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Coordination of the HPC strategy

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Final release of the HPC Ecosystem Balanced Scorecard

Final

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References and Applicable Documents

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List of Acronyms and Abbreviations

BDEC	Big Data and Extreme-Scale Computing
BSC	Balanced Scorecard
CoE	Centres of Excellence (for Computing Applications)
cPPP	contractual Public Private Partnership
DX.Y	Deliverable Number X.Y (Number Y of Work Package X)
EC	European Commission
EXDCI	European eXtreme Data and Computing Initiative
FETHPC	HPC component of FET (Future and Emerging Technologies) programme in H2020
FP7	Framework Programme 7 – predecessor of H2020
H2020	Horizon 2020 – The EC Research and Innovation Programme in Europe following FP7
HPC	High Performance Computing
KPI	Key Performance Indicator
R&D	Research and Development
R&I	Research and Innovation
R&D&I	Research and Development and Innovation
ROI	Return on Investment
SRA	Strategic Research Agenda (Multi Annual Roadmap)
WP	Work Package

Executive Summary

This report comprises the EXDCI final deliverable D7.4 “Final release of the HPC Ecosystem Balanced Scorecard”. In the context of EXDCI, Work Package 7 “Impact monitoring-methods and tools” addresses impact monitoring of the H2020 R&I activities linked to the HPC contractual Public Private Partnership strategy. Previously, EXDCI WP7 deliverables reported on the motivation for the initial methodology and tool-set, its update and first realisation. This methodology has been applied for the elaboration of the HPC cPPP 2016 Progress Report, which was the key document delivered for the mid-term review of all cPPPs in 2017.

The HPC Ecosystem Balanced Scorecard (BSC) is a central component of the developed methodology. Key Performance Indicators defined in the HPC contractual Public Private Partnership (cPPP) were taken up and integrated into the appropriate BSC perspectives, as explained in a previous deliverable (D7.3).

This D7.4 deliverable focuses on the consolidated findings after the end of the cPPPs mid-term review, and summarises them from the perspectives of industrial competitiveness and socio-economic impact, and operational and management aspects of the programme.

As of this early 2018 standpoint, the EU HPC global ecosystem has gained important momentum and made significant qualitative progress in terms of organisation, stakeholder mobilisation, and the dynamics among projects and related consortia. The first quantitative effects of the H2020-funded projects can already be observed. Stakeholders from industry (large companies and SMEs) have also been taking a more active role in the programme, compared with FP7 HPC programmes predating the HPC cPPP.

Commencing in 2016, and gathering momentum in 2017, major new policy developments in the area of EU High Performance Computing have also taken place, creating a favorable context for further development and impact of the HPC cPPP, in particular related to EuroHPC in the future.

1 Introduction

The purpose of Work Package 7 in EXDCI on "Impact Monitoring – methods and tools" is to support informed decision-making in relation to the development of the European HPC Ecosystem and the impact of the R&I activities linked to the HPC cPPP (contractual Public Private Partnership) strategy [1]. For this purpose it contributes to generating and gathering data and creating the necessary analysis and monitoring tools.

Work Package 7 comprises two tasks, which are aligned with its two central objectives:

1. providing a set of methodologies and processes to be used in the measurement of European HPC Ecosystem development and progress;
2. performing periodic monitoring of the implementation of the HPC cPPP strategy.

Task 7.1 "Methodology and establishing data capture procedures and tools" in EXDCI covers the first aspects and comprises the previous deliverables D7.1 "Initial methodology and monitoring tool-set" and D7.3 "Final methodology and monitoring tool-set" (cf. [9] and [11] resprectively). These reports detail and explain our methodological choice (the Balanced Scorecard, BSC for short) and describe also the tool-set used for the implementation. This methodology has been applied for the elaboration of the HPC cPPP Progress Report of 2015 and 2016 – as well as for the 2017 report, which will be delivered in May 2018.

Task 7.2 "Data capture and analysis" covers the second objective of WP7: the application of the methodology, specifically the implementation of the BSC, for monitoring the development of the European HPC ecosystem and the impact of the actions relating to the HPC cPPP. The output of that monitoring was presented during the regular cPPP meetings, and fed into the annual cPPP reports and, more particularly, the mid-term assessment of the HPC cPPP in 2017. Deliverable D7.2 "First release of the HPC Ecosystem Balanced Scorecard" [10] documents the work done in this context.

Deliverable D7.4 is the second and last deliverable related to EXDCI Task 7.2. In light of the cPPP mid-term review which was performed between May and October 2017, this report focuses on the overall experience and findings related to impact assessment in HPC cPPP.

The remainder of this report is organised as follows: Section 2 sets the scene with a brief discussion of the context, the methodology, our KPIs and our data sources. Section 3 is organised along the following three perspectives:

- Industrial Competitiveness and Socio-Economic Impact
- Operational aspects of the programme
- Management aspects of the programme

For each of the perspectives, we provide preliminary results for 2017, analyse tendencies (based on the figures between 2014 and 2017) and review the implementation aspects of our approach. Moreover, we sketch – where possible – first ideas on how the implementation could be improved for the second half of H2020, i.e., the cPPP progress reports for 2018, 2019 and 2020. The conclusion in Section 4 can be considered as the conclusion of all WP7-related activities, and the outlook refers to possible work in EXDCI-2[1].

[1] At the time of writing this report, EXDCI-2 was accepted and the Grant Agreement was being prepared – expected to commence during Q2 of 2018.

2 Scope, history and methodology

In this chapter, we provide a reminder of the context and history of cPPP monitoring since 2015, the underlying methodology, as well as a short summary of the related KPIs and our data sources.

2.1 Timeline and history

As shown in Figure 1, the activities of WP7 are strongly intertwined with the cPPP reporting activities. The current contractual framework for HPC cPPP covers the period 2014-2020, requiring annual progress reports. EXDCI started in September 2015 and runs till February 2018[2], giving rise to 4 WP7 deliverables.

