# 사람, 공간, 정보의 새로운 연결
## 로보틱스, 자율주행, AI

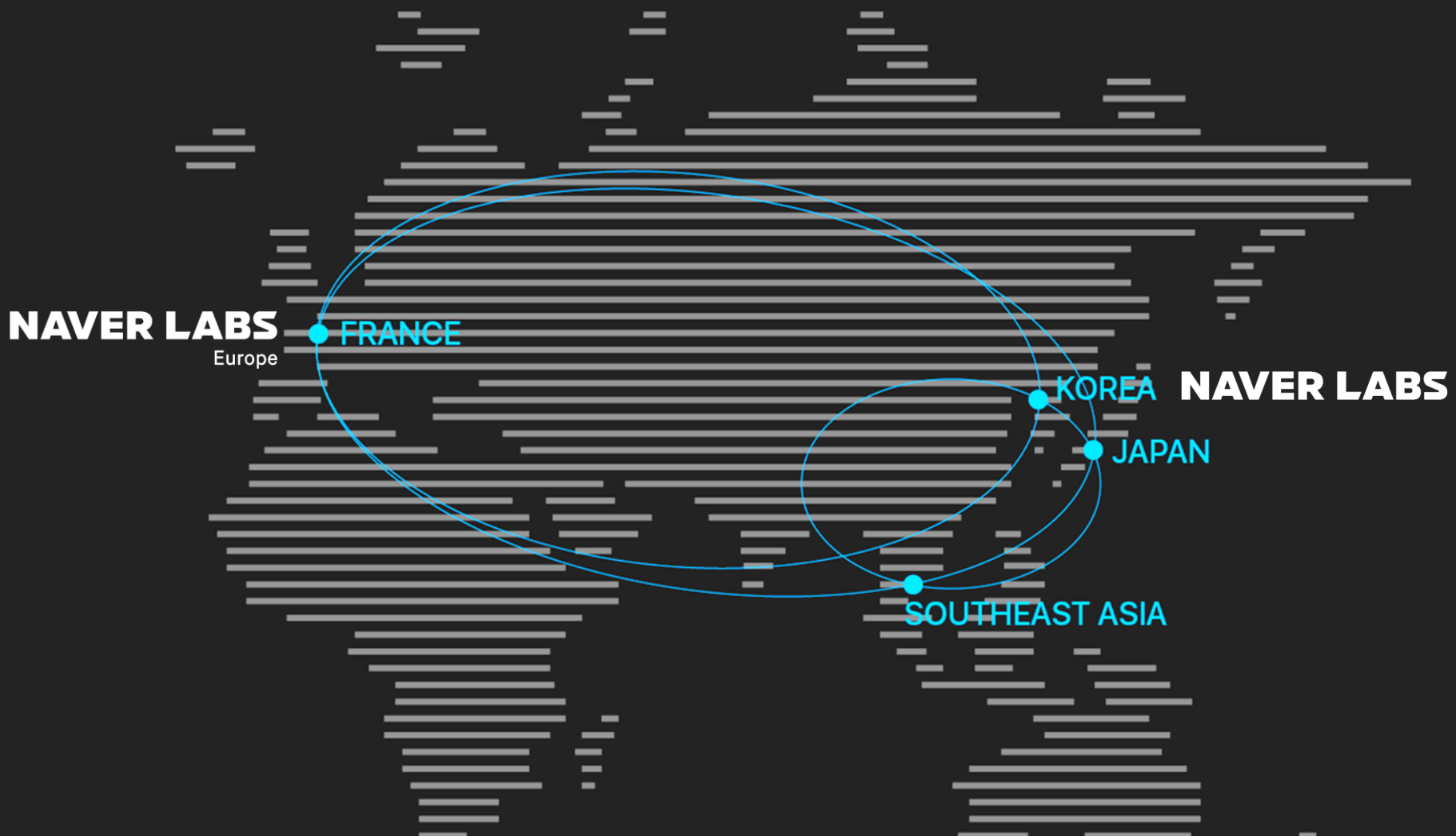
**석상옥**
네이버랩스 대표, 카이스트 기계공학과 겸직교수

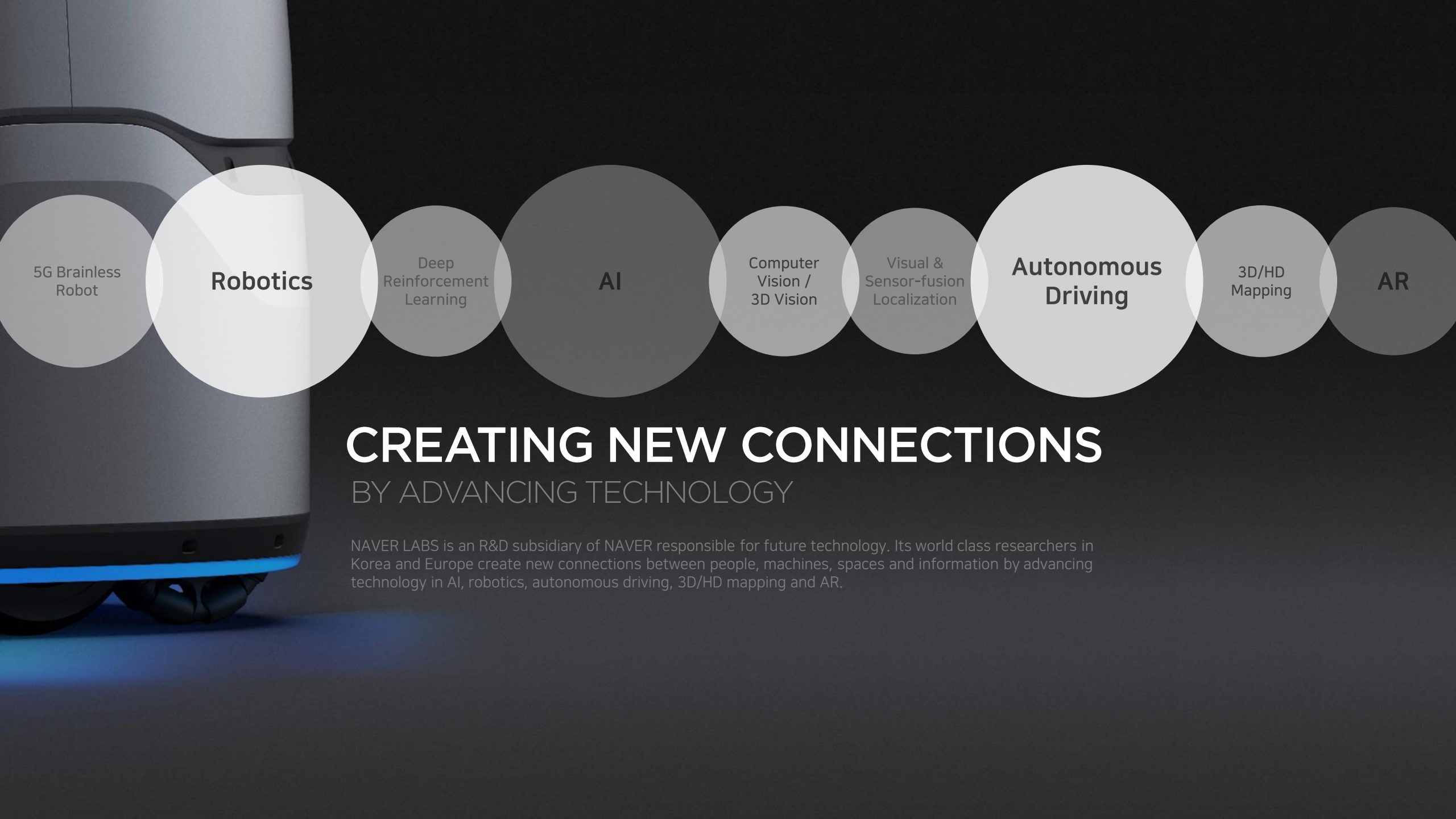


NAVER LABS


NAVER LABS

# Global AI R&D Belt






# CREATING NEW CONNECTIONS

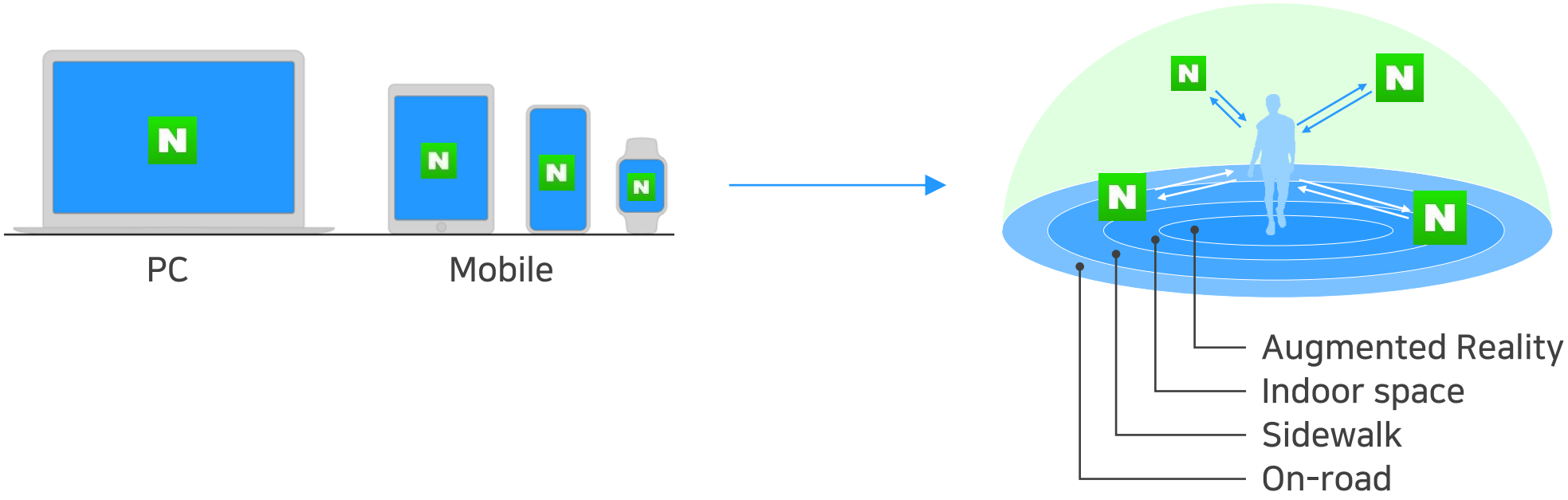
## BY ADVANCING TECHNOLOGY

NAVER LABS is an R&D subsidiary of NAVER responsible for future technology. Its world class researchers in Korea and Europe create new connections between people, machines, spaces and information by advancing technology in AI, robotics, autonomous driving, 3D/HD mapping and AR.

# connect **NAVER** to **PHYSICAL WORLD**

**High performance sensors, AI, robots, and autonomous driving technologies are approaching a critical point of popularization, tearing down the barrier between physical and virtual spaces.**

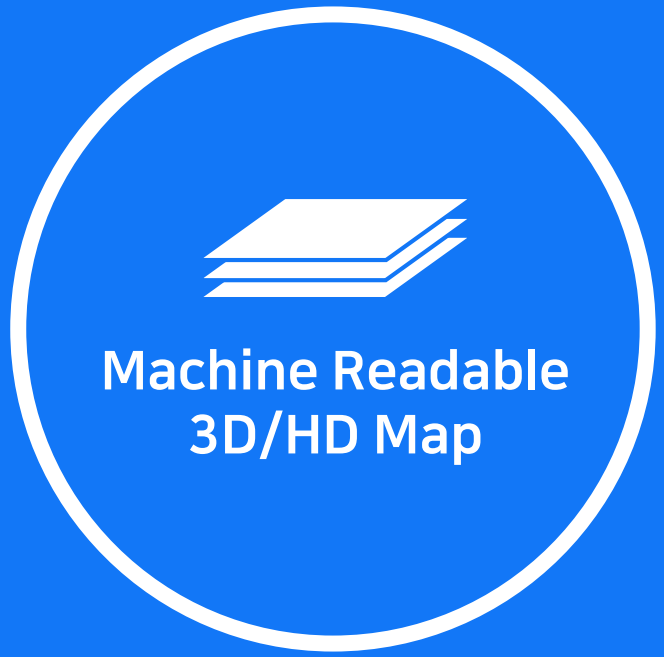
Even with the continuation of NAVER's core business of connecting information and services,
its aspects, channels and even methods will be rapidly redefined.
As such, our current endeavor is putting forward the core technologies
and differentiated platforms, and developing/procuring them.



# 지도, 문자보다 오래된 정보의 그릇


5. ISLAND
6 miles between
4. ISLAND
6 miles between
6. ISLAND
3. ISLAND
7. ISLAND
2. ISLAND
1. ISLAND
BITTER RIVER
BITTER
BITTER
BITTER
MOUNTAIN
CITY
ARMENIA
HABRAN
BABYLON
ASSYRIA
CITY
BIT JAKINU
WATERSTREAM MARSH
BITTER
CITY
DERI

# 1st Step, Mapping




Localization

Path Planning

# Roadmap

Seamless 3D/HD Spatial Data
(indoor, outdoor & on-road)

