Emergency Traffic Lights Routing System

Henry V. Pham

The **Emergency Traffic Lights Routing System** is invented to search for shortest routes with pre-green traffic lights for a predefined distance before rescue vehicle moving to rescue fires, rescue critical health condition people, and even rescue in disaster emergency situations. Traffic lights are in some geometry layout, and this invention applies the **G-NETWORK** layout and **G-ROUTING** algorithm to search for fastest route and apply G-ROUTING protocol to transmit messages from one traffic light to another using Neighbor-to-Neighbors networking technology which was used in **G-ROUTING ALGORITHM METHODOLOGY** invention.

The existing traffic lights controllers can be improved to support **Emergency Traffic Lights Routing System** by adding RF wireless device into the traffic light controller for each traffic corner. The RF device in traffic light controller only needs to use low power and enough to have signals covering its traffic lights neighbors to form a Neighbor-to-Neighbors networking layout. The database requires for Neighbor-to-Neighbor networking is simple with the properties of the neighbors like distances and directions from a traffic light or a node. Traffic light is not a re-routable node, and the system will handle the routing and set the properties of node-to-nodes for forwarding protocol in traffic light routing operation. When receiving an emergency call request, the rescue station system will look into the database for the destination traffic light ID and trigger the system for a fastest route starts from the rescue station; only rescue stations have the system that can trigger a rescue route and **forward green command** to a list of routing traffic lights. The routing traffic lights will take turns to turn **green light for a given initial distance** and **keep green lights ahead** with a maximum velocity of the rescue vehicle. The rescue vehicle can be equipped with an RF device carrying in the last rescue vehicle to notify the traffic light back to normal condition, to end the route when the vehicle passes by. If this device is not equipped or not available on the rescue vehicle for any reason, the traffic lights will be green after received the command and stay for maximum of 15 minutes; when this situation happens, the traffic lights on the route will **flash red** for maximum of 1 hour after 15 minutes green timeout, then the traffic lights will go back to normal control condition. The system also provides testing protocol and testing sequences to test signal propagation one-to-one across the traffic lights networks.

henryvpham@gmail.com

Emergency Traffic Lights Routing System

Henry V. Pham

Figure-1: FIREFIGHTER STATION COMMUNITY WITH FIRE SPOT SAMPLE

The above **Figure-1** shows a sample of a neighborhood with a Fire spot on top right of the drawing and a Firefighter station at the lower left corner. When a fire spot is reported, a closest local Firefighter station will get notify and the Emergency Traffic Lights Routing System will be triggered to search for fastest route and starts sending TX command message to the closest traffic light with a series of routing traffic lights nodes, then one forwards to the next routing traffic light until reached the final traffic light. Next sections will show details about the routing methodology and the operational protocol for TX message forwarding to each routing ones with initial required green distance and time delay from each traffic light to keep the desired green distance ahead of the emergency vehicle.

Emergency Traffic Lights Routing System

Henry V. Pham

Traffic Lights Signals Coverage

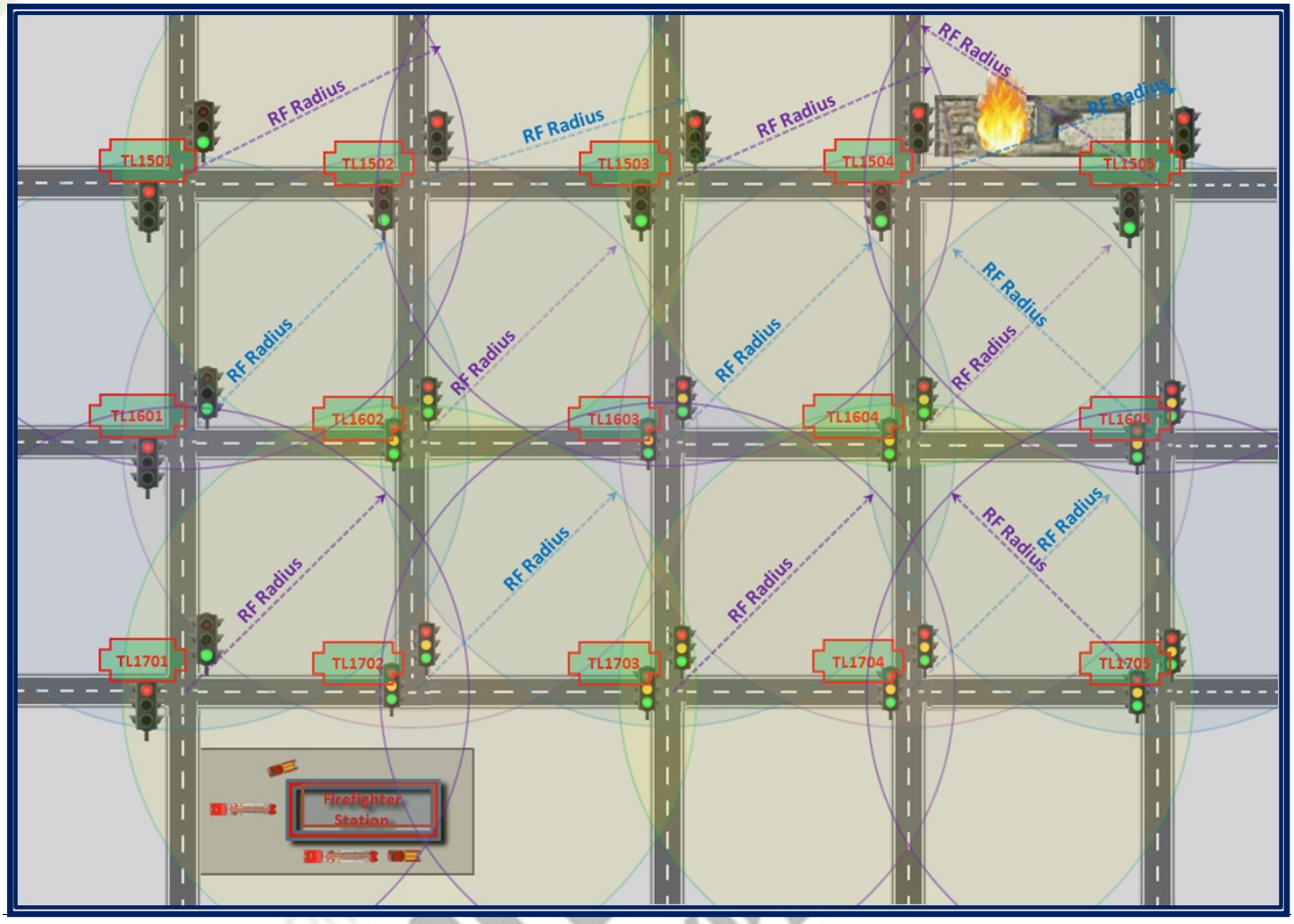


Figure-2: TRAFFIC LIGHTS RF SIGNALS COVERAGE LAYOUT

Traffic lights signals coverage is required to cover within neighbors of each traffic light to form a 'G-NETWORK' layout with neighbor-to-neighbors methodology. Traffic light RF devices do not need much of power and not need to have high power signals to transmit over of other neighbors; the RF signal can be used with 1GHz frequency. The RF signals for traffic lights should only be used for emergency and should not be combined with internet networking to prevent hacking from taking over the city traffic lights' controllers. Only traffic lights control center, Firefighter stations, and Hospital Emergency stations can have the device and the Emergency Traffic Light Routing System at the station to trigger the emergency routes.

Emergency Traffic Lights Routing System

Henry V. Pham

Traffic Lights Layout

Traffic lights in city should be in uniform layout and can have some shortcuts or diagonal lines in form of G-NETWORK layout, and this is perfect to use G-ROUTING algorithm in this Emergency Traffic Lights Routing System. **Figure-3** below shows an uniform traffic lights layout with compact symbol on top right corner (North direction on top), and Firefighter station at TL number '**1701**' and a Fire spot at TL number '**1504**'. In this invention for traffic lights, only the traffic lights within the highlight rectangle to be listed in the database for shorten the list for more readable. For more details of G-ROUTING algorithm, the routing rules and high population nodes are shown and described details in the **G-ROUTING ALGORITHM METHODOLOGY** invention.

