Attachment A

Uses of IEEE 1366 and Catastrophic Days

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Major Event Day (MED)

- Next few slides cover the MED Basics
- Good baseline for Catastrophic Day discussion

Why MED Methodology was created

- Sound Basis for Measuring Performance.
- A clearer view of performance, both on a
  - Daily basis and
  - During Major Events
- Can form a solid basis for review of operational effectiveness, decision making and policy making.
- More consistent benchmarking.

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Foundations of the Process

- Definition must be understandable by all and easy to apply.
- Definition must be specific and calculated using the same process for all utilities.
- Must be fair to all utilities.
  - Large and small, urban and rural….
- SAIDI was chosen as the indicator…
  - because it is size independent and
  - it is the best indicator of system stresses beyond those that utility's staff, build and design to minimize.

Two Categories for Measurement

- The 2.5 Beta Methodology allows segmentation of reliability data into two distinct sets for review.
  - One set represents those events of such a reliability magnitude that a *crisis mode* of operation is required to adequately respond. (*major events*).
  - The other set represents the reliability impact of those events that a company has built the system to withstand and staffed to respond to in a manner that does not require a crisis mode of operation. (*day-to-day operation*).

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Seven Simple Steps

1. Collect values of daily SAIDI for five sequential years ending on the last day of the last complete reporting period. If fewer than five years of historical data are available, use all available historical data

2. If any day in the data set has a value of zero for SAIDI, do not include that day in the analysis.

3. Take the natural logarithm (ln) of each daily SAIDI value in the data set.

4. Find α (Alpha), the average of the logarithms (also known as the log-average) of the data set.

5. Find β (Beta), the standard deviation of the logarithms (also known as the log-standard deviation) of the data set.

6. Compute the major event day threshold, T_{MED}, using the equation:

$$T_{MED} = e^{(\alpha + 2.5\beta)}$$

7. Any day with daily SAIDI greater than the threshold value T_{MED} that occurs during the subsequent reporting period is classified as a major event day.

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Major Event Days – A few facts

- A day in which the daily system SAIDI exceeds a threshold value, T_{MED} that is determined by using the 2.5 beta method.
  - *For example, if T_{MED} = 3 minutes, than any day where more than 3 minutes of SAIDI is accrued is declared a major event day*
- Activities that occur on major event days should be separately analyzed and reported. Nothing is "Excluded"!!

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Benefits of the Approach

- Adoption of the 2.5 Beta methodology
  - will allow for consistent calculation of reliability metrics,
  - provide companies and commissions with a more accurate indication of a Company’s controllable service quality results,
  - allow a clear review of company response to crisis mode events, and
  - provide a less distorted indication of the reliability results for companies of all sizes.

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Catastrophic Days

- Experience with certain companies' application of IEEE Std. 1366 found that unusually large events ("catastrophic") lead to changes in t_{med} which often impact the next 5 years of underlying SAIDI
- Distribution Reliability WG formed a Task Force to investigate

Catastrophic TF Goals

- Development of a method to handle significant outliers could improve the major event threshold calculation process
- Several methods were proposed
  - Beta Variables (Two originally contemplated)
  - Box and Whiskers

Mission

- To develop a method for handling extreme outlier days to ensure that subsequent underlying performance is reflective of real performance, and is not tainted by the extreme outliers

Methods Evaluated

- 1) IEEE Std. 1366
  - Leave the definition as it currently stands
- 2) "Bouford" heuristic Method
  - Apply 4.15β to establish the existence of a catastrophic day, which is removed from the data set; thereafter, apply 2.5 β method as usual
- 3) Statistical "Box 'n Whiskers" method
  - Evaluate the 5 year period using box and whiskers, looking for outliers (both high and low) in excess of 3 times the inner quartile range, remove any high or low outliers from the dataset; thereafter, apply 2.5 β method as usual

- Note: In the past, other methods, including robust estimation were considered

Process

- Identify companies with catastrophic days
- Evaluate the impact of these days, on SAIDI, applying the proposed methods
- Identify companies with no catastrophic days
- Incorporate them into the total population being evaluated
- Review underlying SAIDI, impact on t_{med}, etc. for each company represented

