Academy of ICT Essentials for Government Leaders

Module 4

ICT Trends for Government Leaders

Rajnesh D. Singh

APCICT
ASIAN AND PACIFIC TRAINING CENTRE FOR INFORMATION
AND COMMUNICATION TECHNOLOGY FOR DEVELOPMENT

The Academy of ICT Essentials for Government Leaders Module Series

Module 4: ICT Trends for Government Leaders

This work is released under the Creative Commons Attribution 3.0 License.
To view a copy of this license, visit http://creativecommons.org/licenses/by/3.0/

The opinions, figures and estimates set forth in this publication are the responsibility of the authors, and should not necessarily be considered as reflecting the views or carrying the endorsement of the United Nations.

The designations used and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Mention of firm names and commercial products does not imply the endorsement of the United Nations.

United Nations Asian and Pacific Training Centre for Information
and Communication Technology for Development (UN-APCICT)
Bonbudong, 3rd Floor Songdo Techno Park
7-50 Songdo-dong, Yeonsu-gu, Incheon City
Republic of Korea

Telephone: +82 32 245 1700-02
Fax: +82 32 245 7712
E-mail: info@unapcict.org
http://www.unapcict.org

Copyright © UN-APCICT 2009

ISBN: 978-89-955886-3-5 [94560]

Design and Layout: Scandinavian Publishing Co., Ltd. and studio triangle
Printed in: Republic of Korea

FOREWORD

The 21st century is marked by the growing interdependence of people in a globalizing world. It is a world where opportunities are opening up for millions of people through new technologies, expanding access to essential information and knowledge which could significantly improve people's lives and help reduce poverty. But this is possible only if the growing interdependence is accompanied by shared values, commitment and solidarity for inclusive and sustainable development, where progress is for all people.

In recent years, Asia and the Pacific has been 'a region of superlatives' when it comes to information and communication technologies (ICTs). According to the International Telecommunication Union, the region is home to over two billion telephones and 1.4 billion mobile phone subscribers. China and India alone accounted for a quarter of all mobile phones in the world by mid-2008. The Asia Pacific region also represents 40 per cent of the world's Internet users and the largest broadband market in the world with a share of 39 per cent of the global total.

Against this background of rapid technological advancement, many have wondered if the digital divide will disappear. Unfortunately, the response to this question is 'not yet'. Even five years after the World Summit on the Information Society (WSIS) was held in Geneva in 2003, and despite all the impressive technological breakthroughs and commitments of key players in the region, access to basic communication is still beyond the vast majority of people, especially the poor.

More than 25 countries in the region, mainly small island developing countries and land-locked developing countries, have less than 10 Internet users per 100 persons, and these users are mostly concentrated in big cities, while on the other hand, some developed countries in the region have a ratio of more than 80 Internet users per 100. Broadband disparities between the advanced and developing countries are even more striking.

In order to bridge the digital divide and realize ICT potentials for inclusive socio-economic development in the region, policymakers in developing countries will need to set priorities, enact policies, formulate legal and regulatory frameworks, allocate funds, and facilitate partnerships that promote the ICT industry sector and develop ICT skills among their citizens.

As the Plan of Action of the WSIS states, "… each person should have the opportunity to acquire the necessary skills and knowledge in order to understand, participate in, and benefit from the Information Society and Knowledge Economy." To this end, the Plan of Action calls for international and regional cooperation in the field of capacity building with an emphasis on creating a critical mass of skilled ICT professionals and experts.

It is in response to this call that APCICT has developed this comprehensive ICT for development training curriculum – the *Academy of ICT Essentials for Government Leaders* – consisting presently of eight stand-alone but interlinked modules that aim to impart the essential knowledge and expertise that will help policymakers plan and implement ICT initiatives more effectively.

APCICT is one of five regional institutes of the United Nations Economic and Social Commission of Asia and the Pacific (ESCAP). ESCAP promotes sustainable and inclusive socio-economic development in Asia and the Pacific through analysis, normative work, capacity building, regional cooperation and knowledge sharing. In partnership with other UN agencies, international organizations, national partners and stakeholders, ESCAP, through APCICT, is committed to support the use, customization and translation of these *Academy* modules in different countries, and their regular delivery at a series of national and regional workshops for senior- and mid-level government officials, with the objective that the built capacity and acquired knowledge would be translated into increased awareness of ICT benefits and concrete action towards meeting development goals.

Noeleen Heyzer

Under-Secretary-General of the United Nations
and Executive Secretary of ESCAP

PREFACE

The journey in developing the *Academy of ICT Essentials for Government Leaders Module Series* has truly been an inspirational eye-opening experience. The *Academy* has not only served to fill a gap in ICT capacity building, but has also paved a new way for curriculum development – through people's participation and ownership of the process.

The *Academy* is the flagship programme of APCICT, which has been developed based on: results of a comprehensive needs assessment survey involving over 20 countries in the region and consultations with government officials, members of the international development community, and academics and educators; in-depth research and analysis of the strengths and weaknesses of existing training materials; feedback from participants in a series of APCICT-organized regional and sub-regional workshops on the usefulness and relevance of the module content and the appropriate training methodology; and a rigorous peer review process by leading experts in various ICT for development (ICTD) fields. The *Academy* workshops held across the region provided an invaluable opportunity for the exchange of experiences and knowledge among participants from different countries, a process that has made the *Academy Alumni* key players in shaping the modules.

The national roll-out of eight initial *Academy* modules marks the beginning of a vital process of strengthening existing partnerships and building new ones to develop capacity in ICTD policymaking across the region. APCICT is committed to providing technical support in rolling out the *National Academies* as its key approach towards ensuring that the *Academy* reaches all policymakers. APCICT has also been working closely with a number of regional and national training institutions that are already networked with central-, state- and local-level governments, to enhance their capacity in customizing, translating and delivering the *Academy* modules to take national needs and priorities into account. There are plans to further expand the depth and coverage of existing modules and develop new ones.

Furthermore, APCICT is employing a multi-channel approach to ensure that the *Academy* content reaches wider audiences in the region. Aside from the face-to-face delivery of the *Academy* via regional and national *Academies*, there is also the APCICT Virtual Academy (AVA), the *Academy's* online distance learning platform, which is designed to enable participants to study the materials at their own pace. AVA ensures that all the *Academy* modules and accompanying materials, such as presentation slides and case studies, are easily accessible online for download, re-use, customization and localization, and it encompasses various functions including virtual lectures, learning management tools, content development tools and certification.

The initial set of eight modules and their delivery through regional, sub-regional and national *Academy* workshops would not have been possible without the commitment, dedication and proactive participation of many individuals and organizations. I would like to take this opportunity to acknowledge the efforts and achievements of the *Academy Alumni* and our partners from government ministries, training institutions, and regional and national organizations who participated in the *Academy* workshops. They not only provided valuable input to the content of the modules, but more importantly, they have become advocates of the *Academy* in their country, resulting in formal agreements between APCICT and a number of national and regional partner institutions to customize and deliver regular *Academy* courses in-country.

I would also like to add a special acknowledgment to the dedicated efforts of many outstanding individuals who have made this extraordinary journey possible. They include Shahid Akhtar, Project Advisor of the *Academy*; Patricia Arinto, Editor; Christine Apikul, Publications Manager; all the *Academy* authors; and the APCICT team.

I sincerely hope that the *Academy* will help nations narrow ICT human resource gaps, remove barriers to ICT adoption, and promote the application of ICT in accelerating socio-economic development and achieving the Millennium Development Goals.

Hyeun-Suk Rhee

Director
UN-APCICT

ABOUT THE MODULE SERIES

In today's 'Information Age', easy access to information is changing the way we live, work and play. The 'digital economy', also known as the 'knowledge economy', 'networked economy' or 'new economy', is characterized by a shift from the production of goods to the creation of ideas. This underscores the growing, if not already central, role played by information and communication technologies (ICTs) in the economy and in society as a whole.

As a consequence, governments worldwide have increasingly focused on ICTs for development (ICTD). For these governments, ICTD is not only about developing the ICT industry or sector of the economy but also encompasses the use of ICTs to engender economic as well as social and political growth.

However, among the difficulties that governments face in formulating ICT policy is that policymakers are often unfamiliar with the technologies that they are harnessing for national development. Since one cannot regulate what one does not understand, many policymakers have shied away from ICT policymaking. But leaving ICT policy to technologists is also wrong because often technologists are unaware of the policy implications of the technologies they are developing and using.

The *Academy of ICT Essentials for Government Leaders* module series has been developed by the United Nations Asian and Pacific Training Centre for Information and Communication Technology for Development (UN-APCICT) for:

1. Policymakers at the national and local government level who are responsible for ICT policymaking;

2. Government officials responsible for the development and implementation of ICT-based applications; and

3. Managers in the public sector seeking to employ ICT tools for project management.

The module series aims to develop familiarity with the substantive issues related to ICTD from both a policy and technology perspective. The intention is not to develop a technical ICT manual but rather to provide a good understanding of what the current digital technology is capable of or where technology is headed, and what this implies for policymaking. The topics covered by the modules have been identified through a training needs analysis and a survey of other training materials worldwide.

The modules are designed in such a way that they can be used for self-study by individual readers or as a resource in a training course or programme. The modules are standalone as well as linked together, and effort has been made in each module to link to themes and discussions in the other modules in the series. The long-term objective is to make the modules a coherent course that can be certified.

Each module begins with a statement of module objectives and target learning outcomes against which readers can assess their own progress. The module content is divided into sections that include case studies and exercises to help deepen understanding of key concepts. The exercises may be done by individual readers or by groups of training participants. Figures and tables are provided to illustrate specific aspects of the discussion. References and online resources are listed for readers to look up in order to gain additional perspectives.

The use of ICTD is so diverse that sometimes case studies and examples within and across modules may appear contradictory. This is to be expected. This is the excitement and the challenge of this newly emerging discipline and its promise as all countries begin to explore the potential of ICTs as tools for development.

Supporting the *Academy* module series in print format is an online distance learning platform — the APCICT Virtual Academy (AVA – http://www.unapcict.org/academy) — with virtual classrooms featuring the trainers' presentations in video format and PowerPoint presentations of the modules.

In addition, APCICT has developed an e-Collaborative Hub for ICTD (e-Co Hub – http://www.unapcict.org/ecohub), a dedicated online site for ICTD practitioners and policymakers to enhance their learning and training experience. The e-Co Hub gives access to knowledge resources on different aspects of ICTD and provides an interactive space for sharing knowledge and experiences, and collaborating on advancing ICTD.

MODULE 4

In just a short few decades, the use of information technology systems has completely transformed how we live, work and play. New markets and new business models have emerged to support the entry, storage, processing, analysis and presentation of information, and these are continuing to evolve and advance at a rapid pace. Global stock markets are now driven by trade in technology-based companies as much as commodity and traditional industries, and information technology is continually being looked at in new ways as a means to deliver improvements in socio-economic conditions, and as a tool for achieving the Millennium Development Goals (MDGs). So where did all these technological developments come from and where are they headed? This module will try to answer this question and provide some insights into current trends in information and communication technology (ICT) and its future directions. It will also look at some of the key technical and policy considerations when making decisions for ICT development in the local and regional context.

Module Objectives

This module aims to:

1. Provide an overview of the evolution of ICT and the role it plays in today's dynamic global environment;

2. Describe current and emerging technologies and their impact; and

3. Describe the key components of ICT infrastructure, and the associated policy and technical considerations.

Learning Outcomes

After working on this module, readers should be able to:

1. Describe current and emerging technologies and their impact;

2. Describe the critical components of ICT infrastructure;

3. Identify key policy and implementation considerations in making effective ICT infrastructure development decisions at the local/national level; and

4. Describe the status of ICT infrastructure, projects and programmes in terms of current technological developments and trends, and in terms of the relevant policy issues.

TABLE OF CONTENTS

List of Case Studies

Technology Briefs

Highlights

List of Figures

List of Tables

Acronyms

3G	Third Generation
ADSL	Asymmetric Digital Subscriber Line
AM	Amplitude Modulation
APCICT	Asian and Pacific Training Centre for Information and Communication Technology for Development
APNIC	Asia Pacific Network Information Centre
ARPA	Advanced Research Projects Agency
ARPANET	Advanced Research Projects Agency Network
ccTLD	Country Code Top Level Domain
CERN	European Organization for Nuclear Research
CO	Central Office
CPE	Customer-Premises Equipment
CPU	Central Processing Unit
CRT	Cathode Ray Tube
DBMS	Database Management System
DNS	Domain Name System
DoS	Denial-of-Service
DSL	Digital Subscriber Line
DSLAM	Digital Subscriber Line Access Multiplexer
DVD	Digital Versatile Disc or Digital Video Disc
ERP	Enterprise Resource Planning
ESCAP	Economic and Social Commission for Asia and the Pacific
FDDI	Fiber Distributed Data Interface
FLOPS	Floating point Operations Per Second
FM	Frequency Modulation
FOSS	Free and Open Source Software
FSF	Free Software Foundation
FTP	File Transfer Protocol
FTTD	Fibre to the Desktop
FTTH	Fibre to the Home
GHz	Gigahertz
GIS	Geographic Information System
GSM	Global System for Mobile Communication
gTLD	Generic Top Level Domain
LAN	Local Area Network
IAB	Internet Architecture Board
IANA	Internet Assigned Numbers Authority
ICANN	Internet Corporation for Assigned Names and Numbers
ICT	Information and Communication Technology
IEEE	Institute of Electrical and Electronics Engineers
IESG	Internet Engineering Steering Group
IETF	Internet Engineering Task Force
IGF	Internet Governance Forum
IP	Internet Protocol
IPTV	Internet Protocol Television
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
IRTF	Internet Research Task Force
ISOC	Internet Society
ISP	Internet Service Provider
ITU	International Telecommunication Union
IXP	Internet Exchange Point

LCD	Liquid Crystal Display
MAN	Metropolitan Area Networks
MDG	Millennium Development Goal
MHz	Megahertz
MMS	Multimedia Messaging Service
NAP	Network Access Point
NAT	Network Address Translation
NRO	Number Resource Organization
NSFNet	National Science Foundation Network
OECD	Organisation for Economic Co-operation and Development
PABX	Private Automatic Branch Exchange
PAN	Personal Area Network
PC	Personal Computer
PDA	Personal Digital Assistant
PSTN	Public Switched Telephone Network
RFC	Request for Comment
RFID	Radio Frequency Identification
RIR	Regional Internet Registry
SaaS	Software as a Service
SCCN	Southern Cross Cable Network
SCS	Structured Cabling System
SMS	Short Messaging Service
sTLD	Sponsored Top Level Domain
TCO	Total Cost of Ownership
TCP/IP	Transmission Control Protocol/Internet Protocol
TLD	Top Level Domain
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UPS	Uninterruptible Power Supply
USA	United States of America
USB	Universal Serial Bus
UTP	Unshielded Twisted Pair
VoIP	Voice over Internet Protocol
VPN	Virtual Private Network
W3C	World Wide Web Consortium
WAN	Wide Area Network
Wi-Fi	Wireless Fidelity
WiMax	Worldwide Interoperability for Microwave Access
WLAN	Wireless Local Area Network
WSIS	World Summit on the Information Society
WWW	World Wide Web

List of Icons

Case Study

Policy Considerations

Questions To Think About

Something To Do

Test Yourself

1. TECHNOLOGICAL EVOLUTION: BROAD DEVELOPMENTS

This section aims to:

- **Describe key technological developments that have shaped today's information technology landscape;**
- **Discuss the issue of digital divide, and some methods to measure it from an access and infrastructure perspective;**
- **Provide a basis for discussion in defining access to information and communication technologies (ICTs); and**
- **Outline the policy considerations that are relevant to national ICT planning.**

Policy considerations

As you read through this section, consider the following from a policy perspective:

- Establishing a National ICT Taskforce that considers advances in technology in a critical manner and provides timely and relevant input into the overall national planning process;
- Formulating a national ICT strategy with balanced input from all stakeholders, and taking into account both global technology trends and local needs;
- National statistics collection efforts that include an ICT aspect to aid in planning and development;
- Policy reform efforts underpinned by market liberalization and competition but balanced by access cost structures and service provisioning to ensure that service providers offer the required services in a reasonable manner; and
- Policymaking that explores alternative forms of access and, in particular, the potential of mobile telephony and convergence.

1.1 Introduction: The Information Age

In just a few short decades, the use of information technology systems has completely transformed how we live, work and play. New markets and new business models have emerged to support the entry, storage, processing, analysis and presentation of information, and these are continuing to evolve and advance at a rapid pace. Traditional primary industry-based economies have transitioned to being knowledge-based economies, India and Malaysia being but two examples. Global stock markets are now driven by trade in technology-based companies as much as commodity and traditional industries, and information technology is continually being looked at in new ways as a means to deliver improvements in socio-economic conditions and as a tool for achieving the Millennium Development Goals (MDGs).

So where did all these developments come from and where are they headed? This module will try and answer this question and provide some insights into current trends in ICT and its future directions.

A quick succession of technology breakthroughs has revolutionized how we communicate and exchange information. Probably the first major breakthrough was the invention of Morse code in 1837, which allowed the conversion of physical movement into electrical impulses that could travel long distances. This was followed by the setting up of an experimental telegraph line in 1844 to transmit data between Washington, DC and Baltimore, Maryland in the USA. By 1858, the first telegraph lines had been laid across the Atlantic, setting the stage for 'international communication'.

In 1875, Alexander Graham Bell invented the telephone, and thus began a new era in 'personal communication'. The era between 1910 and 1920 brought AM radio stations, and by the 1940s television was available, broadcasting sound together with images. The first electronic computer was created in 1943 and, with the invention of the microprocessor in the 1970s, affordable computing for the masses began to show promise.

The 1980s introduced the personal computer (PC) to the general public. IBM launched the IBM PC in the USA in 1981, and subsequently in other regions of the world. While other companies were offering PC products, IBM's offering was based on open standards, the first of its kind on the market. Most of these PC products had similar operating systems, which meant that users were able to interact with each other through the sharing of data and applications.

The 1990s saw desktop computing gain momentum with rapid advances in technology and processing power, and a reduction in prices. This was also the era of the Internet entering the mainstream, moving into the corporate world and into people's homes and rapidly becoming the emblem of the Information Age. The creation of the World Wide Web was a catalyst in the move from research to mass acceptance, and today the Internet and its related technologies drive businesses and economies globally.

But the evolution has not stopped there. The Internet is making possible new ways of doing things. The use of the Internet to send and receive voice communication is a prime example. Cloud computing, which is now coming to the fore at a rapid pace, is perhaps the next evolutionary stage in computing for the masses.

This section looks at some of the key technological developments that have taken place, and the way they are shaping the present as well as the future. It also briefly discusses the digital divide and suggests some measurable indicators (with a focus on access and infrastructure), and provides different perspectives on access to ICT.

Technology Brief

Cloud Computing

Cloud computing is a term that is increasingly being used to describe the evolution of computer resources delivery from dedicated discrete devices to shared centrally located device clusters. The 'cloud' in cloud computing refers to a centrally available network and is typically a reference to the Internet, although it is possible to deliver cloud computing on a private network as well (e.g. an organization may wish to run such a system internally on a private network for its own specific use).

In cloud computing, instead of installing and running applications on PCs, applications are made available from a central point on the Internet typically using Web-based technologies. The applications themselves are hosted on infrastructure that is specially designed to handle the requirements of users who could be dispersed across a city, a country, or the world.

As hardware technology improves and connectivity costs decline, cloud computing is becoming more and more attractive as an alternative to traditional computing. For mobile users, the greatest advantage is being able to access their usual suite of applications from wherever they are. Often this also means being able to access these applications from smaller mobile devices (e.g. Palmtop computers and Smartphones) rather than laptops. There are cost benefits at the corporate level as well: hardware infrastructure can be located in areas with lower costs (premises, utility and connectivity costs are the primary motivators); a larger pool of users share system resources, maximizing utilization; and management tasks are made easier with upgrades and updates delivered centrally.

As is often the case with the technology world, innovation has not stopped at delivering applications from the 'cloud'. Now companies are working on delivering complete Web-based operating systems (see Figures 1a and 1b). Designed to work much like a computer within the 'cloud', these Internet browser-based systems provide users with the look and basic functionality of a local computer contained within an Internet browser window. This could very well help bring computing to those who cannot afford a PC.

Figure 1a. Example of a Web-based operating system: Desktoptwo

(Source: http://www.desktoptwo.com)

»

»

Figure 1b. Example of a Web-based operating system: ZimDesk

(Source: http://www.zimdesk.com)

1.2 The Digital Divide

Simply put, the ‘digital divide’ describes the haves and have-nots of the Information Age. The Organisation for Economic Co-operation and Development (OECD) defines the digital divide as:

> the gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard to both their opportunities to access information and communication technologies (ICTs) and to their use of the Internet for a wide variety of activities.
>
> The digital divide reflects various differences among and within countries.[1]

ICTs play an important role in any economy today. Some governments use ICTs to improve administration and management functions. Others use ICTs for health and education. And then there are some economies that have capitalized on the economic returns that ICT-based industries can offer. India’s ICT outsourcing sector, which is expected to generate some USD 75 billion in revenues from software and services exports by 2010, is a prime example of building an industry around ICT.[2]

To compete in an increasingly globalized marketplace, economies need to not only use ICT, but also ensure the availability of ICT to all sectors of the economy. This requires a significant investment in infrastructure and capacity building, and a policy environment that fosters

1 OECD, “Glossary of Statistical Terms: Digital Divide,” http://stats.oecd.org/glossary/detail.asp?ID=4719.

2 NASSCOM, *NASSCOM Strategic Review 2008 Executive Summary,* http://www.nasscom.in/upload/SR2008_Exec_%20Summary.pdf.

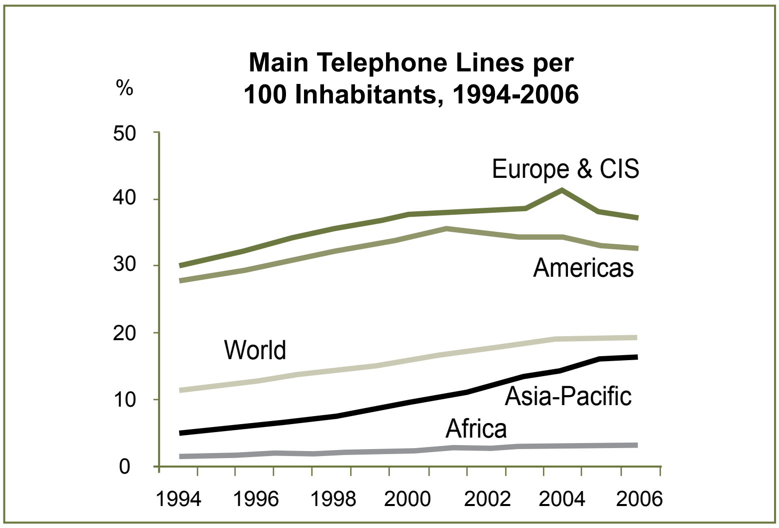
innovation and growth. For this reason, not all economies particularly in the developing world have been able to fully maximize the opportunities offered by ICTs. Hence the digital divide.

How is the digital divide measured? Some basic indicators that are typically used are:

- Access infrastructure – computers, and other devices and systems that potentially provide access (e.g. mobile phones, televisions, community access centres)
- Communication infrastructure – Internet bandwidth, mobile phone coverage, telephone, Internet/broadband
- Teledensity or number of telephone lines per 100 people in a particular region (see Figure 2)
- Household income (and whether there is capacity to purchase and subscribe to ICTs)
- ICT skills curriculum in education
- Use of ICT by gender and minority communities
- Government policies for enabling access (e-government, competition/regulatory frameworks, tariff structure)

Figure 2. Main telephone lines per 100 inhabitants, by region, 1994-2006

(Source: Telecommunication Development Sector, "Global ICT Developments," ITU, http://www.itu.int/ITU-D/ict/statistics/ict)



The Partnership on Measuring ICT for Development[3] is an international, multi-stakeholder initiative — with partners including the OECD, International Telecommunication Union (ITU), United Nations Conference on Trade and Development (UNCTAD), UN Regional Commissions, and the World Bank — to improve the availability and quality of ICT data and indicators, particularly in developing countries. It has developed a list of core indicators[4] that can be collected by countries to provide a global, uniform set of statistics on the Information Society, including:

- ICT infrastructure and access
- Access to, and use of, ICT by households and individuals
- Use of ICT by business
- ICT sector and trade in ICT goods

3 Measuring the Information Society, "Partnership on Measuring ICT for Development," UNCTAD, http://new.unctad.org/default____600.aspx.

4 United Nations, *Core ICT Indicators: Partnership on Measuring ICT for Development* (United Nations, 2005), http://new.unctad.org/upload/docs/Core%20ICT%20Indicators_Eng.pdf.

ICT infrastructure and access core indicators (see Table 1) are centred on individual use and accessibility, and most indicators are on a per capita basis. There are 10 core indicators, with two additional indicators forming an extended set of 12 indicators. The indicators provide statistics on two forms of access to information that are perhaps traditionally important in developing countries. Use of these in national statistics collection efforts by governments is a proactive approach to measuring some important local ICT indicators and contributes to benchmarking these on a global level.

Table 1. Indicators for ICT access and infrastructure suggested by the Partnership on Measuring ICT for Development

Basic core	
A1	Fixed telephone lines per 100 inhabitants
A2	Mobile cellular subscribers per 100 inhabitants
A3	Computers per 100 inhabitants
A4	Internet subscribers per 100 inhabitants
A5	Broadband Internet subscribers per 100 inhabitants
A6	International Internet bandwidth per inhabitant
A7	Percentage of population covered by mobile cellular telephony
A8	Internet access tariffs (20 hours per month), in USD, and as a percentage of per capita income
A9	Mobile cellular tariffs (100 minutes of use per month), in USD, and as a percentage of per capita income
A10	Percentage of localities with public Internet access centres by number of inhabitants (rural/urban)
Extended core	
A11	Radio sets per 100 inhabitants
A12	Television sets per 100 inhabitants

Source: ITU, "Partnership on Measuring ICT for Development: Core List of Indicators," http://www.itu.int/ITU-D/ict/partnership/material/set_core_ICT_indicators.pdf.

