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## Conference Paper

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# An analysis of the structure, actors and interrelationships producing Luxembourg's ICT ecosystem

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## ***Abstract***

There is substantial analytical value in examining the structure of the ICT sector by deploying the notion of ecosystems, which can help to reveal new insights into the role of key actors and their interrelationships. This paper aims to provide a thorough analysis of Luxembourg's ICT ecosystem, which until now has received limited research attention in the international arena. Key actors comprising and producing the ecosystem are identified and analysed according to a layered model devised by Martin Fransman (2001). The primary output is a detailed mapping of the Luxembourgish ICT ecosystem. The findings indicate that Luxembourg's ICT ecosystem consists of nearly 2000 different actors of which the majority are micro and small software development companies. Nevertheless, some large telecommunications network operators in which the government holds a substantial stake appear to perform a decisive role from an economic perspective. More recently, the role of different types of service providers, particularly subcontractors to financial actors, has grown in prominence, with trends suggesting that this is subject to continue. The research has also identified some limitations to the Fransman model and suggests several extensions as well as a stakeholder analysis to gain a deeper understanding of the issues at stake. It is intended to be of use and interest to policy-makers, managers, and decision makers or actors operating within and across different layers of ICT ecosystems.

***Key words:*** Luxembourg, ICT, ecosystems, Fransman.

***JEL codes:*** L86, L88

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## 1. Introduction

Information and communication technology (ICT) is a crucial sector of the Luxembourgish economy. According to Eurostat, in 2013, the sector contributed approximately 7% of GVA (Service des Médias et des Communications, 2013).<sup>1</sup> In international terms, particularly compared with other European countries, this is very high. The sector includes about 2000 companies, employing circa 5% of the active working population (European Commission, 2015). In part this is due to a number of internationally renowned actors (such as, for example, Amazon, eBay, iTunes, KABAM, Microsoft, PayPal, Rakuten, RealNetworks, Skype and Vodafone) that have chosen Luxembourg as their base to access the European market and in part due to the high demand of ICT services in Luxembourg's well developed financial industry (Luxembourg for Business, 2013a).

Luxembourg's ICT sector is also one of the most innovative sectors in Luxembourg, with over 20% of "persistent innovators" (Statec, 2014). According to the Global Information Technology Report, Luxembourg offers an "ideal environment to support new technology innovations" (World Economic Forum, 2015). In 2015 the country ranked ninth worldwide when it came to leveraging ICTs for social and economic impact<sup>2</sup>, the importance of the ICT sector for the Luxembourg government is also highlighted by its ranking as fourth and fifth, respectively in terms of government success in ICT promotion and the importance of ICT to the government's vision (Luxembourg for Finance, 2015).

For several years, the government has been promoting Luxembourg as a key location for ICT with the aim of attracting new activities, establishing new businesses and encouraging private investment (Luxembourg for Business, 2013b). Efforts have also been made to develop ICT research and development, with a focus on security, reliability and the trustworthiness of ICT systems and services (Funck, 2013).

In order to provide policy-makers with a comprehensive analytical foundation, scholars often propose to examine the ICT sector as an business ecosystem, which consists of a number of interconnected organisations and actors (Kim, Lee, & Han, 2010). Fransman (2010 p. xxi) suggests that "every country has an ICT ecosystem, although the players, their symbiotic interactions and the institutions in which they are embedded are different. The task of national policy-makers and regulators in all countries is to understand how their ICT ecosystem works, its strengths and weaknesses, and what might be done to improve its contribution". Thus, it is the purpose of this paper to shine an investigative light on Luxembourg's ICT ecosystem, which until now has received limited research attention in the international arena.

Although there exists a wide range of studies examining ICT ecosystems in different countries (Elixmann, Schwab, & Stappen, 2003; Hulsink, 1999; Sutherland, 2013; Symeou, 2009), none of these provides an overview of the ICT sector in Luxembourg. Consequently, this paper will rectify this shortcoming and focus on the structure of the ICT ecosystem in Luxembourg. In order to do this, the actors in the ecosystem are identified and mapped against Fransman's four-layer model and the main characteristics of the ICT ecosystem in Luxembourg identified using the different secondary statistical data sources that are available. More specifically, the paper will describe and explain the structure and

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<sup>1</sup> This paper builds on the definition of the ICT sector and the underlying classification suggested in OECD (2011). This definition of ICT includes IT goods and services, information content as well as telecommunications goods and services including their manufacturing and production.

<sup>2</sup> in the Networked Readiness Index (World Economic Forum)

main characteristics of Luxembourg's ICT ecosystem, with a particular focus on economic characteristics, and analyse the roles and interrelationships of different actors and organisations.

It is expected that this study will lead to a better understanding of the innovative forces that shape the ecosystem. As one of the few, perhaps only study, analyses of ICT ecosystems in small countries, this study is important and unique. Moreover, it is intended to be of use and interest to policy-makers, managers, and decision makers or actors within the different layers of the ICT ecosystem in Luxembourg and beyond.

The remainder of this paper is structured as follows. Section 2 briefly presents models used to analyse and evaluate the ICT sector and argues the case for the application of the layered model proposed by Fransman. Attention then shifts to the main outcomes of the study. In section 3, the main actors are identified and their activities within the different layers detailed with a focus on layer 3 (service layer) highlighted. Section 4 presents an overview of the ICT ecosystem in Luxembourg, identifies limitations of the Fransman model. It suggests complementing the layer model with a stakeholder analysis approach and suggests avenues for future research. Finally section 5 provides conclusions and shows avenues for further research.

## 2. From Value Chains to Ecosystems

There is a wide range of models available to make sense of the structure of the ICT industry. Many of these apply or develop Porter's value chain to the ICT (Maitland et al., 2002) or have extended this model to become a so-called value networks (Li & Whalley, 2002, Peppard & Rylander, 2006, Rafique et al., 2012). This idea, which has also been taken up and developed further by, for example, Hallikas et al. (2008) or Oestreicher et al (2012). Similarly, Porter's model of competitive forces (Porter, 1990) has been adapted to the ICT environment (Karagiannopoulos, Georgopoulos, & Nikolopoulos, 2005). Along the same lines, Briglauer (2004) has developed a generic reference model in order to assess competition in different communications markets from a regulatory perspective. Additional work has been done in characterizing the ICT ecosystem as a network (Garcia & Vicente, 2012), as well as looking into how such networks are built and maintained (Partanen & Möller, 2011).

These models are essentially linear ones, but today's business environment is complex and dynamic and presents multiple relationships where companies are interacting to deliver their products and services. As a consequence, the ICT sector is increasingly characterized as a socio-technological (eco)system facing asymmetric and delayed feedback structures, which lead to turbulent changes (instability/existence of multiple equilibria) and high uncertainty.

Koslowski, Longstaff, Vidal & Grob (2012) see the ICT sector as an ecosystem with many heterogeneous organizations that are woven together into a web of links and responds interactively to forces in the environment. The understanding of the dynamics of one domain in isolation from others is impossible and demands both a systemic and evolutionary view to be adopted. The ecosystem approach to describe markets and hierarchies has first been mentioned by Moore (1993). According to Kim, Lee, & Han (2010) an ecosystem can be defined as an economic community involving many companies working together to gain comparative advantages as a result of their symbiotic relationships. The authors also argue that ecosystems permit companies to create new value that no company could achieve alone. Likewise, they identified symbiotic relationships that can provide some benefits for related parties such as consumers and partners. For a more recent discussion about using the ecosystems model to analyse the ICT sector see, for example, Basole, Park, & Barnett (2015). The

authors have used advanced mapping techniques to quantify and visualise the competitive dynamics shaping the ICT ecosystem.

Hence, it is important to examine ICT ecosystems in order to understand the co-evolution between technological and economic as well as regulatory forces and developments to provide a comprehensive basis for policy makers, For the purpose of understanding the structure of the ICT ecosystem in Luxembourg, we propose here to use a layer model described by Fransman (Fransman, 2001, 2002a, 2002b, 2004, 2006, 2014).

When looking at the supply side of the ICT ecosystem, four types of actors are identified:

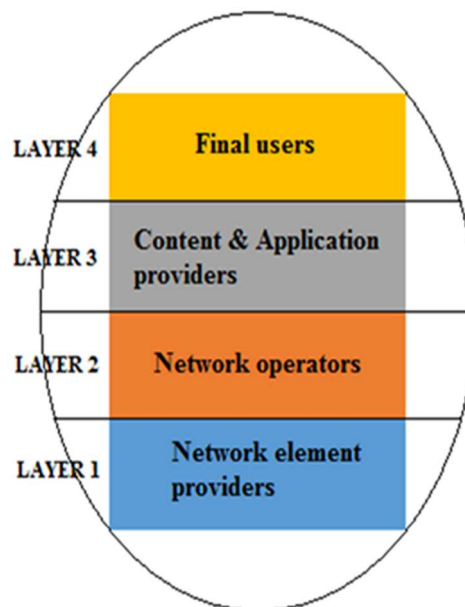
**Layer I:** Network element providers (e.g. Cisco, Samsung, Alcatel-Lucent, Ericsson, Nokia Networks)

**Layer II:** Network operators (fixed and mobile) (e.g. BT, Deutsche Telekom, Vodafone)

**Layer III:** Content & application providers (e.g. Google, Apple, YouTube)

**Layer IV:** Final consumers and users of ICT services

*Figure 1 - The 4 Layer model according to Fransman*



Fransman (Fransman, 2007) suggested this model building on experiences made by telecommunications and ICT engineers over time in using layered models for organising their work and knowledge interdependencies. Such a model allows a clear definition of the industry or ecosystem boundaries and subsectors, a modularisation and hierarchy of the the different categories of actors within the system as well as the ‘interfaces’ and relationships between actors. It also allows to describe the industrial organisation of the ICT ecosystem, the identificarion of the location of R&D. It allows to identify entry and exit barriers and most importantly the role of the customers or consumer. It thus provides a simple yet effective way to gain a good understanding of the different types of actors, their respective roles and importance to the sector as well the interrelations that occur between them.

