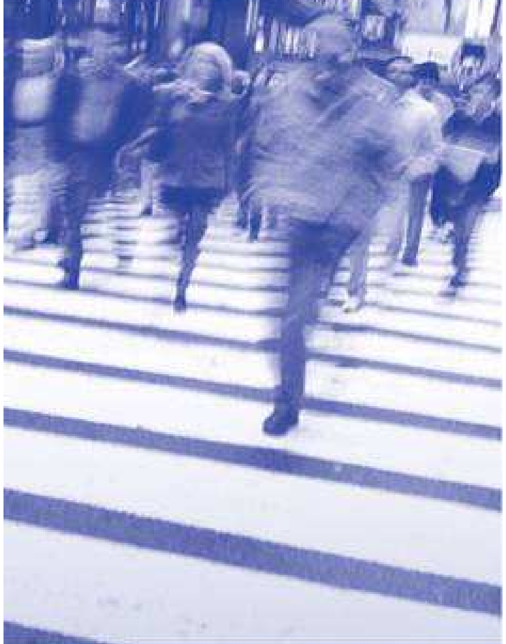

CIVITAS
Cleaner and better transport in cities

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

Monza

T81.1: Urban Traffic Control (UTC) System in Monza

City of Monza

January 2011

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 advantages 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. Further information on this issue can be accessed via specialized websites of various universities and commercial suppliers.

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, a technological partner of the Municipality of Monza in the ARCHIMEDES project.

RoadManager® is already in use in several Italian cities (e.g. Catania, Latina, Florence for about 35 intersections involved with the new Light Rail Train line 1 Santa Maria Novella – Scandicci).
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 Measure 82 is devoted to manage such priority requests.

Measure 81 concerning UTC application in Monza covers 2 tasks:

- Task 11.8.5 UTC System in Monza (Research 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 the deliverable R81.1 and consist of defining the exact activities to be carried out to pursue the centralised management of the traffic light controlled intersections.

- Task 8.16 UTC System (Demonstration tasks)
Implementation by PA 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.

During the research stage for this measure, eight intersections of the CIVITAS Corridor for private traffic (hereinafter: corridor") were selected and equipped with appropriate devices (see deliverable R81.1 for details). The corridors are presented in Figure 1: the CIVITAS corridor. For private vehicles this is identified with the dark line (for West to East direction, left to right in the picture: viale Battisti, via Regina Margherita, via Boccaccio, via Cantore, beginning of viale Libertà).

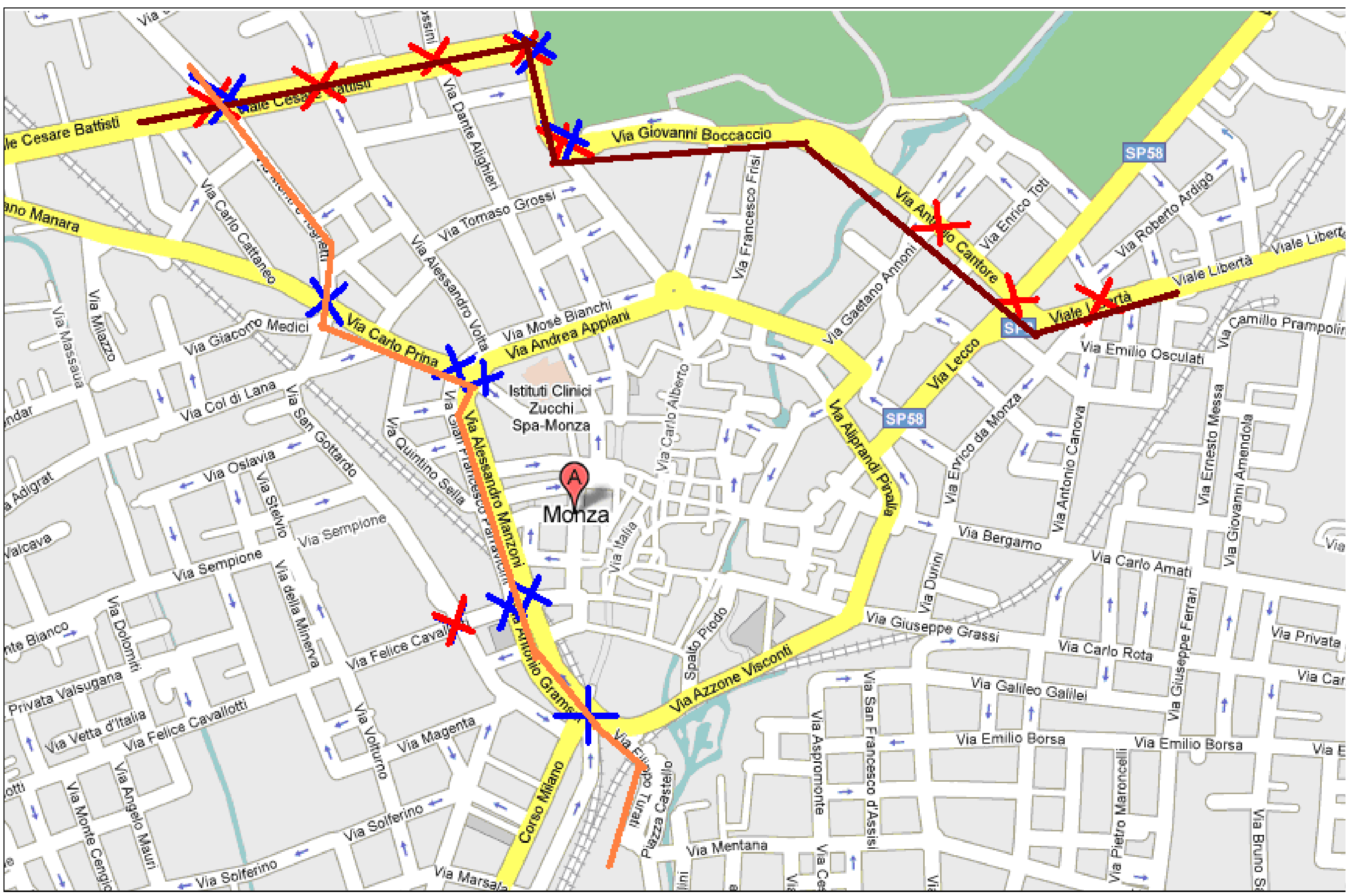


Figure 1 - The CIVITAS Corridors in Monza

This 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 bounded by a wall, whose perimeter measures 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, from 7am to 7pm for working days only.

This corridor consists of eight intersections; they are listed from West to East and labelled with the unique number that identifies each traffic light set within the city:

1- Battisti-Boito-Monti e Tognetti (19)
2- Battisti-Donizetti-Volta (58)
3- Battisti-Dante-Rossini (44)
4- Brianza-Regina Margherita-Battisti (18)
5- Regina Margherita-Boccaccio (17)
6- Annoni-Cantore (15)
7- Lecco-Cantore (16)
8- Libertà-Merelli (13)

These intersections will be clustered in coordination groups: this means that a variation of a traffic light plan executed in one of the intersections of each group determines a fall back on the others. The three intersections along Viale Cesare Battisti and one of the two close to Villa Reale are shown in Figure 2.

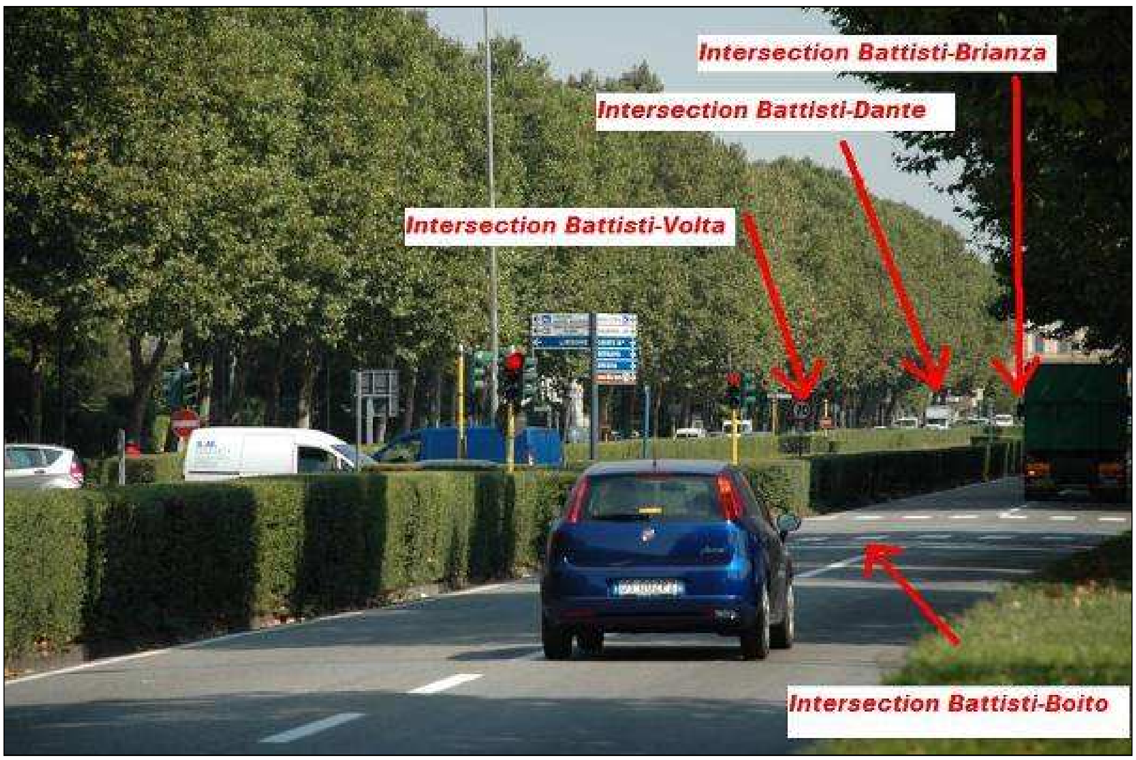


Figure 2 - Coordination Group 1, viale Battisti

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

3.1 Summary Description of the Task

Within this demonstration task the following actions have been accomplished:

a. Collection of information and analysis of traffic light plans currently active at the relevant intersections;

b. Design and coding of new coordinated traffic light plans keeping into account the results of microsimulation activities carried out in the RTD stage;
c. Activation and test of the new traffic plans

Such activities are described in the §4.1.

It has to be pointed out that demonstration tasks described in this document will be interconnected with the evaluation activities that for this measure will enter the crucial stage in February 2011; as typically occurs while setting up an UTC system, measurements executed in the evaluation stage are likely to provide information to adjust and tune parameters of the coordinated traffic light control.

This means that the traffic light plans presented in this deliverable could be modified as the evaluation stage progresses.

In section 4.1 the analyses carried out to define the traffic light plans on the corridor are described. Such analyses started from a detailed study of the plans currently active, without centralised management. The current plans take into account the constraints resulting from the physical characteristics of the carriageways involved (e.g. viale Regina Margherita, see section 4.1.3 and Figure 9)

Examining the structure and the performances of local plans and keeping into account the results of the microsimulation activities carried out in the RTD stage, a specific analysis has been pursued to design new traffic light strategies to optimise the throughput of the corridor with the same set of sensors installed, since at the moment the installation of additional sensors is not expected. The new strategies have to be designed keeping into account priority policies for public transport fleet, as expected by measure no. 82.

The job has been carried out in four stages:
1. analysis and optimisation of the three intersections on viale Battisti (19, 58, 44);
2. analysis and optimisation of the two intersections close to Villa Reale (18, 17);
3. analysis and optimisation of the five intersections together (19, 58, 44, 18, 17);
4. analysis and optimisation of the three remaining intersections (15, 16, 13);

4 UTC System in Monza

4.1 Description of the Work Done

4.1.1 General information

This paragraph is dedicated to the presentation of several general concepts needed to understand the subsequent paragraphs where the job is described in detail.

Task One
The first task is the collection of the information concerning the traffic light systems which manage the intersection and related information concerning the planning of traffic light system. Such as stages, split of green light use among the different stages, eventual on-call pedestrian movements etc.

Task Two
The second task is to identify and enumerate all the movements to be served at the intersection, both for vehicles and for pedestrian that are managed by traffic lights. Each movement is managed

by one or more lights whose lamps are connected to signal groups of the Traffic Light Controller (TLC); each signal group is submitted to safety checks by specific electrical circuits of the TLC.

For each signal group several elements of basic information are established which is held for each traffic light plan that manages each intersection. Such information is mandatory and is coded in protected structures of the TLC. The TLC itself will continuously check that this information is not violated during the operations, both whether the TLC is running a local plan and whether the TLC is running a centralised plan originated within the RoadManager system.

The mandatory information to be coded is:

- the amber time for each signal group;
- the minimum green time for each signal group;
- the intergreen matrix among signal groups, which expresses the seconds that must expire when a signal group gets amber and when a conflicting signal group get green; the intergreen matrix is an extension of the conflict matrix; to compute the values of the elements of the intergreen matrix, the amber time of the first signal group that is switching to amber must be known as well as the necessary time that vehicles take to complete their path and to free the intersection area.

