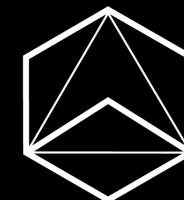


# AUTOWARE 101

The History and Future of  
The Autoware Foundation

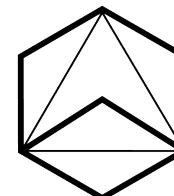


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# New Phone, Who Dis?

Joshua Whitley  
Owner and Founder  
Whitley Software Services

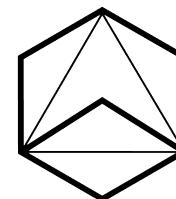
System Architect  
The Autoware Foundation



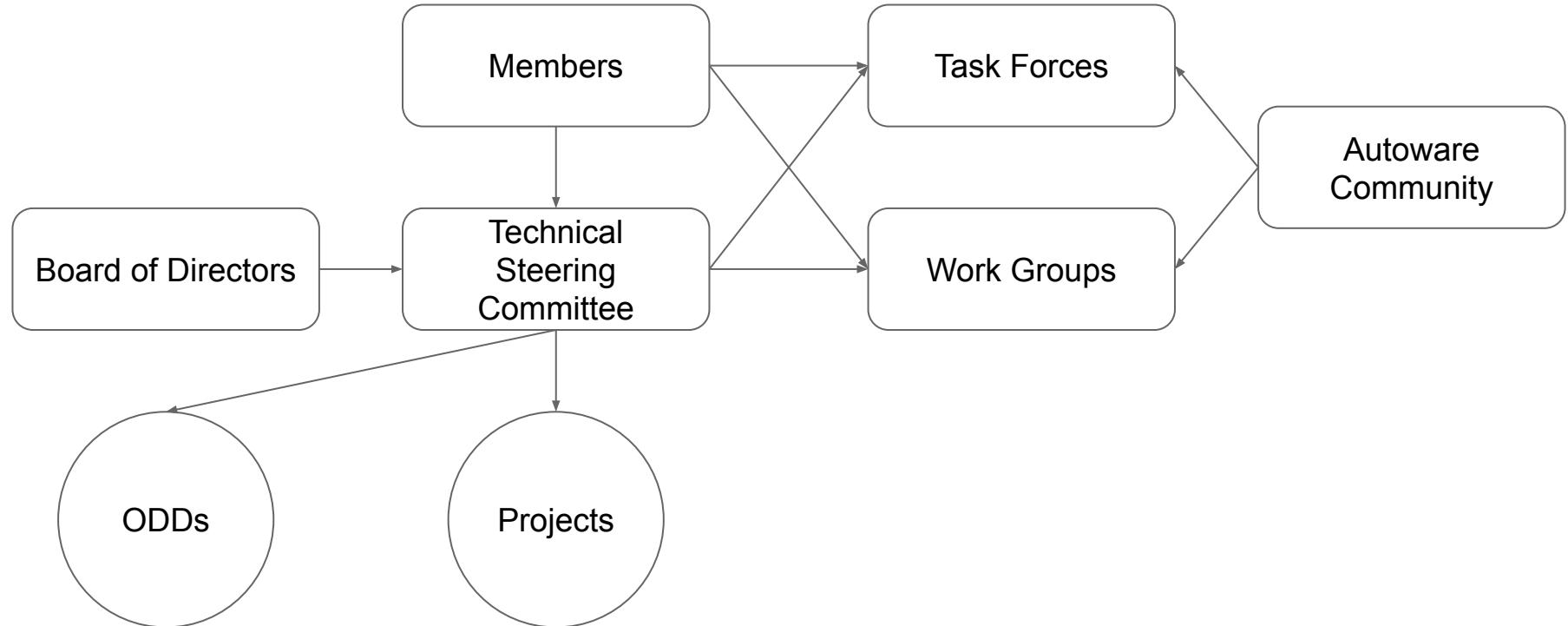
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AUTOWARE  
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# What is The Autoware Foundation?

