European Economic and Social Committee

TEN/487
High-Performance Computing: Europe's place

Brussels, 11 July 2012

OPINION

of the
European Economic and Social Committee
on the
Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - High-Performance Computing: Europe's place in a Global Race
COM(2012) 45 final

_____

Rapporteur: **Ms Caño Aguilar**

_____

Rue Belliard/Belliardstraat 99 — 1040 Bruxelles/Brussel — BELGIQUE/BELGIË
Tel. +32 25469011 — Fax +32 25134893 — Internet: http://www.eesc.europa.eu

EN

On 18 April 2012 the European Commission decided to consult the European Economic and Social Committee, under Article 304 of the Treaty on the Functioning of the European Union, on the:

> *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – High-Performance Computing: Europe's place in a Global Race*
> COM(2012) 45 final.

The Section for Transport, Energy, Infrastructure and the Information Society, which was responsible for preparing the EESC's work on the subject, adopted its opinion on 25 June 2012.

At its 482nd plenary session, held on 11 and 12 July 2012 (meeting of 11 July), the European Economic and Social Committee adopted the following opinion by 143 votes to 1 with 3 abstentions.

*

* *

1. Summary and recommendations

1.1 Overall, the EESC endorses the Commission's Communication and strongly supports its objectives. High Performance Computing (HPC) is essential to knowledge advancement and is the basis for the development of many innovative products, processes and services.

1.2 HPC is included within the Digital Agenda and is a vital instrument in today's research and economies where it is relevant to energy, climate, health, social, economic and defence policies. HPC has strategic importance for the Europe 2020 Strategy.

1.3 The EESC supports the development of a European HPC eco-system and the PRACE research infrastructure set up to this end, which is intended to ensure the wide availability of HPC resources on equal access terms for all potential users and actors in the EU, especially those from universities and SMEs.

1.4 In addition to the financial and contract-law aspects of an efficient HPC eco-system, two other tasks are equally important in developing HPC further. These are the development of next-generation computer hardware (exascale computers) and the development and dissemination of the very advanced instruments necessary for their use, i.e. the software. Both these areas should given equal attention.

1.5 The EESC supports the proposal to double the EU's current HPC investment to EUR 1.2 bn per year. This means that an additional EUR 600 m. is required, which would be mainly provided by the EU, the Member States and industrial users. This would bring the amount invested by the EU up to the level of other regions of the world. Approximately half of this increased investment should be spent on the procurement of HPC systems and test beds and the remaining half split equally between training and the development and up-scaling of HPC software.

1.6 This will require research institutes and universities to work with industry. The Committee believes that public-private partnerships, a tried and tested tool, are especially suitable here. Pre-commercial procurement could also be considered in individual cases, but the Commission certainly should not require this as the only choice.

1.7 The Member States and the EU would also need to provide substantial support for this. These resources are needed both directly - to accomplish the tasks described above for the further development of an efficient HPC system, and indirectly to train the high and medium-level specialist staff needed, i.e. universities and their staff.

1.8 Against the background of the economic and financial crisis, the Committee urges the Council and the Member States not to neglect the measures needed for HPC, which are needed to boost the economy and competitiveness. There would otherwise be a risk of precipitating a dangerous downwards spiral.

1.9 The Committee believes that the main priority is a competitive HPC system in Europe and for Europe. This objective does not imply a protectionist industrial policy. Rather, the focus should be on developing and using the necessary know-how, and maintaining or creating jobs and decision-making levels needed for HPC development and use in Europe. Further joint ventures with today's leading global players in technology who also operate or are engaged in R&D in Europe and with European companies possessing state-of-the-art expertise in specific HPC segments could at the same time create the critical mass needed to compete with China's expected future market leadership.

2. Gist of the Commission Communication

2.1 The Communication highlights the strategic importance of High-Performance Computing (HPC) (High-performance computing (HPC) is used in the Communication as a synonym for high-end computing, supercomputing, world-class computing, etc., to differentiate it from distributed computing, cloud computing and compute servers.). It builds on the Communication on ICT Infrastructures for e-Science and the conclusions of the Council asking for "further development of computing infrastructures such as the Partnership for Advanced Computing in Europe (PRACE www.prace-ri.eu)" and to "pool investments in high-performance computing under PRACE".