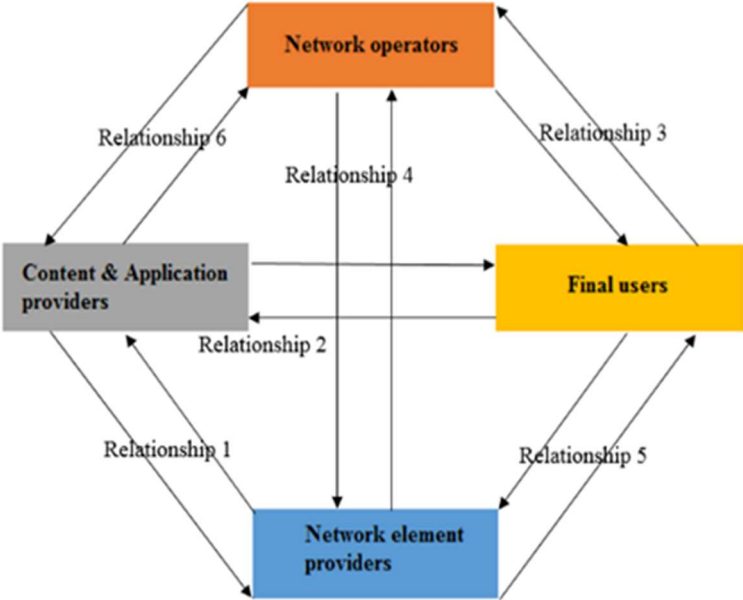
On the other hand, it is essentially a static model, which fails to reflect the dynamics of change. Moreover, it is not well suited to identify modes of cooperation and coordination between the different

actors nor does it cope with diversity within the different layers. Finally, it does not take into account externalities such as interacting institutions or organisations as for example regulators or financial institutions.

Acknowledging these developments, Fransman (2007, 2010, 2011), has focused on the role of the dynamic, or, as Fransman calls them ‘symbiotic’ relationships between the different layers and their role in innovation (Fransman, 2014). This is shown in figure 2. These relationships can be described as multi-dimensional, representing financial and material flows as well as information and input flows into the innovation processes within the ecosystem.

In the ‘new ICT ecosystem’ (i.e., post-internet), users are gaining a presence on the supply side of the system by co-creating with suppliers. In contrast to the so-called ‘old ICT ecosystem’ (i.e., pre-internet), which could be described as a closed innovation system with the most important links being between network operators and network suppliers (Layers I and II), the new ICT ecosystem is more open, more dynamic and more complex. In recent years, the focus has shifted to the interaction between platform, content and application providers (Layer III) and the ecosystem has become more dynamic, with the relationships between the different actors and the environment also becoming more complicated.

Figure 2 - Symbiotic relationships between the 4 layers



An example of how this model can be used to understand the interactions between different actors is provided by, among others, Arlandis & Ciriani (2010). Their paper includes a detailed database of players in the different layers but takes a high-level view by looking at different economic clusters such as the EU, the US and Asia and they have been able to the relative (compared to the EU) dominance of US and Asia’s ICT ecosystems. Another application of the Fransman model can be found in Veugelers (2012). Here the model is also used to understand why Europe’s ICT companies are lagging behind the US in particular with regard to the “leading platform providers who are capturing most of the value in the ICT ecosystem”. It is argued that a very fragmented EU market, lack of entrepreneurial mind-set, as well as lack of risk capital are the main stumbling blocking points to the development of the ecosystem.

### 3. Applying Fransman’s model to Luxembourg

#### 3.1. The key economic indicators and the performance of the ICT ecosystem

This section presents economic indicators pertaining to the ICT ecosystem in Luxembourg. The figures provided are based on the data on the classification NACE rev.2 (STATEC, 2008), which does not include manufacturing and trade of ICT products but does include media and content production. It is, therefore, necessary to remember this when interpreting the figures and tablea provided below.

Table 1: Key economic indicators from 2008 to 2013 (source: Eurostat)

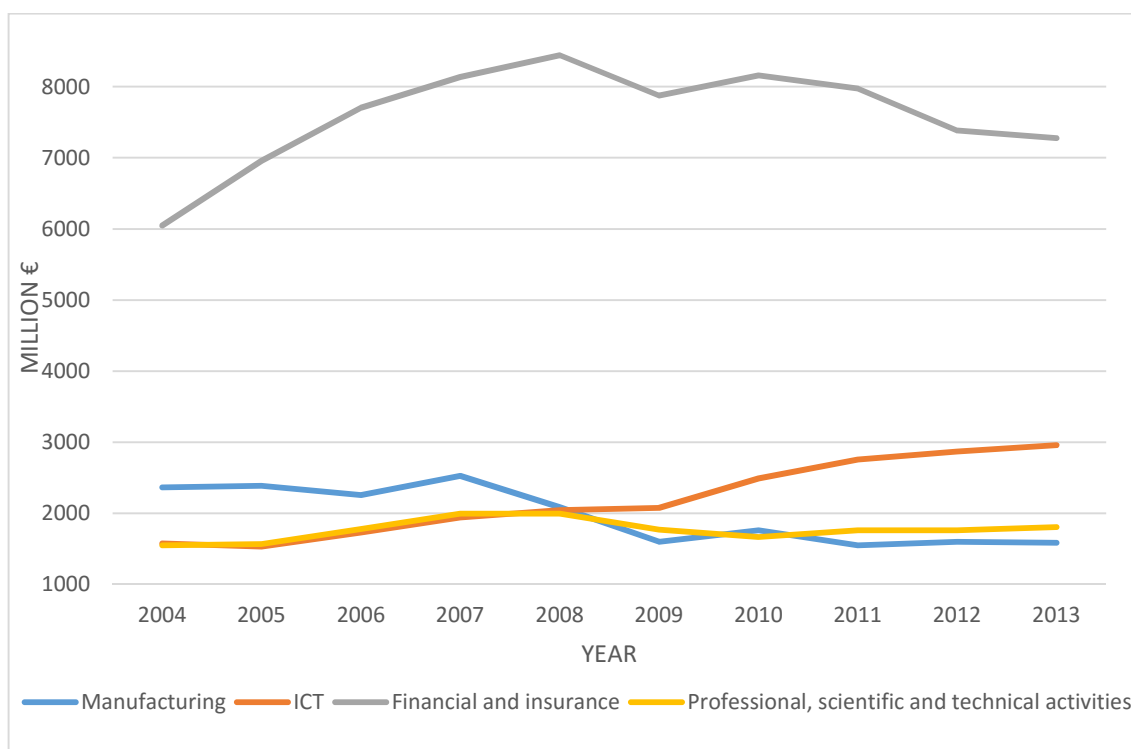
Economic indicators	Year	2008	2009	2010	2011	2012	2013	Growth rate 2008-2013
Number of companies		1565	1584	1682	1792	1920	2013	-
Percentage of total companies (%)		6.0%	6.1%	6.2%	6.4%	6.6%	6.8%	13%
Employment (1000 people)		13.6	13.8	14.0	14.7	15.0	15.4	13%
Percentage of total employment (based on persons)(%)		3.9	3.9	3.9	4.0	4.0	4.0	3%
Gross value added (at basis prices)(in million Euro)		2031.3	1980.9	2253.8	2454.6	2462.4	2537.7	25%
Gross value added (at basis prices)(%)		6.0	6.2	6.3	6.5	6.4	6.2	3%
Turnover (in million Euro)		5940.5	6045,2	6535,8	6507,8	8051.0	na	na
Compensation of employees (%) of total		4.9	5.1	5.0	5.2	5.1	5.1	4%
Compensation of employees (in million Euro)		850.6	913.5	947.6	1,034.3	1,060.7	1,099.6	4%
Business enterprise R&D expenditure (BERD) (in million Euro)		na	22.4	na	19.0	na	na	na
Business enterprise R&D expenditure (BERD) (% of GDP)		na	0.06	na	0.04	na	na	na

Table 1 confirms that the ICT sector plays an important role in the economy of Luxembourg and contributes significantly to its employment. All economic indicators of the ICT sector in Luxembourg show continuous growth in the period under review despite the financial crisis of 2009. During this crisis, the share of ICT employment in total employment and the turnover demonstrated a stable growth, whereas gross value added (GVA) showed little decrease in 2009 and rapid growth in again in 2010.

The contribution of ICT services to the total GVA is higher than the share this sector takes in total employment. The figures for business enterprise R&D expenditure (BERD) are not available for the recent years, but those for 2009 and 2011 show nearly insignificant investments in R&D by ICT actors.

In comparison to other economic sectors such as manufacturing, financial and insurance services, the evolution and impact of the ICT sector on GVA shows a continuous growth from to 2004 to 2013 - see Figure 1 below. As of 2009, the significance of the ICT sector for GVA became even greater than that of manufacturing and professional, scientific and technical activities becoming the second most important of Luxembourg’s economic activities behind its financial sector. In that respect, the ICT ecosystem contributes to the efforts of subsequent Governments to diversify Luxembourg’s economy (Barthelemy, 2014; PWC, 2011).

Figure 3: The evolution of GVA by sectors from 2004 to 2013



Source: adapted from OECD. Calculations of OECD based on Statec data (OECD, 2015)

### 3.2. Evolution of the number of actors according to company size

As shown below (table 2 and figure 4), the number of actors in the sector has also grown substantially (34%) since 2008. The number of young small and medium size companies contributes most to this growth, they grew by 296 (37% increase) and by 148 (33% increase), respectively. The increase in the number of companies with more than 50 employees was less important. At the same time, the number of companies with more than 250 employees grew by 2 (67% increase).