- Autoware.AI was started in 2015 by Shinpei Kato at Nagoya University.
- Today, Autoware.AI is supported by the largest autonomous driving open source community with 3800+ stars on GitHub and 1700+ accounts on Slack.
- Autoware.AI has found widespread and international adoption as it is used by more than 100 companies and runs on more than 30 vehicles in more than 20 different countries.
- Courses using Autoware are offered in 5 countries.
- Automotive OEMs are using Autoware for Mobility as a Service (MaaS) development.
- Autoware has been qualified to run on driverless vehicles on public roads in Japan since 2017.
- Now we are taking Autoware to the next level.
- Website: <https://autoware.org/>



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## Autoware Foundation Structure

## PREMIUM

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**Apex.AI** **ARM**



**embotech\***



**Velodyne  
LiDAR**

## INDUSTRIAL

---



**AISAN TECHNOLOGY**



**AXELL CORPORATION**



U.S. Department of Transportation  
Federal Highway  
Administration



**TATA CONSULTANCY SERVICES**

## ACADEMIC & NON-PROFIT MEMBERS

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## Autoware Foundation Members



# Current Autoware Projects



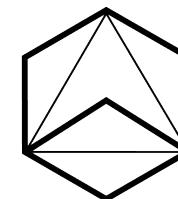
AUTOWARE.AI



AUTOWARE.AUTO



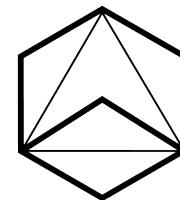
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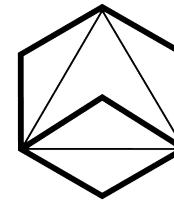


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# Autoware.IO - What is it?



- Autoware.IO will provide heterogeneous hardware reference platform with tools, unified interface design, and test framework
- Autoware.IO relies on member participation to integrate their solutions onto platforms which support Autoware.Auto and Autoware.AI software stacks
- Enable heterogeneous SoCs on open specification (such as 96Boards Automotive Specification but not exclusively) supporting Autoware.ai/Autoware.auto
- Enable software developers and hardware device manufacturers
- Provide Simulation & Tools
- Ease Sensor and ECU integration
- Allow Hardware-Agnostic Vehicle Control

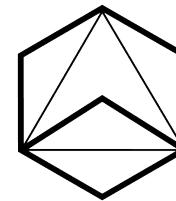


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# Autoware.IO - What is it?



- Website : <https://www.autoware.io/>
- Hardware reference design:  
<https://discourse.ros.org/t/wg-rp-autoware-reference-platform-definition-documentation/9949>
- The first open designed hardware platform with available BSP is here:  
<https://discourse.ros.org/t/open-source-and-free-software-for-autocores-pcu/12418>
- Hardware documentation here:  
[https://github.com/autocore-ai/autocore\\_pcu\\_doc/](https://github.com/autocore-ai/autocore_pcu_doc/)

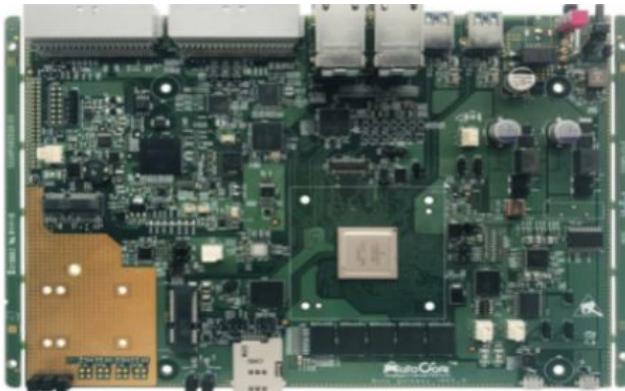


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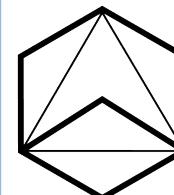
AUTOWARE.IO

