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**DELIVERING INTEGRATED TRANSPORT
MODES AND SERVICES TO CUSTOMERS**

**COMPREHENSIVE PROGRAM FOR THE MODERNIZATION OF
THE MEXICAN FEDERAL ROAD NETWORK**

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1. ABSTRACT

The road network is the backbone of Mexico's transport system, handling 67% percent of cargo and 99% of passengers. In addition to continuing to construct and maintain the road infrastructure, there are growing demands to operate the road network by providing the best possible levels of safety and service.

In order to meet these needs, the Ministry of Communications and Transport has proposed investments in the road sector that are unprecedented in Mexico's recent history, focusing on development of complete projects to maintain the national road network in an efficient, modern and comprehensive manner and modernization of road planning, execution, maintenance and management.

To achieve this, the Ministry is seeking to take advantage of existing technologies, tools and systems in order to develop projects that will enable it to provide users with homogeneous, integrated services for the entire road network and to optimize the management of this network as part of a wide-ranging modernization project for the basic federal road network.

This comprehensive vision is expressed in the "Comprehensive Program for the Modernization of the Federal Road Network," which aims to improve safety and the quality of service provided to users, to make the road management tools more efficient and to increase the added value of the network for the economic and social activities that are served by road transport.

The projects under development as part of the "Comprehensive Program for the Modernization of the Federal Road Network" are described in this document and include the planning and implementation of geographic information systems for road management; the planning and instrumentation of programs and methodologies for improving road safety; the design and instrumentation of multi-year contracts for the maintenance of the federal road network; the design and instrumentation of a program for the monitoring, instrumentation and supervision of road bridges; the updating and modernization of signaling; and the design and instrumentation of intelligent transport systems.

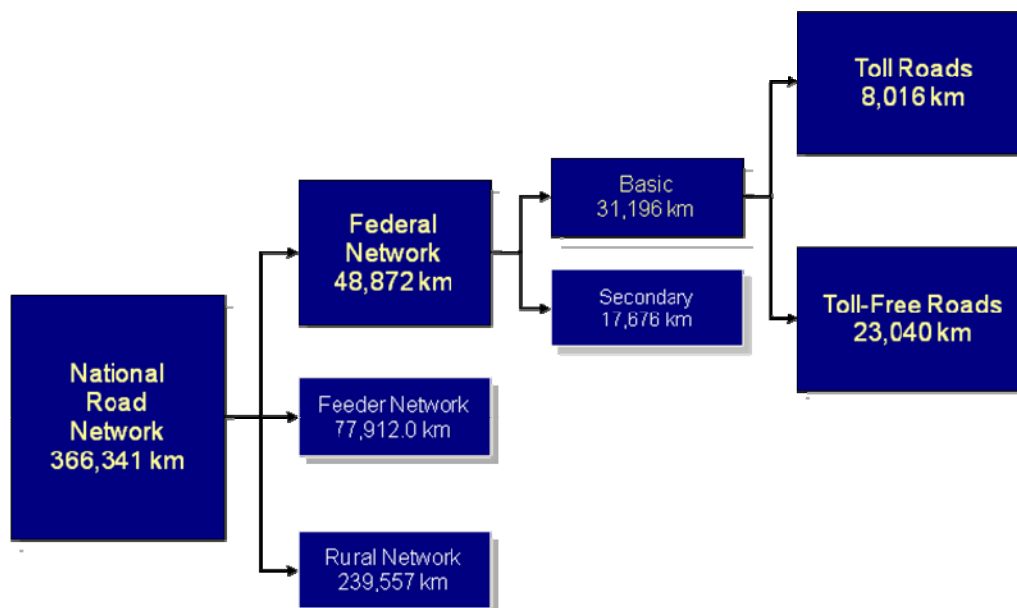
2. BACKGROUND

The road network is the backbone of the transport system in Mexico, since 67% percent of cargo and 99% of passengers in the country travel along it: it provides access to all regions of the country.

Mexico's federal road network is classified as shown in Figure 1.



Figure 2 – Classification of the Mexican Federal Road Network.



According to its jurisdiction, the national road network is classified as federal, state and municipal. In the case of the federal road network, the construction, maintenance and

operation is the responsibility of the Ministry of Communications and Transport or of private individuals contracted through public-private partnership schemes such as concessions, service provision projects or multi-year road maintenance contracts.

