Embracing the IoT: Ideas are Easy, Execution is Hard

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Our Speakers

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Conflict of Interest

Julian Goldman, MD

Has no real or apparent conflicts of interest to report.

David Niewolny, MBA

Has no real or apparent conflicts of interest to report.

Agenda

- The Current State of Healthcare
- The IoT is Changing the World
- Ideas are Easy, Execution is HARD
- How to Harness the Power of the IoT
- Real World Implementations / Clinical Outcomes

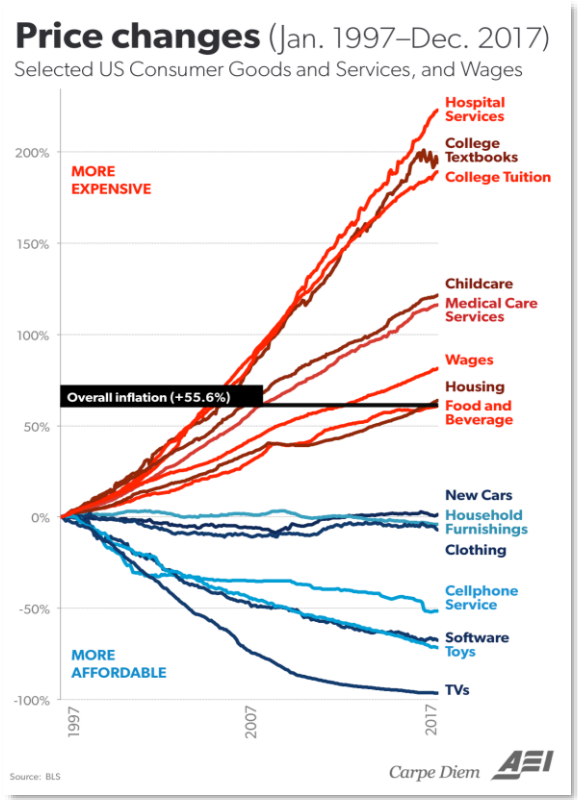
Learning Objectives

- Explain the benefits of plug-and-play interoperability within a healthcare environment
- Analyze the wide range of healthcare data-connectivity requirements
- Compare and contrast the most common connectivity architectures in healthcare
- Identify the best system level architecture for the transportation and analysis of unprecedented amounts of data securely, reliably, and in real time

The Current State of Healthcare

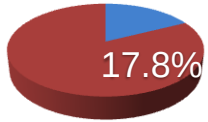
In the US today:

- Preventable medical errors in hospitals are the **3rd highest cause of death** behind cancer and heart disease.
  - **200,000 – 400,000** deaths
- Lack of medical device interoperability **costs >$30B** to the healthcare system.
- **900 million** elders age 60+
  - 1.2 billion by 2025
- Estimated physician shortage of **>50,000** by 2025

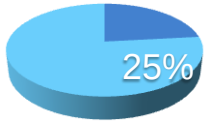


US HEALTHCARE SPENDING
AS SHARE OF GDP

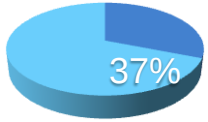
ACTUAL **2018**



PROJECTED **2025**

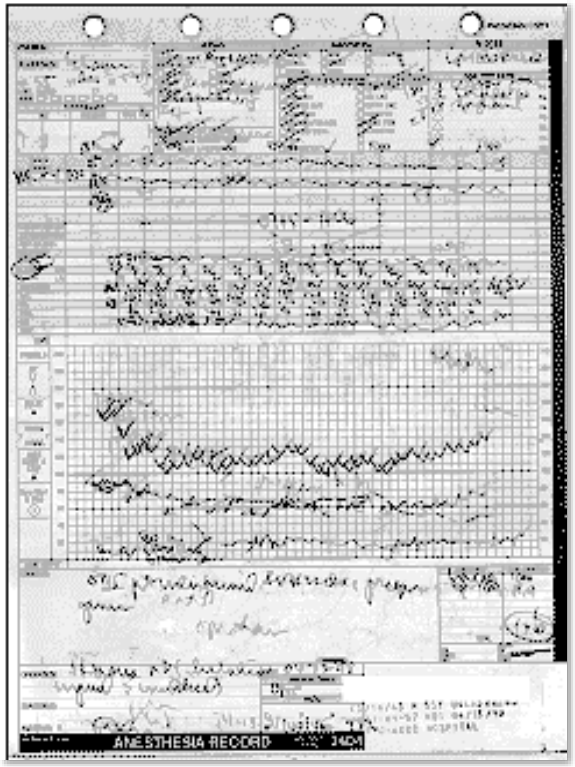


PROJECTED **2050**

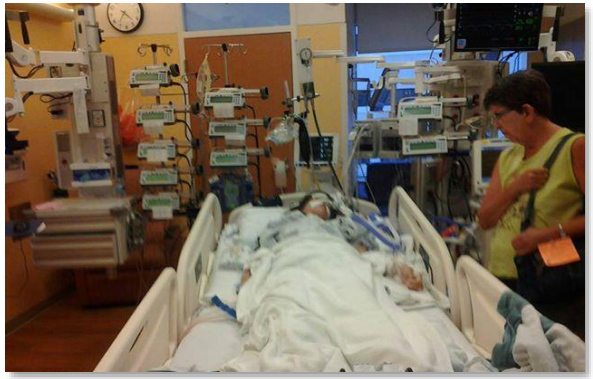


Source: World Health Organization – McKinsey, Continua Alliance, AEI

The "good old days"?



More Devices, More Complexity



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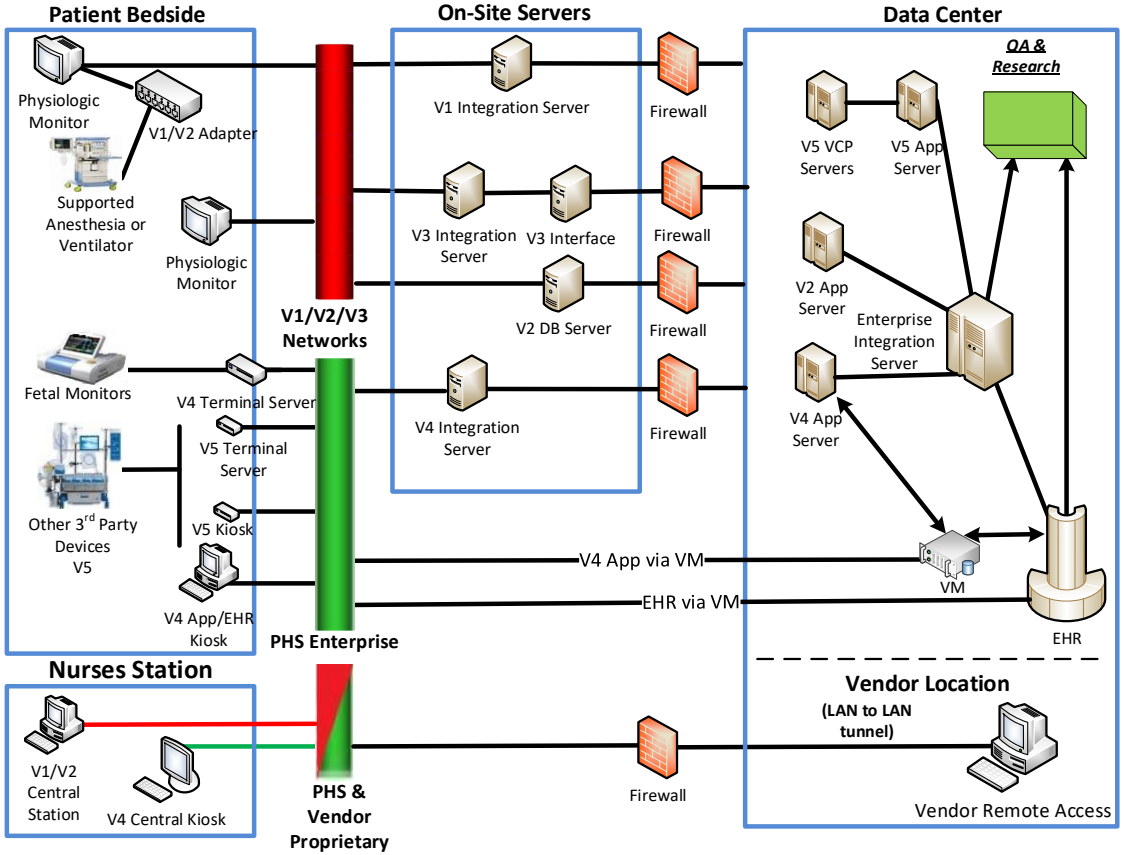
Typical Medical Device Data Architecture