# Autoware.IO - Current Status

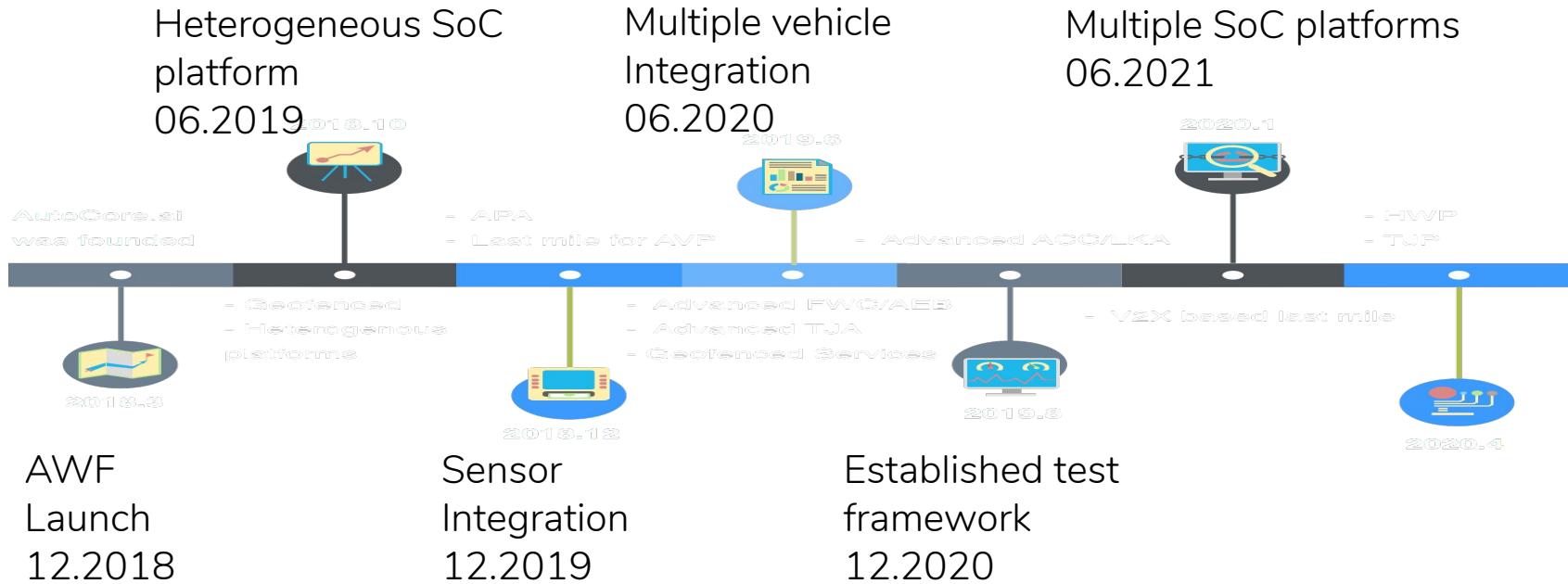


## Product Features

- Heterogeneous computing platform for autonomous driving/ADAS
- Auto-grade platform with CAN/UART/AVB, TSN capable Ethernet
- Design with functional safety, redundancy, built-in customisation
- Integrated development environment through development, debug, validation and deployment
- Continuously platform software updates and development SDK
- Fully validated stack with functional algorithm modules
- Open source application software stack for autonomous driving/ADAS

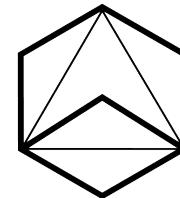


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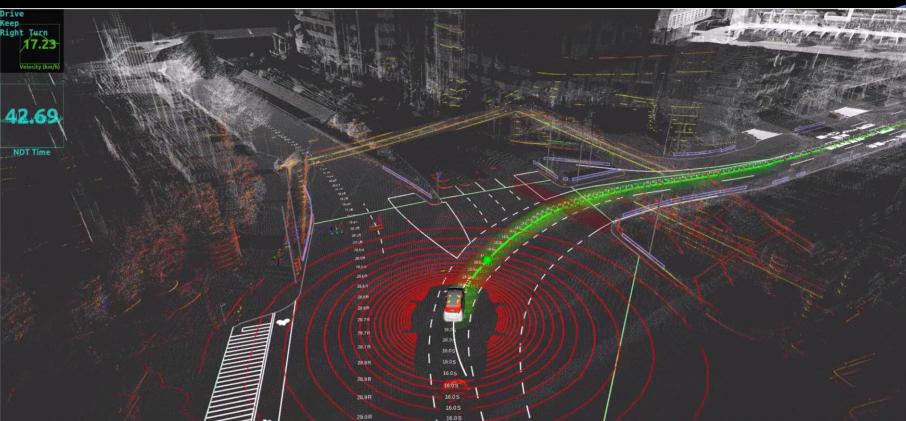


