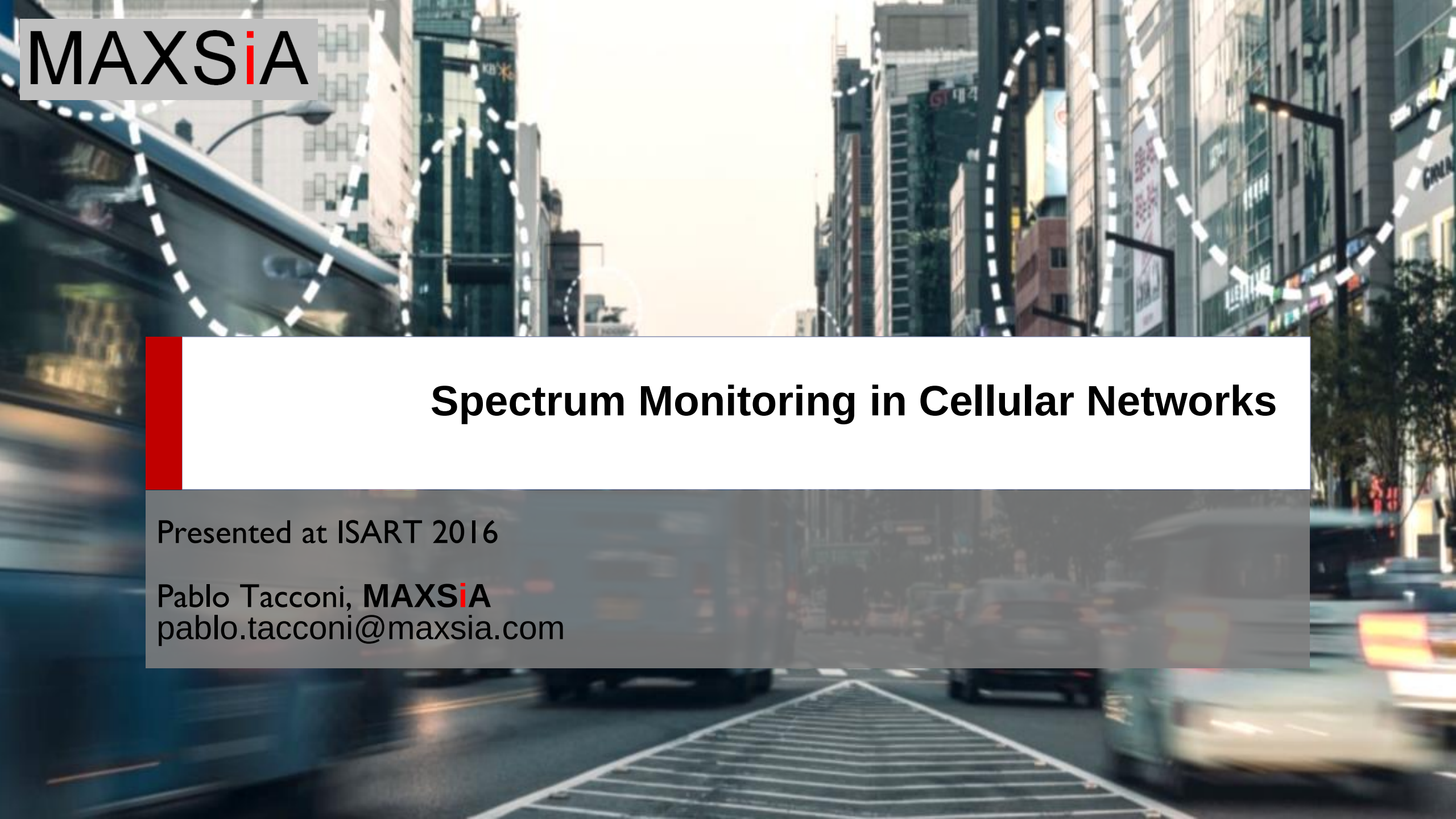

Spectrum Monitoring in Cellular Networks

Presented at ISART 2016

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Interference is a receiver problem

- **Interference is a receiver problem.**
  - **Interference**, regardless of its source, **is only a problem if it impacts the ability of the receiver from properly decoding the desired signal**
- Therefore, **there is no better place to measure for interference than at the receiver itself**.
  - Measurement are performed exactly where it matters, using the same antenna, cabling, and electronics

- From a technology point of view, **it is relatively easy and cheap to add spectrum monitoring capabilities to a receiver**
  - This is true in modern cellular base-stations (1), but also in many other modern communication systems
  - Modern base-station receivers use data converters to digitized the entire receive band, and then use digital down converters to select the desired channel within the band.
  - **Spectrum monitoring can be enabled by capturing a segment of the RF waveform at the receiver front-end, and making the it available for post processing**.

