

The Software Tools for Networking column contains brief presentations of software tools that are freely available on the Internet and could be useful for the readers of this magazine. Each presentation is based on an extended abstract submitted by the authors of the tools that was copy edited and checked for accuracy against the version of the tool available on the Internet. Authors willing to have their tools presented in this manner should send a 300-word description of their tool in ASCII format with the URL of the tool by email to Olivier Bonaventure (bonaventure@ieee.org) with an indication that the description is submitted for the IEEE Network Software Tools for Networking column. Appropriate tools will be presented in this column.

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TCP Statistic and Analysis Tool

Marco Mellia

<http://tstat.tlc.polito.it>

Tstat is able to analyze traces in real time, using common PC hardware, or to start from previously recorded traces in various dump formats (libpcap, DAG, etc.). Besides the more common IP statistics, derived from analysis of the IP headers, Tstat is also able to rebuild each TCP connection status looking at the TCP header in the forward and backward packet flows. Indeed, the software assumes to receive as input a trace collected on an edge node, such that both data segments and ACK segments can be analyzed. When used on a core link, Tstat will ignore flows whose backward path does not cross the measurement point. The TCP flow analysis allows the derivation of novel statistics, such as the congestion window size, out-of-sequence segments, and duplicated segments.

Statistics are collected distinguishing between clients and servers, but also identifying internal and external hosts (i.e., hosts located inside or outside the edge node used as a measurement point). Instead of dumping single measured data, for each measured quantity Tstat builds a histogram, collecting the distribution of that given quantity. Every 15 min it produces a dump of all the collected histograms. A set of companion tools are available to produce time plot or aggregated plot over different time spans. Moreover, a Web interface is available that allows the user to travel among all the collected data, select the desired quantity, and directly produce graphs, as well as retrieve the raw data that can then later be used for further analysis.

More than 80 different types of histograms are available, comprising both IP and TCP statistics. They range from classic measures directly available from packet headers (e.g., percentage of TCP or UDP packets, packet length distribu-

tion, TCP port distribution) to advanced measures related to TCP (e.g., average congestion window, RTT estimates, out-of-sequence data, duplicated data).

Tstat derives from S. Ostermann's *tcptrace* and is written in standard C. It was developed on Linux Redhat systems with 2.2 and 2.4 kernel versions, but should also work on other UNIX variants. The Web site provides many examples, and there is a mailing list for technical support.

Mtools

S. Avallone, M. D'Arienzo, M. Esposito, A. Pescape, S. P. Romano, G. Ventre

<http://www.grid.unina.it/grid/mtools>

Mtools is a collection of tools for analyzing network performance through the generation of UDP packets flows that traverse the network and the measurement of the one-way delay and round-trip time of each packet. Some of its possible applications are evaluation of the capacity of a network to serve incoming traffic (by loading it in different ways), verification of the accuracy of an analytic model that estimates throughput and packet transmission time based on some assumptions on the traffic source (this raises the need to simulate that particular traffic source), and comparison between different configurations of the same network.

The main features of Mtools compared to other packet generators are the possibility of modeling both packet interdeparture times and packet sizes as random processes (actually constant, uniformly distributed and exponentially distributed), the possibility of specifying the seed value for these random processes (in order to exactly repeat a particular pattern), and the possibility of recording both packets arrived at the receiver and those transmitted by the sender. Moreover, thanks to R. Davies' random number generator library (included in Mtools), Mtools is easily extensible to support a wide variety of

traffic source models (e.g., the last version allows modeling the packet interdeparture times as a Pareto distributed random variable, in order to generate self-similar traffic).

Mtools is written in C++ and currently can be compiled on the Linux and FreeBSD operating systems, requiring only the standard C++ libraries (a Windows version will be released as soon as possible). Installation instructions are provided, and limited support is available by email.

