

SUBJECT INDEX

Note: Page numbers followed by “*f*” indicate figures, “*t*” indicate tables, “*b*” indicate boxes, and “*ge*” indicate glossary terms.

A

- Accountable key infrastructure, *see* AKI
- ACM (Association of computing machinery), 151*t*, 345
- Active users, 137, 138*t*, 139
- AD, *see* Architectural decision
- Added-value services, 207, 211–213
- ADLs (Architecture description languages), 53, 54, 62, 74, 213, 221, 222, 403*ge*
- Advanced applications, 391, 392, 396
- Agile service networks (ASN), 5, 6
- AKI (Accountable key infrastructure), 111*t*, 117–119, 122
- Algorithms, 15, 23, 30, 64, 142, 256–258, 261, 267, 268, 270, 287, 288, 292, 293, 296, 358, 378, 378*t*, 379, 383, 384
- Allocation requests, 328, 330–332, 334–336, 345
- Analytic models, 34*f*, 35, 36, 38, 40
- Analytics, 7, 8, 33–35, 37–39, 41–44, 169, 174, 177, 254, 274, 312, 395
- Analytics lifecycle, 33, 34, 37
- Analytics tools, 34, 35, 174, 175
- Apache software foundation, 199, 200, 364
- APIs (Application programming interfaces), 25, 36, 40, 194, 267, 269–271, 275, 278, 324, 334, 335, 339, 371, 372, 394, 401*ge*, 403*ge*
- Application architectures, 50, 53, 58, 60, 61, 63–65, 67, 73, 79, 85, 86, 228, 248, 404*ge*
- Application components, 156, 308, 325, 405*ge*
- Application development, 194, 275
- Application feature model, 53, 57, 60, 61
- Application framework, 128
- Application inputs, 239, 240
- Application instances, 227–229, 233, 338
- Application layer, 133, 136, 137, 143, 312
- Application level, 227, 233
- Application manager, 338–341, 342*f*
- Application manifest, 338, 340, 347, 403*ge*
- Application migration, 148, 150, 154, 155
- Application nodes, 135–137
- Application performance, 132, 261, 276
- Application programming interfaces, *see* APIs
- Application server, 133, 137, 138*t*, 139, 140, 143
- Applications
 - cloud-based, 6, 84, 399
 - intensive, 256, 258, 275, 277, 278, 340
 - new, 39, 201, 271, 338, 391, 392, 400*ge*
 - novel, 395, 396, 398
- AR (Architectural refactoring), 228–230, 232, 240, 241*t*, 243, 247, 248, 249*t*, 403*ge*
- Architects, 1–6, 67, 227, 230, 399, 400*ge*
- Architectural decision (AD), 54, 233, 241, 248, 249*t*, 403*ge*
- Architectural model elements, 77, 79, 80
- Architectural models, 69–72, 75, 77, 79, 81, 83, 84, 86, 87, 184
- Architectural patterns, 228, 229, 232–234, 242*f*, 243, 247, 403*ge*
- Architectural perspectives, 54, 233
- Architectural refactoring, *see* AR
- Architectural refactorings, 228–230, 232, 241*t*, 248, 403*ge*
- Architectural runtime model, 70–73, 75, 76*f*, 78, 79*f*, 80, 81, 87, 403*ge*
- Architectural tactics, 54
- Architecture conformance, 85, 86
- Architecture description languages, *see* ADLs
- Architecture design decisions, 1–4, 399
- Architecture metamodel, 73, 74, 78
- ARPKI (Attack resilient public-key infrastructure), 111*t*, 119, 122
- ASN (Agile service networks), 5, 6
- Association of computing machinery, *see* ACM
- Attack resilient public-key infrastructure, *see* ARPKI
- Attackers, 106, 109, 111, 113, 114, 116, 122, 397
- Attacks, 106, 109–111, 113, 114, 116, 117, 119, 123, 357, 358, 392, 396, 397
- Auditable version control systems, *see* AVCS

