

MODULE-1

(Mobile Computing Basics) Introduction to mobile computing – Functions, Middleware and Gateways, Application and services. Mobile computing architecture – Internet: The Ubiquitous network, Three tier architecture for Mobile Computing, Design considerations for mobile computing.

Mobile Computing

- ▶ **Make information accessible anywhere and at any time**
- ▶ **Mobile computers will be equipped with a wireless connection to the fixed part of the network, and, perhaps, to other mobile computers.**
- ▶ **Mobile voice communication is widely established throughout the world**
- ▶ **Rapid increase in the number of subscribers to the various cellular networks**
- ▶ **Able to send and receive data across these cellular networks**
- ▶ **To transmit data from remote locations to other remote or fixed locations**

Aspects of mobile computing

- ▶ **User mobility**
- ▶ **Device portability**

Different names of Mobile Computing

- ▶ **VHE – Virtual Home Environment (Connect to a Foreign Network)**
- ▶ **Anywhere, anytime information**
- ▶ **Nomadic computing**
- ▶ **Pervasive computing**
- ▶ **Ubiquitous computing (Appear anytime and everywhere)**
- ▶ **Global service portability**
- ▶ **Wearable computers**

Mobile Computing Functions

- ▶ **User Mobility**
- ▶ **Network Mobility**
- ▶ **Bearer Mobility**
- ▶ **Device Mobility**
- ▶ **Session Mobility**
- ▶ **Agent Mobility**
- ▶ **Host Mobility**

