Subway Customer Metrics Improvements

This document outlines the improvements New York City Transit made to its subway customer-focused performance metrics—Additional Platform Time (APT), Additional Train Time (ATT), and Customer Journey Time Performance (CJTP), in January 2021 to improve the accuracy of the input train data.

Methodology

The subway customer metrics improvements enhanced the accuracy of the train movement data used to calculate passenger waiting and travel times. These train movement data improvements fall into three main categories, discussed in detail below:

- Calibration/fixes to B Division (i.e., letter lines) actual train arrival and departure time data (except L)
- Calibration/fixes to A Division (i.e., number lines and 42 St S) actual train arrival and departure time data (and L)
- Improvements to scheduled dwell times

B Division:
When introduced, B Division subway customer metrics (except the L line) relied primarily upon two relatively imprecise data sources for actual train arrival and departure times at stations: Bluetooth Beacon data, and times manually entered by train dispatchers at select stations. However, once PLC data (short for Programmable Logic Controller—essentially, track circuit data) became available for the entire B Division, going back to September 2019, NYCT built a process for transforming the data into accurate records of train arrivals and departures*. This new PLC process was completed in late 2020.

Once the new PLC process became available, it provided not only a basis for more accurate metrics from that point forward, but also a means of calibrating the historical Beacon/manual data. The difference between new and old arrival and departure times was calculated for every B Division train stop between September 2019 and March 2020. These differences were then aggregated by line, stop, track, and direction, and averaged (with some outlier exclusion). These averages formed a set of calibration factors that were used to convert past Beacon or manual data into estimates of what the new, more accurate PLC times would have been. When the development of these calibration factors was completed, in December 2020, it became possible to release the revised customer metrics.

PLC stop arrival/departure times don't represent "true" dwell times, however. PLCs record when a train enters and leaves the track circuit(s) that span a station platform, whereas dwell time is usually considered to be the time between when a train completely stops, "wheel stop", and when it starts moving again, "wheel start". A second level of calibration was required to convert from PLC data, or other sources calibrated to PLC estimates, to final dwell time estimates.

The factors for this second level of calibration were derived by manually observing train wheel stop and wheel start times for B Division trains at stations across the system and comparing these times with PLC arrival/departure times. The results showed the difference between PLC times and true dwell times was mostly determined by the difference between a train's length and station platform length. Based on this finding, the average PLC-dwell arrival and departure time differences were calculated from the observation data for the three train-platform length differences on the B Division: 0 ft, 120 ft, and 300 ft. These form the second set of calibration factors applied to B Division train data.

* Note: some limited PLC data for sections of the B Division was available, and used for customer metrics, prior to Sept. 2019

Finally, NYCT implemented a process which replaced missing or excluded aberrant Beacon data with typical calibrated dwell times for each stop, line, and track.†

A Division and L:
For the A Division and L lines, the calibration process was much simpler. ATS-A (track circuit data for the 1, 2, 3, 4, 5, 6, and 42 St S lines), 7 line PLC, and L line CBTC data provide arrival and departure times of equivalent accuracy to that of the B Division PLC process described above. The only calibration required was to adjust for the difference between ATS-A/PLC/CBTC arrival/depart times and wheel stop/wheel start dwell times, like with the B Division. As with the B Division, these calibration factors were derived from manual observation of train dwell times, compared to ATS-A/PLC/CBTC times for the same train stops.

Schedule Adjustments:
The new process also changed scheduled dwell times to more accurately reflect service expectations. Previously, a default 45-second scheduled dwell everywhere was assumed. These were replaced with 30-second scheduled dwells, except at certain high ridership stations where 45 or 60 second scheduled dwells are used.

Comparison of Results

NYCT's revision of the subway customer metrics entailed not only the use of the improved process going forward, but also the revision of previously reported numbers going back to the beginning of customer metrics reporting. This was done to ensure the metrics continue to represent meaningful trends in subway performance, with no "artificial" change in the numbers at the start of a new process. In other words, a revision of the complete history was needed to allow for "apples to apples" comparisons over time. The section below describes the impact of the revised process on the metrics results.

