How do /cmd_vel, /odom, and /scan work together to enable robot navigation?

In a ROS-based navigation system, the topics **/cmd_vel**, **/odom**, and **/scan** work together to achieve autonomous robot movement.

The **/cmd_vel** (command velocity) topic carries motion instructions in the form of linear and angular velocities. These values are generated by a planner, controller, or teleoperation node and sent to the robot's base. The motor controllers then execute these commands, causing the robot to move in the desired direction and speed.

The **/odom** (odometry) topic provides continuous feedback about the robot's position and orientation relative to a starting frame. It is typically calculated using wheel encoder data and, in some cases, fused with IMU inputs for improved accuracy. Odometry allows the navigation stack to estimate how far the robot has traveled after receiving velocity commands, enabling localization and path tracking.

The **/scan** topic streams data from a LiDAR or laser scanner. It publishes distance measurements that describe the surrounding environment. This information is used for obstacle detection, collision avoidance, and mapping. By interpreting the laser readings, the navigation system can plan safe paths around objects.

Together, **/cmd_vel** provides control, **/odom** ensures position awareness, and **/scan** offers environmental perception, forming a closed-loop system for reliable navigation.