Network Protocols Handbook

Javvin Technologies, Inc.

ISBN: 0-9740945-1-X

Network Protocols Handbook

Copyright © 2004 Javvin Technologies Inc. All rights reserved.
13485 Old Oak Way
Saratoga CA 95070 USA
408-872-3881
handbook@javvin.com

First Edition Released July 2004
ISBN: 0-9740945-1-X

All rights reserved. No part of this book may be reproduced or transmitted in any form or by any means electronically or mechanically.

Warning and Disclaimer

This book is designed to provide information about the current network communication protocols. Best effort has been made to make this book as complete and accurate as possible, but no warranty or fitness is implied. The information is provided on an “as is” basis. The author, publisher and distributor shall not have liability nor responsibility to anyone or group with respect to any loss arising from the information contained in this book and associated materials.

Table of Contents

Network Communication Architecture and Protocols 1
OSI Network Architecture 7 Layers Model 1
Other Network Architecture Models: IBM SNA 4
Network Protocol: Definition and Overview 6

Protocols Guide 8
TCP/IP Protocols 8
Application Layer Protocols 10
BOOTP: Bootstrap Protocol 10
DCAP: Data Link Switching Client Access Protocol 11
DHCP: Dynamic Host Configuration Protoco 12
DNS: Domain Name System (Service) protocol 13
FTP: File Transfer Protocol 14
Finger: User Information Protocol 16
HTTP: Hypertext Transfer Protocol 17
HTTPS: Secure Hypertext Transfer Protocol (S-HTTP) 18
IMAP & IMAP4: Internet Message Access Protocol (version 4) 19
IRCP: Internet Relay Chat Protocol 21
LDAP: Lightweight Directory Access Protocol (version 3) 22
MIME (S-MIME): Multipurpose Internet Mail Extensions and Secure MIME 23
NAT: Network Address Translation 24
NNTP: Network News Transfer Protocol 25
NTP: Network Time Protocol 26
POP and POP3: Post Office Protocol (version 3) 28
rlogin: Remote Login in UNIX Systems 29
RMON: Remote Monitoring MIBs (RMON1 and RMON2) 30
SLP: Service Location Protocol 32
SMTP: Simple Mail Transfer Protocol 33
SNMP: Simple Network Management Protocol 34
SNMPv1: Simple Network Management Protocol version one 35
SNMPv2: Simple Network Management Protocol version 2 37
SNMPv3: Simple Network Management Protocol version three 39
SNTP: Simple Network Time Protocol 41
TELNET: Terminal emulation protocol of TCP/IP 43
TFTP: Trivial File Transfer Protocol 44
URL: Uniform Resource Locator 45
Whois (and RWhois): Remote Directory Access Protocol 46
X Window/X Protocol: X Window System Protocol 47

Presentation Layer Protocols 48
LPP: Lightweight Presentation Protocol 48
Session Layer Protocols 49
RPC: Remote Procedure Call protocol 49
Transport Layer Protocols 51
ITOT: ISO Transport Service on top of TCP 51
RDP : Reliable Data Protocol 52
RUDP: Reliable User Datagram Protocol (Reliable UDP) 54
TALI: Tekelec's Transport Adapter Layer Interface 55
TCP: Transmission Control Protocol 56
UDP: User Datagram Protocol 58
Van Jacobson: Compressed TCP protocol 59
Network Layer Protocols 60
Routing Protocals 60
BGP (BGP-4): Border Gateway Protocol 60
EGP: Exterior Gateway Protocol 61
IP: Internet Protocol (IPv4) 62
IPv6: Internet Protocol version 6 64
ICMP & ICMPv6: Internet Message Control Protocol and ICMP version 6 65
IRDP: ICMP Router Discovery Protocol 66
NARP: NBMA Address Resolution Protocol 67
NHRP: Next Hop Resolution Protocol 68
OSPF: Open Shortest Path First protocol (version 2) 69
RIP: Routing Information Protocol (RIP2) 70
RIPng: Routing Information Protocol next generation for IPv6 71
RSVP: Resource ReSerVation Protocol 72
VRRP: Virtual Router Redundancy Protocol 73
Multicasting Protocals 74
BGMP: Border Gateway Multicast Protocol 74
DVMRP: Distance Vector Multicast Routing Protocol 75
IGMP: Internet Group Management Protocol 76
MARS: Multicast Address Resolution Server 77
MBGP: Multiprotocol BGP 78
MOSPF: Multicast Extensions to OSPF 80
MSDP: Multicast Source Discovery Protocol 82
MZAP: Multicast-Scope Zone Announcement Protocol 83
PGM: Pragmatic General Multicast Protocol 84
PIM-DM: Protocol Independent Multicast – Dense Mode 85
PIM-SM: Protocol Independent Multicast-Sparse Mode 86
MPLS Protocals 87
MPLS: Multiprotocol Label Switching 87
CR-LDP : Constraint-based LDP 89
LDP: Label Distribution Protocol 90
RSVP-TE: Resource Reservation Protocol - Traffic Extension 91