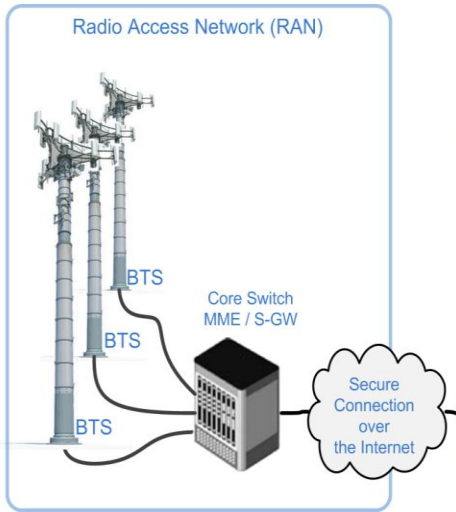
(1) Nokia Future Works, "Sniff out and fix interference without drive testing", *Insight Newsletter*, Nokia 2014.
http://networks.nokia.com/news-events/insight-newsletter/articles/sniff-out-and-fix-interference-without-drive-testing

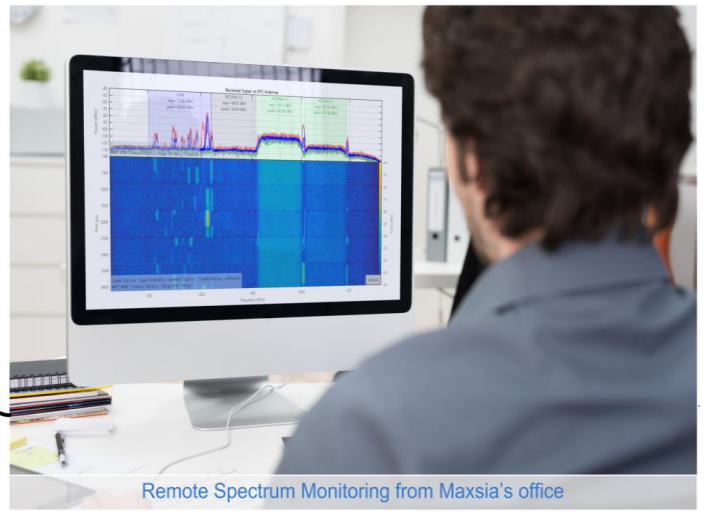
Interference detection in cellular networks is changing

- In the past, detecting interference in cellular networks looked like this

The traditional approach for diagnosing interference is to send an RF expert to the cell site. The RF expert visits the cell site and makes RF measurements using a portable spectrum analyzer.
This approach is both slow and very expensive; requiring highly-trained individuals, expensive test equipment, and many hours of labor.

