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List of Acronyms and Abbreviations

CoE	Centres of Excellence for Computing Applications
CSA	Coordination and Support Action
D	Deliverable
EC	European Commission
EU	European Union
EXDCI	European Extreme Data & Computing Initiative
FET	Future and Emerging Technologies
FP7	Seventh Framework Programme, European Union research and development funding programme
H2020	Horizon 2020 – The EC Research and Innovation Programme in Europe
HPC	High Performance Computing
ISV	Independent Software Vendor
ISC	International Supercomputing Conference
IT	Information Technology
KPI	Key-Performance Indicator
PCP	Pre-commercial procurement
PPI	Public procurement of innovation
PRACE	Partnership for Advanced Computing in Europe; Project Acronym
PRACE-3IP	PRACE Third Implementation Phase Project
R&D	Research and Development
R&I	Research and Innovation
SME	Small and Medium Enterprise
SRA	Strategic Research Agenda
TRL	Technology Readiness Level
WG	Working Group
WP	Work Package

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Executive Summary

The European HPC ecosystem seems to lack SMEs and start-ups. Are there specificities to HPC that make it particularly difficult for SMEs and start-ups to succeed in this domain in Europe?

The goal of the present report is first, to know more about potentially upcoming HPC start-up projects and second, to understand the HPC intrinsic difficulties that start-ups and SMEs in HPC face. **The report focuses on the *situation as perceived today by start-ups and SMEs*.**

To know more about potentially upcoming start-ups, we gathered via the EXDCI survey information from the Centres of Excellence and the FETHPC projects about mature technologies within their projects for future start-ups. It turns out that three projects have detected start-up mature technologies yet, and five out of 35 projects plan specific support actions for emerging start-ups and SMEs.

To understand how start-ups and SMEs perceive their situation, we interviewed 14 start-ups and SME in HPC. According to those interviews, access to market, clients with reluctance to innovation, and financial issues are the major concerns of the start-ups and the SMEs. Thus, tight links to the ecosystem are perceived as key element to success. Due to intrinsic specificities of the HPC market, this is particularly important in HPC compared to other markets.

The starting point of our investigations was a document issued by the SME Work Group of ETP4HPC giving some recommendations for a start-up friendlier HPC ecosystem in Europe. Via a survey and via interviews, we are able to underpin and to refine the findings of the Work Group.

The findings will be shared with the HPC projects and will also be discussed at the EXDCI Technical Meeting in Barcelona in September as a starting point for discussions on a start-up friendlier HPC ecosystem in Europe.

1 Introduction

The European HPC ecosystem seems to lack SMEs and start-ups. And it seems particularly true for software start-ups, as shows the list of several European software companies who failed, such as CAPS, Atair software, Compaan Design, or Verum. Others were acquired by major non-European companies. Such acquisition often come in pair with some loss of value via loss of employments, of competitive advantage or of know-how for Europe [10].

Are there specificities to HPC which make it particularly difficult for SMEs and start-ups to succeed in this domain in Europe? **The goal of the report is first, to get some insight in potentially upcoming HPC start-ups and second, to understand the intrinsic difficulties start-ups and SMEs face today.**

In order to know more about upcoming start-ups, we gathered information from the Centres of Excellence and the FETHPC projects¹ via the EXDCI survey. One section of the survey focuses on start-up mature technologies and the project's support activities related to start-ups and SMEs. We describe the findings of this part of the survey in **Section 2**.

To understand the difficulties start-ups and SMEs face, we interviewed 14 start-ups and SMEs. The interviews were conducted as a structured discussion, based on the questionnaire given in Annex. The results of these interviews are given in **Section 3**.

The starting point of our investigations was a document issued by the SME Work Group (SME-WG) of ETP4HPC. It points some high-level problems and gives some recommendations for a start-up friendlier HPC ecosystem in Europe (cf. Annex 5.1). The findings of the interviews underpin and refine the statements of the SME-WG.

The chosen approach for this report focuses on the *situation as perceived by start-ups and SMEs today*. As such, it does not take into account explicitly the point of view of other stakeholders (such as academics, HPC centres, or major companies).

Furthermore, this survey does not claim to be representative. However, despite the diversity of the interviewed start-ups and SMEs, the interviewees recurrently mentioned the issues presented in Section 3. We strongly believe that those recurrent issues deserve attention.

All anecdotes or opinions taken from the interviews haven been validated for publication by the interviewees. This was done by sending the interviewees prior to publication excerpts of this report with a request to validate the text fragment for publication. The interviewees are referenced anonymously with [I1] to [I16.]

Most of the findings of this report are relevant for start-ups and SMEs, as they share many similarities. It will be explicitly stated if we refer to start-ups or SMEs in particular. Furthermore, we will stick in this report to a simplified definition of start-up by characterising it as an entrepreneurial project, which yet has no finalised product or has no customers for its product.

To conclude this report, **Section 4** summarises the findings and indicates how this work will be pursued within EXDCI. The **Annex** gathers additional information on the EXDCI survey (Section 5.3.1), the interviews (Section 5.3.2), and some existing initiatives related to innovation at European level (Section 5.2). Interestingly, most of the interviewees naturally issued recommendations and ideas for improvement. Those contributions are input to the EXDCI deliverable on global recommendations (deliverable D4.4).

¹ jointly referred to "HPC projects" in this report
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2 Input of the HPC projects on start-up and SME support

In order to maintain a strong and efficient HPC ecosystem in Europe, it is crucial to understand the contributions of the currently running HPC projects (FETHPC and CoE-projects²) to the European HPC landscape.

