CS7000: A REVOLUTIONARY MULTIPROTOCOL RADIO

Reason For Developing the CS7000

Way back when I first started with Ham Radio, there were articles on how to design your own radios, kits for building them, and complete radios like those available now. At that time the Hams were able to design state of the art radios. Unfortunately, for most of us, those days are long gone as the technology involved in designing radios has become so advanced that, for the most part, only those Hams who are graduates of MIT or CalTech can design their own.

My goal in the design of the CS7000 was to create a radio that can be modified by the Radio Amateur Community with capabilities that go beyond what is commercially available. Because the manufacturing techniques in designing a good quality radio are so complex, I decided to design a state of the art piece of hardware, with an extensible software capability that will allow Hams to completely customize features of the radio.

Summary of the CS7000 Capability

The new CS7000 will enable you to:

1. Add industry standard protocols such as D-STAR, DMR, Fusion, NXDN, P25 and Analog
2. Develop new protocols specifically for your application
3. Send digital data such as Slow Scan TV, GPS, and Data Files.
4. Send voice and data from your radio directly to the Internet allowing the radio to act as a Hot Spot for D-STAR or DMR without any additional hardware or computers.
5. Send voice and data from your radio directly to the internet allowing the radio to bypass the Hot Spot and communicate directly with the world wide networks.
6. Remote your radio from any place in the world using your PC and the SIP protocol.
7. Add APPS whose functions are limited only by your imagination
8. And most important of all, if you do not like the firmware architect because it does not meet your needs, you will be able to completely redo it.

Hardware Architecture

The CS7000 is like a CS700 on steroids. The CS700 consists of a conventional double conversion superhetrodyne radio with a special chip to process the DMR format. The DVSI vocoder is done in firmware with the encode and decode functions taking up a significant amount of resources of the high speed microprocessor.

The CS7000 has three microprocessors to extend the performance of the overall product and allow the system to do in firmware multiple protocols whose limitation is only defined by the amount of memory available and the imagination of the user. There is also the capability to extend the product beyond the basic protocols so it can do things Hams could only dream about.

The primary microprocessor is a STM32F405VGT6. This is an ARM Cortex M4 32 bit high speed microprocessor. It has 1 Megabyte of internal flash memory, 196 Kilobytes of internal ram, and executes anywhere from byte instructions to floating point and DSP instructions. It has a clock speed of up to 168 MHz and executes 210 Dhrystone Mips.

The second microprocessor is a DVSI 3000R. This microprocessor uses a TMS320F2811 core and is dedicated to executing the AMBE and AMBE +2 Vocoder formats and other algorithms. Communication between the Primary microprocessor and the AMBE 3000R is by means of a serial port.

The third microprocessor is integrated into the optional WiFi adapter. This part contains the hardware to allow the system to communicate over the internet or other private IP connections with a minimal amount of overhead. Communication between the primary microprocessor and the WiFi adapter is by means of a serial port.

To increase the capability of the CS7000 we incorporated an 8 Megabyte serial flash memory. This allows the memory to hold an extensive amount of voice prompts, programming files, and firmware. To allow multiple protocols that extend beyond the 1 Megabyte of internal flash memory, the external flash memory can be used to overlay portions of the extended protocols.

There is no reason to believe this hardware architecture will not support the following protocols:

D-STAR
DMR
NXDN
FUSION
P25
dPMR
ANALOG

Because this radio is designed for Hams rather than Commercial use, we do not have to be 100% compatible with the entire protocol defined by various organizations. This will make it much easier for Hams to work with various protocols and not have to implement non-essential features such as trunking.

Software Architecture

What makes this product revolutionary is the ability to let Hams extend the radio's capability. Hams will have the following control over the radio:

1. They will have the source code of the entire radio so it can be modified to achieve any objective. The kernel of the radio will be well documented and we expect that Hams will evolve the kernel

to make it increasingly more powerful. For the programmers out there, when I use the word Kernel, think of Linux or Microsoft's Net Framework.

2. On top of the kernel, various protocols can be added.
3. On top of the protocols, apps can be added.

The Kernel

The Kernel consists of the basic routines to operate the radio. Examples of those routines include:

Keyboard Programming Interface
Read and write to Flash Memory
Keypad Scanning
Analog Tone Decode
Analog Tone Encode
Initializing and changing the frequency of the PLL
Reading and writing to the D/A and A/D Converter
GFSK Modem
4FSK Modem
LCD Display Routines
Interrupt Handlers
PWM Generation
DTMF Encoding
DTMF Generation

There are many reasons why you would want to change the Kernel. One of them would be to make the product more efficient. As an example, let's assume the Reading and Writing to Flash Memory takes 1000 bytes of programming memory. Some talented Ham might figure a way to reduce the memory size to 500 bytes. That is 500 bytes that could be used for something else.

