The Internet as a Liquidity Mechanism:

From Analogy to Isomorphism (?)

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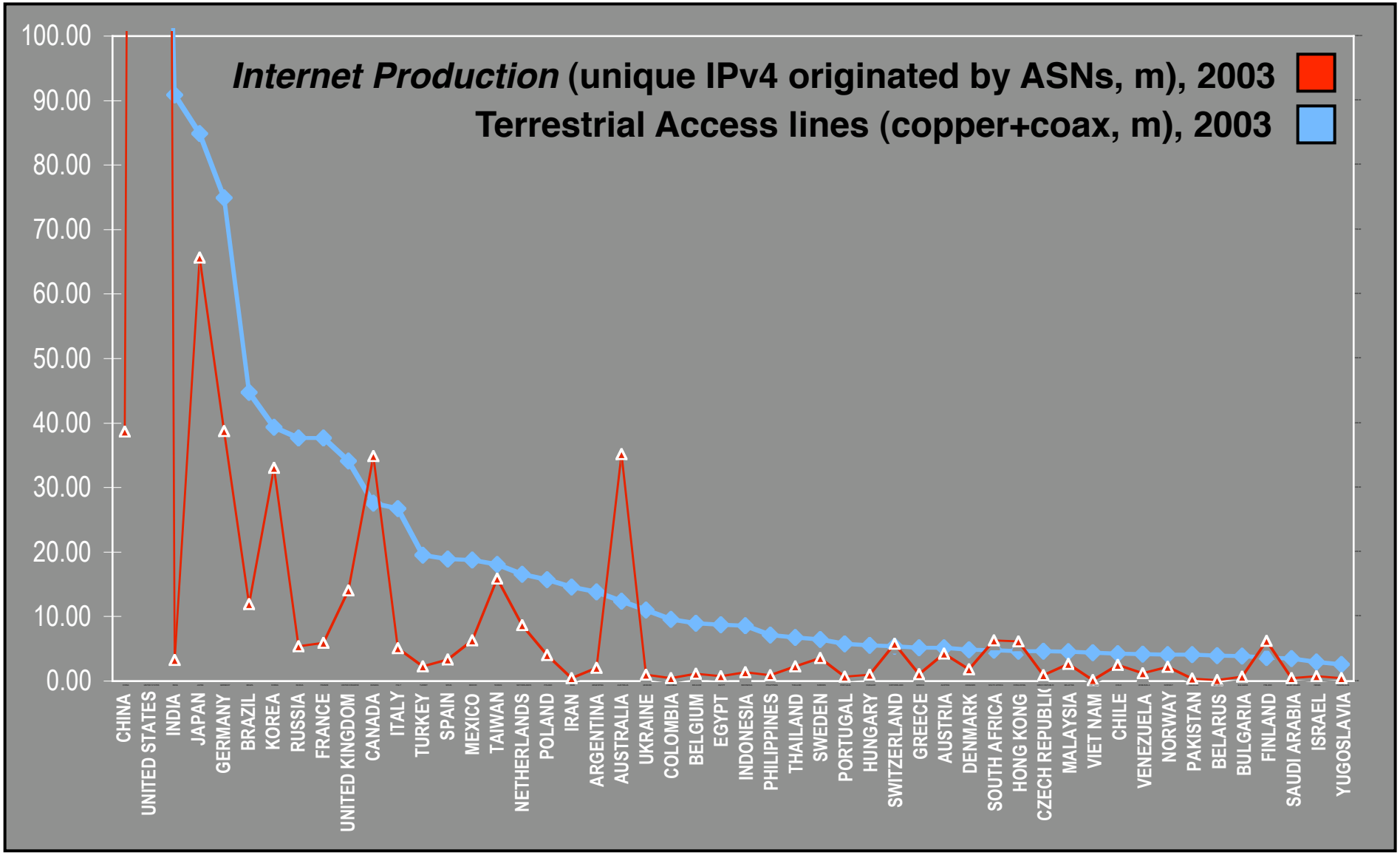
Started as a simple *analogy*....

