**Bots Tokenomics study**

**Simulation code:**

We have built a complete algorithm that simulates the gameplay of 4 bots. Each bot will select different missions with different lengths in a random fashion. Resources that are given per mission are fixed considering Token Guy’s numbers. Nevertheless, these numbers will be tweaked along the process to fit into our final needs. Gameplay also considers that bots run out of energy and includes a mission to recharge the bot (which accounts for gameplay time).

Our main goal is to fine-tune emission numbers and experience numbers to have a fully levelled up bot **within 6-8 months of playtime**. To do so, we will start simulating the gameplay to set the experience thresholds for leveling. Then we will use a Montecarlo simulation to close in the exact emission values per mission.

**Fixed assumptions:**

Resources have the following importance: plastic>metal>silicon thus making plastic the most common resource and silicon the scarcest. From here, we assume that leveling rarity will always require the following ratios. 3:2:1 (plastic/metal/silicon). Bit cost will be simulated.

Recharge times will always be **40 energy/hour**.

**Mission experience simulation**

Missions XP & Energy

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Energy Cost / hour** | **XP on mission Success** | **XP on mission Fail** |
| **Plastic** | 2 | 30 | 9 |
| **Metal** | 3 | 40 | 12 |
| **Silicon** | 4 | 50 | 15 |

Based on this fixed numbers we have run 1000 simulations of 500 missions each (2000 missions in total per simulation) to get a precise number of obtained experience per hour.

**Table 1**. Numbers obtained from 1 random simulation (500 missions per bot)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Bot Name** | **Simulation Number** | **Total Game Time (Hours)** | **XP Earned** | **Average XP/hour** |
| **Bot 1** | 74 | 2.058,5 | 52.720 | 25,61 |
| **Bot 2** | 74 | 2.039,6 | 49.936 | 24,48 |
| **Bot 3** | 74 | 2.101,3 | 56.272 | 26,78 |
| **Bot 4** | 74 | 2.109,8 | 51.696 | 24,50 |

Please find all simulations on the attached document *xp\_final\_results\_1000\_runs.csv*. Having run the numbers, we calculated the average experience per hour. **This number is 24,8**. Below we show the distribution of the experience earned per hour for all simulations. As you can see the standard deviation of the simulation is less than 1, so we are confident that the obtained number sets a solid base to keep building the leveling experience.

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With the exact experience per hour accurately calculated, we can establish the maximum XP that a bot can achieve over a period of 6 to 8 months, which lies within the range of 107.136 to 142.848. Understanding the maximum achievable experience allows us to design a leveling curve that accelerates quickly at the early levels and then gradually slows down in its progression. In the table below, you’ll find the leveling progression throughout all the leveling steps.

**Table 2.** Leveling progression and expected reaching time.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Level** | **Required XP** | **Accumulative XP** | **Expected**  **Time (hours)** | **Accumulative Expected Time (Hours)** |
| Level 1 | 0 | 0 | 0,0 | 0,0 |
| Level 2 | 300 | 300 | 12,1 | 12,1 |
| Level 3 | 600 | 900 | 24,2 | 36,3 |
| Level 4 | 900 | 1.800 | 36,3 | 72,6 |
| Level 5 | 1400 | 3.200 | 56,5 | 129,0 |
| Level 6 | 1025 | 4.225 | 41,3 | 170,4 |
| Level 7 | 1095 | 5.320 | 44,2 | 214,5 |
| Level 8 | 1175 | 6.495 | 47,4 | 261,9 |
| Level 9 | 1280 | 7.775 | 51,6 | 313,5 |
| Level 10 | 1410 | 9.185 | 56,9 | 370,4 |
| Level 11 | 1580 | 10.765 | 63,7 | 434,1 |
| Level 12 | 1780 | 12.545 | 71,8 | 505,8 |
| Level 13 | 2030 | 14.575 | 81,9 | 587,7 |
| Level 14 | 2350 | 16.925 | 94,8 | 682,5 |
| Level 15 | 2740 | 19.665 | 110,5 | 792,9 |
| Level 16 | 3240 | 22.905 | 130,6 | 923,6 |
| Level 17 | 3875 | 26.780 | 156,3 | 1.079,8 |
| Level 18 | 4675 | 31.455 | 188,5 | 1.268,3 |
| Level 19 | 5710 | 37.165 | 230,2 | 1.498,6 |
| Level 20 | 7050 | 44.215 | 284,3 | 1.782,9 |
| Level 21 | 8790 | 53.005 | 354,4 | 2.137,3 |
| Level 22 | 11085 | 64.090 | 447,0 | 2.584,3 |
| Level 23 | 14115 | 78.205 | 569,2 | 3.153,4 |
| Level 24 | 18165 | 96.370 | 732,5 | 3.885,9 |
| Level 25 | 23630 | 120.000 | 952,8 | 4.838,7 |

