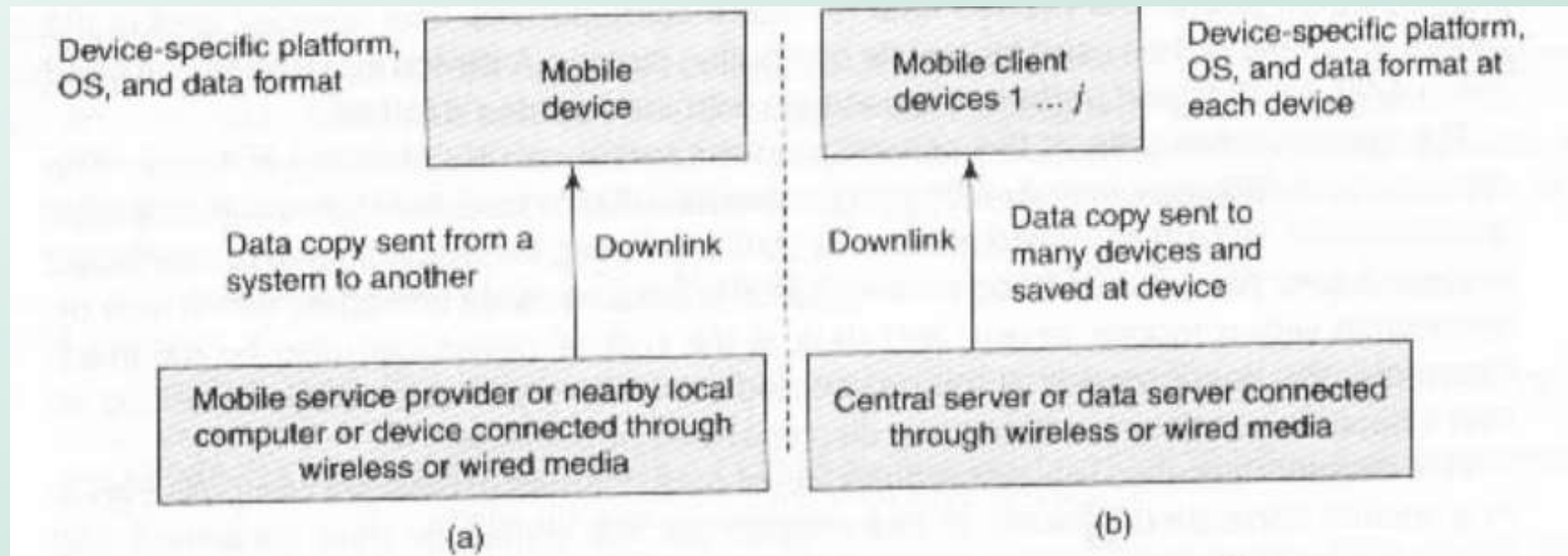


Data Synchronization

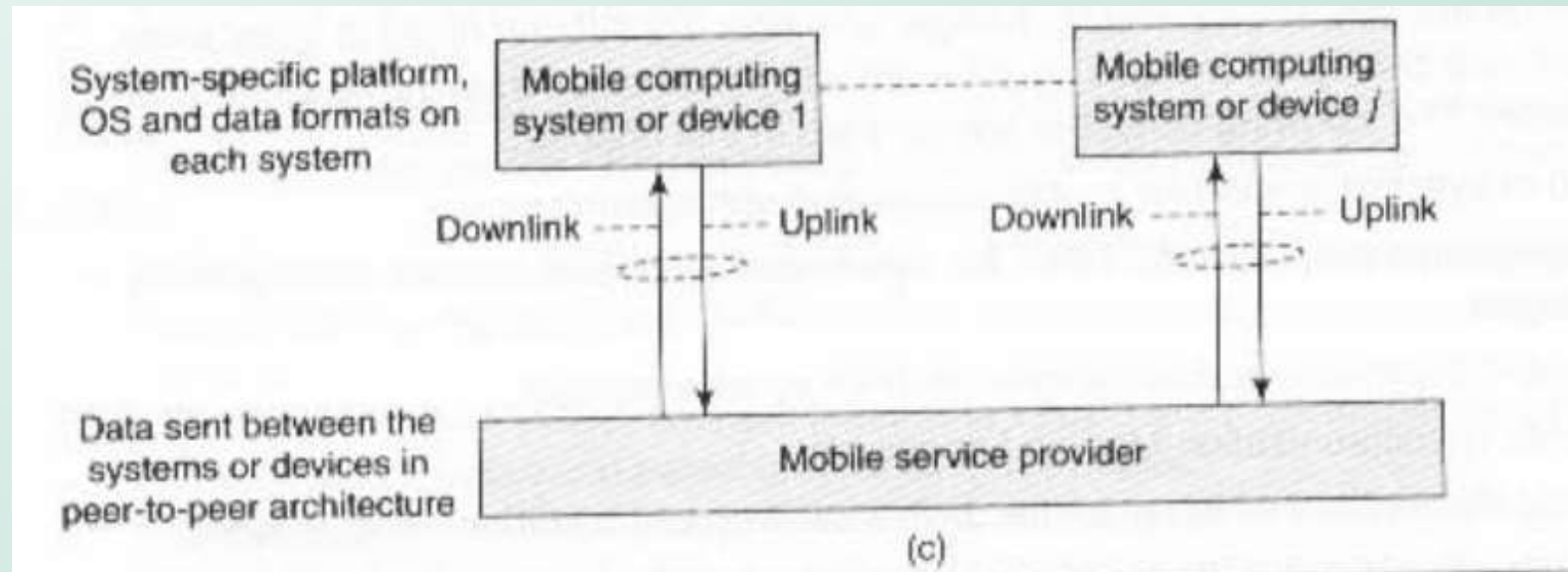
Synchronization

- Data disseminated and replicated at remote stations may occur in number of ways
- Data replication may be done by copying the data from one place to another place, or copying data from one place to many other places, or copying the data from many places to many other places
- For example music files are copied into iPod, iPhones, and to several devices
- The replicated data may be full copy or a partial copy

Synchronization



Synchronization



Synchronization

- **Full copy replication** – Means that the full set of data records replicates according to certain domain-specific data format rules at the replicating devices or system.
- **Partial copy replication** – A subset of the data set copied according to certain domain specific rules at the device or systems
