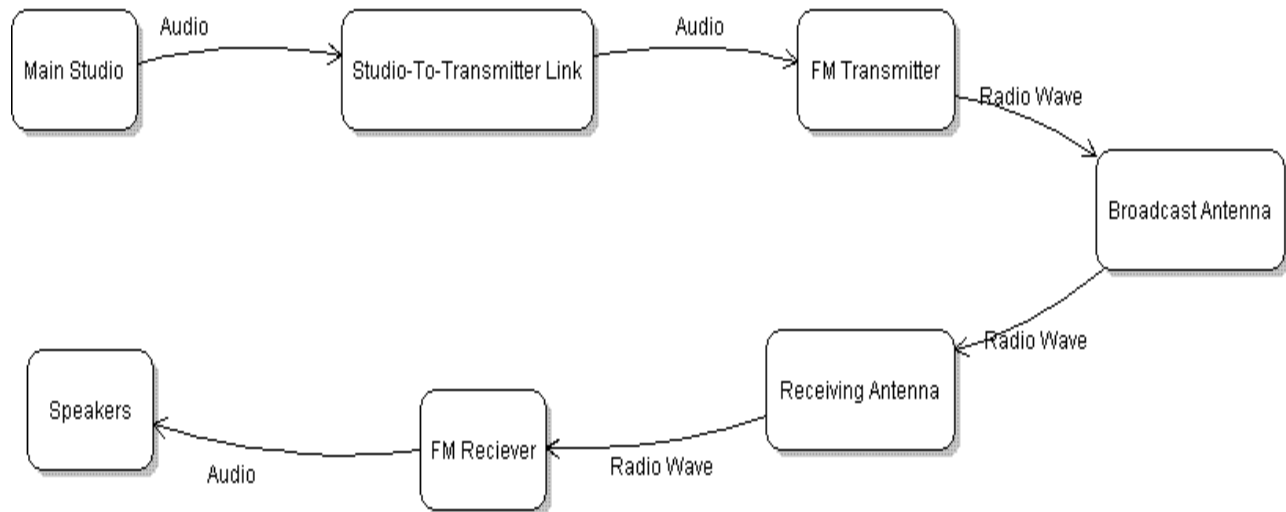


Sound Around Town

When planning for a radio station, you might encounter a situation where your studio is far away from your antenna. In this case, you can use a Studio-to-Transmitter Link. This document explains the STL options available to you and what you need to keep in mind when choosing a solution.

The whole transmission process for broadcasting sound requires :



The function of the Studio-to-Transmitter Link (STL) in the transmission process is to send sound from the studio to the transmitter. STLs can be wired or wireless depending on your equipment. If you are fortunate enough to have your studio and your transmitter in the same building then a simple cable will do. If you can't put them in the same place because of your own needs or the FCC's rules, here are a few things to consider when planning a long distance STL:

- **Line of Sight:** STLs are simplest when you are able to “see” the transmitter site from the studio.
- **Stereo or Mono:** Sound is reproduced mono-phonically (Mono) where audio is in the form of one channel, or stereo-phonically (Stereo) where the audio is in the form of multiple channels. The method must be chosen to reflect what you want to broadcast in.
- **Cost:** The cost varies based on the distance traveled and method used.
- **Audio Quality:** STLs generally change the format of the signal, reducing the transmission audio quality.
- **Delay:** Depending on the method used, there may be a constant delay present.
- **Bi-directionality:** Automation systems require a signal from the transmitter back to the studio

Here is a list of methods currently used to move sound from your studio to a remote transmitter:

Type	Advantages	Disadvantages	Average Cost
Shielded cable	Cost effective; reliable under short distances	Not good for long distance(<100ft)	\$50
Microwave	Point-to-Point hops allows for long distances; minimal interference; high analog quality	Need license for transmission frequency; costly	\$3500 - \$6000
CODECS	High digital quality; minimal interference	Bandwidth fluctuates; broadcast delay	\$600 - \$3000
Remote Pick-Up Unit (RPU)	Point-to-Point hops allow for long distances; high analog quality	Need license for transmission frequency; designed for temporary use	\$3500



Shielded Cable: This is the simplest method, it might be all you need. As the cable gets longer things get more complicated.

Disadvantages: The longer the wire, the more it acts like an antenna and the more likely it is to pull in the signals of other local radio stations. So the first thing you would like is the cable to be shielded, meaning there are one or two inner conductor and then a metal shield that helps keep other signals out. The best is if you can have the whole line be balanced. When a line is balanced, there are special circuits at each end of the line which *cancel out the noise* that happens along it. Most mixers and transmitters have balanced audio inputs and outputs. As cables get longer than a few hundred feet, the noise gets louder and the signal gets quieter. Amplifiers can help, but they amplify the noise too and eventually the noise adds up!

Advantages: Since it is just a wire that doesn't need any configuration, all you need to do is simply connect the audio output of your studio into the audio input of the transmitter and you are done! Along with using a shielded cable, make sure the exposed parts of the connection are shielded as well to protect from rodents and other environmental factors.