Table 2: Market structure and growth rates by company size

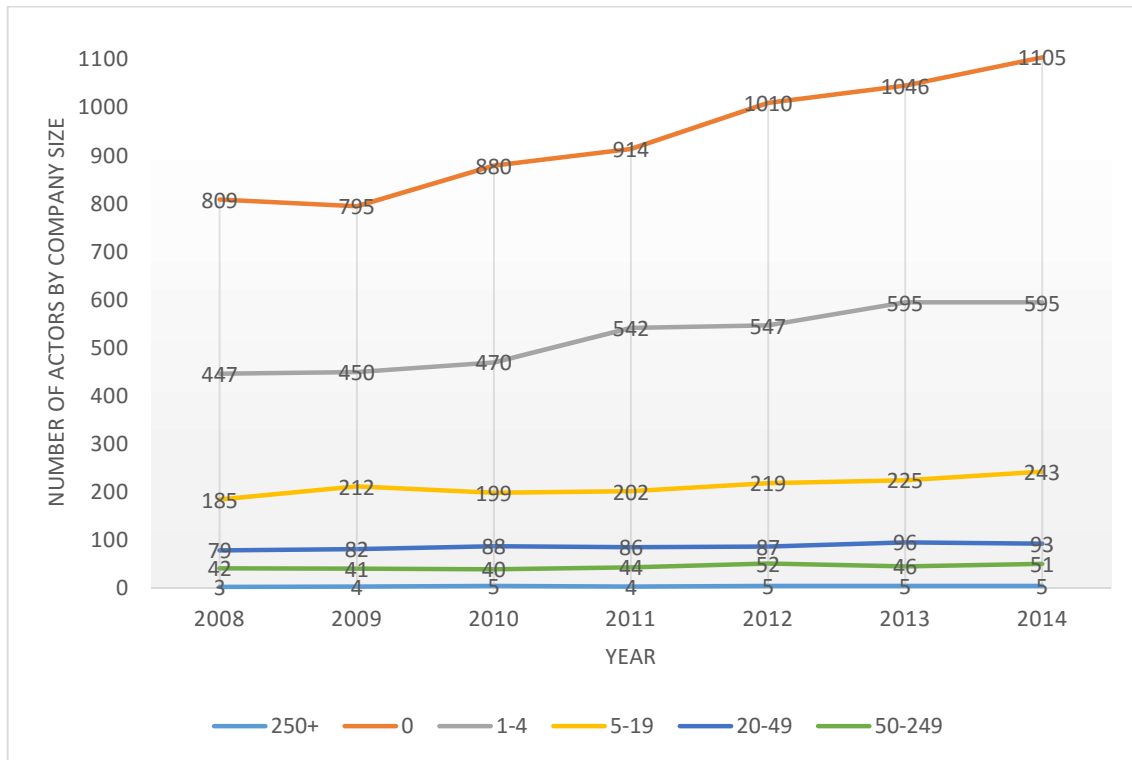
Year No of employees	Year								Growth rate 2008- 2014
	2008	2009	2010	2011	2012	2013	2014		
0	809	795 -2%	880 11%	914 4%	1010 11%	1046 4%	1105 6%	296 37%	
1-4	447	450 1%	470 4%	542 15%	547 1%	595 9%	595 0%	148 33%	
5-19	185	212 15%	199 -6%	202 2%	219 8%	225 3%	243 8%	58 31%	
20-49	79	82 4%	88 7%	86 -2%	87 1%	96 10%	93 -3%	14 18%	
50-249	42	41 -2%	40 -2%	44 10%	52 18%	46 -12%	51 11%	9 21%	
250+	3	4 33%	5 25%	4 -20%	5 25%	5 0%	5 0%	2 67%	
<b>Total</b>	<b>1565</b>	<b>1584 1%</b>	<b>1682 6%</b>	<b>1792 7%</b>	<b>1920 7%</b>	<b>2013 5%</b>	<b>2092 4%</b>	<b>527 34%</b>	



Source: Statec Répertoire systématique des entreprises luxembourgeoises (2008-2014)

Figure 4 shows also that over 90% of the companies with the ICT sector in Luxembourg have less than 20 employees and that there are only a handful of mid-size or larger actors.

Figure 4: Growth (number of actors) by company size



Source: Statec Répertoire systématique des entreprises luxembourgeoises (2008-2014)

### 3.3. Evolution of actors according to Fransman’s layers

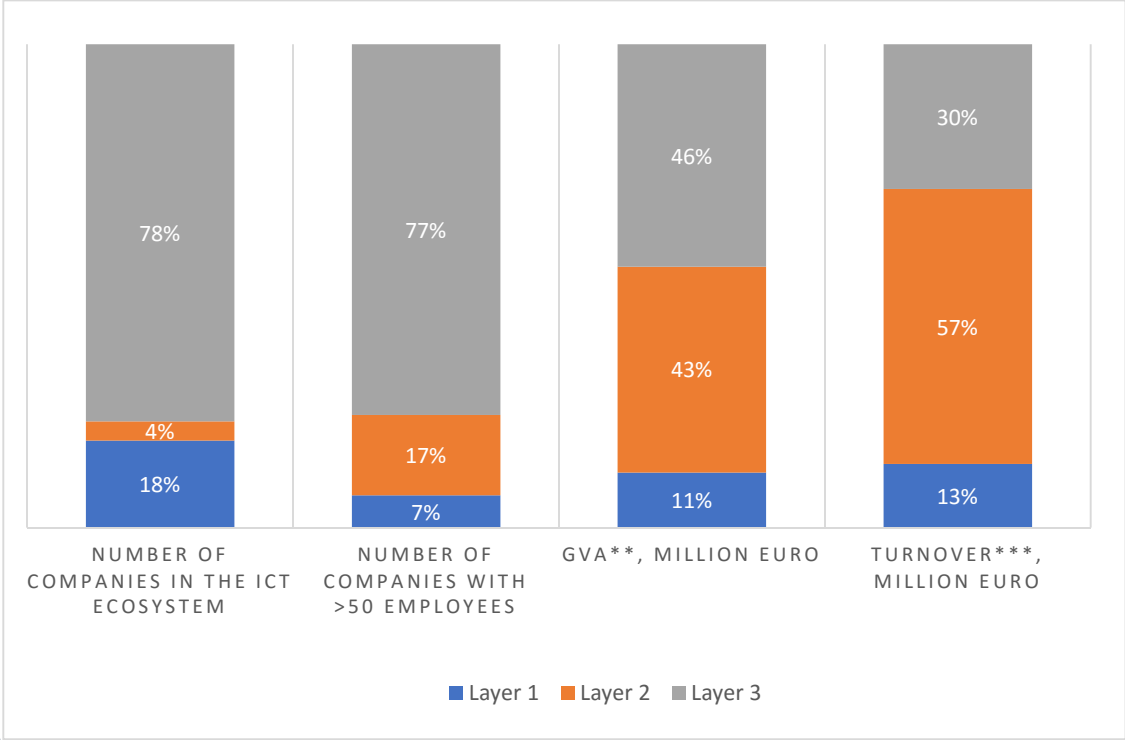
While the previous section presented an overall picture, we will now apply Fransman’s model to identify more precisely those activities located within the different layers. Table 3 and figure 5 below have been build up by counting the actors within the different NACE codes. This means that media and content production have now been excluded, whereas manufacturing and trading of ICT goods has been included.

The highest impact on the total growth in terms of the number of companies has been achieved in layer 3, the content and applications layer. This layer also dominates in the ICT ecosystem of Luxembourg, with 1670 companies in 2014. The biggest growth is visible in the subsections ‘Other software publishing’ (28 items and 88%), ‘Computer programming’ (314 items and 82%), ‘IT consulting’ (88 items and 17%) and ‘Data processing, hosting and related activities’ (48 items and 160%).

There were about 240 companies active in layer 1 (network element and infrastructure providers). Most of these are distributors of international or global hardware manufacturers, as only 5 local ICT manufacturing companies were registered in Luxembourg. There is no manufacture of consumer electronics, magnetic and optical media in the country given the fact that the high standard of living implies high salaries and therefore high production costs. This clearly confirms the importance of services for Luxembourg’s economy. Layer 2 (network providers) is the smallest in the ICT ecosystem

of Luxembourg in terms of the number of actors consisting of only 88 companies. As can be observed from table 3 (below), all subsections except fixed line telecommunication providers show uniform growth. It is also layer 2 that provides the largest contribution in terms of GVA to Luxembourg's economy.

Figure 5: The relative importance of different layers



Source: author's calculations based on database of Eurostat, Statec, Editus, Paperjam Guide. Notes: \*\*GVA in 2009, \*\*\*Turnover in 2011

The market share within the ICT ecosystem is presented from different perspectives in Figure 5 and Table 3. It appears that layer 3 is by far the largest in terms of the number of companies at both the sectorial level as well as in terms of key actors followed by layer 1 and, finally, layer 2. In terms of GVA and turnover, the analysis of the market share suggests that although layer 2 is considerably inferior to layer 1 and layer 3 regarding the number of companies, it plays the most important role in the economy of Luxembourg. As can be observed, layer 2 and layer 3 share GVA and jointly compose 89% of the total. The following sub-sections will provide a more in-depth look into the activities within the different layers.

**Table 3: Evolution of actors in different layers and subcategories**

NACE	Description	2008	2009	2010	2011	2012	2013	2014	2008-2014
58.210	Publishing of computer games	2	2	2	1	2	5	5	
			0%	0%	-50%	100%	150%	0%	150%
58.290	Other software publishing	32	33	41	40	41	48	60	
			3%	24%	-2%	3%	17%	25%	88%
62.010	Computer programming	383	412	451	499	588	641	697	
			8%	9%	11%	18%	9%	9%	82%
62.020	IT consulting	530	528	544	582	597	619	618	
			0%	3%	7%	3%	4%	0%	17%
62.030	Computer facilities management	24	22	26	29	37	39	43	
			-8%	18%	12%	28%	5%	10%	79%
62.090	Other information & computer activities	158	145	140	143	129	128	120	
			-8%	-3%	2%	-10%	-1%	-6%	-24%
63.110	Data processing, hosting and related activities	30	36	46	47	54	59	78	
			20%	28%	2%	15%	9%	32%	160%
63.120	Internet portals	10	11	12	19	22	26	31	
			10%	9%	58%	16%	18%	19%	210%
63.990	Other information services n.e.c.	15	13	16	15	16	12	11	
			-13%	23%	-6%	7%	-25%	-8%	-27%
95.110	Repair of computers and peripheral equipment	9	10	11	10	8	7	6	
			11%	10%	-9%	-20%	-13%	-14%	-33%
95.120	Repair of communication equipment	1	1	1	1	1	1	1	
			0%	0%	0%	0%	0%	0%	0%
<b>Layer 3 (Content &amp; Applications Providers)</b>		<b>1194</b>	<b>1213</b>	<b>1290</b>	<b>1386</b>	<b>1495</b>	<b>1585</b>	<b>1670</b>	
			2%	6%	7%	8%	6%	5%	40%
61.100	Fixed Line Telecommunications	15	16	15	16	14	12	13	
			7%	-6%	7%	-13%	-14%	8%	-13%
61.200	Wireless Telecommunications	6	8	9	9	9	7	8	
			33%	13%	0%	0%	-22%	14%	33%
61.300	Satellite Telecommunications	6	7	12	14	14	15	16	
			17%	71%	17%	0%	7%	7%	167%
61.900	Other telecommunications activities	47	44	44	42	47	48	51	
			-6%	0%	-5%	12%	2%	6%	9%
<b>Layer 2 (Network Operators)</b>		<b>74</b>	<b>75</b>	<b>80</b>	<b>81</b>	<b>84</b>	<b>82</b>	<b>88</b>	
			1%	7%	1%	4%	-2%	7%	19%
26.110	Manufacture of electronic components	1	0	0	1	1	1	1	
			-100%	-	-	0%	0%	0%	0%
26.200	Manufacture of computers and peripheral equipment	1	1	1	1	1	1	2	
			0%	0%	0%	0%	0%	100%	100%
26.300	Manufacture of communication equipment	1	1	1	1	2	2	2	
			0%	0%	0%	100%	0%	0%	100%
46.510	Wholesale of computers, computer peripheral equipment and software	178	178	182	175	176	172	170	
			0%	2%	-4%	1%	-2%	-1%	-4%
46.520	Wholesale of components and electronics and telecommunication	60	64	59	62	59	62	67	
			7%	-8%	5%	-5%	5%	8%	12%
<b>Layer 1 (Network Element Providers)</b>		<b>241</b>	<b>244</b>	<b>243</b>	<b>240</b>	<b>239</b>	<b>238</b>	<b>242</b>	
			1%	0%	-1%	0%	0%	2%	0%
<b>Total ICT companies</b>		<b>1509</b>	<b>1532</b>	<b>1613</b>	<b>1707</b>	<b>1818</b>	<b>1905</b>	<b>2000</b>	
			2%	5%	6%	7%	5%	5%	33%