Autonomous & Intelligent
Machine Platform

Natural Human-machine
Interaction

# M1

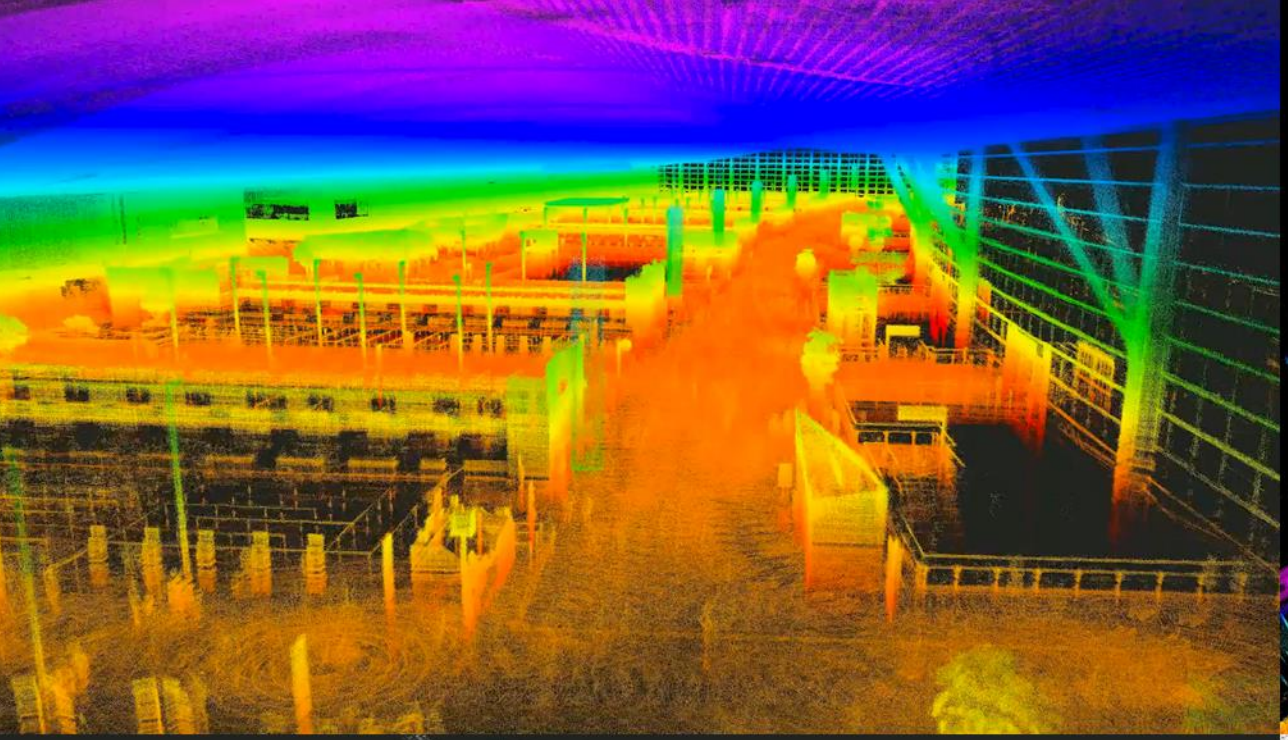
Indoor 3D/HD Mapping Robot

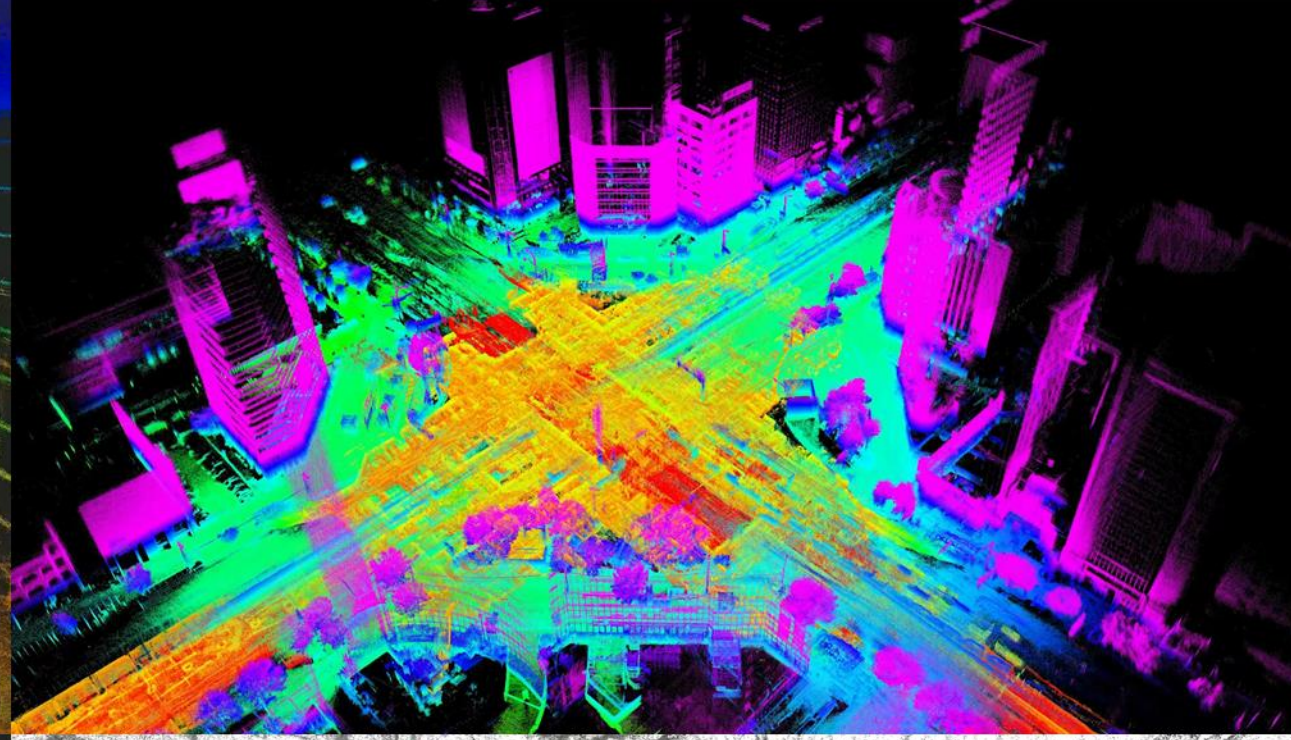
# M1 & COMET

Indoor, single-story space → Stair, Sidewalk, Outdoor, etc.