Questions To Think About

Consider the suggested indicators above. How relevant are they for measuring the digital divide? Are there some other indicators that you feel would be more appropriate in your country, or perhaps at a global level?

Something To Do

Consider the suggested indicators above and rank them according to what you think should be their order of priority. Include in the list other indicators that you feel are appropriate.

Training participants may do this by country groups.

1.3 Access to ICT

Fundamental to understanding and working towards eliminating the digital divide is an understanding of 'access to ICT'. Access to ICT means different things to different people. Figure 3 summarizes the major points in a somewhat hierarchical manner.

Figure 3. Access to ICT hierarchy

(Credit: Rajnesh D.Singh)

Access to financial resources determines the ability to invest in the necessary skills education and training to effectively use ICTs, purchase the necessary equipment and services, and maintain them.

Access to basic computing skills is necessary to operate, understand and interact with ICTs.

Access to a power source is necessary to power a computing device as well the communication infrastructure.

Access to a computing device is essential to interact with and use ICTs.

Access to Internet provision infrastructure is necessary to get connected to the Internet itself.

Access to the Internet allows one to navigate and use the wealth of information and services available online. Cost of Internet access is also an important consideration here.

Access to content allows one to find applications and services of interest and perhaps even to contribute the same.

Access to localized content allows one to find applications and services in one's own language or dialect, and is of particular relevance to the developing world where a large part of the population may not read or write English, the dominant language of the Internet.

Questions To Think About

Consider the dimensions of access to ICT outlined above. Are they relevant in your own context? Can you identify some other dimensions that should be included?

Something To Do

From the dimensions of access to ICTs outlined above, choose one or two that you feel are the most important and describe how they impact on the digital divide.

Training participants may do this activity in groups.

Access to ICT has many potential components, and each component has accompanying challenges. Often, technology is not the issue because technical solutions to problems are nearly always available (see below). The more significant issues are usually policy-related — i.e. fostering a policy environment that is conducive to alleviating access issues in a holistic manner, and building capacity, whether human or financial. Governments can play a strong role in alleviating lack of access by putting in place an effective national ICT strategy and a progressive policy environment that promotes competition, innovation and ultimately, socio-economic growth.

If finance and related factors were not an issue, can access issues be resolved? Let's take a typical rural setting with no access to the Internet and no electricity, and where the only way to communicate with the outside world is through the use of an ageing radio telephone service. How do we provide access to ICT to this village? Some possibilities are:

Satellite-based Internet access – Install a satellite ground station to provide two-way communication via the Internet to the outside world.

Local connectivity – Install a Wi-Fi-based Local Area Network covering the village and its immediate surroundings.

Power source – Install a solar-based power system with a sufficient quantity of batteries to provide extended system autonomy in times of inclement weather and similar circumstances.

Telephony – Install a Voice over Internet Protocol (VoIP)-based telephone system that is available village-wide through the Wi-Fi system. Portable Wi-Fi phones could also be used for mobility, if desired. VoIP to analogue telephone adapters could be used to provide a standard telephone in every house for villagers to have a familiar interface for using the system.

Local content – Install a local file and Web server for the village. Encourage villagers to learn computing skills and contribute to content on the server, and to develop a local information resource (e.g. local agricultural data, weather, community events). Additionally, the server could provide a locally stored copy of regularly accessed files and applications to minimize external Internet bandwidth usage.

Computing devices – Provide every household with a low-power computing device (e.g. one of the low-cost laptops being made available by various organizations and entities such as One Laptop per Child, Intel Classmate, and ASUS EeePC).

Community training - Provide training sessions to the old and young alike to enable them to take advantage of the opportunities that technology provides.

Note: Refer to the Current and Emerging Technologies section of this module for more information on the technology referred to above, and to the case study on AirJaldi: Wireless Networking in the Himalayas in a later part of this module.

The foregoing shows that technology is almost always available to address problems of access. What is more challenging is having the political will to effect the required change. To effectively deliver on the promise of ICT, it is important for governments to set up a multi-stakeholder national ICT Taskforce that can coordinate with different stakeholders (both internal and external) and provide guidance and advice on ICT strategy. Often, substantial external assistance is available for such initiatives and these should be explored.

Highlight

The Policy Response to Bridging the Digital Divide

Governments can play a key role in bridging the digital divide and setting the foundation for a future knowledge-based economy. This role can be that of enabler, motivator or catalyst.

The government can act as an enabler by promoting infrastructure projects and by providing the private sector with the necessary fiscal and policy environment to innovate. Customs tariff reductions on ICT goods and tax rebates on ICT infrastructure projects are two examples of fiscal policies that could encourage infrastructure investment. A reduction in customs tariffs for ICT goods has a two-fold effect: 1) it reduces the cost of ICT for business; and 2) it brings down the cost of ICT equipment for consumers. Lower consumer pricing would mean more computers purchased, which means more demand for services, which in turn leads to a robust ICT service industry (including greater demand for telecommunications/Internet services). Tax rebate schemes (for example) can encourage the business sector to invest in ICT to improve business processes. Tax rebates may also be applied to the hiring of ICT graduates, to give businesses an incentive to employ them. An increase in the demand for ICT graduates would encourage training providers to produce more ICT graduates and continually improve their training offerings. Competition among service providers is also important. Based on local conditions, there should be a deregulation/competition strategy for telecommunications services, which ideally should also extend to the international gateway.

In most developing economy settings, the government is one of the largest, if not the largest, employer. It also usually has a vast amount of information that it needs to disseminate. By simply moving to an e-government model of operation, the government can act as a catalyst in bridging the digital divide while also improving its administrative efficiency and facilitating access to government services online. This in turn provides opportunities for the private sector to invest in ICT, whether as a supplier of goods and services directly to the government or to other businesses that do so. There is likely to be a flow-on effect from the workplace as well: government employees who are parents may be motivated to provide ICT access for their children, based on what they see and learn at work. This then begins a cycle that ultimately leads to demand for better access, which can be met in due course. »

» The promotion of an appropriate, relevant and forward-looking ICT curriculum in schools is another key area for government support. Children must be exposed to ICT as early as possible, beginning with the primary school level, and a phased approach could take them through to secondary school and beyond. The government should provide schools with the necessary resources by leveraging its bilateral and multilateral partnerships for assistance in this area.

Another high-priority area for the government should be the provision of ICT training and support to small businesses and rural settings. Examples include setting up an agricultural information system for farmers that can provide up-to-date crop, weather and market pricing information in rural areas, and basic business bookkeeping and management training for small businesses, as well as basic accounting software.

Note: For a more in-depth discussion of the policy approach to bridging the digital divide, refer to Module 1: The Linkage between ICT Applications and Meaningful Development and Module 2: ICT for Development Policy, Process and Governance in APCICT's Academy of ICT Essentials for Government Leaders module series.

Questions To Think About

Do you agree that when bridging the digital divide technology is often not the issue and that the greater challenge is having the appropriate policy response and the political will to effect change? Why or why not?

Something To Do

For the individual reader

Identify 3-5 key policy actions that are necessary to bridge the digital divide in your country. Do any of these have a challenging technical component to them? Explain your answer.

For training participants

Undertake a roundtable discussion on "More often than not, technology is not the issue in bridging the digital divide. The more significant issue is having the right policy approach and the political will to effect change."

The trainer will pick 3-5 training participants to serve as panellists in this roundtable discussion. They will be given 10 minutes to prepare and 20 minutes to discuss. This will be followed by a 10-minute question and answer session involving all other participants.

Highlight

Using Mobile Phones to Bridge the Digital Divide

Can mobile phones help bridge the digital divide especially in developing countries?

While a mobile phone may not be able to do everything that a PC can (although that gap is narrowing rapidly with the new generation of 'Smartphones'; see *Technology Highlight – Device Convergence: My Phone is My Computer* later in this module), perhaps mobile phones can be a step in the right direction. Consider the following facts:

- Mobile phones are cheap, with some models retailing for less than USD40 in developing countries.
- Mobile phones generally have a long battery life, which is an important factor for their use in settings where electricity may not be readily available.
- Core infrastructure to support mobile phone services is generally already in existence, covering populated areas. Developing countries have some of the highest take-up rates for mobile phones, usually because landlines are unavailable.
- Most, if not all, mobile phones today have a Web browser of some kind, as well as Short Messaging Service (SMS) and Multimedia Messaging Service (MMS) facilities. Some are converged devices with FM radios and flashlights.
- Various information services are available over the mobile service, as are websites supporting access by mobile phones. This in itself is a business opportunity in-country.
- Prepaid mobile phone services do away with the need for deposits and credit checks. This gives low-income earners the opportunity to connect.
- In community settings, a person (or a group of persons) may be able to set up a 'telecentre' using mobile phones to offer services for a nominal fee. This creates another business opportunity.
- Commercial transactions via mobile phones are available in many markets. These include mobile banking and 'nano-finance' transactions (i.e. low-value transactions such as paying another person electronically by transferring phone credit to his/her mobile phone). This is aside from the quick access to information that having a mobile phone could enable, which is another business opportunity to support nano-finance-based transactions.

The foregoing list of facts suggests that the now ubiquitous mobile phone is a real and practical means to bridge the digital divide in many developing country settings.

Learning how to use a mobile phone is also much easier than learning how to use a PC, and there are fewer application software-oriented issues to deal with. With rapid advances towards converged devices, mobile phones with additional functions are now being designed especially for the developing world. »

» The ultimate success of most projects depends to a large extent on self-sustainability and sound business models. However, for mobile phones to be effective in helping to bridge the digital divide, an appropriate regulatory environment must be in place to ensure that mobile phone services can evolve and adapt to market demand. Second, the service fee structure should encourage wider effective use, including use by low-income earners and economically disadvantaged communities. Governments can play a key role in ensuring that these requirements are met through appropriate policy reform, which may include market liberalization and competition, a review of access cost structures, and ensuring that service providers offer the required services in a way that delivers maximum benefits in terms of technology and affordable access.

1.4 The Telecommunications Evolution

Current telecommunications systems that we tend to take for granted began perhaps with the invention of Morse code, followed by telegraphy and the telephone. Rapid advances in technology led to the development of broadcast radio, television, the computer and the Internet which is now shaping the future of telecommunications. The transformation of the humble telephone invented by Alexander Graham Bell (see Figure 4) into the converged telephone that can be used for browsing the Internet and purchasing goods and services from anywhere in the world, perhaps represents the most remarkable transformation in the telecommunications evolution.

Figure 4. Alexander Graham Bell speaking into his invention, the telephone c. 1876

(Source: http://en.wikipedia.org/wiki/Image:1876_Bell_Speaking_into_Telephone.jpg)

Convergence refers to the evolution of electronic devices from being single-purpose, single-function devices to multi-function devices. More and more features and functions are bundled into one device, which means that a user can use the same device to carry out multiple functions. Some practical examples of device convergence include Smartphones that integrate a mobile phone with many other functions such as a camera, music player and Web browser (see *Technology Brief – Device Convergence: My Phone is My Computer* later in this section), and multi-function printers that integrate a computer printer, scanner, fax machine, etc. into one physical device.

Convergence is not limited to the consumer device level. It is also taking place at the network and services level where, for example, multiple services such as voice, data and video are delivered by one service provider (using the Internet as the delivery medium). Operator convergence has led to one service provider offering services normally associated with different industries. An example is a telecommunications carrier offering television services. This has led to a blurring of traditional roles and sectors, and businesses and organizations are now finding themselves having to compete against new and unexpected rivals, and having to explore alternative business models to ensure continued business survival. This sometimes means collaboration with competitors and confronting interoperability issues head-on to ensure that revenue streams are able to evolve in an ever-changing marketplace.

Convergence at the device level is perhaps evolving the fastest. Consider the Personal Digital Assistant (PDA) that was introduced in the early 1980s to provide an electronic diary/calendar to replace a printed one. Today's PDAs are highly integrated devices providing voice communication, PDA functions, Internet access and multimedia functions. Rapid advances in technology coupled with heightened consumer demand has paved the way for companies to bundle more and more features and functions in one device, and firmly establish the commercial viability of the concept of convergence.

The evolution of the computer games controller (or console) is another example of device convergence. When first introduced in the market, the games console simply provided feedback to the computer to enable players to manipulate characters in a computer game (e.g. the 'joystick' moving a character or object around the screen). Today's games console bears little resemblance to the early 'joystick'. Games consoles such as the Sony Playstation and Microsoft Xbox are highly integrated entertainment systems that can provide Internet access, play high-quality movies and hi-fi sound, and even serve as a DVD player and built-in hard disk drive.

Test Yourself

What kind of mobile phone do you own? Would it qualify as a converged device? Why or why not?

Something to Do

Take a poll of what kind of mobile phones you and your colleagues own and establish how many are converged devices.

Technology Brief

Device Convergence: My Phone is My Computer

Released in early 2007, the Nokia E61i (see Figure 5) is perhaps one of the best examples of device convergence at present. It is much more than a phone, as it provides functionality approaching that of a typical computer. In addition to being a GSM-based mobile phone, the Nokia E61i features:

- A full QWERTY keyboard, with a layout similar to that of a standard keyboard, as well as a navigation joystick
- A 320x 240 pixel 24-bit display screen that can display 16 million colours
- A 220MHz processor as its CPU
- 64MB of internal memory
- An external memory card slot supporting Micro Secure Digital cards up to 2GB in size for application and file storage
- Wi-Fi Wireless LAN supporting IEEE 802.11b and IEEE 802.11g
- Bluetooth, Infrared and USB
- Support for all major GSM networks (quad-band)
- Built-in Voice-over-IP client
- Built-in loudspeaker
- Internet applications: Web browser, e-mail client, instant messaging clients
- Personal Information Manager applications: Calendar, To-do List, Alarms, Reminders, Notes and Contacts, Synchronize Tool to connect to Microsoft Outlook
- Productivity applications: word processor, spreadsheet, presentation, Acrobat Reader for PDF files, zip file utility, file manager
- Multimedia applications: MP3 Player, RealPlayer for video and audio playback, including streaming video, voice recorder for recording calls or notes, and text-to-speech message reader
- Built-in camera (2 megapixel) offering still and video recording
- Support for direct printing to Bluetooth-enabled printers
- Support for virtual private networking
- Up to 9 hours talk time and 17 days standby time, depending on use

With this feature set, the Nokia E61i is able to provide most if not all of the office/work-related and other functions that a typical user would need on a daily basis. With suitable services from a mobile service provider (i.e. voice and data/Internet), this device could replace a computer, particularly for a person requiring mobility.

Figure 5. Nokia E61i: A highly converged Smartphone

(Credit: Rajnesh D. Singh)

Many economies that have successfully harnessed ICT as a catalyst for development and progress (Hong Kong, Japan, the Republic of Korea and Taiwan are examples in the region) have done so by investing early in ICT infrastructure and ensuring that there are sound ICT-based strategies and policies in place to drive growth. Establishing a national ICT Taskforce whose membership includes all stakeholders, including civil society and user groups, is essential. With such a Taskforce in place, developing a sound national ICT strategy or improving an existing policy should be a little bit easier.

However, the need to have appropriate national infrastructure to drive ICT-supported growth cannot be emphasized enough. The next section looks at some key infrastructure components and discusses some emerging trends that should be taken into account when developing national ICT infrastructure and policies and strategies to drive growth.

Test Yourself

1. Evaluate the status of ICT infrastructure in your home country. Highlight what is lacking (in terms of the technical, infrastructure, human resource/capacity, and policy aspects), what course of action can be taken, and what policy recommendations you would make.
2. Is the use of cloud computing a means to bridge the divide? Why or why not?
3. What role do you see for Smartphones in the future? Could they replace a mobile computer (i.e. laptop)? Why or why not?

Further Reading

Textually.org, "Archives for Mobile Phone Project – Third World,"
http://www.textually.org/textually/archives/cat_mobile_phone_projects_third_world.htm.

2. NETWORK BUILDING BLOCKS

This section aims to:
- **Describe the key building blocks that make up today's modern communication systems;**
- **Provide insight into new technologies and trends related to building communication systems; and**
- **Identify the policy considerations relevant to building communication systems.**

Technology evolves, and is embraced, at a rapid pace, particularly in the developed world. This is a challenge for the developing world where users have to cope with these rapid changes often without the necessary resources, and they are either forced to adapt to new technology or miss out on it altogether, which further widens the digital divide. VoIP is one example of this, as are today's video-based websites (such as YouTube) which require significant bandwidth to operate efficiently.

In order to appreciate the technical challenges in delivering some of today's rapidly evolving technology, it is important that policymakers and decision makers in developing countries have an appreciation of the basic building blocks that make up modern communication networks. This section will look at some of these building blocks, and explore some of the new technologies and trends that are emerging.

Policy considerations

As you read through this section, consider the following from a policy perspective:

- Using appropriate technology to 'future-proof' infrastructure — for example, deploying optical fibre networks instead of copper-based networks for critical backbone connections;
- Exploring the possibility of regional and sub-regional cable networks to provide for system redundancy and stability;
- Assessing the benefits that a robust national cable infrastructure can provide;
- In Internet service provision, the need to ensure that there is a level playing field, particularly for customer premises equipment (CPE) and wholesale/international gateway services; and
- In situations where terrain and deployment costs hamper service provision using cable-based systems, the use of wireless systems and/or satellite-based delivery of services and putting fair regulatory mechanisms in place to allow feasible delivery of services.

2.1 Connectivity Medium

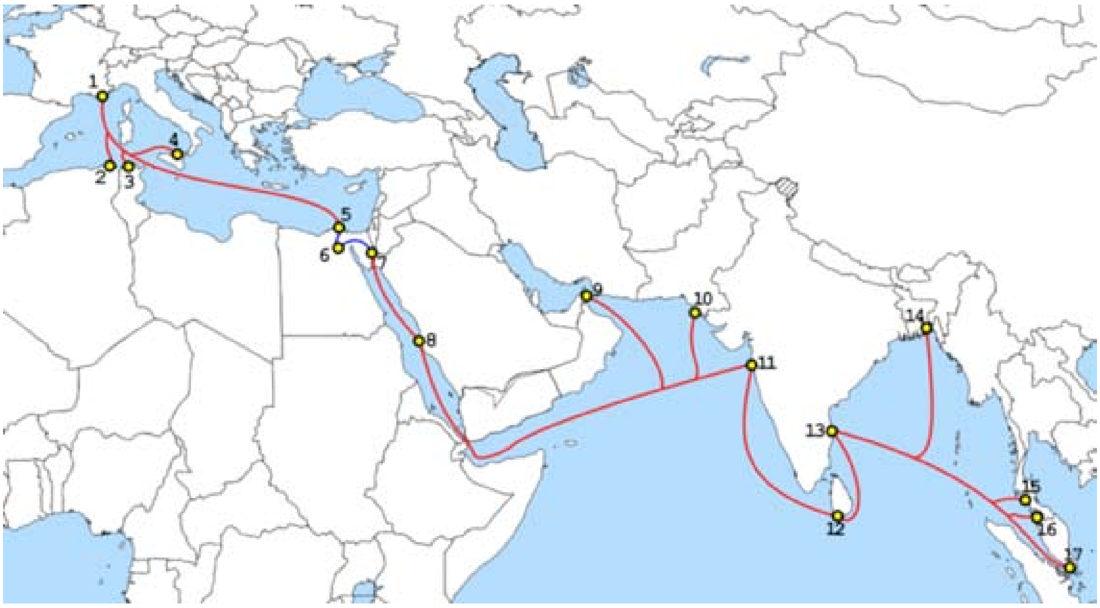
For two or more systems to be able to communicate, there must be some sort of connectivity medium between them. This can be a physical medium, such as cable, or wireless, as with mobile phones.

In this context, a **connectivity medium** refers specifically to a dedicated connection (whether wired or wireless) between two nodes, as distinct from a virtual connection that could be established between two systems over another medium such as the Internet.

The physical medium has traditionally been copper-based cable. However, in the last decade or so optical fibre cable has increasingly been used, particularly for connection over large distances. Trans-ocean connections (i.e. linking the US with Africa, Asia, Europe and the Pacific) (see Figure 6 for the *South East Asia-Middle East-Western Europe or SEA-ME-WE cable system*) all use optical fibre cable, which has a larger information-carrying capacity (or bandwidth) than copper-based cable. It is also immune to electromagnetic interference because it employs light to encode and transmit information instead of electrical impulses as with copper-based cable.

Figure 6. SEA-ME-WE 4 submarine telecommunications cable

Landing points: 1. Marseille, France; 2. Annaba, Algeria; 3. Bizerte, Tunisia; 4. Palermo, Italy; 5. Alexandria, Egypt; 6. Cairo, Egypt (overland); 7. Suez, Egypt (overland/return); 8. Jeddah, Saudi Arabia; 9. Fujairah, United Arab Emirates; 10. Karachi, Pakistan; 11. Mumbai, India; 12. Colombo, Sri Lanka; 13. Chennai, India; 14. Cox's Bazar, Bangladesh; 15. Satun, Thailand; 16. Melaka/ Malacca, Malaysia; 17. Tuas, Singapore (Source: J.P. Lon, http://en.wikipedia.org/wiki/Image:SEA-ME-WE-4-Route.png)



The use of optical fibre cable has also been adopted at the national, metropolitan, and even premises level. Many economies have implemented optical fibre networks as part of their national infrastructure strategy due to the advantages it offers in terms of bandwidth and resilience against interference, and its potential for 'future-proofing' backbone infrastructure.

Future-proofing refers to making educated and informed choices when selecting products and services. That is, these choices are made keeping in mind the need to support expansion and scalability in the future such that expenditure is minimized by not having to pay for products and services twice, or by ensuring the ability to upgrade parts of a system rather than completely replacing the system.

It is generally possible to tap (or break into) a copper-based cable because the cable uses electrical signals to transmit and receive information. This is harder to do with an optical cable that uses light to transmit and receive information. An attempt to tap an optical cable would lead to a loss of signal level, which can be detected. In this sense, an optical cable provides for a somewhat more secure system.

At the metropolitan level, many cities have optical fibre rings or loops (typically deployed by a telecommunications carrier) to better serve business and consumer needs. One or more physical cables may connect strategic points within the city, and the service provider is able to establish virtual circuits (i.e. a connection between points on a communication network that are not necessarily physically interconnected but relies on intelligence within the network to connect the points seamlessly) between any two or more points within the network.

At the premises level, optical fibre is often used to link floors within a building, or to link buildings (e.g. in a campus-type environment).

Optical fibre is also now being used to provide very high-speed, interference-resilient connections between file servers, and even to the user's home or desktop.

Highlight

Fibre to the Home and Fibre to the Desktop

In Fibre to the Home (FTTH), which is available in some countries, services are provided from the service provider to the user's premises over optical fibre cable. Usually, optical fibre is used by the service provider to connect its networks and systems, and the link to the user's premises (sometimes referred to as 'the last mile') is delivered over copper cable or perhaps wireless technology. With FTTH, optical fibre is used to deliver signals right into the user's premises. This allows for large data pipes, as well as bundling of services (i.e. Internet, voice and television) over a very high-speed cable. FTTH is available in some Asian markets, such as Japan, the Republic of Korea and Taiwan.

Fibre to the Desktop (FTTD) is a variation of this where optical fibre cable is used to deliver connectivity right up to the user's computer. This is more common in the corporate environment (although it is not yet widely deployed due to cost considerations) where FTTD guarantees high-speed connectivity, or in environments where there is a lot of electrical interference (such as factories). Some corporate file servers in data centres are interconnected using optical cable, instead of copper cable, for better performance.

Wireless as a connectivity medium is often used for point-to-point links where the laying of cable would be prohibitively expensive (due to terrain, existing structures, environmental factors, and so on), or for mobility (i.e. mobile phone networks), or for point-to-multi-point applications over a dispersed area. Because wireless mediums typically use a licensed radio spectrum, the relevant national spectrum management authority allocates a radio spectrum (or channels) and this is normally subject to technical requirements and a spectrum fee. The exception is Wi-Fi or Wireless LAN networks that use internationally allocated open spectrum in the 900MHz, 2.4GHz or 5GHz range, although there may still be some sort of radio license fee required, depending on local policies.

A point to note here is that anyone can transmit on channels or frequencies used by Wi-Fi and there is no allocation for exclusive use. Wi-Fi equipment is cheap and popular for deploying community networks at home and in the office. This is why congestion can be a problem. Moreover, because microwave ovens also use the same allocated spectrum (as do many other devices, including cordless telephones, burglar alarms, electric gates, etc.), reliability can be a problem and the use of Wi-Fi for mission-critical activities should be carefully assessed.

2.2 Network Devices

The previous section described the connectivity medium used to link two or more systems. This section explores components that may be used at each end of the connection.

Customer Premises Equipment (CPE) is a term usually used to describe equipment that is installed at the end of a link, say from a telecommunications service provider. This equipment effectively serves as the 'gateway' through which one side of a link communicates with the rest of the network. Traditionally this equipment was always owned by the service provider and leased to the customer as part of the service. In recent times, with deregulation in the CPE segment of the network in many countries, customers may elect to supply their own CPE, or source it from a third party. The CPE device is configured with the necessary parameters to be able to access the service provider's network. Some devices are single-purpose only — i.e. all they do is interface with the rest of the network at the service provider end, and have a port to connect to the customer's network. Other devices are multi-function: they will interface with the service provider's network as well as with the customer network, and provide additional services (e.g. routing, security). Examples of CPE include analogue and DSL modems, Network Termination Units, Data Termination Units, Terminal Adapters and Private Automatic Branch Exchange (PABX) systems.

