



ATLANTA, GA
OCTOBER 11-14

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2021 Fall
Technical Forum
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Wireline Access Network

Upstream OFDMA Anomaly Detection and Triaging

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Upstream OFDMA

Initial deployments

- OFDMA is being turned on by many operators in the field

PNM metrics

- ~8 new PNM features

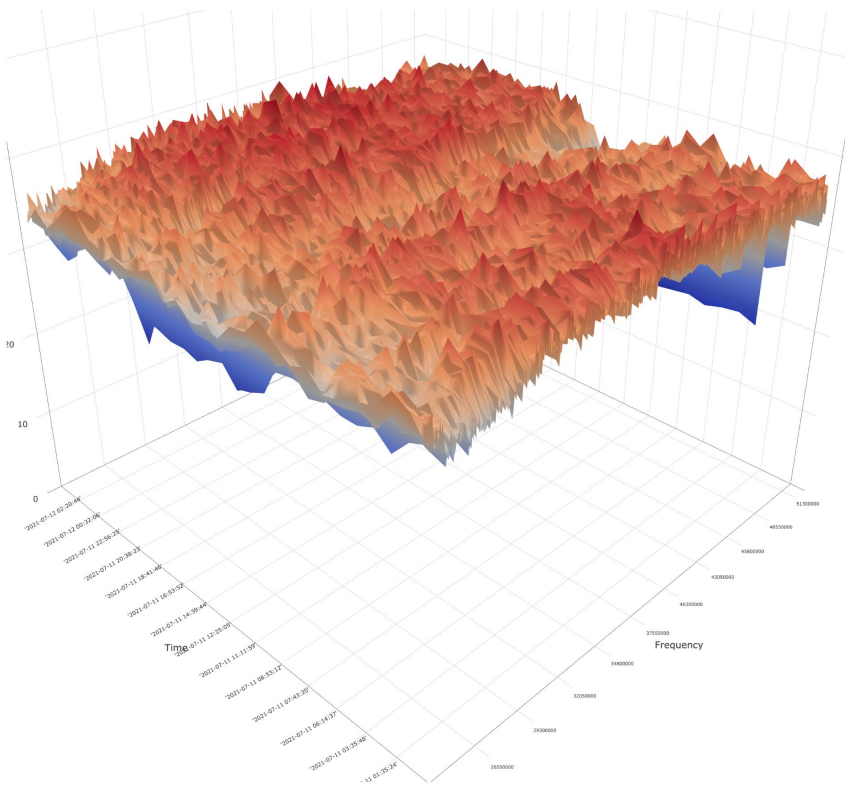
US RxMER

- Measured at CMTS, per CM

First views of an OFDMA Upstream data set

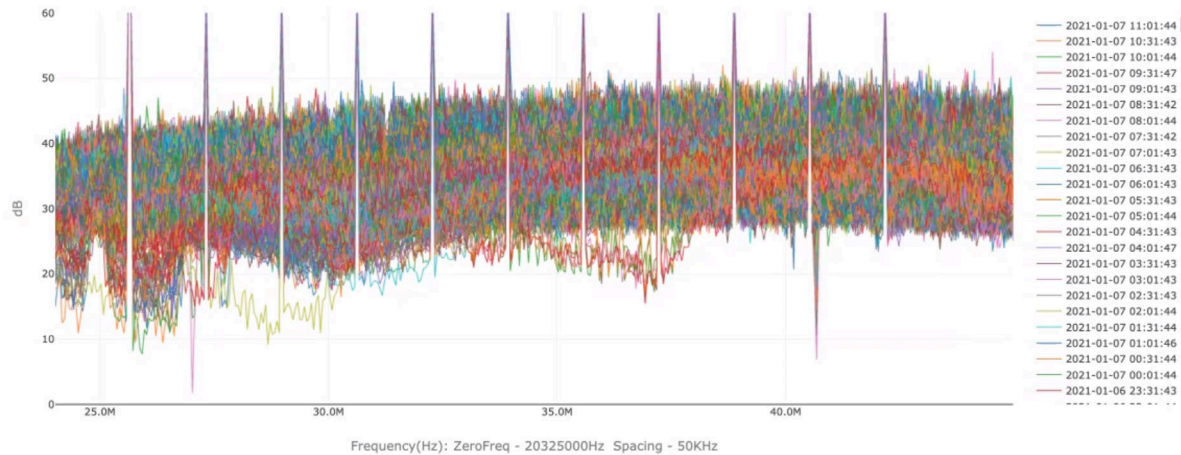


Upstream RxMER

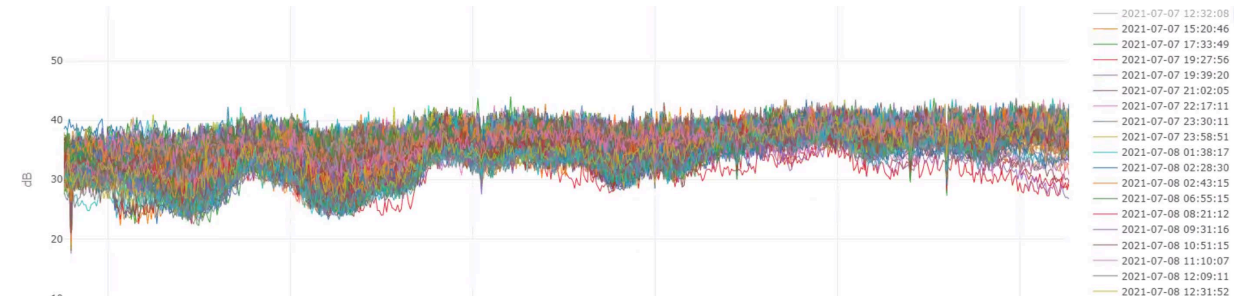


RxMER captures over time

Variations and Impairments