The survey launched by EXDCI is a common effort of WP2, WP4, and WP7 to gather in a centralised way information from the projects relevant to different WPs to the EXDCI project (cf. Annex 5.3.1).

2.1 Results on start up mature technologies and SME support

Overall, 26 out of the 35 contacted HPC-projects coordinators answered the questionnaire. The preliminary analysis of the results was shown at the EXDCI workshop during the HPC summit week in Prague in May 2016 [2].

2.1.1 *Start-up mature technologies*

Question :

Have you already detected technologies from your project with potential for technology transfer (either via licensing, patent filing or via the creation of start-ups)?

Regarding the question related to start up mature technologies, three projects reported about detected technologies with potential for technology transfer.

At least two of the technologies mentioned are open source software related to quantum physics, which are under development for almost a decade now. Two other technologies mentioned are today freely available for academic purposes. Further discussion with the projects will be necessary in order to understand whether there is a real desire and opportunity to transfer the codes to industry or whether the primarily wish is to strengthen the uptake of the code within the community.

17 out of the 26 respondents answered that it is early in the project's activity to give information about start-up mature technologies. We expected this answer, as the projects only started end of 2015.

2.1.2 *Support for start-up mature technologies*

Questions:

Which actions are planned in your project in order to support the emerging technologies of your project? Examples could be: familiarize with entrepreneurship; events/links towards the local innovation ecosystem; support and advice for start-up projects; ... Please list below

In your opinion, what could be done to support those emerging technologies?

On which support provided by the participant's institutions for technology transfer, licensing and entrepreneurship does your project rely? Please list below

² H2020 call IDs: FETHPC-1-2014, FETHPC-2-2014, EINFRA-5-2015
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The next three questions were about support for technologies with potential for transfer. Seven (out of 26) projects reported on actions planned within the project to support emerging technologies:

- One project plans to set up a joint workshop with users of the targeted application domain.
- Three projects mentioned workshops towards software vendors and other technology providers.
- Two projects listed training and communication actions, such as summer schools, or fairs.
- Extensive prototyping activity was listed by one project.

In addition, four projects had suggestions on how to support those emerging technologies. To three projects, the key is to promote their usage, either via workshops with industrial partners or via a “centralised and highly visible online showroom”. Follow-up projects and Extreme Scale Demonstrators were also mentioned as beneficial for emerging technologies. One project emphasises the importance of support on adoption at an “early point of time.”

Four projects reported to rely on the experience and support of the public research entities involved in their project. One project indicated to rely on the support offered by EuroLab4HPC, TETRACOM and HiPEAC.

2.1.3 Support for SMEs

Questions:

Are actions planned in your project (or with partners) in order to emphasize/ promote the SMEs of your project? Examples could be: (Co-)financing of a common booth at a business convention; specific sub-events focusing on the SMEs, ... Please list below

In your opinion, what should be done to highlight your project's SMEs?

Two projects reported on specific actions within the project to promote SMEs: dissemination events, creation of “communities of practice” and exchanges of best practices. The question about what should be done to highlight SMEs was answered by five projects. They suggest to set up an online register for HPC SMEs to improve their visibility and to advertise the SME’s competences towards industrial partners, actions to “raise awareness of mutual benefits”, dissemination events, and co-design/co-development partnerships with academic and industrial partners. One respondent suggests to “install a quota system regarding participation of SMEs over the European funded projects/calls”

Finally, we asked for contact details of SMEs involved in their project that would accept to be interviewed by phone. Those contacts were part of the interview series described in Section 3.

2.2 Conclusion of the results

Despite some interesting answers, the question remains why the respondent rate in this section of the survey was so low. For comparison, the questions in other sections of the questionnaire collected between 17 and 26 answers per question.

Does this mean that the projects do not consider those topics as important? Or perhaps it means that the projects do not consider it as their role to support and endorse start-ups and SMEs?

Indeed, start-ups are more often associated with the legal entity they emerge from than with collaborative projects. This is probably because the duration of technology maturation and start-up creation exceeds the typical duration of a research project running for three years. Second, the legal entity often provides financial support for the start-up. As such, it is natural to link the start-ups to the entity they emerge from.

However, examples exist where European R&I projects play a central role in bringing technology to market. For example, Kaleao and ZeroPoint Technology are direct results of the EUROSERVER project [13]. As of today, the technology planned to be commercialised by Kaleao is used in three currently running HPC projects.

3 Input from the field: interviews with start-ups and SMEs

3.1 Unstructured Interview

In addition to the information gathered via the survey, we conducted a series of interviews to get more insight in current HPC start-ups. We also interviewed some SMEs: first, because SMEs and start-ups share many characteristics, and second, because SMEs may be considered as “start-ups who successfully passed the initial phase”. The testimonies on their start-up phase may be helpful for today’s start-ups.

For the interviews, we chose an open format based on discussion rather than on a closed set of questions. The questionnaire in Section 5.4 was used as guideline for the interviews. Annex 5.3.2 gives more detailed information about interviews were set up and on the related ethical issues.

3.2 Main interview results

This survey does not claim to be representative. Nevertheless – and despite the diversity of the interviewed start-ups and SMEs - the interviewees recurrently mentioned the issues below. We strongly believe that those recurrent issues deserve attention.

