SEARCH FOR COMMUNICATION EMITTERS PART TWO

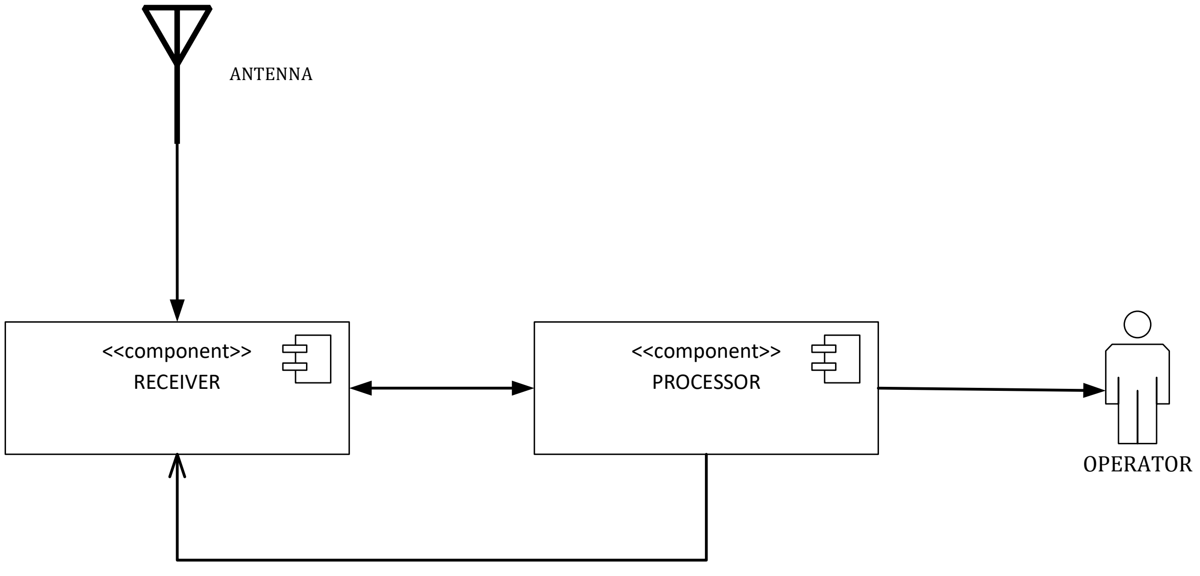
System Configurations

The configuration of an EW system has infinite possibilities. The purpose here is only to discuss the configuration features which impact search. The three general configurations considered are:

- Single receiver;
- Search and monito receiver;
- Search monitor and special receivers;
- Systems with emitter location capability.