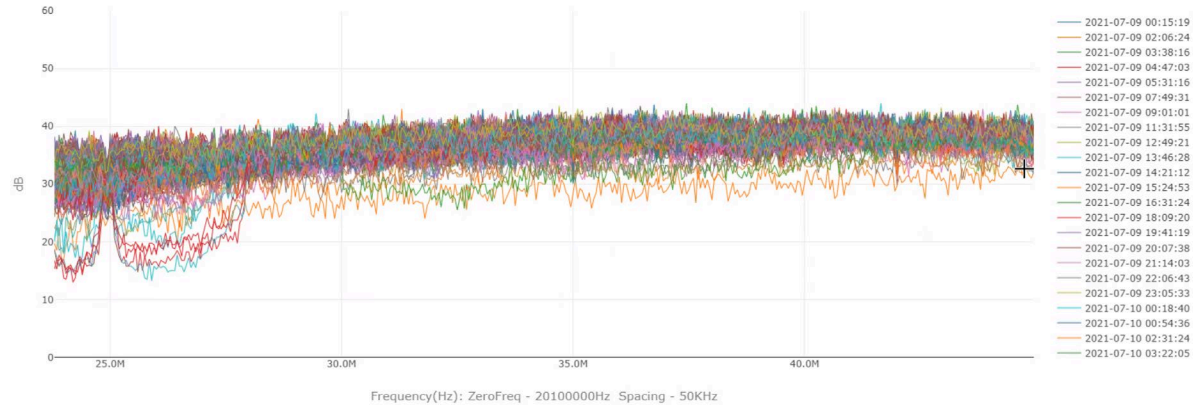


High variation over time

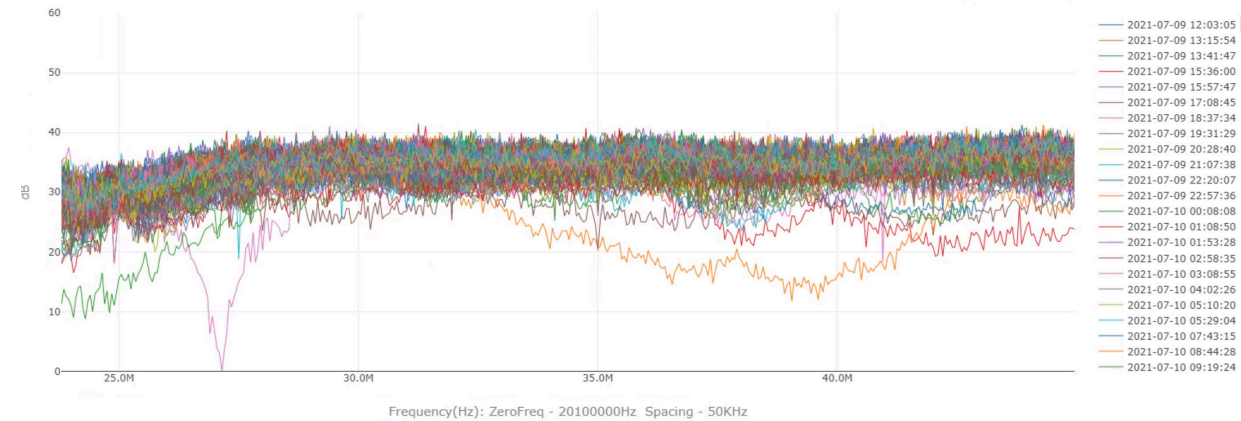


Lower variation but impedance mismatch is observed

Outliers

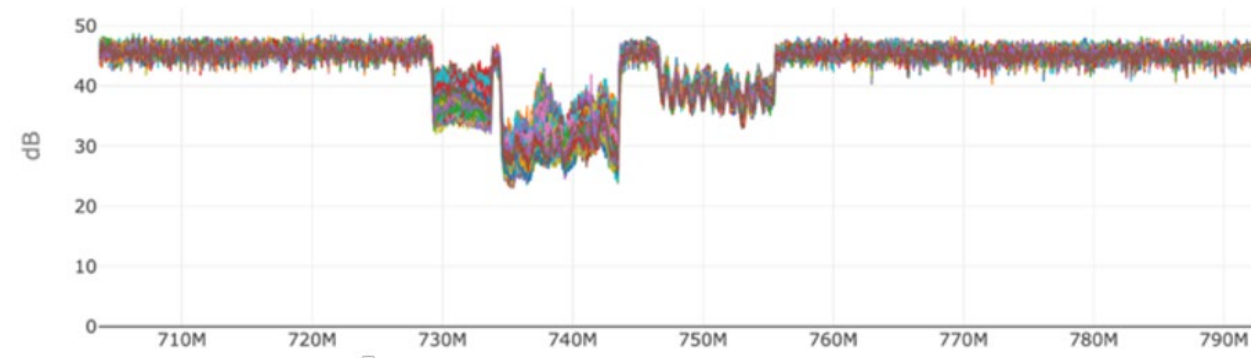


Ingress-like impairments on lower frequency end



Outlier RxMER captures

Compare DS RxMER with US RxMER



Downstream has low variance



Upstream has high variance

- Impairments/anomalies on downstream are easy to characterize
 - Easy to categorize patterns, label samples and train a machine learning model
- Upstream does not have clear features to latch onto

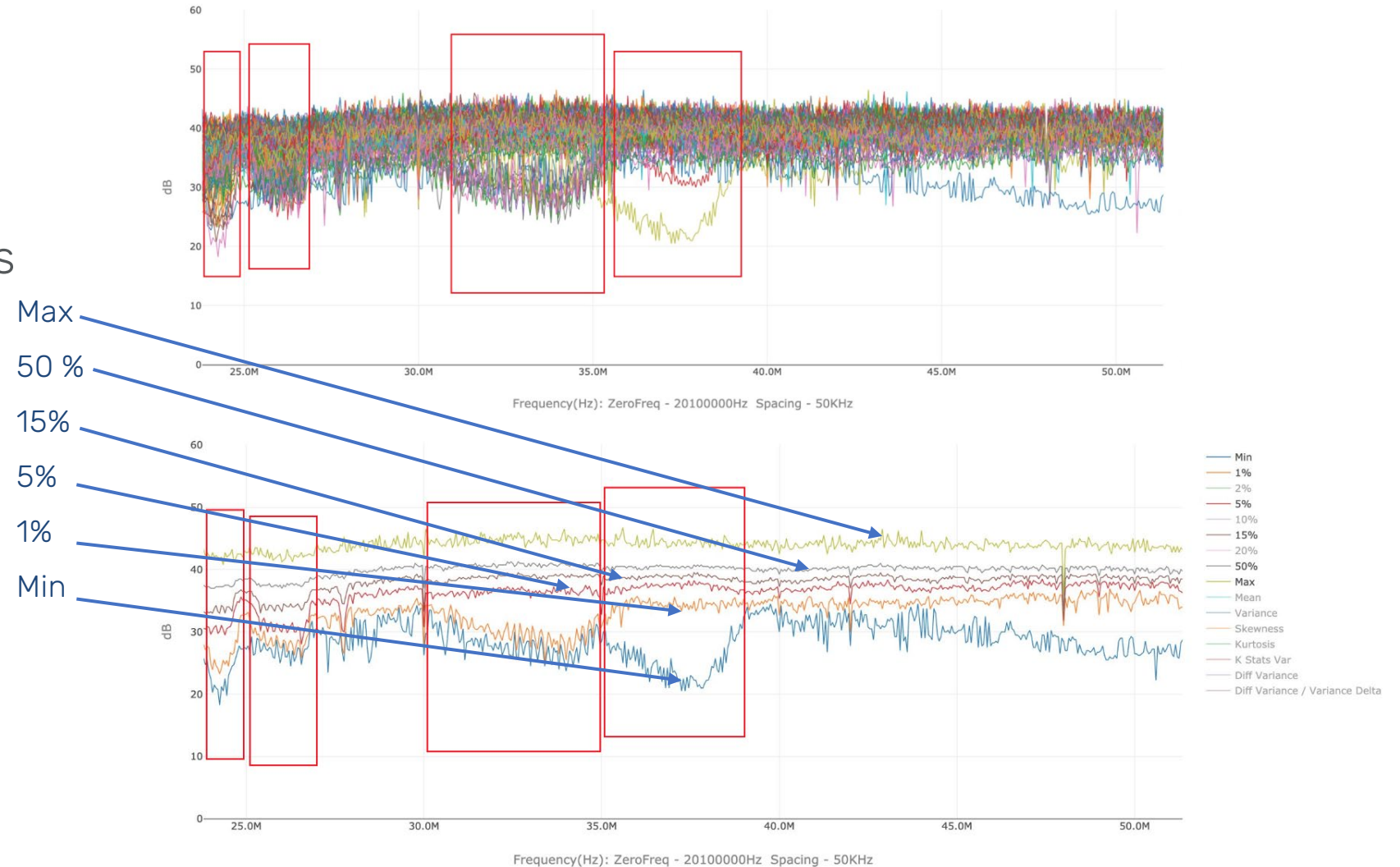
Statistical analysis

- Percentiles
- Variance
- Skewness
- Kurtosis
- MER Time series
- Time Clustering of data



