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NSF grant aims to improve resilience of safety-critical networks

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The initial prototype of the cyber-physical network with sensors and data logging systems will be extended as the project progresses.

Washington State University researchers have received a three-year National Science Foundation grant to develop new networking technologies to improve the resilience of safety-critical networks that are used in aircraft, cars, and power grids.

Led by Monowar Hasan, assistant professor in the School of Electrical Engineering and Computer Science, the researchers aim to develop, evaluate, and test techniques for more efficient utilization of network resources.

“We are designing solutions for better resource management in critical infrastructure systems,” said Hasan.

Cyber-physical systems like those used in power grids, planes, cars, and industrial control plants are, of course, complex and have a lot of constraints. So, for instance, in a plane, one kind of technology controls the aircraft while another manages the entertainment system, and another system is used for announcements for passengers and crew. Each of the complex systems has different protocols and uses different hardware and tools, but with a variety of cabling, protocols, and computer module requirements for each system, their management ends up adding extra weight, complexity, and inefficiency to the system.

At the same time, communication in these sophisticated systems has to follow stringent timing and performance constraints. In a plane, car, or on the power grid, timely delivery of critical computerized messages is essential. So, for instance, a car’s anti-lock braking components that don’t receive timely signals

from the brake pedal might end in deadly consequences such as skidding the vehicle.

Monowar Hasan

“If something is wrong in those critical systems, even if there is even less than a millisecond of delay in decision making or to react, it can be very catastrophic,” said Hasan.

As part of the approximately $600,000 grant, the researchers will use newer programmable switching technologies and management protocols to simplify the complex safety-critical networks, allowing system engineers to profile application requirements and meet their stringent timing/safety constraints. The ideas being developed in this project will enhance the resiliency of many safety-critical sectors, such as automobiles, avionics, power grids, and digital agriculture.

“The safety-critical networks need more sophisticated solutions to ensure that their service guarantees are met,” said Hasan. “We will build one seamless, unified network architecture for safety-critical systems, adopting newer switching technologies to provide better resiliency, fault tolerance, and resource management.”

In recent years, WSU researchers have demonstrated the feasibility of using switching technologies to enhance such

safety-critical systems. They have designed algorithms and showed the work as a proof-of-concept.

“We can’t just take the technologies used in general systems, like traditional computers or traditional networks, and use those capabilities to safeguard the safety-critical systems due to additional constraints such as stringent delay, safety, certification requirements, lack of computing power, energy limitations,” he said. “We want to design a software-controlled programmable architecture for complex distributed systems. It will reduce weight and cost, improve the overall management and debugging, and provide better accountability and response techniques in the event of faults or cyberattacks.”

The researchers are devising novel routing, scheduling, fault tolerance, and anomaly detection techniques for time and safety-critical cyber-physical networks. They aim to evaluate and test their work in prototype drones and small-scale autonomous vehicles. As part of the project, Hasan will also develop teaching modules for computer science and electrical engineering classes.

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