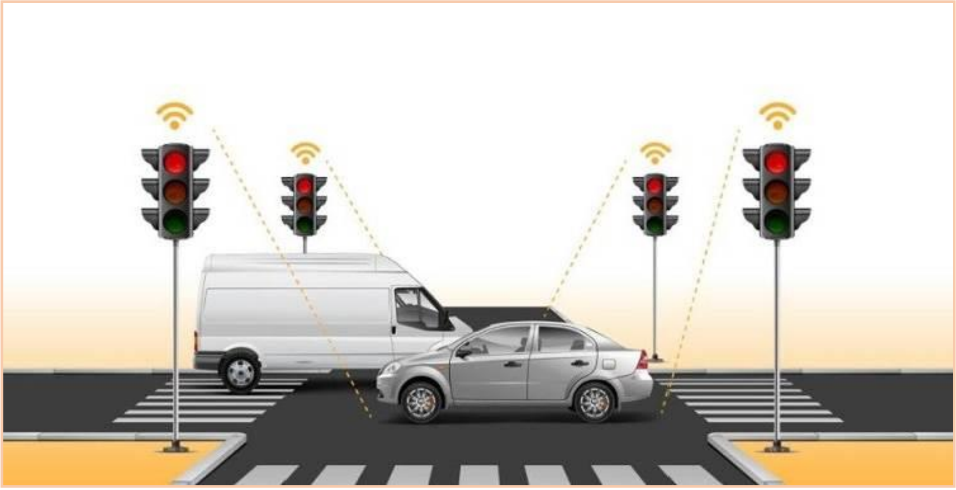
# OPERATING A NEW URBAN TRAFFIC CONTROL SYSTEM (UTC) FOR THE CITIES OF NICOSIA & LIMASSOL IN CYPRUS




**Alexis A. Avgoustis**

*Executive Engineer/Traffic Signals Team Leader*

*Public Works Department*

*Ministry of Transport, Communications & Works*

*Republic of Cyprus*

*aavgoustis@pwd.mcw.gov.cy*

*Tel. +357-22-806645 (direct)*



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**ABSTRACT**

The focus of this paper is to describe the new Urban Traffic Control System (UTC) for the cities of Nicosia and Limassol in Cyprus as a measure to significantly improve traffic conditions and road safety on the road network.  Successful UTC systems around the world have proven that by introducing adaptive control and bus priority (and emergency vehicle priority) the benefits are many and crucial for an efficient and smooth road network.

Traffic Signal Management is one of the most cost-effective ways to keep traffic moving. This paper will describe the methodology to be followed as well as the proposed technology and updating of an outdated UTC. The renovation and operation of a Traffic Control Centre focused on traffic management, bus and emergency vehicle priority at several corridors in both cities will also be discussed. Anticipated benefits include the reduction of travel time and delays, congestion, emissions and improvement of road safety conditions.

The new UTC is fully funded by the EU Cohesion Policy Programme “THALIA 2021-2027” and is estimated to cost around Euro 7.2 million (around GBP 6.1 million) plus VAT.

## *INTRODUCTION*

With a population of around 950,000 people, over 2 million tourists per year, a road network of more than 7,750km of paved roads and nearly 700,000 registered vehicles, the island faces a challenging situation when it comes to keeping traffic moving safely and efficiently. In addition to growing traffic, Cyprus' road safety record is one of the worst within the European Union and delays experienced by motorists are extremely high if we take into consideration the relatively short distances on the island.

Traffic in major cities was coordinated over the past 25 years via UTC/SCOOT at 90 junctions in Nicosia, Limassol and Larnaca. However, SCOOT operated on TC12 and analogue leased lines that were expensive and inefficient based on obsolete telecommunications.

In 2022, the Ministry of Transport, Communications and Works (MTCW) and the Public Works Department (PWD) that is responsible for signals all over the island, embarked on designing and procuring a new Urban Traffic Control System for the cities of Nicosia and Limassol, after traffic studies were conducted in all four major cities. Tenders for the new UTC were submitted in late May 2024 and an award is anticipated in the Autumn months in order for the new system to be implemented in 2025-2026 at 125 signalized junctions (75 in the capital, Nicosia and 50 in Limassol).

## SCOOT/HISTORY *Existing Traffic Monitoring and Management System*

PWD operated an Urban Traffic Control System (SCOOT), supplied by SIEMENS UK, initially installed in 1992, which used to collect real time traffic data from 90 intersections in Nicosia, Limassol and Larnaca via induction loops (occupancy loops) and microwave detectors. The system was used for signal optimization and its main scope was to reduce junction delays and traffic congestion. SCOOT operated for many years with great success in providing better traffic conditions for the main corridors of the three cities. UTC/SCOOT is outdated and has been non-operational since 2021-22. It is important to note that it operated with analogue communications (TC12), older software versions and, in most junctions, had obsolete equipment or was out of service.

PWD proceeded with a Terms of Reference preparation in order to procure a new UTC system based on new technologies and solutions (adaptive control) having also in mind upcoming bus corridors in Nicosia and Limassol as well as the provision of emergency vehicle priority.

