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# Surgical Robotics: The Convergence of Smart Connectivity and Data-Driven Technologies in Healthcare




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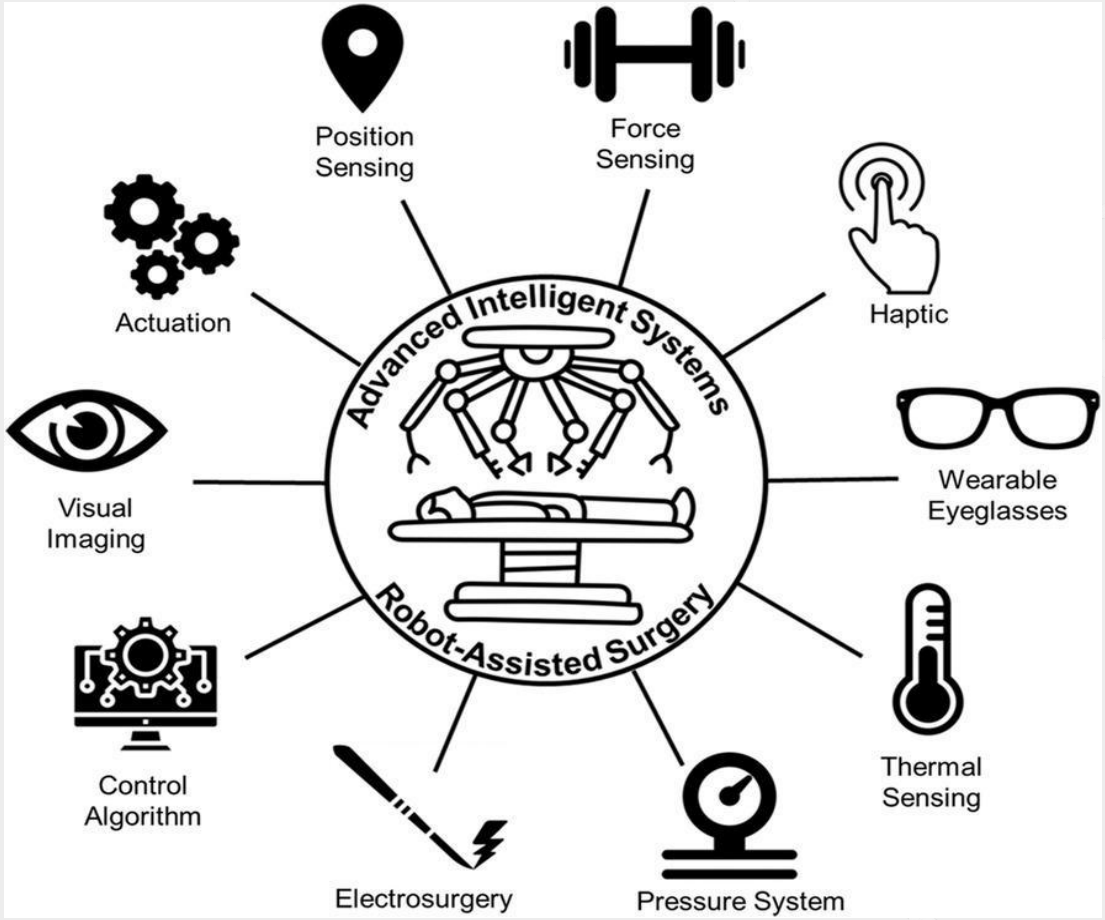
Market Development Manager: Healthcare

# Benefits of Robotically-Assisted Procedures

- Smaller incisions
- More precise and effective treatments
- Faster patient recovery

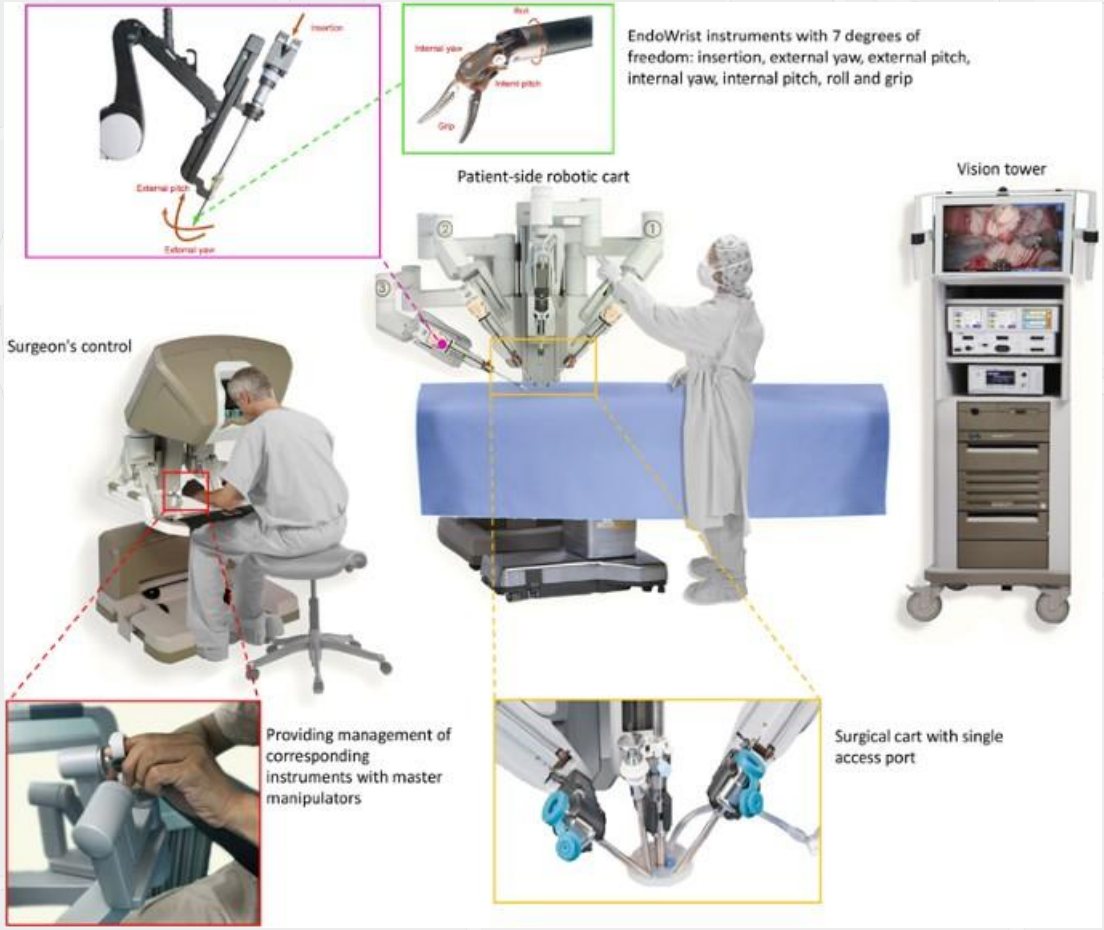
# Surgical Robotics: Advanced Intelligent Systems




**Converging Data-Driven Technologies**

# Key Drivers of Surgical Robotic Systems

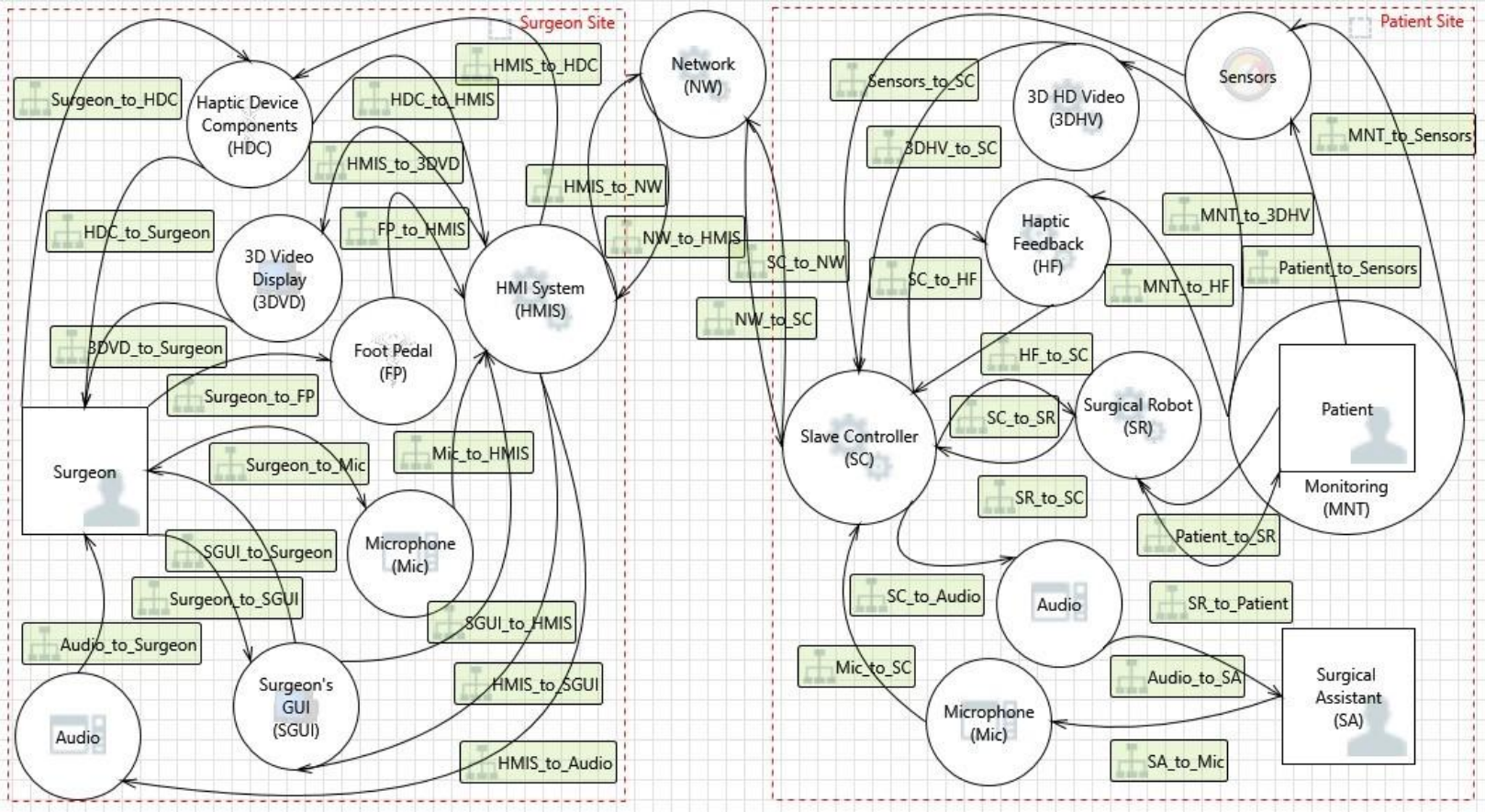
- Advanced data-driven technologies, visualization and instrumentation
- Improved clinical efficiency, usability and automation
- Device modularity and portability
- Remote operation and monitoring