- ***Routed public IP addresses = logical "ends"***
  - Grouped based on country code of origin-AS
  - *Plus uncountable RFC 1918, private nets*
  - *Recognizing that pre-CIDR patterns were very different*
- ***Access facilities terminations = physical "ends"***
  - PSTN "main lines," cable "subscriber households"
  - *Plus harder to count coax, fiber, terminations*
- ***1:1 correlations <u>not</u> expected, but observation of similar countries : similar ratios might be interesting...***
- **<u>Question: Are national jurisdictions relevant?</u>**

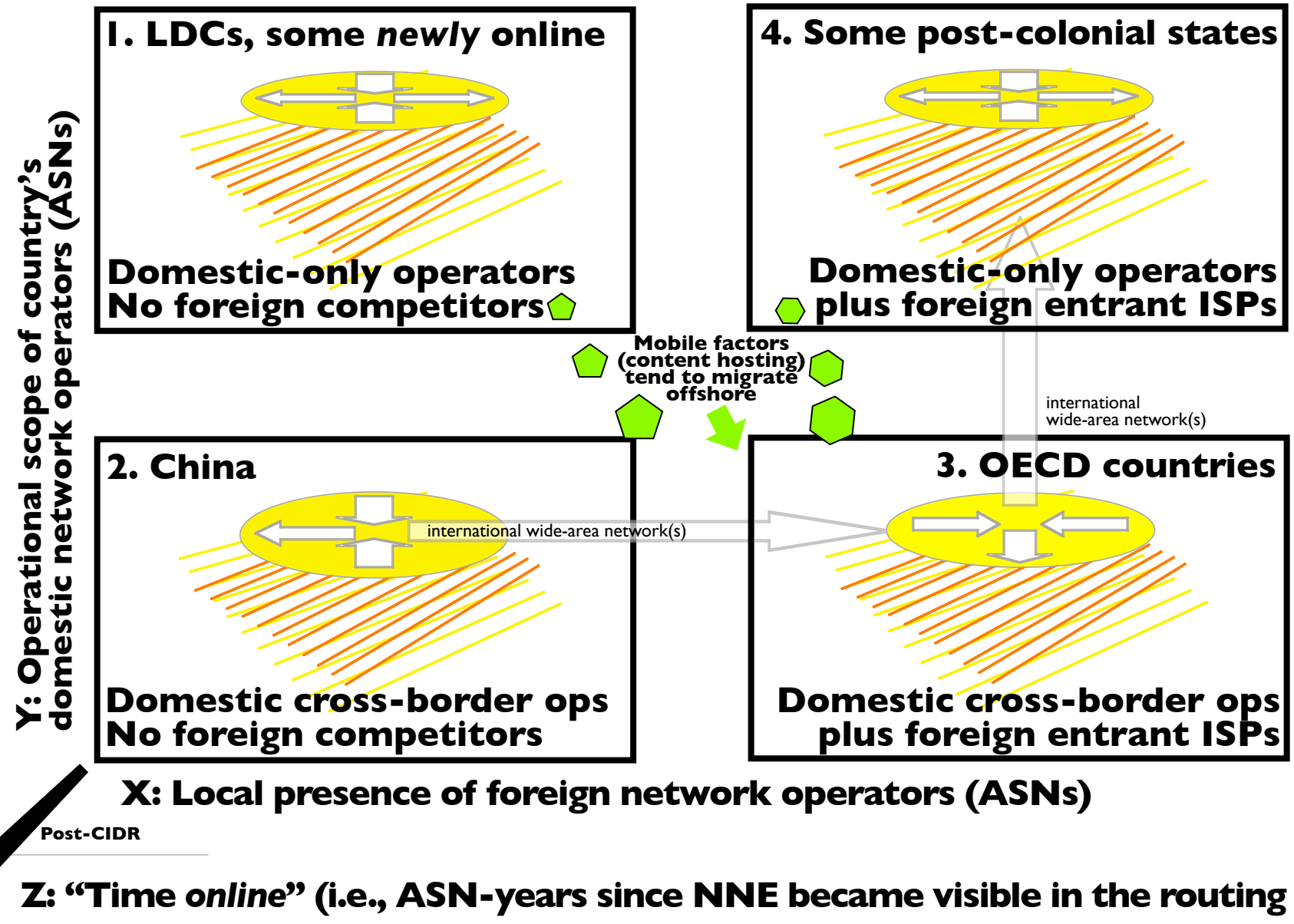
Early results - *interesting (?)*



Analogy *inoperable* without knowing more about ASNs...

