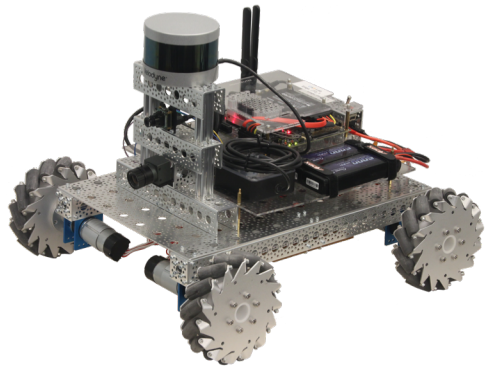
HydraOne:
An Indoor Experimental Research and Education Platform for CAVs

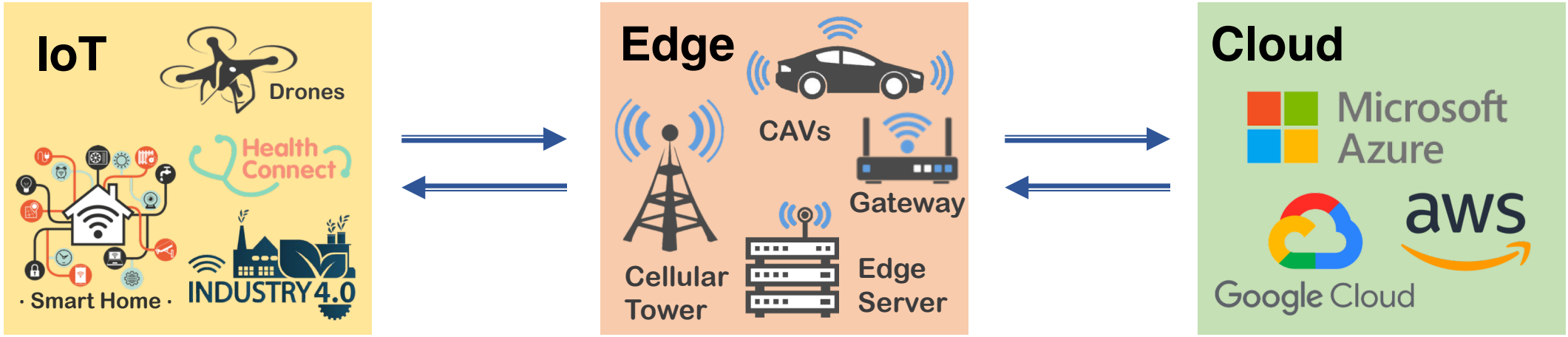
Yifan Wang, Liangkai Liu, Xingzhou Zhang, Weisong Shi

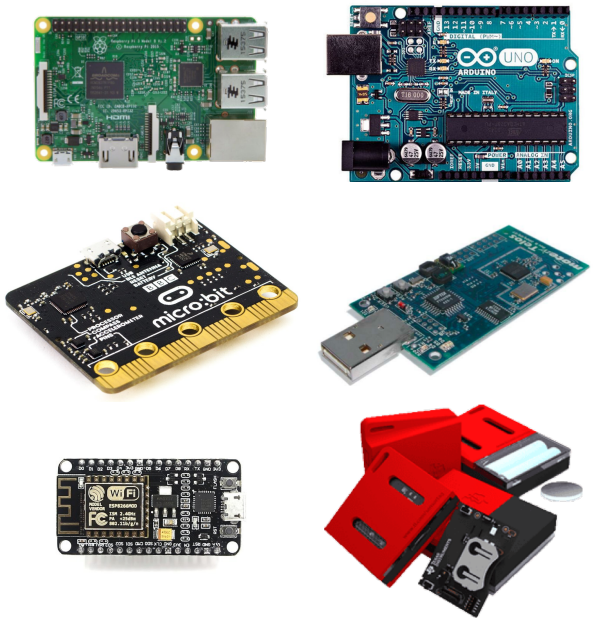
Wayne State University

Institute of Computing Technology, Chinese Academy of Sciences



Research and Education Platforms





For Edge Computing?

