Peer-to-Peer Networks

TECHNISCHE
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Solution 1

H#1.1 Domain Name System

a) Hierarchical Structure - Draw the corresponding graph to the structure of the following domain names: lists.gnu.org, de.wikipedia.org, www.p2p.informatik.tu-darmstadt.de, www.informatik.tu-darmstadt.de, www.tk.informatik.tu-darmstadt.de

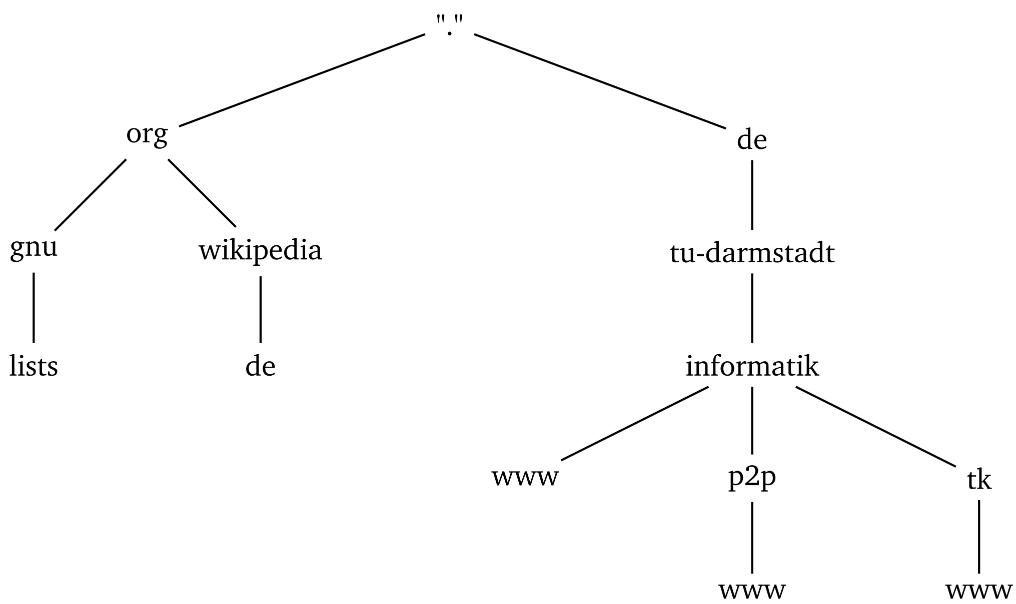

Figure 1: The corresponding graph to the structure of the given domain names

b) Zones - Domains can be split into zones according to that hierarchical structure of subdomains. Each zone can be managed by distinct servers, as presented in the lecture. Why is DNS not simply run by a set of central directory servers?

Centralized DNS would produce the following problems:

Single point of failure: If the centralized server-systems are down, the complete system would be down.

Traffic volume: A huge traffic volume would be generated, if each web browser would request a "hostname to IP address" translation to this single-system. It is also a performance problem.

Distant centralized database: A huge database would be needed without any given redundancy.

Maintance: Every change (e.g ip - hostname mapping) must be managed and maintained on a single-system.

A centralized DNS could not scale like a decentralized system.

H#1.2 RFC

a) What is an RFC (Request for Comments)? Read up on the history of RFCs and sketch how they are used today. (Consult the RFC-Editor if in doubt)

"Memos in the Requests for Comments (RFC) document series contain technical and organizational notes about the Internet. They cover many aspects of computer networking, including protocols, procedures, programs, and concepts, as well as meeting notes, opinions, and sometimes humor." [Edi]

"RFCs are numbered (roughly) consecutively, and these numbers provide a single unique label space for all RFCs. RFCs are published online through a number of repositories, and there is an online index of RFCs. The RFC series has been assigned ISSN 2070-1721. All RFCs, Internet-Drafts, and associated editorial discussion are covered by the IETF Note Well policy." [Edi]

b) Read RFC 2119. Why is it important to precisely define such words when talking about protocols?

