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Mesh Networking With Raspberry Pi

Introduction

Internet access is the lifeblood of modern living. Many people depend on the Internet for working, staying abreast of current events, communicating with friends or loved ones, and accessing entertainment. Though there is often Internet access available via hotspots or the cell network there are occasions when this is not the case. Natural disasters and other unforeseen events can damage the existing infrastructure and hamper aid efforts.

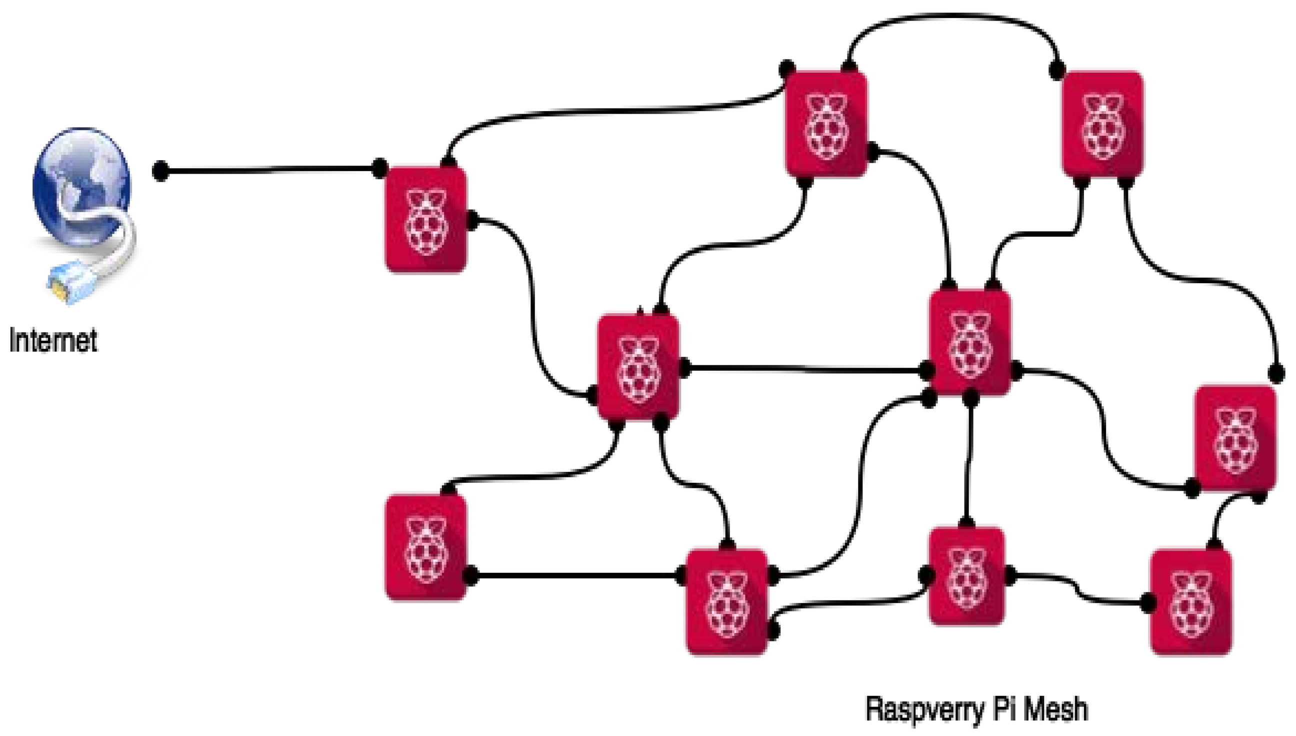

Figure 1. Big picture view of network Topology

Potential Applications

The low cost Raspberry Pi computer can be employed as a building block for providing wireless access to the internet if wired access exists, or it can serve as a standalone regional communications network. Properly configured multiple Raspberry Pi computers can provide wireless internet coverage for situations such as disaster relief, providing network access in rural areas, and providing a rapidly deployable solution for providing localized network coverage coverage   for outdoor events.

