Report 06: Final Report: Project description and Support Documents for ITS – UTMS Project for Greater Kingston Area, Jamaica

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ABBREVIATIONS

CAPEX Capital Expenditure

CBA Cost Benefit Analysis

CBR Cost Benefit Ratio

CEA Cost Effectiveness Analysis

CO Carbon monoxide

CO_2 Carbon dioxide

CVD Clean Vehicles Directive [1]

DK Denmark

DOT Department of Transportation

EFA European Free Alliance

EREV Electric Vehicles with a Range Extender

ERR External Rate of Return

EV Electric Vehicle

EXW ExWorks

FEV Full Electric Vehicle

FR France

g gram

gal Gallon

GIZ Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

GKA Greater Kingston Area

GTZ Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH

ICE Internal Combustion Engine

IDB Inter-American Development Bank

IT Italy

ITS Intelligent Transportation Systems

[1] European Commission's Clean Vehicle Portal: Directive 2009/33/EC

JMD	Jamaican Dollar
kg	Kilogram
lb	Pound
LCV	Light Commercial Vehicle
MCV	Medium Commercial Vehicle
NPV	Net Present Value
NL	The Netherlands
NOx	Nitric Oxide and Nitrogen Dioxide
NWA	National Works Agency
OLC	Operational Lifetime Cost
OPEX	Operational Expenditure
PC-S	Small Passenger Car
PC-M	Medium Passenger Car
PC-L	Large Passenger Car
PHEV	Plug-in Hybrid Electric Vehicles
PL	Poland
PM_{10}	Particulate Matter 10 micrometers or less in diameter
$PM_{2.5}$	Particulate Matter 2.5 micrometers or less in diameter
PrT	Private Transport
PuT	Public Transport
SOP	Standard Operational Procedures
SUTP	Sustainable Urban Transport Project
SUV	Sport Utility Vehicle
SWE	Sweden
THC	Totally Hydrocarbons
UK	United Kingdom
US$	United States Dollar
US$ M	Million United States Dollar

UTMS Urban Traffic Management System

VOC Volatile Organic Compounds

1 PROJECT OBJECTIVE AND SCOPE

1.1 MAIN PROJECT COMPONENT OBJECTIVE

The main objective of the present project component is the improvement of energy efficiency in urban mobility in the Greater Kingston Area. The goals will be achieved through the implementation and operation of Intelligent Transportation Systems (ITS) that will coordinate traffic flows over several corridors.

1.2 GENERAL OBJECTIVES

As all mobility and technology projects the following objectives will also have to be taken into account:

- **Traffic safety:** The project shall maintain or improve traffic safety for all users.
- **Respect:** The project design shall include measures to enhance respect for vulnerable road users such as pedestrians.
- **Sustainability:** The project design shall assure sustainability through operational independency.
- **Scalability:** The project design shall allow the project to grow if needed.

1.3 LINES OF ACTION

The objective will be achieved through the following lines of action:

- **Line of action 1:** Coordination of currently non coordinated traffic lights on the main corridors and access roads. This will allow for a more homogeneous traffic flow and less travel time and involuntary stops.
- **Line of action 2:** Improvement of traffic planning, traffic planning processes and traffic planning competences. This will allow to make maximum use of the new technological infrastructure towards maximization of benefits.
- **Line of action 3:** Driver information systems. This will allow drivers to take routing decisions based on the current traffic dynamics.
- **Line of action 4:** Operational and maintenance autonomy. This will allow to attend traffic and technological incidents in a fast and efficient matter.

1.4 ENABLING FACTORS

The enabling factors are:

- **Telecommunications:** An integrated telecommunications network based on high speed fiber optic cable, robust switching technology and an efficient network layout.
- **Sensors:** Deployment of a traffic sensor network to acquire traffic flows, traffic movements and detect specific vehicles along the main corridors.
- **Information:** Installation of variable message signs giving reliable and up to date traffic information to the travelers.
- **Supervision:** CCTV cameras on important intersections in the traffic network.

- **Software:** Specialized software for traffic planning and operation of the system
- **Tools:** Specialized equipment for maintenance tasks in the communication network and on the traffic light infrastructure.
- **Knowledge:** Knowledge of planning and operation processes.
- **Processes:** Documentation of standard operational procedures

1.5 AREA OF INTERVENTION

The greater Kingston area covers the following cities:

- Kingston
- Portmore
- Spanish Town

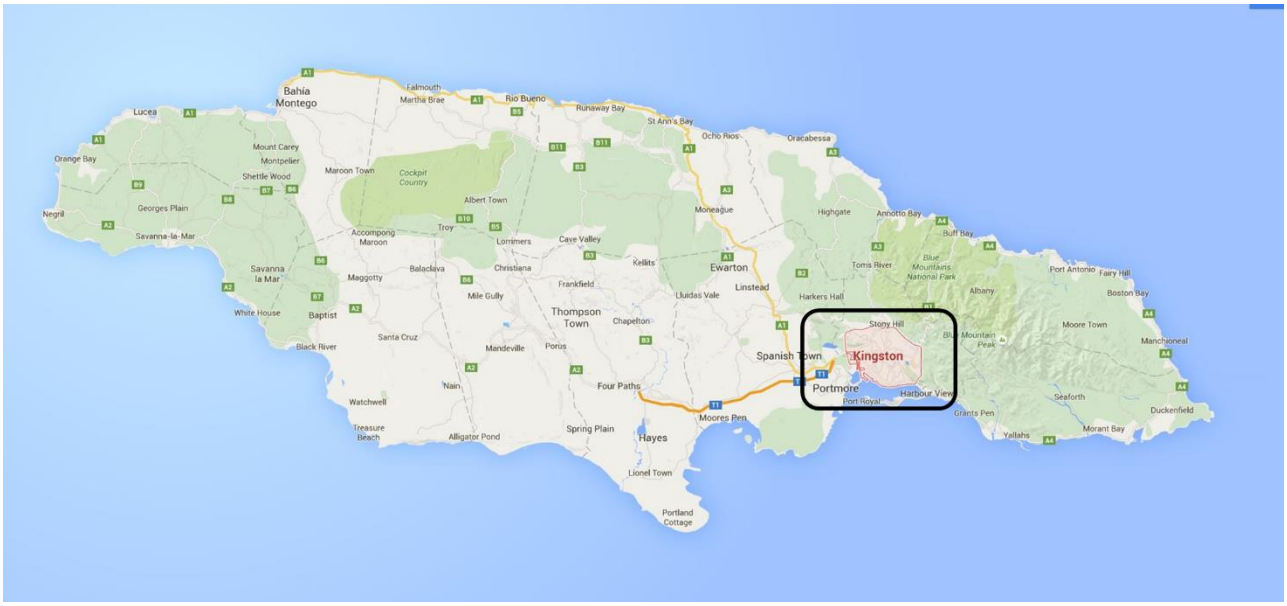

Figure 1 - General location of Greater Kingston Area

1.6 CURRENT SITUATION

Currently the Greater Kingston Area and the whole of Jamaica do count on traffic control equipment. Signal timing is updated regularly by the traffic engineers from NWA. Nevertheless, the impact is far below the technologies capabilities, due to the lack of communications, which are needed to enable coordinated and dynamic traffic regulation schemes.

This means that the vast majority of controllers are not interconnected with the traffic control computer, neither do they have sensors that detect the current traffic situation, making them work on isolated fix time, not allowing any direct, dynamic and timely interaction with the traffic or coordinated traffic schemes over several intersections.

The time between the detection of traffic patterns and the implementation of updated signal timing can take weeks, months and sometimes years, while with traffic sensors connected to the local controller, this delay can shrink to minutes, seconds or in newer technologies even to instants.

To allow more efficient traffic regulation schemes, the following main enabling technologies and components are needed:

- **Communications:** A reliable communications network that enables 1) the gathering of online traffic information through sensors and 2) the central command to achieve cooperation between the different traffic controllers on corridors in the road network.
- **Controller hardware:** Hardware that enables the interconnection of and functional enhancement of existing traffic controllers
- **Software & methods:** Software, methods and training to enable the engineers of NWA to implement and maintain dynamic and coordinated traffic regulation schemes
- **CCTV:** Cameras to enable visualization of incidents, special events and other situation and dynamic decision taking.
- **Sensors:** Additional sensors that enables the detection not only of local traffic situations, but also the mobility patterns and mean travel times in the city.
- **Signalization:** Additional means of communication with driver, through dynamic message signs enabling drivers to take decisions on their mobility routing choices.

The current traffic control system has a standard 3.5 level logical architecture scheme. The architecture is clearly identifiable, only partially implemented, but allows easy expansion and modernization of the system.

1.7 PRESENT PROJECT

One of the big advantages in the Greater Kingston Area is the availability of a vast amount of underground tubing, ready to receive fiber optic cable. Also some fiber optic cable is already available.

Being civil works one of the biggest concerns in cost, environmental requirements and project schedules, this underground infrastructure is ready to go, minimizing risks of delays and allowing the project to be a pure telematics technology project rather than a mix of technology and civil works.

During the design process, the logical architecture scheme was streamlined, expanded to new technology elements and updated to a pure 3 level architecture, integrating all existing and usable elements.

The current project is focused on providing the following additional or enhanced elements:

- **Central control:** Deployment of the high level ITS integration platform SunGuide, from the Florida DOT. Enhancement of server capacity. Installation of modern tools for traffic planning and traffic modelling. Installation of additional firewall protection against outside intrusions.
- **Communications:** Installation and splicing of fiber optic cable. Deployment of a reliable and rugged communications backbone throughout the Greater Kingston Area. Deployment of manageable switches on intersection level. Provision of spare ducts for maintenance purposes.

- **Peripheral devices:** Update of traffic controllers with memory modules, conflict monitors and communication interfaces. Deployment of non-invasive detectors for traffic presence, traffic count, travel time, traffic patterns and license plate recognition. Deployment of dynamic message signs. Deployment of CCTV cameras.
- **Operational capacity and training:** Documentation of baseline and evolving traffic. Development of standard operational procedures SOPs. Training in current and new system components, as well as planning and modelling. Coaching in planning, operation and maintenance.
- **Others:** Provision of necessary instruments and tools for maintenance of existing and new technologies and components.

Figure 2 - Greater Kingston Area cities

1.8 PROJECT SCOPE

The project scope comprises implementation of new and additional technologies in the framework of a multi-level approach:

Figure 3 - Pillars of sustainable mobility in ITS related projects [2]

The project components related with the pillars for sustainable mobility in the current project are:

- **Technology:** The project shall include the **provision of technologies** required to achieve operational conditions that allow the coordination of existing and new traffic lights.
- **Infrastructure:** The project shall include **no physical infrastructure**, all necessary physical and civil infrastructure is provided by the NWA
- **Planning:** The current project shall include the **provision of high end planning tools and training** in tools and methods, to enable NWA to make maximum use of the technologies to be implemented.
- **Enforcement:** The current project shall include the **provision of enabling technologies** that allow NWA to do better supervision and support enforcement done by other agencies.
- **Behavior:** The current project shall deliver improvements in urban mobility quality that bring further **improvement of behavior** of drivers as well as people in other motorized or non-motorized means of transport.

[2] Source: Manual for ITS Design, SIT Ltda, Colombia, 2014

2 TRAFFIC MODEL

The traffic model realized a comparison (impact analysis) between 2 scenarios:

- Kingston without ITS Project (current situation)
- Kingston with ITS Project (future situation)

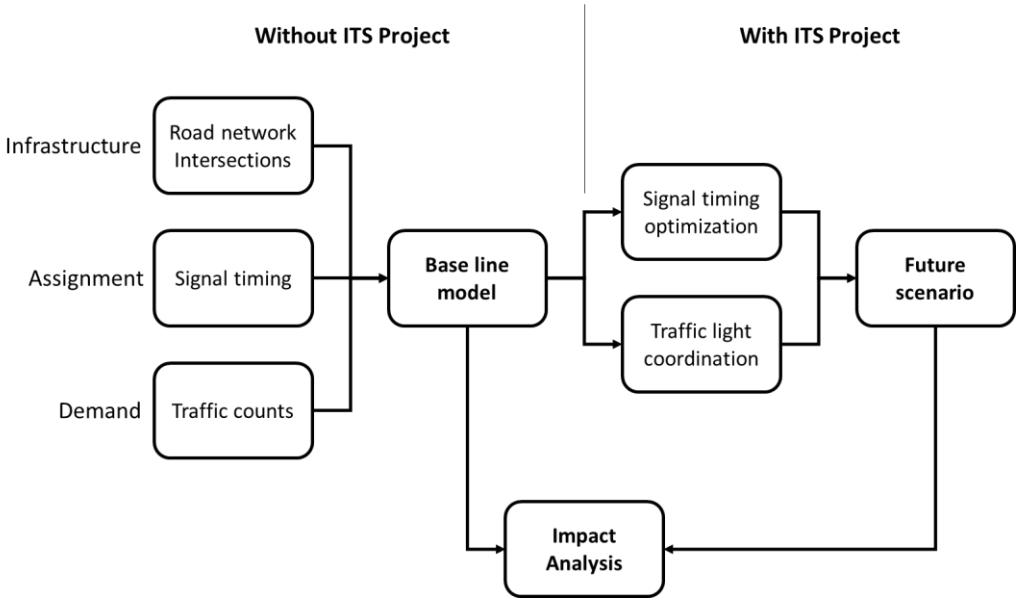

Figure 4 - Logical development of traffic model

Being:

- **Infrastructure:** Road network, intersections, usage rules, etc.
- **Assignment:** Current signal timing of the signalized intersections, turn relations, etc.
- **Demand:** Traffic counts data, etc.
- **Base line model:** Model of current situation (Kingston without ITS Project)
- **Optimization:** Signal timing optimization, traffic light coordination, etc.
- **Future scenario:** Model of future scenario (Kingston with OTS Project)
- **Impact analysis:** Comparison of current and future scenario, fuel consumption, some environmental indicators, etc.

3 GENDER ASPECTS

3.1 CURRENT SITUATION

The planning, operation and maintenance of the new system is responsibility of the Planning and Research Directorate of NWA.

The current staff and gender distribution are (female in red):

NWA Planning and Research Directorate

Traffic Management Unit – Traffic Signal / Road Marking Crews

Distribution: 38% female (F), 62% male (M)

- Michael Saunderson (M)
- Dane Lawrence (M)
- Barrington Cross (M)
- Judy Kaye Grant (F)
- Judy Watson (F)
- Michael Smith (M)
- Georgia Henry (M)
- Peter McDonald (M)
- Dalton Brown (M)
- Zodi Ann Clachar (F)
- Gareth Hutchinson (M)
- Oshane Lyn (M)
- Kerry Kay Graham (F)
- Chadae Walker (F)
- Nicrissant Thomas (F)
- Shawn Mitchel (M)

Planning Unit – Engineering / Counts Crew

Distribution: 50% female (F), 50% male (M)

- Rae Parchment (M)
- Angelina Brown (F)
- Kathrine Sharpe (F)
- Stephanie Bromfield (F)
- Leonie Bryan (F)
- Justin Naylor (M)
- Kurt Vaugh Clarke (M)
- Dottson Bando (M)

4 DESIGN

4.1 LOGICAL PROJECT ARCHITECTURE

The project will maintain the 3 logical system architecture levels as the existing system, including second level peripheral devices lice signals and sensors in the peripheral devices.

