Associate Professorship of Embedded Systems and Internet of Things
Department of Electrical and Computer Engineering
Technical University of Munich

Runtime Deployment, Management and Monitoring of Web of Things Systems

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Embedded Systems and Internet of Things

Department of Electrical and Computer Engineering

Munich | December 14, 2020

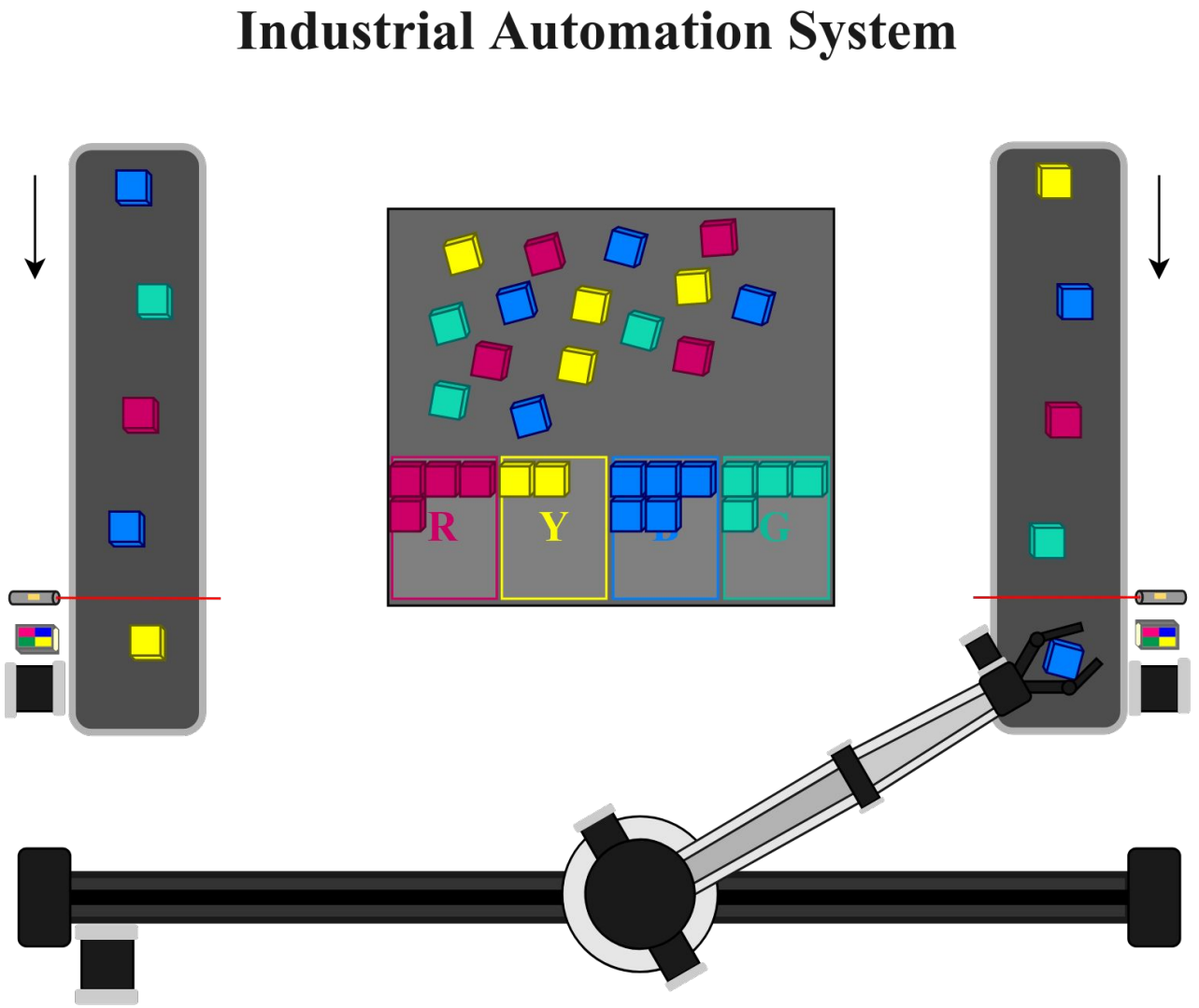
1. Introduction

2. Approach

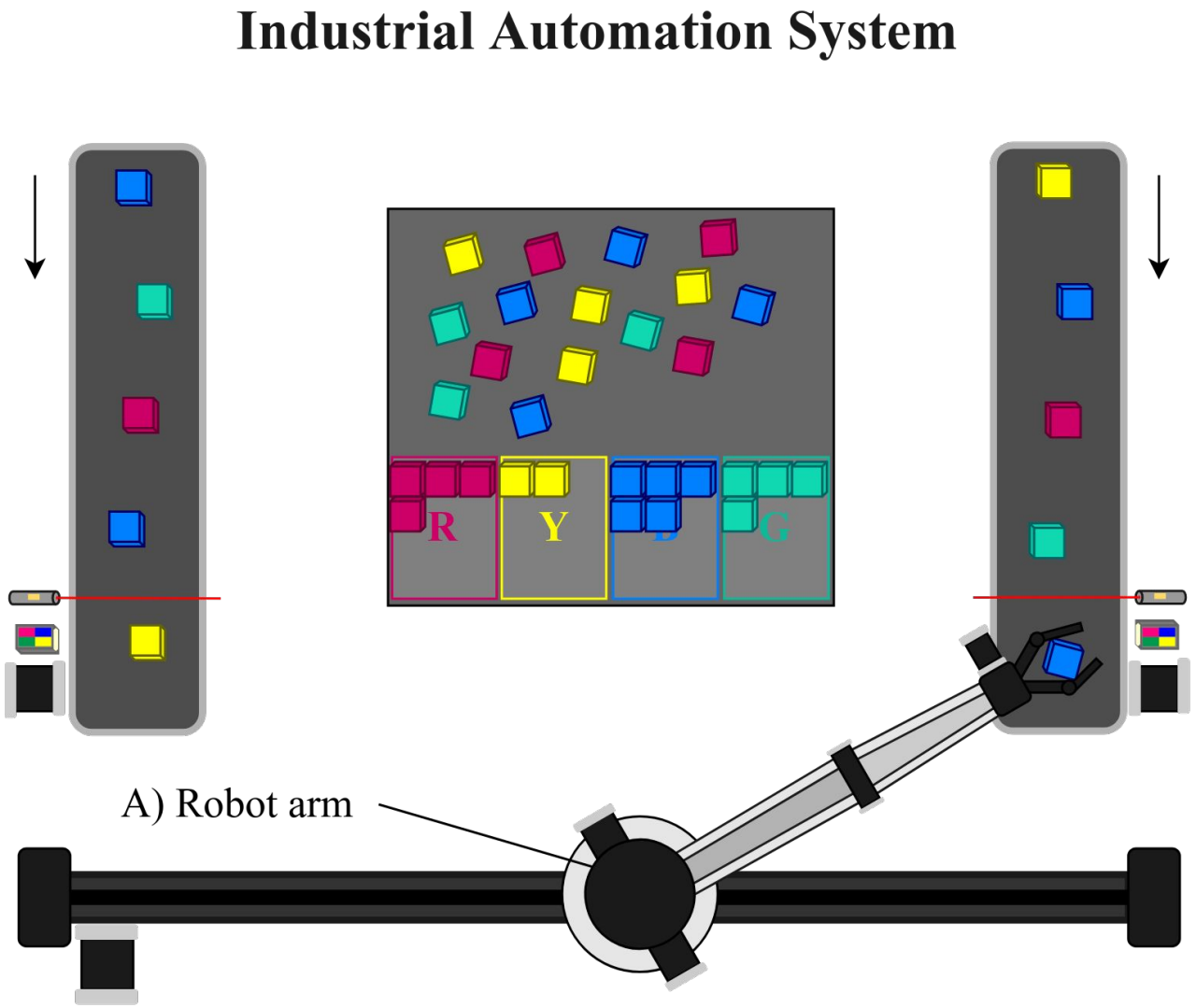
3. Evaluation

4. Conclusion

Motivation



Motivation



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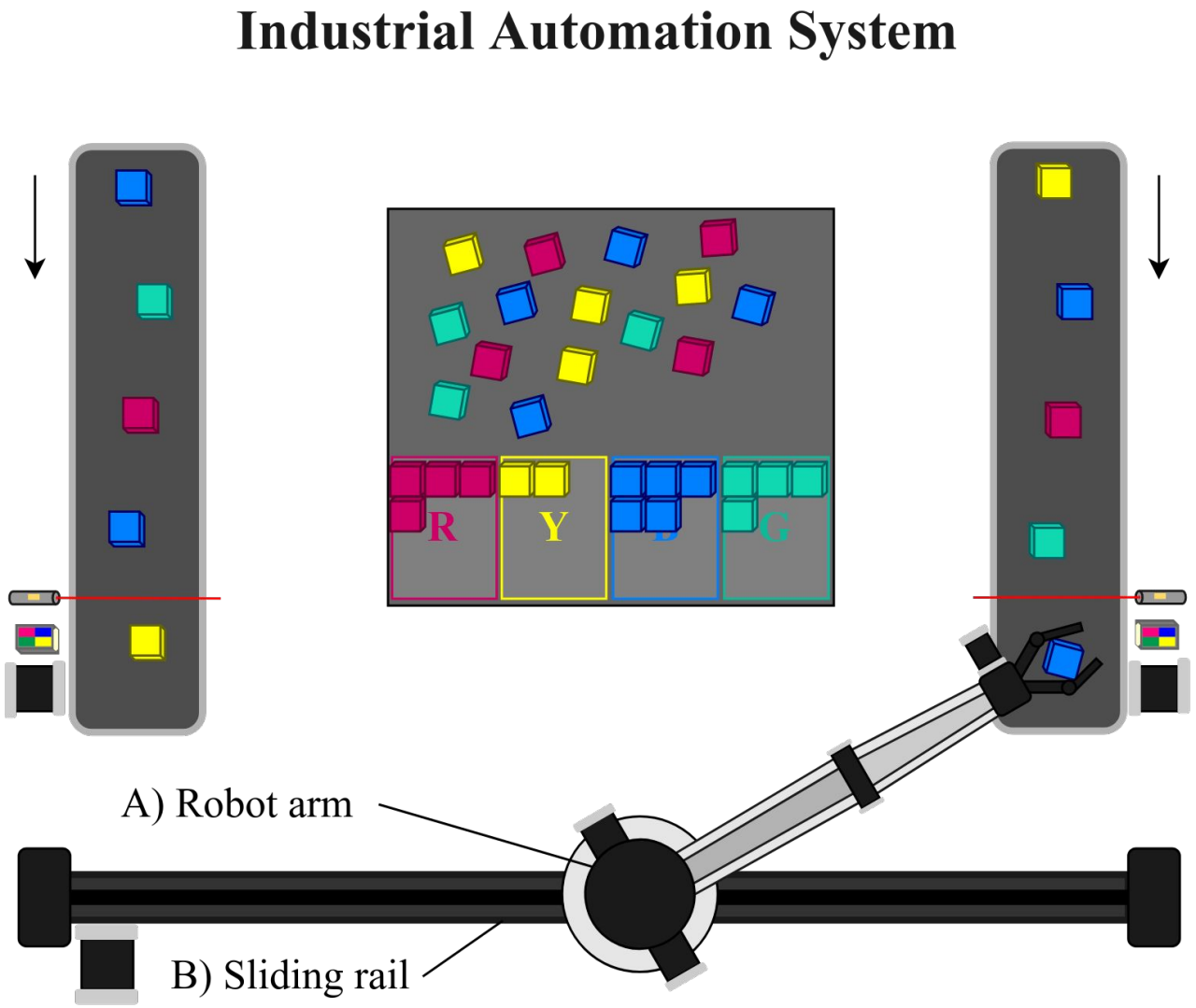
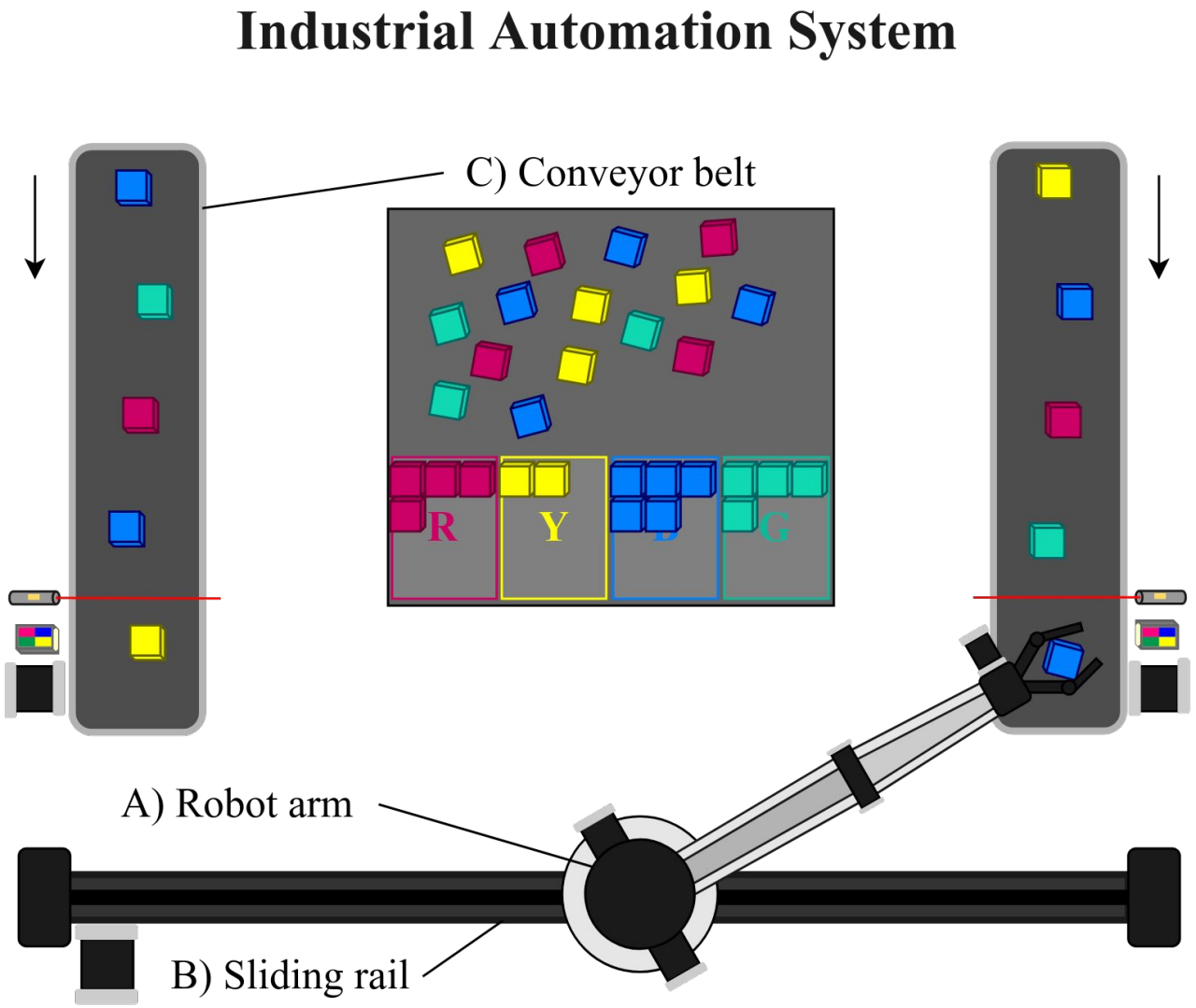
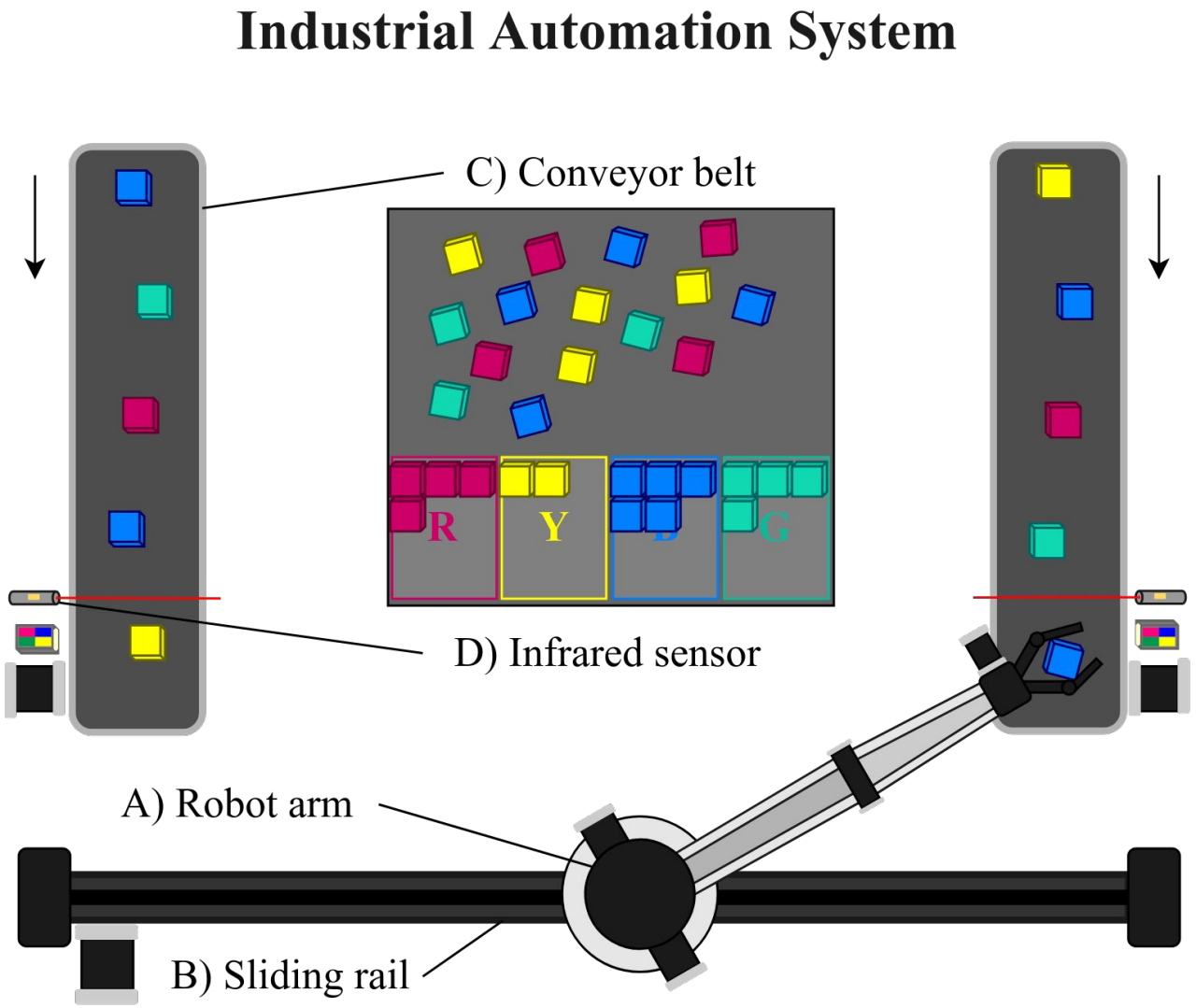