<M1/M1X>

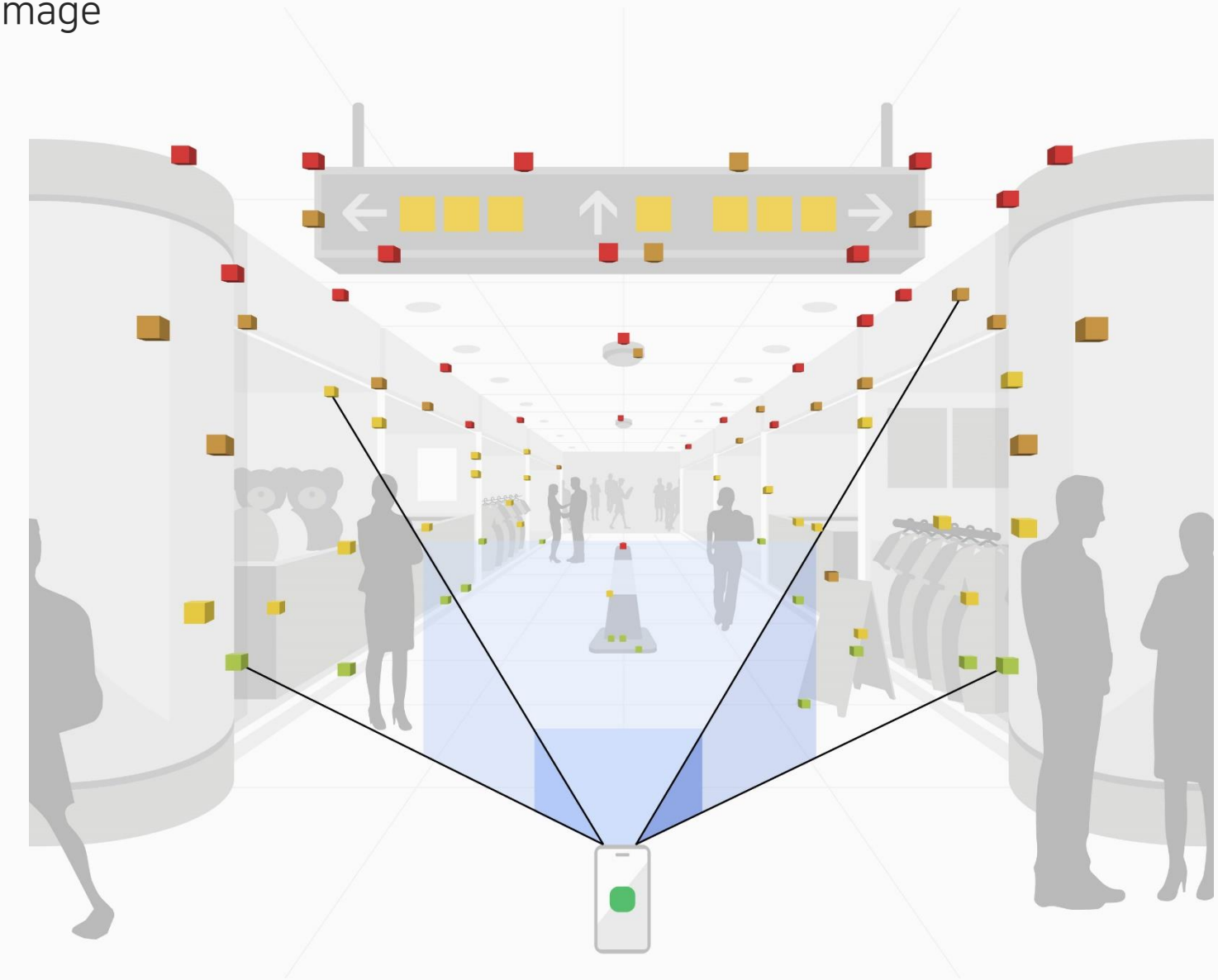
<COMET>



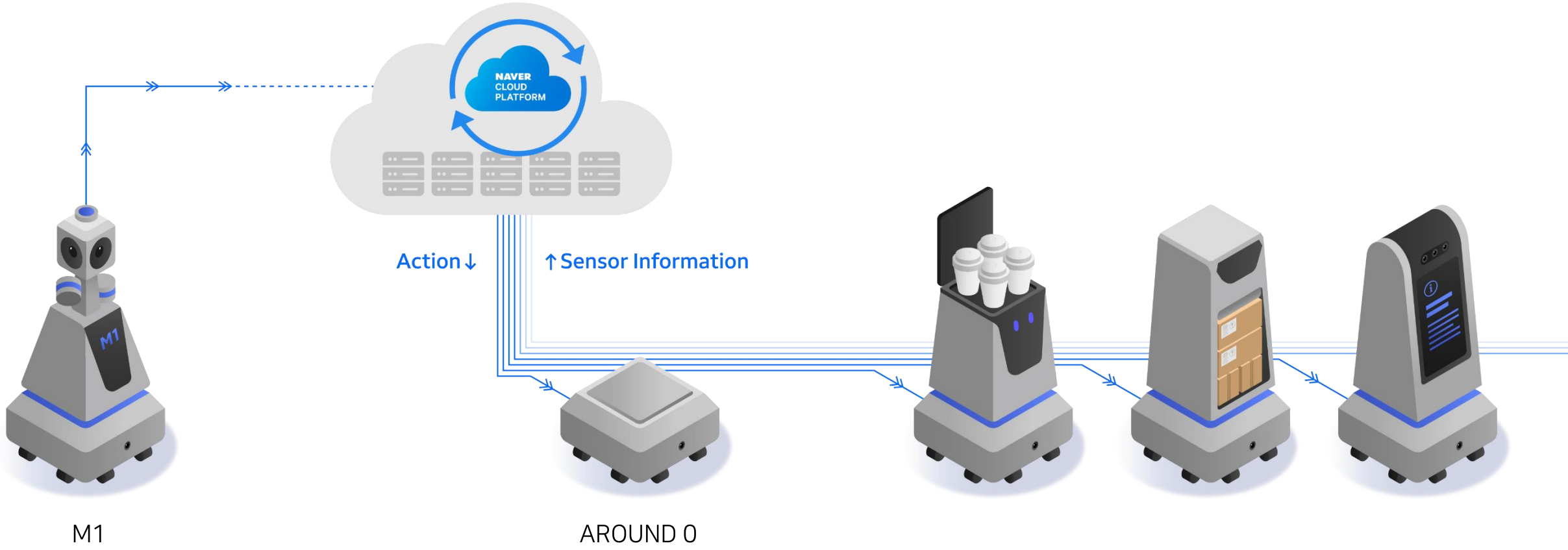


# Visual Localization

Finding location by image



# Map Cloud → AROUND Platform



# No Laser Scanner

2017 | 2018 | 2019

Cheap LiDAR → No LiDAR

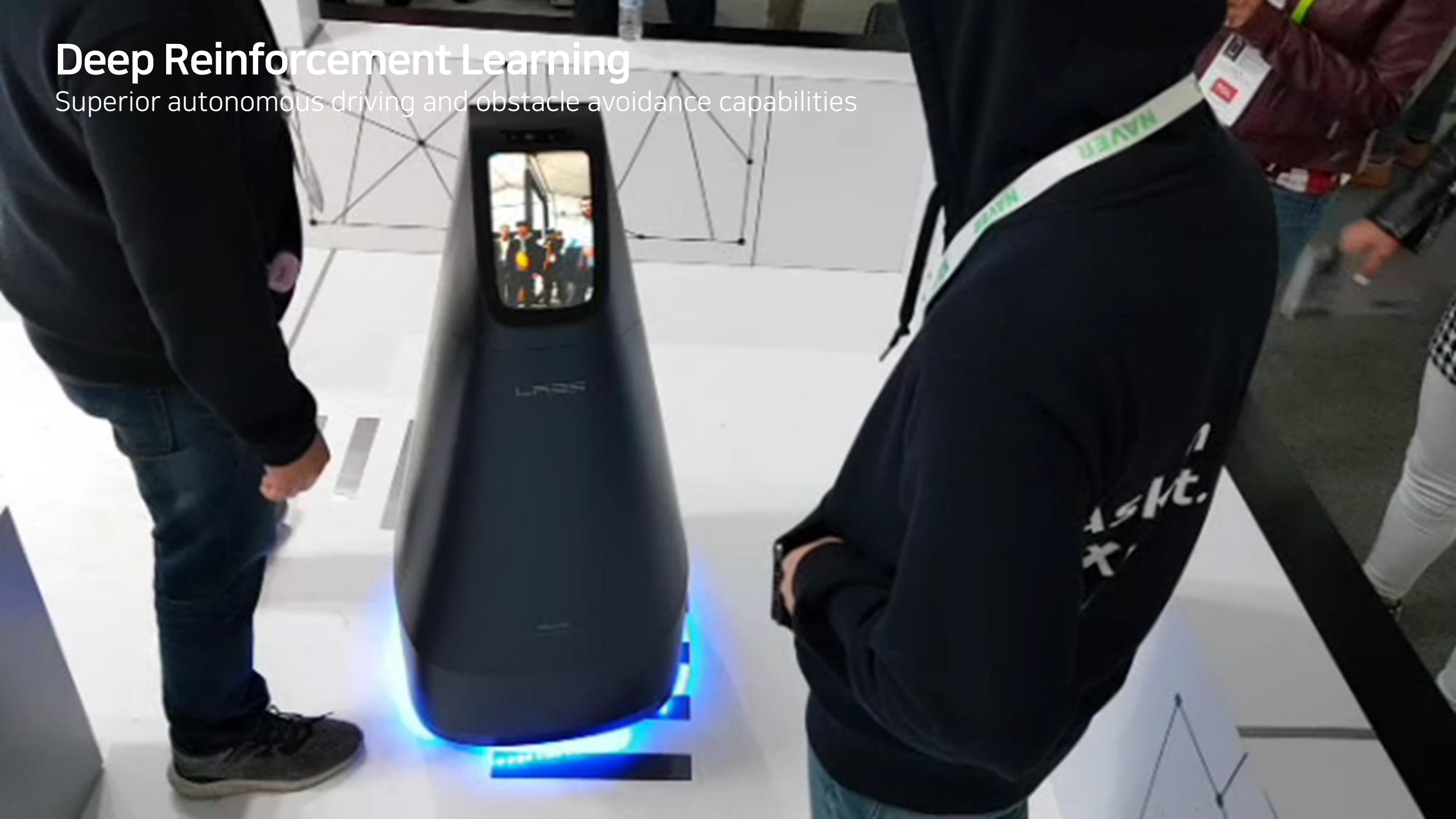

**AROUND** B
Book Delivery Robot


**AROUND** G
Guide Robot with AR Navigation


**AROUND** C
Café Delivery Robot

# Deep Reinforcement Learning

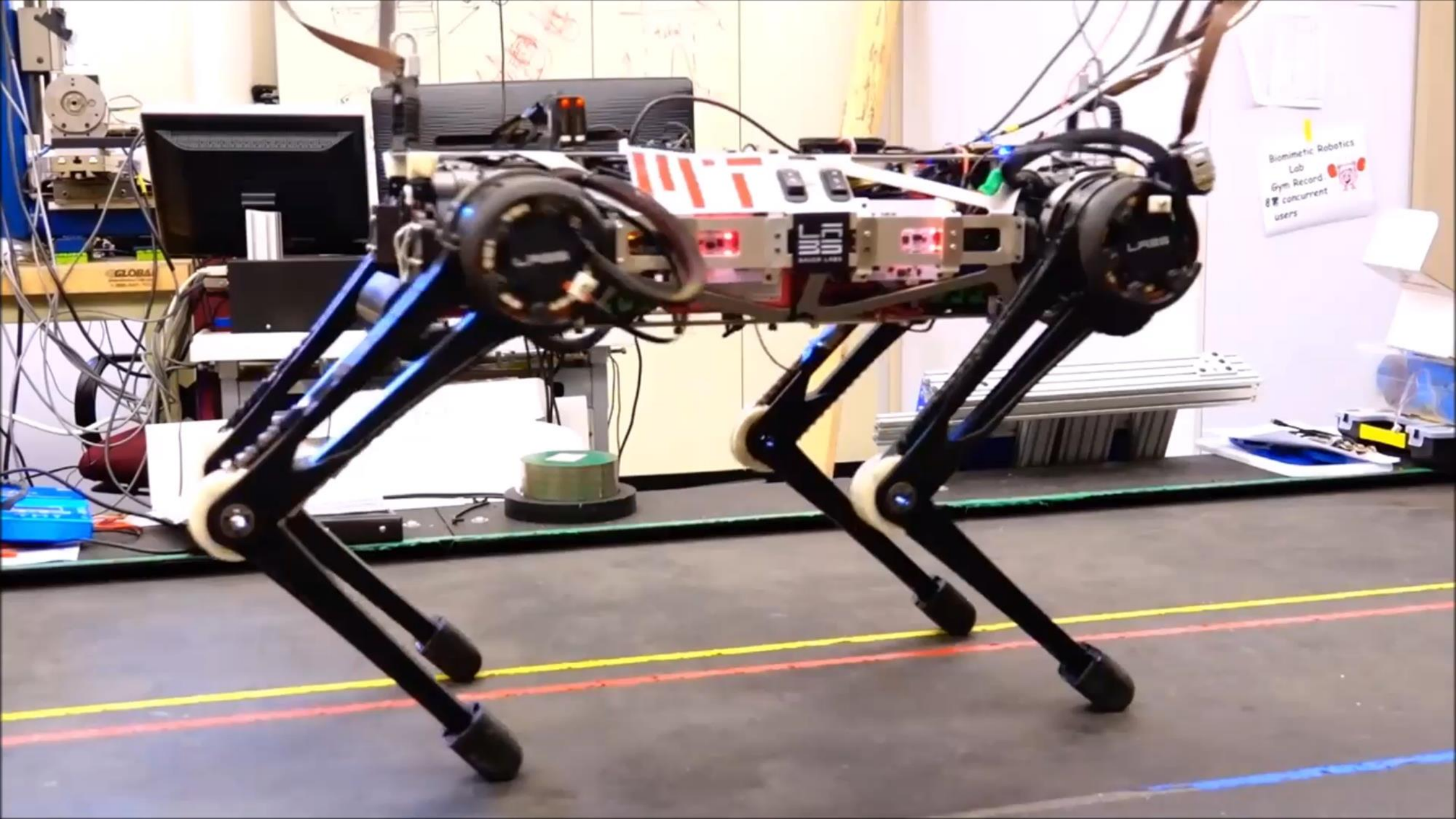
Superior autonomous driving and obstacle avoidance capabilities



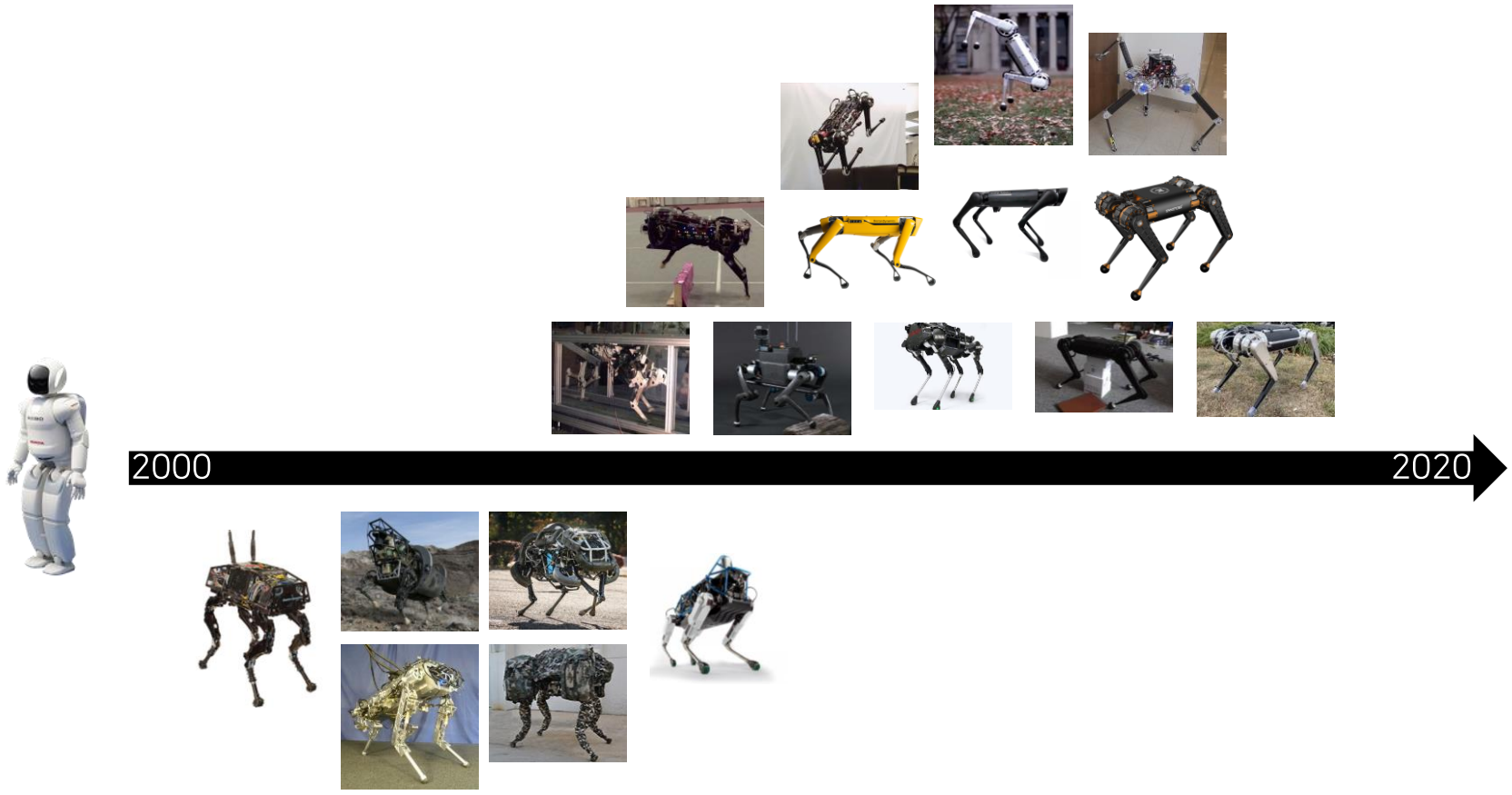
# Wheel-based 로봇의 한계는

**Indoor**
휠베이스 로봇

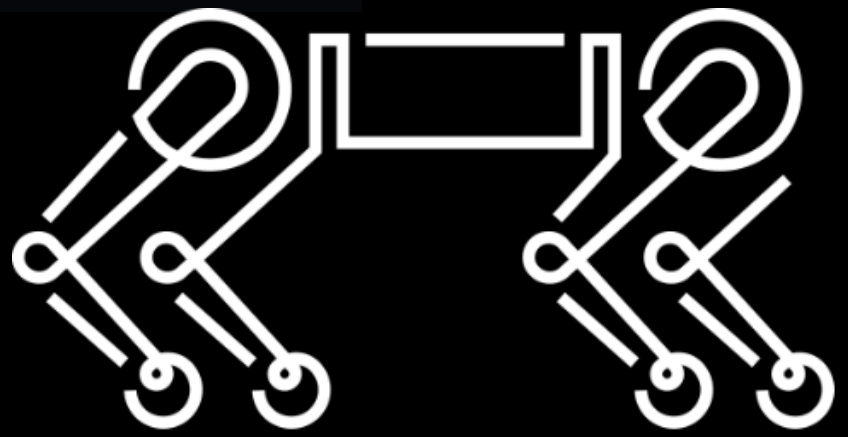
**Sidewalk**
4족 보행 로봇


Biomimetic Robotics
Lab
Gym Record
8 concurrent
users

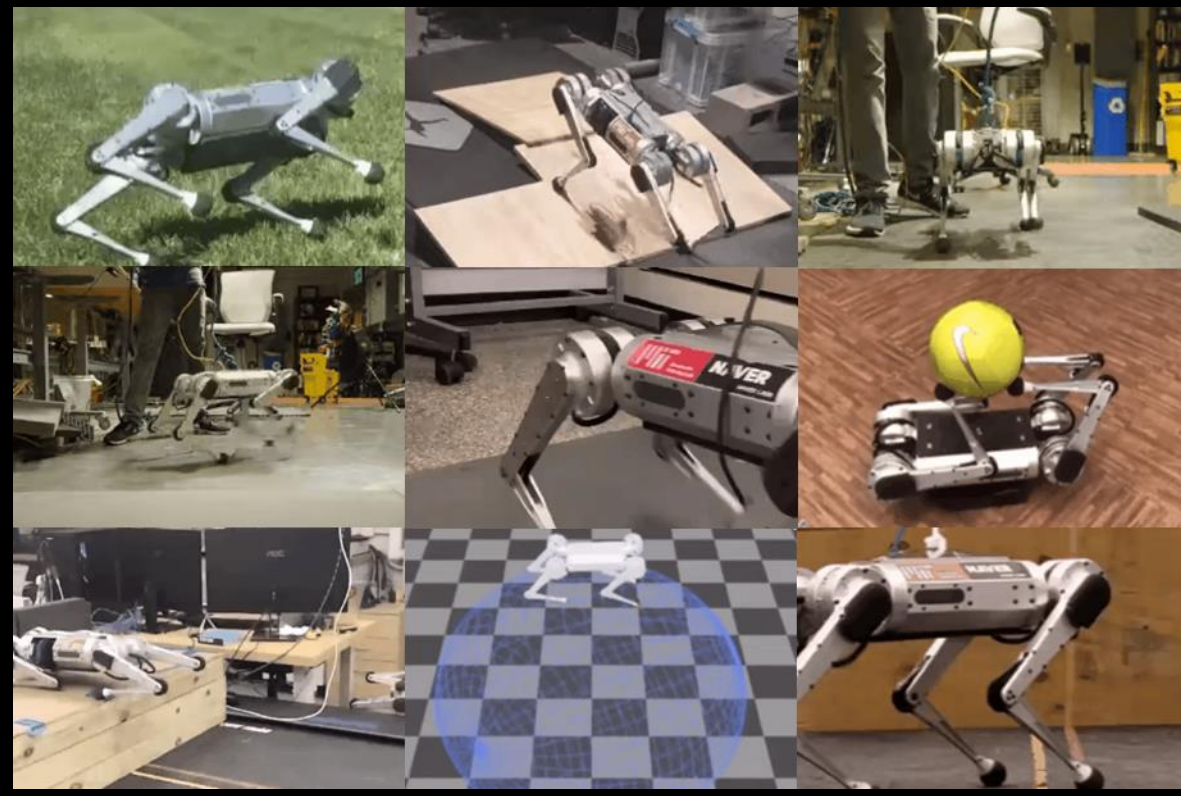
# Proprioceptive actuator - Paradigm shift