- ***ASNs as network service brokers / financially responsible parties for routing (access) services***
  - Wholesale telecom inputs are a prerequisite for ASN eligibility, utility
  - Potential for growth bounded by service revenues/input costs
  - Leading input cost has *until recently* always been telecom inputs
  - Size variations (*normalized*) give rise to *market structure-like* patterns
  - Quantity of originated resources is cumulative fact, so *age matters*
  - Scope of service provision not always aligned with national territory
  - Many other data interpretation challenges (ARDs, region codes, etc.)

"*Similar*" countries & ratios (?)



Analogy *inoperable* without knowing more about ASNs...

- ***ASNs as micro-level redistributors of scarce IP address resources, with responsibility for implementing "prudent stewardship" mandate***
  - ASNs presumably impose some approximation of RIR-level ***needs-based distribution rules*** on individual customers
  - Ideally, such "prudence" would enable end user value-creation to pace or exceed routing system upkeep costs, thereby *maximizing* sustainability & overall system lifetime
  - However, competition plus customer demand for greater addressing and routing flexibility may promote ***perverse incentives*** to ***over-assign*** and/or excessively ***de-aggregate***...
  - Conversely, absent competition such customer demands may go unfulfilled even when they are "technically justified," as a result of *perverse incentives* to ***under-assign*** and/or ***over-aggregate***... *(part of some RIRs' founding folklore)*

Knowing more about ASNs requires *historical understanding* of addressing & routing

- ***RIRs emerged to fulfill <u>economic & commercial</u> need for an independent maintainer for critical industry-wide shared resources***
  - CIDR shaped the technical requirement, and RFC 2050 codified overarching rationale & mechanics, but ***accelerating growth and competition-driven risks of resource exhaustion*** were the ultimate root cause for all of these developments
  - Limited availability of addresses and of routing system "carrying capacity" imposed firm (but somewhat dynamic) limits on max number of directly attachable resources, and also max population of independently varying entities that could be added by competing, autonomous routing services providers
  - RIR ***initial allocation*** and ***subsequent allocation*** rules were intended to mitigate and forestall the inevitable conflicts of interest over these shared resources

Dev history of IP addressing & routing suggests the top risks

- ***Exhaustion of unique (public) IP addresses...***
  - Inability to attach additional resources to the Internet
  - Recovery requires address multiplexing or new address format(s), either of which require introduction of new ***conversion frontiers***
- ***Introduction of variably independent routing entities in excess of routing system carrying capacity...***
  - Increasing risk of catastrophic routing system collapse
  - Prevention or recovery requires partitioning DFZ into two or more routing domains -- end of one-stop shopping global default route, plus new ***conversion frontiers***
- ***Partitioning bad b/c functionally equivalent to trade barriers that limit the "extent of the market"***

Epiphany... (?)

Working Backwards:

Tightly integrated, high value exchange system built with critical shared resources...

...one vulnerable to risks of premature disintegration resulting from hoarding or squandering of those resources...