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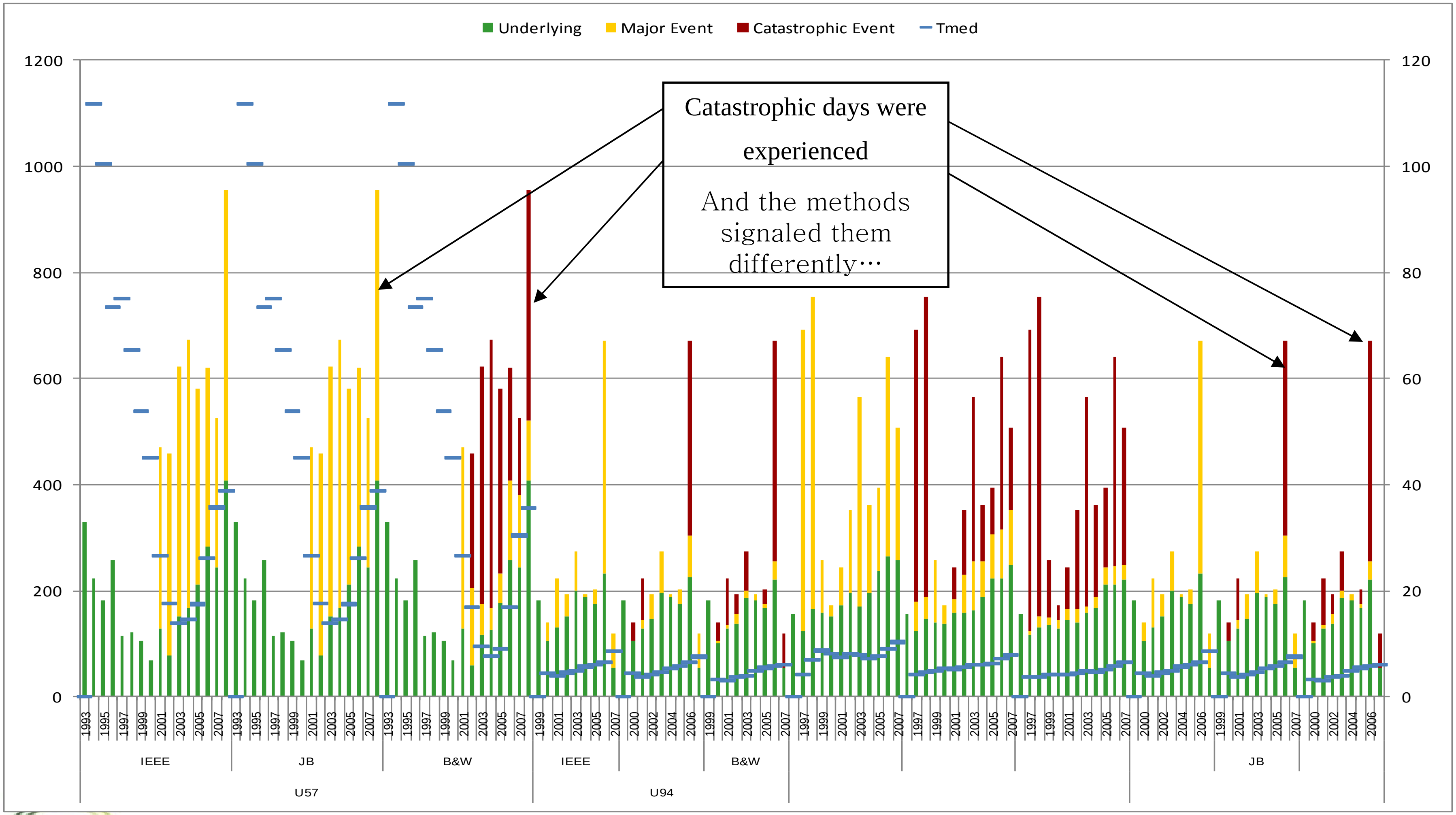
Findings

- Catastrophic event days DO exist within the data and hold the potential for not properly signaling underlying SAIDI, particularly in subsequent years after the event
- An outlier handling method needs to be developed
- Both Bouford and Box ‘n Whiskers identify outliers, however Bouford appears to handle most consistently and rationally

Case Studies



Conclusions

- The Task Force finds that none of the methods identified to handle catastrophic days is able to consistently operate reasonably across all data sets tested
- The Task Force recommends that an addition in the standard in either Section 6.3 or the Annex be included to inform standard users about the issue

New Section 6.3 in 1366

When using daily SAIDI and the 2.5β method, there is an assumption that the distribution of the natural log values will most likely resembles a Gaussian distribution, namely a bell-shaped curve. As companies have used this method, a certain number of them have experienced large-scale events (such as hurricanes or ice storms) that result in unusually sizable daily SAIDI values. The events that give rise to these particular days, considered "catastrophic events," have a low probability of occurring. However, the extremely large daily SAIDI values may tend to skew the distribution of performance toward the right, causing a shift of the average of the data set and an increase in its standard deviation. Large daily SAIDI values, caused by catastrophic events, will exist in the data set for five years and could cause a relatively minor upward shift in the resulting reliability metric trends. While significant study was undertaken to develop objective methods for indentifying and processing catastrophic events (in order to eliminate the noted effect on the reliability trend), the methods that were developed, in order to be universally applied, caused, for many utilities, catastrophic events to occur far too often to accept as being reasonable. In addition, the elimination of catastrophic events from the calculation of the major event threshold caused, in some utilities, a rather large increase of days identified as Major Event Days in the following five years. It is recommended that the identification and processing of catastrophic events for reliability purposes should be determined on an individual company basis by regulators and utilities, since no objective method has been devised that can be applied universally to achieve acceptable results.

2010 Benchmarking

- Following slides are from the Distribution Reliability WG 2010 Benchmarking survey
- Survey utilizes IEEE Std 1366 including MED definition

Benchmarking

- Data is Never exactly the same!
- Two main reasons for differences:
  - Data Collection Process/System Differences
  - Exclusion Criteria Differences (Basis)
- IEEE Std. 1366
  - addresses data basis issues by clearly defining the rules.
  - It DOES NOT address the data collection issues
    - This is being addressed by IEEE P1782

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Classification of Respondents

- Urban, Suburban, Rural
  - Rural <= 50 cust/mi (31 cust/km)
  - Suburban > 50 cust/mi <150 cust/mi
  - Urban >= 150 cust/mi (93 cust/km)
- 2010 Survey
  - 10 Urban companies
  - 18 Suburban companies
  - 28 Rural companies
  - 32 Evenly blended companies
  - 19 Unclassified companies

Classification of Respondents

- 78,634,730 customers represented in US & Canada
- Small, Medium, Large
  - Small =< 100,000 customers
  - Medium >100,000 and <1,000,000 customers
  - Large >= 1M customers
- 2010 Survey
  - 26 Small companies
  - 56 Medium companies
  - 27 Large companies

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Respondents

- More than 200 Companies have responded at some time
- 2010 Survey
  - 106 unique entries responded in 2010; 109 total entries in 2010

All Respondents 2010							
		SAIDI IEEE	**SAIDI All**	**SAIFI IEEE**	**SAIFI All**	**CAIDI IEEE**	**CAIDI All**
0	MIN	21.43	42.29	0.42	0.68	20.61	29.02
1	Q1	89.47	124.58	0.92	1.16	87.94	102.08
2	MEDIAN	127.71	211.34	1.17	1.41	106.15	132.51
3	Q3	158.43	346.97	1.46	1.83	122.18	194.33
4	MAX	548.39	1806.34	4.65	5.11	219.92	743.70

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Summary Details by Utility Size