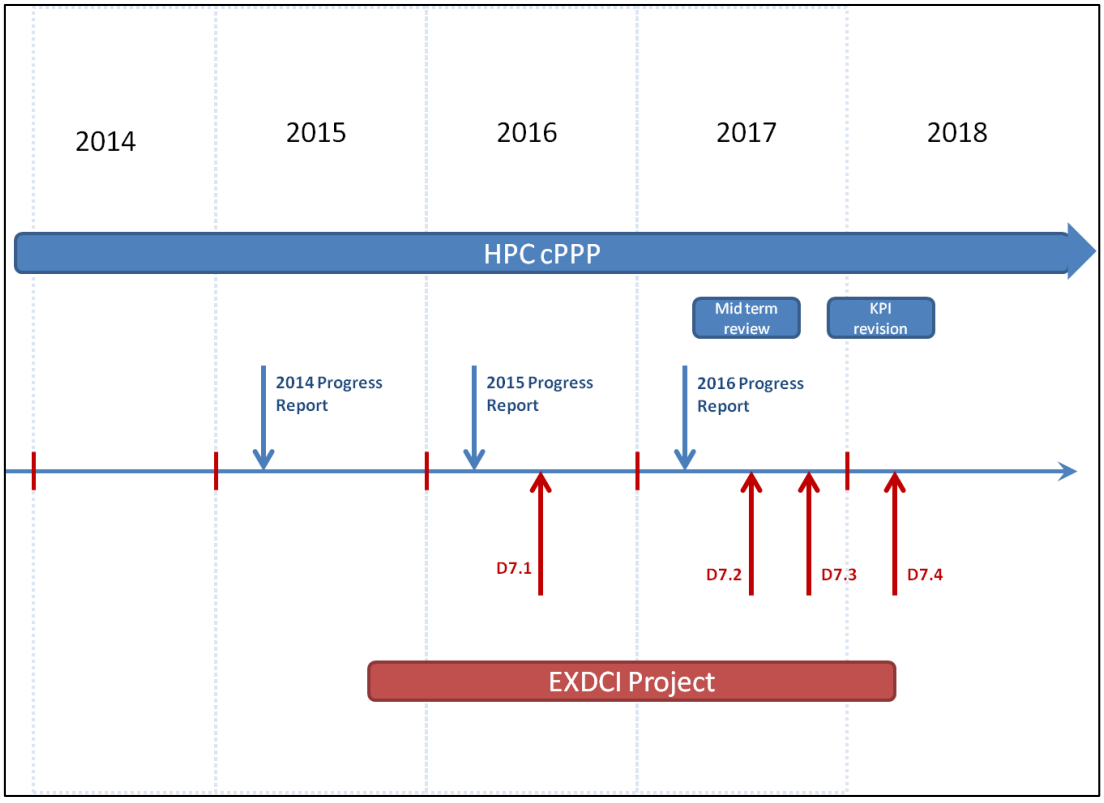


Figure 1: Timeline and history of progress monitoring activities in HPC cPPP and EXDCI WP7

2.2 Methodology : Balanced Scorecard

As extensively presented in D7.1 and D7.3, we use the approach of the Balanced Scorecard (BSC for short) for the analysis of the HPC cPPP ([4] and [5] respectively). As a very

[2] A request to extend the project duration is pending, but this does not affect WP7.

compact reminder and for the sake of completeness, we summarise in Table 1 below the three perspectives which are drawn from the HPC cPPP categorisation, as well as their associated goals.

PERSPECTIVE	GOAL
Industrial Competitiveness and Socio-Economic Impact	Increase market share
	Create innovation environment in HPC (exploited patents and standards)
	Increase employment
	Support growth of SME
Operational aspects of the programme	Effective research programme and coverage
	Develop performance of HPC technologies
	Provide education, training, skills development
	Increase use of HPC
	Develop a HPC software ecosystem
	Generate patents, inventions and contributions to standards
Management aspects of the programme	Dissemination and awareness
	Effective execution

Table 1: Perspectives and Goals of the BSC

2.3 cPPP mid-term review

The contractual arrangements of the cPPPs stipulated that there should be a mid-term review performed by independent experts. The review process took place in 2017 and is summarised below - more elements are given or referenced in Annex 5.1.

In a first phase, the experts were given written input; in addition to the annual progress reports and various documentation from the private partners, a set of additional questions was addressed (given in Annex, cf. Section 5.1) In June 2017, each cPPP had a 2-hour interview with a subgroup of the Expert Group. The review ended in October 2017 with the release of the public report [3].

The general outcome of the global review was positive: cPPPs are considered relevant, useful instruments, but more time would be needed to assess the socio-economic impact.

Regarding the HPC cPPP in particular, our progress reports acknowledged significant ecosystem development, increased industrial participation (in particular compared with FP7) and a good portfolio of projects started in 2015, then extended in 2016. The experts acknowledged that promising, but still early, effects have also been observed in job creation, patents, and innovation from large and small companies. More efforts and progress are expected from the role and involvement of SMEs in the ecosystem and the H2020 projects in general. Finally, the largest fraction of H2020 funding still has to be injected under Work Programme 2018-2020, the actual effects of which will be measurable later on.

A consequence of this mid-term evaluation is the re-design of the KPI framework, following a strong recommendation of the Expert Group. The European Commission services started the coordination of such a process in December 2017. Three meetings took place in Brussels for this purpose, in December, January and then February, with representatives from all cPPPs.

As the KPIs are laid out in both the H2020 regulations as well as in contractual arrangements, the purpose is to further specify them and facilitate the reporting exercise, rather than provide a full redefinition. The effort has been focused on a limited group of core indicators, trying to define more precisely a shared vision and methodology across all cPPPs – regarding data collection and interpretation. The common set of KPIs would be as follows:

- Mobilised private investments
  To understand and capture/show the level of industrial engagement within a given cPPP, including actual expenditure related to individual projects
- Number of new skills and/or job profiles
  To understand how job profiles and skills are being created and developed within the activities of the cPPP
- Impact of a cPPP on SMEs
  To understand the impact of the activities on SMEs under the cPPP
- Number of innovations which are at least exploitable
  To understand the technological outputs of the cPPP

This is still work in progress at the time of writing this deliverable, and should also lead to a new organization of progress reports from 2018 onwards, planning for a core part which shall be public.

2.4 Analysis of data sources

Over the years, different data sources have nourished the annual progress reports (cf. D7.1 and D7.3). As shown in Table 2, some sources provide recurrent input, other more intermittent or demand-driven input.

Source	2014	2015	2016	2017
ETP4HPC internal survey	x	x	x	x
EXDCI survey (FETHPC+CoE projects)		x		
ETP4HPC Annual report	x	x	x	x
Analyst study			x	
PRACE KPIs	x	x	x	x
EC H2020 stats	x	x	x	x
Public sources (internet, other reports and public registers)	x	x	x	x

Table 2: Data sources

The table shows that the main data sources for the progress reports over the past years have been the annual internal survey amongst ETP4HPC's members, the data provided by the EC on the different calls, as well as the PRACE KPIs. These three sources have provided steady input over the last years, thus allowing meaningful comparison between the years and the assessment of tendencies and trends over the multi-year period.

The KPIs related to “Industrial Competitiveness and Socio-Economy Impact” rely strongly on the survey amongst the members of ETP4HPC. The input provided by the EC (such as the number of submitted and accepted proposals, distribution of funding by type of partners) is the basis for the evaluation of the main operational aspects – the R&I programme is fully implemented under Horizon 2020.

The current implementation has some weaknesses. For example, we were not in a position to perform periodic surveys of all running projects (EXDCI only performed one such early campaign). CoEs and FETHPC projects cannot be expected to respond to annual surveys (there is no contractual commitment for them to do so) – also because many aspects of the surveys are only relevant for project final objectives and subsequently project results following project execution, and not easily measurable during the execution of the project.

Similarly, we only had one outsourced analyst study in 3 years. The budget of the current coordination and support action limited the ability to sub-contract frequent external studies. Moreover, the resources of WP7 to handle the overhead of such sub-contracting in a proper way were also limited.

These less-frequently recurring sources however provided very valuable additional input. However, it is more difficult to draw conclusions and to understand evolution and changes as less data for comparison is available.

The survey amongst ETP4HPC’s members is the only recurring source for the evaluation of the industrial competiveness. How this dependency could be reduced is part of our ongoing work. Difficulties inherent to this kind of survey are however persistent, notably regarding the sensitivity of industrial partner regarding their business data or strategy. The intervention of external specialists/analysts proved to be a possible mitigation here, using acknowledged methods of confidentiality management. But again, the coupling and correlation of different approaches requires important resources and efforts.

Re-iterating a survey in EXDCI 2 comparable to the first EXDCI study, thus providing second data sets at an interval of 4 years, could be considered, in particular on topics with latency, e.g. exploitation of patents, SME business and turnover evolution due to H2020 support. Such an approach may provide interesting additional input.

The same applies for the analyst study carried out in 2017, which could not be conducted every year. A second, comparable study in 2019 or 2020 might allow the monitoring of changes in the quantitative part of the survey, and more importantly, also in the qualitative part: for example, comparing the assessment of the H2020 efforts as perceived by the beneficiaries could provide very valuable input for the overall assessment of the HPC cPPP.

