently adopted this postulate by treating the velocity of light c as an isotropic constant in Earth Centred Inertial (ECI) reference frame. But the consequent notions of '**relative** time dilation' and '**relative** length contraction' could not be absorbed or adopted in modern technology. On the contrary, we are going to establish a most precise global time standard for all observers at rest or in relative motion, through ' Primary Atomic Reference Clock in Space (PARCS)' [5]. PARCS is an atomic-clock mission scheduled to fly on the International Space Station (ISS) in early 2005.

In Global Positioning Systems (GPS), satellite communications and space missions, we need to keep the atomic clocks and other frequency standards synchronised on almost continuous basis. For this there is a continuous thrust towards improving the Time and Frequency Transfer techniques [6, 7], to reduce the transfer uncertainties well below the accepted uncertainty levels in the primary frequency standards [8]. However, currently the desirable uncertainty levels in time and frequency transfers are achieved only after statistical averaging over long periods of time, often exceeding 24 hours. With ever advancing accuracy thresholds, the contribution of assumed isotropic constant speed of light in ECI frame is suspected to be significant in the current time and frequency transfer uncertainties. Therefore, the necessity of detecting the Universal reference frame, by making use of modern advancements in technology, is quite acute.

3. Relevant Technologies

For detection of the Absolute reference frame we must be able to distinguish and differentiate between the effects of slow velocity of material objects in comparison with the velocity of light. This calls for extremely fine resolutions in distance and time measurements. As such the modern advancements in technology that are relevant for the detection of Universal reference frame are listed below. None of these technologies were available a century ago when SR was propounded.

I. Cesium atomic clocks (NIST-F1) with an uncertainty of about one second in 20 million years and with a time resolution of the order of a fraction of a nano-second. These clocks are electronically locked on to certain natural transition or resonant frequency of the Cesium atom and are extremely stable.[8]

II. Modern telecommunication engineering with accurate real time transmission and reception of high-speed data through advanced modulation techniques in Giga-hertz carrier frequency range.

III. The GPS technology has enabled high precision measurement of time and distance all over the globe. GPS satellites broadcast a timing signal along with information identifying the time for which the tick corresponds. Through current GPS time transfer techniques, it is possible to achieve timing uncertainties well below one nano-second. Generally there is sufficient bandwidth in the communications link that raw data can be transferred along with the timing pulses in real time [9].

IV. Modern computer technology for real time high-speed data processing and micro-controller based sophisticated automated systems.

4. <u>Experimental Set up</u>

Let O be a point fixed with respect to the Universal or Absolute reference frame. Let us consider a rectangular Cartesian coordinate system **XYZ** with origin at point O and fixed with respect to the Universal reference frame. **Let the velocity of light be an isotropic constant c in this reference frame.** Further, let us assume that a space ship A is moving at a uniform velocity **U** with respect to the reference frame XYZ. Let us consider another coordinate system X' Y' Z' with origin at point A and moving with the space ship. That means X' Y' Z' is a local coordinate system to the space ship A and is moving **velocity U with respect to XYZ.**

Let the coordinate system X' Y' Z' be oriented parallel to XYZ such that the coordinate axes AX' , AY' , AZ' are parallel to OX, OY, OZ respectively. In order to experimentally determine the velocity **U** of this space ship or the Observer Station A, a space probe B_1 is sent out in X' direction to a distance of a few thousand kilometers. Let U_1 be the component of **U** in the direction AB_1. We assume that both of the Observer Station A as well as the probe B_1, are equipped with precisely synchronized Rubidium atomic clocks and identical microprocessor controlled Transponders, to transmit and receive coded signal pulses automatically. We can safely assume that at the time of commencement of the experiment, the point O coincides with A and axis OX is parallel to AB1.

At a certain instant of time t_n let the space probe B_1 be at a distance D_n from A and moving at a uniform velocity V_1 along AB_1 with respect to reference frame XYZ, as shown in **figure 1**. Here it is not important to assume the joining line AB_1 to be always parallel to OX or AX' . But it is important to assume that the velocity U_1 is the component of velocity **U** along the joining line AB_1. Also it is important to assume that the velocity V_1 is the component of velocity **V** of the probe B_1 along the joining line AB_1. Direction AB_1 is known in the local coordinate reference frame X' Y' Z' . Exact position of A in the reference frame XYZ is not required for this experiment.

