Access Terminals for The Next Generation

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1. INTRODUCTION

This Report discusses the likely features of the next generation of Access Terminals that will be required in response to the rapid progress that is being witnessed in various areas such as Telecomm and Information Technology, wired and wireless broadband access technologies, integration of multiple forms of media streams, and the tools that enable mobility.

The emergence of the Internet has caused a paradigm shift in the way we transact business and has opened up a vast range of possibilities for traditional businesses and service providers to reach end consumers with their products and services.

The PC-centric model for access to the Internet is no longer scalable because of the high cost of ownership and the high barriers to usability. Alternative platforms and technologies for access to the Internet can now emerge as viable business propositions to the ubiquitous PC.

India is well placed to leverage the emergence of new communications technologies because its current infrastructure is in a nascent stage. We do not have to worry so much about backward compatibility and can choose from the best available options.

The Government of India should create an enabling framework in which different research and development institutions and private industry can participate in the joint development and creation of the communications infrastructure that is so critical to our success in this new millennium. While the Internet revolution has created a global village, we have to think global but act local. We have to create our own unique solutions based on our own unique requirements.

This Report discusses areas in which we can contribute towards initiating a national effort to create a set of platforms that are appropriate to our needs. The Report discusses current access terminals, emerging trends in the home, some enabling technologies, and then provides suggestions for a few technology projects that could be taken up in participation with industry.

1.1 A Brief Overview of Access Terminals

1.1.1 Access Terminals

What is an access terminal?

- Any device that serves as a delivery platform for the Client end of an Application
- Enables a user to interact with a service provider or host computer to obtain a service

A few general attributes are

- An Input mechanism
  - Keyboard, Mouse, Touch Panel, Voice etc.
- An Output device
  - CRT Monitor, TV, LCD Display, Voice etc.
- Some connectivity options are
  - Direct connection through a Serial or Parallel interface
  - Through a remote connection
    - An Analog Modem for remote dial-up
    - Cable-Modem
    - ISDN Dial-up

        - ADSL digital modem
        - IrDA Port
    - Through a LAN connection
        - Wired or Wire-less

It may also have a few other attributes such as

- Some local processing capability
- Display rendering
- Forms entry and input validation

Given below are some examples of traditional access terminals

- VT100, IBM-3270
- PCs, Notebooks, Subnotebooks
- X-terminals
- POTS Telephone, Cellular Phone, TV

Some other examples of

Access terminals, representing newer paradigms, are

- Interactive TV
- Web TV, Settop Boxes, Integrated Receiver-Decoder (IRD)
- Internet Access Devices
- Thin Clients, Network Computers, Web Pad, Email terminals
- PDAs, Palmtops, Pagers, Data Collection Devices
- Phone enhancers
- Cellular Phones
- Smart Phones
- VoIP Terminals
- IP Phones

As can be seen from the examples given above, the definition of Access Terminals is very broad and encompasses generations of technological progress. Traditionally, access terminals have been based around a keyboard and display, but the next generation of technologies promises to create an even richer user experience. Access Terminals are increasingly being used in mobile environments. This creates a unique set of problems that need to be addressed. Devices need to have a smaller foot-print, consume low power, and work with a wide range of connectivity options.

1.2 Internet Access Devices

With the introduction of several new access methods, individuals no longer need to feel intimidated by the Internet. Several new technologies will make accessing the Internet less intimidating to individuals.

Most people are aware of the Internet but think it is too difficult to learn and that computers are too expensive. These excuses are no longer viable with today's technologies. New products are entering the market that will allow individuals to access the Internet without purchasing a PC. Getting on-line and accessing the Internet can now be done through the following:

- Screen phones
- World Wide Web (WWW or Web)-browsing TVs
- Set-top boxes
- Digital cellular phones and
- Handheld PCs.

Most of the new access methods are centered around TVs. Game machine makers, PC manufacturers and television makers are introducing hybrid devices that enable consumers to surf the Internet and view television programming from one system. There are three methods of TV-based access: PCs with large screens, large-screen TVs with built-in Web browsers and set-top boxes that can be used with almost any TV.

PCs with large screens provide TV-based access through a device that is basically a big screen PC with an integrated television tuner. The components of the system include a TV-like monitor, a box containing the computer portion, and a wireless keyboard. Companies such as NetTV Inc. and Gateway 2000 have entered into the market with WorldVision and Destination. According to NetTV, "By converging many exciting capabilities NetTV provides functions that connect the TV with the Internet, allow the TV to control the Internet, allow the Internet to drive the TV, and merge the power of the computer with the functions of the TV..." <http://www.nettv.net/background/home.htp>. Big screen PCs are taking home entertainment systems to a new level. They are now putting the power of the Internet right in the living-room.

Another TV-based access device is an Internet access box such as WebTV. This box works with the existing TV to provide Internet access. For individuals who are intimidated by the Internet, WebTV is a good way to get started on "surfing the net." WebTV is built to be easy to setup, send e-mail, and browse the Web. The unit allows for five e-mail addresses for sending and receiving messages. Also, if the TV has picture-in-picture capability, individuals can browse the Web while still watching a TV program <http://face2face.com/vidprod.html#4> <http://face2face.com/ vidprod.html>.

The third type of TV-based access device is the set-top box. The capabilities of these boxes depend on the manufacturer. For instance, Curtis Mathes has developed UniView. This particular set-top box has e-mail and Web-browsing Internet abilities as well as fax and conference-phone functions. NewCom Inc. has developed a different set-top box that has a built-in Web browser, e-mail software, and a proprietary windowing operating environment (Popular Mechanics <http://popularmechanics.com/>, p.60). Two other companies, Boca Research and ViewCall America are working on offering a set-top box with the On-TV Internet Service. Sega teamed with On-TV when developing its NetLink device, a plug-in cartridge that turns a Sega Saturn videogame into a Web browser.

TVs are not the only alternative to PCs for accessing the Internet. Telephones may also be used for Internet access. The main Internet function available through the phone is e-mail. E-mail can be received on both desk-top phones as well as cellular phones. AT&T has developed PocketNet, a digital cellular phone that can receive Internet e-mail. AT&T PocketNet service applications will allow you to access information virtually anytime, anywhere <http://www.airdata.com/pock_net/ apps.htm>. E-mail isn't the only capability that PocketNet offers. Other services provided by AT&T include receiving financial news, other

news, weather updates, package tracking, air travel information, ground travel information, movie information and lottery information.

Handheld PCs (HPC) are the newest technology entering the Internet access product line. HPCs are developed around the Microsoft Windows CE operating system. They can also run the Pocket Internet Explorer. These handheld devices offer all the functionality of a PC in a machine that weighs about one pound. Many well-known PC software applications such as Microsoft Word and Microsoft Excel have been made into "pocket-sized" versions for use on the HPCs. COMDEX features a compact and easy-to-type keyboard, with easy operation and functionality employing popular Windows-based applications software and remote communications capabilities <http://www.hitachi.com/News/Press/news-9611132.html>. Cassiopeia offers similar features. Both devices are designed for personal or business use.

