

# RobotPerf

An Open-Source, Vendor-Agnostic, Benchmarking Suite for Evaluating Robotics Computing System Performance



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ACCELERATION  
ROBOTICS



HARVARD  
UNIVERSITY



Carnegie  
Mellon  
University



JOHANNES KEPLER  
UNIVERSITÄT LINZ



BARNARD



BOSTON  
UNIVERSITY





# Introduction

# Motivation

## Robotic Applications



Real-Time  
Systems

Moore's Law &  
Dennard Scaling

Heterogeneous  
Hardware

# Overview

Robotic Applications



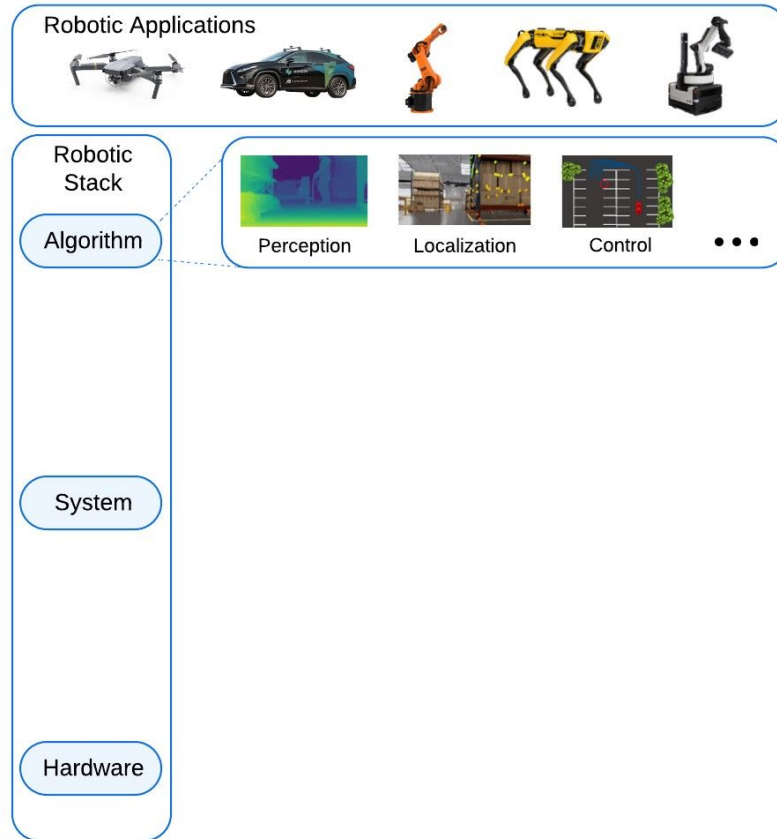
Robotic Stack

Algorithm

System

Hardware

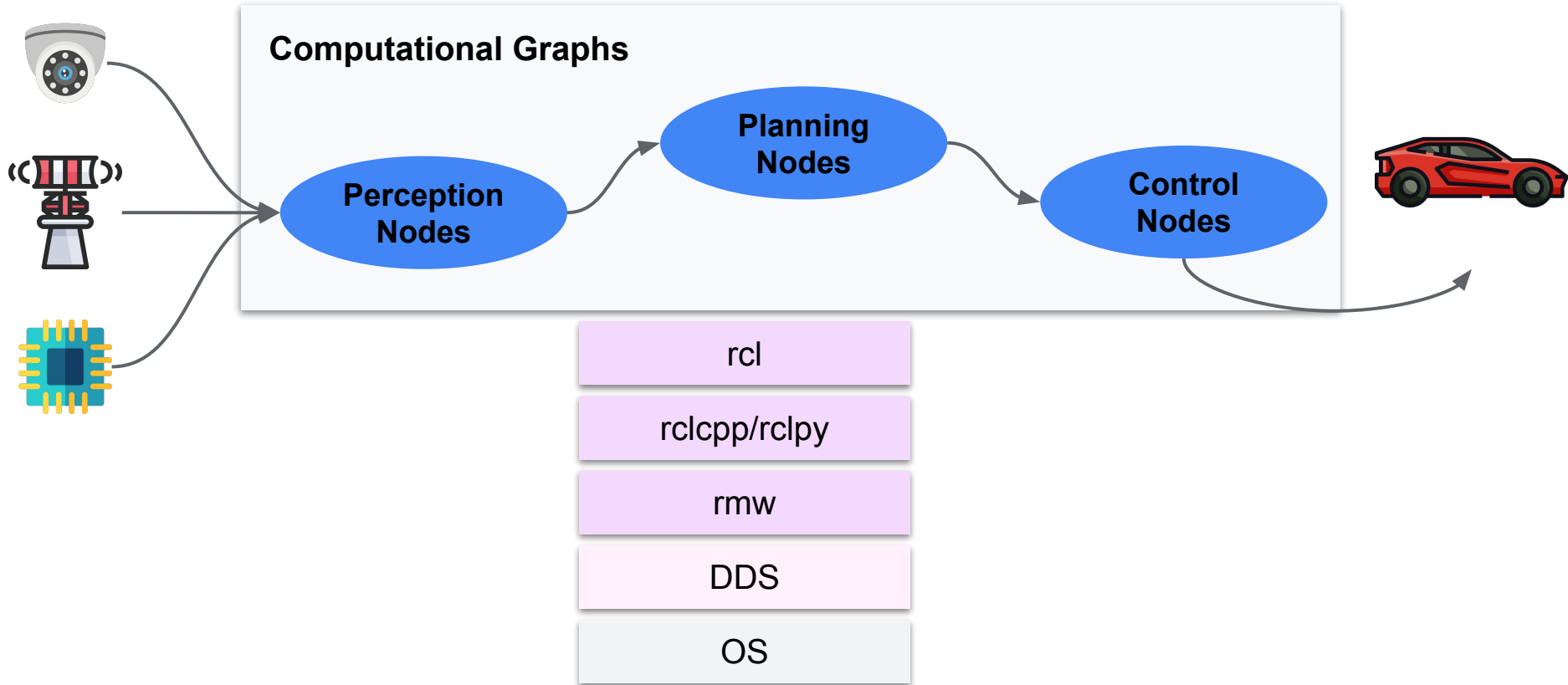
# Overview



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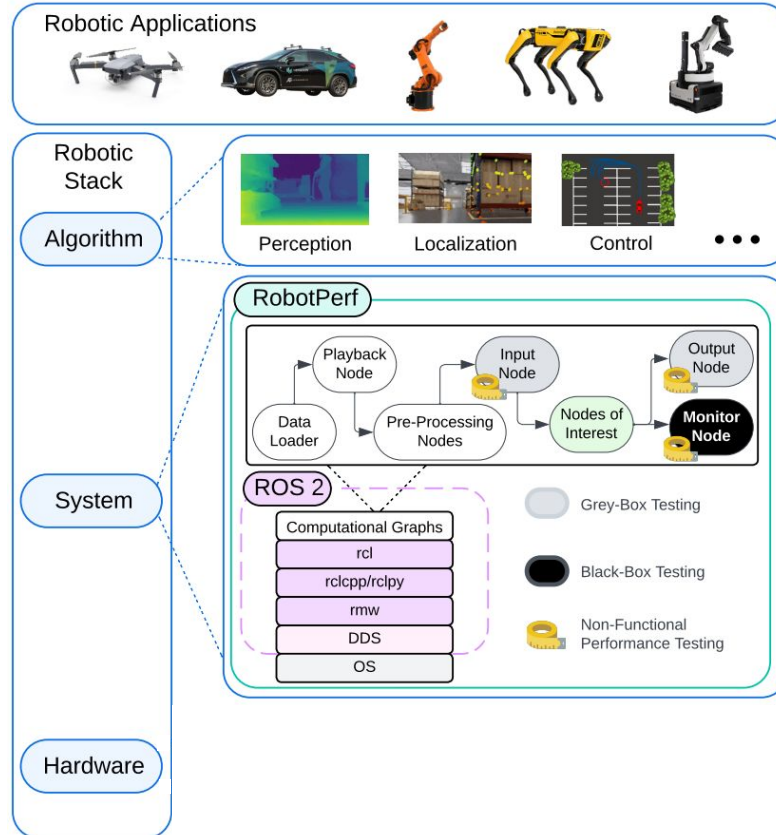


# Background

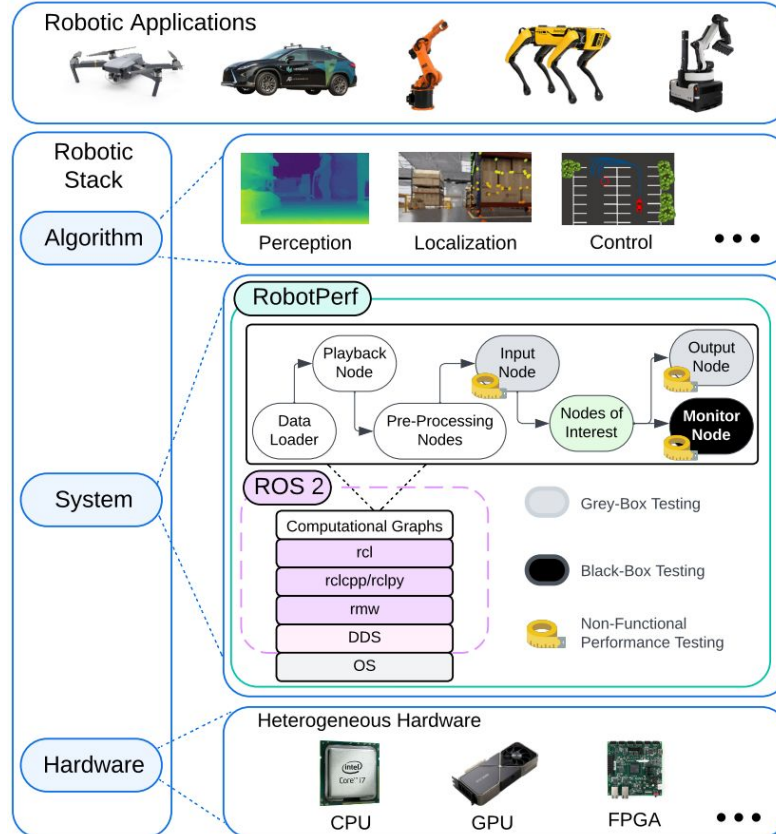




# Overview



# Overview





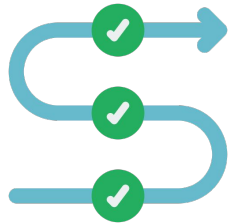
# RobotPerf Principles

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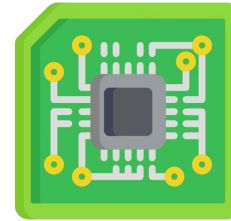
Non-Functional  
Performance  
Testing



