CLOUD COMPUTING IN LUXEMBOURG

OPPORTUNITIES & CHALLENGES

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EXECUTIVE SUMMARY

Recently, cloud computing has become a major focus for discussion and policy for many businesses and ICT decision makers. What is sometimes sold as *the* new ICT technology is in fact not really new at all – virtualisation has existed for many years. However, with technological leaps in the fields of processing power, storage capacity and high speed data communication networks, cloud computing now offers new opportunities to improve the use of IT-resources and to generate new business opportunities for providers.

Cloud computing - defined by the National Institute of Standards & Technology (NIST) as a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources, such as networks, servers, storage, applications and services, that can be rapidly provisioned and released with minimal management effort or service provider interaction – is the subject of many white papers that have been published over the last couple of years. The NIST model promotes availability and is composed of:

- Five essential characteristics: On-demand self-service, broad network access, resource pooling, rapid elasticity, measured service,
- Three service models: Software as a Service (SaaS), Platform as a Service (PaaS), Infrastructure as a Service (IaaS),
- Four deployment models: Private cloud, community cloud, public cloud, hybrid cloud.

No single paper has yet taken into account the positioning of cloud computing in the quite specific Luxembourg economy. Having decided to develop a paper on this issue, EuroCloud Luxembourg wanted to avoid yet another description of cloud computing and the usual list of the pros and cons of such a sourcing model.

EuroCloud Luxembourg instead intended to analyse the specific situation of Luxembourg, its cloud computing users and providers. The final purpose was to draft a meaningful list of achievable actions to be taken by public authorities, associations and individual enterprises acting as providers or users of cloud computing services.

This approach led to the structure of the present document. A detailed presentation of the identified action points follows the executive summary. These actions and recommendations are based on the findings of the Luxembourg market, which are to be found in Section II.

The action plan elaborated by EuroCloud Luxembourg is intended to develop attractive framework conditions in Luxembourg for investments in cloud computing technology and operations of cloud solutions. It is not necessarily limited to the territory of Luxembourg.

The plan, with its underlying actions, has 2 clearly defined and mirrored objectives:

- The promotion of Luxembourg in the cloud computing and SaaS market,
- The promotion of cloud computing and SaaS in the Luxembourg market.

The actions that have been identified are to be executed by different actors. The public authorities will of course play a prominent role, but others, such as consultants, academics, data centres, associations, etc., will be expected to actively participate. For some of these actions an independent coordination role would be beneficial. EuroCloud Luxembourg is ready to take up this challenge.

1. **Develop and promote Luxembourg in the Cloud Computing and SaaS Market.**

Luxembourg, as a cloud services centre, must be "put on the map". Public authorities have to endorse the strategic positioning of the local cloud industry. Not being able to position itself as a low cost centre, Luxembourg's offer has to be based on high added value services and applications.
According to EuroCloud Luxembourg, this positioning should be based on Luxembourg's current strengths: high quality infrastructure, skilled personnel, a culture of reliability, trust and security - to mention but a few. This political action must be followed by the establishment of an ecosystem capable of responding quickly, and in a cost efficient way, to changing business needs. Due to the limited size of Luxembourg, a "coordination function" could help achieve the objectives in shorter time.

Once the ecosystem is in place, the available services should be promoted. This requires an improvement in the visibility of Luxembourg's cloud computing capabilities. Luxembourg For Business (LFB) proud to promote ICT, Luxembourg For Finance (LFF) and ICTluxembourg, the new trade association of ICT service and technology users and providers, can play a key role.

Existing regulations must be benchmarked and evaluated against international customer needs. This applies specifically to PFSs, who could offer cloud services to users outside Luxembourg.

An appropriate cloud services offer, especially aiming at SME's, should be stimulated. The provision of various quality levels, meeting different business needs, should be encouraged and supported.

Technology based businesses, such as cloud services, are fast out-dated and competitive advantages are quickly lost. A permanent research and innovation process has to be put into place in order to stay a step ahead, supported by both public authorities and the private sector.

2. **Develop and promote Cloud Computing and SaaS in the Luxembourg Market**

Cloud Computing is a leading-edge technology of strategic importance for the development and diversification of the Luxembourg economy. There is a need to increase awareness of cloud computing's benefits and to give guidance to those SME's looking for improved IT sourcing. EuroCloud Luxembourg considers that current investment aid schemes must be put under scrutiny and adapted to ensure a level playing field between companies that wish to use cloud computing, and those investing in their own IT resources.

Out-tasking the ICT into a cloud requires the reinforcement of the trust of end users in cloud applications. The introduction of an appropriate legal framework covering issues such as bankruptcy and data privacy could become a cornerstone of the Luxembourg cloud computing ecosystem.

Such a legal framework will give assurances regarding the ownership of data, access to data and business continuity. Market driven certification schemes will further increase the trust of end users and best-practice checklists would allow end users to select the appropriate service package.

However legal frameworks need to be enforceable. Inbuilt features must assure the cyber security of cloud computing solutions and provide the right level of trust. Public authorities must be staffed and equipped to provide effective guidance as well as the supervision and control functions necessary to guarantee the compliance of cloud service providers with rules on security and confidentiality.

To stimulate the Luxembourg cloud market, public authorities should lead the way by deploying or using cloud solutions for their own purposes. Other successful projects should be used as showcases by the cloud industry as a whole.

There will be a need to support user companies who migrate their current IT architecture to the cloud, and to develop guidelines to define and monitor service contracts and SLAs. Guidance rules will also be a valuable tool for cloud service providers when developing their service offering. Indeed, sharing the same basic understanding of cloud computing needs as their customers will be helpful to companies investing in connectivity and cloud infrastructure.

Finally, EuroCloud Luxembourg highlights the fact that the design, implementation and operation of cloud solutions require a highly skilled labour force. The attractiveness of Luxembourg for IT experts needs to be an integral part of a comprehensive strategy.

Eurocloud Luxembourg encourages all the participants of the new cloud computing ecosystem to take up these many challenges by acting fast and with determination.

I.   RECOMMENDATIONS

Cloud computing and SaaS are future IT trends. This is largely confirmed by the strategic positioning of major international IT players and by the growth figures in the market.

Although a few early adopters have already taken advantage of the potential of the cloud, many other companies do not foresee opportunities to adopt such models yet. Many other companies haven't even analysed the cloud computing concept.

These facts motivated EuroCloud Luxembourg to launch three working groups in 2010 to analyze the current business, technical and legal framework in Luxembourg in relation to cloud computing (IaaS, PaaS, SaaS) and to make suggestions on how to improve the positioning and promotion of the local industry in this field. This report is based on the results generated by these three working groups. EuroCloud Luxembourg was assisted in this task by the Public Research Centre CRP Henri Tudor. It is written for the attention of the public authorities and focuses on the following aspects:

- Identify on the one hand the strengths of Luxembourg, and on the other hand the missing pieces to make Luxembourg a competitive and attractive country for the cloud computing business in Europe and beyond;
- Propose an action plan to remove any road-blocks stemming from legal, business, technical or standards issues which impede the development of the cloud computing business in Luxembourg;
- Make recommendations to the public authorities for the creation of an attractive environment for all actors in the cloud computing business, and contribute to related discussions at the EU level if needed;
- Propose efficient administrative procedures and support schemes to encourage SME's and start-up companies from the cloud computing sector to establish their business in Luxembourg;
- Improve, through targeted information campaigns, the knowledge base of all potential user companies (with special focus on SME's) concerning the opportunities and risks related to cloud computing applications.

These ambitious goals fully support the government's effort to diversify the economy, especially in the domain of ICT through the "Luxembourg for Business proud to promote ICT" initiative.

A. PROMOTE AND DEVELOP LUXEMBOURG FOR CLOUD COMPUTING

Develop attractive framework conditions in Luxembourg for investments in cloud computing technology and activities.

Action 01 - Endorse the strategic positioning and value proposition for Luxembourg as a cloud service centre

The main challenge for Luxembourg is its positioning on the international market. The analysis shows that there is great potential to position Luxembourg for cloud computing, especially thanks to the reputation it has built up around trust and safety and to its expertise in critical data management (linked to Support PFS status and underlying governance model). Now is the time for Luxembourg to reap the benefits of this reputation and expertise.

This action has prerequisites:
- To conduct an analysis of the existing cloud computing offer and competences in Luxembourg;
- To provide a market study on the cloud computing business models with the highest potential for the local industry, combined with an analysis of local cost structures and framework conditions

(legal, technical, economic) compared to other EU countries. This will determine the pertinence and feasibility of the different models.

To this end, an existing document (PWC 2010) could be built upon by looking at the other EU countries and gathering information on: the reliability of the energy supply and grids, current electricity prices and fluctuations, energy efficiency and the CO_2 footprint, the reliability of the electronic communications infrastructure and data centres, the presence of a level playing-field for competition, connectivity to other countries and available IT competences and skills.

The following "general principles" have been identified from discussions within the EuroCloud Luxembourg working groups:

- Focus on cloud models with high quality and security requirements. Also, Luxembourg must aim for the niche of business services in the cloud rather than IT cloud services.
- Develop services with a high added value: If the prices of services in Luxembourg are higher than in other countries it is imperative to be positioned in the field of cloud services with high added value. Some European competitors have the same pricing level, together with a well-known brand identity. It is therefore necessary for Luxembourg to develop a brand identity. This could include:
  - High security for critical data: Rely on the expertise of Luxembourg in the management of financial data. To make this idea relevant, it is necessary to identify a promising business case. This could relate to the management of critical data such as patents, health data, contracts or finances.
  - Confidentiality management: "Companies reluctances to switch to cloud appear more legitimate the more we approach critical applications. A study conducted on the performance of different platforms has shown that so far the response times are highly variable and that the error rates can be prohibitive." (AFDEL 2010). Privacy and performance (response times and availability) are gaining importance. They could be loss-leader arguments which should be completed by longer term arguments. Benefitting from the private banking image, Luxembourg clouds could readily be considered as 'trusted environments'. The perceived advantages of Luxembourg (secure, reliable, trusted, neutral) should encourage large enterprises to establish their private/hybrid clouds here.
  - Security and agility,
  - Backup centres for multinationals and nation states,
  - European transaction computing and back office administration,
  - Centre of excellence for new protocols and in the field of interoperability,
  - Back-office and data processing businesses require reliable and diverse links to their front offices,
  - Test bed: International organizations can use their (small) Luxembourg subsidiaries as a test bed for the wider organization to test the provisioning of, initially, non-critical applications from a cloud platform
- A horizontal approach could also be envisaged such as being positioned in the field of cloud services specifically dedicated to the needs of SME's.

Inevitably, there is an impact from external market on internal market and vice versa. The investments made to develop the external market could have a positive impact on the development of the domestic market. And conversely, the immaturity of the national market could slow down the development of the external market. It is therefore important to develop a coherent action plan that includes both actions that seek to develop Luxembourg's position on the international market and to boost the cloud market in Luxembourg.

Action 02 - Establish and coordinate a cloud ecosystem on a country wide level

Competition and multiple cloud offers are essential to the establishment and support of a dedicated ecosystem capable of responding quickly and cost efficiently to dynamic business needs. On the other hand, encouraging collaboration and synergies between cloud providers is essential to develop an ecosystem that can ensure a large service offer. Hardware manufacturers (networks, servers and storage), operating systems publishers, software editors, hosting providers, internet service providers and operators should have a platform at their disposal that allows them to work together in order to ensure optimal coverage of the entire IT value chain.

In other terms, they should all participate to the establishment of a "virtual cloud at country level". Identifying and implementing a Public-Private Partnership (PPP) will help ensure the viability of a large service offer in an open, interoperable and collaborative environment. In general, larger companies develop their own private cloud and then capitalize on their experiences to switch to a hybrid or public cloud.

A similar action was proposed by ADEN (Association pour le Développement Economique) with the idea to create 'local cloud communities' to ensure the economic and technological independence of France and to promote the economic development of its territories. (The full text in Appendix AFDEL also shares this opinion: "*A French cloud (…) would have a clear leverage effect on the industry and in particular on the software industry in France (…). It is therefore necessary that France commits itself to this choice, by getting the future industry's leaders around the table and build a public-private partnership to support this development.*" (AFDEL 2010). This idea is also confirmed by Pew Research Centre's paper (Pew Research Center 2010).

Luxembourg's economy could also benefit from a similar action where the government is a catalyst to foster the development of the cloud computing market. The essential elements are a commitment to invest in the development of an ecosystem, through a PPP, coupled with the creation of a steering committee in charge of implementing the overall cloud computing strategy.

This collaborative model has several advantages:

- To allow Luxembourg to avoid being dependent on other countries.
- The convergence between the manufacturers, editors and operators within the partnership could make Luxembourg able to control/support more technologies and hence more solutions.
- The partnership would enable manufacturers, publishers and operators to acquire an increasing know-how and facilitate the proposition of global solutions to foreign companies desiring to establish themselves in Luxembourg.
- The solution providers could have access to more efficient infrastructures.
- Application Programming Interfaces (API) could be developed to enable each of the solutions to be easily interfaced with the other solutions available in the Luxembourg based cloud.

This plan implies the implementation of the following actions:

- Establish and coordinate a network of alliances ("multiple stakeholders' platform") for certain specific businesses or public sectors (an interesting business case would be the health and social services sectors).
- Agree on the use of an open standard allowing the interfacing of the various installations and exchanges between the proposed solutions within the ecosystem. A priority in this regard would be to implement the government's proposal to establish a "référentiel d'interopérabilité" providing an exchange interface between platforms of different cloud providers.
- Work with providers on technical and legal issues as well as on new economic models.

Action 03 - Promote Luxembourg in the international cloud computing hub

In order to improve the visibility of Luxembourg on the international scene as a centre of expertise for the management of sensitive data in the cloud environment, a structured and commonly shared "communication plan", covering what Luxembourg has to offer to companies that look for an attractive place to locate their cloud computing business, is to be worked out with public authorities. Focus should be on attracting SaaS service providers to Luxembourg.

A systematic presence at the major events and trade fairs for cloud computing in the EU is necessary to promote Luxembourg as a hub for cloud computing services. This requires sharing data on the major events for the cloud industry and agreeing on a clear value proposition offered by the country as a whole. Highlighting the benefits of local cloud computing offers, as well as the benefits associated with a PFS status for managing sensitive data, should be an integral part of official presentations.

The promotional agency "LFB *proud to promote ICT*" and LFF, together with "ICTluxembourg" from the private sector, will have to take the lead in implementing this action point.

The current situation regarding taxation could help attract international cloud operators to Luxembourg. Two options are available for companies which are described in detail in part II.H.3 - Legal issues (p. 31). Luxembourg could attract international operators working on both possible scenarios: First of all, low corporate taxation should provide for a tax-attractive location for the headquarters of a Cloud Service Provider (CSP) - in line with the national objective to attract new headquarters to the country. Any server will be on national territory and hence multi-taxation will not be possible.

