



A new approach to controlling your model railroad

*An introduction by Steve Shrimpton*

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The WifiTrax concept will allow you to connect your entire model railroad to your home Wi-Fi network giving you a flexible and versatile method of control from almost any hand-held device or computer on your network

## What is WifiTrax?

### Cab Control

WifiTrax is a form of Cab Control. Cab control allows more than one locomotive to run on the same section of track and be controlled independently.

Without Cab Control, locomotives must be controlled by varying the DC voltage on a section of track, so all locomotives on that section behave the same. If you want to run more than one locomotive on a layout at the same time, you must break the track into sections and switch each section to a selected DC controller. This is the traditional way to build model railway layouts.

Cab Control is a name for any control system that allows you to directly control a locomotive, while keeping a constant voltage on the track. The track then becomes nothing but a power supply, though with some systems it also carries signals as in DCC but NOT in WifiTrax.

### The DCC Cab Control System

In the early 1990's DCC was invented. This is Digital Cab Control and uses pulsed power on the track to allow commands to be sent to each locomotive so that it can receive commands independently to increase or reduce speed. DCC is very popular and is supported by NMRA Standards and manufactured by many companies. It has the disadvantage that the track voltage is used to send signals so this method of data transfer has limited bandwidth, is specific to model railroads and therefore cannot make optimal use of modern developments in networking. Also, care must be taken to ensure that all DCC devices can operate together, so strict standardization is essential.

## WiFi Cab Control

Technology has moved on and I can now introduce a simpler system for Cab Control leveraging a technology that is in widespread general use. I have named it WifiTrax. Wi-Fi is common in many households and allows high-bandwidth communication between any pair of Wi-Fi enabled devices such as between a computer and a printer or indeed a computer and a model locomotive if both are connected to a local Wi-Fi network. DCC locomotive decoders have a microcomputer and for WifiTrax we simply use a more powerful microcomputer that also contains a Wi-Fi transceiver. Instead of receiving commands from a DCC Command Controller via pulse encoding on the track, the WifiTrax Controller receives its commands directly from any computer on the Wi-Fi network *using existing standardized technology*.

A computer program (firmware) running in the WifiTrax Controller receives commands via the Wi-Fi Network and acts upon them to control the locomotive motor, lights and maybe other exciting things such as sound and *even vision*.

Just as with DCC, you can use WifiTrax Controllers to control other items on your layout in a similar manner. Turnouts are an obvious example. Lighting, signals and turntables are others. Also, power district control is usually necessary since you may have reversing loops and maybe you want to run DC or DCC locomotives on the same layout. All of this comes within the WifiTrax concept.

Just a reminder: what are Power Districts or Blocks? These are sections of track whose power can be controlled independently and the polarity reversed as required. Maybe you want to power down some locos in a shed, but mainly you need them because you have a reversing loop, so you need to switch the direction of the power to the block that the locomotive returns to after traversing the loop to avoid a short circuit when the wheels bridge the gap. I'll explain all that detail in an application note.

Figure 1 shows a Wi-Fi network with a laptop, desktop and a smart phone or tablet just such as you might already have in your home or club. It becomes a WifiTrax network when the computers have one or more WifiTrax apps installed and you have some model railroad hardware with WifiTrax Controllers such as the locomotives, switches (turnouts or points) and power controllers as in Figure 1.

Together the computers in Figure 1 control two model railroad locomotives, one switch and one power blocks. Of course, the computers need not be dedicated to the model railroad and they need not be permanently in place. Only one computer or hand-held device is needed to control the model railroad but with more operators, more app installations will be needed so folks can move around controlling their part of the layout operation.

It is worth noting that WifiTrax power block or switch controllers usually do not just control one item as shown in Figure 1. In fact, one controller will control several switches or power blocks. You can install them around your layout as convenient to minimize wiring. On our web site we provide preliminary information on these.

