

ROAD NETWORK OPERATIONS HANDBOOK

Chapter 2 Road Network Operations

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2.1 DEFINITION

Road network operations can be defined as all traffic management and user support activities intended to permit, improve, or facilitate the use of an existing network, whatever its conditions of use.

Road network operations concerns all activities directly related to the concept of service to the user of a road network (person, freight transporters, and public transport operator) and to service improvement.

It therefore differs from:

- *improvement* of the infrastructure, which consists in equipping it and adjusting its geometric and physical characteristics;
- *maintenance* of the infrastructure, designed to ensure the preservation, quality of use and renewal of road assets;
- *traffic policing powers* that concern general or local rules of road use, whether permanent or temporary.

Road network operations require defined levels of service and associated quality indicators to quantify user satisfaction and the efficiency of the whole road system when considered part of a global transport system. Road network operations require continuous consultation between all the partners concerned: police, call-out services, network operators, etc. In addition, operation-related concerns must be taken into account from the design and development stage of the infrastructure.

2.2 THE BIG SHIFT

2.2.1 DEFINITION

Until recently road administrations main goal was building and maintaining a road network. Of late, there has been a transition from this traditional approach to an operation function that includes a policy oriented towards the user. This transition has been termed here “the Big Shift”, consistent with the work of expert working groups on the matter¹.

“The Big Shift” may have different concrete meanings according to the context where the detailed description is undertaken. In practice however, in all the possible approaches, two developments or shifts are relevant for road network operations. These shifts can be described as the shift from road construction to road network optimisation and the shift from road network optimisation to road network user support. Together these shifts can be referred to as a big shift, because they both refer to the change of emphasis from road construction to road network operations, which is a much wider spectrum.

- From road construction to road network optimisation

This is the shift from building roads as such to the optimisation of the use of existing roads or road networks.

This optimisation can generally be realised by better traffic management, reaching from re-active traffic influencing at point level (like traffic regulation at crossroads) to pro-active traffic influencing at network level (like traffic regulation to better guide economic relevant traffic streams to vital economic centres during rush hours).

Major organisational changes are needed in order to make this shift; thus, much emphasis is placed on the description of those changes and the change process to implement the changes.

- From road network optimisation to road network user support

This is the shift from road network optimisation (i.e. traffic management) to the support of road network users (i.e. support for traffic participation or traveller information).

In this shift, a clear distinction is made between two views: the Outside-in view and the Inside-out view. In the Outside-in view, emphasis is on the services needed by road users. In the Inside-out view, emphasis is on the operations needed to deliver the services. From his point of view, a road user “participates in traffic”, while a traffic manager, from his point of view, is involved in “traffic management”. Good traffic management may lead to a better optimisation of the road network, from the point of view of the traffic manager. However, this does not yet imply that traffic management is primarily directed at road user support. This again is another shift in approach.

2.2.2 POLICY ASPECTS

The policy aspects of “the Big Shift” can be described through a three level approach¹:

Strategy: this is the level where policy objectives are translated into road network performance requirements in qualitative terms of traffic flow, traffic safety, convenience, etc. The strategy will be derived in “missions” as defined later.

Tactics: this is the level where network performance requirements are translated into network “functions” with a certain quality. Furthermore, “services” are defined on this level, which indicate the network functionality to be performed at a certain quality level.

Operation: at this level we are confronted with organisational requirements, procedures and protocols and with the implementation of tools and strategies in order to meet the user needs.

The relationship between the three levels is illustrated in Figure 2.1.