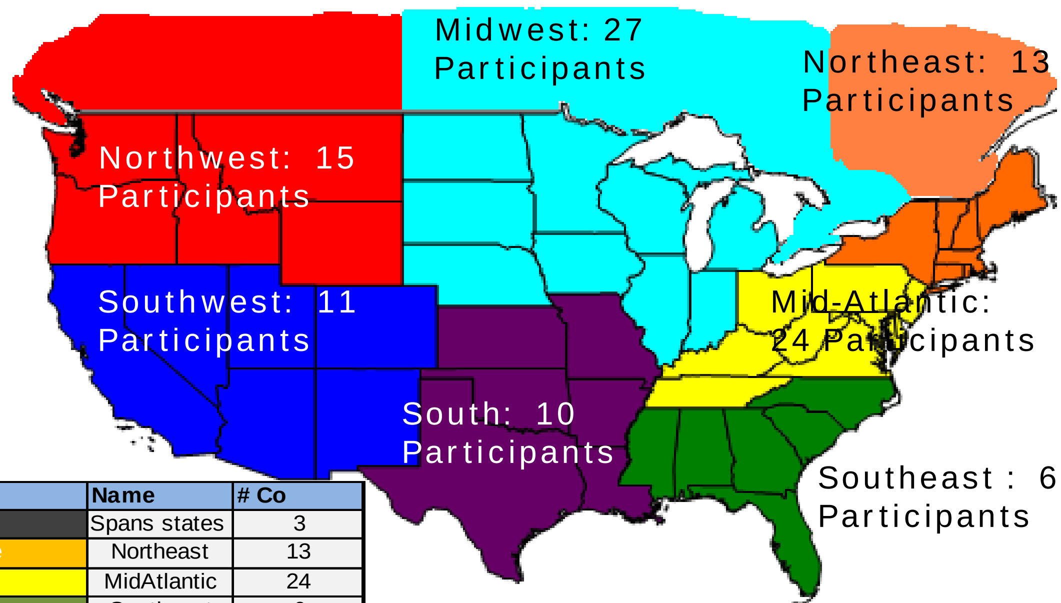
Small Respondents 2010							
		SAIDI IEEE	SAIDI All	SAIFI IEEE	SAIFI All	CAIDI IEEE	CAIDI All
0	MIN	48.91	48.91	0.65	0.72	61.39	68.33
1	Q1	75.72	116.89	0.92	1.26	77.38	88.83
2	MEDIAN	120.99	162.53	1.24	1.43	97.13	108.79
3	Q3	161.97	314.64	1.47	1.98	116.57	151.51
4	MAX	548.39	1806.34	4.14	4.73	217.38	743.70

Medium Respondents 2010							
		SAIDI IEEE	SAIDI All	SAIFI IEEE	SAIFI All	CAIDI IEEE	CAIDI All
0	MIN	21.43	42.29	0.42	0.68	20.61	29.02
1	Q1	94.85	129.52	1.01	1.15	90.68	108.83
2	MEDIAN	131.84	210.27	1.23	1.48	106.26	133.90
3	Q3	159.62	348.15	1.45	1.83	122.17	198.83
4	MAX	418.40	1564.35	4.65	5.11	199.01	574.41

Large Respondents 2010							
		SAIDI IEEE	SAIDI All	SAIFI IEEE	SAIFI All	CAIDI IEEE	CAIDI All
0	MIN	53.64	78.23	0.54	0.88	65.84	73.51
1	Q1	94.27	142.48	0.90	1.09	89.85	121.52
2	MEDIAN	124.13	247.69	1.06	1.35	110.35	167.84
3	Q3	157.73	326.67	1.24	1.62	128.39	237.42
4	MAX	219.29	559.52	2.03	2.51	219.92	416.09

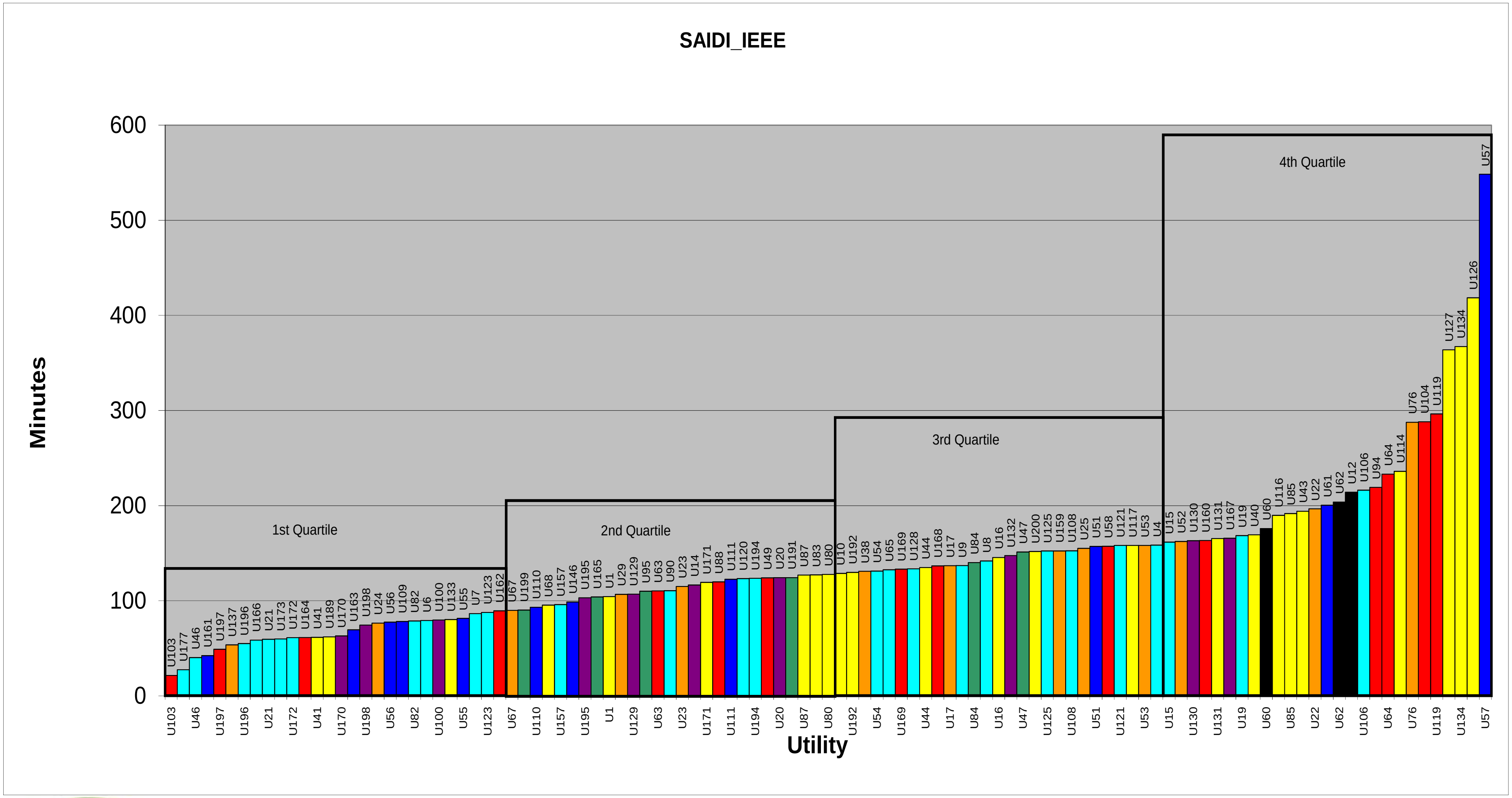
Regions represented by the participants...