5. <u>The Experiment</u>

Let at time t_n the transponder at A be triggered to send a signal pulse from A towards B_1 with coded information of t_n contained in the pulse. Let T_{da} and T_{db} be the hardware time delays in generation and transmission of the pulses at A and B_1 respectively. Therefore, the first pulse will actually leave transponder A at time $\tau_n = t_n + T_{da}$. Let this pulse reach B_1 at time t_{n+1} to trigger a return pulse from B_1 towards A with the coded information of time t_{n+1} contained in the return pulse. This return pulse will actually leave transponder B_1 at time $\tau_{n+1} = t_{n+1} + T_{db}$. Let this return pulse reach A at time t_{n+2} to trigger another forward pulse from A towards B_1 with the coded information of time t_{n+2} contained in the forward pulse. This forward pulse will actually leave transponder A at time $\tau_{n+2} = t_{n+2} + T_{da}$. Let this forward pulse reach B_1 at time t_{n+3} to trigger another return pulse from B_1 towards A with the coded information of time t_{n+3} contained in this return pulse. And so on ….

Let this process of forward and return pulses with enclosed coded information about their times of arrival, continue for a certain period of time. This data about the time of arrival of each of the forward and return pulses will keep getting analysed in real time in the dedicated microprocessors to compute U_1, V_1 and D_n as per the following important relations. The difference in the time of origin of a new pulse and the time of arrival of previous pulse in each transponder is assumed constant, equal to the hardware time delays T_{da} and T_{db} , which could be determined with high precision in real time. A block diagram of a transponder used for the reception and transmission of the coded timing pulses is given at **figure 2**.

During the time interval t_n to t_{n+1}, out of which the signal propagation time is only $[t_{n+1} - \tau_n]$ or $[t_{n+1} - (t_n + T_{da})]$, the distance travelled by first forward pulse is given by,

$$c. [t_{n+1} - (t_n + T_{da})] = [D_n + (V_1 - U_1).T_{da}] + V_1. [t_{n+1} - (t_n + T_{da})]$$

or $$\mathbf{(c - V_1). (t_{n+1} - t_n) = D_n + (c - U_1).T_{da}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \mathbf{(1)}$$

Here the term $[D_n + (V_1 - U_1).T_{da}]$ represented the separation distance between A and B_1 at the instant of time τ_n when the leading edge of the signal pulse leaves the station A. At the instant t_{n+1} the leading edge of the signal pulse reaches transponder B_1. The term $V_1. [t_{n+1} - (t_n + T_{da})]$ represents the distance travelled by probe B_1 along AB_1 in XYZ reference frame, during the propagation time of the signal pulse.

During the time interval t_{n+1} to t_{n+2}, out of which the signal propagation time is only $[t_{n+2} - \tau_{n+1}]$ or $[t_{n+2} - (t_{n+1} + T_{db})]$, the distance travelled by first return pulse is given by,

$$c. [t_{n+2} - (t_{n+1} + T_{db})] = [D_{n+1} + (V_1 - U_1).T_{db}] - U_1. [t_{n+2} - (t_{n+1} + T_{db})]$$

or $$\mathbf{(c + U_1). (t_{n+2} - t_{n+1}) = D_{n+1} + (c + V_1).T_{db}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \mathbf{(2)}$$

Here too the term $[D_{n+1} + (V_1 - U_1).T_{db}]$ represented the separation distance between B_1 and A at the instant of time τ_{n+1} when the leading edge of the pulse leaves the probe B_1. At the instant t_{n+2} the leading edge of the pulse reaches the transponder A. The term $U_1. [t_{n+2} - (t_{n+1} + T_{db})]$ represents the distance travelled by station A along AB_1 during the propagation time of the signal pulse.