Concentrators and multiplexers are devices that are typically used by the service provider to build and deliver its network. **Concentrators** are used to connect a number of usually slower connections to a higher speed connection. A typical application is for an Internet Service Provider (ISP) using a concentrator to connect dial-up modem connections from customers. A **multiplexer** takes several input signals and combines these into one output signal for transmission. This may be used by the service provider to move information to other parts of the network, or to connect with other service provider networks in an efficient manner.

Routers are used to connect two or more networks. An example is an organization's internal network connecting to the public network (i.e. the Internet).

Network switches are used to connect users on an internal Ethernet network in one physical location. In the past, **network hubs** were used to do this. But switches provide greater bandwidth, speed and reliability.

> **Switches** provide guaranteed bandwidth per port, whereas hubs share the total available bandwidth over all ports. Thus, switches are far more efficient. Problems such as collisions in hubs (when two ports transmit at the same time) do not exist in switches.

A **wiring closet** is a central location where cabling on a building floor (or the entire building) terminates and interconnects. The wiring closet will typically include some form of rack to house equipment, patch panels at which cable from user outlets terminate, patch leads that interconnect ports and outlets within the wiring closet, cable management panels to organize patch leads, switches to connect user outlets to network services, and intermediate distribution frames to interconnect with other services or locations (e.g. voice and other floors). They may also include fans for cooling the closet and back-up power devices (refer to TECHNOLOGY BRIEF: Structured Cabling later in this section for more background information).

A **Local Area Network** (LAN) is a network contained within a relatively small area, such as an office, home, building or group of buildings in a campus environment. Connection speeds within a LAN are high relative to other kinds of networks (e.g. WANs).

A **Wide Area Network** (WAN) is a network that is dispersed over a large geographic area. This could be within a city, within a country, between countries, or between continents. WANs are typically used to link an organization's LANs at different locations for seamless communication.

Wireless Local Area Network (WLAN) refers to the use of wireless technologies to build a LAN. WLAN technology may also be used for point-to-point or point-to-multi-point links over larger distances.

Metropolitan Area Network (MAN) refers to a network larger than a LAN but still contained within a finite geographical area (e.g. a city). A MAN is usually built by an organization and access services are offered to multiple organizations and individuals for whom the services can work as discrete private networks.

Personal Area Network (PAN) is a more recent term used to describe communication between devices that an individual or a small group of individuals (e.g. around a desk) may have. The range of PANs is usually no more than several meters.

Technology Brief
Ethernet

Ethernet refers to the family of LAN technologies standardized under the Institute of Electrical and Electronics Engineers (IEEE) 802.3 standard. Over the years Ethernet has become the de facto choice in implementing end networks, replacing technologies such as Token Ring and Fiber Distributed Data Interface (FDDI). Ethernet is available for use on coaxial cable (the original medium called 10Base-5 for thick coaxial cable and 10Base-2 for thin coaxial cable), copper-based twisted-pair cable (Unshielded Twisted Pair or UTP) and optical fibre cable. Wireless LANs (or Wi-Fi), standardized as IEEE 802.11, also use Ethernet as their underlying technology. The data rates currently available are:

- 10Mbps – referred to as 10Base-T Ethernet
- 100Mbps – referred to as 100Base-T (for copper networks) or Fast Ethernet
- 1,000Mbs – referred to as 1000Base-T (for copper networks) or Gigabit Ethernet
- 10,000Mbs – referred to as 10GBase-xx (depending on medium) or 10-Gigabit Ethernet

Work is being undertaken by the IEEE to introduce the next generation of Ethernet networks, referred to as 100 Gigabit Ethernet (or 100GbE). This standard targets two speeds: 40GBit/s that will run over a variety of media, and 100GBit/s that will run over specific optical fibre but with the advantage of greater connection distances (up to 40km).[5]

There are several other terms used when discussing telecommunications issues, particularly with respect to service providers and infrastructure. These are listed below.

Central Office (CO) usually refers to premises housing a telephone exchange and associated equipment. Each particular area or region typically has a telephone exchange that connects calls between lines from the same region, or to lines in other telephone exchanges in other regions, depending on what the customer has dialled. The CO also generally provides connectivity for data as well as voice lines and is thus integral to a functioning communication network.

International Gateway refers to a special telephone exchange that serves as the link between a national network and networks in other countries, and which facilitates international telephone calls. An international gateway typically handles voice and data circuits, and the links to other countries may be through various connectivity media, including submarine optical cable, terrestrial cable and satellite links.

5 Wikipedia, "100 Gigabit Ethernet," Wikimedia Foundation Inc., http://en.wikipedia.org/wiki/100_gigabit_Ethernet.

Earth Stations (or Satellite Earth Stations or Teleports) are the surface-based end of a satellite communication link and are typically configured to operate with specific satellites offering communication carrier services. Earth Stations are generally used to link an International Gateway with another network. However, there are also applications where an Earth Station may provide connectivity to locations within a country. Figure 7 shows the satellite earth station used by the Republic of Kiribati in the Pacific Islands.

Figure 7. Satellite Earth Station, Republic of Kiribati

(Credit: Rajnesh D. Singh)

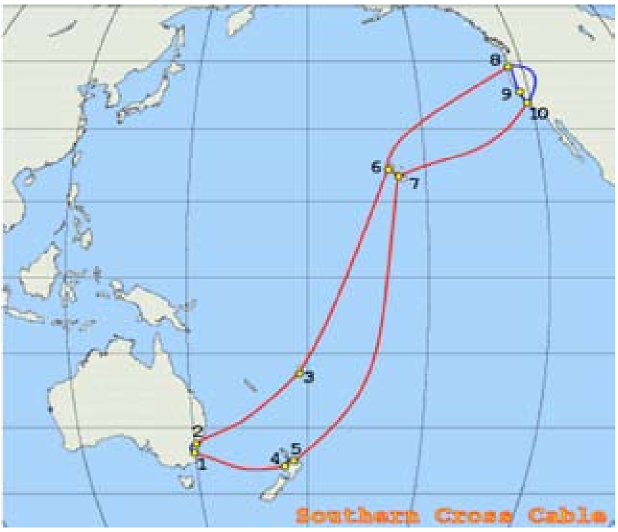
An Internet Service Provider (ISP) is a communication service provider that provides access to the Internet and related services. Historically, ISPs were operated by telephone companies. However, in recent times the service has been subject to deregulation in many economies, resulting in the private sector and other organizations offering ISP services. There are various types of ISPs in existence. Some are 'virtual ISPs' that buy services from other ISPs wholesale and on-sell to retail customers without actually owning or operating much of the infrastructure. Some have their own infrastructure and operate as a real physical ISP, while others only provide services to other ISPs in the form of upstream connections to the Internet.

Highlight
The Southern Cross Cable Network

The Southern Cross Cable Network (SCCN) is a submarine optical fibre cable system linking the US West Coast to the Pacific (see Figure 8 for a geographic layout of the cable). It is configured with redundant cable paths and is self-healing in case of physical damage, to allow network continuity. It is owned by a consortium comprising Telecom New Zealand (50%), SingTel-Optus (40%) and Verizon Business (10%).[6] The initial capital investment was about USD 1.3 billion and the cable has a planned 25-year lifespan.

Figure 8. The Southern Cross Cable Network

(Source: J.P. Lon, http://upload.wikimedia.org/wikipedia/en/thumb/e/eb/Southern-X-Cable-Route.png/375px-Southern-X-Cable-Route.png)



When commissioned in November 2001, the SCCN had a capacity of 80Gbps and it provided the most direct route to the Internet hubs of the West Coast of the USA for most of its landing points. The landing points are: 1. Alexandria, NSW, Australia; 2. Brookvale, NSW, Australia; 3. Suva, Fiji; 4. Whenuapai, New Zealand; 5. Takapuna, New Zealand; 6. Kahe Point, Hawaii, USA; 7. Spencer Beach, Hawaii, USA; 8. Hillsboro, Oregon, USA; 9. San Jose, California, USA (Terrestrial Connection only); 10. Morro Bay, California, USA.

In January 2003, system capacity was upgraded to 480Gbps. Further upgrades in 2008 will provide a total capacity of 860Gbps. Current technology allows the cable system to have a total capacity of 2400Gbps or 2.4Tbps.[7]

Aside from Australia, New Zealand and Hawaii, the SCCN connects Fiji, a Pacific Island country, directly to the Internet hubs of the USA over a high-speed link, which could attract ICT-based businesses serving US-based customers to be located in Fiji.

6 Southern Cross Cable Network, "About Us," http://www.southerncrosscables.com/public/AboutUs/default.cfm?PageID=9.
7 Southern Cross Cable Network, "Big Upgrade for Southern Cross Cable Network," http://www.southerncrosscables.com/public/home/whatsnewdetail.cfm?WhatsNewID=14.

Test Yourself

1. Do you see a role for regional cable networks? What impact could such networks have in your region in terms of access provision and cost?
2. How important is it to 'future-proof' investments in infrastructure in the context of national planning?
3. Is there a role for delivery of communication services by satellite in your region? If yes, are there specific instances where this would be required as an alternative to traditional communication services delivery?

3. THE INTERNET: INFORMATION SUPERHIGHWAY

This section aims to:

- **Describe the key components that make up today's Internet;**
- **Discuss Internet applications and technologies, and the impact they have in the way we communicate now and in the future;**
- **Provide some insight into the organizations involved in the technical and policy aspects of the Internet;**
- **Identify emerging technologies and trends related to the continued development and evolution of the Internet; and**
- **Outline the policy considerations that are relevant to the development of the Internet.**

Policy Considerations

As you read through this section, consider the following from a policy perspective:

- Fostering competition in Internet service provision and ensuring that there is appropriate 'unbundling' of local loop services (i.e. separation of infrastructure from the services that run over it);
- Interconnecting government agencies and institutions using appropriate infrastructure, and fostering commitment to online delivery of as many government services as possible;
- Security and stability of national Internet infrastructure through such means as domain name system (DNS) root server mirrors, Internet Exchange Points (IXPs) and international connectivity redundancy;
- Legislative responses to cyber security (e.g. anti-SPAM legislation and consumer protection on the Internet);
- Maximizing opportunities offered by Internet technology to deliver services and information;
- Providing appropriate regulatory flexibility to ensure the continued evolution of Internet technologies and their use (e.g. liberalization of VoIP and development of broadband Internet from both access and cost perspectives);
- Adopting new technology and deploying forward-looking strategies for infrastructure development (e.g. adopting Internet Protocol version 6 (IPv6) and the use of wireless networks to serve remote and dispersed communities);
- Building an environment that is conducive to the development of community-based networks, particularly in rural environments where commercial provision of services may not be feasible;
- Exploring opportunities to develop regional and sub-regional networks to reduce dependence on particular international links;
- Engaging with regional and international organizations on matters of Internet and ICT policy;
- Using open standards in system deployment to ensure interoperability among systems; and
- Ensuring that the ICT regulatory and policymaking arm of government is proactive in its approach and engages with stakeholders from all sectors, and that it has the capacity to research and assess new technology trends so they can be rapidly adopted where appropriate.

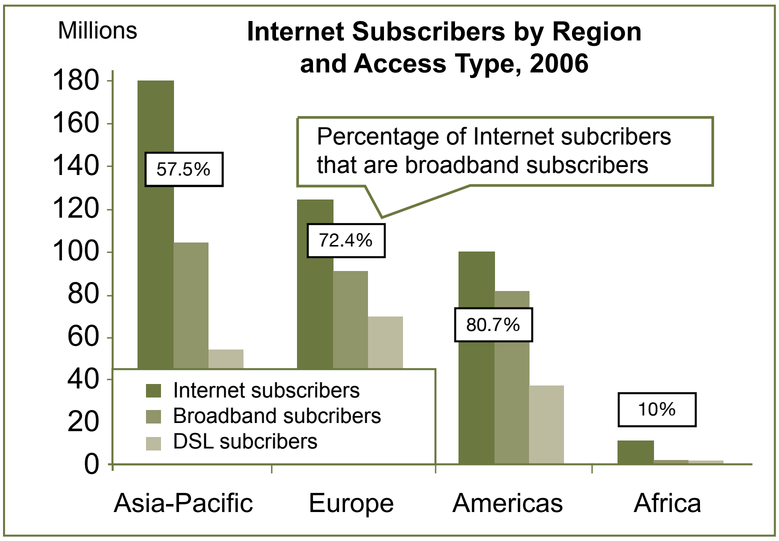
3.1 Introduction

The Internet can best be described as a 'network of networks'. It exists as a global and publicly accessible series of interconnected computer networks that exchange information using the Internet Protocol (IP). In just three decades, the Internet has transitioned from a research network into what it is today — an integral part of daily life for people all over the world.

The growth and influence of the Internet in the past decade has been phenomenal, to say the least (see Figure 9 for an overview of Internet subscribers by region as of 2006). Voice communication over the Internet, blogging, Internet radio, Internet television, social networking sites, cloud computing, and Internet-based user applications have all contributed immensely to the rise in popularity and acceptance of the Internet as the primary communication method for many. The Internet has also given rise to many businesses and industries generating billions of dollars in revenue, which makes the Internet an integral part of the global economy.

Figure 9. Internet subscribers by region and access type, 2006

(Source: ITU, http://www.itu.int/ITU-D/ict/statistics/ict/graphs/ap5.jpg)



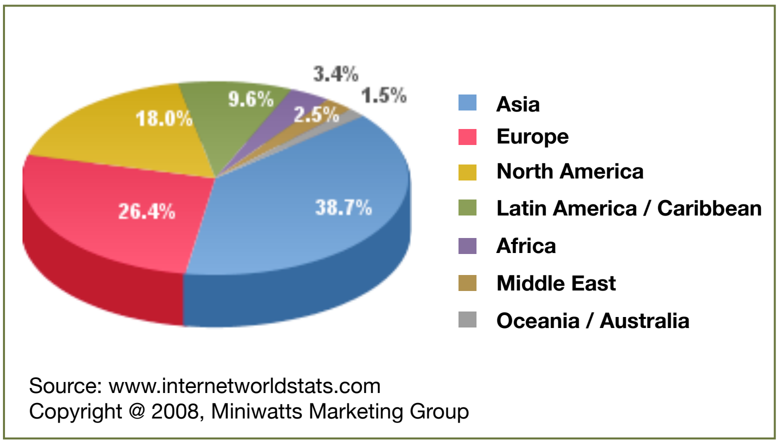
Perhaps the catalyst in the explosive growth of the Internet for the general public was the invention of the World Wide Web (WWW) in 1989 by Tim Berners-Lee at the European Organization for Nuclear Research (CERN).[8] This gave rise to an easy-to-use interface for managing information and resources on the Internet, so much so that the Internet browser is now one of the most used applications in computing.

According to Internetworldstats.com, there were some 1.3 billion Internet users in the world as of 31 December 2007.[9] Research by the Internet Systems Consortium indicates over 500 million domain hosts as of January 2008.[10] Both of these surveys suggest how remarkable Internet growth has been. The concern now is how to get the next billion people online[11] and how to ensure that the Internet is secure and stable for all who use it.[12]

8 World Wide Web Consortium, "Tim Berners-Lee," http://www.w3.org/People/Berners-Lee/Overview.html.
9 Internet World Stats, "Internet Usage Statistics," Miniwatts Marketing Group, http://www.internetworldstats.com/stats.htm.
10 Internet Systems Consortium Inc, "ISC Domain Survey: Number of Internet Hosts," http://www.isc.org/ds/host-count-history.html.
11 Janna Anderson, "Digital inclusion: Working toward getting the next billion people online … and the billions to follow," Imagining the Internet, http://www.elon.edu/e-web/predictions/igf_rio_11_13.xhtml.
12 Internet Society, "Initiatives for 2008-2010," http://www.isoc.org/isoc/mission/initiative/trust.shtml.

Figure 10. World Internet users as of December 2007

(Source: Craig Roth, http://ccsblog.burtongroup.com/collaboration_and_content/WindowsLiveWriter/ICANNOnItsWayOneoftheBiggestChangestothe_A419/WorldInternetUsers2.gif)



Asia in particular has made remarkable advances with Internet technologies since the introduction of the Internet to the region (see Figure 10 for an overview of world Internet users by region). These include the level of broadband Internet use in East Asia (e.g. Japan and Republic of Korea), which is among the highest in the world, and early efforts to adopt IPv6, the next version of the core Internet technology (see IPv6 later in this section for more information). In most instances, the government has contributed significantly to this rapid adoption of Internet technology. In the Republic of Korea, for example, the government led the way in establishing clear objectives for a networked nation, and itself spent large amounts of money to connect all government and public institutions through a high-speed network. It proactively engaged with industry and set national targets, one of which was that by 2005 80 per cent of Korean households would have access to Internet connections at speeds of 20Mbps or more.

Similarly, IPv6 development has had significant government and industry support. This stemmed from recognition of the need to provide connectivity for the large population base in Asian countries (there are simply not enough IP addresses in IPv4, the current version of the Internet, to cater to the Asian population), and of the potential of embedding Internet technology in various appliances and devices, which would provide an economic return to the ICT industry in these countries.

In addition, Asia, with its many languages and scripts, is leading the way in using local languages on the Internet. Across Asia, websites and information are available in local languages, which is an important factor in getting the ‘next billion online’. Recent moves to allow the use of local scripts in the domain name part of websites (referred to as IDNs or Internationalized Domain Names) at the global level will also facilitate these efforts.

3.2 Internet Infrastructure Components

There is no doubt that the Internet is now a critical part of the global economy, which makes it an important component of any national infrastructure, like electricity, transportation services and water supply.

So what actually constitutes the Internet infrastructure and what are some of the key services required to ensure that the Internet stays up and running? Aside from utility services, secure premises, human and technical resources, and various regional and international organizations with administrative and coordination functions (refer to the discussion of Internet organizations later in this section), several issues need to be addressed to ensure that the Internet functions as it should. Some of these are discussed below.

Domain name system (DNS)[13]

The DNS is a critical although usually non-visible part of the Internet. The World Wide Web is typically accessed using a domain name. Similarly, an e-mail is sent using a domain name relative to the person the e-mail is being sent to. For example, to use Google to do a search for something, a person would type in 'www.google.com' into a Web browser. To access his/her Hotmail account, an individual would type in www.hotmail.com (or www.yahoo.com for a Yahoo account). 'Google.com', 'hotmail.com' and 'yahoo.com' are domain names. A Hotmail e-mail address such as robert@hotmail.com uses the 'hotmail.com' domain name.

These domain names are relatively easy for people to remember and use. Computers and other machines connected to the Internet, however, use IP addresses. Simply put, an IP address (referred to as IP version 4 or IPv4) consists of four sets of numbers with each set demarcated by a dot (e.g. 202.62.124.238). These numbers refer to a machine connected to the Internet. Each machine connected to the Internet has a unique IP address. When a domain name is used to access a service on the Internet (e.g. by typing 'www.google.com' into a Web browser), the Internet's DNS is used to translate these readable domain names into IP addresses that are then used to find and send/receive information to specific machines on the Internet. This process is called a DNS request.

A DNS request is generally straightforward, except for the scale of requests on a daily basis. There are billions of IP addresses currently allocated, and many billions of DNS requests are made each day. A single person going about his/her usual daily routine on the Internet can make a hundred or more such requests per day. With hundreds of millions of people using the Internet at any given time, and IP addresses changing daily with upgrades and new installations and so on, the number of requests made is quite staggering. Accordingly, the Internet's infrastructure must be able to serve all such requests.

> Denial of Service (or DoS) attacks can be used to 'crash' the Internet. Such attacks work by inundating Internet servers with so many requests that they cannot handle these and stop responding.
>
> *For a more in-depth discussion of Internet Security issues, refer to Module 6 – Network and Information Security and Privacy in APCICT's Academy of ICT Essentials for Government Leaders module series.*

The set of three letters at the end of 'www.google.com' (COM) refers to the top-level domain or first-level domain. Other top-level domains are GOV, INFO, NET, ORG and a number of others. The unique two-letter combinations for every country (e.g. AU for Australia, FJ for Fiji, HK for Hong Kong, IN for India, RU for Russia, TV for Tuvalu, and VN for Viet Nam) are also included in the list of top-level domains.

13 The discussion in this section is adapted from Marshall Brian, "How Domain Name Servers Work," HowStuffWorks, Inc., http://computer.howstuffworks.com/dns.html.

The second-level domain name is usually the name by which we know a website. In our example above, Google is the second-level domain name. There are millions of second-level domains under the COM domain, since there can be no duplication of second-level domains within a top-level domain. However, duplication is allowed across domains. For example, two google.com names are not possible but it is possible to have google.com and google.net, which refer to two different machines and may have different functions.

The first three letters of a domain name (e.g. www) refer to the host name (see Figure 11). It specifies the name of a specific machine with a specific IP address in a domain. Within a domain, there could be millions of unique host names (i.e. no two host names within a domain should be the same).

Figure 11. Functional parts of a typical domain name

Who is service[14]

To avoid duplication of names in a given domain, applications for a domain name are checked against the whois database, a central listing of the owners and name servers for each domain. The whois database is managed by an organization or company. For example, a US-based company called Network Solutions maintains the COM list. When someone applies for a COM domain name, the application is processed by a Registrar (a company providing domain name registration services) which is authorized by Network Solutions to add names to its whois database. This is done for a fee, called the domain name registration fee, and there is a revenue-sharing agreement between the parties concerned. The same applies to other domains such as ORG and NET.

Large companies and organizations that have hundreds of thousands of IP addresses and host names would typically want to maintain their own sub-list or domain name server for their own domain. For example, Google, which probably has many thousands of computers and servers, would want to maintain its own list of machines under the google.com domain. Similarly, all of the country-related top-level domains (called country code Top-Level Domains or ccTLD) would typically be administered by each country or a nominated organization (e.g. Australia would run AU, Hong Kong would run HK, India would run IN, Kiribati would run KI, and so on).

Many **ccTLDs** have been successfully commercialized. For example, the TV ccTLD belonging to Tuvalu (in the Pacific Islands) is marketed to television operators, which generates substantial revenue for the small island nation. In this sense, ccTLDs are like a commodity, provided the particular ccTLD allocation means something. For example, Niue's (also in the Pacific Islands) ccTLD NU translates to 'new' in Swedish and is marketed quite successfully in Sweden.

14 The discussion in this section is adapted from Marshall Brian, "How Domain Name Servers Work," HowStuffWorks, Inc., http://computer.howstuffworks.com/dns.htm.

Root name servers[15]

The DNS is a distributed database. For example, Google is completely responsible for dealing with the DNS for google.com. It maintains all of the hosts that exist on its domain and it changes its database of hosts whenever it wants or needs to. This is done by modifying the DNS for google.com that handles the requests for machines that are hosted there. Requests by every registered domain are handled by a DNS that is administered by a person who maintains the records in that server. There are millions of DNS servers administered by millions of people throughout the world, which makes the DNS highly distributed. And yet it behaves like a single, integrated database.

A DNS accepts requests from computer applications to convert domain names into IP addresses, as well as requests from other DNS to convert domain names into IP addresses. The server responds to a request in one of four ways:

1. It gives an IP address because it already knows the IP address for the domain.
2. It contacts other DNS servers to find the IP address for the domain requested.
3. It gives an IP address for a name server that might know the IP address of the domain requested.
4. It gives an error message saying the requested domain name is invalid or does not exist.

When a website address is typed into a Web browser, the browser communicates with a name server in order to be able to convert the domain name and host in the address into an IP address. The browser then uses the IP address to request the Web page from the machine with that IP address. The name server is normally set up on the computer's Internet connection settings and is usually provided by the ISP. These days, the name server is usually automatically allocated when connecting to an ISP or corporate network. Thus, the computer knows which name server to talk to. The Web browser contacts the name server and says, "Convert this domain name to an IP address."

If the name server knows the IP address, it will return the IP address to the browser. If it does not know the address, then it will search for the IP address by contacting one of the 'root name servers' (also referred to as root servers). Each local name server knows the address of all known root servers. These root name servers know the IP addresses of all name servers that handle the top-level domain. The name server used by the computer in the example above would ask the root name server for www.google.com and the root would say, "I don't know the IP address for www.google.com but here is the IP address for the COM name server that can tell you," thus providing a path to the page being requested.

Root servers are therefore vital to the whole Internet system. Currently there are 13 assigned root servers around the world that are allocated the letters A through M, and these are maintained by different organizations. Each server has multiple machines supporting it in case of failure, and these root servers literally have hundreds of mirrors around the world for further redundancy. A 'root mirror' has an exact copy of the information held by a root.

The root servers are updated several times a day and this updated information then becomes available to the rest of the Internet through the DNS system hierarchy of asking the root servers for location information on a domain that is unknown to a local name server.

15 Ibid.

Figure 12. Root servers in the Asia Pacific region

(Source: APNIC, http://www.apnic.net/services/rootserver)

It is possible for a country to install a root server mirror in-country by contacting the organizations that run the various root servers. Figure 12 shows the Internet root servers in the Asia Pacific region as of March 2008. An in-country root server mirror helps maintain Internet stability and performance by providing 'local' access to the information contained in the root server instead of obtaining the information from an off-shore source. This reduces the response time for requests, and frees up international bandwidth being used by DNS requests. However, the number of Internet users impacts this: more users mean more bandwidth being used for root server queries.