Data Link Layer Protocols **92**
ARP and InARP: Address Resolution Protocol and Inverse ARP 92
IPCP and IPv6CP: IP Control Protocol and IPv6 Control Protocol 93
RARP: Reverse Address Resolution Protocol 94
SLIP: Serial Line IP 95

Network Security Technologies and Protocols 96
AAA Protocols **98**
Kerberos: Network Authentication Protocol 98
RADIUS: Remote Authentication Dial In User Service 99
SSH: Secure Shell Protocol 100
Tunneling Protocols **101**
L2F: Layer 2 Forwarding Protocol 101
L2TP: Layer 2 Tunneling Protocol 102
PPTP: Point-to-Point Tunneling Protocol 104
Secured Routing Protocols **105**
DiffServ: Differentiated Service Architecture 105
GRE: Generic Routing Encapsulation 106
IPsec: Security Architecture for IP 107
IPsec AH: IPsec Authentication Header 108
IPsec ESP: IPsec Encapsulating Security Payload 109
IPsec IKE: Internet Key Exchange Protocol 110
IPsec ISAKMP: Internet Security Association and Key Management Protocol 111
TLS: Transport Layer Security Protocol 112
Other Security Protocols **113**
SOCKS v5: Protocol for sessions traversal across firewall securely 113

Voice over IP and VOIP Protocols 114
Signalling **116**
H.323: VOIP Protocols 116
H.225.0: Call signalling protocols and media stream packetization for packet-based multimedia communication systems 118
H.235: Security and encryption for H-series (H.323 and other H.245-based) multimedia terminals 120
H.245: Control Protocol for Multimedia Communication 121
Megaco/H.248: Media Gateway Control Protocol 122
MGCP: Media Gateway Control Protocol 123
RTSP: Real-Time Streaming Protocol 124
SAP: Session Announcement Protocol 126
SDP: Session Description Protocol 127
SIP: Session Initiation Protocol 128
SCCP (Skinny): Cisco Skinny Client Control Protocol 130
T.120: Multipoint Data Conferencing and Real Time Communication Protocols 132

Media / CODEC **134**
G.7xx: Audio (Voice) Compression Protocols 134
H.261: Video Coding and Decoding (CODEC) 136
H.263: Video Coding and Decoding (CODEC) 137
RTP: Real-Time Transport Protocol 139
RTCP: RTP Control Protocol 140
Other Protocols **141**
COPS: Common Open Policy Service 141
SCTP: Stream Control Transmission Protocol 142
TRIP: Telephony Routing over IP 143

Wide Area Network and WAN Protocols 144
ATM Protocols **146**
ATM: Asynchronous Transfer Mode Reference Model 146
ATM Layer: Asynchronous Transfer Mode Layer 147
AAL: ATM Adaptation Layer (AAL0, AAL2, AAL3/4, AAL5) 148
ATM UNI: ATM Signaling User-to-Network Interface 151
LANE NNI: ATM LAN Emulation NNI 153
LANE UNI: ATM LAN Emulation UNI 155
MPOA: Multi-Protocol Over ATM 157
ATM PNNI: ATM Private Network-to-Network Interface 159
Q.2931: ATM Signaling for B-ISDN 160
SONET/SDH: Synchronous Optical Network and Synchronous Digital Hierarchy 162
Broadband Access Protocols **164**
BISDN: Broadband Integrated Services Digital Network (Broadband ISDN) 164
ISDN: Integrated Services Digital Network 165
LAP-D: ISDN Link Access Protocol-Channel D 167
Q.931: ISDN Network Layer Protocol for Signaling 169
DOCSIS: Data Over Cable Service Interface Specification 170
xDSL: Digital Subscriber Line Technologies (DSL, IDSL, ADSL, HDSL, SDSL, VDSL, G.Lite) 171
PPP Protocols **172**
PPP: Point-to-Point Protocols 172
BACP: PPP Bandwidth Allocation Control Protocol (BACP) 173
BAP: PPP Bandwidth Allocation Protocol (BAP) 173
BCP: PPP Bridging Control Protocol 174
EAP: PPP Extensible Authentication Protocol 175
CHAP: Challenge Handshake Authentication Protocol 176
LCP: PPP Link Control Protocol 177
MPPP: MultiLink Point to Point Protocol (MultiPPP) 178
PPP NCP: Point to Point Protocol Network Control Protocols 179
PAP: Password Authentication Protocol 180
PPPoA: PPP over ATM AAL5 181
PPPoE: PPP over Ethernet 182

