

INDEX

UNIT I

Chapter 1 : Introduction to Ubiquitous Computing
1-1 to 1-25

Syllabus : Concept of Ubiquitous Computing and Advantages, Ubiquitous Computing Applications and Scope, Properties of Ubiquitous Computing, Modelling the Key Ubiquitous Computing Properties. Ubiquitous System Environment Interaction. Architectural Design for UbiCom Systems : Smart DEI Model.

1.1 Concept of Ubiquitous Computing..... 1-1

1.1.1 Definition..... 1-1

1.1.2 Features 1-2

1.1.3 Concepts of a Ubiquitous Environment..... 1-2

1.1.4 Working of Ubiquitous Computing..... 1-2

1.1.5 Advantages of Ubiquitous Computing 1-3

1.2 Ubiquitous Computing Applications and Scope 1-4

1.2.1 Personal Memories..... 1-4

1.2.2 Adaptive Transport Scheduled Service 1-5

1.2.3 Foodstuff Management 1-6

1.2.4 Utility Regulation..... 1-7

1.2.5 Scope of Ubiquitous computing..... 1-7

1.3 Core Properties of UbiCom Systems 1-7

1.4 Modelling The Key Ubiquitous/Pervasive Computing Properties 1-8

1.4.1 Introduction..... 1-8

1.4.2 Distributed ICT Systems..... 1-9

1.4.2 (A) Networked ICT Devices..... 1-9

1.4.2(B) Transparency and Openness 1-10

1.4.3 Implicit Human Computer Interaction (IHCI) 1-10

1.4.3(A) The Calm Computer 1-10

1.4.3(B) Implicit Versus Explicit Human-Computer Interaction..... 1-11

1.4.3(C) Embodied Reality Versus Virtual, Augmented and Mediated Reality..... 1-11

1.4.4 Context-Awareness 1-12

1.4.4 (A) Three Main Types of Environment Context : Physical, User, Virtual..... 1-12

1.4.4(B) User-Awareness 1-12

1.4.4 (C) Active versus Passive Context-Awareness..... 1-13

1.4.5 Autonomy..... 1-13

1.4.6 Intelligence..... 1-14

1.4.7 Holistic Framework for UbiCom : Smart DEI 1-15

1.5 Ubiquitous System Environment Interaction..... 1-15

1.5.1 Human ICT Device Interaction (HCI) 1-17

1.5.2 ICT Device to Physical World Interaction (CPI)..... 1-18

1.6 Architectural Design for UbiCom Systems : Smart DEI Model 1-18

1.6.1 Smart Devices..... 1-20

1.6.1(A) Weiser's ICT Device Forms : Tabs, Pads and Boards..... 1-20

1.6.1(B) Extended Forms for ICT Devices : Dust, Skin and Clay..... 1-20

1.6.1(C) Mobility..... 1-21

1.6.1(D) Volatile Service Access 1-21

1.6.1(E) Situated and Self-Aware 1-21

1.6.2 Smart Environments 1-22

1.6.2(A) Tagging, Sensing and Controlling Environments 1-22

1.6.2(B) Embedded Versus Untethered 1-23

1.6.2(C) Device Sizes 1-23

1.6.3 Smart Interaction..... 1-24

UNIT II

Chapter 2 : Ubiquitous Computing Smart Devices and Services
2-1 to 2-44

Syllabus : Smart Devices and Service properties, Smart mobile devices and Users, Mobile code, Smart Card Devices and Networks, Service Architecture Models. Service Provision Life-Cycle. Virtual Machines and Operating Systems, OS for Mobile Computers and Communicator Devices.