Industrial Automation System
R
Y
G
A) Robot arm
B) Sliding rail

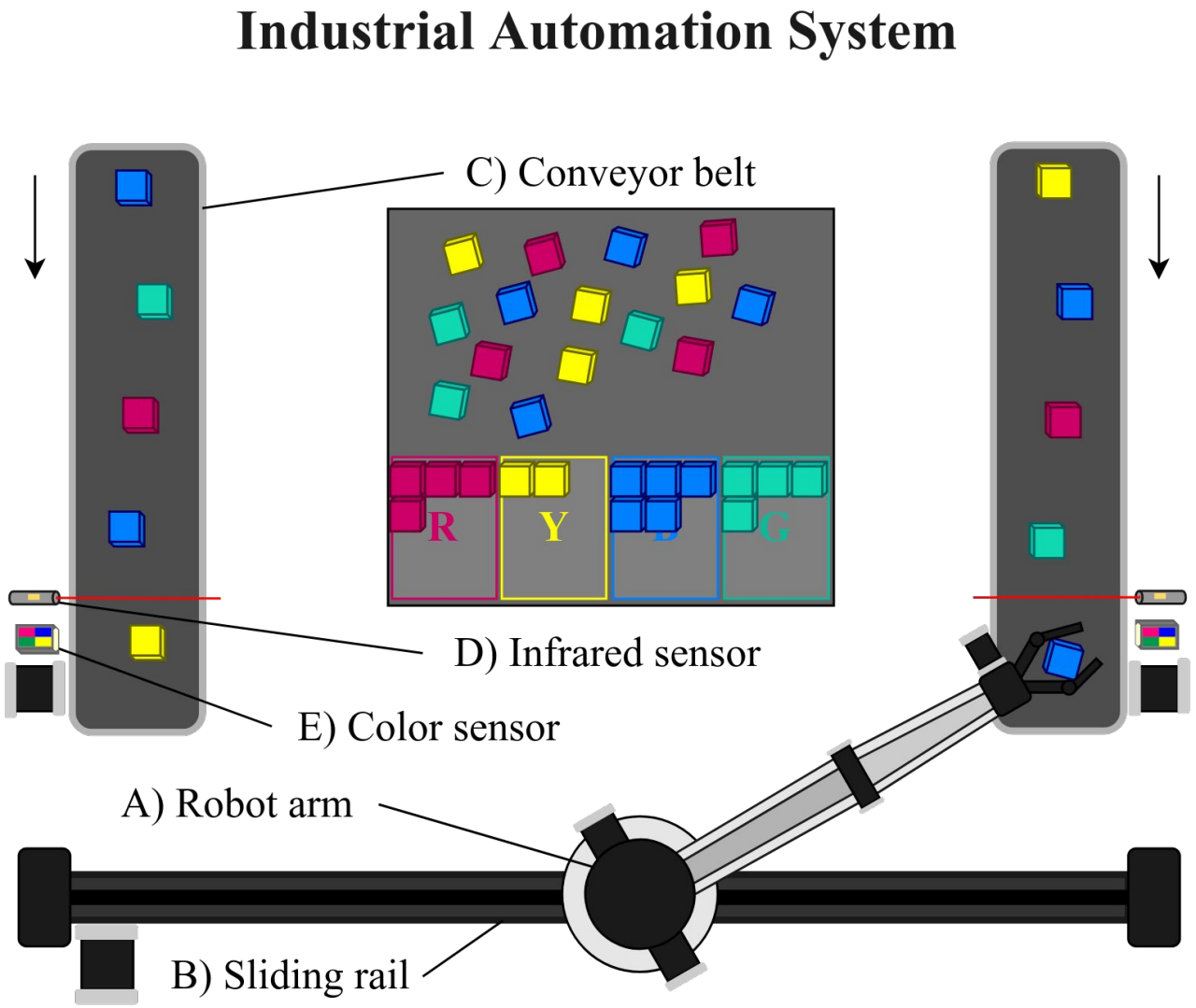
Motivation


Industrial Automation System
C) Conveyor belt
R
Y
G
A) Robot arm
B) Sliding rail

Motivation


Industrial Automation System
C) Conveyor belt
R
Y
G
D) Infrared sensor
A) Robot arm
B) Sliding rail

Motivation


Industrial Automation System
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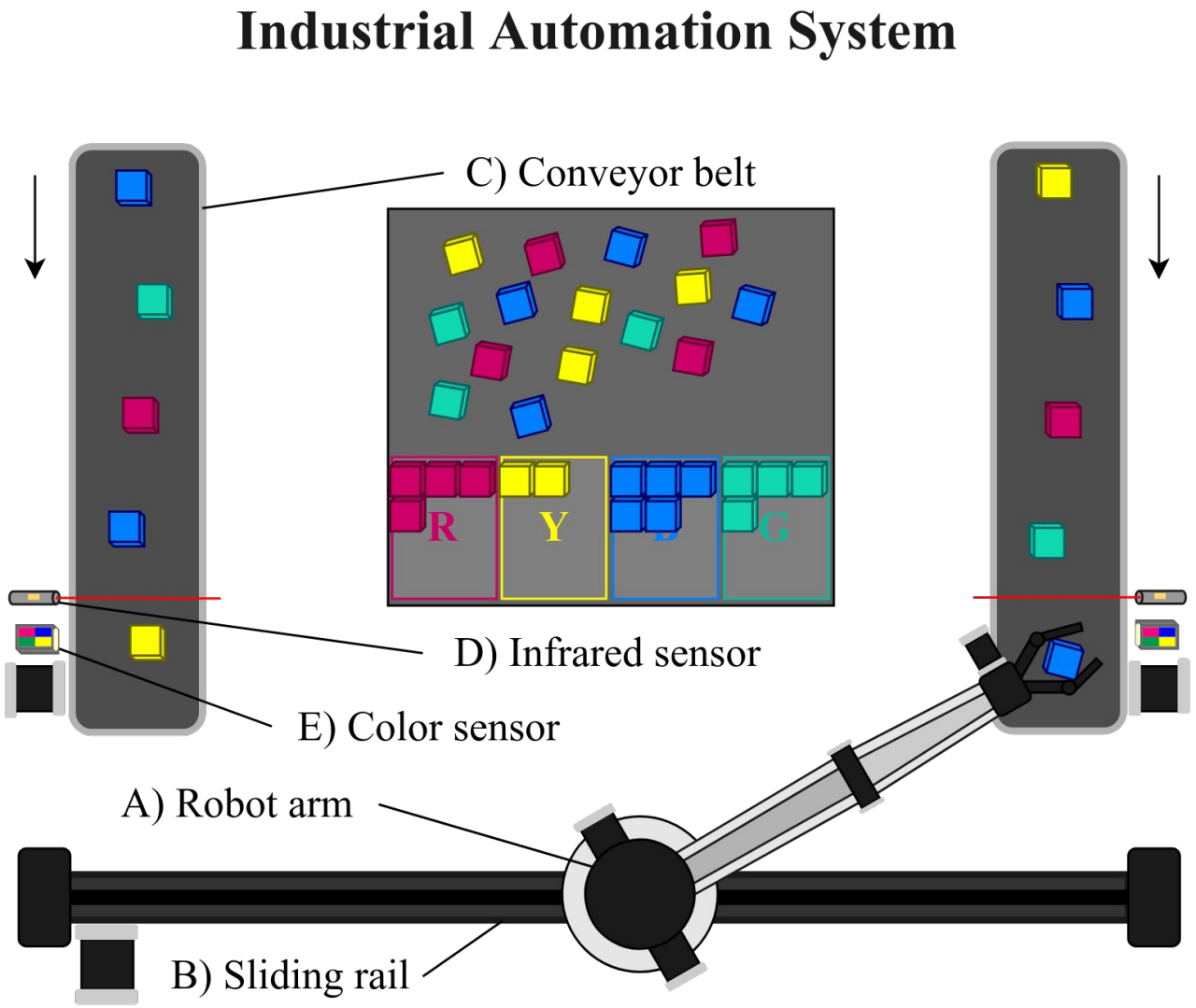
Motivation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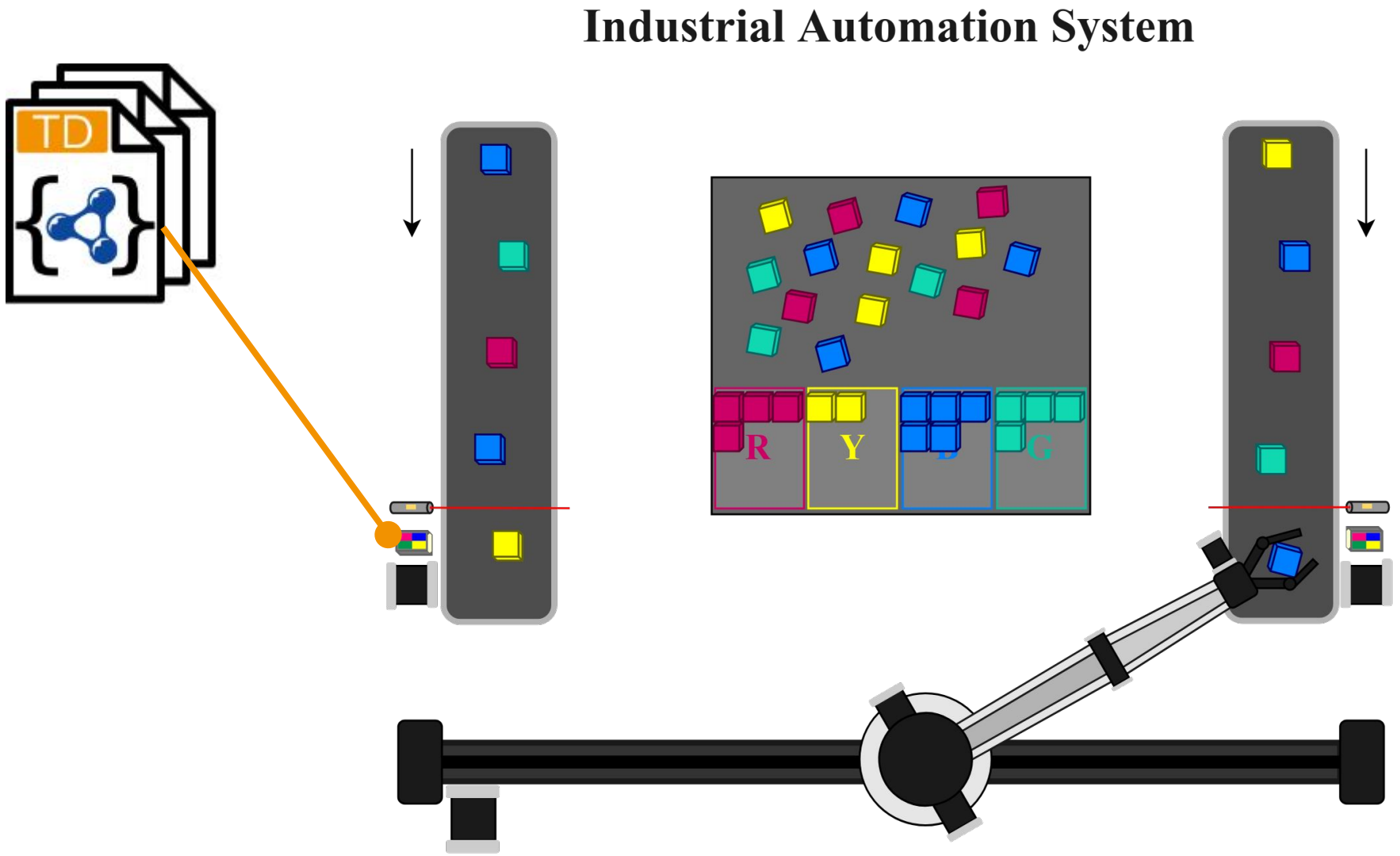

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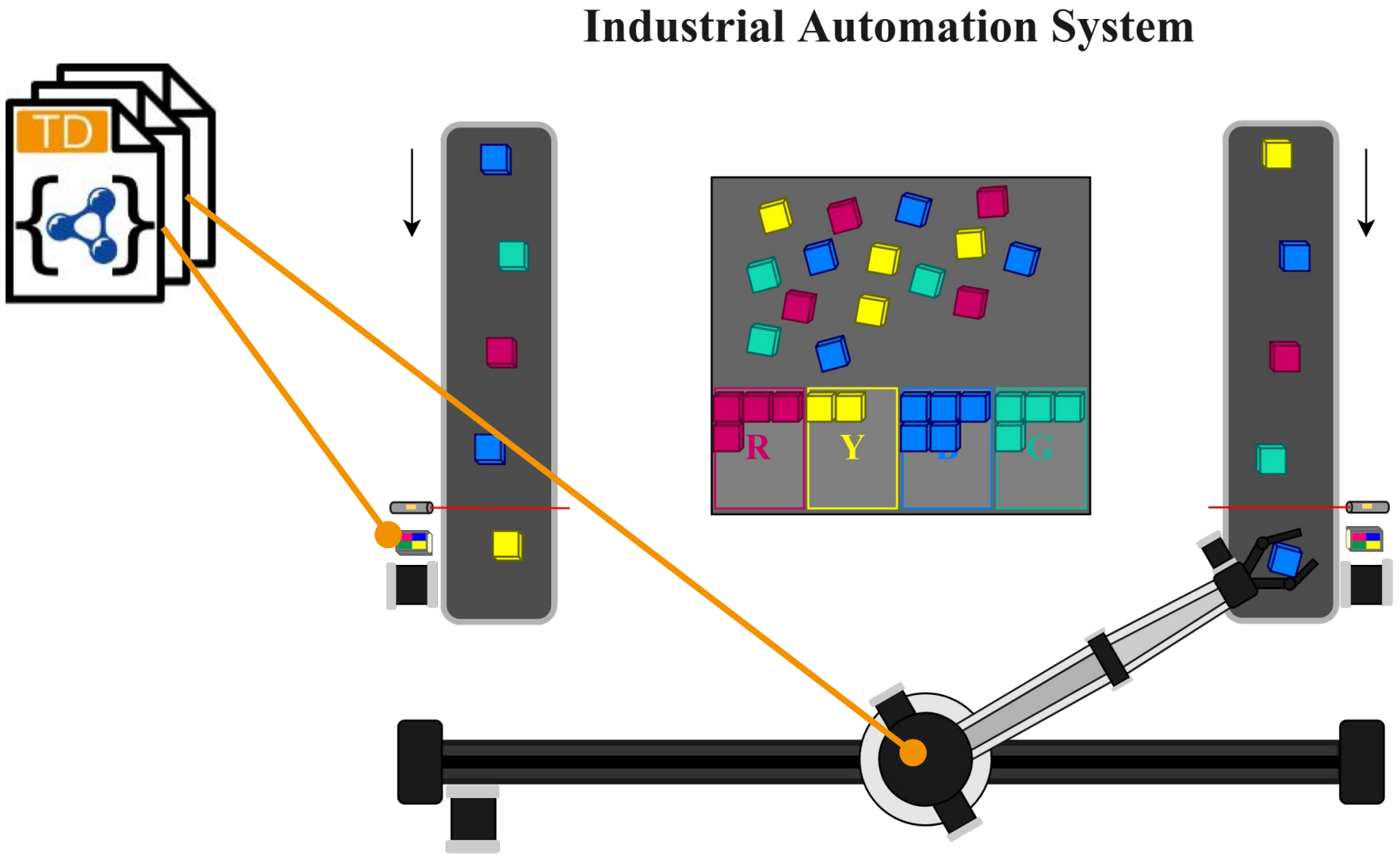

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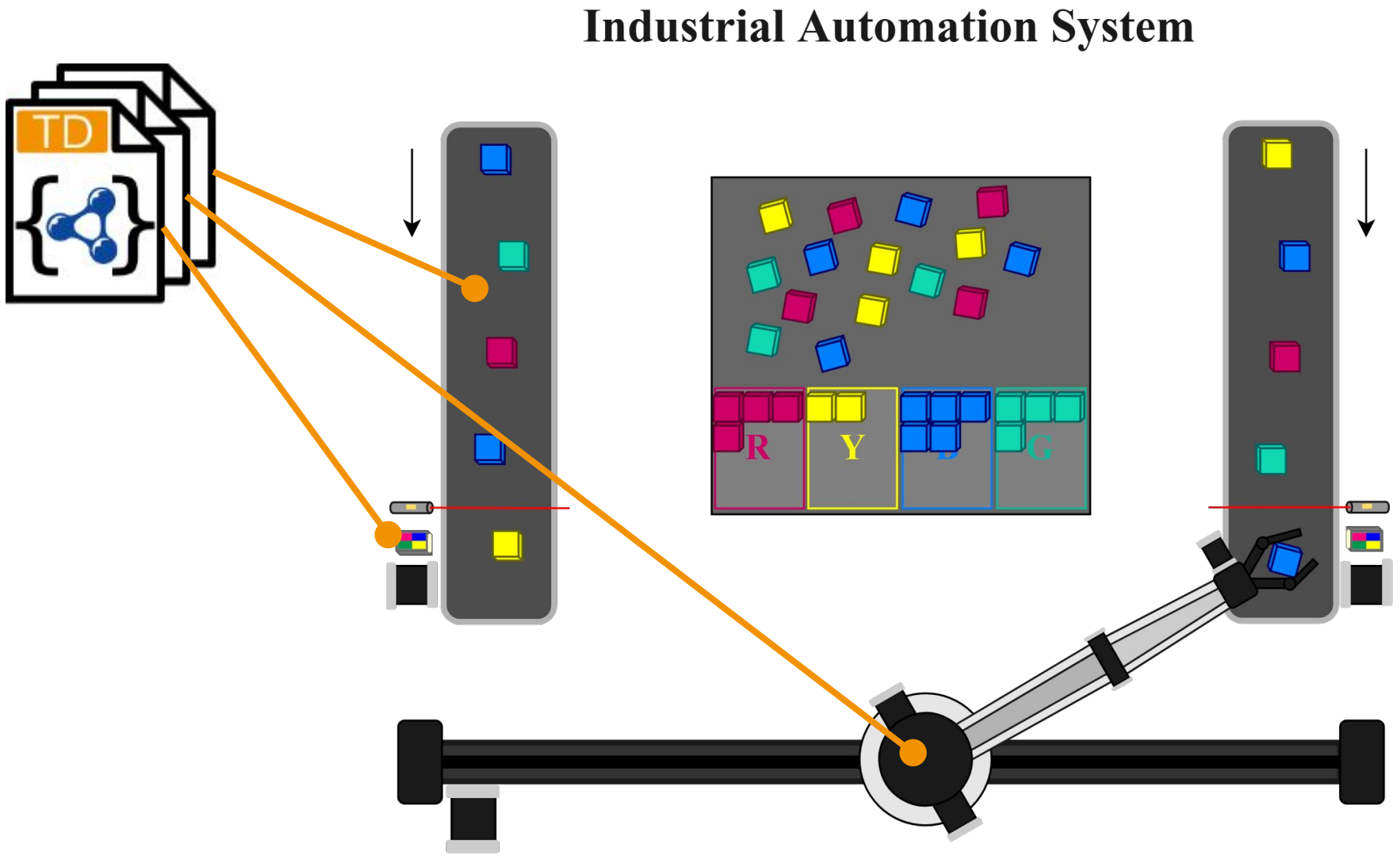
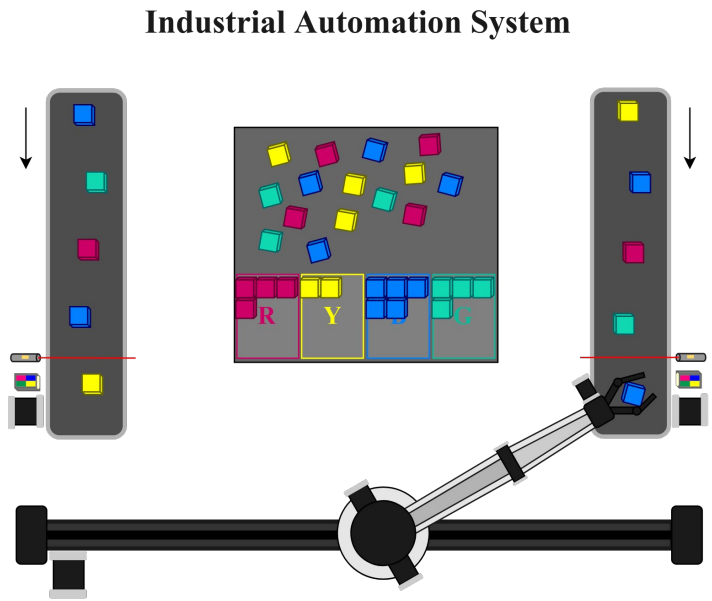
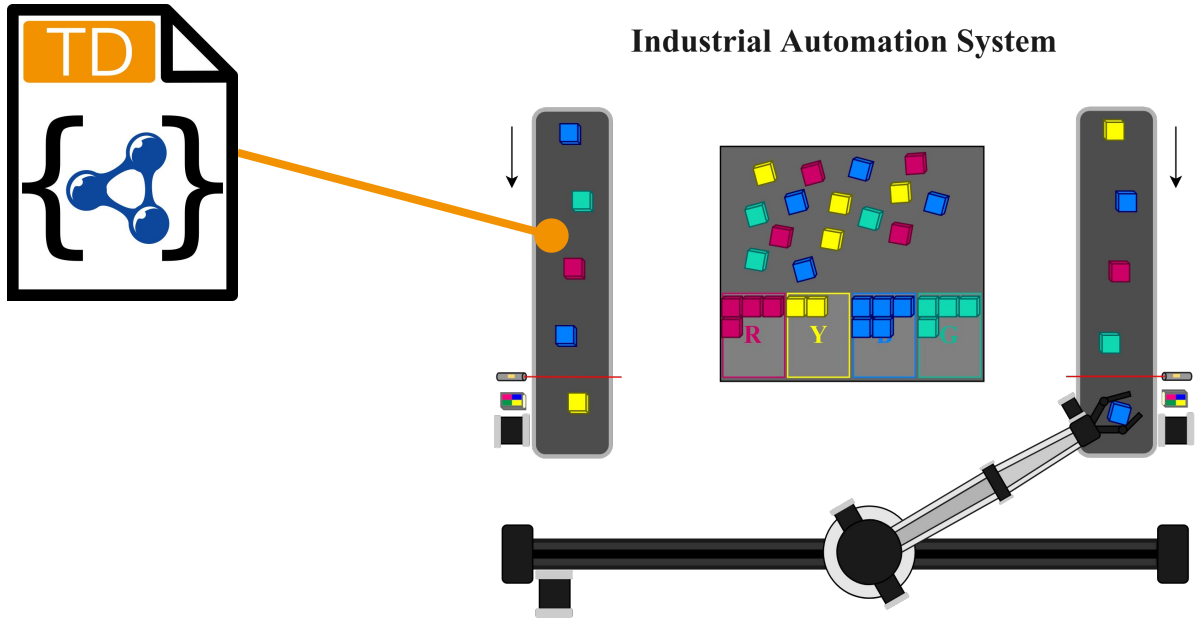