AUTOWARE.AI

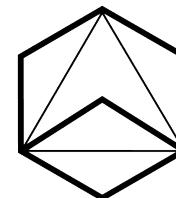


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# About Autoware.AI - What is it?



- Based on ROS 1
- Intended to be full self-driving stack (SAE Level 3/4)
- Supports many vehicle platforms
- Contains:
  - Launch files
  - Configuration files
  - Example neural networks (pre-trained)
  - Example maps
- Website: <https://autoware.ai/>
- Repository: <https://github.com/Autoware-AI/autoware.ai/>
- Documentation: [https://github.com/Autoware-AI/autoware.ai /wiki](https://github.com/Autoware-AI/autoware.ai/wiki)



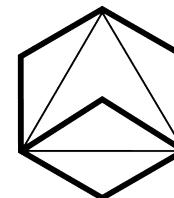
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AUTOWARE.AI

# About Autoware.AI - History

- Started in 2015 by Shinpei Kato at CMU
- Many features initially developed by students at Nagoya University, Japan
- Officially released in August, 2015
- Tier IV formed in December, 2015; Provided most development until mid-2018
- Moved from Github to Gitlab in June, 2019
- Moving back to Github in June, 2020



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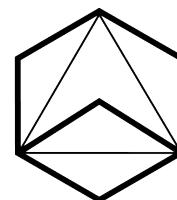


AUTOWARE.AI

# About Autoware.AI - Current Status

- Originally built on ROS Indigo
  - Currently supports ROS Melodic
- Contains over 209,000 lines of code
- Multiple implementations of algorithms in:
  - Control
  - Localization
  - Perception
  - Planning
  - Simulation
- Supports multiple simulators (LGSVL, CARLA)

Autoware Version	Ubuntu 14.04	Ubuntu 16.04	Ubuntu 18.04
v1.14.0			x
v1.13.0			x
v1.12.0		x	x
v1.11.1		x	
v1.11.0		x	
v1.10.0		x	
v1.9.1	x	x	
v1.9.0	x	x	

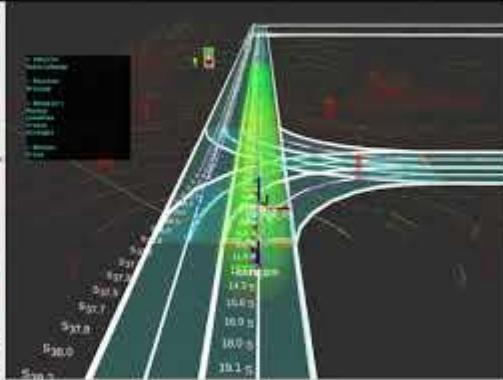


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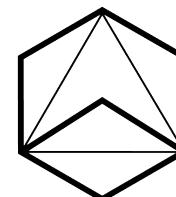
AUTOWARE.AI

# About Autoware.AI - Current Status



## AutonomouStuff Open Autonomy Pilot

- Slightly modified version of Autoware.ai
- Used in active, urban environments
- <https://autonomoustuff.com/services/open-autonomy-pilot/>



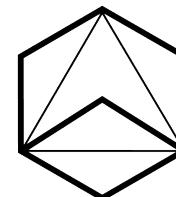
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AUTOWARE.AI

# About Autoware.AI - Current Status

- Not designed for functional safety
- Grew organically - code quality and development best-practices not priorities
- Development started early in Autonomous Vehicle revolution
- Excellent for R&D and testing



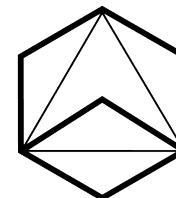
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# About Autoware.AI - Future

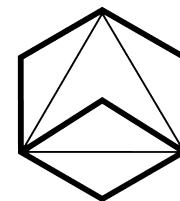
- December 2020 (1.15.0) - last major version
- January 2021 through December 2022 - maintenance-only
- December 2022 - EOL



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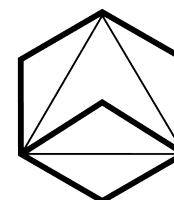


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# About Autoware.AUTO - What is it?



