NETWORKPROGRAMS™

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Network Programs
Embedded Competency

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1 About Network Programs

Founded in the United States in 1992, Network Programs (www.networkprograms.com) is a pioneering software development outsourcer and innovator of the global delivery model. With a management team drawn from leading global IT/telecom companies, we develop technology used in communications networks, contact centres and consumer electronics. A wholly-owned subsidiary of the Jubilant Group, a US$650M company, our solutions cover a wide range of software development services – onsite and offshore – provided to the telecommunications, electronics and business process outsourcing (BPO) industries. With headquarters in India, we operate 4 domestic sales and support offices. Internationally we maintain offices in the United States, Japanese and Australia, in addition to channel partners located in Bangladesh, Sri Lanka and the Middle East.

Our Credentials

- With a team of more than 200 software engineers who have completed numerous projects, our delivery model is based on global resourcing, robust domain expertise, and proven quality affirmed by certifications for SEI CMM level 5, ISO 9001:2000 and BS7799 for information security. In addition, we adhere to the social accountably standard SA8000.
- With domain expertise in multiple industry verticals that includes finance, retail, telecom, electronics, contact centres and automotives, we have successfully positioned ourselves as one of the leading global IT service providers.
- Possessing the flexibility to work with leading IT corporations as well as smaller technology innovators, we have a proven track record of maintaining long-standing customer relationships with leading global companies among the Fortune 500 and Global 1000.
- Our management team hails from premier telecom institutions like C-DOT (India's premier telecom R&D centre), Lucent Technologies (formerly Bell Labs), Telcordia (formerly Bellcore), IBM and Siemens.

Solutions @ Network Programs

Software Development Services

We provide an array of software services including research and development, design, applications development, testing, maintenance and system integration. With 15+ years experience, our teams focus on solutions for network management, business and operations support systems, switching technology and embedded systems. With extensive experience in cutting-edge convergence technologies -- wireline, wireless and broadband, and Internet infrastructure -- our solutions include software for internet television (IPV), radio frequency identification (RFID), smart cards and biometric systems. In the embedded space, we develop software solutions for real-time operation systems (RTOS), kernels, protocol stacks, codecs, device drivers, etc. We also provide hardware development support for board support packages (BSP), field programmable gate-arrays (FPGA), and application-specific integrated circuits (ASIC) services for used in semiconductors.

This document provides briefs the Network Programs projects in embedded technology space.

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2 Embedded Projects – An Overview

In addition to executing client projects in the embedded technology domain, Network Programs has also focussed on products. The Network Program team has a deep understanding in the embedded area in various technologies like signaling and communication protocols, processing and management of network devices.

Network Programs software embedded system development expertise can be highlighted as follows:

Application development – Application for the MPEG-2 based DVB compliant integrated receiver decoder (Set Top Box), embedded printer spooler, etc., API development/stacks/ protocol/TCP/IP domain, digital fax encryption system.

Porting of RTOS/Kernel on custom hardware – Network Programs has worked on different x86, MIPS, ARM based-hardware systems with expertise to port user applications across custom hardware platforms to meet user requirements.

Development of device drivers and firmware – Network Programs has expertise to develop device drivers for various devices such as smart cards, remote controls, I2C bus, serial ports, parallel ports, touch screen, LEDs, LCDs, PCI Cards, etc.

Porting applications between different RTOS – With considerable experience in porting applications on RTOS such as pSOS+ and Nucleus+, Network Programs has successfully conducted projects that required porting of application from one operating system to another due to factors such as cost.

Feature enhancement for existing systems – Network Programs possesses an expertise in handling projects that involve adding features to an embedded system as per user requirements.

Performance tuning of embedded applications, design, interoperability testing and test automation for existing platform is also achieved.

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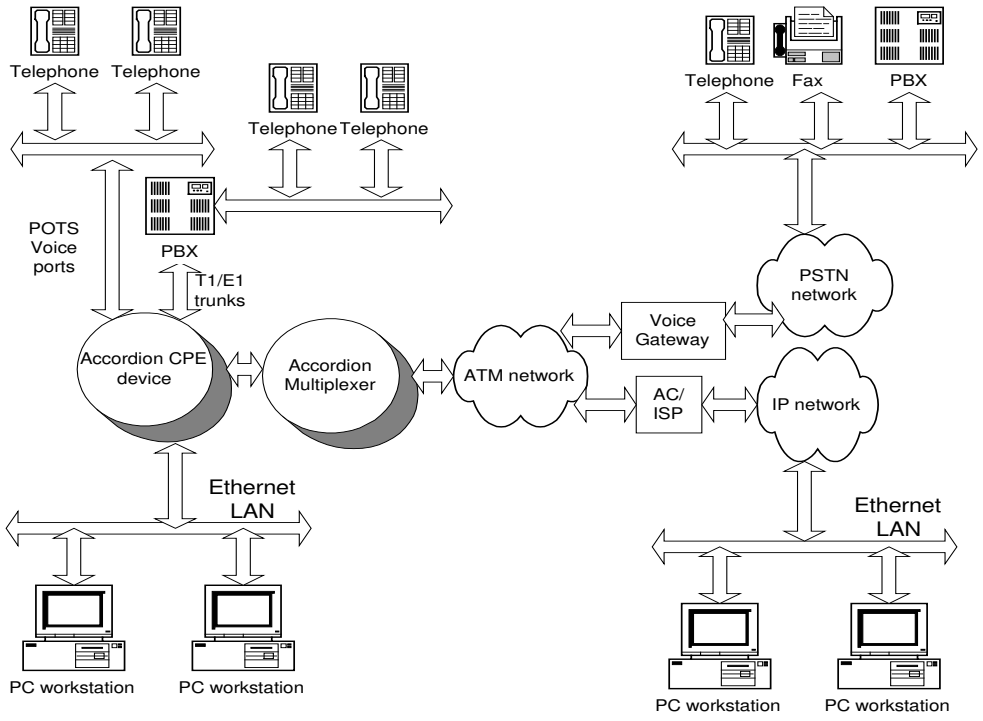
3 Network Programs Projects in the Embedded Space

3.1 Accordian (USA – Onsite)

Project Description

Accordion developed an onsite PoP solution for BLECs and CLECs. This included development of customer premises equipment with voice and data connectivity (named VODEM, i.e. Voice and Data Multiplexed) and a central box to multiplex the traffic from various VODEM devices (named BEST, i.e. Bandwidth ElaSTisizer).