WoT Thing Description



WoT Thing Description



WoT Thing Description

TD of Conveyor Belt

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        "minimum": -100.0,
        "maximum": 100.0
    },
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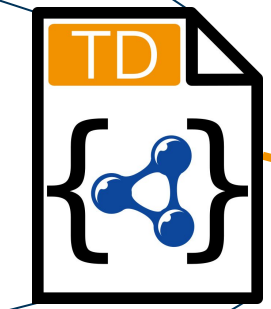
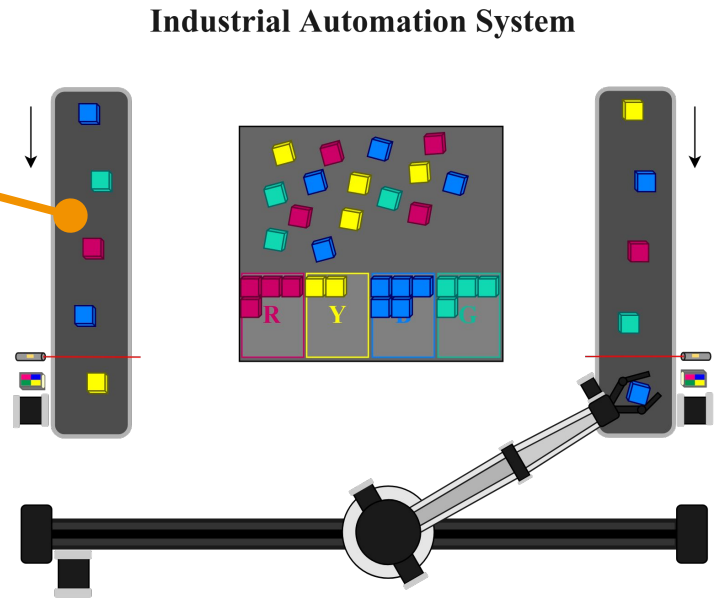
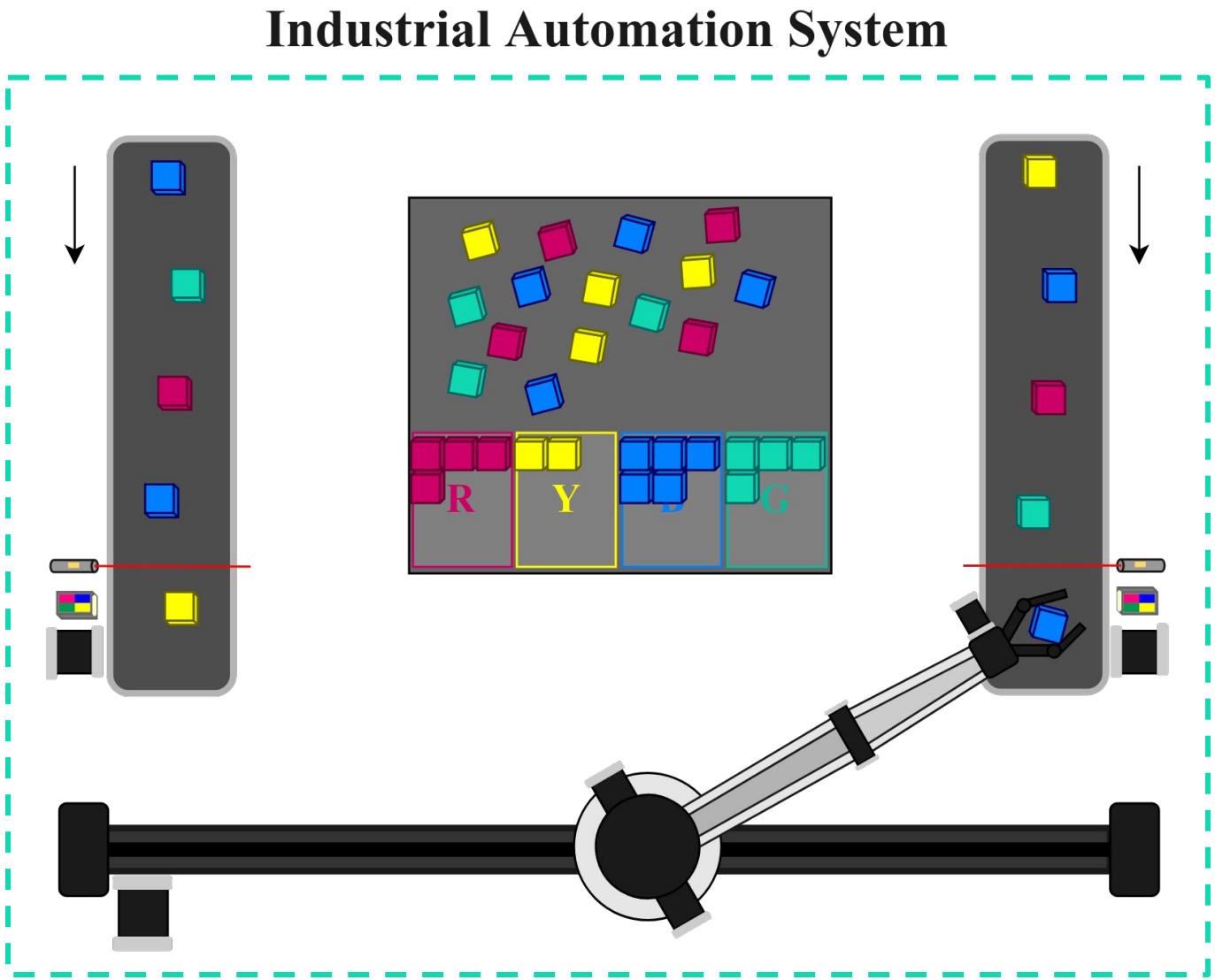
        "type": "string",
        "enum": [ "on", "off" ],
    }
],
"actions: [
   "start": {...},
   "stop": {...},
],
"events: [
   "emergencystop": {...},
],
"security": [...]
```

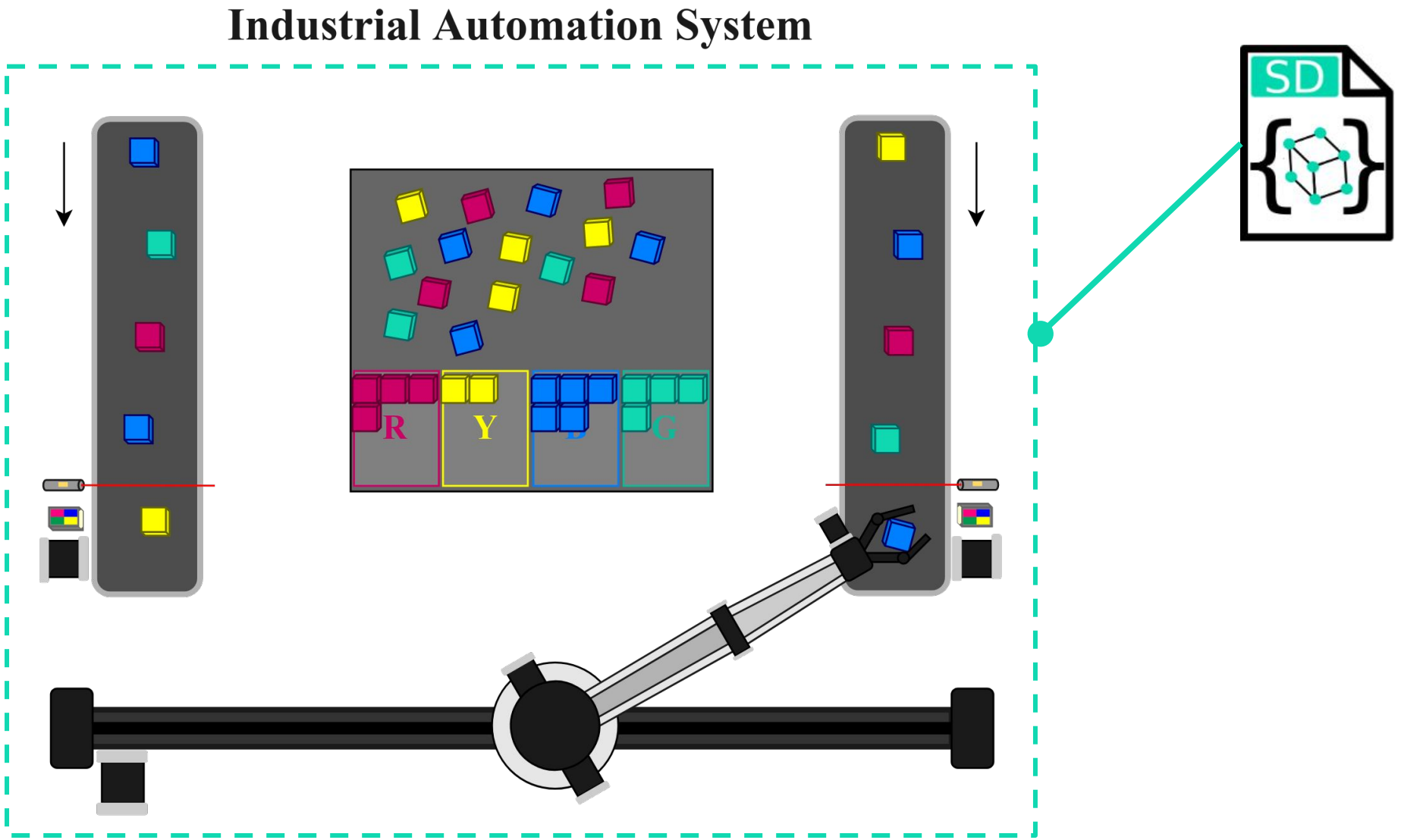




WoT System Description



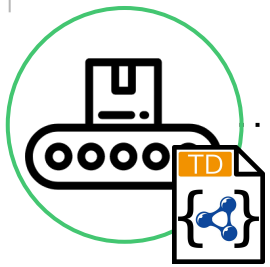
WoT System Description



Problem Statement

Thing Description

Allows modelling simple and complex **standalone Things**



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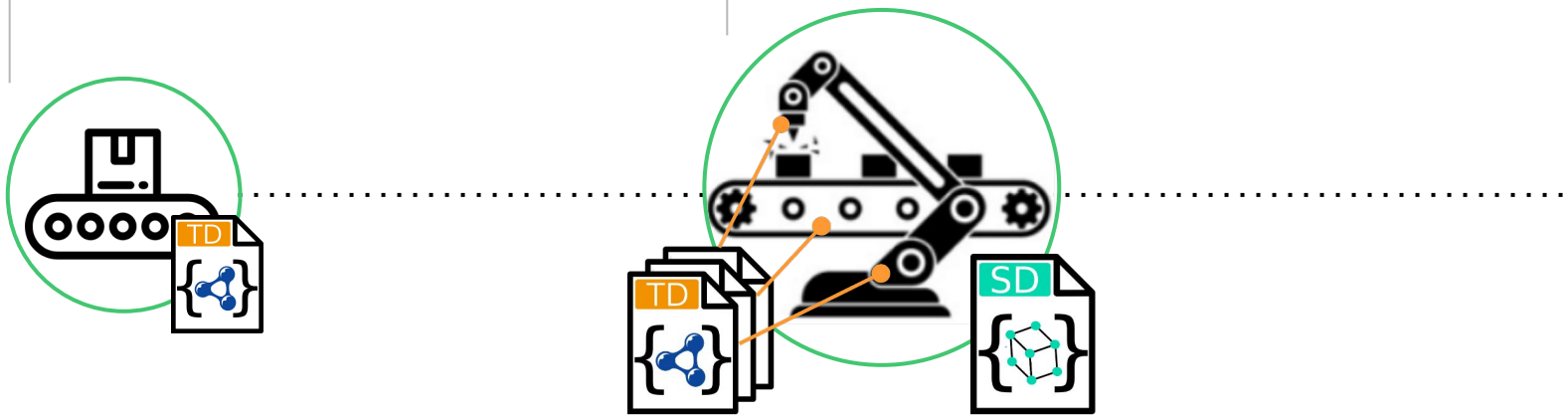
System Description

Allows describing interaction logic between Things, in order **to create WoT Systems**



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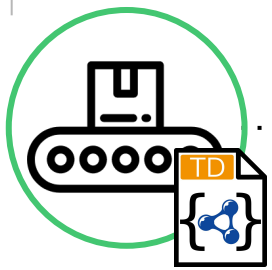
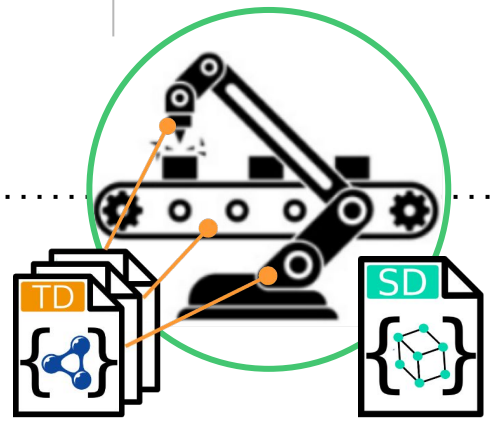


System Description

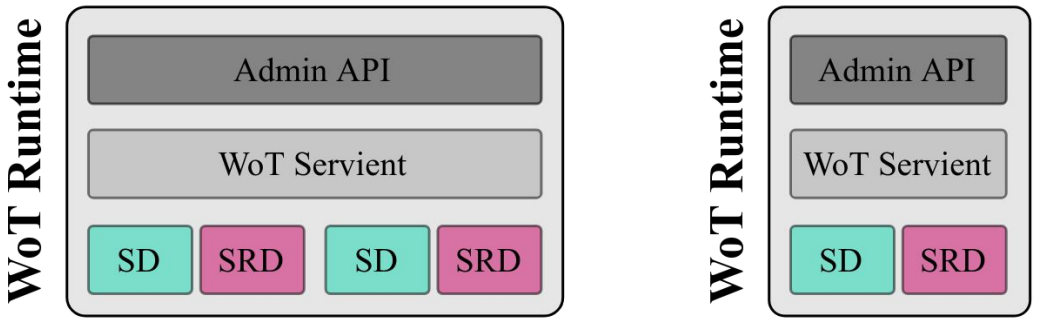
Allows describing interaction logic between Things, in order **to create WoT Systems**



Development Tools

