

# **ADVANCED MANAGEMENT SYSTEMS FOR WINTER OPERATIONS-**

## **S.I.S.M.A PROJECT**

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The modern winter road operations came into being in Italy in the 1960s on the Bologna – Florence motorway (appennins element of **Motorway of the sun**) in the sense that the most advanced systems for de-icing and preventing snow from laying were used right from the start.

In the same element of motorway, starting from 1999, winter operations motorway were handled in a new way. Side by side with the old specialists the latest management techniques were deployed aimed at overcoming the difficulties of snow clearing in conditions of ever more intense and heavier traffic and in places where the morphology of the route and the climate are among the most critical in our country.

The result for which we are working is a **perpetually “black”** road, which is without snow or ice in all climatic and traffic conditions.

Modern operations for winter operations were introduced onto the Bologna – Florence motorway in the 1960s. Right from their first introduction the most advanced de-icing systems and techniques for preventing snow from settling on the roadway were used.

The personnel making up the organisation has been specially trained and carefully distributed along the section and has been equipped with a formidable quantity of vehicles and means. Between Sasso Marconi and Prato there are 75 items of anti-snow and anti-ice equipment that operate on three sections from four fixed bases with their own supplies and depots, and each with its own management structure, all co-ordinated by a radio control centre in Florence.

Part of this organisation travels continually up and down the road section constantly ready to intervene on the basis of metrological forecasts and the data obtained from 10 automatic weather stations distributed along the route which provide data on the temperature of the pavement and the air as well as on other physical data used to predict the formation of ice and snowfalls. The rest of the organisation is available on call in case snow is forecast.

Large salt depots are situated along the route and containing two types of snow-melting liquids: sodium and calcium chloride used in three different compositions:

- simple sodium chloride (mined halite chosen in preference to marine salt for its purity and fineness for effective use in only small quantities) for temperatures of up to 6 – 8 degree below zero;
- calcium chloride in solution for spraying applications, the most effective against snow;
- viscous salt, a mixture of sodium chloride and calcium chloride brine used on draining pavement and bridges as it and its de-icing action, effective up to 10-15° below zero, remains far longer than the other two.

All the salt-spreaders are equipped to handle solid, normal or viscous salt while special spraying equipment distributes liquid salt.

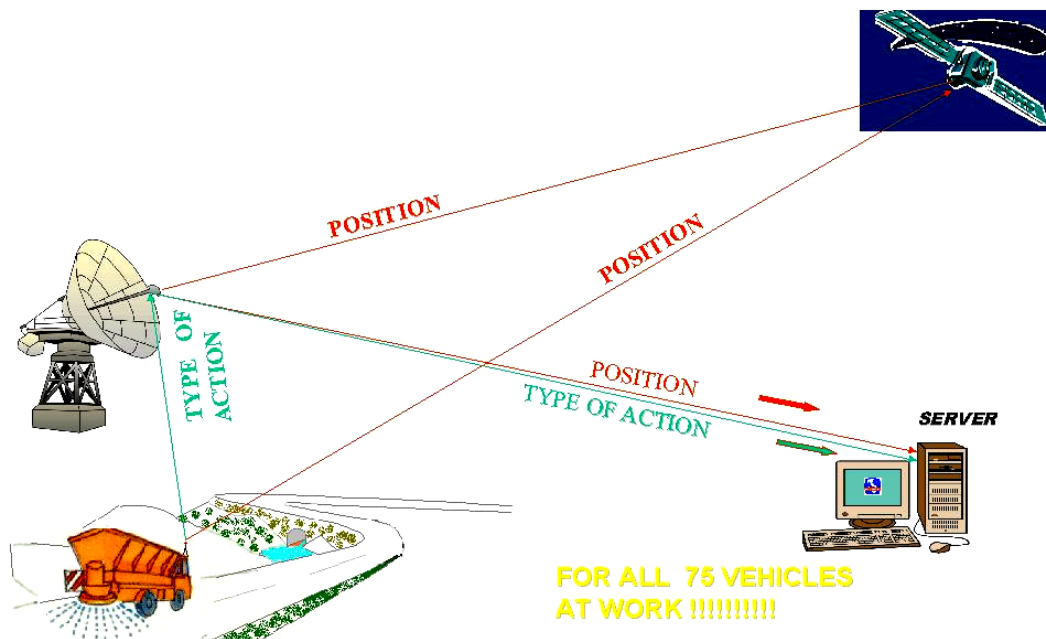
**This is the traditional situation. What has been added starting from the 1999-2000 season?**