Italian laws and engineering best practices provide the basic information to address this topic; in the ARCHIMEDES context in Monza, such information is already coded in the traffic light controller. The new centralised plan designed must carefully take into account this information.

As far as amber times are concerned, the Italian practices that apply (determined by-laws and regulations) require the following values:

- for vehicles approaching the intersections at 50 Km/h: 3 seconds
- for vehicles approaching the intersections at 60 Km/h, or for intersections where also High Occupancy Values are present: 4 seconds
- for vehicles approaching the intersections at 70 Km/h: 5 seconds

It is not possible, by Italian laws and regulations and in order to increase safety, that the general speed limit at intersections managed by traffic light exceeds 70 Km/h.

- for pedestrian flows, 1 second for each metre of road to be crossed.

As far as minimum green times are concerned, the practices in Monza require 10 seconds for vehicle flows and 8 seconds for pedestrian flows; it has to be highlighted that in Italy pedestrians can start walking with green colour and the amber time ensures they can safely complete the crossing. This practice is different to what occurs in the other European Countries, where safety for pedestrians is typically assured by red colour and not by amber light on for an extended period (30 meters crossing requires 30 seconds amber!).

As far as intergreen values are concerned, their value depends on the geometrical aspect of the intersections.

In Figure 3, the layout of intersection 19 is depicted; red arrows point out the pedestrian movements; blue arrows indicate vehicles movements. On the white background the signal group number are shown; pedestrian movements are associated with vehicle movements.

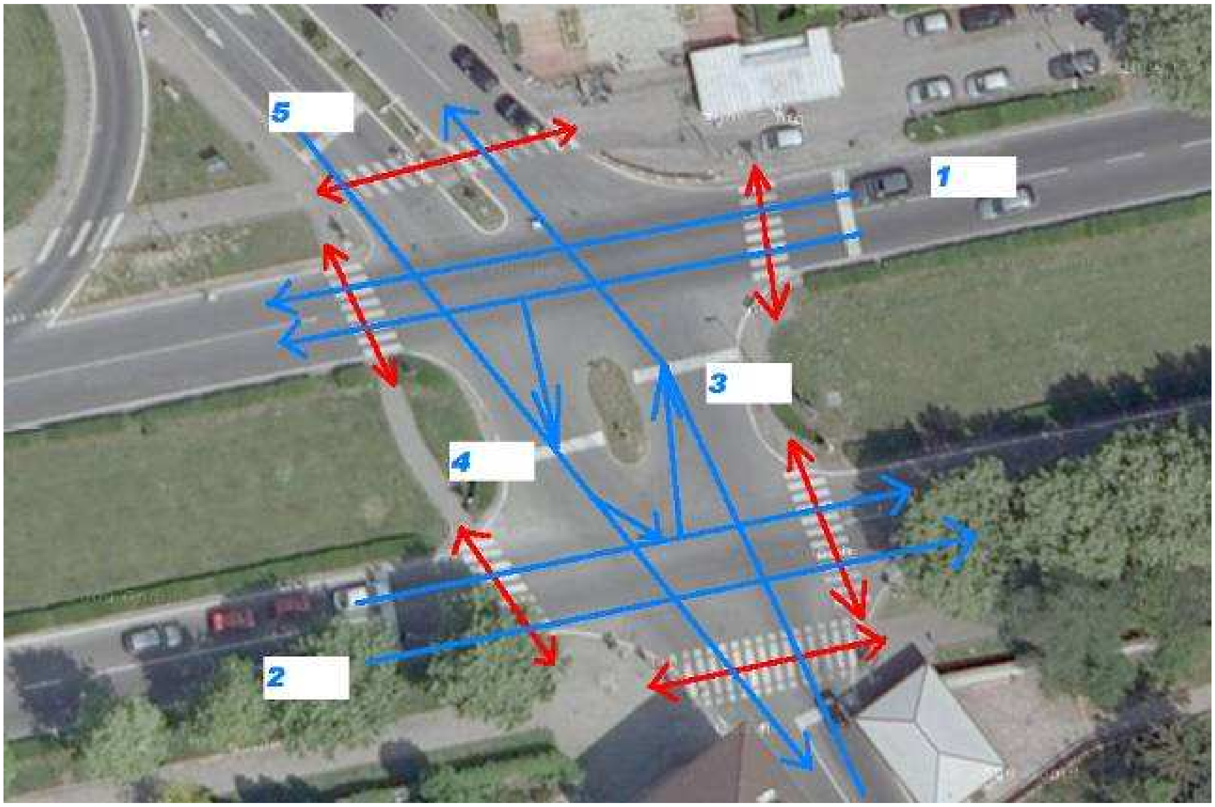
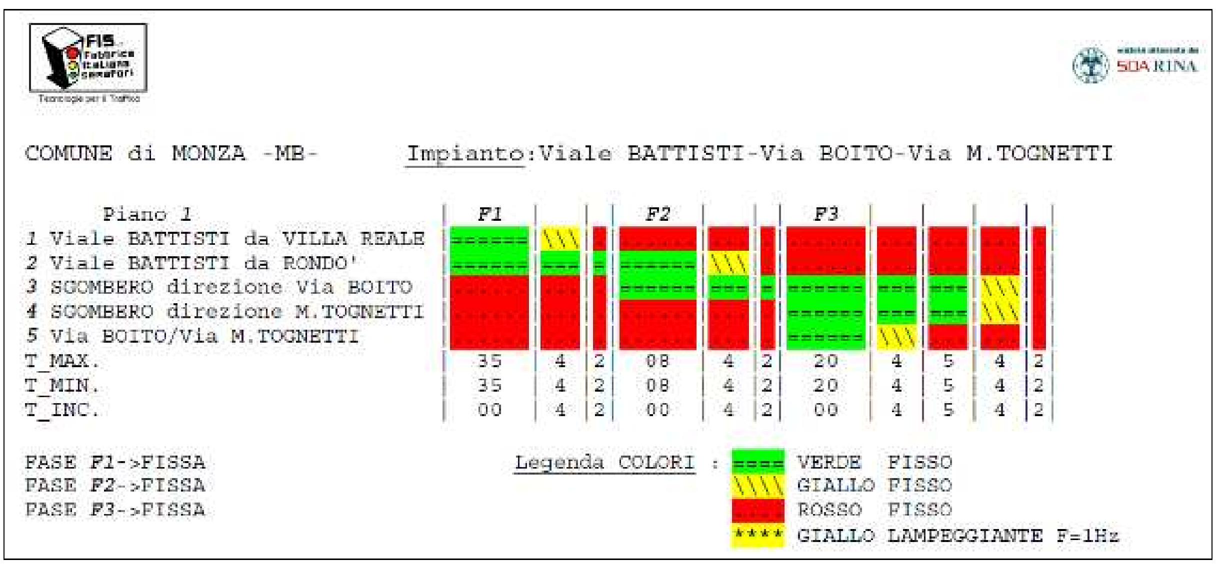


Figure 3 - Vehicle and pedestrian movements at intersection 19

In Figure 4, the local plan is shown through a “linear representation”, as reported form the official documentation (in Italian). The signal group name (1 to 5) distinguishes every line with the red/green/amber streaming and matches what is depicted in Figure 3 above.



FIS Fabbrica Italiana Semafori Tecnologie per il Traffico

SDA RINA

COMUNE di MONZA -MB- Impianto:Viale BATTISTI-Via BOITO-Via M.TOGNETTI

Piano 1	F1			F2			F3				
1 Viale BATTISTI da VILLA REALE	======	\\\	-	------	---	-	------	---	---	---	-
2 Viale BATTISTI da RONDO'	======	===	=	======	\\\	-	------	---	---	---	-
3 SGOMBERO direzione Via BOITO	------	---	-	======	===	=	======	===	===	\\\	-
4 SGOMBERO direzione M.TOGNETTI	------	---	-	------	---	-	======	===	===	\\\	-
5 Via BOITO/Via M.TOGNETTI	------	---	-	------	---	-	======	\\\	---	---	-
T_MAX.	35	4	2	08	4	2	20	4	5	4	2
T_MIN.	35	4	2	08	4	2	20	4	5	4	2
T_INC.	00	4	2	00	4	2	00	4	5	4	2

FASE F1->FISSA
FASE F2->FISSA
FASE F3->FISSA

Legenda COLORI :
==== VERDE FISSO
\\\\ GIALLO FISSO
---- ROSSO FISSO
**** GIALLO LAMPEGGIANTE F=1Hz

Figure 4 - Intersection no. 19, local plan

Figure 4 needs to be interpreted in the following way:
considering signal group no.1 (the first line), the traffic light will be green for 35 seconds, then will be amber for 4 seconds, then will be red for 2 + 8 + 4 + 2 + 20 + 4 + 5 + 4 + 2 seconds. The same interpretation rule holds for the other 4 signal groups.

In case the logic driving the traffic light is more complex, such linear representation is not adequate to show the behaviour, and also a directed diagram must be coded. A graph for another intersection of the corridor is used and described in section 4.1.3.

Another concept needed for a complete comprehension of traffic light plans, is the concept of "*stage*"; this is an easy concept that every car driver sees at every traffic light: a stage is a configuration where lamps of signal groups keep the same colour for quite a long time to allow vehicles (or pedestrians) to flow. In Figure 4 you can find just above the coloured representation of the traffic light plan the indication of 3 stages, F1, F2 and F3. F1 is the stage devoted to vehicle travelling on the corridor (signal groups 1 and 2 are green); F2 allow vehicles coming from west to turn left (signal groups 2 and 3 are green); F3 allow vehicles that cross the corridor to flow (signal groups 4 and 5 are green). Pedestrian movements go accordingly.

Form a conceptual point of view, it should be noted that stage times can be stretched; this does not occur in the local plan under comment here, but this could happen in centralised plans as described in the next paragraphs.

Between stages are "*transitions*". Transitions allow a switch from one stage to another to happen, safely ensuring that pedestrians and vehicles can complete their manoeuvre before allowing other movements to start. In Figure 4, transitions are constituted of the patterns between stages.
Also in the centralised context, transitions are fixed.

4.1.2 Analysis and optimisation of the three intersections on viale Battisti (19, 58, 44)

This is the group of intersections that has been equipped and tested, relying on the studies and results achieved in the RTD stage through the microsimulation approach.

4.1.2.1 Baseline: local plan on the Traffic Light Controllers

This is the baseline found, as reported in deliverable R81.1; the three intersections are currently running fixed time plans that do not change during the day. Table 1 shows the cycle times of these three intersections:

Intersection no.	*Cycle time (seconds)*
19	90
58	100
44	100

Table 1 - Intersections on viale Battisti, cycle time for local plan

For more detail, the structure of the local plans is described in Figure 4 for intersection no. 19, Figure 5 for intersection no. 58, and Figure 6 for intersection no. 44.

