ADLINK
Leading EDGE COMPUTING

Accelerating Development of Smart Medical Robots

ADLINK Helps Robot Makers Bring Hospitals into the Future with ROS 2 Solutions

www.adlinktech.com

Current Developments and Challenges for Smart Medical Robots

Aging populations and low birth rates are becoming the norm around the world. Improvements in quality of life have led to increasing emphasis on the quality and safety of medical care. The increasing labor requirements of the medical industry that logistics now plays an important role in medical systems. Medical logistics encompasses the routine operations and management activities of every hospital department, from the transmission of administrative documents to the delivery of medical supplies and specimens. Increasing awareness of the risks posed by transmission of infectious diseases has put the spotlight on automation in the medical industry and the shortages in medical workers. Medical robotics is now a critical technology used for standard tasks such as hospital disinfection, cleaning, delivery of medical resources, and care of patients under quarantine. Their use greatly enhances the efficiency and standard of care in hospitals by reducing the workload of medical staff and preventing cross-infection.

How quickly robot makers can develop medical robots for special applications will be a key future indicator of leadership in smart healthcare. ADLINK drew on years of experience in the development of industrial can be used with my correction in highlight Internet-of-Things (IoT) platforms and ROS 2 (Robot Operating System 2) technology to offer a highly flexible, high integrated and highly compatible solution that can help hospitals and robotic system integrators realize the vision of rapid development for smart medical service robots.

Medical Service Robots Key to Medical Logistics

In a traditional hospital, most of the logistics is handled manually. There is no clear distinction between the routes used by people and supplies. Hand-delivering supplies the conventional away also incurs the risk of cross-infection between different types of staff. Items may also become contaminated, damaged or lost. In recent years, the robotics industry has made rapid advances in robotic sensors, decision-making and control systems thanks to continued improvements in robot operating systems, artificial intelligence (AI) technologies and communications.

The most widespread applications of medical service robots right now are transporter robots and disinfection robots. Both types of robots offer immediate benefits for reduction of cross-infection, and improved operational efficiency.

Transporter Robots: One of the huge challenges facing hospitals today is the shortage of medical staff. Transporter robots can deliver supplies 24 hours a day, 7 days a week. They can also be used to replenish medical devices. The introduction of a smart, high-performance system for transporting supplies can distribute supplies more efficiently and greatly reduce the risk of cross-infection.

Disinfection Robots: Hospital-acquired infection (HAI) is another thorny issue facing hospitals today. The use of disinfection robots can lower the risk of infection by reducing the amount of contact between staff and pathogens. Such robots can automatically scan the hospital environment and recommend a disinfection path. They can also detect badly contaminated surfaces for heavy-duty disinfection. Intelligent programming ensures that disinfection tasks can be completed with high efficiency.

