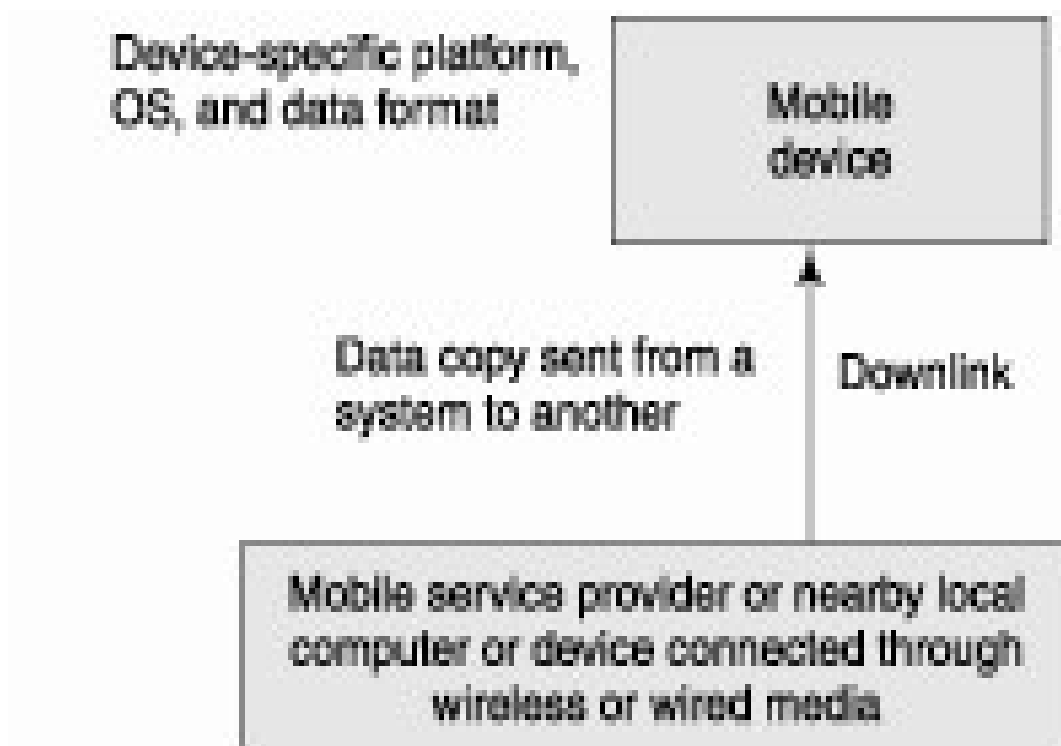


Unit-3

Synchronization in Mobile Computing Systems

Synchronization:

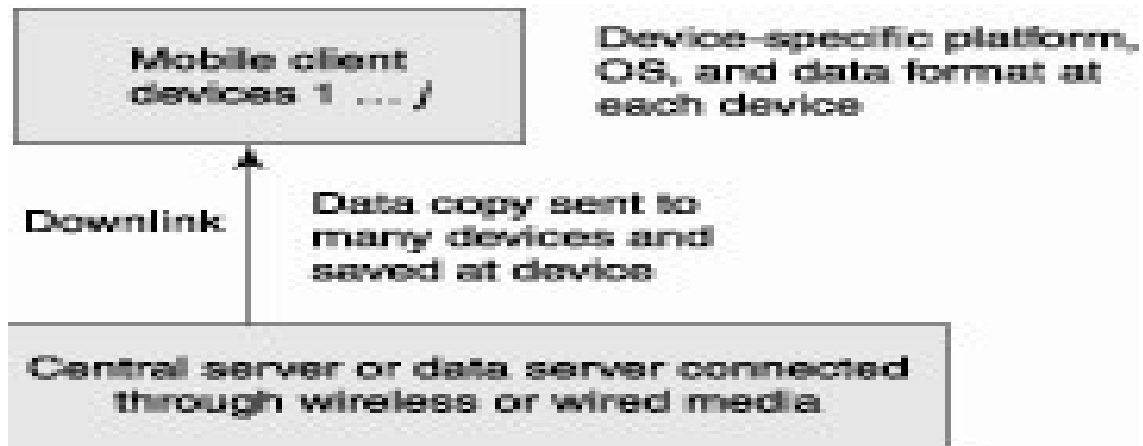
- Data replication at either remote or local location (s) may entail copying of data at one place after copying from another (i.e., recopying), copying from one to many others or from many to many others
- For example, videos of faculty lectures or music files get replicated at a mobile phone
- **Data replication from data source and device**



