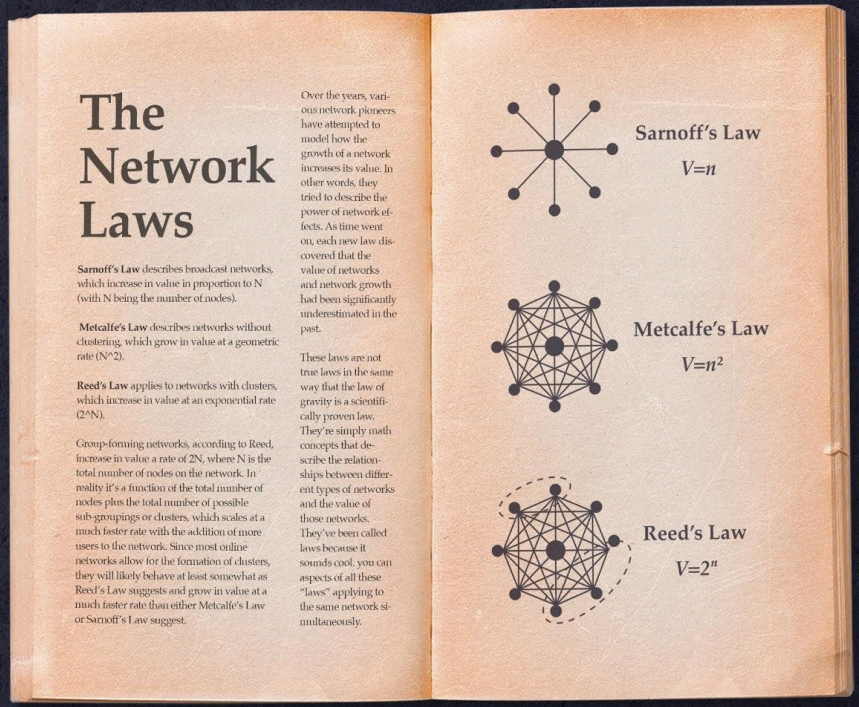
THE NETWORK EFFECTS BIBLE

NfX



The Network Laws

Sarnoff's Law describes broadcast networks, which increase in value in proportion to N (with N being the number of nodes).

Metcalfe's Law describes networks without clustering, which grow in value at a geometric rate (N^2).

Reed's Law applies to networks with clusters, which increase in value at an exponential rate (2^N).

Group-forming networks, according to Reed, increase in value a rate of 2N, where N is the total number of nodes on the network. In reality it's a function of the total number of nodes plus the total number of possible sub-groupings or clusters, which scales at a much faster rate with the addition of more users to the network. Since most online networks allow for the formation of clusters, they will likely behave at least somewhat as Reed's Law suggests and grow in value at a much faster rate than either Metcalfe's Law or Sarnoff's Law suggest.

Over the years, various network pioneers have attempted to model how the growth of a network increases its value. In other words, they tried to describe the power of network effects. As time went on, each new law discovered that the value of networks and network growth had been significantly underestimated in the past.

These laws are not true laws in the same way that the law of gravity is a scientifically proven law. They're simply math concepts that describe the relationships between different types of networks and the value of those networks. They've been called laws because it sounds cool. you can aspects of all these "laws" applying to the same network simultaneously.

by James Currier & the NFX Team

About

– NfX –

NFX is an early stage venture firm based in San Francisco that is transforming how true innovators are funded. As founders ourselves, we built 10 network effect companies with more than $10 billion in exits across multiple industries and geographies.

We believe that creating something of true significance starts with seeing what others do not.

www.nfx.com @nfxguild

Roadmap

Part I - Why Network Effects Are Important

Part II - How Networks Work

Part III - Network Properties

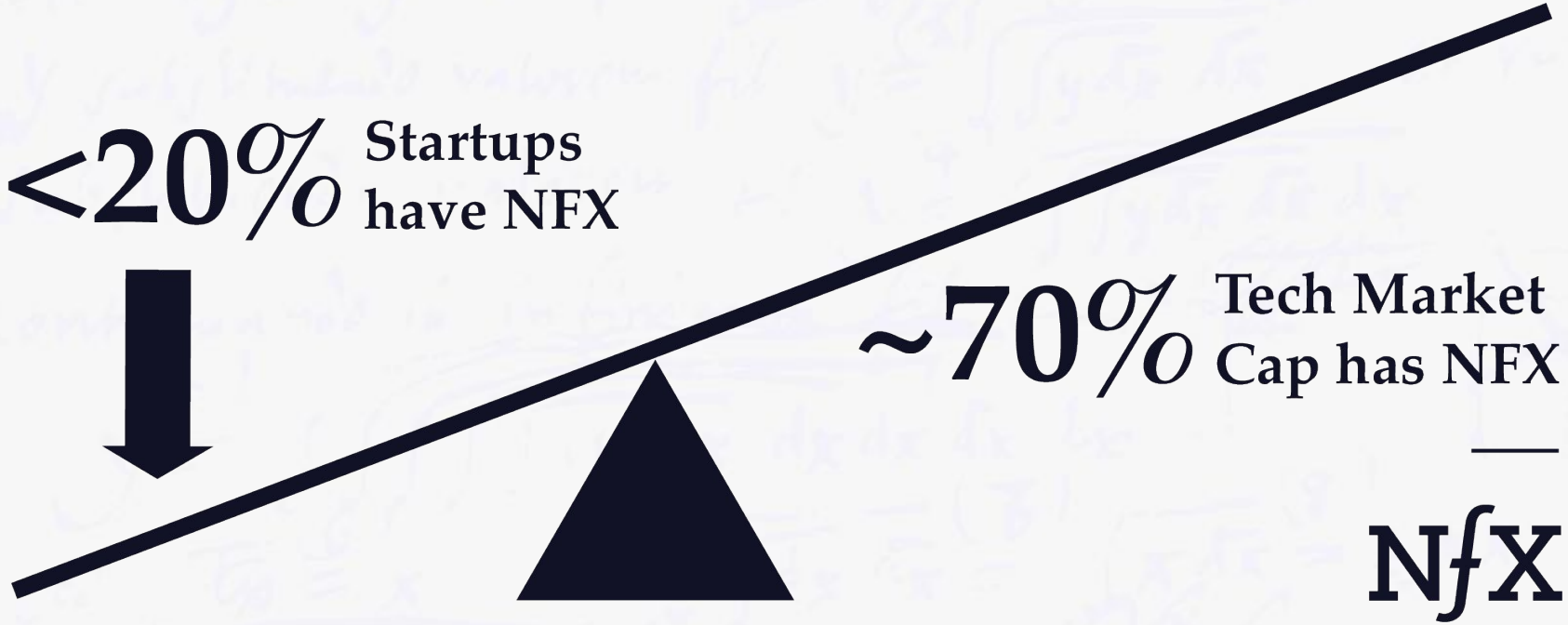
Part IV - Building and Maintaining Network Effects

Part V - Related Concepts

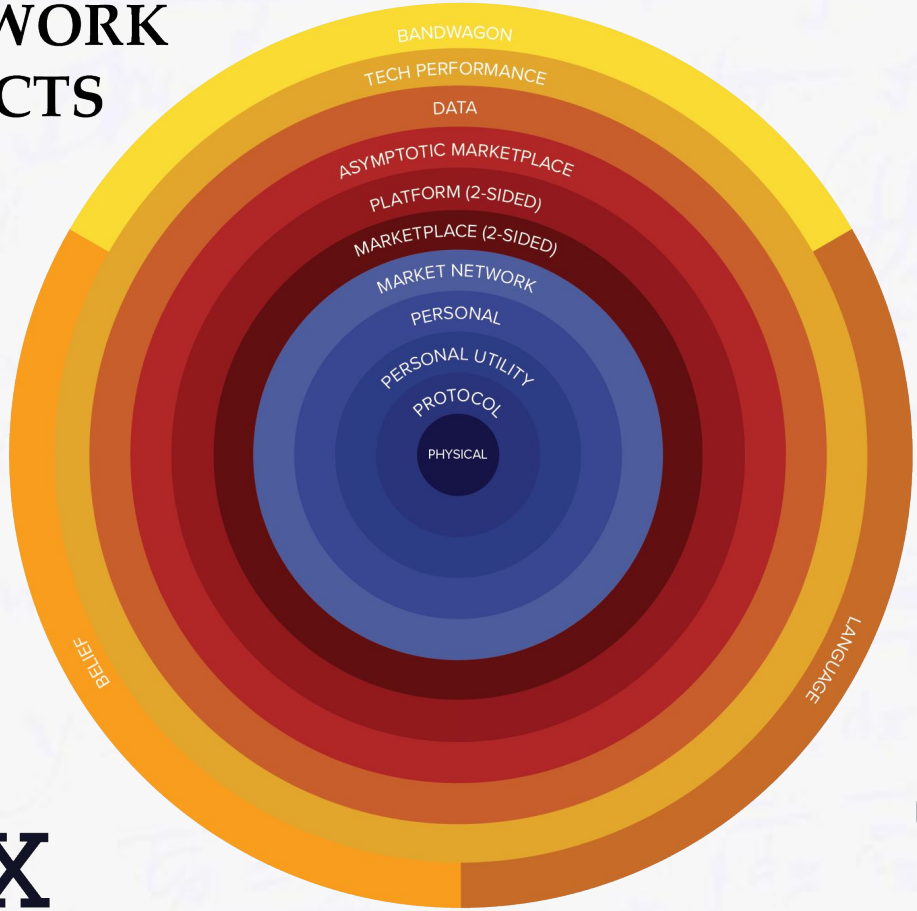
Part I

Why Network Effects Are Important

70% of the value created in technology since 1994 has been driven by network effects. Still, too few Founders understand network effects well, nor know how to design them into products.



NETWORK EFFECTS MAP



[There are 4 main defensibilities in the digital world]:

Scale, Embedding, Brand, and Network Effects.

Of these four, network effects are the most powerful.

SCALE EMBED BRAND

NfX

The 13 Network Effects

(and counting…)

1) **Physical** (landline telephones)
2) **Protocol** (ethernet)
3) **Personal Utility** (iMessage, WhatsApp)
4) **Personal** (Facebook)
5) **Market Network** (HoneyBook, AngelList)
6) **Marketplace** (eBay, Craigslist)
7) **Platform** (2-sided) (Windows, iOS)
8) **Asymptotic Marketplace** (Uber, Lyft)
9) **Data** (Waze, Yelp!)
10) **Tech Performance** (BitTorrent)
11) **Language** (Google, Xerox)
12) **Belief** (currencies, religions)
13) **Bandwagon** (Slack, Apple)

Network Effects Case Studies

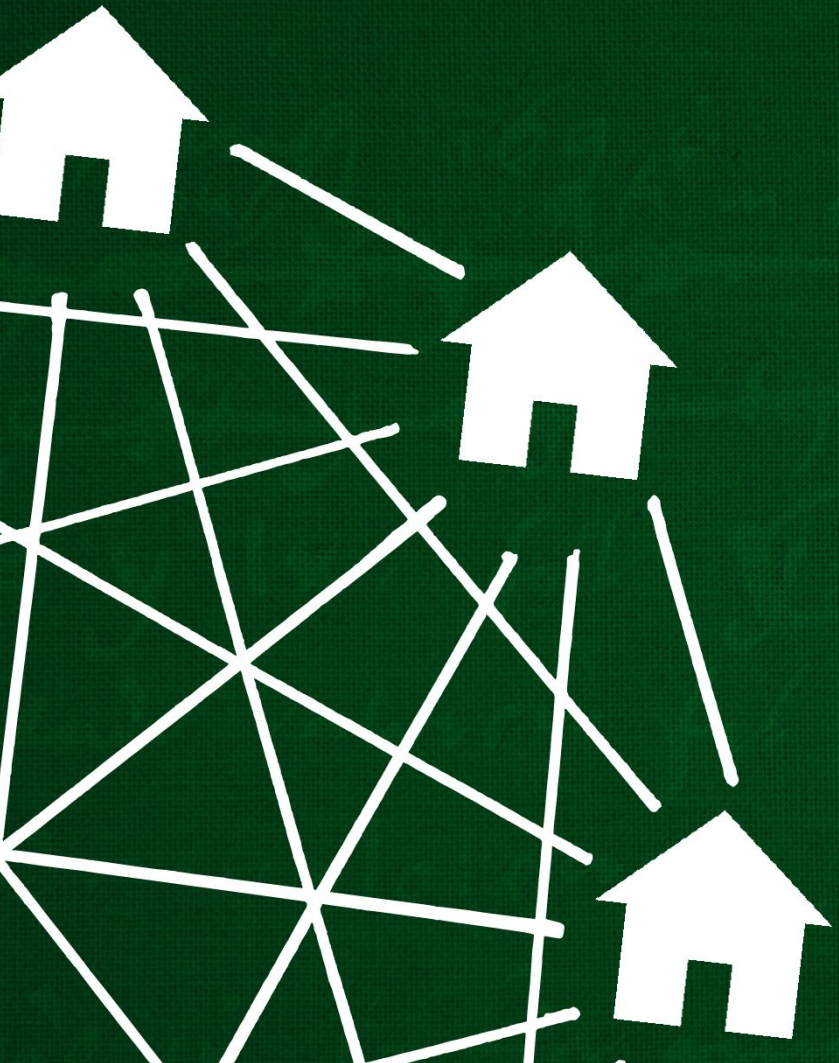
The NFX map applied to category-leading companies

The Network Effects of facebook

We don't think most people really understand Facebook yet. It is the most powerful network effects company we've ever seen, with no less than six of the thirteen known network effects currently working in its favor. On top of that, Facebook has fortified itself with all three other defensibilities: brand, scale, and embedding.