And below we show the leveling curve throughout the different levels.

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Now that we have modelled the evolution curve of the experience, we need to determine the $BITS emission per mission. To do so, as we did with the experience, we’ll set a specific values per success/failed mission, considering the % of success mission.

**$BIT emissions simulation**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Success Rate** | **$BIT on mission Success** | **$BIT on mission Fail** |
| **Plastic** | 60% | 10 | 5 |
| **Metal** | 50% | 15 | 8 |
| **Silicon** | 40% | 20 | 10 |

As $BIT is a “global” currency, meaning that is not intrinsically tied to the bot, we will assume that a regular player will first try to bring all his bots to level 5, thus spending $BIT evenly between them, and after that, will focus on maxing out a bot. Having this in mind, we’ll need to calculate the average $BIT per hour earned by a bot (considering it will be levelled at least to level 5) and then stablish an evolutionary curve for it.

We ran 1000 simulations of 1000 missions each (4M in total) to get the average $BIT emissions per hour. From there we will model the requirements for $BIT leveling.

**Table 3**. Numbers obtained from 4 random simulations (1000 missions per bot)

|  |  |  |  |
| --- | --- | --- | --- |
| **Simulation #** | **Total Game Time (Hours)** | **$BIT Earned** | **Average $BIT/hour** |
| **150** | 16.772,7 | 220.573 | 13,15 |
| **400** | 16.967,0 | 227.299 | 13,39 |
| **700** | 16.999,4 | 226.797 | 13,34 |
| **995** | 17.222,1 | 231.488 | 13,44 |

Please find all simulations on the attached document *bit\_emissions\_results\_1000\_runs.csv*. Having run the numbers, we calculated the average $BIT emission per hour. **This number is 13.2**. (Bear in mind that along the 1000 missions, players will need to recharge their bot quite often, so they won’t be earning $BIT nor experience). Below we show the normal distribution of the expected $BIT emissions for all simulations. As you can see the standard deviation of the simulation is less than 0.3, so we are confident that the obtained number sets a solid base to keep building the leveling experience.

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Following the same reasoning applied to the experience leveling, with the exact $BIT per hour accurately calculated, we can establish the maximum $BIT that a player can achieve having 4 active bots going on missions during a period of 6 to 8 months, which lies within the range of 228.096 (57.024 x 4) to 304.128 (76.032 x 4).

Now we need to consider that these initial quantities will be first distributed evenly between the 4 bots, at least until they reach level 5 (last level of common rarity). After that we assume that the player will try to max-out one bot. Having this in mind we present the following numbers as $BIT requirements for leveling up a bot.