During the time interval t_{n+2} to t_{n+3}, out of which the signal propagation time is only $[t_{n+3} - \tau_{n+2}]$ or $[t_{n+3} - (t_{n+2} + T_{da})]$, the distance travelled by second forward pulse is given by,

$$c. [t_{n+3} - (t_{n+2} + T_{da})] = [D_{n+2} + (V_1 - U_1).T_{da}] + V_1. [t_{n+3} - (t_{n+2} + T_{da})]$$

or $$\mathbf{(c - V_1). (t_{n+3} - t_{n+2}) = D_{n+2} + (c - U_1).T_{da}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \mathbf{(3)}$$

Since the net separation velocity between A and B_1 is $(V_1 - U_1)$, the increase in D_n during the time interval t_n to t_{n+2} is also given by,

$$\mathbf{(V_1 - U_1). (t_{n+2} - t_n) = D_{n+2} - D_n} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \mathbf{(4)}$$

Subtracting equation (1) from (3), we get

$$(c - V_1).(t_{n+3} - t_{n+2} - t_{n+1} + t_n) = D_{n+2} - D_n \quad \ldots\ldots\ldots\ldots\ldots\ldots.. \quad (5)$$

Therefore, from equations (4) and (5) above,

$$(V_1 - U_1).(t_{n+2} - t_n) = (c - V_1).(t_{n+3} - t_{n+2} - t_{n+1} + t_n) \quad \ldots\ldots\ldots \quad (6)$$

or $U_1.(t_{n+2} - t_n) = V_1.(t_{n+3} - t_{n+1}) - c.(t_{n+3} - t_{n+1}) + c.(t_{n+2} - t_n)$

or $U_1 = V_1.(t_{n+3} - t_{n+1}) / (t_{n+2} - t_n) + c - c.(t_{n+3} - t_{n+1}) / (t_{n+2} - t_n)$ …….. (7)

Further, the increase in separation distance D_{n+1} during the time interval t_{n+1} to t_{n+2} is also given by,

$$\mathbf{(V_1 - U_1).(t_{n+2} - t_{n+1}) = D_{n+2} - D_{n+1}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \mathbf{(8)}$$

Substituting from (2) and (3) into (8),

$$(V_1 - U_1).(t_{n+2} - t_{n+1}) = (c - V_1).(t_{n+3} - t_{n+2}) - (c + U_1).(t_{n+2} - t_{n+1}) + c.(T_{db} - T_{da}) + (V_1.T_{db} + U_1.T_{da})$$

or $$V_1.(t_{n+2} - t_{n+1}) = (c - V_1).(t_{n+3} - t_{n+2}) - c.(t_{n+2} - t_{n+1}) + c.(T_{db} - T_{da}) + (V_1.T_{db} + U_1.T_{da})$$

or $$V_1.(t_{n+3} - t_{n+1} - T_{db}) = c.(t_{n+3} - 2t_{n+2} + t_{n+1} + T_{db} - T_{da}) + U_1.T_{da}$$

or $$\mathbf{V_1 = c.[(t_{n+3} - 2t_{n+2} + t_{n+1} + T_{db} - T_{da}) / (t_{n+3} - t_{n+1} - T_{db})] + U_1.T_{da} / (t_{n+3} - t_{n+1} - T_{db})} \quad \ldots.. \mathbf{(9)}$$

Substituting this value of V_1 from equation (9) to equation (7) we get,

$$\mathbf{U_1 = \frac{\left[c.(t_{n+3} - 2t_{n+2} + t_{n+1} + T_{db} - T_{da}) + U_1.T_{da}\right]}{(t_{n+3} - t_{n+1} - T_{db})} . \frac{(t_{n+3} - t_{n+1})}{(t_{n+2} - t_n)} + c.\frac{(t_{n+2} - t_n - t_{n+3} + t_{n+1})}{(t_{n+2} - t_n)}}$$

