Index

802  202, 207
    see also Ethernet
802.1D  202
802.11a (“WiFi”)  297, 298
802.11b (“WiFi”)  297–8
802.11g (“WiFi”)  298
802.16 (“WiMax”)
    access technology  301
    standardization  76
802.17, see Resilient packet ring (RPR)
802.1ad (“Provider Bridges”)
    features  203
    standardization  76
802.1ab (“Backbone Provider Bridges”)
    features  203
    standardization  76
802.20  301
802.3ae (10 Gbps LAN), standard  76, 204

Application-empowered optical network
    (AEON)  525
Application Grid  7
Application-initiated connections  229
ARPANET  101
ASON, see Automatically switched optical networks (ASON)
Assured forwarding  107
Asynchronous transfer mode
    (ATM)  199
Authentication, authorization, and accounting (AAA)  59, 114, 136
    example of network service  114
    trust model  137
Automatically switched optical networks
    (ASON)  74, 313
Autonomous system (AS)  186, 189, 254

Bandwidth characteristics  256
    achievable bandwidth  256
    available bandwidth  256
    capacity  256
    utilization  256
Behavioral control  224–9
    L1  224
    L2  224
    Berkeley sockets  179
BGP, see Border gateway protocol
    BIC  153, 160
    BIC TCP  160
Biomedical Informatics Research Network (BIRN)  316

Access Grid  7
Ad hoc wireless networks  297
Additive increase multiplicative decrease (AIMD)  172
AEON, see Application-empowered optical network (AEON)
AIST, see National Institute of Advanced Industrial Science and Technology
    (AIST)
All-photonic  235–6
    network service  235

Grid Networks: Enabling Grids with Advanced Communication Technology  Franco Travostino, Joe Mambretti, Gigi Karmous-Edwards  © 2006 John Wiley & Sons, Ltd
Bit error rate (BER) 219
Border gateway protocol (BGP) 65, 189
component of grid network infrastructure 135
element of IP networks 198
BPEL4WS, see Business process execution language for web services (BPEL4WS)
Broadband over power lines (BPL) 301
Burst 240–50
Burst control packet (BCP) 242
Business Process Execution Language for Web Services (BPEL4WS) 70, 89, 139
component of grid network infrastructure 139
standardization 70

CA*net4 292, 326
California Institute of Telecommunications and Information Technology (Calit2) 34
CANARIE 326–7
CAVERNsoft 181
CERN 25–6
CESNET 321
CHEETAH (circuit-switched high-speed end-to-end transport architecture) 316
CineGrid 33–6
Cipher block chaining (CBC) 194
Closeness characteristics 257–8
Cognitive radio 298–9
Collaboration 18–23
Command line interfaces (CLI) 127
Common information model bindings of a grid network infrastructure 113, 127
standardization 73
Community scheduler framework (CSF) 119
Composable-UDT 178
Computational science 26–7
Congestion loss 268
class-based QoS 271–2
distributed deflection 270–1
local deflection 270
neighbor deflection 270
Control plane 225–6
functions 226
DAME, see Distributed Aircraft Maintenance Environment (DAME)
Data Grid 7
Data mining 30–3
Decentralization 56, 280
Decreasing AIMD or DAIMD 176–7
Delay characteristics 256–7
Department of Energy (DOE) 323
Determinism 220
Differentiated services code point (DSCP) 187
Differentiated services field 86–7, 105–7, 187–8
DiffServ 87, 93, 105, 106–7, 188
Distributed Aircraft Maintenance Environment (DAME) 36–41
Distributed Management Task Force (DMTF), profile 73–4
Distributed optical testbed (DOT) 314
DOE, see Department of Energy (DOE)
DOT, see Distributed optical testbed (DOT)
DRAC service plane 65
DRAGON (Dynamic Resource Allocation via GMPLS Optical Networks) 316–17
DWDM-RAM 123–6, 134
features 123–4
overview 123–4
Dynamic Ethernet intelligent transit interface (DEITI) 94
Dynamic range 237