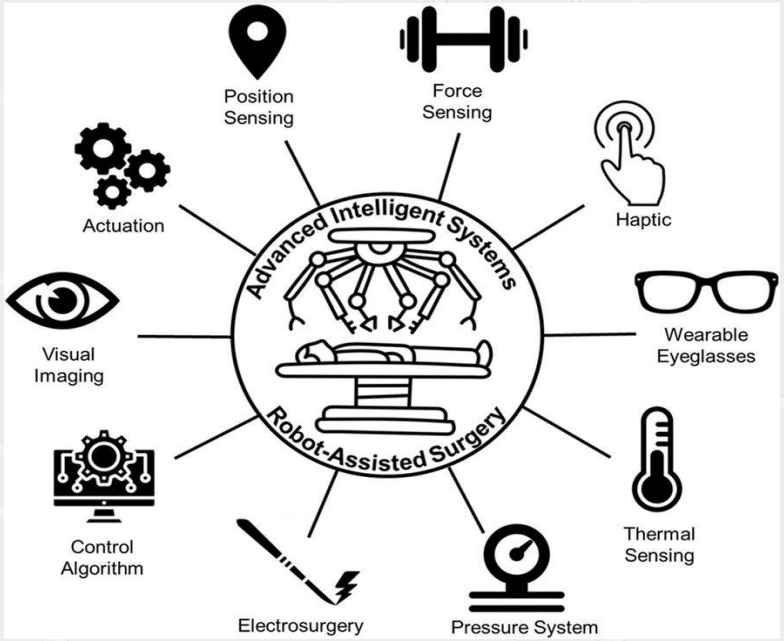


# Key Development Challenges

- Surgical robotics (SR) systems are safety-critical and need high reliability and security.
- SR manufacturers need to develop products efficiently and support many devices and use-cases.
- Increased cybersecurity regulatory standards and expectations across the industry.

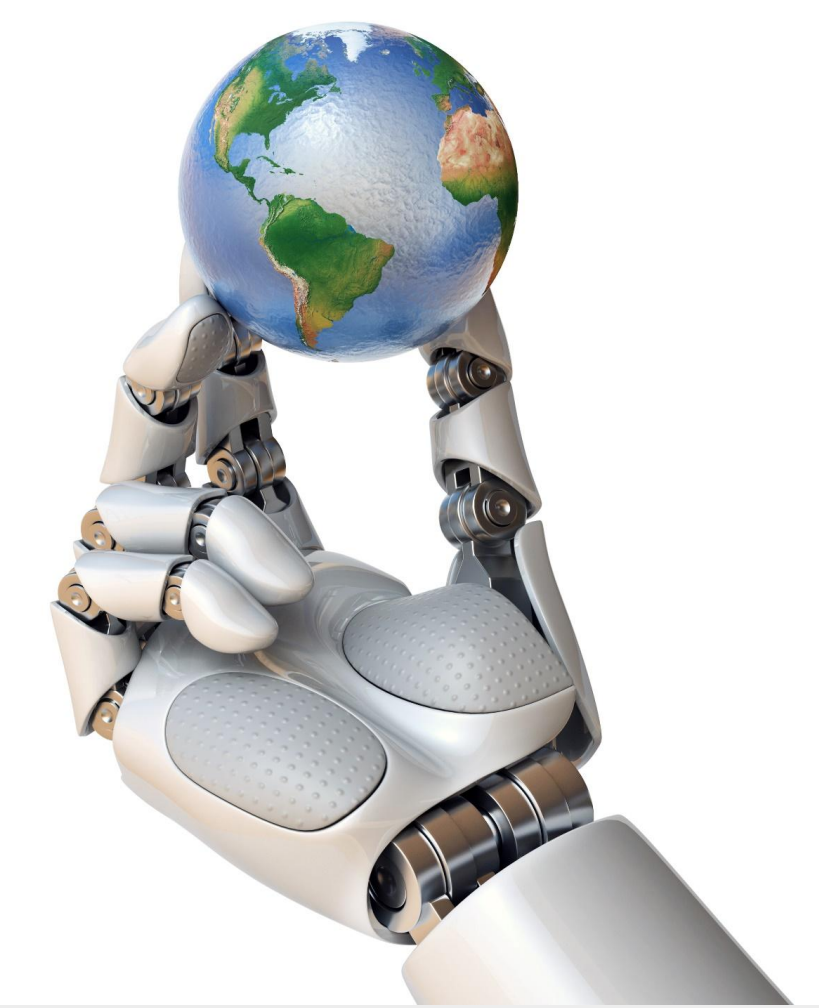
# Surgical Robotics: Complex and Distributed Systems




## Data Connectivity Design Challenge

# Why RTI? We Enable Smart Machines.



By enabling a new generation of intelligent distributed systems, RTI boldly seeks to transform entire industries.

We particularly seek applications that promote a sustainable, safe, green, and healthy planet.

# Key Design Requirements in Surgical Robotics

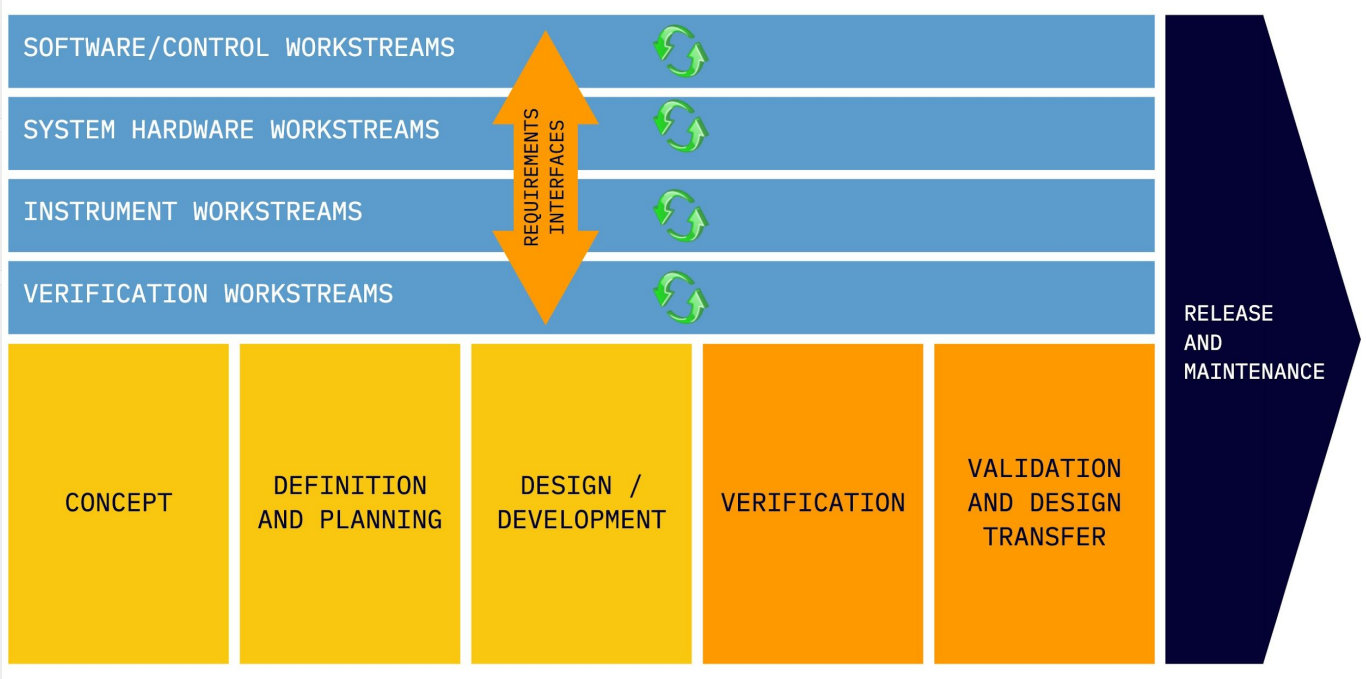
- Safety:
  - Fail safe, no single point of failure
- Performance:
  - Real-time, low-latency
- Reliability
  - Fault tolerant, high-quality
- Cybersecurity
  - Security by design (end-to-end)
- Interoperability/Flexibility
  - Upgradeable, configurable

Cybersecurity Risks:

- Regulatory approval
- Threat landscape
- Safety
- Hospital/User Expectations
- Business Risks