2.1 Smart Devices : Applications and Requirements 2-1

2.1.1 CCI..... 2-1

2.1.2 CPI 2-2

2.1.3 Smart Devices : iHCI and HPI 2-3

2.1.4 Applications and Requirements..... 2-5

2.1.5 Mobile Devices..... 2-5

2.1.6 Ubiquitous Computing Properties 2-6

2.1.7 Service Properties..... 2-6



2.2	Smart Mobile Devices and Users.....	2-6	2.6.3(E)	On-Demand Service Access.....	2-32
2.2.1	Mobile Service Design.....	2-6	2.6.3(F)	Event-Driven Architectures (EDA)	2-33
2.2.1(A)	SMS and Mobile Web Services.....	2-7	2.6.3(G)	Shared Data Repository	2-35
2.2.1(B)	Java VM and J2ME	2-9	2.6.3 (H)	Enterprise Service Bus (ESB) Model.....	2-35
2.2.1(C)	.NET CF.....	2-10	2.6.3(I)	Volatile Service Invocation.....	2-36
2.2.2	Mobile Code	2-10	2.6.4	Service Composition	2-36
2.2.3	Mobile Devices and Mobile Users.....	2-11	2.6.4(A)	Service Interoperability	2-37
2.3	Smart Card Devices and Networks	2-12	2.7	Virtual Machines and Operating Systems.....	2-38
2.3.1	Introduction.....	2-12	2.7.1	Virtual Machines	2-38
2.3.2	Smart Card OS	2-13	2.7.2	BIOS	2-39
2.3.3	Smart Card Development.....	2-13	2.7.3	Multi-Tasking Operating Systems (MTOS).....	2-39
2.4	Device Networks.....	2-13	2.7.4	Process Control	2-40
2.4.1	HAVi, HES and X10	2-14	2.7.5	Memory Management.....	2-41
2.4.2	Device Discovery.....	2-14	2.7.6	Input and Output	2-42
2.4.3	OSGi.....	2-16	2.8	Operating Systems for Mobile Computers and Communicator Devices.....	2-42
2.5	Service Architecture Models.....	2-17	2.8.1	Microkernel Designs	2-42
2.5.1	Partitioning and Distribution of Service Components	2-17	2.8.2	Mobility Support	2-42
2.5.2	Multi-tier Client Service Models.....	2-17	2.8.3	Resource-Constrained Devices.....	2-43
2.5.2(A)	Distributed Data Storage	2-18	2.8.4	Power Management.....	2-43
2.5.2(B)	Distributed Processing	2-18	2.8.4(A)	Low Power CPUs.....	2-43
2.5.2(C)	Client-Server Design	2-19	2.8.4(B)	Application Support.....	2-44
2.5.2(D)	Proxy-based Service Access.....	2-19			
2.5.3	Middleware	2-21	UNIT III		
2.5.4	Service Oriented Computing (SOC).....	2-21	Chapter 3 : Actuation and Control 3-1 to 3-29		
2.5.5	Grid Computing	2-22	Syllabus : Tagging the Physical World, Sensors and Networks, Micro - Electro-Mechanical Systems (MEMS), Embedded Systems and Real-Time Systems. Programmable and PID type control system, Robots.		
2.5.6	Peer-to-Peer Systems	2-23	3.1	Tagging The Physical World.....	3-1
2.5.7	Device Models.....	2-25	3.1.1	Life-Cycle for Tagging Physical Objects	3-2
2.6	Service Provision Life-Cycle.....	2-26	3.1.2	Tags : Types and Characteristics	3-3
2.6.1	Network Discovery.....	2-26	3.1.3	Physical and Virtual Tag Management	3-4
2.6.2	Service Announcement, Discovery, Selection and Configuration	2-27	3.1.4	RFID Tags.....	3-5
2.6.2(A)	Web Service Discovery	2-28	3.1.4 (A)	Active RFID Tags.....	3-5
2.6.2(B)	Semantic Web and Semantic Resource Discovery....	2-28	3.1.4(B)	Passive RFID Tags	3-6
2.6.3	Service Invocation	2-29	3.1.5	Personalised and Social Tags	3-7
2.6.3(A)	Distributed Processes	2-29	3.1.6	Micro Versus Macro Tags	3-7
2.6.3(B)	Asynchronous (MOM) Versus Synchronous (RPC) Communication Models.....	2-30	3.2	Sensors and Sensor Networks	3-8
2.6.3(C)	Reliable Versus Unreliable Communication.....	2-31	3.2.1	Overview of Sensor Net Components and	
2.6.3(D)	Caches, Read-Ahead and Delayed Writes.....	2-32			



