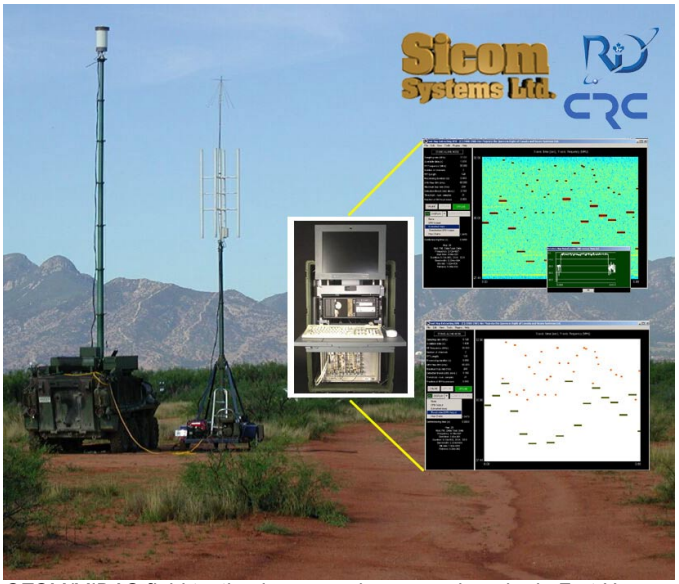
June 2002

Wideband Digital Signal Processor for Frequency Hopping Signal Intercept Receivers

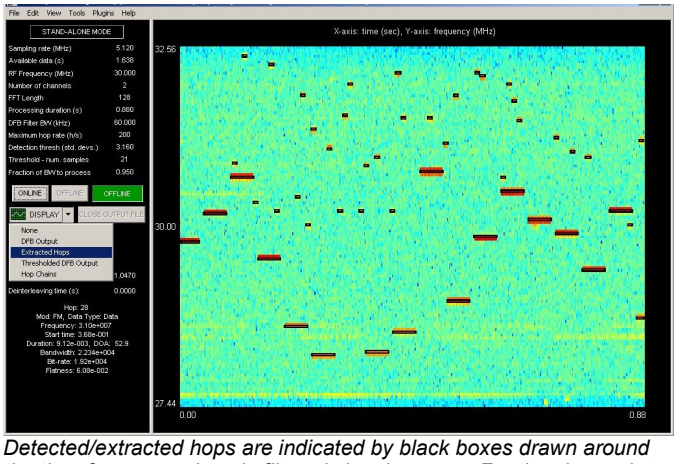
Sicom Systems Ltd. has developed a real-time, digital signal processor (SP) for use in Communications Electronic Support Measures (CESM) applications, where low probability of intercept (LPI) signals such as those from frequency hopping radios are intercepted by a wideband intercept receiver. The LPI-SP is a software-defined solution that has been designed with flexibility in mind; and will easily integrate into any wideband receiving system.

One configuration of the LPI-SP developed for integration into the Canadian Military Digital Analysis System (MiDAS) runs on a standard 1GHz Intel dual Pentium™ III computer; and was successfully tested in the field in June 2001 during the Foreign Comparative Testing (FCT) trials at Fort Huachuca, Arizona. Real-time processing against frequency hopping signals in the military VHF band was achieved through proprietary algorithms combined with SIMD programming techniques.



CESM/MiDAS field testing in armored personnel carrier in Fort Huachuca, Arizona in June 2001.

This approach has resulted in an effective reduction of about three orders of magnitude in computational complexity compared with using conventional digital solutions, allowing real-time operation to be achieved using personal computer (PC) technologies. One of the key advantages of this approach is that speed-ups can be had at virtually no cost, simply by exploiting newer and faster off-the-shelf PCs. Already since the 1 GHz Pentium™ III was used in June 2001, 2 to 3 times the throughput is achieved simply by using Pentium™ IVs.



Detected/extracted hops are indicated by black boxes drawn around the time-frequency domain filtered signal energy. For the shown data set, a 20 hop/s and a 100 hop/s radio were active.

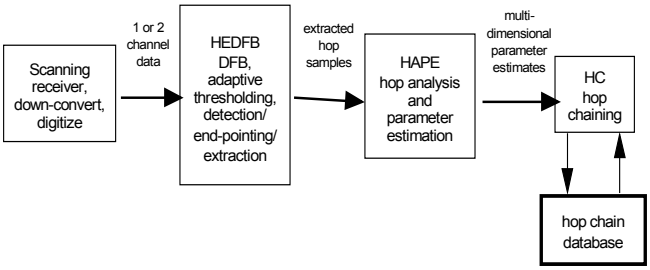
For the FCT configuration, the LPI-SP operated continuously in real-time on successive sub-band signals, where each sub-band represented a 5 MHz window into the military VHF band (30 to 88 MHz). It performed automatic hop detection and narrowband signal extraction, allowing parameter estimation & de-interleaving (to identify emitters) to be carried out subsequently on the extracted hops. The hop signal information from each sub-band was archived to a hop/emitter data base for additional offline analyses.