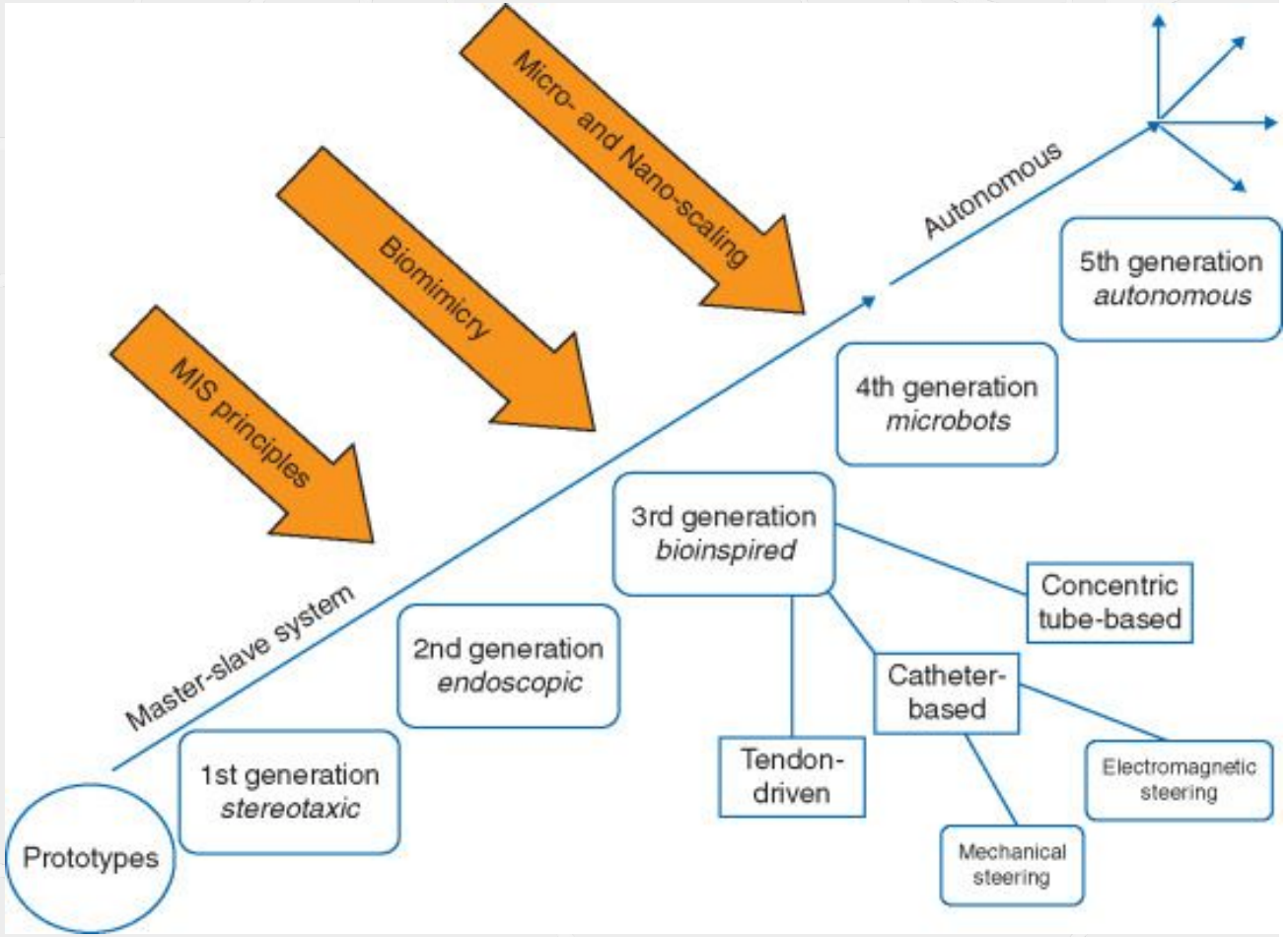
# Need to develop flexible systems efficiently

- Efficient use of software resources
- Parallel development
- Configurable/upgradeable
- Reusable and Reference architectures

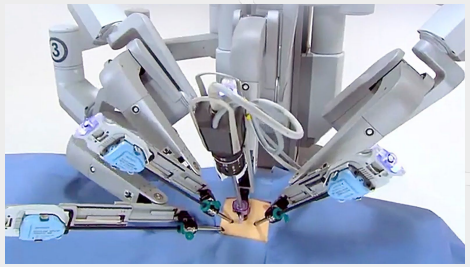


# Need to develop flexible systems efficiently

- Applications
  - Urologic
  - Gynecological
  - General Surgery
  - Neurosurgery
  - Orthopedic surgery
  - Others
- Needs
  - Adapt to user needs and clinical applications
  - Leverage evolving enabling technologies
  - Next-generation systems



