



# Event Detection From RF Sensing Space Symposium 2018 Technical Track

16 April 2018

# RF Sensing Background

- In 2010 Kratos RT Logic created a commercial network of SATCOM RF EMI Monitoring and Geolocation Services
- Over the last 8 years we've realized that RF is useful for more than just SATCOM monitoring
- RF sensing provides a rich source of data that can be correlated with space and world events



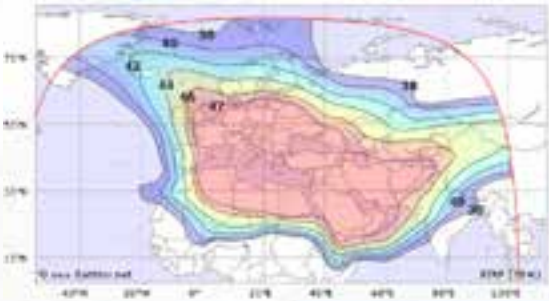
# What is RF Sensing?



All satellites transmit RF signals; communications, mission payloads, or telemetry state of health



Observing these signals from the ground provides insight into satellite health, position, interference, and RF patterns of life



Ground systems must be within the beam footprints; SATCOM beams have unique shapes; TT&C signals are often omni-directional

Specialized equipment digitizes the RF signals and transfers the data to processing systems

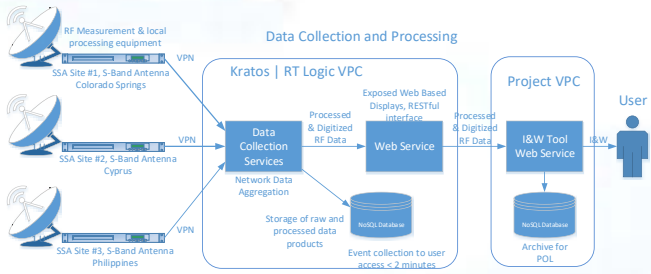


RF Sensing Measurements	
Center Frequency	Modulation Waveform
Bandwidth Utilized	Symbol/Data Rate
EIRP	Es/No, Eb/No
C/No, C/N	Bit Error Rate

RF observations include a variety of measurements collected continuously and archived over long durations



“Big Data” techniques processes terra bytes of measurements into meaningful & actionable information



Satellite events, position, trends, are refined from the RF data and provided to users

# EMI Jamming and Geo-Location Events

- SATCOM EMI is a common RF event; most events are unintentional; some are nefarious
- EMI includes jamming and piracy
- In one EMI example; our systems detected stepped CW signals programmed to maximize interference – this was intentional EMI
- Geo-location of the source attributed the culprit to a North Korean jamming site



- Another type of EMI event is the piracy of SATCOM bandwidth
- In this case, our systems noticed the interference in between authorized carriers. Upon investigation it was determined to be a DVBS signal
- The broadcast was routed to a receiver where a propaganda broadcast video was observed



- We've seen SATCOM EMI correlated with:
  - Pirated Sporting Events
  - Missile Testing
  - Arab Spring Uprising
  - Syrian Civil War

# Extension to Space Situational Awareness

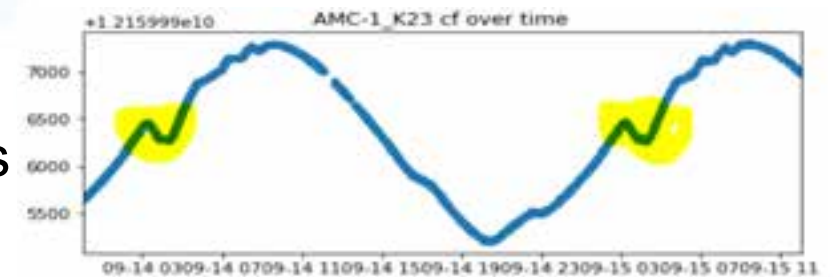
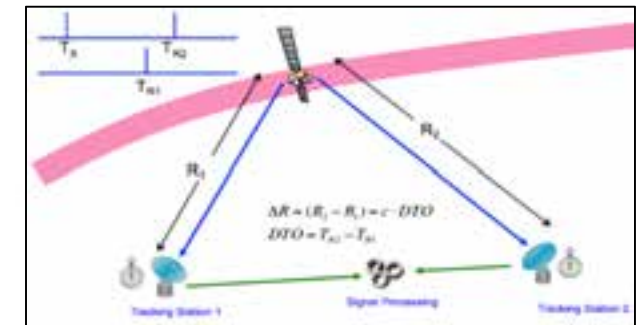
- RF Sensing supports Space Situational Awareness

