Staker Reward Calculation

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Motivation

This document outlines how rewards are calculated for each staker in more detail.

NOTE: This documentation and code contains parameter config values. These config values are for illustration purposes only in order to explain how the code executes through examples. Such configs will be set at different values upon launch.

Stake Periods

- We can picture a staker's lifetime as a series of `stakePeriod`s. Each `stakePeriod` begins when a staker's staked LINK changes when they stake or unstake and lasts until the next time their staked LINK changes when they stake or unstake again.
- A staker's multiplier continues to grow until either
  - A new `stakePeriod` is started
  - The multiplier has reached the maximum ramp-up period
- A staker's total rewards is just the sum of the rewards earned within each `stakePeriod`
- When a new `stakePeriod` starts
  - The staker's multiplier is reset to 0

    - Unclaimed rewards due to the multiplier from the previous period are rolled over to the next `stakePeriod` if rewards are not forfeited. This is reflected by updating the staker’s `storedReward` field.

Calculating rewards in a `stakePeriod`

`StakerReward` struct

Unset

```
struct StakerReward {
  uint112 finalizedBaseReward;
  uint112 finalizedDelegatedReward;
  uint112 baseRewardPerToken;
  uint112 operatorDelegatedRewardPerToken;
  uint112 claimedBaseRewardInPeriod;
  StakerType stakerType;
  uint256 storedBaseReward;
  uint256 earnedBaseRewardInPeriod;
 }
```

Calculations

- The total rewards a staker has earned over their lifetime is given by. In the code `totalRewards` is tracked by the `finalizedReward` variable in the `StakerReward` struct.

$$finalizedReward_n = finalizedReward_{n-1} + claimable_n$$

- This can be generalized to:

$$finalizedReward_{total} = \sum_{stakePeriod=0}^{stakePeriods} claimable_i$$

- We can calculate the amount of claimable rewards by:

$$claimable_n = multiplier * (earnedRewards_n + unclaimedRewards_{n-1})$$

- Earned rewards are calculated by:

$$earnedRewards = stakerPrincipal * (vestedRewardPerToken - baseRewardPerToken)$$

- vestedRewardPerToken is the amount of LINK rewards made available to per staked LINK in the pool. It is given by

$$vestedRewardPerToken_n = vestedRewardPerToken_{n-1} + \frac{emittedLINK_n}{totalPoolStakedLINKAmount_n}$$

- baseRewardPerToken is the vestedRewardPerToken the last time the staker struct was updated.
- The unclaimed rewards is calculated by:

$$unclaimable_n = earnedRewards_n + unclaimedRewards_{n-1} - claimable_n$$

Ending a stakePeriod

A stakePeriod is ended whenever finalizeReward is called on the reward vault.

1. Update the staker's finalizedReward with the amount of rewards they have earned since the last time their rewards were updated.

    1. earnedRewards = stakerStakedLINKAmount * (vestedRewardPerToken - baseRewardPerToken)
    2. finalizedReward += earnedRewards * multiplier
2. Calculate unclaimed rewards

    1. If rewards are to be forfeited then they are shared amongst the remaining stakers. Example
    2. If rewards are not forfeited then we set the staker's storedBaseReward to the unclaimable amount.
3. Reset their multiplier to 0

    1. We need to ensure that the staker's claimable reward does not change at the moment a stakePeriod ends.

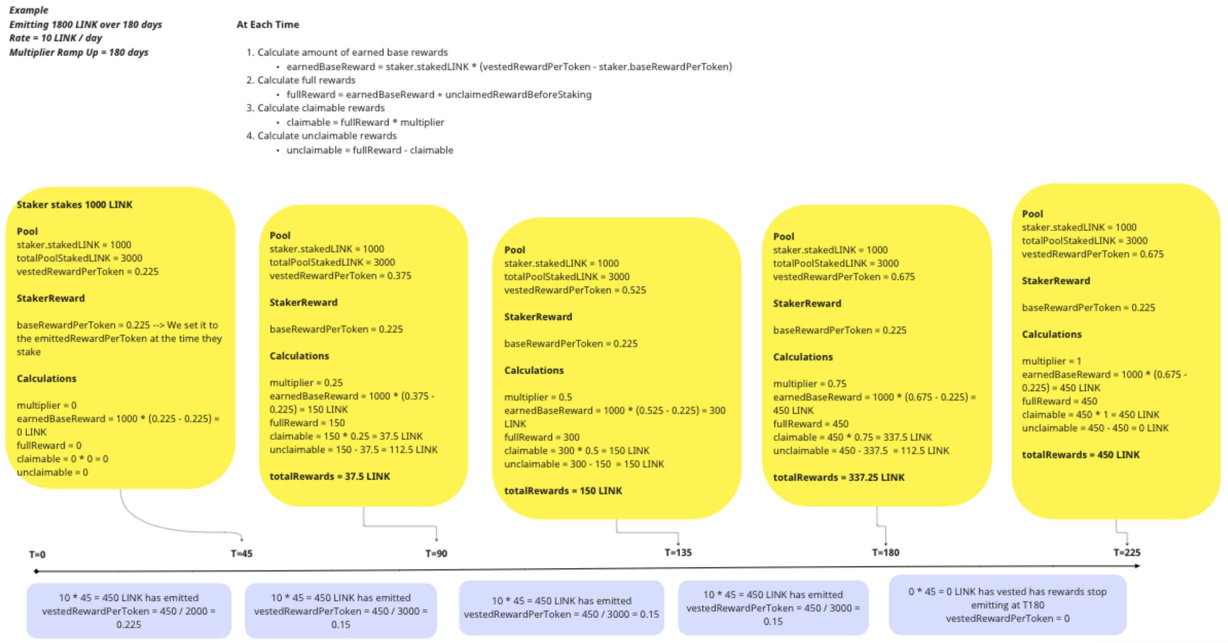
2. Resetting the multiplier to 0 will result in the reduced formula below right after finalizing the reward.

$$totalRewards_n = totalReward_{n-1}$$

Tracking Missed And Already Earned Rewards

- The `StakerReward` struct stores the amount of missed and earned rewards per token in the `baseRewardPerToken` field. This field is updated whenever the staker's reward is updated when the `_updateStakerReward` function is called inside `finalizeReward`
- The formula to calculate the amount of rewards the staker has earned since the last time their reward was updated is given by

$$earnedRewards = stakerPrincipal * (vestedRewardPerToken - baseRewardPerToken)$$



Example
Emitting 1800 LINK over 180 days
Rate = 10 LINK / day
Multiplier Ramp Up = 180 days

