

FREE CATALOG   GEAR MALL   USER REVIEWS   MP3s  
GEAR GIVEAWAYS   TECHNICAL SUPPORT   PRODUCT ADVICE  
HELP   CUSTOMER SERVICE   [www.zZounds.com](http://www.zZounds.com)   BEST PRICES

## How to Save Lives with CE: Data Critical Corp's RhythmStat XLS Interview with developers David Albert, MD and Landgrave Smith, Ph.D.

by Rebecca Rohan

**Heart patients sometimes have symptoms that aren't caused by a heart attack, and trying to decide whether symptoms merit a trip to the emergency room or not can delay care until it's too late. On the other hand, the cost of emergency medicine and the rules of managed care make it difficult for many people to dial 911 with every symptom. A quick assessment of whether or not to get to a hospital can mean the difference between life and death. Data Critical Corp. of Redmond, WA has made that quick assessment possible by creating a CE-based application that lets physicians see a patient's electrocardiogram (ECG) wherever the physician is, whenever the patient has a problem.**

Data Critical's David Albert, MD patented software that starts with information from a small chest device with electrodes that records the heart's electrical activity, and uses an algorithm to change from thirty seconds' to five minutes' worth of that activity into a sound file, which the patient plays into a phone. A doctor can then read the ECG on Data Critical's CE-based software on a hand-held device.

"Traditionally, the patient would call a person on the phone who works for a company that offers a service, then hold up the device to a phone and push a button that transmits the ECG as a frequency-modulated audio sound wave to equipment at the other end that turns it into an ECG," said Dr. Albert. "At the receiving end, a technician sees the ECG and either prints it out on paper or prints it on screen, and can tell the patient to alert an ambulance if the patient has a serious enough problem."

"On the receiving end, people had large boxes that turned (the signal) back into an ECG," Dr. Albert continued. "The basis of my innovation was several years ago, when I realized hand-held PCs were beginning to have sound capability." Albert saw that handhelds could record audio sound files in high enough resolution to perform digital signal sound processing. "I could create a product that allowed a physician using a regular phone -- wired or wireless -- to received ECGs directly from a patient in real time."

Albert and his R&D team first developed RhythmStat XL

System on the Psion Series 3 but decided to take advantage of the RISC processor and the real time multi-tasking digital signal processing of Windows CE on the Palm-sized PC. Written in C++ under the Windows Visual CE SDK, the CE software targets palm-size PCs rather than handhelds, because they have the basic form factor of the Palm Pilot, the form factor requested by his customers. Albert's software is meant to run interchangeably on all palm PCs, and has been tested on the Casio Cassiopeia, Everex Companion, and Philips Niño.

"Now we have a product that allows a patient to call a doctor on their phone and lets the doctor monitor that patient directly with no additional equipment," says Albert. Doctors get an off-the-shelf palm-sized computer, install a compact flash memory card half the size of a credit card, load the program into the card the user will load and run -- and they've turned their palm sized PC into a patient monitor.

### **Non-Clinical Trials and Tribulations**

When Dr. Albert ported his software from the Psion to the first available Casio, it worked perfectly -- but didn't work on the second generation Casio or Niño. The manufacturer had changed the audio recording hardware. The software told Albert he was getting the same kind of file, but the data was several times as large in amplitude. The specifications for hardware change from generation to generation and from vendor to vendor. Even though the Casio E-10 had 4Mb memory and the newer Casio E-11 had 8Mb, it wouldn't work until they figured out the amplitude variable. "We had to make sure it could work with whatever (hardware) was there," Albert said.

The move was worth it. "CE gave us things we didn't have with the previous version (on Psion)," according to Albert. "We took advantage of the 32-bit real-time multitasking -- developing for the Windows CE required little learning compared to other operating systems. Our people had worked on Win 32/NT -- but they had also developed on very small machines like the Psion and others, and were very familiar with the Win 32 API and the limitations a handheld platform has. You don't have same (system) resources as on an NT machine. You still have to understand how to develop your application so it's an efficient use of resources."