Currently, the PWD operates a traffic monitoring and management system collecting information from a number of field devices installed on the primary road network, then analyses and provides information to interested agencies and road users regarding travel time and prevailing traffic conditions. The software platform is OMNIA-MISTIC developed by SWARCO-MIZAR SPA. The product installed is the

OMNIA Platform which receives real-time data from traffic detection units and Bluetooth devices via GPRS. The traffic platform MISTIC encompasses a dynamic model to estimate various traffic parameters upon the road network. It allows the insertion of incidents using the Datex II protocol. These platforms will be utilized by the new UTC. To comply with requirements of NAP – National Single Access Point, an update of the overall solution is in progress, including existing and planned roadside devices and equipment:

- **65 existing counters (75 to be added)** Traffic Detection Units in Nicosia, Limassol, Larnaca and Paphos and the interurban road network in order to provide real-time traffic data such as traffic flow, traffic composition, headways and actual speeds.
- **12 existing Weigh-in-Motion (WIM)** units installed in the interurban road network collecting real-time traffic data such as traffic flows, traffic composition, headways, actual speeds and axle weight.
- **60 (105 to be added) Bluetooth Detection Devices** installed in Nicosia at key junctions and the interurban road at key intersections and approximately every 12km. The devices collect real time, travel times on key sections of the road network.
- **26 (170 new CCTV Cameras to be installed)** at key junctions of the Nicosia Road network and the Inter-urban road network to offer a visual confirmation of the prevailing road conditions in the city network. The video is recorded and kept for a short period in the PWD Traffic Management Centre.
- **4 (40 new VMS to be installed) Variable Message Signs (VMS)** on the Inter-Urban Road Network
- **12 Bicycle Detection Units** have been installed in Nicosia and Paphos, on cycle ways.
- **A TMS Traffic Management System**, collects information from a number of field devices installed on the primary road network, analyses and provides information to interested agencies and road users regarding travel time and prevailing traffic conditions
- A **Public Transport ITS System**, which includes the development of a Fleet Management and Passenger Information System, as well as the Automated Bus Fare Collection System
- A **GIS platform called GNOSIS** developed by the KOIOS Research Centre of Excellence of the University of Cyprus
- **Existing UTC/SCOOT Control Room**

## Shift to Adaptive Control

The cities of Nicosia and Limassol are currently experiencing a rapid increase in traffic and outdated signal timing at several junctions in both cities needs to shift to adaptive control and a new UTC. Adaptive control will improve throughput and the average performance of the network with reduced travel time and emissions as well as delay control. Adaptive control is very popular in the UK, a lot of Asian countries as well as Australia and New Zealand. It was proven in the past with SCOOT that traffic can operate under much better conditions, safer and greener. Delays in both cities have reached abnormal numbers, and given the small distances it makes the problem worse. Adaptive signal control is proven to accommodate traffic patterns, alleviate congestion and smoothen traffic flow. Bus lanes on bus corridors will be a new system that drivers will need to adapt to as well as and the city signalling program.

The new Cyprus UTC is proposed to operate via Radar and/or Video. Currently tenders received with internationally recognized UTC solutions on offer are being evaluated. The traffic sensors will collect traffic data at 125 intersections in both cities with 75 of them on adaptive control to cover 7 bus corridors. Traffic data will be collected by the system provider and a before-and-after study will be done. A continuous collection of traffic data and re-evaluation of adaptive control strategies will lead to better traffic conditions. Where the adaptive control will be enforced (75 of 125 locations) the solution provider will have Video Detection Units as well as Radar and/or Video Detection, depending on the providers solution/methodology.

## *A NEW UTC/TECHNOLOGY -New Cyprus UTC Architecture*

The scope of the new UTC will include the supply, installation and 5-year maintenance of a new system for the cities of Nicosia and Limassol, integration with UTC controllers of Larnaca and Famagusta, and future integration of other controllers as soon as they are available with standard protocols.

The UTC System will be both hierarchical and distributed. Optimal control strategies will be determined at the higher (area) level, while traffic signal control is actuated at the lower (intersection) level. The higher (area) level co-ordinates the intersection control units, providing them with optimization criteria and network wide reference control strategies. Each intersection is then controlled independently according to the actual traffic conditions encountered at the intersections, but the local optimization is performed according to the global goals. Strategies will be computed at a centralized level and at intersection level according to the rolling horizon technique. At area level, optimization will be performed on a 30-minute horizon and repeated every 5 minutes; at intersection level the horizon is 2 minutes long and the optimization is repeated every 3 seconds.