At Each Time

1. Calculate amount of earned base rewards
   - earnedBaseReward = staker.stakedLINK * (vestedRewardPerToken - staker.baseRewardPerToken)
2. Calculate full rewards
   - fullReward = earnedBaseReward + unclaimedRewardBeforeStaking
3. Calculate claimable rewards
   - claimable = fullReward * multiplier
4. Calculate unclaimable rewards
   - unclaimable = fullReward - claimable

Staker stakes 1000 LINK

Pool
staker.stakedLINK = 1000
totalPoolStakedLINK = 3000
vestedRewardPerToken = 0.225

StakerReward

baseRewardPerToken = 0.225 --> We set it to the emittedRewardPerToken at the time they stake

Calculations

multiplier = 0
earnedBaseReward = 1000 * (0.225 - 0.225) = 0 LINK
fullReward = 0
claimable = 0 * 0 = 0
unclaimable = 0

Pool
staker.stakedLINK = 1000
totalPoolStakedLINK = 3000
vestedRewardPerToken = 0.375

StakerReward

baseRewardPerToken = 0.225

Calculations

multiplier = 0.25
earnedBaseReward = 1000 * (0.375 - 0.225) = 150 LINK
fullReward = 150
claimable = 150 * 0.25 = 37.5 LINK
unclaimable = 150 - 37.5 = 112.5 LINK

totalRewards = 37.5 LINK

Pool
staker.stakedLINK = 1000
totalPoolStakedLINK = 3000
vestedRewardPerToken = 0.525

StakerReward

baseRewardPerToken = 0.225

Calculations

multiplier = 0.5
earnedBaseReward = 1000 * (0.525 - 0.225) = 300 LINK
fullReward = 300
claimable = 300 * 0.5 = 150 LINK
unclaimable = 300 - 150 = 150 LINK

totalRewards = 150 LINK

Pool
staker.stakedLINK = 1000
totalPoolStakedLINK = 3000
vestedRewardPerToken = 0.675

StakerReward

baseRewardPerToken = 0.225

Calculations

multiplier = 0.75
earnedBaseReward = 1000 * (0.675 - 0.225) = 450 LINK
fullReward = 450
claimable = 450 * 0.75 = 337.5 LINK
unclaimable = 450 - 337.5 = 112.5 LINK

totalRewards = 337.25 LINK

Pool
staker.stakedLINK = 1000
totalPoolStakedLINK = 3000
vestedRewardPerToken = 0.675

StakerReward

baseRewardPerToken = 0.225

Calculations

multiplier = 1
earnedBaseReward = 1000 * (0.675 - 0.225) = 450 LINK
fullReward = 450
claimable = 450 * 1 = 450 LINK
unclaimable = 450 - 450 = 0 LINK

totalRewards = 450 LINK

10 * 45 = 450 LINK has emitted
vestedRewardPerToken = 450 / 2000 = 0.225

10 * 45 = 450 LINK has emitted
vestedRewardPerToken = 450 / 3000 = 0.15

10 * 45 = 450 LINK has emitted
vestedRewardPerToken = 450 / 3000 = 0.15

10 * 45 = 450 LINK has emitted
vestedRewardPerToken = 450 / 3000 = 0.15

0 * 45 = 0 LINK has vested has rewards stop emitting at T180
vestedRewardPerToken = 0

Staker Lifetime `stakePeriod` Examples

Stakers Take No Action

Stakers no action

vestedRewardPerToken: The amount of LINK rewards emitted per staked token
= previousVestedRewardPerToken + vestedLINKBetweenPeriod / totalStakedLINK

multiplier: The staker's current multiplier
= (currentTime - averageStakedAtTime) / multiplierRampUp

storedReward - Stores any unclaimable rewards before the multiplier is reset
= unclaimable

baseRewardPerToken: The amount of missed and already distributed rewards per token.
= vestedRewardPerToken at the time a staker stakes/unstakes

finalizedReward: The amount of rewards that have been saved before the staker's multiplier changes
previousFinalizedReward + fullReward * multiplier

fullReward: The amount of rewards that have been vested to the staker since the last time their reward was finalized
= storedReward + (vestedRewardPerToken - baseRewardPerToken) * principal

claimable: The amount of full rewards that the staker can claim after the multiplier is applied
= multiplier * fullReward

unclaimable: The amount of full rewards that the staker cannot claim yet due to their multiplier
= fullReward - claimable

getReward: The amount of rewards the staker can claim today
= finalizedReward + claimable

Example
Emitting 1800 LINK over 180 days
Emission Rate = 10 LINK / day
Multiplier Ramp Up = 180 days

Day 0

Emitted LINK = 0
vestedRewardPerToken = 0

StakerReward struct variables

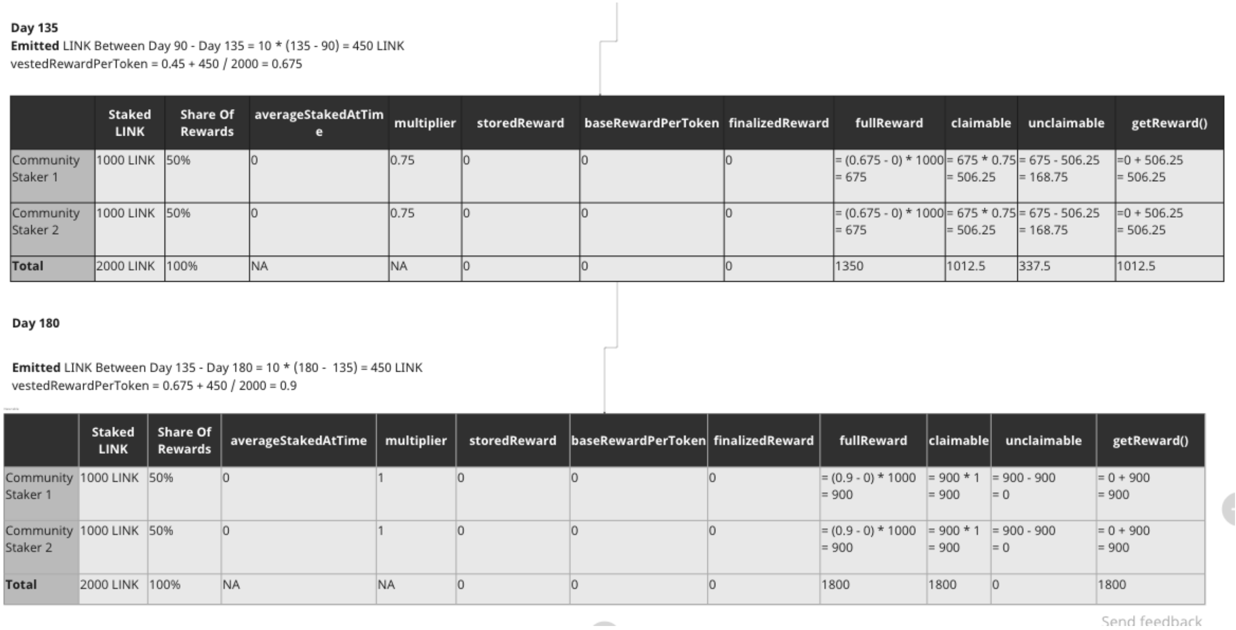
Calculated Values

	Staked LINK	Share Of Rewards	averageStakedAtTime	multiplier	storedReward	baseRewardPerToken	finalizedReward	fullReward	claimable	unclaimable	getReward()
Community Staker 1	1000 LINK	50%	0	0	0	0	0	0	0	0	0
Community Staker 2	1000 LINK	50%	0	0	0	0	0	0	0	0	0
Total	2000 LINK	100%	0	0	N/A	0	0	0	0	0	0