Biomimetic Robotics Lab | NAVER LABS



# MIT Mini-Cheetah Workshop @IROS 2020



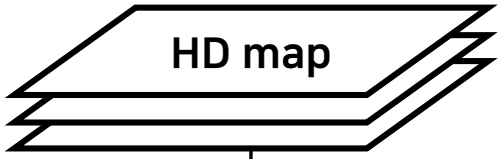
# 도로 또한 로봇의 영역

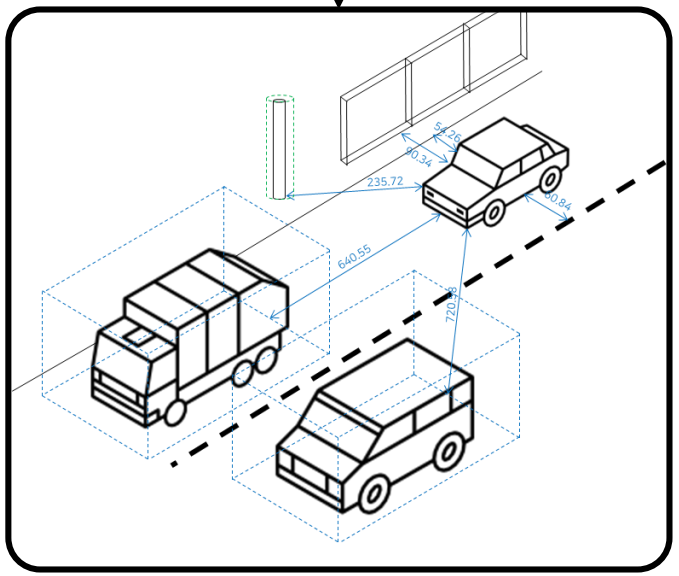
**Indoor**
휠베이스 로봇

**Sidewalk**
4족 보행 로봇

**On the Road**
도로 자율주행 로봇

# HD Map, 도로 자율주행을 위한 핵심데이터이자 제2의 센서



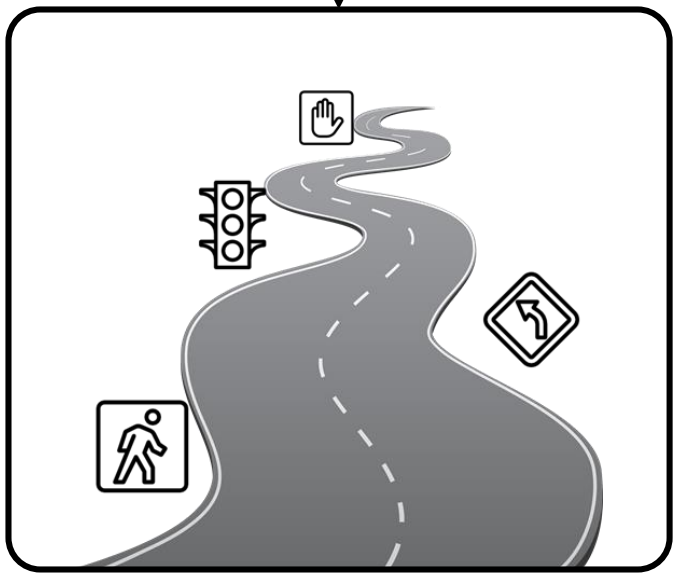




## Precise Localization

More precise localization
achieved via HD maps

## Global Route Planning

More effective route planning
in complex city centers



## Perception

Advance prediction of key recognition
objects using HD map data

# 실내 vs 도로

도로에서 HD맵이 더욱 중요한 이유

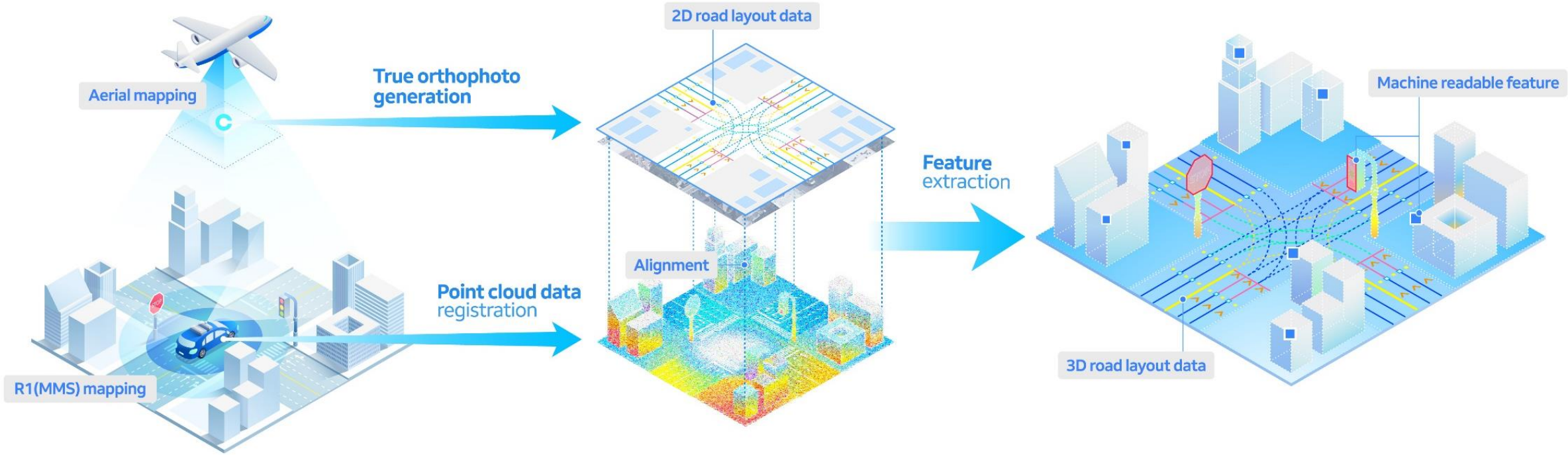
**실내 자율주행 로봇**


- ✓ 빌딩, 지하터널 등의 환경
- ✓ 이동 속도의 차이
- ✓ 비상시 취할 수 있는 옵션
- ✓ 비상시 초래할 결과의 크기

**도로 자율주행 로봇**

# 항공사진 기반 3D/HD 매핑

독자적인 Hybrid HD Mapping 기술

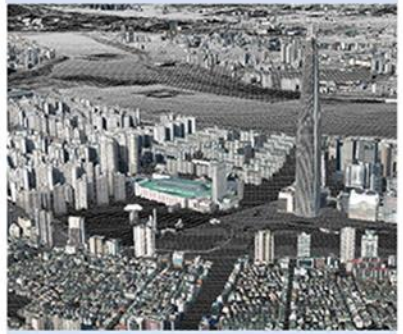


# 도시 단위의 정밀 매핑

서울시/성남시 등과의 지속적 협력

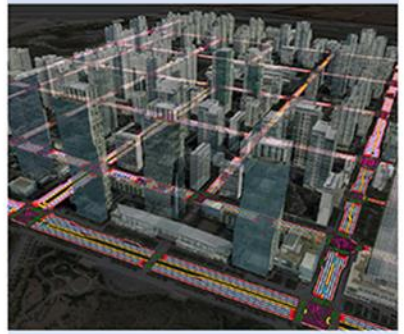
항공사진측량 → Trueortho 기반 도화 → MMS 데이터 결합

### 3D 모델링 지도



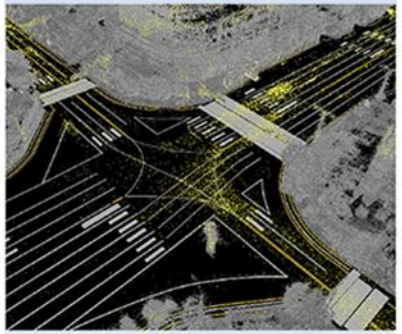
AR 및 도시 계획용 시뮬레이터등에
활용할 수 있는 3D 공간 데이터

### 로드 레이아웃 지도



차선단위 길안내, ADAS 등에
