NETWORK MANAGEMENT PROTOCOLS IN INTERNATIONAL TELEPHONE CALLS: A REVIEW

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ABSTRACT

From contemporary knowledge international telephone service is a special brand of subscriber facility. At any point in time the telephone industry casts reflections on the history of the system for objective planning purposes. This study examined the current State-of-the-art in respect of initiating and completing an international telephone call from any point under the sun. The literature on international telephone communication described the telephone development in relation to the technology that supports the transformation of the system in modern times. The study was adapted from the congestion theory that explains the processes that lead to telephone traffic exigencies. This theoretical frame of thought facilitated the understanding of the processes through which voice signal transverses from its focused analysis of the hurdles through which international telephone business operates. From those objective analyses it was found that the international telephone message signaling systems are highly regulated to protect the interest of stakeholders.

Keywords: *Netwotwork management protocol, international telephone call, traffic congestion*

INTRODUCTION

In developed telephone systems the telephone is used daily, anytime, anywhere, and the users are both poor and rich individuals. The widespread use of the telephone has turned it into a commonplace experience. In the industrially and economically developed societies almost everybody has access to a telephone. Only an insignificant number of households in the United States are without a telephone set, although individuals in these households have access to paid telephones or public free phones. Telephones are in the offices, homes, hotel suites and motel rooms, arenas, and in hallways of public buildings. The telephones are also widely distributed at many land transit places, such as streets, courts, pitches, camps, beaches, harbours, fairgrounds, gas filling stations, and border areas. For the travelling and touring public, there are telephones in the ocean lines, aircrafts, motor vehicles and trains. With cellular technology, telephone users are able to move with pocket phones from place to place.

The extensive distribution of telephones and the unlimited access to their use explains why they are taken for granted. In spite of the obvious widespread distribution and use of the telephones in the developed telephone systems, there are countries which have telephones for the privileged few. The masses in those countries, who regard this facility as luxury, are excluded from the communication conveniences provided by the telephones. On the other hand, people in the developed telephone systems are still surrounded with myths regarding the technical aspects of this system of electronic communication. Not many telephone users, for instance, are familiar with the nature of a telephone signal and how it travels through the circuits from the transmission point to its destination, including the type and characteristics of the various media conveying it.

The traffic and congestion theories, the basic issues in the telecommunications industry, are still a puzzle to many telephone users who contend that these issues are nothing more than abstract thinking. The relationships inherent in the concepts of telephone traffic, signaling, switching, codified telephone numbering, call routing, and channel, the fundamental issues of importance to the telecommunications industry are either haphazardly or not understood at all by the dialing public. Neither

have the concepts of analog and digital systems of voice transmission captured the curiosity of the subscriber. The basic function of noise and radio transmission parameters governing the telephone signal delivery process remains a puzzle to the average subscriber.

In any case, the telephone subscribers would probably argue that they do not have to understand these issues, which they believe is the domain of the telephone technician, engineer, and technologist and beyond their capability and scope of knowledge. While the argument may be plausible, they are nevertheless affected, in varying degrees, by these issues whether they are aware or not. Every subscriber is affected by the operation of traffic and congestion on the telephone circuits and trunks. Because these issues explain the behaviour of signal transmitted over the circuits and trunks when traffic loads are high and the lines are congested the subscriber is subject to their negative impact since they have direct effect on the quality of service received for their subscription charges.

However, most subscribers are probably well acquainted with the sample formula for placing a local or long-distance call. But they may probably not worry about the need to understand the technical processes involved in the production, transport and delivery of a quality voice signal from source to destination, let alone the factors affecting the voice quality received at the destination. Ultimately, a technically informed subscribing public is an asset to the telephone industry. This ideal situation remains the aspiration of the industry although the realization of the goal is in the distant future. The subscriber is the subject of this discussion because he/she is in the center of the telephone industry, influencing all planning and implementations designed to meet satisfactory services.

