CHAPTER 5

Dynamic Modelling of the Internet

5.1 Introduction

In Chapter 1, the idea was presented that some spatial interaction could be defined as a cone of converging time lines (Figure 1.5). This convergence, connecting origin-destination pairs, is defined by the rate of time-discounting (and distance minimisation) and its rate is a function of the technology of transfer. The previous theoretical and empirical work concentrated on origin-destination trips from a shopping mall to residences. However, time-discounting behaviour is not exclusively found at shopping centres. Rather, the time-space convergence means that, at least theoretically, the mathematical operators can be projected beyond this interaction to larger distance scales and smaller time scales. The manifestation of this 'quantum leap', in a change of scale, is the Internet. The key question is whether the interaction near the singularity of the convergence (that is, at very small time scales) is the same as our shopping modelling of the previous chapters. If it is, then there should be a type of gravity interaction and a periodic internet demand wave circumnavigating the world relative to the Earth's rotation. Near this singularity, spatial interaction offers some peculiar features, such as, virtual distance between origin-destination pairs and the ability to go forwards or backwards to different time zones relative to the location of the computer. The RASTT model has been applied extensively, in the previous chapters, to the study of trips to and from point densities (shopping malls) between time-lines, where its time-dependent solutions are relative to centre opening and closing times. In the case of the Internet, the time boundary is a moving day-night transition from the rotation of the Earth and the solutions of the model, with the same operators, should have similar features to our previous work. In this chapter (based on Baker, 2001), the retail space-time trip (RASTT) model will be applied to the Internet, exploring the type of wave developed and the nature of distance decay. The model will be tested using data from the Stanford Internet experiments for the year 2000.

The Stanford experiments were undertaken by Dr Les Cottrell at the Linear Accelerator Centre, Stanford, USA. It features 27 global monitoring sites in 2000, pinging transactions every hour to 171 remote hosts distributed around the world. The experiment measures the time taken from pings between origin-destination pairs and the amount of packets shed from congestion on the route. What is meant by 'packet loss'? When too many packets arrive on an origin-destination trip, routers hold them in buffers until the traffic decreases. When the buffer fills up during times of congestion, the router drops packets. Packet loss is what is being measured here as a proxy of peak demand. The Stanford experiments have been running from 1998 to 2004 with various numbers of monitoring sites and remote hosts. The year 2000 had the greatest connectivity between the number of monitoring sites and remote hosts and presents the best opportunity to test the model. One site in northeast US

(Chicago) was selected to test the RASTT model, namely, **hepnrc.hep.net.gif** because it possessed the greatest number of connected remote hosts. It is with this case study that the model will be tested for spatial and temporal interaction (Figure 5.1).

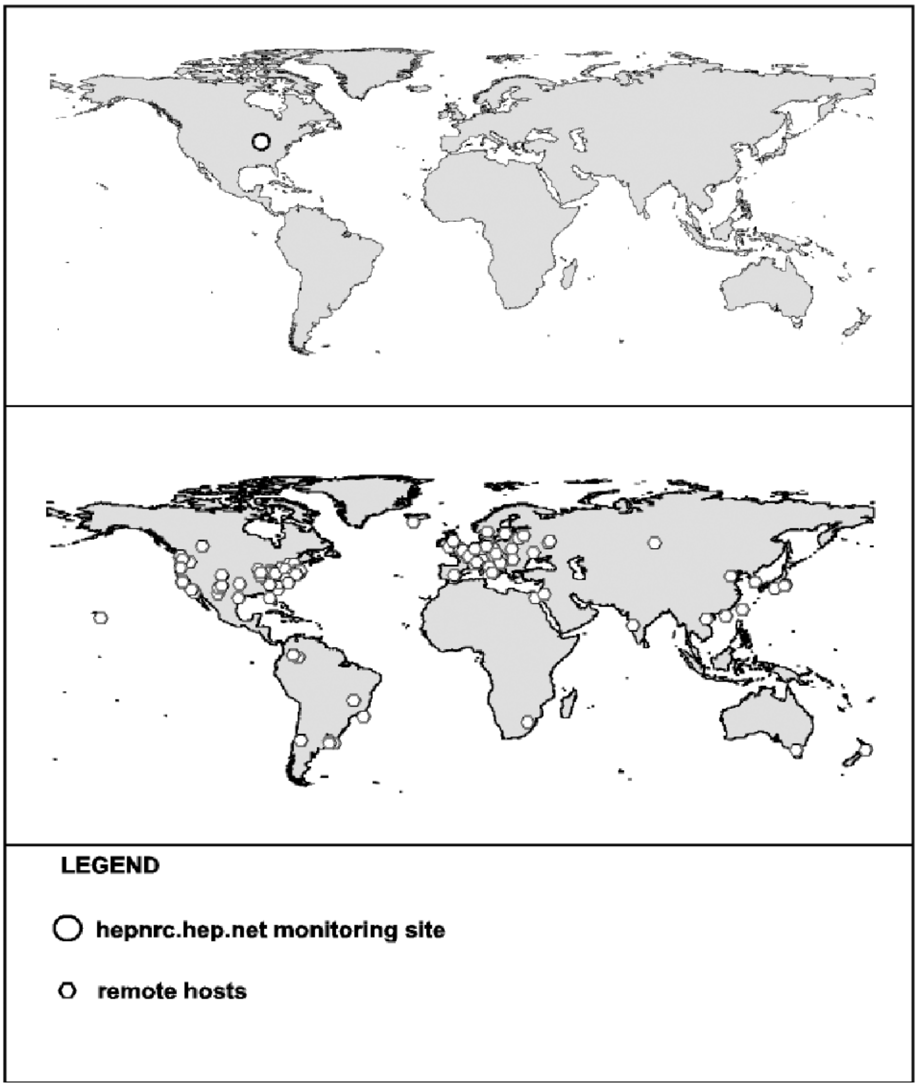

Figure 5.1 The Location of the **hepnrc.hep.net.gif** Monitoring Site (top) and the Remote Hosts (bottom)