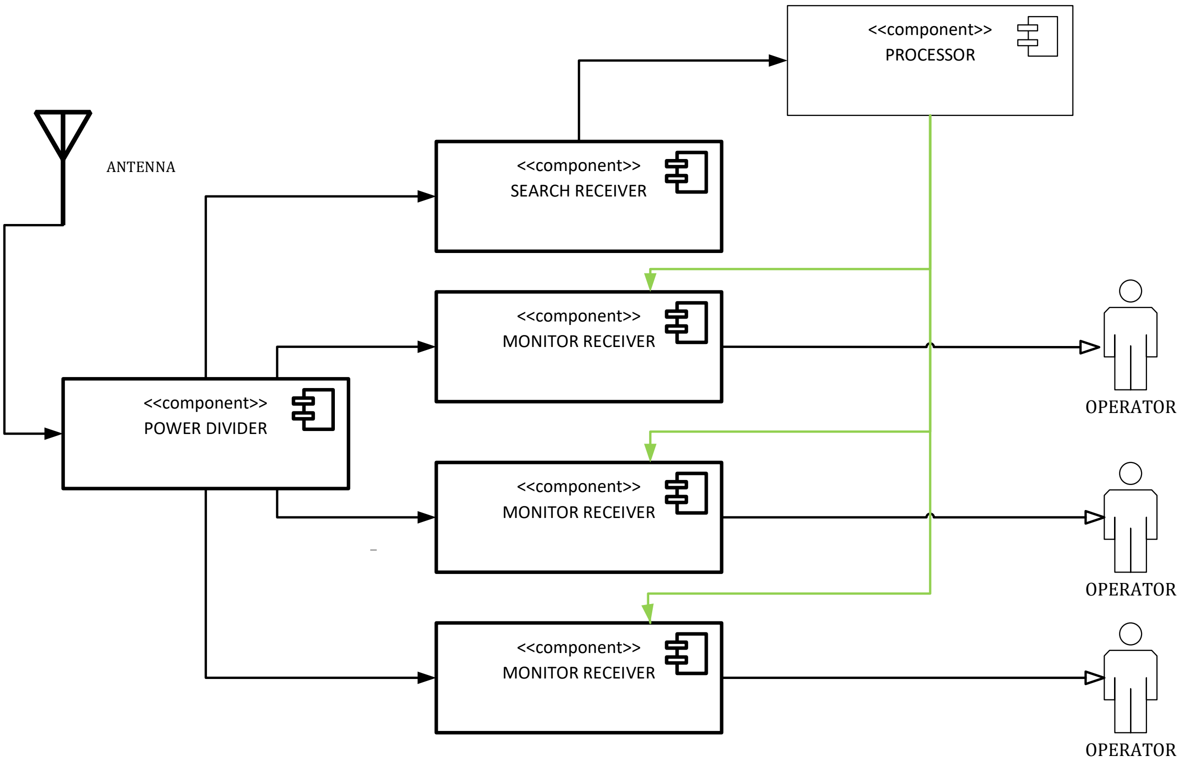
Single Ricever

When a system has only one receiver as shown in Figure 6.3, that receiver must search for a signal of interest and then monitor that signal as long as required before search can resume. While this approach simplifies the system, it has great disadvantages in the probability of intercept in a rapidly changing environment or when various signals of interest have different priority.



Search and Monitor

It is very common to use one receiver to search and have one or more receivers than can be assigned to signals of interest for long-term monitoring or data collection. The search receiver can be either the same type as the monitor receivers, or it can be a wideband receiver that determines only frequency.



Special Receiver

Special receivers have special attributes that are used as required, particularly in systems which employ the sequential qualification search strategy. Example of special receivers are:

- Digital modulation analysis receiver;
- Direction Finding receiver
- Special receiver for LPI signals.

When the search receiver encounters a signal, it typically only determines the frequency. This may not be enough information to determine whether or not a monitor receiver should be assigned to that signal. A digital receiver can perform an FFT to produce the frequency spectrum of the signal. Analysis of this spectrum can determine

- The modulation of the signal.
- The modulation parameters
- If it is encrypted, what type of encrypter.

All of this information may be enough to evaluate the priority of the signal to determine if one of the system's monitor receivers should be assigned to it. A direction-finding receiver is part of a direction-finding (DF) system, which will typically have its own antenna array. Most direction-finding systems can make a quick, but not too accurate estimate of the angle of arrival of the signal. This can be reported out to a processor as a parameter which will help determine the priority of the signal. The DF system then normally averages several measurements and calculations to determine the direction of arrival to full specified accuracy. The priority assigned to the signal may be used to determine if the signal is worth the processing time to develop a full accuracy direction of arrival.

The receiver types used in EW and reconnaissance systems and their features appropriate to the search problem. Superheterodyne receivers measure frequency and recover any type

of signal modulation. They typically receive only one signal at a time, so they are not affected by multiple simultaneous signals. They can have good sensitivity, depending on the bandwidth. One important feature of superheterodyne receivers is that they can be designed with almost any bandwidth, providing a trade-off between frequency coverage and sensitivity Compressive (or micro-scan) receivers sweep a wide frequency range very quickly—often within a single pulse width. They measure the frequency and received signal strength of multiple simultaneous signals, and have good sensitivity; however, they cannot recover signal modulation.