Processes	3 -8	4.1.3	Personal Computer Interface	4-1	
3.2.2	Sensor Electronics.....	3 -10	4.1.4	Mobile Hand-Held Device Interfaces	4-2
3.2.3	Physical Network : Environment, Density and Transmission	3 -12	4.1.4(A)	Handling Limited Key Input : Multi-Tap, T9, Fastap, Soft keysand Soft Keyboard.....	4-3
3.2.4	Data Network : Addressing and Routing	3 -13	4.1.4(B)	Handling Limited Output	4-3
3.2.4(A)	Sensor Networks Versus Ad Hoc Networks	3 -13	4.1.5	Games Console Interfaces and Interaction	4-4
3.2.4(B)	Data Processing : Distributed Data Storage and Data Queries	3 -14	4.1.6	Localized Remote Control : Video Devices	4-5
3.3	Micro Actuation and Sensing : MEMS	3 -15	4.2	Abstract User Interface via Basic Smart Devices	4-5
3.3.1	Fabrication	3 -15	4.2.1	Introduction	4-5
3.3.2	Micro-Actuators.....	3 -16	4.2.2	Multi-Modal Visual Interfaces.....	4-5
3.3.3	Micro-Sensors.....	3 -16	4.2.3	Gesture Interfaces	4-6
3.3.4	Smart Surfaces, Skin, Paint, Matter and Dust.....	3 -17	4.2.4	Reflective Versus Active Displays	4-8
3.3.5	Downsizing to Nanotechnology and Quantum Devices	3 -18	4.2.5	Combining Input and Output User Interfaces and Tangible User interface.....	4-9
3.4	Embedded Systems and Real-Time Systems.....	3 -19	4.2.5(A)	Touch screens	4-9
3.4.1	Application-Specific Operating Systems (ASOS)	3 -21	4.2.5(B)	Tangible Interfaces	4-10
3.4.2	Real-Time Operating Systems for Embedded Systems	3 -21	4.2.5(C)	Organic Interfaces.....	4-10
3.5	Programmable and PID Type Control System	3 -22	4.2.6	Auditory Interfaces.....	4-11
3.5.1	Programmable Controllers.....	3 -22	4.2.7	Natural Language Interfaces	4-11
3.5.2	Simple PID-Type Controllers	3 -23	4.3	Abstract User Interface via Wearable and Implanted Devices	4-12
3.5.3	More Complex Controllers.....	3 -23	4.3.1	Posthuman Technology Models	4-12
3.6	Robots	3 -24	4.3.2	Virtual Reality and Augmented Reality	4-12
3.6.1	Robot Manipulators.....	3 -25	4.3.3	Wearable Computer Interaction.....	4-12
3.6.2	Mobile Robots.....	3 -26	4.3.3(A)	Head(s)-Up Display (HUD)	4-13
3.6.3	Biologically Inspired Robots	3 -26	4.3.3(B)	Eyetape.....	4-13
3.6.4	Nanobots	3 -27	4.3.3(C)	Virtual Retinal Display (VRD).....	4-14
3.6.5	Developing UbiCom Robot Applications.....	3 -27	4.3.3(D)	Clothes as Computers	4-14
UNIT IV					
Chapter 4 : Human Computer Interaction 4-1 to 4-22					
Syllabus : User Interfaces and Interaction for devices, Abstract user interface through Basic Smart Wearable and Implanted Devices. Human-Centered Design (HCD).					
User Models : Direct and indirect user input and modelling, modelling users' planned tasks and multiple tasks-based computing.					
4.1	User Interfaces and Interaction for Devices	4-1	4.4	Human Centered Design	4-15
4.1.1	Introduction.....	4-1	4.4.1	Introduction	4-15
4.1.2	Diversity of ICT Device Interaction	4-1	4.4.2	Human-Centered Design Life-Cycle	4-15
			4.4.3	Methods to Acquire User Input and to Build Used Models	4-16
			4.4.4	Defining the Virtual and Physical Environment Use Context.....	4-17
			4.4.5	Defining the Human Environment Use Context and Requirements.....	4-17
			4.4.5(A)	User Characteristics.....	4-17
			4.4.6	Interaction Design	4-18

4.4.6(A) Conceptual Models and Mental Models 4-18

4.4.7 Evaluation 4-19

4.5 User Models 4-19

4.5.1 User Models : Acquisition and Representation 4-19

4.5.2 Indirect User Input and Modelling..... 4-20

4.5.3 Direct User Input and Modeling..... 4-20

4.5.4 User Stereotypes..... 4-20

4.5.5 Modeling Users' Planned Tasks and Goals 4-21

4.5.6 Activity-Based Computing 4-21

4.5.7 Situation Action versus Planned Action Models..... 4-21

4.5.8 Multiple Tasks-based Computing 4-22

UNIT V

**Chapter 5 : Ubiquitous Computing Privacy
Ubiquitous Computing 5-1 to 5-20**

Syllabus : Ubiquitous computing privacy definition, Solove's taxonomy of privacy, legal background, Interpersonal privacy, Ubicomp challenges to privacy : Collection scale, manner and motivation, data types, data accessibility; Case study of privacy solution such as Protecting RFID tags, ways of addressing privacy in Ubicomp.

