Contents

	Prefac	e to the	e second edition	XV	
	Preface				
	About	the aut	hor	xxvii	
	About	the con	tributing authors	xxix	
		wledger	0	xxxi	
PAR	t one	Μ	lotivation – components and markets	1	
1	Intro	iuction	1	3	
	1.1	Compo	nents are for composition	3	
	1.2	Compo	nents – custom-made versus standard software	4	
	1.3	Inevital	bility of components	6	
	1.4	The na	ture of software and deployable entities	8	
	1.5	Compo	nents are units of deployment	10	
	1.6	Lesson	is learned	12	
2	Mark	et vers	sus technology	17	
	2.1		a market	18	
	2.2	Fundar	nental properties of component technology	19	
	2.3	Market	t development	21	
		2.3.1	Strategic Focus (January 1995)	21	
		2.3.2	Ovum (1995)	22	
		2.3.3	IDC (May 1996)	22	
		2.3.4	Forrester Research (October 1996)	23	
		2.3.5	IDC (April 1999)	24	
		2.3.6	ComponentSource (2001)	25	
		2.3.7	Flashline (2001)	25	
3	Stan	dards		27	
	3.1	The ut	most importance of (quasi) standards	27	
	3.2	Wiring	standards are not enough	29	
	3.3	Too ma	any competing standards are not useful	30	
	3.4	Where	is software component technology today?	31	
	3.5	What's	s next?	-32	

PAR	т тwo	Fo	oundation		33
4	What	a com	ponent is and is not		35
	4.1	Terms a	nd concepts		35
		4.1.1	Components		36
		4.1.2	Objects		37
		4.1.3	Components and objects		38
		4.1.4	Modules		39
		4.1.5	Whitebox versus blackbox abstractions and reuse	Э	40
		4.1.6	Interfaces		42
		4.1.7	Explicit context dependencies		44
		4.1.8	Component "weight"		45
	4.2	Standar	rdization and normalization		46
		4.2.1			47
		4.2.2	Standard component worlds and normalization		47
5	Comp	onents	, interfaces, and re-entrance		49
	5.1	Compor	nents and interfaces		50
		5.1.1	Direct and indirect interfaces		50
		5.1.2	Versions		52
		5.1.3	Interfaces as contracts		53
		5.1.4	Contracts and extra-functional requirements		54
		5.1.5	Undocumented "features"		54
	5.2	What b	elongs to a contract?		55
		5.2.1	Safety and progress		55
		5.2.2	Extra-functional requirements		55
		5.2.3	Specifying time and space requirements		56
	5.3	Dress of	code – formal or informal?		57
	5.4	Callbac	ks and contracts		58
	5.5	Exampl	les of callbacks and contracts		59
		5.5.1	A directory service		60
		5.5.2	A client of the directory service		61
		5.5.3	Same client, next release		62
		5.5.4	A broken contract		64
		5.5.5	Prevention is better than cure		65
		5.5.6	Proofing the directory service		66
		5.5.7	Test functions in action		66
	5.6	From o	callbacks to objects		67
	5.7	From i	nterobject consistency to object re-entrance		74
	5.8		terference and object re-entrance: a summary		77
	5.9		sses and multithreading		79
	5.10	Histori	es		79
j	5.11	Specif	ication statements		81
6	Poly	morphi	sm		83
	6.1	-	tutability - using one for another		83
	6.2		subtypes, and type checking		- 88
	6.3	More	on subtypes		90
	6.4		languages and types		93