Other WAN Protocols 183
Frame Relay: WAN Protocol for Internetworking 183
LAPF: Link Access Procedure for Frame Mode Services 185
HDLC: High Level Data Link Control 186
LAPB: Link Access Procedure, Balanced 187
X.25: ISO/ITU-T Protocol for WAN Communications 188

Local Area Network and LAN Protocols 190
Ethernet Protocols 191
Ethernet: IEEE 802.3 Local Area Network protocols 191
Fast Ethernet: 100Mbps Ethernet (IEEE 802.3u) 193
Gigabit (1000 Mbps) Ethernet: IEEE 802.3z (1000Base-X) and 802.3ab (1000Base-T) and GBIC 194
10 Gigabit Ethernet: The Ethernet Protocol IEEE 802.3ae for LAN, WAN and MAN 196
Virtual LAN Protocols 198
VLAN: Virtual Local Area Network and the IEEE 802.1Q 198
IEEE 802.1P: LAN Layer 2 QoS/CoS Protocol for Traffic Prioritization 200
GARP: Generic Attribute Registration Protocol 202
GMRP: GARP Multicast Registration Protocol 203
GVRP: GARP VLAN Registration Protocol 204
Wilress LAN Protocols 205
WLAN: Wireless LAN by IEEE 802.11 protocols 205
IEEE 802.1X: EAP over LAN (EAPOL) for LAN/WLAN Authentication and Key Management 207
Other Protocols 209
FDDI: Fiber Distributed Data Interface 209
Token Ring: IEEE 802.5 LAN Protocol 210
LLC: Logic Link Control (IEEE 802.2) 211
SNAP: SubNetwork Access Protocol 212
STP: Spanning Tree Protocol (IEEE 802.1D) 213

Metropolitan Area Network and MAN Protocols 215
DQDB: Distributed Queue Dual Bus (Defined in IEEE 802.6) 216
SMDS: Switched Multimegabit Data Service 217

Storage Area Network and SAN Protocols 219
FC & FCP: Fibre Channel and Fibre Channel Protocol 221
FCIP: Fibre Channel over TCP/IP 222
iFCP: Internet Fibre Channel Protocol 224
iSCSI: Internet Small Computer System Interface (SCSI) 226
iSNS and iSNSP: Internet Storage Name Service and iSNS Protocol 228
SCSI: Small Computer System Interface 229

ISO Protocols in OSI 7 Layers Reference Model 231
ISO ACSE: Association Control Service Element 233
ISO CMIP: Common Management Information Protocol 235
CMOT: CMIP Over TCP/IP 237
ISO FTAM: File Transfer Access and Management protocol 238
ISO ROSE: Remote Operations Service Element Protocol 239
ISO RTSE: Reliable Transfer Service Element Protocol 241
ISO VTP: ISO Virtual Terminal (VT) Protocol 242
X.400: Message Handling Service Protocol 243
X.500: Directory Access Protocol (DAP) 245
Presentation Layer 246
ISO-PP: OSI Presentation Layer Protocol 246
Session Layer 248
ISO-SP: OSI Session Layer Protocol 248
Transport Layer 250
ISO-TP: OSI Transport Layer Protocols TP0, TP1, TP2, TP3, TP4 250
Network Layer 252
CLNP: Connectionless Network Protocol (ISO-IP) 252
ISO CONP: Connection-Oriented Network Protocol 254
ES-IS: End System to Intermediate System Routing Exchange Protocol 255
IDRP: Inter-Domain Routing Protocol 256
IS-IS: Intermediate System to Intermediate System Routing Protocol 257

