

Part V

Appendices

A

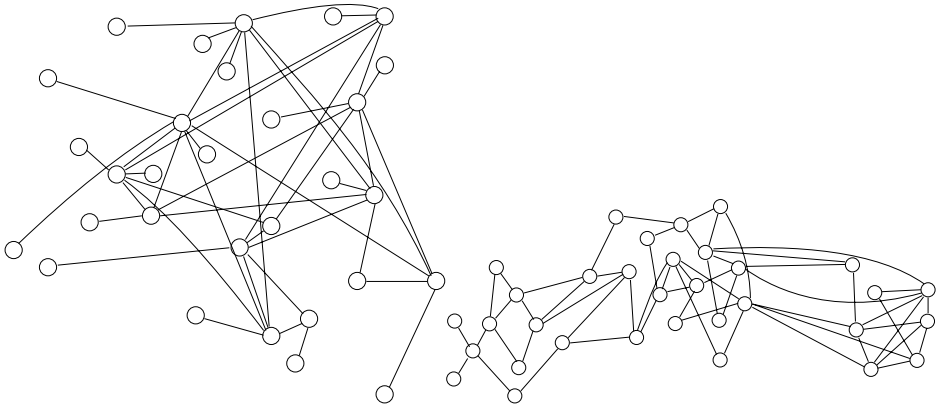
Topologies Used in the Experiments

Throughout the various experiments in this book, different network topologies have been used. As the properties of the topology influence the outcome of the experiments, we base most of the experiments on real-world topologies of Internet network service provider (INSP) networks.

These topologies are depicted in Figures A.1 to A.3. The properties of the underlying graphs are more important than the shape of these topologies. Their basic graph properties are listed in Table A.1.

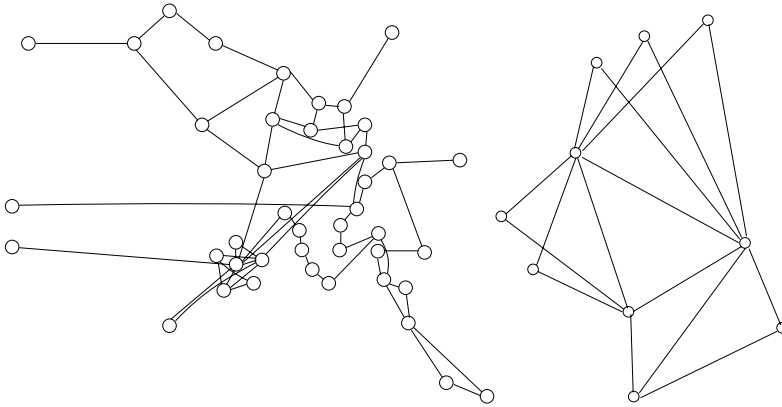
- The number of nodes and links are listed.
- *Dia.* denotes the diameter of the graph; the diameter is the length (number of hops) of the longest path of the set of all the shortest paths between all nodes.
- The hop-plot is the proportion of all nodes that can be reached within a certain number of hops. For example, for the Deutsches Forschungsnetz (DFN) topology from a random node, on average 97% of all other nodes can be reached within four or less hops. The diameter and the hop-plot are a measure of the connectivity properties of the graph and the lengths of the shortest paths between node pairs.
- The outgoing node-degree of a node is the number of outgoing links connected to that node. The average outgoing node-degree and the standard deviation of the outgoing node-degree distribution are also listed in the table.

We tried to include many real-world topologies; as providers are reluctant to reveal their true network topology in every detail, some of the topologies had to be altered slightly compared to the true topology. However, this mostly affects the node placement and not the connectivity properties of the topologies needed for the experiments. Also, some artificially created topologies are included (Artificial-1 to 3). They were created using Tiers V1.2 with the parameters listed in Table A.2. The setting of these parameters was based on the findings of Heckmann *et al.* (2003). Finally, star and cross topologies were added for the Quality of Service (QoS) experiments because they allow creating a lot of cross traffic at well-defined points.