MESOS

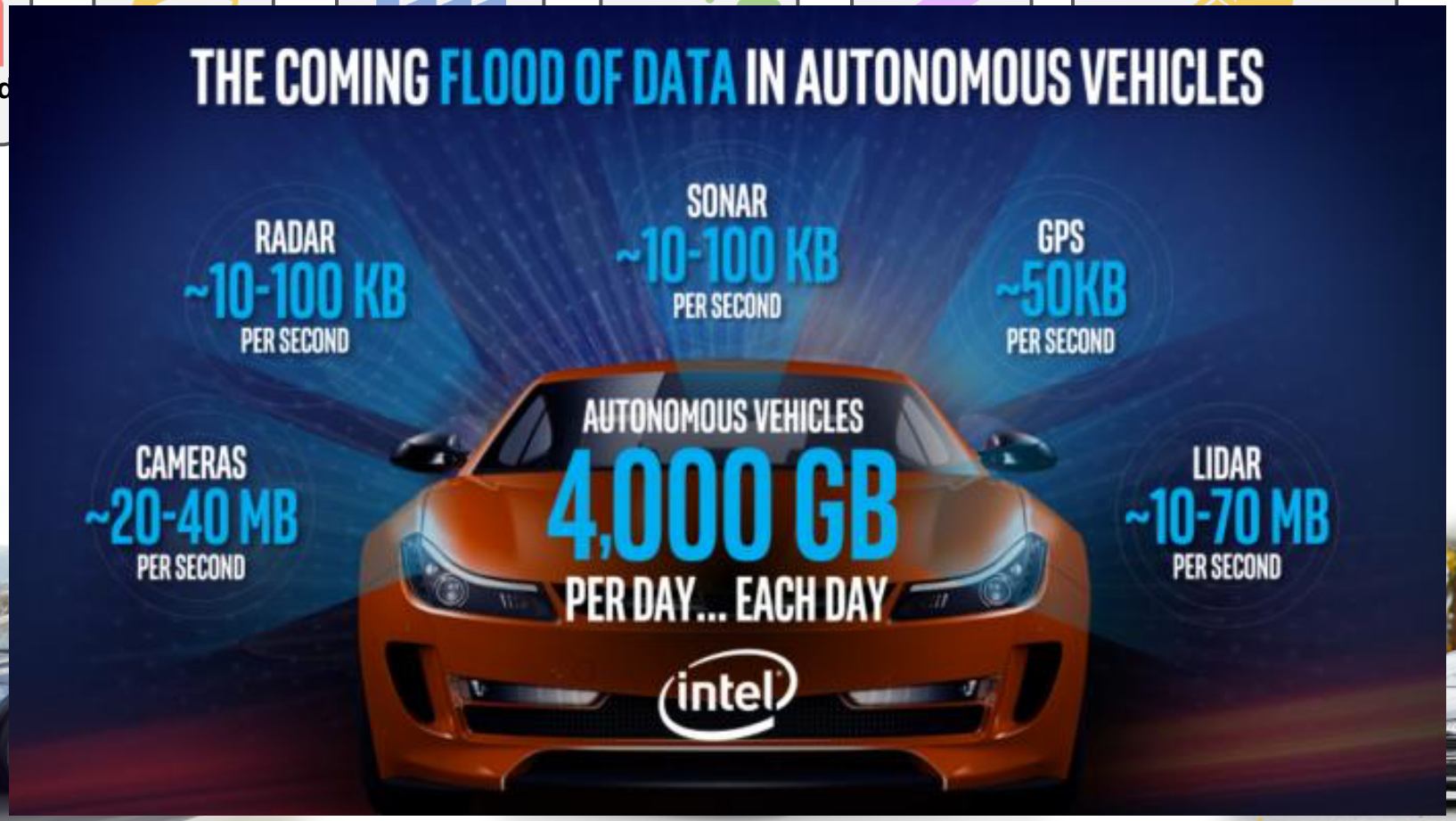
openstack.

kubernetes

Edge Computing on CAVs

Connected Health

.....