# RTI Connext: A Connectivity Framework Designed for Intelligent Distributed Systems


Streaming Analytics & Control

HMI/UI

IT, Cloud & System of Systems Connectivity

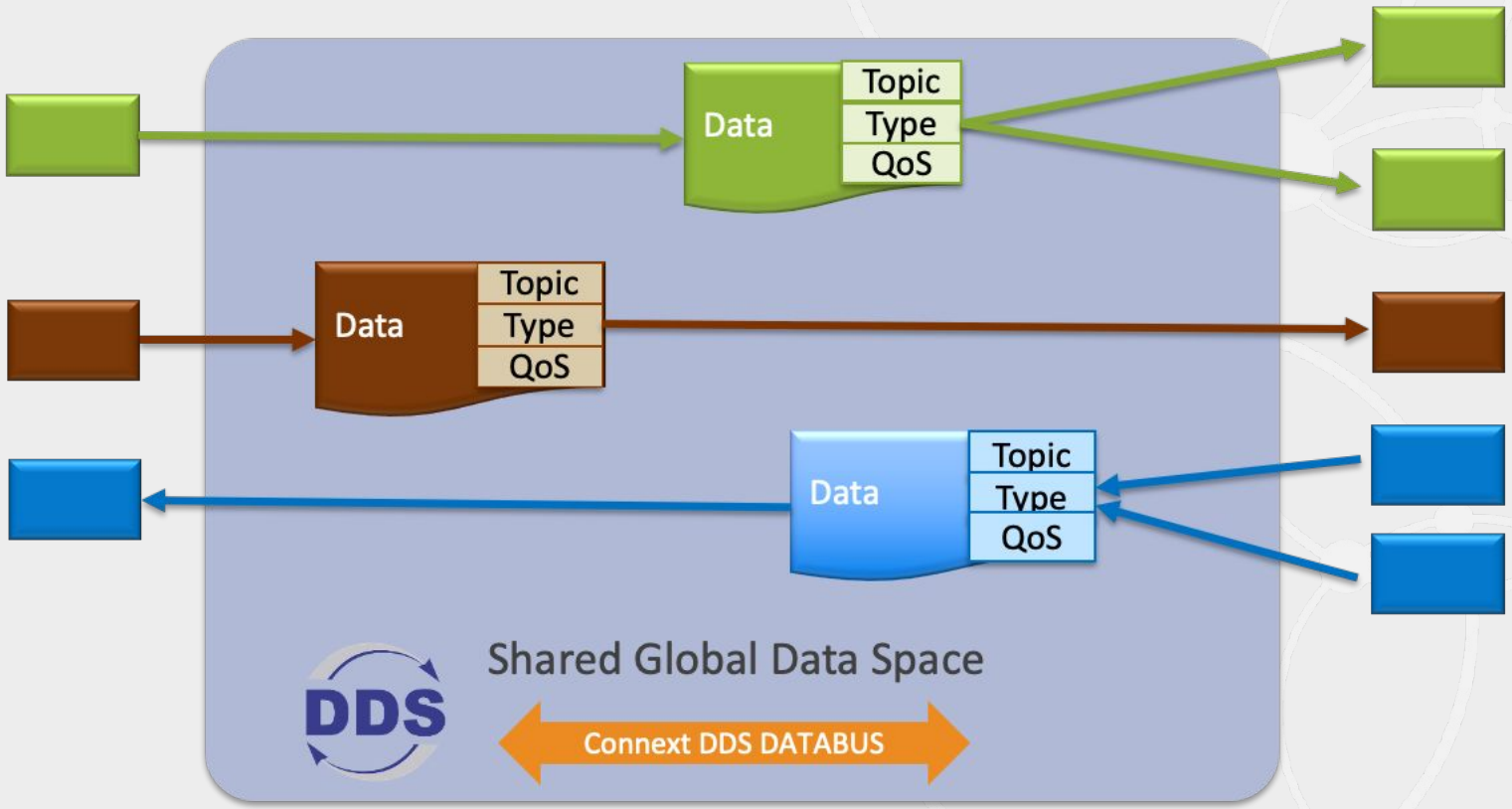
RTI Connext Databus

Sensors

Actuators

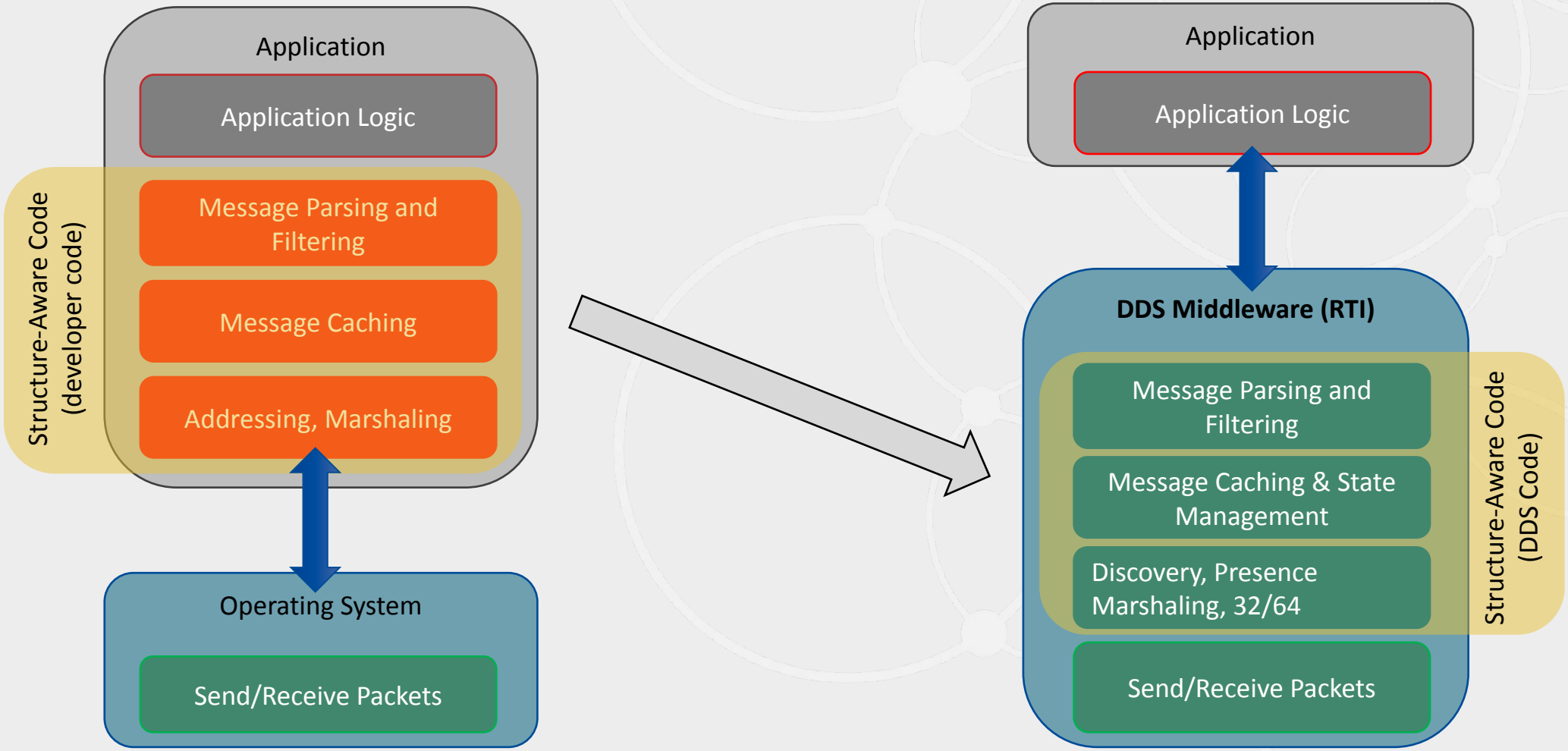
**Attributes: Sensing and Control in Real-Time, Safety-Critical, Cybersecurity**

# Data Centricity in the Virtual DDS Databus




- Applications interface only to the data
- Loosely coupled
- Configurable for different sources
- No single point of failure
- Fast, reliable, scalable, secure