The diagram below depicts the network architecture showing the connectivity of Accordion devices in the existing networks.

VODEM provides 10/100 Mbps Ethernet connectivity for data communication with customers. IP traffic can be exchanged with Internet or with the customers connected with other VODEM over this link.

VODEM also provides 16 voice ports for telephone connection and E1/T1 trunk for PBX connection so that a customer can make phone calls to customer connected with other VODEMs or with users connected on PSTN.

BEST (Bandwidth ElaSTisizer) provides VDSL connectivity to VODEMs for upto 56 Mbps link bandwidth and DS3 based trunk connectivity to ATM network. It provides end-to-end PVC links from VODEM to voice gateway for voice traffic and from VODEM to ISP for data traffic.

Features

The Network Programs team was involved in developing and integrating the following for VODEM box:

- Providing power on self-test
- BSP diagnostics
- Porting, integration and configuration of data protocol stacks involving RouterWare and WindRiver IP stacks for IP, TCP, UDP, NAT, DHCP, and RIP
- Porting, integration and configuration of data transport protocol stacks involving DCL stack of IPOA and RouterWare stack of PPP and PPPoE
- Writing call control engines for JetStream and CopperCom protocols for call handling of access network
- Writing device drivers to interface with the DSPs for AAL functionality and for voice DSPs
- DSP code maintenance for AAL handling and voice time slots to ATM sample conversion activities
- Statistics collection for voice and data traffic and reporting it periodically to proxy agents
- Database interfaces for accessing configuration and event data
- Integration of embedded web-server, agranet EmWeb/CLI, onto the accordion box
- Design and implementation of the interface between the web-server with the SNMP agent
- Design and implementation of the complete CLI on the web interface

Technologies Used

- C++
- C
- VxWorks
- Agranet EmWeb/CLI
- HTML

3.2 DWDM Simulator – A Network Programs Product

Project Description

A DWDM device is an optical network component that allows broadband networking in multiples of gigabits. Dense Wavelength Division Multiplexing (DWDM) is a better way to use fiber capacity than Time Division Multiplexing (TDM) techniques.

DWDM enhances bandwidth through multiplexing of multiple optical signals at different yet closely spaced wavelengths over a single fiber, giving the advantage of distinct visibility and identification of each stream at the lowest level, the physical layer. While TDM forces the network devices to process and multiplex the various wavelengths, where timing synchronization, high-speed electronic circuitry and other engineering issues become of paramount importance.

DWDM technology allows true multiplexing of different information payloads, enabling them to be transported across the optical network transparently.

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Optical networks based on DWDM technology comprise of terminals, add-drop multi-plexers and cross-connects. The device definition is based on the purpose and functionality of the device, and devices may be engineered to flexibly position them with a choice of functions.

Within a DWDM network, all information transfer is managed at the optical level, with a possibility of wavelength change as a signal traverses from one point to another through intermediate nodes. Devices, that provide mapping of user information to the DWDM domain, are known as edge devices. By definition, a terminal is always an edge device, while the other device types may perform edge device functions.

This product provides a framework for simulating a DWDM based device for the purpose of management from an SNMP system. Suitable definition of the MIB can make it appear as a terminal, add-drop multiplexer or a cross-connect. For edge devices, additional non-DWDM MIBs can be added, based on interfaces that need to be simulated.

Suitable scripting can be done to manipulate the MIB values to simulate the device parameter value changes, as viewed by the manager. The DWDM simulator can issue notifications in the form of SNMP traps for signaling alarms and events.

The DWDM technology has basic management information identified as MIBs based on DWDM RFC. As the DWDM RFC matures towards the standards track, the DWDM simulator can accommodate any changes as they occur, by suitable changes in the MIB definition and behavior scripts.

The simulator aids the development of Element and network management system for DWDM devices, as it allows deferment of actual DWDM equipment till a late stage in the development cycle. It can also be used to analyze the definition and impact of enterprise MIBs, as they are planned for the DWDM system, without going through the stage of actual implementation in the device. Thus it not only expedites the management software development cycle, but also reduces its dependency on the hardware device cycle.

Features

- The device can be defined with device definition files, representing SNMP MIB objects
- Traps can be generated dynamically
- The behavior is provided to simulate real change of device values and the script files are used for real-time behavior

Technologies used

- C++
- VC++
- NT/W2K compliant
- SNMP V2
- DWDM MIB (ASCII) & DWDM Behavior Script (ASCII)
- Optical MIB (Draft-stewart-atommib-opticalmib-02.txt)