AVCS (Auditable version control systems), 354, 358, 362–365, 403*ge*

B

Big data, era of, 13, 15
 Big data analytics, 8, 38, 173, 174, 196, 279, 312, 394, 395
 Big data applications, 30, 43, 60, 199, 271, 275, 278, 391, 394
 Big data architectures, 7, 8, 33, 38, 49, 54, 67, 128, 129, 173*f*, 178, 398
 Big data environment, 39, 45, 52, 56
 Big data implementation, 167
 Big data processing, 39, 46, 129, 169, 170, 173, 174, 183, 263, 278, 312, 391, 394, 396, 397
 Big data projects, 34, 46, 49, 171
 Big data reference architecture, 52*f*
 Big data solutions, 37, 41–46, 48, 56, 167, 171, 172, 175, 176*f*, 177, 178, 273
 Big data systems, 19, 23, 27, 49, 50*f*, 52–54, 55*f*, 57, 58, 60, 61, 63, 66, 67, 128, 129, 130*f*, 135, 137, 256, 257*t*, 258, 271–273, 396, 401*ge*
 Big data technologies, 8, 50, 168, 174, 280, 393, 394, 401*ge*
 Big data workloads, 276, 277
 Biodiversity, 92, 93, 95, 96, 98–100, 403*ge*
 Browser, 105–108, 110–113, 115, 116, 119, 138, 307*t*

C

CA (Certificate authority), 106, 108–110, 113–120, 122, 403*ge*
 CA model, 106–108, 122
 current, 120, 122
 Candidate model, 78, 82
 CEP (Complex event processor), 43, 185, 197, 198
 Certificate authority, *see* CA
 Certificate issuance, 108, 109, 118
 Certificate management, 107, 117
 Certificate management transparency, 110, 115, 122
 category of, 119, 122, 123
 Certificate revocation lists, *see* CRL
 Certificate transparency, *see* CT
 Certificates, 22, 106–113, 116–120, 122, 306*t*, 310, 314, 403*ge*
 multiple, 109, 112–114, 116, 118
 received, 107, 109, 110, 112, 113, 120, 122
 Checkpointing, 296–300, 306*t*, 308–310, 312, 315
 workflow-level, 293*f*, 298, 299

CIMI (Cloud infrastructure management interface), 325*t*, 336
 Class diagrams, 213, 374, 375, 376*f*
 Classification categories, 152, 155–158
 Client requests, 25, 111, 112, 138, 143, 359
 Clients, 25, 107, 108, 111, 113, 114, 119, 120, 122, 127, 128, 135, 138*t*, 139, 141, 143, 191, 353–355, 357, 358, 359*f*, 360–364, 396, 405*ge*
 Cloud, 1–8, 91, 92, 97–101, 147, 148, 150–152, 154, 155*t*–158*t*, 162–164, 273, 278–280, 293, 294, 306*t*, 307*t*, 308, 313–315, 367–370, 395–399, 403*ge*, 404*ge*
 Cloud applications, 75, 135, 137, 144, 228, 233, 241*t*, 248, 391, 395, 397, 405*ge*
 Cloud architectures, 223, 397, 398
 Cloud autoscaling, 91–93, 97, 99, 100
 Cloud autoscaling process, 97–99
 Cloud-based services, 403*ge*, 404*ge*
 Cloud computing, 69, 92, 100, 127, 128, 149, 155*t*, 163, 164, 171, 227, 228, 253, 255, 273, 367, 385, 386, 395, 403*ge*
 Cloud computing environments, 15, 231, 233, 285, 385
 Cloud computing platform, 7, 326, 327
 Cloud ecosystem, 94*f*, 94, 95, 96*f*/96–99, 398, 400*ge*, 403*ge*
 Cloud environments, 2, 3, 91, 92, 161, 227, 228, 230, 232, 233, 247, 273, 368, 369
 Cloud infrastructure management interface, *see* CIMI
 Cloud marketplaces, 1, 2, 5
 Cloud migration, 148, 150, 151, 153, 161, 163, 247, 403*ge*
 Cloud model, 171, 172
 Cloud platforms, 47, 150, 171, 311, 324, 326, 329, 340, 345, 394, 398
 Cloud provider characteristic, 157*t*, 158*t*, 160
 Cloud providers, 4, 6, 70, 71*f*, 71, 95, 128, 155*t*, 156*t*, 157*t*, 161–164, 171, 172, 273, 314, 323, 324, 349, 353, 371, 372, 385
 public, 353, 357, 362
 Cloud resources, 279, 323, 324, 326, 337, 338, 340, 349, 367, 370, 374, 375, 385, 386, 404*ge*
 Cloud service providers, 3, 5, 158*t*
 Cloud services, 46, 69, 223, 273, 311, 353, 368, 371, 403*ge*
 Cloud storage, 273
 Cloud tenants, 323, 324, 326, 336, 340, 347, 349
 Cloud-architecture, 2, 217–219, 222, 223
 Cloud-based architectures, 5–7, 213

