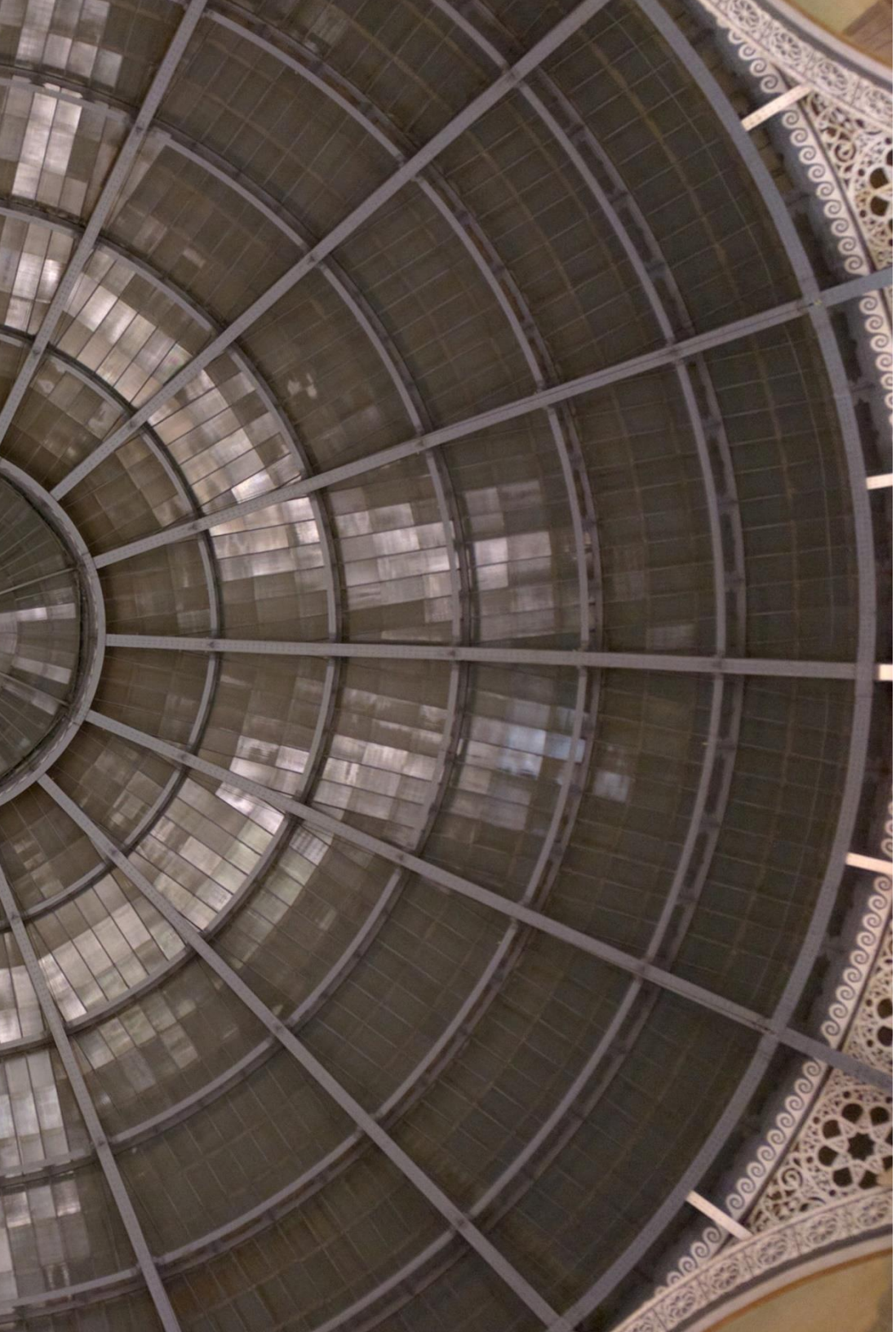

Anritsu: Managing interference in densified networks

A conversation with Tom Elliott,
Sr. Product Manager,
Anritsu Company
By Monica Paolini, Senza Fili

In collaboration with

RCRWireless
INTELLIGENCE ON ALL THINGS WIRELESS

SENZA FILI

Anritsu
envision : ensure

Profile

Anritsu

Founded over 120 years ago, Anritsu Corporation is a global provider of communications test and measurement solutions.