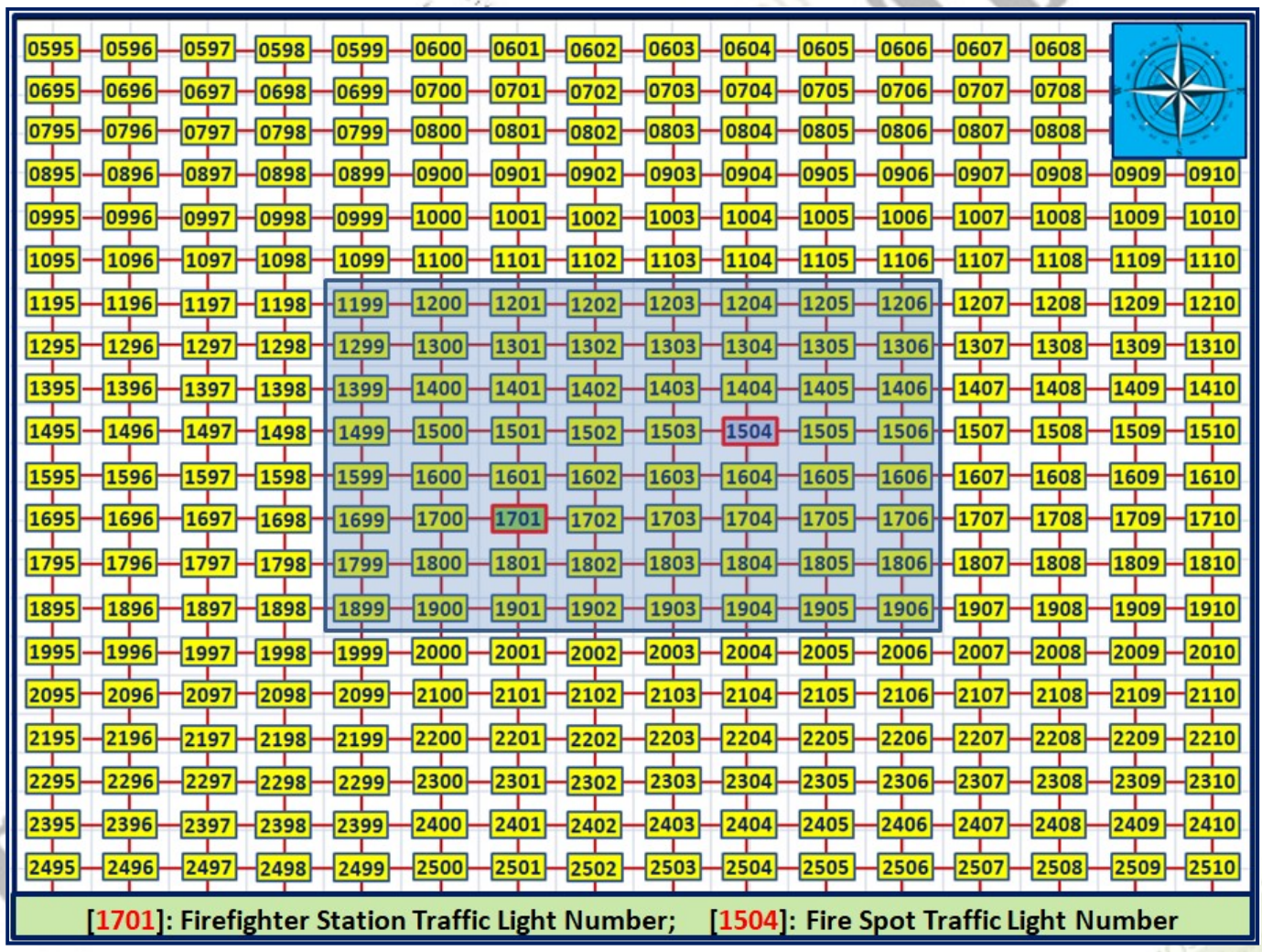


Figure-3: TRAFFIC LIGHTS NEIGHBOR TO NEIGHBORS COMMUNITY LAYOUT

Pham, Henry V.
henryvpham@gmail.com

Emergency Traffic Lights Routing System

Henry V. Pham

Traffic Lights' Properties Database Requirements

Table-1 below shows database table for the traffic lights in the highlight square in **Figure-3** above which showing enough to cover routing for the Firefighter station and the Fire spot as shown in **Figure-1**. As required from the **G-ROUTING** algorithm methodology with the **G-NETWORK** layout invention, each traffic light (**TL**) must have its neighbors' properties like direction and distance for each neighbor's traffic light. Traffic lights in **red** color are the neighbors of a traffic light that will be shown later in section that introduces diagonal lines for shortcut route methodology which should be used in reality for traffic lights. Table-1 shows traffic light **TL1503** has 5 neighbors '**TL1403; TL1504; TL1603; TL1602; TL1502**' of clockwise direction start from 12 O' clock. **TL1403** has a distance of '**808.0**' in '**North**' direction; **TL1504** has a distance of '**807.5'** in '**East**' direction; **TL1603** has a distance of '**804.5**' in '**South**' direction; **TL1602** has a distance of '**1068.5'** in '**South-West**' direction which only be shown later in **Figure-5** for diagonal traffic lights routing; **TL1502** has a distance of '**802.5'** in '**West**' direction. This traffic light is a sample routing node from the database table as shown below; other traffic lights are having the same format 'Neighbor-to-Neighbors' configuration layout.

Emergency Traffic Lights Routing System needs a database that mapping the crossed streets names for lookup the **closest traffic light number** of a destination address as shown in **Table-2**; this is a simple way for software UI application can draw the local network traffic lights layout and show the routes to the destination traffic light so the ambulance or firefighter drivers can follow the direction from the UI application. The traffic lights would have RF wireless devices with signals can cover to their neighbors. The UI application in system should have a capability to identify which next routing traffic light will be approaching on the UI traffic lights layout. Another option could be used in conjunction with a Map Service Provider or the Cell eMap System that can set or configure traffic light numbers on the real map which provide better when the ambulance or firefighter drivers can follow the direction on the real map. Emergency Traffic Lights Routing System is invented for local emergency traffic lights routing only and cannot be triggered from remotely for security purpose;