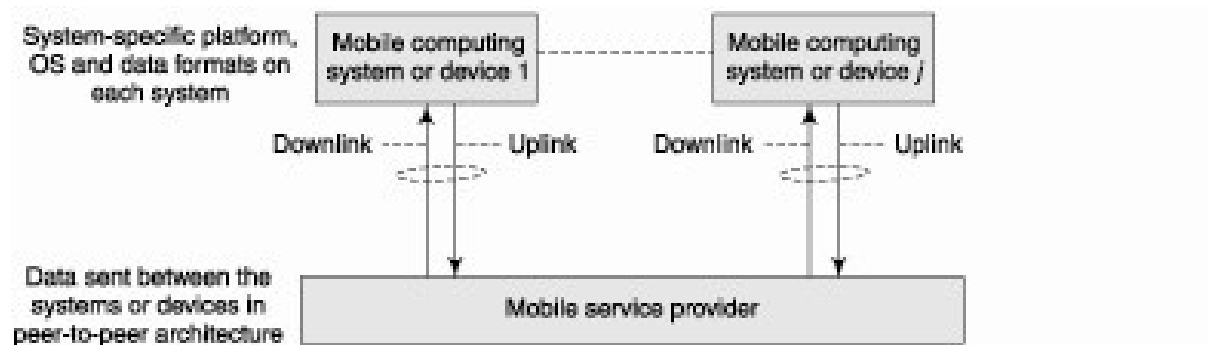
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- **Data replication from data source server to many clients (devices)**

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Data replication among systems and devices in peer to peer architecture



One to many synchronization

- Each system or device caches the data pushed from the server or sends a pull request to the central server and gets a response

Many-to-many synchronization

- Employs peer-to-peer architecture where each system is capable of sending pull requests and of pushing responses

Full copy from a source

- Means that the full set of data records replicates according to certain domain-specific data format rules at the replicating devices or systems
- A server having a set of 8 images with resolution 640×640 pixels

Partial copying of data from the source

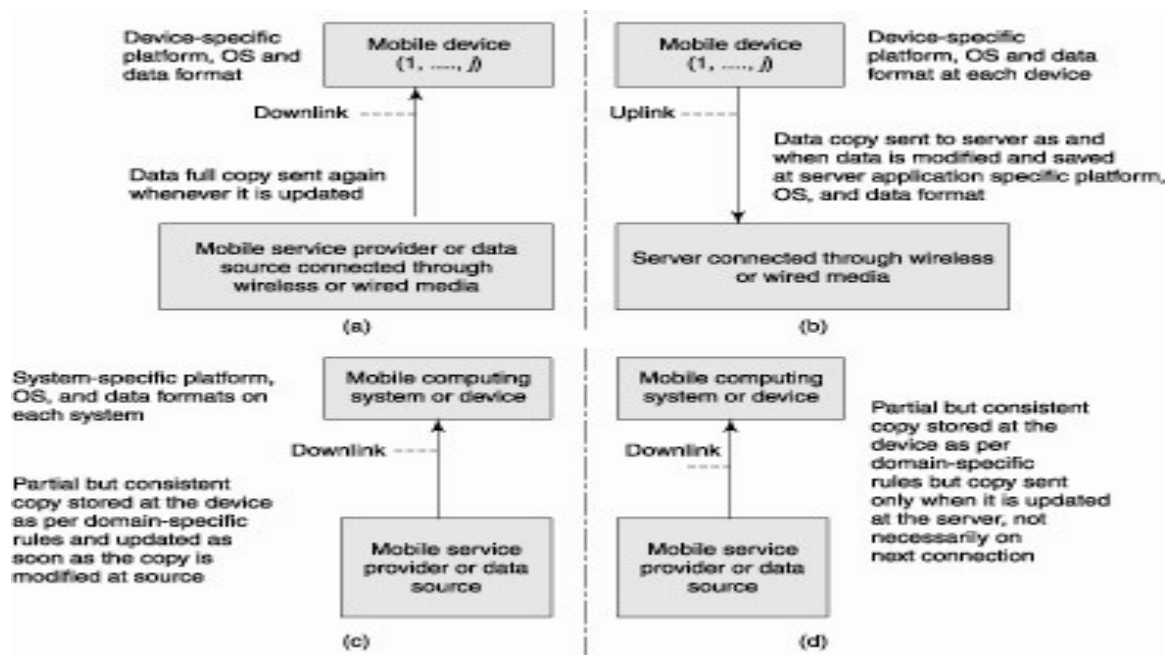
Synchronization In Mobile Computing Systems