Sources: Statec Répertoire systématique des entreprises luxembourgeoises (2008-2014)

### 3.4. Layer 1 – network element providers

Layer 1 (network element providers) consists mainly of distributors or local branches or subsidiaries of international or global ICT equipment providers like for example Cisco, Ericsson, Huawei, Nokia Networks, HP, IBM, Oracle, EMC etc. Most of these international companies have established small sales offices<sup>3</sup> in Luxembourg, attracted by its favourable economic conditions, the geographic location of the country and, most importantly, the demands of a well-developed financial industry. There is no foreign direct investment by these companies in local research and development activities. There are,

<sup>3</sup> Eg. Cisco's office does only employ 5 people in charge of the local market (source: Cisco Luxembourg)

however, also 5 small (less than 10 people) local manufacturing companies that are mainly active in the design and production of specific communication interfaces for example in satellite communication. This can be explained by the small size of the country, the lack of investment in manufacturing and the lack of skilled workforce.

### 3.5. Layer 2 – network operators

Layer 2 (network operators) consists of 88 companies, out of which 11% are companies with more than 50 employees. Companies acting in layer 2 provide high speed internet, cable TV, fixed line telephony, satellite and mobile connections.

According to the Institut Luxembourgeois de Régulation (Institut Luxembourgeois de Régulation, 2015), there were 4632 people employed in this layer, while its revenues totalled €534.7 million and investments amounted to €215 million. Broadband coverage reaches 100% and Luxembourg is among the European leaders in terms of broadband penetration. As of 2013, the only income growth drivers are high speed broadband Internet and mobile Internet, which are marked by increasing revenues. However, they represent only 6% of the total telecom revenue.

POST Telecom is the major contributor to layer 2. It is the incumbent national telecom operator, providing fixed, wireless, mobile network and other ICT services. In terms of the revenue, market share held by POST Telecom remains stable and superior to alternative operators, showing more than 50% in 2013 (Institut Luxembourgeois de Régulation, 2015). Other companies that compete with POST Telecom are Telindus Telecom, Tango, a subsidiary of Proximus Belgium and part of the Vodafone group, and Joinexperience, a recently established Luxembourgish company.

Another big player in layer 2 is SES (Société européenne des satellites), one of world leaders in the provision of satellite services. Having been founded in Luxembourg in 1985 with the support of the Luxembourg government, it still maintains its global headquarters there. SES operates 42 satellites, providing services to 99% of the world's population. SES offers a wide range of services such as high-speed data transmission, TV channels, internet access, secure network and communication solutions.

Actors in layer 2 are partly regulated by “Institut Luxembourgeois de Régulation (ILR)” which is the national regulatory authority for Luxembourg (Binsfeld, Whalley, & Pugalis, 2015).<sup>4</sup>

### 3.6. Layer 3 – content and application providers

As discussed in the previous section, layer 3 (content & application providers) is the ‘largest’ layer in terms of the number of actors. It consists of 1670 companies, out of which a major part (97%) are companies with less than 50 employees. The larger companies in this layer are mainly active in e-commerce, software, ICT-consulting and -integration as well as data centre operators. In the following, we will identify specific sub-layers of actors and briefly describe these.

#### 3.6.1. E-commerce

E-commerce is defined here as “buying and selling of products and services through an electronic medium over the internet”. Luxembourg was the first European country to create a specific, clearly defined and secure legal framework for e-commerce (PWC, 2011) and it also had, at least until 2015, the lowest standard VAT rate of 15% on e-commerce services within the EU and just 3% on e-books. This attractive rate of taxation, together with good communication infrastructure, has led several

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<sup>4</sup> A complete and permanently updated list of all actors in this layer can be found on the web site of ILR. [www.ilr.public.lu](http://www.ilr.public.lu) accessed 23.4.2016

players in the gaming (online video games) and gambling sector to set up their headquarters in Luxembourg or even install their technology centres for Europe in the country. This, in turn, has attracted low-latency Internet providers to expand their ICT operations to include Luxembourg (PWC, 2011). Global brands in the media and Internet world such as Amazon, eBay, iTunes, PayPal and Skype or global telecommunications providers such as Vodafone all have their European headquarters or major operations based in Luxembourg. Revenues from e-commerce in Luxembourg grew 32% in 2013. Online stores sold products and services for about €950 million. The total online sales for this year are expected to reach €1.03 billion. That would represent a percentage growth of 8% (Marx, 2014). However, the fiscal advantages mentioned above are about to disappear in 2015 in accordance to EU regulations (Fayot & Funck, 2012; Funck, 2013). It is expected that this will have a substantial negative effect on e-commerce activities in Luxembourg.

### 3.6.2. Software publishing

Software development and publishing have been growing substantially over time. The software development market in Luxembourg consists of a wide range of small and very small (1 person), some medium sized local players as well as local branches of global actors. They produce computer and mobile applications and software products for different business sectors (e.g., financial applications to facilitate the management of operational risk linked to foreign exchange, and straight-through processing software for connectivity between banks which need to communicate directly), healthcare (e.g., health data management and archiving), transport (e.g., for aerial cargo services), web development, etc.

### 3.6.3. Professionals of the financial sector

Professionals in the financial sector (PSF) are regulated entities offering financial and related services. PSF are supervised by the 'Commission de Surveillance du Secteur Financier (CSSF)'. PSF are divided into 3 subgroups depending on the type of business conducted and services provided: investment firms, specialized PSF and support PSF (Deloitte, 2013). Support PSF act as subcontractors offering operational services on behalf of banks or other PSFs. According to CSSF (2014), in the end of 2014, 315 PSF firms were identified in Luxembourg, 81 of them being support PSF (26% of PSF market) with 9 043 employees.

### 3.6.4. Fintech companies

Financial services technology (FinTech) is the application of technology (software, hardware and services) to financial services. According to KPMG (2014), there were about 150 companies in Luxembourg in 2013 that provided software, infrastructure and IT services to all financial segments (including the PSFs). Although the majority of FinTech companies (93%) have less than 250 employees, 50% of the revenues were generated by companies with more than 250 employees. Fintech is currently considered as having a high potential for development given the size and importance of the financial sector in Luxembourg and is one of the focus areas evident in the actions of the current government (Gray, 2017; Labro, 2015; Luxembourg for Finance, 2015; Thibaut, 2015).

### 3.6.5. Datacentres

Luxembourg boasts one of the most modern data centre parks in Europe and currently has 19 data centres, all of which offer a high level of security and availability with low latency connections to all of the major European Internet hubs (Luxembourg for Business, 2013c). The absence of a server tax and low energy prices made establishment of data centres in Luxembourg attractive for public and private customers, including European Commission as well as for many financial institutions. A full suite of hosting services is provided: colocation services, virtual private servers, managed hosting and web hosting.

### 3.6.6. Cloud service providers

Cloud services provide businesses with the possibility to having their data and files stored on IT infrastructures accessible through the Internet. This helps to reduce the companies' costs associated with the installation and maintenance of equipment. Companies in Luxembourg offer cloud services on an infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS) basis. They offer secure, low latency, highly available cloud services. Nevertheless, many organizations in financial sector avoid using cloud services for security reasons. In order to support this developing area, and to secure cloud services in Luxembourg, the government has undertaken a range of investments. Existing legal and regulatory frameworks are aimed at providing a higher level of protection for organizations that operate with sensitive and confidential data (PwC, 2011).

### 3.6.7. ICT consulting and Integration

Companies need to efficiently use IT resources, in order to achieve their business objectives. Due to a high demand in this field, many companies in Luxembourg provide a variety of IT consulting services that may include the design, implementation and support of IT systems. The primary objectives of IT consulting include simplification, improvement or redesign of business processes using IT solutions, ensuring data security, etc. According to Statec, Luxembourg hosted 618 companies whose main activity in 2014 was IT consulting (Poujol, 2014b). The companies with more than 50 employees are presented in Appendix 3. In addition to these companies, IT consulting is provided by audit firms such as the 'Big Four' (KPMG, Deloitte, PwC, Ernst & Young) and other companies from the ICT sector.

### 3.6.8.E-archiving

There is already a legal framework concerning electronic archiving in place in Luxembourg. However, this framework does not provide sufficient legal guarantees regarding the destruction of an original document that had already been digitalised. To overcome this limitation, a team of experts was brought together to design a legal framework based on a new law on electronic archiving and an update of other impacted laws (Civil code, Commercial code, Financial sector law). The proposed new regulation has recently been adopted by the parliament and it is expected that this will lead to the creation of a set of new service providers similar to the "PSFs" mentioned above (Poujol, 2014a; Raizer, 2015).