- SSA and safety of flight is a global concern
- RF sensing systems have multiple uses
- Collection of Satellite transmissions can help fill gaps in traditional optical and radar coverage



- RF Sensing provides:

- Ranging and Ephemeris generation - active and passive
- Maneuvering satellite indication events
- Satellite anomaly events

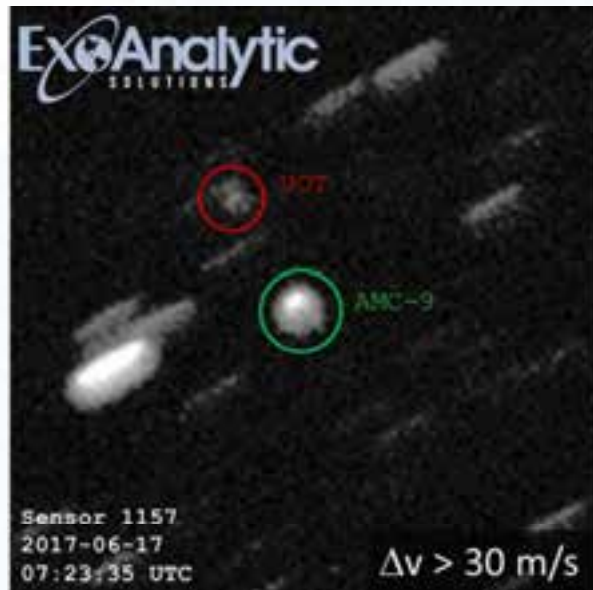


# Satellite Health and Anomaly Detection Events

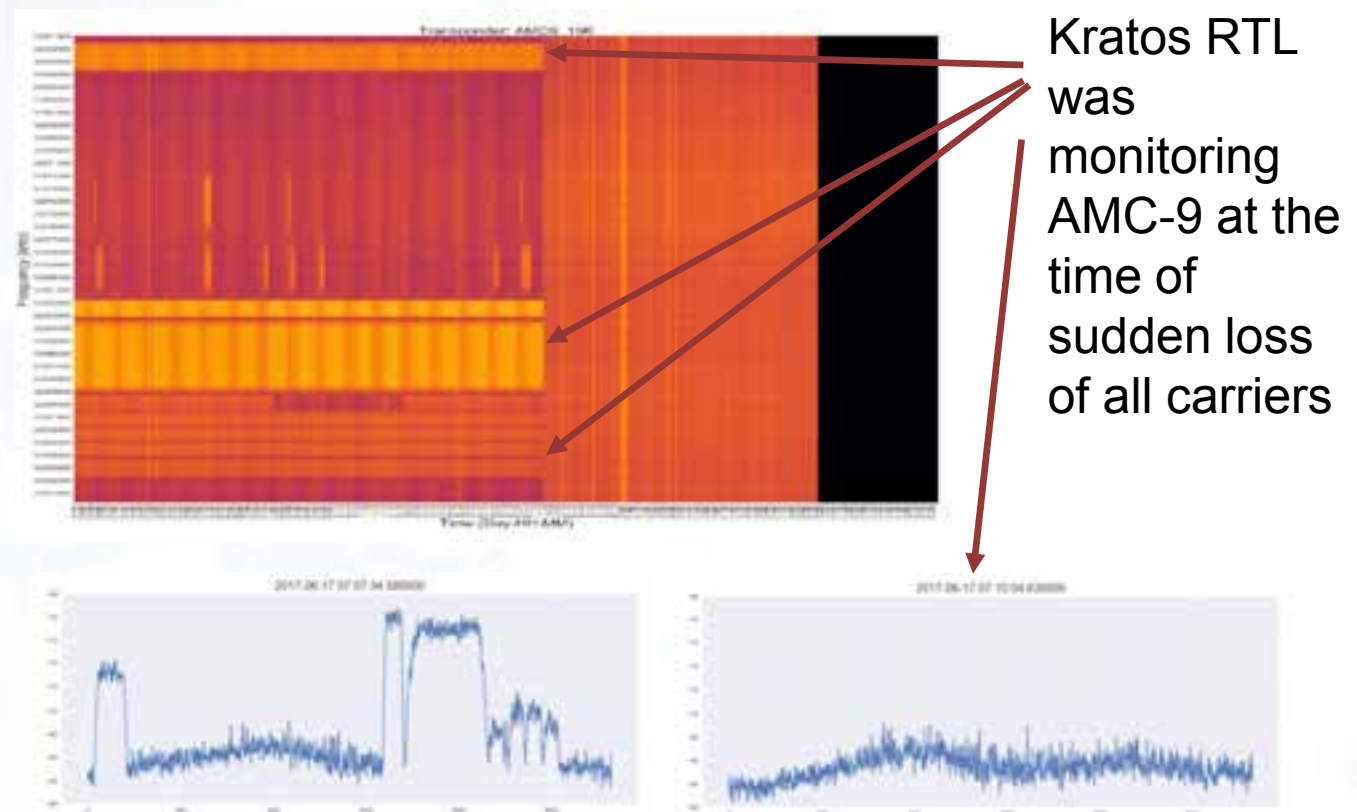
- RF observations can be the first sign of a failing satellite

