.mo

Macau

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Total population	538,100 (2007)
Literacy rate	93.5% of the population aged 15 and above (August 2006)
GDP per capita	USD 36,357 (MOP 292,165)
Computer ownership	68.0% of households (August 2006)
Fixed-line telephones per 100 inhabitants	33.9
Mobile phone subscribers per 100 inhabitants	151.1
Internet users per 100 inhabitants	22.8
Domain names registered .mo	2,346 (June 2008)
Broadband subscribers per 100 inhabitants	21.4%
Internet domestic bandwidth	20 Mbps/1 Mbps (downstream/upstream)

(Sources: Macao Network Information Center 2008; Statistics and Census Service 2008)

OVERVIEW

Information and communication technology (ICT) plays an important role in the economic, political, social, and cultural life of the Macau Special Administrative Region (MSAR) of China. This can be seen from the fact that there are more mobile phones in Macau than there are people (794,323 mobile phones for a population of 531,400), and about a fifth of the population (119,913) is subscribed to the Internet. An automatic passenger clearance system for smart identity (ID) card holders at Macau's border gate checkpoint has been in place since 2006, speeding up clearing time for the 27 million visitors to Macau in 2007.

Policies and updated news from the government are posted at official websites for general public access and most of the notification regarding social services is now disseminated through websites, email, and short message services (SMS). Furthermore, Macau's first certification service provider called eSignTrust, which is accredited by the MSAR government and managed by the Macao Post in accordance with the Electronic Documents and Signatures Law (EDS Law, Law No. 5/2005 of MSAR), has been promoting the use of electronic certificates.

TECHNOLOGY INFRASTRUCTURE

The first Global System for Mobile Communication (GSM) digital mobile service in Macau, Internet services, and the Guangdong–Zhuhai–Macau Synchronous Data Hierarchy (SDH) 622 Mbps Transmission System were launched in 1995. Two years later, the Integrated Service Data Network (ISDN) service and a series of value added services (VAS) were launched and the connection of the South East Asia–Middle East–West Europe–3 (SEA–ME–WE–3) submarine cable to Macau's Landing Point was realized.

In 1999, the public telecommunications concession was renewed to 2011 and all analogue mobile telephone networks were terminated. Internet broadband service was launched in 2000 and the Plesiochronous Digital Hierarchy (PDH) Microwave Links to Hong Kong were replaced by SDH Microwave Links a year later. Mobile telephone services have been liberalized and number portability has been launched.

Commercial wireless broadband service was launched in 2005 and 3G mobile telephone service two years later. The fibre network and radio systems carry voice and data traffic across the territory.

Apart from mobile and Internet services, all public telecommunication lines are still provided by the Companhia de Telecomunicações de Macau (CTM) under a monopoly concession, which has resulted in relatively high prices. Furthermore, interconnect lines between operators and international lines increase the operating cost.

To receive terrestrial television signals from Hong Kong and mainland China, several antenna service providers installed antennae up in the hills and relay the TV signals with boosters spaced at intervals through TV cables across buildings. Although these providers have never been licensed, most households have been using these illegal services for some 20 years now. This is also despite the establishment of Macau Cable TV, Limited (MCTV) in 2000 as the only paid service television (TV) company in Macau with a concession contract until 2015.

KEY INSTITUTIONS AND ORGA-NIZATIONS DEALING WITH ICT

The key organizations dealing with ICT in the government sector are Direcção dos Serviços de Administração e Função Pública (SAFP — Public Administration and Civil Service Bureau) and Direcção dos Serviços de Regulação de Telecomunicações (DSRT — Bureau of Telecommunications Regulation).

The SAFP was formally established in 1994 to modernize communications, provide technical assistance, and ensure a reliable and secure information flow between governmental departments. The SAFP is also one of the pioneers in e-government development in Macau.

