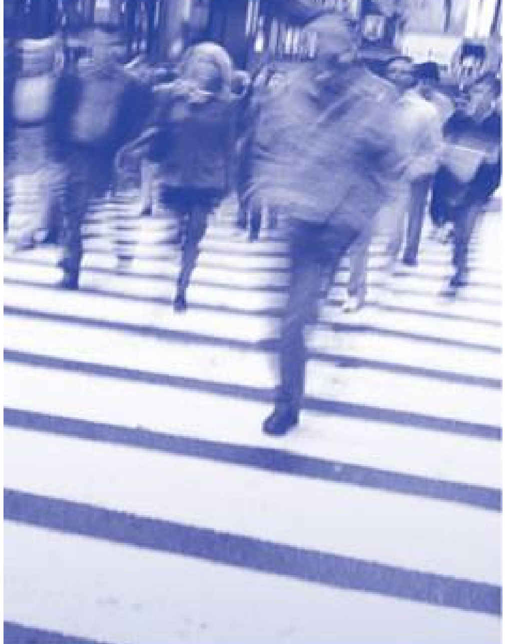

CIVITAS
Cleaner and better transport in cities

ARCHIMEDES
AALBORG • BRIGHTON & HOVE • DONOSTIA - SAN SEBASTIÁN • IAȘI • MONZA • ÚSTÍ NAD LABEM

Monza

R81.1 - Study of UTC System Technical Design in Monza

City of Monza

September 2009

THE CIVITAS INITIATIVE
IS CO-FINANCED BY THE
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1 Introduction

1.1 Background CIVITAS

CIVITAS - cleaner and better transport in cities - stands for CIty-VITAlity-Sustainability. With the CIVITAS Initiative, the EC aims to generate a decisive breakthrough by supporting and evaluating the implementation of ambitious integrated sustainable urban transport strategies that should make a real difference for the welfare of the European citizen.

CIVITAS I started in early 2002 (within the 5th Framework Research Programme);
CIVITAS II started in early 2005 (within the 6th Framework Research Programme) and
CIVITAS PLUS started in late 2008 (within the 7th Framework Research Programme).

The objective of CIVITAS-Plus is to test and increase the understanding of the frameworks, processes and packaging required to successfully introduce bold, integrated and innovative strategies for clean and sustainable urban transport that address concerns related to energy-efficiency, transport policy and road safety, alternative fuels and the environment.

Within CIVITAS I (2002-2006) there are 19 cities clustered in 4 demonstration projects, within CIVITAS II (2005-2009) 17 cities in 4 demonstration projects, whilst within CIVITAS PLUS (2008-2012) 25 cities in 5 demonstration projects are taking part. These demonstration cities all over Europe will be funded by the European Commission.

Objectives:

- to promote and implement sustainable, clean and (energy) efficient urban transport measures
- to implement integrated packages of technology and policy measures in the field of energy and transport in 8 categories of measures
- to build up critical mass and markets for innovation

Horizontal projects support the CIVITAS demonstration projects & cities by :

- Cross-site evaluation and Europe wide dissemination in co-operation with the demonstration projects
- The organisation of the annual meeting of CIVITAS Forum members
- Providing the Secretariat for the Political Advisory Committee (PAC)
- Development of policy recommendations for a long-term multiplier effect of CIVITAS

Key elements of CIVITAS

- CIVITAS is co-ordinated by cities: it is a programme “of cities for cities”
- Cities are in the heart of local public private partnerships
- Political commitment is a basic requirement
- Cities are living ‘Laboratories' for learning and evaluating

1.2 Background ARCHIMEDES

ARCHIMEDES is an integrating project, bringing together 6 European cities to address problems and opportunities for creating environmentally sustainable, safe and energy efficient transport systems in medium sized urban areas.

The objective of ARCHIMEDES is to introduce innovative, integrated and ambitious strategies for clean, energy-efficient, sustainable urban transport to achieve significant impacts in the policy fields of energy, transport, and environmental sustainability. An ambitious blend of policy tools and measures will increase energy-efficiency in transport, provide safer and more convenient travel for all, using a higher share of clean engine technology and fuels, resulting in an enhanced urban environment (including reduced noise and air pollution). Visible and measurable impacts will result from significantly sized measures in specific innovation areas. Demonstrations of innovative transport technologies, policy measures and partnership working, combined with targeted research, will verify the best frameworks, processes and packaging required to successfully transfer the strategies to other cities.

1.3 Participant Cities

The ARCHIMEDES project focuses on activities in specific innovation areas of each city, known as the CIVITAS corridor or zone (depending on shape and geography). These innovation areas extend to the peri-urban fringe and the administrative boundaries of regional authorities and neighbouring administrations.

The two Learning cities, to which experience and best-practice will be transferred are Monza (Italy) and Ústí nad Labem (Czech Republic). The strategy for the project is to ensure that the tools and measures developed have the widest application throughout Europe, tested via the Learning Cities activities and interaction with the Lead City partners.

1.3.1 Leading City Innovation Areas

The four Leading cities proposed in the ARCHIMEDES project are:

- Aalborg (Denmark);
- Brighton & Hove (UK);
- Donostia-San Sebastián (Spain); and
- Iasi (Romania).

Together the Lead Cities in ARCHIMEDES cover different geographic parts of Europe. They have the full support of the relevant political representatives for the project, and are well able to implement the innovative range of demonstration activities proposed.

The Lead Cities are joined in their local projects by a small number of key partners that show a high level of commitment to the project objectives of energy-efficient urban transportation. In all cases the public transport company features as a partner in the proposed project.

