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SRG 7 STUDY REPORT: CYBER-PHYSICAL SYSTEMS (CPS) FOR REAL-TIME IoT

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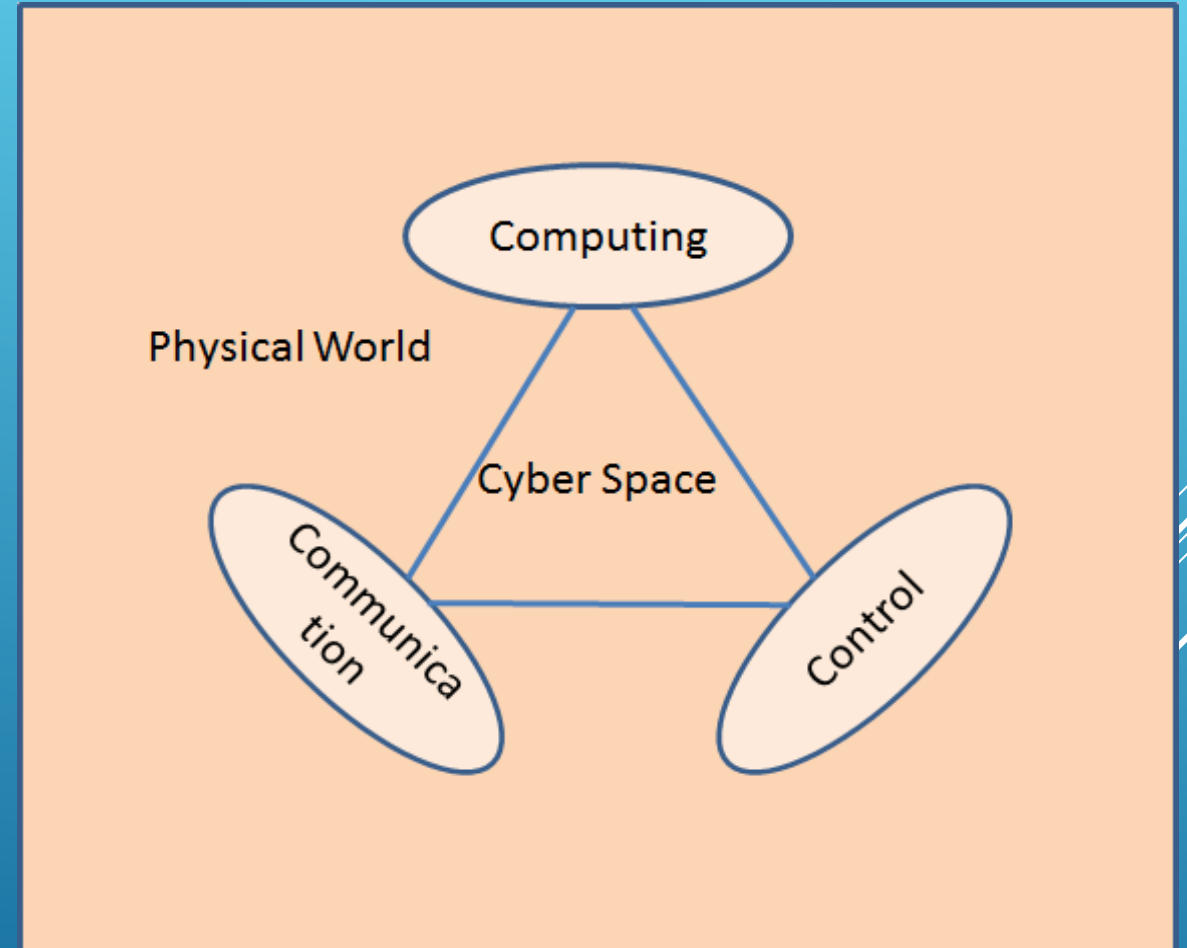
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In collaboration with WSN

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Background

- At the 5th ISO/IEC JTC 1/WG 10 Meeting, 9-13 May 2016 in Berlin, Germany, ISO/IEC JTC 1/WG 10 approved the establishment of the SRG 7 on Cyber Physical Systems (CPS) for IoT.

  - The preliminary report was submitted on 20 July.

- At the 6th ISO/IEC JTC 1/WG 10 Meeting, 5-9 Sep 2016 in Busan, Korea, ISO/IEC JTC 1/WG 10 approved the re-establishment of the SRG 7 on Cyber Physical Systems (CPS) for IoT.

