A. The application of intelligent transport systems technology

The application of Intelligent Transport Systems (ITS) technology is an important mark of transport development in cities with relatively advanced systems of transportation. The major application areas of ITS technology include electronic road pricing, traffic management, integrated ticketing systems for different public transport modes, and traveller information. Typical applications like en-route traffic information systems using Variable Message Sign (VMS), traffic surveillance and incidence management are quite common, especially for the management of expressways. Electronic Toll Collection (ETC) is in use in many developing countries such as China, Malaysia, Philippines, and Thailand. Hong Kong, China and Singapore have introduced more comprehensive electronic toll and parking fee management systems.

In Singapore, an electronic road pricing system was introduced in 1998. It replaced the famous Area Licensing Scheme and the Road Pricing Scheme. There are gantries at the entrances of the central area restricted zone, expressways and other main roads. The system automatically deducts charges from a stored-value magnetic card inserted into the in-vehicle unit when motorists drive pass an electronic road pricing gantry during operational hours. The city has also introduced other ITS systems to improve traffic circulation, which include the Road Information Management System, the Expressway Monitoring and Advisory System, Green Link Determining, J-Eyes (to monitor real-time traffic conditions), and the Bus Lane Enforcement Camera System. Singapore also uses the Internet to provide real-time travel information to the public through a system called Traffic Scan. Introduced in 1999, Traffic Scan is linked to the systems mentioned above and gathers information on travel speeds by probing into the Global Positioning System (GPS) technology currently used by taxi companies. It may be mentioned here that the city has 17,863 taxis, which are operated by four major companies and many of which are equipped with GPS receivers. The information provided by Traffic Scan is updated every five minutes or can be manually updated by a user at any time.

The introduction of smart card integrated ticketing systems for public transport systems is another significant development, with the first large-scale smart card integrated ticketing system introduced in Hong Kong, China in 1997. The contactless cards offer a common ticketing system for more than 30 transit operators providing bus, ferry and rail services. There were 7.2 million cards in active use, with 6.2 million journeys occurring daily.212

In 2002 the Land Transport Authority of Singapore awarded a US$ 78-million contract to an alliance made up of San Diego-based Cubic Corporation and ERG Transit Systems, headquartered in Perth, Australia to introduce an integrated smart card fare collection system for the island state's five public transit operators that make up the public transport network of Singapore. It will be used on a bus fleet of about 3,750 units, as well as the mass transit railway and the light rail network and involves an initial 22,000 readers and an initial five million smart cards.

The Singapore CFC system will also include high-tech ticketing units, separately supplied by the Cubic Corporation under a $ 23.6-million contract that calls for smart card vending machines to be installed in all LTA rail and bus terminals. Cubic's General Ticketing

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Machine supplied to Singapore will sell, revalue, retrieve, and recycle CFCs. As well as selling, revaluing, retrieving and recycling CFCs, the Singapore system includes an interactive touch screen display and a multi-language application including English, Tamil, Malay, and Chinese, along with a credit and debit card payment capability.  

### B. IT in the maritime sector

#### 1. Terminal automation

Many mainline ports in the ESCAP region have achieved productivity gains in recent years, but these may be insufficient for the rapid changes in ship size and technology. Additional investments in new container- and cargo-handling technology are likely to be needed.

For example, the Port of Singapore has invested in automated container handling technology for its new Pasir Panjang terminal. Without this new technology it would not have been possible for the port to deliver the speed of handling (330 moves per hour) considered to be compatible with economic operation of the new mega-ships of greater than 6,000 TEU capacity. This was demonstrated when the port set a container handling record of 203 moves (333 TEU) per vessel hour at its non-automated Tanjung Pagar Terminal, which was still 127 moves per hour short of the efficiency level needed for economic operation of mega-ships.

In Australia, stevedoring company Patrick, working together with Kalmar Industries, the equipment manufacturer, and the Australian Centre of Field Robotics at Sydney University, has developed an Automated Straddle Carrier system. The Automated Straddle Carrier is the first free-ranging automated equipment in use in the port industry worldwide. Patrick started initial development of the system in 1996. There are now five fully Automated Straddle Carriers are now under trial at a purpose built test site at Fisherman Islands, Brisbane, which is being developed into the world's very first Automated Straddle Carrier Terminal.

A key design objective for the project was to maintain the flexibility that characterizes conventional, manned Straddle Carrier operations. Patrick reports: “The design allows the ASC to be introduced in any size terminal worldwide, without the need and limitations of hard wiring or underground sensors, which is itself a major milestone in automation technology. Traffic Management Systems control the paths and travel of the ASC, acting not only as the first level of anti collision, but to maximize equipment productivity and enhance resource management. The Traffic Management System will interface with most standard Terminal Management systems to enhance terminal performance and facilitate the introduction of Straddle Automation”.

