WIRELESS AND MOBILE NETWORK
(Assignment –II)

Submitted in partial fulfilment of the requirements for the degree of

Master of Technology in Information Technology

by

Vijayananda D Mohire

(Enrolment No.921DMTE0113)

Information Technology Department
Karnataka State Open University
Manasagangotri, Mysore – 570006
Karnataka, India

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CERTIFICATE

This is to certify that the Assignment-II entitled WIRELESS AND MOBILE NETWORK, subject code: MT31C submitted by Vijayananda D Mohire having Roll Number 921DMTE0113 for the partial fulfilment of the requirements of Master of Technology in Information Technology degree of Karnataka State Open University, Mysore, embodies the bonafide work done by him under my supervision.

Place: ________________ Signature of the Internal Supervisor

Date: ________________ Name

Designation

Preface

This document has been prepared specially for the assignments of M.Tech – IT III Semester. This is mainly intended for evaluation of assignment of the academic M.Tech – IT, III semester. I have made a sincere attempt to gather and study the best answers to the assignment questions and have attempted the responses to the questions. I am confident that the evaluators will find this submission informative and evaluate based on the furnished details.

For clarity and ease of use there is a Table of contents and Evaluators section to make easier navigation. Evaluators are welcome to provide the necessary comments against each response; suitable space has been provided at the end of each response.

I am grateful to the Infysys academy, Koramangala, Bangalore in making this a big success. Many thanks for the timely help and attention in making this possible within specified timeframe. Special thanks to Mr. Vivek and Mr. Prakash for their timely help and guidance.

Candidate's Name and Signature Date

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RESPONSE TO ASSIGNMENT – II

Question 1 What is Integration of Toll/Tandem Functionality into the MSP?

Answer 1

Consolidation in the next-generation network is really about voice and data convergence.

Switched voice services still represent the bulk of most service provider's revenue. Carriers must continue their investment in a narrow band infrastructure to satisfy their growth requirements for these services and to find their expansion into new services. However, they realize that the impact of the data explosion, mainly generated by the Internet and networked computing, must be addressed through investment in a broadband infrastructure. In order to maximize their investment, service providers are seeking convergence of their voice infrastructure within this broadband network.

Most equipment vendors agree on the high level architecture to achieve this goal. As shown in Figure 1, off-board call servers have replaced the toll and tandem switches. Many years of development have gone into the creation of various call-processing stacks to implement the level of sophistication and robustness consumers have come to expect of the switched voice network. To replicate an integrated solution on a broadband platform would simply be too daunting from the perspective of investment and time to implementation. Many established and new entrant vendors are supplying their call-processing technology on off-board platforms that control various network elements by an API. This separation of the networking fabric (or infrastructure) also allows the network elements and call processing engines to scale independently. These off-board platforms are typically off-the-shelf Unix based workstations that follow a much more aggressive price/performance growth rate when compared to the price/performance ratio of the call processing solution for integrated narrowband offerings.

In conjunction with a Call server, a gateway function is required to perform the internetworking function of the data and control planes, from narrowband to broadband. While some vendors believe this interworking function is yet another separate networking element, this can be cost-effectively addressed as an integrated function of the MSP.