The second option could also be interesting for Luxembourg (particularly when bearing in mind the loss of the VAT advantage from December 2014). Luxembourg could consider offering an exemption, with servers being considered as a permanent establishment (like in the UK), removing multi-taxation issues for the CSP. Luxembourg is well connected to the European network and could therefore play a role in the establishment of a wider European Cloud network, even when the central management is not in the country. This option does not exclude an evolution towards the first option (full establishment in one country).

Action 04 - Conduct a study on the PFS status, within and without Luxembourg

The PFS status guarantees compliance with high governance standards in outsourcing activities in the financial industry in order to ensure confidentiality of sensitive information. This competence is a key element in a strategy that aims at positioning the country as a cluster for secure and high added value cloud offers. A SWOT analysis, covering the associated benefits of doing business with a support PFS company, and possible constraints for promoting the PFS status internationally, is needed. This is important to attract large corporations ("groups") to the country and to estimate the effort required to align the PFS status to their existing practices.

This point has been raised on several occasions by the Support PFS association. EuroCloud Luxembourg fully supports this proposal.

Action 05 - Diversify the service offer of data centres

Companies offering data centre services should have a product offer that is more aligned to the expectations of SMEs in Luxembourg and to the current offer of IaaS/PaaS services. A larger offer of services from the data centres (from Tier II to Tier IV) would stimulate diversification in on-line services offers and attract more companies to the country. The current service offer is perhaps too "high-end" for certain companies. This impacts the proposed prices and can result in a misalignment with the expectations of certain foreign companies who are considering establishing themselves in Luxembourg to benefit from cloud computing services.

If more services are to be offered (i.e. a more diversified offer), then there could also be a need to consider the electricity needs to support a growing number of data centres/services. Moreover, if electricity prices have to remain at a competitive level, the access as a country to different electricity supply channels is of key importance for potential investors in the cloud business. This has been mentioned by AFDEL (2010): "*Whilst 95% of the European companies manage their own datacentres internally, IDS expects that the global market for datacentres will grow from 725 million euros today to more than 2 billion euros in 2013. This trend could even be amplified since ICD expects that 78% of the datacentres will become obsolete within 12 to 18 months. In fact, the volume of IT data has been multiplied by 69 over the past 10 years, whilst the number of required servers to handle this data has multiplied by 10. This intensification creates an issue for the electrical supply of the equipment. According to APC, over the past 5 years, the average density of the racks grew from 5 to 40 servers (thanks to blade servers). The electrical consumption of a rack has therefore passed from 2 to 20 kW.*"

Action 06 - Stimulate R&D in the field of cloud computing and SaaS
ENISA (European Network and Information Security Agency) identified cloud computing as one of the five priority areas for future research. It is closely linked to the research on computer security in the next Framework programme.

Cloud computing being a leading-edge technology, RDI in this field needs to be integrated into national R&D strategy and funding programs. A coordinated approach by public and private research actors is key to achieving critical mass in terms of competences and know how. Relevant public bodies need to actively support the integration of local companies, especially SME's, in European programs in this field. Since there are opportunities to develop SaaS solutions in the Luxembourg market, further efforts should focus on stimulating innovation in this field. Among them, the following actions may be performed:

- Encourage both the development and sharing of new ideas through Workshops encouraging the IT communities (e.g. developers, infrastructure providers and users) to imagine new usages and services.
- Open forums providing both citizens and companies with opportunities to formulate proposals of new services.
- Fiscal incentives for SaaS providers to establish and develop their business from Luxembourg (interpretation of current IPR tax regime (Article 50 bis LAR)).

Make use of available data; identify public data which is technically usable and socially useful and provide it companies to encourage them to develop new services.

B. **PROMOTE AND DEVELOP CLOUD COMPUTING IN THE LUXEMBOURG MARKET**

Cloud computing is a leading-edge technology of strategic importance for the development and diversification of the Luxembourg economy. In order to create a critical mass of competences and a viable ecosystem, the local cloud computing service offers need to be promoted both internationally and on the local market. In parallel, specific incentive schemes and support mechanisms need to be put in place to encourage the use of cloud applications by end-users.

1. RAISE AWARENESS, IMPROVE REPUTATION AND BUILD TRUST

Action 07 - Increase the awareness of cloud computing's benefits and propose guidance to SME's
Develop actions to explain how cloud computing can effectively change a business through dedicated events like the "EuroCloud Luxembourg Awards 2011". Awareness should not only be targeted at the IT

departments but also at business lines and government. Particular attention should be paid to SMEs since they represent a large proportion of the Luxembourg market for cloud services and solutions.

Awareness should be raised by answering the following questions:
- How can I have tailored cloud services that suit the unique needs of my company?
- How can I mitigate and manage the risks related to adopting a cloud solution?
- How can I assure that my organization exploits all possible benefits from cloud computing?
- How can I communicate the benefits of cloud computing to my teams? Convince them that it's not only about the technology?
- How effective is the protection of data (security) from my various service suppliers?
- How can I ensure that the negotiated SLAs are designed to achieve the best possible outcomes for my company?
- How can cloud computing help my company access new markets?
- How can cloud computing enable the adoption of new business models?
- How can cloud computing help me reduce costs? Is the ROI of cloud computing competitive? Note: There are various criteria for performing a cost comparison and it should be made clear how a cloud solution can be compared to a traditional IT solution.

To compensate for the lack of information and knowledge of SMEs regarding cloud computing, and more generally e-services, a public-private taskforce should be created to inform and support SMEs. Composed of experts, this taskforce could be dedicated to e-services and cloud computing and its mission would be to provide answers to questions from SMEs and, more importantly, to help them to ask the right questions.

Action 08 - Develop financial aid schemes for companies wishing to use cloud computing
In financial terms, migrating to a cloud based IT system means moving from a CAPEX to an OPEX model. As financial incentive schemes, whether direct subsidies (régime d'aide à l'investissement…) or fiscal instruments (régime des bonifications d'impôt pour investissement Article 152bis LIR…), are based on fixed investments, an in-depth analysis should be conducted to see if current rules do not penalize cloud computing investments – are they considered to be an expense and not an investment? To promote the exploitation of the cloud, particularly by SMEs, the government should review the scope of investment incentives and make the cloud eligible for such financial aid schemes.

Action 09 - Reinforce trust of end users in cloud applications
As highlighted throughout this report, guaranteeing trust and security in cloud applications is the key factor to develop the market. Since ISO norms or other internationally recognized norms and standards for the whole cloud computing value chain are not yet available, and will not be in the near future (currently a study group ISO/IEC JTC1/SC38/SG1 on cloud computing is working on a standardization approach), there is a potential to develop private certification schemes.

As most cloud offers have a multi-territorial dimension, Luxembourg needs to take a pro-active approach towards European or international initiatives in this field, be it by public or private stakeholders.

An interesting initiative in this respect is the "SaaS Quality Seal" proposed by EuroCloud Germany. EuroCloud Luxembourg will evaluate the potential benefits for Luxembourg based companies to have access to this certification scheme which would need to be adapted to local laws on data protection and data retention.

Regarding the deployment of cloud applications in the Luxembourg financial industry, the support PFS status is compatible with the use of cloud technologies in outsourcing if sufficient guarantees covering traceability, transparency, confidentiality of information are in place. This has been confirmed by the CSSF in its 2009 and 2010 annual reports.

More generally, in order to increase the trust of end users in cloud applications, the sector could furthermore provide a "best practices check-list" to assist companies (especially SME's) who enter into negotiations with cloud service providers.

Action 10 - Clarify the legal framework for cloud computing and in particular in Luxembourg

In order to encourage the deployment of cloud computing, an appropriate legislative framework at both the European and Luxembourg level needs to be put in place. This is particularly relevant as regards data protection rules or interoperability rules and standards. A comprehensive study should help clarify legal issues regarding the use of cloud computing. A proactive approach in this field could help attract investments to Luxembourg.

Action 11 - Data recovery and continuity of service

In particular, the case of data recovery by the client in case of bankruptcy of a CSP needs to be tackled. Luxembourg should push for a legislative solution to this unsolved and critical issue that will affect the uptake of the cloud business. Specifically, being the first to clarify and regulate this point, Luxembourg could turn the current lack of guarantees for data owners in bankruptcy cases into an opportunity.

Action 12 - Encourage public authorities to deploy cloud solutions

Cloud computing can provide new and improved applications for use in Luxembourgish public life, notably for government services, public administrations and education. The government should be made more aware of the benefits of cloud computing since public management (through eGov services) could also reap further benefits from shared applications. On the other hand, the involvement of the public sector could offer an additional virtuous boost to cloud computing. A recommendation from EuroCloud France was that uptake by public administrations would offer a considerable leverage to cloud computing in the IT market.

In order to encourage cloud adoption, the following tasks could be performed:
- Monitor government initiatives in other countries (see examples in Appendix));
- Define a workshop program with public institutions to present these initiatives and their benefits;
- Create a taskforce to analyse specific needs related to public services.

2. FACILITATE CLOUD, ASSIST COMPANIES TO DEVELOP THEIR KNOW-HOW

Action 13 - Develop guidance to define and monitor both contracts and SLA

Given the specificities of cloud computing, develop guidelines for defining both contracts and service level agreements (SLA) between companies and CSP. These guidelines on "how to define and monitor an SLA" may be further developed through the following steps:
- Develop methods, tools and guidelines for defining and monitoring an SLA;
- Identify the relevant criteria to include in an SLA.

Action 14 - Support cloud service providers in developing their service offering

Support those companies that aim to deliver cloud services to develop a pragmatic approach for their business development. To develop a pragmatic approach, companies may be given help to:

- Define their business model, including strategy and market positioning. Give them examples of business models covering all aspects: taxation, VAT, Intellectual Property;
- Anticipate the impact, implicit in an SaaS migration, on the organisation;
- Anticipate and manage the impact of cloud services delivery on financial statements;
- Adapt project management methods for cloud computing development;
- Port existing applications to cloud computing.
- Migrate from 'software' logic to 'service' logic by addressing new challenges, such as internationalization of solutions, evolution of the client relation, scalability of offers, profiling, service level engagement.

Action 15 - Invest in connectivity and encourage private investments in cloud infrastructure

The competitiveness of cloud service offers is heavily dependent on ultra-fast communication networks and international connectivity. In order to position Luxembourg as a hub for e-services, the timely implementation of a broadband strategy is of key importance. Additionally, it would be of interest to propose support schemes encouraging investments by private stakeholders in cloud infrastructures.

This may be developed through an initiative of joint investment between government and CSP, such as a "Public Private Partnership" (PPP).

Action 16 - Invest in competences and skills

In order to leverage and sustain the development of a cloud computing cluster in Luxembourg, several actions tied to knowledge development should be launched:

- Public authorities have to invest in the development of their own core competencies that are relevant to cloud computing. Understanding the cloud business is a prerequisite for reaping the benefits of this technology shift as regards IT deployment.
- Launch information campaigns for SMEs about the shift of competences needed in a cloud business environment. Indeed, in a cloud model, companies need less technical competences but more managerial, strategic and contractual competences.
- Integrate cloud computing in current training programs and push for specific modules and programmes at a post secondary level.

Action 17 - Cyber security and trust

In order to position Luxembourg as a hub for e-services and build up credibility and trust on a European and international level, the administrative and supervisory bodies need to dispose of more resources and competences to ensure effective guidance and to fulfil the control functions needed to guarantee compliance with rules on security and confidentiality in online business models.

Action 18 - Increase awareness and visibility of the Luxembourg market supply

The Luxembourg potential in terms of cloud applications and services should gain momentum in both awareness and visibility. Different actions should be considered

- Publish studies on the Luxembourg offers and capabilities. An existing PwC study exists on the Luxembourg data centres (PWC 2010). Since this study is mainly oriented towards IaaS (infrastructure), a further study should focus on the Luxembourg offers in terms of SaaS (software). The current SaaS offers, the related CSP and their service levels should be covered in this study. The latter should be available on the LFB proud to promote ICT Web site.
- Launch specific promotional initiatives such as the EuroCloud Luxembourg Awards 2011, or the EuroCloud Days in 2012.

Action 19 - Develop financial and IP advantages for cloud computing projects

A lot of start-up companies believe they can play an active role in the cloud computing market, mainly by offering SaaS services and applications. Luxembourg could develop various ways of private or public financial support to these start-up SaaS companies which are active on the cloud computing market.

Existing direct aid schemes and fiscal instruments (as the IP tax regime) need to be evaluated to make sure they cover the cloud business. As the intellectual property rights are the economic asset in the SaaS business, Luxembourg has to make sure this asset is protected and can be exploited in a fiscally friendly way. Existing IPR regimes need to be put under scrutiny in that regard.

Examples of supportive measures are, for example, a favorable tax scheme to provide incentives for participation in cloud computing projects. This could also include a VAT recovery scheme or specific direct tax incentives for cloud computing projects.

However, the government should avoid investing too much in exploratory projects since these should be funded through the dedicated R&D budgets.

II. FACTSHEET ABOUT CLOUD COMPUTING AND LEGAL FRAMEWORK IN EUROPE

A. INTRODUCTION

An emerging vision of the future of the Internet forecasts the intensive use of the Internet of Services where users (individuals or companies) no longer own and manage their computing resources (e.g. servers) but use services on demand without having to deal with their complexity. That summarizes the concept of cloud computing.

Practically for business users, cloud computing can be defined as an approach to use applications, storage facilities, computing power and communication resources like so many ubiquitous, on-demand "services". These can be accessed through a simple Internet connection, without having to manage the complexity of the underlying infrastructure. The first consequence of this configuration is that users no longer own and manage their servers but they access their distant providers' servers. The second impact is that applications and data are no longer necessarily stored on a local server but in a "cloud", which means on several interconnected remote servers and storage facilities that can be located across the planet.

Large multinational companies as well as local SMEs can be concerned by cloud computing but, of course, benefits are quite different from each side. On the one hand, from an SME perspective, it will give access to storage capacities, processing powers and communication facilities they never could afford before. It will also make it possible to deploy services quickly and easily and to overcome technical concerns (configuration, maintenance, update and backup). On the other hand, for a large company which has IT infrastructures under the responsibility of its IT department, moving to cloud computing implies a change of strategy by shifting from an investment model (CAPEX) to a subscription model and the implementation of a new IT governance.

If many advantages can be listed, this change requires also that we pay special attention to contractual issues related to the particular model of cloud computing. It implies the development of the necessary skills related to the negotiation, drafting, monitoring and follow-up of SLA.