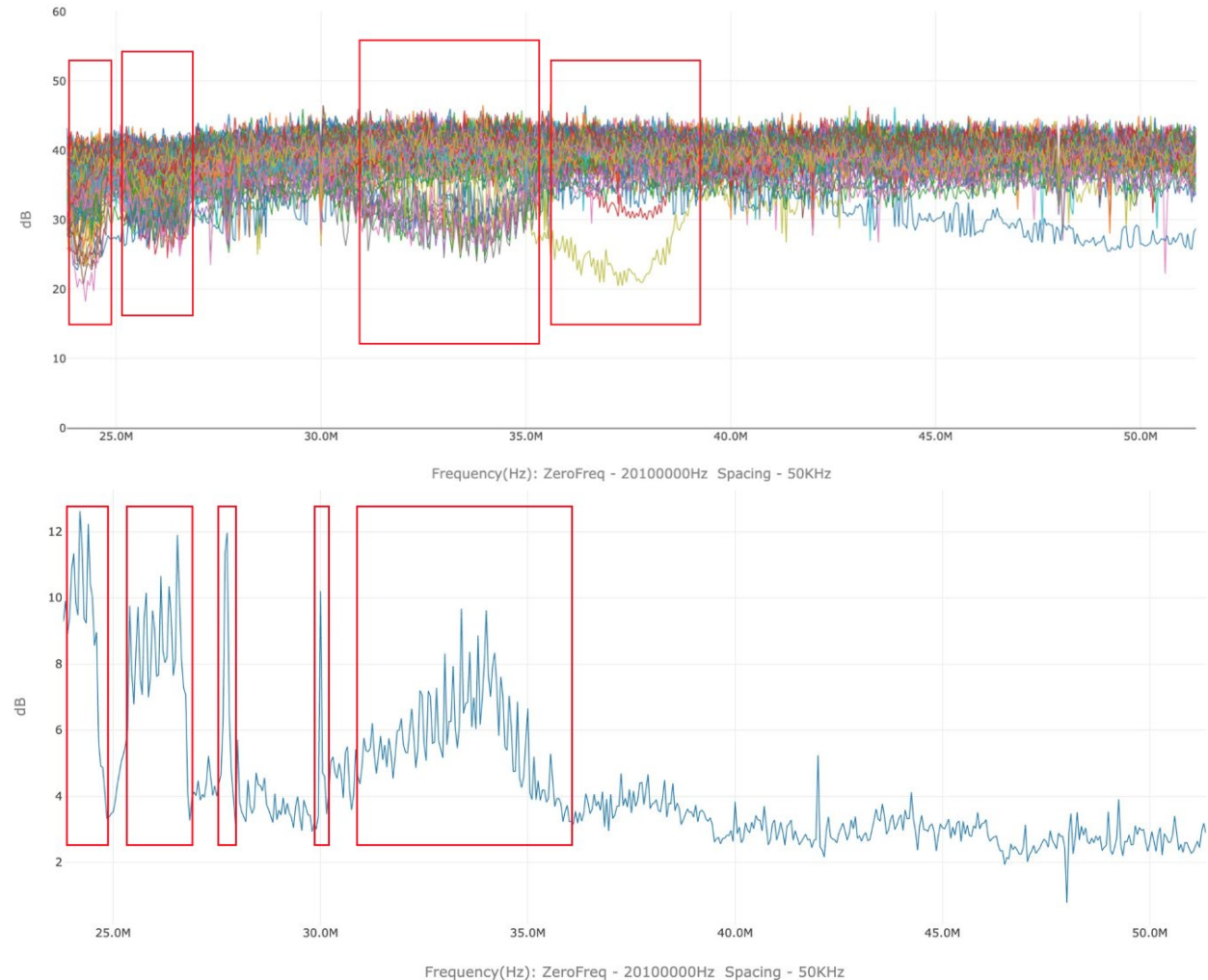
Percentiles

- Distribution of MER values
- Intermittent issues
- Persistent issues



Variance

- A statistical measurement of the spread between numbers in a dataset
- Calculated for each subcarrier
- A good issue indicator
- Cannot differentiate issue types
- Needs research on setting thresholds