Cisco Protocols 258
CDP: Cisco Discovery Protocol 259
CGMP: Cisco Group Management Protocol 260
DTP: Cisco Dynamic Trunking Protocol 261
EIGRP: Enhanced Interior Gateway Routing Protocol 262
HSRP: Hot Standby Router Protocol 263
IGRP: Interior Gateway Routing Protocol 264
ISL & DISL: Cisco Inter-Switch Link Protocol and Dynamic ISL Protocol 265
RGMP: Cisco Router Port Group Management Protocol 266
TACACS (and TACACS+): Terminal Access Controller Access Control System 267
VTP: Cisco VLAN Trunking Protocol 268
XOT: X.25 over TCP Protocol by Cisco 270

Novell NetWare and Protocols 271
IPX: Internetwork Packet Exchange protocol 273
NCP: NetWare Core Protocol 274
NLSP: NetWare Link Services Protocol 275
SPX: Sequenced Packet Exchange protocol 277

IBM Systems Network Architecture (SNA) and Protocols 278
IBM SMB: Server Message Block protocol 280

APPC: Advanced Program to Program Communications (SNA LU6.2) 281
SNA NAU: Network Accessible Units (PU, LU and CP) 282
NetBIOS: Network Basic Input Output System 284
NetBEUI: NetBIOS Extended User Interface 285
APPN: Advanced Peer-to-Peer Networking 286
DLSw: Data-Link Switching protocol 288
QLLC: Qualified Logic Link Control 289
SDLC: Synchronous Data Link Control 290

AppleTalk: Apple Computer Protocols Suite 291

DECnet and Protocols 293
Microsoft Protocols 295
Microsoft CIFS: Common Internet File System 295
Microsoft SOAP: Simple Object Access Protocol 296
Xerox Protocols 297
Xerox IDP: Internet Datagram Protocol 297

SS7 / C7 Protocol Suite: Signaling System # 7 for Telephony Signalling 298
ISUP: ISDN User Part 300
MAP: Mobile Application Part 302
MTP2 and MTP3: Message Transfer Part level 2 and level 3 304
SCCP: Signalling Connection Control Part of SS7 306
TCAP: Transaction Capabilities Application Part 307

Network Protocols Dictionary: From A to Z and 0 to 9 309

Major Networking and Telecom Standard Organizations 327

Network Communication Protocols Map 328

Protocol Name

VTP: Cisco VLAN Trunking Protocol

Protocol Description

VLAN Trunking Protocol (VTP) is a Cisco Layer 2 messaging protocol that manages the addition, deletion, and renaming of VLANs on a network-wide basis. Virtual Local Area Network (VLAN) Trunk Protocol (VTP) reduces administration in a switched network. When you configure a new VLAN on one VTP server, the VLAN is distributed through all switches in the domain. This reduces the need to configure the same VLAN everywhere. VTP is a Cisco-proprietary protocol that is available on most of the Cisco Catalyst Family products.

VTP ensures that all switches in the VTP domain are aware of all VLANs. There are occasions, however, when VTP can create unnecessary traffic. All unknown unicasts and broadcasts in a VLAN are flooded over the entire VLAN. All switches in the network receive all broadcasts, even in situations where few users are connected in that VLAN. VTP pruning is a feature used to eliminate (or prune) this unnecessary traffic.

By default, all Cisco Catalyst switches are configured to be VTP servers. This is suitable for small-scale networks where the size of the VLAN information is small and easily stored in all switches (in NVRAM). In a large network, a judgment call must be made at some point when the NVRAM storage needed is wasted, because it is duplicated on every switch. At this point, the network administrator should choose a few well-equipped switches and keep them as VTP servers. Everything else participating in VTP can be turned into a client. The number of VTP servers should be chosen so as to provide the degree of redundancy desired in the network.

There are three version of VTP so far. VTP Version 2 (V2) is not much different from VTP Version 1 (V1). The major difference is that VTP V2 introduces support for Token Ring VLANs. If you are using Token Ring VLANs, you need to enable VTP V2. Otherwise, there is no reason to use VTP V2.

VTP version 3 differs from earlier VTP versions in that it does not directly handle VLANs. VTP version 3 is a protocol that is only responsible for distributing a list of opaque databases over an administrative domain. When enabled, VTP version 3 provides the following enhancements to previous VTP versions:

- Support for extended VLANs.
- Support for the creation and advertising of private VLANs.
- Improved server authentication.
- Protection from the “wrong” database accidentally being inserted into a VTP domain.
- Interaction with VTP version 1 and VTP version 2.
- Provides the ability to be configured on a per-port basis.
- Provides the ability to propagate the VLAN database and other databases.