Albert says this is especially true of real-time applications. With CE, it takes an understanding of running separate threads for different operations -- and exploiting the deterministic aspects of a real-time system means understanding when you're going to get things back from a given algorithm or subroutine thread. "That's very important for signal processing," Albert explained.

### **The Surprise Could Cause A...**

"One picture's worth a thousand words," said Albert, who claims doctors' eyes bug out of their heads because they replaced a large proprietary box with something that weighs a fraction of the weight of the keyboard they were using before. Albert himself had some surprises, for good and for ill. "We weren't sure what kind of processing power we were going to have -- we ran versions of the same RISC processor -- MIPS RISC chip, Hitachi -- the performance was phenomenal. We have the ability to do things in real time we hadn't had on the previous platform."

"What we've learned is that, despite the fact that MS provides the vendors with a so-called hardware specification (that's supposed to run) on whatever their hardware is ... vendors still have some ability to make their products unique," says Albert. "On the surface, everything is supposed to be the same, but look under the hood at the amplitude of digitized audio signals, and they can change -- not only between different vendors, but between different versions for the same vendor. Our program worked on one and not the other." But once the algorithm changed, the product did work. "It doesn't matter what vendor or what version you plug it into," says Albert, "we believe that it will be able to work on anything in the family of palm-sized PCs."

"The quality of the screens on the palm-size PCs have gotten better since the first generation over a year ago," says Albert. "The ECG looks better -- it's easier to see under varying light conditions." Albert says today's better backlighting makes it easier for a doctor dining by candlelight in a restaurant with his wife to view an ECG.

Albert is also happy with the choice of the palm-sized PC because it's versatile. "The other applications that are built into the palm-size PCs are very good," says Albert, so physicians can use the calendar, phone book, and other applications as a personal organizer. "We get those benefits by putting our product on that platform."

Landgrave Smith, Ph.D., an important developer on the project, said one of the attractions was the screen size relative to the overall size of the device, as well as the pen technology and multi-tasking. But Dr. Smith lamented the lack of paper documentation for platform-specific calls. "How do you turn on the little enunciator light on the Casio? Niño has two of them," added Smith, who wanted to use the light as a recording-active indicator.

"Access to documentation is not convenient," said Smith. "You don't find very much on programming CE at book stores. Some Win 32 APIs are not honored by the CE operating system." It's taken trial and error. For example, Smith wanted access to the voice recording subsystem. "You can do it by way of activating a voice control -- you have to hide that behind your application. I

found that in online documentation that let me get started. It turns out that recording can be activated by a Win 32 API call." But Smith wants it buffered instead of going to a file so he won't have to lose space in a wave file to do file writes and reads - so he can pass the address of the buffer to a demodulator, and the address of a new buffer to a recording facility, and bounce them back and forth in real time.

Smith adds that, "whether or not a palm PC will be equal to the task of real time modulation has yet to be demonstrated. Hopefully by the end of the weekend, I will have that working." But what Smith had found so far was in reference material on Win 32 APIs in the broadest sense, not in CE documentation. "Over time CE documentation will accumulate," Smith adds.

FDA approval for the medical product took about six months. Smith says FDA approval boils down to two things: being aware of broad requirements for claims you can make, and being very precise and disciplined about the way in which you write the programs. "For example, write the program in such a way that it has minimal dependencies," says Smith. "Don't expect the operating system to do something for you; do it explicitly. Make sure the code does exactly what you intend it to do, and nothing else."

## Biography



*David Albert, MD is Chairman and Chief Scientist at Data Critical Corp. He did his undergraduate work at Harvard and his medical training at Duke. His hobbies are magic, traveling, and jointly developing children with his wife. They have a 13-year-old girl, boys 8 years and 18-months, and another boy due in May.*



*Landgrave Smith, Ph.D. is Senior Software Scientist at Data Critical Corp. He was the second person hired and has been at Data Critical for five years. Smith got his doctorate in Biological Psychology from the University of Oklahoma Health and Sciences Center, College of Medicine. His hobbies include programming, competition shooting, and building a house.*

[Return to table of contents](#)

Copyright © 1999 [Miller Freeman, Inc.](#), a [United News & Media](#) company.