IMPLEMENTATION AND MANAGEMENT OF SOFTWARE FOR DATA COMMUNICATION NETWORKS WITH OSI AND CCS7 MODELS

M.Sc. THESIS

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VERİ İLETİŞİM AĞLARINDA OSI ve CCS7 YAPILARINA UYGUN YAZILIM GELİŞTİRİLMESİ ve PROJE YÖNETİMİ

YÜKSEK LİSANS TEZİ
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FORWORD

The adaptation of the OSI model to a modern communication system, Common Channel Signalling No.7(CCS7) is handled in this thesis for a digital switch and the implementation of the related software is given.

I would like to mention my special thanks to my supervisor Prof.Dr. Eşref Adalı and to my DMS Design Manager Mr. Bahadır Çınar.

M. Güney Güçer
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ÖNSÖZ</td>
<td></td>
<td>ii</td>
</tr>
<tr>
<td>TABLE OF CONTENTS</td>
<td></td>
<td>iii</td>
</tr>
<tr>
<td>ACRONYMS</td>
<td></td>
<td>v</td>
</tr>
<tr>
<td>SUMMARY</td>
<td></td>
<td>viii</td>
</tr>
<tr>
<td>ÖZET</td>
<td></td>
<td>ix</td>
</tr>
<tr>
<td>CHAPTER 1.0</td>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>CHAPTER 2.0</td>
<td>NETWORK ARCHITECTURES</td>
<td>9</td>
</tr>
<tr>
<td>CHAPTER 3.0</td>
<td>OPEN SYSTEMS INTERCONNECTION</td>
<td>12</td>
</tr>
<tr>
<td>3.1 The Physical Layer</td>
<td></td>
<td>13</td>
</tr>
<tr>
<td>3.2 Data Link Layer</td>
<td></td>
<td>13</td>
</tr>
<tr>
<td>3.3 Network Layer</td>
<td></td>
<td>14</td>
</tr>
<tr>
<td>3.4 The transport layer</td>
<td></td>
<td>14</td>
</tr>
<tr>
<td>3.5 The Session Layer</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>3.6 The Presentation Layer</td>
<td></td>
<td>16</td>
</tr>
<tr>
<td>3.7 The Aplication layer</td>
<td></td>
<td>17</td>
</tr>
<tr>
<td>CHAPTER 4.0</td>
<td>INTRODUCTION TO COMMON CHANNEL SIGNALLING No.7 (CCS7)</td>
<td>19</td>
</tr>
<tr>
<td>4.1 CCS7 System</td>
<td></td>
<td>21</td>
</tr>
<tr>
<td>4.2 CONs and PROS OF CCS7</td>
<td></td>
<td>23</td>
</tr>
<tr>
<td>4.3 Transmission Network</td>
<td></td>
<td>26</td>
</tr>
<tr>
<td>4.4 Network Configuration</td>
<td></td>
<td>29</td>
</tr>
<tr>
<td>4.5 System Architecture Overview</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>4.5.1 Level 1, Signalling Data Link Functions</td>
<td></td>
<td>32</td>
</tr>
<tr>
<td>4.5.2 Level 2, Signalling Link Functions</td>
<td></td>
<td>32</td>
</tr>
<tr>
<td>4.5.3 Level 3, Signalling Network Functions</td>
<td></td>
<td>33</td>
</tr>
<tr>
<td>4.5.3.1 Signalling message handling functions</td>
<td></td>
<td>33</td>
</tr>
<tr>
<td>4.5.3.2 Signalling network management functions</td>
<td></td>
<td>34</td>
</tr>
<tr>
<td>4.5.4 Level 4, User Part Functions</td>
<td></td>
<td>37</td>
</tr>
<tr>
<td>CHAPTER 5.0</td>
<td>RELATIONSHIP BETWEEN CCS7 FUNCTIONAL LAYERS and OSI LAYERS</td>
<td>39</td>
</tr>
<tr>
<td>CHAPTER 6.0</td>
<td>APPLICATION OF CCS7 ON A SERVICE SWITCHING POINT (SSP)</td>
<td>43</td>
</tr>
<tr>
<td>6.1 Implementation for Layers 1-2-3 (Message Transfer Part)</td>
<td></td>
<td>44</td>
</tr>
<tr>
<td>6.2 Managing Different Protocols</td>
<td></td>
<td>45</td>
</tr>
<tr>
<td>6.3 Software Structure for Layers 1-2-3</td>
<td></td>
<td>48</td>
</tr>
<tr>
<td>CHAPTER 7.0</td>
<td>SOFTWARE IMPLEMENTATION OF LEVEL 3</td>
<td>52</td>
</tr>
<tr>
<td>7.1 Basic types gates and utilities</td>
<td></td>
<td>56</td>
</tr>
<tr>
<td>7.2 Datafill and table control of the new network</td>
<td></td>
<td>57</td>
</tr>
<tr>
<td>7.3 Distribution and Discrimination functions</td>
<td></td>
<td>58</td>
</tr>
<tr>
<td>7.4 Signalling Network Management</td>
<td></td>
<td>59</td>
</tr>
<tr>
<td>7.5 CCS7 Test Utility -C7TU</td>
<td></td>
<td>61</td>
</tr>
</tbody>
</table>
7.6 SOFTWARE STRATEGY .......................... 64
CHAPTER 8.0 SOFTWARE MANAGEMENT FOR COMPUTER CONTROLLED
SWITCHES ........................................ 67
8.1 Software Library ............................... 68
RESULT ............................................. 72
REFERENCES ...................................... 77
APPENDIX C7TU USAGE and LOGS ......... 79
C.V. .................................................. 89
ACRONYMS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>ASCII</td>
<td>American Standards Comittee for Information Interchange</td>
</tr>
<tr>
<td>CC</td>
<td>Central Control Module</td>
</tr>
<tr>
<td>CCITT</td>
<td>International Telephone and Telegraph Consultative Comittee</td>
</tr>
<tr>
<td>CCS</td>
<td>Common Channel Signalling</td>
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<tr>
<td>CCS7</td>
<td>Common Channel Signalling No.7</td>
</tr>
<tr>
<td>CIC</td>
<td>Circuit Identification Code</td>
</tr>
<tr>
<td>CM</td>
<td>Central Control Module</td>
</tr>
<tr>
<td>C7BASEUI</td>
<td>CCS7 Data Types Module</td>
</tr>
<tr>
<td>C7LINK</td>
<td>CCS7 Links table</td>
</tr>
<tr>
<td>C7LKSET</td>
<td>CCC7 Linksets table</td>
</tr>
<tr>
<td>C7LLVTIM</td>
<td>CCS7 Link Verify Transactor Module</td>
</tr>
<tr>
<td>C7NWKTC</td>
<td>C7NETWRK Table Control Module</td>
</tr>
<tr>
<td>C7MHPR</td>
<td>CCS7 Message Handling Protocol Module</td>
</tr>
<tr>
<td>C7MTPDIS</td>
<td>CCS7 MTP Discriminator/Distributor Module</td>
</tr>
<tr>
<td>C7MTPUI</td>
<td>CCS7 Message Transfer Part Module</td>
</tr>
<tr>
<td>C7RTESET</td>
<td>CCS7 Routeset Table</td>
</tr>
<tr>
<td>C7SNMHDŁ</td>
<td>CCS7 SNM Message Handler Module</td>
</tr>
<tr>
<td>C7SNTYPE</td>
<td>CSC7 Signalling Network Types Module</td>
</tr>
</tbody>
</table>
C7SNUTIL  CCS7 Signalling Network Utilities Module
C7TIMER   CCS7 MTP Timer Table
C7TKUTIL  C7TRKMEM Table Control Module
C7TRKMEM  CCS7 TRunK MEMbers Table
C7TU      CCS7 Test Utility
C7TUCI     C7TU Test Utility Commands Module
C7TUCIP    C7TU Common Interface Procedures Module
C7TUUI     C7TU User Interface Module
C7TUFRMT   C7TU Default User Formats Module
C7TULINK   CCS7 Test Utility Link Commands Module
C7TULOG    C7TU Log Definitions Module
C7TUPMH    CCS7 TUP Message Handler Module
C7TYPES    CCS7 Base Types Module
DMS        Digital Multiplex Switch
DUP        Data User Part
DPC        Destination Point Code
DTC        Digital Trunk Controller
EBCDIC     Extended Binary Code Decimal Interchange Code
IAM        Initial Address Message
ISDN        Intelligents Systems Digital Network
ISUP        Integrated Services Digital Network User Part
ISO        International Standards Organization
LGP        Link General Processor
LPP        Link Peripheral Processor
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSU</td>
<td>Message Signalling Unit</td>
</tr>
<tr>
<td>MTP</td>
<td>Message Transfer Part</td>
</tr>
<tr>
<td>OPC</td>
<td>Origination Point Code</td>
</tr>
<tr>
<td>OSI</td>
<td>Open Systems Interconnection Reference Model</td>
</tr>
<tr>
<td>PB</td>
<td>Peripheral Board</td>
</tr>
<tr>
<td>PDTC</td>
<td>PCM30 Digital Trunk Controller</td>
</tr>
<tr>
<td>PTS</td>
<td>Per Trunk Signalling</td>
</tr>
<tr>
<td>SCCP</td>
<td>Signalling Connection Control Part</td>
</tr>
<tr>
<td>SCP</td>
<td>Service Control Point</td>
</tr>
<tr>
<td>SL</td>
<td>Signalling Link</td>
</tr>
<tr>
<td>SIO</td>
<td>Service Information Octet</td>
</tr>
<tr>
<td>SLC</td>
<td>Signalling Link Code</td>
</tr>
<tr>
<td>SLS</td>
<td>Signalling Link Selection</td>
</tr>
<tr>
<td>SNM</td>
<td>Signalling Network Management</td>
</tr>
<tr>
<td>SO</td>
<td>Switching Office</td>
</tr>
<tr>
<td>SSP</td>
<td>Service Switching Point</td>
</tr>
<tr>
<td>STP</td>
<td>Signal Transfer Point</td>
</tr>
<tr>
<td>ST</td>
<td>Signalling Terminal</td>
</tr>
<tr>
<td>TCAP</td>
<td>Transaction Capabilities Application Part</td>
</tr>
<tr>
<td>TUP</td>
<td>Telephone User Part</td>
</tr>
</tbody>
</table>
SUMMARY

This thesis has been devoted to investigate one of the recent innovations in telecommunications area; CCS7 Signalling System, understand its concepts, compare it with the OSI model and examine how such a system is applied on a digital network by the help of computer technology.