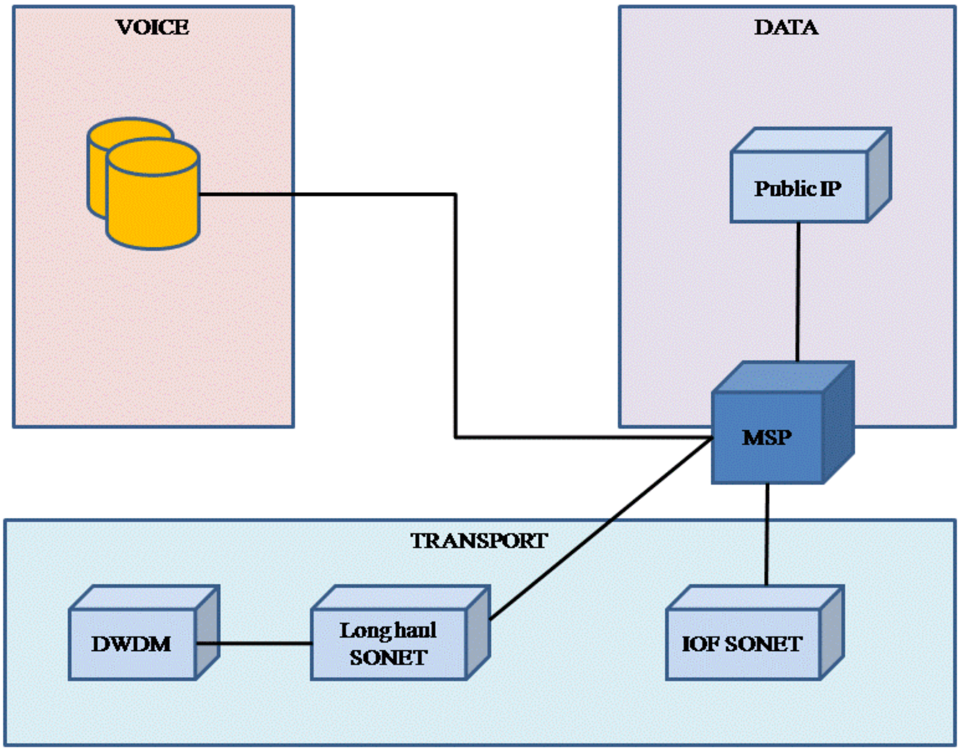

Figure 1 Toll and Tandem Switch replacement

Evaluator's Comments if any:

Question 2 Explain Cellular Network. and CDMA

Answer 2

Cellular Network:

A cellular network provides cell phones or mobile stations (MSs), to use a more general term, with wireless access to the public switched telephone network (PSTN). The service coverage area of a cellular network is divided into many smaller areas, referred to as cells, each of which is served by a base station (BS). The BS is fixed, and it is connected to the mobile telephone switching office (MTSO), also known as the mobile switching center. An MTSO is in charge of a cluster of BSs and it is, in turn, connected to the PSTN. With the wireless link between the BS and MS, MSs such as cell phones are able to communicate with wireline phones in the PSTN. Both BSs and MSs are equipped with a transceiver. Figure 2 illustrates a typical cellular network, in which a cell is represented by a hexagon and a BS is represented by a triangle. The frequency spectrum allocated for cellular communications is very limited. The success of today's cellular network is mainly due to the frequency reuse concept. This is why the coverage area is divided into cells, each of which is served by a BS. Each BS (or cell) is assigned a group of frequency bands or channels. To avoid radio co-channel interference, the group of channels assigned to one cell must be different from the group of channels assigned to its neighboring cells. However, the same group of channels can be assigned to the two cells that are far enough apart such that the radio cochannel interference between them is within a tolerable limit.

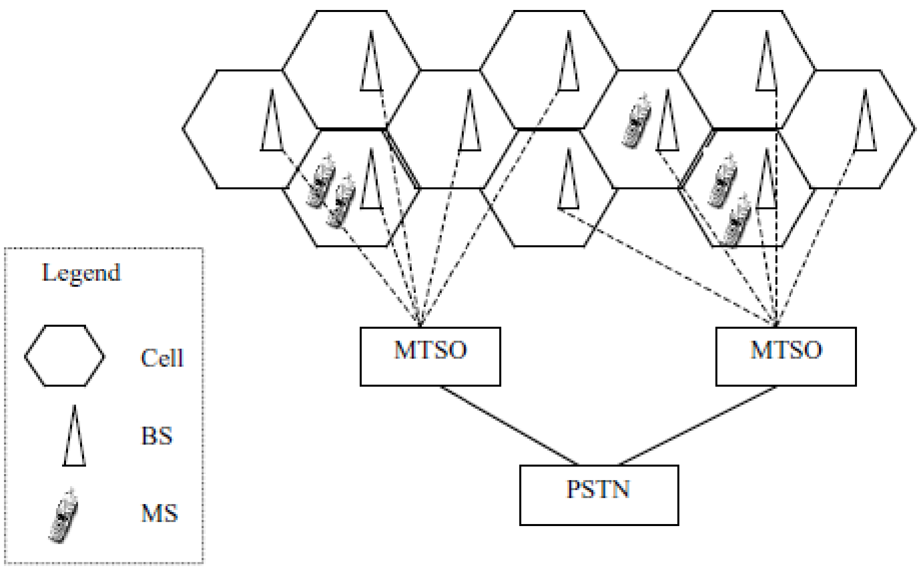

Figure 2 Typical Cellular Network

Typically, seven neighboring cells are grouped together to form a cluster, as shown in Figure 3 (Seven cell cluster). The total available channels are divided into seven groups, each of which is assigned to a cell.