#### 2. Port community systems

A major thrust of IT development in the maritime sector over the last five years has been the development of port community systems. Port community systems are defined by Digital Ship Ltd as: “computer networks which link up the port with all the companies that use it, including hauliers, rail companies shipping lines, feeder ports, shippers and customs officers. Most port community systems are extremely complex and developed over many

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years; the communication between the different players is often a mix of direct data exchange through telephone lines (commonly called EDI, electronic data interchange) as well as data exchange using internet protocols such as XML.216

Singapore’s PSA Corporations PortNet system is regarded by many as the world’s leading port community system. In July 2000, PSA Corporation entered into an agreement with the Port of Dalian to build an IT system for North-East China, and more recently and agreement has been signed to develop a port community system for the port of Seattle.

The PortNet community system is now fully Internet-based. All users of the port, including shipping lines and agents, as well as government departments, such as customs, can communicate electronically via this common platform. In 2001, over 70 million transactions were undertaken via the system.

PSA is continuing to develop enhancements to the PortNet system. Recent additions include GEMS, an e-business solution designed to help shipping lines manage their empty container inventories, and EZShip, a suite of products that facilitate lines’ transshipment processes.217

C. Reducing pollution from vehicle emissions

1. Integrated strategies

Improving air quality in major cities is a major challenge for governments, and one which will become ever more difficult as the concentration of populations in urban areas continues.

New strategies, based on a coordinated multi-faceted approach to the reduction of vehicle emissions, will be necessary if this challenge is to be met effectively.

2. Planning

Planning options are a major tool for developing a spatial city structure that allows for the use of more environmental friendly transport means.

Environmental assessment has proven to be an effective tool to predict environmental effects. Not only does it help to predict environmental impacts, it also proposes mitigation and compensation measures. In order to better take account of the environment in planning and to improve existing spatial structures, the comparatively new tools of scenario planning, strategic environmental assessment and integrative assessment can be used.

The Integrated Vehicle Emission Reduction Strategy for Greater Jakarta, Indonesia offers a useful planning model for addressing the emission problems common to many large cities in developing nations.218 In an attempt to address the lack of integration that exists between policies and strategies related to pollution control and transport, the action plan


published in July 2002 proposes a comprehensive vehicle pollution control strategy consisting of improvements to four interlinked components:

- Clean vehicle technology;
- Clean fuels and emission standards;
- Transportation and land use planning; and
- Appropriate maintenance.

In keeping with the trend towards participative practices, the action plan was developed through broad based involvement of stakeholders including national and local government, the private sector, industry associations, non-government agencies and donor agencies. The action plan recommends:

- A multi-sectoral approach, involving decision-making and implementation of activities aimed at vehicle emissions reduction but coordinated under one umbrella organisation;
- Institutional capacity building including training of agency staff so that they are able to successfully implement the vehicle emissions strategy;
- Formal and informal education and public awareness raising initiatives;
- Introduction of the polluter pays principle supported by clear regulations and strengthened law enforcement;
- Adoption of the Precautionary Principle in the development of fuel specifications;
- The incremental establishment of new vehicle emissions standards in line with the introduction of cleaner technologies and cleaner vehicle fuel; and
- The institution of travel demand management strategies to control the number of vehicles on the road.

Other examples of similar strategies include the NSW Government’s 25-Year Air Quality Management Plan, Action for Air, for the Greater Metropolitan Region of Sydney.219

3. Emission control

The environmental impact of the growth in vehicle numbers, particularly in the rapidly developing mega cities of Asia, has been reduced by the introduction of stricter emission control standards – and more consistent enforcement of those standards – in many countries. Changes to vehicle design standards and improvements to emission testing have reduced the impact of the vehicles on air quality.

Lead-free gasoline was introduced in Colombo in 1997 with a planned total phase-out by 2005. Under the current Government, the Ceylon Petroleum Corporation (CPC) accelerated the plan by discontinuing the production and sale of leaded gasoline in mid-2002. In addition, the Government plans to further improve urban air quality by introducing new vehicle emission and fuel quality standards.

Recent preliminary studies sponsored by the US Agency for International Development (USAID)/US-Asia Environmental Partnership Programme (US-AEP) showed

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that ambient lead levels in Colombo have dropped 80 per cent six months after phasing out lead in gasoline in June 2002. The studies also suggest that the introduction of unleaded gasoline has contributed to a marked (86 per cent) reduction in blood lead levels in traffic policemen. This indicates the magnitude of the health impact and the benefits of the lead reduction programme.