  - The report was on 17 Jan

- At the 7th ISO/IEC JTC 1/WG 10 Meeting, 15-17 February 2017 in Santa Clara, USA, ISO/IEC JTC 1/WG 10 approved the re-establishment of the Subgroup Rapporteur Group (SRG) 7 on Cyber Physical Systems (CPS) for Real-Time IoT

What is CPS

- **An engineering system that deeply embeds**
  - **computing,**
  - **communication, and**
  - **control**
- **Into the physical system, perceives and controls the physical process through computing process, seamlessly combining cyber space and physical world.**
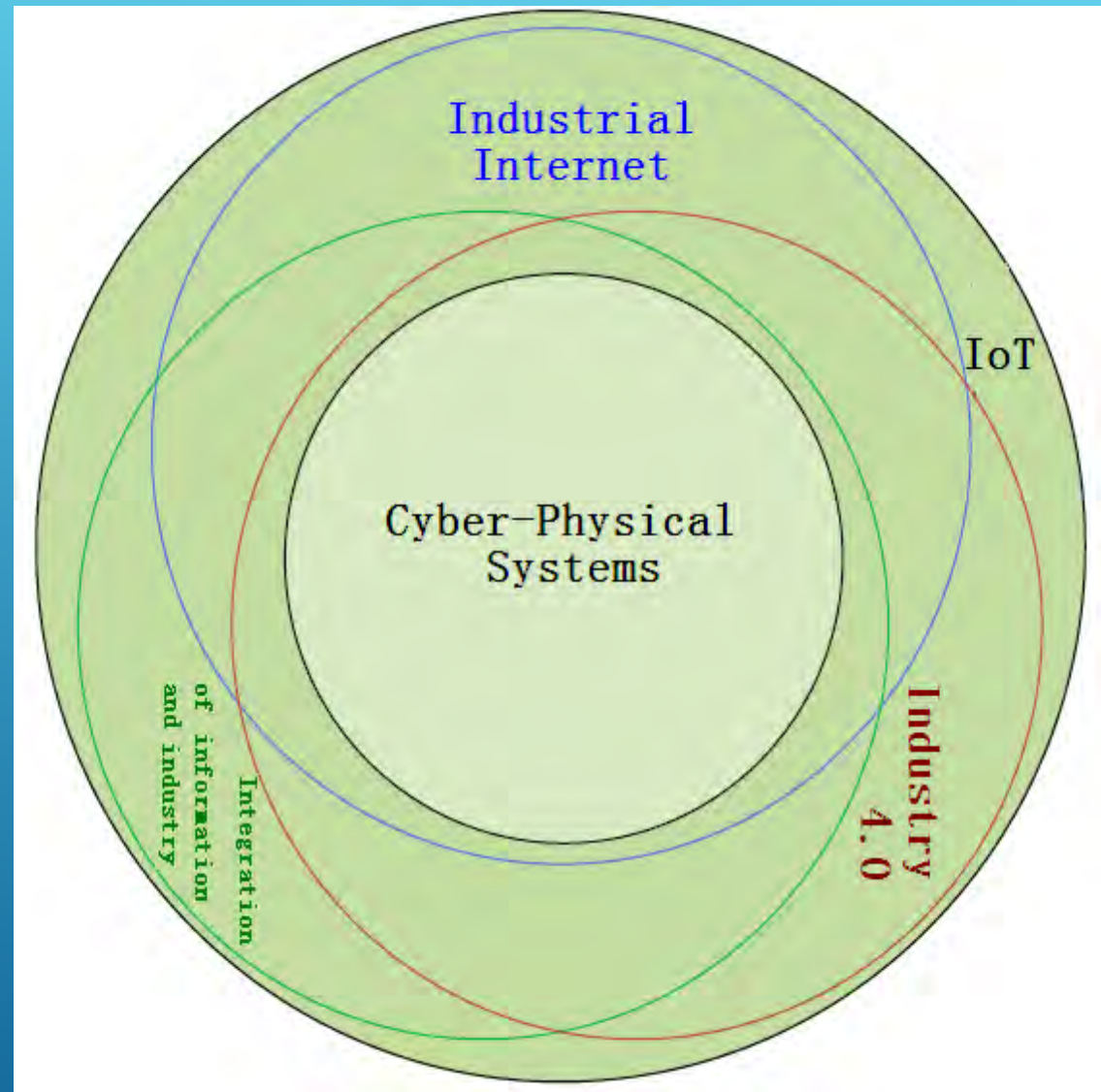
The first CPS summit