Cloud-based services, 41, 91, 92, 94–97, 99–101, 223, 398, 403*ge*
 removing, 95, 96, 99
 Cloud-based software applications, 70, 71, 84, 87
 Cloud-based systems, 2–4, 69, 156, 403*ge*, 404*ge*
 Cloudbus WMS, 368, 370, 372*f*, 372, 374, 378–380, 382, 384–386
 Cloudbus workflow management system, 373
 Clusters, spark, 268, 269, 271
 CoCoME (Common component modeling example), 70, 71*f*, 71, 72, 75, 80, 82
 CoCoME scenario, 72, 80–82
 Coevolution, 94, 97, 100
 Common component modeling example, *see* CoCoME
 Communication service provider, *see* CSP
 Complex event processing system, 198, 201*t*–204*t*
 Complex event processor, *see* CEP
 Component data processing server, 61, 64, 66
 Component data storage, 61, 66
 Component information management server, 61, 63, 64, 66
 Component structure, 71, 72, 79, 85
 Components
 architectural, 1, 7, 372*f*, 374*f*–376*f*, 399
 stateless, 233, 234, 245*t*
 Computational resources, 19, 132, 155, 312
 Computations, 8, 9, 106, 186, 263, 266, 267, 269, 270, 276, 277, 279, 292, 297, 309, 344, 345, 363, 364, 378, 379, 403*ge*–406*ge*
 Connections, 27, 61, 62, 64, 107, 109, 111, 112, 114, 116, 138, 139, 194, 217, 307*t*
 Consistency models, weak, 23, 24
 Costs, operational, 5, 6, 19, 22, 23, 273, 357
 CRL (Certificate revocation lists), 107, 109
 Cross-resource scheduler, *see* CRS
 CRS (Cross-resource scheduler), 338, 339, 346, 349
 CSP (Communication service provider), 42, 42*f*, 43
 CT (Certificate transparency), 111*t*, 116–118

D

Data events, 187, 191, 192
 Data execution, 191, 193, 201*t*
 Data intensive computing, 259
 Data lake, 35, 36*f*, 36–38, 40, 43, 44, 46, 168*t*, 173, 404*ge*
 Data models, 24, 57, 59*t*, 60, 207, 215–217, 222, 400*ge*
 key-value, 59*t*, 60, 61

Data stream management systems, 184, 185, 197, 198, 404*ge*
 Data stream management systems, *see* DSMS
 Data systems, cloud-based big, 127, 128, 130, 131*f*, 135, 136*f*, 143, 144
 Data warehouse solution, 172, 175, 176*f*, 176, 177
 Data-intensive workflows, 290, 293–295
 Database management systems, *see* DBMS
 Database service, 70, 82, 95
 Database-as-a-Service (DBaaS), 70, 71*f*
 DataConversion component, 216, 217
 DataConversion service, 216, 217, 219
 Dataflow engine, *see* DFEs
 DBaaS (Database-as-a-Service), 70, 71
 DBMS (Database management systems), 185, 194, 198, 404*ge*
 Deadline, 5, 286, 296, 302, 305, 379, 382–384, 384*t*, 404*ge*, 405*ge*
 Degree montage workflow, 382
 Denial of service (DoS), 109, 122
 Deployment diagram, 62–64
 Descriptive architectural runtime models, 77, 78*f*, 82
 Design decisions, 2, 4, 54, 65, 67, 77, 84, 399, 400*ge*
 choice of architecture, 2, 399
 Design rule set, 60–65
 Design rules, 50, 53, 60–65, 67, 404*ge*
 Development models, 70, 75, 85, 86
 DFEs (Dataflow engine), 329, 330, 332, 340–342, 342*t*, 343, 343*f*, 343*t*, 344, 404*ge*
 Disruptive tenants, 127, 132, 133, 135, 137–142, 144, 403*ge*–405*ge*
 Distributed resources, 287, 290, 310, 311, 370, 372, 373
 DNS security extensions (DNSSEC), 115
 DNSSEC (DNS security extensions), 115
 Domain objects, 235, 239, 246
 Domain owners, 109, 116, 117, 119, 120
 Domain servers, 107–109, 111–115, 120
 Domains, 29, 49–51, 54, 74, 107, 109–111, 113–120, 122, 151, 211, 247, 258, 269, 290, 404*ge*
 DoS (Denial of service), 109, 122
 DSMS (Data stream management systems), 184, 185, 197, 198, 203*t*, 404*ge*
 Dynamic content, 70–72, 79, 86, 87