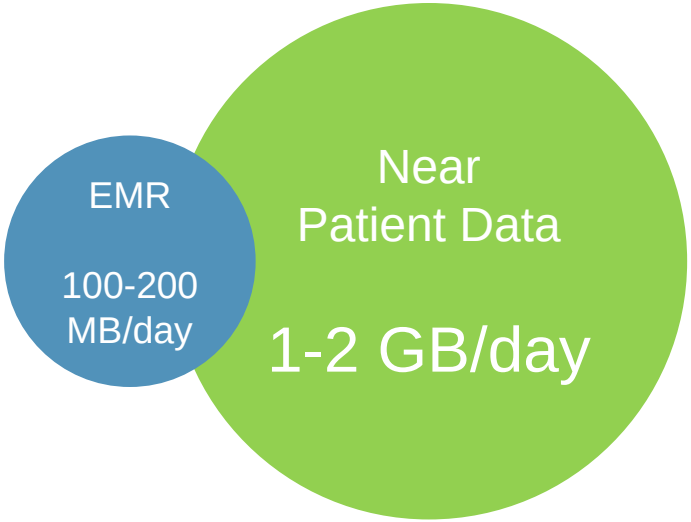


LEGEND

BLUE	= Location Zone
RED	= DMZ Network
GREEN	= Enterprise Network
VM	= Virtual Machine
V1-V5	= Integration Vendor 1 thru 5

We can do better!

“We need to change what is expected of technology in healthcare”



“We need complete, accurate and contextually aware data”

“How many ventilators do I have in use right now?”

“Why can’t this be automatically put in the medical record?”

“Why can’t an infusion pump be paused when the person is overdosing?”

“I want to monitor every patient at every bed in every country I have a hospital”

“How do I take my 30 years of experience and use it to help a new physician provide high quality healthcare?”

Questions/User Needs from MGH’s MDPnP Program Clinical Scenario Repository

Mistakes Kill & Inefficiency is Costly

Hospital error is the 3rd leading cause of death in the U.S. and inefficiency reduces patient outcomes

"… the anesthesiologist forgot to resume ventilation after separation from cardiopulmonary bypass…

Every surgical team surveyed has experienced this error!

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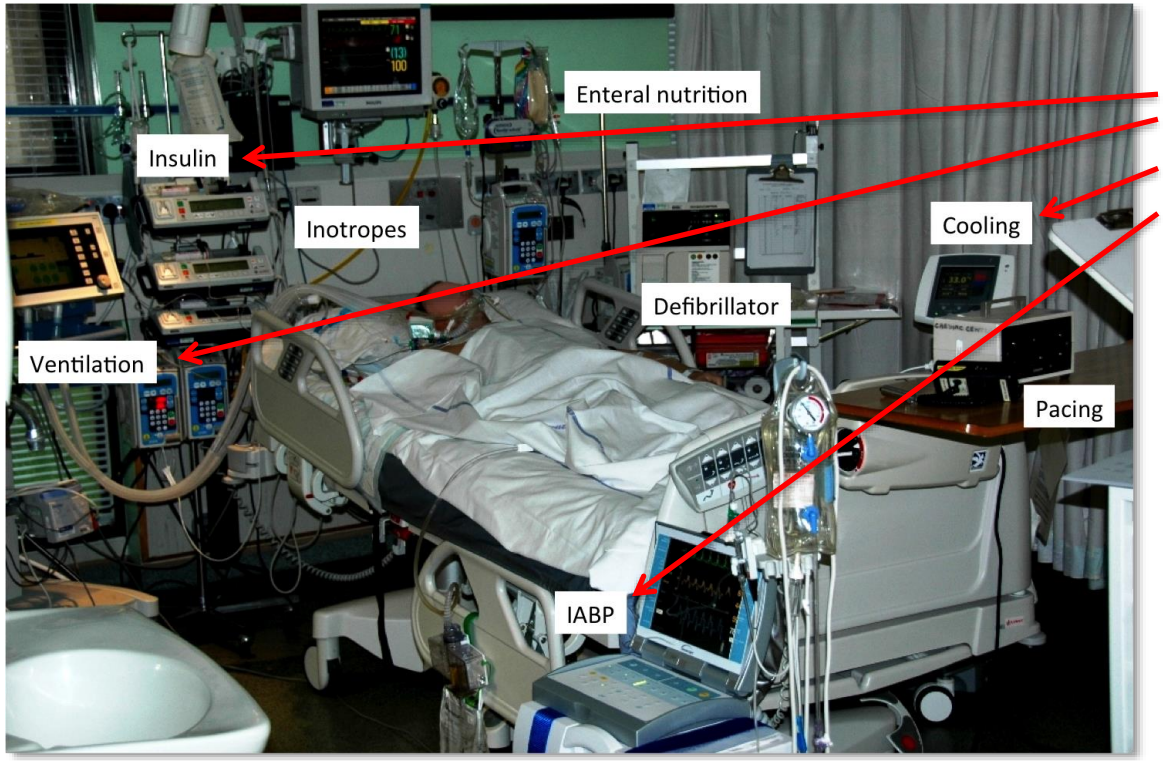
An Integrated Clinical Environment (ICE)



ICE Platform

What if… Integrating Clinical Environments can enable apps to rapidly and safely implement solutions?

Real-Time CDS

App detects Pulseless Electrical Activity and provides real-time Clinical Decision Support (RTCDS)

Developed on OpenICE, an open source research platform built by MD PnP.

