



Beluga vs. AMCL: The Localization Upgrade You Didn't Know You Needed



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This ebook will help you understand the limitations of Nav2's AMCL and why Beluga—developed by experts who work with localization every day—is a powerful, flexible alternative built for ROS 2. If you're working with mobile robots and need more control, sensor flexibility, and better maintainability, this is your sign to upgrade. Get practical insights, comparisons, and migration tips from the team behind Beluga.



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Beyond Nav2 AMCL — Modern Localization

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For years, the AMCL package has been the go-to localization method in ROS projects for indoor mobile robots, offering simple and efficient 2D pose estimation from LiDAR and odometry sensors. It implements the well known Adaptive Monte Carlo Localization method.

The package origins can be traced back to the very first versions of ROS, and some of the code dates from several years earlier. The most recent incarnation of the package is the Nav2 AMCL package under the umbrella of the Navigation 2 project.

During that time, the field of localization techniques has continued to evolve, and high quality, complex input sensors are now much cheaper and widespread than they were when AMCL was first introduced. Coupled with the availability of a high amount of embedded computing power, robot designers are no longer confined to the humble 2D lidar as the only localization helper. Depth cameras, Time-of-flight cameras, 3D lidars, and multi-camera arrays are only examples of the sensor arrays hardware frequently comes equipped with.

The original AMCL localization package has not kept pace with the times, however, and in fact the development of the project has slowed down over time. The AMCL code has long outlived far beyond what the original authors intended, and for that reason modularity, extensibility and maintainability were not inbuilt into the project when first created. Over time this has made it progressively more difficult to further develop new features into the code, and very few were added after the first few years. As of



today, the AMCL package is still constrained to 2D lidars and only two different drive types, not even closely in line with the variety of options available to robot designers today.

This was the state of affairs that inspired the Ekumen engineers to start the development of Project Beluga two years ago. The aim was to create a library of reusable components that robotic engineers can use to build custom localization solutions for their robots from first principles, and to use this framework to build a fully backwards-compatible AMCL localization package for ROS. The library is called Beluga, and the localization package built from it is Beluga AMCL.

Why Move Beyond Nav2 AMCL?



Beluga AMCL running on an Andino robot (Raspberry Pi 4B)

While Nav2 AMCL continues to provide localization services to countless robots, development of the project has mostly stalled and the project will most likely remain in maintenance mode for the foreseeable future.

The package provides limited sensor support, and the rigidity of the code makes it hard to extend or customize.



The Beluga localization library provides a path forward, offering the ability to create custom localization solutions from basic modules such as sensor models, and motion models.

The Beluga AMCL ROS package provides a near zero-effort transition path for current users of Nav2 AMCL willing to move to a Beluga-based localization system, and the node itself is in itself a blueprint showing how to use Beluga library modules to build a custom localization package system.

Meet Beluga and Beluga AMCL



Beluga AMCL running on an Turtlebot 2 robot (Raspberry Pi 4B)

Beluga is a modern C++17-based localization library designed from the ground up for maintainability, performance, and testability.

It provides composable modules that implement the basic algorithms needed to create a Monte Carlo Localization filter, such as sensor models, motion models, estimation algorithms, particle set management, resampling algorithms, and others.

Beluga AMCL is the Adaptive Monte Carlo Localization package for ROS 2, built out of Beluga library components. Beluga AMCL is fully backwards compatible with Nav2 AMCL, to enable a simple transition path for current users of the latter.



Benchmark Summary

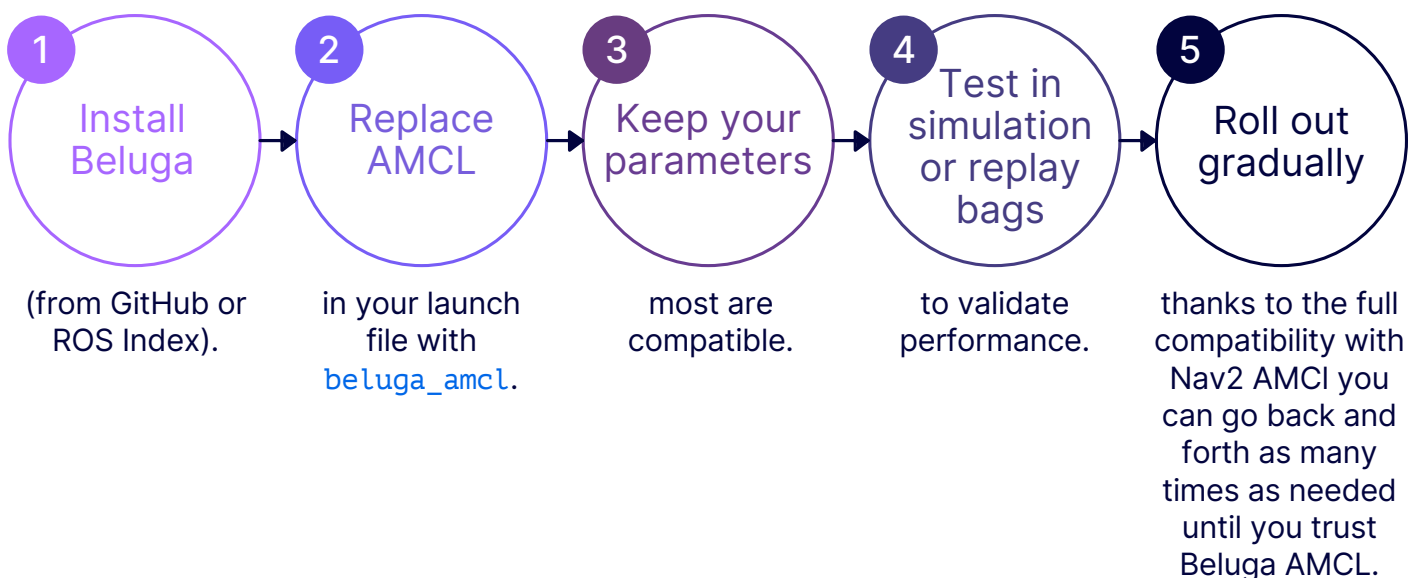
Beluga AMCL has been benchmarked using public datasets recorded on real robots to validate its performance head-to-head against Nav2 AMCL.

From the analysis of the results it can be seen that Beluga AMCL performs at the same level of accuracy of Nav2 AMCL for the same Adaptive Monte Carlo Localization configuration set.

Resource-wise, Beluga AMCL also closely matches the compute and memory footprint performance of Nav2 AMCL for most cases, while having a much lower memory footprint than Nav2 AMCL for certain configurations and application cases such as large map sizes.

Migrating to Beluga AMCL

Switching is simple:





Next-Week Checklist



- ☒ Read the docs and identify any parameter differences.
- ☒ Set up a simulation or testbag run.
- ☒ Install and run Beluga AMCL in your current setup.
- ☒ Compare outputs with Nav2 AMCL.
- ☒ Plan a real-world test and get team feedback.
- ☒ Define rollout steps for your full fleet.

KPIs to monitor: localization error, CPU/memory usage, and integration time for new sensors.

Ready to Go Beyond AMCL?

Beluga brings localization up to today's software standards—without breaking what already works. It offers the flexibility, maintainability, and extensibility that modern robotics projects demand, preparing your system for future needs and new sensor integrations.

If you want to experience the benefits of Beluga firsthand or need help migrating your localization stack, feel free to contact Ekumen at contact@ekumenlabs.com. We are already assisting other companies in adopting Beluga and can help tailor the solution for your unique robotics challenges.



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