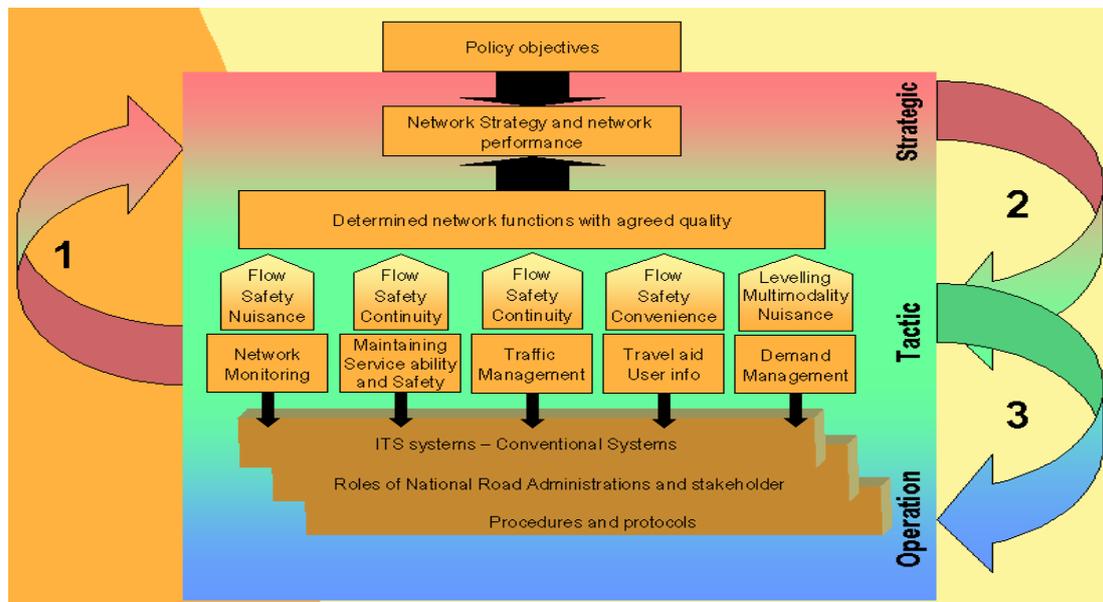


Figure 2.1 The Big Shift

ITS are present in each level although more specifically in the tactical and operational levels. Although they are not the only tools available to realise the transition to the “Big Shift” their development in recent years and their important potential give them a major role within new road network operations policy and more conventional services such as signing, emergency operations, etc.

- Strategic Level

In the global transport framework, the National Road Authorities have, in general unambiguous policy goals concerning traffic safety, traffic flow, economic prosperity, and sustainability. However, these goals are not explicitly translated into road network performance requirements. Formulating recommendations on how to do this is the first challenge of the strategic level.

Current practice demonstrates that measures, including ITS tools, are implemented as a reaction to identified local traffic problems (re-active policy). It is rare that measures are the result of a clear strategic network vision or formulated performance requirements for the road network. Hence, measures are not always focused on facilitating transport network functions as a whole or even road network functions (pro-active policy). This is a further challenge of the strategic level.

- **Tactical Level**

On the tactical level operation services were often implemented to solve local problems and were isolated from a more global framework. In this way they were often considered as additional tasks, complementing major services such as building or maintaining the network.

It is now common that ITS are implemented to solve local traffic problems. For example, lane signalling or variable message signs (VMS) are in most cases installed to prevent local congestion. It is desirable to aim for the situation where ITS facilitate defined functions in the road network which are necessary to meet the defined road network performance requirements.

The challenge of the tactical level (functions and services) is to take these constraints into account and to integrate them as a whole when following the recommendations of the strategic level.

- **Operational Level**

On the operational level the present practice is one of systems and equipment orientation. Whatever the latter may be it is also considered as an appendix to the road network operation without a real recognition of the added value its good implementation and working can bring to the global function “service to the user”. In the same way it is common practice to develop and implement new ITS along the roadside. In the past two decades the number of ITS used by road network authorities has increased dramatically. New systems are still being developed and installed.

However, it can be illustrated that neither ITS nor conventional systems and equipment are always operated and maintained properly and effectively. In these cases the organisations which operate the systems and tools are not always well tuned to their strategic tasks.

Technical solutions can be presented through services. This notion indicates that services are made up of systems installed in organisations trained to operate the systems effectively. These organisations are driven by policy objectives. To meet policy objectives the attitude and behaviour of the road user is often critical. Therefore ITS should be customer oriented: oriented towards the road user. Hence, a service orientation is desirable rather than a systems orientation, which is currently common. The same occurs with more conventional tasks such as the organisation of roadwork, the design of the signing, the emergency call-out, etc.

In many case procedures and protocols have to be reviewed and mirrored against this context of service to the user. This is the major challenge of the operational level.