- Region 0: Spans States or Unknown
- Region 1: Northeast
- Region 2: Mid-Atlantic
- Region 3: Southeast
- Region 4: Midwest
- Region 5: Southwest
- Region 6: South
- Region 7: Northwest

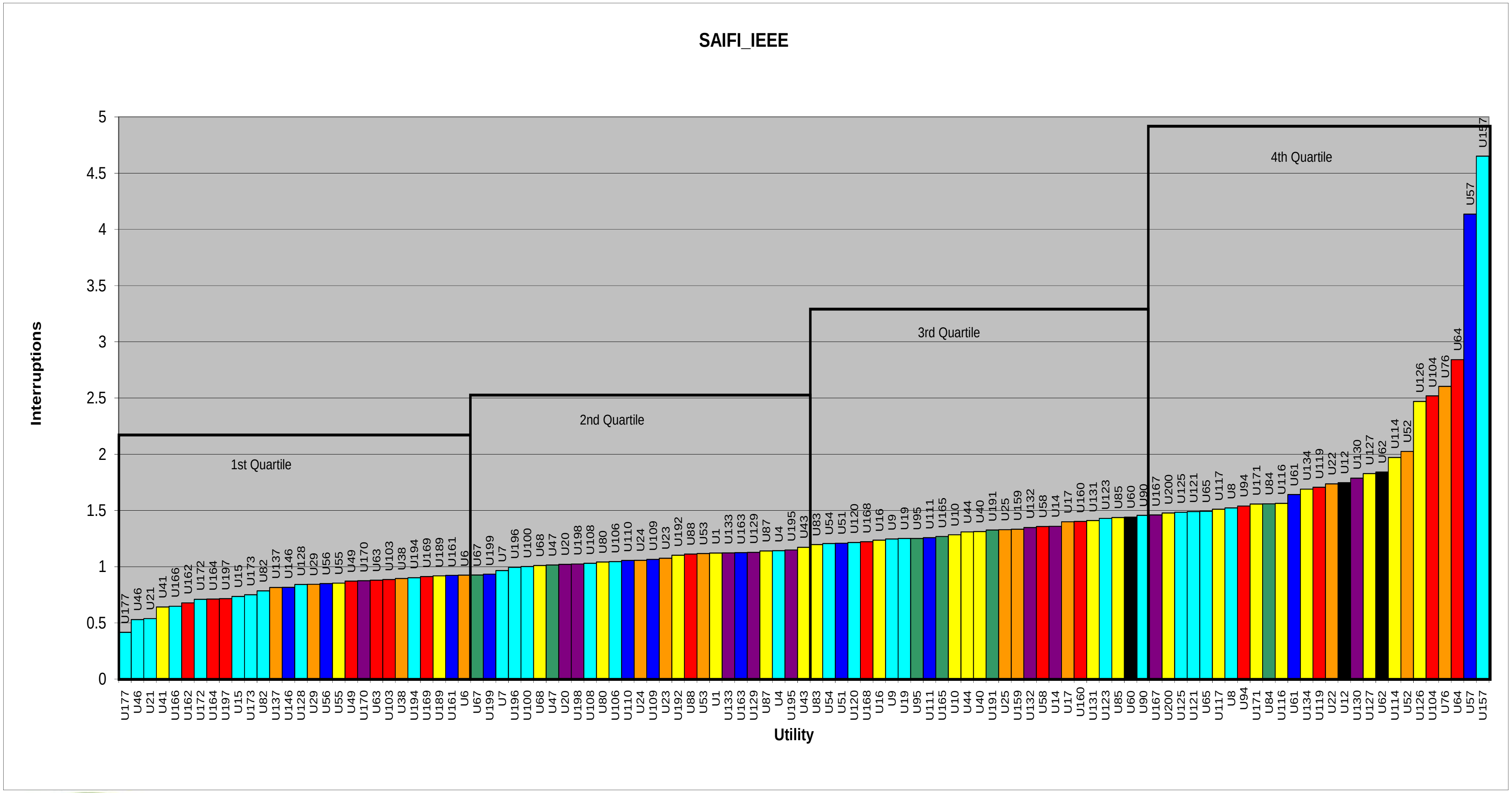


Region	Color	Name	# Co
0	Black	Spans states	3
1	Orange	Northeast	13
2	Yellow	MidAtlantic	24
3	Green	Southeast	6
4	Light Blue	Midwest	27
5	Dark Blue	Southwest	11
6	Purple	South	10
7	Red	Northwest	15
		2010 Total	**109**