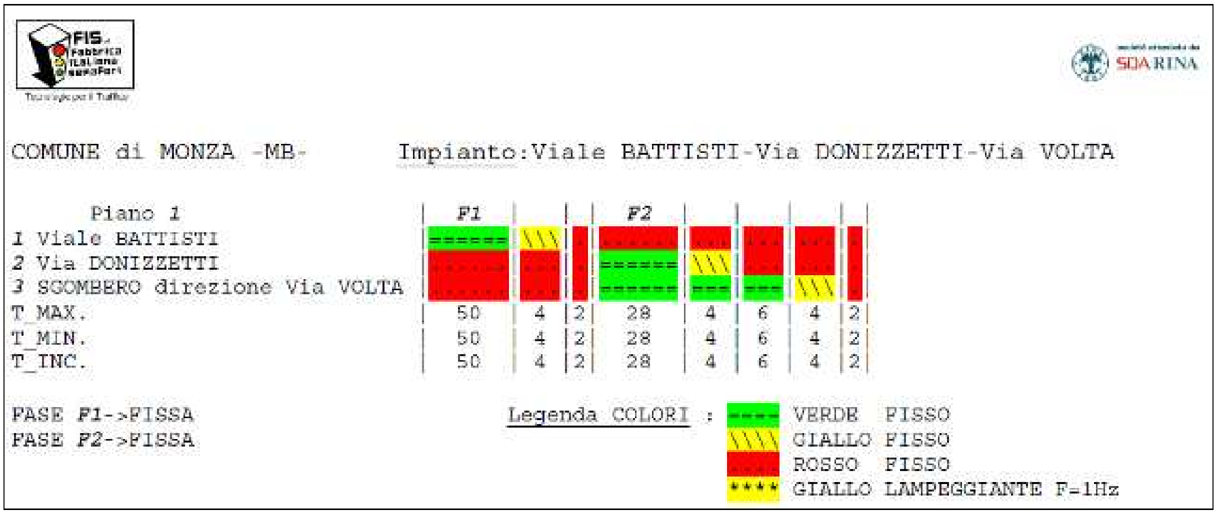


Figure 5 - Intersection no. 58, local plan

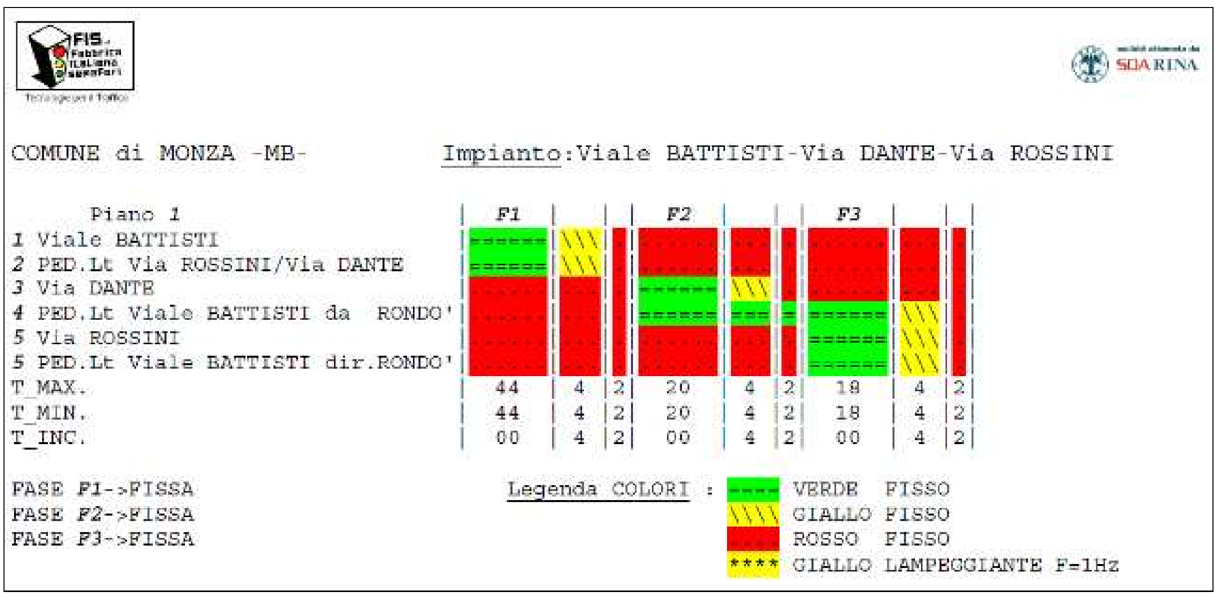


Figure 6 - Intersection no. 44, local plan

As already assessed through microsimulation, the performances of these three intersections can be improved by synchronizing and coordinating their traffic light plan. Synchronization means the same cycle time; coordination means to design offset and split keeping into account all the three intersection together.

4.1.2.2 Design: centralised RoadManager plans

The new plans of the three intersections of this group are presented in Figure 7. The red status of the traffic light is represented without colouring the bar, to make the picture more readable.

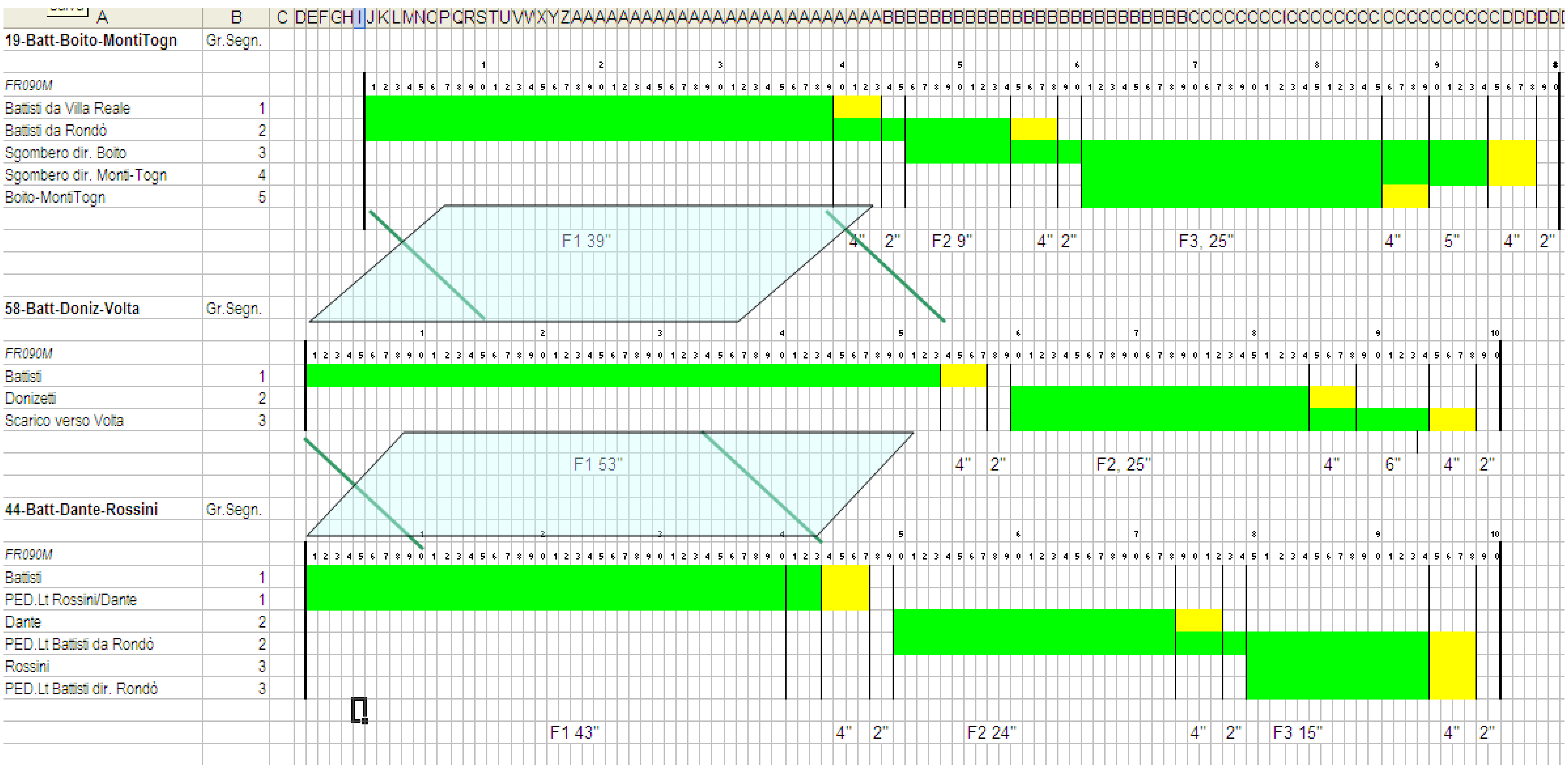


Figure 7 - Intersections no. 19, 58 and 44, centralised plans

From Figure 7, it can be concluded:

the cycle time of the three traffic light plan is 100";
the same structure of the local plan is kept (how stages succeed);
stage F1 (the first stage of the traffic light plan) ad intersections 58 and 44 begins at the same second; stage F1 of intersection 19 begins 5 second later; this allows to maximise the benefits of the green waves in both directions on the corridor (viale Battisti)(to see how green waves operate in these three plans, you have to notice the cyan polygon and the two oblique dark green bars lying between the plans between the F1 stages.)

The angle estimates the speed that vehicles typically have on the corridor; in a free flow condition, a car which starts when the traffic light becomes green takes approximately 15 seconds to reach the second intersection and another 15 seconds to reach the third intersection. Nevertheless, the typical situation, worsening at peek hours, concerns vehicles that remain on the corridor; thus the time spent by vehicles to reach the next intersection is useful to know for vehicles which have already stopped in the corridor.

As a concrete example, when considering the direction East-West. from Villa Reale to viale Battisti; vehicles on the corridor must cross the following intersections: 44, 58, 19. The most critical intersection is the last one; examining Figure 7, the duration of F1 stage for this plan is 39"; the duration of stage F1 for the previous intersection, no. 58, is longer (53"); this means that when the corridor has dense traffic, the saturation flow for the corridor in East-West direction at intersection 58 is greater than that at intersection 19.

The green time for the corridor in East-West direction at intersection 19 can't be increased since there is a strong demand also in the opposite direction on the corridor with a significant number of vehicles that turn left, toward the city hospital.. In addition, especially at peak hours, there is also a strong need to turn left from the corridor in East-West direction toward the centre of the city (movements no. 1 and then no. 4 in Figure 3). Since the buffer for such vehicles is very short, the spillback stops the left lane of the corridor, dramatically reducing the saturation flow of the corridor.

The traffic light plan involving these three intersections has been active for several months with good results; these results will be measured and analysed in detail in the evaluation stage.

In Figure 8 the screen of the RoadManager application which shows the section of the corridor of viale Battisti is presented through the following elements:

1. The upper-left window shows viale Battisti with the three intersections managed by the RoadManager UTC, through the symbol of a clock with a tag which indicates the current centralised management the group ("100RO_05") and the three grey rectangular symbols with a tag which indicates the current centralised running plan ("P04") on each intersection.

2. Three windows showing for each intersection the current plan, as sequence of green, amber and red elements; each column represents a second of time; each row is referred to a signal group.

In section 4.1.6 more detailed explanations on the RoadManager system are given.

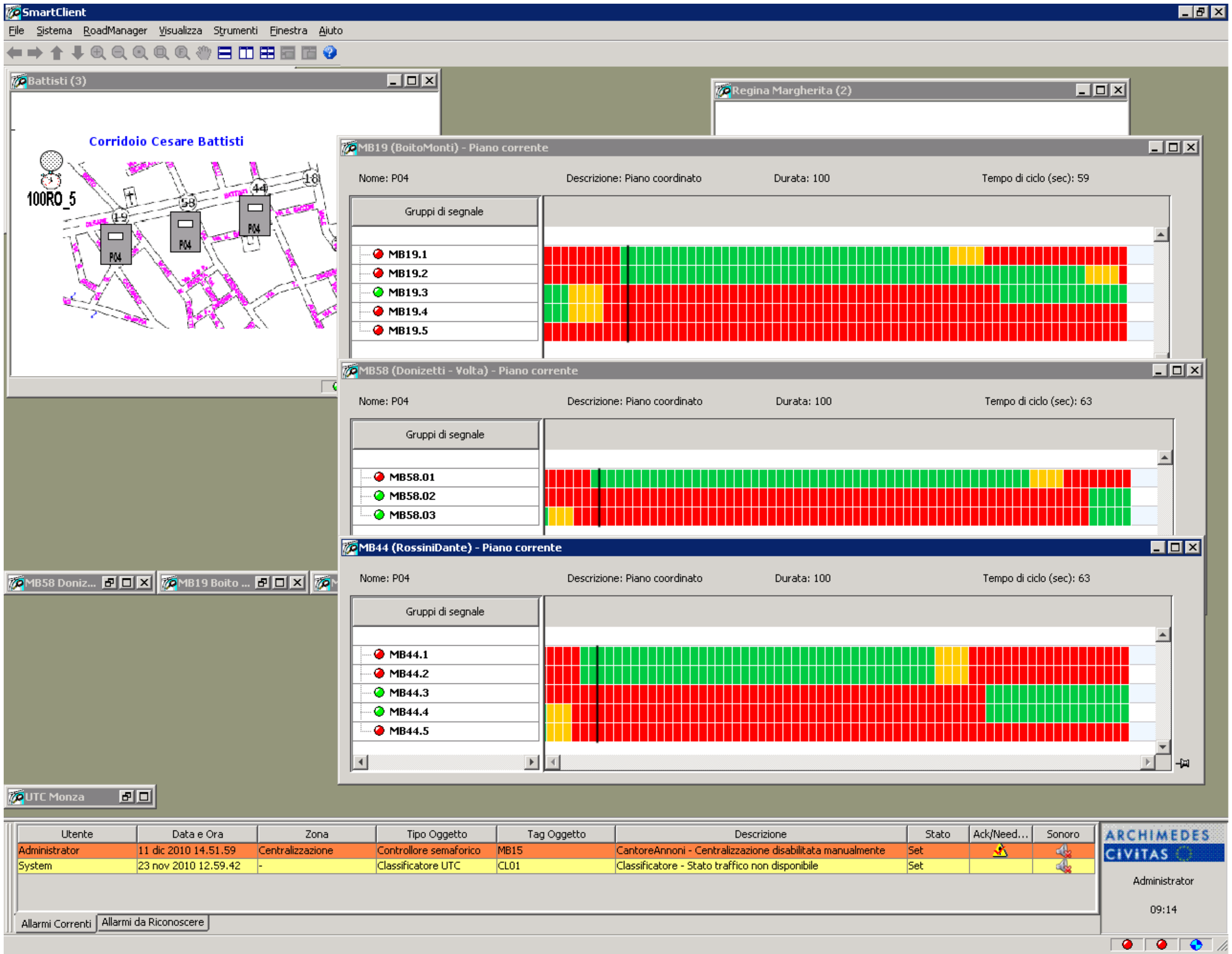


Figure 8 - RoadManager screen for the intersection 19, 58 and 44 on viale Battisti

4.1.3 Analysis of the two intersections close to Villa Reale (18, 17)

This is the most critical section of the CIVITAS corridor; its layout is depicted in Figure 9. In particular, the two segments labelled as "B" and "C" in Figure 9 form the principal bottleneck of the entire corridor. Segments B and C contain at most 30-35 cars: eventual spillbacks cause congestion in the intersection areas, both for intersection 17 and for intersection 18. Thus, the role of traffic light planning is crucial to manage this section.

