34th Annual INCOSE international symposium

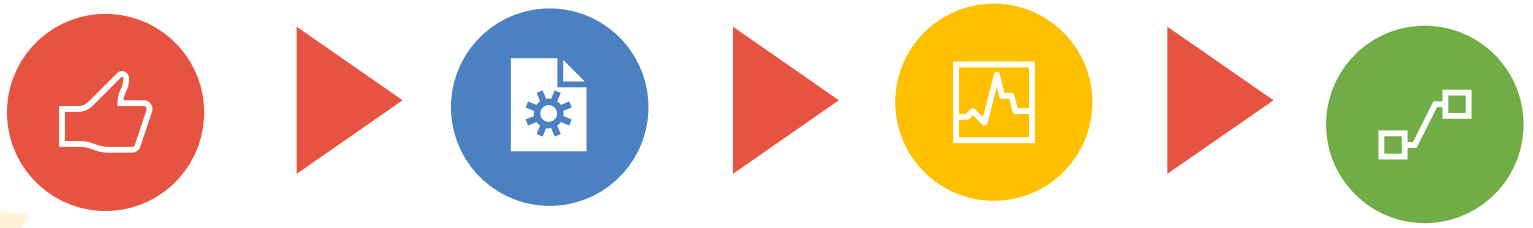
hybrid event

Dublin, Ireland
July 2 - 6, 2024

Raquel L. V. Radoman, Michael Henshaw, Melanie King, Tim Rabbets

An holistic view of the implementation of the Open Architecture Approach in military systems

Presentation Outline



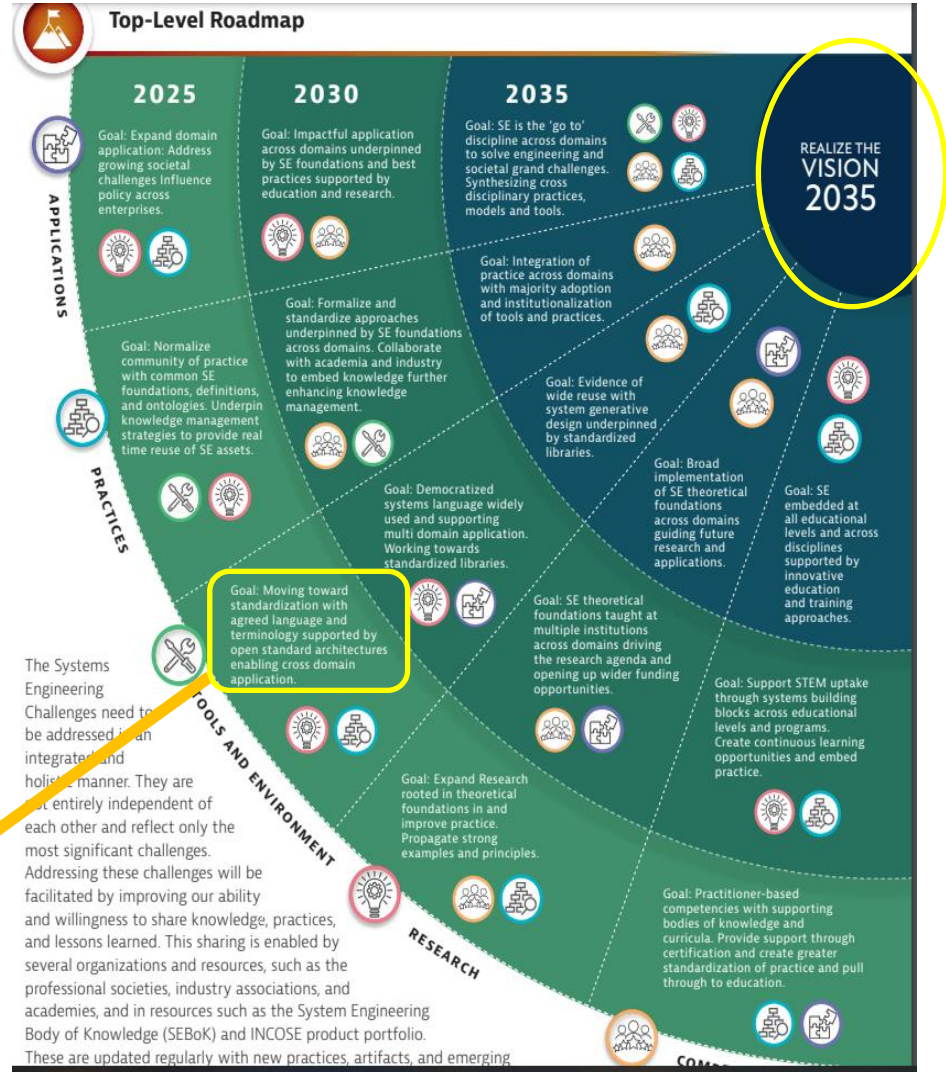
Introduction Methodology Results Conclusion

Introduction

Context

Open Architecture as a concept is not new…

… Resurge of interest following the technological shifts and need for fast threat response



https://www.incose.org/publications/se-vision-2035

"Moving toward **standardization** with agreed **language and terminology** supported by **open standard architectures** enabling cross domain application"

Context

+ Potential benefits are promising

+ Number of applications of OA is extensive

- Accomplishment has varied

- Procedures to achieve the benefits are disparate and unclear (synergy of technical and commercial challenges)

- Applications predominantly originate from few governments such as the UK, the USA, and certain NATO members.

Objective

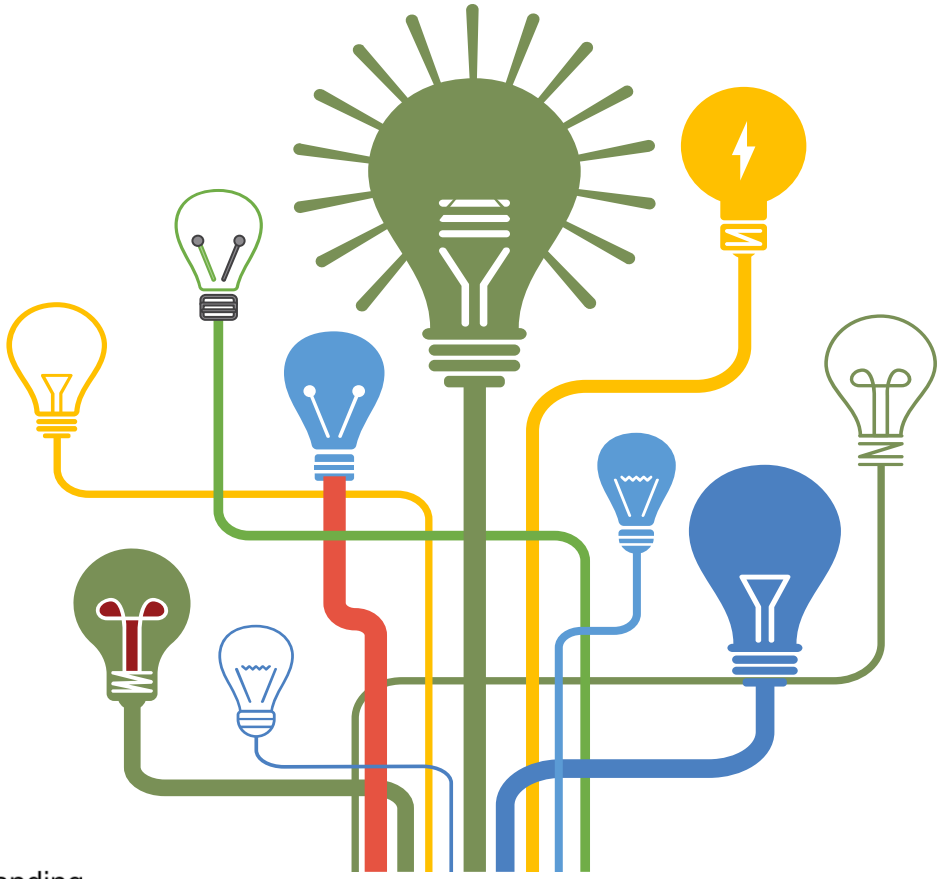
The objective is to show how System Thinking Tools can be applied to provide an Holistic Analysis of the OA approach while exploring Different perspectives to offer to the Decision-makers a clearer understanding of the Big picture of the approach

Understanding of what are OA

Benefits

Challenges

Particullarly those that haven't started to address integration challenges in which OA may offer benefit



Methodology

Overall approach

Data Collection

Interviews
+
Literature (grey, public domain)

Domains					
Land	Air	Maritime	Multi-domain	Commercial	Multiple domains
6	2	2	3	3	3

Sector		
Industry	Government	Academia/consultancy groups
9	6	4

Country/ Group of Nations		
UK	NATO	Multiple Countries
10	1	8

Role		
Technical	Management	Both
9	3	7

Data analysis

Thematic Analysis

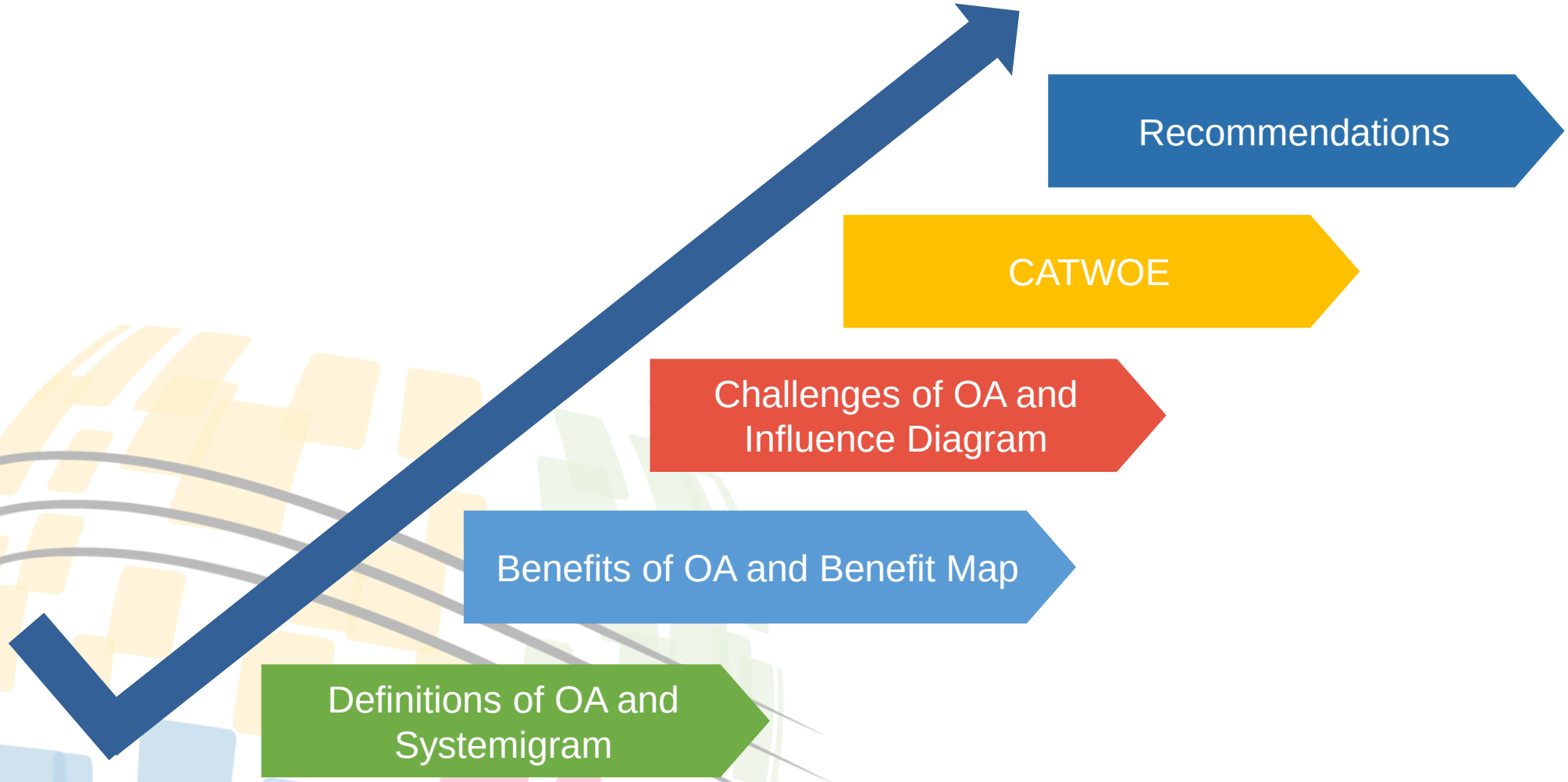
Data representation

SSM + Systems Thinking Tools

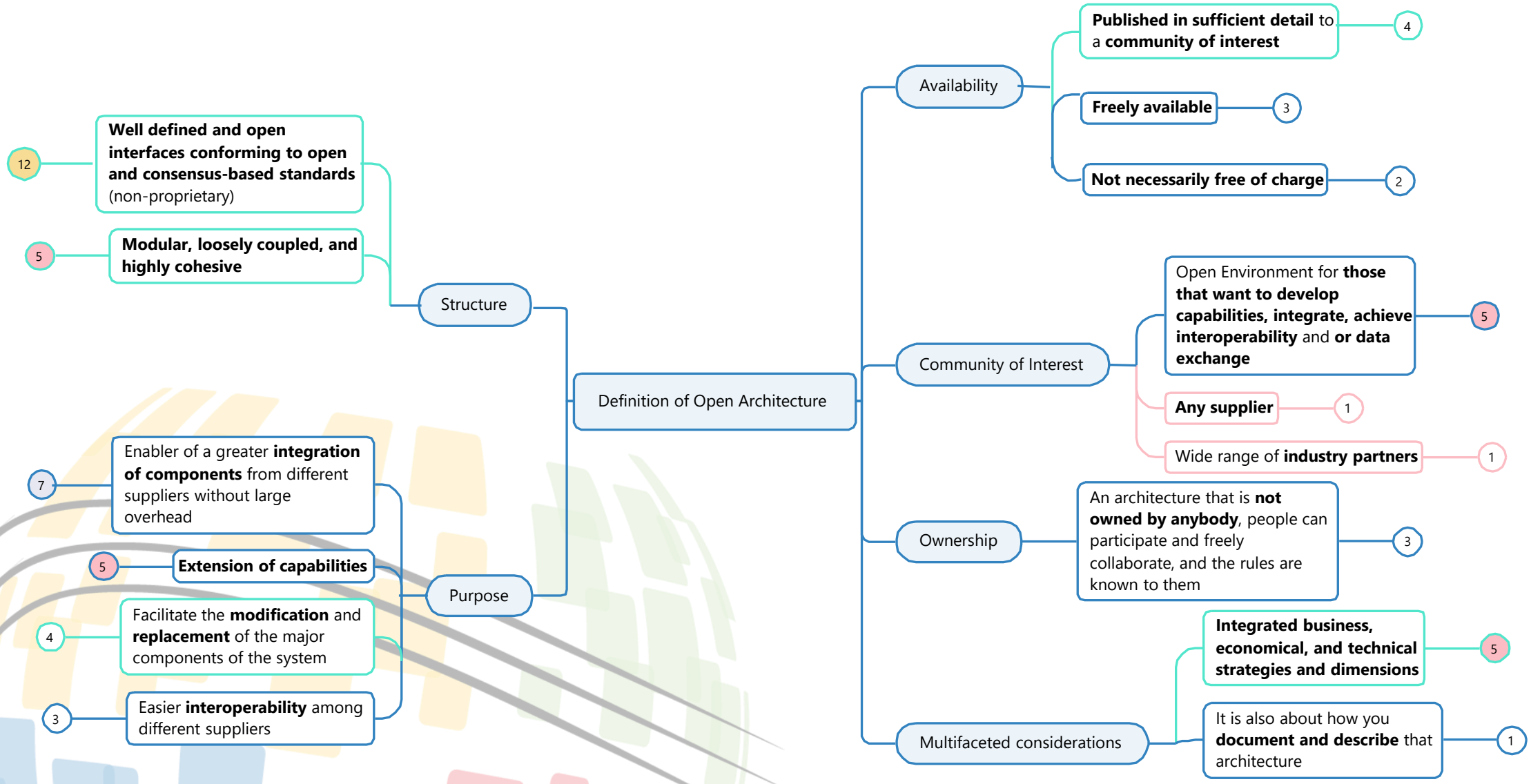
- Systemigram
- CATWOE
- Influence Diagram
- Benefit Map