For **deployment, management, and monitoring** of WoT Systems

Overview



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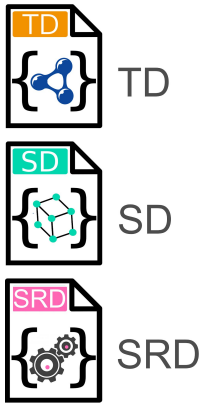
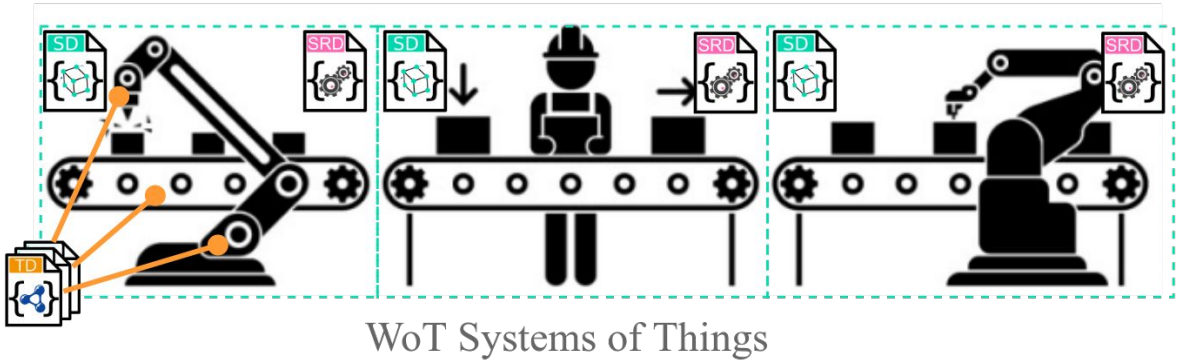
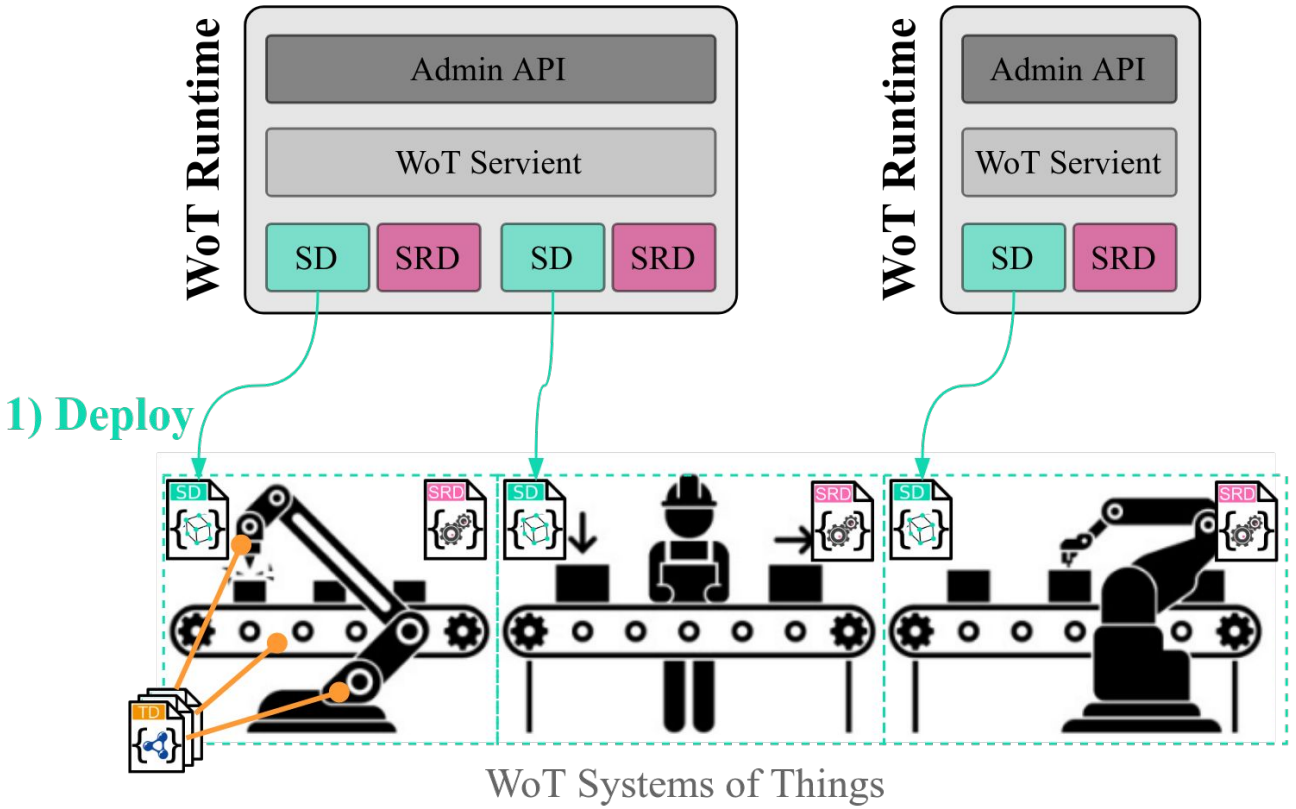




WoT Systems of Things

Overview



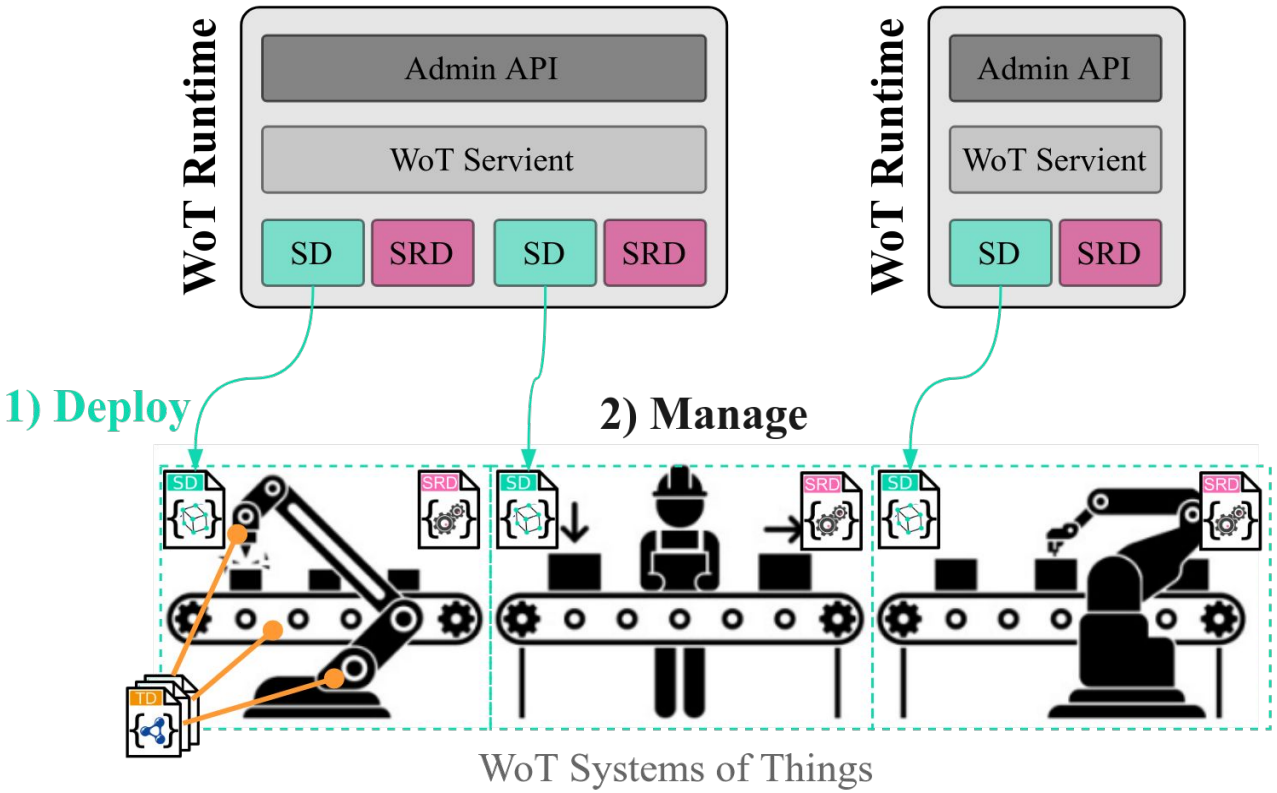
KEY

TD

SD

SRD

Overview



KEY

TD

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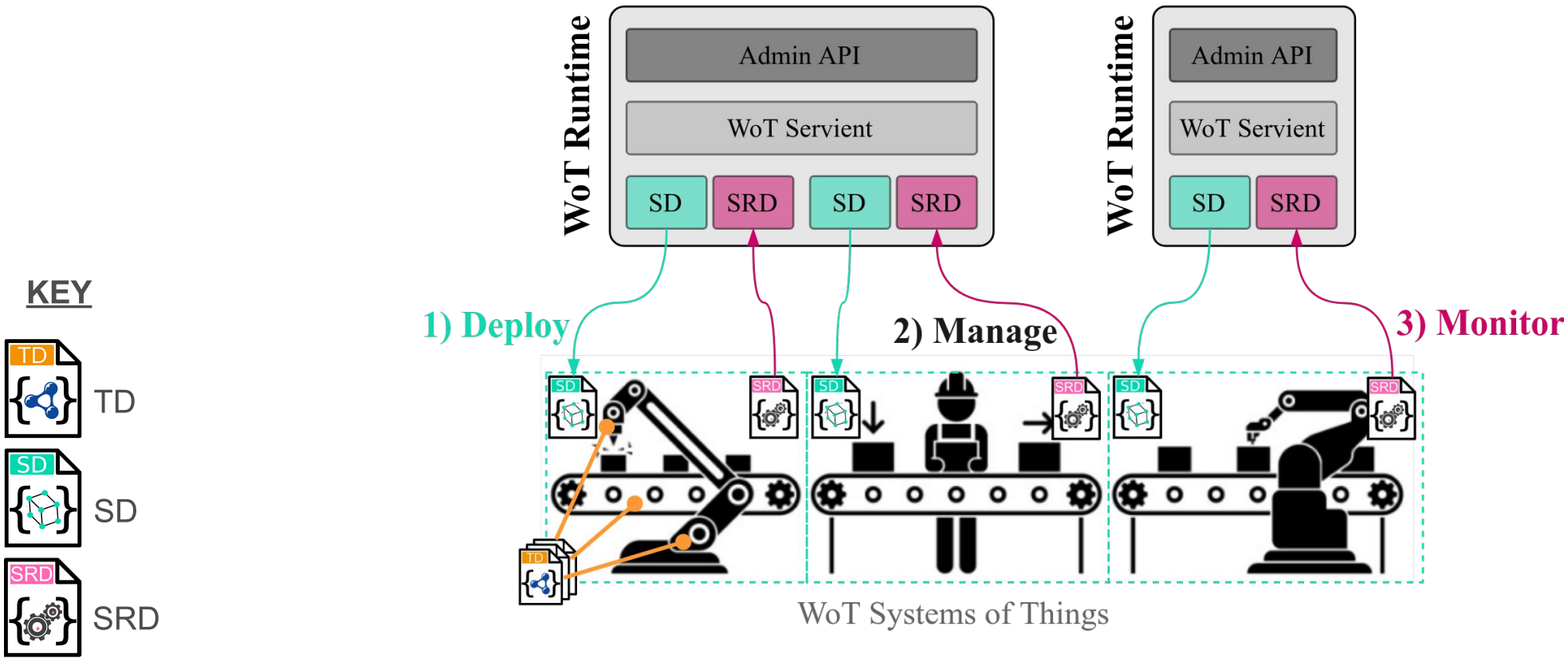
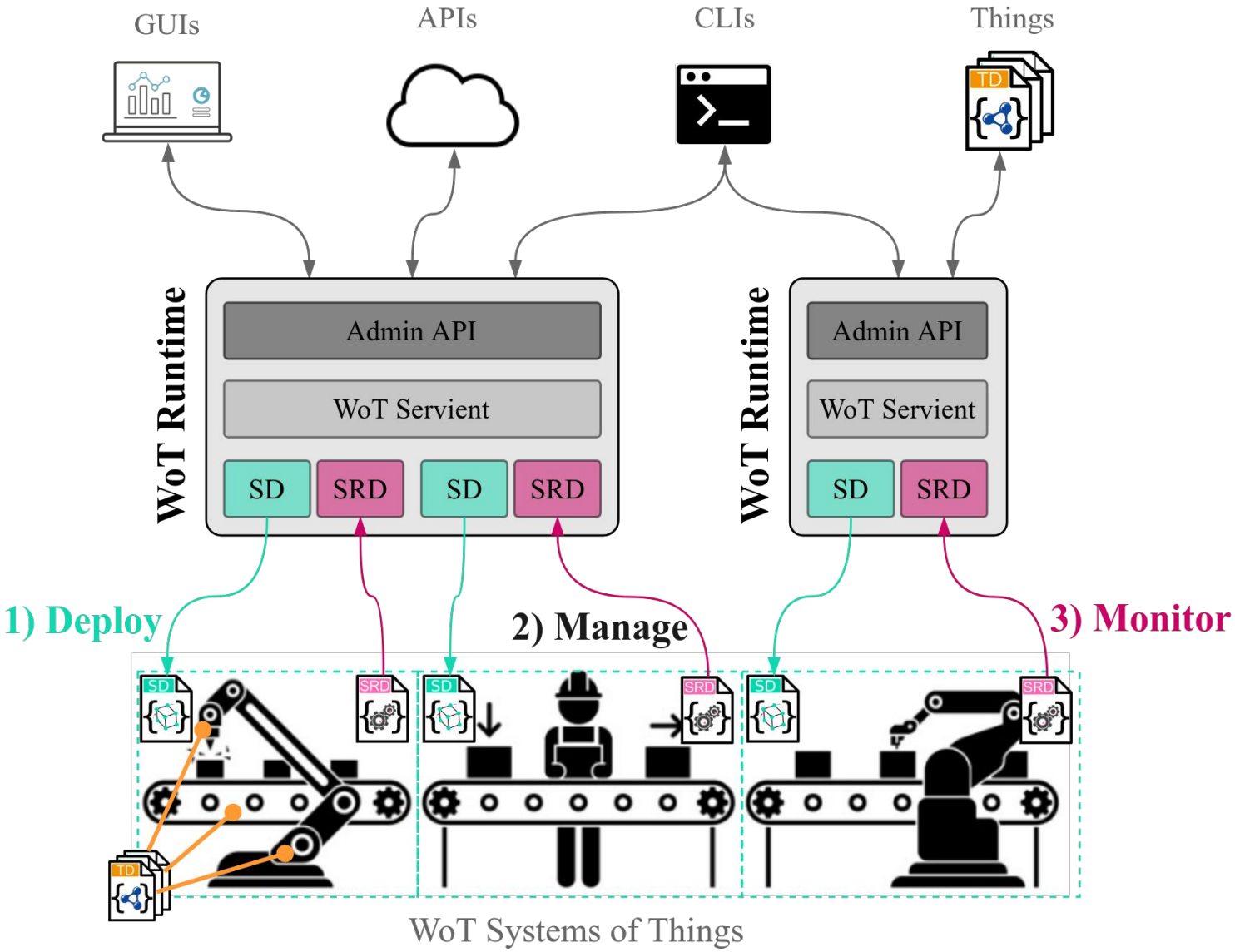
Overview


WoT Runtime
Admin API
WoT Servient
SD
SRD
SD
SRD
WoT Runtime
Admin API
WoT Servient
SD
SRD
1) Deploy
2) Manage
3) Monitor
WoT Systems of Things
KEY
TD
SD
SRD

Approach

Overview



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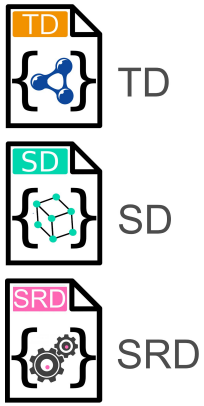
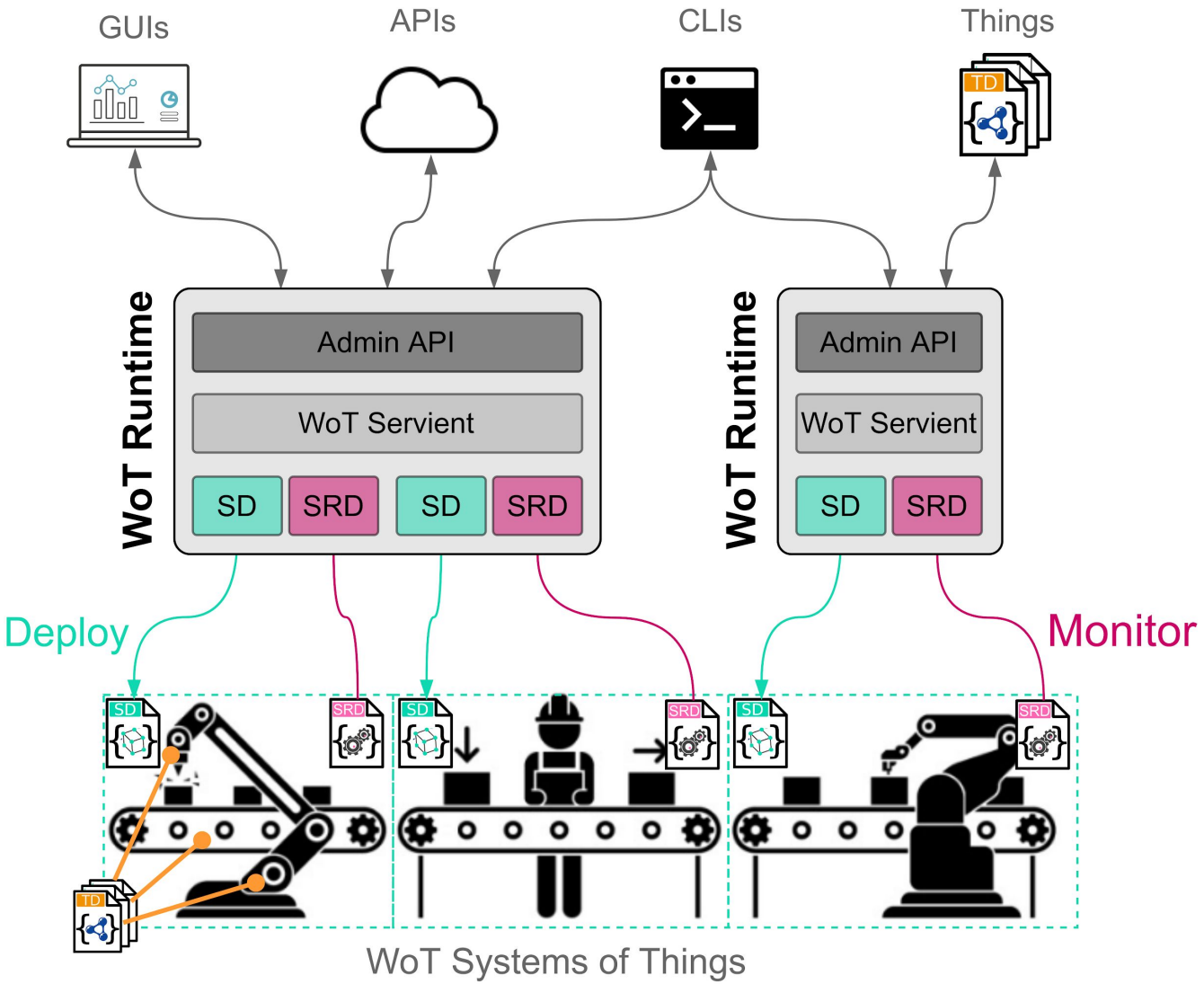


Approach

Overview



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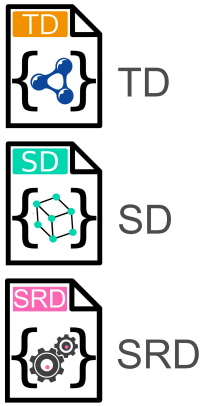
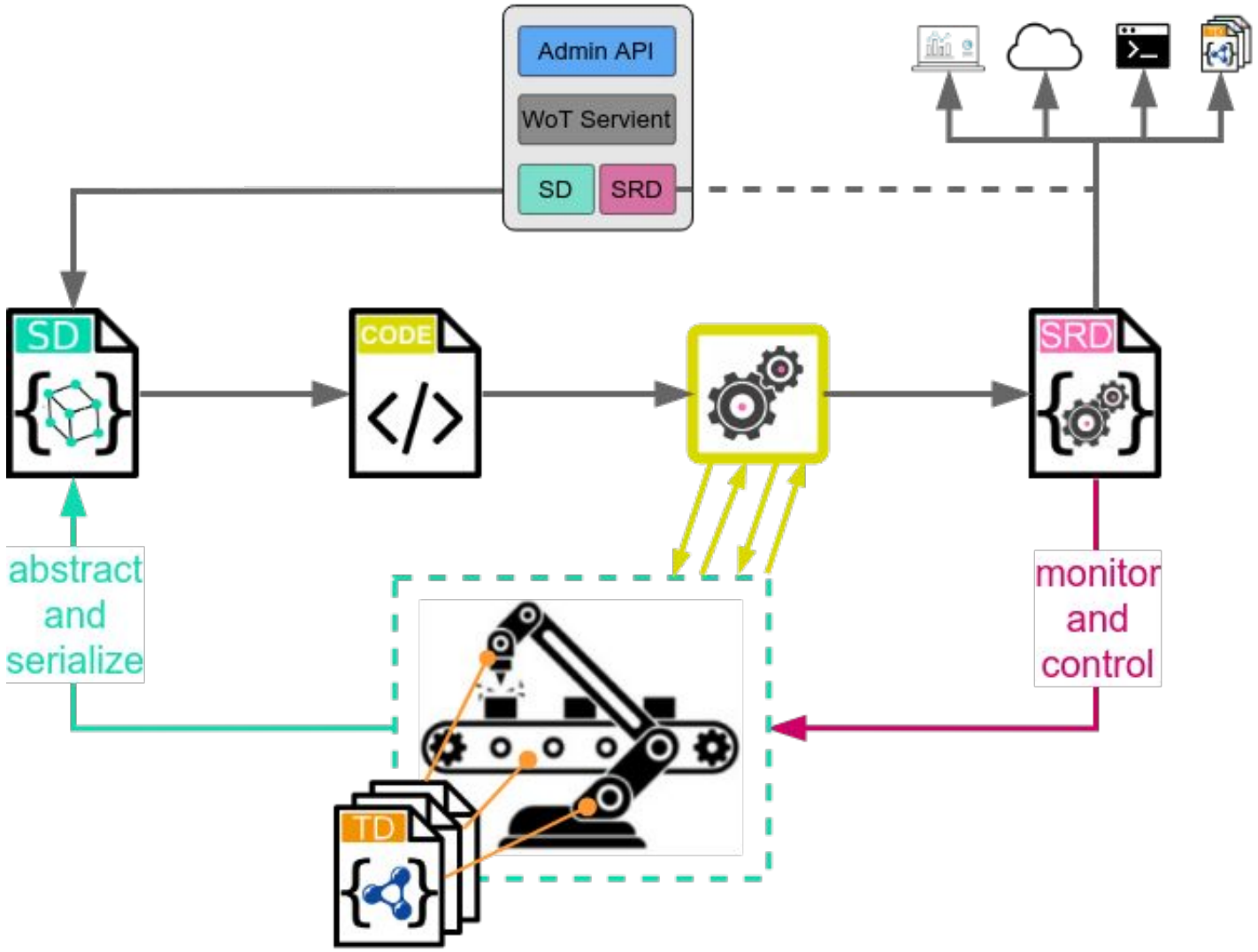


Methodology



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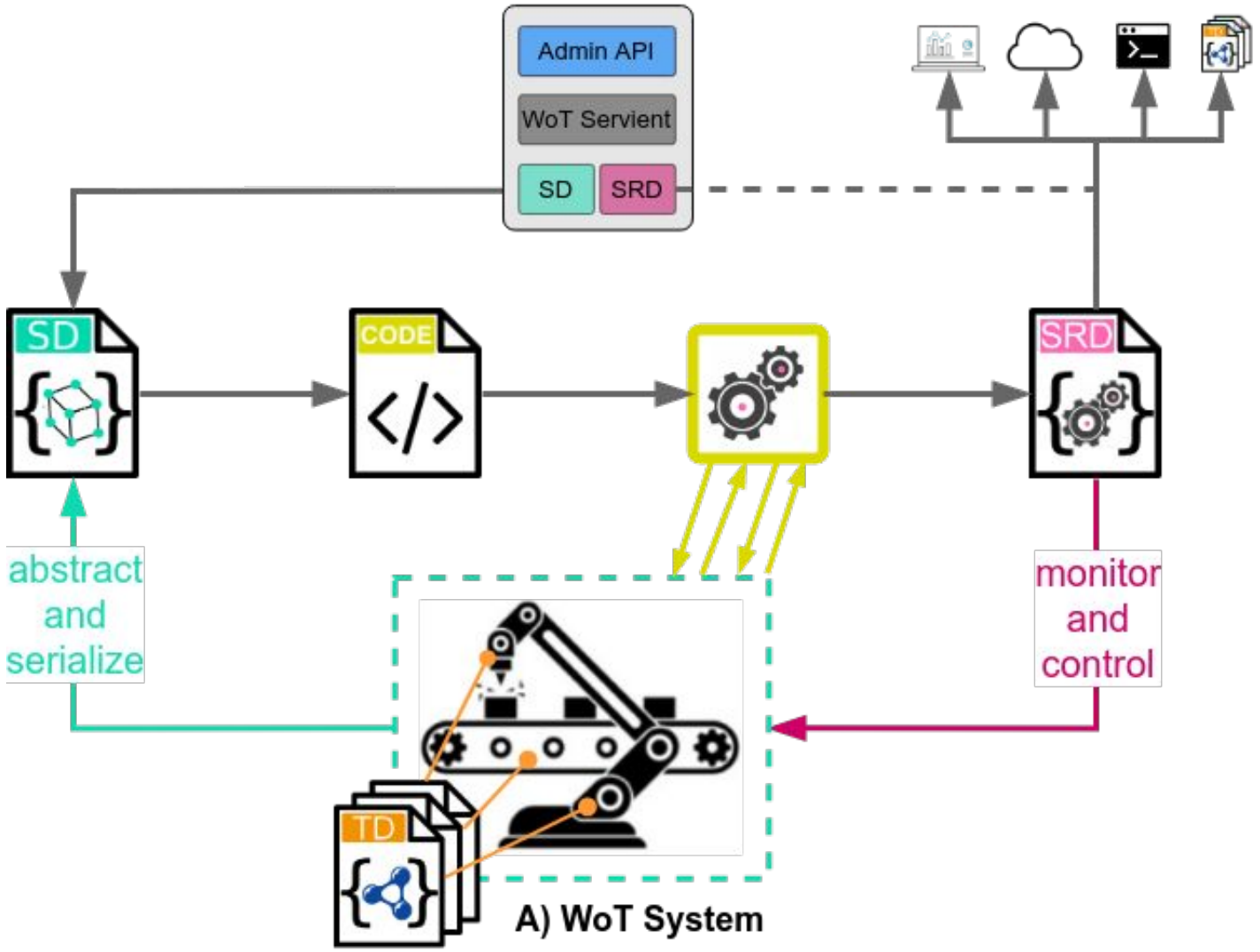

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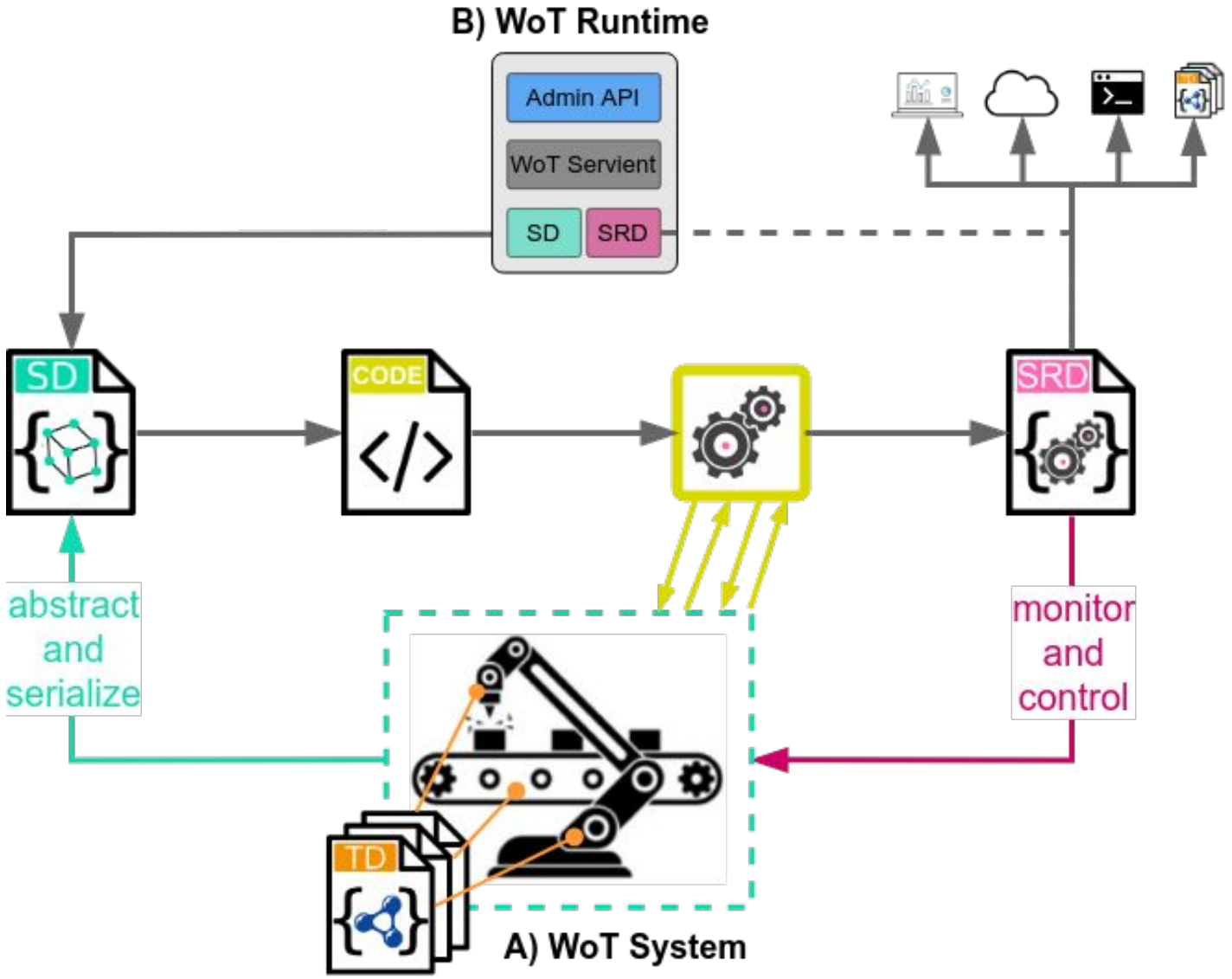

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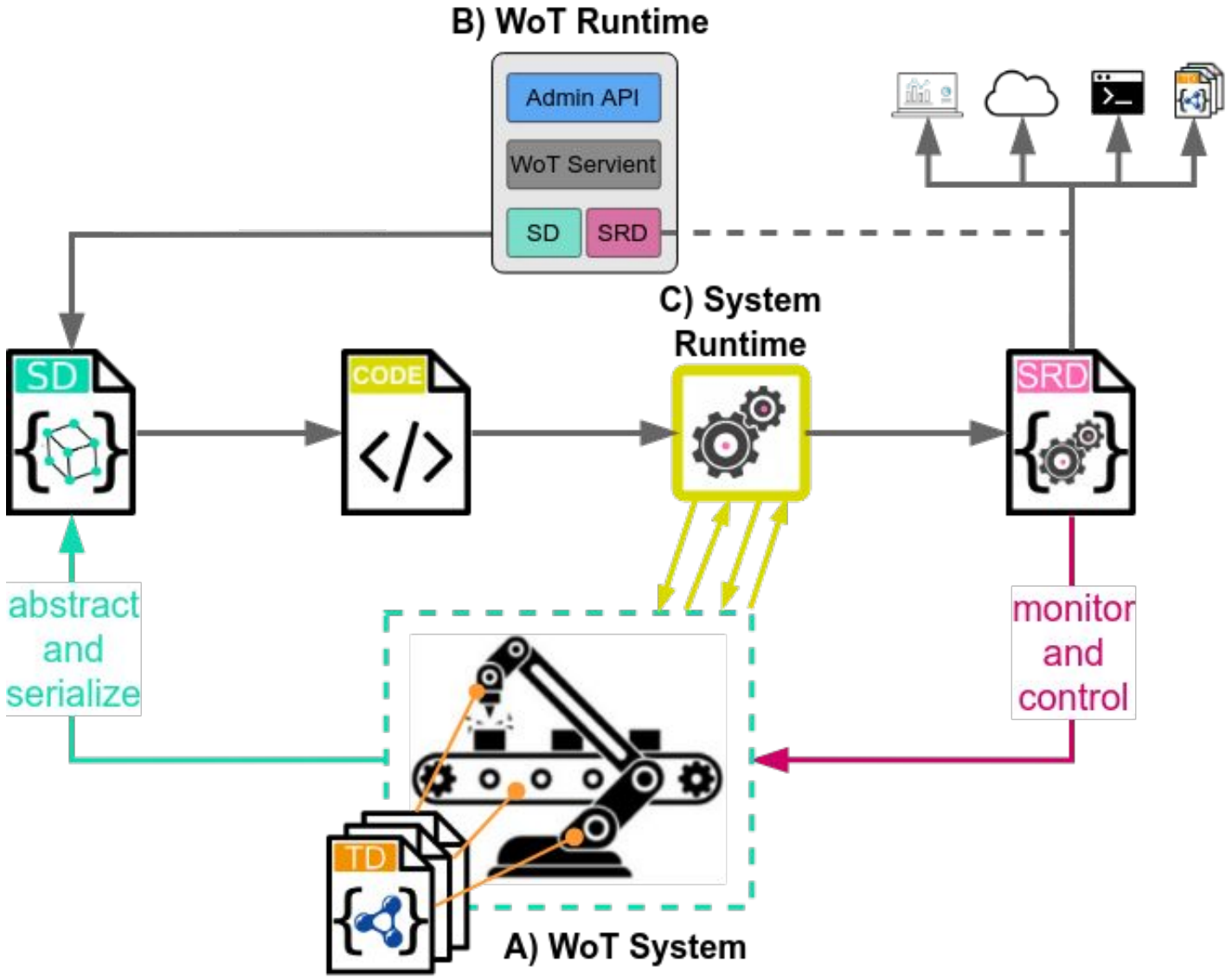

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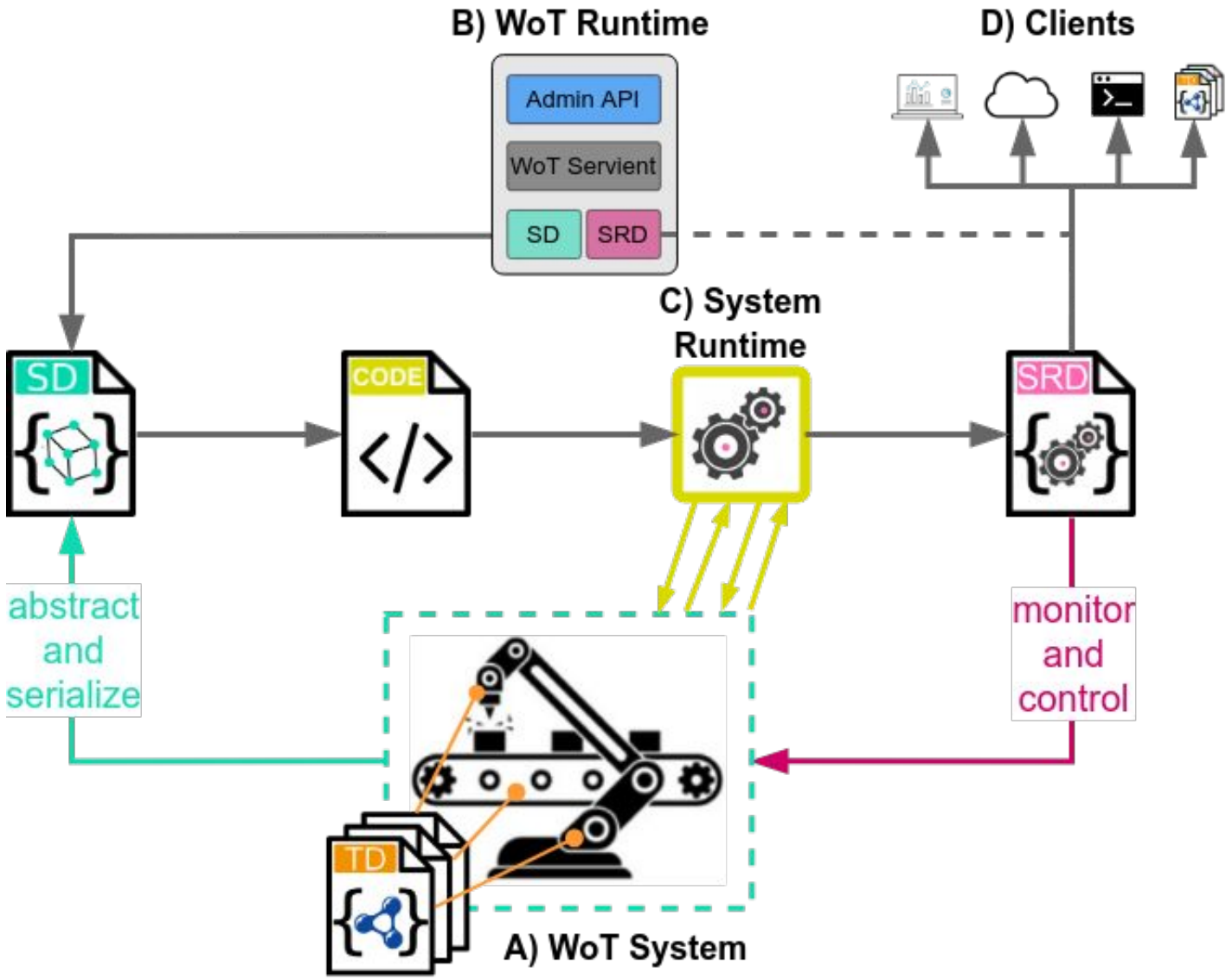