Peering and transit

Peering arrangements are usually set up between two ISPs so that they can exchange customer traffic destined for each other's network without cost to either party (this is the standard definition although sometimes there are costs involved). Two ISPs will set up a physical interconnection between their networks and exchange routing information so that each network knows where the other is and which path to follow. In this way they know the customers downstream of the ISPs, but not upstream. Some of the benefits of peering include being able to move potentially large amounts of data between the two ISPs without having to use their connection to the Internet backbone. This effectively frees up bandwidth, saves transit cost (see below), and improves access speeds for each ISP's customer base.

Transit is another form of interconnection between ISPs. It is generally used for connecting an ISP to a larger upstream ISP that provides a path to the global Internet backbone. In other words, a transit ISP sells Internet bandwidth wholesale to ISPs that generally serve localized markets. The pricing is usually based on an access-speed-per-month basis (e.g. 10Mbits/second per month) and is subject to a minimum volume of bandwidth. This sort of arrangement may also require the downstream ISP to pay 'volume-based' charges where the more bandwidth they consume in the month, the more it costs them.

Transit (or international transit) is the developing world's primary method of connecting to the global Internet. The ISP is essentially required to pay for the outbound traffic to the Internet from its network, as well as the inbound traffic to its network. Paying for inbound traffic means that the ISP is actually paying for the rest of the world to connect to its network.

Internet Exchange Points (IXPs)

The IXPs are important for ensuring Internet routing efficiency and stability. The value of an IXP is realized when there are more than two ISPs in operation wanting to interconnect. An IXP is basically an extension of the peering concept: physical infrastructure (as in peering but on a larger scale and between multiple parties) is put in place to enable the ISPs involved to exchange Internet traffic between their networks without cost. IXPs may be commercial operations, or they may work on a non-profit basis where the costs of running the IXP are shared among those connecting to it.

IXPs provide two major benefits: lower cost and improved quality of service. Without an IXP, inter-ISP traffic (domestic and foreign) is generally exchanged outside the country, typically through satellite links or (where available) submarine optical cable. Transit costs come into play for inbound and outbound traffic and are borne by the ISP. Most countries employ satellite links for connectivity, which introduces significant latency (delay) in the network. Without an IXP, domestic traffic is also exchanged internationally and network latency translates to 'slow connections' for users and presents itself as a barrier to Internet-based businesses. There is also a direct impact on locally hosted content as users find it more efficient to host sites offshore.[16]

Regional IXPs are being promoted by a number of organizations, including the Internet Society and OECD,[17] particularly in developing country contexts.

Questions To Think About

What do you think of the IXP concept? Do you see how it can improve Internet access and stability? Do you see a need for one (or more) IXP in your home country?

16 Rajnesh D. Singh, *Internet Exchange Points: A Pacific Perspective* (2008).
17 "Ask the economists: Internet & development - towards a Wider World Web?" Online debate hosted by Sam Paltridge, on OECD website, 21 Februaray 2008, http://www.oecd.org/document/29/0,3343,fr_2649_34855_40067741_1_1_1_1,00.html; and Internet Governance Forum, "Internet Traffic Exchange in Less Developed Internet Markets and the Role of Internet Exchange Points (IXP)," http://www.intgovforum.org/BPP2.php?went=31.

Something To Do

Form small groups and consider the issue of IXPs and the state of Internet provision in your home countries, and answer the following questions:

1. Do you see value in having IXPs? Why or why not?
2. Suggest how a regional IXP can be set up in your country/region. Will it require political intervention, or would ISPs be open to the initiative?

International redundancy

International redundancy should likewise be a core feature of national Internet infrastructure. Often in developing countries the international gateway has one link to the Internet backbone (although this is slowly changing). With increasing dependence on the Internet as a medium for business, communication, entertainment and research, network continuity is critical and international gateway providers must be encouraged to have redundancy in their links to the Internet backbone.

Highlight

The Internet Traffic Report

The Internet Traffic Report monitors the flow of data around the world. It then displays a value between zero and 100, with higher values indicating faster and more reliable connections. The site is updated every five minutes and uses the 'ping' test to measure the roundtrip time along key paths of the global Internet. The report is accessible at http://www.internettrafficreport.com.

3.3 Internet Applications

There is a tendency among the general public to define the public face of the Internet — i.e. the World Wide Web — as the Internet itself. This is not correct. The Internet is a physical interconnection of networks around the world that share resources in various forms. One of these resources is the World Wide Web. This section describes this and some other common applications on the Internet, as well as some newer Internet applications.

World Wide Web (or Web)

The Web "is a system of interlinked hypertext (text on a computer that will lead users to other related documents on demand)[18] documents accessed via the Internet."[19] These documents (or pages) may contain text, images, sound, video and other forms of multimedia.

18 Wikipedia, "Hypertext," Wikimedia Foundation, Inc., http://en.wikipedia.org/wiki/Hypertext.
19 Wikipedia, "World Wide Web," Wikimedia Foundation, Inc., http://en.wikipedia.org/wiki/World_Wide_Web.

E-mail

E-mail or electronic mail is a method of creating, sending, receiving and storing messages over an electronic communication system, the most common of which is the Internet.

Highlight

Spam

SPAM, Unsolicited Bulk Email or Unsolicited Commercial Email is the often large-scale misuse of electronic messaging systems to send unsolicited messages, such as advertisements, to a large number of recipients. It is also sometimes related to fraud and other criminal activity on the Internet.

The cost of mass mailing SPAM is very low: there is little cost beyond the management of the mailing list in the spammer's possession (which is often bought from individuals and companies crawling the Internet looking for e-mail addresses and who then sell the obtained addresses to spammers). Given the general absence of anti-spam legislation in most jurisdictions, there is little deterrent for spammers. The spam problem has escalated to such a degree that it is estimated that some 80 per cent or more of all e-mail traffic is SPAM.[20]

The costs of SPAM are high. For developing countries, if 80 per cent of all e-mail traffic is SPAM, then that equates to a lot of wasted bandwidth, the cost of which is ultimately borne by the ISP and passed on to the user through slower access speeds as well as higher prices for access. Moreover, computer systems waste resources processing irrelevant messages, and people spend time reading and sometimes being duped by messages making false promises (e.g. large sums of money, gifts, 10 years of good luck). There are also security issues. Malicious code could also be embedded in these messages, which can affect computer systems or user data. Indeed, anti-SPAM legislation should form part of the national ICT strategy for developing countries as the costs of not going down this path may become too high to bear.

For more information on SPAM and related issues, refer to Module 5 - Internet Governance and Module 6 – Network and Information Security and Privacy in APCICT's Academy of ICT Essentials for Government Leaders module series.

Questions To Think About

1. What is your stand on the abuse and misuse of Internet applications such as e-mail?
2. How serious is the SPAM problem in your home country? How much SPAM (or junk e-mail) do you personally receive on a daily basis?
3. Aside from the adverse impact of SPAM on Internet bandwidth and access speeds, what other effects of SPAM have you observed?

20 Messaging Anti-Abuse Working Group, "Email Metrics Report," http://www.maawg.org/about/EMR.

Something To Do

For the individual reader
Identify 3-5 ways in which e-mail systems may be abused in your organization, and suggest ways by which such abuse could be addressed.

For the training participant
Form small groups and come up with strategies to (i) educate government officials and staff about abuse and misuse of e-mail and Internet systems; and (ii) counter abuse of e-mail and Internet systems.

You have 15 minutes to prepare, and 10 minutes to present your group's strategies.

FTP

File Transfer Protocol (FTP) provides a method to transfer data between computers using a network. File sharing takes place over a Transmission Control Protocol/Internet Protocol (TCP/IP) network, provided both computers are configured to allow FTP access (which is available through various software applications).

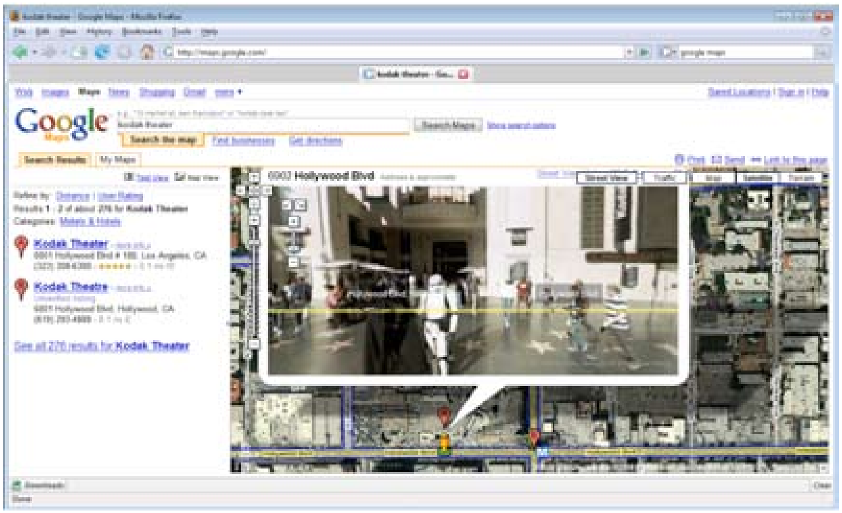
GIS on the Internet

Geographic Information System (GIS) is widely used to analyze, edit, store, share and display geographically referenced data. GIS finds use in many sectors, including land information systems, emergency services, asset management and tracking, environmental assessments, urban planning and logistics.

The use of Internet-based technologies to access and manipulate GIS information has come to the fore in recent times. Google Maps, Google Earth, Microsoft Virtual Earth and Live Maps are some examples of this trend. These applications are taking on many GIS-related functions, such as allowing users to mark locations and embed comments on maps and share this information with others. Google Maps is quite popular for working out street directions and the location of buildings and landmarks in major metropolitan areas around the world, as it offers interactive pictures of locations in some cities (particularly in the US) through which one can view the location from various angles and 'walk' down the street looking at surroundings composed of still photographs merged together (see Figure 13).

Figure 13. The Kodak Theatre, Los Angeles, USA as shown on Google Maps

(Source: http://maps.google.com)



Technology Brief

VoIP: The Internet as a Telephony Medium [21]

Every so often a piece of technology comes along that completely revolutionizes the way we live and work. The telephone, the desktop computer and the Internet are examples of these kinds of technology. In recent years, Voice-over-Internet Protocol or VoIP, which marries these three technologies (the telephone, the computer and the Internet), has had such a profound effect on the global communication industry that it has led to a paradigm shift in how we design and use telecommunications systems.

An important point to note is that VoIP is delivered as an application, with an entirely different service provider delivering the infrastructure. That is, an ISP provides Internet connectivity (the infrastructure) while a VoIP service provider offers the necessary software/hardware technology to allow VoIP calls (the application) over the Internet connection. This separation of application and infrastructure is possible through use of the Internet Protocol and is representative of the telecommunications paradigm shift.

VoIP evolved from the use of computers to make voice calls over the Internet. In the early years, this meant users plugging in a headset into a PC running VoIP software and talking to another user with a similar setup. Users would typically contact each other to arrange a time when both would come online to ‘talk over the Internet’. VoIP has evolved in leaps and bounds since these early rather ‘geek’ type efforts. Today the phrases ‘IP Telephony’, ‘Internet Telephony’ and ‘VoIP’ all generally refer to delivery of communications services using the Internet Protocol.

Over the last couple of years service providers and network operators have moved rapidly to adopt IP as part of their communication infrastructure. Currently there are three types of VoIP call flows in use:

»

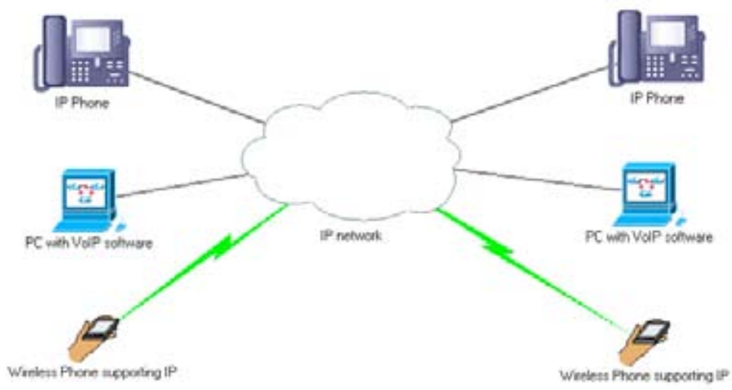
21 Rajnesh D. Singh, *VoIP: Voice over Internet Protocol Status and Industry Recommendations* (2007).

(i) IP device to IP device

In this type of call an IP device at one end makes a call directly to another IP device at the other end. The IP device can be a dedicated IP phone, or a software application (generally referred to as 'softphone'). The call flows purely over an IP network from end to end (see Figure 14).

Figure 14. VoIP call flow: IP device to IP device

(Credit: Rajnesh D. Singh)

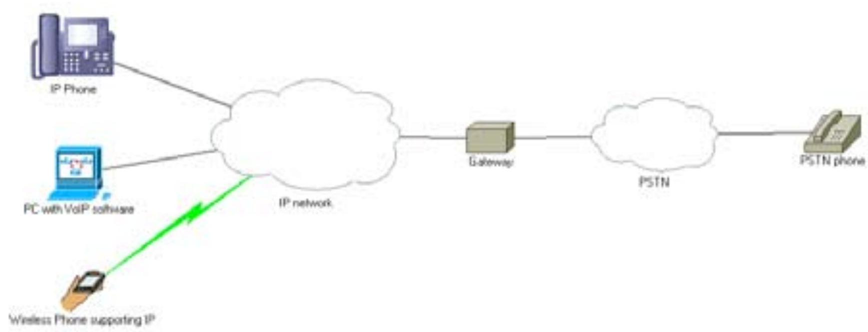


(ii) IP device to PSTN

In this type of call an IP device at one end makes a call to a standard Public Switched Telephone Network (PSTN) phone at the other end. The IP device can be a dedicated IP phone, or a software application (generally referred to as 'softphone'). The call flows over an IP network via a VoIP gateway to the PSTN (see Figure 15).

Figure 15. VoIP call flow: IP device to PSTN

(Credit: Rajnesh D. Singh)



(iii) PSTN to PSTN

In this type of call a standard PSTN phone at one end makes a call to another standard PSTN phone at the other end. The call flows through the PSTN from one end via an IP network to the PSTN at the other end (see Figure 16).

Figure 16. VoIP call flow: PSTN to PSTN

(Credit: Rajnesh D. Singh)

New services have been introduced, such as presence detection (the ability to know through some form of online signalling whether a person is available or not) and the 'universal number' concept (i.e. one can have the same phone number from anywhere in the world as long as there is a suitable Internet connection), which are both forms of distributed intelligence. IP-based technology provides other benefits, such as:

- Delivery of voice, and the seamless convergence of data, voice and video applications across multiple and diverse devices;
- Easier and less expensive upgrades as a large number of these can be done via software or firmware;
- Rapid development of new innovations at lower cost by using an open architecture system rather than closed proprietary systems; and
- Improvements to equipment life cycle, as feature enhancements, updates and systems maintenance can be done electronically, improving performance and lowering maintenance costs over the life of the system.

Full adoption of IP in communication networks will take several years to complete, with co-existence of the PSTN and IP networks expected to continue through this transition period.

The potential benefits of adopting VoIP for both service providers and users include the following.

Improved access to information:

- It enables growth in penetration of information services to the home whether via cable, DSL or other emerging access technologies.
- VoIP is media-independent.
- It promotes social development through access to an integrated IP network that facilitates distance learning, telemedicine and e-government.
- It promotes economic development through access to new markets.

Elimination of boundaries:

- VoIP gives users the flexibility to use one or more communication devices, such as a PC, telephone, PDA, wireless phone, or perhaps a TV set top box.
- VoIP integrates voice in other services that can be offered cost effectively since the network operation is streamlined.
- VoIP eliminates boundaries between wireless and wired devices and facilitates interconnection.
- VoIP permits geographic independence and mobility, and it has the potential for convenience of access via one number anywhere.

»

Reduction of costs:

- For voice traffic, data is compressed and transmitted over an IP-based computer network, which means that VoIP uses up to 90 per cent less bandwidth than a traditional PSTN call.
- Packet-switched networks can cost about a third of a circuit-switched system and can save about 50-60 per cent in operating costs.

Consistent quality of service:

- IP networks can be specifically designed to deliver quality of service for VoIP.
- 'Managed IP' networks support the capability to prioritize voice traffic and ensure consistent communication regardless of how congested the network is.
- In a well-designed environment the user is typically not able to distinguish any difference in quality between a managed VoIP call and a traditional PSTN call.

There are several policy issues around VoIP that should be considered when working on a VoIP strategy. These include:

Numbering – It is quite possible that in the future, Session Initiation Protocol addresses and 'handles' or nicknames may be used for addressing and making calls, and there must be some way of mapping these to traditional telephone numbers. This may require a special range of telephone numbers to be allocated to VoIP service providers to allow seamless integration with incumbent telephone service providers. Number portability, or allowing users to keep their telephone number when switching service providers, is also important in some markets.

Emergency service access – Access to emergency services is generally viewed as an important part of voice communication service provision. It is important to consider whether the existing telecommunications infrastructure for emergency services is compatible with VoIP access, including caller location functions. Governments can stipulate that VoIP service providers clearly outline limitations of their service and ensure that users know and understand these limitations.

Universal service – Universal service is generally defined as the provision of a defined minimum set of services to all users at an affordable price. Governments may stipulate that this minimum set of services include connection to the PSTN and public access telephone services at fixed locations (i.e. emergency call phones), public phones, and special measures for disabled users. The provision of universal service can be handled by one or more operators, and governments can require VoIP service providers to contribute to the cost of providing such services.

Network security – Because communication services are critical to a country's infrastructure, service providers are generally expected to take appropriate measures to safeguard their systems. Since VoIP can transition through the public Internet, these measures could include safeguarding against viruses and DoS attacks. Service providers can also be required to inform users of potential security risks from the services they provide.

Law enforcement access – Law enforcement authorities generally require access to communication networks as part of their work. Appropriate technology needs to be implemented to allow lawful interception (where authorities can listen in to, »

» or record, communications as part of collecting evidence or monitoring of criminal activity and other purposes approved by law) of communication services as well as interoperability.

VoIP offers a whole new way of doing things, and with the push to bridge the digital divide it makes possible one network delivering voice, data and video seamlessly. From a policy point of view, there is a need to implement timely and flexible regulatory processes that will ensure that the technology available evolves and is able to deliver on its promise. The ultimate objective should be that users are able to use an application or device of their choice on the network on condition that it does not harm the network, and that users are able to fully exploit the services available.

3.4 Internet Organizations

No discussion of the Internet today would be complete without mention of the organizations involved in its development, administration and governance. The Internet is generally regarded as a loosely organized collaboration of various international organizations that are all working towards the common good and continued security and stability of the global Internet. Decisions and policy directions are often determined by a consensus-based bottom-up process. This is a shift from the traditional top-down model of governance where governments and inter-government organizations and agencies made the policy recommendations and directives. For example, the policy input into the traditional telecommunications sector came from regulators and policymakers on the advice of agencies such as ITU. What prevailed was an enforcement type process rather than a collaborative engagement process, as decisions were made and implemented perhaps with some dialogue with telecommunications service providers but with little input from society at large. With the advent of the Internet and associated technologies, this decision-making process has had to adapt to a changing environment, which demands multiple stakeholder input into the policy process.

The multiple stakeholder model encompasses all sectors, including the private sector, civil society and user groups. At times this poses a challenge to established practices and norms. However, with the rapid move towards convergence, it is imperative that governments understand and move toward an inclusive multiple stakeholder engagement process. This would ensure that an informed decision is made on policy issues that takes into account the wider public's views and concerns. An important point to note here is that traditional telecommunications policy issues have become for the most part general public policy issues. For example, telecommunications access costs, competition, and adoption of new technologies such as VoIP for service delivery are areas where consumers are demanding choice in all its forms, from pricing to customer service to being able to choose a service provider at will.

The multiple stakeholder model also means that governments and ICT policymaking departments in particular, must keep abreast of global technological advances and engage not only with local stakeholders but also with the various international organizations that are involved in the development and evolution of the Internet. One way to achieve this is through the establishment of a unit within the regulatory department that is dedicated to researching and analysing new technologies and their impact locally, and to coordinating with various non-traditional ICT standards and policy organizations. The following is a brief overview of some of these international organizations.

The Internet Society[22]

The Internet Society (ISOC), a non-profit organization founded in 1992, provides leadership in addressing public policy issues on the future of the Internet, and is the organizational home for the groups responsible for Internet infrastructure standards, including the Internet Engineering Task Force (IETF) and the Internet Architecture Board (IAB). It also acts as a global clearinghouse for Internet information and education, and as a facilitator and coordinator of Internet-related initiatives around the world. ISOC also helps run international network training programmes for developing countries. Moreover, it has played an important role in setting up and maintaining Internet infrastructure in many countries.

ISOC has more than 80 organizational members and more than 28,000 individual members in over 90 chapters around the world. ISOC's most recent initiative is the creation of regional bureaus to serve the regional Internet community. Currently ISOC regional bureaus serve Latin America and the Caribbean, Africa, and South and Southeast Asia. ISOC has offices in Washington, DC, USA, and Geneva, Switzerland.

IETF

The IETF develops and promotes standards and protocols covering TCP/IP and other technologies related to the Internet. According to the IETF's RFC3935: A Mission Statement for the IETF:

> The goal of the IETF is to make the Internet work better. The mission of the IETF is to produce high quality, relevant technical and engineering documents that influence the way people design, use, and manage the Internet in such a way as to make the Internet work better. These documents include protocol standards, best current practices, and informational documents of various kinds.[23]

The IETF carries out its functions through various working groups, and much of the work is done via mailing lists. There are also three meetings held every year. There is no formal membership requirement for the IETF.

The actual Internet standards are published in the form of a Request for Comment (RFC). RFCs essentially document research and technologies associated with the Internet and are then offered for peer review and comments. Some of these are subsequently published as Internet standards by the IETF. Not all RFCs are Internet standards, as some are published for informational purposes. Editing and publishing of RFCs are carried out by the RFC Editor,[24] which is funded by the Internet Society.

IESG

The Internet Engineering Steering Group (IESG) oversees the technical management of the IETF and the Internet standards process. This is done in line with the rules and procedures approved by ISOC's Board of Trustees.

---

22 This section is adapted from Internet Society, "Introduction to ISOC," http://www.isoc.org/isoc.
23 Network Working Group, *Request for Comments: 3935 - A Mission Statement for the IETF* (Internet Society, 2004), http://www.ietf.org/rfc/rfc3935.txt.
24 RFC Editor, http://www.rfc-editor.org.

IRTF

The Internet Research Task Force (IRTF) is a sister organization to the IETF. Its stated mission is "[t]o promote research of importance to the evolution of the future Internet by creating focused, long-term and small Research Groups working on topics related to Internet protocols, applications, architecture and technology."[25] The IRTF is managed by the Internet Research Steering Group, which functions like the IESG.

IAB

The IAB is tasked by the Internet Society with the overall technical and engineering development of the Internet. It oversees a number of Task Forces, including the IETF and the IRTF. The IAB looks at the 'big picture' of the Internet and engages in long-term planning and coordination. It also acts as the appeals board for appeals against IESG actions; appoints and oversees the RFC Editor; approves the appointment of the Internet Assigned Numbers Authority (IANA); acts as an advisory body to ISOC; and oversees IETF liaisons with other standards bodies.

IANA[26]

The IANA is responsible for coordinating some of the key elements that keep the Internet running smoothly. While the Internet is renowned for being a worldwide network that is free from central coordination, there is a technical need for some key parts of the Internet to be globally coordinated and the coordination role is undertaken by the IANA.

Specifically, the IANA allocates and maintains unique codes and numbering systems that are used in the technical standards ('protocols') that drive the Internet. These include the DNS root and the global pool of IP addresses that it allocates to Regional Internet Registries (RIRs).

The IANA is one of the Internet's oldest institutions, with its activities dating back to the 1970s. Today it is operated by the Internet Corporation for Assigned Names and Numbers (ICANN), an internationally organized non-profit organization set up by the Internet community to help coordinate IANA's areas of responsibilities.

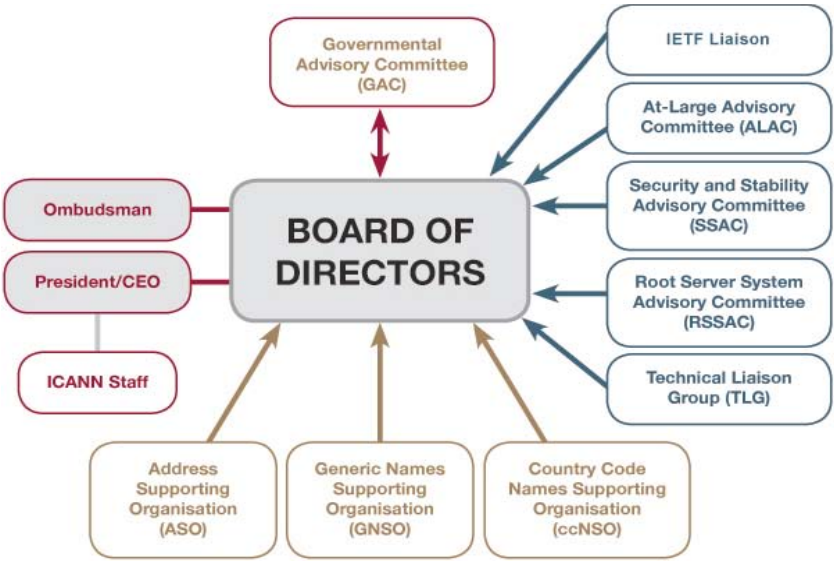
ICANN

ICANN coordinates the overall unique identifiers on which the Internet runs. This includes IP addresses and the DNS. The technical functions of ICANN are generally handled by IANA, which is funded and operated by ICANN. The rest of ICANN's activities relate to coordination of policy. Much of this work is done through a set of Supporting Organizations and Advisory Committees (see Figure 17).