2.2 The Committee calls on Member States, industry and the scientific communities, in cooperation with the Commission, to step up joint efforts to ensure European leadership in the supply and use of HPC systems and services by 2020.

2.3 HPC systems are being developed to make it possible to address societal and scientific grand challenges more effectively, such as early detection and treatment of diseases, deciphering the human brain, forecasting climate evolution or preventing large-scale catastrophes, and to cater for the needs of industry to innovate in products and services.

2.4 The challenges facing the development of even more powerful HPC systems cannot be met by mere extrapolation, but require radical innovation in many technologies. Industrial and academic players in the EU have the opportunity to reposition themselves in the field.

2.5 The EU invests substantially less on acquiring high-end computing systems than other regions (only half compared to the US, at a similar level of GDP). Consequently, the amount and performance of computing systems available in the EU are simply too low compared to other world regions, and R&D budgets devoted to HPC are tight.

2.6 The rest of the Communication covers:

- *the Partnership for Advanced Computing in Europe (PRACE),*
- *Europe's expertise in the supply chain,*
- *the benefits for Europe of re-engaging in HPC,*
- *the challenges ahead,*
- *an HPC action plan for Europe,*
- *governance at EU Level,*
- *pre-commercial procurement mechanisms and pooling of resources,*
- *further developing the European HPC eco-system.*

3. General comments

3.1 Overall endorsement

3.1.1 Overall, the EESC endorses the Commission's Communication and strongly supports its objectives. Many new products, processes and services are developed on the basis of high-performance computing, which is not only one of the most important key technologies, but also essential to being able to research complex systems. HPC is, therefore, a key component of the Europe 2020 Strategy.

3.1.2 By developing and using increasingly powerful computers, HPC has become a major third pillar for research and development in recent decades, not only complementing the "conventional" pillars of experimentation (including demonstration and testing) and theory, but also becoming an integral part of them, leading to the emergence of the new field of

simulation science. HPC is also an important tool for obtaining complex data and for analysis and forecasting systems. HPC is included within the Digital Agenda and has become a vital instrument in today's research and economies, where it is relevant to energy, climate, health, economic, social and defence policies.

3.2 **Supercomputers**

The key hardware used in HPC is made up of "supercomputers", which display two specific features:

- they can only achieve full performance by running a huge number of individual computers (processors) simultaneously, i.e. in parallel. In fact, supercomputers are now being designed with up to a million separate processors. In order to make optimum use of such highly complex computers, extremely advanced and complex software must be developed and made available to users This is a very specialised development task that has so far been widely undervalued;
- the power requirements for even more powerful computers are increasing to levels which are currently thought to be unachievable. Unless completely new components are developed that will reduce power requirements by 99%(!), a new-generation supercomputer (exascale computer) would need at least one power station of its own with an output of 1000 MW in order to function. Reducing these power needs to more realistic levels is a huge technological challenge which does not seem easy to achieve.

3.3 **Aspects of a European support policy**

In the EESC's opinion, the Communication addresses not so much the scientific and technical challenges as the European support and development policy which the Commission considers necessary in order to meet them, and proposals for the instruments that can be used to achieve this. However, the EESC has some reservations in this regard and recommends that a further round of consultations be conducted (see point 4.4).

3.4 **Hardware-software balance**

One of the EESC's main recommendations is to examine software aspects as an equally vital part of the problem more intensively and to prepare solutions, particularly with regard to developing, testing and disseminating the necessary software for users. There is a considerable need for research, development, education and training for the different levels of qualification systems and users. This means that sufficient support is needed for the corresponding measures in universities, research centres and industry. The EESC recommends that the Commission remedy this shortcoming.

3.5 Skilled staff – universities and resources

In this regard, one major hindrance lies in the training and availability of sufficiently skilled staff, for example, http://www.hpcwire.com/hpcwire/2012-04-04/supercomputing_education_in_russia.html, not only for the necessary R&D tasks but also in order to operate HPC systems effectively. These aspects should be taken into account within the support measures. Essential to this are universities with sufficient financial and human resources, where a sufficient number of internationally recognised software experts and development engineers teach and carry out research, and where, on the basis of R&D experience, high-level training can be offered.