## 4. Discussion

An analysis of the ICT sector in Luxembourg shows that the sector has endured pronounced growth and, consequently, is a core component of the Luxembourgish economy generating about 7% of the country's GVA . Applying Fransman's model to Luxembourg's ICT ecosystem allowed to identify a huge number (almost 2000) of actors, many of which are focussing on software development activities. It also allowed to identify that most of the GVA is generated in the network layer 2 by telecommunications network operators in which the Luxembourgish Government holds a substantial stake and that there is nearly no real local production activity of ICT goods and equipment (layer 1).

In addition, the research found that the majority of companies in the ICT sector are small-to-medium sized enterprises (50 employees or less). Indeed, many are micro-enterprises with only one owner/employee. The ICT sector's contribution to the country's GVA shows continuous growth from year to year, while other industries, e.g., manufacturing, financial and insurance, professional, scientific and technical activities show a slight decrease. Hence, whilst some traditional sectors of Luxembourg's economy are declining, the importance, size and economic contribution of the ICT

sector continues to grow. In comparison to other European nations, the Luxembourgish ICT sector performs admirably, particularly in terms of employment (including a net increase of approximately 700 new jobs per annum) and GVA uplift.

Layer 3 (content & application providers) is the biggest and the most rapidly growing layer. It provides a diversity of content, applications, software and services and mostly consists of small companies. It should be noted that big worldwide ICT companies (e.g., Amazon, PayPal, iTunes, eBay) also belong to this layer. The financial orientation of the country's economy influences the evolution of the ICT sector in general and, in particular, of layer 3. The high demand of high quality secured IT services from the financial sector stimulates the development of new services and products aimed at supporting the sector. As a consequence, financial technologies (FinTech) have been rapidly growing over the last years in Luxembourg (KPMG, 2014). Layer 3 particularly focuses on support Professionals of the Financial Sector (PSF)(Commission de Surveillance du Secteur Financier, 2014).

Layer 2 (network operators) is the smallest part of the ICT ecosystem in terms of the number of actors, however, its contribution to the economy of country is high. The main contribution to this layer is delivered by incumbent telecommunications operator POST Telecom as well as by the 4 mobile network operators.

Layer 1 (network element providers) has the lowest contribution to the GVA. There are a few small manufacturing companies and this layer is dominated by sales representations of ICT equipment manufacturers.

#### 4.1. Moving beyond the Fransman model

As shown above, the Fransman model helps to examine how the sector is structured, identify key actors and investigate their roles, interrelationships and contribution to the ICT ecosystem. The major actors in the sector can be readily identified and mapped according to Fransman's model. It should be noted however, that the model is static whilst ecosystems are dynamic. In addition, the analytical distinctions of Fransman's layers are not necessarily appropriate for all ICT actors. Therefore, any application of the model can only provide a limited snapshot at a specific moment in time.

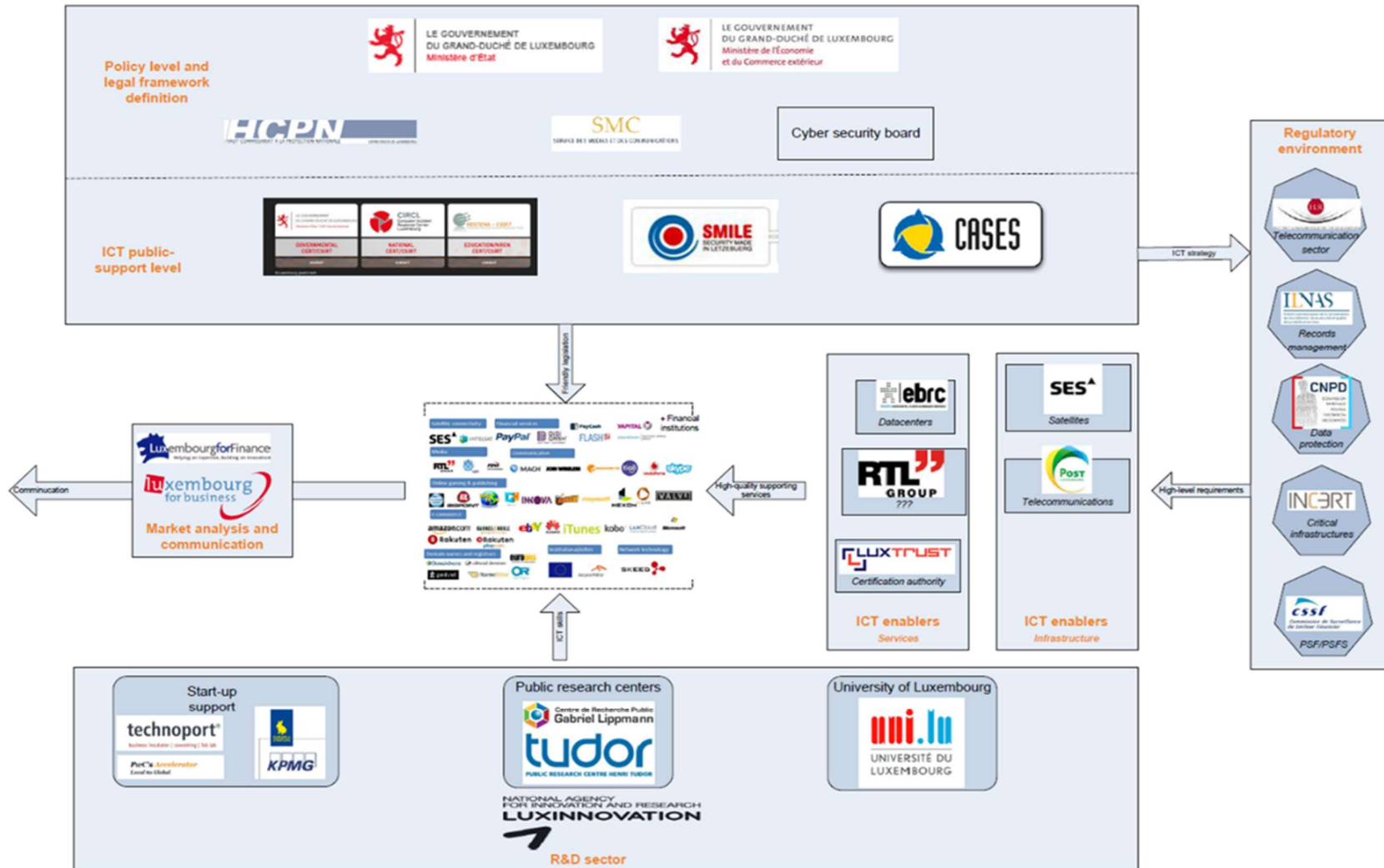
Moreover, and perhaps more importantly, the Fransman model does not fully acknowledge the role and importance of institutions or organizations not belonging to the core 4 layers but nevertheless affect and interact with the ecosystem. The authors propose therefore to extend the model as shown in figure 6 below in order to include these, particularly external stakeholders such as administrations, institutions, regulators, R&D organisations etc.

Focussing on the above mentioned "symbiotic relationships" within the ecosystem, we identified stakeholders at the government and political level that shape the regulatory and policy environment for ICT within the framework of the regulatory packages set by EU (European Commission, 2014).

Similarly, the scope of the analysis had also to be extended to the different state-owned agencies and institutions that provide support to the ICT sector in terms of public funding, awareness raising and training (upper box in figure 6). See for example the strategy called "Digital Lëtzebuerg" which aims to set a framework for the development of the ICT ecosystem in medium terms (Bettel, 2014).



Figure 6: The ICT ecosystem and external influencers.



Source: Luxembourg Institut for Science and Technology



The next group of additional actors identified concerns regulation in the broadest sense, including the national regulatory authority<sup>5</sup>, the competition authority<sup>6</sup>, the national standards agency<sup>7</sup>, the data protection commission<sup>8</sup> as well as regulatory authorities for the financial sectors (right box in figure 6). The ICT ecosystem is also supported by R&D activities and organizations such as the University of Luxembourg, public research centers but also venture capitalists and incubators (lower box in figure 6).

When looking closer into the ecosystem itself (middle part of figure 6), Fransman allows to identify ICT enablers that provide the underlying infrastructures; these include network element providers and network operators corresponding to the layers 1 and 2 of Fransman's model. Building on this, one can find the ICT service enablers that would fit within Fransman's third layer and the customers or users of ICT of which some have been identified in the diagram above. These correspond to Fransman's fourth layer. They include most of the actors in Luxembourg's well developed financial sector (KPMG, 2013).

Finally, we can also identify several institutions or organizations, private and public that are active in promoting the sector both nationally and internationally. In addition, the ICT ecosystem is supported, represented and promoted by a number of different associations, governance bodies and media: Thus, for example media have created several specialized monthly publications which illustrate the development of the sector<sup>9</sup> or incubators have launched several business games or hackatons<sup>10</sup>.

Professionals and users of different parts of the ICT ecosystem create federations and business platforms, and organize events with the aim of exchanging their knowledge, ideas, broaden their network and promote the sector on the national, European and international levels. These activities confirm the interest to this sector and its importance to the country. The interest to the sector is also attributed to the number of business incubators established by different public and private actors such as for example the professional chambers or some of the larger local banks, and accelerators focused on the development of ICT.

In order to better understand the interests and influences of these actors, the authors conducted a stakeholder analysis as shown in figure 7. A full list of these actors as well as a brief description of their activities is provided in annex.