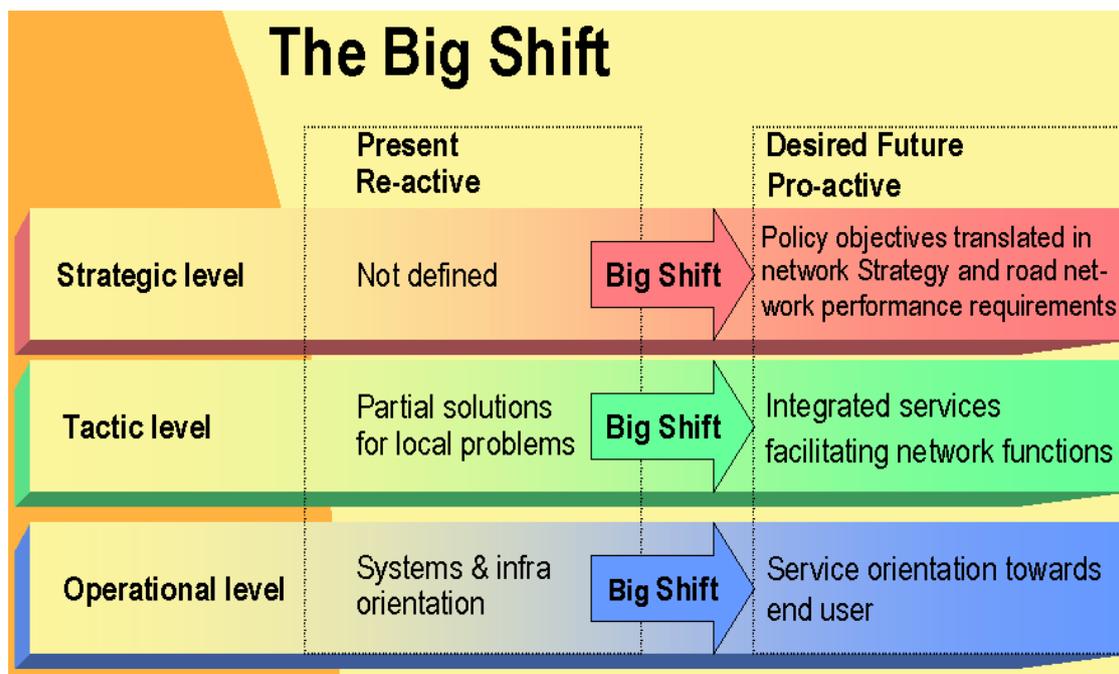


Figure 2.2 The Big Shift Levels

2.2.3 GLOBAL TRANSPORT USER SUPPORT

Besides what has been described as “the Big Shift” there is another shift to consider, the shift from road network user support to transport user support.

This is the shift in which road network services delivered to road users are seen as part of the transport services delivered to transport users in a broader sense.

This shift is relevant for road network operations and may increasingly become so in the future. However, this handbook will focus on road network operations and not the broader area of transport operations. The shift to the global transport user support is covered in more detail in Annex A: “Transport user support”.

2.3 ROAD NETWORK USER SUPPORT

The emphasis given to the user in the whole road network operation system becomes so important that it is essential to clearly specify the two views related to the shift from road network optimisation to road network user support as they were already distinguished in § 2.2.1 : the Outside-in and the Inside-out views.

2.3.1 TWO VIEWS

In the Outside-in view, the starting point is the user. His needs lead to the identification of services that he might want to receive. The user in this case is the road user. The basic need of the road user is to use the road for moving people or goods.

The Inside-out view is focused on the suppliers and the operations that are needed to deliver the services. To deliver services something must be done (processes) and something must be there (provisions). Road network operations consist of the processes and provisions that are needed to deliver the service "road user support". Suppliers are the road network operators that carry out the operations to deliver the services.

The users and their needs are in the demand domain. The suppliers and the operations are in the supply domain. Services are positioned between those domains. That is why dealing with services to support users is different from dealing with operations.