Network effects have defined Facebook throughout their history. 10 years ago we wrote that Google should buy Facebook at any cost because of their powerful network effects — and time has more than vindicated the argument. More than any other factor, Network Effects predict the future of Facebook.

Read the full case study here.



The Network Effects of trulia®

Trulia revolutionized the US real estate market by successfully creating an online marketplace for real estate. Trulia's Founder & former CEO Pete Flint (currently a managing partner at NFX) says Trulia built three distinct types of network effects into the core of its business — data, marketplace, and market network — in order to achieve success, leading to a massive $3.5 billion exit and an industry-shaping merger.

Read the full case study here.

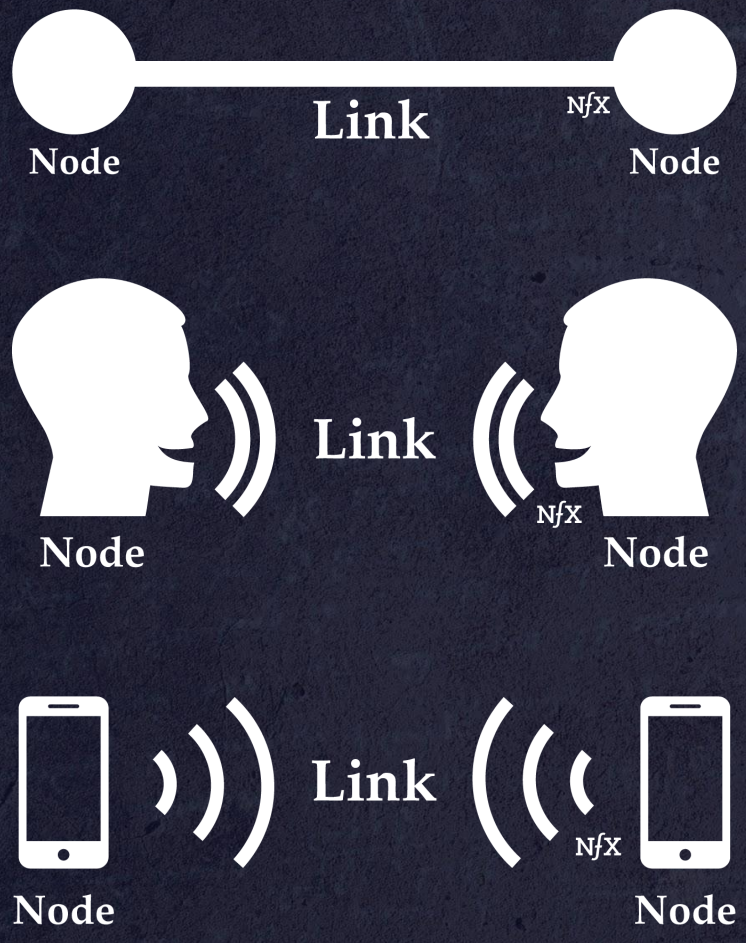
The Network Effects of UBER

Most people think of Uber as a true 2-Sided Marketplace. As shown in the NFX Map, true 2-Sided Marketplaces have some of the most powerful network effects and therefore strong defensibility. But, in reality, Uber is an asymptotic marketplace which has much weaker network effects. For this and other reasons, Uber is more vulnerable than most realize.

Read the full case study here.

Part II

How Networks Work



Networks are any set of nodes and links

Nodes are network participants. Not all nodes are equal in function and importance. **Central nodes** have a high relative number of links, and **marginal nodes** have fewer links.

Network size can be measured by the total number of nodes in a network, and **degree** is a measure of the number of links each node has.

Links are the connections between nodes in a network. Links vary in terms of directionality, the strength of the connection, and the frequency of activity.

Network density is the proportion of links to nodes within a network.

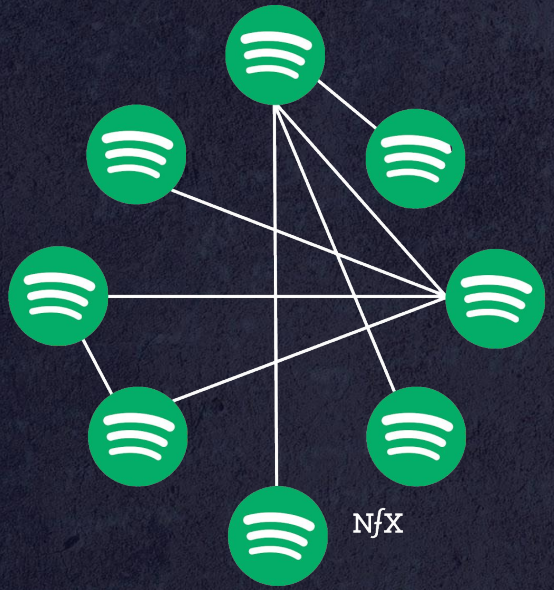
Read more about Nodes and Links

Network Density

[Read more about Network Density]

Network density is the ratio of its links to nodes. The higher the ratio, the greater the density of the network. Typically, the higher the density of the network, the more powerful its network effects are.

Founders should build products to promote higher network density. Within a network, density is usually distributed unevenly. At the beginning, Founders should typically focus on the "white-hot center" of your network, where the density and activity are highest, and let the network grow from there.



Low Density

High Density

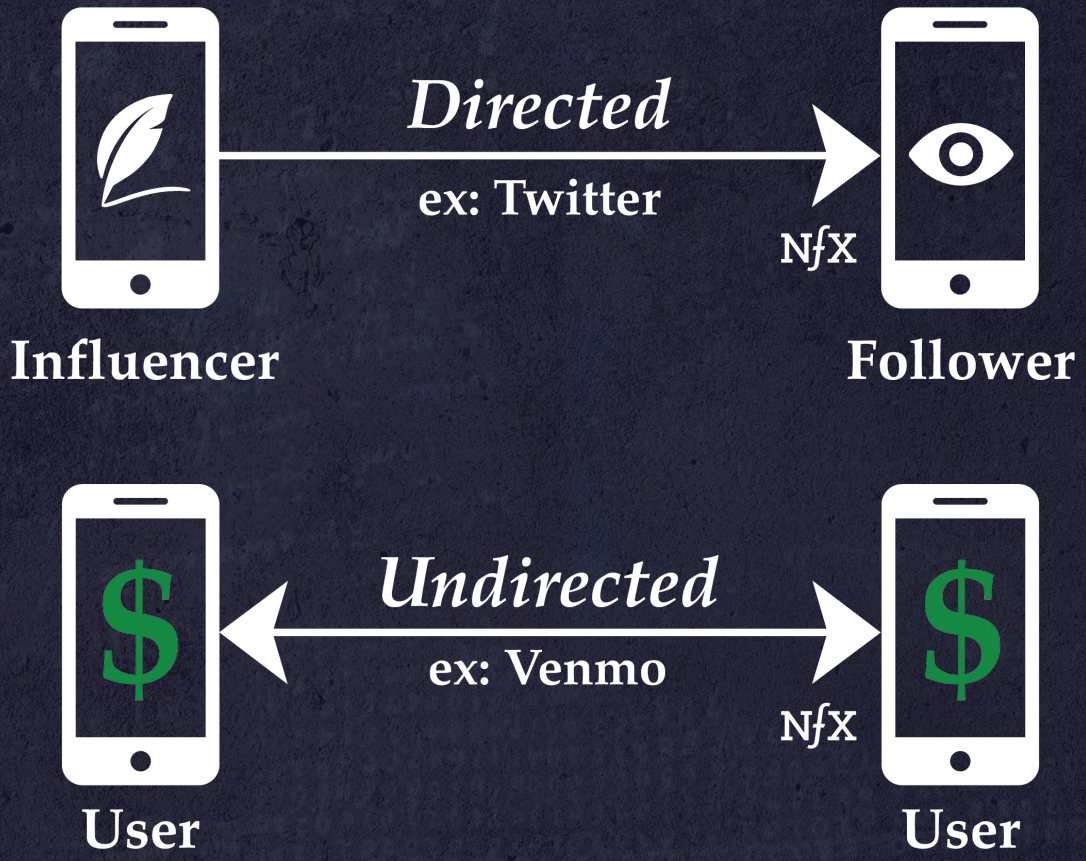
Directionality

A link between nodes can be either **directed** or **undirected**.

Directed links denote one-way relationships. When the interaction between one node and another isn't reciprocated, it's a directed link.

Undirected links are two-way, reciprocal relationships. The interaction between two nodes on a network with undirected links flows both ways.

[Read more about Directionality]



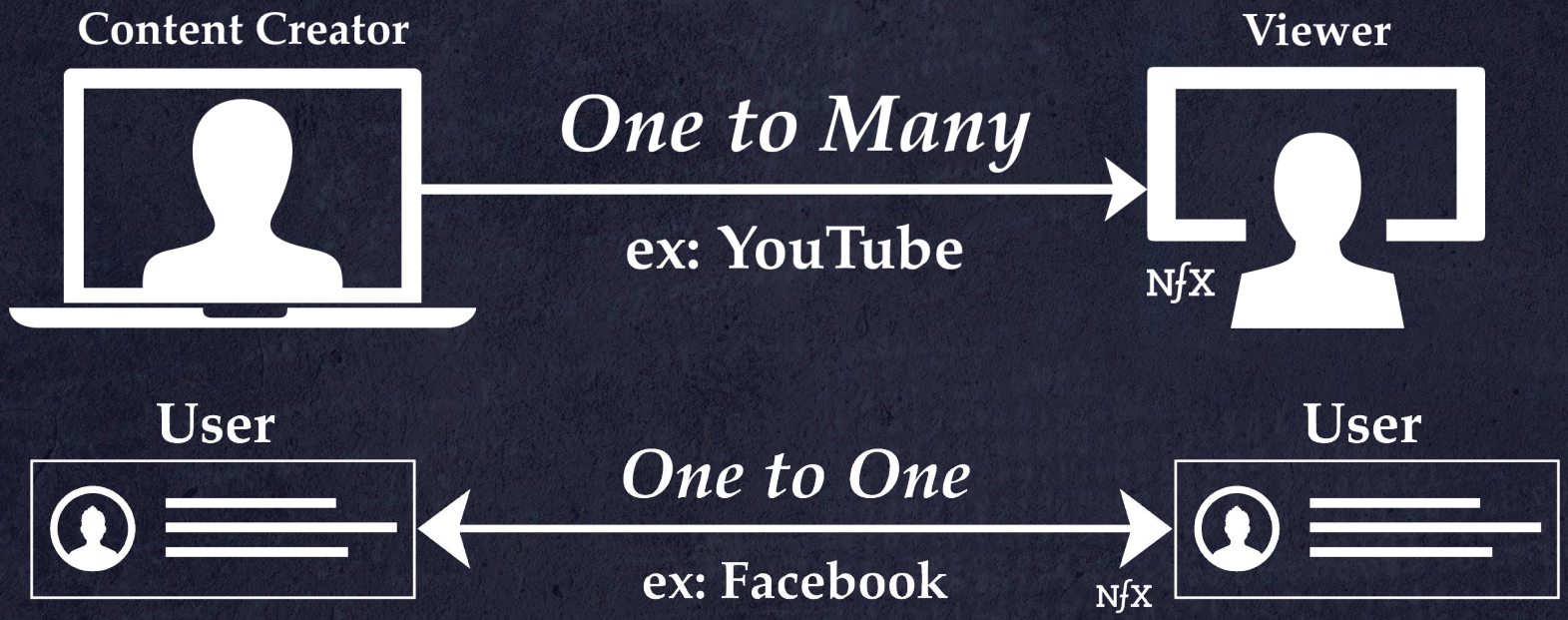
One-to-One vs. One-to-Many

[Read more about One-to-One vs. One-to-Many]

Relationships between nodes in a network can be **one-to-one**, or they can be **one-to-many**.

YouTube is an example of a network with one-to-many links (accounts with large followings that they don't follow back).

Facebook has one-to-one connections at its foundation.