Another reason would be to extend its capability. To do NXDN, DMR, and some other formats require a Four level FSK Encoder and Decoder. That might be a nice routine to add to the basic kernel. Even if it is not part of the basic kernel, Connect Systems will make available various routines to enable CS7000 owners to construct various protocols.

The Protocols

Connect Systems will provide certain protocols such as D-STAR and we are going to enable the talented hams develop other protocols for the product. There are over three million Radio Amateurs and some of them have developed some amazing products. This platform will enable those talented individuals to add other protocols.

The Apps

For people who are familiar with the smart phones, you know that you can add apps to your basic phone. We have the same capability within the CS7000. The number of apps that can be written is only limited by your imagination. Some of the possible apps:

* Determining the closest repeater with an optional GPS microphone
* Using the CS7000 as a DSTAR hot spot with an optional WiFi module
* Using the CS7000 to talk directly into the world wide network bypassing any DSTAR Hot Spot
* Record a Net Meeting while you are away from your base station
* Record any traffic directed specifically to you
* Press a button to generate your Call Sign using either voice or code
* Decoding Morse Code

Free Apps or Paid for Apps

The people who write the Apps have a choice of either giving away the Apps or charging for them. To help with piracy for the paid for Apps, each radio has a unique ID number and that ID number can be tied to the program.

Applications For Commercial Customers

You might have a unique application for a commercial customer you would like to exploit. Because all our radios are commercial grade and cover commercial frequencies, you will have the opportunity to sell to those customers. We will sell you as many radios as you want to buy at the great Ham pricing and then you can then add your unique application to the product and sell it to that customer.

Analog verses Digital Formats

If you are one of those Hams who thinks that this radio is only for those working on digital formats you are wrong! There are many applications for the Analog Radios that can be done. Some examples:

1. Recording Net Meetings
2. Operating your radio remotely from any place in the world
3. Decoding Morse Code
4. Automatically sending your call sign using Voice or Morse Code
5. Act as a service monitor to align your receiver and transmitter

Pricing and Availability

The CS7000 will have an introductory price of $199 for the basic radio and $249 with the Integral WiFi Module. We are taking orders now with shipping on a first come first ordered basis. Expected shipment will start about November of 2014. There is no need for any deposit or credit card to place an order.

Contact Information

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Update message below from: https://groups.yahoo.com/neo/groups/CS7000/conversations/messages/3663

Quote:

Date: 10 Jan 2016 17:29:07 -0800
To: <CS7000>
From: jwanger[at]pacbell.net
Subject: Status of CS7000

The original hardware design of the CS7000 was completed over a year ago and was based on the CS750. To successfully complete this project Connect Systems had to have a stable CS750 and the cooperation of Covalue, the designer of the firmware and hardware of that radio. This plan ran into two issues. The first issue was the CS750 took over a year longer to complete than expected and the second issue was not being able to get the full cooperation of Covalue in the design.

To continue the use of the hardware design of the CS750 it would be necessary to use the C5000 baseband chip. This has a problem in that the C5000 specifications is not accurate and it would be necessary to communicate with the manufacturer of that part to understand the problems and that would only be possible if we understand Mandarin Chinese. To go back to Co-Value for help would not be possible because they do not have the time to help us with that design because of the other work they are doing.

To get around the design issues, a few months ago it was decided to take a completely new approach. The radio would be designed from scratch and would use only key parts that could be bought from companies that speak and understand English. The hardware design is now finished and is being checked by other people to look for mistakes before it is released for prototypes.

Much of the firmware design that was worked on during the past year is still good so we are not starting from the beginning. The hardware design we are using is state of the art and was not possible at the time the original design was started. One of the key features that people say they wanted was a dual band radio. At this time last year it was not possible based on the constraints we were working with and the state of the art at the time. It has been a year since that statement was made and now the state of the art allows a dual band radio to be made.

At the time the design was originally started, the goal was to have the radio do DMR, Analog, and DSTAR. It was never determined if we had the ability to do NXDN, Fusion, P25, and dPMR. We now have the hardware resources to do it all although there would not be a commitment to do anything that does not ship with the radio.

Some of the changes that is being made to the hardware to increase its versatility is as follows:

Increase the amount of Flash Memory from 64 Megabits (8 Megabytes) to at least 256 Megabits (32 Megabytes).

Change the Microprocessor from the STM32F4 series to the STM32F7 series. This gives a significant advantage in speed and memory compared to the old part.

Change the baseband chip. This gives a significant advantage in implementing some of the more advanced features of the various formats as well as implementing new formats.