1.2.1 What Do these Devices Mean for the Potential User?

The three types of TV-based devices are obviously for the home. From their descriptions, they seem to be user-friendly devices that can be used in the comfort of your living-room. With WebTV, exploring the Web with family and friends is placed in a comfortable setting and is done through remote control. <http://www.webtv.net/pc/wisit.shtml>. People are more familiar with the functionality of a remote control than they are with the PC. TV-based access devices are the perfect solution for individuals who are intimidated by the PC.

Telephone and HPC access seem more suited for business applications. They do not appear to have much use for the consumer. These two devices seem to have more application for the traveling business professional that needs to access their e-mail and other Intranet resources. The AT&T PocketNet is even described as a "wireless Internet appliance designed specifically for the mobile professional" <http://www.airdata.com/pock_net/prod_svc.html> <http://www.airdata.com/ pocket_net/prod_svc.htm>.

All of these devices do provide alternate means of accessing Internet resources. For individuals who only want to surf the Web or send and receive e-mail, these are possibly the answers. However, PCs offer so much more than just Internet access. For families with small children, it is going to be almost impossible to get an education without having access to a computer. Students at all levels of education are being required to use PCs for such things as research and writing papers. For families that can afford to buy these alternate access devices, investing a little bit more to get the full functionality of a PC is recommended. The "big-screen PCs" cost the same, if not more, than a PC.

However, these devices as well as PCs are becoming more affordable for middle-income families. The only individuals who will probably not have access in their homes are low-income families.

Access speeds of up to 56kbps account for the vast majority of the global Internet subscriber base. A small ‘power user’ segment of the market has ISDN access and the larger organisations (corporate and government) have higher speed leased line Internet access. All of these current access technologies oblige the customer to remain fixed in one location.

1.2.2 Alternative Fixed-Access Technologies

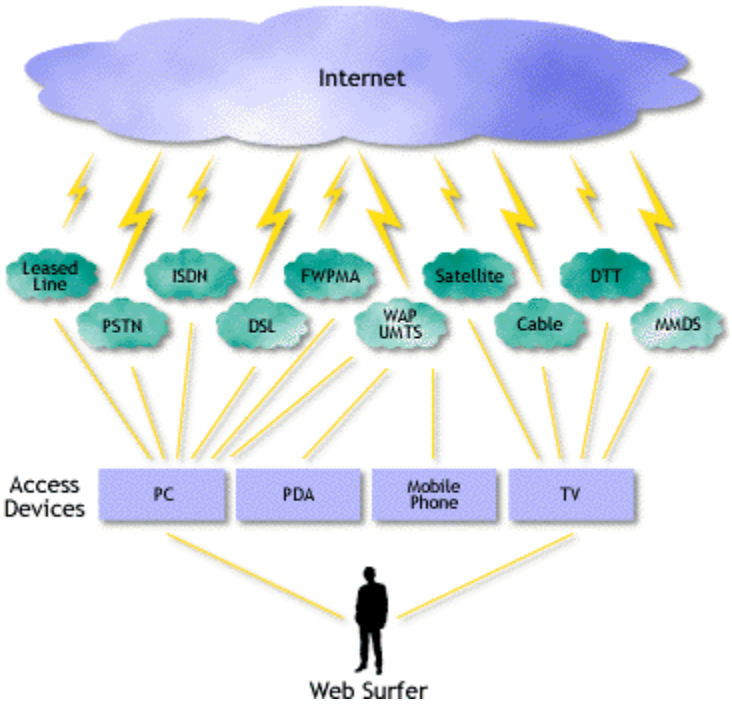
However, the technological landscape is changing rapidly. The xDSL suite of technologies will enable high-bandwidth Internet access via the currently installed copper local loop. Digital cable TV in tandem with cable modems, will facilitate the provision of bundled TV, telephony and high-speed Internet access via TV sets. Fixed wireless point-to-multipoint access (FWPMA) - otherwise referred to as wireless local loop - will also enable the provision of high bandwidth Internet access via new technological means. And

last, but not least, digital terrestrial TV (DTT) will introduce an alternative mass-market Internet access medium to the public.

1.2.3 New Mobile Access Technologies

Despite the obvious benefits of all these new technologies, they suffer from the constraint that they are essentially 'fixed' access technologies, i.e. they do not provide mobile Internet access. Mobile operators internationally have identified this as a major opportunity and are working with leading international vendors to develop a range of Internet-enabled high-bandwidth services. This will result in a quantum shake-up of the Internet market. The new wireless access protocol (WAP) provides a universal open standard for bringing Internet content and advanced value added services to mobile phones and other wireless devices. WAP-enabled mobile devices will provide access to information and transaction services such as flight bookings, stock price information, banking services, entertainment ticketing, etc. Likewise, the bandwidth constraints of GSM are soon to be obliterated with the introduction of general packet radio service (GPRS) and enhanced data for GSM evolution (EDGE) technologies, which deliver bandwidth well in excess of 56kbps - the current limit of most PSTN modems. In the medium term future, universal mobile telecommunications system (UMTS) will offer multi-megabit wireless access direct to the handheld device, thereby bringing the cellular market into a domain comparable with fixed xDSL functionality.

The days of the PC as the sole Internet access device are numbered. Penetration of PCs into the consumer sector is dwarfed by the penetration of TV sets, mobile phones, and game consoles, all of which are capable of being Internet-enabled.



Alternative Internet Access Options

Demand for wireless Web access is being fuelled by the growing adoption of Internet use as the de facto means of communication and information retrieval as well as by the increasing use of wireless devices. User demand is particularly strong in three key areas: e-mail messaging, Web browsing, and pull content or Web clipping. The key to successful deployment of wireless Web services is for providers to find cost-effective means of translating standard Web content to the formats accessible by handheld devices and

smart phones in terms of screen size, access and processing speeds, and ability to retrieve and display graphics.

We can now see some very clearly definable trends

- Moving from PC-centric to non PC-centric alternatives

  The traditional "Wintel" architecture of the PC entails a high cost of ownership because of the extent of resources required by a PC and its proprietary software. This can be brought down by investing in the concept of open source software and open hardware platforms. Non-PC architectures are also eminently suitable for various embedded applications because of lower power consumption.

- Thin Clients, NCs

  Thin Clients and Network Computers are already available but have not yet created a successful beachhead for deployment. At best, they have replace the traditional X-Terminal with a more modern variant. However, Thin Clients have huge potential because of their connectivity and low cost.

