



34th Annual **INCOSE**
international symposium

hybrid event

Dublin, Ireland
July 2 - 6, 2024



A New Horizon for Healthcare Delivery: A System of Systems Perspective and Governing Proposition

Introduction: What is the Healthcare Delivery System and what is wrong with it?

Interest in the healthcare sector has increased over two decades ago.

Healthcare improvement has been shaped by four seminal works by the (IOM).

- To Err is Human report (1999): 98,000 patients were killed by healthcare each year attributed to healthcare errors.
- Crossing the Quality Chasm (2001): drew attention to issues of underuse, overuse. what we know Vs. what we apply
- Building a Better Delivery System (2005): the potential of systems engineering
- Best Care at Lower Cost (2013): standard systems engineering is needed, and healthcare was and would remain a human centered endeavor



How that system looks like!

It is described as a collection of autonomous units operating independently with their own standards and metrics.

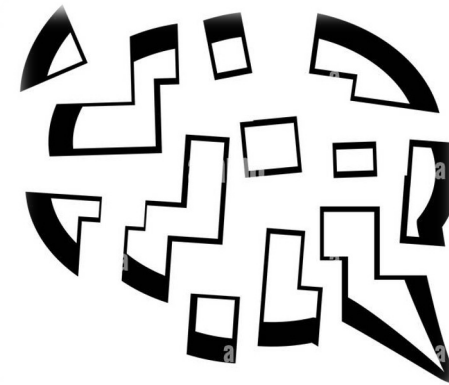
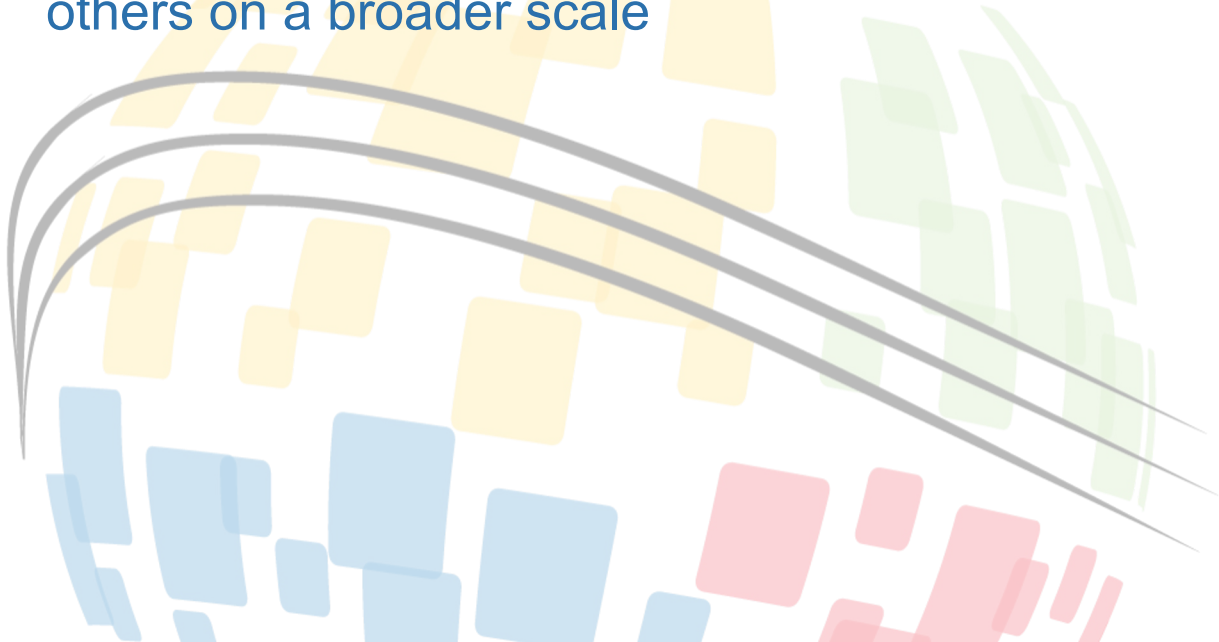
Building a Better Delivery System (2005)

A cottage industry, marked by fragmentation at various levels of government wherein fragmentation occurs at the federal, state, and local levels.

Commonwealth Fund Commission's 2008 report

(Elhauge, 2010) delves into the various dimensions of fragmentation.

- treatment of specific illnesses
- fragmented approaches in caring for individual patients, patients over time, patient groups
- others on a broader scale



Repercussions and cost of fragmentation

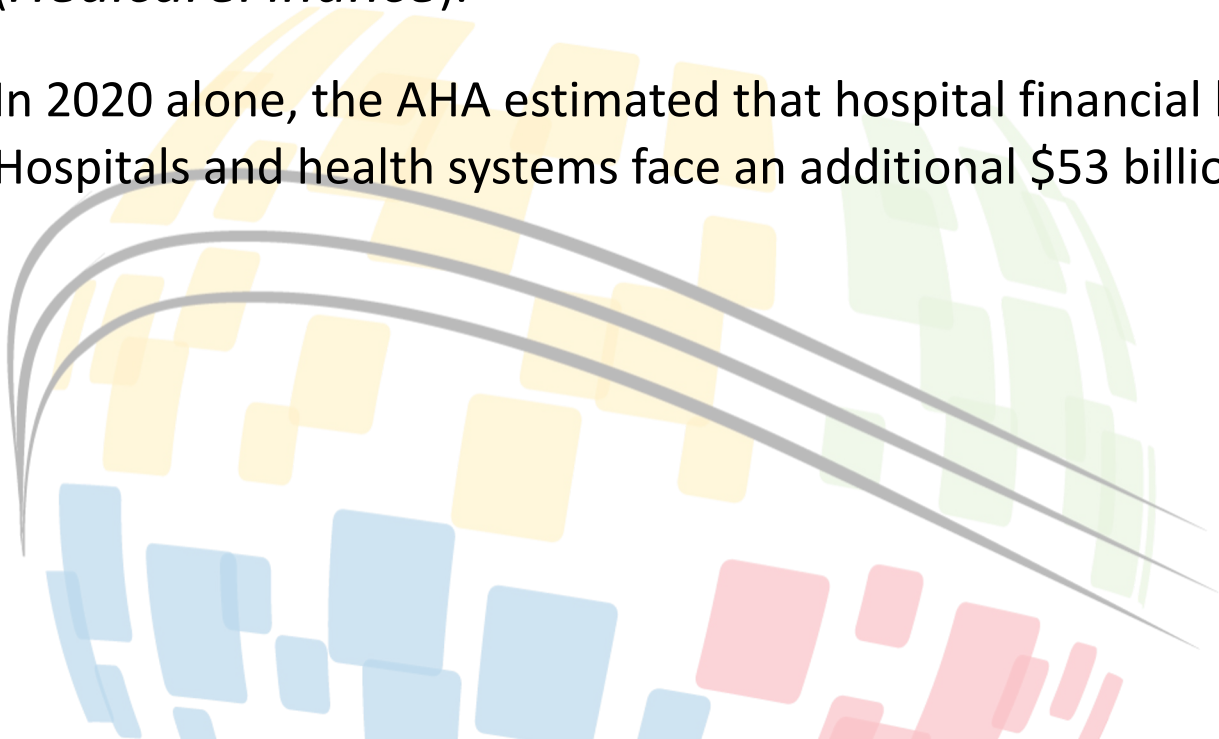
The United States has one of the highest costs of healthcare in the world.

In 2021, U.S. healthcare spending reached \$4.3 trillion, which averages to about \$12,900 per person.
(CMS, National Health Expenditure Data, December 2022).

Fragmentation was associated with \$4,542 higher healthcare spending *(Frandsen et al 2015)*.

Fragmented care led to a 25% increase in medical costs and 16% more visits to the emergency room
(HealcareFinance).

In 2020 alone, the AHA estimated that hospital financial losses were at least \$323.1 billion *(AHA 2020)*.
Hospitals and health systems face an additional \$53 billion to \$122 billion in losses in 2021 *(AHA 2021)*.



There are numerous endeavors to comprehend and enhance healthcare in both public and private sectors

- The National Healthcare Service Change Model
- The initiatives of the Agency for Healthcare Research and Quality
- The efforts by the Institute for Healthcare Improvement.



(SEBoK) highlights three approaches that share common characteristics:

1. Lean Six Sigma
2. Industrial engineering
3. Healthcare systems engineering.

They mentioned that while various tailored approaches exist for enhancing healthcare delivery, the majority are based on one of these three approaches or a combination of them.

To reform this system, beyond the three conventional approaches, we are employing a different approach that has not been applied to the healthcare industry.

Our approach consists of six parts, each building upon the previous one.

Deconstructing

Start by deconstructing the healthcare system to discern its underlying nature.

Typify the system

To pinpoint potential challenges and propose corresponding solutions.

Unexplored Territory

Emphasizing the overlooked aspect of dependence within SoS

Systemic approach

Employing a systemic approach to explore avenues for improvement

Collaborative Issue

Unravel the correlation between the identified system type and fragmentation.

