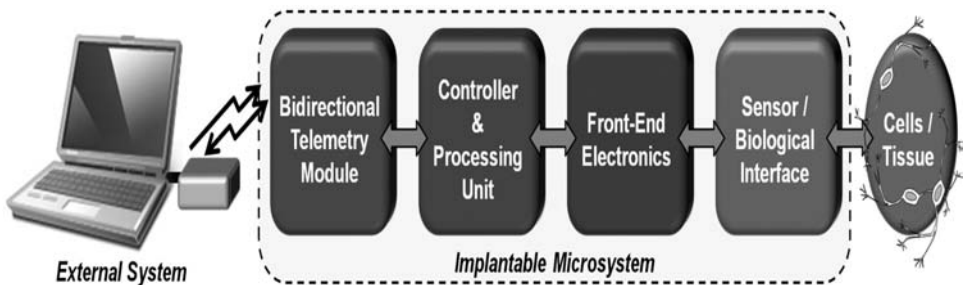

The Neural Microsystems Testbed

Euisik Yoon, Interim Technical Director

The Neural Microsystems Testbed weaves together research across the various WIMS thrusts and universities to realize full, stand-alone, implantable microsystems. These microsystems unite wireless communication, low-power control and processing, and biological interface technologies for comprehensive functionality. Design and implementation of optimum wireless architectures is a major focus of this work. Another essential aspect is developing leading technology for the modules and their integration, including sensors, probes, electrodes, cables, and packages.

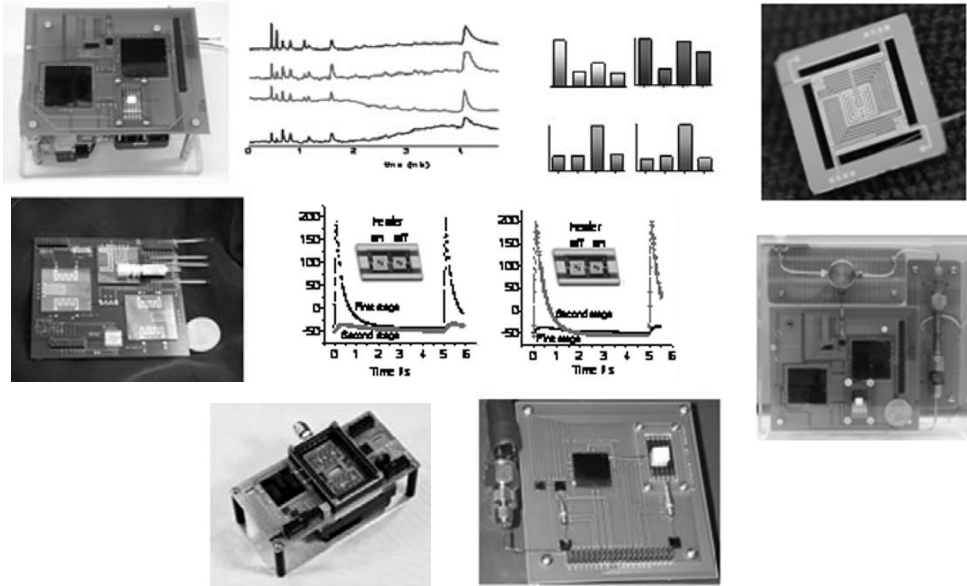


General block diagram of the wireless implantable microsystems being developed under the Biomedical Sensors and Subsystems Thrust.

The multidisciplinary projects within this testbed cover a wide variety of applications from the recording of biosignals to the stimulation of different tissues and organs. The recently completed first-generation microsystem targeted the recording of control signals from the motor cortex for use in overcoming paralysis. Successful *in vivo* use has been demonstrated. The second generation expands to neural stimulation as well as recording. It is intended for neural mapping research, including cochlear nucleus mapping from an array of five probes with 160 sites implanted for simultaneous recording in the dorsal and ventral cochlear nucleus. An advanced cochlear implant microsystem incorporates mixed-signal electronics in a hermetically sealed package and an ultra-flexible electrode array. Work in array technology targets positioning the array deep within the scala tympani to achieve broad frequency range and close to the modiolar wall to minimize stimulation thresholds. Parylene probes with monolithically-formed backing structures have been fabricated to provide the needed stiffness and curl when used with an articulated insertion tool.

The Environmental Monitoring Testbed (EMT)

Robert J. M. Gordenker, EMT Technical Director



The Environmental Monitoring Testbed (EMT) integrates sensors, actuators, and analytical subsystems with interface, control, wireless RF-communication, and power modules to create microsystems for monitoring a range of environmental parameters. Currently, the EMT serves primarily to focus efforts across all thrusts within the WIMS Center concerned with field-deployable micro gas chromatography (μ GC) systems. The fabrication of MEMS columns, preconcentrator/focuser modules, micro- and nanoscale sensor arrays, and various MEMS interconnection devices is now routine. Device performance and production yields have improved steadily, and components from various projects can be interchanged as needed to achieve the system performance goals driven by specific applications in ambient pollution monitoring, homeland security, and biomedical diagnostics. Custom designed valve manifolds and innovative flow-channel interconnection methods minimize dead volumes, non-specific adsorption, and the overall footprint of μ GC prototypes. Control circuits for actuating heaters, pumps and valves, and read-out circuits for temperature sensors and signal processing of sensor responses are designed for deployment across the range of projects. Custom PCB substrates are used for both fluidic and electrical circuits. Command and control functions are implemented via code written in LabView, which provides great flexibility to the researchers as they experiment with the various EMT systems. An embedded μ controller solution is being developed for low-power mobile and robot-mounted deployments. Communication protocols rely on standard wired and wireless networks, enabling remote operation and networking of multiple instruments.