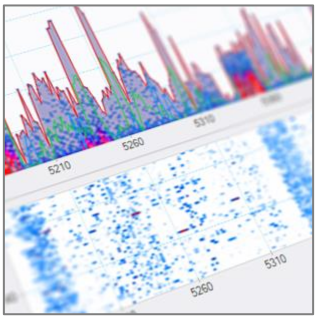
TARANA

BROADBAND REINVENTED

Introduction to ABIC

The Problem



In many fixed wireless access use cases, the 5 GHz unlicensed band is really the only practical spectrum option. Propagation physics and the prevalence of obstructions in most deployment environments require operation in sub-6 GHz territory. The mobile operators who pay dearly for licensed spectrum in those bands naturally prefer to maximize their return on that investment by using it to provide revenue-generating mobile access. For the many other categories of operators without access to licensed spectrum, 5 GHz is really their only choice.

The accessibility of this unlicensed band is both its strength and debilitating weakness. Because anyone can use it, in areas with any population density worth commercial attention, it's filled with activity. Trends in Wi-Fi standards and usage — along with proliferating line-of-sight transport links — are only making this problem worse. For operators interested in fixed wireless as a more affordable and practical alternative to fiber, who therefore require reliable, high-bandwidth links, the increasingly unmanageable interference in the 5 GHz band is a show-stopper issue.

The wireless equipment community's consistent response is to offer a variety of forms of the same, cleverly disguised non-solution, typically referred to as "interference mitigation" or "channel adaptation." These terms sound comforting, but the approach fails in an ever-increasing range of circumstances as congestion in the unlicensed band continues to worsen everywhere. Examined closely, the essence of this default solution is simply hopping to a different — but not necessarily better — channel in the band when performance in the current channel degrades. Just like changing lanes on a completely stalled rush-hour freeway, when a radio system faces a fully-busy 5 GHz band, simple channel changing cannot solve the problem, no matter how rapidly it might be done.

We thought we should be able to find a better way, because we're working with a different set of radio resources from everyone else. Our Gigabit 1 (G1) next-generation fixed wireless access platform is built on a novel combination of a large number of radio degrees of freedom, ample real-time signal processing capacity, and advanced algorithms that use precise and rapidly-adaptive digital beam- and null-forming (along with a number of other techniques) to carefully coordinate the distribution of radio energy along multiple dimensions — both on each link and across a system of links in a network. This allows us to deliver 10x gains in spectral efficiency over prior radio systems, truly unprecedented performance in the face of obstructions and dynamic channel conditions, and much higher practical deployment density through perfect co-channel interference management. Using these unique capabilities as a springboard, we've spent a lot of quality time over the past couple of years exploring how we might directly address the unmanaged interference problem in 5 GHz as well, rather than settling for simple (doomed) evasion like the rest of the industry.

While some believe the opening up of the 6 GHz spectrum will be a panacea for operators hungry for reliable links, in fact the issues discussed here apply to *any* unlicensed spectrum, not just 5 GHz. Although 6 GHz is likely to have less interference initially, we believe that characteristic will rapidly disappear as operators deploy. Which will leave operators with the same problem they currently experience today in 5 GHz.

The Solution: Invention

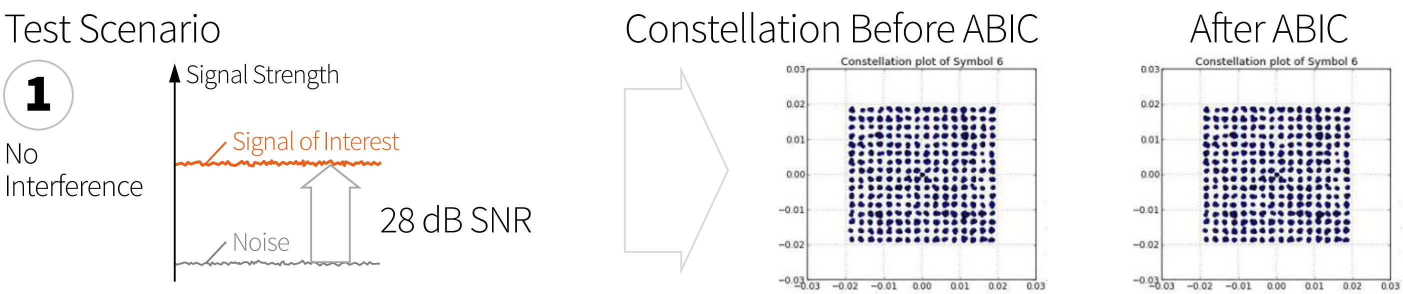
The result of our team's research and development work is a completely new approach to handling unmanaged interference in unlicensed spectrum we call Asynchronous Burst Interference Cancellation, or ABIC. As we report in the next few pages, this invention by the Tarana team — which involved breaking substantial new ground in radio signal processing — demonstrably solves the problem, as intended, in ways the industry has never seen before.