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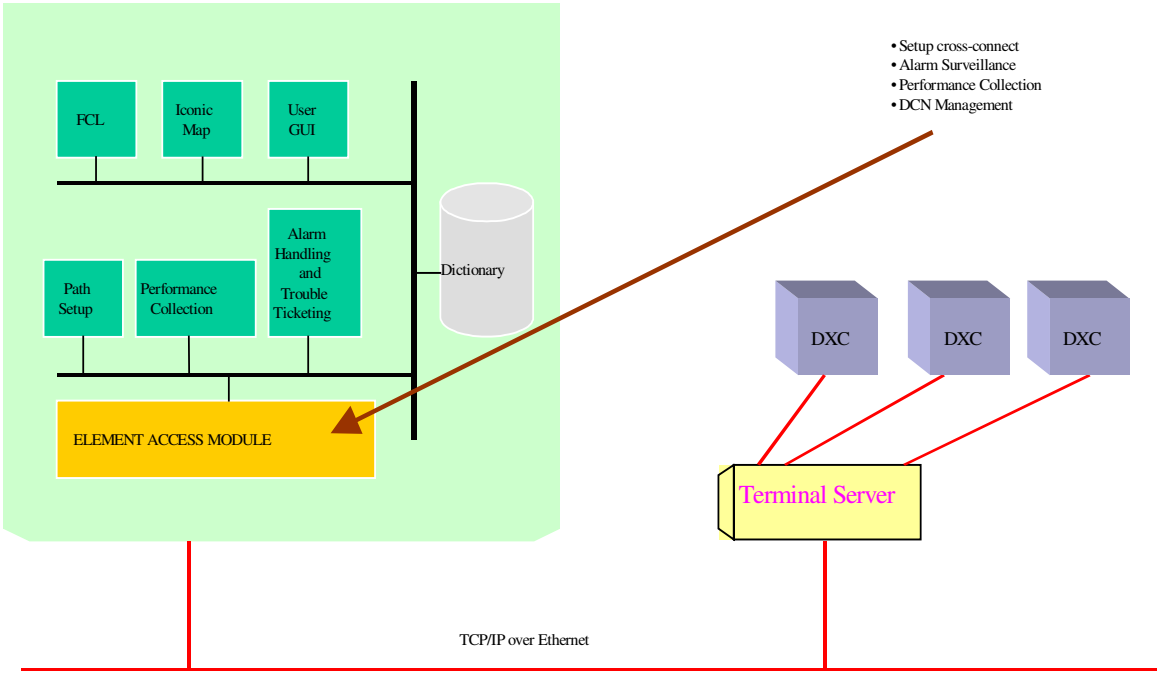
3.3 Digital X-Connect Element Access Module

Client: DSC Corporation Denmark

Project Description

Element Access product for the TMN environment gives access to the client's SONET/SDH cross connects systems. It operates in the digital TeMIP environment and complies with the general management and user interface conventions for this environment. It also manages the data communication network (DCN) to transport data between the computer system and the network elements.
Element Access provides a subset of management and gateway functions that include establishing connections, reporting alarms and collecting performance counters.



Features

- Surveillance of SDH electrical terminations at STM-1 rate and SDH optical terminations at STM-1/STM-4 rates
- Surveillance of asynchronous T3 terminations
- Setting up and tearing down cross connections at SDH VC4 and VC3 rates for unidirectional, bi-directional and broadcast connections
- Performance data collection for SDH signals
- Alarm logging
- DCN management for access to the SDH cross connects systems

Technologies Used:

- Digital TeMIP

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- C++
- ITU-T Object Model for SDH

3.4 Convergent Multi-service Access System (CMAS)

Client: Proposal for a project, USA

Project Description

The CMAS system combines all the access technologies of currently available systems. It supports the complete range of subscribers - starting from POTS to FTTH. The system is flexible in terms of new technology introduction and capable of handling large bandwidths. Apart from providing an integrated platform for existing services to the end customer, it enables easy introduction of new services.

The CMAS system introduces the Passive Optical Network (PON) as the access network for the broadband subscribers. It uses passive fiber-optic couplers and splitters to route traffic. PON systems are very efficient at the local access network as they are available at lower cost, provide higher reliability and have true broadband capability.

CMAS taps all the advantages of the PON by creating virtual exchanges (remote terminal) which in turn are connected with a central office (CO) switch through a fiber link. These virtual exchanges provide broadband services to the end subscribers. They can be deployed over a small geographical area as well as cater to larger areas. High availability can be provided through alternative connectivity between the host terminal at the CO and the remote terminal(s), to safeguard against fiber cuts and link failure.

The proposed system consists of two parts.

- *Host Terminal (HT):* This is co-resident with the CO switch and interfaces with the remote terminals over the PON based access network. The HT has support for interfacing with multiple transmission or switching systems supporting various technologies and acts the gateway for the PON.
- *Remote Terminal:* This system is co-located with the end user, which could be close to the building or even within the premises. It provides point to multi-point optical feeder for all the subscribers requiring different bandwidth starting from POTS to very high bit rate services like live korroke.

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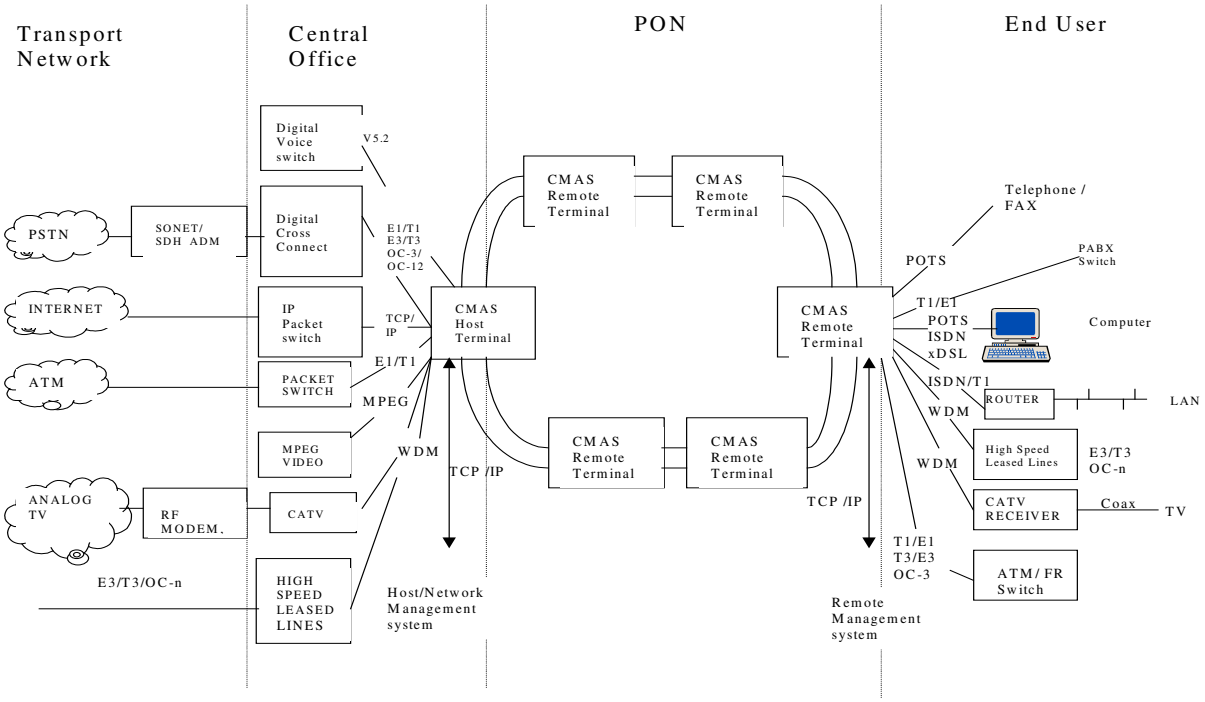

