

IIIT HYDERABAD

Confluence: Industry-Academia Roundtable

Cyber Physical Systems, the hardware software convergence

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Introduction	2
Use cases today	2
Digital Twin and Sensors to collect data points	2
Application of CPS in road safety	3
Use of CPS in Consumer Electronics and Home Automation	3
CPS in defence sector	3
CPS in education field	3
B. Challenges of CPS	3
Making a device unique	3
Underestimating the infrastructure need for AI	4
Continuous training and Continuous Inference of models	4
No production of sensors in India	4
Higher investment in technology	4
C. Hardware Software Convergence	4
Security of the devices	5
Emergence of Edge Computing	5
Summary and Next steps	5

Introduction

A confluence session on “Cyber Physical Systems , the hardware software convergence “ was organized by IIITH as part of its Annual R&D showcase 2022. The session was attended by Industry leaders, technologists, innovators and researchers to understand about cyber physical convergence and the possible solutions. This paper captures the deliberations of the confluence roundtable.

The cyber physical systems field is gaining traction with the growing convergence of hardware and software systems. As we are all aware, Cyber physical systems (CPS) is an emerging discipline that involves engineered computing and communicating systems interfacing the physical world by increased use of Computing, Internet, and “smart” IoT devices. CPS currently has generated a lot of interest among not just academia and industry, but also the government as they set up the National Mission on Interdisciplinary Cyber Physical Systems program. The discussion was broadly on topics like relevant use cases today and technology challenges faced, and more on hardware software convergence.

A. Use cases today

The convergence of hardware and software is of topical interest in recent years. Cyber physical systems (CPS) is being immensely used in healthcare, mobility, smart devices and a whole lot of other areas. Cyber-Physical Systems allow organizations to take timely and optimal interventions/ actions. By understanding the real world use cases, the industry academia collaboration can also scale to a next level.

1. Digital Twin and Sensors to collect data points

There are vast applications of CPS as we see today. Digital twin is one of the popular use cases to collect data points. Predictive maintenance can be an extension of this domain area , used across industries and is utmost important . In the Indian context, there is huge demand for smart metering which includes gas, electricity and water. More use cases are getting enabled in this domain because of the lower power consumption of smart meters.

2. Application of CPS in road safety

Road safety in India is of paramount importance. How vehicles can be instrumented in such a way that collision alerts can be sent before accidents occur. The data thus collected on the cloud can also be used in predicting accidents based on the area and time of the day. This is one of the direct applications of AI and data science for road safety and infrastructure.

3. Use of CPS in Consumer Electronics and Home Automation

One of the biggest use cases within home automation is smart locks or smart security systems. Companies are working on innovative smart locks ways in which it can be opened up. Another biggest segment is wearables. People are taking to wearables to understand health parameters, fitness parameters and different moods. Sensors are being used to collect and analyze all the data very fast and has become a fast-growing market.

4. CPS in defense sector

The armed forces currently work in groups. One of the major challenges they face is making the existing legacy systems autonomous. For instance, can a defense tank be manned by 2 people instead of 45 people and use more autonomous systems? CPS can be used to a large extent in making systems autonomous. Another use is in predicting areas with mines and retrieving them. A predictive model based on geographical conditions that can also analyze drifting is the need of the hour.

5. CPS in education field

One other use case of CPS is in the field of education. By setting up remote experiment labs, students from across India especially rural school children can access labs 24 * 7. This can then be scaled up and stack different experiments and students across the world can have remote access to such virtual labs.

B. Challenges of CPS

1. Making a device unique

To make a device very unique, one needs to use a physical unclonable function which looks at the physical properties of the semiconductor device. This is one of the biggest challenges as any malicious user can program the address of one device on other devices. Setting up a unique key such as a fingerprint to seal all credentials can be one of the non-functional requirements.

2. Underestimating the infrastructure need for AI

To run AI inferencing to a level that it is transparent to the end users, certain hardware capabilities are needed and those are not very easy to be deployed. A model has to be fully optimized and trained to deploy it. As later on, upgrading a model is an extremely complex process. Specialized hardware with a lot of power requirements and specialized software are required to be deployed to run the models at a certain speed. The infrastructure is the biggest barrier to see the real power of AI.

3. Continuous training and Continuous Inference of models

While speaking of Cyber physical systems, it is imperative to take all aspects of functional and non functional requirements as a life cycle and not individually. The AI models need to be built, modified and deployed often like any software. They need to be continuously trained. The challenge of CPS today is lack of continuous training and continuous inference from the data collected and monitoring the effectiveness of AI.

4. No production of sensors in India

The first thing when we talk of IOT or Cyber Physical Systems is sensors. One of the biggest challenges faced is that most of the sensors we currently deploy are either imported from China or the US. India does not produce sensors. To scale CPS in a secure way, India needs to produce sensors at a low cost rate and adapt them into different models.

5. Higher investment in technology

Buying technology for smart cities or hospitals turns out to be very expensive. Technology changes at a very fast pace and upgrading the existing technology is a major challenge. Hence we need to think of other alternatives to buying like renting the technology to minimize the costs.

C. Hardware Software Convergence

As we know machine learning, deep learning algorithms are all meant to boost performance in a lot of use cases. Convergence of Hardware, Software also plays an important role in CPS. There are challenges associated with the convergence which we need to overcome.

1. Security of the devices

Security is one of the main challenges that comes with the deep learning algorithms. Devices are focussed on more bandwidth, more network, low power, low cost computing and the like. Although hardware is required, shifting to software is important too.

2. Emergence of Edge Computing

CPS has different technologies. Emergence of edge computing needs to be pursued while designing as machine learning, deep learning algorithms are already a part of CPS systems, A challenge here is that the ML space is a rapidly evolving field. And then in parallel we have the architecture area. By the time they all converge in a nice architecture, next generation ML models are evolved and they have a different structure. To bridge this gap we need good tools.

Summary and Next steps

Subsequent to the confluence roundtable, IIITH will consider the use cases mentioned in the domains discussed along with all the challenges mentioned for hardware software convergence. Though there are challenges in hardware software convergence, investment in compilation to solve that ecosystem needs to be developed. The cyber physical systems field is already gaining traction with the growing convergence of hardware and software systems. The field is being applied across fields from healthcare to smart cities mission to hardware solutions. More collaboration between industry and academia can pave a path for the future of CPS in India.

Confluence Roundtable Panelists:

Panelists: Mr. Venkatesh Narasimhan (Silicon Labs) , Mr Anbumani (Intel) , Mr. B Sridhar (TCS) , Mr. Sachin Gaur, Mr. Khush Mishra, Mr. Kishore Dutt (Zen Technologies) , Mr. Sudhakar Sadasivuni (Microsoft) , Mr. Janakiram (Jankiram & Associates), Prof Suresh Puri, Prof Sachin, Ms. Anuradha

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