Until recently, not many people were international telephone literate as many developing countries did not have a national telephone network. Even the most sophisticated domestic telephone subscriber did not know how to pace and complete an international telephone call. The insignificant number of international telephone callers had to rely on the centrally located national calling booths. This was a prepaid service. The caller prepaid; he is given a card and is located a booth for the international call. The calls were usually limited in duration, depending on the value of the calling card. Most callers request and use the attendant's assistance.This study

was designed to examine the mode of international telephone call and the protocols that are associated with it. Precisely, the discussion and analyses focused on the following issues.

1. The use of international dialing codes
2. The international number digit formats
3. The subscriber access interface network
4. The formalities associated with international call
5. The protocol for dialing international telephone number

TRAFFIC CONGESTION IN TELEPHONE CALLS

Traffic in this context is defined as "the aggregate of messages using a group of circuits and trunks, and is measured in terms of duration and the number of signaling" (Freeman, 1991). The subscriber is affected by the impact of line congestion because of the direct relationship between line congestion and the standard of service provided by the operators at that given point in time. The number of calls from a group of subscribers may be in progress simultaneously. This experience follows a regular pattern of fluctuation featuring throughout the day (Syski, 1992). This explains why telephone traffic managers often specify appropriate facilities to cope with such situations and meet satisfactory quality during periods of maximum demand on the lines (busy period). This also explains why a subscriber occasionally receives a call supervisory signal, announcing that the lines are busy and intimating the subscriber to call later. Lost calls are known to be common during the busy hour, indicating that such calls have found all facilities busy in the group they are offered and at the instant they are offered. These problem circumstances are typical of international trunks, but often at the other end of the less developed countries where telephone systems are lagging behind with electromechanically-based switching devices. Conversely, the digital switching technology in the competitive telephone systems of the developed countries has the capability to handle these problems with alternative call routine facilities.

The international service has inherent problems. The environment of international telephone communication is beset with traffic congestion. Only few calls are delivered hitch free. Most calls are jammed because of

congestion. The caller is frequently told that the networks are busy. For courtesy, the customer is told to call back later and the caller does not usually have a two-way facility to ask the network manager when to call back. These problems are a feature of international telephone calls and are responsible for the frustration that subscribers suffer.

The problems associated with international telephone traffic are relatively worse with the landline system. The system is laboured to establish international standardization. Different national telephone systems maintain local standards. As expected, the industrialized nations run sophisticated national network systems. Even these technologies -based, highly developed systems have continued to face problems at the international service because of the lagging systems overseas.

EMERGENCE OF TELEPHONE SYSTEM OF COMMUNICATION

Most telephone book authors, writers and analysts could hardly complete any work on the subject without looking back to the history of the telephone system of communication. Fischer (1991) recalled Alexander Graham Bell, the name to which he credited the invention of the telephone technology. Harlow (1971), described the telephone system as the use of wire transmission of sound between widely removed locations. Fortner (1993) observed that in the early stage the telephone messages relied on telegraph switching devices. For this technical reason there was an early marriage of convenience between the telegraph and the telephone. According to Forester (1987) although the modern telephone technology has introduced a wireless system, yet most signal transmissions still depend on wire as a medium. This development received support from the invention of amplifiers, repeaters, submarine cables, and communication satellite that substantially increased the capability of the telephone to transmit long-distance voice messages. And for the most current development, the invention of the transistor, the introduction of large-scale integrated circuits, and the digital signal processor, the telephone technology attains its sophisticated status.

Similarly, some writers prefer to highlight the development of the national telephone systems. The U.S. experience is probably used by writers to explain the technology-based development of a national telephone system.

Row II (1998) explained that the U.S. telephone waited for the emergence of the computer technology before the modern capabilities that introduced wide-ranging features into the U.S. telephone system. In his contribution, Derfler (1993) observed that the development of computer-telephone integration (CTI) greatly enhanced the U.S. telephone system. The CTI equates the early marriage between the telegraph and the telephone. However, for standardization the U.S. telephone industry continues to face opposition from foreign, often lagging systems.