- A subset of the data set copied according to certain domain-specific rules at the devices or systems
- Assume that a server has a hourly data set of 24 temperature records with $\pm 0.1^{\circ}\text{C}$

Synchronization in Mobile computing systems:

Defined as the process of maintaining the availability of data generated from the source and maintaining consistency between the copies pushed from the data source and local cached or hoarded data at different computing systems without discrepancies or conflicts among the distributed data

- A copy which may not be identical to the present data record at the data-generating source, but must satisfy all the required functions and domain-dependent specific rules
- **Full copy Synchronization at the device when the server sends data**
- **Full copy Synchronization at the server when the device sends data**
- **Partial copy Synchronization of consistent copy without the delays.**
- **Partial copy Synchronization of consistent copy but after delays**



Data Synchronization Types:

- Required between the mobile device and service provider ,Between the device and personal area computer With nearby wireless access point (in WiFi connection),Another nearby device
1. Two-way synchronization of partial or full copies of data.
 - Between mobile-device and personal-area computer

Synchronization In Mobile Computing Systems

- For example, whenever the list of contacts and personal information manager data is modified at any of them, it is made consistent after synchronization

2. Server-alerted synchronization.

- The server alerts the client the data modification or additions
- The client synchronizes the modified or new data by pull request
- For example, alerting new e-mail and the device pulls that.

3 One-way server-initiated synchronization

- Server initiates synchronization of any new modification since communication of last modification
- Sends modified data copies to the client
- When a new email arrives at a server, it initiates the synchronization as and when the device connects to the server and pushes the mail.

4 Client initiated refresh synchronization

- The client initiates synchronization with the server for refreshing its existing data copies
- For refreshing the configuration parameters saved at the server for it .
- For example, a computer or mobile device initiates refreshing of the hoarded contacts and personal information data either at periodic intervals or as and when it connects

5. Client-initiated synchronization

- With the server for sending its modifications, for example, device configuration for the services
- For example, a client mobile device initiates synchronization of the mails or new ring tones or music files available at the server either at periodic intervals or as and when it connects to it ,

6. Refresh from client for backup and update synchronization

- The client initiates synchronization
- Sends backup to the server for updating its data
- For example, a computer or mobile device initiates refreshing of the hoarded contacts and personal information data either at periodic intervals or as and when it connects to the server

7. Slow (full data copy and thorough) synchronization

- Client and server data compared for each data field and are synchronized as per conflict resolution rules
- Full copy synchronization usually takes place in idle state of the device

Synchronization In Mobile Computing Systems

- Not immediately on connecting to the server, that's why called slow
-

Formats of Synchronized Data Copies

Can be different from each other at client and server

- When the data at a source synchronizes with the data at other end, it does so as per the format specified at that end