Results

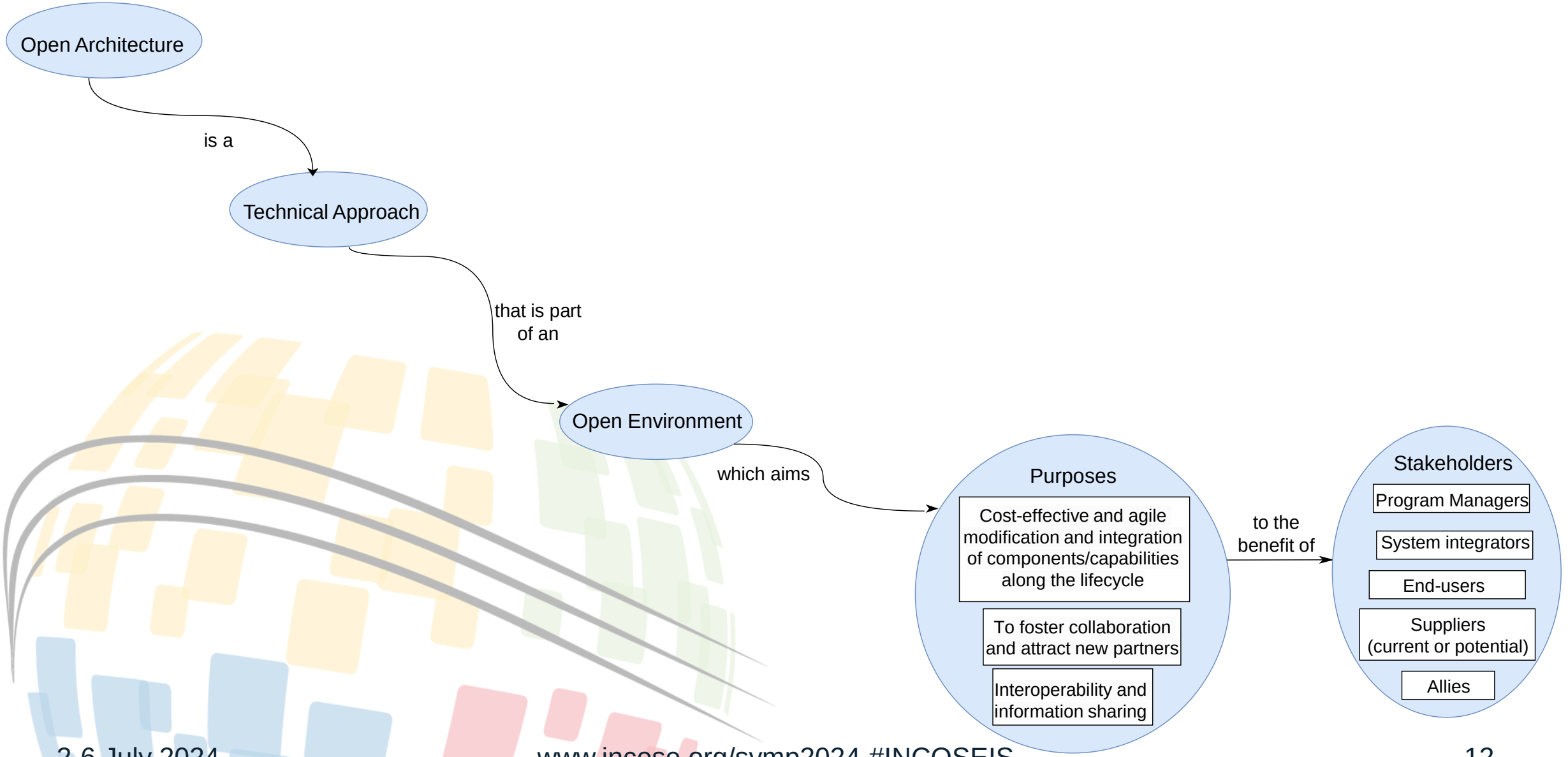
Presentation of the results



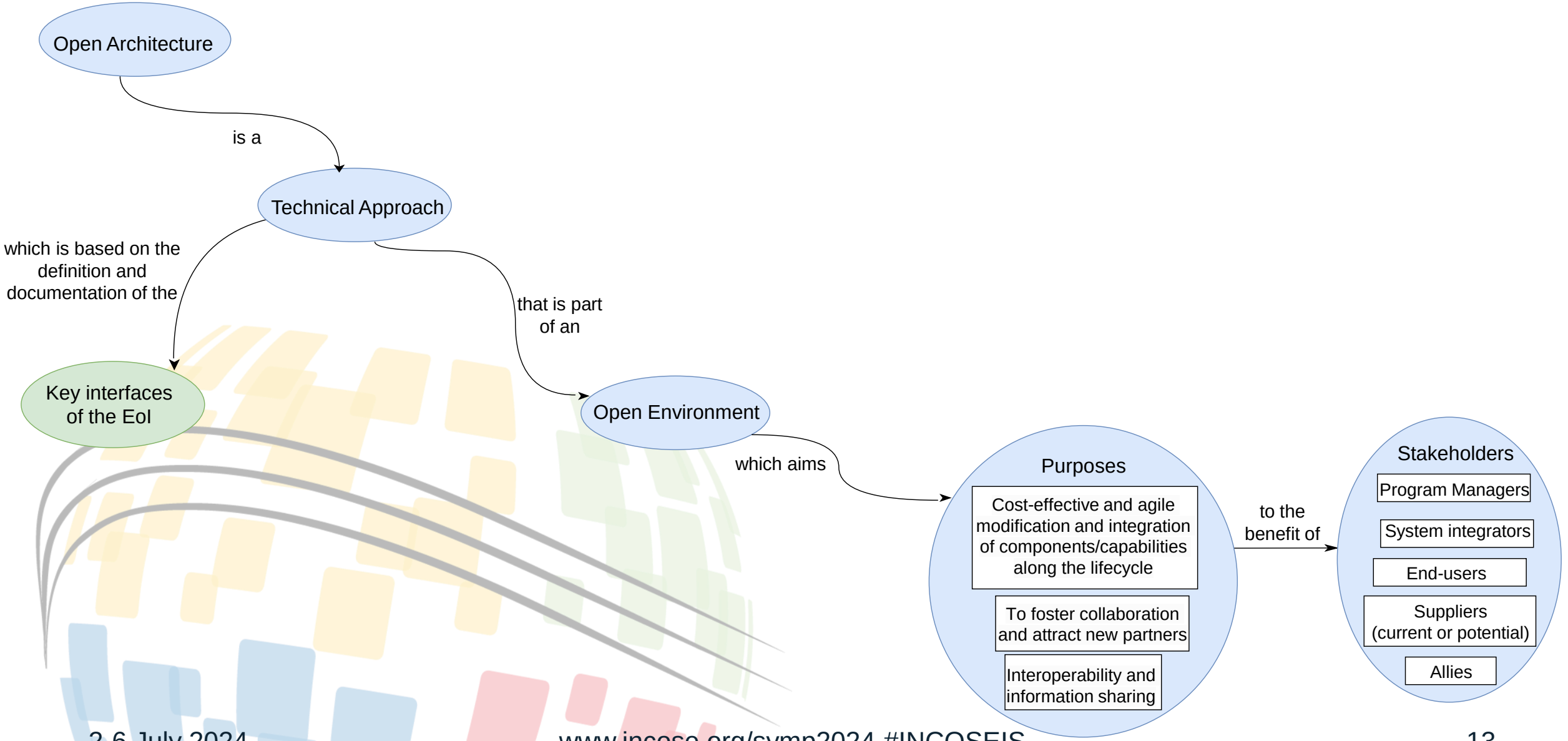
Definitions of Open Architecture



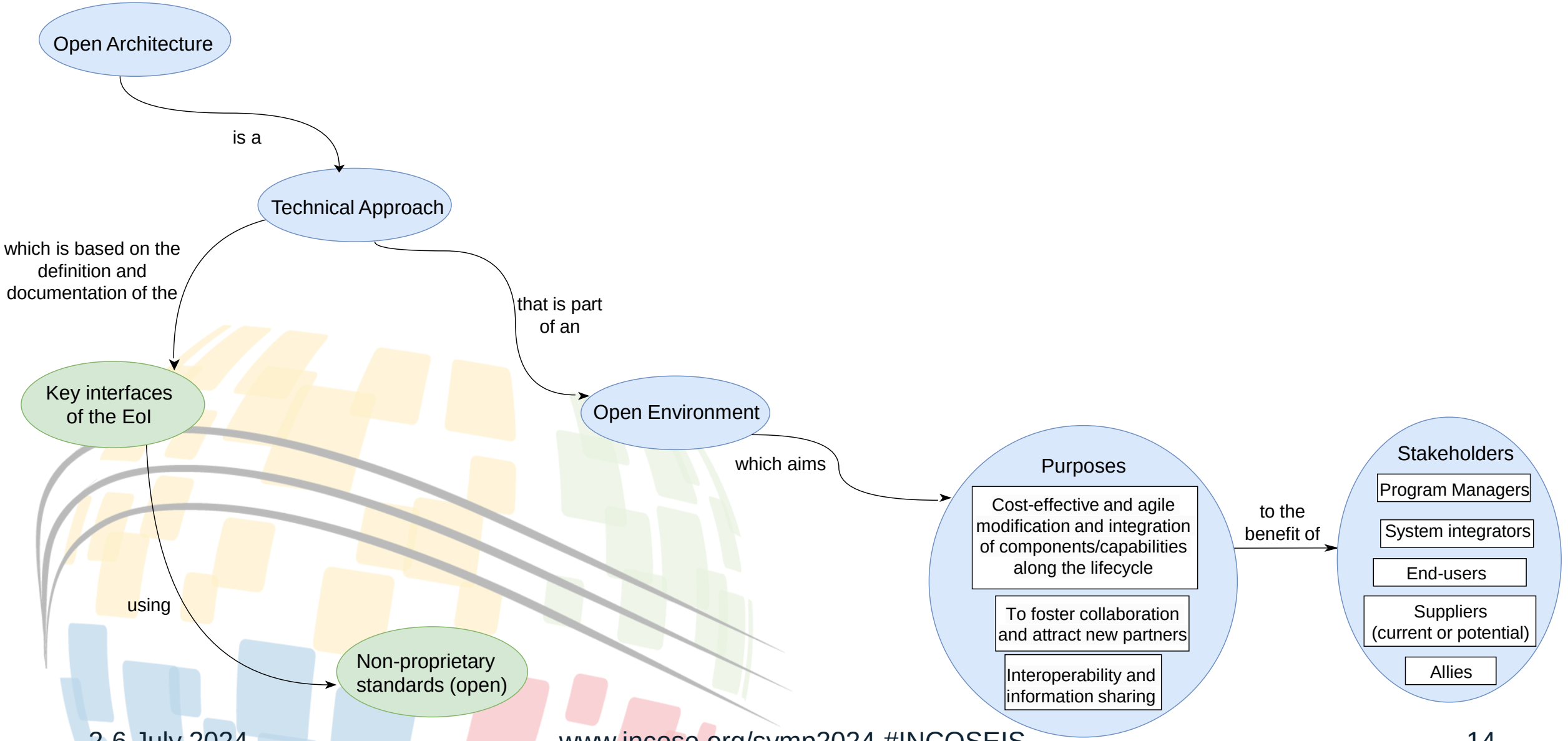
Systemigram



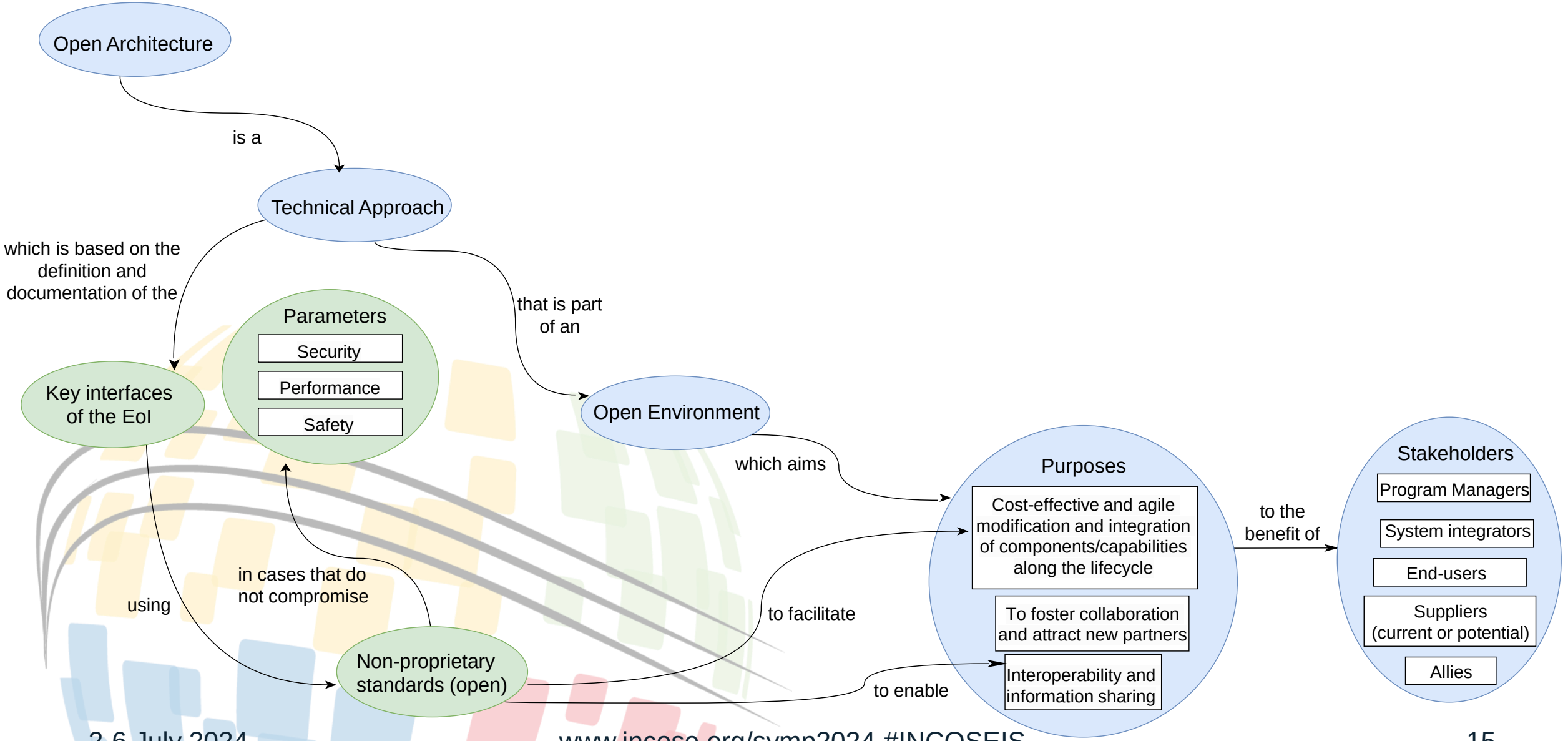
Systemigram



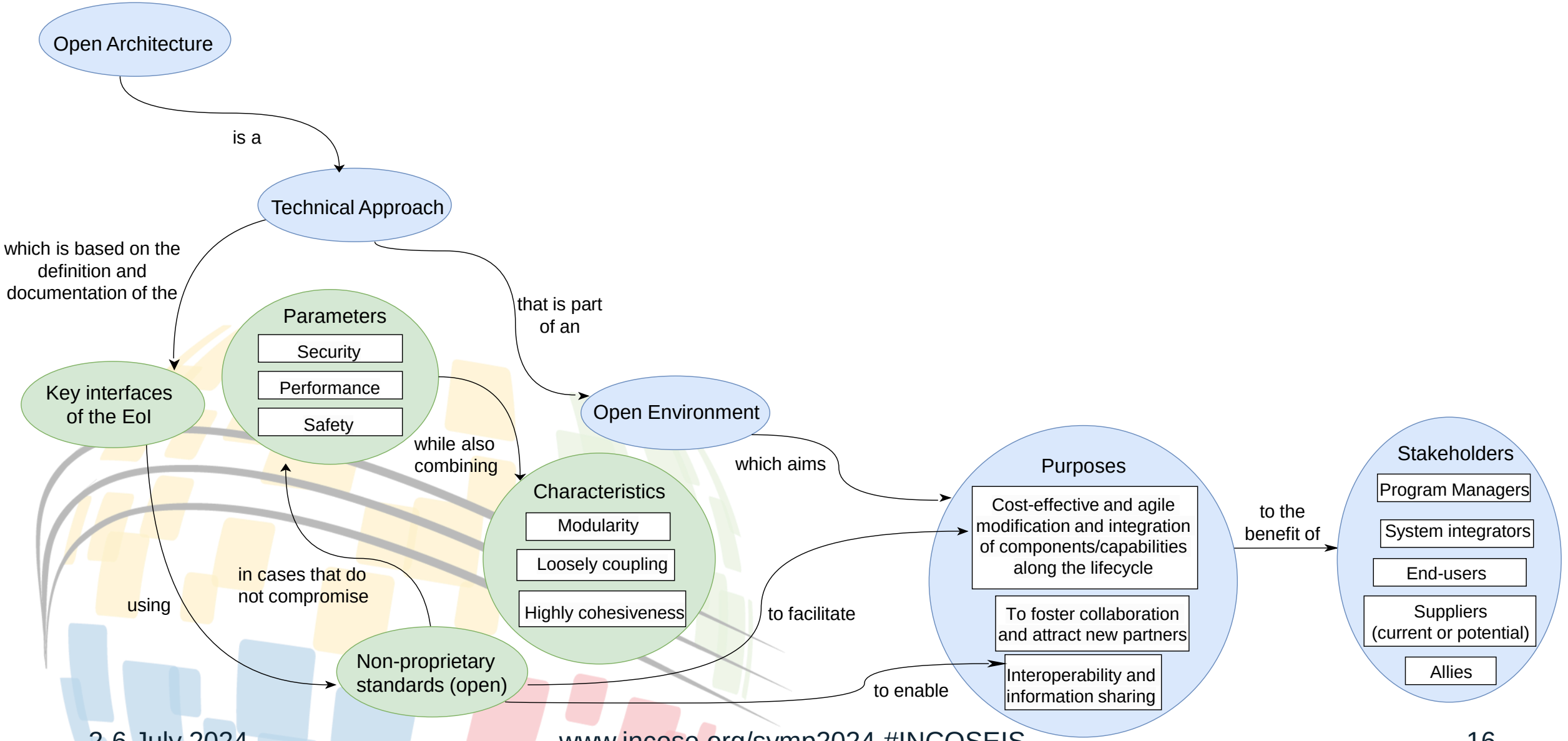
Systemigram



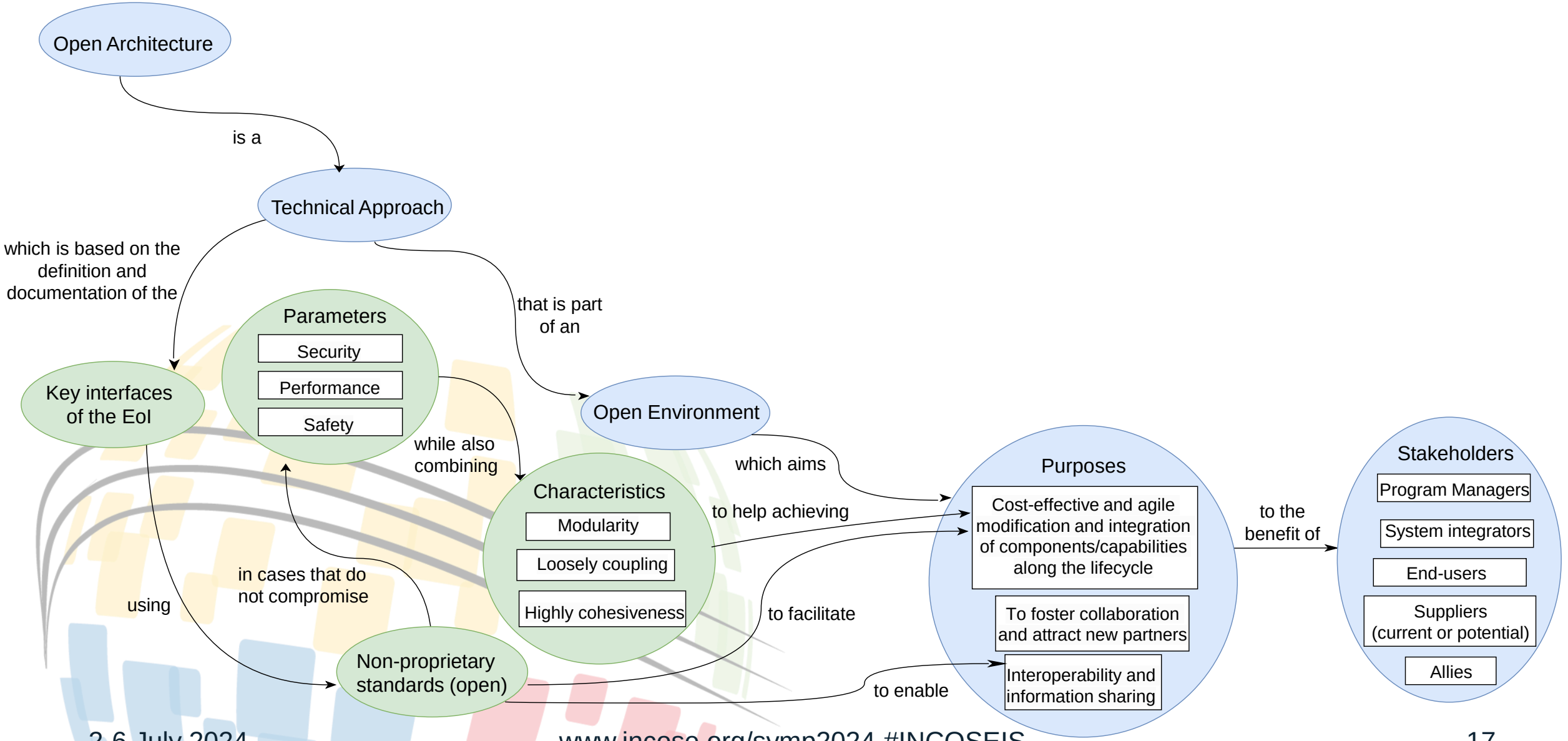
Systemigram



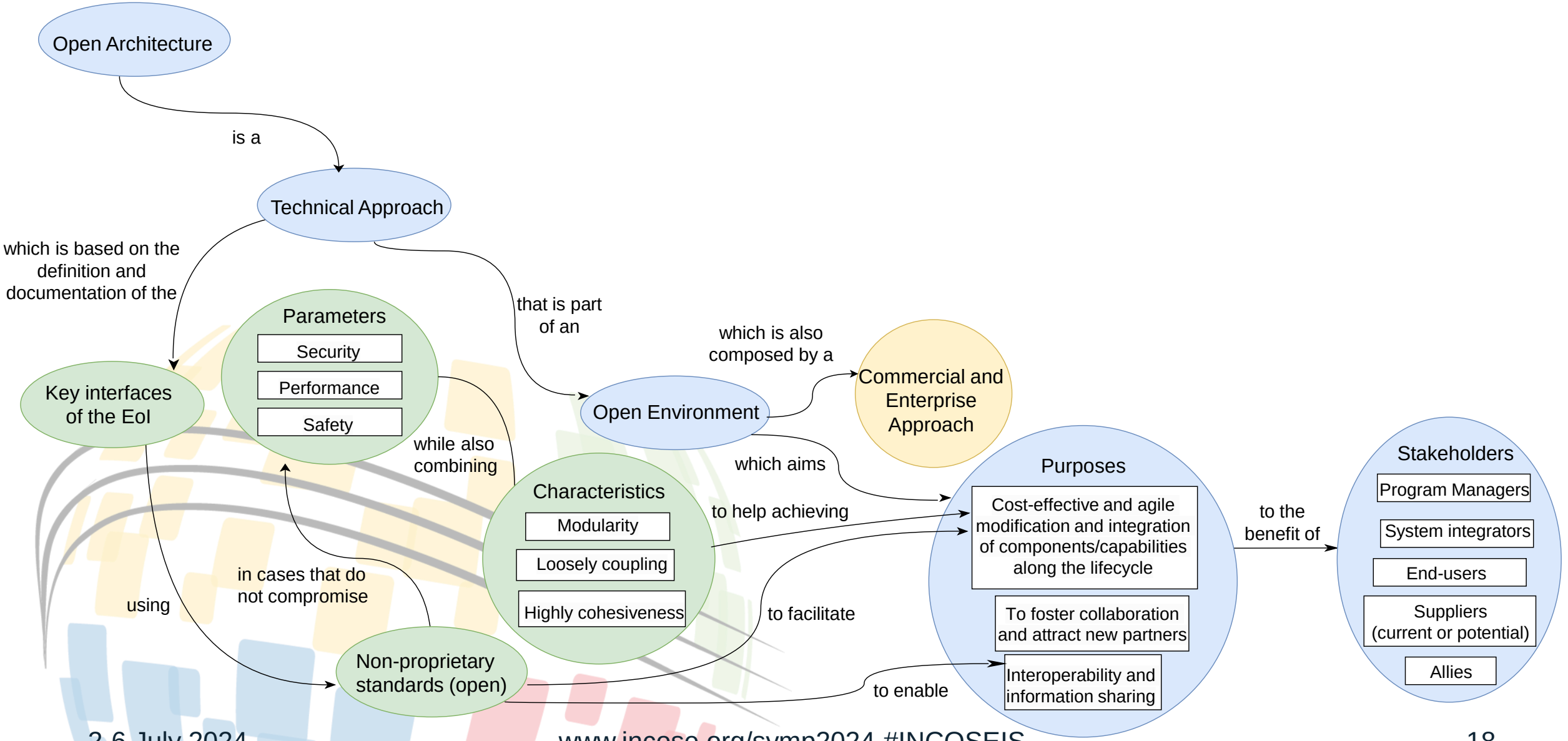
Systemigram



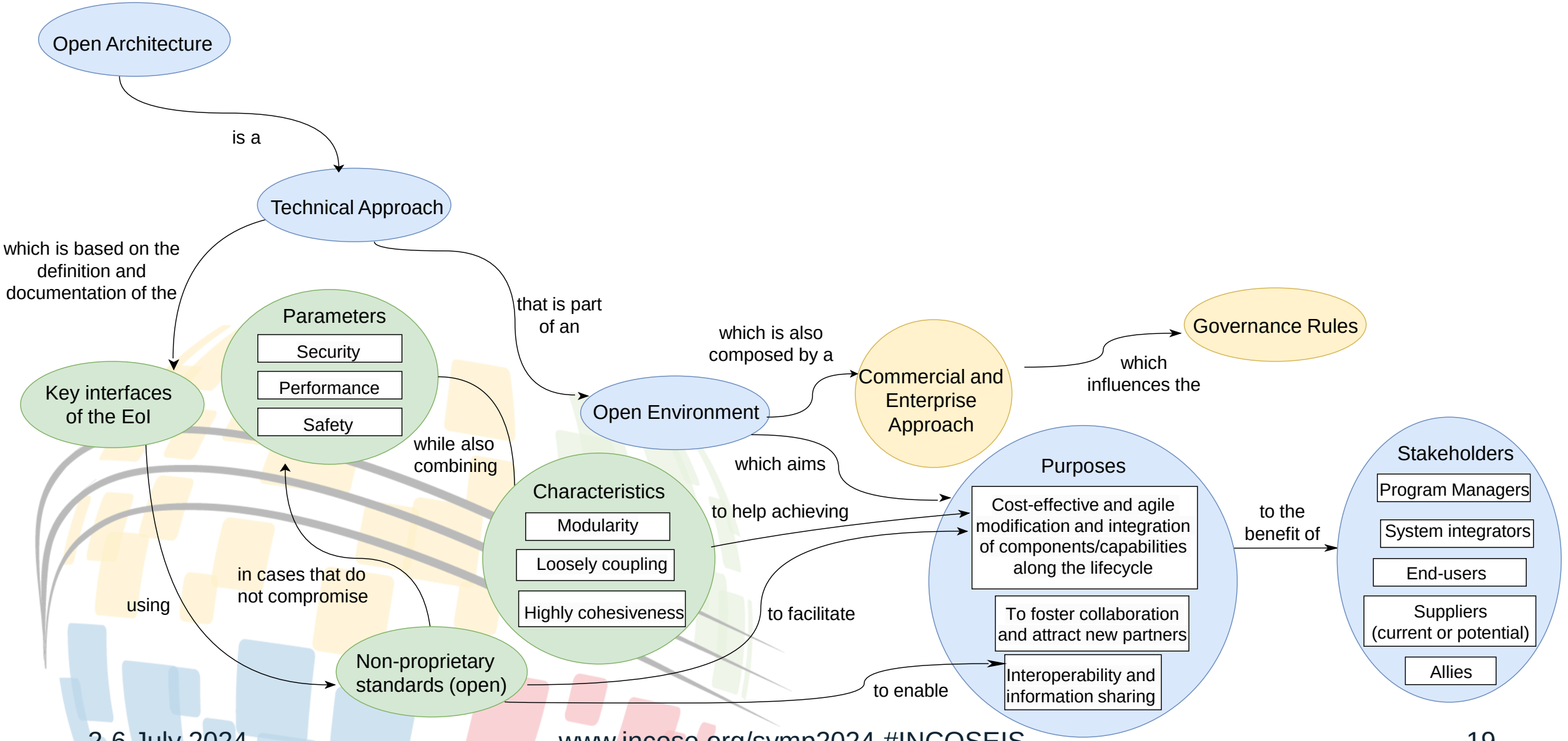
Systemigram



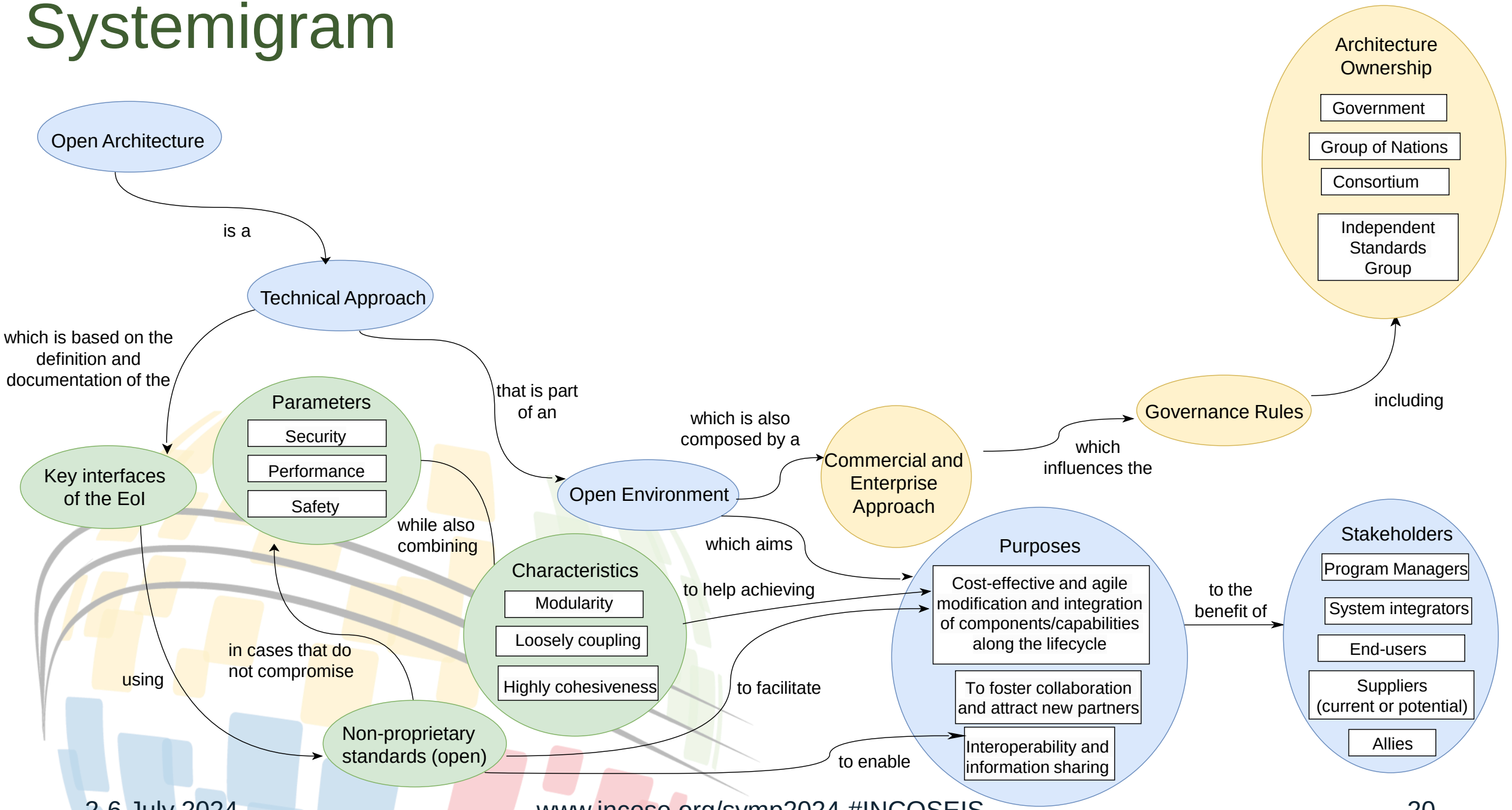
Systemigram



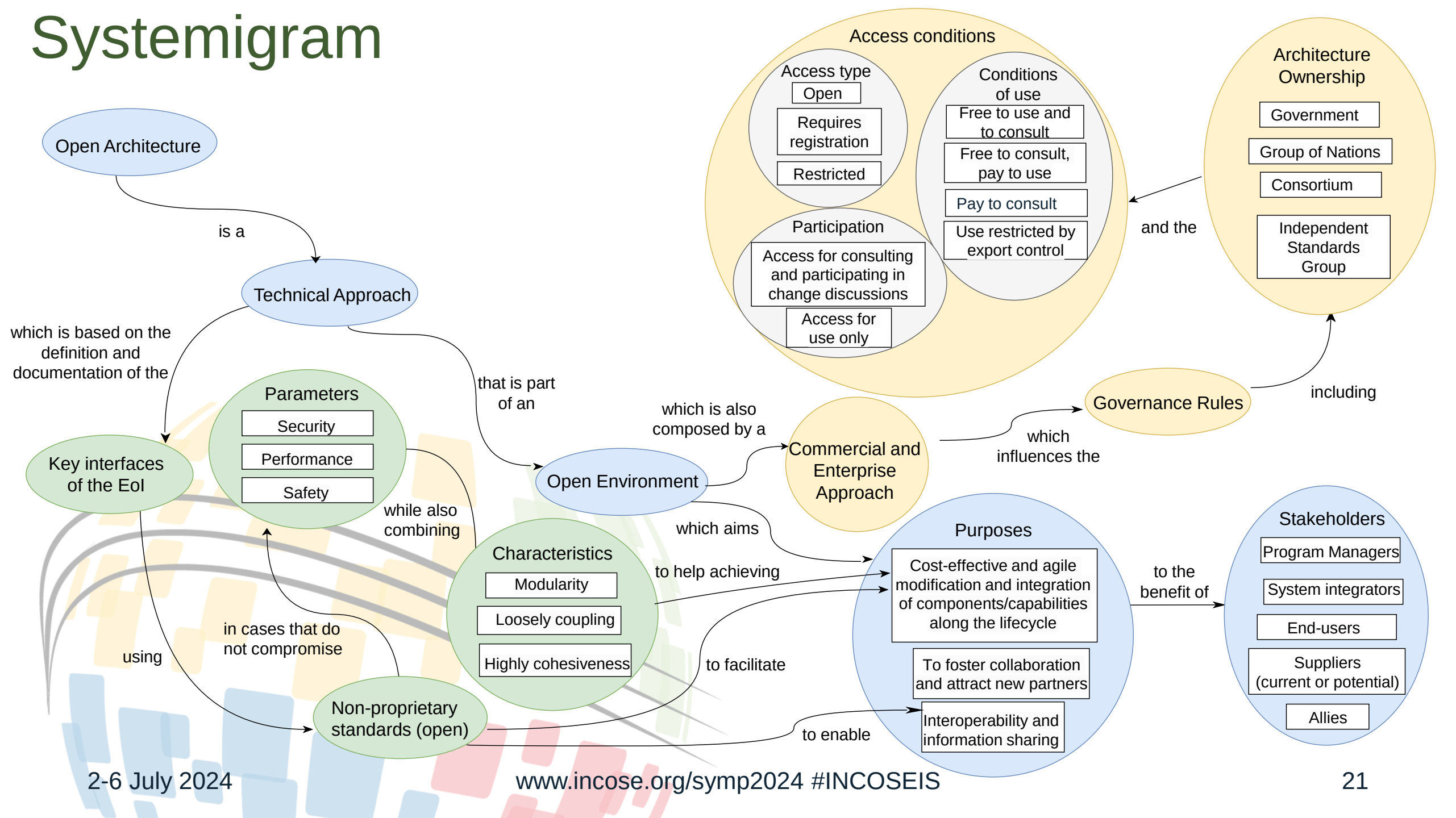
Systemigram



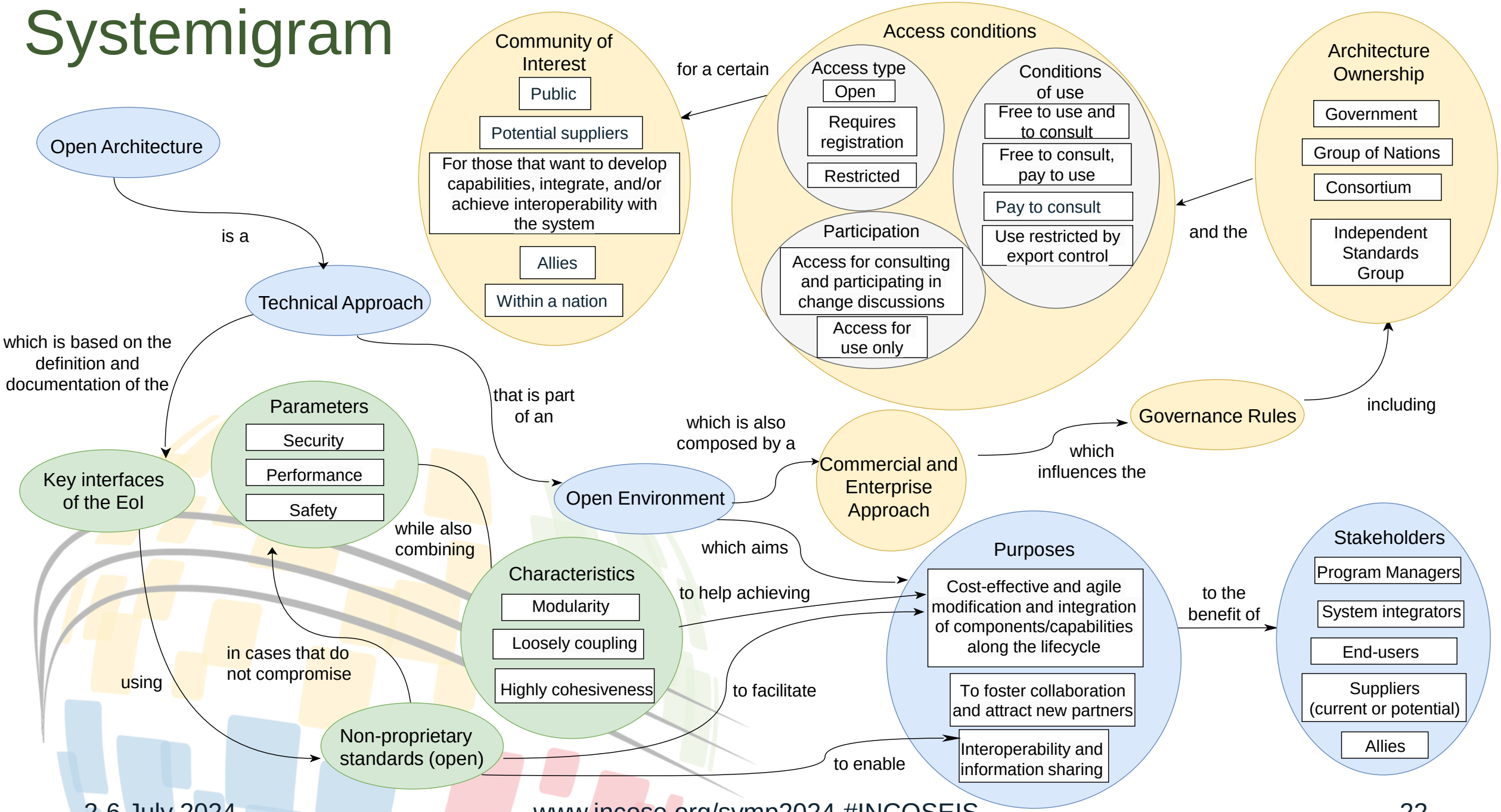
Systemigram



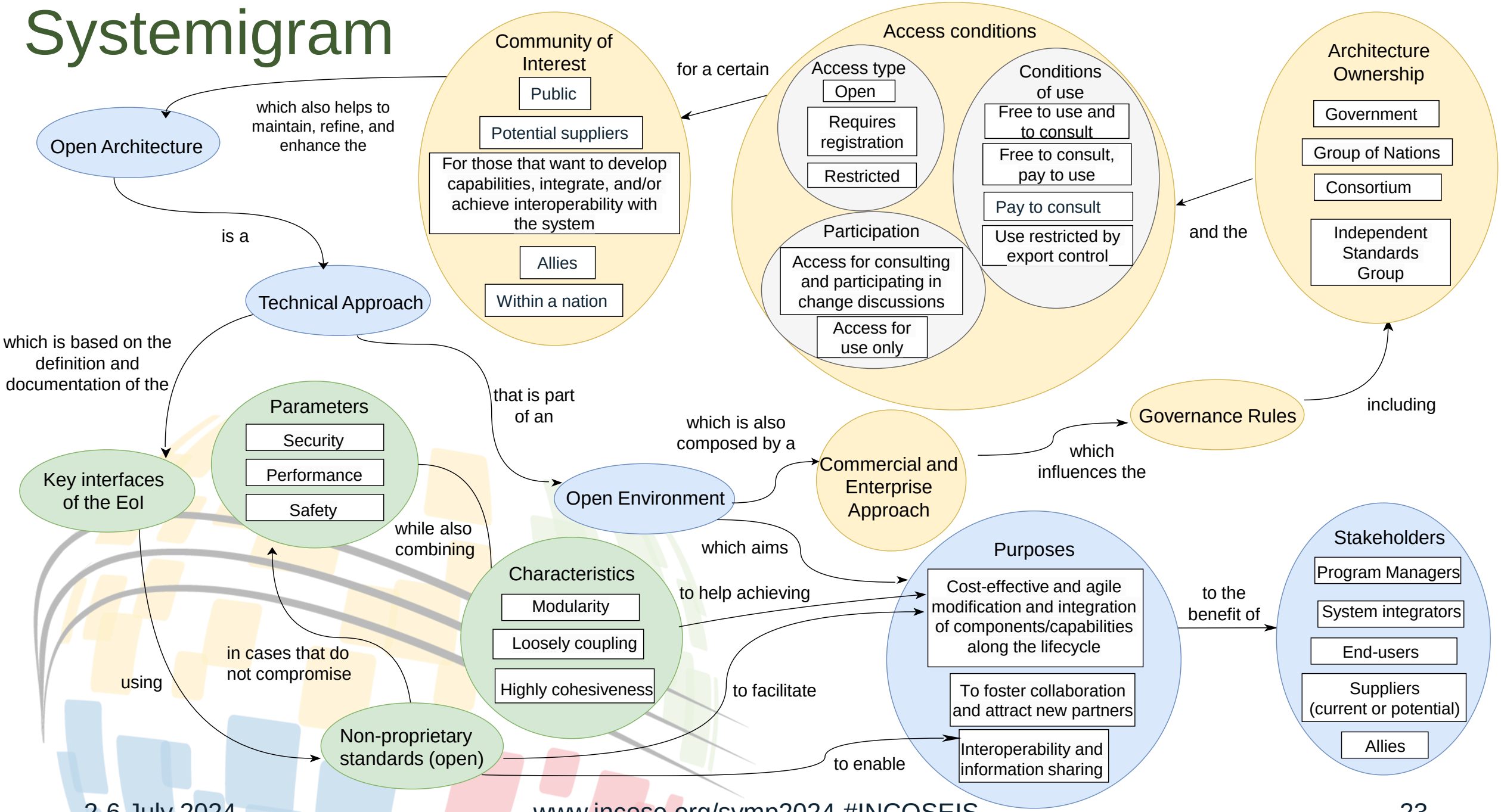
Systemigram



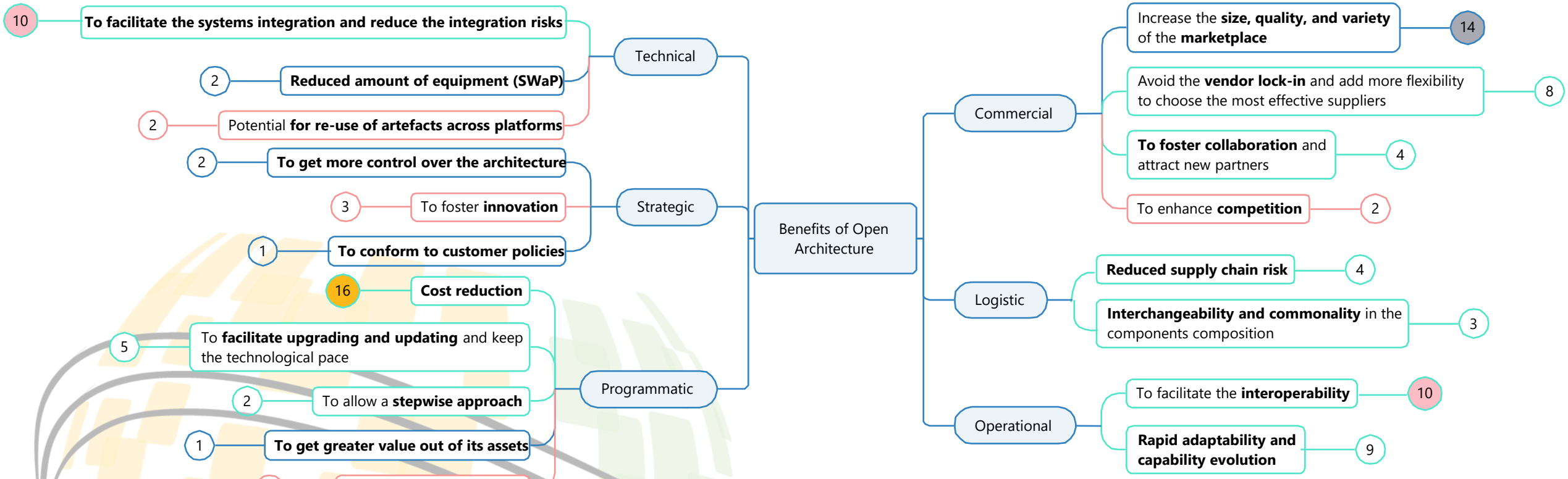
Systemigram



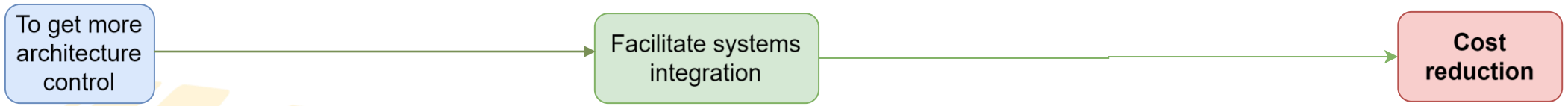
Systemigram



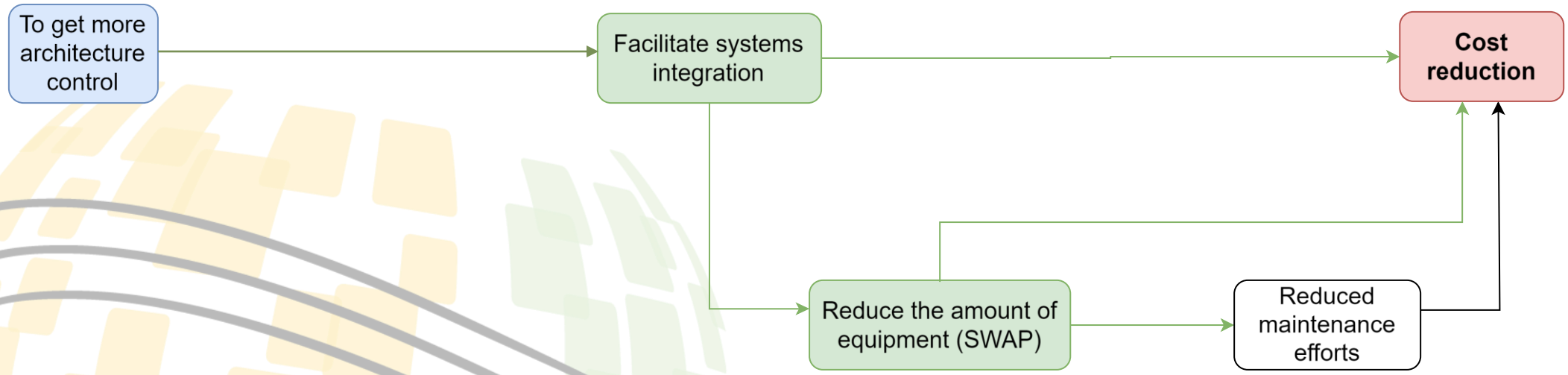
Benefits of Open Architecture



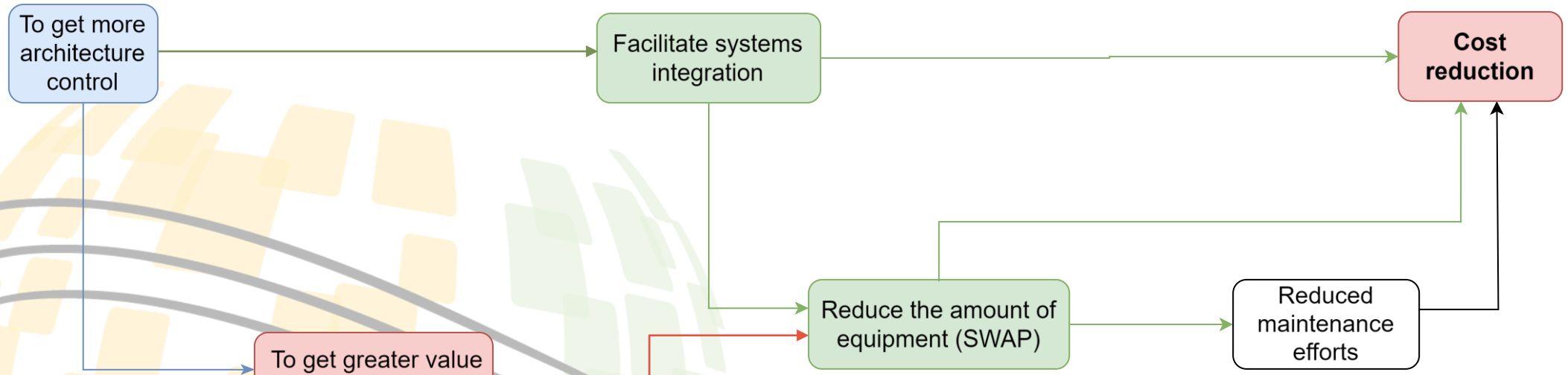
Benefit Map – Cost Reduction



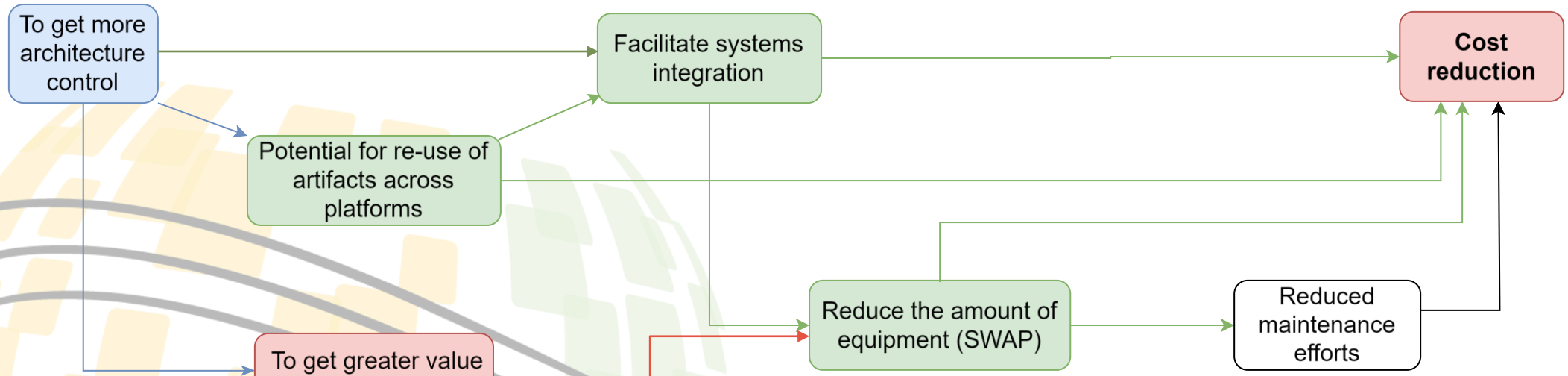
Benefit Map – Cost Reduction



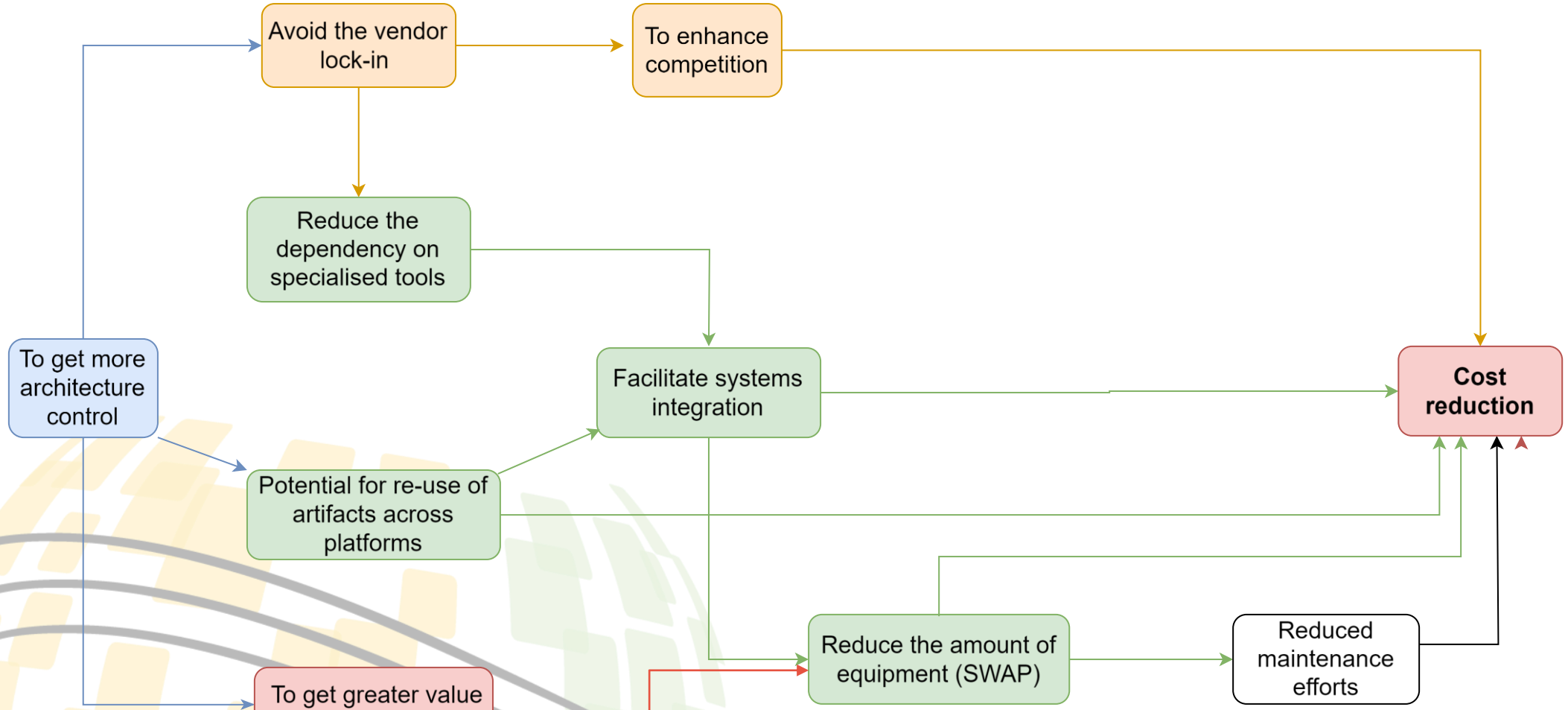
Benefit Map – Cost Reduction



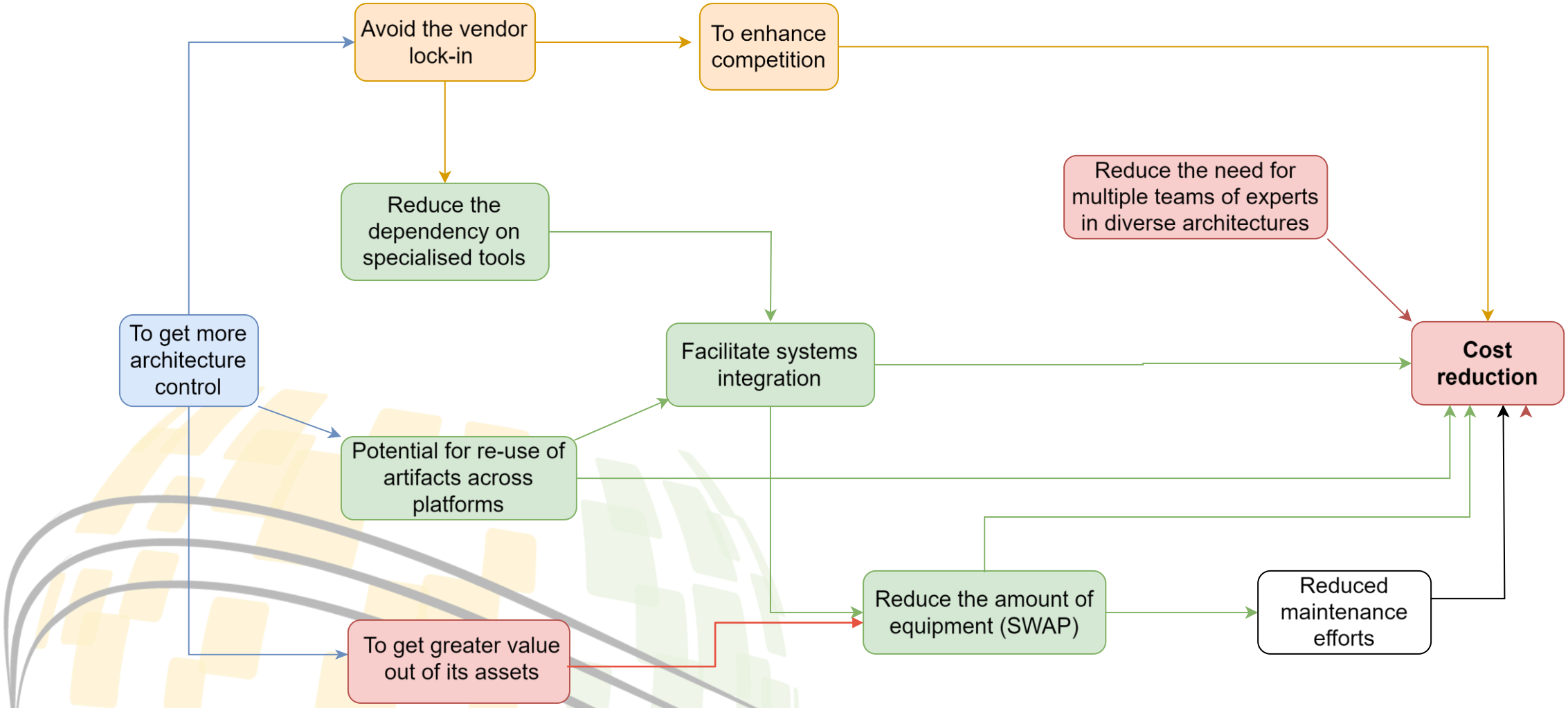
Benefit Map – Cost Reduction



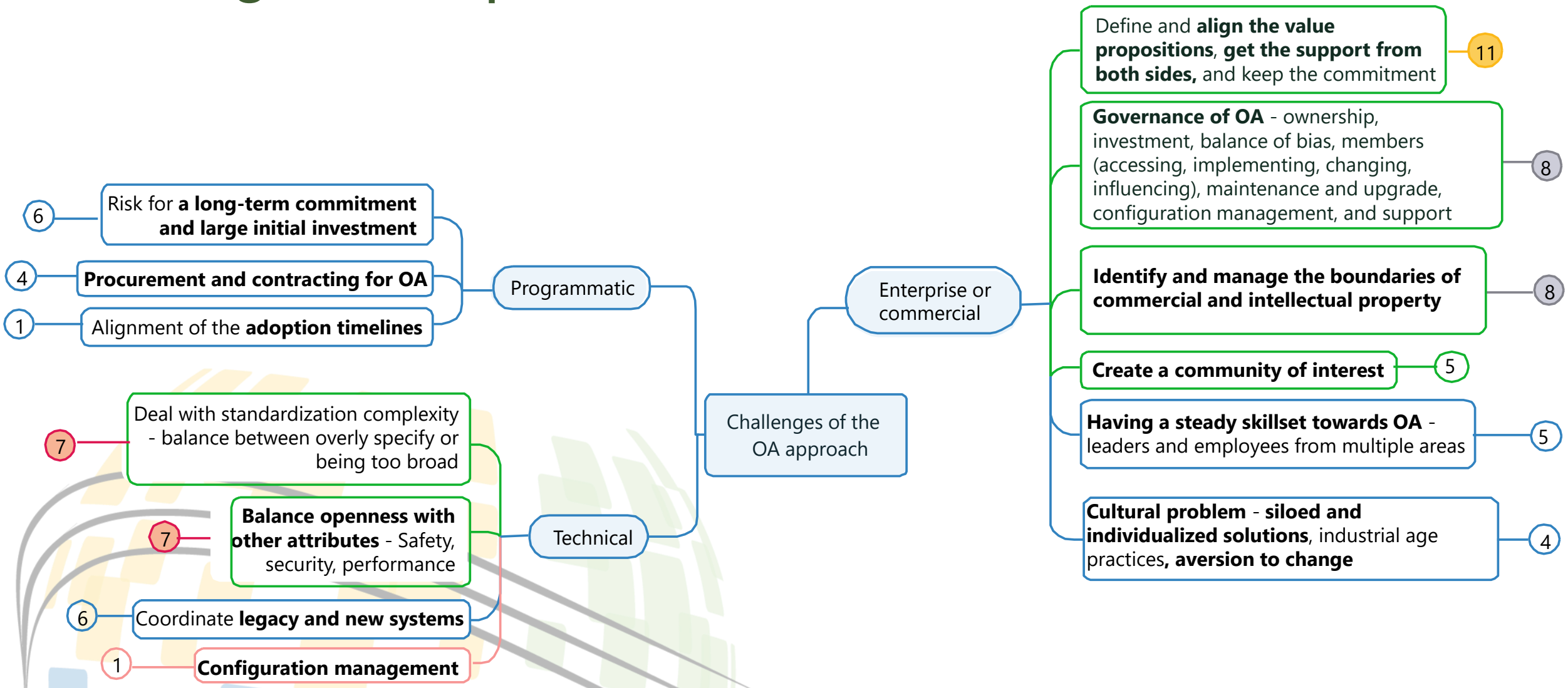
Benefit Map – Cost Reduction



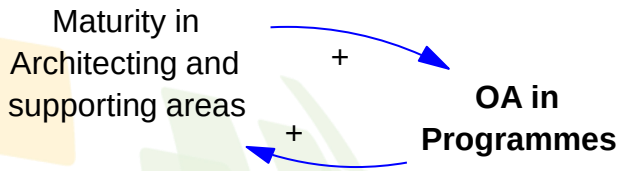
Benefit Map – Cost Reduction



Challenges of Open Architectures

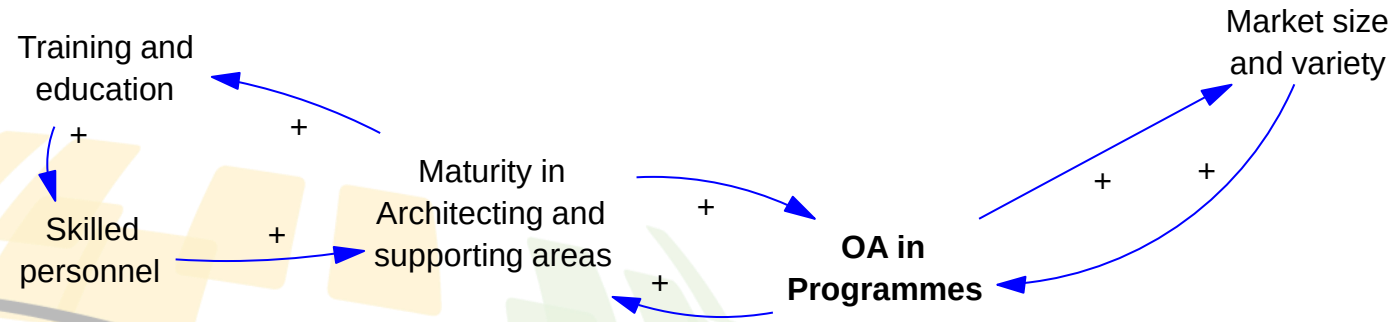


Influence Diagram

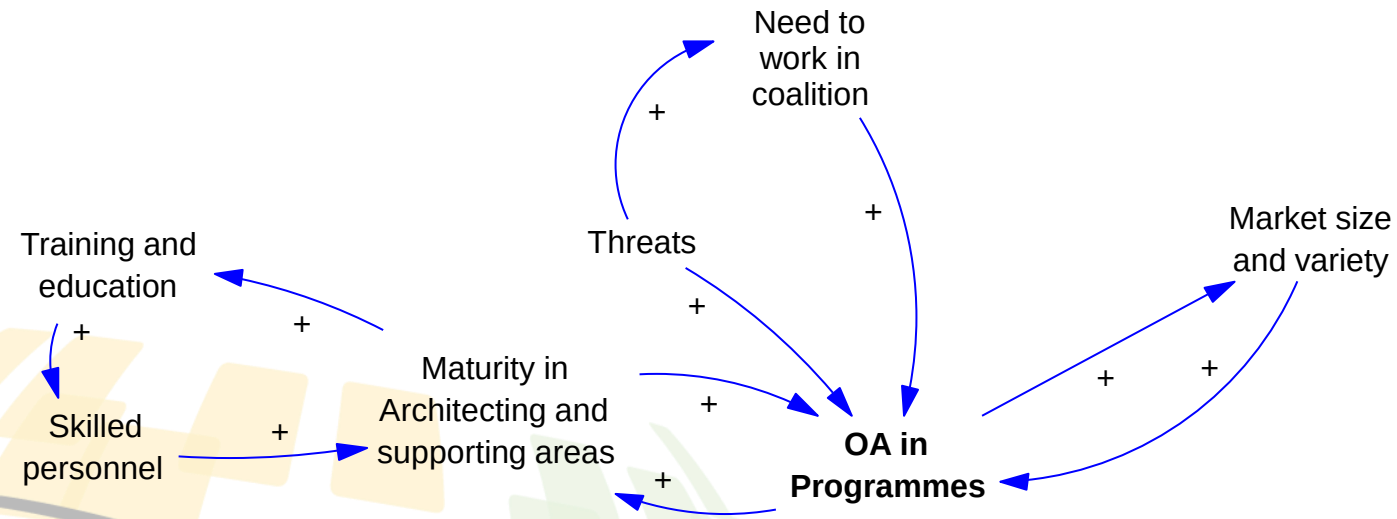


Influence Diagram

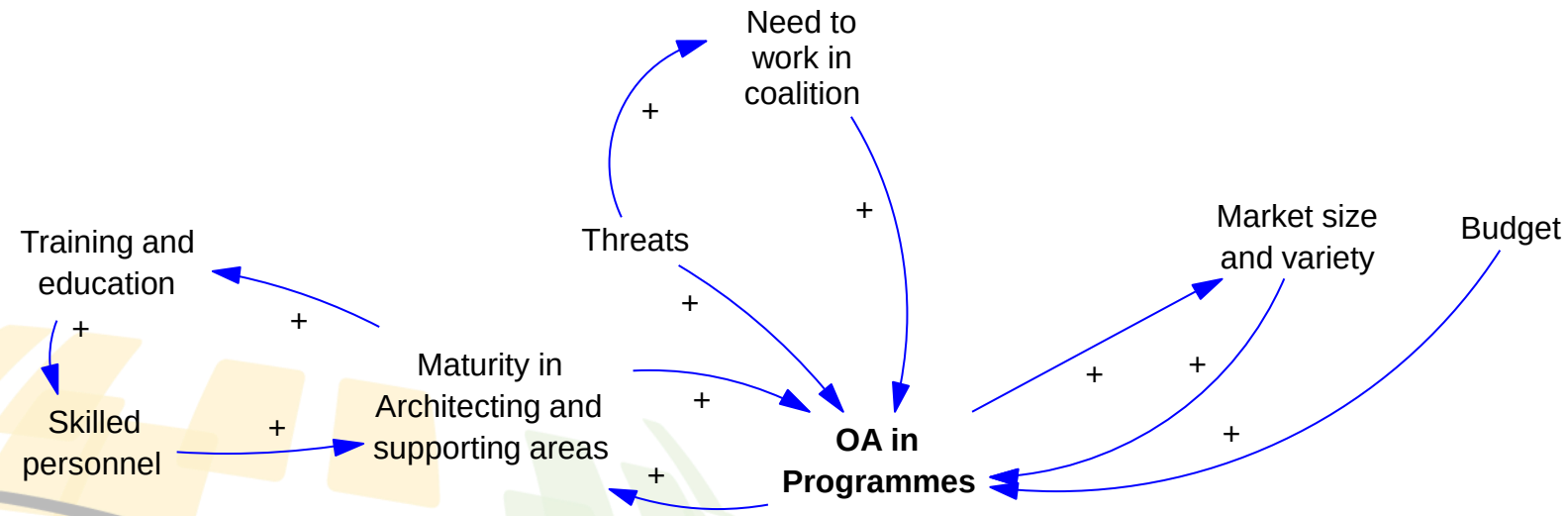
Influence Diagram



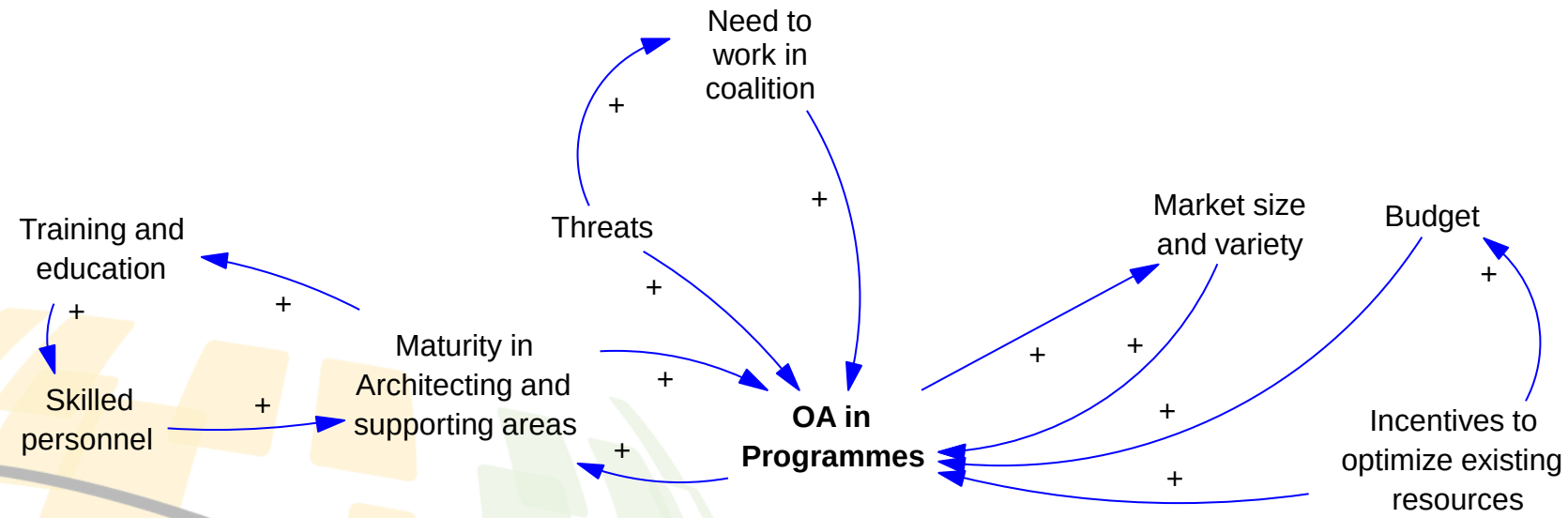
Influence Diagram



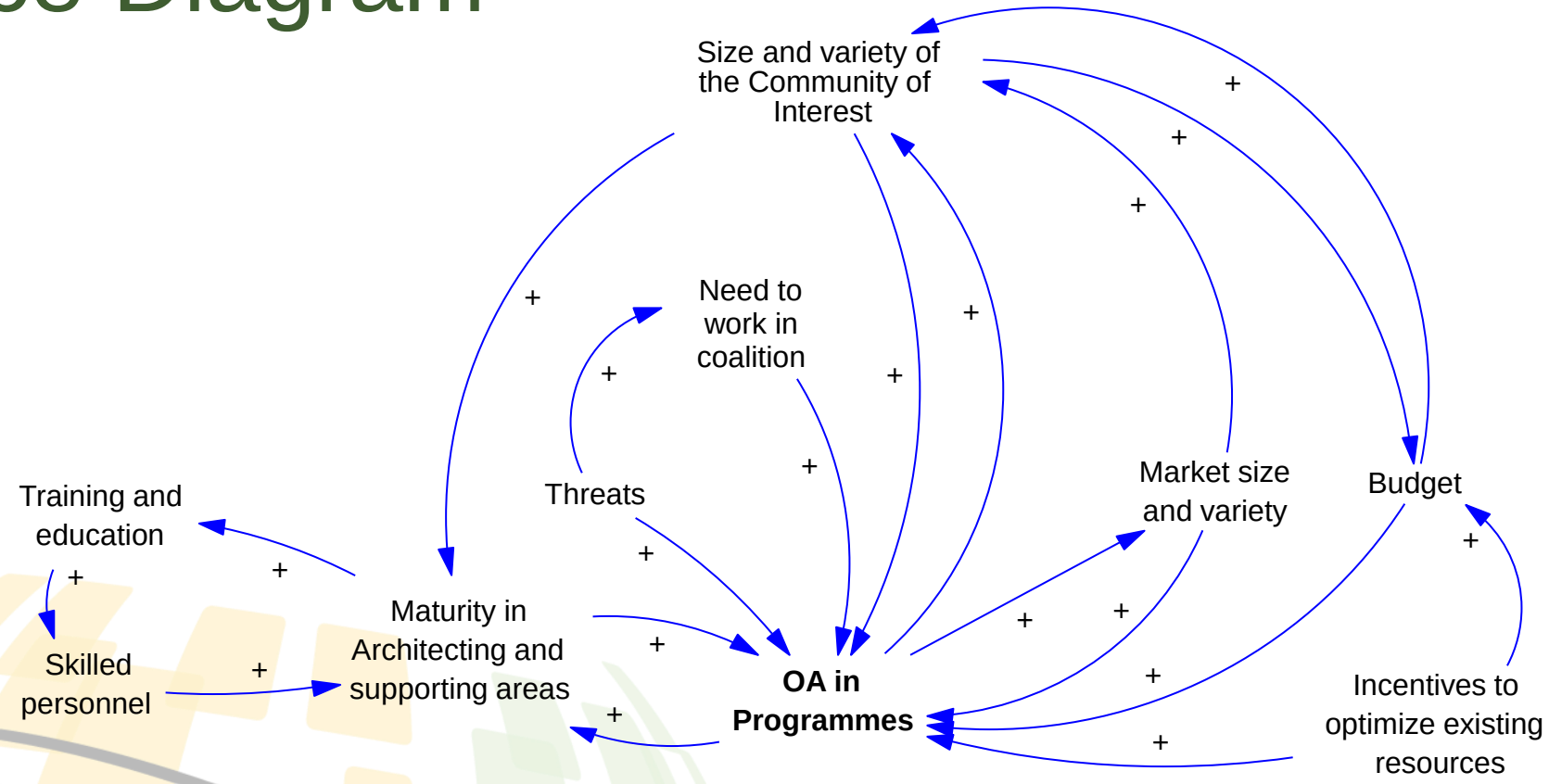
Influence Diagram



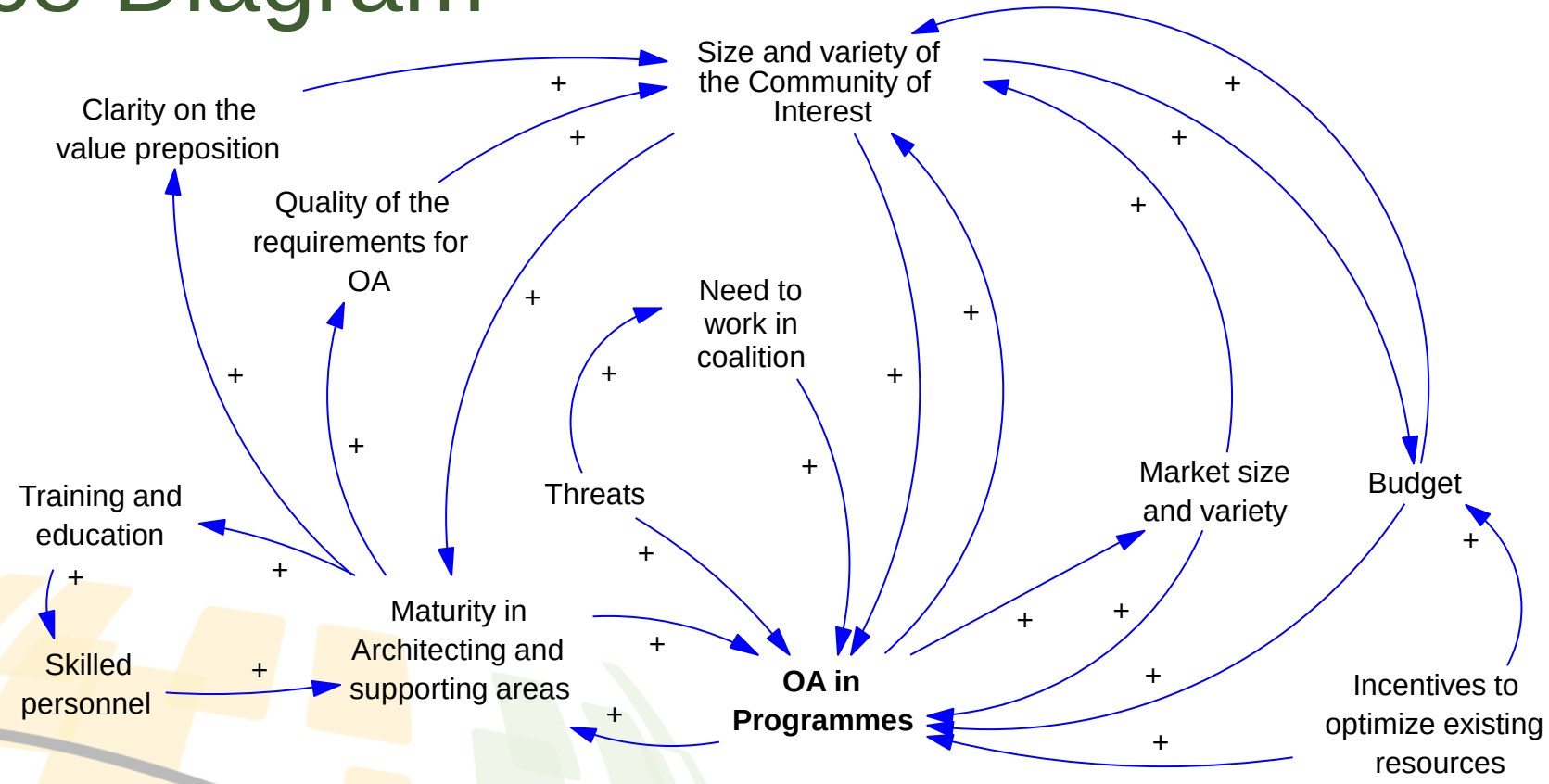
Influence Diagram



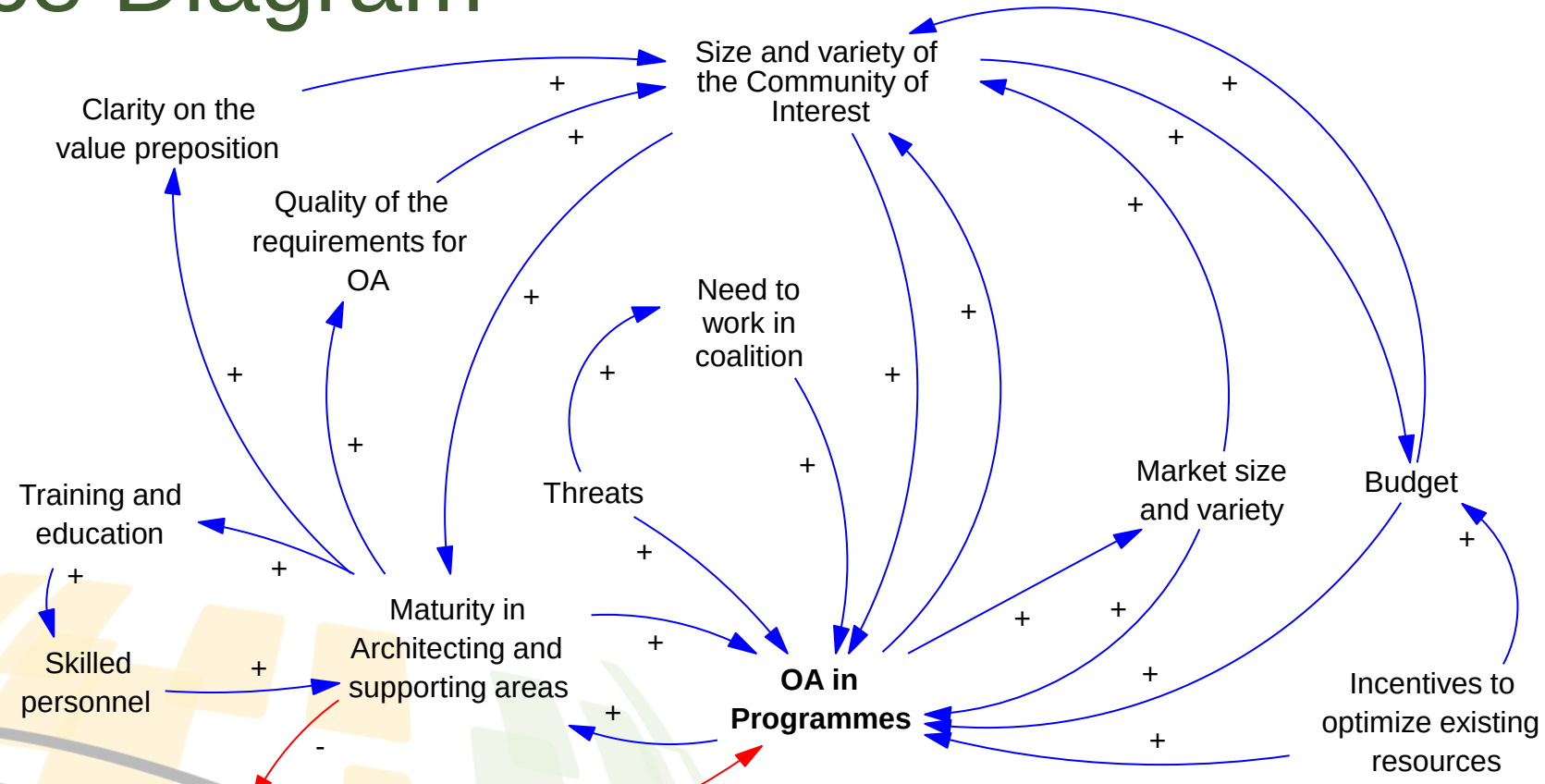
Influence Diagram



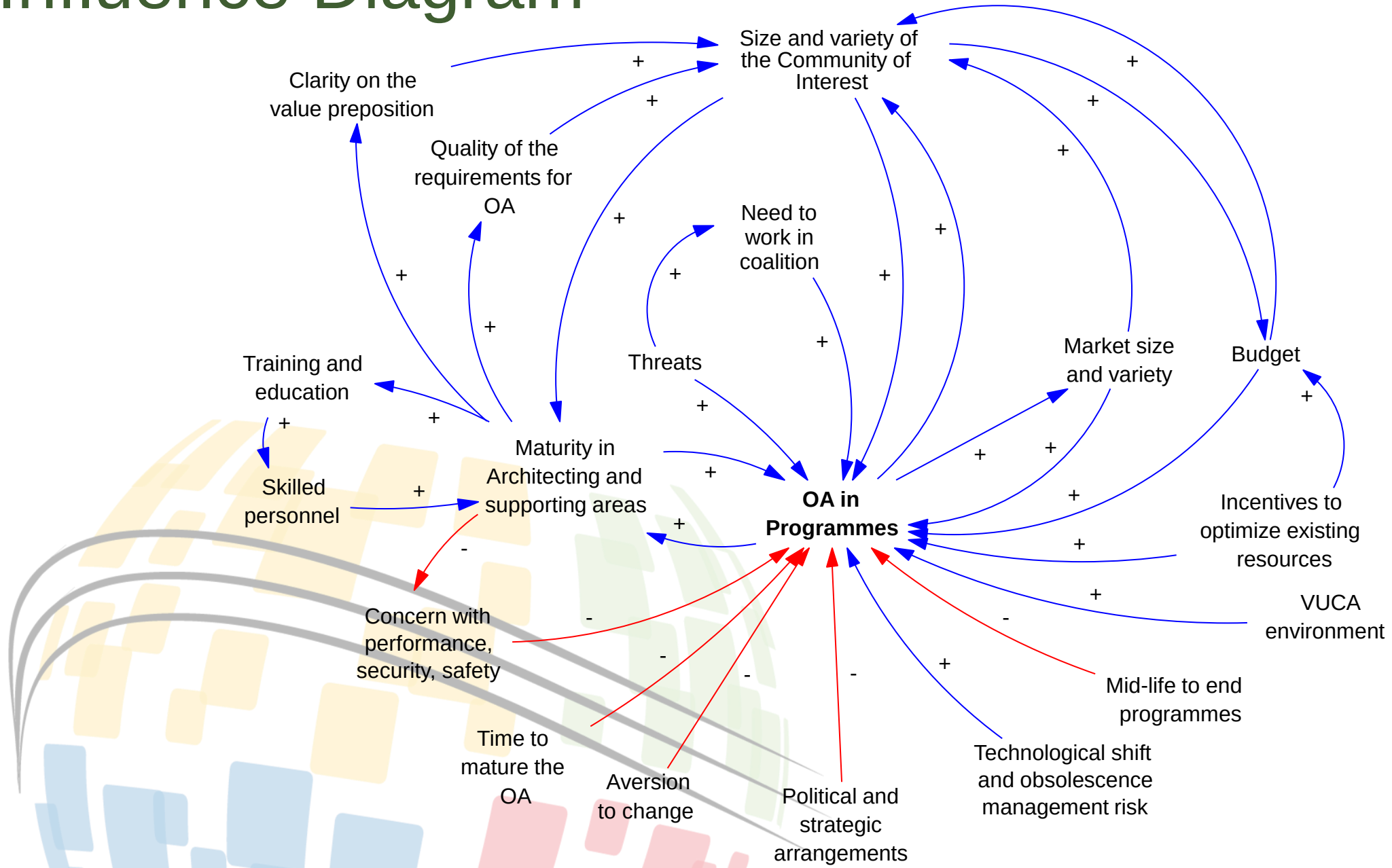
Influence Diagram



Influence Diagram



Influence Diagram



BATWOVEs - worldviews

Architectural control

- B Beneficiaries
- A Actors
- T Transformation