As shown in the speech of Viviane Reding, European Commissioner for company information and media at that time, given in Stockholm on November 24th 2009, Europe has already realized the importance for its economy to deploy resources to catch up: *"Internet can help us meet the challenges of the future; it's the key for the European economy to get out of the crisis. It is up to Europe and its companies to seize their chance and develop these applications and online technologies that have the potential to significantly increase the economic and social efficiency of many systems in their daily operations."*

Key figures and forecast on the estimated market size of cloud computing
- "**Gartner** Executive Programs Worldwide Survey of More Than 2,000 CIOs Identifies Cloud Computing as Top Technology Priority for CIOs in 2011."[1]
- **Gartner**, the Gartner's Hype Cycle Special Report for 2010 (Fenn, Gammage and Raskino 2010), evaluates trends and the maturity of 1.800 technologies. Cloud computing and private cloud computing appear at the peak of 'Inflated expectations' and should hit the mainstream in less than five years.

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[1] http://www.gartner.com/it/page.jsp?id=1526414; Gartner; January 2011

Figure 1 - Hype Cycle for Emerging Technologies
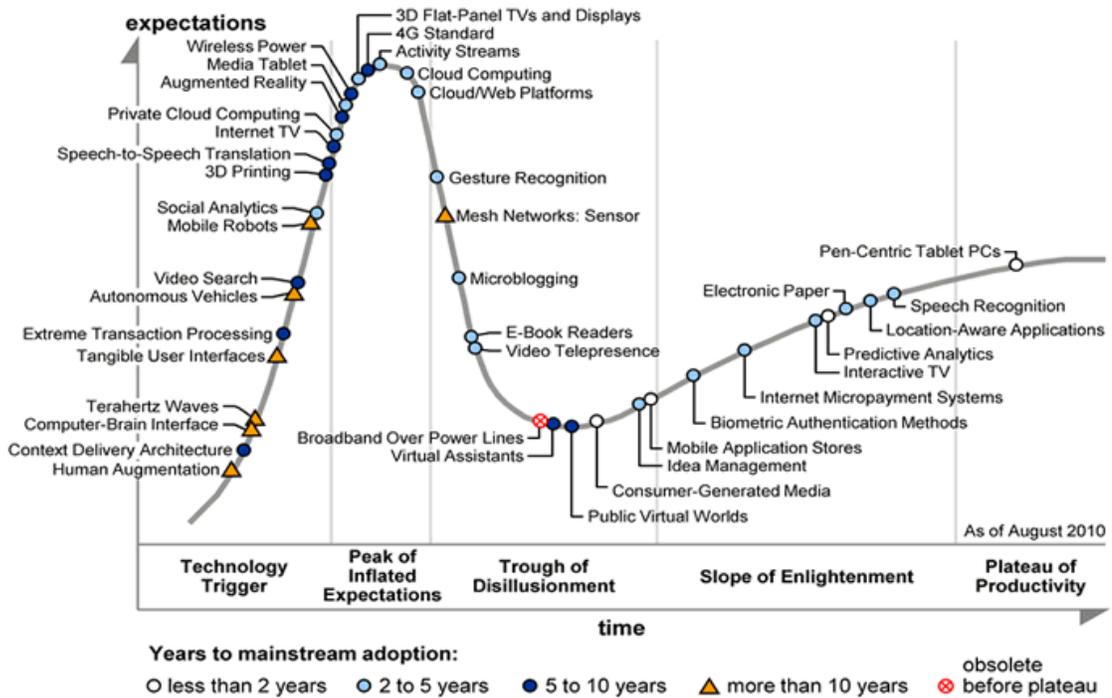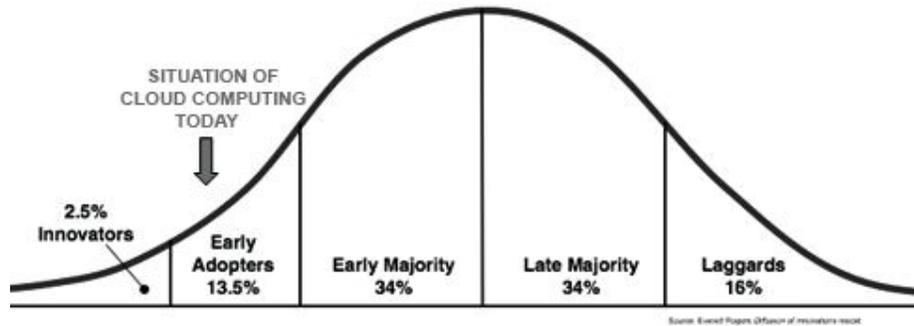

Source: Gartner, August 2010

These projections are promising and they show that we are actually still in the 'early adopters' phase and on the way to entering in the 'early majority' phase of the Figure 2.

Figure 2 - Diffusion of Innovation

Source: Everett Rogers

B. DEFINITIONS

There are many definitions of cloud computing. Gartner Inc. proposes a simple one:

A style of computing where massively scalable IT-enabled capabilities are delivered as a service via the internet.

The European Commission defines cloud computing in the Expert Group Report «The Future Of Cloud Computing – Opportunities For European Cloud Computing beyond 2010″ (European Commission 2010) as follows:

A 'cloud' is an elastic execution environment of resources involving multiple stakeholders and providing a metered service at multiple granularities for a specified level of quality (of service).

The National Institute of Standard & Technology (NIST) proposes a more detailed definition which is clear and synthetic (Mell and Grance 2011):

Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model promotes availability and is composed of:
- *Five essential characteristics: On-demand self-service, broad network access, resource pooling, rapid elasticity, measured service,*
- *Three service models: Software as a Service (SaaS), Platform as a Service (PaaS), Infrastructure as a Service (IaaS),*
- *Four deployment models: Private cloud, community cloud, public cloud, hybrid cloud.*

These 3 definitions, including one academic, one European and one American, can provide a complete view of what constitutes cloud computing. Throughout the work done by the three working groups and associated researchers, the last definition has been used.

C. MAIN FEATURES OF CLOUD COMPUTING

Cloud computing is basically an ICT architectural and operational model allowing easy access, via networks, to mutualized and configurable resources that can be managed on the fly (commissioning and decommissioning). This solution brings elasticity, reliability, adaptability, quality of service and availability in terms of non-functional aspects. Cloud computing also entails economic advantages such as cost reduction through economy of scales, less operational cost through a pay per use approach, improved time to market and the ability to turn capital investments into operational expenditures. The use of cloud computing services is also considered as a way to address sustainable development issues (i.e., green IT).
"Semantics play a powerful and important role (…). The terms 'portal', 'CRM' and even 'customer' (versus 'end-user' or 'channel partner') can have widely divergent meanings."[2] So in order to avoid confusion, one should distinguish between cloud computing service users/consumers (such as the company which signs the SLA) and the end user of cloud computing services (employee of the company, customer of the company).

The main features described by NIST are following ones:

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[2] http://www.technewsworld.com/story/72290.html

Table 1 - Main features of cloud computing

Features	Definition
On-demand self-service	A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service provider.
Broad network access	Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, tablets, laptops, and workstations).
Resource pooling	The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. There is a sense of location independence in that the customer generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level of abstraction (e.g., country, state, or datacenter). Examples of resources include storage, processing, memory, and network bandwidth.
Rapid elasticity	Capabilities can be elastically provisioned and released, in some cases automatically, to scale rapidly outward and inward commensurate with demand. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be appropriated in any quantity at any time.
Measured Service	Cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported, providing transparency for both the provider and consumer of the utilized service.

Source: Extract from NIST definition

D. SERVICE MODELS OF CLOUD COMPUTING

Cloud computing utilizes virtualization[3], service-oriented software[4], and grid computing technologies[5] among others. Being a distributed ICT model, cloud computing allow access to resources and services provided by distributed servers and storage facilities interconnected and accessible through the internet. This kind of model is characterized by three services levels:

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[3] Virtualization: creation of "*a virtual version of a device or resource, such as a server, storage device, network or even an operating system where the framework divides the resource into one or more execution environments.*" (Webopedia)

[4] Service-oriented software: software application which is "*constructed based on independent component services with standard interfaces.*" (W.T. Tsai, Yinong Chen, Gary Bitter and Dorina Miron; *Introduction to Service-Oriented Computing*)

[5] Grid computing: "*Unlike conventional networks that focus on communication among devices, grid computing harnesses unused processing cycles of all computers in a network for solving problems too intensive for any stand-alone machine.*" (Webopedia)

- Access service of remotely hosted and executed applications (SaaS – Software as a Service);
- Access service of remote execution frameworks for user's application(s) (PaaS – Platform as a Service);
- Access and management services of remote and virtualized resource (IaaS – Infrastructure as a Service).

Table 2 - Service models of cloud computing

Models	Definition
Software as a Service (SaaS)	*The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g., web-based email), or a program interface. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.*
Platform as a Service (PaaS)	*The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages, libraries, services, and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly configuration settings for the application-hosting environment.*
Infrastructure as a Service (IaaS)	*The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, and deployed applications; and possibly limited control of select networking components (e.g., host firewalls).*

Source: NIST

Figure 3 - Components of cloud computing
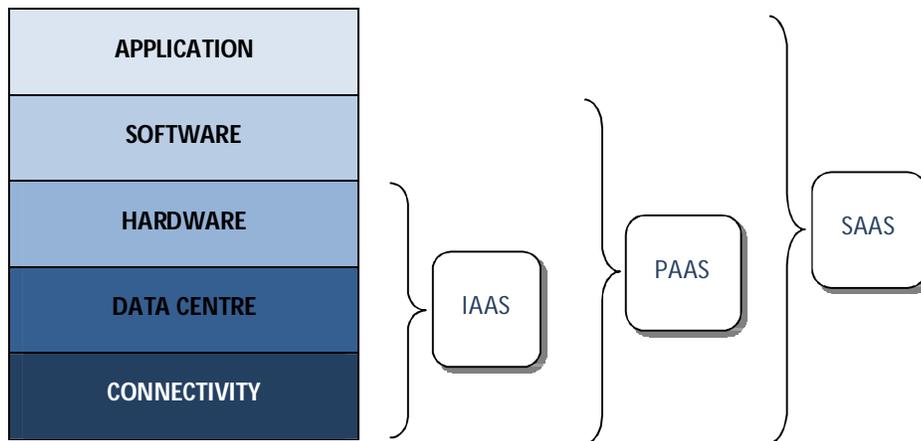
Note: some definitions of cloud computing also add other layers, such as BPaaS for 'Business Process as a Service', NaaS for 'Network as a Service', MaaS for Monitoring as a Servicer, etc. More generally, the term 'X as a Service' (XaaS) means 'Anything as a Service' and refers to all the services which are accessible from the Internet and based on the cloud computing business model. In this report, we keep to the three layers proposed by NIST (IaaS, PaaS and SaaS).

From a technical point of view, the cloud architecture is based on five components (represented as layers on Figure 3). The first component is **Connectivity** allowing communication between all physical distributed systems that compose the cloud architecture (within a Data Centre and/or between Data Centres). The **Data Centre** provides virtualized resources (storage space, CPU, RAM, etc) as IaaS solution to the final user. **Connectivity** is used to interconnect the cloud computing services of the provider and the customer who wants to access the resources. A **Software** layer could be used on the **Hardware** layer and could be limited to an Operating System (Linux, Windows, BSD, Solaris, etc.) or provide an OS and some kind of middleware, or executing platform like a web server (Apache, Lighttp), a data base management system (Oracle, MySQL), an application server (Tomcat), etc. providing to the final user a PaaS solution. Finally, an **Application** layer working on the **Software** layer allows the final user to access remote applications accessible most of time through an internet browser and considered as SaaS solutions. It should be stressed that it will be sometimes difficult to know where an SaaS starts and where it stops. E.g.: Is a web banking solution an SaaS?

In order to provide the first three levels of services (from IaaS to SaaS), the cloud computing concept is based on the use of proven technologies. Depending on the kind of technology the user has access to, the service level will differ. If the access is on the hardware layer of the cloud (directly or through virtualized resources), the user consumes some IaaS. If he accesses the software layer (as en executing platform for his own applications), he consumes some PaaS. Finally when the user accesses applications remotely through the web which are provided by Cloud Service Provider's (CSP), he consumes SaaS. Figure 3 above represents these levels.

As summarized in Figure 3, the service provided will be considered as SaaS, PaaS or IaaS depending on the layer to which a user accesses i.e. IaaS concerns layers from Connectivity to Hardware, PaaS concerns layers from Connectivity to Software and SaaS concerns layers from Connectivity to Application.

E. DEPLOYMENT MODELS OF CLOUD COMPUTING

Cloud computing comes in several forms. Mainly you hear about 3 major models described as "public cloud", "private cloud", and "hybrids cloud". You may also hear about "Community cloud". A lot depends on the way cloud infrastructure is defined and implemented in your organisation. See Table 3 below for definitions.

Table 3 - Deployment models of cloud computing

Models	Definition
Private cloud	*The cloud infrastructure is provisioned for exclusive use by a single organization comprising multiple consumers (e.g., business units). It may be owned, managed, and operated by the organization, a third party, or some combination of them, and it may exist on or off premises.*
Community cloud	*The cloud infrastructure is provisioned for exclusive use by a specific community of consumers from organizations that have shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be owned, managed, and operated by one or more of the organizations in the community, a third party, or some combination of them, and it may exist on or off premises.*
Public cloud	*The cloud infrastructure is provisioned for open use by the general public. It may be owned, managed, and operated by a business, academic, or government organization, or some combination of them. It exists on the premises of the cloud provider.*
Hybrid cloud	*The cloud infrastructure is a composition of two or more distinct cloud infrastructures (private, community, or public) that remain unique entities, but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load balancing between clouds).*

Source: NIST

F. INTRINSIC CHARACTERISTICS OF CLOUD COMPUTING

All articles about cloud computing offer their list of properties to define the concept of cloud computing. For our part, we will retain four key characteristics to differentiate this model from conventional solutions:
- Pay per use;
- Elasticity and scalability;
- Multi-tenancy;
- Service driven model.

Some of these characteristics correspond to conventional solutions. However, when considered together, they differentiate cloud computing from other conventional solutions.

These features will lead to advantages and disadvantages, which are described in sections II.G and II.H.

1. PAY PER USE

A 'pay per use' billing system means that there is no longer a purchase of software licenses or hardware, but periodic rental of services, or payment in proportion to use. As opposed to traditional models, a 'pay per use' model offers several advantages:

- It does not require massive up-front investments and thus lowers barriers to entry, accelerates Return on Investment (ROI) on business projects (OPEX vs CAPEX), minimizes risks related to massive IT investments and smooth costs over time;
- It improves cost control;
- It reduces tedious accounting manipulations related to the amortization of acquisition.

Possible evolution

A possible evolution of this aspect lies in the way of charging for services. Rather than paying per user, the price unit should be adapted to the sector and to the mode of consumption. For instance, in the healthcare sector, a mobile solution for the management of the medical records should be invoiced per bed. On the human resources side, a solution of electronic archiving should be invoiced per payslip. An ERP solution should be invoiced per business process, etc.

