Market Incentives & Mechanism Design in Decentralized Distributed Ledger Systems and Meta-Platform Theory

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Reading List

J. Currier, “The NFX Archives: Foundations for Mastering Network Effects,” *NFX.com*, https://www.nfx.com/post/network-effects-archives

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Mnemonic

GitHub

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Papers

Distributed and Decentralized Computing Systems

distributed = computation happens at multiple sites

non-distributed = computation happens at one site

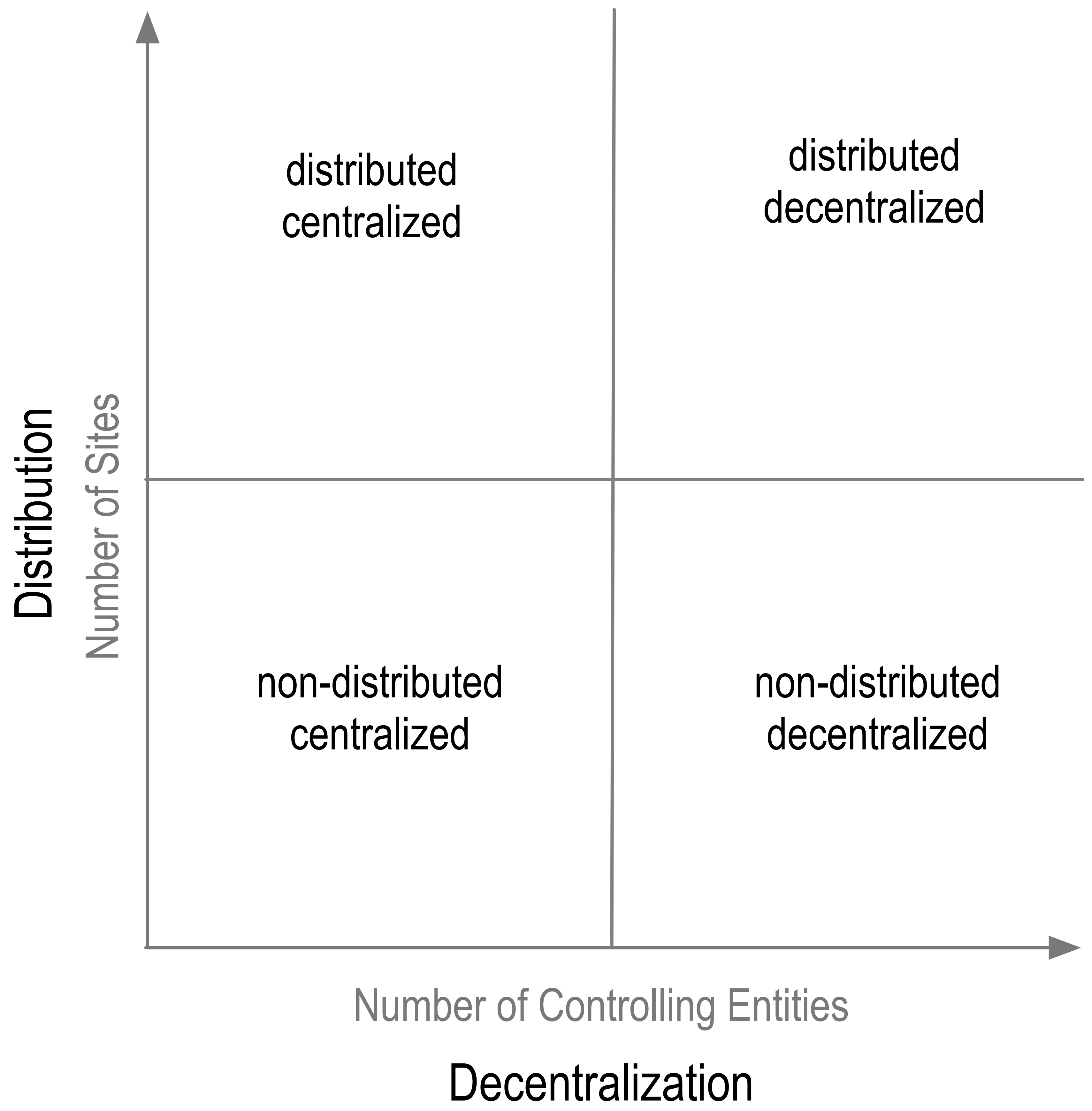
centralized = computation controlled by a single entity

decentralized = computation controlled by more than one entity

computing system may be some combination of *centralized* (*decentralized*) and distributed (*non-distributed*).

decentralization may occur to a degree.

- system decentralization may lie on a spectrum of strongly decentralized to weakly decentralized.



Algorithmic Mechanism Design & Control Theory

Mechanism design is a field in economics and game theory that takes an engineering approach to designing economic mechanisms or incentives, toward desired objectives, in strategic settings, where players act rationally.

Algorithmic mechanism design lies at the intersection of economic game theory and computer science. It combines ideas such as utility maximization and mechanism design from economics, rationality and Nash equilibrium from game theory, with such concepts as complexity and algorithm design from discrete mathematics and theoretical computer science.

Control theory in control systems engineering is a subfield of mathematics that deals with the control of continuously operating dynamical systems in engineered processes and machines. The objective is to develop a control model for controlling such systems using a control action in an optimum manner.

(See https://en.wikipedia.org/wiki/Mechanism_design, https://en.wikipedia.org/wiki/Algorithmic_mechanism_design, https://en.wikipedia.org/wiki/Control_theory)

Platform Business Models

Multi-Sided Platform (MSB), Two-sided Networks, N-sided Networks, Network Markets.

Think Airbnb or Uber

Primary *advantage* of a platform business model is *value capture* through *network effects*

A platform is a business based on enabling value-creating interactions between external producers and consumers.

A platform is an automated intermediary

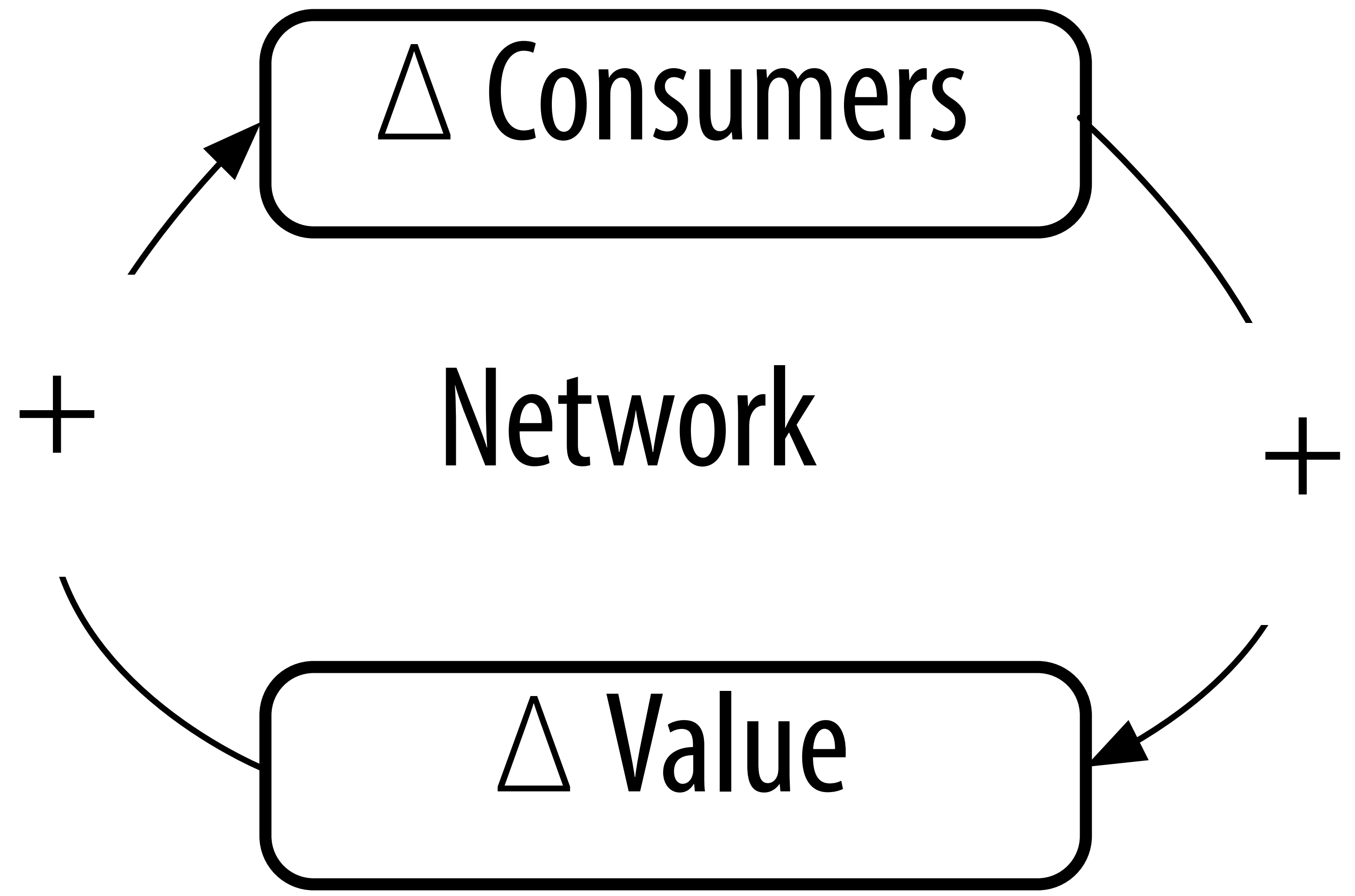
A platform provides an open, participative infrastructure and sets governance conditions for these interactions.

