# Chapter 5
# Peer-to-Peer Networks: Interdisciplinary Challenges for Interconnected Systems

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## ABSTRACT

*Peer-to-peer networks are one of the main sources of Internet traffic, and yet remain very controversial. On the one hand, they have a number of extremely beneficial uses, such as open source software distribution, and censorship resilience. On the other hand, peer-to-peer networks pose considerable ethical and legal challenges, for instance allowing exchanges of large volumes of copyrighted materials. This chapter argues that the ethical quandaries posed by peer-to-peer networks are rooted in a conflicting set of incentives among several entities ranging from end-users to consumer electronics manufacturers. The discussion then turns to the legal, economic, and technological remedies that have been proposed, and the difficulties faced in applying them. The last part of the chapter expands the scope of ethical issues linked to peer-to-peer networks, and examines whether existing laws and technology can mitigate new threats such as inadvertent confidential information leaks in peer-to-peer networks.*

## INTRODUCTION

Since their inception in 1999 with the Napster file-sharing service, peer-to-peer networks have grown to become a predominant source of Internet traffic (Karagiannis et al., 2005; Basher et al., 2008). One of the reasons behind the success of peer-to-peer networks is that they have many uses. For instance, in contrast to a centralized server that would have to bear over a awarm of hosts, peer-to-peer networks facilitate information dissemination by spreading the load, thereby reducing infrastructure costs. Applications that take advantage of the cost reduction offered by peer-to-peer infrastructures include software distribution, for example open-source software such as the Linux kernel,[1] or proprietary software such as World of Warcraft patches.[2]

As another societal benefit, peer-to-peer systems offer increased censorship-resilience thanks

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to their decentralized organization. Once a file is in a peer-to-peer network, it is extremely difficult, if not impossible, to completely remove that file from the network, due to both the sheer number of machines in the network that may host a copy, and the rate at which users join and leave the network.

For all their advantages, peer-to-peer systems pose considerable ethical and legal challenges, which stem from a conflicting set of incentives among the different network participants. As a case in point, a significant share of peer-to-peer traffic has historically consisted of copyrighted materials. Indeed, for end users, the ability to download "free" content often proves tempting, particularly when considering that most consumers are either unaware of, or have a basic misunderstanding of copyright law. As a response, copyright holders, most notably the music and movie industries, have been aggressively investigating legal and technological means to reduce, disrupt, or even abolish peer-to-peer network traffic.

To add further confusion, Internet service providers (ISPs) have adopted a more ambiguous position, due to the economic conundrum they face. On the one hand, peer-to-peer applications are a driver for consumers to purchase higher levels of broadband connectivity, which translates into higher revenue for ISPs. On the other hand, the explosion of peer-to-peer traffic puts a severe strain on network infrastructure, which results in increased costs for ISPs. Consequently, some service providers have been known to treat peer-to-peer traffic as undesirable, e.g., by downgrading its priority when it enters their network, without necessarily advertising this fact to their customers.

In this chapter, we will first examine in greater detail the incentive misalignment among the actors in peer-to-peer networks. We will then briefly summarize the legal issues associated with peer-to-peer networks, especially the questions of contributory infringement and vicarious liability. In this context, we will provide an overview of the legal and economic remedies that the content industry and service providers have entertained to tackle challenges posed by peer-to-peer networks.

In the third part of the chapter, we will describe the technological arsenal that content industry and Internet service providers have been using to limit peer-to-peer traffic, as a complement to legal recourse. We will present "interdiction technologies" for which patent applications have been filed. We will distinguish between methods that target content (i.e., files) from those that target peer-to-peer hosts (i.e., actual machines). We will use this distinction to inform our discussion on the ethical and legal dilemmas that the application of these interdiction technologies presents.

In the fourth, and final, section, we will explain how the problem of controlling information flow in peer-to-peer networks far exceeds the mere realm of copyright enforcement. We will show that the assumption that the content present in the network is voluntarily introduced by end-users may be flawed. Studies indeed document that private data (e.g., credit card numbers) are often accidentally leaked due to end-user misconfiguration. Even more perniciously, recent viruses and worms have been seen to exploit peer-to-peer infrastructures to leak and disseminate private information on a large scale.

We will conclude by discussing whether or not existing interdiction technologies can mitigate these new threats. We will use these recent developments to highlight the modern ethical challenges that society faces in dealing with peer-to-peer networks.

## THE ROOT OF THE PROBLEM: CONFLICTING INCENTIVES

We argue that the root causes of the rapid rise of peer-to-peer filesharing of copyrighted materials belong more to the economic realm, than to the technical realm. To be sure, technology has acted as a primary catalyst in the development of peer-to-peer filesharing – but, far from being slanted