Or

$$\mathbf{U_1.\left[1 - \frac{T_{da}(t_{n+3} - t_{n+1})}{(t_{n+3} - t_{n+1} - T_{db})(t_{n+2} - t_n)}\right] = c.\frac{(t_{n+3} - 2t_{n+2} + t_{n+1} + T_{db} - T_{da})}{(t_{n+3} - t_{n+1} - T_{db})} . \frac{(t_{n+3} - t_{n+1})}{(t_{n+2} - t_n)} + c.\frac{(t_{n+1} - t_n) - (t_{n+3} - t_{n+2})}{(t_{n+2} - t_n)}}$$

Or

$$U_1.\left[\frac{(t_{n+3}-t_{n+1})(t_{n+2}-t_n)-T_{da}(t_{n+3}-t_{n+1})-T_{db}(t_{n+2}-t_n)}{(t_{n+3}-t_{n+1}-T_{db})(t_{n+2}-t_n)}\right]$$

$$=c.\frac{[(t_{n+3}-t_{n+2})-(t_{n+2}-t_{n+1})+(T_{db}-T_{da})](t_{n+3}-t_{n+1})}{(t_{n+3}-t_{n+1}-T_{db})(t_{n+2}-t_n)}$$

$$+c.\frac{(t_{n+3}-t_{n+1}-T_{db})[(t_{n+1}-t_n)-(t_{n+3}-t_{n+2})]}{(t_{n+3}-t_{n+1}-T_{db})(t_{n+2}-t_n)}$$

Or

$$U_1=c.\frac{(t_{n+3}-t_{n+1}).[(t_{n+1}-t_n)-(t_{n+2}-t_{n+1})]}{(t_{n+3}-t_{n+1}).(t_{n+2}-t_n)-T_{da}.(t_{n+3}-t_{n+1})-T_{db}(t_{n+2}-t_n)}$$

$$+c.\frac{T_{db}.[(t_{n+3}-t_{n+2})-(t_{n+1}-t_n)]+(T_{db}-T_{da})(t_{n+3}-t_{n+1})}{(t_{n+3}-t_{n+1}).(t_{n+2}-t_n)-T_{da}.(t_{n+3}-t_{n+1})-T_{db}(t_{n+2}-t_n)}$$

.... (10)

Using this value of U_1 we can compute V_1 from equation (9).

Now using these values of U_1 and V_1, we can easily compute D_n, D_{n+1} and D_{n+2} from equations (1), (2) and (3) respectively.

Special Case when V_1=U_1

In this case when $V_1=U_1$ or the separation distance AB_1 is fixed, we can compute U_1 from equations (1) and (2) only as,

$(c+U_1).\ [t_{n+2} - (t_{n+1} + T_{db})] = (c-U_1).\ [t_{n+1} - (t_n + T_{da})]$

Or $U_1.\ [t_{n+2} - (t_{n+1} + T_{db}) + t_{n+1} - (t_n + T_{da})] = c.[t_{n+1} - (t_n + T_{da}) - t_{n+2} + (t_{n+1} + T_{db})]$

Or $U_1.\ [(t_{n+2} - t_n) - T_{da} - T_{db}] = c.[(t_{n+1} - t_n) - (t_{n+2} - t_{n+1}) + (T_{db} - T_{da})]$

$$U_1=c.\frac{[(t_{n+1}-t_n)-(t_{n+2}-t_{n+1})+(T_{db}-T_{da})]}{[(t_{n+2}-t_n)-T_{da}-T_{db}]} \qquad \text{.........(11)}$$

6. <u>The Result</u>

Hence the most important result of this analysis is the computation of velocity component U_1 as given by equation (10) or (11). This is the component of velocity **U** of the space ship A, in the direction of AB_1. A significant point to be noted here is that this result mainly depends on a few intervals of time, which could be measured precisely with modern atomic clocks. Essentially the U_1 is found to be proportional to the ratio of the difference in propagation times of forward and return pulses to the sum of their propagation times.