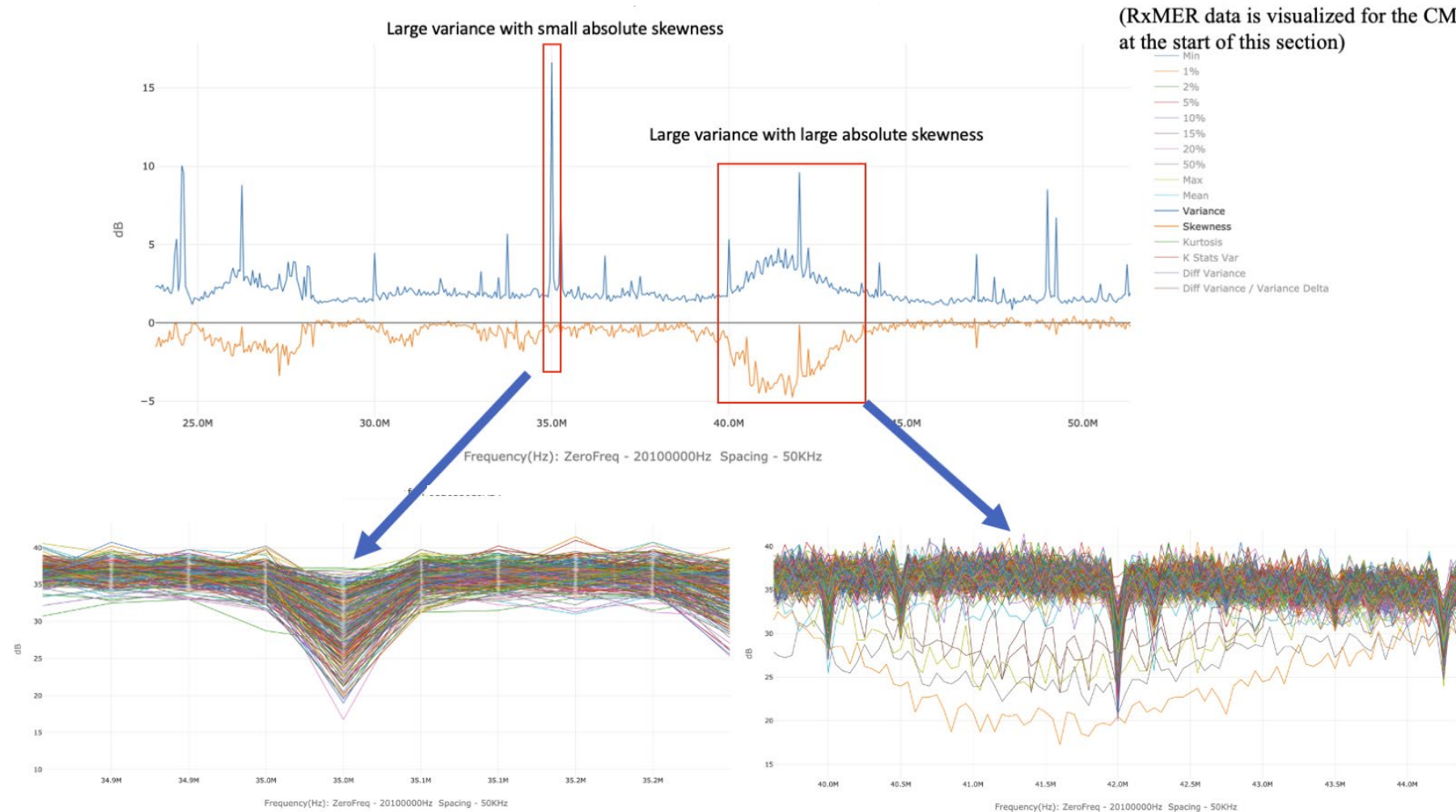


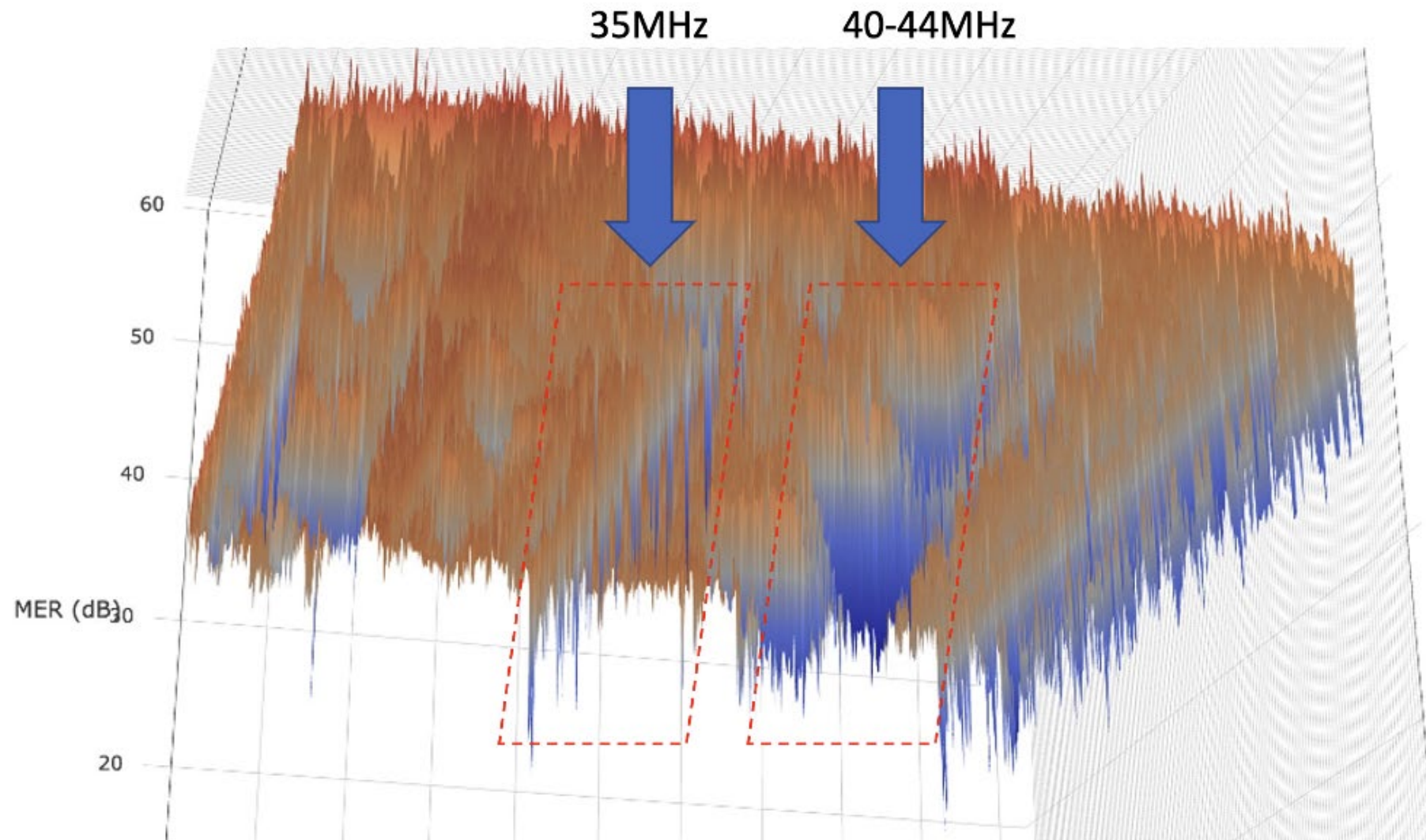
Skewness

- A measure of the asymmetry of the probability distribution
- Can identify intermittent issues
- The absolute value of skewness is used



Identifying intermittent vs persistent issues





Kurtosis

- A measure of the “tailedness” of the probability distribution
- Higher kurtosis corresponds to greater extremity of deviations
- Useful when combining with variance and skewness

