LPS Navigation System

Henry V. Pham

The **LPS Navigation System** is designed to guide, navigate for any moving objects, vehicles, airplanes with LPS devices equipped that based on the **LPS** – **Local Positioning System** and the **Cell ëMap Live Updates System** inventions.

The GPS system works great for objects or devices in outside open space, but the accuracy is not yet satisfied and could be more than few meters errors. The GPS system operates with many different levels of frequency (L1 frequency at 1.575 GHz, L2 frequency at 1.227 GHz, etc…). With the current FCC approval of 5.0 GHz RF transmitter, the LPS system can operate at this frequency or even higher to provide the LPS system more accurate and works anywhere in any environments. The GPS devices and the satellites are too far from each others, so the difference of distances from point-to-point of the GPS devices is hard to calculate and yield more errors compare to the LPS system. The GPS system works great for large objects in outside open area, but not for small objects. If the Atomic Clock oscillator can be improved to 10x faster or higher, we will have even higher accuracy than within 12 inches. The LPS towers are small and cheap to develop and can be powered by solar and have their own IDs and can be separated by 1 to 5 kilometers apart with lower power of transmitting; and they can be linked together for self-collaboration after first installation.

With this new **LPS Navigation system** that uses LPS towers along the roads, across neighbors, city to cities; any moving smart devices, smart cars, flying cars, airplanes or unmanned vehicles that equipped with LPS receivers will able to pin point the current location and position on the e-maps that defined LPS towers along the way. The **Cell eMap Live Updates System** invention already defined the LAT Cell eMap in 10° layout, 1° layout and down to the $1km^2$ Cell eMap layouts. The Cell eMap layout system will define the LPS towers locations on the Cell eMap system; when this is ready, any moving devices, moving objects or moving vehicles will receive the cell e-maps signals along the way and easy to navigate anywhere along the cell e-maps based on the predefined positions of the LPS towers. The LPS towers are easy to collaborate, maintain, and improve without worry of devices out of clock synchronization or power outage. The LPS transmitter device towers can be installed anywhere and easy to collaborate with a simple **LPS Collaborator device** or with a **LPS 'PAIR' button** to synchronize neighbors' distances when their clocks are synchronized.

henryvpham@gmail.com

LPS Navigation System

Henry V. Pham

LPS Towers Layout

The LPS towers are new and recommended to layout more evenly and geometry as possible and at any given position should be at least covered with 3 towers signals; and one tower signal should overlap the others to provide one device can communicate to at least their 2 other neighbor towers. With great layout, we can collaborate the entire LPS network towers automatically easy without manually using the LPS Collaborator device as mentioned in the LPS – Local Positioning System invention. Figure-1 below shows a simple of LPS tower layout in geometry.