The computation of velocity component U_1 in the direction AB_1 as shown above, is just one step towards final determination of the velocity vector **U** of the space ship A in the XYZ coordinate reference frame. Let us further assume that space probes B_2 and B_3, similar to probe B_1, are sent out in the directions of AB_2 and AB_3 as shown in the figure. Through the same procedure as described above, we can compute the velocity components U_2 and U_3 in the directions of AB_2 and AB_3 respectively. Once we know three velocity components U_1, U_2 and U_3 along three non-coplaner known directions AB_1, AB_2 and AB_3, we can then easily compute the resultant velocity vector **U** of the Observer Station with respect to the XYZ reference frame. For this, let us assume that the direction cosines of AB_1, AB_2 and AB_3 in the local coordinate reference frame X' Y Z' are known to be (l_1, m_1, n_1), (l_2, m_2, n_2) and (l_3, m_3, n_3) respectively. Since all three coordinate axes of reference frame X' Y' Z' are parallel to the corresponding coordinate axes of reference frame XYZ, the above mentioned direction cosines of AB_1, AB_2 and AB_3 will also be valid in coordinate frame XYZ. Therefore, the components of the resultant velocity vector **U** along the X, Y and Z axes are given by,

$$U_x = l_1U_1 + l_2 U_2 + l_3 U_3 \qquad \text{.............................. (12)}$$

$$U_y = m_1U_1 + m_2 U_2 + m_3 U_3 \qquad \text{.............................. (13)}$$

$$U_z = n_1U_1 + n_2 U_2 + n_3 U_3 \qquad \text{.............................. (14)}$$

And the magnitude of the resultant velocity **U** is therefore given by,

$$\mathbf{U} = \sqrt{\mathbf{U}_x^2 + \mathbf{U}_y^2 + \mathbf{U}_z^2} \qquad \text{..............................(15)}$$

With well below a nano-second time transfer accuracy feasible with modern technology, the net velocity **U** of the space ship could be determined to an accuracy of a few meters per second provided the separation distance D_n is of the order of a few thousand kilometers. This in turn amounts to the precision with which we can detect and establish the Preferred or Universal reference frame.

7. Invalidation of the main Postulate of SR

The computation of velocity components U_1, U_2 and U_3 mainly depends on the isotropic constant velocity of light **c** in the chosen reference frame and a sequence of discrete precision time measurements 't_n' with a set of properly calibrated and synchronized atomic clocks. The functioning of atomic clocks is completely independent of the chosen reference frame, just as the orbital energy states of atomic electrons are completely independent of the reference frame. Thus the velocity components U_1, U_2 and U_3 or the resultant velocity vector **U** of the Observer Station A in the chosen reference frame will be governed by the value of **c** in that frame. Hence, in any other inertial reference frame in relative motion with respect to XYZ, the resultant velocity vector of the Observer Station will be different from **U** only if the velocity of light in that frame is not an isotropic constant **c**. However, as per the main postulate of SR, there are infinitely many inertial reference frames in which the velocity of light can be taken as an isotropic constant **c**. That means **if we assume the fundamental postulate of SR to be valid, then we are bound to obtain the same unique velocity vector U of the space ship A in all inertial reference frames. But that is physically impossible.** The velocity vector of the space ship A must be different in different reference frames in relative motion.

This leads us to the conclusion that the coordinate reference frame XYZ must be a unique or Preferred or Absolute reference frame with a unique attribute of an isotropic constant velocity of light c, in which we experimentally obtain an absolute velocity vector **U** for the Observer Station A. In all other inertial reference frames in relative motion with respect to XYZ, the Observer Station velocity must be different from **U** and hence the velocity of light cannot remain an isotropic constant **c** in such frames. That means the fundamental postulate of SR, implying an isotropic constant velocity of light c in all inertial reference frames in relative motion, is invalid thereby leading to the invalidity of kinematical consequences (that is, the **relative** time dilation and **relative** length contraction) of SR. However, the kinematical relations of SR may still be used as a mathematical model to co-relate the distance and time measurements in two inertial reference frames in relative motion, in which the speed of light is **assumed** to be an isotropic constant **c**.

Finally, at the end of the analysis, we determine the velocity vector **U** of the observer station A with respect to XYZ coordinate reference frame. It obviously implies that with respect to our own position A or with respect to our local coordinate frame X' Y' Z' , we have determined the velocity (-**U**) of XYZ or the Universal or Absolute reference frame. With this we confirm the detection and establishment of the Preferred or Universal reference frame.