3.2.1 *Reluctances to innovation?*

One interviewee pointed out the particularly dynamic attitude of the HPC technologies providers: open to innovation and always looking for new alliances and strategic partnerships [I14]. However, HPC clients seem sometimes more reluctant to innovation. The anecdote below may illustrate how difficult it can be to get “novel” pieces of technology into large HPC systems [I16]:

“What the users want”

A large European HPC centre wishes to update its machines, but will not consider buying GPUs or other types of accelerators as its mainstream technology. Apparently, their users are not proactively adopting “novel technologies” (e.g. programming of GPUs), and the HPC centre’s role is above all to provide infrastructure to the user, i.e. to provide what the users ask for.

Introducing novel technologies represents a considerable effort in convincing and training the users, and it bears the risk that the users will not accept the novel technology. In addition, being innovative and providing new technologies to the users is not rewarded. This situation may lead HPC centres to a risk-averse attitude reluctant to innovation.

To be clear: This is not about promoting accelerators or about the usefulness of accelerators in HPC in general. The interviewee intended to point out that computing centres have their own missions, their own obligations and their own constraints (such as providing a general-purpose HPC computing infrastructure to their users). This may lead to sometimes to less innovative technical choices.

The following testimony is another example of reluctance to innovation that some interviewees feel [I2]:

“We don’t say it’s novel”

The company develops some novel type of accelerator-technology. During the discussion, the interviewer points out the fact that this approach is particular disruptive and novel. “Yes”, says the interviewee, “but we don’t say that. We are developing APIs allowing our clients to use programming languages and methods they are familiar with.” In other words, the company seeks to hide the novelty in order to avoid rejection and to minimise the entrance barrier by providing a seamless integration based on today’s methodologies and tools.

Whether this reaction to new solutions is due to lack of willingness to adopt innovations or consequence of constraints the potential customers believes having to respect, needs to be further analysed.

3.2.2 *Getting into the market*

No one ever got fired for buying Intel: ([I8], inspired by the saying in the 80s about “No one ever got fired for buying IBM”). This sentence captures the feeling of most interviewees. To them, HPC (in the sense of very large HPC systems) is a closed and often protected market that is very difficult to penetrate for start-up or SMEs [I8]. The interviewees perceive this as a particular strong hurdle for getting into the market.

The interviewees have developed different strategies to cope with this market situation, and only 3 out of 14 SMEs claim large HPC systems as their primary market today. Whereas some of them seek to enter the market by the side door, some others choose consciously to stick to smaller HPC systems [I5].

One way to enter the HPC market by the side door is to focus first on application-oriented clients: One interviewee got the impression that for some HPC centres, the machine itself is the object of interest and in consequence, some HPC centres seem to care about status and brand of their machine. He felt on the contrary, that some applied research labs, focus about machines that solve their problems (and the machine itself is just a tool for their research and not the object of research itself). To one interviewee, it was easier to become supplier for an applied research lab. In a second step, this served as reference for the HPC world [I5].

Another way to enter the market is by focusing first on smaller systems to gain experience before targeting the large HPC systems. In practice, this approach seems difficult due to requested references, as described by one interviewee as follows [I7]:

“You need to be in to get in”

To become a contributor or supplier for a Top500-machine, a reference of an already successful contribution to another Top500-machine is de facto mandatory. This leads to a vicious circle for SMEs: You need a reference to get involved, but you are not given the chance to acquire this reference.

A third way to enter the market is open to SMEs coming from other domains: well-established SMEs get into HPC due to new technical developments, new usages or new application domains. For example, a company providing connection solutions for liquid cooling systems for many years for the chemical and the automotive industry now gains interest in the HPC market.

3.2.3 *Coping with public procurement*

Public entities account for a large part in the HPC market. According to some interviewees, procurement rules and other administrative constraints imposed on public entities are sometimes difficult to meet for smaller companies.

One example of such a constraint that is difficult to meet for smaller companies are bank guarantees against financial losses.

In order to be compliant with their own obligations, public entities commonly require different kind of bank guarantees from their suppliers – irrespectively of whether the supplier is a small or a large company. However, to smaller company these obligations can cause serious worry, as pictured below [I13].

Another hurdle for SMEs

A SME contracted with a European HPC centre for a new cluster worth about € 500k, with payment after acceptance. Contracts were signed and everything was on track. However, due to internal constraints of the HPC centre, the funds had to be spent before a pre-defined date (which was not communicated during the tender phase), otherwise, the HPC centre would lose the budget. The problem was that the date of acceptance was after the financial deadline.

To solve this situation, the HPC centre accepted to pay the SME before acceptance under the condition that the SME's bank could issue a guarantee on € 500k. As the SME had not that much cash on their accounts, their bank could not issue this guarantee. In return, if the centre would have paid, then the bank could issue the guarantee.

This led to a vicious circle: the HPC centre wanted a guarantee before paying and the bank of the SME could not provide such a guarantee before receiving the funds. It took weeks and a lot of phone calls and discussion to sort out this issue: Eventually, the HPC centre accepted to wire the money to a direct account at the bank, which allowed the bank to issue the guarantee, which then allowed the HPC centre to finalise the money transfer.

This guarantee request would have been a non-issue for a large company – but it is a supplementary hurdle for a SME.

Another problem faced in particular by system integrators is the need of cash to pre-finance systems. Typically, public entities pay after acceptance, but the system integrator himself has to pay his suppliers after delivery. According to [I13] pre-funding can go up to € 7.000k , obviously depending on the size of a cluster. These amounts have to be funded for a period varying from 3 months up to 6 or 7 months, also depending on the nature of the solution and the acceptance criteria of the final customers. Again, this pre-financing is much less of an

issue for a large company – but for an SME this may be impossible to do. This not only requires a considerable amount of cash, but also limits the number of parallel contracts for an SME.