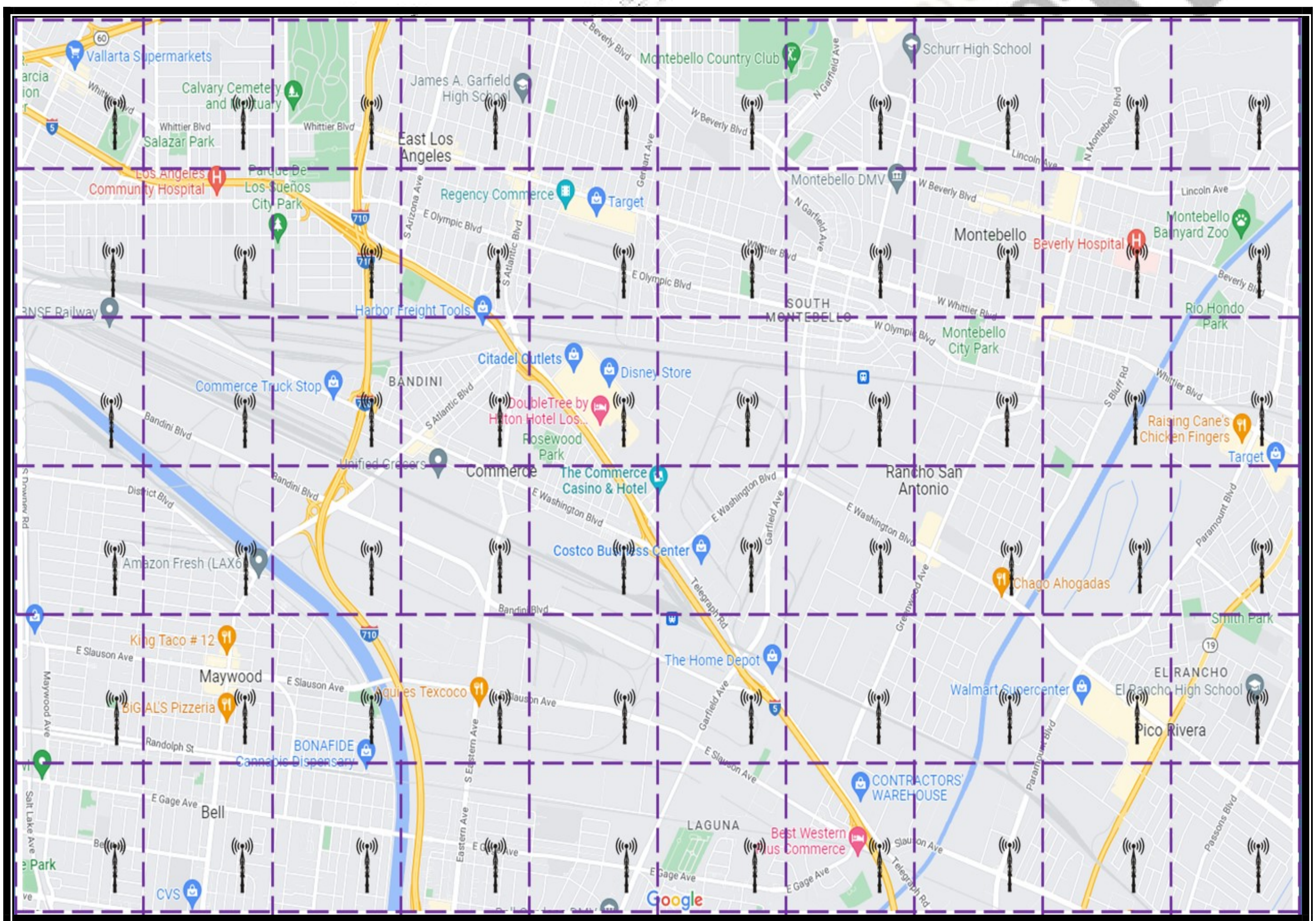

Figure-1: LPS Towers layout

henryvpham@gmail.com

LPS Navigation System

Henry V. Pham

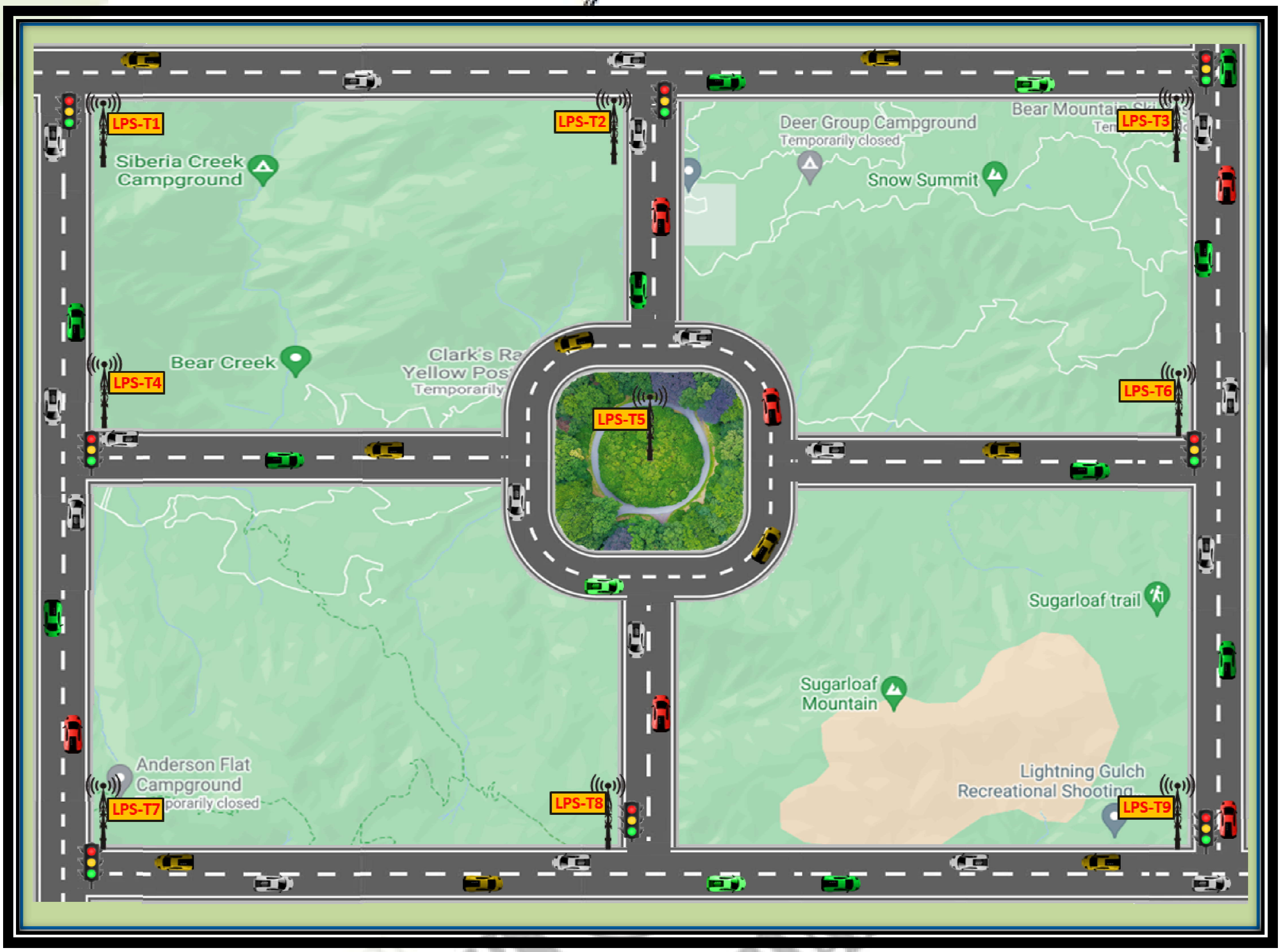

Figure-2: LPS Towers Closer Look layout

Figure-2 above shows a closer look layout of LPS towers on the roads. Depends on the power of the LPS transmitter, the distance between each tower can be different. The LPS transmitter can be powered by solar if the location is satisfied with solar energy to operate every season, for more convenient and be more independent to install at any location on earth. When planning for LPS Navigating System, the planers should estimate for number of LPS towers and locations of each tower to have the good estimate of LPS tower ID range more accurately for future expandable to larger LPS tower network. Note that the **LPS Navigating System** should be used with the **Cell eMap Live Updates System** to set locations of each LPS tower correct on the maps.

LPS Signals Coverage

As mentioned above, the LPS Navigation System will have signals coverage of 3 or more LPS towers at any given position within the LPS local community and apply signal propagation to trigger atomic Clock Synchronization or use for Missing LPS Tower Alert across the LPS towers from or to the LPS Control Center. Figure-3 below shows the LPS signal coverage for a map layout on the road.

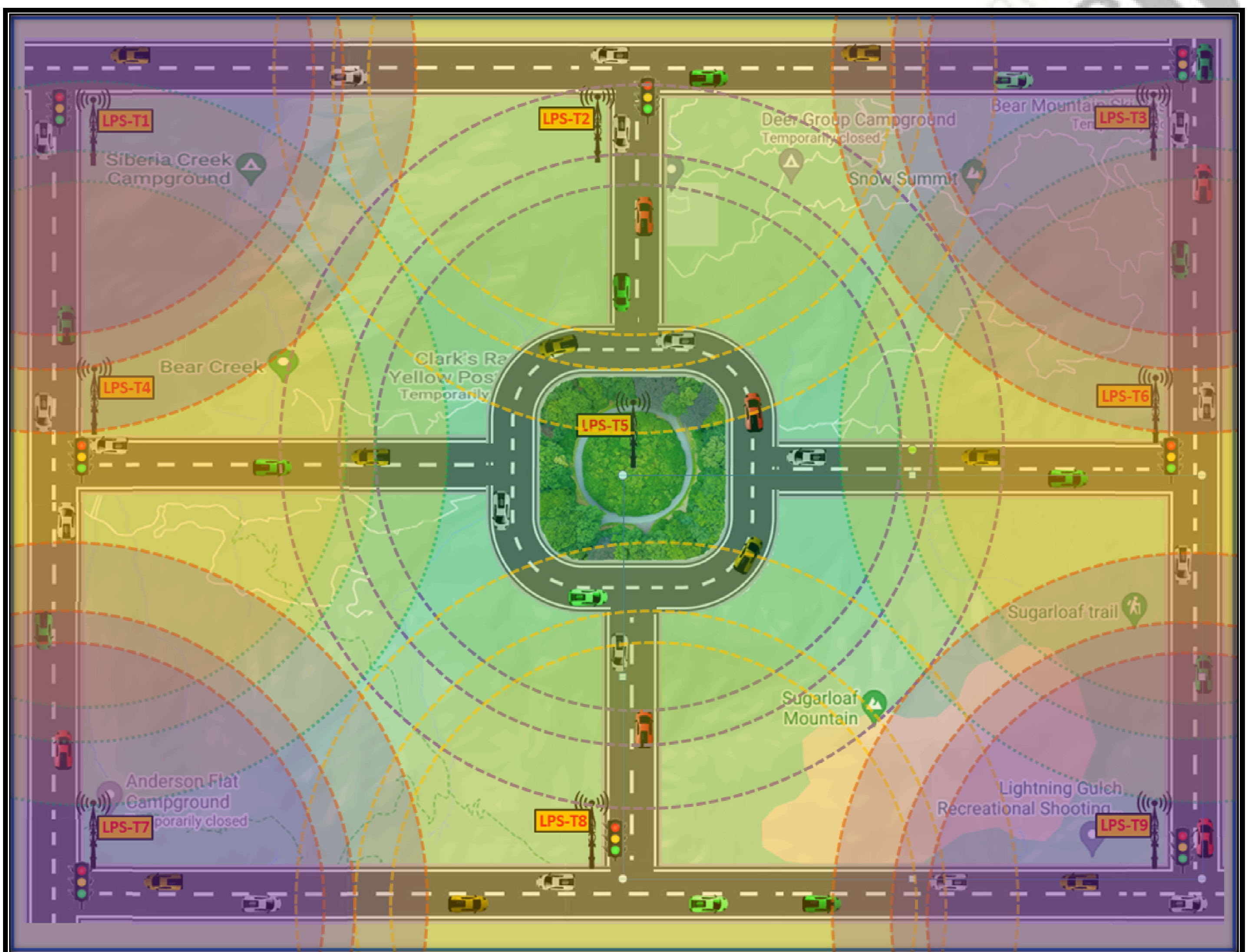

Figure-3: LPS Signals Coverage

Pham, Henry V.
henryvpham@gmail.com

LPS Navigation System

Henry V. Pham

The LPS Navigation System will provide cars driving on the street with more accurate positions and more secured without worry of unknown tracking sources like our existing map navigation system on cars or on current smart devices. Currently, the GPS navigation system on cars or on smart devices can be updated anytime without your knowledge and can be hacked or tracked while you are driving. With this new system plus the Cell eMap Live Updates System, the map is broadcasting and the cars or smart devices will pick up the next cell maps for next moves with the details points of interest or traffic notifications which are controlled by local organization offices; and the cars and smart devices will not be hacked or tracked with cell e-maps broadcasting while travelling along the roads. Figure-4 shows cars are travelling along the roads while receiving LPS signals.