2 Monza

Monza is a city on the river Lambro, a tributary of the Po, in the Lombardy region of Italy, some 15km north-northeast of Milan. It is the third-largest city of Lombardy and the most important economic, industrial and administrative centre of the Brianza area, supporting a textile industry and a publishing trade. The City of Monza is probably best known for hosting a Formula One Grand Prix. It has approximately 121,000 inhabitants and 58,500 companies, i.e. one for every 13 inhabitants. As a result Monza is also one of the engines of the Italian economy.

Monza is affected by a huge amount of traffic that crosses the city to reach Milan and the highways nodes located between the two cities. It is also an important node in the Railways network, crossed by routes connecting Milan with Como and Switzerland, Lecco and Sondrio, Bergamo and Brianza. "Regione Lombardia", which in the new devolution framework started in 1998, has full responsibility for establishing the Local Public Transportation System (trains, coaches and buses) and has created a new approach for urban rail routes using an approach similar to the German S-Line or Paris RER.

Monza has recently become the head of the new "Monza and Brianza" province, with approximately 750,000 inhabitants, so will gain the full range of administration functions by 2009. Plan-making responsibilities and an influence over peri-urban areas will require the city to develop new competencies.

In this context, the objective of the City of Monza in participating in CIVITAS as a Learning City is to set up an Urban Mobility System where the impact of private traffic can be reduced, creating a new mobility offer, where alternative modes become increasingly significant, leading to improvements to the urban environment and a reduction in energy consumption (and concurrent pollution).

3 Background of the Deliverable

The aim of the measure 81, which this deliverable is associated to, is to design and implement an Urban Traffic Control (UTC) technological system that contributes to maximize the flow of traffic through the identified CIVITAS corridor in the city of Monza.

Urban Traffic Control systems have been developed to manage in a coordinated way intersections driven by traffic lights. One of the main advantage gained by the application of UTC systems is to make available the opportunity to vary green times, duration of cycle times, green waves depending on traffic conditions, day of the week, hour of the day and so on.

There are different conceptual approaches beside actual UTC systems available on the market. The main distinction is between the ones referring to the “plan selection approach” and the other ones referring to the “adaptive control” approach. There is a continuous discussion in the community of transport engineers about pro’s and con’s of the two approaches, that can not be discussed in this document.

In Archimedes, the approach selected for managing the intersections belonging to the corridor identified in Monza is the plan selection approach. The UTC selected is RoadManager® designed and implemented by Project Automation, technological partner of the Municipality of Monza in the Archimedes project. RoadManager® is already in use in several Italian cities (e.g. Latina, Florence for the intersections involved by the new LRT line 1 Santa Maria Novella – Scandicci soon to be activated).

Roadmanager® is designed to manage priority requests issued by Automatic Vehicle Location / Automatic Vehicle Management (AVL/AVM) technological systems in use on Public Transport fleets as well. This is an important requirement for Archimedes in Monza, since the Measure 82 is just devoted to manage such priority requests.

Measure 81 concerning UTC application in Monza covers 2 tasks:

- Task 11.8.5 UTC System in Monza (RTD tasks)

Project Automation (PA) has carried out a study to apply the Roadmanager® UTC system in Monza; the results of the study are shown in this deliverable and consist in defining the exact activities to be carried out to pursue the centralisation of the intersections selected.

- Task 8.16 UTC System (Demonstration tasks)
Implementation by PA and TPM (the local public transport provider) of the centralised control through the Roadmanager® UTC System on a set of selected intersections applying the rules defined in the research task 11.8.5.

3.1 Summary Description of the Task

Within this research task the following actions has been accomplished:

a. choice of the intersections to be considered, under the indications provided by the experts of the Municipality of Monza (the CIVITAS corridors);
b. definition of the work to be done concerning the electronic equipment installed at every intersection to be put under UTC control; subsequent choice of the equipment to be procured;
c. equipment procurement;
d. equipment installation and/or revamping;
e. transport engineering analysis of the corridor through the Microsimulation approach.

Such activities are described in the §4.1.

4 UTC System in Monza

4.1 Description of the Work Done

This paragraph is dedicated to the detailed description of the work carried out in the Research Stage.

4.1.1 Choice of the intersections to be considered

The first task accomplished has been driven by the experts of the Municipality of Monza at the beginning of the execution of Archimedes; it has been the identification of the CIVITAS corridor for private vehicles, depicted with the dark line in Figure 1.