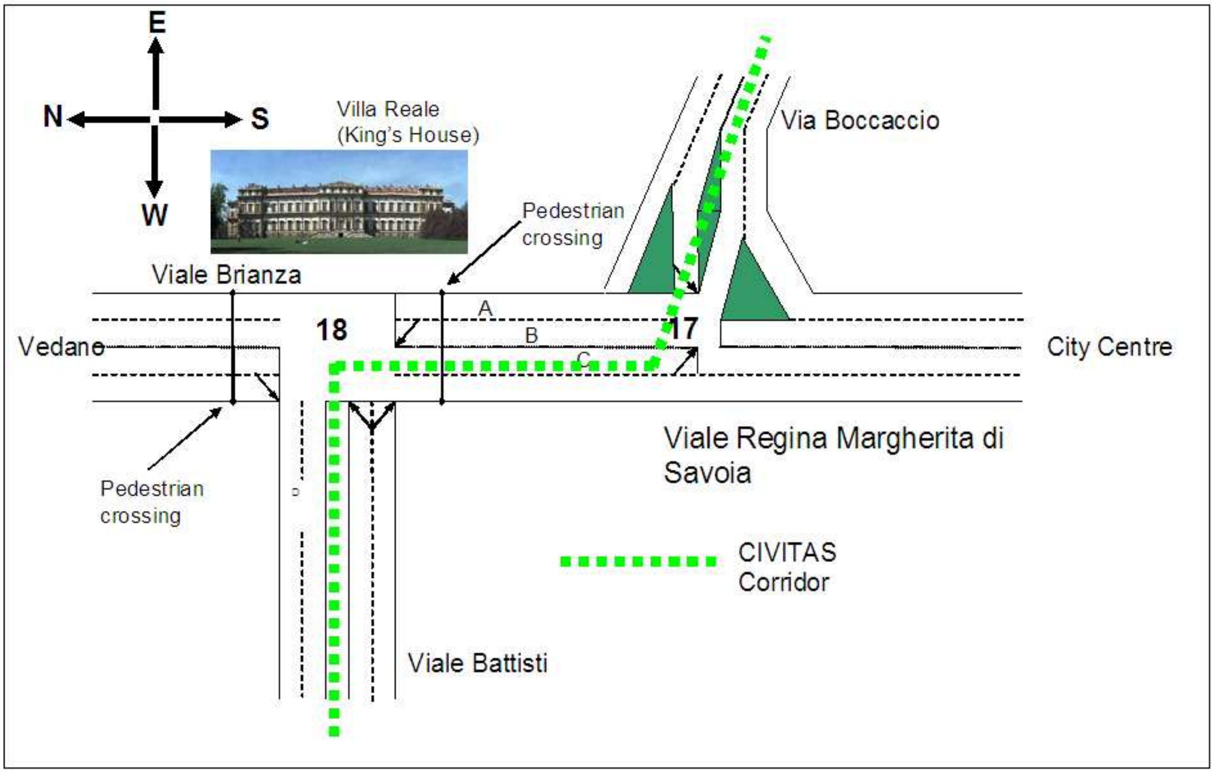


Figure 9 - Villa Reale section of the CIVITAS corridor

The most important requirements that traffic light planning must ensure are the following:

- segments A and B must be free when at intersection no. 17 vehicles coming form the Centre of the city get green light. This constraint is very important, since the throughput of the corridor coming from via Boccaccio is much higher than the one coming from the Centre of the city, the green light for this last movement must occur in a precise moment of the cycle;
- segment C must be free when at intersection no. 18 vehicles coming from Vedano get green, for the same reason of the previous case;
- segment D on viale Battisti should be as free as possible when vehicles are coming from segment B get green; this aspect concerns the coordination between intersection no. 17, 18 and 44, currently not addressed.

All these considerations, as well as others not mentioned here, rely on measurements carried out on site, especially on the saturation flows of the single links.

4.1.3.1 Local plan on the Traffic Light Controllers

The analysis carried out for the two intersections no. 17 and no. 18 relies strongly on the local plans. Such local plans were in fact accurately designed to face the physical constraints due to the specific links among these intersections. In particular, these two intersections were equipped with loop detectors and electrical connections amongst the two traffic light controllers. This infrastructure allows the two controllers to execute plans which have the capability to adjust the duration of stages depending on the current demand on the links entering the intersections ensuring the synchronisation between particular stages.

The local plan manages in a proper way the requirements described in the previous paragraph, namely the way to fill in and to empty sections B and C; nevertheless the following aspects could be improved:

- the two pedestrian crossings at intersection no. 18 are currently managed on demand but jointly; when a pedestrian pushes the button to ask green on one crossing, also the other crossing gets green.
- the cycle time of the local plan in working days is 160", but it would be useful to shorten it;
- from a more general transport point of view, the movement coming from the town of Vedano is preferred with respect to the corridor; this issue is evident in off peak hours, when it is quite common to find queues on the corridor, especially in the West to East direction, and no vehicles are queued on via Brianza, coming from Vedano.

4.1.3.2 Centralised plan: Pedestrian crossing separately activated, cycle 160"

Starting from the considerations expressed in section 4.1.3.1, a set of new plans for the couple of intersections 17 and 18 has been progressively designed, to optimise the performances meeting the requirements written above for this section of the CIVITAS corridor.

The first update of the local plan structure is aimed at adjusting the plan uncoupling the two pedestrian movements, keeping the same cycle time.
In order to achieve such uncoupling, an electrical intervention has been required, cabling the two set of lamps used for the two pedestrian movements to two different signal groups. In particular:

- if no pedestrian requests are issued, the stage F2b is executed without getting green for pedestrians (Regina Margherita crossing, South); the duration of F2b stage depends on the vehicle demand issued by loop detector; the pedestrian stage F3 is skipped;
- if there is a request issued by pedestrians on Brianza crossing (North), both pedestrian signal groups get green in stage F3; stage F2b is closed without getting green to pedestrians and its duration depend on the vehicle demand;
- if there is a request issued by pedestrians on Regina Margherita crossing (South), stage F2b is executed at its maximum duration and stage F3 is skipped.

The seconds of green saved during the cycle are used in the last stage of the plan, which has the similar pattern of stage F1, using an automatic feature of the RoadManager system; this is the stage devoted to the CIVITAS corridor under optimisation.

The proposed approach allows for the optimisation of the cycle when only the pedestrian request for Regina Margherita crossing is activated; this request is more frequent that the other one, so benefits are expected.

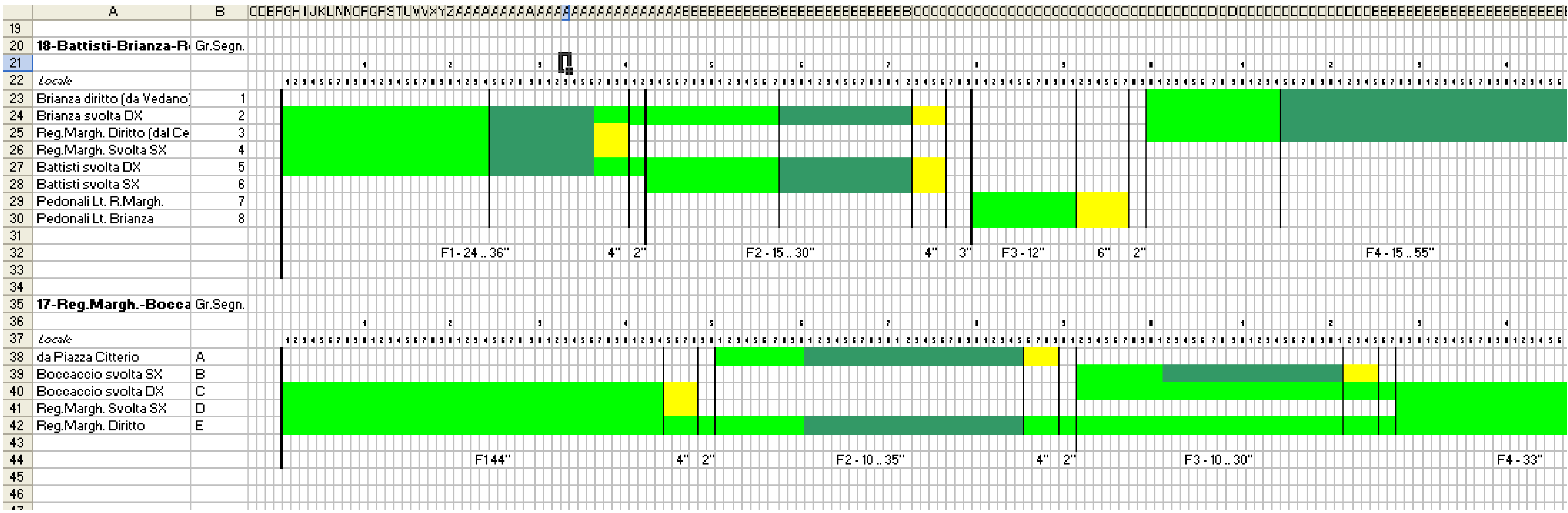


Figure 10 - Intersections 17 and 18 (Villa Reale), local plans

The dark green patterns indicate a “conditioned green”, depending typically on the presence of a car on the links entering the intersections, measured through inductive loops.

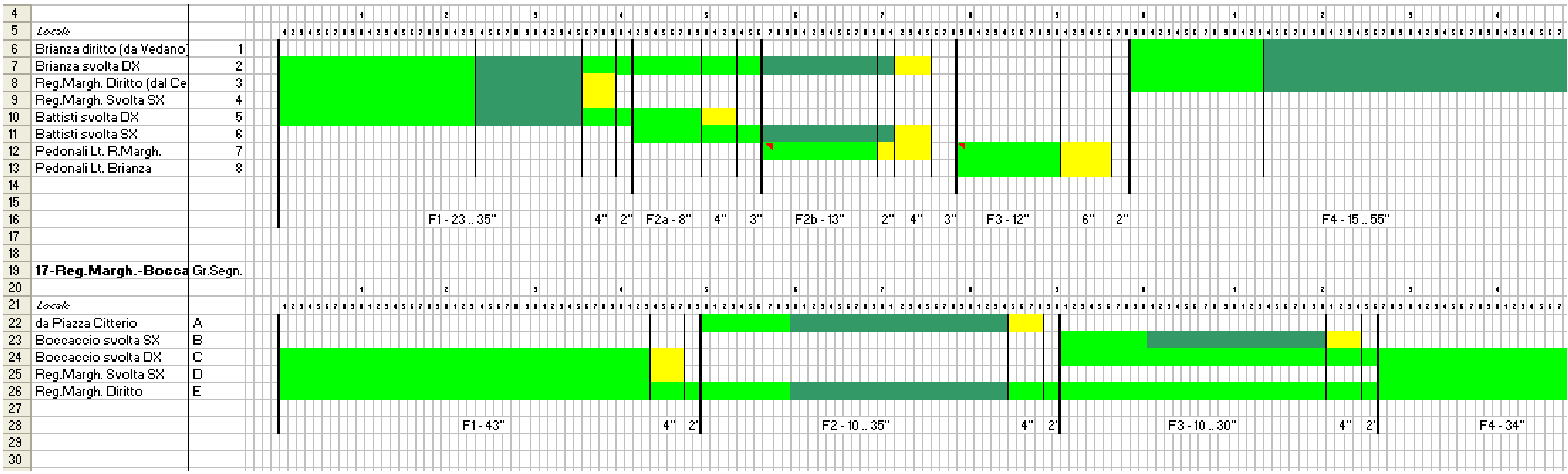


Figure 11 - Intersections 17 and 18 (Villa Reale), centralised plan no. 1, 160" cycle

4.1.3.3 Centralised plan: Pedestrian crossing separately activated, cycle 150”

The traffic light plan proposed in the §4.1.3.2 needs further adjustments if it is expected to manage together the intersections 17 and 18 with the intersections formerly described lying on viale Battisti. The proposed approach is to decrease the cycle time to 150”; since the cycle time adopted for the traffic light plans of viale Battisti is 100”, this allows a synchronisation with a factor of 2/3: two cycles of 150” are coherent with 3 cycles of 100”.