- Partial replication should have consistency and do discrepancy and all basic features of original data
- Data consistency means if there is data modification at the server then the modification should reflect in the data with in the device within a defined period

Synchronization

There are two ways of synchronization

One-to-many synchronization

- This type of synchronization is occurred in the client server architecture. Here the server maintains a synchronization server, it may separate accounts of different users for that data
- The synchronization server, synchronizes the data and disseminates the copies to each and every client

Synchronization

There are two ways of synchronization

Many-to-many synchronization

- This type of synchronization is done in peer-to-peer architecture
- Each system is capable of pushing the data to other systems as well as getting the data by sending pull requests

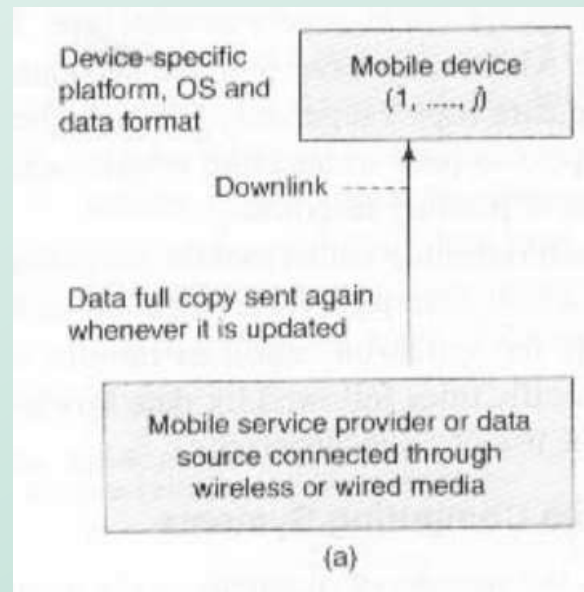
Synchronization in mobile computing systems