		3	
6.5	Types, i	nterfaces, and components	93
6.6	The par	adigm of independent extensibility	95
6.7	Safety b	by construction – viability of components	98
	6.7.1	Module safety	99
	6.7.2		99
	6.7.3	,	100
6.8		security, trust	101
6.9		ions of independent extensibility	102
	6.9.1	Bottleneck interfaces	103 104
	6.9.2	Singleton configurations	104
C 40	6.9.3	Parallel, orthogonal, and recursive extensions on versus immutability of interfaces and contracts	104
0.10		Syntactic versus semantic contract changes	105
		Contract expiry	105
		Overriding law	106
611		orms of polymorphism	100
0.11			207
Obje	ect versu	is class composition or how to avoid inheritance	109
7.1		nce the soup of the day?	109
7.2		avors to the soup	111
	7.2.1	Multiple inheritance	111
	7.2.2	Mixins	113
7.3		basic ingredients	115
7.4	•	gile base class problem	115
	7.4.1	The syntactic fragile base class problem	116
7 -	7.4.2	The semantic fragile base class problem	116
7.5		ince – more knots than meet the eye	117
7.6		ches to disciplined inheritance	122
	7.6.1 7.6.2	The specialization interface Typing the specialization interface	122 123
	7.6.2		123
	7.6.4		125
	7.6.5	Representation invariants and method refinements	130
	7.6.6	Disciplined inheritance to avoid fragile base class problems	130
	7.6.7	Creating correct subclasses without seeing superclass code	131
7.7		lass to object composition	133
7.8		ding versus delegation (or making object composition as problematica	
		ementation inheritance)	. 135
7.9	•	review of delegation and inheritance	138
		scale and granularity	139
8.1		fabstraction	140
8.2		faccounting	141
8.3		f analysis	141
8.4		f compilation	142
8.5		f delivery	143
8.6		f deployment	143
8.7	UNITS 0	f dispute	143

7

8

8.8

Units of extension

Contents

vii

145

	8.9	Units of fault containment	146
		Units of instantiation	146
	8.11	Units of installation	147
	8.12	Units of loading	147
	8.13	Units of locality	149
	8.14	Units of maintenance	150
	8.15	Units of system management	150
		Summary	150
9	Patte	rns, frameworks, architectures	151
	9.1	Forms of design-level reuse	152
		9.1.1 Sharing consistency – programming languages	152
		9.1.2 Sharing concrete solution fragments – Ilibraries	153
		9.1.3 Sharing individual contracts – interfaces	154
		9.1.4 Sharing individual interaction fragments – messages and protocols	155
		9.1.5 Sharing individual interaction architecture – patterns	156
		9.1.6 Sharing architecture – frameworks	158
		9.1.7 Sharing overall structure – system architecture	162
		9.1.8 Systems of subsystems – framework hierarchies	164
	9.2	Interoperability, legacies, and re-engineering	166
10	Progr	amming – shades of gray	169
		Different programming methods for different programmers	169
	10.2	Programming to a system	172
	10.3	Connection-oriented programming	172
	10.4	Connection-oriented programming – advanced concepts	175
	10.5	Events and messages	181
		10.5.1 Message syntax and schema – XML	183
		10.5.2 Events versus calls	185
		10.5.3 Call syntax and protocol – SOAP	186
	10.6	Ordering of events - causality, races, and glitches	187
		Very late binding – dispatch interfaces and metaprogramming	189
	10.8	Degrees of freedom – sandboxing versus static safety	192
	10.9	Recording versus scripting	192
11	What	others say	195
		Grady Booch (1987)	195
		Oscar Nierstrasz and Dennis Tsichritzis (1992 and 1995)	196
		Gio Wiederhold, Peter Wegner, and Stefano Ceri (1992)	196
		Ivar Jacobson (1993)	197
		Meta Group (1994)	197
		Jed Harris (1995)	197
		Ovum Report on Distributed Objects (1995)	198
		Robert Orfali, Dan Harkey, and Jeri Edwards (1995, 1996)	198
		Johannes Sametinger (1997)	199
		0 UML 1.3 Standard (1999)	200
		1 Desmond D'Souza and Alan Wills (1999)	200
		2 Krzysztof Czarnecki and Ulrich Eisenecker (2000)	201 202
		3 Peter Herzum and Oliver Sims (2000)	202
	11.1	4 CBSE Handbook (2001)	205

