ISSN:2229-6093
Kadali.Mohan Swamy et al ,Int.J.Computer Technology & Applications,Vol 3 (6), 1954-1958

OVERVIEW OF CCS7 SIGNALLING

KADALI.MOHAN SWAMY *V.SAVAN RAMESHBHAI* *A.RAMA KRISHNA*

IV/IVB.Tech, KLUNIVERSITY *IV/IVB.Tech, KLUNIVERSITY* *Asst.Prof, KLUNIVERSITY*

Abstract

The CCS 7 is a Common Channel signalling system. That is, instead of signalling being associated with each traffic channel, a common signalling channel is used for all circuits. This signalling in telecommunication network establishes and realizes temporary connections, in accordance with the instructions and information received from subscriber lines and inter- exchange trunks, in the form of various signals. Therefore, it is necessary to interchange information between subscriber lines and between different exchanges. Though these signals may differ widely in their implementation they are collectively known as telephone signals. In this paper we discuss about CCS7 system architecture, protocol stack, link congestion and performance.

Keywords: IN (Intelligent Network),MTP (Message Transfer Point), SCCP(Signalling Connection Control Part), TCAP (Transaction Capabilities Application Part)

1. Introduction:

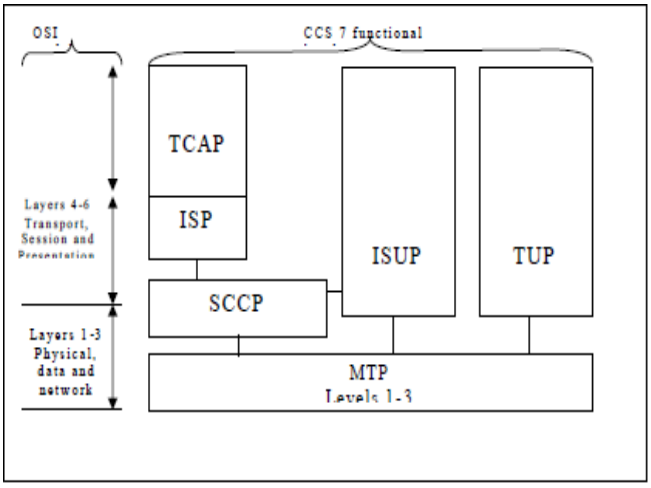
Common Channel Signalling (CCS) was designed in 1950s for analogue telecommunication and later adapted for digital exchanges.

Signalling is a co-coordinator of the telecommunication world. Why? Because any basic movement or function, such as; call set-up, call tearing down, dialled digits, routing information, voice mail calls, providing dial tone, call waiting tone, network management, network control, network maintenance, etc. All have to be transfer to exchanges with a function of messages. This system is known as Signalling System 7 (ss7 or c7). SS7 relies on Common Channel Signalling (CCS), a signalling method.

As telecommunication systems increased in complexity such as Intelligent Network (IN), GPRs, in near future UMTS or any other third party services. The new services required more complex functions such as, bi-directional signalling capabilities, and flexible call set-up and third party series database access.

2. CCS 7 System Architecture

The CCS 7 is a Common Channel Signalling system. That is, instead of signalling being associated with each traffic channel, a common signalling channel is used for all circuits. This signalling channel consists of one or more signalling links, which can use diverse routes for resilience. A signalling can typically handle several hundred circuits. CCS 7 consists of number of different parts designed to provide different services within the different network. The main parts can be seen in figure 1. The MTP and at least one "User Part" will always be present since this represents the minimum useable functionality. A "User Part" is a part of CCS7 protocol which uses the service of the MTP. The CCS7 has a number of levels. But these do not much exactly to layers in the OSI model as shown in the figure below, with the exception of the SCCP part, which shares the functionality between level 3 and level 4.



I. 3.CCS7 Protocol Stack

The ccs7 protocol stack comprises of four layers. With reference of the OSI 7-layer model, the correspondence between the layers is depicted.