3 Summary of main findings from cPPP progress reports

Using the three BSC perspectives cited earlier, in this section we analyse the preliminary findings for 2017, as well as trends and tendencies based on the data of 2014 - 2016. Moreover, we review the implementation of our approach, and sketch – where possible – first ideas on how the implementation could be improved for the second half of H2020, i.e., the cPPP progress reports for 2018, 2019 and 2020.

As also emphasised by the mid-term review Expert Group, we are still at a very early stage for assessing the impact of the cPPPs since the first projects launched have not yet been completed and many more projects are to come (see page 20 of the public report [3]). This is also reflected in the spending curve: as reported in D7.2, from the total foreseen cPPP budget of 700 M€, a total of 176 M€ had been committed to projects as of June 2016, and an estimated 50% (84 M€) had actually been distributed to projects in June 2017, which corresponds to 12% of the cPPP's budget, and does not mean that this has all been spent immediately.

Another limiting factor of today's analysis is latency: some effects will only become fully visible (and measurable) in a couple of years, i.e., after the end of H2020. Examples of effects that have a time delay are ROI and the number of (successful) start-ups based on H2020 research results. The Independent Expert Group of the cPPP mid-term review was also fully aware of these limitations. It suggests ex-post evaluations of the cPPP to better evaluate this delayed effects.

3.1 Data collection for 2017 cPPP progress report

As in previous years, a survey amongst the members of ETP4HPC is being conducted. This study provides input in particular to the assessment of the competitiveness and the economic impact on H2020 R&I funding.

The survey was launched in December 2017 and is still open. Due to the on-going KPI revision process, this action will have to be adjusted and complemented anyway: this is only a useful but intermediate step.

The main efforts for this survey have been to lower the burden for the respondents, as much as possible, and at different levels:

1. Improved support for respondents:
   Despite our efforts, feedback from the previous year showed that respondents lacked an understanding of why this questionnaire is launched ("Why do you need to know this?") and how the data would be used. This year, in addition to our e-mail campaign, we organized a webinar to provide to all ETP4HPC members detailed information and a chance to ask questions. Moreover, we offered to all the respondents the option to collect the data via teleconference (to alleviate the burden of filling in the online questionnaire).
2. Simple questions:
   Based on the feedback of the previous years, we reviewed the wording of some questions that were viewed as ambiguous in the past, but without compromising the core of the survey. This allows for comparison with the previous years.
3. Tackling confidentiality issues
   Confidentiality is a major concern and one of the main reasons why potential respondents do not answer the questionnaire. Besides a better explanation of the

purpose and the use of this data, we also reviewed some questions with respect to privacy concerns, as for example the questions related to the leverage factor. In the previous survey, respondents were asked to indicate (1) the total amount of granted H2020 funding and (2) the total amount of additional private investments in HPC R&I, and we calculated the leverage factor based on these figures. As many respondents were reluctant to share this figure (in particular their private investments), we added the option allowing them to indicate directly their leverage factor.

The preliminary results given in the sections below make use of these partial figures. As of today, only very global and partial data from the EC (on the 2017 FETHPC call) are available, and the PRACE KPIs are not available yet for 2017.

Another evolution in this year's ETP4HPC survey is the inclusion of very simple qualitative questions on the added value of H2020 R&I funding. Such questions had been previously introduced in last year's outsourced study, interviewing a subset of 10 ETP4HPC private members who are active in FETHPC projects. We again used these questions in the global survey this year. Preliminary results on more than 25 members show very positive and clear acknowledgement of the crucial role of H2020 funding:

Question	**Option**	**#of respondents**
Which of these statements best describes the type of *(H2020-funded R&D)* activity your organisation is involved in?	A new R&D direction never tried before	12
	An advancement of an existing R&D initiative	15
	Other	2
If your organisation had not received H2020 funding, what would you have done?	We would not have pursued the R&D initiative	4
	We would have pursued this R&D initiative on a more limited basis	21
	We would have pursued this R&D initiative	1

Table 3: Qualitative Evaluation of H2020 R&I funding

Additional comments collected:

- *"We are able to start risky and groundbreaking research projects due to our involvement in the H2020 R&I program. Such research projects would be very difficult for us to achieve without the European funding;"*
- *"Providing management services & investigating new business opportunities arising from potential new business collaborations with new products and services developed in the projects."*
- *"Fostering the use of HPC technologies amongst the industrial tissue."*
- *"The projects allow us to invest in much more ambitious Earth system model development, in particular in the area of numerical methods, programming models and on-the-fly post-processing of model output data. They also provide us with much better and collaborative access to new technologies."*

- *"We helped (an SME) to discover and to evaluate new simulation & modelling methodology based on Single Core Modelling with positive performance improvement in their process."*

3.2 Industrial Competitiveness and Socio-Economic Impact

The main indicators to understand the impact of cPPP-related funding on industrial competitiveness can be summarised as follows:

- Evolution of the global market share of European HPC technology
- Private investments in HPC R&I complementing H2020 funding ("leverage factor")
- Influence of H2020 R&I on the creation of new jobs
- Impact of H2020 funded R&I on the ecosystem's capability to innovate (for example by creating start-ups).)

3.2.1 *Tendencies and trends*

Hyperion market analyses (confirmed by a more detailed study as part of our subcontracted analyst study of early 2017, cf D7.2 [10]) indicated a slight increase of **the global market share** of European HPC vendors from 4.4% in 2013 to 4.9% in 2016, showing positive momentum for European vendors even prior to HPC cPPP. As of today, we have no new elements on this evolution: the effects of the cPPP can only be assessed later.

Based on the survey amongst ETP4HPC's members, the **investment in private R&I funding** was estimated to be in the range of 165-210 M€ in HPC technologies and 150-225 M€ in other HPC-related R&I in 2016. The detailed analysis by Hyperion in 2017 supports these figures: the study indicates that five of the nine companies interviewed had already augmented the H2020 project funding with their own funds as of the beginning of 2017. Some of the companies plan to invest substantial additional money in the R&I projects, either before the H2020 projects are completed or in subsequent efforts to develop products and bring them to market (a factor of 3-4 for extra investment is commonly mentioned). Knowing that 62% of the participants in cPPP-related calls are not members of ETP4HPC [10] sheds a different light on this number: the real additional investment from private sources could be more significant than our estimate, which is based on ETP4HPC members only.

The preliminary 2017 results show that 17 out of the 22 respondents having received EU funding acknowledge **leveraging R&I funding** by private means. 7 out of the 17 respondents are companies (5 SMEs and 2 large companies). These figures show that a high percentage of those benefiting from H2020 funding also provide additional private resources. This supports the hypothesis above that a significant fraction of the private investments could not be identified or assessed yet as of today.

In order to understand if and how the cPPP-related funding contributes **to new jobs**, we also rely on the survey amongst ETP4HPC members. In 2016, the members reported 91 new jobs as a direct consequence of the research funded via H2020. As of today, the 33 respondents to the current survey declared 152 new jobs in 2017.

Regarding **innovation within the European HPC ecosystem**, we saw several SMEs being acquired by large companies in 2016 (for example Nice was acquired by Amazon Web Services, and Allinea acquired by ARM). For 2017, ETP4HPC members did not report any new start-ups, but some research organisations reported on 5 start-up projects (which should be launched in 2018) arising from H2020 funding in the domains of bio-technologies, aviation and visualisation. A follow-up discussion by telephone will provide more details on the

product/activity of those start-ups and will aim to understand the role of patents in this context.

3.2.2 *Analysis of current implementation*

The main issues we face when assessing the industrial competiveness and the economic impact of the cPPP are (1) the latency until the effect of injected resources becomes measurable, and (2) our survey limitation for the time being to ETP4HPC members only, and not reaching all the H2020 beneficiaries. Both issues are serious and difficult to overcome. Whereas the first limitation is conceptual, the second is of organisational nature.

