Modeling **3Rs** of Digital Business Ecosystems:

Roles, Responsibilities, and Resilience

Prof. Jelena Zdravkovic

Department of Computer & Systems Sciences (DSV)

Stockholms universitet

What is DBE?

And why do we need it?

Stockholms universitet

Ecosystems in nature:
Mississippi river

The Mississippi River is an internationally important river ecosystem and an ecological lifeline for North America people since they first settled along the river.

The river and its 30-million-acre floodplain provide vital habitat for more than 870 species of fish and wildlife, including dozens of rare species.

It is the largest pre-colonial settlement in North America thrived along the banks near present day St. Louis, Illinois, bringing economic and cultural wealth to people since they first settled along the river.

The Mississippi watershed covers 41 percent of the continental United States and provides drinking water to more than 50 municipalities.


The focus of the ecosystem is **sustainable survival and balance** –
long-term health of its diverse actors.

From ecosystems in nature to business

Digital Business Ecosystems (DBE) are the business networks of organisations, individuals, and technologies characterized with:

digital environment

platform, services, data, smart devices.

heterogeneity

different types of actors: companies, etc.

symbiosis

relationships between actors: responsibilities, trust, etc

co-evolution

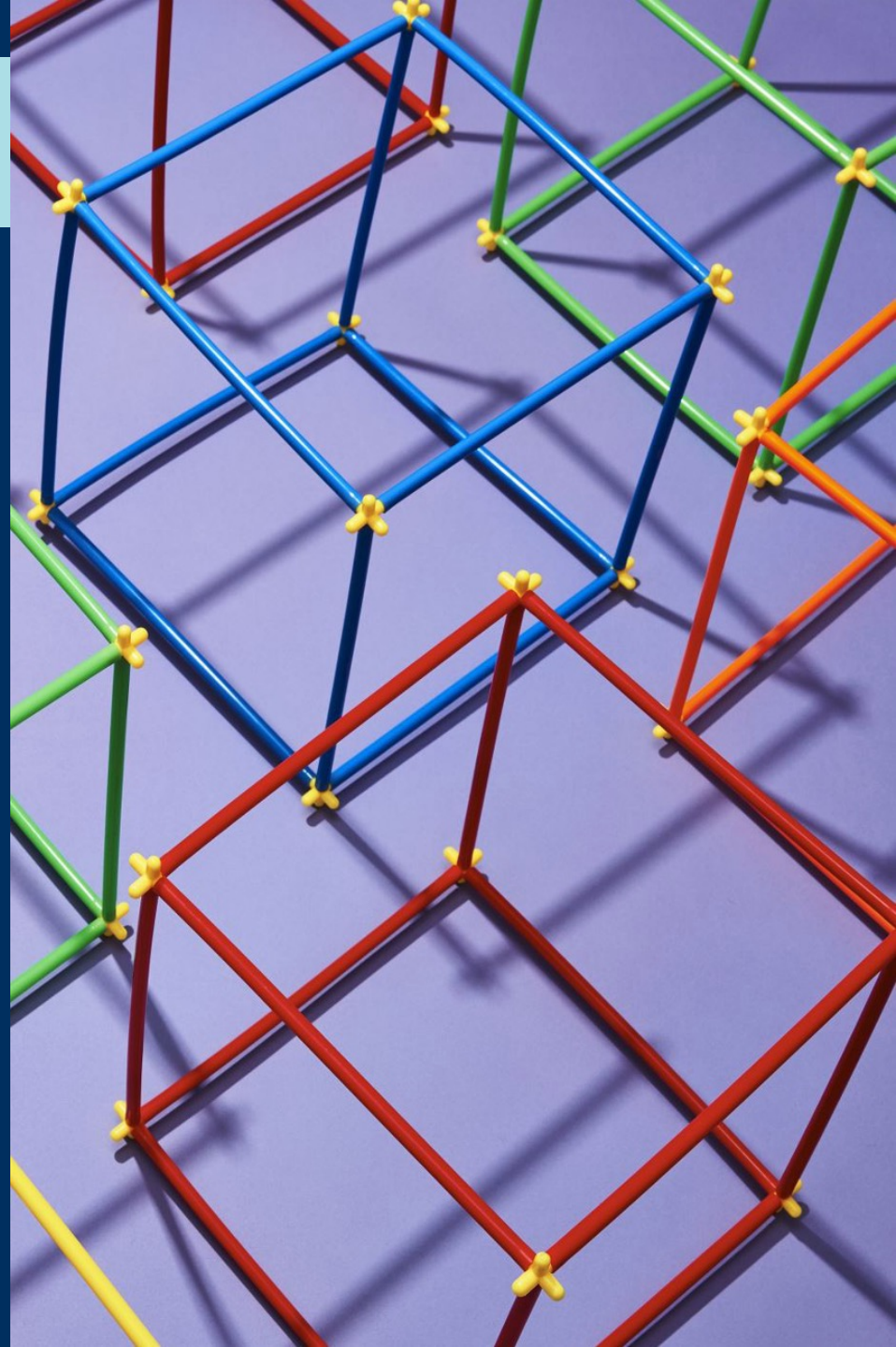
collective transformation of actors: innovation, etc.

self-organization

system's independence and adaptation

Moore, J.F.: Predators and prey: a new ecology of competition. Harvard Business Review 71, 75–86 (1993)

Senyo, P.K., Liu, K., Effah, J.: Digital business ecosystem: Literature review and a framework for future research. International journal of Information Management 47, 52–64 (2019)



From ecosystems in nature to business

DBE are distinguished by their **complex and evolving nature due to dynamic involvement of diverse actors** each having unique interests, responsibilities, and requirements while continuously interacting through a wide range of digital assets. These characteristics boost the magnitude of the system's tasks, leading to various challenges and difficulties in efficient management.