2. ELASTICITY AND SCALABILITY

The 'elasticity' characteristic means that cloud computing has the ability to quickly respond to a strong need to increase or decrease the resources, even if this need is exceptional. This gives the illusion to the client of having a limitless and on demand capacity, removing the need to plan consumption.

According to some studies, the minimum average of use of ITC resources is 10% in most companies.[6] The flexibility which is offered by cloud computing to the service subscriber allows the avoidance of this kind of situation[7]. Indeed, by being able to match the curve of available capacity to the curve of the real needs, overcapacity is avoided and the infrastructure will never be used under capacity.

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[6] (AFDEL 2010)

[7] Of course a cloud computing services provider will have to face the basic ROI and capacity management issues.

Figure 4 - Capacity versus Demand Curve
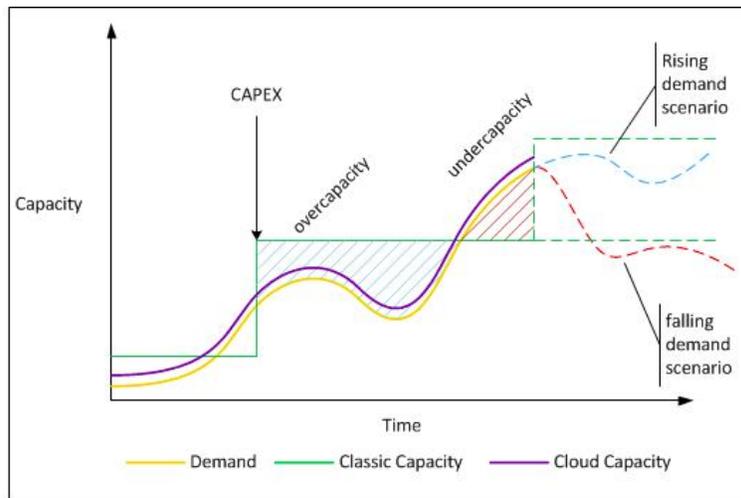
Source: Amazon

3. MULTI-TENANCY

Cloud computing enables shared IT services as opposed to dedicated services. The services are owned by multiple providers and can be co-located in a single data centre, allowing the sharing of management and performance overheads. Furthermore, the shared infrastructure enables significant reductions in terms of cooling and power supply, the power generator in case of breakdown and the fire safety system. These savings can be reflected in the cost of treatment facilities and storage.

4. SERVICE DRIVEN MODEL

Each CSP, whether an IaaS, SaaS or PaaS provider, commits to an SLA to ensure a certain level of service. The content of the SLA, the quality criteria and the expected levels are negotiated with the client. On the CSP side, service management is of utmost importance while on the client side, SLA control is of real importance.

The use of cloud computing services offers a range of service quality improvements. It does indeed enable a guaranteed capacity but, more than anything, it guarantees the availability of services, it ensures service continuity by reducing service interruptions due to IT infrastructure upgrades and maintenance and it allows better and quicker responsiveness – which in turn should improve customers' satisfaction. Finally, as a CSP must comply with the law, it is an opportunity for the client to improve regulatory compliance such as in the domain of electronic archiving.

G. LEVERS OF ADOPTION OF CLOUD COMPUTING

There are many business benefits to adopting cloud computing services. These depend on several parameters, such as the size of the enterprise, its activities, its organization or its maturity, but the main advantages already noted by enterprises can be summarized as follows:

1. Cost control;
2. Low barriers to entry;
3. Time to market reduction;
4. Focus on core business and core competencies;
5. Ecological footprint reduction.

1. COST CONTROL

Regarding cost control, the cloud computing model is interesting for several reasons:

- It gives the possibility to have an up-to-date view on consumption through 'pay per use';
- It allows a reduction in operational costs such as assistance, maintenance and upgrading;
- It enables economies of scale thanks to infrastructure sharing in data centres (reduction of costs related to infrastructure, cooling system, power supply, power generator, fire safety system, etc.);
- It is based on the concept of industrialization of services and therefore allows the sharing of service quality costs among all customers. An indirect advantage of this model is that consumers can access services with high quality at lower cost and they benefit from on-going developments made by the supplier on the services it delivers. It reduces the cost of changes while it gives the possibility to benefit from recent developments.
- It avoids wasting time and money on the maintenance and renewal of IT infrastructure.

Of course, cost saving potential can be different depending on the deployment model the consumer is choosing. According to (Centre for Economics and Business Research 2010), "*hybrid ranking (is) the highest, followed by public and then private.*"

2. LOWER BARRIERS TO ENTRY TO MARKET

As mentioned previously, the cloud computing model does not require massive up-front investments for the consumer because these investments are made by the CSP. This is a real advantage for small companies who did not have sufficient budgets to acquire large IT infrastructures. It represents a great opportunity for SMEs "*which are no longer dependent on their ability to invest up front. Rapid deployment, payment for use, elasticity and ubiquity: all of this is contributing to make available to SMEs the same IT resources as to large accounts. It also allows increased agility.*" (AFDEL 2010) With cloud computing, SMEs can start with a small infrastructure and extend it when needed. This gives them the possibility to compete with large enterprises in terms of IT investment, whether material or resources.

As the Luxembourg economy is mainly composed of SME (95%), it represents a major opportunity for the country.

3. TIME TO MARKET REDUCTION

"*In an economic area whose cycles have been accelerated due to the very fact of new technologies, companies need to deploy or adapt very quickly their ICT environment. The need for reactivity often encounters, without the use of cloud computing, the unavoidable delays associated with acquisition, and installation of new tools and data migration. The standard rates of implementation now settling in weeks rather than months, new organizational models are needed.*" (AFDEL 2010)

In this context, the use of cloud computing services brings some solutions by allowing:

- Reduction of solutions cycle development;
- Improvement of responsiveness to business changes;
- The ability to initiate system use without commitment or delay;
- Faster access to the capabilities of new resources;
- Greater agility in service innovation.

4. FOCUS ON CORE BUSINESS AND CORE COMPETENCIES

Cloud computing can facilitate a virtualization of the company's IT environment and allow it to focus more on its core business because the technical environment can benefit from:

- Transparent updates;
- Infrastructure independency;
- Distributed data/services -> location independency;
- No need to look for, hire and retain a skilled ICT labour force in-house.

"*The logical consequence of less attention to issues of internal computer maintenance, storage capacity, SWs/HWs upgrade, of saving time and of less budget spent on these issues, drive end users[8] to better concentrate their efforts and attention to their heart of their business. But it needs to be done in parallel of human resources measures to support end users in their new missions.*" (AFDEL 2010)

The required investments in IT resources (technical and human) can be replaced by a service provision through "the Cloud", which could be better suited for companies wanting less in-house activities due to their different business model or different IT needs. A good example can be found with an SME who wants to use certain applications without needing either IT competences or infrastructure.

It should be stressed that a new form of IT governance has to be implemented in order to supervise the compliance of services' provision with the signed SLAs. This new form of IT governance requires an increased coordination between the CSP and the customer. Both need to understand their expectations and needs related to the customer's core business and the required level of virtualization. Roles and responsibilities must be attributed to this necessary coordination and the traditional decision committees will need to take into account other criteria to prioritize their IT expenses. For example, maintenance activities still need to be planned, but the customer will need to be informed when these activities could hinder the provision of IT services through the Cloud. The customer should be able to accept or refuse the period of maintenance. The traditional decisions on the execution plan for maintenance activities, the allocation of the necessary human resources (competences) or the current status of the IT infrastructure, are no longer to be managed by the customer. This means that the customer needs less time, money and fewer competences to perform his IT maintenance.

5. ECOLOGICAL FOOTPRINT REDUCTION

We can consider that the cloud is an environmentally friendly solution for several reasons:

Avoid the under use of machines
" *According to several corroborating studies, an enterprise server in classic mode is used on average for 10% of the time but remains connected at all times, consuming a large amount of unnecessary electricity and occupying space.*"[9]
Cloud computing enables the transition from a situation where each company uses a server below its capacity to a situation where servers, which have become virtual, are assembled on a single machine to maximize storage space, computing power and therefore power consumption. During the inactivity of a server, another virtual server can exploit the resources for its own purposes, optimizing the use of servers and reducing unnecessary expenditure of electrical energy.

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[8] In our case, we are talking of cloud computing services subscribers.

[9] http://www.virtu-all.fr/rubrique,cloud-computing,1246838.html

In addition, "*the new cloud infrastructure may 'disconnect' themselves some of their physical components in case of underutilization (e.g. night or weekend) (...) without affecting the availability of the applications themselves*"[10] and of the data stored in the cloud.

Reduce the number of machines
The consequence of the previous point is that fewer servers are needed, thus reducing considerably the amount of energy needed to manufacture all of these machines and also reducing the amount of raw materials needed for the IT industry (water, copper, lead, mercury, etc.).

Avoid oversizing infrastructures
Rather than buying oversized servers in an attempt to cater for potential needs, cloud computing allows the use of only the power and storage capacity required. The peak activity of a client can then be supported by the reduced activity of other customers over the same period of time. -> This allows smoothing between multiple clients.

Limit the untimely renewal of computers / personal devices
Stress for equipment renewal (computers, servers, storage, communication equipment) to gain processing power and storage capacity is reduced. Now, a good Internet connection is enough .cf. emergence and success of the ultra-light notebook to allow a flexible response to the needs of mobility: they are less powerful than traditional computers, but they have network connections that allow them to access storage capacity and the computing cloud.

Use low-energy infrastructures
Data centres are logically built to reduce their environmental footprint. They are therefore based on standard low power consumption, reducing the energy required for cooling. In addition, in most cases, they recycle the heat produced by the machines to heat the offices. Finally, some go even further, settling down next to energy infrastructures to re-use the heat produced.

But if the cloud contributes to sustainable development, it must also take into consideration a paradox: the promises of Cloud may attract more and more users with more and more requirements which inevitably will increase the level of energy consumption. However, since the cloud will result in the loss of a significant number of small energy-consuming treatment centres, the final energy balance will be favourable for Cloud Computing.

H. OBSTACLES TO ADOPTION OF CLOUD COMPUTING IN EUROPE

Despite of all these idealistic promises, cloud computing still leaves several issues unresolved. There is a need to evolve and grow to reach a sufficient maturity stage to encourage greater adoption.

Currently, the major issue for cloud computing is probably the lack of confidence that it inspires. Trust is central in an outsourcing relationship, especially when it relies on an 'all virtualized' model. Several reasons can explain this mistrust:

- Concerns about security and privacy;
- Loss of data control and data recovery issues;
- Legal issues;
- Lack of interoperability and standards;
- Capacity limitation of networks.

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[10] http://www.virtu-all.fr/rubrique,cloud-computing,1246838.html

1. CONCERNS ABOUT SECURITY, PRIVACY AND LOSS OF DATA CONTROL

Security

Security is the main barrier of cloud computing, and especially in Luxembourg with its large banking sector. The reason for this barrier is the fact that data is 'scattered in the clouds'. Security challenges can be described as four different types:

- Network Security,
- Server Security,
- Software Security,
- Data Security.

These issues exist for what is called 'classic' IT infrastructure, but the answer to each of them is much more complex in a cloud environment. Some people reassure themselves by saying that security in the cloud is not worse than security in most conventional infrastructure. But there are threats that we need to be aware of, which may originate from a lack of sufficient security measures from cloud suppliers. Uploading key data to a cloud service is not without risk. Indeed it is based on supplier reliability and the measures this supplier takes to secure their data. It is therefore important to establish how data is protected (simple password, firewall, etc.) and how it is encrypted.

Privacy

The question of maintaining data confidentiality is also particularly sensitive. Any user of a service, whether provided in the cloud or not, is entitled to expect a guarantee from its supplier pertaining to the confidentiality of its data. The distrust that may exist regarding the level of privacy guaranteed by the cloud model has two aspects. On the one hand, data can be stored on servers that may be remotely located, even in different countries. On the other hand, the infrastructure is shared and it is psychologically difficult to accept loading sensitive data to the same server as a competitor!

As shown by Arnaud David, Attorney at August & Debouzy: "*This 'trust' can be recovered during the contract negotiations by obtaining certain guarantees: availability, confidentiality and security of data or hosted applications.*"[11] To gain confidence from their customers, CSP must sign contracts where their service levels are well defined. But they also have to guarantee the service levels they undertake with their own suppliers. For this, the Service Level Agreements (SLAs) defines:

- Rules: access policies and identity management, workflows, liability, property rights;
- Methods of control: evidence, checking points for the user that what has been defined in the SLA is met; audit implementation modality by a third party.

Customers can also take a number of measures to reduce security risks:

- Strengthen the criteria for selecting CSP, always ascertain the capabilities of the service;
- Conduct safety audits with the CSP;
- Require suppliers to be certified (e.g. ISO 27001);
- Conduct a risk analysis to determine the level of risk that is acceptable, while always keeping in mind the potential risks for stored data;
- Use multiple CSP, which use different IT resources, to avoid a technical disruption leading to a total disruption of the enterprise's activities.

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[11] http://www.rslnmag.fr/le-debat-rsln/2010/6/18/le-cloud_buzzword-ou-revolution_/

2. LOSS OF DATA CONTROL AND DATA RECOVERY ISSUE

"*With cloud computing, companies lose control of their applications and control of their data location.*"[12] As for security, trust remains critical as far as data control is concerned. To gain this trust, the CSP must be able to prove that in each transaction, the data handled is kept confidential. This implies ensuring traceability of data, of actions applied to the data and of the environments within which the data is used. In an attempt to respond to this need for traceability, working groups are examining the implementation of an open standard, CloudLog, to standardize the format of the logs in the cloud.

But beyond data traceability, the question of data management and availability is still present. A company risks losing valuable data if contracts do not specify clearly the backup and recovery services offered by the supplier. An outsourcing relationship based on cloud therefore requires clear contract terms, service commitments from the supplier as well as penalties for non-compliance with these covenants.

These issues of security, privacy and loss of control of data are particularly relevant for the public cloud, but they are much less critical in the context of private cloud with restricted access.

3. LEGAL ISSUES

At both the European and Luxembourg level, there is no legislative and regulatory frameworks directly dedicated to the use of cloud computing. Several obstacles to the use and application of cloud computing come from the legislative and regulatory frameworks in force, and their inadequate application to cloud computing.   The following points summarize a set of potential legal issues related to the use of cloud computing. They have been highlighted from both academic and practitioner literature. The latter are not specifically dedicated to the application / use of cloud computing in Luxembourg.

Protection of intellectual property: by using cloud computing, organizations may transfer or use sensible or protected data within the cloud. In that context, organizations should consider the protection of their intellectual property. On the other side, the CSP should also consider the protection of its intellectual property. These considerations are essential and should occur during the definition of the contractual clauses, notably within the SLA or specific appendixes. (Jaeger 2009) and (Balboni 2010),

The identification of both data controller and data processor: the protection and security of personal data underlying the use of cloud computing are legislated by the Directive 1995/46/EC, as transposed in the Luxembourg legislation by the law of 2 August 2002, as amended. In a subcontracting perspective, this Directive distinguishes the data controller and the data processor while providing them with specific duties. Being relevant in case of subcontracting, such a distinction of roles and duties raises issues when using cloud computing since the distinction between both are not always evident (Balboni 2010).

