CIRCUIT AND PACKET SWITCHING IMPLICATIONS FOR TELECOM OPERATORS

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Abstract

The telecom technologies and the industry are changing at a rapid pace. Operators' survival is no longer guaranteed, but earned based on sound prudent and proactive planning in line with the trend in the industry. The pervasiveness of the Internet is a major factor influencing current innovations in the industry. Packet is the envelope by which information transported over the Internet is packaged. This means that telecom innovations are currently based on packet technology. It has been over a decade that vendors have brought to the market switching technologies that are packet based, but it is sad that most operators are still deploying circuit-based switches. This paper is intended to bring to the attention of the operators this trend in the industry. Furthermore, it discusses the benefits of packet over circuit technology based on experience of dealing with major telecom Operators in Europe.

1.0 Introduction

Until the last three decades, telecom had been defined by voice circuit switching, which dates back to the beginning of the 20th century when automatic telephone switches were first deployed (1,2). In the mid 70s, AT&T started researching the possibility of an out of band signalling network to curb fraudulent telephone calls and this led to the invention (3) of system signalling 7 (SS7). SS7 is based on packet technology and this meant that in the late 70s the telephone network became a fusion of both circuit and packet oriented technologies; circuit for the voice bearer and packet for signalling. It was unthinkable decades ago that voice could be successfully carried by packet due to its real time characteristics. However, advances in digital communications, communications media and high-speed networks paved the way for the transport of voice with packets.

It was only a matter of time that vendors and operators began to demand for a single robust, scalable and flexible technology that would carry

voice along with data (4). Packet technology met this demand. In fact by 2002, Lucent Technologies had stopped the development of circuit oriented class 5 switches, along with many other vendors. Some vendors are still selling their circuit oriented left over switches to unsuspecting operators in the developing nations.

Future technologies are packet based. This implies that the circuit-oriented switches would be incompatible with new technology and hence obsolete. Those who deploy packet technology now would be able to integrate it with future telecom network technologies. Operators should be wise and stop deploying the circuit oriented switches because it would become cash drain when they are not able to integrate it with new technology in the future.

Undoubtedly, packet technology is the way forward (4,5). This paper would discuss briefly the concept of circuit and packet technologies. The structures of circuit and packet switching technologies would be used to put across the concepts. Thereafter, the implications of the two technologies with regard to operators' business are examined particularly, lease line saving, service differentiation, switching ports savings are discussed. Finally, conclusions and recommendations are given.

2.0 Circuit Switching

The traditional Plain Old Telephone (POT) network is circuit switched network. This method of switching connects and dedicates a circuit for each call before transmission can begin. The connected circuit is reserved for the duration of the call. Once the transmission is completed, the circuit is then released for other calls. It has the advantage of providing better QOS because of guaranteed resources for the duration of the transmission\call. But this advantage is also its undoing as resources are not efficiently used. Take for example, suppose subscriber 'A' wishes to communicate with subscriber 'H' in Figure 1. The connection via Jos, Bauchi, Enugu, Uyo and Oron is first established and remain dedicated for the duration of the communication.

3.0 Packet Switching

Unlike circuit switching, circuits are not dedicated for communication purposes in packet switching. Circuits in packet switching carry data from different sources. That means that extra information (6) is required for routing the data, controlling traffic from overloading a circuit and for correcting errors due to losses or corruption of data in transit. However, this overhead has negligible effects compared to the savings based on the efficient utilisation of switching resources. Several packets representing a given information can traverse different routes to get to the desired destination. The packets sent may not sequentially arrive at the distant end, but are

rearranged to maintain the original order. The first packet switching is X.25, which was deployed in the 60s (7). A special case of packet switching is cell relay developed in the 90s (8), which is a fixed length packet used in ATM networks for high speed transmission of video, voice and data. Packets are used for the transport of Internet protocol and as the Internet became more popular, packet technology predominantly increased in popularity. It is more cheaper and efficient when compared with circuit switching and it is these and other reasons that modern day switches are packet based. So, operators that still purchase circuit oriented switches do so out of ignorance.

4.0 High Level Network Structure

Every network configuration differs from one operator's network to another, so also are the services to be met. In the Wireline/Wireless voice world a meshed configuration is used for the highest level of switched network interconnectivity, but in general the overall architecture is usually hierarchical in nature as we can observe from the Nitel's high-level architectural configuration given in Figure1. On the other hand, the data networks, which are divided into LAN, MAN and WAN, follow a different architectural model. LAN stands for Local Area Network, MAN for Metropolitan Area Network and WAN for Wide Area Network. The LAN configurations are Ethernet, Ring, Star and Hybrid in nature. The MAN and WAN follow similar model as shown in Figure 2.