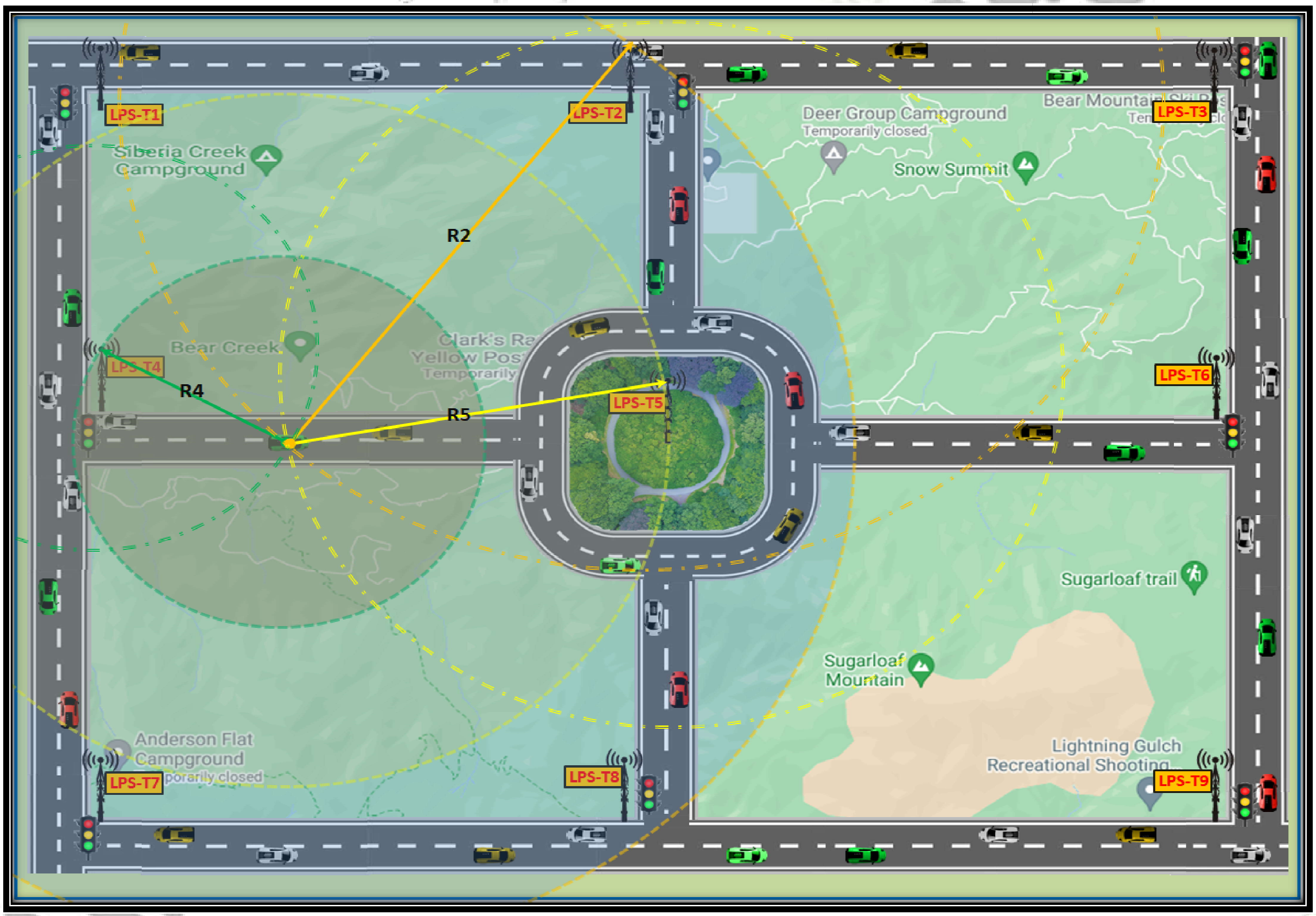

Figure-4: LPS Towers and Cars on Navigation System

Pham, Henry V.
henryvpham@gmail.com

The LPS Calculations

The **LPS Collaborator device** as mentioned in the **LPS – Local Positioning System** invention is used for LPS collaboration of each transmitter and the LPS receivers at their position zero. When the LPS transmitters are installed, the user can easily put the LPS-Collaborator device at closest point at position zero of the transmitter (beacon) and must be within 12 inches and as closest as possible for the greatest LPS accuracy. When the LPS Collaborator is at the closest at position zero of a transmitter-1 in Figure-5 below which is referenced from the LPS invention, the user just press a button on the LPS Collaborator device to synchronize and get clock offset of the transmitter-1 and the LPS Collaborator device. The LPS Collaborator device will save the clock ticks of transmitter-1 to keep track with its own clock. Then the user can bring the LPS Collaborator device to the second transmitter-2, and do the collaboration at position zero for transmitter-2 same procedure as collaboration at transmitter-1. The LPS Collaborator device now has the clock offset of both transmitter-1 and transmitter-2. The LPS Collaborator device at position zero of transmitter-2 can now track the distance from transmitter-1 to transmitter-2 by the transmission time in nanoseconds with the ratio of 3.336 ns per meter. For **LPS Navigation System**, we will use a large number of LPS devices, and LPS devices will be able to set atomic clock and their neighbor LPS towers' distances to support **Automatic Clock Synchronization** across LPS towers from the LPS Control Center besides using the **LPS Collaborator device**.

Figure-5 and Figure-6 are referenced from the LPS invention shows the calculation of LPS accuracy as below.

Assume: f = 5GHz; λ = (299,792,458 m/s)/(5,000,000,000) = 0.05995849;

Position 1: d1 = 1000 meters; then t1 = (1000 m)/(299,792,458 m/s) = 3,335.641 ns;
Position 2: d2 = 1001 meters; then t2 = (1001 m)/(299,792,458 m/s) = 3,338.977 ns;

Difference in time: t2 – t1 = 3,338.977 ns - 3,335.641 ns = **3.336 ns (per meter)**

With the Atomic Clock and High Frequency Transmitter, the difference of 3.336 ns per meter is significant. So, the LPS system can be accurate more than 12 inches or 30 cm.