8. Practical Feasibility of the Experiment

Through the foregoing analysis we have logically proved the invalidity of the main postulate of SR. But this does not undermine the necessity of quantitative measurement of the velocity **U** with which an observer station fixed with respect to Earth, say, moves in the Universal reference frame. This can be practically done by making use of the currently available technology. Two technically feasible arrangements for conducting this important scientific experiment are given below. However, the crucial steps for each of these arrangements are the development and **fabrication** of special Timing Response Transponders and their **positioning** on the satellites involved in the experiment. Special dedicated software can provide a continuous record of velocity **U** of the observer station with respect to the Universal reference frame, in real time.

I. We can make an earth based control station as an Observer Station and use any three Geo-synchronous satellites or GPS satellites as the probes to determine the velocity **U** of the Earth with respect to the Universal Reference frame. However the ionospheric and tropospheric signal delays, if not properly accounted for, [9] may reduce the accuracy of these measurements.

II. We may integrate the task of establishing the Preferred or Universal reference frame as described above, with the PARCS – a Primary Atomic Reference Clock in Space mission scheduled to fly on the International Space Station (ISS) in early 2005. The mission, funded by NASA, involves a laser-cooled Cesium atomic clock, a high stability hydrogen-maser oscillator, and a time-transfer system using GPS satellites. [5] Here too, any three Geo-synchronous or GPS satellites will be used as probes to determine the velocity **U** of the Earth with respect to the Universal Reference frame.

9. Timing Response Transponders

The special Transponder or microprocessor controlled transmitter receiver unit will effectively constitute the most crucial link of the whole experiment. The transponder unit is essentially required for receiving, processing and transmitting of coded timing pulses. Four identical multi-channel transponder units will be required for the experiment; one to be located at the observer station A and other three to be located at the probes B_1, B_2 and B_3. A block diagram of the transponder unit is given at figure 2. All ' state of the art' , commercially available circuit components and sub-assemblies may be used for fabrication of these transponder units.

As soon as the incoming coded timing pulse enters the front-end receiver circuit, a trigger pulse is generated from the leading edge of this pulse and sent to the timer latch, micro controller and the time interval counter (TIC). The main pulse is then demodulated and decoded to transfer the incoming digital timing data t_n (preferably up to 10^{16} nanoseconds) to the microprocessor. On activation by the trigger pulse, the timer latch reads out the current time t_{n+1} in digital format and sends it to the microprocessor. The microprocessor stores this timing data in memory and transmits the t_{n+1} digital data further for coding, modulation and transmission of the coded timing pulse from the transmitter. At the commencement of transmission of the outgoing timing pulse another trigger pulse is generated and sent to the TIC to generate the time delay T_d data in digital format and fed to the micro-processor.

The most critical component of the whole unit is the atomic clock or the frequency standard used for measuring accurate instants of time. For achieving the best accuracy, it is desirable to employ the Cesium atomic clocks as primary standards of time in stand-alone mode for all the transponder units. But on the considerations of portability and cost, it may be desirable to use Rubidium atomic clocks for this purpose. However, before actual deployment, these atomic clocks will have to be tested and calibrated for accuracy and stability. The atomic clock or its oscillator is primarily used for steering the Oven Controlled Crystal Oscillator (OCXO) to provide controlled frequency output for the timer and telecommunication operations. Of course, in the actual experimental application, if it is feasible to keep all four transponder units continuously synchronised with primary frequency standards through GPS time and frequency transfer service, then we may do away with the requirement of ' stand alone' atomic clocks. In such a case the reference frequency may be provided to the OCXO directly from a dedicated GPS receiver.

Concluding Remarks

In conclusion we may highlight the most crucial result of the foregoing analysis that by making use of modern advancements in technology, especially in respect of high precision atomic clocks and satellite communication, we can determine the absolute velocity of an object with respect to a Preferred or Universal reference frame in real time. That means we can experimentally detect and establish a Preferred or Universal reference frame, which had been postulated to be non-existent in SR. With this the main postulate of SR stands invalidated. Further, with the experimental establishment of a Preferred or Universal reference frame, the hitherto discredited notion of Aether again comes into focus of scientific investigation.