The NITEL hierarchical architecture in Figure1 is divided into three stages of network connectivity: Secondary Center (SC), Primary Center (PC) and Local Exchanges (LEC). We have shown at most four LEC connecting to a PC and four PCs connecting to Bauchi and Enugu. The SC is the highest level of connectivity and it forwards all the traffic from the PC through other SCs. The PCs perform similar functions for the LEC. The Switches used in the SC are Class 4 switches, while class 5 is used in the LEC. The PC is usually a Class 4, but can also be a Class 5 switch. In Figure 1, we observe that the seven SCs in Bauchi, Abuja, Kaduna, Ibadan, Lagos, Benin and Enugu are meshed together. Suppose a subscriber 'A' in Bukuru, Plateau State wishes to call a subscriber 'H' in Oron, Akwaibon State. The call will traverse through Jos PC, Bauchi SC, Enugu SC, Uyo PC, Oron LEC to 'H' subscriber.

Similarly, the packet technology has three main switching stages as shown in Figure 2. The three stages are Access, Distribution and Core switching technologies. The core as SC in Figure 1 provides the highest level of switching connectivity and the basic function of forwarding packets at extremely high speed. The access network elements connect an application to the distribution network elements and finally through the core elements. Packet technology is often layered.

5.0 Implications for Operators

The implications of circuit-oriented and packet-oriented technologies for operators are examined based on experience of working with some European operators: KPN, Deutsche Telecom, BT, Telecom Italia, T-Mobile, Orange, vodafone, etc. It is for this reasons that Pound Sterling would be used for computations here.

Packet has quality of service (QOS) issues, particularly for voice migration which is still been resolved particularly where the Internet is involved, but the benefits of moving to packet core can never be over emphasised. Different operators have different needs, reasons and benefits for migrating to packet. While there are many reasons in favour of packet-oriented network as opposed to circuit-oriented network, I shall present four simple benefits here. First, the cost of lease lines is a major contributor to operator's operating expenses (OPEX). I know of operators leasing more than 10,000 E1s and that leads them to incur enormous OPEX. My research and experience from working with major operators in EU and the US show that using a packet core technology would cut the leased line costs to less than a sixth and the investment in the core can be recovered within two years (2). In most cases it would take less than a year to break-even when migrating voice traffic to the packet core technology. Second, future revenue generation is of a major concern for operators and services that can be offered to customers are a major revenue driver. Both benefits are presented below. Third, ports on the switching elements are areas where enormous capital cost savings can be achieved. Finally, I shall briefly discuss other implications such as logistics, Voice Over IP (VoIP), etc.

5.1 Lease Line Savings

The diagram of Figure 3 shows a simplified circuit switched and packet switched architectures. The circuit switched network has seven Mobile Switching Centers (MSC) or class 4 switches, with all the switches meshed together. Traditionally, all core circuit switches are meshed together. In this case each of the seven switches have connections to PSTN. The total links (or pipes) between the meshed switches is given by n(n-1)/2, where n is the number of switches meshed in the network. In this case the links are 7(7-1)/2 = 21. Some links require over 60 E1s. So, if we assume an average of 50 E1s per link then we would require 1050 E1s to service the 21 links.

On the packet side, a packet voice gateway (VG) is added to each MSC and then connected to ATM packet core. Each MSC is then directly connected to the ATM core with few E3s or a single or two interfaces of STM-1. There are 16 E1s in an E3. The E1, E3 and STM-1 respectively would carry 30, 512 and over 2000 simultaneous voice conversations. Although the STM-1 is over 70 times the capacity of E1, the

pricing of the leased lines is not proportionately calculated. As a matter of fact, it may be interesting to note that in the UK, outside the central London region, the main line rental per km is CHEAPER for STM-1 than E1, going by British Telecom (BT) published Lease Line pricing for 2002 (9). So, if the 1050 E1s were reduced to just less than 200 STM-1 at a price, which is not much different. You can immediately see the savings from lease line, which could add up to millions of pounds/or billon of Naira per month. From my experience, in most cases the cost of adding a packet core is recouped between the first year and the second year.

5.2 Switching Port Savings

Physical ports are the physical interface points into the switch. The prices of switching elements are computed on the bases of ports. A typical class 5 E0 Ports would cost about £500 and class 4 about £250. But the same port in a packet switch would cost less than £40. That is a very significant margin because the ports can add up to tens of thousands. Moreover, by moving to packet core, as you can observe from the Figure 2 and the discussion in section 5.1, several ports are freed up in the MSCs for other uses. The port savings represents a significant saving for the migration into packets.