TRACE KTU

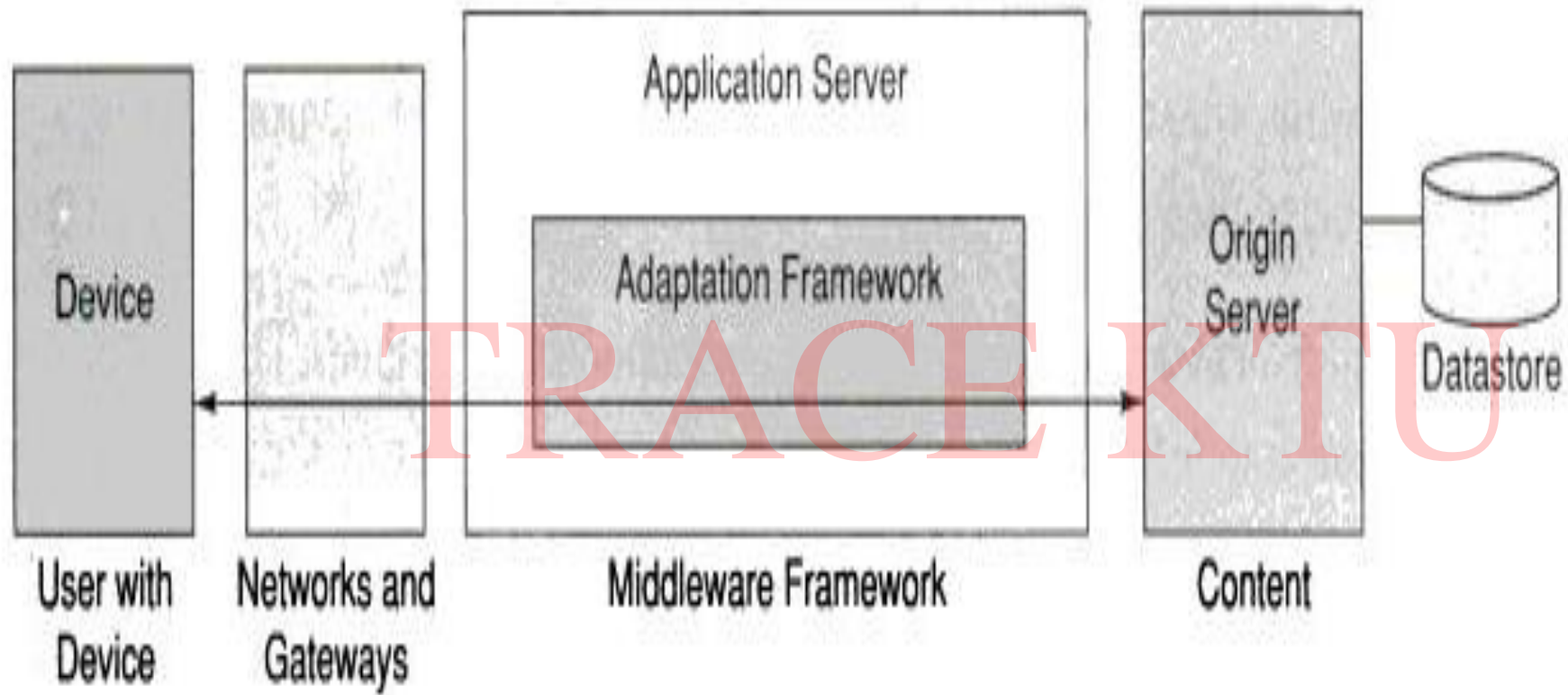


Figure 1.1 Mobile Computing Functions

Mobile Computing Devices

- ▶ Mobile computing can be either a computing (desktop, laptop, or a palmtop computer) or a communication device (fixed Line telephone, a mobile telephone or a digital TV)
- ▶ The device is a combination of hardware (**User Equipment (UE)**) and software (**User Agent (UA)**) (**Web browser**)

MIDDLEWARE AND GATEWAYS

- ▶ **Software layer between a user application and operating system is a middleware**
 - ▶ **Communication middleware, object-oriented middleware, message-oriented middleware, transaction processing middleware, database middleware, behavior management middleware, Remote Procedure Call (RPC) middleware**
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- ▶ **1. Communication middleware.**
 - ▶ **2. Transaction processing middleware,**
 - ▶ **3. Behavior management middleware,**
 - ▶ **4. Communication gateways.**

Communication middleware

- ▶ **Communicate with different nodes and services through different communication middleware**
- ▶ **Different connectors for different services will fall in this category**
- ▶ **A cell phone and a PC (Function, Speed, Capacity, Size, OS etc.)**

Transaction Processing Middleware

- ▶ **Session-oriented dialogue (Warning, Ok etc.)**
- ▶ **This is done through an application server**
- ▶

Behavior Management Middleware

- ▶ **Different devices deliver differently**
- ▶ **One application for the Web, another for WAP, and a different one for SMS**

Communication Gateways

- ▶ **Gateways are deployed when there are different transport bearers or networks with dissimilar protocols.**
- ▶ **IVR gateway to interface Voice with a computer, or a WAP gateway to access Internet over a mobile phone**