The main problem of the Bologna- Florence motorway **is the need for immediate intervention** as heavy goods traffic makes up more than 50% of all traffic with the result that if a single goods vehicle skids on snow and blocks the carriageway, all the traffic is immediately blocked, including the snow clearing vehicles.

Naturally after the first timely operation designed to prevent the snow from settling there must follow a non quantifiable number of other operations until the phenomenon no longer obtains, and between these operations it is necessary to deal with all the micro-problems that can arise which could otherwise develop into macro-problems with the consequent blockage of traffic.

It is very important to know the **location, in real time**, of all the vehicles and **what they are doing**: i.e. the operations being carried out.

As from 1 November 1999<sup>1</sup>, this has been made possible through a new centralised control system (at varying levels of the sub-sections and section) to determine the location and operating mode of each vehicle engaged on ice removing and snow-clearing operations called **S.I.S.M.A. Satellite localization of snow-ice removig vehicles.**



The vehicles are equipped with GPS, global positioning system, devices that allow them to determine the geographical co-ordinates of their position through the satellites within reach of their sensors. The data is relayed through a GSM non-voice telephone that every minute issues a series of SMS coded messages regarding the vehicle's position as also its operating conditions as inferred from on-board sensors but differentiated according to the type of vehicle in question (salt-spreader, sprayer, snow plough<sup>2</sup>). If the vehicle is in a tunnel or cannot communicate with a sufficient number of satellites, a measure of the space travelled by the odometer of the vehicle will still enable the system to locate it, whose processor will discharge all non-despatched messages as soon as the vehicle returns to ordinary transmission mode.

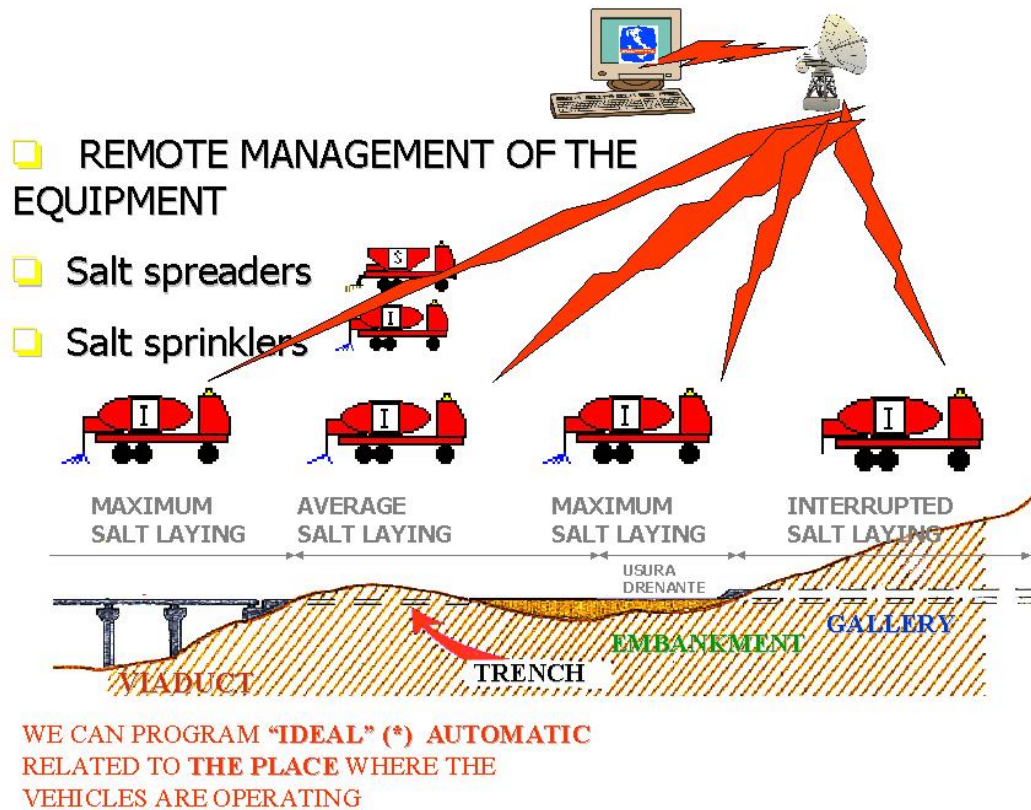
The set of data is handled by **Routinform 99** software prepared by the company Giletta of Saluzzo(Italy).