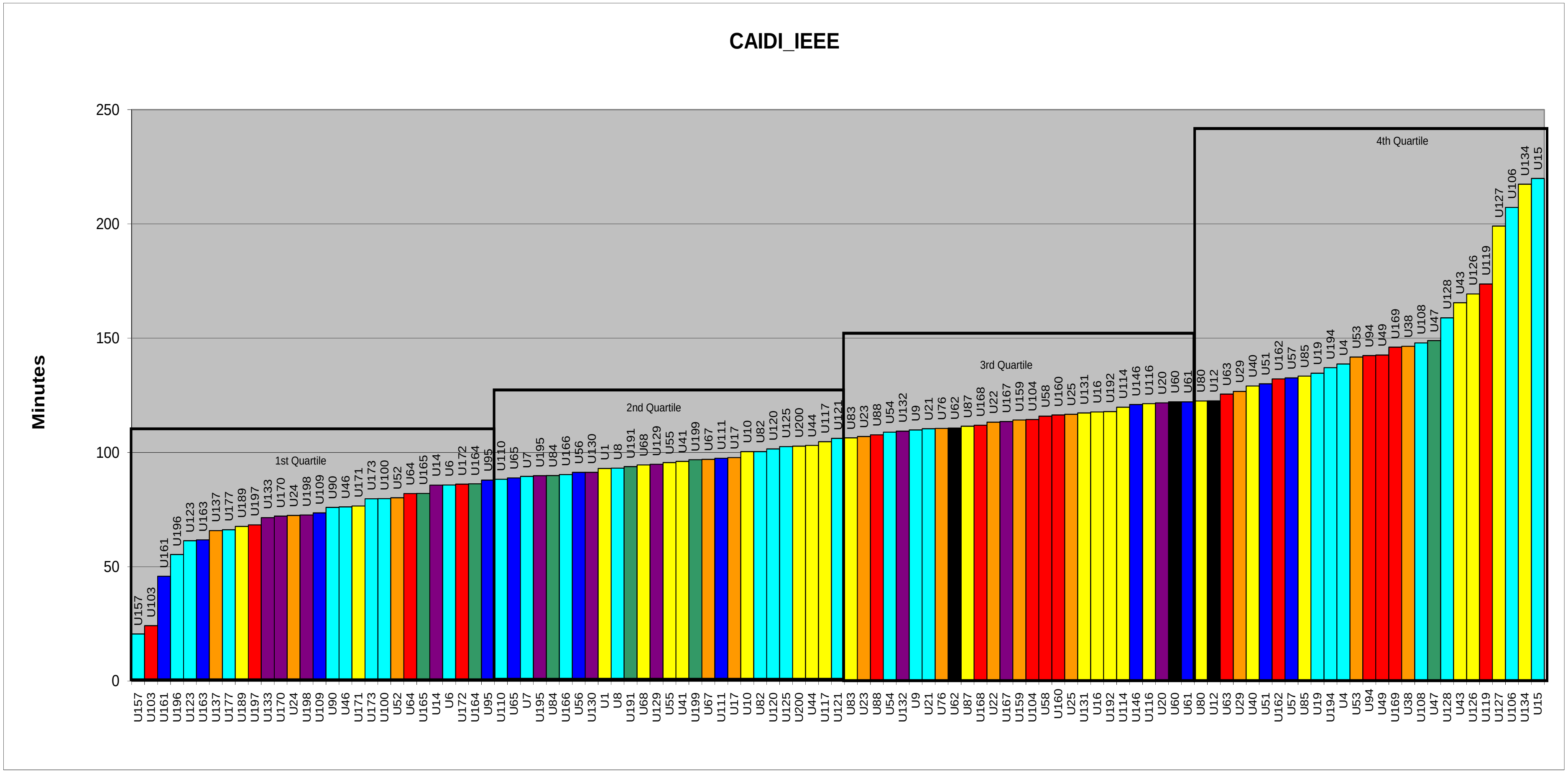
SAIDI IEEE, across the continent...



SAIFI IEEE, across the continent…



CAIDI IEEE, across the continent…



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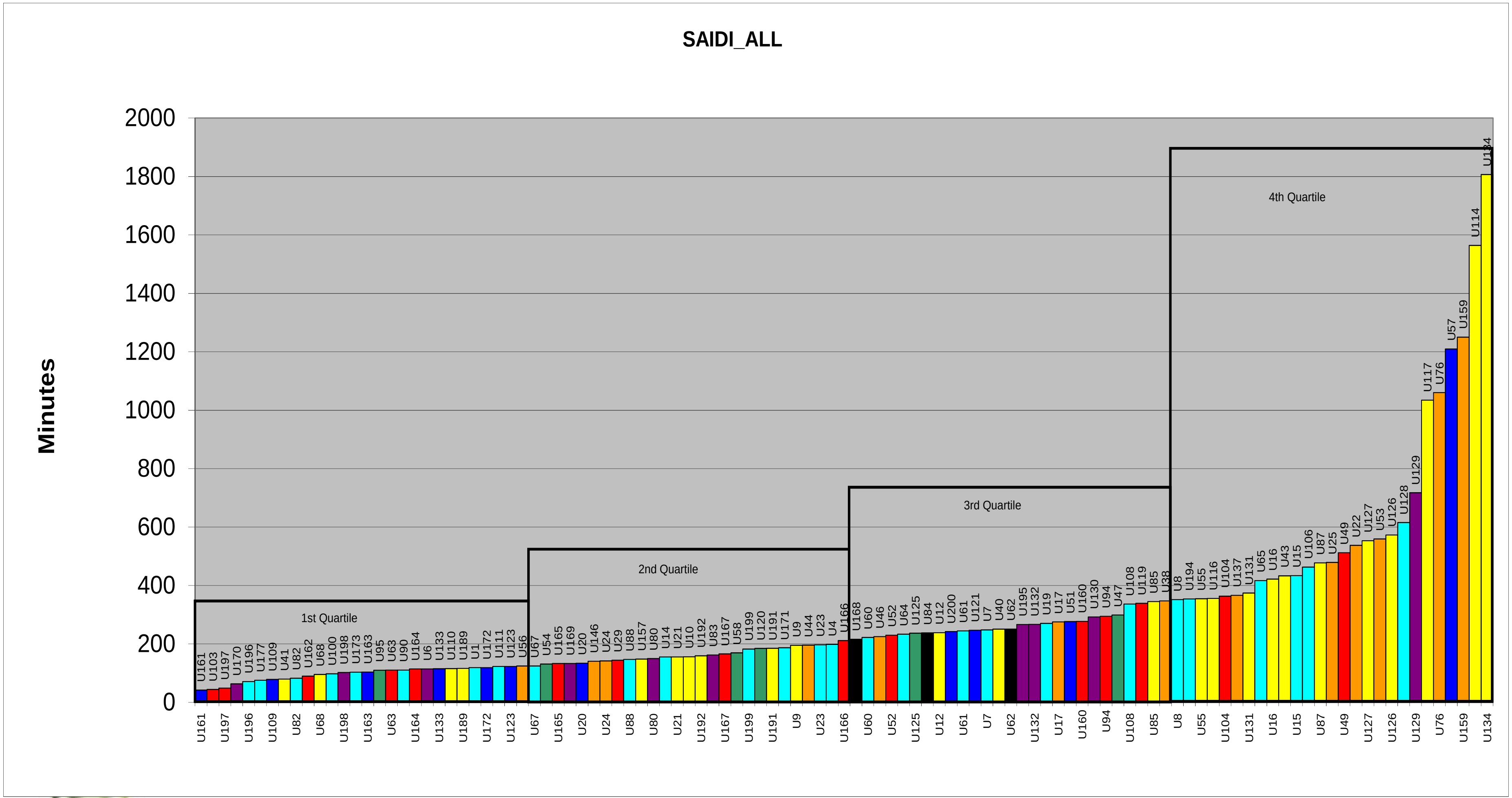
Data Review