The reduction form 160” to 150” must be carefully designed: particular attention will be paid to the start up sequence of the vehicles, so some adjustments to minimize these start up times are proposed. In particular:

- if there is a pedestrian request for Regina Margherita crossing (South), the stage F3b is executed at its maximum extension, getting green to pedestrians;
- if there is not a pedestrian request for Regina Margherita crossing (South), the stage F3a is executed, without getting green for pedestrians (Regina Margherita crossing, South); the duration of F3a stage depends on the vehicle demand issued by loop detector;
- if there is a request issued by pedestrians on Brianza crossing (North), stage F5 is executed, getting green to pedestrians waiting six second for their safety; this time is overestimated, but the need is to be sure that vehicles coming from the Centre of Monza directed to Vedano can cross the entire area of the intersection before getting green to pedestrians;
- if there is not a request issued by pedestrians on Brianza crossing (North), stage F5 is skipped and the last stage that has a pattern like F1, dedicated to the corridor, can take such green time.

This behaviour is summarised in the diagram presented in Figure 12.

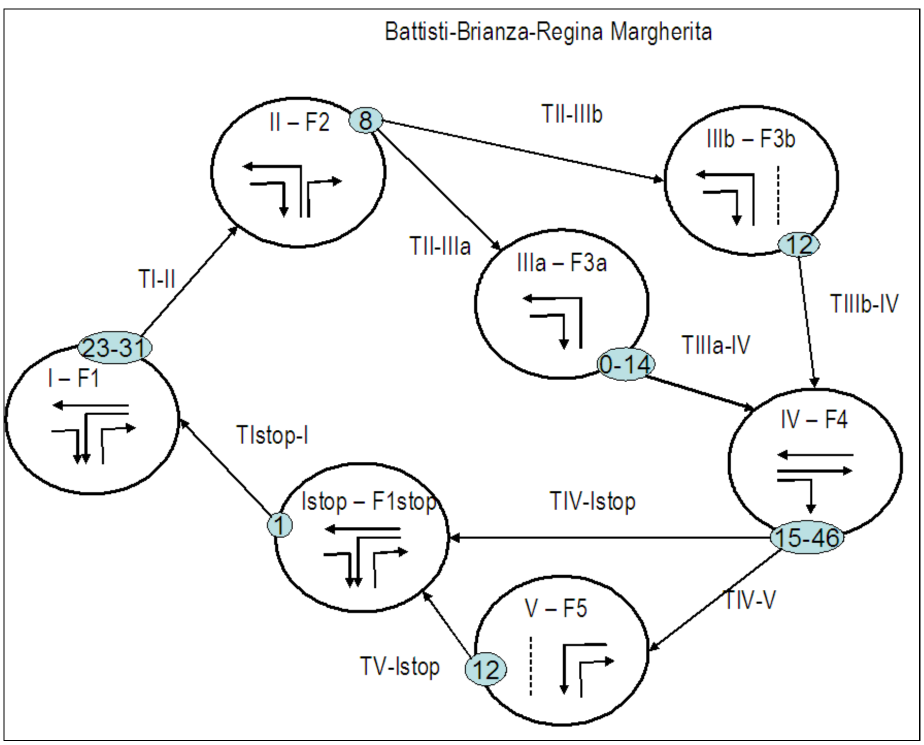


Figure 12 - Intersections 17 and 18, centralised plan no. 2, 150" cycle, graph of stages

The diagram presented in Figure 12 allows for a better understanding of the plan behaviour. The nodes of the diagram represent a stage; the arc connecting two nodes represent a transition (see §4.1.1 for the definition of stage and transitions); the small blue circle where arcs depart from represent a decision point about the completion of a stage and about the choice of the next stage; in the simplest case (e.g. node I - F1, on the left of the picture) the decision to close the stage depends on the reaching of a duration together with the status of a detector gathering information about the presence of cars. In particular, the minimum duration of the stage is 23”; the maximum duration of the stage is 31”; such maximum duration is achieved only if there are cars that need to go.

For stage II-F2 the situation is slightly more complicated: after the duration of the stage (8”), if there is a pedestrian request for Regina Margherita crossing (South), then the plan continues on stage F3b, else on stage F3a.

As briefly anticipated in §4.1.1, this is the case where the linear coloured representation doesn’t provide the necessary information to understand the plan behaviour.

4.1.4 Green Wave Battisti – Villa Reale

As stated previously, the proposed approach is to decrease the cycle time to 150”; since the cycle time adopted for the traffic light plans of viale Battisti is 100”, this allows for a synchronisation with a factor of 2/3: two cycles of 150” are coherent with 3 cycles of 100”.

In Figure 13 a joint representation of the traffic plans for the five intersections so far mentioned is reported. Through specific coloured markers (orange and red), it is possible to check the synchronization between the 100” and the 150” cycles.

These plans are currently under experimentation and assessment, with the supervision of experts from Project Automation and/or from the Municipality. The evaluation stage, carried out with a strong interaction will provide the right feedback to adjust these plans as well as to determine a set of plans to be applied during holidays or other particular situations.

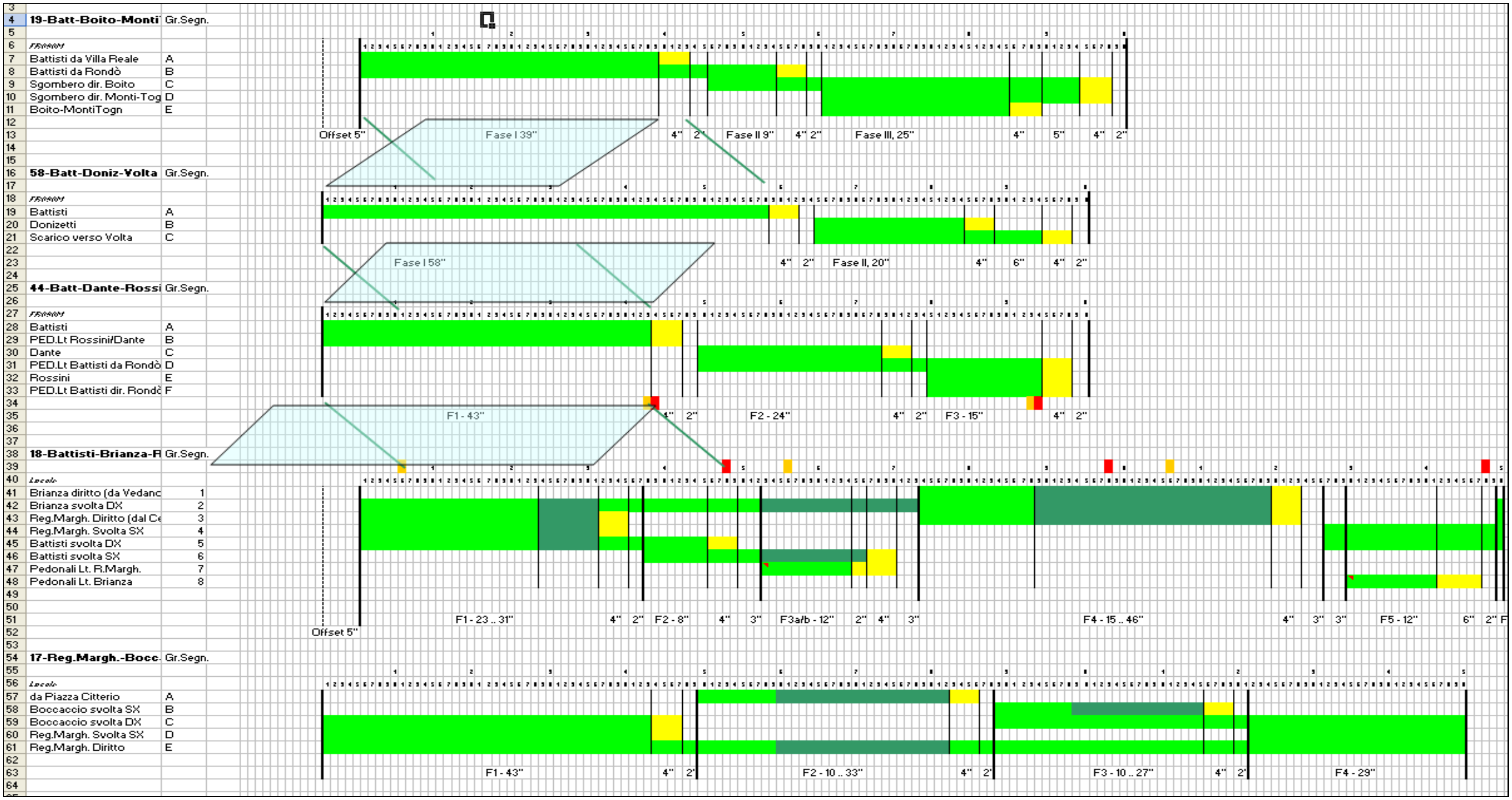


Figure 13 - Intersections 17, 18, 19, 44 and 58: centralised plan, 150" – 100” cycles

4.1.5 Coordination group Lecco-Cantore-Libertà

This section of the corridor is constituted of the three intersections no. 15, 16 and 13.

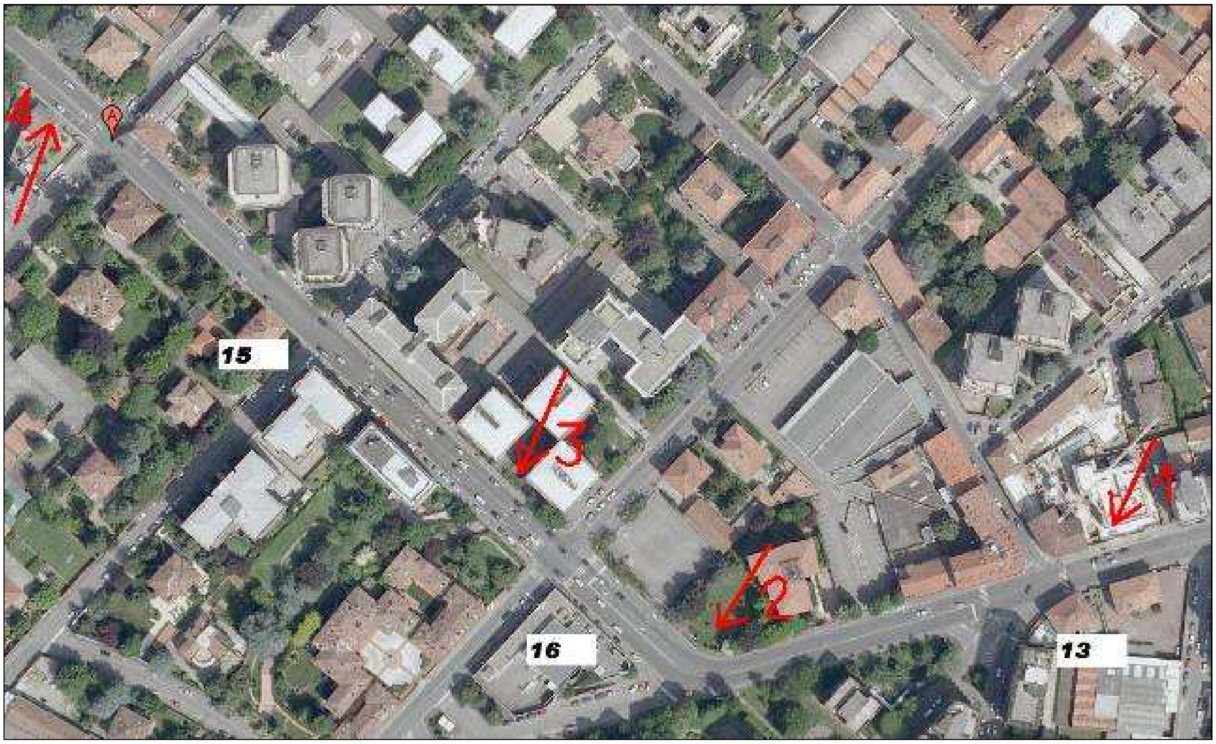


Figure 14 - Section of the corridor with intersections 15, 16 and 13: layout

In Figure 14 an aerial picture is presented to indicate the peculiarities of this section, pointed out by the numbered red arrows in the picture, hereinafter described:

1- the access to intersection no. 13 from the East is on two lanes, and the demand is important both in peak and off-peak hours;
2- continuing in the corridor in the East-West direction, in this point the two lanes merge in only one lane, since at intersection 16 (the most critical of this group) the approach at the intersection is on three lanes, one for each feasible direction (straight, left, right); this is the most congested part in the East-West direction, due to the merging; from this point on, traffic continues on one lane for about 100 meters and then can split on two lanes;
3- this point is important for the West-East direction of the corridor; the approach at the intersection no. 16 is on three lanes; two for the corridor (also the right turn is admitted) and the third for the left-turn. This movement is very important, especially in the evening peak hours; sometimes the spillback generated by vehicles waiting to turn left reaches the point no. 4.