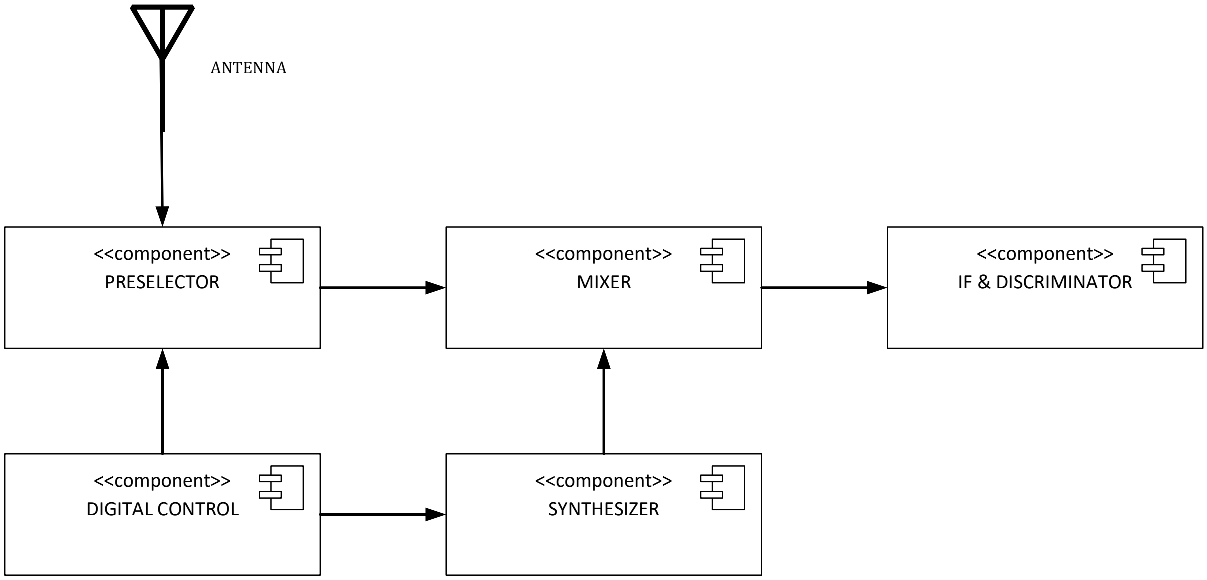
Channelized receivers simultaneously measure frequency and recover the full modulation for multiple signals as long as they are in different channels. They can also provide good sensitivity, depending on the channel bandwidth. However, the narrower the bandwidth the more channels are required to cover a given frequency range. Digital receivers digitize a large frequency segment which is then filtered and demodulated in software. They can measure frequency and recover the full modulation for multiple simultaneous signals. They can provide good sensitivity.

Search Receivers

Receiver Type	Sensitivity	Information Determined
Instantaneous frequency measurement	Low	Provides only frequency, can handle only one signal at a time
Superheterodyne	High	Provides frequency, recovers modulation, receives one of multiple simultaneous signals
Channelized	High	Provides frequency, recovers modulation, can receive multiple simultaneous signals
Compressive	High	Provides only frequency
Digital	High	Provides frequency, recovers modulation, can receive multiple simultaneous signals, performs spectral and other analysis

Digitally Tuned Receiver

A digitally tuned receiver has a synthesizer local oscillator and an electronically tuned preselector to allow very fast selection of any signal frequency within the tuning range. Tuning can be either by operator or computer control.



Digital Receiver

Since digital receivers have a great deal of flexibility, they may one day handle the whole search and monitor job. They are restricted by the state of the art in digitization and computer processing (versus size and power requirements)— but the state of the art in these areas is changing almost daily. Watch digital receivers for the near future