LPS Navigation System

Henry V. Pham

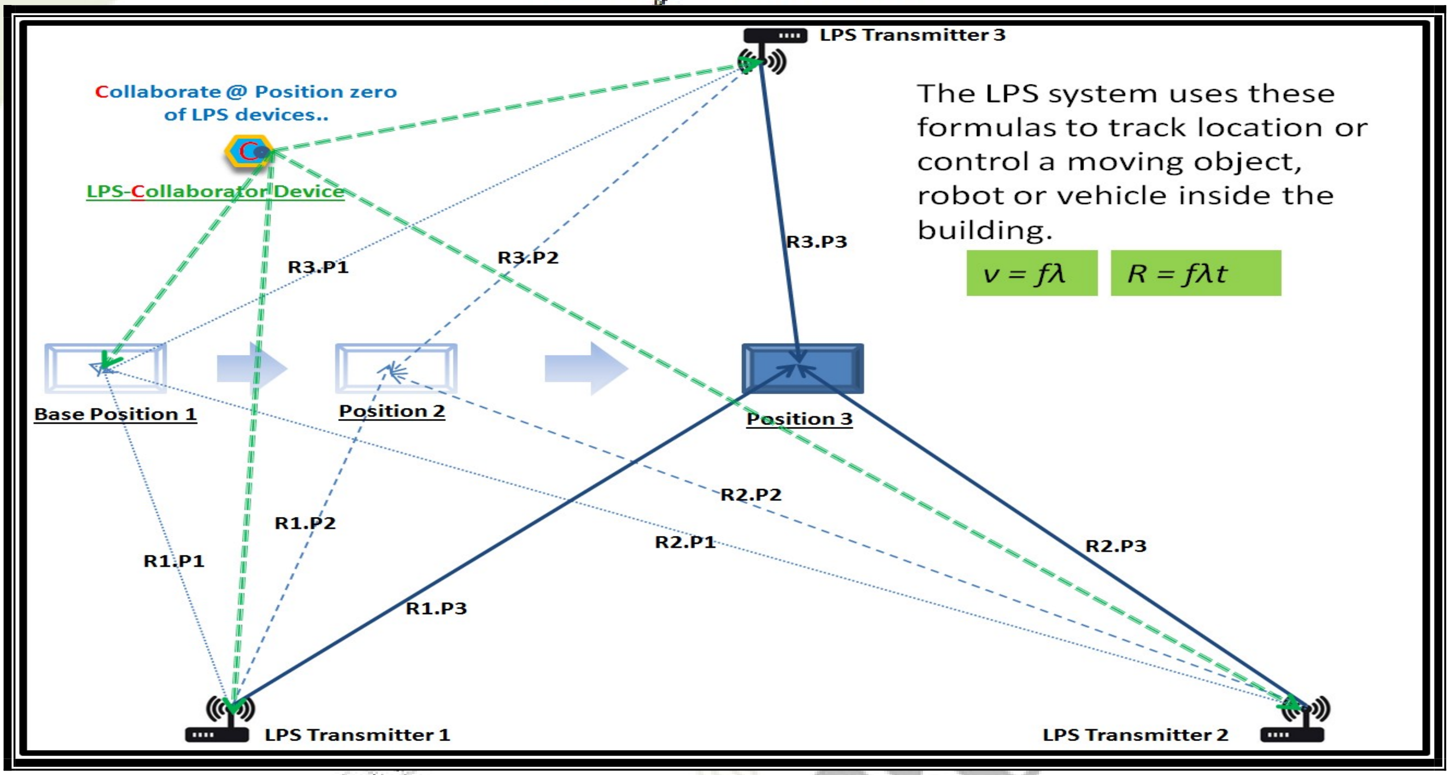

Figure-5: LPS Positions Locations Calculations (Referenced from the LPS invention)

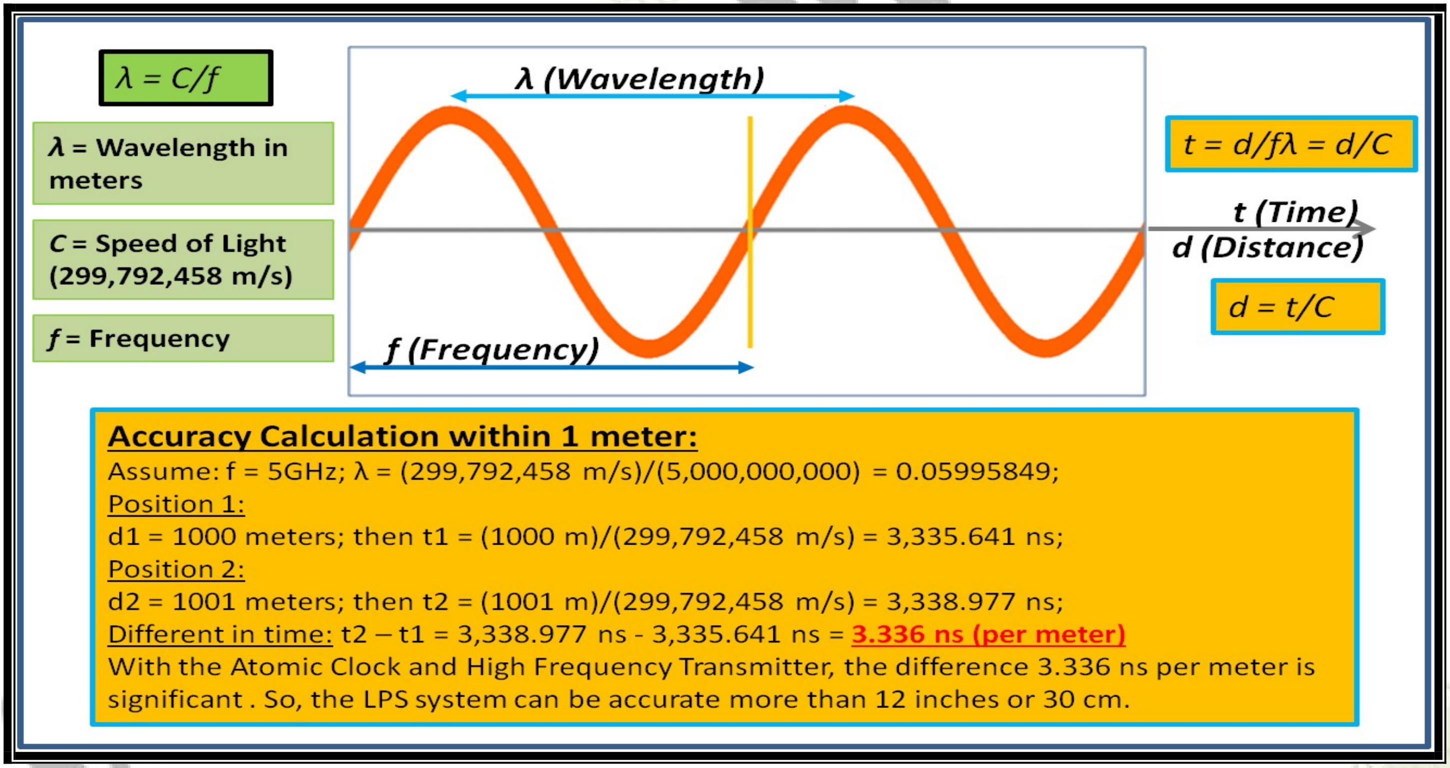

Figure-6: Frequency and Wavelength Calculations (Referenced from the LPS invention)

Table-1 below is referenced from the LPS – Local Positioning System invention, shows the LPS broadcasting info of each transmitter. Each transmitter can transmit a short stream of data contains LPS Transmitter ID, Second Counter up to 4 bytes, and a 4-byte Nanosecond Counter within the same interval. The faster the broadcast LPS info rate, the more LPS accuracy is. Table-1 below shows the LPS transmitters broadcast interval of 1 second, and this is good enough for slow objects like robot cleaners and robot carriers. For flying objects or fast moving objects, the broadcast interval could be 1 ms or faster depends on the LPS system capability. Column 'LPS Collaborator Offset Time' shows the time-counters offset of the Collaborator device and the 4-LPS Transmitters.