# RTI Connext Communication Framework Accelerates Development



# RTI Connext is solving the design challenges of Robotically-Assisted Systems

**RELIABILITY/ PERFORMANCE**

No single point of failure

Low-latency connectivity for real-time access, control, monitoring

Optimized remote network connectivity for mobile devices/systems

**INTEROPERABILITY/ SCALABILITY**

Scalability to thousands of devices

Configurable/adaptable data inputs across devices, programs, legacy systems

**EFFICIENCY/FLEXIBILITY**

Allows teams to focus on applications over infrastructure

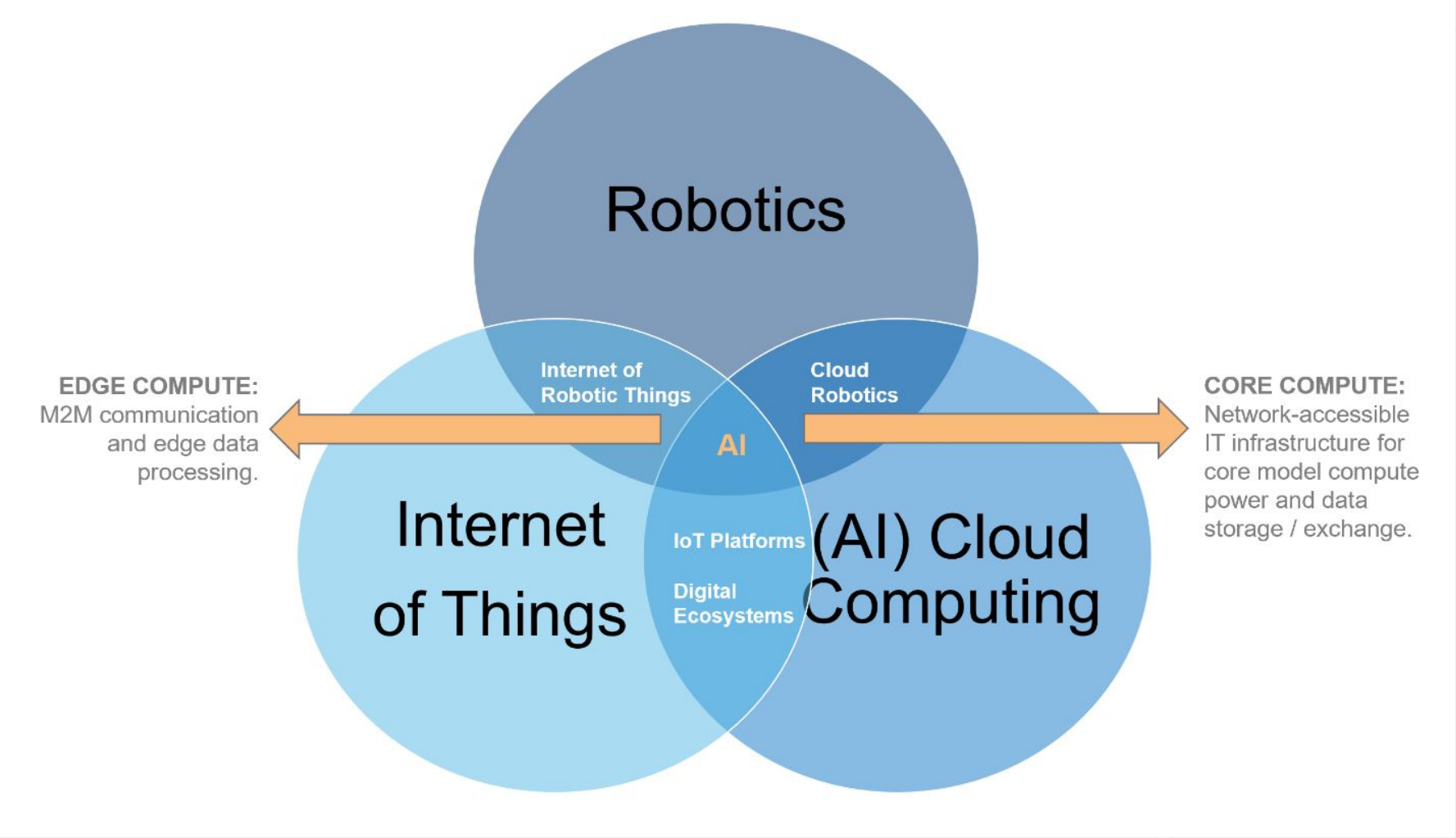
Reusable, loosely coupled architecture

Accelerates development of adaptable/upgradeable systems

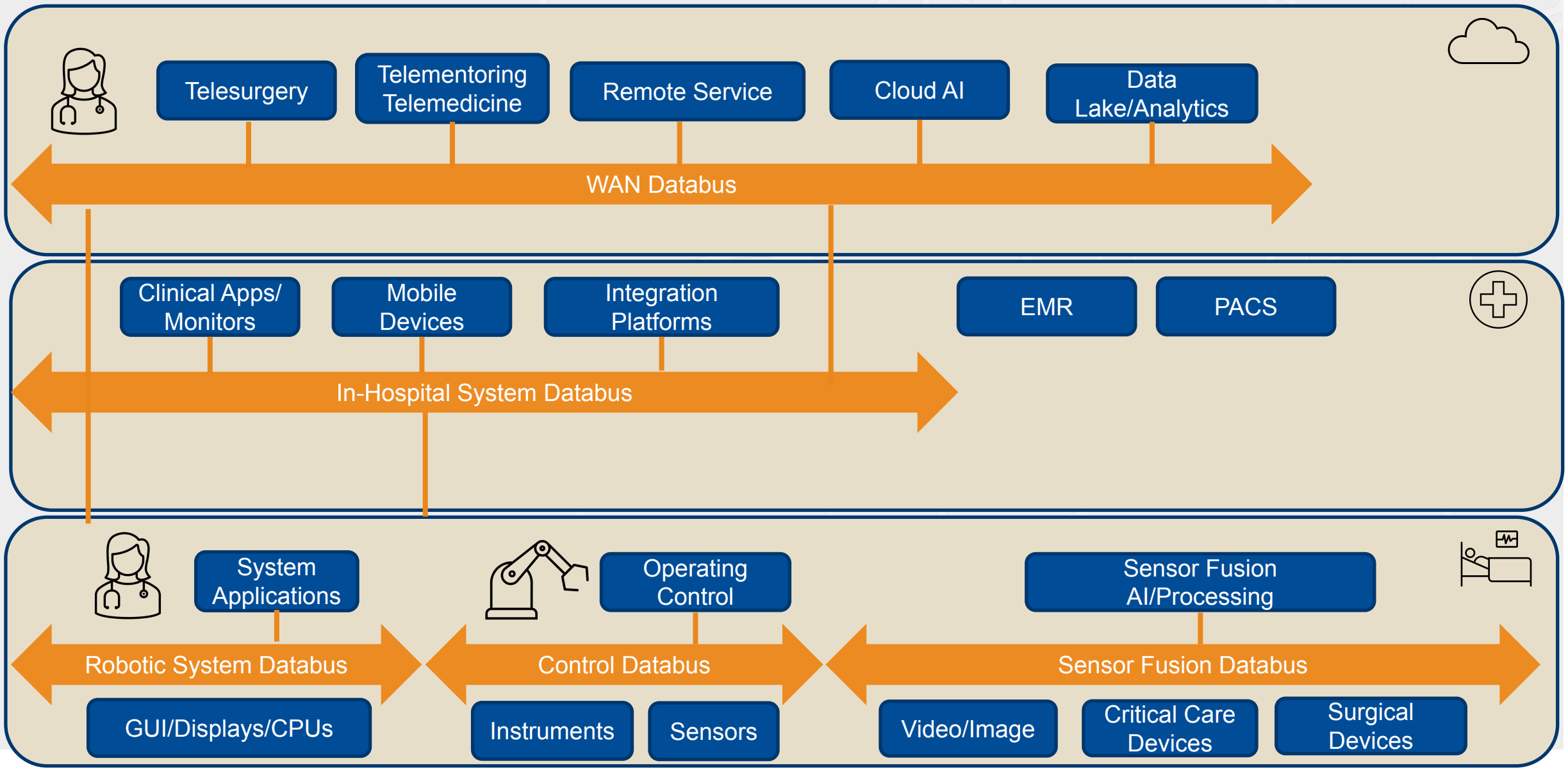
**CYBERSECURITY**

Fine-grained/configurable security built-in

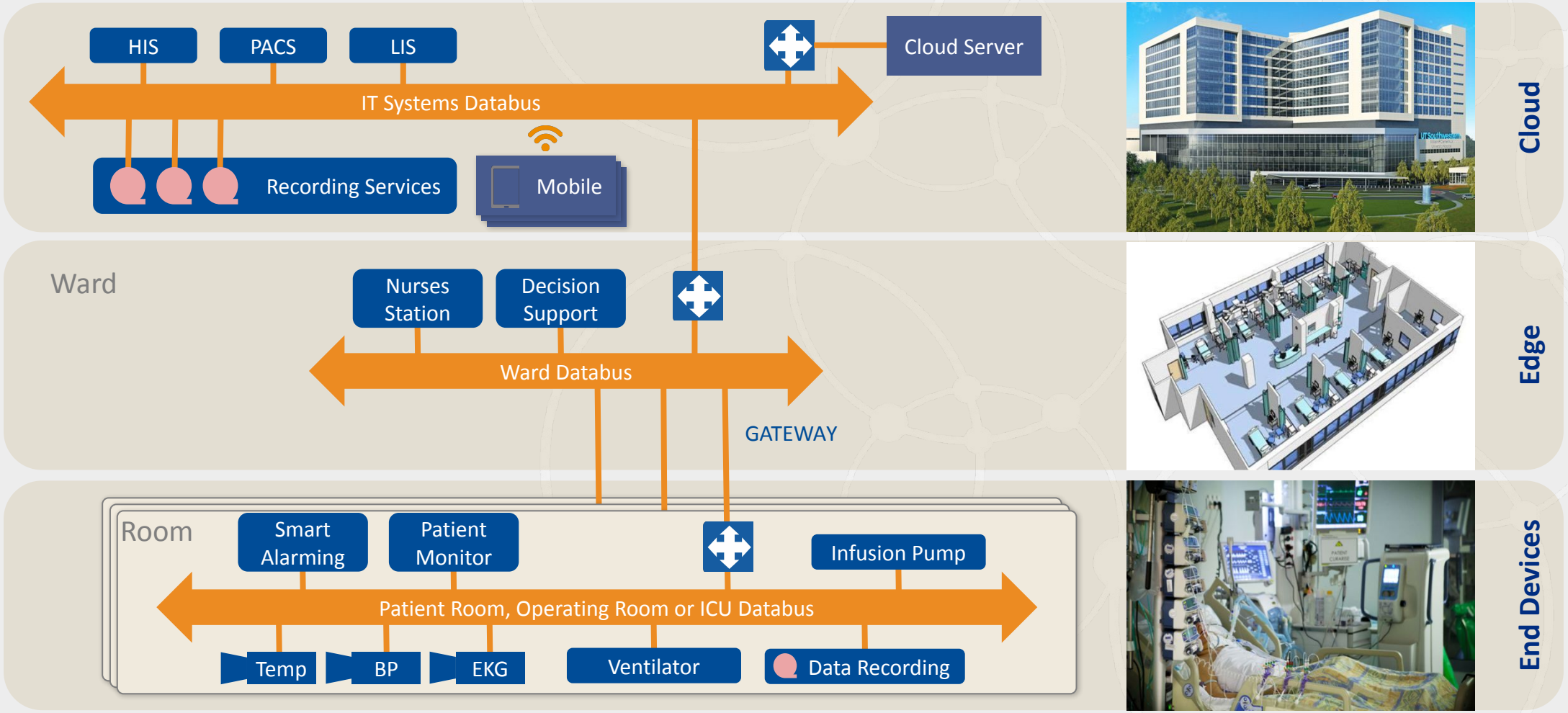
# Internet of Robotic Things



# Surgical Robotics: A Common Connectivity Framework



# Smart Medical Device Connectivity: RTI Connext




Routing Service

# RTI Connext: Enabling next-generation healthcare systems

- Robotic-Assisted Systems are intelligent and complex digital ecosystems across devices, systems, and networks
- Data-centric connectivity is needed to address the demanding and simultaneous design requirements for these systems and fully leverage data-driven technologies
- As the leading software framework for intelligent and safety-critical distributed systems, RTI Connext is enabling and accelerating the development of surgical robotics, imaging, and connected medical devices with flexible, reliable, and secure data-centric connectivity

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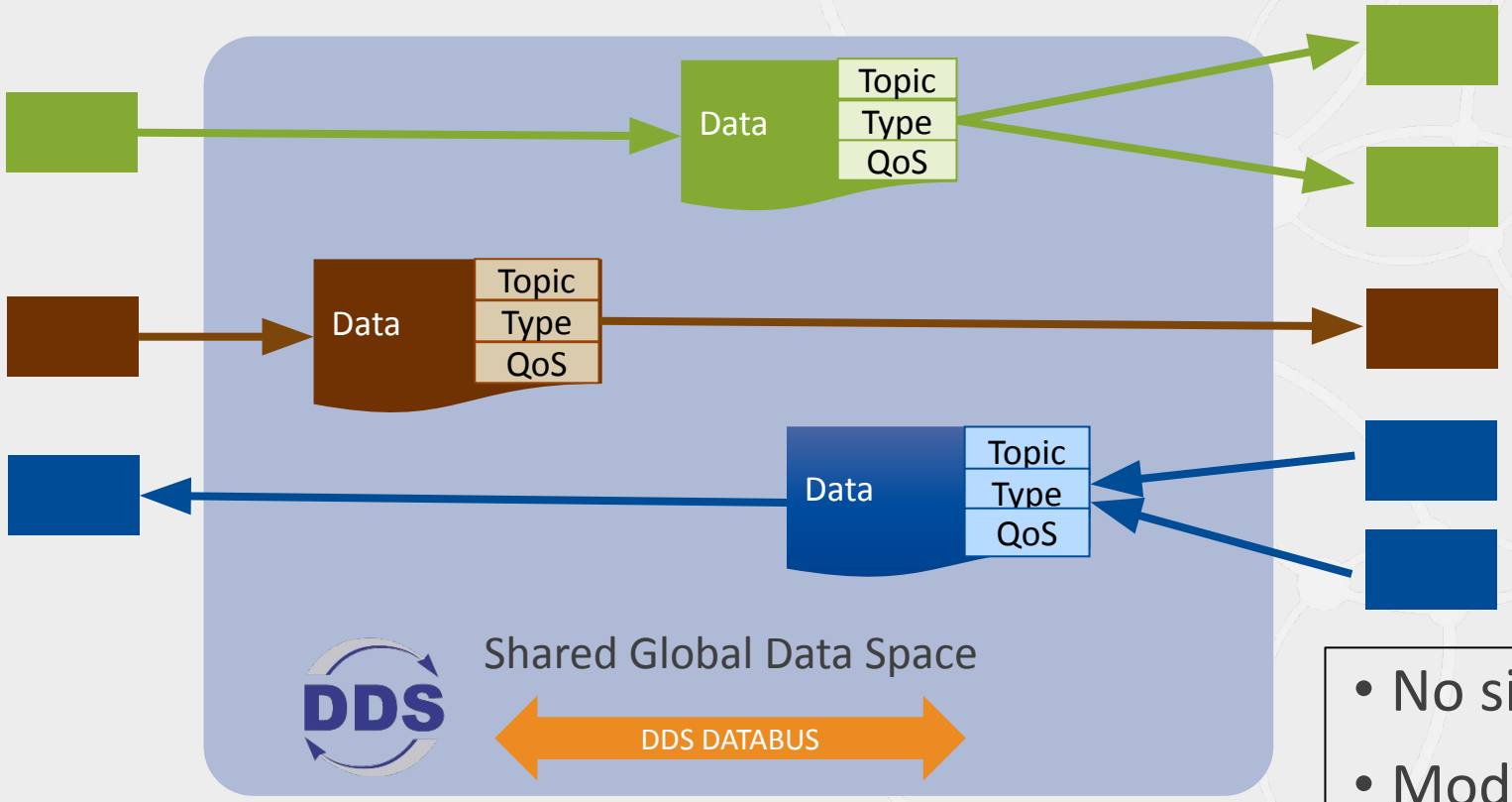
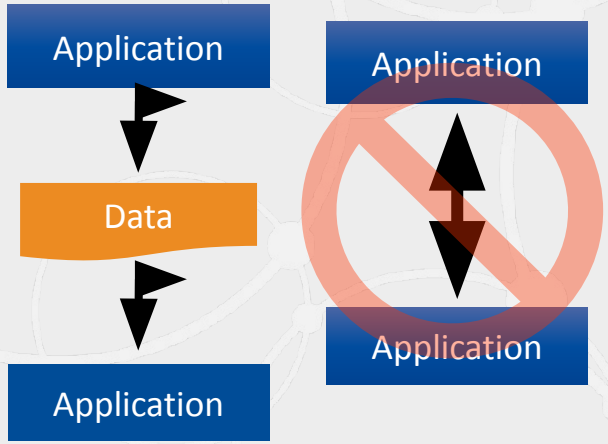
# END

# Data Centricity: Data is the Interface (Virtual Databus)




- No single point of failure
- Modular, Scalable, Configurable
- Adaptable for different data sources
- Fully distributed/configurable security