Formats of Database records

- The records indexed enabling search by querying using the indexes, for example, the relational database records
- The database record retrieved by sending a query specifying the entries in these indexes
- Format DB2 at server and DB2e Every place at the mobile device

Flat file Synchronization

- Data can be interpreted only if the file is read from beginning to end and that data cannot be picked from anywhere within the file
- For example, an XML or html file at the server synchronizes with the file at the device which is in text format or is a binary file depending upon the information format
- Ex: Information format in mobile computing XML document format
- For transmission it is WBXML (WAP Binary XML) content format

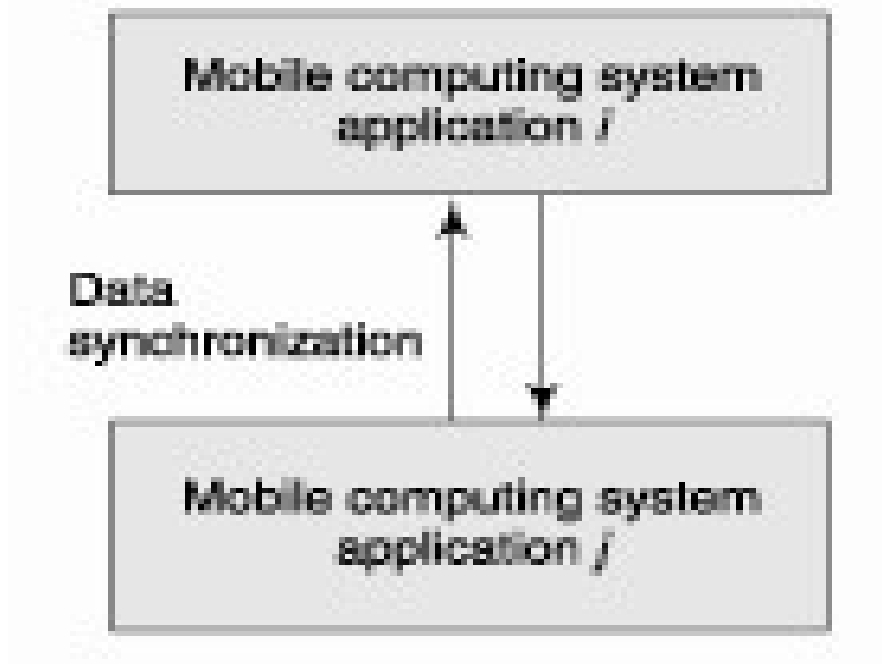
Address book data at a mobile device with the data transmitted in WBXML format

Device-specific storage Format

- AAC (Apple Audio Communication) files used for audio communication with an Apple iPhone
- A file in AAC format synchronizes with music files in some other format at a computer or remote website serving the music files
- At a mobile device the *Contacts* information in vCard format
- Calendar, tasks-to-do list, and journal information are in vCalendar, vToDo, and vJournal formats, respectively

Usage Models for Synchronization in Mobile Applications

- Four usage models employed for synchronization in mobile computing systems
 1. **Synchronization between two APIs within a mobile computing system**