- Multi-function PDAs

  Multifunction PDAs already provide a diverse range of functions such as personal information management, email access, and simple word-processing and spread-sheets. The next generation of PDAs will expand on this basic functionality by integrating a Smart Card based digital wallet or personal ATM, for a whole range of financial transactions and services.

- Increasing popularity of Cellular Phone as a delivery vehicle for various applications through WAP enabled services

  WAP enabled cellular phones are becoming available but their functionality is severely constrained because of low transmission bandwidth and small display size. Once we have GPRS and 3G wireless services, the transmission bandwidth problem will be eased. Small, high resolution LCD displays will also make it possible to render more complex content on small mobile devices.

- Internet focused services

  Today, various types of businesses, including the traditional brick-and-mortar businesses, have the opportunity to leverage the success of the Internet and come up with richer services and better methods of delivery to reach wider target audiences.

  However, this requires substantial focus on creating high bandwidth Internet infrastructure, low cost of access, security for information transfer, and a legal framework for verification, acceptance, authentication and non-repudiation of electronic documents. India can take the lead by developing a model legal framework for electronic transactions.

- Tethered v/s Untethered connectivity

  Various forms of connectivity offer differing levels of convenience. The traditional method of wired connectivity tethers the user to the access terminal. On the other hand, wireless connectivity will enable the user to break away from the tether and take the access terminal wherever she wishes to.

- Fixed v/s Mobile Computing
  - Mobility will become a very important requirement for the next generation of access terminals
  - Secure and authenticated access will be an important requirement

Mobile computing opens up a whole range of technical issues that need to be addressed. In the traditional model, a device is given an IP address at the point of attachment either as a fixed IP address or as a dynamically generated IP address by a DHCP Server. When the user moves to a different location, a new IP address has to be assigned.

However, we would like to envisage a scenario in which billions of Internet-enabled appliances or mobile devices will be identified by globally issued IP addresses. As the user moves with the device to different local points of attachment, the device continues to be accessible through the globally assigned, unique IP address. The issues relating to mobility are covered in Mobile IP sections of the next generation TCP/IP (IPv6) standards.

This is analogous to a cell-phone base roaming service which enables a user to be accessible wherever such roaming service is available, through a unique telephone number assigned to her.

- Platform independence
  - Linux operating system
  - Java, Chai, Jini, E-speak

  We feel that India should invest in acquiring expertise in open source OS platforms such as Linux, which is available on a range of hardware options and does not require any license fees to be paid to commercial entities. Linux, and variants such as Embedded-Linux or Mobile-Linux, have a strong base of world-wide developer support, and have proved to be very successful in the last few years.

  As hardware technologies improve, we can port Linux to different platforms and retain our investments in software applications.

- Alternative forms of Input
  - Keyboard, Mouse
  - Voice Input
    - Various forms of speech recognition will be required
    - Recognizers for Discrete and Continuous Speech
    - Speaker independent, easily trainable

- Alternative forms of Output
  - TV, LCD Display
  - Voice Output
  - Text-to-Speech
    - Language independence
    - Phonetic dictionaries
  - Interactive Voice Response Systems (IVR)

Display technologies will move towards crisp, high resolution, small-sized colour LCD displays as costs are lowered. Such technologies are being advanced by various Japanese and South Korean manufacturers. Unfortunately, there is no major initiative in India, on this front.

Text-to-Speech will become an important for of output because it enables hands-free operation. Various Email Readers are already available that can accurately read email for the client. The Simputer, developed by the Simputer Trust of Bangalore, uses Text-to-Speech as an important output mechanism so that people with lower levels of literacy can also use the Simputer.

Interactive Voice Response (IVR) technology is already being deployed by various governmental agencies such as the Railways, for providing information to users through the telephone. IVR systems guide the user

through voice-based menus accessed from a touch-tone phone. These are very effective in delivering of unassisted services to the user.

1.2.4 Some Trends in the Home

Since the Home consumer market is a strong driver of demand for such technologies, it is important to review what is happening in this market. These are some of the other trends that are driving technology for access terminals:

- Residential Services need an Access Terminal with diverse capabilities
    - Integration of the Home's communication needs
        - Internet access
            - Browsing
            - WEB or POP3 / IMAP unified messaging
            - Email & Chat services
        - POTS Telephony
        - Telephony answering machine
        - Fax and Voicemail
        - TV programming
- The future is increasingly the networked home
    - Broadband connection to the Home through Cable or xDSL
    - Wired or unwired connectivity in the Home and beyond
    - Convergence of residential telecom and datacom services is taking place
- Devices at home are getting "smarter" and interconnected
- Smart Home Automation
    - Security Camera monitoring and control
        - Control of home alarm and security systems through remote access
    - Control of HVAC equipment through remote access
    - Powerline communication through spread-spectrum techniques
    - Remote management of appliancesInternet enabled consumer appliances, also called "Internet Appliances", are making an appearance in the marketplace
- Various types of Internet access devices
    - Web TV
        - A device that allows the TV to be used for display of Internet content
        - Essentially a shared device, not very suitable for browsing
        - Tethers the user to the TV
    - Wireless Web Pad
        - A device that may have its own built-in LCD display
        - To provide a personal Internet browsing experience
        - Wireless connectivity enables the user to move around the house
    - Settop, Integrated Receiver Decoder (IRD)
        - A device with a built-in, real-time MPEG2 Decoder
        - Access to TV broadcast programming through Satellite, Cable or Terrestrial media
        - Key enabler for digital services such as Interactive TV
    - Gaming Consoles
        - Typically found in hotel rooms for a broad range of interactive services for hotel guests
    - Smart Phones
- Changing Consumer profile
    - From the technologically literate to mass market users
    - Products now have to satisfy wide range of users
    - Ease of use is very important

- Non-PC centric consumer appliances becoming available
    - The "Wintel" PC architecture is too complex for most embedded applications
    - Small size, Low power consumption is important
    - Intuitive, iconic user interfaces required
    - The "Internet Appliance" concept is appealing
- Opportunities for both existing and new players to deliver new services
    - Provision of interactive financial services
    - Smart Card based Digital Wallet / Personal ATM
    - On-line shopping
    - Home banking
    - Video-on-Demand services

Clearly, we can see the tremendous amount of opportunity that exists in the "Internet appliance" market. We need to be able to create a diverse range of platforms and technologies that can serve these needs.

1.2.5 The Enabling Technologies

Just as we need to recognize the emerging trends in the various types of access terminals, we also need to recognize the enabling technologies that will make the provision of products and services a reality.