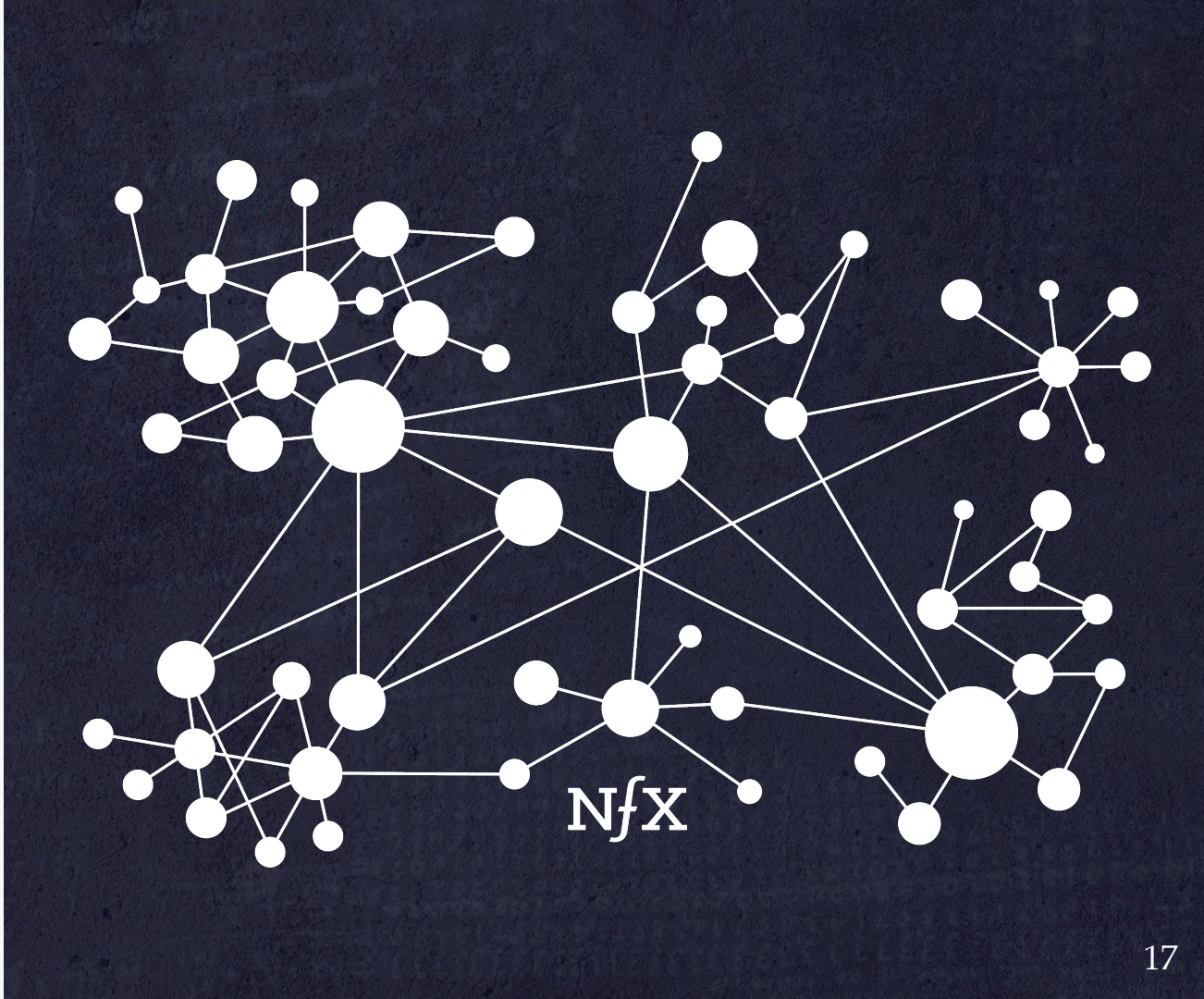
Clustering

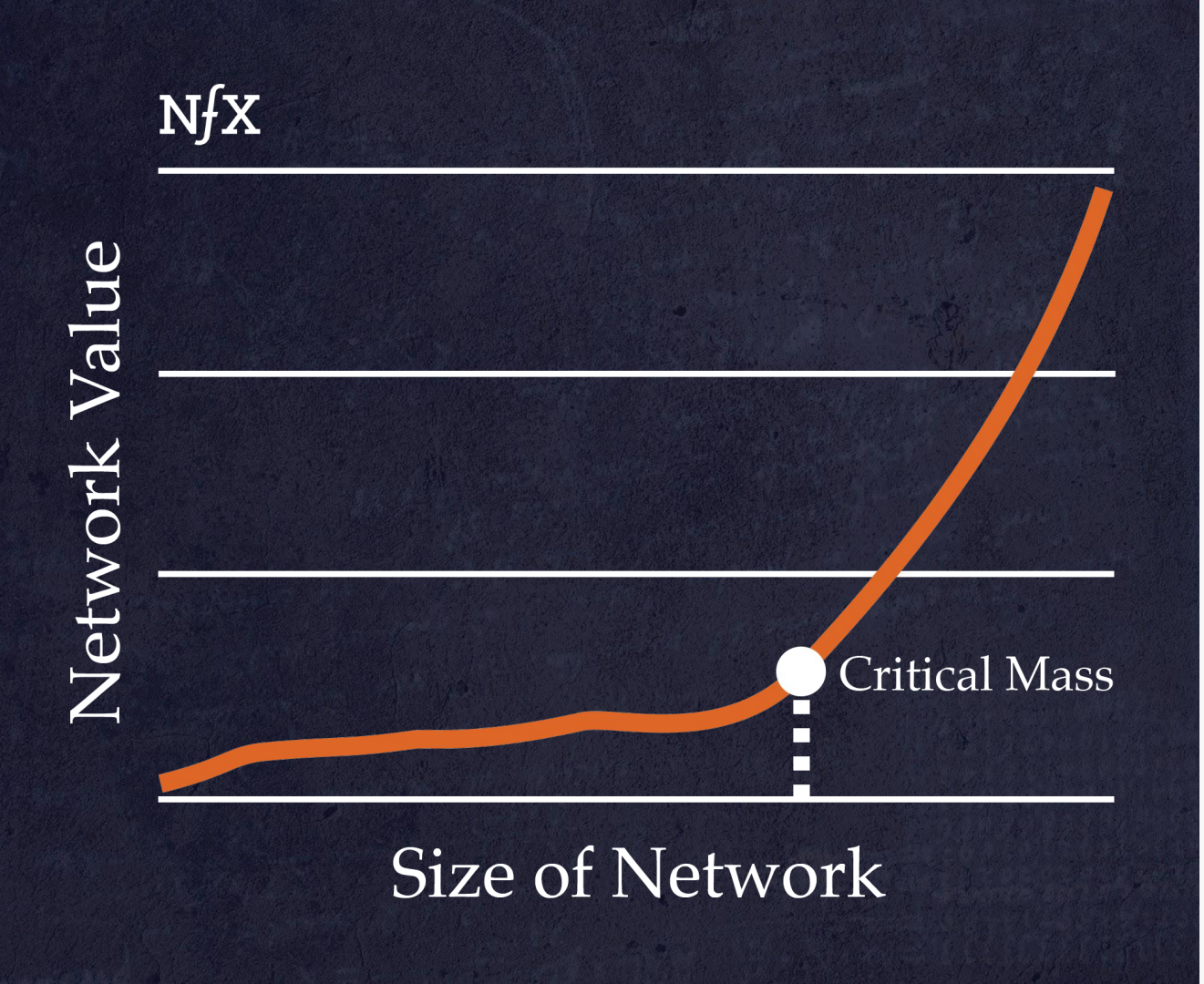
Within real-world networks, nodes are unlikely to be dispersed evenly. They tend to cluster or form local groupings that are more tightly knit than the network at large.

If you look at how you use services like Slack or Facebook Messenger, where you form subgroupings that are more tightly-knit and active than the broader network, you can see some examples of clustering.

A **"clustering coefficient"** measures the degree of clustering in a network. Often, the higher the clustering coefficient, the faster the value of the network increases as usage grows.

[Read more about Clustering]





Critical Mass

The **critical mass** of a network refers to the point at which the value produced by the network exceeds the value of the product itself and of competing products.

Most products with network effects must ultimately reach critical mass in order to fully take advantage of the defensibility provided by their network effects.

Before the size of the network reaches critical mass, the product remains quite vulnerable and may not have much value to users.

Read more about Critical Mass

The Network "Laws"

[Read more about the Network Laws]

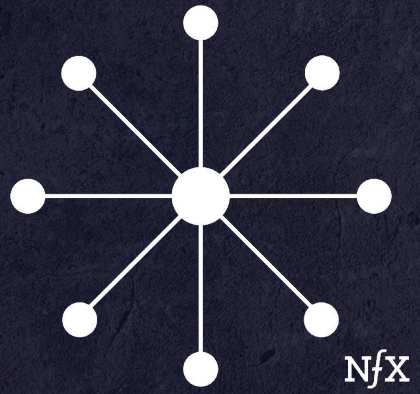
These laws describe the rate at which network value increases as they scale.

Sarnoff's Law describes broadcast networks, which increase in value in proportion to *N* (with N being the number of nodes).

Metcalfe's Law describes networks without clustering, which grow in value at a geometric rate (*N^2).*

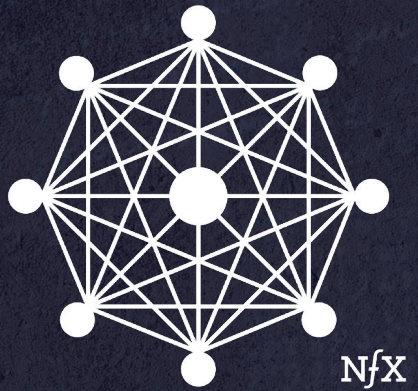
Reed's Law applies to networks with clusters, which increase in value at an exponential rate (*2^N)*

Sarnoff's Law



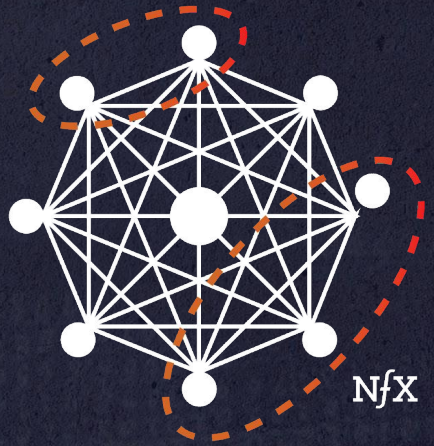
$V=n$

Metcalfe's Law



$V=n^2$

Reed's Law



$V=2^n$

Part III

Network Properties

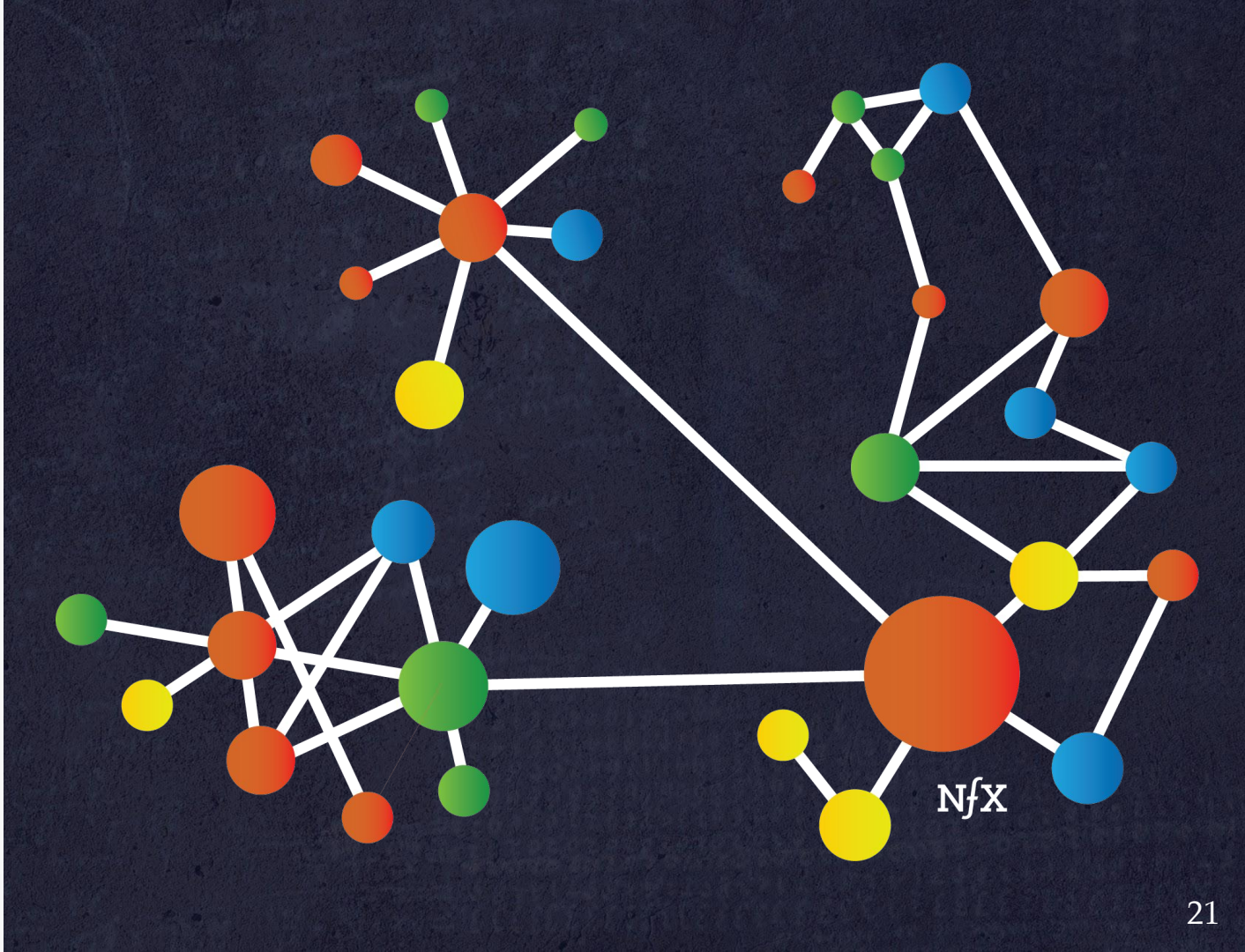
Irregularity

Real-world networks tend to have clusters, hot spots, and dead spots.

