NANOTECHNOLOGIES FOR INFORMATION PROCESSING

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This presentation comes at a time where most of the projects are in the Nanotechnology Information Devices(NID) action in Framework Programme 5 (FP5) have ended or are nearing completion. It is hence a good moment to assess the results of this initiative. We will also provide a picture of actions in nanoscale information technology devices in Framework Programme 6 (FP6), and complete with the first elements being proposed for Framework Programme 7 (FP7).

The work on Nanotechnology for information processing in IST finds its roots in the upstream microelectronics research undertaken in the ESPRIT Microelectronics Advanced Research Initiative (MEL ARI) from 1994-2000. While MEL-ARI was heavily oriented towards semiconductor electronics, the follow-up Nanotechnology Information Devices (NID) activity promoted multidisciplinary research concepts bringing quantum physics, materials sciences, nanomechanics, chemistry and biology together with the traditional disciplines of electronics and computing into multidisciplinary research projects towards new potential avenues for information processing. This direction is being pursued in FP6 and is likely to be extremely relevant for FP7.

The objective of the NID action was to achieve superior performance of information processing and storage systems through operations at the atomic and molecular scale.

The action successfully attracted more than 30 projects to develop future visions of information processing systems. These projects, with a total EC contribution of 50M€, produced many research results to realise new types of nanometer scale **devices**, **architectures** and designs for information processing systems that are adequate for nano-scale implementation, and tools and techniques for the **fabrication** of structures with critical dimensions below 10 nm.

The results on **devices** range from advanced CMOS solutions to atomic-level structures for the processing of information, and the projects strongly contributed to the development of emerging technologies such as nanotubes devices, ballistic junctions, single electron memories, atomic chips, and molecular devices. Progress on **architectures** is usually more elusive as it has to foresee future developments in devices, interconnects and application requirements, but notable progress was reached in terms of architectures for fault-tolerance, on interconnects, and on very far-reaching new architectural concepts. In the area of **fabrication** methods, the groundwork performed in the NID projects has been instrumental in the launch of the new discipline of nano-imprinting, which is now further pursued in the NAPA project supported by the Nanotechnology, Materials and Processes priority of FP6.

An important result of the NID action has also been the development of a vibrant research community, as can be seen from the growing success of the Trends in

NanoTechnology series of conferences, and in the setup of the PHANTOMS network to support interactions among this community. Finally, the joint effort to publish the "nanotechnology roadmap for nanoelectronics 2000" was very instrumental in the establishment of nanoelectronics and nanotechnologies as main research themes, and in particular in promoting the introudction of the new "Emerging Research Devices" chapter of the International Technology Roadmap for Semiconductors (ITRS).

Another sign of the success of the NID initiative is the much higher priority given in the EC Framework 6 to the areas of Nanoelectronics in Priority 2 (IST) and Nanotechnology in Priority 3 (NMP) of the Programme. This increased emphasis on nanotechnologies and nanoelectronics is also taking places in many other parts of the world such as the USA and Japan.

As a result of the first calls for proposals for FP6 in IST, major areas in nanoelectronics are supported through large projects covering CMOS and lithography for the 45 nm node and below. Another set of projects in the Microsystems and micro-nanosystems area target the diversification of electronics with polymer materials, microsystems and other devices, with particular interest for applications in health and ambient intelligence systems. These new IST projects are also complemented by new projects in Priority 3 covering areas such as nanosciences, materials, nanofabrication, and multidisciplinary research.

A major part of the 3rd call for proposals for IST (closing on 22 September 2004) is a set of 4 Future and Emerging Technology Initiatives, including "Emerging Nanoelectronics" and "Quantum Information Processing and Computing" (QIPC). In addition, the joint IST-NMP call (closing on 14 November 2004) covers "Materials, Equipment and Processes for Production of Nano-Photonic and Nano-Electronic Devices". The timing of these calls will allow the successful projects to start early 2005, thereby allowing continuity with NID projects started in 2001.

The new Workprogramme of IST to cover the 2005-2006 is currently in preparation. Future and Emerging Technologies has proposed 3 new proactive initiatives for Call 4, to be launched provisionally in November 2004. These are entitled "Advanced Computing Architectures", "Presence and Interaction in Mixed Reality Environments", and "Situated and Autonomic Communications". They are likely to be complemented, as in the first part of FP6, by the possibility to submit advanced research projects in upstream IST topics through the FET Open call.

The process of preparation of the 7th Framework Programme (FP7) is now well on its way, with a number of important Commission Communications published, notably on "Europe and basic research" (COM 2004-9 of 14/01/04), on a "European strategy for nanotechnology" (COM 2004 338 of 12/05/04) and on "Science and Technology" (COM 2004 353 of 16/06/04). This process will eventually lead to the adoption of the FP7, expected to start end 2006. Major new directions currently on the table for the new programme include a new approach to the support of basic research, an emphasis on public-private partnerships in key domains for competitiveness, and on the introduction of the topics of space and security in the contents of the programme.