3.1. Level-1

Any node with the capability of handling CCS7 is termed a 'Signalling Point'. The direct interconnection of two signalling points with CCS7 uses one or more 'signalling links'. Level 1 of the 4-level structure defines 'the physical, electrical and functional characteristics of the signalling link. Defining such characteristics within level 1 means that the rest of the signalling system (level 2 to 4) can be independent of the transmission medium adopted. By keeping the interface between levels 1 and 2 constant, any changes

within level1 do not affect the higher levels. In a digital environment, usually the physical link is a 64 Kbps channel. This is typically within a digital transmission system using pulse-code modulation (PCM). Other types of link (including analogue) can be used without affecting levels 2 to 4.

3.2. LEVEl-2

Level 2 defines the functions that relevant to an individual signalling link, including error control and link monitoring. Thus, level 2 is responsible for the reliable transfer of signalling information between two directly connected signalling points. If errors occur during transmission of the signalling information, it is responsibility of level 2 to invoke procedures to correct the errors. Such characteristics can be optimised without affecting the rest of the signalling system, provided that the interfaces to levels 1 and 3 remain constant.

3.2. LEVEL 3

The functions that are common to more than one signalling link, i.e. signalling network functions and 'signalling network management' functions. When a message is transferred between two exchanges, there are usually several route that the message is transferred between two exchanges, there are usually several routes that the message can take including via a signal-transfer point. The message-handling functions are responsible for routing of the messages
Through the signalling network to correct exchange. Signalling network management functions control the configuration of the signalling network. These functions include network reconfigurations in response to status change in the network. For example, if an exchange within the signalling network fails, the level 3 of CCS7 can re-route messages and avoid the exchange that has failed.

3.3. Message Transfer Point (MTP)

Levels 1 to 3 constitute a transfer that is responsible for transferring information in messages from one signalling point to another. The combination of level 1 to 3 is known as the message transfer point (MTP). The MTP controls a number of signalling message links and network management functions to ensure correct delivery to appropriate exchange in an uncorrupted form and in the sequence that they were sent, even under failure conditions in the network.

3.4. LEVEL 4

Level 4 comprises the 'user parts'. The meaning of the messages transferred by the MTP and the sequence of actions for a particular application is defined by the 'user parts'. A key feature is that many different user parts may use the standardised MTP. Hence, if new requirements arise, that had not been foreseen **II.** previously, the relevant user part can be enhanced without modifying the transfer mechanism or affecting other user parts. Three user parts have been defined, the Telephone User Part (TUP), the ISDN User Part (ISUP) and the Data User Part (DUP). Along with SCCP, this provides the Network Layer functionalities of the OSI model. The user parts of NSP are Operations and Maintenance Application Part (OMAP) and Mobile Application Part (MAP).

3.5 Signalling connection control Part (SCCP)

The Signalling Connection Control Part (SCCP) has the functions of the network as well as the transport layers of the CCS7 protocol stack. Together with the MTP, it provides true OSI transport layer capabilities. Unlike MTP which provides only datagram service, SCCP provides connection –oriented and connection-less service as well.
Thus, while MTP is sufficient for circuit switched applications like TUP and ISUP, for non-circuit related applications, such as database querying, the enhanced addressing capability of SCCP is required. SCCP has a unique scheme of addressing and routing based on Global Titles. SCCP utilizes the service OF MTP to route its payload from one node to other.
In addition to routing transaction related messages submitted by the Transaction Capabilities Application Part (TCAP), SCCP also segments and sequences large TCAP messages to fit into the MTP packet size. At the distant node it is the responsibility of the peer SCCP to re-assemble the segmented message.

3.6. Transaction Capabilities Application Part (TCAP)

TCAP is an application part in the CCS7 stack and is responsible for establishing dialogue with remote databases. It carries the data of higher layers like INAP and MAP and invokes remote operations. An operation at remote end requires a series of queries and responses as part of a TCAP dialogue.

TCAP layer is a compound layer in the sense that it is composed of two sub-layers, namely, Transaction Sub layer (TSL) and Component Sub layer (CSL).

Transaction Sub layer is responsible for establishing, managing and maintaining the integrity of the dialogue whereas Component Sub layer is responsible for packing the upper layer message into a component and assigning an invoke ID to the component.