3. INTRODUCTION

In Mexico, for many years it has been recognized that the communications and transport infrastructure is a key element for national development. Throughout the various stages of history, the building of railroads, ports, roads and airports has been a constant example of Mexico's efforts to modernize and extend the benefits of communication to all of its inhabitants and to every region.

The present time is no exception, since efforts continue to generate and put into service new infrastructure of all types. With the ruling guide of the National Infrastructure Program 2007-2012, the development of new infrastructure in Mexico has been accelerated to overcome accumulated backlogs, extend network coverage, create opportunities and improve living standards. As a result, during the present federal administration (2007-2012), the investment in road infrastructure will be the highest in Mexico's modern history.

Today, however, infrastructure development faces more challenges than ever before, because in addition to satisfying the mobility demands of a population of almost 110 million inhabitants with rising levels of income per capita, there is also the need to maintain Mexico's existing infrastructure heritage, to modernize works that require more capacity or better quality, to operate increasingly complex infrastructures providing better services for users and making road travel safer and more comfortable.

In response to pressure from society, legislators and the media for government to improve the levels of road safety, quality of service and investment, the Ministry of Communications and Transport is implementing the "Comprehensive Program for the Modernization of the Federal Road Network" made up of various projects, so that Mexico's road users will receive a high-quality, integrated, homogeneous service.

3.1. The National Infrastructure Program 2007-2012 and the road sector.

The National Infrastructure Program 2007-2012 sets out the objectives, strategies, goals and actions for improving the coverage, quality and competitiveness of the infrastructure. This program seeks to stimulate the modernization of the national infrastructure in all sectors, and in the transport area includes actions in the road, railroad, airport and port subsectors.

In the road sector, the National Infrastructure Program 2007-2012 considers investments that are unprecedented in the recent history of Mexico. According to the Program, the

main objectives for roads include constructing and modernizing the federal road network to improve safety, making the management and operation of the road system more efficient and improving the quality of the services provided to road users.

The general objectives of the road Program are as follows:

- ❑ To put into service 100 projects for complete roads, including 20 bypasses and access roads, 20 new roads, 42 widened and modernized roads, 15 interstate roads and 3 border bridges.
- ❑ To maintain the national road network in an efficient, modern and comprehensive manner to improve service quality and safety while lowering operating costs for users.
- ❑ To expand the network of rural roads and feeder roads and ensure their maintenance.
- ❑ To improve the institutional capacity of the Ministry of Communications and Transport and make road planning, execution and management more efficient.

In order to improve user service quality and safety and lower operating costs on the federal road network, the Ministry is developing various actions to answer users' needs.

In recent years, the growing availability of technological and management tools and systems and public-private partnerships has opened up new possibilities for the operation and management of the road network. In this context, the Ministry has worked on the individual development of several projects that entail the use of these innovations, which could be incorporated into a broader project, with a comprehensive vision of modernizing the federal road network, under the name of "Comprehensive Program for the Modernization of the Federal Road Network," with which it aims to advance towards the achievement of one of the National Infrastructure Program's major objectives.

4. THE COMPREHENSIVE PROGRAM FOR THE MODERNIZATION OF THE FEDERAL ROAD NETWORK IN MEXICO

4.1. Objectives of the Program

The objective of the "Comprehensive Program for the Modernization of the Federal Road Network" is to improve the management, safety and quality of services provide to users, to make the road management tools more efficient and increase the added value of the network for the economic and social activities that are served by road transport.

The program aims to provide a homogeneous, consistent service on the stretches belonging to the basic federal network, improve planning and optimize the allocation of resources, improve management of the existing infrastructure, optimize the supervision of road projects and develop tools for better information processing and decision making.

The program involves providing the basic road network (approximately 31,000 km.) with a package of services and management tools that includes the comprehensive maintenance of the different stretches in accordance with performance standards, attention to black spots and better road safety levels, real-time information supply, management of and attention to operating incidents through the installation of traffic control centers, attention to and follow-up of structures, with emphasis on special bridges and improved signposting and systematization of the information given to the user.

4.2. Components of the program

The Comprehensive Program for the Modernization of the Federal Road Network includes various efforts to provide better user services, which are being achieved through the following projects:

- Information and management systems
- Development of geographic information systems for road management
- Planning and instrumentation of programs and methodologies to improve road safety
- Design and instrumentation of multi-annual road maintenance contracts
- Design and planning of a monitoring, instrumentation and supervision program for road bridges
- Updating and modernization of road signaling
- Design and instrumentation of intelligent transport systems.