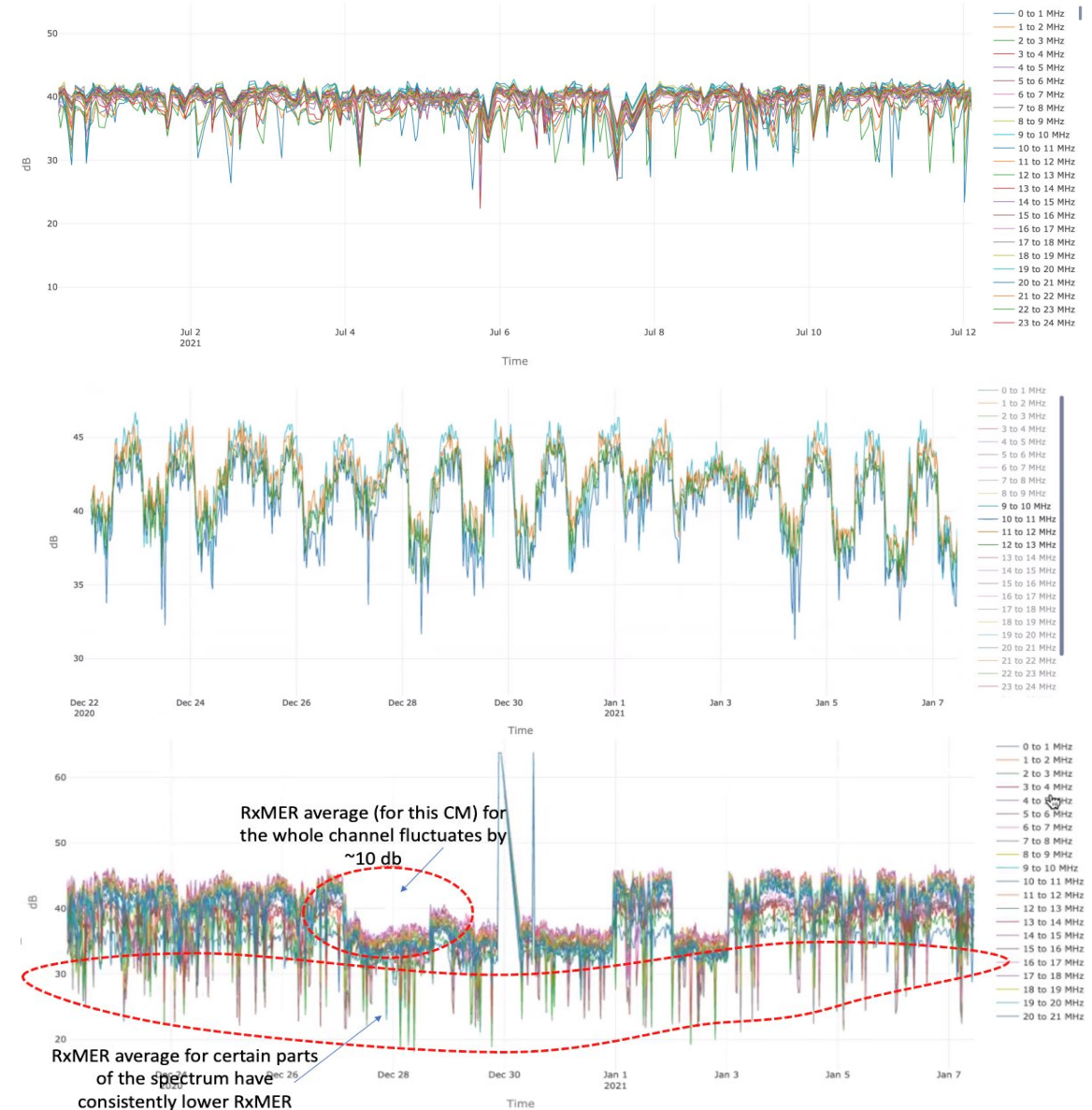


Time Series

Average MER values for each incremental 1MHz on the OFDMA channel

Daily variation pattern

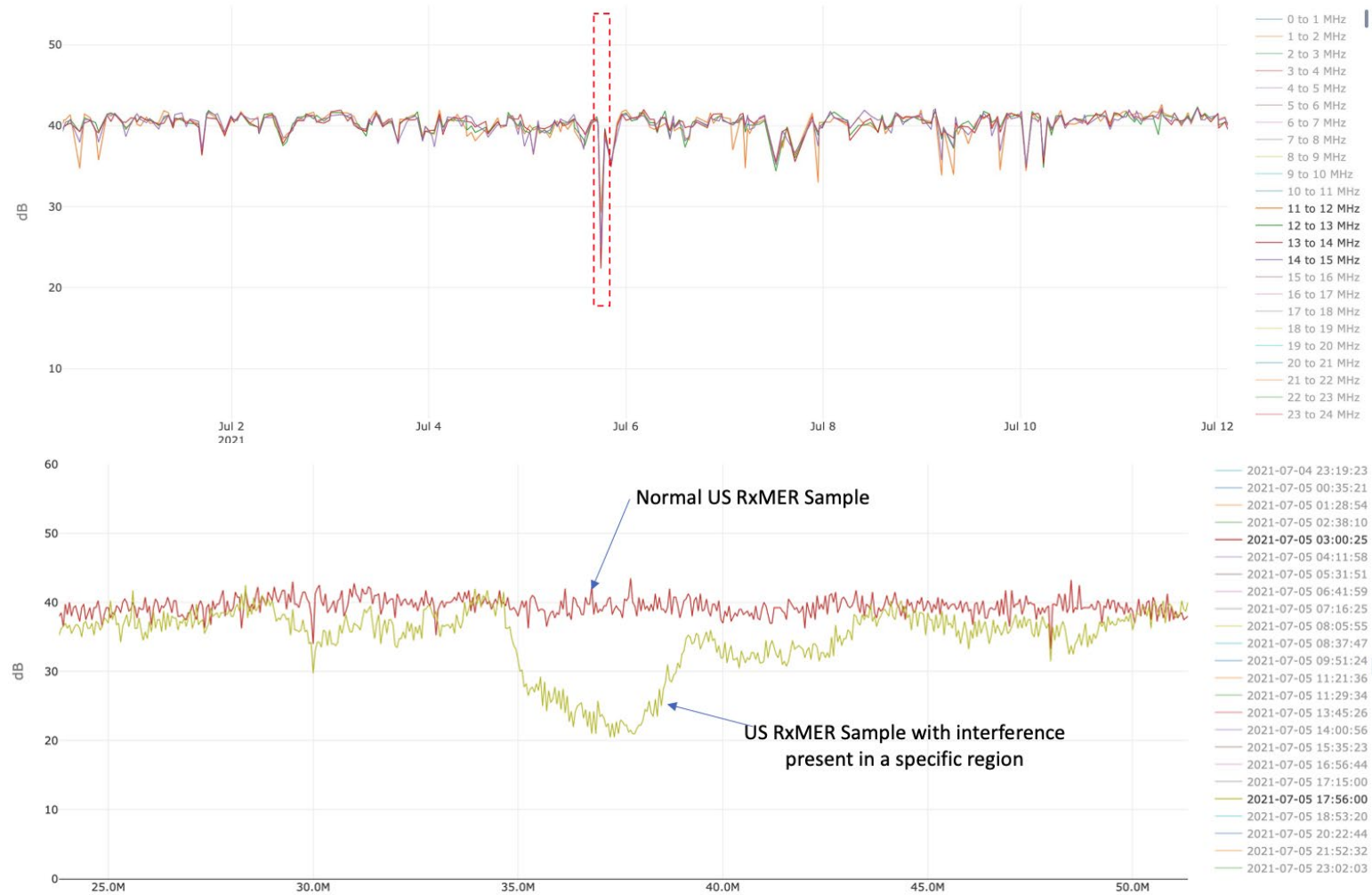
Significant abnormal variations observed on MER time series



Time Series

Identified issue: MER values drop
~18dB

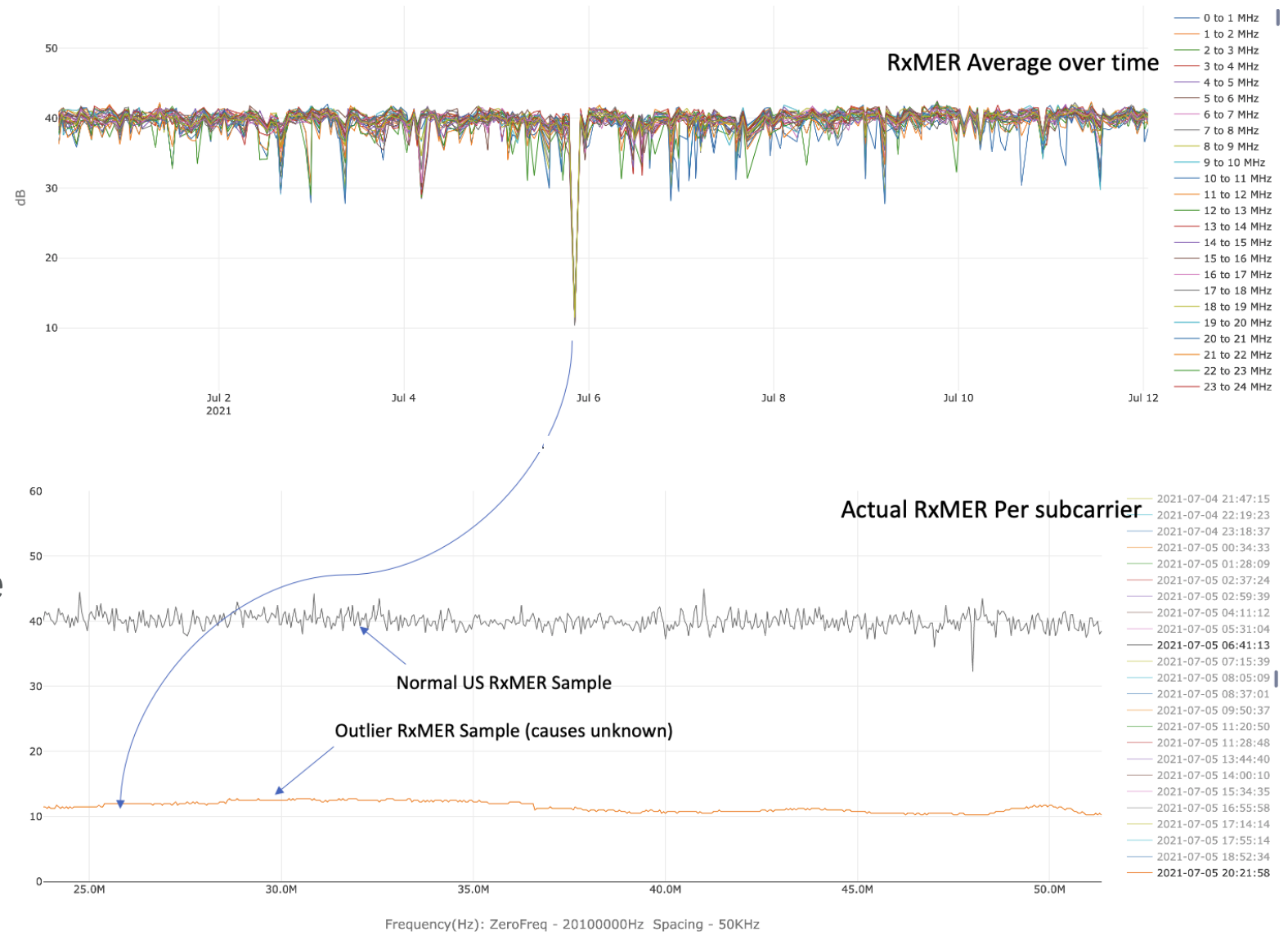
Target the sample with this issue
using the timestamp