E

EAI (Enterprise application integration), 29
 Ecology-inspired pattern, 97, 98*f*, 99

Ecosystem, 36, 45, 93–95, 97, 98, 170, 207, 212, 213, 223, 224
 EMS (Energy management system), 65, 67
 End-users, 128, 150, 151, 345
 Energy management system, *see* EMS
 Engines, 184, 185, 187, 188, 190, 191, 197, 200, 202, 261, 277, 370, 371, 373, 375, 377, 381
 Enterprise application integration (EAI), 29
 Enterprise applications, 148, 150, 151, 153, 231, 235, 239, 240, 404*ge*
 existing, 158, 227, 228
 Enterprises, 1, 6, 42, 147, 148, 150–152, 171, 172, 391, 393, 396, 397, 401*ge*
 European conference on software architecture, *see* ECSA
 Evolution, 4, 6, 29, 33, 53, 67, 73, 92–100, 198, 248, 280, 399, 404*ge*
 Exascale, 280
 Execution contexts, 73, 79, 80, 82

F

Facebook, 13, 23, 29, 42, 53, 54, 61, 63, 64, 67, 106, 187, 240, 254, 264, 393, 400*ge*
 Failure modeling, 303, 304*f*, 304
 Failure probability, 302–305
 Failures, 21, 22, 25, 150, 151, 194, 195, 257*t*, 260, 265, 266, 285, 290, 291, 295–297, 299, 301–305, 308, 309, 313, 314, 396
 Family feature model, 53, 60, 61, 63–67, 404*ge*
 Fault-tolerance, 9, 22, 248, 285–290, 292*f*, 292, 293, 295–297, 300–302, 304, 309, 310, 314, 315
 Faults, 202, 262, 285, 286, 289–291, 291*f*, 296, 308–310, 313, 315
 Feature model, 49–51, 54, 58, 60, 62, 67, 404*ge*
 Feature modeling, 49, 51
 File versions, 354–358, 360, 361, 363
 arbitrary, 354–357, 359
 new, 355, 358, 360, 361, 405*ge*

G

General-purpose computation on graphics processing units, *see* GPGPUs
 Generative approach, 217, 220–224
 GFS (Google file system), 254, 259–261, 312
 Google file system, *see* GFS
 GPGPUs (General-purpose computation on graphics processing units), 276, 323, 325, 339

GPUs (Graphics processing unit), 194, 276, 277, 326, 405*ge*
 Graph data model, 59*t*, 60, 61
 Graphics processing unit, *see* GPUs
 Grid computing, 100, 309
 Grids, 285, 293, 306*t*, 307*t*, 308, 311, 313, 315, 369, 386

H

Hadoop, 8, 9, 24, 183, 184, 199, 263–266, 268–270, 272*t*, 272, 2723, 274*t*, 279, 293, 294, 313
 Hadoop distributed file system, *see* HDFS
 Hardware resources, 19, 91, 95–97, 100, 128, 192
 Harness, 194, 261, 323–326, 336, 338, 341, 345, 349, 350
 Harness cloud platform, 324, 340
 Harness platform, 326, 338, 340, 342, 347
 Harness resource managers, 328, 331, 335, 336
 HDFS (Hadoop distributed file system), 8, 9, 64, 173, 263, 264, 266, 268–270, 272*t*, 273, 276–278, 293, 294, 312
 Heterogeneous resources, 293, 302, 323, 326, 327, 329, 331, 335*f*, 339, 341
 High performance computers, *see* HPC
 Hosting big data, 167
 HPC applications, 340, 349
 HPC (High performance computers), 256, 271, 272, 279, 280, 404*ge*
 Hyperscalability, 14, 19, 396
 Hyperscalable systems, 13, 14, 19, 20, 27, 396
 Hyperscale, 14, 22, 23, 26, 30
 Hyperscale systems, 14, 20–22, 28, 30

I

IaaS clouds, 369, 374
 IEEE Xplore, 51, 148, 149, 151*t*, 153*t*
 Implementation level, 69, 71, 75, 77, 78
 In-memory processing, 57, 59*t*, 60, 64, 65, 277, 280
 In-stream processing, 57, 59*t*, 60
 Indicators, 2, 147, 148, 150*t*, 151*t*, 151, 152*t*, 153*t*, 153, 155, 157*t*, 158*t*, 159, 160, 162–164, 403*ge*, 404*ge*
 Information, biotic, 92, 97
 Input data, 185, 256, 258, 260, 261, 268, 269, 276, 308, 309, 312, 378, 381
 Intensive frameworks, 256, 258, 259, 268, 275–278, 280
 Internet of things, *see* IoT