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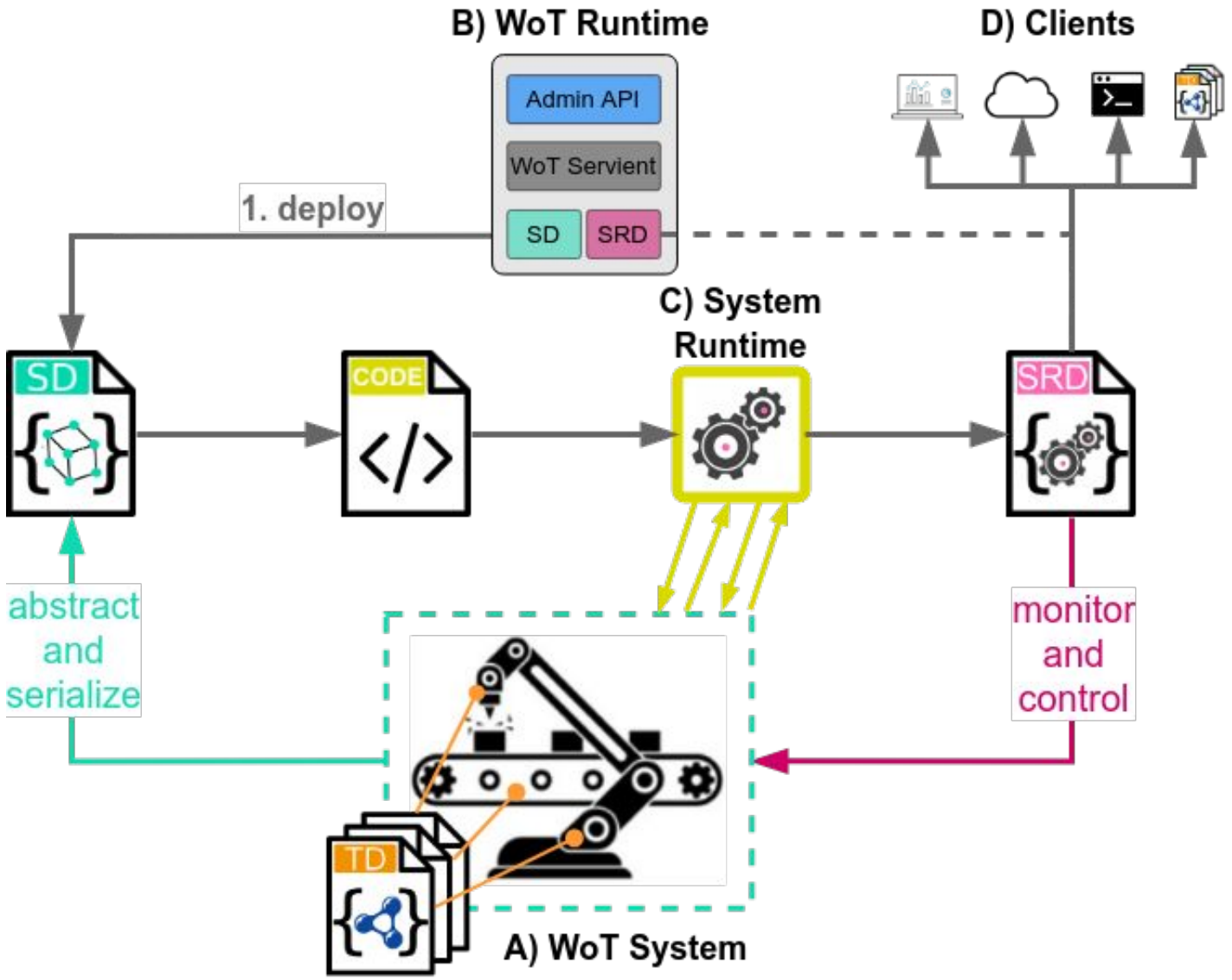

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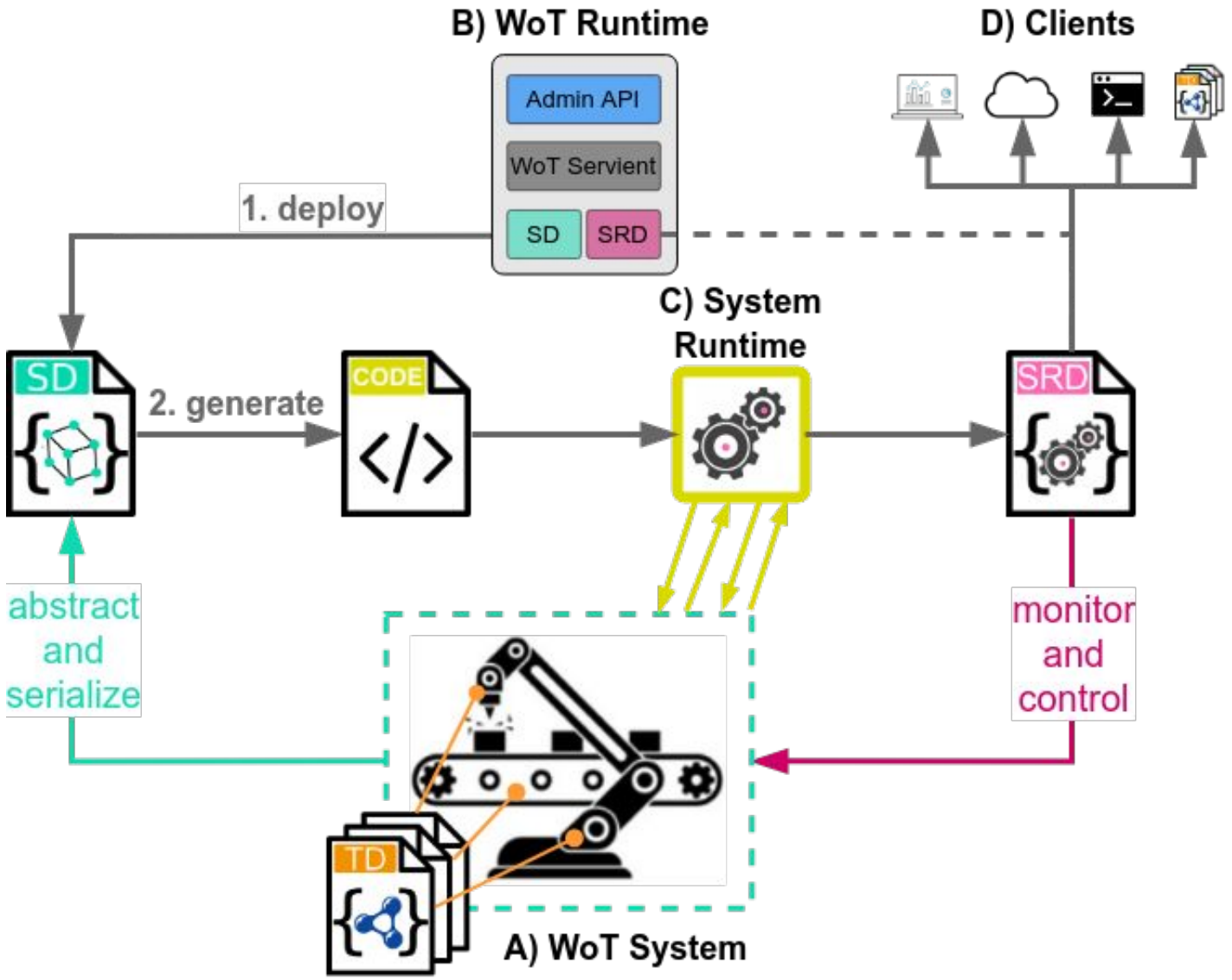
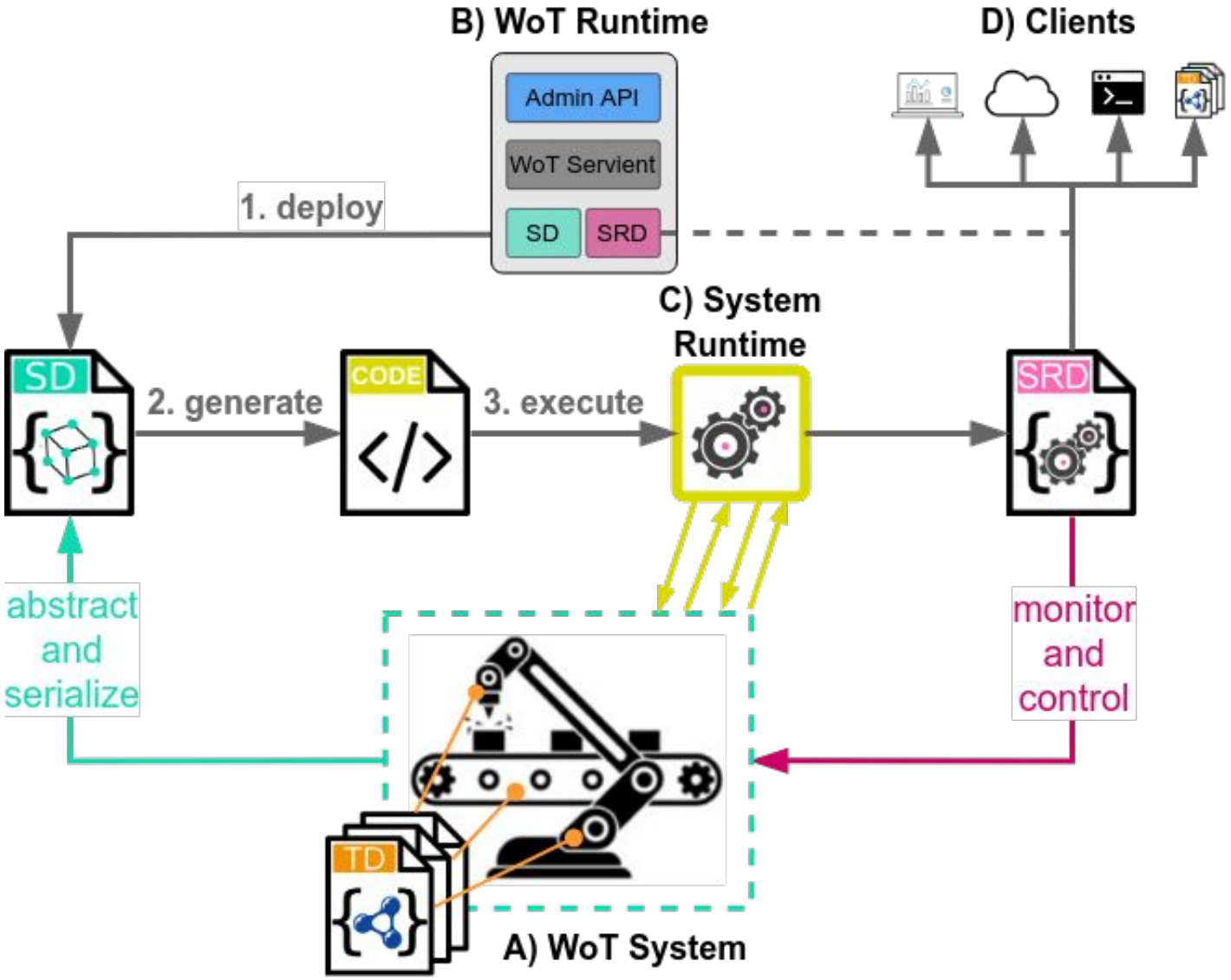
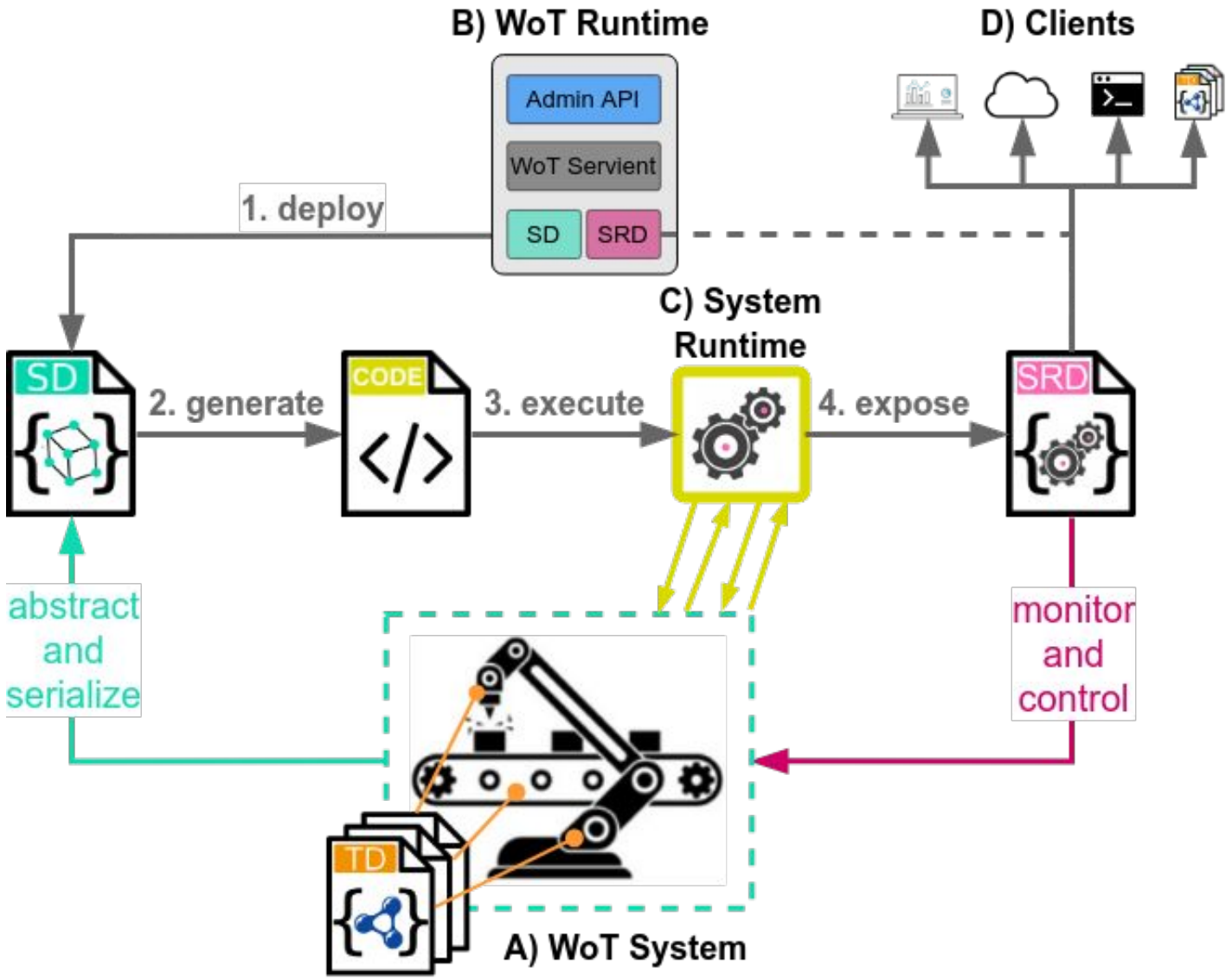


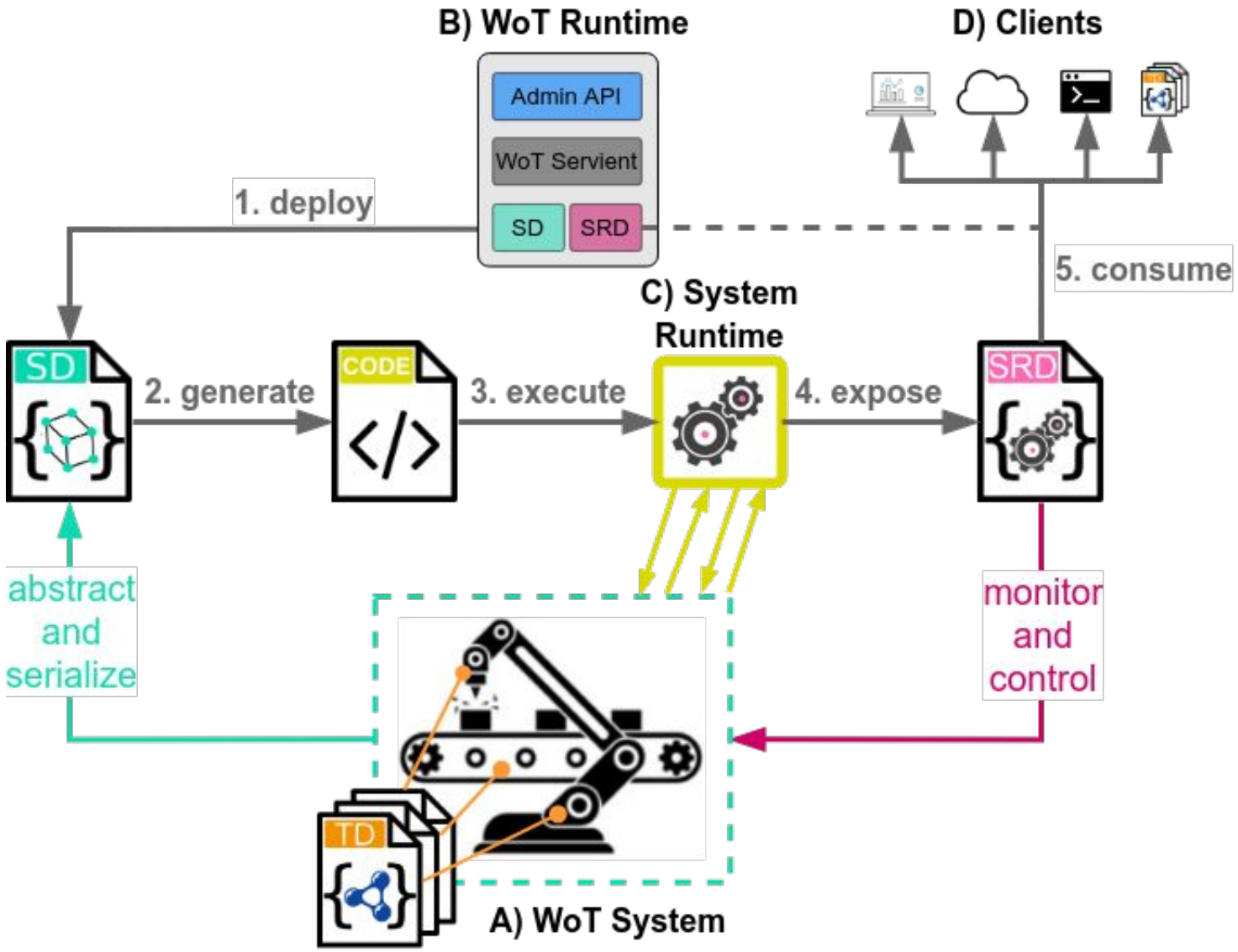
Methodology



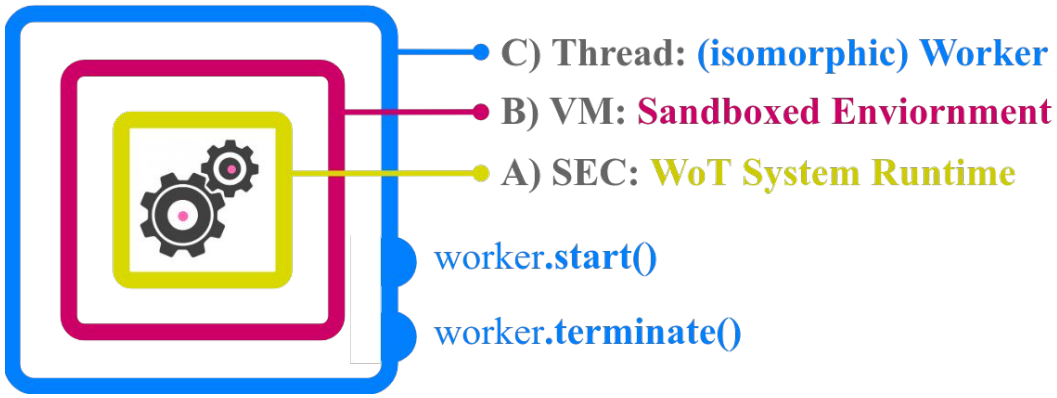
Methodology

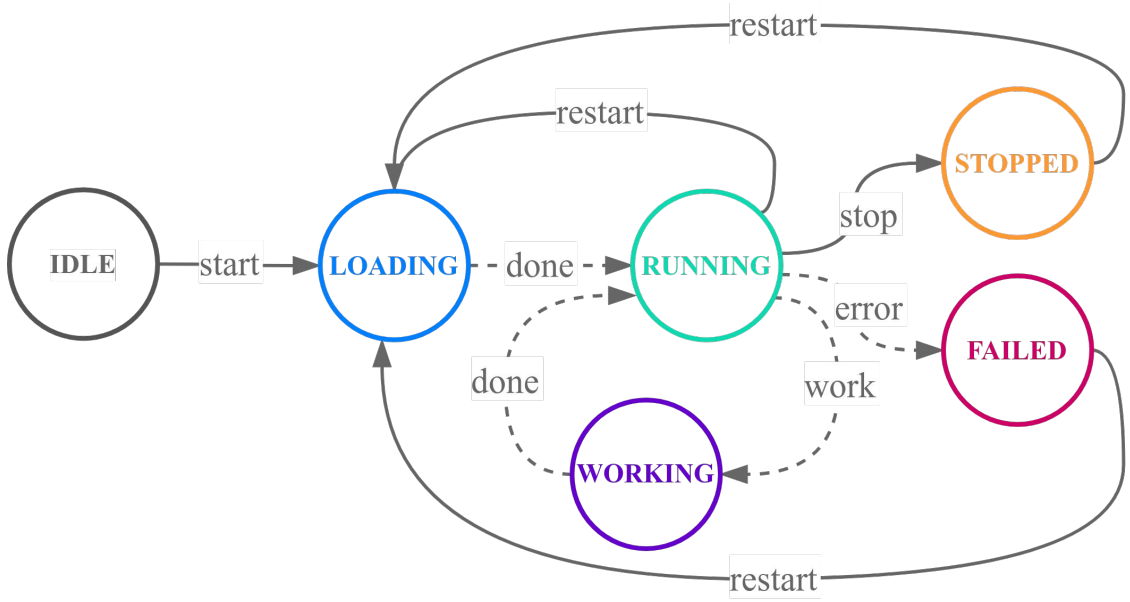


Methodology



Execution Environment and Control





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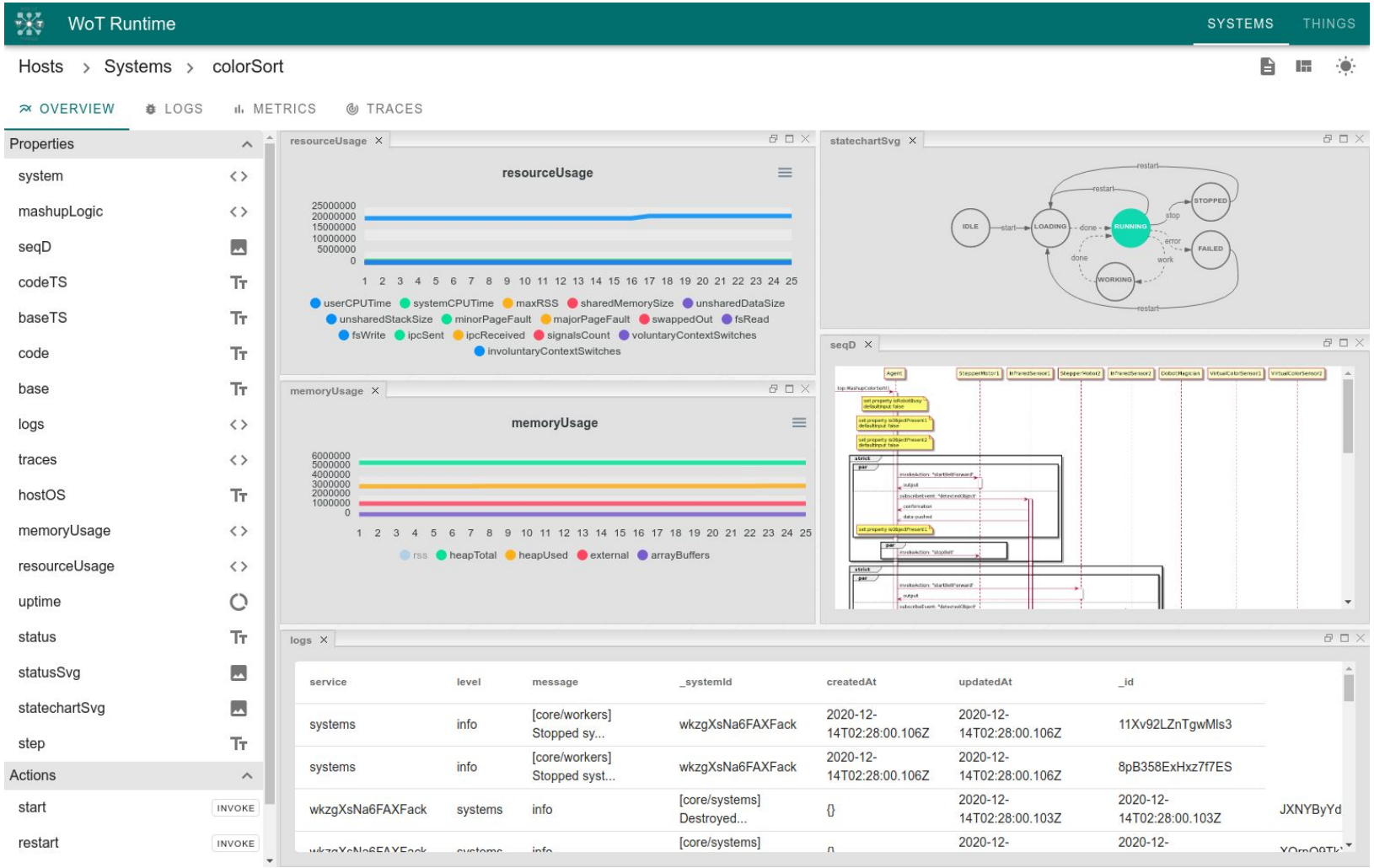
WoT Runtime UI - System Dashboard



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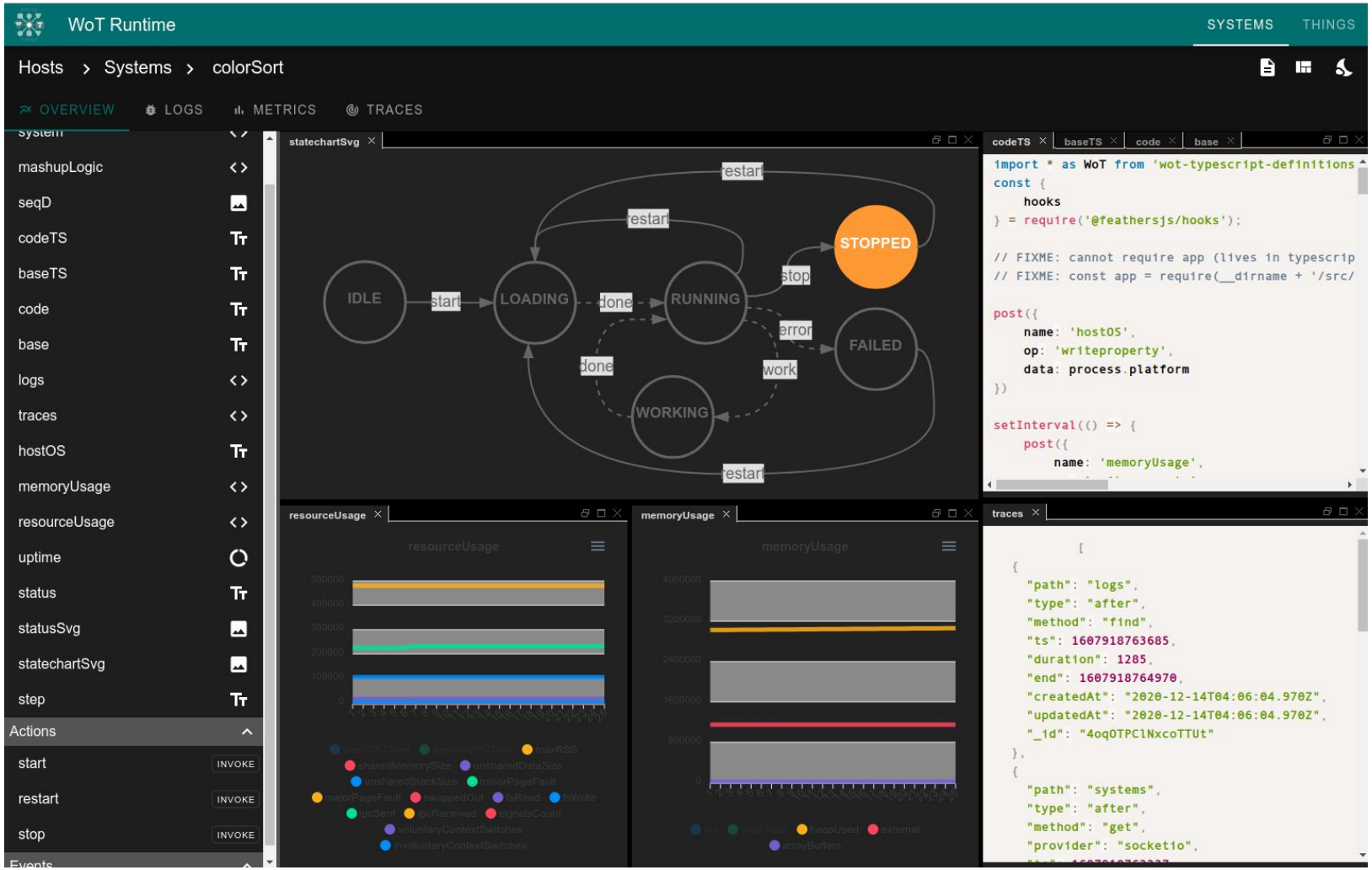
WoT Runtime UI - System Dashboard (dark)



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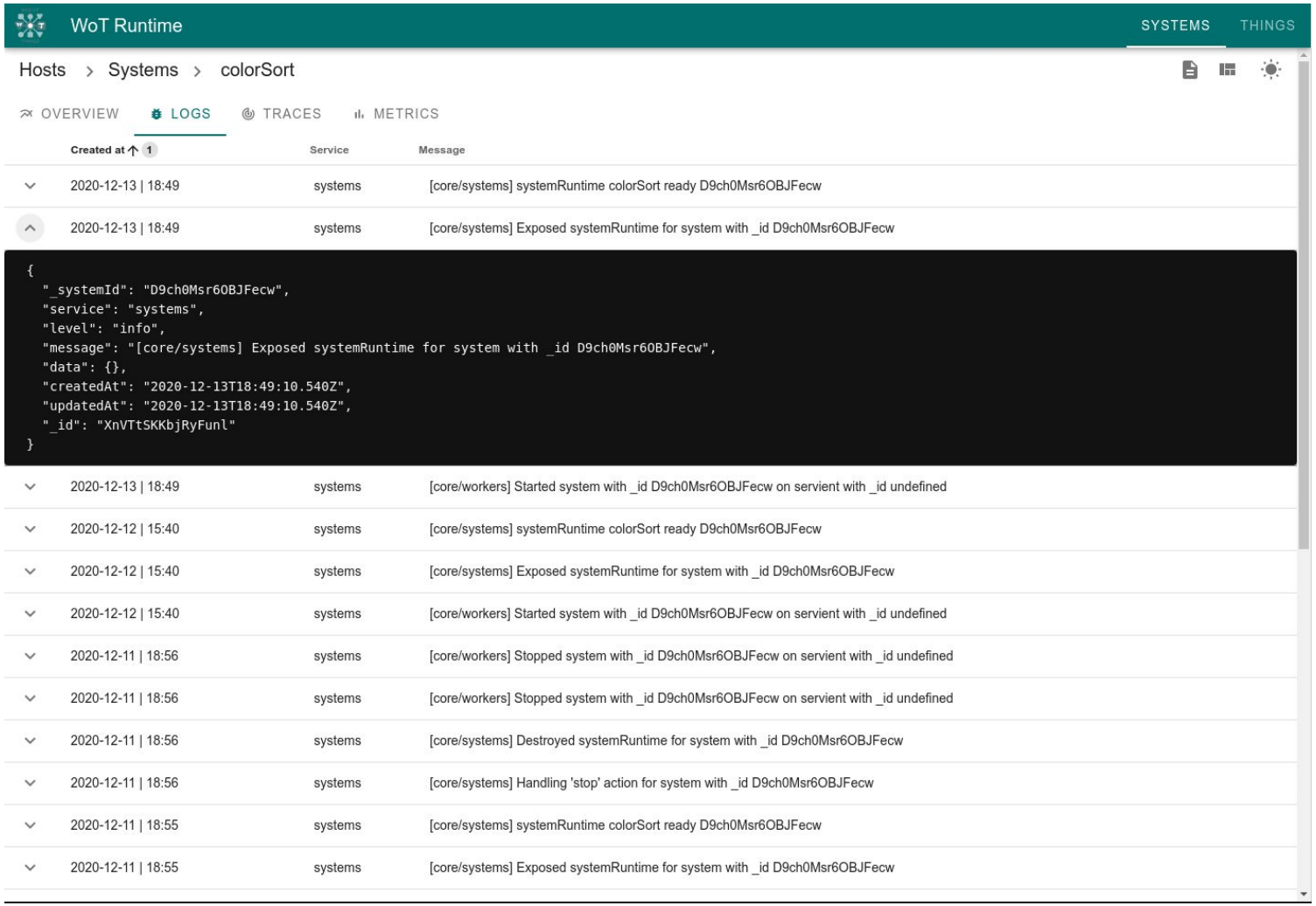
WoT Runtime UI - Logs



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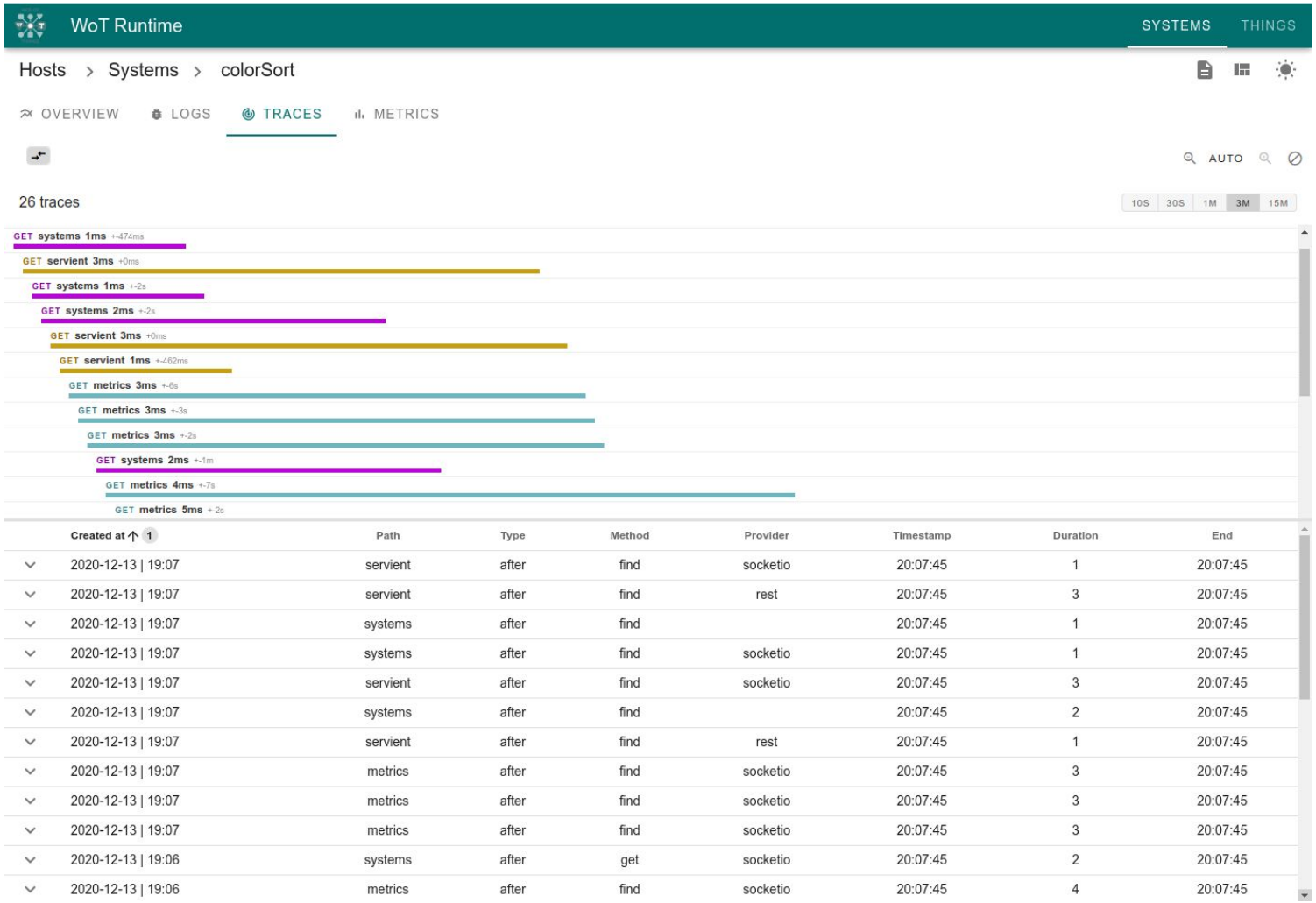
WoT Runtime UI - Traces



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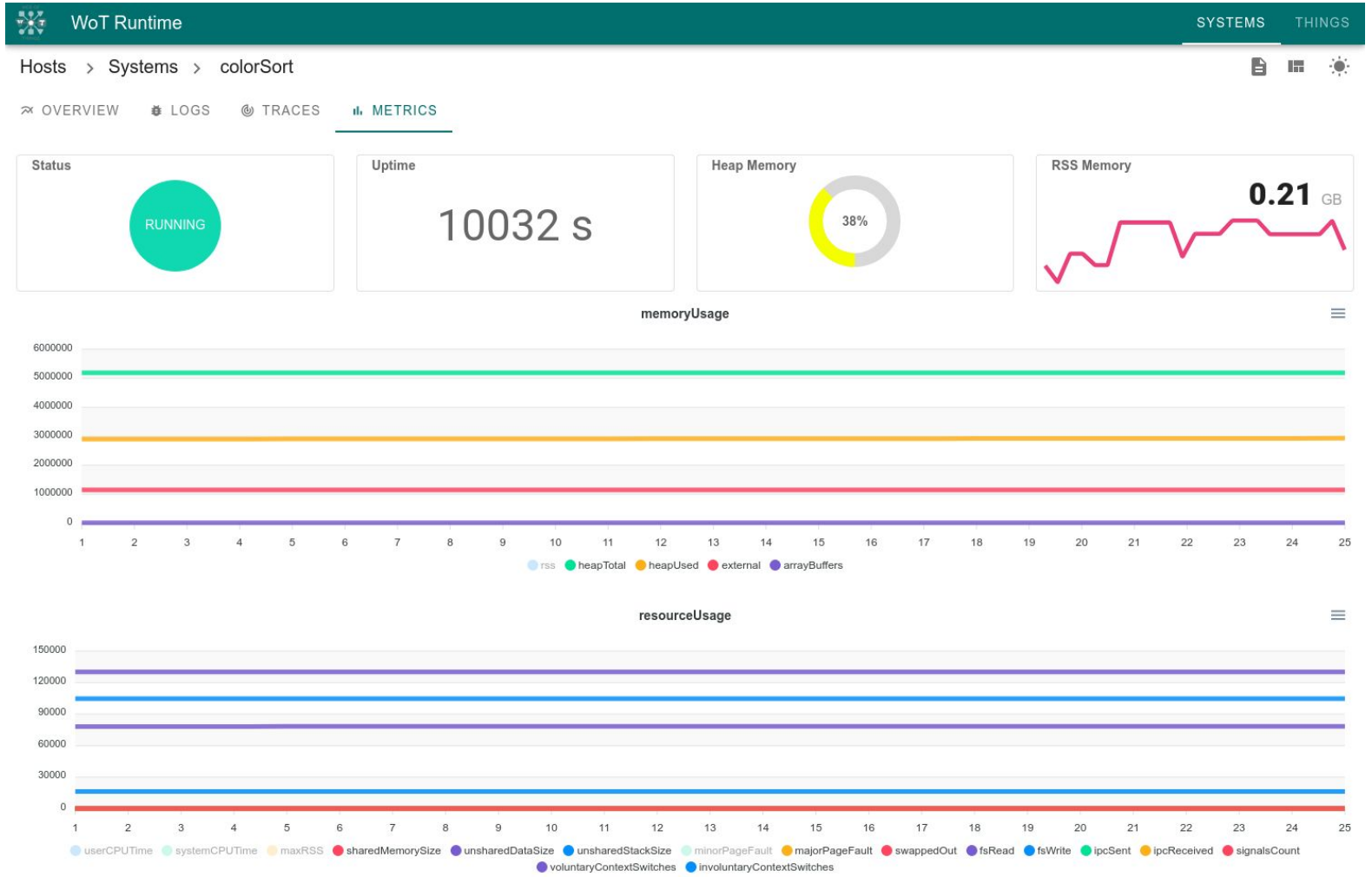
2020-12-13 | 19:07	servient	after	find	rest	20:07:45	3	20:07:45
2020-12-13 | 19:07	systems	after	find		20:07:45	1	20:07:45
2020-12-13 | 19:07	systems	after	find	socketio	20:07:45	1	20:07:45
2020-12-13 | 19:07	servient	after	find	socketio	20:07:45	3	20:07:45