www.openice.info

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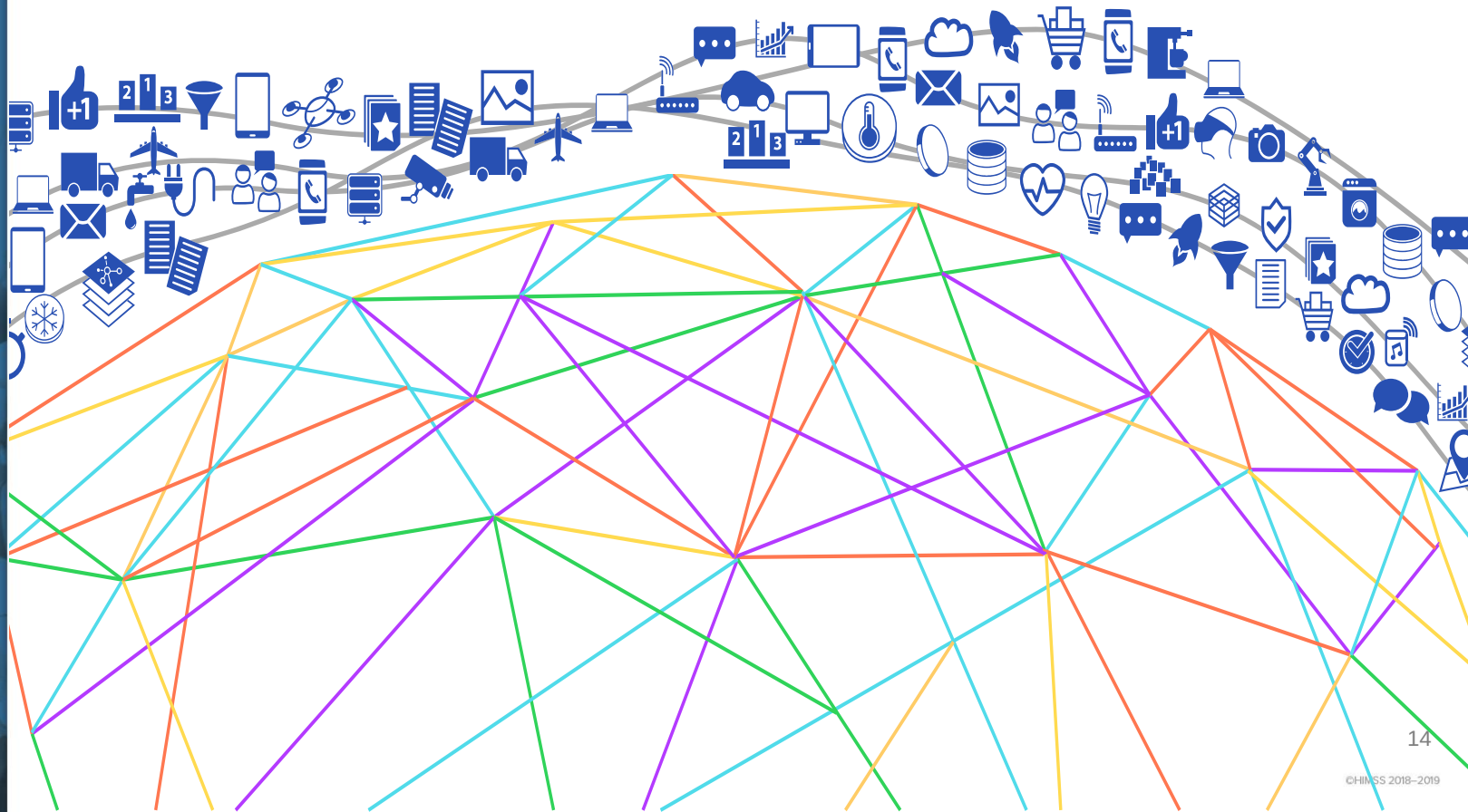
What is the Internet of Things?



The IoT Transforms Industries

Music
Physical records -> Subscription streaming

Spotify

Television
Cable -> TV-on-Demand

HBO GO

Retail
Brick-and-mortar -> Digital marketplaces

amazon

Transportation
Personal cars -> Ride-share -> Self-driving ride-share

lyft

Publishing
Printed newspapers -> Online news feeds

HUFFPOST

Healthcare
Capital equipment -> Usage-based
Fee for service -> Value-based care

Why is this so HARD to implement?

Connectivity

So many choices….

Interoperability

Is it even possible?

Security

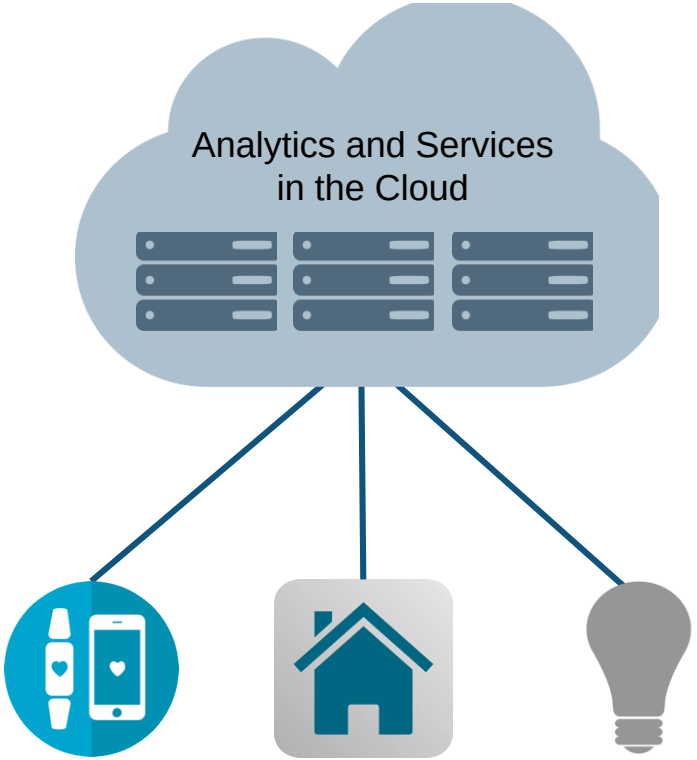
What does this even mean?

Real-Time Analytics

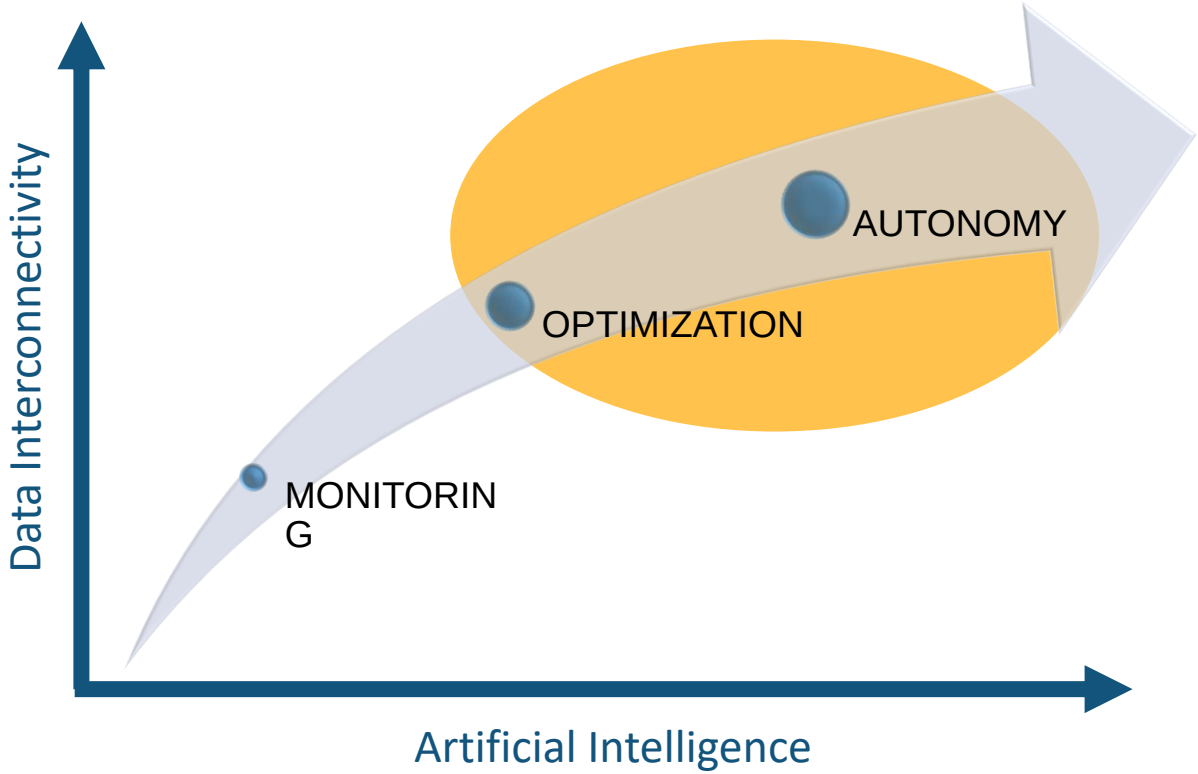
Are we even ready for this?