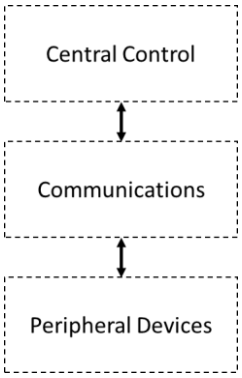

Figure 5 - Main logical architecture levels

4.1.1 Central Control

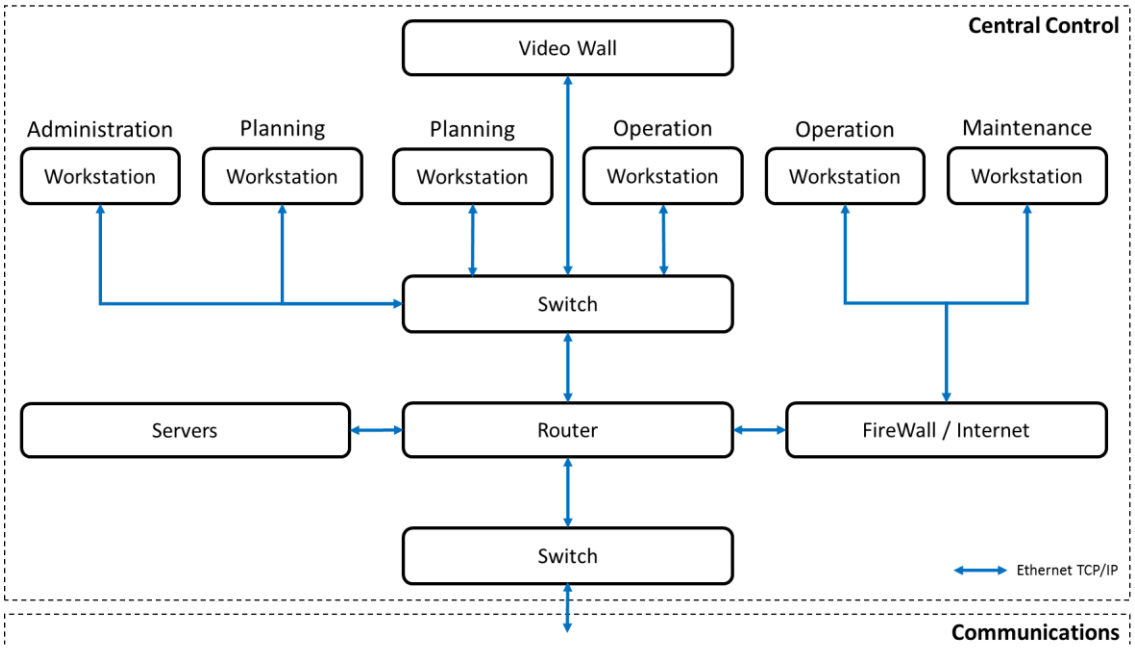

Figure 6 - Central Control Logical Architecture

4.1.2 Communications

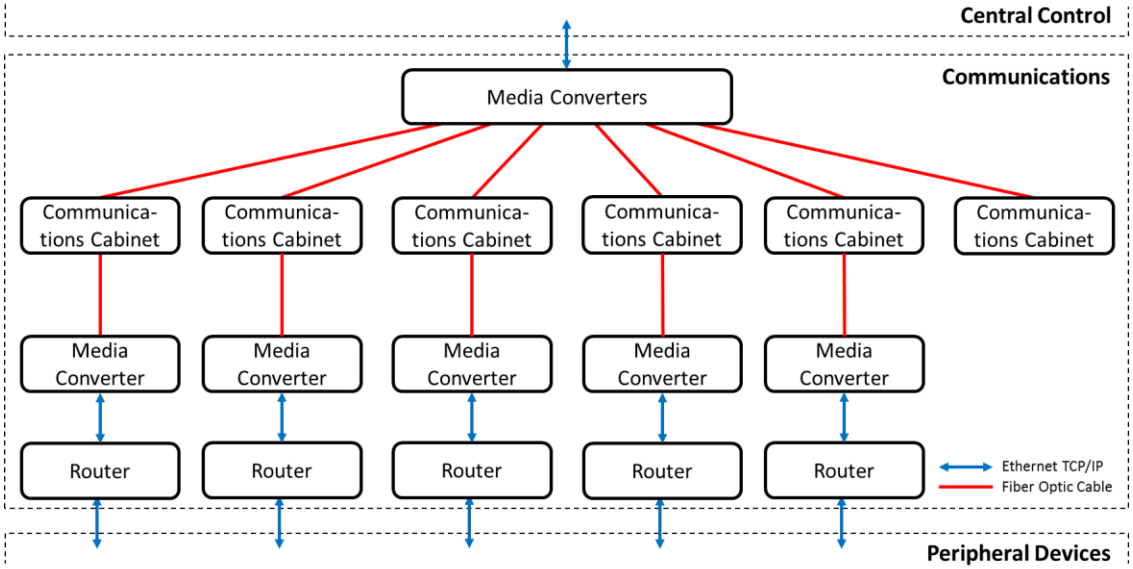

Figure 7 - Communications Logical Architecture

4.1.3 Peripheral devices

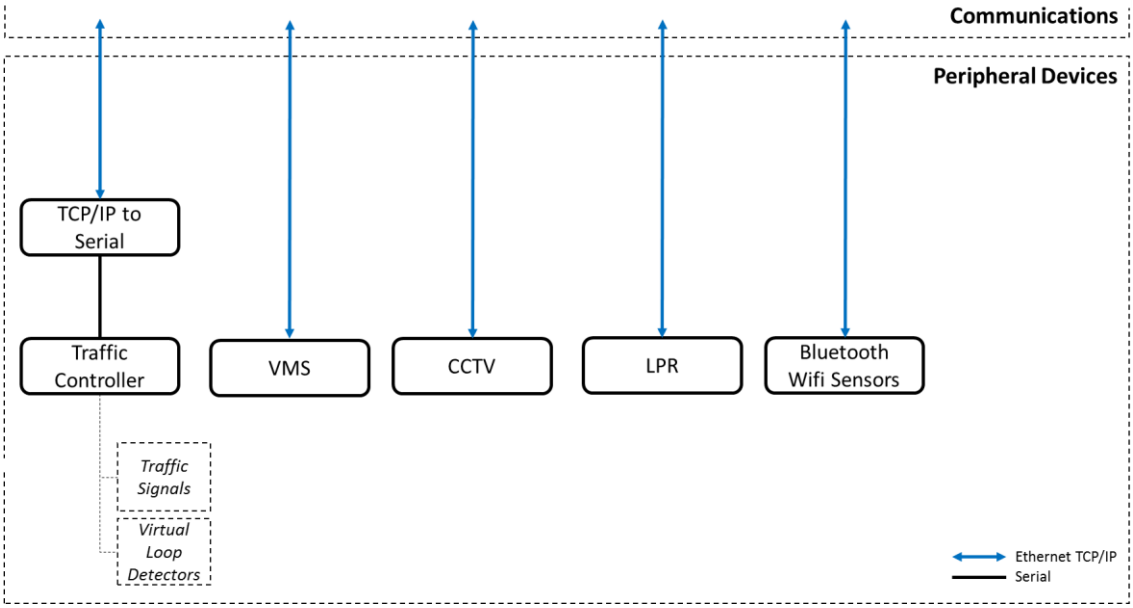

Figure 8 - Peripheral Devices Logical Architecture

4.2 FIBER OPTIC COMMUNICATIONS NETWORK

4.2.1 (011000 & 012000) ITS Backbone

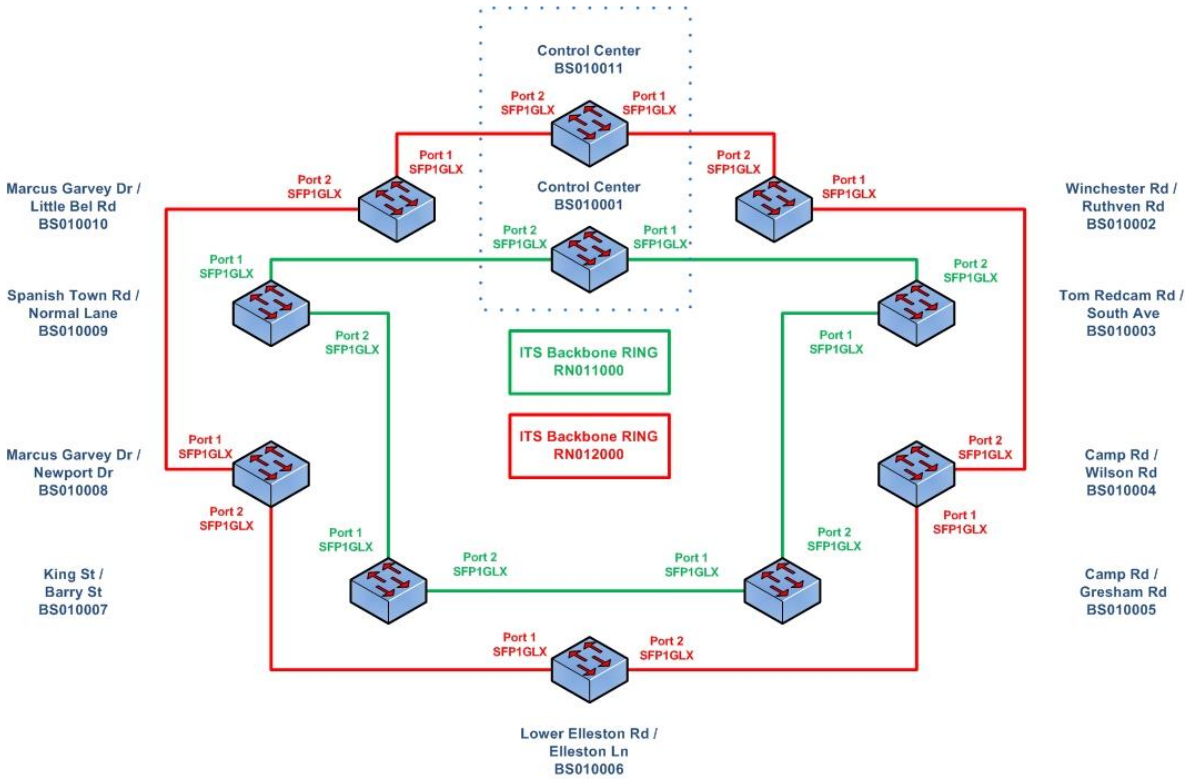

Figure 9 – Fiber Optic Rings 011000 & 012000 Logical design

Inventory Backbone ITS

ITS ID	NE	Net ID	Ring ID	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10	Port 11	Port 12
BC010001	BS010001	011000	011000	G 011000	G 011000	G 021001	F 011001	F 01007	F 011008	F 011009					
BC010002	BS010002	012000	012000	G 012000	G 012000	F 12006	F 012007	F 012008	F 012009	F 012010	F 012011	F 012012			
BC010003	BS010003	011000	011000	G 011000	G 011000	F 011005	F 011006	F 011007	F 011008	F 011009					
BC010004	BS010004	012000	012000	G 012000	G 012000										
BC010005	BS010005	011000	011000	G 011000	G 011000	F 011003	F 011004	F 011005	F 011006						
BC010006	BS010006	012000	012000	G 012000	G 012000	F 012003	F 012004	F 012005							
BC010007	BS010007	011000	011000	G 011000	G 011000	F 011002	F 11003	F 011004							
BC010008	BS010008	012000	012000	G 012000	G 012000	F 012002	F 012003	F 012004	F 012005						
BC010009	BS010009	011000	011000	G 011000	G 011000	G 021001	F 011001	F 011002							
BC010010	BS010010	012000	012000	G 012000	G 012000	F 012001	F 012002	F 012013							
BC010001	BS010011	012000	012000	G G12000	G 012000	F 012001	F 012002	F 012006	F 012007	F 012008	F 012009	F 012010	F 012011	F 012012	F 012013

Table 1 – Fiber Optic Rings 011000 & 012000 Ports

4.2.2 (011001) Washington Spanish

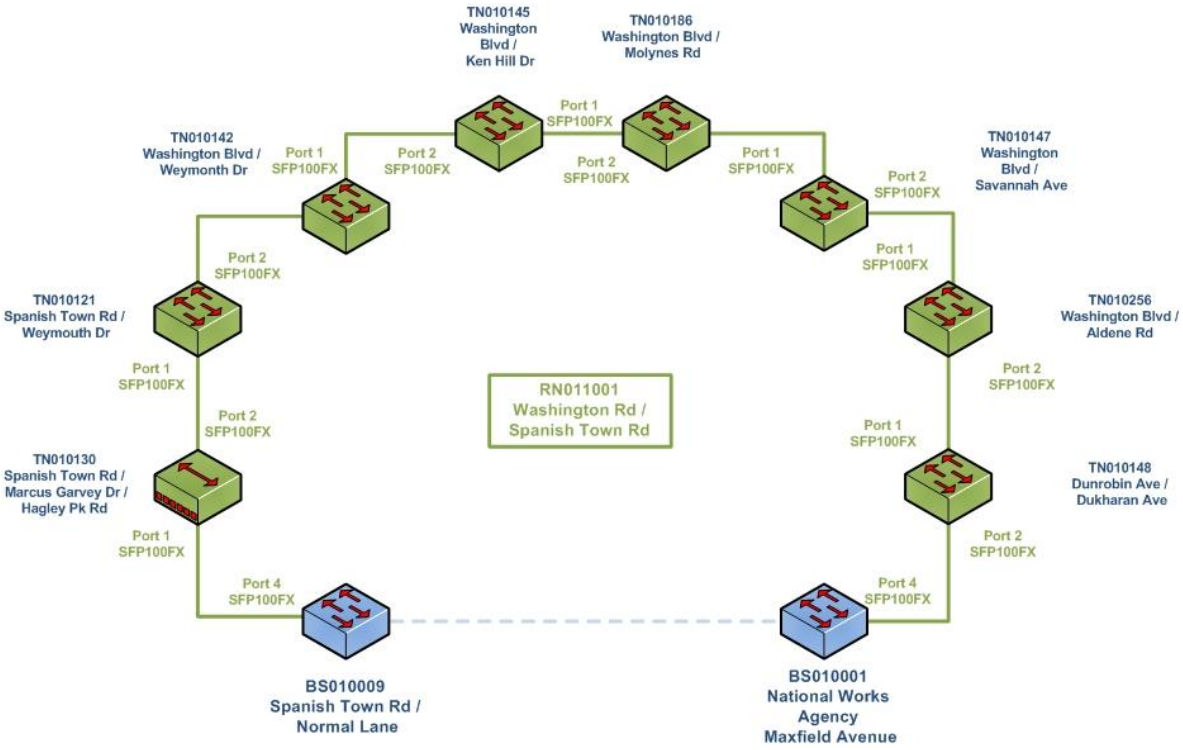

Figure 10 – Fiber Optic Ring 011001 Logical design

Inventory Ring 011001

ITS ID	NE	Net ID	Ring ID	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10	Port 11	Port 12
BC010001	BS010001	011000	011000	G 011000	G 011000	G 021001	F 011001	F 01007	F 011008	F 011009					
010121	TN010121	011000	011001	F 011001	F 011001										
010130	TN010130	011000	011001	F 011001	F 011001										
010142	TN010142	011000	011001	F 011001	F 011001										
010145	TN010145	011000	011001	F 011001	F 011001										
010147	TN010147	011000	011001	F 011001	F 011001										
010148	TN010148	011000	011001	F 011001	F 011001										
010186	TN010186	011000	011001	F 011001	F 011001										
010256	TN010256	011000	011001	F 011001	F 011001										
BC010009	BS010009	011000	011000	G 011000	G 011000	G 021001	F 011001	F 011002							

Table 2 – Fiber Optic Ring 011001 Ports

4.2.3 (011002) Spanish Town Road - William Grant Park

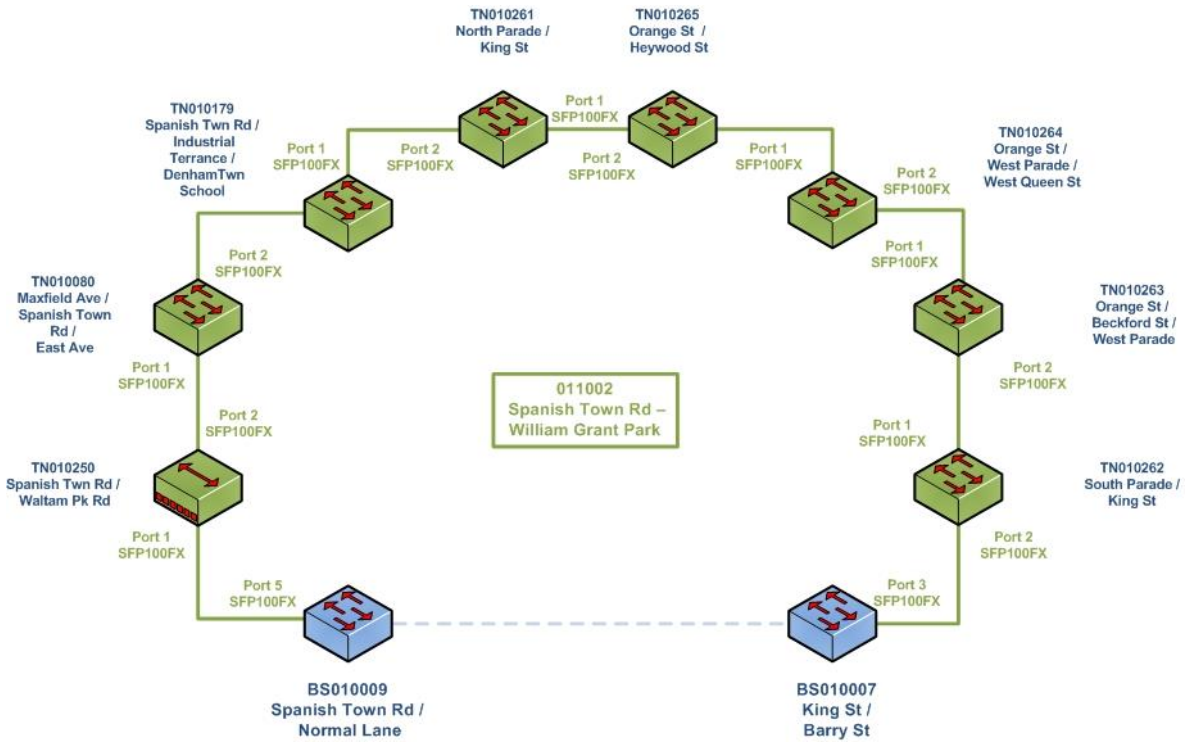

Figure 11 – Fiber Optic Ring 011002 Logical design

Inventory Ring 11002

ITS ID	NE	Net ID	Ring ID	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10	Port 11	Port 12
BC010007	BS010007	011000	011000	G 011000	G 011000	F 011002	F 11003	F 011004							
010080	TN010080	011000	011002	F 011002	F 011002										
010179	TN010179	011000	011002	F 011002	F 011002										
010250	TN010250	011000	011002	F 011002	F 011002										
010261	TN010261	011000	011002	F 011002	F 011002										
010262	TN010262	011000	011002	F 011002	F 011002										
010263	TN010263	011000	011002	F 011002	F 011002										
010264	TN010264	011000	011002	F 011002	F 011002										
010265	TN010265	011000	011002	F 011002	F 011002										
BC010009	BS010009	011000	011000	G 011000	G 011000	G 021001	F 011001	F 011002							

Table 3 – Fiber Optic Ring 011002 Ports

4.2.4 (011003) Downtown

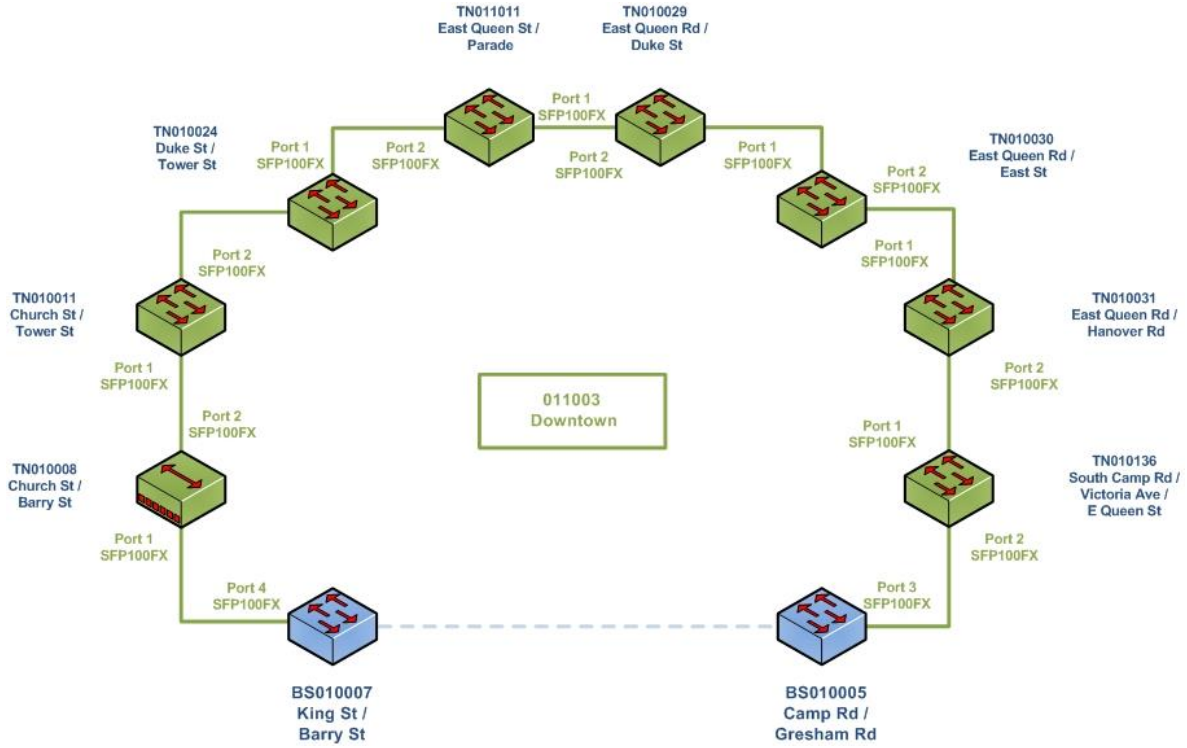

Figure 12 – Fiber Optic Ring 011003 Logical design

Inventory Ring 011003

ITS ID	NE	Net ID	Ring ID	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10	Port 11	Port 12
BC010005	BS010005	011000	011000	G 011000	G 011000	F 011003	F 011004	F 011005	F 011006						
010008	TN010008	011000	011003	F 011003	F 011003										
010011	TN010011	011000	011003	F 011003	F 011003										
010024	TN010024	011000	011003	F 011003	F 011003										
010029	TN010029	011000	011003	F 011003	F 011003										
010030	TN010030	011000	011003	F 011003	F 011003										
010031	TN010031	011000	011003	F 011003	F 011003										
010136	TN010136	011000	011003	F 011003	F 011003										
011011	TN011011	011000	011003	F 011003	F 011003										
BC010007	BS010007	011000	011000	G 011000	G 011000	F 011002	F 11003	F 011004							