활용되는 차선 구조 및 노면기호 정보

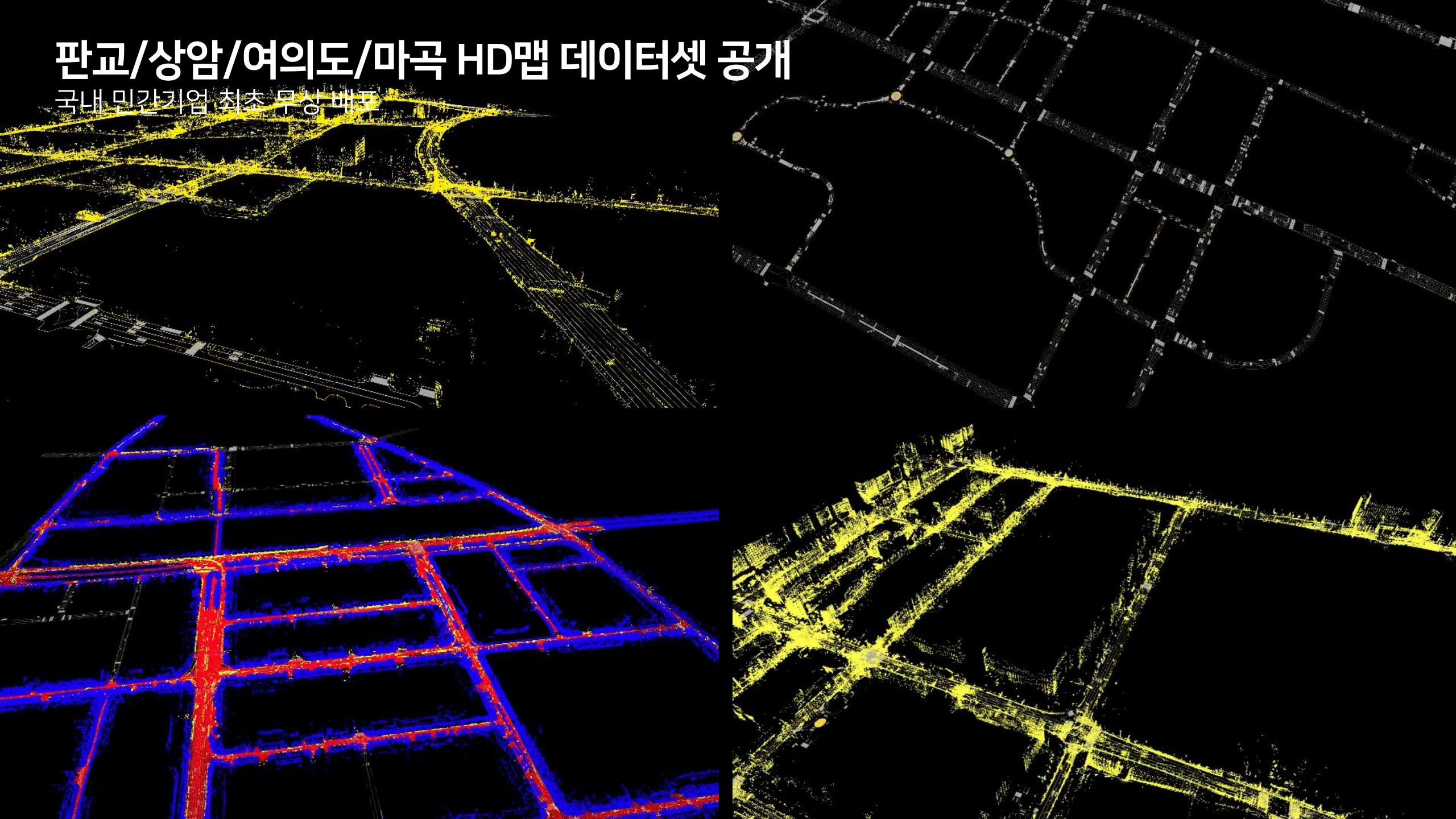
### HD맵



자율주행을 위한 핵심 데이터

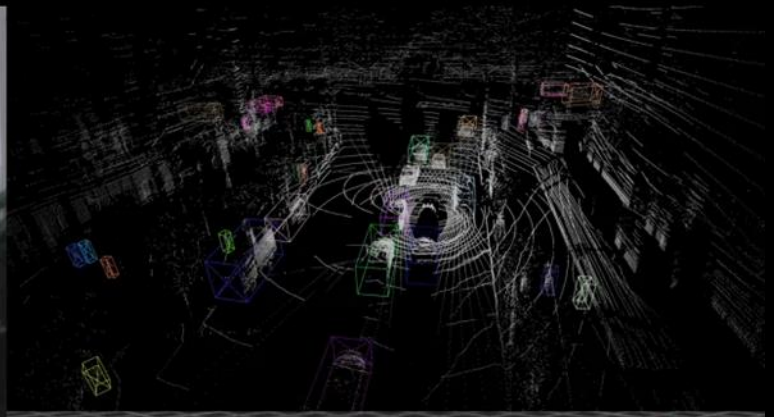
# 판교/상암/여의도/마곡 HD맵 데이터셋 공개

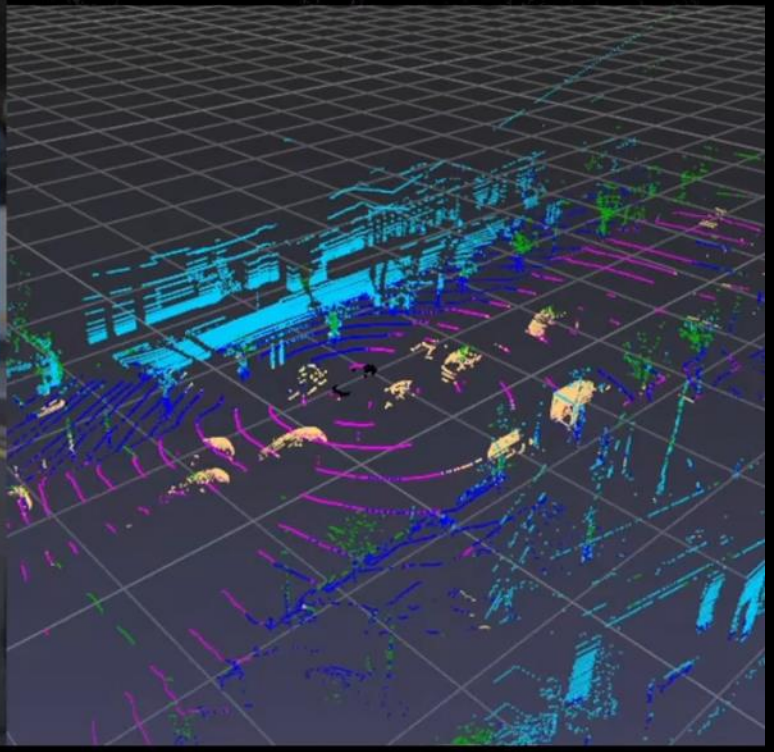
국내 민간기업 최초 무상 배포



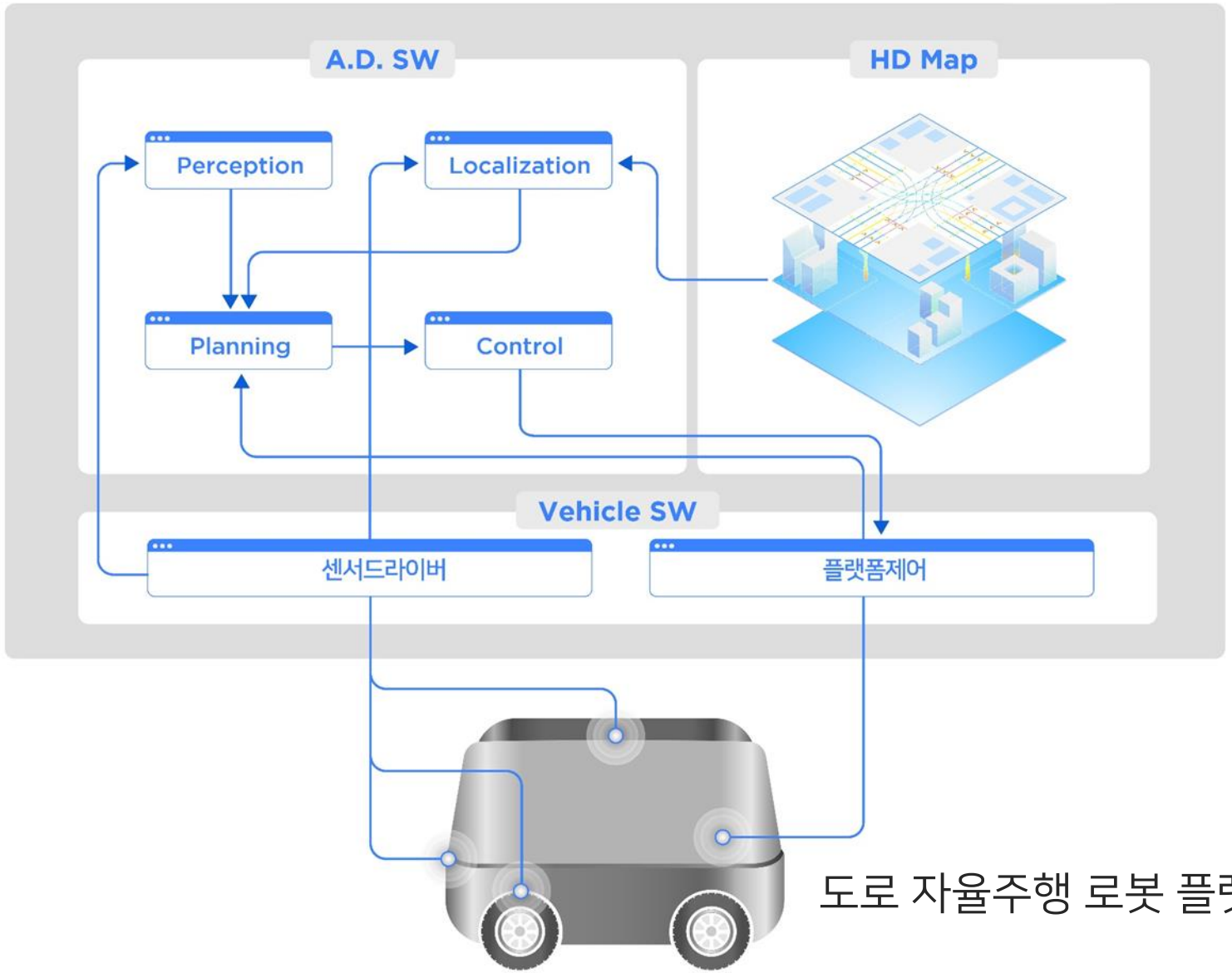
# Perception

Camera / RADAR / LIDAR / HD Map / Sensor Fusion

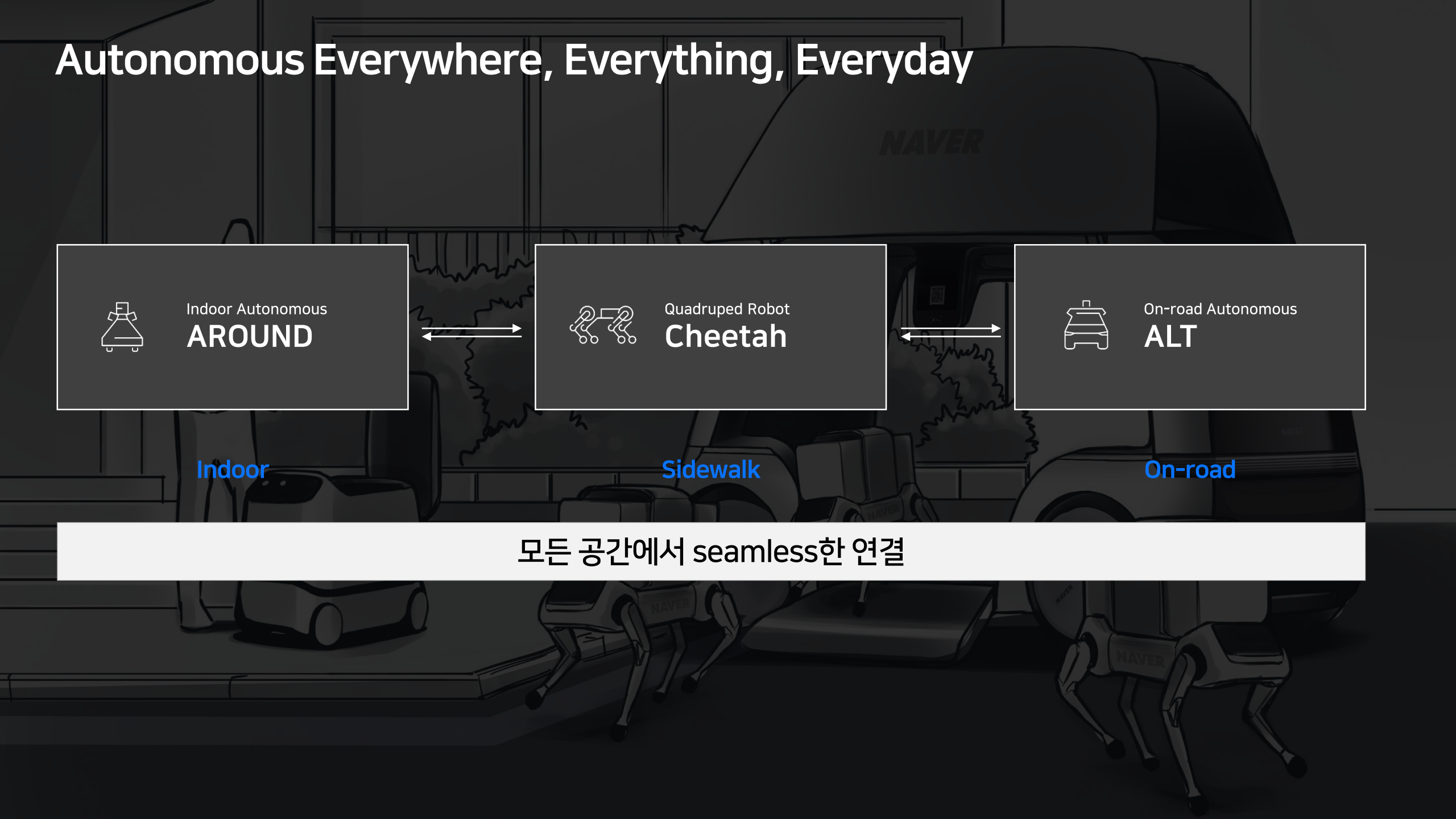


# Full Spectrum of Autonomous Driving



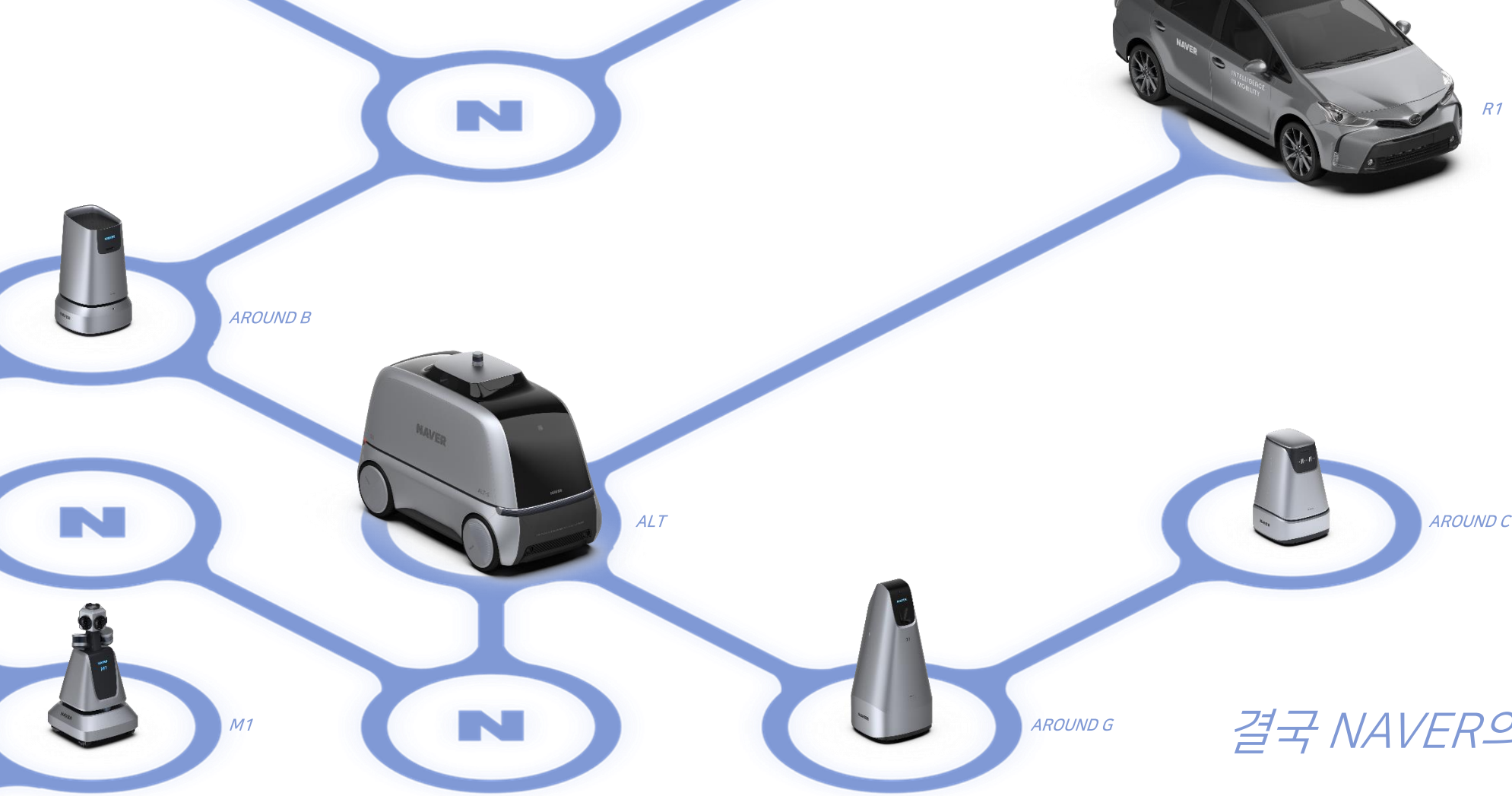

도로 자율주행 로봇 플랫폼, **ALT**

# Autonomous Everywhere, Everything, Everyday



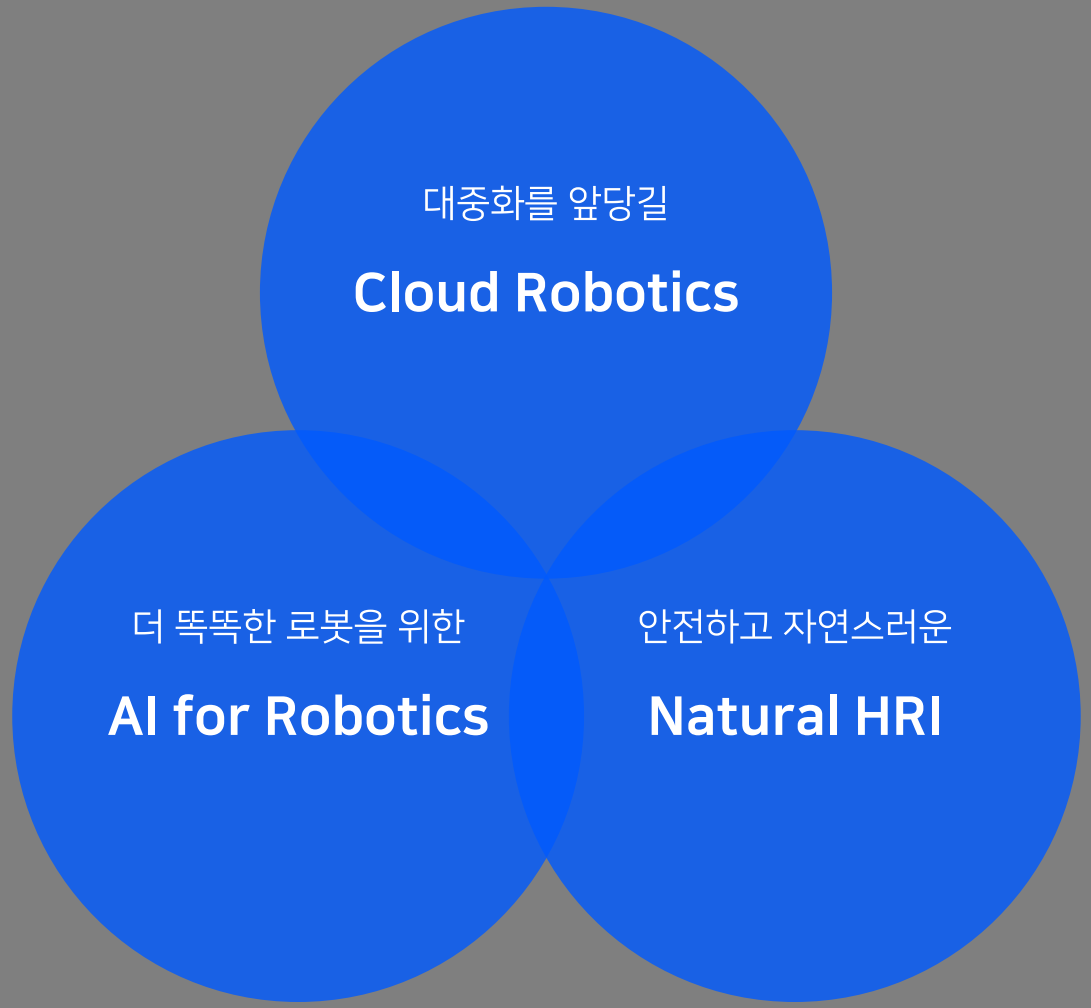

# A-CITY

Autonomous **Everywhere Everything Everyday**

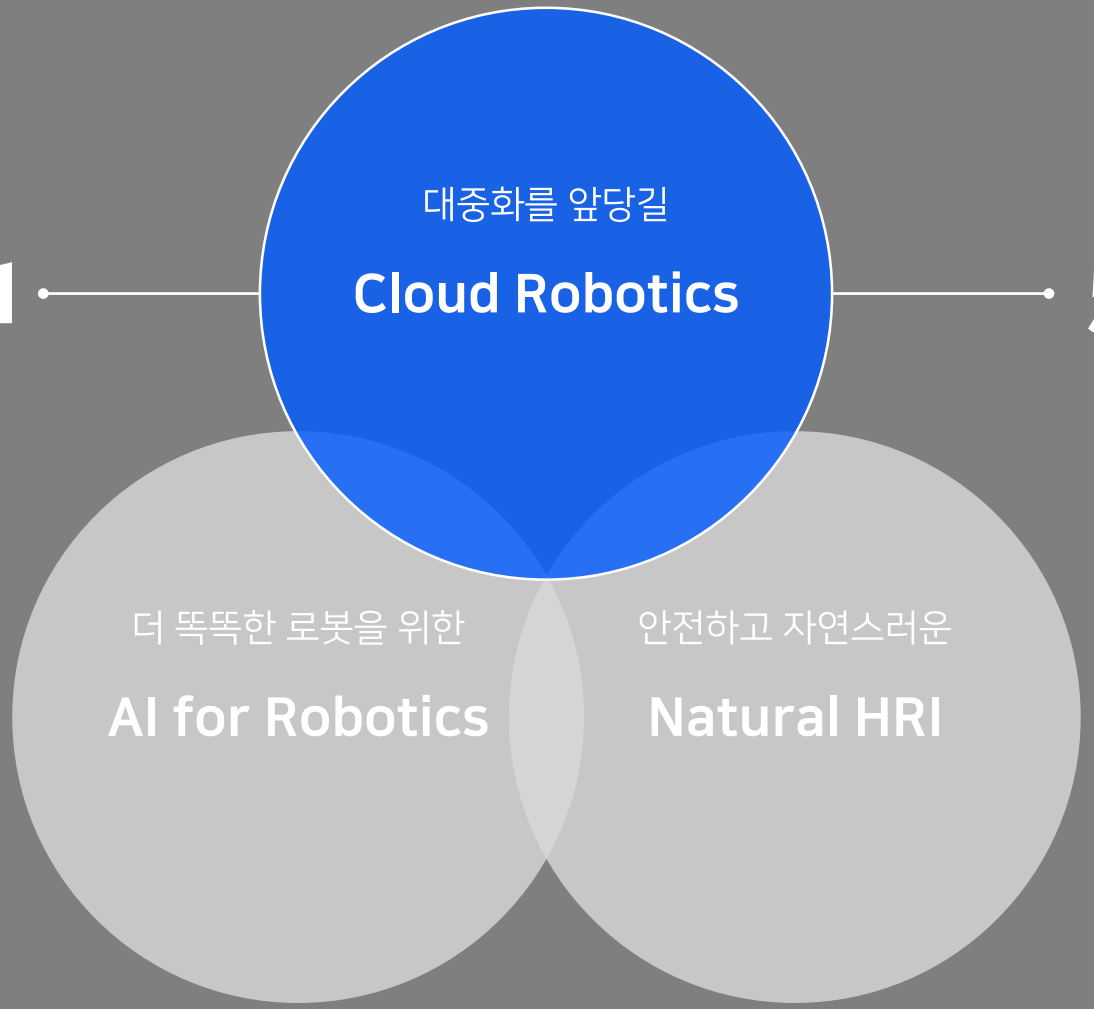



*결국 NAVER의 로봇은*

어떤 일상 공간에서든
**사람과 공존하기 위한 로봇**


대중화를 앞당길
Cloud Robotics
더 똑똑한 로봇을 위한
AI for Robotics
안전하고 자연스러운
Natural HRI

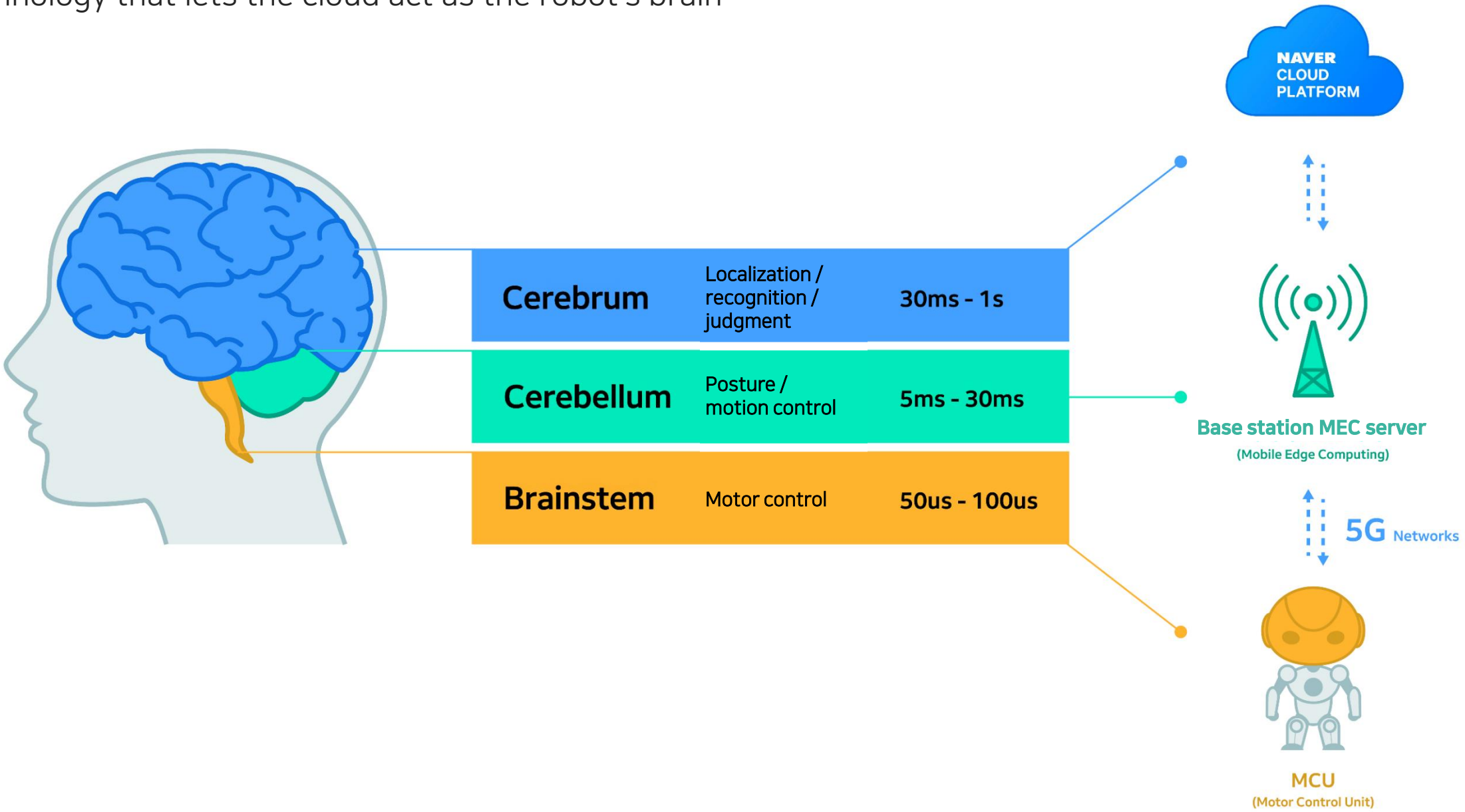
NAVER Cloud




5G networks

# 5G Brainless Robot

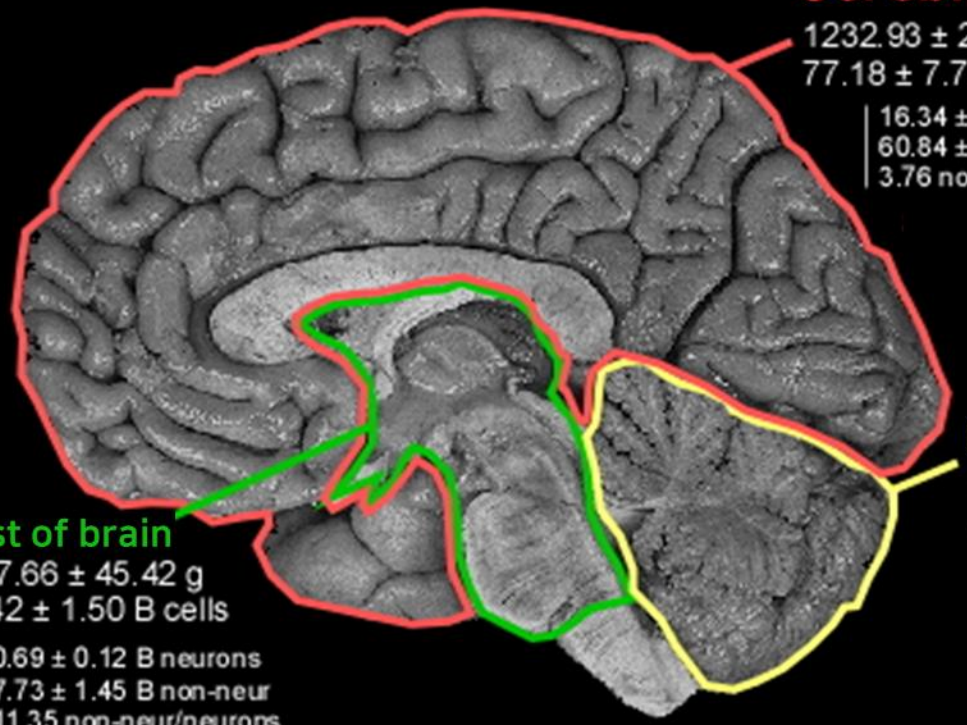
Technology that lets the cloud act as the robot's brain



## Whole Brain

1508.91 ± 299.14 g
170.68 ± 13.86 B cells

86.06 ± 8.12 B neurons