- It is defined as the process of maintaining the availability of data generated from the source and maintaining consistency between the copies pushed from the source and local cached or hoarded data at different computing systems without discrepancies or conflicts among the distributed data.
- Data synchronization helps mobile users in accessing data and using it for computing on mobile devices.
- Data synchronization helps mobile users in hoarding the device data at the personal area computer

Synchronization in mobile computing systems

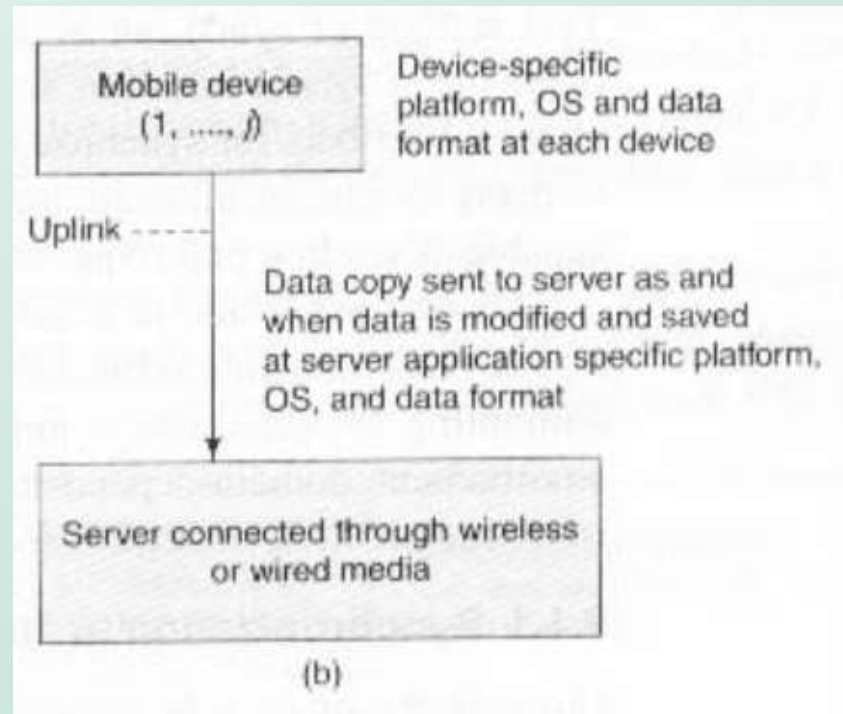
The following are the direct processes in data synchronization

Synchronization between the server and device when the server sends full copy



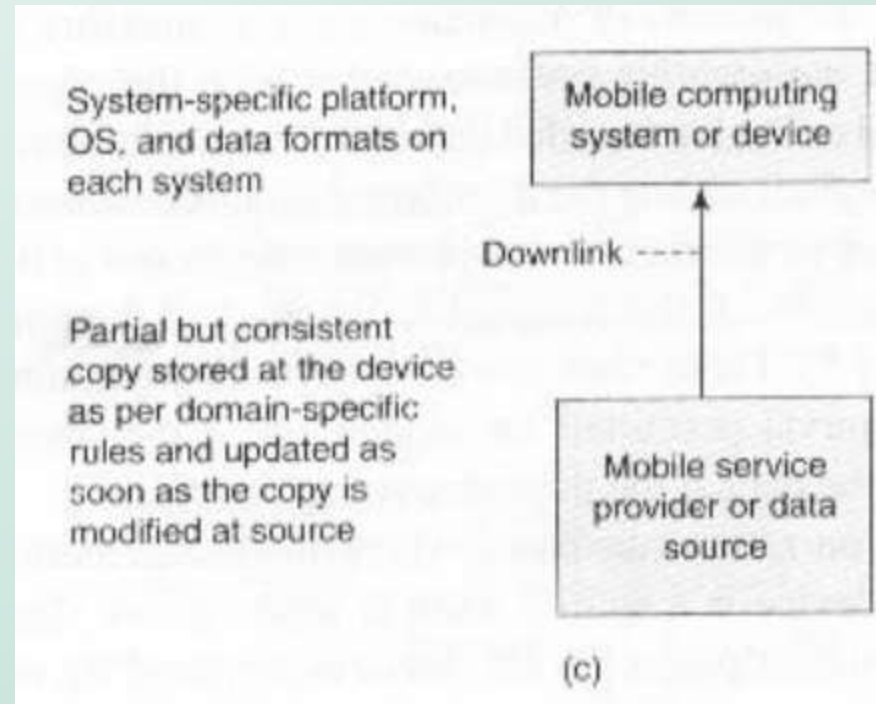
Synchronization in mobile computing systems