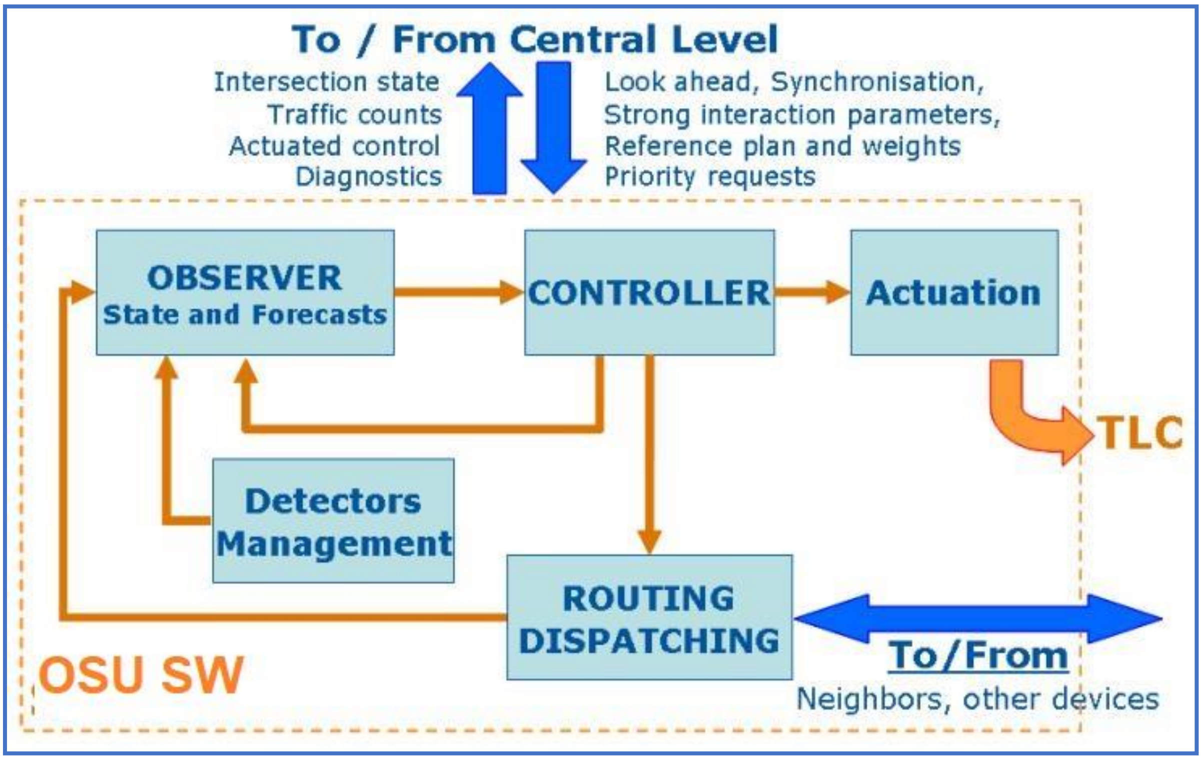
Local intelligence is very important for the new UTC System. The software that will compute the local control functions in the Roadside Unit must be included in the Outstation Unit (OSU), a System for Priority and Optimization of Traffic. The Roadside Unit is the communication unit between UTC as the backend software at the Operational Control Centre, the site controller installed on every controlled intersection. UTC will be used to uniquely identify all the software modules/functions that operate at a Central Level. The OSU will be connected to the traffic signal controller by means of a serial interface. OSU software will continuously exchange information with:

- The adjacent roadside units to co-operate in the computation of the local control strategy;
- The higher (area) level to receive commands, priority requests and reference control strategies (recommended/computed by the area level) and to provide traffic parameters, actuated control strategy and diagnostic information

## *Local Level Functions of the New UTC System*

The UTC lower (intersection) level, from this point on called Local Level, is based on a network of OSUs. The Local Level software module must carry out the following functions:

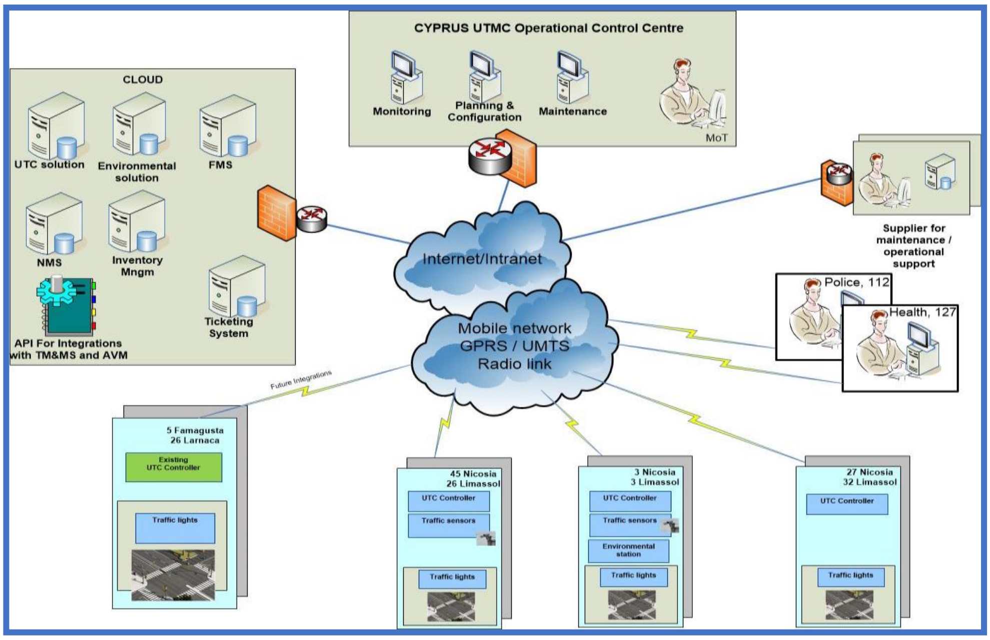
- Traffic signal controller interface (Actuation) to control signal groups or signal plan phases (via serial port or digital I/O).
- Intersection Control
- Adaptive – OSU software runs fully adaptive and applies dynamic optimization concepts based on a traffic model of the intersection based on measures by detectors and data exchange with nearby intersections. Cycle time, green splits and co-ordination offsets are continuously (every few seconds) and dynamically optimized, based on the intersection status, demands for public transport priority and status of nearby intersections, following the Central Level optimization criteria and network wide reference control strategies. In case of absence of communication with nearby intersections and the Centre, the local unit can run in adaptive mode, using only the data coming from the local detectors and locally stored traffic demand profiles.
- Plan Selection – OSU software applies the control strategy determined by the Central Level where signal plans coordinated with fixed offset are triggered from libraries according to traffic conditions and other specific criteria.
- Intersection Status estimation – this function provides the real-time estimation of the controlled intersection status and forecasts the status over the complete optimization horizon. Forecasts are based on measured traffic demands (arrivals) and estimated statistical profiles of traffic data. The intersection status estimation provides the basis for intersection control in both Adaptive and Plan Selection modes.
- Local Level diagnostic status monitoring – the diagnostic status is continuously updated for all system components. All diagnostic data is stored and made available through dedicated screens and detailed reports. Availability indicators to support maintenance and automatic alarms are generated via UTC for irregular situations.
- Communication Management manages the data exchange between Central Level and with adjacent peripheral units.