On the other hand, China, Japan and France have developed national telephone systems of their choice. China national plan, which was implemented a decade ago, was large-scale and for this reason it has been attracting the attention of analysts for evaluation of the project. Dow Jones (1998) described China's telephone system as a poor subscriber access network. That the low volume of internet access in China testifies to the lagging telephone development in that country because telephone and the internet are integrated communication systems(Boucher, 1996).

Other analysts have focused on the transmission technology. Feher (1991) believed that national systems that have not developed their transmission capabilities would lag behind the western standard of telephone technology. He cited the application of microwave radio transmission backbone. Leibold (1997) noted that access codes used in international dialing were often not observed by some national telephone systems and it accounts for lack of standard quality service. For a similar reason, Bear (1996) believed that some national systems were unable to handle telephone traffic problems.

Some writers focus on the direction of engineering. Freeman (1991) contented that telephone system engineering was poor in some national telephone systems, which was responsible for poor quality service. Syski (1992) believed that some national systems were unable to cope with the congestion traffic problem. However, he observed that radio noise was responsible for poor quality service in the less developed telephone systems. Some of the guidelines in the use of the telephone switching facilities have come from the international supervising agencies of ITU. Most of these recommendations aim at establishing standardization for member countries. The review of the pertinent literature facilitated the investigator's

understanding of the processes involved in the transmission of international telephone call from any point in the world. The environment of international telephone system is meticulously managed under the agreement of the subscribing international community. The international agencies such as the CCITT or ITU-T are empowered to implement the various recommendations of the plenary assembly which meets at reasonable intervals to consider issues affecting the use of the facilities provided by the organization. The critical issues which frequently come to the agenda are reviews of channel and frequency allocations, numbering and coding formats, signaling and switching systems, traffic control, transmission lines management, and special services such as Integrated Services Digit Network (SIDN).

Codified numbering formats: The basic knowledge of the global numbering plan is probably an important consideration because the format provides the dialing access by which the various domestic telephone networks interconnect to the international network. Essentially, the international numbering plan is accomplished through the assignment of codes. The globe is partitioned into zones according to geographic regions. The zones are demarcated to allow the subscribing countries to use the access codes assigned to them in their various regions. Table 1 provides an illustration of the current zoning structure. At present, there are 9 zones in the structure, and the United States, Canada and the Caribbean are in the North American zone 1. Africa on the other hand, is in zone 2. South America occupies zone 5, while Europe is assigned zones 3 and 4. Russia and former Soviet Republics are on zone 7, while South-East Asia occupies zone 9. Far-East Asia is in zone 8, while Australia and the Islands around it occupy zone 6 (CCITT Recs. 1988) (1).

Numbering Plan Applications: In each zone, each country is assigned a national code, usually referred to as "country code". Some country codes place a charge for their application, while some are toll-free codes. A set of identification system is used to designate different types of number formats to facilitate access to local, national or international transit networks. The code categories include the International Code, Country Code, National Trunk Code, Escape Code, National Destination Code, and Destination Network (DN) Code, respectively. The number formats include, subscriber

number, National significant number and International number (CCITT Recs. (2). These codes are backed up with approved digits that allow the selection of different types of number formats for variety of dialing purposes. The categorization is revised at different intervals of time to ensure dynamic applications of the formats.

Selection and Applications of International Dialing Codes: The international number specifies the number of digits to be dialed by a subscriber in one country making a call to a subscriber in another country to obtain access to the automatic outgoing international exchange switch facilities. The international number consists of the country code (CC) of the required country, followed by the area of city code, and then the subscriber's local phone number. The country code, on the other hand, is the combination of two of three digits which identify the called foreign country. The subscriber number is the called party's local phone number to be dialed to reach the called party in the foreign country.

Other numbering formats with specific identities include, the National Trunk Number with a combination of digits to be dialed by a local subscriber to reach another subscriber in the same country, but outside the calling subscriber's area number plan. The Trunk code is a number that a subscriber has to dial before the called party's number, in cases where the two subscribers are in different numbering areas (known as Area code in the North American regional numbering plan). The National Significant Number is the number dialed after the National Trunk to reach a subscriber in the same country a group of countries in one integrated numbering plan, but outside the same local network. The number comprises the national trunk followed by the subscriber's number.