EarthScope 316
EGEE, see Enabling Grids for E-Science (EGEE)
Electronic Visualization Laboratory (EVL) 20, 23, 34, 324
Enabling Grids for E-Science (EGEE) 330
End-to-end principle 8, 101–2
Endpoint reference 129
EnLIGHTened 319
Enterprise Grid Alliance (EGA), profile 69–70
E-science applications 219
Ethernet
Ethernet-over-SONET 206–7
future wire rates 204
metro and WAN challenges 202
OAM 205
profile 201–5
provider-provisioned service 69
<table>
<thead>
<tr>
<th>Term</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethernet-over-SONET</td>
<td>109</td>
</tr>
<tr>
<td>EU datagrid</td>
<td>259</td>
</tr>
<tr>
<td>Euro-Link</td>
<td>324</td>
</tr>
<tr>
<td>EVL, see Electronic Visualization Laboratory (EVL)</td>
<td>166-7</td>
</tr>
<tr>
<td>eVLBI</td>
<td>284</td>
</tr>
<tr>
<td>Expedited forwarding (EF)</td>
<td>106</td>
</tr>
<tr>
<td>Explicit congestion control protocol (XCP)</td>
<td>166-7</td>
</tr>
<tr>
<td>Exterior BGP (EBGP)</td>
<td>189</td>
</tr>
<tr>
<td>Exterior gateway protocol (EGP)</td>
<td>189</td>
</tr>
<tr>
<td>Extra-Grid</td>
<td>7</td>
</tr>
<tr>
<td>FAST</td>
<td>153, 158, 159–60</td>
</tr>
<tr>
<td>Fault detection</td>
<td>263–4</td>
</tr>
<tr>
<td>Fiber switches (FXCs)</td>
<td>217</td>
</tr>
<tr>
<td>Fiber to the premises (FTTP)</td>
<td>300</td>
</tr>
<tr>
<td>Forward equivalent class (FEC)</td>
<td>268</td>
</tr>
<tr>
<td>Frame relay</td>
<td>198, 200</td>
</tr>
<tr>
<td>Free space optics (FSO)</td>
<td>301</td>
</tr>
<tr>
<td>FXCs, see Fiber switches (FXCs)</td>
<td></td>
</tr>
<tr>
<td>G.7042</td>
<td>109</td>
</tr>
<tr>
<td>G.709</td>
<td>109</td>
</tr>
<tr>
<td>GÈANT2</td>
<td>322</td>
</tr>
<tr>
<td>GEL, see Global E-science laboratory (GEL)</td>
<td></td>
</tr>
<tr>
<td>General-purpose architecture for reservation and allocation (GARA)</td>
<td>93, 107, 121</td>
</tr>
<tr>
<td>Generic framing procedure (GFP)</td>
<td>109</td>
</tr>
<tr>
<td>standard</td>
<td>74</td>
</tr>
<tr>
<td>Generic route encapsulation (GRE)</td>
<td>200</td>
</tr>
<tr>
<td>GENI, see Global Environment for Network Innovations (GENI)</td>
<td>522</td>
</tr>
<tr>
<td>GGF NM-WG</td>
<td>255</td>
</tr>
<tr>
<td>GigaPort</td>
<td>325, 327</td>
</tr>
<tr>
<td>GLIF open lightpath exchange (GOLE)</td>
<td>324, 325</td>
</tr>
<tr>
<td>GLIF, see Global Lambda Integrated Facility (GLIF)</td>