*Outstation Unit Operation*

## *System Overview*

The new UTC will be the main solution for integrated management of mobility and urban traffic management in Cyprus. Through other already awarded tenders, the PWD is currently replacing the signal equipment in the cities of Larnaca and Paralimni/Ayia Napa (Famagusta), Limassol and Paphos with the possibility to add other junctions on to the UTC in the future. The equipment installed is mainly YUNEX Traffic Controllers ST950 ELV and ST750 ELV and new SWARCO ITC-3 controllers that will be installed over the next few months. The architecture schematic is shown below:

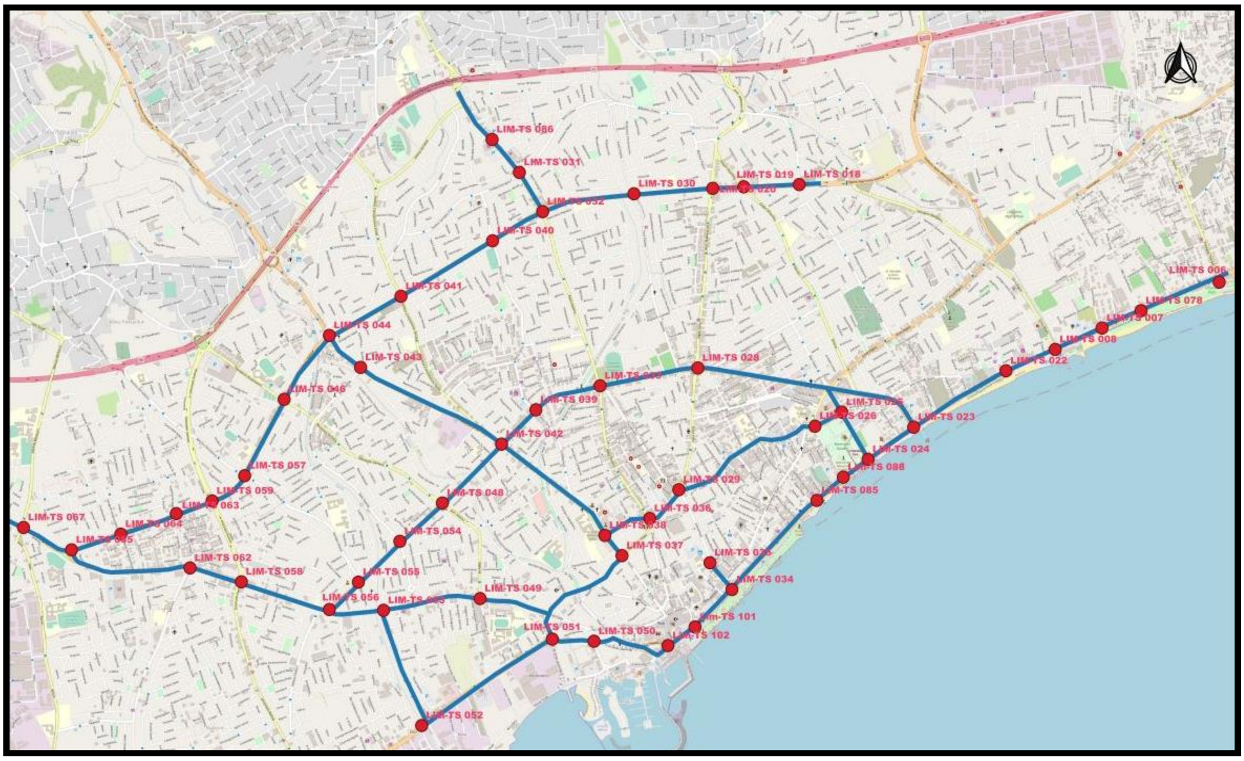


The UTC system will include backend control systems and will be able to support 75 intersections in Nicosia and 50 intersections in Limassol, with each system capable of being expanded up to 500 intersections and 500 Pelican Crossings (PED Controllers). UTC back-end application will perform the central processing required for the UTC system including display and alarms.