		Contents	tx.
PAF	RT THRE	E Component models and platforms	205
12	Obje	ct and component "wiring" standards	207
	12.1	Where it all came from	207
	12.2	From procedures to objects	209
	12.3	The fine print	210
		12.3.1 Specification of interfaces and object references	210
		12.3.2 Interface relationships and polymorphism	211
		12.3.3 Naming and locating services	211
		12.3.4 Compound documents	212
	12.4		214
		12.4.1 XML, XML Namespaces, XML Schema	215
		12.4.2 XML support standards	220
		12.4.3 XML document object and streaming models	221
		12.4.4 SOAP	222
		12.4.5 XML web services: WSDL, UDDI, WSFL, XLANG	224
	40 5	12.4.6 Web services and programming models	229
	12.5	Which way?	230
13	The C	DMG way: CORBA, CCM, OMA, and MDA	231
	13.1	At the heart – the object request broker	231
		13.1.1 From CORBA to OMA	235
		13.1.2 CORBA timeline	237
		13.1.3 A bit of history – system object model (SOM)	238
	13.2	Common object service specifications (CORBAservices)	239
		13.2.1 Services supporting enterprise distributed computing	240
		13.2.2 Services supporting architecture using fine-grained objects	242
	13.3	CORBA Component Model	247
		13.3.1 Portable object adapter	247
		13.3.2 CCM components	248
		13.3.3 CCM containers	252
	13.4	CORBA-compliant implementations	252
		13.4.1 BEA's WebLogic	253
		13.4.2 IBM's WebSphere	254
		13.4.3 IONA's Orbix E2A Application Server Platform	255
		13.4.4 Borland's Enterprise Server	255
	125	13.4.5 Non-for-profit implementations CORBAfacilities	256 256
		Application objects	256
		CORBA, UML, XML, and MDA	257
	13.7	13.7.1 Meta-object facility	258
		13.7.2 Model-driven architecture (MDA)	259
	4 1		
14		un way – Java, JavaBeans, EJB, and Java 2 editions	261
	14.1	Overview and history of Java component technologies 14.1.1 Java versus Java 2	261
			262
		14.1.2 Runtime environment and reference implementations	263
	14.2	14.1.3 Spectrum of editions – Micro, Standard, and Enterprise Java, the language	265
	14.∠	14.2.1 Interfaces versus classes	270
		דשיליד ווונכוומרבא גבואת לוסאבא	273

Contents

		14.2.2 Exceptions and exception handling		278
		14.2.3 Threads and synchronization		279
		14.2.4 Garbage collection		282
	14.3	JavaBeans		284
		14.3.1 Events and connections		286
		14.3.2 Properties		288
		14.3.3 Introspection		289
		14.3.4 JAR files – packaging of Java components		292
	14.4	Basic Java services		293
		14.4.1 Reflection		293
		14.4.2 Object serialization		296
		14.4.3 Java native interface		298
		14.4.4 Java AWT and JFC/Swing		299
		14.4.5 Advanced JavaBeans specifications		300
	14.5	Component variety – applets, servlets, beans, and Enterprise beans		302
		14.5.1 Java server pages (JSP) and servlets		304
		14.5.2 Contextual composition – Enterprise JavaBeans (EJB)		308
		14.5.3 Data-driven composition – message-driven beans in EJB 2.0		316
	14.6	Advanced Java services		316
		14.6.1 Distributed object model and RMI		317
		14.6.2 Java and CORBA	· .	318
		14.6.3 Enterprise service interfaces		319
		14.6.4 Java and XML		323
	14.7	Interfaces versus classes in Java, revisited		323
	14.8	JXTA and Jini		324
		14.8.1 Jini – federations of Java objects		325
		14.8.2 JXTA – peer-to-peer computing		326
	14.9	Java and web services – SunONE		328
15	The N	Aicrosoft way: COM, OLE/ActiveX, COM+, and .NET CLR		329
	15.1	The first fundamental wiring model COM		330
	15.2	COM object reuse		335
	15.3	Interfaces and polymorphism		338
		15.3.1 Categories		339
		15.3.2 Interfaces and versioning		340
	15.4	COM object creation and the COM library		340
		Initializing objects, persistence, structured storage, monikers		342
	15.6	From COM to distributed COM (DCOM)		343
		Meta-information and automation		345
	15.8	Other COM services		346
		15.8.1 Uniform data transfer		346
		15.8.2 Dispatch interfaces (dispinterfaces) and dual interfaces		347
		15.8.3 Outgoing interfaces and connectable objects		348
	15.9	· · ·		349
		15.9.1 OLE containers and servers		350
		15.9.2 Controls – from Visual Basic via OLE to ActiveX		351
	15.1	0 Contextual composition and services		353
		15.10.1 COM apartments – threading and synchronization		354
		15.10.2 Microsoft transaction server – contexts and activation		355
		15.10.3 COM+ - generalized contexts and data-driven composition		356

