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Traffic and accidents monitoring system on ANAS National Road Network

Pier Paolo Cartolano

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What is ANAS S.p.A.

National Ordinary Roads and Highways

25.369 Km

of which 1310 km of Highways

Total Investments

2,1 billion €

Financial Statements 2014

Established in 1928, ANAS is now a joint-stock Company 100% owned by Ministry of Economy, and plays the role of primary Road Manager in charge of the Italian Road and Highway Network, with an extension of 25.000 km.

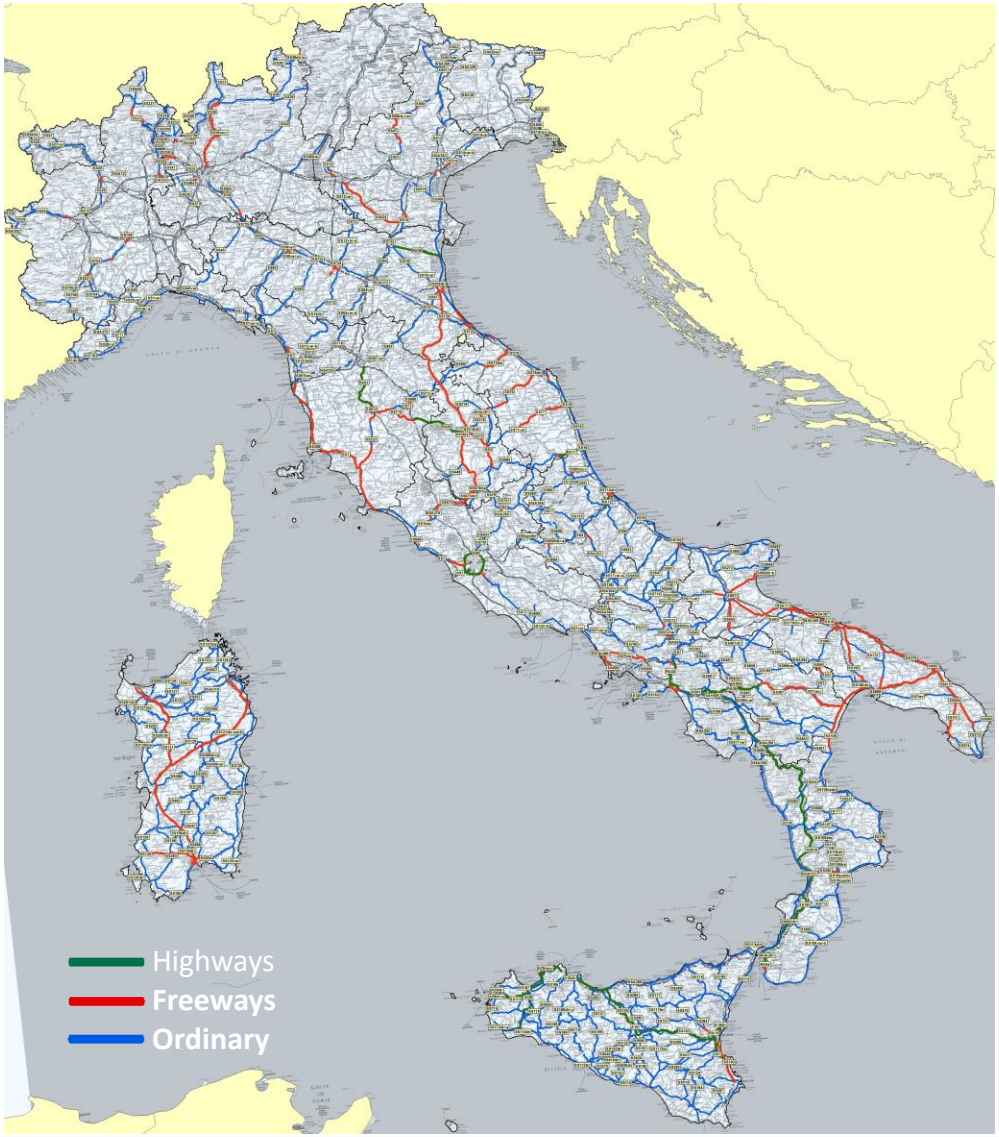
Thanks to the considerable experience accumulated in more than 80 years of operation and to the knowledge of its staff, Anas has expanded its range of services, being able to play a supporting role to government agencies and offer itself as a catalyst in Italy and abroad in the services design, construction and road maintenance.

The functions attributed to Anas are management , maintenance, gradual improvement of roads and highways, and the design and construction of new roads and highways.

Activities related to the realization of those functions are the contribution to define a multi-year planning process and to quality requirements in compliance with regulations.

In order to develop such activities, the knowledge of the traffic amount and its features in addition to circulation and safety levels on ANAS roads, is nowadays absolutely essential.

ANAS S.p.A. Road Network



It is a complex network composed by no-toll highways, freeways and ordinary roads, in both rural and urban contests, widespread on the Italian territory.

The project presented has been primarily realized to fill the gap in data collection for Annual Road Vehicular Census, a procedure whose scope was the estimation of the Annual Average Daily Traffic (AADT) on ANAS Roads.

Before the implementation of the Automatic System taking place, traffic data were acquired one day per month through human view classification and manual counters, covering 800 Observation Sites (roadside small prefabricated booth) every five years and 400 ones average each year.

At the time of the project, taking into consideration these premises and the statistical purpose of the project itself, a statistical estimation of sample size of road monitoring section was launched,

Due to the extension of the whole heterogeneous ANAS road network, characterized by ordinary, highways and freeways without any toll system, widespread on the Italian territory, both in rural and urban contests, the result highlighted a minimum of 1.500 sites.

