UNLEASH THE POWER OF LIMITLESS CONNECTIVITY
Wireline Access Network

Upstream OFDMA Anomaly Detection and Triaging

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Introduction

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
US RxMER Observations

Upstream RxMER

RxMER captures over time
US RxMER Observations

Variations and Impairments

High variation over time

Lower variation but impedance mismatch is observed
US RxMER Observations

Outliers

Ingress-like impairments on lower frequency end

Outlier RxMER captures
OFDM vs OFDMA

**Compare DS RxMER with US RxMER**

Downstream has low 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

Upstream has high variance
Start understanding the new upstream data

Statistical analysis

• Percentiles
• Variance
• Skewness
• Kurtosis
• MER Time series
• Time Clustering of data
Statistical analysis

Percentiles

• Distribution of MER values
• Intermittent issues
• Persistent issues
Statistical analysis

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
Statistical analysis

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

Corelate Skewness and Variance
Persistent Issues vs Intermittent

35MHz

40-44MHz
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
MER as time series

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
MER as time series

Identified issue: MER values drop 30dB across all subcarriers

Target the sample with this issue using the timestamp
Experimenting with statistics

Clustering Analysis

• Natural clusters of the statistics of subcarriers
• Potential ways to infer thresholds
• Potential usage of centroids
• Possible feature extraction methods
Grouping the samples captured over time

**Time Clustering**

**PMA Use case**

- Improved OFDMA robustness
- Capacity gains
Data capturing issues

US RxMER Measurement Discontinuities

CM appears to be offline for this time period

CM appears to be in partial Service (on OFDMA channel) for this time period
Data capturing issues

CMs Missing RxMER across a Node

[Graph showing CMs with missing RxMER]

Down time percentage: 22.448% Total downtime events: 63
Health Score

CM Health Score

Individual parameters from a CM, weighted together

Node Health Score

Aggregated metrics from all CMs → Node upstream health
Reference application

US RxMER Data Analytics Application

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

Anomaly Detection

Define Anomaly Categories

Anomaly Detection Methods

Correlation of Different Measurement data
Thank You!

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