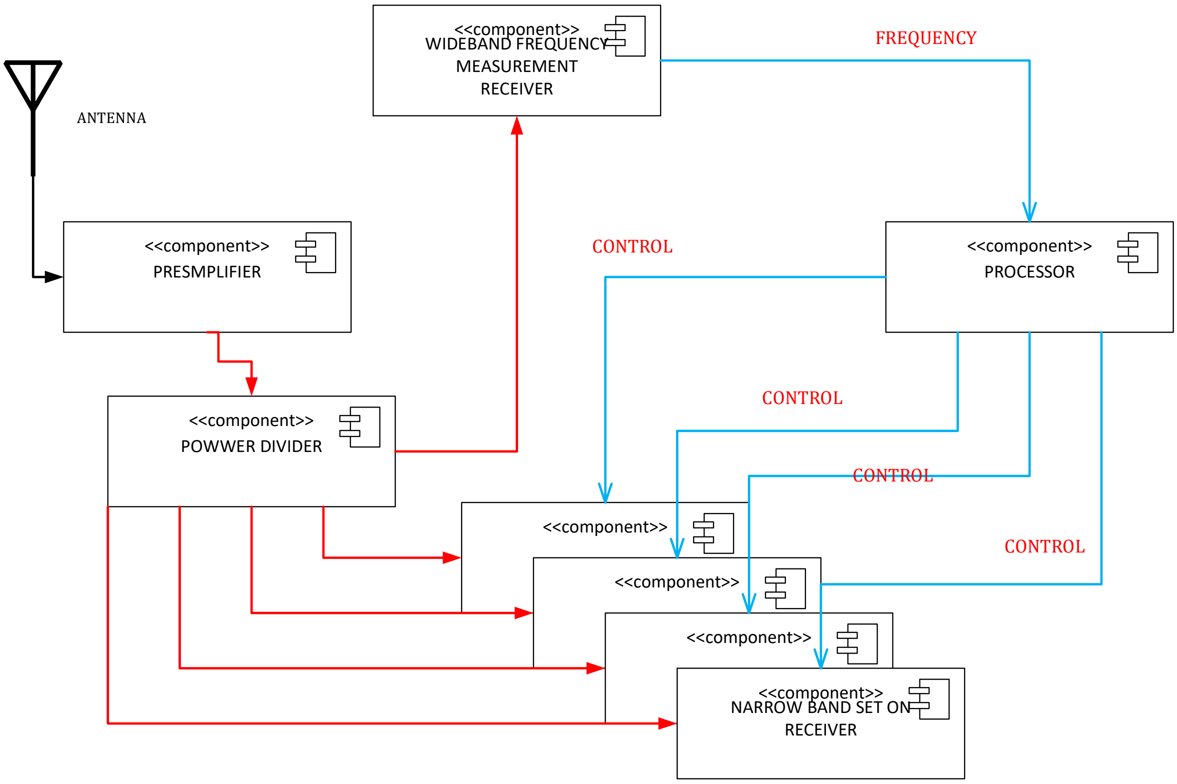
Frequency Measuring Receiver

This is another approach. Again, the antenna output must be power divided and one receiver provides set-on information for multiple narrowband receivers. However, now a wideband frequency measurement receiver is used. The frequency measuring receiver can be an IFM receiver, a compressive receiver, or (if practical) a Bragg cell

. Since this receiver can only measure the frequency of the signals present, the processor must assign the set-on receivers based only on frequency. The processor will keep a record of all signals which have been recently found. Typically, it will assign monitor receivers only to new or high-priority signals.

The frequency measuring receiver can be an IFM receiver, a compressive receiver, or (if practical) a Bragg cell receiver. Since this receiver can only measure the frequency of the signals present, the processor must assign the set-on receivers based only on frequency. The processor will keep a record of all signals which have been recently found. Typically, it will assign monitor receivers only to new or high-priority signals.

Because some types of frequency measurement receivers have poorer sensitivity than the narrowband set-on receivers, they may not be able to receive some of the signals that could be monitored. A mitigating factor is that it often requires less received signal strength to detect the presence of a signal and measure its RF frequency than is required to get the full signal modulation.



Low Probability of Intercept Signal

Low probability of intercept (LPI) signals are design to challenging the receiving systems attempting to detect them. LPI signals are very broadly defined, including any feature which makes the signal harder to detect or the emitter harder to locate. The simplest LPI feature is emission control reducing the transmitter power to the minimum level that will allow the threat signal (radar or communication) to provide adequate signal-to-noise ratio in the related receiver.

The lower transmitter power reduces the range at which any hostile receiver can detect the transmitted signal. A similar LPI measure is the use of narrow-beam antennas or antennas with suppressed side lobes. Since these antennas emit less off-axis power, the signal is more difficult for a hostile receiver to detect. If the signal duration is reduced, the receiver has less time in which to search for the signal in frequency and/or

angle of arrival—thus reducing its probability of intercept. However, when we think of LPI signals, we most often think of signal modulations which reduce the signal's detectability, LPI modulations spread the signal's energy in frequency, so that the frequency spectrum of the transmitted signal is orders of magnitude wider than required to carry the signal's information Spreading the signal energy reduces the signal strength per information bandwidth. The challenge that all LPI modulations pose to the search function is that they force an unfavourable trade-off of sensitivity versus bandwidth. In some cases, the structure of the spreading technique allows some advantage to the receiver, but this requires some level of knowledge about the modulation characteristics and can significantly increase the complexity of the receiver and/or its associated processor.