Day 90

Emitted LINK Between Day 0 - Day 90 = 90 * 10 = 900 LINK
vestedRewardPerToken = 900 / 2000 = 0.45
Multiplier Ramp Up = 180 days

	Staked LINK	Share Of Rewards	averageStakedAtTime	multiplier	storedReward	baseRewardPerToken	finalizedReward	fullReward	claimable	unclaimable	getReward()
Community Staker 1	1000 LINK	50%	0	0.5	0	0	0	= (0.45 - 0) * 1000 = 450	225	225	= 0 + 450 * 0.5 = 225
Community Staker 2	1000 LINK	50%	0	0.5	0	0	0	450	225	225	= 0 + 450 * 0.5 = 225
Total	2000 LINK	100%	0	NA	0	0	0	900	450	450	450



Day 135
Emitted LINK Between Day 90 - Day 135 = 10 * (135 - 90) = 450 LINK
vestedRewardPerToken = 0.45 + 450 / 2000 = 0.675

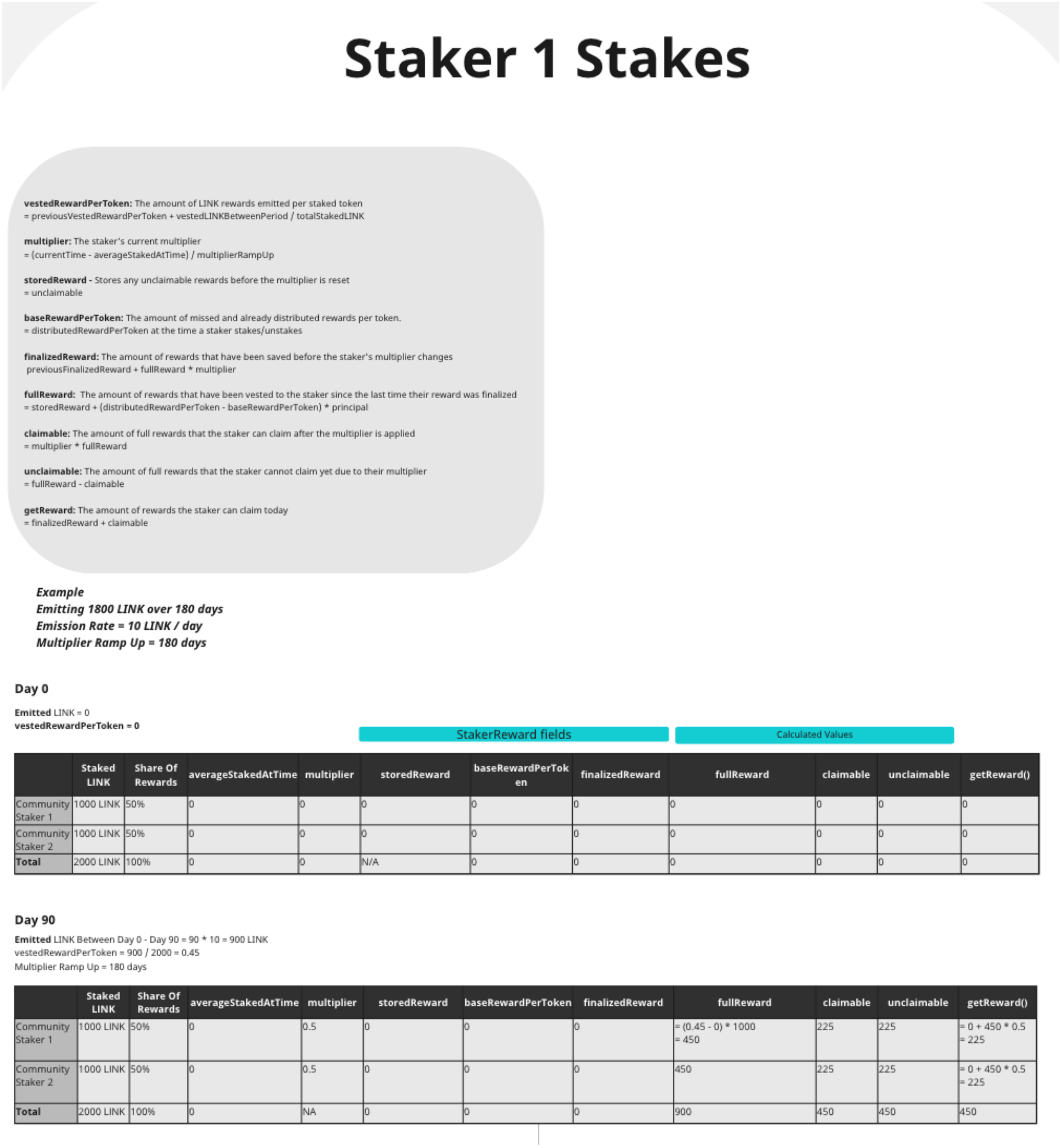
	Staked LINK	Share Of Rewards	averageStakedAtTime	multiplier	storedReward	baseRewardPerToken	finalizedReward	fullReward	claimable	unclaimable	getReward()
Community Staker 1	1000 LINK	50%	0	0.75	0	0	0	= (0.675 - 0) * 1000 = 675	= 675 * 0.75 = 506.25	= 675 - 506.25 = 168.75	=0 + 506.25 = 506.25
Community Staker 2	1000 LINK	50%	0	0.75	0	0	0	= (0.675 - 0) * 1000 = 675	= 675 * 0.75 = 506.25	= 675 - 506.25 = 168.75	=0 + 506.25 = 506.25
Total	2000 LINK	100%	NA	NA	0	0	0	1350	1012.5	337.5	1012.5

