THE MANY FACETS OF INTERNET TOPOLOGY AND TRAFFIC

D. ALDERSON
Operations Research Department,
Naval Postgraduate School, Monterey, CA 93943, USA

H. CHANG
Department of EECS, University of Michigan
Ann Arbor, MI 48109-2122, USA

M. ROUGHAN
School of Mathematical Sciences,
University of Adelaide, Adelaide 5005, Australia

S. UHLIG
Network Architectures and Services,
Delft University of Technology, Delft, The Netherlands

W. WILLINGER
AT&T Labs-Research, Florham Park, NJ 07932, USA

ABSTRACT. The Internet’s layered architecture and organizational structure give rise to a
number of different topologies, with the lower layers defining more physical and the higher
layers more virtual/logical types of connectivity structures. These structures are very dif-
ferent, and successful Internet topology modeling requires annotating the nodes and edges
of the corresponding graphs with information that reflects their network-intrinsic meaning.
These structures also give rise to different representations of the traffic that traverses the
heterogeneous Internet, and a traffic matrix is a compact and succinct description of the
traffic exchanges between the nodes in a given connectivity structure. In this paper, we
summarize recent advances in Internet research related to (i) inferring and modeling the
router-level topologies of individual service providers (i.e., the physical connectivity struc-
ture of an ISP, where nodes are routers/switches and links represent physical connections),
(ii) estimating the intra-AS traffic matrix when the AS’s router-level topology and routing
configuration are known, (iii) inferring and modeling the Internet’s AS-level topology, and
(iv) estimating the inter-AS traffic matrix. We will also discuss recent work on Internet con-
nectivity structures that arise at the higher layers in the TCP/IP protocol stack and are more
virtual and dynamic; e.g., overlay networks like the WWW graph, where nodes are web
pages and edges represent existing hyperlinks, or P2P networks like Gnutella, where nodes
represent peers and two peers are connected if they have an active network connection.

1. Introduction. The design and implementation of most complex systems is inevitably
broken down into simpler subsystems that tend to be separately optimized and implemented
and then interconnected, often in an ad-hoc manner. A prime example of this approach is
the architecture of the Internet, which is comprised of a modular design based on a dual
decomposition of functionality—a vertical separation into layers and a horizontal decentral-
ization across network components [121]. One of the most visible manifestations of the
Internet’s vertical decomposition is the 5-layer TCP/IP protocol stack, consisting of (from

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