The planning, design, execution and management of these projects are part of an infrastructure information system that is based on two basic applications:

- A single systematic inventory process for the road network and information collection, which includes, among other things, data relating to the geometric characteristics, signs, drainage works, chaining, capacities, road surface (IRI, depth of wheel tracks, etc.) of all stretches of the federal road network.
- A geographic information system that gives the same geographic base for the storing, organization, processing and display of the information acquired systematically in the various applications with an appropriate institutional structure to keep it updated and in service.

The program for the modernization of the basic federal road network is founded on the premise that the information, the collection, the systems and the IT applications, such as the services that can be provided through various projects, are executed within an integrated transport network in which the user should receive a homogeneous service that does not distinguish who is responsible for providing the service (the Ministry, a private concessionaire, a state government, etc.).

Therefore, by establishing a single set of standards for collection of information, the aim is to optimize the compilation, integration and coordination of the information and use it consistently to evaluate strategies for infrastructure planning, construction, maintenance, operation, management, etc. The objective is to promote the performance of complete analyses and provide comprehensive services that take into account all the elements of the infrastructure and all the actors participating in the provision of transport services.

The rationalization of the infrastructure management process through a single information system that makes it possible to visualize each stretch of the road network in a joint and organized manner, associating the image with indicators, information and characteristics of the road is a crucial effort in which parameters and protocols will be established for the collection and handling of the information. The diagnosis, organization and consolidation of the information about the road network will facilitate its transparent integration for each of the stretches and help improve the quality of the services offered to the users.

A general description of each project in the program is presented below:

4.2.1. Information and management systems

In order to achieve the goals established in the National Program, it is necessary to improve the coordination and the allocation of resources to investment projects, as well as to establish better mechanisms for selecting and determining priorities with social or economic benefits as criteria. Therefore, it is extremely important to attend to the needs for data, information and knowledge to support decisions and actions required by the infrastructure development project.

Due to the length of the road network, the various actors involved in its administration and management and the large amount of data that supports the definition of the best strategies and programs of action, as well as for creating performance indicators, the instrumentation of a comprehensive information and management system is in process, which will make it possible to optimize the resources available for the administration of the network.

To this end, work is being carried out at present on the creation of an information system directed at presenting information and providing services related to the road infrastructure. This system will allow for the comprehensive management of the road stretches by means of a single identifier of the roads nationwide that will allow the centralized management of the network and the possibility of performing analyses that take into account all the elements of the infrastructure, the operation and the easement, of rationalizing the administration of road maintenance and operation and obtaining the best choice of strategies and actions.

The information system for the roads of Mexico will have both external and internal components. The former will be offered to road users on the Ministry of Communications and Transport's portal and will include various services to facilitate road use and provide public information about the progress of the projects. The internal component will seek the consolidation and homogenization of the information about the road network contained in various sources and tools under standardized criteria; this information can be used to create executive dashboards that show the situations of each of the activities involved in the management of the road network in an accurate, clear, efficient manner and in real time, in turn improving the quality and timeliness of decisions.

4.2.2. Geographic information systems

This geotechnological development project seeks to provide useful geospatial data and information for the management of the road system and the strategic planning of transport.

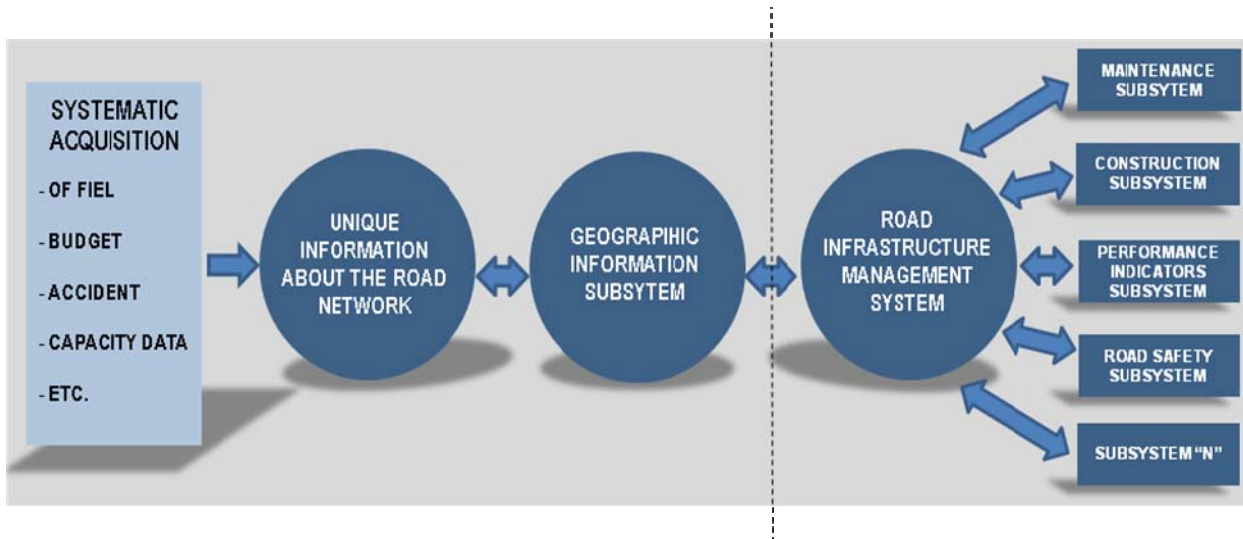
The objectives and/or specific products under development as part of the project are:

- A geospatial database for the national road infrastructure, with geographic variables, which will become an official source of data for the national road network and will be the basis for the instrumentation of applications to provide additional services to customers.
- A geographic information system conceived as a geotechnological tool to produce strategic information and knowledge to support decisions and aid in the solution of territorial problems.
- A geospatial data server that will allow hundreds of users to consult it at the same time and improve the layout of the data.
- A standard for geospatial data management that will facilitate problem solving with regard to the creation, use, layout, flows and other cartographic and statistical data processes for the federal road network.
- A geotechnological development unit with cutting-edge geoinformatic technology, with highly specialized personnel and a development program directed at satisfying the demands and needs of the road sector with regard to geospatial data management (creation, visualization, consultation, handling, analysis and modeling) and generating research and highly trained personnel.

The Geographic Information System will provide a single geoinformatic platform for the storage, organization, processing and display of road information and will be the basis for the development of the management systems in which specific modules will be instrumented, such as those for planning the road system, projects/construction,

maintenance, monitoring and instrumentation of structures, road operation, road supervision and safety (see Figure 3).

Figure 3 – Diagram of the information and management system for Mexican roads.



4.2.3. Road safety

In Mexico, road safety is one of the principal public health problems; therefore, actions must be taken to prevent road accidents and mitigate their harmful effect on society.

Today the Ministry of Communications and Transport is developing various programs and actions that focus on road safety. With regard to infrastructure, it has a program for attending to conflict points and a review of the vertical and horizontal road signs and the cleaning of the roadways. With regard to the operation of road transport, it carries out psychophysical and medical examinations, as well as toxicological operations, the renewal of licenses for federal public road transport personnel, thematic or seasonal safety operations and regulates the weight and dimensions of hazardous loads on road transport.

In addition to the above, the Ministry seeks to implement a Comprehensive Road Safety Program that creates long-term policies aimed at improving road safety on federal roads. Some elements included in this program are actions to update and modernize the rules and regulations relating to road safety, improving traffic management and user information, optimizing the preservation and maintenance of the infrastructure, modernizing and renovating the infrastructure with new systems and technologies, improving safety in road work areas, establishing and promoting road safety designs and safety elements and carrying out road safety audits using internationally proven methodologies.

With regard to the latter, the Ministry considers that the application of the International Road Assessment Program (IRAP), on the federal road network will help reduce the severity of the road safety problem and save lives thanks to safer roads.

The program promotes joint action by the public and private sectors, multilateral organizations and non-governmental organizations, to assess the safety of the roads by means of tours of inspection and videos and a measurement and assessment system to prepare infrastructure investment plans that will include viable, effective measures to improve road safety.

In its first stage, the IRAP program is being instrumented, together with other Central American countries in the Pacific Corridor of the Mesoamerican Region, and in its second stage the basic federal network will be extended and be divided into 7 regions to facilitate the collection of support data and field indicators and processing the information.

The results of applying this methodology to the entire basic federal network will include an assessment of the attributes of the road stretches with regard to road safety, an evaluation of their safety levels, the preparation of investment plans to improve road safety and the undertaking of corresponding investments. By applying this methodology, the Ministry aims to continually raise the percentage of the network with better road safety attributes and in that way reduce risks to users.