Time Series

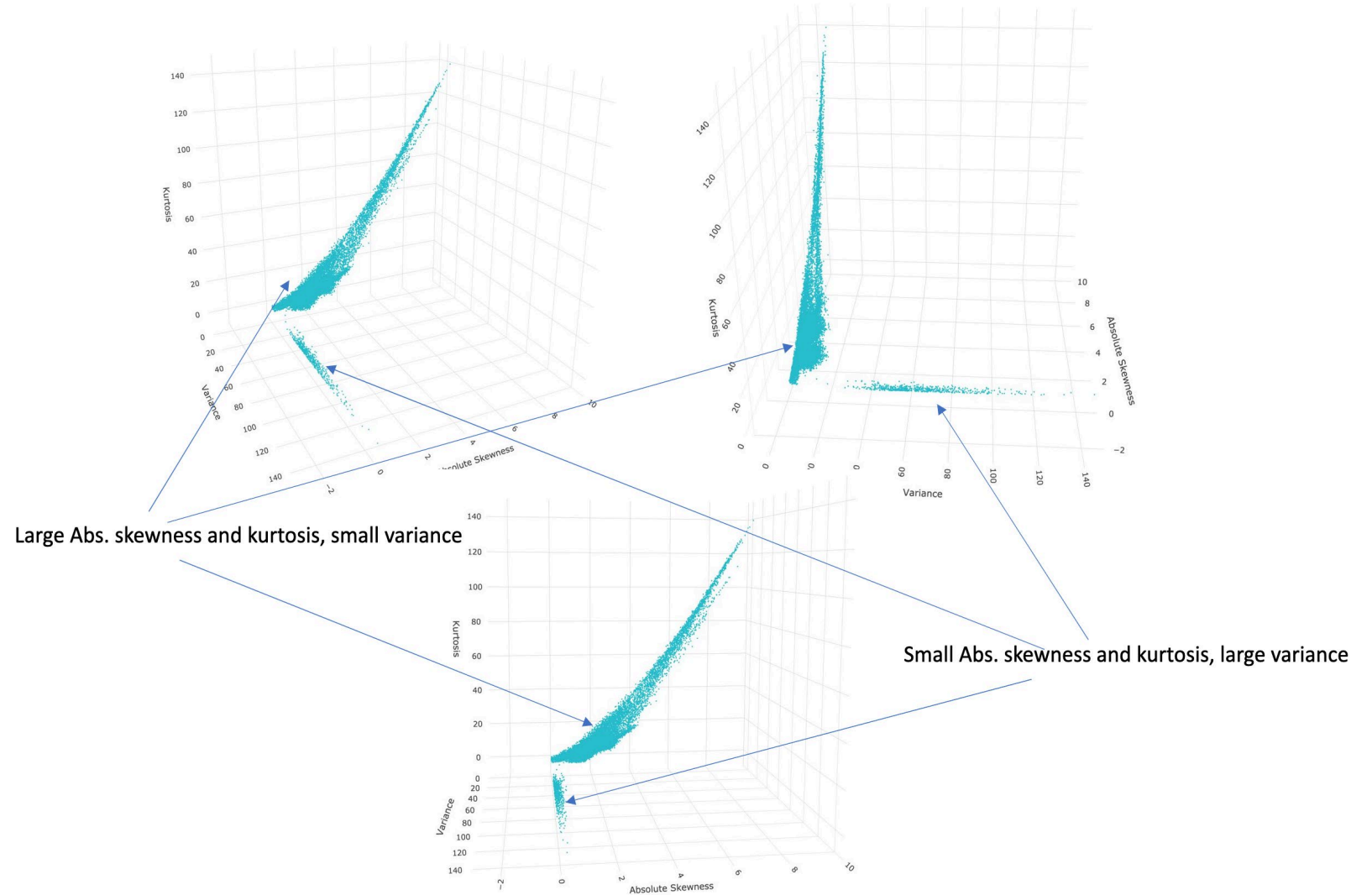
Identified issue: MER values drop 30dB across all subcarriers

Target the sample with this issue using the timestamp



Clustering Analysis

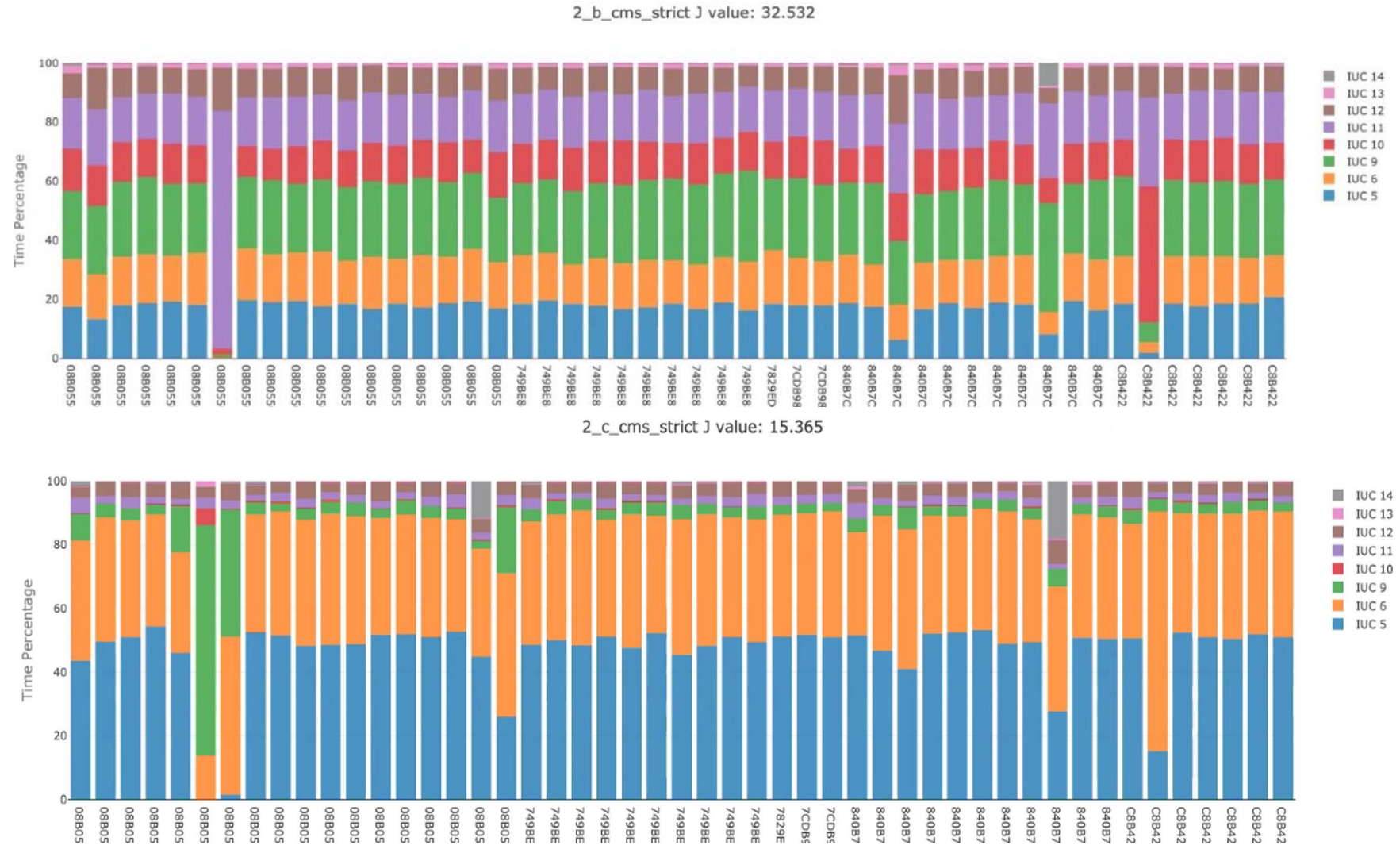
- Natural clusters of the statistics of subcarriers
- Potential ways to infer thresholds
- Potential usage of centroids
- Possible feature extraction methods