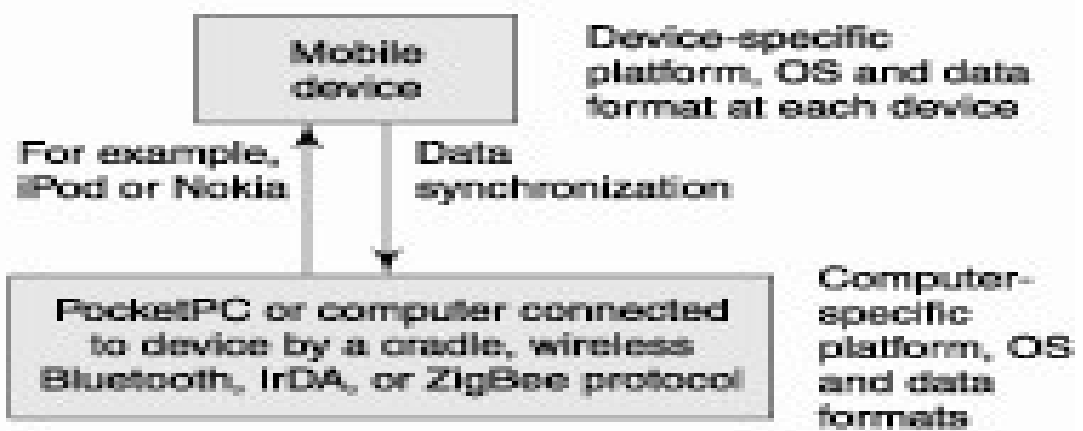


The data generated by an application synchronized and used in another application

An API running at the device synchronizes data with another application on the same or another device or computer .

- Data records at personal information manager (PIM) API synchronized with the email API
- When email from a new source retrieves at the email API in the device, the name and email address data fields at the application saved as new data record at PIM API

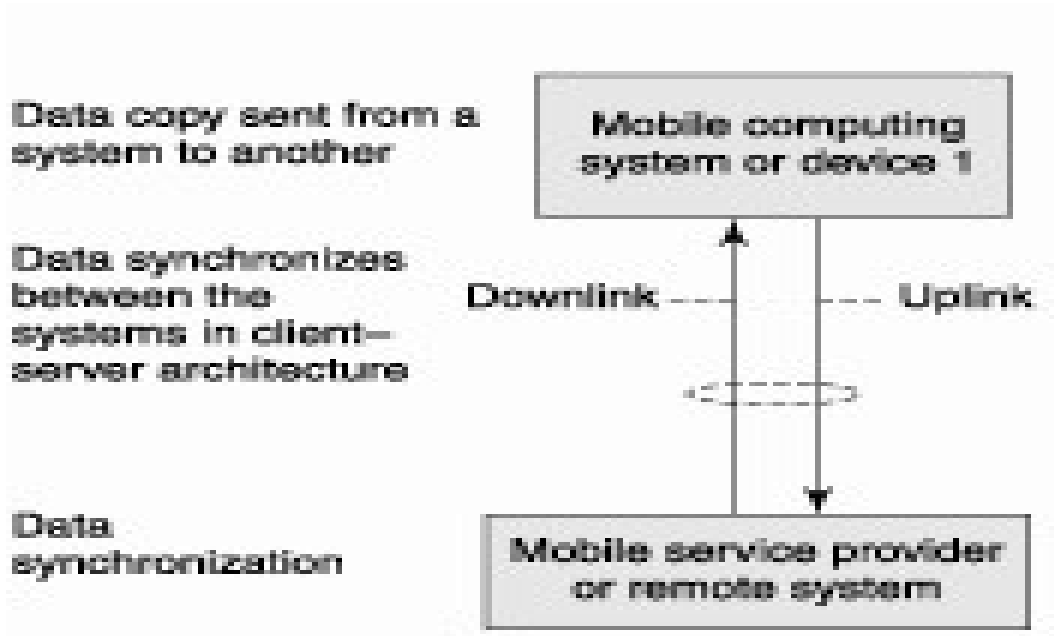
2. Synchronization between the device and nearby device