In 2000, one of the key functions of the Direcção dos Serviços de Correios, Telefonicos e Tegraphicos de Macau (CTT — Telephony and Telegraphy Bureau) in telecommunications was transferred to a newly established office called Gabinete para o Desenvolvimento das Telecomunicações e Tecnologias da Informação (GDTTI — Office for the Development of Telecommunications and Information Technology). This was eventually transformed to the DSRT in 2006. As its name implies, the DSRT is the regulatory body for all public telecommunications in Macau.

In addition, there are key ICT-related committees directly under the supervision of the Macau chief executive. They are: the Macau Foundation (FMAC), the Science and Technology Committee (CCT), and the Science and Technology Development Fund (FDCT). The FMAC was established in 2001 to promote activities related to science and technology. The CCT was established in 2002 as a consultative body to advise the MSAR government on the formulation of policies to promote technological development and modernization. The CCT can also freely establish ad hoc committees to meet its overall mission. The committee members are appointed by the chief executive. Nine internationally renowned scholars are also appointed as advisors to the committee.

Established in 2004, the FDCT (www.fdct.gov.mo) subsidizes the development of educational programs, research, and other related projects to promote and enhance science and technology knowledge, improve productivity and competitiveness, facilitate development through innovative projects, and enhance socio-economic development of high-priority technology-transfer projects as well as patent applications. Eligible to receive the FDCT subsidies are local universities, academies, affiliated research and development (R&D) centres, local non-profit private organizations, laboratories and entities, registered entrepreneurs, enterprises, and individuals involved in development projects.

Two non-profit institutions devoted to scientific research, technological development, technology transfer, and training in ICT and electronics are the United Nations University — International Institute for Software Development (UNU-IIST) and Instituto de Engenharia de Sistemas e Computadores de Macau (INESC — Institute of Engineering Systems and Computers).

Innovative programs in ICT are provided by the University of Macau (UMAC), which is owned by the MSAR government; the University of Science and Technology, a private university; and the Instituto de Inter-universitário de Macau (IIUM — Macau Inter-University Institute), a private Catholic university.

The Cyberlab of the Centro de Produtividade e Transferência de Tecnologia de Macau (CPTTM — Macau Productivity and Technology Transfer Center) offers a variety of ICT training, support, and certification services for adult lifelong learning, whereas Direcção dos Serviços de Educação e Juventude (DSEJ — Education and Youth Affairs Bureau) oversees kindergarten, primary, and secondary schools.

In the private sector, all of the mobile operators, namely, CTM, Hutchison Telephone (Macau) Company Limited, Smartone Mobile Communications Limited, and China Unicom (Macau) Limited, play an important role in ICT projects. Kong Seng Paging Limited is a private company that is heavily involved in ICT projects in Mainland China.

Teledifusão de Macau S.A. (TDM — Macao TV Broadcasting Co.) was established in 1988 with the Macau government as the major shareholder. It has one Chinese and one Portuguese channel, and it provides free television and radio broadcast services. Radio Macao, a subsidiary of TDM, also has one Chinese and one Portuguese channel. Both share the same website (www.tdm.com.mo). In addition, there is one commercial radio station called Green Village.

MCTV is the only paid service television company in Macau. It offers 70 different channels from around the globe through digital transmission and reception systems. Advanced technology is used in digital transmission to broadcast television programs. Specifically, satellite signals of different programs are sent to the satellite receiver situated in Coloane and then converted into digital signals under MPEG-2 DVB technology. MPEG-2 DVB can avoid the detrimental effects of climate changes, guaranteeing the delivery of high-quality and high-speed television signals. The satellite signals deciphered in Coloane are transmitted to the lighthouse of Guia Mountain through fibre optics, and then relayed throughout Macau by microwave.

The Macao Communications Museum was officially inaugurated in 2006 as part of the Macao Post. The museum seeks to stimulate public interest, particularly among school children, in the scientific and technical aspects of telecommunications. The exhibits allow visitors to understand the evolution of the

means and techniques of communications as well as the front-end technologies.