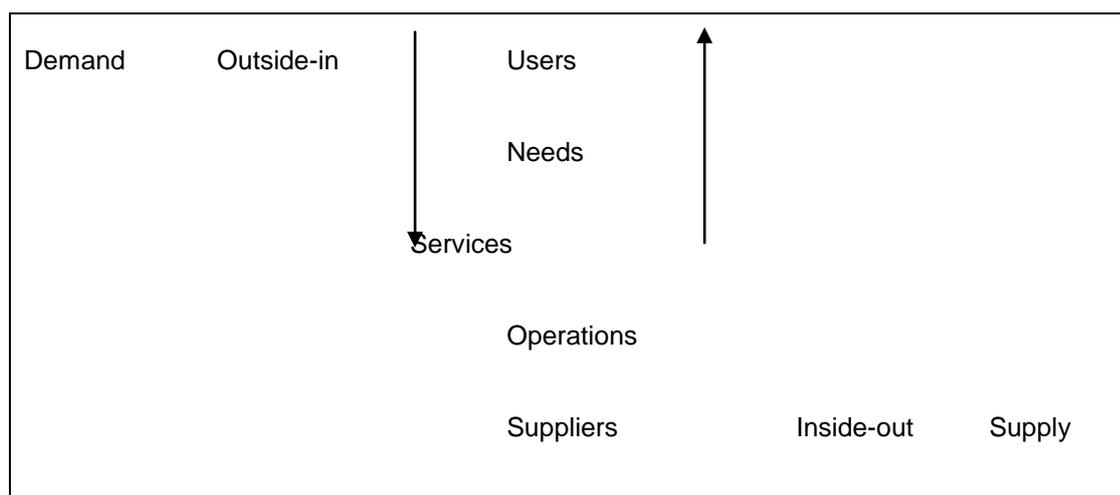


Figure 2.3 Road Network User Support

2.3.2 THE SERVICE CONCEPT

In general, user services can be expressed as support for something the user wants to do, in this case use the road for moving people or goods. In the model of the two views, services that are directly delivered to the user are the "front-office" services. These are tangible and are directly perceivable by the user. The "back-office" services (related to technical systems, control centres, etc) are part of the Inside-out view.

Users, operations, and suppliers are concrete entities. Needs and services are more abstract by nature. This makes dealing with operations different from dealing with services. Quality of operations generally can be measured directly by the supplier himself. Measuring the quality of services is dependent on the way users perceive and appreciate the services. For several reasons this perception and appreciation is not stable.

- i. Perception and appreciation are subjective: People may differ in the way they perceive and appreciate the same service. This also may change over time.
- ii. Perception and appreciation are inter-subjective: People influence each other in the perception and the appreciation of services. Having travelled in a different environment, like a different country, may also lead to a different perception and appreciation of services back home that have not changed in the meantime.
- iii. Familiarity: One gets easily used to comfort over time. Discomfort however tends to remain annoying.

Understanding the perspective of the road user is of utmost importance. This starts with formulating desired services in his terms (e.g. “support for traffic participation” rather than “traffic management”). It then becomes essential to realise that delivering these services and the measurement of the quality of the services is not an easy task as it is dependent on users’ perception and appreciation, which by nature is not very stable.

2.4 ROAD NETWORK OPERATION FIELDS AND CORRESPONDING MISSIONS

Five main fields can be identified:

- Network monitoring;
- Maintaining road serviceability and safety;
- Traffic control;
- Travel aid and user information; and
- Demand management.

Each field has aspects that are important to the quest for a better level of service to be provided for the user, but none of them holds any real precedence over the others. Moreover, each of them are related to the shifts as they are described in § 2.2. The first three (Network monitoring, Maintaining road serviceability and safety and Traffic control) refer more to road network optimisation although “Maintaining road viability and safety” is also related to the shift to road user support as travel aid and user information mainly. The “Demand management” operation field creates some links with the third shift to transport user support.

2.4.1 NETWORK MONITORING

Network monitoring covers all measures, resources, and procedures that enable the operator to observe and find out the condition of the network and its use as quickly and completely as possible.

Network monitoring mainly covers supervision of traffic conditions and supervision of external events (weather or other natural events) likely to affect its use.

i. Supervision of traffic conditions

The first aim is to predict or detect failure or disturbances as quickly as possible, in order to take the necessary steps to remedy the situation in due time. Its quality is characterised by a detection delay (interval between the time the incident occurs and the time the management service is warned of this incident) and the reliability of the information collected.