This is because complex systems have **irregularities**. The nature and configuration of nodes and links can vary widely throughout a single network.

For Founders, it's important to recognize these irregularities and go after the densest, most active "white-hot center" of the network.

[Read more about Irregularity]



Real Identity, Pseudonymity, & Anonymity

Many network effect businesses require users to create a profile that's visible to other nodes in the network. Networks with profiles tied to a node's real identity, like your real personal name or real company name, are typically more effective at building network effects than networks with pseudonymous profiles (e.g. user-generated handles like "Tiger123") or completely anonymous networks.

Read more about network identity

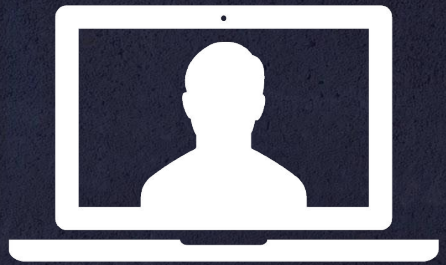
Anonymity

Ex: Whisper, Yik Yak

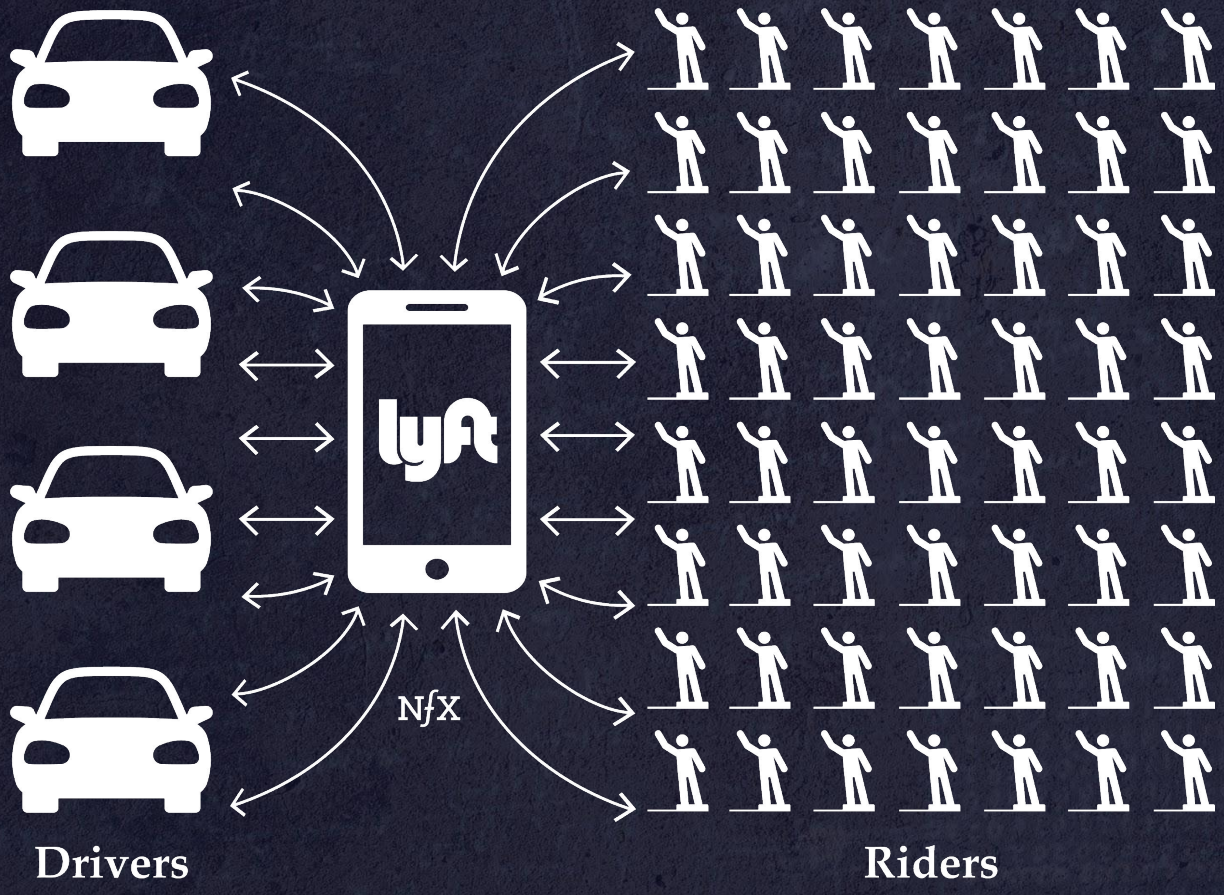
Pseudonymity

Ex: Twitter, Reddit

Real Identity



Ex: Facebook, LinkedIn



Asymmetry

This term relates mostly to marketplaces, whether that marketplace is 1, 2, 3, or N-sided.

In nearly every marketplace, one side - or one type of node - is harder to acquire than the other. In a "demand-side marketplace," the demand side (buyers) are harder to acquire. In a "supply-side marketplace," the sellers are harder.

Look for these various asymmetries in a marketplace and prioritize which types of demand or supply will be the best to attract first, second, and third. Then focus on developing tactics to crack the highest-value target first.

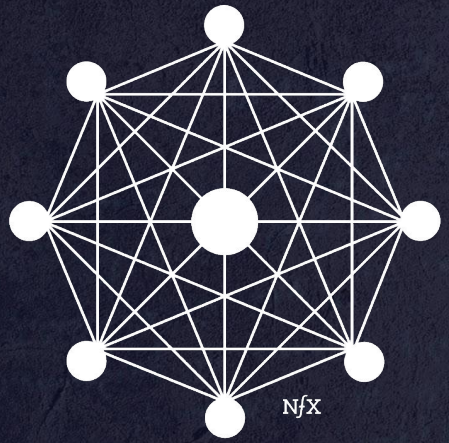
Read more about network asymmetry

Homogeneous vs Heterogeneous Networks

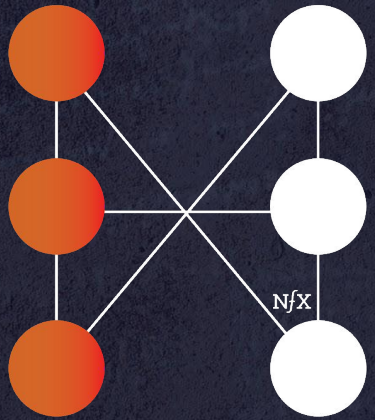
[Read more about Homogeneous vs. Heterogeneous Networks]

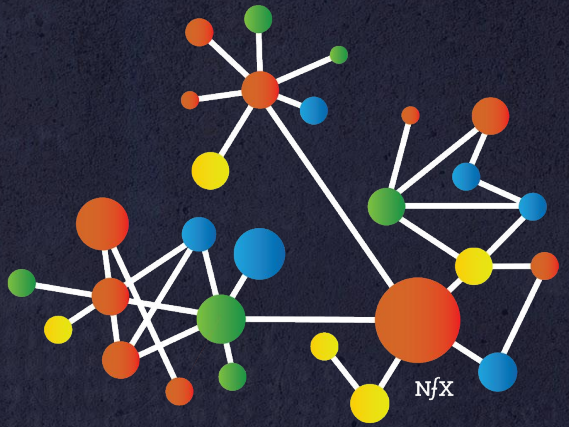
Homogeneous networks are networks where all the nodes have the same function in the network. One user is interchangeable with the next in the basic function they perform. In a landline telephone network, for example, each node (telephone) performs basically the same function as any other.

Heterogeneous networks are networks where there are two or more classes of nodes categorized by both function and utility. Buyer nodes on eBay, for example, are on the network for fundamentally different reasons from seller nodes.



Homogeneous Network





Heterogeneous Networks

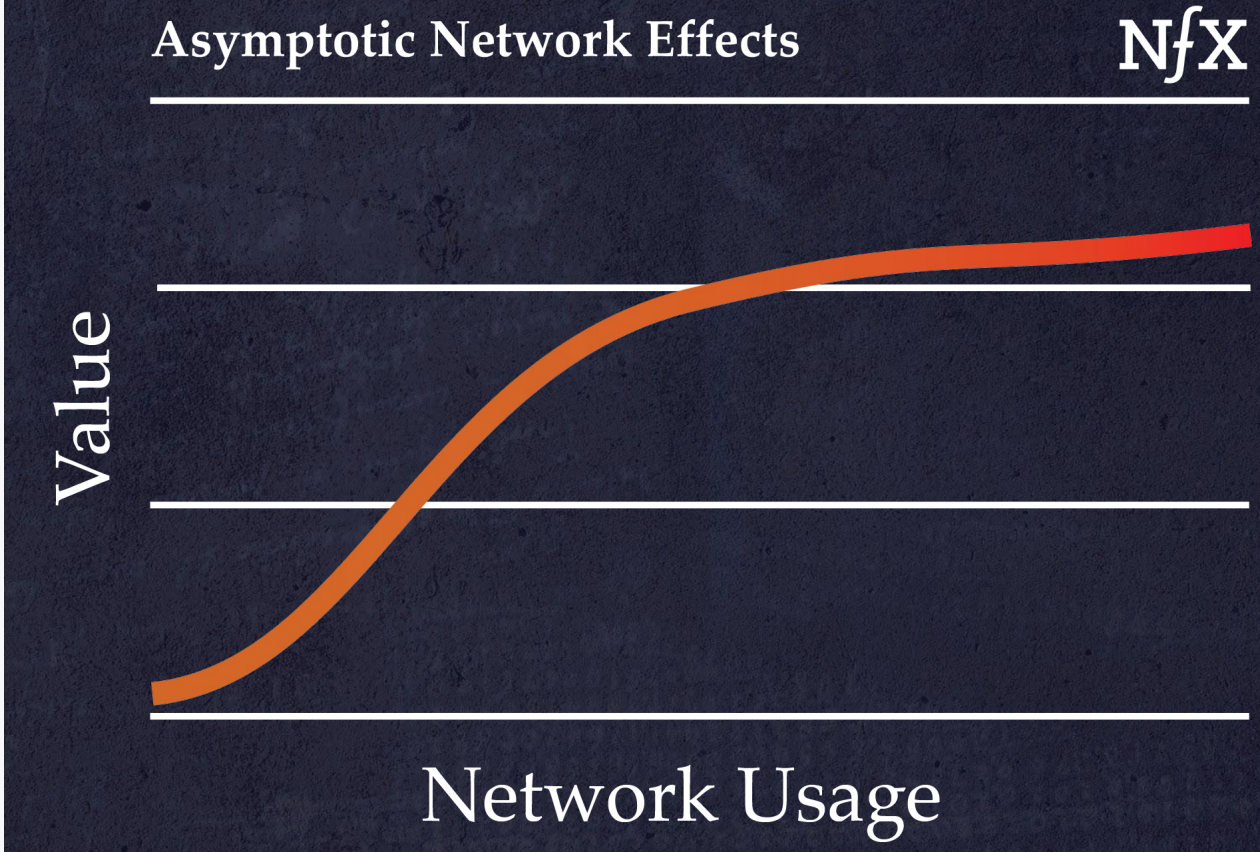
Asymptotic Network Effects

Asymptotic network effects are network effects with diminishing returns.

Recall the basic definition of network effects: as usage of a product grows, its value to each user also grows. In some cases, however, network effects can start to weaken after certain point in the growth of the network.

Growth in an asymptotic network, after a certain size, no longer benefits the existing users. Examples include Lyft/Uber and most data network effects.