Synchronization between device as a data generating source and server when device sends full copy



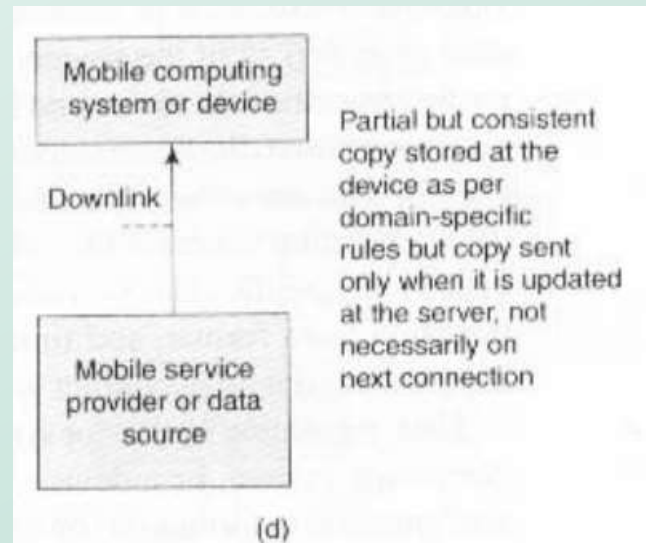
Synchronization in mobile computing systems

Synchronization between server and device when partial but consistent copy stored at device and updated as soon as the copy modifies



Synchronization in mobile computing systems

Synchronization between server and device for partial but consistent copy stored at the device, but the modified copy at server need not be send to the device on the next transaction



Types of Synchronization

- **Two way synchronization** : Partial or full copies of data are synchronizes between device and server
- **Server alerted synchronization** : In this method when the data is modified at server, then it generates the alerts the to the clients, now the client synchronizes
- **One way server initiated synchronization** : In this method server initiates synchronization of any new modifications since the communication of last modification. Now the server sends the modified copy to the client
- **Refresh synchronization at client** : In this, client initiated the synchronization with the server for refreshing its data and refreshing its configuration parameters saved at server

Types of Synchronization

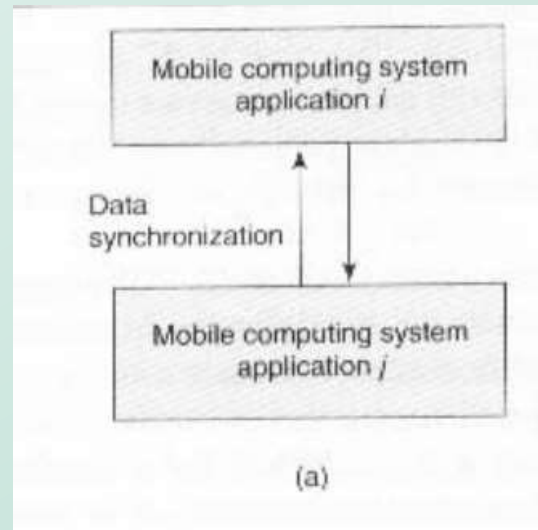
- **Client initiated synchronization** : Here the client initiates synchronization with the server for sending its modifications
- **Refresh from client for backup and update synchronization** : Here the client initiates the synchronization and sends backup to the server for updating its data
- **Slow synchronization** : In this method client and server data copies are compared field by field and are synchronized as per conflict resolution rules

Formats of Synchronization Data copies

- **Database records** : Here the records are indexed to facilitate search operation by placing the query
- **Flat files** : In this, the data should be interpreted as a single unit. That is we should read the files from beginning to end, data should not be picked from the middle of the file
- **Device specific storage** : Sometimes a device may use the specific storage format for synchronize data with the server. The device specific format is depending upon a specific protocol used by the device