- W Worldview — The context that makes the transformation of the purposeful activity meaningful
- O Owner
- V Victim
- E Environment

BATWOVEs - worldviews

Architectural control

B Beneficiaries

A Actors

T Transformation

W Worldview

Guarantee more control over the architecture of the system can prevent the vendor lock and give more freedom to choose the most suitable solutions and potentially reduce costs throughout the lifecycle.

O Owner

V Victim

E Environment

BATWOVEs - worldviews

Architectural control

B Beneficiaries

A Actors

T Transformation

The transformation caused/intended by the purposeful activity

W Worldview

Guarantee more control over the architecture of the system can prevent the vendor lock and give more freedom to choose the most suitable solutions and potentially reduce costs throughout the lifecycle.

O Owner

V Victim

E Environment

BATWOVEs - worldviews

Architectural control

B Beneficiaries	
A Actors	
T Transformation	From closed systems to systems with key interfaces using the required open standards. From depending on the supplier to make changes in the systems (add components and capabilities) to being able to choose other options in the market or even in-house.
W Worldview	Guarantee more control over the architecture of the system can prevent the vendor lock and give more freedom to choose the most suitable solutions and potentially reduce costs throughout the lifecycle.
O Owner	
V Victim	
E Environment	

BATWOVEs - worldviews

Architectural control

B Beneficiaries	Who benefits from the transformation (customers)
A Actors	
T Transformation	From closed systems to systems with key interfaces using the required open standards. From depending on the supplier to make changes in the systems (add components and capabilities) to being able to choose other options in the market or even in-house.
W Worldview	Guarantee more control over the architecture of the system can prevent the vendor lock and give more freedom to choose the most suitable solutions and potentially reduce costs throughout the lifecycle.