Additional Platform Time (APT):
For both A and B Divisions, the old and revised APT are almost exactly the same, as shown in the charts below. This is not surprising, as changes to dwell times do not affect how much train service was provided, and it is the amount of service provided that mainly determines average wait time, and thus, APT. The small systematic differences on some individual lines fall into three categories:

- Fixing issues in actual train data that occasionally caused some modeled trips to require multiple trains (e.g., the C)
- Small APT differences for particular months/lines are generally due to schedule data issues when the metrics were originally run, which are now resolved.
- More accurate departure times affecting scheduled timed transfers, on lines where a large portion of ridership came from transfers (e.g., Rockaway Shuttle).

The last source of difference became more common on the B Division during spring and summer 2020. This is due to train on-time performance significantly improving due to the dramatic decrease in subway ridership brought about by the COVID-19 pandemic. With trains running faster, the switch from Beacon to calibrated PLC data pushed many train stop arrival times from just on time to a bit early. These early arrivals caused many modeled passengers to "just miss" their scheduled train, and thus have to wait a full headway for the next train. This effect is expected to diminish once ridership returns to normal levels.

Additional Train Time (ATT):
For both A and B Divisions, the revised process ATT is significantly lower than previously reported ATT, across reported history. This is because, on average, the new actual dwell times are longer than the effective dwells used in the old process, while the average scheduled dwell got shorter. When actual dwells

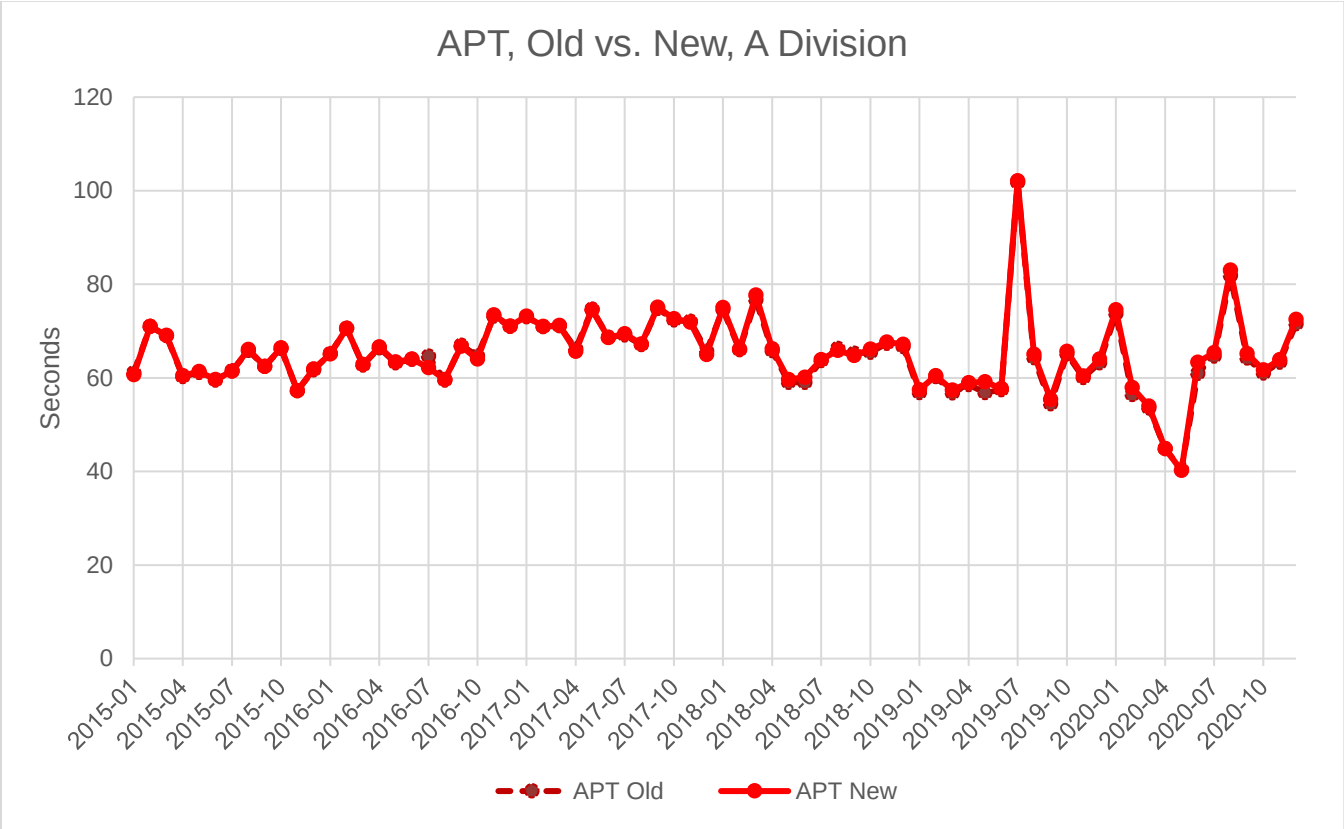
† Note: Most of the aberrant data excluded are weeks where Beacon dwells are too high, so by excluding them, NYCT made its reported performance worse, not better.