# Performance Testing Types



**Functional**



**Non-Functional**

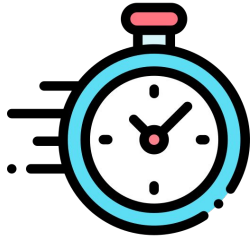
# RobotPerf Principles

Non-Functional  
Performance  
Testing

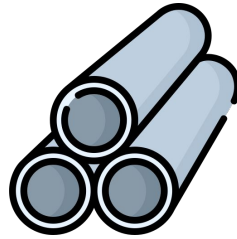


Real-Time  
Metrics

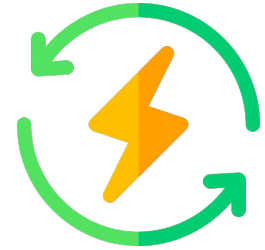
# Real-Time Metrics



Latency

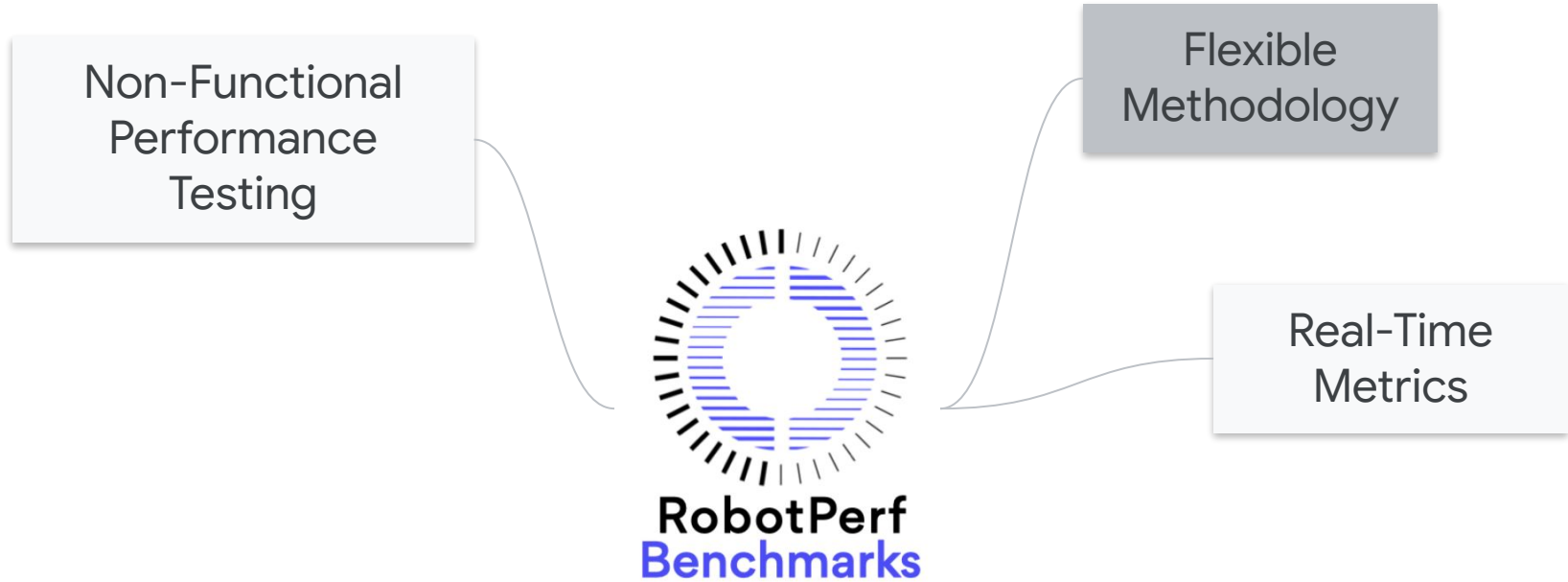