The big amount of estimated sites suggested the adoption of a “step-by step” approach.

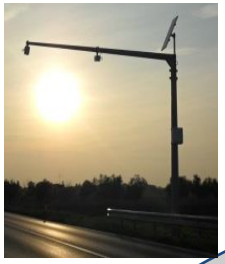
Counting Vehicles: from census by sample to continuous measuring

800 Observation Sites
use of manual counters

2010

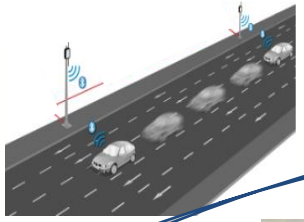
2012

About 1.000
Automatic Counting
Traffic Sections
(ACTS)

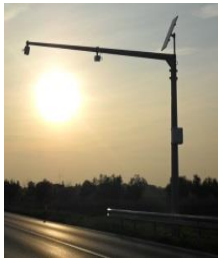


2013

Over 250 Bluetooth Tracer



2014



Other 250 ACTS
1.250 average in
total

17 Section with
Wheight In Motion & Dangerous Goods Systems

2015

2016

Over 60 Vergilius System
Average Speed Control

ANAS
VERGILIUS

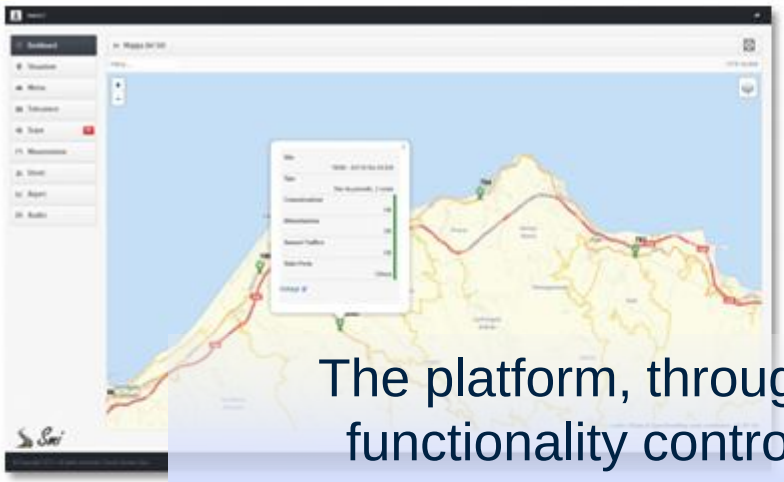
The activities to realize the automatic system started in the third quarter of 2010 with *ad hoc* surveys on the whole Italian Territory. At the end of 2011 all required 1.000 installations were completed and the system was fully implemented, and starting from 2012 data collection activities started.

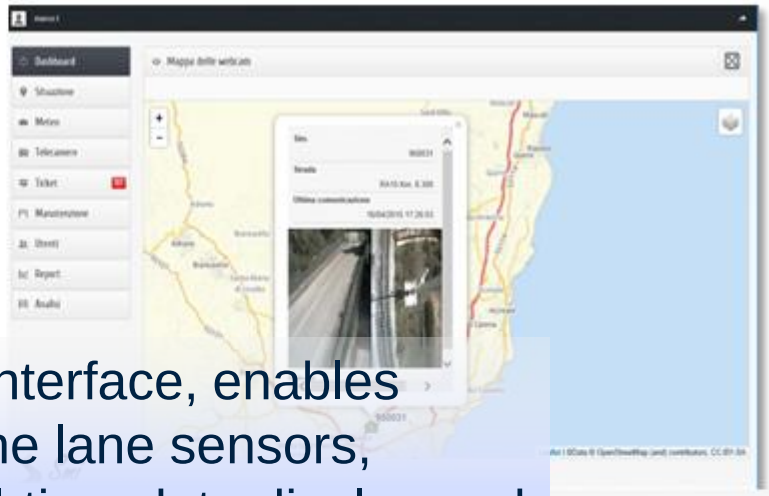
A second phase of development in Italian Southern Regions, recently EU-Founded through the PON Network and Mobility 2007/2013 approved by European Communities C (2007) 6318 of 07/12/2007 introduced other useful tools for traffic control and management.

This Development phase involved the construction of over 250 new ACTS equipped with traffic sensors and Bluetooth MAC address detectors, of which average 20 stations dynamic weighing of vehicles and detecting vehicle transporting dangerous goods.

In 2015 the definition and development of a data interchange node between different platforms has been also completed. Datex II has been selected as standard data model and now exchanging traffic information between disparate systems is possible, like those generated from Vergilius System (Anas average speed control system).

ANAS Platform for Monitoring and Analysis





The platform, through an interface, enables functionality controls of the lane sensors, maintenance management, real-time data display and download of preset reports of archived data.

Through the actual Monitoring System Interface, the operators are able to visualize the master data of each site, access an archive of useful diagnostic information to detect faults and malfunctions and view a photo archive.

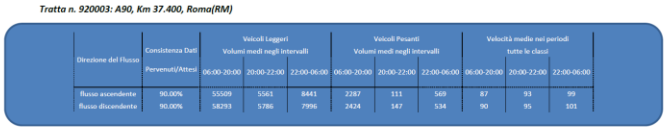
The overall functionality of the system, updated in real time, is represented on the map by icons indicating the operational status of the station. For each station, diagnostic information are presented using interactive charts.