A platform facilitates the exchange of goods, services, or social currency amongst participants thereby enabling value creation or co-creation for all participants.

Primary activity of a platform is external orchestration/coordination of interactions between third parties.

(See Platform Revolution 2016, NFX Archives, Tomorrow 3.0)

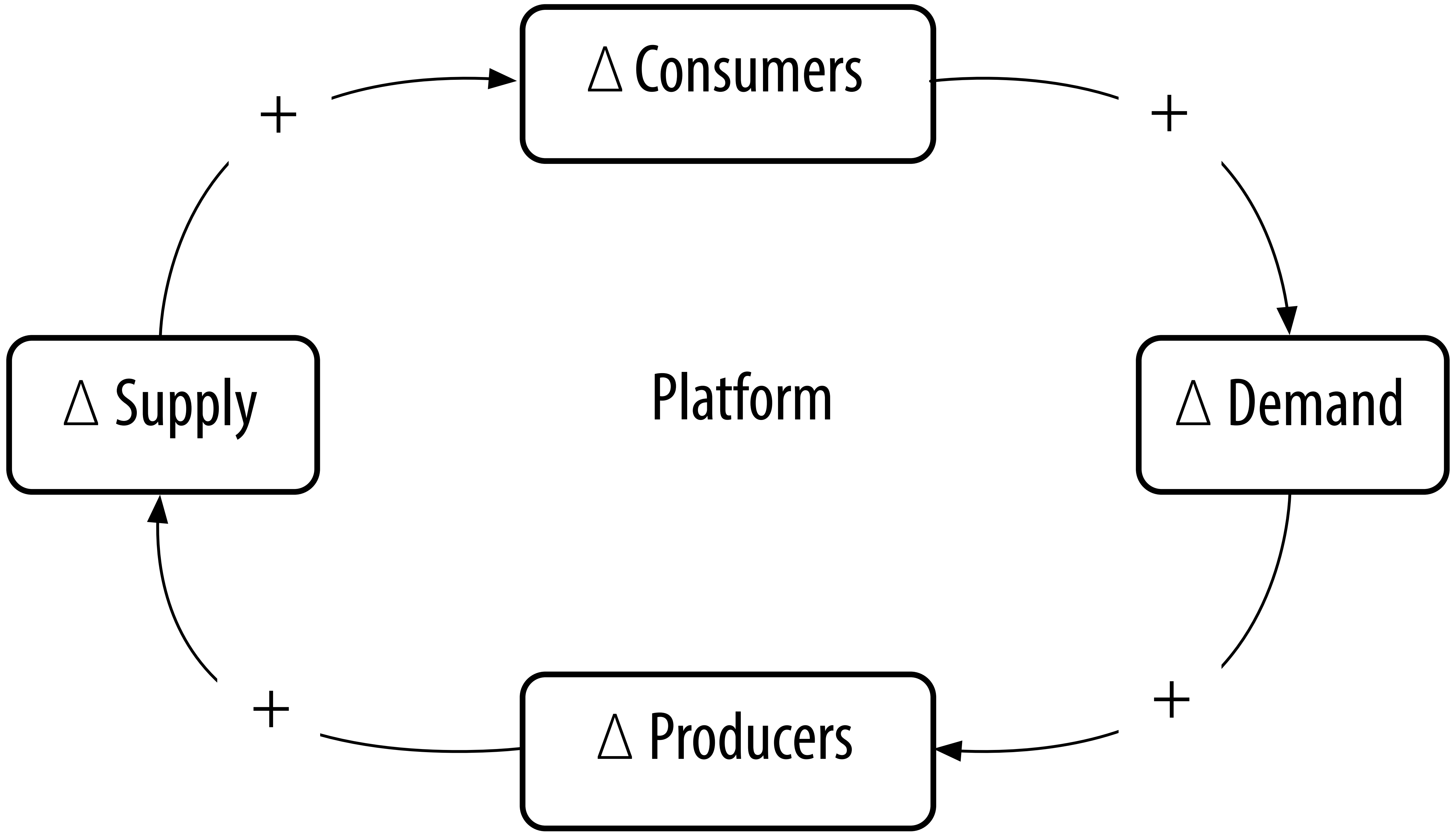
Single-Sided Network Effect



more consumers increases value which attracts more consumers

demand side driven

Two-Sided Network

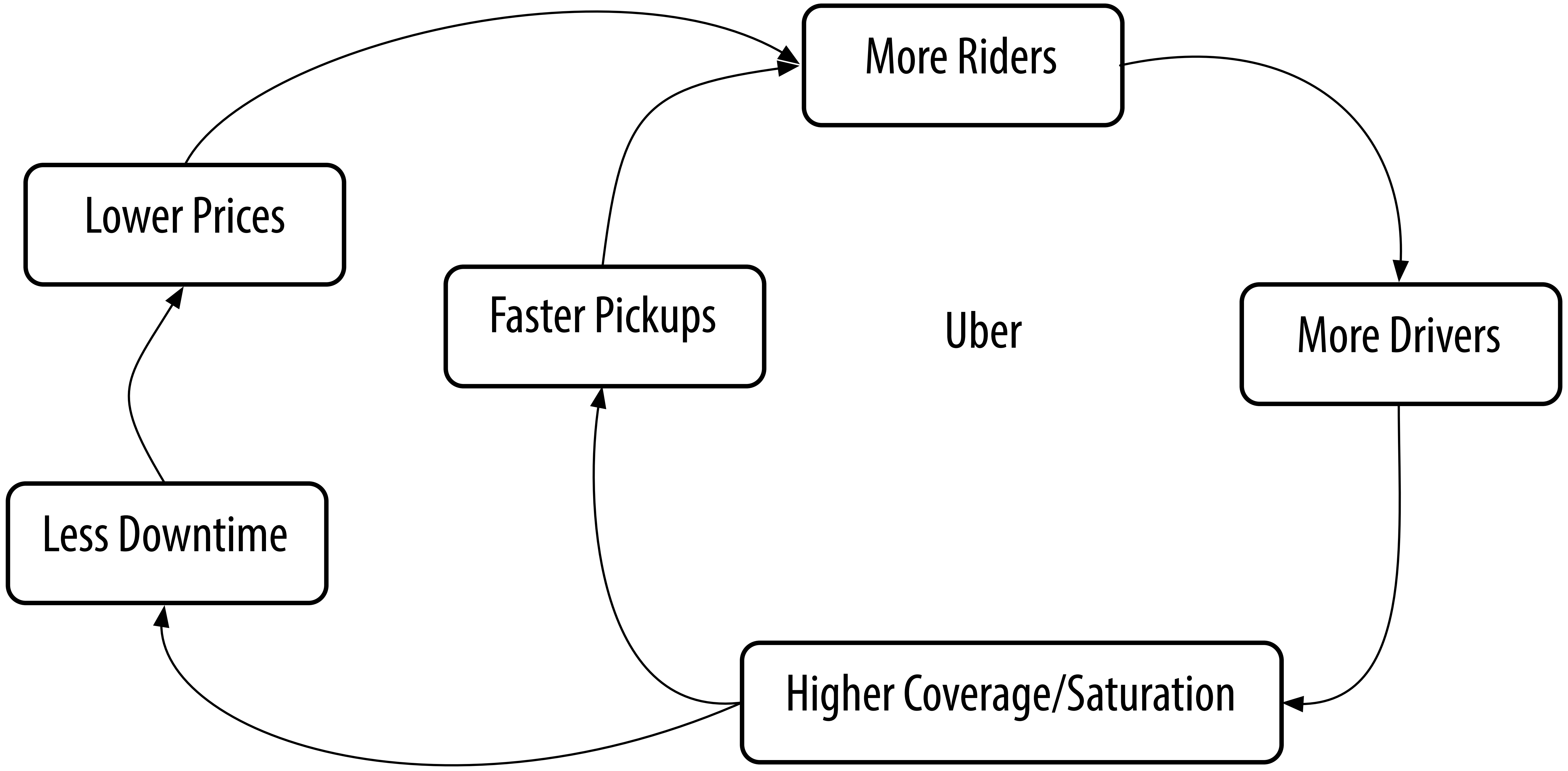


more consumers drive demand which attracts more producers

more producers drive supply which attracts more consumers

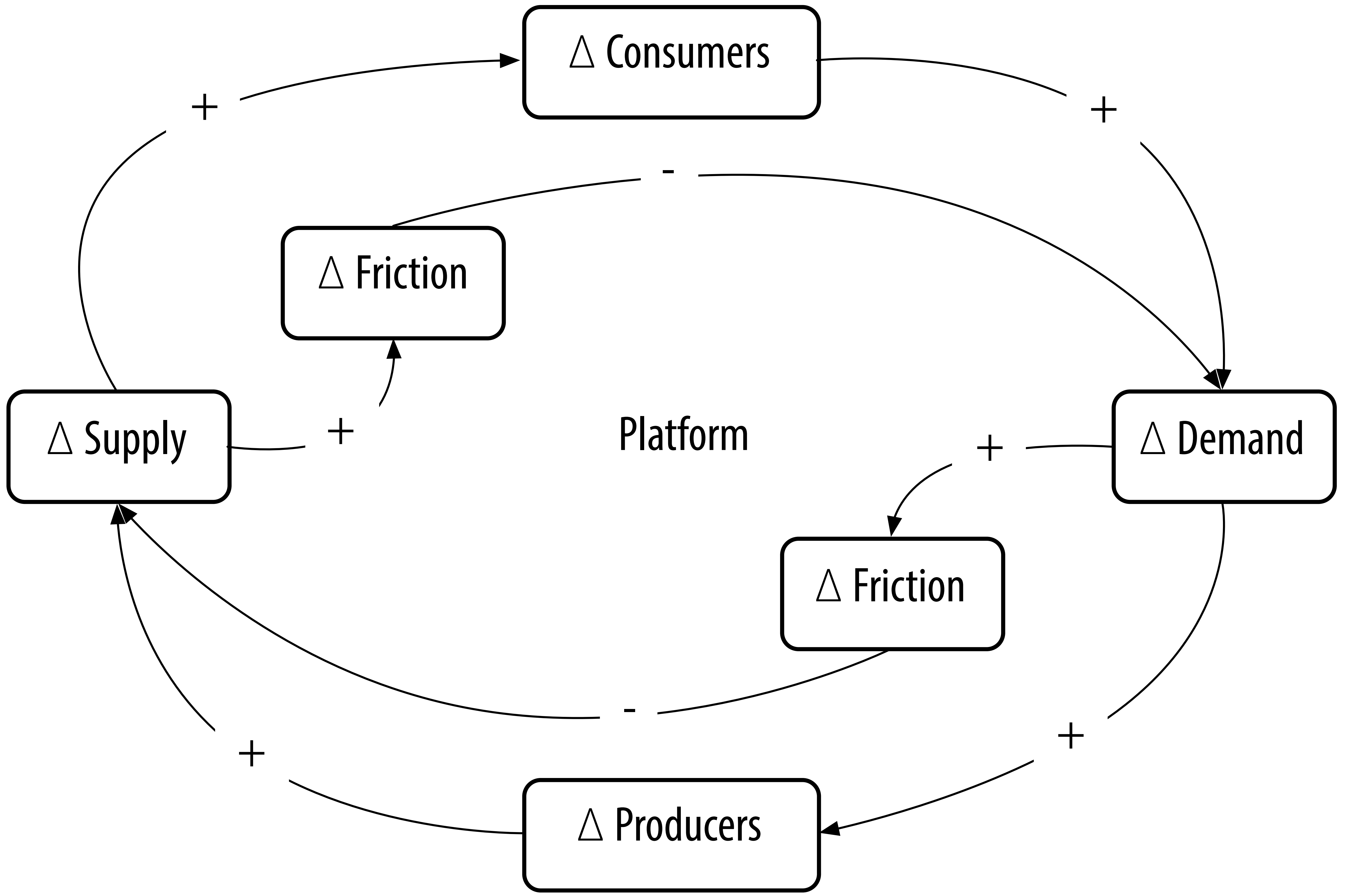
both demand and supply side driven

Example



More Riders
Lower Prices
Faster Pickups
Uber
More Drivers
Less Downtime
Higher Coverage/Saturation

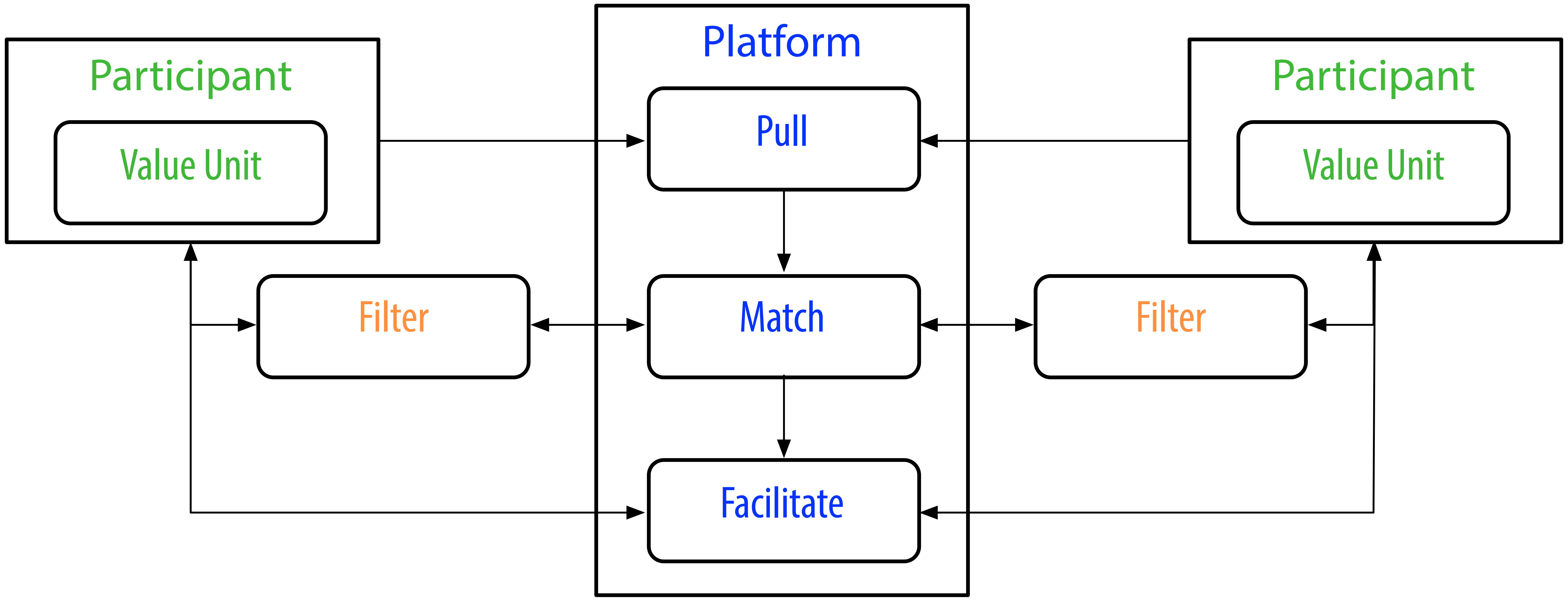
Negative Cross-Side Network Effects



More supply choice increases friction e.g. customer confusion in producer selection thereby decreasing demand

More demand choice increases friction e.g. producer failure in customer satisfaction thereby decreasing supply

Platform Business Model



Core Interaction = Participant/Value unit + Filter

Platform = Pull + Match + Facilitate

Two-sided network effects

Demand economies of scale (network effect multipliers of value)
that eventually drive
Supply economies of scale (production efficiency)

Transaction Costs

Triangulation:

Find, Filter, Match

Transfer:

Transport, Deliver, Pay

Trust:

Competency, Reliability, Honesty

Platforms sell reductions in transaction costs

To a consumer, all costs look like transaction costs

(Michael Munger, Ronald Coase: Transaction Costs)

Enablement

Distributed network computation enables platforms

Distributed consensus enables more secure platforms

Platform lock in induces exploitation via information asymmetry

Decentralized distributed consensus enables more trustworthy platforms

Distributed AI provides *scalable super-efficient user controlled re-intermediation*

Platform governance matters

Decentralization Advantage

Although *decentralization* can reduce triangulation and transfer costs, its primary *potential advantage* is in reducing trust costs!