Anritsu's measuring instruments support multiple areas:

- Mobile wireless communications, RF and microwave: base station analyzer, Bluetooth and WLAN tester, cable and antenna analyzer, conformance test system, interference hunt, PIM analyzer, peripheral equipment, power meters and sensors, signal analyzer, spectrum analyzer, signal generator, signaling tester, shield box, trace management, vector network analyzer, handheld vector network analyzer
- Digital broadcast: Digital broadcast analyzer
- Devices and components test: Bit-error-rate testing, eye pattern analyzer, vector network analyzer, signal generator, optical spectrum analyzer, peripheral equipment
- Transport: IP/Ethernet testers, SDH/SONET/OTN analyzers, PDH/DSn analyzers, multi-layer network test platform
- Optical: OTDRs, multi-layer network test platform, optical loss test set / light source / optical spectrum analyzer, video inspection probe

In addition, Anritsu has recently introduced SkyBridge Tools™ to manage cloud data. SkyBridge Tools helps mobile operators with documentation and reports, real-time analytics, automated assessment of RF sweeps and PIM test results.

The ability to automate and scale testing and monitoring in wireless networks is crucial for operators moving to multi-layer, multi-RAT networks and with DAS; the number of tests needed to assess performance rapidly increases with complexity and makes manual field testing time consuming and expensive in terms of staff resources.

Anritsu solutions also help operators with densified networks to identify the different sources of interference that affect macro-cell and small-cell networks and to manage interference, if necessary, in real time.

The portfolio of Anritsu measuring instruments is well suited for indoor densified networks. It consists of solutions for both the wireless and optical segments; they can test and monitor both the access and backhaul/fronthaul portions of mobile networks.

Anritsu testing solutions in different environments *Source: Anritsu*

Anritsu

Managing interference in densified networks

A conversation with Tom Elliott, Sr. Product Manager, Anritsu Company

Monica Paolini: In this conversation with Tom Elliott, a Senior Product Manager at Anritsu in the United States, we discuss how testing evolves as operators densify their networks with DAS, small cells and other solutions.

Tom, could you give us an introduction on the approach to densification at Anritsu and what your role is within the company?

Tom Elliott: As far as personal work on densification, I've been heavily involved with redefining what field testing means for DAS. The idea of a test as being a return loss, or a distance-to-fault really isn't working too well for the DAS people.

We've also had a focus on received signal quality. I and others have been heavily focused on the idea of spectrum assurance, the idea that you can have a variety of ways to make sure that your uplink is clean.

With LTE in particular, a clean uplink really helps capacity, and capacity is what densification is all about.

Monica: You're personally more involved in the DAS testing, but at Anritsu, you cover other areas with respect to densification, too.

Tom: Personally, I've been involved in DAS testing and interference. Others in Anritsu are involved in the full range of tests that we do, as well as spectrum monitoring.

Monica: What is different about DAS testing? The end result is to make sure that the QoE is good for the subscriber.

Tom: In a tower installation test, you have cables going up the tower. You have antennas, maybe some splitters, and other passive RF components. A typical tower test would have 25, 50, 100, maybe even 150 sweeps of some nature. We're talking about return loss, distance-to-fault, cable loss, PIM, and maybe some fiber test. That can be handled by the existing processes.

When you move to a DAS system, especially a neutral-host DAS system, where you need to test three or four frequency bands on every cable, those tests multiply, and they multiply dramatically.

A medium-sized DAS install could have several thousand tests. A football stadium, for instance, may have as many as 15,000 tests. It's the sheer scale that becomes a problem. You're talking about months, man-months, spent dealing with these tests.

Monica: Is automation going to help this? Networks are becoming more complex, not less complex. How is testing going to evolve with the increase in complexity?

Tom: Automation can help this. In manufacturing, for many years, there's been a piece of software called a test executive. It sets up tests, it automates the tests, it runs the tests, it collects the results, and generates statistics.

We need something similar to that for the field, something to automate the field tests, and DAS is a perfect setup to do this. At the same time, there's the idea of removing some of the possibilities for error out of the DAS testing.

In the work we've done with some of our DAS installers, we're finding when we come in, there might be a 10% error rate on these files. Say I have 5,000 files, I sample 500 files. I can't check every one of them, so I sample.

I say, "OK, it's good." I pass them off to my end customer. They look at 5,000 tests and say, "What am I going to do with this?" They sample the tests. They sample different tests, and if there's a 10% error rate, chances are they're going to find some problems. The results all come back to the testing contractor, and we get into this loop.

The problem was expressed to me best this way: "I have 1,000 traces in a directory on my PC. Which ones are missing? Which traces are duplicated? Which traces are misnamed? I haven't even gotten to which traces fail judgment." The existing processes, which are based on a tower technique, just do not scale.