The network architecture of CCS7 is compared with the recommendations of OSI and the design of the layer 3 is enhanced by suggesting a new network type and message label to be used. Areas of the software where the network type is created is updated and thus the structure of the system is examined.

CCS signalling protocol is a form of data communication in which all information is transferred in labelled messages. Since all information is transferred independently of the telephone channels, it is possible to transfer all kinds of information via the signalling channel, and to route the signalling in different ways through the system, depending on line conditions.

CCS No.7 has been designed to provide different user groups with their own sets of messages. This makes it easy to implement new messages for one user group without affecting other user groups in the system. This capability of the system is emphasises in the thesis and by creating a new network type and message label, the software development phase of a computer controlled switch is given.

This thesis mentions about network architecture in data communications, signalling protocols, CCS7 principles, layers and concepts; and their correspondence to OSI layers. After the general building blocks of the CCS7 system is introduced, networking structure using a CCS system is given.

The software product management strategy of the computer controlled switch is given to illustrate how different requirements are fulfilled on the system.
ÖZET

VERİ İLETİŞİM AĞLARINDA OSI VE CCS7 YAPILARINA UYGUN YAZILIM GELİŞTİRILMESİ VE PROJE YÖNETİMİ


OSI modeli, yedi katmandan oluşan ve herbiri birbirinden bağımsız işlev gören bir yapıyı önerir. Böylece tasarım kolaylaştığı gibi, katmanlar arasındaki protokollerle tanımlanan iletişim, sistemin farklı kullanıcılar tarafından dahili aynı temel fonksiyonlara işlenmesini ve ortak bir iletişim ağının tanımlanmasını mümkün kılar.

OSI modeli, günümüzün sayısal bilgisayarlardan oluşan telekomünikasyon ağıları için de güzel bir model teşkil etmektedir. Sayısal santrallarda bilgisayar teknolojisinin tüm olanakları kullanıldığından ve santralların işlevinde büyük ölçüde üzerindeki yazılımın önemi olduğundan, OSI modeli sayısal telekomünikasyon ağılarında kolayca kullanılabilir. Böylece, telekomünikasyon ağları için OSI'yi temel alan ve CCS7 (Common Channel Signalling No7: Ortak Kanal Haberleşmesi-Numara 7) olarak anılan bir sistem geliştirilmiştir.

Bu çalışmada OSI modeli ve CCS7 modeli karşılaştırmalı olarak incelenmiş ve CCS7 modelinin ele alınan sayısal santralda nasıl işlev gördüğüırdelememiş. Sistem için yeni, lojik bir şebeke önerilerek bu şebeke'nin yazılımı gerçekleştirilmiştir.

Tez, şu ana başlıklar altında toplanmıştır:

- Bilgisayar Ağıları Mimarisi
- OSI
- CCS7
- OSI ve CCS7 ilişkisi
- Katman 3- Mesaj Transfer Bölümü için yazılım
- Yeni bir lojik şebeke'nin tanıtılaması
- Yazılım Proje Yönetimi

Bölüm 3'de OSI modeli tanıtılmıştır. OSI modeli yedi bağımsız katmandan oluşur.

- Fiziksel katman
- Veri katmanı
- Şebeke katmanı
- Taşıma katmanı
- Bölüm katmanı
- Presentasyon katmanı
- Uygulama katmanı

Bu katmanların işlevleri bölüm 3'de ayrıntılı olarak verilmiştir.

Bölüm 4'de OSI modeline dayanan ve telekomünikasyon ağları için önerilmiş olan CCS7 modeli tanıtılmaktadır. CCS7 yapısındaki veri iletişimini, temel çağrı işaretlemesini yanında, veri tabanı erişimi gibi geliştirilmiş özelliklere sahiptir. CCS7 iletişiminde çağrıya ilişkin kontrol işaretlemesi konuşma kanalı üzerinden değil, sadece işaretlemeye ayrılmış ayrı bir kanal üzerinden yapılır. Böylece düğümler arasında ayrı bir kanal üzerinde veri iletişimini yapabilir; oysa konvansiyonel işaretlemeye çağrıya ilişkin işaretlemeye konuşma kanalı üzerinde yoğunlaştırmak kullanılmaktadır. Bu özelliğiyle CCS7 veri tabanı erişimi gibi yeni yeteneklere sahip olabilmştir. Bölüm 4'de CCS7 ve mimarının yapısını incelenmiş, CCS7 katmanlarının OSI katmanlarına benzerliği vurgulanmıştır.


Bölüm 6'da Mesaj, Transfer Bölümü için önerilen şebeke şebeke tasarıması ele alınmıştır. Yeni şebekeyi yönlendirme biriminin varolan birimlerden farklı ve daha geniş tutulması önerilmiştir. Bunu
Cumhurbaşkanlığı tarafından gereklilik için Katman 3’e ilişkin tüm mesaj formatlarının değiştirilmesi ve yazılımda bu mesajları gerçekleyen prosedürlerin yeni birime göre tasarlanması gerekmektedir. Böylelikle sistem önerilen şebeke üzerinden gelen mesajları doğru değerlendirilir ve gönderilenecek olan mesajlarda ise yeni şebekevi gönderilecek şekilde yönlendirme birimini düzenleyecektir.

Mesaj Transfer Bölümü OSI katmanlarının ilk üçüne karşı düşünüldü ve CCS7 yapısı içindeki işlevleri CCITT standartlarıyla belirlenmiştir. Mesaj Transfer Bölümünün işlevleri şu ana başlıklar altında toplanabilir:

1- Katman 1 ve Katman 2: İşaretleme hattı:
Bu katmanlar verinin transmisyonuna ilişkin fiziksel ortamı sağlar ve transmisyon esnasında doğabilecek hataları düzeltmekten, bit dizilereinin doğru olduğundan sorumludur. Oldukça düşük seviyede yer alırlar.

2- Katman 3: İşaretleme Şebekesi Fonksiyonları

a- İşaretleme Mesajlarının İşlenmesi
- Mesaj Yönlendirme
- Mesaj Ayırdetme
- Mesaj Dağıtımı

b- İşaretleme Şebekesinin Yönetimi
- İşaretleme Trafiğinin Yönetimi
- İşaretleme Hattının Yönetimi
- İşaretleşmenin Yönlendirilmesi

Bu çalışmada, önerilen yeni şebeke için Mesaj Transfer Bölümünün bahsedilen işlevlerinin yazılımı genişletilecektir. Belirtilen fonksiyonlar, sistemde yazılım olarak prosedürlerle gerçekleştirecektir. Bu prosedürler yeni şebekeyi tanıyacak ve yeni şebekeyin işaretleşme formatındaki mesajlarla işlevini yürütecek şekilde yeniden tasarlanacaktır.
Yeni lojik şebekenin tasarımını, sistemde varolan yazılımın yeni tanımlarla genişletilmesiyle gerçekleştirir. Yazılım şu ana başlıklar altında toplanmıştır:

- Temel tip tanımlamaları, hizmet programları ve değişkenlerin tanıtıması
- Sistem tablolarının yeni şebeke için doldurulması ve ilgili yazılımin genişletilmesi.
- Katman 3 fonksiyonlarından dağıtım, ayırdetme ve yönlendirme, fonksiyonlarının yazılıminin yeni şebeke için genişletilmesi.
- Katman 3 Şebeke yönetim fonksiyonu altındaki prosedürlerin yeni şebeke için genişletilmesi ve mesaj formatlarının yeniden uyarlanması.
- Test Yazılımın yeni mesaj formatı ve şebeke için geliştirilmesi. Yeni mesaj oluşturan mesajları, mesajları görüntüleyen, istenen bir hat üzerinden gönderilmesini sağlayan ya da mesajın yutulmasını sağlayan prosedürler yeni şebeke'nin test edilmesini sağlayacaktır.


Böylelikle aynı santral üzerinde değişik fonksiyonlar elde edilir. Önerilmiş olan şebeke belirtilen proje yönetim esaslarına göre gerçekleştirilmiştir. Sonuç olarak, modern bir sayısal telekomünikasyon şebekesi yeni bir lojik şebekeyi kabul edecek şekilde gerçekleştirilmiş, ilgili yazılım modüller yapida tasarlanarak, sistemdeki varolan diğer lojik şebekeleri etkilemeden işlev görecek şekilde yazılım geliştirme yöntemleri kullanılarak tasarlanmıştır.
CHAPTER 1.0 INTRODUCTION

The widespread usage of computers has resulted in various computer networks to be used so that they can communicate with one another. The continuous growth in the industry has resulted in a common model to be defined for computer systems that communicate on a network. The model is called Open Systems Interconnection Reference Model (OSI). This model is based on a layered architecture where each layer accomplishes some specific functions.[1]

The OSI model has proven to be so successful that it has also been adopted to be used in telecommunication systems which are network architectures of digital switches. Because the computer technology is used in today's digital switches, and they are run by a computer software, in fact today's digital switches are a sort of computer.
The OSI reference model has been used in Common Channel Signalling System Number7 for digital telecommunications.

In this thesis, in order to investigate the role of computers in digital telecommunications, I would like to investigate a recent system, CCS7, how it uses the OSI reference model in its architecture, and emphasise the role of software in adapting this modern system to a network.

In computer communications, OSI standards exist for messaging protocols. In telecommunications, No7 signalling is used for communicating between nodes that use messages with certain formats. Both protocols depend on layers and have common approaches between them. Considering that the modern, digital switches are in fact computers, the aim of this thesis is to investigate these protocol layers and implement a software that enables CCS7 to accept a new protocol.