COPYRIGHT© PHAM

Emergency Traffic Lights Routing System

Henry V. Pham

TL #	Traffic Lights (TL) neighbors	Distance/Direction to TL neighbors (meters)
- - -	- - -	- - -
TL1199	TL1099; TL1200; TL1299; TL1198	TL1099:=[816.0/N]; TL1200:=[828.5/E]; TL1299:=[826.0/S]; TL1198:=[808.5/W]
TL1200	TL1100; TL1201; TL1300; TL1199	TL1100:=[819.0/N]; TL1201:=[889.5/E]; TL1300:=[856.0/S]; TL1199:=[888.5/W]
TL1201	TL1101; TL1202; TL1301; TL1200	TL1101:=[829.0/N]; TL1202:=[899.5/E]; TL1301:=[876.0/S]; TL1200:=[858.5/W]
TL1202	TL1102; TL1203; TL1302; TL1201	TL1102:=[849.5/N]; TL1203:=[919.5/E]; TL1302:=[896.5/S]; TL1201:=[878.5/W]
TL1203	TL1103; TL1204; TL1303; TL1202	TL1103:=[879.5/N]; TL1204:=[929.0/E]; TL1303:=[899.5/S]; TL1202:=[948.5/W]
TL1204	TL1104; TL1205; TL1304; TL1203	TL1104:=[889.5/N]; TL1205:=[959.0/E]; TL1304:=[869.5/S]; TL1203:=[948.5/W]
TL1205	TL1105; TL1206; TL1305; TL1204	TL1105:=[879.0/N]; TL1206:=[969.5/E]; TL1305:=[899.5/S]; TL1204:=[968.5/W]
TL1206	TL1106; TL1207; TL1306; TL1205	TL1106:=[919.5/N]; TL1207:=[929.5/E]; TL1306:=[919.5/S]; TL1205:=[978.5/W]
TL1207	TL1107; TL1208; TL1307; TL1206	TL1107:=[917.5/N]; TL1208:=[939.5/E]; TL1307:=[925.5/S]; TL1206:=[918.5/W]
TL1299	TL1199; TL1300; TL1399; TL1298	TL1199:=[816.0/N]; TL1300:=[828.5/E]; TL1399:=[826.0/S]; TL1298:=[808.5/W]
TL1300	TL1200; TL1301; TL1400; TL1299	TL1200:=[819.0/N]; TL1301:=[889.5/E]; TL1400:=[856.0/S]; TL1299:=[888.5/W]
TL1301	TL1201; TL1302; TL1401; TL1300	TL1201:=[829.0/N]; TL1302:=[899.5/E]; TL1401:=[876.0/S]; TL1300:=[858.5/W]
TL1302	TL1202; TL1303; TL1402; TL1301	TL1202:=[849.5/N]; TL1303:=[919.5/E]; TL1402:=[896.5/S]; TL1301:=[878.5/W]
TL1303	TL1203; TL1304; TL1403; TL1302	TL1203:=[879.5/N]; TL1304:=[929.0/E]; TL1403:=[899.5/S]; TL1302:=[948.5/W]
TL1304	TL1204; TL1305; TL1404; TL1303	TL1204:=[889.5/N]; TL1305:=[959.0/E]; TL1404:=[869.5/S]; TL1303:=[948.5/W]
TL1305	TL1205; TL1306; TL1405; TL1304	TL1205:=[879.0/N]; TL1306:=[969.5/E]; TL1405:=[899.5/S]; TL1304:=[968.5/W]
TL1306	TL1206; TL1307; TL1406; TL1305	TL1206:=[919.5/N]; TL1307:=[929.5/E]; TL1406:=[919.5/S]; TL1305:=[978.5/W]
TL1307	TL1207; TL1308; TL1407; TL1306	TL1207:=[917.5/N]; TL1308:=[939.5/E]; TL1407:=[925.5/S]; TL1306:=[918.5/W]
TL1399	TL1299; TL1400; TL1499; TL1398	TL1299:=[816.0/N]; TL1400:=[828.5/E]; TL1499:=[826.0/S]; TL1398:=[808.5/W]
TL1400	TL1300; TL1401; TL1500; TL1399	TL1300:=[819.0/N]; TL1401:=[889.5/E]; TL1500:=[856.0/S]; TL1399:=[888.5/W]
TL1401	TL1301; TL1402; TL1501; TL1400	TL1301:=[829.0/N]; TL1402:=[899.5/E]; TL1501:=[876.0/S]; TL1400:=[858.5/W]
TL1402	TL1302; TL1403; TL1502; TL1401	TL1302:=[849.5/N]; TL1403:=[919.5/E]; TL1502:=[896.5/S]; TL1401:=[878.5/W]
TL1403	TL1303; TL1404; TL1503; TL1402	TL1303:=[879.5/N]; TL1404:=[929.0/E]; TL1503:=[899.5/S]; TL1402:=[948.5/W]
TL1404	TL1304; TL1405; TL1504; TL1403	TL1304:=[889.5/N]; TL1405:=[959.0/E]; TL1504:=[869.5/S]; TL1403:=[948.5/W]
TL1405	TL1305; TL1406; TL1505; TL1404	TL1305:=[879.0/N]; TL1406:=[969.5/E]; TL1505:=[899.5/S]; TL1404:=[968.5/W]
TL1406	TL1306; TL1407; TL1506; TL1405	TL1306:=[919.5/N]; TL1407:=[929.5/E]; TL1506:=[919.5/S]; TL1405:=[978.5/W]
TL1407	TL1307; TL1408; TL1507; TL1406	TL1307:=[917.5/N]; TL1408:=[939.5/E]; TL1507:=[925.5/S]; TL1406:=[918.5/W]
TL1499	TL1399; TL1500; TL1599; TL1498	TL1399:=[816.0/N]; TL1500:=[828.5/E]; TL1599:=[826.0/S]; TL1498:=[808.5/W]
TL1500	TL1400; TL1501; TL1600; TL1499	TL1400:=[819.0/N]; TL1501:=[889.5/E]; TL1600:=[856.0/S]; TL1499:=[888.5/W]
TL1501	TL1401; TL1502; TL1601; TL1500	TL1401:=[806.0/N]; TL1502:=[788.5/E]; TL1601:=[806.0/S]; TL1500:=[808.5/W]
TL1502	TL1402; TL1503; TL1602; TL1501	TL1402:=[807.0/N]; TL1503:=[802.5/E]; TL1602:=[803.5/S]; TL1501:=[788.5/W]
TL1503	TL1403; TL1504; TL1603; TL1602; TL1502	TL1403:=[808.0/N]; TL1504:=[807.5/E]; TL1603:=[804.5/S]; TL1602:=[1068.5/SW]; TL1502:=[802.5/W]
TL1504	TL1404; TL1505; TL1604; TL1503	TL1404:=[804.0/N]; TL1505:=[805.5/E]; TL1604:=[807.5/S]; TL1503:=[807.5/W]
TL1505	TL1405; TL1506; TL1605; TL1504	TL1405:=[806.0/N]; TL1506:=[808.5/E]; TL1605:=[804.5/S]; TL1504:=[805.0/W]
TL1506	TL1406; TL1507; TL1606; TL1505	TL1406:=[919.5/N]; TL1507:=[929.5/E]; TL1606:=[919.5/S]; TL1505:=[978.5/W]
TL1507	TL1407; TL1508; TL1607; TL1506	TL1407:=[917.5/N]; TL1508:=[939.5/E]; TL1607:=[925.5/S]; TL1506:=[918.5/W]
TL1599	TL1499; TL1600; TL1699; TL1598	TL1499:=[816.0/N]; TL1600:=[828.5/E]; TL1699:=[826.0/S]; TL1598:=[808.5/W]
TL1600	TL1500; TL1601; TL1700; TL1599	TL1500:=[819.0/N]; TL1601:=[889.5/E]; TL1700:=[856.0/S]; TL1599:=[888.5/W]
TL1601	TL1501; TL1602; TL1701; TL1600	TL1501:=[806.0/N]; TL1602:=[809.5/E]; TL1701:=[807.5/S]; TL1600:=[902.0/W]
TL1602	TL1502; TL1503; TL1603; TL1702; TL1701; TL1601	TL1502:=[806.0/N]; TL1503:=[1068.5/NE]; TL1603:=[813.5/E]; TL1702:=[902.5/S]; TL1701:=[1076.5/SW]; TL1601:=[809.5/W]
TL1603	TL1503; TL1604; TL1703; TL1602	TL1503:=[806.5/N]; TL1604:=[808.5/E]; TL1703:=[803.5/S]; TL1602:=[813.5/W]
TL1604	TL1504; TL1605; TL1704; TL1603	TL1504:=[807.5/N]; TL1605:=[809.5/E]; TL1704:=[808.5/S]; TL1603:=[808.5/W]
TL1605	TL1505; TL1606; TL1705; TL1604	TL1505:=[804.5/N]; TL1606:=[807.5/E]; TL1705:=[809.5/S]; TL1604:=[809.5/W]
TL1606	TL1506; TL1607; TL1706; TL1605	TL1506:=[919.5/N]; TL1607:=[929.5/E]; TL1706:=[919.5/S]; TL1605:=[978.5/W]

Pham, Henry V.
henryvpham@gmail.com

TL1607	TL1507; TL1608; TL1707; TL1606	TL1507:=[917.5/N]; TL1608:=[939.5/E]; TL1707:=[925.5/S]; TL1606:=[918.5/W]
TL1699	TL1599; TL1700; TL1799; TL1698	TL1599:=[816.0/N]; TL1700:=[828.5/E]; TL1799:=[826.0/S]; TL1698:=[808.5/W]
TL1700	TL1600; TL1701; TL1800; TL1699	TL1600:=[819.0/N]; TL1701:=[889.5/E]; TL1800:=[856.0/S]; TL1699:=[888.5/W]
TL1701	TL1601; TL1602; TL1702; TL1801; TL1700	TL1601:=[807.5/N]; TL1602:=[1076.5/NE]; TL1702:=[804.5/E]; TL1801:=[808.5/S]; TL1700:=[902.5/W]
TL1702	TL1602; TL1703; TL1802; TL1701	TL1602:=[808.5/N]; TL1703:=[807.5/E]; TL1802:=[809.5/S]; TL1701:=[804.5/W]
TL1703	TL1603; TL1704; TL1803; TL1702	TL1603:=[807.5/N]; TL1704:=[809.5/E]; TL1803:=[806.5/S]; TL1702:=[807.5/W]
TL1704	TL1604; TL1705; TL1804; TL1703	TL1604:=[808.5/N]; TL1705:=[809.5/E]; TL1804:=[805.5/S]; TL1703:=[809.5/W]
TL1705	TL1605; TL1706; TL1805; TL1704	TL1605:=[809.5/N]; TL1706:=[806.5/E]; TL1805:=[807.5/S]; TL1704:=[809.5/W]
TL1706	TL1606; TL1707; TL1806; TL1705	TL1606:=[919.5/N]; TL1707:=[929.5/E]; TL1806:=[919.5/S]; TL1705:=[978.5/W]
TL1707	TL1607; TL1708; TL1807; TL1706	TL1607:=[917.5/N]; TL1708:=[939.5/E]; TL1807:=[925.5/S]; TL1706:=[918.5/W]
TL1799	TL1699; TL1800; TL1899; TL1798	TL1699:=[816.0/N]; TL1800:=[828.5/E]; TL1899:=[826.0/S]; TL1798:=[808.5/W]
TL1800	TL1700; TL1801; TL1900; TL1799	TL1700:=[819.0/N]; TL1801:=[889.5/E]; TL1900:=[856.0/S]; TL1799:=[888.5/W]
TL1801	TL1701; TL1802; TL1901; TL1800	TL1701:=[806.0/N]; TL1802:=[809.5/E]; TL1901:=[807.5/S]; TL1800:=[902.0/W]
TL1802	TL1702; TL1803; TL1902; TL1801	TL1702:=[806.0/N]; TL1803:=[813.5/E]; TL1902:=[902.5/S]; TL1801:=[809.5/W]
TL1803	TL1703; TL1804; TL1903; TL1802	TL1703:=[806.5/N]; TL1804:=[808.5/E]; TL1903:=[803.5/S]; TL1802:=[813.5/W]
TL1804	TL1704; TL1805; TL1904; TL1803	TL1704:=[807.5/N]; TL1805:=[809.5/E]; TL1904:=[808.5/S]; TL1803:=[808.5/W]
TL1805	TL1705; TL1806; TL1905; TL1804	TL1705:=[804.5/N]; TL1806:=[807.5/E]; TL1905:=[809.5/S]; TL1804:=[809.5/W]
TL1806	TL1706; TL1807; TL1906; TL1805	TL1706:=[919.5/N]; TL1807:=[929.5/E]; TL1906:=[919.5/S]; TL1805:=[978.5/W]
TL1807	TL1707; TL1808; TL1907; TL1806	TL1707:=[917.5/N]; TL1808:=[939.5/E]; TL1907:=[925.5/S]; TL1806:=[918.5/W]
---	---	---
TRAFFIC LIGHTS' NEIGHBORS PROPERTY TABLE		