Healthy ecosystems allow all participants to thrive, despite asymmetries.

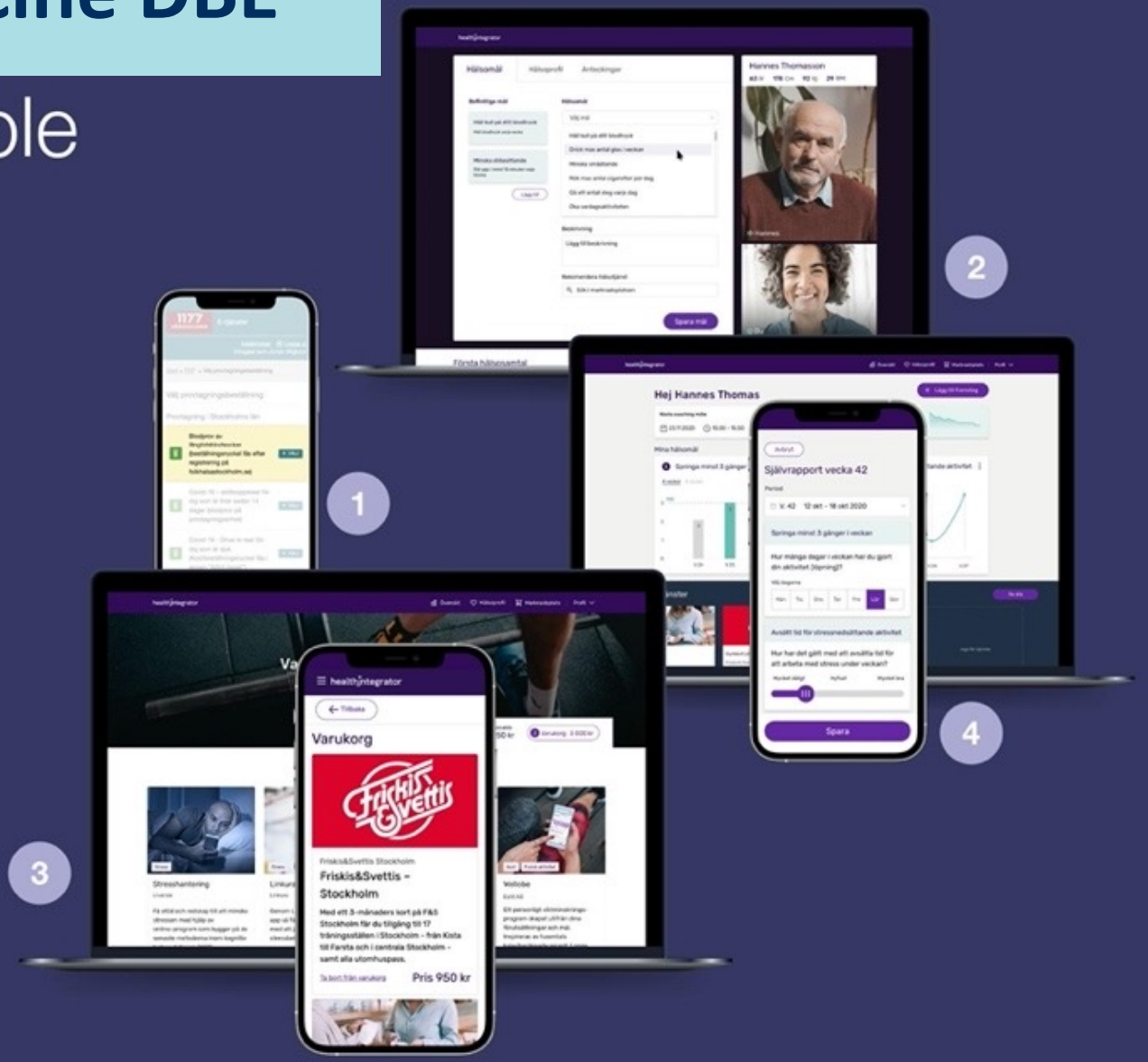
If one actor dominates excessively (e.g., controlling all standards, data, or profits), others may abandon the ecosystem—or regulators may step in.

In DBE, trust, openness, and shared governance are critical to long-term success. Overly closed or extractive ecosystems often stagnate.

DBEs are about survival (resilience) and creating a balanced structure where innovation and participation are attractive for all actors.

Health Integrator: Digital Vaccine DBE

Ecosystem for healthy people



Digital Vaccine DBE

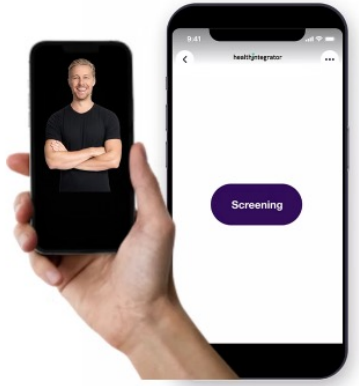
The aim of the Digital Vaccine DBE is to shift the focus in healthcare from reactive to proactive by providing tailored care based on personal needs and supporting healthier lifestyle habits and to reduce the financial burden of healthcare on the public healthcare system.

Actors are diverse - digital and physical health service providers, health product suppliers, different types of individual end users, health coaches, a data analysing institute, investors, and the support from the public sector – Stockholm Region.

DThe Digital Vaccine DBE has successfully been applied to pre-diabetic patients, people who are at risk for type 2 diabetes which is a condition costing the Stockholm Region about 2.5 billion Swedish kronor annually.