Transmitter	Sequence No.	[LPS-ID]+[Seconds:Counter]+[Nanoseconds:Counter]	LPS Collaborator Offset Time
XMTR1	1	[ID-XMTR1][5001][900,500,100]	[0][900,500,100]
	2	[ID-XMTR1][5002][900,500,100]	[0][900,500,100]
	3	[ID-XMTR1][5003][900,500,100]	[0][900,500,100]
	4	[ID-XMTR1][5004][900,500,100]	[0][900,500,100]
	5	[ID-XMTR1][5005][900,500,100]	[0][900,500,100]
	..	...	...
XMTR2	1	[ID-XMTR2][6001][700,300,100]	[1000][700,300,100]
	2	[ID-XMTR2][6002][700,300,100]	[1000][700,300,100]
	3	[ID-XMTR2][6003][700,300,100]	[1000][700,300,100]
	4	[ID-XMTR2][6004][700,300,100]	[1000][700,300,100]
	5	[ID-XMTR2][6005][700,300,100]	[1000][700,300,100]
	..	...	...
XMTR3	1	[ID-XMTR3][7001][500,200,100]	[2000][500,200,100]
	2	[ID-XMTR3][7002][500,200,100]	[2000][500,200,100]
	3	[ID-XMTR3][7003][500,200,100]	[2000][500,200,100]
	4	[ID-XMTR3][7004][500,200,100]	[2000][500,200,100]
	5	[ID-XMTR3][7005][500,200,100]	[2000][500,200,100]
	..	...	...
XMTR4	1	[ID-XMTR4][8001][300,700,100]	[3000][300,700,100]
	2	[ID-XMTR4][8002][300,700,100]	[3000][300,700,100]
	3	[ID-XMTR4][8003][300,700,100]	[3000][300,700,100]
	4	[ID-XMTR4][8004][300,700,100]	[3000][300,700,100]
	5	[ID-XMTR4][8005][300,700,100]	[3000][300,700,100]
	..	...	...

Table-1: Simple of 4 LPS XMTRs with Data broadcast every second (Referenced from LPS invention)

The LPS Navigation System Protocol

The **LPS Navigation System** is designed with the following **LPS protocol** in normal mode; LPS tower will send every interval with its ID, following its second-counter, and its nanosecond-counter, and then following with the distances between its neighbors. The distances between its neighbors will use for calculation of the circle of the 3 points, 3 LPS towers; these distances will be used to calculate the radius **R** at center point $\mathbf{P_c}$ of the **Triangle Circle Radius**. This radius **R** will be used to relatively calculate distance of the signal travelling time $\mathbf{t_n}$ verse the time $\mathbf{t_c}$ that travels to the same distance **R** of each tower. The $\mathbf{P_c}$ point can be used as a perfect collaboration position for all 3 towers for mobile collaboration or during LPS towers installation. Table-2 below shows the sequences of each tower broadcasting in 1 second interval with 2 neighbor towers. In real world, the LPS Navigation System should broadcast every 100 millisecond interval for accuracy of moving cars, flying cars, airplane and unmanned vehicles. The **LPS Navigation System** is also designed to support automatic adjust atomic clock using **Automatic Clock Synchronization** propagation to collaborate the LPS towers clocks within limit LPS Towers IDs in range; this feature will show in section "**The LPS Towers Clock Synchronization Propagation**". When one LPS tower is miscalculating the distances with its neighbors or when power outage or in case lost of LPS tower, the system will use Alert Protocol which will show in later section "**LPS Towers Alert**".

When a device at its zero position not yet moving, the device can start try setting itself for its atomic clock ticks based on the neighbor LPS towers that have been received their broadcasting LPS signals. The position prediction will start with the closest LPS tower and the position $\mathbf{P_c}$ center of the 3 LPS towers. First, the LPS receiver of the object get the signal travelling timing differences and compare to the closest LPS tower ($\mathbf{T_3}$ in Figure-7); then adding this timing to the time $\mathbf{t_c}$ of the center point. This could be the best prediction position timing. The LPS receiver will try to use this clock timing counters of $\mathbf{T_3}$ plus time $\mathbf{t_c}$; and compare with the signal travelling time from $\mathbf{T_1}$ and $\mathbf{T_2}$ by checking the LPS signal data for timing difference of both from $\mathbf{T_1}$ and $\mathbf{T_2}$ compare to $\mathbf{T_3}$. Note that the LPS towers clocks are synchronized and they are sending LPS signals with the same interval and not necessary sending at the same clock ticks. The LPS receiver can try to adjust its own clock ticks with this prediction plus try checking couple times for next set of LPS receiving signals from all 3 LPS towers. Note that the timing interval is every 1 second in this case; the LPS receiver can adjust based on the next receiving messages by play a nanosecond number of ±5 to get the correct clock for the distance calculation and compare with the $\mathbf{t_c}$ based on equal distances **R** center point to all 3 LPS towers.

Tower	Sequence No.	[LPS-ID][Seconds:Counter][Nanoseconds:Counter] [LPS-ID$_1$:Distance$_1$][LPS-ID$_{n-1}$:Distance$_{n-1}$][LPS-ID$_{n:}$:Distance$_n$]
XMTR1	1	[ID-XMTR1][5001][500,100,000][ID-XMTR2:<Distance$_{1-2}$>][ID-XMTR3:<Distance$_{1-3}$>]
	2	[ID-XMTR1][5002][500,100,000][ID-XMTR2:<Distance$_{1-2}$>][ID-XMTR3:<Distance$_{1-3}$>]
	3	[ID-XMTR1][5003][500,100,000][ID-XMTR2:<Distance$_{1-2}$>][ID-XMTR3:<Distance$_{1-3}$>]
	4	[ID-XMTR1][5004][500,100,000][ID-XMTR2:<Distance$_{1-2}$>][ID-XMTR3:<Distance$_{1-3}$>]
	5	[ID-XMTR1][5005][500,100,000][ID-XMTR2:<Distance$_{1-2}$>][ID-XMTR3:<Distance$_{1-3}$>]
	..	...
XMTR2	1	[ID-XMTR2][5001][500,100,000][ID-XMTR1:<Distance$_{2-1}$>][ID-XMTR3:<Distance$_{2-3}$>]
	2	[ID-XMTR2][5002][500,100,000][ID-XMTR1:<Distance$_{2-1}$>][ID-XMTR3:<Distance$_{2-3}$>]
	3	[ID-XMTR2][5003][500,100,000][ID-XMTR1:<Distance$_{2-1}$>][ID-XMTR3:<Distance$_{2-3}$>]
	4	[ID-XMTR2][5004][500,100,000][ID-XMTR1:<Distance$_{2-1}$>][ID-XMTR3:<Distance$_{2-3}$>]
	5	[ID-XMTR2][5005][500,100,000][ID-XMTR1:<Distance$_{2-1}$>][ID-XMTR3:<Distance$_{2-3}$>]
	..	...
XMTR3	1	[ID-XMTR3][5001][500,100,000][ID-XMTR1:<Distance$_{3-1}$>][ID-XMTR2:<Distance$_{3-2}$>]
	2	[ID-XMTR3][5002][500,100,000][ID-XMTR1:<Distance$_{3-1}$>][ID-XMTR2:<Distance$_{3-2}$>]
	3	[ID-XMTR3][5003][500,100,000][ID-XMTR1:<Distance$_{3-1}$>][ID-XMTR2:<Distance$_{3-2}$>]
	4	[ID-XMTR3][5004][500,100,000][ID-XMTR1:<Distance$_{3-1}$>][ID-XMTR2:<Distance$_{3-2}$>]
	5	[ID-XMTR3][5005][500,100,000][ID-XMTR1:<Distance$_{3-1}$>][ID-XMTR2:<Distance$_{3-2}$>]
	..	...

<u>**Table-2: The LPS Navigation towers Data broadcast every second**</u>

henryvpham@gmail.com

The LPS Positions and Distances Calculation

The LPS Navigation System is designed to have at any given position there are at least 3 LPS towers signals covered it. With a theorem of given 3 points, there is 1 only 1 circle passes through these points. With these statements in mind, we can choose at least one best triangle of 3 towers that closest to the navigating position $\mathbf{P_n}$ to calculate at the first position without moving or travelling.