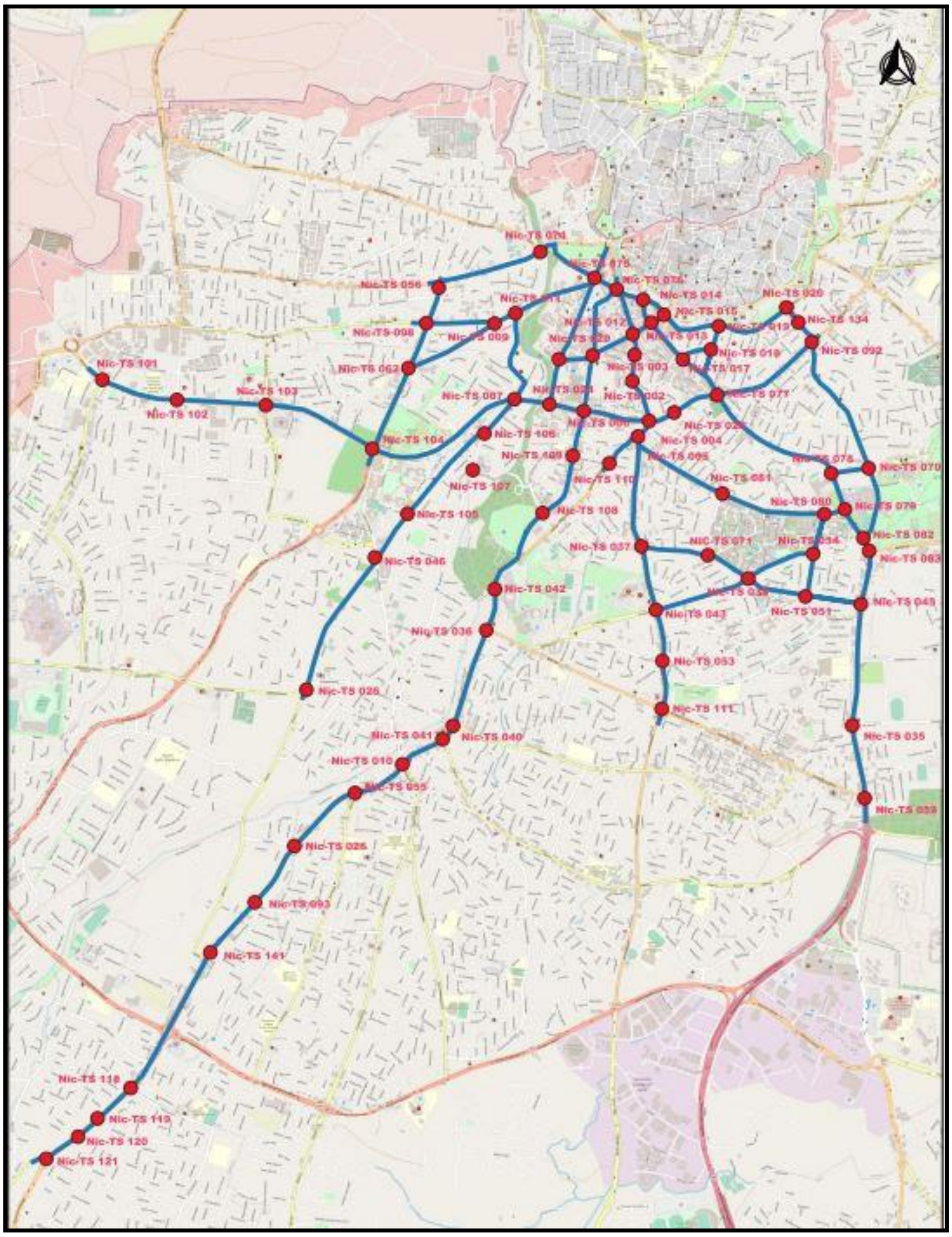
The UTC system will have a Distributed Control System with two levels (a central controller and a field master controller) for coordination, with control actions determined through real time adaptive capabilities. The new UTC platform will be based on open communication protocols and API to facilitate integration to other systems in the future and must include a UTC user-friendly interface with interactive maps for monitoring and control.

The architecture of the platform is divided into the following layers:

- <u>Data collection:</u> the platform collects, integrates and stores traffic information. This information will be both static and dynamic, even in real-time when communications allow it.
- <u>Data processing:</u> elaborated data is made available for the management modules.
- <u>Operation and management:</u> the platform is enabled to manage the infrastructure and services that are under their responsibility.
- <u>Presentation:</u> includes all the user and operator interfaces for the publication of the data and interaction with the system.




**Limassol UTC Scope (50 locations)**



*Nicosia UTC Scope (75 locations)*

As a minimum, the new UTC system will integrate the following functionalities:

- Management of the basic infrastructure
- Event Management
- Plan Management
- Traffic data
- Traffic control
- Bus Priority
- Data Acquisition System (traffic controllers and traffic detectors)
- Decision Support System (DSS)
- GIS Map with zoom and movement controls
- User and roles management

- Traffic and operations reports
- Key Performance Indexes (KPI) and dashboards
- Communications management
- Monitoring of standards-based IP-videos from the video-detectors
- Remote Demand Activation for Traffic Controllers

In addition, the system will be compatible with the following emerging technologies:

- V2I, V2V, V2X
- Big Data
- Internet of Things (IoT)
- Artificial Intelligence (AI)
- Green Light Optimized Speed Advisory (GLOSA)

The system will be based on standard technologies (i.e., MS operation system, SQL DB) and protocols and open interfaces to connect new extensions by integration of other traffic control systems (i.e., CCTV, VMS). The UTC system will have an open architecture. The supplier will provide all interfacing requirements including the protocols, communication formats, etc. so that other systems can be interfaced with the UTC solution.

The UTC system will provide real time traffic adaptive capabilities based on real time traffic data, will be fully adaptive, and will select the best traffic control strategy. The UTC will monitor the traffic in real time and automatically implement adaptive traffic signal timing. The UTC parameters will be controlled by the operators.

The system will be configurable to provide the capability of a green wave along a string of traffic lights, and be capable of operating under fixed time plan by time of day.