Table-1: TRAFFIC LIGHTS WITHIN FIREFIGHTER STATION & FIRE SPOT NEIGHBOR TO NEIGHBORS PROPERTY TABLE

TL #	CROSS STREET 1	CROSS STREET 2	CLOSER STREET 1	CLOSER STREET 2	CLOSER STREET (n)
---	---	---	Small Streets Closer to the TL (Optional)	Small Streets Closer to the TL (Optional)	Small Streets Closer to the TL (Optional)
TL1501	15th Street	1st Ave			
TL1502	15th Street	2nd Ave			
TL1503	15th Street	3rd Ave			
TL1504	15th Street	4th Ave			
TL1505	15th Street	5th Ave			
TL1601	16th Street	1st Ave			
TL1602	16th Street	2nd Ave			
TL1603	16th Street	3rd Ave			
TL1604	16th Street	4th Ave			
TL1605	16th Street	5th Ave			
TL1701	17th Street	1st Ave			
TL1702	17th Street	2nd Ave			
TL1703	17th Street	3rd Ave			
TL1704	17th Street	4th Ave			
TL1705	17th Street	5th Ave			
---	---	---			
TRAFFIC LIGHTS LOOKUP TABLE BY CROSS STREETS					

Table-2: TRAFFIC LIGHT SIMPLE DATABASE WITH CROSS STREETS

Emergency Traffic Lights Routing System

Henry V. Pham

Search for Shortest Route

Apply the optimization **G-ROUTING** algorithm to search for the shortest route along the crossed quadrant for the 1st traffic light number '**1701**' at the firefighter station to the destination traffic light number '**1504**' by starting with clockwise in outward direction with 90° turns at 12 O' clock with only North, East, and South then West directions. **Table-3** shows the sequences step-by-step for the optimization routes with ignoring the diagonal lines of traffic lights.

1. Start with TL number '**1701**' on the **left side**, there are 4 neighbor TL numbers '**1601, 1702, 1801, 1700**' in order of clockwise direction start at 12 O' clock; the following step '1.1' starts with 1st TL number '**1601**' with the outward directions has neighbor number '**1501**'; the next step '1.2' starts with 2nd TL number '**1702**' with the outward directions has neighbor TL number '**1703**'; the next steps would be the same for the other TL numbers '**1801**' with the neighbor TL number '**1901**' and '**1700**' with neighbor TL number '**1699**' in steps '1.3' and '1.4'.
2. Start with destination TL number '**1504'** on the **right side**, there are 4 neighbor TL numbers '**1404, 1505, 1604, 1503**' in order of clockwise direction start at 12 O' clock; the following step '1.1' starts with 1st TL number '**1404**' with the outward direction neighbor TL number '**1304**'; the next step '1.2' starts with 2nd TL number '**1505**' with outward direction neighbor TL number '**1506**'; the next steps would be the same for the other numbers '**1604**' with the neighbor TL number '**1704**' and '**1503**' with neighbor TL number '**1502**' in steps '1.3' and '1.4'.
3. Continue from both sides step-by-step with the sequences shown in **Table-3**, the optimization algorithm found a shared TL number '**1704**' in **East** direction of the TL number '**1701**' and in **South** direction of destination TL number '**1504**'; found another shared TL number '**1501**' in **North** direction of the source TL number '**1701**' and in **West** direction of destination TL number '**1504**'. These 2 shared TL numbers will create the 2 routes along the crossed quadrant of traffic lights with the series of routing TL numbers '**1701, 1601, 1501, 1502, 1503, 1504**' with 1 turn (North-to-East) direction as shown in **Table-5**; and '**1701, 1702, 1703, 1704, 1604, 1504**' with 1 turn (East-to-North) direction as shown in **Table-7**.

Pham, Henry V.
henryvpham@gmail.com

4. To complete searching for any shortcut routes within crossed quadrant, **Table-4** below shows the sequences with step-by-step starts with TL number '**1701**' on the **left side**, there are 2 neighbor TL numbers '**1601, 1702**' within the crossed quadrant in order of clockwise direction; the following step '1.1' starts with 1st TL number '**1601**' has 2 neighbor TL numbers '**1501, 1602**'; the next step '1.2' starts with 2nd TL number '**1702**' has 2 neighbor TL numbers '**1602**, **1703**' with duplicated TL number '**1602**' from the previous steps; the next steps would be the same for the other TL number '**1501**' in step '1.1.1' with the neighbor TL number '**1502**'; and '**1602**' with neighbor TL numbers '**1502, 1603**' in steps '1.1.2'. Note that the duplicated nodes (TL) numbers are eliminated by computer programming algorithm. The **right side** should be the same step-by-step sequences until both sides found a shared TL number; with more and more iterations, the algorithm will find more shared TL numbers for more routing options. **Table-4** below shows 3 shared TL numbers (**1501**; **1603**; **1704**) for 3 routes to compare to choose the best one.
5. The search result for 1st route with shared TL number '**1501**' with **1 turn** with total distance of '**4,012.00 meters**' is shown in **Table-5**; the 2nd route with shared TL number '**1603**' with **2 turns** with total distance of '**4,046.50 meters**' is shown in **Table-6**; and the 3rd route with shared TL number '**1704**' with **1 turn** with total distance of '**4,037.50 meters**' is shown in **Table-7**. So, the best route is the 1st one as shown **Table-5**. **Figure-4** shows the graphical traffic light routing for the 1st route from the Firefighter station to the destination traffic light.

START TL @ FIREFIGHTER STATION				START TL @ FIRE SPOT		
Steps	TL#	TL Neighbors		Steps	TL#	TL Neighbors
1	1701	1601, 1702, 1801, 1700		1	1504	1404, 1505, 1604, 1503
1.1	1601	1501		1.1	1404	1304
1.2	1702	1703		1.2	1505	1506
1.3	1801	1901		1.3	1604	1704
1.4	1700	1699		1.4	1503	1502
1.1.1	1501	1401		1.1.1	1304	1204
1.2.1	1703	1704		1.2.1	1506	1507
1.3.1	1901	2001		1.3.1	1704	1804
1.4.1	1699	1698		1.4.1	1502	1501
SEARCHING FOR CROSSING QUADRANT WITH OUTWARD DIRECTIONS						

Table-3: SEARCH FOR CROSSING QUADRANT WITH 90° OUTWARD DIRECTIONS G-ROUTING ALGORITHM

Emergency Traffic Lights Routing System

Henry V. Pham

START TL @ FIREFIGHTER STATION				START TL @ FIRE SPOT		
Steps	TL#	TL Neighbors		Steps	TL#	TL Neighbors
1	1701	1601, 1702		1	1504	1604, 1503
1.1	1601	1501, 1602		1.1	1604	1704, 1603
1.2	1702	1602, 1703		1.2	1503	1603, 1502
1.1.1	1501	1502		1.1.1	1704	1703
1.1.2	1602	1502, 1603		1.1.2	1603	1703, 1602
1.2.2	1703	1603, 1704		1.2.2	1502	1602, 1501
OPTIMIZATION SEARCHING WITHIN CROSSED QUADRANT						

Table-4: SEARCH WITHIN CROSSED QUADRANT OPTIMIZATION G-ROUTING ALGORITHM

Route/Step #	Traffic Lights #	Direction	Prev. Neighbor Distance (m)
1/1	1701	START	0.00
1/2	1601	N	807.50
1/3	1501	N	806.00
1/4	1502	E	788.50
1/5	1503	E	802.50
1/6	1504	E	807.50
Total Steps := 6	Total Turns := 1 (N,E)		Total Distance := 4,012.00

Table-5: FOUND CROSSED QUADRANT OPTIMIZATION ROUTE -1

Route/Step #	Traffic Lights #	Direction	Prev. Neighbor Distance (m)
2/1	1701	START	0.00
2/2	1601	N	807.50
2/3	1602	E	809.50
2/4	1603	E	813.50
2/5	1604	E	808.50
2/6	1504	N	807.50
Total Steps := 6	Total Turns := 2 (N,E,N)		Total Distance := 4,046.50

Table-6: FOUND CROSSED QUADRANT OPTIMIZATION ROUTE -2

Route/Step #	Traffic Lights #	Direction	Prev. Neighbor Distance (m)
3/1	1701	START	0.00
3/2	1702	E	804.50
3/3	1703	E	807.50
3/4	1704	E	809.50
3/5	1604	N	808.50
3/6	1504	N	807.50
Total Steps := 6	Total Turns := 1 (E,N)		Total Distance := 4,037.50

Table-7: FOUND CROSSED QUADRANT OPTIMIZATION ROUTE-3

henryvpham@gmail.com

Emergency Traffic Lights Routing System

Henry V. Pham

Figure-4: SHORTEST TRAFFIC LIGHT TO TRAFFIC LIGHTS TO DESTINATION ROUTE-1

Figure-4 is the street and traffic lights view of **Figure-1** above, and it shows the fastest route (route-1) from above routing sequence. Next section will have diagonal lines introduced into this traffic lights layout to demonstrate the G-ROUTING algorithm can find the shortcut when this layout is adding with streets in North-East direction from traffic light number '**1701**' to '**1602**', and traffic light number '**1602**' to '**1503**'. **Figure-5** in next section will show this shortcut route by the G-ROUTING algorithm.