Technologies Used

Not Applicable

3.5 Video Service Delivery System

Client: Fujitsu Japan

Project Description

The video service delivery system was implemented as a strategic solution for end-to-end system integrators to provide an early vision for the next generation of enterprise implementing customer-centric business processes for broadband network services. It entailed provisioning video services using an ATM switch at the CO over an access network right up to the customer premises.

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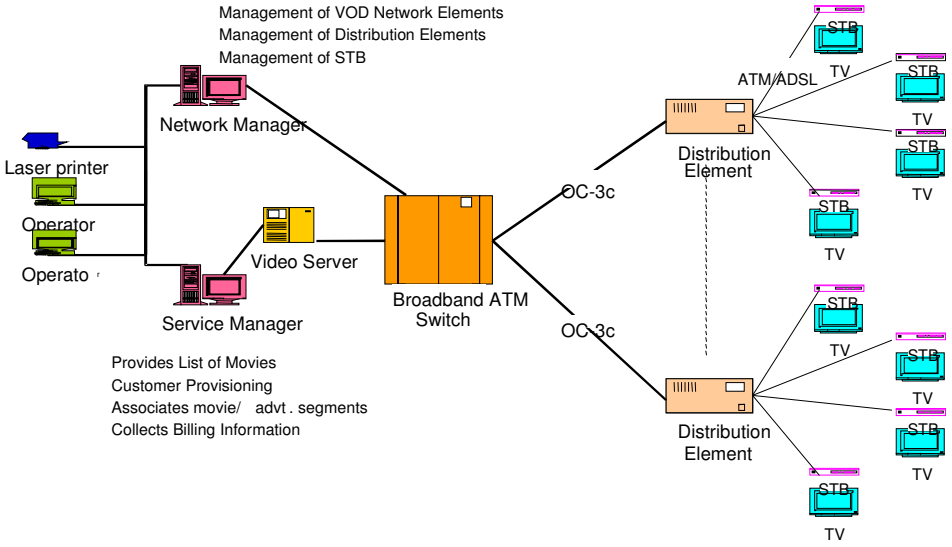

The ATM switch-based core network and distribution elements that constitute the access network support the network. The video service delivery is managed through L1GW and L2GW

The various function blocks are mentioned below. Some of the function blocks translate directly into physical devices.

STB: It represents the subscriber unit. When powered on, it contacts the network provider (L1GW) and gets the list of service providers. Upon selection of a movie from a service provider, the information is passed to the video server via STB proxy, which in turn delivers the movie to the STB. STB can exercise video controls like play, pause, forward and rewind. Network Programs conducted the complete hardware and software design of the STB.

STB implements HTML/HTTP like protocol to access L1GW, L2GW and video server. DAVIC recommends MHEG5 and DSM-CC UU/UN. However in current implementation, HTTP is used instead of MHEG5. DSM-CC related software is implemented on STB proxy.

STB Proxy: This part of the part of STB is implemented on L2GW. The HTTP to DSM-CC mapper is implemented as STB proxy on L2GW.

L1GW: It represents the network provider and provides the list of service providers to STB. It plays the following additional roles:

- As network manager, L1GW has functionality to configure and manage part of VOD network comprising of:
  1. Access network - Distribution element using S5 flow protocol stack (SNMP based)
  2. STB/STB proxy - using S5 flow protocol stack
- As ARP server, L1GW has functionality to provide IP address to all the ATM components in the VOD network.
- As provisioning server: L1GW provisions STB when it is started. It provides STB its ATM address, IP address and other address required by network or NMS.

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L2GW: It represents the service provider and does customer provisioning and provides the list of movies (along with information about content provider) to the STB and usage data collection that can be used for billing.

- As session manager (DSM-CC UN Server), L2GW has functionality to provide a session oriented connection between STB (and/ or STB Proxy) and video server. As resource manager (DSM-CC UN Server), L2GW has functionality to maintain configuration information of the set top box.

- As STB proxy, L2GW has functionality to have CORBA 2.0 compliant ORB and provide mapping between STB Native Protocol (HTTP) and DSM-CC UU as mentioned above.

Video Servers: These are the repositories of movies. The content operating system prepares/ stores movies on the video servers and providers all the information to the service management along with rate. The video server (a component of content operating system) plays movies selected by STB as per the video control (play, forward, rewind and pause).

Core Network: The client ATM switch represents core network by providing 155MBPS ATM links to video servers, L2GWs, L1GW and distribution elements. For the delivery system, it is a SVC link.

Access Network: The distribution element designed by Network Programs represents access network, which works as 155MBPS/ 6MBPS ATM/ ADSL multiplexer.

Technologies Used

- C, C++
- Linux, Windows
- UNI 3.0
- MPEG 1.0
- DAVIC 1.0
- ATM

3.6 Broadband/ Narrowband Switching Projects

Client: Fujitsu (Japan)

Project Description

Network Programs has worked with Fujitsu ATM switch software team in the areas of call processing, traffic management, automatic protection switching and performance monitoring for a four year duration, from 1996. The features have been developed based on ATM forum as well ITU-T standards for the switches developed for North American and European markets.