<td>97, 291, 328–9</td>
</tr>
<tr>
<td>Global Environment for Network Innovations (GENI)</td>
<td>522</td>
</tr>
<tr>
<td>Global E-science laboratory (GEL)</td>
<td>224</td>
</tr>
<tr>
<td>Global Grid Forum (GGF), profile, 10, 68</td>
<td></td>
</tr>
<tr>
<td>Global Lambda Grid</td>
<td>7</td>
</tr>
<tr>
<td>Global Lambda Integrated Facility (GLIF)</td>
<td>97, 291, 328–9</td>
</tr>
<tr>
<td>GLORIAD, see Global Ring Network for Advanced Application Development (GLORIAD)</td>
<td>529</td>
</tr>
<tr>
<td>Globus toolkit</td>
<td>115–17</td>
</tr>
<tr>
<td>data management</td>
<td>119</td>
</tr>
<tr>
<td>execution management</td>
<td>118–19</td>
</tr>
<tr>
<td>extensible I/O</td>
<td>122</td>
</tr>
<tr>
<td>monitoring and discovery</td>
<td>119–20</td>
</tr>
<tr>
<td>security</td>
<td>120</td>
</tr>
<tr>
<td>GOLE, see GLIF open lightpath exchange (GOLE)</td>
<td></td>
</tr>
<tr>
<td>Grid</td>
<td>2–3</td>
</tr>
<tr>
<td>Grid abstraction</td>
<td>2, 4, 5–6</td>
</tr>
<tr>
<td>Grid architectural principles</td>
<td>1</td>
</tr>
<tr>
<td>Grid customization</td>
<td>5, 14</td>
</tr>
<tr>
<td>Grid decentralization</td>
<td>4, 11–12</td>
</tr>
<tr>
<td>Grid determinism</td>
<td>4, 11</td>
</tr>
<tr>
<td>Grid dynamic integration</td>
<td>4, 12</td>
</tr>
<tr>
<td>Grid first class entities</td>
<td>1–2</td>
</tr>
<tr>
<td>Grid infrastructure software</td>
<td>114</td>
</tr>
<tr>
<td>Grid network infrastructure software</td>
<td>114–15</td>
</tr>
<tr>
<td>Grid network services</td>
<td>219, 235–40</td>
</tr>
<tr>
<td>Grid- OBS</td>
<td>246–50</td>
</tr>
<tr>
<td>Grid programmability</td>
<td>4, 10</td>
</tr>
<tr>
<td>Grid resource allocation and management (Globus’ GRAM)</td>
<td>116</td>
</tr>
<tr>
<td>Grid resource sharing</td>
<td>4</td>
</tr>
<tr>
<td>Grid resources</td>
<td></td>
</tr>
<tr>
<td>coordination</td>
<td>233–5</td>
</tr>
<tr>
<td>discovery</td>
<td>231</td>
</tr>
<tr>
<td>scheduler</td>
<td>235</td>
</tr>
<tr>
<td>Grid scalability</td>
<td>4, 12</td>
</tr>
<tr>
<td>Grid security</td>
<td>5, 13</td>
</tr>
<tr>
<td>Grid services</td>
<td>219</td>
</tr>
<tr>
<td>Grid types</td>
<td>7–14</td>
</tr>
<tr>
<td>Grid virtualization</td>
<td>4</td>
</tr>
</tbody>
</table>
Grid web services 83
GridFTP 25
features 121–2
standardization 68
GUNI (Grid UNI) 239