increase, but end-to-end run times stay the same, this entails shorter actual stop-to-stop run times, and thus shorter actual passenger travel times. Likewise, when scheduled dwell times decrease, but scheduled end-to-end run times stay constant, that implies scheduled stop-to-stop run times must increase, and thus scheduled passenger travel times increase. When scheduled time increases, and actual time decreases, ATT must decrease.

This pattern does not strictly hold for all lines at all times, however. For example, the L consistently has slightly higher ATT in the new process, because its actual dwells decreased on average after calibration. The new ATT on the 7, meanwhile, is higher or lower than before depending on the month, which is due to PLC data on the line becoming unavailable intermittently over the past few years.

It should be noted that the difference in old and new A Division ATT is very consistent, in the 8-11 sec range, but the B Division difference is generally higher from early 2018-present than in 2017. This is due to Beacons being phased in gradually over 2017 and early 2018, replacing old PLC data, I-TRAC data, and interpolated data that are changed less by calibration than Beacon data. Regardless of these wrinkles in the data, the revised process did not change the high-level historical trends in either A or B Division ATT.

Customer Journey Time Performance (CJTP):
For both A and B Divisions, CJTP is generally higher now than previously reported. This reflects the shorter average travel times and unchanged average wait times. Generally, patterns in old vs. new CJTP are the inverse of those for old vs. new ATT, reflecting the fact that “better” means lower for ATT, and higher for CJTP. The exception to this rule is spring and summer 2020, when for the B Division CJTP is a bit lower after calibration. This is due to the dramatic decrease in ridership due to COVID-19, which led to significant decreases in train running times. This, in turn, caused the switch from Beacon to calibrated PLC data to push many train stop arrival times from just on time to a bit early. These early arrivals caused many modeled passengers to “just miss” their scheduled train, and thus have to wait a full headway for the next train. This effect is expected to diminish once ridership returns to normal levels.