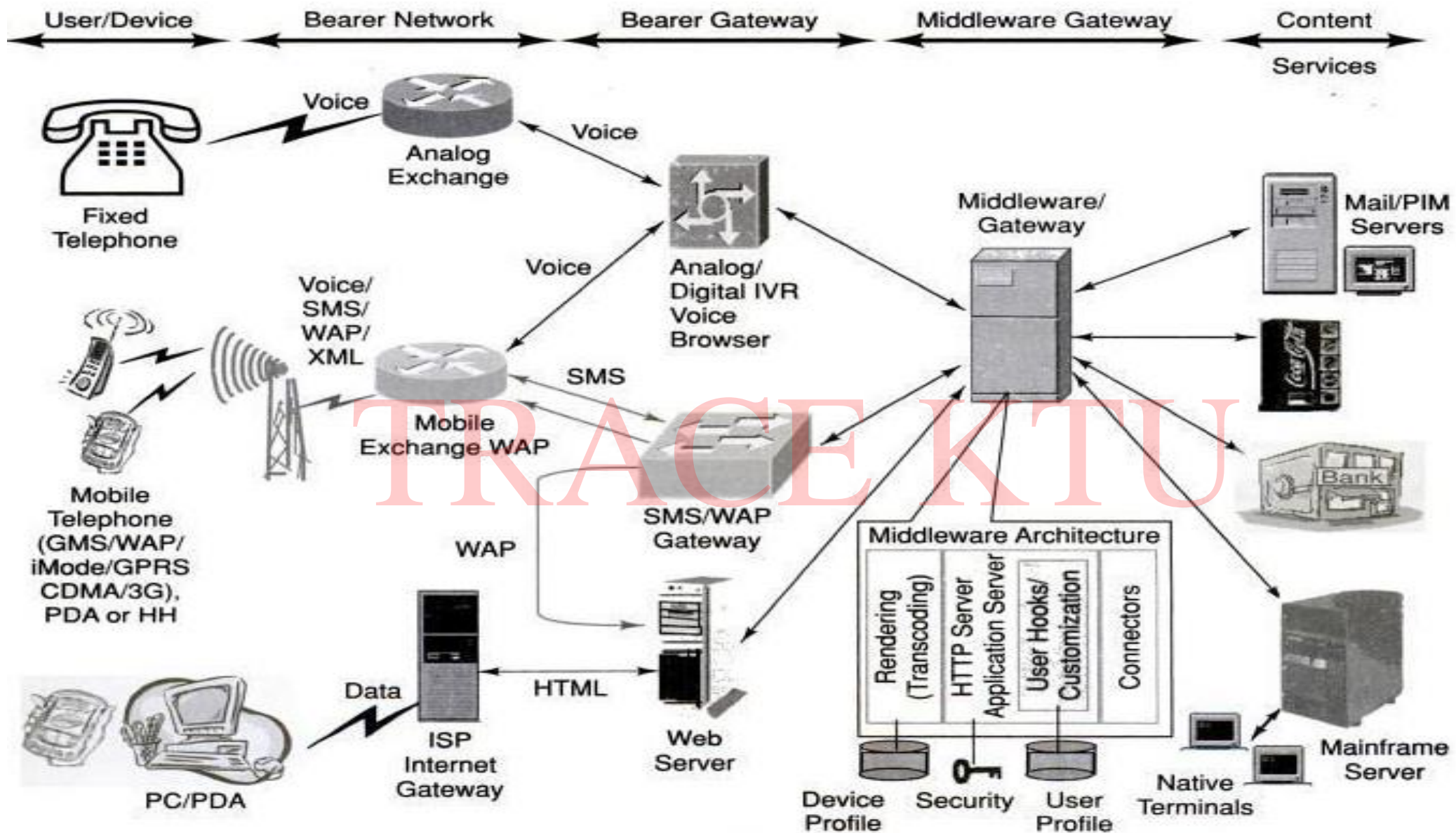


Figure 1.2 Schematic Representation of a Mobile Computing Environment

APPLICATION AND SERVICES

- ▶ **Mobile Users** (mobile executives, sales people, service engineers, farmers in the field, milkmen, newspaper boys, courier or pizza delivery boy)
- ▶ **The applications or services run on the origin server. These are also known as content servers**
- ▶ **Different users need Different Applications. (Elders- Communications Others- Entertainment)**
- ▶ **Personal: Belongs to the user (wallet, medical records, diary).**
- ▶ **Perishable: Time-sensitive and of relevance and passes quickly (general news, breaking news, weather, sports, business news, stock quotes).**
- ▶ **Transaction-oriented: Transactions need to be closed (bank transactions, utility bill payment, mobile shopping).**
- ▶ **Location-specific: Information related to current geographical location**
- ▶ **Corporate: Corporate business information {mail, Enterprise Requirements Planning (ERP), inventory, directory, business alerts, reminders}.**

- ▶ **Entertainment:** Applications for fun, entertainment. Social networking sites like Facebook can be part of this category.
- ▶ **News:** This is a very big basket of applications having different types of news. News could be political, current affairs, breaking news,. business news, sports news, community news, etc
- ▶ **Youth:** This is a very high growth market with different applications to suit the lifestyles of the youth. These are primarily message-based applications like person-to-person messaging, chat, forums, dating, etc.
- ▶ **Weather:**
- ▶ **Sales force automation:** This group will offer many applications. It will cater to the large population 'of sales personnel. Applications will include sales order bookings, inventory enquiry, shipment tracking, logistics related applications
- ▶ **m-broker:** Getting correct and timely information related to different stocks are very important
- ▶ **Telebanking:** We need to access our bank information for different transactions