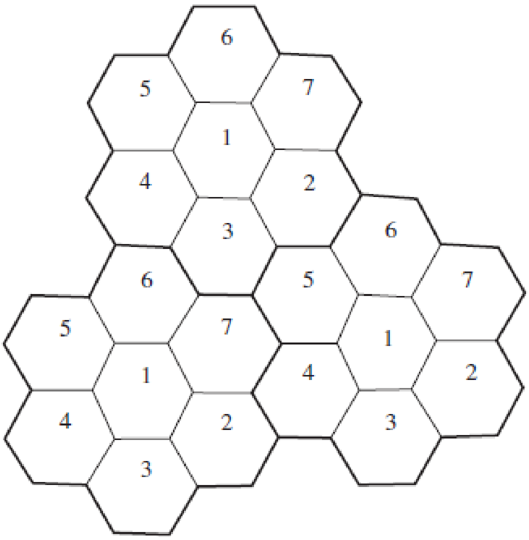

Figure 3 Frequency Reuse

In Figure 3, the cells marked with the same number have the same group of channels assigned to them. Furthermore, the cells marked with different numbers must be assigned different groups of channels. If there are a total of M channels allocated for cellular communications and if the coverage area consists of N cells, there are a total of MN/7 channels available in the coverage area for concurrent use based on the seven-cell reuse pattern. That is the network capacity of this coverage area. Because of explosive growth of mobile phone subscribers, the current network capacity may not be enough. Cell splitting is one technique that used to increase the network capacity without new frequency spectrum allocation. In this technique, the cell size is reduced by lowering antenna height and transmitter power. Specifically, an original cell is divided into four smaller cells. After cell-splitting, the coverage area with N cells originally will be covered by 4N smaller cells. Therefore, the new network capacity is 4MN/7, which is four times the original network capacity. In reality, bigger cells are not completely replaced by smaller cells. Therefore, cells of different sizes (e.g., pico, micro, and macro cells) may coexist in one area. This allows high-speed subscribers to use bigger cells, which reduces the number of hand-offs (to be explained later). Sectoring is another technique to increase the network capacity. In sectoring, the cell size remains the same, but a cell is divided into several sectors by using several directional antennas at the BS instead of a single omnidirectional antenna. Typically, a cell is divided into three 120° sectors or six 60° sectors. The radio co-channel interference will be reduced by dividing a cell into sectors, which reduces the number of cells in a cluster. Therefore, the network capacity is increased. Digital technology can also be used to increase the network capacity. Transmission of digitized voice goes through three steps before the actual transmission: speech coding, channel coding, and modulation. Speech coding is to compress voice. For example, a short voice segment can be analyzed and represented by a few parameter values. These values cannot be transmitted directly because wireless transmission is error prone, and a small change in these values may translate into a big change in voice. Therefore, data representing compressed voice should be arranged carefully, and redundancy should be introduced such that a transmission error can be corrected or at least detected. This process is called channel coding. Finally, the output data from channel coding are modulated for transmission. A good speech-coding scheme combined with a good channel coding scheme will greatly reduce the amount of bandwidth needed by each phone user and therefore increase the network capacity while keeping the quality of voice unchanged. The channels assigned to a cell are used either for voice or for control. A voice channel is used for an actual conversation, whereas a control channel is used to help set up conversations. Both voice and control channels are further divided into forward (or downlink) and reverse (or uplink). A forward channel is used to carry traffic from the BS to the MS, and a reverse channel is used to carry traffic from the MS to the BS. The channels assigned to a cell are shared by MSs located in the cell. Multiple access methods are used to share the channels in a cell. Each MS has a home MTSO, which is the MTSO where the mobile user originally subscribed for wireless services. If an MS moves out of the home MTSO area, it is roaming. A roaming MS needs to register in the visited MTSO. An MS needs to be authenticated against the information kept in its home MTSO before any service can be rendered by the network. The services include making a call, receiving a call, registering the location, and so forth. These services are possible because of a widely used global, common channel-signalling standard named SS7 (Signalling System No. 7).