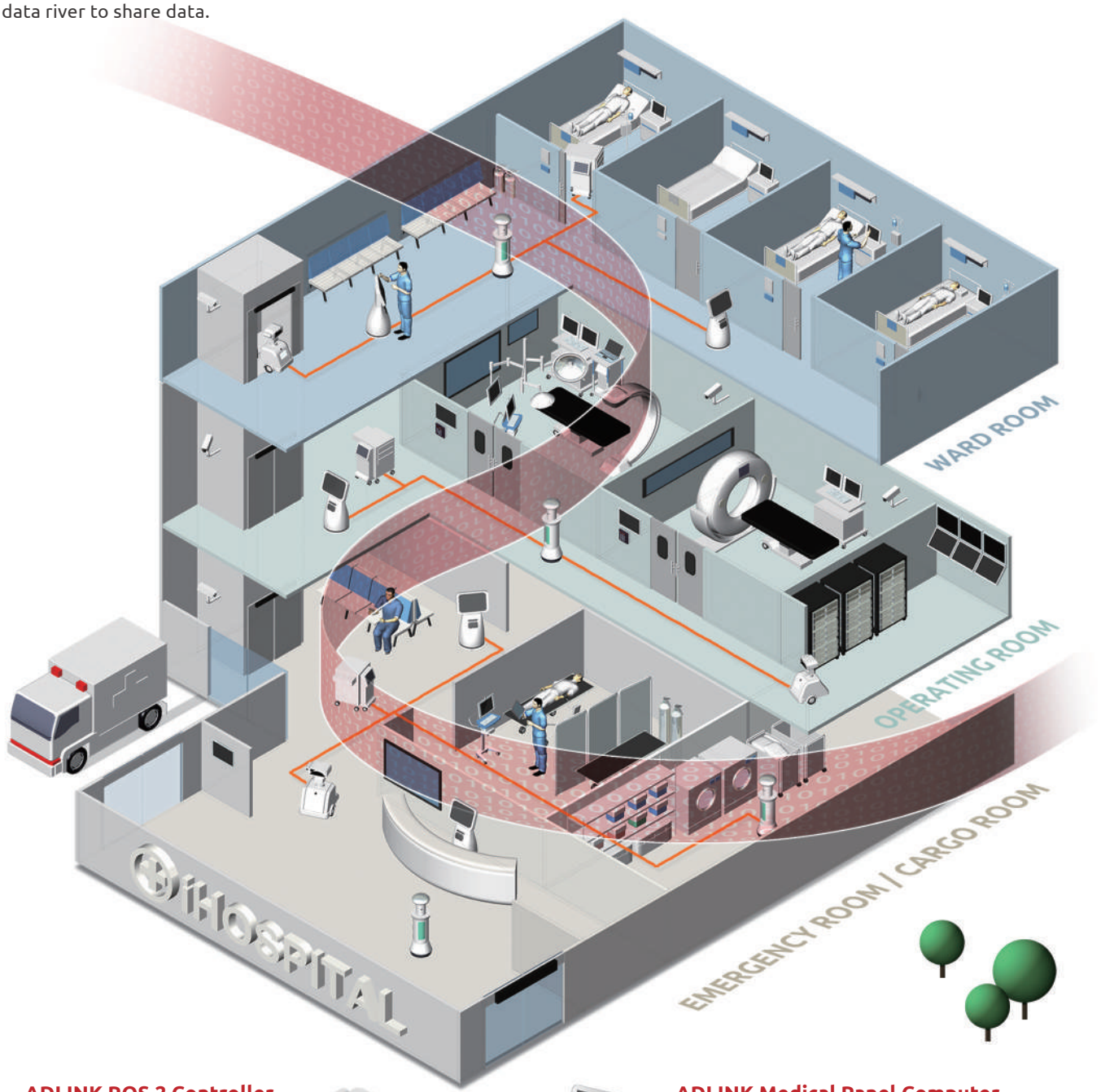
The introduction of medical service robots offers the following advantages for hospital logistics:

- ***Separation of supply deliveries reduce risk of cross-infection or disease transmission***
- ***Highly flexible deployment that can be progressively expanded from partial to complete hospital coverage***
- ***Makes the hospital smarter and more competitive***

ROS 2 & DDS Data River

Using DDS as a backbone, ROS 2 provides a uniform data exchange environment, like a data river, for Autonomous Mobile Robots (AMRs) to communicate with each other in a hospital.

Other equipment adopting DDS technology such as medical panel computers can also use the data river to share data.