4.1.5.1 Baseline: local plan on the Traffic Light Controllers

The three intersections are currently running fixed time plans that do not change during the day, each one of them with a cycle of 90", as reported in Figure 15, Figure 16 and Figure 17.

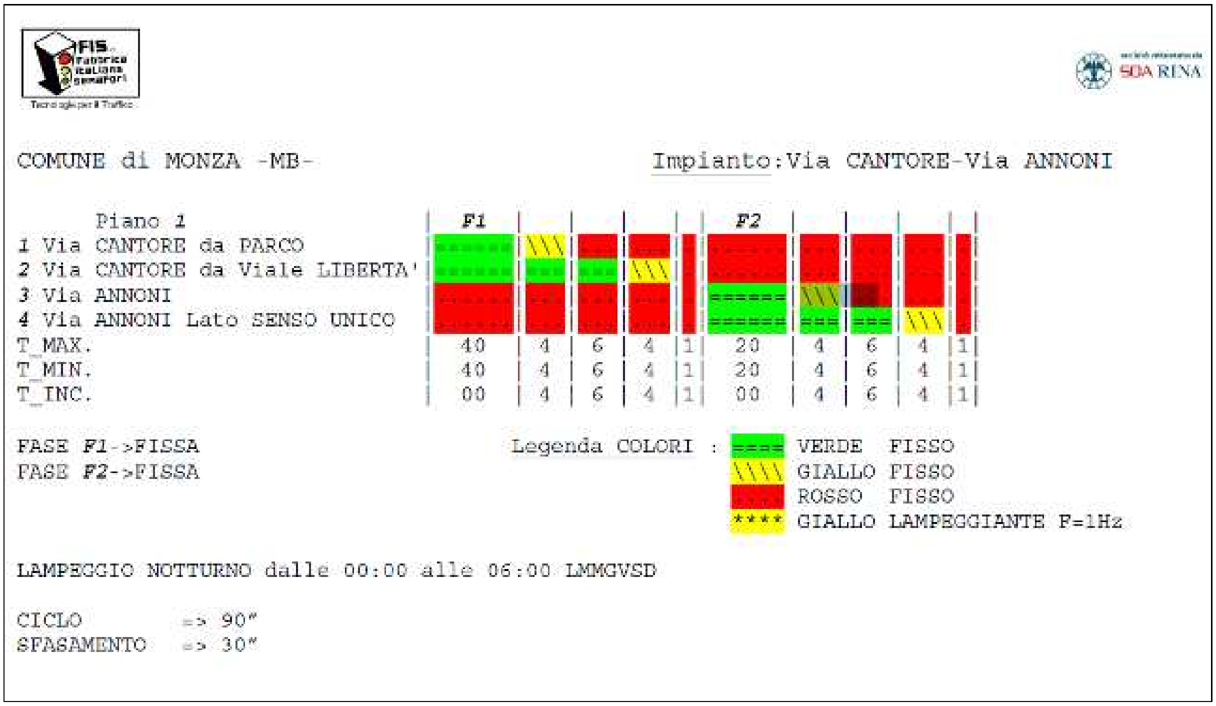


Figure 15 - Intersection no. 15, local plan

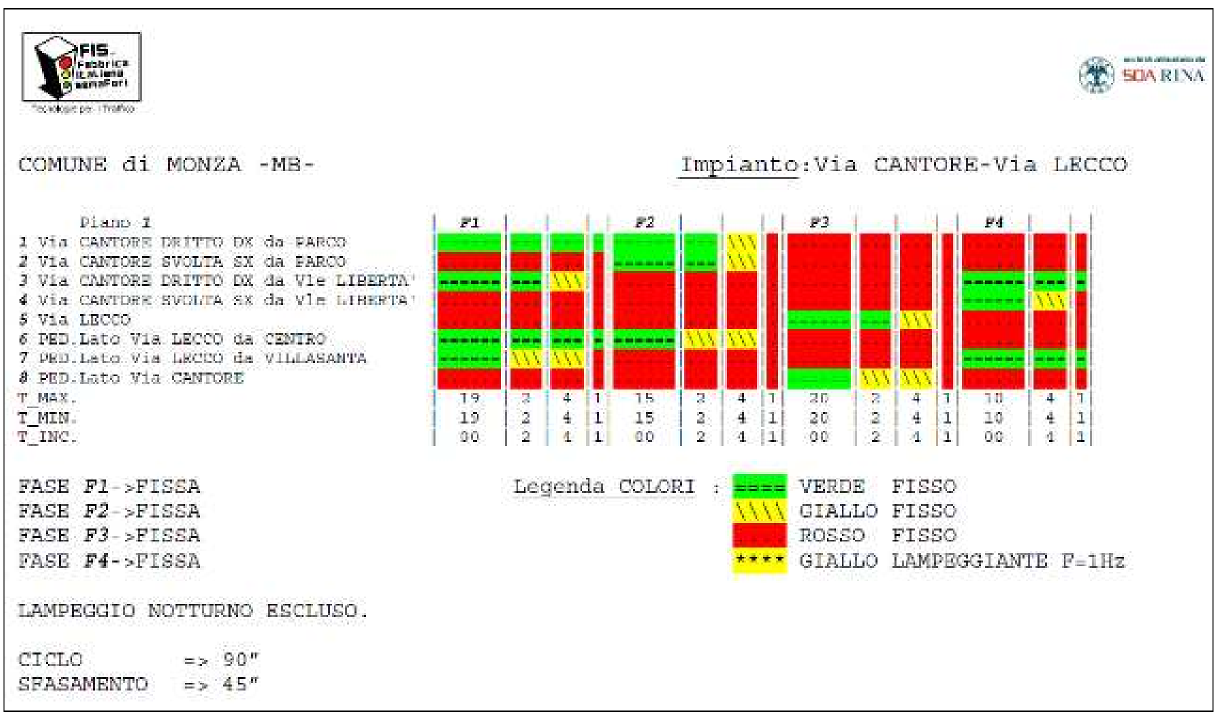


Figure 16 - Intersection no. 16, local plan

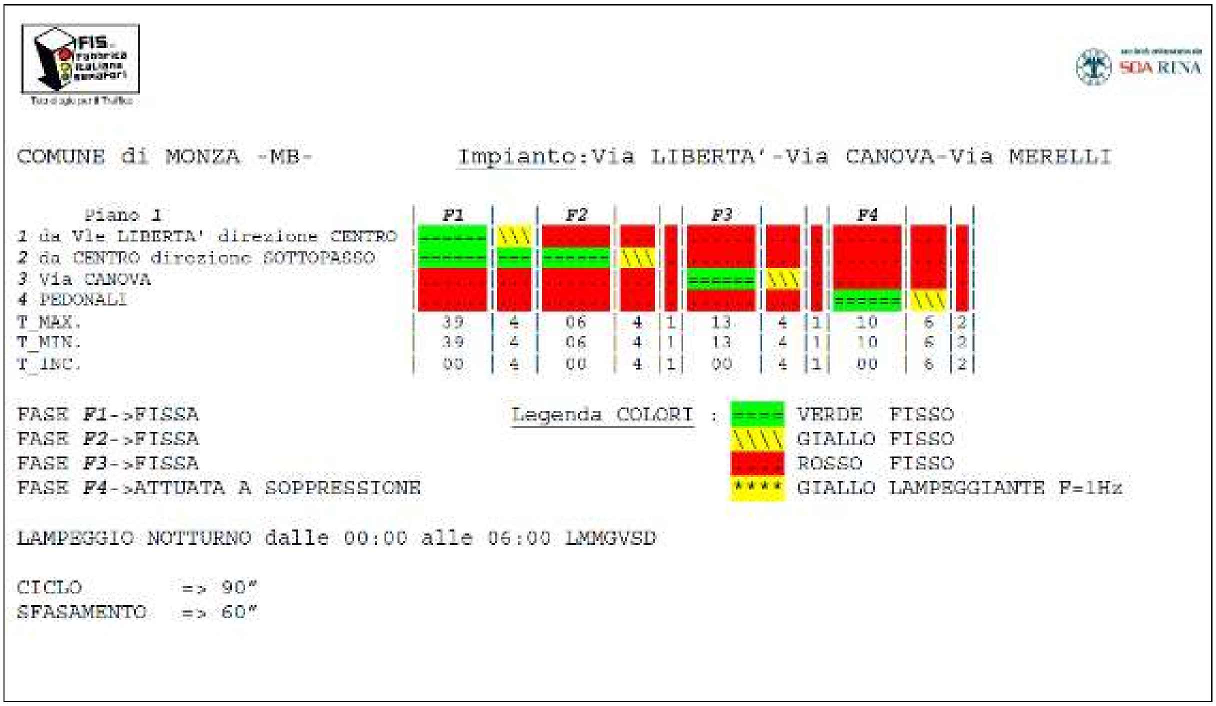


Figure 17 - Intersection no. 13, local plan

Only at intersection no. 13, the stage F4, is dedicated to pedestrians, is on-call, so it is suppressed if no calls have been issued.

These traffic light plans are coordinated, through a green wave in the direction West-East with an offset of 15” amongst the three intersections.

4.1.5.2 Design: centralised RoadManager plans

The new plans of the three intersections of this group are presented in Figure 18 and in Figure 19 below. The red status of the traffic light is represented without colouring the bar, to make the picture more readable.

The same structure of the local plan has been kept; these are the new features:

- the duration of the cycle has been extended from 90” to 100”, both for morning peak and evening peak hours;
- the extension of 10” has been assigned in the morning to the corridor, except in the evening peak plan: in this case the extension has been assigned to the left turn in the West- East direction; as described in the introduction to this section, this movement is important in the evening as frequent spillbacks are present, causing congestion along the corridor.

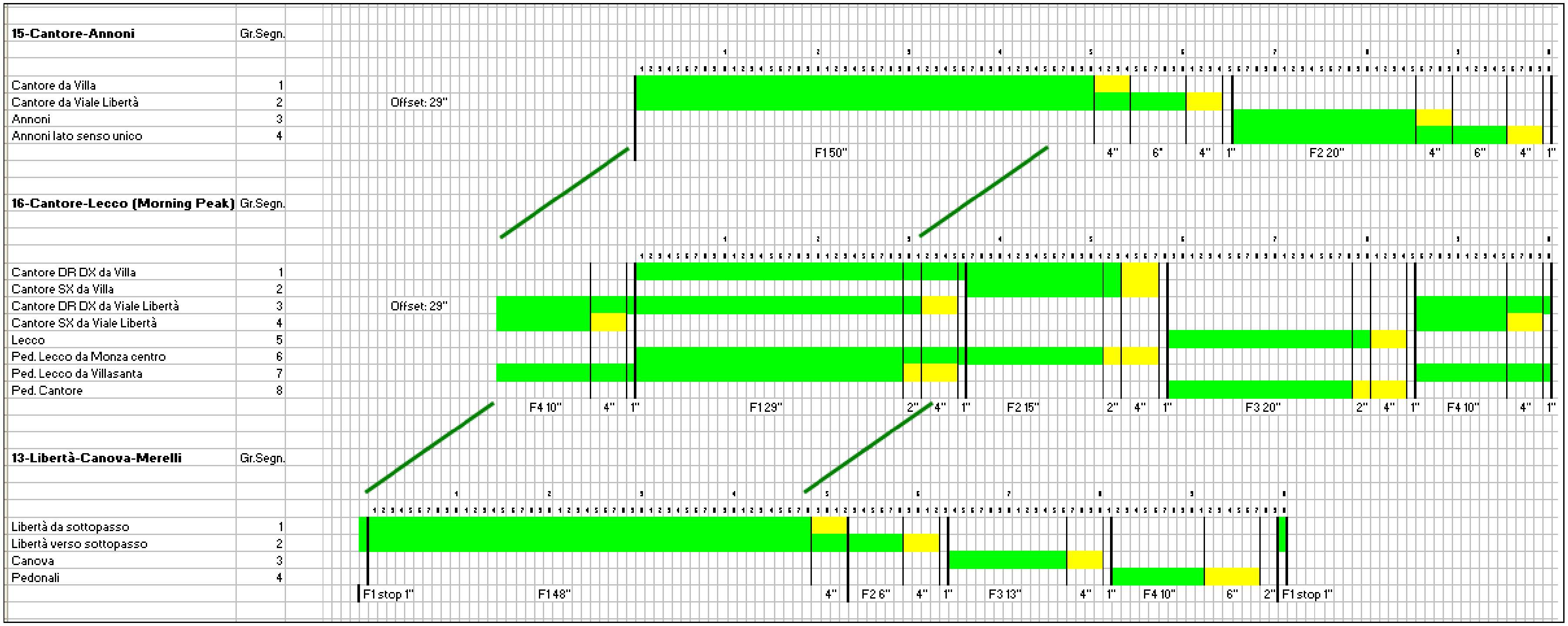


Figure 18 - Intersections 15, 16 and 13; centralised plan, 100” cycle, morning peak