Microwave: This is the most common way for radio stations to move high quality audio. The audio comes out of the mixing board, into an audio processor and into a microwave transmitter (typically 5 to 20 watts), and then up a cable and out a microwave dish. This dish is really carefully aimed at another identical dish, which needs to be in a *direct line-of-sight* with the studio. The dish on the other side goes down into the microwave receiver, coming out as audio. If the link is a composite type suitable for stereo, then the audio goes straight into your transmitter using a BNC connector and a short run of coaxial cable. If the link is mono audio, then it goes into another audio processor, which then goes into the FM transmitter.

Disadvantages: You are required to use one of the frequencies in the *special broadcaster STL band*, in the 900 MHz range. To get a frequency, you call up a local frequency co-ordinator, and request a channel at http://www.sbe.org/sections/freq_local.php. You must file for a *Broadcast Auxiliary License* on the channel given by the FCC. The licensing process is straightforward as long as there is an open frequency.

Advantages: The advantage of using licensed bands is they are licensed *to you and only you*, so they are less susceptible to interference. The microwave transmitters also keep the audio signal quality high during the transmission process.

Some bands, such as the 2.4 GHz band used for Wi-Fi, have *power limits* for equipment which can be used without a license. Most units are simple FM transmitters and radios set up to operate in a band of frequencies reserved for radio STLs.

Private Fixed Point-to-Point Link: FCC rules allow business and not-for-profit organizations to get these. Links can be digital, analog, and can be in various frequency bands and channels have various bandwidths, all with more than adequate capacity for one way FM broadcast audio. You might be able to get a *used link* from a local business or common carrier (telephone company). You might also ask a local amateur radio or ham club to help license and rig it up. Frequency coordination is through commercial service firms and costs somewhat

more than \$200 per link. If you get analog stuff good for the 952 band, it might operate very much like a regular broadcast FM microwave, but under this different category of license.

If the transmitter is not in a direct line of sight, you may need a second STL paired with another transmitter, receiver and pair of dishes. If you are really clever, you can use other techniques like a large metal reflector, or a special bridge point that simply amplifies the signal it caught. Each time you put in another line of sight STL, it is referred to as another *hop*.

We have seen equipment prices for single hop full microwave systems go for between \$3500 and \$6000. Mono STLs are often quite a bit cheaper than stereo STLs. In fact, some STLs, to do stereo, are simply two mono STLs put together.

Another thing to keep in mind with STLs is used STL units from before the early 1990s are illegal to use by low power stations. This is because the standards for STLs were changed at that time, and new STLs had to comply with stricter standards. You can still find some for sale because some were actually grandfathered in at the time of the rule change. Even though there are some out there that are still in service, it is not legal to use them in a new installation. Consequently, the used market for STL systems is a little tougher for the buyer than with some other pieces of equipment.



CODECS: The term CODEC refers to a device/program which can digitize an analog signal into a binary format. The process of digitizing an analog signal is called *encoding*. Audio CODECs encode audio every few micro seconds which produces a binary code of ones and zeroes. Using clever compression techniques, the CODEC can send out a stream of ones and zeroes over a low bandwidth connection. It is sent to another receiving CODEC which decodes the ones and zeroes into an audio signal. The final analog audio won't sound exactly the same as the audio at the studio, but with a good CODEC, it will sound pretty darn close.

Disadvantages: There is an inherent delay in the transmission created by the encoding and decoding of the signal. The delay depends on the encoding method used, but it usually causes what is on the air to be a few seconds behind what is live. During the course of its use, conditions on the transmission line often change over the course of the day (as the sun shines on the wire, as squirrels run up and down the lines etc.) When this happens the modems on each side have to renegotiate, and throws off the buffer. When you run out of buffer, you start to get dropouts, like you hear on internet radio when bandwidth gets scarce. Also, some CODECs

may not be designed for use all the time and could just plain overheat because their cooling systems were not designed with 24-7 use in mind!

Advantages: The compression techniques implemented in the CODECs allow them to produce quality digital audio. Since it is in a digital format, techniques can be used to improve the audio quality as well. Working within the digital format also opens up many more methods for transmitting and usually results in multiple solutions.

Different CODECs have their own particular advantages and disadvantages. Since they are usually transferred over copper wire telephone lines, the bandwidth for transmission is usually limited to around 4 kHz, which isn't great for radio sound. For this reason, encoding algorithms are implemented to improve the fidelity of audio signal. To avoid a troubleshooting nightmare, stick to a particular CODEC. Combining different CODECs creates more problems than it solves!

Here is a list of CODECs:

Integrated Service Digital Network: or *ISDN*, is a CODEC transferred over the telephone copper wires you see all over your neighborhood. Telco companies usually offer services in increments of 64 *kbps*, kilobytes per second. ISDN uses two types of “channels” for communication, 64 *kbps* bearer and 16 *kbps* data channels. This allows bi-directionality in the transmission, allowing for automation. Telco companies offer 2 ISDN solutions, *Basic Rate Interface (BRI)* or *Primary Rate Interface (PRI)*. The difference is in the amount of bearer and data channels you get. The more channels you get, the higher the final audio quality.