Python Routeing Toolkit

R. Mortier

<http://www.sprintlabs.com/ipgroup/PyRT>

The Python Routeing Toolkit (PyRT) is a tool written in Python that supports the passive collection and offline analysis of routing protocol data. It collects data by forming minimal router peering sessions and dumping the routing PDUs received over these sessions. PyRT currently supports BGPv4 and IS-IS. Among its advantages is the fact that no routing information is ever advertised and only a minimal amount of information is injected into the network.

The collected data is dumped in the standard MRT format as supported by the RouteViews and RIPE/RIS projects. PyRT also provides a library of routines for parsing, displaying and manipulating MRT format data files. A few example applications using PyRT are included in the distribution.

PyRT is open source (under the GPL licence) and was developed on RedHat 7.1 Linux with Python v2.1.1 and tested against GNU Zebra v0.91a and Cisco 7xxx routers. PyRT has been deployed on a tier 1 ISP for over six months without incident. Data collected has been used to analyze BGP churn, IP level link failures, and IGP/EGP interaction.

REMOTE

K. Christensen

<http://www.csee.usf.edu/remote>

Parallel independent replications (PIR) is one means of speeding up the execution phase of a simulation modeling project. Simulation modeling is a much used method for performance evaluation of computer networks. In contrast to most existing PIR tools that are UNIX-based, REMOTE tool allows for automatic remote execution of Windows console mode programs (i.e., a .exe or .com "DOS mode" program) on network-connected Windows PCs. This enables idle

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The New Books and Multimedia column contains brief reviews of new books in the computer communications field. Each review includes a highly abstracted description of the contents, relying on the publisher's descriptive materials, minus advertising superlatives, and checked for accuracy against a copy of the book. The reviews also comment on the structure and the target audience of each book. Publishers wishing to have their books listed in this manner should send copies and appropriate advertising materials to Ioanis Nikolaidis at the address below, with an indication that books are intended for the *IEEE Network* New Books and Multimedia column. Appropriate books will be reviewed in the column.

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Wireless Local Area Networks

Benny Bing, Ed., 2002, Wiley Inter-science, ISBN 0-471-22474-X, 244 pages, hardcover.

The collection of chapters on the topic of wireless local area networks (WLANs) edited by Benny Bing, is a timely review of both standardized and emerging technologies in this area. The level of presentation is less academic and more technology-oriented. This is not surprising given that the multiple authors involved have a common denominator; they all come from the wireless industry. Nevertheless, the result is a book with a wide view of current technological solutions and challenges. The reader will find the solutions discussed in this book to be present in commercial systems available now (or in the near future). Likewise, the audience is assumed to be technology-driven ranging from students to middle management with a background in science. Naturally, there is a lot of detail to be presented on the current standards (particularly IEEE 802.11), which has a certain impact on the priorities of many of the authors. About half of the chapters include aspects of IEEE 802.11. In particular, there is extensive coverage of the evolution of 2.4 GHz and 5 GHz WLAN standards, illustrating primarily modulation and physical characteristics. The 5 GHz radio spectrum regulations are also presented as well as quality of service (QoS) and multimedia support standardization attempts. The increasing importance of security in WLANs does not go unnoticed either, discussed in terms of both MAC-level encryption as well as authentication for access control to local LANs, and as VPN support. Bluetooth is present in two chapters, where the emphasis is placed more on the architecture and coexistence aspects with 802.11b rather than the protocol itself. An assortment of chapters complements the basic theme of standardization in LANs. In them, we find an introduction of ultra-wideband (UWB) wireless

technology as well as three chapters dealing extensively with the business case for mobile operators and enterprises in selecting or interacting with WLANs.

IP for 3G: Networking Technologies for Mobile Communications

Dave Wisely, Philip Eardley, and Louise Burness, 2002, John Wiley & Sons, ISBN 0-471-48697-3, 295 pages, hardcover.