High Performance Networking Research
Group (GHPN-RG) 64, 69, 114
High-speed TCP, standardization 161–2
Hoplist 255–6
Host channel adapter, see Infiniband
Hourglass design 186

iCAIR, see International Center for Advanced
Internet Research (iCAIR)
Infiniband
features 211–14
MPI libraries 214
remote direct memory access 214
standard 75–6
virtual lane 213
web services representation 213
Infiniband Trade Association (IBTA), profile
75–6
Institute of Electrical and Electronics
Engineers (IEEE) 76
Inter Grid 7
Interior BGP (IBGP) 189
Interior gateway protocol (IGP) 189
International Center for Advanced Internet
Research (iCAIR) 324
International Organization for
Standardization 51
International Telecommunication Union
(ITU) 74–5
Internet 8, 11
Internet Engineering Task Force (IETF)
58, 71–3
Intra-Grid 7
IntServ 107
IP multicast 194
IP packet delay variation (IPDV) 257
IPsec 193
IPSphere Forum, profile 71
IPv6 57, 72, 192–5
ISO 51
ITU-T NGN 74, 278–80
I-WAY 8
I-WIRE 314–15
Japan Gigabit Network II (JGN II) 317
JGN II, see (Japan Gigabit Network II)
Job Submission Description Language
(JSDL) 90
Joint wavelength assignment (SPP-JWA)
267
Just-enough-time 245
Just-in-time 239
JuxtaView 22
KISTI, see Korean Institute of Science and
Technology Information (KISTI)
Korean Institute of Science and Technology
Information (KISTI) 224
L1 (layer 1)
benefits 219–21
connection type 235
high capacity 220
network services 217, 219
VPN 221–2
L1 QoS 109
Lambda User Controlled Infrastructure For
European Research (LUCIFER) 320–2
LambdaGrid 19, 110, 224
LambdaStream 178–9
LambdaVision 20, 21
LAN-PHY 285, 287, 290
Large Hadron Collider (LHC) 25, 229, 234
Layer 1 Virtual Private Network (L1VPN),
standard 73, 110, 221
Layer 1, see L1 (layer 1)
Layer 3 185–95
Layer 4 186, 192
Light-emitting diodes (LEDs)
access technology 301
drive technology 300
Lightpath 14, 217
The link capacity adjustment scheme (LCAS)
109
features 207
standard 74
Loss characteristics 257
LUCIFER, see Lambda User Controlled
Infrastructure For European Research
(LUCIFER)
Management plane 225
MaxNet 163–6
Measurement methodologies 254
Media access control (MAC)  76, 109, 198
MEMs switching  248
Meta-schedulers  234
Metro Ethernet Forum  202, 204
Monitoring and discovery services (Globus’ MDS)  116
MPI
  MPI forum profile  71
  with InfiniBand  211–14
MPLS-TE, see Multiprotocol label switching with traffic engineering (MPLS-TE)
MSPP, see Multiservice provisioning systems (MSPP)
Multiprotocol label switching with traffic engineering (MPLS-TE)  227
Multi Router Traffic Grapher (MRTG)  258
Multiservice provisioning systems (MSPP)  316
Multiprotocol label switching (MPLS),  284
  profile  198–201
  in shared network infrastructure  200
  virtual private networks  200–1
  with grid network services  201
National Institute of Advanced Industrial Science and Technology (AIST)  316
National Institute of Information and Communications Technology (NICT)  317
National Lambda Rail (NLR)  327–8
National Science Foundation (NSF)  314, 316
NetBLT  173
NetFlow  129
NetherLight  286, 292, 325–6
Network abstraction  53
Network address port translation (NAPT)  57, 192
Network determinism  54–6
Network quality of service  100–1, 102
Network resource management system  64–5, 123
Network self-organization  279–80
Network user categories  50
Network virtualization  52–3
Network Weather Service  133
Network–network interfaces (NNI)
  component of grid network infrastructure  135
  standard  75
NewReno  151, 157–8
Next-generation network (NGN), see ITU-T NGN
NICT, see National Institute of Information and Communications Technology (NICT)
NLR, see National Lambda Rail (NLR)
NSF, see National Science Foundation (NSF)
O-NNI, see Optical network-network interface (O-NNI)
OBGP  96
OEO, see Optical-to-electrical-to-optical (OEO)
OFA, see Optical fiber amplifier (OFA)
Offset  242
OIF, see Optical Internetworking Forum (OIF)
OMNI, see Optical Metro Network Initiative (OMNI)
OMNInet  312–13
On-demand provisioning  220
OOO, see Optical-to-optical (OOO)
Open Communications Architecture Forum (OCAF), standardization  75
Open Grid optical exchanges  283–91
Open Grid services architecture (OGSA)  62
  standardization  68
Open Grid services exchange  281–2
Open services communications exchange  281–3
Open shortest path first (OSPF)  65, 189, 198
Open Systems Interconnect model  51–2
Open Systems Interconnection basic reference model  51, 279
OpEx (operational Expense)  220
Optical burst switching  240–50
Optical cross-connect (OXC)  248
Optical dynamic intelligent network (ODIN)  65, 95
Optical fiber amplifier (OFA)  313
Optical Internetworking Forum (OIF)
  demonstration  204
  NNI  221
  profile  75
  UNI  221
Index