2020-12-13 | 19:07	systems	after	find		20:07:45	2	20:07:45
2020-12-13 | 19:07	servient	after	find	rest	20:07:45	1	20:07:45
2020-12-13 | 19:07	metrics	after	find	socketio	20:07:45	3	20:07:45
2020-12-13 | 19:07	metrics	after	find	socketio	20:07:45	3	20:07:45
2020-12-13 | 19:07	metrics	after	find	socketio	20:07:45	3	20:07:45
2020-12-13 | 19:06	systems	after	get	socketio	20:07:45	2	20:07:45
2020-12-13 | 19:06	metrics	after	find	socketio	20:07:45	4	20:07:45

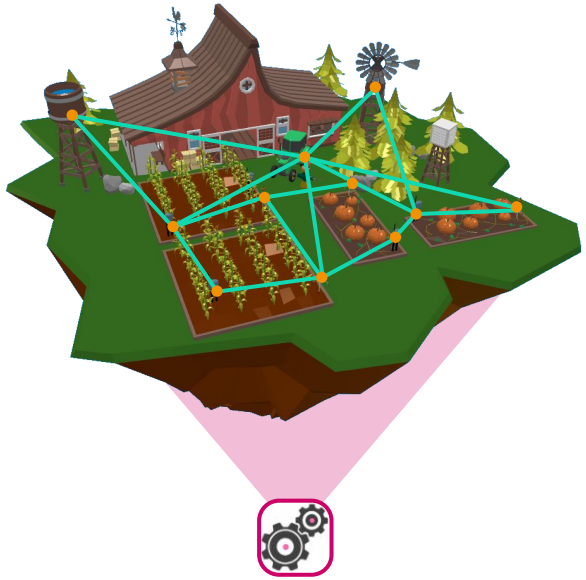
Research Professorship of Embedded Systems and Internet of Things
Department of Electrical and Computer Engineering
Technical University of Munich

WoT Runtime UI - Metrics



Results

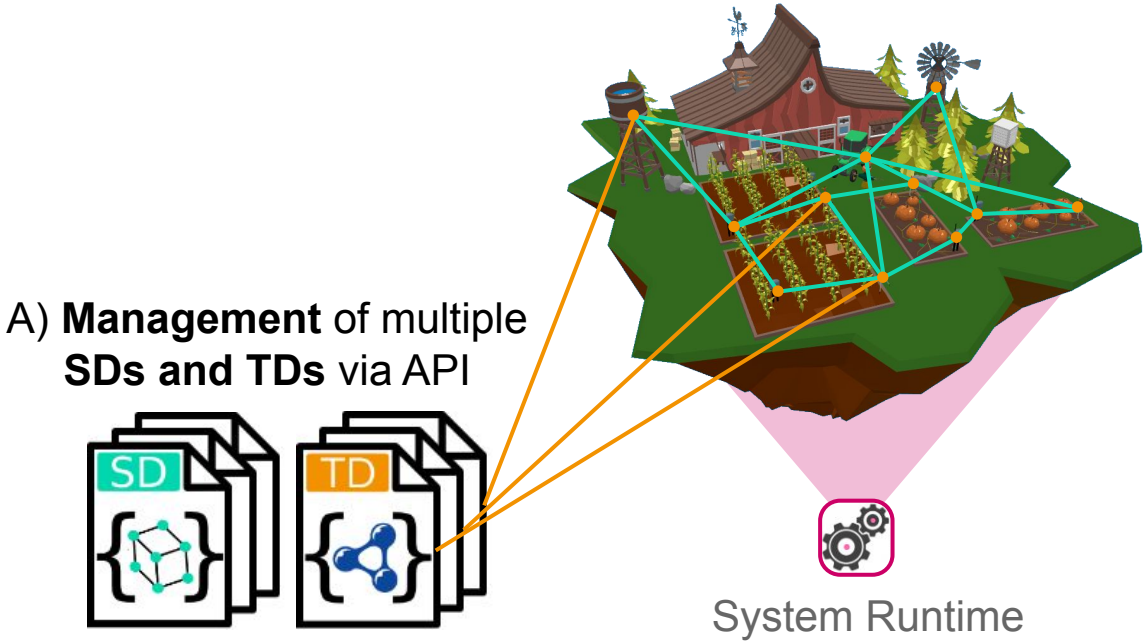
Smart Farm Simulation Use Case



System Runtime

Results

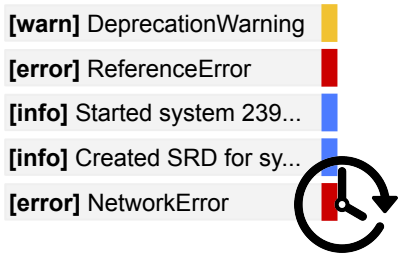
Smart Farm Simulation Use Case



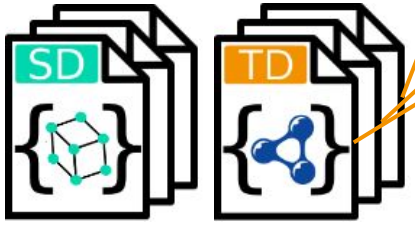
Results

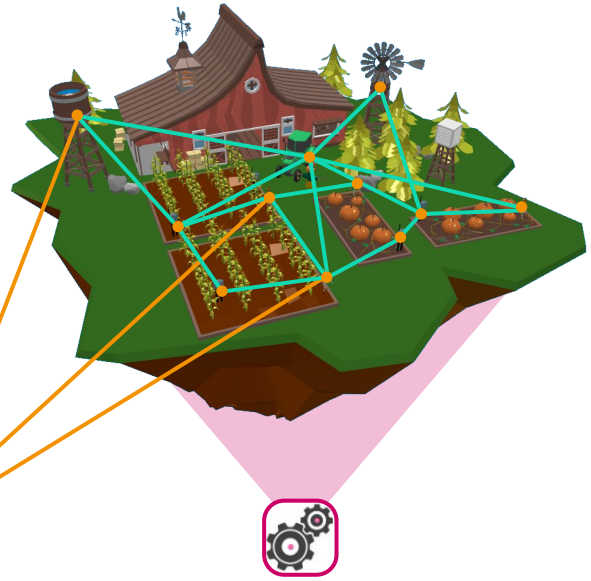
Smart Farm Simulation Use Case

B) Runtime monitoring via
logs, metrics and traces



A) **Management** of multiple
SDs and TDs via API



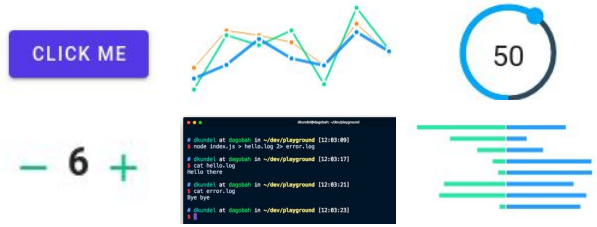


System Runtime

Results

Smart Farm Simulation Use Case

C) Mashup **monitoring and control** via auto-generated GUI



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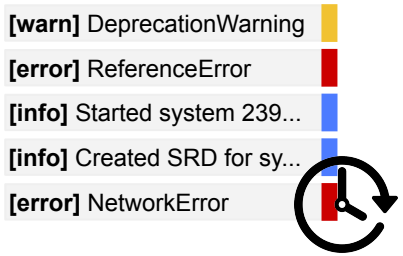