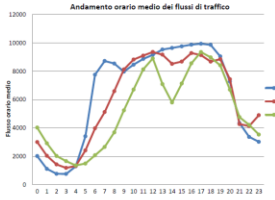
State of electric and communication signal power supplied, sensor's operability and traffic detected are immediately accessible.

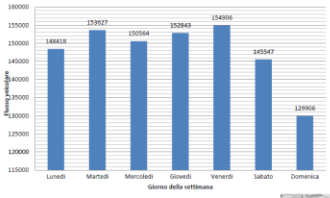
The communication interfaces make the data collected and processed through the system accessible through more than one analysis application.

System user interface allows predefined reporting. Periodic Reports on traffic volumes provides to ANAS employees statistical picture of the traffic for each measurement station, through indication of weekday average volume of vehicles and speed, differentiated by vehicle type and time slots, average daily trend of traffic flow, distribution of Level of Services.

Measuring and analysing hazard of roads







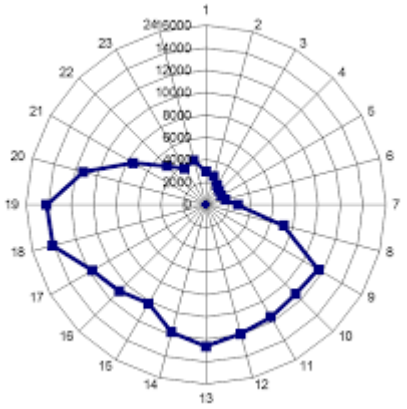
Giorno di punta del periodo: *venerdì 4 marzo 2016*
Volume giornaliero di punta: *164749 [veicoli/giorno]*

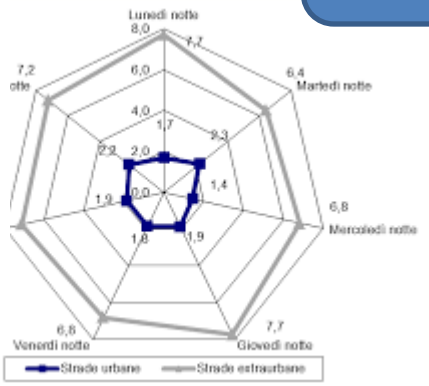
Ora di punta:*domenica 13 marzo 2016 ore 17:00-18:00*
Flusso dell'ora di punta: *10630 [veicoli/ora]*

Giornate con rilevamenti completi: *85*

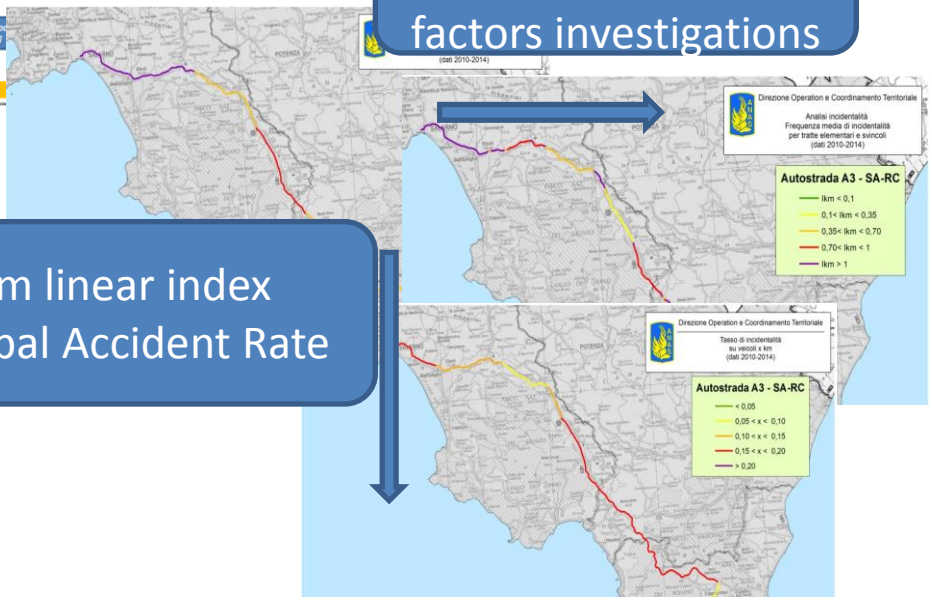
Anas S.p.A. – società a socio unico | Direzione Operation e Coordinamento Territoriale

Variabili indipendenti	Totale (n.)					
Totale	1144					
Sesso						
maschio	792					
femmina	352					
Punti decurtati						
no	702					
si	442					
Possesso di patente						
patente minima	925					
altra patente	219					
Tipo di veicolo						
quattro ruote	938					
due ruote	206					
Età						
<30	428					
30-64	643	51,8	48,2	0,69	1,06	(0,79-1,42)
≥ 65	73	57,5	42,5	0,74	0,91	(0,52-1,58)
Esperienza di guida in anni (media ± DS)	9,6±9,8	9,3±9,5	10±10,10	0,44	1,01	(0,99-1,02)





From link analysis to road and risk factors investigations



From linear index to Global Accident Rate

The information collected through traffic sensors are integrated with official road accidents data acquired from the national institutional bodies appointed to gather information on road accidents with people involved (ISTAT and ACI).

To increase safety levels, the System acts linking traffic database to accident database allowing for example to characterize the road accident phenomenon through an appropriate process that provides a better picture of the risk associated with each road.

An example is the Global Accident Rate (GAR) on road segments, which quantifies the number of wounded and fatalities in relation to the number of vehicle transits, the hazard index that provides a measure of the intrinsic danger of the road.