- ▶ **m-shopping:** This mobile application is used to shop with the help of mobile devices like Palm top, Pocket PC, mobile phones, etc.
- ▶ **Micropayment-based application:** Micropayments involve transactions where the amount of money involved is not very high-it could be a maximum of Rs 1000 (\$ 25).
- ▶ **Interactive games:** Many mobile network operators have started offering different types of contests and interactive games that can be played through mobile phones
- ▶ **Interactive TV shows:** Many TV companies around the world use email, SMS and Voice as a bearer for interactive TV or reality TV shows. Nowadays viewers vote for their favorite TV stars using SMS.
- ▶ **Digital/Interactive TV:** These are interactive TV programs through digital TV using set-top boxes and Internet. Video-on-demand, community programs, healthcare, and shopping applications are quite popular under this media category.
- ▶ **Experts on call:** This is an application system for experts. Experts use these services to schedule their time and business with clients
- ▶ **GPS-based systems:** Applications related to location tracking come under this category
- ▶ **Remote monitoring:** This is important for children at home where parents monitor where their children are or what are they doing. Also, monitoring and controlling of home appliances will be part of this application

- ▶ **Entertainment:** This contains a very large basket of applications starting from horoscope to jokes
- ▶ **Directory services:** This includes information related to movies, theatre, public telephones, restaurant guide, public information systems and Yellow pages
- ▶ **Sports:** This service offers online sports updates. In India live cricket score is the most popular mobile computing application.
- ▶ **Maps/navigation guide:** This is an application which has a lot of demand for traveling individuals
- ▶ **Virtual office:** There are many people who are self-employed and do not have a physical office
- ▶ **m-exchange for industries :** Small shops prefer mobile instead of computer for money transactions.
- ▶ **m-exchange for agricultural produce :** Farmers can get information about where to get a good price for their product, it helps both farmers and consumers.
- ▶ **Applications for speech/hearing challenged people:** Text-based communication can help rehabilitate some of these disabled individuals.
- ▶ **Agricultural information:**
- ▶ **Corporate knowledge-based applications**

- ▶ **Community knowledge-based applications**
- ▶ **Distance learning**
- ▶ **Digital library**
- ▶ **'Telemedicine and healthcare**
- ▶ **Micro-credit schemes**
- ▶ **Environmental protection and management**
- ▶ **e-governance:**
- ▶ **Virtual laboratories**
- ▶ **Community forums**
- ▶ **Law enforcements (access to criminal records, information related to vehicles, or even a picture of the accident site taken through a MMS phone)**
- ▶ **Job facilitator**
- ▶ **Telemetric applications (vehicle tracking; meter reading; health care and emergency services)**
- ▶ **Downloads**
- ▶ **Alerts and notifications**

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INTERNET-THE UBIQUITOUS NETWORK

- ▶ Any content to be available anywhere
- ▶ There are two networks which are ubiquitous
- ▶ Telecommunication network and the Internet network
- ▶ Both these networks are in real terms the network of networks. (Different networks have been connected together using a common protocol) (glue)
- ▶ Three types of basic content: audio, video and text. Some of these content can tolerate little delays in delivery whereas some cannot.
- ▶ Packet switched networks like Internet are better suited for content which can tolerate little delays.
- ▶ circuit switch networks are better suited for real-time content that cannot tolerate delays
- ▶ A ubiquitous needs to use these networks to take the content from one place to another. network can be divided into three main segments, viz., Core, Edge and Access.

Core

- ▶ Backbone of the network
- ▶ This is the innermost part of the network.
- ▶ The primary function of the core network is to deliver traffic efficiently at the least cost.
- ▶ This part of the network deals with transmission media and transfer points.