Some of the key technology drivers are

- **System-on-Chip** (SOC) technologies
    - Low power high integration CPUs such as
        - ARM, StrongARM, Xscale
        - PowerPC, Crusoe, Lexra
    - Advanced functionality in single package
    - Integration of multiple cores such as RISC & DSP
    - Diverse range of I/O options
    - Built-in boot loader
    - Possibility of creating product differentiation
    - Securing of Intellectual Property in Silicon
- **Battery** technologies
    - Increasingly higher power density, lower size and lower volume
    - "Smart battery" control for fine grain battery management
    - Multi-chemistry chargers
    - Customizable form factors

- **Mobile IP**
  - The ability to retain a single global IP address irrespective of the point of attachment to the IP network is an important attribute of a mobile wireless device
  - Platform-independent Mobility Agents required
  - Seamless integration into IP network at any suitable point of attachment without user interaction
- **Broadband** connectivity
  - ADSL / G.Lite
  - CableModem

- **Wireless** technologies
  - LAN technologies
    - Bluetooth, DECT, IEEE-802.11b
  - WAN technologies
    - DECT, GSM, CDMA, WCDMA, GPRS, 3G
  - User interfaces
    - WML, WAP, XML etc.

- **DSP** technologies
  - For real-time multiple streams of media
    - Data, Voice, Video

- **Speech** technologies
  - Speech Recognition
  - Text-to-Speech
  - Speech Synthesis

    We should develop our own technologies for speech recognition, speech synthesis and text-to-speech because speech input and output will remove one of the major barriers of access to the fruits of IT for the illiterate user.

    However, because of the diverse range of languages and dialects, there is a unique set of challenging problems to be solved. A national effort in this direction will give us immense dividends. For example, we cannot expect to easily adapt western-language oriented speech recognition technologies to our requirements.

    Speaker-dependent and Speaker-independent recognizers will be required for a diverse range of applications. Recognizers for discrete and continuous speech will be required. Recognition engines should be developed and freely licensed to application developers to create their own application- and domain-specific dictionaries.

    Text-to-Speech systems will be an important form of output that help will popularize IT solutions and products. We should develop language independent speech synthesizers that can use different phonetic dictionaries to generate speech output in different languages.

- **Smart card** technologies
  - For secure and authenticated transactions
  - For device personalization
  - Newer products and services at the doorstep
  - E-commerce enabler

Smart Cards are going to play an increasing role as a basic enabling technology for a vast range of financial and personalization services and applications. Multi-purpose Citizen Cards can create a diverse range of applications that will bring e-governance closer to the masses.

In this context, we should develop our own Smart Card technologies such as a Smart Card Controller IC, encryption software, non-volatile storage, contact-based and contact-less interfaces, packaging etc. and manufacturing facilities that can create very large volumes of smart cards cost effectively. For example, the Semiconductor Complex at Chandigarh could churn out millions of these devices.

- **Security & Authentication** protocols
  - PKI compatible infrastructure
    - Digital Signatures, Digital Certificates
    - Message Digests
    - Certification Authority

- **IPv6**
  - IP for the next generation
  - IPSec for secure IP connectivity and VPNs
  - Mobile IP for freedom from point of attachment
  - Enhanced capability for addressing
  - Quality of Service provisioning for media streams

- **Gateway** Devices
- Profusion of standards such as
  - Home RF, Home PNA, OSGi, MHP etc.
- Unique method of consolidating access to "smart" home appliances from the Internet
- Enables, consolidates and manages streams
  - Data, Voice, Internet, Multi-media traffic
- Connects to a Wide Area Network
  - Analog Modem, ISDN, ADSL, CableModem
- Connects to a Local Area Network
  - Wired networks
    - Ethernet, Fast Ethernet, Token-ring
  - Wireless networks
    - Bluetooth, DECT, IEEE802.11b
  - Power-Line communication
    - Spread Spectrum communication
- Platform for delivery of multiple services through the Internet
  - Provides connection to intelligent appliances in the Smart Home
  - Energy management and control
  - Linking energy meters to external service providers
  - Safety and security services
  - Health-care monitoring services
  - Home Automation services
  - Device control and maintenance
  - Electronic commerce services
- Integration into existing products such as
  - Settop boxes
  - Cable Modems
  - Residential gateways
  - Routers etc.
- Driven by open standards such as

  - Open Services Gateway Initiative (OSGi)
  - Universal Pug-and-Play (UPnP)
  - Home Audio Video Interoperability (HAVi)
  - Multimedia Home Platform (MHP)
  - CE-Bus
- User interface technologies
  - HTML, XML, XHTML
  - WML, WAP

It has been estimated that there are about 400 million cellular phone users world-wide and that by the year 2003 this number is expected to cross one billion users. This means that a very large number of mobile devices will be used.

Another statistic tells us that approximately 6 billion devices will have their own IP addresses by 2005. This can only come about when IPv6 gets deployed in the IP network. This upgrade to the current TCP/IP standards will also incorporate 2 major advances to overcome current limitations of TCP/IP.

Firstly, security issues in the network will be addressed through protocol enhancements such as IPSec. Current enhancements such as SSL require an application to be SSL-aware. With IPSec it is possible to implement security in the network without requiring an application to be aware of it. Of course, security at the application level will still be required.

Secondly, Mobile-IP will ensure that each device can retain its own global IP address rather than an address assigned at the point of attachment. When a device moves from one location to another, intelligent "mobility agents" will ensure transparent access to the device.

1.3 The Case for Broadband Access to the Internet

Traditionally, Internet access in the home has been centred on the Home PC and a dial-up network connection to an Internet Service Provider (ISP). An analog modem connection is generally slow and unable to cope with the rich multimedia content available on the web. Surfing at such low connection speeds generally results in a frustrating experience and is one of the main causes of the relatively low penetration of the Internet in an average Indian home. Cost is of course another major barrier to be overcome. However, with the emergence of various types of broadband connectivity services such as ADSL and Cable Modem, at a decreasing cost, the user now has a wider set of alternatives.

Cost effective broadband services will increase the acceptability of the Internet as a powerful medium for the delivery of applications in areas such as education, entertainment and business-to-consumer commerce.

While a traditional Home PC with an external ADSL modem could do the job, an integrated solution such as the ***Generic Internet Access Device*** (**IAD**) provides the possibility of a wider range of services to be offered through the box. Such a device should ideally be located in an "Internet Kiosk" with access to one or more of the broadband access technologies. While the concept of a Kiosk-based device encourages sharing, it should incorporate features that enable it to be personalized for a specific user session. Lower total cost of access will be a desirable result. The success of the PCO Kiosk, the pervasive ISD/STD booth, in opening up telecomm services to the masses is replicable in the Internet domain too.

We believe that the IAD will become an important consumer appliance that has enough unique selling propositions to make it a worthwhile business proposition.

1.3.1 An "Internet Appliance"

An "Internet Appliance" is a frequently used term nowadays and broadly encompasses a range of consumer appliances that are Internet enabled. The concept offers a virtually limitless range of possibilities in its interpretation. The basic underlying theme is always ease of use, as in a conventional consumer appliance. Any consumer appliance's function is to do a few specific things, and do them well. We believe that a standard PC does not qualify on the basis of "ease of use" criteria, as an Internet Appliance, even though it can still do the job of providing Internet access.