The cloud's physical location (1): data transferred within the cloud are located in the CSP's data centre(s). The location of the latter may raise jurisdictional concern(s). More precisely, the user of cloud computing has to ensure that the data may be transferred to the CSP's data centre(s) in such a

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[12] http://www.marketing-professionnel.fr/tribune-libre/cloud-computing-outil-competitivite-entreprises.html

way that it is compliant with the legislation of its country of domiciliation, the European legislations or alternative regulations . (Ruiter 2011)

The cloud's physical location (2): legally it is also important to know the domiciliation of a party in case of litigation. The place of domiciliation is determined by (a) statutory seat, (b) central administration or (c) principal place of business. For example, it is important to have the central administration in Luxembourg for control by the government and bank confidentiality (Art. 60(1) regulation 44/2001).
It is very difficult, but important, to know the place of provision of the services in cloud computing.

Subcontracting issue: in case of subcontracting, the outsourcing organization is responsible for subcontractors' compliance with the relevant legislations. In case of cloud computing, there is no direct jurisdiction and it is unknown if a CSP may be legally considered as a subcontractor. Therefore there is a question mark about the legal responsibility of organizations using cloud computing. (Ruiter 2011)

Taxation issue: taxation is reported as an important element for commercializing cloud computing since it can be a constraint on its financial success. A potential issue related to direct taxation has been reported in the literature: a business' presence in another country, be it through a factory or through a branch, can be considered as a "permanent establishment" and hence justifies taxation of the company's generated profits by the local government (OECD 2003). If a CSP has several components, clusters, servers, nodes in various states, then the local governments can claim part of the profits generated by these elements. This can result in high costs for compliance and tax litigation risks with the local authorities. Of course this is only the case when the local tax authorities believe that the components are permanent establishments of the CSP.

The general OECD principle is that servers are considered as permanent establishments if they are fixed, carry out totally or partially the business of the company and these activities are not of preparatory or auxiliary nature (OECD 2008, p.97-99). The components are nearly always identified as permanent establishments (but the analysis must be done on a case-by-case basis) and hence subjected to taxation (e.g. France, Italy and Spain). A notable exception can be found in the UK where components are exempted as permanent establishments and hence no taxes are levied on the profits generated by them.

This means that there are two options for a CSP (Stanoevska S. K. 2009):
- Centralize a Cloud in one country to avoid discussions about the same amount of profits to be taxed in several countries.
- Locate the servers in countries where servers are not deemed to be a permanent establishment of the CSP.

Luxembourg has the opportunity to offer a solution to both options. First of all the low corporate taxation should provide for a tax-attractive location for the headquarters of a CSP (which should be in line with the national objective to attract new headquarters to the country). Any server will be on the national territory and hence multi-taxation will not be possible.

The second option could also be interesting for Luxembourg (also when bearing in mind the loss of the VAT advantage in December 2014). Luxembourg could consider offering an exemption of servers being considered as a permanent establishment (like in the UK), leading to no multi-taxation issues for the CSP. Luxembourg is also well connected to the European network and could therefore play a role in the establishment of a wider European Cloud network, even though the central management is not in the

country. This option does not exclude an evolution to the first one mentioned (full establishment in one country).

Data access: the external CSP seems to determine the amount of control regarding encryption, access, firewalls or intrusion detection.

Data recovery: particular scenarios should consider data recovery from the cloud to the contracting organization. Among them, there is the bankruptcy of the CSP, and also that of the contracting organization, the non-payment of the contracting organization to the CSP or the non-respect of contract from the CSP. Currently there is no legislation that foresees data recovery in any particular scenario. As a result, data recovery should be considered within the contractual clauses, notably within the SLA agreement.

4. LACK OF INTEROPERABILITY AND STANDARDS

"*Interoperability is an essential concept for the Cloud to be fair, open and competitive.*" (Select industry group to the European Commission 2011)

To achieve the requested interoperability, the industry needs technology standards including data standards. The fact that the supplier has used a non-common technology is not a problem in itself. But the supplier must guarantee to the customer to be able to convert data to be compatible with other systems of more common use. Without these guarantees, the customer is under the risk of being taken as a 'hostage' by his CSP (vendor lock-in). Thus the CSP is free to make a change in pricing without giving the customer the possibility to react. A standard must therefore emerge to ensure the client's reversibility so that he can at any time retrieve his data, switch to another supplier, or resume managing his own data. Many organizations have been created to work towards open international standards. The best known are called Open Cloud Manifesto, Open Cloud Consortium, Distributed Management Task Force (DMTF) and include the biggest names: IBM, Cisco, SAP, VMware, ...[13]

More concretely, many consortia are organized to assess the relevance and the need to implement their own standards in cloud computing.

5. CAPACITY LIMITATION OF NETWORKS

Trends, like Internet of Things, social networks and open data, combined with the emergence of new devices and sensors in the business area, are actually resulting to the emergence of new data intensive services. This will not only lead to the production of more and more important data, but in addition, data exchanges between multiple devices will pass through existing networks.
Even if data can be compressed, it will result in a huge and growing need for storage capacity and bandwidth. Some cities, such as London for example, are already saturated and can no longer provide for the installation of new data centres or new cable broadband networks.

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[13] "*300 acteurs du marché sont signataires de l''Open Cloud Manifesto'. Quelques grands principes ont été édictés engageant ces prestataires à : apporter des solutions ouverts ; ne pas rendre captifs leurs clients ; utiliser et adopter des normes existantes et à en limiter la multiplication ; engager des efforts d'amélioration pour répondre prioritairement aux besoins des clients (et non pour de pures raisons techniques) ; à collaborer avec les organismes de normalisation, les groupes défense et les communautés de l'informatique dans le nuage afin de ne pas entrer en conflit, ou en redondance, avec elles.*" http://www.virtu-all.fr/rubrique,cloud-computing,1246838.html

"*The current growth of social networks and multimedia exchange (mostly on the consumer side) cannot be supported in the long term by the networks, regardless of technological advances to come.*" [14] The question thus arises as to the ability of data centres and network infrastructure to assume that exponential growth of digital exchanges and data they produce.

I. CLOUD MARKET TRENDS IN EUROPE

While cloud computing has already experienced a significant growth, many expect it to continue for the coming years (Gartner, 2010; Analysys Mason, 2010[15]; WinterGreen Research, 2010 and Global Industry Analysts, 2010). However, it will occur with a lower year-on-year growth rate over the next five years (Analysts Manson). According to a Forbes study[16], the growth for 2011 will be explained by:

- The users' replacement of new procurement with cloud strategies;
- The start of users with private clouds as a stepping stone to public clouds;
- The users' awareness about security;
- The users' move to private clouds as a backup to public clouds.

According to (Wintergreen Research 2010), the global markets for IaaS, PaaS and SaaS software and services sales, when considered together, are expected to grow from $20.3 billion in 2009 to $100.4 billion by 2016.

Currently, cloud computing is mainly developed in USA. While several initiatives to develop cloud computing have been launched at the national level, the European situation still presents delays when compared to the USA. The problem is that none of these initiatives have reached a particular level of importance providing them with an international visibility. This delay is reflected in the level of both cloud infrastructures in Europe and European CSP. Currently, there is no significant European company offering cloud services. Every model of cloud services is dominated by US companies (e.g. Amazon, IBM, Microsoft and Google). The same is true for the cloud infrastructures; most are located in USA and replicated in Europe.

1. SAAS VS PAAS VS IAAS MARKET

According to a PAC's study on "*Trends and evolution in cloud computing market in Europe*" (2010), the market for SaaS is the most mature in Europe, compared to IaaS and PaaS. It was initially primarily focused on IT services, which means they were dedicated to IT departments by helping them to run the business cheaper and faster. The SaaS model enjoyed the greatest market evolution as compared to the IaaS and PaaS markets. Now, this cloud service model is shifting towards a business service focusing on the redesign of core business processes. It currently presents the greatest potential for further development. The major players come from the USA, among them there are Amazon Web Services LLC and Rackspace GoGird. The SaaS market may be segmented along main business services as follow[17]:

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[14] http://www.virtu-all.fr/rubrique,cloud-computing,1246838.html

[15] http://www.forbes.com/2010/07/12/cloud-computing-growth-entrepreneurs-technology-informationweeksmb.html

[16] http://blogs.forbes.com/ciocentral/2010/12/27/2011-cloud-computing-predictions-for-cios-and-business-technology-leaders/; Forbes; December 2010

[17] For list of offers, see 'ERP en mode SaaS : les grands éditeurs tous présents' on www.indexel.net

- Enterprise Resource Planning (ERP): different domains across organizations are covered by these applications like finance/accounting, manufacturing and sales. Until now, they mainly affect small and medium businesses.
- Sales and Customer relationship management (CRM): this is one of the main segments of the SaaS Market and it is a significant portion of the CRM market as it represented 20% of income of the entire CRM market in 2009.
- Human Resources Management (HRM)
- Supply Chain Management (SCM): strongly correlated with ERP, SCM applications aim to improve and automate some portions of the supply logistics by reducing inventories and delivery times.
- Financial and Accounting Solutions
- Content management, communication and collaboration: this category includes services such as content management, document management, enterprise social networks, collaborative solutions, web conferences, e-learning solutions.
- Personal productivity: aim at increasing employee productivity, at facilitating more rapid reporting of business processes, hosted mobile applications, document-editing applications.
- Content creation: the exchange of data such as videos, pictures and sounds represents a high volume and still limits the supply in the application of content creation. However, infrastructure development and new possibilities offered by the cloud in terms of storage capacity should help open many doors to such applications.

At the opposite end of the SaaS, the European market for PaaS probably presents the lowest interest among the cloud stakeholders. This is mainly explained by three reasons. Firstly, the PaaS is probably the most difficult to understand among the lay audience. Secondly, the emergence of PaaS is limited by a lack of standardization at the level of programming languages. According to an AFDEL's study (2010), the PaaS position will stay limited in Europe if no real standard emerges. Thirdly, the skills which are needed to implement and operate PaaS solutions are not yet really developed. Currently, the PaaS market is segmented into several services developed along different functional areas. Among them, there are:
- General purpose
- Business Intelligence
- Integration
- Development and Testing
- Database

The IaaS model of cloud computing encompasses services like backup, recovery and web serving (moving web servers, management and analytic tools). According to the AFDEL (2010), the IaaS market may be segmented in three segments, namely:
- Back-up and storage services:
- Compute services:
- Private cloud computing:

The European IaaS market is a growing market. While less developed than the SaaS market, it has experienced an expansion these last 5 years. However, according to PAC's study, this expansion will be limited in the near future due to price pressure.

2. PUBLIC VS HYBRID VS PRIVATE CLOUD

Among the different models of cloud computing it is the hybrid cloud that is expected to experience the greatest growth, followed by private cloud and public cloud respectively. The Centre for Economics and

Business Research (2010) has forecasted the cumulative macroeconomics benefits across five European economies18 at € 763.297 million for the period between 2010 and 2015 (see Table 4). Among these benefits, 39,3% is expected to arise from the adoption of hybrid cloud computing, 35,1% from private cloud computing and 25,6% from public cloud computing. According to West (2011), the emergence of hybrid cloud computing does not mean spending will slow down. However, it points to a transition period where investments will not yet be fully strategic but will instead focus on short-term priorities.

Table 4 - Cumulative Economic Benefits 2010-2015, by Cloud Model

|	Private	Hybrid	Public	EMEA
	€ mil	€ mil	€ mil	€ mil
Business development opportunities	41,230	58,534	27,893	127,657
Business creation	72,214	72,352	70,587	215,153
Net total cost savings *of which:*	68,644	62,041	10,055	140,740
– *IT CapEx savings*	*32,493*	*75,249*	*46,940*	*154,682*
– *IT OpEx savings (FTEs / productivity)*	*20,531*	*32,728*	*20,570*	*73,829*
– *IT OpEx savings (power & cooling)*	*15,620*	*24,822*	*15,907*	*56,349*
– *additional cloud services expenditure (PAYG)* *	-	*70,758* -	*73,362* -	*144,120*
Indirect GVA	85,784	107,055	86,908	279,747
Total Economic Benefit	267,872	299,983	195,443	763,297
Direct and Indirect employment ('000s)	754.2	842.8	799.2	2,396.2

Source: (Centre for Economics and Business Research 2010)

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[18] France, Germany, Italy, Spain and the UK

A. STAKEHOLDERS ON THE LUXEMBOURG CLOUD COMPUTING MARKET

Many actors may be potentially involved in or impacted by the cloud computing model.

Figure 5 - The cloud computing ecosystem in Luxembourg
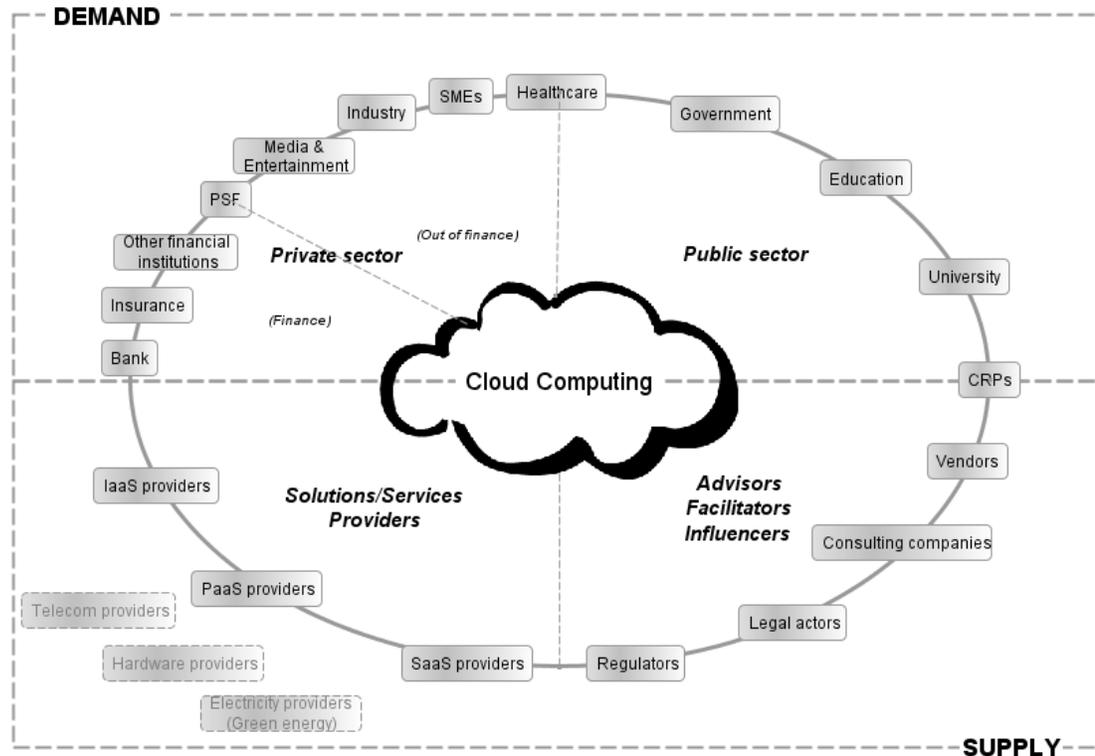
Source: Adapted from (KPMG 2011)

1. THE DEMAND SIDE

The demand side includes a virtually unlimited list of potential cloud users. For Luxembourg, it is interesting to distinguish between the public sector, the private financial sector and the remaining private sector.