5.3 Differentiation Services

A proactive operator is always looking for revenue generating avenues. Incidentally, the voice services are very mature and, and as such offers no room for differentiation. On the contrary, the packet technology services are a cash cow. In other words, the packet technology offers unprecedented revenue opportunities for operators. Some of the services are given in Figure 4 below.

As you would observe, I have listed both the traditional voice services and opportunities the packet technology offers. Customers are currently enjoying some of the packet-based services but the multimedia services, which would definitely result in big corporate businesses, are yet to be fully tapped. Most of the services are self-explanatory, but the multimedia services would be described briefly.

5.3.1 Audio Conferencing

It provides the capabilities to allow bi-directional audio communications sessions amongst three or more users. The conferences can be ad hoc or scheduled. The conferences require real time synchronous communications.

5.3.2 Video Conferencing

Video Conferencing provides the capabilities to allow bi-directional video communications sessions amongst three or more users.

5.3.3 Video Broadcasting

It provides the capability to allow near real-time uni-directional video communications for groups of users. The broadcast may be interactive requiring the use of a conference server.

5.3.4 Video Streaming

It provides the capability for multiple users to negotiate and receive streaming audio and video formats in near real-time or store and forward mode.

5.3.5 White Boarding

It provides the capability for sharing the electronic equivalent of the chalkboard or flip chart. Participants at different locations may simultaneously write and draw on an on-screen notepad viewed by everyone.

5.3.6 Presence and Availability Management

It provides the capability to provide the network information of the status of mobile users and their availability for communications. An example of a service is Instant Messaging, which enables users to send and receive instant messages to their "chat" group members.

5.3.7 Application Sharing

It allows a user the capability to remotely control application based software, in which multiple participants can interactively work in an application that is loaded on a single user's computer. Application viewing is similar to application sharing; however, although all users can see the document, only one person can actually edit it at any given point in time.

5.4: Other Implications

Voice over IP (VoIP) is a cheap way to carry corporate and service provider long distance calls using packet technology. VoIP is one of the services implemented en route to migration to packet technology. Operators using packet technologies, such as ATM and private IP packet core could leverage that technology to sell cheap packet bandwidth to corporate customer and ISP that would support their PBX trunking costs. That is a win – win situation for both operator and customers. Note that I specifically talked about VoIP in private IP environment and not in the Internet because of the quality of service issues associated with the public IP.

The circuit-oriented switches are very bulky and require large space. It is usually more expensive and requires much more special skills to maintain. On the other hand, packet switch boxes are smaller in size, easily moved about, require less space, easy to maintain, shorter time to install and as such shorter time to deploy.

6.0 Conclusions and Recommendations

This paper examined the salient features of circuit and packet based technologies. Experience gained from working with major

operators in Europe and the US has been used to give the implications of both technologies for telecom operators' business. Specifically, lease lines, switch ports, service differentiation and other parameters have been used to compare both switching technologies. Packet switching, because of its numerous benefits is the preferred technology and indeed underlies the current trend in switching innovation.

Most manufacturers have stopped manufacturing circuit-based switches (MSC, Class 4/5, etc) as far back as 2001. Similarly, most wise operators in advanced countries have stopped deploying the circuit-based switches as far back as 2002. However, it is sad that most manufacturers or suppliers are still shipping left over circuit-based switches to unsuspecting operators in the developing countries. This would be a cash drain for such operators in the near future because of perceived inability to integrate the switches with future innovation in the telecom industry.

It is recommended that operators who have contracted for circuit based switches, but who have not yet deployed all or some of the switches should renegotiate with their suppliers. It is also recommended that operators who have deployed their circuit-based switches should begin migration plan to packet technology. Guidelines on circuit to packet migration strategy have been given elsewhere (10). It would no doubt cost money to renegotiate a contract or make new contracts for migration, but the profitability of the business based on the packet migration would obviously cater for the additional cost in the very near future. Packet-based switches would lead to a robust, scalable, flexible and more profitable business for telecom operators.

References

1. Atkinson, J. "Telephony," Pitman, 1948.

2. Robertson, J. H., "The Story of the Telephone," Scientific Book Club, 1948.

3. AT&T Technical paper, "ITU Signalling System 7", International Switching Symposium, Spring, 1987.

4. Odinma, A,. "Advances in Media Convergence for Information Systems", NICCOM2002, Abuja, October, 2002.

5. WWW.3GPP.Org.

6. Stalling, W., "Data and Computer Communications," 5th ed., Prentice Hall, NJ, 1997.

7. Russell, T., "Telecommunications Protocols," McGraw-Hill, D.C., 1997.

8. CCITT-Series Recommendation, Geneva, January, 1990.

9. "Private circuits pricing information" BT, January 2002.

10. Odinma, A,. "The Convergence of Telecom Network and migration strategies for operator", NSE Electrical Div. Conference, October, 2004.