3.6 European HPC eco-system: PRACE

3.6.1 What is PRACE?

The need for a European HPC infrastructure which can be used by all partners was recognised and promoted by the operators and users of national HPC centres in 2005. Representatives of 14 European countries initially founded the PRACE partnership, which aimed to promote, use and further develop HPC in Europe.

This resulted in HPC being selected as one of the first ESFRI list (CESE 40/2009) Research Infrastructures. After the legal, financial, organisational and technical conditions had been established, in 2010 PRACE AISBL (International non-profit making association) was founded with its headquarters in Brussels. It aims to provide users from all the partners with access to Europe's five most powerful nationally-established HPC systems. PRACE currently has 24 members, including members from Israel and Turkey. PRACE is receiving funding for three projects in FP7, in particular for work on porting, optimisation and petascaling of applications and for intensive user training and education. Currently, four partner countries (Germany, France, Italy and Spain) have each agreed to provide computing power to the value of EUR 100 million each. An independent Scientific Steering Committee determines the allocation of user quotas in a pan-European peer review process.

3.6.2 Committee position on PRACE

The EESC supports the **further development of a European HPC eco-system** and the **research infrastructure set up** to this end, which ensures, or is intended to ensure, the wide availability of HPC resources on equal access terms. It is to be ensured that all potential EU users and actors, especially those in universities or SMEs who are not directly connected to the PRACE organisation, are able to cooperate in developing and using resources on equal terms with all other stakeholders. In principle, the issue is not only the more straightforward and no doubt soluble problem of creating equal access conditions for existing HPC resources, but also that of researching, developing and finally acquiring a completely new HPC eco-system which would be **many orders of magnitude more powerful, using exascale computers** (see point 4.1 below) **at its hub and including the development of the**

advanced software suited to it. In this regard, the EESC recommends avoiding rushed concentration processes and decisions regarding a specific common system in order to allow for the competition and multiplicity of possible approaches and ideas required for the eco-system to succeed and to achieve the highly ambitious aim that has been set. This delicate issue of balanced research, development and competition policies is covered in the specific comments below. In this regard, the EESC sees a need for fresh discussions among the potential stakeholders.

3.7 **Appeal to the Council and Member States**

3.7.1 The economic crisis in many EU Member States means that there is an understandable tendency to make savings in training, research and development. This would, however, result in a disastrous downwards spiral, as it is precisely these new technologies, innovations and related skills which will be needed to boost economic growth and competitiveness.

3.7.2 The Committee therefore strongly urges the Council and all Member States not to fall back on the easier option, but to invest instead in new developments and the conditions they require and, in order to safeguard future prospects, provide increased support rather than make cutbacks.

4. **Specific comments of the Committee**

4.1 **The Exascale Project**

The development of the next generation of supercomputers has been dubbed the "Exascale Project". To this end, it is necessary to decisively improve, and probably completely redevelop, the individual components which determine power consumption at all levels of the common system. This is a difficult task when it comes to cooperation between research centres and industry, with their conflicting demands.

4.2 **Cooperation between research centres and business**

The EESC has already expressed its views on this complicated subject area on several occasions (for example, see CESE 330/2009), including in its recent opinion (CESE 806/2012) on Horizon 2020 in which it recommended that "new approaches to industrial and competition policy should therefore be considered.

It is questionable here whether 'pre-commercial procurement' would provide a suitable instrument for cooperation between research centres and business. The Committee therefore recommends that the different objectives, which are sometimes mutually incompatible, and requirements of research policy, innovation policy and industrial policy should be identified, and discussed and clarified with the various stakeholders. Special arrangements may even be needed in certain cases" (see also point 4.4 of this draft opinion).

4.3 **Development efforts for the Exascale Project**

In the specific case of the Exascale Project it will be necessary, in accordance with modern R&D practice, to involve both large and small companies, including the most successful global players (see also point 4.5) from the various areas (such as processors and the many other components) in partnerships between the research sector and industry, and at the same time to avoid any hasty decisions. It will only be possible to draw up an optimised blueprint for a common system once it is known what components have been or could be developed, and how they perform. Unfortunately, there have been cases in the past when this aspect was overlooked, resulting in failure.