Even organisations which are formally linked to ETP4HPC are reluctant to provide confidential information. In any case, ETP4HPC membership creates neither contractual links nor binding obligations related to the participation of its members in H2020 projects; and these projects usually encompass a mix of member and non-members of the association. It is difficult to see how an organization such as ETP4HPC could be legitimate for collecting information from its industrial members in these conditions, and all the more from non-ETP4HPC members. The data collection issue has been discussed extensively during the cPPP mid-term review. It could be interesting to explore if the EC, as a funding entity contracting with the project consortia, could be empowered to collect data of this type from the project participants – e.g. by leveraging the existing and powerful mechanisms of project reviews.

3.3 Operational Aspects of the HPC cPPP programme

The ETP4HPC Strategic Research Agenda (SRA) [15] is the main input for the definition of R&I under the HPC cPPP umbrella. However, the R&I projects are fully implemented and operated under Horizon 2020 instruments and rules (the SRA being officially mentioned as the detailed technical reference accompanying the call for project texts). This operational setting makes it possible to carry out direct global monitoring of the programme via H2020 project statistics. Relevant (anonymous) data extraction is being periodically carried out by the EC team on the public side of the cPPP. Annual progress reports deliver detailed analyses of these statistics.

Table 3 (on the next page) details the H2020 calls related to the cPPP (HPC technology and applications). Research and Innovation Actions (RIA) as well as Coordination and Support Actions (CSA) are listed.

Call reference	Call title		Closing date	Selected projects
FETHPC-1-2014	HPC Core Technologies, Programming Environments and Algorithms for Extreme Parallelism and Extreme Data Applications	RIA	25 November 2014	19
FETHPC-2-2014	HPC Ecosystem Development	CSA	25 November 2014	2
E-INFRA-5-2015	Centres of Excellence for computing applications	RIA	14 January 2015	9
FETHPC-01-2016	Co-design of HPC systems and applications	RIA	26 September 2016	2
FETHPC-02-2017	Transition to Exascale Computing	RIA	26 September 2017	11
FETHPC-03-2017	Exascale HPC ecosystem development	CSA	26 September 2017	2

Table 4: H2020 HPC calls related to the cPPP

Table 4 below summarises relevant aggregate information.

	2015-2017	2015 - Q1 2018
# of H2020 calls implemented	3	4
Avg. time-to-grant	7 months	7 months
Total H2020 funding committed	€176.1 million	€219.5 million
# of running projects	30	32
# of new projects to start during the year	2 (RIA)	11 (RIA) + 2 (CSA)
Projects coordinated by ETP members	12	19
Participating organisations	321	429
Unique participations	186	221
non-ETP member participations	62%	62%
Industry (non-SME) participations	22%	Not processed yet
SME participations	11%	Not processed yet

Table 5: Statistics on cPPP-related H2020 projects

As already mentioned, the largest fraction of cPPP-provisioned funding has not been granted yet - different cPPP-related calls have not yet been launched, coming only in Work-Programme 2018-2020 (which is now published; its earliest calls are closing in March 2018, so the next new projects to be granted would start around the end of 2018). A detailed description of all currently-running FETPHC and CoE projects can be found in the Handbook (cf. [14]).

3.3.1 *Tendencies and trends*

As of today, we do not have any analysis regarding the **effectiveness and the coverage of the Research Programme** with respect to the 2017 calls, and no global update and synthesis across WP2014-2015 and WP2016-2017. EXDCI-2 in particular will further elaborate on these aspects.

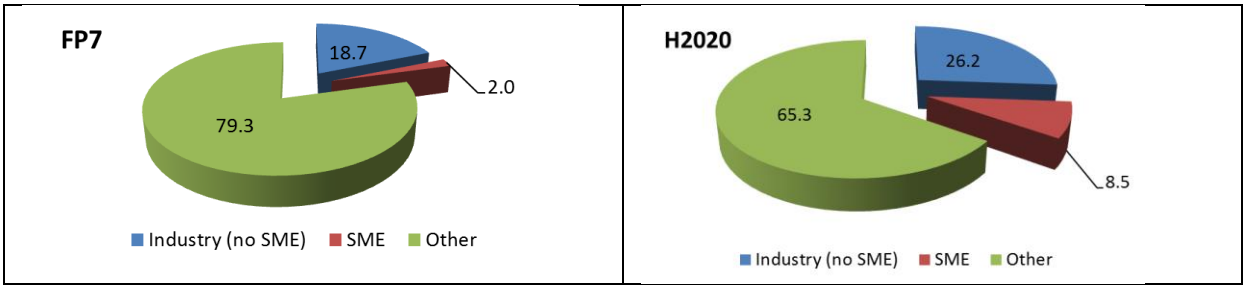
The cPPP mid-term review report also gives indications on the average quality rate and the average success rate (cf. Table 6 below, reproduced from the report of the Independent Expert Group of the cPPP mid-term review [3]). For the HPC cPPP, the average quality rate (i.e., the number of proposals above the threshold/ eligible proposals) is around 66% with an average success rate of 29%. The high quality of the proposals and the relatively high acceptance rate show that the cPPP related R&I calls represent an attractive funding opportunity for high-level research.

	Average time to grant (days)	Average quality rate (%) - proposals above threshold/eligible proposals	Average success rate (%) - funded projects/eligible proposals for funding
FP7	313	45.3%	16.8%
Horizon 2020	233	45.0%	11.0%
5G	203	52.5%	23.8%
Big Data	200	50.0%	17.0%
EeB	198	22.6%	12.1%
EGVI	219	41.4%	19.9%
FoF	205	25.0%	12.4%
HPC	219	66.7%	29.7%
Photonics[5]	218	59.7%	19.5%
Robotics	216	39.4%	10.1%
SPIRE	205	19.2%	8.6%

Reproduced from the report of the Independent Expert Group of the cPPP mid-term review [3]

Table 6: cPPP average quality/success rates

The review reveals as well that **SME**s are not sufficiently present in cPPP-related R&I projects: only 11% of all project partners are SMEs; although this figure is low (compared to other cPPPs), we still see strong progress compared to FP7. As indicated in Figure 2, the participation of SMEs rose from 2% to 8.5%.



Reproduced from Deliverable D7.2"First release of the HPC Ecosystem Balanced ScoreCard" [10]

Figure 2: Evolution of industry and SME participation in Exascale projects FP7/H2020

To convert a research prototype into a stable and scalable system (or component) seems to be a particularly difficult and drawn-out process in the HPC sector. The production of large-scale prototypes and demonstrators as the outcome of R&I projects is unfortunately more the exception than the rule. The concept of Extreme-scale Demonstrators hooks in to this: by gathering different pieces of technology from R&I projects and combining them into one large Demonstrator running real-life applications. As such, the Extreme-scale Demonstrators are a way of maturing and firming up research prototypes, and to prove their effectiveness and scalability as part of a fully operational system [17].

We expect a very strong positive influence of the Extreme scale Demonstrators funded by H2020 (under the call ICT-14-2019) on the **performance of the HPC technologies developed within the cPPP.**

Education, training and skill development are other key aspects that we follow up within the cPPP. The figures we reported previously were mainly based on data from PRACE and from a survey conducted in 2016 amongst the FETHPC projects and the CoEs. To conduct a similar survey in the scope of EXDCI-2 might also provide interesting insight on training and skill development, in particular within the CoE projects.