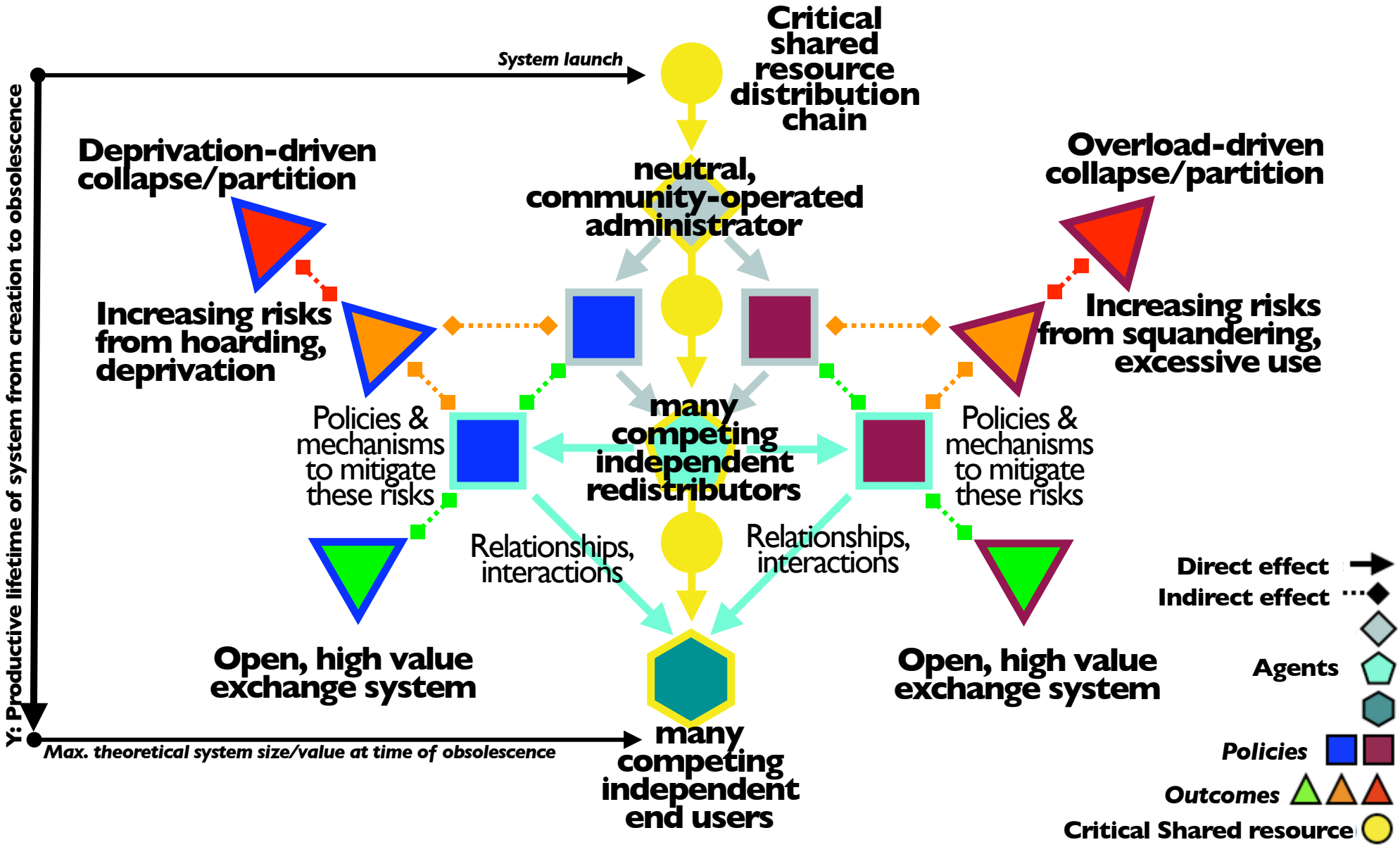
...and composed of many competing independent agents, all with conflicting private incentives to maximize their own use of the resource...

...because of its unique value as a means of accessing and integrating new particants and resources into the system....