# Solving the simultaneous and demanding requirements of Robotically-Assisted Systems

**RELIABILITY/ PERFORMANCE**

No single point of failure

Configurable quality of service parameters

Low-latency connectivity for real-time access, control, monitoring

Optimized remote network connectivity for mobile devices/systems

**INTEROPERABILITY/ SCALABILITY**

Scalability to thousands of devices

Configurable/adaptable data inputs across devices, programs, legacy systems

**DEVELOPMENT EFFICIENCY/SYSTEM FLEXIBILITY**

Allows teams to focus on applications over infrastructure

Cross-platform and modular architecture- transparent to application

Reusable architectures across programs

Accelerates development of adaptable/upgradeable systems

**CYBERSECURITY/DATA ACCESSIBILITY**

Fine-grained and configurable security plugin

Regulatory standards-based

Configurable, on-demand data access

# What are the expectations of next-generation health systems?

- Needs:
  - Proactive, predictive, and patient-centric healthcare delivery
  - Improved outcomes
  - Improved care access
  - Improved clinical efficiency
- Requirements:
  - Interoperability:
    - Data standards
    - Data infrastructure across boundaries/networks/applications
  - Cybersecurity
  - Analytics to improve therapies/outcomes/costs
  - Patient-centric data ecosystem

# Solving the simultaneous and demanding requirements of Robotically-Assisted Systems

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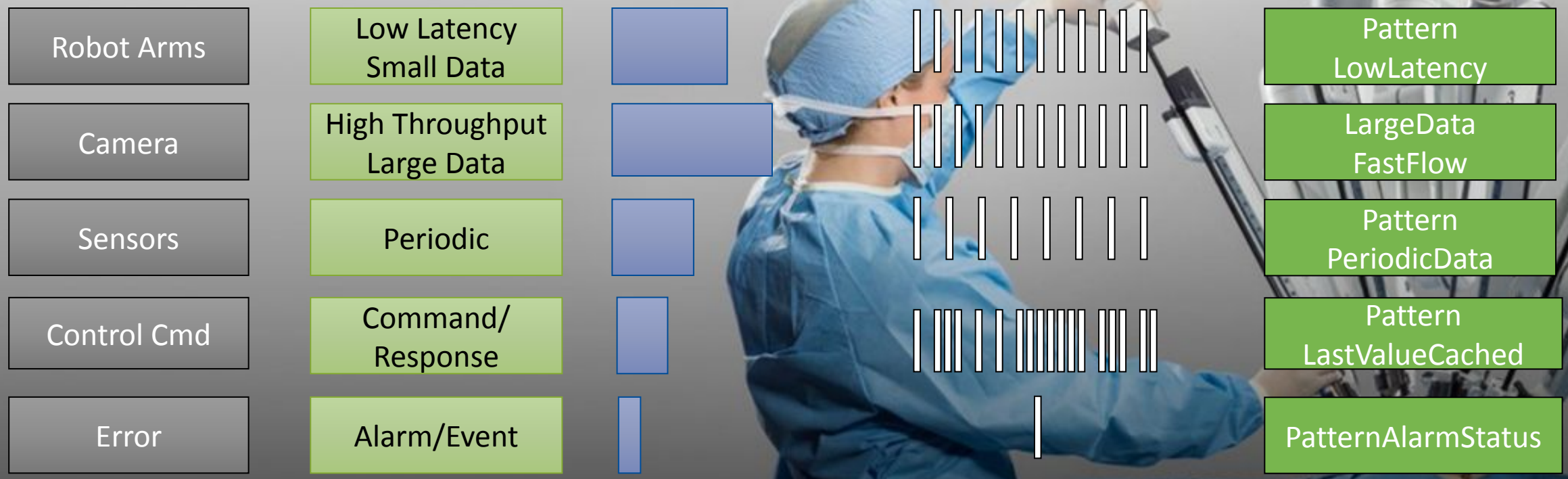
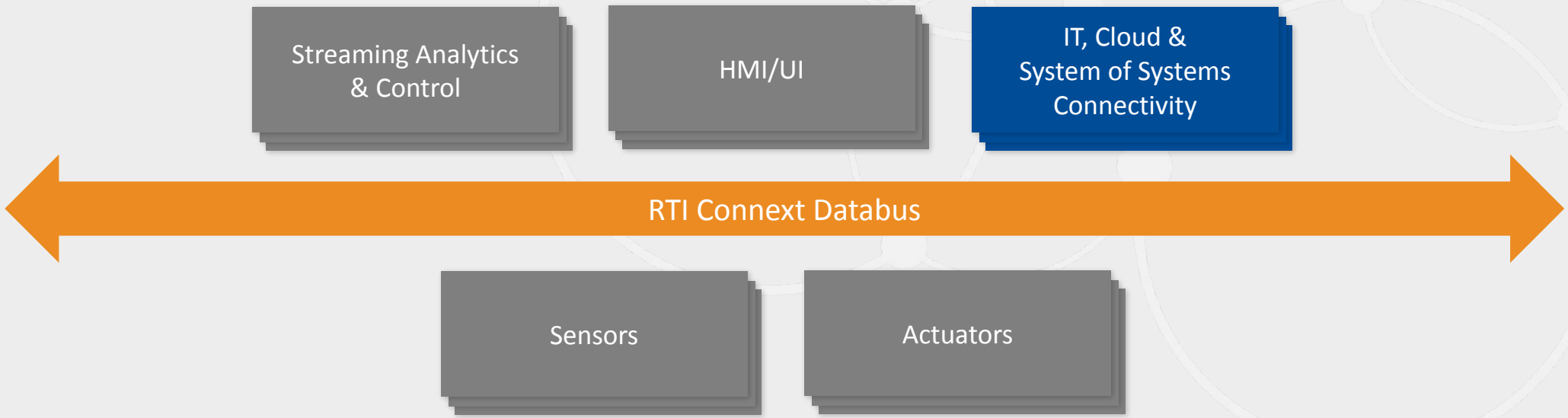
# Surgical Robotics Data Sources
## Configurable Data-Centric Connectivity



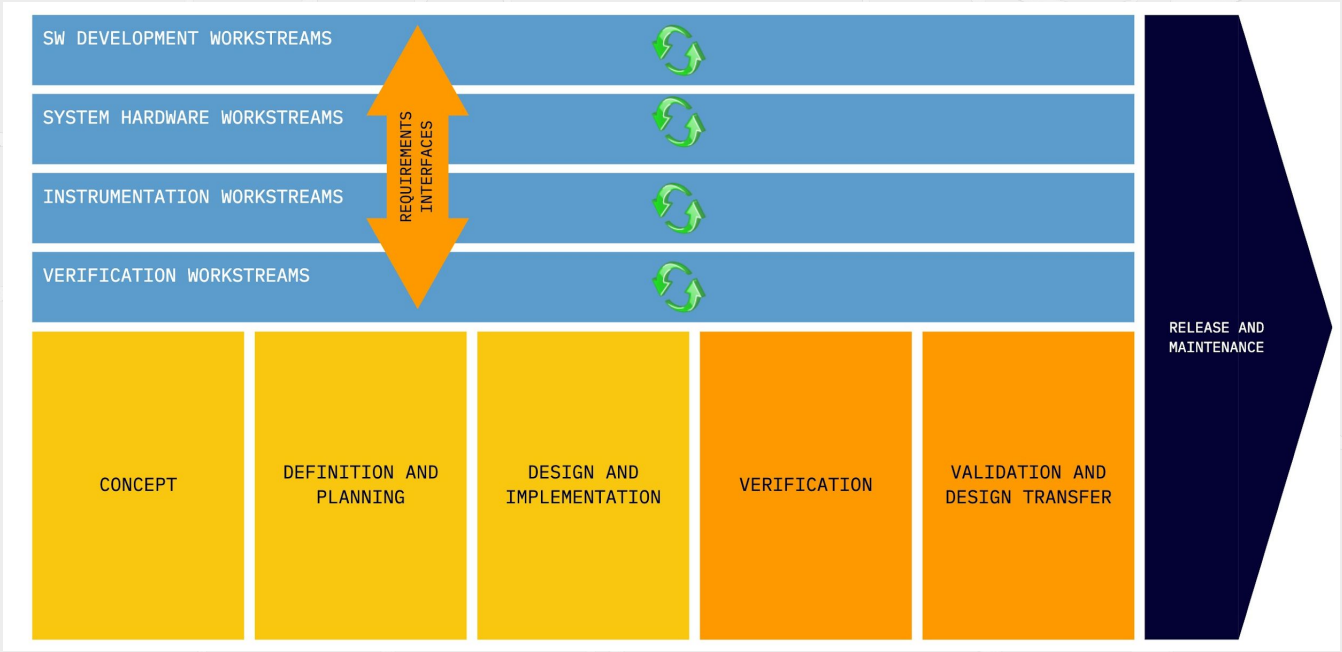
# RTI Connext: A distributed communication framework for Surgical Robotic and intelligent medical devices

- Addresses demanding and simultaneous requirements for safety, performance, reliability, interoperability, and cybersecurity
- Enables utilization of data-driven technologies and sensor fusion
- Accelerates development of scalable, reusable, and flexible applications
- Fine-grained and configurable security design



# Efficient Software Development- Optimize lifecycle

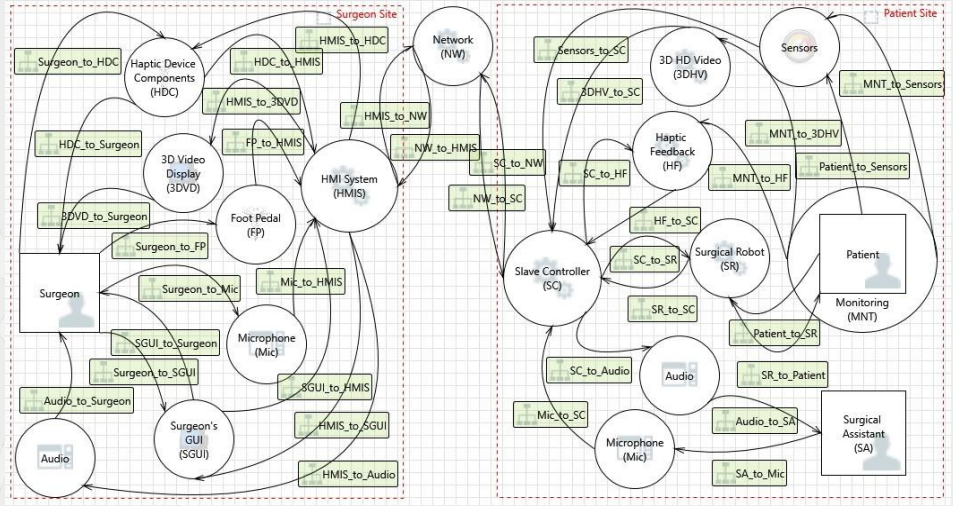
- Efficient use of software resources:
  - Applications over infrastructure
  - Leverage Frameworks
- Concurrent Development
  - Design by Contract/Interface
- Configurable/Upgradeable
  - Loosely coupled architectures
  - Design reuse as requirements programs, products, evolve
  - Reference architecture from device to edge to cloud