- Now, detecting interference in cellular networks can look like this

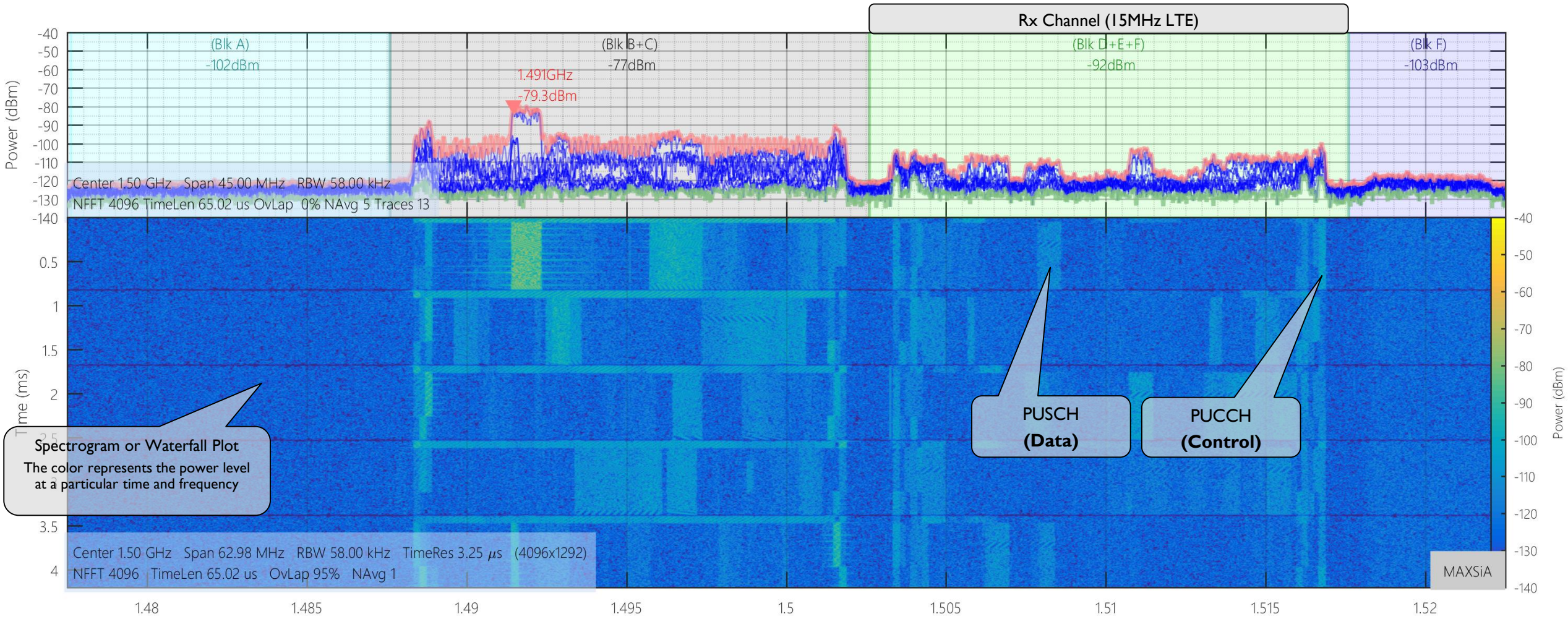




Many modern base-stations have spectrum monitoring capabilities, providing the ability to capture and analyze the RF spectrum in remote and non-intrusive manner.

Case Study – Healthy LTE cell

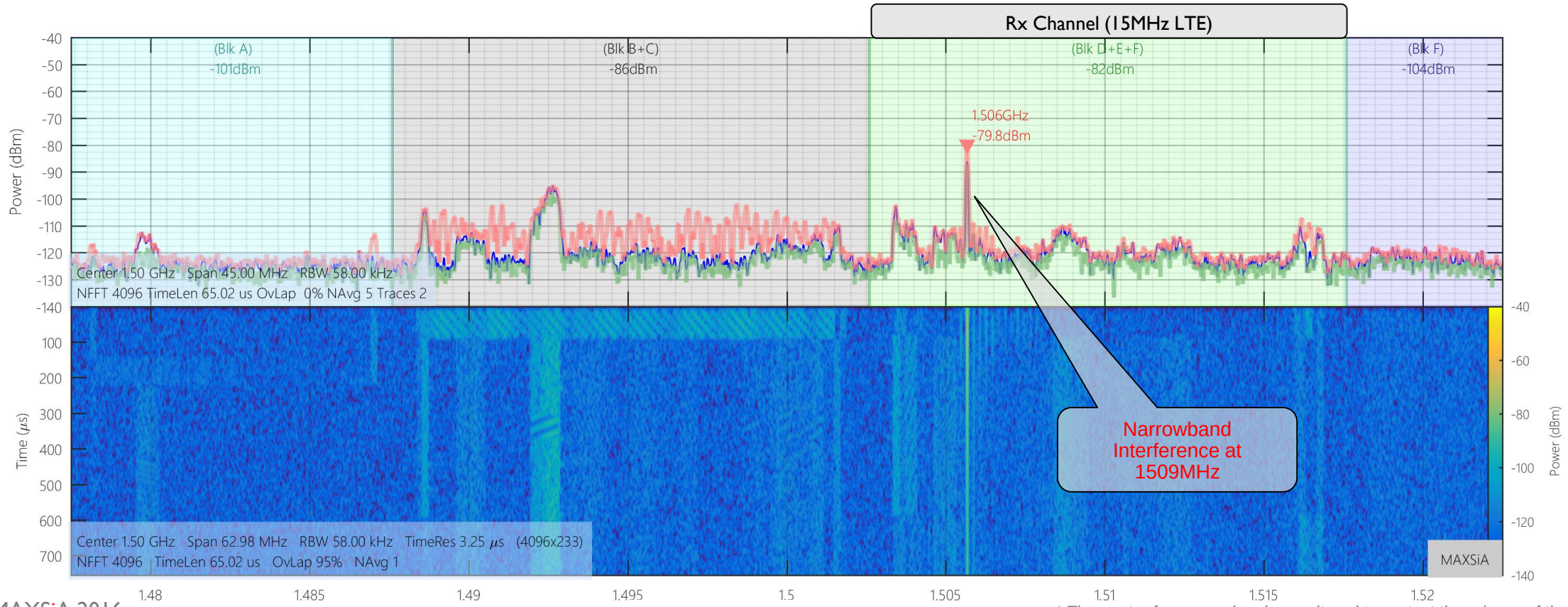
- This data below came from a live LTE base-station. The region in green is the channel used by the base station.



