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# MT4040

**TRAFFIC CONTROLLER**





## MT4040 TRAFFIC CONTROLLER

The MT4040 traffic controller is based on a distributed intelligence, composed by a central industrial type 386 microprocessor and by a series of peripheral microprocessors dedicated to the I / O management and control.

This type of structure allows to realize a traffic controller directed to be a General Purpose peripheral unit, able to manage not only the signal plant itself but to be, once endowed with the proper transmission way (GSM cellular phone or Telephone line), a bi-directional collector of a series of information necessary to the city area managers, providing data concerning private and public traffic and environmental data such as atmospheric pollution.

In this way, the controller becomes sentinel of the area where it is installed, sending automatically requests for servicing interventions for fixing plant anomalies or for simply replacing a burnt lamp, or for sending alarm messages in function of particular environmental or emergency conditions.

The basic configuration of the controller, equipped with four RS232 serial ports, two 485 serial ports, a TTL and a parallel port, enables it to be easily interfaceable with other equipment; moreover the characteristics of General Purpose unit are furtherly highlighted by the fact that the CPU of the controller is predisposed for mounting standard peripheral modules of the family PC 104 and PCMCIA, allowing therefore the conversion of the controller into a powerful and flexible industrial PC.



## GENERAL CHARACTERISTICS

The MT4040 traffic controller has been designed to act, in any type of application, either integrated in a centralized and in an independent system, as a traffic control unit able to make autonomous decisions, to be an information collector and to allow anyway the control, the monitoring and transmission of the information to the devoted corporate body.

The controller can achieve the following main standard features:

- Automatic with fixed times – Manual – All Red
- Actuated by traffic:
  - By memorized or fading reservation – With extendable Green times – With Directional Detection – By Priority Call – By phases affected by extraordinary circumstances.
- Hourly selection through annual calendar table, for flashing mode operation or 16 plans diversified for structure and times.
- Cable and cable-less synchronised function based on internal real-time clock set by satellite GPS interface.
- Priority to Public and Emergency vehicles.
- Automatic switch to daylight time saving according to standard or programmable dates.
- Traffic data collection per Volume or per Speed and Length Classified way, according to configurable parameters, by means of traditional loop sensors or by dual technology infrared and microwave sensors.
- Monitoring of all the connected traffic signal lamps for verifying the good functionality and for signalling the burnt of a single lamp.
- Dynamic plan generation, with capacity of driving by a serial connection, a maximum of 8 satellite Controllers, by a customizable control algorithm that generates in real time the green times in function of traffic flows.
- Capability to be controlled by a remote PC in a Centralized System.
- Automatic alarm message dispatch by mobile or fixed telephone network in case of fault on the controlled plant.

### CONTROLLER'S CAPABILITIES

The MT4040 traffic controller is structured to manage:

- 40 Traffic signal groups (120 power outputs)
- 20 digital relay outputs
- 8 four channel Detectors (32 Detectors)
- 72 Digital inputs
- 16 Programmes selectable remotely or by hourly table with weekly and annual calendar