The main areas captured in this thesis are,

- Network Architectures
• OSI - Open Systems Interconnection

• CCS7 - Common Channel Signalling System No7

• Relationship between OSI and CCS7

• Software implementation of layer 3 - Message Transfer part

• Creation of a new network type

• Software project management

Modern computer architectures consist of layers. The aim is to reduce design complexity making each layer independent from one another and each layer is designed to offer services to the higher layer above it. Logically, each layer in Computer-A communicates with the corresponding layer in Computer-B. Physically, the actual communication occurs on the physical medium which is below the lowest layer. A seven layer architecture has been recommended to be used in modern computer networks which is called OSI (Open System Interconnection). For digital telecommunication systems
a similar architecture has been recommended denoted as CCS7 (Common Channel Signalling system No7).

The OSI reference model has seven independent layers which are

1. Physical Layer

2. Data Link Layer

3. Network Layer

4. Transport Layer

5. Session Layer

6. Presentation Layer

7. Application Layer

The OSI model and the functionality of each layer is given in Chapter 3. OSI layers and their functionalities are investigated. The physical layer
largely deals with mechanical and electrical interfaces. The data link layer implements error handling on the frames and bits transmitted. The network layer controls the operation of the subnetwork. The transport layer provides the session layer with a defined set of message transfer facilities independent of the network. The session layer provides the means to organize and synchronize the dialogue between nodes. The presentation layer is concerned with the syntax of information transmitted between nodes. The application layer provides information services such as file transfer access and management.

The OSI model is suggested for modern communication networks and today's digital switches are in fact computers that are designed to fulfill some specific functions of telecommunication, and they also communicate on predefined networks. Thus a reference has been suggested for communication networks that is based on OSI which is called CCS7 (Common Channel Signalling No.7). The CCS7 form of data communication, besides providing the basic call control signalling, provides support for advanced capabilities such as transaction capabilities for database access.[2]
Common Channel Signalling System No7 is a specialized means of data communication within the telecommunications network. In the thesis, the CCS7 functional architecture is examined and it is compared with OSI reference model. CCS7 partitions the control of a call from the voice path so that inter-office communication is based on a separate data channel. However in conventional signalling, a call's control signals and voice are multiplexed on the same channel. CCS7 meets the requirements of information transfer within the telecommunications network for database access and management, call control and maintenance signalling. In Chapter 4, the CCS7 architecture and building blocks are given.

The CCS7 and OSI models are compared in Chapter 5. The layer 1 to 3 have one to one correspondence in both of the models. The layer 3, denoted as Message Transfer Part in CCS7 architecture is examined in detail throughout the thesis and a logical network implementation is suggested for this layer, and is implemented by software changes. Chapter 6 outlines the implementation of layer 3 on a digital switch.
The new logical network is suggested to have a new routing label; thus the message structure is changed for layer three and all the message handling, routing and evaluation algorithms have to be changed to accept the messages coming over the new network type.

In Chapter 7, the software implementation of the suggested new logical network is handled. The message routing function, message discrimination function (looks at the message and decides if it was destined for that node), message distribution function (delivers the message to the correct user part in layer 4), are changed by software to accept the new network. The software CCS7 test tool is also changed to enable monitoring messages coming over the new network.

In Chapter 8, the software project management utilities of the system are outlined. The software system has a modular structure, so that by picking up the right building blocks of the software and packaging them together, various functionalities can be achieved for different purposes. All the software is present in a library but only the functionalities required are loaded to the switch. This project management approach is
outlined in the last chapter resulting that the suggested network and the software related with it provides the capability to be flexible concerning software maintainability.
CHAPTER 2.0 NETWORK ARCHITECTURES

Today's modern computer networks are built on a structure that consists of a series of layers. The aim is to reduce design complexity making each level independent from one another. Each level is designed to offer services to the higher layer above it. Considering two computers consisting of several layers, each layer in ComputerA communicates with the corresponding layer in ComputerB. The rules and conventions used in this communication is called the 'layer n protocol'. This notation is used to illustrate how layered communication works, but in fact no data is transferred from layer n of ComputerA to layer n of ComputerB; each layer passes information and data to the layer below it until the lowest layer is reached. The actual communication occurs on the physical medium which is below the lowest layer.

There is an interface between each adjacent layer which defines the primitives and services the lower layer offers to the upper layer. When we mention a communication between layer n of ComputerA and layer n
of Computer, it is a virtual communication, because nothing is sent/received between those layers. Let us consider the actual communication between two computers consisting of 7 layers (that is suitable for OSI). A message (m) is produced by a process in layer 7 which is passed to layer 6 according to the specification defined by layer 6/7 interface. Level 6 transforms message (m) to (M) and send to level 5. Let us assume that level 5 does not modify the message and send to level 4. Let us assume that there is a limitation on the message size sent to level 3; so level 4 divides the message into smaller units, associating a header to each unit that includes control information to help level 4 on the destination ComputerB to bring the units together, and routes them to level 3. Level 3 attaches its own headers and routes the units to level 2. Level 2 adds its own headers and trailers and passes the data to level 1 which is the real means of transmission of data. The receiving ComputerB gets the message, the message is moved upwards and its headers stripped off. It finally arrives at level n in ComputerB which assumes that the message is sent to it by level n in ComputerA. It does not need to know or care about the several layer the message has passed through.[3]
Figure 2.1 The concept of layers, protocols, and interfaces.
The International Standards Organization (ISO) have recommended some standards to be used in computer networks. Because the model deals with systems that are open for communications with other systems, it is called the ISO Open Systems Interconnection (OSI).

The OSI suggests seven layers for the computer structure; it defines what each layer should do but does not specify the exact services and protocols to be used in each layer.
3.1 THE PHYSICAL LAYER

The physical layer handles transmission of data over a communication channel. The bits should be sent and received correctly, without any errors. The layer largely deal with mechanical and electrical interfaces.

3.2 DATA LINK LAYER

The physical layer does not pay attention to the structure of the data it is handling. It is the duty of the data link layer to create and recognize frame boundaries. Thus the data link layer takes a raw transmission facility, implements error handling on the bits transmitted by the use of frames and delivers the message to the network layer. It handles problems caused by damaged, lost or duplicate frames.
3.3 NETWORK LAYER

The network layer controls the operation of the subnet. For instance, determining how the packets are going to be routed through the subnet from source to destination is handled by this layer; routes can be fixed, based on static tables or they can be dynamic, being determined by each packet. The addressing issues, message sizes, protocols may cause problems in networks.

It is the duty of the network layer to overcome the problems that arise as packets are delivered from source to destination.

3.4 THE TRANSPORT LAYER

The transport layer forms the interface between the higher application oriented layers and the underlying network dependent layers. It provides the session layer with a reliable message transfer facility independent of the underlying network type. It provides the session
layer with a defined set of message transfer facilities independent of the network.

3.5 THE SESSION LAYER

The session layer allows users on different nodes to establish sessions between them by providing the means to organize and synchronize their dialogue. Some of the services provided by the session layer are,

- Interaction Management. If the data exchange in the dialogue is half-duplex, interaction management provides a means for the data exchange in a synchronized way.

- Synchronization. For data transfer over long periods, control points may be inserted periodically, so that if an error occurs, the transmission is started from a synchronized check point instead of starting all over from the initial state.
• Exception reporting. Nonrecoverable errors are reported to the higher layer.

3.6 THE PRESENTATION LAYER

The presentation layer is concerned with the syntax and semantics of the information transmitted.

The character strings are represented differently in various computers; for instance some use ASCII codes, some use EBCDIC. Since the data structures differ from one computer to another, the presentation layer manages these data structures and converts from the structure used inside the computer to a suitable structure so that computers with different representations can communicate.
3.7 THE APPLICATION LAYER

The application layer provides the user interface to a range of network wide distributed information services such as file transfer access and management, general document and message interchange services.

For instance, various terminal types exist that have different control sequences. When they need to communicate over a network there needs to be a common terminal control sequence to accept all the various types. Another example is the file transfer; transferring files between two different systems handling the different file naming conventions.
Layer Summary

<table>
<thead>
<tr>
<th>Application layer</th>
<th>Presentation layer</th>
<th>Session layer</th>
<th>Transport layer</th>
<th>Network layer</th>
<th>Data link layer</th>
<th>Physical layer</th>
</tr>
</thead>
<tbody>
<tr>
<td>file transfer, access and management, document and message interchange, job transfer and manipulation</td>
<td>transfer syntax negotiation, data representation transformations</td>
<td>dialogue and synchronization, control for application entities</td>
<td>End-to-end message transfer (connection management, error control fragmentation, flow control)</td>
<td>Network routing, addressing, call setup and clearing</td>
<td>data link control (framing, data transparency, error control)</td>
<td>Mechanical and electrical network interface definitions</td>
</tr>
</tbody>
</table>

Figure 3.1 Summary of the OSI layer concepts
CHAPTER 4.0 INTRODUCTION TO COMMON CHANNEL

SIGNALLING NO.7 (CCS7)

Voice communication, in the telephony network is controlled by signaling procedures executed by telephony switches.

Conventional procedures multiplex a call's control signals and voice onto the same trunk. This method is known as Per Trunk Signaling (PTS). Each trunk may be viewed as a combination voice facility and low grade signaling link. Each office must be provisioned with signaling equipment dedicated to individual trunks or as a pool of service circuits.[4]

Common Channel Signaling (CCS) partitions the control of a call from the voice path so that inter office communication is based on a separate data exchange capability.
Figure 4.1 Conventional Per Trunk Signaling Trunks

The CCS procedures provide improved reliability of inter office communication and allow for the exchange of data not related to inter office signaling.

CCS7 procedures also do not require dedicated signaling equipment for each trunk. Figure 42 on page 21 illustrates the CCS method.
Figure 4.2 Common Channel Signaling Trunks

4.1 CCS7 SYSTEM

The objective of CCS7 is to meet present and future requirements of information transfer (circuit and non-circuit related) for inter-processor transactions within the telecommunications network for call control, remote control, database access and management and maintenance signaling. Thus CCS7 can be regarded as a specialized form of data communication within the telecommunications network.
The CCS7 form of data communication, besides providing CCS basic circuit switched call control signaling, provides support for advanced capabilities such as support of transaction capabilities required for services such as database access.

This introduces three special types of nodes in the CCS7 network, the Service Switching Point (SSP), the Service Control Point (SCP) and the Service Transfer Point (STP).