Results: An Industry First in Radio Signal Processing

The essence of the ABIC approach, as the Cancellation part of the name suggests, is to process combinations of inputs to resolve the signal of interest (SoI) out of the "mess" that unmanaged interference creates in the radio channel being used, instead of just attempting to find a clean one. ABIC effectively cancels out all undesired signals in the channel at the receive end of the link, leaving us with an interference-free connection. The results we report here begin with wired in-lab testing in the digital domain, where it is easiest to capture the constellation patterns that show most clearly the performance of the algorithm at the foundation level of resolving only the desired received signal.

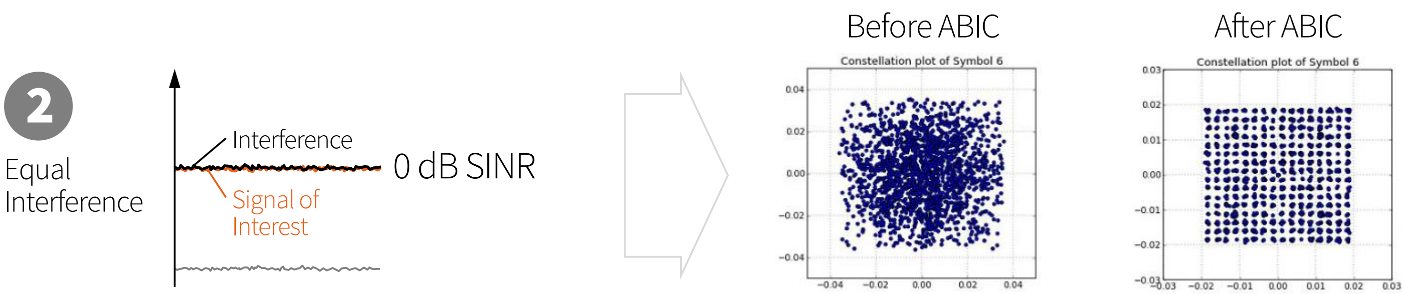
Baseline Wired Testing

In the first test scenario (below), we established a baseline for what constitutes a good processing result for a single link in isolation — an SNR of 28 dB, which enables a 256 QAM constellation in this setup.



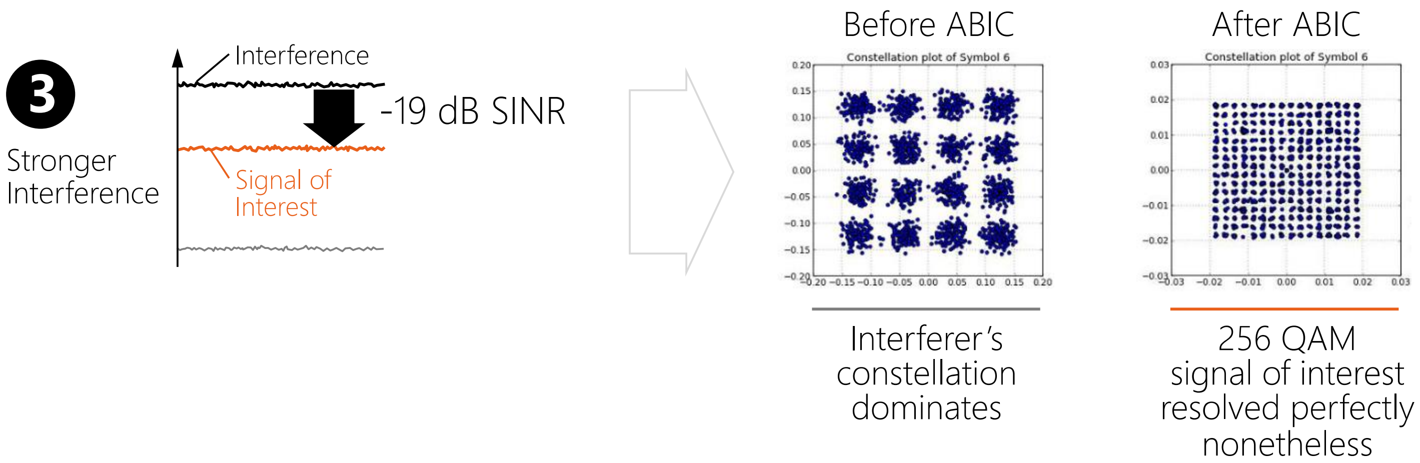
In wired test scenario 2, we added an asynchronous interferer (a signal generator) to the channel at the same power level as the SoI — for an SINR of 0 dB. The attempt at resolving a clean 256 QAM constellation out of the received signal unaided by ABIC, as seen on the left, was clearly not successful.