The second is to collect traffic characteristics in greater or lesser detail (such as flow, occupancy rate, speed, percentage of lorries) in order to monitor or anticipate trends. The required qualities are reliability and completeness of the collection systems (loops, video, etc).

This requires systems for the collection, processing and centralisation of counts and information, organised relations with the safety and emergency call-out services or the assistance services, automatic or non-automatic warning systems (emergency call network, automatic incident detection), and the organisation of regular patrols on the most sensitive roads.

ii. Supervision of natural events

The aim here is to detect or predict any abnormal natural situation (weather or other) likely to affect the level of service of the network, in particular its safety of use. The actors concerned cover both detection as such and the integration of measurements into the prediction models.

The detection systems can simply enable information to be given to the operator concerning the onset (or probability of onset) of difficult weather conditions (fog, black ice, snowfalls, cyclones, etc) or other unfavourable natural events (landslides, floods, etc), together with the resulting advice on road use.

2.4.2 MAINTAINING ROAD SERVICEABILITY AND SAFETY

Maintaining road serviceability covers, in the event of a disturbance, all field operations designed to maintain or restore conditions of road use that are as close as possible to the normal situation.

The main tasks concerned with road serviceability are as follows:

i. Emergency response operations

These operations include not only breakdown services, clearance operations and emergency call-out, but also warning information for users.

In case of an incident, the first aim is to ensure or facilitate quick action by the appropriate emergency services (police, fire brigade, medical services, etc) or more simply the breakdown services. Then the relevant area must be protected and the motorists coming upstream must be warned as quickly as possible. This will require, where applicable, the traffic incident to be isolated by guidance markings, and the traffic flow to be restored after clearing the obstacles (such as an overturned lorry, fallen rocks, etc) and cleaning up the road.

These operations involve a response time: interval between the time the management service learns of an incident and the time the response actually begins or the relevant users are informed.

These operations further require standby of operational teams that can be mobilised within a time period conditional upon the level of service sought by the operator.

ii. Winter service

This concerns both preventive actions and remedial actions (preventive salt spreading, snow clearing, etc) connected with the onset of black ice, snowfalls and other winter conditions. It also requires means of informing motorists and providing advice and assistance, before or during the handling of the event.

iii. Organisation of planned action

This mainly involves organising worksites for the maintenance of equipment, the control of convoys and the monitoring of events.

The aim is to limit inconvenience to users by choosing the least constraining periods and techniques and through information given prior to this anticipated inconvenience.

These tasks require planning (prior study, checking, harmonisation) of operations, which may require teamwork by several operators (such as contractors, road administrations, public operators or concession companies) and the implementation of appropriate guidance marking or alternative routing.

2.4.3 TRAFFIC CONTROL

Traffic control covers all measures, in respect to predetermined objectives, aimed at distributing and controlling traffic flows in time and space, in order to avoid the onset of disturbances or to reduce their impacts. Traffic control is carried out in coordination with, and under the control of, the authorities in charge of traffic policing.

Traffic management tasks make use of any opportunities to spread traffic across time periods or any existence of alternative routes. They can be preventive or remedial.

i. Preventive action

This action aims to adjust travel demand. It can consist of measures to warn users of foreseeable traffic difficulties such as those due to holiday migration traffic, weather or natural conditions, or

planned events. Road users can then change their travel times, choose their route or abandon their trip. Among other tools, variable tolling is also a means of adjusting demand (cf. 3.7.2.).

This action requires:

- A capacity to *predict* traffic disturbances (whether random, foreseeable or recurrent);
- The study of advice or *alternative routes*, that can be used in the event of difficulties; and
- Dissemination of *preventive information* to the users.

ii. Remedial or corrective action

This action is designed to limit the extent or impact of disturbances that occur regularly on major roads, through measures to limit access and divert traffic onto less congested routes.