In 2017, **PRACE** remained the most important player for providing **access to computing resources** and associated services, especially for the European scientific community [7][8][6]. Nonetheless, the usage of HPC in the Cloud and the ever-growing need of computing resources form the Big Data community are leading to the rapid development of cloud-based HPC solutions. Interestingly, this also attracts industrial users who up till now not have used HPC technologies. These new users may be SMEs (for example in manufacturing) or even users from new domains such as agriculture. Many European and national initiatives, such as Fortissimo [13], or SIMSEO [12] in France, provide support to those new users. This momentum must be maintained and strengthened.

3.3.2 *Analysis of current implementation*

The process of translating priorities from the R&I roadmap(s) into calls is not an easy process. As of today it relies on the governance of the cPPP (see next section) and some intermediate technical dialogue points between the industrial association, other stakeholders and the European Commission. The timing and frequency of the SRAs is well aligned with H2020 Work Programmes. The interaction between ETP4HPC and the EC could probably be improved to address how the SRA is implemented in work programmes. Project portfolio management could be improved in different ways, such as periodic assessment of project outcomes, support for the improved dissemination of results and their sustainability, monitoring of overlaps and gaps in order to further reduce, etc.

A first check on all running RIA projects was already carried out by the European Commission in 2016, assisted by external experts. The purpose was to assess the projects allowing experts to formulate recommendations early on in their implementation and possibly spot any issues and mitigate them. EXDCI-2 CSA is planning some more actions in this direction, in a task entitled "Coordination of HPC technology actions" of its Work Package 2 "HPC-HPDA technology roadmap". This task will analyse the results of the FETHPC projects which started in September 2015. Their contribution to the position of Europe in HPC technologies will be assessed, and the most relevant results be identified. Moreover, T2.4 will look how these results can have economic impact.

PRACE activities related to HPC use and training, in particular, are scrutinized in the context of HPC cPPP progress monitoring and impact assessment, but are currently not directly under the responsibility of the cPPP. Moreover, there is no strong causality yet between the HPC technology developed and its impact on PRACE activities, since prototypes stemming from, or using, H2020-funded R&I are just starting to be set up, and no production system is available yet.

ETP4HPC and future EXDCI activities could establish 'observatories' of on-going developments, to monitor

- which prototypes or systems are in the pipeline towards higher readiness levels and the market,
- which have high potential, and
- what the expected market-changing impact would be of at least a few selected projects.

3.4 Management Aspects of the programme

3.4.1 *Tendencies and trends*

Governance of the cPPP

The relationship with the EC, structured in the framework of the HPC cPPP, is now well established and on-going. cPPP Partnership Board meetings are co-chaired by the EC and ETP4HPC Chair, twice a year, with the participation of the 'private side': representatives from the ETP4HPC Steering Board, ETP4HPC office, and representatives from all the CoEs. PRACE representatives are also invited.

ETP4HPC holds one or two General Assemblies per year, inviting all its members, the EC and other selected guests. ETP4HPC has been steadily growing from 15 members in 2013 to almost 90 as at the beginning of 2018; it should be remembered that becoming a member of ETP4HPC is a selective process: some financial and technical commitment is expected from the members.

Dissemination and outreach in the area of the cPPP and EU HPC

DGCNECT has developed a single point of access for all information about the EC HPC strategy, work programmes and other HPC-related news.

ETP4HPC, the EXDCI support action, all FETHPC and CoE projects have strong focus on their dissemination activities which are complementary – ETP4HPC and EXDCI, together with PRACE, focus on ecosystem-level dissemination and networking support, whereas the projects promote their own specific scientific and technical activities and results.

EXDCI has been the opportunity to create a large annual pan-European HPC event, the "European HPC Summit Week", with a first edition in 2016 in Prague and a second in 2017 in Barcelona (Spain), gathering several hundred experts in HPC technology development, HPC infrastructures and HPC applications. The 2018 edition is under preparation: it will take place in Ljubjana (Slovenia) in May 2018.

3.4.2 *Analysis of current implementation*

Over the last 3 or 4 years European HPC momentum has clearly increased.

Important and active bilateral or multilateral relationships have been established with other major European programmes or initiatives such as BigDataValue cPPP (and its private partner BDVA) and HiPEAC in Europe; DoE in the USA; and RIKEN in Japan. With EXDCI support, European HPC experts have been extremely active in the international BDEC initiative [16] and are now preparing its follow-up.

ETP4HPC delivers a Strategic Research Agenda (SRA, [15]) every two years, in line with the timescale of the H2020 Work Programmes, which reflect the suggested research priorities.

After three years of ramping up, the HPC cPPP has now reached a stable configuration with the inclusion of CoEs in its bi-annual Partnership Boards, and increased industry/research interaction. This has been accompanied by important evolutions in the EU HPC landscape, including the recent preparation of EuroHPC [2]. In addition to giving extra momentum to European efforts all along the HPC value chain, EuroHPC will have to be articulated with the governance and operational aspects of the current HPC cPPP implementation.

3.5 Conclusion from the mid-term review

The cPPP mid-term review by the independent experts gave rise to a set of recommendations which are in line with our own perceptions, complementing our findings [3].

These recommendations are reproduced in Table 7 below: they are generic for all cPPPs. No more specific official feedback has been made available. However, some specific self-analysis has started by ETP4HPC already, in collaboration with DGCNECT.

Recommendation #1: *The process of translating priorities from the roadmap into calls should be more participatory, ensuring clear links between roadmaps and calls under a common process between the industrial association and the European Commission. The more focused calls in line with the needs defined in the roadmap will increase the effectiveness and the quality of proposals. An agreed, clearer timeline between the European Commission and private side is suggested, ensuring that time-sensitive priorities are fully implemented.*
Recommendation #2: *The governance of cPPPs should be revised. Associations and the European Commission should enhance the transparency of the management processes, widen the debate and update reference roadmaps focusing on reaching the highest number of stakeholders and the broader society. Furthermore, the systematic dissemination of results, the development of studies of exploitation and the transferability of technical solutions within the same sector and along the supply chain are strongly encouraged. Participation of SMEs and EU-13 countries should be fostered.*

Recommendation #3: *The links between the cPPPs and the other European Commission instruments should be strengthened. The European Commission should take systemic action (e.g. mapping synergies) to develop joint programming, cross-fertilisation and partnerships.*
Recommendation #4: *The Expert Group strongly recommends redesigning the KPI framework of all cPPPs. The redesign process should be coordinated by the European Commission and start soon after the publication of this report.*
Recommendation #5: *In order to enhance the impact of the cPPPs on national and regional policies as a way to increase their EU value-added, Member States should be represented in the cPPPs. The Commission should explore jointly with Member States suitable mechanisms.*
Recommendation #6: *The Expert Group joins the Fab-Lab-App recommendation to move towards a mission-driven approach in the next Framework Programme. Industrial associations and the European Commission should cooperatively mobilise joint investments in order to tackle industrial, scientific and societal challenges. Mobilising joint investment in established missions, through a dynamic and flexible co-fund mechanism may be a way to take the cPPP instrument forward.*

Table 7: cPPP mid-term review generic recommendations

Some of these topics are already addressed, for example first steps to better link HPC SMEs and start-ups to the European SME programme or the global effort on KPI revision. Other recommendations, such as the stronger implication of Member States will take place via EuroHPC [2].

4 Conclusion and next steps

This deliverable should be understood as an intermediate standpoint of the HPC cPPP progress monitoring: considerations on KPI framework redesign are ongoing, while a large fraction of the H2020 HPC R&I funding is not spent yet. In conclusion, these results can only be preliminary. These efforts will be pursued with the support of, and in the context of, EXDCI-2.