Day 180

Emitted LINK Between Day 135 - Day 180 = 10 * (180 - 135) = 450 LINK
vestedRewardPerToken = 0.675 + 450 / 2000 = 0.9

	Staked LINK	Share Of Rewards	averageStakedAtTime	multiplier	storedReward	baseRewardPerToken	finalizedReward	fullReward	claimable	unclaimable	getReward()
Community Staker 1	1000 LINK	50%	0	1	0	0	0	= (0.9 - 0) * 1000 = 900	= 900 * 1 = 900	= 900 - 900 = 0	= 0 + 900 = 900
Community Staker 2	1000 LINK	50%	0	1	0	0	0	= (0.9 - 0) * 1000 = 900	= 900 * 1 = 900	= 900 - 900 = 0	= 0 + 900 = 900
Total	2000 LINK	100%	NA	NA	0	0	0	1800	1800	0	1800

One Staker Stakes



Staker 1 Stakes

vestedRewardPerToken: The amount of LINK rewards emitted per staked token
= previousVestedRewardPerToken + vestedLINKBetweenPeriod / totalStakedLINK

multiplier: The staker's current multiplier
= (currentTime - averageStakedAtTime) / multiplierRampUp

storedReward - Stores any unclaimable rewards before the multiplier is reset
= unclaimable

baseRewardPerToken: The amount of missed and already distributed rewards per token.
= distributedRewardPerToken at the time a staker stakes/unstakes

finalizedReward: The amount of rewards that have been saved before the staker's multiplier changes
previousFinalizedReward + fullReward * multiplier

fullReward: The amount of rewards that have been vested to the staker since the last time their reward was finalized
= storedReward + (distributedRewardPerToken - baseRewardPerToken) * principal

claimable: The amount of full rewards that the staker can claim after the multiplier is applied
= multiplier * fullReward

unclaimable: The amount of full rewards that the staker cannot claim yet due to their multiplier
= fullReward - claimable

getReward: The amount of rewards the staker can claim today
= finalizedReward + claimable

Example
Emitting 1800 LINK over 180 days
Emission Rate = 10 LINK / day
Multiplier Ramp Up = 180 days

Day 0

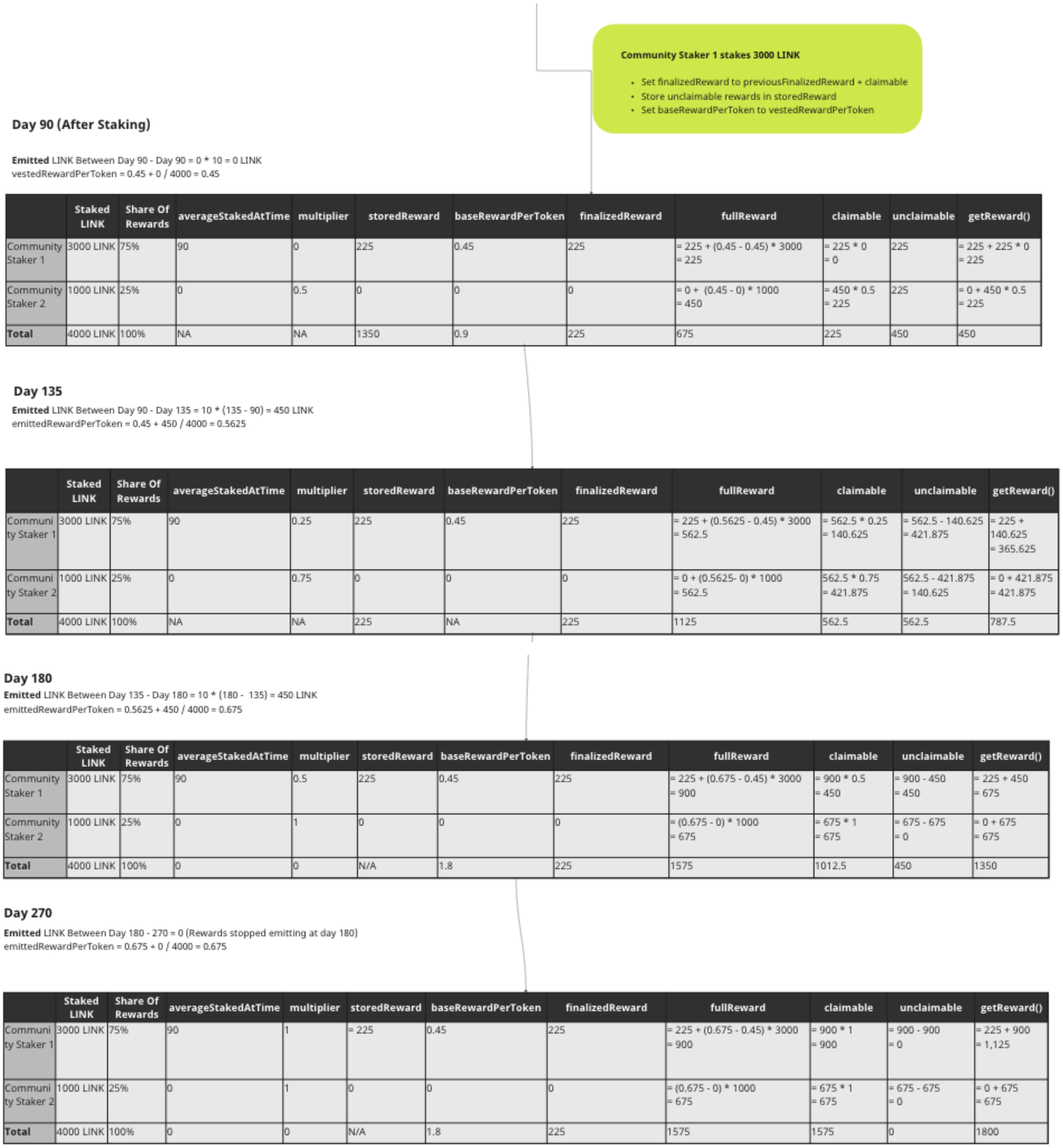
Emitted LINK = 0
vestedRewardPerToken = 0

					StakerReward fields			Calculated Values			
	Staked LINK	**Share Of Rewards**	**averageStakedAtTime**	**multiplier**	**storedReward**	**baseRewardPerToken**	**finalizedReward**	**fullReward**	**claimable**	**unclaimable**	**getReward()**
Community Staker 1	1000 LINK	50%	0	0	0	0	0	0	0	0	0
Community Staker 2	1000 LINK	50%	0	0	0	0	0	0	0	0	0
Total	2000 LINK	100%	0	0	N/A	0	0	0	0	0	0