Using advanced packaging technology to allow more circuitry to be crammed in the same form factor as the CS750.

The CS7000 will be sold in two versions. The first version will be the standard CS7000 which will be a single band UHF radio. The second version will be the CS7010 which will be dual band UHF and VHF.

A few months after the CS7000 is released the CS8010 which is a dual band mobile radio will be sold. With that radio we have the ability to make it into a Quad Band radio that covers the Amateur Frequencies of 144 MHz, 220 MHz, 440 MHz, and 904 MHz. There is no commitment to the Quad band version at this time because we do not know if people are willing to pay more for that type of radio. For technical reasons, we cannot go much below 100 MHz with the current design. In the future we might consider designing a different radio that covers the lower bands that also allows AM and SSB as well as the standard digital formats.

Future implementations of the CS7000 and CS7010 might have a high quality color display, WiFi, Bluetooth, and GPS. However that is for the future so do not expect that type of radio to be announced anytime soon. Future products will be backwards compatible with the current products so any firmware development will be able to be ported to the future products rather easy.

The radios that are being designed are being designed in a manner that will allow us to make them in the United States if we wanted to. The first versions will probably be made in China.

We will release the hardware design and the source code of the firmware. However Connect Systems will retain control of the copyright of the firmware to prevent our Chinese and other competitors from making knockoffs of the radio and selling at prices below my cost. The amateur community will have the ability to make whatever changes they want to the firmware as long as they only use it on the Connect Systems radios. We might make some other restrictions to prevent our competitors from stealing our designs.

Connect Systems has hired a full time programmer to work on the CS7000 to speed the development of the project. We might encourage other people to work on other aspects of the project in parallel with us.

Update message below from: https://groups.yahoo.com/neo/groups/CS7000/conversations/messages/4470

Quote:

Date: 01 Oct 2016 16:15:53 -0700
To: <CS7000>
From: jwanger[at]pacbell.net
Subject: Status of the CS7000

For those that are following this blog, you know we have been at this R&D project for a long time. As with R&D projects, your first or even second attempt at doing things do not always work. There are a few of you who questioned if we will ever get something done. Our problem has always been the hardware. I am happy to say the hardware problem is now resolved and the design is what I originally said would be the ultimate design which is a pure software defined radio.

The first approach was to take the original CS700 radio and add an A/D and D/A converter in parallel with the existing "5000" DMR baseband chip. That approach is sound except we would have to use the DMR baseband chip and that would require the knowledge of our supplier. At the beginning it sounded feasible but as time went on we were able to determine that our existing supplier would not supplier the intellectual property to use that chip and to do it ourselves was impossible unless you can read and speak Mandarin Chinese. It turns out the data sheet for the part is not accurate and you need to work with the Chinese Engineers to develop any product using that chip. That is hard enough to do if you are in China and it is hopeless if you are doing it from this country.

The next approach was to substitute the DMR baseband chip with a part made by CML, an English and American semiconductor company. This required us to develop a compete radio from scratch which is what we did. We went through two iterations of the design before I decided that approach was hopeless with the resources we had within the company. While I believe the schematics might work, we do not have the expertise in house nor the proper test equipment to design the RF stages. For those of you who are in the business knows doing a RF power amp on a small PCB takes some special and unique talent. We did hire someone on the outside that gave us some help but to do the complete job would cost us too much. I think in another year or two we could have developed the RF stage in house.

So I took the next logical step. I found a hardware platform that would do everything we wanted to do. This platform has been available for about a year and the reason I knew about it was because I helped the company get some parts for it about four years ago. So the hardware platform is now finished and I am ready to sell the CS7000 next month. Just kidding. I can sell the hardware but I do not have the software yet. What I could tell you about the hardware is the flash memory is 64 Megabytes and it uses a dual processor consisting of an DSP and Ambe processor that is rated at about 3 billion floating point calculations per second. We are going to use an official DVSI firmware vocoder for the DMR, NXDN, P25 Phase II, and Fusion and either an open source vocoder or an official DVSI vocoder for the DSTAR. A long time ago I

said that was technically a bad idea because it took too much computational resources. That was when I had a process running at less than 200 million floating point calculations per second. The one advantage of this approach is simplicity and the battery will last longer.

While we are making progress, I am not ready at this time to give a time frame to ship the first product. I will just leave it at my original forecast where I said it would be finished about two years ago.