With over 100 man-years experience, Network Programs is equipped to handle ATM software development to cater to the industry needs. Network Programs has executed projects on software development for ATM switch configuration, call processing, and traffic management, automatic protection switching, and performance monitoring for broadband and narrow band.

Extensive development has been done in the following areas:
- familiarization with ATM specifications from ATM Forum as well ITU-T
- call processing for ATM switch
- traffic management for ATM switch

- automatic protection switching for ATM switch
- performance monitoring for ATM switch
- modeling of managed objects in the switch software for design and development
- involvement in all life cycles of the switch software starting from basic investigation to system testing

Technologies Used

- ITU-T recommendations
- C
- Unix
- TBD

3.7 3G Evolium Testing

Client: Fujitsu Evolium

Project Description

UMTS (Universal Mobile Telecommunications System) popularly known as a 'third-generation (3G)' broadband provides services like packet-based transmission of text, digitized voice, video, and multimedia at data rates of two megabits per second (Mbps) (or even higher). UTMS offers a consistent set of services to mobile computer and phone users across the globe. Based on the GSM communication standard, UMTS, endorsed by major standards bodies and manufacturers, is the planned standard for mobile users around the world by 2002. Once UMTS is fully implemented, computer and phone users can be constantly attached to the Internet as and where they travel. Users will have access through a combination of terrestrial wireless and satellite transmissions. Until UMTS is fully implemented, users can have multi-mode devices that switch to the currently available technology (such as GPRS and EDGE) where UMTS is not yet available.

System Features:

Many new protocols have been developed for the four new interfaces specified in UMTS: Uu, Iub, Iur, and Iu.

Fujitsu is involved with the script writing for Uu and Iu interfaces, which are being explained in detail here.

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Uu Interface Protocol Stack

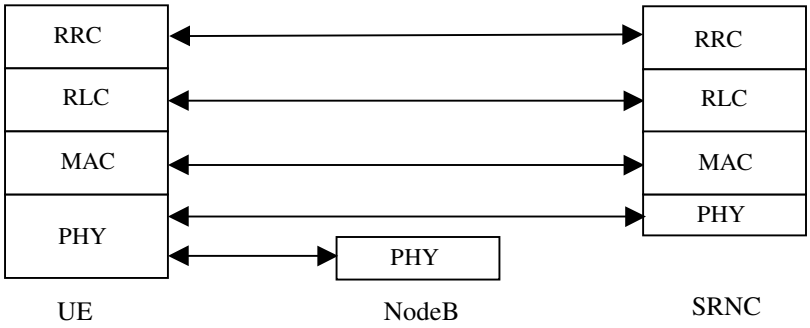

Figure 2: Protocol Termination for DCH, control plane

Iu Interface Protocol Stack

The Iu interface protocol architecture has three planes:

- The radio network control plane, which corresponds to the signaling plane, related to the UTRAN related functions
- The transport network control plane, which corresponds to the signaling plane, related to the establishment/release of the Iu user plane transport bearers
- The user plane which carries user data

Each plane can be divided in two layers:

- The radio network layer, which corresponds to the UTRAN, related functions
- The transport layer, which corresponds to the transport bearers used to carry the radio network related information

The following figure illustrates Iu interface protocol architecture.

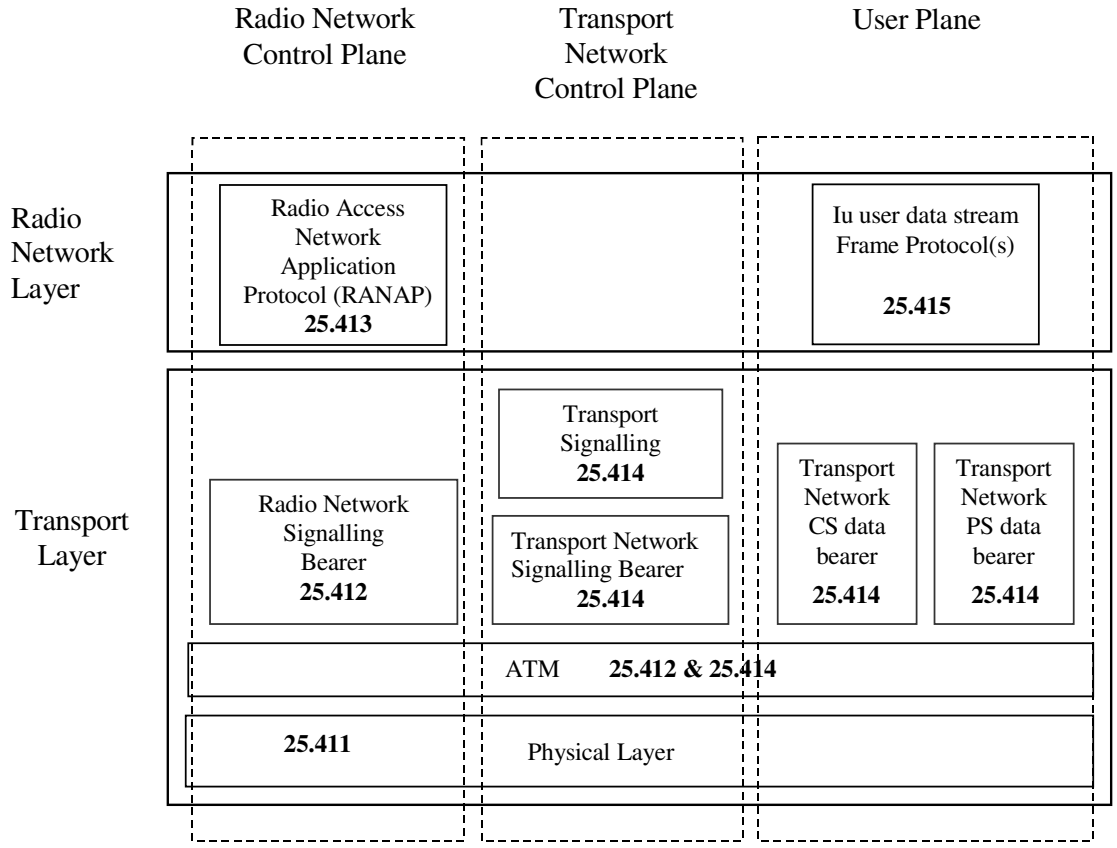

Figure 3: Iu interface protocol architecture

Network Programs' Role:

Network Programs' prime responsibility was to write the test scripts for the TM100 for the Uu interface and the system testing. The scripts were being written in Perl. Since the client was a fresher in the 3G field, the staff members were not very familiar with the 3G protocols and the testing environment. Thus, the team of professionals at Network Programs trained the client's staff and helped them in script writing and testing the Iu interface side.