Figure-7 below shows the formula to find radius **R** of the circle of 3 LPS towers T_1, T_2 and T_3. At this center position $\mathbf{P_c}$ and the clocks are synchronized; so time $\mathbf{t_c}$ from all 3 LPS towers are the same; $\mathbf{t_c} = \mathbf{R / C}$; where **R** is radius of the circle and **C** is the speed of light. By applying the **Parallel Transforming Percentage (P%) Calculations**, then we can calculate the distances from position P_1, P_2 ... P_n based on the timing ratio or timing percentage of $\mathbf{t_c}$ from the center $\mathbf{P_c}$ of the circle of each tower as shown in Figure-7. Given $\mathbf{d_{12} = 221.5\ m; d_{23} = 257.5\ m; d_{13} = 262.5\ m}$; then we can have data transmitting as shown in Table-3 with all LPS towers clock synchronized.

We can calculate,

R = (221.5)(257.5)(262.5)/**SQRT(**(221.5+257.5+262.5)(221.5+257.5-262.5)(221.5-257.5+262.5)(257.5+262.5-221.5)**)** = **143.71 m;**

Then $\mathbf{t_c} = \mathbf{R / C} =$ (143.71 m) / (299,792,458 m/s) $= \mathbf{4.7937\ E^{-7}\ sec = 479.37\ nsec}$

Table-3 below shows the LPS signal data right at the center of the circle position $\mathbf{P_c}$ from three towers with atomic clock synchronization. Given an object moving at a later time to position $\mathbf{P_2}$, and received all 3 LPS towers signals data with1 second interval as,

Received-T1: [ID-**XMTR1**][5010][500,100,000][ID-XMTR2:221.50][ID-XMTR3:262.50] for $\mathbf{7.171620\ E^{-7}}$ seconds of travelling time.

Received-T2: [ID-**XMTR2**][5010][500,100,000][ID-XMTR1:221.50][ID-XMTR3:257.50] for $\mathbf{11.09100\ E^{-7}}$ seconds for travelling time.

Received-T3: [ID-**XMTR3**][5010][500,100,000][ID-XMTR1:262.50][ID-XMTR2:257.50] for $\mathbf{5.67058\ E^{-7}}$ seconds for travelling time.

Assume that the moving object having atomic clock ticks with unknown value. First, we need to try to get to the current atomic clock ticks of those 3 LPS towers right at the position of the object. From the received data packages above; start with the closest LPS tower $\mathbf{T_3}$, we have the difference in time for the 3 LPS towers as below,

$\mathbf{\Delta t_{13} = t_1 - t_3 = 7.171620\ E^{-}7 - 5.67058\ E^{-7}} = 1\mathbf{.50104\ E^{-7}}$ sec
$\mathbf{\Delta t_{23} = t_2 - t_3 = 11.09100\ E^{-}7 - 5.67058\ E^{-7}} = \mathbf{5.42042\ E^{-7}}$ sec

Now, we can start with the prediction that this object is the same distance with position $\mathbf{P_c}$ based on $\mathbf{T_3}$, with these different timing from all 3 LPS towers. We can try to calculate the prediction position based on position $\mathbf{P_c}$, the center of the 3 LPS towers with signal travelling time; then we have,

$\mathbf{t'_3 = t_c = 4.7937\ E^{-7}}$ **sec = 0.000,000,479 sec;**
$\mathbf{t'_2 = 5.42042\ E^{-7}} + \mathbf{4.7937\ E^{-7} = 10.2141\ E\text{-}7}$ sec = **0.000,001,214** sec
$\mathbf{t'_1} = 1\mathbf{.50104\ E^{-7}} + \mathbf{4.7937\ E^{-7} = 6.2947\ E\text{-}7}$ sec = **0.000,000,629** sec

Then, the moving object LPS receiver can try setting the atomic clock relative to the LPS tower $\mathbf{T_3}$ with "[5010][500,100,479]". Next timing interval the LPS receiver will receive another sets of LPS messages of all 3 LPS towers, then we can try to adjust so the atomic clock ticks of the moving object is satisfied with all 3 LPS towers. With this prediction and adjusting receiver atomic clock ticks several times, we can get the correct synchronized clock ticks for moving object right at its current position. Note that the LPS towers atomic clocks are synchronized, but not necessary that they have to send the signal at the same clock tick; they just send the LPS signals at the same interval.

Then we can calculate by 2 methods for confirmation, the traditional and the percentage formulas,

$\mathbf{T_1P_2 = (C)t_1 =}$ (**299,792,458** m/s)(**7.17162 E**$^{-7}$s) = **215 m**; *compare to:*

$\mathbf{T_1P_2 = (P\%(t_1))(R) = (7.17162\ E^{-7})/(4.7937\ E^{-7})(\ 143.71)\ m}$

$\mathbf{= (149.6\%)(143.71)\ m = (1.496)(143.71)\ m = 215\ m}$

$\mathbf{T_2P_2 = (C)t_2 =}$ (**299,792,458** m/s)(**11.09100 E**$^{-7}$s) = **332.5 m**; *compare to:*

henryvpham@gmail.com

T_2P_2 = (P%(t_2))(R) = (11.0910 E^{-7})/(4.7937 E^{-7})(143.71) m

= (231.3674%)(143.71) m = (2.313674)(143.71) m = 332.5 m

T_3P_2 = (C)t_3 = (299,792,458 m/s)(11.09100 E^{-7}s) = 170 m; *compare to:*

T_3P_2 = (P%(t_3))(R) = (5.67058 E^{-7})/(4.7937 E^{-7})(143.71) m

= (118.2931%)(143.71) m = (1.182931)(143.71) m = 170 m

So, at position P_2 the distance to LPS tower-1 is 215 m, distance to LPS tower-2 is 332.5 m, and distance to LPS tower-3 is 170 m; both results for each distance are matching. We can calculate any other positions within these 3 towers with the above values. When the device is travelling to another closer LPS tower, a new triangle will be formed and the device will prepare navigating for the next moves based on the information of the next triangle dimensions received from the other LPS towers.

Tower	Sequence No.	[LPS-ID][Seconds:Counter][Nanoseconds:Counter] [LPS-ID$_1$:Distance$_1$][LPS-ID$_{n-1}$:Distance$_{n-1}$][LPS-ID$_{n:}$:Distance$_n$]
XMTR1	1	[ID-XMTR1][5001][500,100,000][ID-XMTR2:221.50][ID-XMTR3:262.50]
	2	[ID-XMTR1][5002][500,100,000][ID-XMTR2:221.50][ID-XMTR3:262.50]
	3	[ID-XMTR1][5003][500,100,000][ID-XMTR2:221.50][ID-XMTR3:262.50]
	4	[ID-XMTR1][5004][500,100,000][ID-XMTR2:221.50][ID-XMTR3:262.50]
	5	[ID-XMTR1][5005][500,100,000][ID-XMTR2:221.50][ID-XMTR3:262.50]
	..	...
XMTR2	1	[ID-XMTR2][5001][500,100,000][ID-XMTR1:221.50][ID-XMTR3:257.50]
	2	[ID-XMTR2][5002][500,100,000][ID-XMTR1:221.50][ID-XMTR3:257.50]
	3	[ID-XMTR2][5003][500,100,000][ID-XMTR1:221.50][ID-XMTR3:257.50]
	4	[ID-XMTR2][5004][500,100,000][ID-XMTR1:221.50][ID-XMTR3:257.50]
	5	[ID-XMTR2][5005][500,100,000][ID-XMTR1:221.50][ID-XMTR3:257.50]
	..	...
XMTR3	1	[ID-XMTR3][5001][500,100,000][ID-XMTR1:262.50][ID-XMTR2:257.50]
	2	[ID-XMTR3][5002][500,100,000][ID-XMTR1:262.50][ID-XMTR2:257.50]
	3	[ID-XMTR3][5003][500,100,000][ID-XMTR1:262.50][ID-XMTR2:257.50]
	4	[ID-XMTR3][5004][500,100,000][ID-XMTR1:262.50][ID-XMTR2:257.50]
	5	[ID-XMTR3][5005][500,100,000][ID-XMTR1:262.50][ID-XMTR2:257.50]
	..	...