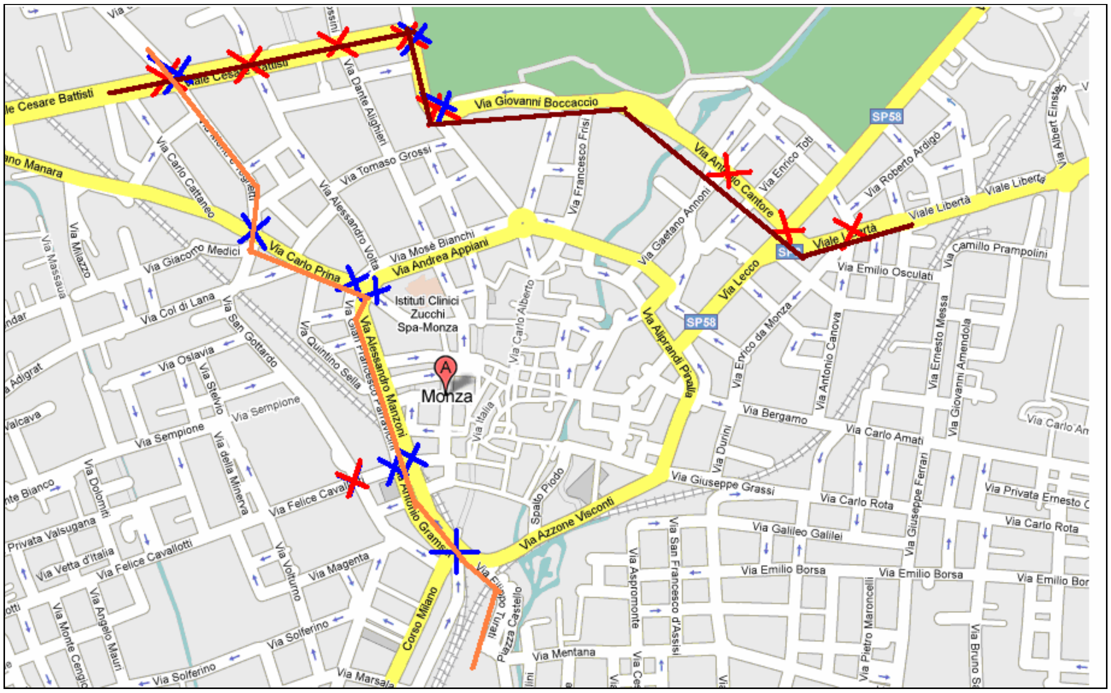

Figure 1 - The CIVITAS Corridors in Monza

This first Corridor has been selected since it is the main route to bypass the Centre of the City on the North of the city. The large green area in Figure 1 is the well known Park of Monza, the largest park in Europe delimited by a wall, whose perimeter measure about 13 Km with an area of 6,850,000 square meters. The Park of Monza is a green barrier without main routes for vehicles; it is possible only for cars to cross it in East-West direction at its opening time .

This first corridor consists of eight intersections which will be grouped in two coordination groups: the five left-most intersections belong to the first coordination group; this means that a variation of a traffic light plan executed in one of such intersections determines a fall back on the others. The four intersections along Viale Cesare Battisti are also shown in Figure 2.

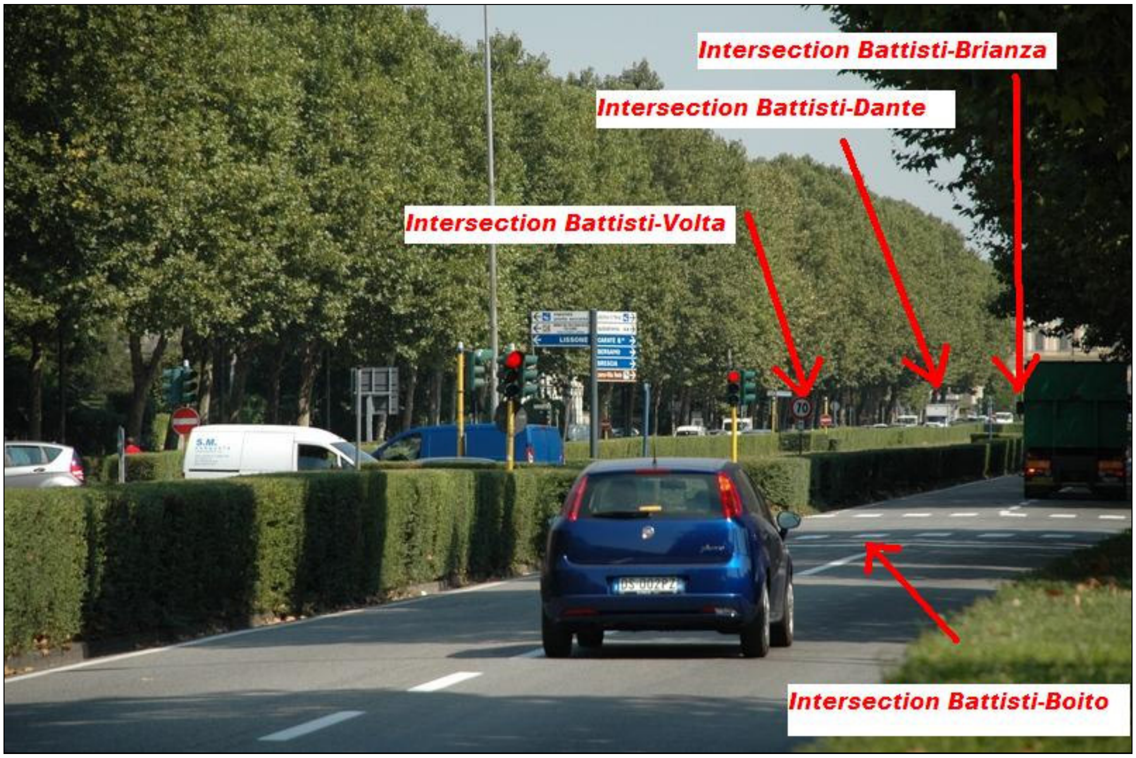

Figure 2 - Corridor 1, Coordination Group 1, viale Battisti

The second coordination group consists of the remaining three intersections on the right part of Figure 1.

In §4.1.6 some considerations emerging by the microsimulation session carried out on four intersection of the first coordination group are presented.

Figure 1 also presents a second Corridor mainly dedicated to Public Transport (depicted by the orange line). As far as UTC is concerned, the intersections involved will be equipped the same as those belonging to the first Corridor. However, the transport engineering analysis will be carried out in Measure 82, dedicated to the Public Transport Priority at such intersections. This second Corridor is affected by many Public Transport routes, which end at the Porta Castello interchange node, located at the bottom of the orange line close to the central Railway Station of Monza.