- Device and computer synchronize their data

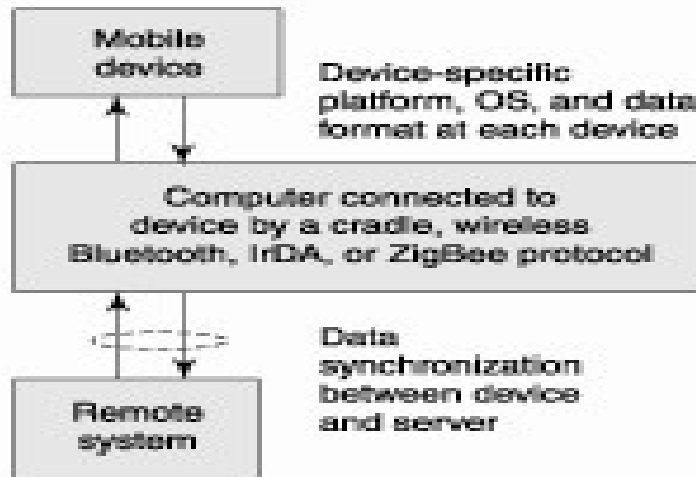
Synchronization In Mobile Computing Systems

- Also called personal area synchronization (PAS)
 - Using PAS software, for example, HotSync or ActiveSync
3. **Synchronization between remote systems and device**



- The device data records synchronize with the mobile service provider server records
 - The remote server or systems synchronize their data with the mobile device
 - The device connects to remote systems on Internet through the wired, wireless mobile service provider, or WiFi network
- Ex : Wireless email synchronization using Intellisync between the device and remote server using SyncML language

4. **Synchronization through a local pass-through system**



- Device data records synchronize with the records of remote system, for example, an enterprise server, through a local computer system
- Ex: The device first synchronizes through ActiveSync or HotSync or Intellisync or Bluetooth to local computer connected by personal area synchronizer

Domain dependent Specific Rules for Data Synchronization

1. Data synchronization in domain-specific platforms and data formats

- Data synchronization between data-generating domain and destined domain, both having different platform and data formats
- EX:A copy of database record at the device structured text or XML format and the device OS platform Symbian
- The record synchronized with the database record at the server where it is in DB2 or Oracle database format and the OS is Windows

2. Domain-specific data-property-dependent synchronization

- Data synchronization between one domain with one property of data and another domain having different property.
- Ex : A data record at a device having an ID specified by a byte synchronizes with the record, which has an ID specified by 16-bit word at the server
- A device using 8-bit ASCII characters for an ID while the server using 16-bit Unicode characters

3. Synchronization up to the last successful act of synchronization

Synchronization In Mobile Computing Systems

- A domain-specific rule that data record considered to be synchronized if it was updated at the last connection .
- Ex: A phonebook records of missed calls, dialled numbers, and received calls
- Data record at the device synchronized with the record in the phonebook
- If it updated at the last connection, then it eventually updates again on the next connection

4. **Memory-infrastructure-dependent based synchronization at the domains**

- A domain-specific rule that data records synchronized up to the allotted memory
- Ex: A remote server maintaining full address book with allotted memory of 8 MB and a device allocated 128 kB for the address book
- Only a part of e-mail database, only 100 new email addresses synchronizes and saves in the device PIM (personal information manager)