The public sector refers to public institutions, notably tied to the Luxembourg government; education, healthcare, public research centres and the University of Luxembourg.

Luxembourgish financial and non-financial private firms have to comply with different legislative and regulatory frameworks. This impacts the cloud computing possibilities available and it therefore makes sense to distinguish between these two sectors.

The Luxembourg financial sector encompasses firms set up under both the Law of 5 April 1993, as amended, and the law of 6 December 1991, as amended. Possessing a massive amount of data and being advanced in terms of both IT capabilities and process maturity, the sector displays significant potential for the adoption of cloud technologies.

The non-financial private sector, for the purposes of this report, is a generic cluster encompassing all remaining private firms. Among these, companies linked to media, entertainment and production, and the SMEs in general, are seen as future users of cloud computing.

2. THE SUPPLY SIDE

The supply side may be split into two categories. On the one hand, there are the cloud service providers offering cloud solutions or services. On the other hand, there are the cloud advisors providing consultancy services on cloud computing and facilitating cloud adoption.

Cloud service providers
- IaaS Providers: includes providers of infrastructure cloud services, creators/operators of data centres, hosting companies;
- PaaS Providers: includes providers of platforms for developers and the providers of all necessary components for application hosting (operating system, software upgrades, security, etc.);
- SaaS Providers: includes publishers offering SaaS solutions, by either using their own infrastructure or by leasing infrastructure from an IaaS/PaaS provider

Cloud advisors, facilitators, influencers
- Consultancy companies: including software and computing service companies (SSII).
- Vendors: encompasses the different cloud resellers within the cloud value chain.
- Regulators: for example the CSSF for the financial sector.
- Legal actors: legal advice on the use and possibilities underlying cloud computing.

Indirect CSP acting on the supply side of cloud computing. For example:
- Telecom providers: bandwidth providers, providing connectivity between the different cloud services, and internet service providers (ISP) managing links from the cloud service to the public internet
- Electricity providers: although the use of cloud computing permits consolidation of energy consumption, no synergy is expected at this level. On top of this, electricity consumption is expected to grow, especially at the data centre level (AFDEL 2010). Further progress on this issue is feasible, which represents a huge potential for green IT and for green energy providers.

B. LEGAL SITUATION

At both the European and Luxembourgish level, there is no legislative and regulatory framework directly dedicated to the use of cloud computing. As a result, its application and use have to comply with different legislative and regulatory frameworks tied to some of its underlying characteristics and specificities. These legislative and regulatory frameworks are tied to:
- Data protection and data confidentiality
- e-Commerce
- e-Invoicing
- e-Communication
- Issues specific to the financial sector.

The main existing legislative and regulatory frameworks applicable to the use and application of cloud computing in Europe and Luxembourg are presented in appendix VII.B.

C. SPECIFITIES OF THE FINANCIAL INDUSTRY

From our understanding of the CSSF position, the use and application of cloud computing in the Luxembourg financial sector shall be authorized if there is compliance to legal and operational principles:

Legal principle: as mentioned in point III.A.1, Luxembourg companies acting in the financial sector have to comply with particular regulatory and legislative frameworks. These will significantly impact their use of cloud computing and the underlying possibilities.

Article 41 of the Luxembourg law of 5 April 1993 requires professional secrecy of financial data. As a result, this Article implies that data cannot cross Luxembourg's borders. For cloud computing, this means the data cannot be located outside Luxembourg. Under this article the public cloud cannot be used for the Luxembourg financial sector.

According to the 2009 CSSF annual report, both data control and traceability within the cloud are to be guaranteed by the cloud's user. This may be considered as prerequisite for the use of cloud computing within the Luxembourg financial sector. (Commission de Surveillance du Secteur Financier 2009, p.228)

Regulatory core principles: supervised financial institutions must keep control of their processes, both technical and business. Such control provides them with greater insurance to effectively assess and mitigate the underlying risks. This permits the financial institutions to better understand and anticipate the level of residual risk that can be accepted.

Technical aspects: supervised financial institutions shall ensure that IT processes and data are subjecte to confidentiality, availability, integrity and traceability principles.

Business processes and the underlying IT: shall comply with continuity and integrity principles and shall ensure a clear view of responsibilities.

D. STRENGTHS AND WEAKNESSES OF LUXEMBOURG

In order to assess the current state of the cloud computing industry, a EuroCloud Luxembourg workgroup undertook a SWOT analysis that aimed to cover the different aspects that constitute a high quality cloud computing offering. There were three main dimensions to the SWOT: economic, technological and legal. For each dimension, a brainstorming session was organized with the items raised being subsequently structured. Although "*Benefits (...) are potentially available to businesses in all sectors and industries*" (Centre for Economics and Business Research 2010), this SWOT analysis did not cover all sectors and is at this stage mainly focused on the government, research centres, SMEs and financial institutions. The results of the SWOT analysis are presented in the appendix **Error! Reference source not found.**.

1. POSITION OF LUXEMBOURG IN THE INTERNATIONAL CLOUD MARKET

Strengths

In the centre of Europe
- Due to its central position and the high proportion of foreign workers, Luxembourg is a country with a high level of multilingualism which facilitates the access to other European markets.

- LU-CIX, the commercial internet exchange, is at the crossroads of traditional European Internet traffic routes.
- An efficient route to the major European Internet networks.

First class infrastructures

- With the set-up of LuxConnect, the entrance of new players and the deployment of affordable Fibre Optical links have been enabled. The Fibre To The Home (FTTH) project will further improve the situation as it is foreseen that by 2013 every business activity area will have access to fibre optics networks with that incorporate network redundancy.
- Luxembourg has first class data centres to host cloud infrastructures and high capacity networks to deliver applications from the cloud to the customer.
- Availability of floor space even for high density environments. Availability of floor space in Top Tier Data centres.
- Supply of electrical power at competitive prices.

Regulated environment

- Regulated environment: proactive, open, business-oriented, business friendly transposition of European directives (especially for e-commerce).
- Unique legal framework to protect outsourced data for IT services in the financial sector.
- Openness of legislator to evaluate the impact of new technologies on the business of the banking sector and to identify points of the regulated framework which should be interpreted and clarified, with respect to the basic principles of security and confidentiality.

Image of trust and security

- Designed to satisfy the high requirements required by the financial and media sectors.
- Luxembourg's reputation for reliability. Strong image of trust and security. The high technical and security requirements of the financial sector have encouraged skilled and knowledgeable market players with a deep data protection culture.
- Creation of a dedicated centre (SnT, Interdisciplinary Centre for Security, Reliability and Trust) at the university improves the visibility of Luxembourg in the field of security and trust.
- Strong links between public and private research in the field of ICT related security and trust.
- Critical competences available in Luxembourg (PKI management, Infrastructure, high end housing).
- Support PFSs (Professional of the Financial Sector) have developed best practices in management of sensitive and critical data, not only for the financial sector but for the entire economy.

Support and agility of the government

- Strong commitment of government and public authorities to improve competitiveness of ICT infrastructure.
- Different landlords / Mix of public and private ownership.
- As a small country, Luxembourg has a supportive government providing agility and good reactivity (Internet backbone, housing facilities, international lobbying...). LuxembourgForICT has clearly demonstrated its support to promote initiatives such as cloud computing. Government easily approachable. Private organizations and public institutions can react quickly to demands from foreign companies intending to develop business in Luxembourg.
- "Marketing Agility": ability to quickly develop a common approach to present Cloud.
- Willingness to make the fiscal environment more attractive (ex. Intellectual Property).

Skills in the field of services

- A habit of transaction process management. Experience in billing management of transactions.
- Although packaged differently to classic SAN environments, all the hardware components needed for a cloud based infrastructure have already been in use for many years in Luxembourg. No risks from a technical point of view and a lot of 'local' expertise.
- Maturity of core components/services for cloud development.
- Local presence of international software integrators with cloud and service oriented architecture expertise.
- Local presence of the major hardware/software cloud solutions suppliers.
- Creation of a dedicated department (SSI, Service Science and Innovation) at the CRP Henri Tudor which improves the visibility of Luxembourg in the field of service engineering.
- Ability to develop strong expertise on cloud software development thanks to the University or Research Centres.
- Know-how in the fields of power and technology.
- Market maturity of suppliers and customers: CSP already offer Business Process Outsourcing (BPO) solutions to the financial industry.

Weaknesses

Lack of positioning and visibility

- Low recognition of Luxembourg as an ICT cluster. There may be opportunities to identify means of differentiation and to position Luxembourg as a centre of competence in certain areas.
- Lack of visibility. A first response could be based on promoting the expertise that lies behind PFS status. Luxembourg should then promote this expertise abroad and also promote local PFS expertise to attract new business from abroad. But if Luxembourg wants to capitalize on its PFS know-how and promote it, it should first conduct a study :
  - o On the PFS status outside Luxembourg.
  - o On the need for regulation: a regulated environment might encourage international organizations to establish their cloud solutions in Luxembourg. It is therefore important that Luxembourg clouds be considered as 'trusted environments'. The regulator is open to develop solutions which satisfy the security requirements of the financial sector and which explore new technical capabilities, such as cloud computing.
  - o On the cost of the PFS status and the necessity of local subsidiaries to align their strategy with their group's strategy.
  - o On the fact that the PFS status currently concerns the local financial industry only.

Focused on high level services only

- Most initiatives have been mainly for the financial sector with its specific high level and costly requirements. Too much focus on the top tier segment. Problem of prices in the top tier.
- Luxembourg is considered expensive: Luxembourg's HR cost might be a major barrier to succeed when selling in the international market.
- Diversify the range of data centres:
  - o Necessity to enable modular or 'as you need' infrastructure for efficient time to market and delivery;
  - o Develop a multi-tier approach in order to attract new business activities.

Size of the market

- Not enough critical mass to obtain international recognition.

- Problem of the critical size (for pricing purposes...).
- Not competitive for mass market adoption.
- Necessity to create cross border agreements.
- Lack of internal energy supply channels. Dependency on external energy providers.

Not enough critical mass in R&D
Institutions that make up the 4CU (4 Research Centres and University) are both clients and suppliers. They are clients of cloud computing with their need for computing capacity and storage and with their use of the cloud in their own fields. They are also suppliers of cloud services in the work they do to advance research into cloud computing and to formalize the methods and tools that help companies move into the cloud.

In its role of provider, R&D needs to be visible and to work to the resolution of technical problems, but:
- No public budget programmes are currently available for research activities in this field.
- There is a strong link between public and private research in the field of ICT related security and trust. But not enough critical mass to obtain international recognition.
- It is necessary to continue to invest in this field of research and innovation.

2. POSITION OF CLOUD ON THE LUXEMBOURG MARKET

Strengths

One length ahead thanks to the banking sector
- Luxembourg's economy is heavily based on the financial sector and influenced by its practices and requirements as regards IT governance. From this point of view, it is clear that the Luxembourg market has an edge. Since the creation of the PFS status, Luxembourg has gained solid experience in managing confidential information.
- Banking, and financial services in general, are among the biggest IT-spenders. The Luxembourg economy has a large number of banking institutions that can serve as important levers to start the cloud computing market in Luxembourg.

Public administration leverage on cloud computing
Government is open to the deployment of e-government cloud solutions for citizens and businesses. "*In 2011 Deloitte predicts e-government (eGov) usage will reach an inflection point. Across developed countries, the proportion of businesses that use eGov services for at least one process is expected to average over 90 percent, up from 75 percent in 2010.*" (Deloitte 2011). And for good reason, some experiences in other countries around the world have already shown that the cloud was able to save money. In the United States, for example, "*The agencies generally saw between 25 and 50 percent savings in moving to the cloud.*" (Brookings Institution 2010) This is a first argument for getting the government to consider cloud computing as an interesting solution. But from a qualitative point of view, "*Cloud computing seems to attract the attention of regional and local institutions. Indeed, some cities or 'communities of communes' are thinking of taking advantage of advanced cloud computing. By virtualizing their infrastructure, they constitute clouds of territorial communities which benefit many local organisations, small peripheral cities, hospitals and social centers, etc.*" [19]

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[19] http://www.virtu-all.fr/rubrique,cloud-computing,1246838.html

The advantage of Luxembourg is that two central administrations already exist: the 'Centre des Technologies de l'Information de l'Etat' (CTIE) and the 'Syndicat Intercommunal de Gestion Informatique' (SIGI). Both entities can constitute levers to enable the government and the municipalities to make services available on the cloud model for their own internal business and for citizens. The existence of CTIE, a provider of computer services for the entire state of Luxembourg, makes it easy to set up a private cloud, managed by the government, for the use of its administrations in order to share software and services.

As far as Government requirements are concerned, they are less complex than for the financial sector. Luxembourg data would not have to 'cross the border'. A private cloud for the government would not therefore have to face the issues related to differences between national jurisdictions. Obviously the requirements for availability need to be seriously analysed when setting up public solutions.

Many SMEs, good profile for cloud computing

If large corporations are generally the first to adopt cloud computing solutions, given their expertise and knowledge in IT, SMEs constitute a huge market to be developed in a second stage. As SMEs make up 97% of the Luxembourg market, this is a strong argument for its economy. If they are well informed, they would represent a considerable potential for the development of the cloud computing market.

From an economic standpoint, this may represent a significant business development opportunity for Luxembourg. Indeed, "*cloud computing (...) shakes up the value chain and significantly reshuffles the cards between the players, especially between large and small ones. Cloud computing can be a powerful development tool for software publishers of all sizes, in that it may offer them access to disproportionate infrastructure capacity in terms of their need and to support their growth.*" (AFDEL 2010). Although Luxembourg contains only a relatively small number of software companies, all companies that have developed, or are developing, applications for their own use may become SaaS vendors that propose their service offer to other companies.