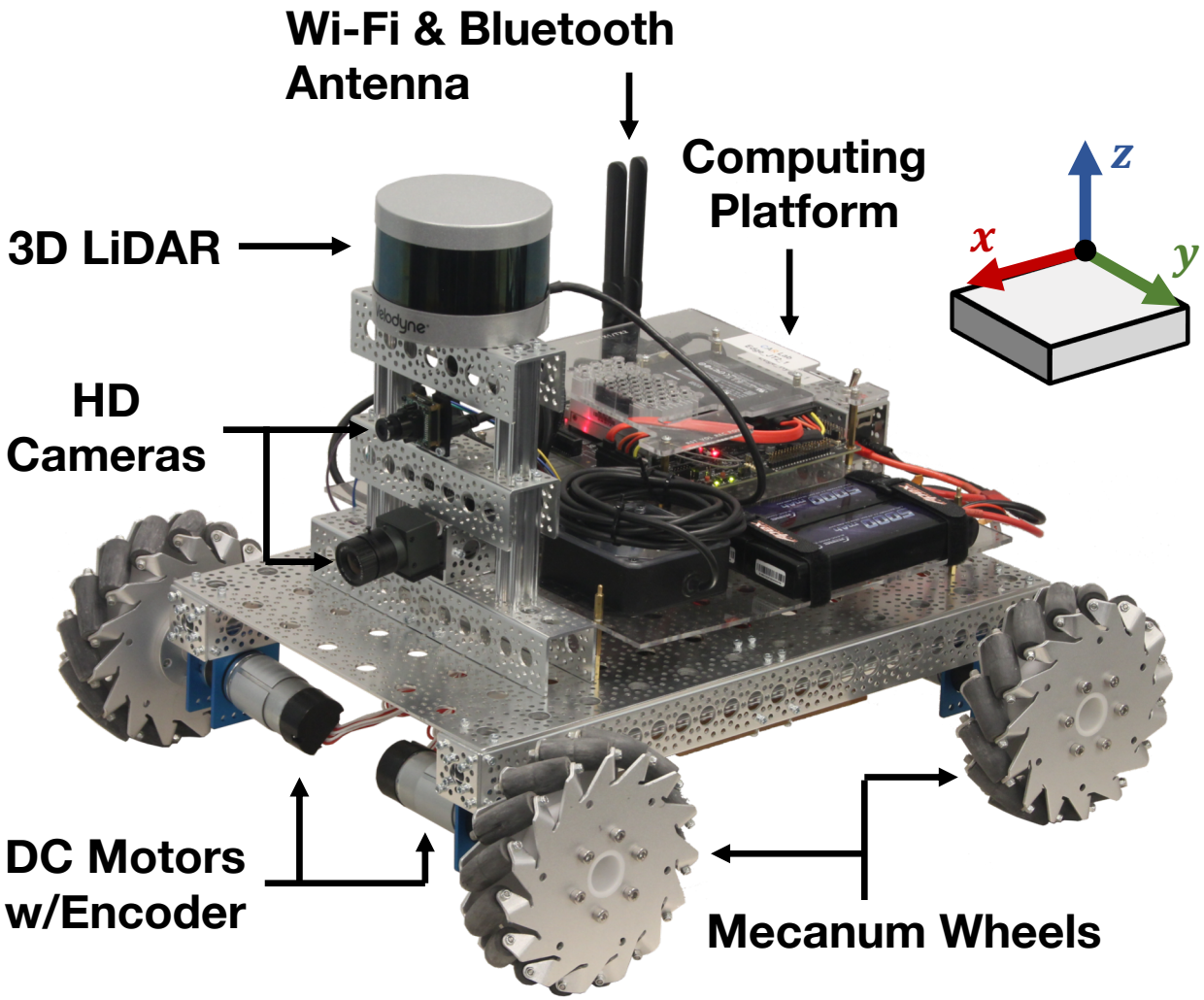
Tesla Autopilot

Google Waymo



Baidu Apollo

HydraOne Overview