To make a call from an MS, the MS first needs to make a request using a reverse control channel in the current cell. If the request is granted by MTSO, a pair of voice channels (one for transmitting and the other for receiving) is assigned for the call. Making a call to an MS is more complicated. The call is first routed to its home MTSO or its visited MTSO if it is roaming. The MTSO needs to know the cell in which the MS is currently located. Finding the residing cell of an MS is the subject of location management. Once the MTSO knows the residing cell of the MS, a pair of voice channels is assigned in the cell for the call. If a call is in progress when the MS moves into a neighbouring cell, the MS needs to get a new pair of voice channels from the BS of the neighbouring cell so the call can continue. This process is called hand-off. A BS usually adopts a channel assignment strategy that prioritizes hand-off calls from neighbouring cells over the new calls initiated in the current cell.

Within a cell covered by a BS, there are multiple MSs that need to communicate with the BS. Those mobile stations must share the air interface in an orderly manner so that no MSs within the cell interfere with each other. The methods for MSs to share the air interface in an orderly manner are referred to as multiple access methods. The popular multiple access methods include (frequency division multiple access) FDMA, TDMA, and CDMA.

CDMA

CDMA takes an entirely different approach from TDMA. In CDMA, multiple MSs share the same wideband of spectrum. Instead of being assigned to time slots as in TDMA, each MS is assigned a unique sequence code. Each MS's signal is spread over the entire bandwidth by the unique sequence code. At the receiver, that same unique code is used to recover the signal. Although the radio spectrum is shared, no interference can arise because the sequence codes used by the sharing MSs are basically orthogonal. Figure 4 illustrates the concept of CDMA. In principle, for CDMA to work, the signals received by the BS from different MSs must be at the same power level. To achieve this, a few bits in the forward control channel are set aside for power control. Specifically, the BS uses these bits to instruct each MS to increase or decrease its output power level such that all signals received at the BS have the same strength.

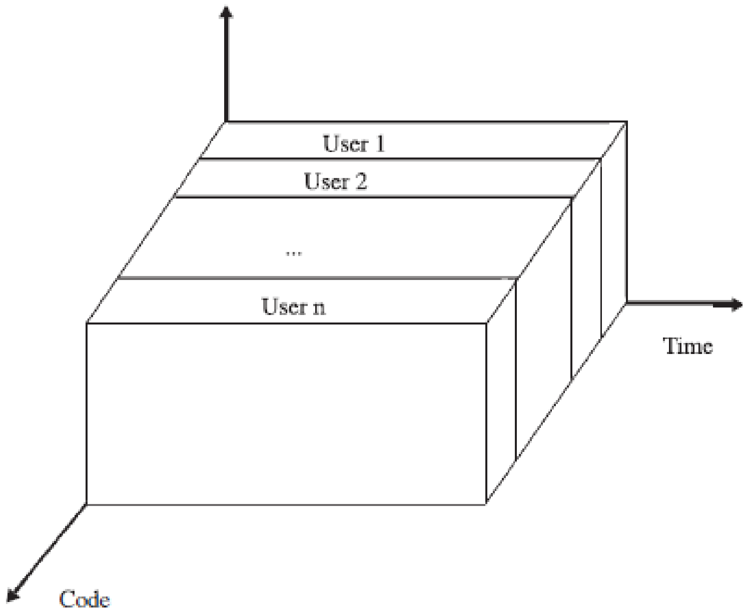

Figure 4 CDMA user provisioning

Code-division Multiple access, a digital cellular technology that uses spread-spectrum techniques. Unlike competing systems, such as GSM, that use TDMA, CDMA does not assign a specific frequency to each user. Instead, every channel uses the full available spectrum. Individual conversations are encoded with a pseudo-random digital sequence. CDMA consistently provides better capacity for voice and data communications than other commercial mobile technologies, allowing more subscribers to connect at any given time, and it is the common platform on which 3G technologies are built. It is a spread spectrum system and the same spectrum is used by all mobile phones, but conversations are kept separate through the use of individual codes. Both data and voice are separated from signals using codes and then transmitted using a wide frequency range. Because of this, there are more space left for data transfer (this was one of the reasons why CDMA is the preferred technology for the 3G generation) which is the broad band access and the use of big multimedia messages)