Figure 1,illustrates the intersections to be centralised to the UTC system are identified by red and blue crosses. Blue crosses will implement the approach provided by Roadmanager® UTC system to manage Public Transport priority requests, faced in depth in Measure no. 82 and related deliverables.

4.1.2 Analysis of the existing equipment

During the month of December 2008, an intervention plan was agreed among the traffic experts of the Municipality of Monza and technicians of Project Automation. The plan started with a deep analysis of the equipment installed in the eight intersections of the first Corridor. Two scenarios emerged:

- the first one concerning intersections managed by a Traffic Light Controller operational for 10/15 years and unable to be centralised by UTC systems: for these intersections, the decision undertaken was to replace it with a newer model of Traffic Light Controller, named “Hydra”, with remote control capabilities;
- the second scenario concerned intersections already equipped by a Hydra Traffic Light Controller but lacking of the specific electronic board which allows the controller to be centralised.

In every case, the Municipality decided upon an equipment upgrade to the most updated version of Hydra model. The upgrading has been carried out during July and August 2009, so the eight intersections involved in the first corridor will be centralised by the end of October 2009.

Figure 3 - New Hydra installed at Donizetti-Volta intersection

4.1.3 Laboratory Test for Interface Protocol with the Traffic Light Controller (TLC)

As part of the second step of the agreed plan, Project Automation asked the Municipality of Monza for a Hydra Traffic Light Controller in order to test in the laboratory software protocol used to exchange information among the UTC system and the controller. The controller was made available at Project Automation premises in January 2009 and specific tests were carried out to test such protocol. The objective of this session was to ensure a correct communication as well as the correct behaviour of Hydra. The test session concluded that the compatibility of the laboratory software protocol was good.

4.1.4 Centralisation of TLCs: Reference Architecture

In order to put a Traffic Light Controller (TLC) under an UTC, the reference Architectural scheme is presented in Figure 4:

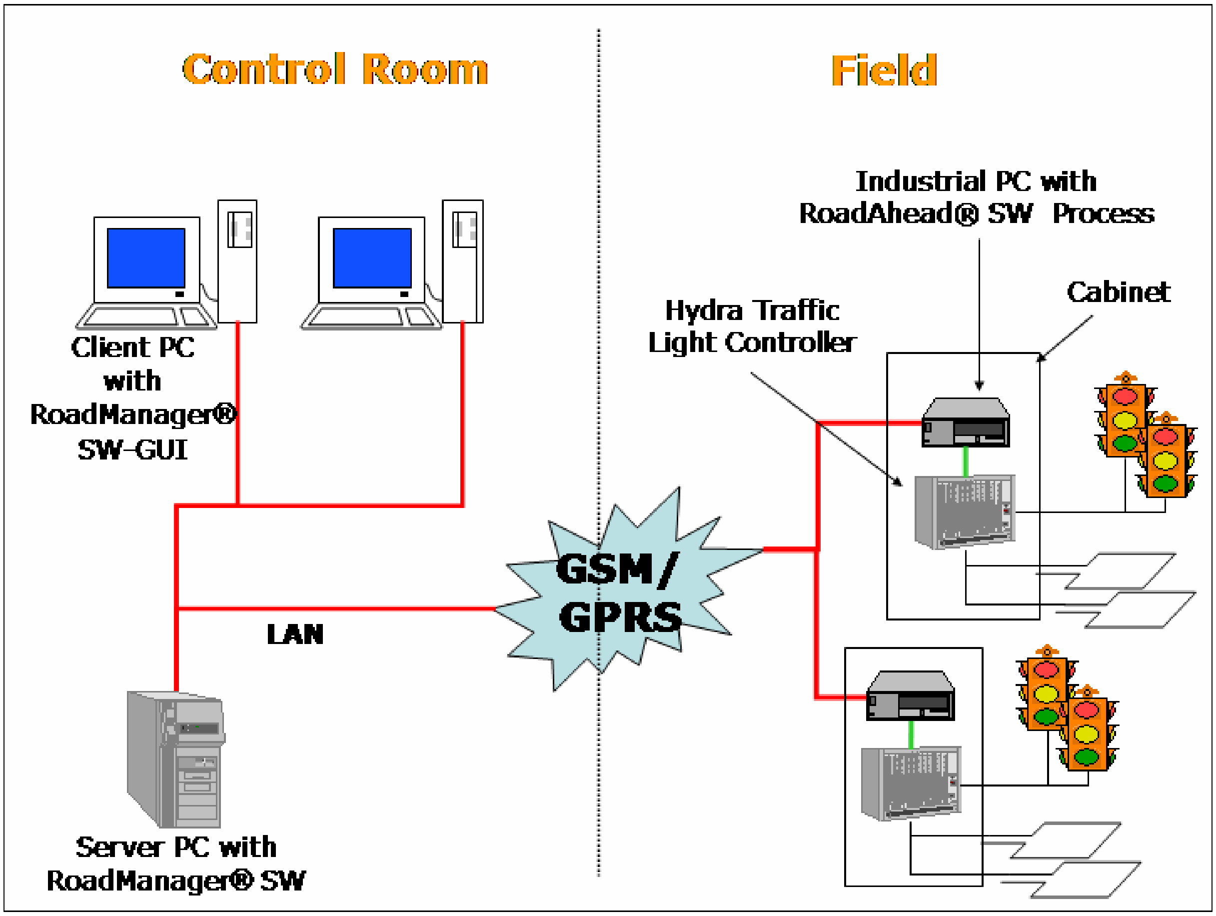

Figure 4 - UTC Reference Architecture

In detail:

- the Server PC to be installed in the Server Farm of the Municipality of Monza will run the Application Server component of the Roadmanager® Software application;
- the Client PC to be installed at Mobility Dept. of the Municipality of Monza will run the Graphical User Interface of the Roadmanager® Software application to allow authorised operators to interact with the system;
- within every technological cabinet installed at the intersections, which is already hosting the Traffic Light Controller, an Industrial PC will be installed; it will run the peripheral software component of the Roadmanager® Software suite, called RoadAhead®;
- The Industrial PC is connected with the Hydra TLC with a serial RS232 link; housing the PC in the cabinet guarantees the robustness of the communication of the data that control the signal controllers according to the UTC configuration on a higher level; moreover, in this way there is a suitable de-coupling from the central level that allows to reduce the amount of data exchanged between the control centre and the peripheral level making suitable a GSM/GPRS link among the Centre and the intersections;

- RoadAhead® will run the traffic light plans sending every second the colour of the lights to the Hydra TLC through the dedicated software protocol (successfully tested in fab as described in §4.1.3); the Hydra TLC will acknowledge the receipt of the command, sending back diagnostic information and eventual counting and density values collected by inductive loops connected to the TLC;
- Following the command by the Central Control Room, Roadmanager® tells single RoadAhead® the specific plan to be executed as well as the timing offset with respect to a timing scale; this allows the system to achieve coordination with the correlated intersections, managed by other RoadAhead® as well.

4.1.5 Centralization of TLCs: engineering aspects

Figure 5 shows the content of the cabinet containing a Traffic Light Controller.

Figure 5 - Internal view of a Cabinet with a TLC in Monza

In order to perform the adjustment of the traffic lights controller to make them suitable for a centralised UTC, the experts of Project Automation have performed an audit of the existing equipment. The audit identified the need for a few technological solutions that have been evaluated. Finally, it has been decided to build a small aluminium board that will be installed within the cabinets to house the controllers.

The board will have:

1. n. 1 industrial PC
2. n. 1 AC/DC power supply
3. n. 1 GSM/GPRS router

4. n. 1 magneto-thermal switch

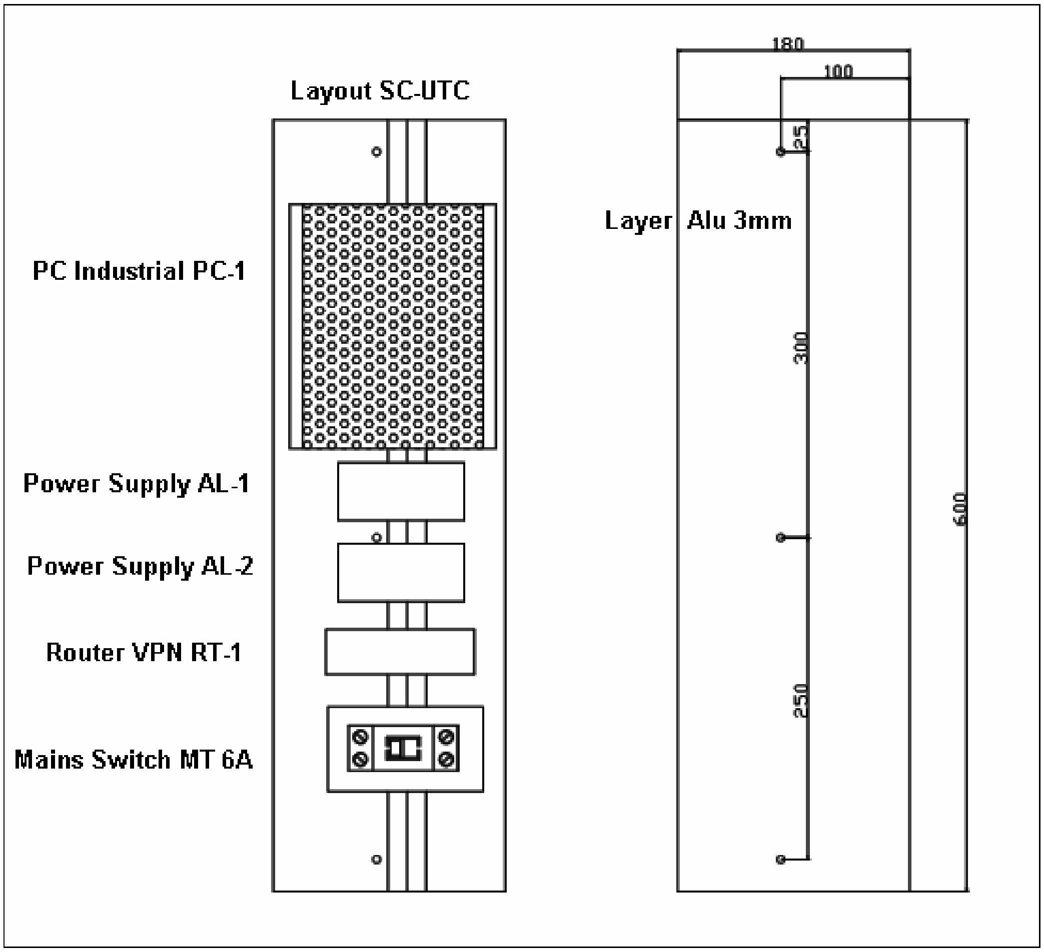

Figure 6 Drawing of the electronic board to be installed in the traffic controller cabinet