APT, Old vs. New, A Division
Seconds
120
100
80
60
40
20
0
2015-01
2015-04
2015-07
2015-10
2016-01
2016-04
2016-07
2016-10
2017-01
2017-04
2017-07
2017-10
2018-01
2018-04
2018-07
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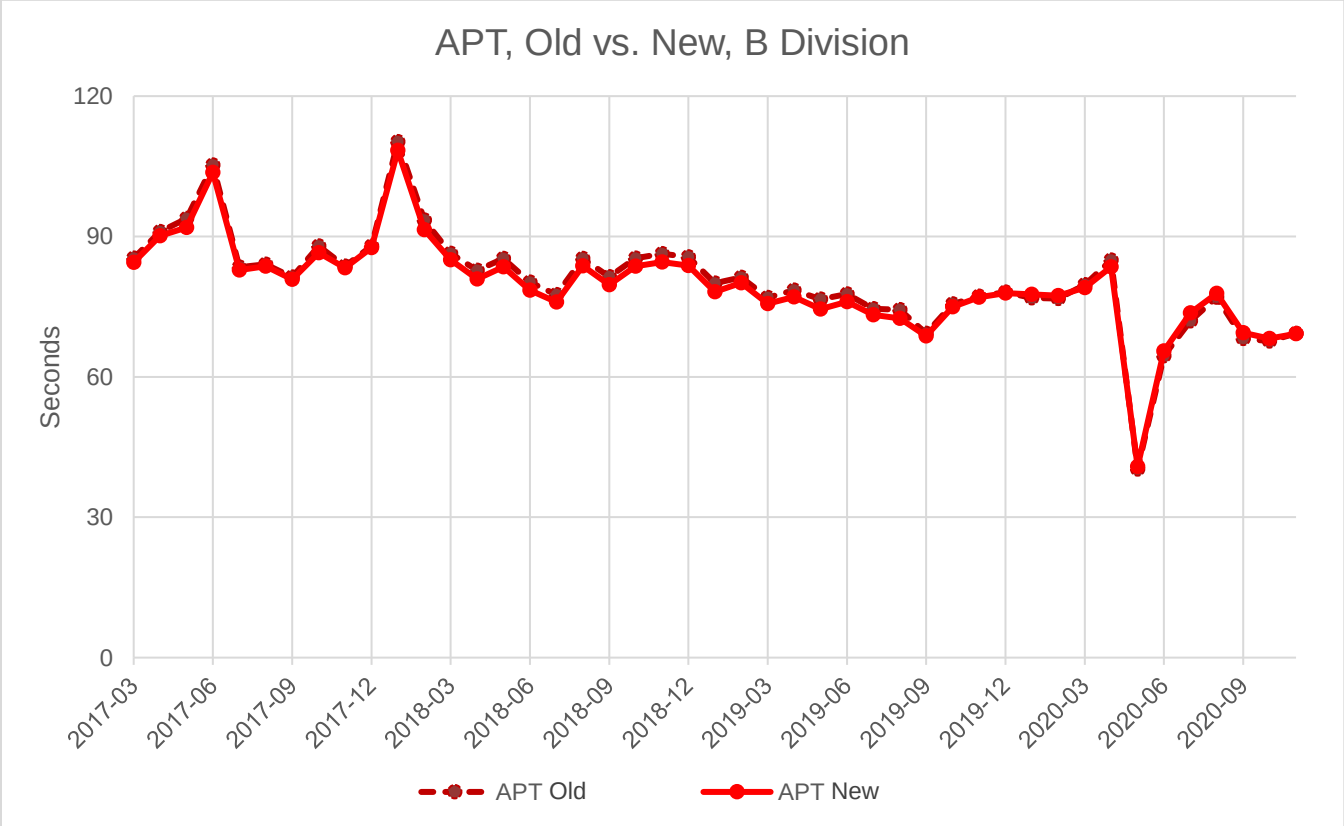