Online interactions make trust harder = increased trust costs

Hidden trust costs are still costs

Conventional ways to reduce trust costs:

- Branding & Reputation
- Certification
- Bonding
- Regulation

Algorithmic Decentralized Governance

autonomic system:

self-regulating, self-governing, self-managing, self-certifying, self-protecting

Distributed decentralized computing systems may provide trustworthy algorithmic market behavioral incentivization and regulation

carrot and stick

Curation

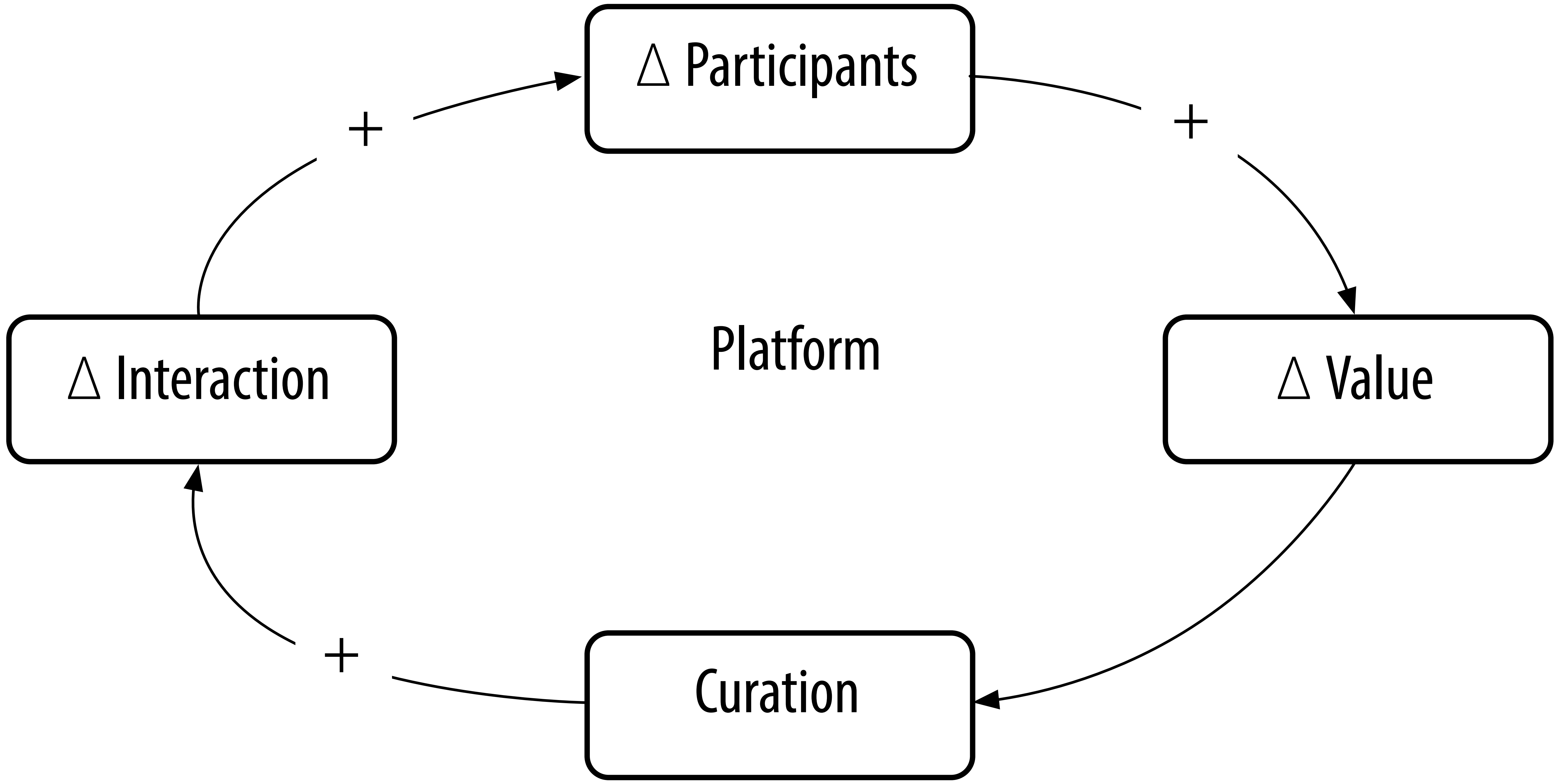
Match + Filter = Curation

Reduces negative cross-side network effects

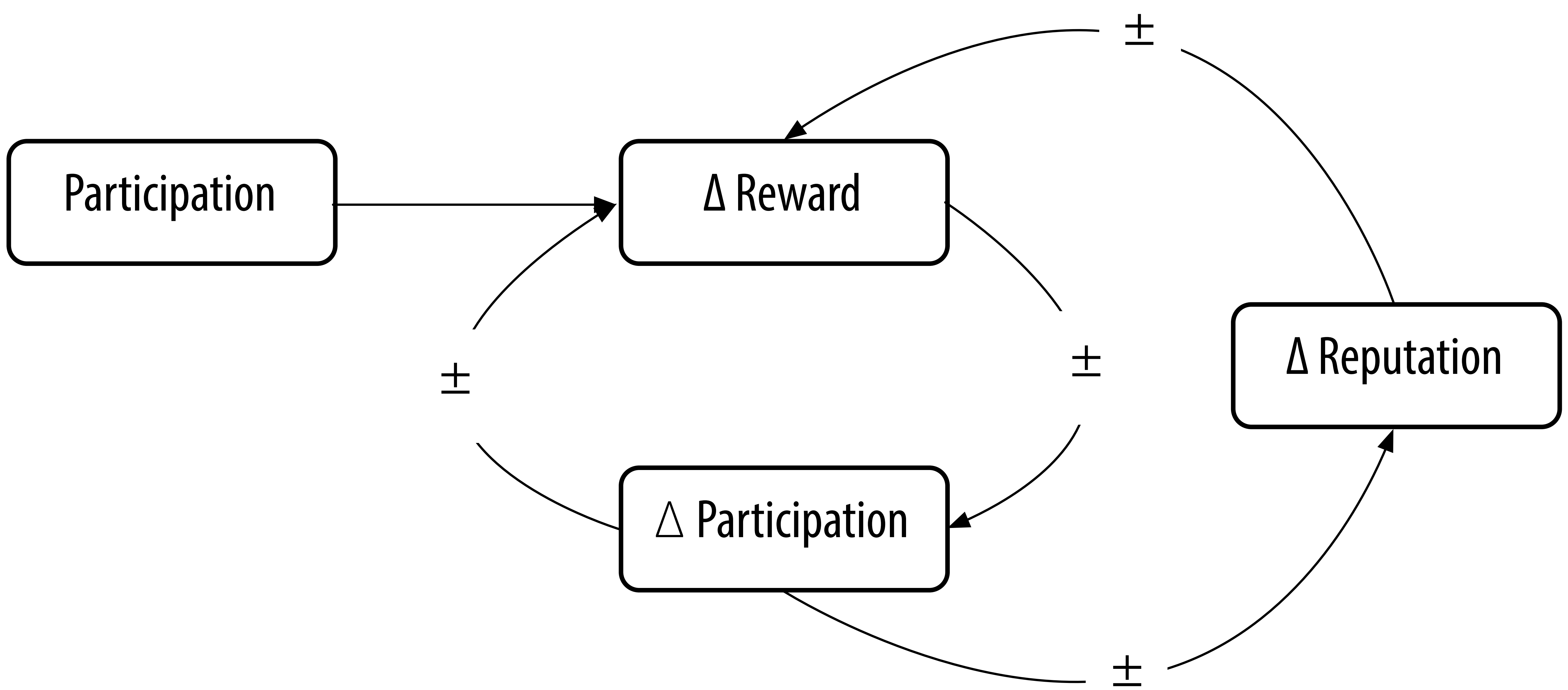
Enhances positive cross-side network effects

