

## Abstract

Abbott has a requirement that a user account be locked out after 10 failed login attempts. This paper is a Monte Carlo simulation of this were the failed attempts is not tracked by user but by user at each data center

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## 1 Background

For a recent release of CHaRM<sup>1</sup> the requirement that a user be locked out after ten failed attempts<sup>2</sup> was tested. This test failed, this feature is managed through Active Directory (AD) so a the issues was elevated to the AD team within BTS. It was determined that AD was functioning as required after BTS raised a ticket with Microsoft™ which replied that the system was working as expected due to the “Smart Logout” feature. Along with issues in how it counts attempts the failed attempts are only counted at each data center, but each request is independently routed to different data centers depending on load and something called “geo-distributed.”

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<sup>1</sup>CHaRM - Complaint Handling and Risk Management System

<sup>2</sup>Per procedure 4-010-001

## 1.1 Assumptions

This simulation is based on the following assumptions.

1. That there are 47 Azure (Microsoft cloud) data centers. Recent Microsoft advertising indicated that there are 47 data centers or backup locations supporting Azure. The specific assumption is that there are no stand-alone backup location but one data center serves as a backup location for one or more other data centers.
2. That any log-in attempt will have an equal chance to be assigned to any available data center
3. That the only impact on the number of attempts prior to lockout is from the counting of failed log-in attempts at the individual data centers. Even though this is a significant impact there are other factors in the "Smart Logout" feature that would potentially increase the total log in attempts.
4. That the random number generator has sufficient entropy for the purpose of this simulation.

## 1.2 Method

Each simulation run will consist of a data center being selected and the failed counter incremented then check to see if that counter has reached ten, what is considered a lock out. the number of attempts is then report for that run. A run will be repeated multiple times and the average and other data will be computed. These simulations will be run multiple times in an attempt to reflect actual behavior.

## 2 Simulations

### 2.1 Two Data Centers

The first simulation will be a simple case with mininual data centers. This will show the impact of the added data center.

Table 1: Simulation Parameters — First Simulation

Parameter	Value
Data Centers	2
Simulation Runs	1,000

## Results

Table 2: Simulation Results — First Simulation

Result	Value
Mean	16.357
Standard Deviation	1.98632738905159
Median	17
Maximum	19
Minimum	10