25 Internet Research Task Force, "IRTF Mission," http://www.irtf.org.
26 This section is adapted from IANA, "Introducing IANA," http://www.iana.org/about.

Figure 17. ICANN organizational structure

(Source: ICANN, http://www.icann.org/about/)



W3C[27]

The World Wide Web Consortium (W3C) is an international consortium where member organizations, full-time staff and the public work together to develop Web standards. Its mission is "[t]o lead the World Wide Web to its full potential by developing protocols and guidelines that ensure long-term growth for the Web." The W3C can be likened to the IETF, except that it focuses on the Web and associated technologies.

The W3C pursues its mission primarily through the creation of Web standards and guidelines, which are called W3C Recommendations. Some 110 W3C Recommendations have been published since 1994. Other activities of the W3C include education and outreach, software development and an open forum for discussion about the Web.

Web interoperability, which refers to the ability of hardware and software used to access the Web to work together, is one of the W3C's goals. The goal is addressed through the publication of open (non-proprietary) standards for Web languages and protocols, through which the W3C seeks to avoid market fragmentation and Web fragmentation.

Tim Berners-Lee, inventor of the World Wide Web, serves as the W3C Director.

WSIS, WGIG and IGF

The World Summit on the Information Society (WSIS) consisted of two conferences hosted by the United Nations. One of its objectives was to bridge the digital divide by improving Internet access in the developing world. The first conference was held in Geneva, Switzerland in 2003, and the second in Tunis, Tunisia in 2005. The ITU took on the role of lead organizer.

27 This section is adapted from W3C, "About the World Wide Web Consortium (W3C)," http://www.w3.org/Consortium.

The Geneva meeting adopted a Declaration of Principles[28] based around shared knowledge and an information society that is accessible to all. A Plan of Action[29] set the goal of bringing 50 per cent of the world online by 2015. However, it did not state how this is to be achieved, nor did it cover funding and Internet Governance issues. For this reason, the Working Group on Internet Governance (WGIG) was created after WSIS Geneva 2003. Its task was “to investigate and make proposals for action, as appropriate, on the governance of Internet by 2005” and present the result of its work in a report “for consideration and appropriate action for the second phase of the WSIS in Tunis 2005.” Specifically, the WGIG was tasked to develop a working definition of Internet Governance and to identify relevant public policy issues and the role of stakeholders in the process.[30]

The second WSIS conference in Tunis in 2005 resulted in the Tunis Commitment[31] and the Tunis Agenda for the Information Society,[32] and the formation of the Internet Governance Forum (IGF).[33] The Tunis Agenda for the Information Society invited the UN Secretary-General to convene a new forum for multi-stakeholder policy dialogue (paragraph 67) by the second quarter of 2006 in an open and inclusive process (paragraph 72). The IGF is a multi-stakeholder forum for discussing Internet Governance issues and supporting the UN Secretary-General in implementing the outcome of the WSIS conferences. An Advisory Group composed of members from the private sector, government and civil society (including the academic and technical community) was formed to advise the IGF Secretariat on matters related to the convening of the IGF meetings.

The IGF has a five-year mandate, with the first meeting held in Athens, Greece in 2006 and the second meeting held in Rio de Janeiro, Brazil in 2007. The 2008, 2009 and 2010 meetings will be held in Hyderabad, India; Cairo, Egypt; and Lithuania or Azerbaijan, respectively. The Athens 2006 meeting was centred around the themes of Access, Diversity, Openness and Security. Critical Internet Resources was added as a fifth theme at the 2007 meeting. It should be noted that the IGF is not a policymaking body but more an open forum for multi-stakeholder dialogue.

Regional Internet Registries[34]

In each region, the management, distribution and registration of public, numeric Internet address space and related resources are the responsibility of an RIR. Five RIRs exist at present (Table 2).

Table 2. Regional Internet Registries

RIR	Region served
APNIC	Asia Pacific
RIPE NCC	Europe and the Middle-East
ARIN	Northern America and sub-Saharan Africa
LACNIC	Latin America and the Caribbean
AfriNIC	Africa

Source: APNIC, http://www.arin.net/community/rirs.html.

28 WSIS, “Declaration of Principles,” http://www.itu.int/wsis/docs/geneva/official/dop.html.
29 WSIS, “Plan of Action,” http://www.itu.int/wsis/docs/geneva/official/poa.html.
30 WGIG, “About WGIG,” http://www.wgig.org/About.html.
31 WSIS, “Tunis Commitment,” http://www.itu.int/wsis/docs2/tunis/off/7.pdf.
32 WSIS, “Tunis Agenda for the Information Society,” http://www.itu.int/wsis/docs2/tunis/off/6rev1.html.
33 IGF, http://www.intgovforum.org.
34 This section is adapted from APNIC, “About APNIC,” http://www.apnic.net/info/faq/apnic_faq/about_apnic.html.

The IANA, which established the RIRs, delegates large ranges of Internet resources (i.e. sets of IP addresses) to the RIRs, which then allocate the resources within their regions. Consistency of policies and promotion of best practice for the Internet are achieved through close coordination among the RIRs and other organizations.

The five RIRs together compose the Number Resource Organization (NRO) which was formed to undertake joint activities of the RIRs, including joint technical projects, liaison activities and policy coordination.

Test Yourself

1. Which organization develops the standards for the core technologies that make the Internet run?
2. Which organization is charged with the administration of the numbers and names that make the Internet work?
3. What RIR serves the region you live in?

3.5 IPv6

IPv6 is the next generation of the Internet Protocol; it will succeed IPv4 on which much of the Internet runs today. IPv4 allows for some four billion IP addresses, a large number of which has already been allocated to organizations and individuals. According to some estimates,[35] this pool of addresses is expected to run out somewhere between 2010 and 2012.

In the early 1990s it became clear that the current number of IP addresses would not be sufficient for the Internet of the future. Various ways to deal with the issue were proposed and the IETF responded by forming working groups. These efforts led to the first RFCs defining IPv6 in 1996 and publication of the current version of IPv6 in 1998.[36]

IPv6 provides for some 340 trillion addresses. The original Internet was built on the idea of end-to-end connectivity (i.e. one machine can communicate directly with another machine), and IPv6 is a step back in that direction.

Network Address Translation (NAT) was invented as a way around the address resource limitations of IPv4. A NAT is implemented in a router or gateway and is able to share one public IPv4 address on the WAN side with multiple computers (with private, non-public Internet routable IP addresses) on the LAN side. Thus it allows many more devices to access the Internet through one public IPv4 address.

35 Geoff Huston, *IPv4 Address Report,* http://www.potaroo.net/tools/ipv4/index.html.
36 Network Working Group, *Request for Comments: 2460 - Internet Protocol Version 6 (IPv6) Specification* (Internet Society, 1998), http://tools.ietf.org/html/rfc2460.

An increase on the number of available addresses, through IPv6, means that there will also be some changes to the way that such addresses are used and displayed on a Web browser for example. An IPv4 address is composed of four groups of digits and looks like the following:

202.62.220.198

An IPv6 address is composed of eight groups of four hexadecimal digits:

2001:0db8:85a3:08d3:1319:8a2e:0370:7334

On a Web browser this will be used and displayed as follows:

IPv4 http://202.62.220.198/
IPv6 http://[2001:0db8:85a3:08d3:1319:8a2e:0370:7344]/

Aside from the increase in the number of IP addresses, IPv6 provides for the following:

Auto-configuration – Devices can be configured automatically when connected to an IPv6 network. When first connected to a network, the device sends a request for its configuration parameters. For networks that are configured to do this, a router will respond with network-layer configuration parameters.

Multicast – The source sends information only once, to be received by many, which helps with network efficiency.

Jumbo grams – IPv4 has a limit of 64kB payload while IPv6 can do up to 4GB.

Security – IPSec, the protocol for IP network-layer encryption and authentication, is an integral part of the IPv6 base protocol.

Mobility – File or data transfer can continue uninterrupted as a device 'roams'.

Quality of service – There is better support for multimedia and other applications requiring quality of service. Performance guarantees are based on priority.

Better routing features – There is more efficient fragmentation reassembly, and support for today's networks and routers.

The IPv6 digital divide

As Internet technology keeps evolving, more and more applications, devices and services will require IP addresses to communicate and integrate into a connected world. This requirement can only be met by IPv6. It is essential therefore to provide for a transition to IPv6 in national ICT strategies. The government can play a key role in ensuring that the national Internet infrastructure is ready to interface with the new Internet. Failure to do so is likely to create an Internet digital divide. Applications and services in the IPv6-enabled part of the world will, more likely than not, rapidly transition to IPv6-based services. In a short span of time, these applications and services will assume that the users they are serving are IPv6-enabled and they will engineer the delivery of their applications and services around this assumption. This will create an IPv6 digital divide for users trying to access the application or service from a non-IPv6-enabled region. It is possible that these users will experience reduced features and functions, or the application or service may not work for them at all.

Moving to IPv6

The greatest need for IP addresses is in the developing world. The majority of IPv4 allocations are with the developed world, in particular North America and Europe. In recent years, Asia Pacific has become the largest and most dynamic Internet market, and this is where the need is greatest. There are not enough IPv4 addresses available to serve the expected demand in this region (see Figures 18 and 19 for an overview of regional IP address allocations). Some Asian countries realized this very early on, and they are now recognized as the leaders in IPv6 research and deployment.

Figure 18. IPv6 allocations – RIRs to LIRs/ISPs

(Source: Numbers Resource Organization, http://www.nro.org.)

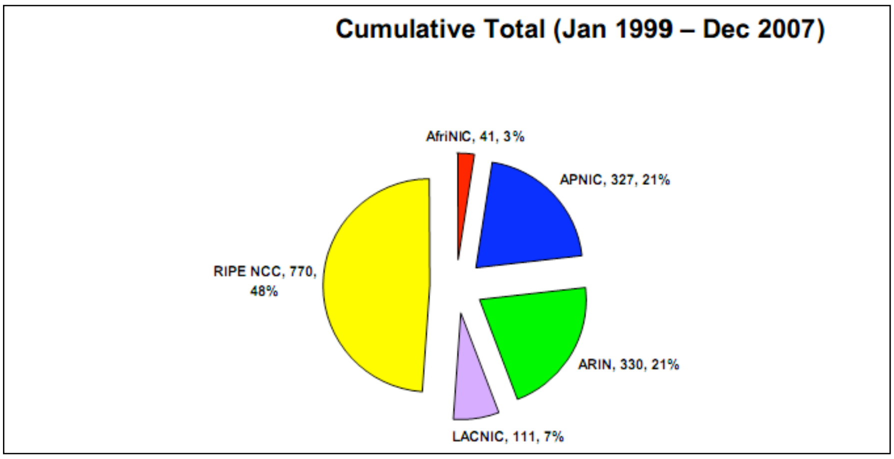
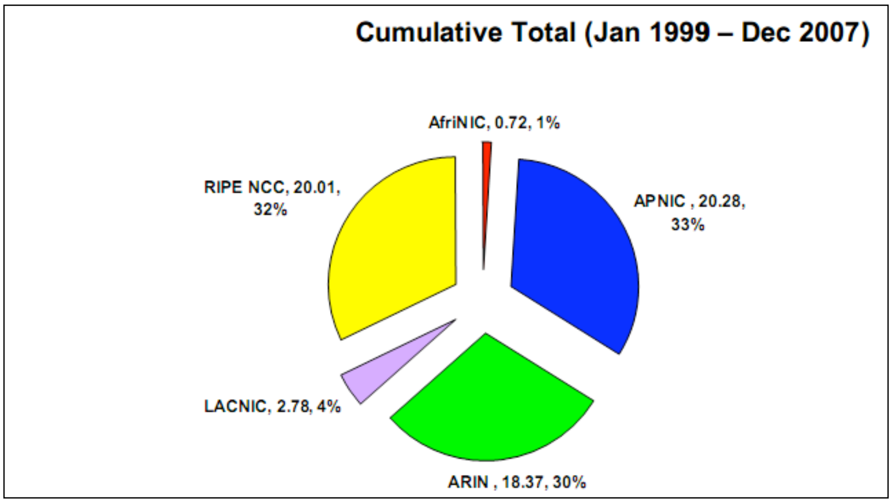


Figure 19. IPv4 allocations – RIRs to LIRs/ISPs

(Source: Numbers Resource Organization, http://www.nro.org.)



The move to IPv6 will not happen overnight. Thorough planning is required, as well as investment in upgrading equipment and, in some cases, applications. The key is to start the planning process early; involve all stakeholders, including the user community; and set in motion a roadmap for deployment.

One feature of IPv6 is the ability to embed IPv4 addresses within it, and this can play an important part in phased deployment as it is possible to run a hybrid network. Both IPv4 and IPv6 will need to be run concurrently in the immediate future to ensure a smooth transition. However, there will likely be some equipment that cannot be upraded to IPv6, and will require replacement. There are some options available in moving to IPv6, including the following:

'Dual Stack' devices – Routers and some other devices may be configured with both IPv4 and IPv6 so they can 'talk' to both types of networks.

IPv4/IPv6 translation – 'Dual stack' devices may be designed to take requests from IPv6 hosts, change them to IPv4, send them to the IPv4 destination, and then process the return information the same way.

IPv4 tunnelling of IPv6 – IPv6 devices that do not have a direct all-IPv6 path between them may be able to communicate by encapsulating IPv6 datagrams within IPv4.

At the operating system level, IPv6 has been available for quite some time. Linux has had IPv6 support since 1996 (kernel v2.1.8). Microsoft Windows XP (SP1) Server 2003 and later versions generally have IPv6 available in some form, although it may require activation and configuring. Windows Vista is IPv6-enabled by default, as is Mac OS X v10.3 'Panther' and later versions.

IPv6 also requires changes to the Internet's DNS, and several ccTLDs have already done this, including FJ (Fiji), JP (Japan), KR (Republic of Korea), NZ (New Zealand) and VN (Viet Nam).

The uptake of IPv6 worldwide has been slow. The most likely reason for this is the current lack of a 'killer application' — i.e. an application that requires IPv6 to function and which the user community would be interested in, thereby creating demand. ISPs, particularly in the developing world, have also been slow in promoting end-to-end Internet. They typically prefer to provide customers with one IP address that they expect the customers to use as a shared address, and attach a NAT device to it to provide connectivity to other machines on their internal network.

However, positive steps have been taken in recent times by some governments. In 2005 the US government mandated that US government agencies connect to an IPv6 backbone by June 2008.[37] China launched the China Next Generation Internet Project (based on IPv6) in 2003 with the aim of achieving leadership status in cyberspace.[38] Japan and the Republic of Korea also have an IPv6 strategy, and other nations in the region are at various stages of planning or research towards the same.[39]

Test Yourself

What is the main reason for moving to IPv6?

37 Executive Office of the President, USA, 2 August 2005, M-05-22 Memorandum for Chief Information Officers from the Office of Management and Budget on the "Transition Planning for Internet Protocol Version 6 (IPv6)," http://www.whitehouse.gov/omb/memoranda/fy2005/m05-22.pdf.

38 "China reaps big fruits for future Internet," *People's Daily Online,* http://english.people.com.cn/200609/26/eng20060926_306545.html; and Ben Worthern, "Internet Strategy: China's Next Generation Internet," *CIO Magazine Online,* 15 July 2006, http://www.cio.com/article/22985/Internet_Strategy_China_s_Next_Generation_Internet_.

39 Asia Pacific IPv6 Task Force, "2008 Asia Pacific IPv6 Summit," Taiwan Network, http://www.apipv6tf.org/meetings/summit2008.

Questions To Think About

What is the status of IPv6 deployment in your home country? Is there any discussion about or policy move towards IPv6 in your country?

3.6 Next Generation Computing

As Internet technology has matured, it has given rise to an assortment of new generation technologies, some centred around finding new and innovative ways of doing old things such as interacting with others in a club, making telephone calls or monitoring industrial/manufacturing systems.

Social networks

A new generation idea that has really come to the fore in recent times is social networks. These are based on communities of users who have shared interests and activities and who are interested in interacting with others. For Internet-savvy young people especially, social networking sites are increasingly becoming a replacement for clubs and groups that require a physical presence. Existing social networks represent a great variety of interests, from breeding dogs to dating to growing tomatoes, from environmental action groups to political campaigns to sports and games.

The typical social network site is Web-based, and it provides for user interaction through blogs, discussion forums, file sharing (pictures, documents, music, etc.), chat, e-mail and other forms of multimedia. In some cases there is a marketplace for selling products and services, notification of local and regional events, and the like. Examples of social network sites are Facebook (www.facebook.com), Hi5 (www.hi5.com) and MySpace (www.myspace.com). See Figure 20 for what a typical user page on Facebook looks like.

Figure 20. Facebook social networking website, http://www.facebook.com

(Credit: Rajnesh D. Singh)

There are also social network sites that appeal to, or specifically target, the professional community. These could be centred around an area of work, building a network of contacts, or a referral and reference service. These types of communities revolve around professional or career-related interests and may include discussion boards and forums on topics like management, sales, and the like. Two such sites are LinkedIn (www.linkedin.com) and Xing (www.xing.com). Figure 21 shows the LinkedIn Internet home page.

Figure 21. LinkedIn professional networking website, http://www.linkedin.com

Sensor networks

The increasing computerization of systems and processes in many industries has led to rapid advances in sensor networks, particularly for control and monitoring applications. Smart chips are already being embedded into credit cards, and the use of contactless cards in building access/security systems is common all over the world. There is also an increasing requirement for traceability in food production and processing, which sensor networks can assist with.

The next stage of development is linking various sensor networks and technologies to a larger network, in particular the very public and global Internet. Many companies around the world, but particularly in Japan, are putting much effort into wireless sensor networks, including using IPv6 as the communication protocol.[40]

40 Itarua Mimua, 2004, “Home Network and Sensor Networking technology based on IPv6” (presented at Consumer Electronics Show, 2004), http://www.usipv6.com/CES_Presentations/CES_Itaru_Mimura.pdf.

Technology Brief
RFID

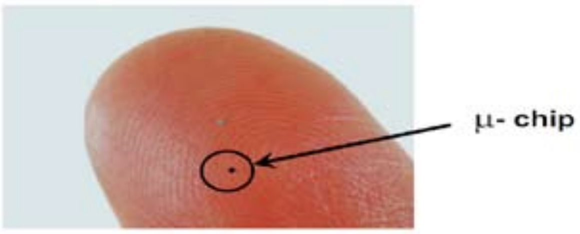
Radio Frequency Identification, commonly referred to as RFID, is a method of identification that uses RFID tags or transponders to store and retrieve data using radio waves. RFID tags can be 'installed' in just about any object, including livestock, human beings and tangible products. Depending on the technology used, these RFID tags can be 'read' from several metres away.

Typical RFID tags are composed of an integrated circuit to store and process information and to generate and process a radio frequency signal, and an antenna for transmitting and receiving information. Recently, chipless RFID tags that can be directly printed onto an item have become available, reducing the per unit cost of using the technology. Recent advances in technology have resulted in smaller and smaller RFIDs (see Figures 22 and 24).

RFID may be compared to barcodes on store products. Barcodes store information such as the manufacturer and product type, and at the store's cashier this information is linked to the price of the item and to stock levels. Shoppers typically wait in a queue for the cashier to scan the barcodes on products they are purchasing and compute the total amount to be paid. With barcodes, it takes a cashier about five minutes to process a shopping trolley full of goods. If the products in the trolley had RFID tags, the scanning process would take mere seconds. An RFID sensor is able to detect and process multiple signals simultaneously, which means that simply pushing the trolley past the cashier would get everything in the shopping trolley processed all at once. This significantly decreases the processing time per customer, and improves the overall efficiency of the sales transaction.

Figure 22. Hitachi's μ-chip, one of the world's smallest RFID tags, measuring 0.4 x 0.4 mm

(Source: Hitachi)



RFIDs are finding applications in many fields. Some countries, the first being Malaysia, have incorporated RFID tags into their passports.[41] These RFID tags contain the information typically printed on a passport and they can also record entry and exit dates and times, as well as a digital picture of the passport holder.

Hong Kong's Octopus Card[42] (Figure 23) is a highly successful example of an RFID application. Introduced in 1997 as a means to pay for travel on Hong Kong's Mass Transit System, the Octopus Card is now used for all forms of public transport, as well as for transactions in convenience stores, fastfood restaurants, vending »

41 Wikipedia, "Biometric passport," Wikimedia Foundation, Inc., http://en.wikipedia.org/wiki/Biometric_passport.
42 Wikipedia, "Octopus card," Wikimedia Foundation, Inc., http://en.wikipedia.org/wiki/Octopus_card.

» machines, service stations, phone booths and car parks. The Octopus Card uses a chip made by Sony in a 'touch and go' system where the user only has to hold the card in close proximity to the card reader for it to be read (i.e. no physical contact is required).

Figure 23. Octopus Card Reader at an MTR Station

(Source: Juntung Wu, http://en.wikipedia.org/wiki/Image:OctopusReaderGate.jpg)

The Octopus system is designed to use a store-and-forward mechanism for transactions, and the card reader does not require a real-time link to a central database system. The transactions can be relayed later at regular intervals for updating and processing. The actual method used depends on the operator's requirements. Hong Kong's Mass Transit Railway (MTR) system links all of its card readers and terminals at a particular station using a Local Area Network. This in turn connects over a Wide Area Network to the MTR head office, from where it links to the central processing centre for the Octopus Card.

Figure 24. Hitachi's RFID powder measuring 0.05 x 0.05 mm, compared to a strand of human hair

(Source: Hitachi)

Grid computing

> If computers of the kind I have advocated become the computers of the future, then computing may someday be organized as a public utility just as the telephone system is a public utility... The computer utility could become the basis of a new and important industry.
>
> John McCarthy,
> MIT Centennial in 1961

These words spoken some 47 years ago by John McCarthy, a pioneer of Artificial Intelligence (he also coined the term), are now a reality. Grid computing or 'distributed computing' refers to having multiple complete computers connected via a network medium such as the Internet or a Local Area Network using Ethernet, processing information in parallel. The concept is based on the fact that with the mass production of commodity computers, it is cheaper to buy and parallel these together than to purchase a supercomputer, which parallels multiple Central Processing Units (CPUs) within one complete machine connected internally. In grid computing, each resource within the grid may be geographically dispersed and each may be managed by a different entity. This is what differentiates it from clusters and data processing centres.

Parallel computing refers to a system where multiple processing operations are carried out simultaneously. It works on the premise that a large problem can be divided into several smaller ones and then solved (or processed) concurrently. New generation computer systems have embraced this in the form of 'multi-core' processors that in effect are two or more processors integrated into one chip.

Grid computing is more suited to instances where the processing of data can happen independently in blocks without having to communicate intermediate results between each processing unit (or computer).

Highlight

The SETI@home Project

Perhaps the most well-known grid computing project is the SETI@home project. The Search for Extra-Terrestrial Intelligence (SETI) project is a scientific attempt to detect intelligent life forms outside Earth. The project analyzes radio signals from space and looks for patterns that may indicate intelligence.

The SETI@home project is an extension of the SETI project. Volunteers download a piece of software and install it on an Internet-connected PC. The software then downloads blocks of data from a central server, analyzes it, and then sends the results back to the central server.

The SETI@home project is based on the fact that most home computers are idle for large amounts of time or are underused given their processing power. The project makes use of this idle time or underutilization to process data.

There are currently over 1.8 million participants in the project, of which over 340,000 are active.[43] The system is capable of performing over 440 teraFLOPS (Floating point Operations Per Second). Compare this to the world's fastest computer as of November 2007,[44] the IBM Blue Gene/L rated at 596 teraFLOPS. Since its inception SETI@home has logged over two million years of aggregate computing time. Although the project has not yet found definitive signs of life elsewhere in the universe, it has proven that the concept of grid computing is feasible and can be an important tool for the scientific community, with processing capabilities comparable to that of supercomputers.

For more information, visit http://setiathome.berkeley.edu.

3.7 Broadband

As the Internet evolves, it gives rise to new technologies, applications and users demanding richer applications, greater interaction and faster speed. In the early days of the Internet, a speed of 14.4kbps using a dial-up modem was considered standard, 28.8kbps was considered very good, and 33.6kbps was something to be proud of. Today, in highly developed parts of the Internet world, speeds of over 1024kbps are not uncommon. In Japan it is possible to get speeds of 100Mbps or more delivered to your home. The need for speed has led to the introduction and acceptance of broadband technologies for Internet access. But what is broadband and how is it defined?

43 BOINC Stats, "SETI@home," http://boincstats.com/stats/project_graph.php?pr=sah.
44 TOP500, "Top 500 Supercomputing Sites Ranking History for the IBM Blue Gene/L," http://top500.org/system/ranking/8968.

Defining broadband[45]

There is a lot of confusion around the definition of broadband, in particular what speed qualifies as broadband. The most important thing to keep in mind is that today broadband is at best a relative term.

In technical terms, broadband is a signal that carries a wide range of frequencies. In this sense, multiple signal streams (e.g. data) are sent concurrently to effectively increase the rate of data transmission. This can be compared to baseband where one signal will use the full bandwidth available in a medium. In simple terms, broadband sends multiple signals over one medium, which effectively increases the speed, while baseband sends one signal over one medium.

So how fast is broadband?

The ITU Standardization Sector (ITU-T) recommendation I.113 defines broadband as a transmission capacity that is faster than primary rate ISDN (which is 1.5 to 2 Mbit/s depending on American or European implementation).[46]

The US Federal Communications Commission[47] defines broadband as 200 kbit/s (0.2 Mbit/s) in one direction, and advanced broadband as at least 200 kbit/s in both directions.

The OECD defines broadband as 256 kbit/s in at least one direction.