Conventional View of the IoT

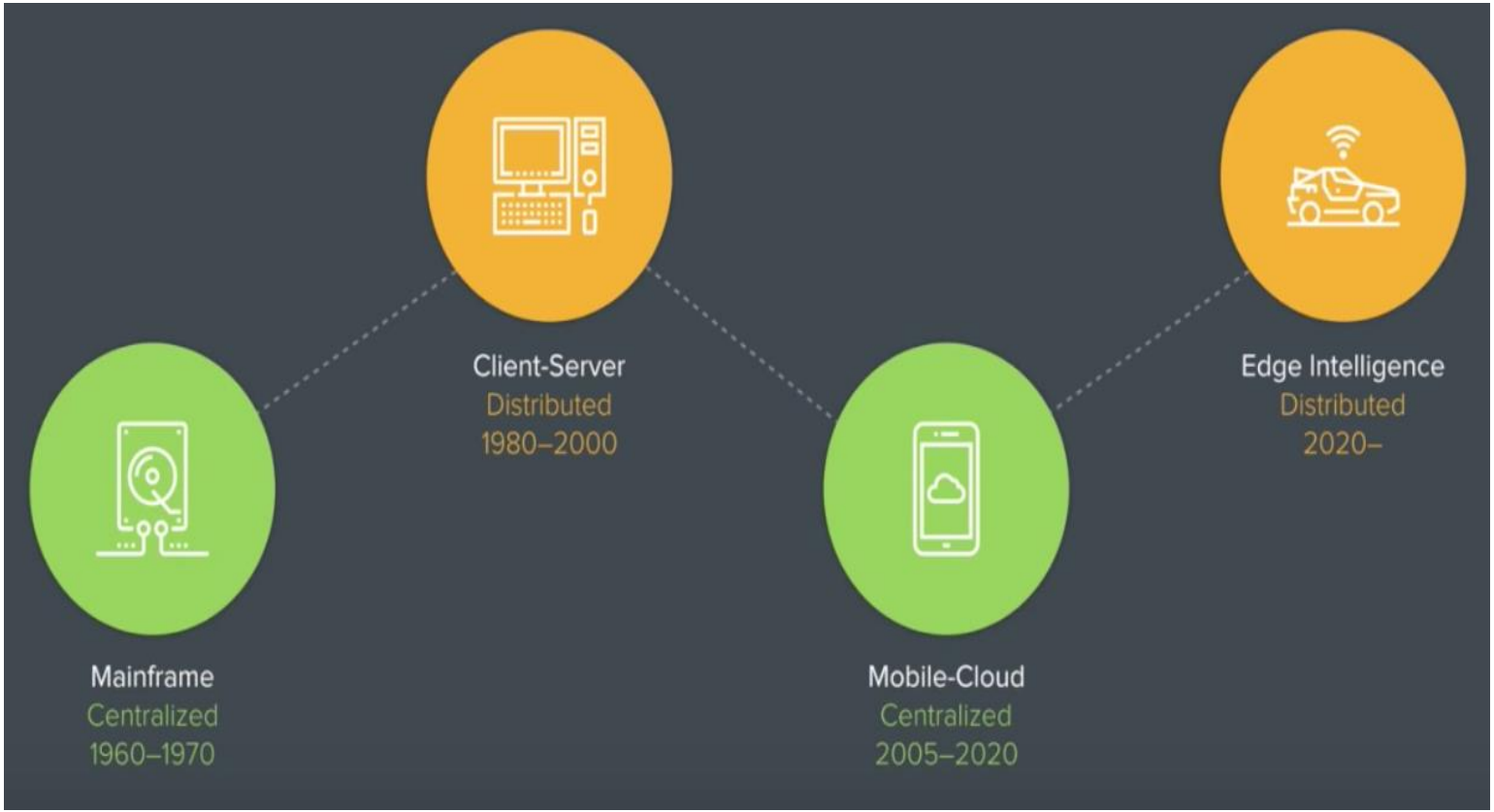
- Cloud-centric
- Consumer application-focused
- Limited scalability and performance
- Poor robustness
- Reduced capability and utility
- Limited security