Edge/Distribution layer

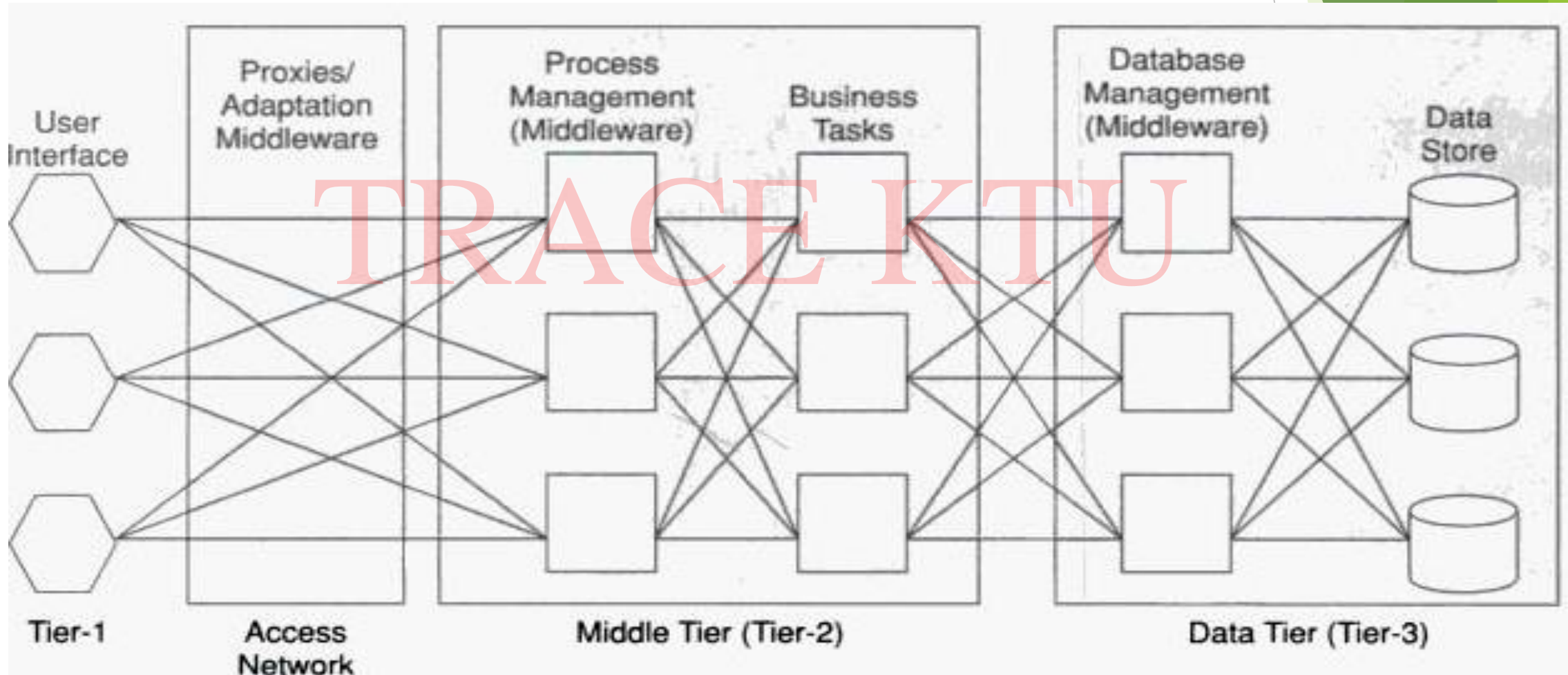
- ▶ It is also responsible for the distribution of traffic.
- ▶ Managed and owned by ISPs or local switches

