of a user to support collaboration among participating parties. This leads us to our hypothesis:

> Often, people in close proximity share a common goal or have a related motivation. Some of them may have valuable information relevant but unknown to others.

The common goal for these mobile Peer-to-Peer applications is to make this information available to other interested parties. Through this, we see new forms of spontaneous collaboration that can be distinguished in *active* and *passive* collaboration (cf. Section 25.1.2).

25.1.1 Mobile Peer-to-Peer Networks and Mobile Ad Hoc Networks

A thorough comparison of (infrastructure-based) Peer-to-Peer and mobile ad hoc networks (MANETs) has been carried out in [82]. The fundamental commonalities between the two are:

- *Decentralized architectures.* Neither network type relies on a central component (a centralized server).
- *Transient connectivity.* In both kinds of networks, nodes connect and disconnect unpredictably. In addition, MANET nodes are mobile and they move in and out of the communication range (which may appear to other nodes as a disconnection).
- *Heterogeneity of resources.* A mobile ad hoc network may be formed by different mobile devices, such as a laptop, mobile phone, or PDA. These devices typically differ in battery life, CPU power, and storage capacity. Likewise, computers that run the same Peer-to-Peer application typically vary in their specification.
- *Sharing of resources.* In both network types, a user actively shares her resources (battery power, CPU power, storage capacity, network connection) with others and the network exploits these resources to provide its services.
- *Identity management.* Both networks have to address the identification of any entity (e.g., nodes, peers, users, and content). This may also include privacy protection, in order to allow users to act anonymously within the network or application.
- *Routing and message forwarding.* Although MANETs handle routing on the network layer and Peer-to-Peer networks handle it typically on the application layer, routing remains a critical issue for both kinds of network.

On the other hand, there exist the following differences:

- *Network size.* Whereas MANETs are generally concerned with networks of a few hundred nodes, modern Peer-to-Peer networks can span much larger networks

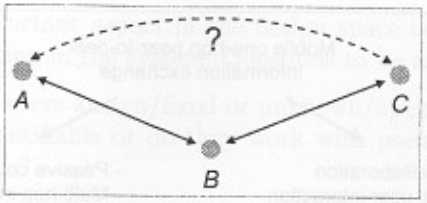

Fig. 25.1: Multi-hop communication.

- *Focus in the ISO/OSI Model.* Research and development of mobile ad hoc networks particularly focuses on the network layer. Several multi-hop routing algorithms have been proposed (see [484, 327]). Conversely, research in Peer-to-Peer networks addresses more the construction of overlay networks in the application layer.

As stated in the introduction, this chapter focuses on *mobile* Peer-to-Peer networks and applications. In many ways, mobile Peer-to-Peer networks are similar to MANETs, since they are also formed by individuals carrying a mobile device. Hence, the networks are of a similar size. However, there are certain important differences between the traditional MANETs and the mobile Peer-to-Peer networks we consider here. MANETs have been investigated in the context of military networks, emergency response, and sensor networks. These networks have several key characteristics in common, namely that *all nodes* in the network are strongly related to each other, trust each other, and share a goal they want to accomplish.

Mobile Peer-to-Peer networks, as we consider them, are formed between *anonymous groups of individuals.* This poses several additional challenges to the network. Consider the situation in Figure 25.1 with A, B, and C as mobile nodes, that is, individuals equipped with mobile devices. A is in communication range of B but not in range of C, who, on the other hand, is in communication range of B. If A wants to communicate with C, all traffic has to be routed via B. Bearing in mind that A, B, and C, a priori, do not know each other, two questions arise:

- What is the incentive for node B to route messages between A and C? Why should node B be willing to donate part of her battery power to enable communication between A and C ?
- Why should node A and C trust and rely on node B for their communication? Node B could easily eavesdrop, manipulate, or just reject messages.

Without an incentive scheme and extra security mechanism built in, the standard multi-hop communication schemes of MANETs appear to fall short of providing for communications in mobile Peer-to-Peer networks.

The alternative to the multi-hop MANETs are the so-called one-hop networks. In these networks, information is not forwarded over several hops;