Road accidents database is filled with descriptive attributes such as date and time, nature of the incident, the number of dead/injured people and the type of vehicles involved in the accident.

On the basis of the data stored or processed by the system, the issue of security through more detailed analysis aimed at identifying those elements that can represent the typical prevailing risk factors (behavioural, technical/structural, environmental) can also be investigated.

One software interface allows to perform statistical analysis of traffic and accidents data, aimed at identifying the most critical sections of road trough the estimate levels of service, the traffic conditions definition, the analysis of accidents through indices and indicators that varies from a time-spacing standpoint.

In addition to that, analysis for critical periods cataloguing (eg. hours of the day or time of year), critical weather or driver conditions and due to system Environment-User-Vehicle or to technical/structural aspects can be carried out.

Overtaking the AADT “pure” statistics

Being aware of punctual measuring limits in real time applications, the system evaluates every 5 minutes some simple indicators, giving a contribution to traffic management :

• the trend of traffic flows (versus previous 12 intervals before);

• the level of traffic volume (versus average volume of previous weekly days).

Designed to capture information and to perform statistical and historical analysis, since the beginning of its operability, it has been set up in order to communicate with a “real time” frequency of 5 minutes.

ANAS has made lots of progress, overtaking the AADT “pure” statistic, making a first step towards Sharing Accessible Information and starting acquiring “real time” measures.

On some itineraries, basically highways and freeways, a significant result in operative traffic management has been reached through real time information.

Being aware of punctual measuring limits in real time applications, the system evaluates indicators like growth/decrease trend and the level of traffic flows.

This information sent to the Operative Regional Control Centers gave a new contribution in operative traffic management.

In addition to that, the instantaneous comparison among the previous day traffic volumes and other data set up as reference parameter, gives the advantage of early evaluation of traffic demand during holiday peak periods.

An anonymous “free on board unit”

Using Bluetooth’s MAC address detector and encrypting every unique ID, data recorded become definitely anonymous.

With this technology a sort of OBU is now available, although depending on frequency and location of Automatic Counting Traffic Sections (ACTS) among itineraries.

the implementation of Bluetooth's MAC address detector systems gives a new perspective in managing real time information.

The development phase implemented Bluetooth's MAC address detector on the over 250 new ACTS, without any additional charge in the offer to tender notice.

That's the reason why the location of stations equipped with this technology are not always compliant with the general criteria applied in ITS projects using bluetooth tracer.

The widespread usage of smartphones, with 50% of mobile market already acquired and the prevision to reach 50 million devices in 2015, in conjunction with systems for hands-free calling via Bluetooth in vehicles, offered as a standard pack by most automakers worldwide, implies that Bluetooth wireless technology is one of the free On Board Unit (OBU) that ANAS can use.

the improved offer to tender notice allowed ANAS to have a first exploration in the field.

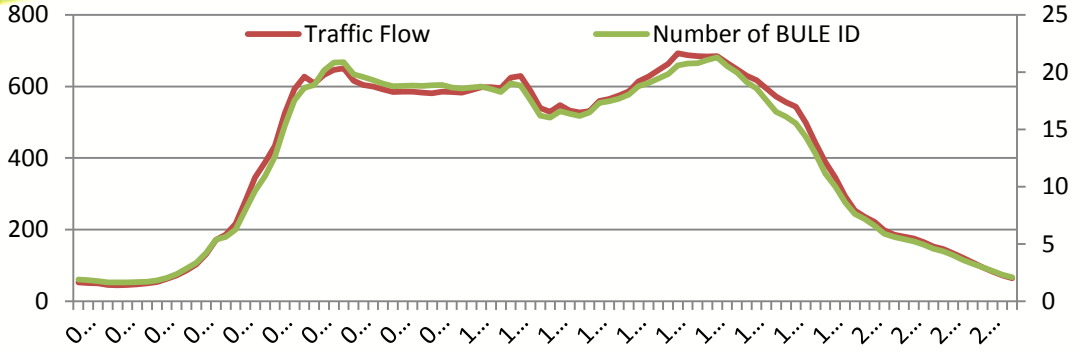
The system is now able also to detect and encode uniquely Bluetooth devices accessing the area covered by the system on board of vehicles passing through.

By encrypting every ID unique Bluetooth (corresponding to the Serial Number String, System device ID or MAC address), the record data become definitively anonymous, in compliance with Privacy Law.

This parameter, in conjunction with the location of registration and time instant relief, flows into a specific central database.

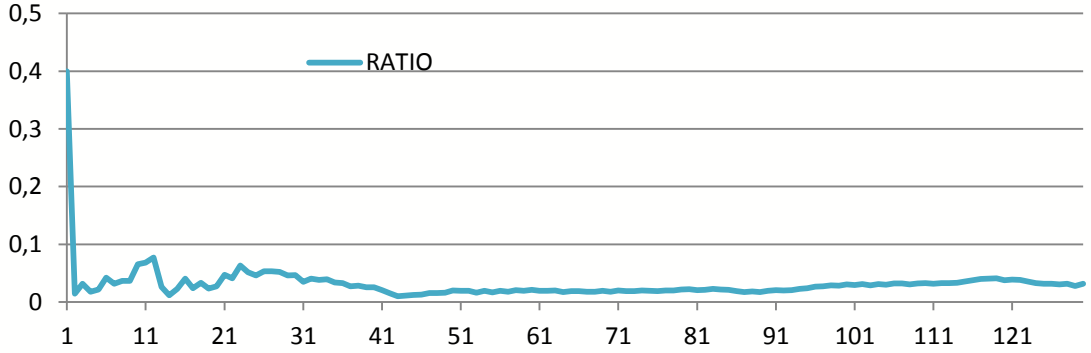
Using data stored some analysis were conducted to better understand the usefulness of this kind of technology,
highlighting any limits and assessing the representativeness of such data in the representation of vehicular road traffic.