O Owner	
V Victim	
E Environment	

BATWOVEs - worldviews

Architectural control

B Beneficiaries	Governments engaged in the OA approach
A Actors	
T Transformation	From closed systems to systems with key interfaces using the required open standards. From depending on the supplier to make changes in the systems (add components and capabilities) to being able to choose other options in the market or even in-house.
W Worldview	Guarantee more control over the architecture of the system can prevent the vendor lock and give more freedom to choose the most suitable solutions and potentially reduce costs throughout the lifecycle.
O Owner	
V Victim	
E Environment	

BATWOVEs - worldviews

Architectural control

B Beneficiaries	Governments engaged in the OA approach
A Actors	The agents of the change
T Transformation	From closed systems to systems with key interfaces using the required open standards. From depending on the supplier to make changes in the systems (add components and capabilities) to being able to choose other options in the market or even in-house.
W Worldview	Guarantee more control over the architecture of the system can prevent the vendor lock and give more freedom to choose the most suitable solutions and potentially reduce costs throughout the lifecycle.
O Owner	
V Victim	
E Environment	

BATWOVEs - worldviews

Architectural control

B Beneficiaries	Governments engaged in the OA approach
A Actors	Government (policy makers, technical requirements team, procurement team)
T Transformation	From closed systems to systems with key interfaces using the required open standards. From depending on the supplier to make changes in the systems (add components and capabilities) to being able to choose other options in the market or even in-house.
W Worldview	Guarantee more control over the architecture of the system can prevent the vendor lock and give more freedom to choose the most suitable solutions and potentially reduce costs throughout the lifecycle.