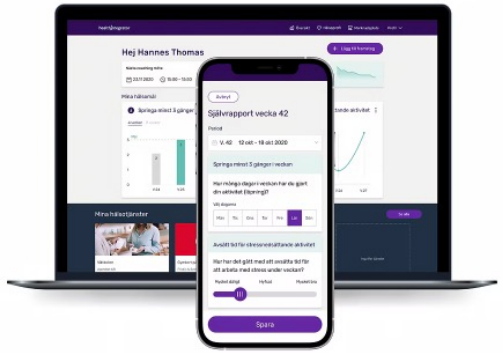
Health status

Fill out health forms and take a blood test for full screening and mapping of your health status. This will give you insights into your health that you and your health coach can use as a starting point.



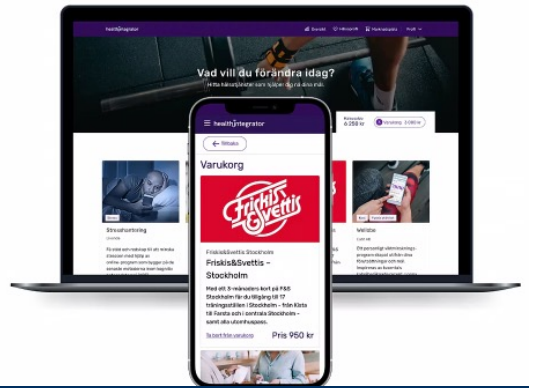
Meet your coach

You and your health coach set up a goal plan adapted to your individual needs. You fill in your goals and can follow your progress on your personal health profile.

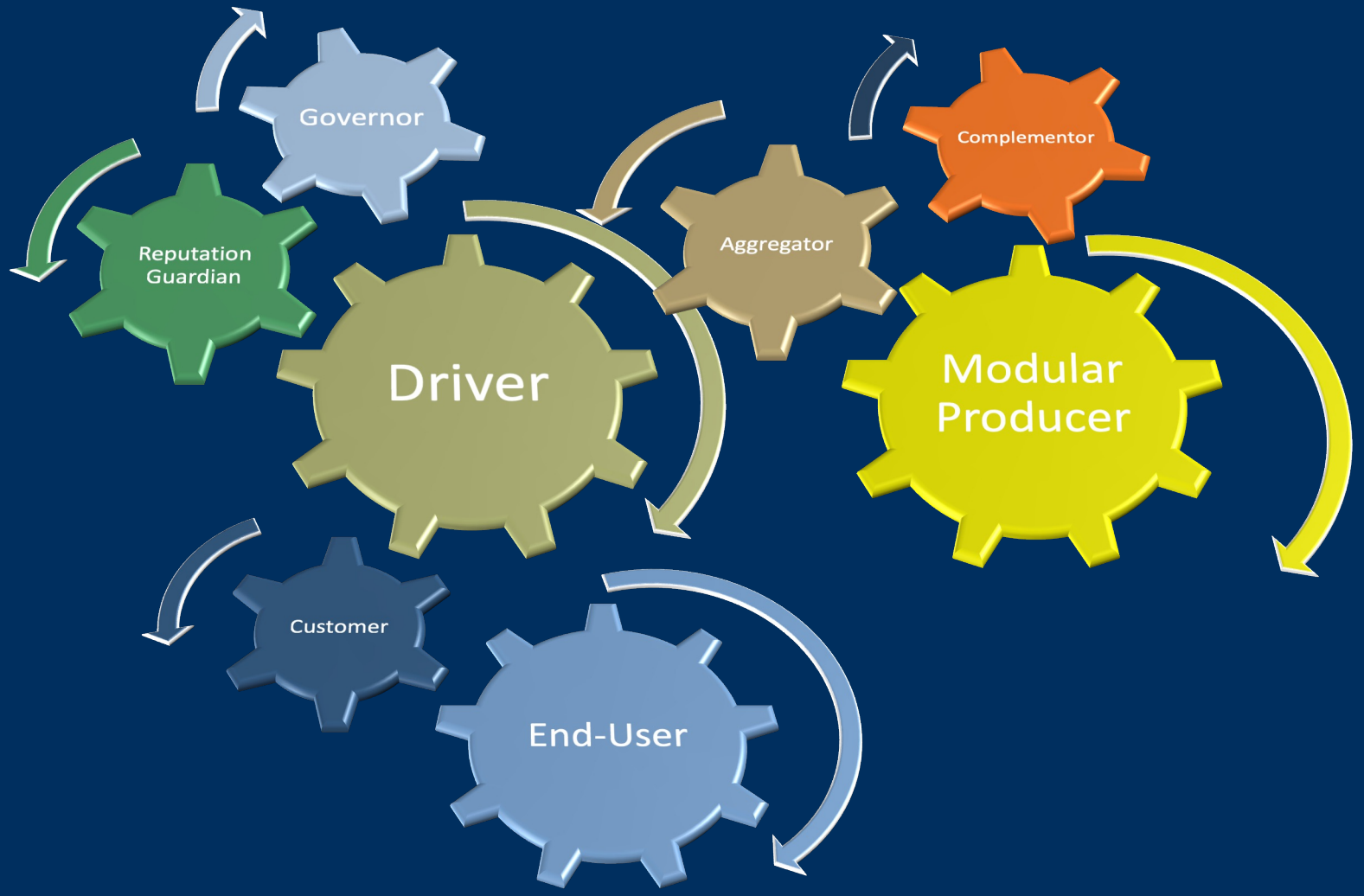


Marketplace

Here you can buy health related services and products to beneficial prices. All services are handpicked to meet the needs of our clients and our coaches are there to guide you to the right choices to make you reach your goals.



DBE Roles and Responsibilities



Why modelling DBE roles?