Functionality

The device used in the research was the Raspberry Pi 3, which is a full fledged computing platform on a single low cost board, which has an onboard Wireless adapter as well as a wired ethernet interface, this was supplemented by the addition of a low cost USB 802.11n WiFi adapter. The Raspberry Pi runs Linux and is configured to provide the necessary services to allow users to connect much as they would when using WiFi access at home or at a Wifi hotspot. Additionally the Raspberry Pi's were configured to connect to each other using a mesh routing protocol which makes it possible to add, remove, or relocate units and have the network reconfigure itself autonomously. The implementation blends a traditional Wireless Local Area Network (WLAN) with a mesh network to allow users and devices with a limited knowledge of networking to reap the benefits made possible by relying on a mesh network routing protocol behind the scenes.

Raspberry Pi Mesh Topolog

Figure 2: A Raspberry Pi Computer Board

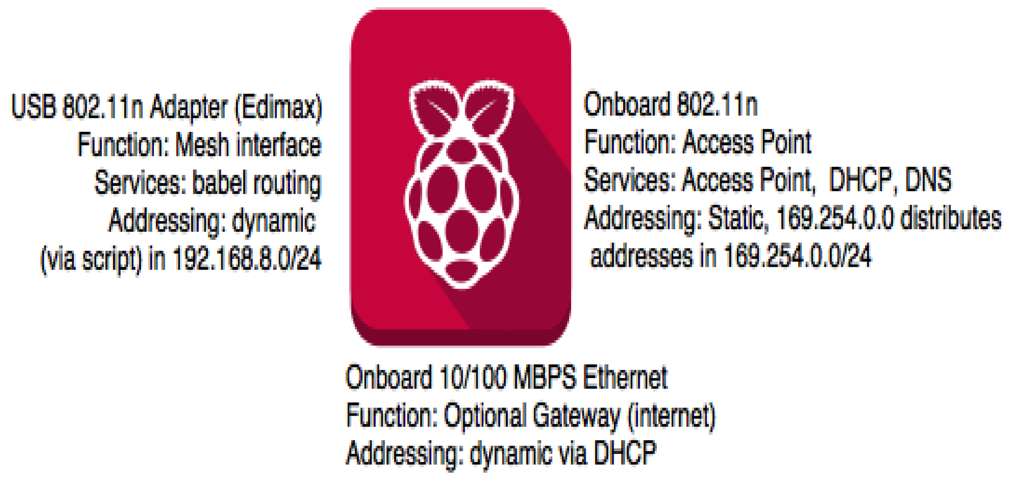

Figure 3.   Detail view of interface configuration for each Raspberry Pi

Mesh Networking

The below diagram demonstrates the differences between a conventional WLAN and a mesh network. On the right is a WLAN, in this mode each device cannot communicate directly with its peers, but must send its traffic via a dedicated router. For example if device A wishes to communicate with device B, the traffic must first travel through the router. Furthermore devices outside the range of the router cannot communicate with other devices. Such is the case for device E, although it may be within radio range of device B or C because it is out of range of the router it cannot participate in the WLAN.

Mesh networks such as the one depicted on the left in the diagram are not restricted by the need to communicate via a central chokepoint. Devices can communicate directly with each other so long as they are within radio range of each other. Furthermore if a device is beyond radio range of its intended recipient it can still communicate with it as its traffic will be routed via its neighbours. For example devices A, B, and C can communicate directly and devices A, B, and D can communicate directly as well. Device C can communicate with device D by using either device A or B as an intermediary; similarly E can communicate with C by sending traffic via E -> D -> A -> C or E -> D -> B -> C, or even E -> D -> A -> B -> C if that happens to be the best route. Routing is determined by weighing the metric of each route and choosing the route which is best suited given the destination.