COPY

Pham, Henry V.
henryvpham@gmail.com

www.TheCloudOSCenter.com

Emergency Traffic Lights Routing System

Henry V. Pham

Introduce Diagonals Traffic Lights Layout

In reality, the traffic lights could not be all in square or rectangle but the traffic lights could be in triangle or diagonal lines as shown in **Figure-5** as a shortcut route. **Table-8** shows the sequences step-by-step for the optimization routes with the diagonal lines of traffic lights within crossed quadrant.

1. Start with TL number '**1701**' on the **left side**, there are 3 neighbor TL numbers '**1601, 1602, 1702**' in order of clockwise direction within crossed quadrant starts at 12 O' clock; the following step '1.1' starts with 1st TL number '**1601**' has neighbor numbers '**1501, 1602**' with duplicated TL number '**1602**' from the previous step; the next step '1.2' starts with 2nd TL number '**1602**' has neighbor TL numbers '**1502, 1503, 1603**'; the next steps would be the same for the other TL number '**1702**' has neighbor numbers '**1602, 1703'**.
2. Start with TL number '**1504**' on the **right side**, there are 2 neighbor TL numbers '**1604, 1503**' in order of clockwise direction within crossed quadrant starts at 12 O' clock; the following step '1.1' starts with 1st TL number '**1604**' has neighbor numbers '**1704, 1603**'; the next step '1.2' starts with 2nd TL number '**1503**' has neighbor TL numbers '**1603, 1602, 1502**' with duplicated TL number '**1603**' from the previous step; the next steps would be the same for the other TL number '**1704**' has neighbor number '**1703'**.
3. Continue from both sides step-by-step with the sequences shown in **Table-8**, and the optimization algorithm found the 1st shared TL number '**1602**', 2nd shared TL number '**1502**', and 3rd shared TL number '**1503**'.
4. The search result for 1st route with shared TL number '**1602**'with **1 turn (NE-E)** with total distance of '**2,952.50 meters**' is shown in **Table-9**; the 2nd route with shared TL number '**1502**'with **2 turns (NE-N-E)** with total distance of '**3,592.50 meters**' is shown in **Table-10**; and the 3rd route with shared TL number '**1503**'with **1 turn (NE-E)** with total distance of '**2,952.50 meters**' is shown in **Table-11**. So, the best route is the 1st one as shown **Table-9**. **Figure-5** shows the graphical traffic light routing for the 1st route from the Firefighter station to the destination traffic light as a shortcut when introducing diagonal lines from **TL1701** to **TL1602** and to **TL1503** in North-East direction.

Emergency Traffic Lights Routing System

Henry V. Pham

START TL @ FIREFIGHTER STATION				START TL @ FIRE SPOT		
Steps	TL#	TL Neighbors		Steps	TL#	TL Neighbors
1	1701	1601, 1602, 1702		1	1504	1604, 1503
1.1	1601	1501, 1602		1.1	1604	1704, 1603
1.2	1602	1502, 1503, 1603		1.2	1503	1603, 1602, 1502
1.3	1702	1602, 1703		1.1.1	1704	1703
DIAGONAL DIRECTIONS OPTIMIZATION SEARCHING WITHIN CROSSED QUADRANT						

Table-8: SEARCH WITHIN CROSSED QUADRANT OPTIMIZATION G-ROUTING ALGORITHM

Route/Step #	Traffic Lights #	Direction	Prev. Neighbor Distance (m)
1/1	1701	START	0.00
1/2	1602	NE	1,076.50
1/3	1503	NE	1,068.50
1/4	1504	E	807.50
Total Steps := 4	Total Turns := 1 (NE,E)		Total Distance := 2,952.50

Table-9: FOUND CROSSED QUADRANT OPTIMIZATION ROUTE -1

Route/Step #	Traffic Lights #	Direction	Prev. Neighbor Distance (m)
2/1	1701	START	0.00
2/2	1602	NE	1,076.50
2/3	1502	N	806.00
2/4	1503	E	802.50
2/5	1504	E	807.50
Total Steps := 5	Total Turns := 2 (NE,N,E)		Total Distance := 3,492.50

Table-10: FOUND CROSSED QUADRANT OPTIMIZATION ROUTE -2

Route/Step #	Traffic Lights #	Direction	Prev. Neighbor Distance (m)
3/1	1701	START	0.00
3/2	1602	NE	1,076.50
3/3	1503	NE	1,068.50
3/4	1504	E	807.50
Total Steps := 4	Total Turns := 1 (NE,E)		Total Distance := 2,952.50

henryvpham@gmail.com

Table-11: FOUND CROSSED QUADRANT OPTIMIZATION ROUTE-3

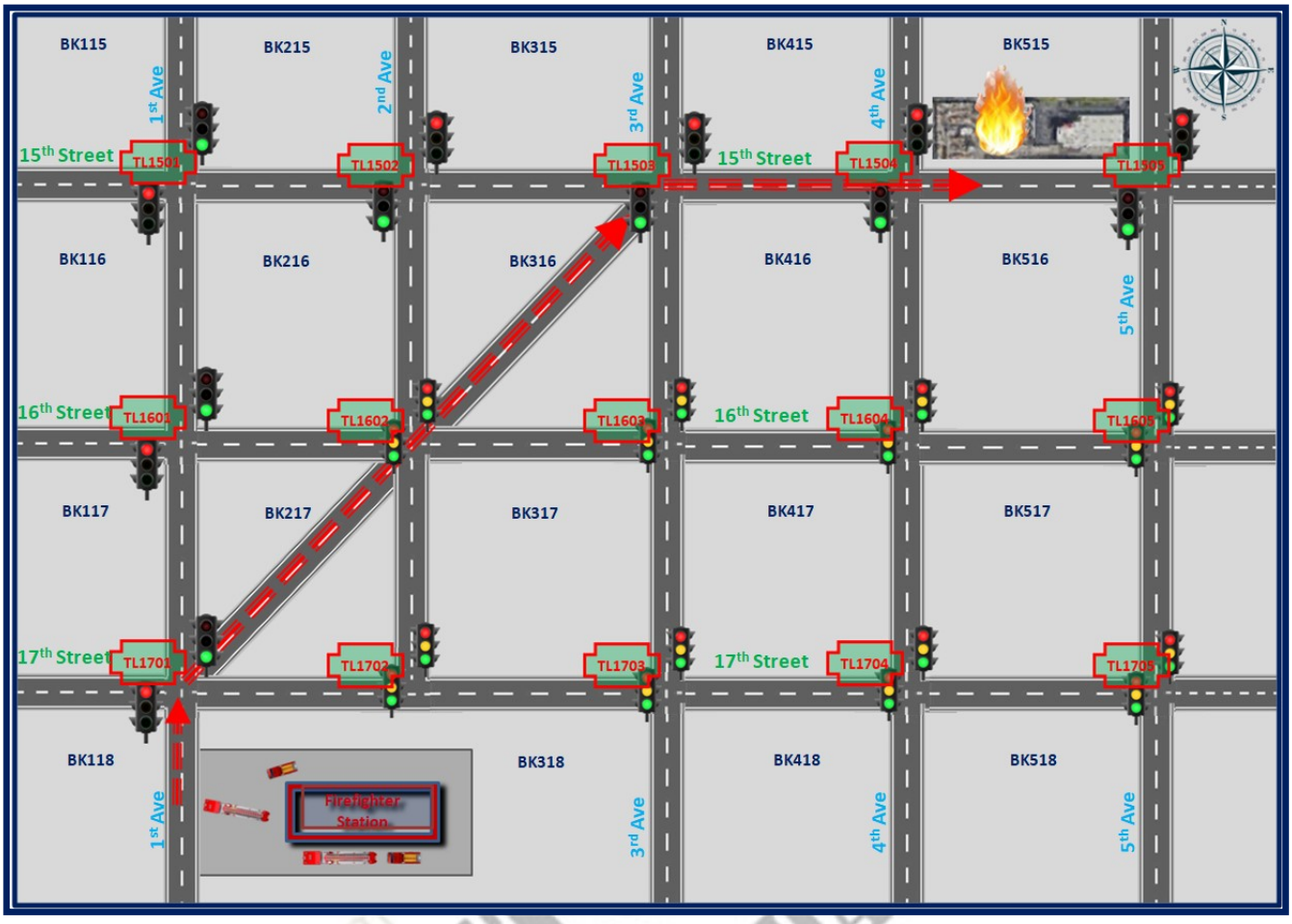
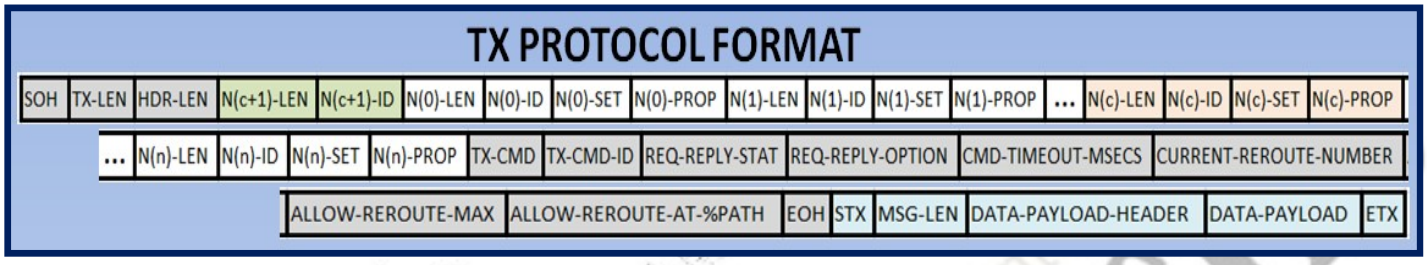