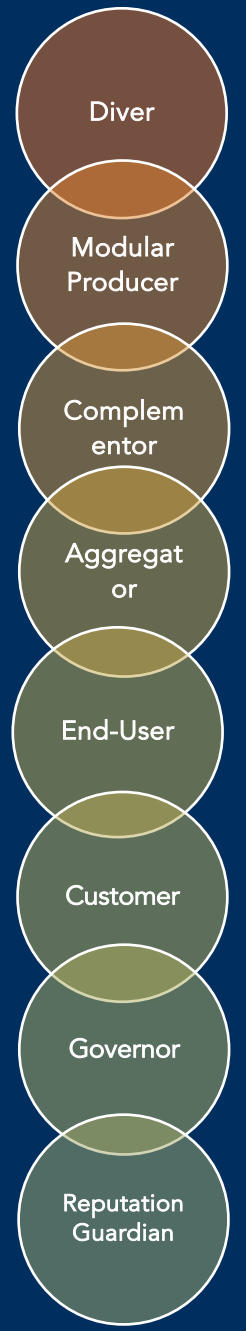
It is about distinguishing roles of DBE actors because of their different, complementing and cohesive responsibilities.

DBE roles* are of archetypal kind and essential for the ecosystem's design as they define the DBE-specific responsibilities of the actors involved and provide underlying knowledge for the capabilities needed in a DBE*.

DBE roles and their corresponding responsibilities are highly significant for the ecosystem's design and stable operations at the run-time, in terms of their resilience.

The size and maturity of a DBE can affect the dynamics of the actors taking on or being given a DBE role.

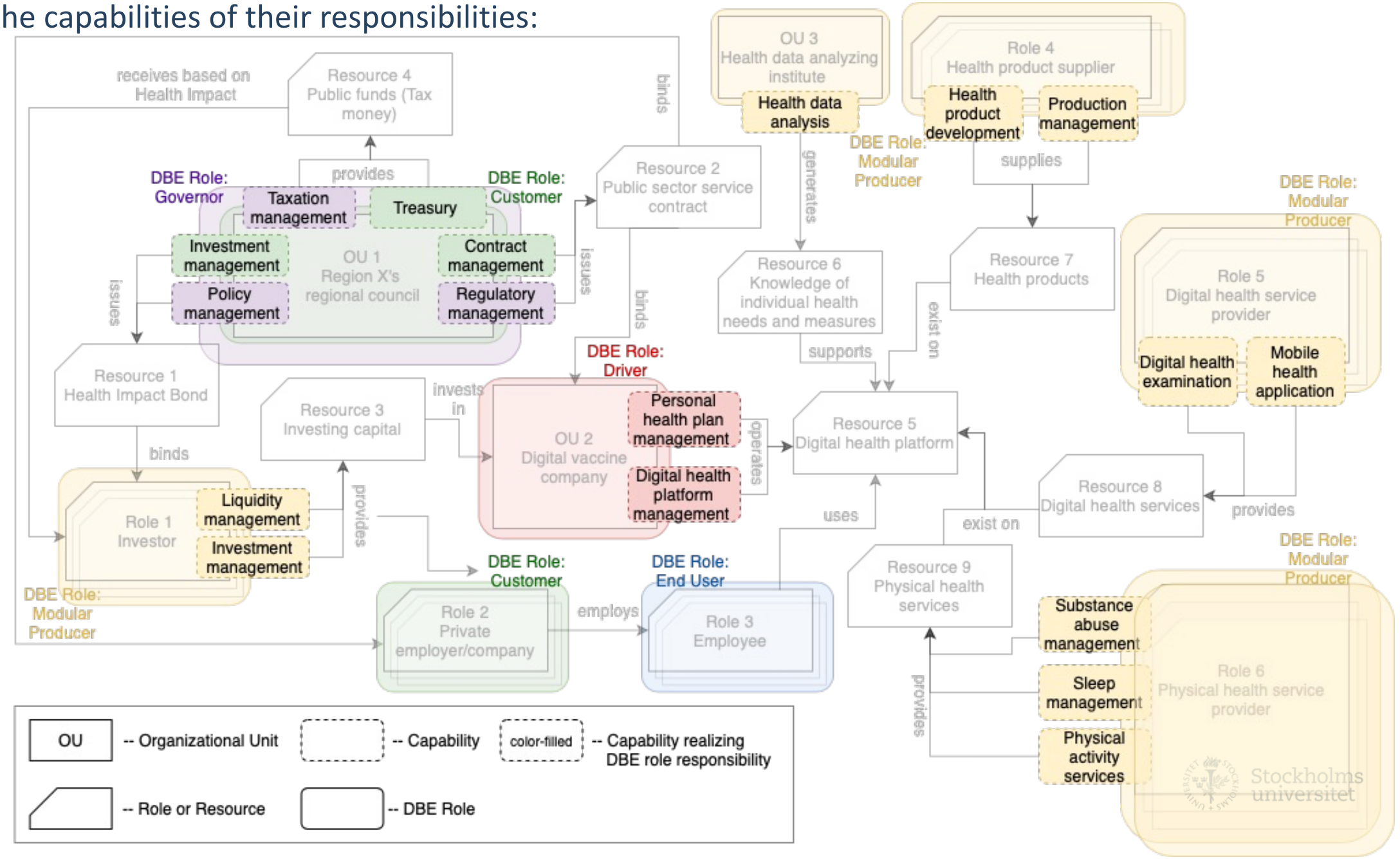
Tsai, C.H., Zdravkovic, J.: A Survey of Roles and Responsibilities in Digital Business Ecosystems. (PoEM Conference2020)



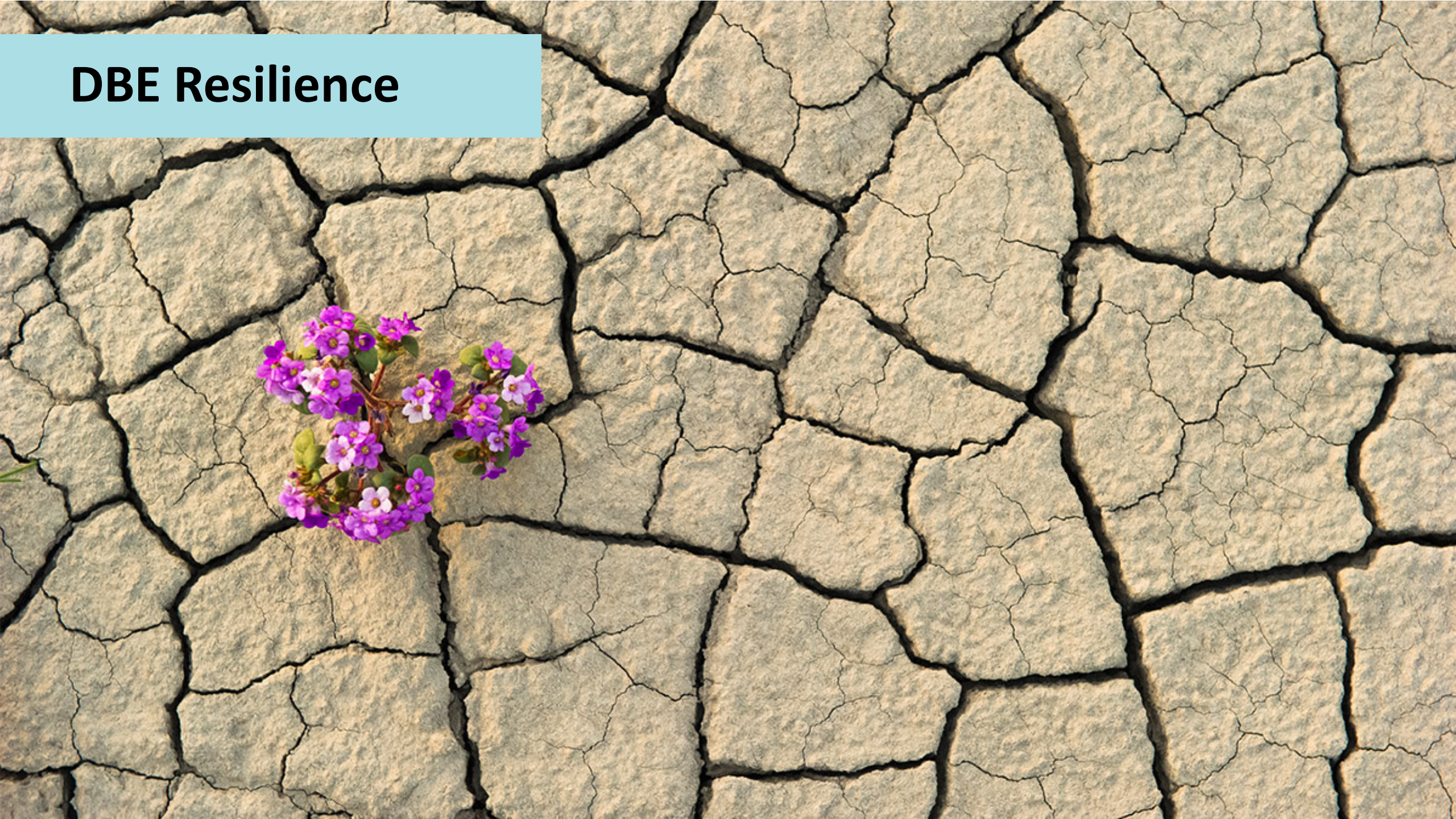
DBE ROLE	RESPONSIBILITY
Driver	sets up a common vision for all actors in a DBE; provides and manages a digital platform; optimizes entry barriers for joining a DBE; acquires and retain actors within a DBE; provides end-products and services to customers and end-users; collects and raise end users' events and feedback
Modular Producer	provides resources within a DBE; resources can be products, services, or knowledge, created by the producer's capabilities.
Complementor	using its capabilities, provides resources that complement the core resources within a DBE, with some added-value features.
Aggregator	collects and combines capabilities and resources within a DBE into end-products or services, created by Modular Producer and Complementor, for offering to Customers and End-Users.
Customer	buys end-products and services offered in a DBE.
End-User	consumes end-products and services offered in a DBE; provides information about its events and feedback to other DBE roles.
Governor	oversees all the actors within a DBE by defining normative artifacts, such as decisions, policies, guidelines, and ethics.
Reputation Guardian	surveys and assesses all DBE actors' trustworthiness, reliability, solvency, and worthiness.

Digital Vaccine

DBE roles and the capabilities of their responsibilities:



DBE Resilience



Resilience – what and how?

It is DBE's ability to remain or recover to a stable state to continuously operate during and after threats, opportunities, or changes , ensuring this survival and supporting performance.

DBE Resilience* relies on four aspects that should be achieved:

Diversity: variety of DBE actors, resources, and capabilities

Efficiency: production and utilization of resources by capabilities

Adaptability: transparency and flexibility to evolve

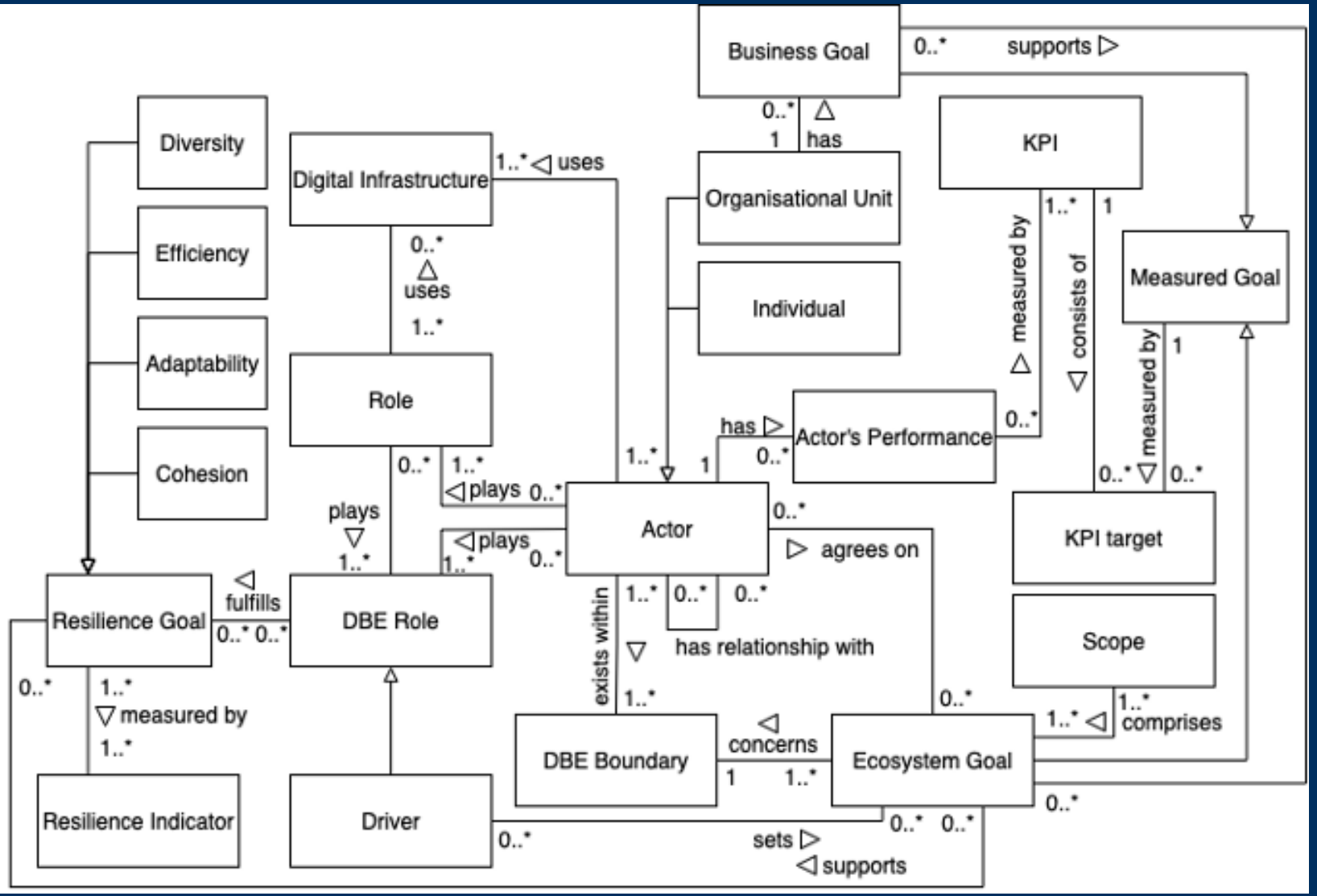
Cohesion: alignment among DBE actors and their capabilities toward a DBE's mission

These aspects can be modeled as **the resilience goals for DBE**.

Resilience indicators are used to calculate the fulfillment of resilience goals.

** **Grabis, J., Tsai, C.H., Zdravkovic, J., Stirna, J**.: Endurant Ecosystems: Model-Based Assessment of Resilience of Digital Business Ecosystems (BIR 2022)*

Resilience analysis, indicators



Resilience indicator Irg shows whether a resilience goal is supported by the ecosystem goals and highlights the resilience goals having the largest relative support (it is calculated by dividing the number of *support relationships* from ecosystem goals to each of the resilience goals by the total nr. of support relationships.)

DBE role fulfilment index Irr shows whether the DBE roles are supported by generic roles and the amount.

Resilience goal-role mutual supporting indicator Irr,rg identifies the relationships among the DBE roles and the resilience goals. (the count of paths leading from DBE roles to resilience goals - unique paths leading from a DBE role to a resilience goal via roles and ecosystem goals.)

”Boatlife” DBE

Boatlife (Skippo) DBE

Skippo AB is a Swedish company aiming to simplify boat life in the Nordics through its DBE.

By aggregating assets in the DBE and integrating various data layers in sea charts, Skippo has created and now provides innovative boating products and services related to boat navigation:

User-friendly navigation tools

Smart auto routing with estimated arrival time

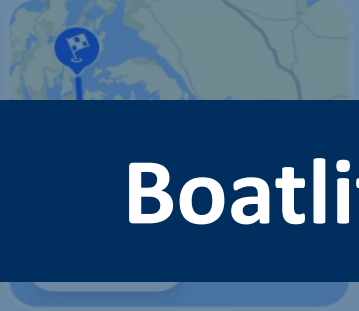
Find destinations and services

Wind and weather on the chart

Sheltered harbour regardless of wind

Find help, AIS boats

....



Smart autorutting med

Skyddad hamn oavsett vind

Hitta den bästa hamnen med filter för vindriktning, ankringstyp och faciliteter.

Användarvänliga navigationsverktyg

Kompass, avståndsmätning och andra verktyg för enkel och säker navigation.

Sök vänner och AIS-båtar

Följ dina vänner på sjön och håll koll på assistansbåtar, tankers och andra båtar.

Vind & väder på sjökortet

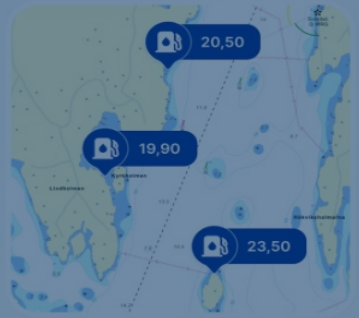
Optimera din färd med väder och [illegible] direkt på sjökortet.

Hitta färdmål och tjänster

Sluta leta! Vi visar dig till närmsta hamn, sjömack, sjökrog eller septiktömningsstation.

Ta dig fram i grundare vatten

Fler detaljer på sjökortet och utmarkerade förtöjningsplatser med specialsjökort från Hydrographica.



Billigaste bränslet på sjön

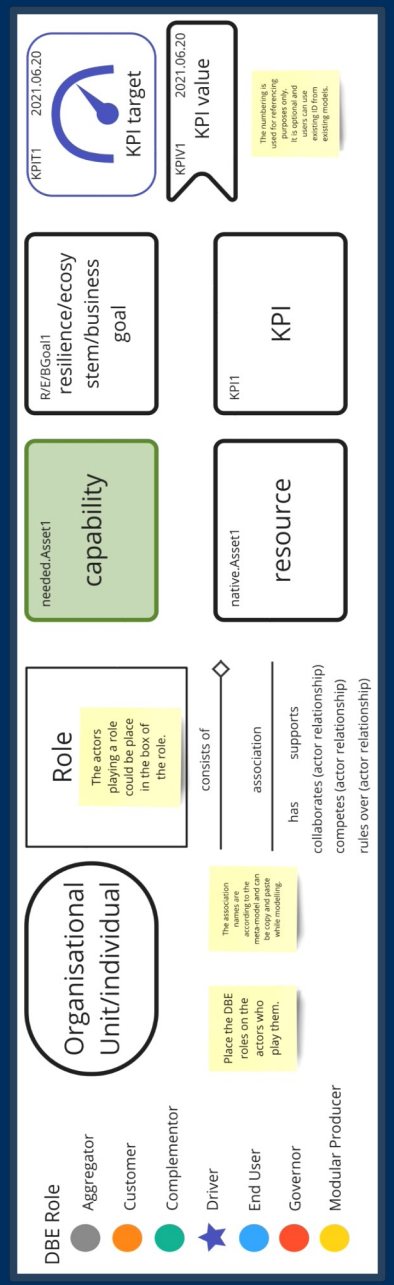
Den närmsta macken är inte alltid den billigaste. Jämför bränslepriser direkt på sjökortet.

Skippo DBE – data driven

Skippo’s main challenges are integrating and packaging data into sea charts, sea charts data caching, and identifying erroneous data in sea charts. Skippo also needs to collaborate with a number of other business actors to address these challenges.

For example: harbour guidance, aerial maps, and detailed special sea charts for shallow waters—integrated from different actors as contributors to better support end users while navigating open waters.

- Boat and home harbour
- Weather
- POIs (eg restaurants, fuel stations)
- Saved routes and tracks
- Boat locations
- Views on website
- Environmental
- App usage
- Harbours



native.Capability1.0
detailed maps development and maintenance

needed.Capability7.0
detailed sea charts development and maintenance

needed.Capability2.0
basic harbour info development and maintenance

needed.Capability3.0
mobile app core development

needed.Capability4.0
sea chart packaging (alt. technique)

needed.Capability5.0
sea chart packaging (current technique)

native.Capability16.0
boat location and information managing

Role - Boat information provider
Complementor
ECC

KPIValue1.0 2024.02.26
-

KPI1
discrepancy (error and error addressing)

KPIValue1.0 2024.02.26
-

Role - private sea chart maker
Complementor
Hydro

Role - nordic sailing platform owner
Driver
Aggregator
Skippo
Modular Producer

Role - sea chart packaging company
Modular Producer
Eniro

native.Capability13.0
map tiling service (sea charts)

native.Capability6.0
sea chart packaging technology (current technique)

native.Capability11.0

needed.Capability8.0
Provide and maintain additional transient data

Role - weather information provider
Complementor
MET.no

native.Capability17.0
wind & weather information managing

needed.Capability6.0
mobile app development

Role - mobile app development company
Modular Producer
Company Z

native.Capability7.0
mobile app development

native.Capability2
detailed harb... info develop... and maintena...

native.Capability3
essential map... development maintenance

native.Capability8
essential maps development and maintenance

native.Capability9.0
essential maps development and maintenance

native.Capability10.0
essential maps development and maintenance

needed.Capability1.0
essential maps development and maintenance

Maritime agency DK
Governor

Modular Producer
Maritime agency FI
Governor

Modular Producer
Maritime agency NO
Governor

End User
Citizen xxx
Customer

native.Capability14.0
populating detailed information

KPIValue1.0 2024.02.26
-

KPI2
user interaction (saved places, added info, shared info with other users)

native.Resource1.0
content delivery servers

Role - cloud server provider
Modular Producer
AWS

needed.Resource1.0
cloud servers

needed.Capability9.0
data catching

KPI5
user consumption

KPIValue1.0 2024.02.26
-

native.Capability15.0
map tiles caching

Role - environmental organisation
Modular Producer
SUs Östersjöcentrum

Modular Producer
Svenska Båtunionen

native.Capability18.0
environmental information managing

native.Capability19.0
environmental information managing

DBE Role
Aggregator
Customer
Complementor
Driver
End User
Governor
Modular Producer

Organisational Unit/individual

Role
The actors playing a role could be place in the box of the role.

consists of

association

has supports
collaborates (actor relationship)
competes (actor relationship)
rules over (actor relationship)

Place the DBE roles on the actors who play them.