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<sup>5</sup> Institut Luxembourgeois de Régulation, see [www.ilr.public.lu](http://www.ilr.public.lu) accessed 16.5.2016

<sup>6</sup> Conseil de la Concurrence, see [www.concurrence.public.lu](http://www.concurrence.public.lu) accessed 16.5.2016

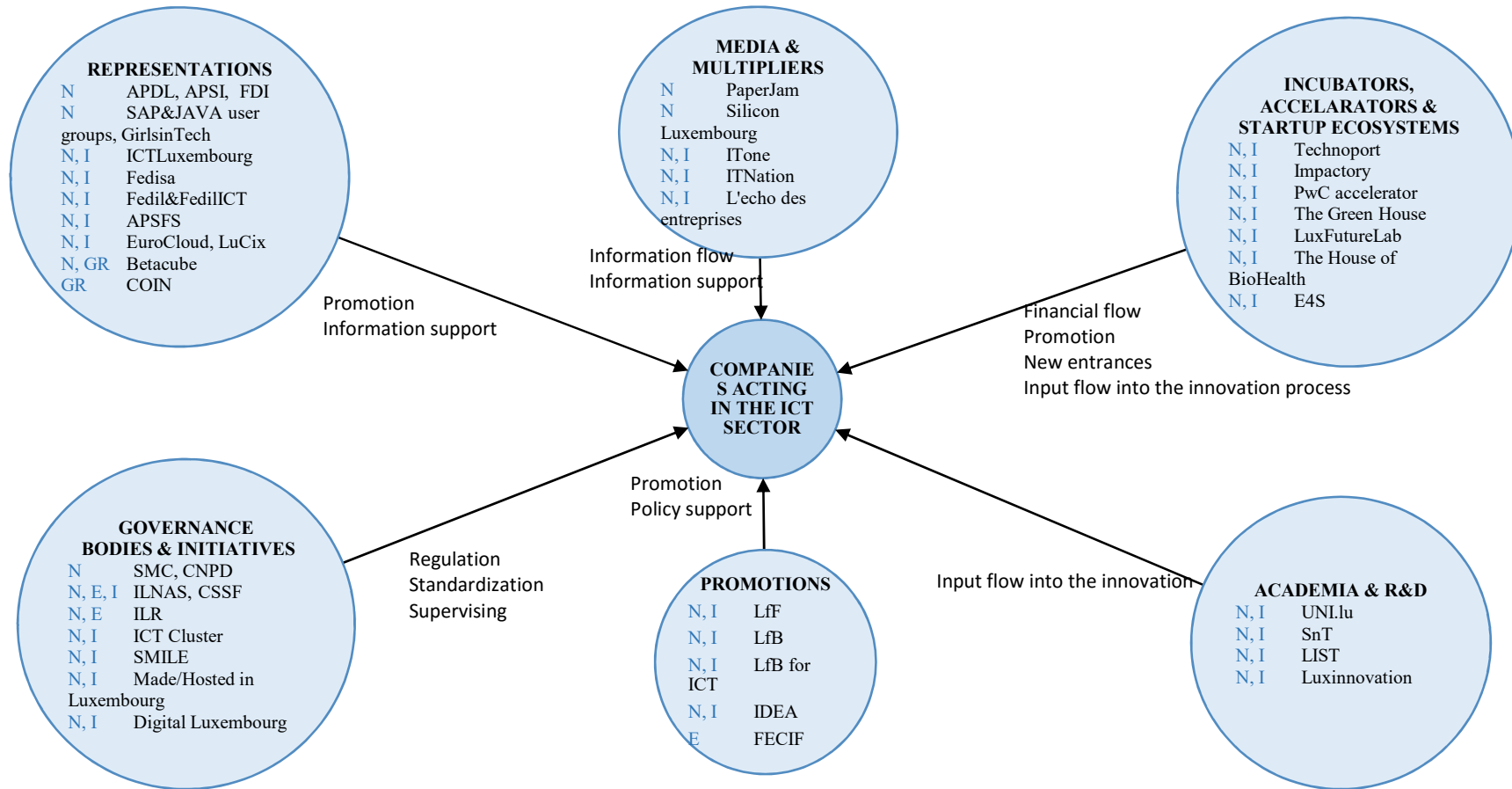
<sup>7</sup> Institut Luxembourgeois de la Normalisation, de l'Accréditation, de la Sécurité et qualité des produits et services, see [www.ilnas.public.lu](http://www.ilnas.public.lu) accessed 16.5.2016

<sup>8</sup> Commission Nationale pour la Protection des Données, see [www.cnpd.public.lu](http://www.cnpd.public.lu) accessed 16.5.2016

<sup>9</sup> See for example [www.itnation.lu](http://www.itnation.lu) or [www.itone.lu](http://www.itone.lu) accessed 1.7.2017

<sup>10</sup> See for example <http://www.luxfuturelab.lu/hackathon-2017/> accessed 1.7.2017

Figure 7 – External stakeholder map of Luxembourg's ICT ecosystem



Notes: The ICT sector promoted or represented on national (N), European (E), international level (I) or in the Greater Region of France, Belgium and Germany (GR),

Sources: author's compilations from different websites

## 5. Conclusions

This study has applied the Fransman layered ICT Ecosystem model to the ICT Ecosystem in Luxembourg. It has shown the evolution and the importance of the ecosystem for with Luxembourg's economy. It has identified that nearly 2000 actors are active within the ecosystem most of which are very small or even one-person software development companies. It has shown that whilst layer 2 is very important in terms of its turnover and value added because of some larger telecommunications operators, most companies are located within layer 3. Consequently, layer 3 has been analysed further and different categories of actors have been identified.

The study has also considered the so-called symbiotic relationships between actors within and across different layers and developed an extended model that shows some of these relationships (see figure 6).

Finally, the role of external but supporting or at influencing stakeholders has also been identified and, bearing in mind the specificities of Luxembourg as a small country, our research suggests, in order to better understand the ICT ecosystem, to extend the Fransman 4 layered model and combine it with a stakeholder analysis looking 6 external groups of stakeholders as shown in figure 8 below:

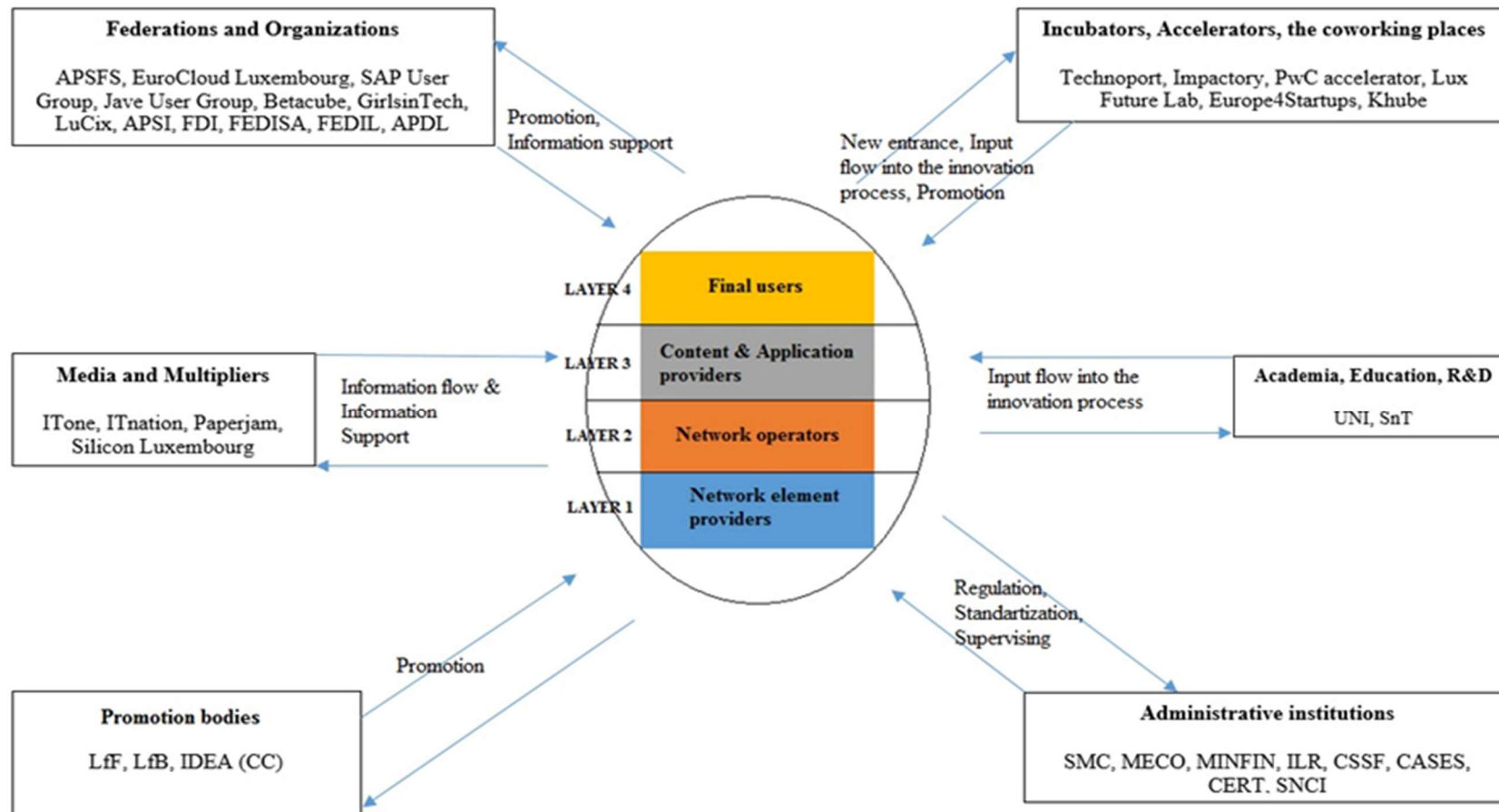
- Government and administrative bodies
- Media and multipliers
- Representation bodies (federation, organizations and users' platforms)
- R&D and academia
- Business incubators, accelerators
- Promotion agencies

Overall, the authors have shown how the Fransman model can be applied to a specific country case and have also identified several potential extensions or improvements to this model.

The difficulty of this study consists of the limited publicly available information. Although detailed information about companies such as financial figures, core business, year of foundation, investment in R&D is collected by Statec and Eurostat, it is not openly available to the public due to data protection issues. The data available in the Statec and Eurostat databases, are often not divided into subsections (according to NACE nomenclature), is limited and not up-to-date.

Therefore, some results, such as GVA, turnover, number of employees, in this study could not be collected and analyzed over the complete period under examination. Getting access to information about the companies' profitability, returns, R&D expenditure would allow to go far deeper in the analysis on a firm level and also look more in-depth into the 'symbiotic relationships' such as networks, cooperation or instead competition relationship between the different actors in the ecosystem.