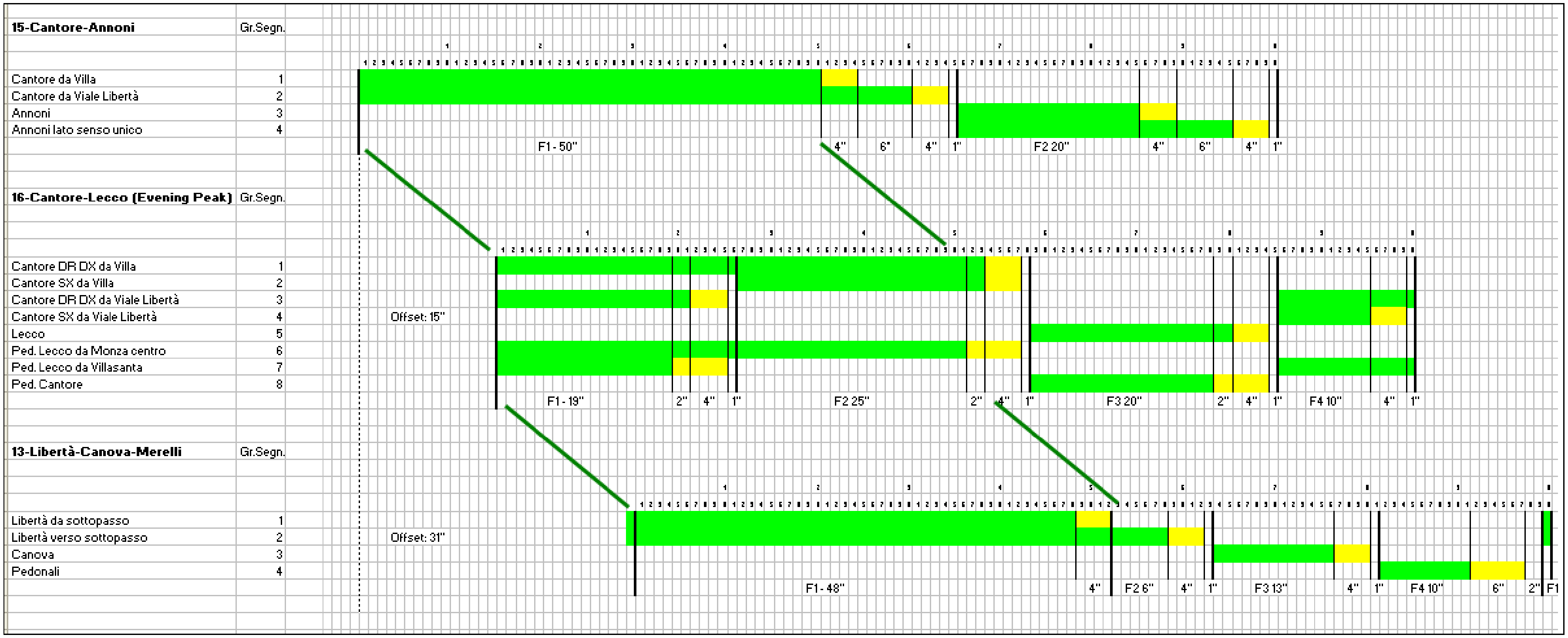


Figure 19 - Intersections 15, 16 and 13; centralised plan, 100" cycle, evening peak

4.1.6 Project Automation RoadManager® application at a glance

The coordination of traffic light control has been implemented through the software suite RoadManager, designed and implemented by Project Automation; RoadManager licenses have been made available to Comune di Monza for the duration of the Archimedes project.

The application server component of the application is currently running on a Windows-XP Virtual Machine created in the VmWare environment in the Project Automation server farm. This server communicates through UMTS connection with the industrial PCs installed in the technological cabinets at the intersections. The system architecture is presented in Figure 20.

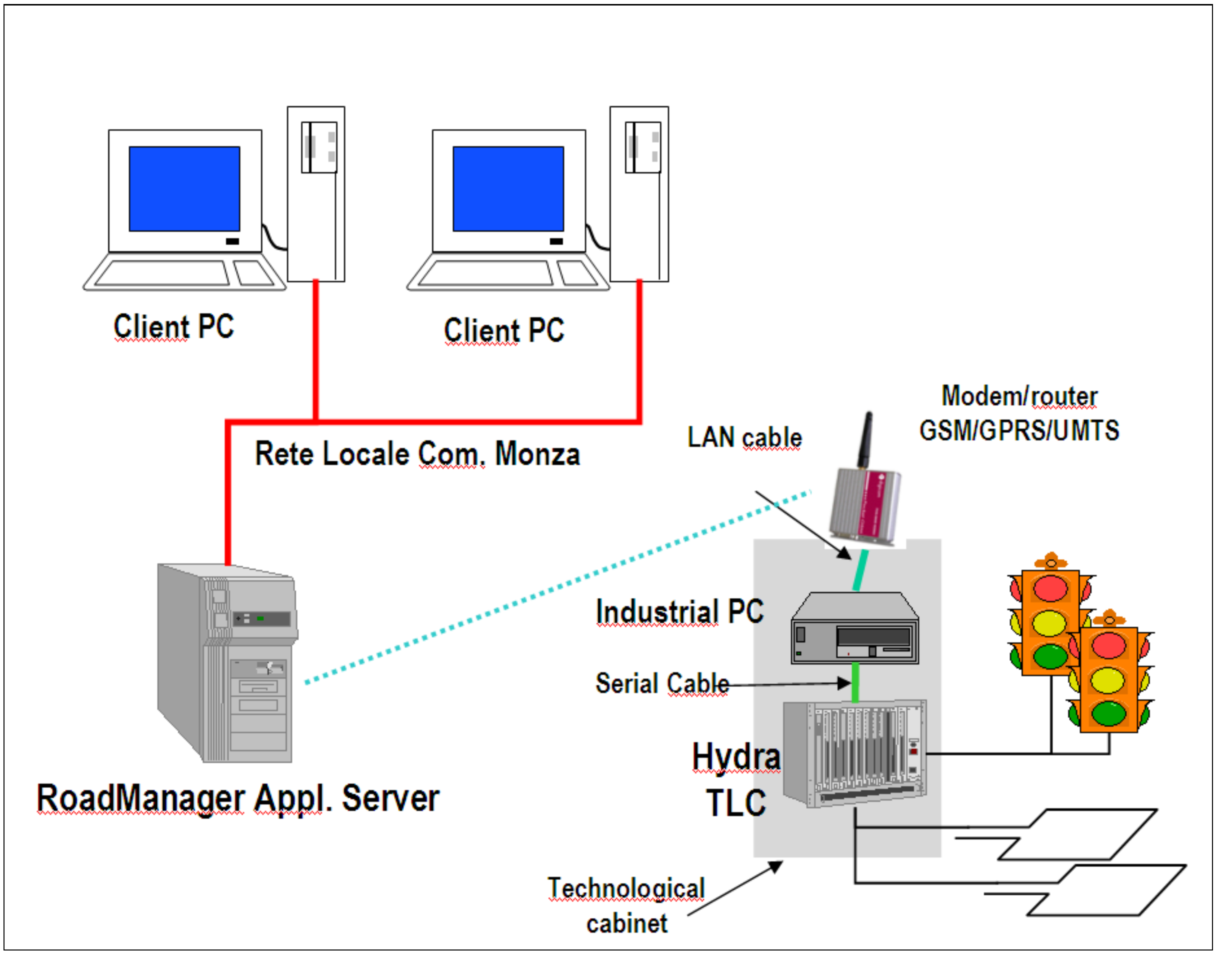


Figure 20 - RoadManager system: the architecture

In the sequel of this paragraph some significant screens of this application are reported, to show the most important features of the tool.

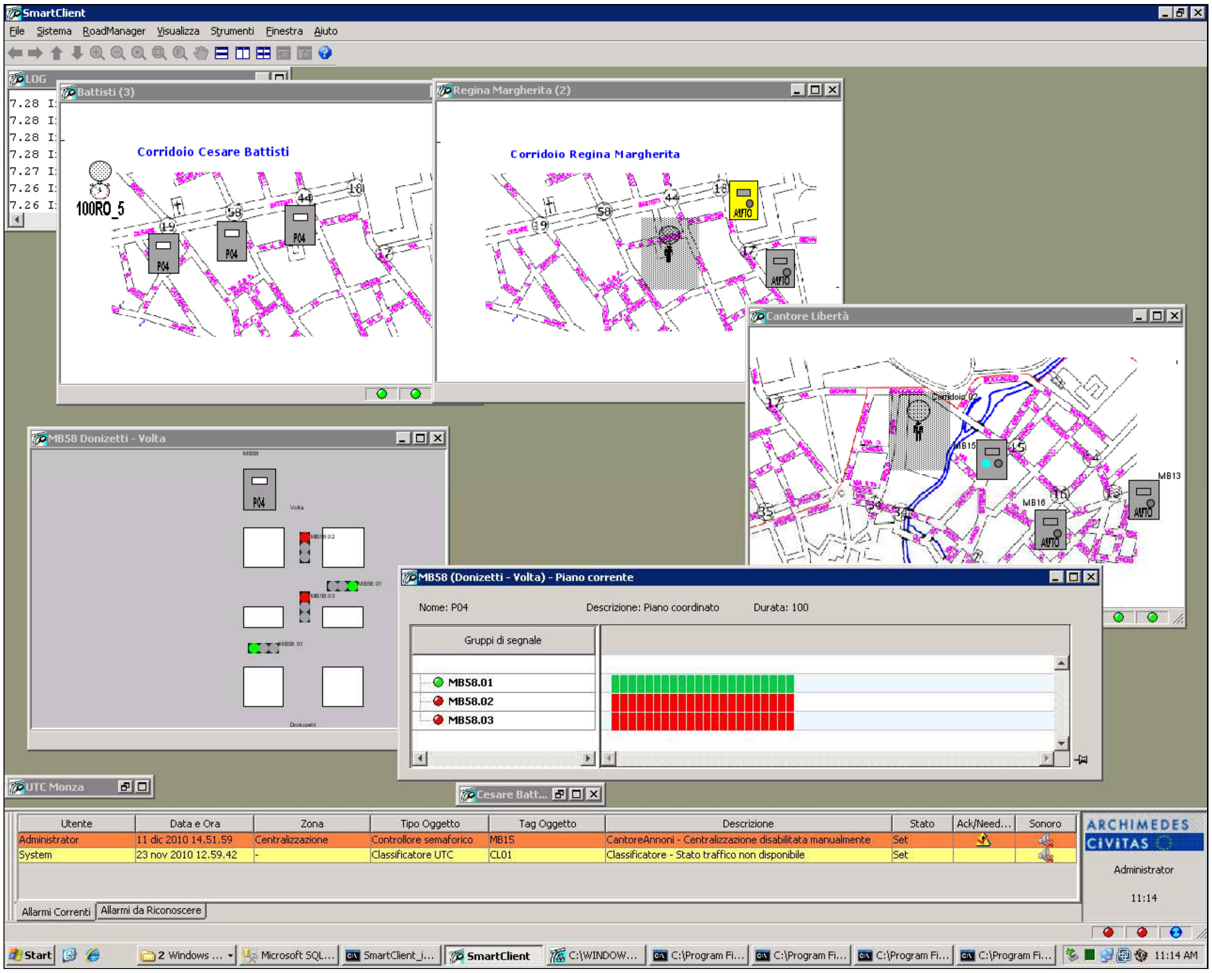


Figure 21 - RoadManager: coordination groups and active plan representation

In Figure 21 above, the following information is presented:

- three windows presenting the status of the coordination groups: in this example it is possible to see the “viale Battisti section (upper-left windows)”, which is active on a centralised control group labelled “100RO_5”; this tag means: 100” cycle, direction East-to-West (“RO” stand for “Rondò”, Italia term that in Monza identifies the end of viale Battisti”); 5 is the offset for creating the green wave.
- a grey-background windows where the status of the lamps at the intersection no. 58 is presented; this windows will be enriched with a real picture of the intersection;
- a self-updating windows presenting the colours (green and red) of the lamp in the last 20 seconds.