Table-3: The 3 LPS Signal Data receiving at P_c Circle-Center of the 3-LPS triangle

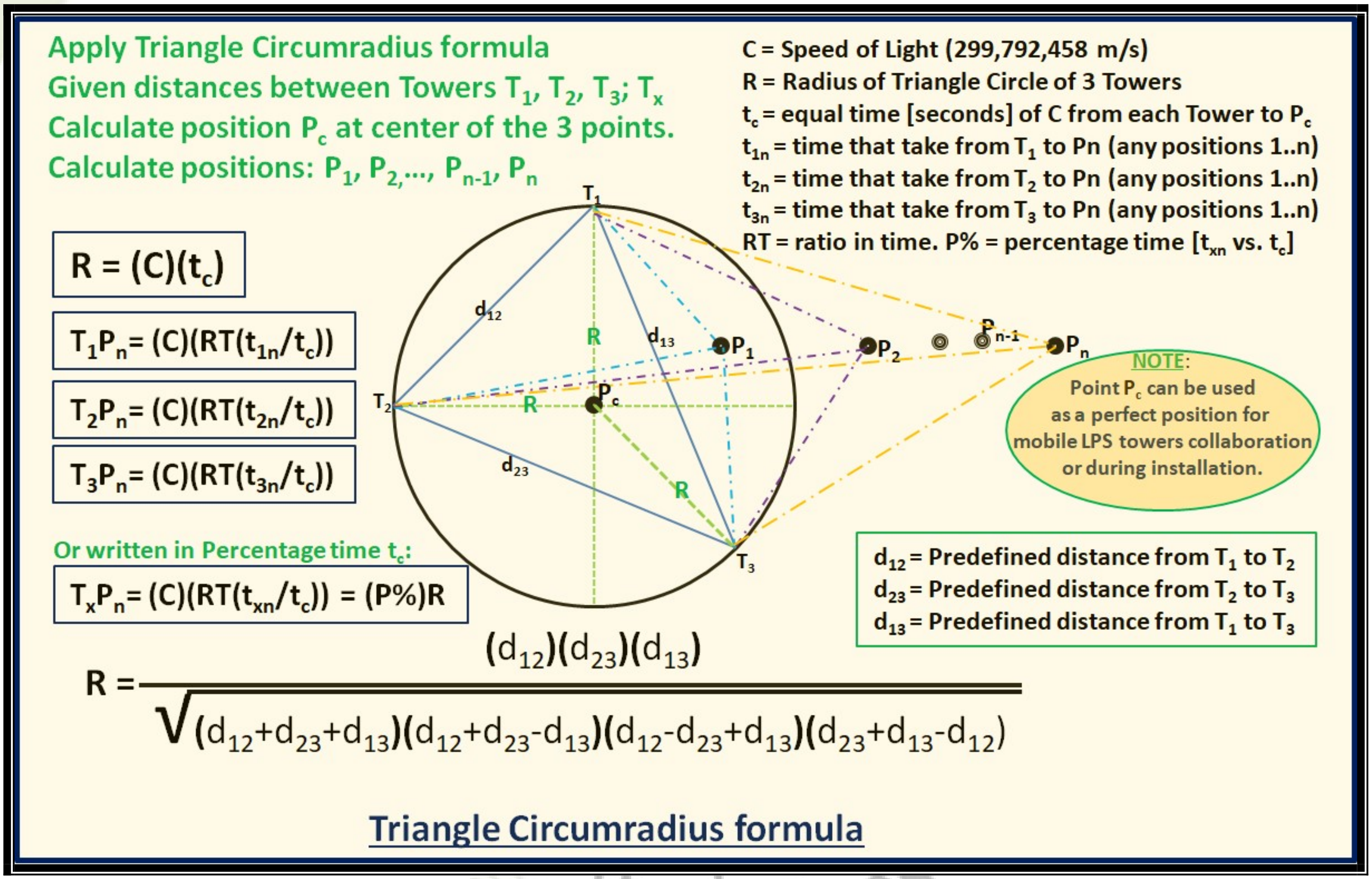

Figure-7: LPS positions

The LPS Signal Propagation

The LPS Navigation System is designed with supporting of signal propagation protocol to allow Clock Synchronization and LPS Missing Alert system. The LPS devices in navigation system allow receiving and sending signal data within LPS towers community with simple protocols defined in this LPS Navigation System only; the LPS devices will not receive signal or data from smart devices or smart vehicles. The smart devices or smart vehicles only receive LPS signals and use for mapping and navigating functions. For larger LPS towers population, we can have more than 1 LPS Control Center to manage LPS towers within the defined range. Figure-8 below shows 2 LPS Control Centers to manage the 2 separate LPS towers communities.