In this case ABIC processing was able to resolve the SoI perfectly, as seen on the right.



In wired scenario 3, as an extreme test, the signal generator was set to a level approximately 80x stronger than the SoI — for an SINR of -19 dB. In this case the receiver's unaided attempt at resolving a constellation out of the signal (without ABIC) appears at first glance to have been successful. Looking more closely at the Before ABIC results, however, it's clear that the receiver has delivered the interferer's 16 QAM constellation — which had completely 'drowned out' the SoI.

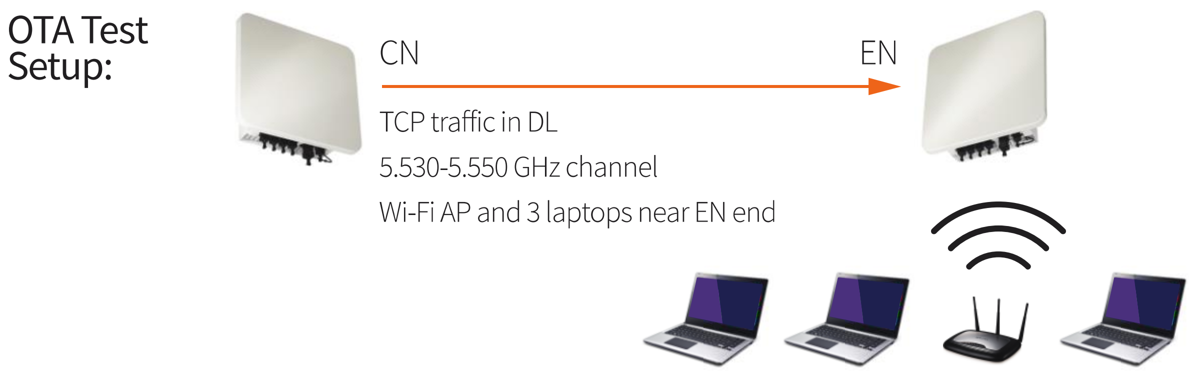
Despite this -19 dB SINR, ABIC processing was again able to resolve the 256 QAM SoI perfectly, as seen on the right.



Over-the-Air Testing

Our second set of test results demonstrates both the throughput impact of ABIC processing in the face of real-world Wi-Fi interference as well as its operation throughout the data frame.