Essential enabling capability for any platform

Curation is applied reputation

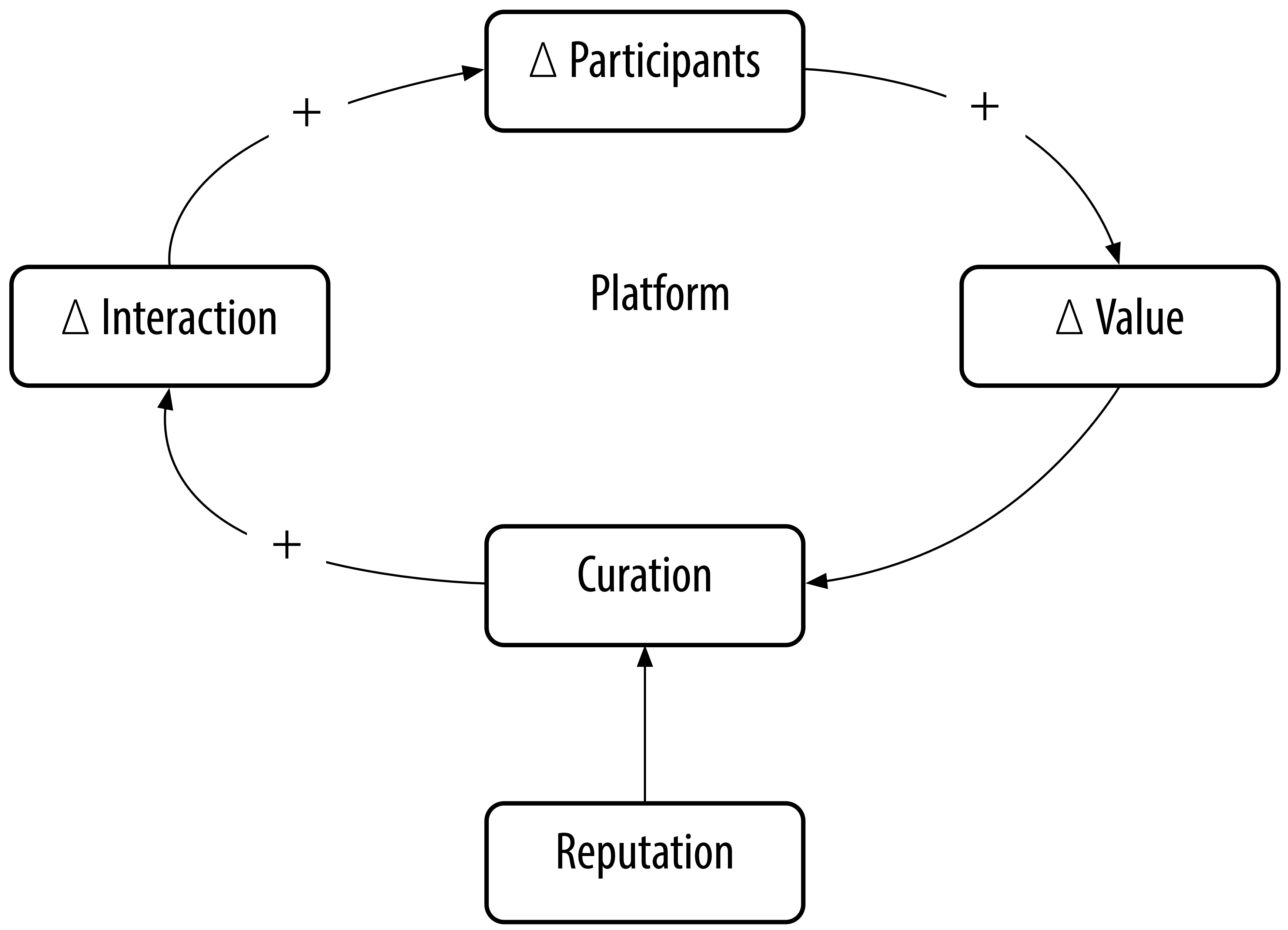


Reputation Driven Interaction



Graduated Participation Interfaces

Reputation Based Curation



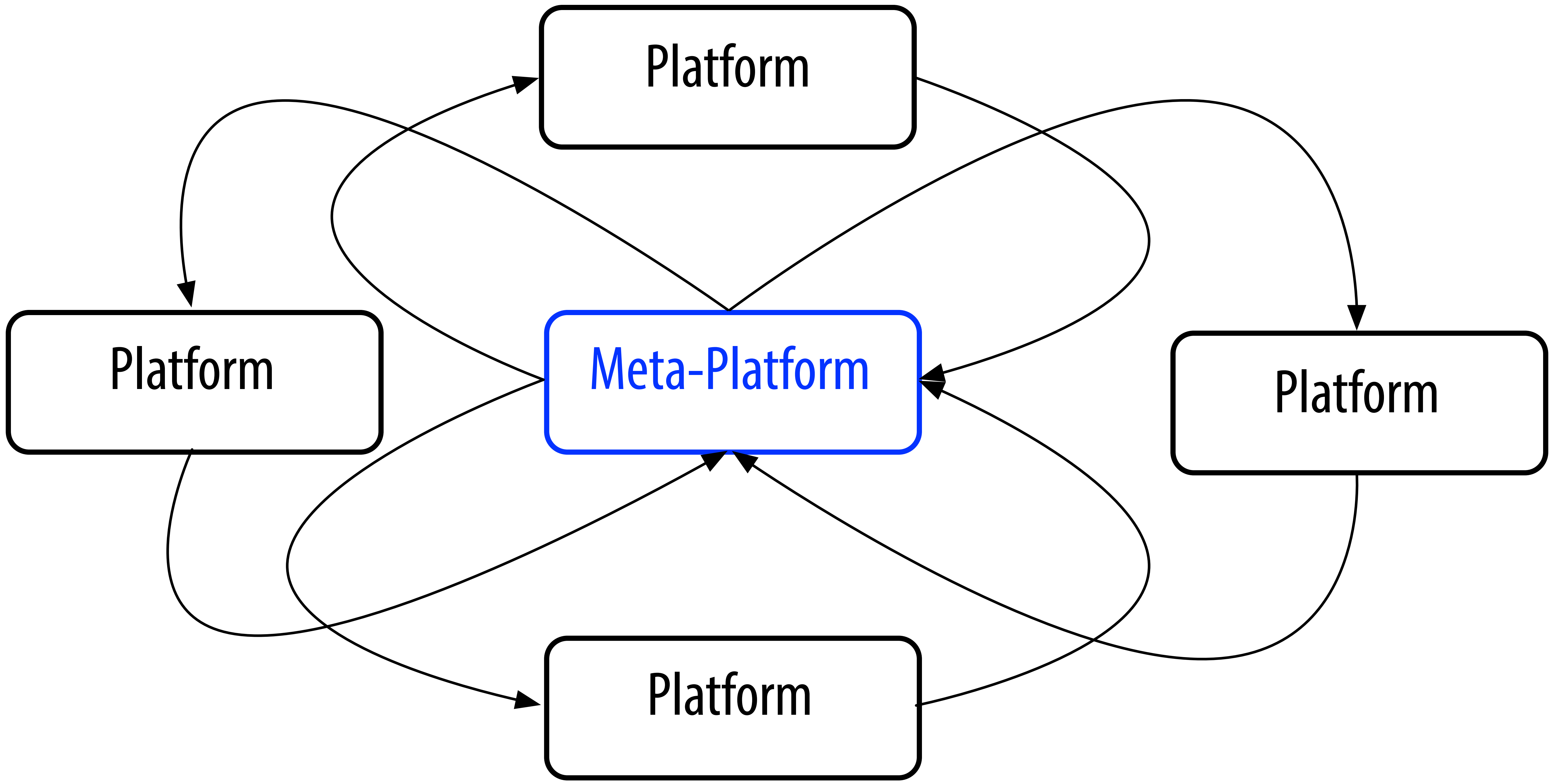
Meta-Platform

Platform that *enables* and *fosters network effects* across and amongst other platforms

Enables network of network effects

Enabled by *contextual transitivity* = value transfer between platforms

Enables long-tail network effects

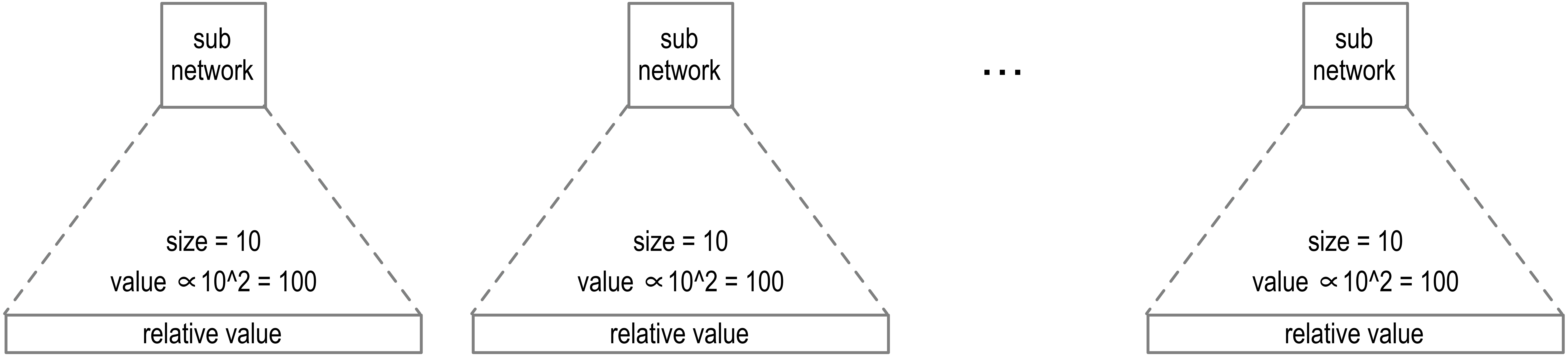


Networks Effects

Metcalf’s Law for platform:

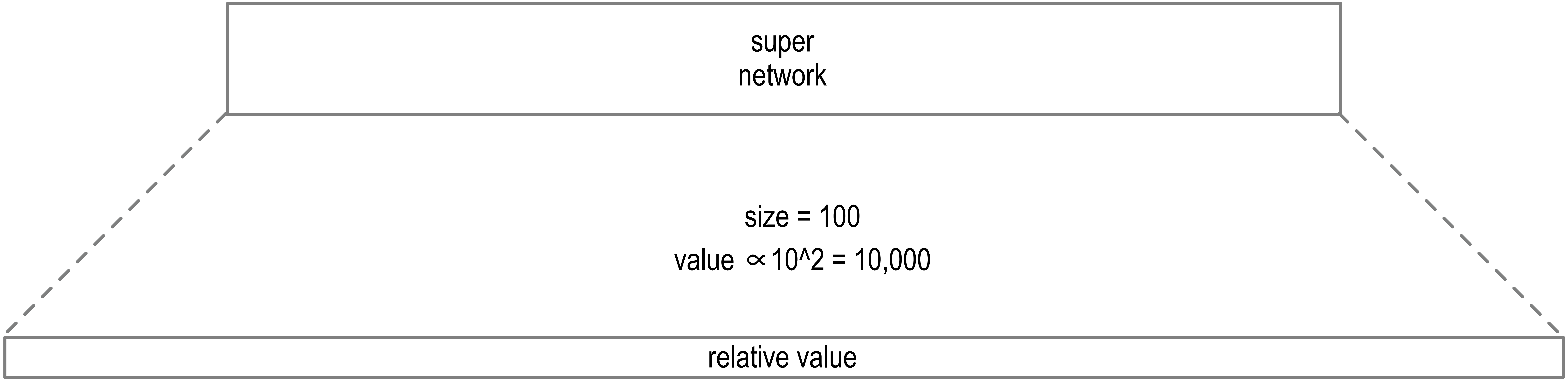
platform value is proportional to the square of the number of participants using the platform

