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Toward Intelligent Transportation Systems for the 2008 Olympics

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Deployment of intelligent transportation systems (ITS) is one of the 12 key areas of research and development in China's 10th Five-Year Plan, lasting from 2000 to 2005. As Figure 1 indicates, China's highway system has grown significantly over the last decade, from virtually nothing to a network of over 25,000 kilometers crossing the nation. It's now the second-longest system in the world, behind the United States. Meanwhile, the Chinese automobile industry has expanded explosively over the last few years. It will reach 20 percent of the worldwide automobile market by 2020, assuming a conservative annual increase of 5 percent (the current rate is over 15 percent) and an annual output of 10 million vehicles.[1] The driving force behind this growth, the sharply increasing number of passenger vehicles (currently close to 30 percent annually), has made urban traffic congestion an even more urgent problem. So, China is quite naturally shifting its focus from building road infrastructure to developing transportation intelligence for high performance and better service.[2]

In 2001, China announced that it had selected the 10 largest cities in the nation as "model cities" for ITS field testing and evaluation. Beijing, the 2008 Olympics host city, was at the top of the list. Beijing has an area of 16,807 square kilometers and a population of more than 13 million permanent residents and five million temporary and seasonal workers. The city roughly has two sections: the suburban rural counties and the central-city districts.

Figure 2a shows the road network for the entire city; Figure 2b shows the section for the central-city districts. As Figure 2 shows, the road network for the central districts expands from six arterial loops, a traffic structure unique in the world. The first loop is a straight segment in the center stretching from east to west. The fifth and sixth loops (see Figure 2a), which connect the districts with the counties, are still under development.

Traffic congestion and air pollution have been the two major problems facing Beijing for decades and are the two central concerns for the successful execution of the 2008 Olympics. Recently, Beijing's government has made tremendous efforts toward solving those problems, and ITS technology will likely play an important role in the solutions.

ITS technology for Beijing and the 2008 Olympics

Since 1999, the Chinese Academy of Sciences (CAS), the Beijing Traffic Administrative Bureau, the Chinese National Center of ITS Engineering and Technology, and the University of Arizona's ATLAS (Advanced Traffic and Logistics Algorithms and Systems) and PARCS (Program for Research for Advanced Systems) research centers have been working together to develop ITS techniques for Beijing traffic control and management. One of the working areas of this cooperation has been the Beijing Traffic Command and Dispatching System.

Figure 3 describes the system's functional architecture. The system comprises the Central Traffic Control and Management Center, its eight regional centers, and seven subsystems. Each subsystem handles one of these areas: traffic monitoring, regulation, guidance, global positioning systems and geographic information systems, emergency handling, data collection, and traffic signal control.

Editor's Perspective

This installment deals with ITS issues in China. Clearly, ITS will play a basic role in the future, and all major cities are working on integrating these new systems into their current scenarios. Along with this, we're witnessing the boost of China's economy and, particularly, its great efforts toward constructing its new transportation network. This installment presents the architecture and the technology that will be the starting point for the construction of the ITS that will be used in Beijing during the 2008 Olympics.

If you have any comments on this department, feel free to contact me. I also seek contributions on the current status of ITS projects worldwide as well as on ideas on and trends in future transportation systems. Contact me at broggi@ce.unipr.it; www.ce.unipr.it/broggi.

—Alberto Broggi

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At this stage, the system employs over 200 TV monitors, 400 automated electronic-traffic-police systems, 250 GPS-equipped traffic-patrolling vehicles, 130 fixed or mobile variable-message systems for traffic and parking, the 122 emergency reporting system (similar to the US 911 emergency system), 1,400 inductance loops and 200 microwave or video traffic-data-collecting units, and 240 intersection controllers. This system will be expanded greatly over the next two years.

One major obstacle to coordinated, intelligent traffic signal control in Beijing is how to incorporate the new system with the existing SCOOT (Split Cycle Offset Optimization Technique) traffic controllers. These controllers were installed at over 100 intersections in the 1980s but are considered a failure. Plans have been made to upgrade the SCOOT traffic controllers with new software and hardware for control and communication.