Throughput



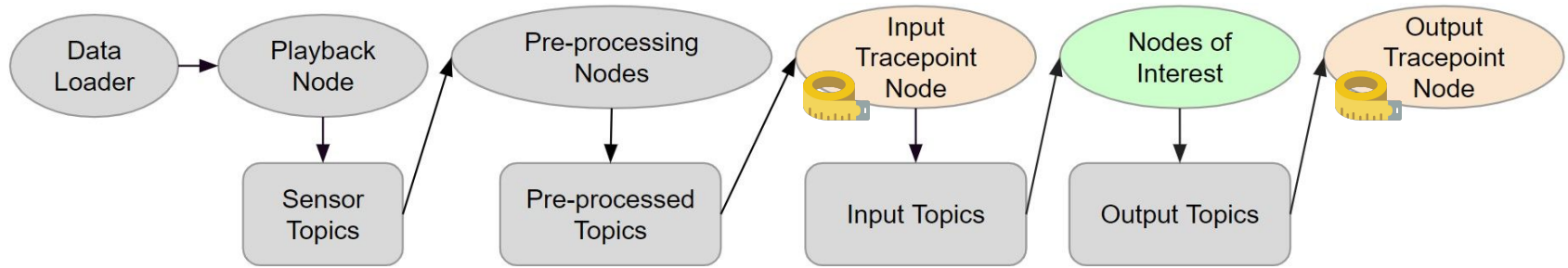
Power

# RobotPerf Principles



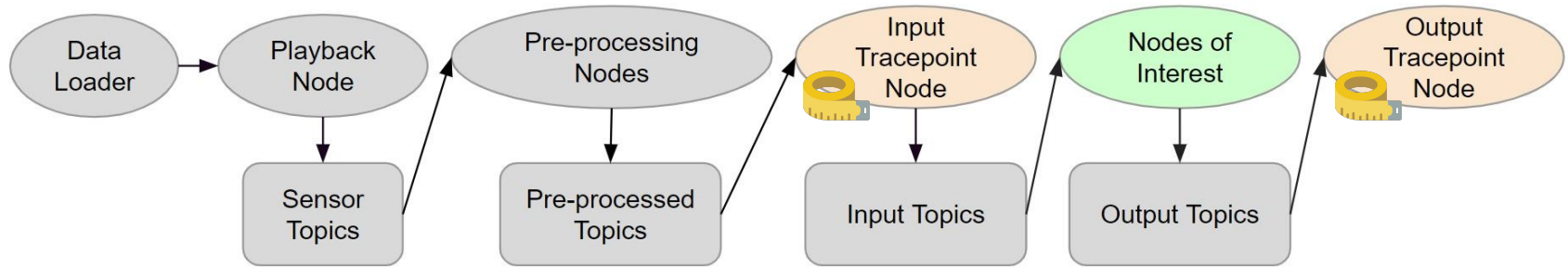


# Methodology Types

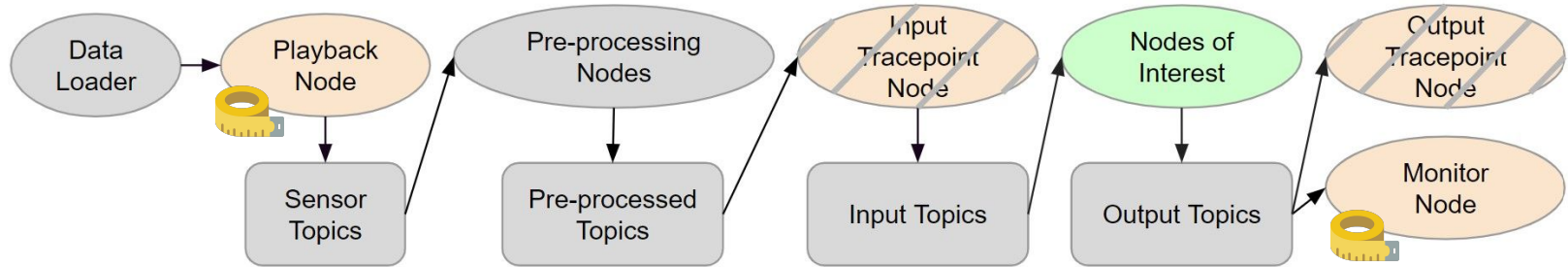


## Grey Box Testing

# Methodology Types

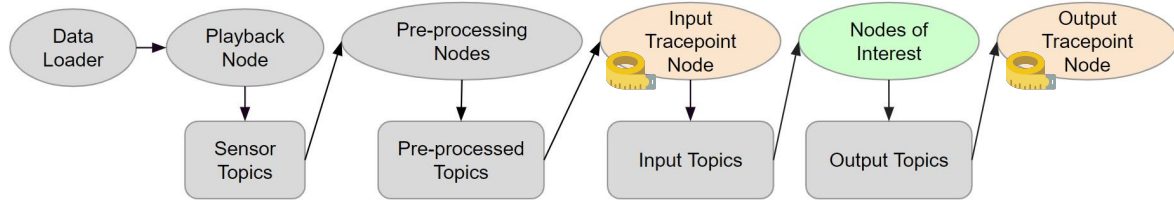


**Grey Box Testing**

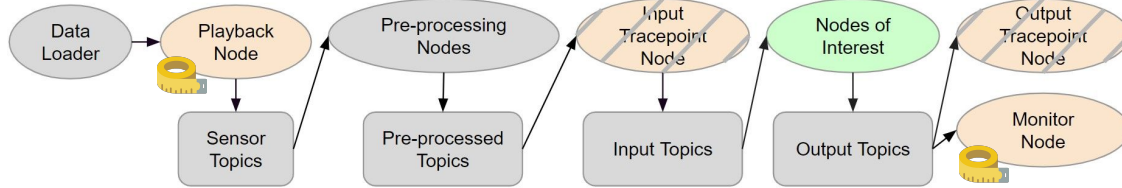