### CPU FEATURES

Microprocessor

Memory

Communication Port

ELAN 386 AMD

1 Mb RAM static disk

1 Mb EEPROM FLASH

1 Mb RAM static

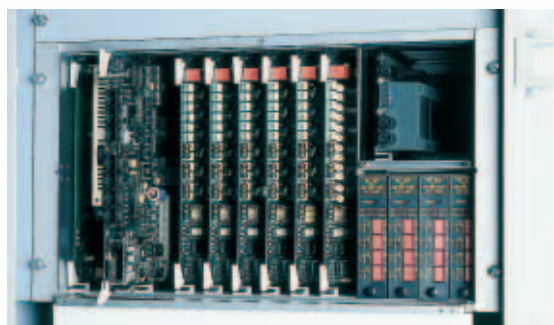
512 Kb EPROM

2 Serial 485 (opt isolated)

4 Serial RS232

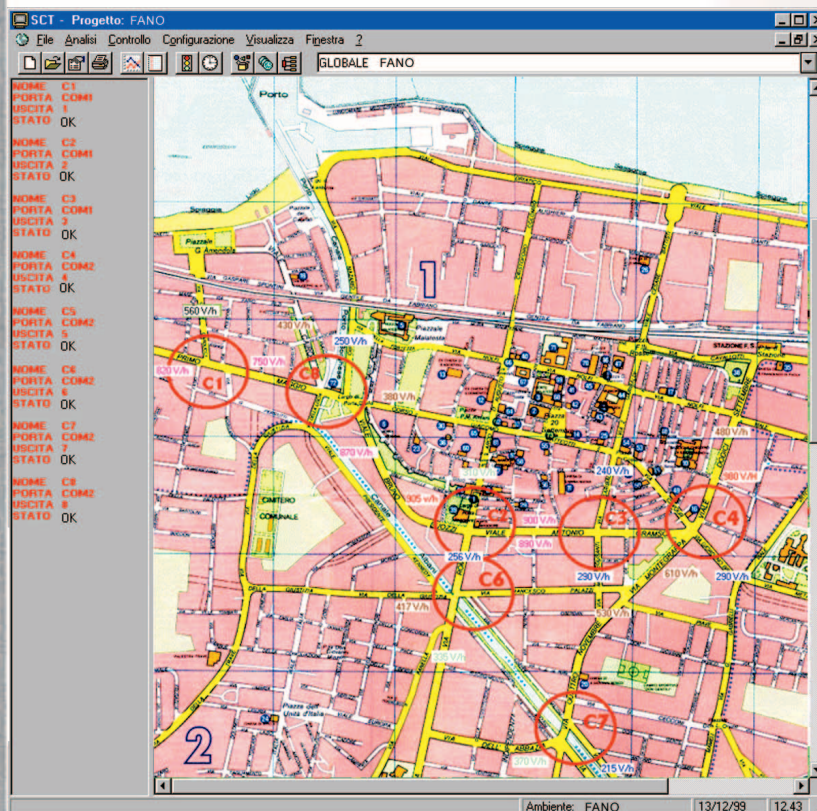
1 Serial TTL

1 Parallel





## CENTRALIZATION



Equipping the controller with the proper HW and SW modules, further to the functions above mentioned, it can become a peripheral unit able to be a transmitting means of information between the central system and:

- Variable message signs for transmitting information to the users.
- Sensors for environmental data collection.
- Management of priority to public means of transport.

In the reality of traffic management it is always more evident the necessity of a general strategy that allows the realization of a coordination of traffic plants dynamically adequate to the traffic demand, coordination that does not only mean the realization of green synchronized waves but that provides the interdependence of actions taken on the different plants and that applies strategies addressed to downflow the traffic road net.

It seems to be every day more important the necessity to dispose of data that can give a precise image of the traffic status in the urban area and of the type of service offered by the technological systems devoted to control it.

In this projection the MT4040 controller gets in as intelligent peripheral unit of a Central Managing System, able in its standard configuration, with the only addition of modem for dedicated line, to take the following actions:

- Execution of commands received by the Central system:
  - Traffic Plan to be actuated
  - Green times to apply to the different phases
  - Cycle and offset time to apply to the current plan
  - Operator's commands
- Dispatch to the Central system, on its request, of the following data:
  - Traffic Data collected during the interrogation period
  - Controller "Log" data
  - Historical archives stored into the controller

The MT4040 beyond being able to be interfaced with most of systems present on the market, disposes of two software packages developed by SCAE and precisely:

- **MAC300W SYSTEM**, turned to realities formed by a maximum of 32 traffic plants
- **GMAC SYSTEM**, turned to realities formed typically by a maximum of 250 traffic plants

The characteristics for which the two systems are fundamentally different are :

- Structure and architecture of the system, the MAC300W is typically a monolithic structure while the GMAC is divided in parts hierarchically interconnected.
- Managing capacities, the MAC300W is a package exclusively dedicated to the management of the traffic plants and of the data to them connected, while the GMAC can integrate a series of services.