IObserve, 70, 72, 73, 77–82, 83*f*, 84*f*, 84, 86, 87, 403*ge*
 IObserve approach, 70, 72, 74, 75, 77, 80, 84, 87
 IObserve context, 73, 75, 87, 403*ge*
 IObserve megamodel, 75, 79*f*, 87
 IoT (Internet of things), 4, 37, 39, 49, 170, 255, 275, 279, 280, 392, 398, 399

J

Java virtual machine (JVM), 201, 203*t*, 263

K

Key, private, 107, 113, 116, 118

L

Legacy applications, 152, 158*t*, 231–234, 370, 386
 single-tenant, 229, 232*f*
 LookUp service, 217–220

M

Machine crashes, 290, 291, 308–310
 Maintenance, 155*t*, 196, 197, 203, 247, 248, 266
 Maintenance costs, 196, 323
 Managers, top-level, 328, 330*t*, 330, 331
 Map tasks, 261, 294, 313, 370
 MapReduce, 7, 9, 199, 254, 257*t*, 257, 259–263, 267, 269, 275–278, 280, 290, 294, 312, 313, 394
 MapReduce application, 261, 265, 278, 279
 MapReduce programming model, 267, 280
 MapReduce tasks, 264, 266, 277
 MapReduce workflow, 290, 293, 312, 313
 Mass storage systems and technologies, *see* MSST
 MDE, *see* Model-driven engineering
 Megamodel, 70, 75, 77, 84, 404*ge*
 Metadata, 27, 41, 45–48, 174, 260, 265, 339, 355, 357–359, 363
 Metamodel, 74, 75, 77, 217
 Migrating, 70, 71, 148, 149, 152, 157*t*, 158*t*, 164
 Migration, 73, 78, 81, 82, 84, 86, 147, 148, 153–155, 156*t*–158*t*, 158–164, 306*t*, 308, 394, 398
 Migration models, 161, 163
 Mis-issued certificates, 107, 109, 113–117, 122
 Mobility services, 210, 219
 Model level, 75, 76*f*
 Model-driven engineering (MDE), 73, 212, 405*ge*
 Model-view-controller, *see* MVC
 Models
 adversarial, 354, 357
 domain, 49–51, 53, 236*f*, 243, 404*ge*

 hybrid, 175, 177, 178*f*

 pull, 201, 202*t*

Modern stream processing platforms, 187, 188

Monitoring approach, 75, 77

Monitoring data, 71, 75, 76*f*, 77, 79, 85, 86, 405*ge*

Montage application, 379, 381

Montage workflows, 378, 379, 380, 380*f*, 381, 381*t*, 384, 384*t*

Multitenancy, 1–4, 7, 160, 174, 228, 232*f*, 232–235, 241, 246–248, 398, 399, 405*ge*

Multitenancy defects, 238*f*, 241*t*

Multitenancy requirements, 233, 246*t*, 246

Multitenant, 3, 4, 231, 235, 241, 245*t*, 246*t*

Multitenant applications, 134*f*, 144, 227, 228, 230, 235, 237, 239, 243, 247

Multitenant databases, 235, 243

Multitenant requirements, various, 2, 3, 399

Multitenant SaaS applications, 227, 229, 240, 247

MVC (Model-view-controller), 136, 231, 234, 235, 240, 241, 248

N

Nodes, master, 260, 263, 380, 381

Nonliving components, 92, 93, 95

Notary servers, 111, 112, 120

Number, total, 131, 344, 363

O

OASIS (Organization for the advancement of structured information standards), 324, 325

Observers, 110–112, 120, 122, 123, 234

OCCI (Open cloud computing interface), 325*t*, 336

OCSP (On-line certificate status protocol), 107, 109

On-line certificate status protocol, *see* OCSP

Open cloud computing interface, *see* OCCI

Open source projects, 169, 170, 199, 265

Operation phase, 69, 70, 77, 79, 85, 86

Operational observations, 70, 77, 86

Operations, proper, 195, 196, 202, 204*t*

Operators, 26, 69–72, 77–80, 82–85, 186, 272

Organization for the advancement of structured information standards, *see* OASIS