A SSP is the source and sink of user generated messages. A SSP is a node in the network which has the capabilities to format distributed processing operations to a Service Control Point and to receive responses from the Service Control Point.

A SCP is a node in the network that provides information to be accessed by other nodes of the network (e.g. a database). A diagram of the CCS7 network architecture is shown in Figure 4.3 on page 24.

A STP is used to divert the messages to other nodes in the system, the messages are destined for SSPs or SCPs and according to load sharing and networking
algorithms, they pass through the STPs to their destination.

The CCS7 system uses signaling links for transfer of signaling messages between exchanges and other nodes in the network served by the system. Arrangements are provided to ensure reliable transfer of signaling information in the presence of transmission disturbances or network failures.[5]

4.2 CONS AND PROS OF CCS7

The advantages gained by the CCS7 system include:

• The trunk facilities and interface equipment are simplified since there is no need to support the signalling function.

• The setup time is fast in comparison to MF or DP pulsing. Trunk holding times are therefore reduced and fewer trunks need to be provisioned.
Figure 4.3 CCS7 Network Architecture

- Many error conditions, such as partial dial, are eliminated, resulting in fewer ineffective attempts on the network.

- Improved call control can be achieved by exchanging new signals, for example, calls that encounter problems can be collapsed and treatment applied as
close as possible to the originator, freeing up trunks on failed calls.

- New services requiring data base support are more easily introduced. Centralized data bases may be attached to the signalling network, and the CCS SO's have indirect access to them.

The constraints with this system include:

- Cross-office delays are longer than for per-trunk-signalling (PTS) where signals may be tandemed electrically, since signals are handled in a store and forward fashion.

- The signalling links support thousands of trunks. Backup links have to be provided to meet the necessary availability requirements in the event of failures.
4.3 TRANSMISSION NETWORK

A transmission (or signalling) network is a set of Signaling Points connected by Signaling Links to provide alternate routes for reliability. The size and complexity of the signaling network depends on the volume of traffic and or the degree of redundancy required for the path between the Signaling Points.

Network Conventions

The naming conventions for components of a CCS7 signaling network are as follows:

<table>
<thead>
<tr>
<th>Databases (DB)</th>
<th>Mass storage of data to support network features, such as 800 number translations.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linkset</td>
<td>A group of Signaling Links connecting two Signaling Points.</td>
</tr>
<tr>
<td>Route</td>
<td>A signaling path between two</td>
</tr>
<tr>
<td>Term</td>
<td>Description</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Route set</td>
<td>A group of routes that provide signaling paths between the same two Signaling Points.</td>
</tr>
<tr>
<td>Service Control Point (SCP)</td>
<td>A Signaling Point in a CCS7 network that provides information (for example from a database) for access by other Signaling Points.</td>
</tr>
<tr>
<td>Service Switching Point (SSP)</td>
<td>A Switching Point that communicates with an SCP.</td>
</tr>
<tr>
<td>Signaling Link (SL)</td>
<td>The interconnections between Signaling Points. They comply with the following naming convention:</td>
</tr>
<tr>
<td></td>
<td>A-Link connects a Switching Office to a Signal Transfer Point in the same region</td>
</tr>
<tr>
<td></td>
<td>B-Link interconnects Signal Transfer Points in different regions</td>
</tr>
<tr>
<td></td>
<td>C-Link interconnects mate Signal Transfer Points in the same region</td>
</tr>
<tr>
<td></td>
<td>D-Link interconnects primary</td>
</tr>
</tbody>
</table>
and secondary Signal Transfer Points in different regions

E-Link connects a Switching Office to a Signal Transfer Point in another region

F-Link interconnects two Switching Offices

Signaling Point (SP) Any node on the Signaling Network.

Signaling Transfer Point (STP) A Signaling Point that does not generate or terminate signaling messages, but transfers messages between incoming and outgoing Signaling Links.

Switching Office (SO) A Switching Point which hosts one or more users (processor of calls). A Switching Office operates strictly as an originator or terminator of call processing messages.
4.4 NETWORK CONFIGURATION

A simple CCS network has disadvantages that are overcome by the signaling network. For example, a simple CCS network has only one alternate path for the signaling.

If the direct link fails signaling can be transferred to the longer path through Signaling Transfer Points. If this link subsequently fails, the Switching Offices cannot communicate with each other, resulting in a complete breakdown of call processing between the Switching Offices.

An improved signaling network, has a number of alternate routes for signaling. If the direct link fails, the switch chooses another route. If that fails, the SSP selects the next route in the routing plan contained in system tables.
If we refer back to the OSI model, handling the network functions is the duty of layer 3 which is the Message Transfer Part (MTP) in the CCS7 network. MTP handles functions like load sharing algorithms and network management. The users of MTP can function properly without any knowledge of the MTP functions and the changes in the network during transmission.

4.5 SYSTEM ARCHITECTURE OVERVIEW

This section outlines the CCS7 signalling system and introduces its functional building blocks. In later sections of the thesis implementation of these building blocks are examined especially for MTP layers which correspond to OSI layers 1-2-3.

The functional diagram of the CCS7 architecture is given below.
Figure 4.4 CCS7 System Functions
4.5.1 Level 1, Signalling Data Link Functions

This level defines the physical, electrical and functional characteristics of a signalling data link and the means to access it.

4.5.2 Level 2, Signalling Link Functions

Level 2 defines the functions and procedures for the transfer of signalling messages over one individual signalling data link. A signalling message delivered by the higher layers is transferred over the signalling link in variable length signal units. The signalling functions include delimitation of signal unit by means of flags, flag imitation prevention by bit stuffing, error detection, error correction and signalling link failure detection utilities.
4.5.3 Level 3, Signalling Network Functions

Level 3 supports the transport functions which are divided into two categories as signalling message handling and network management functions.

4.5.3.1 Signalling message handling functions.

Signalling message handling functions contribute to the transfer of a message to the correct User Part (level 4) or signalling link. These functions are further subdivided into three functions.

- Message Routing. This function selects the link to be used as a message is sent. The routing label in the message is analyzed along with the routing data of the signalling point concerned and the signalling link is determined.
• Message Distribution. This function determines the User Part the received message is to be delivered. The service indicator field in the message is examined and the message is delivered to the user part indicated in this field.

• Message Discrimination. Upon receipt of a message, this function determines whether the message was intended for that signalling point or not by examining the destination point code of the incoming message. If the signalling point is the destination point, then the message is passed to message distribution function for processing. Otherwise, the message is delivered to the routing function (if the SP has transfer capability) so that the message is transferred to the correct destination.

4.5.3.2 Signalling network management functions

Signalling network management functions control the message routing and configuration of signalling network
facilities depending on a predetermined data and information about the network.

In case of failures or congestion, the signalling network management functions provide reconfiguration of the signalling network. Appropriate procedures are used to change the routing of the signalling traffic in order to bypass the faulty links or signalling points.

When a change in the status of a signalling link or route occurs, the appropriate management function is called which may be signalling traffic management, link management or route management.

Signalling Traffic Management This function is used to divert signalling traffic from a link or route to one or more different links or routes, or to temporarily slow down traffic in case of congestion. The following procedures are implemented.

- changeover

- changeback
- forced rerouting

- controlled rerouting

- signalling traffic flow control

Signalling Link Management Signalling link management function is used to restore failed signalling links, to activate idle links and to deactivate aligned signalling links. The following procedures are implemented.

- signalling link activation, restoration and deactivation

- link set activation

- automatic allocation of signalling terminals and signalling data links.

Signalling Route Management This function is used to distribute information about the signalling network status in order to block or unblock
signalling routes. This function implements the following functions.

- transfer-controlled procedure
- transfer-prohibited procedure
- transfer-allowed procedure
- signalling route-set-test procedure
- transfer-restricted procedure
- signalling-route-set-congestion test

4.5.4 Level 4, User Part Functions

Each user part defines the functions and procedures of the system that are particular to a certain type of user, such that the extent of the user part functions
may differ significantly between different categories of users.
CHAPTER 5.0 RELATIONSHIP BETWEEN CCS7 FUNCTIONAL LAYERS AND OSI LAYERS

A major characteristic of the CCS7 system is its modular functional structure, ensuring flexibility for diverse applications.

The CCS7 functional architecture partitions the system into several layers to describe the interconnection and exchange of information between users in a communication system. Figure 7 on page 42 illustrates the relationship between the OSI 7-layer architecture, and the older CCS7 4-level architecture based on the CCITT SS. No.7 4-level protocol model.[6]

OSI Layers 1,2 and 3 comprise the Message Transfer Part (MTP). The function of the MTP is to serve as a connectionless transport system providing a reliable transfer of signalling messages between locations of communicating users or application functions. In this context "user" refers to any functional entity that utilizes the basic transport capability provided by the MTP.
Completing layer 3 is the Signalling Connection Control Part (SCCP). This functional block, situated above the MTP, provides additional functions to the MTP to cater for both connectionless and connection-oriented services. The combination of MTP and SCCP is known as the "Network Service Part" (NSP).

The Integrated Services Digital Network User Part, (ISUP) is one user of the MTP and the SCCP. The ISUP provides inter-exchange signalling to support trunk setup, ISDN access signalling and specialized subscriber facilities.

The Transaction Capabilities Application Part (TCAP) is an application layer protocol. TCAP provides services to support non-circuit related, transaction oriented applications such as database dependent 800 Services and Calling Card Services.

The higher layers of OSI and CCS7 have identical logic, however it is harder to setup a one to one correspondence between OSI and CCS7 for those layers because the design intents for those layers in telecommunication network is aimed to fulfill the requirements in signalling networks but those in OSI
layers are intended the fullfill the requirements for computer networks that have various purposes.

If we take ISDN user part as an example, levels 4 through 7 are considered as a whole process layer because its function is to exchange signalling between nodes to provide trunk setup. Thus presentation, session and transport layers are found as a mass in this user part rather than independent layers. TCAP on the other hand makes a good example for the application layer in a transmission network that corresponds to OSI layer 7; however for TCAP the lower sections 4-5-6 are again incomparable with OSI layers 4-5-6.