Day 90

Emitted LINK Between Day 0 - Day 90 = 90 * 10 = 900 LINK
vestedRewardPerToken = 900 / 2000 = 0.45
Multiplier Ramp Up = 180 days

	Staked LINK	**Share Of Rewards**	**averageStakedAtTime**	**multiplier**	**storedReward**	**baseRewardPerToken**	**finalizedReward**	**fullReward**	**claimable**	**unclaimable**	**getReward()**
Community Staker 1	1000 LINK	50%	0	0.5	0	0	0	= (0.45 - 0) * 1000 = 450	225	225	= 0 + 450 * 0.5 = 225
Community Staker 2	1000 LINK	50%	0	0.5	0	0	0	450	225	225	= 0 + 450 * 0.5 = 225
Total	2000 LINK	100%	0	NA	0	0	0	900	450	450	450



Community Staker 1 stakes 3000 LINK

- Set finalizedReward to previousFinalizedReward + claimable
- Store unclaimable rewards in storedReward
- Set baseRewardPerToken to vestedRewardPerToken

Day 90 (After Staking)

Emitted LINK Between Day 90 - Day 90 = 0 * 10 = 0 LINK
vestedRewardPerToken = 0.45 + 0 / 4000 = 0.45

	Staked LINK	Share Of Rewards	averageStakedAtTime	multiplier	storedReward	baseRewardPerToken	finalizedReward	fullReward	claimable	unclaimable	getReward()
Community Staker 1	3000 LINK	75%	90	0	225	0.45	225	= 225 + (0.45 - 0.45) * 3000 = 225	= 225 * 0 = 0	225	= 225 + 225 * 0 = 225
Community Staker 2	1000 LINK	25%	0	0.5	0	0	0	= 0 + (0.45 - 0) * 1000 = 450	= 450 * 0.5 = 225	225	= 0 + 450 * 0.5 = 225
Total	4000 LINK	100%	NA	NA	1350	0.9	225	675	225	450	450

Day 135

Emitted LINK Between Day 90 - Day 135 = 10 * (135 - 90) = 450 LINK
emittedRewardPerToken = 0.45 + 450 / 4000 = 0.5625

	Staked LINK	Share Of Rewards	averageStakedAtTime	multiplier	storedReward	baseRewardPerToken	finalizedReward	fullReward	claimable	unclaimable	getReward()
Community Staker 1	3000 LINK	75%	90	0.25	225	0.45	225	= 225 + (0.5625 - 0.45) * 3000 = 562.5	= 562.5 * 0.25 = 140.625	= 562.5 - 140.625 = 421.875	= 225 + 140.625 = 365.625
Community Staker 2	1000 LINK	25%	0	0.75	0	0	0	= 0 + (0.5625- 0) * 1000 = 562.5	562.5 * 0.75 = 421.875	562.5 - 421.875 = 140.625	= 0 + 421.875 = 421.875
Total	4000 LINK	100%	NA	NA	225	NA	225	1125	562.5	562.5	787.5

Day 180

Emitted LINK Between Day 135 - Day 180 = 10 * (180 - 135) = 450 LINK
emittedRewardPerToken = 0.5625 + 450 / 4000 = 0.675

	Staked LINK	Share Of Rewards	averageStakedAtTime	multiplier	storedReward	baseRewardPerToken	finalizedReward	fullReward	claimable	unclaimable	getReward()
Community Staker 1	3000 LINK	75%	90	0.5	225	0.45	225	= 225 + (0.675 - 0.45) * 3000 = 900	= 900 * 0.5 = 450	= 900 - 450 = 450	= 225 + 450 = 675
Community Staker 2	1000 LINK	25%	0	1	0	0	0	= (0.675 - 0) * 1000 = 675	= 675 * 1 = 675	= 675 - 675 = 0	= 0 + 675 = 675
Total	4000 LINK	100%	0	0	N/A	1.8	225	1575	1012.5	450	1350

Day 270

Emitted LINK Between Day 180 - 270 = 0 (Rewards stopped emitting at day 180)
emittedRewardPerToken = 0.675 + 0 / 4000 = 0.675

	Staked LINK	Share Of Rewards	averageStakedAtTime	multiplier	storedReward	baseRewardPerToken	finalizedReward	fullReward	claimable	unclaimable	getReward()
Community Staker 1	3000 LINK	75%	90	1	= 225	0.45	225	= 225 + (0.675 - 0.45) * 3000 = 900	= 900 * 1 = 900	= 900 - 900 = 0	= 225 + 900 = 1,125
Community Staker 2	1000 LINK	25%	0	1	0	0	0	= (0.675 - 0) * 1000 = 675	= 675 * 1 = 675	= 675 - 675 = 0	= 0 + 675 = 675
Total	4000 LINK	100%	0	0	N/A	1.8	225	1575	1575	0	1800

One Staker Unstakes

Staker 1 Unstakes

vestedRewardPerToken: The amount of LINK rewards earned per staked token
= previousVestedRewardPerToken + vestedLINKBetweenPeriod / totalStakedLINK

multiplier: The staker's current multiplier
= (currentTime - averageStakedAtTime) / multiplierRampUp

storedReward - Stores any unclaimable rewards before the multiplier is reset
= unclaimable

baseRewardPerToken: The amount of missed and already distributed rewards per token.
= distributedRewardPerToken at the time a staker stakes/unstakes

finalizedReward: The amount of rewards that have been saved before the staker's multiplier changes
previousFinalizedReward + fullReward * multiplier

fullReward: The amount of rewards that have been vested to the staker since the last time their reward was finalized
= storedReward + (distributedRewardPerToken - baseRewardPerToken) * principal

claimable: The amount of full rewards that the staker can claim after the multiplier is applied
= multiplier * fullReward

unclaimable: The amount of full rewards that the staker cannot claim yet due to their multiplier
= fullReward - claimable

getReward: The amount of rewards the staker can claim today
= finalizedReward + claimable

Example
Emitting 1800 LINK over 180 days
Emission Rate = 10 LINK / day
Multiplier Ramp Up = 180 days