Competing Networks



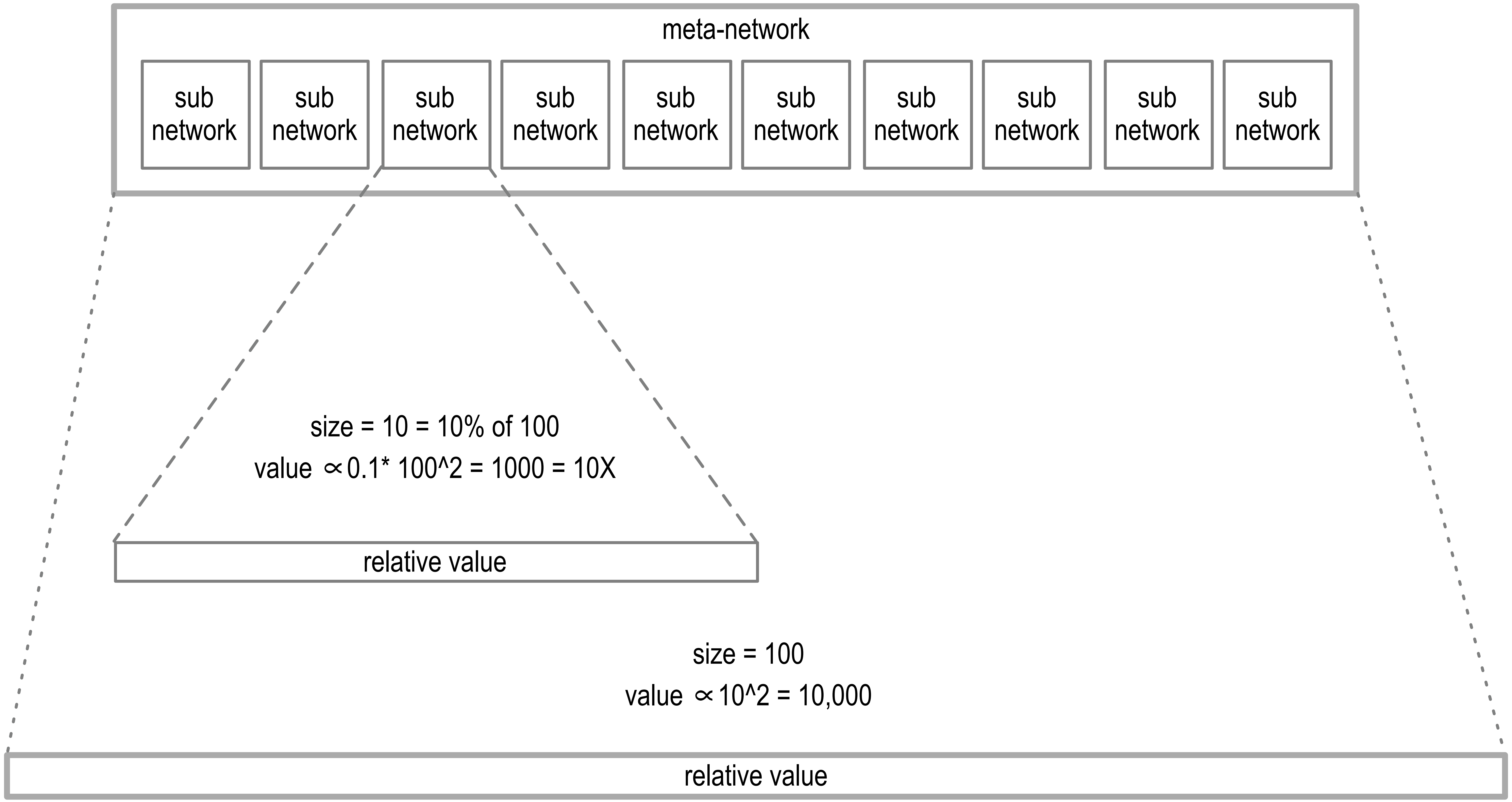
Big Networks Effects

Winner Take All Network



Network of Networks Effects

Cooperating Meta-Network of Networks



Meta-Network Effect

The increase in value due to network effects of any platform participating on a meta-platform is proportionate to the ratio of the meta-platform's size to the platform's size.

N = platform size

$$V(N) \propto N^2$$

M = meta-platform size

$$V(M) \propto M^2$$

$$V(N{:}M) \propto N/M \cdot M^2 = N \cdot M$$

$$V(N{:}M)/V(N) \propto N \cdot M/N^2 = M/N$$

$$N=10,\ V(N) = 100,\ M=100,\ V(M) = 10{,}000,\ V(N{:}M) = 1000$$

$$V(N{:}M)/V(N) = M/N = 10$$

Meta-Platforms Will Eat Platforms

Contextual Transitivity and "The Long Tail"

long-tail = value capture of contextual value = unique value from extreme customization

meta-platform technology enables transfer of value between platforms

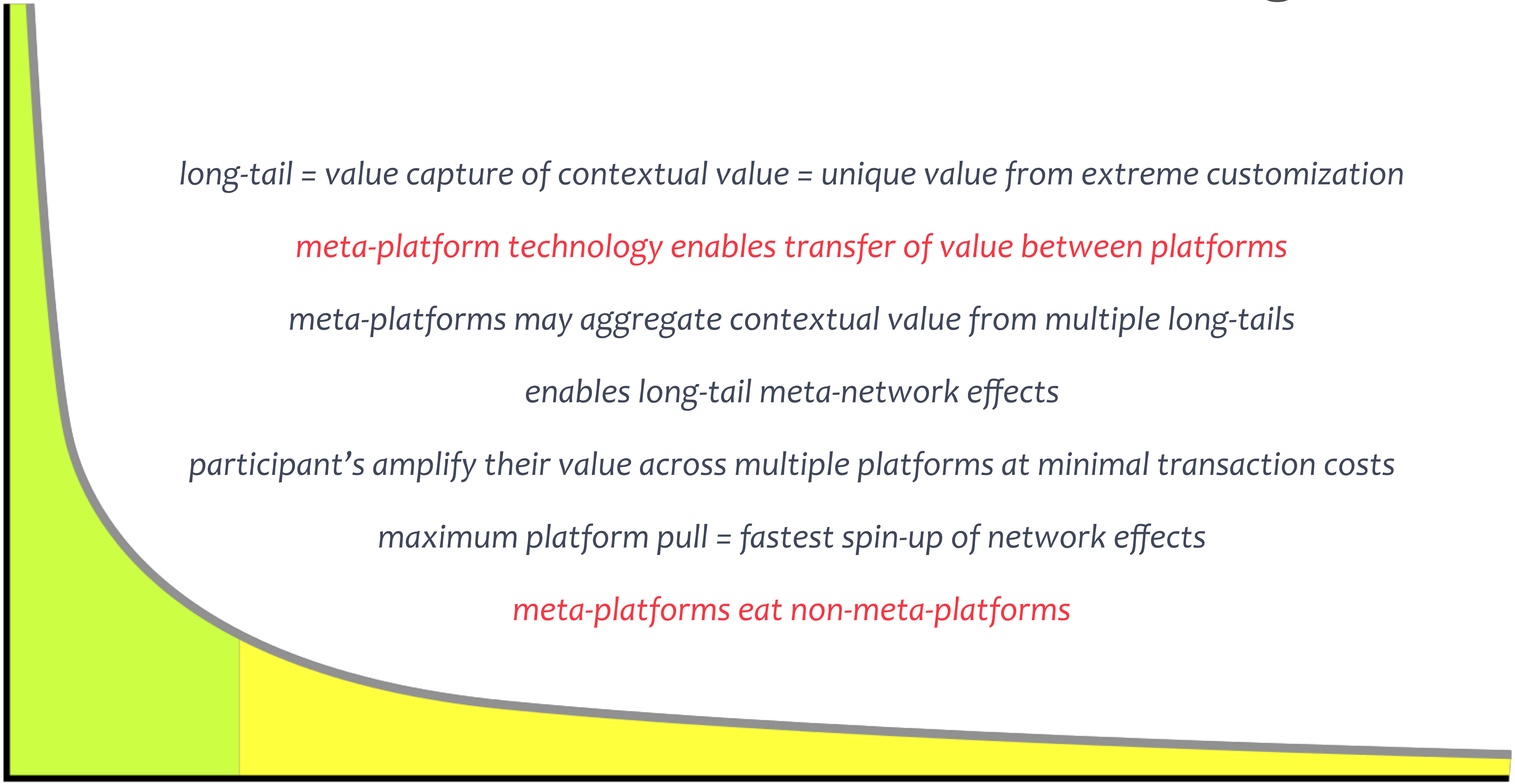
meta-platforms may aggregate contextual value from multiple long-tails

enables long-tail meta-network effects

participant's amplify their value across multiple platforms at minimal transaction costs

maximum platform pull = fastest spin-up of network effects

meta-platforms eat non-meta-platforms



Examples of Meta-Platforms

concept of meta-platform is relative

yesterday’s meta-platforms are today’s platforms

key is identifying tomorrow’s meta-platforms

Yesterday:

Money

Public Markets

Governments and Quasi-Government Institutions

Today:

Internet

Search

Social

Tomorrow:

Decentralized Identity and Reputation

Decentralized Algorithmically Governed Institutions

Decentralized Algorithmically Regulated Marketplaces

Decentralized Autonomic Services

Portable Identity

Security, Privacy, Agency

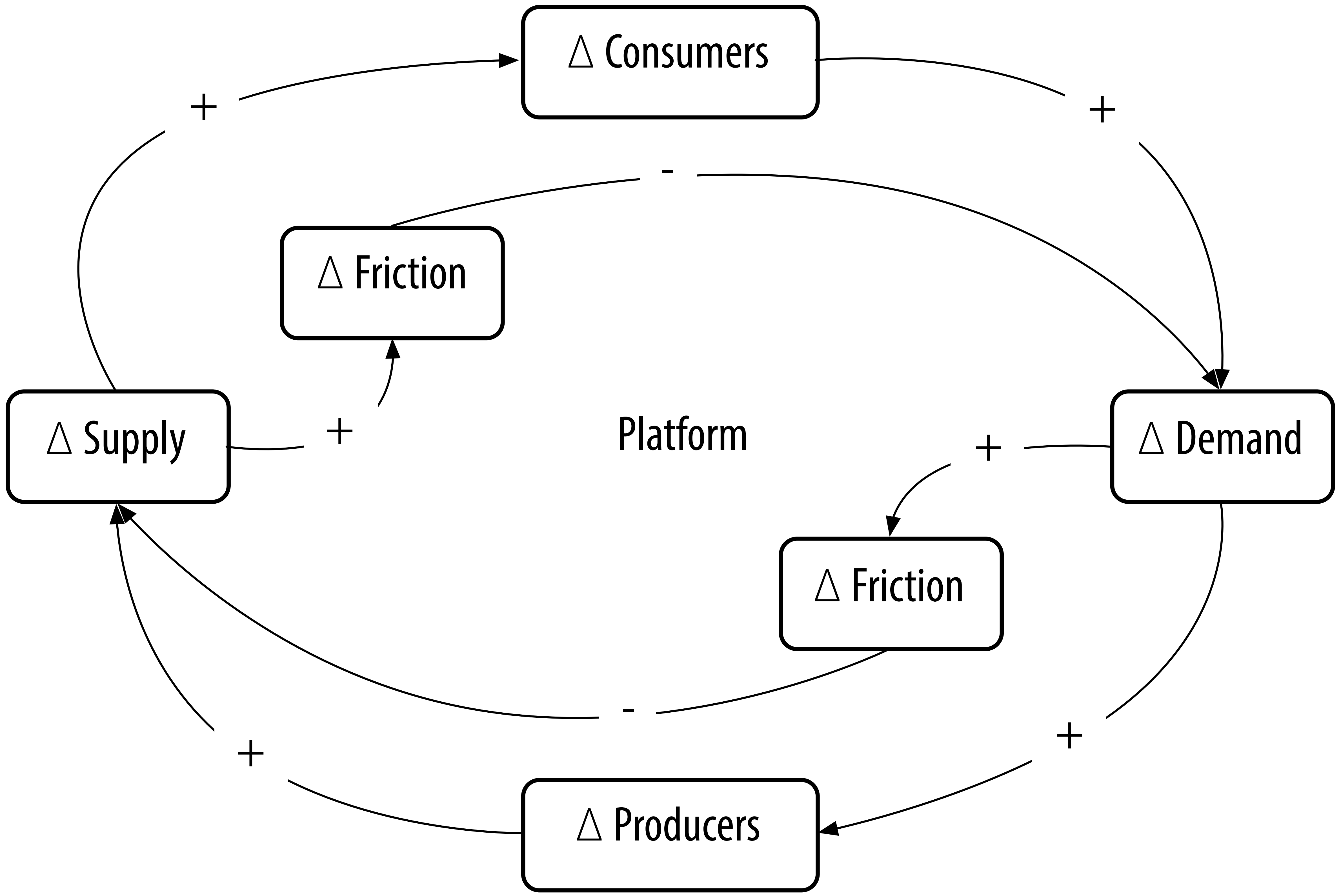
(Trustworthy, Private Preserving, Self-Sovereign)

