

Building the Mobile Internet

Mark Grayson, Kevin Shatzkamer, Klaas Wierenga

Cisco Press

800 East 96th Street

Indianapolis, IN 46240

Contents

	Introduction	xvii
Part I	Introduction	
Chapter 1	Introduction to "Mobility"	1
	Mobility Market	2
	Consumption Trends	5
	Mobile Challenges	9
	Summary	11
	Endnotes	12
Chapter 2	Internet "Sessions"	13
	The Internet and Communication	13
	Packet Switching Versus Circuit Switching	14
	IP over Everything, Everything over IP	15
	Addresses	16
	<i>IPv4 Addresses</i>	16
	<i>IPv6 Addresses</i>	18
	Routing	19
	<i>Routers</i>	19
	<i>Routing Protocols</i>	20
	<i>Broadcast</i>	20
	<i>IP Multicast</i>	20
	<i>Network Address Translation</i>	21
	TCP/IP Five-Layer Model	21
	Layer 1: The Physical Layer	23
	Layer 2: The Data Link Layer	23
	<i>Ethernet</i>	23
	<i>ARP</i>	24
	Layer 3: The Internet or IP Layer	24
	Layer 4: The Transport Layer	24
	<i>UDP</i>	25
	<i>TCP</i>	25
	Layer 5: The Application Layer	27
	<i>Socket API</i>	27
	<i>DNS</i>	28

DHCP 29

HTTP 29

Sessions and Mobility 30

Session Persistence and the Locator-Identifier Problem 30

Building the Mobile Internet 31

Summary 32

Endnotes 32

Part II Mobility Approaches

Chapter 3 Nomadicity 35

Authentication and Authorization 36

Authentication and Authorization in LTE 36

Authentication and Authorization in Wi-Fi Networks 39

Captive Portals 39

802.1X and EAP 39

Authentication and Authorization for Internet Applications 41

Federated Identity 41

Federated Access in LTE 43

3GPP Access 43

Non-3GPP Access 43

Federated Access to Wi-Fi Networks 43

Roaming to Other Wi-Fi Networks 44

802.11u 45

Example of Wi-Fi Roaming: eduroam 45

Federated Access to Applications with SAML 48

Location Information and Context Awareness 49

Location Information in LTE 49

Location Information for Wi-Fi Networks 50

Privacy and Security 50

Privacy and Security in LTE 51

Privacy and Security in Wi-Fi Networks 51

Privacy and Security in SAML 51

DynDNS 52

Summary 52

Endnotes 53

Chapter 4 Data Link Layer Mobility 55

Mobility Across an Ethernet-Bridged Domain	56
Interaction Between Mobility and Dynamic IP Address Allocation	57
Mobility Using Wireless LAN Technology	58
Fast Wireless LAN Local Mobility	59
Wireless LANs and Mobility Across a Layer 3 Domain	62
Interwireless LAN Controller Mobility	64
GPRS Tunneling Protocol	68
GPRS Tunneling Protocol	70
3GPP Mobility Using GTP	73
Access Point Name	73
PDP Context Activation	74
Mobility and Context Transfer	76
Proxy Mobile IPv6-Based Mobility	77
IETF Network-Based Mobility	78
WiMAX Mobility Using Proxy Mobile IP	79
WiMAX Session Establishment	81
PMIPv6-Based WiMAX Session Mobility	82
PMIPv6-Based Session Termination	84
3GPP Mobility Using Proxy Mobile IP	84
Delivering Equivalent GTP Functions with PMIPv6	85
Intertechnology Handover	86
Data Link Layer Solutions to Providing Mobility Across Heterogeneous Access Networks	87
3GPP Generic Access Network	87
Host Impacts of Data Link Layer Mobility	89
Summary	90
Endnotes	91

Chapter 5 Network Layer Mobility 93

Mobile IPv4	96
Mobile IPv4 Technology Overview	97
Network-Specific Terms	97
Network Element-Specific Terms	98
Addressing-Specific Terms	99
Mobile IPv4 Operation	100