An interviewee of a software-based company pointed out another difficulty he faces. Budgets for HPC systems focus mainly on hardware supply and are based on the average hardware lifetime, i.e. approximately every 4 to 5 years. This means for software vendors that they have to collaborate with system integrators such that the software is part of the HPC system [I3].

New procurement procedures have been around now for a couple of years (PCP, PPI) and have been applied to various HPC projects, such as PRACE-3IP. Two interviewees took (or are taking) part of such procedures and consider this approach as “a good formula” [I5]. It allows to create a novel technology for which obviously a need exists [I5]. Furthermore, one interviewee pointed out that PCP helps to better understand the customer’s need than a traditional tender procedure [I3]. On the other hand, the legal obligation to assure competitiveness during all stages of the PCP leads to a dilution of the budget onto the different competitors. For example, four competitors took part in the first phase of PRACE-3IP. One interviewee considers the dilution of the budget onto competitors as a weakness of this approach, particularly in the first phase where the level of effort required is coupled with dilution of the budget amongst project partners within each consortium.

Due to legal and organisational constraints, public entities sometimes adopts a risk-averse attitude by considering it as “safe” and “easier” to proceed “as usual”. In consequence, they seem sometimes less inclined to support or even to recommend new approaches with respect to procurement [I7]:

“Too risky”

A couple of years ago, an important European HPC centre used an innovative procurement procedure to acquire a new machine. The tender was successful, giving rise to co-developments between SMEs, the HPC centre, and bigger companies. The machine delivered was compliant with the centre’s expectation – to cut a long story short: a real success story.

Today, the centre wishes to buy new machines – but the administration of the centre has doubts to apply the innovative procurement procedure again! It turns out that the legal department considers this as “too risky” (even after successful operation a couple of years ago).

Whether there is some real legal risk related to novel procurement procedures, such as PCP for example, or whether the risk is rather perceived by the purchasing entity is not clear.

3.2.4 *Connection to the ecosystem*

All interviewees agree on the importance of being closely linked to the industrial and academic HPC ecosystem. In most cases, one of the (co-)founders brings this link into the company: In some cases, a senior researcher takes the role and backs up the start-up project by his reputation and his network. In other cases, this might be a senior HPC engineer coming from industry who plays this role.

According to the interviewees, these connections are key for being invited to participate in R&I projects and to find an early client willing to buy the new product. One of the start-up we met is today in an isolated situation and struggles particularly hard to find its first customer and to participate in R&I projects [I12].

One interviewee also stated that his company is rarely taking part in R&I projects as he considers the project requires too many resources for a SME. Participation in research projects requires approximately half an FTE – which is often unaffordable for an SME. Nevertheless, being part of the ecosystem is important to him to keep up with new topics and technologies [I13].

3.2.5 *Start-up origins*

The vast majority (11 out of 14) of companies interviewed were either carved out from an existing company or spun off a research lab

In two cases, large companies ceased part of their activities, as these were no longer considered as core business or not in line with the company's strategy – and with permission (and support in some cases) employees continued these activities in the form of new company. In this set up the new company also benefitted already from acquired know how, knowledge of the markets and had in one case easier access to an existing customer base [I1, I13]. By doing so, the maturation phase was shortened and is in some cases supported by a stronger financial basis.

For start up projects emerging from academia, the maturation phase from the first result (patent or prototype) to a product is in some cases considerable. In three cases, it took about 10 years to get to the first marketable product [I2, I11, I12].

3.2.6 *VC's perception of HPC and exit- options*

An interviewee involved in a HW-oriented SME reported on experiences with VCs: “Finding American or Russian investors would have been easy, but finding European investors was much more difficult. I spent $\frac{3}{4}$ of the time with the investors explaining HPC and its business opportunities in general before talking about our product itself and our business story”[I14].

A seed-investor added that, according to his experience, approximately 10% of the investors have a technical background. To him, one particularity of HPC start-ups (compared to internet start-ups for example) is their very strong technical basis. To understand HPC technologies in general requires technical knowledge and an even deeper understanding is necessary to assess a particular business idea. Although this is true for many domains, he finds the HPC technology particularly tricky to understand. According to him, this is definitely a hurdle for investors [I15]. Upon the question on how to encourage funding of HPC start-ups, the seed investor was clear: promote financially successful exit stories.

This leads to the question of viable exit strategies for HPC companies. One interviewee sees for HPC core technologies only one real exit strategy: acquisition by a big player [I14]. According to him, start-ups and SMEs can bring innovative products into the HPC ecosystem, but a big player is later needed to spread it widely. For another interviewee who provides some accelerating-technology, staying autonomous is a real option. Therefore, his business strategy today is based on two lines. The first line is to develop strong partnerships with big players in order to penetrate the market via their clients. The second line is to engage direct

commercial relations and development partnerships with clients from a application domain benefitting most of the new accelerator-type. By doing so, the interviewee does not depend entirely on his collaborations with the big players [I2].

3.2.7 *Open Source Software*

Open implementation of different software stacks, file systems and other system components are widely used in HPC. Three interviewees highlighted the importance of open source software for their companies.

Open source software gives companies a strong base from which to start and compete, and bring value through expertise or through subsequent open or proprietary developments.