While the OECD definition is probably the most common baseline 'broadband speed' around the world, the puritans are likely to disagree. Technically speaking, an analogue modem operating at greater than 600 bits/s (or 0.6kbits/s) is broadband. Higher data rates are obtained by using multiple channels on the same medium, so that two channels at 600 baud would give 1,200 bits/s, four channels would give 2,400 bits/s, and so on. In today's terms this is low data speed broadband because it combines multiple signal streams over the same medium (refer to the definition of a broadband signal above).

Unfortunately, there is no specific all-inclusive globally accepted definition of broadband as evidenced by the varying definitions by different organizations around the world. ISPs capitalize on this fact and typically market anything above dial-up modem services as 'broadband'. Generally speaking, most regulators and policymakers tend to go by the OECD definition and thus Internet broadband is regarded as anything better than 256kbits/s (usually referring to download speed, as upload speeds are generally slower). A point to note is that most ISPs will typically oversell the backbone bandwidth that they have available because most users do not use their full link capacity all the time. This generally works, with users being able to burst up to their link speed most of the time. However, there is likely to be performance degradation at peak times if the available ISP backbone capacity is heavily oversold.

Remember also that most broadband connections are asymmetric in nature. For example, if you subscribe to a 256k package, this will be the maximum download speed while the upload speed is likely to be 64k or another multiple of 64k. This is important to note, as it can affect the use of applications such as VoIP as well as the upload of large amounts of data.

45 Rajnesh D. Singh, "How BROAD is my BAND???!!" Singh-a-Blog, 30 April 2006, http://singh-ablog.blogspot.com/2006_04_01_archive.html.
46 ITU, "The Birth of Broadband," http://www.itu.int/osg/csd/publications/birthofbroadband/faq.html.
47 Federal Communications Commission, http://www.fcc.gov.

Technology Brief

IPTV: The Internet as a Television Broadcast Medium

As broadband Internet becomes more and more accessible in many parts of the world, yet another everyday aspect of life is likely to be transformed. Television (TV) has been around since the 1940s, and the method of delivery and how one watches TV have remained practically the same since then. A TV station broadcasts signals (through wireless or, in some scenarios, over cable), and a TV receiver in one's home receives these signals and transforms the received signal into moving pictures and sound. For over 60 years people have been accustomed to watching a rectangular box with a screen (see Figure 25 for an early generation commercial television set), usually enjoying a prominent location in the living room. But all that is changing.

Figure 25. Braun HF 1 television receiver, Germany, 1959

(Source: Wikipedia, http://en.wikipedia.org/wiki/Image:Braun_HF_1.jpg)

Internet Protocol Television (IPTV) is the delivery of a digital television service over network infrastructure using Internet Protocol. The network infrastructure may be broadband Internet, or it could be what is referred to as a 'closed network' where a service provider will deliver the service and engineer it in such a way that the network is able to deliver the required performance for IPTV at high quality. The service is typically bundled with other services, such as Internet and telephony (commonly referred to as 'triple play' services). This allows the service provider to maximize their investment in infrastructure.

There is also what is commonly referred to as 'Internet Television', consisting of generally freely available television broadcasts delivered over the public Internet and the received quality of which is dependent on the user's Internet access speeds and the ISP's network infrastructure (Figure 26). IPTV requires substantial investment in infrastructure on the part of the service provider, while Internet Television uses existing Internet infrastructure that a customer may already have in place. Consequently, Internet Television is a relatively cheap and quick service although subject to network conditions.

»

» IPTV services usually come with a ‘set-top box’ connected to a display, much like pay television services, whereas Internet Television typically uses a PC to display images and sound. With continued advances in computer technology, which have brought about better products at lower prices, such as large and widescreen computer displays, Internet Television is quite convenient for many users, particularly for obtaining ‘video on demand’ (i.e. users may browse through a catalogue of movies or television programming, and download and view their selection).

Figure 26. Bloomberg Television live on the Internet

(Source: http://www.bloomberg.com)

Many traditional television services providers stream content live on the Internet, usually to increase viewership, which in turn provides revenue from advertising, the traditional income of television service providers. But Internet Television is not only for the traditional service providers; it also offers opportunities for independent content producers to reach a wide, ready audience without having to negotiate with television service companies, or without having to invest heavily in infrastructure to deliver content. In this way, the Internet yet again offers a paradigm shift in the delivery of traditional services — first mail and telephony, and now television.

Questions To Think About

Consider the likely impact of Internet Television. Where do you think is this new technology headed? Does it have a future? If yes, what impact do you think will Internet Television have on traditional television broadcasts?

Broadband access technologies

Broadband Internet access can be delivered in many forms, covering the whole range of connectivity media, from copper cable to optical cable and wireless. Some of the current technologies are described below.

DSL

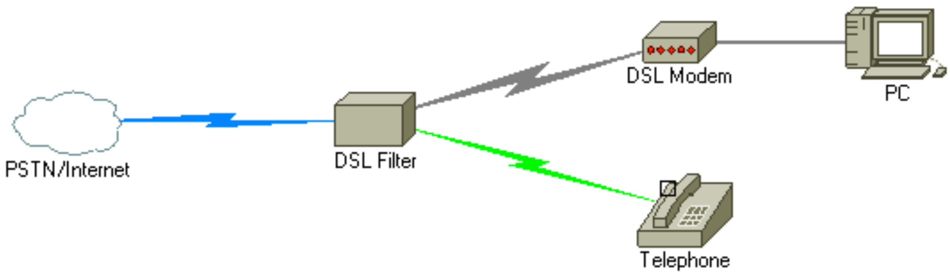
Perhaps the most common form of broadband access is through some form of Digital Subscriber Line (DSL, sometimes referred to as xDSL) technology. DSL uses normal telephone wires (as installed in a telecommunications service) to deliver digital data transmission.

There are many variations of DSL and usually the letter preceding 'DSL' indicates what technology is being used. For example, 'ADSL' refers to Asymmetric Digital Subscriber Line, 'SDSL' refers to Symmetric Digital Subscriber Line, and 'VDSL' refers to Very high speed Digital Subscriber Line.

ADSL is probably the most common DSL service offered by many service providers around the world. In the typical ADSL service, one cable delivers both data and voice. The signal frequencies on the cable are divided into two parts: voice is modulated onto the cable at a lower frequency (i.e. 4 kHz) and the data is modulated at a higher frequency (i.e. 25 kHz and above). At the customer end, a DSL filter is installed to separate the voice and data signals, with the voice connecting to a normal telephone and the data to a DSL modem (Figure 27).

Figure 27. A typical ADSL link

(Credit: Rajnesh D.Singh)



The download and upload speeds on an ADLS link are different, with the download speed being higher. For example, a typical service may be sold as 256k download and 128k upload, designated as 256/128kbps. The speeds available on DSL services range from 64kbps to 24,000kbps. However, the speeds that are possible are dependent on several factors, including the technology used and the quality and condition of the cable installed by the service provider.

DSL also has limitations on the length of the cable between the DSL termination point at the service provider (called Digital Subscriber Line Access Multiplexer or DSLAM) and the customer's premises. This is typically up to around 5km, depending on the DSL technology being used and the cable quality. Higher DSL speeds are typically available for shorter cable lengths, so the farther the customer premises from the DSLAM, the lower the speeds available.

Wi-Fi

Wi-Fi is commonly used to describe Wireless LAN technology conforming to the IEEE 802.11 standard. It uses radio waves to create a communication link between two or more points, with the end devices using Ethernet to complete the link.

Wi-Fi has nearly become a ubiquitous feature of computing life: just about all notebook PCs now come equipped with a Wi-Fi port, as do some mobile phones. Wi-Fi 'hotspots' are increasingly available in various locations, including major airports, hotels and coffee shops. Some cities are also implementing city-wide Wi-Fi networks.[48]

48 Wikipedia, "Municipal wireless network," Wikimedia Foundation, Inc., http://en.wikipedia.org/wiki/Municipal_wireless_network.

The term ‘Wi-Fi’ is used by the Wi-Fi Alliance to describe products based on IEEE 802.11 technology. Wi-Fi used to stand for ‘Wireless Fidelity’ in Wi-Fi Alliance documents[49] (like Hi-Fi for High Fidelity). However, the Wi-Fi Alliance now discourages describing it as such, most likely because it has little relevance to the concept of ‘High Fidelity’ and is thus not an appropriate comparison.

Wi-Fi is available at different speeds:

- 802.11a supports speeds up to 54Mbps and operates in the 5GHz frequency band.
- 802.11b supports speeds up to 11Mbps and operates in the 2.4Hz frequency band. This was the initial speed at which most products were released. It is being replaced with higher speeds.
- 802.11g supports speeds up to 54Mbps and operates in the 2.4GHz frequency band.
- 802.11n is the newest standard currently under development, with ratification by the IEEE expected in June 2009. It operates at the 2.4GHz and 5GHz frequencies and should support speeds over 200Mbps.

The typical range of a Wi-Fi Access Point, which allows Wi-Fi enabled equipment to communicate with each other, is around 30m indoors and 100m outdoors, depending on the environment. 802.11n technology is expected to double this range.

Aside from providing local coverage, Wi-Fi is also being used to provide point-to-point and point-to-multipoint communication links, typically over distances up to several kilometres using high-gain antennae and amplifiers. This can be extended even farther with the use of repeaters.

It is important to note that Wi-Fi broadcasts on an open frequency range, which means that anyone can transmit and receive on these frequencies, leading to congestion and interference. For example, cordless telephones and microwave ovens also use the 2.4GHz frequency band, as do Bluetooth and some electric gate openers and burglar alarms.

Many trials and experiments have been able to deliver functioning Wi-Fi links over 200km from point to point. The maximum point-to-point distance of a Wi-Fi link is hampered by the Earth’s curvature and line of sight requirements (i.e. both points must be able to ‘see’ each other).

WiMax

DSL and Wi-Fi both have limitations on their use, which affects their application for broadband access. DSL requires good cable quality and has a finite range from each DSLAM to achieve reliable high-speed links. The infrastructure costs are also significant. Wi-Fi is a much cheaper technology, but it suffers from range issues. It also uses an open frequency spectrum, which means that anyone can broadcast and receive on these frequencies and congestion can become a major issue.

Enter WiMax, a technology that promises to overcome these limitations by providing high-speed broadband access over wireless technology that is cheaper to deploy (as compared to cable-based systems), and widespread coverage similar to that of mobile phone networks. WiMax is the shortened form of Worldwide Interoperability for Microwave Access, and is an IEEE standard ratified as IEEE name 802.16.

49 Wi-Fi Alliance, *Enabling the Future of Wi-Fi Public Access* (Wi-Fi Alliance, 2004), http://www.wifi.org/white_papers/whitepaper-010204-wifipublicaccess.

The potential of WiMax is often likened to the impact that mobile phones have had on the telephone network. People will find it a much more convenient (and inherently mobile) technology, making WiMax services an easy replacement for DSL and cable-based Internet access. The system is also being engineered for ease of use, as in the case of the mobile phone that is simply switched on to search and connect to the nearest mobile phone base station that it can authenticate with. WiMax works in a similar manner.

WiMax specifications allow speeds up to 70Mbps and a range up to 50km from a base station with no line-of-sight requirements (in optimum environmental conditions) between the user and base station. WiMax can operate at various frequencies ranging from 2 to 11GHz and 10 to 66GHz.

Aside from running WiMax-based networks, WiMax can also be used as a backhaul technology to connect Wi-Fi Access Points (or hotspots), which extends the life of existing Wi-Fi installations. This means that the cost of infrastructure can be lowered by deploying hybrid WiMax/Wi-Fi networks where Wi-Fi is used to provide the local access and WiMax is used as the backbone.

3G

3G is used to describe the third generation of mobile phone communication technology. 3G mobile phones are multimedia devices (often called 'Smartphones') with the ability to send and receive audio and video, and to access the Internet. Smartphones may also include productivity applications like document editors and personal information management features.

The reference to 'generations' refers to qualitative differences in mobile phone technology, with analogue mobile phone systems being generally referred to as 1G, digital mobile phone systems as 2G, and mobile phones with data transfer mechanisms like GPRS as 2.5G. 3G technology offers transfer speeds of up to 3Mbps, compared to the 144kbps offered by 2G phones, and it allows support for a larger number of voice and data customers. Current implementations of 3G technology have transfer speeds of 384kbps for mobile users, and around 2Mbps for fixed users.

3G will allow applications like streaming video (e.g. watching a sports event live), e-mail (particularly sending and receiving large file sizes), Web browsing, GPS-type applications, video calls and various Internet/Web-based applications, to function in a seamless and efficient manner. Japan and the Republic of Korea were early adopters of 3G networks, with deployment completed in 2004 and 2006, respectively. However, although the technology shows much promise, uptake by consumers elsewhere in the world has been somewhat slow. This is partly due to the higher costs involved, particularly for Internet access and the 'pay by volume' model most 3G services use. In some parts of the world, 3G spectrum licenses have been auctioned or sold by the government for significant amounts of money to telecommunications operators, which means that these operators will need to recoup costs when delivering the service.

Test Yourself

1. What is broadband Internet?
2. Of the current Wi-Fi standards, which is the fastest?
3. Identify the two issues that most impact long distance Wi-Fi links.
4. At the customer end, what is used to separate voice and data on a DSL line?
5. What advantage does WiMax have over Wi-Fi?

Highlight

AirJaldi: Wireless Networking in the Himalayas

AirJaldi is a large community wireless network located in and around Dharamsala in North India. Developed in cooperation with the Dharamsala Information Technology Group, the network is also called the Dharamsala Wireless Mesh Community Network. It is run by the Tibetan Technology Centre, which was set up to explore and utilize modern technology in helping the Tibetan community, and hosted by the Tibetan Children's Villages School, which was established to look after the interests of Tibetan refugee children in India.

The network was set up after the Indian government deregulated the use of Wi-Fi in January 2005. By the end of February 2005, the Dharamsala Wireless Mesh Community Network had eight campuses. A wireless mesh network was considered the most suitable for the mountainous terrain in the foothills of the west Himalayan region. A wireless mesh network is a group of network nodes with at least two distinct paths to each node. This enables a network to extend beyond line-of-sight limitations associated with Wi-Fi technology by using paths from neighbouring nodes to reach distant nodes. Wireless mesh networks also provide reliability and redundancy in this manner.

Figure 28. A node in the Dharamsala Wireless Mesh backbone

(Source: AirJaldi, http://drupal.airjaldi.com/node/33)

The Dharamsala Wireless Mesh backbone has over 30 nodes (see Figure 28) sharing a single radio channel, although moves are under way to install multi-channel radio nodes to assist with network scalability. Access to the network is provided to local schools, NGOs and government offices for a nominal fee, and subject to the installation of a node on their premises, which in turn allows the network to increase its reach. Each node on the network uses the same type of radio hardware (called the Himalayan Mesh Router) developed and built locally. Antennae appropriate to the node location are installed with the hardware as some sites require specific types of antennae. All network members receive broadband-type Internet access. According to the AirJaldi website, a total of 6Mbps of Internet bandwidth is available to the network to which over 2,000 computers are connected.

»

» The various uses of the network include Internet access, file sharing, off-site backups, and video playback from archives. A centralized VoIP system has also been installed, providing telephony services to network members through the use of software as well as hardware-based IP telephone handsets. The system is connected to the PSTN. However, due to legal concerns, it only allows incoming calls terminating into the mesh network. Because standard computer keyboards do not support the Tibetan script, VoIP has become an essential means of communication: network members can simply dial others in the network and speak, instead of relying on written communication.

As the mesh network backbone is encrypted and uses specific hardware, wireless access points have been installed at certain nodes to allow roaming mobile devices to connect to the network. The encryption and specific hardware was necessary to ensure network security and quality of service.

The area in which most of the network operates suffers from poor electricity supply. For this reason, a large number of the network nodes are powered by solar panels, which improve network uptime significantly and demonstrate the potential use of the system in areas without regular electricity. In sum, the Dharamsala Wireless Mesh Network is a perfect example of how community networks can flourish under the right regulatory environment.

Source: AirJaldi, "The Dharamsala Community Wireless Mesh Network," http://drupal.airjaldi.com/node/56.

3.8 Interoperability

Interoperability generally refers to the ability of discrete and diverse systems to work together, without need for extra effort by the user. The concept of interoperability is becoming more important with the advent of technology such as cloud computing which assumes that the end devices being used will be compatible with its services.

Generally, systems achieve interoperability by adhering to published standards in their design, engineering and deployment. For example, devices that are 'Internet-enabled' are deemed to be interoperable because they are able to work over the TCP/IP protocol. This is what gives such devices 'interoperability with the Internet'. The network ports available in computers and laptops are another example: these ports adhere to the IEEE 802.3 Ethernet standard, which makes possible communication with other devices with such ports even when the devices come from different manufacturers. In software applications, interoperability plays a part in ensuring that data from one application can be accessed by another application (e.g. being able to create a text file on a Windows PC and accessing and editing it on another computer running Linux).

Interoperability prevents monopolies and fosters competition by ensuring that products from different manufacturers are able to work with each other. For example, interoperability allows a user with a Nokia mobile phone connected to one service provider to communicate with another person with a Sony Ericsson mobile phone with a different service provider.

Interoperability is a major concern in the Information Age where availability of, access to and sharing of information in various forms is central. The public needs to have access to different types of information (e.g. historical data, technical knowledge, best practice guides, statistics, government information services) that are often stored under various systems and processes which may be proprietary, or which exist in a 'closed' environment with limited access privileges. But with interoperability, the sharing and exchange of information ought not to impact on the actual systems hosting it.

To achieve true interoperability, an organization must have reached a state where it is able to fully value and exploit the information it owns, and be in a position to be able to exchange this information efficiently with other organizations. Often the ability to share information leads to the discovery of new opportunities, and this is vital for an increasingly connected and globalized world.

Note: The Wikipedia article on Standards Organizations (available at http://en.wikipedia.org/wiki/Standards_organisations) provides a good summary of various international, industry and regional standards organizations.

For further discussions on interoperability, refer to Module 2: ICT for Development Policy, Process and Governance in APCICT's Academy of ICT Essentials for Government Leaders module series.

Test Yourself

What does interoperability provide and why is it important?

Test Yourself

1. How important is the Internet to you and your country? Based on the information provided in this section, can you identify some key issues with respect to Internet infrastructure and stability in your country?
2. How has the Internet changed our lives, in particular the way we work, live and interact with friends and family? How do you see the future of the Internet evolving?
3. The Internet is an important part of society today. What technical and policy actions do you think are required to ensure continued Internet stability?

4. CONNECTING THE MODERN ORGANIZATION

This section aims to:
- **Give an overview of the total cost of ownership (TCO) when making procurement decisions;**
- **Describe the role of Free and Open Source Software (FOSS), particularly in terms of localization;**
- **Describe the role of modern database management and information systems in an organization;**
- **Describe the role of Internet-based interconnectivity methods in an organization; and**
- **Outline the policy considerations relevant to connecting the modern organization.**

Policy Considerations

As you read through this section, consider the following from a policy perspective:

- Ensuring that procurement and purchasing decisions take into account technology trends, as well as the lifespan of the system, including its TCO;
- Assessing the benefit of adopting FOSS in terms of economic savings, as well as the potential to localize such software to suit local conditions;
- The use of new and emerging application delivery methods that require less in-house technical resources to operate and maintain, such as Software as a Service and Enterprise Resource Planning tools, to provide 'whole of organization' application integration and access;
- The potential to reduce interconnectivity costs by employing virtual private networks as a means of connecting remote locations/offices; and
- The potential benefits of implementing intranets as an organizational information resource.

Today's modern information technology systems are able to provide improved process control and management, as well as enhanced general operational efficiency. But given the bewildering range of hardware and software available, it is important to ensure that the right choice of hardware and software platform is made. This section is not meant to be a definitive guide to selecting hardware and software; rather it provides some background information on factors to consider when making such a selection.

4.1 Hardware Considerations

Hardware is composed of various equipment ranging from desktop PCs to file servers to network equipment, as well as various computer peripherals such as scanners and backup devices.

Computer displays: CRT-based versus LCD

Computer displays or ‘monitors’ have traditionally been designed using Cathode Ray Tube (CRT) technology. In the past couple of years, technology based on Liquid Crystal Display (LCD) has emerged as a viable alternative. CRT-based displays are generally physically large and heavy and require far more desk space than the LCD equivalent. This is an important factor to consider especially where space is limited. The new generation LCD displays also consume far less power than their CRT equivalents; they generate less heat; and they are easier on the eyes. Moreover, in the past year or so the prices of LCD monitors have been decreasing, which means a much lower TCO.[50]

Desktop systems: Thin clients versus fat clients

In hardware terms, a thin client is typically a cut-down version of a PC deployed in a client-server type network environment. A thin client typically only provides a means to access and display data, while the actual processing of data is done on a server. This means that thin clients can be low-power devices relying on a powerful server to handle the processing. In contrast, a fat client can be equated to a typical PC on a network that itself processes data and only uses the network and servers to pass data to other machines, or for storage.

The advantages of thin clients include lower IT administration costs as there is less likelihood of users fiddling with software applications because the applications can be ‘locked down’ to only what is needed for work. This also reduces the possibility of malicious software being installed. Most of the management is done on the server, and updates, etc. can be handled remotely. Should the thin client suffer a hardware failure, it can simply be replaced and the user will be back online quickly, since all data are stored centrally on the server. Other advantages include lower power consumption, a smaller desktop footprint, and generally higher reliability because thin clients typically have fewer moving parts.

Fat clients also have some advantages. These include generally lower powered file servers because processing is typically done on the fat client itself, better multimedia performance as they can have dedicated and powerful graphics controllers, better peripheral expansion options, and lesser reliance on network connectivity (a thin client requires a functional, consistent network).

The decision to go with thin clients or fat clients depends entirely on an organization’s requirements and the applications that it needs to use. A smaller organization would generally be fine deploying fat clients (or PCs) connected to a general-purpose file server for storage and communication purposes. A larger organization with good network infrastructure would perhaps find it more suitable to deploy thin clients.

50 Gartner Total Cost of Ownership, http://amt.gartner.com/TCO/index.htm.

Network systems: 100Mbps versus 1,000Mbps

In a previous section this module discusses Ethernet networks and the technologies available today. The network is a critical part of infrastructure and its design is important, particularly for larger organizations. With falling prices for 1,000Mbps (Gigabit) based network equipment, Gigabit Ethernet Switches (the device that connects a LAN together) should be deployed at least at the server level, and to connect other parts of the LAN. This will provide better bandwidth, and hence better performance between key points of the network as well as between servers and workstations.

A good analogy is a series of water pipes where the maximum amount of water that can flow is determined by the diameter of the smallest pipe. To be effective, the main pipe feeding all of the smaller pipes must have a much larger diameter so that a larger amount of water is able to flow through effectively to each smaller pipe.

Power protection: Uninterruptible power systems

A stable and reliable electrical supply is always a concern particularly in the developing world. Power disruptions can cause severe damage to IT systems. It is important to protect key parts of the IT infrastructure (e.g. file servers, network connectivity equipment and backup devices) from power interruptions. With price reductions (and increasing competition), pricing for uninterruptible power systems (UPS) has decreased to the point where it is possible to deploy these with every desktop PC at a cost factor of around 10-15 per cent of the PC. Ideally this should be factored into the procurement policy to obtain quantity/volume discounts. And it is important to understand the technology behind each UPS as this determines its price as well as its reliability.

Standby or Passive UPS: This is the most basic type of UPS and is essentially composed of a pseudo-sine wave inverter, battery charger and battery. It may contain some basic filtering on the input and output and typically does not include power regulation. Once the input voltage is reduced beyond a threshold, the UPS will use its battery to power the output. This is the cheapest type of UPS device and is only suitable for situations where the power supply is generally stable and the UPS is used only for power blackout conditions.

Line Interactive UPS: This is the next higher level of UPS after the standby type and it can be of different types. Some come with sine wave inverters, some with voltage boosters only and yet others with full voltage regulators. These types of UPS generally have better filtering and are cost-effective in terms of price and performance. They are suitable for environments with frequent power interruptions and for situations where there is continuous variation in the input voltage. The typical Line Interactive UPS is composed of filters, an inverter with some form of voltage regulation, a battery charger and a battery. Most models these days also include communication ports such as a USB to provide power management using software that allows for the attached computer to be properly shut down when there is a power failure.

Online UPS: Many manufacturers describe their UPS as 'online'. However, the only truly online UPS is one that takes the incoming AC voltage, converts it to DC, carries out filtering, and then converts the DC back to AC for the output. This double conversion process provides a highly stable pure sine wave output. A truly online UPS is the best type of UPS available, and it is the most expensive. It is suited to environments with frequent power interruptions and fluctuations. An online UPS may be large-capacity as in the case of a centralized UPS to power a whole department, room or building. Or it could have a smaller capacity for desktop systems and network equipment.

Technology Brief

Structured Cabling

Although not strictly defined as 'hardware', cabling is an integral part of an organization's ICT infrastructure. Without some form of cabling, most networks would not exist (wireless networks are not always the preferred choice due to bandwidth and security limitations). In recent years the concept of structured cabling has come to the fore, particularly for larger networks.

So what exactly is structured cabling?

A structured cabling system (SCS) is a multimedia transportation system. Structured cabling provides a controlled method for the design, installation and administration of cabling infrastructure and is intended to be compatible with all standards-based networking applications. SCS provides the user with an end-to-end system that best suits their business needs and is able to adapt and evolve with changing needs.

Why is an SCS important in today's network systems?

SCS is the lifeline for the entire IT infrastructure of an organization. A well designed SCS will reduce costs at each phase of the IT infrastructure lifespan, namely:

1. Installation
2. Moves, Adds, Changes (MACs)
3. Maintenance and Administration

The typical lifespan of various components of the IT infrastructure are as follows:

- Software = 2 years
- PCs = 5 years
- Servers and Mainframes = 10 years
- Cabling System = 15 years
- Building Shell = 50 years

How do you create an SCS?