Organizational, 155*t*–158*t*, 158

P

Palladio component model, *see* PCM

Parties, 105–110, 115–118, 120, 123, 151, 156*t*, 303, 357, 362, 392

 trusted, 106, 108, 114, 118, 119, 123

PCM (Palladio component model), 73–75, 77, 78, 81, 82, 87
PDPs (Platform deployment package), 325
PE (processing elements), 192, 199, 256, 257, 257*t*, 272, 279, 404*ge*, 405*ge*
Performance isolation, 127, 132–135, 136, 136*f*, 137, 139, 140*t*, 140, 142–145, 405*ge*
Performance isolation approaches, 127, 128, 134*f*, 142, 144
Performance models, 326, 329, 340–341, 342*f*, 347*f*, 348, 349
Performance monitoring, 128, 144
Performance problems, 132, 396
Persistence component, 215, 216
Persistence service, 214–219
Person, 33, 34, 208, 209, 209*f*, 210, 212, 214, 219, 220, 253, 392, 393, 396
Personal data, 207, 209–214, 217–219, 221
Personal data service, 216–219
PKI (Public key infrastructure), 105, 106, 110, 123, 403*ge*, 405*ge*
PKP (Public key pinning), 111, 114, 115
Platform deployment package (PDPs), 325
Platforms, surveyed, 194, 195, 200–202
PNs, *see* Processing nodes
Previous version, immediate, 354, 355, 359, 361, 404*ge*, 405*ge*
Pricing model, 341, 348, 385
Primary studies, 149, 151, 154, 155, 159*f*, 163, 164
Privacy, 7, 8, 37, 38, 56, 59*t*, 61, 71–73, 74, 74*f*, 75, 76*f*, 78, 79, 82, 214, 273, 392, 393, 395–397, 400*ge*, 401*ge*
Processing elements, *see* PE
Processing nodes (PNs), 19, 187, 188, 188*f*, 189, 191, 193, 195, 199
Properties
 tenant data separation, 238, 239, 245*t* 246, 248
 tenant ID, 235, 237, 241, 245*t*
Public clouds, untrusted, 354, 365
Public key infrastructure, *see* PKI
Public key pinning, *see* PKP

Q

QA, *see* Quality attributes
QoS (Quality of services), 3, 5, 6, 91, 93*t*, 98, 99, 140*t*, 144, 288, 289, 312, 367
Quality attributes (QA), 2, 5, 18, 19, 241*t*, 248, 249*t*, 403*ge*

Quality criteria, 149, 152*t*
Quality of services, *see* QoS
Query processing, real-time, 57, 61, 64–66

R

RDIC approaches, 354, 364*t*, 365
Reduce tasks, 261, 262, 294, 313
Reengineering method, 230, 240, 243, 246
Reference architecture, 50, 51*t*, 52–54, 56, 57, 60–62, 66, 67, 74*f*, 75, 87, 129, 370, 371*f*, 386, 404*ge*, 405*ge*
Relational databases, 23, 24, 36, 57, 59*t*, 61, 64, 66, 215, 216, 394
Repository, 37, 73, 353–355, 358–363, 364*t*, 404*ge*, 406*ge*
Request load, 14, 17, 18, 21
Request rate, 133, 138, 139, 404*ge*, 405*ge*
Requesters, 112, 210
Requests, 18, 25, 39, 40, 43, 44, 80, 132, 133, 135, 136, 137*f*, 137, 138*t*, 138, 139, 140, 142*f*, 142, 143, 191, 210, 266, 298, 299, 328–335, 338, 339, 345, 346
Requests per second (RPS), 80, 135, 138
Requirements, significant, 1–4, 7, 8, 391, 395, 397–400
Resource allocation requests, 329, 332, 333*f*, 133, 334*f*
Resource broker, 287
Resource configurations, 341, 347, 349
Resource containers, 74, 81
Resource environment, 81, 403*ge*
Resource instances, 336, 339
Resource managers, 192, 308, 326, 328*f*, 328, 329, 335, 336
 child, 330*f*, 330, 331
Resource pool, 367, 385
Resource pooling, 1, 233
Resource provisioning, 312, 367, 370, 376, 379
Resource relationship, 93, 406*ge*
Resource types, 293, 325, 329, 331, 335
Resources
 allocating, 329, 345
 available, 142, 192, 266, 279, 309, 329, 330, 336, 367, 370, 374, 396
 new, 292, 293
 physical, 6, 19, 275, 279, 339, 369
 remote, 308, 373
 specialized, 326, 327, 349
Retrieve phase, 359, 360, 362, 364