CPS is Real-Time IoT

- **Industrial Internet (II) is IoT**
  - **II renamed as IIoT in 2016.**
  - **CPS is the core of II.**
  - **CPS is IoT.**
- **Industry 4.0 (I4.0) is IoT**
  - **CPPS is the core of I4.0.**
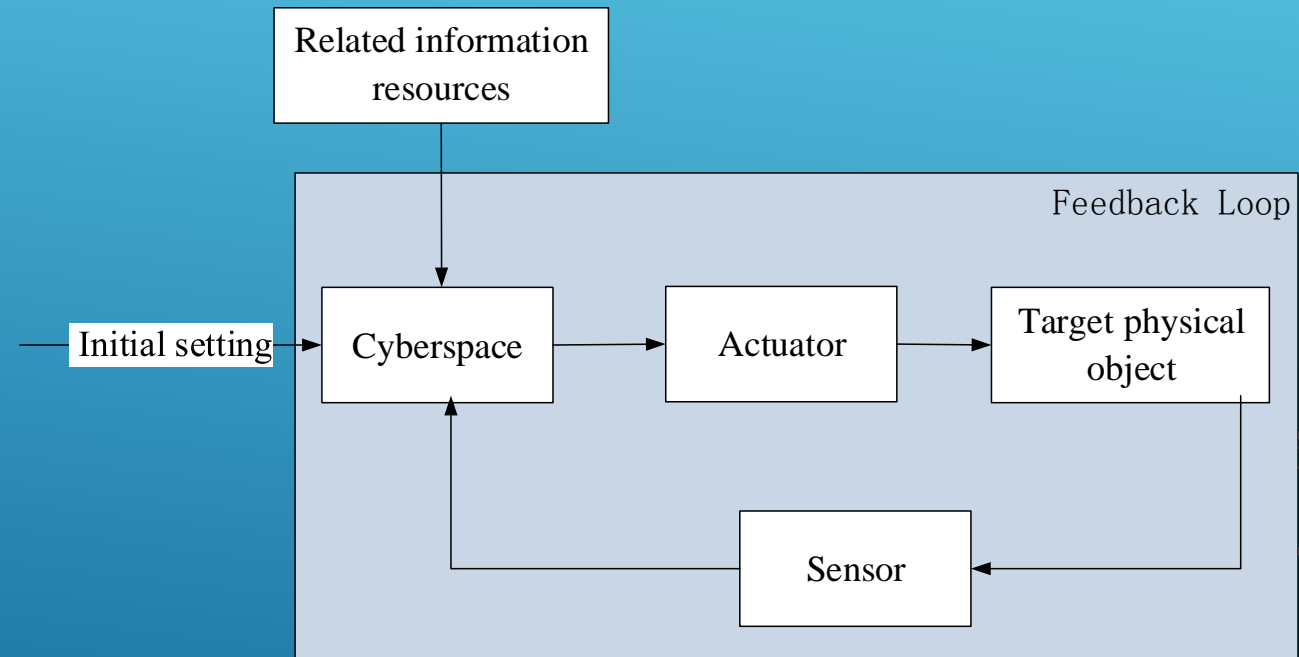 - **CPS is IoT.**

What is a real-time system

- A real-time system is a system whose correctness depends on being able to meet timing constraints.
  - Its correctness depends not only on the logical correctness, but also on the timeliness of its actions.
- Hard real-time systems
  - If timing requirements would be violated, the results could be catastrophic.

What is a real-time system

- Real-time is about deterministic, not about speed
- Confusing terms:
  - deterministic vs predictability
  - timeliness vs real-time
  - reliability

NWIP: The real-Time IoT framework (1/4) - feedback control

▶ Control is covered in the IoT architecture, while it is the key component in a real-time IoT system.

Related information resources

Feedback Loop

Initial setting → Cyberspace → Actuator → Target physical object
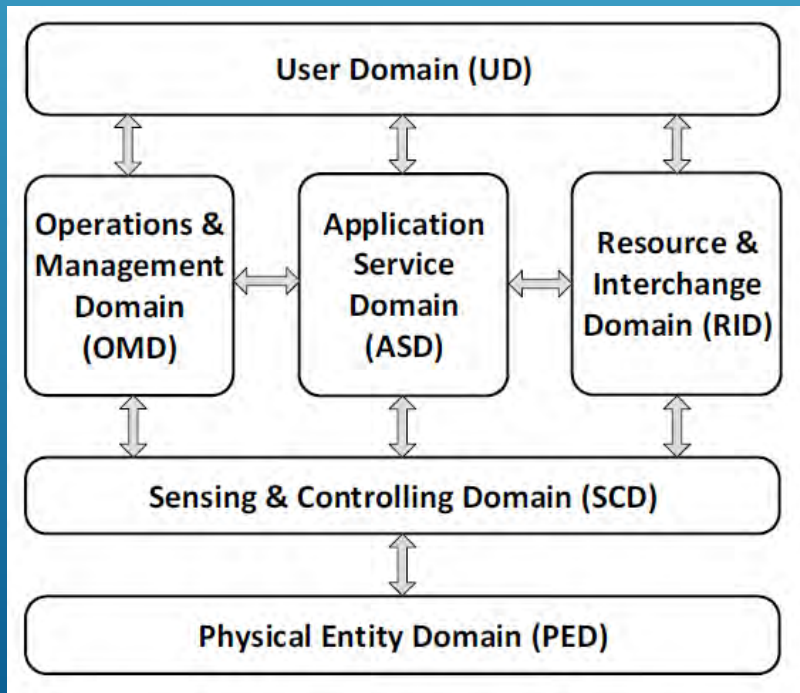
Sensor