Basically, the Internet Access Device is an "Internet Appliance" that provides broadband connectivity to the Internet for web and email access. Additionally, this device should also function as a base platform for the delivery of other services on an incremental basis. It will eventually become a Kiosk or Residential Gateway that can handle a diverse range of services that will be delivered to the user, through the Internet.

While an off-the-shelf solution to Internet access is the Home PC, it is too complex for the basic tasks at hand. The Internet Access Device platform should have features such as POTS telephony, a digital answering machine and VoIP capability within the same platform.

1.3.2 Internet Access Device (IAD) An Overview

The Internet Access Device, in its simplest form, is just such an appliance, which connects the user to the Internet, through an ADSL/G.Lite digital modem, and displays content on the TV screen. It will use an infrared keyboard for text input and a built-in mouse for navigation. A simple browser will render HTML content on the TV screen and also function as an email client for the user.

It will provide an out-of-the-box experience in its ease of use and configurability, in keeping with the concept of an “Internet Appliance”.

The key functional features envisaged are as follows:

- H.323 based VoIP protocol stack, including the echo cancellation and DTMF functionality
- Support for web browsing and email client
- Support for POTS telephony either when the IAD is powered off or when the user wishes not to use the VoIP connection
- An optional hard disk for long-term persistent storage

It is assumed that the IP network will contain Gatekeepers and H.323 Gateways to enable the VoIP phone user to call a regular PSTN phone using the IP network. However, Gatekeeper and Gateway functionality can easily be added to this product.

Adding more features as the product evolves can enhance the basic functionality of the base model. Some of the enhanced features could be:

- Provision of a cable modem
- Support for Smart card reader to enable a host of value added services
- Base-station for a wireless home networking (for example, Bluetooth)

2. ACCESS TERMINAL MARKETS

Intel and Microsoft have together dominated personal computers since the introduction of the first IBM PC. They worked in tandem to create a more powerful operating system (Microsoft) powered by more powerful processors (Intel). However, Palm Computing in 1996 started a revolution in handheld computing that Intel and Microsoft have yet to catch up to. And they may not catch up. Palm, Inc., now an independent public company, owns the Palm operating system, which is a small footprint, easy-to-use operating system designed for pen-input palmtop devices. Palm's chief competitor in the mobile computing device operating system market is Microsoft with its Windows CE operating system. Palm, like Microsoft, licenses its operating system to manufacturers of mobile computing devices. Unlike Microsoft, Palm also makes its own palmtop computers and is the leading worldwide supplier of these devices. In-Stat believes that Palm will continue to offer its own devices and will continue to be selective about which companies it licenses its operating system to.

The PC will be the focus of consumers' Internet activity for the next three years, according to Forrester Research. After 2002, consumers will spread their interactive time among a collection of devices. Providers should build device-specific content, encourage information sharing between devices, and develop cross-device user profiles. They should use all devices for awareness and loyalty but mainly PCs and PDAs for consideration and commerce.

To assess the potential of interactive devices, Forrester surveyed 45 progressive US content and commerce companies, and found that the next five years will see an explosion in multiple-device users.

For years, PCs and Internet access have been nearly synonymous in the eyes of consumers. Now, a pair of surveys look at how consumers feel about getting Internet access through their cell phone or television. Wireless phone users want Internet access and are willing to pay more for the monthly service and the handset to satisfy their wants, according to a survey by The Strategis Group <http://www.strategisgroup.com>. Nearly one-third of the wireless phone users surveyed said they'd spend $13 a month more for the service and $61 more for an Internet-ready handset.

Additional Costs Users Would Pay for Phone with Net Access

Cost	Percent of Interested Users
Nothing	33%
$1-10	27%
$11-15	11%
$16-20	14%
$21 or more	33%

Source: The Strategis Group

The Internet and e-mail are playing a more and more dominant role in our lives. Wireless users are realizing that wireless Internet access would serve a very functional and convenient purpose for getting information when they're away from their home or office. The fact is, wireless services no longer means only voice communications. Today's carriers provide in-depth services such as online transactions, unified messaging, location services, and comparison shopping.

According to The Strategis Group study "CellTRAC™: Cellular and PCS Consumer Trends," 30 percent of wireless users are interested in a phone that would allow them to send and receive e-mail. The data also indicates that 49 percent of potential users are interested in wireless e-mail. The fact that so many potential users are interested in wireless e-mail validates the findings from Europe and Japan, new users are much more likely to depend upon wireless for all their Internet and e-mail access, bypassing fixed Internet access altogether.

Users' Interest in Phones with E-Mail

	Current Users	Potential Users
Definitely Interested	8.3%	13%
Probably Interested	8.0%	13%
Maybe Interested	13.3%	23%
Probably Not Interested	25%	26%
Definitely Not Interested	45%	25%

Source: The Strategis Group

Meanwhile, the outlook for consumer demand for interactive TV is also promising, according to a report by TechTrends, Inc. <http://www.techtrends.com>. The report found that more than 45 percent of US households would consider subscribing to an interactive TV service within a year, assuming one is available in their area. Following price and ease of use, consumers' most important criteria for subscribing to ITV services are feature and content. As cable companies witness strong adoption rates for competing satellite services, and they see telcos preparing to deliver enhanced television services, they are recognizing the need to upgrade their own offerings in order to expand their subscriber base. TechTrends' research has concluded that most US cable subscribers prefer e-mail and Web-browsing as ITV service features. One reason for the popularity of e-mail and Web-browsing over the television is consumers' familiarity and level of comfort with these Internet applications. But some consumers are reluctant to embrace certain TV-based Internet applications, such as e-mail, Web-browsing, time-shifting and online gaming, preferring instead to use their PCs for many of these services. The challenge for service providers will be to lure consumers away from their computers, according to the report. Cable operators will need to emphasize the advantages of TV-based, interactive multimedia applications versus PC-based services, since the number one reason that consumers will not subscribe to ITV services is that they feel their PC is sufficient.

2.1 New Internet Access Devices to Surpass Consumer PCs in Shipments in 2002

Bolstered by the almost-daily announcement of new products, technologies, and vendors, the marketplace for information appliances is rapidly taking off, according to new research from IDC. As an ever-broader group of vendors attempt to address the "Post PC Era," the worldwide market for information appliances will exceed 89 million units, or $17.8 billion, in 2004, up from a market of 11 million units and $2.4 billion in 1999.

The IDC study looks at the PC and Internet appliance market from 1997 to 2002. Last year, PC shipments totaled 31.5 million units, for a 96 percent share of the access market, while shipments for Internet appliances totaled 1.4 million, IDC said. By 2002, PC shipments will grow to 56 million units, while Internet appliance shipments will leap to almost 42 million units, capturing almost 50 percent of the market.