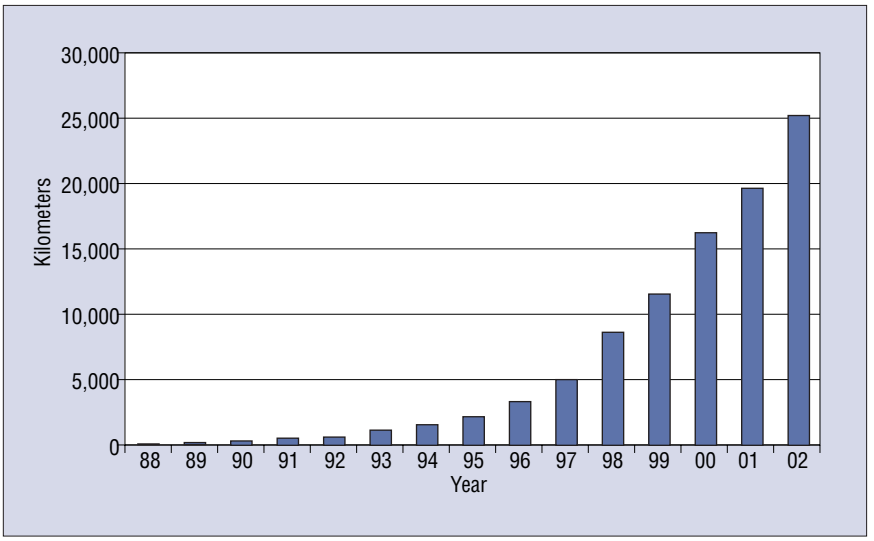

Figure 1. The recent development of highway systems in China.

System architectures and platforms

The focus of ITS R&D for Beijing and the 2008 Olympics is to create an integrated, intelligent traffic-control-and-management system based on real-time traffic data and communication, online GPS or GIS information, and global coordination and optimization strategies. The goal is to develop and implement prototype and deployable ITS modules, platforms, and integration techniques for the Beijing Traffic Command and Dispatching System that can significantly reduce traffic congestion, travel time, and air pollution. Taking into

Figure 2. The Beijing road network: (a) the Beijing metropolitan area and (b) the central-city districts.

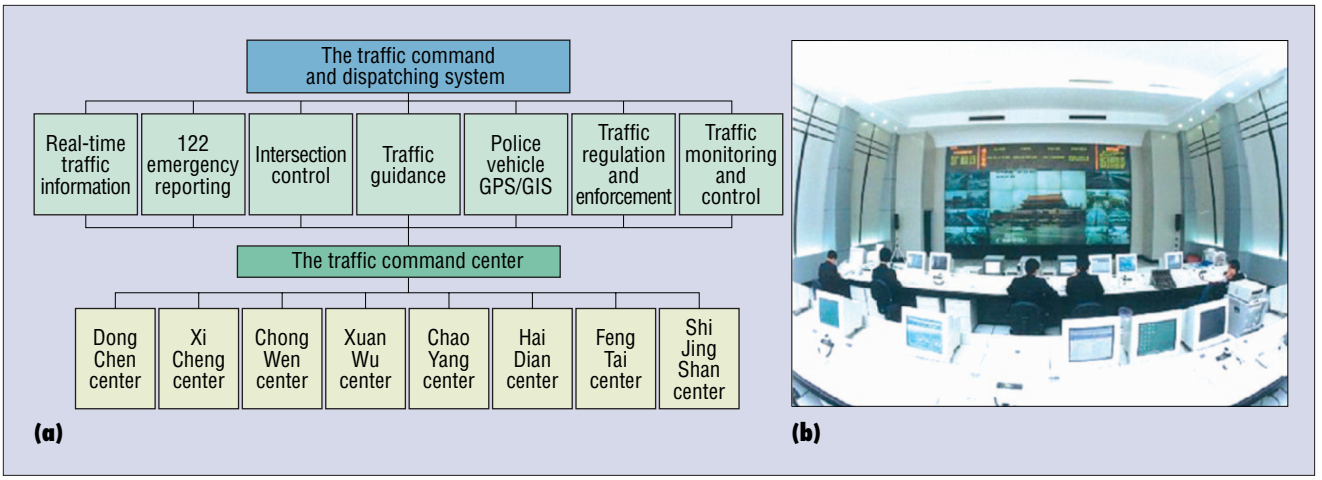

Figure 3. The (a) architecture and (b) control center of the Beijing Traffic Command and Dispatching System.