It requires:

- *Traffic management plans* to be drawn up in conjunction with the police authority and the operators who, for each of the foreseeable disturbances, define the action strategy and lay down in an *instruction book* the rules for initiating measures to be implemented by the services concerned,
- The use of a *permanent or ad hoc detection and monitoring system* on traffic flow conditions: data collection, centralisation and processing with a view to diagnosing the situation and how it may develop, and initiating traffic management measures,
- The implementation of *operational action teams* for guidance marking and closure of access in the absence of automatic systems, or when field monitoring is required;
- *Real-time road user information systems* on disturbances, instructions or recommended routes, and
- The activation of specific equipment for network information/management, such as information systems using variable message signs.

2.4.4 TRAVEL AID AND USER INFORMATION

Travel aid covers all measures to disseminate predictive or current information on traffic conditions and to improve general conditions of network use. Its general aim is safety and user comfort.

Travel aid tasks are not specifically aimed at modifying traffic flows. However, when used for information purposes, they must be closely coordinated with traffic management measures as they may induce users to change their travel time, route or mode of transport. In this context, they may be integrated in broader strategies related to demand management (cf. 3.7.1).

They are carried out on a predictive or real-time basis.

i. Predictive information

This information may be on a weekly, daily or even hourly basis and concerns general traffic condition forecasts and the main anticipated disturbances. Its implementation requires:

- Real-time *centralisation of information* on the network situation (traffic, weather) and on scheduled actions (roadwork, events);
- *Transmission of regular information bulletins* through national or local media (radios, newspapers, television), or specific road information facilities (kiosk, telephone enquiry service, Internet, etc).

ii. Real-time information

This information concerns traffic conditions and disturbances affecting motorists on a given route. It requires:

- A permanent system to *detect and monitor* traffic flow conditions;

- *Real-time information* systems by variable message signs installed along the route, by specialised radios or by telematics servers. It may be necessary to have specific in-vehicle equipment to receive some of the information.

It also includes information to operators of customised services or navigation and guidance systems.

iii. Miscellaneous equipment

This equipment, which is often conventional, is usually designed to improve the level of service to the user. It includes static (such as direction) signs, rest areas, and the installations and equipment designed to improve perception of user charges (such as tolls), disturbing traffic flows as little as possible and reducing the inconvenience to the user.

2.4.5 DEMAND MANAGEMENT

Demand management covers all the operation measures that aim to limit the consequences of a decreasing level of service on a route. This is carried out through actions related to the mobility policy such as improving traffic distribution through time or inciting users to modal transfer.

Operation tasks related to demand management are integrated in a global and multimodal mobility policy with the road being part of it. They are close to some traffic management actions which they mutually complete.

i. Modal transfer

The objective is to create the conditions for increased use of public transport, in order to limit the reduction in level of service of a roadway. This reduction could be due to a temporary capacity decrease (e.g. due to roadwork) or to a saturation phenomena on the road itself or within the served areas. Similar measures may also be taken for other reasons such as air-pollution, recurrent safety risk, etc.

One possible measure, is the real-time information to the user on public transport services and on the existence of multimodal transfer points (park-and-ride, railway stations, train frequencies, etc) through variable message signs or in-vehicle information devices (conventional broadcasting, RDS-TMC, route guidance systems). These actions complement the measures related to travel aid and more conventional information to the users (cf. 3.4).

ii. Actions on road pricing

The objective of this measure is to spread traffic throughout time in order to avoid saturation on a toll motorway, bridge or tunnel. It can also include a better management of the payment systems (conventional toll system or road-pricing system for an urban or motorway network).

Whatever the aims may be, operational constraints make it necessary to limit user discomfort when using the payment system. New electronic payment techniques for optimal management are possible tools to limit the discomfort and to improve road safety and efficiency.

2.5 OPERATING LEVELS AND NETWORK RANKING

The actual implementation of the various services designed to meet road user expectations cannot be organised in the same way for all road networks as the extent of disturbances and the traffic levels vary considerably, and as the functions determined for the networks are subject to ranking. Implementations will differ depending on the type of network, the numbers of users concerned, the frequency of the disturbances and their impacts on traffic flows.

To determine the most appropriate level of operation for a given network, various parameters must be analysed and quantified, such as:

- Road types (geometric characteristics, functions);
- Road capacity;
- Expected traffic levels;
- Type, frequency and extent of disturbances;
- Number of partners involved in network monitoring and response;
- Readily available investment and operations funds.