Figure 1. **Layout of the Experimental Set up**

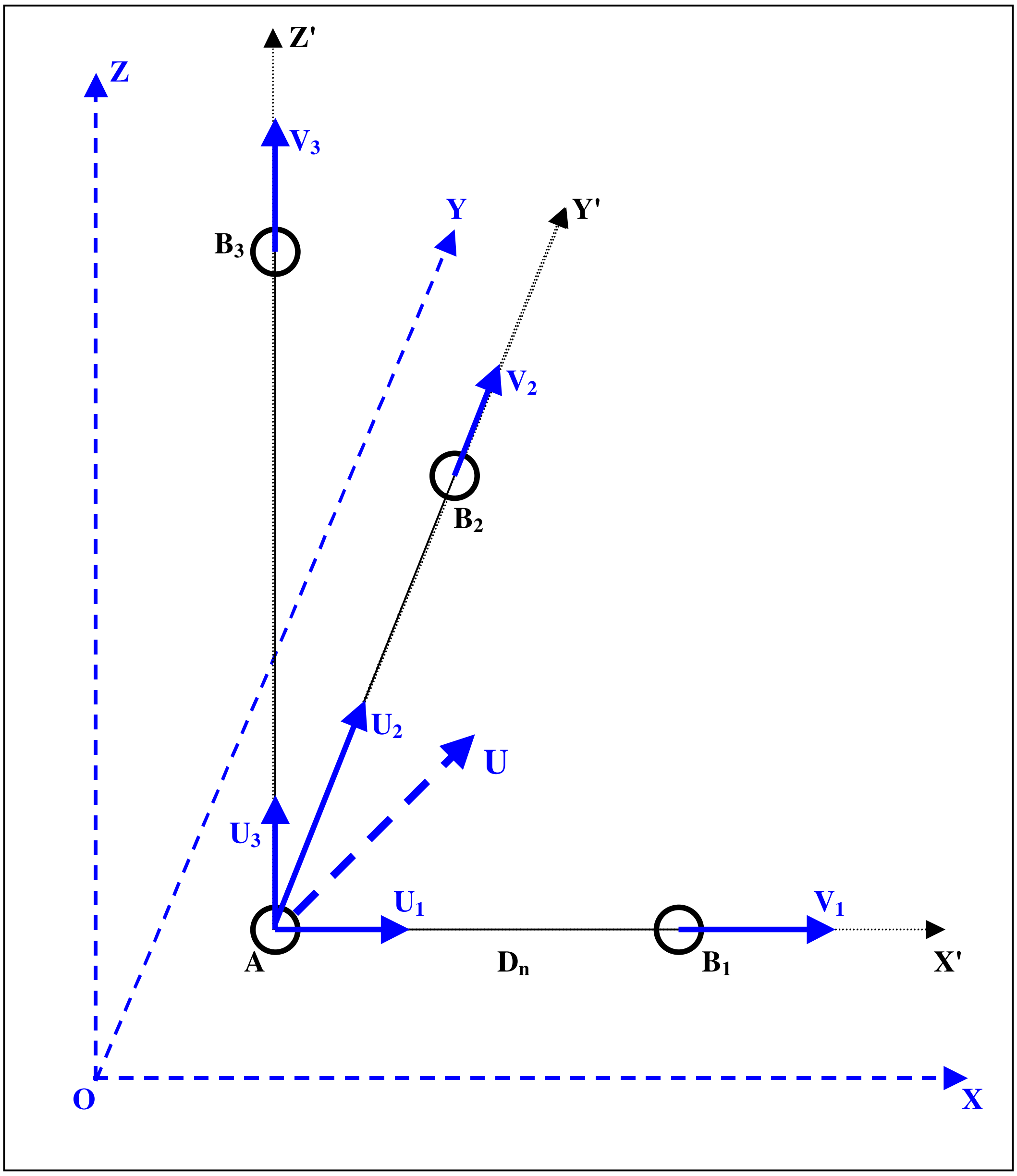
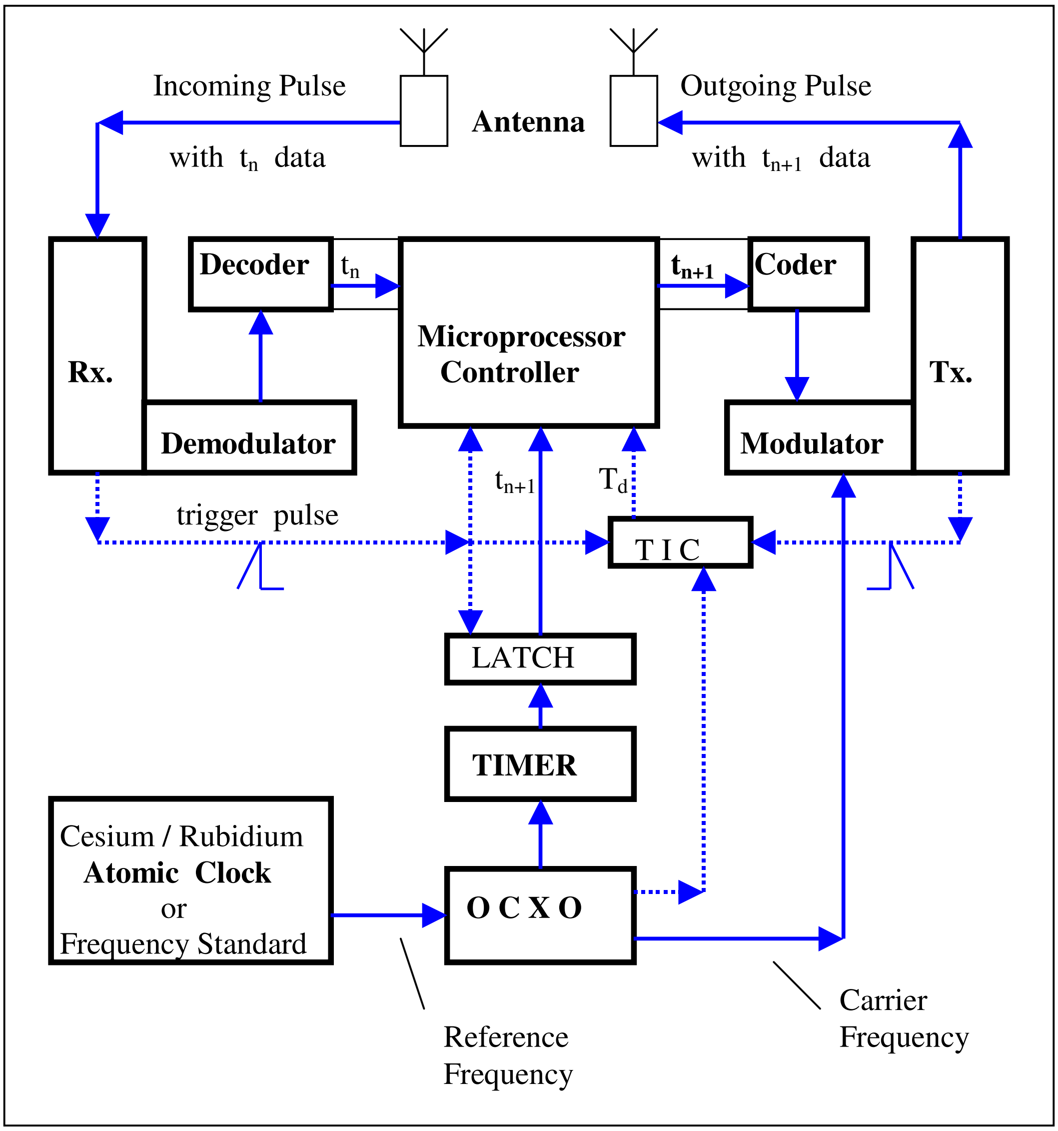


Figure 2. **Block Diagram of Timing Response Transponder**



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