* The center frequency has been altered to protect the privacy of the operator

Case Study – Narrowband Interference in LTE

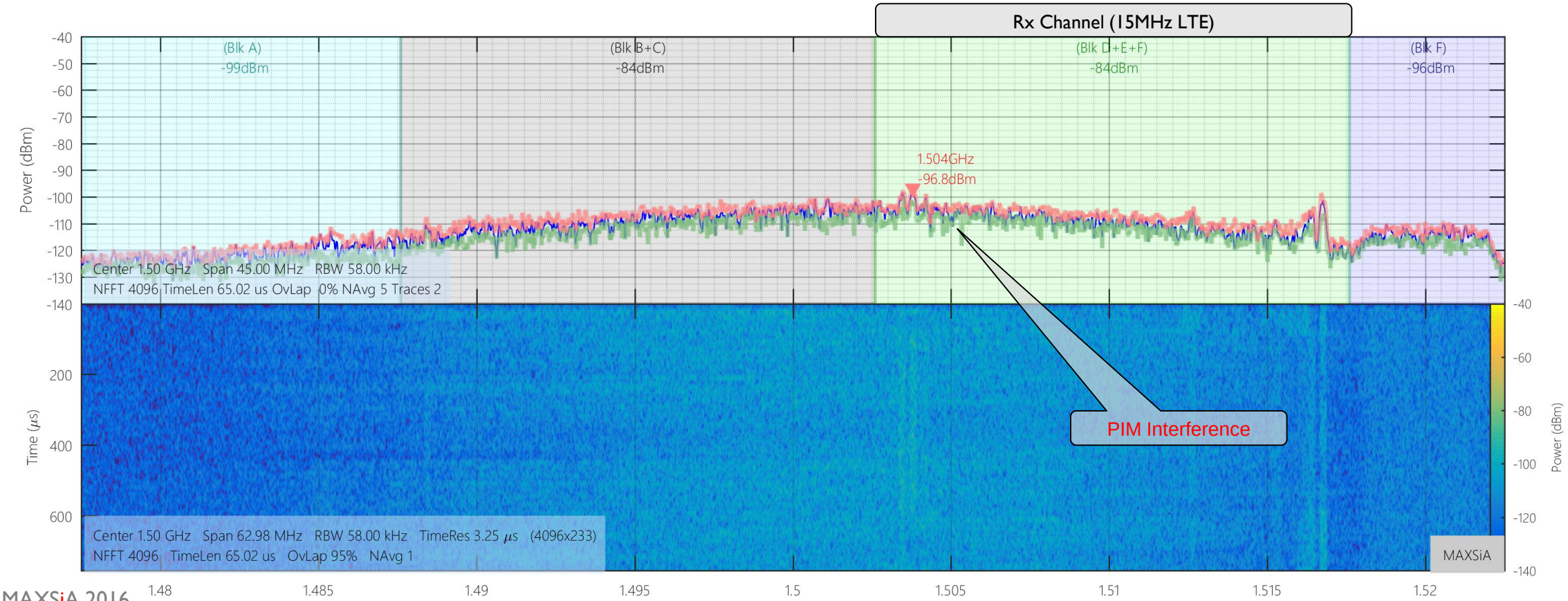
- This data below came from a live LTE base-station. The region in green is the channel used by the base station.
- A narrowband interferer, causing a serious degradation to the cell, was detected
- Upon investigation, it was discovered that the interference was produced by a malfunctioning repeater (Bi-Directional Amplifier)
- The repeater was removed, the performance of the cell improved by 50%