Technology Used:

- C
- Perl
- 3G protocols
- UMTS
- Fujitsu TM100 Switch

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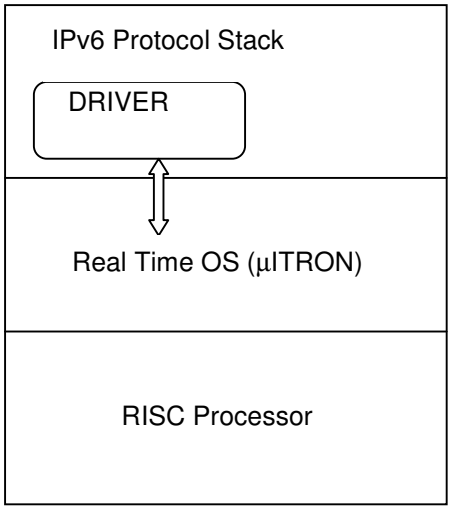
3.8 IPV6 Stack Porting in LSI Devices

Project Description

The proposed IPv6 protocol stack was embedded into LSI devices having RISC processor and real time OS. The protocol stack provides socket interface and IPv6 functions for embedded Internet applications using the LSI device.

System Features:

The protocol stack for IPv6 LSI had three parts as depicted below:



The bottom of the stack consisted of a processor with IPv6 accelerator. The next level was the real time OS. It also contained the Ethernet driver, which was the channel of communication between the IPv6 stack and the hardware level. At the third and the topmost level had a IPv6 protocol stack. The stack provided IPv6 Internet functions like socket interface: TCP, IP, UDP, NDP, and routing.

Network Programs' prime role was to port the stack into LSI devices. The team was also responsible for requirement specifications, design and coding, component testing, integrated testing and systems tests. A test lab was setup at the Network Programs premises that comprised IDE, ICE, simulator, PC's and target board.

The skill set required for IPv6 stack porting:

- Knowledge and understanding of TCP/IP domain
- IPv6 specification
- FreeBSD architecture
- Expertise in the area of embedded environment
- Real time operating system
- Windows 9X/NT
- C and Assemble language

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- Usage of network monitoring tools
- Board support packages

3.9 Development of IPSec SDK

Project Description

The Proposed IPSec SDK would be embedded into LSI devices having processor, IPSec Code Accelerator, IP Stack & associated drivers and Real Time OS. The APIs are provided which will be used by any embedded IP stack developer to enable secure communication over Internet.

System Features:

The IPSec SDK had the following features:

- Embedded OS independent (ITRON, OS9 etc)
- Modular structure, so that it could be easily used by any of the stacks like IPv4, IPv6 etc.
- Provides the standard APIs, which will be used by IPv4 and IPv6 stack
- High-speed processing using the code accelerator chip
- High scalability
- Small module size for embedded system

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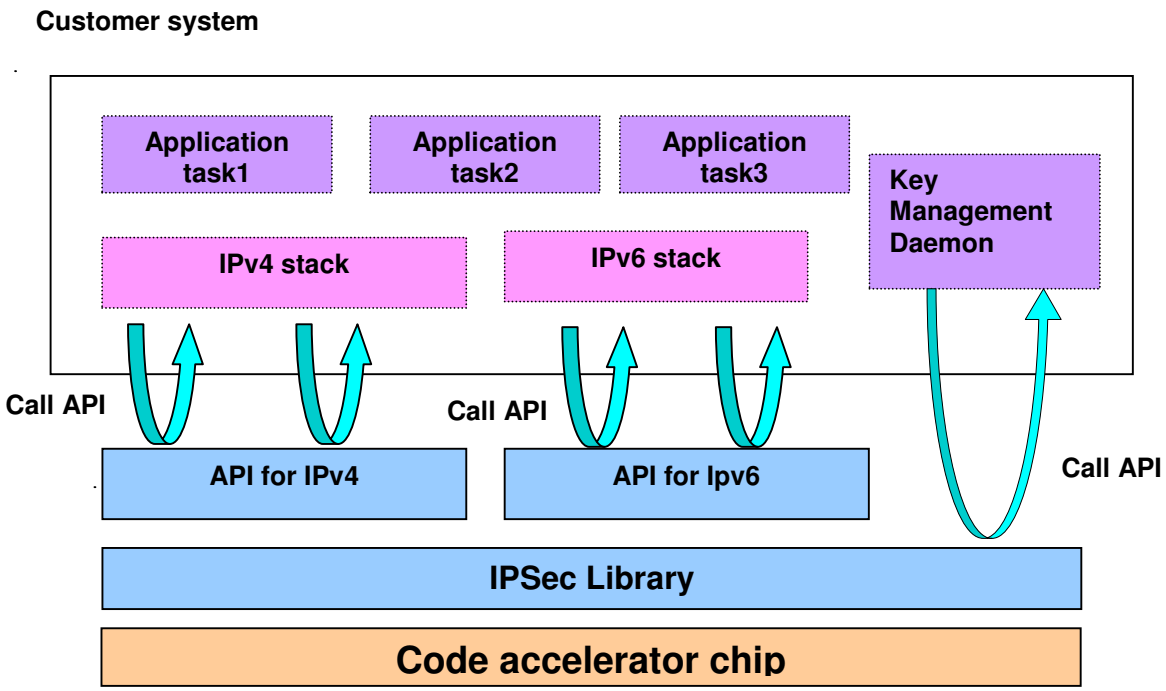