Monica: Also, the DAS systems are evolving. With active DAS, DAS is becoming more complex.

Tom: One thing Anritsu is doing is redefining what a test is. I've talked about a return-loss sweep, a distance-to-fault sweep, a cable-loss sweep, and about having to do these all at three different frequencies.

Why do we need to run nine lab-based tests on each cable and deal with these individually? Don't we have computers? Don't they do things like this? We do have computers, and they do things like this. We can redefine what a test is, from "Here're all these things I have to do to this cable," to "This cable is good or bad." We can remove some of these workflow issues.

There's a MOP, a Method of Procedure. Some companies call this a SOW, or statement of work. By necessity, it's fairly general, but when a technician is faced with an ambiguous situation, what they'll tend to do, rather than have to come back and test again, is they'll take three, four, or five different traces, and let the engineers sort it out.

Typing filenames on the instrument turns out to be a major time sink. Not only do they tend to make a typo once in a while – you would, too, if it was 20 degrees out and blowing like anything – but each technician tends to have his own naming standard, and they leave it to the engineer to sort it out.

There's also some ambiguity in the existing process for instrument setups, and this can lead to situations like "Oh my goodness, it was the wrong start and stop frequency," or "The limit line was wrong," or "Something was wrong. We've got to

Anritsu's testing equipment: cable and antenna analyzer, PIM analyzer, spectrum analyzer , base station analyzer, optical light source / optical power meter *Source: Anritsu*

go back and retest." These sorts of things could be removed by test automation.

Monica: In a DAS environment, you might have a neutral host, so it's not necessarily the operator doing the testing. And the people that are doing the install and the testing might not be as qualified, or have so much RF experience. Doesn't that create additional challenges?

Tom: It certainly does, and I've been involved in some of these. DAS testing, even if you do have RF experience, is a different field than some of the other testing you may have done, and there are certain ambiguities there.

What Anritsu has proposed is an automated field test solution. You may have heard of it by the name of SkyBridge Tools. It's on our external website. It provides setup information for the instruments. It provides test automation when you're on site, and it provides automatic judgment, automatic reporting with cloud-based dashboards, so everybody with a login knows exactly how the job is progressing.

This way, the questions can be asked and answered while the technician is still on site, before they've closed out, before they've gone somewhere else, before they have to come back, before payment is delayed.

Monica: Basically, you can see there is a problem, and then you can dig down specifically in that area, whatever the case may be.

Tom: That's exactly it. The idea is to get things done quickly and done now. Our field tests show that SkyBridge can cut the actual test time by up to 90%. That's a big number, but if we're going from a manual method to a computer-aided method, that's not surprising.

Monica: With densification, the more packed your infrastructure is, the more opportunities you have for interference. That is whether it's indoors or outdoors. How do you deal with that?

Tom: First, maybe I should take a moment and define what the interference mechanism is.

Interference is a receive issue. Signals that get to the radio's receiver affect the front end, and even if it's not the signal you want, it will come in there. It will reduce the sensitivity of your radio receiver. This lowers the radio's sensitivity, and increases your bit error rate, increases your frame rate, increases your dropped calls and all that bad stuff.

The name for this is receiver desense, or desensitization. If it's severe, it's called receiver blocking.

One thing that seems to be a chronic misunderstanding about interference is that interference does not have to be on your receive channel. All it has to do is get to the input of your receiver. It can be on a different frequency.

In other words, it can be in band, but it doesn't have to be on channel, so your receive pre-filter matters. If it gets through your receive pre-filter, if it gets to the input of your receiver, it's interference.

Monica: In terms of the testing, how can you have your testing become more efficient where you have small cells, which are additional sources of interference, when small cells and macro cells are in co-channel deployment?

Tom: Anritsu has a lot of interference solutions, but there's one thing I need to point out, which is that the incoming signal amplitude at the receiver matters.

Small cells have their own unique problems when it comes to interference.

Let's say I have a signal source, an interference source. It's at -40 dBm. It's emitting at -40 dBm. If that signal is a mile from a tower, propagation models say it's going to lose 96 dB by the time it gets to the tower. In absolute numbers, It's going to be -136 dBm at the tower. It's not going to be an issue. The tower won't see it. It won't matter because it's above the small cell's noise floor. We can coexist perfectly happily.

If we're 50 ft from a small cell, the signal will lose 56 dB over 50 ft. That puts the signal at -96 dBm, at the small cell's receive and it's a problem for the small cell.