According to interviewee [I6], it is too expensive and too time consuming for a small company to maintain a substantial piece of software, to develop it further and provide support to the customers [I6]. Today, their offer is based to 90% on open source software and to 10% on proprietary software with the goal to reduce the propriety part step-by-step. Its business model is based on a nice and coherent bundling of existing open source software and additional support and services for its customers. Another software centred company relied heavily on open source software in the beginning, which is today continuously complemented by proprietary code [I3].

A hardware based company concentrated its development efforts on the hardware (about 85% of the effort) and relied heavily on existing open source for the software part of their product. Without this open source software, another 2 or 3 years of development would have been necessary according to the interviewee [I14].

3.2.8 *Conclusion*

The hurdles the SMEs and start-ups perceive are considerable: a market they describe as “closed”, with customers not always open to innovation and administrative constraints (such as procurement procedures, bank guarantees, and the need for references).

Lacking ability or willingness of HPC centres to work with users on enabling exploitation of new technologies is potentially a large obstacle, in particular for SMEs. In consequence, there is definitely a need to explore further to what this perceived reluctance could be due and if it applies only to a fraction of HPC centres. Furthermore, the reluctance to innovation may also be linked to difficulties in positioning novel products and technologies on the market.

The strategies to cope with this situation differ: relying on a strong partnership with a major company, targeting an application-specific market, or focusing on smaller HPC systems.

Thus, it comes with no surprise that tight links to the ecosystem are perceived as key element to success. They provide access to strategic partnerships (for product development and for research) and to first customers. This is probably true for any start up in any market, but due to the particularities of the HPC market, this may be especially true for HPC start-ups.

The maturation and development of new technologies can take several years, and for start-ups coming from academia even up to a decade. Financing this phase is a central issue to the start-ups. One start-up for example developed a service and consultancy activity in another domain to cover the development costs of the HPC technology. And as soon as the HPC branch will be financially sustainable, the service and consultancy activity will diminish [I11]. To get more European investors interested in HPC technologies, financial success stories are needed – and perhaps we should put the spotlight on the existing HPC success stories.

But even beyond that phase, financing remains a crucial issue in order to cope with pre-financing and in order to set up “a financial plan, guaranteeing a steady income over the duration of the projects and beyond” [I7].

4 Conclusion and follow-up

Europe seems lacking start-ups and healthy SMEs in HPC. Why? We collected via the EXDCI survey information from the HPC projects to learn about their start-up mature technologies and to understand what kind of support they provide to start-up and SMEs. Moreover, we interviewed 14 start-ups and SMEs to get insight in the particularities of the HPC ecosystem and the difficulties the start-ups perceive as major.

The basis of this work are the 10 recommendations of the ETP4HPC SME-WG (cf. Annex 5.1). This report underpins via the interviews the issues addressed in these recommendations and takes also into consideration start-ups and SMEs outside the scope of ETP4HPC.

As of today, three projects report on start-up mature technologies and five out of 35 HPC projects plan specific support actions for start-ups and SMEs. Perhaps the projects do not consider it as their role to support and endorse start ups and SMEs? Nevertheless, there have also been some cases, where European R&I projects played a central role in bringing technology to market. For example, Kaleao and ZeroPoint Technology are results of the EUROSERVER project [13].

Access to market, reluctance to innovation on the client side, and financial issues are the major concerns of the start-ups and the SMEs. Thus, it comes with no surprise that tight links to the ecosystem are perceived as key element to success. Due to intrinsic specificities of the HPC market, this is particularly important in HPC compared to other markets.

New technologies and new business opportunities may be beneficial to start-ups. For example, new accelerator technologies, or novel cooling methods invite SMEs well established in other domains to peek into the HPC market. Moreover, start-ups and SMEs dedicated to novel applications such as “Big Data Analytics” will certainly soon enrich the current ecosystem.

This survey does not claim to be representative or complete. Some topics have only been touched upon. For example, the perceived reluctance to innovation on the client side would be worth further joint investigations between SMEs and clients to understand the hurdles and constraints on both sides. And some topics have not been tackled at all, such as the role of standards and patents.

Some interviewees issued naturally recommendations during the discussion. These recommendations will be a starting point for the report on global recommendations (deliverable D4.4).

The report and its findings will be shared with the H2020-projects and will also be discussed at the EXDCI Technical Meeting in Barcelona in September 2016 as a starting point for discussions on a start-up-friendlier HPC ecosystem in Europe.

Whereas this report focused on the start-ups emerging via technology push, we plan to look into opportunities emerging via market pull due to new applications, such as Big Data Analytics.

5 Annex

5.1 Recommendations issued by the Workgroup for SMEs of ETP4HPC

ETP4HPC Position on SME Development



January 2015

ETP4HPC, the European Technology Platform for High-Performance Computing recognises the value of SME participation in the European HPC Value Chain. The development of HPC technologies in Europe should provide a number of SME with an opportunity to become globally competitive players in this market. European SMEs are capable of achieving success in this process; however, a number of support mechanisms are needed to facilitate SME development:

Recommendations:

1. After project completion, its results are not market ready. There should be a **2nd round of financial support** for the projects that qualify during project lifetime for **additional development** (i.e. further funds for the development and market launch phase, e.g. arranging venture capital, marketing activities).
2. We suggest an EU supported platform to facilitate communication with **venture capital**. ETP4HPC should approach the EC to request support in managing this continuous venue involving SME, Start-Ups and Capital (as a joint undertaking of ETP4HPC and the EC)
3. HPC Centres have introduced a requirement for a **demonstrated track record** in their procurement (e.g. systems in top 500) which excludes SMEs. We recommend lowering this requirement in order to allow SMEs to participate.
4. System installation happens before payment is executed –which causes problems for small companies by exerting an excessive financial load on them **SMEs need instruments for finance their orders**. 1/ Request a change in the procurement process (e.g. in the US procurers sometimes pay in advance). 2/ Special loans to be requested from the European Investment Bank (the EC could facilitate this request). It is also recommended to 3/ increase the length of procurement cycles (following the US example).
5. **H2020 SME Instrument** should be analysed in order to identify the areas that might benefit SMEs active in HPC
6. In the next phase (i.e. following a successful start-up) – **training and consulting on SME growth** is needed to stimulate development
7. **Access to the EC and its knowledge resources** – there should be regular meetings between SMEs and the EC
8. SME's finds it hard to enter projects because of their size. SME needs the ability to partner up in consortia and they require the **knowledge** of the procedures related to **EC funding and projects**.
9. We recommend establishing an **ETP4HPC SME Award** – for the best European SME in the area of HPC technology.

10. Creating co-design/co-development partnerships with Research Centres/Universities and other customers (e.g. industry)

5.2 Support for innovation and start-ups at European level

Support actions for start-ups and SMEs play a major role in Europe's strategy for competitiveness. Some examples are the SME instruments and the ESAME website as a central information portal for SME **Erreur ! Source du renvoi introuvable.**, the currently ongoing public consultation under the start up initiative [14], and the set up of an Expert Advisory Group on Innovation in SMEs [12].

Some initiatives at European level seem particularly interesting w.r.t. innovation, start-up and SME support: the FP7-support action TETRACOM, the rapid prototyping activity in EuroLab4HP and EIT Digital.

5.2.1 *EuroLab4HPC* (jointly with Avi Mendelson)

EuroLab4HPC is a Coordination and Support action funded under H2020 with the goal to “federate Europe's research institutions across the system stack towards a long-term research agenda that drives innovation and education in HPC systems” [6]. The consortium is led by Chalmers University of Technology and involves thirteen prominent research organizations across nine countries.

With respect to innovation and start-ups, EuroLab4HPC puts a special emphasis on accelerating the commercial uptake of new HPC technologies by providing “how to” knowledge and financing a series of “Business Prototyping Projects”[7]. The purpose of these projects is to help researchers identify and evaluate early and quickly business cases based on their research results. The projects are selected via an annual call for proposals. Around each technology, a team will be formed consisting of an entrepreneurial lead, a principle investigator and a mentor. Each team is then guided with the support of experts through a process where they will quickly and effectively identify and test critical business related hypotheses, such as:

- Who is the customer? What problem are we solving for them?
- What should our offering be (IP/product/service)?
- How do we reach the customers with our offering?
- How and how much should we charge for it?

This approach is based on the “lean” start-up concept seeking market insight at a very early stage in product development and was already applied successfully to start-up projects at Chalmers. At the first cut-off date in April 2016, three projects were selected with an average funding of €25k.

5.2.2 *TETRACOM* (jointly with Eva Haas and Rainer Leupers)

Whereas EuroLab4HPC focuses on the technology uptake via start-up creation, the TETRACOM coordination action provides new incentives for academia-industry technology transfer via focused, bilateral technology transfer projects (TTPs) across the whole of Europe.

Funded by the European Commission under the 7th Framework Programme, the goal was to “lower the barrier for researchers to make the first steps towards commercialisation of their research results and to bring concrete R&D results into industrial use” [5]. A total of 50 TTPs are being supported and co-funded, covering a multitude of ICT areas, such as the automotive sector, communications and multimedia, data analytics, health, industry 4.0, as well as safety and security. Each TTP brings together one academic partner and one industry partner and implements the transfer of a particular hardware or software technology or intellectual property (IP). The vast majority of TTPs involve industry partners from small/medium enterprises (SMEs), which have reported major benefits from TETRACOM through new products, significant cost savings, or improved processes.

The projects were selected via a competitive call, with a promise of short response time (approximately 8 weeks after call deadline). The duration of a TTP was typically about 6-9 months, with financial support from TERTACOM of €25k in average. 67% of the funded projects involved SMEs.

The basis of a TTP is a joint application of an academic partner and a company, i.e. it requires that the partner and the technology to be transferred have been identified beforehand. This encouraged academics to submit TTP proposals with their “local” industrial partners. Thus, TTPs allowed companies to engage for the first time into EU funded project and to discover exiting funding schemes. It would be interesting to understand if this applies in particular to SMEs.

5.2.3 *EIT Digital* (jointly with Frédéric Renouard)

EIT Digital is currently one of five Knowledge and Innovation Communities (KICs) of the European Institute of Innovation and Technology (EIT), created in 2010.

As a KIC, EIT Digital is focused on entrepreneurship and is at the forefront of integrating education, research and business by bringing together students, researchers, engineers, business developers and entrepreneurs. EIT Digital is a consortium of today 130 universities, research labs and companies (large companies and SMEs) with the goal to develop innovative products and services, start new companies, and train a new generation of entrepreneurs. A key element of EIT Digital is its pan-European network of Co-Location Centres, providing space for co-working and exchange between the partners. The activities of EIT Digital are organised around three pillars: Education, Business and Research.