- Based on ROS 2 and DDS
- Open-Source Autonomous Vehicle Software Stack
  - Intended to support specific Operational Design Domains (ODDs)
  - Provides a modular reference design with clearly-defined APIs
  - Allows extension with other (potentially proprietary) vendor-developed modules
- Usage and API documentation auto-generated  
(<https://autowarefoundation.gitlab.io/autoware.auto/AutowareAuto/>)

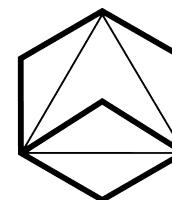


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# About Autoware.AUTO - What is it?



- Developed from the ground-up with the following in-mind:
  - Safety
  - Code quality (multiple linters/static analyzers enforced)
  - Static memory allocation
  - Documentation, documentation, documentation
  - Modularity
- Website: <https://autoware.auto/>
- Repository:  
<https://gitlab.com/autowarefoundation/autoware.auto/AutowareAuto>



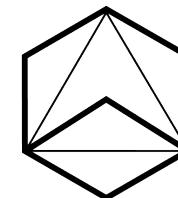
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# About Autoware.AUTO - History

- Development began in August, 2018
- Initial framework and development by Apex.AI (in partnership with Tier IV)
- First release (0.0.1) in August, 2019
- Ongoing, active development by most AWF member organizations
- Active development managed by the Autoware Software Working Group (ASWG)
  - ASWG Meetings are open to the public ([Calendar Link](#))



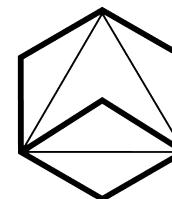
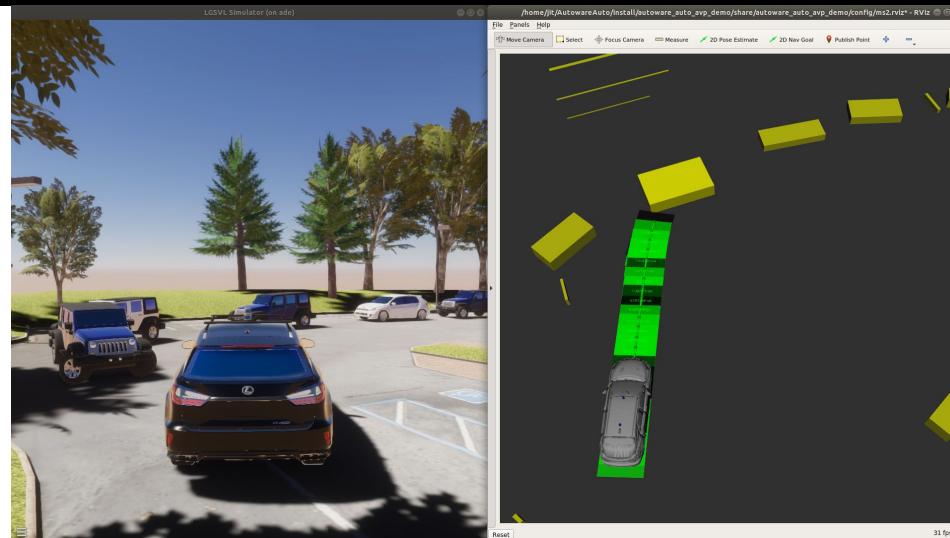
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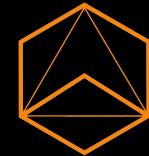
AUTOWARE.AUTO