O Owner	
V Victim	
E Environment	

BATWOVEs - worldviews

Architectural control

B Beneficiaries	Governments engaged in the OA approach
A Actors	Government (policy makers, technical requirements team, procurement team)
T Transformation	From closed systems to systems with key interfaces using the required open standards. From depending on the supplier to make changes in the systems (add components and capabilities) to being able to choose other options in the market or even in-house.
W Worldview	Guarantee more control over the architecture of the system can prevent the vendor lock and give more freedom to choose the most suitable solutions and potentially reduce costs throughout the lifecycle.
O Owner	Agents that can stop or authorize the transformation
V Victim	
E Environment	

BATWOVEs - worldviews

Architectural control

B Beneficiaries	Governments engaged in the OA approach
A Actors	Government (policy makers, technical requirements team, procurement team)
T Transformation	From closed systems to systems with key interfaces using the required open standards. From depending on the supplier to make changes in the systems (add components and capabilities) to being able to choose other options in the market or even in-house.
W Worldview	Guarantee more control over the architecture of the system can prevent the vendor lock and give more freedom to choose the most suitable solutions and potentially reduce costs throughout the lifecycle.
O Owner	Government (by implementing policies and technical requirements). Current supplier, if they deny to share the data with other subsystems (in the case of a current strategic supplier)
V Victim	
E Environment	

BATWOVEs - worldviews

Architectural control

B Beneficiaries	Governments engaged in the OA approach
A Actors	Government (policy makers, technical requirements team, procurement team)