Proposal

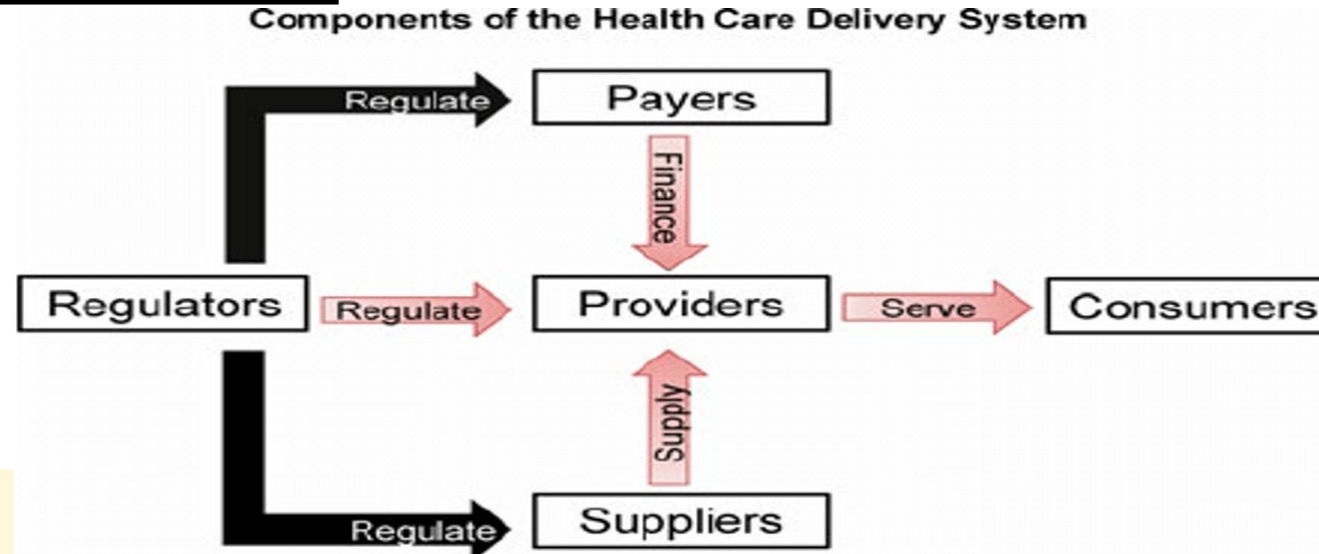
Present our proposal for system reform.

1. Deconstructing the Healthcare System

Deconstructing



The current system is a complex system and consists of a set of independent systems such as clinics, hospitals, pharmacies, community health centers, etc.) with varied goals and interests.



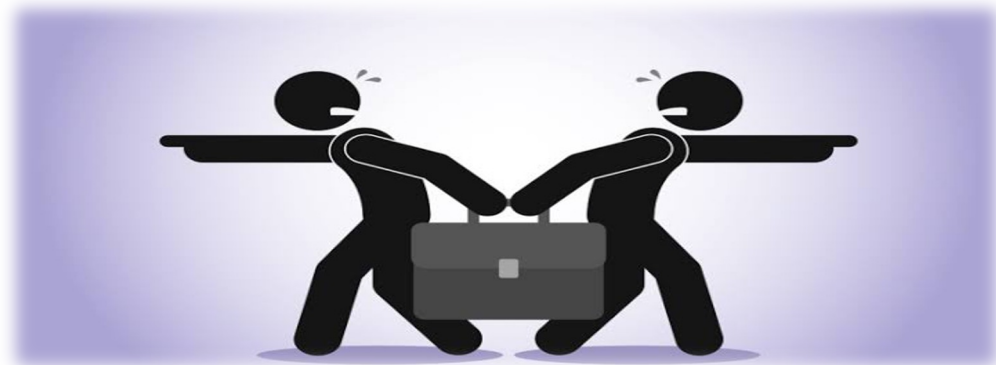
Maxey et al. (2015)

Providers: organizations, services, and professionals involved in delivering healthcare to patients.

Payers: both public and private organizations responsible for financing healthcare services.

Suppliers: entities that provide resources and materials to support healthcare delivery.

Regulators: overseeing and influencing the actions of providers, payers, and suppliers.



The healthcare system is a clash among **competing** forces of stakeholders (communities of interest) who have different performance measures and sub-groups of stakeholders.

Health professionals focus on payment for services and autonomy.

Care facilities seek high-margin services and low supply costs.

Consumers seek accessible services and low out-of-pocket costs.



Payers pursue the right to select risk and limit cost.

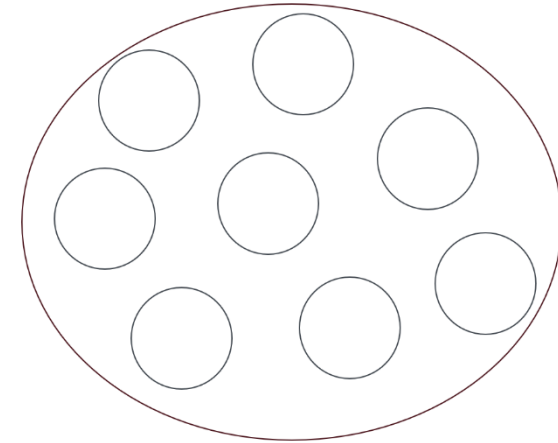
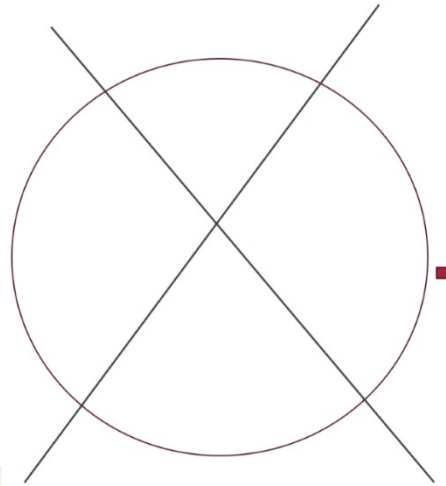
Purchasers want more value at the lowest cost.

Suppliers focus on intellectual property protection and volume.

Engineering a Learning Healthcare System: A Look at the Future, in his presentation William W. Stead As Porter and Teisberg (2006) said that the different stakeholders compete in a zero-sum game.

HDS is NOT a single system with a purpose: it's a complex set of independent systems that have their own objectives, way of operation, and capabilities.

Yet, they collaborate to attain bigger objectives, way of operation, and capabilities that **none of them could do alone.**

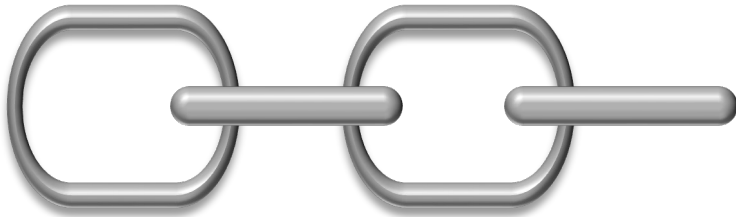


Accordingly, based on the characteristics of the current HDS, we assume that the current HDS **could be** approached and studied as a **SoS**.

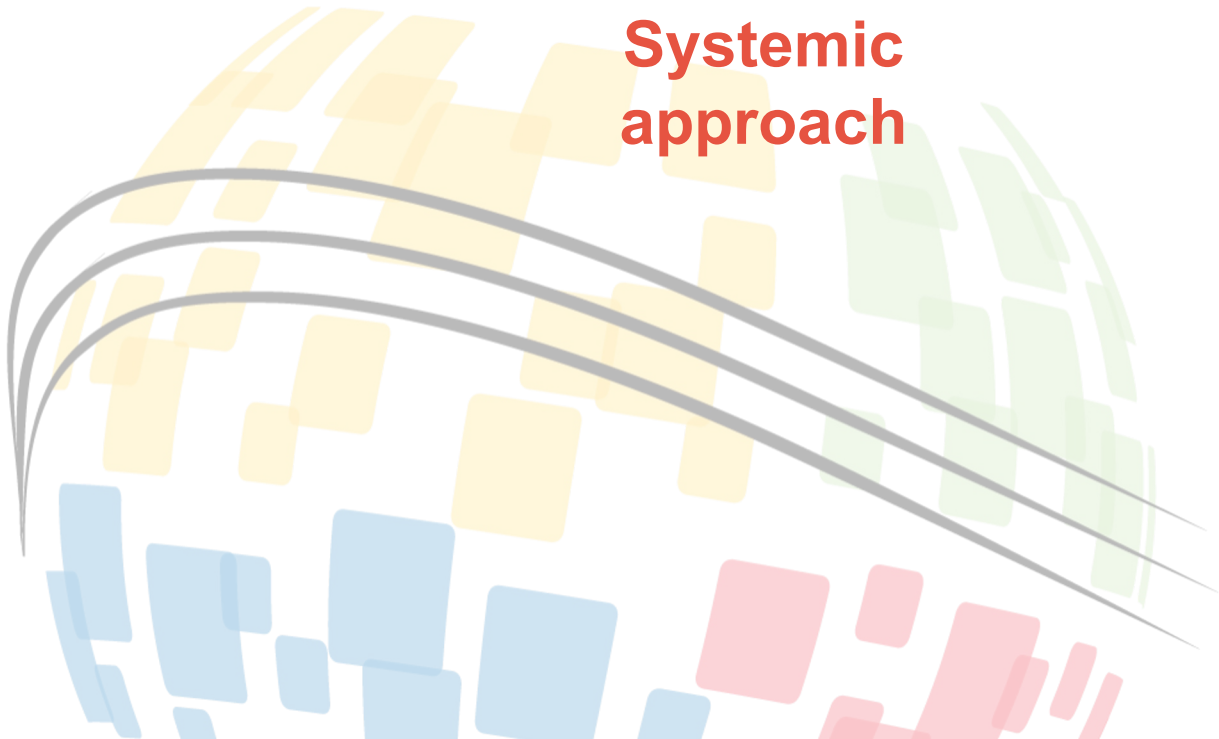
2. The System Approach

Deconstructing

HDS is NOT a single system,
it's a set of systems.