# About Autoware.AUTO - Current Status

- Currently targets Dashing
  - Upgrade to Foxy after AVP Release
- Docker-based development/runtime environment, ADE
  - Supports the addition of simulation environments as Docker volumes in ADE
- Natively supports amd64, arm64



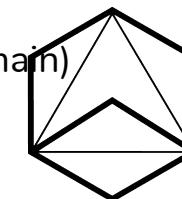
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# About Autoware.AUTO - Current Status

- Supports the following functions
  - Sensing
    - PointGrey/FLIR Color Cameras
    - Xsens GPS/IMUs
    - Velodyne Puck, Puck LITE, and Puck Hi-Res
  - Localization (NDT Matching)
  - Ground Filtering (Ray Classifier)
  - Object Detection (Voxel Grid / Euclidean Clustering)
  - Vehicle Interface (currently through Linux SocketCAN or simulation-specific interfaces)
  - Motion Control (Pure Pursuit / MPC)
- Currently targeting first demonstration ODD (Operational Design Domain)
  - First chosen ODD: Autonomous Valet Parking (AVP)

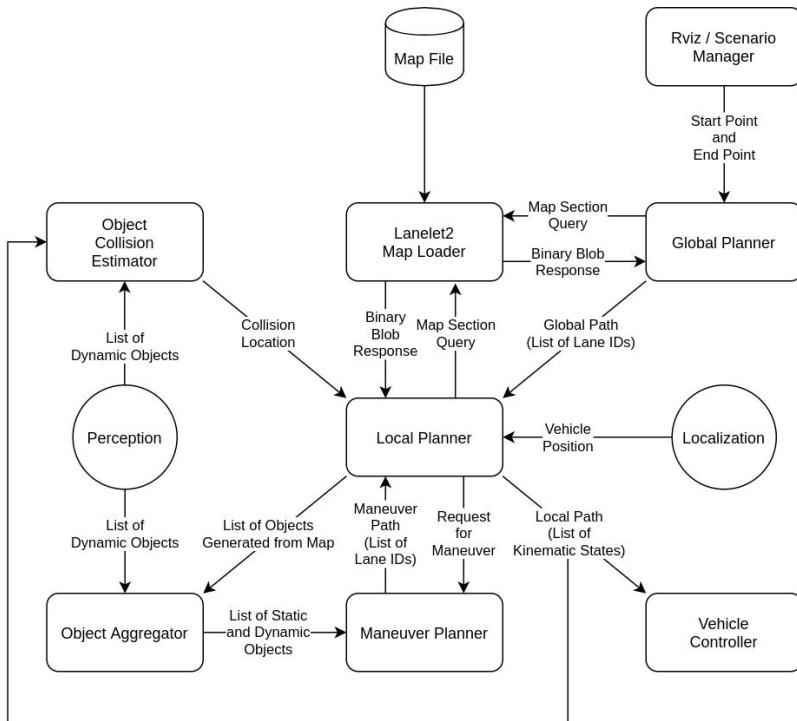


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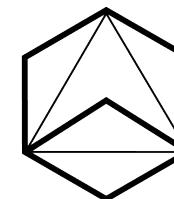


AUTOWARE.AUTO

# About Autoware.AUTO - Current Status



- AVP Status: Milestone 3 (current)
  - HD Map Integration
  - Route Planning
  - Navigation
  - Parking Maneuvers
  - Stopping for Obstacles



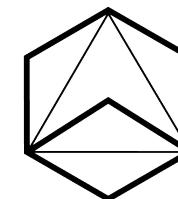
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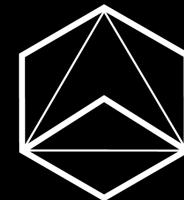
# About Autoware.AUTO - Future

- Milestone 4: On-vehicle Integration
  - Switching from simulation-only to real vehicle sensors and interfaces
  - Configuring hardware
  - Adding any necessary device drivers and vehicle interface nodes
- Milestone 5: AVP Demo!
  - Week-long hack-a-thon (date TBD due to COVID-19)
  - Developing GUI tools
  - Launch file clean-up
- Clean-Up Milestone 1: Post-AVP
  - Adding any missing documentation
  - Implementing best-practices learned during development
- Moving back to Github post-AVP