An Air Quality Management Center (AirMac), which was formed in November 2001 under the Ministry of Environment and Natural Resources to facilitate the air quality management programs, is now focused on developing a Clean Air 2005 action plan and implementing increasingly higher emission standards in January 2004. Through the Action Plan, Euro II equivalent standards will apply for in use vehicles from 1 July 2003 with the intention of moving towards Euro II and Euro III standards by 2007 and 2010, respectively. Euro standards will also apply to fuel quality for gasoline and diesel allowing adequate time for the CPC to introduce changes to its refinery programs.

Arrangements to establish 200 vehicle-testing centres throughout the country are underway. According to Transport Ministry sources, annual mobile emission certificates will be mandatory for all motor vehicles beginning in January 2004. In addition, Sri Lanka is considering banning the importation of two stroke trishaws.

Policies to control the number of motor vehicles can also play a role in integrated strategies. Singapore has a vehicle quota system to manage long-term vehicle population growth at a sustainable rate. Every year, only a moderate increase in number is allowed through this system. Over a period of ten years between 1990 and 2000, the city’s car population increased from 272,475 to 392,961 representing an annual growth of 3.72 per cent. Over the same period, the number of buses increased from 9,298 to 12,300 (2.84 per cent annually), and the number of taxis from 12,239 to 18,327 (4.12 per cent annually).

Restriction of certain types of vehicles such as three wheel diesel vehicles in the urban areas of many of these cities is another measure that has lead to some improvement in air quality.

Over the last ten or more years air quality in Dhaka has significantly deteriorated, very largely because of the increase in vehicle emissions due to the growth in the number of motorized vehicles in the city. Two important sources of fine particulate matter in Dhaka are diesel-powered vehicles and two-stroke engine gasoline vehicles. Among the latter, commercially operated three-wheel taxis – called “baby taxis” which account for more than one-third of the total number of km travelled by all vehicles. In 2000/2001, a programme jointly supported by UNDP and World Bank Energy Sector Management Assistance Programme aimed at reducing emissions produced by the “baby-taxis”. The programme included:

- Quantifying the impact of the use of excess inferior quality lubricant on the baby taxi emissions;
- Training mechanics servicing the vehicles on causes and effects of high emissions (including the health effects);
- Demonstrating the merit of changing lube oil and vehicle maintenance practices through two auto clinics, the first of which provided free vehicle inspection, minor servicing, emission measurement and medical examination to about 1000 drivers, some of whom were also given medication if found ill;

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- Gaining consensus among the downstream petroleum sector about banning the sale of straight mineral oil at gasoline stations and packaging the lubricant so as to discourage overuse; and
- Implementing a range of information sharing and education initiatives to raise awareness among drivers and the public about vehicle emissions.

The programme gained unanimous consensus among the drivers that participated that actions should be taken to reduce emissions from the baby-taxis. Following participation in workshops by more than 100 participants including vehicle marketers, drivers and owners and the traffic police, recommendations were made to ban the sale of straight mineral oil for use in vehicles and to establish new oil quality standards. The Government of Bangladesh picked up on both of these recommendations in 2001. In the same year, one of the lubricant marketers picked up on the recommendation about packaging, and launched a new 60 millilitre sachets of the proper lubricant 2T.221

These collaborative efforts to control vehicle emissions were significantly advanced by the Government’s announcement in 2002 that Dhaka’s two stroke baby-taxis would be banned with the first 18,000 off the road by September of that year. Pre-empting this change, a Bangladeshi company, International Project Support Services System Limited (IPSSL) imported that country’s first tuktuks from Thailand. The ban by the Government complemented its strategy to convert the engines of cars and other vehicles to run on compressed natural gas (CNG) by drawing on the country’s supplies of natural gas.222

According to a bulletin published by the Centre for Urban Studies (CUS) about a Department of Environment Survey, the results of which were released in January 2003, the ban on the baby taxis in late 2002 in Dhaka led to a 30 per cent reduction in the concentration of suspended particles in the air in Dhaka. Although the baby taxis have been replaced by new buses as well as four-stroke baby taxis that run on CNG, the CUS bulletin suggested that most of the two-stroke autorickshaws were now operating in other cities outside Dhaka, contributing to air pollution of those cities.223

4. Cleaner fuels

The quality of fuels for motor vehicles including two and three wheel vehicles is a major factor in the level of air pollution. While fuel quality has been improved in many developed countries through regulation there are still many countries in the Asia Pacific region where fuel is a major contributor to air pollution. A Dialogue for Cleaner Fuels in Asia with 12 major oil companies supported by an ADB and regional and national oil companies was launched in Singapore in July 2003. The Dialogue will identify important issues surrounding cleaner transport fuels and identify implications for the refining industry in Asia for producing cleaner fuels as part of an integrated strategy to improve air quality. The oil companies announced their commitment to the dialogue by endorsing the Singapore Statement, which establishes the dialogue process.