IDC expects Internet appliance shipments to surpass PC shipments and account for the majority of the market by 2004 or 2005.

Personal computers will remain the premier platform for Internet access in 47 million households by the year 2002. TV-based access devices will emerge as the leading non-PC Internet access appliance, providing access in 12.7 million households by the year 2002, growing quickly from 5.2 million household in 2000. Web-enabled screen phones will only capture a fraction of the Internet appliance market, 2.6 million households by the year 2002.

As the Internet becomes more tightly woven into everyday life, an increasing number of consumers will desire the applications and services it can provide. Current online users want access to services in more locations and situations, while many other consumers desire Internet access without the inherent

complexities of PCs. It is clear the PC will not be the only enabling device as both groups find information appliances a solution that can improve their lifestyle and work style.

Information appliances, are an emerging category of digital consumer electronics that provide low-cost, easy-to-use, consumer-focused access to the features and benefits of the Internet. IDC's information appliance taxonomy includes Internet gaming consoles, NetTVs, Internet smart handheld devices, Web terminals, email terminals, and screenphones. As these and other new devices arrive in the next few years, IDC forecasts that U.S. unit shipments of consumer information appliances will outnumber those of consumer PCs by 2002.

In 2000 alone, the number of PDAs (personal digital assistants) sold nearly doubled to 6.9 million units from about 3.6 million units in 1999, according to a report by IDC. Sales are expected to reach a whopping 33.5 million by 2004.

“Handheld computer manufacturers sold 3.5 million devices in 2000, up from 1.3 million in 1999, and raked in $1.03 billion in 2000--more than twice the $436.5 million sold the year before, according to a study by Port Washington, N.Y.-based NPD Intelect.”

The survey highlights the soaring popularity of PDAs (personal digital assistants) made by companies such as Palm, Handspring and Casio, in contrast with falling sales of personal computers. NPD also found that the average selling price of handhelds dropped from $323.98 in 1999 to $293.51 in 2000, an indication of the growing popularity of entry-level models such as Palm's m100 and the impact of price cuts to spur holiday sales.

The devices that will lead the information appliance market are ones that take advantage of existing infrastructures and usage patterns. Devices such as NetTV set-top boxes as well as Internet gaming consoles will benefit from consumers' familiarity with the television. Internet connectivity is also making inroads into the increasingly popular smart handheld device market.

PC suppliers such as IBM, Compaq, and Hewlett-Packard are taking a reserved approach, according to Gens. The issue for these vendors is how to make a profit off a device that costs tens or hundreds of dollars, compared with a PC that costs $1000, he said.

The short-term outlook could spell trouble for these suppliers and give consumer electronics suppliers such as Sony, Nokia, and WebTV Networks an opportunity to enter the Internet appliances market.

Software suppliers such as Lotus face a dilemma with the appliance market and the new customer base. These vendors won't be able to charge high prices for software if an appliance costs between $20 and $200. The evolving market may cause some vendors to walk away because they will be unable to compete. The Internet appliance market is "a developing new IT industry with unique rules.

2.1.1 Web Masters Will Have to Think of Wireless Users' Needs First

Mobile phones have a unique opportunity to become "gateways" for other wireless-capable Internet devices. But manufacturers have to react quickly and correctly to avoid losing profit opportunities. WAP and I-Mode will be forced to merge with Internet standards, possibly rendering them redundant. As networks improve, the imperative for devices to utilize Internet standards will increase. The current software platform war of Microsoft and Symbian may be irrelevant. Both platforms may fail to achieve widespread market adoption.

In-Stat expects that the popularity of wireless Internet access devices will grow substantially, as evidenced by unit shipments, which will experience double and triple digit growth through 2004. Eventually these

devices will displace PCs as the preferred method for accessing data and the Internet throughout much of the world.

Devices are divided into four separate groups: Internet-enabled wireless phones, 2-way paging / messaging devices, mobile computing device (MCD) platforms, and wireless modems.

The market for a variety of highly portable computing products, including tablet PDAs, clamshell PDAs, and smart phones is growing rapidly. Their use and value as business tools has yet to be fully assessed, and there are complex issues for businesses and other organizations to consider in their choice and management. There is considerable variety in terms of functionality. Gartner's segmentation model, which distinguishes voice- and data-first devices and data access and data creation devices, helps to define the basic differences between the products and to guide purchasing decisions. Palm's dominant position in this market continues through 2000, but Palm is challenged within its own camp by innovator Handspring and by others with Microsoft Pocket PC or Symbian EPOC-based products.

The worldwide market for mobile computing devices is forecast to grow from 4.882 million units in 1999 to 6.649 million units in 2000, representing an annual growth rate of 36.2%. The mobile computing device market is also projected to grow to 16.771 million units in 2004, representing an average annual growth rate of 28.0% over the five year forecast period. The rapid adoption of mobile computing devices, due to their low.

According to IDC, it is easy to envision a time in the next few years when the majority of Internet access will be through wireless and not wired devices. IDC estimates that more than 35 million U.S. PC households are online but there are more than 75 million cellular/PCS subscribers and over 40 million paging subscribers.

So, it's very realistic that the majority of Internet access will shift so that it is through wireless and not wired means.

IDC has forecast that by the end of 2002, there will be more wireless subscribers capable of Internet access than wired Internet users. When this happens, there will need to be a fundamental shift in the thinking of the Web community and the IT industry as a whole. Once there are more wireless Internet users than wired users, Web masters may first consider the needs of the wireless users and secondly, the wired PC users. Today, Internet sites have to be retro-fitted for wireless users, but three years from now, it is conceivable they might have to be redesigned for wired users.

2.2 Internet Telephony

There has been a lot of debate whether Internet Telephony should be allowed within the country or not. From the point of view of the consumer it makes a lot of sense to allow Internet Telephony because it lowers the cost of long distance calls. There are deeply entrenched lobbies that have so far prevented this technology from being deployed within the country. However, the advances in technology cannot be denied for too long. Most countries have realized this and have opened up the Internet for voice calls.

The US Telecommunications Act of 1996, "The goal of this new law is to let anyone enter any communications business -- to let any communications business compete in any market against any other." updated the Communications Act of 1934.