ADLINK ROS 2 Controller

ADLINK Medical Panel Computer

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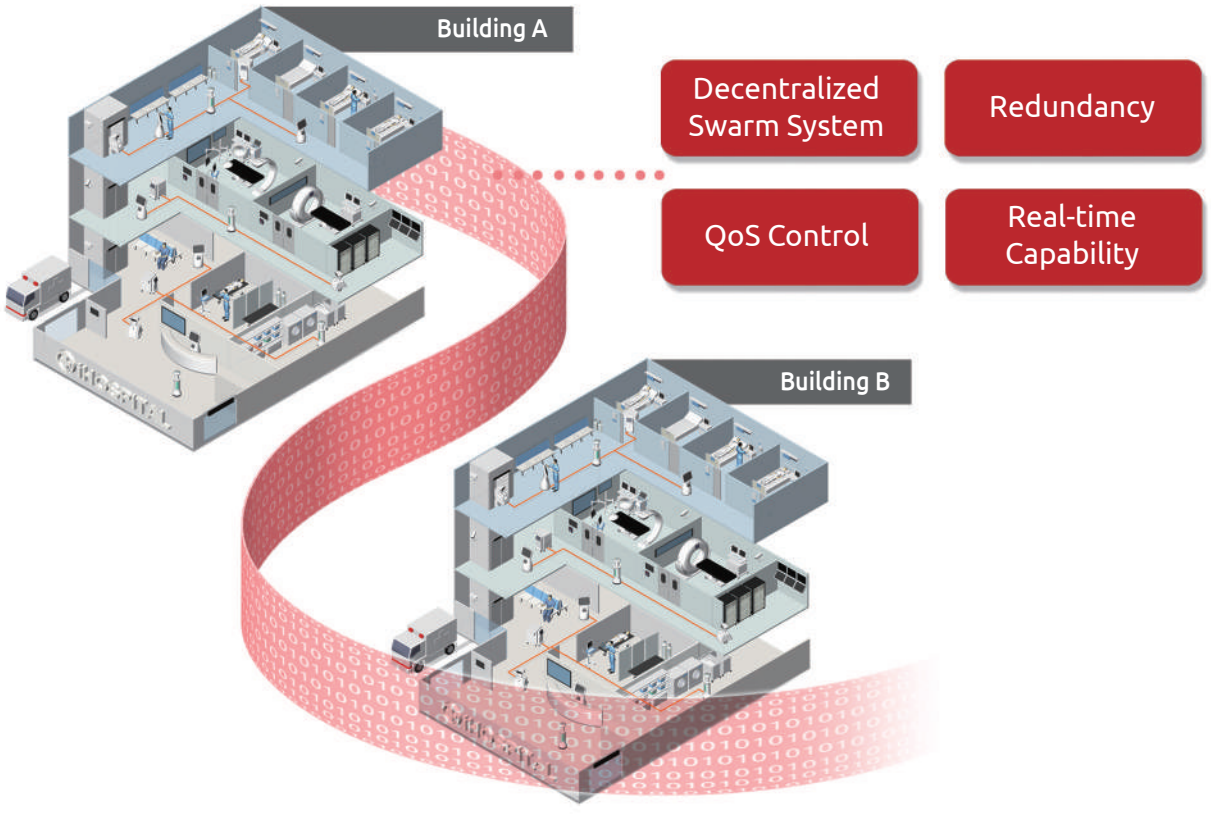
Future Trend will be Data Integration with Medical Systems

Equipment in traditional hospitals are not connected to each other. The robots or medical instruments are all stand-alone entities operating independently. Instruments have stand-alone functionality and medical personnel can only check on the patient's condition using conventional manpower or telephone calls. There was no real-time connection with front-end medical systems. Development of the Internet has given renewed impetus to smart medicine. Robots are no longer stand-alone systems and their connectivity is emphasized. Issues that hamper the free flow of information inside and outside of the medical facility include different network domains as well as communication latency and non-real-time operation. There was no short-term solution to these problems due to deficiencies in the basic structure that lower treatment efficiency. The question of how to provide a sound communication environment and an effective intermediary platform for data exchange highlight the increasing importance of communication quality in smart medicine.

Hospital robots perform their missions in different buildings and on different floors. They also cross between different network domains. In the past, robots must all be connected to the central control center. What a robot does next must be processed using a centralized architecture, a configuration that imposes a very high burden on the system. There is also a lag in commands and actions. Robots can also lose their network connection when entering or exiting an elevator. The communication disruption causes errors during the transmission of commands and data. Here communication technology compatible with Data Distribution Service (DDS) can share robot data in real-time and carry out collaborative edge-computing to decide the most best robot for a mission, repeatedly re-calculate the subsequent schedule, and boost the overall efficiency of collaboration; personnel can also collect data and statistics remotely over mobile devices as well as issue and assign missions in real-time. The use of distributed edge-computing can boost the quality and stability of the data interface with the medical system to realize a smart data-sharing model for smart medicine.