Based on this analysis, three operation levels can be defined:

- Level 1 corresponding to trunk networks in urban areas;
- Level 2 corresponding to major interurban motorway corridors;
- Level 3 corresponding to minor interurban roads to complete the foregoing routes and ensure interlinking at the national, regional or local level.

2.5.1 LEVEL 1: TRUNK NETWORKS IN URBAN AREAS

Urban areas require the development of integrated transport planning and the categorisation of roads depending on the relative importance of their functions pertaining to traffic and local life.

Two categories form the trunk network of the urban area. They are:

- Urban Expressways: e.g. motorways or roads comparable to motorways because they are perceived as such by users owing to their characteristics and conditions of use (separate right-of-way, divided carriageways, grade-separated junctions, no entry for some user categories). They ensure continuity of major national and regional routes in urban areas;
- Roads associated with these Expressways: which similarly ensure a long haul and interchange function beyond the urban area. The traffic function whilst retaining functional relationships with the environment, is dominant and has priority.

i. Specific problems

Trunk networks in urban areas are subject to commuter movements relating to trips between home and work, which give rise to traffic levels causing the road networks to operate at saturation limits. The slightest incident will result in road congestion, which may rapidly degenerate into gridlock of the route and even of a major part of the urban area. But this network is often interlinked and there may be capacity reserves on some other road sections at all times.

Another feature of these networks is the complexity of responsibilities: there are many participating route owners and operators. Continuous consultation is necessary between authorities in order to:

- Adopt a general traffic management strategy on urban expressways and the associated network;
- Co-ordinate this strategy with strategies for urban network management (signalised junctions) and public transport;
- Define possible rules to divert traffic from expressways onto an associated network in the event of excessive congestion due to exceptional events;

- Provide users with high-quality, reliable, relevant road information enabling optimum use of a network while offering the possibility of an inter-modal choice;
- Improve safety through enhanced supervision of the main roads and, in the event of disturbances, restore normal traffic conditions quickly;
- Limit inconvenience to traffic through planning improvements.

ii. Operational objective

The aim is to constantly optimise network use. The functions to be implemented are the permanent activation of traffic management plans drawn up by all the partners concerned. The network supervision system and information processing must be permanent and automated. This is the network on which the density of equipment for collecting and disseminating information will be the greatest.

2.5.2 LEVEL 2: MAJOR INTERURBAN MOTORWAY CORRIDORS

This network includes the motorway and associated network (parallel roads and alternative routes).

i. Specific problems

Over these highly-trafficked corridors, designed for national and international through traffic, flow breakdown is frequent with the onset of busy holiday periods. Their impacts are great as they concern a large number of users and can have upstream repercussions over long distances. In addition, disturbances on the main arterial roads can quickly extend to the parallel roads.

ii. Operational objective

During incidents, the aim is to maintain the best possible flow conditions through optimum use of the network. It is essential to coordinate action between the management services. The resulting traffic management plans must be studied and implemented jointly, with preventive measures that may be required far upstream of the disturbance. They will be activated during the disturbance.

The functions to be implemented are the same as those of level 1. However, the density of equipment will be lower and it will be positioned according to the operational objectives: automatic incident detection in hazardous areas or detection limited to the most sensitive days; user information by variable message signs upstream of points where an alternative route can be chosen; etc.

2.5.3 LEVEL 3: MINOR ROUTES INTERLINKING THE INTERURBAN NETWORK

i. Specific problems

This network consists of roads with moderate traffic levels. These roads are characterised by the fact that major disturbances are rare and their impacts are localised. The number of users involved is also limited.

ii. Operational objective

The main aim is to ensure good road serviceability as well as safe driving conditions over the entire network. For the management of random disturbances, it will generally be unnecessary to organise traffic management plans in advance, or to immediately restore normal traffic capacity on the road, but it is advisable to disseminate the best possible information on the existing inconvenience or its foreseeable onset.

The functions to be implemented consist of organising foreseeable road serviceability operations such as winter maintenance, roadwork planning, and the organisation of convoys, events to limit inconvenience to users and information to users before they set out or during their trip.