Reverse time migration, *see* RTM
 Risks, 4–7, 27, 107, 147, 151, 152*t*, 152, 153*t*, 154, 155, 156*t*, 156, 157*t*, 158–160, 162, 164, 174, 193, 248, 392, 393, 395, 397, 398, 400*ge*, 404*ge*
 RPS (Requests per second), 80, 135, 138
 RTM jobs, 341, 343, 344
 RTM (Reverse time migration), 340, 342
 Runtime models, 76*f*, 85, 86, 403*ge*, 405*ge*
 prescriptive architectural, 77, 78*f*, 81, 87

S

SaaS applications, 136, 227, 228, 233, 247
 Sales service, 71, 81, 82
 Scheduler, cross-resource, 338, 339, 349
 Schedules, 13, 195, 287, 292, 293, 295, 302, 304, 305, 308, 315, 379
 Scheduling algorithms, 278*t*, 288, 302, 303, 374, 377–379, 385
 Scientific applications, 7, 369, 370, 385, 405*ge*
 Scientific workflow management system, 405*ge*
 Scientific workflows, 285, 311, 367–370, 379, 385, 386, 405*ge*, 406*ge*
 Security risks, 162, 395
 Self-aware patterns, 92, 97–99
 Server, 22, 23, 25, 30, 64, 65, 105, 108, 111, 112, 123, 128, 135, 139, 141, 142, 191, 357–364, 404*ge*, 405*ge*
 Service composition, 207, 209, 219–222, 224, 405*ge*
 Service developers, 207, 211–214, 220, 221
 Service instance, 5, 25, 80
 Service interfaces, 211, 212, 215, 233
 Service level agreements, *see* SLAs
 Service providers, 5, 107, 108, 119, 210, 213, 214, 219, 220, 223, 247, 302, 312, 358, 405*ge*
 Service provision, 5, 7
 Service users, 207, 212, 219, 223, 224
 Service-level objective, *see* SLO
 Services
 aggregated, 80, 82
 basic, 219, 220, 223, 405*ge*
 cloud information, 371, 377, 386
 existing business, 176, 177
 grid, 100, 310, 311, 369
 new, 219, 220
 public transportation, 213, 214*f*
 quality of, 91, 140, 141, 144
 querying, 218, 219
 stateless, 25, 26, 233

Skip version, 356, 357, 359, 361–363
 SLAs (Service level agreements), 1, 2, 4–6, 91, 92, 95, 96, 132, 138, 138, 140*t*, 144, 147, 158, 162, 170, 172, 393, 399, 403*ge*
 SLO (Service-level objective), 326, 338, 341, 345, 347, 405*ge*
 Software applications, 5, 73, 79, 80, 86, 127, 147, 148, 164, 227, 228, 403*ge*–405*ge*
 executed, 72, 403*ge*, 405*ge*
 Software architecture, 1, 2, 4, 30, 67, 69, 70, 72, 73, 77–79, 88, 212, 326, 391, 395–398, 401*ge*, 405*ge*
 Software configurations, 91, 95, 96, 99, 100, 403*ge*
 Software development, 355, 404*ge*
 Solution details, 228
 Source category, 155*t*–158*t*
 Source code, 70, 83, 86, 240, 243, 298, 353, 364
 Spark SQL, 270, 271
 Spark streaming, 184, 193, 194, 200–202, 270, 271*t*, 201, 202*t*, 202
 Spring, 187, 199–201, 201*t*–203*t*
 Stream processing, 9, 57, 184–187, 189, 191, 193, 197, 202, 258, 265, 405*ge*
 Stream processing platforms, 184–187, 188*f*, 188, 189*f*, 190, 191, 193, 194, 196*f*, 196–198, 200, 201*t*, 201, 202*t*, 203*t*, 203, 204*t*, 204
 Stream processing systems, 184–187, 189–195, 197, 198, 200, 203
 Studies, 95, 100, 128, 130, 132, 137, 139, 143, 147–149, 150*t*, 150, 151*t*, 151, 152*t*, 152, 153*t*, 153, 154*t*, 154–156, 158, 160, 161*f*, 161–164, 184, 196, 197, 204, 246
 included, 154*t*, 154, 155
 pilot, 147–149, 152
 Subcategories, 152, 154, 158, 160
 Subcomponents, 213, 215
 System categories, 39, 40*f*, 45, 120