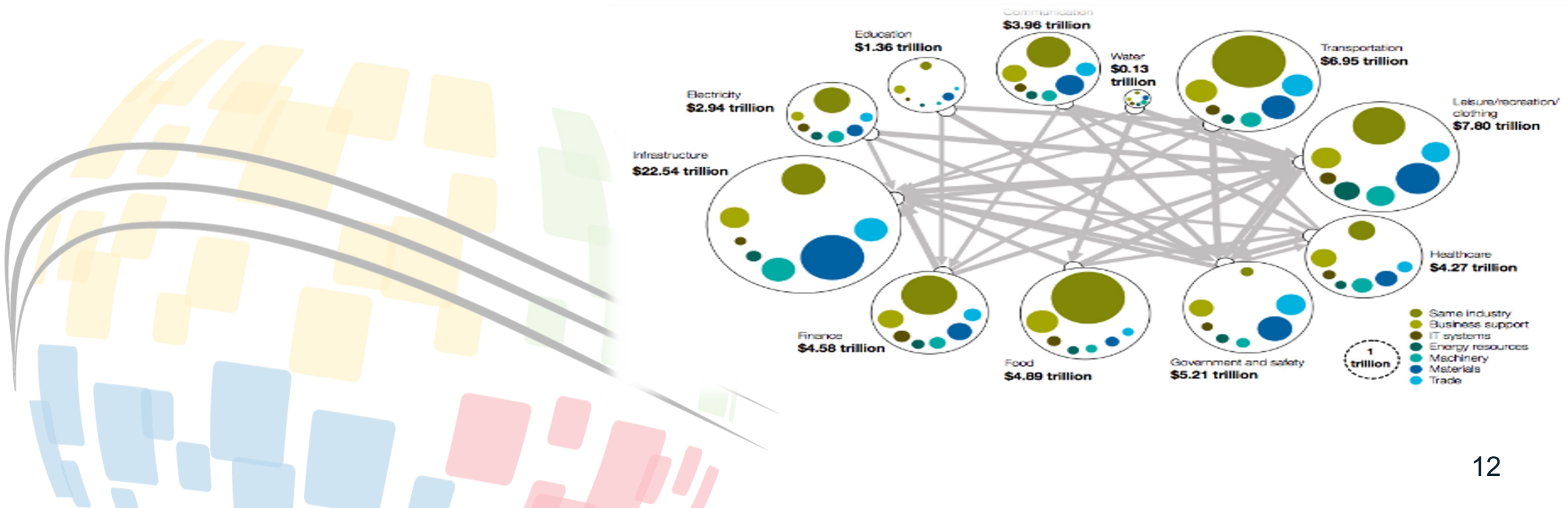


**Systemic
approach**



“SoS is a system-of-interest whose system elements are themselves systems; typically, these entail large scale inter-disciplinary problems with multiple, heterogeneous, distributed systems”.

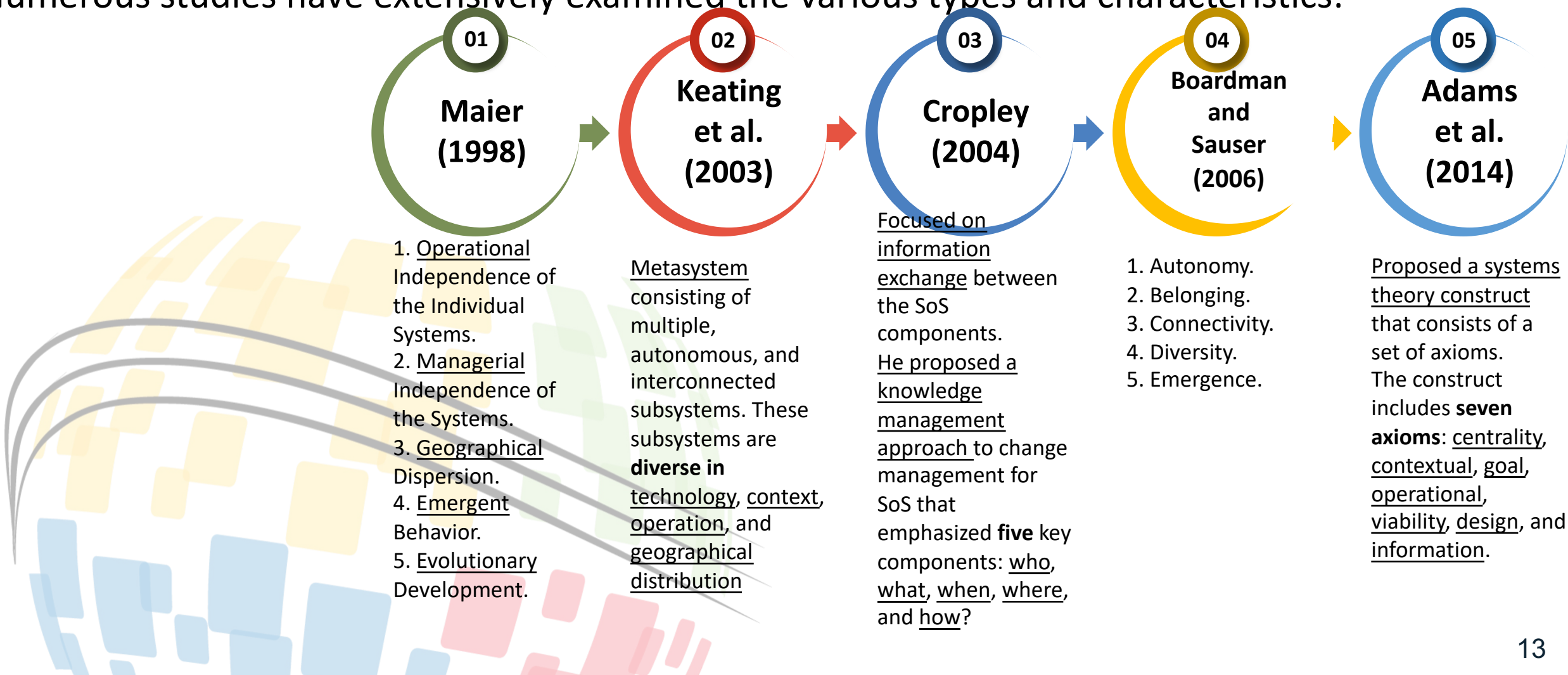
(INCOSE, 2007)



When SoS are acknowledged and treated as such, they can be classified into distinct SoS types, offering a valuable framework for comprehending the nature of SoS.

Dahmann (2014).

Numerous studies have extensively examined the various types and characteristics:

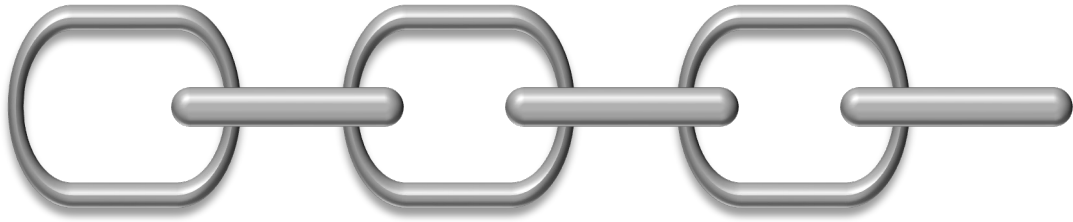


3. SoS types

Deconstructing

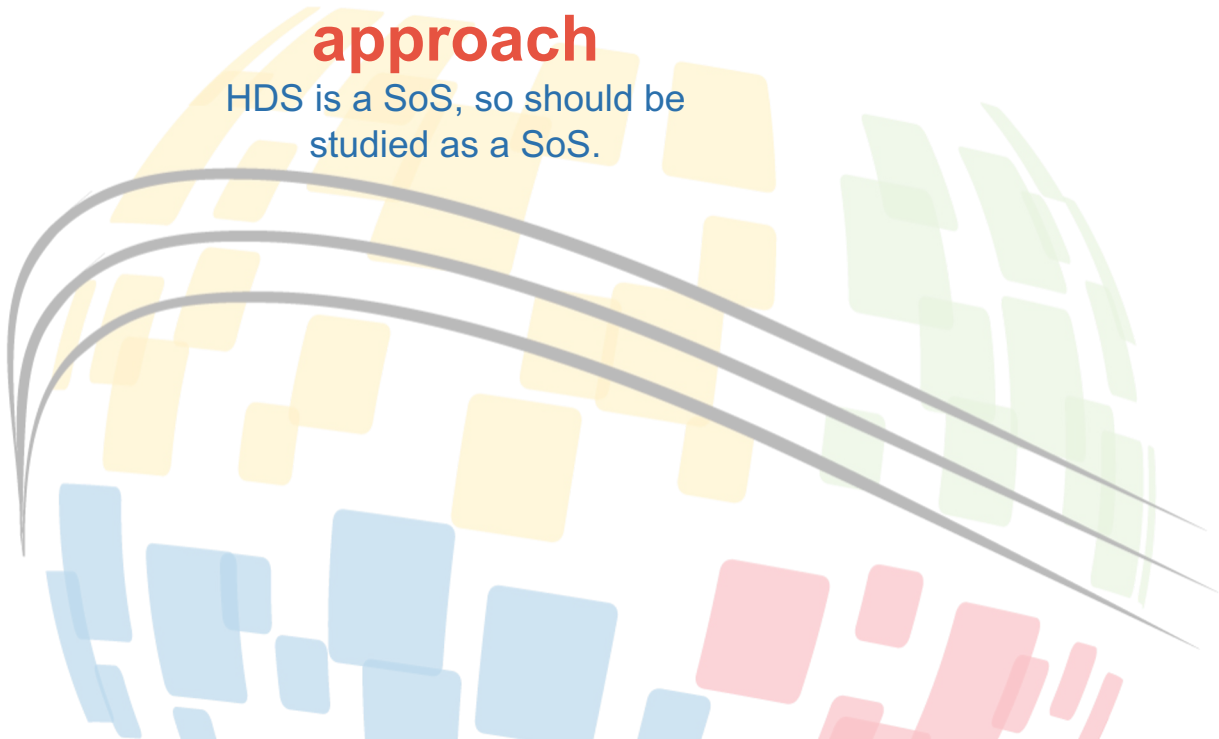
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Typify the system