Benefits of ROS 2 & DDS



Application of ROS 2 & DDS in a Smart Medicine Framework

Accelerate Development by Using ROS 2 as Development Platform for Medical Service Robots

ROS 2 is a design framework proposed by the Open Source Robotics Foundation (OSRF). As an open source operating system for robots, ROS 2 is easy to use, highly functional and boasts a large library of resources. A core design based on DDS means the ROS 2 system truly takes advantage of robotic systems and is particularly well-suited to complex scenarios involving robots working in collaboration. It is now extensively used in many types of robots. The ROS 2 system has the two following advantages:

- *Rich library of robot functions allows for rapid prototyping of anti-epidemic robots*
- *Introduction of DDS military-industrial-grade communication platform to ensure the reliability of the robot system*

ROS 2 offers strong support for the distribution of data between devices and robots as well as the transmission of cloud data. Real-time transmission performance is also very high. Smart medicine is now trending towards an increase in the number of hospital devices and robots. Using ROS 2 and DDS, all that data can be shared in real-time through a unified data exchange framework between a hospital's static devices and moving robots in order to satisfy the requirements of future smart medicine scenarios.

Data Integration between Medical System Units through DDS

Unlike standard transmission protocols based on a publication and subscription model, the spirit of DDS calls for a rigorous hierarchical architecture with low latency and high throughput where each user can define the communication quality required. Hospital information can be updated in real-time for each unit to keep the medical personnel up to date at all times. Robots can also use DDS to share data and mission priority. The most suitable robot for performing a mission can then be selected to maximize robot utilization. Despite the size and complexity of such an information-sharing network, DDS can be easily configured to optimize and enhance the overall network efficiency.

Hospitals and government agencies can use the DDS method to bridge/share data for real-time monitoring, redundancy and synchronization. The advantages of DDS allow for units to be quickly connected to each other. Data in the medical system can be shared to each unit, reducing the unequal distribution caused by out-of-date information and improving the execution efficiency of smart medicine. Imagine such a scenario: Once the diagnosis of a patient has been confirmed, an ambulance from an external agency can immediately upload the status of the infected patient to electronic health record (EHR) databases and the hospital for optimal dispatching. The patient can then be transported by a designated robot to the quarantine area. Alternatively, a patrol robot can remind the patient to change their clothing, introduce them to their surroundings, and connect instruments such as biological detectors. The risk of infection for medical staff is thus reduced. Special delivery robots can deliver amenities to designated wards and then return to a specified area after the mission for disinfection.

1

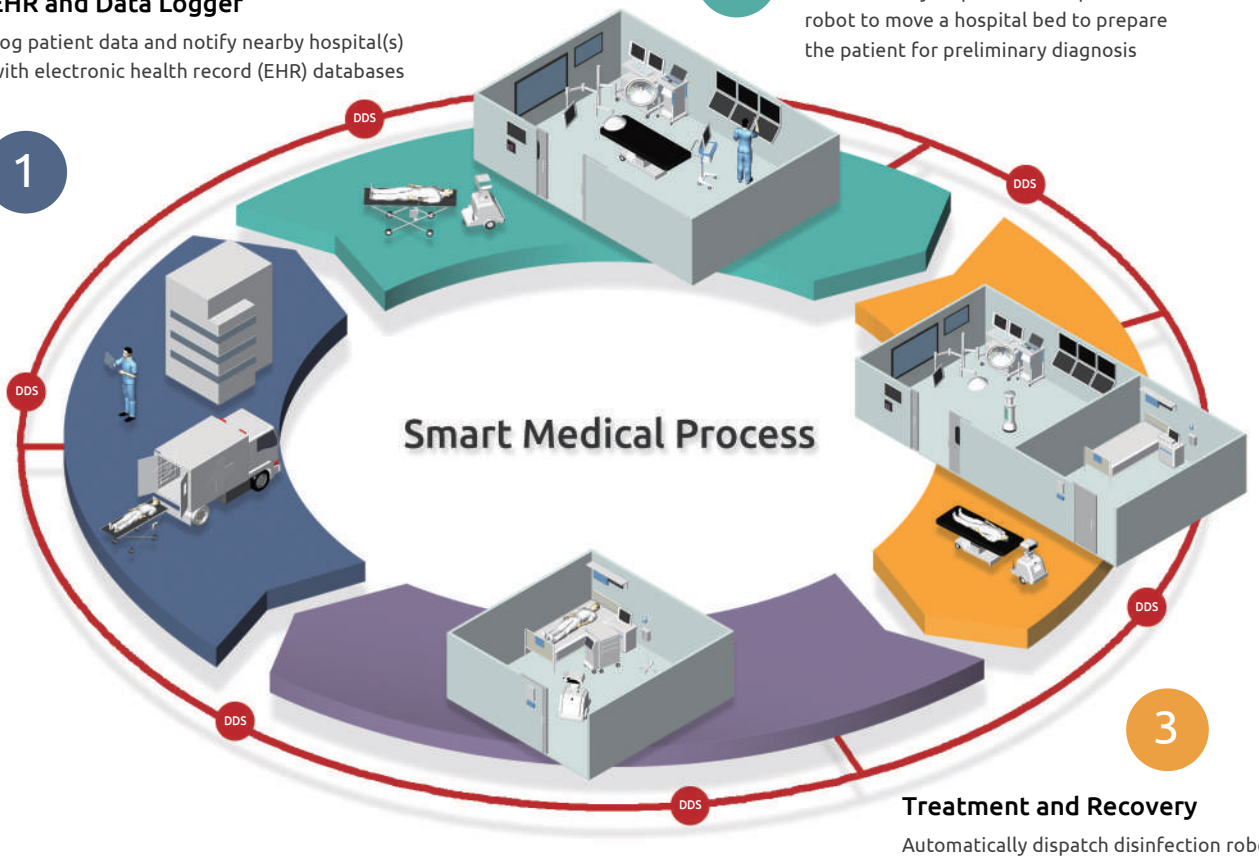
EHR and Data Logger

Log patient data and notify nearby hospital(s) with electronic health record (EHR) databases

2

Robot Dispatch and Diagnosis

Automatically dispatch a transportation robot to move a hospital bed to prepare the patient for preliminary diagnosis



3

Treatment and Recovery

Automatically dispatch disinfection robots to sterilize the operating and recovery rooms, and transportation robots to move medical equipment and supplies

4

Home Monitoring

Set up monitoring robots at home for tracking the patient health

ADLINK's ROS Robot Solution

The robotics industry has continued to grow in recent years. How to build smarter robots more quickly is now a hot topic. ADLINK has now released an ROS 2 controller that customers can use for rapid development of medical service robots; for the communication system of medical systems, ADLINK is offering customers another complete solution for the rapid and reliable integration of internal/external data by hospitals.

Software-Hardware Integration in ROS 2 Controller Supports Rapid Development of Anti-Epidemic Robots

Customers have two ROS robot controller series from ADLINK to choose from. The controllers also come embedded with Neuron SDK, ADLINK's commercial ROS development kit. The complete ROS 2 robot solution from ADLINK lets customers engage in rapid development of robot applications.

ROScube series: ROScube is an industrial-grade robot controller distinguished by its Hard Real-time attribute. In an emergency, this lets robots respond more quickly. The ROScube series consists of two models that differ in the CPU used. The ROScube-X controller uses the Nvidia Jetson AGV Xavier model to integrate the Volta GPU and dual deep-learning accelerators. The GMSL camera model is also supported. It offers high-end AI computing performance with low power consumption. The other model is the ROScube-I with an Intel CPU as its core processor. In addition to the 9th Gen Intel® Core™ i7/i3 processors, there is a rich selection of I/O ports for connecting all kinds of sensors and servos. Support for two PCIe Gen 3 slots allows different cards to be inserted as well. This particular controller can also use the Intel OpenVINO for AI applications making it even more flexible.

ROS Starter Kit series: This series is designed to be compact with a hardware configuration that can be changed if necessary. Its rich array of I/O pins means the customer can still satisfy the various requirements of their robot application even if their robot has only a limited amount of internal space. For AI applications, an MXM slot is available for customers that wish to insert an MXM display card. In addition to the boost in CPU computing power, this will also increase the speed and accuracy of the robot application while reducing latency.

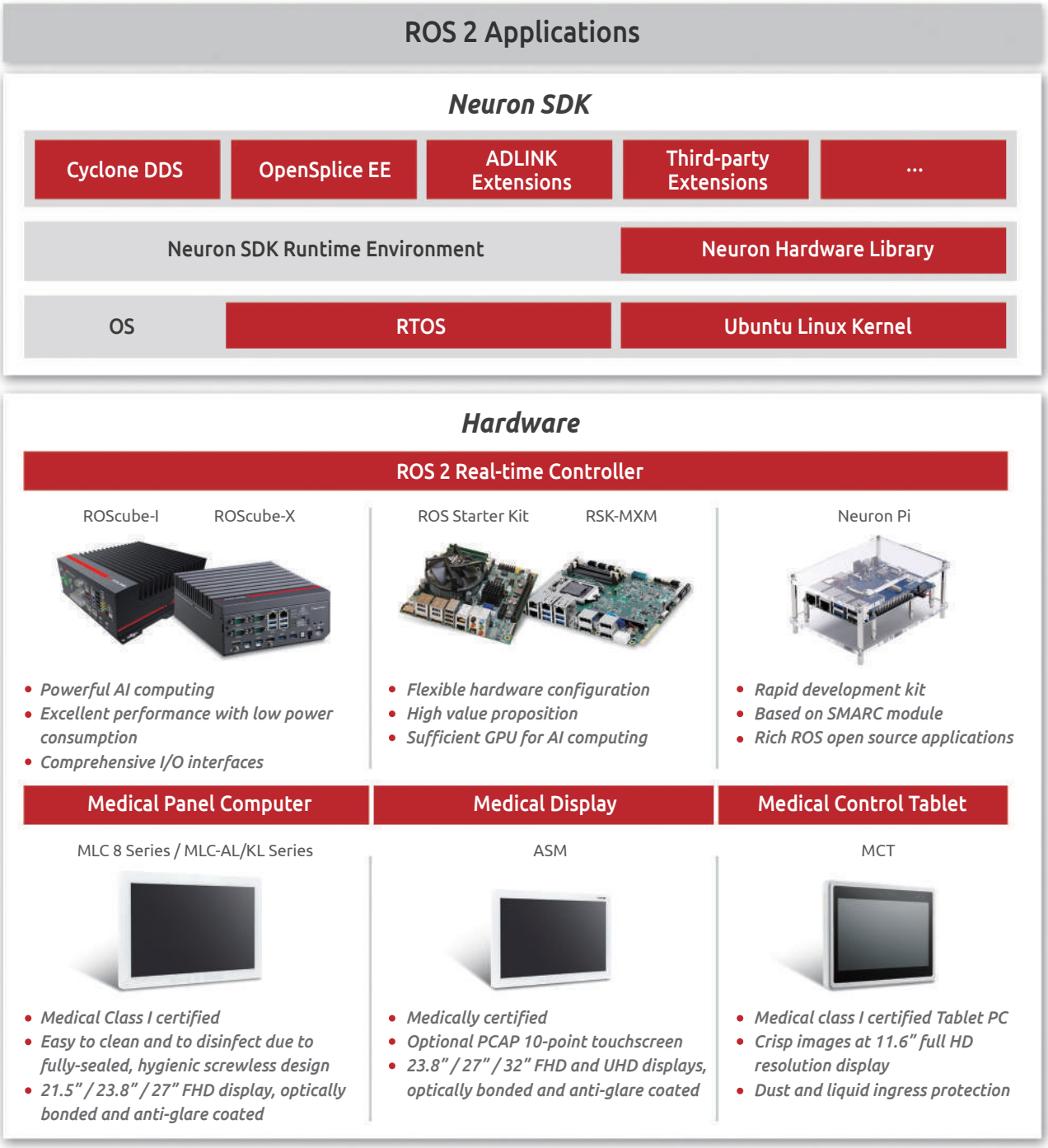
Neuron SDK: The ROS development kit is embedded into the ADLINK robot controller. It provides a development environment for compiling and editing robot applications. Customers can use it to easily develop, test and deploy their robot applications. Customers can reduce costs and shorten the time-to-market by using the rich ROS/ROS 2 application libraries to complete their application prototype in the shortest possible time. Neuron SDK also introduces advanced DDS technology that triples communication performance between multiple robots or internal data transmission in individual robots compared to the open-source ROS 2 environment. For robot application scenarios, this means both expandability and stability.

The advantages offered by ADLINK's ROS solution are as follow:

Simplifies system integration: The software-hardware integration solution from ADLINK provides the customer with a development environment that they can immediately use without having to worry about compatibility issues with the software-hardware environment. ADLINK's expertise in ROS/ROS 2 also means that unlike other suppliers, customers can discuss technical problems with ADLINK for faster troubleshooting.

Software-hardware system optimization: The hardware specifications were designed for the requirements of different robot applications. Hard real-time and optimization using the Neuron SDK provides the customer with enhanced outcomes during robot development.

ADLINK quality assurance: ADLINK supplies the software and hardware for this solution. Once the customer's problem is deployed, ADLINK can offer its professional quality assurance as support.



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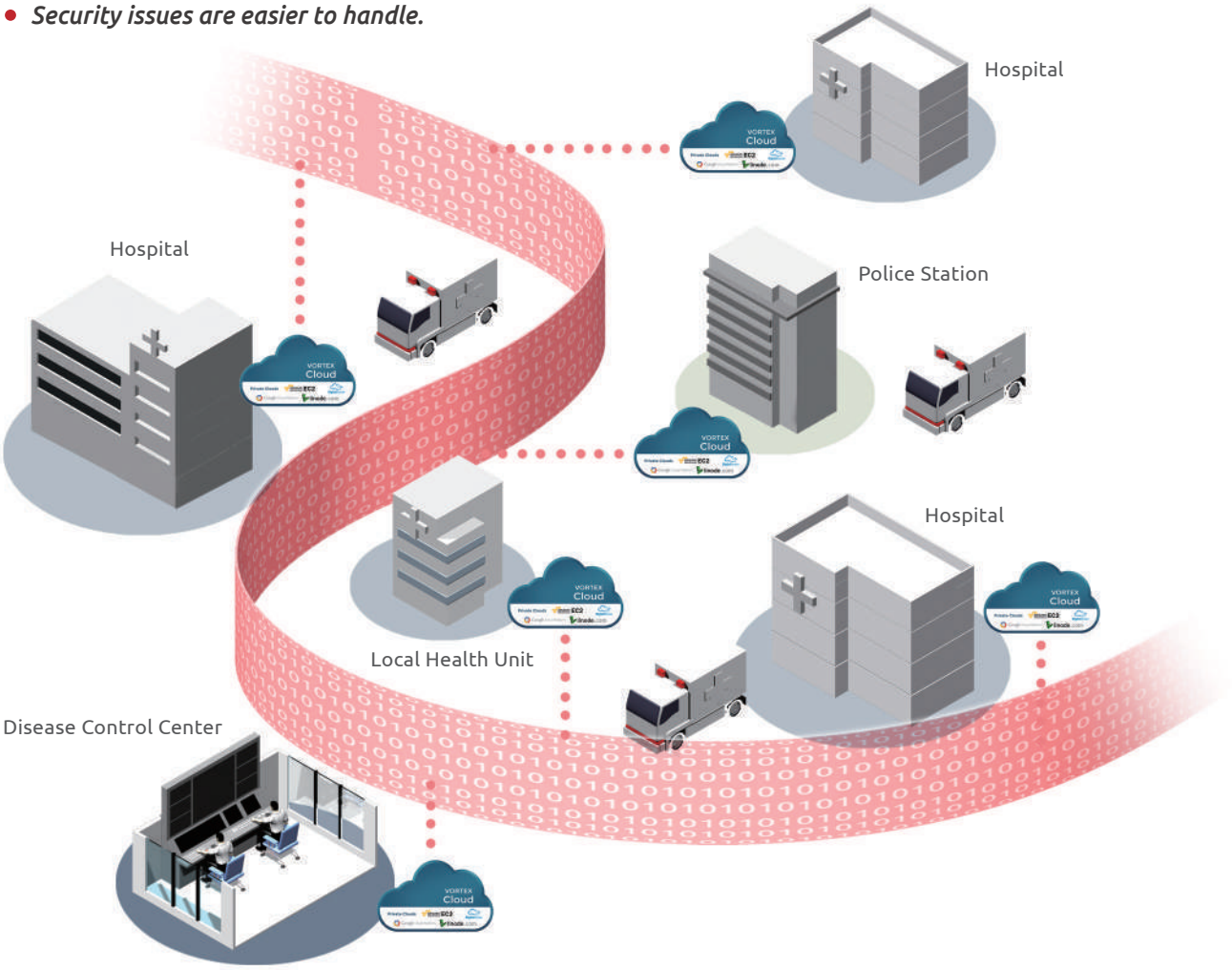
Communication System Solution for Smart Medicine

Vortex Link is offered by ADLINK for the communication system of medical systems. Data sharing via DDS technology provides universally accessible Routing and Discovery service. Vortex Link can be used by any system/device running ROS 2 or DDS software to deliver ubiquitous, transparent data sharing and Internet connectivity. Vortex LINK implements automatic discovery and routing between any nodes. All statistics, medical information, inventory levels and other internal hospital data can use Vortex Link as an access point to keep track of real-time developments. The status of ambulances or logistics vehicles can be linked to the Internet for rapid response and analysis without having to take geographical factors into account. A number of different deployment and connectivity scenarios are supported by Vortex Link including device-to-cloud, system-to-cloud, and connecting multiple LANs into one global system. Plug-ins are available for Vortex Link as well to implement load-balancing between sub-net clusters, redundancy, and backup. Security is divided into three categories: Certificate authority, identity verification, and access control are used to define the read/write permissions of terminal nodes and sub-systems. Online privacy and data security can be effectively protected through these modes.

Vortex Link enables the distribution of data, service, storage, and applications to the edge of the network closer to the devices and users as a way of complementing and enhancing traditional cloud architectures. Keeping data on the edge allows for high-speed transfer services. For medical systems, it offers the following advantages:

- ***Resilience to communication interruptions with the cloud***
- ***Reduces latency while enabling more real-time connections***
- ***Security issues are easier to handle.***



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ADLINK Wants to Help Traditional Hospitals Embrace Smart Medical

During the Industrial Revolution, the invention of the steam engine boosted productivity in an effective manner and completely changed how people live; later, the invention of electricity and the Internet led to all the modern conveniences offered by information and communications technology (ICT) today. All of these changes were the result of an unexpected invention. The rapid development of AI deep-learning techniques in recent years has led to people thinking about how AI can be applied to robots to make the world a better place. That's why all kinds of service robots have been seen working in restaurants, banks, airports, and elsewhere over the past few years. The recent impacts worldwide from infectious diseases have shown what medical service robots and delivery robots can do. In addition to eliminating person-to-person contact, they also helped fill the shortage in medical staffing.

ADLINK is now an industry leader in autonomous robot technology and we offer the most comprehensive package for robot developers. In addition to the real-time controller, the ROS 2 swarm robotics architecture will see swarms of robots working collaboratively in the future. They will also be able to communicate with the infrastructure (robot-to-infrastructure) as well. For example, dozens of meal delivery robots will one day work together on campus with their operating efficiency maximized through optimized schedules. The robots will be connected to the campus security and access control systems to ensure that the correct data is transmitted at the correct time to the correct device/system.

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