T

Tasks, 15, 16, 78, 191–193, 199, 200, 257*t*, 261, 262, 272, 286, 287, 290–296, 298–305, 308–313, 369, 370, 372–375, 377, 378*t*, 378–380, 381, 381*t*, 382, 384–386
 mProjectPP, 379, 384, 385
 Taxonomy, 184, 185, 187, 189, 197, 203, 204, 289, 290, 292
 Tenant data separation, 232, 240, 241, 247, 248
 Tenant data separation defects, 229, 238–240, 243, 246
 Tenant ID, 229, 230, 235, 238, 245*t*
 Tenant identifier, 235, 239, 241, 246

Tenant information, 135, 136
 Tenant owner, 235, 239, 241, 242
 Tenants, 3, 4, 127, 130, 132, 133, 135, 138*t*, 138, 140*t*,
 140–142, 144, 228–230, 233, 235–243, 245*t*,
 245–247, 345, 346, 399, 405*ge*
 abiding, 138*t*, 138–141
 Thin clients, 128, 136, 405*ge*
 TLS (Transport layer security), 113, 358, 404*ge*, 405*ge*
 Topology and orchestration specification for cloud
 applications, *see* TOSCA
 Tork framework, 135–137
 TOSCA (Topology and orchestration specification for
 cloud applications), 324, 325*t*, 336
 Transformations, 34, 62–66, 72, 75, 76*f*, 79*f*, 80–82,
 217, 229, 264, 268, 269, 300, 404*ge*
 Transport layer security, *see* TLS
 Trust, 5, 7, 36, 37, 41, 56, 107, 108, 110, 112–114,
 116, 117, 120, 121*t*, 123, 132, 302, 303, 360,
 396, 397
 direct, 303, 305
 independence of, 107, 108, 114
 recommendation, 303, 305
 Trust agility, 107, 108, 110, 111, 113–115, 117, 120
 Trust models, 302, 303

U

ULSs (Ultra large systems), 29, 30
 Ultra large systems, *see* ULSs
 Uncertainty, 1, 3, 91, 92, 99–101, 289, 290, 302, 304,
 305

V

Value, 4–7, 33, 34, 38, 41, 45–47, 80, 140, 143, 159,
 183, 184, 217, 253, 254, 356, 382, 391, 392
 Value pairs, 261, 262, 313
 VCS, *see* Version control systems
 VCS clients, 355, 357
 VCS server, 355, 357–359, 361, 362
 Version, 21, 123, 170, 197, 310, 325*t*, 354–357,
 359–361, 363, 364*t*, 364, 381, 403*ge*, 404*ge*,
 406*ge*
 new, 21, 27, 170, 171, 199, 356, 359, 361
 pattern-based, 245, 245*t*, 246–248, 364*t*

Version control systems (VCS), 353–355, 357–359,
 363–365, 403*ge*, 406*ge*
 delta-based, 354, 356*f*, 358, 359, 365
 Virtual machines, *see* VMs
 Visualization, 27, 54, 80, 82–84, 86, 253, 254, 278,
 394, 396, 401*ge*
 VM types, 345, 369, 377, 378, 384, 385
 VMs (Virtual machines), 22, 82, 95, 97, 150, 297, 312,
 325, 326, 330, 336, 339, 340, 367, 369–371,
 374–377, 381, 382*t*, 383, 384*t*, 384, 385*t*, 385

W

WCO (Workflow coordinator), 374, 378
 Weakness, 111–120, 263, 315
 WMSs (Workflow management systems, WFMS),
 285, 286*f*, 286–291, 295, 297, 300–302, 305,
 306*t*, 307*t*, 308, 310, 311, 313–315, 367–370,
 371*f*, 385
 Word count application, 261, 262
 Workflow applications, 287, 308, 368, 369, 385, 406*ge*
 Workflow coordinator, *see* WCO
 Workflow engine, 310, 311, 313, 370, 371, 373, 377,
 380, 386
 Workflow execution, 286, 287, 294, 308, 367, 369,
 370, 374, 375, 378*t*, 382–385
 Workflow level, 308–310
 Workflow management systems, *see* WMSs
 Workflow scheduling, 266, 285–287, 288*f*
 Workflow tasks, 287, 290, 367, 370, 378–381, 406*ge*
 Workflows, 85, 262, 266, 277, 285–288, 290, 291,
 293–295, 297, 300–302, 304*f*, 305, 306,
 308–315, 367–370, 372–375, 377, 378*t*,
 378–386, 406*ge*
 abstract, 286, 287, 308, 309

Y

YARN (Yet another resource negotiator), 192, 201*t*,
 266, 268, 272*t*, 274*t*, 277
 Yet another resource negotiator, *see* YARN

Z

Zend skeleton application, 240, 243