“Singapore Statement”

- We, the oil companies\(^a\), that produce and/or provide oil products for the Asian market, which have gathered here in Singapore for the purpose of discussing cleaner air in Asia, share the concerns that air pollution is a serious developmental problem and that for Asia to develop further it is important that citizens are able to enjoy air of a quality which, by recognized standards, such as those recommended by the World Health Organisation, should not cause them harm;

- Air quality is impacted by emissions from a number of varied sources but we recognize that the rapid growth in mobility in Asia has contributed to an increase in emissions in many cities, and that the expected continued growth in number of vehicles will further add to the problem. Countries and cities in Asia experience different levels and types of air pollution, and actions taken to reduce air pollution need to take this into consideration. Any action taken to address air pollution should be based on sound science; and

- To enable ambient air quality in Asian cities to meet appropriate standards will require the identification and implementation of location- and context-specific initiatives, which are based on sound science and which recognize the necessary balance between economic, environmental, and societal needs and impacts. In this regard, we believe it is appropriate that a range of solutions be considered with the aim of identifying those which leads to the most balanced, cost-effective initiatives involving an acceptable overall cost to society, government and the stakeholders.

\(^a\) The oil companies taking part in the launch meeting in Singapore on 21 July 2003 included Bangchak Petroleum Public Company, BP, ChevronTexaco, ExxonMobil, Indian Oil Corporation, Pakistan State Oil, Petron Corporation, PTT Public Company Ltd, Shell, Showa Shell Sekiyu K.K., Singapore Petroleum Company, Thai Oil Company Limited. Although not present at the launch meeting, discussions are ongoing with other companies in the region on their participation in the Dialogue.

Changing the type of fuel used can also make a significant contribution. The Dhaka Clean Fuel Project, supported by ADB, aims to improve air quality in that city by replacing existing diesel buses with new units designed to run on compressed natural gas. 300 new buses, 200 of which will be operated by the public sector transport corporation BRTC and 100 by private sector operators, will be purchased as part of this Tk 5.9 billion project, which commenced in fiscal year 2002-3. The project also includes the construction of supporting infrastructure, including a 60-km gas transmission line and a 100-km distribution line to CNG filling stations, of which 26 will be established in the first year of the project. Policy support for the fuel conversion includes the lifting of import duties on the importation of CNG vehicles and conversion kits.

D. Technological developments affecting air transport

1. Air navigation

The replacement of ground-based air navigation systems by the satellite-based communications, navigation, surveillance/air traffic management (CNS/ATM) systems developed by ICAO continues. Significant technical and operational experience has been gained through trials and implementation of interim CNS/ATM systems that proved the suitability of controller-pilot data link communications (CPDLC) for replacing of high frequency voice communications and automatic dependent surveillance (ADS) systems for
obtaining automatic aircraft position reporting in oceanic airspace. Progress also continues with implementation of Required Navigation Performance (RNP) and the introduction of reduced horizontal separation minima based on establishing RNP airspace. This permits the lateral separation between existing routes to be substantially reduced and has enabled the introduction of a new route structures with significant system-wide benefits.

As a result of these developments, new route structures were introduced in 2001 for the very busy routes over the South China Sea area significantly increasing the traffic flow and enhancing safety across between Pacific Rim States and South-East Asian airports. Additional routes have become available over the Polar regions linking North America with South-East Asia and the Pacific region resulting in significantly shorter flight times, more convenient flight schedules, environmental benefits due to reduced fuel burn, and considerable economic advantages to airlines and the flying public. New routes launched between South-East Asia and Europe across the Bay of Bengal and the Arabian Seas on 28 November 2002 are estimated to save airlines US$ 55 million a year with 30 minutes taken off flight time of 22 hours between Australia and Europe.