84.61 ± 9.83 B non-neur
0.99 non-neur/neurons



## Cerebral cortex (GM+WM)

1232.93 ± 233.68 g
77.18 ± 7.72 B cells

16.34 ± 2.17 B neurons
60.84 ± 7.02 B non-neur
3.76 non-neur/neurons

81.8% of brain mass

**19.0% of brain neurons**

## Cerebellum

154.02 ± 19.29 g
85.08 ± 6.92 B cells

69.03 ± 6.65 B neurons
16.04 ± 2.17 B non-neur
0.23 non-neur/neurons

10.3% of brain mass

**80.2% of brain neurons**

## Rest of brain

117.66 ± 45.42 g
8.42 ± 1.50 B cells

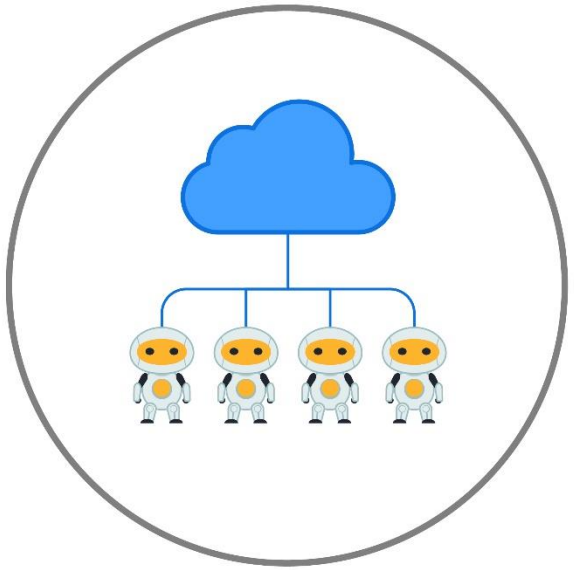
0.69 ± 0.12 B neurons
7.73 ± 1.45 B non-neur
11.35 non-neur/neurons

**7.8% of brain mass**
**0.8% of brain neurons**

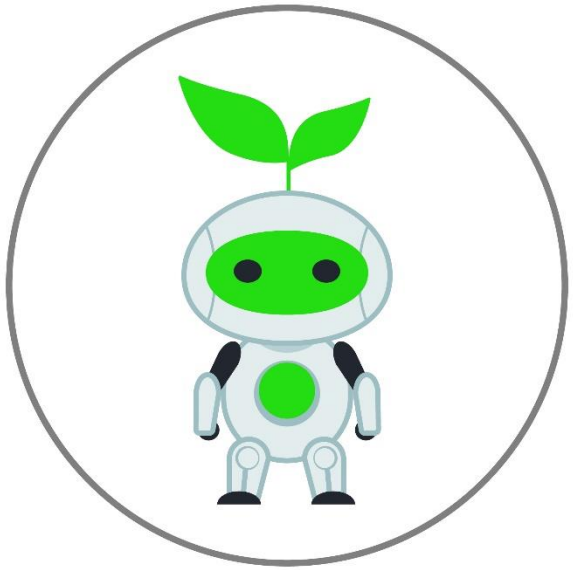
www.suzanaherculanohouzel.com/lab
modified from Azevedo et al., J Comp Neurol (2009)

# Advantages of the 5G brainless robot

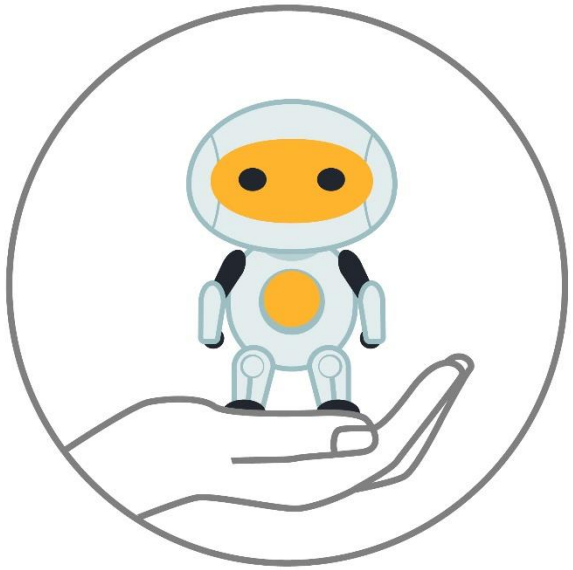
The primer for the popularization of service robots



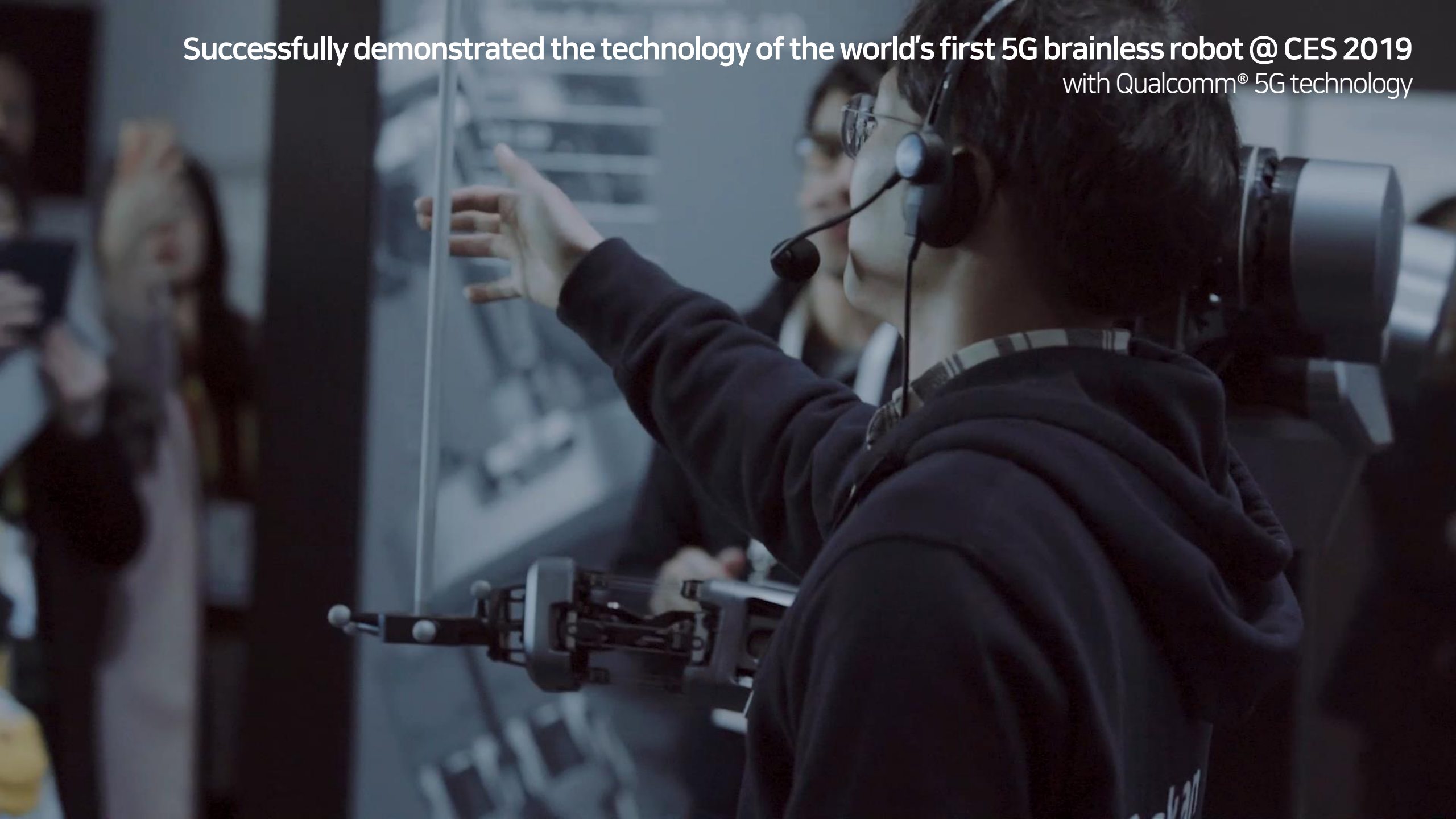
Cloud-based
**Multi-robot simultaneous control**



Connect externally to
high-performance processing power
**Reduce power consumption**