My point here is that when you put in small cells, there're going to be interference sources that will bother a small cell that a macro cell would never see. Interference becomes a bigger problem. Of course, the small-cell reception area is smaller. It's a small cell, after all. But there are other interference sources that will matter to the small cell that a macro tower won't see. Efficiency in finding interference becomes very important.

Monica: How do interference sources change as you move from macro to small cells?

Tom: It depends on the sort of sources we're looking for. There's on-channel interference, there's interference that's off channel but in band, there's impulse noise, arcing, sparking. There are even still jammers around.

We had a case a while ago where a high school teacher had a jammer running during his tests so his students couldn't cheat, and it was shutting down an AT&T sector. Jamming 911 calls? Not good.

We also have harmonics, multiples of an original signal. Some of our TV signal harmonics fall in the PCS band. There is intermodulation, both active and passive intermodulation, that we all know about from PIM testing. There's something called the near-far problem, where a strong interference signal or a strong transmitter will overwhelm a weak desired signal.

All of these are typical interference sources, and we've got a great app note on interference hunting concepts that goes over this in more detail.

As far as making interference hunting more efficient, Anritsu does have a tool set for this, starting with some of the very simplest traditional methods.

We've got the traditional direction-finding tools. We take a spectrum analyzer and a Yagi antenna, look for the strongest signal, and you triangulate. We have map-assisted tools that will actually put a map on a spectrum analyzer. We have car-based signal location, where we can go through and essentially seek the power.

Do you remember the child's game of hot and cold, where one child picks something, and the other child asks, "Am I getting hot? Am I getting cold?" It sorts of works that way, and it's surprisingly fast. Also, it's reliable, because it takes care of issues with multipath, echoes, reflections, and even diffraction.

Another solution is monitoring, because signals aren't always interfering. We can characterize a signal by doing short-term monitoring. Every one of our spectrum analyzers is web enabled. You can hook them up to the internet. You can control them with a browser from a distance. We can drop something off at a site for a week, for two weeks, for three weeks, and see what's happening.

On the other hand, you might be interested in some long-term monitoring. We have a set of headless spectrum analyzers designed specifically for this sort of task, which can be either temporarily or permanently in place, and we have

software to go with it, so you can maintain your signal quality throughout your network as things change. The device is comfortably monitored remotely.

Monica: There is testing that you do at the beginning, but then monitoring is an ongoing effort. Is the relationship between testing and monitoring evolving somehow, with densification and networks that are becoming more complex and dynamic?

Tom: Back when we were mostly concerned about coverage, interference didn't matter so much, because all of our cellular standards have redundancy, and they can handle a certain amount of interference without dropping the call. Every one of those methods of handling interference involves sending out more bits to get the same amount of data. In other words, you've affected your capacity.

As soon as we moved to LTE and we were concerned about capacity and densification suddenly, interference matters, and it matters a lot, because it's hitting your throughput directly. That's why monitoring is becoming of interest to our customers. Network operators, especially, are concerned about their signal quality and their throughput.

If I go back 10 years to CDMA, if we had any interference problem, it would be the easiest thing just to plunk a $4,000 board into a base station and bring up a new carrier, and all of a sudden, you have more capacity.

That's not possible with LTE. The bands don't permit it. If you want to have more capacity, first you need to make the most out of the macro cells you have. That's what spectrum monitoring is about.

Second, once you get your small cells in, or your iDAS or your oDAS, you need to make sure it's performing effectively.

Monica: What is the impact that you're seeing from densification on spectrum assurance?

Tom: Spectrum assurance is Anritsu's name for a family of spectrum monitoring, interference hunting, and signal mapping tools, both indoors and outdoors. We're developing these in response to our customers' requirements for exactly the sort of capacity we've been talking about with LTE and densification.

Monica: Where do you see testing moving in the future?

Tom: We're going to be moving closer to real time. We have all this communication capability now. Our instruments are using it and they will continue to use it.

Cloud-based solutions are tremendously efficient. The test automation for DAS is a cloud-based solution. We're going to see that. You're going to see more control, you're going to see more remote expertise, you're even going to see remote dispatch coming in the future.

Monica: You mentioned real time. What is real time for you in testing? Is it a day, an hour, a minute, a millisecond?

Tom: Real time can be a day, it can be an hour, it can be a minute. Picture this scenario. There is an engineer at a central site somewhere in the world. There's a technician on site in the field. The technician runs some diagnostics. He posts the results in the cloud. The engineer sees the results and downloads some more tests to the technician's equipment. That sort of collaboration is what I am talking about.

Monica: I guess at different sites, and for different needs, you might switch to different time granularity while there?