KEY ICT POLICIES, THRUSTS, AND PROGRAMS

Technical support from Mainland China is one of the considerations in the formulation of ICT policies in Macau. In particular, the Science and Technology Committee studies the integration of regional technological capabilities to adopt the appropriate focus and approach to technology development in the territory. The main focus at present is education and training programs for schools and the community to popularize science and technology and improve science and technology literacy. The approach taken is to allocate funding to install and upgrade hardware in schools, and assign IT staff to help those in need of assistance for further development.

A related initiative is the construction of the Macao Science Centre close to the Macau Cultural Centre, to provide youngsters with a friendly environment where they can broaden their minds and gain more knowledge of cutting-edge technologies that drive the world today.

The computerized Central Library complex is another key ICT initiative. Since August 2007, the Central Library has been providing one hour of free wireless Internet access to visitors with laptops to cope with the increasing demand for the use of the library computers. In January 2008, the coverage and use of free Internet access was expanded.

LEGAL AND REGULATORY ENVIRONMENT FOR ICT DEVELOPMENT

The MSAR government is strongly committed to the protection of intellectual property rights (IPR). It has sought to adopt the best IPR regime in line with international standards and it has strengthened laws to fortify IPR enforcement particularly against piracy.

Recognizing that combating money laundering and the financing of terrorism are essential to sustainable development, the MSAR government campaigned for the passing of the Anti-Money Laundering Law and the Anti-Terrorism Law in 2007. The laws provide for the establishment of a trans-departmental anti-money laundering coordination and working unit and a financial intelligence office, respectively. A supervisory body to ensure the enforcement of the two new laws is now in place.

The Office for Personal Data Protection (GPDP, www.gpdp. gov.mo) was also established in 2007. One of the GPDP's most recent issuances is the 'Principles concerning the protection of personal data in the workplace: Guidelines for employee monitoring'.

DIGITAL CONTENT

A brand new interactive website for the Macau Grand Prix (at http://www.macau.grandprix.gov.mo) was officially launched in September 2007 to provide motorsport fans with access to comprehensive information and the latest news from the Macau Grand Prix (MGP). According to the MGP committee, the new website is designed for visitors of all ages; it is both informative and entertaining, with a photo gallery, the latest news, as well as links to a range of international motor-sport events and Macau-related websites. Visitors may access previous races through archive film footage, and get background information such as a Guia Circuit map, how the circuit corners got their names, and circuit flag signals. During the 54th Macau Grand Prix in 2007, results, race reports, and images were posted throughout the event. The site is available in traditional and simplified Chinese and in Portuguese and English.

In 2007, the Macau Government Tourist Office (MGTO) in cooperation with the University of Macau (UMAC) released the popular MacauMap handheld tourist guide system for smart mobile phones. MacauMap has functions like map viewing, navigation, searching for streets, display of information in Chinese and English, a bus guide, and a restaurant and hotel guide. According to the MGTO, MacauMap provides information on popular walking tours of Macau, including a slideshow of scenes along each of these tours. The previous version won several awards for its innovative and high quality tourist-oriented functions, including the first prize at the 2004 Macau Information and Communication Technology Awards and the grand prize in the Tourism and Hospitality Category of the 2004 Asia Pacific Information and Communication Technology Awards.

The first sign-language educational video compact disc (VCD) was launched in early 2007. The VCD features not only vocabulary, but also the unique lifestyle of deaf persons in Macau. The VCD, which is suitable for beginning learners of sign language, was produced to educate the public on how to communicate with deaf persons as part of a wider plan to enable deaf persons to enter the Macau workforce.

ONLINE SERVICES

The MSAR government portal (www.gov.mo) was officially launched in 2004 as the comprehensive platform by which the public can access information and e-services from all

government departments. The portal provides information in the official languages of Chinese and Portuguese, as well as in English. It contains government information, news and announcements, city information, cultural and recreational activities, e-services, legal advice, and an interface for registering comments and complaints.