Certain words and phrases must be defined to avoid misunderstandings in the description of protocols. If such a keyword is in use describing a protocol, a third person has the ability to understand the meaning of the protocol. As described in [Bra97] the words "MUST", "SHALL" and "REQUIRED" have the same meaning. It is also defined that a definition (with these keywords) is an absolute requirement of the specification.

H#1.3 Modelling and Analysing Graphs

Draw a graph $G = (V, E)$ where nodes V represent courses you attended at the university (include at least 10 courses). A directed edge from A to B is inserted if material from course A was relevant for course B.

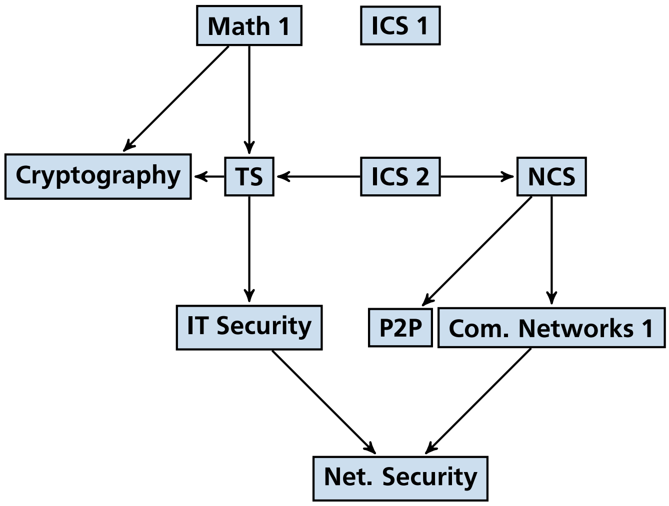

Figure 2: Graph

a) Are there cycles in your graph? What meaning do they have in this model?

There is no cycle in this graph (Figure 2). So the courses have topological order.

If there were cycles, we have cyclic dependencies in the given courses. The courses have no topological order (chicken or the egg causality dilemma).

b) What is the highest in-degree (out-degree) of a node in your graph? What does this mean for the corresponding courses?

$$\begin{aligned}
&\textbf{in-degree}(\textit{ICS 1}) &&= 0 \quad &&\textbf{out-degree}(\textit{ICS 1}) &&= 0\\
&\textbf{in-degree}(\textit{ICS 2}) &&= 0 &&\text{out-degree}(\textit{ICS 2}) &&= 2\\
&\textbf{in-degree}(\textit{Math 1}) &&= 0 &&\text{out-degree}(\textit{Math 1}) &&= 2\\
&\textbf{in-degree}(\textit{NCS}) &&= 1 &&\text{out-degree}(\textit{NCS}) &&= 2\\
&\textbf{in-degree}(\textit{P2P}) &&= 1 &&\textbf{out-degree}(\textit{P2P}) &&= 0\\
&\text{in-degree}(\textit{TS}) &&= 2 &&\text{out-degree}(\textit{TS}) &&= 2\\
&\text{in-degree}(\textit{Cryptography}) &&= 2 &&\textbf{out-degree}(\textit{Cryptography}) &&= 0\\
&\textbf{in-degree}(\textit{IT Security}) &&= 1 &&\textbf{out-degree}(\textit{IT Security}) &&= 1\\
&\textbf{in-degree}(\textit{Com. Networks 1}) &&= 1 &&\textbf{out-degree}(\textit{Com. Networks 1}) &&= 1\\
&\text{in-degree}(\textit{Net. Security}) &&= 2 &&\textbf{out-degree}(\textit{Net. Security}) &&= 0
\end{aligned}$$

The highest in-degree and out-degree are marked above.

The node *Math 1* for example has an out-degree of 2. Two courses (in this case: Cryptography and TS) depend on Math 1. So it is recommended to complete Math 1 before visiting TS and/or Cryptography, wherein Cryptography depends on TS.