A general intercept receiver / LPI-SP follows the architecture shown in the figure below.

Sicom Systems Ltd.
67 Canboro Road, 2nd Floor ▪ P.O. Box 366 ▪ Fonthill, Ontario L0S 1E0 ▪ Tel: 905-892-1875 ▪ Fax 905-892-2249
tnohara@sicomsystems.com www.sicomsystems.com

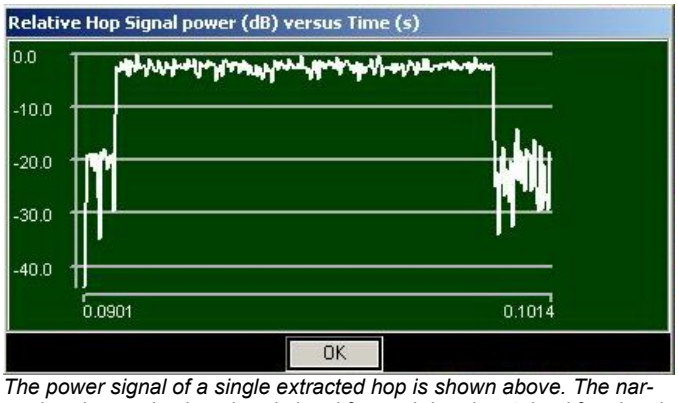
June 2002

Wideband Digital Signal Processor for Frequency Hopping Signal Intercept Receivers



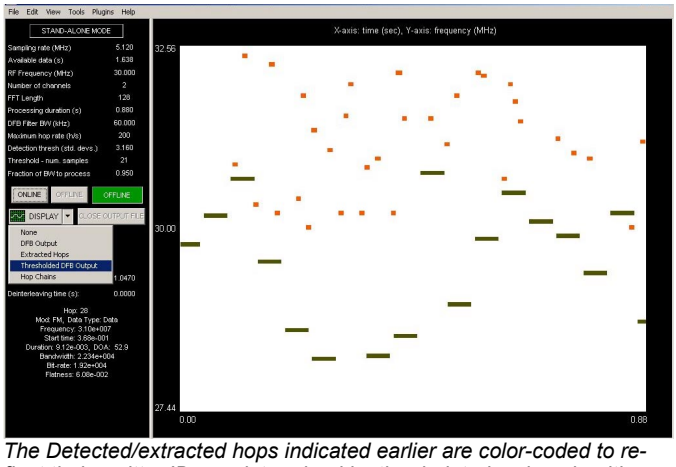
General block diagram of a wideband, LPI-SP.

A fixed, scanning, or stacked wideband receiver collects and digitizes wideband data from one or more antennas. The first stage of the LPI-SP is a hop-extracting digital filter bank (HEDFB) which automatically transforms the received signals into the time-frequency plane and detects hops. For each hop, its complex, narrowband hop signal is extracted, and estimates such as bearing, start-time, end-time, duration, frequency, bandwidth, power, and modulation characteristics such as AM, FM, FSK (with bit rate) are typically calculated.



The power signal of a single extracted hop is shown above. The narrowband, complex baseband signal for each hop is retained for signal analysis (estimation of parameters and de-interleaving) and for signal exploitation.

Hop chaining or de-interleaving is performed next, and can be updated continuously. Hops in one sub-band can be "chained" correctly with similar hops in the same as well as other sub-bands. This allows emitter parameters to be determined on the fly.



The Detected/extracted hops indicated earlier are color-coded to reflect their emitter IDs as determined by the de-interleaving algorithms.

Outcomes of the chaining process are reliable determinations of hop-rate, the hopping bandwidth (start frequency, end frequency) as well as the actual hop frequencies themselves associated with a particular emitter. Start and end times of the transmissions can also be logged.

Once hops associated with a given emitter are determined, their narrowband hop signals (properly time-sequenced), can be logged for additional analyses or exploitation.

Sicom's LPI-SP exploits digital signal processing techniques to overcome the short-comings of analog and compressive intercept receiver solutions. Its HEDFB is designed to maximize sensitivity in a dense, multiple-signal environment.

While the LPI-SP was designed specifically with frequency hopping signals in mind, it can also automatically detect and extract conventional single-channel signals. Its design also makes it suitable for providing real-time queuing information for use in jamming detected signals.

Patents are pending.
Contact Dr. Tim J Nohara for more information.

Sicom Systems Ltd.
67 Canboro Road, 2nd Floor ▪ P.O. Box 366 ▪ Fonthill, Ontario L0S 1E0 ▪ Tel: 905-892-1875 ▪ Fax 905-892-2249
tnohara@sicomsystems.com www.sicomsystems.com