Table 4 – Fiber Optic Ring 011003 Ports

4.2.5 (011004) Downtown II

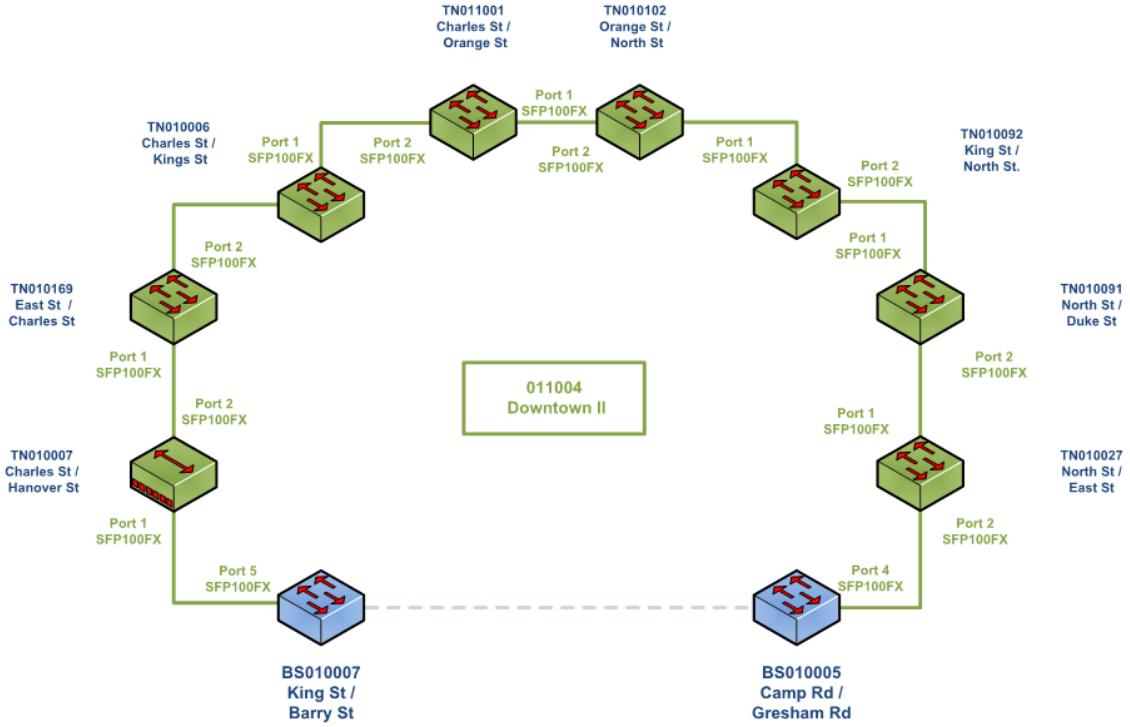

Figure 13 – Fiber Optic Ring 011004 Logical design

Inventory Ring 011004

ITS ID	NE	Net ID	Ring ID	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10	Port 11	Port 12
BC010005	BS010005	011000	011000	G 011000	G 011000	F 011003	F 011004	F 011005	F 011006						
010006	TN010006	011000	011004	F 011004	F 011004										
010007	TN010007	011000	011004	F 011004	F 011004										
010027	TN010027	011000	011004	F 011004	F 011004										
010091	TN010091	011000	011004	F 011004	F 011004										
010092	TN010092	011000	011004	F 011004	F 011004										
010102	TN010102	011000	011004	F 011004	F 011004										
010169	TN010169	011000	011004	F 011004	F 011004										
011001	TN011001	011000	011004	F 011004	F 011004										
BC010007	BS010007	011000	011000	G 011000	G 011000	F 011002	F 11003	F 011004							

Table 5 – Fiber Optic Ring 011004 Ports

4.2.6 (011005) South Camp Road – North Street – Mareascaux Road

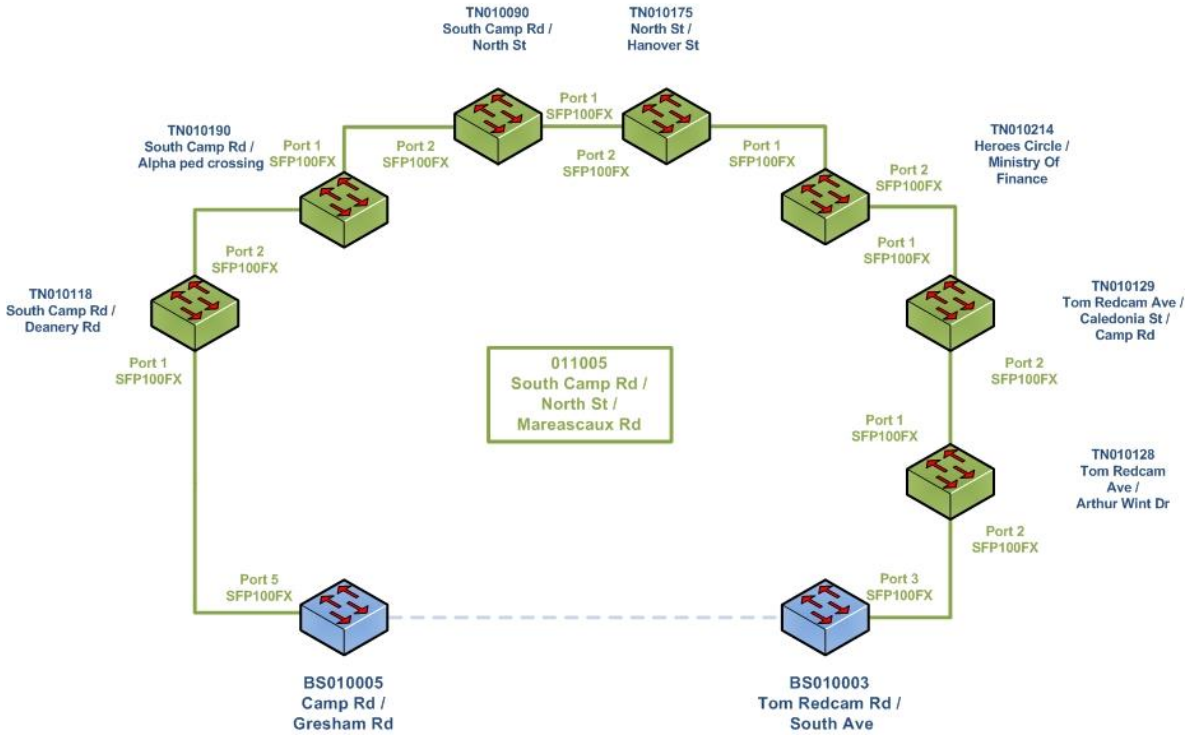

Figure 14 – Fiber Optic Ring 011005 Logical design

Inventory Ring 0110005

ITS ID	NE	Net ID	Ring ID	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10	Port 11	Port 12
BC010003	BS010003	011000	011000	G 011000	G 011000	F 011005	F 011006	F 011007	F 011008	F 011009					
010090	TN010090	011000	011005	F 011005	F 011005										
010118	TN010118	011000	011005	F 011005	F 011005										
010128	TN010128	011000	011005	F 011005	F 01105										
010129	TN010129	011000	011005	F 011005	F 011005										
010190	TN010190	011000	011005	F 011005	F 011005										
010175	TN010175	011000	011005	F 011005	F 011005										
010214	TN010214	011000	011005	F 011005	F 011005										
BC010005	BS010005	011000	011000	G 011000	G 011000	F 011003	F 011004	F 011005	F 011006						

Table 6 – Fiber Optic Ring 011005 Ports

4.2.7 (011006) Orange Street – Half Way Tree Road – Retirement Road

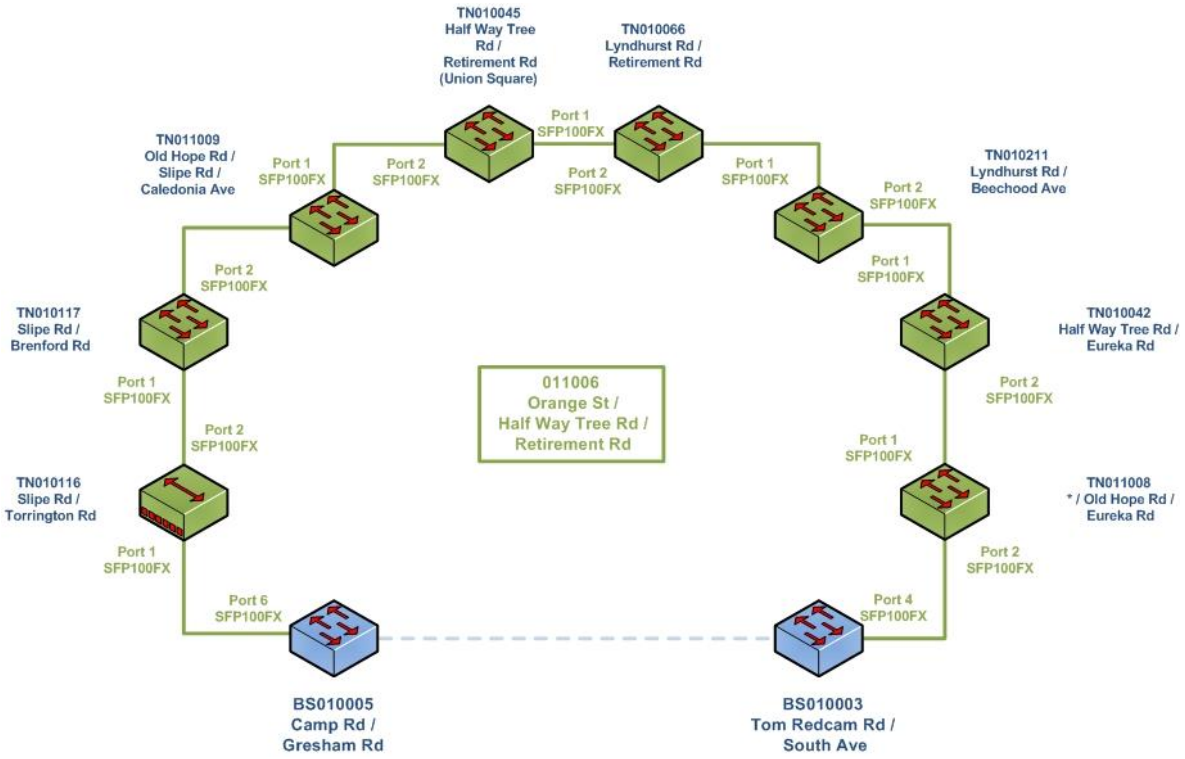

Figure 15 – Fiber Optic Ring 011006 Logical design

Inventory Ring 011006

ITS ID	NE	Net ID	Ring ID	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10	Port 11	Port 12
BC010003	BS010003	011000	011000	G 011000	G 011000	F 011005	F 011006	F 011007	F 011008	F 011009					
010042	TN010042	011000	011006	F 011006	F 011006										
010045	TN010045	011000	011006	F 011006	F 011006										
010066	TN010066	011000	011006	F 011006	F 011006										
010116	TN010116	011000	011006	F 011006	F 011006										
010117	TN010117	011000	011006	F 011006	F 011006										
010211	TN010211	011000	011006	F 011006	F 011006										
011008	TN011008	011000	011006	F 011006	F 011006										
011009	TN011009	011000	011006	F 011006	F 011006										
BC010005	BS010005	011000	011000	G 011000	G 011000	F 011003	F 011004	F 011005	F 011006						

Table 7 – Fiber Optic Ring 011006 Ports

4.2.8 (011007) Oxford Road – Half Way Tree Road – Maxfield Avenue

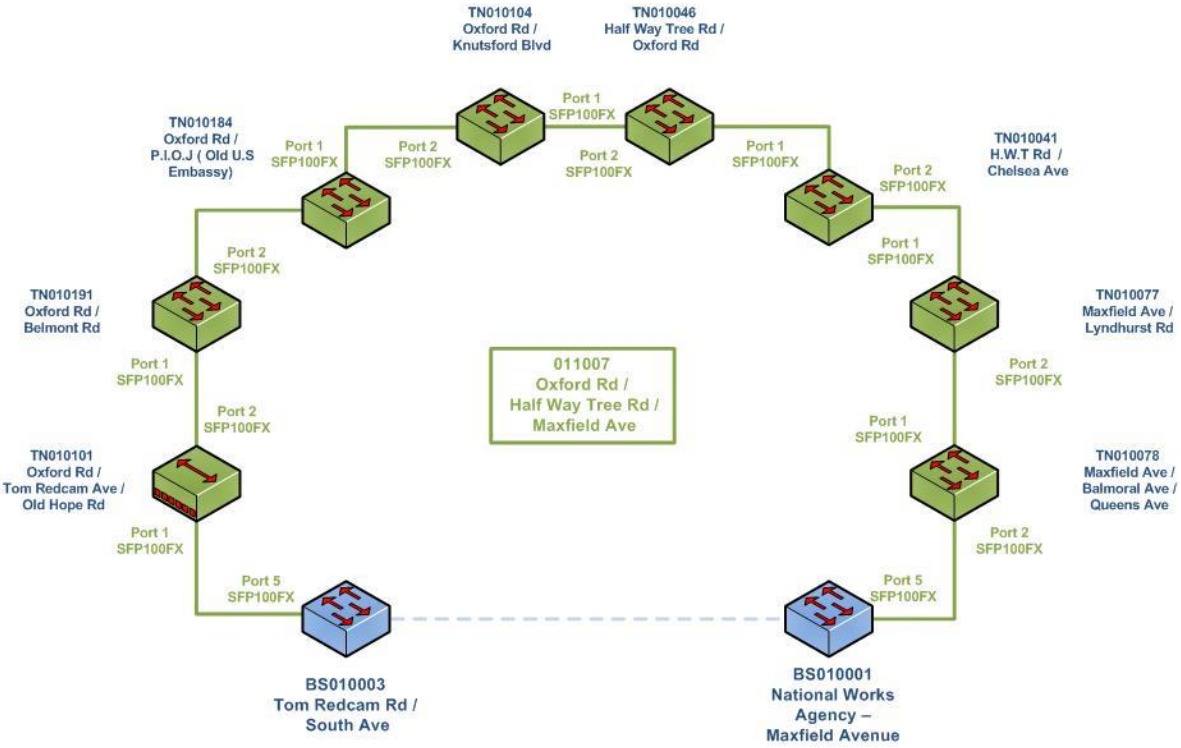

Figure 16 – Fiber Optic Ring 011007 Logical design

Inventory Ring 011007

ITS ID	NE	Net ID	Ring ID	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10	Port 11	Port 12
BC010001	BS010001	011000	011000	G 011000	G 011000	G 021001	F 011001	F 01007	F 011008	F 011009					
010041	TN010041	011000	011007	F 011007	F 011007										
010046	TN010046	011000	011007	F 011007	F 011007										
010077	TN010077	011000	011007	F 011007	F 011007										
010078	TN010078	011000	011007	F 011007	F 011007										
010101	TN010101	011000	011007	F 011007	F 011007										
010104	TN010104	011000	011007	F 011007	F 011007										
010191	TN010191	011000	011007	F 011007	F 011007										
010184	TN010184	011000	011007	F 011007	F 011007										
BC010003	BS010003	011000	011000	G 011000	G 011000	F 011005	F 011006	F 011007	F 011008	F 011009					

Table 8 – Fiber Optic Ring 011007 Ports

4.2.9 (011008) Trafalgar Road – Knutsford Boulevard

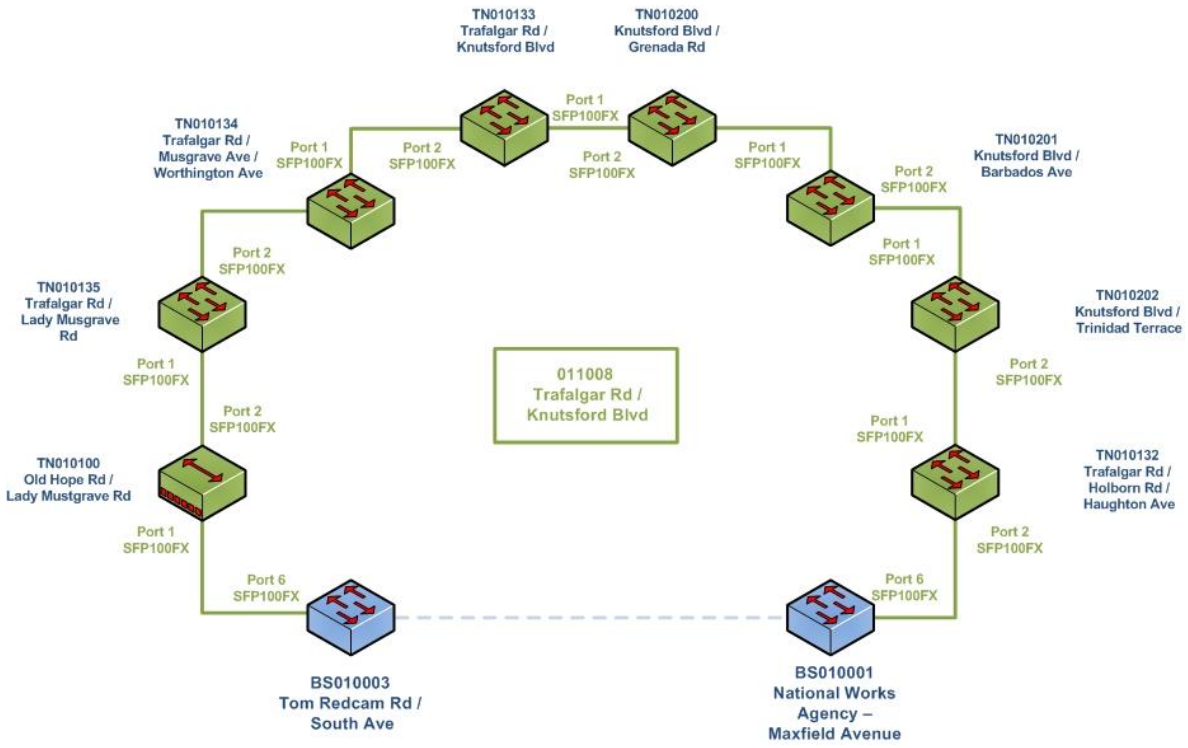

Figure 17 – Fiber Optic Ring 011008 Logical design

Inventory Ring 011008

ITS ID	NE	Net ID	Ring ID	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10	Port 11	Port 12
BC010001	BS010001	011000	011000	G 011000	G 011000	G 021001	F 011001	F 01007	F 011008	F 011009					
010100	TN010100	011000	011008	F 011008	F 011008										
010132	TN010132	011000	011008	F 011008	F 011008										
010133	TN010133	011000	011008	F 011008	F 011008										
010134	TN010134	011000	011008	F 011008	F 011008										
010135	TN010135	011000	011008	F 011008	F 011008										
010200	TN01200	011000	011008	F 011008	F 011008										
010201	TN010201	011000	011008	F 011008	F 011008										
010202	TN010202	011000	011008	F 011008	F 011008										
BC010003	BS010003	011000	011000	G 011000	G 011000	F 011005	F 011006	F 011007	F 011008	F 011009					