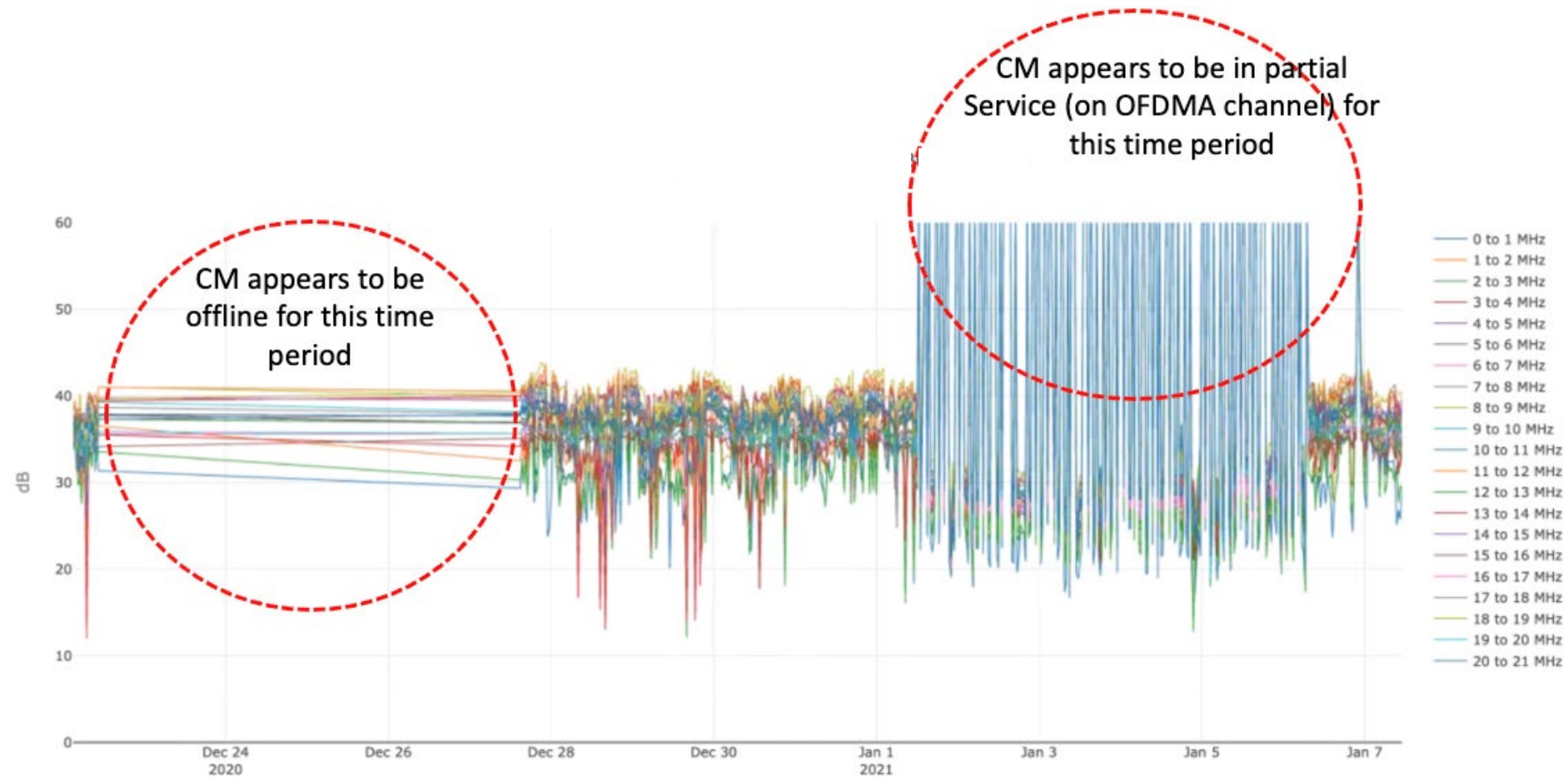
Time Clustering

PMA Use case

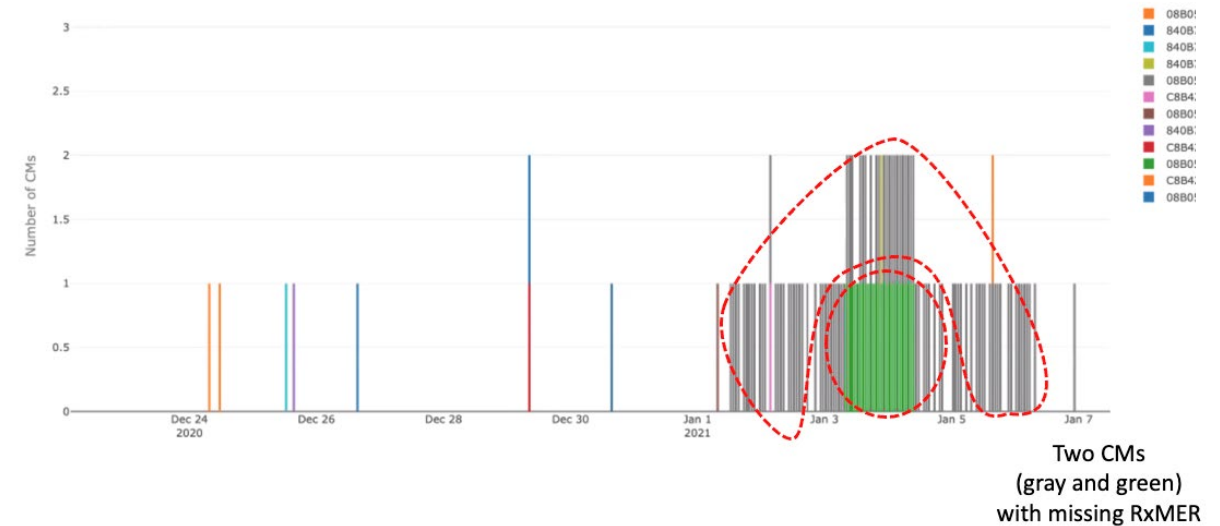
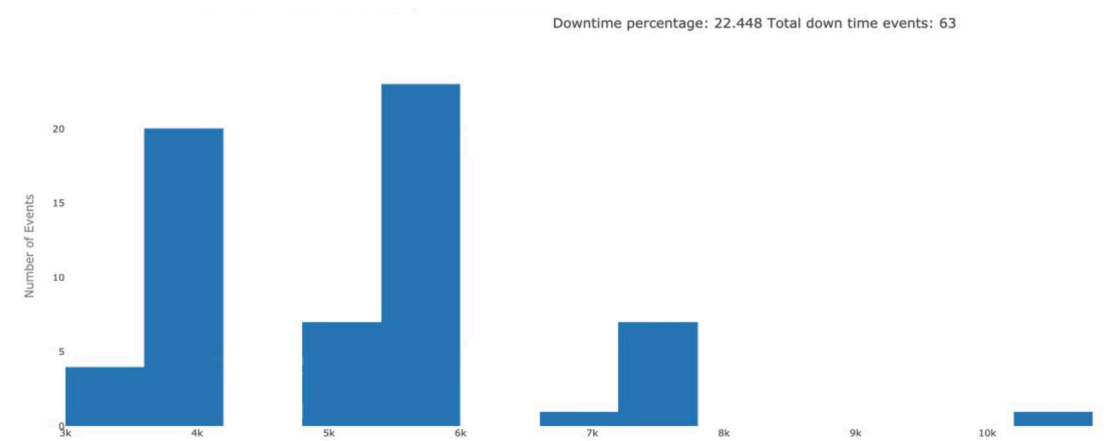
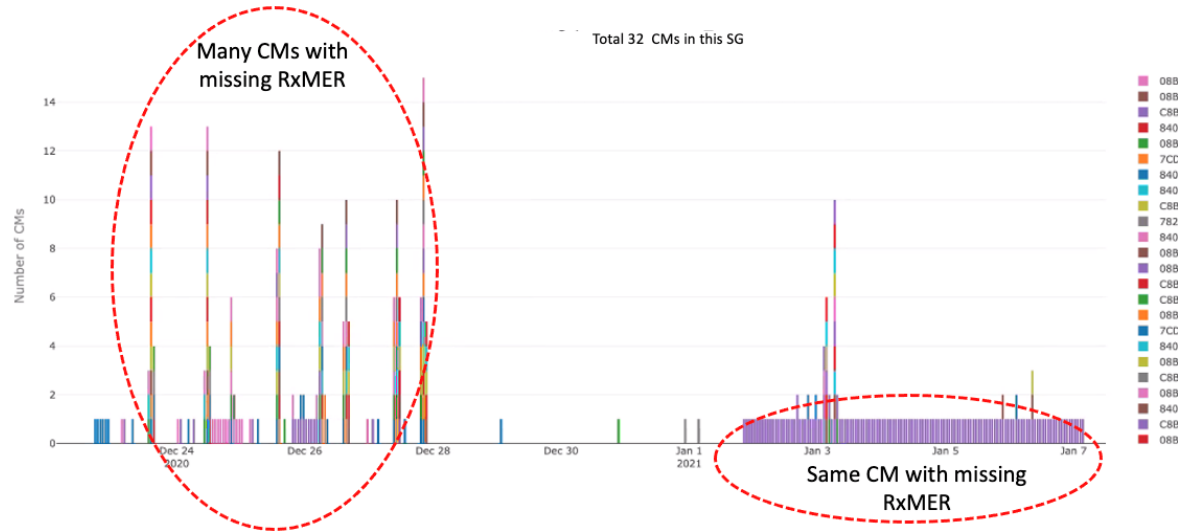
- Improved OFDMA robustness
- Capacity gains