Operating mechanism of the real-time IoT system

NWIP: The real-Time IoT framework (2/4) - System of systems

▶ Multiple SCD modules work alone, yet collaborate with other shared domains to achieve a common goal.
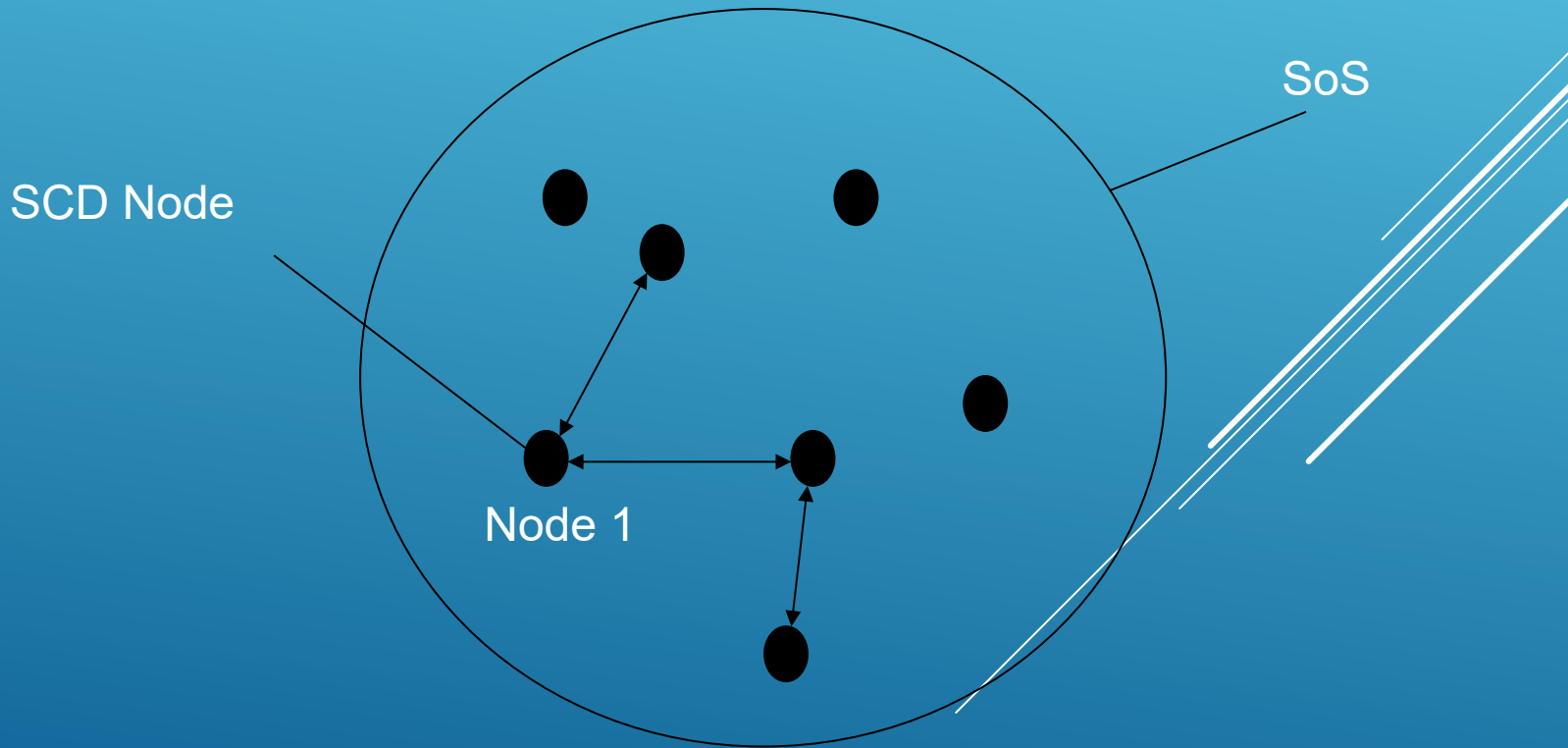
NWIP: The real-Time IoT framework (3/4) - Real-time

▸ Real-time Computing

▸ Real-time Communication

▸ Real-time Control

NWIP: The real-Time IoT framework (4/4) – Safety and Security

▸ The failure of a real-time system could be catastrophic.