Figure-5: SHOREST TRAFFIC LIGHT TO TRAFFIC LIGHTS TO DESTINATION ROUTE-1

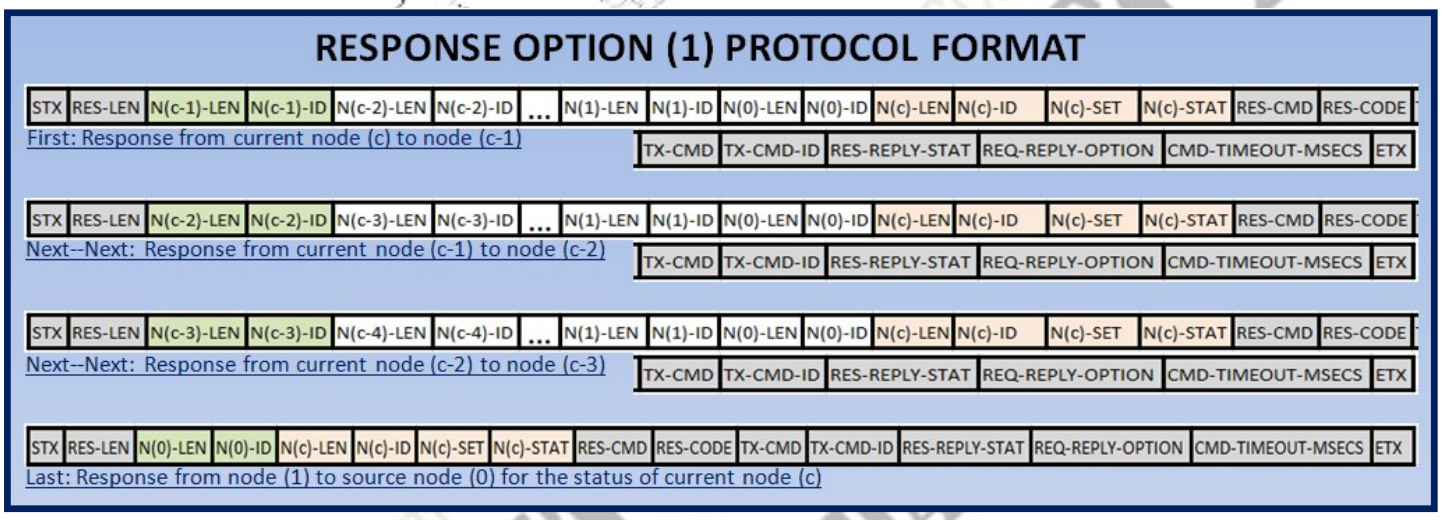
G-ROUTING Protocol Sequence references

The **G-ROUTING ALGORITHM** invention provides TX Protocol Format and RX Response Format as shown in **Reference-1** and **Reference-2** below. **Reference-1** shows the TX Protocol Format when a route is defined with the series of routing nodes 'N(0)…N(c)…N(n)'; where N(0) is the original source node (TL), N(c) is the current node (TL), and N(n) is the destination node (TL). The node with fields that highlight in **light-green** 'N(c+1)' is the next node to be transmitted to. When the field 'N(x)-SET' is set, 'N(x)-PROP' will be filled in either by the system or will ask to be filled in when a node is holding the package to be routed to the others; if this field 'N(x)-SET' is not set or '0x00' value, then the 'N(x)-PROP' will be NULL or empty. **Reference-2** shows response

option-1 with the requirement of every receiving node must replies to the system or the source node when received the data package as an acknowledgement of receiving data package and confirmed transmitting to the next node. This **Response Option-1** is the best option for **Emergency Traffic Lights Routing System**.



Reference-1: -- Figure-11: TX PROTOCOL FORMAT



Reference-2: -- Figure-12: RX RESPONSE OPTION (1) PROTOCOL FORMAT

Traffic Lights Routing Protocol Sequence

Now let's pick the best route in **Table-5** to demonstrate the routing sequence protocol. **Table-12** below shows TX/RX operational protocol forwarding sequence for the route in **Table-5** with the following routing TL nodes '**1701, 1601, 1501, 1502, 1503, 1504**'. From the Firefighter station, controller 'CTRLR' sends out TX message format in **Table-12** with a list of routing TL nodes; a sample node '**TL-1502**' is shown as '0x07:TL-1502:0x01:0x04:788.50' which '0x07' is ID length of '**TL-1502**' following with TL ID, then '0x01' as 'N(c)-SET' field indicates TX message has node property filled in by the system, and '788.50' is the property distance neighbor-to-neighbor (**TL-1501** to **TL-1502**) in meters with 4-bytes long; other TL nodes are shown in the same format in this

TX command '**5F**'. This TX command with parameters '**5F**(**1500**;**25**)' which defined 1500 (meters) as initial required distance to be set **green-lights** distance before the Firefighter truck starts moving; and with maximum defined speed of 25 (m/s). These parameters can be configurable depends on the local traffic condition requirements. Each TL will use these parameters to calculate the time the system requires each TL to be delayed to keep the **green distance** ahead of the Firefighter truck moving. The initial required distance of 1500 meters, so TL-1701 and TL-1601 no need to be delayed since total distance from TL-1701 to TL-1601 is 807.50 meters; **TL-1501** needs to be delayed 4.54 seconds before turns **green** based on the calculation '**(**0 + 807.5 + 806.0 - 1500**)**/25 = **4.54** seconds'. **TL-1502** to be delayed 31.54 seconds before turns **green** based on the calculation '**(**(0 + 807.5 + 806.0 + 788.5 - 1500)/25**)** - **4.54** = **31.54** seconds'; and **TL-1503** to be delayed 32.10 seconds before turns **green** based on '**(**(0 + 807.5 + 806.0 + 788.5 + 802.5 - 1500)/25**)** - **4.54** - **31.54** = **32.10** seconds', and so on. When TL received TX command, this TL **forwards without delaying** to the next routing TL and reply to the control center node right after. **However, the current TL will wait for the previous TL delaying time, and then takes its turn to delay with the delay timing seconds which was calculated above**. The **key point** here is when the TL received TX command, this TL forward to the next TL and reply to the control center to notify the system signal went through properly, and this TL will calculate the distance and the required velocity of the vehicle to be delay before turns **green**; this is the responsibility of each traffic light controller. And of course, the timing '**yellow**-to-**red**' of each traffic light must be used to calculated how much time left to keep **green**.

Table-12 also shows the response with Option-1 protocol, this is the best option for Emergency Traffic Lights Routing System; the system gets the response from each TL for monitoring and tracking purposes. The response sequence of **TL-1501** with 3 steps as shown in **Table-12** below is replying sequence neighbor-to-neighbor '**TL-1501; TL-1601, TL-1701**'. The **red** 'TL ID' field follows the 'RES-LEN' is the next neighbor to be replied back to the control center. Response from 'TL-1701' to control center node is ':**0x5:CTRLR:0x00**:0x07:TL-1501:0x00:5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX'; where '0x07:TL-1501' is the TL node to be responded with acknowledgement 'ACK' to the command '5F'; same format of responding for other TL nodes. The protocol sequence also supports multiple Firefighter stations sharing the same routes at the

COPYRIGHT © PROTECTED
HVPHAM

same time. When a route or part of a route is sharing, the sharing traffic lights will be used the shortest delay timing before turns **green** in forwarding TX message and keep green as longer as the last route requested.

