UNIT II SPATIAL AND TEMPORAL DATABASES 9

Active Databases Model – Design and Implementation Issues - Temporal Databases - Temporal Querying - Spatial Databases: Spatial Data Types, Spatial Operators and Queries – Spatial Indexing and Mining – Applications -– Mobile Databases: Location and Handoff Management, Mobile Transaction Models – Deductive Databases - Multimedia Databases.

MOBILE DATABASES: LOCATION AND HANDOFF MANAGEMENT

Location Management: In cellular systems a mobile unit is free to move around within the entire area of coverage. Its movement is random and therefore its geographical location is unpredictable.

This situation makes it necessary to locate the mobile unit and record its location to HLR and VLR when a call has to be delivered to it. Thus, the entire process of the mobility management component of the cellular system is responsible for two tasks:

A. **location management- identification** of the current geographical location or current point of attachment of a mobile unit which is required by the MSC (Mobile Switching Center) to route the call.
B. **handoff- transferring** (handing off) the current (active) communication session to the next base station, which seamlessly resumes the session using its own set of channels.

One of the main objectives of efficient location management schemes is to minimize the communication overhead due to database updates (mainly HLR).

The current point of location of a subscriber (mobile unit) is expressed in terms of the cell or the base station to which it is presently connected. The mobile units (called and calling subscribers) can continue to talk and move around in their respective cells; but as soon as both or any one of the units moves to a different cell,the location management procedure is invoked to identify the new location.

The location management performs three fundamental tasks:

(a) location update, (b) location lookup, and (c) paging.

- **Location update -** is initiated by the mobile unit, the current location of the unit is recorded in HLR and VLR databases.
- **Location lookup -** a database search to obtain the current location of the mobile unit.
- **Paging -** the system informs the caller the location of the called unit in terms of its current base station. These two tasks are initiated by the MSC.

The cost of update and paging increases as cell size decreases,which becomes quite significant for finer granularity cells such as micro- or picocell clusters. The presence of frequent cell crossing, which is a common scenario in highly commuting zones, further adds to the cost.

The system creates location areas and paging areas to minimize the cost. A number of neighbouring cells are grouped together to form a location area, and the paging area is constructed in a similar way.

It is useful to keep the same set of cells for creating location and paging areas, and in most commercial systems they are usually identical. This arrangement reduces location update frequency because location updates are not necessary when a mobile unit moves in the cells of a location area.

A large number of schemes to achieve low cost and infrequent updates have been proposed, and new schemes continue to emerge as cellular technology advances.

A mobile unit can freely move around in

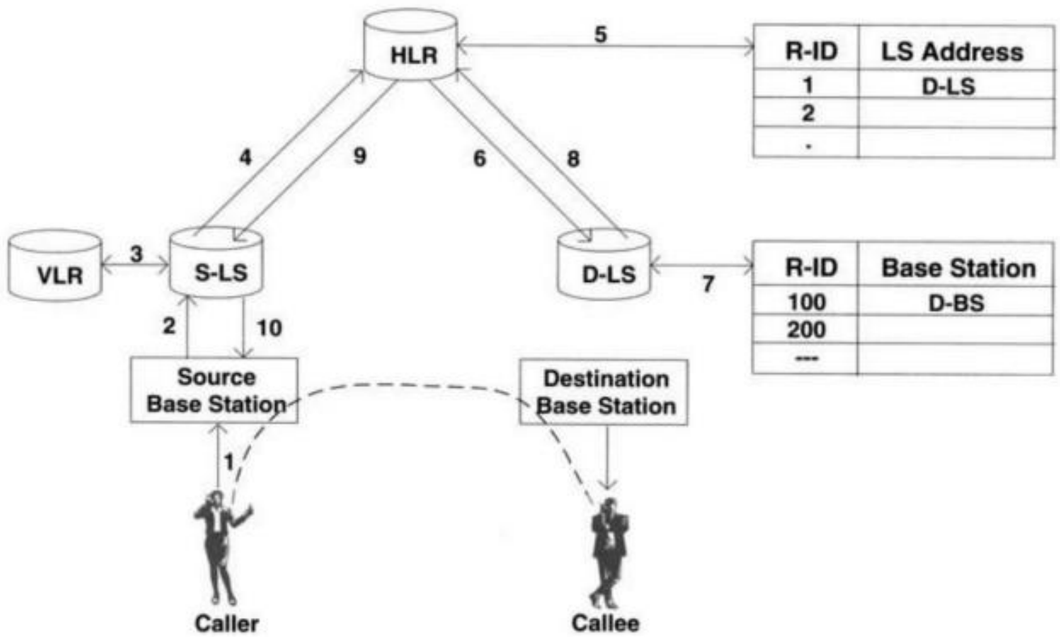
(a) active mode, (b) doze mode, or (c) power down mode.