	15 11	Take two - the .NET Framework	357
	10.11	15.11.1 The .NET big picture	358
		15.11.2 Common language infrastructure	358
		15.11.3 COM and platform interoperation	361
		15.11.4 Exemplary .NET language $-C^{*}$	362
		15.11.5 Visual Studio .NET	366
	15.12	Assemblies - the .NET components	366
		Common language frameworks	368
	20.20	15.13.1 AppDomains, contexts, reflection, remoting	372
		15.13.2 Windows Forms, data, management	375
		15.13.3 Web Forms, Active Server Pages (ASP) .NET	376
		15.13.4 XML and data	377
		15.13.5 Enterprise services	378
		15.13.6 Web services with .NET	378
16	Some	further technologies	381
		Computer Associates' Advantage Plex	381
		Hitachi Appgallery	382
		Groove Transceiver	382
17	Strate	egic comparison	385
		Shared attributes	385
	17.2	Differences	386
	17.3	Consequences for infrastructure vendors	390
		Consequences for component vendors	395
18	Effor	s on domain standards	397
	18.1	OMG Domain Technology Committee	397
		18.1.1 OMG BODTF	398
	18.2	W3C	398
	18.3	Business processes and documents	399
		18.3.1 OASIS and ebXML	399
		18.3.2 RosettaNet and PIPs	400
		18.3.3 BizTalk.org	401
	18.4	DMTF's CIM and WBEM	402
		Java domain standard efforts	403
		OLE for process control	404
	18.7	Industry associations	404
		18.7.1 Information technology industry groupings	404
		18.7.2 Trade associations	405
		18.7.3 User associations	406
19		ing concerns	407
		Domain standards	407
	19.2	5	408
	19.3		408
	19.4		411
	19.5	Foundations – better contracts for better components	412

xi

PAR	r four	Components meet architecture and process	415
20	Comp	onent architecture	417
	-	The roles of an architecture	417
	20.2	Conceptualization - beyond objects?	418
	20,3	Definitions of key terms	419
	20.4	A tiered component architecture	421
	20.5	Components and middleware	423
	20.6	Components versus generative programming	424
21	Comp	oonent frameworks	425
	21.1	Contributions of contextual component frameworks	426
		21.1.1 Foundation and roots	426
		21.1.2 Component frameworks versus connectors	428
		21.1.3 Component frameworks versus metaprogramming	430
		21.1.4 Component frameworks versus aspect-oriented programming	430
	21.2	Frameworks for contextual composition	431
		21.2.1 COM+ contexts	432
		21.2.2 EJB containers	433
		21.2.3 CCM containers	434
		21.2.4 CLR contexts and channels	434
		21.2.5 Tuple and object spaces	436
	21.3	BlackBox component framework	437
		21.3.1 Carrier-rider-mapper design pattern	438 440
		21.3.2 Directory objects	440 441
		21.3.3 Hierarchical model view separation	441 444
		21.3.4 Container modes	444
		21.3.5 Cascaded message multicasting services	440
		21.3.6 Advanced applications based on compound documents	449
		BlackBox and OLE	451
	21.5	Portos – a hard realtime component framework and its IDE	452
		21.5.1 Structure of Portos	453
		21.5.2 Realtime scheduler	455
		21.5.3 Cross-development environment	
22		ponent development	457 457
	22.1	The methodology – component-oriented programming	457
		22.1.1 Problems of asynchrony	458
		22.1.2 Multithreading	458
		22.1.3 Learning from circuit design	460
		22.1.4 Living without implementation inheritance	460
		22.1.5 Nutshell classes	461
		22.1.6 Language support	462
		22.1.7 Dynamic base objects with forwarding semantics	464
	00.0	22.1.8 Caller encapsulation	467
		2 The environment – selecting target frameworks	467
	22.3	3 The tools – selecting programming languages	