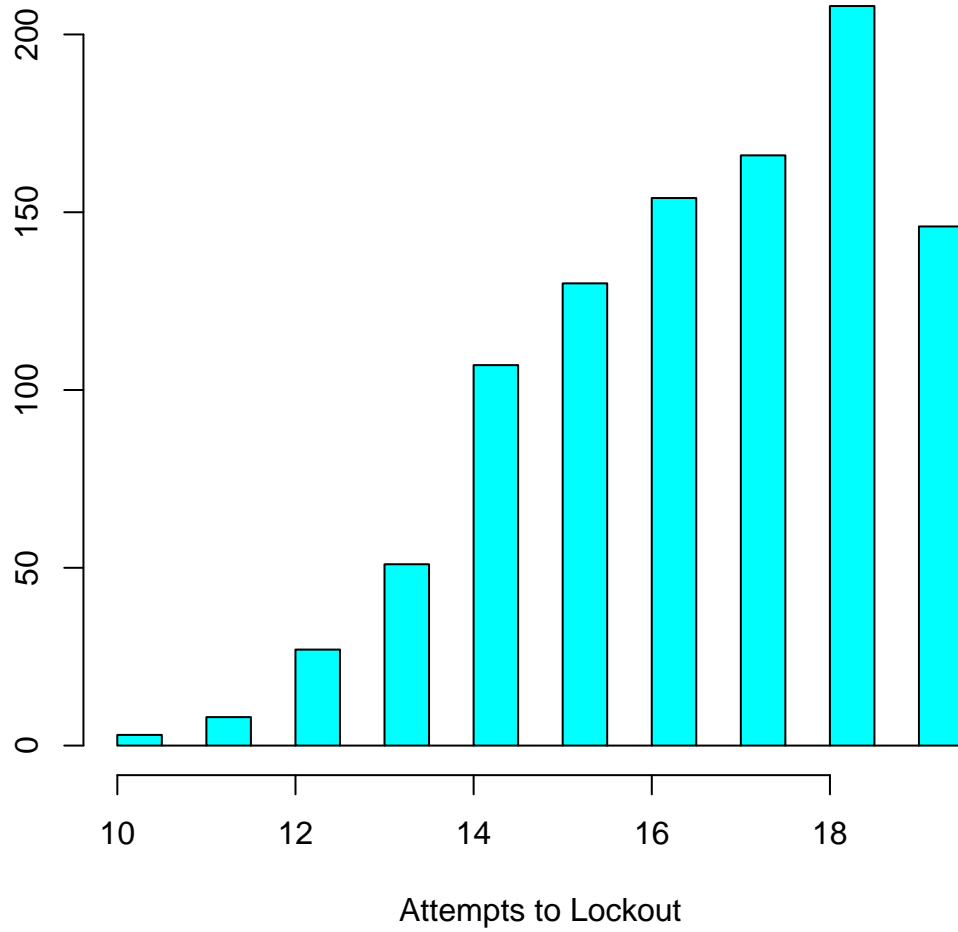


Figure 1: Histogram for 2 data centers

## 2.2 Worse case

This simulation will be for the worse case with 47 data centers hosting Abbott’s Activity Directory

Table 3: Simulation Parameters — Second Simulation

Parameter	Value
Data Centers	47
Simulation Runs	1,000

## Results

Table 4: Simulation Results — Second Simulation

Result	Value
Mean	16.357
Standard Deviation	1.98632738905159
Median	17
Maximum	19
Minimum	10

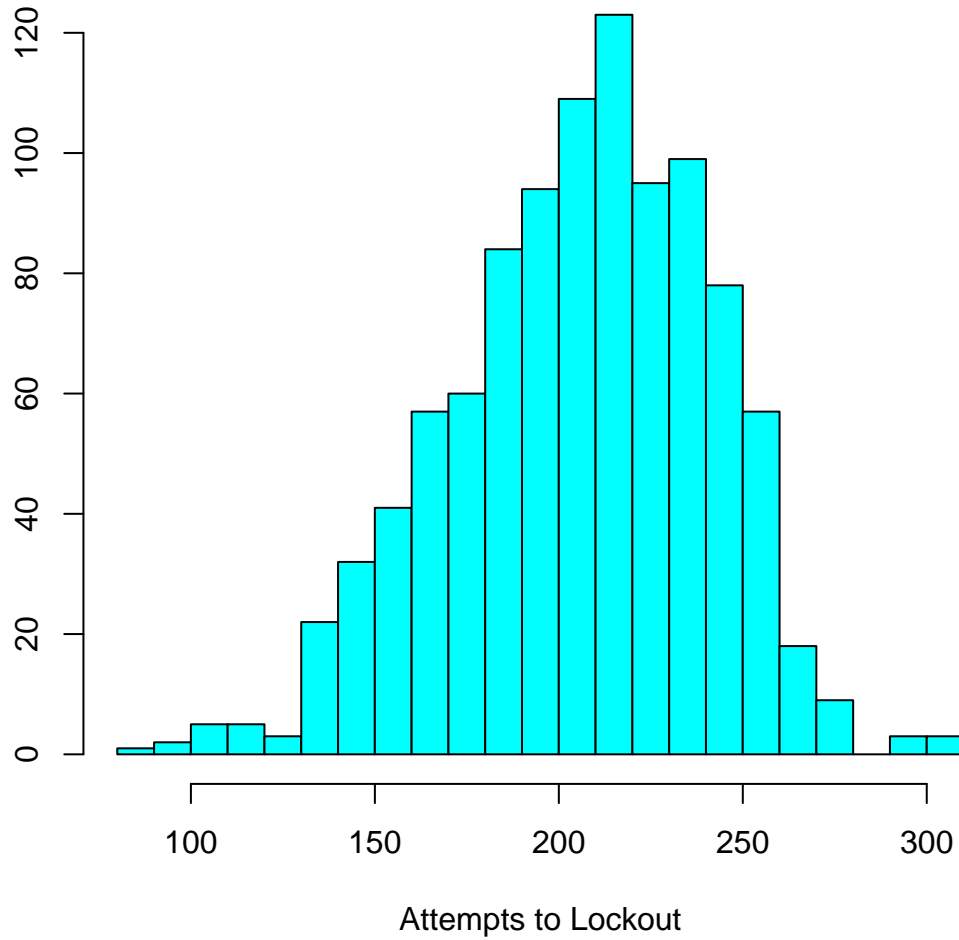


Figure 2: Histogram for 47 data centers

## 2.3 Projection of number of attempts

This graph shows the average number of attempts for data center with a minimum of 2 and a maximum of 47. It also shows a linear fit to the data along with the range for the 99.9% confidence interval. Finally, it shows the theoretical maximum and the required number (10).