**Table 4.** $BIT leveling requirements for a single bot.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Level** | **Required $BIT** | **Accumulative $BIT** | **Expected**  **Time (days)** | **Accumulative Expected Time (days)** | **Expected**  **Time (days & 4 Bots)** | **Accumulative Expected Time (days & 4 Bots)** |
| Level 1 | 0 | 0 | 0,0 | 0,0 | 0,0 | 0,0 |
| Level 2 | 300 | 300 | 0,9 | 0,9 | 0,24 | 0,24 |
| Level 3 | 650 | 950 | 2,1 | 3,0 | 0,51 | 0,75 |
| Level 4 | 1.100 | 2.050 | 3,5 | 6,5 | 0,87 | 1,62 |
| Level 5 | 1.800 | 3.850 | 5,7 | 12,2 | 1,42 | 3,04 |
| Level 6 | 1.975 | 5.825 | 6,2 | 18,4 | 1,56 | 4,60 |
| Level 7 | 2.200 | 8.025 | 6,9 | 25,3 | 1,74 | 6,33 |
| Level 8 | 2.565 | 10.590 | 8,1 | 33,4 | 2,02 | 8,36 |
| Level 9 | 3.080 | 13.670 | 9,7 | 43,2 | 2,43 | 10,79 |
| Level 10 | 3.745 | 17.415 | 11,8 | 55,0 | 2,96 | 13,74 |
| Level 11 | 4.555 | 21.970 | 14,4 | 69,3 | 3,59 | 17,34 |
| Level 12 | 5.515 | 27.485 | 17,4 | 86,8 | 4,35 | 21,69 |
| Level 13 | 6.620 | 34.105 | 20,9 | 107,7 | 5,22 | 26,91 |
| Level 14 | 7.875 | 41.980 | 24,9 | 132,5 | 6,21 | 33,13 |
| Level 15 | 9.275 | 51.255 | 29,3 | 161,8 | 7,32 | 40,45 |
| Level 16 | 10.825 | 62.080 | 34,2 | 196,0 | 8,54 | 48,99 |
| Level 17 | 12.520 | 74.600 | 39,5 | 235,5 | 9,88 | 58,87 |
| Level 18 | 14.365 | 88.965 | 45,3 | 280,8 | 11,34 | 70,21 |
| Level 19 | 16.355 | 105.320 | 51,6 | 332,4 | 12,91 | 83,11 |
| Level 20 | 18.495 | 123.815 | 58,4 | 390,8 | 14,60 | 97,71 |
| Level 21 | 20.780 | 144.595 | 65,6 | 456,4 | 16,40 | 114,11 |
| Level 22 | 23.215 | 167.810 | 73,3 | 529,7 | 18,32 | 132,43 |
| Level 23 | 25.800 | 193.610 | 81,4 | 611,1 | 20,36 | 152,79 |
| Level 24 | 28.525 | 222.135 | 90,0 | 701,2 | 22,51 | 175,30 |
| Level 25 | 31.400 | 253.535 | 99,1 | 800,3 | 24,78 | 200,00 |

As we can see in the table, a single bot would take around 2 years to earn the cumulative $BIT to reach the maximum level, however as we assume that there will be 4 bots earning $BIT, that reduces the time significantly to around 6 months (our initial target). Again, we have designed the leveling experience to match the pattern that the experience leveling requires. Below we display a chart that shows experience & $BIT requirements per level.

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As we can see on the table, from level 1-5 both $BIT and experience required per bot is the same, ensuring that a Player can easily upgrade all their bots to level 5. From there, we have designed a quadratic progression for $BIT as we expect a player to try to max out only one bot so all earned $BIT from the 4 bots will be pooled to upgrade one.

Having experience and $BIT values as already “fixed”, we have run 100 simulations to see the average time a player takes to level up a single bot to level 25 (legendary – level 5) only considering experience and $BIT requirements. That information can be found in the files *‘full\_bit\_emissions\_results\_100\_runs.csv” & “full\_bot\_results\_100\_runs.csv”*

Gráfico

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From the simulations we can see that the average time having set the XP & $BIT levels and emissions can be found around the 200-210 days mark which is around 6-7 months which falls into our expectations of game progression.

Having fixed the values for experience and $BYTE to level, we will adapt the mission emissions rewards to make them fit into the built leveling curve. To make the missions more risk-rewarding we have opened the reward possibilities for longer mission durations. Below you’ll find the final numbers for mission emissions.