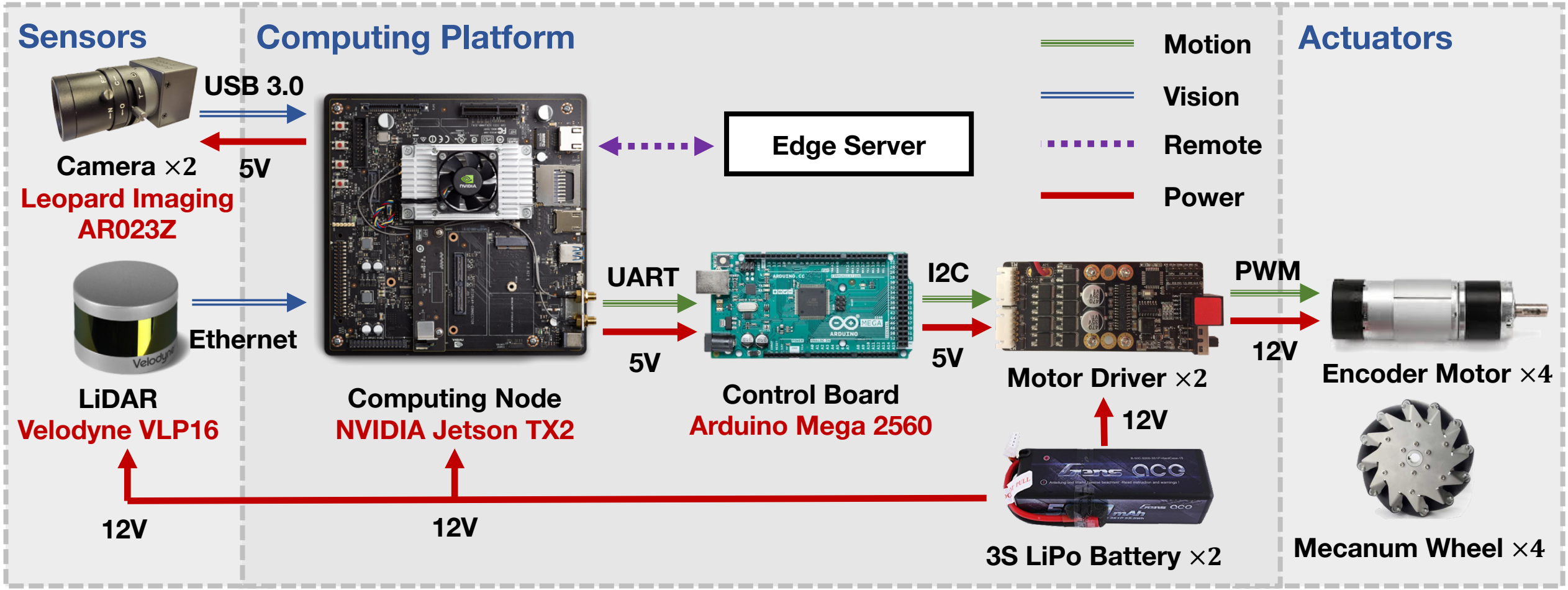


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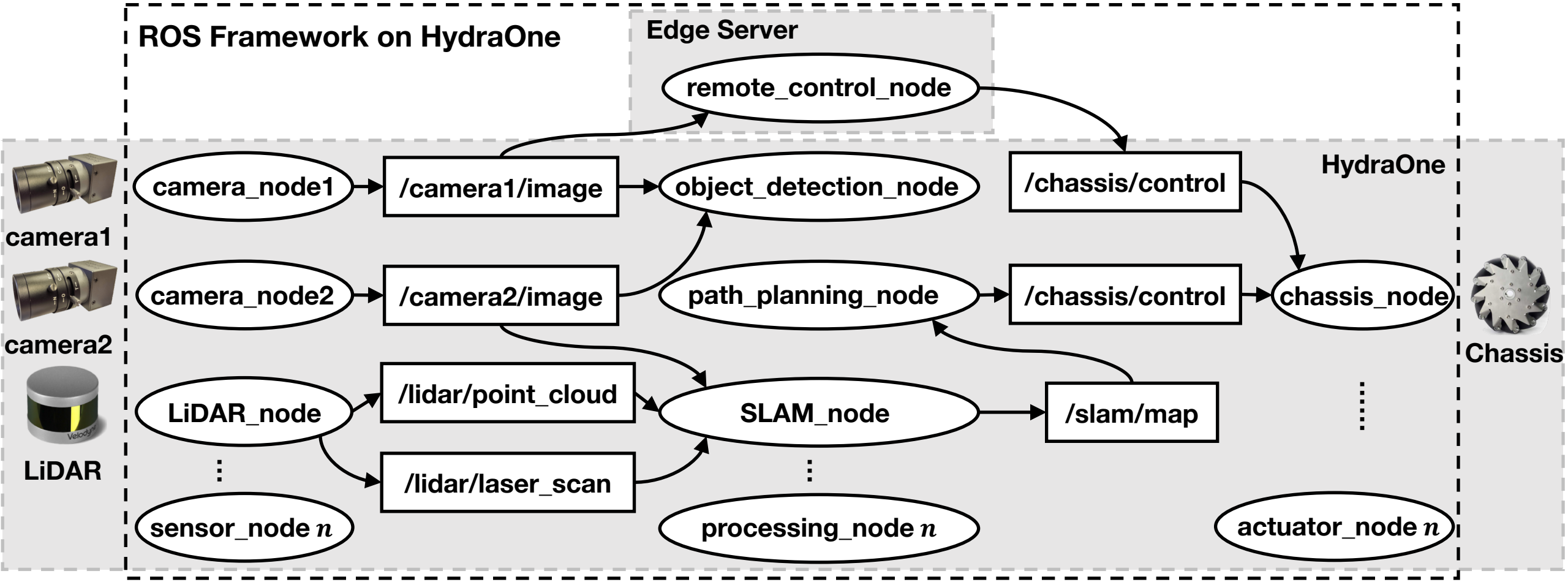