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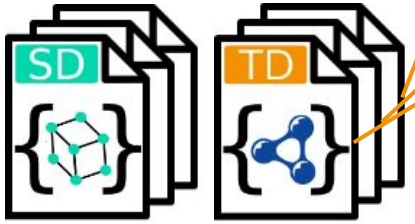

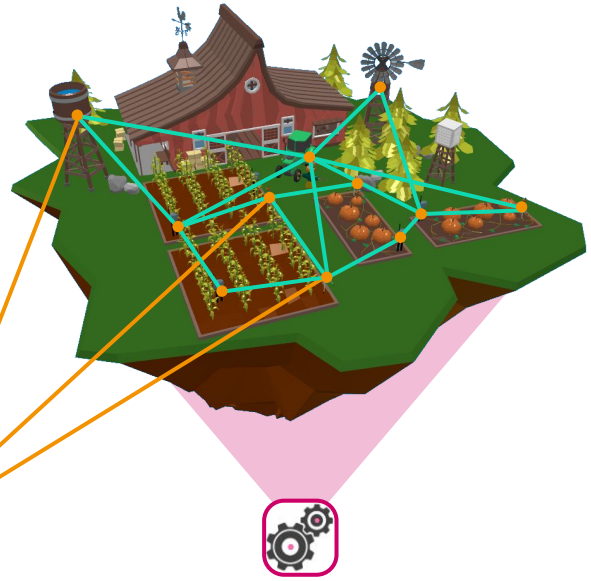

System Runtime

Results

Smart Farm Simulation Use Case

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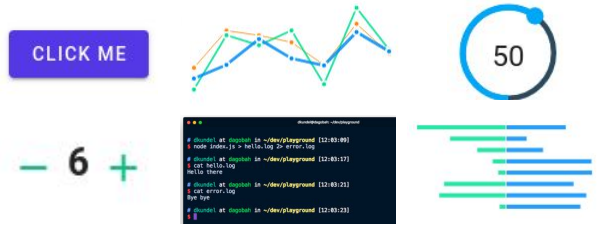
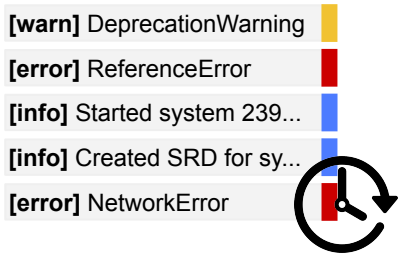
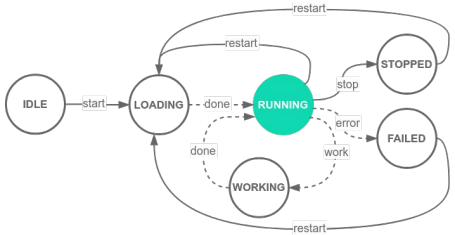


B) Runtime monitoring via **logs, metrics and traces**



D) **Safe and secure** execution environment



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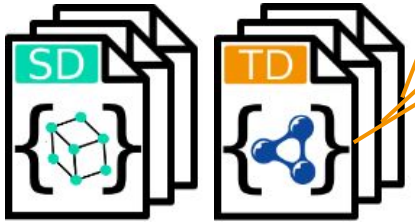

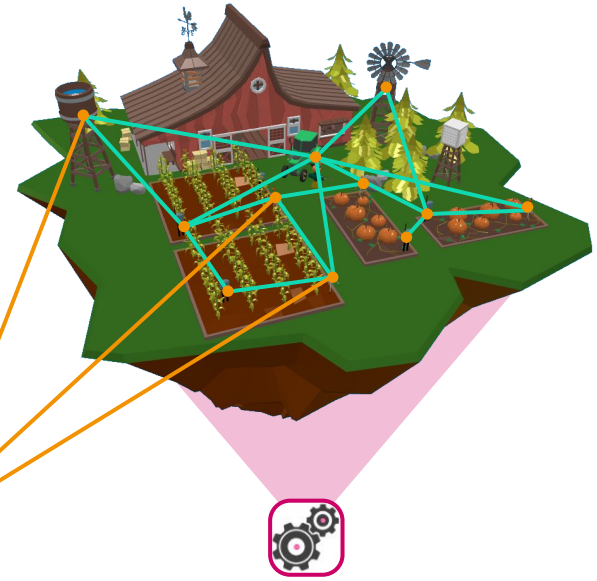

System Runtime

Results

Smart Farm Simulation Use Case

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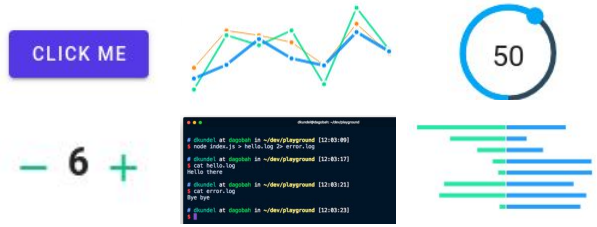

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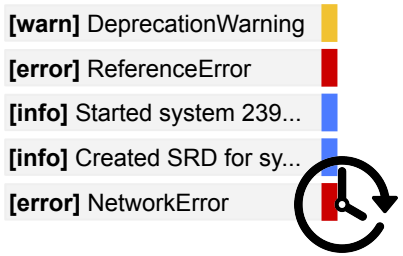

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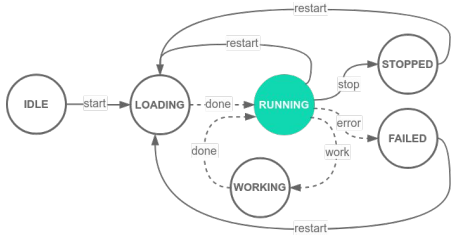

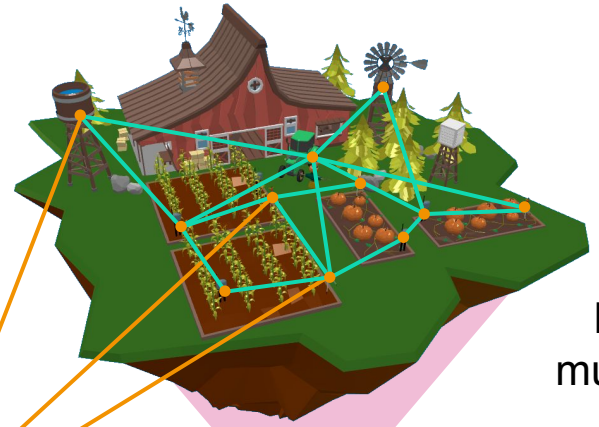

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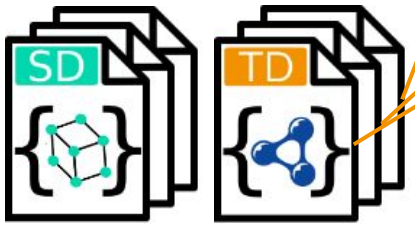
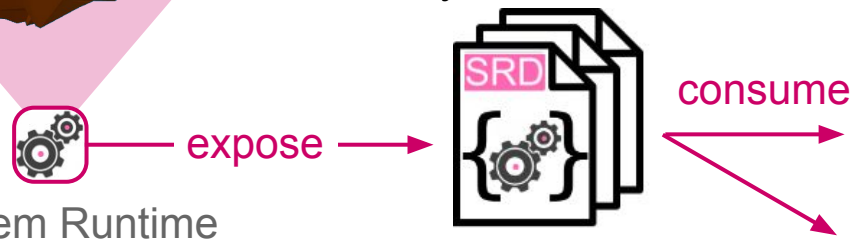


E) **SRD** for composing multi-layered architectures

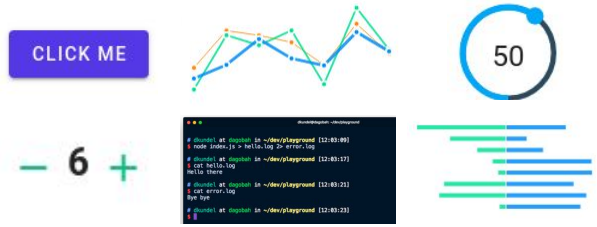


System Runtime

Results

Smart Farm Simulation Use Case