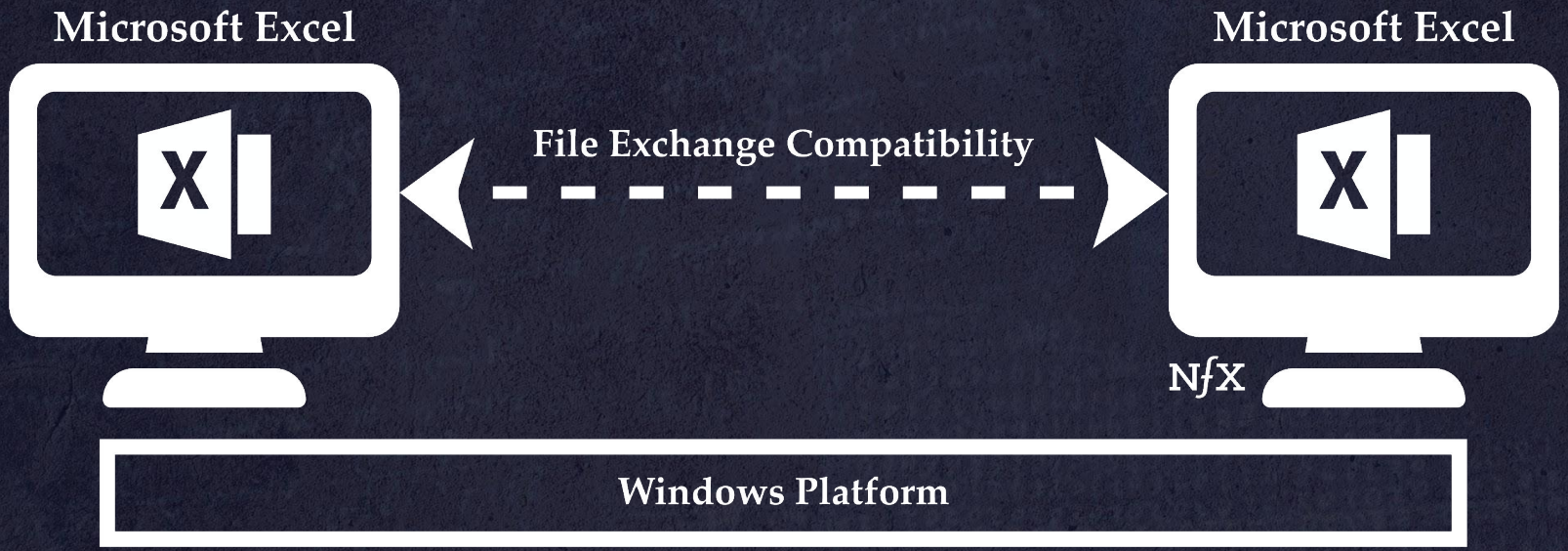
Read more about Asymptotic Network Effects

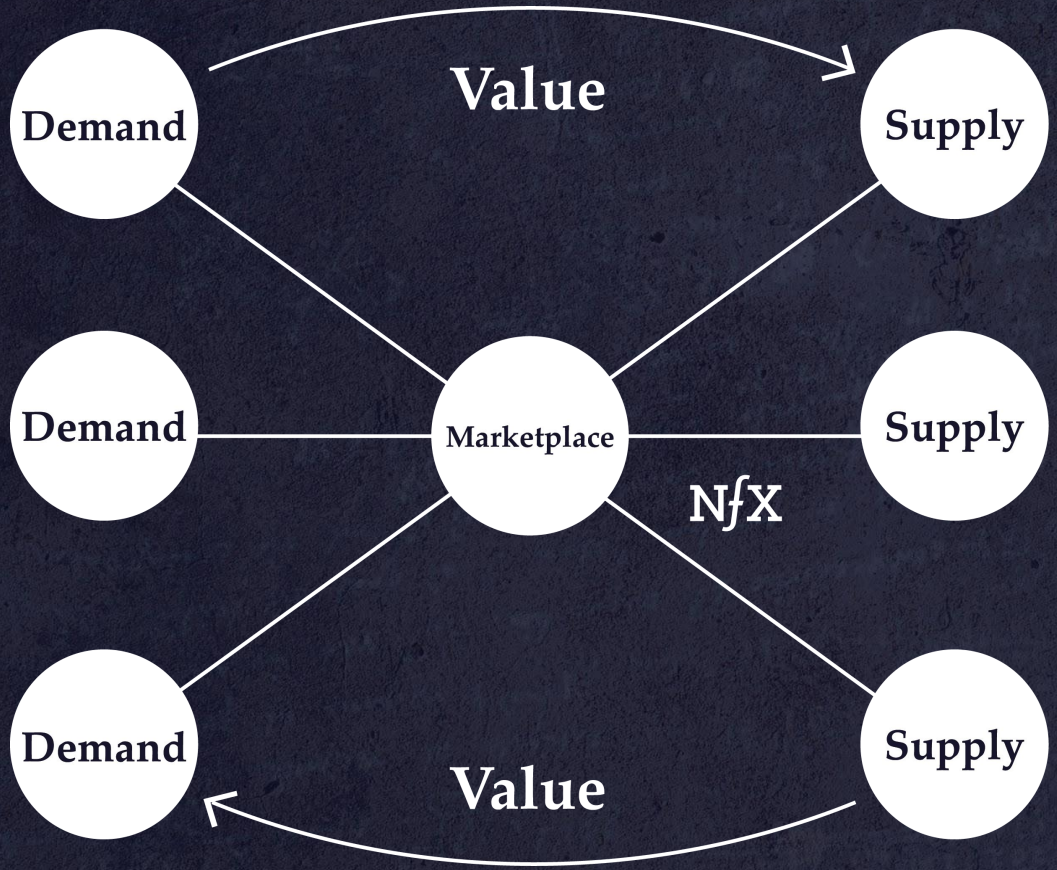


Same-Side Network Effects

[Read more about Same-Side Network Effects]

Same-side network effects are *direct* network effects that occur on the same side of a multi-sided (2-sided or N-sided) network. A platform like Microsoft's OS, for instance, has a same-side network effect because Microsoft users directly benefit from an increase in other same-side users (on the demand side of the platform) since they can interchange Word, Excel, and other files with a greater number of people. This makes both the platform itself and applications developed on the platform more valuable for users.





Cross-Side Network Effects

Cross-side network effects are *direct* network effects that arise from complementary goods or services in a network with more than one side. As opposed to indirect network effects, cross-side network effects refers specifically to the direct increase in value to users on one side of a network by the addition of users to another side. More supply is better for the demand. More demand is better for the Supply.

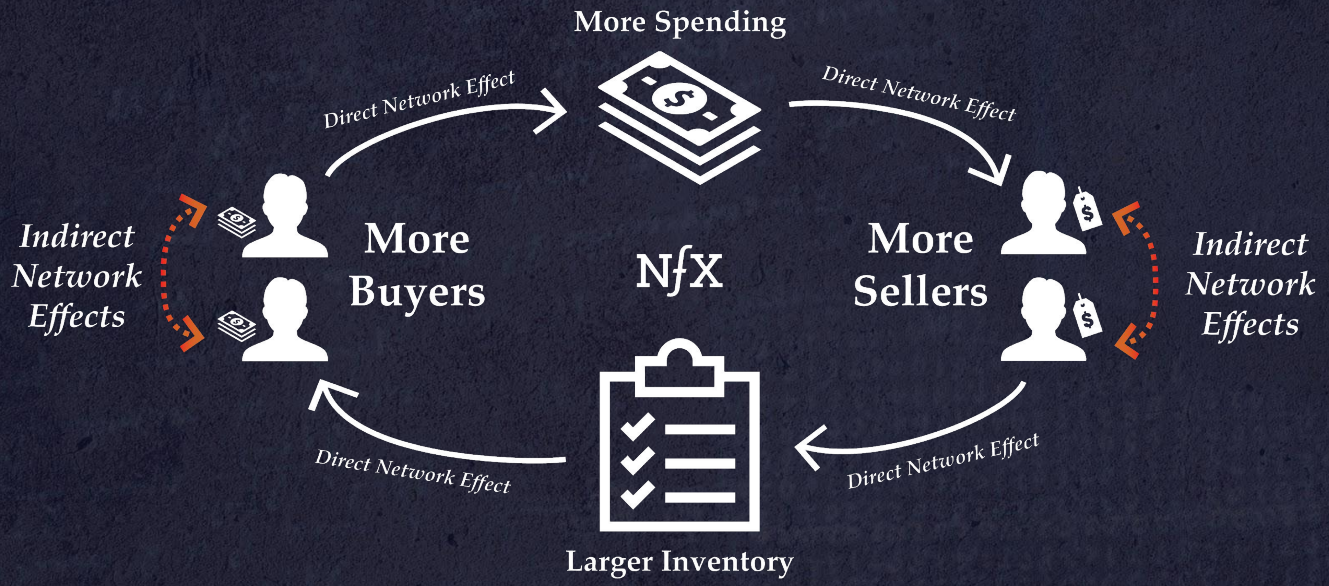
Read more about cross-side network effects

Indirect Network Effects

[Read more about Indirect Network Effects]

Indirect network effects occur when the value of a network increases as a result of one type of node benefitting another type of node directly, but not directly benefiting the other nodes of its same type.

Same-side nodes *indirectly* benefit each other because they create an increased incentive for complementary users on the other side of the network to use the network, which in turn benefits all the nodes on the same side.



Negative Network Effects

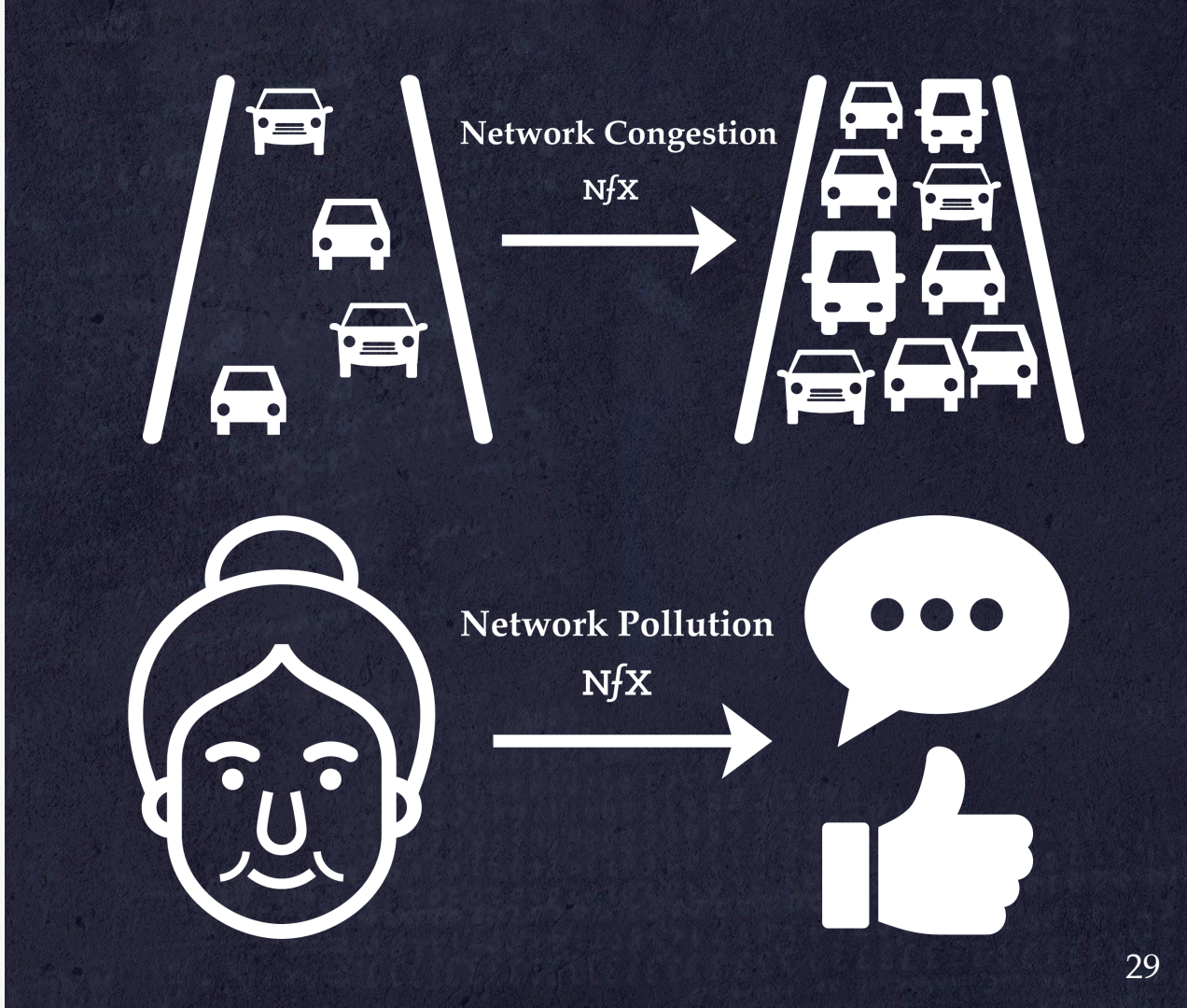
In some situations, more network usage or greater network size can actually decrease the value of the network, leading to **negative network effects**.

Negative network effects can happen in two ways.