Jerry KK6LFS

From: https://groups.yahoo.com/neo/groups/CS7000/conversations/messages/4618

From: Jerry Wanger jerry [at] connectsystems.com
Date: Sun, Mar 26, 2017 at 3:50 PM
Subject: Re: [CS7000] Losing Hope
To: CS7000 at yahoogroups.com

This project started as a modification of the CS700 and later the CS750. To achieve this I needed support from the manufacturer of the CS750. Unfortunately, all I got was "lip service". CoValue was not a large enough company to give the support needed because they were too busy on their own separate R&D schedule.

The original design was based on the C5000 chip for DMR and a separate SDR radio for the other formats. That approach will work for DMR and DSTAR but not sure if it would of worked for the other formats which is always why I never guaranteed it would work for Fusion, NXDN, and P25.

The next generation design would use a super high speed processor which would guarantee the ability to do all the formats but that had a major problem which is why I did not do that at the beginning. Doing DMR in firmware took the Chinese over five years with a good size staff to get a working product. I did not believe the Chinese were incompetent but the problem was much harder than seems to be on the surface.

The current design got around the DMR issue. Its already done! If I want I could even use Tier III with full roaming and Trunking. My next major issue was the vocoder. Because of the company I am working with, I have legal access to the AMBE +2 vocoder in firmware so that solves the problem of NXDN, DMR, Fusion, and P25 Phase II. That left me with getting a DSTAR and P25 Phase I vocoder.

DVSI wants about $150,000 for their implementation of the DSTAR vocoder. At the current time that is too much to pay for a limited market where DVSI want the cash up front. Based on a patent analysis of DSTAR, the technology should be out of patent. However even with that knowledge DVSI was not willing to compromise on price. So the only choice was to get an implantation that was not done by DVSI. Luckily, there is a version floating around somewhere that suppose to work and is free.

In speaking to an expert in the field, even though the DSTAR patents have expired, there is no guarantee that the implementation will be patent free. However that is a chance I will have to take if I am ever going to get the CS7000 finished.

Jerry Wanger KK6LFS

https://groups.yahoo.com/neo/groups/CS7000/conversations/messages/4841

Date: Dec 7, 2017
To: <CS7000>
From: jwanger[at]pacbell.net
Subject: Status of CS7000 from Connect Systems

We are at a point where we are ready to test the DSTAR. The Analog and DMR is currently working. However we are stuck and have been trying for a few months to get a resolution. Here is the story.

Our CS7000 is based on the DP770 DMR and Analog radio from Kirisun. Their hardware is perfect for our requirements and they have already implemented DMR and Analog. For reasons that I am not going to get into, we would not even want to try to implement the DMR portion ourselves. We have covered the reasons in other post.

Kirisun gave us enough links into their source code to maintain the DMR and Analog and at the same time implement the DMR. If we run their firmware unmodified, we should get their standard radio and if we modify their software, we are on our own to fix the bugs.

The radio they gave us has their standard firmware in flash memory and it works when we boot up from flash. When we take their supposedly same firmware and run it through the emulator it does not work. To minimize issues we asked them to supply us with a working radio, a working laptop, and a working emulator. This should eliminate the problems of blaming something not working on a third parties product.

Until we can get their standard unmodified firmware they supplied to work with the radio they supplied to work with the emulator they supplied to work with the PC they supplied, we are at a standstill. We just had one of their sales people deliver a new radio with new firmware (or the same firmware) and we tested it and it still does not work. This radio does have the standard radio in flash so we do not know if the radio they supplied is even working.

This work is being done by one of my employees. I am personally working on another product that in my opinion is going to revolutionize our hobby. It is something that has not been done before and will allow the HAM community to do things they have not been able to do before. I will give details when we are closer to releasing it. It is being entirely designed in the United States and might even be built here.

Jerry Wanger KK6LFS

From: https://groups.yahoo.com/neo/groups/CS7000/conversations/messages/4889

Date: 07 Jul 2018
To: <CS7000>
From: jwanger[at]pacbell.net
Subject: Status of CS7000

Some people are starting to get curious on the status of the CS7000. This group is after all about the CS7000 not about tariffs and other more interesting topics.

We have not been able to get sufficient cooperation from the Chinese to integrate the DSTAR logic into their DMR radio. The person who we interfaced with at the manufacturer left the Company. I don't know if that is good or bad for us. We think we have everything working on the DSTAR logic side but we have no way to completely test it without more cooperation from Kirisun, the manufacturer for that radio.

The person who was doing the work on the CS7000 project is now working on the Large Display project and that will go into production hopefully in the next two months.

From a marketing standpoint, the project may be too late to be viable for the Amateur market. It seems that most HAMS now want dual band radios. I see no hardware platform I could use that has both dual band and the hardware to do DMR and DSTAR and NXDN and FUSION and P25.

I have not given up on the project but I do not know if I can continue supporting it.

Jerry KK6LFS