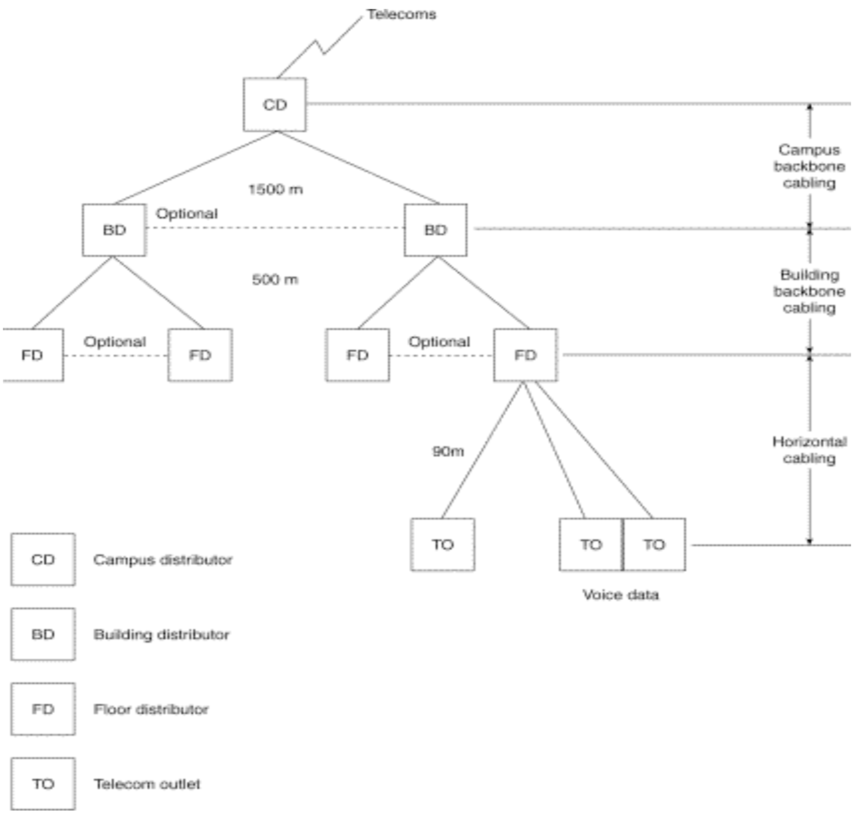
The ISO/IEC 11801 cable model (Figure 29) is the network model on which IEEE 802.3 standards are based.

»

»

Figure 29. ISO/IEC 11801 cable model

(Source: ISO/IEC)



The following terminology is generally used when describing an SCS (refer to Figure 29):

Campus Distributor – The term campus refers to a facility with two or more buildings in a relatively small area. This is the central point of the campus backbone and the telecom connection point with the outside world. In Ethernet LANs, the campus distributor would typically be a gigabit switch with telecom interface capability.

Building Distributor – This is the building's connection point to the campus backbone. An Ethernet building distributor would typically be a 1,000/100- or 1,000/100/10-Mbps switch.

Floor Distributor – This is the floor's connection point to the building distributor. ISO/IEC 11801 recommends at least one floor distributor for every 1,000m2 of floor space in office environments and, if possible, a separate distributor for each floor in the building. An Ethernet floor distributor would typically be a 1,000/100/10- or 100/10-Mbps switch.

»

» **Telecom Outlet** – This is the network connection point for PCs, workstations, print servers, as well as other non-data applications (e.g. voice, video, etc.). File servers are typically co-located with and directly connected to the campus, building or floor distributors, as appropriate for their intended use.

Campus Backbone Cabling – This is typically a single-mode or multimode optical cable that interconnects the central campus distributor with each of the building distributors.

Building Backbone Cabling – This is typically a Category 5 or better UTP or multimode fibre cable that interconnects the building distributor with each of the floor distributors in the building.

Horizontal Cabling – This is predominantly a Category 5 or better UTP cable, although some installations use multimode fibre (the concept of 'fibre to the desktop') which connects the telecom outlet to the floor distributor.[51]

With an SCS installed, system administration is greatly simplified, as is changing and interconnecting devices at user workstations. Data, voice and video can all run over the same cable infrastructure, and there is no need to have separate systems installed for each.

Test Yourself

1. Why should you choose an LCD computer monitor over a CRT-based one?
2. Can voice and video be delivered over structured cabling systems?
3. If your office faces constant power fluctuations, which type of UPS would be the most appropriate?

4.2 Free and Open Source Software

FOSS (also referred to as FLOSS or Free/Libre Open Source Software) has come to public attention in recent years. The relative success of software applications such as the Mozilla Firefox browser and OpenOffice office productivity suite has helped establish FOSS as an alternative to closed source (or proprietary) software.

So what exactly is FOSS?

The Free Software Foundation (FSF) founded by Richard Stallman defines free software as follows:

51 Abridged from Cisco Systems, Inc, *Internetworking Technologies Handbook: An essential reference for every network professional* (Cisco Press, 2003), http://books.google.com/books?id=3Dn9KlIVM_EC&pg=PA137&source=gbs_toc_r&cad=0_0&sig=ACf U3U0P9fxuD_wUJEqhlANPVigaukdjUw#PPA131,M1.

> Free software is a matter of liberty, not price. To understand the concept, you should think of free as in free speech, not as in free beer.
>
> Free software is a matter of the users' freedom to run, copy, distribute, study, change and improve the software. More precisely, it refers to four kinds of freedom, for the users of the software:
>
> - The freedom to run the program, for any purpose (freedom 0).
> - The freedom to study how the program works, and adapt it to your needs (freedom 1). Access to the source code is a precondition for this.
> - The freedom to redistribute copies so you can help your neighbour (freedom 2).
> - The freedom to improve the program, and release your improvements to the public, so that the whole community benefits (freedom 3). Access to the source code is a precondition for this.[52]

FSF has created a set of 'free software licenses' of which the General Public License and Lesser General Public License are perhaps the most widely used.

The Open Source Initiative co-founded by Bruce Perens defines FOSS as follows:

> Open source doesn't just mean access to the source code. The distribution terms of open-source software must comply with the following criteria:
>
> **1. Free Redistribution**
> The license shall not restrict any party from selling or giving away the software as a component of an aggregate software distribution containing programs from several different sources. The license shall not require a royalty or other fee for such sale.
>
> **2. Source Code**
> The program must include source code, and must allow distribution in source code as well as compiled form. Where some form of a product is not distributed with source code, there must be a well-publicized means of obtaining the source code for no more than a reasonable reproduction cost preferably, downloading via the Internet without charge. The source code must be the preferred form in which a programmer would modify the program. Deliberately obfuscated source code is not allowed. Intermediate forms such as the output of a pre-processor or translator are not allowed.
>
> **3. Derived Works**
> The license must allow modifications and derived works, and must allow them to be distributed under the same terms as the license of the original software.

52 GNU Operating System, "The Free Software Definition," Free Software Foundation, http://www.gnu.org/philosophy/free-sw.html.

4. Integrity of the Author's Source Code
The license may restrict source-code from being distributed in modified form only if the license allows the distribution of 'patch files' with the source code for the purpose of modifying the program at build time. The license must explicitly permit distribution of software built from modified source code. The license may require derived works to carry a different name or version number from the original software.

5. No Discrimination against Persons or Groups
The license must not discriminate against any person or group of persons.

6. No Discrimination against Fields of Endeavor
The license must not restrict anyone from making use of the program in a specific field of endeavor. For example, it may not restrict the program from being used in a business, or from being used for genetic research.

7. Distribution of License
The rights attached to the program must apply to all to whom the program is redistributed without the need for execution of an additional license by those parties.

8. License Must Not Be Specific to a Product
The rights attached to the program must not depend on the program's being part of a particular software distribution. If the program is extracted from that distribution and used or distributed within the terms of the program's license, all parties to whom the program is redistributed should have the same rights as those that are granted in conjunction with the original software distribution.

9. License Must Not Restrict Other Software
The license must not place restrictions on other software that is distributed along with the licensed software. For example, the license must not insist that all other programs distributed on the same medium must be open-source software.

10. License Must Be Technology-Neutral
No provision of the license may be predicated on any individual technology or style of interface.[53]

The use and value of FOSS in an organization can generally be summarized as follows:

- Substitution, where a FOSS application is used to replace a proprietary or commercial product (e.g. using OpenOffice instead of Microsoft Office)
- Application of choice in a new deployment (e.g. using Apache Web Server instead of Microsoft IIS)
- Migrating applications to a FOSS platform (e.g. moving from a Microsoft Windows or UNIX-based server to a Linux-based server)

53 Open Source Initiative, "The Open Source Definition," Opensource.org, http://opensource.org/docs/osd.

The motivation for such moves is usually financial: a FOSS-based solution may be much cheaper in terms of licensing costs. Other factors are security and localization.

Highlight

Localization and the FOSS Advantage

An inherent feature of FOSS is its flexibility, in particular the freedom it allows users and developers alike to adapt and enhance the software to their particular needs, including language requirements. Most popular software available internationally is in English, and those who cannot read and write English are often at a disadvantage when it comes to using such software. Some software vendors offer localized versions but usually only in the more widely spoken local or regional languages. There is little commercial incentive for a software vendor to localize software for smaller, regional language sets in developing countries, particularly where the rate of software piracy is high. This is where FOSS can be a solution and indeed provides a significant advantage.

Because FOSS is based on the free-to-modify-and-distribute principle, localizing FOSS software is feasible, particularly if there is a willing and able technical community. The FOSS application can be customized to suit local configurations, to display character sets with the use of special fonts, or even perhaps to provide a better user experience through the modification of the user interface. Localization is made easier as there are set language templates that can be created and linked to the software. At the same time, a large part of the underlying software code essentially remains the same.

Localization also helps build technical expertise in the local community, reduces dependence on imported software, helps narrow the linguistic digital divide, and perhaps even contributes to the growth of the local ICT industry by giving rise to other innovations once confidence levels are established. Many localization efforts have taken place in Asia. The KhmerOS project in Cambodia is an example, and the following excerpt from their vision statement aptly describes the motivation for FOSS localization:

> The KhmerOS project was born from our dream for the state of computer technology in Cambodia in three years. We envision, in 2007, a country where Cambodians can learn and use computers in their own language, a country that does not have to change to a new language in order to use computers! Databases and applications will be developed directly in Khmer, with easy, standard ways to handle names and data.
>
> To achieve this, there must be widespread use of very low cost software, well adapted to Cambodia's economy, business climate, and people. And there must be a standard way to use Khmer.
>
> We believe that in order to enter a digital world without forfeiting its culture, a country must do it by using software in its own language. Software in a foreign language exacerbates the digital divide, makes basic computer training difficult and expensive, closes computer-using jobs to people with little economic resources, impoverishes local culture, and blocks computer-based government processes, as the local language script cannot be used in databases.

»

»

Fortunately, the introduction of the Khmer script in the Unicode standard has opened the door to start developing support for Khmer in different platforms.

Also, there is already free, easy-to-use, high quality software – called Free Software or Open Source Software – that can be used and modified. It includes everything a normal computer user needs: desktops, office applications (word-processor, spreadsheet, presentation tool, and database manager), Internet tools (e-mail, browser, chat, and messengers) and multimedia applications to handle music and video, and many utilities. Many countries are promoting this type of software for their government offices, for businesses, in education, and for the people in general.

In the past, of course, computer use in Cambodia has been mostly in English, and mostly with unlicensed copies of Microsoft Windows products. The fact that there is a new Cambodian Intellectual Property Law means that a user will have to purchase a license for each copy of software sold by companies such as Microsoft that he uses. That is too expensive for most Cambodian computer users.

Open Source software and Khmer Unicode will build the best technological future for Cambodia, and it can be achieved. We welcome you to join us in working for this vision.[54]

Questions To Think About

Do you see a role for FOSS localization in your country? How can localization efforts be introduced, or enhanced, to suit local needs in your home country?

Something To Do

Identify some applications that can benefit from FOSS localization in your home country.

4.3 Database Management System

A Database Management System (DBMS) is computer software designed to manage databases. It provides an ordered method of organizing, storing, managing/manipulating, and retrieving/ displaying information stored in a database. This information can be anything from an

54 Khmer Software Initiative, "Vision," KhmerOS, http://www.khmeros.info/drupal/?q=en/about/vision.

organization's financial records to a hospital's patient records to a country's immigration records. Thus, a DBMS plays an important role in the overall IT infrastructure of an organization.

A DBMS can be complicated (and expensive) software requiring specialists (Oracle is an example), or it can be relatively simple where an average user may be able to get some form of database application running (Microsoft Access, which is bundled into the Microsoft Office suite, is an example). Needless to say, the complicated software is much more powerful. Each type/brand of DBMS is suited to different tasks.

A DBMS essentially stores bits of information that describe something. For example, an inventory record in a financial system may contain things like:

- Part Number
- Unit of measure
- Purchase cost
- Quantity on hand
- Location
- Description
- Colour
- Unit Price
- Serial Number
- Category
- Supplier details
- Sales Tax percentage
- Re-order level

Additionally, the system may contain a picture of the item, and perhaps a specification sheet or brochure. This is a more recent phenomenon in database systems where essentially unstructured or unrelated data (with respect to other items) may be included as part of the overall system, primarily for the user's purposes. A modern DBMS stores data in multiple tables and these data are linked using a 'key' that identifies bits of information related to the key. In the inventory record example above, Part Number would be a logical choice for the key, and each of the items listed would typically be stored in different tables. This would then all be referenced to the Part Number as the key, so that different Part Numbers would return the information related to that particular Part Number.

To save programming time and cost, some commonly used features of a typical DBMS are 'built-in'. These are briefly described below.

Query: This yields information based on specific conditions or requests. For example, in the inventory system example above a query could be, "How many (Quantity on hand) blue (Colour) items are available at location XYZ (Location)?" This query would combine the three attributes indicated and provide a result. A database report writer is used to query the DBMS for the required information and to return results. The actual query can also serve as a security measure programmed by the user into the system. For example, a standard user may not be able to access Supplier details and Purchase Cost information, whereas a supervisor or manager may have access to this information.

Backup and Replication: This is important to guard against equipment failure, or other damage to the system. The DBMS can be backed up to a remote server or in larger systems information may be replicated (i.e. copied) to multiple servers for security and reliability or efficiency purposes. In these larger systems, users may not even know which particular server they are using, which makes the system transparent.

Rules: The DBMS may allow the stored information to be locked down to just one entry. For example, in the inventory record above, Serial Number would generally be unique and no two items would have the same serial number. The DBMS can ensure that the same serial number is not stored for multiple times. In addition, certain information could be programmed to be mandatory for the system. For example, in our inventory record above Part Number, Description, Unit Price, and Sales Tax Percentage could be mandatory information for a user to enter, and each could have minimum character requirements (e.g. Part Number must contain eight characters). If the complete set of information is not entered as required, the system would return an error message to the user to ensure that the rules for data entry are met.

Security: The DBMS may allow the setting up of various levels of security with respect to the data in the system. For example, some users may only be able to view data, others may be able to manipulate data through reports, and others may be able to change data. All these can be programmed and set up to provide consistency and data security. Audit trails can also be maintained to track the changes a user makes.

Calculations and Computations: Generally, some form of computation is also required on the data stored (e.g. the total number of items in a particular category, or the total of value of all items in hand). The DBMS will provide these computations as built-in functions.

Logs and Audit Trails: A log of all activity on the database can be maintained for security purposes or to track who did what and when. This can be useful if mistakes are made in data entry and there is a need to reverse changes made.

4.4 Software Development Process

The term software development process refers to the way in which specific software is developed. It is also sometimes referred to as software lifecycle. The complete process is composed of a set of activities and tasks that contribute to defining, building and delivering software to meet user needs. These are described below.

Domain Analysis: The first step is to determine the domain or background of the software and how it relates to other software — i.e. what is common and what is not. This is to ensure that user requirements are not confused with the requirements of the software developers.

Software Elements Analysis: Determining software requirements is generally the most difficult step. Users will know what they want but not what and how software should do it, which sometimes can be quite ambiguous or contradictory. This is perhaps best summarized by the statement, “I know you believe you understood what you think I said, but I am not sure you realize what you heard is not what I meant.” (The statement is by Roger S. Pressman but it is attributed to many others, including former US President Richard Nixon.)

Specification: This is the task of detailing the exact software to be written, based on user requirements. A critical part of this is how the software will interface with external systems and remain constant and stable.

Architecture: This provides an abstract representation of the software to ensure that the system meets product requirements while also allowing for expansion and scalability. Interfaces to other software and the operating system and hardware are also addressed during this process.

Coding: This is the actual process of writing computer software code which, when run, carries out the functions and tasks required of the application.

Testing: The testing phase is important, particularly where different parts of the system were coded by different teams. Testing ensures that everything works together as specified. This step is part of software quality assurance.

Deployment or Implementation: After the necessary tests have been run, the software is moved into a 'production environment' — i.e. made available for general use.

Documentation: This is a highly critical task, particularly for maintenance and future enhancements. However, it is often overlooked or it receives less attention than it deserves.

Software Training and Support: One can build the most sophisticated and technologically advanced software in the world, but this can be absolutely useless if no one uses it. People tend to resist change, and this is especially true when introducing new software into an organization, particularly when users are not confident in the use of computer systems. A phased introduction is important, as is appropriate training for users. The training should be structured to build confidence in the user, and it should provide the opportunity for the more enthusiastic and able users to mentor others.

Maintenance: Continued maintenance and enhancement of software is probably the largest and most difficult part of the whole software development process. Resolving bugs and issues arising from use of the software in the production environment is time-consuming. Part of maintenance is also the addition of new features and facilities as users realize what features are available and what else would be nice to have. Adding code, or trying to figure out what a certain part of the code does, is hard work, particularly if the original coders are no longer involved and/or there is poor documentation.

Technology Brief

Software as a Service

Software as a Service (SaaS) is an example of how the Internet can help deliver old things in new ways. SaaS is a software delivery platform over the Internet that makes software available ubiquitously or wherever the Internet is available. Instead of installing 'client applications' on user PCs, SaaS uses the Web browser to provide the user client interface.

The actual software is hosted in a data centre that may be operated by the software vendor itself, or hosted by a third party specializing in hosting such applications. The software is not 'sold' to the user in the traditional sense; rather the user pays a fee to use the software, much like a subscription. This has some obvious advantages, including not having to pay up-front costs (which are sometimes substantial) for purchasing the software, investing in infrastructure to host and operate the software, and maintaining both the hardware and software.

SaaS is delivered as a one-to-many application, which means that one installation of the software will serve many, unrelated customers. However, each customer has a 'virtual container' for his/her data that is private and secure. This helps keep costs down for the vendor, and in turn is reflected in lower costs to the user. Because software is delivered via the Internet, users do not necessarily have to standardize on an operating system or hardware for their PC (although some basic requirements are generally recommended by the software provider). The global nature of the Internet also means that the software is available worldwide, which is important if an organization has offices in multiple countries. In the traditional software delivery model, this would have required 'site licences' for each office, as well as hardware infrastructure to host and operate the software. »

» Upgrading applications, or acquiring 'new versions', is always a concern for an organization and SaaS addresses this by providing a 'single version' that is always available to all users. From the user perspective, upgrading the software is not an issue because it happens at the software provider's end; in most instances the user would not even be aware that an upgrade has taken place. For new users deployment is quick: log on to a PC, start the Web browser, navigate to the application homepage, login to the software, and the user is live on the system within minutes. Training and guidance can also be provided over the Internet, making for efficient deployment and use.

SaaS offers great potential for improving productivity and ensuring that an organization spends more time on its core functions than on allocating resources to designing and implementing ICT systems.

For further information, access the InfoWorld Clip on SaaS on the Internet at http://www.infoworld.com/archives/videoTemplate.jsp?Id=665.

4.5 Enterprise Resource Planning

Enterprise Resource Planning (ERP) systems are based on the concept of integrating various data and processes in an organization into one unified system. An ERP system may use various computer application modules with a unified database to store organization-wide data as the key unifying factor.

Before the ERP concept came along, various departments within an organization would have their own computer systems for their specific area of activity. For example, the human resources department would have its own system for personnel details and organizational reporting; the payroll department would process and store data related to wages and salaries; the finance department would store records of financial transactions; and the sales and marketing department would store past, current and potential customer and related contact information. Each of these essentially discrete systems would have a common data set with which it would communicate with other departments. For example, the human resources department and payroll system would exchange information based perhaps on unique employee numbers that would need to be kept constant among all of the systems. This can require significant effort with disparate systems. Any changes or updates to data would need to be communicated and synchronized immediately; otherwise, transactions would not be processed (e.g. an employee not being paid on time due to the lack of updated information).

ERP systems provide a solution by integrating all systems (which may still exist with unique interfaces) through a single unified database. This allows data to be available system-wide, and it reduces the need for constant monitoring and updating between discrete systems. It could also reduce hardware requirements in the sense that multiple applications running on multiple servers could be made to run on one server (or a couple of servers for redundancy and/or scalability). It also reduces cost by doing away with the need for external interfaces between two or more systems to exchange common data.

ERP systems originated from the manufacturing industry but today are used in all types of organizations, including non-profit organizations and governments. Typical modern ERP systems will cover most of the basic functional requirements of an organization with such modules as:

- **Financials** – General Ledger, Debtors, Creditors, Fixed Assets, Cash Flow Management, Budgets
- **Human Resources** – Personnel Data, Payroll, Attendance, Benefits
- **Customer Relationship Management** – Marketing Campaigns, Customer Contact, Service Orders, Quotations, Call Centre Support Data
- **Projects** - Project Resource Allocation, Timelines
- **Supply Chain Management** – Stock Control (Inventory), Order Entry, Purchases, Supply Chain Planning, Scheduling
- **Manufacturing** – Bill of Materials, Resource Scheduling, Workflow Management, Cost Management, Quality Control, Cost Management, Process Management
- **Warehousing** – Product Location, Stock Rotation

With the move towards Web-based systems, an ERP system may also have user interfaces for customers to place and track orders, a product catalogue viewable by the public, or perhaps employee expense reporting.

Most ERP systems are implemented by third parties rather than in-house due to the complexities of deploying such a system. Successful ERP implementation requires certain skill sets and expertise in various areas, from accounting to supply chain management to resource planning. An important aspect of any ERP deployment is appropriate user training and post-deployment support and user assistance. Appropriate acceptable user policies also need to be implemented to ensure data integrity and confidentiality, since an ERP system can provide just about all of the information that an organization needs to operate and this information, if compromised, could be of value to competitors or others with malicious or criminal intent.

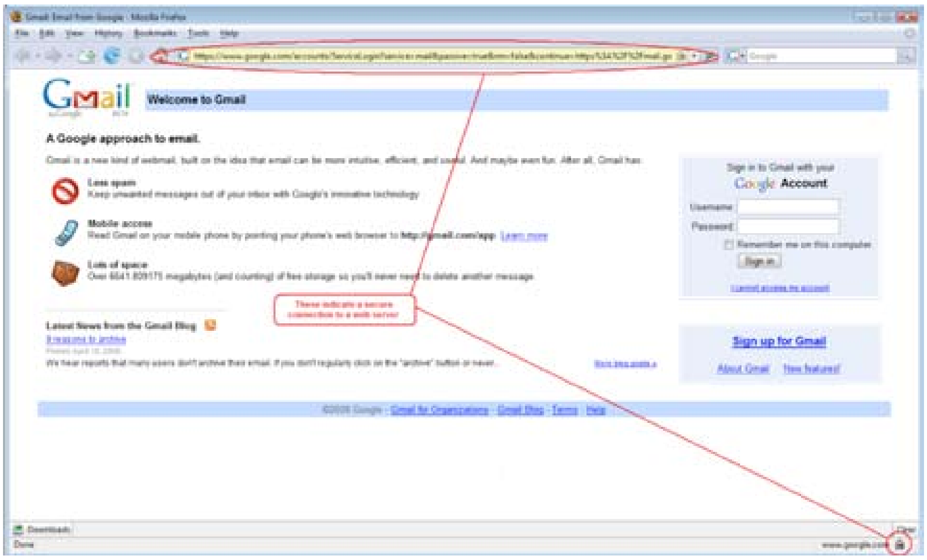
4.6 Internal Intranets

'Intranet' is a play on the word 'Internet' to differentiate a computer network that is essentially internal to an organization but built using Internet Protocols (TCP/IP) from the public Internet. Intranets are normally only available to staff within an organization although they may also be accessed through the public Internet using secure logins, or VPNs. 'Extranet' is a related term that usually refers to an extension of an intranet to external parties trusted by the organization, such as suppliers, customers and other related organizations.

An intranet makes use of various Internet protocols and services to facilitate access to organizational information (e.g. reports) and functional areas (e.g. customer data, product data, financial data). Such information can typically be accessed using a Web browser, often over a secure connection. On a Web browser, a secure connection is characterized by a small padlock at the bottom of the page and the address bar being displayed in a different colour and preceded with 'https' (see Figure 30).

Figure 30. Secure connection to a Web server using a Web browser

(Credit: Rajnesh D. Singh)



One point to note is that intranets do not necessarily provide access to the public Internet, although the same technology is used. In cases where Internet bandwidth comes at a premium, an organization can set up an intranet and use it to host various information obtained from the public Internet and other sources. Examples of such information are anti-virus software updates, brochures, data sheets and reference documents. Hosting these in the internal network saves the organization Internet access costs while also providing quick access to the data.

When made available from the public Internet, intranets are typically implemented using secure gateways that require user authentication before access to the organization's internal data is granted. Encryption may also be employed to protect sensitive data. This is a good practice in any case, particularly over the public Internet.