In these jittery times, the uncertainty of the financial survival of 3G wireless networks, before they are really up and running in many cases, may motivate one to approach the topics covered in *IP for 3G* in a critical fashion. The focus of the book is of course mainly technological, so one finds a case made in the first chapter for the benefits of IP over 3G, the argument being roughly that 2G systems were limited, 2.5G (i-mode, WAP, and GPRS) indicated a mixed picture of success (i-mode rather a success), but also indicated the need to properly interface with a predominantly IP world. Given that voice traffic does not present an interesting growth trend, IP traffic would be a safer bet. Once done with the introduction, one finds a sequence of chapters devoted to examining IP, or 3G wireless, but their synthesis does not arrive until the last two chapters. An introduction to both 3G wireless and IP spans the majority of chapters. The former is accomplished in only one chapter, which is geared toward a mainly MTS-oriented point of view. The latter, IP, is covered in four subsequent chapters. This relatively long coverage of IP is the cost of appealing to a mostly nonexpert audience. Specifically, we find the basics of the end-to-end principle and a layered view of IP, the set of standards for multimedia support over IP (SIP, H.323), IP mobility (in both IPv4 and IPv6) and micromobility protocols, concluding with QoS (TCP's behavior, RED's role, RTP). Information related to 3G is

sprinkled throughout the previous chapters, but it is in the QoS chapter that the connection to 3G is made in earnest. The last chapter provides the IP over 3G synthesis, listing the architecture, routing and mobility, QoS, security, and interfaces to be supported. As far as specifics go, UMTS R4 All IP transport and UMTS R5 IP call control signaling receive the most attention along with presentation of the evolution of cdma2000. Concluding, there are remarks about UMTS beyond R5, the impact of WLANs, and what the evolution toward a 4G future might look like.

Building Broadband Networks

Marlyn Kemper Littman, 2002, CRC Press LLC, ISBN 0-8493-0889-5, 609 pages, hardcover.

The term *broadband* has become overloaded over the years to the point that it appears to be synonymous with "high speed," or more precisely "higher speed" (in comparison to preexisting technologies). This book begins with a well-known case of broadband, the transition from ISDN toward B-ISDN, and asynchronous transfer mode (ATM) in particular, splintering off to cover relevant high-capacity optical technologies such as synchronous optical network/synchronous digital hierarchy (SONET/SDH), wavelength-division multiplexing (WDM), and dense WDM (DWDM). The second group of topics is that of Ethernet networks, in particular the transition from 10 Mb/s to 10 Gb/s Ethernet including niche topics such as HomePNA networks and their indirect relation to Ethernet standards. The wired broadband network part continues in three more areas: frame relay and the two access schemes for residential users, DSL and cable. In a twist on the usual presentation approach, the cable networks chapter includes the wireless "cable" alternatives (MDS, LDMS, MMDS, etc.). The link is thus made to the next major area covered, that of wireless technologies. In particular we find a detailed introduction to all flavors of cellular telephone systems, from AMPS to GPRS to IMT-2000 and further into 3G mobile. The next subset is that of mostly WLANs introduced first through a discussion of infrared (IrDA), laser, spread-spectrum, and orthogonal frequency-division multiplexing (OFDM) techniques, and later exemplified in the form of the 802.11, 802.15, and 802.16 standards. The final wireless part of the book is on satellite

networks encompassing S-UMTS, LEO, MEO, and VSAT networks. Finally, one chapter is devoted to the next-generation Internet development attempts, and security and privacy. Notably the book presents mainly definitions and just a bit of technical detail for each item, and provides a very comprehensive list of the testbeds (academic or not, United States and international) and the key corporate entities or consortia with stakes in each technology. In this sense, the book is better suited for an intermediate nontechnical managerial audience wishing to get a quick overview of the most promising or widely used high-speed technologies and interested in finding the key research, corporate, and user players for each technology.

Extreme Programming Applied

Ken Auer and Roy Miller, 2002, Addison-Wesley, ISBN 0-201-61640-8, 326 pages, softcover.

Extreme Programming Explored

William C. Wake, 2002, Addison-Wesley, ISBN 0-201-73397-8, 159 pages, softcover.

