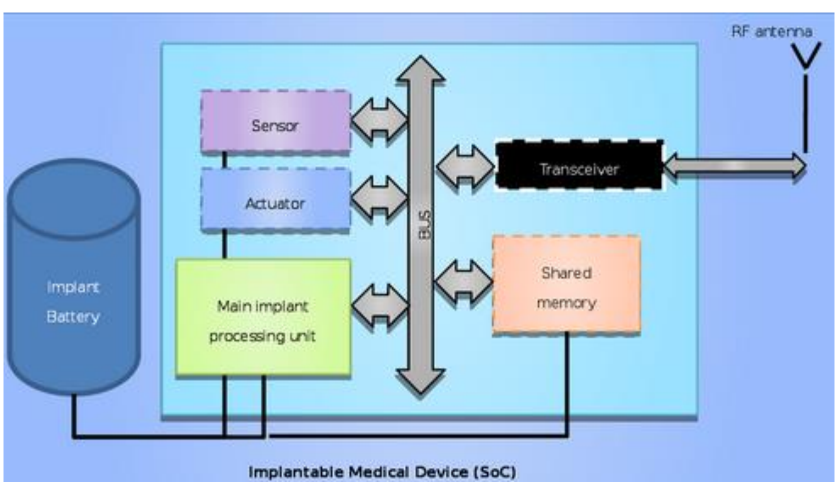
ContributorsSmart Implantable Neurostimulators (SINs)

The SINs (Smart Implantable Neurostimulators) project is focused on the development of soft- and hardware for the next generation neurostimulators. It is a collaboration between the Dutch Neuroscience Department of the Erasmus Medical Center, the Delft University of Technology and the Belgian BRAI²N group (Brain Research center Antwerp for Innovative & Interdisciplinary Neuromodulation).

Neurostimulation is the electrical stimulation of the nervous system, which may be used for the treatment of many medical conditions. The advantage of electrical stimulation over pharmaceutical means is that the stimulation can be applied at specific locations, limiting the side-effects experienced by the patient. Examples of such treatments include chronic pain management through spinal-cord stimulation, inhibiting the tremor observed in Parkinson patients through deep-brain stimulation or preventing epileptic seizures through vagus-nerve stimulation. In addition to limiting the side-effects of the treatment, neurostimulation allows for treatments not previously possible, for example, allowing the deaf to hear using a cochlear implant.

Due to the pervasive nature of aforementioned treatments, neurostimulators are implemented as **wearable** or even **implantable devices**. These are **tightly-constrained embedded devices**, expected to perform their **safety-critical application** on a **limited battery supply** for several years. The treatment-software running on these devices should be **adjustable** (e.g., to update a treatment plan) and monitored remotely, i.e., **secured wireless communication** is required.



Given these concerns and constraints, we are currently working on the following topics within our department:

- **Rapid prototyping of new medical treatments** to improve current health care. Examples include a minimal-delay seizure-prevention treatment and tinnitus treatment [1];
- **Fault diagnosis and tolerance** to guarantee correct functionality throughout a device's lifetime, while minimizing the effect on the energy and power consumption [2,3];
- **Ultra-low-power and energy consumption** to maximize the device lifetime; and
- **Security of wireless communication** to prevent malicious third parties from harming a patient using the wireless link, e.g., by stealing private data or altering device configurations [4,5]

For related publications see: **SINS publications**

References

[1] van Dongen, M. N., et al. "An implementation of a wavelet-based seizure detection filter suitable for realtime closed-loop epileptic seizure suppression", *Biomedical Circuits and Systems Conference (BioCAS), 2014 IEEE*. IEEE, 2014.

[2] Seepers, Robert M., Christos Strydis, and Georgi Nedeltchev Gaydadjiev. "Architecture-level fault-tolerance for biomedical implants", *Embedded Computer Systems (SAMOS), 2012 International Conference on*. IEEE, 2012.

[3] Sourdis, Ioannis, et al. "DeSyRe: On-Demand Adaptive and Reconfigurable Fault-Tolerant SoCs", *Reconfigurable Computing: Architectures, Tools, and Applications*. Springer International Publishing, 2014. 312-317.

[4] Strydis, Christos, et al. "A system architecture, processor, and communication protocol for secure implants." *ACM Transactions on Architecture and Code Optimization (TACO)* 10.4 (2013): 57.

[5] Seepers, Robert M., et al. "Peak misdetection in heart-beat-based security: Characterization and tolerance", *Engineering in Medicine and Biology Society (EMBC), 2014 36th Annual International Conference of the IEEE*. IEEE, 2014.

[6] Seepers, R.M.; Strydis, C.; Sourdis, I.; De Zeeuw, C.I., "Enhancing Heart-Beat-Based Security for mHealth Applications", *Biomedical and Health Informatics, IEEE Journal of , vol.PP, no.99, pp.1-1. [under publication]*