First, **network congestion**, where the network becomes less valuable as a result of increased usage-- as with traffic in a road network.

Second, **network pollution**, where the network grows too large and is polluted with unwanted content -- like your grandmother commenting on your party photos on Facebook.

[Read more about negative network effects]



Part IV

Building and Maintaining Network Effects

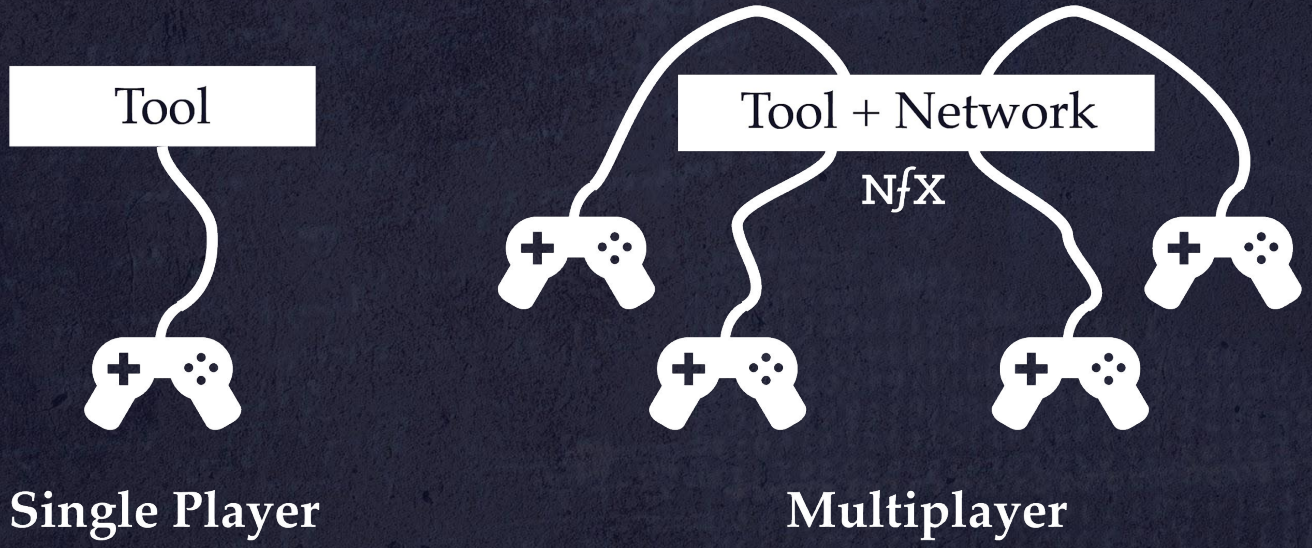
Multiplayer vs Single-Player Mode

[Read more about Multiplayer vs. Single-Player Mode]

"Multiplayer mode" and "single-player mode" are terms that came from the gaming industry, but are useful for discussing network effects.

With single-player mode products, you get the full value of the product no matter who else is using it. For example, filing taxes via TurboTax. With multiplayer mode products, some of the value of using a product (and often the majority of it) comes from other users. A multi-player product lets you feel and benefit from the activity of other users.

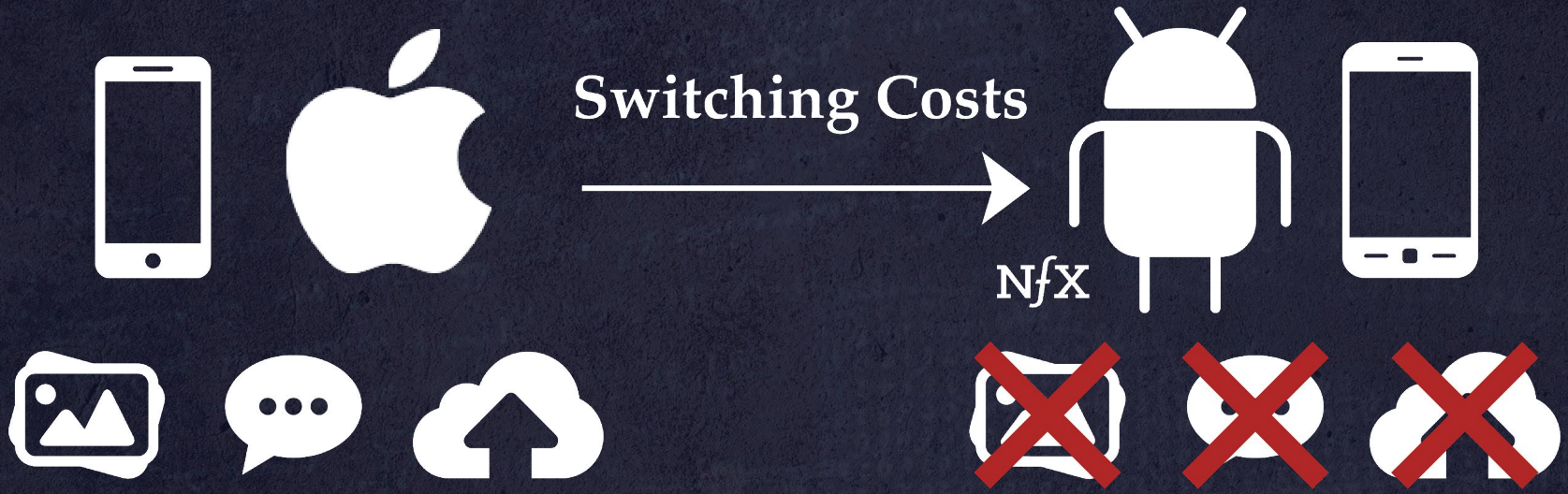
Products can have both single-player and multiplayer value. Watching YouTube videos is a single-player experience. YouTube, with view count and comments, is also a multiplayer experience.

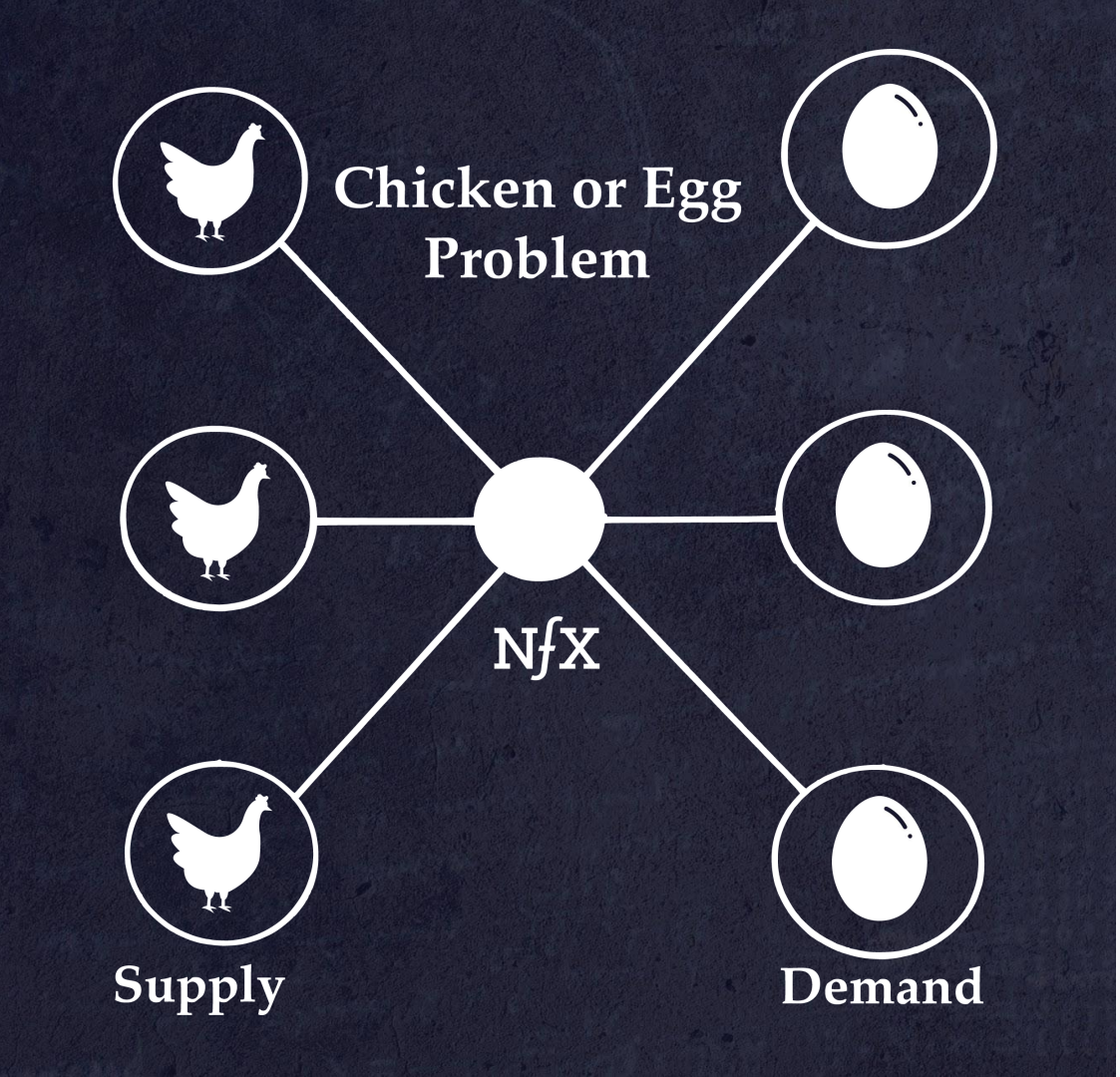


Switching Costs

Switching costs refer to the costs in time, effort, or money that arise when you switch from using one product to another incompatible product. When switching costs are high, it tends to create customer **lock-in** because the customer has more of an incentive to stick with the same supplier throughout their life cycle. Any product that has a lot of defensibility will have high switching costs.

[Read more about Switching Costs]





Chicken or Egg Problem (Cold-Start Problem)

When you first launch a two sided network like a marketplace or a platform, there is often no value to one side of the network until the other side is there too. So which comes first?

There are at least 19 tactics to help solve the **chicken or the egg problem**.

Several of them involve creating a single-player mode product where one side (either the supply side or the demand side, depending on the type of marketplace) can derive value from the software without a network in place.

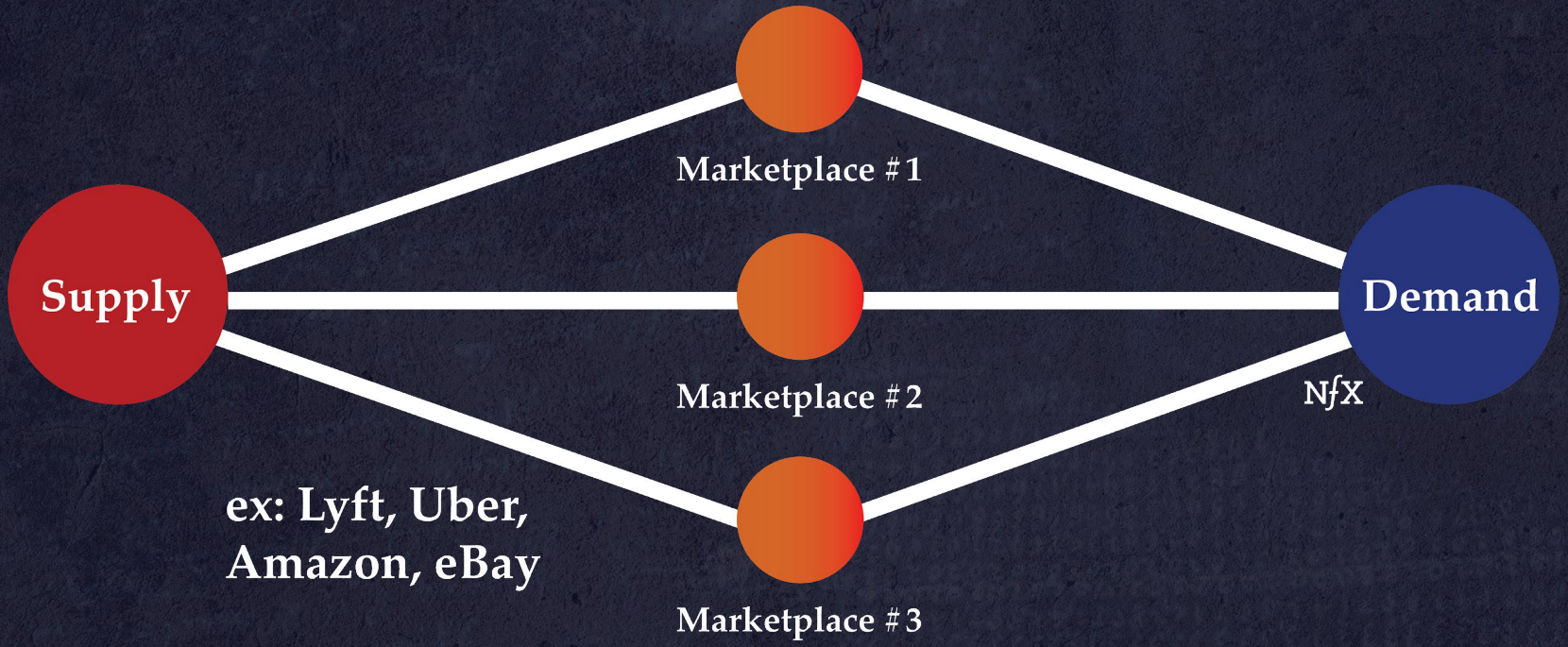
Others involve attracting one side of the marketplace with compensation, such as cash or leads.