Plain Old Telephone Service: or *POTS*, is a CODEC which is transferred over the telephone copper wires. It is the oldest but most used method of communication. It has low bandwidth and offers bi-directionality. The encoding algorithm gives a data stream output of 24 *kbps*.

IP Audio: is a CODEC which is transferred in “packets” of information, which is the same method you use to connect to the Internet. The idea is to have a computer host a high quality MP3 audio stream. The receiving computer near the transmitter site connects to the internet stream and decodes the encoded packets of the audio stream into an audio signal. The quality of your signal depends on the speed of the connection (i.e dial-up, broadband or wireless). An advantage using wireless is it allows you to transfer packets via a *Wireless Local Area Network (WLAN)*. You will be able to transfer the signal via 2.4 GHz 802.11x wireless band. The FCC allows unlicensed communication over this spectrum so you do not need to apply for a frequency as long as the wi-fi transmitter's power is lower than the FCC's limits. Combining a WLAN router and a Wi-Fi directional antenna can allow a transmission range of approx. 20 miles under good circumstances. This distance is subject to antenna properties as well as the environmental factors that the transmission is being done in. A common economic IP CODEC is the Instreamer and Extstreamer made by Barix. The Instreamer does the encoding at the studio and the Extstreamer does the decoding at the transmitter site. There are other more expensive options with fancier features such as adjusting the data rate if the bandwidth fluctuates so you always get the best quality link possible.



Remote Pick-up Unit: A remote Pick-up Unit, or **RPU**, is a device broadcasters use when they want to broadcast a live event such like a sports game or a concert. RPUs involve *directional antennas* that are aimed from the remote site back to the main studio. The FCC sets aside frequency groups allocated for a RPU to transmit. They are near 150Mhz and 450Mhz, which is where most activity occurs.

Advantages: Because they use *directional antennas*, RPUs generally have enough bandwidth and power to deliver broadcast quality audio. These antennas are useful in urban situations because you can focus the transmitted signal directly at the RPU receiver and reject signals from other directions. The main thing to keep in mind is to maintain line-of-sight.

Disadvantages: An RPU was designed for a remote live broadcast and coverage of events; and therefore, are intended for intermittent use, rather than a permanent STL. Sometimes, broadcast stations have been known to use a RPU for months or even years at a time as a temporary studio transmitter link, when their other link has gone down. In some areas this might not cause too much of a problem, where there is not too much competition for these frequencies, but local broadcasters could be upset if someone monopolized one of these channels on a permanent basis. The rules for use of these frequencies specify you can use one of them for 720 hours per year, though of course you could probably switch frequencies indefinitely and stay within the letter of the law. This method is definitely not recommended, but could be useful for temporary use. Remember this is *not* the frequency at which you will be broadcasting!

The FCC sets a sides frequency groups allocated for a RPU at which to transmit. They are near 150Mhz and 450 MHz, which is where most activity occurs. In these slices of the spectrum three major license classifications exist:

Automatic Relay Stations: *ARS Systems* are designed to receive program materiel on one frequency and retransmit on another. With multiple relays, the average area of coverage can be greatly extended.

Base Stations: These are fixed-position transmitters used for communication between the central point and one or more remote points.

Remote pickup mobile stations: These consist of vehicle-mounted and portable transmitters. They are usually licensed as a system in conjunction with a principal base station. These licenses usually specify a minimum and maximum number of mobile transmitters assigned to the base station.

The FCC requires the transmitter power for the an RPU station be limited a level necessary for satisfactory coverage. In any event, not more than 100W can be licensed, so make sure the studio can be reached under this power. If this doesn't work a practical solution would be to get multiple transmitters that operate at different power levels but broadcast on the same frequency. This way you can traverse long distance while keeping transmission power under 100W.

All RPU equipment must be typed checked by the FCC each year for frequency accuracy, deviation and RF power output. For transmitters 3W or greater, it must be equipped with a circuit that will automatically keep the signal within authorized limits. Typical audio bandwidth options are 7.5 kHz, 5 kHz and 20 kHz. Try to find an RPU transmitter with a mic/live option mixer built in to avoid another failure point.

Outside of FCC regulations, careful planning must be done on the placement of the transmitter and receiver RPU. Here is a list of things to keep in mind when planning:

- Maintaining line-of-sight.
- Reflection off of large bodies of water or thick vegetation.
- Normal refraction occurrence when using ultra high frequencies (**UHF**) or very high frequencies (**VHF**).
- Staying away from any high-power transmitting antenna.

Conclusion

Planning an STL requires good communication with the technical staff, the administration and the FCC. A good plan will help you get the best quality signal for the price you can afford. The STL may be the most involved part of a station set up, but a good STL can run for years without maintenance!