**Black Box Testing**

# Methodology Types



**Grey Box Testing**



**Black Box Testing**

Tracing Granularity

Valid Tracer

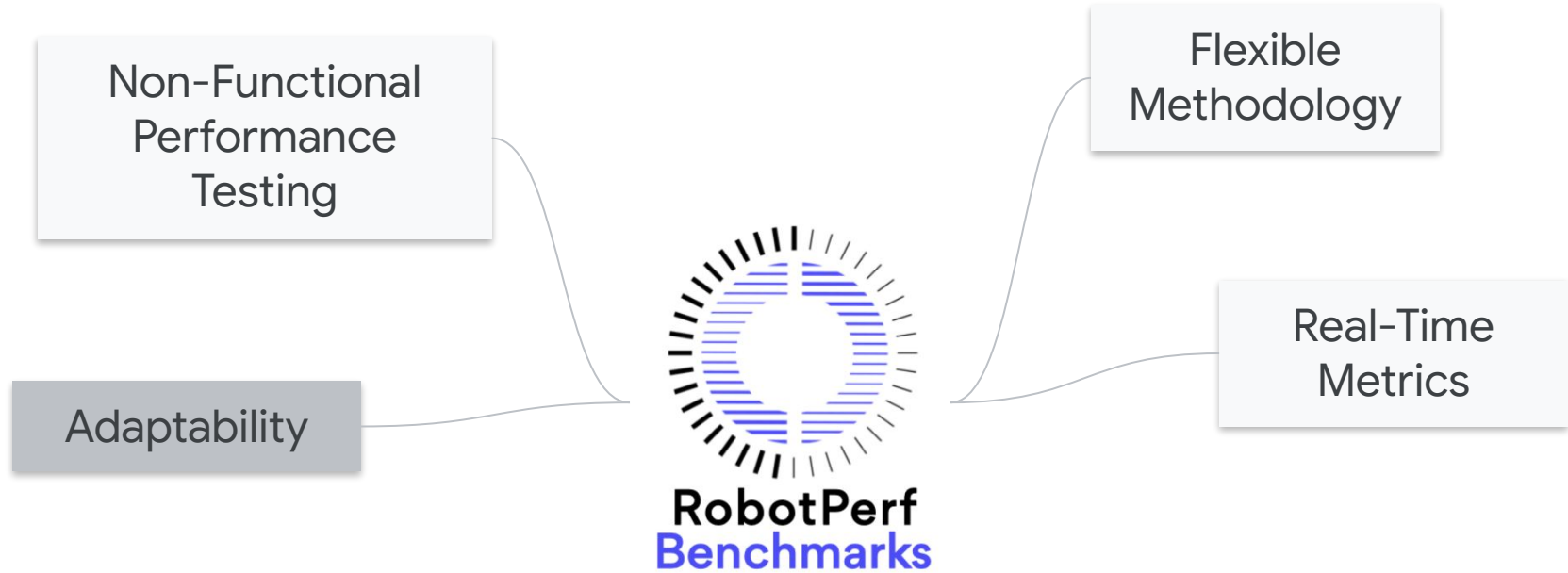
Event Types

Code Modification

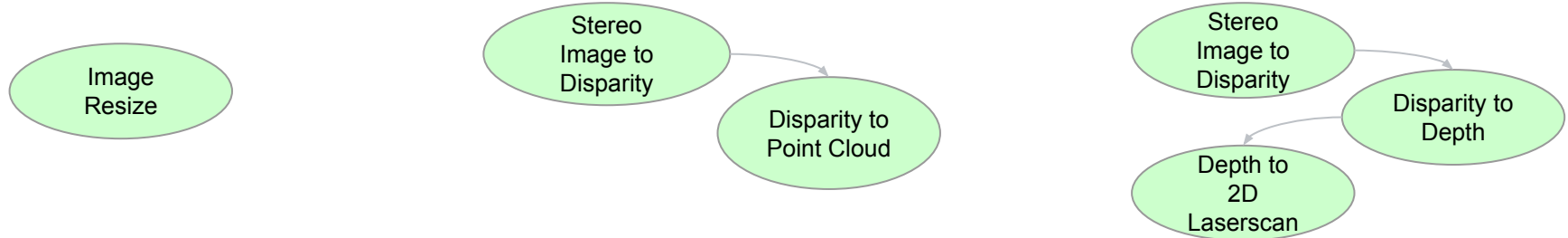
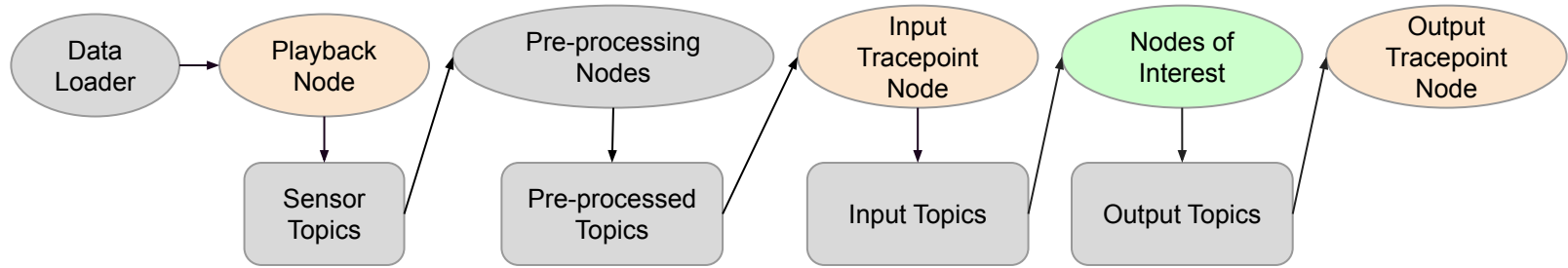
Standard ROS 2 APIs