Table 9 – Fiber Optic Ring 011008 Ports

4.2.10 (011009) Old Hope Road – Wellington Drive

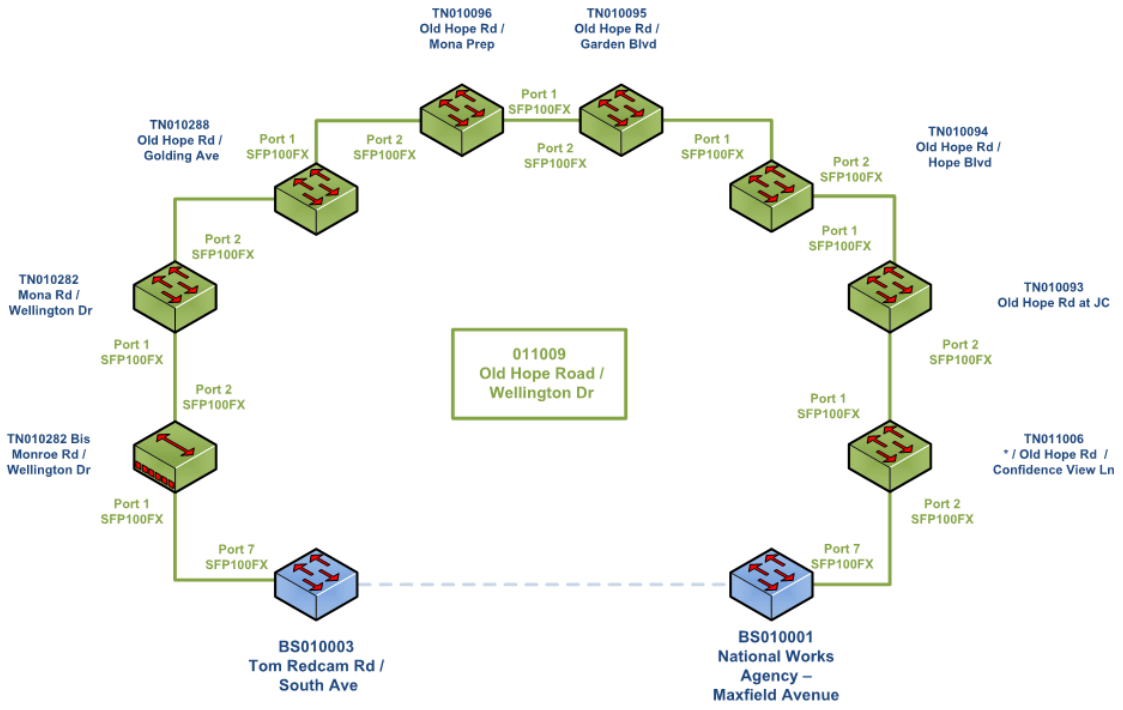

Figure 18 – Fiber Optic Ring 011009 Logical design

Inventory Ring 011009

ITS ID	NE	Net ID	Ring ID	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10	Port 11	Port 12
BC010001	BS010001	011000	011000	G 011000	G 011000	G 021001	F 011001	F 01007	F 011008	F 011009					
010093	TN010093	011000	011009	F 011009	F 011009										
010094	TN010094	011000	011009	F 011009	F 011009										
010095	TN010095	011000	011009	F 011009	F 011009										
010096	TN010096	011000	011009	F 011009	F 011009										
010288	TN010288	011000	011009	F 011009	F 011009										
010282B	TN010282B	011000	011009	F 011009	F 011009										
010282	TN010282	011000	011009	F 011009	F 011009										
011006	TN011006	011000	011009	F 011009	F 011009										
BC010003	BS010003	011000	011000	G 011000	G 011000	F 011005	F 011006	F 011007	F 011008	F 011009					

Table 10 – Fiber Optic Ring 011009 Ports

4.2.11 (012001) Washington Spanish Road

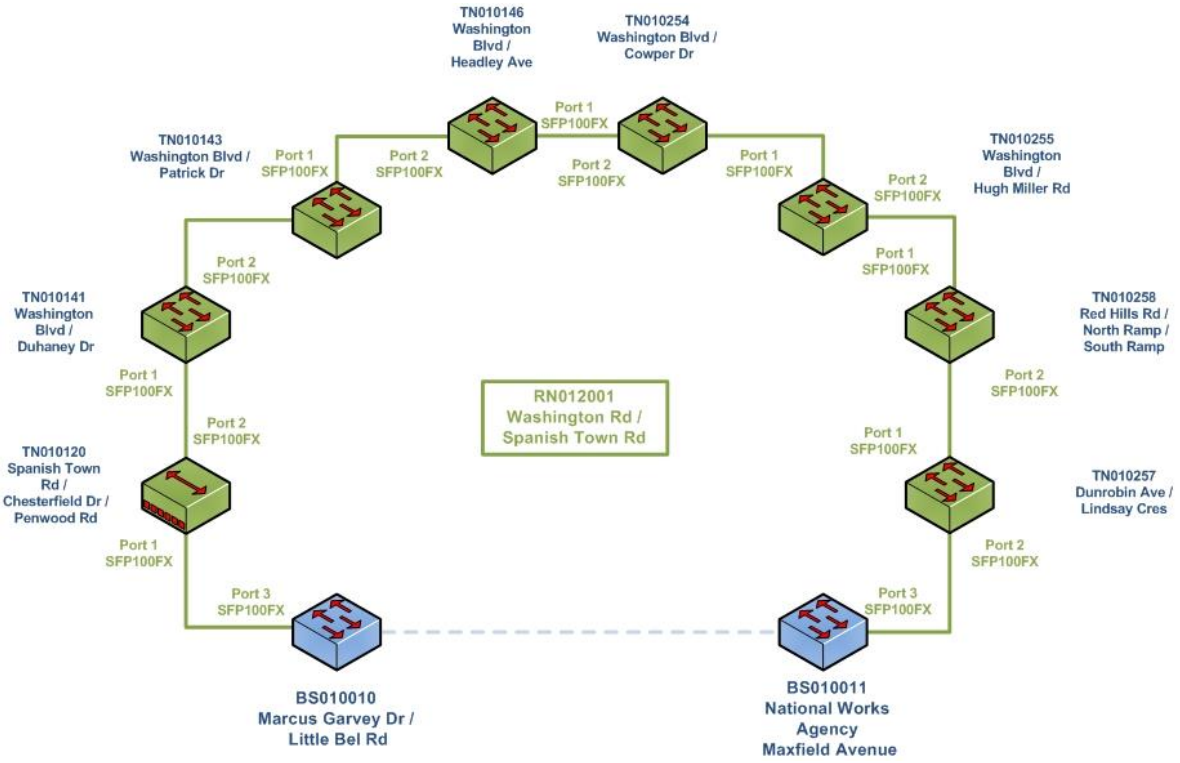

Figure 19 – Fiber Optic Ring 012001 Logical design

Inventory Ring 012001

ITS ID	NE	Net ID	Ring ID	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10	Port 11	Port 12
BC010001	BS010011	012000	012000	G G12000	G 012000	F 012001	F 012002	F 012006	F 012007	F 012008	F 012009	F 012010	F 012011	F 012012	F 012013
010120	TN010120	012000	012001	F 012001	F 012001										
010141	TN010141	012000	012001	F 012001	F 012001										
010143	TN010143	012000	012001	F 012001	F 012001										
010146	TN010146	012000	012001	F 012001	F 012001										
010254	TN010254	012000	012001	F 012001	F 012001										
010255	TN010255	012000	012001	F 012001	F 012001										
010257	TN010257	012000	012001	F 012001	F 012001										
010258	TN010258	012000	012001	F 012001	F 012001										
BC010010	BS010010	012000	012000	G 012000	G 012000	F 012001	F 012002	F 012013							

Table 11 – Fiber Optic Ring 012001 Ports

4.2.12 (012002) Marcus Garvey Drive

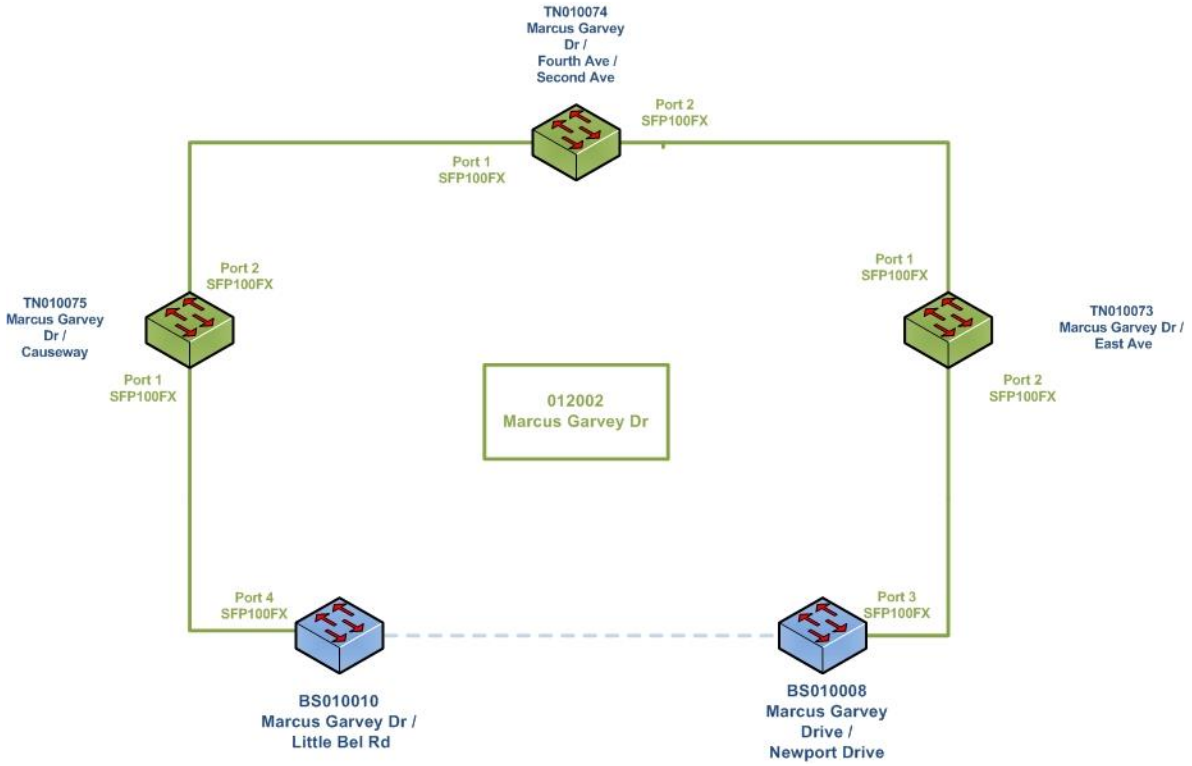

Figure 20 – Fiber Optic Ring 012002 Logical design

Inventory Ring 012002

ITS ID	NE	Net ID	Ring ID	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10	Port 11	Port 12
BC010008	BS010008	012000	012000	G 012000	G 012000	F 012002	F 012003	F 012004	F 012005						
010073	TN010073	012000	012002	F 012002	F 012002										
010074	TN010074	012000	012002	F 012002	F 012002										
010075	TN010075	012000	012002	F 012002	F 012002										
BC010010	BS010010	012000	012000	G 012000	G 012000	F 012001	F 012002	F 012013							

Table 12 – Fiber Optic Ring 012002 Ports

4.2.13 (012003) Port Royal Street

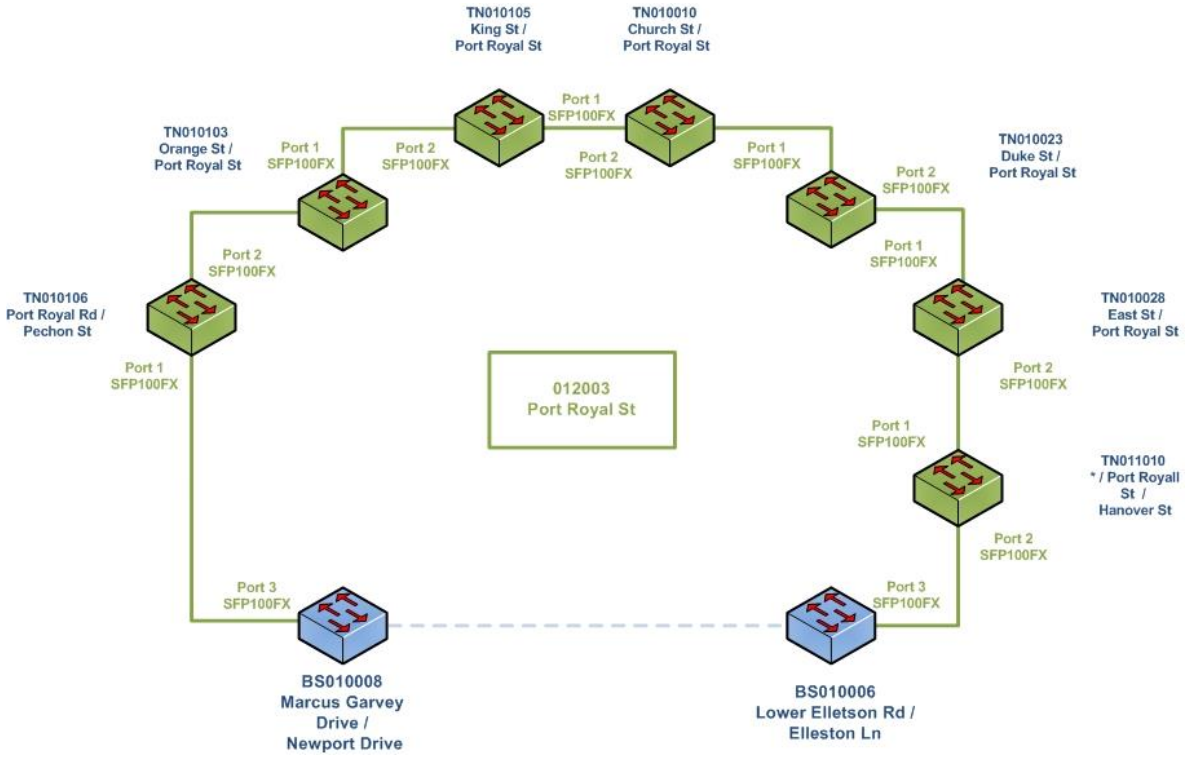

Figure 21 – Fiber Optic Ring 012003 Logical design

Inventory Ring 012003

ITS ID	NE	Net ID	Ring ID	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10	Port 11	Port 12
BC010006	BS010006	012000	012000	G 012000	G 012000	F 012003	F 012004	F 012005							
010010	TN010010	012000	012003	F 012003	F 012003										
010023	TN010023	012000	012003	F 012003	F 012003										
010028	TN010028	012000	012003	F 012003	F 012003										
010103	TN010103	012000	012003	F 012003	F 012003										
010105	TN010105	012000	012003	F 012003	F 012003										
010106	TN010106	012000	012003	F 012003	F 012003										
011010	TN011010	011000	012003	F 012003	F 012003										
BC010008	BS010008	012000	012000	G 012000	G 012000	F 012002	F 012003	F 012004	F 012005						

Table 13 – Fiber Optic Ring 012003 Ports

4.2.14 (012004) Water Lane – Harbor Street

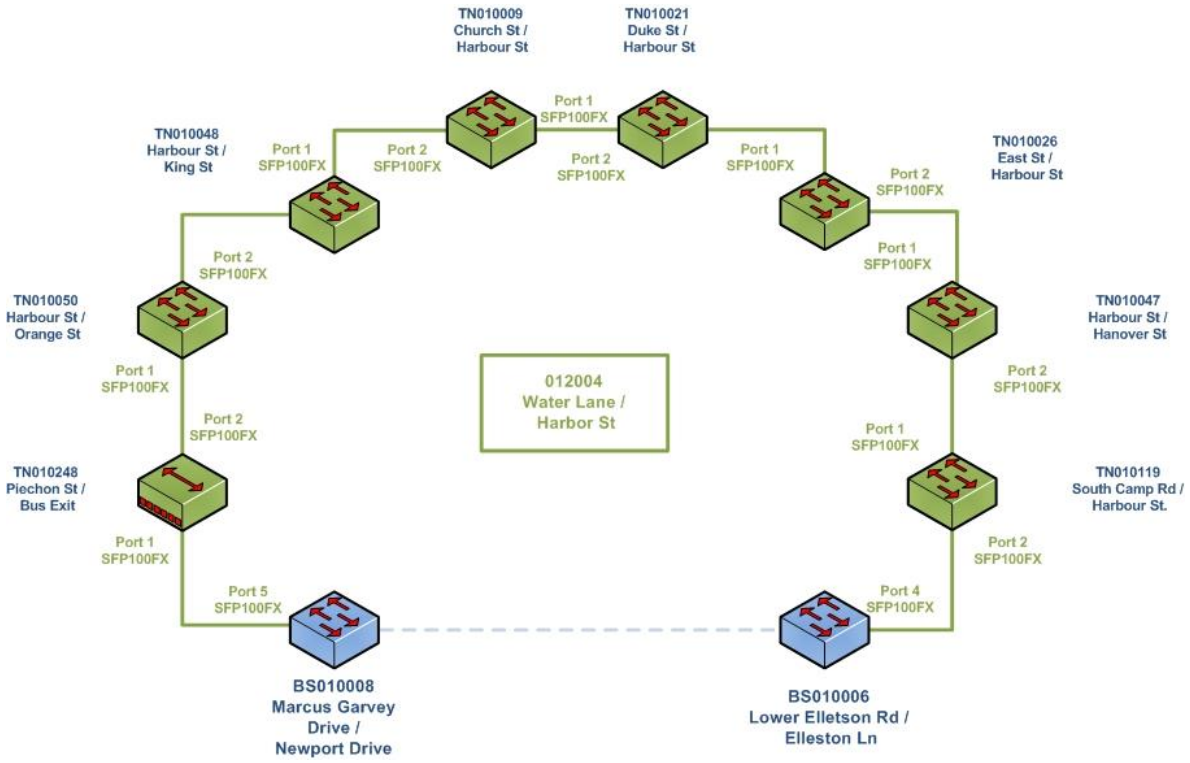

Figure 22 – Fiber Optic Ring 012004 Logical design

Inventory Ring 012004

ITS ID	NE	Net ID	Ring ID	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10	Port 11	Port 12
BC010006	BS010006	012000	012000	G 012000	G 012000	F 012003	F 012004	F 012005							
010009	TN010009	012000	012004	F 012004	F 012004										
010021	TN010021	012000	012004	F 012004	F 012004										
010047	TN010047	012000	012004	F 012004	F 012004										
010048	TN010048	012000	012004	F 012004	F 012004										
010050	TN010050	012000	012004	F 012004	F 012004										
010119	TN010119	012000	012004	F 012004	F 012004										
010248	TN010248	012000	012004	F 012004	F 012004										
BC010008	BS010008	012000	012000	G 012000	G 012000	F 012002	F 012003	F 012004	F 012005						

Table 14 – Fiber Optic Ring 012004 Ports

4.2.15 (012005) Michael Manley Boulevard – Thomas Main Road – windward Road

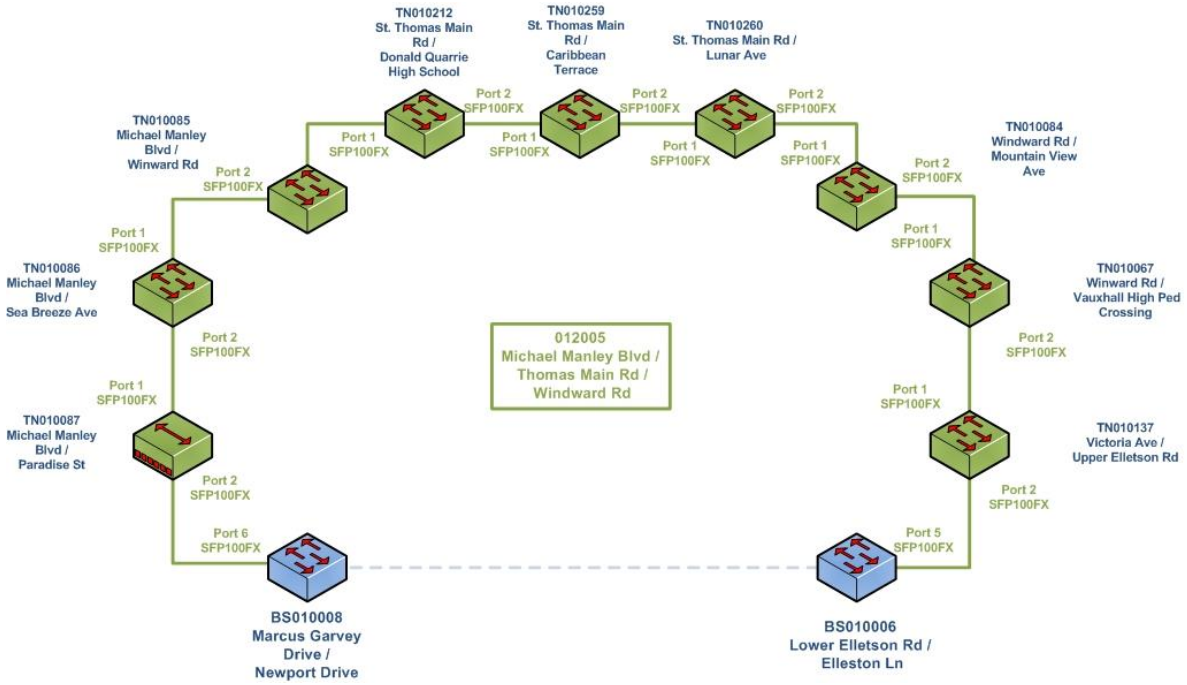

Figure 23 – Fiber Optic Ring 012005 Logical design

Inventory Ring 012005

ITS ID	NE	Net ID	Ring ID	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10	Port 11	Port 12
BC010006	BS010006	012000	012000	G 012000	G 012000	F 012003	F 012004	F 012005							
010067	TN010067	012000	012005	F 012005	F 012005										
010084	TN010084	012000	012005	F 012005	F 012005										
010085	TN010085	012000	012005	F 012005	F 012005										
010086	TN010086	012000	012005	F 012005	F 012005										
010087	TN010087	012000	012005	F 012005	F 012005										
010137	TN010137	012000	012005	F 012005	F 012005										
010212	TN010212	012000	012005	F 012005	F 012005										
010259	TN010259	012000	012005	F 012005	F 012005										
010260	TN010260	012000	012005	F 012005	F 012005										
BC010008	BS010008	012000	012000	G 012000	G 012000	F 012002	F 012003	F 012004	F 012005						

