Outline for Internet Algorithmics

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1 PHILOSOPHY

The material for this class is too large to be covered in more than one lecture in any of the current CSE or ECE courses in networking. It is also appears to be an important area because Internet traffic appears to be doubling every six months or so, with new bandwidth-hungry applications such as radiology and live video streaming adding to the problem. Improved performance, however, requires paying attention to the complete system from the Operating system layers on a client PC, to the algorithms and hardware structures used in routers. While some of the techniques are taught in other courses, this requires a form of inter-disciplinary thinking that we believe can be fostered by such a class. The course can be taken by both CSE and ECE graduate students, together with selected undegraduates.

2 Course Description

We use the term Internet Algorithmics to describe the emerging study of techniques to speed up Internet implementations. Algorithmics includes the use of new algorithms, operating system changes, hardware iinovations, new system decompositions — *whatever* it takes to speed up Internet bottlenecks. A key requirement is systems thinking: problems can often be eliminated by moving them from one part of a system to another. We believe that networking innovations can occur when individual area experts — for example, a protocol implementor and a hardware architect — work together to expose cross-cutting issues and to produce synergistic solutions. To this end, the course begins with a series of simple models for protocols, operating systems, and hardware design. Next, we introduce a set of fifteen principles for efficient implementation.

After working through a number of examples of applying these principles, the the course surveys endnode performance techniques (e.g., copy avoidance, application device channels,

header prediction) and router performanance techniques (e.g., crossbar switch arbitration, IP lookups and packet classification, router scheduling, traffic measurement, intrusion detection). The course will attempt to consistently derive these techniques using the 15 basic principles. We will also a number of real-world examples drawn from commercial and academic Internet systems.

3 COURSE OUTLINE

We will cover the course based on the course outline but with some freedom of expression. For example, this time around I will concentrate on Routers.

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SECTION I: THE RULES OF THE GAME

Chapter 1 Introduction: Algorithmics versus Algorithms, Course Organization

Chapter 2, Models: Protocols, Network Devices, Operating Systems,
Hardware Design, Performance Measures

Chapter 3, Principles

Chapter 4, Case Studies



SECTION III: PLAYING WITH ROUTER PERFORMANCE

Chapter 9, Switching

Chapter 10 Exact Matching

Chapter 11 Prefix Matching

Chapter 12, Packet Classification

Chapter 13. Scheduling
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Chapter 14, Other Router Tasks (Buffer Allocation, Striping, Credit Based Flow Control, Accounting and Measurement, Intrusion Detection)

CONCLUSION