Day 0

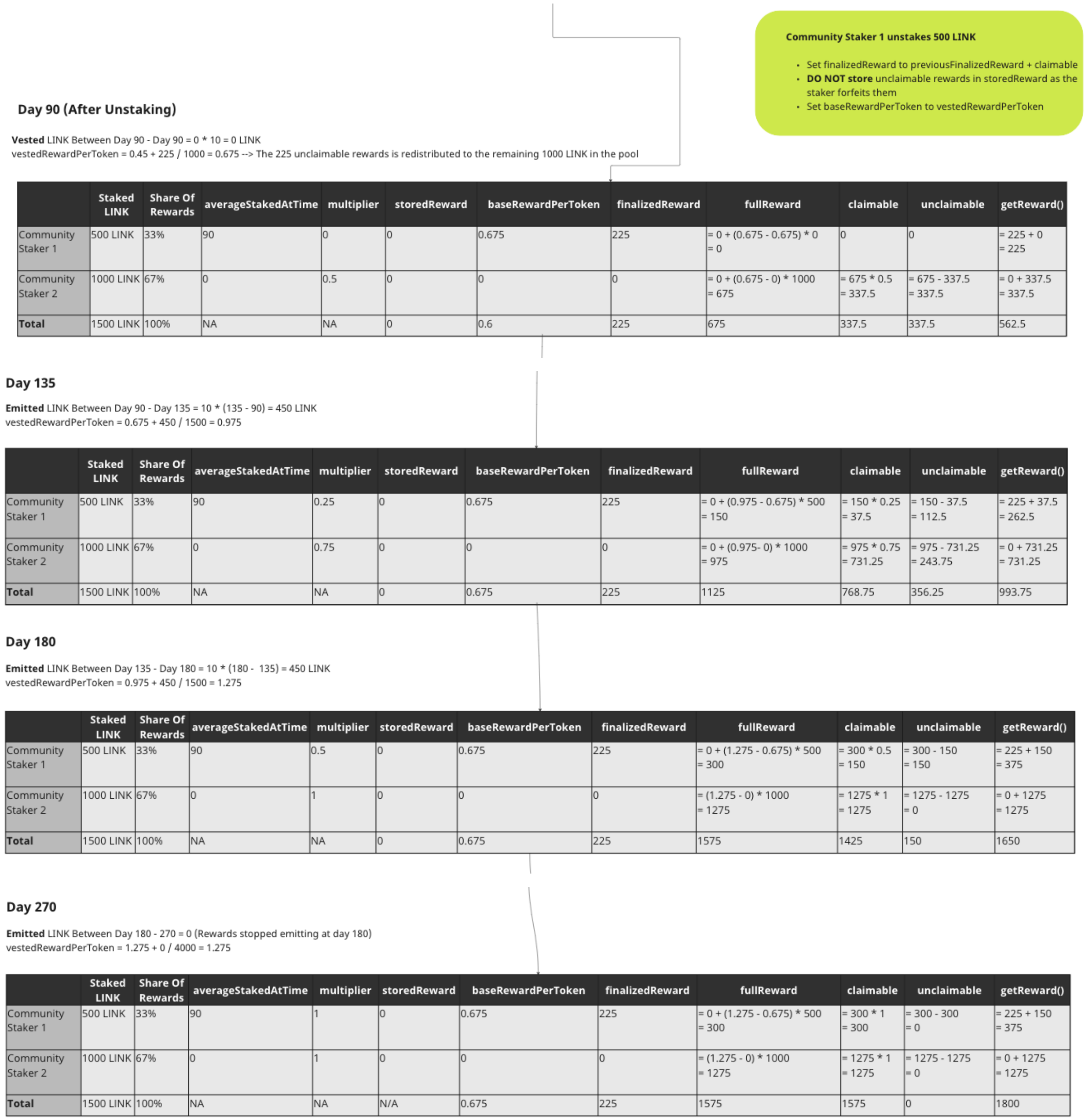
Emitted LINK = 0
vestedRewardPerToken = 0

					StakerReward struct variables			Calculated Values			
	Staked LINK	**Share Of Rewards**	**averageStakedAtTime**	**multiplier**	**storedReward**	**baseRewardPerToken**	**finalizedReward**	**fullReward**	**claimable**	**unclaimable**	**getReward()**
Community Staker 1	1000 LINK	50%	0	0	0	0	0	0	0	0	0
Community Staker 2	1000 LINK	50%	0	0	0	0	0	0	0	0	0
Total	2000 LINK	100%	0	0	N/A	0	0	0	0	0	0

Day 90

Emitted LINK Between Day 0 - Day 90 = 90 * 10 = 900 LINK
vestedRewardPerToken = 900 / 2000 = 0.45
Multiplier Ramp Up = 180 days

	Staked LINK	Share Of Rewards	averageStakedAtTime	multiplier	storedReward	baseRewardPerToken	finalizedReward	fullReward	claimable	unclaimable	getReward()
Community Staker 1	1000 LINK	50%	0	0.5	0	0	0	= (0.45 - 0) * 1000 = 450	225	225	= 0 + 450 * 0.5 = 225
Community Staker 2	1000 LINK	50%	0	0.5	0	0	0	450	225	225	= 0 + 450 * 0.5 = 225
Total	2000 LINK	100%	0	NA	0	0	0	900	450	450	450



Community Staker 1 unstakes 500 LINK

- Set finalizedReward to previousFinalizedReward + claimable
- **DO NOT store** unclaimable rewards in storedReward as the staker forfeits them
- Set baseRewardPerToken to vestedRewardPerToken

Day 90 (After Unstaking)

Vested LINK Between Day 90 - Day 90 = 0 * 10 = 0 LINK
vestedRewardPerToken = 0.45 + 225 / 1000 = 0.675 --> The 225 unclaimable rewards is redistributed to the remaining 1000 LINK in the pool

	Staked LINK	Share Of Rewards	averageStakedAtTime	multiplier	storedReward	baseRewardPerToken	finalizedReward	fullReward	claimable	unclaimable	getReward()
Community Staker 1	500 LINK	33%	90	0	0	0.675	225	= 0 + (0.675 - 0.675) * 0 = 0	0	0	= 225 + 0 = 225
Community Staker 2	1000 LINK	67%	0	0.5	0	0	0	= 0 + (0.675 - 0) * 1000 = 675	= 675 * 0.5 = 337.5	= 675 - 337.5 = 337.5	= 0 + 337.5 = 337.5
Total	1500 LINK	100%	NA	NA	0	0.6	225	675	337.5	337.5	562.5

Day 135

Emitted LINK Between Day 90 - Day 135 = 10 * (135 - 90) = 450 LINK
vestedRewardPerToken = 0.675 + 450 / 1500 = 0.975

	Staked LINK	Share Of Rewards	averageStakedAtTime	multiplier	storedReward	baseRewardPerToken	finalizedReward	fullReward	claimable	unclaimable	getReward()
Community Staker 1	500 LINK	33%	90	0.25	0	0.675	225	= 0 + (0.975 - 0.675) * 500 = 150	= 150 * 0.25 = 37.5	= 150 - 37.5 = 112.5	= 225 + 37.5 = 262.5
Community Staker 2	1000 LINK	67%	0	0.75	0	0	0	= 0 + (0.975- 0) * 1000 = 975	= 975 * 0.75 = 731.25	= 975 - 731.25 = 243.75	= 0 + 731.25 = 731.25
Total	1500 LINK	100%	NA	NA	0	0.675	225	1125	768.75	356.25	993.75