As Web technology evolves, intranets are becoming an important tool in meeting an organization's internal communication and collaboration needs. Intranets may be used for local and remote collaboration on projects for example through the use of internal wikis, forums, and discussion threads. They are able to efficiently deliver internal information on time, particularly if a staff member needs to access data remotely. Internal procedure and policy documents can also be made available in an easy-to-navigate format. Because the information is posted 'online', the most current version is always available to authorized users. And since Web technology is generally cross-platform, users with different operating systems and hardware are able to access and share the information.

Something To Do

List what you think an intranet can do for your organization, and how it can improve general efficiency and access to information.

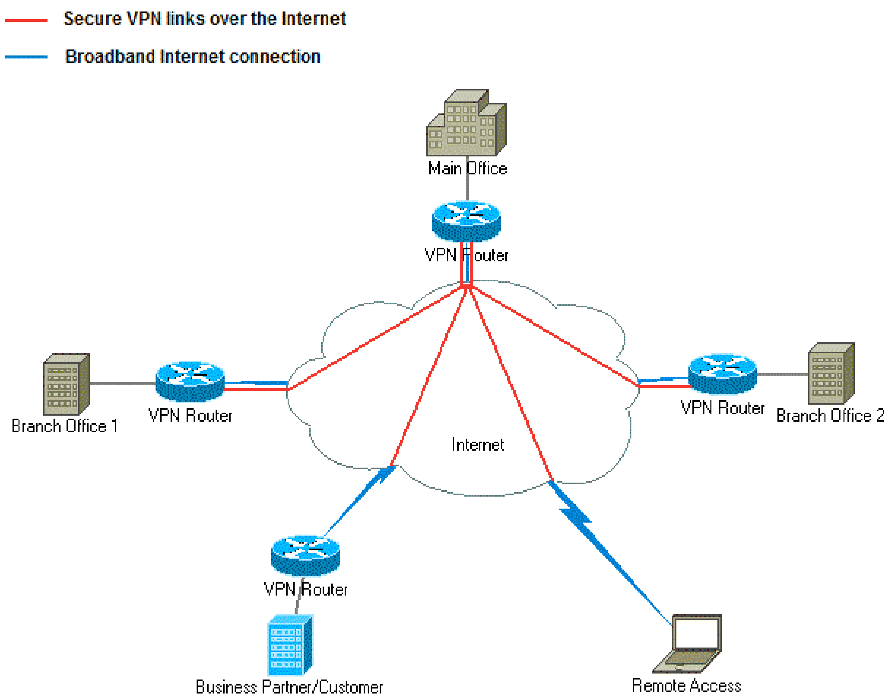
Technology Brief
VPNs to Interconnect Multiple Sites

VPNs have emerged as a convenient and secure way to use the Internet as a medium to interconnect an organization's multiple, physically separate sites or mobile workers.

A VPN operates by creating a protected 'tunnel' over a communication network (e.g. the Internet) to securely and seamlessly connect remote offices and individuals (see Figure 31). All of the sites in a VPN work as if they are part of the organization's internal network, even though the data is flowing across a public network. Various authentication and encryption mechanisms are used to protect the 'tunnel' between the sites, and this can be done at the network level using VPN gateways and at the client level using specific software installed on a PC. Modern operating systems have built-in support for VPNs. In essence VPNs can be compared to having leased lines between sites, except at much lower cost because the Internet is used as the communication infrastructure.

Figure 31. Example of a VPN over the Internet

(Credit: Rajnesh D. Singh)



There are other advantages to VPNs, as follows:

- A connection to a new site can be quickly provided. The only requirement is a functional Internet connection and relevant hardware/software between the sites. Compare this to obtaining a leased line between the sites which can take a considerable amount of time to deploy.
- The link between sites can be quickly scaled up to cater to increased demand. This would normally require increasing the Internet bandwidth rate being used.

»

»

- Various services and applications can be guaranteed performance levels. For example, it is possible to allocate fixed bandwidth resources to VoIP or database access.
- Capital expenditure is reduced because the requirements for a VPN are usually cheaper than those for leased lines. Additionally, there is the potential to reduce operating expenditure by outsourcing support, and even the actual VPN provisioning, to third parties (in markets where they exist).
- The organization's internal network can be accessed from anywhere provided an Internet connection is available.

As with any ICT deployment, appropriate policies must be in place to prevent misuse of VPNs and to protect information. Because a VPN can provide access to all of the services running on an organization's internal network, appropriate security features should be installed. This can include user-level access to parts of the network, and even running two or more VPNs with one VPN for general access and the others for accessing specific information.

T

Test Yourself

1. What are some benefits that an SaaS can provide?
2. Define what a VPN is.

T

Test Yourself

1. How important should TCO be when making a purchasing decision? Should environmental issues also be considered as part of TCO (e.g. energy consumption)
2. Is there a business case for FOSS? Do you (or would you) include FOSS as part of your ICT strategy?
3. How important is localization of software for your region/community? How about localization of content (e.g. Internet content)?
4. How important is it to have an inter-connected organization? How would this help improve efficiency and productivity?

ANNEX

Further Reading

Cisco Systems. Internetworking Technology Handbook. http://www.cisco.com/en/US/docs/internetworking/technology/handbook/ito_doc.html.

Crocker, Dave. Email History. http://www.livinginternet.com/e/ei.htm.

EP.NET LLC. Public Internet Exchange Point Repository. http://www.ep.net/ep-main.html.

Ethernet Alliance website. http://www.ethernetalliance.org.

"How do I" section. Intranet Journal. http://www.intranetjournal.com/howdoi.html.

How DSL Works. HowStuffWorks Inc. http://electronics.howstuffworks.com/dsl.htm.

IEEE 802.3 Higher Speed Study Group website. http://grouper.ieee.org/groups/802/3/hssg/public/index.html.

Imagining the Internet. A project of the Elon University School of Communications and the Pew Internet and American Life Project. http://www.elon.edu/predictions.

InfoWorld. InfoClipz: Software as a Service. http://www.infoworld.com/archives/videoTemplate.jsp?Id=665.

Institute of Electrical and Electronics Engineers website. http://www.ieee.org.

Internet Architecture Board website. http://www.iab.org.

Internet Assigned Numbers Authority website. http://www.iana.org.

Internet Corporation for Assigned Names and Numbers website. http://www.icann.org.

Internet Engineering Steering Group website. http://www.iesg.org.

Internet Engineering Task Force. The Tao of IETF: A Novice's Guide to the Internet Engineering Task Force. http://www.ietf.org/tao.html.

Internet Governance Forum website. http://www.intgovforum.org.

Internet Research Task Force website. http://www.irtf.org.

Internet Society. A Brief History of the Internet. http://www.isoc.org/internet/history/brief.shtml.

Internet Society. Histories of the Internet: A collection of references and readings. http://www.isoc.org/internet/history.

Internet Society website. http://www.isoc.org.

Internet World Stats website. http://www.internetworldstats.com/stats.htm.

KhmerOS website. http://www.khmeros.info.

Metcalfe, Robert M. and David R. Boggs. 1976. Ethernet: Distributed packet switching for local computer networks. *Communications of the ACM* 19 (7): 395–404. (The original Metcalfe and Boggs paper on Ethernet is available at http://portal.acm.org/citation.cfm?id=360253&dl=ACM&coll=ACM&CFID=39370057&CFTOKEN=52797288.)

Miller, Paul. Interoperability: What is it and why should I want it? *Ariadne.* Issue 24 (Web version). http://www.ariadne.ac.uk/issue24/interoperability/intro.html.

Number Resource Organization website. http://www.nro.org.

Road to 100G Alliance website. http://www.roadto100g.org.

Simonelis, Alex. 2005. A Concise Guide to the Major Internet bodies. *Ubiquity,* Volume 6, Issue 5 (15-22 February 2005). http://www.acm.org/ubiquity/views/v6i5_simoneli.html.

Souphavanh, Anousak and Theppitak Karoonboonyanan. 2005. *FOSS: Localization.* Bangkok: UNDP-APDIP. http://www.iosn.net/l10n/foss-localization-primer and http://en.wikibooks.org/wiki/FOSS_Localization.

South East Asia Middle East Western Europe 4 (SEA-ME-WE 4) project website. Sri Lanka Telecom. http://www.seamewe4.com.

Southern Cross Cable Network website. http://www.southerncrosscables.com.

Spamtrackers.eu. SpamWiki website. http://www.spamtrackers.eu.

Templeton, Brad. Reflections on the 25th Anniversary of SPAM. http://www.templetons.com/brad/spam/spam25.html.

TVHistory.TV. Television History – The First 75 Years. http://www.tvhistory.tv.

Van Vleck, Tom. The History of Electronic Mail. A personal memoir. http://www.multicians.org/thvv/mail-history.html.

Wikipedia. Internet Research Steering Group. Wikimedia Foundation Inc. http://en.wikipedia.org/wiki/Internet_Research_Steering_Group.

Working Group on Internet Governance website. http://www.wgig.org.

World Standards Services Network website. http://www.wssn.net.

World Summit on the Information Society website. http://www.wsis.org.

Zakon, Robert H. Hobbes' Internet Timeline v8.2. http://www.zakon.org/robert/internet/timeline.

Glossary

ccTLD	Acronym for Country Code Top Level Domain. This refers to top level domains in the Internet which are allocated to a particular country or territory, nearly always based on its ISO 3166 two-letter code — e.g. AU for Australia, HK for Hong Kong, IN for India, VN for Viet Nam.
DSL	Acronym for Digital Subscriber Line. This technology allows the delivery of high-speed broadband Internet services over typical telephone cables.
GHz	A unit of measure for radio frequencies denoting values in the billions (G) of Hertz (Hz).
gTLD	Acronym for Generic Top Level Domain. This was initially meant to represent a particular type of organization (e.g. COM for commercial organizations). gTLDs are generally available for global use, with some exceptions based on historical reasons with the creation of the Internet in the United States (such as MIL used by the United States Military and GOV used by the United States Government).
IP address	Refers to Internet Protocol address, a unique address allocated to a device connected to a computer network using the Internet Protocol. The network uses the IP address to locate connected devices and forward information.
IPv4	Internet Protocol version 4, the current version of the Internet Protocol. It has limitations on the number of IP addresses available.
IPv6	Internet Protocol version 6, the next generation of the Internet Protocol designed to provide improvements in the number of available IP addresses and other enhancements.
IXP	Acronym for Internet Exchange Point, a special computer network that interconnects various Internet Service Providers (ISPs) so that they may exchange traffic in a more economical manner.
MHz	A unit of measure for radio frequencies denoting values in the millions (M) of Hertz (Hz).
Open Spectrum	Radio frequencies allocated for free use without the need to acquire a license to broadcast signals.
SaaS	Acronym for Software as a Service, a method to deliver software applications over the Internet.
sTLD	Acronym for Sponsored Top Level Domain. These Internet domain names can be registered only by those who meet eligibility criteria laid out by the organization that sponsored the domain name (e.g. ASIA for Asia-based organizations and individuals and TRAVEL for use by those related to the travel and hospitality industry). There are also some non-sponsored TLDs, such as INT for international treaty organizations and EDU for United States-accredited educational organizations.
TCP/IP	Acronym for Transmission Control Protocol/Internet Protocol. This is the technology that the Internet is built on.
TLD	This is the last part of an Internet domain name, after the last 'dot' (e.g. for the domain name www.mywebsite.com, 'com' is the TLD).
VoIP	Acronym for Voice over Internet Protocol. This allows one to make voice (or telephone) calls using the Internet.
VPN	Acronym for Virtual Private Network. This allows the secure interconnection of multiple sites/offices using the Internet. It is increasingly being used as a replacement for traditional methods of interconnecting multiple sites/offices such as leased lines.

A Brief Timeline of the Creation and Development of the Internet

1957	The USSR launched Sputnik, the first artificial earth satellite. The impetus for the creation of the Internet is generally attributed to the US Government's reaction to this launch.
1958	The US Government set up the Advanced Research Projects Agency (or ARPA) within the US Department of Defence to establish a lead presence in science and technology, in particular defence and military technology.
1961	Leonard Kleinrock of the Massachusetts Institute of Technology published the first paper on packet switching. At the time (and until today, although the shift to converged networks and IP is changing all this), telecommunications networks were based on circuit switching technology. Circuit switching works by establishing an exclusive fixed bandwidth, or fixed delay circuit between two points that want to communicate. Packet switching sets up a communication circuit by moving discrete blocks of data (or packets) between two points over links that may be shared with other traffic and where these packets may be subject to variable delay. Generally, packet switching is considered to be more flexible because it allows bandwidth to be dynamically shared and more than two points can communicate over a given link through routing.
1969	Advanced Research Projects Agency Network (ARPANET), the world's first operational packet switching network and the forerunner of today's Internet, was created.
1971	The first e-mail programme was invented by Ray Tomlinson of Bolt Beranek and Newman, Inc., which won the contract to set up the initial ARPANET system) to send messages across a distributed network.
1972	Tomlinson modified the e-mail programme to run over the ARPANET system using the now familiar '@' symbol.
1973	The first international link (to University College of London in the UK) was added to ARPANET and Robert Metcalfe published his PhD thesis outlining the Ethernet. Internal analysis at ARPA suggested that 75 per cent of all traffic on the ARPANET was e-mail. Around this time Vinton Cerf and Robert Kahn also developed the first description of TCP (Transmission Control Program, as it was known then). In December this was published as RFC 675: Specification of Internet Transmission Control Program.[55]
1978	TCP was split into two — Transmission Control Protocol (TCP) and Internet Protocol (IP). This is now commonly referred to as the TCP/IP protocol suite. TCP/IP was born out of a need for seamless connections between networks. ARPANET at the time used the Network Control Program where the network was responsible for guaranteeing reliability. In the TCP/IP model, the hosts (or the points that are communicating) handle reliability, reducing the role of the network in managing information delivery and ultimately allowing different networks to connect. Thus TCP/IP is an open architecture interconnection method and is significant for interoperability of networks.
1979	The first two networks (Stanford University in the US and University College London in the UK) were connected to each other over TCP/IP.

55 Network Working Group, RFC 675: Specification of Internet Transmission Program, Internet Engineering Task Force (December 1974), http://tools.ietf.org/html/rfc675.

1982	The US Department of Defence made TCP/IP the standard for all military computer networking.
1983	ARPANET adopted TCP/IP as its network protocol on 1 January 1983.
1984	The DNS was introduced, which meant that users no longer had to remember path names to other systems.
1985	The Internet Advisory Board (today known as the Internet Architecture Board) held a three-day workshop on TCP/IP for industry, paving the way for its commercial use. The open standard design with no patent or royalty requirements set the stage for rapid acceptance by industry.
1986	The IETF and IRTF came into existence.
1988	The Internet was slowly but surely establishing a global reach. CERN (the birthplace of the World Wide Web protocol in 1989) deployed TCP/IP on its internal network between 1984 and 1988. Much of Europe at that time ran their networks on UUCP Usenet over X.25 links (a protocol suite for connecting to packet-switched networks over common telecom infrastructure — i.e. leased lines, phones, ISDN). By 1988 work was underway to transition Europe's networks to TCP/IP and CERN opened its first external connections.[56]
1989	Australian Academic and Research Network was created using IP exclusively. Japan also connected to the National Science Foundation Network (NSFNet, the immediate forerunner to the public Internet) in 1989, followed by India and the Republic of Korea in 1990, Hong Kong, Singapore and Taiwan in 1991, and Thailand in 1992.[57] ISOC was chartered and the Internet Advisory Board was renamed the Internet Architecture Board and became part of ISOC. Commercial use of the network was generally forbidden, as its primary purpose was supposed to be education and research. However, many were already circumventing this restriction. The late 1980s saw the first ISPs coming into existence. They sought to provide the public access to the regional research networks and alternative network access via gateways using UUCP Usenet. Although some universities were not happy with this non-educational use of the network, it is generally accepted that these commercial ISPs helped reduce access costs, which enabled smaller educational institutions to connect to the network.
1990	ARPANET ceased to exist.
1995	NSFNet went back to being a research network, and various government institutions and commercial operators created their own backbones and interconnections. Regional Network Access Points (NAPs) were created, and these became the main interconnection facility for the various networks. The Internet was now open to full commercial use, without restrictions. NAPs were the forerunner of today's IXPs and they are a critical part of the Internet infrastructure (see the discussion on IXPs in this module for more information).

56 Ben Segal, A Short History of Internet Protocols at CERN (1995), http://www.cern.ch/ben/TCPHIST.html.
57 Kazunori Konishi, Kanchana Kanchanasut, Lawrence Wong and Kilnam Chon, "Internet History in Asia" (presented at the 16th APAN Meetings/Advanced Network Conference, Busan, Republic of Korea, 24-29 August 2003), http://www.apan.net/meetings/busan03/cs-history.htm; and Robert H. Zakon, "Hobbes' Internet Timeline v8.2," http://www.zakon.org/robert/internet/timeline.

Notes for Trainers

As noted in the section entitled 'About The Module Series', this module and others in the series are designed to have value for different sets of audiences and in varied and changing national conditions. The modules are also designed to be presented, in whole or in part, in different modes, on- and off-line. The modules may be studied by individuals and by groups in training institutions as well as within government offices. The background of the participants as well as the duration of the training sessions will determine the extent of detail in the presentation of content.

These 'Notes' offer trainers some ideas and suggestions for presenting the module content more effectively. Further guidance on training approaches and strategies is provided in a handbook on instructional design developed as a companion material for the *Academy of ICT Essentials for Government Leaders* module series. The handbook is available at: http://www.unapcict.org/academy.

Structuring the Sessions

The present module has varied content, all of which can be covered in five days. For workshops of shorter duration, some sessions may be dropped or abbreviated.

It is important to ascertain well in advance the background of workshop participants. This will allow suitable modification of what is presented. If you find that the participants have a sound technical background, you can drop most of the technical parts of the module (mainly in Sections 2 and 3) and refer the participants to the printed manual. If you have participants with a policy background, focus on the policy perspectives highlighted in the module, and link these to the technical content. Both these approaches should allow the module to be covered in three days.

When planning your workshop sessions, try and balance how long participants will sit without a break. For example, you may choose to divide a one-day session into six 60-minute sessions rather than four 90-minute sessions.

The following is a rough guide to suggested content coverage based on time allocated.

For a 90-minute workshop

Provide an overview of the module. Refer to the introductory parts of each section to build your workshop content, and emphasize issues of most relevance to the participants. You may also choose to focus on some key policy issues (you will not have time to cover all policy issues).

For a three-hour workshop

This would be an expansion of the 90-minute workshop structured to provide greater focus on certain sections. Depending on the background of participants, you may wish to run through the module overview and then focus on certain areas, such as access to ICT from Section 1, Internet infrastructure or emerging Internet applications and technologies from Section 3, or FOSS/localization issues from Section 4.

For a one-day workshop

Provide an overview of the module and then focus on one section of most relevance to the audience (e.g. Section 1 or Section 3 or Section 4). Section 2 is mostly informative in nature and can be covered in the overview, with participants being referred to the printed manual to read on their own at a later time. Section 3 is very large in content and many parts of it cannot be taken up within a one-day workshop. Depending on the background of the participants, you could drop the discussion on Internet organizations or Internet applications, and simply refer to the relevant section of the printed manual as further reading.

For a three-day workshop

This time frame should provide you with some flexibility in what to cover. If you find that the participants have a sound technical background, you could drop most of the technical parts of the module (mainly in Sections 2 and 3) and have participants read these on their own at a later time. If you have participants with a policy background, focus on the policy perspectives highlighted in the module and link these to the technical content, but spend more time discussing policy perspectives as a function of technical challenges rather than actual technical nitty-gritty (e.g. not how you build a network but why you build a network). Start the workshop with an overview of the module and then focus as suggested above.

For a five-day workshop

This time frame should, for the most part, allow you to fully cover the module. Begin with a high-level overview of the module, and then expand into each section. To sustain audience interest throughout the five days, ensure lots of audience interaction and use the practical exercises as both a break from content presentation and as a means for making the subject matter more interesting.

Language

An important aspect to running a successful workshop is language. If you have an international audience, some participants may not be able to understand the language of instruction and delivery as well as others. In this case, it is important to include in presentation slides (as much as you can, and without overloading a slide) what you are saying orally. The rationale for this is that often people can read a language better than they can listen to it, particularly when accents and the audio system impact the quality of oral delivery. So participants who may not be able to understand you speaking in a language they are not fluent in may be able to read a slide and understand what you are saying.

If the participants are not local, it is always handy to have a list of common local phrases taught to the participants as a five-minute session at the start of each day. This is also a means of helping the participants settle in more easily.

Interactivity

Try and have as much audience interactivity and practical exercises as possible. Problem-based learning type exercises, in which participants explore authentic issues and problems, are especially useful. Practical group sessions can also allow those with greater facility with the medium of instruction to assist others.

During discussions, it is sometimes good to let the conversation continue if it is headed in the right direction, even if this takes up session time. Like practical exercises, discussion helps participants make sense of the content, stimulates deep (as opposed to surface) learning, and sustains interest.

About the Author

Rajnesh D. Singh is an engineer and entrepreneur combining a strong technical background with extensive management and leadership roles in the commercial and non-profit sectors. He is Chief Operating Officer for PATARA, a technology vendor based in the Pacific Islands, and Chief Operating Officer/Senior Vice-President Operations and Strategy at AvonSys, an Internet start-up serving the Silicon Valley. He has consulted on Communications and Power Infrastructure, Project Management and Business Strategy for medium to large companies and organizations in the Asia Pacific region, and holds several advisory roles across multiple sectors.

Rajnesh has worked extensively with the Asia Pacific Internet community, and has held several leadership roles, including Chair of ICANN's Asia Pacific Regional At-Large Organization, and Chair of the Pacific Islands Chapter of ISOC and the IPv6 Forum Pacific Islands. He has worked extensively on ICT policy, training and capacity building in the Asia Pacific region and has been active in the Internet Governance Forum since its inaugural meeting. His current areas of interest are ICT Policy in Developing and Emerging Economies, Internet Evolution, and Effective Business Strategies for Developing Markets.

UN-APCICT

The United Nations Asian and Pacific Training Centre for Information and Communication Technology for Development (UN-APCICT) is a subsidiary body of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP). UN-APCICT aims to strengthen the efforts of the member countries of ESCAP to use ICT in their socio-economic development through human and institutional capacity-building. UN-APCICT's work is focused on three pillars:

1. Training. To enhance the ICT knowledge and skills of policymakers and ICT professionals, and strengthen the capacity of ICT trainers and ICT training institutions;
2. Research. To undertake analytical studies related to human resource development in ICT; and
3. Advisory. To provide advisory services on human resource development programmes to ESCAP member and associate members.

UN-APCICT is located at Incheon, Republic of Korea.

http://www.unapcict.org

ESCAP

ESCAP is the regional development arm of the United Nations and serves as the main economic and social development centre for the United Nations in Asia and the Pacific. Its mandate is to foster cooperation between its 53 members and 9 associate members. ESCAP provides the strategic link between global and country-level programmes and issues. It supports Governments of countries in the region in consolidating regional positions and advocates regional approaches to meeting the region's unique socio-economic challenges in a globalizing world. The ESCAP office is located at Bangkok, Thailand.

http://www.unescap.org

The Academy of ICT Essentials for Government Leaders

http://www.unapcict.org/academy

The *Academy* is a comprehensive ICT for development training curriculum with eight initial modules that aims to equip policymakers with the essential knowledge and skills to fully leverage opportunities presented by ICTs to achieve national development goals and bridge the digital divide.

Module 1 – The Linkage between ICT Applications and Meaningful Development
Highlights key issues and decision points, from policy to implementation, in the use of ICTs for achieving the Millennium Development Goals.

Module 2 – ICT for Development Policy, Process and Governance
Focuses on ICTD policymaking and governance, and provides critical information about aspects of national policies, strategies and frameworks that promote ICTD.

Module 3 – e-Government Applications
Examines e-government concepts, principles and types of applications. It also discusses how an e-government system is built and identifies design considerations.

Module 4 – ICT Trends for Government Leaders
Provides insights into current trends in ICT and its future directions. It also looks at key technical and policy considerations when making decisions for ICTD.

Module 5 – Internet Governance
Discusses the ongoing development of international policies and procedures that govern the use and operation of the Internet.

Module 6 – Network and Information Security and Privacy
Presents information security issues and trends, and the process of formulating an information security strategy.

Module 7 – ICT Project Management in Theory and Practice
Introduces project management concepts that are relevant to ICTD projects, including the methods, processes and project management disciplines commonly used.

Module 8 – Options for Funding ICT for Development
Explores funding options for ICTD and e-government projects. Public-private partnerships are highlighted as a particularly useful funding option in developing countries.

These modules are being customized with local case studies by national *Academy* partners to ensure that the modules are relevant and meet the needs of policymakers in different countries. The modules are also been translated into different languages. Furthermore, these modules will be regularly updated to ensure their relevance to policymakers, and new modules will be developed that focus on ICTD for the 21st century.

APCICT Virtual Academy (AVA – http://ava.unapcict.org)

- An online distance learning platform for the *Academy*.
- Designed to ensure that all the *Academy* modules including virtual lectures, presentations and case studies are accessible online.
- Enables learners to study the materials at their own pace.

e-Collaborative Hub (e-Co Hub – http://www.unapcict.org/ecohub)

- A resources portal and knowledge sharing network for ICTD.
- Provides easy access to resources by module.
- Users can engage in online discussions and become part of the e-Co Hub's online community of practice that serves to share and expand the knowledge base of ICTD.

Register online to fully benefit from the services provided in AVA and the e-Co Hub at
http://www.unapcict.org/join_form