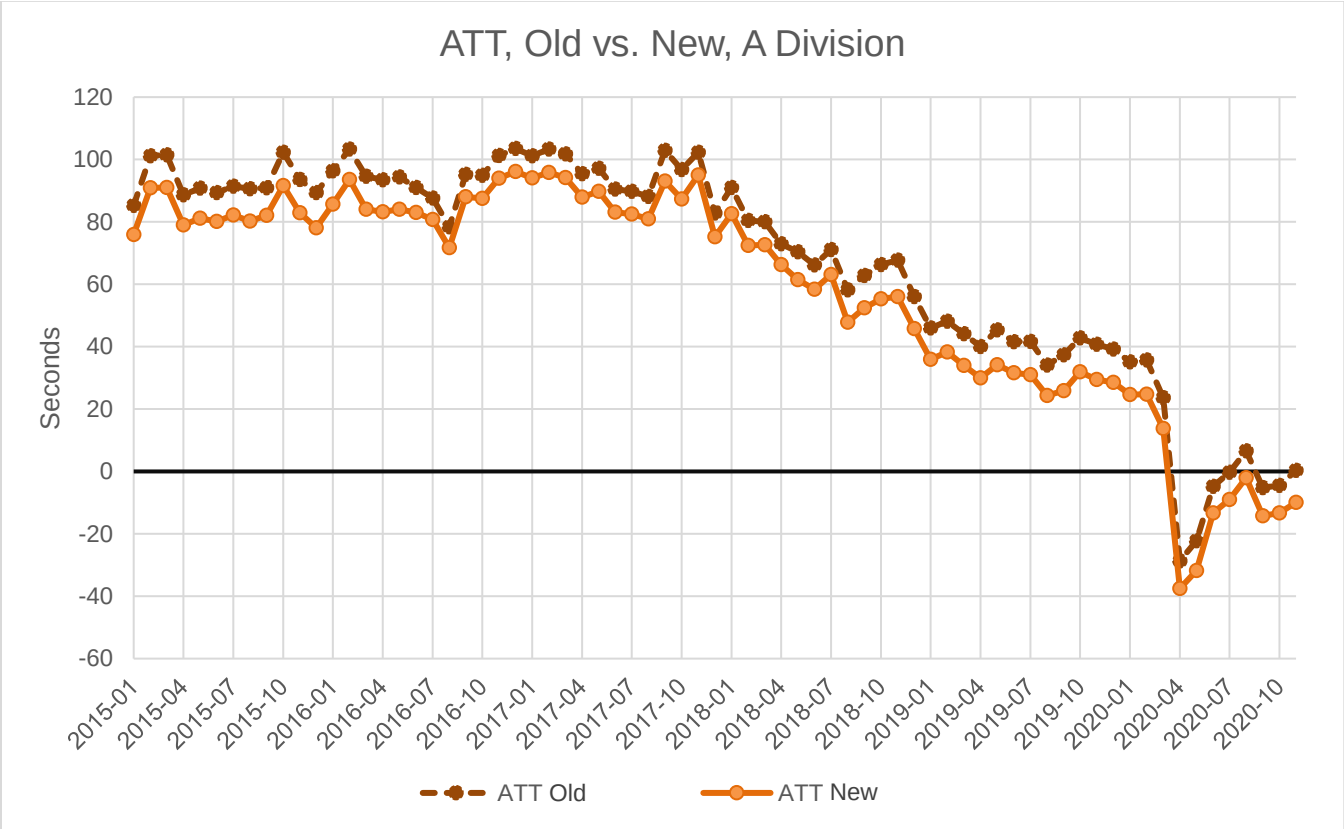
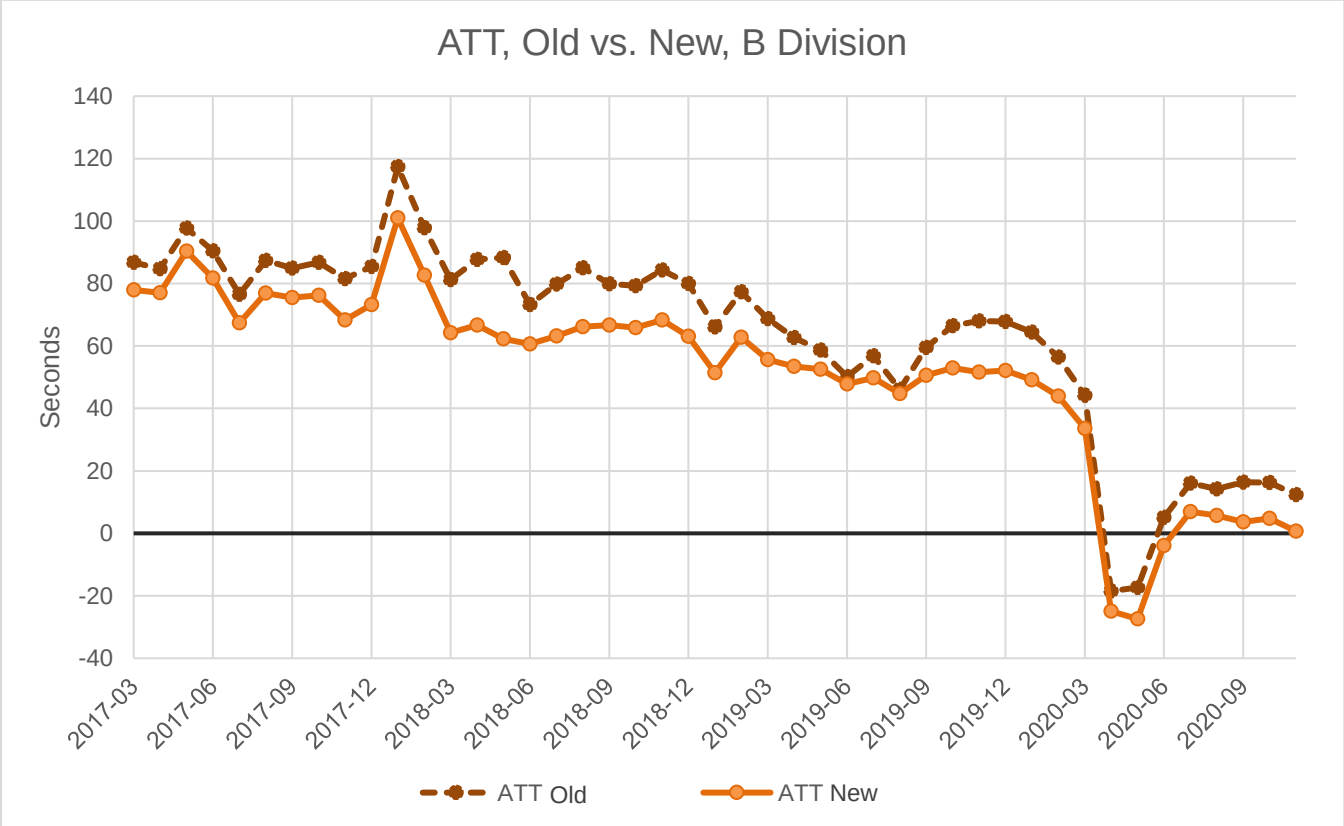
2019-04
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
APT Old
APT New