ROS Kinetic Kame

Hardware Design



Software Framework



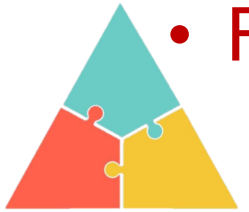
Experimental Enablers



- Design Modularization
  - Test, replace, and upgrade each module on HydraOne

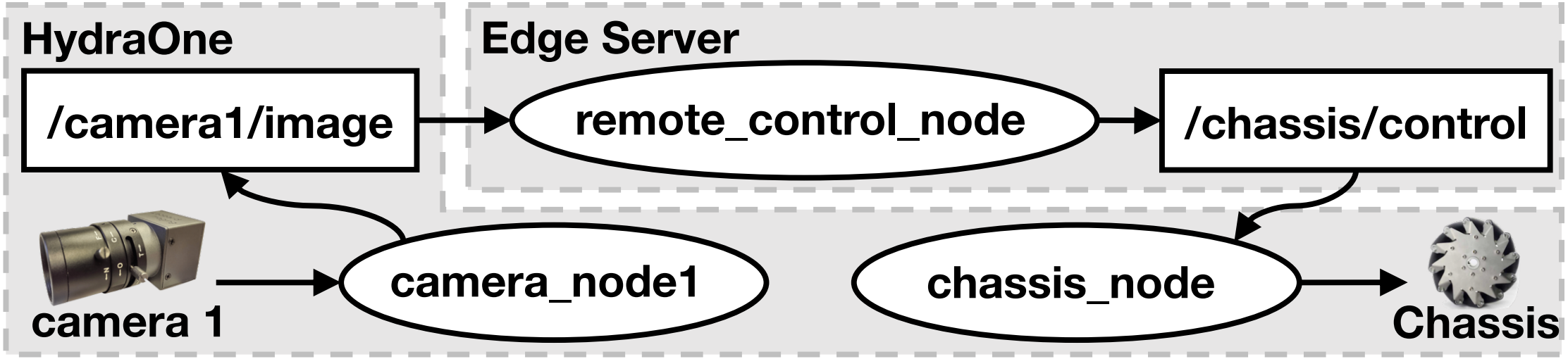


- Resource Extensibility and Openness
  - Mount and develop new resources on HydraOne
  - Access, analyze, and customize any resources on HydraOne



- Function Isolation
  - Prevent exclusive access to hardware resources
  - Isolate the ROS function with other libraries