TX/RX OPERATIONAL PROTOCOL FORWARDING SEQUENCES (CMD:=5F)			
RCVD-TL-ID		**TX/RX MESSAGE FORMAT**	**DELAY SECS**
CTRLR		SOH:TX-LEN:HDR-LEN:0x07:TL-1701:0x5:CTRLR:0x00:0x07:TL-1701:0x01:0x04:0.00:0x07:TL-1601:0x01:0x04:807.50: 0x07:TL-1501:0x01:0x04:806.00:0x07:TL-1502:0x01:0x04:788.50:0x07:TL-1503:0x01:0x04:802.50: 0x07:TL-1504:0x01:0x04:807.50:5F(1500;25):0x01:0x00:0x01:60000:0x00:0x00:0x00:EOH	
TL-1701		SOH:TX-LEN:HDR-LEN:0x07:TL-1601:0x5:CTRLR:0x00:0x07:TL-1701:0x01:0x04:0.00:0x07:TL-1601:0x01:0x04:807.50: 0x07:TL-1501:0x01:0x04:806.00:0x07:TL-1502:0x01:0x04:788.50:0x07:TL-1503:0x01:0x04:802.50: 0x07:TL-1504:0x01:0x04:807.50:5F(1500;25):0x01:0x00:0x01:60000:0x00:0x00:0x00:EOH	0.00
Response	TL-1701	STX:RES-LEN:0x5:CTRLR:0x00:0x07:TL-1701:0x00: 5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	
TL-1601		SOH:TX-LEN:HDR-LEN:0x07:TL-1501:0x5:CTRLR:0x00:0x07:TL-1701:0x01:0x04:0.00:0x07:TL-1601:0x01:0x04:807.50: 0x07:TL-1501:0x01:0x04:806.00:0x07:TL-1502:0x01:0x04:788.50:0x07:TL-1503:0x01:0x04:802.50: 0x07:TL-1504:0x01:0x04:807.50:5F(1500;25):0x01:0x00:0x01:60000:0x00:0x00:0x00:EOH	0.00
Response Sequence	TL-1601	STX:RES-LEN:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1601:0x00: 5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	
	TL-1701	STX:RES-LEN:0x5:CTRLR:0x00:0x07:TL-1601:0x00: 5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	
TL-1501		SOH:TX-LEN:HDR-LEN:0x07:TL-1502:0x5:CTRLR:0x00:0x07:TL-1701:0x01:0x04:0.00:0x07:TL-1601:0x01:0x04:807.50: 0x07:TL-1501:0x01:0x04:806.00:0x07:TL-1502:0x01:0x04:788.50:0x07:TL-1503:0x01:0x04:802.50: 0x07:TL-1504:0x01:0x04:807.50:5F(1500;25):0x01:0x00:0x01:60000:0x00:0x00:0x00:EOH	4.54
Response Sequence	TL-1501	STX:RES-LEN:0x07:TL-1601:0x00:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1501:0x00: 5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	
	TL-1601	STX:RES-LEN:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1501:0x00: 5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	
	TL-1701	STX:RES-LEN:0x5:CTRLR:0x00:0x07:TL-1501:0x00: 5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	
TL-1502		SOH:TX-LEN:HDR-LEN:0x07:TL-1503:0x5:CTRLR:0x00:0x07:TL-1701:0x01:0x04:0.00:0x07:TL-1601:0x01:0x04:807.50: 0x07:TL-1501:0x01:0x04:806.00:0x07:TL-1502:0x01:0x04:788.50:0x07:TL-1503:0x01:0x04:802.50: 0x07:TL-1504:0x01:0x04:807.50:5F(1500;25):0x01:0x00:0x01:60000:0x00:0x00:0x00:EOH	31.54
Response Sequence	TL-1502	STX:RES-LEN:0x07:TL-1501:0x00:0x07:TL-1601:0x00:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1502:0x00: 5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	
	TL-1501	STX:RES-LEN:0x07:TL-1601:0x00:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1502:0x00: 5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	
	TL-1601	STX:RES-LEN:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1502:0x00: 5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	
	TL-1701	STX:RES-LEN:0x5:CTRLR:0x00:0x07:TL-1502:0x00: 5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	

TL-1503		SOH:TX-LEN:HDR-LEN:0x07:TL-1504:0x5:CTRLR:0x00:0x07:TL-1701:0x01:0x04:0.00:0x07:TL-1601:0x01:0x04:807.50: 0x07:TL-1501:0x01:0x04:806.00:0x07:TL-1502:0x01:0x04:788.50:0x07:TL-1503:0x01:0x04:802.50: 0x07:TL-1504:0x01:0x04:807.50:5F(1500;25):0x01:0x00:0x01:60000:0x00:0x00:0x00:EOH	32.10
Response Sequence	TL-1503	STX:RES-LEN:0x07:TL-1502:0x00:0x07:TL-1501:0x00:0x07:TL-1601:0x00:0x07:TL-1701:0x00:0x5:CTRLR:0x00: 0x07:TL-1503:0x00:5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	
	TL-1502	STX:RES-LEN:0x07:TL-1501:0x00:0x07:TL-1601:0x00:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1503:0x00: 5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	
	TL-1501	STX:RES-LEN:0x07:TL-1601:0x00:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1503:0x00: 5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	
	TL-1601	STX:RES-LEN:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1503:0x00: 5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	
	TL-1701	STX:RES-LEN:0x5:CTRLR:0x00:0x07:TL-1503:0x00: 5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	
TL-1504		DESTINATION TL NODE	32.30
Response Sequence	TL-1504	STX:RES-LEN:0x07:TL-1503:0x00:0x07:TL-1502:0x00:0x07:TL-1501:0x00:0x07:TL-1601:0x00:0x07:TL-1701:0x00: 0x5:CTRLR:0x00:0x07:TL-1504:0x00:5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	
	TL-1503	STX:RES-LEN:0x07:TL-1502:0x00:0x07:TL-1501:0x00:0x07:TL-1601:0x00:0x07:TL-1701:0x00:0x5:CTRLR:0x00: 0x07:TL-1504:0x00:5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	
	TL-1502	STX:RES-LEN:0x07:TL-1501:0x00:0x07:TL-1601:0x00:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1504:0x00: 5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	
	TL-1501	STX:RES-LEN:0x07:TL-1601:0x00:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1504:0x00: 5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	
	TL-1601	STX:RES-LEN:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1504:0x00: 5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	
	TL-1701	STX:RES-LEN:0x5:CTRLR:0x00:0x07:TL-1504:0x00: 5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	
OPERATIONAL ROUTE-1			
NOTE: The separator ':' using here is just for viewing only.			

Table-12: SHOREST TRAFFIC LIGHTS ROUTE-1 – TX/RX OPERATIONAL PROTOCOL SEQUENCE

Table-13 below shows TX/RX operational protocol forwarding sequence for the route in **Table-9** with the following routing TL nodes '**1701, 1602, 1503, 1504**' with same operational protocol sequence as shown above with Response Protocol Option-1. Similar to the above description of operational protocol sequence with initial required distance 1500 meters and maximum velocity 25 m/s of the vehicle, TL-1503 delays 25.8 seconds and TL-1504 delays 32.30 seconds before turns **green**.

Emergency Traffic Lights Routing System

Henry V. Pham

TX/RX W/ DIAGONALS OPERATIONAL PROTOCOL FORWARDING SEQUENCES (CMD:=5F)			
RCVD-TL-ID		TX/RX MESSAGE FORMAT	DELAY SECS
CTRLR		SOH:TX-LEN:HDR-LEN:0x07:TL-1701:0x5:CTRLR:0x00:0x07:TL-1701:0x01:0x04:0.00:0x07:TL-1602:0x01:0x04:1076.50: 0x07:TL-1503:0x01:0x04:1068.50:0x07:TL-1504:0x01:0x04:807.50: 5F(1500;25):0x01:0x00:0x01:60000:0x00:0x00:0x00:EOH	
TL-1701		SOH:TX-LEN:HDR-LEN:0x07:TL-1602:0x5:CTRLR:0x00:0x07:TL-1701:0x01:0x04:0.00:0x07:TL-1602:0x01:0x04:1076.50: 0x07:TL-1503:0x01:0x04:1068.50:0x07:TL-1504:0x01:0x04:807.50: 5F(1500;25):0x01:0x00:0x01:60000:0x00:0x00:0x00:EOH	0.00
Response	TL-1701	STX:RES-LEN:0x5:CTRLR:0x00:0x07:TL-1701:0x00:5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	
TL-1602		SOH:TX-LEN:HDR-LEN:0x07:TL-1503:0x5:CTRLR:0x00:0x07:TL-1701:0x01:0x04:0.00:0x07:TL-1602:0x01:0x04:1076.50: 0x07:TL-1503:0x01:0x04:1068.50:0x07:TL-1504:0x01:0x04:807.50: 5F(1500;25):0x01:0x00:0x01:60000:0x00:0x00:0x00:EOH	0.00
Response	TL-1602	STX:RES-LEN:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1602:0x00:5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	
	TL-1701	STX:RES-LEN:0x5:CTRLR:0x00:0x07:TL-1602:0x00:5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	
TL-1503		SOH:TX-LEN:HDR-LEN:0x07:TL-1504:0x5:CTRLR:0x00:0x07:TL-1701:0x01:0x04:0.00:0x07:TL-1602:0x01:0x04:1076.50: 0x07:TL-1503:0x01:0x04:1068.50:0x07:TL-1504:0x01:0x04:807.50: 5F(1500;25):0x01:0x00:0x01:60000:0x00:0x00:0x00:EOH	25.80
Response Sequence	TL-1503	STX:RES-LEN:0x07:TL-1602:0x00:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1503:0x00: 5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	
	TL-1602	STX:RES-LEN:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1503:0x00:5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	
	TL-1701	STX:RES-LEN:0x5:CTRLR:0x00:0x07:TL-1503:0x00:5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	
TL-1504		DESTINATION TL NODE	32.30
Response Sequence	TL-1504	STX:RES-LEN:0x07:TL-1503:0x00:0x07:TL-1602:0x00:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1504:0x00: 5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	
	TL-1503	STX:RES-LEN:0x07:TL-1602:0x00:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1504:0x00: 5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	
	TL-1602	STX:RES-LEN:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1504:0x00:5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	
	TL-1701	STX:RES-LEN:0x5:CTRLR:0x00:0x07:TL-1504:0x00:5F:ACK:5F(1500;25):0x01:0x00:0x01:60000:ETX	
W/ DIAGONALS OPERATIONAL ROUTE-1			
NOTE: The separator ':' using here is just for viewing only.			