The Evolution of the IoT



The Next Phase of the IoT



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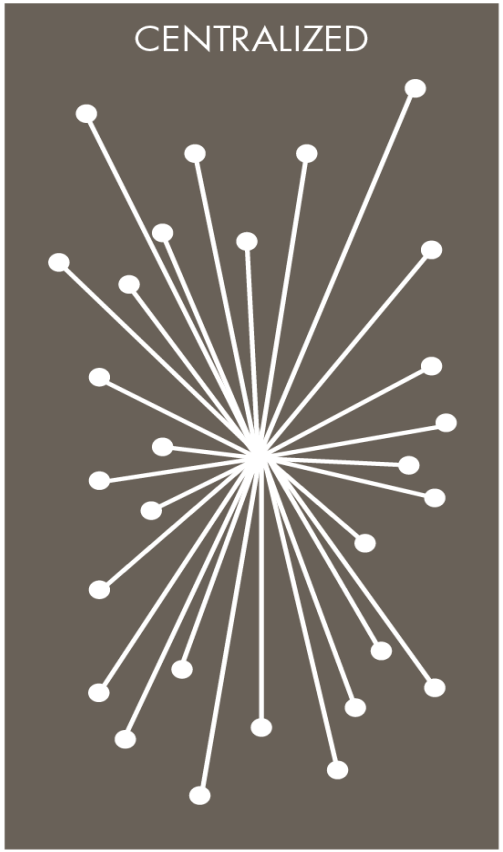
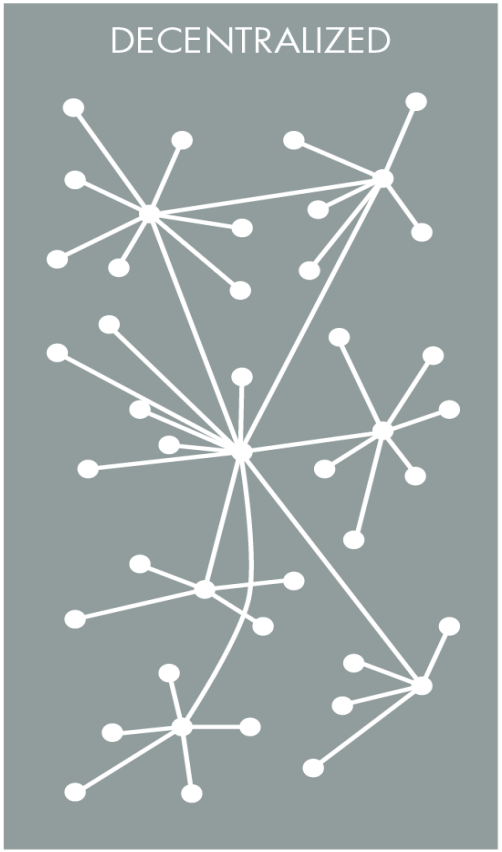
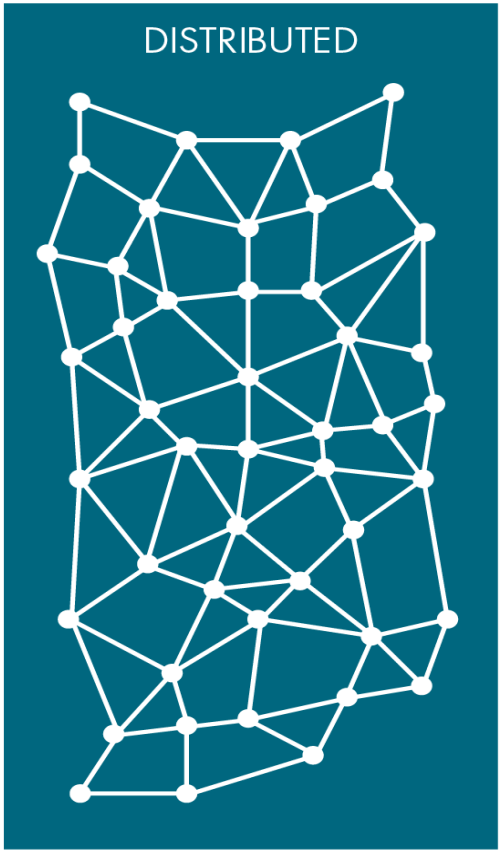
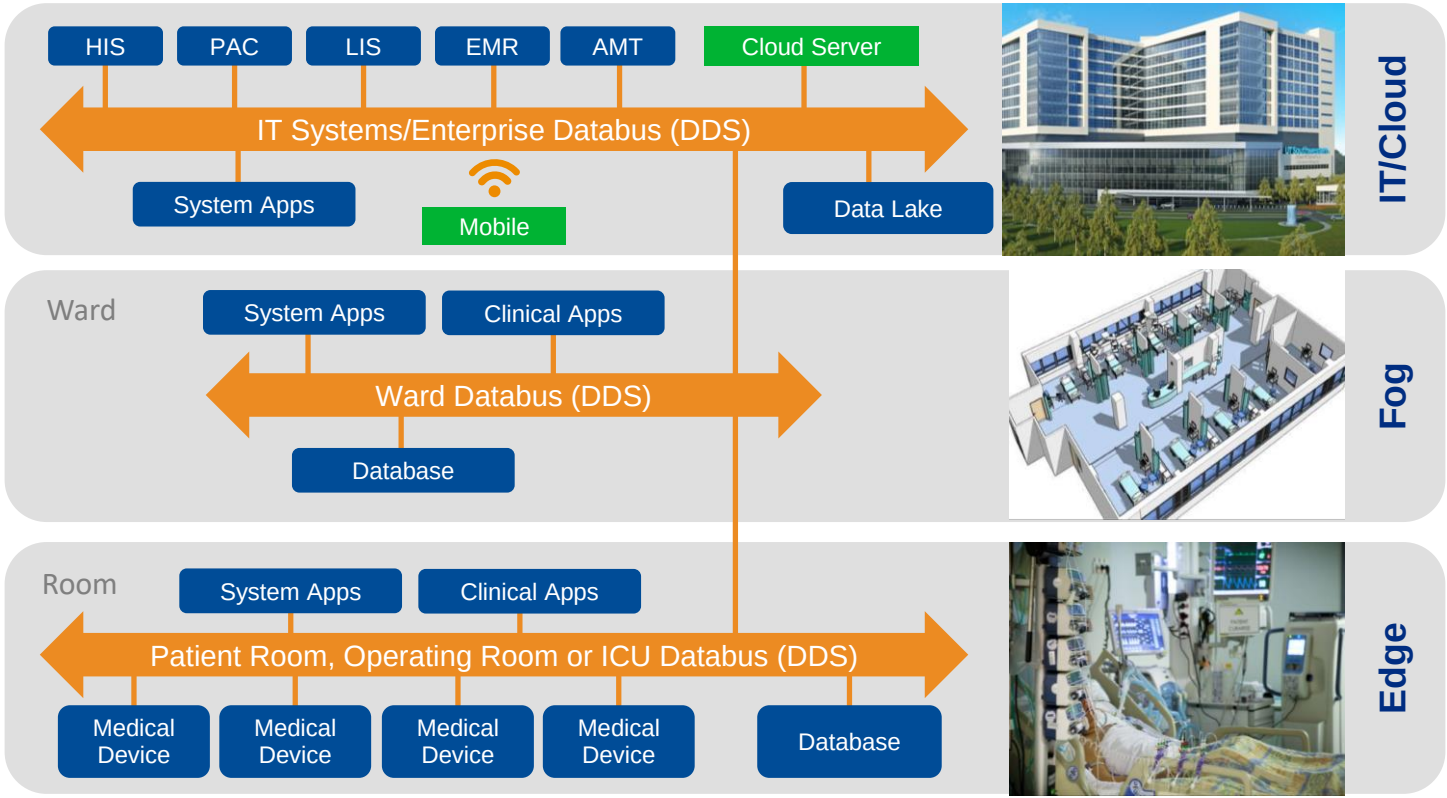
Decentralized Peer to Peer Systems