## TRAFFIC ANALYSIS STATION

### COMPARISON BETWEEN TWO SAMPLE TRAFFIC STUDIES

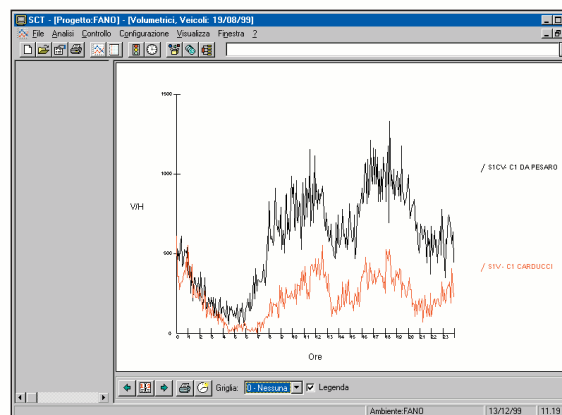
The MT4040 controller, in its standard version, with the only equipping of the necessary detecting sensors (detector A1104S) realizes the functions of a traffic data collection station able to archive and dispose of the following data:

- Volumetric data (quantity and occupancy rate) over a maximum of 32 detecting sections with time period of 5 minutes.
- Classified data over a maximum of 8 detecting sections configurable for:
  - Time period
  - Speed class (max. 16)
  - Length class (max. 8)
  - Archive dimension (circular type)

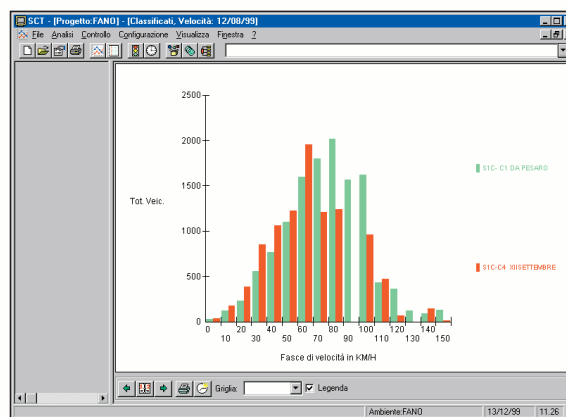
The collected data are stored in circular archives structured as follows:

- Weekly circular archive, configurable for a max. of 4 weeks, for volumetric data
- Configurable archive for classified data

The archives can be locally uploaded by PC or transmitted to remote sites according to what described in the following paragraphs.



