



## Guardian® S Fact Sheet

### About the Guardian S Robot

The Guardian S robot is a revolutionary, first-of-its kind cloud-connected mobile Internet of Things (IoT) and sensor platform that provides inspection and surveillance capabilities to augment human-based inspections in challenging environments. With a uniquely capable, cost-effective and versatile form factor, the Guardian S can be tele-operated from miles away, can reliably traverse challenging terrain including stairs, culverts, pipes, tanks and ferromagnetic vertical surfaces (magnetic version only), and can facilitate two-way real-time video, voice and data communication between the human operator and robot. It assists workers on the job by removing them from direct involvement in hazardous situations, reducing their risk of injury and saving lives.

Weighing ~17 lbs., the Guardian S robot is designed specifically to navigate uneven or challenging terrain and to access small, confined spaces with a 7" diameter opening, going where humans either cannot or should not go. It has garnered industry recognition from Fast Company, Best in Biz, TechConnect Defense and named IEEE Spectrum's ["Robot of the Week"](#) in May 2019.




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### Key Product Attributes

The Guardian S robot makes inspections and remote surveillance safer and more effective:

- Multi-purpose, man-portable mobile IoT platform
  - Built-in, customizable sensor module gathers real-time information
  - Able to transport up to ~10-pounds of additional task-specific sensors while traversing a horizontal surface via an optional payload platform
  - Optional advanced analytics and predictive maintenance functionalities enabled through the Sarcos Command Center
- All-terrain, state-of-the-art visual surveillance
  - Tele-operates & traverses challenging terrain: stairs, culverts, pipes, tanks, and vertical ferromagnetic surfaces
  - Slim form factor enables access to confined spaces (7" diameter openings)
  - Up to 12 hours of surveillance time or ~ 3-mile travel range
  - High resolution visual inspection enabled by six 4K cameras with digital zoom & autofocus with 360° color
  - IP65 certification makes it water protected (dust-tight and protected from water projected from a nozzle)
- Two-way, real-time video, voice, and data communication
  - Built-in, enhanced Wi-Fi and radio connection between the OCU and robot
  - Built-in LTE modem for future cloud-based services (700MHz)
  - Two-way audio between OCU and robot (half duplex PTT)
  - Audio signals and video streams encrypted using state-of-the-art 256-bit AES encryption

- Optional cloud-computing functionality
  - Implemented through the Sarcos Command Center; incorporates all aspects of robot control, data gathering, and analysis in an easy-to-use cloud-based platform:
    - Asset management: Trace, track and understand asset location and health
    - Authorization and Authentication: Authorizes access to robotic control or sensor data
    - Mission Management and Review: Set-up, execution and post-operation review of the sequences of missions and operations
    - Data Collection and Storage: Managed collection and storage
    - Data Analysis: Easy-to-use tools for analyzing collected data
  - Future ability to leverage machine learning, artificial intelligence and enhanced sensors for advanced analytics and predictive maintenance in industrial inspection applications

Industry Applications	The Guardian S robot is a versatile, multi-purpose platform designed to address a vast number of uses cases. It has applicability in industries ranging from defense, public safety, security, non-destructive testing, disaster recovery, infrastructure inspection and maintenance, aerospace, maritime, oil and gas, petrochemical, and mining.	
Availability	The Guardian S robot is commercially available now.	
Information and Images	<p>For more information on the Guardian S robot, please visit: <a href="http://www.sarcos.com/guardian-s">www.sarcos.com/guardian-s</a></p> <p>For imagery of the Guardian S, please visit: <a href="http://www.sarcos.com/media-kit/">www.sarcos.com/media-kit/</a></p>	
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## Guardian® GT Fact Sheet

### About the Guardian GT

The Sarcos Guardian GT robot is a first-of-its-kind large scale industrial exoskeleton robot that provides an unparalleled combination of dexterity and strength for the operator. Mounted on an agile vehicle base that can be powered by batteries, diesel, or natural gas, the single or dual-armed system can lift and manipulate payloads up to 1,000 pounds, dexterously, and with little human effort. Utilizing the Sarcos proprietary high-fidelity force reflection technology, the operator feels the scaled forces experienced by the robot arms, whether the operator is riding inside the robot, or the system is teleoperated from miles away.