<sup>1</sup> the SISMA system run very well and has been extended for other 200 km of Autostrade network (alpine motorway Udine Tarvisio and all part of A1 in Tuscan zone) .In the 2002 winter, will be extended in Ligurian Appennins motorways (over Genoa). See final table.

<sup>2</sup> Other vehicles are also linked up to the system, if it is useful to know their position, for example the mobile crane for vehicle emergencies.

The main outputs of the software are illustrated in the following figure that describes the system in question in the form of video images as they appear to the co-coordinator of the section, and of the sub-section or to whoever else is linked up to the optical – fibre network of Autostrade SpA.

The system can also manage vehicle performance by varying its operations according to the stretch on which it is operating, and especially as regards the appropriate dosage of salt for the morphology of the road. This is obtained by a **self-learning programme implemented over the route**, ahead of



(\*) For some salt spreaders / sprinklers

full-scale winter operations, for each of vehicles in order to distribute the correct quantities on viaducts, fast-icing shadowed areas, areas with drainage pavements and similar (dosages, type of salt (dry or humid) according to a predetermined programme<sup>3</sup>.

Such variations are much more frequent than might be thought. For example on a sub-section of the Bologna-Florence, no less than 90 variations on an 18-kilometre stretch were found. Such a quantity could not be handled manually, even in non-emergency conditions.

**Automatic dosage** is thus particularly effective on these sections, even in normal conditions, in order to prevent the icing of sections while it also ensures that least possible amount of salt will be used; which will not only benefit the environment but also enable stores to last longer, which is especially important when winter operations are prolonged over time (only a few grams of salt per square metre at the right point and at the right moment are necessary).

The coordinator of the operations can in this manner have a minute-by minute update of the location of all the vehicles involved and of their operations as well as being able to give instructions to each one singularly by radio.

<sup>3</sup> Obviously this is possible if the salt spreader has commands designed to vary the memorized dosages, otherwise it is only possible to know what the equipment is doing in simple terms: spreading salt or not, if it has a blade or not, and so on.

The system will naturally also **store the intervention times and all the operations performed**, along with the relative climatic conditions monitored by on-board sensors (at present, generally the temperatures of the road surfaces) and in so doing it provides a highly reliable management tool for verifying efficiency, providing data to the press, accountancy requirements and any legal controversies.

A **survey of the actual state of the road** represents the next stage in the development of the system (which will also be carried out with vehicles in movement equipped with GPS/GSM devices) along with the development of additional sensors for road surface temperature and possibly also other parameters related to weather forecasts such as the temperature and the relative humidity of the air. In practice, with every passage of the vehicle-mounted instrumentation it will be possible to have a continually updated **map of the state of the road surface** and the surrounding environment in order to improve the precision of the decisions on the intervention and for possible communications to the motorway customers (**Autostrade Infomobility**).

The next step will be the use of the internet to host conversations with motorists equipped with the appropriate mobile telephones to whom information can be given in real time, while they are in transit, on the conditions of the pavements: temperature, or rather the possibility of icing, treatment with salt, its effectiveness, etc.

The system, therefore, will not only provide information for management purposes but also real time information for users for the routes actually being negotiated and on all other points of interest.