Daily volume graph



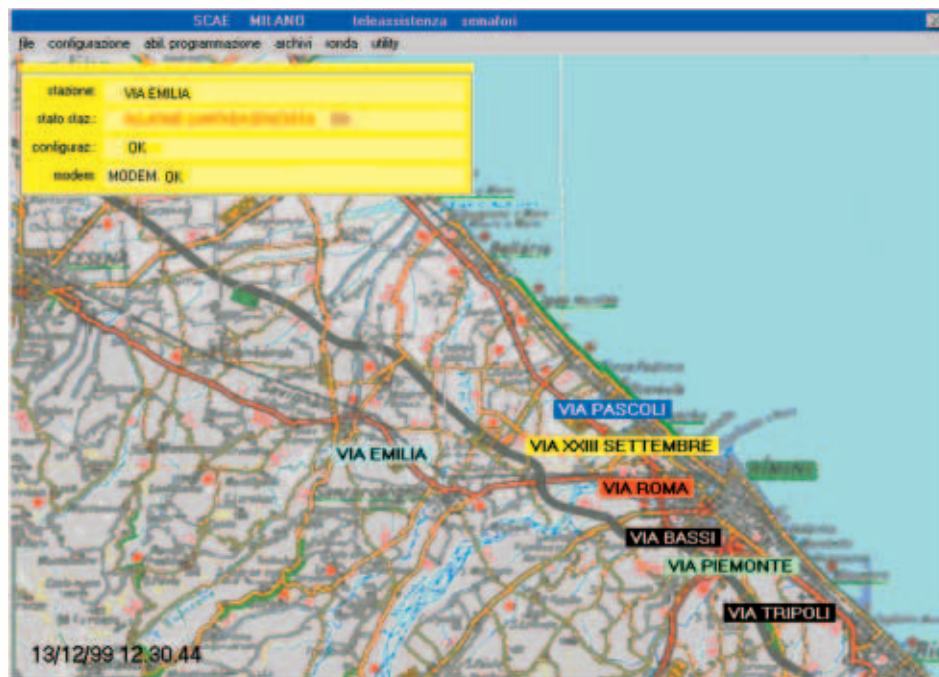
Volume speed histogram

## M O N I T O R I N G

The MT4040 controller equipped with the cellular module TEL 40, or connected through modem to the national telephone network, becomes a unit able to generate spontaneous calls towards a maximum of three remote sites (PC) in case of anomaly occurred on its plant or on the one of the controllers of which it is "master".

This kind of solution allows to improve either the reliability and the availability of the plant, enabling the realization of a quick and efficient servicing.

Besides the management of spontaneous calls the central system software allows, upon operator request, the file transfer from the historical archive of the controller to remote sites, enabling therefore the collection of traffic data from remote sites and the collection of the log files resident into the controller memory.



## CONTROLS AND SECURITIES

Taking into consideration the particular importance of assuring high safety conditions in a traffic signal plant, the controller has been equipped with a series of control circuits, structured in a redundant way and on diversified Hardwares, performed by microprocessors independent from the managing one, and voltage and current sensors that monitor all the controller outputs.

Particularly the voltage sensors on the green lights have been doubled for guaranteeing the safety conditions of the light status reading. The Controller is equipped with the following standard controls:

- I/O modules microprocessor verify:
  - Voltage sensors response to check the conformity to the programmed diagram
  - Response conformity on duplicated voltage sensors applied on green light control
  - Current sensor response by means of A/D converter with a sensibility  $\leq 4W$ , to detect the minimum current on each output
- Green Conflict microprocessor verify by means of a programmable conflict matrix, reading on a separate bus, voltage sensors response (sampling frequency 1KHz):
  - Green and Intergreen Time conflict condition
  - Minimum Green time conflict
  - Red conflict condition
- CPU module specific microprocessor perform data flow conformity
- Hardware Watch-dog verifying microprocessors function

The occurring of the above said controls sets the plant in emergency condition (Flashing mode driven by a separate hardware module). Supply to red and green lamps is cut by a proper relay mounted on each I/O module.

Beyond the emergency controls the equipment also performs the following controls:

- Filter action according to a programmed compatibility matrix, so to prevent that the CPU could transfer incompatible orders to the I/O modules.
- Amperometric check with auto detection of the current load on each output in order to signal the burning of a single lamp (Power range 0÷800 W with 4% tolerance, power value is defined in function of main supply voltage variations).

## DIAGNOSTICS

MT4040 controller is equipped with a series of on-line and off-line diagnostic software controls to facilitate trouble shooting on the whole system, such for instance:

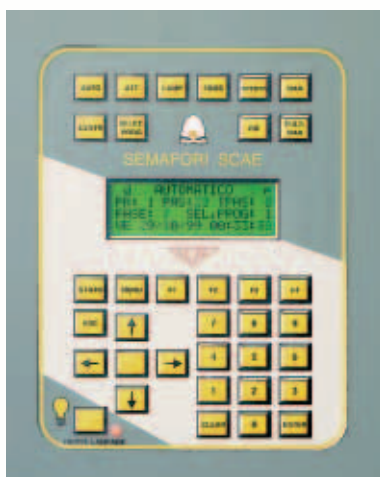
Memories – Serial ports – Loops and/or Detectors – Outputs – Inputs.

The diagnostic allows furthermore to enter, either into files stored in the machine memory and on display, a series of information that allows to examine in details the actual working conditions of the controller, and those occurred during the last 100 (ms) before the erasing of an emergency condition, and also the general historical ones.

This is realized by:

- Recording into a “Black Box” file, all the values read by sensors when occurring the failure (line voltage true rms and form factor, inside temperature, sensor response value on outputs etc.)
- Circular historical file registration of all the functional and alarm changes.
- Showing on display on-line values (line voltage true rms and form factor, inside temperature, sensor response value on outputs ).
- Showing on display the functional status of: input signals, detectors and loops.
- Off-line test that allows the operator to test the signal heads by command of each output.