- Regarding Education, EIT Digital seeks to develop within its “EIT Digital Academy” the entrepreneurial mind-set within the European workforce for sustainable growth and competitiveness, amongst the students at Master and at PhD-level. This means to familiarize the students with methods and tools for detecting business opportunities, for assessing impact of a given technology (w.r.t. society, market...) as well as for developing new businesses. Furthermore, a special emphasize is put on development of soft skills, such as creativity and leadership. At the EIT Digital Master and Doctoral Schools, the students put this directly into practice via a 6-month business-development project.
- The “Business” pillar of EIT Digital provides in particular support for the international development of start-ups and SMEs (“EIT Digital Accelerator”) as well as access to finance (fund raising). Furthermore, it detects and supports new business ideas for international growth via its “EIT Digital challenge”.
- The “Research” pillar provides particular help and support for transforming research results into marketable products through an annual Call in spring.

EIT Digital has chosen eight strategic Innovation Action Lines: Future Network Solutions, Future Cloud, Privacy Security & Trust, Health & Wellbeing, Smart Energy Systems, Urban Life & Mobility, Cyber-Physical Systems, and Smart Spaces. Today, EIT Digital is focussing on topics and research results with a time to market of approximately 2 or 3 years.

Although HPC is seen as a key enabler for all Innovation Action Lines of EIT Digital (cf. Digital Cloud Initiatives [15]), the focus on technologies with a rather short time to market excludes HPC technologies from the EIT Digital “Research” pillar and its Call.

5.3 Approach: field investigation

As mentioned, support actions for start-ups and SMEs are widely discussed topics, having given rise to national and European reports and support actions over the last decade.

The approach chosen for this report is complementary in two ways: First, it focuses on a specific domain within ICT: High Performance Computing, meaning hardware and software components for building supercomputers and high performance computing clusters. Application providing SMEs and start-ups were deliberately excluded to stay as focused as possible. Moreover, it focuses on the *situation as perceived* by SMEs and start-ups. This approach may also help to understand which difficulties are addressed by today’s support actions and which have been tackled less.

The field-based approach builds on information gathered via a survey conducted within the EXDCI project (cf. Section 2). This is complemented by a series of interviews (cf. Section 3).

We interviewed on the one hand SMEs and start-ups and, on the other hand innovation-facilitators of the HPC ecosystem (or at least close to our ecosystem). This includes discussion with the Tetracom project [5], the H2020 Coordination and Support Action EuroLab4HPC initiative about their rapid business prototyping projects [7], and a seed-capital investor.

The first candidates for the interviews were start-ups and SMEs involved in FETHPC and CoE projects. Via the EXDCI-survey we gathered the contact data of companies accepting to be interviewed. This led to 8 interviews. The 6 other interview partners were recommended to us (“you should talk to ...”) via acquaintances within our HPC ecosystem.

The interviewed start-ups and SMEs are probably not a representative sample of the entire HPC-startup landscape in Europe. For example, all interview partners are in one way or another already in contact with the European HPC ecosystems, either via collaborative projects, or via organisations such as PRACE or ETP4HPC. Although the start-ups and SMEs are so different w.r.t to their age, their maturity, their offer and their approach to market, some issues were recurrent. We strongly believe that those recurrent issues deserve attention. They may not be key issues for the entire European HPC start-up scene; they *are* key issues for the start-ups linked to our European HPC-ecosystem.

5.3.1 *EXDCI Survey: Input of the HPC projects on innovation and start-ups*

It is crucial to understand the contributions of the currently running HPC projects to the European HPC landscape.

This is one of the roles of EXDCI: to consolidate the work of the projects and to encourage synergies. To this end, EXDCI set up a questionnaire to gather information from the projects on different topics.

The survey is a common effort of WP2, WP4, and WP7 in EXDCI to gather in centralised way information from the HPC projects relevant to different WPs and aspects to the EXDCI project.

The questionnaire was launched on the 1st of April 2016 via the EXDCI web page (cf. [1]). All the coordinators of the FETHPC projects and the CoE projects were invited to provide feedback, either online via the survey tool or via an interview by phone.

We also set up a webinar explaining the context and the goal of the survey to the project coordinators. In total, 26 out of the 35 projects answered the questionnaire, most via the online survey tool and one project via telephone interview. Some questionnaires were only partially answered.

The first part of the survey was about the scientific contribution of the project to the SRA and the project's approach to transversal issues such as fault tolerance, energy and data management. The answers of this section are input to WP2 (Technological roadmap) and WP4 of EXDCI, which is looking at transversal issues. The second section is dedicated to training (tackled by WP5 in EXDCI): Will the project provide material for training and teaching, such as videos or MOOC-modules or written documents? The third block focused on international collaborations (considerations part of WP6 in EXDCI), and in particular existing links to the Big Data community via BDEC initiative (Big Data and Extreme-scale Computing initiative). The fifth module seeks to gather information relative to some of the KPI which are key elements for the HPC cPPP and the work in WP7.

The fourth section of the questionnaire looked at start-up mature technologies within the projects and support actions to highlight start-ups and SMEs.

The first goal is to get insight into currently emerging technologies with high potential for start-ups. By experience, we know that efforts to further develop such technologies take time and need to be prepared within the project-lifespan (and not after the end of the project). The idea is to detect as soon as possible technologies with potential in order to support their maturation. We concisely opened the scope of the question by asking for any kind of technology "with potential for technology transfer (either via licensing, patent filing or via the creation of start-ups)?". At such an early state it might be difficult/impossible to indicate the transfer path appropriate for this technology.