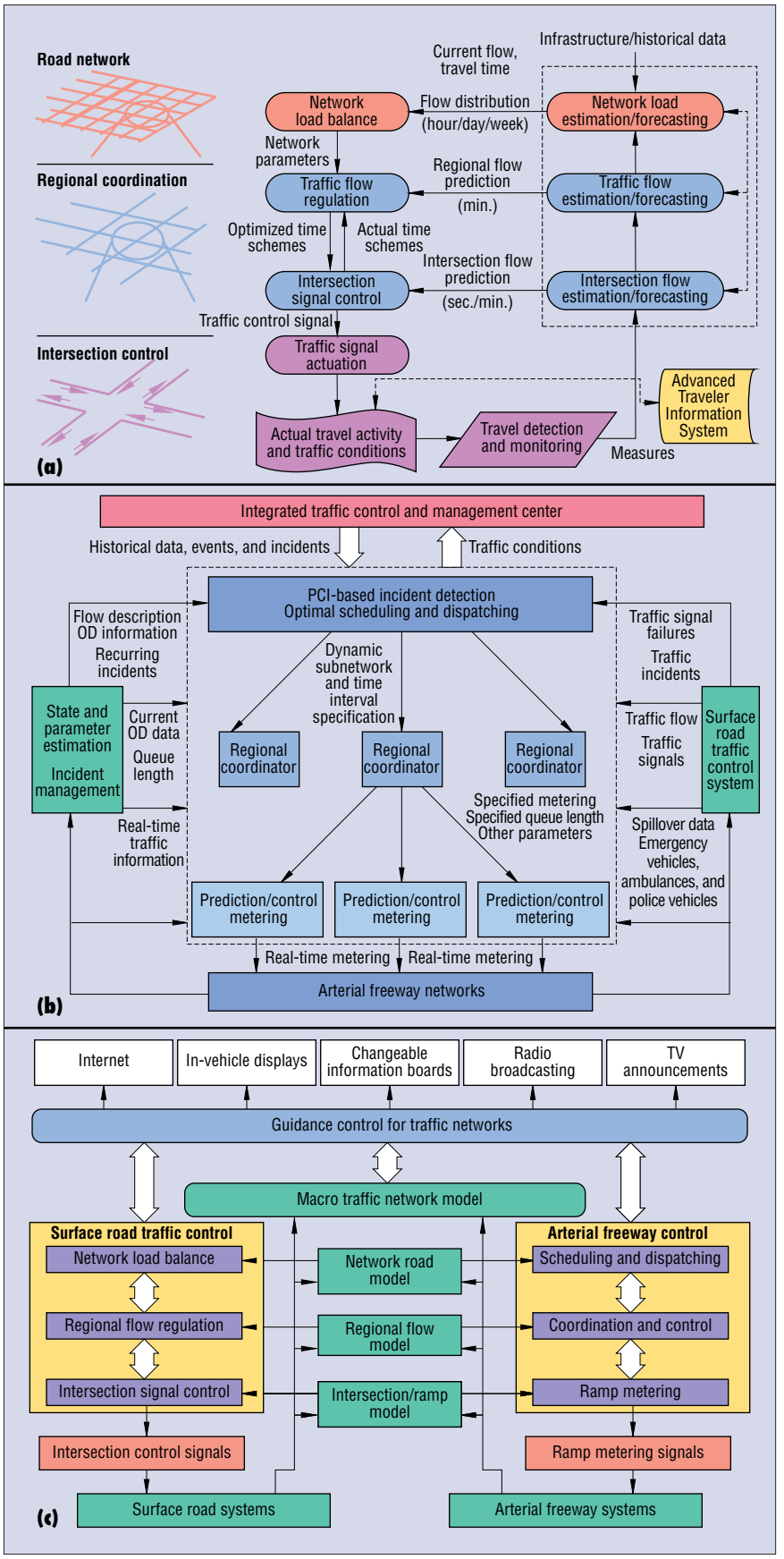

Figure 4. System architectures for (a) networked surface-street intersections; (b) coordinated road and arterial-loop interaction and loop ramp metering; and (c) integrated traffic guidance, monitoring, and dispatching.

consideration the Beijing road network's specific structure and its existing facilities, development has concentrated on building subsystems for

- Networked surface-street intersections
- Coordinated surface road and arterial loop interaction and loop ramp metering
- Integrated traffic guidance, monitoring, and dispatching

Figure 4 presents the three subsystems' architectures.