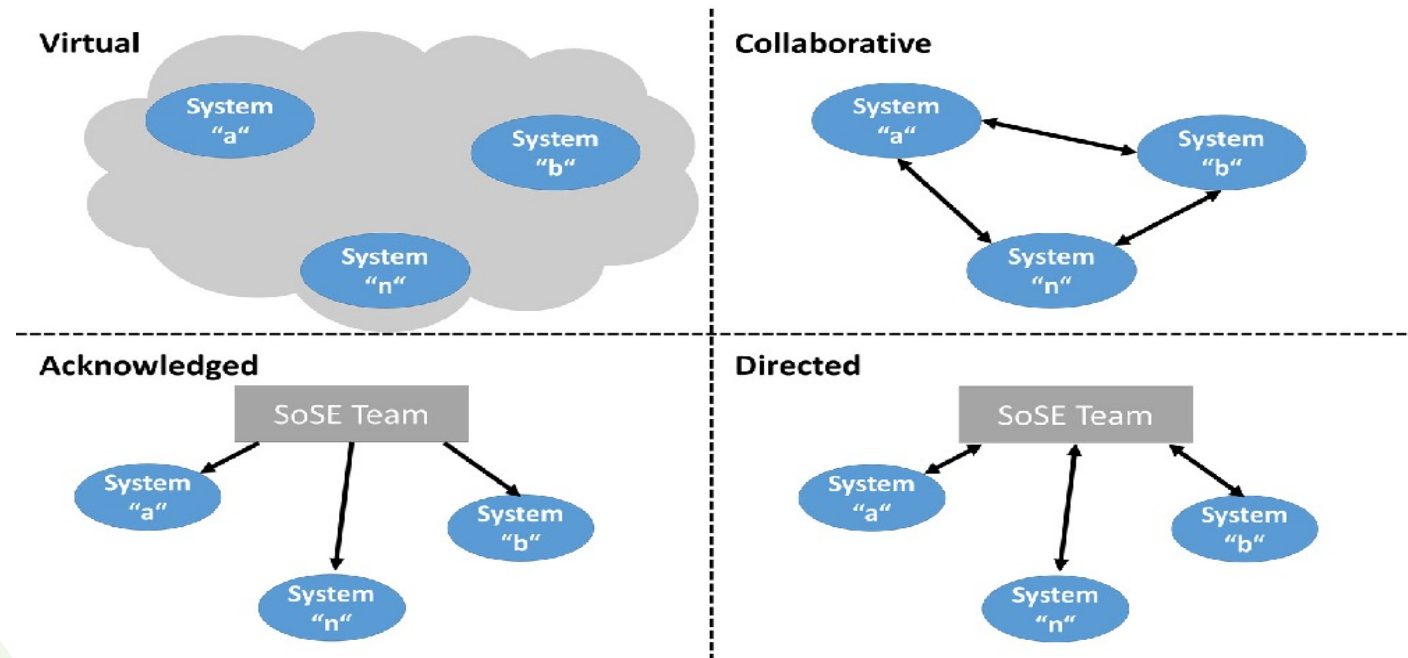


Systemic approach

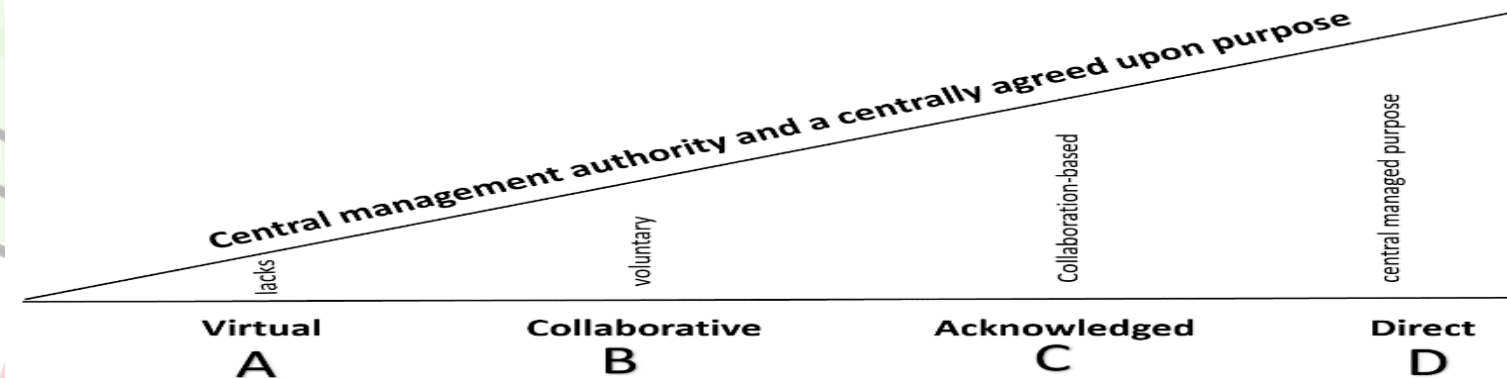
HDS is a SoS, so should be
studied as a SoS.

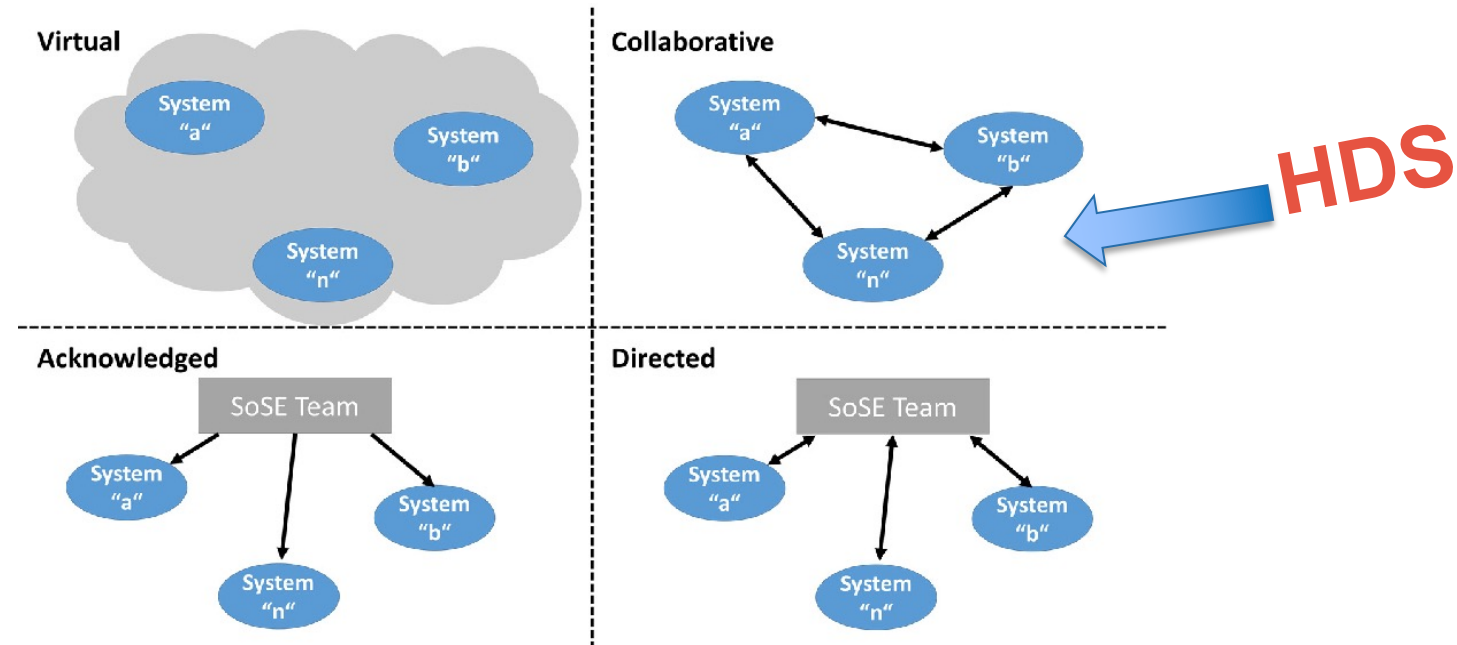


We used the study by Maier as the study is often cited as the original paper on the subject, and, most importantly, provides a classification into four types.



Categories of Systems of Systems (adapted from Lane, 2013)





Categories of Systems of Systems (adapted from Lane, 2013)

The (HDS) falls under the category of a Collaborative (SoS), wherein multiple independent systems come together **voluntarily** to deliver comprehensive services, **operating without** a central authority or standardized communication mechanism.

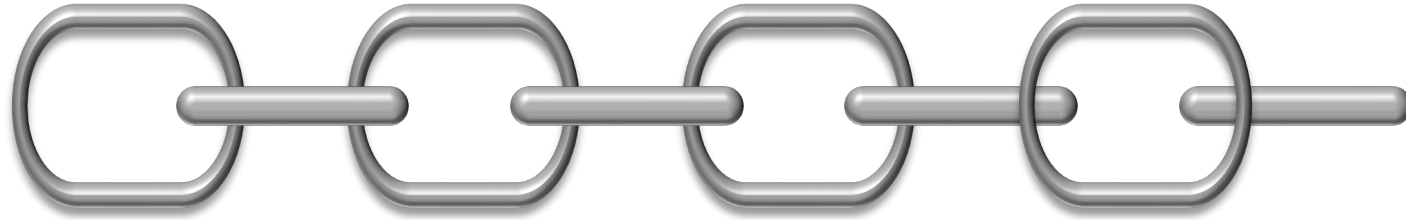
4. Unraveling the Link Between HDS Type and Fragmentation

Deconstructing

HDS is NOT a single system, it's a set of systems.