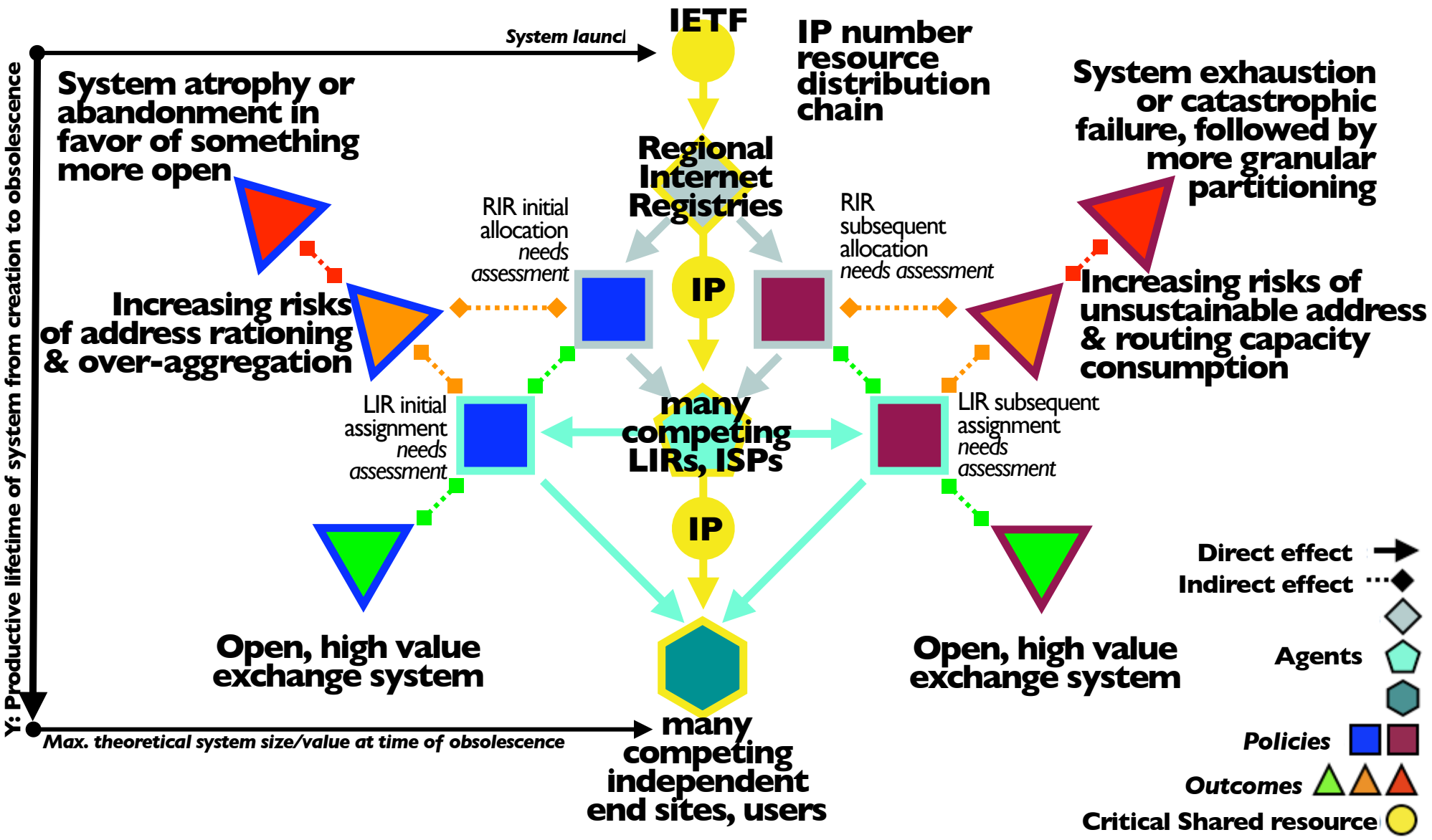
...which is vastly more versatile and efficient than the nonshared precursor exchange system it builds upon....

...manages the conflict by outsourcing resource administration and synchronizing resource policies around a neutral, community-operated administrator....