T Transformation	From closed systems to systems with key interfaces using the required open standards. From depending on the supplier to make changes in the systems (add components and capabilities) to being able to choose other options in the market or even in-house.
W Worldview	Guarantee more control over the architecture of the system can prevent the vendor lock and give more freedom to choose the most suitable solutions and potentially reduce costs throughout the lifecycle.
O Owner	Government (by implementing policies and technical requirements). Current supplier, if they deny to share the data with other subsystems (in the case of a current strategic supplier)
V Victim	Who is a victim of the transformation
E Environment	

BATWOVEs - worldviews

Architectural control

B Beneficiaries	Governments engaged in the OA approach
A Actors	Government (policy makers, technical requirements team, procurement team)
T Transformation	From closed systems to systems with key interfaces using the required open standards. From depending on the supplier to make changes in the systems (add components and capabilities) to being able to choose other options in the market or even in-house.
W Worldview	Guarantee more control over the architecture of the system can prevent the vendor lock and give more freedom to choose the most suitable solutions and potentially reduce costs throughout the lifecycle.
O Owner	Government (by implementing policies and technical requirements). Current supplier, if they deny to share the data with other subsystems (in the case of a current strategic supplier)
V Victim	Suppliers (Primes) that want to keep the dependency
E Environment	

BATWOVEs - worldviews

Architectural control

B Beneficiaries	Governments engaged in the OA approach
A Actors	Government (policy makers, technical requirements team, procurement team)
T Transformation	From closed systems to systems with key interfaces using the required open standards. From depending on the supplier to make changes in the systems (add components and capabilities) to being able to choose other options in the market or even in-house.