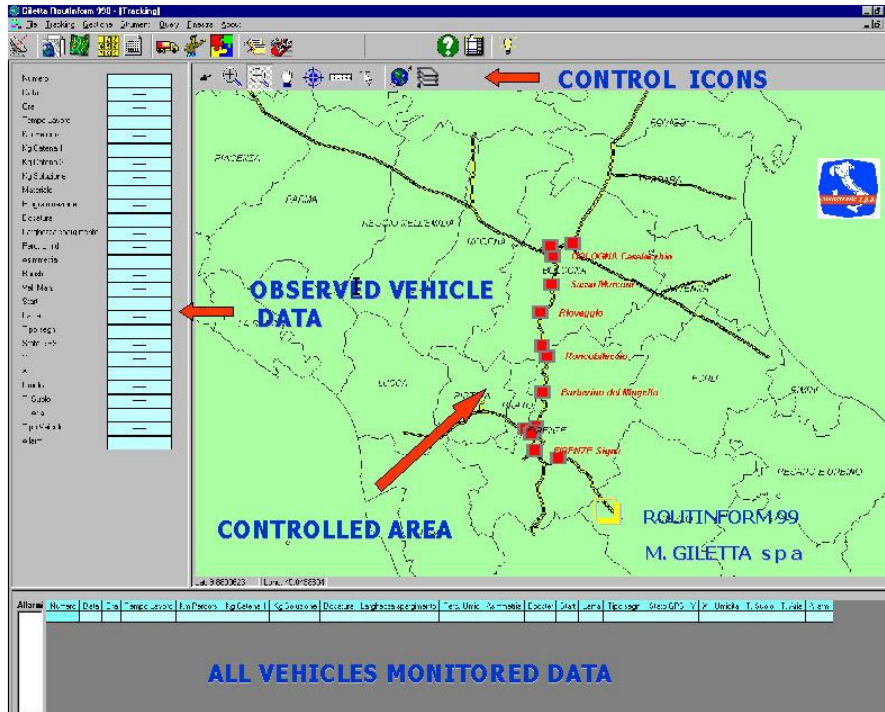
As there is not enough space for us to enter into the details of the system's operation it will suffice for us to remember that:

- the system does not need sophisticated location recalculation systems that will only increase the costs of the GSM without improving the results. The precision of a few dozens of metres is more than sufficient (as its use has shown) for the functions required
- the information, more or less complete according to the type of means available are in all cases sufficient not only to know where a vehicle is but also what it is doing, and in some cases, the materials that it may need
- every item of information is immediately available and is stored with a full set of background particulars necessary for control management and the handling of litigation
- the system can be updated in the future on the base of the experience acquired in its use or for particular needs of different sites; that is, it may be enhanced in order to make forecasts on the state of road, before, during and after snowfalls by equipping the means with suitable sensors
- the functioning of the base systems (GPS and GSM) has been verified on the Apennines between Florence and Bologna with about 75 vehicles and other means of transmission, such as radio – for whose the system has also been designed – can be used.

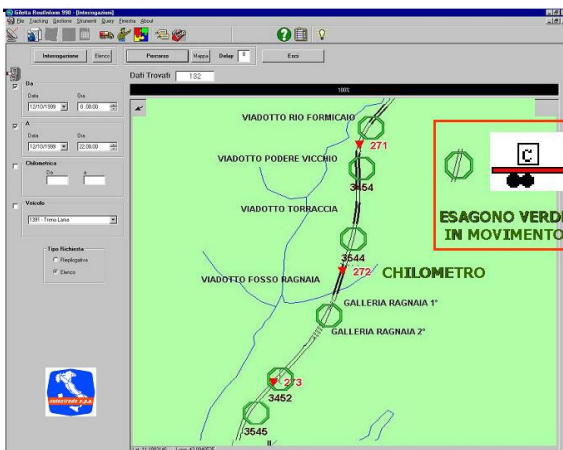
The system is closely connected to the control of salt-spreading, salt-sprinklers and snow-plough use (in the case that they are equipped with microprocessor-controlled electronic regulatory mechanisms). The important know how is not just that which manages and monitors the movements but also the software used in the machines to control the equipment (how to salt, in what quantities and with what salt and in what type of place). It is, therefore, necessary to link the surveying systems and data transmission systems to the command systems of these vehicles. The other types of information are, instead, related to the simplest ON/OFF states of the other parts or of the other vehicles (for example, raising or lowering the blade, moving or stopping, level of fuel, level of salt, etc.)