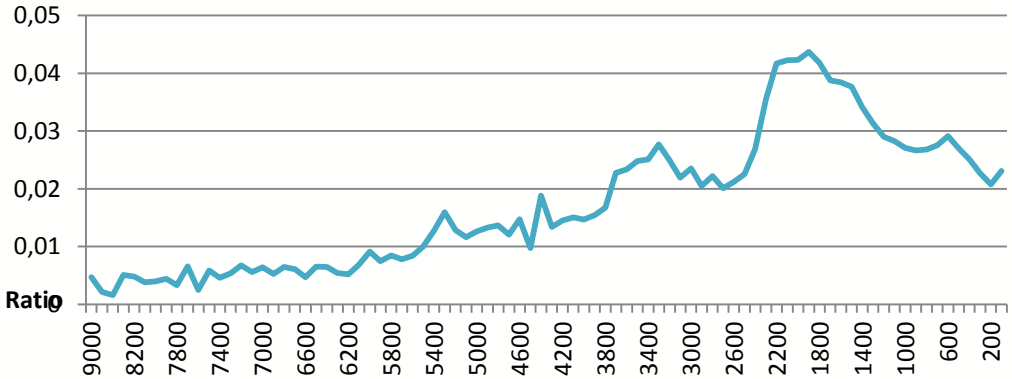
Representativeness of the sample



Similar average trend over time for the whole sample of 250 ACTS

Ratio Blue/traffic as a function of speed: no dependency highlighted





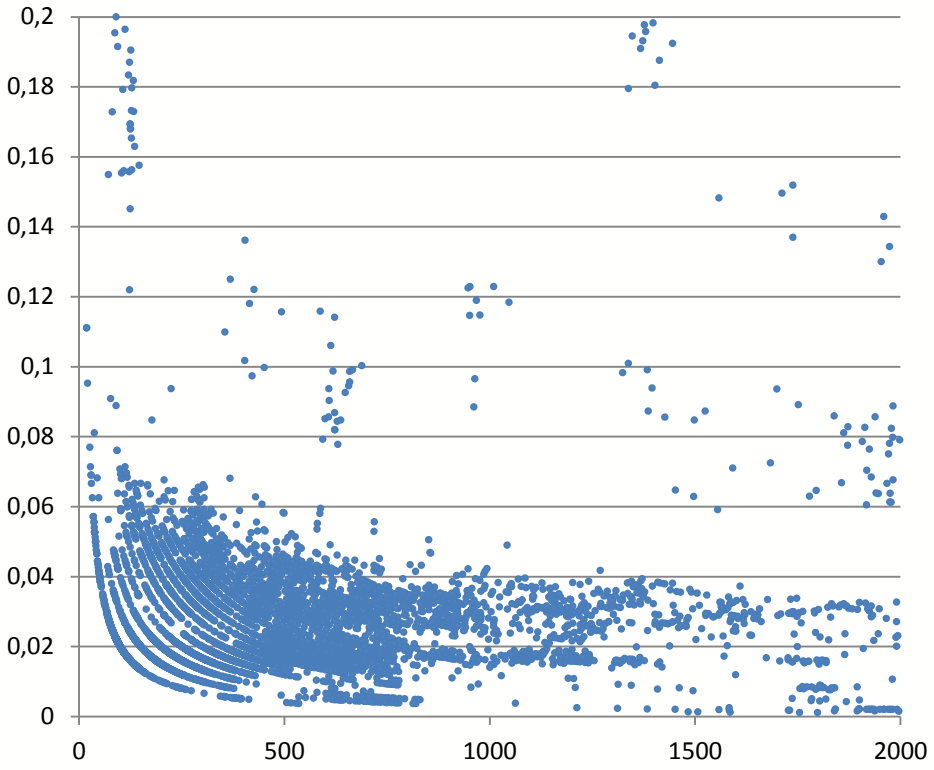
Ratio Blue/traffic as a function of traffic flow: in lower traffic volume higher ratio values

Table and graph showing the relationship between contacts of Bluetooth devices and data traffic underline the similarity of trends over time.
Data of graph were grouped by traffic values (rounded to hundred) and in each group the average number of bluetooth contacts was calculated.
The ratio between average number of Bluetooth ID and the average traffic flow assume low values for the whole of 250 Automatic Counting Traffic Section (approximately 3% percent).
This happens because a large number of stations provided with bluetooth has been located where traffic data were needed and not where bluetooth tracer was useful.
As a consequence, We have a number of sections on rural roads of southern region like Sicily and Calabria, where few or any vehicles have such devices on board.