Typify the system

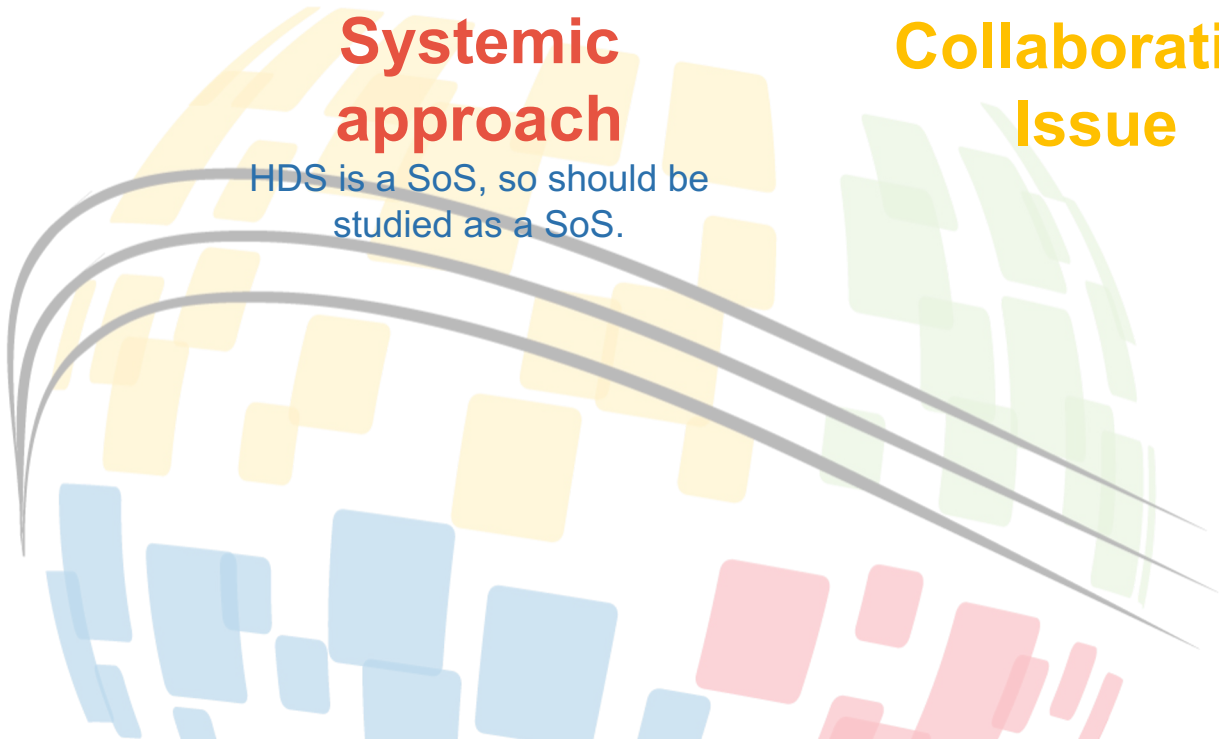
HDS is a Collaborative SoS.



Systemic approach

HDS is a SoS, so should be studied as a SoS.

Collaborative Issue



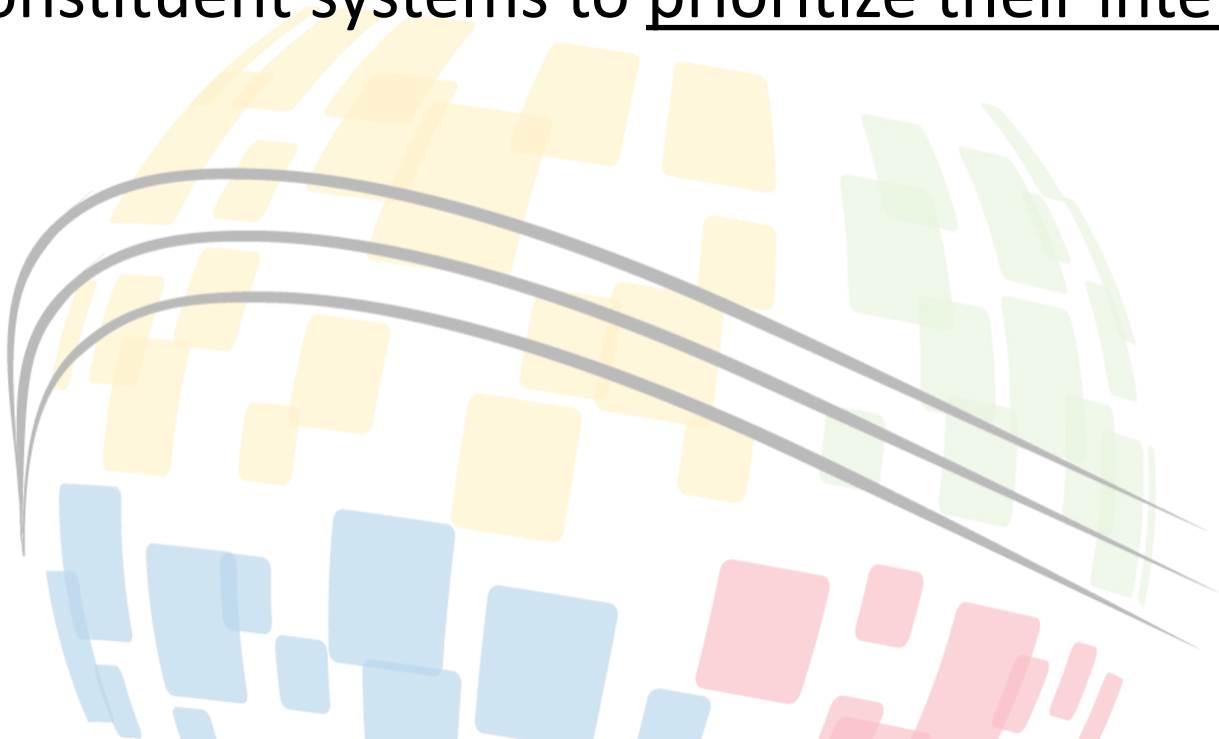
We posit that the **Collaborative (SoS)** nature of the current healthcare system is the **central driver of its fragmentation.**

Some reasons include but are not limited to:

Diverse communities of interest with conflicting values and beliefs lead to self-interest-driven behavior.

Decision-making influenced by authority and coercion allows constituent systems to prioritize their interests over the SoS goals.

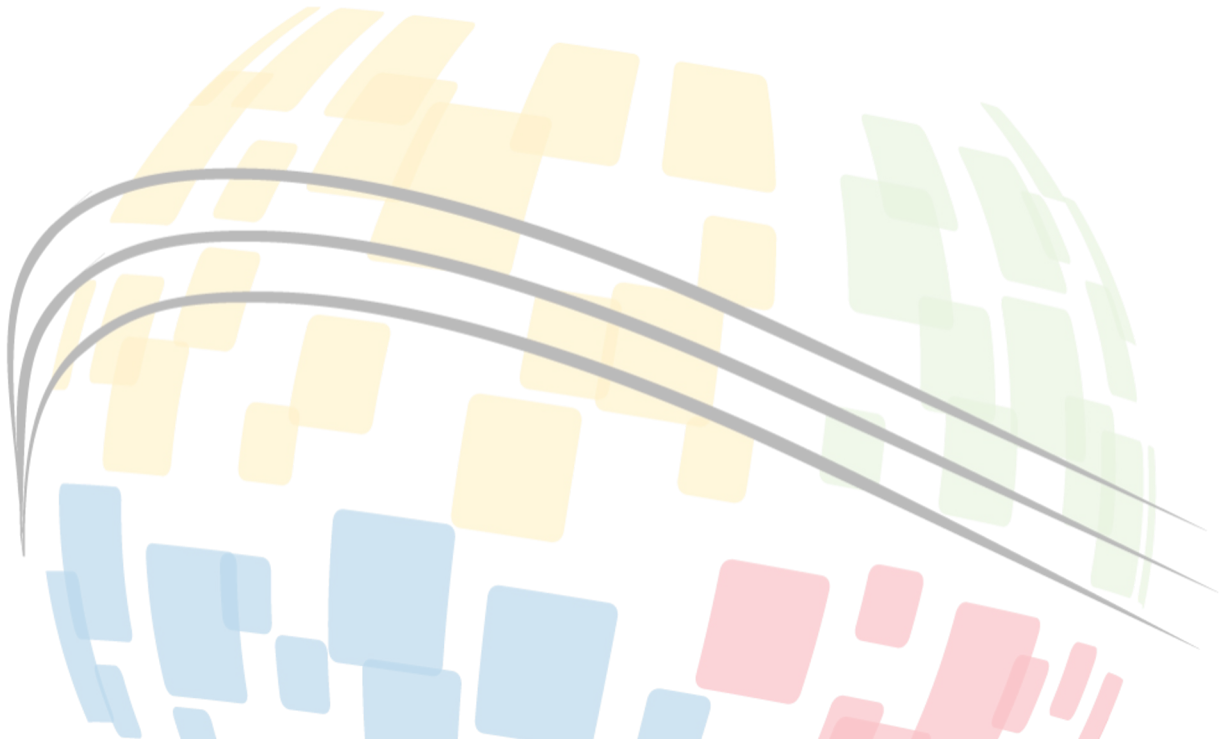
(Jackson, 2003)



Second, systems rarely see the full range of possibilities and do not know what other systems are planning to do.

In SoS, when individual constituent systems are developed in isolation, they disrupt the delicate balance of synergies, hinder the realization of a unified business vision, and impede the achievement of long-term goals.

The Synergism Principle, (Azani, 2009)

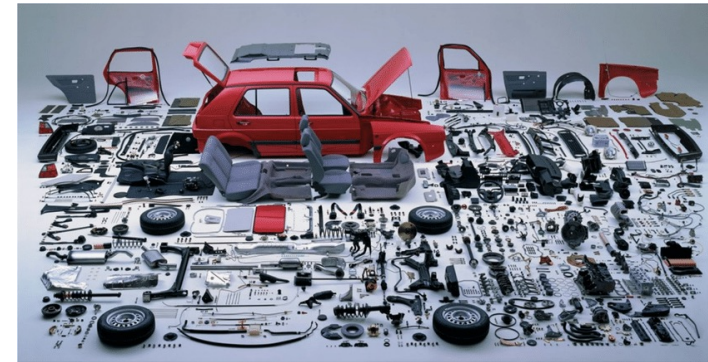


Third, in an ideal situation, the constituent systems being cognizant of one another's plans; however, fragmentation may exist.