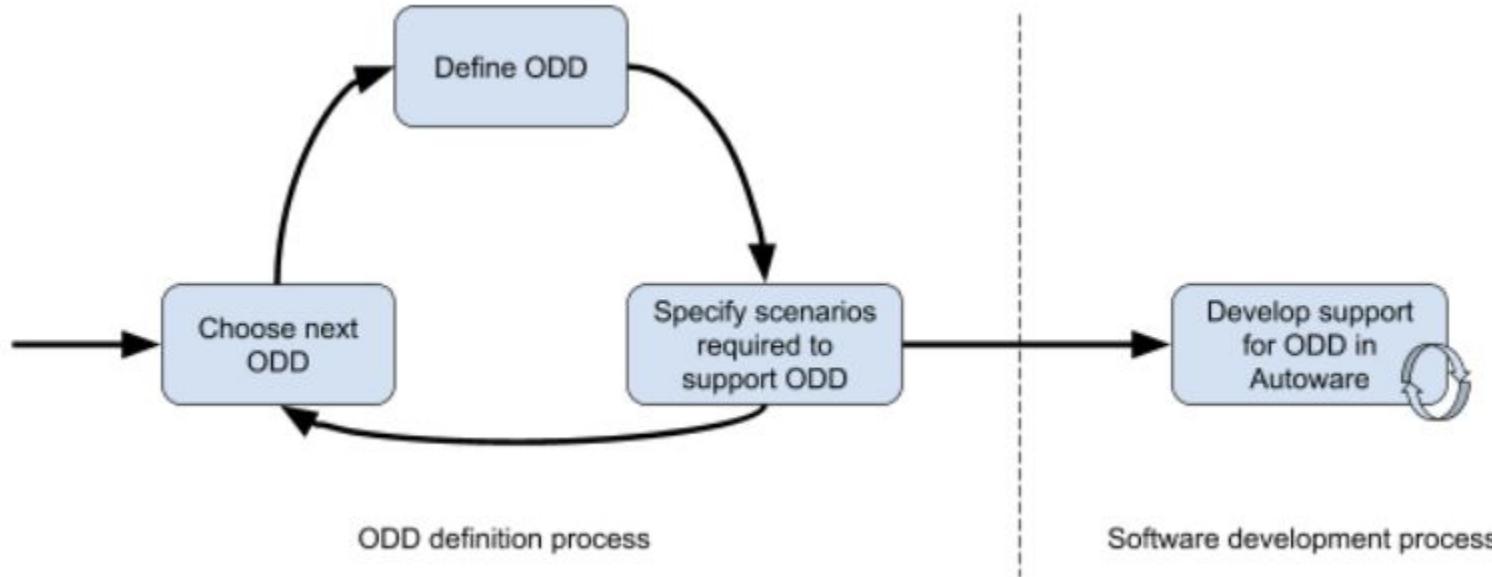


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# AWF Development Cycle



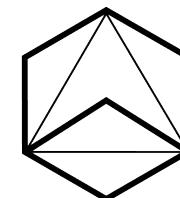
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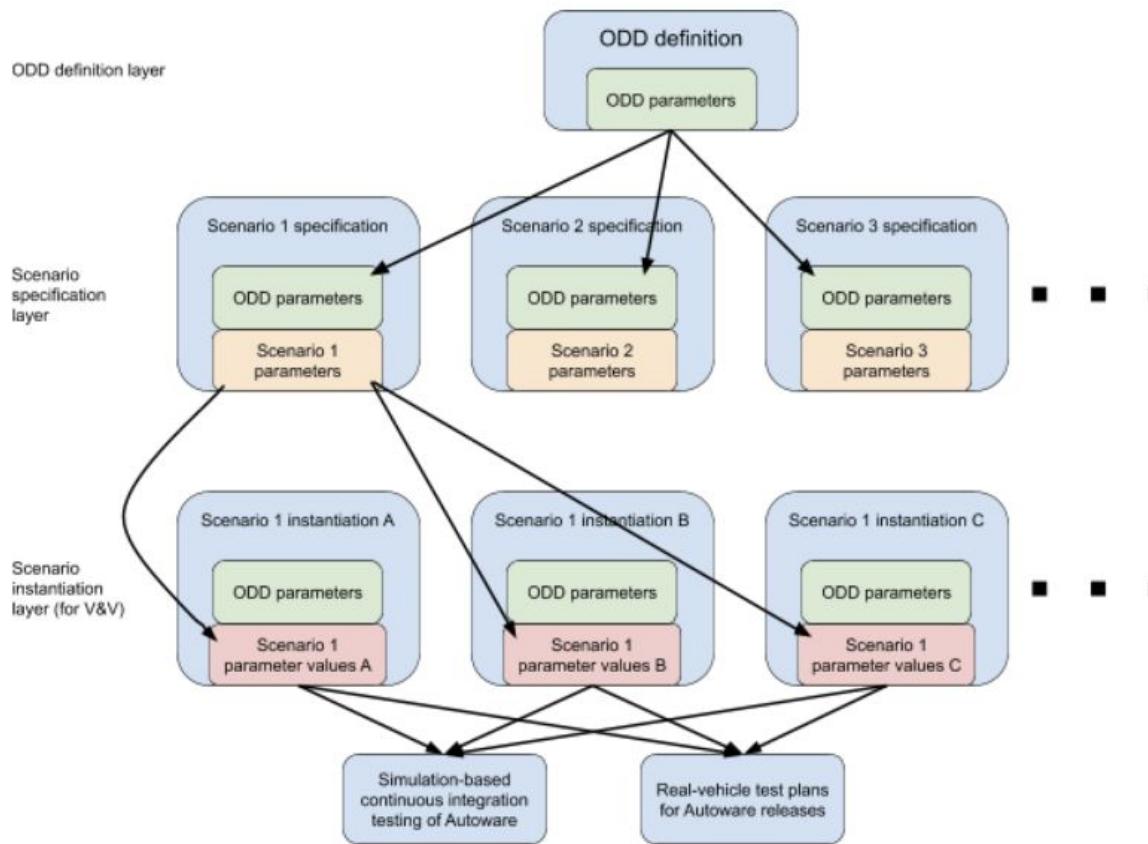
## ODD-Based Development Cycle

# ODD-based Development Workflow

- TSC chooses next ODD
- ODD Work Group (still being formed) scopes and defines ODD
  - Creates machine-readable set of test scenarios
- ASWG implements ODD requirements in Autoware.Auto
- AHWG creates hardware reference configurations and verifies hardware compatibility
- Validation and Verification Task Force uses machine-readable scenarios to validate ODD implementation



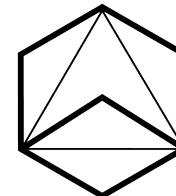
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## ODD-Based Development Cycle

# How to Contribute

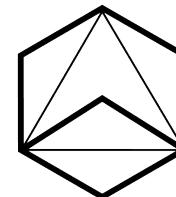
- Follow along on Gitlab! <https://gitlab.com/autowarefoundation/autoware.auto/AutowareAuto/-/issues>
- Learn how to contribute to open-source! <https://github.com/firstcontributions/first-contributions>
- Join us on Slack! <https://autoware.herokuapp.com/>
- Talk to us on Discourse! <https://discourse.ros.org/c/autoware/>
- Join the Foundation! [auto@autoware.org](mailto:auto@autoware.org)



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# Where to Get Support

1. Project-Specific Documentation
  - a. Autoware.AI - <https://github.com/Autoware-AI/autoware.ai/wiki>
  - b. Autoware.AUTO - <https://autowarefoundation.gitlab.io/autoware.auto/AutowareAuto/>
2. ROS Answers (<https://answers.ros.org/questions/scope:all/sort:activity-desc/tags:autoware/page:1/>)
3. File an Issue (**only for confirmed bugs or feature requests** -  
<https://gitlab.com/autowarefoundation/autoware.auto/AutowareAuto/-/issues>)



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