In " Telcos Hear New Voices " by Margrit Sessions, Phillips Tarifica Ltd., she predicts that by 2001, Internet telephony could squeeze nearly US$1.2 billion in revenue out of 16 international service providers, while losses due to e-mail (US$463 million) and Internet fax (US$170 million) will be much less. Expected loss of international call revenue due to: Internet phone, fax, and e-mail, by operator:

Company	Expected Losses (millions of US Dollars)	Loss as a percentage of revenue
AT&T	~350	3.6%
Kokusai Denshin Denwa	~307	10.4%
Deutsche Telekom	~175	4.2%
Telstra Corp. (Australia)	~168	9%
Embratel (Brazil)	~28	11.5%
Bezeq (Israel)	~30	10.7%

"Can Carriers Make Money On IP Telephony? by Bart Stuck and Michael Weingarten, Business Communication Review, Volume 28, Number 8,August 1998, pp. 39-44, discusses the economics of VoIP v/s Traditional Telephony. See http://www.bcr.com/bcrmag/08/98p39.htm.

"What is the reality in the battle over packet-versus-circuit telephony, and what is hype? Looking at the potential savings by cost element, it is clear that in 1998, access arbitrage is the major economic driver behind VOIP. By 2003, we anticipate that switched-access arbitrage will diminish in importance, as the ESP exemption disappears and/or access rates drop to true underlying cost. However, we believe that the convergence between voice and data via packetized networks will offset the disappearance of a gap in switched access costs. As a result, VOIP will continue to enjoy a substantial advantage over circuit-switched voice. Indeed, as voice/data convergence occurs, we see standalone circuit-switched voice becoming economically nonviable."

3. CURRENT STATUS IN INDIA OF R&D IN ACCESS DEVICES

3.1 Present Deployment of Access Terminals

By and large internet access terminals deployed in India are PC-based. One Indian manufacturers have recently introduced TV's with built in internet access capability (Videocon), and others are expected to so, too, shortly.

3.2 Indian R&D in Access Terminals

Innomedia Pvt. Ltd., a Bangalore-based company, has developed a state-of-the-art cable settop box that allow internet access as well as viewing and/or recording of TV programmes.

Also, the Simputer Trust of Bangalore, a joint initiative between Encore Software Ltd. and the Indian Institute of Science, has developed a handheld device with built in modem and integrated browser, which is currently under-going beta tests.

The Indian Institute of Technology, Chennai, has also done extremely commendable work towards development of CoDECT telephony terminals, which have already been deployed in several areas of the country.

Finally, iNabling Technologies, another Bangalore company, has developed and launched in the market a compact, portable e-mail device.

4. CURRENT EDUCATION AND TRAINING IN INDIA

4.1 Course in Universities

4.2 Research in Universities

The only research activities in Universities that we are aware of in the area of access terminals, are:

- Development of a browser for handheld devices
- Development of IML (Information Markup Language) for use in developing applications on handheld devices
- Development of a small-footprint version of Linux, for use in handheld devices
- Development of WiLL technology, including telephony terminals
- Development of Text-to-Speech for Indian Languages (Tamil, Kannada, and Hindi already available)

5. RECOMMENDATIONS

5.1 Some Suggestions on Policy

It is the intent of this Report to put forward a few suggestions for consideration at the highest levels of decision making, in the interests of rapid development of a technology skill base. We feel that there must be strong participation between academia and industry and the Government must be a facilitator for such initiatives.

Recently, The Simputer Trust, a non-profit organization based in Bangalore, has developed an advanced mobile platform and software for a low cost product in its effort to help bridge the digital divide. The development of the Simputer has successfully demonstrated a joint product development effort between academia and industry and there is no reason why such a joint development effort cannot be replicated. Further information about the Simputer is available at its web site, http://www.simputer.org.

A few suggestions, based on our experience as members of the Simputer Trust, are worth mentioning here:

- Use open source model for software
  - Enable different software groups and individuals to participate in development of complex technologies and products
  - Enable "free" access to these technologies for rapid deployment
  - Make use of the vast resources of open software that is already available

- Translate the open source model for software development to the hardware domain also
  - The Simputer Trust has conceptualized such a model for the first time
  - Make "freely" available the technology and solutions to any Indian OEM at a reasonable license fee

- Provide "prime mover" benefit to the initial development group for a specific period of one year after technology is developed, to enable the original group to commercialize the technology so developed

- Create a web based community of developers who can share and participate in the joint development processes

- Patent filing and protection through a single window, and licensing of 3rd party patents through a common entity to reduce costs of development

  We should now work on an infrastructure to enable Internet Telephony on a high bandwidth Internet backbone. There is still much to be done. The current IP infrastructure is based on the IPv4 standards, which do not address the issues of Quality of Service, which are so essential to handling packetized voice data. IPv6 provides for QOS based delivery and also provides a better framework for security, encryption and authentication. We need to migrate within a reasonable time-frame to the IPv6 standards. This will require that software for all switching and routing equipment be upgraded to IPv6. This may not currently be a major task because of our lower installed base of Internet equipment, but will increase in magnitude as the number of Internet users increases.

  Voice Gateways will not only provide basic telephony and fax services but will also enable lots of value-added services, e.g., call-centers, integrated messaging, least-cost routing, etc. Gateways provide three basic functions:

- Interface between the PSTN network and the Internet

  Gateways terminate incoming synchronous voice calls, compress the voice, encapsulate it into packets, and send it as IP packets into the IPnetwork. Incoming IP voice packets are unpacked, decompressed, buffered, and then sent out as synchronous voice to the PSTN connection.

- Global directory mapping

  They provide a translation between the names and IP addresses of the Internet world and the E.164 telephone numbering scheme of the PSTN network.

- Authentication and billing

  They enable the calling and called parties to be authenticated and provide billing information to be plugged into the billing systems of the PSTN network.

5.2 Some Suggestions on Development

From the above discussions it is clear that there are many areas in which joint development consortia consisting of Indian industry and academia could create innovative technologies and products. However, we should try to create critical mass for products and technologies that will provide solutions to the diverse rural communities across the country.

- Initially focus on a few basic technologies and products that will help bridge the digital divide
  - Work on appropriate technologies for rural communities
    - Language interfaces
    - Text-to-Speech
    - Speech recognition
    - Ruggedized packaging
    - System-on-Chip
    - Security & Encryption

- Multi purpose Smart card based “Citizen Card” with various applications such as
  - Ration Card
  - Passport
  - Voter ID Card
  - Driving License
  - Micro banking Passbook

- Wireless based communication technologies for the Local Loop
  - For the last mile problem in remote locations

- Internet or Web Kiosks
  - To take the Internet to the masses (similar to STD booths)

- Internet Appliances

- Develop expertise in open source OS technologies such as
  - Linux, Embedded-Linux, MobileLinux

- Real-time micro-kernels

- Develop an architecture for a family of customizable System-on-Chip (SOC) solutions
  - A high performance, low power RISC Core
    - Preferably compliant with the ARM instruction-set architecture to ensure availability of a vast range of development tools and open software
  - DSP Core
    - For handling multiple forms media streams
  - Multi-protocol MAC Engine for networking
    - Capable of handling Ethernet
    - MAC layer for Cable DOCSIS
  - Security & Encryption Engine
    - To enable real-time encryption
    - AES standard (Rijn-Dael algorithm) in hardware
  - Smart Card controller interface
  - Bus Logic
    - PCI
    - USB or IEEE-1394

    The next generation of mobile, Internet enabled products will be based on devices with a high level of integration in silicon. There will also be the need to integrate data, voice and video streaming capability. This calls for a new generation of System-on-Chip (SOC) solutions in which a RISC core and a DSP Core will play a significant part. We should create a generic, licensable SOC that can be adapted to different applications.