Table 5: Simulation Parameters — Third Simulation

Parameter	Value
Data Centers	2 to 47
Simulation Runs	1,000

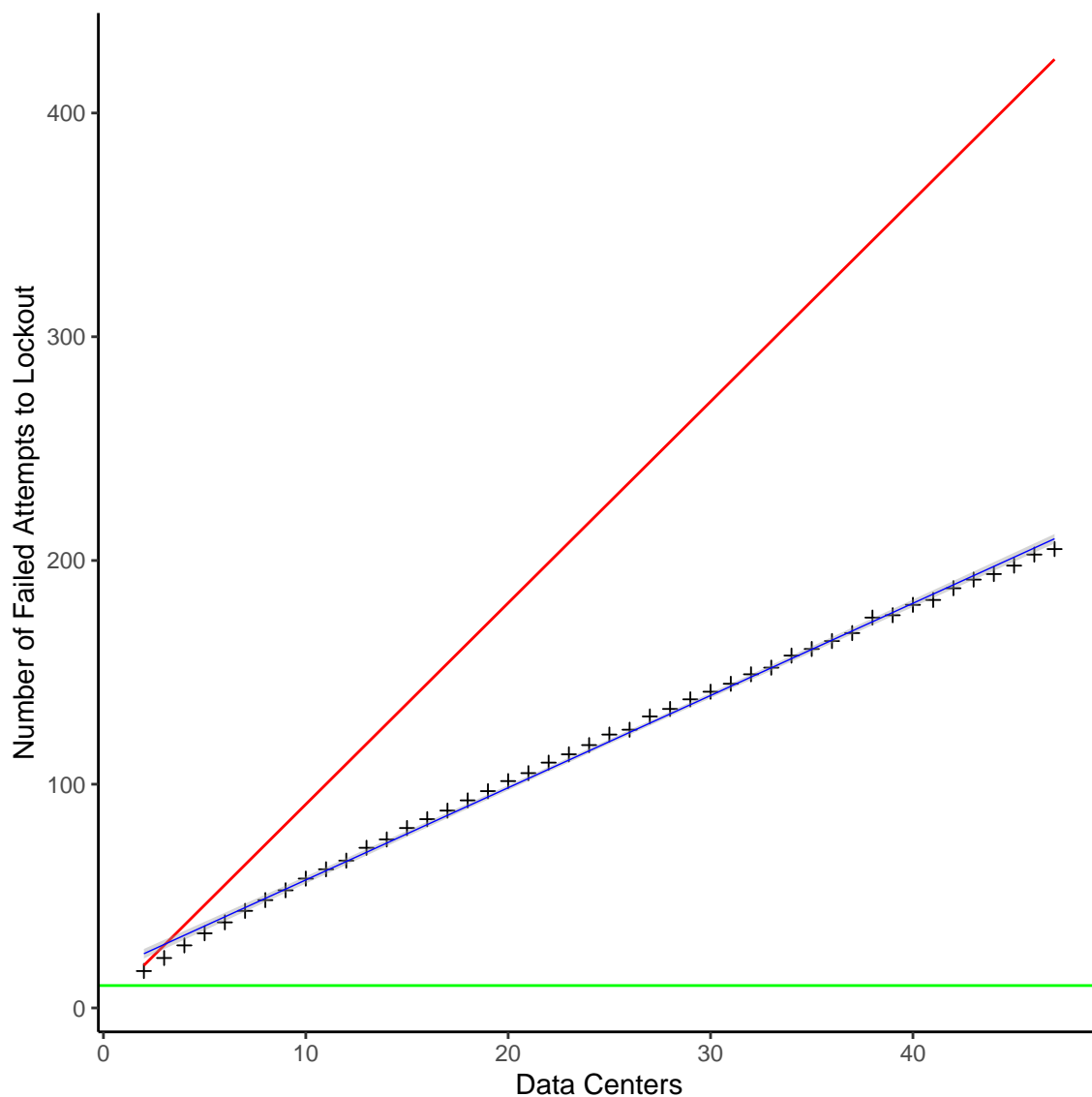


Figure 3: Graph showing predicted number of attempts for lockout for up to 47 data centers

## 2.4 Projection of number of attempts, first ten

This graph shows the average number of attempts for data center with a minimum of 2 and a maximum of 10. This is a new simulation as well that shows that the simulation results are similar between runs. The graph also shows a linear fit to the data along with the range for the 99.9% confidence interval. Finally, it shows the theoretical maximum and the required number (10).