Figure 8 - the Fransman layers within a network of stakeholders



In addition, more work is necessary to move beyond identifying the different actors and identifying interactions in terms of cooperation, collaboration, co-evolution or indeed otherwise. At this stage, the study identified the actors in the different layers in terms of size, numbers, GVA added. It identified also a wide range of partially or completely external stakeholders. It did not, however, at this stage identify whether and how these stakeholders have been able to collaborate in order to develop and promote the ecosystem. The authors have looked at some of these questions in different other contributions and further work is in progress (Binsfeld, 2013; Binsfeld, Pugalis, & Whalley, 2015; Binsfeld & Whalley, 2016; Binsfeld, Whalley, & Pugalis, 2013, 2014, 2016, 2017; Binsfeld, Whalley, et al., 2015).

These limitations notwithstanding, to the best of our knowledge, this is the first time that an in-depth analysis of Luxembourg's ICT ecosystem has been undertaken and the first time that the Fransman model has been applied to a small country.

This helps to redress the research imbalance; whereby small countries are often overlooked by scholars. Such 'smallness' engenders a unique opportunity for research engagement with a majority of primary actors in ecosystems, which might be unfeasible in larger countries.

A comparative analysis between ICT ecosystems of different small countries or specific regional area might be an interesting avenue of further research to identify whether the same proposed extended model could be of a more general application.

## Annex – External Stakeholders

This annex presents external stakeholders in the ICT ecosystem of Luxembourg. In total, 6 groups of external stakeholders are identified based on their activity.

### 1. Governance and administrative bodies

Media and Communication Service (**Service des Médias et des Communications - SMC**) was established in 1991. Its missions are media regulation, protection of data and the digital economy.

Luxembourg Institute of Standardisation, Accreditation, Safety and Quality of Products and Services (**Institut Luxembourgeois de la Normalisation, de l'Accréditation, de la Sécurité et qualité des produits et services - ILNAS**) is a public service under the authority of the Minister in charge of the Economy. ILNAS is a competency network at the service of competitiveness and consumer protection. ILNAS represents Luxembourg's interests in the European and the international standardization organizations.

ILNAS's terms of reference in the field of standardization are:

- to organize, coordinate and develop the wording, dissemination and implementation of normative documents at national level;
- to ensure the participation of the various economic sectors in the development of European and International standards;
- to implement European standards at national level;
- to set up a standards watch;
- to promote the use of standards.

**L'Institut Luxembourgeois de Régulation (ILR)** which regulates the telecommunications, energy sector and postal services. It is an independent regulator, which is financed by the operators of the sector. The ILR competence is to stimulate and guarantee competitiveness, to determine the fees and conditions at which communication networks are operated, to prepare statistics, annual reports and regulations. Also ILR can lead sanctions against operators, which infracted laws or regulation. Its competence is set by Electronic Communication Law and the Spectrum Law. The ILR sets rules in accordance with European directives and national laws.

The **National Commission for Data Protection** (Commission Nationale pour la Protection des Données – CNPD) is an independent authority created by the Act of 2 August 2002 on the protection of individuals with regard to the processing of personal data. It verifies the legality of the processing of personal data and ensures the respect of personal freedoms and fundamental rights with regard to data protection and privacy.

The **Commission de Surveillance du Secteur Financier (CSSF)** is a public institution which supervises the professionals and products of the Luxembourg financial sector. It supervises, regulates, authorizes, informs, and carries out on-site inspections and issues sanctions. Moreover, it is in charge of promoting transparency, simplicity and fairness in the markets of financial products and services and is responsible for the enforcement of laws on financial consumer protection and on the fight against money laundering and terrorist financing.

Objectives:

- to promote a considered and prudent business policy in compliance with the regulatory requirements,
- to protect the financial stability of the supervised companies and of the financial sector as a whole,
- supervising the quality of the organization and internal control systems,
- Strengthening the quality of risk management.

### Some more recent governance initiatives

SECURITYMADEIN.LU is an initiative “**security made in Lëtzebuerg**” (SMILE) launched in February 2015. SMILE is the online source for cyber security in Luxembourg. Its goal is to provide news, relevant information as well as a toolbox with useful cyber security solutions for private users, organizations and the ICT community. It centralizes, all news and other valuable material from its three fields of activity (CASES, AWARE and CIRCL). It builds on the integration of the pre-existing services, infrastructures, platforms, experience and competence of partners, and thus represents a central place for information security awareness-raising, information, support and problem solving material. SMILE also initiates new markets with high added value to deliver high-quality services accessible to municipalities, SMEs and companies of every size, by developing new solutions and competent services for the Luxembourg economy.

**Cyberworld Awareness and Security Enhancement Services (CASES) and Cyber Emergency Response Community Luxembourg (CERT).** Their objectives are to create a community gathering all security professionals under one label and platform and to represent market on national and international levels.

**The Computer Incident Response Center Luxembourg (CIRCL)** is an initiative designed to provide a systematic response facility to computer security threats and incidents.

CIRCL provides a reliable and trusted point of contact for any users, companies and organizations based in Luxembourg, for the handling of attacks and incidents.

CIRCL’s aim is to gather, review, report and respond to cyber threats in a systematic and prompt manner.

The Luxembourg **ICT Cluster** is part of the Luxembourg Cluster Initiative, launched by the Luxembourg Government to encourage networking between the private and the public sectors. The Luxembourg ICT Cluster brings together various actors in the field of ICT in Luxembourg with the goal of fostering new and sustainable business opportunities through collaborative research, development and innovation projects. The cluster provides specific support activities and services to its members and offers a platform for networking, collaboration and exchange of experience. It aims to optimize enabling technology for various sectors and the further development of the existing ICT sector in Luxembourg by encouraging networking and collaboration between the private and public sectors. The Luxembourg ICT Cluster is a network that supports and brings together the various actors in the field of ICT in Luxembourg with the goal of fostering new and sustainable business opportunities through collaborative research, development and innovation projects.

The objective of the initiative “**Digital Lëtzebuerg**” is to strengthen and consolidate the forward positioning of the country in the field of ICT and make it the international ICT center. It promotes the existing initiatives in different sectors and combines them into a comprehensive strategy to increase their visibility. This is done to highlight and promote the completed and ongoing projects in the various ministries to identify opportunities for collaboration and potential coordination measures and to draw perspective areas for development.

The label "**Made in Luxembourg**" is a registered trademark since 1984 at the initiative of the Ministry of Foreign Affairs, the Chamber of Commerce and the Chamber of Trade. The label is used to identify the Luxembourg origin of products and services.

The label "**Hosted in Luxembourg**" is a trademark for holding companies used to identify web applications and webservices hosted in Luxembourg.

## 2. Academia and R&D

**Computer Science and Communications Research Unit (CSC)** of the University of Luxembourg (Uni.lu). Its mission is to conduct fundamental and applied research in the area of computer, communication and information sciences. The goal is to push forward the scientific frontiers of these fields. CSC focuses on such areas as communicative systems, information security, intelligent and adaptive systems, software and systems in particular to strengthen the interdisciplinary centers LCSB and SnT.

The research unit **Laboratory of Algorithmic, Cryptology and Security (LACS)** is part of the CSC. It focuses on cryptography, building secure public-key cryptosystems, computational number theory systems and network security and information security management. As parts of its activities, LACS organize a regular seminar, and an annual workshop.

The **Luxembourg Institute of Science and Technology (LIST)** active in the fields of materials, IT, environment, the space, public and health sectors. LIST was created from the merge of the Public Research Centers Gabriel Lippmann and Henri Tudor in 2015. It benefits from the competences and of these two major actors of the Luxembourg research, established in 1987. LIST participates in several national and European competitive research programs. In order to support companies in their innovation projects, LIST enables them to enhance their competitiveness in regional, national, and international markets. It also contributes to the setting up of new companies in Luxembourg through the development of innovative technology and expertise.

**The Interdisciplinary Centre for Security, Reliability and Trust (SnT)** at the University of Luxembourg contributes to establishing Luxembourg as the European center of excellence and innovation for secure, reliable and trustworthy ICT systems and services. The interdisciplinary approach brings together expertise from engineering, natural, law, and human/social sciences to address common challenges. SnT fosters interaction and collaboration with industrial, international and government partners.

**The Research Unit in Engineering Science (RUES)** is an interdisciplinary group active in the classical domains of civil, electrical and mechanical engineering. The main focus of research is the development of technological solutions, the sustainable and economical use of all kind of resources, the establishment of a center of expertise for the technological requirements of Luxembourg's industrial and public actors.

**Luxinnovation, the national Agency for Innovation and research**, is the first-stop shop for information and guidance on innovation and R&D in Luxembourg including national and European programs. Luxinnovation assists companies in identifying abilities and requirements, finding the right instruments for financial and technological support and facilitating access to support programs for innovation and research at national and European levels.

Its missions are:



- to promote research, innovation, technology transfer and the creation of innovative companies in Luxembourg,
- to inform and support company creators, enterprises, and research organizations,
- to support enterprises, research organizations and promoters of innovative projects at each phase of their projects, from the identification of their needs to assistance in finding financing and the launch of a product or service,
- to assist and advise the government in the area of research, development and innovation,
- to raise public awareness on research, development, innovation, creativity and design

Luxinnovation offers services to actors involved in the fields of R&D and innovation (enterprises, researchers, research organizations, company creators, students, etc.).

### 3. Promotion bodies

**Luxembourg for Finance (LFF)** is the Agency for the Development of the Financial Centre. It is a public-private partnership between the Luxembourg Government and the Luxembourg Financial Industry Federation (PROFIL). Founded in 2008, its objective is to promote the expertise of the financial center and the diversification of its services abroad through different communication channels. The agency continuously monitors global trends and evolutions in finance to identify development opportunities for the Luxembourg financial center and to serve different target markets and target groups. In cooperation with the various professional associations, LFF develops documentation on products and services available in Luxembourg and their relevant legal and regulatory framework. LFF organizes seminars in international business locations and takes part in selected world-class trade fairs and congresses.

**Luxembourg for Business (Lfb)** was founded in April 2008. Lfb operates as a trade promotion agency and functions as a network agency establishing a platform for its members to review, coordinate and improve their trade promotion efforts.

The objective of the **ICT division of Lfb** is to provide companies with a "one-stop-shop" for detailed information on business opportunities in Luxembourg and hands-on administrative guidance and contacts in the ICT and media sectors. It gives company leaders easy access to key decision-makers in Luxembourg. It also aims at developing Luxembourg as an attractive environment perfectly fit to the needs of the digital economy. Finally, the ICT division of Lfb commissions' studies on the Luxembourg market, edits information material and promotes Luxembourg as an ICT and media hub abroad.