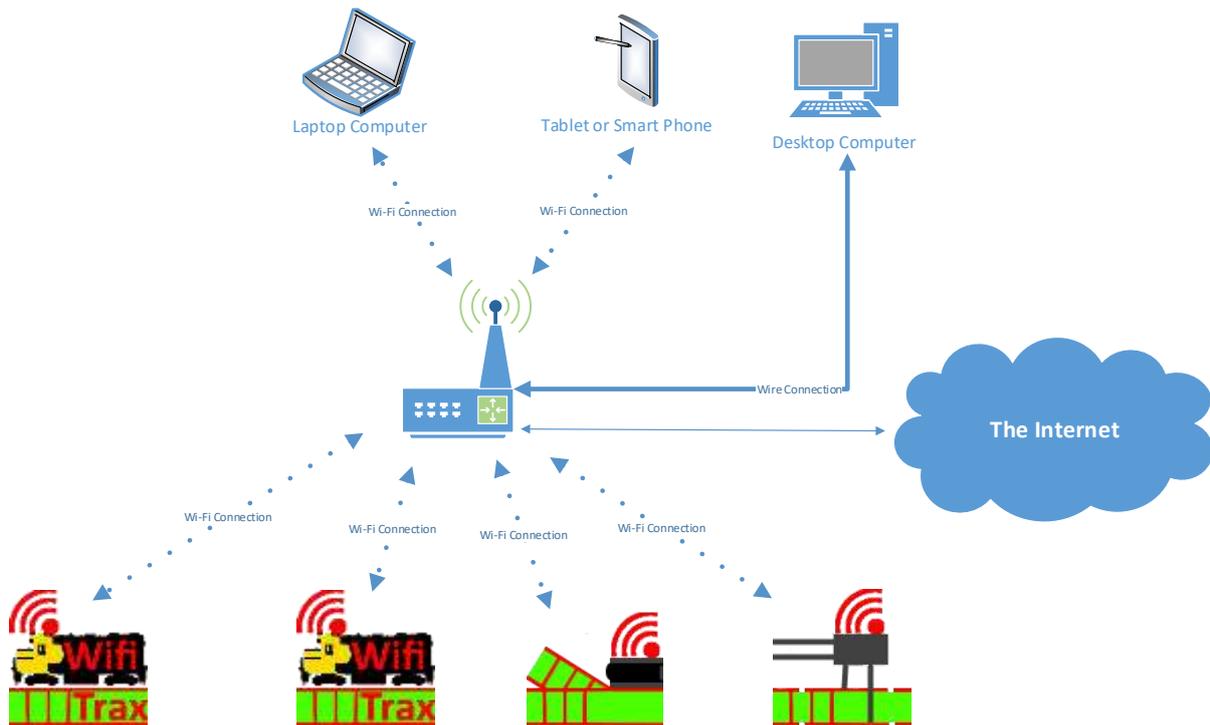


Figure 1 WifiTrax Network Controlling Locomotives, Switches and Power Districts

## Infrastructure Wi-Fi or Wi-Fi Direct (A Technical Discussion)

Most households that have Wi-Fi Networks want to use it to access, not just other computers, printers and scanners within their house, but also the internet. This requires infrastructure Wi-Fi based on using a Wireless Router as an *access point*. The wireless router is a central location that routes information between computers and between computers and the internet.

Another alternative technology that is less common is Wi-Fi Direct. This allows two devices to pass data between them independently of other computers. If you have a tablet and there is a Wi-Fi Direct printer nearby, you can connect to it and print your document without using the router.

Wi-Fi direct may be useful for one smart phone to control one locomotive in a simple scenario. However, the WifiTrax concept is much more general and allows a smart phone app to control one or two locomotives and also other things. To achieve this WifiTrax uses Infrastructure Wi-Fi via a central router acting as an access point. WifiTrax allows your layout to grow! WifiTrax does not currently support Wi-Fi Direct.

Some groups have coined the term DWiC (Direct Wi-Fi Control) to mean directly controlling the locomotive via Wi-Fi using a web page generated from the controlled device itself. This is not the same as Wi-Fi Direct which is a specific Wi-Fi Protocol. WifiTrax is a DWiC system in a sense, but the [DWiC Working Group](#) have also defined this to require that the *presentation* of the means of controlling a device such as a locomotive comes from within the device itself.

In developing WifiTrax, I liked this idea and prototyped the concept but found it limited the richness of the user's control experience. For example, our Loco Controller App provides a speedometer readout of the scale speed. This software is written using a technology called Xamarin and requires custom controls for each supported platform (Android, Windows, IOS). To achieve this using HTML is much more difficult. Also, I wanted to allow Dual Locomotive Control and later, Multiple Switch

Machine Control on a plan-based panel. I did not think that merging HTML pages from each device into one screen using an App would give a satisfactory UI experience.

Nevertheless, in WifiTrax, the locomotive does act as a web server but exposes a Web API to the outside world. An API (Application Programming Interface) is a lower level interface that other computer programs can access to take control of the locomotive.

## Will Standards be Needed?

As I said earlier successful DCC operation relies on strict standards maintained by the tireless work of the NMRA. Is the same necessary for Wi-Fi control? I think not. The reason is that Wi-Fi standards are already present. Each locomotive or other Wi-Fi controlled device responds to commands from an App that communicates directly with it over a common communication environment.

The need for standards may arise from the need for software developers to provide Apps that will communicate with Wi-Fi Controllers from more than one company or indeed with controllers that use a different technology such as Bluetooth. In such a scenario, it will be necessary for manufacturers such as myself to publish their Web APIs and maintain them. An example would be the integration of Wi-Fi Controllers on a layout with the JMRI (Java Model Railroad Interface) which I would be happy to support in the future.

However, it is early days yet and model railroaders can quite happily run DCC, Bluetooth and WifiTrax locomotives on the same layout using the Apps for each manufacturer separately. The only requirement is that the track voltage is compatible with all three (by the way, our Wi-Fi Controller Modules work fine with DCC track voltage, ignoring the signals).

As I said, the underlying communications protocol is *already* an industry standard.

## WifiTrax – Software and Hardware

Most systems these days encompass both Software and Hardware. Hardware is the computers themselves with their electronic circuit boards, screens, keyboards etc. Software is the name for the computer programs that you install to make the computer hardware do something useful. It's called *Software* because you can change it easier than the hardware.