The proposed system had the following layers:

- A code accelerator chip existed at the bottom of the system. This chip provided the commonly used IPSec functions, which are computation intensive e.g. DES/3DES etc.
- The next level was IPSec Library, which used the functionality of the code accelerator chip. This library provided a set of APIs, which was used by the protocol stack.
- The third level consisted of IPv4 and IPv6 protocol stack. The stack provided network layer functions in the system. It provided socket interface to the application programmer.
- At the fourth level, the key management daemon ran, and negotiated the security associations and key material with the remote host by calling the appropriate API from the IPSec library. It used the services of IPv4/IPv6 protocol stack for communicating with the remote host.
- The fifth level had the specific applications that communicated with the applications residing on other hosts over the Internet in a secured way.

3.10 Smart Card

Project Description

The goal of the project was to understand, test and optimize the smart card OS (HiperSIM), a modular, high-performance, smart card OS for the Fujitsu HIFERRON (Fujitsu series of LSI chips used in multipurpose integrated circuit (IC) cards embedded with FRAM technology) family of 32-bit processors.

In general, a smart card is typically a 'credit card' sized form factor with a small-embedded computer chip that can be programmed to perform tasks and store information. Smart cards are of various types like memory cards, processor cards, electronic purse cards, security cards, and JavaCards. A smart card that has a processor is inserted into a smart card reader (commonly called a card terminal) and is available for use. The software wishing to communicate with the reader needs to send some commands to manage the reader things like power up and transfer command to card. The commands are based on the standard ISO 7816 specifications, which define command formats in great detail.

HIPERSIM is firmly founded on the European Telecommunications Standards Institute (ETSI) Smart Card Platform (SCP) series of smart card standards. These standards underpin the most widely used and demanding smart card application – the Subscriber Identity Module (SIM).

The FRAM memory provides a powerful software platform for current and future smart card and wireless applications. This smart card is having a micro kernel derived from mach OS. The Hiper SIM is divided into three layers manufacturer set, developer set and telecommunication set. The manufacturer set is having kernel, file system, cryptography, IO library (T 0 and T 1 protocol) and IO task implementation. The developer set has an application manager and ISO 7816 based file system and cryptographic API. The developer set has a telecommunication set, which gives a framework for the application developers to write applications specific to telecommunication.

A reverse engineering of the HiperSIM OS (proprietary OS based on Mach micro kernel, an OS kernel developed at Carnegie-Mellon University) is done to understand the OS functionality. This is followed by optimization of some of the core components of the OS like file system so that it can fit easily in a limited space in FRAM.

In telecommunication set, the wireless Identity module (WIM) as per the standards is developed and tested out and then finally integrated to the other parts of OS. This involves asymmetric key pair generation, MD5, and SHA1 algorithms support.

The environment used is C language and soft tune workbench along with HiperSIM OS based smart card.

System Features:

The HiperSIM OS based smart card has the following features:

- Based on embedded OS i.e HiperSIM OS (a micro kernel derived from mach OS)
- Modular structure in the sense that every layer publishes well defined set of APIs to other layers
- Support of ISO 7816 file system

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- The OS is designed keeping in mind the memory optimization and takes very less memory
- Scalable
- Small module size for embedded system

Benefits:

The benefits derived from a HiperSIM OS based smart card are:

- **Security**
  - The chip is tamper-resistant
  - Information stored on the card can be PIN code and/or read-write protected
  - Capable of performing encryption
  - Each smart card has a unique serial number
- **Intelligence**
  - Capable of processing and storing information
  - Capable of communicating with computing devices through a smart card reader
  - Information and applications on a card can be updated without having to issue new cards
- **Convenience**
  - Smart cards provide a portable, easy to use way.
  - The HiperSIM OS provides a rich set of APIs at each level.
  - The OS architecture is scalable and modular.
  - With multiple application facility the card can support different types of applications. The user can thus do with fewer cards in his wallet.
  - The card is also called a Java card as it supports JVM with Java Card Applets running over it
- Smart cards are gaining significant popularity in:
  - **Banks:** Many banks in the States are using the card on a trial basis. However, the card has gained maximum popularity in Europe and South Africa.
  - **Medical Applications:** In Germany 80 million people use smart cards for medical consultation with doctors.
  - **Electoral Voting:** The Swedish government has introduced a voting mechanism wherein people can vote with a smart card. It serves as a non-repudiation device.
  - **Entertainment:** Most DSS dishes in the US have smart cards.
  - **Telecommunications:** Smart card is used in many European mobile phones and the US is soon expected to adopt this trend.
  - **Mass Transit:** British Air efficiency was correlated to the rail and air connections. There were many delays because customers could not be tracked while they were in transit, which caused aircraft to be held for phantom customers. To solve this problem, British Air used smart cards, and radio receivers to track their passengers. This reduced the delay in flights as controllers could be given estimated ready times, and new departure slots could be calculated.

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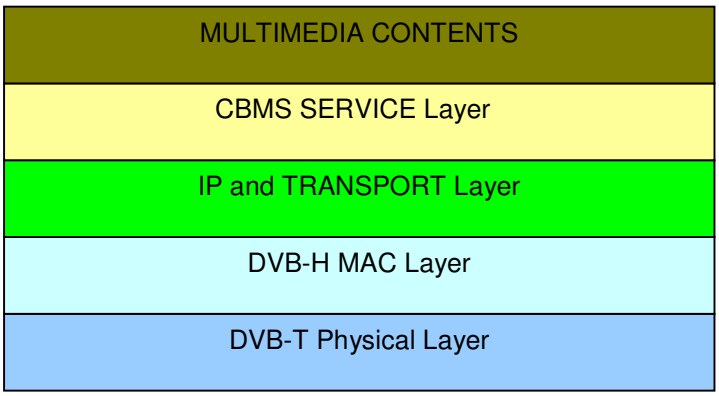
3.11 Digital Video Broadcasting (DVB) : Transmission System for Handheld Terminals (DVB-H)

Project Description

Network Programs has done a study on Digital Video Broadcasting (DVB) for hand held devices. DVB-H technology is used for broadcasting digital TV to the light, battery powered and mobile phone that everybody carries in his or her pocket. Basically, DVB-H provides the necessary features to optimize transmission of 'TV to the mobile' services to hand held devices using strong foundations provided by the DVD-T broadcast transmission system.