Table-13: WITH DIAGONALS SHOREST TRAFFIC LIGHTS ROUTE-1 – TX/RX OPERATIONAL PROTOCOL SEQUENCE

Testing Traffic Lights Routing Sequence

Table-14 below shows TX/RX testing CMD:=[FF] protocol forwarding sequence with Response Protocol Option-1 without delaying of TX message forwarding; and this feature is used for testing purposes only to check and confirm the all the traffic lights are in good condition when the Emergency System is free. This testing sequence can be used to check each row or each column or each route of traffic lights layout for each city or county; and can be testing throughout the entire traffic lights of the local area.

Emergency Traffic Lights Routing System

Henry V. Pham

TX/RX TESTING PROTOCOL FORWARDING SEQUENCES (CMD:=FF)		
RCVD-TL-ID		**TX/RX MESSAGE FORMAT**
CTRLR		SOH:TX-LEN:HDR-LEN:0x07:TL-1701:0x5:CTRLR:0x00:0x07:TL-1701:0x00:0x07:TL-1601:0x00:0x07:TL-1501:0x00:0x07:TL-1502:0x00:0x07:TL-1503:0x00:0x07:TL-1504:0x00:FF(01):0xF1:0x01:0x01:60000:EOH
TL-1701		SOH:TX-LEN:HDR-LEN:0x07:TL-1601:0x5:CTRLR:0x00:0x07:TL-1701:0x00:0x07:TL-1601:0x00:0x07:TL-1501:0x00:0x07:TL-1502:0x00:0x07:TL-1503:0x00:0x07:TL-1504:0x00:FF(01):0xF1:0x01:0x01:60000:EOH
Response	TL-1701	STX:RES-LEN:0x5:CTRLR:0x00:0x07:TL-1701:0x10:0x02:0x1234:FF:ACK:FF(01):0x01:0x00:0x01:60000:ETX
TL-1601		SOH:TX-LEN:HDR-LEN:0x07:TL-1501:0x5:CTRLR:0x00:0x07:TL-1701:0x00:0x07:TL-1601:0x00:0x07:TL-1501:0x00:0x07:TL-1502:0x00:0x07:TL-1503:0x00:0x07:TL-1504:0x00:FF(01):0xF1:0x01:0x01:60000:EOH
Response	TL-1601	STX:RES-LEN:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1601:0x10:0x02:0x1234:FF:ACK:FF(01):0x01:0x00:0x01:60000:ETX
	TL-1701	STX:RES-LEN:0x5:CTRLR:0x00:0x07:TL-1601:0x10:0x02:0x1234:FF:ACK:FF(01):0x01:0x00:0x01:60000:ETX
TL-1501		SOH:TX-LEN:HDR-LEN:0x07:TL-1502:0x5:CTRLR:0x00:0x07:TL-1701:0x00:0x07:TL-1601:0x00:0x07:TL-1501:0x00:0x07:TL-1502:0x00:0x07:TL-1503:0x00:0x07:TL-1504:0x00:FF(01):0xF1:0x01:0x01:60000:EOH
Response Sequence	TL-1501	STX:RES-LEN:0x07:TL-1601:0x00:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1501:0x10:0x02:0x1234:FF:ACK:FF(01):0x01:0x00:0x01:60000:ETX
	TL-1601	STX:RES-LEN:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1501:0x10:0x02:0x1234:FF:ACK:FF(01):0x01:0x00:0x01:60000:ETX
	TL-1701	STX:RES-LEN:0x5:CTRLR:0x00:0x07:TL-1501:0x10:0x02:0x1234:FF:ACK:FF(01):0x01:0x00:0x01:60000:ETX
TL-1502		SOH:TX-LEN:HDR-LEN:0x07:TL-1503:0x5:CTRLR:0x00:0x07:TL-1701:0x00:0x07:TL-1601:0x00:0x07:TL-1501:0x00:0x07:TL-1502:0x00:0x07:TL-1503:0x00:0x07:TL-1504:0x00:FF(01):0xF1:0x01:0x01:60000:EOH
Response Sequence	TL-1502	STX:RES-LEN:0x07:TL-1501:0x00:0x07:TL-1601:0x00:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1502:0x10:0x02:0x1234:FF:ACK:FF(01):0x01:0x00:0x01:60000:ETX
	TL-1501	STX:RES-LEN:0x07:TL-1601:0x00:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1502:0x10:0x02:0x1234:FF:ACK:FF(01):0x01:0x00:0x01:60000:ETX
	TL-1601	STX:RES-LEN:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1502:0x10:0x02:0x1234:FF:ACK:FF(01):0x01:0x00:0x01:60000:ETX
	TL-1701	STX:RES-LEN:0x5:CTRLR:0x00:0x07:TL-1502:0x10:0x02:0x1234:FF:ACK:FF(01):0x01:0x00:0x01:60000:ETX
TL-1503		SOH:TX-LEN:HDR-LEN:0x07:TL-1504:0x5:CTRLR:0x00:0x07:TL-1701:0x00:0x07:TL-1601:0x00:0x07:TL-1501:0x00:0x07:TL-1502:0x00:0x07:TL-1503:0x00:0x07:TL-1504:0x00:FF(01):0xF1:0x01:0x01:60000:EOH
Response Sequence	TL-1503	STX:RES-LEN:0x07:TL-1502:0x00:0x07:TL-1501:0x00:0x07:TL-1601:0x00:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1503:0x10:0x02:0x1234:FF:ACK:FF(01):0x01:0x00:0x01:60000:ETX
	TL-1502	STX:RES-LEN:0x07:TL-1501:0x00:0x07:TL-1601:0x00:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1503:0x10:0x02:0x1234:FF:ACK:FF(01):0x01:0x00:0x01:60000:ETX
	TL-1501	STX:RES-LEN:0x07:TL-1601:0x00:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1503:0x10:0x02:0x1234:FF:ACK:FF(01):0x01:0x00:0x01:60000:ETX
	TL-1601	STX:RES-LEN:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1503:0x10:0x02:0x1234:FF:ACK:FF(01):0x01:0x00:0x01:60000:ETX
	TL-1701	STX:RES-LEN:0x5:CTRLR:0x00:0x07:TL-1503:0x10:0x02:0x1234:FF:ACK:FF(01):0x01:0x00:0x01:60000:ETX
TL-1504		DESTINATION TL NODE
Response Sequence	TL-1504	STX:RES-LEN:0x07:TL-1503:0x00:0x07:TL-1502:0x00:0x07:TL-1501:0x00:0x07:TL-1601:0x00:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1504:0x10:0x02:0x1234:FF:ACK:FF(01):0x01:0x00:0x01:60000:ETX
	TL-1503	STX:RES-LEN:0x07:TL-1502:0x00:0x07:TL-1501:0x00:0x07:TL-1601:0x00:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1504:0x10:0x02:0x1234:FF:ACK:FF(01):0x01:0x00:0x01:60000:ETX
	TL-1502	STX:RES-LEN:0x07:TL-1501:0x00:0x07:TL-1601:0x00:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1504:0x10:0x02:0x1234:FF:ACK:FF(01):0x01:0x00:0x01:60000:ETX
	TL-1501	STX:RES-LEN:0x07:TL-1601:0x00:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1504:0x10:0x02:0x1234:FF:ACK:FF(01):0x01:0x00:0x01:60000:ETX
	TL-1601	STX:RES-LEN:0x07:TL-1701:0x00:0x5:CTRLR:0x00:0x07:TL-1504:0x10:0x02:0x1234:FF:ACK:FF(01):0x01:0x00:0x01:60000:ETX
	TL-1701	STX:RES-LEN:0x5:CTRLR:0x00:0x07:TL-1504:0x10:0x02:0x1234:FF:ACK:FF(01):0x01:0x00:0x01:60000:ETX
TESTING PROTOCOL FORWARDING SEQUENCES		
NOTE: The separator ':' using here is just for viewing only.		

Table-14: TESTING/DIAGNOSTIC TRAFFIC LIGHTS PROTOCOL SEQUENCE

Pham, Henry V.
henryvpham@gmail.com

Emergency Traffic Lights Routing System

Henry V. Pham

Conclusion

The **Emergency Traffic Lights Routing System** is invented with State-Of-The-Art with the main purpose of find a shortest routing distance and set the routing traffic lights turn green ahead of rescue vehicle before the rescue vehicle moving. The system will be great help to rescue fires, rescue critical health condition people, and even great rescue in disaster emergency situations.

The existing traffic lights controllers can be improved to support **Emergency Traffic Lights Routing System** by adding RF wireless device into the traffic light controller for each traffic corner. This invention would be helpful for rescuer team moving on the fastest route with pre-green traffic lights to rescue safer and faster. With existing traffic lights system, rescue vehicles may be stuck in the traffic at high traffic conditions when both sides of the roads are fully with cars and trucks. The **Emergency Traffic Lights Routing System** will help to clear the traffic before the rescue vehicles start moving; this is a great help to rescue in critical emergency situation or in disaster situation in bad traffic condition.

The **Emergency Traffic Lights Routing System** will be great for smart city in the future, and the community will be safer with fast rescue responding.

COPYRIGHT© PH
-HVPHAM
Henry V. Pham

Pham, Henry V.
henryvpham@gmail.com