The association names are according to the meta-model and can be copy and paste while modelling.

needed.Asset1
capability

R/E/BGoal1
resilience/ecosystem/business goal

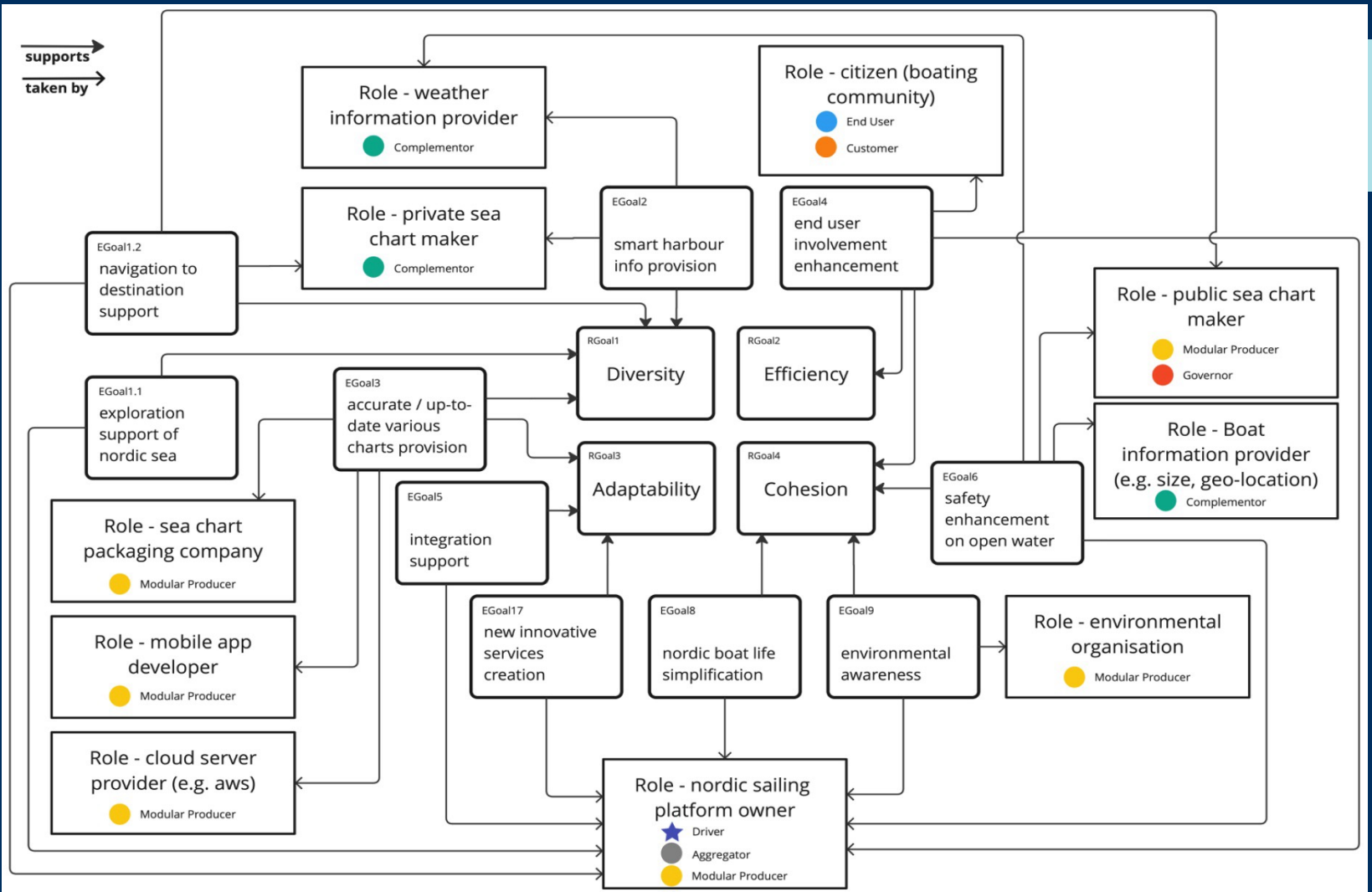
KPIT1 2021.06.20
KPI target

native.Asset1
resource

KPI1
KPI

KPIV1 2021.06.20
KPI value

The numbering is used for referencing purposes only. It is optional and users can use existing ID from existing models.



Resilience goal	Driver	Aggregator	Modular Producer	Comple-mentor	Cus-tomer	End User	Gover-nor	Reputat. Guardian	$I_{(rr,rg)}$
Diversity	2	2	6	3	0	0	1	0	0.318
Efficiency	1	1	1	0	1	1	0	0	0.114
Adaptability	2	2	5	0	0	0	0	0	0.205
Cohesion	3	3	5	2	1	1	1	0	0.363

Resilience Analysis

Resilience indicator Irg shows whether a resilience goal is supported by the ecosystem goals and highlights the resilience goals having the largest relative support (it is calculated by dividing the number of *support relationships* from ecosystem goals to each of the resilience goals by the total nr. of support relationships.)

DBE role fulfilment index Irr shows whether the DBE roles are supported by generic roles and the amount.

Resilience goal-role mutual supporting indicator Irr,rg identifies the relationships among the DBE roles and the resilience goals. (the count of paths leading from DBE roles to resilience goals - unique paths leading from a DBE role to a resilience goal via roles and ecosystem goals.)

A summary and future work

Digital Business Ecosystems are an important type of networked business because of their main characteristics and aspects.

Due to the network complexity and advanced aims, DBE need a method for modeling, design, and runtime management including analysis.

This presentation has taken the focus to the essential concepts (“3R”) that need to be modelled and related in order to facilitate a development method.

One of our incoming works aims to elaborate the inclusion of AI-based data management approaches for DBE optimization, prediction, and even other.

Contact: jelenaz@dsv.su.se

Thank you!