Optical Metro Network Initiative (OMNI) 312–13
Optical network–network interface (O-NNI) 513
Optical switches
design 304–5
futures 306–7
high performance 302
recent advances 303–4
reliability 306
use in core networks 305–6
Optical-to-electrical-to-optical (OEO) 217
Optical-to-optical (OOO) 217
OptiCAT 321–2
OptIPuter 19, 20–2, 34, 110, 315–16
Organization for the Advancement of Structured Information Standards (OASIS) 70, 89
profile 70
OSI 51–2
OSPF, see Open shortest path first (OSPF)
Pacific Northwest GigaPoP (PNWGP) 317
Particle physics 24, 26
Passive optical networking (PON) 300
Path-based protection 266
dedicated path protection (DPP) 266
shared path protection (SPP) 266
Peer-to-peer (P2P) 50, 83
Per-hop behavior (PHB) 106, 187
Photonic integrated circuits (PIC)
core technology 302
general 294
Photonic switch node (PSN) 313
Physical layer, QoS 236
Physical layer impairments 238–9
chromatic dispersion (CD) 239
linear impairments 238
nonlinear 239
polarized mode dispersion (PMD) 238
PIONEIR 322
PNWGP, see Pacific Northwest GigaPoP (PNWGP)
Pseudo-wire emulation 205
PSN, see Photonic switch node (PSN)
QoS, see Quality of service (QoS)
Quality of service (QoS) 87, 217, 218, 220, 255
Quanta 180–2
Radio astronomy 24, 30
Radio frequency identification (RFID) 59, 299
RealityGrid 27
Reconfigurable optical add-drop multiplexers (ROADMs) 218
Recovery 228–9, 264–72
ARQ 264
dynamic restoration 265
preplanned protection 265
protection 229
restoration 229
Reliable blast UDP (RBUDP) 173
Remote direct data placement (RDDP), standardization 72
Remote direct memory access in Infiniband 214
Resilient packet ring (RPR)
features 207–8
requirements posed by Ethernet services 203
Resource reservation protocol (RSVP) 105
Resource reservation protocol with traffic engineering (RSVP-TE) 227
Restoration 264–72
loss 268
RFC 1958 103
RFC 2474 103
RFC 2598 106
RFC 2768 60–1
RFC 3439 103
RFC 768 172
RFID, see Radio frequency identification (RFID)
ROADMs, see Reconfigurable optical add-drop multiplexers (ROADMs)
Routing models 226
Routing information bases (RIBs) 190
Routing information protocol (RIP) 189
Routing metrics 191–2
Routing policies 190
Routing topologies 190
RSVP-TE, see Resource reservation protocol with traffic engineering (RSVP-TE)
SABUL (simple available bandwidth utilization library) 174–5
Scalable adaptive graphics environment (SAGE) 20
Scalable TCP 162
Science Technology and Research Transit Access Point (STAR TAP) 323
SCTP 88
Semantic web
distributed service awareness 139
ontologies 151
standardization 71
Semiconductor optical amplifiers (SOAs) 232
Sensors 299
Separate wavelength assignment (SPP-SWA) 267
Service Grid 6
Service level agreements (SLAs) 53
Service matrix 289
Service-oriented architecture (SOA) 61
Session initiation protocol 138
Shared path protection with joint wavelength assignment (SPP-JWA) 267
Shared path protection with separate wavelength assignment (SPP-SWA) 267
Signal to noise ratio (SNR) 237
Silicon optical amplifiers (SOA) 232
Simple network management protocol (SNMP) 128, 258
Simple path control protocol (SPC) 93, 313
SNMP, see Simple network management protocol (SNMP)
SOA, see Silicon optical amplifiers (SOA)
Software-defined radio (SDR) 298–9
SONET/SDH 109, 312, 316
Ethernet over SONET 206
features exposed via UNIs 208
profile 206
with regard to Ethernet services 202
SPC, see Simple path control protocol (SPC)
SPICE 29–30
SPP-SWA, see Joint wavelength assignment (SPP-JWA); Separate wavelength assignment (SPP-SWA)
STAR TAP 323, 324
StarLight 28, 292, 323–4
StarPlane 318–19
Study group 13 74, 75, 110
SuperJANET 24, 27
SURFnet 27, 28, 327
SURFnet6 138
Switching granularity 235
System to intermediate system (IS-IS) 189
Target channel adapter, see Infiniband
TCP, see Transmission Control Protocol (TCP)
TDM, see Time division multiplexing (TDM)
TE (traffic engineering) 199
Telecommunication management network (TMN) 133
Tell and wait 243
TeraGrid 7
TeraGyroid 27–9
TERENA 329
Testbeds 218, 312–23
Time division multiplexing (TDM) 217
T-LEX (Tokyo Lambda Exchange) 317
Token-based security 156
TOS octet 187
Transaction language 1 (TL1) 53, 128
TransLight 324–5
Transmission Control Protocol (TCP) 88, 147
AIMD 172
binary increase congestion (BIC) metrics 153
profile 160
congestion control
delay-based 149
explicit signal 149
fairness 152
feedback system 150–2
loss-based 149
loss recovery 153
queuing delay 153
responsiveness 152–3
stability 152
throughput 152
fairness 149
FAST
metrics 153
profile 159
high-speed (HS) metrics 156
profile 161–2
NewReno
metrics 153
profile 157–8
Transmission Control
   Protocol (TCP) (Continued)
   profile 147
   proxies 180
   Reno 157
   scalable
   metrics 153
   profile 162
   Vegas 158–9
   Westwood 162–3
   window flow control 147–9
   Tsunami 178