* The center frequency has been altered to protect the privacy of the operator

Case Study – Passive Intermodulation Interference in LTE

- This data below came from a live LTE base-station. The region in green is the channel used by the base station.
- Passive inter-modulation (PIM) was detected. The level of the interference is very strong (18dB rise in the noise floor), and causing seriously degradation to the cell performance
- The passive inter-modulation was the result of a 3rd IM product produced by the non-linear mixing of the base-station LTE transmitter and a WCDMA base-station in the same rooftop.



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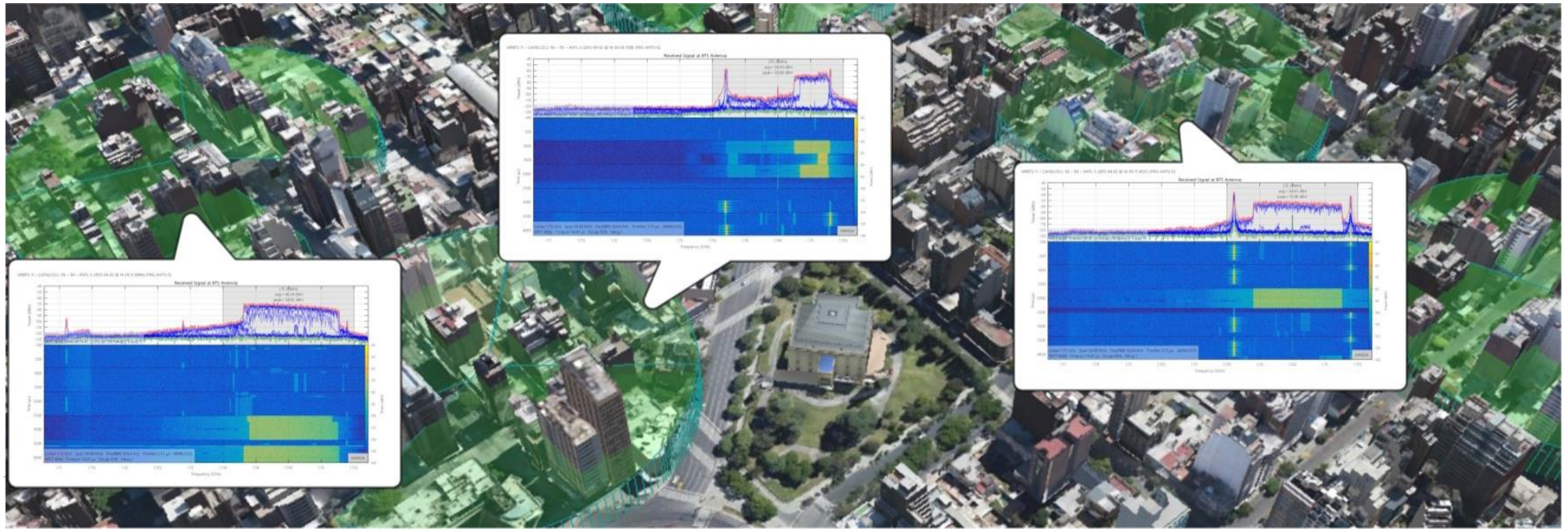
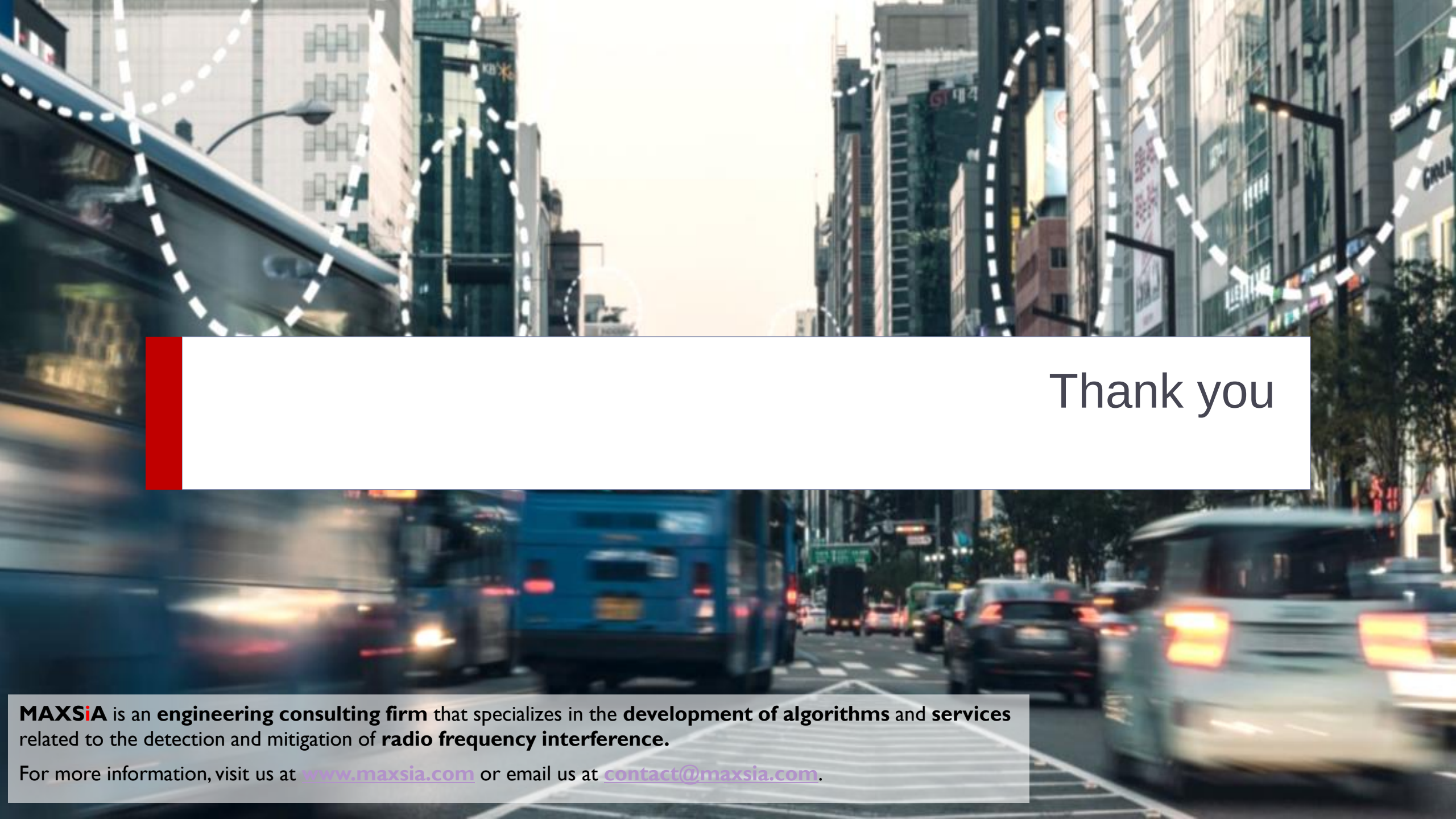
A spectrum monitor in every device?

- If planned in advance, spectrum monitoring capabilities (in the form of IQ waveform captures) can be added to a receiver at a very low cost
  - Waveform capture capabilities can be economically build into the wireless chipsets.
  - This is true for base-station chipset, but likely also for mobile chipset.

- This would allow for automated spectral monitoring and interference detection over entire radio access networks and large geographical areas.





Thank you

MAXSiA is an **engineering consulting firm** that specializes in the **development of algorithms** and **services** related to the detection and mitigation of **radio frequency interference.**

For more information, visit us at www.maxsia.com or email us at contact@maxsia.com.