(a) DFN-like Topology

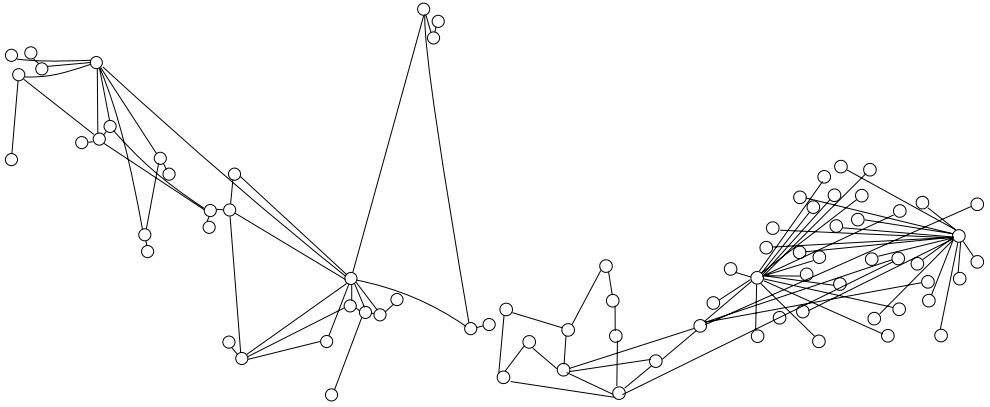
(b) Cable Wireless-like Topology



(c) Colt Telecom-like Topology

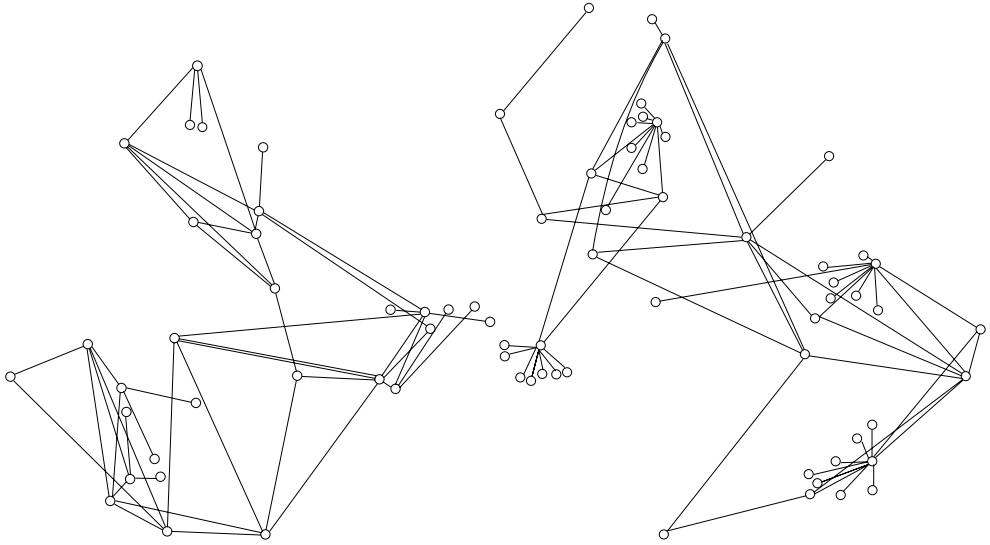
(d) Deutsche Telekom Backbone-like Topology

Figure A.1 Topologies (1)



