



16 October 2024

Self-Driving Sugarbeet Truck Deployment

NDSU UGPTI Autonomous Trucking Conference

Adapting technology developed for the military to increase safety, mobility, and economic vitality within critical commercial supply chain operations.



NDSU UPPER GREAT PLAINS
TRANSPORTATION INSTITUTE



Introduction to Kratos Defense

INTRODUCTION – Kratos Defense

ABOUT Kratos Defense & Security Solutions (NASDAQ: KTOS)

Kratos is a Technology Company in the Defense, National Security, and Global Markets that develops and fields transformative, affordable systems, products, and solutions for United States National Security, Allied Nations, and Global Commercial Enterprises.

Kratos applies leading-edge technologies for:

- Reduced risk and faster deployment
- Real systems working today
- Affordability, especially where scale matters: dollars, units, users, and attrition
- Technology advances that can provide a force multiplier effect
- Forward-looking, fast-acting, and responsive business practices



- Over 3000 Employees
- National Security Focused
- AS9100 / ISO9001 / NIST800-171
- 60+ Locations Worldwide
- 60/40% Production/Services
- Fast Acting & Responsive
- Leading Edge vs. Bleeding Edge
- Force Multiplier Solutions

At Kratos, Affordability is a Technology, and we are changing the way breakthrough technology is rapidly brought to market with products, systems, and technologies in key core areas.

KRATOS[®]
UNMANNED AERIAL SYSTEMS
READY FOR WHAT'S NEXT[™]

Technology

In the Leader Follower Platoon configuration, Navigation data is transmitted from the human driven “Leader” vehicle to the driverless Follower enabling it to navigate its route completely uncrewed.

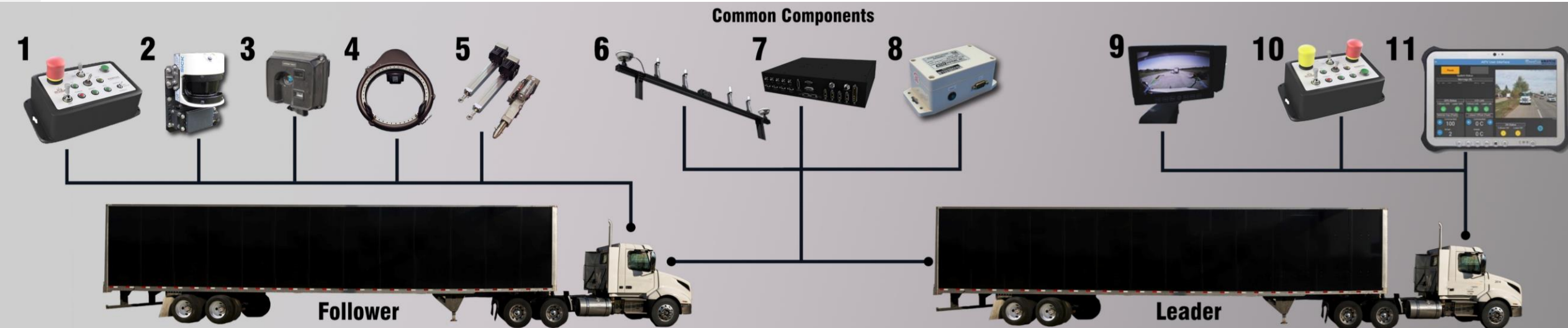
- **System Redundancy** – Includes independent simultaneous navigation, Encrypted Frequency-Hopping, V2V Communications, Fault Monitoring, Obstacle Detection/Avoidance User Interface, Braking Control, E-Stop, Cybersecurity Hardened, **Human in the Loop**
- **Precision Navigation** – Simultaneous RTK GPS for enabling Centimeter-level accuracy and precision INS for GPS-degraded env.
- **Deployment Configuration** – Currently 1 Leader + 1 Follower

Key Advantages for Platooning:

- Enhanced Safety Profile
- Flexible ODD
- Maintained Work Force
- Business Enabler
- Mitigated Edge/Corner Case Complexity
- Recognized Acceptance
- Weather Resilient



The Leader vehicle driver can monitor and control the driverless Follower from the Graphical User Interface



- 1. Safety Rider Operator Control Unit (OCU)** – User interface for system boot-up, manual take-over control interface, E-Stop initiation.
- 2. Front-view Obstacle Detection** – Simultaneous 2D LiDAR and Radar providing 190° forward-view obstacle and vehicle gap intrusion detect and avoid.
- 3. Side-view Obstacle Detection** – 2D LiDAR left- and right-side providing 90° obstacle detection / blind spot situational awareness.
- 4. Steering Actuator** – Bolt-on steering actuator for left/right follower vehicle steering.
- 5. Brake and Throttle Actuators** – Bolt-on brake and throttle actuators for vehicle speed control with Primary and Backup brake actuation.
- 6. Communications & Sensor Rack** – Includes V2V communications, Dynamic RTK (DRTK) GPS antennas, and LiDAR.

- 7. System Control Unit (SCU)** – Modular computer processing system with integrated navigation, V2V communications, and power system.
- 8. Inertial Navigation System (INS)** – Inertial Measurement Unit (IMU) integrated with the navigation system for enhanced and GPS-denied/degraded operation.
- 9. Video Display** – Provides POV from Follower to Leader vehicle and/or remote Control Console.
- 10. Leader Driver OCU** – User interface for system boot-up, A-Stop (yellow) initiation, and Independent E-Stop (red) initiation.
- 11. Graphical User Interface (GUI)** – Leader driver and/or remote Control Console monitor and control system interface.

Deployments

DEPLOYMENT – A proven technology legacy

Kratos offers a legacy of driverless vehicle technologies developed and field-proven with the military then adapted for commercial deployment.

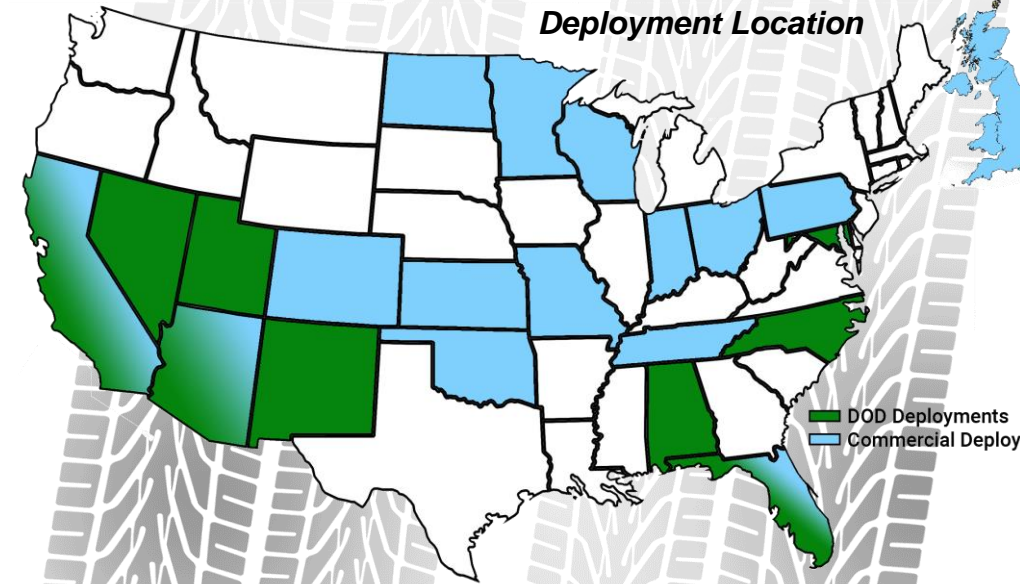
- Field-proven Driverless Technology solutions
- Demonstrated adaptable to diverse ODD deployments
- Proven capable on multiple vehicle types
- Hardened for harsh locations/environments
- Established track record of successful operation

Developed for Defense – *Developed to Enhance training Effectiveness and to Increase Warfighter Safety in dangerous mobile combat/tactical scenarios.*

Adapted for Work Zone Safety – *Adapted to Increase Worker Safety in dangerous mobile highway maintenance Work Zone operations.*

Adapted for Supply Chain Hardening – *Adapted to Enhance supply chain activity augmenting the driver pool hardening the supply chain and enabling business continuity.*

*Nationwide and International
Deployment Location*



Kratos has deployed the first self-driving truck platoon in North Dakota, hardening agriculture supply chain activity against the impacts of truck driver shortages.

- **Maintains** operational capabilities during driver shortages
- **Maximizes** operational and transportation efficiencies
- **Optimizes** production capacity per delivery
- **Enhances** safety

This effort achieved the FIRST:

- North Dakota Leader Follower Platoon
- Northwest Passage deployment location
- Agriculture hauling operation
- Winter deployment under harsh snow/ice conditions
- Self-Driving truck deployment in temperature extremes ranging between -6° to 20°F
- Caged-flatbed trailer deployment
- 99,000 pound haul deployment (each truck with fully loaded trailer)

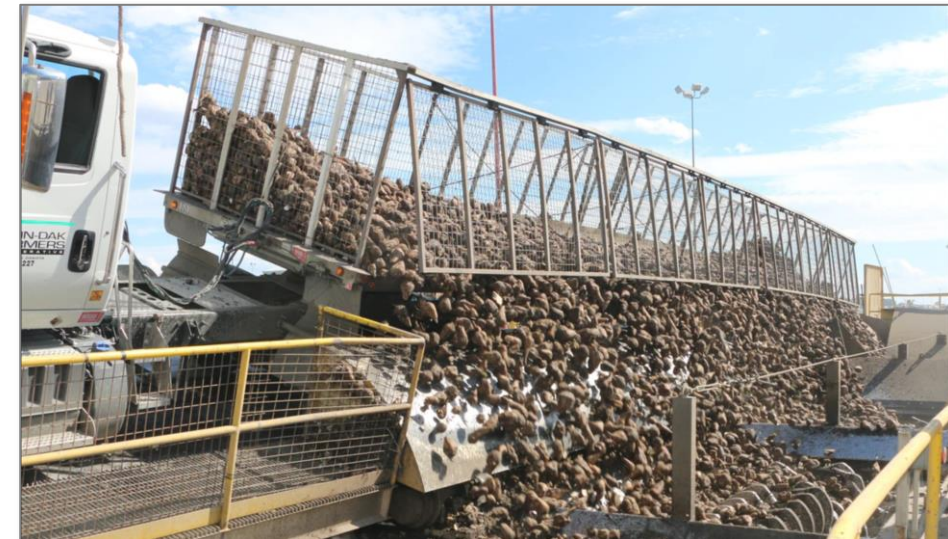


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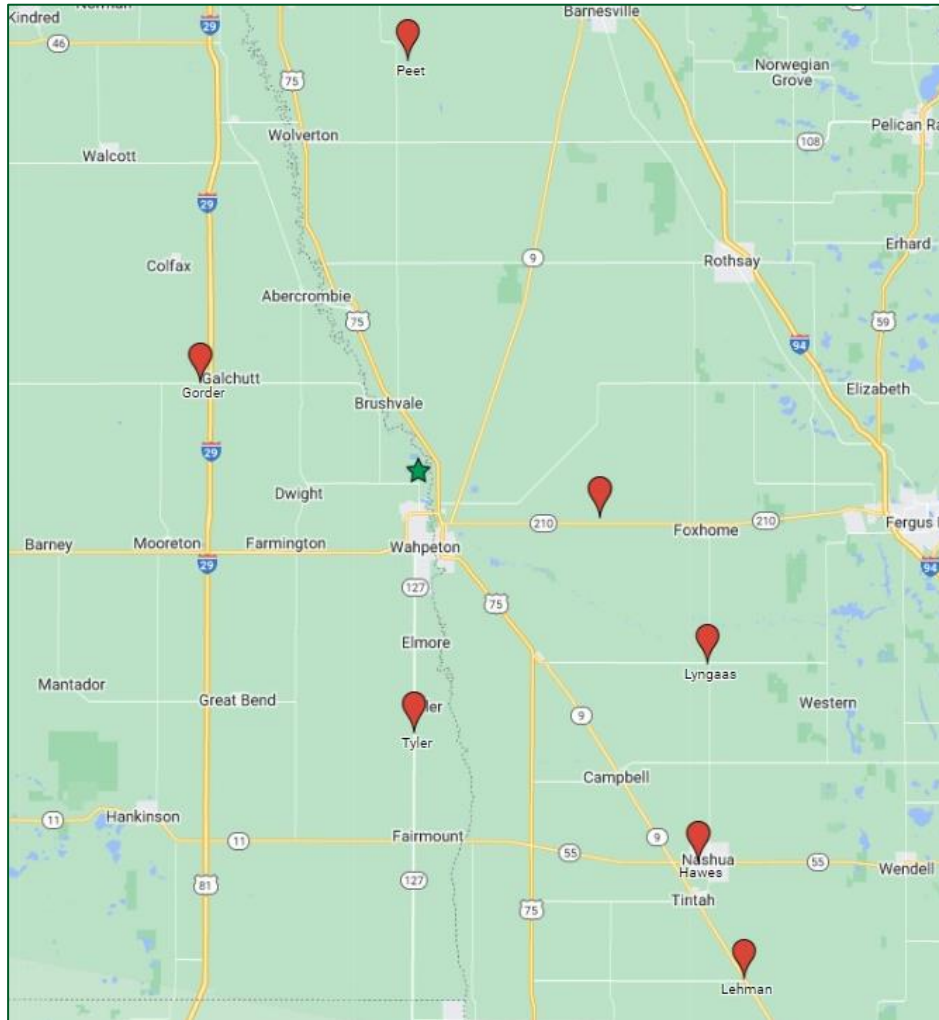
- **Deployment** – From the MDFC processing facility
 - Over the road transportation in automated driving mode
 - Navigation data map provided in near-real time to the driverless follower as leader vehicle drives to loading/unloading locations

- **Loading** – 7 Piling locations distributed across ND and MN
 - Vehicles are loaded while maintaining platooning configuration
 - Once loaded, leader and follower vehicles leave site in automated driving mode.

- **Unloading** – Unloaded at the MDFC processing facility
 - Unloading will require manual driver individually position each truck on the unload platform
 - Once unloaded the leader and follower vehicles are re-aligned in the platooning configuration prior to exiting the facility.



There are seven piling locations distributed across North Dakota and Minnesota feeding the MDFC facility that are being supported with the Kratos auto-platooning system



- **Operating between November and May**
- **Safety Rider onboard Follower at all times**
- **Deployed to North Dakota and Minnesota* locations**
- **Supporting Supply Chain Activity 24/7**

North Dakota Deployment – Approved for full auto-platooning

- Supported 2022/2023 and 2023/2024 Harvest Seasons
- Galchutt and Tyler Piling Locations

Minnesota Deployment – Limited by State Reg/Leg policies

- Supported 2023/2024 Harvest Seasons
- Deployed in full-auto platooning up to the Minnesota Stateline and Idle platooning mode in Minnesota
- Yaggie, Lyngaas, Hawes, Lehman, Peet Piling Locations

North Dakota and Minnesota have legislation to support limited automated platooning, but updates will be required moving forward to enable greater deployment activity

North Dakota – Legislative/Regulatory Updates Needed

- Enable a driverless Follower

Minnesota – Legislative/Regulatory Updates Needed

- Enable deployments on non-trunkable roadways
- Enable a driverless Follower