Henry V. Pham

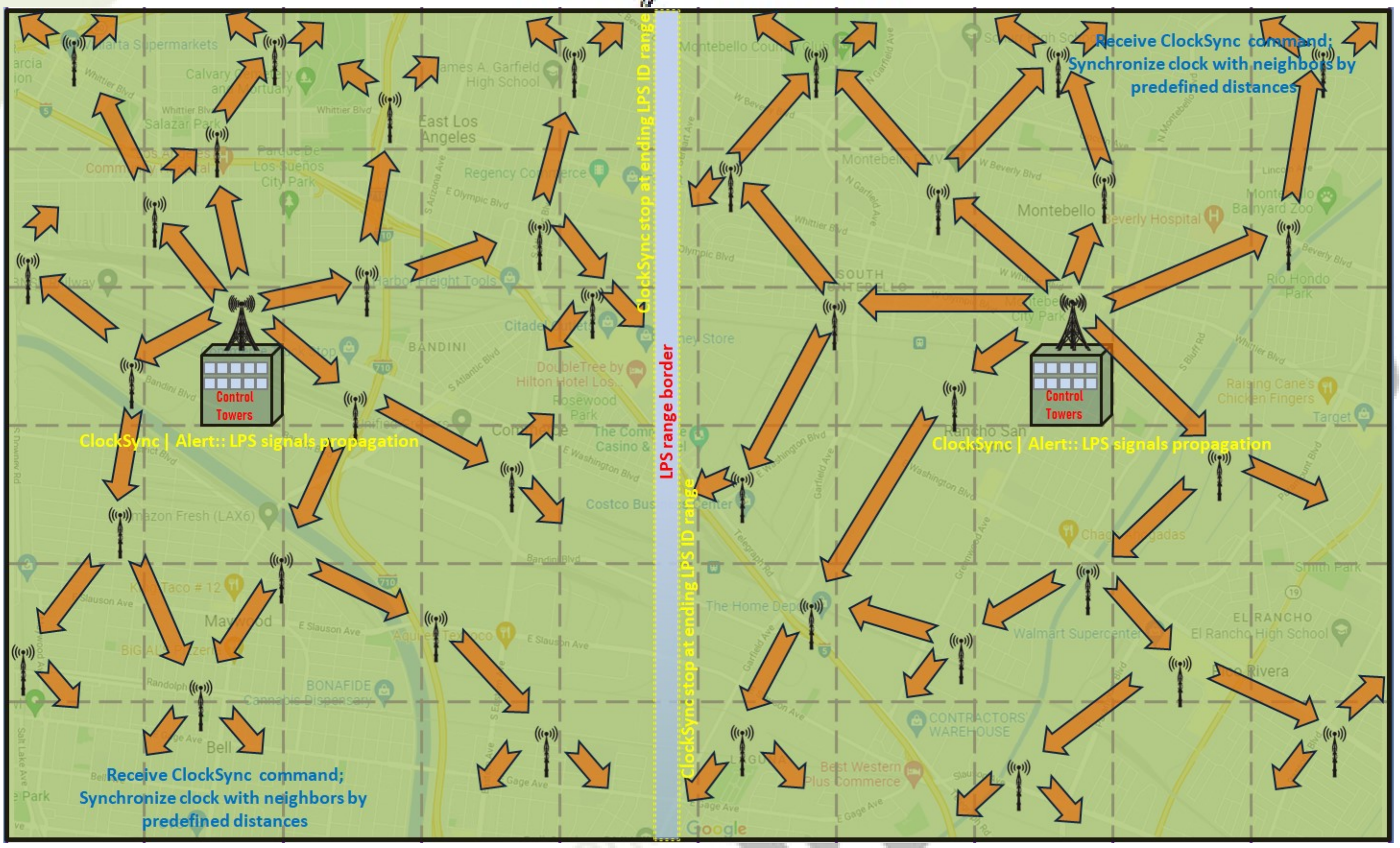

Figure-8: LPS Signal Propagation Control

The LPS Towers Clock Synchronization Propagation

The LPS Navigation System allows the LPS Control Center to roll clock synchronization propagation across the area of LPS towers within desired range that the local office operators want to adjust atomic clocks for automatic collaboration. The LPS Control Center must have the well known positions and accurate atomic clock main LPS towers; these main LPS towers will be used as starting points to send Clock Sync command to other LPS towers. Table-4 below shows the Clock Sync command of each tower, and each tower should only adjust atomic clock by itself within its neighbors LPS towers that have been defined distance between them. At initial setup and install LPS towers, each tower already set its distances to its neighbors' distances; the Clock Sync will use the defined distances to calculate and adjust its atomic clock when receiving Clock Sync command from the LPS Control Center.

Table-4 shows Clock Sync command start with XMTR ID of the LPS sender, Clock Synchronization command 'ClockSync', and the LPS Tower ID range [**AAA** – **NNN**]. If the sender ID is not within the range, then the next receiver will reject or ignore this command to stop the Clock Synchronization propagation. For **initial installation procedure**, the LPS towers should have a '**PAIR**' **button** and the new LPS towers must have atomic clock synchronized with the LPS system. Then these LPS towers can be physically installed to a new LPS towers community and the operator can press and hold 'PAIR' button to pair with their neighbors to synchronize their distances. This installation can be check and confirm using the center point $\mathbf{P_c}$ of the Triangle Circle Radius as mentioned above.

Tower	Sequence No.	[ClockSync][LPS-ID-RANGE-START][LPS-ID-RANGE-END]
XMTR1	1	[ID-XMTR1][ClockSync][ID-XMTR<AAA>][ID-XMTR<NNN>]
XMTR1	2	[ID-XMTR1][ClockSync][ID-XMTR<AAA>][ID-XMTR<NNN>]
XMTR1	3	[ID-XMTR1][ClockSync][ID-XMTR<AAA>][ID-XMTR<NNN>]
	..	...
XMTR2	1	[ID-XMTR2][ClockSync][ID-XMTR<AAA>][ID-XMTR<NNN>]
XMTR2	2	[ID-XMTR2][ClockSync][ID-XMTR<AAA>][ID-XMTR<NNN>]
XMTR2	3	[ID-XMTR2][ClockSync][ID-XMTR<AAA>][ID-XMTR<NNN>]
	..	...
XMTR3	1	[ID-XMTR3][ClockSync][ID-XMTR<AAA>][ID-XMTR<NNN>]
XMTR3	2	[ID-XMTR3][ClockSync][ID-XMTR<AAA>][ID-XMTR<NNN>]
XMTR3	3	[ID-XMTR3][ClockSync][ID-XMTR<AAA>][ID-XMTR<NNN>]
	..	...

Table-4: The LPS System triggers Clock Synchronization Command

The LPS Towers Alerts

The LPS Navigation System is designed to have capability of notification and recognizing for missing or miscalculation of the LPS towers. Each LPS tower will receive the neighbor towers signals and do calculation every hour to check for separation or miscalculation to alert the Control Center.

Table-5 below shows LPS tower XMTR2 sending an alert command to the LPS Control Center by signals propagation from the neighbors LPS towers to the LPS Control Center. When an LPS tower find out itself having miscalculation, then this LPS tower will automatically send alert command 1 time per hour for the first day, 3 times per hour for the next day, then 1 per day for the following days to notify the LPS Control Center for position has been changed or moved that caused miscalculation.

For power outage or lost of LPS tower or the tower is gone for unknown reason, then the neighbors LPS towers will send alert command to the LPS Control Center for missing neighbor LPS tower.

The LPS towers always receive their neighbors LPS positioning signal timing counters data and save the last data, and this last data will be used to notify the LPS Control Center. Table-5 below shows XMTR1 and XMTR3 sending alert command for their failure neighbor, LPS tower XMTR2. The format for this alert command is '[LPS-ID][LPS-FAIL-ID][ALERT][Seconds:Counter][Nanoseconds:Counter]'; where LPS-ID is the tower that forwarding the alert command, LPS-FAIL-ID is the failure tower ID, ALERT is the keyword of failure as an alert command protocol and following with the failure LPS tower last timing counters.

Tower	Sequence No.	[LPS-ID][LPS-FAIL-ID][ALERT][Seconds:Counter][Nanoseconds:Counter]
XMTR1	1	[ID-XMTR1][ID-XMTR2][ALERT][6001][400,200,321]
XMTR1	2	[ID-XMTR1][ID-XMTR2][ALERT][6001][400,200,321]
XMTR1	3	[ID-XMTR1][ID-XMTR2][ALERT][6001][400,200,321]
	..	…
XMTR2	1	[ID-XMTR2][ALERT][6001][400,200,321]
XMTR2	2	[ID-XMTR2][ALERT][6001][400,200,321]
XMTR2	3	[ID-XMTR2][ALERT][6001][400,200,321]
	..	…
XMTR3	1	[ID-XMTR3][ID-XMTR2][ALERT][6001][400,200,321]
XMTR3	2	[ID-XMTR3][ID-XMTR2][ALERT][6001][400,200,321]
XMTR3	3	[ID-XMTR3][ID-XMTR2][ALERT][6001][400,200,321]
	..	…

Table-5: The LPS tower triggers or being triggered miscalculation events

LPS Navigation System

Henry V. Pham

Conclusion

The **LPS Navigation System** is designed with State-Of-The-Art and supports LPS Automation Collaboration with great LPS Alert System to provide great technology for entire world for smart city, navigating vehicles, self-driving cars, flying cars, airplanes, unmanned aircraft, marshal drones, and any other smart devices navigating through the maps.

The **LPS Navigation System** is designed to work with the **Cell ëMap Live Updates System** for large number of LPS towers around the cities, around the country, and around the world; the Cell ëMap Live Updates System invention is also mentioned this invention and is intended to use for locating positions on the Cell eMaps to provide accurate mapping and navigating around the world with great layout of Cell eMap and LPS towers. The LPS towers can be powered by solar; they are small and convenient to install anywhere on any surfaces. This could be great for tall buildings and high mountains to provide obstacle objects to avoid for airplanes, flying cars, unmanned aircrafts and any other flying objects.

The **LPS Navigation System** and the **Cell ëMap Live Updates System**, together will be a great promise mapping and navigating system for our future and our younger generations' futures. This system will use LPS towers along the roads, along the freeway, across the neighbors, city-to-city, and country-to-countries to provide more accurate locations and secured maps than ever with the **Cell ëMap Live Updates System** and this great **LPS Navigation System.**

henryvpham@gmail.com