- **In active mode**, the mobile actively communicates with other subscriber, and it may continue to move within the cell or may encounter a handoff which may interrupt the communication. It is the task of the location manager to find the new location and resume the communication.
- **In doze mode** a mobile unit does not actively communicate with other subscribers but continues to listen to the base station and monitors the signal levels around it
- **In Power down mode** the unit is not functional at all.

When it moves to a different cell in doze or power down modes,then it is neither possible nor necessary for the location manager to find the location.

The location management module uses a two-tier scheme for location- related tasks. The first tier provides a quick **location lookup**, and the second tier search is initiated only when the first tier search fails.

Location Lookup:A location lookup finds the location of the called party to establish the communication session. It involves searching VLR and possibly HLR.



Step 1: The caller dials a number. To find the location of the called number (destination), the caller unit sends a location query to its base station **source base station**.

Step 2: The source base station sends the query to the S-LS (source location server) for location discovery.

Step 3: S-LS first looks up the VLR to find the location. If the called number is a visitor to the source base station, then the location is known and the connection is set up.

Step 4: If VLR search fails, then the location query is sent to the HLR.

Step 5: HLR finds the location of D-LS (destination location server).

Step 6: The search goes to D-LS.

Step 7: D-LS finds the address of D-BS (destination base station).

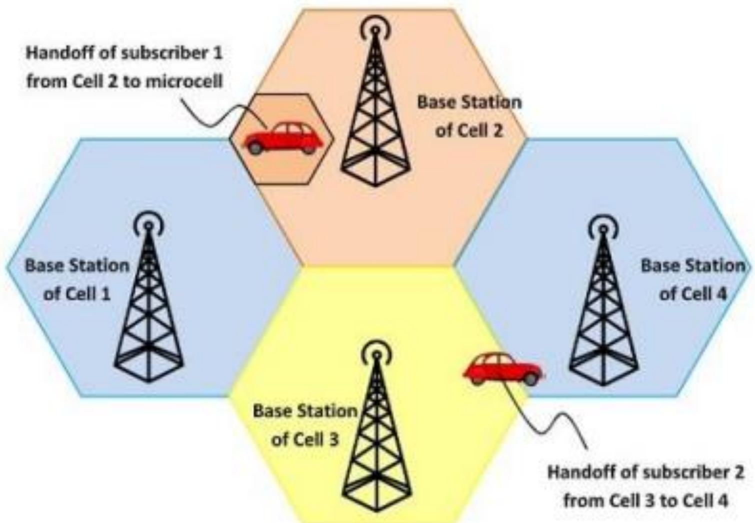
Step 8: Address of D-BS is sent to he HLR.

Step 9: HLR sends the address of D-BS to S-LS (source location server).

Step 10: The address of D-BS is sent to the source base station, which sets up the communication session.

Handoff technology

In cellular communications, the handoff is the process of transferring an active call or data session from one cell in a cellular network or from one channel to another. In satellite communications, it is the process of transferring control from one earth station to another. Handoff is necessary for preventing loss of interruption of service to a caller or a data session user. Handoff is also called handover.



Situations for triggering Handoff

Handoffs are triggered in any of the following situations − If a subscriber who is in a call or a data session moves out of coverage of one cell and enters coverage area of another cell, a handoff is triggered for a continuum of service. The tasks that were being performed by the first cell are delineating to the latter cell.

Each cell has a pre-defined capacity, i.e. it can handle only a specific number of subscribers. If the number of users using a particular cell reaches its maximum capacity, then a handoff occurs. Some of the calls are transferred to adjoining cells, provided that the subscriber is in the overlapping coverage area of both the cells.