Table 15 – Fiber Optic Ring 012005 Ports

4.2.16 (012006) Maxfield Avenue – Eastwood Park Road

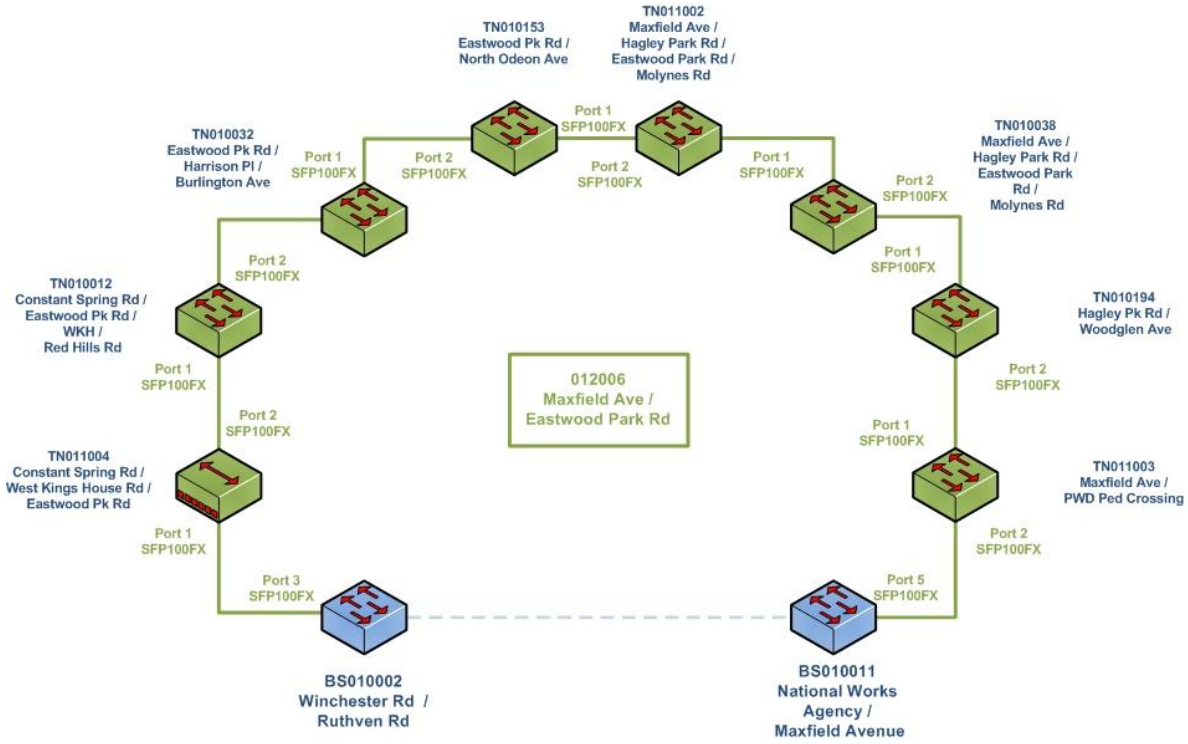

Figure 24 – Fiber Optic Ring 012006 Logical design

Inventory Ring 012006

ITS ID	NE	Net ID	Ring ID	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10	Port 11	Port 12
BC010001	BS010011	012000	012000	G G12000	G 012000	F 012001	F 012002	F 012006	F 012007	F 012008	F 012009	F 012010	F 012011	F 012012	F 012013
010012	TN010012	012000	012006	F 012006	F 012006										
010032	TN010032	012000	012006	F 012006	F 012006										
010038	TN010038	012000	012006	F 012006	F 012006										
010194	TN010194	012000	012006	F 012006	F 012006										
010153	TN010153	012000	012006	F 012006	F 012006										
011002	TN011002	012000	012006	F 012006	F 012006										
011003	TN011003	012000	012006	F 012006	F 012006										
011004	TN011004	012000	012006	F 012006	F 012006										
BC010002	BS010002	012000	012000	G 012000	G 012000	F 12006	F 012007	F 012008	F 012009	F 012010	F 012011	F 012012			

Table 16 – Fiber Optic Ring 012006 Ports

4.2.17 (012007) Constant Spring Road – Waterloo Road

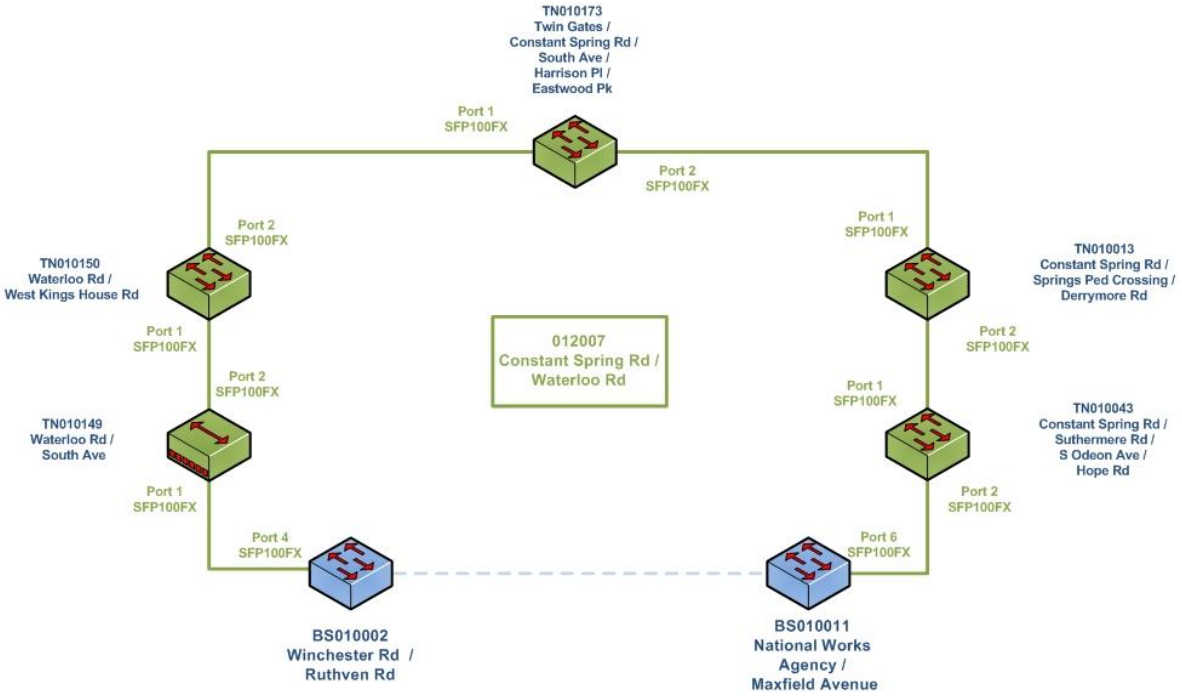

Figure 25 – Fiber Optic Ring 012007 Logical design

Inventory Ring 012007

ITS ID	NE	Net ID	Ring ID	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10	Port 11	Port 12
BC010001	BS010011	012000	012000	G G12000	G 012000	F 012001	F 012002	F 012006	F 012007	F 012008	F 012009	F 012010	F 012011	F 012012	F 012013
010013	TN010013	012000	012007	F 012007	F 012007										
010043	TN010043	012000	012007	F 012007	F 012007										
010149	TN010149	012000	012007	F 012007	F 012007										
010150	TN010150	012000	012007	F 012007	F 012007										
010173	TN010173	012000	012007	F 012007	F 012007										
BC010002	BS010002	012000	012000	G 012000	G 012000	F 12006	F 012007	F 012008	F 012009	F 012010	F 012011	F 012012			

Table 17 – Fiber Optic Ring 012007 Ports

4.2.18 (012008) Constant Spring Road – Upper Waterloo Road

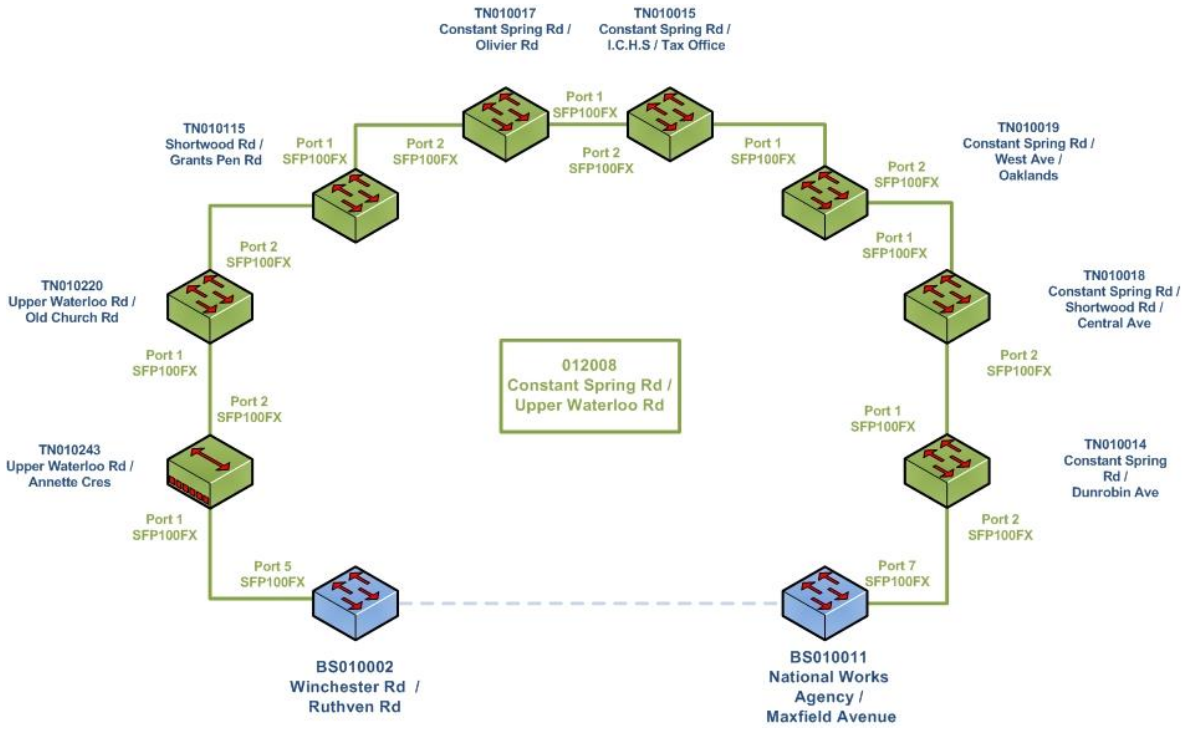

Figure 26 – Fiber Optic Ring 012008 Logical design

Inventory Ring 012008

ITS ID	NE	Net ID	Ring ID	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10	Port 11	Port 12
BC010001	BS010011	012000	012000	G G12000	G 012000	F 012001	F 012002	F 012006	F 012007	F 012008	F 012009	F 012010	F 012011	F 012012	F 012013
010014	TN010014	012000	012008	F 012008	F 012008										
010015	TN010015	012000	012008	F 012008	F 012008										
010017	TN010017	012000	012008	F 012008	F 012008										
010018	TN010018	012000	012008	F 012008	F 012008										
010019	TN010019	012000	012008	F 012008	F 012008										
010115	TN010115	012000	012008	F 012008	F 012008										
010220	TN010220	012000	012008	F 012008	F 012008										
010243	TN010243	012000	012008	F 012008	F 012008										
BC010002	BS010002	012000	012000	G 012000	G 012000	F 12006	F 012007	F 012008	F 012009	F 012010	F 012011	F 012012			

Table 18 – Fiber Optic Ring 012008 Ports

4.2.19 (012009) Half Way Tree Road – Hope Road

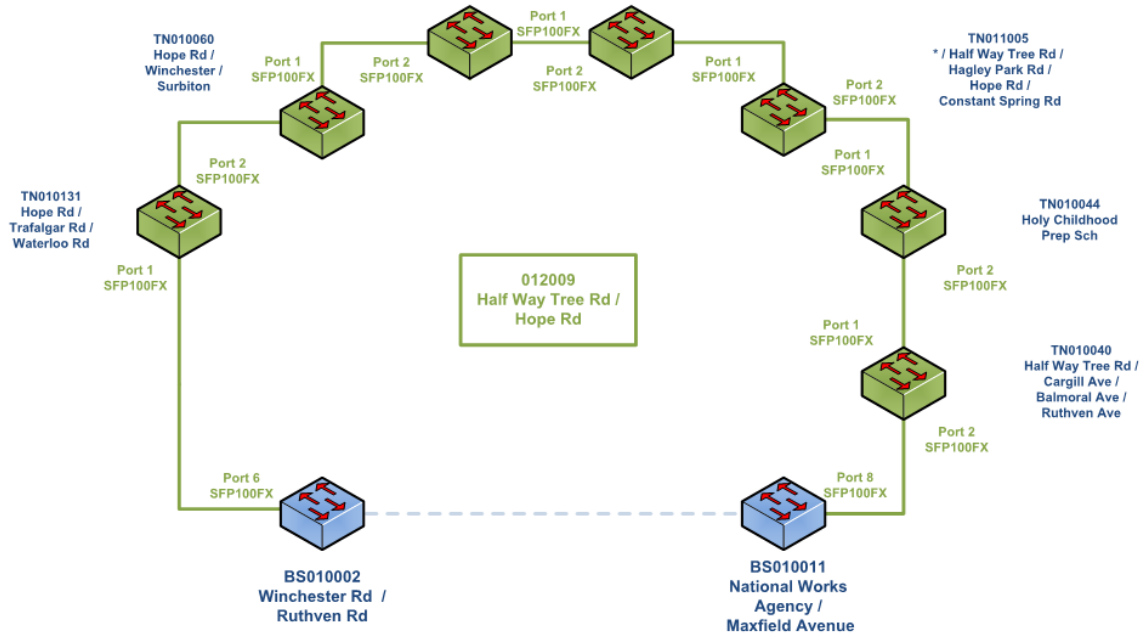

Figure 27 – Fiber Optic Ring 012009 Logical design

Inventory Ring 012009

ITS ID	NE	Net ID	Ring ID	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10	Port 11	Port 12
BC010001	BS010011	012000	012000	G G12000	G 012000	F 012001	F 012002	F 012006	F 012007	F 012008	F 012009	F 012010	F 012011	F 012012	F 012013
010040	TN010040	012000	012009	F 012009	F 012009										
010044	TN010044	012000	012009	F 012009	F 012009										
010060	TN010060	012000	012009	F 012009	F 012009										
010131	TN010131	012000	012009	F 012009	F 012009										
010152	TN010152	012000	012009	F 012009	F 012009										
011005	TN011005	012000	012009	F 012009	F 012009										
011007	TN011007	012000	012009	F 012009	F 012009										
BC010002	BS010002	012000	012000	G 012000	G 012000	F 12006	F 012007	F 012008	F 012009	F 012010	F 012011	F 012012			

Table 19 – Fiber Optic Ring 012009 Ports

4.2.20 (012010) Hope Road – Old Hope Road

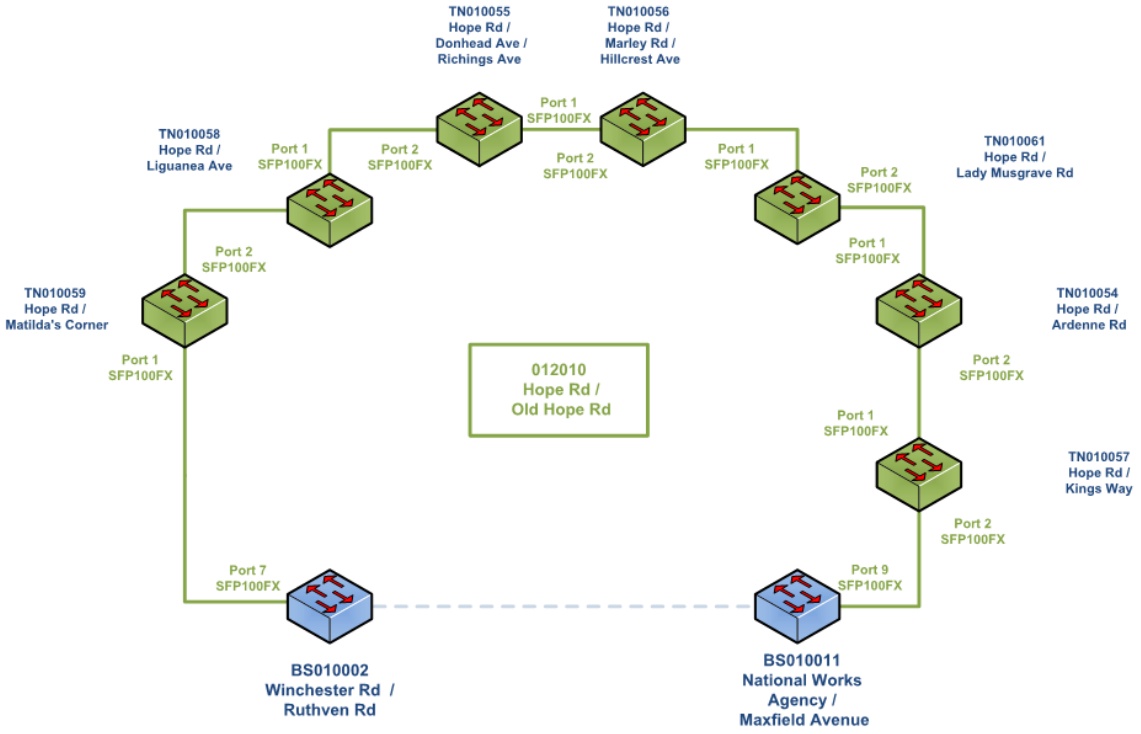

Figure 28 – Fiber Optic Ring 012010 Logical design

Inventory Ring 012010

ITS ID	NE	Net ID	Ring ID	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10	Port 11	Port 12
BC010001	BS010011	012000	012000	G G12000	G 012000	F 012001	F 012002	F 012006	F 012007	F 012008	F 012009	F 012010	F 012011	F 012012	F 012013
010054	TN010054	012000	012010	F 012010	F 012010										
010055	TN010055	012000	012010	F 012010	F 012010										
010056	TN010056	012000	012010	F 012010	F 012010										
010057	TN010057	012000	012010	F 012010	F 012010										
010058	TN010058	012000	012010	F 012010	F 012010										
010059	TN010059	012000	012010	F 012010	F 012010										
010061	TN010061	012000	012010	F 012010	F 012010										
BC010002	BS010002	012000	012000	G 012000	G 012000	F 12006	F 012007	F 012008	F 012009	F 012010	F 012011	F 012012			

Table 20 – Fiber Optic Ring 012010 Ports

4.2.21 (012011) Lady Musgrave Road - East Kings House Road – Barbican Road

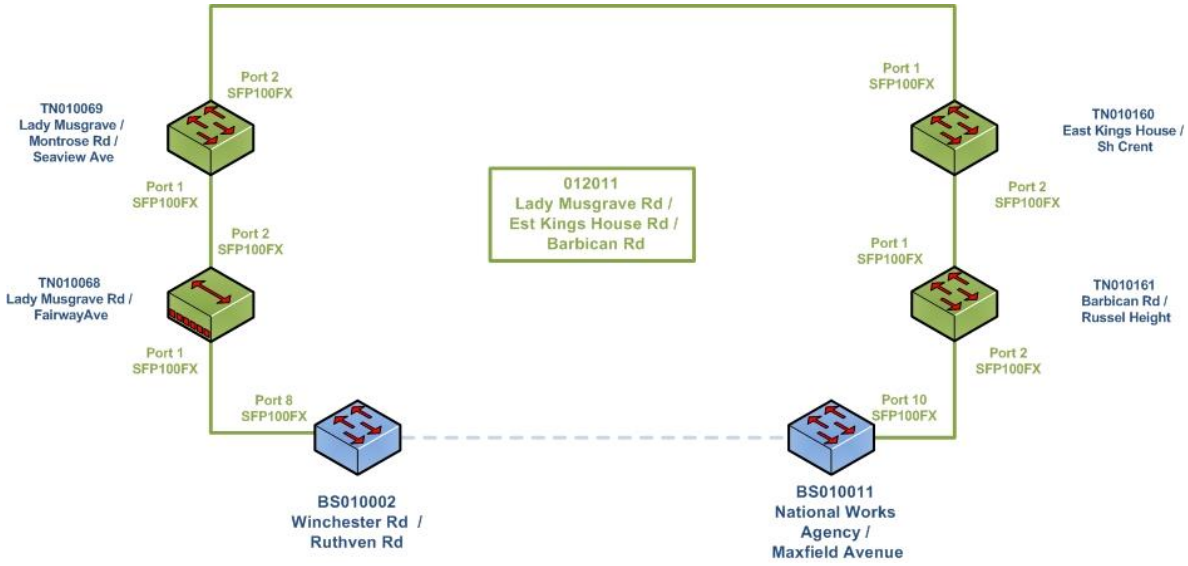

Figure 29 – Fiber Optic Ring 012011 Logical design

Inventory Ring 012010

ITS ID	NE	Net ID	Ring ID	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10	Port 11	Port 12
BC010001	BS010011	012000	012000	G G12000	G 012000	F 012001	F 012002	F 012006	F 012007	F 012008	F 012009	F 012010	F 012011	F 012012	F 012013
010054	TN010054	012000	012010	F 012010	F 012010										
010055	TN010055	012000	012010	F 012010	F 012010										
010056	TN010056	012000	012010	F 012010	F 012010										
010057	TN010057	012000	012010	F 012010	F 012010										
010058	TN010058	012000	012010	F 012010	F 012010										
010059	TN010059	012000	012010	F 012010	F 012010										
010061	TN010061	012000	012010	F 012010	F 012010										
BC010002	BS010002	012000	012000	G 012000	G 012000	F 12006	F 012007	F 012008	F 012009	F 012010	F 012011	F 012012			

Table 21 – Fiber Optic Ring 012011 Ports

4.2.22 (012012) Mountain View Avenue – Old Hope Road

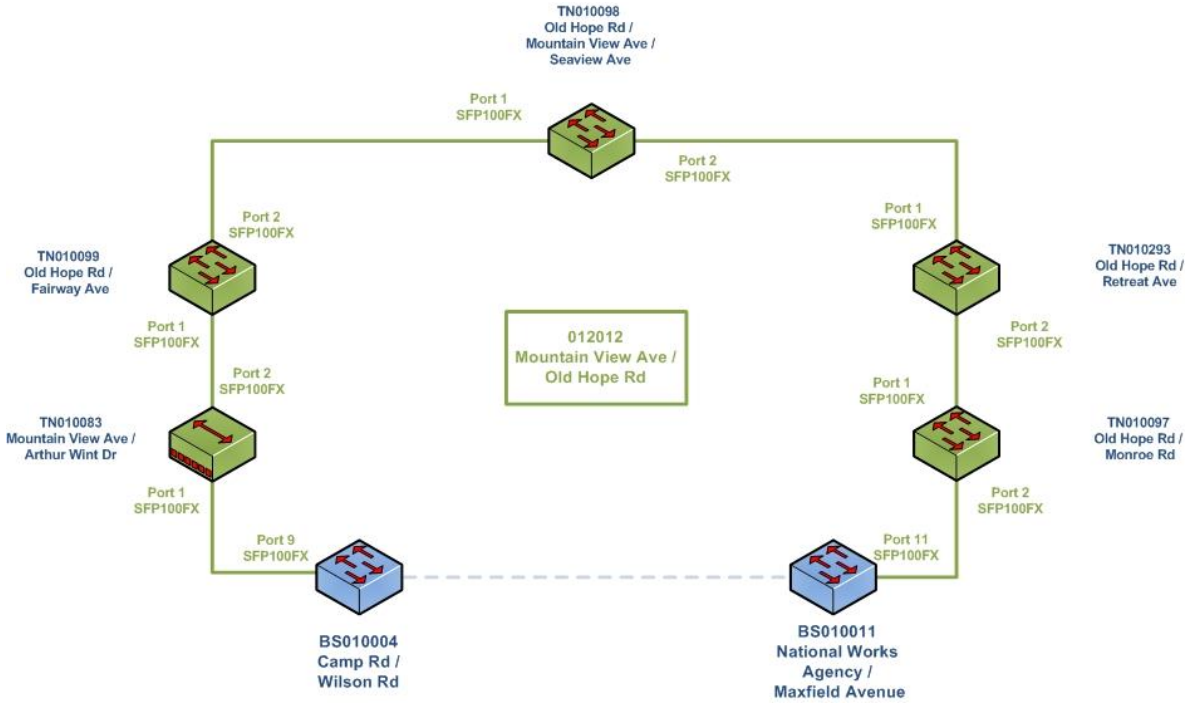

Figure 30 – Fiber Optic Ring 012012 Logical design

Inventory Ring 012012

ITS ID	NE	Net ID	Ring ID	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10	Port 11	Port 12
BC010001	BS010011	012000	012000	G G12000	G 012000	F 012001	F 012002	F 012006	F 012007	F 012008	F 012009	F 012010	F 012011	F 012012	F 012013
010083	TN010083	012000	012012	F 012012	F 012012										
010097	TN010097	012000	012012	F 012012	F 012012										
010098	TN010098	012000	012012	F 012012	F 012012										
010099	TN010099	012000	012012	F 012012	F 012012										
010293	TN010293	012000	012012	F 012012	F 012012										
BC010004	BS010004	012000	012000	G 012000	G 012000										

Table 22 – Fiber Optic Ring 012012 Ports

4.2.23 (012013) Hagley Park Road – Waltham Park Road – Molynes Road –Bay – Farm Road

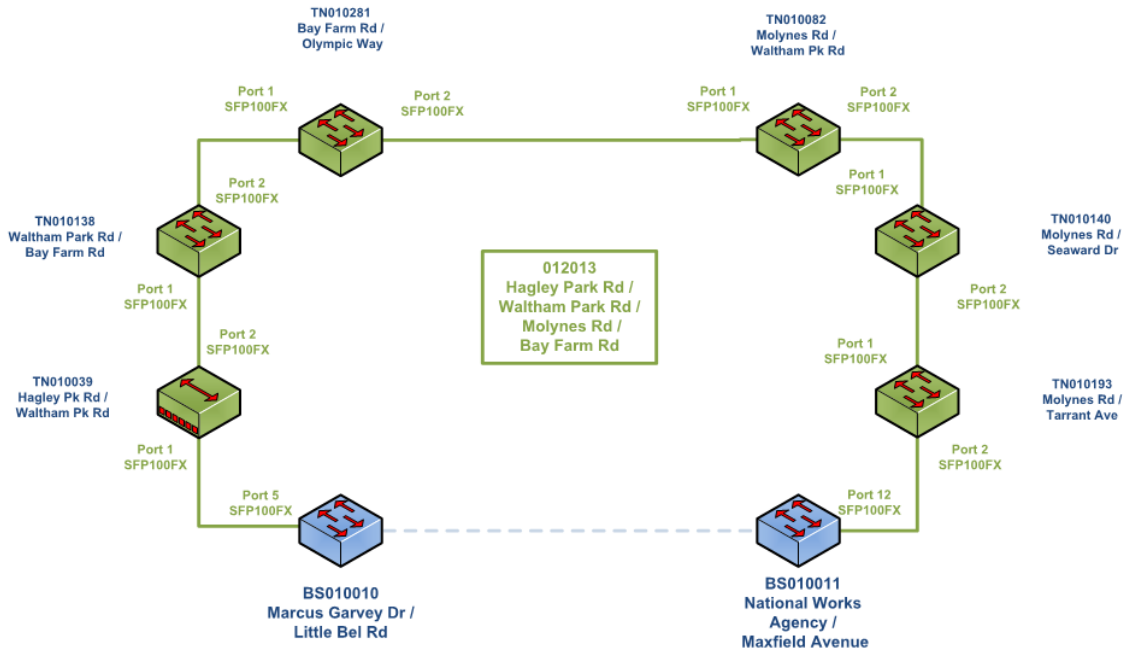

Figure 31 – Fiber Optic Ring 012013 Logical design

Inventory Ring 012013

ITS ID	NE	Net ID	Ring ID	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10	Port 11	Port 12
BC010001	BS010011	012000	012000	G G12000	G 012000	F 012001	F 012002	F 012006	F 012007	F 012008	F 012009	F 012010	F 012011	F 012012	F 012013
010039	TN010039	012000	012013	F 012013	F 012013										
010193	TN010193	012000	012013	F 012013	F 012013										
010082	TN010082	012000	012013	F 012013	F 012013										
010138	TN010138	012000	012013	F 012013	F 012013										
010140	TN010140	012000	012013	F 012013	F 012013										
010281	TN010281	012000	012013	F 012013	F 012013										
BC010010	BS010010	012000	012000	G 012000	G 012000	F 012001	F 012002	F 012013							

Table 23 – Fiber Optic Ring 012013 Ports

4.2.24 (021001 & 021002) Spanish Town

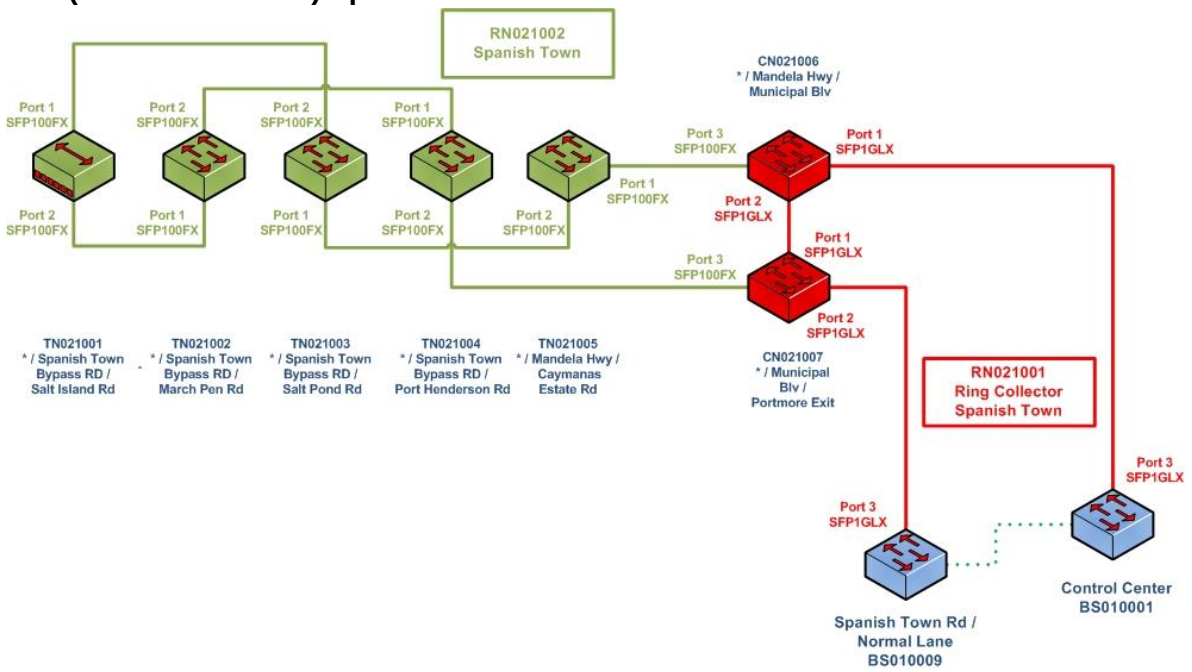

Figure 32 – Fiber Optic Rings 021001 & 021002 Logical design

Inventory Ring 021001 & 021002

ITS ID	NE	Net ID	Ring ID	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10	Port 11	Port 12
BC010001	BS010001	011000	011000	G 011000	G 011000	G 021001	F 011001	F 01007	F 011008	F 011009					
021001	TN021001	011000	021002	F 021001	F 021001										
021002	TN021002	011000	021002	F 021001	F 021001										
021003	TN021003	011000	021002	F 021001	F 021001										
021004	TN021004	011000	021002	F 021001	F 021001										
021005	TN021005	011000	021002	F 021001	F 021001										
021006	CN021006	011000	021001	G 021001	G 021001	F 021002									
021007	CN021007	011000	021001	G 021001	G 021001	F 021002									
BC010009	BS010009	011000	011000	G 011000	G 011000	G 021001	F 011001	F 011002							

Table 24 – Fiber Optic Rings 021001 & 021002 Ports

5 TECHNICAL MINIMUM REQUIREMENTS

The following list shows general minimum technical requirements used for the project and budget layout of the technological components and that will have to be confirmed and updated 2 months prior to the bidding process.

5.1 CENTRAL CONTROL

5.1.1 Server

Minimum technical specifications:

- **OS:** Windows Server
- **Processor:** 2 Processors Intel Xeon E5-2640v2, 2.0 GHz, 20 MB Caché
- **RAM:** 64 GB
- **FO Ports:** 2 HBA ports with 8 Gb
- **Ethernet:** 4 ports
- **Expansion bays:** 7 PCI bays
- **Disk bays:** 8 bays for 2.5-inch hot-plug HDD
- **HDD:** 2 600 GB SAS HDD, 10 KRPM, hot-plug
- **Raid:** Integrated RAID 1 controller
- **Power Supply:** 750 W redundant
- **Format:** Rack installation
- **Network:** LAN ports with independent administration and IPMI support

5.1.2 Workstation

Minimum technical specifications:

- **OS:** Latest version of Windows with 64 bits
- **Type:** Desktop PC
- **Processor:** Intel Core i7 4th generation
- **RAM:** 16 GB, one module
- **HDD:** 2 x 1 TB SATA
- **Graphics adapter:** Independent graphics processor with 3 D acceleration and resolutions up to 4 screens in 12=920 x 1080 pixels
- **LAN:** Gigabit
- **WLAN:** Wi-Fi 802.11 a/b/g/n, dual-band, Wi-Fi Direct, DLNA, Wi-Fi hotspot
- **Bluetooth:** Version 3.0, A2DP
- **Connectors:** 2 x USB version 2.0, 2 x USD version 3.0, 1 x RJ for speaker for headphones, 1 x RJ45 for LAN
- **Accessories:** Mouse and keyboard
- **Webcam:** Full HD with audio

The workstations include 2 PC screens thin the following minimum technical specifications:

- **Type:** LCD
- **Size:** 28 inch, visible
- **Illumination:** LED back lit
- **Brightness:** 250 cd/m2
- **Contrast:** 600:1
- **Response time:** 5ms
- **Vision angle:** 160 degrees x 160 degrees
- **Resolution:** (Full HD) 1920×1080 pixels
- **Connectors:** HDMI, RJ para audio
- **Speakers:** Integrated

5.1.3 FireWall

Minimum technical specifications:

- **Users:** 200
- **Support:** non restricted nodes
- **Speed:** 1.9 Gbps
- **Full DPI speed:** 300 Mbps
- **VPN speed:** 1.1 Gbps
- **Site to site tunnels:** 75
- **VPN client licenses:** 10
- **VPN SSL licenses:** 2
- **Connections:** 225000
- **Interfaces:** 8 x 1GbE
- **Format:** Rack installation

5.1.4 Printer

Minimum technical specifications:

- **Type:** Color laser
- **Speed:** 20 ppm
- **Resolution:** 600 ppp
- **Memory:** 32 Mbyte
- **Duplex:** automatic
- **Size:** US Letter
- **Capacity:** 250 pages
- **Ports:** USB version 2,0, Ethernet
- **Wireless connectivity:** Wifi
- **Copy:** Multi copy de 100, 600 ppp
- **Scanner:** Resolution de 600 ppp x 120 ppp, color 24 bits, US Letter
- **Fax:** Speed 33,6 kBit/s – G3, memory for 250 pages

5.1.5 Furniture

Minimum technical specifications:

- **Workspaces:** 4
- **Includes:** Office 5-wheel chair and desk

The furniture has to fit in the work environment provided by NWA and will be defined and explained in the obligatory field visit.

5.1.6 Local network wiring

Additional network wiring to integrate all new components in the existing control system. All wirings have to be compliant with national standards in Jamaica

5.1.7 SunGuide software

Minimum technical specifications:

- Florida DOT SunGuide software in its most recent version.

5.1.8 VMS software

Minimum technical specifications:

- **OS:** Latest version of Windows with 64 bits
- **Language:** English
- **Functionalities:** Parametrization, management and operation of the VMSs

In case, the VMS software is embedded in the peripheral devices, the above mentioned functionalities have to be provided through a web browser.

5.1.9 Virtual loop software

Minimum technical specifications:

- **OS:** Latest version of Windows with 64 bits
- **Language:** English
- **Functionalities:** Parametrization, management and operation of the virtual loops

In case, the virtual loop software is embedded in the peripheral devices, the above mentioned functionalities have to be provided through a web browser.

5.1.10 ALPR software

Minimum technical specifications:

- **OS:** Latest version of Windows with 64 bits
- **Language:** English
- **Functionalities:** Parametrization, management and operation of the ALPR

In case, the ALPR software is embedded in the peripheral devices, the above mentioned functionalities have to be provided through a web browser.

5.1.11 CCTV software

Minimum technical specifications:

- **OS:** Latest version of Windows with 64 bits
- **Language:** English
- **Functionalities:** Parametrization, management and operation of the virtual loops

In case, the virtual loop software is embedded in the peripheral devices, the above mentioned functionalities have to be provided through a web browser.