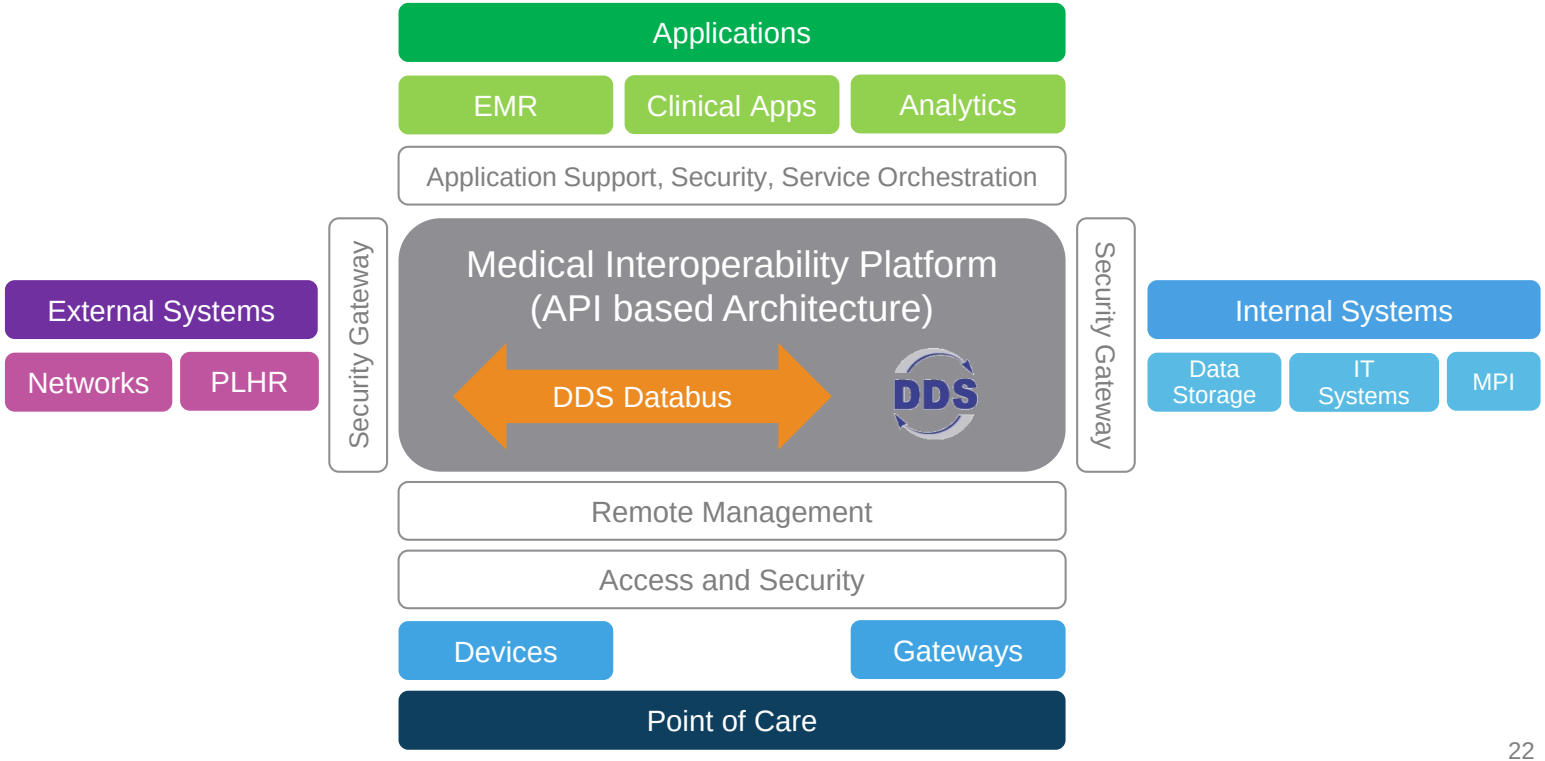




Edge Intelligence in Healthcare



Standards Based Interop Platform

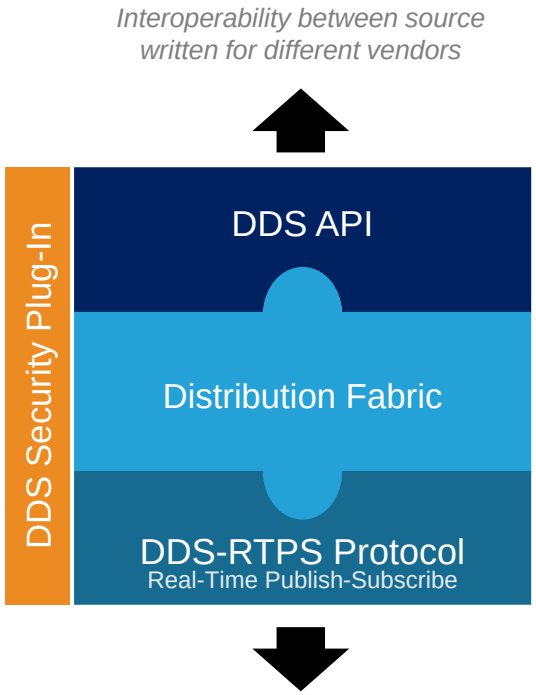


DDS: Open IoT Standard

- Data Distribution Service (DDS) is an open industry standard for data-centric connectivity
- From OMG, the world's largest systems software standards organization
  - UML, DDS
  - Industrial Internet Consortium (IIC)

OBJECT MANAGEMENT GROUP

DDS



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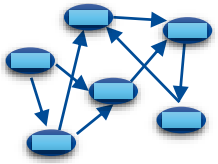
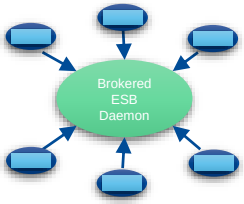
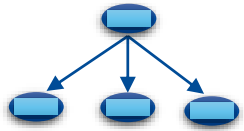
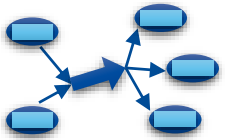
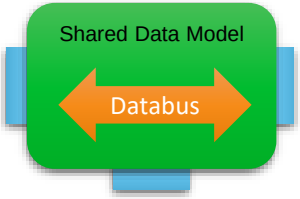
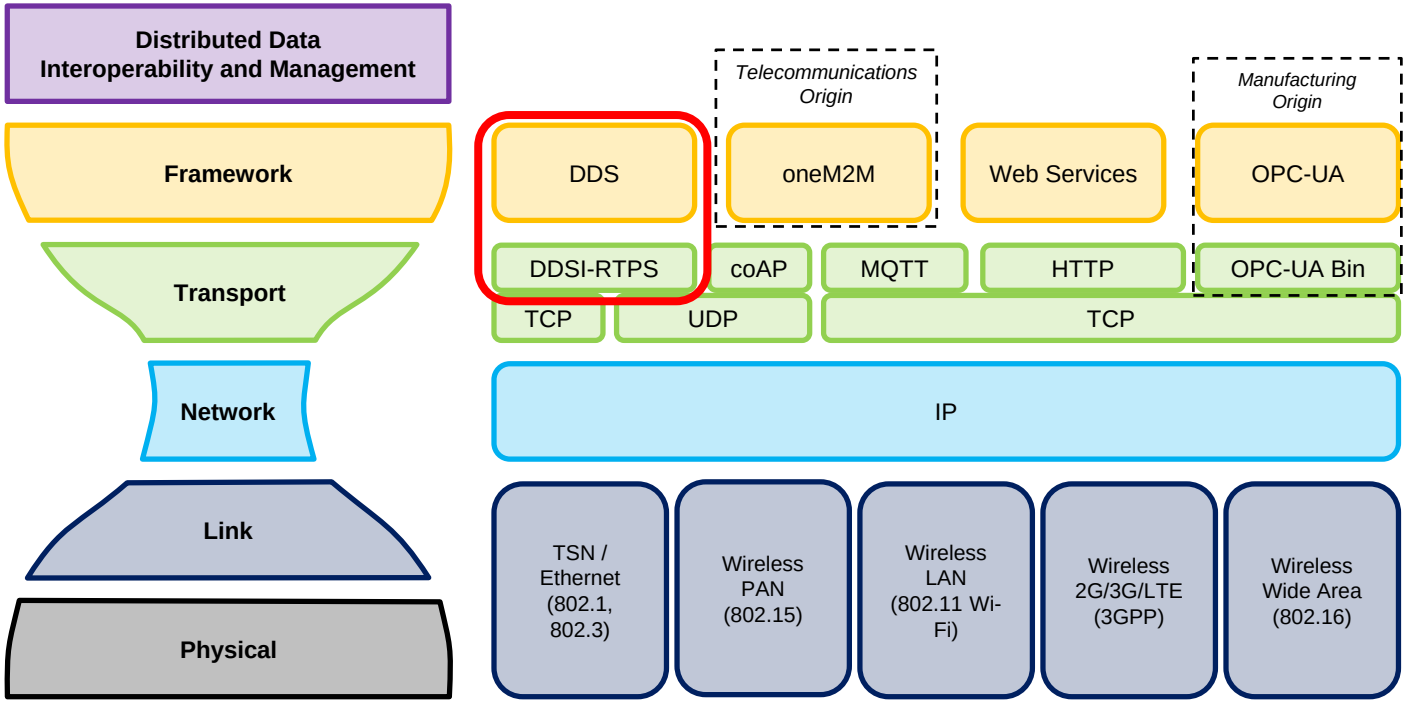
Designed to Manage Complexity

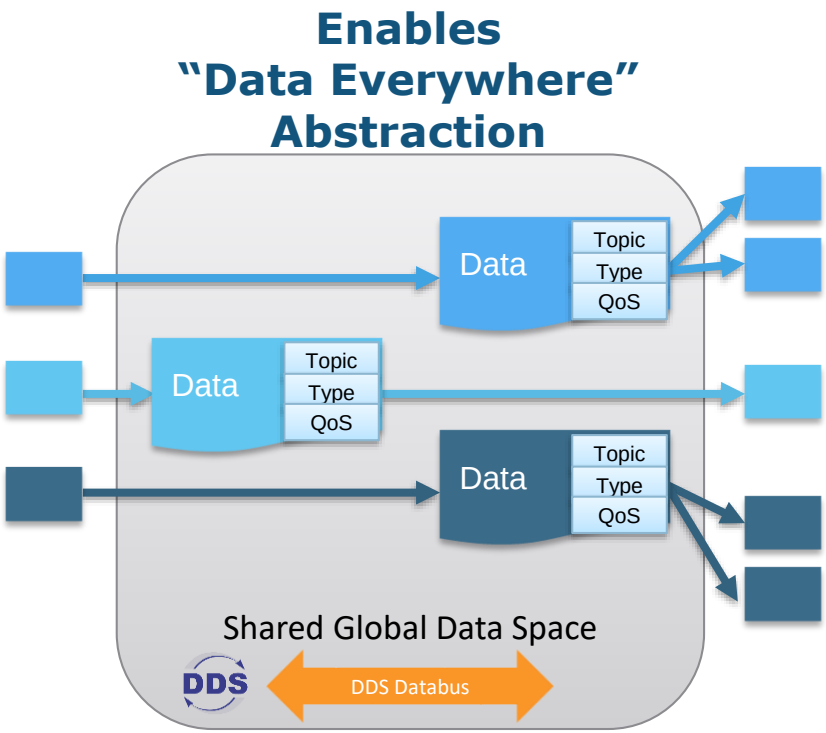
Point-to-Point	Client/Server	Publish/Subscribe	Queuing	Data-Centric
				
