Re-clustering of the CCF Division Research Programs
and Reasons for EMT to Stay *Status Quo Ante*

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Though I joined the National Science Foundation as a full-time IPA only two months ago, I believe that as the lead EMT Program Director I will be allowed to object to various re-clustering configurations which purportedly plan to eliminate the Emerging Models and Technologies for Computation Cluster[1] as an independent entity in the CCF Division. It appears to me that the proposed re-clustering models for the CCF Division research programs will lead to either (1) subsuming the entire EMT Cluster within the Theoretical Foundations Cluster, or (2) breaking up the EMT Cluster to allow its constituent individual fields of research to merge with other compatible clusters in the CCF Division. The reasons for my objection are given below.

(1) Reasons against merging EMT with the Theoretical Foundations (TF) Cluster

I concur with those, and perhaps there are good many of them in the CCF Division, who think that the EMT Program with its multifarious and interdisciplinary research projects should not be merged with the TF Cluster. While the "theoretical physicists" treat the problems in quantum computing more rigorously by applying the theories of quantum physics and quantum statistics, the "computer theorists" largely work on somewhat simplified matrix-based abstraction of the quantum computing model. As a result, the orders of magnitude advantages of quantum computing over classical computing for various computational problems, often claimed by computer theorists, may not be achievable by a physical quantum computer consisting of thousands of quantum-bits. There are apparent lacuna between the actual physical models and the simplified computational models which may prevent quantum computers from achieving the spectacular computational speed advantages projected by theoreticians. Whether this is true or not, I believe that the EMT along with the Directorate of MPS should independently pursue their missions to achieve more realistic results in quantum computing and communication.

Moreover, quantum computing is only a small fraction of various disparate research projects currently being funded under the EMT program. The majority of the research projects in the EMT program such as nanotechnology, DNA self-assembly, synthetic biology, and biologically inspired computing cannot be tackled by the existing theoretical techniques in the discrete domain of complexity analysis. The existing theories of digital computation are far cry from the classical mathematics and quantum physics like the non-equilibrium and lattice-scale Green's functions, density function theory, density matrix, and self-consistent envelope functions which are generally employed to model many of these nascent technologies. While these mathematics and physics based theories are reasonably well developed in the literature, the real challenges that the EMT program help overcome are to create the innovative hardware and software deliverables that will spur the growth of nanotech and biotechnology market.

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[1] Emerging Models and Technologies for Computation Cluster

This cluster seeks to explore computational models, techniques, and systems based on emerging and future technologies. Research and education projects are supported in computing systems based on nanotechnology, quantum computing and communication, and computational devices and architectures inspired by the processing of information in living matter. The portfolio of awards examines concepts in new computing architecture, quantum and biologically inspired computing, as well as micro- and nano-systems.

(2) Reasons against breaking up the EMT Program

I believe that the EMT program can serve as a synergistic hub to catalyze research activities in many program areas within the CCF Division. For example,

(i)   The Design Automation program can seek co-funding from the EMT cluster for research works in evolutionary nanoelectronics systems using nanotube and nanowire FET's.

(ii)   Computer Architectures program similarly can co-fund research projects with the EMT cluster on self-assembled neuromorphic architectures, revolutionary architectures using spintronics, and perhaps synthetic biological systems.

(iii)   Computer Theory program can synergistically work with the EMT cluster to co-fund research projects on quantum algorithms for NP-complete problems, quantum modeling of Turing machine problems, and general-purpose computing by quantum-bits.

(iv)   Communications program can possibly share funding with the EMT cluster in applications of quantum communications and self-organized biological models in practical wireless and sensor networks.

(v)   Signal Processing program will be able to assist the EMT cluster in biological signal processing and genetic information processing.

(vi)   Software program can work with the EMT cluster in bioinformatics and genome data search. Further, the EMT cluster along with the DA program and the Software program can jointly fund research projects to develop hierarchical and multi-scale simulation and optimization tools for various emerging technologies that are likely to make commercial inroad.

The EMT program can even transcend the boundaries of the CISE Directorate and establish partnership with on-going programs in the directorates of engineering, biology, physics, chemistry, and material sciences. International research and education programs are now seeking co-funding with the EMT program to foster international collaboration in nano-bio-info technologies with China, Japan, Europe and other developing countries.

The heliocentric capability of the EMT program will be significantly weakened and occluded by any effort to cannibalize the program and fit its constituent fields of research within the scopes of different clusters in the CCF Division.

(3) Parallax between External Views and CCF Clusters Should Be Eliminated

The external views of emerging technologies are generally articulated by an international committee of engineers and scientists who analyze the prospects of various cutting edge technologies in the annual reports of the Emerging Devices and Models published by the International Technology Roadmap for Semiconductors (ITRS). The current EMT program elements in the NSF support these external perspectives and researchers can connect their works with the goals and objectives of the NSF EMT program. Any new re-clustering model that seeks dismembering of the EMT program or merging the entire EMT program into the TF Cluster under a different title is likely to confound the research community who NSF intends to serve. Transparency and consistency with the outside world must be paramount if the prime objective of the CCF Division is to maximize the effectiveness of the EMT program. Any parallax between external views about emerging models and technologies and the proposed new CCF clusters must be eliminated by all means.

(4) NSF Inside Issues: Fund Allocation and Programmatic

In order to enable the CCF Division to award the most meritorious proposals within the core EMT program and the cross-programs as listed above, I believe that using the notion of a hyper-cluster model within the CCF Division will be appropriate. The EMT hyper-cluster concept can be construed as an NSF Inside view for fund allocation and proposal management. The budget for emerging models and technologies can be divided by the CCF Division Director into two parts: (i) Budget for the "core" EMT research projects, and (ii) Budget for "cross-programs" within the EMT hyper-cluster that may include only the relevant CCF programs. While the EMT program directors can directly fund new projects from the core program, the use of funds allocated to the hyper-cluster should be collectively decided by the designated program directors of the EMT hyper-cluster. I believe that this approach will enable the CCF Division to serve the research community very effectively. Our cardinal objectives will be to recognize the most meritorious research proposals irrespective of which program solicitations they are submitted to the NSF, and fund those deserving proposals for the benefit of science and technology. It is less important who the PD's are in the award letters since most of the rotational program officers leave NSF much before the completion of the grants they initiate. Therefore, the notion of hyper-cluster can be adopted to achieve all the desirable goals of new models of re-clustering without actually requiring the EMT cluster to change.

EMT Workshops will Provide Valuable Feedback from the Experts – Let us Wait

Finally, I would like to mention that the EMT Cluster is planning to organize three different workshops during September-December 2007 for its three program elements: (i) Biologically Inspired Computing, (ii) Quantum Information Processing, and (iii) Nanoelectronics. Over the past few years, the EMT Program itself has emerged due to the unification of these individual program elements in phases in order to fund a variegated collection of visionary, multi-disciplinary research projects. The current research grantees and an invited group of experts will attend these workshops in order to sharply define the scope and objectives of the future EMT program as well as to create tentative roadmaps for the emerging bio, nano, and quantum technologies. These EMT workshops will produce comprehensive technical reports which will include reflections and recommendations of the experts.

Therefore, for the time being, let the EMT Computation Cluster remain *status quo ante*.

NB: Please feel free to edit this first draft and send me your corrections. Thank you.

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