23	Comp	oonent distribution and acquisition	469
	23.1	Building what sells – applications not components?	469
	23.2	Product cataloging and description	470
	23.3	Component location and selection	471
	23.4	Superdistribution	472
	23.5	Intermediaries	473
24	Comp	oonent assembly	475
	24.1	Systematic initialization and wiring	475
	24.2	Visual component assembly	476
	24.3	Compound documents to supersede visual assembly -	476
	24.4	Components beyond graphical user interface environments	477
	24.5	Managed and "self-guided" component assembly	478
	24.6	End-user assembly	478
	24.7	Component evolution	479
25	On th	e horizon	481
	25.1	Advanced object composition	481
		25.1.1 Delegation	481
		25.1.2 Split objects	482
		25.1.3 Environmental acquisition	483
		25.1.4 Dynamic inheritance	483
	25.2	New forms of object and component abstraction	483
		25.2.1 Subject-oriented programming	483
		25.2.2 Aspect-oriented programming	484
		25.2.3 XML components	485
PAR	T FIVE	Markets and components	487
26	Gamu	ut of markets	489
	26.1	Components	489
	26.2	Component platforms and infrastructure	490
	26.3		490
		26.3.1 Component design and implementation tools	490
		26.3.2 Component testing tools	491
		26.3.3 Component assembly tools	491
		26.3.4 Component system diagnosis and maintenance	492
	26.4	Professional services	492
		26.4.1 Component system and framework architects	492
		26.4.2 Component assembly consultants	493
		26.4.3 Component configuration management	493
		26.4.4 Component warehouses, marketing, and consulting	494
		26.4.5 Component operators, web services, application service providers	494
27	New	professions	495
	27.1	Component system architect	495
	27.2	•	496
	27.3		497
	27.4	Component assembler	497

Contents

xiii

28	A con	nponent marketing paradox	499	
	28.1	Branding	500	
	28.2	Pay per use	500	
	28.3	Co-placement of advertisements	503	
	28.4	Leveraging on newly created markets	504	
	28.5	Leverage of integrative forces	505	
Epilogue 50				
Ap	pendix	A Java versus C [#] versus Component Pascal	509	
	Usefu	I addresses and bibliography	515	
	Gloss	ary	543	
	Index		571	

Trademark notice

AppleScript, Cyberdog, HyperCard, Macintosh, Mac OS, NeXT, OpenStep, QuickTime and SANE are trademarks of Apple Computer, Inc., registered in US and other countries.

Tuxedo and WebLogic are registered trademarks of BEA Systems, Inc.

Borland, the Borland Logo, Delphi [™], C++Builder[™], Borland® VisiBroker® - RT are trademarks or registered trademarks of Borland Software Corporation in the United States and other countries. Jbed is a registered trademark of esmertec, inc.

CBToolkit, **CBConnector**, **ComponentBroker**, **DSOM**, PowerPC®, **REXX**, SOM®, VisualAge® and WebSphere® are trademarks of International Business Machines in the United States, other countries, or both.

Orbix, OrbixCOMet Desktop and OrbixWeb are trademarks of IONA.

LEGO® is a trademark of the LEGO Group.

Netscape and the Netscape N and Ship's Wheel logos are registered trademarks of Netscape Communications Corporation in the US and other countries. Netscape Communicator and Netscape Navigator are also trademarks of Netscape Communications Corporation and may be registered outside the US.

Authenticode®, ActiveX®, Visual C#[™], **COM**, **COM**+, **DCOM**, **OLE**, EXCEL®, **Internet Explorer**, Microsoft® Office, Word®, Microsoft®.NET[™], PowerPoint®, Visual Basic®, Visual C++®, Visual J++®, Visual Studio® and Windows® are either registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries.

BlackBox, Component Pascal, Direct-To-COM and Safer OLE are trademarks of Oberon Microsystems, Inc.

CORBA®, CWM™, IIOP®, MOF™, **OMA**, OMG Interface Definition Language (IDL)[™], UML[™] and XMI® are either registered trademarks or trademarks of the Object Management Group, Inc. in the United States and/or other countries.

X/Open® and OSF/1® are registered trademarks of The Open Group in the US and other countries. R/3® is a registered trademark of SAP AG in Germany and in several other countries all over the world. Sun, Sun Microsystems, the Sun Logo, EJB[™], Enterprise JavaBeans[™], J2EE[™], Java[™], JavaBeans[™], Java Naming and Directory Interface[™], **Java Naming and Discovery Service**, Java[™] Servlets, JavaMail[™], JavaServer Pages[™], JDBC[™], JNDI[™], JSP[™], Java[™] RMI, and Solaris[™] are trademarks or registered trademarks of Sun Microsystems, Inc. in the United States and other countries.

Texas Instruments Composer is a trademark of Texas Instruments.

W3C® and XML are trademarks or registered trademarks of the World Wide Web Consortium, Massachusetts Institute of Technology.