TickTalk: Timing API for Federated Cyber-Physical Systems

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The goal of this research is to enable a broad spectrum of programmers to successfully create apps for distributed computing systems including smart and connected communities, or for systems that require tight coordination or synchronization of time. Creating an application for, say, a smart intersection necessitates gathering information from multiple sources, *e.g.,* cameras, traffic sensors, and passing vehicles; performing distributed computation; and then triggering some action, such as a warning. This requires synchronization and coordination amongst multiple interacting devices including systems that are Internet of Things devices that may be connected to safety critical infrastructure. Rather than burden the programmer with understanding and dealing with this complexity, we seek a new programming language, sensor and actuator architecture, and communications networks that can take the programmer's statements of "what to do" and "when to do," and translate these into "how to do" by managing mechanisms for synchronization, power, and communication. This approach will enable more rapid development of these types of systems and can have significant economic development impact. The proposed approach has four parts: (1) creating a new programming language that embeds the notion of timing islands - groups of devices that cooperate and are occasionally synchronized; (2) creating a network-wide runtime system that distributes and coordinates the action of code blocks-portions of the program-across devices; (3) extending the capabilities of communications networks to improve the ability to synchronize devices and report the quality of synchronization back to the runtime system, enabling adaptive program behavior; and (4) extending device hardware architecture to support synchronization and time-respecting operation.

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