Portable Identifiers & Attributes

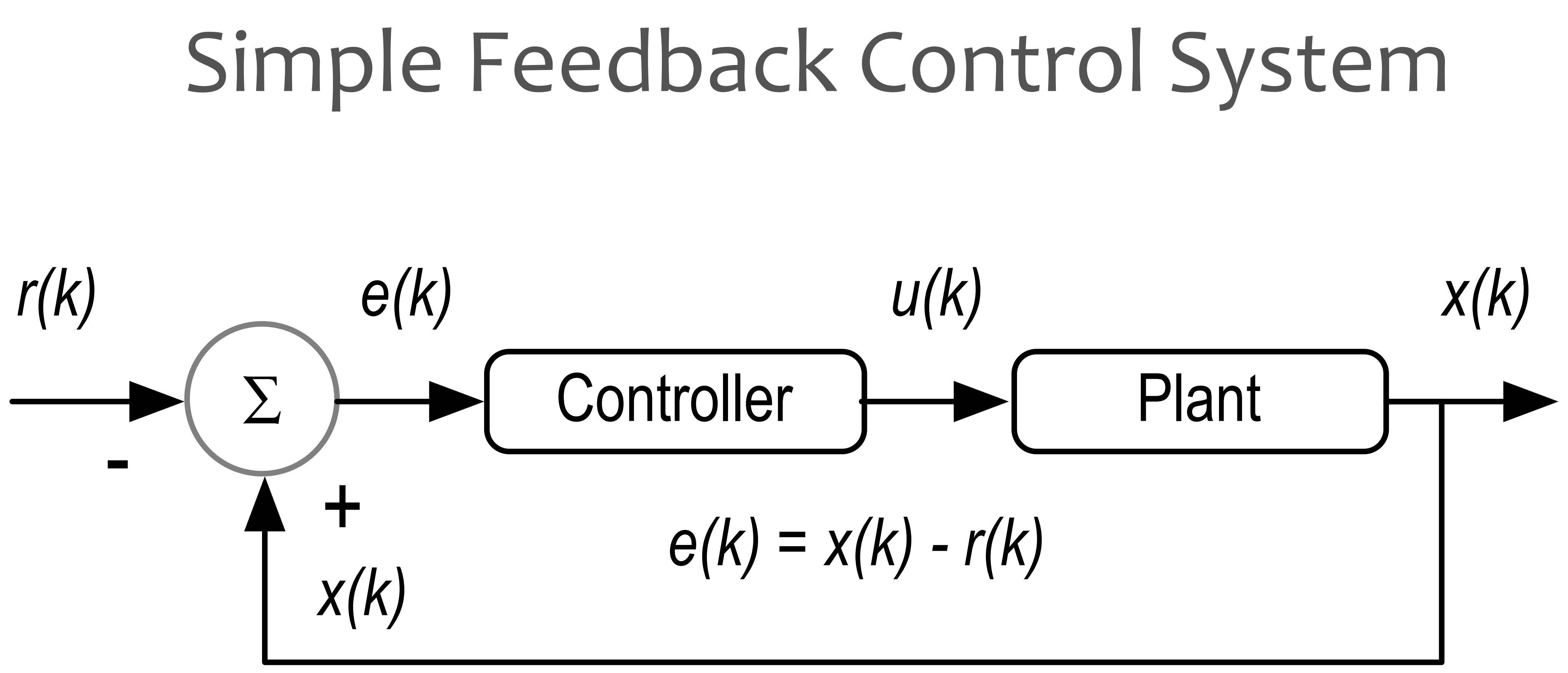
Decentralized Root of Trust

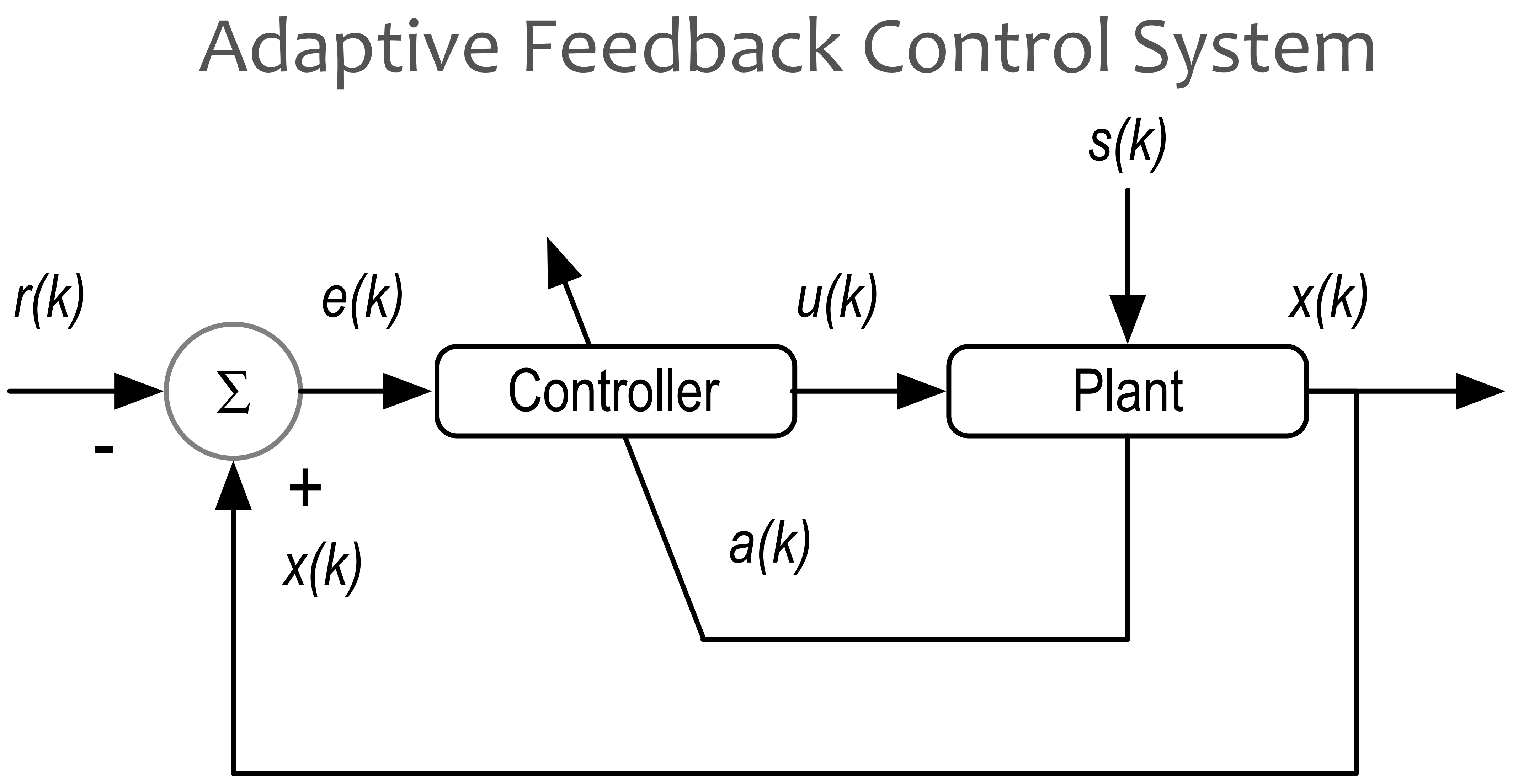
Feedback System Behavior

Uncontrolled System



Feedback Control to Regulate System Behavior





Decentralized distributed consensus data structures provide a trustworthy algorithmic infrastructure for adaptive feedback control of platform participant behavior using market incentives as control inputs

Solving the Pseudonymity Splitting Problem

Pseudonymity induces bad online behavior

Increases trust transaction costs

Linear rewards incentivize splitting or identity to minimize retribution against bad online behavior

Nonlinear rewards incentivize non-splitting = consistent identity with good behavior

Linear Reward

$$y = bx$$ y is reward, x is activity

$$\bar{y}(k) = \sum_{i=1}^{2} y_i(k) = \sum_{i=1}^{2} bx_i(k) = b\sum_{i=1}^{2} x_i(k) = b\left(x_1(k) + x_2(k)\right)$$

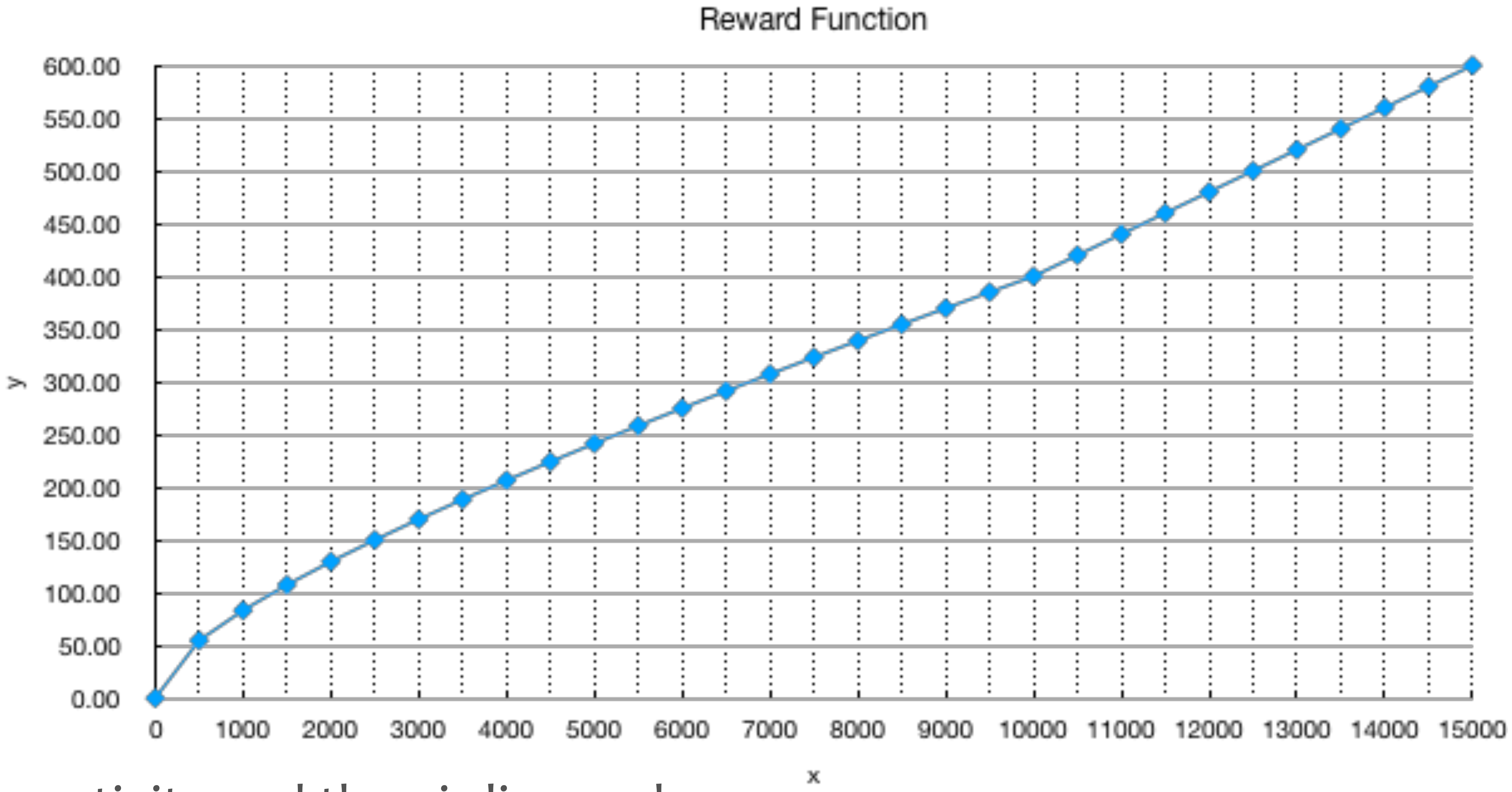
Suppose an entity's total activity is $10,000 and splits it with $8000 for one and $2000 for the other with b equal to 0.03.

The individuals rewards are 0.03(8000) = 240 and 0.03(2000) = 60 and the total, 300 is the same as 0.03(10000) = 300.

With this type of reward function there is no disincentive to splitting

Non-Linear Reward

$$y = \begin{cases} 0.2\left(x + (10000x)^{1/2}\right) & x < 10000 \\ 0.4x & x \geq 10000 \end{cases}$$



Nonlinear up to 10,000 in activity and then is linear above 10,000.

Any split in activity below 10,000 results in less total reward to the entity.

This penalizes cheap participation and rewards concentrated behavior up to a point.

Weighted Linear Reward

$$y = bwx$$

y=reward, x is activity, *w* is bond or stake

$$y = \begin{cases} \left(\dfrac{0.01}{1000} w\right) x & w < 4000 \\ 0.4x & w \geq 4000 \end{cases}$$

The reward function is nonlinear in (*w*, *x*) up until the amount of bond reaches 4000 and is linear in *x* above that.

This rewards concentration of behavior up to a point and penalizes cheap participation.

Quadratic Voting Incentivizes Splitting

$$z(k) = I[w(k)] = \left(w(k)\right)^{1/2}$$

z=influence intensity, w is stake , *I is the influence function*

$$\overline{z}(k) = \sum_{i=1}^{M-1} y_i(k) = \sum_{i=1}^{M} I[w(k)] = \sum_{i=1}^{M-1} \left(w(k)\right)^{1/2}$$

y are split identities

$$(25)^{1/2} + (25)^{1/2} = 5 + 5 = 10$$

$$(50)^{1/2} = 7.071$$

Naive quadratic voting incentivizes cheating by splitting.

Weighted nonlinear quadratic voting rewards consistent identities

Reading List

J. Currier, “The NFX Archives: Foundations for Mastering Network Effects,” *NFX.com*, https://www.nfx.com/post/network-effects-archives

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Conclusion

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