5.2 COMMUNICATIONS

5.2.1 Switch FX

Minimum technical specifications:

- **Physical Ports:** 6 electrical ports Auto MDI/MDIX 10/100 BaseT and 2 ports 100Base-FX SC SingleMode – More than 25km
- **Standards:** IEEE 802.3 for 10Base-T, IEEE 802.3u for 100Base-TX y 100Base-FX, IEEE 802.3ab for 1000Base-T, IEEE 802.z for 1000Base-X, IEEE 802.3ad for LACP (Link Aggregation Control Protocol), IEEE 802.3x for Flow control, IEEE 802.1D for STP (Spanning Tree Protocol), IEEE 802.1p for COS (Class of Service), IEEE 802.1Q for VLAN Tagging, IEEE 802.1D for STP (Spanning Tree Protocol), IEEE 802.1w for RSTP (Rapid Spanning Tree Protocol), IEEE 802.1s for MSTP (Multiple Spanning Tree Protocol), IEEE 802.1x for Authentication, IEEE 802.1AB for LLDP (Link Layer Discovery Protocol)
- **General:** MAC Address: 8000
- **Priority Queue:** 4
- **Matrix:** More than 1,6 Gbps
- **VLANs:** 256
- **Port rate limiting:** User Define
- **Security Features:** IP Police security feature - Enable/disable ports - MAC based port security - Port based network access control (802.1x) - VLAN (802.1Q) to segregate and secure network traffic - Radius centralized password management - SNMPv3 encrypted authentication and access security
- **Software Features:** STP/RSTP/MSTP (IEEE 802.1D/w/s) - TOS/Diffserv supported - Quality of Service (802.1p) for real-time traffic - VLAN (802.1Q) with VLAN tagging and GVRP supported - IGMP Snooping - IP-based bandwidth management - Application-based QoS management - DOS/DDOS auto prevention - Port configuration, status, statistics, monitoring, security - DHCP Client/Server **-** Full Web Access and monitoring
- **Network Redundancy:** STP/RSTP/MSTP, IEEE 802.1D/w/s.
- **Monitoring:** SNMP
- **Console Port**: RS232
- **Led Indicator**: power – system ready – link ports
- **Power:** 110 VAC – Optional with external DIN RAIL Mount Power Supply Industrial Design

- **Physical Characteristic:** DIN RAIL MOUNT – Industrial design
- **Environmental:** Storage Temperature -0 to 85°C (32 to 185°F) - Operating Temperature -0 to 70°C (32 to 158°F)
- **Regulatory approvals:** EMI: FCC Part 15, CISPR (EN55022) class A - EMS: EN61000-4-2 (ESD), EN61000-4-3 (RS), EN61000-4-4 (EFT), EN61000-4-5 (Surge), EN61000-4-6 (CS), EN61000-4-8, EN61000-4-11 – Shocks: IEC60068-2-27 – Free Fall: IEC60068-2-32 – Vibration: IEC60068-2-6 – Safety: EN60950-1
- **MTBF(hours):** 70000
- **Warranty:** 5 years

5.2.2 Switch ITS SFP

Minimum technical specifications:

- **Physical Ports:** 8 electrical ports Auto MDI/MDIX 10/100/1000 BaseT and 4 SFP Ports 100/1000 Base X
- **Standards:** IEEE 802.3 for 10Base-T, IEEE 802.3u for 100Base-TX y 100Base-FX, IEEE 802.3ab for 1000Base-T, IEEE 802.z for 1000Base-X, IEEE 802.3ad for LACP (Link Aggregation Control Protocol), IEEE 802.3x for Flow control, IEEE 802.1D for STP (Spanning Tree Protocol), IEEE 802.1p for COS (Class of Service), IEEE 802.1Q for VLAN Tagging, IEEE 802.1D for STP (Spanning Tree Protocol), IEEE 802.1w for RSTP (Rapid Spanning Tree Protocol), IEEE 802.1s for MSTP (Multiple Spanning Tree Protocol), IEEE 802.1x for Authentication, IEEE 802.1AB for LLDP (Link Layer Discovery Protocol)
- **General:** MAC Address: 8000
- **Priority Queue:** 4
- **Matrix:** More than 24 Gbps
- **VLANs:** 256
- **IGMP multicast groups:** 128 x VLAN
- **Port rate limiting:** User Define
- **Security Features:** IP Police security feature - Enable/disable ports - MAC based port security - Port based network access control (802.1x) - VLAN (802.1Q) to segregate and secure network traffic - Radius centralized password management - SNMPv3 encrypted authentication and access security
- **Software Features:** STP/RSTP/MSTP (IEEE 802.1D/w/s) - TOS/Diffserv supported - Quality of Service (802.1p) for real-time traffic - VLAN (802.1Q) with VLAN tagging and GVRP supported - IGMP Snooping - IP-based bandwidth management - Application-based QoS management - DOS/DDOS auto prevention - Port configuration, status, statistics, monitoring, security - DHCP Client/Server **-** Full Web Access and monitoring
- **Network Redundancy:** STP/RSTP/MSTP, IEEE 802.1D/w/s.
- **Monitoring:** SNMP
- **Console Port**: RS232
- **Led Indicator**: power – system ready – link ports
- **Power:** 110 VAC – Optional with external DIN RAIL Mount Power Supply Industrial Design
- **Physical Characteristic:** DIN RAIL MOUNT – Industrial design

- **Environmental:** Storage Temperature -0 to 85°C (32 to 185°F) - Operating Temperature -0 to 70°C (32 to 158°F)
- **Regulatory approvals:** EMI: FCC Part 15, CISPR (EN55022) class A - EMS: EN61000-4-2 (ESD), EN61000-4-3 (RS), EN61000-4-4 (EFT), EN61000-4-5 (Surge), EN61000-4-6 (CS), EN61000-4-8, EN61000-4-11 – Shocks: IEC60068-2-27 – Free Fall: IEC60068-2-32 – Vibration: IEC60068-2-6 – Safety: EN60950-1
- **MTBF(hours):** 70000
- **Warranty:** 5 years

5.2.3 Switch GE Rack

Minimum technical specifications:

- **Physical Ports:** 8 electrical ports Auto MDI/MDIX 10/100/1000 BaseT and 16 SFP Ports 100/1000 Base X
- **Standards:** 33 IEEE 802.3 for 10Base-T, IEEE 802.3u for 100Base-TX y 100Base-FX, IEEE 802.3ab for 1000Base-T, IEEE 802.z for 1000Base-X, IEEE 802.3ad for LACP (Link Aggregation Control Protocol), IEEE 802.3x for Flow control, IEEE 802.1D for STP (Spanning Tree Protocol), IEEE 802.1p for COS (Class of Service), IEEE 802.1Q for VLAN Tagging, IEEE 802.1D for STP (Spanning Tree Protocol), IEEE 802.1w for RSTP (Rapid Spanning Tree Protocol), IEEE 802.1s for MSTP (Multiple Spanning Tree Protocol), IEEE 802.1x for Authentication, IEEE 802.1AB for LLDP (Link Layer Discovery Protocol)
- **General:** MAC Address: 8000
- **Priority Queue:** 4
- **Matrix:** More than 48 Gbps
- **VLANs:** 256
- **IGMP multicast groups:** 128 x VLAN
- **Port rate limiting:** User Define
- **Security Features:** IP Police security feature - Enable/disable ports - MAC based port security - Port based network access control (802.1x) - VLAN (802.1Q) to segregate and secure network traffic - Radius centralized password management - SNMPv3 encrypted authentication and access security
- **Software Features:** STP/RSTP/MSTP (IEEE 802.1D/w/s) - TOS/Diffserv supported - Quality of Service (802.1p) for real-time traffic - VLAN (802.1Q) with VLAN tagging and GVRP supported - IGMP Snooping - IP-based bandwidth management - Application-based QoS management - DOS/DDOS auto prevention - Port configuration, status, statistics, monitoring, security - DHCP Client/Server **–** Full Web Access and monitoring
- **Network Redundancy:** STP/RSTP/MSTP, IEEE 802.1D/w/s.
- **Monitoring:** SNMP
- **Console Port**: RS232
- **Led Indicator**: power – system ready – link ports
- **Power:** 110 VAC
- **Physical Characteristic:** 19 inches rack-mountable – Industrial design

- **Environmental:** Storage Temperature -0 to 85°C (32 to 185°F) - Operating Temperature -0 to 70°C (32 to 158°F)
- **Regulatory approvals:** EMI: FCC Part 15, CISPR (EN55022) class A - EMS: EN61000-4-2 (ESD), EN61000-4-3 (RS), EN61000-4-4 (EFT), EN61000-4-5 (Surge), EN61000-4-6 (CS), EN61000-4-8, EN61000-4-11 – Shocks: IEC60068-2-27 – Free Fall: IEC60068-2-32 – Vibration: IEC60068-2-6 – Safety: EN60950-1
- **MTBF(hours):** 70000
- **Warranty:** 5 years

5.2.4 Power Supply

Minimum technical specifications:

- **Type:** Industrial, rugged
- **Power:** 30W
- **Voltages:** According to switches

5.2.5 SFP GX

Minimum technical specifications:

- **Type:** SFP optical transceiver, single-mode
- **Typical Distance:** 10km
- **Wavelength:** 1310nm
- **Physical Characteristic:** Industrial design
- **Environmental:** Storage Temperature -0 to 85°C (32 to 185°F) - Operating Temperature -0 to 70°C (32 to 158°F)

5.2.6 SFP FX

Minimum technical specifications:

- **Type:** SFP optical transceiver, single-mode
- **Typical Distance:** 30km
- **Wavelenght:** 1310nm
- **Physical Characteristic:** Industrial design
- **Environmental:** Storage Temperature -0 to 85°C (32 to 185°F) - Operating Temperature -0 to 70°C (32 to 158°F)

5.2.7 FO patch cord

Minimum technical specifications:

- **Radius curvature:** <0.30 dB typical (UPC)
- **Return loss:** <0.55 dB typical (UPC), <0.55 dB typical (APC)
- **Radius curvature:** 7 – 25mm
- **Apex offset:** 0 – 50um
- **Temperature coefficient:** 120 tg
- **Length:** 5 m

5.2.8 CAT 5 patch cord

Minimum technical specifications:

- **Type:** CAT 5 Ethernet cable
- **Cable diameter:** 0.215 in. (5.5mm) nominal
- **FCC compliance:** ANSI/TIA-1096A (formerly FCC Part 68); contacts
- plated with 50 microinches of gold
- **IEC compliance:** IEC 60603-7
- **PoE compliance:** Supports IEEE 802.3af/802.3at and proposed 802.3bt type 3 and
- type 4 PoE applications
- **Safety compliance:** cULus Listed; UL 1863 and CAN/CSA-C22.2 (UL File E129886)
- **Length:** 3 feet

5.2.9 FO service cable

Minimum technical specifications:

- **Type:** Single-mode optical fiber for laying pipeline
- **Capacity:** 4 strand
- **Conectorizado:** Service cable will come preassembled at one end with SC / PC connectors or LC / PC as appropriate to the node
- **Size:** Typically less than 60 meters
- **Jacket:** central loose tube - armored / Single Jacket - Anti-rodent type - waterproof – UV protection – corrugated Steel tape armor
- **Standards:** ITU-652 single-mode fiber, IEC 61034 smoke density, IEC 60754 Part 1 & 2. Test On Gases Evolved During Combustion of Electric Cables, IEC 60332-1 Tests on electric and optical fiber cables under fire conditions

5.2.10 FO splice closure

Minimum technical specifications:

- **Type:** Domo for use in junction boxes or outside
- **Capacity:** 96 splices
- **Accesses / outputs:** 4

5.2.11 Communications cabinet

Minimum technical specifications:

- **Type:** ITS Roadway 332
- **Size:** 66 in. H x 24 in. W x 30 in. D
- **Standard:** CALTRANS
- **Doors:** 2 doors, 1 front, 1 back
- **Installation:** Base mount
- **Locking system:** 3 point
- **Purpose:** Enclosure for outdoor equipment
- **Thickness:** 0.125-inch aluminum

5.2.12 FO Cable

Minimum technical specifications:

- **Type:** Single-mode optical fiber for laying pipeline
- **Capacity:** 48 strand
- **Jacket:** central loose tube - armored / Single Jacket - Anti-rodent type - waterproof – UV protection – corrugated Steel tape armor -
- **Standards:** ITU-652 single-mode fiber, IEC 61034 smoke density, IEC 60754 Part 1 & 2. Test On Gases Evolved During Combustion of Electric Cables, IEC 60332-1 Tests on electric and optical fibre cables under fire conditions

5.2.13 HDPD Duct

Minimum technical specifications:

- **With:** 500mm

5.2.14 Radio

Minimum technical specifications:

- **Frecuency:** TBD with NWA
- **Modulation:** QPSK, 16, 32, 64, 128, 256 QAM, hitless ACM
- **Forward Error Correction:** LDPC
- **User interface:** 1 Gb Eth. (10/100/1000) (IEEE 802.3ac 1000BASE-T), recommended cable S/FTP CAT7
- **Power Supply:** PoE, 40 - 60 VDC, IEEE 802.3at to 100m, user interface
- **Operating Temperature Range:** - 30 to + 55°C (ETSI EN 300019-1-4, class 4.1.)
- **Mechanical design:** FOD (Full Outdoor)
- **Configuration & management:** HTTPS, SSH, Telnet
- **Real time monitoring:** RSS, SNR, BER
- **Diagnostic tools:** spectrum analyzer, pinger, constellation diagram
- **History charts:** temperature, power supply, RSS, SNR, BER, data rate
- **Statistics:** independent counters for radio and Ethernet line and for all types of packets
- **Installation:** RSS voltage indication at BNC connector
- **Network management:** SNMP ver.2c including configurable TRAPs
- **EMC:** ETSI EN 301 489-1 V 1.8.1 (2008-04), ETSI EN 301 489-17 V1.3.2 (2008-04)
- **Electrical Safety:** EN 60 950-1:2004

5.3 PERIPHERAL DEVICES

5.3.1 Variable message sign

Minimum technical specifications:

- **Matrix type:** Alphanumeric.
- **Colours set:** Monochromatic amber 590/595 nm.

- **Character height:** 320 mm.
- **Rows:** 3
- **Columns (characters per row):** 12
- **Total amount of characters per display:** 36
- **Single character matrix:** 5 x 7 pixel. Letter size: H 320mm x W 228.5 mm
- **Mount:** Outdoor
- **Access:** Rear doors
- **Protection:** IP 55
- **Pollution de Operating temperature:** T1 & T2 (-25 +60° C) EN12966.
- **Operating humidity:** 10% ÷ 90%
- **Cooling system:** Forced external ventilation controlled by CPU and by thermostat.
- **Heating system:** Heating controlled by CPU and by thermostat. gree: D2 EN12966
- **Data communication:** Ethernet 10/100TX, RS485.

5.3.2 Virtual loop detector

Minimum technical specifications:

- **Zones:** 8
- **Lanes:** 2
- **Detection:** Count, presence, classification by vehicle length
- **Interface:** Ethernet TCP/IP
- **Power requirement:** 110VAC

5.3.3 Bluetooth Wifi sensor

Minimum technical specifications:

- **Temperature range:** -20° to 75° C (industrial option: -40° to 85° C)
- **Relative humidity:** 10% to 90% non-condensing
- **Power requirements:** 5VDC
- **Power Supply:** included
- **Power consumption:** < 5 Watts
- **CPU:** 1 GHz Cortex ARM7
- **Connectivity:** (wired) 10/100BaseT
- **Data Capture Rate:** 250,000 records per hour
- **Wifi:** 1 Watt 2.4Ghz Radio
- **Data Interface:** NTCIP Center-to-Center XML
- **MTBF:** > 100,000 hours
- **Data Latency:** 35 Seconds
- **Data Storage Capacity:** 100MB (internal) / 32GB (USB storage)

5.3.4 ALPR

Minimum technical specifications:

- **Sensor Type:** CMOS

- **Sensor Technology:** Global shutter
- **Resolution:** 1936 pixels x 1216 pixels
- **Sensor Size:** 1/½”
- **Exposure Control:** Programmable
- **Lighting Type:** Infrared LED Array
- **Lighting Control:** Pulsed and synchronized. Integrated power stage
- **Wavelength:** 940 nm
- **Range:** 30m
- **RAM:** DDR3 8GB 1600MHZ
- **Hard Disc:** SSD with extended range
- **Shooting Modes:** Software and Hardware
- **License Recognition Plate Engine:** Lector Engine High Flow
- **Communication:** Gigabit Ethernet (Ethernet 10/100/1000)
- **Power supply:** 48 DC / Consumption 40W / included
- **Operating temperature:** -20ºC to 60ºC
- **Housing:** Waterproof stainless steel housing for use indoors and outdoors (IP67)

5.3.5 CCTV Camera

Minimum technical specifications:

- **Image Sensor:** 1/2" Progressive Scan CMOS
- **Effective Pixel:** 2.1M Pixels
- **Min. Illumination:** F1.5, AGC On: Color: 0.002 Lux, B/W: 0.0002 Lux, 0 Lux with infrared
- **White Balance:** Auto/Manual/ATW/Indoor/Outdoor/Flourescent Lamp/Sodium Lamp
- **AGC:** Auto/Manual
- **Signal to Noise Ratio:** ≥ 55dB
- **Digital Noise Reduction:** 3D DNR
- **Light Compensation:** High Light Compensation / Back Light Compensation
- **Wide Dynamic Range:** 120dB
- **Shutter Speed:** 50Hz: 1 ~ 1/30,000s, 60Hz: 1 ~ 1/30,000s
- **Day & Night:** Day / Night / Auto Sensing - IR Light Field
- **Digital Zoom:** 16X
- **Privacy Masking:** 24 privacy masks programmable, optional multiple colors and mosaics
- **Focus Mode:** Auto/Semiautomatic/Manual
- **Enhancements:** Optical Defog, Multi-Casting
- **Focal Length:** 5.9mm - 135.7mm, 23X Optical Zoom
- **Zoom Speed:** Approx. 3.3s (Optical Wide-Tele)
- **Angle of View:** 59.8° - 3.0° (Wide-Tele)
- **Min. Working Distance:** 10 ~ 1500mm (Wide-Tele)
- **Aperture Range:** F 1.5 ~ F 3.4
- **Pan/Tilt Range:** Pan: 360° Endless Tilt: -15° ~ 90° (Auto Flip)

- **Pan/Tilt Speed:** Pan Manual Speed: 0.1° ~ 300° /s Pan Preset Speed: 540° /s Tilt Manual Speed: 0.1° ~ 240° /s Tilt Preset Speed: 400° /s
- **Proportional Zoom:** Rotation speed can be adjusted automatically according to zoom multiples
- **No. of Presets/Position Accuracy:** 300 / Preset position return accuracy +/- 0.1°
- **Patrol:** 16 Patrols, up to 32 presets per patrol
- **Pattern:** 10 Patterns, with the recording time not less than 10 minutes per pattern
- **Power-Off Memory:** Support
- **Park Action:** Preset / Patrol / Pattern / Pan Scan / Tilt Scan / Random Scan / Frame Scan /
- **PTZ Position Display:** On / Off,
- **Preset Freezing:** Support
- **Scheduled Task:** Preset / Patrol / Pattern / Auto Scan / Tilt Scan / Random Scan / Frame Scan /
- **Compatibility:** SunGuide approved list

5.3.6 Conflict monitor

Minimum technical specifications:

- **Compatibility:** McCain 170 controller

5.3.7 ATM Modem

Minimum technical specifications:

- **Type:** 400 Ethernet Card
- **Compatibility:** McCain 170 controller

5.3.8 Memory module

Minimum technical specifications:

- **Type:** 412C memory module
- **Compatibility:** McCain 170 controller

5.4 OPERATIONAL CAPACITY AND TRAINING

5.4.1 Baseline and impact documentation

Minimum technical specifications:

- Documentation of the base line just prior to project implementation based on traffic counts and speed measurements and impact documentation. Documentation of project impact.

5.4.2 Traffic model software

Minimum technical specifications:

- **OS:** Latest version of Windows with 64 bits
- **Language:** English
- **Model levels:** Macroscopic (static model), mesoscopic (dynamic model), microscopic (dynamic model), hybrid mesoscopic – microscopic (dynamic model), all in one single executable
- **Maps:** Direct import from OpenStreetmaps.org

- **Network size:** unlimited
- **Static assignment:** Private vehicles, public transport
- **Dynamic traffic assignment:** Stochastic route choice, dynamic user equilibrium
- **Modes:** Public transport, private transport, nm motorized transport
- **Adaptive control interfaces:** With the microscopic simulator: SCATS, SCATS-RMS, SCOOT, Fast SCOOT UTC, UTOPIA, VS-Plus and as customized developments also ETRA, INDRA, SICE, Telvent, Telent and ZGZ Prio. With the mesoscopic simulator: SCATS and UTOPIA.
- **Network import:** CONTRAM, Cube, Paramics, Synchro, Vissim, Visum, Aimsun
- **Compatibility:** left hand driving

5.4.3 Traffic signal timing software

Minimum technical specifications:

- **OS:** Latest version of Windows with 64 bits
- **Language:** English
- **Network signal timing calculations:** Cycle Time, Phase Times, Signal Offsets
- **Compatibility:** left hand driving

5.4.4 SOP development

Minimum technical specifications:

- Standard operational procedures for daily operations, planning and modelling processes from data collection to controller programming
- The outline of the SOP development has to be delivered with the offer and will be evaluated.