Tom: Absolutely. Monitoring typically uses a 15-minute window. Troubleshooting would require updates in a few seconds. If we're building a DAS system, maybe once a day is enough. It depends on the task.

Monica: Monitoring allows you to identify and fix a problem, but also it allows operators to optimize the use of the network resources. Can you help them with that as well?

Tom: Yes. We do have a product line that provides a big-iron software application, called Master Claw, that is a service-assurance solution.

We also have a software application called Vision. It works with our long-term RF monitoring probes, and it helps characterize when signals occur and what they look like; it helps figure out where the signals are occurring, within a few blocks, by triangulation; and it provides all the necessary information to dispatch a team to go and find that signal.

Now we can sit in a central place somewhere, let's say somewhere in the US, characterize an interference on three or four sectors in, say, Los Angeles, and dispatch a local team to go find it when we're ready to. That's the sort of real-time,

continuous, cloud-connected thing we're talking about here.

Monica: Real-time optimization, and then you also mentioned the cloud virtualization part. What is that virtualization? How is virtualization in the cloud changing your solutions?

Tom: Obviously, our solutions are becoming more connected, and you can expect that to continue in the future. We have a wide world of connection, at least electronically. Barriers are falling, as evidenced by this on-line interview. We're many miles apart, and it's working just fine.

We expect this sort of collaboration in field tests to continue. After all, field tests naturally have experts in one location, and the man on the ground in a different location. As soon as you do that, electronic communication becomes just a natural solution.

Glossary

CDMA	Code division multiple access
DAS	Distributed antenna system
DSn	Digital signal *n*
iDAS	Indoor DAS
LTE	Long Term Evolution
MOP	Method of procedure
oDAS	Outdoor DAS
OTDR	Optical time domain reflectometer
OTN	Optical transport network
PCS	Personal communications service
PDN	Plesiochronous digital hierarchy
PIM	Passive intermodulation
QoE	Quality of experience
RAT	Radio access technology
RF	Radio frequency
SDH	Synchronous digital hierarchy
SONET	Synchronous optical networking
SOW	Statement of work
WLAN	Wireless local area network

About Anritsu

Anritsu Company is the United States subsidiary of Anritsu Corporation, a global provider of innovative communications test and measurement solutions for 120 years with offices throughout the world. Anritsu's "2020 VISION" philosophy engages customers as true partners to help develop wireless, optical, microwave/RF, and digital instruments, as well as operation support systems for R&D, manufacturing, installation, and maintenance applications. In addition to supporting precision microwave/RF components, optical devices, and high-speed electrical devices for communication products and systems, Anritsu provides a large portfolio of solutions to meet the growing demand for in-building wireless services from DAS to small cell environments.

About Tom Elliott

Tom has 20 years of experience in the telecomm industry working with RF and cellular technologies. Tom has concentrated on test and measurement for cellular base stations for much of this time. Tom is a Product Manager for Anritsu Company with worldwide responsibility for wireless service providers. He focuses on improving network performance and making technicians more productive through the technologies and tools of Anritsu. Tom has taught hundreds of technicians, written several procedures and courses, and regularly receives the input of technicians, managers, directors, and CTOs on new test requirements as the wireless network evolves.

This conversation is included in the Senza Fili report
"Massively densified networks. Why we need them and how we can build them,"
prepared in collaboration with RCR Wireless News.
Download the report at www.rcrwireless.com and www.senzafiliconsulting.com

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About Senza Fili

Senza Fili provides advisory support on wireless technologies and services. At Senza Fili we have in-depth expertise in financial modeling, market forecasts and research, white paper and report preparation, business plan support, strategic advice, and due diligence. Our client base is international and spans the entire value chain: clients include wireline, fixed wireless and mobile operators, enterprises and other vertical players, vendors, system integrators, investors, regulators, and industry associations.

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About the interviewer

Monica Paolini, PhD, is the founder and president of Senza Fili. She is an expert in wireless technologies and has helped clients worldwide to understand new technologies and customer requirements, create and assess financial TCO and ROI models, evaluate business plan opportunities, market their services and products, and estimate the market size and revenue opportunity of new and established wireless technologies. She frequently gives presentations at conferences, and writes reports, blog entries and articles on wireless technologies and services, covering end-to-end mobile networks, the operator, enterprise and IoT markets. She has a PhD in cognitive science from the University of California, San Diego (US), an MBA from the University of Oxford (UK), and a BA/MA in philosophy from the University of Bologna (Italy). You can reach her at monica.paolini@senzafiliconsulting.com.

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