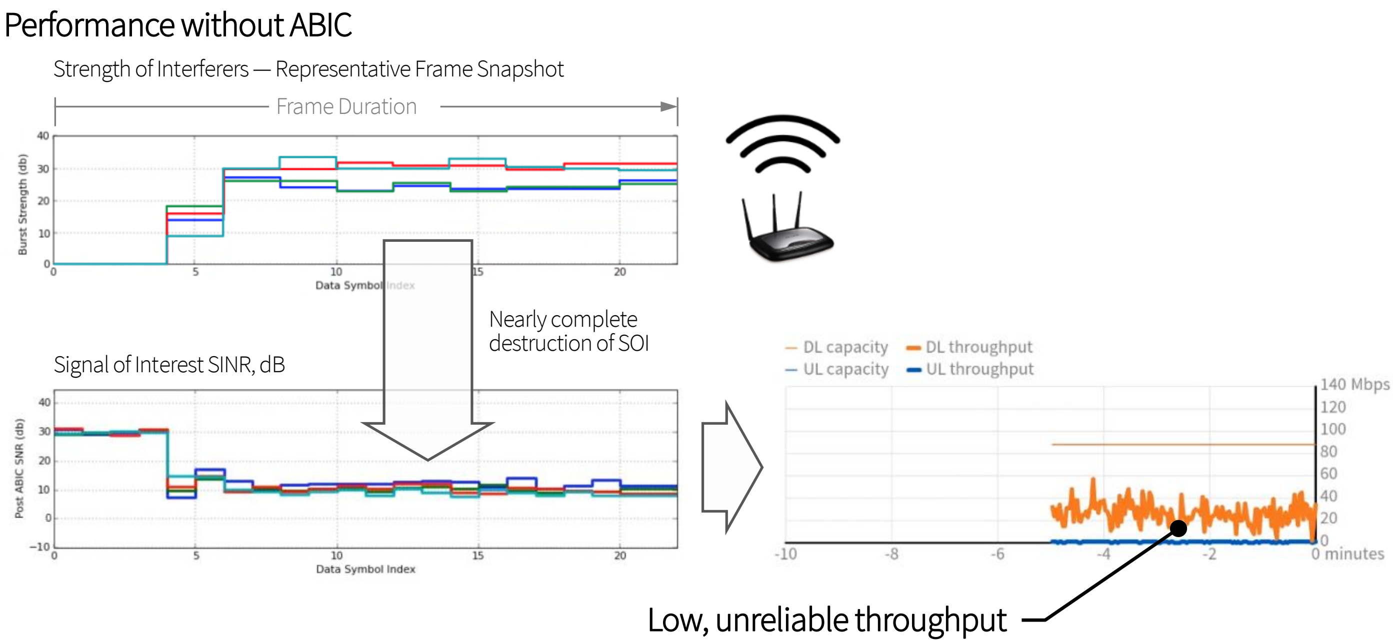
This test setup involved a single link, using commercially-available Tarana product in a standard configuration at 5.5 GHz. The sources of interference included an off-the-shelf Wi-Fi access point set to operate in the same channel as the Tarana link (at US power settings), performing essentially continuous traffic exchange with three laptop Wi-Fi clients in its vicinity. The access point and laptops were placed near the receiving end of the link.



The charts on the left side of the graphic below track the pre-ABIC per-data-symbol interference strength relative to the noise floor ("INR" in dB) received by the Tarana platform over the course of its 5 ms data frame, and the resulting SoI SINR — as captured by a development-platform interface that provides monitoring of the Tarana commercial gear at internal sample points. The figure on the right shows the connection's downlink capacity and throughput over time.