W Worldview	Guarantee more control over the architecture of the system can prevent the vendor lock and give more freedom to choose the most suitable solutions and potentially reduce costs throughout the lifecycle.
O Owner	Government (by implementing policies and technical requirements). Current supplier, if they deny to share the data with other subsystems (in the case of a current strategic supplier)
V Victim	Suppliers (Primes) that want to keep the dependency
E Environment	Elements of the environment that influence the transformation (enablers and barriers)

BATWOVEs - worldviews

Architectural control

B Beneficiaries	Governments engaged in the OA approach
A Actors	Government (policy makers, technical requirements team, procurement team)
T Transformation	From closed systems to systems with key interfaces using the required open standards. From depending on the supplier to make changes in the systems (add components and capabilities) to being able to choose other options in the market or even in-house.
W Worldview	Guarantee more control over the architecture of the system can prevent the vendor lock and give more freedom to choose the most suitable solutions and potentially reduce costs throughout the lifecycle.
O Owner	Government (by implementing policies and technical requirements). Current supplier, if they deny to share the data with other subsystems (in the case of a current strategic supplier)
V Victim	Suppliers (Primes) that want to keep the dependency
E Environment	Market size (If there are limited options available, it is likely that the government will remain with the original suppliers)

BATWOVEs - worldviews

Fostering collaboration and innovation, and improving the marketplace

B Beneficiaries

A Actors

T Transformation

W Worldview

By fostering collaboration, a broader variety of solutions and combined capabilities are enabled, improving the marketplace and potentially leading to innovation.