Constituent systems are striving to fulfill their individual local requirements to the utmost, and that may engender conflicts with the overarching capabilities of the SoS.

Although the SoS capability needs should be met by the constituent systems as they meet their own local requirements, in many cases the SoS needs **may not be consistent with** the requirements for the constituent systems.

INCOSE's 7 Pain Points, Capabilities and Requirements



The sum of the parts is neither equal, nor greater than the whole SoS.

Furthermore, the protection of intellectual property rights (IPRs), where each participating organization harbors its unique objectives



This occasionally may conflict with the overarching goals of the SoS.

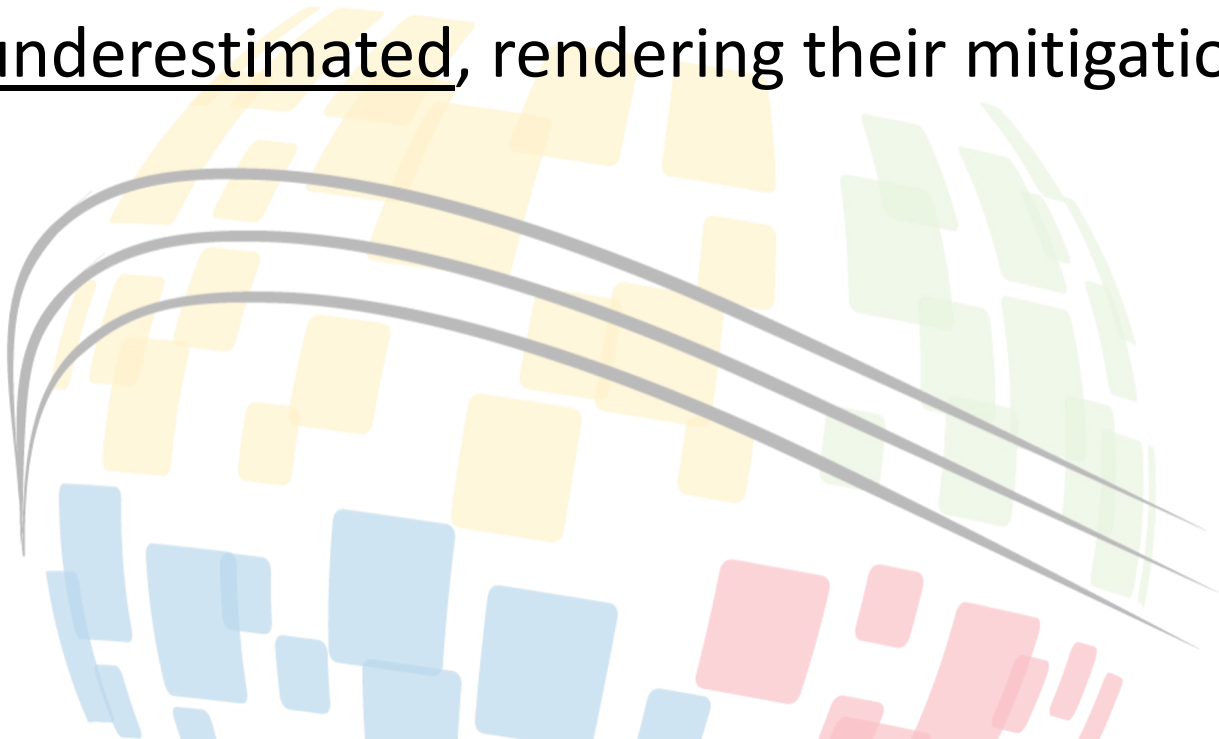
(Henshaw et al. 2013)



Additionally, being unrecognized Collaborative (SoS) can result in unacknowledged risk on the SoS level.

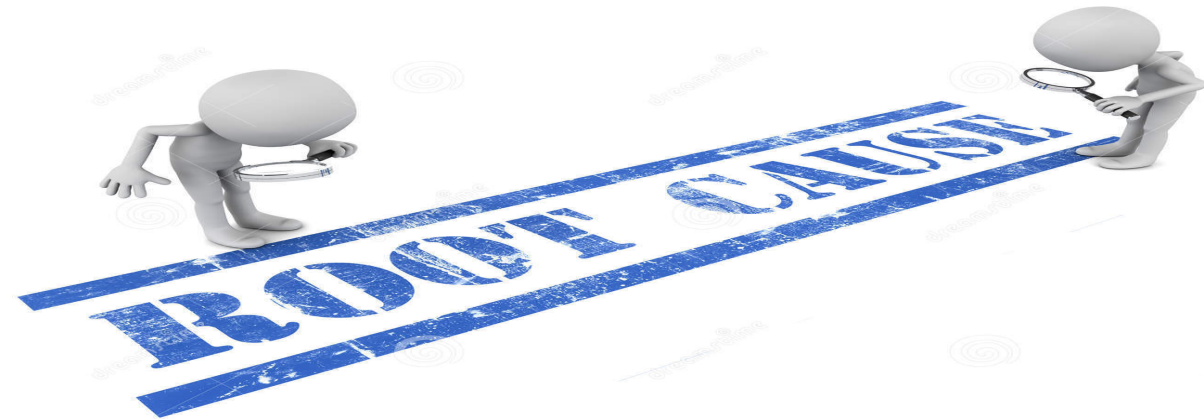
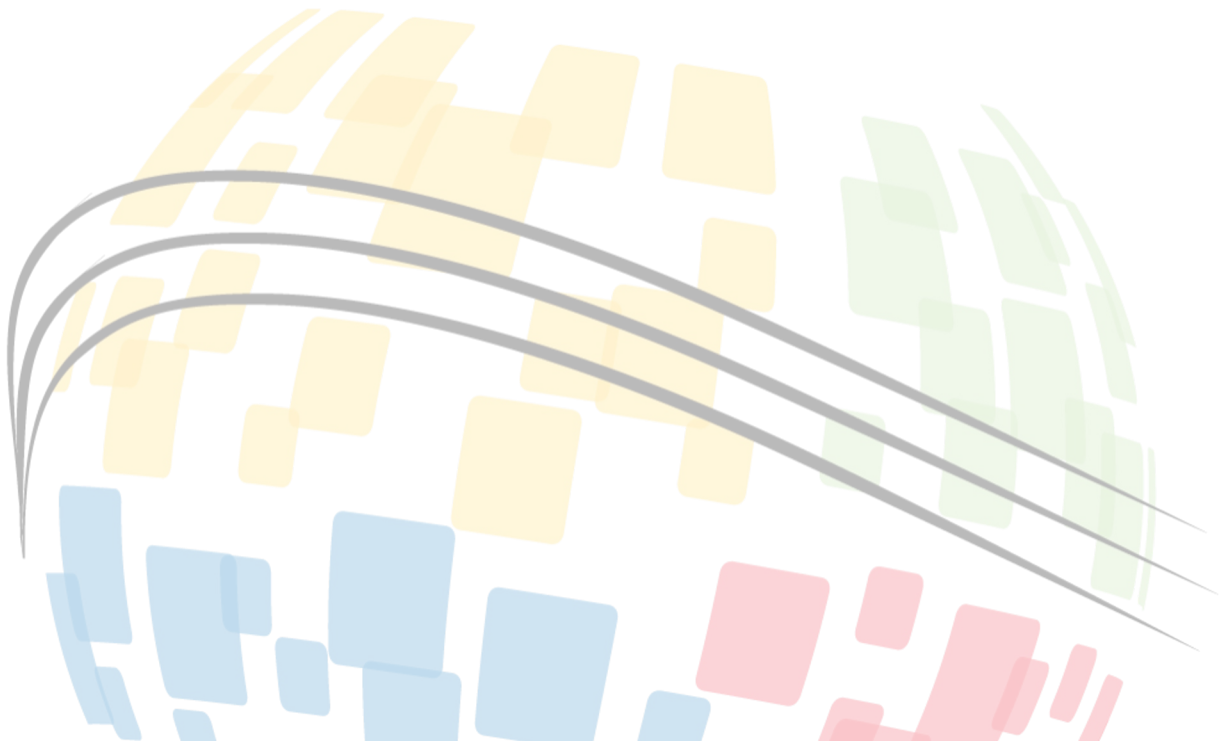


Unfortunately, that may lead to significant risks going unnoticed or underestimated, rendering their mitigation plans inadequate.



This elucidates that the **Collaborative SoS** nature within the current healthcare system **serves as the primary catalyst for its fragmentation.**

Contrary to its common **reference** as a healthcare **system**, it was **neither** intentionally designed as a system **nor** has functioned as one.



5 & 6. The Proposed Concept of Solution for HDS Transformation

Deconstructing

HDS is NOT a single system,
it's a set of systems.

Typify the system

HDS is a Collaborative SoS.

Unexplored Territory

Focus on the interdependence;
observe the unobservable.

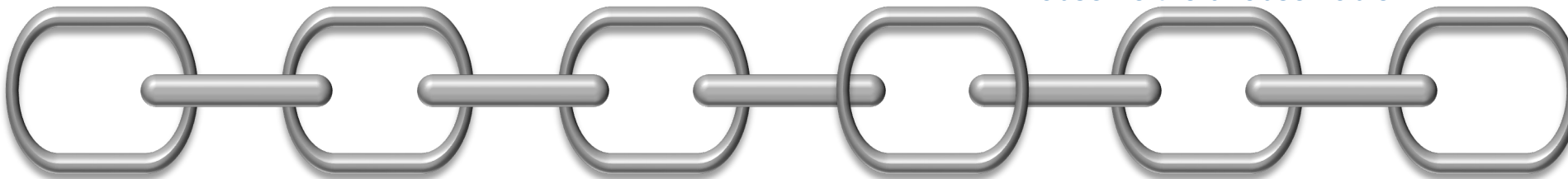
Systemic approach

HDS is a SoS, so should be
studied as a SoS.