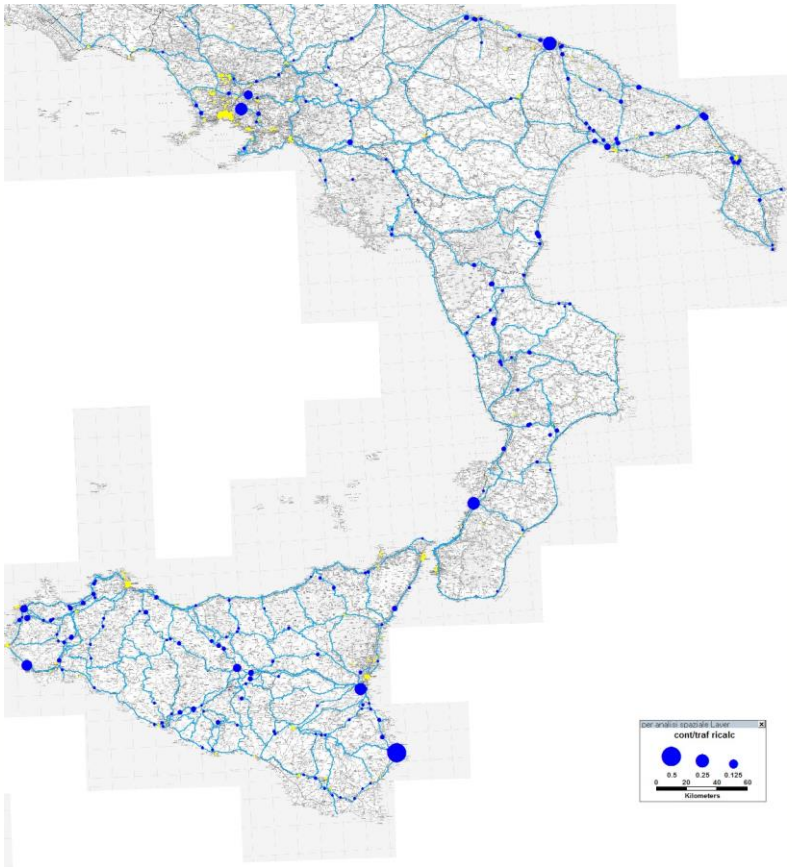
Once established that the trend of contacts is similar to the trend of traffic flow, we have investigated if there were other variables from which the ratio blue / traffic depended on.
As about speed impact analysis, the data were significant only above 40 km/h, due handful local station that recorded a lower value of that average speed.
Within the significant range of average measured speed, no functional dependence of the ratio from vehicles speed was found.
Differently, a variability of the ratio varying the amount of transit vehicles has been highlighted. .
As you can see at the lower traffic volume a higher ratio value has been calculated.

Traffic and geographical dependence

The function of Ratio with traffic flow and the geographical cluster of higher Ratio values shown in a scatter plot diagram



Average Ratio increase on the route near big cities.



Distributing the value pairs in a scatter plot of the ratio relation with the traffic flow level measured appeared even more evident.

Groups of close values were more thoroughly investigated, and were found to belong to specific local control units.

the mean values of each group have been then located, and, as shown in the right figure, the higher ratio are measured at major urban centers with values of ratio near 25%.

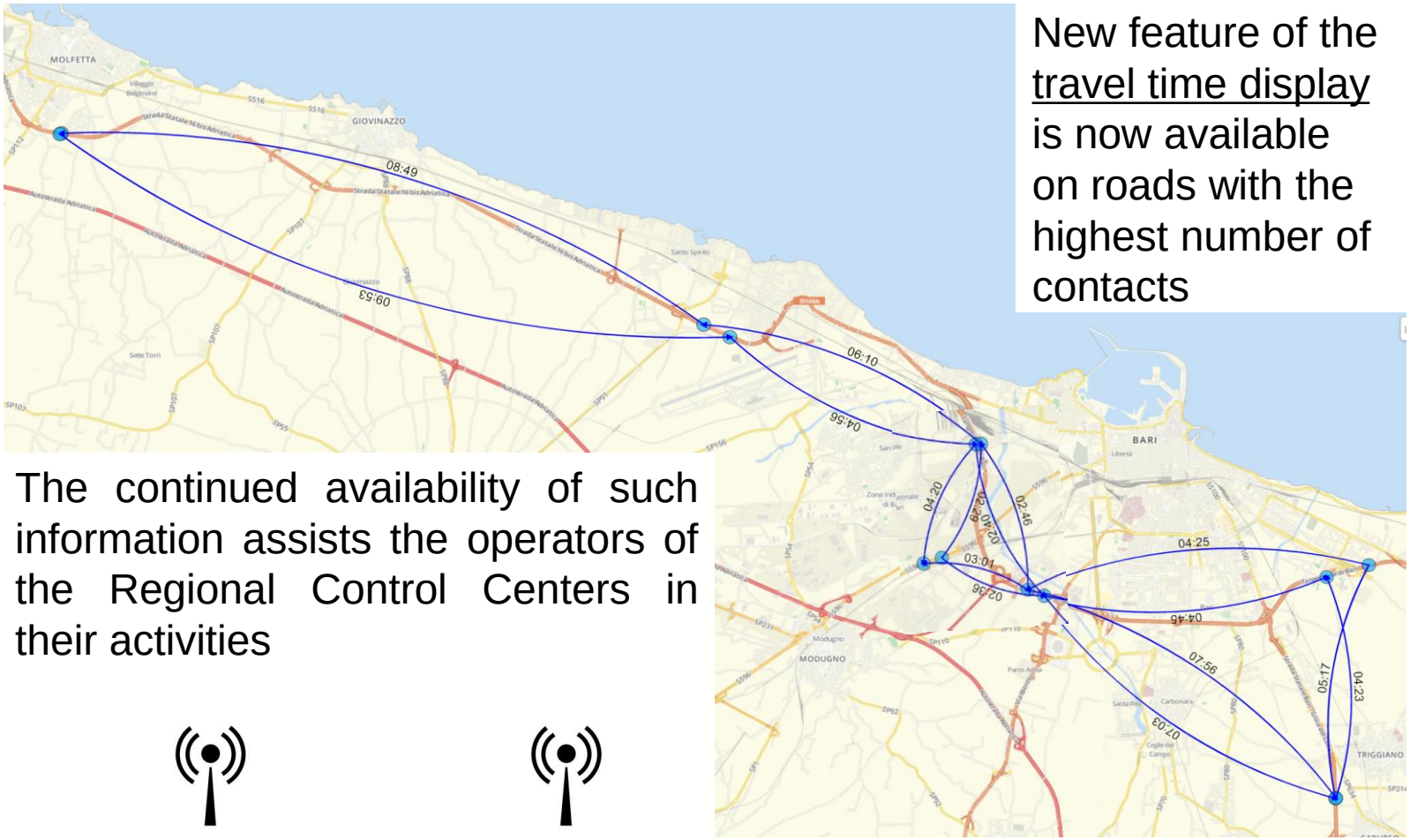
A little bit lower values of ratio has been measured along the highways and freeways connectin big cities .