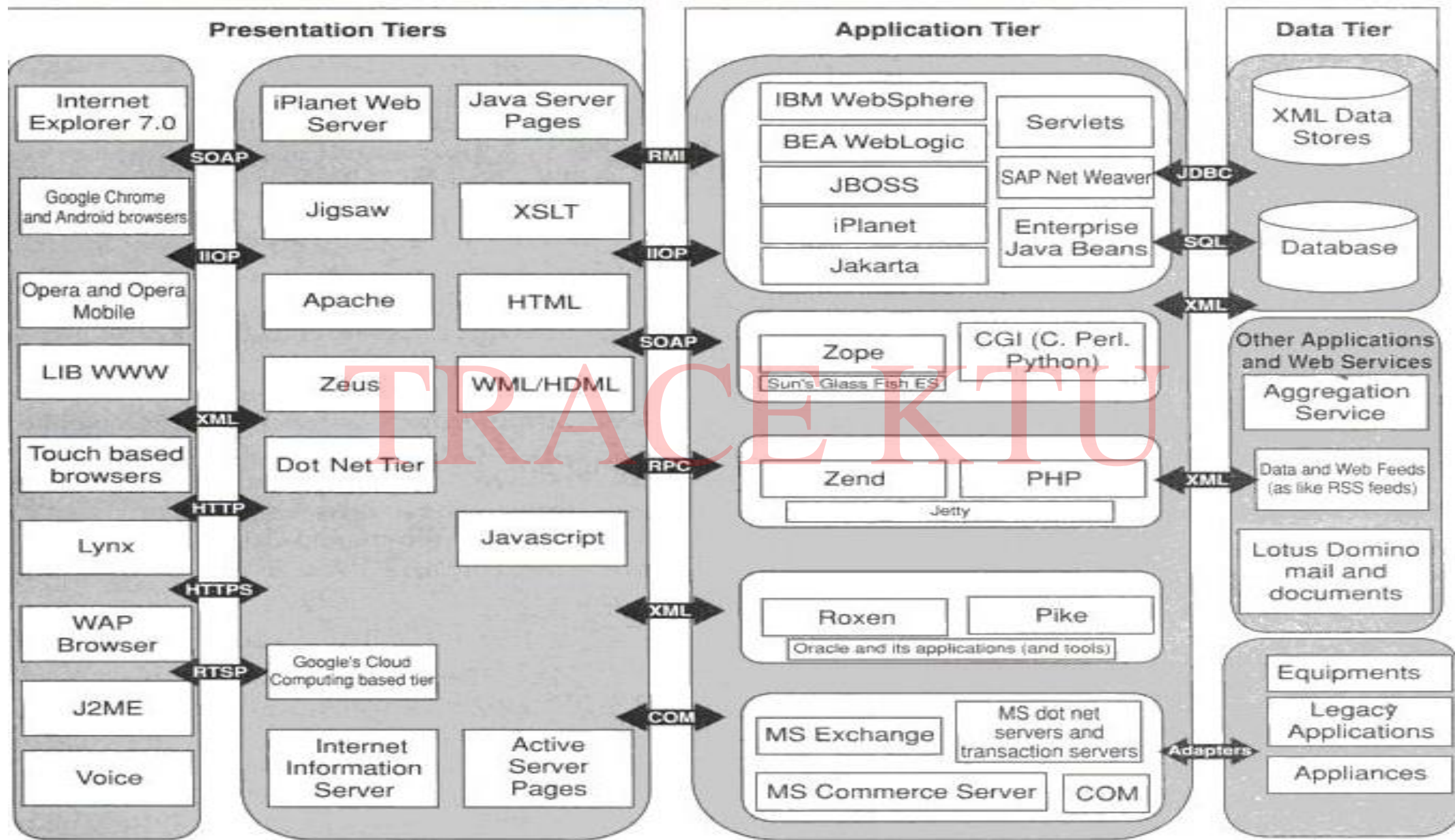
Access

- ▶ How the end point or the device access the network
- ▶ Either wireline or the wireless. From the mobile computing point of view, this will be mostly through the wireless.

ARCHITECTURE FOR MOBILE COMPUTING

- Mobile computing uses three-tier architecture





User Interface or Presentation(Tier-1)

- ▶ **Deals with user facing device handling and rendering.**
- ▶ **This is the layer of agent applications and systems**
- ▶ **These applications run on the client device and offer all the user interfaces**
- ▶ **This tier is responsible for presenting the information to the end user.**
- ▶ **Humans receive information from machines (visual and audio)**
- ▶ **Humans feed the data to the system using keyboard, touch screen or Voice.**
- ▶ **Includes web browsers**