				
TCP Sockets	MQTT XMPP OPC CORBA	Fieldbus CANbus ZeroMQ JMS	AMQP Active MQ	DDS

Key Connectivity Standards



Source: Industrial Internet Consortium Reference Architecture

DDS – Medical Grade Connectivity

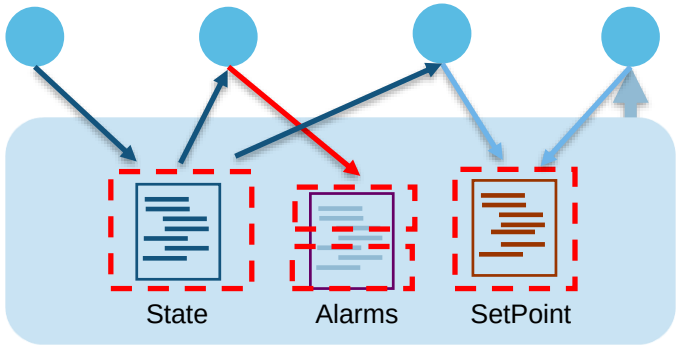


Naturally, massively parallel

- **Data Centric**
  - Applications interface only to data
  - Every application gets everything it needs, when it needs it
- **High Performance**
  - <10us Latency
  - >40GB/s Thoughput
- **Highly Reliable and Secure**
  - Deployed in 1000's of mission critical applications
- **Interoperable**
  - Provides syntactic interoperability via open DDS standard technology
- **Scalable**
  - Proven scalability to millions of nodes via layered databus architecture

Secure Dataflow

- **Dataflow Level Security**
  Secure each piece of data in addition to securing the “pipe”



- **Complete Protection**
  Utilize DDS Security by appropriately securing the data (by type) in real time

Data Item	Authentication	Access Control	Integrity	Non-Repudiation	Confidentiality
Device Diagnostic Data	X		X		
Remote Commands	X	X	X	X	
Patient Data	X	X	X		X

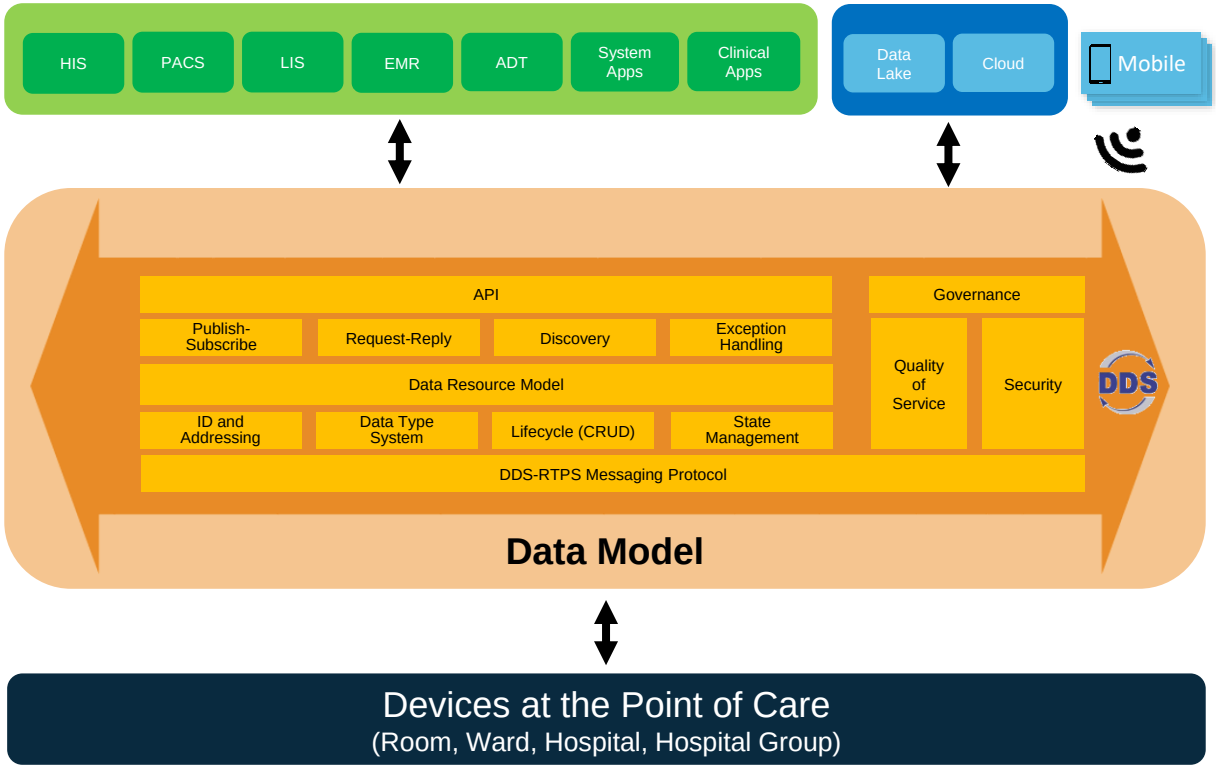
DDS Availability and Adoption

~6 Commercial DDS Vendors

~6 Open Source DDS Implementations

Adopted by major standards bodies:

A Data-Centric Healthcare IoT Platform

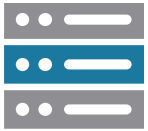


DDS - The Foundation of Healthcare IoT

Interoperability

Reliability

Secure and Seamless Data Flows



Interfaces to External Systems

Scalability

Support ALL Necessary Data Types

Open, Member/Vendor Neutral, No Blocking

Benefits for Providers

Clinicians

- Patient Specific Solutions
- Real-Time Clinical Decision Support
- Contextualized Workflow

C-Suite

- Data-Rich Decisions
- Improved Quality Metrics
- Transforming the Industry

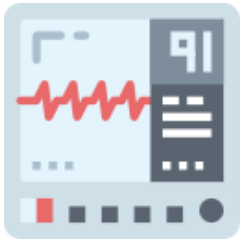
IT & Clinical Engineers

- Simplified Integration
- Simplified Management and Maintenance
- Optimize Assets and Technology

