

## **NextFlex Community FHE Requirements for Medical, Health & Wearables**

In support of the IEEE Heterogenous Integration Roadmap, Jason Marsh, Director of Technology at NextFlex, recently spoke on behalf of the NextFlex community led by Mark Poliks of Binghamton University and Nancy Stoffel of GE Global Research. NextFlex was pleased to participate given the broad industry support for roadmap activities, and noted that support for the Medical, Health and Wearables TWG has increased significantly. Roadmapping is core to NextFlex's DNA, having ramped up multiple roadmapping activities over the past two years. Establishing a roadmap that is shared by industry leaders to help guide investment and development to advance manufacturing capabilities to extend beyond Moore's law is critical to the development of wearable and implantable medical devices, as well as for delivering on the promise of the Internet of Things.

The medical devices of tomorrow, as we drive toward clinical grade accuracy, need to be stretchable and conformable to be effective in human monitoring. Sensors of all types will factor in – chemical, electrical, and RF – and the biomarkers monitored have greatest value when continuously monitored. Heterogenous integration of devices, as they evolve into full systems that include actuators, sensors, MEMS devices, RF communication, power electronics, GPUs, CPUs, memory, will be essential for FHE-enabled devices. However, they will require a different form factor, and rigid silicon interposers will be replaced by thin plastic film substrates. The good news is that both traditional lithography-based subtractive processing as well as additive and semi-additive manufacturing options can be utilized for FHE applications. The real benefit of an FHE-enabled device is that it takes the system out of the package, and components can be easily mixed and matched depending on the device design, and most importantly, it is scalable. And, besides being conformable or stretchable, the devices are lightweight, sometimes weighing a fraction of their rigid version counterparts.

Examples of applications for heterogenous integration for imaging modalities, human health monitoring sensors, implantable devices and diagnostic systems were discussed, and an example of the NextFlex technology roadmap for wearable devices was presented and positioned as part of the overall roadmapping activity among the 10 technical working groups now active at NextFlex. To be successful, several "asks" were made on behalf of the NextFlex community, including: the need for unpackaged thin die, compliant flexible interconnect and attach methods, encapsulation methods for a range of environments, including on-body, high/low temperature and humidity. Development of these functional requirements will greatly accelerate FHE-enabled medical devices.

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