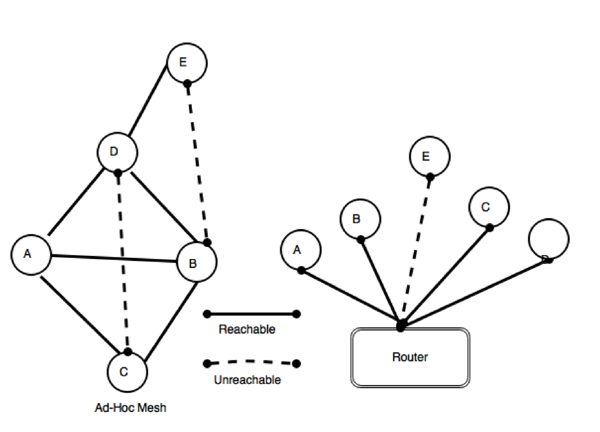

Figure 4. Mesh Topology vs. WLAN Topology

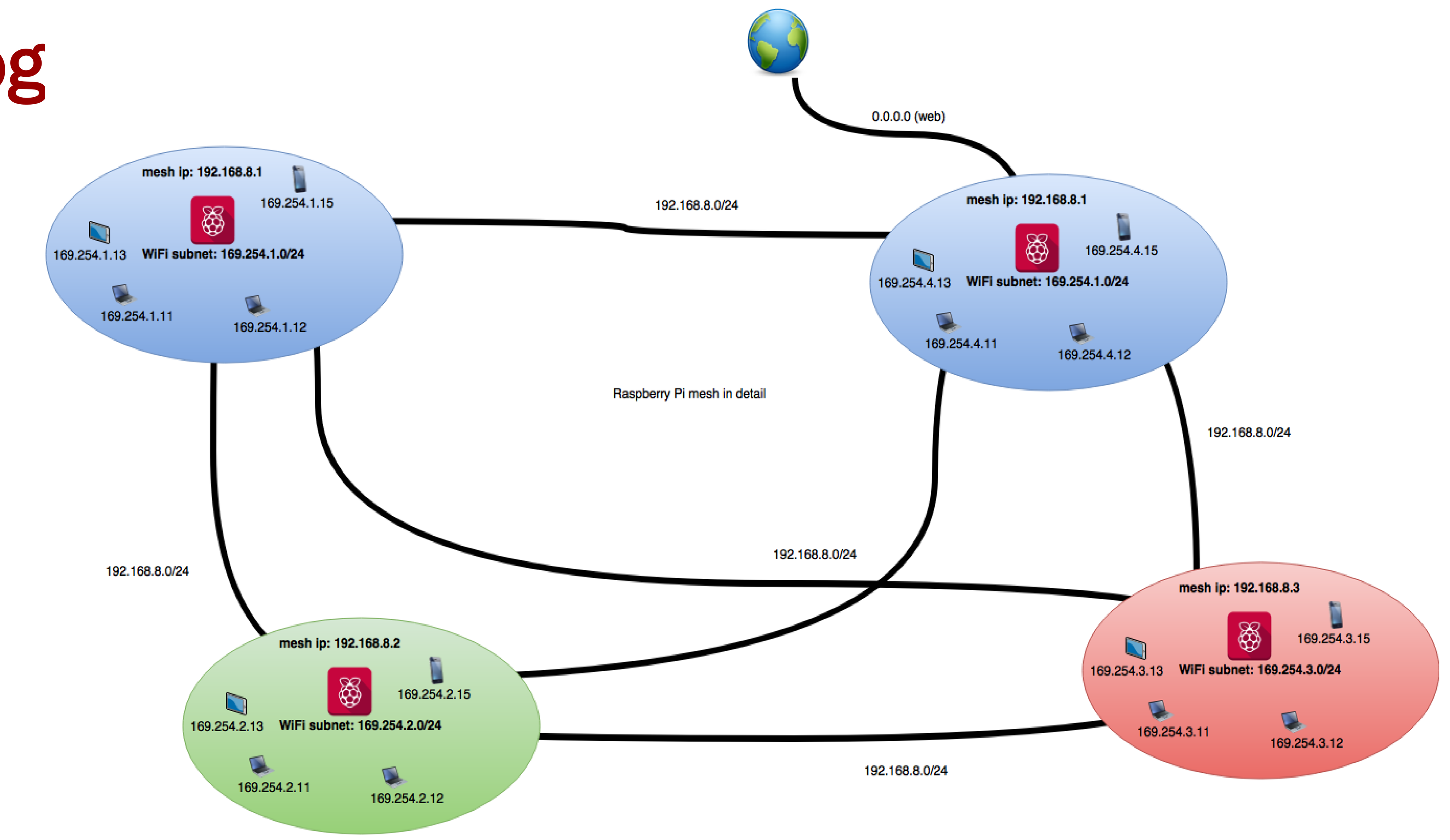

Figure 5. Detail view of network Topology

Detail Setup

Each individual Raspberry Pi is running a full complement of network services. This includes a firewall, software which provides Access Point (AP) functionality, Dynamic Host Configuration Protocol for assigning addresses to clients connecting to the Access Point, DNS for hostname resolution and a mesh routing protocol used to provide a resilient and flexible backbone for the mesh.

Conclusion

For a modest investment a flexible and resilient communications network can be implemented to serve under numerous conditions.