Day 180

Emitted LINK Between Day 135 - Day 180 = 10 * (180 - 135) = 450 LINK
vestedRewardPerToken = 0.975 + 450 / 1500 = 1.275

	Staked LINK	Share Of Rewards	averageStakedAtTime	multiplier	storedReward	baseRewardPerToken	finalizedReward	fullReward	claimable	unclaimable	getReward()
Community Staker 1	500 LINK	33%	90	0.5	0	0.675	225	= 0 + (1.275 - 0.675) * 500 = 300	= 300 * 0.5 = 150	= 300 - 150 = 150	= 225 + 150 = 375
Community Staker 2	1000 LINK	67%	0	1	0	0	0	= (1.275 - 0) * 1000 = 1275	= 1275 * 1 = 1275	= 1275 - 1275 = 0	= 0 + 1275 = 1275
Total	1500 LINK	100%	NA	NA	0	0.675	225	1575	1425	150	1650

Day 270

Emitted LINK Between Day 180 - 270 = 0 (Rewards stopped emitting at day 180)
vestedRewardPerToken = 1.275 + 0 / 4000 = 1.275

	Staked LINK	Share Of Rewards	averageStakedAtTime	multiplier	storedReward	baseRewardPerToken	finalizedReward	fullReward	claimable	unclaimable	getReward()
Community Staker 1	500 LINK	33%	90	1	0	0.675	225	= 0 + (1.275 - 0.675) * 500 = 300	= 300 * 1 = 300	= 300 - 300 = 0	= 225 + 150 = 375
Community Staker 2	1000 LINK	67%	0	1	0	0	0	= (1.275 - 0) * 1000 = 1275	= 1275 * 1 = 1275	= 1275 - 1275 = 0	= 0 + 1275 = 1275
Total	1500 LINK	100%	NA	NA	N/A	0.675	225	1575	1575	0	1800

Claiming Rewards

Requirements

- Staker’s multiplier does not get reset to 0 when they claim rewards.
- Staker does not forfeit any rewards.

Approach

- Because we do not want to reset the staker's multiplier, a new `stakePeriod` is not started when a staker claims rewards but instead `fullReward` and `claimable` are calculated to take into account the amount of rewards a staker has claimed when they call `claimReward`. These formulas are shown below and `earnedBaseReward` is the amount of rewards a staker has earned since the last time they claimed rewards.

$$fullReward = storedReward + claimedBaseRewards$$

$$claimable = multiplier * fullReward - claimedBaseRewards$$

- The above formula allows us to keep the staker's earned reward the same at the time they claim rewards.

```
Unset
Example Params

Assume that at T90 we have the following params

multiplier = 0.5
earnedBaseRewards = 100 --> 100 LINK has emittted to the staker at T90
unclaimedRewardsFromPreviousStakePeriod = 0 --> Let's assume that
they claimed everything from the last stake period

======= T90 Before claiming rewards =======

claimedBaseRewards = 0 --> 0 as the staker has not claimed anything yet

fullReward
    = earnedBaseRewards + unclaimedRewardsFromPreviousStakePeriod
+ claimedBaseRewards
    = 100 + 0 + 0 = 100

claimable
        = multiplier * fullReward - claimedBaseRewards
```

```
           = 0.5 * 100 - 0
           = 50 --> Staker can claim 50 LINK of rewards

totalRewards
           = claimedBaseRewards + claimable
           = 0 + 50
           = 50 --> Staker has earned 50 LINK of rewards

======= T90 After Claiming 50 LINK Rewards =======

claimedBaseRewards = 50 --> This gets set to 50 because the staker has
just claimed 50 LINK of rewards

fullReward
      = earnedBaseRewards + unclaimedRewardsFromPreviousStakePeriod
+ claimedBaseRewards
      = 0 + 0 + 100 = 100

claimable
           = multiplier * fullReward - claimedBaseRewards
           = 0.5 * 100 - 50
           = 0 --> Drops to 0 because staker should not be able to claim
any rewards

totalRewards
           = claimedBaseRewards + earnedBaseRewards
           = 50 + 0
           = 50 --> This remains the same after the staker claims the
reward
```

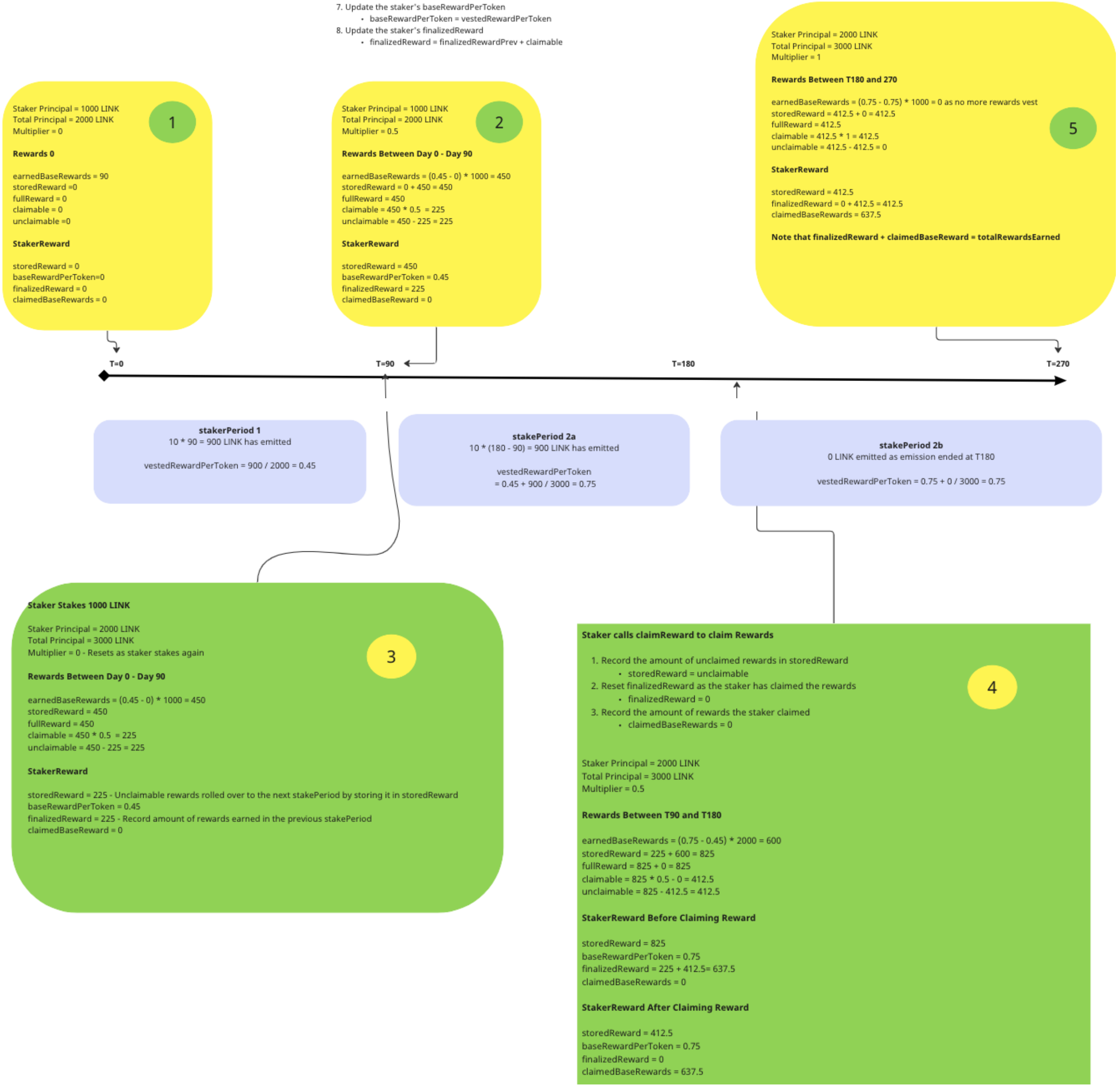
- When a staker calls `claimReward`
  - We reset their `finalizedReward` to 0 as they have claimed those rewards
  - We store the amount they claimed into `claimedBaseRewards` variable. The `claimedBaseRewards` value is set to 0 when we transition into a new stake period.
  - We store any unclaimed rewards to their `storedReward` variable.