Ultimately, access codes used for international dialing are country-based, that is, the access code used depends on the country from which an international call is placed. The ITU-T recommendations specify 00 as the preferred code. The European Union uses this code as Standard International Access Code. However, the 00 code is not universally adopted at present.

Table 1: Some of the exception to the 00 code

Country	Codes	Country	Codes
Australia	001	Norway	095
Canada	011	Papua (New Guinea)	05
Colombia	90	Russia	8W10
Denmark	009	Singapore	001
Japan	001	Spain	07
Mexico	98	Sweden	009
Nigeria	009	U.S.A	011

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There are significant variations in the assignment of codes in different countries. In some of these nations an area code has only digit 1 or two digits, 01, which may be assigned to the capital city of that country. An example is Lagos (Nigeria), which maintained 01 code as then capital of Nigeria. Even though the city is no longer the capital of Nigeria it nevertheless retains the code as the largest city in the country.

The International Number Digits Formats: The numeric size of a telephone number used for international dialing is a basic issue in placing an international telephone call. The current position is that an international dialing number may carry a numeric size in the range of a maximum of 12, and exceptional cases of 15 digits. Although the 15 digit size is already in use in some countries, yet the universal application is still debated (Leibold, 1997) for countries in the 12 digit limit. The CCITT recommendations specifies that International number should not exceed 12 digit and dialing subscribers in the automatic switch services should not use more than this number after dialing the country's international access code. For the countries using the 15 digit exception, the digit size represents the combined number code segments: the International Access Code, the country Code, Area or City Code and the subscriber number. On the one hand, the 15 digits range has the advantage of facilitating capacity extra numbering capacity within countries, thereby expanding the numbering capacity for international calls. On the other hand, the limitation of the 15 digit format is that such numbers may require manual operator-handling, especially in

the less developed telephone systems where standard switches are not capable of automatic switch devices. Table 2 represents a sample of selected countries to illustrate a complete international dialing format.

Table 2: Complete Dialing format for an International Telephone Number

Country	Int'l Access Code	country Code	City/Area Code	Subscriber No.
Nigeria	009	234	87 (Calabar)	225-879
U.S.A.	011	1	202 (W/DC)	865-0334
Japan	001	03	81 (Tokyo)	4567-8901

Source: Abstracted from TELECOM Digest, FAQ, January, 1993.

Subscriber-Access Interface Network Application: A telephone subscriber resident in any part of the world has the potential to access any other subscriber in any part of the world. Such calls are routed over a vast international network based on direct, high traffic routing trunks. In some cases there may be third country transit exchanges, connecting one or more international switching centers (ISCs) in each country CCITT recommendations (3). Understandably, each country runs its own national network that occupies a pivot position as a functional part of the international network. A telephone call is routed to its destination over the network based on the telephone number provided by the subscriber.

Placing an International Call: The requirements for successful completion of international call are the responsibility of the subscriber, at first instance. Given today's technology-supported facilities, a subscriber would have access for international call transmitted over the digital exchange switches that facilitate connection to digital telephones. The digital exchange switches permit calls to be routed when congestion points have to be avoided. These switches have the capacity to select a variety of routes for the call. The current technologies are developed to handle the problem of inflexible routing system based on the rapidly replaced electromechanical switching system. Thus, the modern digital switching system provides fully programmable call routing operation. With these capabilities, calls are processed digitally without having to the resort to so-call solid-state switching method (involving equipment movement). A digital subscriber uses a digital system provided by (ISDN) which connects his line to the local serving ISDN -equipped exchange switch facilities (CCIT Recommendations) (4).

The computer-based technology provides not only call control devices, but also error detection mechanism through error control coding to enable voice traffic to be automatically converted to digital format for use with digital transmission facilities (Boucher, 1996). The capacity provides a wide variety of user access interface network services such as ISDN (CCITT Recommendations) (5). On the other side of the picture, the international call subscriber may not, however, assume that a call transmitted at one point will be routed through all the network interfaces-traveling over all the interconnecting transmission links to its final destination without interruption.