Table 6: Simulation Parameters — Fourth Simulation

Parameter	Value
Data Centers	2 to 10
Simulation Runs	1,000

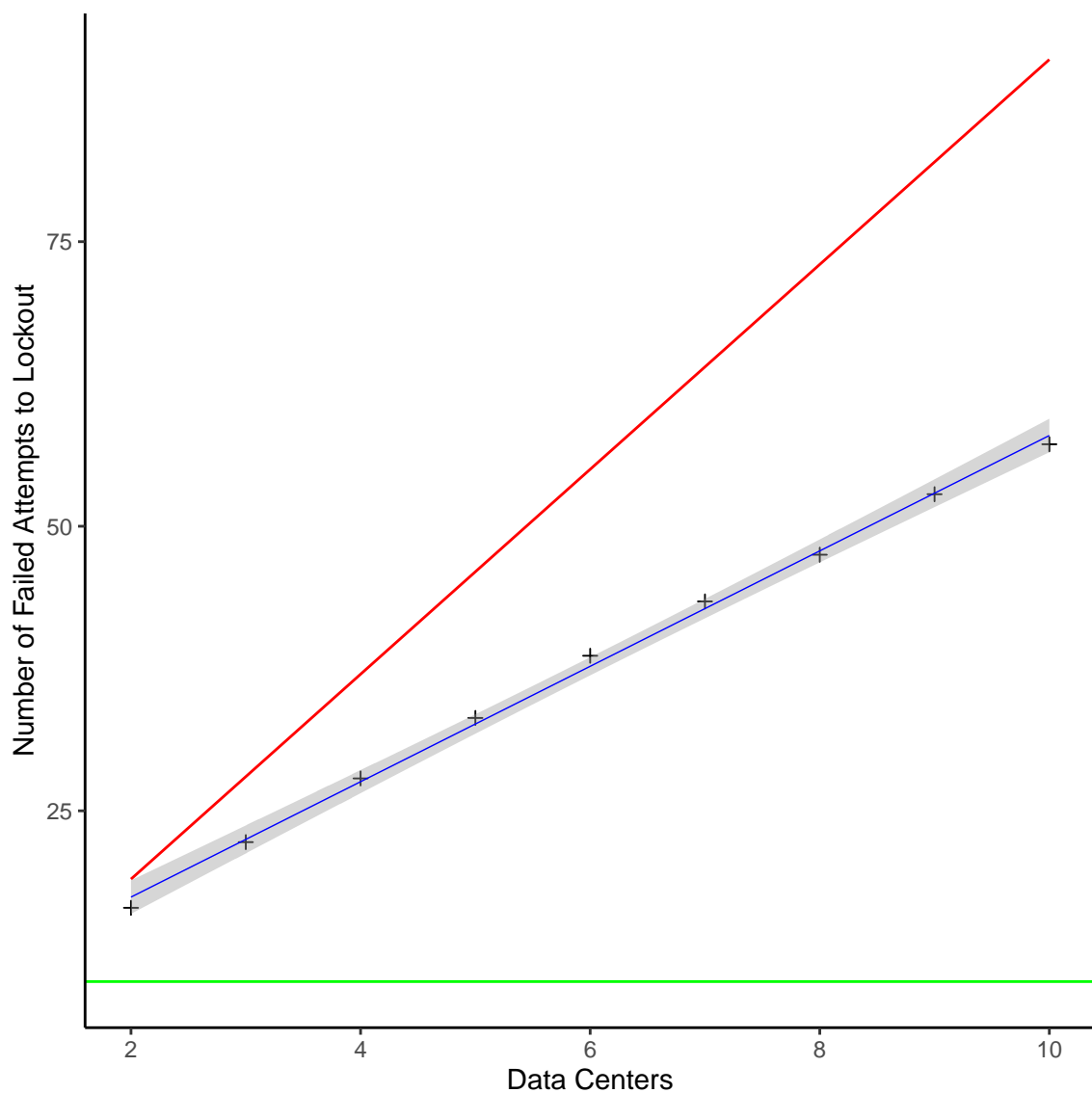


Figure 4: Graph showing predicted number of attempts for lockout for up to 10 data centers