Detailed Example

Example
Emitting 1800 LINK over 180 days
Emission Rate = 10 LINK / day
Multiplier Ramp Up = 180 days

At end of each *stakePeriod* when *finalizeReward* is called

1. Calculate vestedRewards
    - vestedRewards = emissionRate * elapsedTime
2. Update vestedRewardPerToken
    - vestedRewardPerToken = vestedRewardPerTokenPrev + vestedRewards / totalPrincipal
3. Calculate earned base rewards in between time periods
    - earnedBaseRewards = (vestedRewardPerToken - baseRewardPerToken) * stakerPrincipal
4. Update storedReward in the StakerReward sturct
    - storedReward = storedRewardPrev + earnedBaseRewards
5. Calculate the fullReward the staker should earn in the period before applying their multiplier
    - fullReward = storedReward + claimedBaseRewards
6. Calculate the staker's claimable and unclaimable rewards
    - claimable = fullReward * multiplier - claimedBaseRewards
    - unclaimable = fullReward - claimable
7. Update the staker's baseRewardPerToken
    - baseRewardPerToken = vestedRewardPerToken
8. Update the staker's finalizedReward
    - finalizedReward = finalizedRewardPrev + claimable



Staker Principal = 1000 LINK
Total Principal = 2000 LINK
Multiplier = 0

Rewards 0

earnedBaseRewards = 90
storedReward =0
fullReward = 0
claimable = 0
unclaimable =0

StakerReward

storedReward = 0
baseRewardPerToken=0
finalizedReward = 0
claimedBaseRewards = 0

Staker Principal = 1000 LINK
Total Principal = 2000 LINK
Multiplier = 0.5

Rewards Between Day 0 - Day 90

earnedBaseRewards = (0.45 - 0) * 1000 = 450
storedReward = 0 + 450 = 450
fullReward = 450
claimable = 450 * 0.5 = 225
unclaimable = 450 - 225 = 225

StakerReward

storedReward = 450
baseRewardPerToken = 0.45
finalizedReward = 225
claimedBaseReward = 0

Staker Principal = 2000 LINK
Total Principal = 3000 LINK
Multiplier = 1

Rewards Between T180 and 270

earnedBaseRewards = (0.75 - 0.75) * 1000 = 0 as no more rewards vest
storedReward = 412.5 + 0 = 412.5
fullReward = 412.5
claimable = 412.5 * 1 = 412.5
unclaimable = 412.5 - 412.5 = 0

StakerReward

storedReward = 412.5
finalizedReward = 0 + 412.5 = 412.5
claimedBaseRewards = 637.5

Note that finalizedReward + claimedBaseReward = totalRewardsEarned

stakerPeriod 1
10 * 90 = 900 LINK has emitted

vestedRewardPerToken = 900 / 2000 = 0.45

stakePeriod 2a
10 * (180 - 90) = 900 LINK has emitted

vestedRewardPerToken
= 0.45 + 900 / 3000 = 0.75

stakePeriod 2b
0 LINK emitted as emission ended at T180

vestedRewardPerToken = 0.75 + 0 / 3000 = 0.75

Staker Stakes 1000 LINK

Staker Principal = 2000 LINK
Total Principal = 3000 LINK
Multiplier = 0 - Resets as staker stakes again

Rewards Between Day 0 - Day 90

earnedBaseRewards = (0.45 - 0) * 1000 = 450
storedReward = 450
fullReward = 450
claimable = 450 * 0.5 = 225
unclaimable = 450 - 225 = 225

StakerReward

storedReward = 225 - Unclaimable rewards rolled over to the next stakePeriod by storing it in storedReward
baseRewardPerToken = 0.45
finalizedReward = 225 - Record amount of rewards earned in the previous stakePeriod
claimedBaseReward = 0

Staker calls claimReward to claim Rewards

1. Record the amount of unclaimed rewards in storedReward
    - storedReward = unclaimable
2. Reset finalizedReward as the staker has claimed the rewards
    - finalizedReward = 0
3. Record the amount of rewards the staker claimed
    - claimedBaseRewards = 0

Staker Principal = 2000 LINK
Total Principal = 3000 LINK
Multiplier = 0.5

Rewards Between T90 and T180

earnedBaseRewards = (0.75 - 0.45) * 2000 = 600
storedReward = 225 + 600 = 825
fullReward = 825 + 0 = 825
claimable = 825 * 0.5 - 0 = 412.5
unclaimable = 825 - 412.5 = 412.5

StakerReward Before Claiming Reward

storedReward = 825
baseRewardPerToken = 0.75
finalizedReward = 225 + 412.5= 637.5
claimedBaseRewards = 0

StakerReward After Claiming Reward

storedReward = 412.5
baseRewardPerToken = 0.75
finalizedReward = 0
claimedBaseRewards = 637.5