Besides conventional system analysis and decision-making techniques, major new methods used in developing those subsystems include intelligent control, agent-based control and programming, game theory, data mining, data fusion, fuzzy logic, neural networks, and genetic algorithms. The software platform and integrated development environment, called GreenPass-iTOP, have been developed for both online and offline operations for network communication, system configuration, data collection, monitoring and inspection, simulation and forecasting, and information analysis and broadcasting, as well as traffic control, guidance, and dispatching. An artificial transportation system has been developed to test, evaluate, and validate the GreenPass-iTOP system, using the agent-programming technique from Artificial Societies. A more detailed description of this system appears elsewhere.[3,4]

Laboratory and field testing and evaluation

In 1999, the Chinese Academy of Sciences established the ITS Laboratory for developing, testing, and evaluating traffic control and management systems. Figure 5 shows some facilities at the ITS Lab, which is located at the CAS Institute of Automation's Intelligent Control and Systems Engineering Center in Beijing. Figure 6 shows the hardware architecture and an earlier version of the intersection traffic controller developed in the ITS Lab. The version in the figure is based on the Type 2070 Advanced Traffic Controller specification (a US standard) and an embedded application-specific operating system (ASOS). An expanded, comprehensive testing laboratory will be established soon in the National Field Testing Facility for ITS in Tong County, Beijing.

Figure 5. The Chinese Academy of Sciences ITS Laboratory.

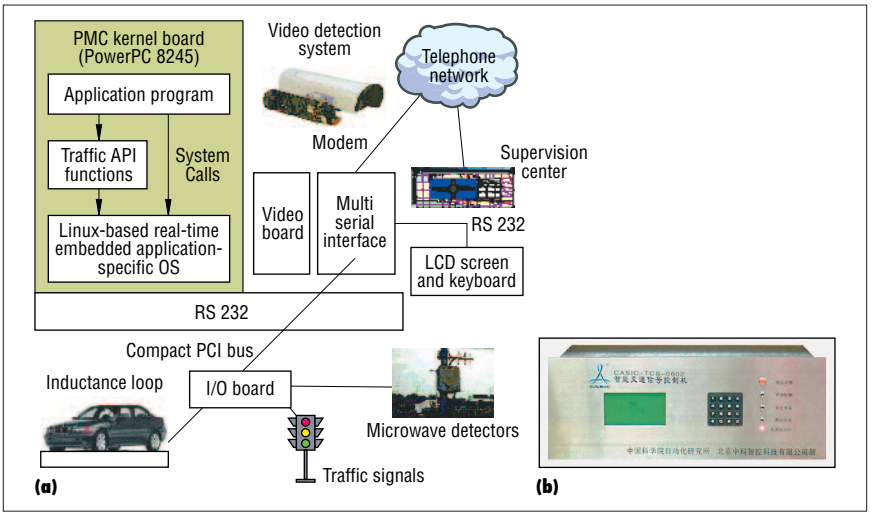

Figure 6. The CASIC Intersection Traffic Signal Controller: (a) hardware architecture and (b) prototype.

Since 2002, systems have been deployed for traffic control in cities outside Beijing, and the CAS is conducting several site evaluations.

The control and management of Beijing's traffic system offers a golden opportunity to validate and deploy ITS concepts and techniques for both China and the world. Although tremendous progress has occurred over the last three years, the road to a fully functional and integrated intelligent-traffic-operation system in Beijing will still be long and difficult. With only five years left, we hope that the efforts of this project and many others will make the 2008 Olympics not only a grand festival of world athletes but also an exciting demonstration of effective ITS technology. ■

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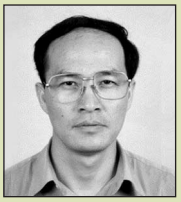

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