O Owner

V Victim

E Environment

BATWOVEs - worldviews

Fostering collaboration and innovation, and improving the marketplace

B Beneficiaries

A Actors

T Transformation

From monolithic solutions provided by a single supplier to modular and open solutions where multiple companies can participate and contribute with different expertise, including SME.

W Worldview

By fostering collaboration, a broader variety of solutions and combined capabilities are enabled, improving the marketplace and potentially leading to innovation.

O Owner

V Victim

E Environment

BATWOVEs - worldviews

Fostering collaboration and innovation, and improving the marketplace

B Beneficiaries	Governments, potential suppliers, SME, Primes that are engaged in the approach
A Actors	
T Transformation	From monolithic solutions provided by a single supplier to modular and open solutions where multiple companies can participate and contribute with different expertise, including SME.
W Worldview	By fostering collaboration, a broader variety of solutions and combined capabilities are enabled, improving the marketplace and potentially leading to innovation.
O Owner	
V Victim	
E Environment	

BATWOVEs - worldviews

Fostering collaboration and innovation, and improving the marketplace

B Beneficiaries	Governments, potential suppliers, SME, Primes that are engaged in the approach
A Actors	Governments, potential suppliers, SME, Primes that are engaged in the approach
T Transformation	From monolithic solutions provided by a single supplier to modular and open solutions where multiple companies can participate and contribute with different expertise, including SME.
W Worldview	By fostering collaboration, a broader variety of solutions and combined capabilities are enabled, improving the marketplace and potentially leading to innovation.
O Owner	
V Victim	
E Environment	

BATWOVEs - worldviews

Fostering collaboration and innovation, and improving the marketplace

B Beneficiaries	Governments, potential suppliers, SME, Primes that are engaged in the approach
A Actors	Governments, potential suppliers, SME, Primes that are engaged in the approach
T Transformation	From monolithic solutions provided by a single supplier to modular and open solutions where multiple companies can participate and contribute with different expertise, including SME.
W Worldview	By fostering collaboration, a broader variety of solutions and combined capabilities are enabled, improving the marketplace and potentially leading to innovation.
O Owner	Governments (responsible for creating the environment) and suppliers (engaging in the environment)
V Victim	
E Environment	

BATWOVEs - worldviews

Fostering collaboration and innovation, and improving the marketplace

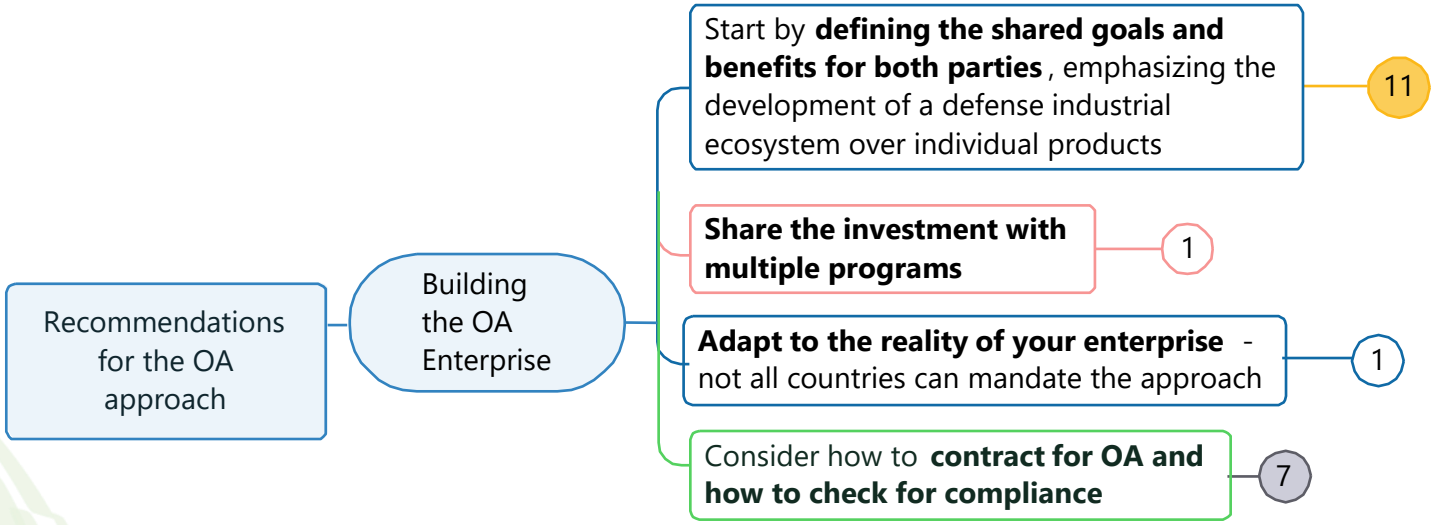
B Beneficiaries	Governments, potential suppliers, SME, Primes that are engaged in the approach
A Actors	Governments, potential suppliers, SME, Primes that are engaged in the approach
T Transformation	From monolithic solutions provided by a single supplier to modular and open solutions where multiple companies can participate and contribute with different expertise, including SME.
W Worldview	By fostering collaboration, a broader variety of solutions and combined capabilities are enabled, improving the marketplace and potentially leading to innovation.
O Owner	Governments (responsible for creating the environment) and suppliers (engaging in the environment)
V Victim	Suppliers (Primes) that want to keep the dependency
E Environment	

BATWOVEs - worldviews

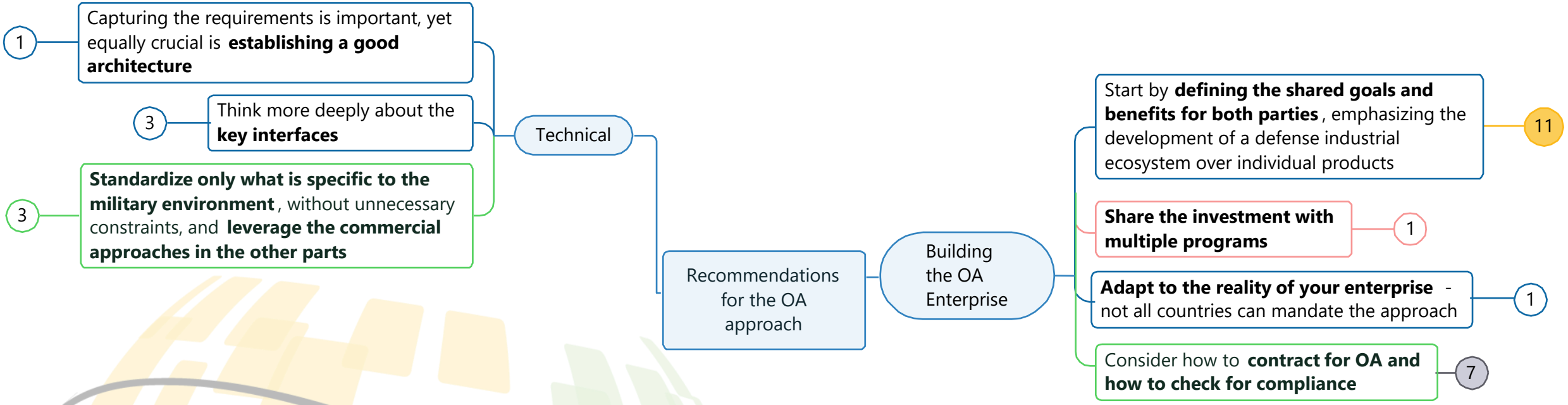
Fostering collaboration and innovation, and improving the marketplace

B Beneficiaries	Governments, potential suppliers, SME, Primes that are engaged in the approach
A Actors	Governments, potential suppliers, SME, Primes that are engaged in the approach
T Transformation	From monolithic solutions provided by a single supplier to modular and open solutions where multiple companies can participate and contribute with different expertise, including SME.
W Worldview	By fostering collaboration, a broader variety of solutions and combined capabilities are enabled, improving the marketplace and potentially leading to innovation.
O Owner	Governments (responsible for creating the environment) and suppliers (engaging in the environment)
V Victim	Suppliers (Primes) that want to keep the dependency
E Environment	Procurement policies to facilitate the engagement with SME (less rigorous process, requiring certificates), strategic influence of the primes, market size

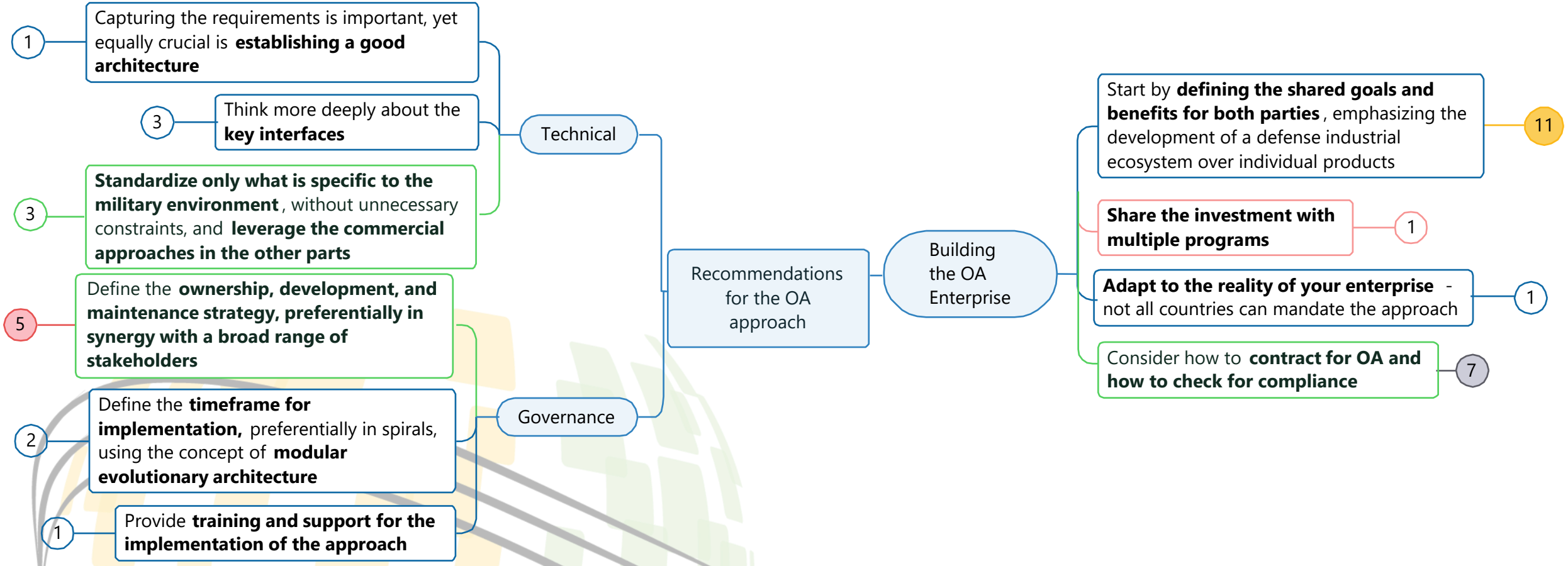
Recommendations



Recommendations



Recommendations



Conclusion

Conclusion

We demonstrated how a combination of systems thinking tools can help to build an holistic understanding of the OA approach, particularly for those who are beginning to recognize problems that can be addressed through this approach.

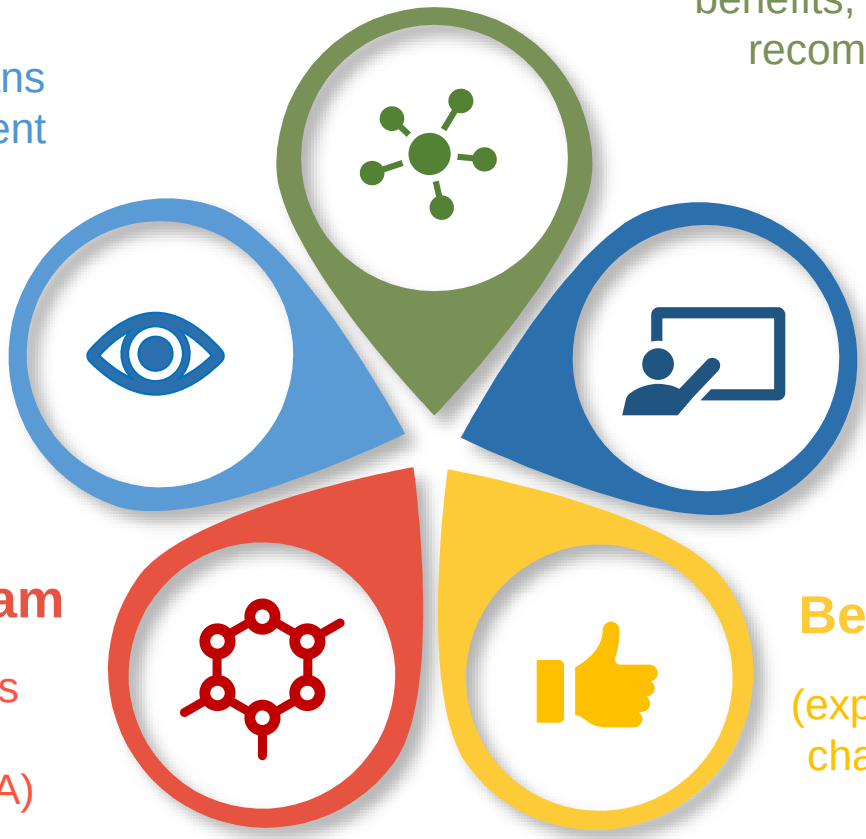
CATWOE

(What the OA means according to different perspectives)

"WHY", "WHO", and overview of the "HOW" for each perspective

Thematic Maps

(categorizing definitions, benefits, challenges and recommendations)



Systemigram

(diagrammatic explanation of OA)

"WHAT"

Influence diagram

(explain some factors that influence the implementation of OA)

Influence the "HOW"

Benefit Map

(explain the benefit chain that the OA can bring)

"WHY"

Questions, comments?

r.lampaca-vieira-radoman@lboro.ac.uk

34th Annual INCOSE international symposium

hybrid event

Dublin, Ireland
July 2 - 6, 2024

www.incose.org/symp2024
#INCOSEIS