Collaborative Issue

Being Collaborative (SoS) is
the central driver of
fragmentation.

Proposal



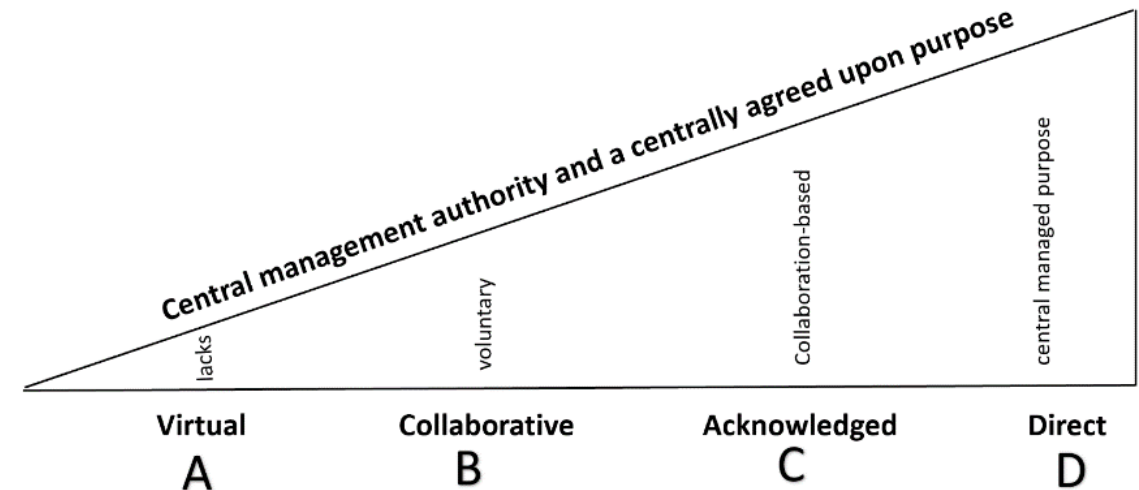
Numerous studies have investigated the use of different types of (SoS).

- (Vaneman and Jaskot, 2013), (Lock, 2012), (Keating, 2015), and (Lane and Valerdi, 2010) advocate for the adoption of directed or acknowledged SoS.
- (Fan and Mostafavi, 2018) and (Zhu and Mostafavi, 2014) propose a fusion of Directed and Collaborative SoS.

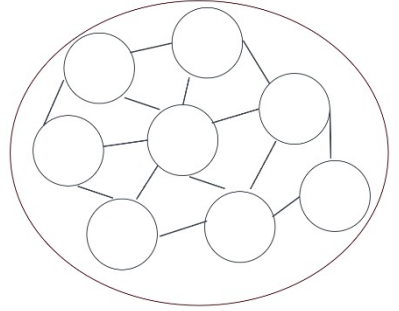
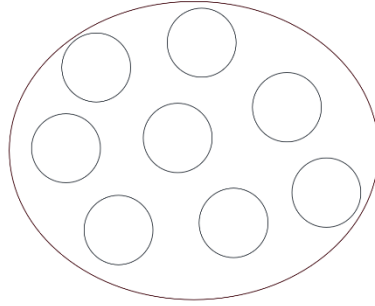
These studies provide insights into the benefits and drawbacks of adopting certain SoS types in specific contexts.

It is important to note that:

- There are limitations in using or transferring to a specific type of SoS.
- the objective is not to achieve a merger of two distinct types of systems to capitalize on the strengths of each system.

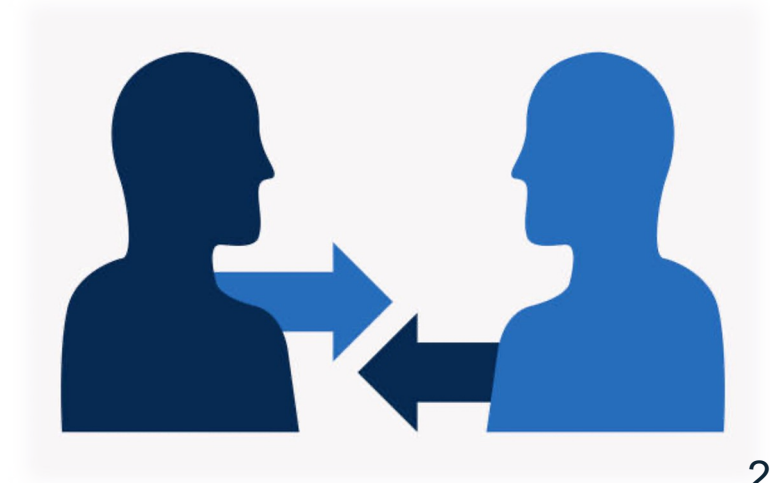


To illustrate our proposal, it is imperative to fill the research void in the existing literature regarding the characteristics of SoS.



in-depth investigation uncovers **symbiotic** and **commensalism** relationships.

However, this aspect, with its inherent relationships, has been often overlooked. Therefore, it is imperative to consider that dependency association.



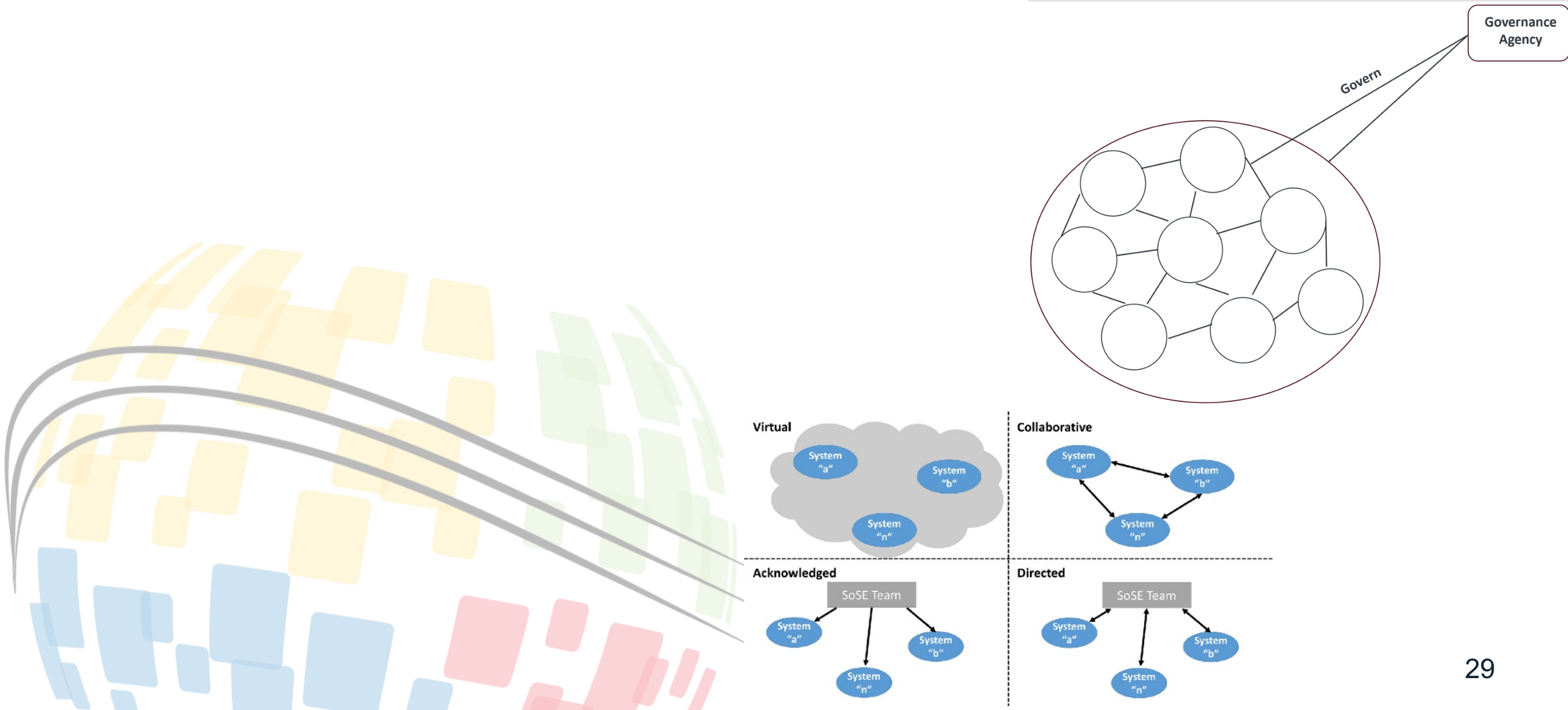
So, **viewing both aspects** of dependence and independence **changes everything** and fundamentally **alters various facets of SoS design, or reform, and strategic decision-making.**

This emphasizes paying more **attention to the dependency** aspect and strategically **determining which elements should be centralized or controlled.**