- Develop a complete 3G / 4G Protocol Stack
  - UMTS, GPRS, Edge protocols
  - Speech Coding (3GPP-Adaptive Multi Rate)
  - RF and Baseband integration on a single device
  - Low power
  - Create User customizable Intellectual Property suite
  - Freely licensable to Indian OEMs
  - OFDM
  - SDM

- Develop a national foundation for compliance with the global Public Key Infrastructure (PKI)
  - Security, encryption and authentication protocols and the framework should be standardized
  - PKI Servers are required
  - Independent Certification Authorities are required
  - Legal framework for the acceptance of digital signatures on electronic documents for enabling of e-commerce
  - Open source software is available for the standard algorithms

    The digital revolution will not be possible without an indigenous infrastructure and legal framework for secure transactions. We should create a national infrastructure compliant with the PKI standards and affiliate national Certification Authorities with global certification authorities such as Verisign and Entrust.

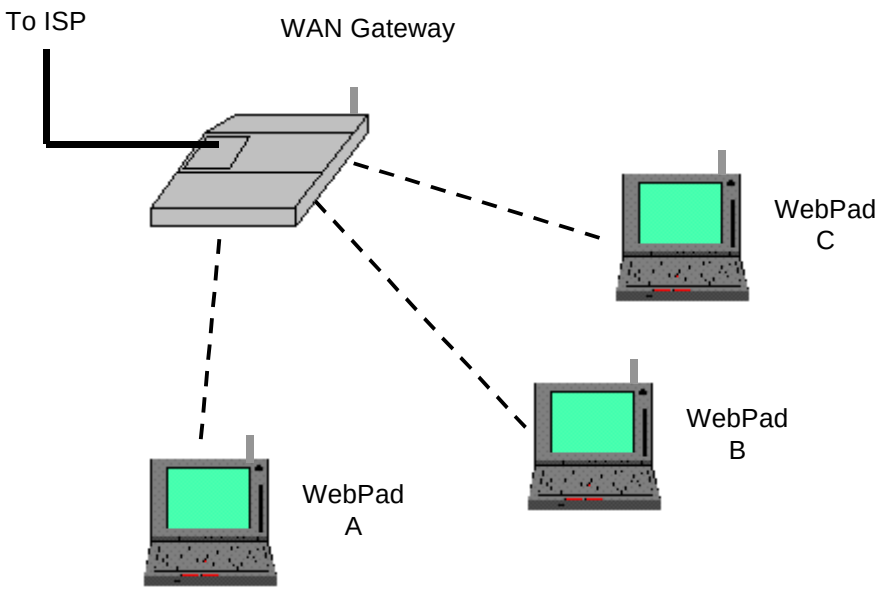
    However, we also need to develop our own encryption algorithms for deployment in sensitive areas where national security is extremely important. Such indigenous encryptions algorithms should seamlessly plug into the PKI infrastructure to achieve user selectable levels of security.

In this context it is useful to point out that the US National Security Agency has selected an algorithm for the next generation of encryption, based on an international, open competitive bidding process in which all the competing algorithms were vetted by globally recognized cryptographic experts. This new standard, called the Advanced Encryption Standard (AES), has adopted the Rijn-Dahl algorithm submitted by a crypto team from Belgium. This competitive process has taken 4 years of effort as part of an open-standards setting activity. The AES algorithm is now publicly and freely available for use in any applications. It uses 3 key sizes of 128, 192 and 256 bits.

We should develop specialized ASIC/VLSI hardware solutions based on the AES standard for deployment in different applications. The AES algorithm is easily implementable in hardware.

- Develop a family of Residential Gateway products
  - A device that acts as a bridge between internal and external networks
  - Platform independence
  - Network independence
  - Integration of Voice, Data and Video services to the Home through a Broadband Connection
    - POTS telephony, Digital Answering Machine
    - Voice-over-IP services
    - Video Conferencing
  - Routing between Home LAN and the Internet
  - Firewall, Proxy, Network Address Translation
  - IPSec and VPN support
  - Secure messaging
  - Seamless integration with wireless mobile devices in the Home
  - For access to smart appliances in the Home
  - Embedded Server for
    - Deployment of technology independent services
    - Device configuration, management and control
    - Remote management of services
  - Classification according to various types of services
    - Communication oriented services
      - Email, Internet access
      - Firewall, network address translation
    - Command, control and telemetric services
      - Energy management
      - Remote control and diagnostics
    - E-commerce related services
    - Safety and security services
      - Burglar alarms
      - Home critical-care monitoring
    - Recreation services
      - Interactive TV
      - Video-on-Demand, streaming Audio/Video
      - Chat rooms, Games etc.
  - Compliance with open standards such as OSGi
  - Customizable design freely available for licensing to Indian OEMs

A typical scenario consisting of mobile wireless WebPads connected through a Residential Gateway is given below:



- Develop an infrastructure for Internet Telephony
  - Develop Voice Gateway products to handle multiple protocols such as H.323, MGCP, SIP
  - Develop consumer-end Voice Terminal products such as smart phones and IP phones.

- Develop a Patent Regime and infrastructure for Indian IP
  - Build a portfolio of Intellectual Property (IP) in Hardware designs, ASICs, Software, Algorithms, Products
  - For protection and commercial exploitation of our own intellectual property
  - For ease of access to Indian partner companies
  - As a bartering mechanism for licensing IP from other patent holders, worldwide
  - Encourage small and medium enterprises to invest in IP creation and registration

ANNEXURE 1

1. Telecommunications Act of 1996, Pub. LA. No.104-104, 110 Stat. 56 (1996).

2. http://www.fcc.gov:80/telecom.html

3. For informal background see "WTO negotiations on basic Telecommunications" - http://www.wto.org/wto/services/tel.htm

4. http://www.packeteer.com/solutions/voip/sld006.htm

5. Telia press announcement: 1999-01-25

6. Mary E. Thyfault, Equant To Roll Out Voice-Over-Frame Relay Service, InformationWeek Daily, 10/21/98.

7. "Strategies for Navigating the Convergence of Voice and Data Networks", by Pedro Arroyo, Ray Gilstrap, Randy Huang, Peter Laudat, a report for EE290X: Strategic Computing and Communications Technology, U. C. Berkeley, 11 May 1998, http://haas.berkeley.edu/~laudat/finalproject.html.