## MAN MACHINE INTERFACE



The controller is equipped with a display and a programming panel that could be placed also at a maximum distance of 300 meters from the controller, endowed with:

LCD Display with 80 characters for displaying the functional status, the alarm and diagnostic messages.

Customized Keyboard for management and programming.

The MMI interface takes particularly care of the diagnostics and programming aspects, in fact on the panel are clearly shown all messages indicating the functional status of the controller, the alarm conditions, the results of the diagnostic tests and the programming data.



## PROGRAMMING SOFTWARE

The basic software, structured to allow an easy solution of the demanding necessities from simple intersections, allows to easily solve also the more complex situations so to arrive at the generation in real time of the green times according to traffic status.

The controller programming can be realized through resident panel or through PC with a dedicated software running under WINDOWS, that allows, on the same PC, also to test the realized programs, displaying the lighting up of the signal heads with the possibility to insert through a keyboard, interactive orders for simulating external events.

The Upload and Download functions of the programs can be realized without service interruptions.

The controller programming data are subject to (password) for safety purposes and are resident on EEPROM FLASH type memories for storing information without battery back-up supply.

The programming software allows furthermore to collect the data stored in the controller file, their displaying in graphic and numerical format and their exporting in acquirable formats from other programs running under WINDOWS.

## MODULARITY

The controller modularity complies with the EUROSTANDARD format.

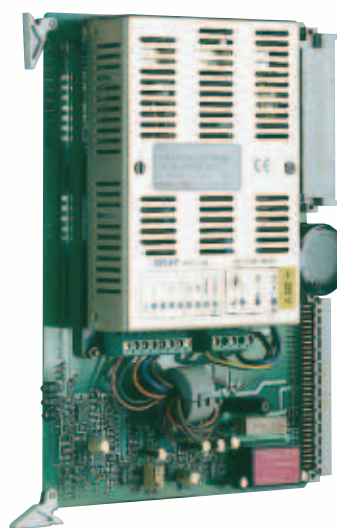
The basic cards of the equipment are:

MODULE AL 40	Power Supply
MODULE AL 40-24	Auxiliary circuits Power Supply
MODULE CPU 40	Central Unit
MODULE PRO 40	Control Panel
MODULE I/O 4-12-40	I/O Interface (12 outputs - 4 inputs current and voltage sensors)

### EXTENSION and OPTIONAL CARDS

The controller can be equipped with a series of cards, such as:

A1104S	4 Channels Detector
GPS 40	GPS interface
TEL 40	GSM Modem
PC104	Memory Card



MODULE AL 40



MODULE CPU 40

## TECHNICAL CHARACTERISTICS

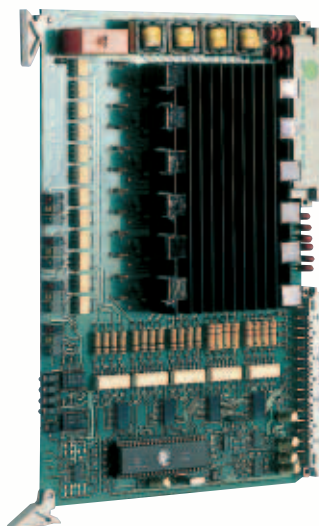
Main supply:	230 V- 20% +15%
Consumption (lamps excluded):	100 W
Maximum Controller charge:	6500 W
Maximum charge for each Output:	800 W
Output protection:	fuses 4A type EF
Hold time:	= 100 ms

Cabinet:	in press-forged polyester
	h= 1090 mm L= 590 mm w = 320 mm
	in stainless steel INOX AISI
	430 oven painted
	h= 1210 mm L= 615 mm w= 430 mm
	(other realization on request)

Operating temperature: - 20 +60°C



Municipality of MILANO  
standard version



MODULE I/O 4-12-40

## A P P L I C A T I O N S

### HOURLY PLAN SELECTION OF AN ISOLATED PLANT

The controller is provided with an annual calendar clock and with a configurable hourly plan selection table that allow the programmable insertion of the flashing mode and of one of the sixteen available plans, according to the following modalities:

- \* Weekly daily, for example in a specific time of all Mondays
- \* By days of the week, for example in a specific time from Monday to Friday
- \* In one day of the year, for example in a specific time of all the 25th April every year
- \* In a day of a specific year, for example in a specific time of the only 29th February 2000

This method allows to adapt the traffic signal cycle to the changes of traffic according to statistic previsions based on pre-programmed time values and on traffic data collection campaigns that can be realized either traditionally and analyzing the data collected by the controller itself by loops.