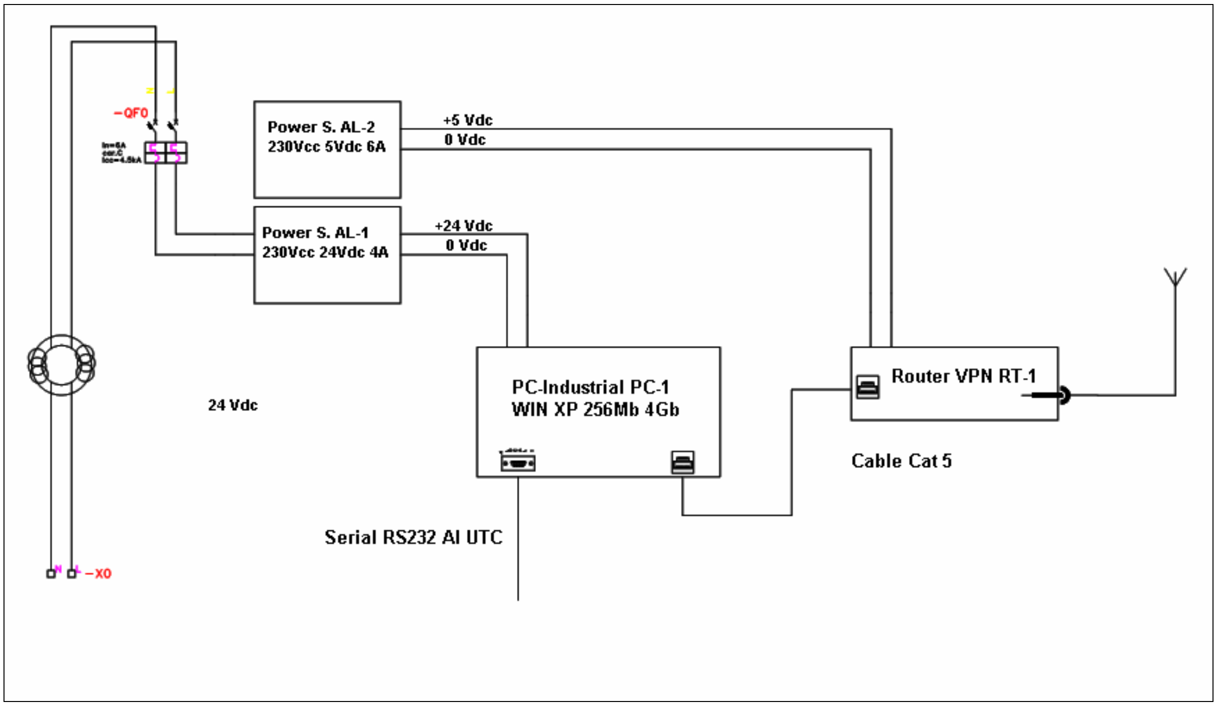

Figure 7 Drawing of the electrical connection of the board

4.1.6 Procurement of equipment for the centralisation

The equipment to be installed in the technological cabinet has been ordered and will be available in September 2009. The mounting of the equipment will be carried out by the end of October 2009.

Once the Industrial PC installation has been completed and the link with the TLC established, the current traffic light plan operational on the TLC will also be configured within the RoadAhead® system, which will then take over the control of the TLCs. The local controllers will continue performing all the necessary safety controls (intergreens, minimum times, amber times ad so on).

4.1.7 Setup of the equipment at Central level

Setup of the equipment at Central level (server PC, client PCs), installation of the RoadManager UTC application licensed by Project Automation will take place by end of year 2009.

4.1.8 GSM/GPRS wireless connection with the central computer

In order to establish a communication between the control centre of the UTC system and the peripheral controllers by the intersections a wireless technology has been selected. This technology has a modest management cost, without any particular civil work and it is very flexible and allows to transmit/receive data using GMS/GPRS technology. The industrial PC will have a router able to house a SIM capable of data communication and configured to establish a protected connection with the network of the central control system.

4.1.9 Microsimulation

4.1.9.1 Microsimulation Basis

Microsimulation is a rather modern technique that simulates the behaviour of whole traffic networks down to the level of single vehicles. The level of detail achievable with modern microsimulators is such that once a model has been created it can be used to test the result of the application of new policies without costly experiments on the road. In order to be useful for this purpose, a microsimulation model must first behave consistently with the current situation of the study network. In the future, the model of the CIVITAS corridor will be used to validate all the traffic control plans to be developed for the UTC.

4.1.9.2 Microsimulation of the Current Situation

The microsimulator used in this work is TSS-Getram Aimsun. So far, the model includes four intersections of the first group of the first corridor. The fifth intersection of the first group of this corridor will be soon included into the model as soon as the data of its current timing will become available. Nevertheless, the model has already reached a good level of reliability.

The four intersections already considered are:

N.	*Intersection*
1	Via Boito/Via Monti e Tognetti
2	Via Donizetti/Via Volta
3	Via Rossini/Via Alighieri
4	Viale Brianza/Viale Regina Margherita

The first step in creating the model was to obtain geometrical measurements of the network, in particular the distances between the intersections. Then, the actual timings of the four intersection where measured on site and included into the model. Three of the four intersections are currently running fixed times that do not change during the day. Intersection N.4 also runs fixed times, but the pedestrian crossing is on demand. The following table shows the cycle times of the four intersection, for the fourth one including the pedestrian crossings:

N.	*Cycle time (seconds)*
1	90
2	96
3	100
4	140

In the model, for sake of simplicity, we assumed that in intersection 4 a pedestrian call is present during every cycle. In the other three intersections, the pedestrian movement are parallel to the traffic.