(a) SWITCH-like Topology

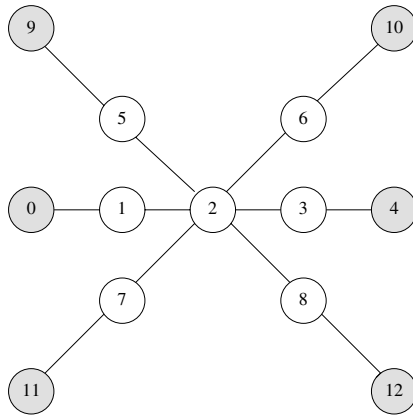
(b) Artificial-1 Topology



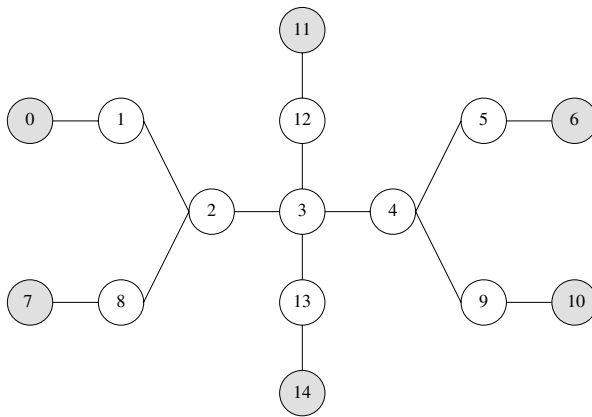
(c) Artificial-2 Topology

(d) Artificial-3 Topology

Figure A.2 Topologies (2)



(a) Star Topology



(b) Cross Topology

Figure A.3 Topologies (3)

Table A.1 Properties of the Topology Graphs

Topology	# Nodes/ Edge Nodes	# Links	Dia.	Hop-plot _{1;2;3;4;5}	Degree _{av}	Degree _{stddev}
<i>DFN</i>	30/30	97	5	0.11; 0.41; 0.79; 0.97; 1.0	3.13	2.84
<i>C & W</i>	33/33	107	12	0.11; 0.25; 0.39; 0.51; 0.62	6.48	2.64
<i>Colt</i>	43/43	107	17	0.07; 0.16; 0.26; 0.36; 0.47	4.98	2.34
<i>Telekom</i>	10/10	34	2	0.38; 1.0; 1.0; 1.0; 1.0	6.80	4.31
<i>SWITCH</i>	31/31	80	9	0.09; 0.28; 0.57; 0.81; 0.92	5.16	6.89
<i>Artificial-1</i>	47/47	106	7	0.05; 0.33; 0.50; 0.85; 0.95	4.51	6.88
<i>Artificial-2</i>	30/30	150	10	0.09; 0.26; 0.4; 0.55; 0.65	10.0	9.50
<i>Artificial-3</i>	47/47	180	10	0.05; 0.23; 0.35; 0.56; 0.66	7.66	10.06
<i>Star</i>	13/6	12	4	0.15; 0.42; 0.81; 1.0; 1.0	1.85	1.3
<i>Cross</i>	15/6	14	6	0.133; 0.3; 0.55; 0.81; 0.96	1.86	0.88

Cable & Wireless (C&W), Colt Telekom Europe (Colt), Deutsches Forschungsnetz (DFN), Deutsche Telekom Backbone (Telekom), Swiss Education and Research Network (SWITCH)

Table A.2 Tiers Parameters Used for the Generation of the Artificial Topologies

Abbreviation	Function	Artificial-1	Artificial-2	Artificial-3
<i>NW</i>	Number of WANs*	1	1	1
<i>NM</i>	Number of MANs per WAN	1	2	2
<i>NL</i>	Number of LANs per MAN	2	3	2
<i>SW</i>	Number of nodes per WAN	9	6	7
<i>SM</i>	Number of nodes per MAN	4	4	4
<i>SL</i>	Number of nodes per LAN	17	4	8
<i>RW</i>	Redundancy of the links within a WAN	3	6	5
<i>RM</i>	Redundancy of the links within a MAN	2	3	3
<i>RL</i>	Redundancy of the links within a LAN*	1	1	1
<i>RMW</i>	Redundancy of the links between MANs and WANs	4	9	7
<i>RLM</i>	Redundancy of the links between LANs and MANs	1	6	6

* In Tiers V1.2 only *NW* = 1 and *RL* = 1 are supported