To facilitate the formulation and implementation of macroeconomic policies and private investment decisions, the MSAR government joined the General Data Dissemination System (GDDS) of the International Monetary Fund (IMF) last August 2007. The GDDS regularly disseminates comprehensive economic, financial, and social statistics aligned with international statistical standards to the international community. The Dissemination Standards Bulletin Board for Macau is available at http://dsbb.imf.org/Applications/web/gdds/gddscountrycategorylist/?strcode=MAC.

Another recently implemented e-service is a traffic fine record system that traffic violators can check to settle their traffic fines within 15 days from the date of offence. This is part of the Road Traffic Law that took effect in October 2007 the implementation of which involves the Public Security Police Force, Land, Public Works and Transport Bureau, Legal Affairs Bureau, and Civic and Municipal Affairs Bureau.

During the winter and early spring, the level of salt in Macau's tap water reaches a record of 500 parts per million. In late 2006 the MSAR government formed a Salinity Response Task Force to discuss measures to tackle the seasonal increase in salinity of the water supply. Among other measures, a four-level 'Salinity Scale for Potable Water' distinguished by colours is made available to the public on a daily basis via the mass media and the Internet.

The MSAR government continues to improve social welfare and social security by providing greater assistance to disadvantaged members of society, promoting the concept of sustainability in social welfare to create a healthy city with healthcare for all, and promoting disease control and prevention in the entire community through the mass media and the Internet.

ICT-RELATED EDUCATION AND CAPACITY-BUILDING PROGRAMS

Based on the 'Fundamental Law of the Non-tertiary Education System', the MSAR government has been investing more in non-tertiary educational resources. Providing ICT-related equipment and connectivity, such as more powerful desktop computers and servers, wireless and fibre campuses, and a projector per classroom, constitutes a large part of the investment.

According to statistics from the Education and Youth Affairs Bureau, there were 86,821 students in formal education and 3,673 students in recurrent education in academic year 2007–2008. The total enrolment was 2.3 percent higher than total enrolment in the previous year. There were 5,100 teacher in 2007–2008, up 6.03 percent from 2006–2007 and making for an improved teacher–student ratio of 1:17.7 compared to the previous year's 1:18.3. The MSAR government is equipping elementary schools with various hardware and software and providing teachers with professional training that would enable them to teach and act as life mentors, promote holistic development of young people, advocate patriotic education about the motherland and Macau, and create a space for young people to demonstrate their abilities and creativity.

According to the MSAR government, the Education Development Fund will provide more resources to help schools improve campus environments and facilities, improve the quality of teaching materials, and facilitate curricular reforms. The latter is envisioned to include small-class teaching, nurturing students whose academic results are outstanding, and providing ordinary students with opportunities to accumulate experience and unlock their potential for successful careers in different industries. Incentive programs are being laid to improve school management and training programs for teachers. In addition, a new student loan scheme that does not impose restrictions in terms of family income is now available.

However, there is a shortage of ICT personnel in Macau, which puts schools at a disadvantage. Because the wages of

Macau Memory Project Lacks Skilled Personnel

The Macau Memory Project (MMP) and Macau Document Information Resource Database (MDIRD) are the core themes of the platform that is used to consolidate and preserve valuable historical information about the Macau culture. The project includes information from the databases of all libraries and organizations, as well as valuable scientific information on Macau on the Internet. The objective is to give the public fast and effective access to up-to-date information to improve the capability and competitiveness of scientific research in Macau. However, the project has been slowed by lack of skilled staff to collect and input the information.

school ICT personnel are lower and the scope of work much narrower than in the private sector, most of the experienced ICT personnel move to the private sector, leaving the schools with less-experienced ICT staff. This in turn affects the quality of ICT teaching and use (see 'Macau Memory Project Lacks Skilled Personnel').

OPEN SOURCE/OPEN CONTENT INITIATIVES

The MSAR government has been promoting the use of open source software and platforms in line with the emphasis on IPR protection. In this connection, the CPTTM has been offering a wide range of Linux courses such as Linux Fundamentals, Linux Network and Security Administration, Linux System Administration, and Linux Administrator Diploma Program. The courses aim to develop network servers who can configure and maintain a Linux system. Linux is widely used by small and medium-sized enterprises in Macau.

