

CPSC 155b: Solutions to Homework Assignment 3

Question 1:

There are no entities in the gnutella system that play the distinguished role of "server." Each member of a gnutella network is the "peer" of each other member and can issue requests, forward requests, and respond to requests. By contrast, the Napster system does have servers. A Napster client connects to a server to communicate the fact that it is online, the list of files that it is willing to share, and the file that it is looking for, and the server directs the client to another client who is online and can provide the desired file; then the "peer-to-peer" file exchange between the two clients takes place. More succinctly, a "pure peer-to-peer" architecture is one in which all participating entities are peers; a "peer-to-peer" system that is not pure has some participants that play distinguished roles and hence are not peers of the ordinary participants.

The pure peer-to-peer nature of gnutella makes it difficult for copyright holders to sue for infringement. Without distinguished servers that direct traffic, centralize control, and keep track of which files the "peers" are exchanging, it is not clear which single entity can be held responsible and hence not clear whom to sue. This can be regarded as a disadvantage of the pure peer-to-peer architecture or an advantage, depending upon whether or not one is a copyright holder.

A serious disadvantage of the pure peer-to-peer systems in use today, including gnutella, is inefficiency. Centralized, professionally managed servers can direct file-exchange traffic so that the load is balanced throughout the network and redundant file exchanges are avoided; there is no distinguished participant to play this load-balancing role in a pure peer-to-peer system. Inefficiency in gnutella takes several forms, including exponential "request flooding": If the average gnutella node has c neighbors and the average request has time-to-live d , then an average request can result in more than c^d messages, which is wildly impractical for large values of c and d .

Lack of centralized control can give the peers in a pure peer-to-peer system the opportunity for creativity and enhancement of the overall system's functionality. For example, different nodes in a gnutella network can interpret requests in different ways; a requester may get multiple responses to the same query, and this can be a significant advantage in situations in which queries do not have straightforward, uncontroversial answers.

Question 2:

Examples include but are not limited to:

DVD movie distribution. The technical-protection system (TPS) has several ingredients, including R/W'able copy-control marks, CCS encryption, and Macrovision signals (to inhibit analog copying). None of these ingredients works perfectly; indeed, the CCS algorithm has been decisively "broken," and its weaknesses are well known in the technical community. Thus, this TPS is a form of curb-high protection. However, movie piracy directly attributable to flaws in the DVD TPS has not been a major problem for the industry, and the DVD format is considered a commercial success. Overall, the DVD TPS is adequate for the purpose of "keeping honest people honest," and the movie industry has nontechnical means with which to go after large-scale pirates.

Business-to-consumer (B2C) retail sites that protect user-account data (such as credit card numbers and postal addresses) with passwords. It is well known that many people use the same password for multiple purposes (*e.g.*, the computer system at work, an Amazon account, and a

PIN for ATM access) and that they write passwords in datebooks, desk calendars, and other easily accessible places so that they do not have to remember them. Thus, passwords constitute a curb-high protection measure. Thieves could in principle use stolen passwords to buy goods from web-based retailers and charge them to other people's accounts. In practice, this has not been a major problem. The facts that stolen passwords would not be usable for long (because victims would change their passwords or close their accounts once they got charged for something they did not buy) and that many B2C retail sites offer good service and reasonable prices make password theft not worth most potential thieves' time and effort.

As explained in Appendix G of **The Digital Dilemma**, there was a very widely deployed computer file system that had a "don't copy" flag that could be set for each file. Anyone with a rudimentary knowledge of computer programming could circumvent this copy-control measure, but undoubtedly many people confronted with a "cannot copy that file" error message assumed that the file in fact could not be copied. Many if not most users are not programmers or, even if they are, do not try to do things that the file system "tells them" they are not supposed to do.

Firewalls. As explained in the January 25 lecture, off-the-shelf firewall products that are not installed and configured by experts can often be penetrated. Nonetheless, they have proved adequate for many organizations' needs. Because the amount of skill needed to penetrate a firewall varies with the skill of the firewall administrator (and the very best administrators can make the task quite difficult indeed), the term "knee-high protection" is probably better in this context than "curb-high protection."

Question 3:

The point of this question is that some of the relevant standards were developed specifically for music distribution, but some were developed for broader purposes. Examples of correct answers include but are not limited to:

Standard Internet and WWW protocols such as FTP, HTTP, and HTML, which provide a communications infrastructure in which innovative services such as Napster can be developed and deployed.

Standard formats for audio files, most notably MP3, and standard software for creating formatted audio files, most notably the CD-ripper program.

Standard encryption algorithms (*e.g.*, DES and AES) and standard digital-signature schemes (*e.g.*, RSA and DSA). There are ongoing standardization attempts for more general digital-rights management platforms, such as SDMI ("secure digital music initiative"), but as of now they have not been widely deployed and adopted.

Standard e-commerce enablers, *e.g.*, SSL for credit-card payments over the Internet. (To be precise, I conjecture that these enablers *will* be relevant, because people will eventually start paying for Internet music-delivery.)

De facto standard products and services for distributing and playing audio files, *e.g.*, Napster, WinAmp, and RealPlayer.

Question 4:

Important similarities include but are not limited to:

Both are prime examples of the importance of network effects in Internet services.

Both are consumer-to-consumer (C2C) services.

Both are technically well designed and well executed; users are happy.

Both have inspired interesting work in academia and in the broader Computer Science research community. For example, the success of eBay is one of the main motivations (albeit not the only one) for recent work on computational aspects of auction design, and the success of Napster has focused many computer scientists' attention on "content protection" mechanisms, on business models for Internet-based content distribution, and on how intellectual-property law affects and is affected by developments in computer and networking technology.

Important differences include but are not limited to:

eBay is a profitable company with a well articulated, successful business model and millions of paying customers. By contrast, Napster is basically a piece of software. Although it is technically a "company," it does not now have and has never had any paying customers. The closest it has come to articulating a business model is to say that it plans to launch "a subscription service"; it has not specified exactly what a "subscription" entitles a subscriber to and how much it would cost. All of the company's operating funds have so far come from investors (both venture capitalists and Bertlesmann AG).

Both companies are potentially vulnerable to charges that they engage in or facilitate unlawful activity. Music companies can claim that Napster facilitates violation of their copyrights. Potential buyers can claim that, under eBay sellers' auction rules, they submitted winning bids but did not get the item because of flaws in eBay's operations systems. Dissatisfied buyers could claim that eBay facilitated fraudulent claims by sellers. In fact, all of these types of claims have been litigated, but the two companies have fared quite differently in court: eBay has successfully defended itself, and Napster hasn't.