4.4 **Support approach - Public Private Partnerships**

Given the great importance of having an efficient HPC system in Europe and for Europe, the Committee therefore recommends that the Commission, in cooperation with the many possible stakeholders (particularly members of the PRACE platform), develop and jointly propose the desired support approach before implementing the initiatives described in the Communication under review. The Committee believes that in particular public-private partnerships (PPPs) are a tried and tested instrument which have already proved themselves being a suitable instrument for achieving HPC development objectives. Therefore pre-commercial procurement, favoured in the Commission proposal, whilst possibly appropriate in individual cases, ought not to be imposed generally.

4.5 **Global players**

To this end, it should be made clear that the main priority is to obtain a powerful, competitive HPC system in Europe and for Europe. As this sector so far is dominated by global players (like IBM, CRAY or INTEL) whose holdings, manufacturing facilities and research centres are spread throughout the world, the EESC believes it is important in these circumstances that the know-how needed for the development and use of HPC and the corresponding jobs and decision-making levels also exist in Europe or be established. Further cooperation with today's leading firms but also with emerging companies that might become tomorrow’s leaders could, for example, also create the critical mass needed to withstand China's expected future market leadership.

4.6 **Greater financial resources**

The EESC supports the proposal to double Europe's current HPC investment to EUR 1.2bn per year. This means that an additional EUR 600m. is required, which would be mainly provided by the EU, the Member States and industrial users. This would bring the amount invested by the EU up to the level of other regions of the world. Approximately half of this increased investment should be spent on the procurement of HPC systems and test beds and the remaining half split equally between training and the development and up-scaling of HPC software.

The high financial requirements are linked to the high cost of HPC. A high performance computer costs over EUR 100m, while system maintenance and operation cost at least an additional EUR 20m per year. This calls for public-private partnerships, examples of which already exist in the countries leading the HPC field.

4.7 Equal opportunities and intellectual property rights

The Communication sets out the great difficulty that European HPC manufacturers have in selling their products to the public sector in non-EU countries with national manufacturers. When it comes to using HPC for highly strategic areas (such as nuclear energy, defence industry, oil and gas industries), meeting the security requirements is virtually impossible. However, the European research projects developed in the context of the Framework Programme could indirectly benefit companies in non-EU countries.

Bearing in mind that all the contracting parties to the WTO Government Procurement Agreement must honour the provisions relating to national treatment and non-discrimination (Article III), the EESC supports the Commission's intention to raise the issue of equal access to the HPC market in trade relations with non-EU countries.

The Committee therefore supports the intentions to clarify and defend intellectual property rights set out in the Commission proposal on Horizon 2020 (COM(20011) 809 final, 30.11.2011)

4.8 HPC and power consumption

The challenges for the future will include power consumption as a factor limiting the development of HPC (The Greening of HPC - Will Power Consumption Become the Limiting Factor for Future Growth in HPC? Munich, 10 October, 2008. http://www.hpcuserforum.com/presentations/Germany/EnergyandComputing_Stgt.pdf.) (see also point 3.2). Using current technologies, exascale systems will consume vast quantities of power that will increase operating costs (it is estimated that power will account for 50% of these) and environmental pollution.

Various proposals have been made to achieve energy-efficient technologies, such as hybrid computers, although these raise other issues ("(…) Progress in lower-power devices may make it feasible to build future systems with Exascale performance. (…) However (…) how do we exploit (…) this disruptive technology?" *A Strategy for Research and Innovation Trough High Performance Computing*, University of Edinburgh 2011).. When it comes to the architecture, for instance, many energy-saving strategies have been developed, such as the definition of islands with different voltages (which can even be switched off), or the use of low-power memories (with drowsy cache cells) and the selective switch-off of units. In processors, multi-core, multi-thread and cluster architectures can help achieve a balance

between computing power and the objective of reduced energy consumption and heat generation (Green IT: Tecnologías para la Eficiencia Energética en los Sistemas TI, Universidad Politécnica de Madrid, 2008).

The EESC therefore suggests making support for energy-saving technologies an integral part of the EU's HCP project.

Brussels, 11 July 2012

The President
of the
European Economic and Social Committee

Staffan Nilsson