Fiscal incentives

In the Réglement Grand Ducal of December 21, 2007, the Chamber of Deputies of Luxembourg introduced an Article 50a related to income tax (cf. Appendix VII.C - TAX law on intellectual property in LuxembourgTAX law on intellectual property in Luxembourg). This new article is intended to encourage innovation by granting tax benefits to income generated from intellectual property rights of a company which is taxable in Luxembourg. This tax regime applies to copyright in computer software, patents, trademarks or trade, drawing or model. Revenues generated by these intellectual property rights or by the sale of these rights are exempt up to 80%. This law also aims to promote research and development, by allowing a company, which itself uses its own patent, to deduct from income the equivalent of 80% of a license fee that would have been paid to a third party.

This tax measure should further encourage Luxembourg companies to develop software and to protect the results of their research and development activity. There have been few software editors in Luxembourg until now, but with this law they may become more numerous because of the opportunities offered by cloud computing to create new services and to migrate existing services in the cloud. This could be a great opportunity for Luxembourg as the software can be seen as the engine or the visible part of the iceberg of the cloud infrastructure. Indeed the software will enable the provision of services to the customer and hence enable the latter to operate its business.

However, the weakness of this law is that it is not sufficiently well-known in Luxembourg, and even less abroad. It really deserves to be promoted internationally to attract business.

Market emulation
- Global willingness of the business community to move toward the cloud.

- Some multinationals are players who are likely to invest in new technologies and to drive the market. Some of them are actually considering outsourcing a part of their activity.
- Value-added services/packages are already available in the cloud in Luxembourg.
- Opportunity for local actors to exploit niches by developing specific solutions, which meet the requirements of the regulator and supervisory authority.

Weaknesses

Limited and high standard IaaS offer
- The infrastructure exists, there is the capacity to propose IaaS but still no (or few) industrialised/standardized IaaS offerings/solutions (for instance, payment is in terms of physical "rack space" and not in terms of global capacity).
- Too focused on a high level offer with first class data centres. This poses a problem of cost for small businesses that do not need a high level of infrastructure and do not want to pay as much.
- No (or few) industrialized PaaS solutions in Luxembourg.
- Few custom applications/ developments are 'cloud ready', investment has to be made that can be difficult to justify (viewed as a technical investments with no direct benefit for business).
- Little awareness of the existing SaaS solutions.
- No best practices allowing the comparison of offers.
- No reference price. Customers compare prices but they forget that cloud computing is based on the 'on demand' principle.

Lack of awareness of the demand side
- Enterprises, and especially SMEs, need help to understand what cloud computing is, to identify opportunities for their business and relevant services and also to be reassured about the reliability of cloud computing. The most important difficulty is to convince companies to outsource their data. This is particularly true for the banking sector, which is ready to outsource applications but not data.
- Enterprises need to be accompanied in the mutation of their IT management, from the sourcing strategy definition stage to the concrete migration stage. It is difficult for them to take the decision to move or not to the cloud without first knowing why and with which ROI. Some guidance actions should be developed to assist customers/companies in their migration to the cloud and particularly to help them to analyse their critical data, to identify non critical workload and determine the value of cloud computing for them.

Slow progress of know-how and tools of the supply side, market immaturity
- Low maturity of the Luxembourg market actors, experimental stage in the domain of cloud computing. Insufficient existing business cases. Not positioned on international map.
- Links and networks are very recent and so do not yet have industry or market maturity and are unknown outside.
- Lack of knowledge on the impact of cloud computing on software architecture.
- Service oriented architecture is not well deployed, but is mandatory in term of development of solutions.
- Development skills are unaware of cloud specificities.

The risk of these weaknesses is that clients are lost to foreign CSP (off-shoring). It is therefore necessary to take initiatives to boost cloud computing on the national market.

Lack of SaaS applications

SaaS is announced as the model with the highest added value, but the supply side of SaaS application is still very low. The points mentioned above can probably explain this finding, but there may be other reasons for it.

- There is no software patent in Europe. The element that could help develop the SaaS offering would be to have the possibility to apply intellectual property rights to SaaS applications.
- Although Luxembourg has adopted a tax incentive scheme for R&D, it is possible the country is not considered a good place to invest.

Legal issues

When considering the financial sector, the data location within the cloud remains an important barrier for market participants in adopting cloud solutions. According to the Art. 41 of the Luxembourg law of 5 April 1993, professional secrecy of financial data is required. Under this article, data can cross the Luxembourg borders under certain very restrictive conditions (encrypted and covered by the Luxembourg legal framework and supervisory authorities). This means the data cannot be located outside Luxembourg within a cloud. However, an exception may be envisaged when using the "Server Farm" concept to implement cloud computing between different entities of the same company which are located in different European countries. Further clarifications and approvals are still required to make this solution operational.

When considering a cloud solution, implying a data transfer to a country outside Europe (e.g. private sector), protection and privacy of personal data must be considered. While the standard contractual clauses set up by the Commission Decision 2010/87/EU provide an appropriate basis for the data transfer outside Europe, a notification procedure implying a prior approval of the Commission Nationale pour la Protection des Données (CNPD) is still required in Luxembourg. Moreover, on the basis of this Commission Decision, the CNPD has the "quasi" obligation to accept the notification. This administrative burden has a cost and may constitute a barrier for the development of cloud computing in Luxembourg.

IV.   CONCLUSION

Cloud Computing is no longer a buzz word in Luxembourg. It is a reality from both the demand and the supply sides. The infrastructure exists, but has not yet been packaged sufficiently as an IaaS offering. The same is true for PaaS, where the technologies are already adopted intra company, but not yet offered on a standardized scale. Regarding SaaS, a few actors are present but seem to lack the market recognition they deserve. A comprehensive strategy to position Luxembourg in these growing markets is needed. This strategy should entail both elements to promote Luxembourg as a hub for the cloud computing business in the European Union as well as to promote the use of cloud applications by end users.

The action plan proposed by EuroCloud Luxembourg should be considered as a catalyst to rally all key actors from the public and private sector around this common goal.

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VI.   ACRONYMS

4CU	CRP Gabriel Lippmann, CRP Henri Tudor, CRP Santé, CEPS and University
API	Application Programming Interfaces
BPaaS	Business Process as a Service
BPO	Business Process Outsourcing
Capex	Capital Expenditure
CNPD	Commission Nationale pour la Protection des Données
CRM	Customer relationship management
CRP	Public Research Centre
CSP	Cloud Service Provider
CSSF	Commission de Surveillance du Secteur Financier
CTIE	Centre des Technologies de l'Information de l'Etat
EMEA	Refers to the UK, France, Germany, Italy and Spain, a subset of the company's global presence (acronym used by EMC Corporation)
ERP	Enterprise Resource Planning
FTTH	Fiber To The Home
GDP	Gross Domestic Product
IaaS	Infrastructure As A Service
ICT	Information and Communication Technologies
ISP	Internet Service Provider
IT	Information Technology
LFB	Luxembourg For Business
LFF	Luxembourg For Finance
Opex	Operational Expenditure
PaaS	Platform As A Service
PPP	Public-Private Partnership
PFS	Professional of Financial Sector
R&D	Research And Development
ROI	Return on Investment
SaaS	Software As A Service
SAN	Storage Area Network
SIGI	Syndicat Intercommunal de Gestion Informatique
SLA	Service Level Agreement
SME	Small and Medium Enterprise
SnT	Interdisciplinary Centre for Security, Reliability and Trust
SWOT	Strengths, Weaknesses, Opportunities, Threats

VII. APPENDICES

A. ABOUT EUROCLOUD LUXEMBOURG

1. EUROCLOUD LUXEMBOURG BOARD MEMBERS

Mme Amal Choury, Chairwoman
M. Marc Hemmerling, Vice Chairman
M. Marcel Origer, Vice Chairman
M. Romain Lanners, Secretary General
M. Laurent Cornet, Member
M. Bernard Drappier, Member
M. Sébastien Genesca, Member
M. Gérard Hoffmann, Member
M. Renaud Oury, Member

2. MEMBER COMPANIES

ABBL a.s.b.l.
Accenture S.à.r.l.
Allen & Overy Luxembourg
Atoz S.A.
Bull PSF S.A.
Centre de Recherche Public Henri Tudor
CETREL S.A.
Champ Cargosystems S.A.
Cisco Systems Luxembourg Sàrl
Deloitte S.A.
Dimension Data Luxembourg
e-Business & Resilience Centre S.A.
e-Kenz S.A.
EMC Luxembourg PSF S.à.r.l.
Entreprise des Postes et Télécommunications
European Data Hub S.A.
EZC Group S.A.
Fedil - Business Federation Luxembourg
Fujitsu Technology Solutions (Luxembourg) S.A.
Hewlett-Packard Luxembourg S.C.A.
IBM Services Financial Sector Luxembourg S.à.r.l.
ike Consulting S.à.r.l.
LAB Document Vault PSF S.A.
Logica Luxembourg S.A.
LuxCloud S.A. (Datacenter Luxembourg S.A.)
LuxConnect S.A.
P&T Consulting S.A.
PricewaterhouseCoopers S.à.r.l.
Telecom Luxembourg S.A.
Telindus S.A.
Verizon Business S.A.

B. LEGISLATION OVER CLOUD COMPUTING

Legal issue related to the use of cloud computing	Legislation's name	Type of legislation	Country of application	Content
Data protection & data confidentiality	Directive 1995/46/EC on the protection of individuals with regard to the processing of personal data and on the free movement of such data (currently under revision)	European Directive	EU Member States	The Directive has been set-up with view to harmonize the privacy laws of the different Member States. Through its 32 articles dealing with personal data handling, it provides a legislative framework setting a basic standard on privacy protection. The Directive provides "*individuals with a notice of the use of information, a form of consent for use of information, require access to his/her data, require the integrity and security of the data and set demands for enforcement*" (Ruiter & Warnier; 2010; "Privacy Regulations for Cloud Computing - Compliance and implementation in theory and practice"). The Directive is currently under revision.
	Law of 2 August 2002 on the protection of persons with regard to the processing of personal data, as amended	Luxembourg law	Luxembourg	The law transposes the Directive 1995/46/EC within the Luxembourg legislation
	Law of 30 May 2005 laying down specific provisions for the protection of persons with regard to the processing of personal data in the electronic communications sector and amending Articles 88-2 and 88-4 of the Code of Criminal Procedure, as amended	Luxembourg law	Luxembourg	The law transposes the Directive 2006/24/EC, as amended, within the Luxembourg legislation
	Commission Decision 2010/87/EU on standard contractual clauses for the transfer of personal data to processors established in third countries under	European Directive	EU Member States	It covers standard contractual clauses for the transfer of personal data to processors established in third countries under Directive 95/46/EC of the European Parliament and of the Council.

	Directive 95/46/EC of the European Parliament and of the Council			
FSPs of support status	Circular 07/307	Luxembourg law	Luxembourg	This circular aims at providing explanations and precisions regarding particular dispositions of the law of 13 July 2007.
	Law of 13 July 2007 on markets in financial instruments transposing the Directive 2004/39/EC and the Article 52 of the Commission Directive 2006/73/EC	Circular	Luxembourg	The law transpose the Directive 2004/39/EC (the MiFIDirective) and the Article 52 of the Commission Directive 2006/73/EC (the implementing Directive).
	Directive 2004/39/EC of the European Parliament and of the Council of 21 April 2004 on market markets in financial instruments amending Council Directives 85/611/EEC and 93/6/EEC and Directive 2000/12/EC of the European Parliament and of the Council and repealing Directive 93/22/EEC.	Directive	EU Member States	*"The European Union (EU) establishes a comprehensive regulatory framework governing the organized execution of investor transactions by exchanges, other trading systems and investment firms. As such, it sets up, among others, a single authorization for investment firms to enable them to work throughout the EU, with a minimum of formalities, while strengthening the protection of clients."* (source: http://europa.eu/legislation_summaries/internal_market/single_market_servic es/financial_services_general_framework/l24036e_fr.htm)
	Law of 5 April 1993 on the financial sector, as amended	Luxembourg law	Luxembourg	The law covers different field relating to the access to professional activities in the financial sector (including "FSPs of support"), obligations concerning cross-border credit transfers), prudential supervision of the financial sector, Reorganisation and winding up of certain financial sector professionals, deposit-guarantee schemes in credit institutions, compensation schemes for investors in credit institutions and investment firms, penalties, amendments, repeals and transitional provisions
e-Commerce	Directive 2000/31/EC on certain aspects of information society services, in particular electronic commerce, in the Internal	European Directive	EU Member States	The Directive covers certain legal aspects of information society services with a particular focus on electronic commerce within the Member States. More particularly, "*it provides a legislative framework for electronic commerce in Europe, establishes harmonized rules on particular issues related to electronic commerce, enhances the cooperation between Member States and the roles of*

	Market (Directive on electronic commerce)			*self-regulation*" (source: http://ec.europa.eu/internal_market/e-commerce/directive_en.htm).
	Law of 14 August 2000 on electronic commerce amending the Civil Code, the new code of civil procedure, commercial code, penal code	Luxembourg law	Luxembourg	The law covers different topics which are the general dispositions, electronic proof and electronic signature, penalties, commercial communications, contracts electronically contracted, Intermediaries service providers' responsibility and electronic payments.
e - Invoicing	Council Directive 2001/115/EC amending Directive 77/388/EEC with view to simplifying, modernising and harmonising the conditions laid down for invoicing in respect of value added tax	European Directive	EU Member States	The Directive 2001/115/EC amends the Directive 77/388/EEC *with view to simplifying, modernising and harmonising the conditions laid down for invoicing in respect of value added tax* (Directive title). Under specific conditions, it provides the e-Invoicing with a legislative status
	Law of 1st July 2003 on value added tax - Invoicing and electronic commerce	Luxembourg law	Luxembourg	The law completes and amends the law of 12 February 1979, as amended, on value added tax. More particularly, it transposes the Council Directive 2001/115/EC within the Luxembourg law and, *inter alia*, legally recognizes the use of e-invoicing in Luxembourg. According to Ernst & Young, "*it is clear that there is no legal impediment to the implementation of e-Invoicing in Luxembourg*" (inspired from Ernst & Young, 2009, "E-invoicing - Luxembourg: a practical case-study").
e-Communication	Law of 30 May 2005 laying down specific provisions for the protection of persons with regard to the processing of personal data in the electronic communications sector and amending Articles 88-2 and 88-4 of the Code of Criminal Procedure, as amended	Luxembourg law	Luxembourg	The law transposes the Directive 2006/24/EC, as amended, within the Luxembourg legislation

C. TAX LAW ON INTELLECTUAL PROPERTY IN LUXEMBOURG

Règlement grand-ducal du 21 décembre 2007 portant exécution de l'article 50bis, alinéa 6 de la loi modifiée du 4 décembre 1967 concernant l'impôt sur le revenu[20]

«**Art. 50bis.**
(1) Les revenus perçus à titre de rémunération pour l'usage ou la concession de l'usage d'un droit d'auteur sur des logiciels informatiques, d'un brevet, d'une marque de fabrique ou de commerce, d'un dessin ou d'un modèle sont exonérés à hauteur de 80% de leur montant net positif. Est à considérer comme revenu net, le revenu brut diminué des dépenses en relation économique directe avec ce revenu, y compris l'amortissement annuel ainsi que, le cas échéant, une déduction opérée pour dépréciation.