Another initiative in open source is use of Web-based JAVA and ASP.NET programming in conjunction with Structured Query Language (SQL) or Oracle database by a group of ICT personnel. They share scripts to be used in different areas of business such as human resource management, attendance record, payroll system, inventory control, and point-of-sale applications. An enterprise resource planning platform across offices and branches is being studied.

ICT RESEARCH AND DEVELOPMENT

The FDCT sponsors the ICT projects of various institutions. One of these was a project by Chipidea Microelectronics called 'full high definition, multi-format video analog front-end intellectual property in 65nm CMOS' that was completed in January 2008. Complementary Metal Oxide Semiconductor (CMOS) is widely used in electronic appliances. The newly developed product has a low voltage of 1.2 volt and low power.

The Portuguese/Chinese Bi-directional Translation System (PCT) is a project that aims to develop a software system for translating Portuguese and Chinese documents bi-directionally (see 'A Bi-directionaly Translation System').

To achieve sustainable development and improve the quality of life of Macau residents, the MSAR government has been promoting a more diversified industry portfolio. A Research Centre for Sustainable Development Strategies was set up in 2006 to help formulate policies and strategies for sustainable development. One of its key focus areas is ICT.

CHALLENGES AND OPPORTUNITIES

Macau has been experiencing rapid economic and social growth in recent years. But its greatest challenge is the shortage of skilled human resources. This has become a bottleneck for sustainable development. The MSAR government has increased efforts to upgrade the skills of local employees, including helping middle-aged residents with a poor educational background to attend suitable job-transfer training and improving the job matching assistance. Still the structural unemployment and lack of ICT expertise remains unresolved.

Encouraging more professional ICT personnel abroad to work in Macau seems inevitable for the sustainable development of ICT in the territory. However, the increasing number of overseas employees has caused concern among local workers and deepened social conflicts. The MSAR government seeks to balance the interests of all parties while ensuring that the local citizens' employment rights are given first priority.

The tax received from the gaming industry has resulted in an income surplus that the MSAR government invests in ICT education as well as in development funds. Although there are uncertainties and conflicts of interest, the opportunities for the development of ICT hardware and software are enormous given the support of the MSAR government.

As the concession contract of CTM will expire in 2011, the MSAR government will have to decide whether the local fixed

A Bi-directional Translation System

The Portuguese/Chinese Bi-directional Translation System (PCT, http://www.inesc-macau.org.mo/pct/) aims to make documents in Portuguese and Chinese equally accessible in various media (i.e. text editor and the Web). The system provides pronunciation in Portuguese, Mandarin, and Cantonese using voice synthesis technology. According to the Institute of Computer and System Engineering, which developed the system, the pronunciation function, stability and accuracy of mouse tracking, and dictionary content have been improved for compatibility with the Microsoft Windows environment in English.

The PCT is available for free download. Many Portuguese and Chinese learners, as well as university students studying translation, use it frequently.

line and international services and leased lines are to be liberalized to encourage benign competition. If it opts for liberalization, many business opportunities will be created for foreign investors and manufacturers.

The concession of MCTV will expire in 2015. In the meantime there are eight antenna service providers illegally providing TV signals to the majority of households. This problem has remained unresolved for over two decades. It will be a great challenge for the MSAR government and the 'illegal' service providers as well as MCTV to arrive at a compromise given the number of households benefiting from the illegal service. Some solutions suggested by the community include revoking the MCTV concession to create fair competition, cutting off or disconnecting the illegal antenna service, and having the antenna service providers provide signals to MCTV. The DSRT needs to take the initiative to resolve the issue.

The lack of sophisticated ICT research centres in Macau prevents further development of high-tech ICT projects. It may however be possible to attract renowned scientific and research centres to set up a branch in Macau, thus providing an important opportunity for the internationalization of ICT development in Macau.

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