The model thus obtained is shown in 8.

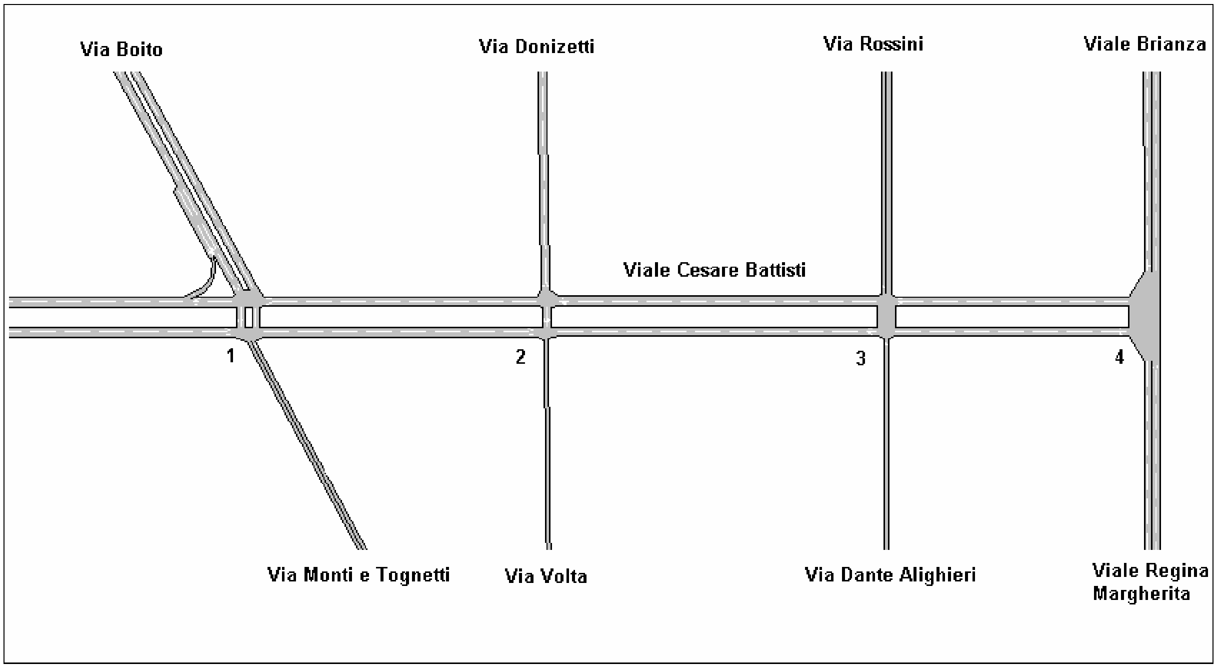

Figure 8 - Viale Battisti coordination group

The next step in creating the model was to populate it with traffic. Traffic flows were obtained with an ad-hoc campaign sampling small intervals during the morning peak. The origin/destination matrix was then fine tuned until the model showed a behaviour that was consistent with what is normally observed on the road. Particular care was used in ensuring that the queues for in the model in the same places as they do in the real network. Finally, the traffic flows used in the model are shown in the following table.

Entrance	Flow (vehicles/hr)
Viale Cesare Battisti	1750
Via Boito	700
Via Monti e Tognetti	400
Via Donizetti	500
Via Rossini	400
Via Dante Alighieri	450
Viale Brianza	1100
Viale Regina Margherita	1100

Please note that via Volta is a one way road exiting from Viale Cesare Battisti.

4.1.9.3 Microsimulation of the coordinated corridor with UTC

The next step was to establish a coordination along Viale Cesare Battisti in the direction leading from West to East. This is the direction that experiences the highest traffic volumes during the day. For the traffic light plan managing the four intersections selected, the longest cycle time (140 seconds) has been adopted. In attempt, the spare green available in the other three intersections was simply given to the main phase of Viale Cesare Battisti. This strategy proved immediately not to be viable as it leads to unusual queuing along the side roads. After several microsimulation runs a good solution was found, which involved changing the phasing of the most complex intersection. The model now clearly shows platoons of vehicles building up at the first intersection and then propagate along the network. As the traffic on the side roads is not negligible, the simulation shows that the offsets between all the intersections must be set up carefully. Cars coming from the side roads accumulate along Viale Cesare Battisti and they must be dispersed before the arrival of the next platoon. With all these assumptions, the model shows that coordination could reduce the travel time along the corridor and in the direction considered by 28% along the chosen corridor. The medium travel time of the whole network, despite having coordinate only one direction, shows a reduction of 14%.

Figure and 10 show the result of two runs of Aimsun, one with the current control and one with the introduction of coordination. The colours from green to red show the increasing delay induced by the traffic light control system on the vehicles flowing in the corridor in West/East direction, where the green indicates a low delay and the red indicates a high delay.