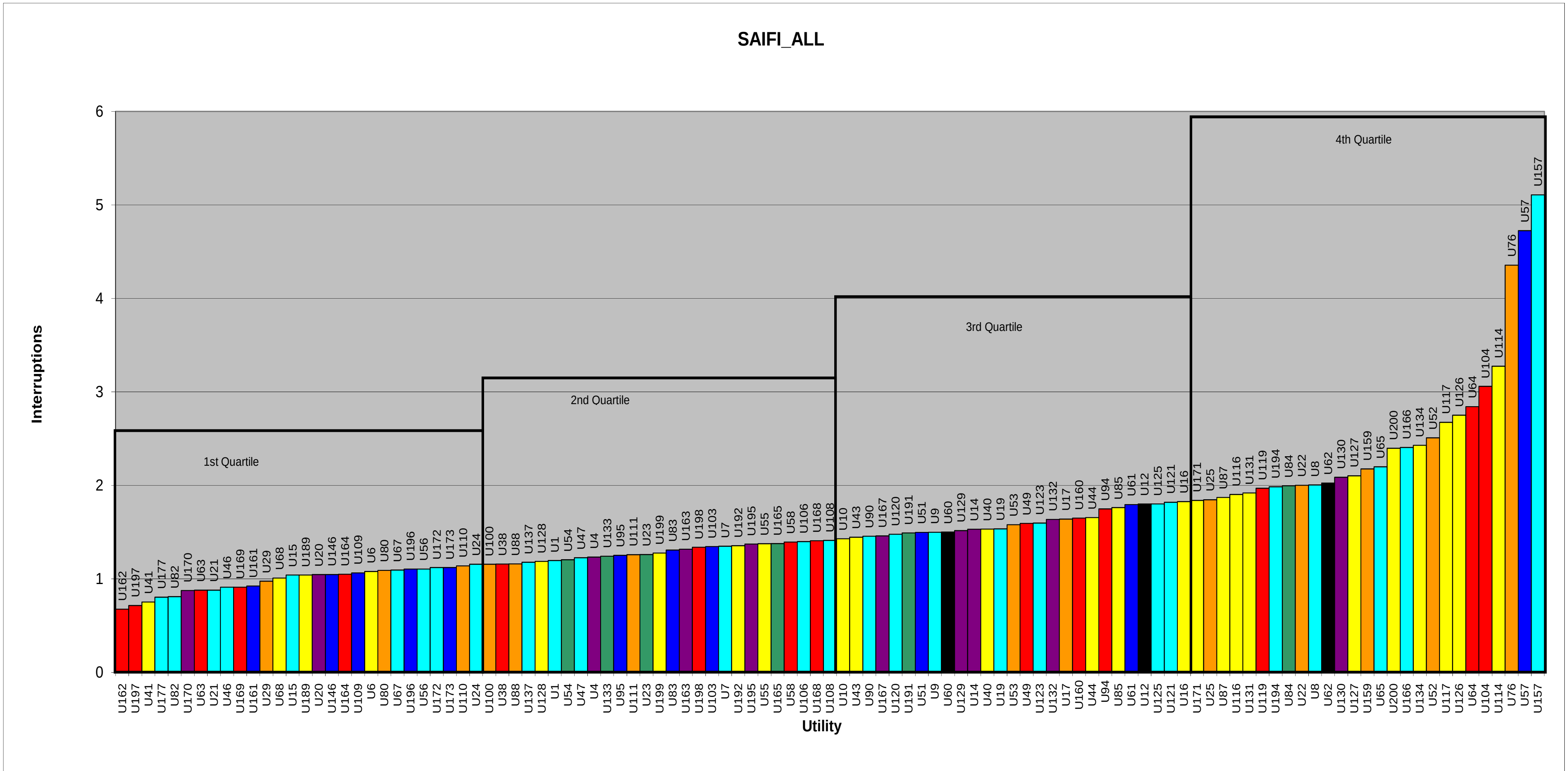
- Reviewing "All" data, that is the data that includes everything customers experienced can lead to conclusions about how companies handle major events.