### HOURLY PLAN SELECTION COORDINATING AN INTERSECTION NETWORK

The multi plan coordination in a wireless way can be realized by equipping a network of MT4040 controllers with the GPS 40 module. That module provides the automatic updating of the clocks of the controllers by synchronizing them with the absolute time sent by the orbiting satellites over the controller installation point.

The user should set inside the controller the time zone value of the installation zone. This enables to realize a perfect synchronization between the traffic cycles of the different controllers with a plan change, perfectly synchronized, at a fixed time according to the modalities specified in the previous paragraph.

### DYNAMIC PLAN GENERATION IN AN ISOLATED PLANT

The MT4040 controller, in its standard configuration, with the only addition of the proper sensors (detectors and loops of macro regulation) and of the specific configuration software, is able to calculate and apply the traffic times able to satisfy the real traffic demands.

This method is fundamentally different from the one defined in the previous paragraph since it does not conform the traffic times in function of statistical pre-calculated previsions, but, acquiring values of real demand of traffic intensity, it calculates the green times necessary to discharging the demand, applying them in place of the pre-programmed ones that are used only during bad system operating conditions (failure of sensors, etc.).

From that it rises the necessity of installing sensors different from those of micro regulation, that estimate only the quantity of discharged traffic in function of the applied green time, such sensors, that must be installed at a distance from the stop lines approximately estimable around 100 meters, are identified as sensors of macro regulation and they acquire, in a way not affected by the semaphoric cycle, the quantity of traffic relevant to the discharging demand.

The cycle management through the combined action of micro and macro regulation sensors enables to reach an optimal condition in which the maximum green times applied in the calculating period, are proportional to the real traffic quantity to be discharged, and in the single green period the action of micro regulation sensors regains the eventual excesses.

### DYNAMIC PLAN GENERATION IN A LOCAL INTERSECTION NETWORK

#### NETWORK WIRELESS COORDINATION

The intersection network is coordinated without information exchange, equipping the controllers with GPS40 module, according to the previously described modalities. The network can be formed by controllers operating in dynamic plan generation and by controllers operating in hourly plan selection. In this case the controllers operating in dynamic plan generation, calculate and distribute the cycle time requested by the hourly table of plan selection, between the different green times, proportionally to the traffic demand.

Therefore this solution maintains, for the controllers configured in plan generation, the capacity of generating green times, but with the restraint that their sum is anyway equal to the cycle time set as hourly.

#### COORDINATION WITH DATA CONNENCTION NETWORK

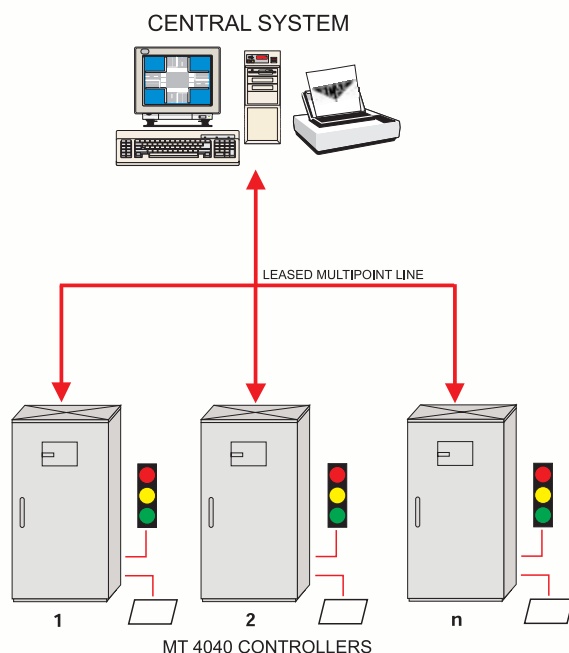
Realizing a local data transmission network that interconnects the controllers, by serial line RS485, or via modem for distances higher than 1000 meters, there is the possibility to realize a coordinated network of a maximum of 8 controllers operating in dynamic plan generation. The controller on which the dynamic generation software is configured becomes in this case the "master" system, that, collecting the traffic data by the macro regulation sensors connected to all the controllers, calculates: the cycle time and its relating repartition in the green times to be assigned to each phase and the offset time, to apply to each controller.