- 17 June 2017 an abrupt loss of signal from AMC-9 occurred

- Event correlated with satellite breakup observed by

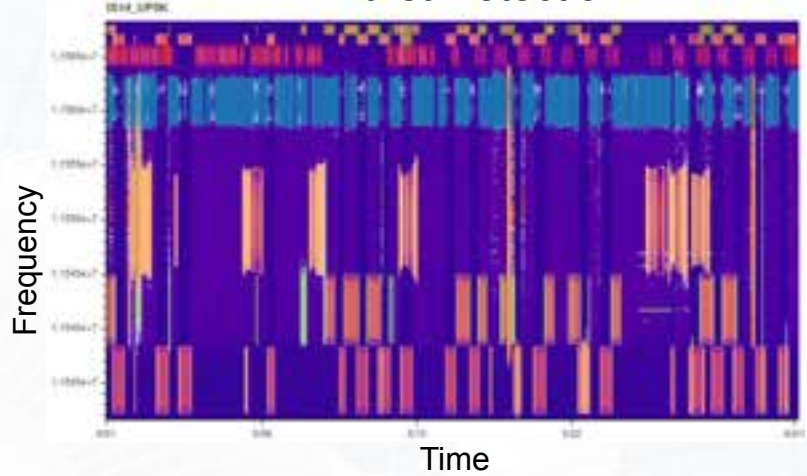


Kratos RTL identifies LOS at 7:06

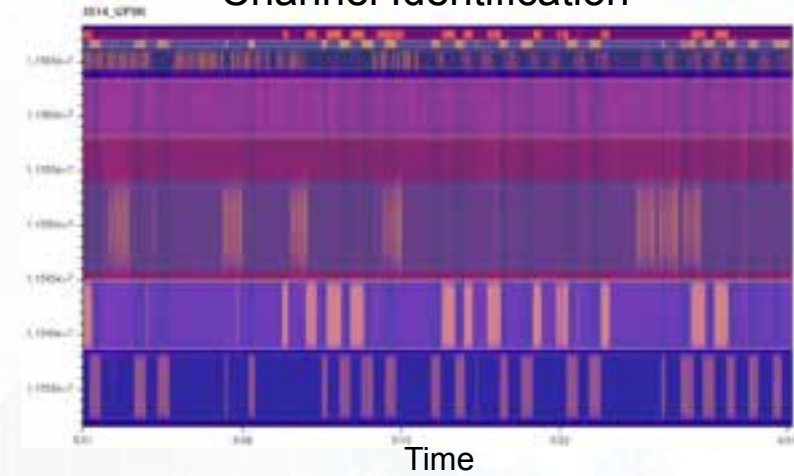


# Spectrum Classification

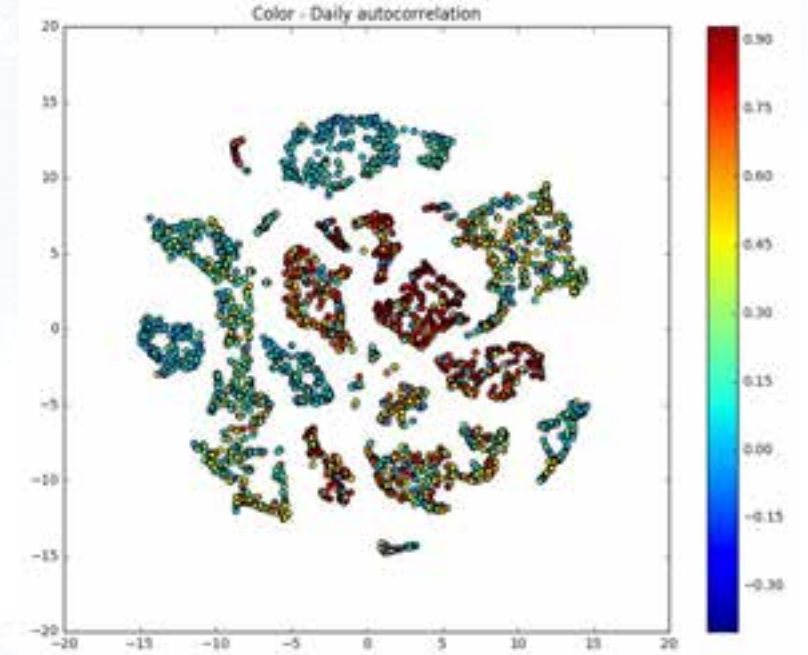
Burst Detection



Channel Identification



Signal Classification

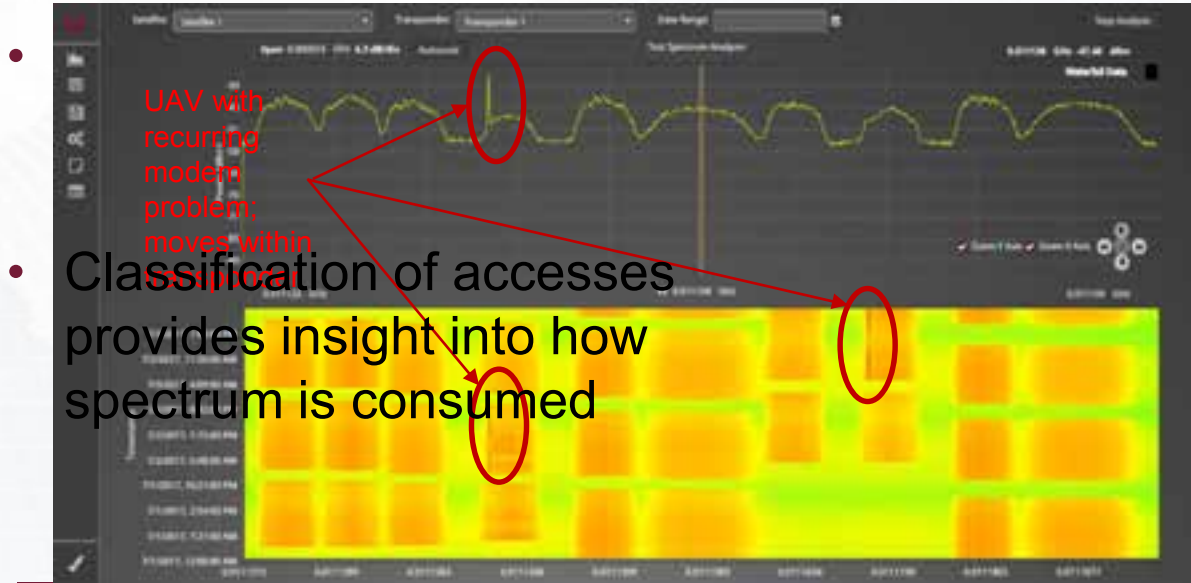


Raw (blind) data identification

Categorize data

Correlate/Analyze data

Visualize / Inform



- In this view, an access attributed to a UAS with a faulty modem is visible in the waterfall
- Spectral classification provides insight into RF events

In conclusion, RF Sensing provides insight into:

- Electromagnetic Interference sources
- Satellite Health and Space Situational Awareness
- Spectrum usage

Questions?

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