Mobile IPv4 Agent Discovery	101
<i>Agent Advertisements</i>	101
<i>Agent Solicitations</i>	102 •
Mobile IPv4 Registration and AAA	103
<i>Mobile IPv4 Registration</i>	103
<i>RRQ and RRP Messages</i>	105
<i>Authentication Extensions</i>	108
<i>Mobile IPv4 AAA Interactions</i>	109
<i>RADIUS Interactions</i>	111
<i>Diameter Applications</i>	112
Mobile IPv4 Tunnels, Bindings, and Datagram Forwarding	114
<i>Tunneling and Reverse Tunneling</i>	115
<i>Mobile IPv4 and Layer 2 Interactions</i>	117
Mobile IPv4 in Practice	119
<i>3GPP2 Implementation of Mobile IPv4</i>	119
Mobile IPv6 Technology Overview	122
Mobile IPv6 Operation	123
<i>Bidirectional Tunneling Mode</i>	123
<i>Route Optimization Mode</i>	124
<i>Mobile IPv6 Messages and Message Formats</i>	126
<i>Dynamic Home Agent Discovery</i>	130
<i>Mobile IPv6 Bootstrapping</i>	131
<i>RADIUS Support for Mobile IPv6</i>	131
<i>Diameter Support for Mobile IPv6</i>	134
<i>Network Mobility Basic Support Protocol</i>	134
Mobile IPv6 in Practice	135
<i>WiMAX Forum NWG Implementation of Mobile IPv6</i>	136
Dual-Stack Mobile IP	140
Mobile IPv4 Extensions to Support IPv6	141
Mobile IPv6 Extensions to Support IPv4	142
MOBIKE Technology Overview	143
IKEv2 Terminology and Processes	144
<i>IKEv2 IKE_SAJNIT</i>	145
<i>IKEv2 IKEJKUTH</i>	146
<i>IKEv2 Message Formats</i>	148

	MOBIKE Protocol	150
	<i>MOBIKE Call Flows</i>	151
	<i>Connectivity Discovery</i>	152
	<i>Network Address Translation (NAT) Traversal</i>	153
	Authentication and Accounting	154
	MOBIKE in Practice	155
	<i>Security Architecture for Non-3GPP Access to Evolved Packet System (EPS)</i>	156
	Summary	159
	Endnotes	160
Chapter 6	Transport/Session Layer Mobility	161
	Lower-Layer Mobility Implications to the Transport Layer	162
	Solving Mobility Above the Network Layer	165
	SCTP	166
	SCTP Functional Overview	167
	SCTP States	168
	<i>Initiation</i>	168
	<i>Data Transfer</i>	169
	<i>Shutdown</i>	173
	SCTP Messages	173
	<i>Message Format</i>	173
	<i>Chunk Types</i>	174
	<i>SCTP Extensions</i>	176
	Multipath TCP	179
	Resource Pooling Principle	180
	MPTCP Functional Architecture	181
	Path Management	184
	MPTCP Application Impacts	185
	MPTCP for Mobility	185
	MSOCKS: An Architecture for Transport Layer Mobility	186
	TLM Protocol	187
	MSOCKS Summary	189
	Other Transport Layer Mobility Approaches	189
	Migrate Internet Project	190
	Migratory TCP	190

Session Layer Mobility Approaches	191
Summary	193
Endnotes	194

Chapter 7 Application Mobility 195

User-Centric Mobility	195
Application Mobility Using the Domain Name System	197
Applicability of DDNS to Interdevice and Intradvice Mobility	198
Application Mobility Using the Session Initiation Protocol	199
SIP and Capabilities	199
SIP Methods	200
SIP Message Format	201
<i>SIP Request and Status Lines</i>	201
<i>SIP Header Fields</i>	202
<i>SIP Message Body</i>	203
Basic SIP Mobility	204
<i>SIP Registration</i>	204
<i>SIP Authentication</i>	205
<i>SIP Rendezvous Service</i>	207
<i>SIP UA Mobility Example</i>	208
SIP Session Mobility	210
<i>SIP REFER-Based Session Mobility</i>	210
<i>3PCC-Based Basic Session Mobility</i>	212
<i>3PCC-Based Enhanced Session Mobility</i>	213
Other Application Aspects for Supporting Mobility	214
Summary	215
Endnotes	216

Chapter 8 Locator-Identifier Separation 219

Approaches to Locator-Identifier Separation	221
HIP	222
Benefits and Challenges	224
Locator-Identifier Separation Protocol - Mobile Node (LISP-MN)	225
LISP	225
LISP-MN	227
Benefits and Challenges	228

NAT66	229
Benefits and Challenges	230
Identifier-Locator Network Protocol (ILNP)	231
Benefits and Challenges	232
Summary	232
Parting Thoughts	232
Endnotes	233
Index	235