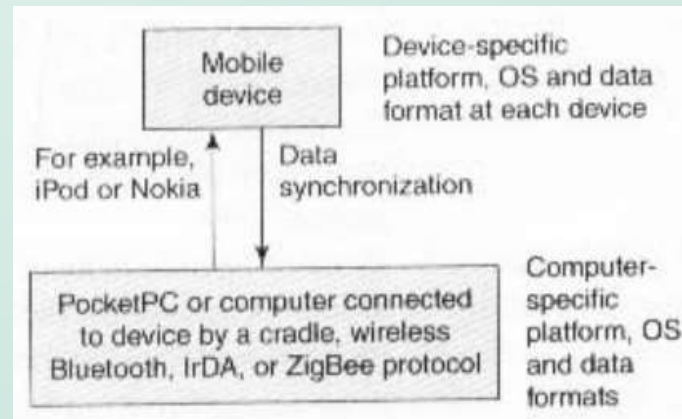
Usage models for Synchronization

- **Synchronization between two APIs with in a mobile computing system :** The usage model for synchronization between two application programming interfaces is the data generated by an application is synchronizes and used in another application.



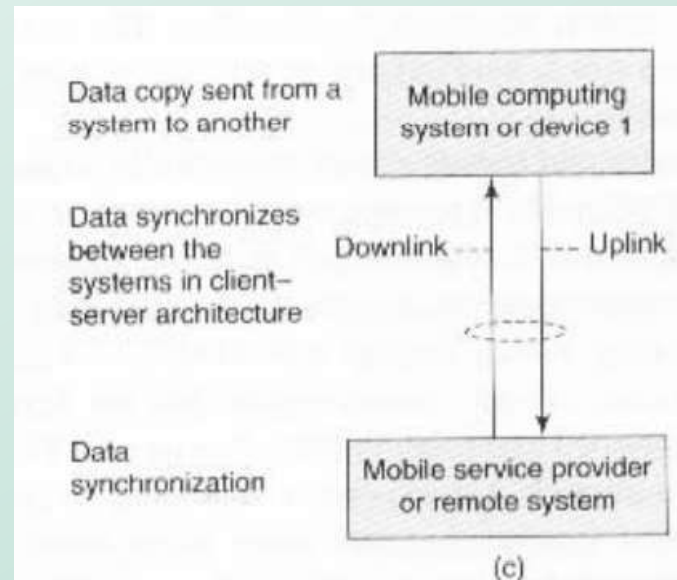
Usage models for Synchronization

- **Synchronization between the device and nearby local computer or device connected through a wireless or wired network** : The synchronization is in between device and nearby personal computer



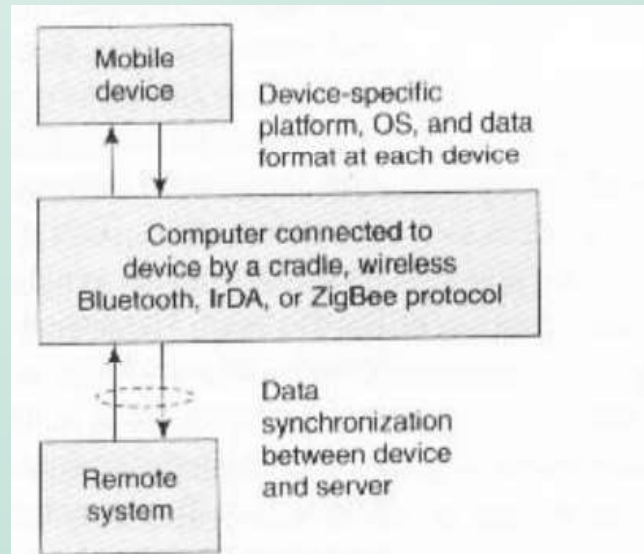
Usage models for Synchronization

- **Synchronization between remote system and the device** : The device data records synchronize with the mobile service provider server records and vice versa. Here the device connects to remote systems on Internet through the wired, wireless mobile service provider, or WIFI.