Remote Control




```
For Holonomic mode (strafing), hold down the shift key:
---------------------------
   U    I    O
   J    K    L
   M    <    >

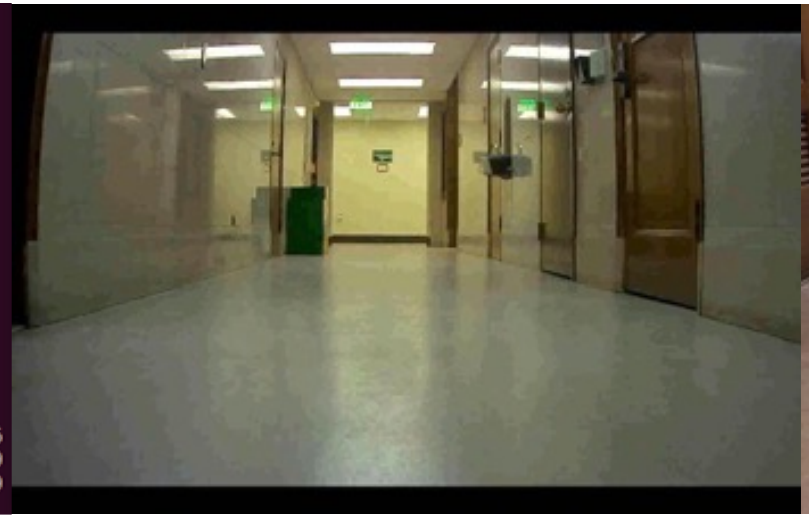
t : up (+z)
b : down (-z)

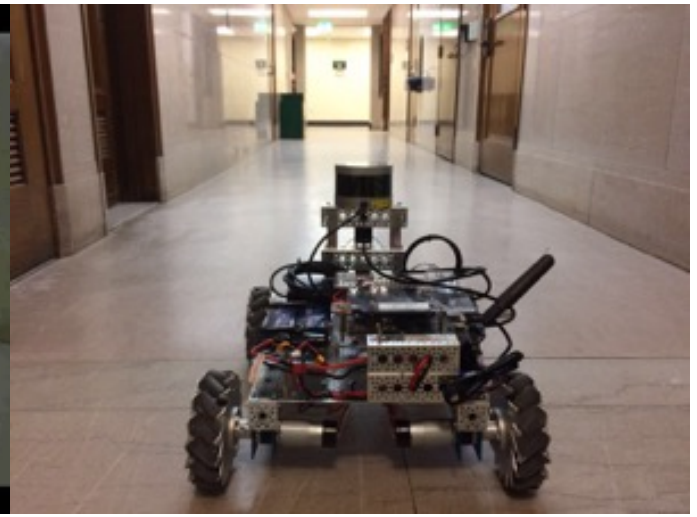
anything else : stop

q/z : increase/decrease max speeds by 10%
w/x : increase/decrease only linear speed by 10%
e/c : increase/decrease only angular speed by 10%

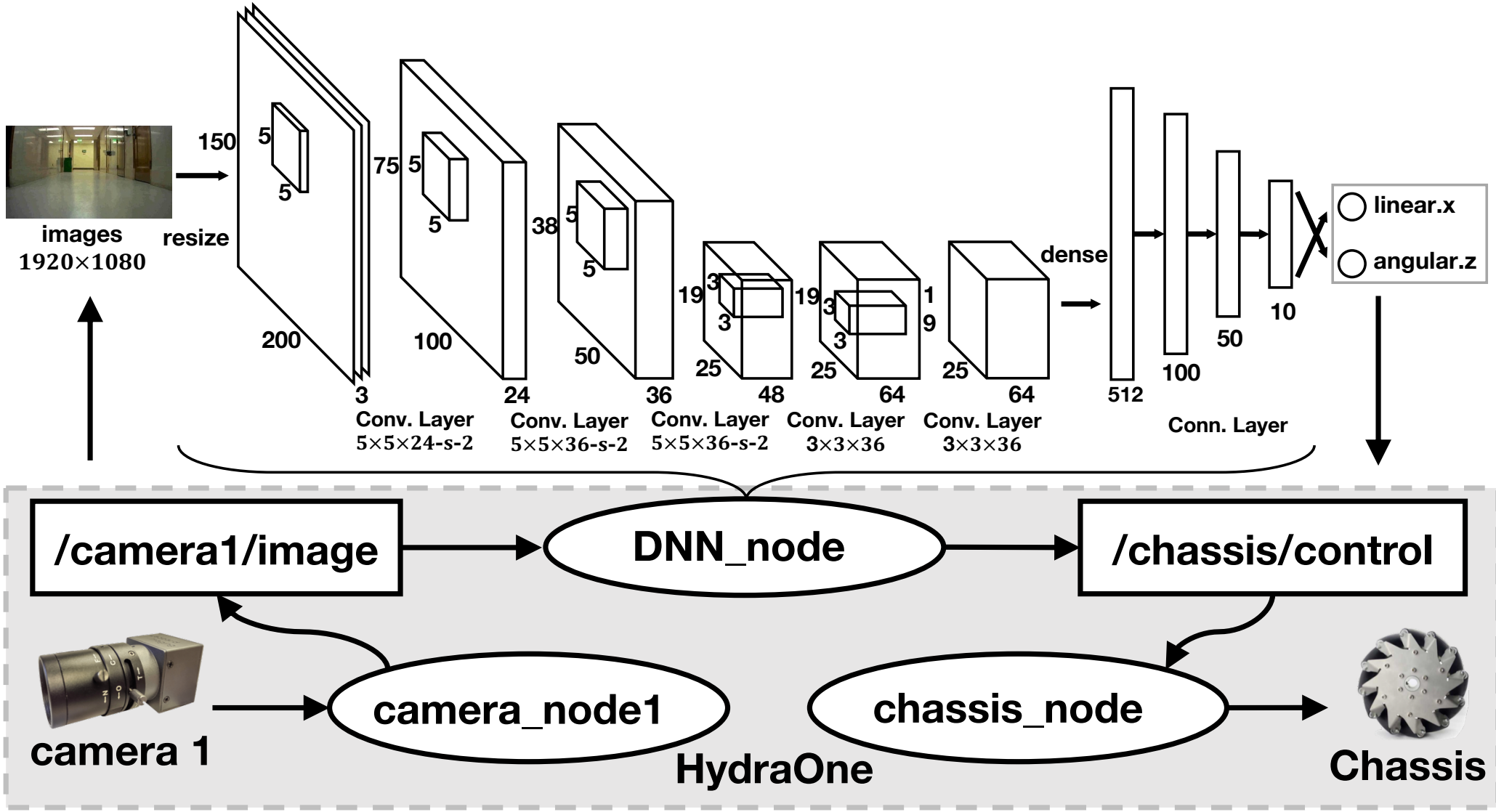
CTRL-C to quit

currently:      speed 2.29748649318     turn 4.59497298636
currently:      speed 2.5272351425      turn 5.05447028499
currently:      speed 2.77995865675     turn 5.55991731349
```