US RxMER Measurement Discontinuities

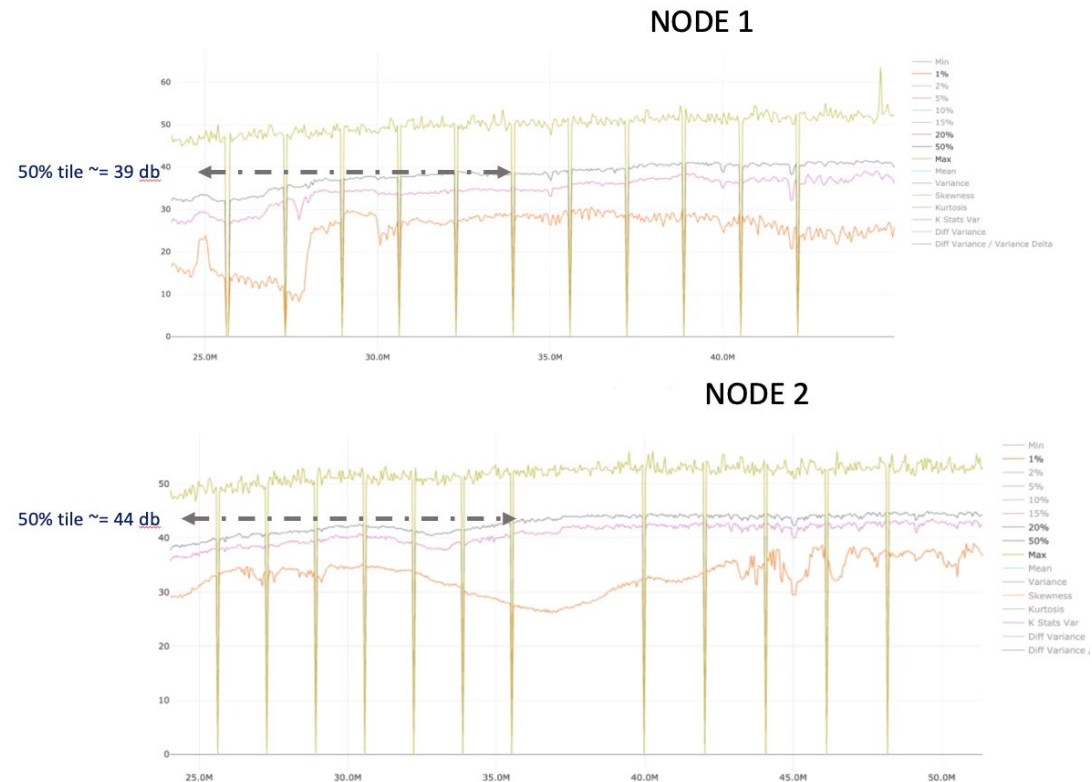


CMs Missing RxMER across a Node



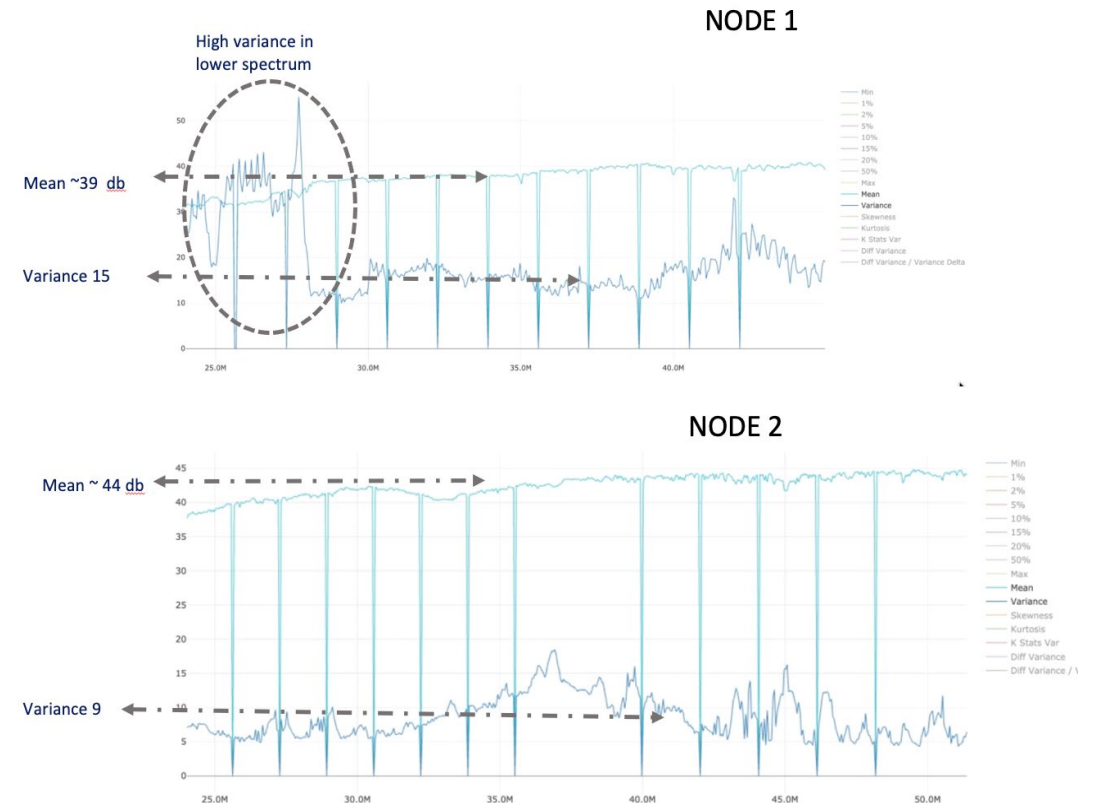
CM Health Score

Individual parameters from a CM, weighted together



Node Health Score

Aggregated metrics from all CMs \rightarrow Node upstream health



US RxMER Data Analytics Application

- All the metrics and methods can
 - Identify troubled CMs
 - Identify troubled Nodes
- Prioritize maintenance for CMs/Nodes

CM MAC	Spacing	First Active Sub-carrier	First Active Sub-carrier Frequency	Interface Number	SG Name	Average Variance (lower spectrum)	Average Variance (higher spectrum)	Average Skewness (lower spectrum)	Average Skewness (higher spectrum)	Average Kurtosis (lower spectrum)	Average Kurtosis (higher spectrum)	Downtime Percentage	Gap Time Percentage	Show Data
08B0	50	74	24025000	34259153	AM	182.14	161.22	0.92	0.93	-0.38	-0.3	22.448	33.036	Show Data
08B0	50	74	24025000	34259153	AM	46.21	32.62	1.81	1.79	6.68	7.21	6.633	4.719	Show Data
7CDBI	50	74	24025000	51003593	AM	29.22	25.73	1.54	1.43	9.03	6.4	4.081	2.679	Show Data
08B0	50	74	24025000	34259153	AM	27.42	24.05	-1.56	-2.21	5.34	8.64	0	0	Show Data
7CDBI	50	74	24025000	51003593	AM	26.93	35.09	-0.45	-0.44	-0.54	-1.08	0	0	Show Data
94917	50	74	24025000	51003593	AM	26.02	24.24	0.38	0.29	6.28	3.55	1.148	0.256	Show Data
840B7	50	74	24025000	34259153	AM	25.03	18.81	-0.33	-1.03	2.16	5.93	0.255	4.591	Show Data
7CDBI	50	74	24025000	51003593	AM	23.55	29.39	-0.45	-0.37	-0.25	-1.12	0	0	Show Data
840B7	50	74	24025000	51003593	AM	23.34	22.06	0.07	0.17	4.94	2.01	0.765	0.255	Show Data
840B7	50	74	24025000	34259153	AM	22.81	25.35	-1.17	-2.3	3.71	9.84	0	2.041	Show Data

Showing 1 to 10 of 113 entries

Anomaly Detection

Define Anomaly Categories

Anomaly Detection Methods

Correlation of Different Measurement data





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Thank You!

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