C) Mashup **monitoring and control** via auto-generated GUI



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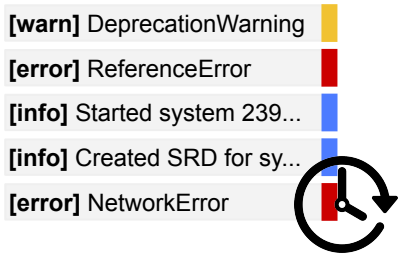

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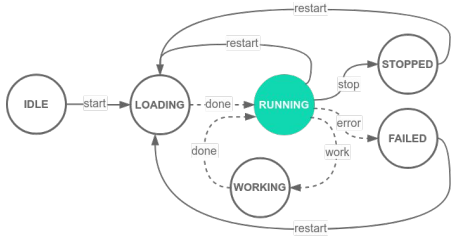

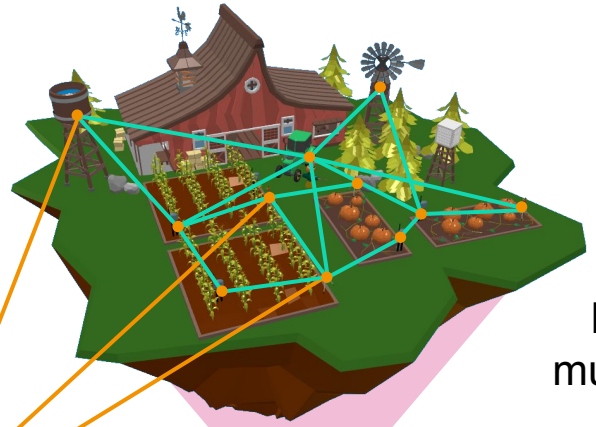

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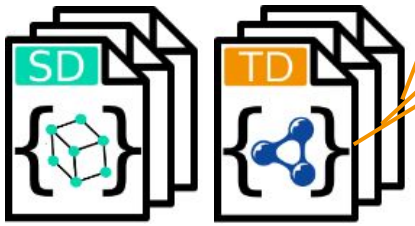
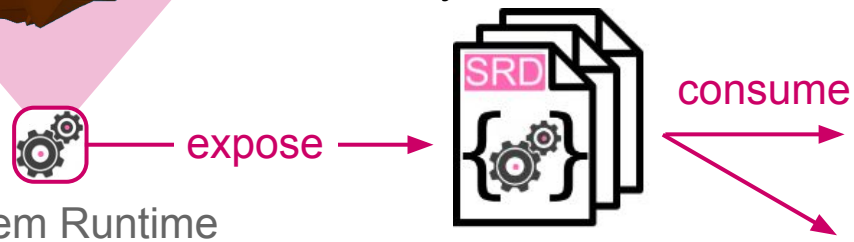


E) **SRD** for composing multi-layered architectures



System Runtime

Conclusion

In conclusion:

- The WoT Runtime Framework introduces an additional WoT building block for:
    - remote deployment of SDs into safe execution Environments,
    - management of WoT System Runtimes,
    - and monitoring and control through the auto-generated SRD

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  - remote deployment of SDs into safe execution Environments,
  - management of WoT System Runtimes,
  - and monitoring and control through the auto-generated SRD
- The SRD allows composing multi-layered WoT architecutes
- The approach is evaluated in two use cases
  - An industrial automation scenario
  - and a smart farm simulation

  demonstrating how the proposed solution works in practice
- The WoT Runtime framework lays the basis for future in distributed WoT architectures

Thank you for your attention