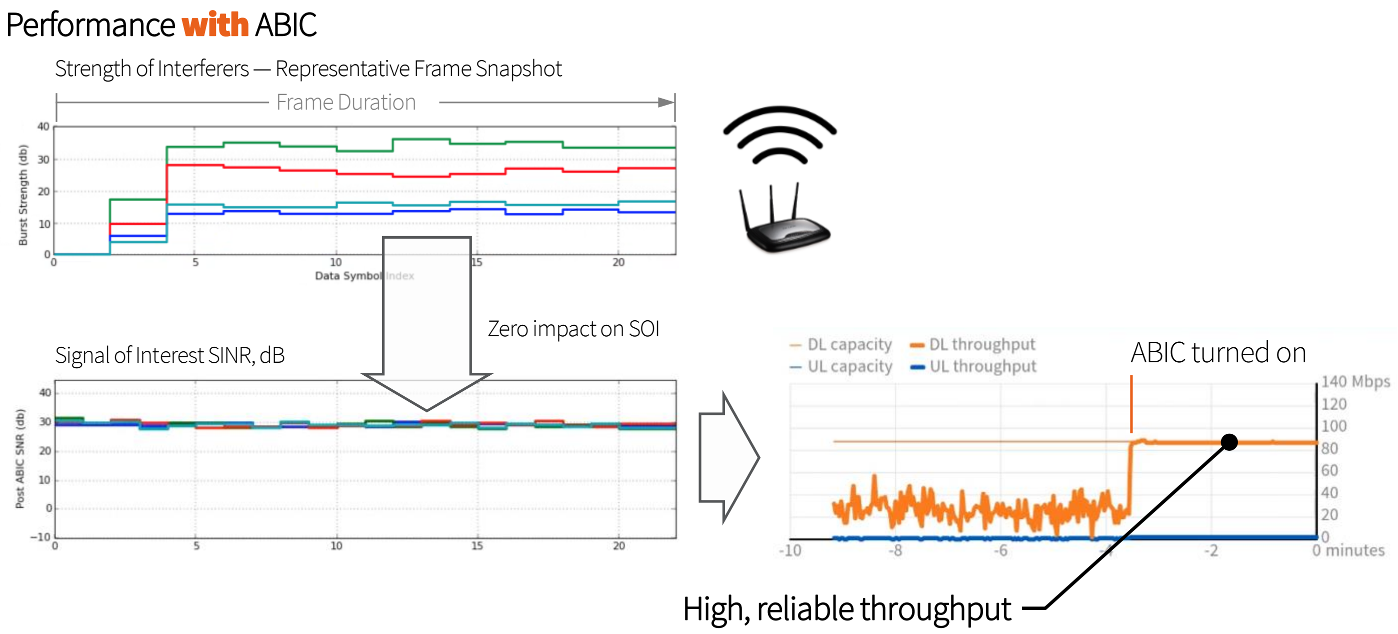
The intra-frame behavior of ABIC is a key metric to examine and understand, since unlicensed-band interference sources are inherently asynchronous with the G1 frame. This means that while the pre-ABIC beam- and null-forming solution derived at the beginning of the frame can eliminate interference from sources seen at that time — this is why the interferers seen are zero at the outset of the frame in the upper left chart below, and SoI SINR is initially high — the efficacy of that frame-start beamforming solution decays quickly as Wi-Fi interferers (as in this example) move on to their next randomly-scheduled pattern of communication.

As shown below, the Wi-Fi interference in this pre-ABIC test regularly took 20 dB off of the SoI SINR, yielding the low and unstable throughput over time shown at right below, averaging at best 25% of the link's maximum capacity.



It's worth noting that without application of all the normal (pre-ABIC) resources built into the Tarana platform — mentioned in our introduction — its performance would have decayed completely to that seen by operators testing conventional wireless transport solutions in 5 GHz circumstances with heavy interference: namely an inability to carry any traffic at all.

In contrast to the pre-ABIC over-the-air results, the post-ABIC picture is again one of perfection. By operating over the duration of the frame, ABIC fully and continuously cancels the co-channel Wi-Fi interference sources, suppressing their signals by up to 40 dB and yielding steady throughput at 100% of link capacity.



In Sum

The implications for the industry of our interference cancellation invention are nothing less than profound. The Tarana engineering team has transformed hundreds of MHz of unlicensed spectrum “real estate” from an ever more polluted and useless wasteland into prime beachfront property. Operators using ABIC-powered next-generation fixed wireless access from Tarana can now leverage the unlicensed band with all the confidence in stable, high performance normally reserved for licensed spectrum. Moreover, as operators deploy into new band such as 6 GHz all of the benefits discussed here will continue to apply.

We know that the wireless industry remains awash in vendor marketing hype, as always. We understand the natural skepticism this motivates, and we have grown accustomed to customers saying “I’ll believe it when I see it” in response to our reports of unprecedented results over obstructed links, with dynamic channels, and with dense co-channel interference from neighboring links of our own. We also know the radical results we’ve just reported here will likely prompt similar responses. We invite you to come see for yourselves. ABIC is more than ready to serve you.

About Tarana

Tarana Wireless, Inc. is the performance leader in next-generation fixed wireless access network solutions, powered by a number of industry-first and well-proven breakthroughs in perfect, multidimensional optimization of radio signals. Its Gigabit 1 fixed access system overcomes previously insurmountable network economics challenges for service providers in both mainstream broadband and underserved markets, using free unlicensed spectrum. The company is headquartered in Milpitas, California, with additional research and development in Pune, India. For more information, visit taranawireless.com.