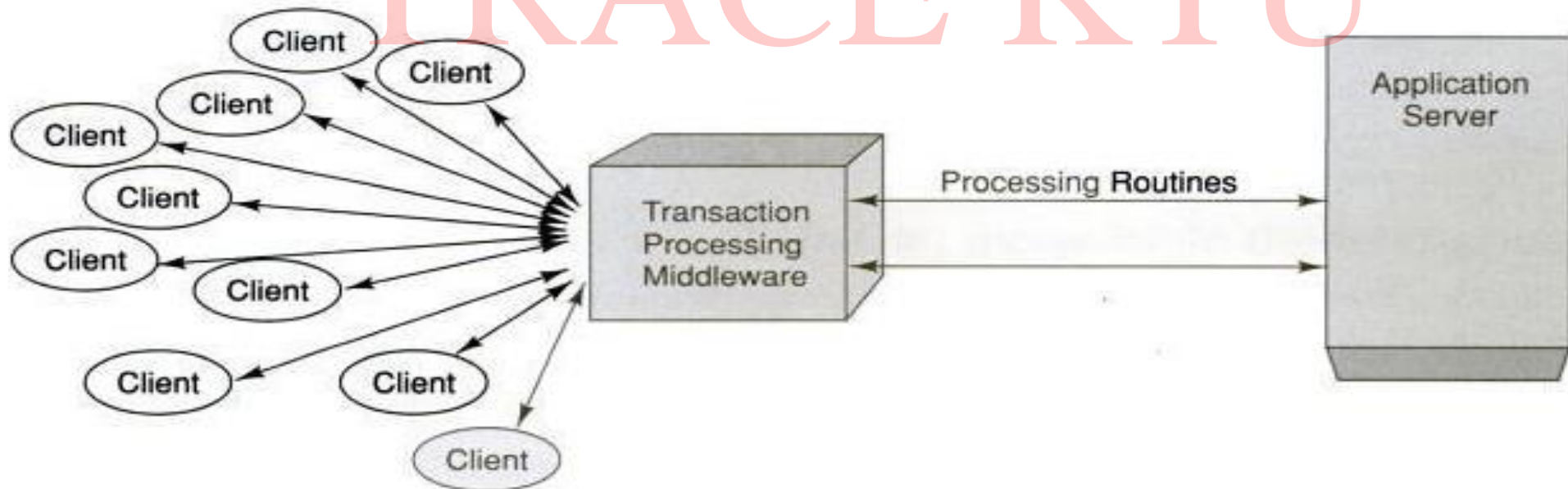
Process Management or Application Tier (Tier-2)

- ▶ **The application tier or middle tier is the "engine" of a ubiquitous application**
- ▶ **Logic and rules are executed**
- ▶ **Message-oriented Middleware,**
- ▶ **Transaction Processing Middleware.**
- ▶ **Database Middleware,**
- ▶ **Communication Middleware.**
- ▶ **Distributed Object and Components.**
- ▶ **Transcoding Middleware**

Message-oriented Middleware (MOM)

- ▶ MOM loosely connects different applications through asynchronous exchange of messages.
- ▶ The message can contain formatted data, requests for action, or unsolicited response.
- ▶ MOM uses **asynchronous (usually)** and synchronous (request/response) message passing.
- ▶ MOM is most appropriate for event-driven applications.
- ▶ When an event occurs, the application notifies subscribers that the event has happened.

Transaction Processing (TP) Middleware



Transaction Processing (TP) Middleware

- ▶ TP is used in data management, network access, security systems, delivery order processing, airline reservations, customer service, etc.,
- ▶ TP middleware maps numerous client requests through application-service routines to different application tasks.
- ▶ TP middleware includes numerous management features, such as restarting failed processes, dynamic load balancing and ensuring consistency of distributed data.

Communication Middleware

- ▶ Communication Middleware is used to connect one application to another through some communication middleware. Eg.telnet
- ▶ These types of middleware are quite useful in the telecommunication world

Distributed Object and Components

- ▶ An example of distributed objects and components is CORBA (Common Object Request Broker Architecture)
- ▶ CORBA enables collaboration between systems on different operating systems, programming languages, and computing hardware

Transcoding Middleware

- ▶ Transcoding Middleware is used to transcode one format of data to another to suit the need of the client.
- ▶ Transcoding is used for content adaptation to fit the need of the device. Content adaptation is also required to meet the network bandwidth needs.

Database Management or Data Tier(Tier-3)

- ▶ The Data Tier is used to store data (both temporary and permanent data)
- ▶ The data can be stored in any form of datastore or database.