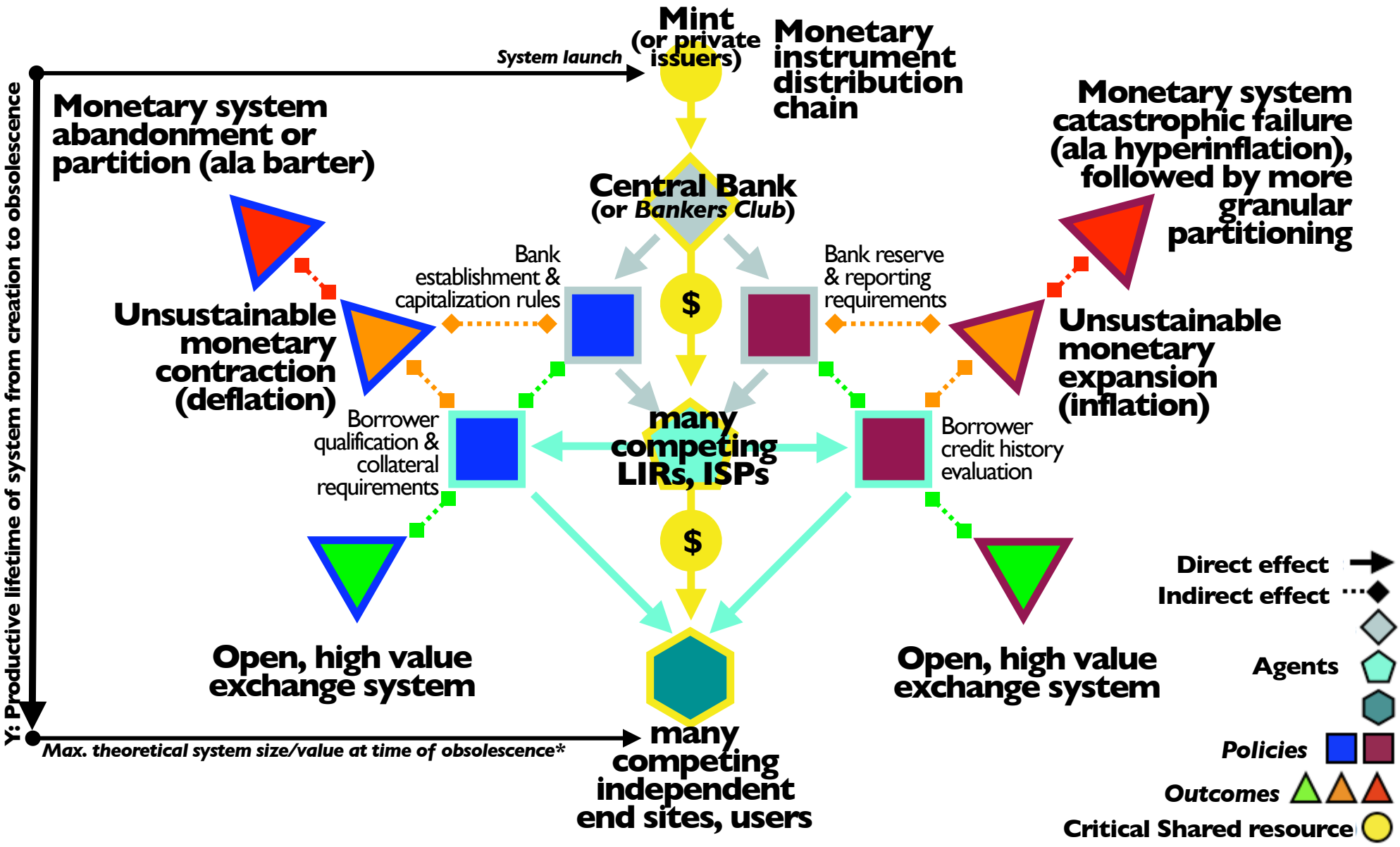
In generic graph form...



...Or labeled to map the Internet...



...it maps neatly onto another graph...



...and leads to other intriguing insights...

- ***TCP/IP is a liquidity technology, and the Internet is a liquidity system, in exactly the same way that this is true of the monetary technologies and the banking and financial system***
  - Association with a public IP address defines the instantaneous boundaries of the system, just as possession of money does in the conventional economy
  - *Unlike money,* IP addresses do not need to circulate to provide sustained liquidity because packet-borne real factors are non-rival
  - Statistical multiplexing provides of the most important sources of efficiency in both systems (in the monetary world it's called *fractional reserve banking*)
  - IPv4's quantity constraints make it exactly like the monetary gold, e.g., during the most recent "gold standard" era. That said, even an infinite supply currency is subject to many of the same risks...

...and leads to other intriguing insights...

- **"*End to End Arguments*" is a normative *liquidity rule*, functionally equivalent to the kind of rules that central bankers rely on to try to maintain a functional monetary environment**
- **The "IPv6 *transition*" is the functional equivalent of a voluntary currency migration under "normal" (non-collapse) economic conditions**
  - There is no precedent for something like this in human history, although episodes of total failure are quite common
- **This insight might provide a useful update or counterpoint to RFC 5218...**

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Questions...thanks!

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