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Chronoloom: **Validation of self-organized synchronization in the GHz-regime for the application in future microelectronic systems**

In biological systems synchronization can self-organize robustly and efficiently in highly noisy environments and in the presence of strong heterogeneities and considerable time-delays. This inspired us to patent a novel synchronization concept for the next generation electronic systems. Now we organize to deliver our technology to, e.g., *distributed massive MIMO* or globally distributed computation. It has the advantage that during synchronized operations the clocks' times do not drift apart from each other at any time, as in state-of-the-art reference time approaches such as clock-trees, *NTP* and *GNSS*.



In the context of our project "*Chronoloom*" we develop a modular and scalable architecture design for the implementation of this novel synchronization layer for large, or spatially distributed electronic systems. This includes two prototype production runs in *BiCMOS* technology at *60 GHz* and the setup of a demonstrator, advancing from *technology readiness level (TLR) 4* to *7*. In networks with hundreds of clocks we show the scalability and modularity of this concept. We show that in synchronized states no phase-drifts occur, and that the quality of such synchronized states exceeds that of an individual clock. The project lays the foundation for the application of this technology in many different areas, e.g., in distributed antenna arrays, indoor navigation, drone and robot swarms, autonomous driving, and datacenters. It also acts as an enabling technology and creates new applications and markets. It is planned to start-up a company or to enter a *Technology*-T*ransfer* program with this solution to synchronization.

In summary this patented synchronization concept (*EP2957982*) delivers:

- **global synchrony:** no phase drift between spatially distributed clocks as compared to hierarchical time-distribution methods
- **high precision:** quality of synchronized states exceeds the quality of the individual free-running clocks
- **simplicity:** based on standard electronic components, the performance gains are achieved by novel architectural concepts
- **technical soundness:** based on a well-understood mathematical model that guides the control of self-organized synchronization dynamics
- **proof of concept:** prototype circuitry has been set up to show the validity of the theoretical results and methods at up to *24 GHz*

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