The node *Cryptography* has an in-degree of 2. This course depends on two courses (here: TS and Math 1). So it is recommended to complete Math 1 and TS before visiting Cryptography.

Course-nodes with an in-degree of 0 have no dependency (here: Math 1, ICS 1 and ICS 2). So it is recommended to complete these courses first.

Course-nodes with an out-degree of 0 are no dependency-nodes (here: ICS 1, Cryptography, P2P and Net. Security).

c) Name all nodes of degree 0.

The Course-node *ICS 1* has a degree (= in-degree + out-degree) of 0.
(see list in b)

H#1.4 Failure Probability

Alice and Bob want to exchange notes through their classmates. There are k = 5 classmates between them and n = 20 students in class including Bob and Alice. It is assumed that events are independent.

Alice now wants to send a message to Bob via the shortest possible path.

a) How likely does a message reach Bob, if each student has a probability of p = 0.1 to get caught by the teacher while forwarding a message? (Precisely think of how often the message is forwarded)

The shortest path from Alice to Bob: $Alice \rightarrow L \rightarrow M \rightarrow N \rightarrow O \rightarrow P \rightarrow Bob \Rightarrow 6$ **forwardings**

$$\begin{aligned} P(SuccessForwarding) &= (1-p)^{forwardings} = (1-0.1)^6 = 0.9^6 = 0.531441 \Rightarrow 53.1441\% \\ P(UnsuccessForwarding) &= 1 - P(SuccessForwarding) = 1 - 0.531441 = 0.468559 \Rightarrow 46.8559\% \end{aligned}$$

b) Assume the teacher is not paying attention, but 2 students are squealers and will forward by passing notes to the teacher. As Alice and Bob are new in class, they do not know who they are. Alice and Bob will not tell on each other. How high is the probability that a message reaches Bob under that assumption?

$$Q(X) := \textit{probability, X (shortest path node) is not a squealer, under condition no squealer is found, yet}$$

$$\begin{aligned} Q(L) &= \tfrac{16}{18} \\ Q(M) &= \tfrac{15}{17} \\ Q(N) &= \tfrac{14}{16} \\ Q(O) &= \tfrac{13}{15} \\ Q(P) &= \tfrac{12}{14} \end{aligned}$$

$$\begin{aligned} P(SuccessForwarding) &= Q(L) \cdot Q(M) \cdot Q(N) \cdot Q(O) \cdot Q(P) &&= 0.5098 \Rightarrow 50.98\% \\ P(UnsuccessForwarding) &= 1 - P(SuccessForwarding) &&= 1 - 0.5098 = 0.4902 \Rightarrow 49.02\% \end{aligned}$$

c) How high is the probability if both assumptions are made?

$$O(X, Y) := \textit{probability, successfull forwarding } (X \rightarrow Y)$$

$$\begin{aligned} O(Alice,\ L) &= \tfrac{16}{18} \cdot 0.9 &&= 0.8 \\ O(L,\ M) &= \tfrac{15}{17} \cdot 0.9 &&= 0.79412 \\ O(M,\ N) &= \tfrac{14}{16} \cdot 0.9 &&= 0.7875 \\ O(N,\ O) &= \tfrac{13}{15} \cdot 0.9 &&= 0.78 \\ O(O,\ P) &= \tfrac{12}{14} \cdot 0.9 &&= 0.77143 \end{aligned}$$

$$\begin{aligned} P(SuccessForwarding) & &&= \prod 0.27093 \Rightarrow 27.093\% \\ P(UnsuccessForwarding) &= 1 - P(SuccessForwarding) &&= 0.72907 \Rightarrow 72.907\% \end{aligned}$$

References

[Bra97] S. Bradner. Rfc 2119. WWW: http://www.rfc-editor.org/rfc/rfc2119.txt, March 1997.

[Edi] RFC Editor. Rfc editor. WWW: http://www.rfc-editor.org/RFCoverview.html.