Protocol Structure

The format of the VTP header can vary depending on the type of VTP message. However, they all contain the following fields in the header:

- VTP protocol version: 1 or 2 or 3
- VTP message types:
  - Summary advertisements
  - Subset advertisement
  - Advertisement requests
  - VTP join messages
- Management domain length
- Management domain name

Summary Advertisements

When the switch receives a summary advertisement packet, it compares the VTP domain name to its own VTP domain name. If the name is different, the switch simply ignores the packet. If the name is the same, the switch then compares the configuration revision to its own revision. If its own configuration revision is higher or equal, the packet is ignored. If it is lower, an advertisement request is sent.

Summary Advert Packet Format:

8	16	24	32bit
Version	Code	Followers	MgmtD Len
Management Domain Nance (zero-padded to 32 bytes)			
Configuration Revision Number			
Updater Identity			
Update Timestamp (12 bytes)			
MDS Digest (16 bytes)			

- Followers indicate that this packet is followed by a Subset Advertisement packet.
- The updater identity is the IP address of the switch that is the last to have incremented the configuration revision.
- Update timestamps are the date and time of the last increment of the configuration revision.
- Message Digest 5 (MD5) carries the VTP password if it is configured and used to authenticate the validation of a VTP update.

Subset Advertisements

When you add, delete, or change a VLAN in a switch, the server switch where the changes were made increments the configura-

tion revision and issues a summary advertisement, followed by one or several subset advertisements. A subset advertisement contains a list of VLAN information. If there are several VLANS, more than one subset advertisement may be required in order to advertise them all.

Subset Advert Packet Format:

8	16	24	32bit
Version	Code	Sequence Number	MgmtD Len
Management Domain Nance (zero-padded to 32 bytes)			
Configuration Revision			
VLAN - info field 1			
.....			
VLAN - info field N			

The following formatted example shows that each VLAN information field contains information for a different VLAN (ordered with lower valued ISL VLAN IDs occurring first):

V - info - len	Status	VLAN - Type	VLAN - name Len
ISL VLAN - id		MTU Size	
802.10 index			
VLAN - name (padded with zeros to multiple of 4 bytes)			

Most of the fields in this packet are easy to understand. Below are two clarifications:

- Code—The format for this is 0x02 for subset advertisement.
- Sequence number—This is the sequence of the packet in the stream of packets following a summary advertisement. The sequence starts with 1.

Advertisement Requests

A switch needs a VTP advertisement request in the following situations:

- The switch has been reset.
- The VTP domain name has been changed.
- The switch has received a VTP summary advertisement with a higher configuration revision than its own.

Upon receipt of an advertisement request, a VTP device sends a summary advertisement, followed by one or more subset advertisements. Below is an example.

8	16	24	32bit
Version	Code	Rsvd	MgmtD Len
Management Domain Nance (zero-padded to 32 bytes)			
Start - Value			

- Code—The format for this is 0x03 for an advertisement request
- Start Value—This is used in cases where there are several subset advertisements. If the first (N) subset advertisement has been received and the subsequent one (N+1) has not, the Catalyst only requests advertisements from the (N+1)th one.

Related protocols

IEEE 802.1Q

Sponsor Source

VTP is a Cisco protocol.

Reference

http://www.cisco.com/en/US/products/hw/switches/ps708/products_configuration_guide_chapter09186a008019f048.html#1017196
Understanding and Configuring VLAN Trunking Protocol

Protocol Name

XOT: X.25 over TCP Protocol by Cisco

Protocol Description

The X.25 over TCP protocol (XOT) is designed by Cisco to transport X.25 over IP internets. The X.25 Packet Level requires a reliable link level below it and normally uses LAPB. XOT is a method of sending X.25 packets over IP internets by encapsulating the X.25 Packet Level in TCP packets.

TCP provides a reliable byte stream. X.25 requires that the layer below it provide message semantics, in particular the boundary between packets. To provide this, a small (4-bytes) XOT header is used between TCP and X.25. The primary content of this header is a length field, which is used to separate the X.25 packets within the TCP stream.

In general, the normal X.25 protocol packet formats and state transition rules apply to the X.25 layer in XOT. Exceptions to this are noted.