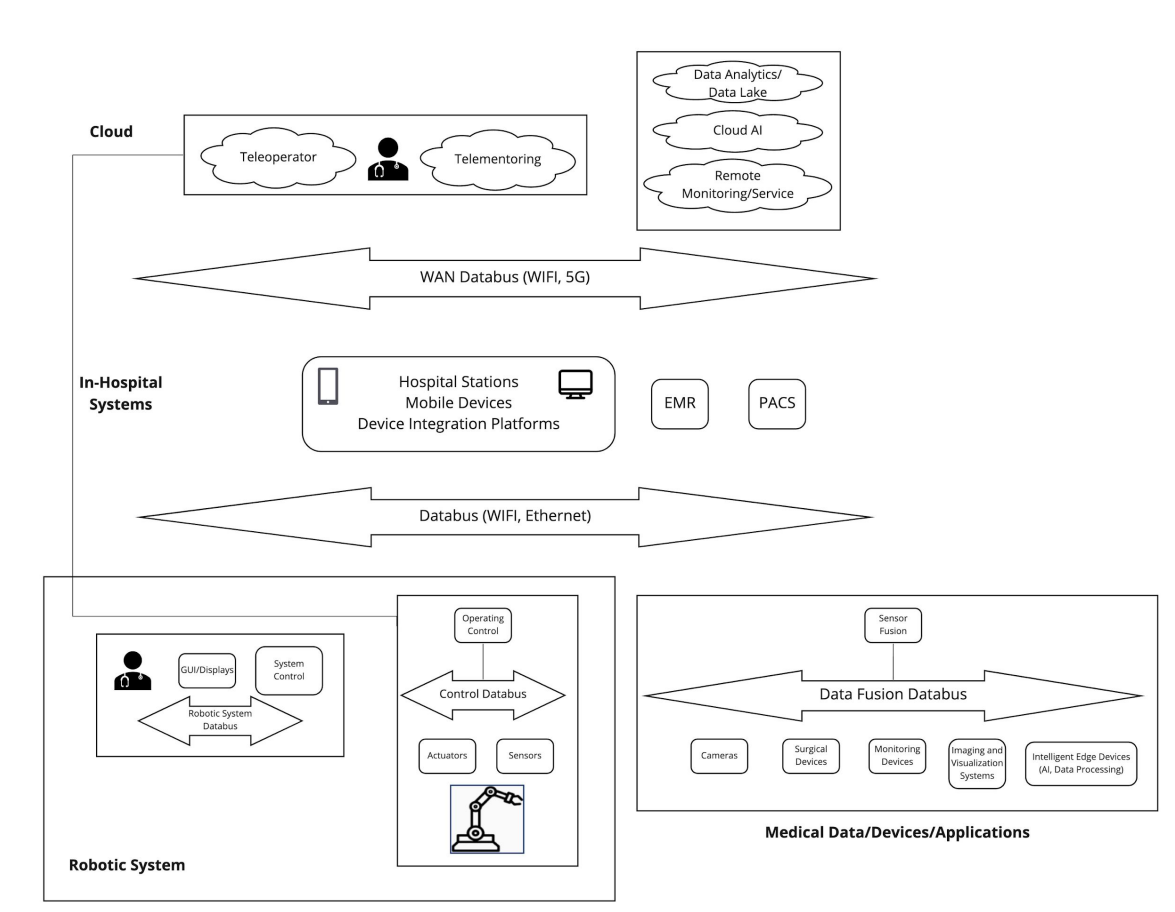
# Cybersecurity Concerns and Risks

**Fine-grained and configurable cybersecurity controls are needed to design secure end-to-end communications across the device ecosystem.**

| Concerns | Risks |
|---|---|
| Regulatory Approval | Regulatory rejection/delays- systems need to be “secure-by-design” |
| Threat Landscape | Medical systems are a target, Increased level of security threats, intentional/unintentional use cases |
| Safety | Security=Safety. Need to address security risk inherent in complex systems |
| Hospital/User Expectations | Hospitals actively assessing device security risks |
| Business Risks | Exponential costs to business, potential IP/Revenue risk, reputation, liability |



# A Common Connectivity Framework

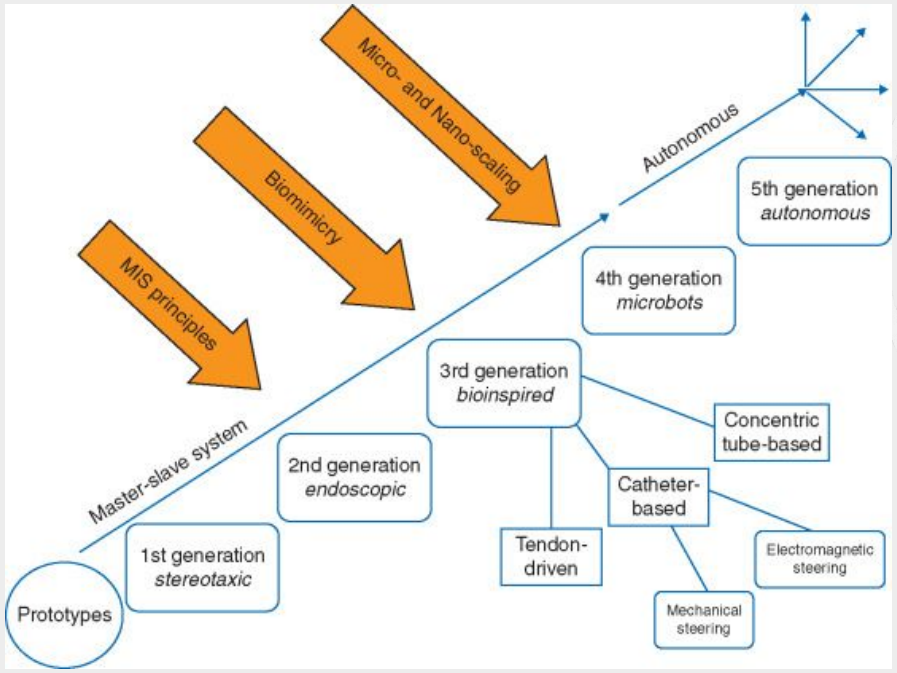



- **RTI Connext:**
  - Reliability/Performance
    - No single point of failture
    - Low-latency/real-time
  - Interoperability/Scalability
    - Configurable/adaptable data models across devices/programs/systems
  - Efficiency/Flexibility
    - Reusable reference architecture
    - Framework designed for safety-critical distributed systems
  - Cybersecurity
    - Fine-grained/configurable

# Flexible Data Connectivity for Current and Next-Generation Systems

## Applications

- Urologic
- Gynecological
- Neurosurgery
- Orthopedic Surgery
- General Surgery
- Interventional Systems




| Requirement Attributes | Needs |
|---|---|
| Adapt to user needs | System usage is expanding to a broader array of clinical applications and local/remote environments<br><br>Increased needs for usability, lower costs, smaller devices, more precise treatments, care efficiency |
| Leverage multiple and evolving enabling technologies | Next-generation imaging, AI, machine learning algorithms, navigation integration<br><br>New sensors, visualization technologies |
| Next-generation systems | Data/sensor fusion for precise and autonomous control<br><br>Remote operation for increased access |

# Efficient software development to optimize lifecycle

| Requirement Attributes | Needs |
|---|---|
| Efficient use of development resources | Allow team to focus on application over infrastructure/core competencies<br><br>Leverage state-of-the-art tools, frameworks for infrastructure development and diagnostics |
| Incremental and Concurrent Development | Allow local and distributed teams to design and test to interfaces and work in parallel |
| Configurable and upgradeable systems | Loosely coupled architectures<br><br>Allow systems/architectures to be reused as new features and data requirements evolve<br><br>Leverage reference architectures across programs and product families from the device to the edge to the cloud |

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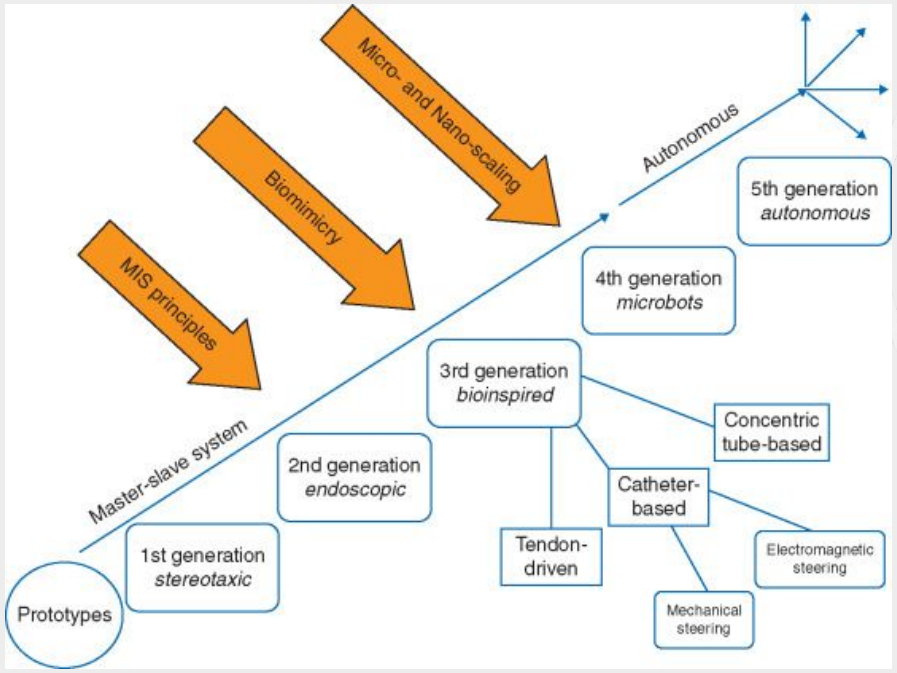