Read more about the Chicken or Egg Problem

Multi-Tenanting

[Read more about Multi-Tenanting]

Multi-tenanting occurs when there are low costs or no costs to simultaneously participating in competing networks at the same time. When the two sides of a marketplace switch between services to get to the other side of the marketplace at no cost, that's multi-tenanting. For example, both riders and passengers frequently switch between Uber and Lyft to find rides/passengers.



Disintermediation

Disintermediation is a vulnerability that mostly applies to Marketplaces and Market Networks. It happens when, after initially connecting through a marketplace or market network product, users take future transactions off the product and transact directly, without paying a fee to the marketplace.

For example, you might hire someone to build IKEA furniture using Taskrabbit, and then exchange numbers so that you can hire them for future jobs directly.

This is a significant problem for marketplaces and market networks because repeat purchase is critical to most transactional networks.

To help prevent disintermediation, you can provide tools, reputation, insurance, compliance, leads and other incentives.

Read more about Disintermediation

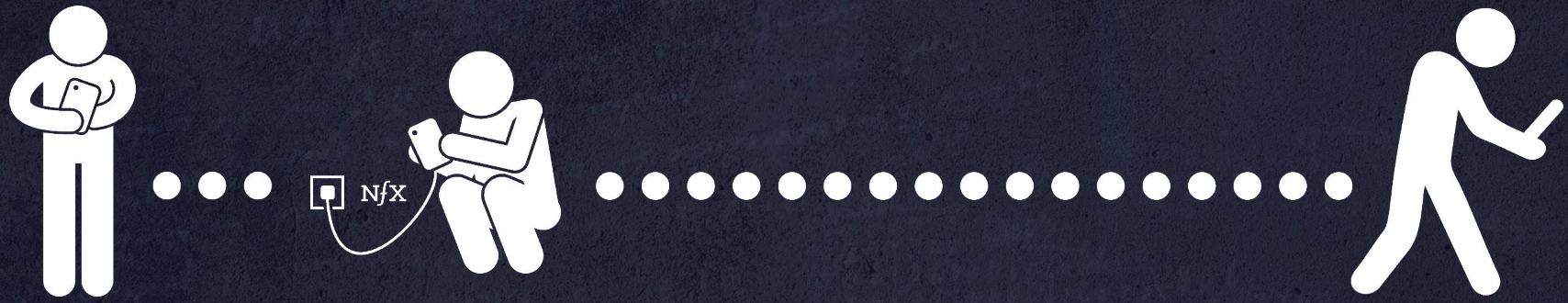
Retention

[Read more about Retention]

Retention is about how often your users return to use your product. This can make a big difference in how powerful the network effects of a product are.

Recall that network effects happen when increased *usage* of a network leads to greater value. Usage can increase in one of two ways: either new users join the network, or existing users increase their usage.

Any drop off in usage from existing users will weigh against the growth of the network from new users. That's why retention is so important for building network effects.



Part V

Related Concepts

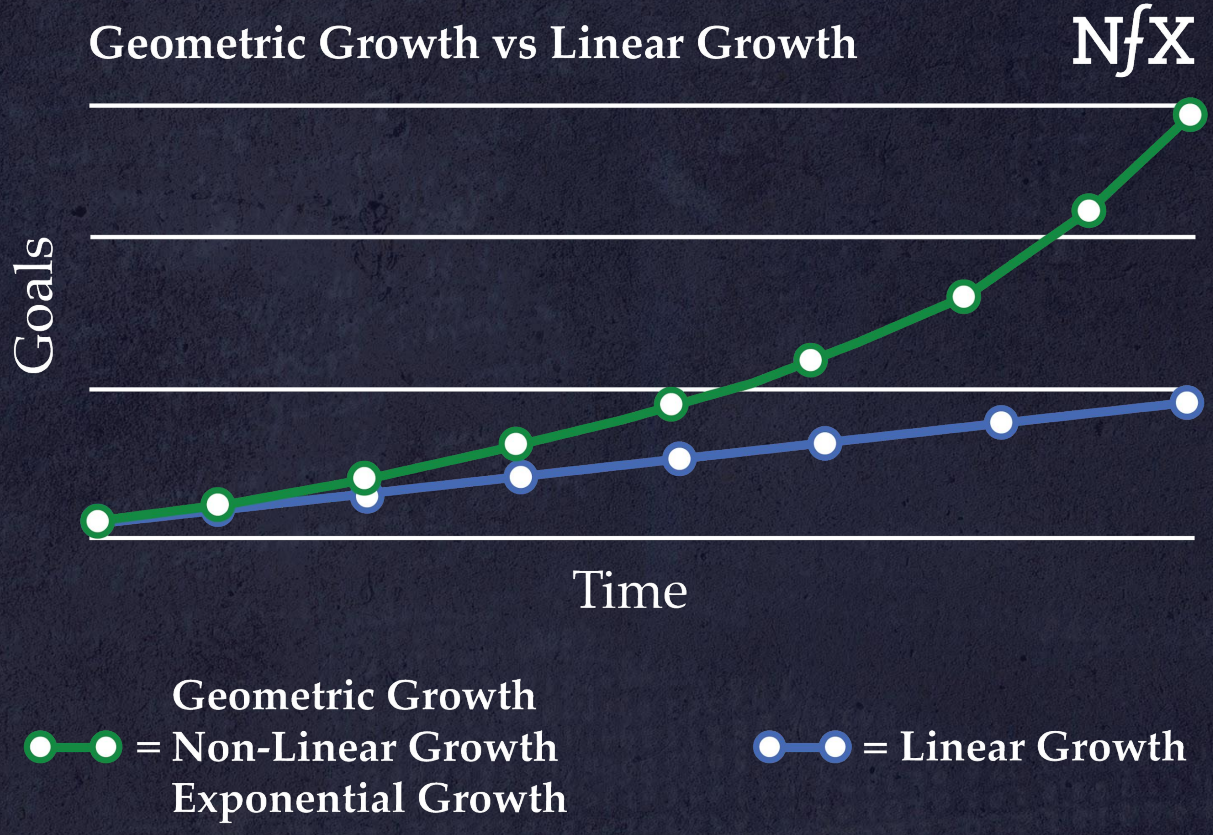
Geometric Growth vs. Linear Growth

Businesses with neither viral effects nor network effects tend to produce linear, straight-line growth. Linear growth can produce a business, but not the kind of high impact, exciting growth we're all looking for.

We all want the green-line growth curve, but it is not a network effect. It's a growth curve.

Founders should push themselves and their teams to reach geometric growth. Network effect businesses, once they hit the tipping point, typically show this type of geometric growth.

[Read more about Geometric vs. Linear Growth]

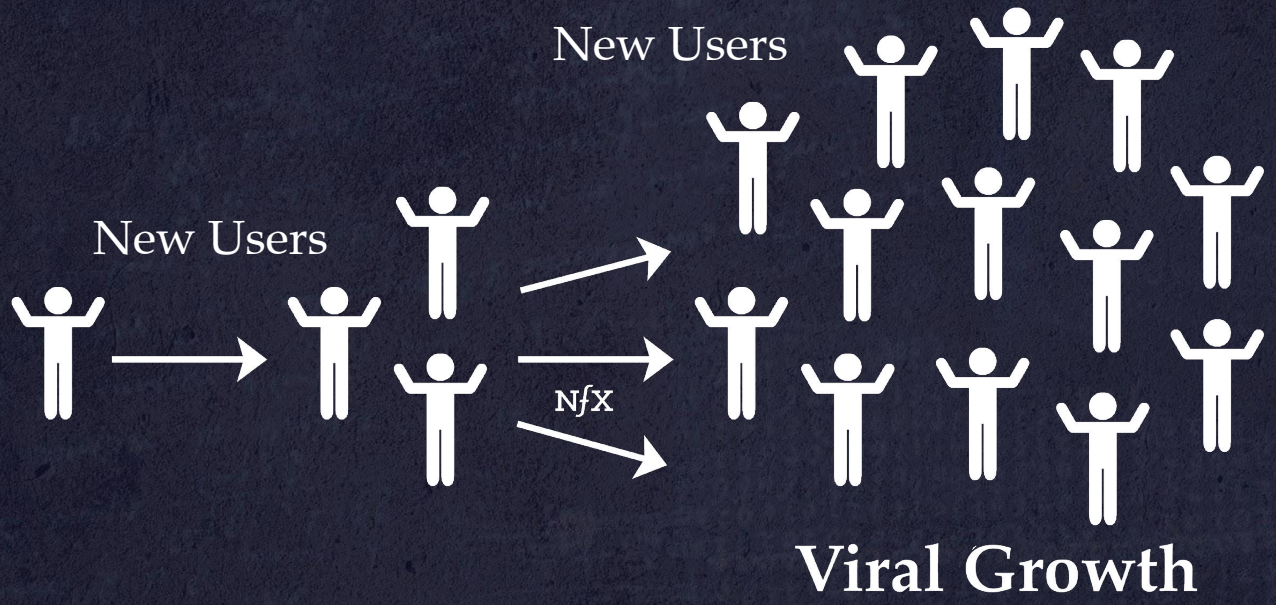


Viral Effects & Virality

[Read more about viral effects & virality]

Viral effects are different than network effects, but many people confuse the two because they are both positive feedback loops, and because they were experienced together in famous companies like Facebook, Twitter, and WhatsApp over the last 15 years.

Viral effects are about growth -- when existing users bring you more new users for free. Network effects are about defensibility: a product gets more valuable when more people use it. A product or service with viral effects has a "viral coefficient", which is the number of new users that join as a result of each user.



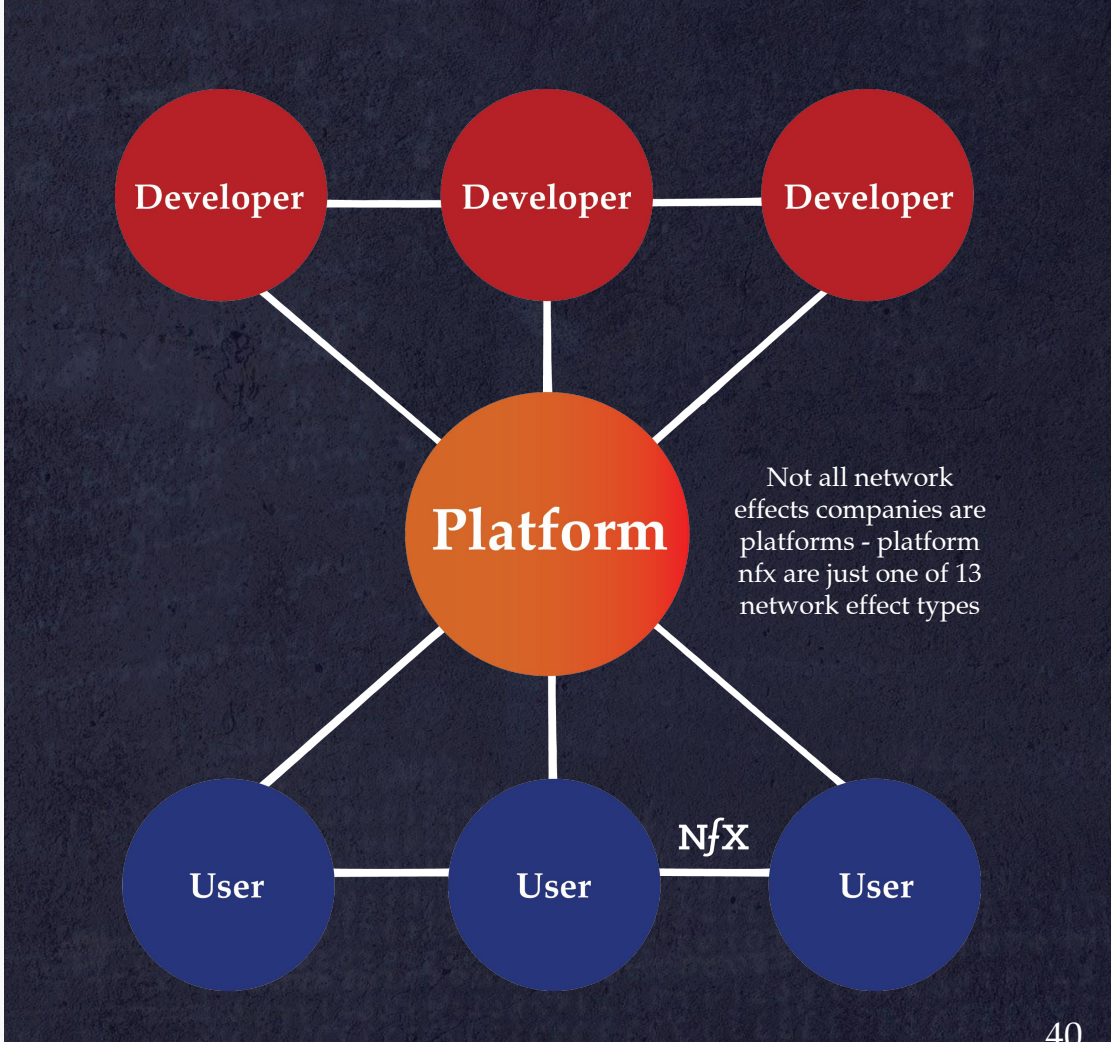
“Platform Business Model”