Little values on the rest of the investigated road network .

Encouraged by the results obtained, some applications have been implemented on local units subsets considered significant in terms of representativeness of the sample and useful in infomobility application.

On the basis of April blue data the 80% of sites recorded less than 1 contact per minute, 10% between 1 and 2 contacts per minute, 5% between 2 and 5 and 5% more than 5 contacts per minute.

First info-mobility applications



New feature of the travel time display is now available on roads with the highest number of contacts

The continued availability of such information assists the operators of the Regional Control Centers in their activities

We have identified two areas where to carry out some useful info-mobility applications, where the number of contacts per minute were significant and meaningful:

one near the city of Bari (where ANAS manages the Main road network near the city)

one near city of Rome specifically on the Roma-Fiumicino Highway (connecting Rome with Fiumicino airport).

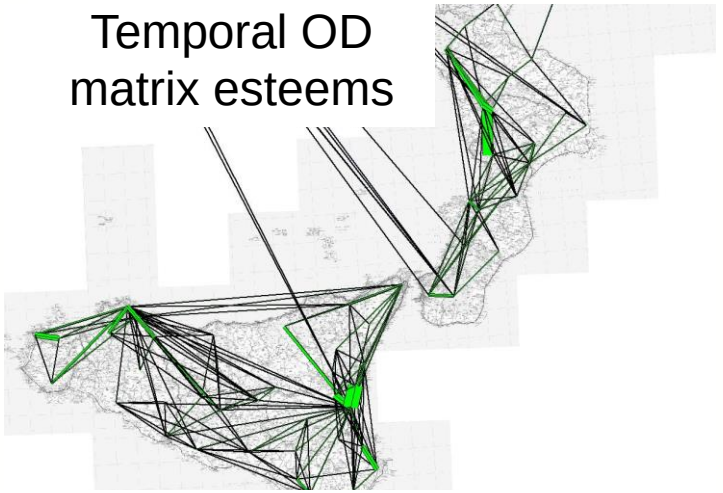
Through the Monitoring System Interface, travel times between couples of traffic sections are now shortly calculated and visualized.

Travel time is now calculated as the average of the most plausible values of the 15 minutes interval travel times set.
Most plausible values of travel time are those between 1.5 and 0.5 the value of mode.

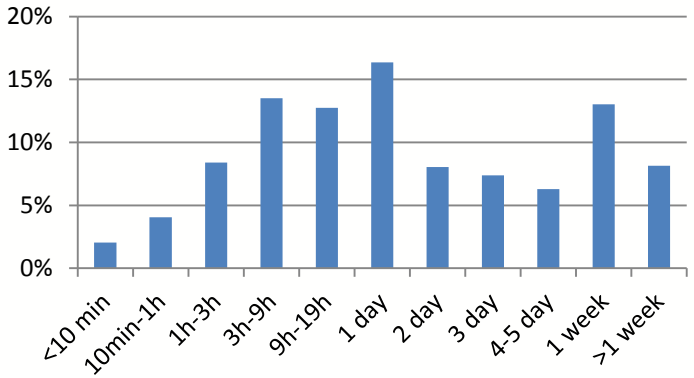
Generation of Automatic alarm has not been implemented yet, due to the absence of an organic ITS project, but the continuous availability of information assists our operators of the Regional Control Centers to manage road operations.

Increasing knowledge of our customers and road performances

Temporal OD matrix esteems



Frequency distribution of round trip



Speed/flow measured relationship

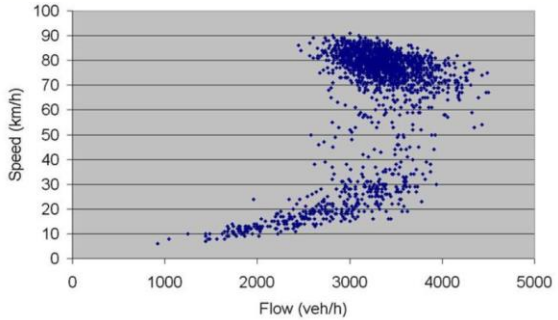
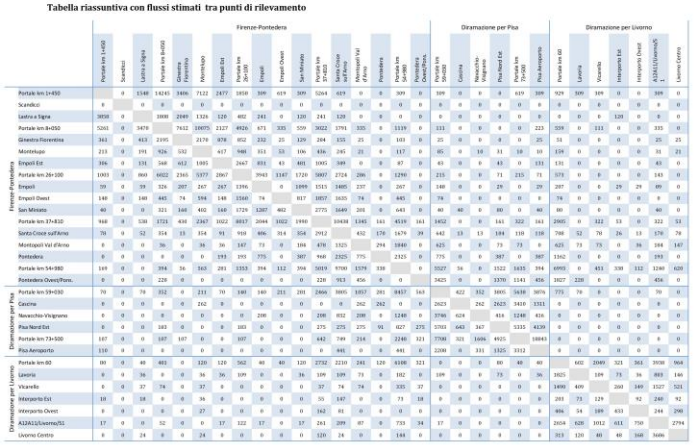


