USER STORY

Carleton University Develops New Technology to Help Prevent Unauthorized WiFi Network Access with MATLAB® and the Anritsu Signature™

Most wireless networks (WiFi) based on 802.11 standards offer data encryption, password-protection, and other media access control. Even with such security measures, however, unauthorized users within the signal's range can still gain network access.

Researchers at Carleton University in Ottawa, Ontario are working to prevent such unauthorized access by "fingerprinting" WiFi transceivers based on the unique RF signal's characteristics. To create a "transceiverprint," a fingerprint of a transceiver, researchers characterize a transceiver's signal before matching it with a list of existing transceiverprints.

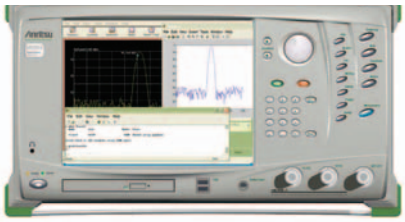
They are using MATLAB® with Anritsu's Signature High Performance Signal Analyzer throughout the WiFi fingerprinting process to quickly acquire, process, and classify the WiFi measured signals.

THE CHALLENGE

In the initial stage of the project, Carleton captured, preprocessed, and classified the RF signals of fifteen WiFi transceivers from six manufacturers. For the next stage, researchers needed to acquire and analyze the signals of a much larger number of transceivers, which was no longer manageable via their current process.

"In that system set-up, we would spend two days just importing and preprocessing the enormous amount of data that we captured," says Jeyanthi Hall, a doctoral candidate at Carleton University's School of Computer Science.

In the original set-up, the process involved capturing the data in an external device, manually reformatting and importing the data into MATLAB, and removing anomalous signals. With multiple captures from this larger group of transceivers, this exercise would extend research time by weeks.



MATLAB installed on the Anritsu Signature High Performance Signal Analyzer.

THE SOLUTION

Hall and her supervisors, Michel Barbeau and Evangelos Kranakis, are automating the data acquisition and preprocessing phases with MATLAB and the Anritsu Signature.

"With the integration of MATLAB with the Anritsu Signature High Performance Signal Analyzer, the data automatically appears in the MATLAB environment," explains Eric Hakanson, a product manager at Anritsu. "Users can focus on getting the answers they want, instead of figuring out how to input and output the data."

The Carleton research team uses an Anritsu Signature to capture WiFi RF signals and transfer the resulting IQ vectors into MATLAB, which can run on the instrument. "MATLAB functions preprocess the data and extract a set of transceiverprints from amplitude, frequency, and phase components. The profiles are then created using a subset of the transceiverprints. Hundreds of remaining transceiverprints are classified in minutes,"

THE CHALLENGE

To acquire, process, and classify real RF data more efficiently

THE SOLUTION

Use MATLAB with the Anritsu Signature High Performance Signal Analyzer to acquire signal measurements and perform data processing and analysis for RF fingerprinting

THE RESULTS

- Data acquisition and preprocessing time reduced from days to minutes
- Detection accuracy increased
- Application memory usage decreased

> *With the tight integration between MATLAB and the Anritsu Signature High Performance Signal Analyzer, transferring the data to MATLAB is now automated and has dramatically reduced our data acquisition and preprocessing time.*
>
> Jeyanthi Hall, Carleton University

states Hall. "The integration with MATLAB makes the whole data acquisition and preprocessing phases much more efficient."

They use MATLAB, the Signal Processing Toolbox, and the Neural Network Toolbox to support the implementation of the project.

The Signal Processing Toolbox enables the team to plot and analyze the captured signals in the time and frequency domains.

To increase the accuracy of matching and classifying WiFi transceiverpints to existing profiles, Carleton uses MATLAB to develop a statistical classifier and Bayesian filter. This enables them to detect intruders by identifying the transceiver model and manufacturer that had transmitted the signal. The researchers also use the Neural Network Toolbox to develop a self-organizing map for selecting transceiverprints for the profile.

Carleton researchers will use MathWorks tools with their Anritsu Signature in the next stage of the project, which will include more than 100 WiFi transceivers and an increased number of signal characteristics to analyze, thus further refining the fingerprinting process.

With the continued support of the Natural Sciences and Engineering Research Council of Canada (NSERC) and Mathematics of Information Technology and Complex Systems (MITACS), Hall and her supervisors plan to evaluate the implementation of their algorithms on a customized hardware platform.

"We've received a lot of interest commercially for this application," says Hall. "Using MATLAB and Simulink®, we will eventually demonstrate how a signal is received, fingerprinted, and matched online."

THE RESULTS

- **Data acquisition and preprocessing time reduced from days to minutes.** "Now, the measurements of the signals are sent directly to MATLAB where they are preprocessed," says Hall. "A process that took days now takes a few minutes."
- **Detection accuracy increased.** "In the first stage of the project, we were successful in correctly detecting and classifying 94% of the transceiverprints," explains Hall. "MATLAB and the Anritsu Signature make acquiring and analyzing signal characteristics easier and will enable us to achieve an even higher success rate."
- **Application memory usage decreased.** "With MATLAB and the Neural Network Toolbox, we rapidly explored different options and created a statistical classifier that decreased memory requirements while increasing application performance," explains Hall.

To learn more about Anritsu and the Anritsu Signature High Performance Signal Analyzer, visit **www.us.anritsu.com/signature**

To learn more about the Radio Frequency Fingerprinting Project at Carleton University, visit **www.scs.carleton.ca**

APPLICATION AREAS

- Communications
- Data analysis
- Instrumentation
- Signal processing
- Test and measurement

PRODUCTS USED

- MATLAB
- Simulink
- Signal Processing Toolbox
- Neural Network Toolbox
- Anritsu MS2781A Signature High Performance Signal Analyzer with options 22 and 40

www.mathworks.com

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