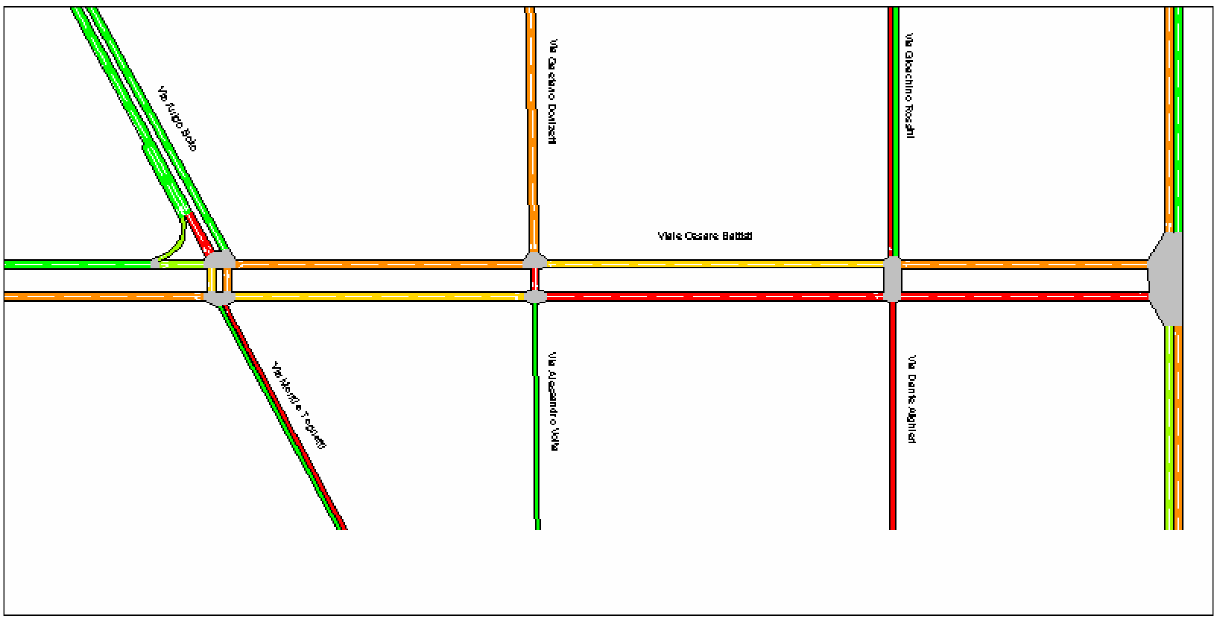

Figure 9 - The result of an Aimsun run of the corridor with the original control

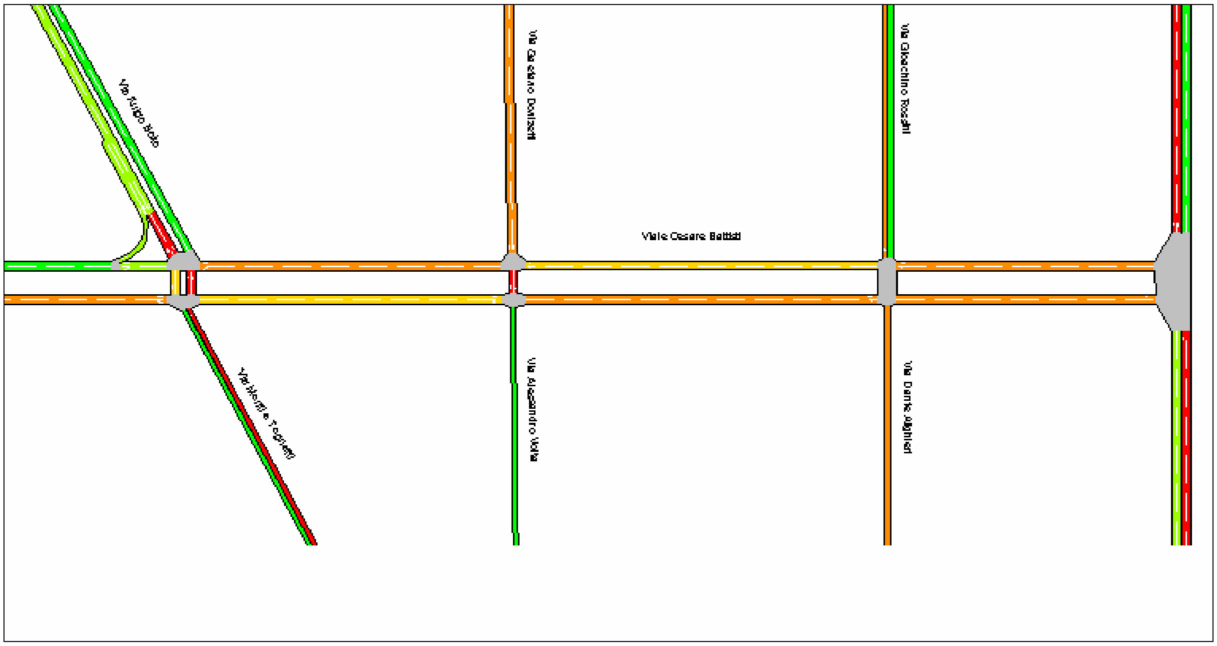

Figure 10 - The result of an Aimsun run of the corridor with the coordinated control

The simple model was also used to show the Municipality of Monza the benefits of microsimulation in allowing the validation of control strategies before deploying them.

4.2 Problems Identified

No functional issues have as yet been identified.

4.3 Mitigating Activities

Not applicable.

4.4 Future Plans

As written in this document, the Research stage concerning the application of an Urban Traffic Control in Monza will be completed when the entire chain of signals has been proven to be effective; the demonstration tasks will then start deploying the activities on all the intersections involved in the project.

The application of microsimulation will remain within the set of the research activities, providing the right information for coding the traffic light plans for all the intersections, grouped in the relevant coordination group.

When the demonstration stage has been established, evaluation stage B will take place, following the approach depicted in the relevant documents.