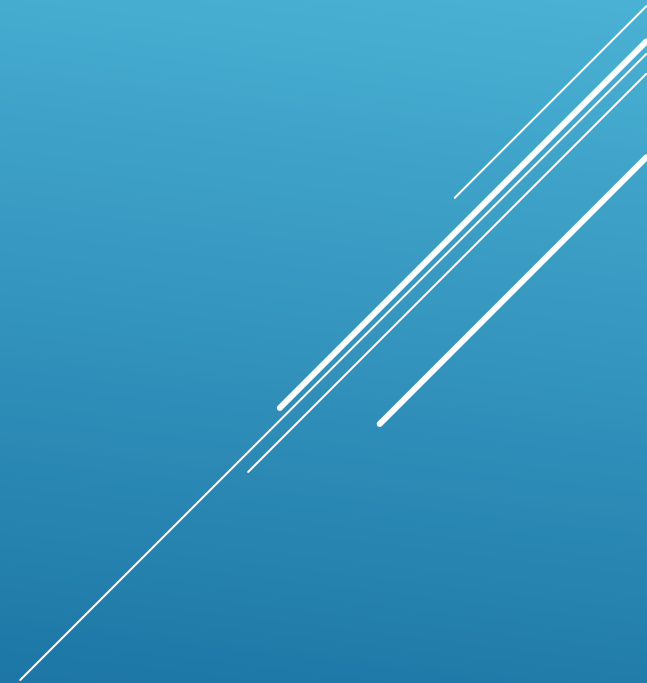# Other standardization opportunities

- NWIP: Real-time OS.
- NWIP: Deterministic network.
- NWIP: Real-time wireless sensor network.

Real-time IoT system metrics

- Dependability
- Connectivity
- Dataflow
- Device Interaction Patterns
- Field Storage
- Interface Complexity
- Physical Requirements
- Development
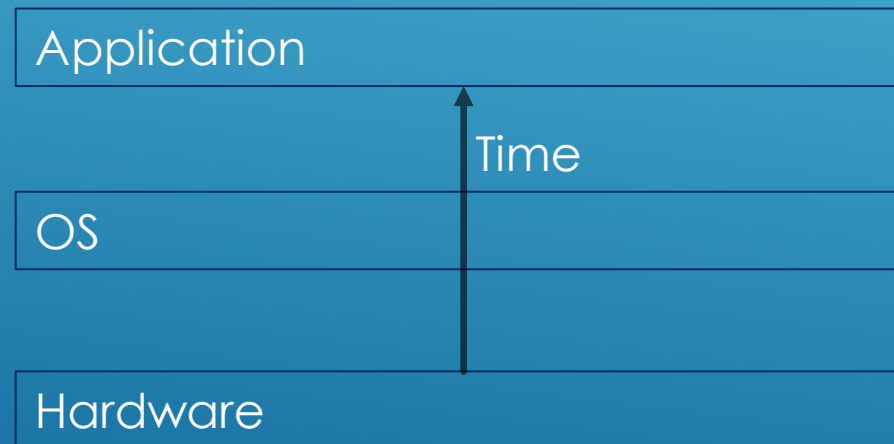- Services

WHY REAL-TIME IOT SYSTEM?

Computer System vs Real-Time system

A real-time system is a computer system that satisfies real-time requirements.

- A task must finish within a specified time, i.e., the deadline.

Yet Real-Time system is treated as a distinct discipline.

Application

Time

OS

Hardware

IoT System vs Real-Time IoT system

A real-time IoT system is an IoT system that satisfies real-time requirements.

Real-time IoT will expand on IoT's aspects that concern with "time":

- Control
- System of systems
- Real-time
- Safety & Security

Why not just the term CPS?

- CPS is perceived differently by different people: academia, industry, literature

- CPS is called CPPS in I4.0

- Real-time IoT covers a broader range than CPS does

The consequence of no Real-Time Internet

▸ Anxiety of IoT using the Internet

▸ No real-time support by the Internet: Net-Neutrality

▸ Hard to add Real-time support as an afterthought: QoS, GENI

Quote from the 2006 first CPS meeting

- What would a suitable real-time technology infrastructure look like for the long-term future?
  - Helen Gill

- Our answer: Real-time IoT