Post-Processing

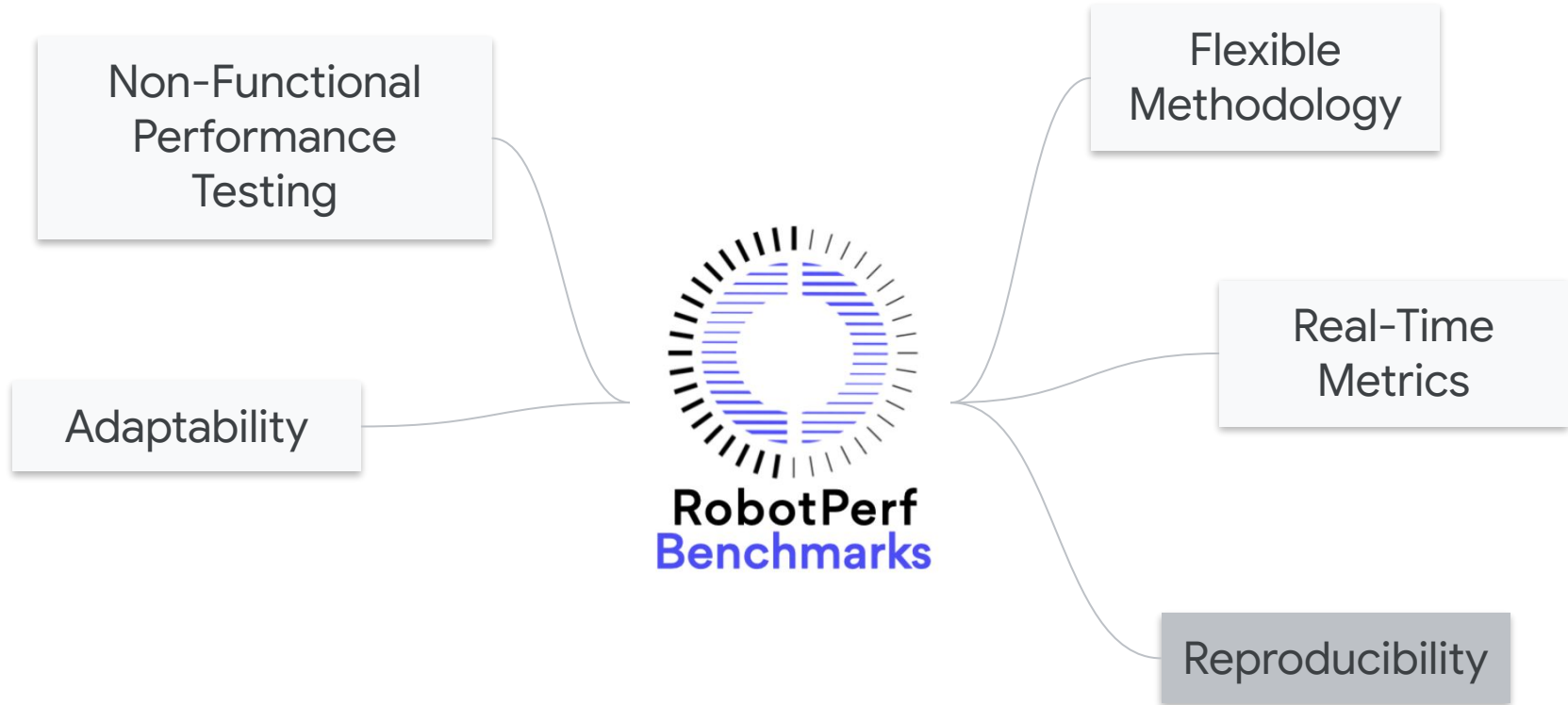
# RobotPerf Principles



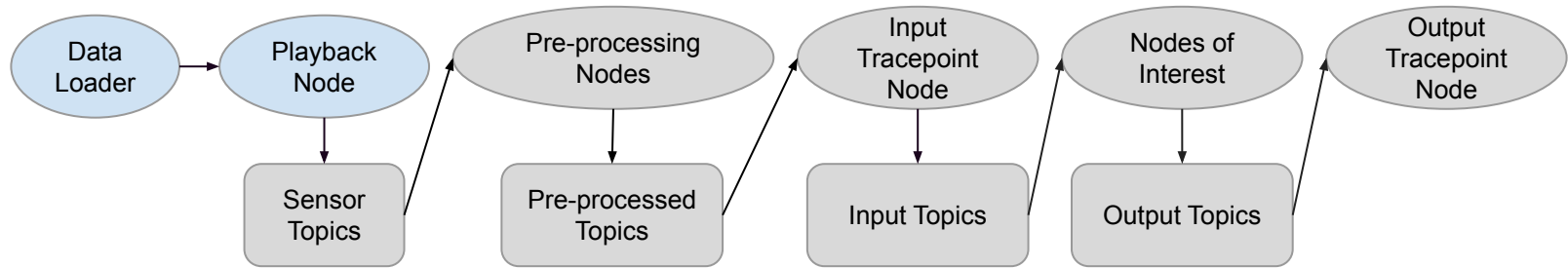
# Adaptability



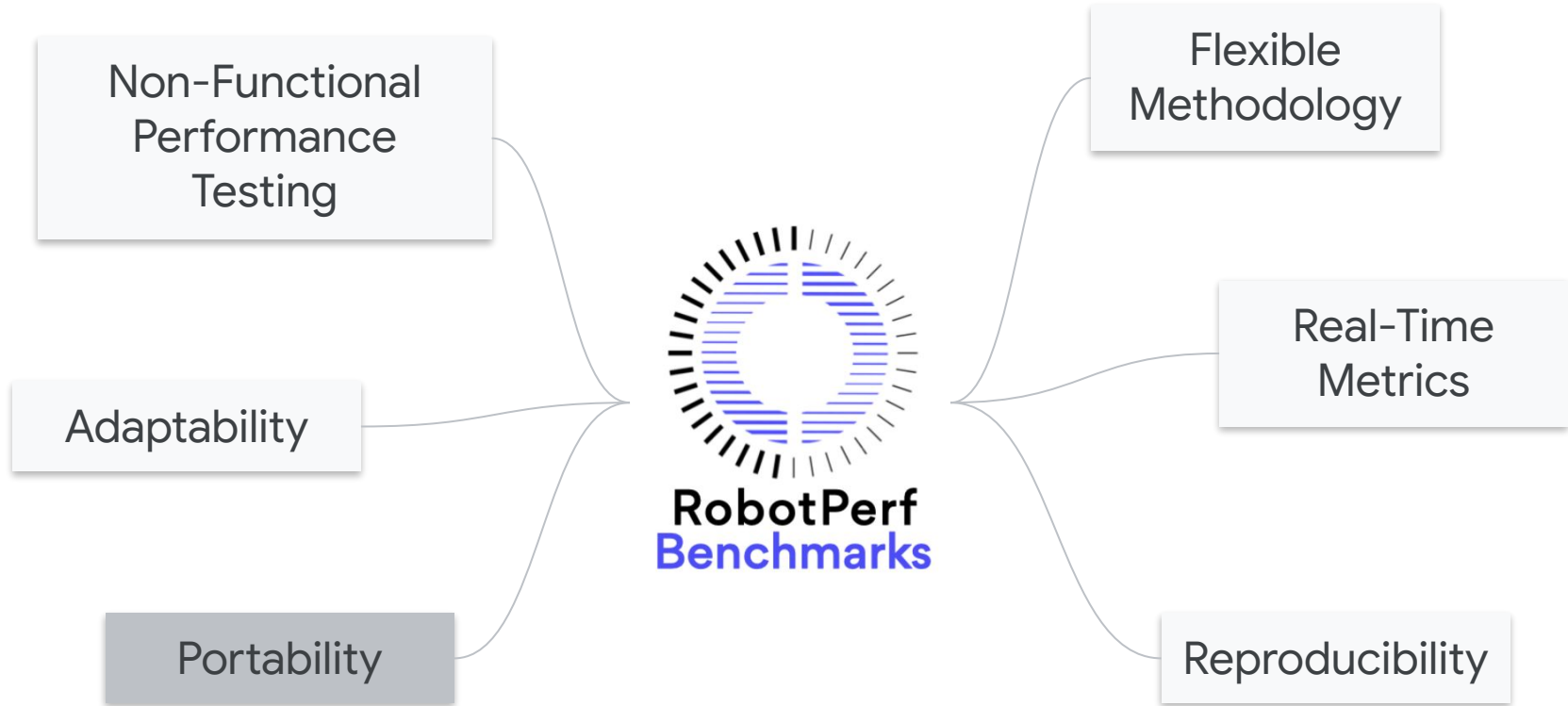
# RobotPerf Principles



# Reproducibility



# RobotPerf Principles

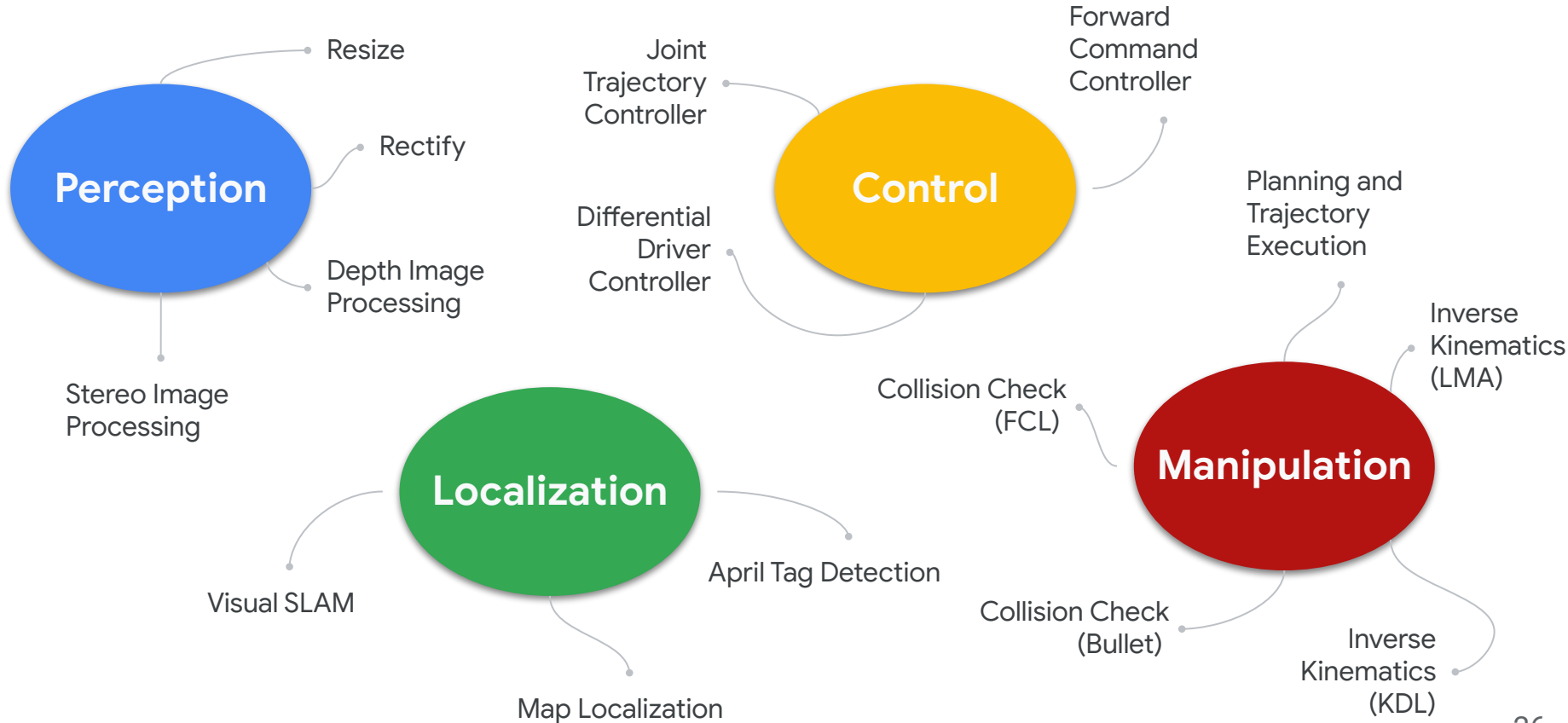






# RobotPerf Results

# Benchmarks



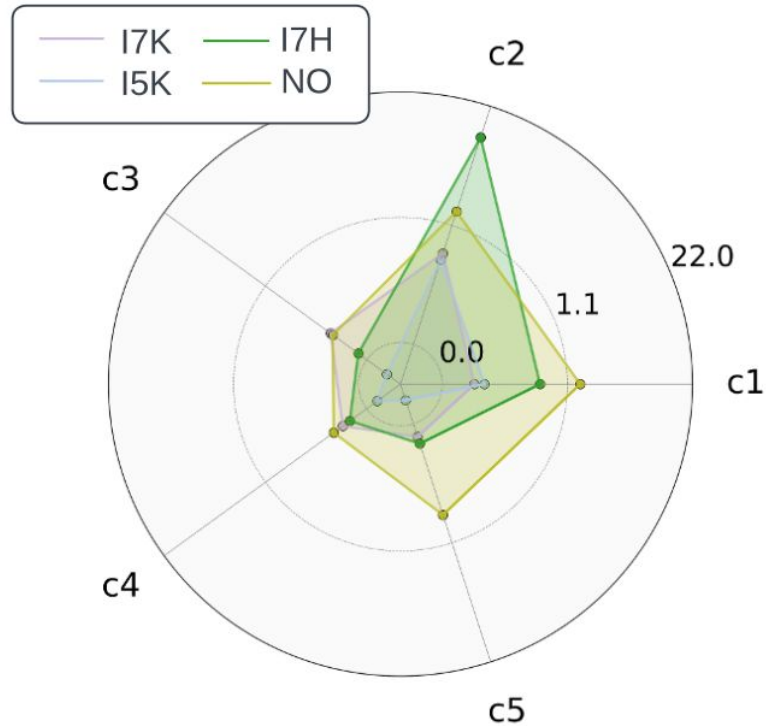
# Takeaways

Quantitative Approach to  
Hardware Selection

Representative Assessment of  
Heterogeneous Hardware

Assessment of Acceleration  
Benefits

# Hardware Selection



- [NO] (60W) NVIDIA AGX Orin Dev. Kit
- [I7K] (95W) Intel i7-8700K
- [I7H] (125W) Intel i7-12700H
- [I5K] (125W) Intel i5-13600K

# Representative Assessment

- [I5U] (15W) Intel i5-8250U
- [AR] (65W) AMD Ryzen 5 PRO 4650G
- [I7K] (95W) Intel i7-8700K
- [I7H] (125W) Intel i7-12700H
- [I5K] (125W) Intel i5-13600K
- [I9K] (125W) Intel i9-12900KF

## General-Purpose Hardware

- [NN] (5W) NVIDIA Jetson Nano
- [QR] (5W) Qualcomm RB5 Robotics Kit
- [JX] (30W) Jetson AGX Xavier
- [NO] (60W) NVIDIA AGX Orin Dev. Kit
- [I7N] (295W) Intel i7-12700H + NVIDIA GeForce RTX 3060