Our approach for assessing the evolution of the cPPP, the Balance Scorecard (BSC), has proven to be robust over the past number of years. If need be, revised KPIs can be taken into account without affecting the BSC. This guarantees continuity and comparability, thus allowing for meaningful comparisons between the different years and also to document tendencies.

For this first half of the cPPP and its assessment, the quality and the quantity of gathered data has been one of the main issues. We rely today on a small, but persistent and recurrent set of main data sources: the data provided by PRACE and by the EC, as well as the annual survey amongst ETP4HPC members. Reflections on how to enrich this database are currently ongoing and will be pursued in EXDCI-2. The issue of data collection has also been raised in the frame of the mid-term review, in particular for "one of the most important KPIs of the cPPPs, industry leverage" – this a concern shared by all cPPPs.

A second important issue is latency: some effects of European R&I funding will only become fully visible (and measurable) in a couple of years, i.e., after the end of H2020. Examples of effects with delay are return on investment (ROI) and the number of (successful) start-ups based on H2020 research results. This too has been acknowledged by the Independent Expert Group in their final report.

Moreover, in 2018, EuroHPC will take shape, and this is expected to strongly influence the European ecosystem in the upcoming years, amplifying and accelerating the momentum of the trends we have already observed.

5 Annexes

5.1 Mid-term review elements

Official timeline of the cPPP mid-term review	
May 16th 2017	• Submission of annual cPPP progress report • Submission of input to the additional questions
End of May 2017	• Publication of a staff working document by the EC
June 12th 2017	• Interview (F2F) with the Group of Experts
October 2017	• Final report of the Group of Experts

The interview took place on June 12th 2017 with the following participants:

External Experts from the Expert Group	Carmen Lucia CONSTANTINESCU
	Maurizio PILU
	Maria Margarida PINTO
For ETP4HPC	Jean-Pierre PANZIERA *Chairman of ETP4HPC*
	Jean-Philippe NOMINE *Lead on all cPPP reporting activities*
Representing HPC cPPP stakeholders	Jean-Pierre PANZIERA *Chief Technology Director for HPC at ATOS/Bull – a large European company*
	David LECOMBER *Senior Director for HPC Tools at ARM and former Allinea CEO - representing a large international company and a European SME*
	Peter BAUER *Deputy Director of Research at ECMWF - a large European research organization and user community representative - operating a large production computing facility*
Observers	Andrea FELTRIN *DGCNECT – representing the Public side of HPC cPPP*
	Gustaf WINROTH *DG for Research and Innovation*

5.1.1 *Reproduction of answers elaborated by HPC cPPP*

In the next pages, we reproduce the answers elaborated by HPC cPPP (ETP4HPC and CoEs) to address a set of seven additional questions, prior to the June interview with the expert subpanel.

Data reporting of the cPPPs to the mid-term review and annual monitoring exercise 2016
cPPP Mid Term Review Questions (June 2017)

Preamble

The HPC cPPP motivation relies on the main following facts:

- All scientific disciplines are becoming "computational" today. Modern scientific discovery requires very high computing power and capability to deal with huge volumes of data.
- Industry and SMEs are increasingly relying on the power of supercomputers to invent innovative solutions, reduce cost and decrease time to market for products and services.
- HPC is part of a global race. Many countries have announced ambitious plans for building the next generation of HPC with exascale performance and deploying state-of-the-art supercomputers.
- The HPC cPPP brings together technology providers and users via the ETP4HPC Association and Centres of Excellence (CoE) for computing applications - focusing on technologies and applications pillars of the European HPC strategy. HPC cPPP's main goals and high-level objectives serve H2020 overall objectives by stimulating industrial leadership in related technologies and their use to tackle scientific and societal challenges:
- Develop the next generation of HPC technologies, applications and systems towards exascale; to build a European world-class HPC technology value chain that is globally competitive - synergy between technology development, applications and computing infrastructure; to achieve a critical mass of convergent resources in order to increase the competitiveness of European HPC vendors and solutions;
- Achieve excellence in HPC applications delivery and use; to leverage the transformative power of HPC to boost European competitiveness in science and business.

Question 1: Which improvements at a project level or at other levels are necessary to further enhance and maximise the impact of projects in line with the overall objectives of Horizon 2020?

In the first half of H2020 (2014 to mid-2017), a number of projects have been granted funding in the scope of the HPC cPPP:

- 21 technology projects on different hardware and software building blocks for future exascale systems – from calls inspired by ETP4HPC SRA (Strategic Research Agenda - HPC Multi-Annual Roadmap)
- 9 Centres of Excellence for Computing Applications (CoEs)
- 2 coordination and support actions.

The essentially bottom-up process of project selection led to a rather fragmented effort, and with some areas of the SRA not properly covered, with a risk of lack of leadership on important topics and competencies. CoEs also tend to duplicate some efforts between projects initially setup in a purely competitive selection process; and some important topics are underrepresented in the current portfolio.

A mixed approach of enhanced bottom-up selection process and more formal top-down coordination might be considered in general to mitigate the heterogeneous and fairly complex nature of research under Horizon 2020:

- better enforce the SRA - and other roadmaps such as on applications – coverage
- 'defragment' project allocation and better pool and focus efforts

Regarding HPC technology, possible directions to be further investigated could be:

- a more flexible modulation of project sizes and selection criteria (impact/excellence) depending on the topics, objectives and technology readiness targeted
- enhanced monitoring and analysis of project outcomes in a continuous way, so as to identify and steer synergies in the mid-term, fostering integrative paths towards exascale capable systems and solutions,

- beyond the mere development of building blocks (the Extreme Scale Demonstrators concept proposed by ETP4HPC is a step in this direction: the pooling of technologies arising from the FETHPC project portfolio in concerted actions to achieve the overriding goals for European exascale systems development can be achieved via the execution of the larger-scale "Extreme scale Demonstrator" projects as proposed in the updated SRA from 2015 and currently in discussion for the 2018-20 Work Programme)

CoEs also need to have a long-term funding perspective to provide the necessary stable and reliable service to their supported communities as well as appropriate career paths and job security to their employees. With the current three-years funding cycles this stable setup cannot be established and more long-term, perhaps institutionalized, schemes need to be envisaged.
The CoE concept should cover the full HPC user community as much as possible. This requires the establishment of CoEs in areas not yet covered but potentially also some re-structuring of the existing CoEs. There are areas of common interest (like performance optimization, support for new hardware and software technologies, training, etc.) where synergies between CoEs can be exploited through transversal activities but also synergies based on the computational techniques employed in different domains could be exploited. Depending on the size and complexity of the supported communities, codes, and data management needs, different sizes and organizations of CoEs are to be envisaged, including strategic, formal collaborations among a set of CoEs on certain aspects. Under the current, rather static, competitive call and project structures this is however difficult to achieve.

Question 2: What has been the impact of the cPPP and their roadmaps on national (and regional) research policies in the EU Member States? What is the impact of the cPPP on EU policies, especially those related to industry?

