

What if cars and surgical robots spoke the same language?

From highways to hospitals, ASU's Hokeun Kim is creating a common framework to keep cyberphysical systems reliable

By Kelly deVos, ASU News
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Self-driving cars already navigate city streets.

Robots assist doctors in delicate surgeries.

Even your thermostat can make decisions about how to adjust the temperature in your home to help save energy and money.

These technologies are no longer futuristic.

All of these scenarios depend on cyberphysical systems or technologies that connect computers with people and the physical infrastructure they rely on. These systems promise convenience, efficiency and sometimes even life-saving benefits. But behind that promise lies a nagging question: Can we trust these systems to work reliably and safely, every single time?

That's the issue [Hokeun Kim](#) is tackling with his latest research. Kim is an assistant professor of computer science and engineering in the [School of Computing and Augmented Intelligence](#), part of the [Ira A. Fulton Schools of Engineering](#) at Arizona State University.

Backed by a grant from the [National Science Foundation](#), Kim is helping lead the development of Lingua Franca, an open-source software framework designed to bring order and safety to some of the most complex technologies in the world.

"When lives are on the line, reliability and timeliness aren't optional," Kim says. "Lingua Franca takes care of the messy details of networking and concurrency so domain experts can focus on what they do best, whether that's cars, medicine or energy systems without worrying about integration."

Why complexity can be dangerous

Cyberphysical systems are in cars, power grids, medical devices and even in smart homes. Unlike ordinary apps on your phone, these systems don't just crunch data. They interact with the physical world, where milliseconds can make the difference between safety and disaster.

But as these systems grow more advanced, they also become harder to build. Engineers today must juggle multiple layers of technology, such as network communication, real-time scheduling and artificial intelligence on top of their domain expertise. That complexity leaves room for subtle mistakes.

Many developers rely on popular platforms like [Linux](#) or [Robot Operating System](#) because they make prototyping fast. But those frameworks aren't always reliable when it comes to real-world deployment. Messages between components can arrive out of order, leading to unpredictable or even dangerous results.

That's where Lingua Franca stands out. It provides a deterministic approach. This means that, given the same inputs, a system behaves the same way every time. Engineers will no longer have to write tricky coordination code to manage timing or communication between components. Lingua Franca handles that automatically, giving developers confidence that their systems will perform consistently.

"Right now, many tools give you speed but not reliability," Kim explains. "Lingua Franca is designed to give you both."

From cars to clinics

The power of this approach has already been put to the test. In one study, Kim's team applied Lingua Franca to an open-source self-driving car platform. They discovered that, by eliminating unpredictable message timing, their tools prevented dangerous situations where the system might misinterpret whether a car was moving forward or in reverse.

The implications go far beyond cars. With Lingua Franca, factory robots could coordinate shutdowns in emergencies with flawless precision. Energy grids could balance renewable sources across networks without unexpected failures. And in health care, connected devices could monitor and respond to patient needs without risking miscommunication between sensors and machines.

The new NSF project is designed to accelerate this kind of real-world adoption. Over the next two years, Kim and his collaborators, including Distinguished Professor Emeritus Edward A. Lee from the University of California, Berkeley, will build out Lingua Franca's capabilities, strengthen its testing infrastructure and establish a sustainable open-source community around it.

The vision is not just a powerful tool but a trusted ecosystem for designing the next generation of cyberphysical systems.

This award also builds on Kim's history of tackling security and reliability challenges in emerging technologies. In 2024, he [partnered with industry](#) to make edge devices, or small computers embedded in objects like smart light bulbs and doorbell cameras, both smarter and safer. His solution allowed these devices to run AI locally while keeping personal data private.

Lingua Franca represents the next leap forward: moving from safeguarding individual devices to orchestrating entire systems of devices, vehicles or machines.

“My long-term mission is to help people make better decisions with technology,” Kim says. “That means building tools that researchers, developers and companies can trust to work reliably in the real world.”

More than just software

What makes this project especially ambitious is its focus on people, not just code. Open-source software thrives when it has an active, diverse community of contributors. Kim and his collaborators are putting as much effort into community building as they are into technical development.

That means setting up governance structures to guide contributions, recruiting developers from industry and academia, and ensuring high-quality documentation so newcomers can get involved.

It also means bringing Lingua Franca into classrooms.

The framework is already being used in embedded systems courses at ASU and UC Berkeley, where students get hands-on experience programming real-time systems with inexpensive robotic kits. The approach makes advanced computer science accessible — sometimes for less than the cost of a textbook.

The roadmap is ambitious: new testing infrastructure, outreach events like workshops and bootcamps, and collaborations with industries from automotive to health care. By the end of the project, the team hopes to have not only a mature framework but also a vibrant community ensuring its long-term success.

For Kim, the motivation is simple. As our reliance on intelligent machines deepens, we need to be able to trust them completely.

“I want to make sure that when we rely on these systems in our cars, our hospitals or our cities, they don’t fail us,” he says. “That trust is essential if we’re going to embrace the technologies that define the future.”

This story originally appeared on [ASU News](#).

Main image



Hokeun Kim works on a laptop in a robotics lab. Kim is an assistant professor of computer science and engineering in the School of Computing and Augmented Intelligence, part of the Ira A. Fulton Schools of Engineering at Arizona State University. With support from the National Science Foundation, he is developing an open-source software framework that helps cyberphysical systems in cars, power grids and medical devices operate safely and dependably. Photographer: Erika Gronek/ASU