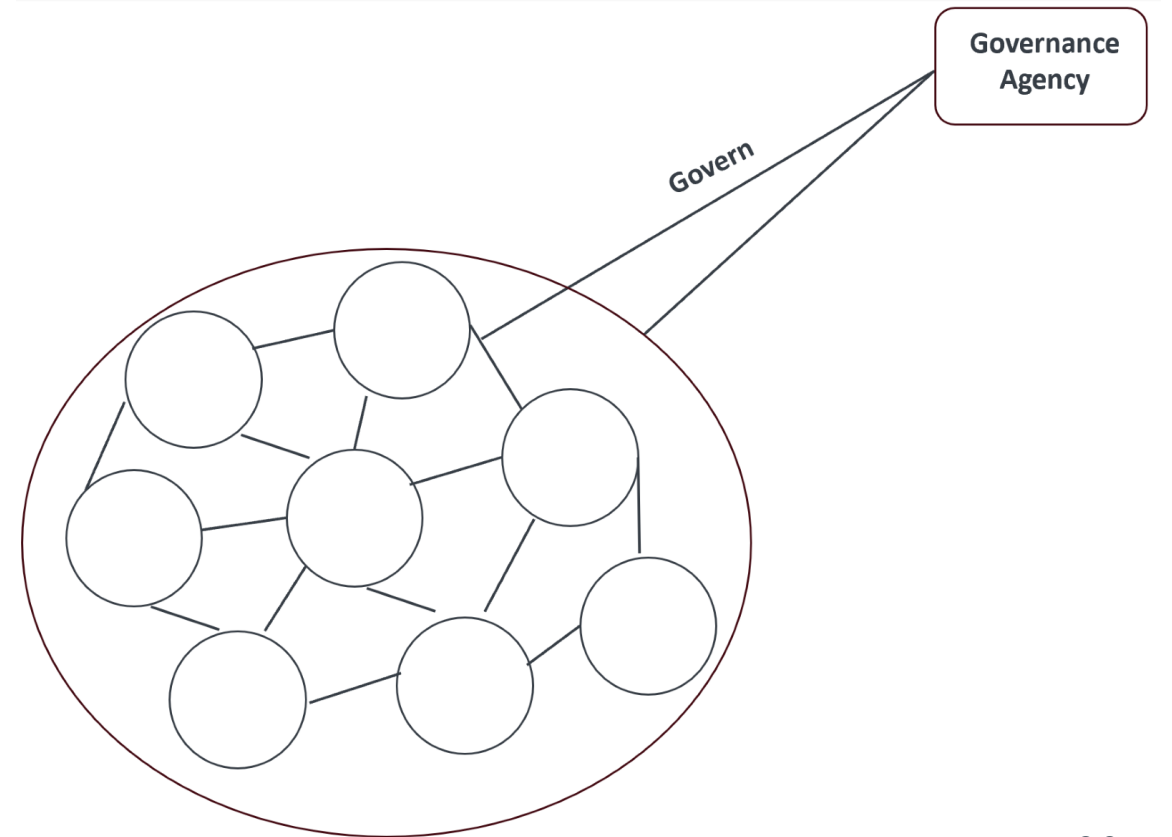


The question now arises: how?

We propose a new construct for the (SoS), where an external governing entity holds the power to determine the objectives and drivers of the Healthcare SoS.



That is to ensure that all constituent systems are committed to the healthcare SoS's values while also allowing them to manage their systems in a way that maximizes their gains.



Sum up

Deconstructing

HDS is NOT a single system, it's a set of systems.

Typify the system

HDS is a Collaborative SoS.

Unexplored Territory

Focus on the interdependence; observe the unobservable.

Systemic approach

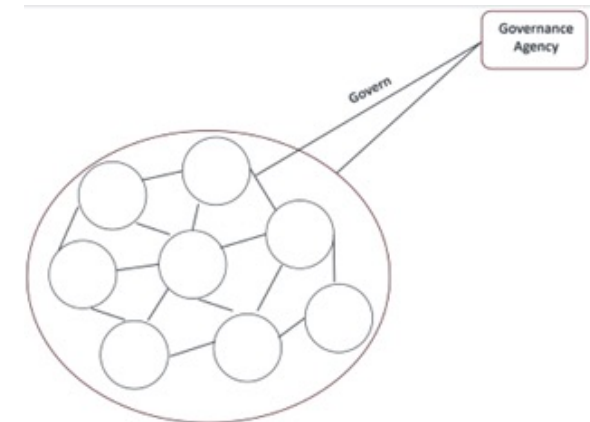
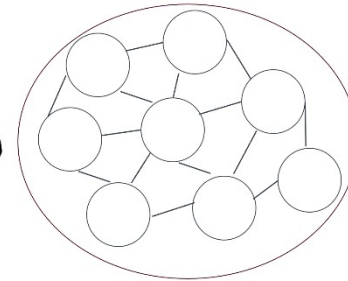
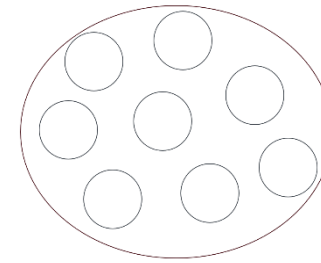
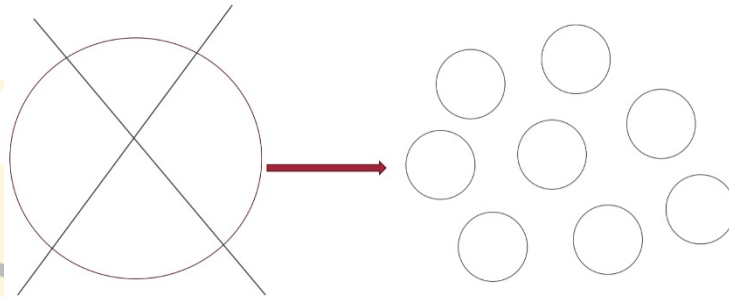
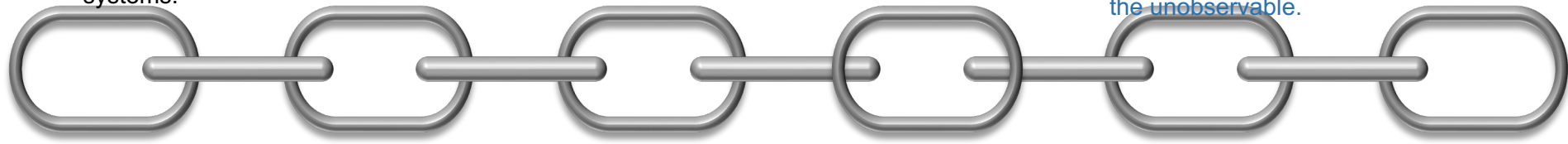
HDS is a SoS, so should be studied as a SoS.

Collaborative Issue

Being Collaborative (SoS) is the central driver of fragmentation.

Proposal

External governing entity



It's clear that the current research in this new construct is still in its early stages.

The main point is to initiate a pivotal dialogue among SoS practitioners on:

- urging a focused examination of healthcare as a SoS.
- advocates a paradigm shift in SoS design and reform.

Also, it is imperative to acknowledge that there are inherent limitations and numerous areas that warrant further exploration.

Further investigation is essential to:

- delineate the scope and boundaries of the governing entity
- establish its authority and decision-making mechanisms.

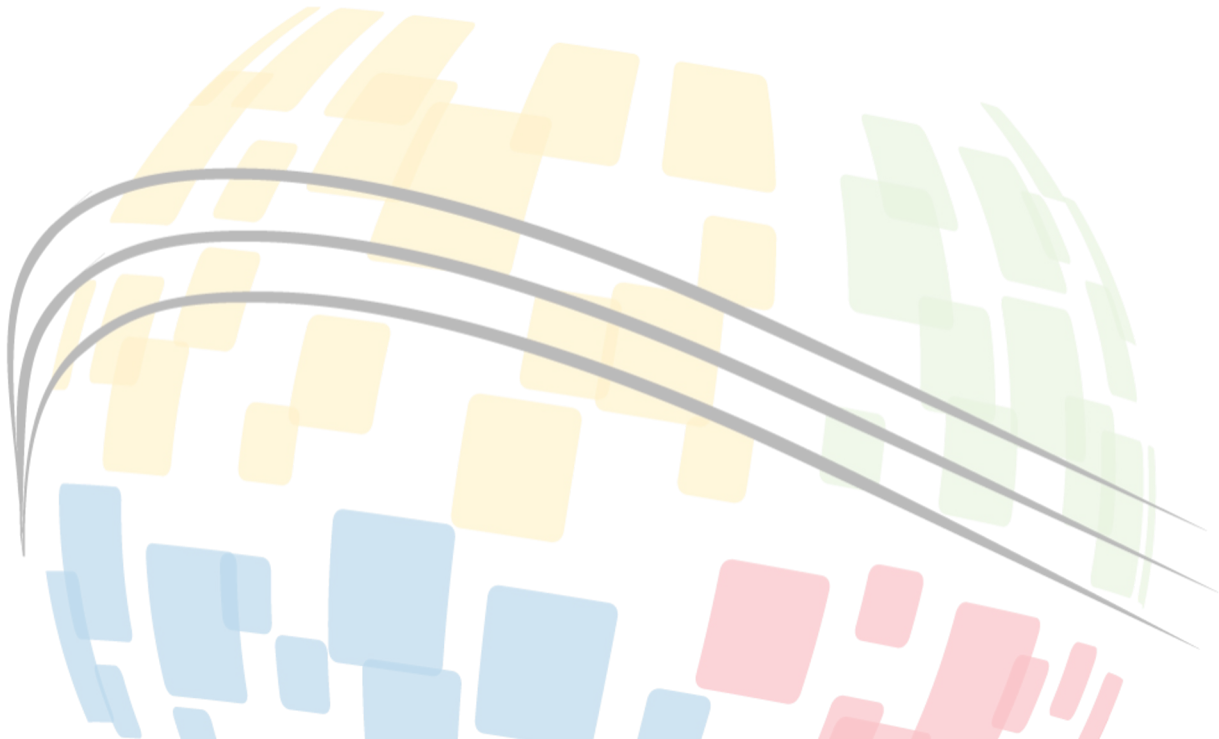


Future Work

The literature contains numerous SoS governance frameworks; however, we are committed to adopt a framework that aligns with the specific characteristics presented in this paper.

Therefore, next steps are:

- First, we will conduct a comprehensive literature review of existing SoS governance frameworks to identify the most suitable one that aligns with our new paradigm.
- If no existing framework proves adequate, we will leverage the insights gained from this review to develop a tailored framework that meets the needs of our proposed paradigm.





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