APT, Old vs. New, B Division
Seconds
120
90
60
30
0
2017-03
2017-06
2017-09
2017-12
2018-03
2018-06
2018-09
2018-12
2019-03
2019-06
2019-09
2019-12
2020-03
2020-06
2020-09
APT Old
APT New


ATT, Old vs. New, A Division
Seconds
120
100
80
60
40
20
0
-20
-40
-60
2015-01
2015-04
2015-07
2015-10
2016-01
2016-04
2016-07
2016-10
2017-01
2017-04
2017-07
2017-10
2018-01
2018-04
2018-07
2018-10
2019-01
2019-04
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
ATT Old
ATT New


ATT, Old vs. New, B Division
Seconds
140
120
100
80
60
40
20
0
-20
-40
2017-03
2017-06
2017-09
2017-12
2018-03
2018-06
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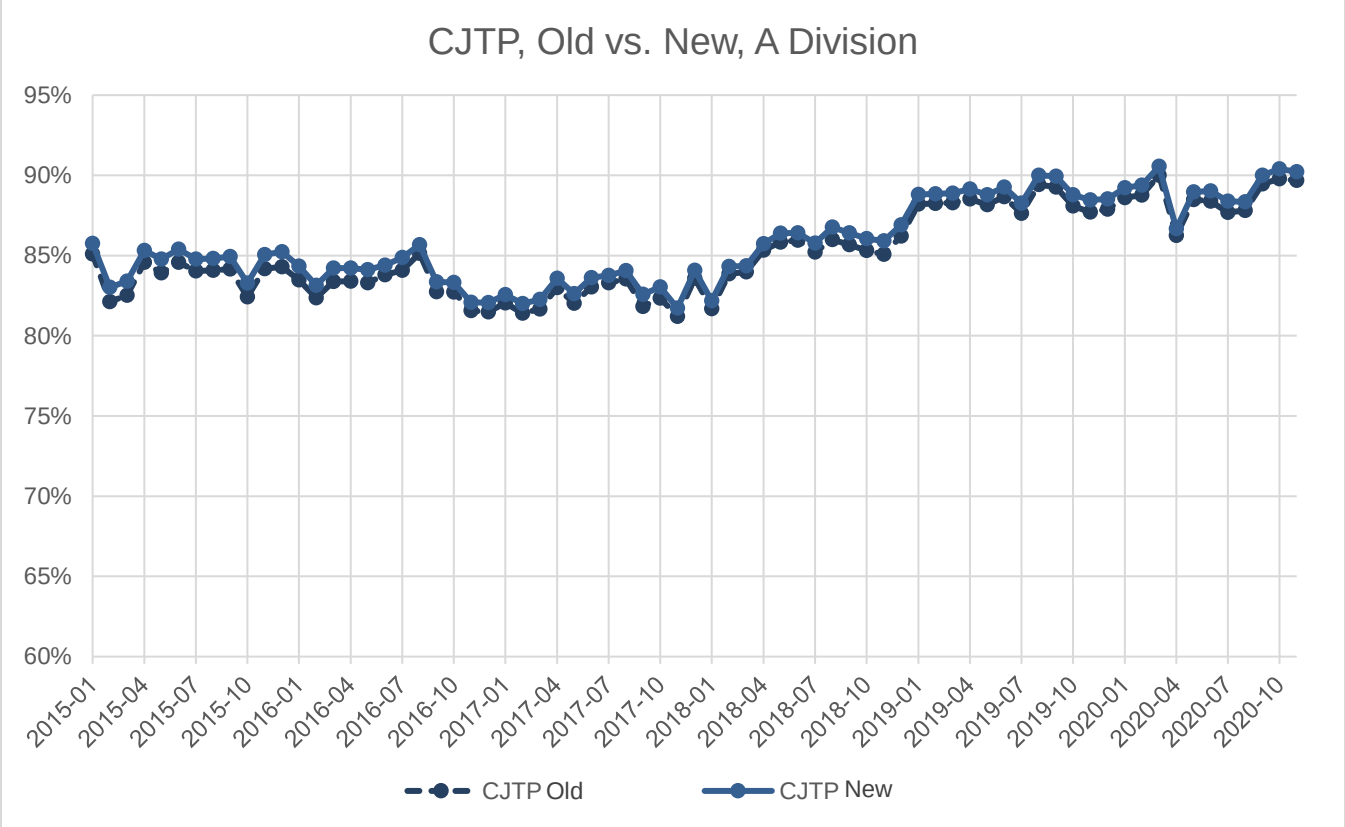
2019-12
2020-03
2020-06
2020-09
ATT Old
ATT New