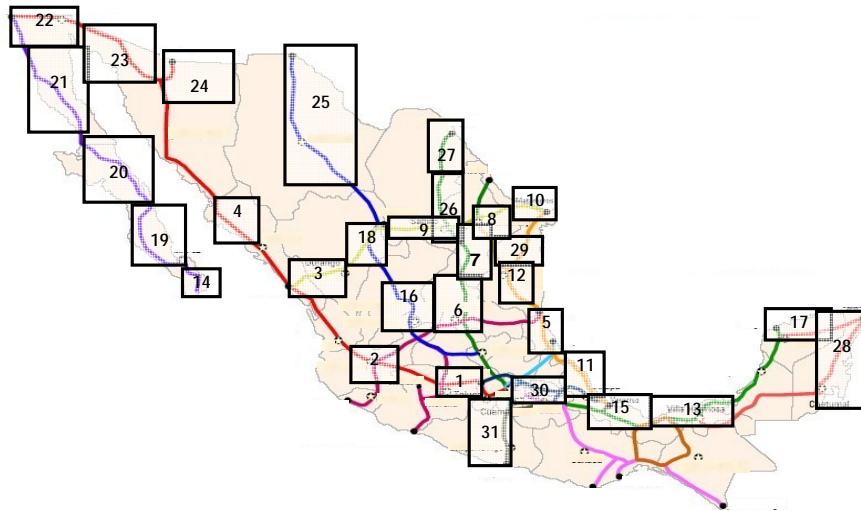
4.2.4. Multi-annual maintenance contracting

Through this project, the Ministry of Communications and Transport proposes the use of multi-year maintenance contracts on the basic federal road network to improve the physical conditions of the stretches under maintenance, reduce operating costs, provide better user service and cut maintenance costs.

The new contracting scheme represents a fundamental change in the way maintenance is contracted, since it calls for the contractor to carry out all maintenance activities as part of a single contract (routine maintenance, periodic maintenance, reconstruction and road services); moreover, contractors will be compensated based on results, that is, for complying with performance standards. The contracts will be awarded for terms of five to ten years and their scope will be for the contractor to carry out maintenance work on bundles of stretches of the federal network (mainly corridors and the basic network) to comply with preestablished performance standards.

To date the 31 groups of stretches shown in Figure 4 have been identified, and a 661.8 km package has already been contracted in the state of San Luis Potosi. With the instrumentation of the multi-year road maintenance contracts, the Ministry seeks to provide homogeneous service quality on the toll-free federal network, including traffic services and user service and a physical condition that meets previously established performance standards.

Figure 5 – Road packages that will be attended to through multi-year maintenance contracts.



The multi-year road maintenance contracts will offer important benefits, since they will improve the quality of user service by requiring 100% good physical condition by the third year of the contract, providing joint services on the toll-free federal network and unifying maintenance standards on all stretches. In addition, this will generate efficiencies in the administration of the program by reducing the number of contracts and contractors. It will also generate efficiencies for the private sector by allowing long-term planning, agreements with suppliers and larger scale purchases, recovering the investments in equipment and machinery and in general carrying out better quality work.

4.2.5. Monitoring, instrumentation and supervision of road bridges

The monitoring of the structural integrity of civil works, such as bridges and tunnels, has improved due to advances in the technology for sensors, communication and information systems. The possibility of carrying out real-time remote monitoring and analysis to determine the conditions of these civil works is now a reality that permits the use of new schemes for the inspection and assessment of the structures, which will improve safety and prolong their useful life, as well as the development of more effective administrative systems to optimize the application of maintenance resources.

The Ministry of Communications and Transport's comprehensive bridge safety program is being developed in a high-technology center at the Mexican Institute of Transport for the monitoring and assessment of the principal bridges in Mexico, which will count on instrumentation for their remote monitoring.

The Ministry also seeks to instrument bridges representative of all existing bridges on the road network to identify structural problems and plan corrective actions that will enable it to

overcome undermining and corrosion problems and guarantee the safety of road network users.

The comprehensive bridge safety program will generate greater reliability and safety in the operation of the bridges on the federal road network, increase the efficiency and effectiveness of the maintenance work for Mexico's most important bridges and cut maintenance costs due to opportune restoration actions in the face of normal or extraordinary damage or deterioration.

4.3. Updating and modernization of road signs

The Ministry of Communications and Transport is also developing actions to improve road safety by improving road signs under its "Strategic plan for the improvement of the road signs and road safety devices." The objective is to improve road signs and safety devices on Mexico's federal roads and provide simple, clear, legible, uniform, efficient, modern signs with safety devices that will contribute to lowering the accident rate.