Even though we can not build a definite one to one correspondence with higher layers of OSI and CCS7, the similarities between them and the way CCS7 architecture has been applied to computers in the telecommunications network is worth investigating and this has resulted in modernization and standardization for the transmission network.[7]
Figure 5.1 CCS7 4-level Reference Model
CHAPTER 6.0 APPLICATION OF CCS7 ON A SERVICE

SWITCHING POINT (SSP)

In this thesis, the DMS (Digital Multiplex Switch) is taken as an example to a modern digital switch. The software and hardware architecture is examined that fulfill the OSI standards, and then the software that runs on the systems is enhanced for layer 3 of OSI model. Depending on its functionality in the transmission network, DMS can be a SCP, STP or a SSP. In order not to make the content of this thesis specific to DMS, it can be regarded as a SSP unless not specified.

The functional architecture of a CCS7 system was given in previous sections with a related figure Figure 5.1

In this section the implementation of a CCS7 system on a SSP is examined.
The Message Transfer Part (MTP) is investigated throughout the thesis since it has a one to one correspondence with OSI layers one to three.

The software structure of the MTP is studied and a software proposal is given to enhance the existing structure so that messages with a different frame structure can be handled by MTP; speaking in OSI language this would mean introducing some new protocols to the system.

6.1 IMPLEMENTATION FOR LAYERS 1-2-3 (MESSAGE TRANSFER PART)

The OSI layers 1-2-3 have one to one correspondence with the CCS7 layers 1-2-3. Those layers are referred as MTP (Message Transfer Part). The higher layers of OSI and CCS7 have identical logic as discussed in the previous section; however it is harder to setup a one to one correspondence between OSI and CCS7 for those layers.
This thesis will investigate enhancing the layer 3 functions of a CCS7 system implemented on a SSP. In the existing software, according to the CCITT standards, the Origination Point Code (OPC), and destination point code (DPC) values are 14 bits. This thesis examines how this 14 bit value can be upgraded to 24 value. This would require a new network type to be defined. While implementing this enhancement to the software, the functionalities of layers one to three are studied.

In this section the implementation of this new network is investigated to be adapted to a SSP. The functional areas of a CCS7 system were given in previous sections. The functions that are affected by introducing a new routing label and network type are examined in detail.

6.2 MANAGING DIFFERENT PROTOCOLS

There are various OPC and DPC requirements brought by different countries or standards, for example using
different overlay of CCITT 14 bits or extending the signalling point code range.

The message signalling unit (MSU) is given in the figure Figure 6.1 on page 49. Routing label portion of the MSU is changed in this thesis to examine its affects in the functional layers of the system.

The message routing label is given below for the new network.

The OPC and DPC values in the routing label are extended from the CCITT recommended 14 bit value (Blue Book Q704) to 24 bit values by this thesis in order to examine how the layer 1-3 functionalities have been implemented on a SSP.
<table>
<thead>
<tr>
<th>SLC</th>
<th>OPC</th>
<th>DPC</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>4</td>
<td>24</td>
</tr>
<tr>
<td>24</td>
<td>24</td>
<td></td>
</tr>
</tbody>
</table>

First bit transmitted

Figure 6.1 Routing label structure

DPC is the Destination Point Code
OPC is the Origination Point Code,
SLC is the signalling link code and is used to indicate the signalling route.

Since there are various layouts of the routing label and networks are created to support them, tables are used to discriminate those differences. Tables are datafilled by keys pointing to which networks will be used. An incoming message is evaluated by looking at the network overlay it comes from, and a message that will be sent to a certain network is prepared according the offsets in the outgoing message. This leads to the conclusion that extending the OPC and DPC values from 14 to 24 bits would require procedures and protocols to evaluate this new network.
The first step to define a new network is to datafill it in tables that depend on networks. The second step is to write new procedures to evaluate this new network overlay. The third step is to modify the existing software structure for routing, discrimination, and distribution functions.

The implementation of these steps are given in the following subsections.

6.3 SOFTWARE STRUCTURE FOR LAYERS 1-2-3

The software that supports the SSP has a modular structure. Using gates, and binding in targets for these gates different functionalities can exist on the same SSP without disrupting one another.
<table>
<thead>
<tr>
<th>MSU</th>
<th>F</th>
<th>CK</th>
<th>SIF</th>
<th>SIO</th>
<th>LI</th>
<th>F</th>
<th>I</th>
<th>B</th>
<th>FSN</th>
<th>B</th>
<th>BSN</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>CK</td>
<td>Check bits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>Flag</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LI</td>
<td>Length indicator</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIF</td>
<td>Signalling information field</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIO</td>
<td>Service information octet</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FSN</td>
<td>Forward sequence number</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BSN</td>
<td>Backward sequence number</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FIB</td>
<td>Forward indicator bit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIB</td>
<td>Backward indicator bit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**TUP**

| TUP message info parts | H1 | H0 | Telephone label |

**MTP**

| MTP message info parts | H1 | H0 | Routing label |

**SIO**

<table>
<thead>
<tr>
<th>Sub-service field</th>
<th>Service indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>D C B A</td>
<td>D C B A</td>
</tr>
</tbody>
</table>

**Service Indicator data examples:**

- **DCBA**
  - 0000: Signalling network management (MTP)
  - 0001: Signalling network testing and maintenance (MTP)
  - 0011: Signalling connection control part (SCCP)
  - 0100: Telephone User Part (TUP)
  - 0101: ISDN User Part (ISUP)

**Figure 6.2 Signalling message structures**
The modules implement unique functionalities, such that preparing a correct user-uses combination those modules are compiled together to execute the desired features. The CCS7 implementation has the same modular logic. There are hundreds of CCS7 modules in the SSP. In this section only the ones that needs to be modified or enhanced in order to create a new network type will be given.

It is seen from the functional view that the MTP functions are not centralized in a certain place in the hierarchy, but contrarily distributed throughout the system.

The computing system (denoted as CC or CM) is the top software structure which is programmed by using a high level language. CM is the main controlling function.

The peripherals are the processors which are closer to the outside world. They are the first ones to receive and evaluate the signals and the messages. If the CM should be notified of the messages then the peripherals send it to the CM. [8]
Figure 6.3 Functional view of CCS7 Signalling on the SSP

In the following section the software relationship is given among these processors for CCS7 network implementation.
The CCS7 implementation of the software is distributed through the system. The parts of software that needs to be changed are given below as building blocks; and then each building block is handled separately. It is sometimes hard to discriminate the functions of one block from another, because they share some data and messaging functions between them. In those functional building blocks the names of the modules are listed where the actual definitions and code resides. You can see that some functionalities exist both in CM and peripheral software such as signalling utilities and even the names of the modules are same to have concurrency. This would conclude that it is more reasonable to investigate the software in terms of functionality. The figure explains the modular structure of the CCS7 software.

The top two building blocks reside in Central Module where we see Table Control, and the C7-Test-Utility (C7TU) which is a software signalling utility to
simulate CCS7 messaging on the SSP. The third block shows procedures for signalling utilities.

The distribution and discrimination functions reside in peripheral software along with the signalling network management utilities. The tables controlled by CM software are downloaded to the peripherals which is shown as static data download.

The signalling utilities are implemented both in the CM and the peripheral software cause there is messaging between those two.

In order to introduce a new network to the system which uses a different layout of Origination Point Code and Destination Point Code, those functional blocks mentioned above need to be changed to be capable of handling the new message formats. The functional layers of the system that will be affected can be listed as:

Basic types, gates and utilities. These are changed to define and manage the new network types.
Figure 7.1 Software changes required to create a new network type.
Datafill and table control of the new network. The related tables are changed to handle the new formats and procedures. Table control software should be enhanced to download these to the peripherals.

Distribution and Discrimination functions. These functions are modified to recognize new network format in the messages.

Signalling Network Management. This function is enhanced to handle the management with the new network. Signalling utilities and procedures are changed according to the new network.

Test Utility. The C7TU test tool is changed so that the messages can be sent to and received from the new network with the proper format without any mismatches, and it must be verified that the changes do not cause any disturbance to the existing networks.
7.1 BASIC TYPES GATES AND UTILITIES.

The basic types, gates and utilities are defined in a common software so that the common utilities can reach and recognize common definitions. The definition of the CCS7 message, its refinements according to various standards (i.e. CCITT, ANSI) are found in a common software. An external CCS7 message incoming to the SSP might need to be redefined according to SSP intra messaging structures and evaluated; also when an outgoing message is prepared to be sent to the outside world it would require overlays and evaluations to be done. These utilities are found in the common software. The definition of the new network type will also be made here; and new refinements will be introduced according to the new message range.

The software changes introduced by this thesis for basic types and utilities will reside in modules C7TYPES(CCS7 Base Common Types), C7BASEUI(CCS7 data types), C7MTPUI(CCS7 Message Transfer Part), C7TKTYPE(CCS7 Trunk Type Definitions), C7SNTYPE(CCS7 Signalling Network Types).
7.2 DATAFILL AND TABLE CONTROL OF THE NEW NETWORK

CCS7 messages are routed using links, linksets and routesets which are defined in tables. The hardware configuration of the system is defined by these tables for the CCS7 system. The definition of the links and routes connecting different SPs are defined with tables. The network type is used in these tables so that the system would know what kind of a network configuration the message is incoming from or outgoing to.

Tables consist of tuples which include fields for various purposes. The new network type is entered as a new tuple with its new OPC and DPC values. Other tables (C7LINK C7LKSET and C7RTESET) refer to this table for the network and use the network field in their tuples.

Thus, this thesis changes the table control software to enable it to accept; i.e add/delete/change/verify the new network type.

The types used by the tables are bound in to a table for reference. If the table control software can not find the type it does not recognize it and thus the tuple can not be added. The appeareance of the point
codes are changed with a refinement for the new network which is called CCITT7X network.

Tables C7TIMER, C7NETWRK, C7LINK, C7LKSET and C7RTESET are changed to accept the new network type.

The software changes are made in modules C7TKUTIL(Table Control for C7TRKMEM) and C7NWKTC(C7NETWRK Table Control). Also a new module is created to bind in the procedures specific to the new network.