Figure 1: Nitel's Circuit Based Hierarchical model

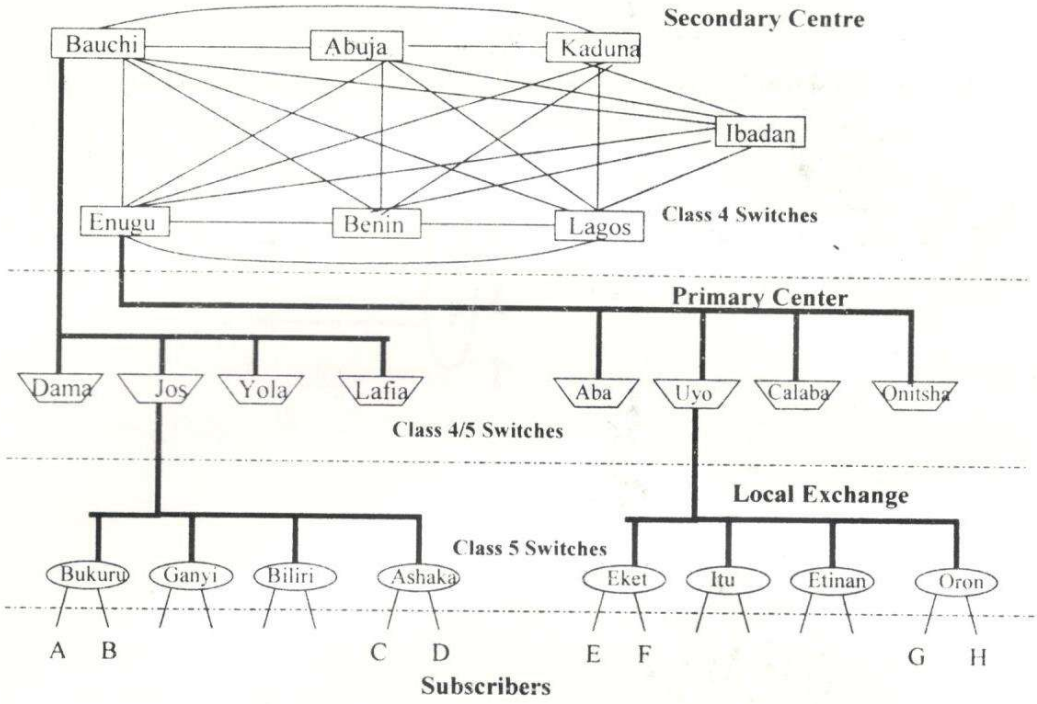

Figure 2: Data Switching Stages

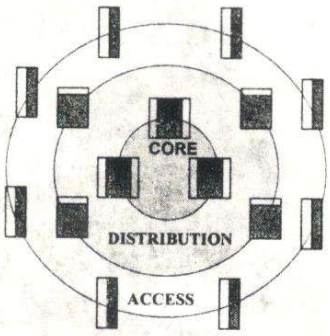

Figure 3: Comparing Circuit and Packet Networks

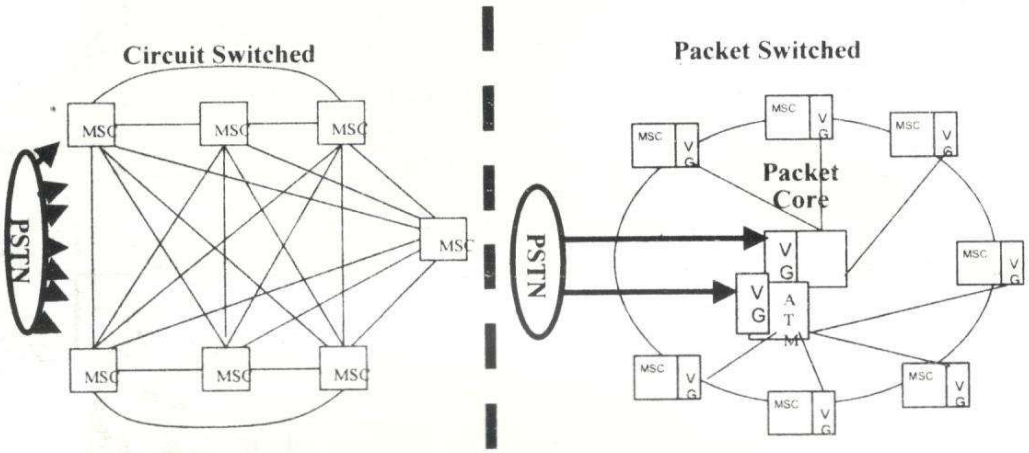

Figure 4: Services Opportunities Offered by packet Technology