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| Next-generation systems | Data/sensor fusion for precise and autonomous control<br><br>Remote operation for increased access |

# Software Connectivity Design Requirements

- Safety:
  - Fail safe, no single point-failure
- Performance:
  - Real-time/Low-latency
- Reliability:
  - Fault tolerant, high quality
  - Cybersecurity:
    - End-to-End security controls
- Flexibility:
  - Upgradeability, configurability, and interoperability

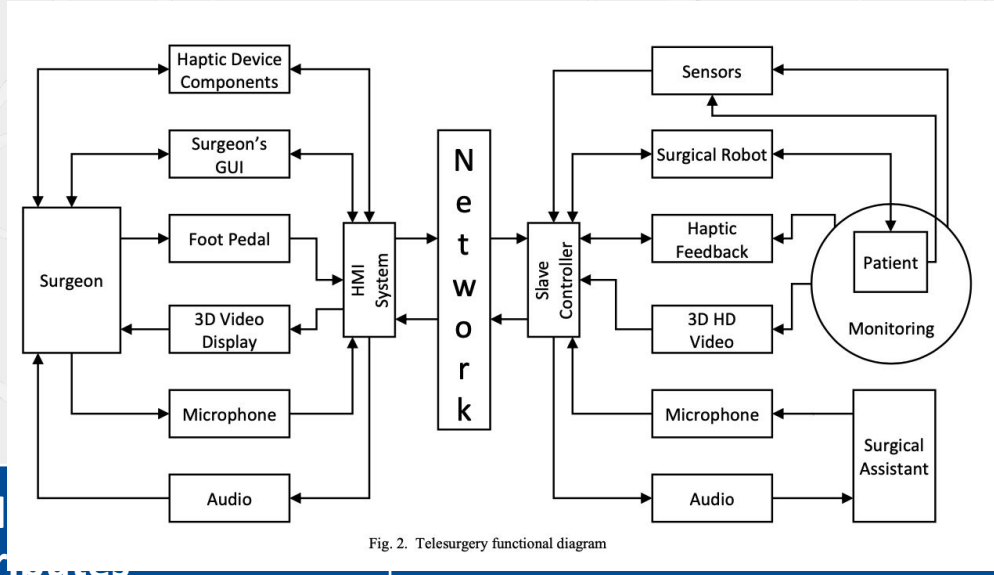
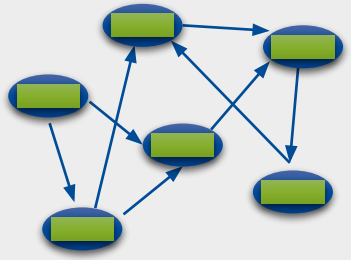


Fig. 2. Telesurgery functional diagram

| Req... Attr... | |
|---|---|
| Safety | Fail-safe architectures, redundancy, N... recalls/regulatory holds |
| Performance | Real-time, low-latency communicatio... |
| Cybersecurity | Confidentiality, Integrity, Availability across the device ecosystem for all us... cases<br><br>Regulatory/HDO/Business requirements |

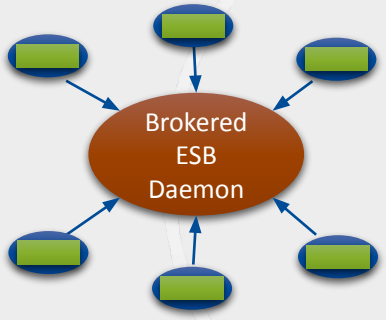
# Messaging - Prevalent *Real-Time* Communications

Point-to-Point



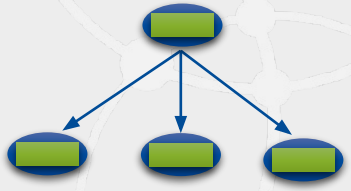
TCP Sockets

Client/Server



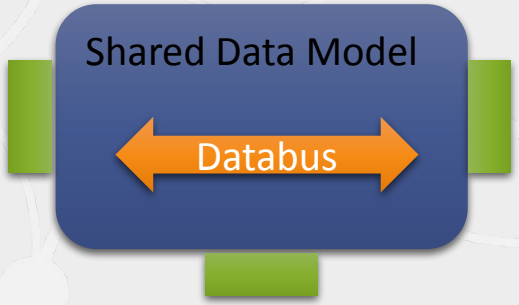

MQTT
XMPP
OPC
CORBA

Publish/Subscribe



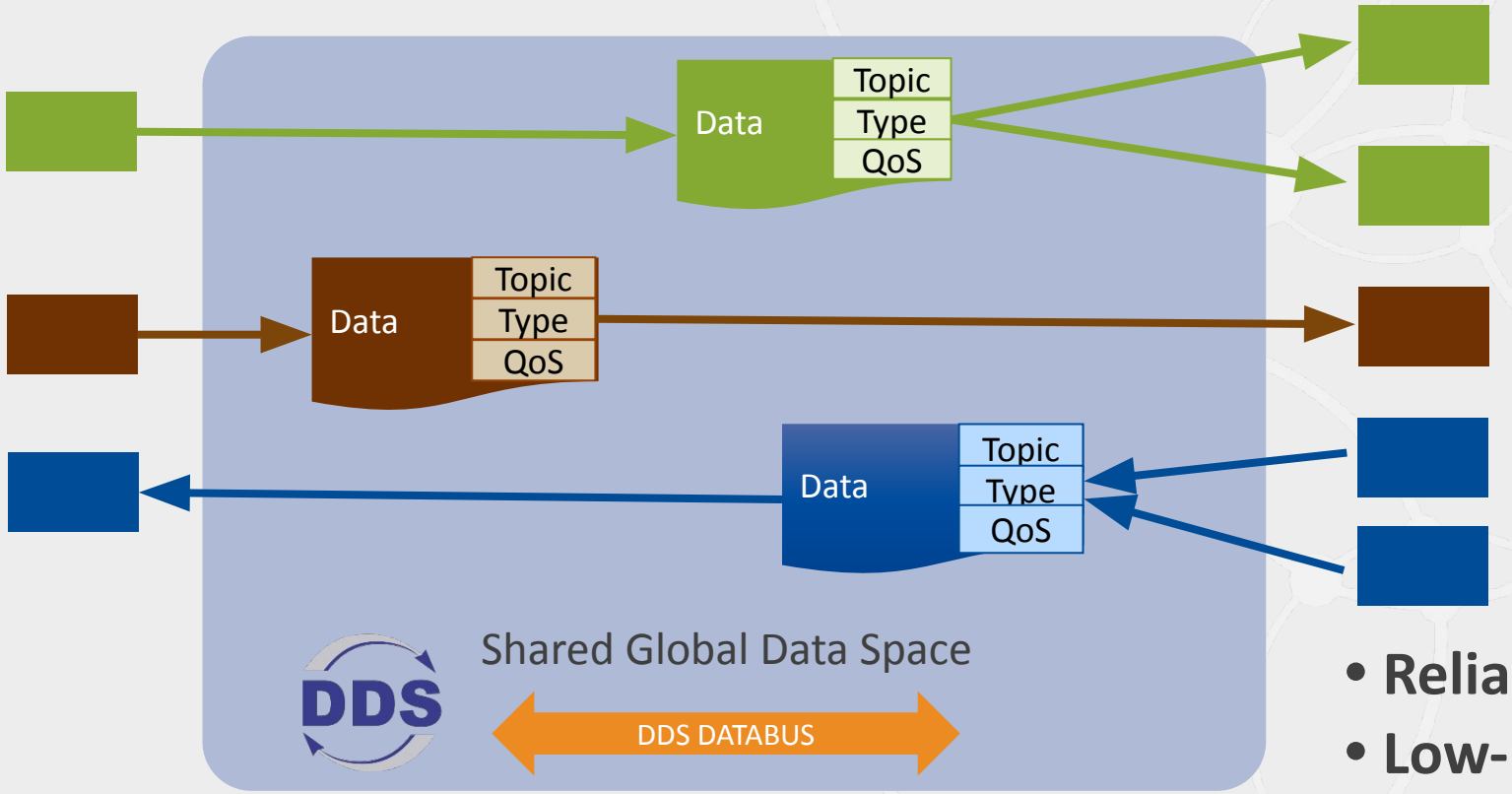
Fieldbus
CANbus
ZeroMQ
JMS

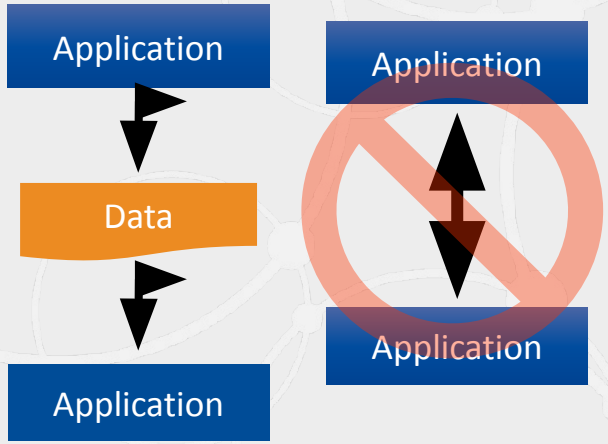
Data-Centric




DDS

# Data Centricity: Data is the Interface (Virtual Databus)




- Reliable- no single point of failure
- Low-latency
- Modular, Scalable, Configurable
- Adaptable for different data sources
- Fully distributed/configurable fine-grained security

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