- The following slides show data without segmentation.

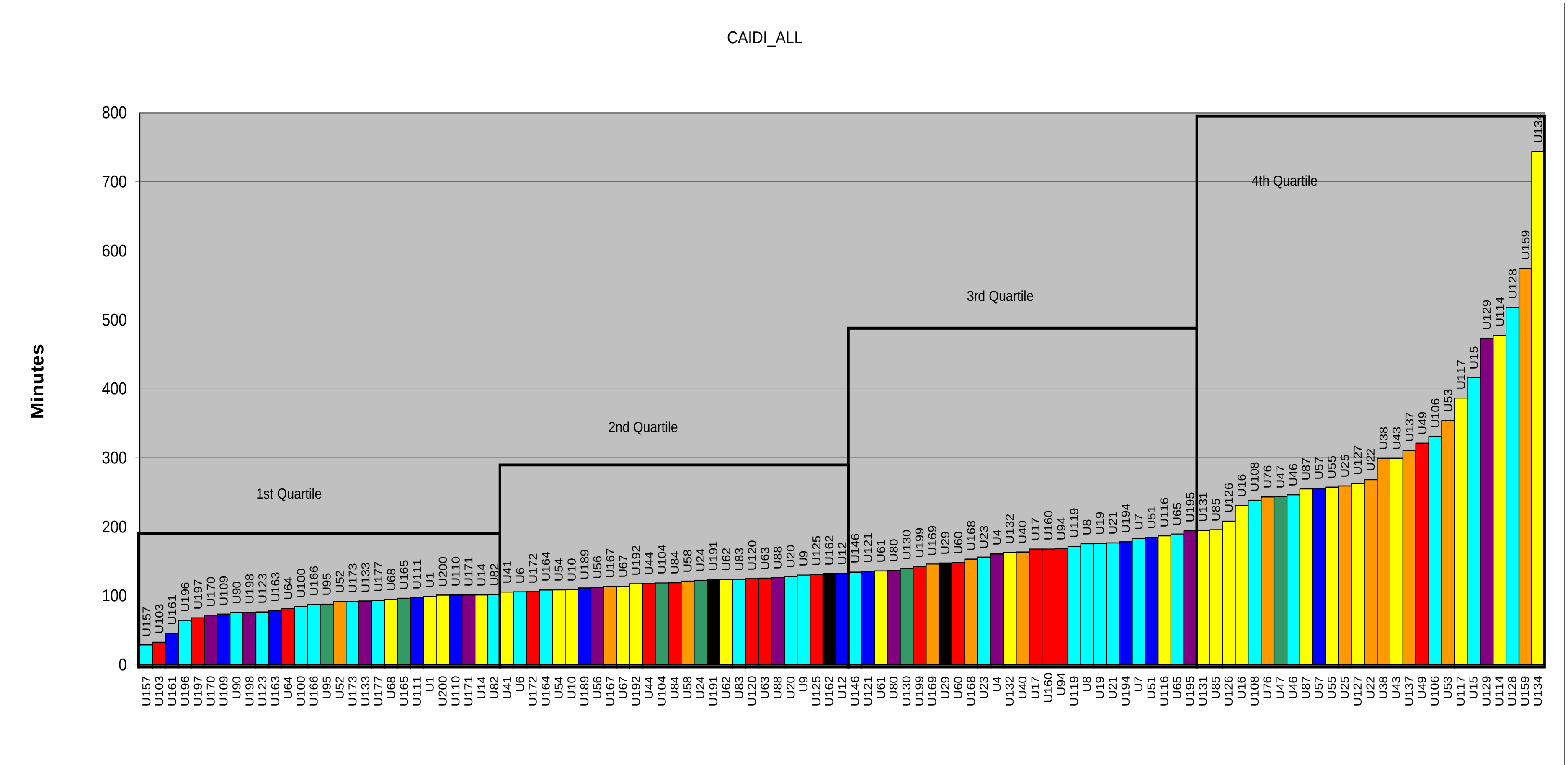
SAIDI, across the continent…



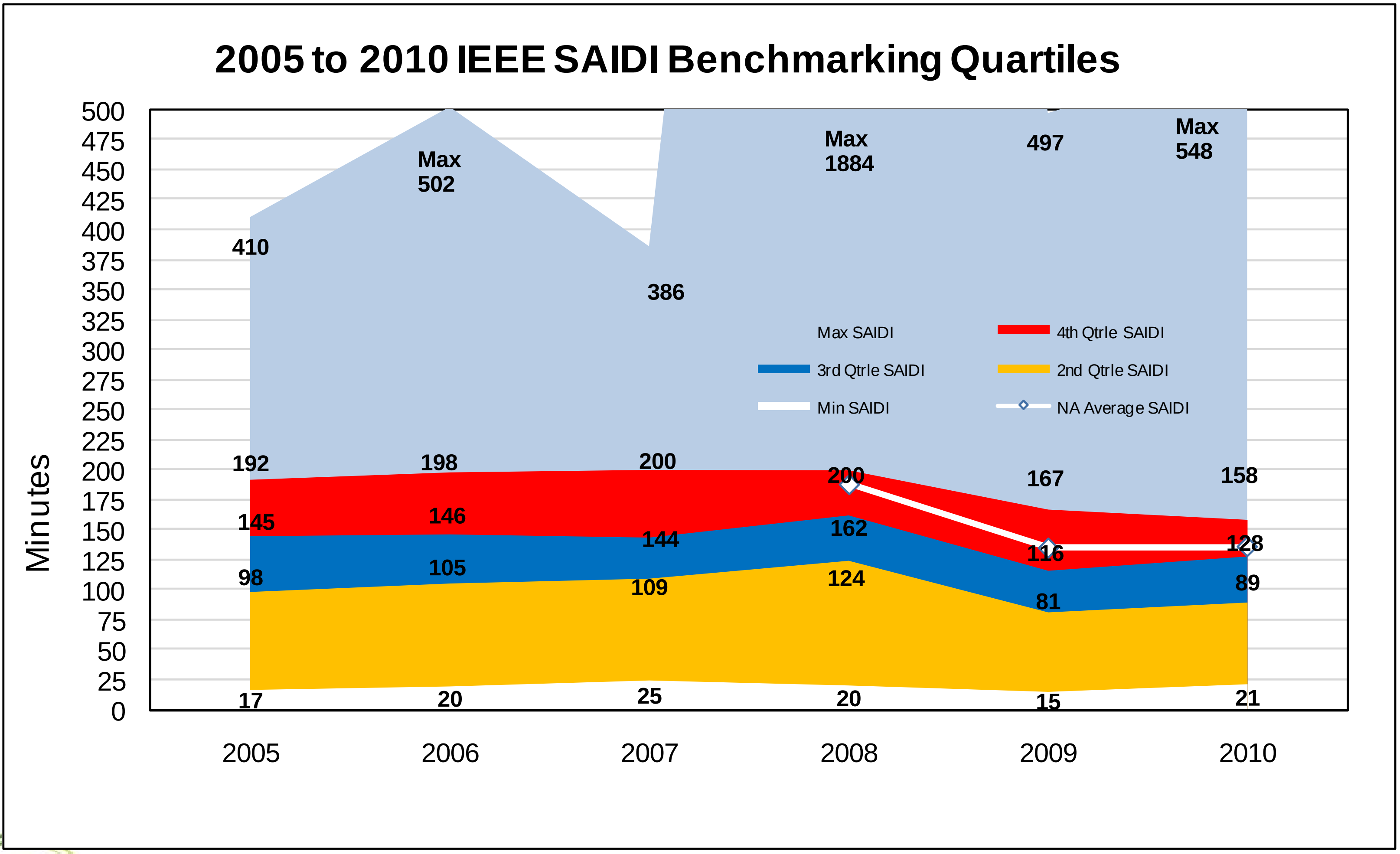
SAIFI, across the continent...