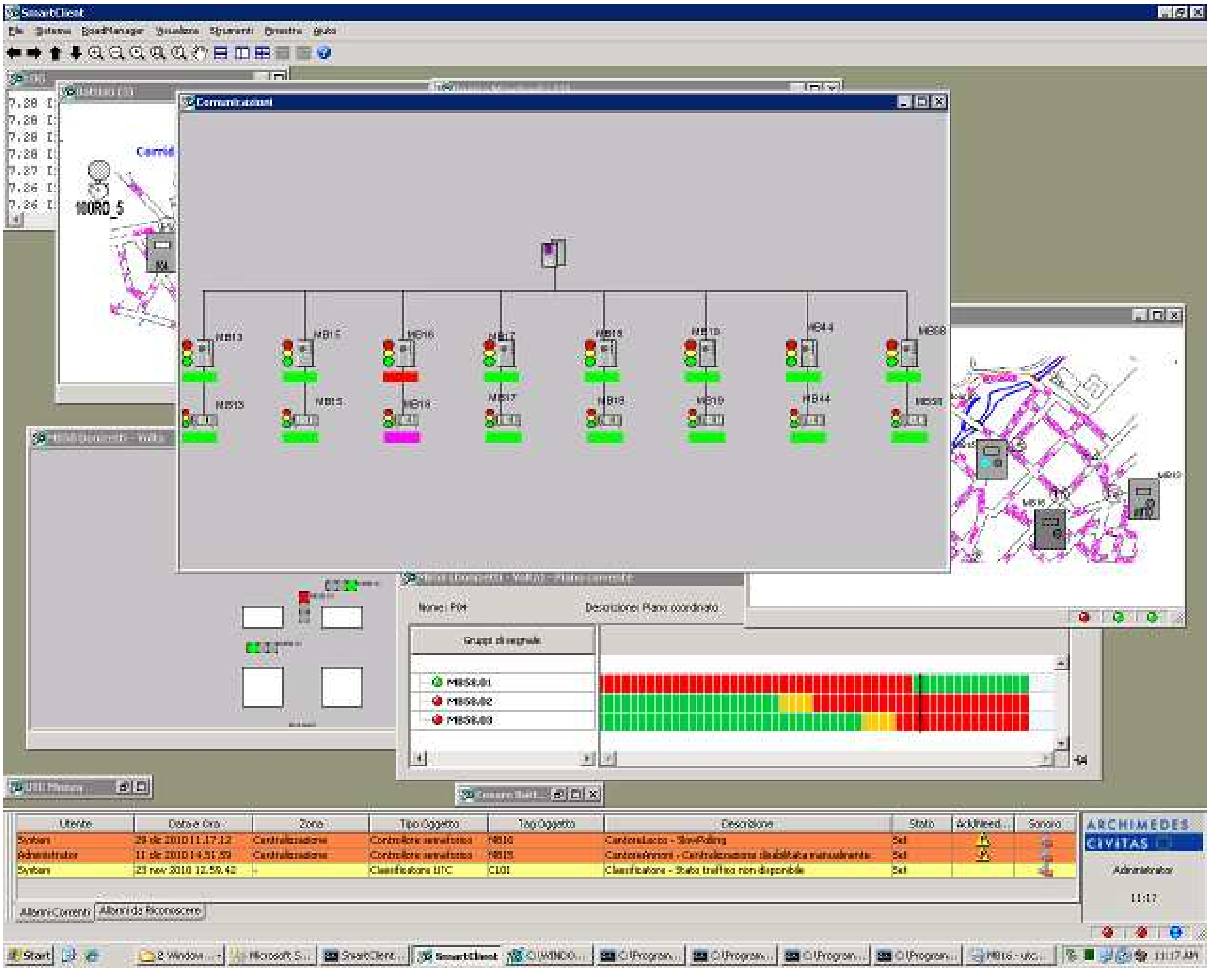


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Figure 22 - RoadManager: communication status

In Figure 22 the windows showing the status of the communication with the peripheral installation are presented.

Seven intersections are connected, as shows by the two green symbols; the upper symbol represent the peripheral software process of the RoadManager suite which centralise the traffic light controller; the lower symbol indicate the status of the Traffic Light controller.

The third peripheral installation is reported in the example to be in a non operative status; in this case, the peripheral software process has been voluntarily killed to show the capabilities of the system to detect such failure.

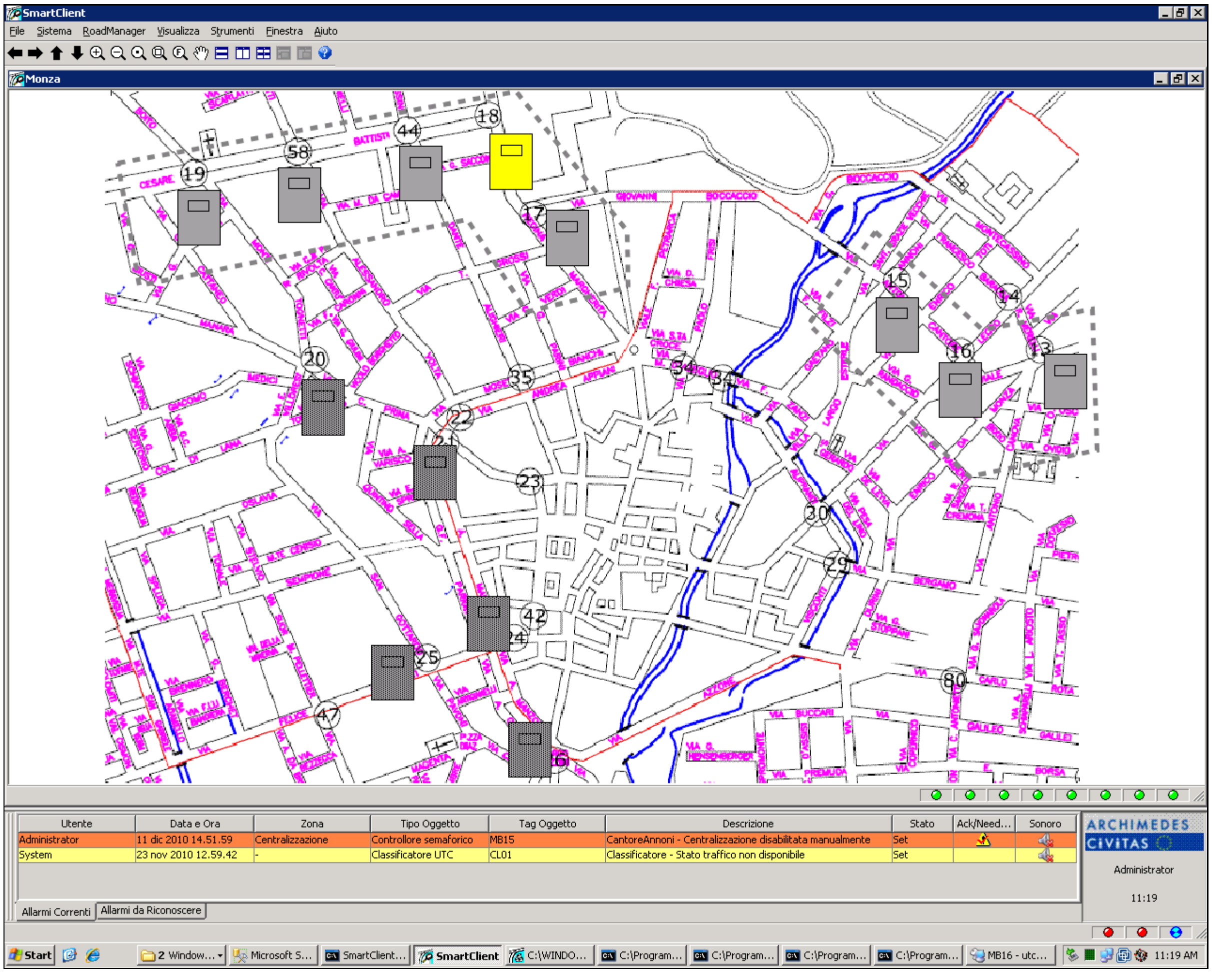

Figure 23 - RoadManager: the general view

In Figure 23 the general view of the part of the city of Monza involved by centralised traffic light control is presented.

The eight graphical elements in the upper part refer to the intersections of the CIVITAS corridor for private vehicles, as described in this document. Seven of them are grey-coloured, meaning that no active alarms are reported. The eighth symbol is yellow-coloured, meaning the presence a non critical alarm; more precisely, a loop detector is reported as non operative.

The remaining five symbols in the lower part of the windows are reported in a dark grey colour; this means that they are configured in the system but they are not yet active. More precisely, the activities on these intersections concern the Measure no. 82 (Public Transport Priority); the equipment to centralise these traffic light controllers will be procured in the next months.

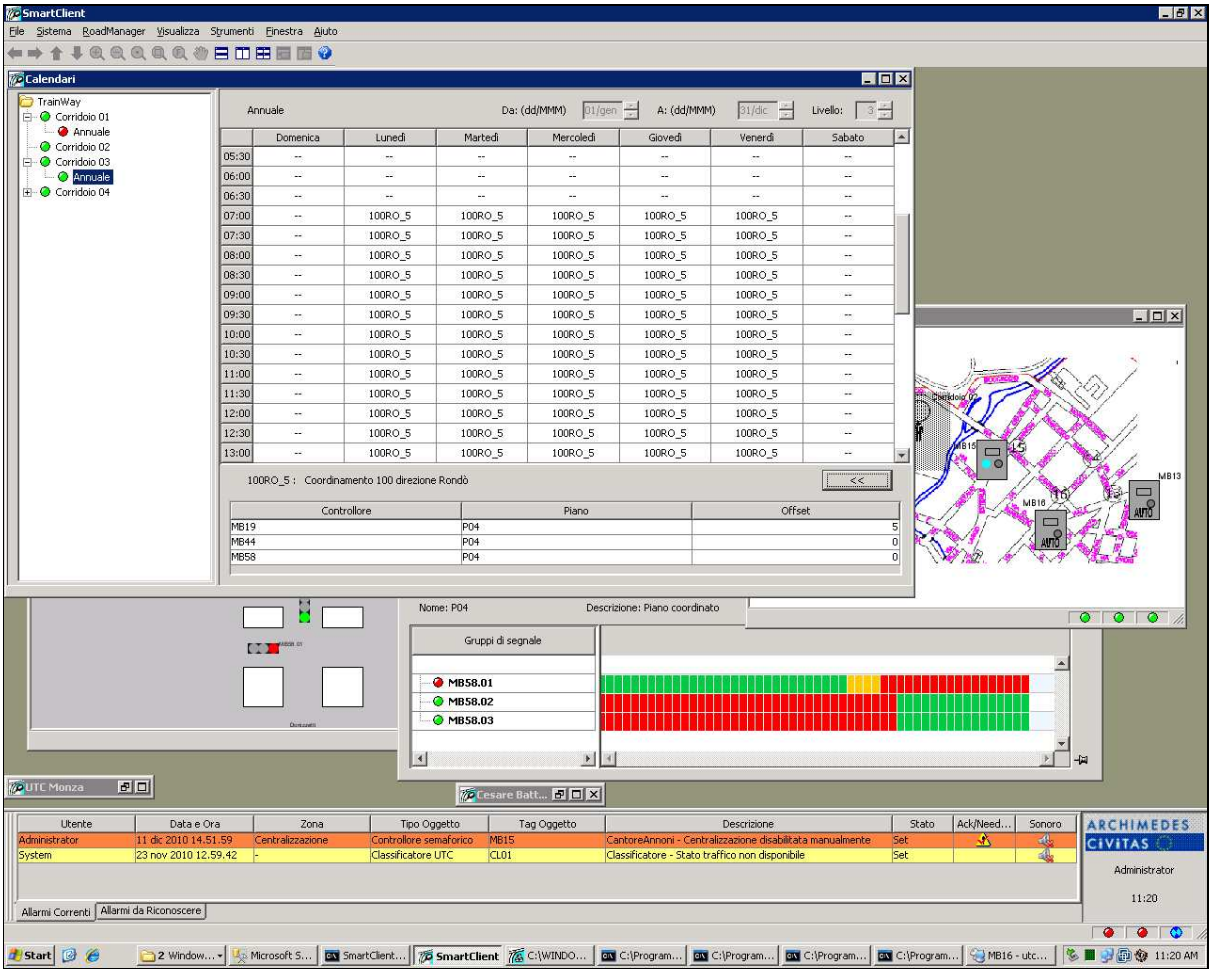

Figure 24 - RoadManager: calendar definition

In Figure 24 the windows to operate on calendars are presented. In the upper part of the window, there is a grid with the day of the weeks as columns and the 30-min slots of the days in the rows.
In the example presented, the calendar refers to the “Viale Battisti” section of the corridor; in the working days, starting from 7:00am up to 8:00pm the coordination group plan “100RO_5” has to be active.
In the lower part of the windows, the detail of the coordination group plan “100RO_5” is shown, describing which the traffic light plans are for each of the intersections belonging to the group as well as the offset value in seconds.

RoadManager allows definition of as many calendars as the authorised user wishes, targeted to different periods of the year.

4.2 Problems Identified

No functional issues have as yet been identified

4.3 Mitigating Activities

Not applicable.

4.4 Future Plans

The future plans will consist of:

- possible review and adjustments to the plans proposed in this deliverable as they will be evaluated in the specific task;
- as the centralised plans become stable, other particular situations will be faced (e.g. events at the racetrack that generate specific demand profiles on viale Battisti);
- new requirements that will emerge by Measure no. 82 (Public Transport Priority in Monza): some of the proposed plans could be adjusted to implement new approaches to extend green light for the movements affected by the transit of buses of the Public Transport fleet;
- detailed evaluation according to the measure evaluation plan..