The Guardian GT robot has been successfully demonstrated to improve material handling and assembly significantly, safely completing in minutes tasks that typically take several workers many hours to perform, while minimizing the risk of human injury. It is relevant to a magnitude of global markets, including commercial/industrial, public safety, logistics, disaster recovery, nuclear, maritime, petroleum, construction and heavy equipment manufacturing, and others. The Guardian GT earned the Frost & Sullivan 2017 North American Technology Innovation Award in the dexterous mobile robot category because of the impact it will have across all these industries and was named IEEE Spectrum's "[Robot of the Week](#)" in November 2018.

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### Key Product Attributes

#### **Intuitive to Use**

The Guardian GT robot's seven-foot arm boasts seven degrees of freedom, plus a task set-specific end effector that allows the operator to reach objects seven feet in front and to the sides of the mobile platform. These arms act as a natural extension of the operator's own arms and are kinematically equivalent to the human body so that the Guardian GT robot's arms move in the same direction, with the same speed and at the same time, as the human operator's movement. As a result, the Guardian GT robot's system is intuitive, robust, and safe to operate even in dangerous or hazardous environments. It requires minimal training and enables handling of difficult-to-manipulate objects with a high degree of control.

#### **Highly Dexterous**

The Guardian GT robot can execute an almost limitless number of dexterous tasks such as utilizing off-the-shelf power tools to perform mission-specific functions like cutting, grinding and finishing, plasma cutting, cleaning, and joining. It can also acquire and empty a disposal bin, turn valves, push buttons, place pipes for connection, and assemble large pipe flanges on to mating flanges with studs.

## Energetically Autonomous

The Guardian GT robot is energetically autonomous, using batteries, diesel fuel, or propane for the energy source, allowing it to be truly mobile, with seven hours or more of continuous operation.

Use Cases / Tasks	<p>Examples of dexterous tasks that could be performed by the Guardian GT robot include:</p> <ul style="list-style-type: none"><li>• Allows ship-building workers to accomplish in one to three minutes what it takes two or three people eight to 12 hours to complete, and do it far more safely (e.g., picking up plates for welding, extracting pieces from a burn table, handling heavy materials, etc.)</li><li>• Provides nuclear power plant cleanup and decommissioning by performing precision removal and disposal of parts and hazardous materials; Can be teleoperated for nuclear reactor inspection and maintenance</li><li>• Utilizes off-the-shelf power tools to perform mission-specific functions like cutting, welding, grinding and finishing, plasma cutting, cleaning, joining, and applying protective coatings</li><li>• Turns knobs, pushes buttons, places pipes for connection, assembles large pipe flanges onto mating flanges with studs</li><li>• Palletizes and de-palletizes, loads and unloads supplies</li><li>• Erects temporary shelters and repairs equipment</li><li>• Provides humanitarian assistance, safely moves heavy rocks and debris in a controlled manner and assists with Med-Evac</li></ul>
Availability	<p>The Guardian GT robots are built to order based on each customer's unique requirements.</p>
Information and Images	<p>For more information on the Guardian GT, please visit: <a href="http://www.sarcos.com/guardian-gt">www.sarcos.com/guardian-gt</a></p> <p>For imagery of the Guardian GT, please visit: <a href="http://www.sarcos.com/media-kit/">www.sarcos.com/media-kit/</a></p>



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## Guardian® XO® Robot Fact Sheet

### About the Guardian XO Exoskeleton Robot

The Sarcos Guardian® XO® full-body battery-powered exoskeleton is a first-of-its-kind wearable robot that enhances human productivity while keeping workers safe from strain or injury. Based on research and development initially funded by DARPA starting in 2000 and based on a prototype that has been recognized as one of the world's leading innovations, the Sarcos Guardian XO wearable robot represents the next step in the evolution of high-performance, highly dexterous, mobile robots. Time Magazine selected an early prototype as the Innovation of the Year.