As the ordinary snow-clearing fleet is made up of numerous types of equipment, the system foresees that they are equipped with a minimum of sensors so as to provide for an informed and harmonious management of the motorway section.

It is, therefore, possible to fit out critical sections of the network as self-standing islands by transforming the sensors, the surveying units as well as the management software, depending upon the set of equipment already available on these sections, rather than by uniforming all the equipment which would be enormously anti-economic.



The company Giletta of Saluzzo that developed the SISMA management software according to the indications of Autostrade SRC/AMZ and using the pre-existing digital maps<sup>4</sup>, in addition to equipment which comprised devices of its own production also looked after the devices produced by other manufacturers (Epoke, Danish; Weisser, German, etc.) in order that all the equipment can be managed in the most homogeneous manner possible.



The plan that must be implemented in order to bring the management of the critical sections up to the required operating level involves equipping all the vehicles before the onset of the winter season and entails a critical revision of all the management criteria for the operations (some of which may be obsolete or no longer pertinent for the traffic conditions).

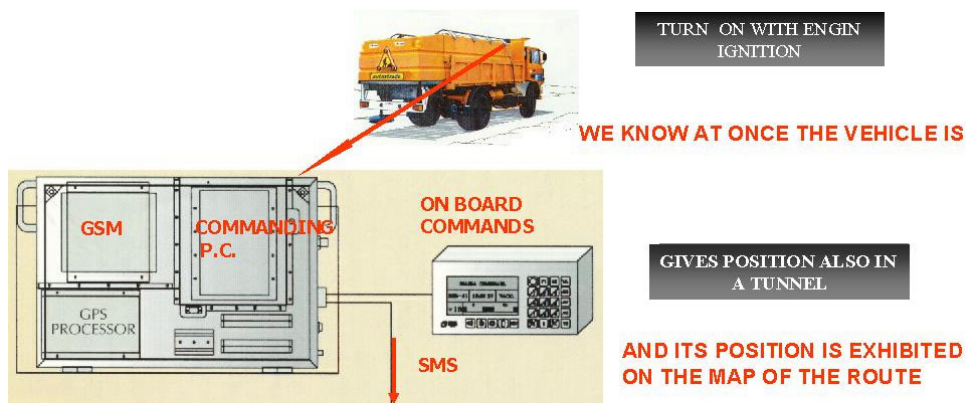
<sup>4</sup> In the absence of digital maps it is still possible to make a preliminary survey of the route on a “once only basis” thus obtaining a simplified alignment but nonetheless effective for the organisational purposes of snow operations.



These changes must be made without offending the susceptibility of the personnel by adducing the (founded) reason of the need to implement the new SISMA system.

For this purpose corrective actions for behaviour held to be no longer appropriate for the results required must be included in the training for the use of the system by consulting the managers responsible for the single sections and/or the entire route in order to reach a commonly agreed upon operational procedure, which will then be that used for the season of experimental application.

## ☐ GPS POSITION OF VEHICLES



THE POSITION IS LOCATED WITH AT LEAST TWO SATELLITES.  
THE CORRECTION OF THE POSITION IS MADE OF A FEW METRES,  
SUFFICIENT FOR PURPOSE OF THE SYSTEM.

It must be clear that the SISMA methodology cannot by itself resolve all the problems, especially in the parts most congested by heavy traffic as the solution is the result of the interaction between a better monitoring of the actions in progress and the work of whoever operates the means controlled by the SISMA system.

Today, march 2001, the SISMA system is used on the following devices

Devices	A-1 Nord	A-1 Sud	A-23	TOTALE
Salt spreaders	n.28	n.19	n.13	<b>n. 60</b>
Snow clearing	n.26	n.17	n. 21	<b>n. 64</b>
Salt sprinklers	n. 7	n. 4	n. 6	<b>n. 17</b>
Unimog	n.5	n. 2	--	<b>n. 7</b>
Rescue cars ACI	n. 5	n. 2	--	<b>n. 7</b>
Vans for Viability	n. 2	--	--	<b>n. 2</b>
			<b>TOTAL</b>	<b>157</b>

Rome 7/11/2001