## Heterogeneous Hardware

- [KK] (15W) Kria KR260
- [KV] (36W) Kria KV260

## Reconfigurable Hardware

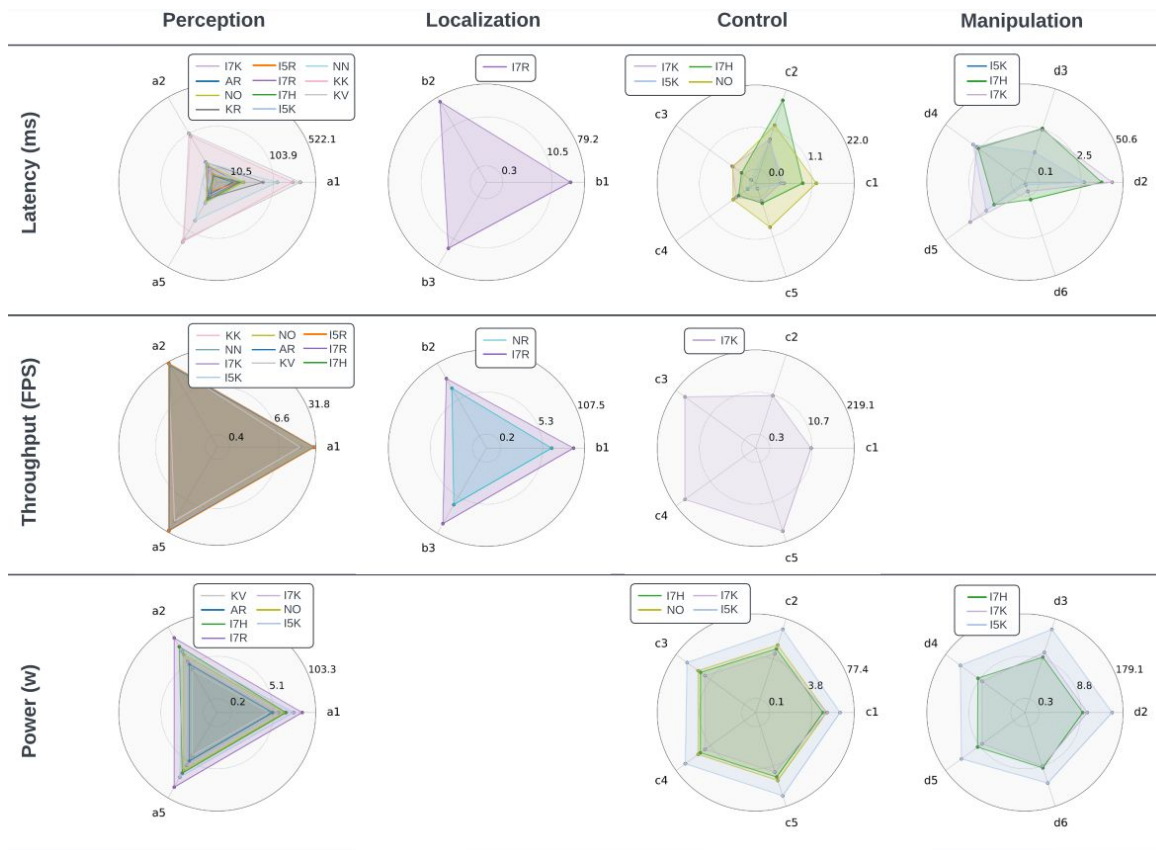
- [KR] (35W) Kria KR260 (ROBOTCORE® Perception)
- [NR] (80W) NVIDIA AGX Orin Dev. Kit (ROBOTCORE® Perception)
- [I7T] (145W) Intel i7-12700H (ROBOTCORE® Transforms)
- [I5R] (315W) Intel i5-13600K + NVIDIA GeForce RTX 3060 (ROBOTCORE® Perception)
- [I7R] (315W) Intel i7-12700H + NVIDIA GeForce RTX 3060 (ROBOTCORE® Perception)

## Accelerator Hardware

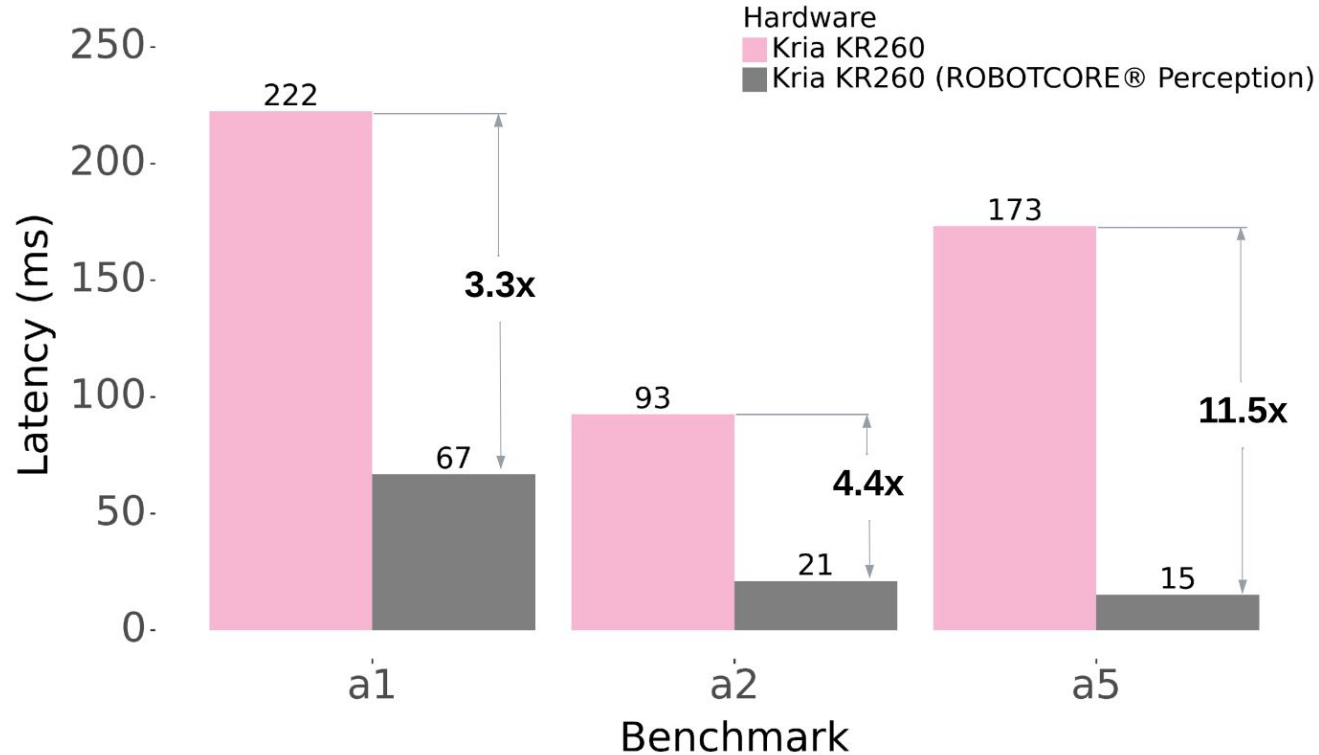
Grey Box

Black Box

# Representative Assessment



# Acceleration Benefits



# Join the Community!







Thanks!

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