CDMA is a digital air interface standard, claiming 8 to 15 times the capacity of analog. It employs a commercial adaptation of military, spread-spectrum, single-sideband technology. Based on spread spectrum theory, it is essentially the same as wireline service - the primary difference is that access to the local exchange carrier (LEC) is provided via wireless phone. Because users are isolated by code, they can share the same carrier frequency, eliminating the frequency reuse problem encountered in AMPS and DAMPS. Every CDMA cell site can use the same 1.25 MHz band, so with respect to clusters, n=1. This greatly simplifies frequency planning in a fully CDMA environment.

CDMA is an interference-limited system. Unlike AMPS/ TDMA, CDMA has a soft capacity limit; however, each user is a noise source on the shared channel and the noise contributed by users accumulates. This creates a practical limit to how many users a system will sustain. Mobiles that transmit excessive power increase interference to other mobiles. For CDMA, precise power control of mobiles is critical in maximizing the system's capacity and increasing battery life of the mobiles. The goal is to keep each mobile at the absolute minimum power level that is necessary to ensure acceptable service quality. Ideally, the power received at the base station from each mobile should be the same (minimum signal to interference)

CDMA has a number of advantages for a cellular network:

1. **Frequency diversity:** Because the transmission is spread out over a larger bandwidth, frequency-dependent transmission impairments, such as noise bursts and selective fading, have less effect on the signal.
2. **Multipath resistance:** In addition to the ability of DS-SS to overcome multipath fading by frequency diversity, the chipping codes used for CDMA not only exhibit low cross correlation but also low autocorrelation. Therefore, a version of the signal that is delayed by more than one chip interval does not interfere with the dominant signal as much as in other multipath environments.

3. **Privacy:** Because spread spectrum is obtained by the use of noise like signals, where each user has a unique code, privacy is inherent.
4. **Graceful degradation:** With FDMA or TDMA, a fixed number of users can access the system simultaneously. However, with CDMA, as more users access the system simultaneously, the noise level and hence the error rate increases; only gradually does the system degrade to the point of an unacceptable error rate.

A number of drawbacks of CDMA cellular should also be mentioned:

1. **Self-jamming:** Unless all of the mobile users are perfectly synchronized, the arriving transmissions from multiple users will not be perfectly aligned on chip boundaries. Thus the spreading sequences of the different users are not orthogonal and there is some level of cross correlation. This is distinct from either TDMA or FDMA, in which for reasonable time or frequency guard bands, respectively, the received signals are orthogonal or nearly so.
2. **Near-far problem:** Signals closer to the receiver are received with less attenuation than signals farther away. Given the lack of complete orthogonality, the transmissions from the more remote mobile units may be more difficult to recover. Thus, power control techniques are very important in a CDMA system.
3. **Soft handoff:** As is discussed subsequently, a smooth handoff from one cell to the next requires that the mobile unit acquires the new cell before it relinquishes the old. This is referred to as a soft handoff and is more complex than the hard handoff used in FDMA and TDMA schemes.

The dominant technology for 3G systems is CDMA. Although three different CDMA schemes have been adopted, they share some common design issues. lists the following:

1. **Bandwidth:** An important design goal for all 3G systems is to limit channel usage to 5 MHz. There are several reasons for this goal. On the one hand, a bandwidth of 5 MHz or more improves the receiver's ability to resolve multipath when compared to narrower bandwidths. On the other hand, available spectrum is limited by competing needs, and 5 MHz is a reasonable upper limit on what can be allocated for 3G. Finally, 5 MHz is adequate for supporting data rates of 144 and 384 kHz, the main targets for 3G services.
2. **Chip rate:** Given the bandwidth, the chip rate depends on desired data rate, the need for error control, and bandwidth limitations. A chip rate of 3 Mcps (mega-chips per second) or more is reasonable given these design parameters.
3. **Multirate:** The term *multirate* refers to the provision of multiple fixed-data-rate logical channels to a given user, in which different data rates are provided on different logical channels. Further, the traffic on each

logical channel can be switched independently through the wireless and fixed networks to different destinations. The advantage of multirate is that the system can flexibly support multiple simultaneous applications from a given user and can efficiently use available capacity by only providing the capacity required for each service. Multirate can be achieved with a TDMA scheme within a single CDMA channel, in which a different number of slots per frame are assigned to achieve different data rates. All the subchannels at a given data rate would be protected by error correction and interleaving techniques (Figure 5a). An alternative is to use multiple CDMA codes, with separate coding and interleaving, and map them to separate CDMA channels (Figure 5b).

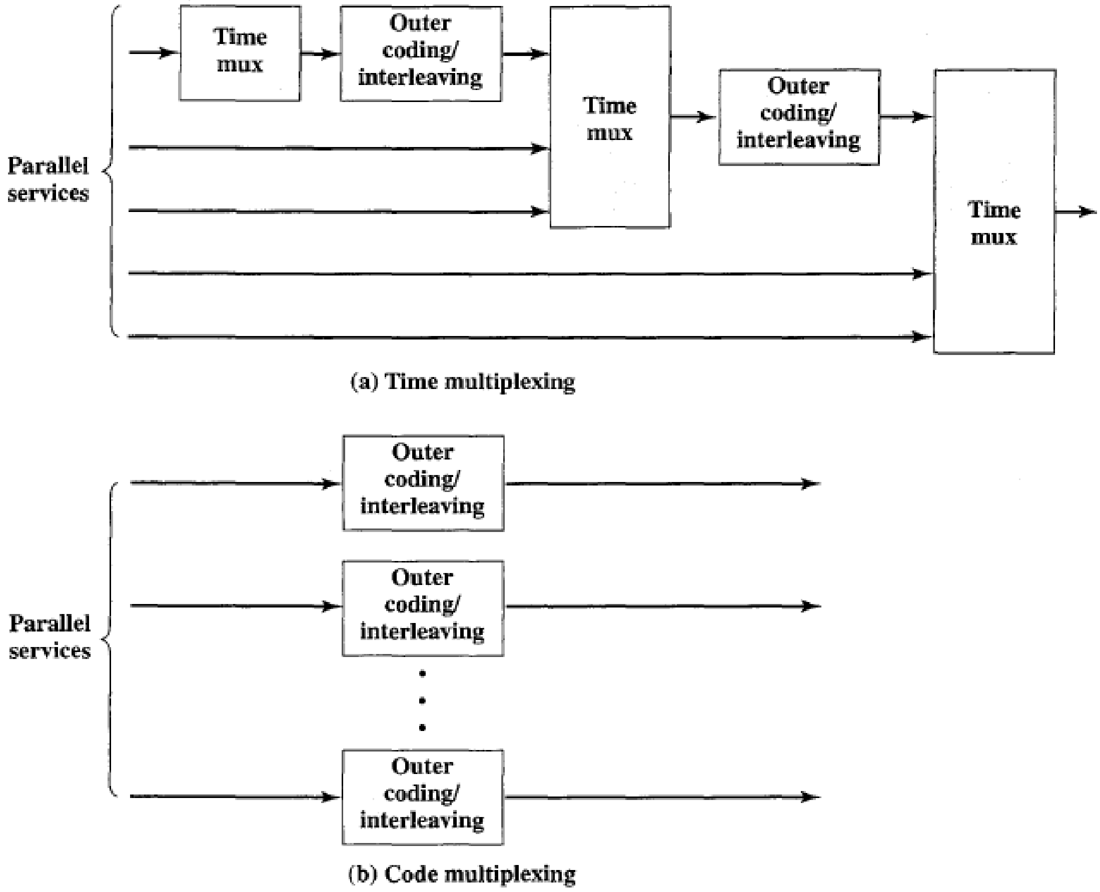

Figure 5 Time and Code Multiplexing principles

Evaluator's Comments if any: