



**Advancing Cyber Security:  
Dr. Salim Hariri, UA Autonomic Computing Lab**

*By Jorge Gonzalez-Garcia*

Tucson, ARIZ. – When Dr. Salim Hariri, Director of the University of Arizona's Autonomic Computing Lab, was a young boy growing up in Damascus, Syria, he built a tiny radio with one transistor. "I always dreamed of being an electrical engineer," Hariri recalls. "Even as a little kid I was playing with circuits. And, I dreamed of working abroad and doing exciting things. What exactly I didn't know, but that was always my dream."

Nowadays, Dr. Hariri, a well-respected cyber security expert and professor in the university's College of Engineering, dreams of computer systems that manage and protect themselves against cyber-attacks. And slowly but surely, he and his team are turning that dream into reality.

This spring day he sits with family and colleagues in a large banquet room at the university, a long way from his Syrian homeland. Dr. Hariri, a fit and trim 54 years old, looks around the room and smiles. He is clearly enjoying the recognition from his peers, as one of a select few being honored for innovative work this day.

When asked to describe his groundbreaking work, he searches carefully for the right words. "At the Autonomic Computing Lab, we research and develop software systems that allow computer systems to manage themselves," he explains. "The problem today with current systems is that you have to spoon feed every single instruction for that system to operate properly."

An approach that is labor-intensive and outdated in today's Internet world, according to Dr. Hariri. "It is very hard to anticipate all the interactions with outside computer networks. That's why we have so many problems with cyber security," he says. "With an autonomic system, it is designed to manage and protect itself."

When it's suggested that this concept sounds more than a little futuristic, the computer scientist pauses to find the right way to communicate that the future is now in his field of cyber security. "We're taking steps toward that ultimate goal. For example, in the old days, a pilot would fly an airplane and it was all manual operation, from takeoff, to flight, to landing. Now planes fly on auto-pilot for 90% of the flight."

Dr. Hariri explains that the goal is efficiency and security, not necessarily one hundred percent automation. "We can start with the manual-intensive tasks that don't need human involvement every step of the way," he says. "And, where you have big impacts, we can make this part semi-automatic." The university professor looks across the table to see if his explanation is sinking in. Hopeful now, he goes on, "So, we tell the system administrator: These are the steps we can take and these are the consequences.

Would you like us to implement these steps? And as we perfect the process, it becomes more and more acceptable. This is the evolution of the automating process."

At the heart of the process is an innovative algorithm developed by Dr. Hariri and his team. "If we detect a cyber security threat or attack, we look at the pattern of activity, and from that we build a case that points to the ultimate goal," he says. "The algorithm takes the manual steps and automates them by using software."

If this sounds like high-tech detective work with scientists walking crime scenes and examining clues left by the criminals, the analogy is close to the mark. The researcher prefers to describe it in more scientific terms. "My specialty is anomaly behavior. To protect computer systems, we need to understand how they operate under normal circumstances. We figure out the parameters, the

matrix which defines normal operation. And then we build algorithms to capture any deviation from that."

Dr. Hariri meets on a regular basis with administrators from government agencies and large corporations to discuss cyber security. His challenge is convincing administrators to approach security with a new mindset. "The problem is that is they keep investing in the same paradigms," he says. "These are based on signature type verification. This outdated technology no longer works when it comes to providing good security. And they spend \$30 to \$40 billion dollars a year on this outdated technology."

The cyber security expert explains, "What I tell them is that you need to invest in the new paradigms. Your thinking has to be out of the box. Now, finally, I see that they are starting to recognize the need to factor in behavior, especially anomaly behavior. I have been promoting this for years, but finally they are starting to move in this direction. In science, we always say that going down the wrong path, will always produce the wrong result. But I do see a shift in their thinking. And, that makes me hopeful."

Dr. Hariri is confident that the Autonomic Computing Lab will play an important development role in developing new cyber security safeguards in an internet world exploding with connected mobile devices. "Today we have about 2.5 billion devices on the Internet," he explains. "And we expect that to reach 30 billion devices in the next few years. It's what we call the 'Internet of Things.' There will be sensors on clothing, and sensors in homes and offices. Everything will be connected. And that increases vulnerabilities."

"So, I believe that the research we do in the lab will play a big role in helping us cope with that complexity," he says. "When you're talking about 30 billion devices, you really need to build technologies based on autonomic computing systems that can self-manage and self-protect. And my hope is that my research team will play an important role in the deployment and spread of these Web applications and services."

To bring these applications and services to the commercial market, Dr. Hariri started a cyber security company called Avirtek. "We licensed the technology behind the algorithm so that we can commercialize the software and services we offer," he says. "The university owns the intellectual property. They have a technology transfer patent process. An individual or startup can license this technology, and use it as part of new cyber security software they are introducing."

When asked if recent news reports of cyber-attacks by a special unit of the Chinese Army were a surprise to experts in the field, he smiles and shakes his head. "In our field, it is well known that the Chinese are very active in using cyber warfare to advance their goals. They monitor Internet traffic 24/7, and this activity is well known internationally. The attacks are coming from China, and also from Russia and eastern Europe."

Asked if he noticed a reaction from his Chinese students when the news reports came out, the UA professor shakes his head and replies, "No, not really. I have a couple of Chinese students, and sometimes I say look there's a story about Chinese cyber-attacks, and they just laugh, and we laugh together."

As a university educator, Dr. Hariri wants his students to take two important things with them out into the real world: research skills and integrity. "We teach them how to be good researchers, and how to approach problems in a systematic way. Also, we teach them integrity. This is very important. If you are doing research you have to recognize other peoples' work."

When asked if he gets calls from engineering students back in Syria wanting to come to the U.S. to study with him at the University of Arizona, Dr. Hariri replies, "Yes, I do. If a student is qualified to meet admission standards, I'm a strong supporter. In fact, I have one in my lab who escaped from Damascus just three years ago. And, he is doing research on critical infrastructure protection, and doing very well. And I'm supporting him while he is studying here."

So, a human success story for Dr. Salim Hariri, Director of the UA's Autonomic Computing Lab. Out of the tragedy of the Syrian civil war, a rescue, a chance for a new life, and a path to a successful career. "This a helping hand I can offer. The students there are in very bad shape. At their university, there is no safety, no security. If I can help them pursue their education, like I did, then I am glad to do."

To think it all started years ago with a young Syrian boy playing with circuits and building a tiny radio. And dreaming of being an engineer one day.