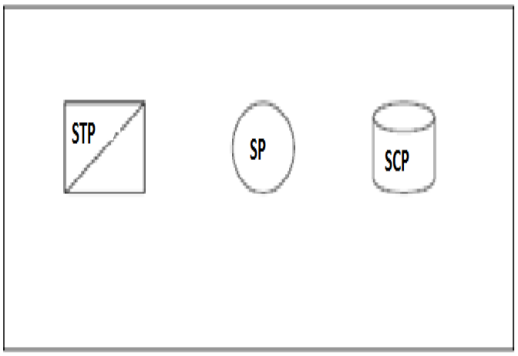
When CCS7 is specified as a signalling system, level 4 specifies a number of call-control functions. Indeed, the circuit-related mode of CCS7 is so closely associated with controlling the set-up and release of physical circuits that it is essential that some aspects of call-control are defined within the user part specification in order to optimise the procedures that are adopted.

4.Signalling Network Elements

Before we go deeper in this subject let us have a look at some signalling network elements; their function and

signalling link types as well as basic signalling terminology.

The SS7 network is built up with three essential elements, and connected by a signalling link.



4.1. Signalling transfer point (STP)

STP is the packet switch of the SS7 network. They receive and route signalling messages towards the desired destination (Destination point code (DPC)) in this case the MTP is used only. STPs are employed for this reason. Usually STPs are deployed to network as a pair for redundancy reasons. There is two type of method that STP can be used in GSM.

1. Combine STP, which means every MSC also used as a STP as well as call processing also handles the signalling transfer for the destinations. Which combine STPs are spends or needs more capacity.

2. Stand alone STP, used for transferring SS7 signalling messages between Signalling points (SP). Stand alone STPs sometimes also called pure STP.

4.2. Signalling Point (SP)

SPs are telephone switches (end office or tandems) equipped with SS7 software and terminating signalling links. They are generally originated, terminate, or switch calls.

SPs also have two subset depending on whether or not SP is sending the message or receiving it.

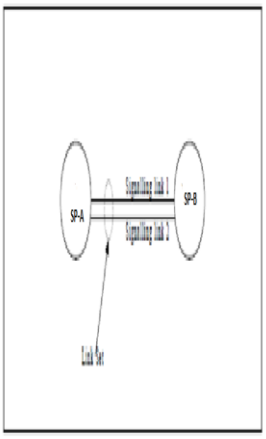
In the case of SP is sending message, it becomes Originating Point Code (OPC). Otherwise, SP becomes Destination Point Code (DPC).

4.3. Signalling Control Point (SCP)

Basically SCPs are database that provides necessary information for more advance call processing capabilities.

4.3. Signalling link (SL)

A signalling bi-directional data link is needed to connect the SPs and STP to each other as in figure 3. These links are virtually same all over the world, which are supports the same lower layers of the protocol. In Europe SL carry information of a rate 64kbps time slot of the 31 channels (EI) and in North America they carry 54kbps which is 24 (DS-1) channels.



4.5. Signalling Link Set (SLS)

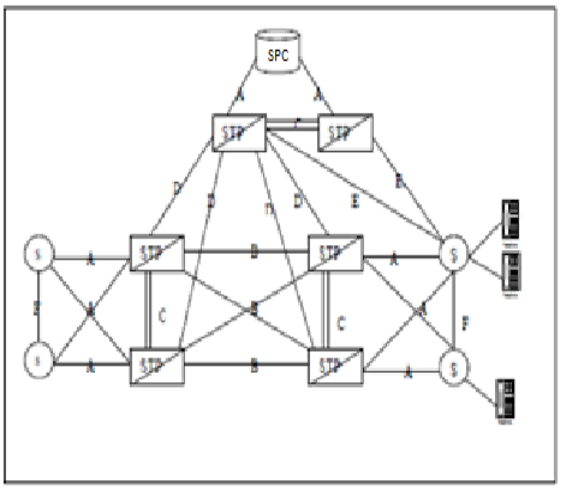
A number of signalling links tie the same signalling points (SP) in other words MSC A to MSC B is called signalling link set (SLS) as shown above figure. All the links set must be connected to same adjacent node.

III. 5.CCS 7 Link Types

There are six types data links are used in SSC 7 to connect the various node. The link specifications and what types of nodes, which are interface, are described below.

A Links:

An “A” or “Access” links carry the traffic of the network in the CCS 7 network. A links connect STPs to SCPs or SPs. The “A” links provides access into the database and network via the STPs.



B Links:

"B" or bridge link connects pair of STP to another pair of STP at the same hierarchical level, such as national STPs to national STPs.

C Links:

A "C" or Cross link interconnects pair of STPs to another pair of STP and is used primarily administrative traffic. The "C" link is used only when a STP has no other route available to a destination signalling point due to link failure/s. For redundancy reasons these links are always deployed to network in pairs.

D Links:

The "D" or diagonal link connects STPs on different (primary and secondary) hierarchical levels such as national STP to international STP. Sometimes this link also called as a "Quad" link. Within the same network, "D" link may refer as a "B" link.

E Links:

An "E" or Extended link connects an SSP or SP to any other STP that is not in the same network.

F Links:

An "F" or fully associated link connects two adjacent SSPs or SCPs. Fully associated links usually are not used in networks with STPs. For reason/s if SSp cannot connect to STP, the F links allows SSPs by using SS7 protocol to access the SS7 data base.

6. CCS 7 Link Performance

The CCS 7 links must be remain available for CCS7 traffic at all the time for reliability of the signalling network, with a minimum 10 minutes downtime for a link set per year or should be better than 0 minutes downtime for a link set per year or should be better than 99.9998% a year. In addition all the links within the link set must be defined with load share functionality when a link fails the other must be able to take the offered traffic. As in the STPs, if one fails other one (mate) must be able to handle the failed one traffic too. Now what does it mean? Suddenly if links are occupied with a high traffic than they can handle. For this reason CCS7 links are usually designed to operate 40% of traffic on any link. In other words, links are designed to carry 0.4 Erlang (E) traffic. Some operator are designed their CCS7 to handle the offered traffic with 30% or 20% and leave the rest for redundancy. For some reason any link failure in the link set other, links will be responsible to carry the failed link traffic. With 40% (30% or 20%) utilized capacity to carry the traffic, as well as CCS7 network management messages with 80% capacity.

6.1. CCS 7 Links Changeover and Change-back

The changeover is message (CCO, changeover order) that used to divert traffic away from a failed link. The change-back message (CBD, change-back declaration) is used when the failed link has recovered. It tells traffic that it may now resume over the link.

IV.

6.2. CCS 7 Load Sharing

The load sharing purpose is to distribute the messages by a predefined distribution law and to balance the traffic to achieve a near uniform level 2 processing the load. The load sharing is applicable on two stages:

a. Distribution of messages within the route sets i.e. between two or more DPCs.
b. Distribution of messages within the links composing the link set without a load sharing links may go for unnecessarily congestion.

V.

VI.

6.3. Link Congestion

When the transmission and re-transmission buffers are occupied at level 2 beyond the limit, the level 2 sends congestion indication to level3.If one link gets congested within a link set, the entire Link set gets congested towards a destination, the destination also considered being congestion state.

7. CONCLUSION

Common Channel Signaling is being adopted throughout the world in national and International networks for numerous reasons. The main reasons are: The rapidly changing control techniques of exchanges, the limitations of CAS systems and the evolutionary potential of CCS systems. With Common Channel Signaling (CCS) systems, the philosophy is to separate the signalling path from the speech path. The separation occurs both within the exchange and external to the exchange thus allowing optimization of the control processes, switch block and signalling systems, in a CCS environment, the switch block routs

the speech paths as before, however, a separate path internal to the exchange routs the signalling (denoted by a dotted line). This approach allows maximum flexibility in optimizing exchange and signalling development. The approach gains maximum benefit when adopted in parallel with the introduction of digital exchanges and digital transmission systems. CCS system being particularly efficient in these circumstances.

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