

- **Education:** Nowadays, educational institutions such as colleges and universities, plan to eliminate the old cabling system that was used to provide on-campus network access to students. As a better alternative, one efficient strategy that can be used instead to cover their entire campus is the wireless mesh network. By mounting dozens of indoor and outdoor routers, everybody on campus is able to connect to the network easily.
- **Intelligent Transport System:** As a future application, car makers and telecommunication companies are conducting research on developing Intelligent Transport Systems (ITS) powered by street and highway-based wireless mesh networks. Using an automated network of surveillance cameras and in-car sensors, public safety officials can tightly monitor traffic accidents and dangerous road conditions.

### 2.3.1 Single-Channel Single-Radio Wireless Mesh Networks

In a single-channel single-radio network, each node has only a single radio and operates on a single channel to communicate (see Figure 2.6 (a)). In such networks, the throughput capacity has a significant limitation. In [12], the theoretical upper bound of per node throughput capacity is asymptotically limited by  $O(1/\sqrt{n})$  where  $n$  is number of nodes in the network. Hence, as the number of nodes in a network increases, the throughput capacity degrades very rapidly. In practice, the situation is even worse and this is because of many facts that have not been considered when deriving the network capacity in theory. For instance, overheads of routing and transport protocols or using a realistic Medium Access Control (MAC) are two examples of such facts that exist in reality but neglected when it comes to theoretical analysis of network capacity. Experiments show that in a string topology network with use of CSMA/CA based MAC, the throughput degrades to  $1/n$  of the raw channel bandwidth [13]. One of the main factors that contributes to such degradation is the exposed terminal problem (Section 2.1) and is intensified by the use of single radio per node in single-channel networks. One of the most effective approaches to enhance the throughput capacity of such networks is to use systems with multiple channels and multiple radios per node (MCMR). In a MCMR network, nodes may possess many radios and use different channels for communications.

### 2.3.2 Multi-Channel Single-Radio Wireless Mesh Networks

Any end-to-end path in a multihop network should utilize all available channels in a way that maximizes the number of simultaneous transmissions in the network area. Unfortunately, a key limitation of single-radio wireless devices is that they can only use one channel at a time