**High-performance,**
**high-precision control**
regardless of robot's physical size



# Successfully demonstrated the technology of the world's first 5G brainless robot @ CES 2019

with Qualcomm® 5G technology


NAVER
CLOUD PLATFORM

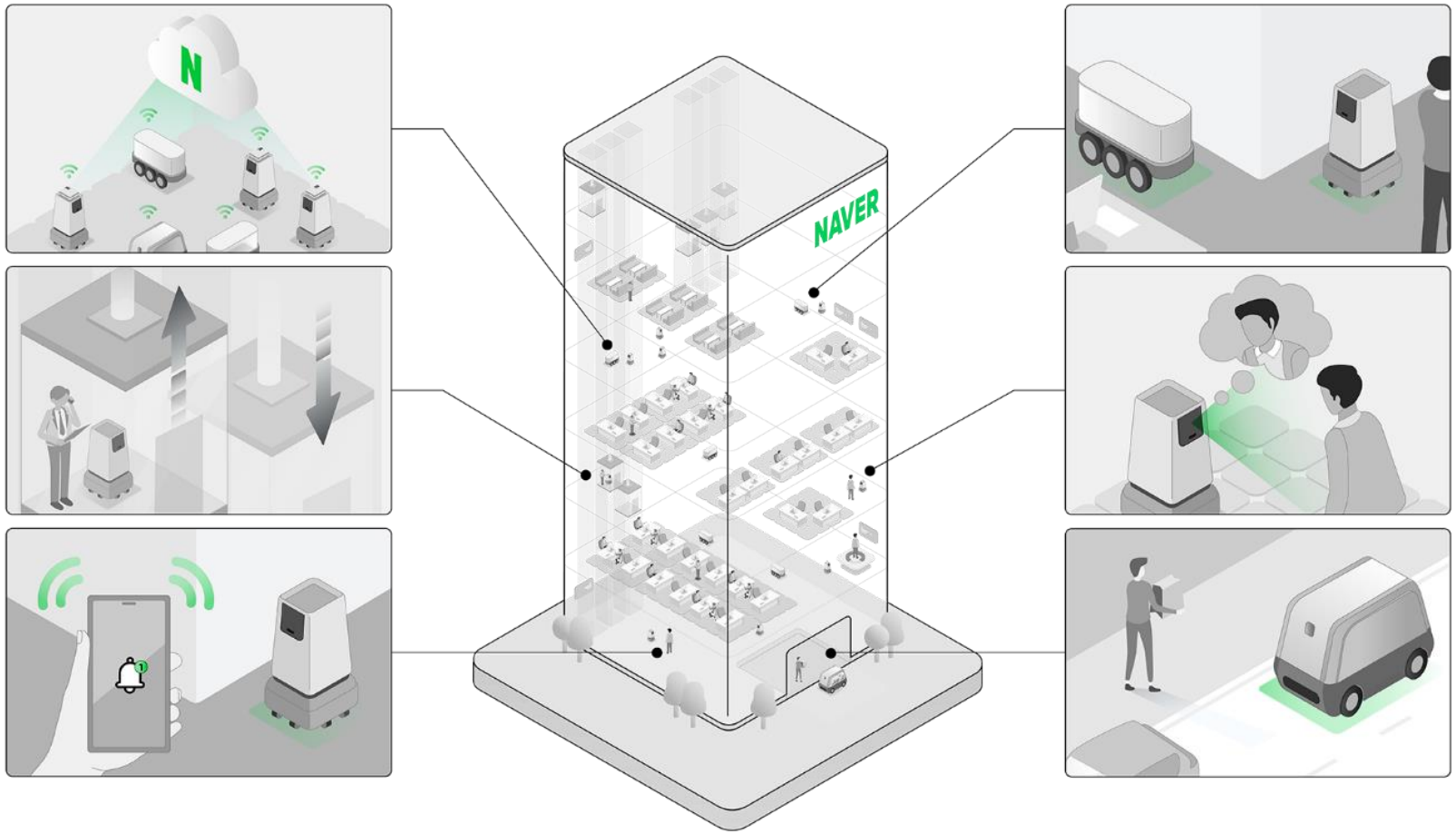
Big Data Processing

Edge Cloud

Brainless Robots

# 네이버 제2사옥 = 로봇친화형 빌딩

# A Set of Technological Convergence Bldg.



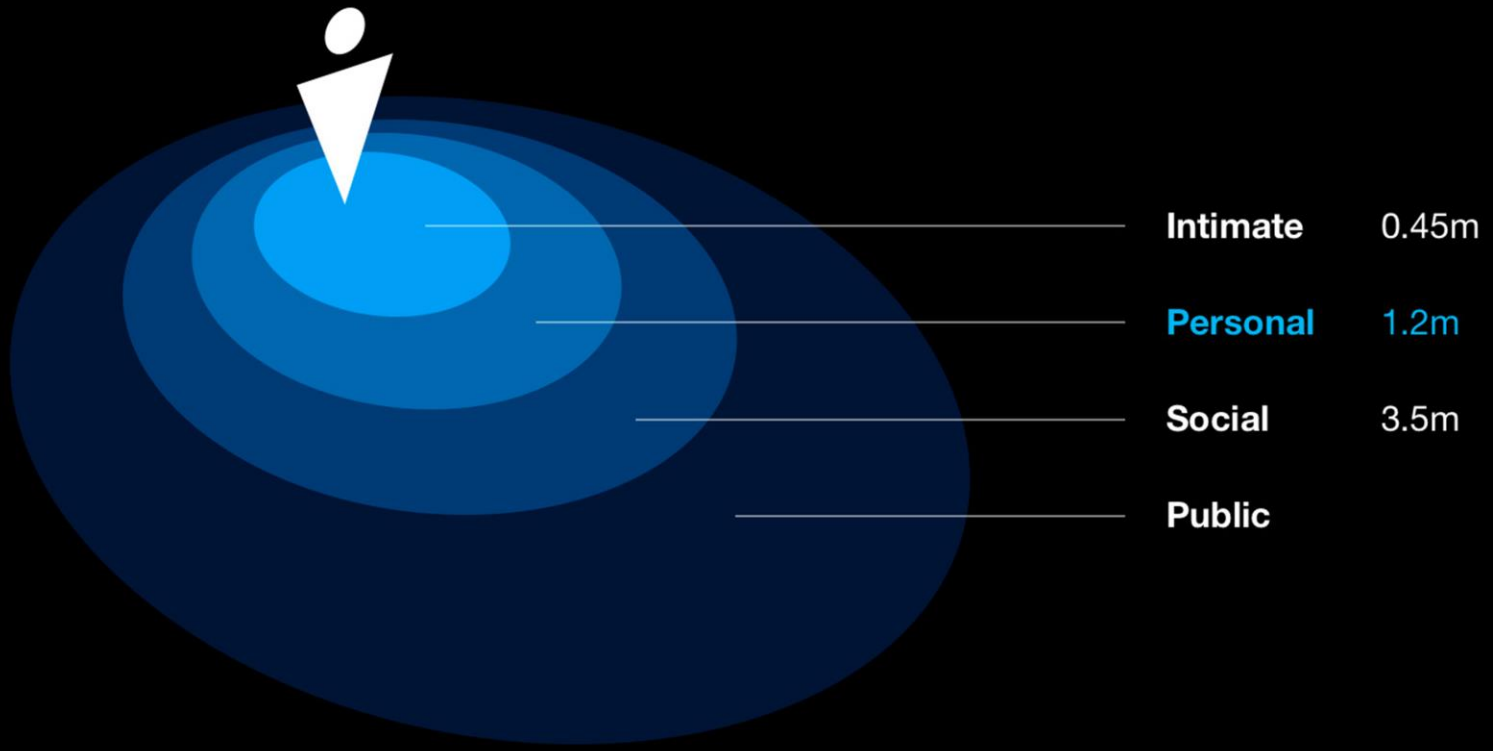
# Pilot Test for HRI

**(Human Robot Interaction)**

@ GreenFactory



# HRI 선호도에 따른 주행 성향 최적화 실증






# AROUND D

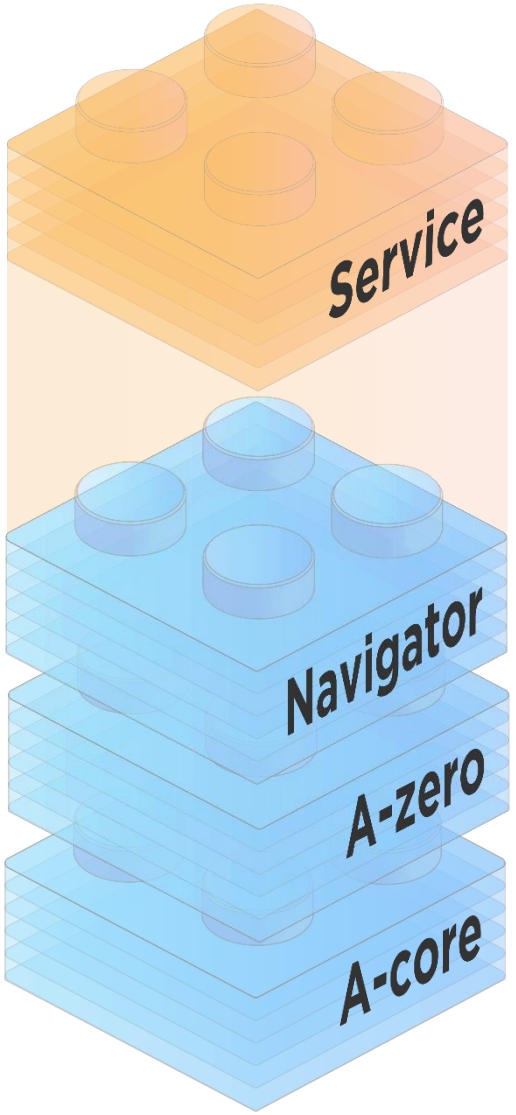
Autonomous Delivery Robot

- 브레인리스 로봇
- No LiDAR → 비전 기반 측위
- 강화학습 기반 주행
- Gaze - 직관적인 인터랙션
- HW/SW 확장성

# 다양한 확장을 위한 HW/SW 시스템

**AROUND** zero






**Applications**
Delivery, Security, Guidance, etc.

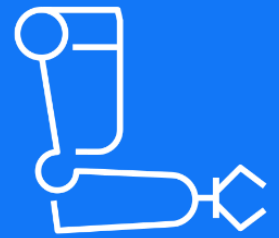
**DRL & HRI based Agent**
로컬경로생성, 장애물회피, 위기대응 등

**AROUND-zero S/W**
제어, 구동, 센싱 등의 핵심 컴포넌트

**S/W Framework**
고성능, 저메모리, 고효율의 프레임워크

Mobility

Pick & place



# AMBIDEX

A robotic arm with mechanisms analogous to a human arm

## Unique Cable-Driven Mechanisms

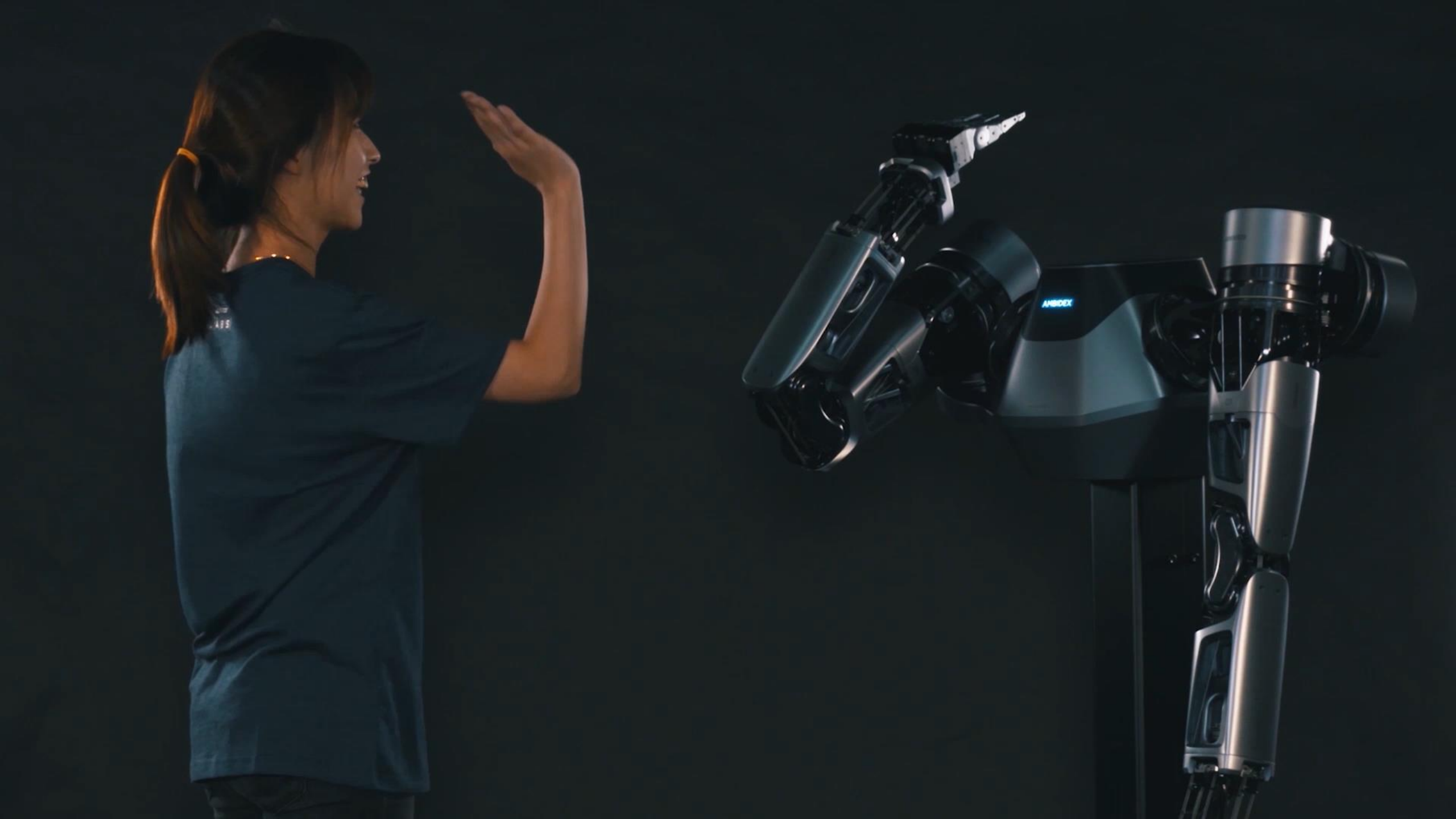
7 degrees of freedom, much like the human arm
Innovative mechanism to increase strength and power in all joints

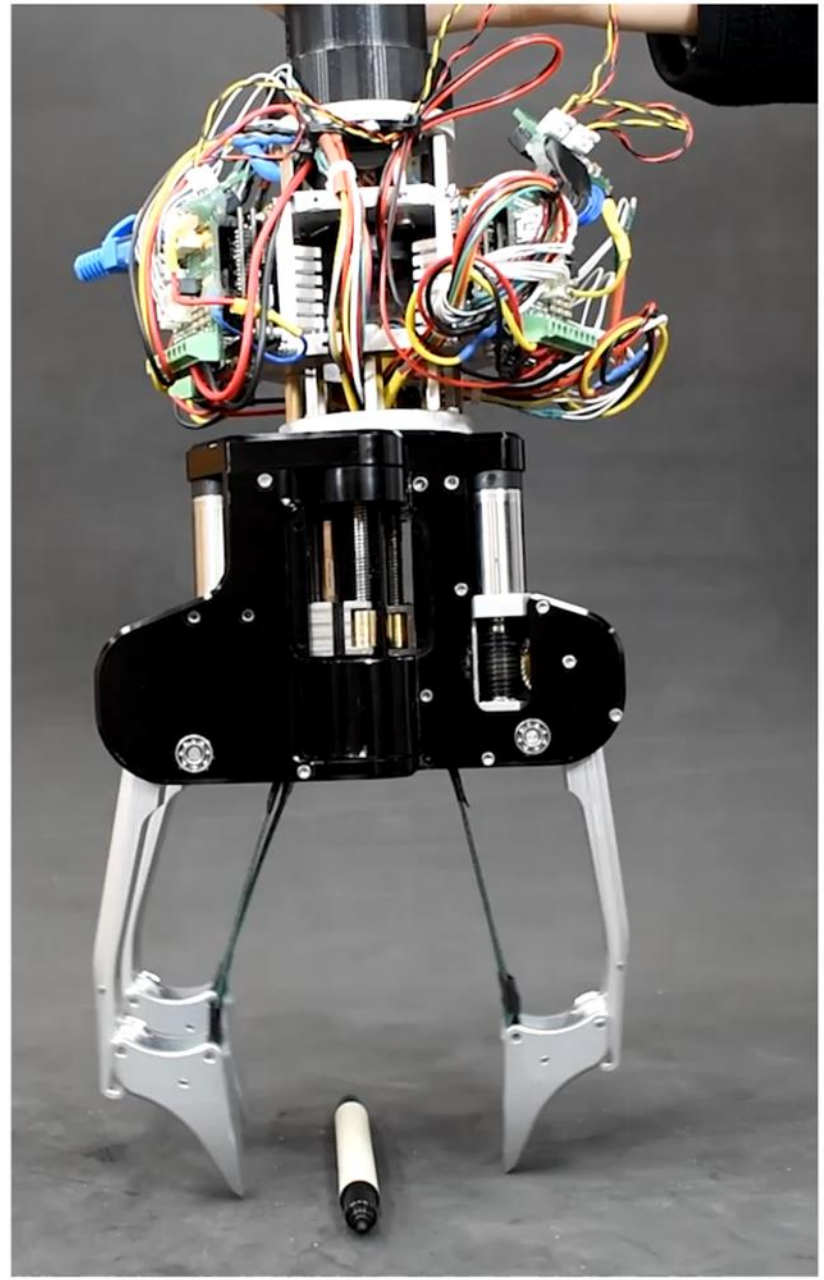
## Light but Strong

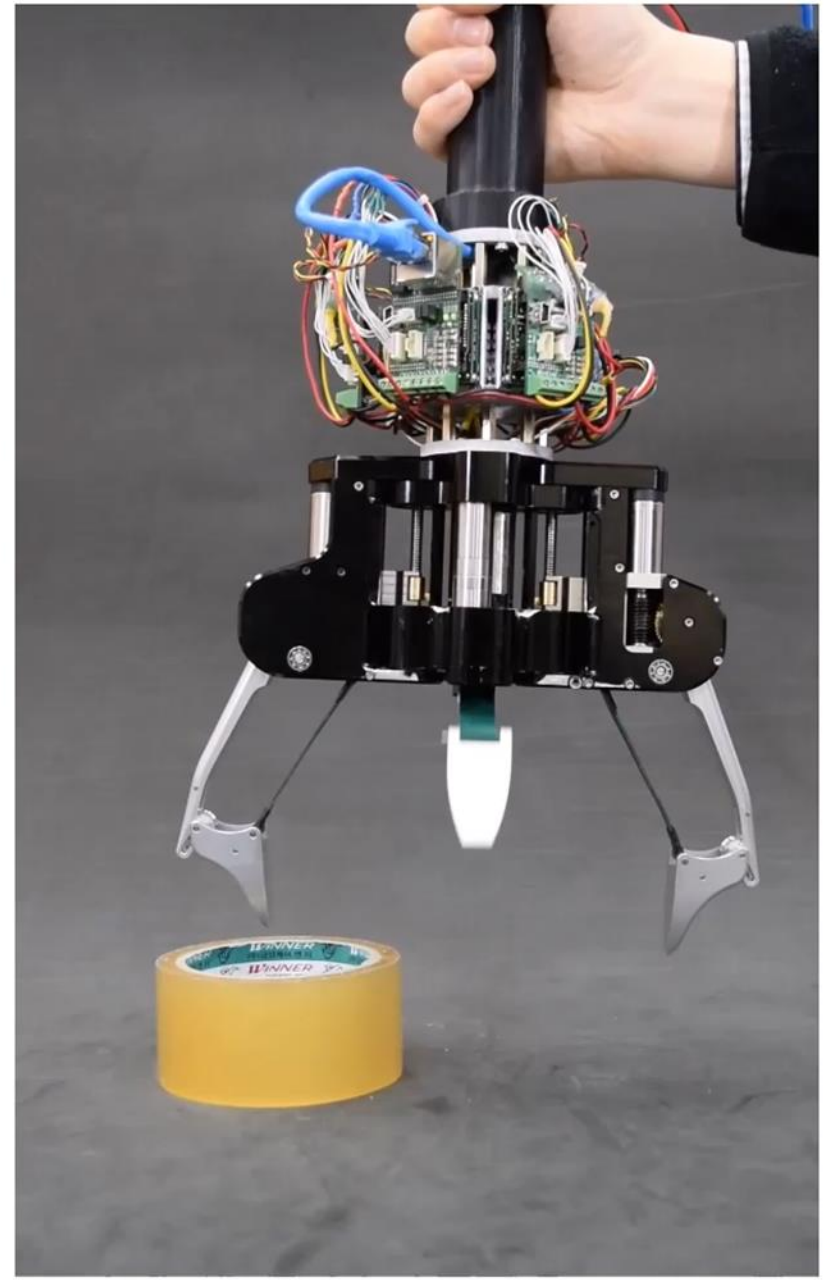
Joints lighter and more flexible than the human arm
Safe even while operating with speed and precision