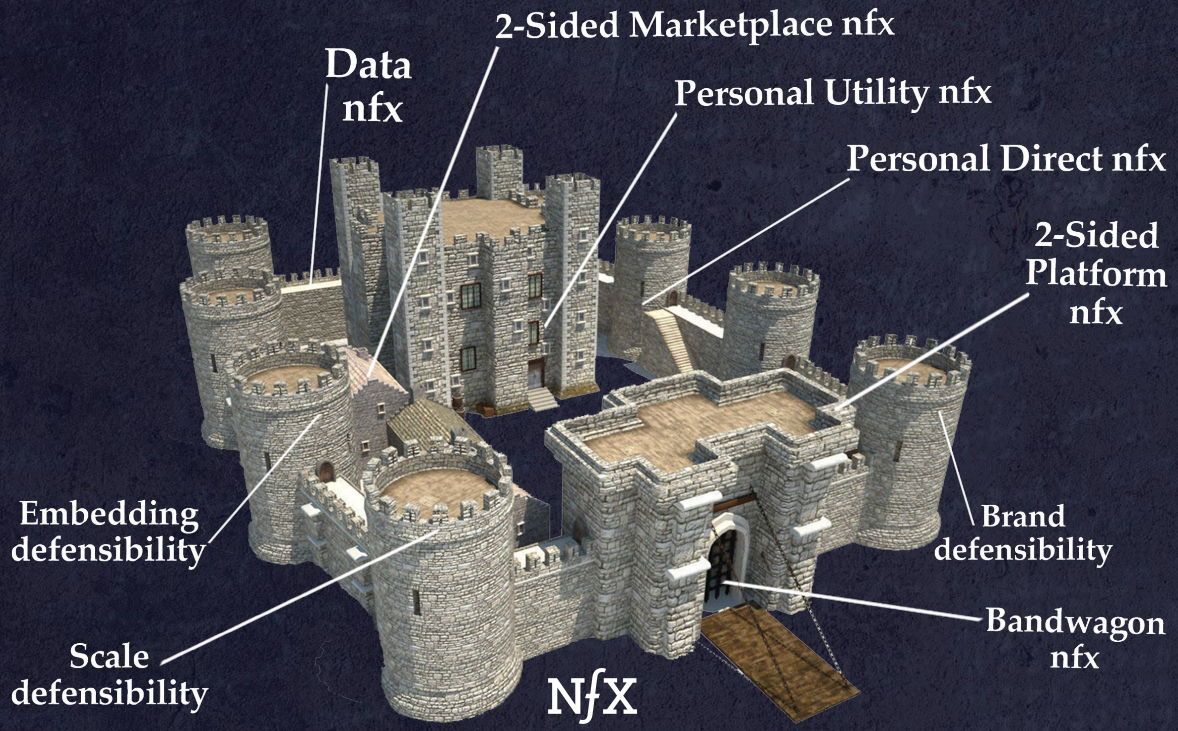
This is a recent term that is commonly used to talk about ALL companies with network effects. In our opinion, it’s too generic and conflates too many concepts together.

We think that one network effect is a “2-sided platform network effect.” We prefer to break out the 13 different network effects because we think it produces more a precise and revealing analysis.

To raise money today, it’s popular to say “make your product a **platform**.” But we think this refers to a specific type of approach where other independent companies are building their own products on your product.

[Read more about the platform vs. network effect business model]





Reinforcement

An important thing to know about network effects is that once you have one going, it's much easier to build all the other defensibilities on top of it, including other network effects.

This "reinforcement effect" is often underappreciated by Founders, especially when they're preoccupied with growth.

Continually looking for and launching new defensibilities is important because they reinforce each other. The more you have going the better, as long as you don't lose operational focus in the process.

Read more about Reinforcement

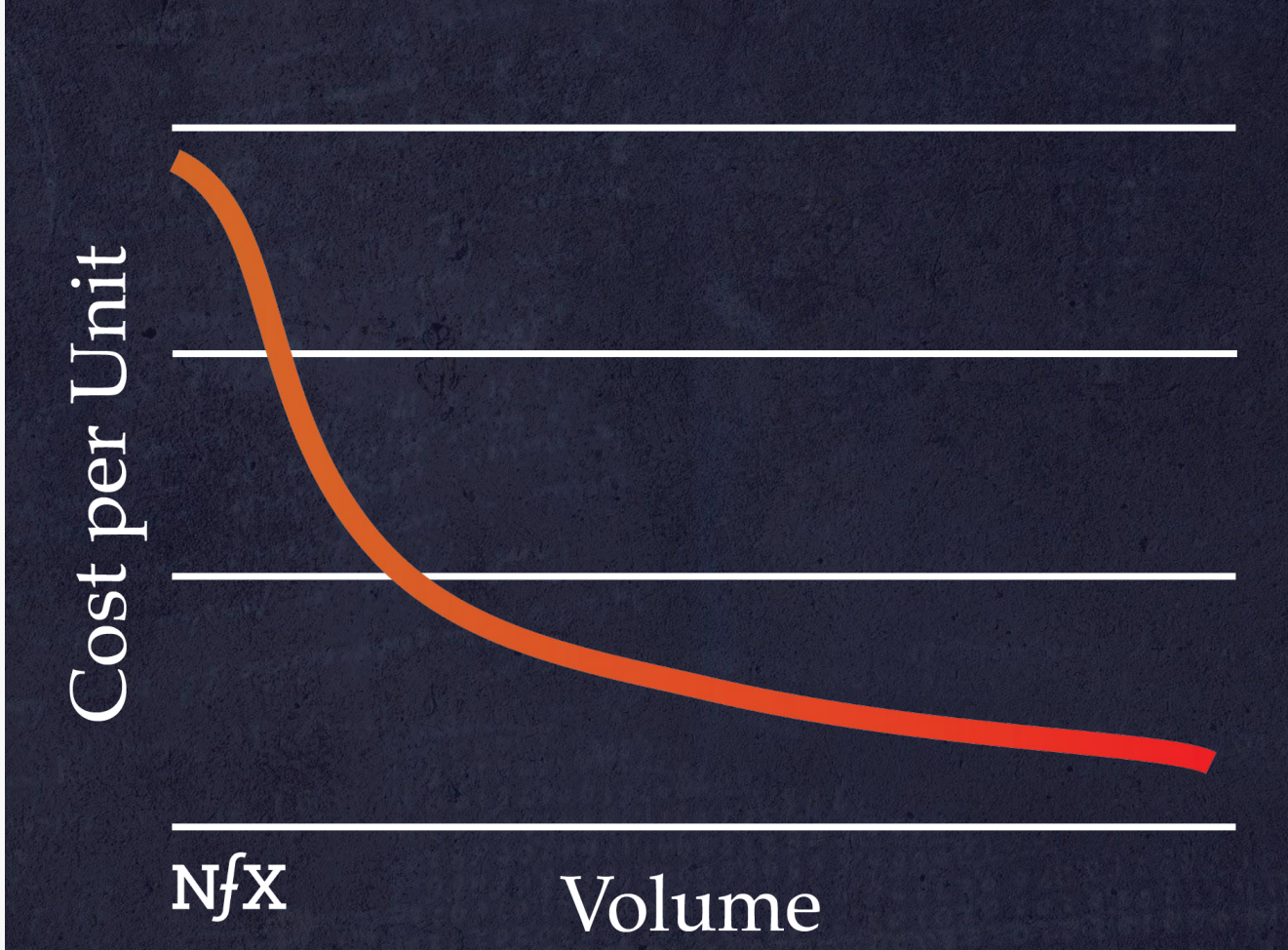
Scale Effects

Scale effects are easy to confuse with network effects because they both become stronger in relation to the number of users.

Network effects cause products to become more valuable *to users* as the network grows, increasing defensibility by increasing product value.

Scale effects, on the other hand, lead to lower per-unit production costs as the fixed costs of production are spread out among a greater number of units — meaning a higher profit margin which can increase defensibility against competitors with less favorable margins.

[Read more about Scale Effects]



Brand

Brand defensibility is different from network effects. Like scale, the strength of your brand is correlated with the growth and usage of your product, so it's easy to confuse brand with network effects. However, they work very differently.

Brand arises when people know who you are and what you do. A well-established brand identity comes with *psychological* switching costs. People are less likely to switch to an unknown or lesser-known brand from yours because psychologically they will default toward what's familiar.

[Read more about Brand]

Embedding

Embedding is an effective defensibility strategy that involves integrating your product directly into a customer's operations so the customer can't rip you out and replace you with a competitor without incurring significant cost in terms of time, energy, or both.

Embedding can work with network effects to make your business more defensible, but they are separate concepts. Business models based on embedding include Oracle and WorkDay.

[Read more about Embedding]

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About

– NfX –

NFX is an early stage venture firm based in San Francisco that is transforming how true innovators are funded. As founders ourselves, we built 10 network effect companies with more than $10 billion in exits across multiple industries and geographies.

We believe that creating something of true significance starts with seeing what others do not.

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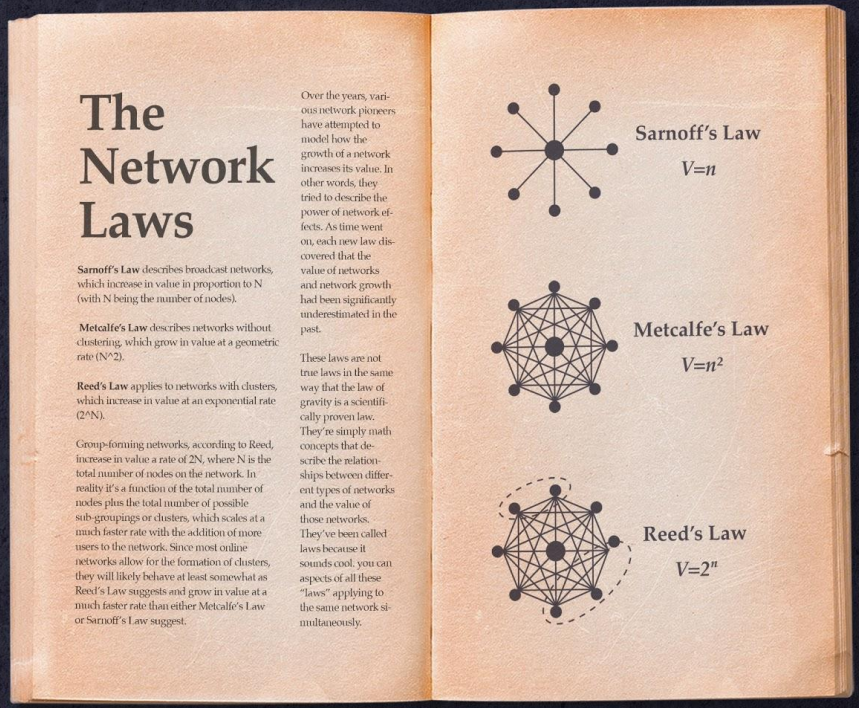

The Network Laws

Sarnoff's Law describes broadcast networks, which increase in value in proportion to N (with N being the number of nodes).

Metcalfe's Law describes networks without clustering, which grow in value at a geometric rate (N^2).

Reed's Law applies to networks with clusters, which increase in value at an exponential rate (2^N).

Group-forming networks, according to Reed, increase in value a rate of 2N, where N is the total number of nodes on the network. In reality it's a function of the total number of nodes plus the total number of possible sub-groupings or clusters, which scales at a much faster rate with the addition of more users to the network. Since most online networks allow for the formation of clusters, they will likely behave at least somewhat as Reed's Law suggests and grow in value at a much faster rate than either Metcalfe's Law or Sarnoff's Law suggest.

Over the years, various network pioneers have attempted to model how the growth of a network increases its value. In other words, they tried to describe the power of network effects. As time went on, each new law discovered that the value of networks and network growth had been significantly underestimated in the past.

These laws are not true laws in the same way that the law of gravity is a scientifically proven law. They're simply math concepts that describe the relationships between different types of networks and the value of those networks. They've been called laws because it sounds cool. you can aspects of all these "laws" applying to the same network simultaneously.

by James Currier & the NFX Team