Protocol Structure

16	32bit
Version	Length

- Version - The version number. It must be 0. If no zero number is received, the TCP session must be closed.
- Length - The length of the packet. Values must be legal X.25 packet lengths. If the length field has an illegal value, then the TCP connection MUST be closed.

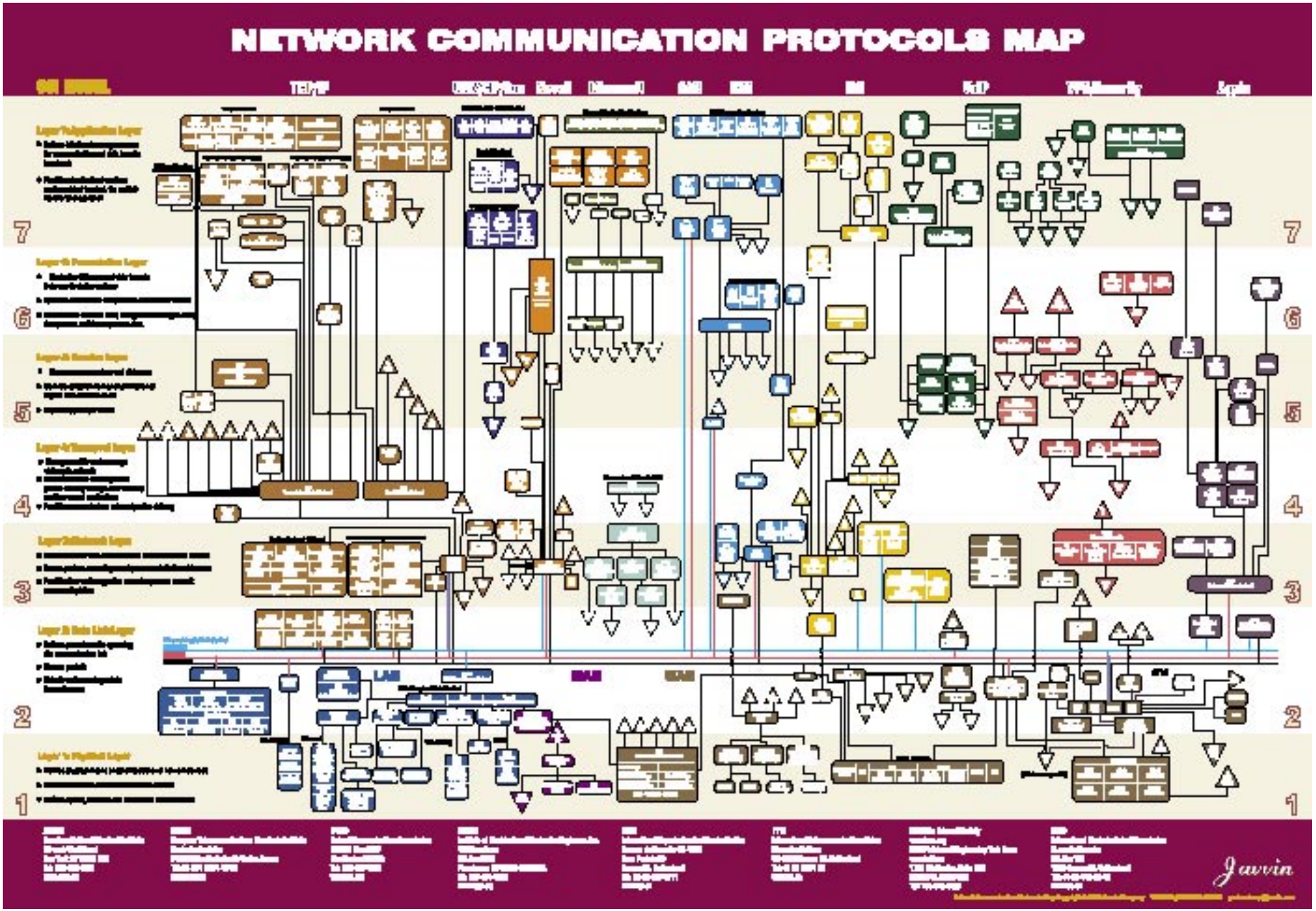
Related protocols

IP, TCP, X.25

Sponsor Source

XOT is a Cisco protocol and circulated in IETF (http://www.ietf.org) RFC1613.

Reference

http://www.javvin.com/protocol/rfc1613.pdf
Cisco Systems X.25 over TCP (XOT)

Network Communication Protocols Map