Fundamentals of Molecular Nano-Communication Networks at IEEE ICC 2012

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The concept of nanotechnology was first pointed out by the 1965 Nobel laureate physicist Richard Feynman in his famous speech entitled “There’s Plenty of Room at the Bottom” in December 1959. The main focus of his speech was about the field of miniaturization and how he believed that humans would create increasingly tinier and powerful devices in the future. In the 21st century, nanotechnology is providing a new set of tools to the engineering community to design and manufacture devices in a scale ranging from one to a few hundred nanometers.

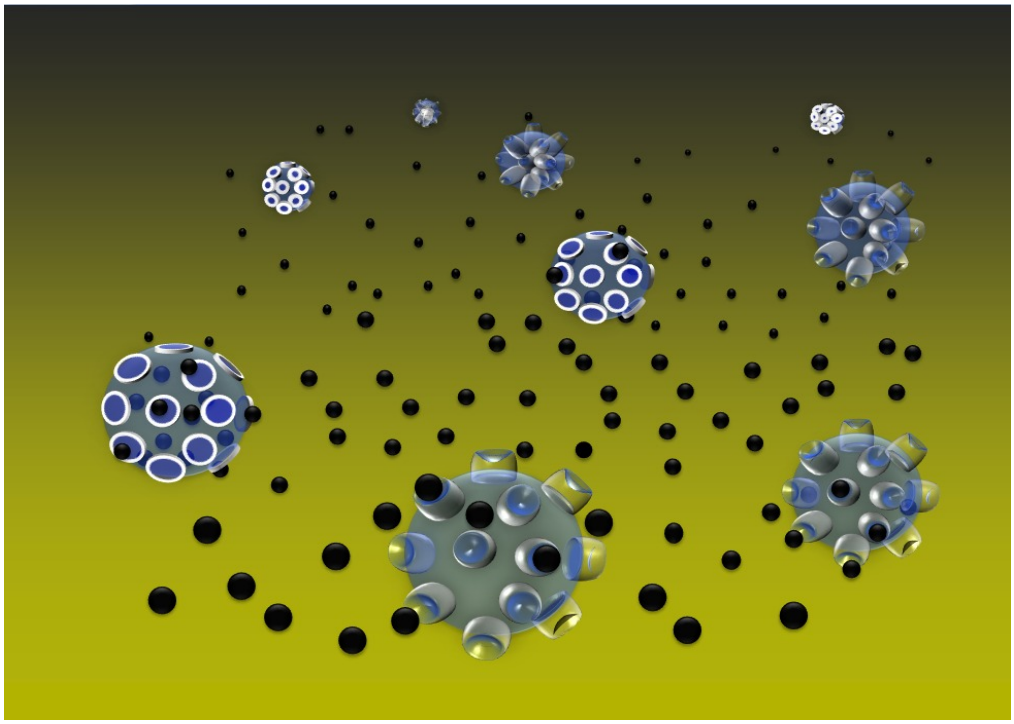
At this scale, a nano-machine is defined as a device, which consists of nano-scale components, able to perform a specific task at nano-level, such as computing, data storing, sensing and/or actuation. Due to its low complexity and small size, the tasks performed by one nano-machine are very simple and restricted to its close nano-environment. Nano-machines can be interconnected to execute more complex tasks in a distributed manner. The resulting nanonetworks are envisaged to expand the capabilities and applications of single nano-machines, both in terms of complexity and range of operation.

The envisioned applications of nanonetworks range from the biomedical field, in intra-body diagnosis and intelligent drug delivery, to the industrial fields, as a support to the monitoring and control of goods production and waste disposal, and security/safety applications, such as a countermeasure for biological and chemical attacks from the nanoscale. However, all these applications require communication among nano-machines, which, for the time being, still poses a major challenge.

On Tuesday, June 12 at the IEEE International Conference on Communications (ICC 2012) to be held June 10 – 15 at the Ottawa Convention Centre in Ottawa, Canada, I will present a radically new branch of research focused on investigating the use of molecules to encode and transmit information among nanomachines as a viable solution to the communication needs at the nanoscale. This research is the main

objective of the Fundamentals of Molecular Nano-Communication Networks (MoNaCo) project, which was recently funded by the US National Science Foundation (NSF).

In the MoNaCo project, molecular communication is studied as a radically new communication paradigm, which demands novel solutions, including the identification of existing molecular communication mechanisms, the establishment of the foundations of molecular information theory, or the development of architectures and networking protocols for nanomachines. Molecular communication is a highly interdisciplinary topic, which spans wireless communication and networks, biology and mechanical engineering. For this, we take the position that not only will molecular nanonetworks have great relevance to biological physical systems, but also taking a bio-inspired approach to the design of nanonetworks is an optimal pathway to viable solutions.



The research on molecular nano-communication networks will make contributions along four broad directions: the theoretical characterization of the molecular communication channel for a network of nanomachines, the definition of suitable molecular communication protocols for the transmission of information, the engineering of standard tools for the simulation of molecular nano-communication networks and the realization of testbeds for their experimental validation. Since to date the realization of artificial nanomachines is still under development, the researchers in this field are taking advantage of the large presence of molecular nano-communication networks in nature in order to realize testbeds based on already available bio-components, such as populations of genetically engineered bacteria. The tight connection of this cutting edge research field with biology will ultimately enable both the bio-inspired study of molecular nano-network architecture and their realization with tools already available in nature.

These contributions will have a significant impact on research in nanotechnology,

biology and information and communication technologies, since this project will represent the entrance of these three main communities to this converging field, following a more realistic and integrated approach. The impact of this research will be far-reaching for basic science, education, and technology, with profound benefits for society.

For more information on IEEE ICC 2012, please visit http://www.ieee-icc.org/2012 [1] or feel free to contact Heather Ann Sweeney of IEEE ComSoc at h.sweeney@comsoc.org [2]. Furthermore, all website visitors are also invited to network with colleagues and peers, share their professional experiences or address IEEE ICC 2012 issues through the conference's Facebook, Linkedin and Twitter pages.

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