5. **Synchronization with temporal properties of data**

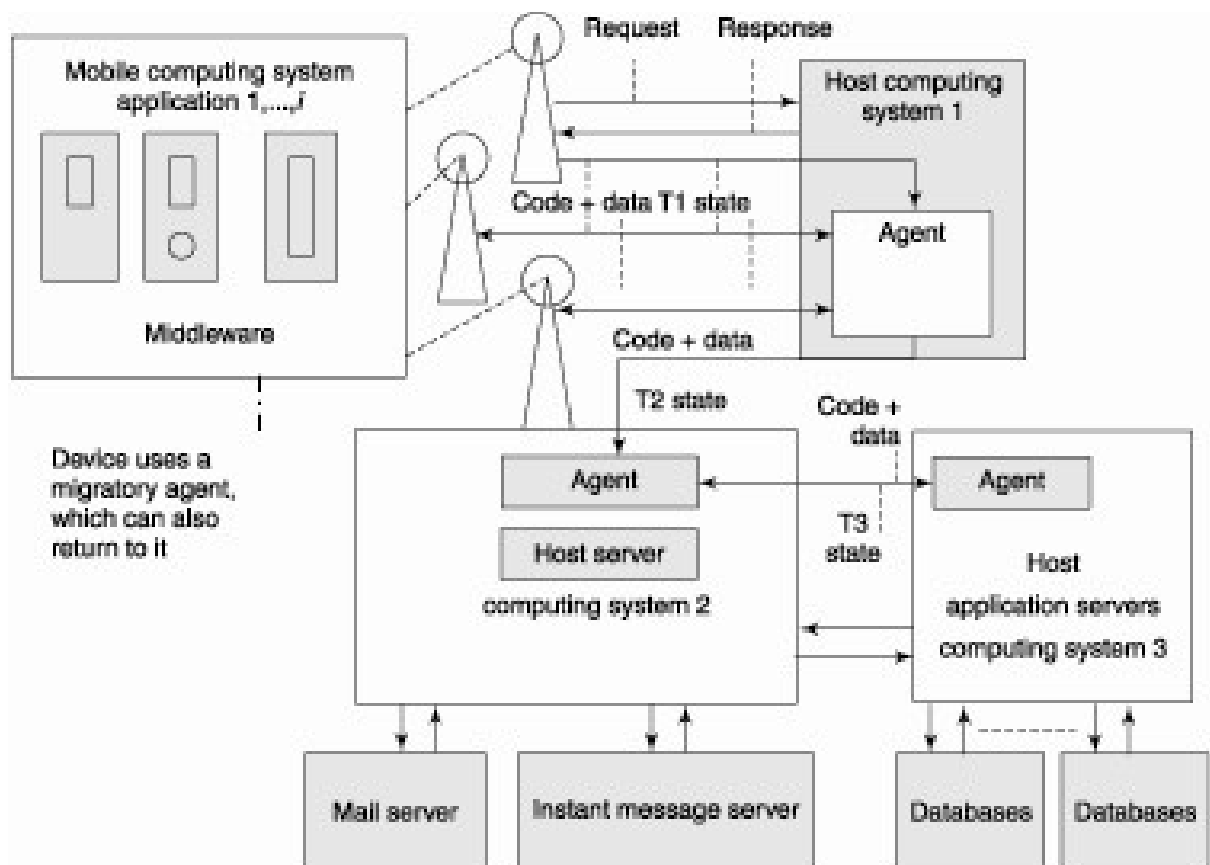
- Domain-specific rule that data records synchronized with data generated at source within specific time interval and at time specified at the domain
- Ex: The flight time table data set of device synchronized every week and weather report once every day
- At the device weather report updated and synchronized up to the last day
- Eventually updates on a day if available at the server

Mobile Agent

- Consists of software with data, which can move from one computing system to another autonomously, Functions for a device or system on the present host.
- Described as an autonomous software which runs on a host with some data
- Dynamically moving software to another host (which has other required data) as and when required
- A powerful tool for distributed applications and retrieval of remote host information
- Has dynamic software that runs on different hosts at different times

Synchronization In Mobile Computing Systems

- Makes available the resources of its host to the resource-scarce devices, discovers new resources, and monitors the distribution of resources
- Also manages the network and the distributed computing systems
- Very effective alternative to the use of application-specific server(s) and device middleware for retrieving information and messages
- **Example of a Mobile agent-based architecture**
- Agent moves at instants T1, T2, and T3 to process a request, get email, and get records from a database, respectively
- When a mobile agent moves at instant T1, T2, or T3, it saves its own state at the host and transmits this saved state to the next host in order to resume execution of the codes starting from the saved state
-



- **AgentOS, an operating system**
- Developed in 2006
- Provides application virtualisation environment

Synchronization In Mobile Computing Systems

- Allows automatic thread migration (ATM)
- The threads running on the host being independent of the OS

AgentOS Application virtualisation environment

- An application instead of running in its own environment provided by the OS and the system hardware actually runs at a host OS and host system hardware of the mobile agent of that system
- To a user, the application appears to be running at the system environment while it is actually running at the host environment, which is host to the agent