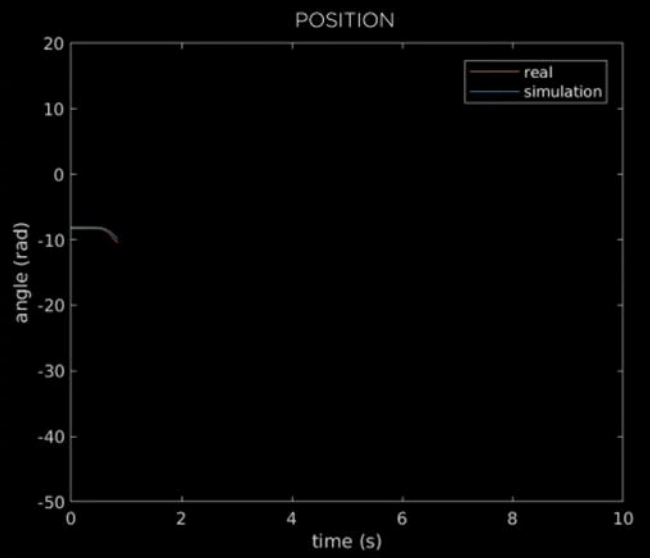
Weight: 2.63 kg
Based on drive part for one arm; 6.8 kg including body

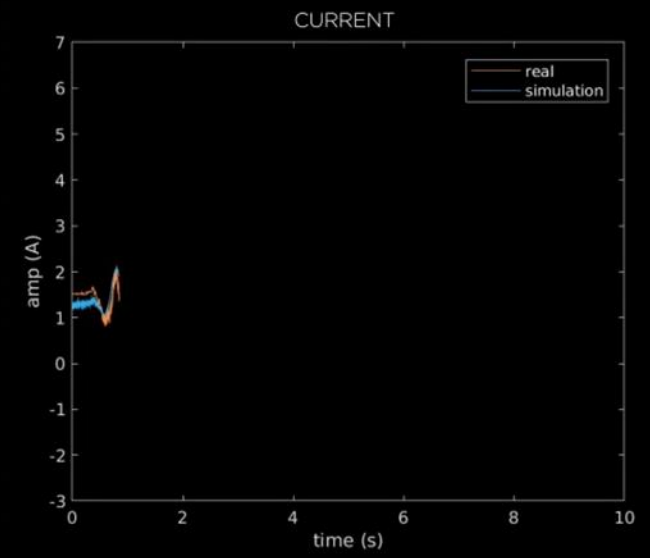
Speed: max. 7 m/s
Load: max. 3 kg


ANBIDEX




WINNER



LABS
NAVER LABS

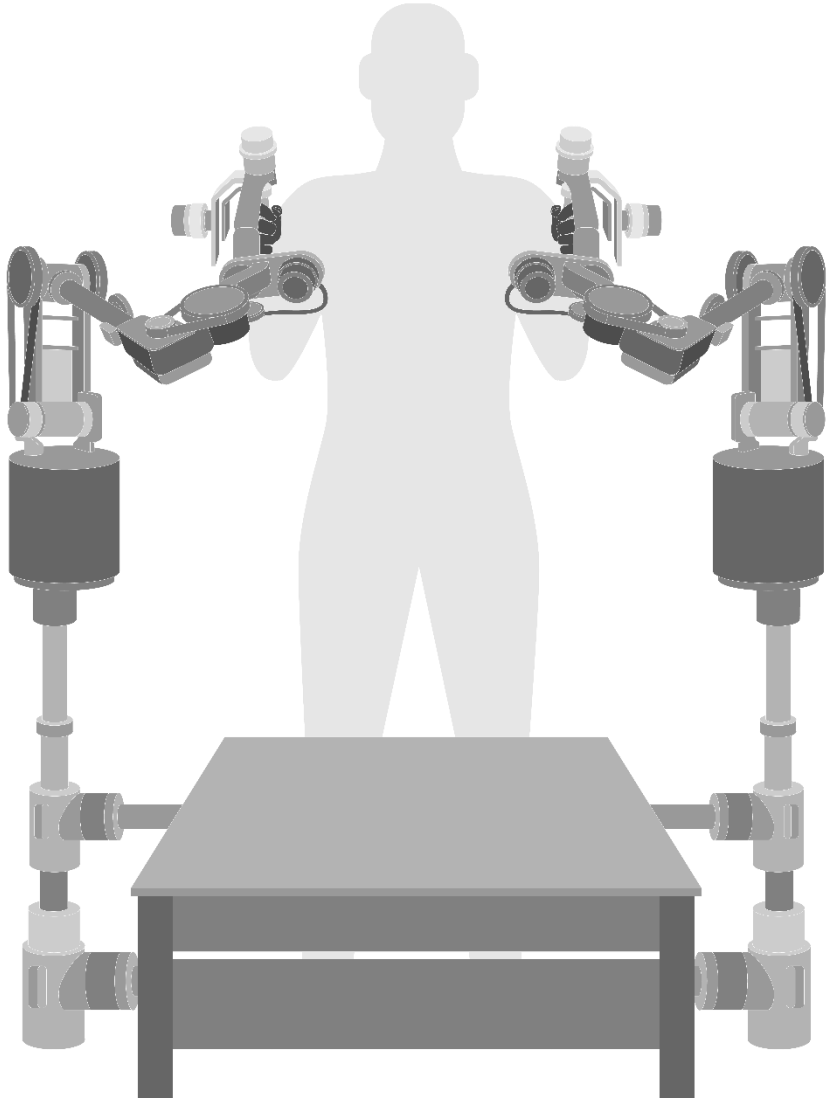
# Physical Intelligence

# 로봇, 사람을 학습

Human's Physical Intelligence

# 햅틱 디바이스

사람의 physical intelligence를 가르치기 위한 도구

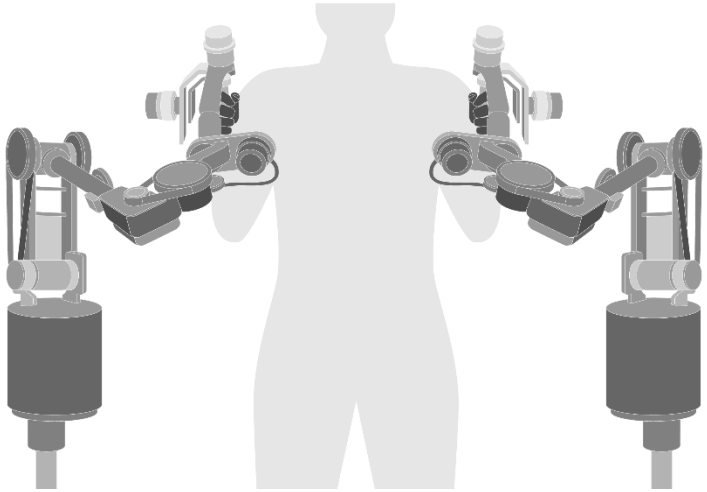


NAVER LABS Haptic Device 1.0

- **Human Scale Device**
- **7 Degrees of Freedom**
- **Bilateral Teleoperation**
- **Hierarchical Control**
- **1:1 Task Space Mapping**

# Bilateral Teleoperation

양방향으로 힘이 전달되며 학습 레퍼런스 생성

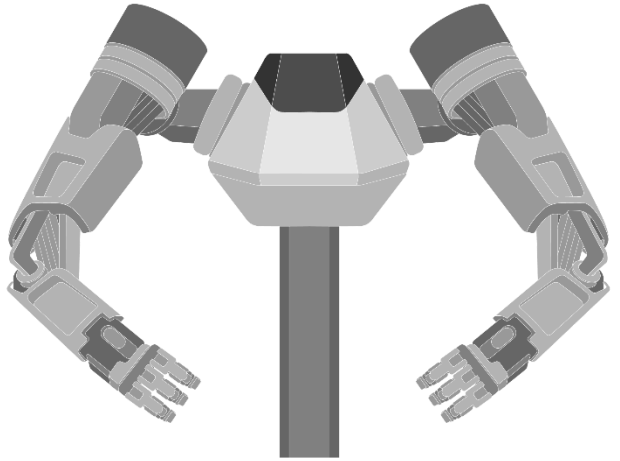


<Haptic Device>

Control

**Bilateral Operation**

Feedback



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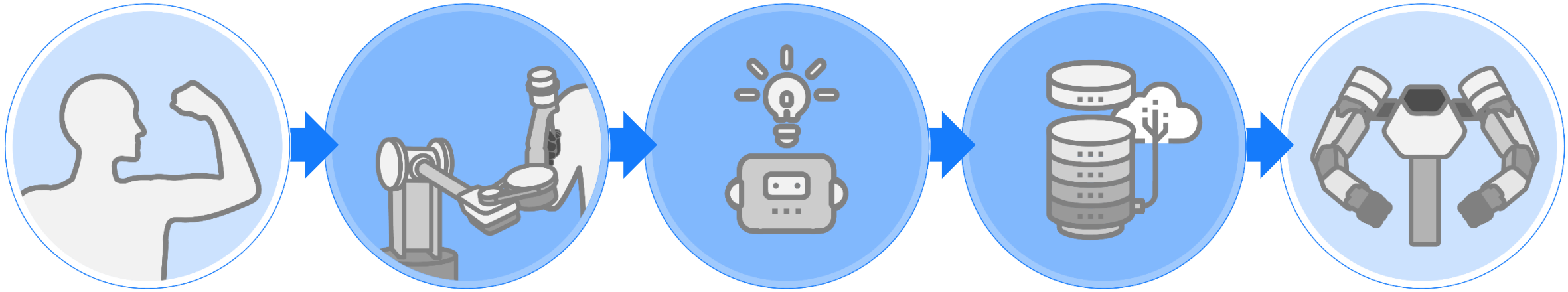
**Reference for Task Learning**


INTELLIGENCE
IN MOBILITY

# 사람의 힘 제어 능력을 학습하는 로봇



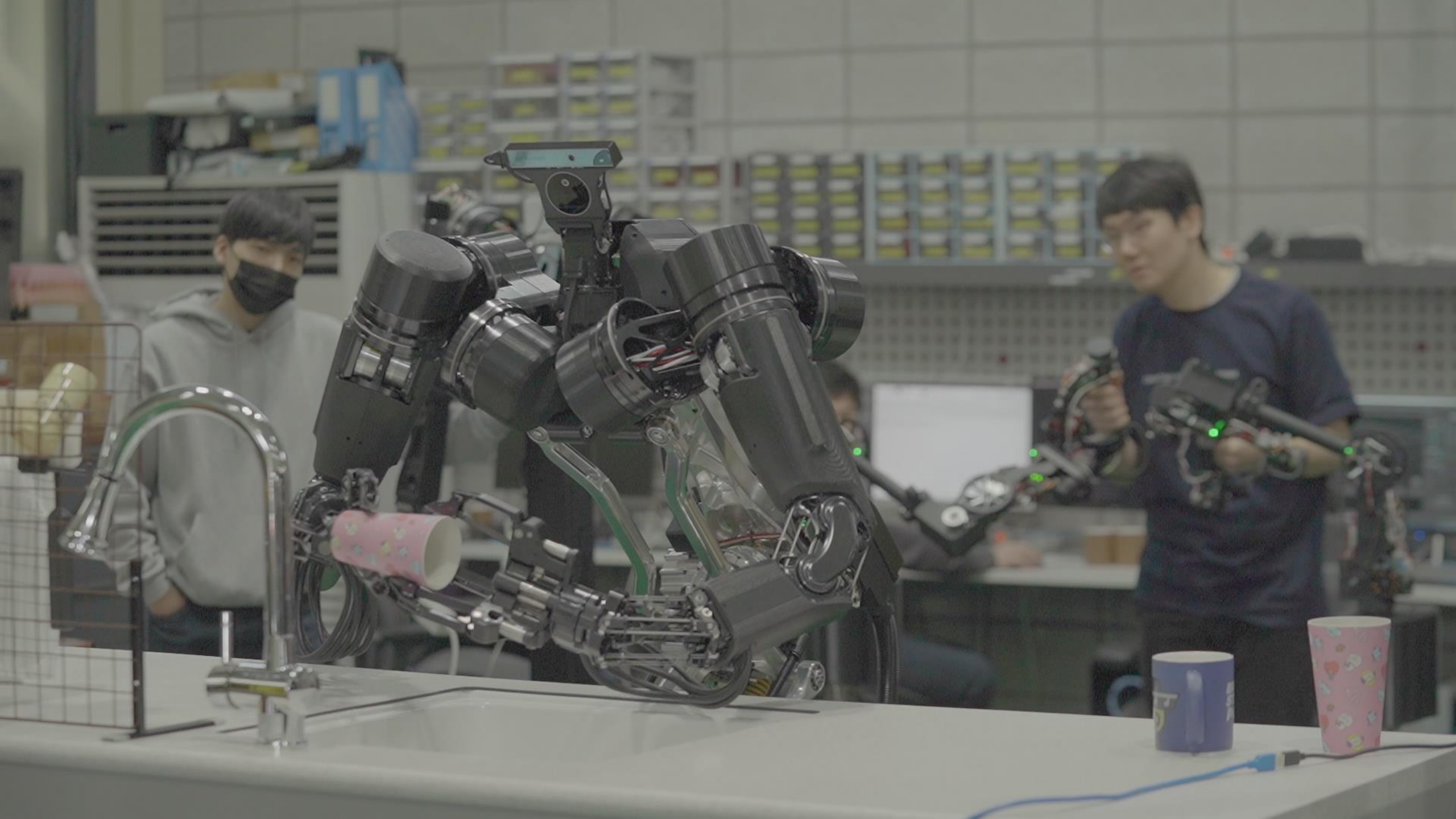
사람의
Physical Intelligence

Bilateral Teleoperated
Haptic Device

학습 레퍼런스 생성
(Real-world Interface Data)

강화학습 등
다양한 방법으로 학습

로봇의
Physical Intelligence



# 사람과 공존하는 로봇

새로운 연결의 가능성

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End of Document

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Thank You

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