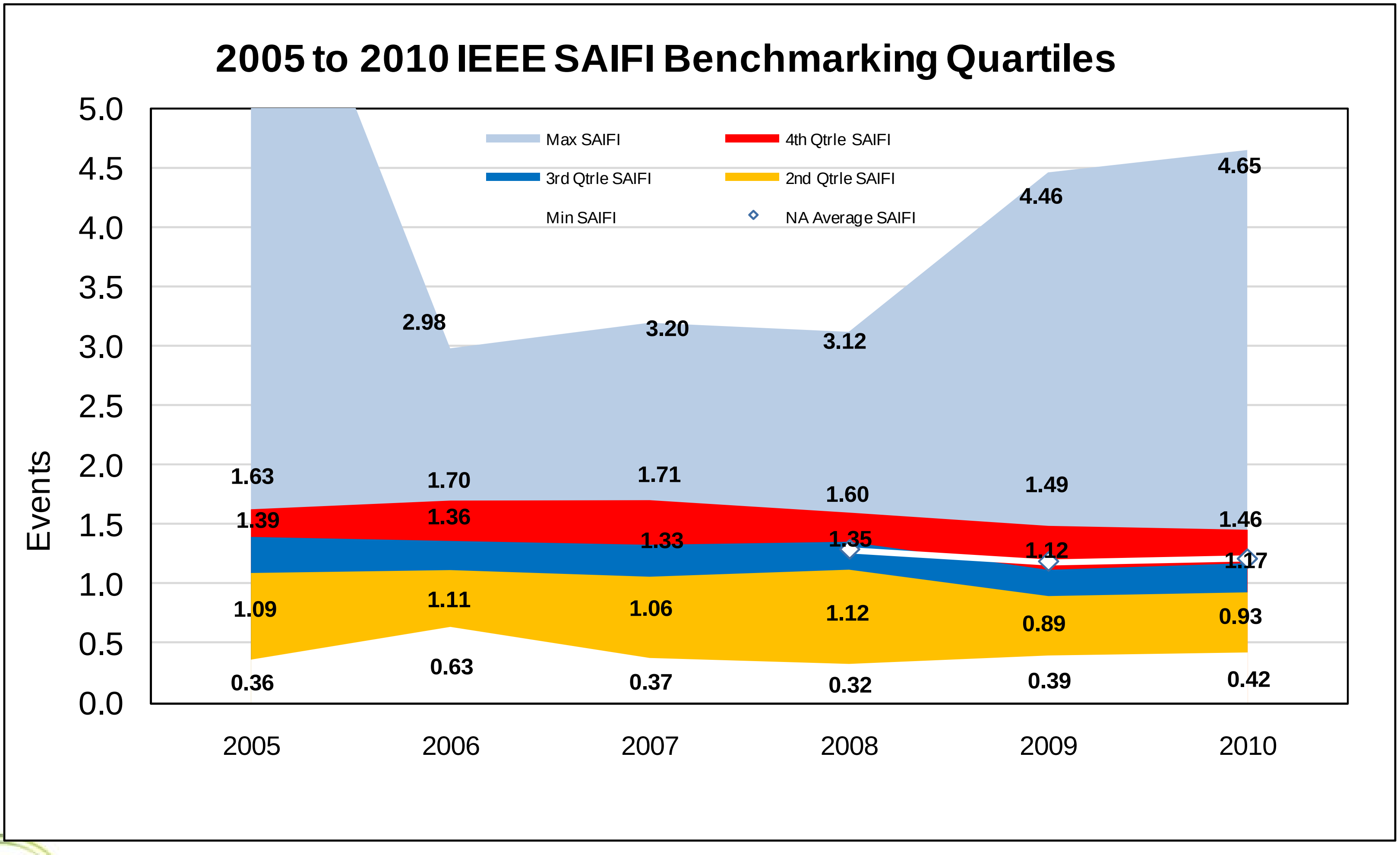
CAIDI, across the continent...



2010 IEEE Survey – Trends for SAIDI by Quartiles



2010 IEEE Survey – Trends for SAIFI by Quartiles



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2010 IEEE Survey – Trends for CAIDI by Quartiles