(2) Lorsqu'un contribuable a lui-même constitué un brevet et qui est utilisé dans le cadre de son activité, il a droit à une déduction correspondant à 80% du revenu net positif qu'il aurait réalisé s'il avait concédé l'usage de ce droit à un tiers. Est à considérer comme revenu net au sens du présent alinéa, la rémunération fictive diminuée des dépenses en relation économique directe avec ce revenu, y compris l'amortissement annuel ainsi que le cas échéant une déduction opérée pour dépréciation.
La déduction est accordée à partir de la date de dépôt de la demande de brevet. En cas de refus de la demande de brevet, la déduction antérieurement opérée doit être ajoutée au bénéfice imposable de l'exercice d'exploitation au cours duquel le refus a été notifié au contribuable.

(3) La plus-value dégagée lors de la cession d'un droit d'auteur sur des logiciels informatiques, d'un brevet, d'une marque de fabrique ou de commerce, d'un dessin ou d'un modèle est exonérée à hauteur de 80%. Par dérogation à la phrase précédente, la plus-value est imposable à raison de la somme algébrique de 80% des revenus nets négatifs dégagés par ledit droit au cours de l'exercice de la cession ou des exercices antérieurs pour autant que ces revenus nets négatifs n'ont pas été compensés en vertu des dispositions de l'alinéa 4, numéro 2.
L'exonération prévue par la première phrase du présent alinéa est également refusée dans la mesure où le prix d'acquisition des droits mis en compte pour la détermination du revenu de cession a été réduit par le transfert d'une plus-value en vertu des articles 53 et 54.

(4) L'application des alinéas 1 à 3 du présent article est soumise aux conditions suivantes:
1. le droit doit avoir été constitué ou acquis après le 31 décembre 2007;
2. les dépenses, amortissements et déductions pour dépréciation en rapport avec le droit sont à porter à l'actif du bilan du contribuable et à intégrer dans le résultat au titre du premier exercice pour lequel l'application des dispositions des alinéas susvisés entre en ligne de compte pour autant que pour un exercice donné ces frais ont dépassé les revenus en rapport avec ce même droit.

(5) L'application des alinéas 1 et 3 est soumise à la condition additionnelle que le droit n'ait pas été acquis d'une personne qui a la qualité de société associée. Une société est à considérer comme société associée au sens du présent alinéa
a. si elle détient une participation directe d'au moins 10% dans le capital de la société bénéficiaire du revenu,
ou

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b. si son capital est détenu directement à raison d'au moins 10% par la société bénéficiaire du revenu, ou

c. si son capital est détenu directement à raison d'au moins 10% par une troisième société et que celle-ci détient une participation directe d'au moins 10% dans le capital de la société bénéficiaire du revenu.

(6) Le contribuable peut recourir à toute méthode d'évaluation généralement utilisée pour l'évaluation des propriétés intellectuelles. Aux fins d'application de l'alinéa 3, la valeur estimée de réalisation du droit cédé doit être établie conformément à l'article 27, alinéa 2.

Les entreprises présentant les caractéristiques d'une micro, petite ou moyenne entreprise peuvent cependant établir la valeur estimée de réalisation d'un droit décrit à l'alinéa 3 à 110% de la somme algébrique des dépenses qui ont diminué la base d'imposition du cédant pour l'exercice de la cession et pour des exercices antérieurs.

Sont considérées au sens du présent alinéa comme micro, petites ou moyennes entreprises, les entreprises répondant aux critères établis par règlement grand-ducal.»

D. PROPOSITION DE CRÉATION DE 'CLOUD COMMUNAUTAIRES LOCAUX' EN FRANCE

L'ADEN propose la création de 'cloud communautaires locaux' dans le cadre du grand emprunt national[21]

Objectif : assurer l'indépendance technologique et industrielle de la France et favoriser le développement économique de ses territoires

Paris, le 10 mai 2010 –   Révolutionnant l'usage des technologies et les modèles de compétitivité, le cloud computing est au cœur des enjeux économiques. Il figure à ce titre parmi les priorités du grand emprunt national qui prévoit de consacrer à son développement plusieurs centaines de millions d'euros.

Dans cette perspective, Jean Pierre Brulard le Président de la commission 'Infrastructures' de l'Association pour le développement de l'économie numérique en France (ADEN) vient de publier une proposition en faveur du déploiement de 'clouds communautaires locaux', impulsé par les pouvoirs publics locaux et soutenu par le grand emprunt.

Cette stratégie alternative vise à garantir l'indépendance technologique et industrielle de la France, tout en dotant ses territoires des ressources et moyens technologiques indispensables au développement de leur économie, de leur attractivité et de leur compétitivité.

Des clouds locaux interconnectés

Le modèle proposé par l'ADEN consiste, sous l'impulsion des pouvoirs publics locaux (conseils généraux, conseils régionaux, municipalités, structures intercommunales,...) et dans le cadre de partenariats entre acteurs publics et privés, de créer un maillage de centrales numériques éco-responsables (datacenters) et de plates-formes de services et d'infrastructures numériques partagées, répondant aux besoins informatiques tant des entreprises, administrations et établissements publics que des citoyens.

A terme, l'interconnexion de ces clouds communautaires locaux permettra de mutualiser les applications et les capacités de traitement. Ils constitueront ainsi une infrastructure nationale offrant à moindre coût les trois types de services qui caractérisent le cloud computing :

- services applicatifs pour les entreprises, les administrations, les établissements publics et les particuliers (ou Software-as-a-Service),
- services de plate-forme pour le développement et la distribution d'applications et d'activités numériques (ou Platform-as-a-Service),
- services d'infrastructures (ou Infrastructure-as-a-Service), permettant aux utilisateurs de s'affranchir des coûts d'acquisition et de maintenance associés à une informatique internalisée.

Répondre aux grands défis des 20 prochaines années

En adoptant ce modèle original, donnant un rôle décisif aux acteurs locaux dans le développement de l'économie de l'immatériel et de la société numérique, la France renforce sa capacité à relever les défis économiques, sociétaux et environnementaux des prochaines décennies :

- **Souveraineté nationale**, notamment face aux grands acteurs américains et asiatiques du cloud computing, en conservant sur son territoire les savoir-faire et compétences technologiques stratégiques, ainsi que les données privées et industrielles sensibles ;

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[21] Communiqué de presse publié par l'ADEN le 10 mai 2010

- **Sauvegarde et de création d'emplois**, grâce au développement d'une offre d'externalisation d'infrastructure IT de proximité, évitant les délocalisations à l'étranger et facilitant le développement du télétravail et de nouvelles activités ;
- **Développement de marchés clés pour l'avenir**, en favorisant l'émergence d'une économie territoriale dématérialisée performante et sécurisée dans les domaines de la santé, de l'éducation, de la justice, de l'administration ;
- **Développement économique et aménagement du territoire**, en renforçant d'une part la compétitivité des TPE, PME-PMI et ETI régionales grâce à une meilleure utilisation des technologies et à l'externalisation de leurs infrastructures, et, d'autre part, l'attractivité des territoires pour les investisseurs et les entreprises, grâce à la présence d'infrastructures IT de proximité à l'état de l'art ;
- **Développement durable**, grâce à des centrales numériques à haute performance énergétique, contribuant à la réduction de l'empreinte carbone des acteurs économiques ;
- **Développement technologique et innovation**, en remédiant à l'obsolescence du parc de datacenters français et à leur sous-utilisation, et en soutenant le développement d'écosystème d'innovation associant universités, centres de recherches, entreprises établies et start-up innovantes.

Lancer rapidement les premières initiatives

L'ADEN considère que, dans le contexte actuel de rationalisation et de rigueur budgétaire, la mise en œuvre volontariste de centrales numériques locales éco-responsables s'inscrit en priorité dans une démarche évolutionnaire et incrémentale vis-à-vis des investissements significatifs déjà réalisés par les acteurs publics et para-publics locaux. C'est autour de ce premier socle que pourront s'agréger des plates-formes mutualisées de services et d'infrastructures numériques à destination des acteurs publics, privés et des citoyens.

L'ADEN propose que les premières expérimentations de clouds communautaires locaux soient menées sous forme de partenariats publics-privés dans le cadre de la consultation publique qui devrait être lancée prochainement par le Commissariat aux Investissement du grand emprunt national.

E. SOME EXAMPLES OF CLOUD COMPUTING INITIATIVES IN GOVERNMENT

"*Aux Etats-Unis : une politique volontariste, un catalogue d'applications*
Trente-sept pages pour un 'État des lieux du cloud dans l'administration': en mai 2010, Vivek Kundra, le Chief Information Officier (en photo ci-contre) des États-Unis, publiait une feuille de route nourrie, fixant les objectifs de l'utilisation du cloud par le secteur public dans le pays. 'D'ici à septembre 2013, tous les investissements technologiques des agences fédérales devront avoir été examinés sous l'angle du cloud. Dès que celui-ci sera moins coûteux qu'une autre solution, il devra être privilégié', peut-on notamment y lire.
Dès septembre 2009, la Maison Blanche avait mis en ligne le site Apps.gov à destination des administrations fédérales. En proposant un catalogue d'applications et de services de cloud computing, fournis par des prestataires déjà référencés par l'État, il simplifie considérablement le processus d'achat. Autre piste envisagée : le recours à des services de messagerie et d'agenda, hébergés dans le nuage, pour près de 100 000 fonctionnaires dès 2011.

Au Japon : un nuage gouvernemental
Le Japon a choisi de créer, d'ici à 2015, un nuage gouvernemental destiné à accueillir les différentes institutions gouvernementales japonaises. Baptisée 'Kasumigaseki cloud', du nom du quartier de Tokyo dans lequel la plupart des ministères sont situés, l'initiative permettra de consolider les ressources informatiques de l'État au sein d'un seul nuage privé. Au-delà de la réduction des dépenses informatiques, le projet vise également à privilégier une informatique plus respectueuse de l'environnement. Le 'Kasumigaseki cloud' fait partie d'un plan plus général d'investissements dans les nouvelles technologies, auquel le gouvernement japonais consacre un budget de 100 milliards de yens (environ 1 milliard d'euros).

Au Danemark : finies, les factures en papier ?
À bien des égards, le Danemark, avec ses 5,5 millions d'habitants et son taux de pénétration d'Internet qui est l'un des plus forts au monde, fait partie des pionniers européens du cloud computing. La NITA (Agence nationale des nouvelles technologies) a déjà expérimenté la migration dans le nuage de deux de ses plus importantes plateformes informatiques. La première, Digitaliser.dk, est un réseau d'échanges, entre administration et communauté informatique, sur la modernisation numérique de l'État (au menu : discussion sur l'Open Data, les formats et les standards, etc.). La seconde, NemHandel, est un service gratuit qui permet à tout prestataire de l'État d'envoyer ses factures dans un format électronique standard, comme l'impose la loi danoise. Lancé en 2007, ce service a pour objectif de permettre aux 300 000 PME danoises, plus habituées à envoyer des factures papier à leurs clients, de travailler pour le gouvernement.

Au Royaume-Uni : le "G -Cloud"
C'est une feuille de route pour un régime d'athlète. Le rapport 'Government ICT strategy', présenté par le gouvernement britannique à la fin de l'année 2009, fixe les grandes orientations du gouvernement en matière d'investissements technologiques d'ici à 2020. Pilier de cette stratégie ? Le cloud computing. Première étape : diminuer drastiquement le nombre de fermes de serveurs du gouvernement pour passer de 130 aujourd'hui à une dizaine seulement. Cet ensemble porte même un nom :"G -Cloud", pour 'nuage gouvernemental'. Cette rationalisation sera accompagnée du lancement d'un 'magasin applicatif', permettant le partage d'applications et de services, pour lequel 500 millions de livres

d'économies sont attendus en 2020. Une réforme portée, comme aux États- Unis, par un responsable rattaché au gouvernement : John Suffolk, 'her Majesty's Government Chief Information Officer'"[22]

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F. EUROCLOUD ASSOCIATION

"The cloud model stands for global reach, ecosystem partnerships and integration. Our goal in developing EuroCloud is to promote SaaS and cloud services and applications across Europe and encourage its take up. EuroCloud will be an accelerator of business, of technological relationships and application integration. It will represent the cloud industry in Europe — taking into account local differences — and be an excellent platform for exchanges with America or Asia."

Pierre-José Billotte, EuroCloud General Coordinator

1. WHY BUILD SUCH A BUSINESS NETWORK?

The vision of EuroCloud, including the brand, was created in 2009 by Pierre-José BILLOTTE, Founder & Chairman of the French ASP forum for the following reasons:

- Europe has a fast growing SaaS and Cloud Computing industry, but each country is currently operating separately with few contacts in other European countries.
- National SaaS vendors are growing and are looking to build European and international relationships through business and technological partnerships.
- The European Authorities do not currently recognize the European Cloud Computing industry, which is an industry that can help stimulate the economic and technological environment to promote new Cloud Computing industries.
- Cloud Computing implies application integration into an Application-Oriented Ecosystem. Developing new application partnerships, both European and worldwide represents the next crucial step.

EuroCloud, the pan European Cloud Computing business network, through action at both local and European levels will help to answer these new demands.

2. EUROCLOUD GOALS

- To build a pan European network organized in two tiers with a national level (France, Spain, England, Belgium, etc.) and a European level. The national level focuses on local topics and the European level on European topics, under the EuroCloud brand (or another if appropriate in a national setting). Only companies who have an interest in Cloud Computing and participate in the Cloud ecosystem can be members of the network.
- Build relationships with the European authorities (Commission and Parliament) to help recognize the Cloud Computing industry as the future of IT in Europe and to promote a stimulating environment for development and growth of the industry.
- Promote business relationships between members throughout Europe and internationally with counterparts such as SIIA.
- Promote technological relationships between members throughout Europe and internationally.

About EuroCloud Luxembourg

EuroCloud Luxembourg is a non-profit organization that has been founded in December 2009 with the support of Fedil Business Federation Luxembourg and ABBL. EuroCloud Luxembourg is an active member of the pan European Cloud Computing and SaaS business network EuroCloud.
EuroCloud Luxembourg mission statement:

- Contribute to the development of the cloud computing business in Luxembourg by creating an exchange platform « Cloud ecosystem » for cloud service providers;
- Promote and encourage the uptake of cloud services and applications on a national and international level;
- Participate in the development of a legal framework for cloud computing on a national and European level.

EuroCloud Luxembourg has a fast growing membership. Currently 31 companies are members of the organization representing a broad range of service providers from the cloud computing business.

More information about the EuroCloud network can be found under http://www.eurocloud.org/

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