Cells are often subdivided into microcells. A handoff may occur when there is a transfer of duties from the large cell to the smaller cell and vice versa. For example, there is a traveling user moving within the jurisdiction of a large cell. If the traveler stops, then the jurisdiction is transferred to a microcell to relieve the load on the large cell.

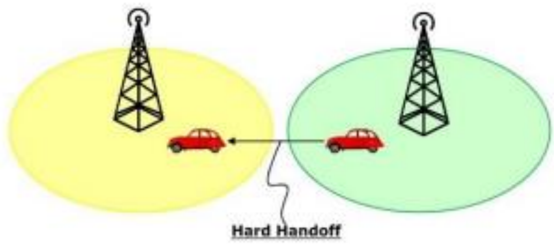
Handoffs may also occur when there is an interference of calls using the same frequency for communication.

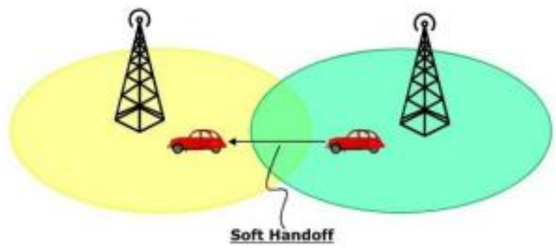
Types of Handoffs

There are two types of handoffs −

- **Hard Handoff −** In a hard handoff, an actual break in the connection occurs while switching from one cell to another. The radio links from the mobile station to the existing cell is broken before establishing a link with the next cell. It is generally an inter-frequency handoff. It is a <break before make= policy.

- **Soft Handoff –** In soft handoff, at least one of the links is kept when radio links are added and removed to the mobile station. This ensures that during the handoff, no break occurs. This is generally adopted in co-located sites. It is a <make before break= policy.





- **Mobile Assisted Handoff**

  Mobile Assisted Handoff (MAHO) is a technique in which mobile devices assist the Base Station Controller (BSC) to transfer a call to another BSC. It is used in GSM cellular networks. In other systems, like AMPS, a handoff is solely the job of the BSC and the Mobile Switching Centre (MSC), without any participation of the mobile device. However, in GSM, when a mobile station is not using its time slots for communicating, it measures signal quality to nearby BSC and sends this information to the BSC. The BSC performs handoffs according to this information.

DEDUCTIVE DATABASE

A deductive database is a database system that can make deductions (i.e. conclude additional facts) based on rules and facts stored in the (deductive) database. Datalog is the language typically used to specify facts, rules and queries in deductive databases. Deductive databases have grown out of the desire to combine logic programming with relational databases to construct systems that support a powerful formalism and are still fast and able to deal with very large datasets. Deductive databases are more expressive than relational databases but less expressive than logic programming systems. In recent years, deductive databases such as Datalog have found new application in data integration, information extraction, networking, program analysis, security, and cloud computing.

Deductive databases reuse many concepts from logic programming; rules and facts specified in the deductive database language Datalog look very similar to those in Prolog. However important differences between deductive databases and logic programming:

- Order sensitivity and procedurality: In Prolog, program execution depends on the order of rules in the program and on the order of parts of rules; these properties are used by programmers to build efficient programs. In database languages (like SQL or Datalog), however, program execution is independent of the order of rules and facts.
- Special predicates: In Prolog, programmers can directly influence the procedural evaluation of the program with special predicates such as the cut, this has no correspondence in deductive databases.
- Function symbols: Logic Programming languages allow function symbols to build up complex symbols. This is not allowed in deductive databases.
- Tuple-oriented processing: Deductive databases use set-oriented processing while logic programming languages concentrate on one tuple at a time.

A Deductive Database is a type of database that can make conclusions or we can say deductions using a sets of well defined rules and fact that are stored in the database. In today's world as we deal with a large amount of data, this deductive database provides a lot of advantages. It helps to combine the RDBMS with logic programming. To design a deductive database a purely declarative programming language called Datalog is used.

The implementations of deductive databases can be seen in LDL (Logic Data Language), NAIL (Not Another Implementation of Logic), CORAL, and VALIDITY.