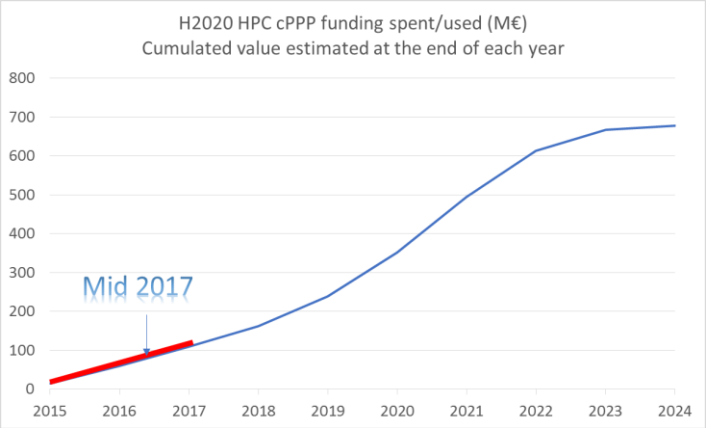
The cPPP is a European organisation and agreement directly signed between the EC and so-called 'private' stakeholders represented by ETP4HPC association, an industry-led think tank with large companies, SMEs and research centres. In 2012 ETP4HPC was founded by stakeholders from France, Germany, Italy, Spain and UK. The HPC cPPP entered in force beginning of 2014. ETP4HPC now has members from 16 EU+ member states (15 EU member states plus Norway). Centres of Excellence have joined the governance of the cPPP but they are currently projects and have no established legal form.
The key R&D&I themes and strategic targets of the HPC cPPP have then been taken up in EU global strategy and policy statements at the highest level, with a stronger EC position/strategy on European Cloud Initiative, including the HPC & Exascale goals (April 2016).
The HPC cPPP has helped to raise the understanding in the different member states that pan-European, coordinated efforts are necessary in HPC. This has been followed up by initiatives involving member states such as IPCEI and EuroHPC. Seven member states have recently signed the "EuroHPC" declaration on an HPC co-operation framework for a pan-European infrastructures, which is highly aligned with the strategic goals of the HPC cPPP regarding the value chain vision. Within this framework more formal links between cPPP and Member States will be established.

Question 3: What have been the leverage effects under the cPPP? The question refers to both the triggered private investment, and other relevant effects, such as subsequent closely related research and development activities within the remit of the cPPP.

Early observed effects of the cPPP have been extensively documented in the 2016 progress report.
The status of the cPPP funding and industrial participation is the following:

- 176 M€ of H2020 funding have been committed so far in the scope of the cPPP, out of which 142 engaged in 2015- 2016; a simple simulation of the progressive effective use of the funding gives an optimistic estimate of at most 84 M€ mid-2017 (see figure below; the blue part of the curve is based on projections of future Work Programmes and is not meant to be used in the reasoning here). This might be a bit

optimistic because even manpower setup and consumption may not be fully linear at the start of all projects, and ramp up progressively; not to mention equipment and for instance hardware prototypes for those projects who encompass some, for which most expenditure is usually not performed before the mid-term of the project



- Out of this funding, an average33% goes to industry (2/3 of which to large companies, 1/3 to SMEs)

Market share

One of the main indicators used is the market share of European suppliers. We use IDC/Hyperion definition and figures of EU suppliers share in the EU HPC broader market (servers + storage + software). This share grew from 4.4% in 2013 to 4.9% in 2016, showing positive momentum prior to any HPC cPPP potential effects.

NB: EU fraction of global HPC market consumption grew from 26.5% in 2013 to 27.8% in 2016 according to IDC; one of the objectives of the cPPP is to improve this market share of EU suppliers in Europe, but with solutions that are globally competitive and can also be exported outside Europe. Forecasts indicate continued growth of this market share of EU suppliers in Europe, with a lower bound of ca. 7-8% in 2019-2020 currently estimated by Hyperion – an underestimation in our opinion, not encompassing the future extra effects of the cPPP.

Private investments, jobs

From a sample of 9 interviewed companies – incl. 4 EU SMEs - involved in 12 FETHPC (technology) projects, accounting for 26 M€ of H2020 funding - which is most of the cPPP funding going to industry via the FETHPC first round of projects:

- 11 patents were secured with the help of Work Programme 2014-15 funding
- 61 jobs creations are expected - Hyperion/IDC and others confirm that most job creation related to advanced R&D happens after the R&D project is finished, especially when a commercial product or solution is being prepared for and introduced into the market. But SMEs in particular already reported actual recruitments.
- We estimate the matching of the cPPP funding (700 M€) by related private side R&D efforts will be achieved
- the companies plan to invest substantial additional money in the R&D projects, either before the H2020 projects are completed or in subsequent efforts to develop products and bring them to market (a factor of 3-4 for extra investment is commonly mentioned); this has been started already by some companies in some of the projects.

Other effects

- Increased participation in standardisation efforts: many ETP4HPC organisations (from industry as well as from research) are represented in standard bodies, essentially concerned with parallel programming models or languages, software frameworks for HPC, file systems; some ETP4HPC companies are also active and proactive contributors to HPC related standards on CPU, memory, IO, interconnect and storage.

- Stimulation of training and knowledge dissemination via CoEs and FETHPC projects, in addition to established effort by PRACE since several years (PRACE Advanced Training Centres in 6 different countries; International Summer School; Seasonal Schools)
- Stimulation of numerous software development, all along the supercomputing software stack -system software, middleware, solvers libraries and applications – augmenting/improving existing software of new software being developed
- Significantly increased mobilisation and collaboration of HPC ecosystem stakeholders and better combination of skills and competencies via a denser network of projects – and more ecosystem spirit building via global community events such as the yearly European HPC Summit Week.

Question 4: What interests are shared between the cPPP and other cPPPs and what overlaps and synergies – if any - can be observed? How is the situation in respect of this cPPP and other funding instruments?

The HPC cPPP has been collaborating with BDVA (Big Data cPPP) to investigate synergies between the respective SRAs: for HPC technologies, the data analytics requirements will drive the architectural development not least through new usage models; the possibilities for high performance data analytics will open up new opportunities for the applications covered by the developing BDVA SRIA.
There have been several HPC projects support via Eureka/ITEA programmes ("EC-organised – nationally funded"), in which different ETP4HPC members were involved; partners involved in either/both FETHPC and ITEA projects had similar and consistent contents and objectives in both programmes.
FORTISSIMO projects help European manufacturing SMEs to be more competitive globally through the use of simulation services running on a High Performance Computing cloud infrastructure. The Fortissimo 2 project funded by the European Commission under the H2020 Framework Programme for Research and Innovation is part of the ICT Innovation for Manufacturing SMEs (I4MS) action (www.i4ms.eu) and a follow-on action to the Fortissimo project established in 2013 (see www.fortissimo-project.eu for details on both initiatives). The project is coordinated by the University of Edinburgh and involves manufacturing companies, application developers, domain experts, IT solution providers, HPC cloud service providers and HPC centres, many of them members of ETP4HPC.
In the Communication on the European Cloud Initiative (COM(2016) 178 final), announcing the EC aim to support, together with the EU Member States and European industry, the creation of a world-class European High Performance Computing (HPC) and Big Data ecosystem built on two exascale computing machines, one of the specific objectives stated in the Communication is to "foster an HPC ecosystem capable of developing new European technology such as low power HPC chips".
In April 2017, the EC published a call to set up a Framework Partnership Agreement (FPA) meant to establish such a stable and structured environment – to develop European low-power microprocessor technologies underpinning the build-up of future machines for exascale-class HPC, big data and emerging applications. Future strengthened relationships and links with the micro-electronics ecosystem and entities such as ECSEL are expected in this context.

Question 5: Did activities of the cPPPs lead to a disruptive market creation over the years and if yes in which markets? What activities have been undertaken to increase impact on the market beyond project level? (to be answered to the extent possible) Which steps should be taken to promote further innovation overall?

The first wave of projects covered by ETP4HPC SRA are still ongoing, i.e. it is far too early to identify disruptive market creation or specific actions by the HPC cPPP to assist market impact. Market impact is often if not always at the solution level, a mix of technology and use. Technology projects (FETHPC) have a strong co-design dimension, which is good to make technology and applications closer; CoEs encompass some co-design activities as well. This kind of approach should get to a wider dimension and higher level before we can observe disruptions at a significant level (new service or solution).