   UCLP, see User-controlled lightpaths (UCLP)
   UDP 88, 146, 167
   UDP-based data transfer protocol (UDT)
   174
   UK e-science 24, 27
   UKLight 24, 26, 326
   UltraLight 330
   UltraScience Net 323
   Uniform resource identifier (URI) 90
   Universal description, discovery, and
   integration (UDDI) 90
   User-controlled lightpath architecture
   (UCLP) 95–6
   User-controlled lightpaths (UCLP) 30, 32,
   321
   example of grid network infrastructure
   123
   views on resource scheduling 135
   User datagram protocol (UDP) 105, 146,
   171–8
   profile 146–7
   User–Network Interfaces (UNI) 53, 89
   bindings of a grid network infrastructure
   127
   definition 208–10
   fit with SOA 209
   relationship with other interfaces 208–10
   requirements posed by grid applications
   208–10
   standard 75

   Vertically integrated optical testbed for large
scale applications (VIOLA) 65,
   123, 318
   Virtual bridged local area networks 94
   Virtual concatenation (VCAT) 109, 207
   features 207
   standard 74

   Virtual organization 50, 51, 53
   Virtual private LAN services 205
   Virtual private networks
   BGP/MPLS IP VPNs 201
   general considerations for layer 2 197–8
   layer 1 210
   layer 3 205
   MPLS based 283, 284
   OAM 204
   with UNI 208–9
   Visualization 18–23, 55
   vLANs 76, 93, 95
   Vol-a-Tile 22

   W3C 71
   WS-Agreement
   component of grid network infrastructure
   151
   standardization 68
   WAN-PHY 76, 287
   Wavebands 217
   Wavelength division multiplexing (WDM)
   218, 240
   Web Based Enterprise Management
   (WBEM) 53, 65, 73
   bindings of a grid network infrastructure
   127, 128
   standardization 73
   Web services business process execution
   language 89
   Web Services Definition Language (WSDL)
   89–90
   Web Services Resource Framework (WSRF)
   10, 89
   WS-Notification
   component of grid network infrastructure
   130
   standardization 70
   World Wide Web Consortium (W3C),
   profile 71
   WS Resource Framework
   component of grid network infrastructure
   129–30
   standardization 70
   WSBPEL 89

   XML 71, 90

   Y.1512, see Layer 1 Virtual Private Network
   (LIVPN)