The real time fully adaptive control system will provide the capability to calculate in real time the optimal cycle times, effective green time ratios, offsets and change intervals for all system traffic signal controllers.

The UTC System will be able to support:

- Security at the system interface to log on current users with variable rights
- System Availability of 99.9%
- Download/upload parameters to controllers
- Unattended operation
- Alarms for all system malfunctions
- Backup machine changeover that will allow for central processor changeover in the event of a computer failure
- Printers and Video wall display

Systems will be capable of interfacing with UTC from a wide variety of manufacturers through modular expansion using the TCP/IP protocol. UTC field and OCC equipment will be capable of adding Pedestrian signal heads and related functionality and controls.

The initial timing plans will be installed by the Contractor/Supplier of the UTC based on current initial traffic study and current timing plan on the intersections. The system will run pre-timed until a corridor is installed and then will run adaptive. Traffic data will be collected for future development of timing plans based on time of day, day of week, week of month and month of year.

## *Traffic Control*

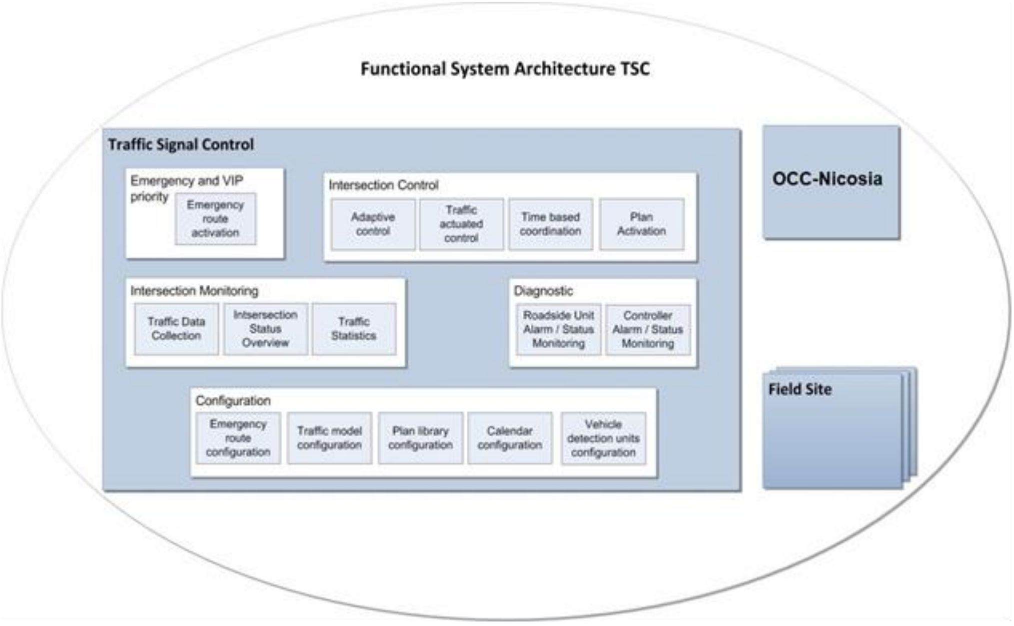
The system will be able to integrate the new traffic controllers and vehicle detectors, and the adapted traffic controllers once upgraded. The system will be equipped with different traffic operation modes in terms of Traffic Command and Control capabilities, so as a minimum, the system will be able to run the following Traffic Operations Modes:

- Manual
- Pre-Fixed signal phase times
- Actuated or specifically demanded traffic phases
- Micro-regulation traffic stage/phase duration
- Timetable traffic plan library selection
- Dynamic traffic plan selection
- Adaptive traffic mode
- Specific traffic operation modes for green waves in avenues and public transport prioritization

The adaptive control mode of the system will be fed by vehicle detectors collecting traffic data parameters including flow and occupancy from the urban traffic network for the optimization of the cycle, split and offset. Traffic data collected from the vehicle detectors will be managed in real time to allow the online generation of traffic plans to be deployed by the new traffic controllers. The control modes of the system will be deployed under the following basis:

As general criteria for the new traffic controllers considering its location and importance:

- The adaptive control mode will be deployed in at least 50% of the new traffic controllers of the city of Nicosia.
- The adaptive control mode will be deployed in at least 80% of the new traffic controllers of the city of Limassol
- The rest of the new traffic controllers will work on dynamic traffic plans selection mode, where the online generation of traffic plans, as adaptive does, is not required.




***Functional System Architecture – Traffic Signal Control***

## *Events Management/Handling by UTC*

The new UTC will include the following categories of events:

- Transit events – Events affecting public transportation services
- Traffic events – Events affecting private transportation
- Generic events – Other events not categorized (e.g., sport events)
- Alerts – Warnings to the operator (e.g., weather events)

As well as, the following types of events:

- Incident
- Construction
- Special
- Lane closures

The system will allow as a minimum categories and subcategories with the following classification:

- Draft
- Open: Unconfirmed, Active, Inactive, Resolved
- Closed: Finished, Cancelled, Cancelled by conflict

At a minimum, the events will support the following commands: event detail, notes, open report, acknowledge ownership, require ownership, release ownership, transfer ownership, blog, status, Actions/Plans to be executed and resources.