7.3 DISTRIBUTION AND DISCRIMINATION FUNCTIONS

The discrimination function examines the destination point code (DPC) field of the incoming message to determine whether the message is destined for itself. If the received message is not routed for the received destination than the message is directed to the routing function. If the message is destined for the receiving signalling point, it is directed to the distribution
function which checks the service indicator (SIO) and send the message to the corresponding User Part.

Because these functions evaluate the information in the routing label like DPC and SIO, the software utilities that handle the discrimination and distribution functions are changed to accept messages with the new 24 bit values and the new network type.

The distribution and discrimination functions implemented in modules C7MTPDIS(CCS7 MTP Discriminator/Distributor) and C7TUPMH(CSC7 TUP Message Handler) are changed to support the new network created by this thesis.

7.4 SIGNALLING NETWORK MANAGEMENT

It should be noted that examining the detailed functionality of these management procedures is beyond the scope of this thesis. However since these procedures use CCS7 messages and this thesis changes the routing label of these messages, this thesis brings an impact on the handling of these procedures indirectly.
Since the routing label format is changed in the signalling network management functions; these messages should be refined according to the OPC and DPC definition of the new network type. These messages are defined in the common software, and utilities that handle those messages are changed to be capable of handling the new message refinements.

All the SNM (signalling network management) messages are redefined by the software. In order to illustrate the changes, the format of the Transfer Allowed (TFA) message is given as an example; the label field which was 32 bits is changed to 56 bits in the new network type, the destination field is changed from 14 bits to 24 bits. This is done in the common software where all messages are defined. Handling of these messages are done by using gated procedures in the utility software. The change in the TFA message is illustrated in Figure 7.2 on page 61.

The SNM messages are defined for the new network in module C7SNTYPE( CCS7 Signalling Network Types) with new point code values. Module C7SNMHDL(CCS7 SNM Message Handler) is updated to recognize new message formats for the network along with module C7MHPRIM(CCS7 Message
The TFA message format according to the CCITT standards

<table>
<thead>
<tr>
<th></th>
<th>Destination</th>
<th>H1</th>
<th>H0</th>
<th>Routing label</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>14</td>
<td>4</td>
<td>4</td>
<td>32</td>
</tr>
</tbody>
</table>

The TFA message format with new routing label definition

<table>
<thead>
<tr>
<th></th>
<th>Destination</th>
<th>H1</th>
<th>H0</th>
<th>Routing label</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>24</td>
<td>4</td>
<td>4</td>
<td>56</td>
</tr>
</tbody>
</table>

Figure 7.2 Changes to the SNM messages

Handling Protocol) where the actual actions are taken upon receipt of these messages.

7.5 CCS7 TEST UTILITY -C7TU

C7TU test utility has been implemented to help user of higher layers to test their CCS7 interactions. This tool enables the user to monitor, intercept, build
and send CCS7 messages. Match entries are constructed for messages with specific fields; and the matching ones are logged. CCITT and ANSI network variants are supported. Thus, when a new network type is created, this tool has to be modified to recognize this network type. C7TU also shows the user all available CCS7 messages; this set will be given in the appendix section.

- **MONITOR command.** This command allows the user to monitor messages that satisfy the criteria given as parameters to the command which are the name of the link related with the message, the direction of the message i.e. incoming or outgoing, the message code i.e. IAM etc.

- **BUILD command.** This command allows the user to build CCS7 messages as he/she wishes. The user can specify the network type i.e. CCITT, ANSI that the message should belong to, specify the message code i.e. IAM, and give the message body as a hex code.

- **INTERCEPT command.** Intercept is used to 'eat' messages that satisfy the criteria given as
parameters to the command; which are the link name the message is related to, the message code and the directions.

- **ALTER command.** This command is used to alter a message built by using the BUILD command.

- **SEND command** is used to send messages to/from a link.

- **DISPLAY command** shows the messages that have been built by using the BUILD command.

- **STATUS command** shows the status of the session such as monitored or intercepted messages.

- **REMOVE command** is used to remove a match entry entered for monitoring or intercepting.

This thesis introduces a new layout of message with a new network; the message building, monitoring, intercepting and logging utilities of the CCS7 Test Utility are changed to handle these messages.
The C7TU enhancements are made in modules C7TUUI (C7TU user interface module) C7TUCI (C7TU Test Utility Commands Module) C7TUCIP (C7TU Common Interface Procedures Module) C7TUFRMT (C7TU Default User Formats Module) C7TULINK (CCS7 Test Utility Link Commands Module) C7TULOG (C7TU Log Definitions Module) to support the changes.

Examples to the C7TU logs and its usage will be given in the appendix section.

7.6 SOFTWARE STRATEGY

- New type definitions is done in related modules, point code overlays and refinements, new MTP label are defined.

- Table control software is added to support the new network type. New procedures are created to bind in read/write/verify aspects for the new network type. Existing logical data structures are modified to accept the new network type.
• Utility procedures for signalling protocols are changed to accept the new network type.

• Software changes are done required to bring up the links.

• Gated aspects are implemented for the peripheral software.

• Changes are made to handle Signalling Network Management messages with the new network type.

• The message handling process from the far-end is changes to recognize messages coming over the new network type and the procedures to deliver the message to the correct user-part is changed so that messages can be acceptable for higher layers.

• Changes are made to CCS7 Test Utility procedures to build, send, intercept and monitor the messages with the new format.

After these changes are made to the software, by means of project management utilities of the data base library
a new product is created which supports the new network. The project management approach is given in the following section.
CHAPTER 8.0  SOFTWARE MANAGEMENT FOR COMPUTER

CONTROLLED SWITCHES

Today's digital switches are in fact modern computers that are run by a software. Behind the hardware that is intended specifically for telecommunications, usually a software is present. This software might be a high level language or a low level depending on the requirements of the system.

Throughout this thesis, DMS is taken as an example to a modern digital switch. This section outlines the software development phases and management for DMS.
8.1 SOFTWARE LIBRARY

The building blocks of the software are called modules which consist of section. The 'interface' section of a module defines the variables, procedures data structures that might be used by other modules. The implementation sections contain the actual implementation of these procedures and some local data that is used only in the module that can not be referred to by any other modules. Depending on the USES-USER relation software structures are developed for different needs and perspectives.

DMS uses a high-level language called PROTEL for coding the modules. On a DMS system roughly 6000-10000 modules exist. These modules are maintained in a software library so that various users can reach and update those modules. Each module has an issue attached to it so that the issue is incremented each time the module is updated and it helps the user to have a track on the history of the module. When a user is updating the module, its status is changed as OPEN so that no other user can update it and overwrite the changes.[9]
In the software library, modules that are created to implement a specific function are collected together under groups called SUBSYSTEM. The SUBSYSTEMS are gathered together to build AREAS which is the main software structures for the library. By using these conventions, it is easy to group the software into functional areas for the library.

The latest issues of the modules are compiled with determined intervals (one week) to show the latest status of the software which is called 'context'.

Since there are various requirements for different countries and software applications, a different software product is produced for each market by using the building blocks; modules, subsysyms and areas. A module specific to Turkey is not included in the product for China for example. This is achieved by 'packaging'. Packaging is the means of determining the list of modules that coexist in a software product. Since there are thousands of modules (6000-10000) that can coexist on switch, packaging is done for subsystems to make grouping easier.
Figure 8.1 Structure of the software building blocks

In the process to build a software product, the subsystems are chosen that will construct the product.
Using the library architecture and tools, the user-uses relations are determined for the modules in those subsystems which go on like a tree structure so that an ordered module list is determined. Using this ordered module list a software product is created.

The list of modules in the product are retrieved from the library in binary form (compiled modules) and a is transferred to a type to be loaded to the switch.

Managing the software structure under small building blocks, defining hierarchies for structures and keeping these in a library makes it possible for various development groups to work in consistency and maintain the flexibility to create different products on a common base.
RESULT

In this thesis, computer communication is investigated on a computer controlled switch. The application of OSI and No7 recommendations are examined and an enhancement is suggested to the existing communication protocols for level 3. The implementation of this suggested enhancement is made by software changes. Throughout the thesis, areas of the software architecture that support level 3 functionalities are investigated and a detailed implementation example is given as well as project management utilities for different protocols on the system.

In the thesis network architectures of modern communication systems are examined which are based on independent layers that offer services to the higher layer above it. The OSI (Open Systems Interconnection) model that has been recommended by the ISO(International Standards Organization) is investigated. OSI suggests seven layers to be used for communication networks.
1. Physical Layer

2. Data Link Layer

3. Network Layer

4. Transport Layer

5. Session Layer

6. Presentation Layer

7. Application Layer

These layers and their functionalities are investigated. The physical layer largely deals with mechanical and electrical interfaces. The data link layer implements error handling on the frames and bits transmitted. The network layer controls the operation of the subnetwork. The transport layer provides the session layer with a defined set of message transfer facilities independent of the network. The session layer provides the means to organize and synchronize the dialogue between nodes. The presentation layer is concerned with the syntax of
information transmitted between nodes. The application layer provides information services such as file transfer access and management.

The OSI model is suggested for modern communication networks and today's digital switches are in fact computers that are designed to fulfill some specific functions of telecommunication, and they also communicate on predefined networks. Thus a reference has been suggested for communication networks that is based on OSI which is called CCS7 (Common Channel Signalling No.7. The CCS7 form of data communication, besides providing the basic call control signalling, provides support for advanced capabilities such as transaction capabilities for database access.

The CCS7 architecture is examined and it is seen that it is in fact very similar to that of OSI model with its layered structure.

A section is devoted to examine the relationship between CCS7 functional layers and OSI layers. OSI layers 1-2-3 has one to one correspondence with CCS7 layers 1-2-3. In the CCS7 network these layers are called MTP (Message
Transfer Part). The software structure and implementation of the MTP is investigated.

Even though CCITT brings standards to use some protocols in communication networks, there are various slight changes to these standards and protocols brought in by different countries. Thus two countries claim to be using CCITT but in fact have many differences in their protocols of the communication networks. In order to cope with this, 'logical networks' are defined for these communication networks.

In the thesis a new network is suggested to be created that will differentiate from the existing networks by its point codes. The software implementation of this suggested network is made. The steps to design the network and implement it by software are discussed.