Question 6: Taking into account the current role of private for-profit entities in the innovative ecosystems of the cPPPs, how should private industries be considered in future Framework Programmes and what kind of financial support should they receive? There is a discussion whether industry should be funded and, if so, whether loans or other forms of assistance instead of grants are appropriate. What are your arguments in respect of this discussion? Please distinguish between large industry and SMEs in your replies.

Close collaboration between industry and research all along the HPC value chain (from technologies and solution setup to uses and applications to tackle scientific societal and industrial challenges) is crucial. Industry must be considered as an integral part of the R&I ecosystem. In tthe area of HPC co-design is of utmost importance and this is mostly about structured dialogue between users (code developpers, end users, computing centres operators) and technology suppliers, and R&D grants within suited projects such as in H2020 HPC cPPP are a privileged way to achieve this.Compared with FP7, industry presence in HPC H2020 has significantly increased; some FETHPC projects are even coordinated by industrial companies, and it can already be observed these projects have positive effects on more effective co-design, shortened time to prototype delivery etc.

- For larger organisations, the R&D&I funding provided by the Framework Programme enables them, and in particular their research wings, to address higher-risk activities, which would not otherwise be possible within existing, internal budgets.
  NB: international organisations probably see the possibility to collaborate with other partners in a regulated environment (i.e. the context of a formal collaborative project) as the key motivation; tactically strengthening their local ecosystem rather than strategically funding important projects
- For many SMEs, internal budgetary constraints means that they have to focus on current business and the immediate product development needs arising from that business. The funding for participation in the Framework Programme allows them investigate new technologies and innovative business directions, which is very positive.
- From early observations, we saw that Framework Programme projects “sow the seeds” (with staff initially hired for the projects) that subsequently grow into sustained employment options for SMEs. But R&D participation via a loan would likely not be attractive/feasible for many SMEs in general.
  Ther are many SMEs in ETP4HPC (ca. 30 out of 80 members,), an internal SME Work Group was formed and delivered a number of recommendations and observations:
  - After R&D project completion, results are not always 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). Could there be an EU-supported platform to facilitate communication with venture capital?
  - Special loans could be requested from the European Investment Bank (the EC could facilitate this request) in the case of a SME HPC system vendor ‘scaling up’ their ambitions and capacities (we have a few such SMEs in Europe) and delivering large systems to large sites – which causes problems for small companies by exerting an excessive financial load on them SMEs need instruments for finance their orders. OR: request a change in the procurement process (e.g. in the US procurers sometimes pay in advance)
  - H2020 SME Instrument seems to be underutilised by HPC SMEs -should be analysed
- The funding on project-basis makes continuous and steady R&D efforts in general difficult (few exceptions, when there is convergence of pieces of R&D in a project with an industrial roadmap that was anyway defined at a global strategic level). This leads to situations where research results are abandoned because:
  - they are too immature yet, and
  - there is no more public financing for pushing it further and/or getting to a higher TRL level
  - and because the development at this stage is so costly and risky, that a company does not want to take the risk.

  In such situations, public funding can complement private funding, which would allow to mitigate the risk for the private party.

However, it is considered that having companies rely too heavily on public funding (startups in particular) can be dangerous or unproductive – public funding should rather be a catalyst for startups or SMEs to scale up, or for larger companies to motivate, consolidate or secure strategic visions.

Question 7: How do you see the future of cPPPs in the next Framework Programme?

cPPPs can be an appropriate framework for continued interaction between the private side and the EC. But the current setup and "modus operandi" of the HPC cPPP only allows limited interaction, with two formal meetings per year, and no operational role nor real coordinating not steering influence – cPPP in current setup can present incentives to the ecosystem, and to some extent monitor activities, but has mostly an advisory role.
NB: CSAs offer support for some actions in the cPPP scope, they are very important to develop some community/ecosystem spirit, but at the risk of extra overhead and fragmentation of visions. A peer-level interlock with frequent information/ideas sharing exchange could for instance be of great benefit for a consistent and executable European HPC roadmap.
Improved inter-PPP collaboration could/should be built on precise and documented analysis or commonalities or complementarities, and focus on specific axes, beyond general principles (this is what HPC and BDVA cPPP are trying to do concretely).
Generally speaking, further simplification of tools and procedures (FP instruments) would be appreciated, including easier and more flexible funding sources mixing (structural funds, national, EC funding……)

5.2 Summary of main KPI figures

This table summarises KPIs and trends as documented in May 2017. These figures are part of the 2016 Progress Monitoring Report, and the basis of the cPPP mid-term review of 2017.

	Perspective	Key Performance Indicator (KPI)	
1	Industrial Competitiveness and Socio-Economic Impact	Global market share of European HPC	• From 4.4% in 2013 to 4.9% in 2016, showing positive momentum prior to HPC cPPP effects (to be measured later than current mid-term of first H2020 projects)
2	Industrial Competitiveness and Socio-Economic Impact	HPC additional investments	• EU ecosystem yearly R&D effort est. at least in the range of 165-210 M€ in HPC technologies and 150-225 M€ in Other HPC R&D • Est. 4-fold leveraging factor for industrial effort per public euro in the cPPP
3	Industrial Competitiveness and Socio-Economic Impact	Jobs	• 61 job creations in HPC technology industry for the first 26 M€ of H2020 funding
4	Industrial Competitiveness and Socio-Economic Impact	Innovation Environment in HPC (European HPC start-ups – creation – growing…)	• Several SME acquisitions by large companies • 2 SMEs bringing FP7 HPC R&D to the market

5	Operational aspects of the programme	Research programme effectiveness and coverage	• 3 calls implemented, 19 FETHPC projects, 2 CSAs, 9 CoEs running (30 projects for 141 M€ + 2 forthcoming for 35 M€) • 321 participating organizations • 62% non-ETP members participating • 33% industry participation (11% SME and 22% non-SME)
6	Operational aspects of the programme	Performance of HPC technologies developed	• FETHPC only led to internal prototypes for the time being • FP7 MontBlanc and Deep prototypes deployed • DEEP production Booster to be installed in FZJ • MontBlanc3 prototype will bring ARM-based processors into commercial SEQUANA architecture
	Operational aspects of the programme	People, education, training and skills development	• 6 PRACE Advanced Training Centres • Ca. 1000 participants in FETHPC and CoE projects training sessions and workshops
8	Operational aspects of the programme	HPC use	• FP7 projects DEEP, MontBlanc prototypes open to user communities
9	Operational aspects of the programme	HPC Software ecosystem	• To be further elaborated
10	Operational aspects of the programme	Patent, inventions and contributions to standards in HPC by H2020 funded project	• 11 patents secured with the help of 26 M€ of Work Programme 2014-15 funding
11	Management aspects of the programme	Efficiency, openness and transparency of the PPP Consultation Process	• Info Day April 2014 at the launch of HPC cPPP (140 participants from 20 EU countries) • 2 cPPP Partnership Boards per year since June 2014 (ETP4HPC members and CoE representatives seat on the private side) • 1 or 2 ETP4HPC General Assemblies per year • ETP4HPC Strategic Research Agenda involves ca. 200 experts
12	Management aspects of the programme	Dissemination and Awareness	• HPC Summit Week conference in May 2016 in Prague gathered over 300 participants in total • DGCNECT's single point of access to all information about the EC HPC strategy and work programmes • ETP4HPC website gathers community news and information - HPC cPPP in a dedicated branch • PRACE web site for community information, as well as EXDCI and Eurolab-4-HPC web pages

Table 8: KPI summary from 2016 Progress Monitoring Report