This strategic plan seeks to maintain the signs and safety devices in optimal conditions in accordance with the resources available and the road sign programs and projects defined; to carry out quality audits; update and homogenize the regulations, maintain them in effect and generate institutional support to keep them up to date; to promote the use of cutting-edge technology for signposting and its management through the implementation of intelligent transport systems and georeferencing; and to administer the resources related to signposting through management and result administration systems.

4.3.7. Design and instrumentation of intelligent transport systems

In the face of the impossibility of continuing to expand the infrastructure and the need to improve the safety, efficiency, competitiveness and accessibility of the transport system, the Ministry of Communications and Transport is also working actively on the instrumentation of technologies for the modernization of the transport system. Telecommunications and information technologies, under the banner of Intelligent Transport Systems (ITS), have demonstrated that they are an innovative instrument for reducing problems in the transportation system for travelers and for goods. As a result of applying information processing, communications, control and electronics technologies, ITS will make it possible for roads, vehicles and users to develop and become "more intelligent" and in that way the operation and safety of the transport systems will improve, providing many useful services for the users.

Although in Mexico the implementation of ITS and the acceptance of their benefits are still at an early stage, the Ministry believes that they have great potential and therefore it aims to promote their development on the federal road network to improve the quality of service and user service on the roads. The sequence of activities with which it has been decided to implement ITS is as follows:

- To build a national ITS architecture, which was completed several years ago.
- To develop and implement comprehensive ITS strategies with long-term vision, which should be flexible and integrated into the national vision of the transport sector as a whole.
- To adopt user-centered applications that improve services while sensitive to user behaviour
- To integrate the distribution of services among the various transport modes.
- To administer the implementation of ITS projects efficiently.

Today in Mexico, various projects are being carried out to lay the foundations for an orderly, structured and comprehensive application of ITS. These are as follows:

1. National Strategic Plan for the Planning, Development and Implementation of Intelligent Transport Systems in Mexico (Mexican Strategic ITS Plan). The plan sets out the strategies and actions needed to have an ITS program for the operation and management of the infrastructure, which should be effective, consistent, integrated and stable.
2. Program for the Development and Updating of ITS Processes, Standards and Protocols in Mexico. This program develops recommendations for the integration and interoperability of ITS systems between various operators through the adoption of a nationwide open protocol and standard, with institutional support, directed at ITS processes, with diverse manufacturers and offering countries; and interoperability of management and traffic control systems, among other relevant features.
3. National User Information System. The objective of this system is to provide users nationwide with permanent information available in the media about weather, road and traffic conditions, activities and events on the road (modernization, maintenance, incidents, closures), with the necessary visual support to reduce delays and offer the user safer, more reliable and comfortable travel.
4. Strategic plan for the modernization and improvement of electronic toll collection (ETC) at the national level. This plan defines a public policy for the nationwide standardization of the specifications for these systems' operations and an ideal operating model. It also identifies regulatory aspects and actions of a technological, commercial and legal nature to migrate from the present situation to the ideal model and thus increase the effectiveness of the electronic means of toll payment, in such a way that crossing times at the toll plazas are reduced, the use of the infrastructure is optimized and the use of and access to these means of payment are facilitated.

5. CONCLUSIONS

The Comprehensive Program for the Modernization of the Federal Road Network aims to provide users with homogeneous, consistent services on the road network through the implementation of technology and the development of tools and systems that will permit the optimization of the planning, building, maintenance and operation of the road network.

For this purpose, it is essential to have reliable, up-to-date information and optimize its collection, integration and coordination through information and management systems that make it possible to improve decision making and evaluate the best strategies for the road infrastructure.

The Program integrates various projects that are developed individually, but with a common vision of modernizing the federal network in the long term. The program does not substitute or eliminate efforts in progress, nor does it require a rapid instrumentation, but rather adopts a gradual implementation that will allow the use and integration of the present systems and technologies to the desired architecture without leading to rejection by the users.

There are still pending challenges for consolidating a more modern, safer, more efficient, competitive and accessible sector in all the regions and communities in Mexico. In each of these transport modes, the Ministry of Communications and Transport seeks to meet this need, in such a way as to offer homogeneous, consistent services to the users along the transport network. The next step is to structure the transport network and its services with a renewed vision in such a way that it will be intermodal, sustainable and integrated and will provide consistent, integrated user services among the various transport modes.

Given the importance of the road infrastructure for Mexico's transport system, the Comprehensive Program for the Modernization of the Federal Road Network aims to set itself up as the basis on which the services of the other transport modes are integrated, using the technological tools as well as the strategic and regulatory approaches it establishes.