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## Ecosystem carryover in a digital ecosphere and market explosion

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**Abstract:** The area of concern is digital ecosystems in a digital ecosphere. The research question is: What is the ecosystem carryover potential of a digital ecosphere? This is framed with Adner's theory of business ecosystem carryover and ecosystem disruption as well as earlier conceptualization of a digital ecosphere by the author. The method is conceptual development anchored in a mapping of the Danish Digital Ecosphere and an illustrative single case study of a digital startup. The contribution is a conceptualization of ecosystem carryover in a digital ecosphere and an illumination of the following potential market explosion. The Danish Digital Ecosphere includes about 2000 digital startups and more than 27.500 employees.

**Keywords:** Digital ecosphere; digital ecosystems; digital startups; business ecosystems; ecosystem carryover; ecosystem disruption; market explosion.

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### 1 Digital ecosystems in a digital ecosphere

The term ecosphere is adopted from biology where e.g., the earth is an ecosphere including multiple co-existing ecosystems. Following this, a digital ecosphere is constituted of multiple digital ecosystems (Rosenstand 2021a).

Digital ecosystems are typically used to describe the digital platform industry leveraging AI, big data, and IoT. On a general level, the characteristics of ecosystems are described as decentralized architecture: "No single point of failure or control; ...should be dependent upon any single instance or actor; equal opportunities for access for all; [and (ed.)] scalability and robustness" (Nachira et al. 2007). I argue, this philosophy of no single point of failure or control also can be applied to a digital ecosphere. As an example, the Danish Digital Ecosphere was started with Digital Hub Denmark (n.d.) – a private-public partnership – as secretary. However, the funding behind this initiative is stopped, and it is discussed how one of the digital ecosystems in Table 1 can be the operator for the ecosphere's secretariat when applying for funding. An operator role can move; thus, the secretariat is not a single point of failure.

**Table 1** Danish digital ecosystems and xTech in the Danish Digital Ecosphere.

Dig. ecosystem	Tech industry	Ecosystem organization
FinTech	Financial tech	Copenhagen Fintech
HealthTech	Health tech	Health Tech Hub Copenhagen
Robotics	Automation tech	Odense Robotics
CreaTech	Creative tech (e.g., games/VR)	Vision Denmark
PropTech	Property and construction tech	PropTech Denmark
AgriTech	Agri and food tech	Agro Food Park
EdTech	Education tech	EdTech Denmark
xTech	Other than above	No organization

Source: Rosenstand (2021a).

Regional mapping of digital ecosystems is not easy in practice. It is hard to get aligned quality data because they are owned by multiple data-driven ecosystem organizations, that highly value control of the data. In The Danish Digital Ecosphere, the digital ecosystems are in control through a steering committee of the consortium, where they e.g., align principles for data protocols and policies for mapping approximately 2000 digital startups designed for fast growth with more than 27.500 employees (Digital Denmark, 2023, p. 16), where less than half of the digital startups are in xTech (c.f. Table 1). This work is outlined in Table 2 and can be accessed online at Danish Starups in Numbers (n.d.). The method for this is outlined in an earlier publication by the author (Rosenstand 2021b).

Since 2019 I have worked with the acceleration of experience across the digital ecosystems in Table 1. My role is network manager of the Danish Digital Ecosphere, orchestrating the ecosphere's governance (Rosenstand 2021b). The core of the governance is the steering committee with ecosystems' CEOs and me as network manager. The CEOs are a special type of innovation managers, as they continually innovate their ecosystems.

**Table 2** Marked verticals in The Danish Digital Ecosphere.

Tech vertical	Submarket vertical	
FinTech	Accounting & payroll	InsureTech
	Business solutions & platforms	Money transfers
	Corporate infrastructure	P2P lending
	Cryptocurrencies	Payment process. & networks
	Data analytics provide	Pension & WealthTech
	Digital banking	RegTech & Security
	Direct lending	
HealthTech	Children & youth health	Healthy behavior & wellness
	Diagnostics & diag. support	Mental health
	Disease management	Platforms & logistics
	Healthy aging	Women's health
Robotics	Manufacturing	Security & inspection
	Logistics & transport	Construction & building
	Agriculture & food	Energy
	Health and welfare	Environment
	Defense	
CreaTech	Advertisement	Interactive
	Games	
PropTech	Construction and design	Other
	Investment and finance	Smart city and mobility
	Market	Space-as-a-service
	Operation and management	
AgriTech	ConsumerTech	Network platform
	Feeding technology	Precision technology
	Field monitoring	Robot technology
	Food delivery	Software solutions
	Food safety	Storage monitoring
	Food surplus & waste managm.	Trading platform
	Kitchen & restaurant tech	Vertical farming
	Livestock monitoring	
EdTech	Management systems	Game & play
	Advanced tech	STEAM
	Digital content & Onl. learning	Workforce & skills
	Assesment, mentoring & credentials	Language & sub. spec. learning
xTech	[36 subverticals. E.g. ComTech, SoundTech, and SportTech ]	

Source: Danish Startups in Numbers (n.d.).

## 2 Ecosystem carryover

The ecosystem's CEOs have a diplomatic mindset. Conventional competitive strategy is rooted in a military mindset of "... captured ground, direct adversary, and zero-sum games... ecosystem strategy is rooted in the diplomatic mindset of coexistence, coalition building, and finding shared strategic interests" (Adner 2021, p. 69). Following this, the ecosystem CEOs are open to exchanging experience and coordinated learning. Together we have been looking for additional systematic ways of creating value across digital ecosystems.

According to Adner, ecosystems are constituted as value systems, which can be reconfigured for success by separating, combining, relocating, adding, and subtracting ecosystem elements (Adner 2012). Ecosystem elements in Adner's perspective are activities supported by a business, business partners, and other key actors such as customers. To this end, it can be argued that Adner has a focus on what we can term business ecosystems, as their function is creating businesses with competitive value propositions.

The steering committee of The Danish Digital Ecosphere visited startups in Agro Food Park (n.d.) in November 2022. One of these companies is the initial AgriTech startup Cordulus (n.d.) which is described below. Together with the startup's CEO we imagined how the company could carry over value to other markets. Generalizing this thought experiment caused the following research question:

*What is the ecosystem carryover potential of a digital ecosphere?*

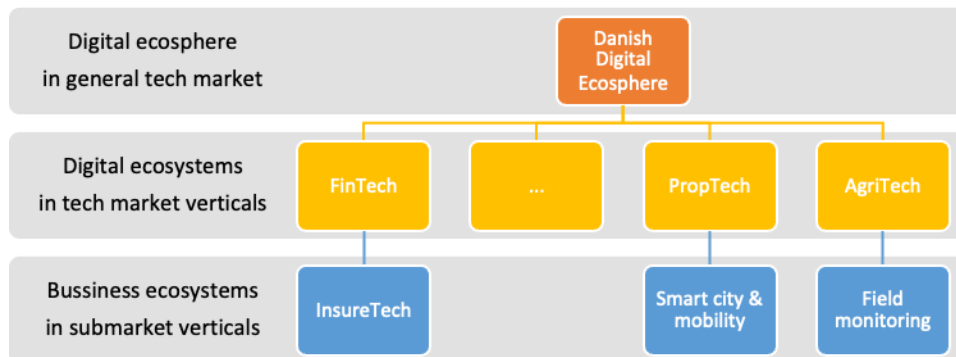
A digital ecosystem is in my experience always constructed as a bottom-up emergent phenomenon. None of the digital ecosystems in Table 1 is initially top-down constructed. They emerge when a critical mass of digital startups and domain-affiliated key actors find a common synergic interest in organizing themselves as an ecosystem, and an innovation manager takes the leader- and ownership of this process. In my experience, the threshold for a critical mass is around 40 digital startups.

Digital ecosystems as in Table 1 are second-order ecosystems to Adner's business ecosystems, as they provide a habitat, where startups and other key actors of the digital ecosystems efficiently can separate, combine, relocate, add, and subtract business ecosystem elements. Shortly, digital ecosystems provide ecosystem efficiency for forming business ecosystems.

Figure 1 illustrates the conceptual hierarchy between a digital ecosphere in the tech market, digital ecosystems in tech market verticals, and business ecosystems in submarket verticals. The example in Figure 1 is subtracted from Table 2.

A business ecosystem can be constructed top-down; however, it is constructed with partners (not alone), and not all at once, and the construction is based on three principles (Adner 2012, 2021):

1. Establish a minimum viable business ecosystem.
2. Follow a path of staged expansion.
3. Deploy business ecosystem carryover.



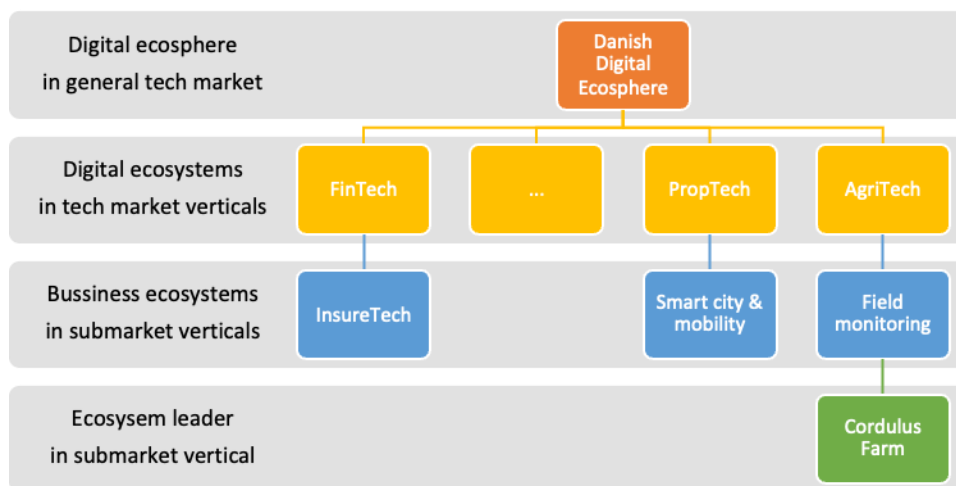
**Figure 1** Conceptual hierarchy of digital ecosphere and ecosystem types. The figure is not an organigram.

A digital ecosystem provides an efficient environment for supporting Adner's first principle, establishing a minimum viable business ecosystem. This should bring evidence of new or increased value creation to all the partners of the business ecosystem. If you are a digital startup and part of an efficient digital ecosystem, you will have easy and fast access to potential ecosystem elements such as suppliers, platforms, technologies, talents, credit facilities, and customers.

The second principle, following a path of staged expansion, is also more efficient within a digital ecosystem, because there is access to knowledge, experience, skills, and attitudes for how to onboard new partners that can bring additional value and/or bring on the next partner.

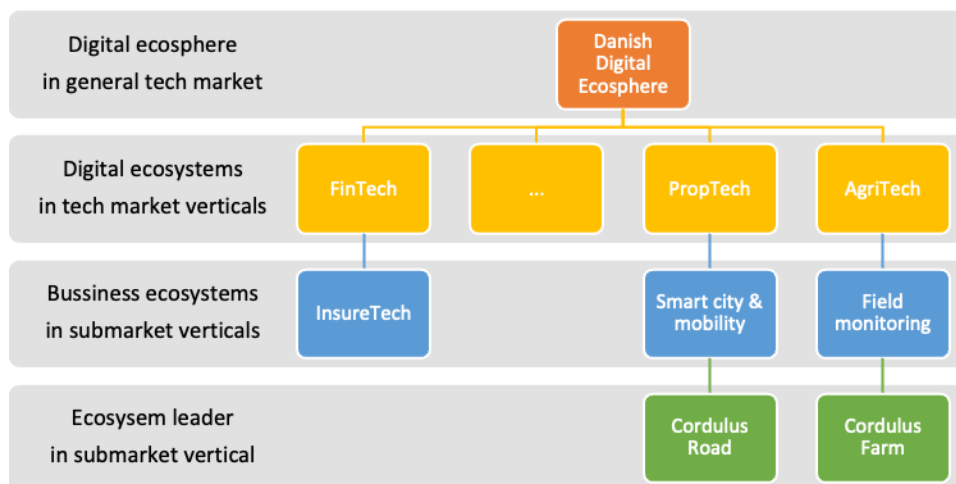
The third principle, business ecosystem carryover, regards the area of concern for this paper, as it "... highlights the potential for leveraging [business ecosystem (ed.)] elements that were developed in the construction of one ecosystem to enable the construction of a second ecosystem" (Adner, 2021, p. 75). This also supports Adner's newer concept of ecosystem disruption, which "... is not about mere substitution [of business ecosystem elements (ed.)], but about redefinition of value" (Adner, 2021). Adner's primary perspective is on incumbent companies'; the perspective of this research-in-progress is on entrants in the form of digital startups leveraging ecosystem disruption opportunities.

This main point is that ecosystem disruption opportunities can be orchestrated in a digital ecosphere, which is illuminated with an example. The digital startup Cordulus was founded in 2015. The point of departure was the AgriTech/Field Monitoring submarket vertical powering farming decisions with reliable weather information. The data source is Cordulus farm stations with weather sensors, which transform weather data into actionable information for farmers, who e.g., can avoid chemical runoff, improve spraying, and achieve higher yields (Cordulus Farm, n.d.). The business ecosystem, with Cordulus as the ecosystem leader, includes elements such as farmers, hyper-local weather forecasts, weather stations-as-a-service, support, dealers, and suppliers. This is illustrated with the green box "Cordulus Farm" in Figure 2.



**Figure 2** Cordulus as ecosystem leader in submarket vertical.

Today Cordulus has deployed 2.500 active weather stations in 11 countries providing valuable data. As a new official strategy from 2023, Cordulus has decided to provide and harvest weather data in multiple industries, and thus create value across industries with what they term hyper-local weather forecasts. As part of this strategy, Cordulus changed its name from Field Sense. Following this strategy, they have entered the PropTech/Smart city & mobility submarket with road weather stations for winter maintenance (Cordulus Road, n.d.). This example of a business ecosystem carryover across digital ecosystems is illustrated in Figure 3.



**Figure 3** Example of business ecosystem carryover across digital ecosystems.

A short thematic interview following up on the ecosphere’s steering committee meeting with Cordulus in Agro Food Park was conducted with Cordulus’ CEO about challenges and opportunities for business ecosystem carryover in the Danish Digital Ecosphere.

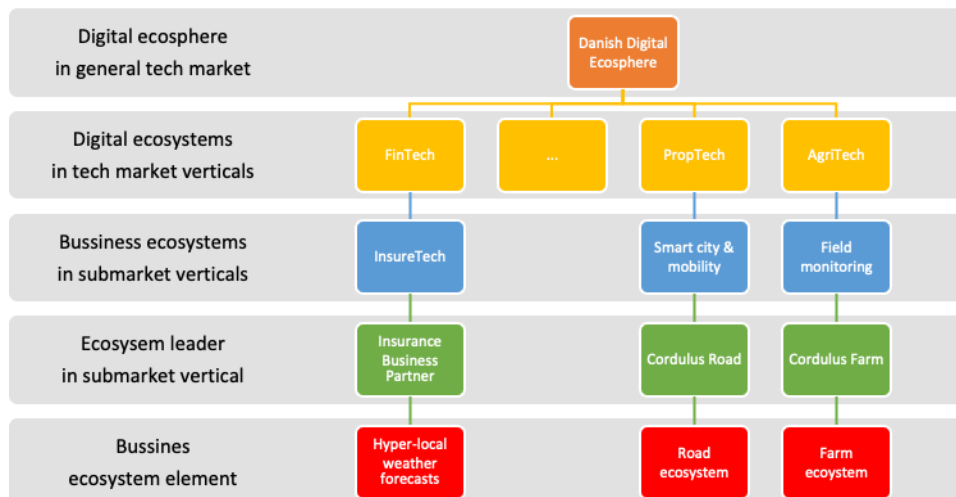
Business ecosystem carryover from a sub-vertical in one digital ecosystem into another digital ecosystem is a challenge because you enter a new business domain, where you both must understand the domain and its rationales. Moreover, you must start over with Adner’s three phases of business ecosystem construction in the challenging role of being an ecosystem leader in a foreign domain. Therefore, Cordulus’ CEO argues that he from now on prefers carryover into other existing business ecosystems with another ecosystem leader who really possesses the relevant domain expertise. During the interview, the CEO provided some examples of this type of carryover opportunity; illustrated in Table 3.

**Table 3** Examples of Cordulus’ carryover opportunities. Cordulus’ existing market presence in PropTech and AgriTech is excluded.

Carryover to	Business case
FinTech	Back-testing on historical data for agriculture insurances
HealthTech	Safety in outdoor work according to weather conditions
Robotics	Optimal deployment of agricultural robots and drones
CreaTech	Include real-time weather data in flight simulator game
EdTech	Include locations based real-time weather data in geography lessons

Source: Qualitative interview with Cordulus’ CEO John Smedegaard.

Moving to a new market domain and identifying business ecosystem partners in an unknown territory is an uncertain affair, and it might be too much of a threshold for market expansion. To this end, the digital ecosphere can become handy, as it can support what I term core business ecosystem element carryover from one digital ecosystem’s submarket to another digital ecosystem’s submarket. This is exemplified in Figure 4 with carryover to the submarket vertical FinTech/InsureTech with an insurance business partner ‘Back-testing on historical data for agriculture insurances’ listed in Table 3.

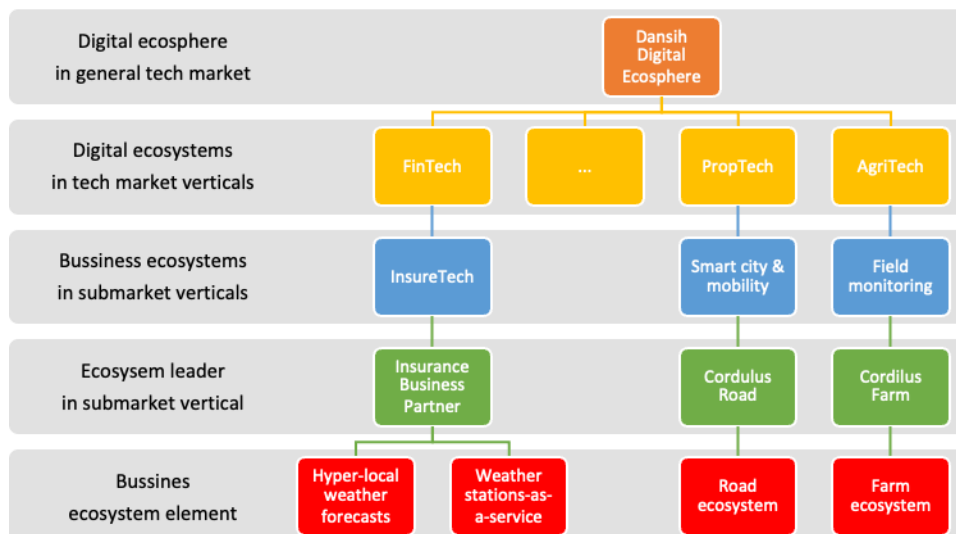


**Figure 4** Example of business ecosystem element carryover.



All of Cordulus’ business ecosystem elements in the original ArgiTech/Field monitoring submarket are termed Farm ecosystem in Figure 4. Simplified with the Road ecosystem in Figure 4; the business ecosystem carryover to the PropTech/Smart city & mobility submarket required a new business unit and value proposition with a copy of the Farm ecosystem, where farm managers are substituted with road managers. However, the core business ecosystem element carryover is attractive and far less risky than the exemplified business ecosystem carryover to PropTech; because they only have to carryover a core business ecosystem element of their business ecosystem; hyper-local weather forecasts. Moreover, this support Cordulus in focusing on its core expertise strengthening its deep growth and competitive position, and thus not risking surface growth with too “... many products for many customers. [Making them (ed.)] vulnerable to disrupters” (Christensen et.al., 2016, p. 185).

More core business ecosystem elements carryovers could be added to the example, e.g., it might bring value to an insurance company to deploy weather stations-as-a-service, increasing Cordulus’ data source, as illustrated in Figure 5.



**Figure 5** Example of carryover of two business ecosystem elements.

From the insurance partner’s perspective, they are probably already an ecosystem leader with domain expertise and a customer base and can ‘simply’ expand its existing business ecosystem with Adner’s second principle. To the insurance partner, this would be an ecosystem disruption opportunity in their competitive area, with e.g., a better value proposition to customers in the agricultural industry.

The case study illustrates mutual market access, where FinTech and AgriTech can get mutual access to each other’s submarket verticals without digital disruption of each other, and at the same time, they would strengthen their guard against disruption. The example could also include the PropTech vertical, but the point would be the same. To this end, each carryover opportunity in Table 3 represents a new Tech market, where these markets in return can gain access to Agri- and PropTech’s markets.

### 3 Implications & further research

In a digital ecosphere, digital data, like Cordulus' weather data, is the core value behind carryover. Because all digital startups have some sort of data processing as their core business ecosystem element, these elements can potentially be used for what I term a plug-and-play carryover strategy.

A digital startup being part of a digital ecosphere, and not 'just' a single digital ecosystem can be a competitive advance because the market potential explodes. With seven ecosystems as in The Danish Digital Ecosphere, the potential market explosion is a factor  $6+5+4+3+2+1 = 21$ , which is the number of connections in a heptagon multiplied by 2, equal to 42. Multiplied with 2 because the market connections between digital ecosystems are potentially mutual. Put into a formula the carryover potential of a digital ecosphere is equal to  $e*(e-1)$ , where e is the number of digital ecosystems in the ecosphere.

Table 4 shows the theoretical ecosystem carryover potential of a digital ecosphere. A lot of practical conditions will, of course, impact the practical market potential; but everything else being equal, Table 4 illuminates, why systematic work with business ecosystem element carryover within a digital ecosphere across digital ecosystems can have explosive competitive implications for the market size accessible to digital startups. This work requires mapping digital startups in market and submarket verticals as outlined in Table 2 plus a focus on the digital startup's core business ecosystem elements.

**Table 4** Number of ecosystems in an ecosphere and potential market explosion.

#Ecosystem	Fomular	Potential market explosion factor	Polygon
1	$1 * (1-1)$	0	Monogon (dot)
2	$2 * (2-1)$	2	Diagon (line)
3	$3 * (3-1)$	6	Triangle
4	$4 * (4-1)$	12	Tetragon
5	$5 * (5-1)$	20	Pentagon
6	$6 * (6-1)$	30	Hexagon
7	$7 * (7-1)$	42	Heptagon
8	$8 * (8-1)$	56	Octagon
9	$9 * (9-1)$	72	Nonagon
10	$10 * (10-1)$	90	Decagon

Source: Ecosystem carryover potential formula.

A research question following this research-in-progress is: How to optimize digital ecosphere efficiency by orchestrating core business ecosystem element carryover?

Following this, one important consideration is, that adding digital ecosystems to a digital ecosphere implicates a potential market explosion; however, it is not a simple task to orchestrate the following explosion in complexity. This complexity versus potential market size must be balanced.

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CEO Michael Ambjørn & (former) Hub Director Jakob Stoumann, PropTech Denmark  
CEO Anne-Marie Hansen, Agro Food Park  
CEO Esben Trier, EdTech Denmark  
CEO Nicolaj Christensen & Head of Communications Jakob Frier, Digital Hub Denmark

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