Characteristics of a mobile agent

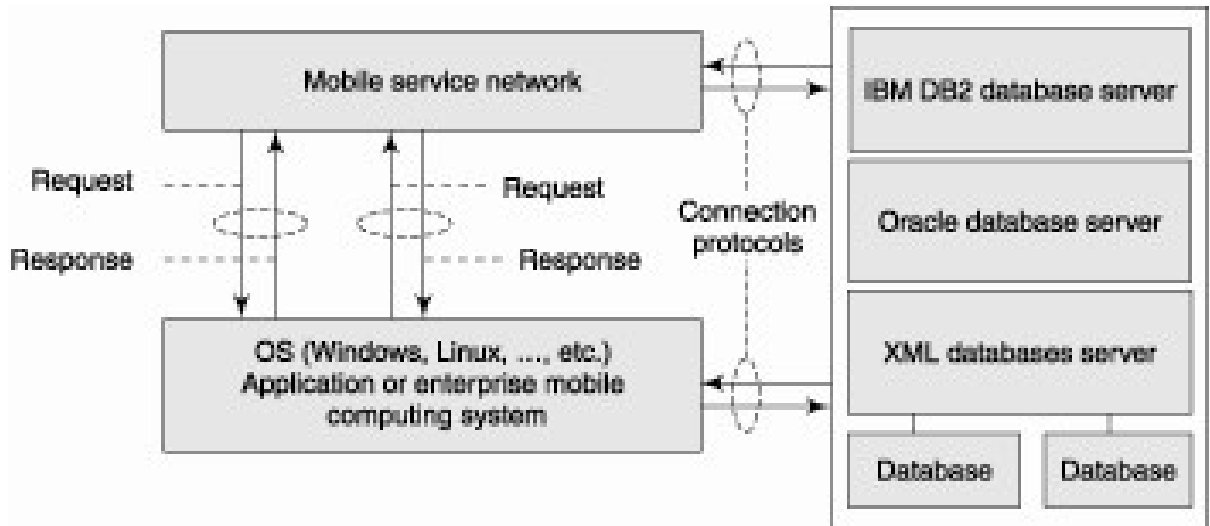
1. Mobility of code and data from one computing system (host) to another
 2. Ability to learn in order to adapt code and data to the host computing system
 3. Ability to clone, extend, or dispose itself after its role finishes
 4. Compatibility to the hosts
 5. Ability to continuously and autonomously process requests and send responses and alerts
- An alert— an unsolicited message, record, or information

Advantages of a mobile agent

1. Asynchronous running of codes on diversified heterogeneous hosts
2. Reduced computational and data requirements on the devices with limited resources
3. Tolerance to connection failures
4. Only the agent source (for example, device middleware, which sends the agent) needs to be modified in order to redefine the functions expected from the agent
4. There is no need of a centralized or an application-specific server
5. An agent can send the requests to a computing system as well as generate responses for requests from the system. An agent thus has certain similarities to peer-to-peer architecture
6. The connection protocol and the connecting network between host and source are immaterial

Peer-to-peer architecture

- Each system or device can send a request to and get a response from the other
- Each device can have access to databases or database servers



Latency Issues in use of the agent

- Migration latency means waiting period in migrating from one host to another
- Collaboration latency means waiting period in start of collaboration between the application server and the service-requesting system
- An agent possess migration and collaboration latencies
- **Environment- and platform-specific and security Issues in use of the agent**
- There can be environment- and platform-specific difficulties in implementing adaptability and compatibility at diversified hosts
- In addition, security-specific issues related to an agent moving from one host to another

Mobile agent design:

A client server computing model requires that an already existing object is used to send responses on request or is controlled from a proxy class on the client

Aglets :

- Aglet is a java based agent. Java has the Mobil agent platform and library which are used for building applications based on mobile agent

Synchronization In Mobile Computing Systems