5.4.5 System training

Minimum technical specifications:

- Training in installation, operation, parametrization of all new peripheral devices.
- The outline of the system training has to be delivered with the offer and will be evaluated.

5.4.6 Planning training

Minimum technical specifications:

- Training on methods, tools and procedures for traffic planning and modelling.
- The outline of the planning training has to be delivered with the offer and will be evaluated.

5.4.7 SunGuide training

Minimum technical specifications:

- Training in parametrization and operation of the central SunGuide system
- The outline of the SunGuide training has to be delivered with the offer and will be evaluated.

5.4.8 Coaching

Minimum technical specifications:

- **Activity:** Coaching process in planning, modelling and operation of the system

- **Duration:** 3 months
- **Presence:** 1 week per month
- **Expert:** The CV of the coaching expert has to be delivered with the offer and will be evaluated.

5.5 OTHERS

5.5.1 Lift truck

Minimum technical specifications:

- **Height:** 5m
- **Capacity:** 2 persons

Lift truck for maintenance of traffic signal and ITS equipment.

5.5.2 Fiber optic splicer

Minimum technical specifications:

- **Type:** Fusion Splicer
- **Applicable Fibers:** Single-mode (G.652 & G.657), Multimode (G.651), DS (G.653), NZDS (G.655)
- **Cladding Diameter:** 80 µm to 150 µm
- **Coating Diameter:** 100 µm to 1,000 µm
- **Fiber Cleave Length:** 5 to 16 mm
- **Typical Average Splice Loss:** 0.02 dB with SM, 0.01 dB with MM, 0.04 dB with DS, 0.04 dB with NZDS, measured by cut-back method relevant to ITU-T and IEC standards
- Splicing Time: SM FAST mode — 7 seconds; SM AUTO mode — 12 seconds; AUTO mode — 15 seconds
- **Arc Calibration Method:** Automatic, real-time and by using results of previous splice when in AUTO mode, manual arc calibration function available
- **Splicing Modes:** 100 preset and user programmable modes
- **Storage of Splice Result:** Last 2,000 results to be stored in the internal memory
- **Fiber Display:** X or Y, or both X and Y simultaneously. Front or rear monitor display options with automated image orientation
- **Magnification:** 300X for single X or Y view, or 160X for X and Y view
- **Viewing Method:** Dual cameras with 4.73 inch TFT color LCD monitor
- **Operating Condition:** 0 to 5,000 m above sea level, 0 to 95%RH and -10 to 50°C respectively
- **Mechanical Proof Test:** 1.96 to 2.25N
- **Tube Heater:** Built-in tube heater with 30 heating modes; auto-start function
- **Tube Heating Time:** Typical 14 seconds with FP-03 sleeve, 17 seconds with FP3 (40), 5-16 seconds with Fujikura micro sleeves
- **Protection Sleeve:** Length 60 mm, 40 mm, micro
- **Splice/Heat Cycles with Battery:** Typical 200 cycles with power save functions activated
- **Power Supply:** Auto voltage selection from 100 to 240 V AC or 10 to 15 V DC with ADC-18, 14.8 V DC with BTR-09 battery

- **Terminals:** USB 1.1 (USB-B type) for PC communication. Mini-DIN (6-pin) for HJS-02/03 and SH-8 tube heater

5.5.3 Fiber blower

Minimum technical specifications:

- **Duct range:** 25mm – 63mm
- **Cable range:** 6mm – 32mm
- **Cable feeder:** Cast aluminum, hydraulically powered
- **Speed:** 90 m / min
- **Tools:** included

5.5.4 Portable ground penetrating radar

Minimum technical specifications:

- **Type:** All terrain
- **Odometer:** Integrated
- **Depth:** 8 m
- **Storage:** Compact flash
- **Display:** 7-inch color LCD
- **Weight:** max 25kg
- **Power Supply:** Battery pack

5.6 FIELD VISIT

An obligatory field visit is recommended during the bidding process.

6 CAPEX, OPEX

6.1 REFERENCE BUDGET

The following table resumes the bill of materials and reference budget to put the current [project in place.

Jamaica ITS - Greater Kingston Area - Bill of Materials & Reference Budget							V.07, 7.8.2016
Item	**Central control**	**#**	**Unit**		**Subtotal**	**122,600.00**	**USD**
3.3.1.1.1	Server	2	UN	5,000.00	USD	10,000.00	USD
3.3.1.1.2	Workstation	4	UN	4,000.00	USD	16,000.00	USD
3.3.1.1.3	Firewall	1	UN	5,000.00	USD	5,000.00	USD
3.3.1.1.4	Printer	1	UN	600.00	USD	600.00	USD
3.3.1.1.5	Furniture	1	GL	5,000.00	USD	5,000.00	USD
3.3.1.1.6	Local network wiring	1	GL	2,000.00	USD	2,000.00	USD
3.3.1.1.7	SunGuide software	1	UN	80,000.00	USD	80,000.00	USD
3.3.1.1.8	VMS software	1	UN	1,000.00	USD	1,000.00	USD
3.3.1.1.9	Virtual loop software	1	UN	1,000.00	USD	1,000.00	USD
3.3.1.1.10	ALPR software	1	UN	1,000.00	USD	1,000.00	USD
3.3.1.1.11	CCTV software	1	UN	1,000.00	USD	1,000.00	USD
Item	**Communications**	**#**	**Unit**		**Subtotal**	**1,153,380.00**	**USD**
3.3.2.1.1	Switch FX	186	UN	1,700.00	USD	316,200.00	USD
3.3.2.1.2	Switch ITS SFP	19	UN	2,200.00	USD	41,800.00	USD
3.3.2.1.3	Switch GE Rack	12	UN	5,000.00	USD	60,000.00	USD
3.3.2.1.4	Power Supply	204	UN	120.00	USD	24,480.00	USD
3.3.2.1.5	SFP GX	42	UN	150.00	USD	6,300.00	USD
3.3.2.1.6	SFP FX	84	UN	120.00	USD	10,080.00	USD
3.3.2.1.7	FO patch cord	76	UN	40.00	USD	3,040.00	USD
3.3.2.1.8	CAT 5 patch cord	632	UN	40.00	USD	25,280.00	USD
3.3.2.1.9	FO service cable	204	UN	300.00	USD	61,200.00	USD
3.3.2.1.10	FO splice closure	216	UN	300.00	USD	64,800.00	USD
3.3.2.1.11	Communications cabinet	11	UN	1,200.00	USD	13,200.00	USD
3.3.2.1.12	FO Cable	90000	MTS	5.00	USD	450,000.00	USD
3.3.2.1.13	HDPD Duct	10000	MTS	2.50	USD	25,000.00	USD
3.3.2.1.14	Radio	8	UN	6,500.00	USD	52,000.00	USD
Item	**Peripheral devices**	**#**	**Unit**		**Subtotal**	**1,543,200.00**	**USD**
3.3.3.1.1	Variable message sign	5	UN	25,000.00	USD	125,000.00	USD
3.3.3.1.2	Virtual loop detector	68	UN	4,500.00	USD	306,000.00	USD
3.3.3.1.3	Bluetooth WiFi sensor	39	UN	4,500.00	USD	175,500.00	USD
3.3.3.1.4	ALPR	56	UN	10,000.00	USD	560,000.00	USD
3.3.3.1.5	CCTV Camera	62	UN	3,500.00	USD	217,000.00	USD
3.3.3.1.6	Conflict monitor	94	UN	500.00	USD	47,000.00	USD
3.3.3.1.7	ATM Modem	161	UN	250.00	USD	40,250.00	USD
3.3.3.1.8	Memory module	161	UN	450.00	USD	72,450.00	USD
Item	**Operational capacity and training**	**#**	**Unit**		**Subtotal**	**200,000.00**	**USD**
3.3.3.2.1	Baseline and impact documentation	1	GL	15,000.00	USD	15,000.00	USD
3.3.3.2.2	Traffic model software	1	UN	40,000.00	USD	40,000.00	USD
3.3.3.2.3	Traffic planning software	1	UN	10,000.00	USD	10,000.00	USD
3.3.3.2.4	SOP development	1	GL	40,000.00	USD	40,000.00	USD
3.3.3.2.5	System training	1	GL	25,000.00	USD	25,000.00	USD
3.3.3.2.6	Planning training	1	GL	15,000.00	USD	15,000.00	USD
3.3.3.2.7	SunGuide training	1	GL	25,000.00	USD	25,000.00	USD
3.3.3.2.8	Coaching	3	UN	10,000.00	USD	30,000.00	USD
Item	**Others**	**#**	**Unit**		**Subtotal**	**180,000.00**	**USD**
3.3.4.1.1	Lift truck	1	UN	70,000.00	USD	70,000.00	USD
3.3.4.1.2	Fiber splicer	1	UN	25,000.00	USD	25,000.00	USD
3.3.4.1.3	Fiber blower	1	UN	50,000.00	USD	50,000.00	USD
3.3.4.1.4	Portable ground penetarting radar	1	UN	35,000.00	USD	35,000.00	USD
	Total system cost					**3,199,180.00**	**USD**
	Administration, utility, unforseen expenses					**300,820.00**	**USD**
	Total project cost					**3,500,000.00**	**USD**

Table 25 - Referebce budget

6.2 CAPEX

Two CAPEX are being calculated, one (CAPEX 1 or CAPEX new) only taking into account the budget of the IDB project, showing the benefits per US Dollar spent in the current project and another one (CAPEX 2 or CAPEX existing) taking into account the IDB project budget plus an estimate valuation of existing technological and civil infrastructure giving an overall impression of a wider cost benefit analysis, and putting CAPEX 1 into a more integrated perspective.

- **CAPEX 1:** Cost to put the project in place
- **CAPEX 2:** Cost to put the project in place plus an estimate value of the existing technological and civil infrastructure.
- **OPEX:** Power consumption of additional technological components.

The CAPEX 2 analysis includes past infrastructure and technology investments that were included at a current approximate purchase value.

The total budget for present component is 3.5 M US$

The existing infrastructure and technology value estimate, itemized by control center, communications and intersections is approximately 9.97 M US$. Summing existing infrastructure and technology and project budget for the present component the CAPEX 2 value is approximately 13.47 M US$

7 OTHER POSSIBLE INITIATIVES

There are many factors that influence fuel efficiency in transportation. Starting with the direct factors like engine size and efficiency, vehicle automation, climate, traffic speed [3], trip type, driving style as well as external factors like city and transport planning, driver and user information, signal timing and many others.

To identity other possible initiatives towards better fuel or energy efficiency in transportation 1) an understanding of typical factors that impact fuel efficiency in transport as well as 2) the taking into current of the current Jamaican context is needed.

As a result, and seeing the size of the current public transport operations, the following measures seem valid to be discussed at this time:

- **Soft measures:** Transportation planning (PuT Planning), driver behavior (PuT driver training)
- **Hard measures:** Vehicle specifications (PuT vehicle size), electric vehicles (EVs)

7.1 PUT PLANNING

7.1.1 Introduction

Planning is considered the first, cheapest and often most cost effective approach to improve mobility. This also applies to public transport planning, being the goal of planning to provide a good quality service at an affordable cost or impact.

Offering to little capacity results in a bad quality service (jammed buses), offering to much capacity in high and unjustified operational costs (empty buses). These operational costs are directly related with OPEX (labor, fuel, …) and CAPEX (inadequate fleet size, …)

7.1.2 International experiences

International experiences in this area are:

Sistema Integrado de Transporte Terrestre

- **Entity:** Transportes Metropolitanos de Trujillo
- **Location:** Trujillo, Peru
- **Project:** Optimization of public transport routes and dispatch frequencies

Sistema Estratégico de Transporte Publico

- **Entity:** Movilidad Futura SAS
- **Location:** Popayan, Colombia
- **Project:** Implementation of an integrated public transport system

[3] Note: The present ITS UTMS Project will certainly have an important impact on PuT operations, as mean traffic speed on the main corridors will increase

7.1.3 Possible actions for Jamaica

During the field visits in Kingston, most of the observed public transport vehicles had very low occupancies even in peak hours, suggesting that 1) schemes of illegal competition to PuT might exist, 2) the routes and or dispatch frequencies might be improved and or updated or 3) the vehicle size was not chosen according to technical needs. In any case the visual diagnostics suggest important potential for better fuel efficiency.

Therefore, an analyses of the demand and supply situation in Kingston could help identify existing bottlenecks and allow the creation of programs and projects for PuT energy efficiency improvement.

7.2 PUT DRIVER TRAINING

7.2.1 Introduction

Driver behavior has been a worldwide successful means of reducing fuel consumption in Private Transport (PrT) and Put Transport (PuT). Typical activities that are being trained are:

- shift up to a higher gear as soon as possible, with a maximum engine speed of 2500 rpm (for diesel a maximum of 2000 rpm);
- keep the speed as steady as possible
- drive at low engine speeds in the highest gear possible;
- look ahead as much as possible and anticipate other traffic
- if you have to decelerate or stop, release the throttle early and coast the vehicle with a gear engaged;
- stop the engine, even at shorter stops. Start again without pressing the throttle; and
- use, if possible, in-car instruments like a rev counter, cruise control and trip-fuel meter.

Improvements in urban areas are much higher than in rural areas or highways (***Error! Reference source not found.***) but depend strongly on the vehicle type (***Error! Reference source not found.***)(***Error! Reference source not found.***)(***Error! Reference source not found.***) and driving location. But what is certain is that any effect of coaching in eco driving (***Error! Reference source not found.*****Error! Reference source not found.**) even if small will bring great improvement.

7.2.2 International experiences

International experiences in this area are:

ecoDriver “Supporting the driver in conserving energy and reducing emissions”

- **Entity:** University of Leeds
- **Location:** Seven cities in France, Germany, Italy, Netherlands, Spain, Sweden and UK
- **Project:** Reduction in CO2 emissions and fuel consumption in road transport by encouraging the adoption of green driving behavior
- **Impact:** Reductions in fuel consumption and CO2 have of an average of 4.2% with the highest saving (5.8%) on rural roads. Embedded systems (the more elaborate systems, closely linked to the vehicle) with fuel savings up to 6%

GTZ – Sustainable Urban Transport Project (SUTP)

- **Entity:** GIZ (Former GTZ)
- **Location:** Worldwide
- **Project:** Reduction of fuel consumption in public transport through driver training in ecoDriving. Pilot studies in public transport systems worldwide.
- **Impact:** Average fuel savings nearly 20% in Public Transport vehicles pilot in Santiago de Chile. Average fuel savings of 7-15% in Public Transport vehicles pilot in Jakarta. Average fuel savings of 14.2% in Public Transport vehicles pilot in Buenos Aires.

7.2.3 Possible actions for Jamaica

As a phase step a driving behavior base line will have to be established. These baselines are usually developed using automatic clustering techniques. One example is the CGI format (***Error! Reference source not found.***). This format is easily understood and still has a significant enough statistical basis. The analysis should focus mainly on typical urban public transport trips (long, medium, short routes) qualifying good, average and bad behavior.

In a second phase selected drivers should be trained for an eco-driving pilot. Based on the results a larger scale project can be designed. Also incentive models for eco driving might be interesting.

7.3 PuT VEHICLE SIZE

Vehicle size and its corresponding engine size, should be according to technical needs of the tasks the vehicle has to perform. For example, for hilly roads more torque might be required than or flat roads, also more power will be required for higher speeds, less power for lower speeds.

Being the vehicles the most important cost position in most public transport operations, the adequate size of vehicles and engines has a considerable impact on the overall operational efficiency and fuel efficiency.

7.3.1 International experiences

International experiences in this area are:

Regulation on bus types for the Trujillo Province

- **Entity:** Provincial Municipality of Trujillo
- **Location:** Trujillo, Peru
- **Project:** Definition and regulation of bus sizes and technical specification towards more fuel efficiency, safety and comfort for the public transport operations in the Trujillo province
- **Impacts:** In process of implementation. Projected fuel savings are considerable as the new regulation possibly results in complete public transport fleet renewal in the mid-term.

7.3.2 Possible actions for Jamaica

As mentioned above the observation of PuT operations in Kingston suggest the possibility that the vehicle size – task ratio might be checked and confirmed.

A study on requirements for different routes and times should help to identify possible potentials for mid and long term improvements in energy efficiency.

In case of positive study results a program for fleet renovation could be designed.

7.4 ELECTRIC VEHICLES

7.4.1 Introduction

Electric vehicles can be one part of a solution to cut emissions from the transport sector, and in the longer run, when transport needs to be fully decarbonized (), the options available are electric vehicles and sustainable second (or third/fourth ...) generation biofuels. Electricity can also play an important role in improving resource efficiency in transport. [4]

According to The Greens/EFA there are however several threats that can turn this opportunity into a greenwashing project for electricity producers and car manufacturers. Among the concerns are the need of an integrated approach, taking into account factors as:

- The integration of e-Mobility with technology development as systemic approach to sustainable transportation and the development of the energy sector.
- Demand management, smarter city and land use planning, promotion of non-motorized means of transport and public transport as part of e-Mobility promotion.
- Bi directional energy transfer out off and into the energy system, making electric vehicles (EV) truly part of a smart energy system.
- Not making e-Mobility a counterproductive element in social and economic development.
- Considering the overall approach of electric vehicles, including operational costs and waste management.

Also, and most importantly, electric vehicles must run on green power.

7.4.2 Types of electric vehicles

In e-Mobility many types of electric vehicles can be distinguished, being the most important:

- **Full Electric Vehicles (FEVs):** that have an electric engine and batteries for energy storage, no internal combustion engine (ICE).
- **Plug-in Hybrid Electric Vehicles (PHEVs):** that have both an ICE and an electric engine, with a battery that can be charged on the grid.
- **Electric Vehicles with a Range Extender (EREVs):** that have an electric engine and an ICE that can be used to charge the battery and so extend the vehicle's range. The battery of an EREV can be charged on the grid.
- **Diesel Electric Hybrid V (DEHV):** that have an electric engine and a high efficiency diesel ICE that can be used to charge the super capacitor, successfully addressing environmental concerns of battery disposal.

[4] Source: Greens/EFA: Position on electric mobility, www.greens-efa.eu

7.4.3 International experiences

International experiences in this area are:

Electric Bus Feasibility Study

- **Entity:** ETS
- **Location:** Edmonton, Canada
- **Project:** Electric bus feasibility study for the city of Edmonton
- **Impacts:** Expected environmental impact of using 40 electric buses in Edmonton would generate GHG saving of 38% to 44% compared to diesel buses used in the same way. These savings will reach 72% to 74% by 2034 as the Alberta electricity supply base gets cleaner with the progressive phasing out of coal-fired power generation.

All-Electric Transit Bus Demo in Winnipeg

- **Entity:** Winnipeg Transit
- **Location:** Winnipeg, Canada
- **Project:** Use of New Flyer Xcelsior battery-electric transit buses in daily service as part of an electric bus demonstration for understanding battery and charging technology.
- **Impacts** 400.000 CA$ per year in fuel savings. Charging stations have the capacity to recharge the bus in about 10 minutes after each round trip on the route

7.4.4 Possible actions for Jamaica

Taking into account that Jamaica still has some way to go towards highly efficient or real green power, a step by step implementation, starting with the design of pilot projects using FEVs and DEHVs in public transport might be convenient. Based on the learnings, policies and programs towards more sustainability in transportation could be developed.

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