Questioning Extreme Programming

Pete McBreen, 2002, Addison-Wesley, ISBN 0-201-84457-5, 201 pages, softcover.

A sequence of books published by Addison-Wesley cover the area of Extreme Programming (XP). Three particular specimens listed here are three sides to the story of the same software development technique. The appeal of XP is its apparent freedom, which brings up a frequent question: "Is XP a return to the dark ages?" (as put in the *Questioning XP* book) in response to XP's particular encouragement of small teams and "frequent small releases" (quick production of software that provides just the basic functionality and subsequent refinements). As with all topics that exude an almost religious desire to convert infidels or enlighten the misguided, XP's power draws greatly in strength from the prose of books written about it. That is, the concepts behind XP are simple enough for most to understand, which means that the ink spent on XP is about making a case in support of it (or against it), rather than just describing it. To this end we find a variety of approaches. The approach in *Extreme Programming Explored* is that of

a hands-on example of Java code being transformed before the reader's eyes as well as comments on XP team practices and how one can describe the actual process (including the roles each person involved, programmer, customer, and manager, play each day in an XP project). The scope of *Extreme Programming Applied* is to provide a hint as to the mental and emotional barriers to overcome and the priorities in applying XP (highest risk tasks first) drawing from

real-life experience. Finally, *Questioning Extreme Programming* tries to answer the questions of skeptics as to the advantages of XP but also to answer questions that someone well versed in software engineering may ask of the substance of XP as a sound SE approach. Clearly, all three books are meant for the specific groups of software engineers and software development practitioners who have a stake in understanding or using the properties of XP.

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Reference Manual for Telecommunications Engineering, Volumes 1 and 2, 3rd Edition

Roger L. Freeman, 2002, Wiley-Interscience, ISBN 0-471-41718-1. (two vols.), 3551 pages, hardcover.

At more than 1700 pages per volume in two volumes, Roger L. Freeman provides us with an updated version of his classic reference work. The books clearly target a single set of engineers and practitioners who work on the development or production of actual telecommunications networks and cannot be satisfied by vague descriptions or introductory material. What matters to them are numbers, facts and figures. The rationale behind Freeman's book is that this is probably the best way to keep in order a set of reference materials that every engineer ends up compiling over the course of his/her career but without having to copy a stack of standards documents. In other words, standards documents can be seen as including three types of information; information with which an engineer or practitioner working on a particular field becomes familiar (and does not need reference materials to recall), and then some information that is much too detailed to be of real immediate applicable value (hence not really needed except in special cases). The third kind of information, what is left after you remove the other two, is what one could call vital to the standard but tedious. It is this third kind of information one finds in Freeman's book. The volumes come with an

excellently organized index, and a remarkable number of illustrations, equations, tables, and graphs. A certain thematic affinity is preserved over successive chapters, but, as its author recognizes too, once in a while topics cross at multiple points, an excellent example being the topic of noise in its multiple appearances in different settings. The book starts with telephony topics (traffic, switching, signaling, modulation, multiplexing, etc.) to technologies related to radio (wireless) transmission, television, fax, and data transmission, the Internet protocols, and more protocols than one would care to number. Freeman's book is quite possibly the most comprehensive reference work in telecommunications, barring having to read actual standards documents. It is the impression of the reviewer, however, that this third edition should signal the transition to CD-ROM format from the current heavy two-volume set.

Advanced Linux Networking

Roderick W. Smith, 2002, Addison-Wesley, ISBN 0-201-77423-2, 752 pages, softcover.

There are at least two commendable aspects of Roderick W. Smith's book *Advanced Linux Networking* in addition to the wide scope that extends over a set of tools, services, and configuration options. Namely, Roderick Smith makes a decent effort to present the less discussed and rather esoteric features of networking in Linux (using Samba to act as a CD recording server is one such example as a case where generally untapped functionality is exploited).