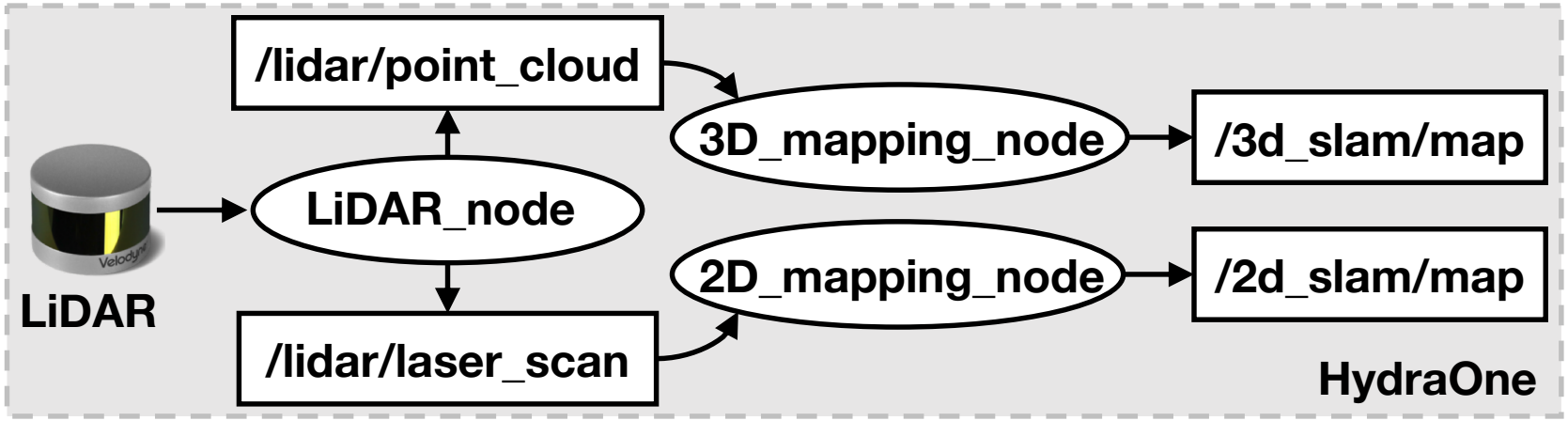


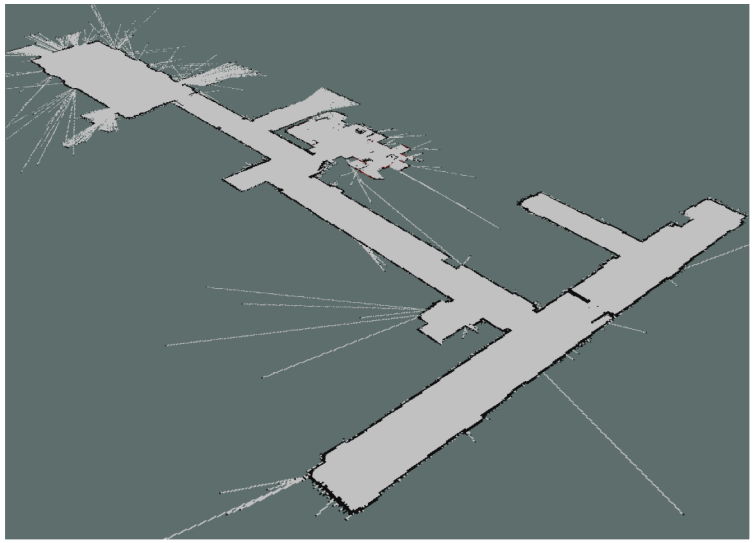


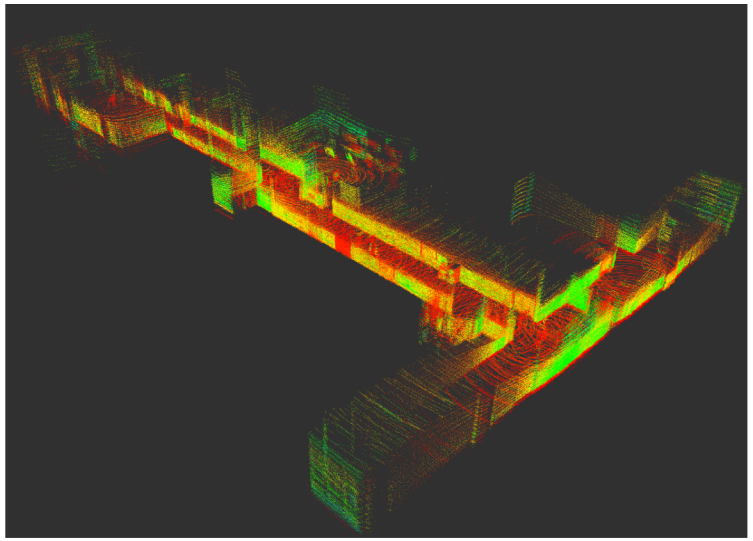
End-to-end Autonomous Driving



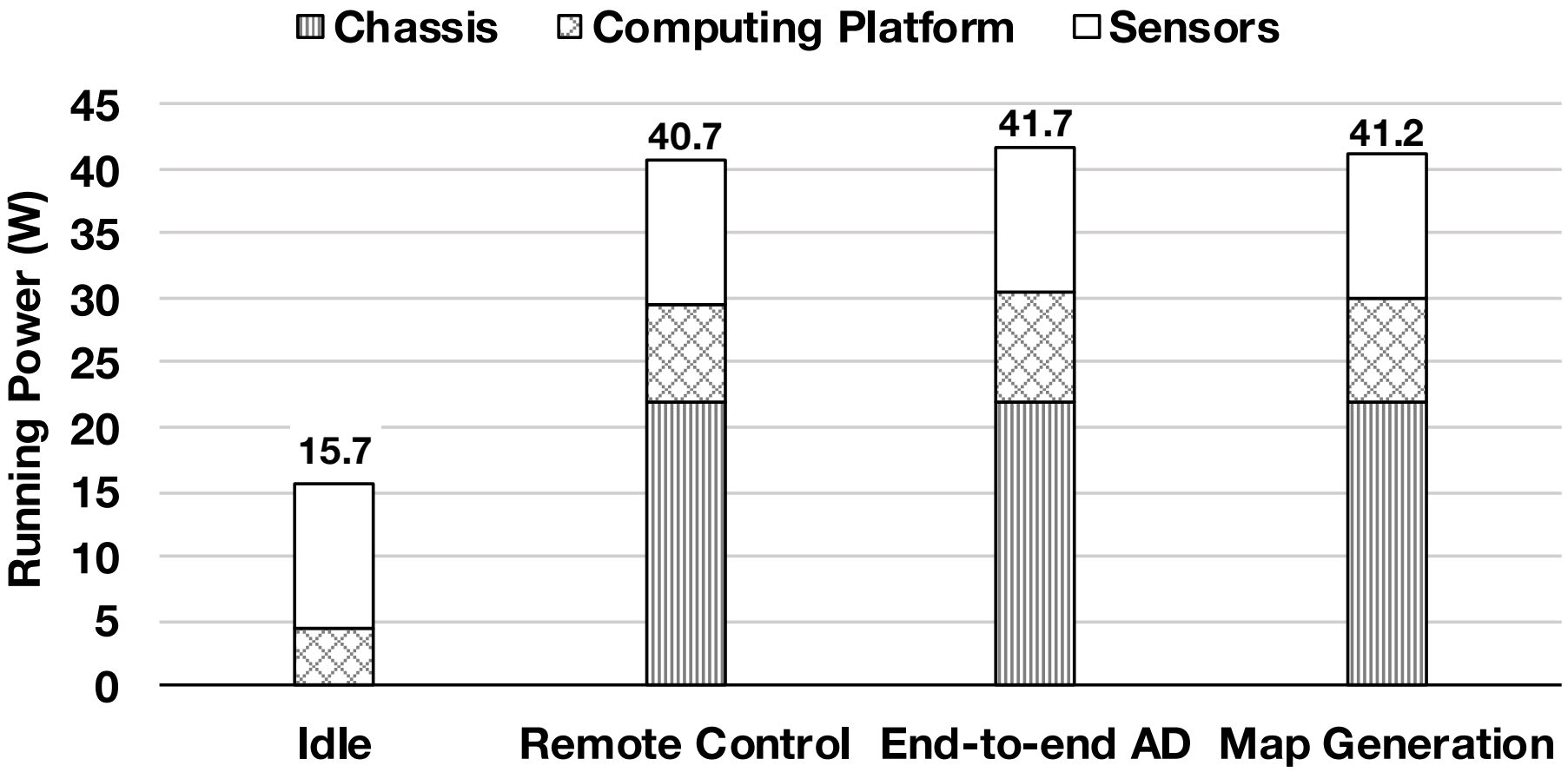
Map Generation







Energy Efficiency



Conclusion

- HydraOne, research and education platform for CAVs
- Supported research problems for CAVs
  - Autonomous driving algorithms
  - Vehicle-to-everything (V2X) applications
  - Computing system and architecture on CAVs
  - Operating system designed for CAVs
  - Trusted execution environments on CAVs
  - …
- Be valuable to researchers, developers, and students

Thank You
Q & A

http://thecarlab.org/

Yifan Wang: wangyifan2014@ict.ac.cn
Liangkai Liu: liangkai@wayne.edu

Discussion

- What kind of feedback you are looking to receive
  - ➢ We would like to know what kind of CAVs research platform do the researchers want, and what kind of CAVs applications they cannot deploy and evaluate in the real-world environment due to the research platform missing.
- The controversial points of the paper
  - ➢ The most controversial point is the HydraOne is an indoor platform, so the environment of HydraOne might not be as complicated as outdoor vehicles. Some CAVs applications need further modifications when evaluating in outdoor scenarios, for example, the lane detection application.
- The open issues the paper does not address
  - ➢ This paper did not discuss how other researchers use the platform remotely. At this point, we need to think about how to replicate the same design for other people.
- Under what circumstances the whole idea might fall apart.
  - ➢ The whole idea of HydraOne will be challenged if other researchers found it is very difficult to use the proposed platform.