## *Adaptive Control*

The new UTC software as mentioned earlier will offer full adaptive technology for managing UTC controllers in full adaptive mode, with corridors for BUS Priority and centralization capabilities up to 500 sites. The offered UTC will be capable to elaborate/analyse signal plans (cycle time, green splits and coordination offsets) and coordination based on real time traffic data. Its adaptive algorithm will be based on a traffic model. The adaptive algorithm will be executed at intersection level and will be able to run even when losing connection with the central system. It will also incorporate information/data and signal plans from adjacent intersections. Finally, the public transport priority will be considered as one of the criteria for cycle optimization.

## *Environmental and Meteorological Data Sources*

The UTC system will integrate environmental and meteorological information in order to enable operators to complete the situational awareness view with environmental information, leverage such air quality information for decision making, abnormal situations detection, response plans and/or public warning dissemination. Using the Copert or Handbook Emission Factors for Road Transport (HBEFA) models, it will be able to provide the following KPI by section: CO2 Emissions, NOx Emissions, CO Emissions and Hydrocarbons emissions. Six environmental stations, three in each city will be installed and connected to the new UTC and the Operational Control Centre.

## *Traffic Sensors - Vehicle Detection Systems (VIDS)*

VIDS, as mentioned earlier must utilize all non-intrusive sensors based in two major technologies:

- Video Based Detection System
- Radar Based Detection System

A Video Based Vehicle Detection Unit or Radar Unit will be installed at each signalized intersection. The vehicle detection system will detect vehicles by processing video images and providing detection outputs to a traffic signal controller. The Video Based Vehicle Detection Unit will include cameras covering all directions and turning movements within the intersection, or the Radar Vehicle Detection Unit will include Radar Units covering all directions and turning movements within the intersection.

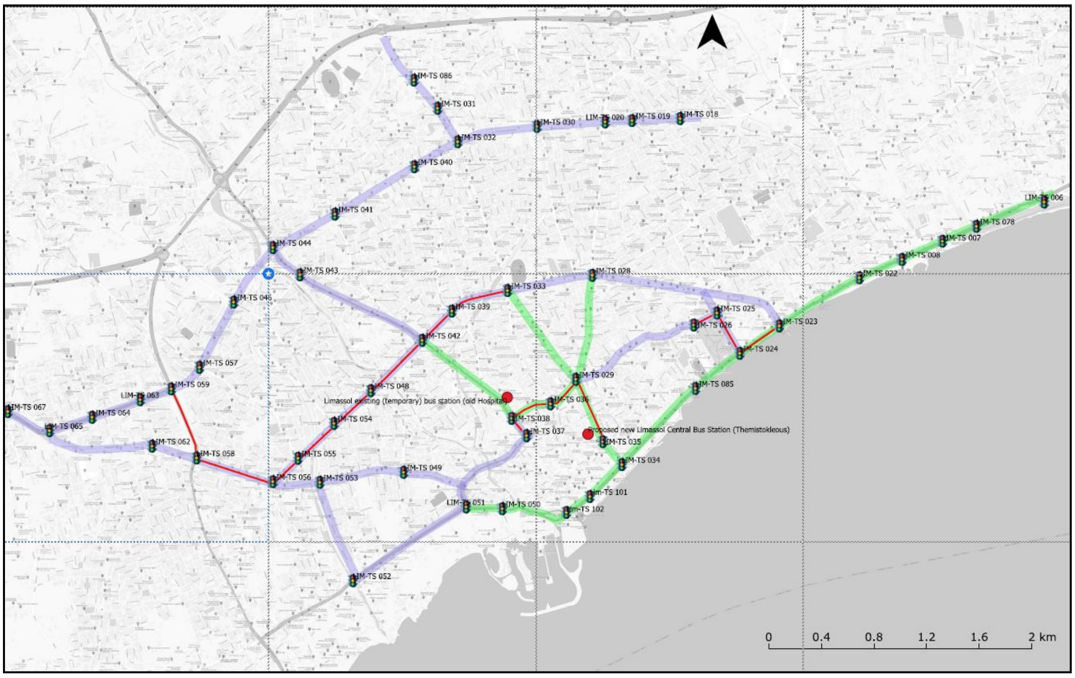
In addition to presence detection, the VIDS will be capable of performing the following calculations in real time and transmit the values from each camera view for any visible lane, without the addition of another device:

- Speed, Volume, Lane Occupancy, Vehicle length

## *Public Transport Priority (PTP)*

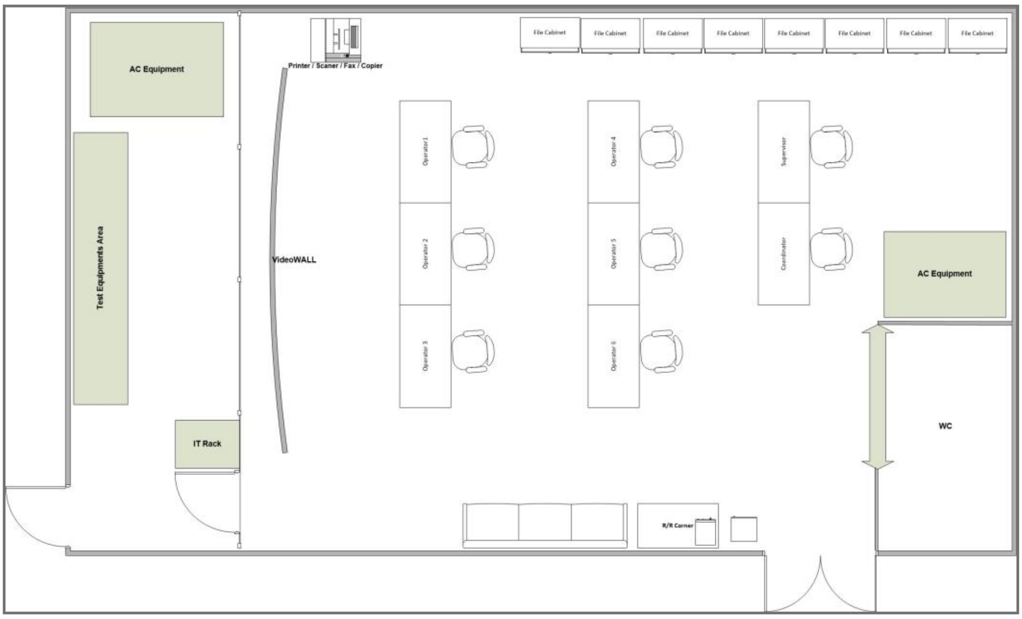
Historically, PTP was never used in Cyprus. The development of a bus system that includes telematics and an Automated Vehicle Location system began in 2009 and is expanding rapidly. The new UTC will utilize the existing system and the Public Transport Priority function will be based on the predicted arrival time of the Public Transport Vehicle at the intersection, and priority requests provided by the existing AVM system. Through the new UTC we will design, supply, install, commission and test the public transport priority system on the renewed signal controllers of the bus corridors. For sake of clarity, the term “Bus Priority” identifies the possibility to offer public transport vehicles a privileged passage at the traffic light junctions duly equipped with appropriate sensors and logics. The privilege consists of favouring, although not ensuring, the green light when the public transport vehicle reaches the junction as well as the time needed to cross it.

The aim is to increase the probability of having a green light when a public transport vehicle arrives, in order to decrease the average travel times and to increase the regularity of the service. Absolute priority and unconditional green light at every controlled traffic light will not be allowed. The implementation is performed by means of variations in the timing of the traffic light, in order to keep a Green Wave in the Priority Corridors, preserving the safety procedures for road users. This kind of intervention involves the urban traffic in general, and particularly along the roads and at the crucial spots involved in the traffic light controlling actions performed to favour Public Transport. In a centralized traffic light system, all the controllers are typically coordinated; the priority logics developed by the required system will ensure that, at the end of the action, the traffic light diagram goes back to the correct cycle time and in line with the control of the system group. The new UTC will operate in adaptive mode at three bus corridors in Nicosia and four in Limassol based on the initial design. The Limassol Bus Corridors are shown below:



## *Operational Control Centre (OCC) – Traffic Control Centre*

The new UTC will operate on Cloud Services while a Traffic Control Centre will be used for day-to-day traffic management. The existing SCOOT room will be renovated and upgraded in order to provide the necessary facilities for running a UTC for both cities. The OCC will have room for up to eight (8) operators and a manager as well as a testing area where controllers will be stored to test configurations as well as a video wall and supporting facilities (server and PCs, printers/scanners etc.) for the operators. The operators will have access to the PWD Traffic Management Systems and NAP facilities (counters/Bluetooth devices/VMS/CCTV etc) The layout is shown below:




## *Expected Results and Benefits*

Adaptive signal control technologies over conventional signal systems are proven to be efficient and deliver significant benefits as they can automatically adapt to unexpected changes in traffic conditions in real time, improve travel time reliability, reduce congestion and fuel consumption. Key Performance Indicators (KPIs) relate to the expected benefits of the new UTC based on the previous UTC/SCOOT system that operated in Cyprus as well as the anticipated benefits based on the design of the new UTC by the PWD.

Some of the expected benefits include the following:

- Reduction of travel time by ~10-25%
- Reduction of delays by ~15-35%
- Reduction of start-stop conditions by ~10-30%
- Reduction of public transport travel time by 28%

- Reduction of emissions by ~10-15%
- Reduction of fuel consumption by ~8-10%
- Reduction of incident handling time by up to 30%
- Time savings for commercial vehicles and logistics
- Improved air quality and reduction of fuel consumption. Overall, a better quality of life in Cyprus
- Reduction of serious accidents
- Reduction of aggressive driving behavior, including red-light running
- Postponement or eliminate the need to construct additional road capacity

## *Conclusions/Next Steps*

The new UTC is the way forward for the PWD when it comes to managing traffic and coordinating signals all over Cyprus. An ambition project with numerous anticipated benefits to provide better traffic conditions for the motorists at least for the next 15-20 years. The technology and smart equipment available ensure that the results will be beneficial in all respects as mentioned in this paper.

The capability of the system to add junctions from all cities is an added benefit and a way of remote traffic management. Once the new UTC operates successfully PWD will be able to further expand it to meet the demands for smarter and efficient traffic management at junction and network level. Linking the new UTC with the services offered by the National Access Point is also a target to maximize the benefits of both systems and resources as well.

Bus Priority as well as Emergency Vehicle Priority are key elements of the new UTC system as the Ministry of Transport is directing funds for modal shift via the bus concession contracts and will need to be successful in order to assist in this direction.

***References:***


- PS/60/2022/G(O) Tender Documentation and Technical Specifications for the new UTC system for Nicosia and Limassol, published by PWD
- CYSTAT – Cyprus Statistical Services Department, Ministry of Commerce, Cyprus
- Sustainable Urban Mobility Plans for Nicosia, Limassol, Larnaca and Paphos, PWD
- Traffic Signals Team of the Transport Planning Section of PWD.