The use of LDL and VALIDITY in a variety of business/industrial applications

1. LDL Applications:

This system has been applied to the following application domains:

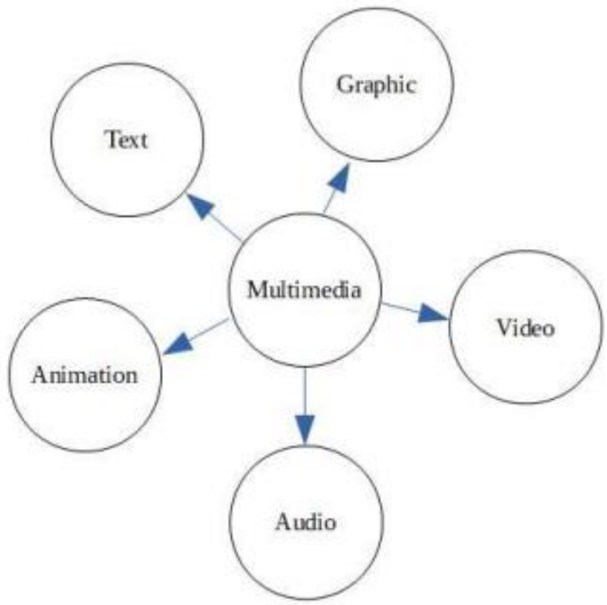
- Enterprise modeling
- Hypothesis testing or data dredging
- Software reuse

2. VALIDITY Applications:

- Electronic commerce
- Rules-governed processes
- Knowledge discovery
- Concurrent Engineering

MULTIMEDIA DATABASE

The multimedia databases are used to store multimedia data such as images, animation, audio, video along with text. This data is stored in the form of multiple file types like .txt(text), .jpg(images), .swf(videos), .mp3(audio) etc.



Contents of the Multimedia Database

The multimedia database stored the multimedia data and information related to it. This is given in detail as follows −

- **Media data:** This is the multimedia data that is stored in the database such as images, videos, audios, animation etc.
- **Media format data:** The Media format data contains the formatting information related to the media data such as sampling rate, frame rate, encoding scheme etc.
- **Media keyword data:** This contains the keyword data related to the media in the database. For an image the keyword data can be date and time of the image, description of the image etc.
- **Media feature data:** The Media feature data describes the features of the media data. For an image, feature data can be colors of the image, textures in the image etc.

Challenges of Multimedia Database

There are many challenges to implementing a multimedia database. Some of these are:

- Multimedia databases contain data in a large type of formats such as .txt(text), .jpg(images), .swf(videos), .mp3(audio) etc. It is difficult to convert one type of data format to another.
- The multimedia database requires a large size as the multimedia data is quite large and needs to be stored successfully in the database.
- It takes a lot of time to process multimedia data so the multimedia database is slow.

Multimedia databases are the main source of interaction between users and multimedia elements. Multimedia storage is characterised by the following −

- Massive storage volumes.
- Large object sizes.
- Multiple related objects.
- Temporal requirements for retrieval.

A multimedia database system stores and manages a large collection of multimedia data, such as audio, video, image, graphics, speech, text, document, and hypertext data, which contain text,text markups, and linkages. Multimedia database systems are increasingly common owing to the popular use of audio-video equipment, digital cameras, CD-ROMs, and the Internet. There are multimedia database systems include NASA's EOS (Earth Observation System), various kinds of image and audio video databases, and Internet databases.

There is two main groups of multimedia indexing and retrieval systems which are as follows –

Description-based retrieval systems:

It is used to build indices and perform object retrieval based on image descriptions, such as keywords, captions, size, and time of creation. Description-based retrieval is labor-intensive if performed manually. If automated, the results are typical of poor quality.

For instance, the assignment of keywords to images can be a difficult and arbitrary service. The latest development of Web-based image clustering and classification techniques has enhanced the quality of definition-based Web image retrieval because image surrounded text information and Web linkage information can be used to extract proper description and group images describing a similar theme together.

Content-based retrieval systems:

It can support retrieval based on the image content, such as color histogram, texture, pattern, image topology, and the shape of objects and their layouts and locations within the image. Content-based retrieval facilitates visual characteristics to index images and improves object retrieval based on feature similarity, which is highly desirable in several applications.

In a content-based image retrieval system, there are often two kinds of queries − image sample-based queries and image feature specification queries. Image-sample-based queries find all of the images that are similar to the given image sample. This search analyzes the feature vector (or signature) extracted from the sample with the feature vectors of images that have been extracted and ordered in the image database.