The ideal situation is not a common experience with international telephone trunks and inter-exchange switches that handle call routing jointly with the less developed telephone systems that are still relying on the less capable switching and transmission equipment. The actual experience in international telephone calls is one in which a call is routed through various modes of switching exchanges-digital switching-electromechanical switching-step-by-step automatic switching method of "progressive control", crossbar common control routing technique and reed relay-dependent electronic switches. All of these forerunners of the present sophisticated digital exchange switches are still in use in some countries that are exchanging calls with competitive telephone systems.

An American-based subscriber may have placed an international call with a digital touch-tone phone through the local exchange digital switch facilities to the called party's country where the electromechanical switching device is used by the Local Central Office (LCO) which connects to its subscribers' dial pulse rotary telephones. This explains why international calls are far from smooth delivery from source to destination. However, to keep the international trunks occupied the new technology provides built-in capability which allows it to route calls over the facilities of the older switching systems (Feher, 1991). In spite of these facilities, an international call may still fail if the national trunk is congested and all the facilities are found busy in the group they are offered and at the time and instant the call is offered (Kleinrock, 1962).

Dialing the International Telephone Number: Placing an international call involves voice signal transmission from point X in one country to point

Y in another country via the international network. The international telephone subscriber chooses one of a number of options. He may use the Direct Dialing (DD), or Operator-Assisted Dialing (OAD). And at the called party's end of the transmission line, he may decide to send his message on a person-to-person, or station-to-station basis. In the direct dialing alternative, the subscriber is responsible for providing the foreign number he is calling, the so called "Initial Address Message" (IAM) containing all the information required by the next international exchange to route the call. He must demonstrate a basic understanding of the conventions governing international calls in order to initiate and complete ad call.

An understanding of the codes assignment format will be appropriate in enabling him to figure out the international access code assigned to the country from which he is placing a call. For this call to be properly routed through the transmission points linking switches on the line to the switching facilities of the called party's country, he has to know the access code of that country. For the destination in view, the call has to go through the national trunk number of that country for final routing through the facilities of the local central office exchange to the called Party's telephone.

On the other hand, if the subscriber chooses to send his call via operator-Assisted procedure, he faces even greater responsibility as he would be expected to make an international call request to a local trunk operator. The carrier operator, in turn, requests the subscriber to furnish the complete dialing number of the overseas called party to include the digit format (international access code of the country from which the call is originated; the called party's country code; the called party's national trunk number, and the called party's telephone number), after which the operator undertakes to send the call digitally and the subscriber is charged for operator's assistance, time, and distance. The Operator Assisted call placing involves a supervisory call progress signal, which the subscriber receives in the form of audible tone or recorded announcement that conveys call progress or call failure information to the subscriber. A sample call progress information formats would be as follows: "You are on the line, Sir", or "The called number is ringing, but no answer," "The lines are busy at the called party's end", "You can try later" "Thank you for using

MCI". In the Person-Person call delivery, the subscriber is charged only if the called party directly receives the call or his answering machine. On the other hand, the station-to station delivery imposes a charge on the subscriber as long as someone in the station receives the call whether on behalf of the called party or not.

Signaling Links: Telephone calls are voice messages that are converted to binary mode for transmission over a set of links connecting signal points on the network. A signal may be transmitted over one or more intermediate signal points that handle the relay at the network interface. Ultimately, the network in the case of link failures change the routing of signaling traffic in order to by-pass the faulty links or signaling points after obtaining information from the faulty signaling points (Sps) and the signaling transfer points (STPs) concerned

Message Load-Sharing Function: The destination point code (DPC) that comes with a routing label must usually indicate more than one signaling link than may be used to carry the message. This allows network service managers to select alternative signaling link that permits traffic load-sharing between signaling links belonging to the same link set, and load-sharing between links not belonging to the same link set. The CCITT Recommendations mandates the operation of both cases for any signaling point in the international network. In the first of the two instances, the traffic flow carried by a link set is shared between different signaling links belonging to that links set as in the case of a set directly interconnecting the originating and destination points (loading-sharing within a link set). In the second instance, traffic relating to a given destination is shared between different signaling links not belonging to the same links set, although the link set does not directly interconnect the originating and destination points (loading-sharing between link sets).

Eventually, competence in the use of the facilities for international telephone calling would take the subscriber to the specific competence-based area, such as signaling, switching, numbering, routing network structure and services. These areas of competence seem to dominate the discussions in international telephone services since they provide clues to the basic understanding of how international telephone system works, one

of the most frequently asked questions. Thus, the subscriber who wants to maximize the benefit to international telephone calling would probably take the route that this discussion prescribes. It sounds unlikely most subscribers, although some would be willing to take the trouble if given the opportunity to receive training for this kind of user competence.

The Area Codes are based on distinct geographic areas into which the region is divided for this purpose. The local exchange codes are typically assigned to local exchanges that provide basic switching functions within each definitive geographic area. Exceptions are service Access Codes (SCs) which do not conform to geographic demarcation. These non-geographic codes provide caller access to Local Exchange Carrier (LECs) and Interchangeable Exchange Carrier (IECs).

Network Configurations: The structure specifies hierarchical network configuration with automatic, alternate routing facility to provide rapid and efficient connections. With alternative routing facility a call coming on the first route is easily rerouted to the next available route in the network if that route is held in traffic congestion. A 10-digit address format on which routing between terminals is based is assigned to an eligible subscriber. Either CCITT's No. 7 (SSN7) common channel or in-band (MF) signaling systems are used for signaling between exchange switching points. Incoming calls on the local exchange network must deliver a minimum of 4 digits for the local serving exchange (end-offices) switching equipment to connect the relaying of signals is handle by the signal transfer point (STP). The CCITT defines an STP as a signaling point at which a message received on a signaling link is transferred to another link outside of both sender and receiver signaling links. The signaling network provides the transport functions of directing the sender's message to the receiver's signaling link. In practice, however, a signaling point (SP) can as well be an originating point, destination point, or a signal transfer point.

Message labeling is used to accomplish the objective of proper message routing. Each message bears a message label. A standard message label contains a portion used for message routing (routing label). The routing label provides specific indication of destination, originating point, a code used for load sharing; all of which identify the receiver.

In turn, a standard routing label assumes that each signaling point in the signaling network codes. Message labeled according to international and national codes plans contain network service information indicating the status of the message such as originating and destination points. Message handling functions comprise message discrimination, message routing, and message distribution. Message discrimination is used at each signaling point to determine whether or not a received message is destined to that signaling point or is for onward routing if it is for onward routing. It is transferred to the message routing function. Message routing, on the other hand, is used to select each signaling message to be sent, including the signaling link to be used. Figure 2 provides an illustration of the signaling labeling, selection and routing functions.

Generally, message routing is based on the analysis of the routing label of the message together with predetermined data at the signaling link concerned. The common labels are destination point code (DPC), which indicates the destination of the message; the originating point code (OPC), showing the originating point of the message. Ultimately, message routing is destination code-dependent, but it must bear a load-sharing code that permits different portions of the signaling traffic to a particular destination to distribute over two or more signaling links. In the event of failures in the signaling network the routing of message previously using the failed route is modified in a predetermined manner under the control of the signaling traffic manager (Bear, (1976). There are some advantages in using uniform routing of a message belonging to different potential users, but the service indicator included in each message empowers the traffic manager to use different routing plans for different potential users.

CONCLUDING REMARK

International telephone calls though have inherent problems must not be expected to be hitch free at all times. The fact remains that the mechanism controlling the functionality of this equipment is the product of man's innovation. This goes to say that there is no perfection whatsoever in man's activities. However, effective signaling network management enhances quality international telephone calls. The signaling network

management services are basically of four types, which include signaling traffic management, signaling link management, and signaling route management. These management functions cover the issues of failure and restoration of a signaling link within the signaling network in the events of trunk or line congestion due to high traffic loads. These are accomplished by providing traffic control to handle congestion problem and to provide reconfiguration of the signaling.

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