The switch that the network is created for is investigated in its software implementation; the software has a modular structure. Putting the modules in some specific order and in some specific packages, it is possible to fulfill various requirements. Thus the benefit of the modular structure is to have many
functionalities with different building blocks of the software.

The software implementation of the network and its adaption to the switch is given and the these is concluded by the related software management utilities.

The implementation of these changes and its effect on the software structure of the system helps us to go through the steps for understanding and investigating the architecture of computer communication in modern switches.
REFERENCES


APPENDIX -A C7TU USAGE AND LOGS

This section gives examples on C7TU usage and lists all the available CCS7 message set for testing.

The following are the list of commands used in C7TU. Commands exist to help the user to monitor/intercept/display/send.. messages.

C7TU LINK:
help
******** C7TU LINK ILPT7 ENVIRONMENT ********
ALTER - alter the bytes in the built message
BUILD - build a CCS7 message to be sent
DISPLAY - display the built message
DUMP - display MATCH table in hex format
HELP - generate this text
INTERCEPT - intercept messages at the ST interface
MASK - set the MASK bytes of an entry
MATCH - set the MATCH bytes of an entry
MONITOR - monitor messages at the ST interface
QUIT - exit C7TU LINK environment
REMOVE - cancel an intercept / monitor request or a build entry
RESTORE - send the MATCH table entries to MSB
SELECT - select PMs and attributes
SEND - insert the message at ST interface
STATUS - display the status of the C7TU LINK environment

Enter "Q <command name>" for more information.
select all
SELECT done
quit
status
******* C7TULINK Environment *******

LIU7 FTA Tracing Throttle

Item Disp NI Nettype Dir Link Dist Msg SI H0 H1
0 MON ALL CCITT IN ALL EXT XXX TUP

Figure A.1 The example shows that ALL INcoming CCITT TUP messages from ALL links have been selected to be monitored. 93/10/18 18:09
<<*>> SNSED37AE C.O. IMAGE <<*>>
display 0

<table>
<thead>
<tr>
<th>C7TU MESSAGE</th>
<th>SIO</th>
<th>DPC</th>
<th>OPC</th>
<th>SLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>num type length ni pr si XXXX XXXX XXXX XXXX XXXX XXXX</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 TRSC 13 0 2 TUP --- default routing label ---</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Message bytes:

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

07 00 FD 04 PD FD 24 00 00 00 50 06 77

Figure A.2 This example illustrates that a TUP RSC message has been built up.
The following list gives the available C7TU messages.