**IDEA** is an economic policy Think Tank launched by the Chamber of Commerce of Luxembourg. IDEA endeavors to work as an autonomous, versatile and open entity and strives to lead reflections in terms of sustainable development in Luxembourg by pursuing the general economic interests of the country, and to contribute to the improvement of the socio-economic debate. Its ambition is to contribute to this debate through high-quality economic analyses and innovative ideas presented and discussed in public within the framework of open debates with various audiences.

**The European Federation of Financial Advisers and Financial Intermediaries (FECIF)** was chartered in June 1999 for the defense and promotion of the role of financial advisers and intermediaries in Europe. It is the European body representing European financial advisers and intermediaries. FECIF is keen to promote PSF.

## 4. Representation

**The Support PSF Association (APSFS)** is a non-profit organization founded in 2007 in order to represent the interests of companies operating under the status of support PSF. The mission of the association is to inform, help and encourage synergies between member companies and the proactive treatment of subjects directly linked to the development of the Support PSF industry. It promotes PSF status on the international level."

**EuroCloud Luxembourg** acts as a coordination platform to position Luxembourg as a leader in the field of Cloud computing and SaaS applications. It aims to contribute to the development of the cloud computing business in Luxembourg by creating an exchange platform for cloud service providers, to promote and encourage the uptake of cloud services and applications, and to develop legal framework for cloud computing on a national, European and international levels. EuroCloud Luxembourg organizes EuroCloud Luxembourg Awards.

**Association for Data Protection in Luxembourg (APDL)** is a non-profit association aimed to promote the exchange of experiences, knowledge and ideas within all individuals regularly practicing law, economics, engineering and research. It aims to contribute to the dissemination of knowledge, particularly through the organization of conferences, by the communication and documentation of the actions or training partnerships and to create links in Luxembourg and abroad and particularly in the European Union with any entity of the same material.

**Association of the Society information (APSI)** is a business federation focusing on the ICT industry in general. Its mission is to inform, represent and defend the interests of member companies and participate in the promotion of the ICT sector information in Luxembourg. Since 2009 association organizes APSI days to introduce the ICT sector.

**Comité d'Organisation des Interactivités Numériques (COIN)** is an association and online community established in 2012. It aims to federate the actors of the video game creation in a network, to promote the careers and trainings, help in starting businesses, to promote cultural aspects related to video game creation through events, such as the organization of Game Jams in the Greater Region.

**The Integrators Federation in Telecommunications, IT, Multimedia and Security (Fédération des Intégrateurs - FDI)**. The group of professionals with interests that cover all activities professional groups in ICT, multimedia and security systems. Their clients are companies in all sectors of the economy, from public sector to private clients via banks, hospitals and SMEs.

**Business Federation Luxembourg (Fedil)** was founded in 1918, is representing companies in the sectors of industry, construction and business services. FEDIL's main objectives are to defend the professional interests of its members and analyze all economic, social and industrial issues relating thereto, to develop the spirit and solidarity among Luxembourg employers. Maintaining regular contact with the national and European levels with politicians, public authorities, the business community and trade unions, the FEDIL strives to influence political and administrative decisions in the interests of free enterprise. In order to promote the Luxembourg economy, the FEDIL also participates in numerous trade missions abroad. They also have set-up a subgroup **FedilICT** – the platform for ICT companies that are member of Fedil-

**The Federation of Alternative Operators Luxembourg (La Fédération des Opérateurs Alternatifs du Luxembourg - OPAL)** was founded in 2007, the association aims at the promotion of telecommunication services and the representation and defense of the interests of alternative operators

to the bodies in charge of the market, including the ILR, relevant ministries, business and labor rooms and European authorities.

The **Association des Antennes Collectives AAC** – represents both commercial and public cable TV network operators and promotes internet network competition between traditional fixed networks and cable TV networks.

**The Luxembourg SAP User Group** created in 2006, forms part of the FEDIL, it regroups all companies (e.g., international groups, SMEs, actors from the public sector or the industry, the health care, transportation and logistics) using SAP. Its mission is to share project experience between different SAP users, to detect and address local specific requirements towards SAP.

**Betacube** organizes regular Hyperlink meetups. This event allows web professionals, developers, designers, entrepreneurs and startups share their knowledge and expertise about new technologies, methodologies, ICT, new media, marketing and other web related disciplines. The aim of Betacube is to build an active web community in Luxembourg and in the Greater Region.

**Girls in Tech Luxembourg** is part of Girls in Tech Worldwide (created in 2007 in USA), and has been founded in January 2014. The organization promotes, supports and educates entrepreneurial and innovative women in the technological space.

**LUxembourg Commercial Internet eXchange (LU-CIX)** was founded in 2009 as a cross-industry initiative of national and international internet players. It hosted in four data centers in Luxembourg. The organization allows internet service providers to exchange internet traffic between their networks. To promote the exchange of contacts, experience and ideas in the ICT sector of Luxembourg and beyond, LU-CIX organizes Luxembourg Internet Days.

**The Luxembourg Java User Group (LuxJUG)** is a independent, non-profit and moderated newsgroup. It provides a place and an infrastructure to share experiences and knowledge about the Java platform and related technologies.

**Federation of ILM (Information Lifecycle Management), Storage and Archiving in Luxembourg (FedISA)** act as a part of FedISA International. The purpose of FedISA is to create a relevant forum for professional users, providers and consultants in the field of archiving and information security. It aims:

- to bring together stakeholders and inform them by working with existing national associations to educate the public and the private sectors to the concepts of ILM and digital archiving,
- to promote the use of digitized information by contacting the public law and private law organizations, national, regional and local authorities,
- to inform and assist project managers on technological developments, new processes and new regulations in performing work of many technological monitoring that legal and normative,
- to promote the introduction of norms and standards in the professional repository involved in conservation processes, exchange, and digitized information.

**The YAJUG is a Java User Group.** It aims to promote the technologies, applications and methods related to Java, to foster the associated open-minded culture, to be the link between research, users and suppliers of Java, to support the exchange of experience and expertise gathering all stakeholders around Java.

**ICTluxembourg** is a non-profit coordination platform for trade associations. The organization brings together ICT professionals for discussions on the future of the sector, represents the interests of all national and international companies and supports key initiatives. It aims to enhance synergies, exchange of information and best practices between all the players of the sector and to create a welcoming environment that will attract and retain ICT companies. It supports and fosters ICT related projects and initiatives throughout the country for a strong national positioning and a more effective international reach. It is made up of several major federations and associations in the field of IT and its ICT users: FDI, APSI, EuroCloud APSFS, FEDIL-ICT, OPAL, the association of CATV operators and ABBL (the Luxembourg Bankers's Asssocation). On the international level, ICTluxembourg works in close cooperation with Luxembourg for Business and Luxembourg for Finance. ICTluxembourg participates in the business and trade missions organized by the Luxembourg government.

## 5. Incubators, Accelerators and Coworking Places

**Technoport® ltd.** is a coworking place and technology oriented business incubator, was created in June 2012 as the result of the merge between the former technology-oriented business incubator Technoport® and business support infrastructure Ecostart.

The goal of Technoport® is to promote and support the creation and development of innovative and technology-oriented companies. It provides entrepreneurs with office space, equipment, human and technical resources.

Technoport® organizes Startupweekends, Apps Foundry Contests events.

**The Impactory** is a coworking space and a business incubator where creative people come to share their knowledge, discuss on projects and ideas and learn from the others. The Impactory has been created in March 2012, which promotes social entrepreneurship and innovation in Luxembourg. Recently Impactory merged with a similar initiative called 123GO to become **Nyuko**.

**PwC's Accelerator** helps companies to become global, providing access to business networks and decision makers, reviews sales and delivery approach to create value, ensures instant visibility in selected markets.

**The Green House** incubator promotes startups in ICT, mobile, social media, gaming and digital health sectors.

**The Lux Future Lab** is a business incubator, created in 2012 by Luxembourg bank BGL BNP Paribas as a part of its corporate social and economic responsibility program. The Lux Future Lab providing office space, training programs, coaching, access to the lux future lab networks, both national and international, and support for marketing services, events management, new entrepreneurial activity in Luxembourg. Majority of companies which work in The Lux Future Lab have business related to ICT.

**The House of BioHealth** incubator inaugurated in 2015, supported by the Ministry of the Economy, BioHealth and ICT clusters, promotes startups and existing businesses in the areas of biotechnology, ICT and environmental technologies.

**Europe4StartUps (E4S)** is a non-profit organization which helps e-business and multimedia companies coming from all over the world and wishing to develop, startup or boost their ventures in Europe by providing 12 preselected companies with 12 months of premium cloud storage, network and other business services for free.

## 6. Media support and Multipliers

**ITOne**, created in 2007, IT One strives for the recognition of Luxembourg's ICT community, the development of the entire sector and the promotion of its professionals as well as for the diffusion of best practices, innovative solutions and valuable services. IT One's web portal deals with ICT trends and topical issues at national and international scales. In order to promote sector, IT One organizes awards and events (an annual event, the IT One Gala, where national practices are rewarded with the Luxembourg ICT Awards), the ICT Spring Europe, a two-day international event and IT Days Luxembourg, the Information Security Days, an event focused on security-

**ITnation** is the magazine specialized in B2B communication, news and event organization for IT professionals.

**Paperjam** is the leading magazine for the business world in Luxembourg and strongest media brands in the country founded in 2000.

**The Paperjam Club** which was launched in 2008, consists of over 600 member companies and over 4,000 executive members. It offers its members a variety of events, allowing exchange of knowledge and ideas through networking. The Club is approved by the Ministry of Economy.

Founded in 2013, **Silicon Luxembourg** is a media channel designed to profile startups and promote entrepreneurial activity in Luxembourg. Media platform aims to bring together all entrepreneurial and startup information from Luxembourg and become contact for entrepreneurs and investors from around the world."

**L'Echo des entreprises**, publication of FEDIL, is devoted to economic and social issues affecting companies in the sectors of manufacturing, construction and business services. As such, it represents a targeted advertising medium of choice, its readership is composed, mostly, executives, business managers and other decision makers, including political on national and international levels.

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