DVB-H can be described as a set of technical features consisting of a MAC layer (embedding MPE-FEC & time slicing) and a physical layer (Terrestrial Digital Video Broadcasting), which permit the broadcast, over existing or entirely new DVB-H networks of rich multimedia contents carried in IP datagrams.

The figure below shows the DVB-H stack running on hand held devices to receive digital TV broadcast. DVB-H uses its own MAC layer over DVD-T physical layer to allow concurrent access to the physical medium and to adapt the data message to the physical frame.



DVB-H uses Multi Protocol Encapsulation (MPE) to insert the IP datagrams into MPEG Transport Stream.

Our focus of study is IP and transport layer. The DVB-H uses UDP on transport layer and RTP, RTCP on application layer for transferring the streams. NPI has already developed VoIP products using RTP and RTCP implementations.

The CBMS (Convergence of Broadcast and Mobile Systems) service layer is responsible for presentation layer. It uses MPEG-4 or MPEG-2 for encoding audio.

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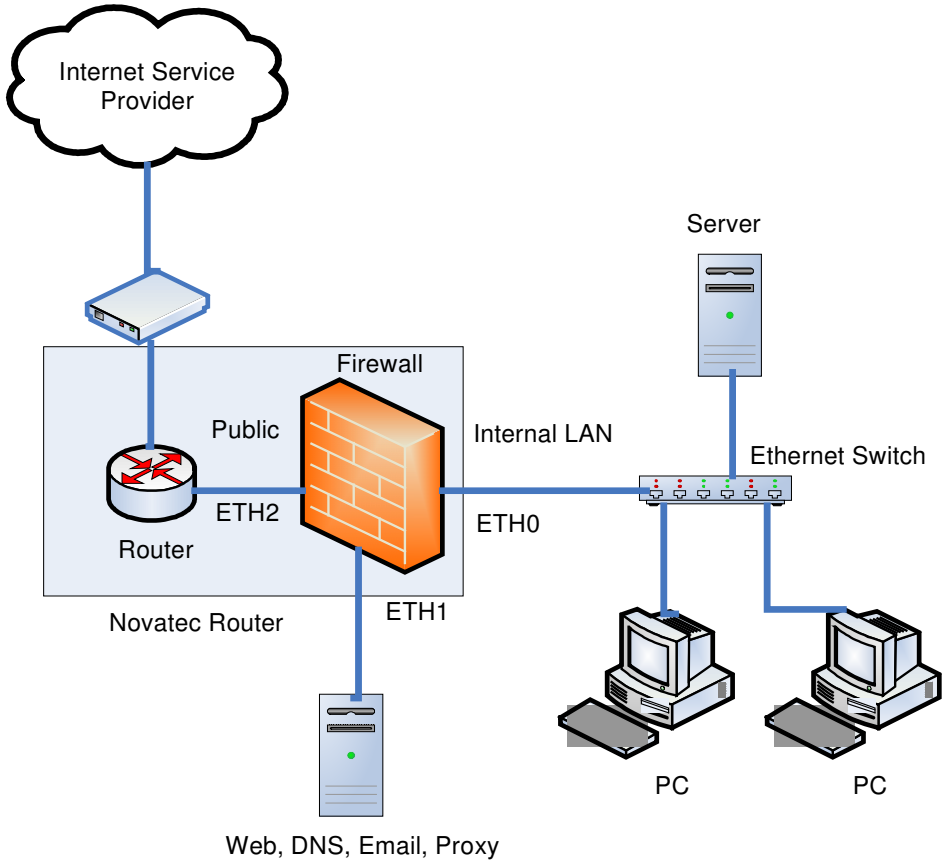
3.12 Broad Band Router (BB Router)

Project Description

This project builds on open source, ARM based router/firewall pre-product prototype. The following figure depicts the network architecture and its most common use within a typical network & connection to the Internet via a leased line connection to an ISP. The router performs routing and limits access between public Internet and the private company network as shown in the figure. At the same time it allows specific servers including email & web to operate in a network segment isolated from both the public Internet and the company local internal LAN.



Technology Used:

- RIP, OSPF routing protocols
- IPTables packet filtering
- VPN, NAT/PAT, static NAT
- SNMP, DNS relay, DCHP server
- UPnP

- Telnet, Web GUI

Router Functionality
LAN ports: 10/100 Mbit/s Ethernet
PPP/MPPP, CHAP, PAP
DHCP, DNS, RIP, OSPF, UPnP

Firewall Functionality
NAT
Access lists/address/service filtering
PPTP/L2TP/IPSec VPN
Packet stateful inspection
Circuit level proxy
Security Alerts/Intrusion Detection/DoS attacks

Configuration & management functionality
SNMP
Web GUI, remote management & configuration
Security updates
Ready made scripts for various set-ups

3.13 Other Embedded System Projects

- **Intelligent Terminal Controller Card** (112 terminals) for the EISA bus.
- **Multi-channel Paging Unit**.
- 8 degree of freedom **Mobile Robot with Learning Capabilities**.
- **Perception Analyzer System** for market research. It is essentially a remote data acquisition system. This can acquire data from upto 64 analog channels on an RS 232-C link.
- **Remote Controlled Stereo Satellite TV Receiver**. The system has 100 channels of digitally tunable video and audio.

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