Another important technological application is the Reduced Vertical Separation Minimum (RVSM), which permits a reduction in vertical separation between aircraft from 2000 feet to 1000 feet, thereby providing an increase in the number of levels aircraft can use on a route, thus increasing the capacity of the airways. RVSM was initially introduced in the Pacific Region in February 2000 and subsequently extended to the Western Pacific and South China Sea area in 2002. RVSM will become operational over the Bay of Bengal and Arabian Sea on 27 November 2003. When completed, seamless RVSM operations for traffic flows will be available from the west coast of the United States across the Pacific to Asia and Australasia, through the Middle East region to Europe and across the Atlantic to the east coast of North America.

2. Airline and airport operation

Technological development affects airlines at both the equipment and the customer-service levels. Since 1995, a number of new aircraft types have been certified and introduced into service. Both Boeing and Airbus, the two main jet aircraft manufacturers, now claim to offer a full family of aircraft types in terms of range and aircraft capacity, thus enabling airlines to better fit the aircraft type required to their different markets. Furthermore, within each aircraft type, the manufacturers have continued to develop derivatives of all types to meet particular market needs and operator requirements. These new models incorporate advanced technology and provide for significant improvements in fuel efficiency while reducing noise levels and increasing passenger comfort. Long-range versions of Boeing’s 747s, 767s and 777s and Airbus A330s and A340s also permit non-stop ultra-long haul services over extreme and remote terrain. As a result, airlines are developing direct services connecting a far greater number of cities than was possible previously. Airbus points out that its new 555-seat A380 embodies the latest technologies for materials, systems and industrial processes and says that the A380 will reduce unit costs by another 15 per cent while carrying 35 per cent more passengers than its nearest competitor on long routes such as London to Singapore. Major carriers in the Middle East and the Asian Pacific region have shown considerable interest in this new aircraft type and will be introducing it into service in the period 2006-2008.

The introduction of technology into the sales, marketing and distribution of the airline product continues to make rapid progress and is having a significant impact. Despite a large downturn in booking, the four global Computer Reservations Systems – Amadeus, Galileo, Sabre and Worldspan – remained strong and continued with programmes to help the airlines and travel agents use their respective systems via the Internet to cut down training costs and improve productivity. However, the airlines of the Asian Pacific region generally have been
somewhat slower than their counterparts in Europe and North America to use the Internet for marketing and selling their products and in introducing electronic ticketing. These developments are altering the marketing and selling of the airline product, as well as the traditional relationship between airlines and intermediaries such as travel agents.

Traditionally, customs and immigration procedures (border controls) have been considered to be the greatest obstacles to the smooth flow of traffic through airports, but new challenges have emerged in recent years in the form of enhanced aviation security, new public health and quarantine measures, and complex airline and airport procedures. However, the construction of new airports and the upgrading of others in the region have enabled the development and introduction of new automation processes in baggage-handling, processing and flow-management, and the design of state-of-the-art terminal and air cargo processing facilities. Further technological and operational advances are expected to have even greater impacts on customer-processing by airlines and at airports in the future. More than 110 States already issue or plan to issue machine-readable travel documents (MRTDs), primarily passports, and ICAO recently published a blueprint for a worldwide, standardized system of identity confirmation based on MRTDs enhanced with biometrics to enable the speedier passage of travellers through airport controls, heightened aviation security and added protection against identity theft.

3. Air transport and the environment

Standards and policy positions regarding aircraft noise have long existed in the international aviation community. The phasing out of operations by the so-called Chapter 2 jet aircraft is well-advanced and the Council of ICAO adopted a new, more stringent standard for jet and large propeller-driven aircraft for applicability on 1 January 2006. ICAO is pursuing the concept of a balanced approach to aircraft noise management, consisting of four principal elements, namely, noise reduction at source (quieter aircraft), land-use planning and management around airports, noise abatement operational procedures, and operating restrictions.

Scientific research, as well as policy development on the emissions side, continued to make slow but steady progress. A study by the Intergovernmental Panel on Climate Change (IPCC), undertaken at the request of ICAO, concluded in 1999 that aircraft are estimated to contribute about 3.5 per cent of emissions (from human activity) that affect climate change. This is a percentage that is expected to grow because of aviation’s rapid rate of growth, and despite improvements in aircraft and engine technology.

Policy-making concerning aircraft emissions is being given increasing attention by States following the adoption in 1997 of the Kyoto Protocol to the United Nations Framework Convention on Climate Change, which includes a provision that developed countries, working through ICAO, should pursue the limitation or reduction of greenhouse gases from aviation bunker fuels. Accordingly ICAO has been monitoring advances in technology and has been developing guidance material on operational measures to reduce emissions. ICAO also has been working on policy options to limit or reduce greenhouse gas emissions from civil aviation, including the potential role of market-based options such as emissions-related levies, emissions and voluntary agreements.