The controllers network is therefore managed according to a local dynamic strategy that provides the exigencies of coordination and of influence between the different plants.



## MAC300W SYSTEM

### System architecture



The MAC300W is a system structured upon two levels:

#### □ Central level

Formed by a PC station that carries out the following functions:

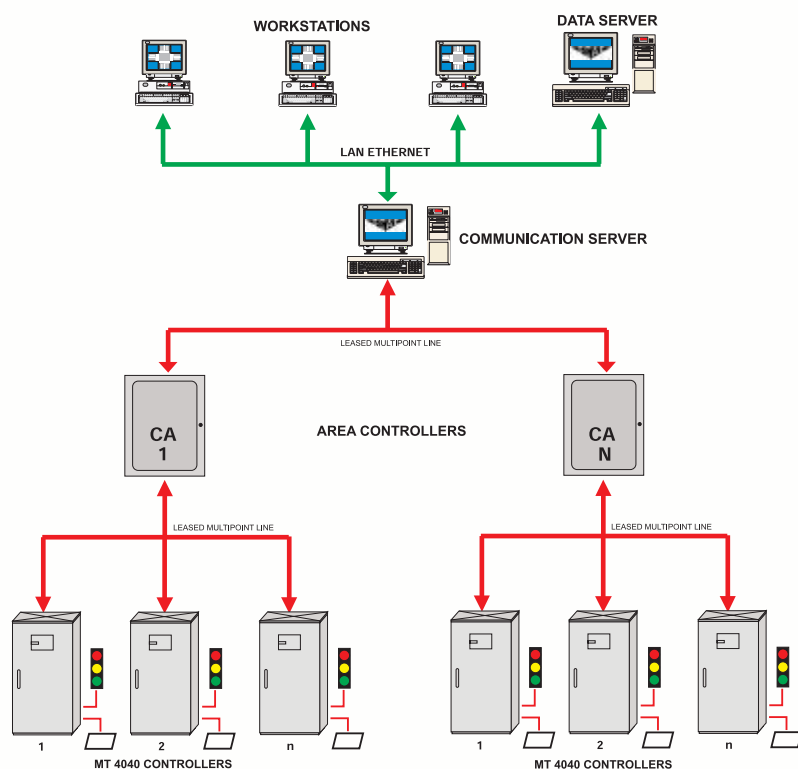
- Operator interface with interactive MMI
- Management of the alarm archives and of the system's "log"
- Management of traffic data archives
- Management of the consulting and the displaying of archive's data
- Elaboration and actuation of the control strategies, with possibility to divide the controlled area in five different zones each managed according to one's own strategy.

#### □ Peripheral level

Formed by the traffic controllers and by the field components to them connected.

## GMAC SYSTEM

### System architecture



The GMAC system presents a HW/SW structure that allows the integration in future phases of the packages necessary for providing the Devoted Body with an essential tool for the control and management of traffic in the urban area.

The functions and activities that can be integrated are:

- Control and monitoring of the traffic signal plants.
- Management of the public and emergency means of transport.
- Management of VMS systems (Variable Message Sign).
- Guidance to parking.
- Environmental monitoring.
- Urban cartographical systems.

The system is based on a structure with redundant intelligence distributed between the following three levels:

- Higher Level, formed by the Control and Supervision Centre.
- Intermediate Level, formed by the Area Controllers.
- Lower Level, formed by the Traffic Controllers.

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