**C7TU:**

<table>
<thead>
<tr>
<th>MSG CODE</th>
<th>DESCRIPTION</th>
<th>DI SI H1H0</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTC</td>
<td>ST Maintenance</td>
<td>01 X XX</td>
</tr>
<tr>
<td>LDR</td>
<td>ST Loader</td>
<td>02 X XX</td>
</tr>
<tr>
<td>MON</td>
<td>ST Monitor</td>
<td>03 X XX</td>
</tr>
<tr>
<td>EXT</td>
<td>C7 External (NO MATCH ALLOWED)</td>
<td>04 X XX</td>
</tr>
<tr>
<td>.</td>
<td>SNM Signalling Network Management</td>
<td>. 00 XX</td>
</tr>
<tr>
<td>.   .</td>
<td>CHM Changeover/back Msqs</td>
<td>. . 01</td>
</tr>
<tr>
<td>.   .</td>
<td>COO Changeover Order</td>
<td>. . 11</td>
</tr>
<tr>
<td>.   .</td>
<td>COA Changeover Ack</td>
<td>. . 21</td>
</tr>
<tr>
<td>.   .</td>
<td>CBD Changeback Declaration</td>
<td>. . 51</td>
</tr>
<tr>
<td>.   .</td>
<td>CBA Changeback Ack</td>
<td>. . 61</td>
</tr>
<tr>
<td>.   .</td>
<td>ECM Emergency Changeover Msqs</td>
<td>. . 02</td>
</tr>
<tr>
<td>.   .</td>
<td>ECO Emergency Changeover Order</td>
<td>. . 12</td>
</tr>
<tr>
<td>.   .</td>
<td>ECA Emergency Changeover Ack</td>
<td>. . 22</td>
</tr>
<tr>
<td>.   .</td>
<td>FCM Traffic Flow Control Msqs</td>
<td>. . 03</td>
</tr>
<tr>
<td>.   .</td>
<td>RCT Routeset Congestion Test</td>
<td>. . 13</td>
</tr>
<tr>
<td>.   .</td>
<td>TFC Transfer Controlled</td>
<td>. . 23</td>
</tr>
<tr>
<td>.   .</td>
<td>TFM Transfer Flow Msqs</td>
<td>. . 04</td>
</tr>
<tr>
<td>.   .</td>
<td>TFP Transfer Prohibited</td>
<td>. . 14</td>
</tr>
<tr>
<td>.   .</td>
<td>TCP Transfer Cluster Prohibited</td>
<td>. . 24</td>
</tr>
<tr>
<td>.   .</td>
<td>TFR Transfer Restricted</td>
<td>. . 34</td>
</tr>
<tr>
<td>.   .</td>
<td>TCR Transfer Cluster Restricted</td>
<td>. . 44</td>
</tr>
<tr>
<td>.   .</td>
<td>TFA Transfer Allowed</td>
<td>. . 54</td>
</tr>
<tr>
<td>.   .</td>
<td>TCA Transfer Cluster Allowed</td>
<td>. . 64</td>
</tr>
<tr>
<td>.   .</td>
<td>RTM Routeset Test Messages</td>
<td>. . 05</td>
</tr>
<tr>
<td>.   .</td>
<td>RSP Rtset Test Prohibited</td>
<td>. . 15</td>
</tr>
<tr>
<td>.   .</td>
<td>RCP Rtset Test Cluster Prohib.</td>
<td>. . 35</td>
</tr>
<tr>
<td>.   .</td>
<td>RSR Rtset Test Restricted</td>
<td>. . 25</td>
</tr>
<tr>
<td>.   .</td>
<td>RCR Rtset Test Cluster Restrict</td>
<td>. . 45</td>
</tr>
<tr>
<td>.   .</td>
<td>MIM Management Inhibit Messages</td>
<td>. . 06</td>
</tr>
<tr>
<td>.   .</td>
<td>LIN Link Inhibit</td>
<td>. . 16</td>
</tr>
<tr>
<td>.   .</td>
<td>LUN Link Uninhibit</td>
<td>. . 26</td>
</tr>
<tr>
<td>.   .</td>
<td>LIA Link Inhibit Ack</td>
<td>. . 36</td>
</tr>
<tr>
<td>.   .</td>
<td>LUA Link Uninhibit Ack</td>
<td>. . 46</td>
</tr>
<tr>
<td>.   .</td>
<td>LID Link Inhibit Denied</td>
<td>. . 56</td>
</tr>
<tr>
<td>.   .</td>
<td>LFU Link Forced Uninhibit</td>
<td>. . 66</td>
</tr>
<tr>
<td>.   .</td>
<td>LIT Local Inhibit Test</td>
<td>. . 76</td>
</tr>
<tr>
<td>.   .</td>
<td>RIT Remote Inhibit Test</td>
<td>. . 86</td>
</tr>
<tr>
<td>.   .</td>
<td>DLM Data Link Msgs</td>
<td>. . 08</td>
</tr>
<tr>
<td>.   .</td>
<td>DLC Data Link Connect Order</td>
<td>. . 18</td>
</tr>
<tr>
<td>.   .</td>
<td>CSS Connection Successful</td>
<td>. . 28</td>
</tr>
<tr>
<td>.   .</td>
<td>CNS Connection Not Successful</td>
<td>. . 38</td>
</tr>
<tr>
<td>.   .</td>
<td>CNP Connection Not Possible</td>
<td>. . 48</td>
</tr>
<tr>
<td>.   .</td>
<td>SNT Sig. Network Test</td>
<td>. 01 XX</td>
</tr>
</tbody>
</table>
CSLT  Sig. Link Test for CCITT  01
CSLTM  Signalling Link Test Msg  11
CSLTA  Signalling Link Test Ack  21
SRT  Sig. Route Test for Japan  03
SRTM  Signalling Route Test Msg  23
SRA  Sig. Route Test Ack for Japan  04
SRTA  Signalling Route Test Ack  84
USNM  Japan Unassigned Main Area  14
USNS  Japan Unassigned Sub Area  24
USNU  Japan Unassigned Unit Area  34
SNTS  Sig. Network Test Special  02 XX
SLT  Sig. Link Test  01
SLTM  Signalling Link Test Msg  11
SLTA  Signalling Link Test Ack  21
SCCP  Sig. Connection Control Part  03 XX
UDT  SCCP Unitdata Message  03 09
UDTS  SCCP Unitdata Service Message  - 0A
TUP  Telephone User Part  04 XX
BIAM  Initial address message  - 0000
BIFAM  Init & final addr msg  - 0100
BSAM  Subsequent addr msg  - 0200
BFAM  Final address message  - 0300
BASI  Additional setup inf  - 0401
BSND  Send N digits  - 0202
BSAD  Send ALL digits  - 0302
BSASI  Send addit setup inf  - 0402
BACM  Address complete  - 0003
BCONG  Congestion  - 0203
Bacon  Terminal congestion  - 0303
BCNA  Connex not admitted  - 0403
BREA  Repeat Attempt  - 0503
BSEN  Subscriber engaged  - 0603
BSOOO  Subscriber out of order  - 0703
BSTR  Subscriber transferred  - 0803
BANM  Answer  - 0004
BCLR  Clear  - 0104
BRAN  Reanswer  - 0204
BREL  Release  - 0304
BCFC  Coin and fee check  - 0404
BOOR  Operator overide  - 0504
BHWR  Howler  - 0604
BEXT  Extend call  - 0704
BCTF  Circuit free  - 0005
BBLO  Blocking  - 0105
BUBL  Unblocking  - 0205
BBLA  Blocking ack  - 0305
BUBA  Unblocking ack  - 0405
.. BOVLD  Overload  .  0505
.. BCFSN  Confusion  .  0007
.. BCSIM  ISDN Composite service info  .  0107
.. BSSRV  Send service  .  0207
.. BSRV  Service  .  0307
.. BACI  Additional call information  .  0407
.. BOPCN  Operator condition  .  0507
.. BUTUD  User-To-User data  .  0607
.. BSWAP  Swap  .  0707
.. TIAM  Initial Address Message  .  11
.. TIAI  Initial Address with more info  .  21
.. TSAM  Subsequent Address Message  .  31
.. TSAO  SAM with one signal  .  41
.. TGSM  General fwd setup info message  .  12
.. TCOT  Continuity Signal  .  32
.. TCCF  Continuity failure Signal  .  42
.. TGRQ  General Request Message  .  13
.. TAMC  Address Complete Message  .  14
.. TCHG  Charging Message  .  24
.. TSEC  Switch equip congestion fail  .  15
.. TCGC  Ckt group congestion signal  .  25
.. TNNC  Natl net congestion signal  .  35
.. TADI  Address incomplete message  .  45
.. TCFL  Call failure signal  .  55
.. TSBB  Subscriber busy signal  .  65
.. TUNN  Unallocated number signal  .  75
.. TLOS  Line out of service signal  .  85
.. TSST  Send special info tone signal  .  95
.. TACB  Access barred signal  .  A5
.. TDPN  Digital path not provided signal  .  B5
.. TMPR  Misdialed trunk prefix  .  C5
.. TEUM  Ext unsuccessful bkwd setup info  .  F5
.. TANU  Answer signal, unqualified  .  06
.. TANC  Answer signal, charge  .  16
.. TANN  Answer signal, no charge  .  26
.. TCBK  Clear back signal  .  36
.. TCLF  Clear forward signal  .  46
.. TRAN  Reanswer signal  .  56
.. TFOT  Forward transfer signal  .  66
.. TCCL  Calling party clear signal  .  76
.. TEAM  Ext answer message indication  .  F6
.. TRLG  Release guard signal  .  17
.. TBLO  Blocking signal  .  27
.. TBLA  Blocking Ack signal  .  37
.. TUBL  Unblocking signal  .  47
.. TUBA  Unblocking Ack signal  .  57
.. TCCR  Continuity check req signal  .  67
TRSC  Reset ckt signal  . -  77
TMGB  Mtc oriented grp blocking msg  . -  18
TMBA  Mtc oriented grp blocking ack msg  . -  28
TMGU  Mtc oriented grp unblocking msg  . -  38
TMUA  Mtc oriented grp unblock ack msg  . -  48
THGB  HW fail oriented grp block msg  . -  58
THBA  HW fail oriented grp block ack msg  . -  68
THGU  HW fail oriented grp unblock  . -  78
THUA  HW fail oriented grp unblock ack  . -  88
TGRS  Ckt group reset msg  . -  98
TGRA  Ckt group reset ack msg  . -  A8
ACPI  Calling Party Information msg  . -  62
ACPR  Calling Party Info Request msg  . -  33
AMSC  Mixed Signalling Case Message  . -  73
ASCC  Switching or ckt congestion  . -  C5
ASLI  Subscriber Line Intercepted  . -  D5
AISC  Incompatible Service Class  . -  E5
AANS  Answer Signal  . -  16
APRL  Forced Release Signal  . -  C6
CCHP  Charge Pulse  . -  1C
COPR  Operator  . -  1D
CSLB  Subscriber Local Busy  . -  1E
CSTB  Subscriber Toll Busy  . -  2E
CMAL  Malicious Call  . -  1F
CCRA  Calling Party Answer  . -  2F
CMPM  Meter Pulse Message  . -  2C
TUPP  Telephone User Part Plus  . -  0F
TPAI  Initial Address with more info  . -  XX
TPSAM  Subsequent Address Message  . -  21
TPSAO  SAM with one signal  . -  31
TPGSM  General fwd setup info message  . -  41
TPCOT  Continuity Signal  . -  12
TPCCF  Continuity failure Signal  . -  32
TPGRQ  General Request Message  . -  42
TPACM  Address Complete Message  . -  13
TPECC  Switch equip congestion fail  . -  14
TPCGC  Ckt group congestion signal  . -  15
TPNNC  Natl net congestion signal  . -  25
TPADI  Address incomplete message  . -  35
TPCNN  Unallocated number signal  . -  45
TPSSB  Subscriber busy signal  . -  55
TPCSS  Call failure signal  . -  65
TPCSS  Subscriber busy signal  . -  65
TPUNN  Unallocated number signal  . -  55
TPLOS  Line out of service signal  . -  85
TPSSST  Send special info tone signal  . -  95
TPACB  Access barred signal  . -  A5
TPEUM  Ext unsuccessfl bkw setup info  . -  F5
TPANC  Answer signal, charge  . -  16
TPANN Answer signal, no charge
TPCBK Clear back signal
TPCLF Clear forward signal
TPRAN Reanswer signal
TPRLG Release guard signal
TPBLO Blocking signal
TPBLA Blocking Ack signal
TPUBL Unblocking signal
TPUBA Unblocking Ack signal
TPCCR Continuity check req signal
TPRSC Reset ckt signal
TPMGB Mtc oriented grp blocking msg
TPMBA Mtc oriented grpblking ack msg
TPMGU Mtc oriented grp unblking msg
TPMUA Mtc oriented grp unblk ack msg
TPHGB HW fail oriented grp blk msg
TPHBA HW fail oriented grpblck ack msg
TPHGU HW fail oriented grp unblock
TPHUA HW fail oriented grp unblo ack
TPGRS Ckt group reset msg
TPGAA Ckt group reset ack msg
TPNRU Ntwrk Release Unavailable
ISUP ISDN User Part
IAM Initial Address Message
SAM Subsequent Address
INR Information Request
INF Information
COT Continuity
ACM Address Complete
CON Connect Message
FOT Forward Transfer
ANM Answer
UBM Unsuccessful Back Set-Up
REL Release
SUS Suspend
RES Resume
RLSD Released
RLC Release Complete
CCR Continuity Check Request
RSC Reset Circuit
BLO Blocking
UBL Unblocking
BLA Blocking Ack
UBA Unblocking Ack
GRS Reset Circuit Group
CGB Circuit Group Blocking
CGBA Circuit Group Blocking Ack
... CGU Circuit Group Unblock       - 19
... CGUA Circuit Group Unblock Ack  - 1B
... CMR Call Modification Request  - 1C
... CMC Call Modification Complete - 1D
... RCM Reject Connect Modify     - 1E
... FAR Facility Request          - 1F
... FAA Facility Accepted         - 20
... FRJ Facility Reject           - 21
... FAD Facility Deactivated      - 22
... FAI Facility Information      - 23
... LPA Link Loop-around Ack      - 24
... CSVR Select & Validate Request- 25
... CSVS Select & Validate Response- 26
... DRS Delayed Release           - 27
... PAM Pass Along                - 28
... GRA Reset Circuit Group Ack   - 29
... CQM Japan Circuit Query       - 2A
... CQI Circuit Query             - 2A
... CQR Circuit Query Reply       - 2B
... CPF Call progress message     - 2C
... USR User to User Info.        - 2D
... UCIC Unequipped CIC           - 2E
... CFN Confusion                 - 2F
... CRG2 Charge information       - 31
... CRA Circuit reservation ack   - E9
... CRM Circuit reservation message- E9
... CVR Circuit validation response- EB
... CVT Circuit validation test    - EC
... EXM Exit message              - ED
... A7REL Austrian Release        - 0B
... A7LPA Austrian Loop Back Ack  - EF
... FVBF Fangen Vorb Freig        - FB
... ALT Japan Alerting            - FC
... FVB Fangen Vorbereiten        - FC
... PRG Japan Progress            - FD
... FANG Fangen                   - FD
... CRG Japan Charge              - FE
... EIN Einhaengen                - FE
... AUF Aufschalten               - FF
... DUP0 Data User Part 0         06 XX
... DUP1 Data User Part 1         07 XX
... LSM Linkset Management (NO MATCH ALLOWED) 05 X XX
... LMSB LSM MSB/LIU to ST Msgs   - A0
... LCF Configure (LIU)           - 9F
... STR Start Align               - A0
... STP Stop Align                - A1
... EMR Emergency                 - A2
EMC  Emergency Ceases
LPO  Local Processor Outage
LPR  Local Processor Recover
OMQ  OM Query
CFG  Configure (MSB)
QLS  Query Link State
LKN  Link Number
CGP  Congestion parms
LSTM  LSM ST to MSB/LIU Msgs
ALP  Align Progress
ISV  In Service
OOS  Out Of Service
EMA  Emergency Ack
ECK  Emergency Ceases
LOA  Local Pro Outage Ack
LRA  Local Pro Recover Ack
OMR  OM Reply (MSB)
CFA  Config Ack (MSB)
CPA  CongestionParms Ack
LSR  Link State Reply
LNA  Link Number Ack
RPO  Remote Processor Outage
RPR  Remote Processor Recover
LCA  Config Ack (LIU)
LOM  OM Reply (LIU)
RSM  Routeset Management (NO MATCH ALLOWED)
RMSB  RSM MSB/LIU to ST Msgs
LRC  Retrieval Complete (LIU)
FLS  Flush ST
RTB  Retrieve BSNT
RRF  Retrieve Request FSNC
RST  Retrieval Stop
CAU  Congest Audit
RSTM  RSM ST to MSB/LIU Msgs
LRR  Retrieval Reply (LIU)
LRCA  Retrieval Complete Ack (LIU)
FLR  Flush Reply
BSN  BSNT Reply
RTV  Retrieved Msg
RTR  Retrieval Reply
CNG  Tx Congestion
Cirrculum Vitae

Melek Güney Güçer was born in Istanbul in 1967. She had her highschool education in Kadikoy Anadolu Lisesi. She started her university education in 1985 in Istanbul Techical University. Having her BS decree in 1989 from the Department of Computer Engineering she started her masters degree and also began performing her career as a DMS Software Design Engineer in Netas. Meanwhile she was sent to England for a year by her employer to work on DMS features which were to be implemented in Netas in a near future.

She is currently working in DMS Software Design Department in Netas.