CJTP, Old vs. New, A Division
95%
90%
85%
80%
75%
70%
65%
60%
2015-01
2015-04
2015-07
2015-10
2016-01
2016-04
2016-07
2016-10
2017-01
2017-04
2017-07
2017-10
2018-01
2018-04
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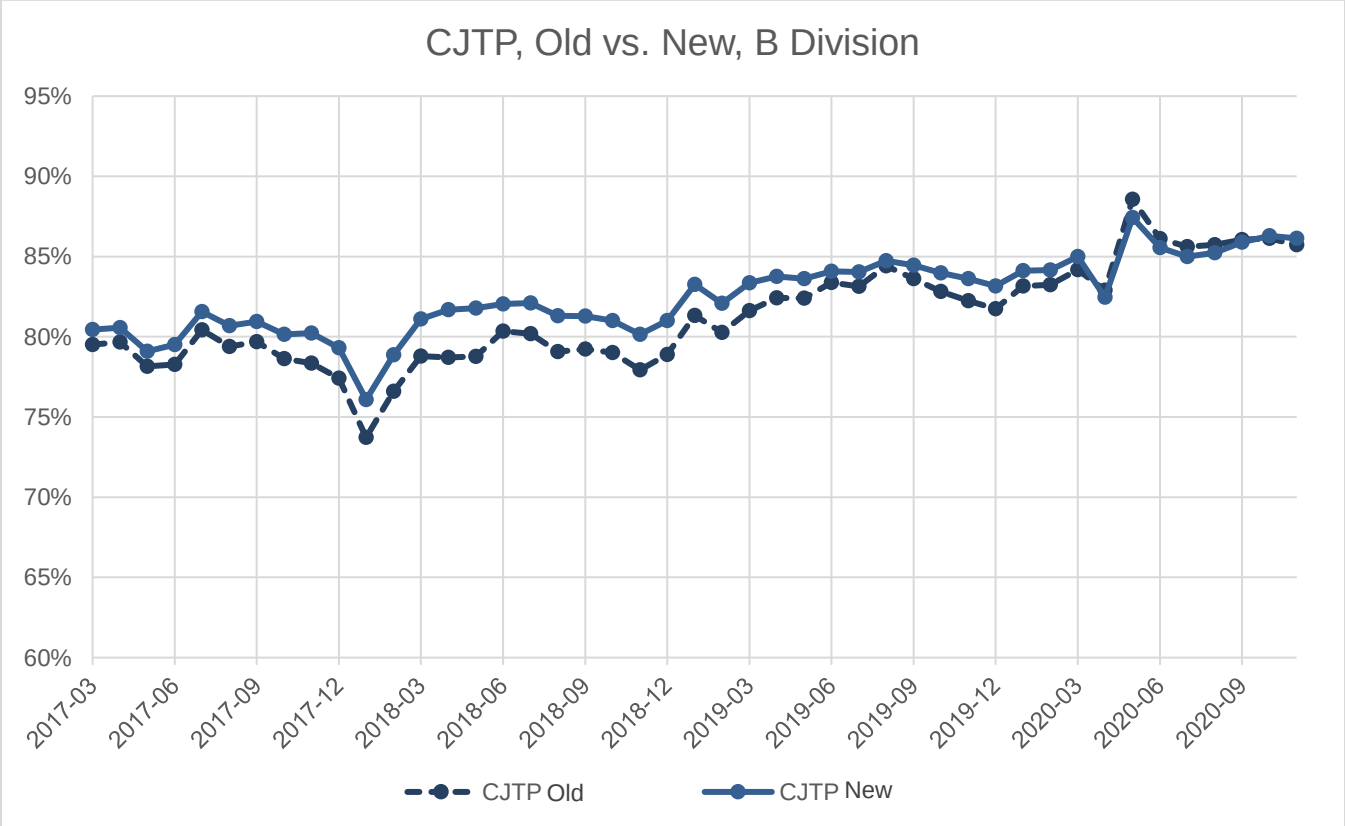
2020-07
2020-10
CJTP Old
CJTP New


CJTP, Old vs. New, B Division
95%
90%
85%
80%
75%
70%
65%
60%
2017-03
2017-06
2017-09
2017-12
2018-03
2018-06
2018-09
2018-12
2019-03
2019-06
2019-09
2019-12
2020-03
2020-06
2020-09
CJTP Old
CJTP New