14.1 Introduction

An electrical engineer in training, Paul Baran joined the RAND Corporation in 1959. While working at RAND on a scheme for U.S. telecommunications infrastructure to survive a “first strike,” he conceived of the Internet and digital packet switching, the Internet’s underlying data communications technology. Using minicomputer technology of the day, Baran (1964) demonstrated in a simulation suite that a distributed packet switched communications network can better withstand massive destruction to individual components than centralized or decentralized networks. Baran’s conceptual drawings in Figure 14.1 serve as a vivid example of the distinctly different network patterns under centralized versus decentralized control.

Fig. 14.1 Baran’s conceptual networks for data communications (Baran, 1964)
This chapter explores transportation networks under centralized versus de-centralized control. Focusing on the governmental provision of transportation infras-tructure, Chapter 13 presented a game-theoretic analysis of governance choice at a central versus local level, considering the benefits and costs associated with alternative governance patterns. In order for mathematical tractability, however, this analysis only examined an idealized, small serial network. Chapter 10 constructed System Of Network Incremental Connection (SONIC) which created a transportation network link-by-link during its early deployment phase, although this model, growing a network based on the myopic “strongest-link” heuristic, does not consider the institutional organization that underlies this process.

Extending the efforts in the previous chapters, this chapter aims to construct a more realistic representation of governmental control on transportation networks. Adopting the basic form of the SONIC model, this chapter develops System Of Network Incremental Connection for Governance Choice (SONIC/GC), which predicts the incremental deployment of a transportation network under alternative governmental initiatives, and compares the resulting system performances. While it is generalizable to any surface transportation network, the model is developed with a particular focus on road networks.

The complexity in modeling the provision of transportation networks arises from the many actors who design, construct, expand, manage, maintain, operate, commercialize, and use transportation networks during the evolutionary process of transportation development. Stripped to its essence, transportation infrastructure is provided and operated in a value chain in which three key groups of players, including customers (travelers), financiers (bank), and providers (in this case, central or local governments), are involved. Therefore, the deployment of a transportation network is played out as the outcome of the strategic decisions made by these players under their independent initiatives. Main assumptions regarding the players are laid out below.

Travelers prefer a route on a transportation network that incurs less generalized travel cost, which includes travel time and monetary costs they pay for travel, such as parking, fuel taxes and user tolls. A deterministic behavioral mechanism assumes travelers have perfect information regarding travel time over the entire network and they always choose the least cost route from their origin to destination. A stochastic theory, on the other hand, relaxes this assumption and includes a random component in travelers’ perception of travel time, assuming that travelers choose routes to minimize their perceived travel cost.

A bank allows jurisdictions to save the surplus of their revenue for future investment, or borrow from the future for present spending. The bank pays interest for the savings and provides loans at an interest rate. It is assumed that a rational bank would prioritize its loans to investment projects with funding needs trading off risk for reward. For simplicity, this study assumes a central bank agent and no spread between the rate for savings and the rate for lending.

Providers of transportation infrastructure could be public or private, at a central or a local level. This analysis concentrates on its public provision led by central or local governments, which was the common practice for road financing during the