**Mission emissions simulation**

**Table 5.** Total mission emissions.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Success Rate** | **$BIT on mission Success** | **$BIT on mission Fail** | **Junk on mission Success** | **2-hour mission (success)** | **4-hour mission (success)** | **8-hour mission (success)** |
| **Plastic** | 60% | 10 | 5 | 2-3 | 5-7 | 9-14 | 18-28 |
| **Metal** | 50% | 15 | 8 | 2-4 | 4-6 | 7-12 | 14-24 |
| **Silicon** | 40% | 20 | 10 | 2-5 | 3-5 | 5-10 | 10-15 |

As you can see, we’ve tried to keep the ratio between resources as we have mentioned on the beginning of this study. With these numbers, we run 1000 simulations of 1500 missions for each 4 bots and we obtained the average resource/hour. As you can see in the graphs below, the standard deviation of the simulation is negligible, thus making our numbers and future assumptions accurate.

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Descripción generada automáticamente

**Table 6.** Average hourly emissions per resource.

|  |  |
| --- | --- |
|  | **Emission per hour** |
| **Plastic** | 0.66 |
| **Metal** | 0.44 |
| **Silicon** | 0.24 |
| **Junk** | 1.53 |

As you can see, we have kept the ratio between plastic:metal:silicon at 3:2:1, meaning that timewise, 3 plastic are equal to 2 metal and 1 silicon (in mission time) similar to Ogame’s mechanics (3:2:1, metal:cristal:deuterium). Junk emission is different as it is rewarded on all three missions (similar to $BYTE) but we have offered a slightly higher reward for less successful missions. Having this numbers fixed, it was just a matter of understanding the leveling times (dictated by experience & $BYTE costs) and adjust the rarity upgrade costs to it.

**Table 7.** Projected material emissions.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Emission per hour** | **4 bots emissions per hour** | **1 day emissions** | **1 month emissions** | **6 months emissions** |
| **Plastic** | 0.66 | 2.64 | 63.36 | 1900 | 11404 |
| **Metal** | 0.44 | 1.76 | 42.24 | 1267 | 7603 |
| **Silicon** | 0.24 | 0.96 | 23.04 | 691 | 4147 |
| **Junk** | 1.53 | 6.12 | 146.88 | 4406 | 26438 |

Having these numbers in mind and assuming that all resources are expended when a bot upgrades its rarity, we have set the following values for the upgrade costs. Keep in mind that the days to reach are the required days that all 4 bots should be on missions non-stop to attain the total resources. This has been shaped similarly to the days that a bot takes to reach the level that allows to change rarity.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Rarity** | **Days to Reach** | **Plastic** | **Metal** | **Silicon** | **Junk** |
| **Uncommon (Level 5)** | 10 | 635 | 420 | 230 | 1465 |
| **Rare**  **(Level 10)** | 20 | 1265 | 845 | 460 | 2940 |
| **Epic**  **(Level 15)** | 50 | 3165 | 2110 | 1150 | 7345 |
| **Legendary**  **(Level 20)** | 100 | 6335 | 4225 | 2305 | 14685 |
| **Totals** | 180 | 11400 | 7600 | 4145 | 26435 |

To prove that all numbers fit into our initial objective, we run 1000 simulations of 1500 missions each (around 9-10 months of gameplay) to see how the leveling curve reacted with the proposed mission emissions.

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As you can see in the image, where 4 random simulations are plotted, the general leveling progression, despite the changes on the level emissions is quite similar to the one that we plotted for XP/$BYTE, meaning that we are still within the 6-8 months timeframe to get a fully levelled bot. Now the average days to take a bot to the max level sits around 225-250 days due to the difficulty to upgrade a bot from epic to legendary rarities, (fully intended difficulty).

With this final simulation we conclude the Tokenomics for the Bots. All final number can be found in the “Maths.xlsx” document and all simulation numbers can be found in the drive.