Database Middleware

- ▶ It runs between the application program and the database.
- ▶ These are sometimes called database connectors as well. Examples of such middleware will be ODBC,JDBC, etc.
- ▶ Using these middleware, the application will be able to access data from any data source.
- ▶ Data sources can be text files, flat files, spreadsheets, or a network, relational, indexed, hierarchical, XML database, object database, etc.

DESIGN CONSIDERATIONS FOR MOBILE COMPUTING

- ▶ The mobile computing environment needs to be context-independent as well as context-sensitive.
- ▶ The term "context" means, all the information that helps determine the state of an object. This object can be a person, a device, a place, a physical or computational object.

Content with context awareness

- ▶ Build each application with context awareness.
- ▶ There are different services for different devices.
- ▶ For example, a bank decides to offer mobile banking application through Internet, PDA and mobile phone using WAP.
- ▶ <http://www.mybank.com/inet.html>, - Assumes that user will use computers to access this service. (offer big pages with text boxes and drop down menus. Can be added a few animated pictures for the new product the bank is launching.)
- ▶ http://_www.mybank.corn/palm.html - for a PalmOS PDA. Display size is small, the screen to be compact for the PDA and do not offer the same product animation.
- ▶ <http://www.mybank.com/wap.wml>, - Mobile user, Completely different user interface. Remove all the graphics and animations.

Content switch on context

- ▶ Another way is to provide intelligence for the adaptation of content within the service.
- ▶ All access the bank's service through <http://www.mybank.com>
- ▶ This intelligent code decide whether to route the request to <http://mybank.com/inet.html> or <http://www.mybank.com/palm.html> or <http://www.mybank.com/wap.wml>.

Content transcoding on context

- ▶ An underlying middleware platform that performs the adaptation of the content based on the context and behavior of the device.

Client Context Manager

- ▶ Client Context Manager to gather and maintain information related to the client device, user, network and the environment surrounding each mobile device.
- ▶ All these information will be provided by a set of Awareness Modules. The Awareness modules are sensors.
- ▶ These sensors can be hardware sensors or software sensors or a combination of these two.
- ▶ A hardware sensor can be used to identify the precise location of a user; whereas, a software sensor can be used to determine the type of the user agent.

Type of Application (Native or Mobile Web)

- ▶ Determine type of application.
- ▶ If your application requires local processing. access to local resources than consider designing a native application.
- ▶ A native application is hard to maintain. Requires separate distribution and upgrade infrastructure, are compatible only with target device/platform, requires more effort (sometimes huge) to port on different devices.
- ▶ A mobile web application is compatible with all devices with internet connection and a browser

Target device

- ▶ Target device and platform (OS) plays a key role throughout design decisions making process.
- ▶ Design decisions are influenced by target device's screen size, resolution, orientations, memory, CPU performance characteristics. Operating systems capabilities, device hardware, user input mechanism (touch/non-touch), sensors (such as GPS or accelerometer etc.

User experience

- ▶ User interface should be rich, intuitive and responsive.
- ▶ While using mobile application user is often distracted by external or internal (e.g. incoming call when user is in middle of a wizard) events.
- ▶ Screens should be identified with consideration (Long data entry forms may irritate user)

Resource Constraint

- ▶ Every design decision should take into account the limited CPU, memory and battery life. Reading and writing to memory, wireless connections, specialized hardware, and processor speed all have an impact on the overall power usage.
- ▶ In some cases, application processing should be offloaded from the device to avoid excessive resource consumption

Multiple Platforms

- ▶ Same code base should support iPhone and iPad or Android Phone and Android tablet will arise. Architect should consider portability as important architectural goal.

Security

- ▶ Devices are more vulnerable than desktop, primarily due to lack of awareness.
- ▶ Moreover device can be lost easily. Ensure that the device – server communication is secured and server accepts request only from authentic source (device).
- ▶ Confidential application or data are stored in locally, ensure that the data is encrypted.

Network Communication

- ▶ Compress large text / XML data to lesser network traffic. Design for asynchronous communication.
- ▶ Two important considerations
- ▶ What is on appropriate model for mobile computing systems
- ▶ Whether mobility should be mode transparent to applications.