Usage models for Synchronization

- **Synchronization between remote system and the device through local computer** : In this case the synchronization is happened between remote server and mobile device through a local system. Here first the synchronization takes place between local system and mobile node by using the Bluetooth, then the local system synchronizes the data at remote server by using WLAN, WIFI etc.



Domain dependent specific rules for data Synchronization

- A mobile computing system consists of multiple domain in which data synchronization takes places.
- Data in mobile device domain has different rules for storage and usage compared with remote system

Domain dependent specific rules for data Synchronization

- **Data synchronization in domain specific platforms and data formats** : Here data synchronization can take place between data generating domain and destined domain, both have different platform and format
- **Domain specific data property dependent synchronization** : Data synchronization takes place one domain with one data property and another domain having different property
- **Synchronization up to last successful act of synchronization** : One of the domain specific rule is the data record is considered to be synchronized if it was updated at the last connection

Domain dependent specific rules for data Synchronization

- **Memory infrastructure dependent rule based synchronization at two different domains:** Here the domain specific rule is the data records are synchronized up to the allotted memory
- **Synchronization with temporal properties of data :** A domain specific rule that data records synchronized within specific time interval and within time specified by the domain

Personal Information Manager

- It is a software that manages the data. Now a days most of the smart phones have a specialized API for PIM
- The PIM API may also include the synchronizer with other devices and applications
- The function of the PIM is, creation of data copies, updating, replacement, addition and deletion of data record
- The PIM is also responsible for sending of data to API and receiving of data from another API, as well as sorting of the record

Personal Information Manager

- It may also manages the data copies at the devices for user. It also provides multiple selections and various options through PIM API
- It has several applications such as calendar, address book , teaks to do etc..

Synchronization and conflict resolution strategies

- Conflict in synchronization arises when a data copy changed at one end but not simultaneously modified at other ends. Therefore, the same data item at two ends is not the same

Different types of conflict resolution rules are

1. **Priority-based resolution rule** : Data server can be specified as dominant higher priority entity for conflict resolution of synchronized data records
2. **Time Based resolution rule** : Data node P specified as dominant entity when P always receives copies first from the server S

Synchronization and conflict resolution strategies

3. **Information based resolution rule** : Data node can be specifies as dominant entity when information specific to it is synchronized with other nodes
4. **Time stamp based resolution rule** : Time stamp based resolution rule necessitates that a time-stamp must be used while sending a data copy. The copy found to be latest resolves the conflict
5. **User interaction based resolution** : An API at a device allows a user to interact with the device and this interaction resolves the conflict arising out of the duplicate or multiple entries

Synchronizer

- It is a software tool for synchronization. It resides at the host. If the synchronizer host is a server then it is called synchronization server.
- Synchronizer is configured as per specified domain dependent and conflict resolution rules
- Synchronizer finds any data item or record appended at the data set
- The synchronizer discovers modifications with respect to the last action of synchronization on specified data copies which has been deleted , added, or modified.
- It resolves the conflict as per the resolution rules

Synchronizer

- A synchronizer adopts the method for synchronization more efficient compared to one in which the synchronizer directly retrieves the changed record
- First logs in the information about the records which have been changed and then retrieves the changed records by just setting or resetting a flag called dirty or invalid flag.
- When associated flag in set state (=1) , record R state is modified or invalidated since previous synchronization. When in reset state(=0), R is not modified or invalidated since previous synchronization. Reduces the possibility of conflicting entries at the server hosting the synchronizer

Synchronizer Example

An example that shows the use of flags by synchronizer :

- Contact in PIM data of a mobile phone device D.

Contact name = N_i

Flag = f_{nd}

- The synchronizer act is as follows
 1. Synchronizer Action 1
 2. Synchronizer Action 2
 3. Synchronizer Action 3
 4. Synchronizer Action 4

Mobile Agents for Synchronization

- Mobile agents is deployed for synchronization
- The synchronization agent software recognizes inconsistency and conflict in data received at a client from the connected remote server, local server, or a device using resolution rules.
- Characteristics is that it can migrate from one node to another in a mobile computing system to another and if needed, to another host for data synchronization
- A synchronizer can use a method for synchronization, which employs a mobile agent .

Thank You