The second goal was to understand how the projects perceive their role with respect to start-ups and SMEs. We were inquiring on actions that are planned within the projects or by project partners to support start up creation. Further, we asked whether specific actions are planned during the project to highlight or to support the SMEs of the project consortium.

5.3.2 *Interviews: Input from start-ups and SMEs*

In addition to the information gathered via the survey, we conducted a series of interviews to get more insight in current HPC start-ups. Further, we also interviewed some SMEs, considering SMEs as a "start-ups who passed the initial phase".

Out of the 14 interviewees, we classify five as start-ups, i.e., entrepreneurial projects (independent of their legal status or the date of creation) without a first client as of today (cf. definition in Section 1). Two more have only recently engaged in partnerships with larger companies.

Twelve out of those 14 interviewees are intrinsic HPC-related companies. Two of the companies have their traditional market outside HPC, but are now getting into the HPC-domain.

The interview partners were either (co-)founders or people holding key-function in the company. Only one interview included a female interviewee. Eleven interviews took place face-to-face during the HPC Summit Week in Prague in May 2016 or on the margins of the ISC conference in Frankfurt (June 2016), and 6 others were conducted by phone.

For the interviews, we chose an open format based on discussion rather than on a closed set of questions. The Questionnaire in Section 5.4 was used as guideline for the interviews. Due to the absence of a defined set of questions, the evaluation of the interviews is less formal. For example, in the course of some of interviews the role of open source software came up, but this was not necessarily a point of discussion in all interviews.

5.3.3 *Ethical considerations regarding the interviews*

Some pieces of information given by the interviewees were public, others were confidential. In order to be compliant to French and European regulations regarding confidential data, we asked the participants to sign an informed consent form. All participants were briefed about the purpose of this interview, on how the data is used and stored, as well as about their right to abandon the discussion at any time without giving reasons (cf. Annex, Section 5.5).

We attributed a Participant-ID to every interviewee and agreed with the interviewees that data will only be used in anonymised form. Regarding the use of the information for this report, all anecdotes, facts or opinions taken from the interviews haven been validated for publication by the interviewees. This was done by sending the interviewees prior to publication excerpts of this report with a request to validate the text fragment for publication.

5.4 Questionnaire

Questionnaire



*... on entrepreneurial experience in
HPC-related domains*

This questionnaire serves as basis of interviews in the frame of the European Project EXDCI (<https://exdci.eu/>). The purpose of these interviews is to gain insight into entrepreneurial experience in HPC. This interviews provide in particular input to deliverable D4.2 (Report on start-up mature technologies) and to D4.3 (Report on tools for start-up and SME in HPC) of EXDCI.

1. Origins of the project/ company

- Who started it off ? Why ?
- What were the technological assets at the beginning?
- By whom (at local, national or European level) did you get financial help/entrepreneurial advise/ ... ?
- When looking back: On which aspect/topic would you have needed support?

2. Growing

- What kind of institution help did you get (employer, research lab, EC, region, ...)
- What other kind of help/support did you get (personal network, ...)
- Role of EU projects / institutions/ PRACE
- How did you get into the right circles?
- What were you missing?
- What is according to you the key to growing successfully ?
- Particularities of the HPC world

3. Needs today

- W.r. t client acquisition
- W.r.t. product development / positioning
- W.r.t R&D needs
- Particularities of the HPC ecosystem

5.5 Informed consent form

Informed Consent Form



Interviews on entrepreneurial experience in HPC

Purpose: The purpose of this interview is to gain insight into entrepreneurial experience in HPC. ETP4HPC is a partner of the EXDCI project (<https://exdci.eu/>). The sub-task 4.2 on “SME support”, seeks to get a vision of current start-up projects in HPC and to understand their domain-specific constraints. To this end, I interview start-ups and SMEs about their experiences in entrepreneurship in HPC as input to the deliverable D4.2 (Report on start-up mature technologies) and to D4.3 (Report on tools for start-up and SME in HPC) to the EXDCI project.

Procedure: If you agree to participate, you will be asked questions regarding the origins of the company you founded or you currently work for, and how it evolved over time.

Risks and Discomforts: There are no foreseeable risks in participating in this interview-series beyond those experienced in daily life.

Duration: The interview will take about 60 minutes.

Confidentiality: In this context, “data” consists of my notes and an informal summary (approximately 2 pages). You have been assigned a code name for use in the summary and in any subsequent publications that might arise. The reference document with your name and contact details is kept separately, and is not accessible to anyone but me. The summary is stored on the personal back-up disk of Maïke Gilliot; the reference document is stored off line.

The summary in its current form will neither be shared, nor used it for another purpose. However, I may extract anecdotes or examples from the interview for the deliverable. In this case, I will use the above code and formulate the text in a non-identifiable way and you will be asked for approval before publication. You may request modifications, or ask to not include the anecdotes or examples at all.

Right to ask questions: Please contact Maïke Gilliot (maïke.gilliot@teratec.fr) with questions, complaints or concerns about this interview.

Voluntary participation: Your decision to be interviewed is voluntary. You can stop at any time. You do not have to answer any question without giving any reason. Refusal to take part in or withdraw from this interview will involve no penalty or loss of benefits you would receive otherwise. You will not be paid for taking part in this study.

Informed Consent Form



Consent: You must be 18 years of age or older to take part in this interview-series. If you agree to the information outlined above, please sign your name and indicate the date below. You will be given a copy of this consent form for your records.

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