Second, he makes an honest effort to avoid Linux distribution-specific aspects and to write a book that appeals to all users alike. This latter feature comes at the cost of having to notify the reader regularly of inconsistencies that may creep across different distributions and how to approach the problem under each distribution. Another dimension of the book is acceptance that Linux systems have to cohabitate with deployed Microsoft-based operating systems. Thus, a rather healthy emphasis on Samba services is obvious throughout. Specifically, the book is split into four parts: (a) low-level configuration, (b) services in a LAN, (c) Internet-wide services, and (d) security and router functionalities. The low-level configuration spans kernel-level configuration options, basic TCP/IP configuration, certain alternative configurations (AppleTalk, IPX/SPX, NetBEUI), and establishing services via the inetd (and xinetd) server. The second part is a collection of topics covering DHCP, Kerberos setup, Samba services, NFS services, LPD (including LPRng) printer services, time (NTP) services, email "pull" (POP, IMAP) services, news (NNTP) services, remote login (rlogin) services, remote GUI access (X and VNC) services, font services, as well as a collection of tools for remote maintenance (SWAT) and backup (AMANDA). The Internet services part covers DNS services, SMTP services (sendmail, exim, postfix, procmail), Web services (apache, kHTTPd), and FTP services. The security part is (surprisingly!) not devoted to SSH alone but a presentation of intrusion monitoring, system security maintenance, the "chroot jail" concept, advanced routing (including filtering) options, NAT and firewalls, and finally setting up VPNs (using PPTP or FreeS/WAN).

Geographic Location in the Internet

Behcet Sarikaya (ed.), 2002, Kluwer Academic Publishers, ISBN 1-4020-7097-7, 214 pages, hardcover.

Geographic Location in the Internet is a book targeted to an audience who wishes to learn the basics of the available location-based techniques. In particular, it considers cellular networks, and how accurate characterization of location is accomplished and made available to software applications and services on mobile devices. Part of the discussion naturally revolves around the notion of location-aware location-based services. We are introduced to the topic via an

colleagues who wish to "loan" CPU cycles over a weekend (or other period of non-use of their PCs). No special configuration or installation of the master or remote PCs is required. Security features minimize the chance of anyone other than a designated master accessing files or other resources on the designated remote PCs. The REMOTE tool is written in ANSI C as a Windows console mode program (and can be built with both Borland and Windows C/C++ compilers). The Winsock interface is used for communications. The REMOTE tool is a lightweight remote program executor. It does not have capabilities to redistribute jobs based on load, recover jobs from failures, and so on as do much more complex remote program executors, such as Condor. Support is provided by the author, and ideas for future revisions are solicited.

SOFTWARE TOOLS/from page 3

PCCPU cycles to be used for compute-intensive tasks such as executing simulation models. The REMOTE tool consists of a master PC with a host list and job list. The host list contains all Windows PCs running the remote program. The job list contains a list of executable files and their associated input and output files. The master program sends out the executable and input files to the remote PCs and then receives the output files sent back from the remote PCs. No changes are required to programs to be executed remotely. To a user, it appears as if all programs executed on the single master PC. The host and job lists are manually built, but remote PCs running the remote executor can be automatically detected.

The REMOTE tool consists of two executable files: master.exe and remote.exe. The remote.exe file can be emailed to

application programming interface (API) that provides the interface between a location-based application and a location-dependent server, that of Mobile Location Protocol (MLP), developed by the Location Interoperability Forum (LIF). The rest of the book could be characterized as a collection of contributed chapters aimed at provide the available location determination (and update) techniques, especially in cellular networks, and then to indicate how the location information can be used in the context of Session Initiation Protocol (SIP) as a vehicle of presenting the application of location information in client-server interactions. The cellular network chapter describes the information possible to extract at which-network component and the location technologies that can be used in GSM, ITA/EIA-136, IS-95, and UMTS. Essentially the techniques discussed are based on timing differences in transmission arrivals, and then extend to discussion of GPS services and ways to describe geographical areas. The presentation of cdma2000 location services is given special attention along with the operation of location services in all-IP networks. In a departure from the purely descriptive style of other chapters, a chapter on update protocols of location information also provides quantitative evidence in a comparison of different schemes. The closest the book comes to

describing an actual application is a geographic search engine in the sixth chapter, while the two last chapters describe which elements and properties of location-based systems could be considered sensitive private data, and which policies and trust relationships are desirable in the particular context.