There is also a term – *Firmware* – which is software that is not so easy to change because it's stored in a semi-permanent memory of some kind such as *Flash* memory. Usually upgrading the firmware is quite a big event.

Figure 2 shows an example of a WifiTrax control system. The Loco Operator App installed in the tablet sends commands to the WifiTrax firmware installed in the WMH-20 hardware unit installed in a locomotive.

## WifiTrax Software

In the WifiTrax concept software takes the form of several *Apps*. Anyone with a smart phone or a tablet knows what an app is. It's a piece of software that you download either free or for a small fee from an app store such as that run by Google, Microsoft or Apple. The WifiTrax apps run on Android and Windows 10. We also plan to support Apple IOS fairly soon.

The WifiTrax Apps allow you to operate your model railroad. For example, our first app, called “Loco Controller”, allows you to control one or two locomotives. There will also be a Signal Tower App that

will allow you to control the switches, power districts, and other track related items on your layout. We can imagine others such as apps providing for freight loads, signalling, fast clocks, lighting etc.

Of course, if a group of people are operating a model railroad, each one can be using a smart phone or tablet for walk around control. One or more dispatchers or tower operators could be sitting at fixed-position laptops or desk tops. One of these apps could be controlling time of day and dimming the lighting above the railroad as night falls.

An example of a WifiTrax App is our first release, Loco Operator, an app that can be installed in a tablet or computer to operate one or two locomotives.

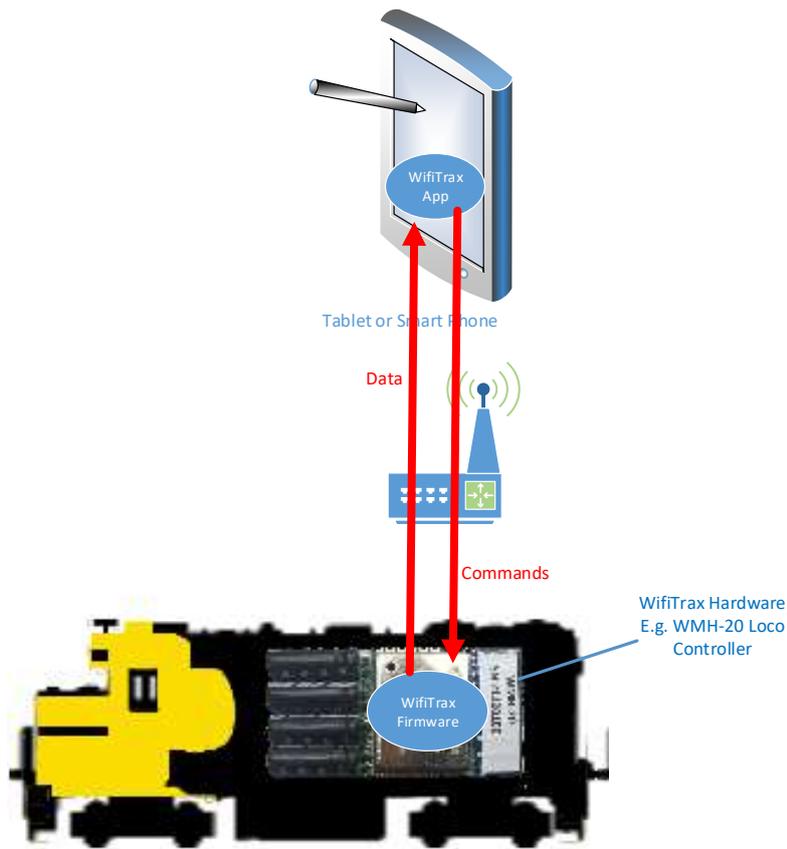


Figure 2 Example of a WifiTrax Control System Loco Operator App, WMH-20 Hardware and the WifiTrax Firmware within it

## WifiTrax Firmware and Hardware

The control system of the locomotive in Figure 2 is completed using a WMH-20 Loco Controller module installed in a locomotive (WMR-10 is an alternative). When the module leaves the factory, the WifiTrax Firmware is installed within it. This firmware is the computer program that receives commands from the Loco Operator App and responds to them by controlling the locomotive in the manner specified by each command. For instance, one command turns on the headlight, another sets the required speed, another sets the direction etc. Another way to put it is that the firmware implements the Web API that is exposed on the Wi-Fi network.

Some commands require return of data to the Loco Operator App, in fact a periodic “heartbeat” command is sent about every second by Loco Operator which causes the firmware to return the speed measured from the back-emf of the motor and other telemetry data. This is used to drive the speedometer visible on the Loco Operator App.

## Helpful Documents and Links

You can obtain these from our website [www.wifitrax.com](http://www.wifitrax.com) from the Articles menu.

- (1) [WifiTrax FAQ](#) – Answers to many common questions.
- (2) [Managing your Model Railroad Wi-Fi Network](#) - This will tell you in detail how to set up your Wi-Fi network to control your model railroad.