5.1 Ubiquitous Computing Privacy Definition 5-1

5.1.1 Definition..... 5-1

5.1.2 Explanation..... 5-1

5.2 Solove's Taxonomy of Privacy 5-3

5.2.1 Introduction..... 5-3

5.2.1(A) Information Collection..... 5-3

5.2.1(B) Information Processing..... 5-3

5.2.1(C) Information Dissemination..... 5-4

5.2.1(D) Invasion 5-4

5.3 Legal Background..... 5-4

5.4 Interpersonal Privacy..... 5-6

5.5 Ubicomp Challenges to Privacy 5-7

5.5.1 Collection Scale..... 5-8

5.5.2 Collection Manner..... 5-9

5.5.3 Data Types 5-10

5.5.4 Collection Motivations 5-10

5.5.5 Data Accessibility 5-11

5.6 Privacy Solution : Protecting RFID Tags..... 5-11

5.6.1 Communication Confidentiality and Anti-Collision
Protocols..... 5-13

5.6.2 Access Control/Tag Deactivation..... 5-15

5.6.3 Proxies 5-16

5.7 Ways of Addressing Privacy in Ubicomp..... 5-18

5.7.1 Understand Your Application
(Consider Users and Use) 5-18

5.7.2 Define the Problem
(Think Attacker Model in Security)..... 5-19

5.7.3 Know Your Tools (Get the Technical Details Right) .. 5-19

UNIT VI

**Chapter 6 : Ubiquitous Communication
and Management 6-1 to 6-40**

Syllabus : Data Networks, Audio Networks, Wireless Data Networks, Ubiquitous Networks, Service oriented networks, network design issues; Configuration and Security management, Service oriented computer and information management, Context awareness.

6.1 Data Networks 6-1

6.1.1 Introduction 6-1

6.1.2 Network Protocol Suites 6-1

6.1.3 Addressing 6-2

6.1.4 Routing and Internetworking..... 6-2

6.2 Audio Networks..... 6-4

6.2.1 PSTN Voice Networks 6-4

6.2.2 Intelligent Networks and Information Science Multimedia
Subsystems 6-4

6.2.3 ADLS Broadband..... 6-5

6.2.4 Wireless Telecoms Networks 6-5

6.2.5 Audio Broadcast (Radio Entertainment) Networks 6-6

6.3 Wireless Data Networks 6-7

6.3.1 Introduction 6-7

6.3.2 Types of Wireless Network 6-7

6.3.2(A) WLAN and WiMAX..... 6-9

6.3.2(B) Bluetooth..... 6-9

6.3.2(C) ZigBee..... 6-10

6.3.2(D) Infrared..... 6-10

6.3.2(E) UWB..... 6-11

6.3.2(F) Satellite and Microwave Communication..... 6-11

6.3.3 Roaming between Local Wireless LANs..... 6-12

6.4 Ubiquitous Networks 6-12

6.4.1 Wireless Networks 6-12



6.4.2	Power Line Communication (PLC).....	6-13	6.7	Configuration and Security Management	6-25
6.4.3	Personal Area Networks.....	6-13	6.7.1	Configuration Management	6-25
6.4.4	Body Area Networks.....	6-14	6.7.2	Security Management.....	6-26
6.4.5	Mobile Users Networks	6-15	6.8	Service Oriented Computer and Information Management	6-28
6.4.5(A)	Mobile Addresses	6-15	6.8.1	Metrics for Evaluating the Use of SOA	6-28
6.4.5(B)	Single-Path Routing	6-15	6.8.2	Distributed Resource Management and the Grid	6-29
6.4.5(C)	Multi-Path Routing in Mobile Ad hoc Networks (MANETs).....	6-16	6.8.3	SLA Management of Services	6-30
6.5	Service-oriented Networks	6-16	6.8.4	Policy-based Service Management	6-30
6.5.1	Service-Orientation at the Network Edge.....	6-17	6.8.5	Pervasive Work Flow Management for Services.....	6-31
6.5.2	Content-based Networks.....	6-18	6.8.6	Information Management.....	6-31
6.5.3	Programmable Networks.....	6-18	6.8.6(A)	Information Applications	6-32
6.5.4	Overlay Networks	6-19	6.8.6(B)	Rich Versus Lean and Soft Versus Hard information	6-32
6.5.5	Mesh Networks.....	6-19	6.8.6(C)	Managing the data Explosion	6-33
6.5.6	Cooperative Networks	6-21	6.8.6(D)	Managing Multimedia Content	6-34
6.6	Network Design Issues.....	6-21	6.8.6(E)	Managing Lean and Hard Data using RDBMSs	6-35
6.6.1	Network Access Control.....	6-21	6.8.6(F)	Managing Information	6-36
6.6.2	Ubiquitous Versus Localised Access	6-22	6.9	Context Awareness.....	6-37
6.6.3	Dominant Network Access : Firewalls, NATs and VPNs	6-22	6.9.1	Introduction	6-37
6.6.4	Group Communication : Transmissions for Multiple Receiver	6-23	6.9.2	Three Main Types of Environment Context : Physical, User, Virtual	6-38
6.6.5	Internetworking Heterogeneous Networks	6-24	6.9.3	User-Awareness	6-38
6.6.6	Global Use : Low-cost Access Networks for Rural Use	6-24	6.9.4	Active versus Passive Context-Awareness	6-39
6.6.7	Separating Management and Management from Usage	6-25	6.9.5	Autonomy.....	6-39
			6.9.6	Intelligence.....	6-40