Advanced MPLS Design and Implementation

Vivek Alwayn, 2002, Cisco Press, ISBN 1-58705-020-X, 469 pages, hardcover.

Network engineers and administrators, as well as people interested in the design, implementation, and support of provider or enterprise networks, have had to become familiar in recent years with the MPLS technology. The strong motivation for adopting MPLS has been the immediate ability to support VPNs with small overhead, as well as to provide a set of basic tools for traffic engineering and, consequently, QoS, tasks. To a certain degree it has also encouraged the interoperability of ATM and IP networks wherever ATM installations were already deployed. The three introductory chapters present a historical perspective of MPLS as the alternative to the initial complicated IP-over-ATM schemes; subsequently is explained how the defining characteristic of MPLS, that of labels, relate to routers' and

paths, how they are assigned, and how they are distributed. Not surprisingly, once done with the introductory material, attention is drawn to VPNs. A large fraction of the people using MPLS are likely to do so at least for the versatility of establishing VPNs in a way that avoids the overheads and cost of connection-oriented VPNs, GRE, IPSec, and other proposals of essentially tunneling over the basic forwarding provided by an underlying network layer. The juxtaposition of other techniques with MPLS is illustrated in Chapter 4, while the next two chapters provide the two main versions of VPN support in MPLS: as a packet-based MPLS VPN or an ATM-based MPLS VPN. In two subsequent chapters, we find two additional degrees of freedom introduced by MPLS, that of traffic engineering via control and selection of routing paths, and that of QoS capabilities based on the separation and/or aggregation of traffic. The final chapters deal with design issues and the more advanced topics, especially in relation to mostly optical environments, such as multiprotocol lambda switching. Despite the Cisco slant, unless there is a need to present a particular case study (as in the chapter on how to set up a packet-based or ATM-based MPLS VPN) via its configuration scripts, most of the text does not require strong familiarity with Cisco equipment configuration.

IEEE COMMUNICATIONS MAGAZINE FEATURE TOPIC — GMPLS

Scope

The Generalized MultiProtocol Label Switching (GMPLS) is a very hot topic, which is currently under standardization by IETF and ITU. GMPLS is the next step of MPLS; it provides a generalized signaling control protocol standard for the multiple types of switching. It is our expectation that GMPLS is going to shape a new control plane for the future IP-networks and to simplify the control functions supporting multiple types of switching. In particular, the so-called GMPLS-oriented Label Switching Router (LSR) architecture is concreted for better performance, and impacts many aspects of future IP-networks. This Feature Topic of IEEE Communications Magazine seeks to present a series of state-of-the-art articles on GMPLS-related topics. In particular, we are interested in tutorial and survey articles on, but not limited to, the following topics:

- GMPLS Architecture
- GMPLS-oriented QoS
- GMPLS-oriented OAM
- GMPLS-oriented Wireless Handoff
- GMPLS-oriented Scalability

- GMPLS-oriented Label Switching Router (LSR) System
- GMPLS-oriented Link Management
- GMPLS-oriented Mobile IP-Networks
- GMPLS-oriented All-Optical IP-Networks
- GMPLS-oriented New Issues

Schedule

Submission Deadline: November 1, 2002
 Acceptance Notification: January 15, 2003
 Final Manuscript Due: March 31, 2003
 Publication Date: June 1, 2003

Submission

Please submit your complete paper in a .doc or .pdf file to the Editor-in-Chief, gskuo@ieee.org for paper review.