Tabella riassuntiva con flussi stimati tra punti di rilevamento



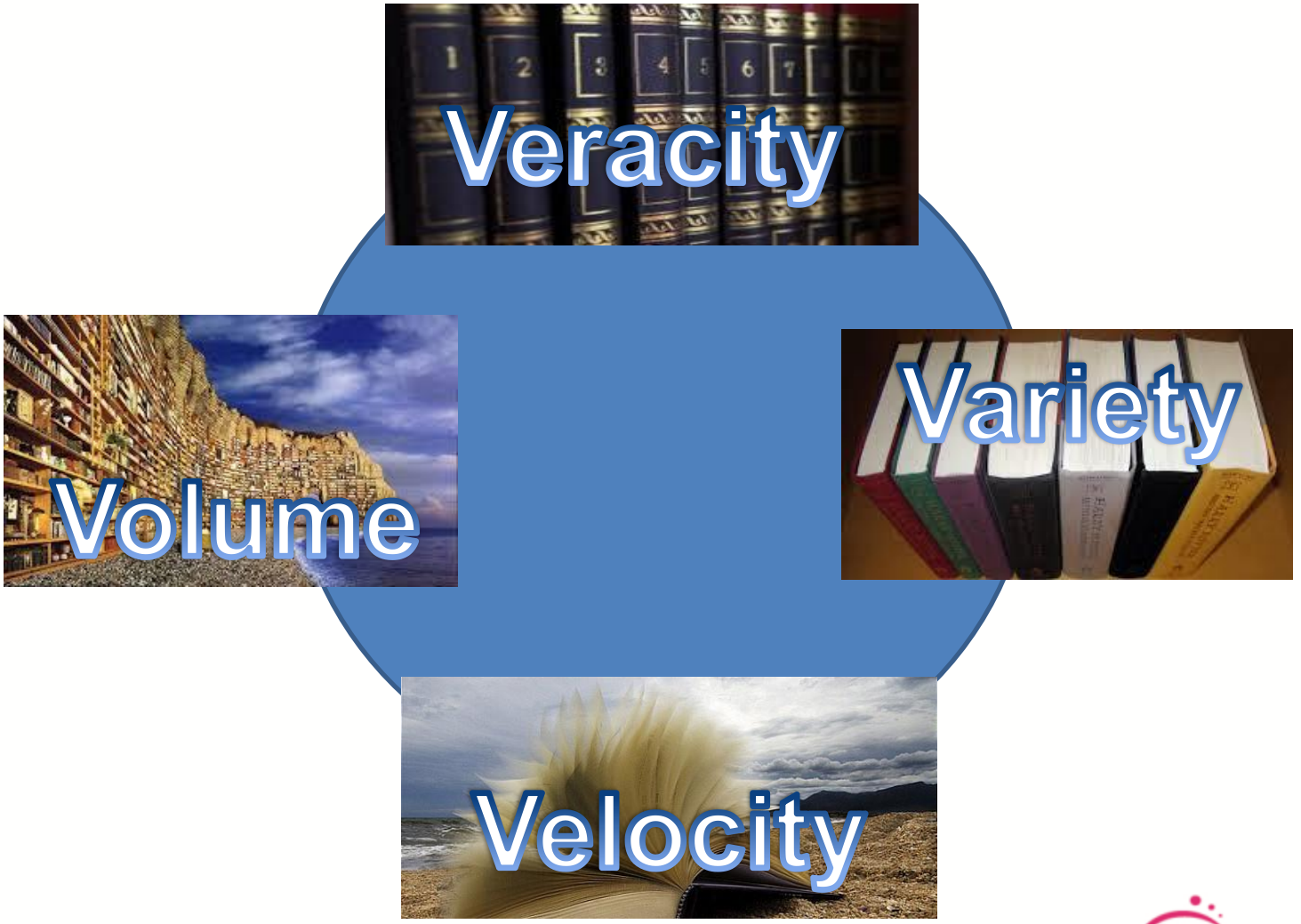
Their spread on a heterogeneous road network like ANAS' one, gives, in addition to the information in scope, an overall picture of the support provided by this technology.

By archiving traffic data, an additional important value has been introduced in the Company, changing the acquired real-time information from "disposable" to "storable".

This has led to a sort of re-use to better describe road functional characteristics (speed/flow relationship on the basis of measured traffic data and average measured travel times) and measured Level of Service for statistical purpose.

The availability of future information (like average measured travel times or speed calculation on road section, flow curves calibration and, finally yet importantly, demand analysis based on temporal OD matrix measure) is nowadays limited to those parts of highways with more than one ACTS with this kind of technology.

Conclusion



Disposing of internal information on average travel times, captured by Bluetooth's MAC address installed on ACTS and without any need for devices to be connected, may offer a supplementary source of information for improving "Variability" reducing the inconsistency shown sometimes by data, and the "Veracity" in generating information.

Assuming the principle that accuracy in big data may lead to more confident decision making and better decisions can mean greater operational efficiency, cost reductions and reduced risk, sharing a consistent dataset with those that pursue this goal is over welcome.