The Sarcos Guardian XO exoskeleton enables workers to perform hours of physical activity, including repetitively lifting and manipulating heavy or awkward objects, that would otherwise be impossible for a single human to perform. The Guardian XO exoskeleton is capable of repeatedly lifting and manipulating up to 200 pounds without fatigue or strain with near-continuous operation with hot-swappable batteries. The human operator bears none of the weight of the exoskeleton or its payload, and it can be donned and doffed in under one minute. It also requires minimal operator training because it permits natural, fluid, and intuitive movement.

The Guardian XO exoskeleton is relevant to a multitude of large global markets, such as manufacturing of all types, construction, utilities, logistics, oil & gas, automotive, aviation, public safety, and defense industries.

Offered via a fee-based Robotics-as-a-Service (RaaS) model, the Guardian XO exoskeleton delivers multiples of an individual employee's productivity for the cost of a single employee, while reducing costly occupational injuries, creating a clear and compelling return-on-investment for Sarcos customers.

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### Key Product Attributes

#### **Power Consumption**

The Guardian XO exoskeleton robot is designed to operate near continuously with hot-swappable batteries. It is extremely power efficient, requiring ~400 watts of power while walking at human speed, which represents a 90+ percent reduction in power typically required for humanoid robots. Additionally, the Guardian XO robot is designed to allow its battery modules to be "hot-swapped" in the field within seconds without loss of power to the unit.

#### **Reducing Load Strain**



The Guardian XO exoskeleton robot does not add weight or inertia (metabolic drag) like unpowered exoskeleton technology. Instead it supplies the energy to handle itself. The robot can offload up to 100 percent of the weight the worker is bearing through the suit's structure to the ground, reducing the operator's metabolic output and the chance of strain or injury.

#### **Safety**

The Guardian XO exoskeleton robot enables workers to safely and easily lift up to 200 pounds repeatedly without exertion, strain, or injury. It prevents both daily fatigue and long-term physical degradation from humans performing physically taxing jobs. The Guardian XO robot is equipped with scaled dexterous end effectors and force feedback features enabling an operator to easily perform highly precise tasks with heavy tools or components. The Guardian XO robot also contains built-in software controls that manage what should and shouldn't be done in the suit. These controls help prevent workers from performing unsafe tasks.

## **Ease of Use**

The Sarcos Guardian XO exoskeleton allows humans wearing the suit to move in a natural, fluid, and intuitive manner while working on a variety of terrains. It also enables access to tight or confined spaces that big machinery cannot operate within. Utilizing the Sarcos proprietary advanced control system, called the "Get-Out-of-the-Way" control, the Guardian XO exoskeleton is designed to eliminate any perception of latency between the movement of the human operator and the exoskeleton. The control system relies on a suite of sensors integrated into the exoskeleton, foregoing the need to affix sensors directly onto the human body. This control system enables the Guardian XO exoskeleton to respond to the operator's movements in milliseconds, allowing the operator to intuitively control the robot in a way that leverages their instincts and reflexes and minimizes the need for extensive human training.

Availability	"Alpha" units of the Sarcos Guardian XO exoskeleton will begin shipping to customers in early 2020 with commercial availability in late 2020.
Information and Images	<p>For more information on the Guardian XO exoskeleton, please visit: <a href="http://www.sarcos.com/guardian-xo/">www.sarcos.com/guardian-xo/</a></p> <p>For imagery of the Guardian XO exoskeleton, please visit: <a href="http://www.sarcos.com/media-kit/">www.sarcos.com/media-kit/</a></p>
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<https://www.youtube.com/c/sarcosrobotics>

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