Benefits for the Ecosystem

Patients

Payers



Device OEMs

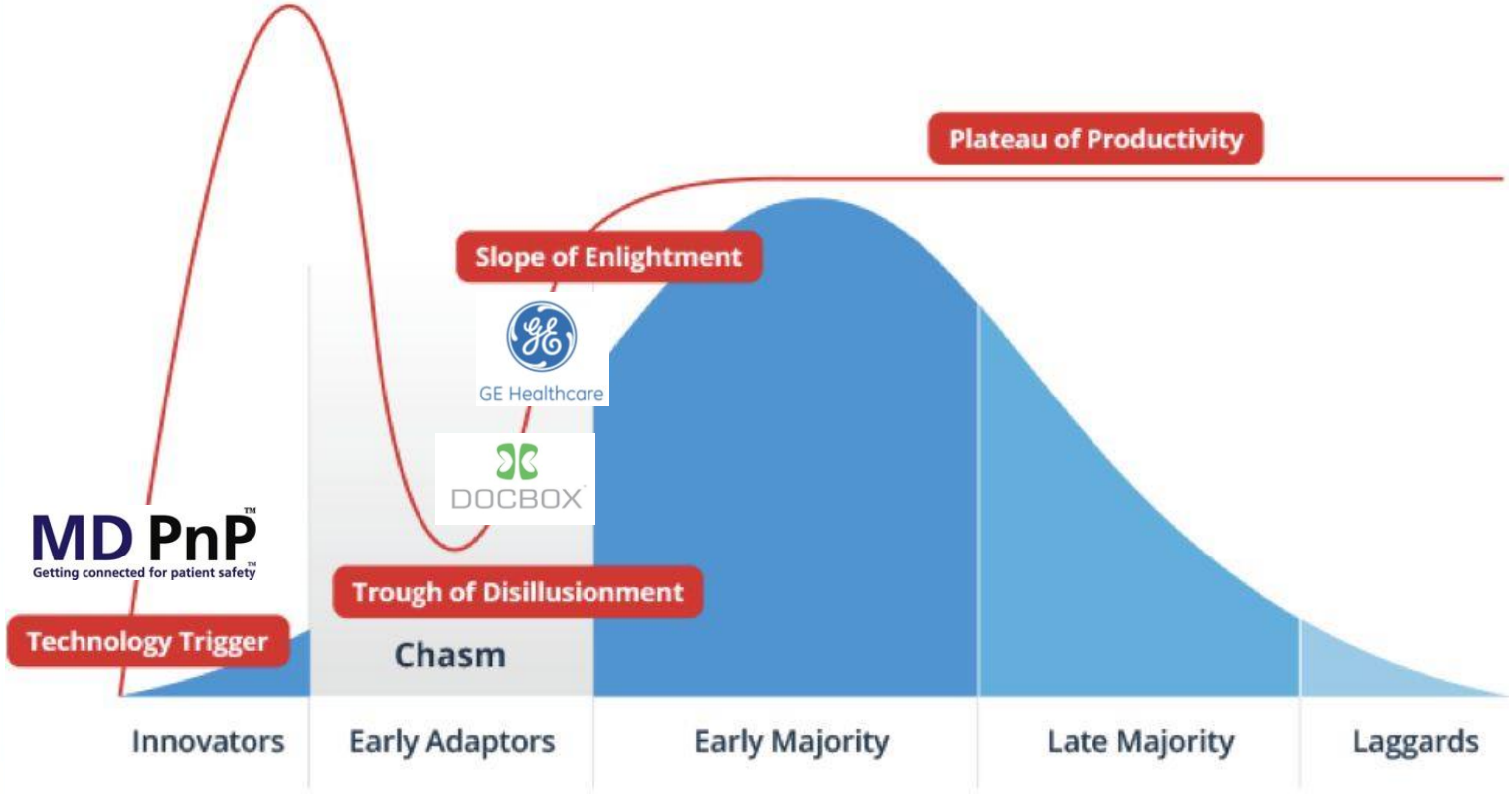
Patients	Payers	Device OEMs
Lowers Risk of Medical Error	Complete Visibility in Patient Stay and Cost	Speeds Development
Improved Clinical Experience	Audit Trail	Lowers Development Cost
Lower Cost	More Complete Public Health Data	Simplified Integration

Key Components Needed for Success

- **Data Model for Near Patient Data (Semantic/Organizational)**
  - This architecture is only successful with a comprehensive and extensible, widely-accepted and widely-adopted data model.
  - Ideally there would be a small number of harmonized data model driven by system integrators, major medical device OEMs, provider networks, or a standards organization.
  - Suggest starting with existing standards and expanding as needed to meet the needs of a diverse set of clinical scenarios.

- **Ability to Interface with Legacy and Enterprise Architectures**
  - Proprietary Device (Coms Protocol/Data Structure) <-> DDS + Data Model
  - DDS + Data Model <-> Restful API + FHIR Data Model
  - 3rd party ecosystem should develop to optimize development efforts

Timeline for Adoption



Source: Hype Cycle (Gartner), Crossing the Chasm (Geoffrey Moore)

MD PnP (OpenICE Platform)

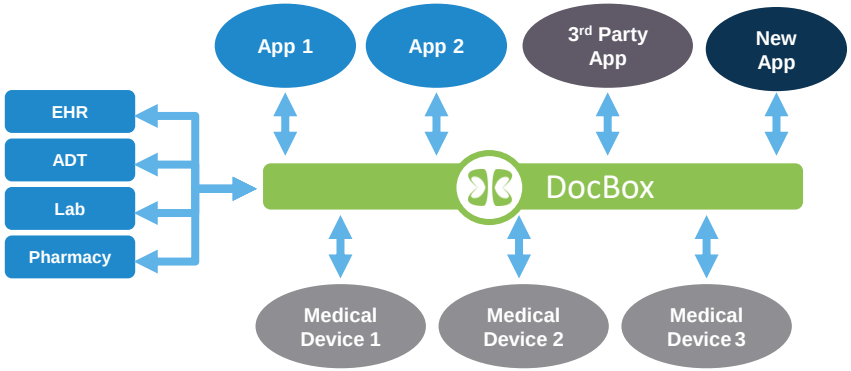
- Program established 2004 at Mass General Hospital/Partners Healthcare
- Lab opened 2006 for research on achieving safe, secure interoperable medical systems (standards, technologies, products). Expanded 2017.
- Clinical, biomed, computer science, and IT subject matter experts
- Publish research to enable safe interoperability
- Develops OpenICE open-source interoperability research platform www.openice.info
- $22M research funding primarily from DOD, NIH, NSF, DHS (FDA-MITRE)
- Multiple collaborative lab prototyping and public demonstrations with industry, academia, and government

Example of collaborators

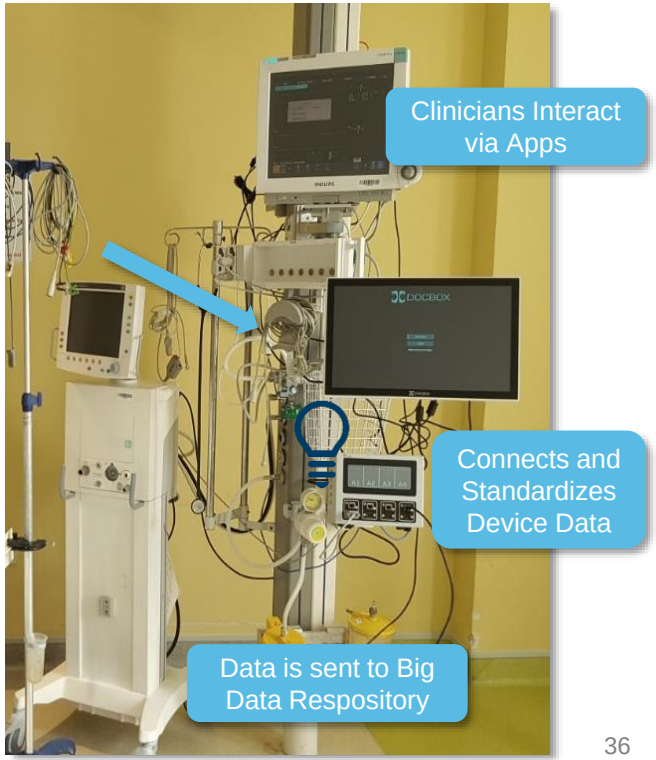
MD PnP™
Getting connected for patient safety™

http://mdpnp.mgh.harvard.edu/

DocBox Platform



- **Vision** - Utilize an standard approach to create an infrastructure where data can be leveraged at motion and at rest in order to improve, safety, efficiency and efficacy of care.
- **Simplified Infrastructure** - Data is aggregated in real-time; it is stored, analyzed, and available in an standard format.
- **Enable Key Apps** - Data is made available for applications to connect in real-time and retrospectively. This enables solutions for visualization, automation, and real-time decision support.
- **Framework for Safety and Security** - Platform provides a shared infrastructure which is leveraged by applications to enhance patient safety and cybersecurity



GE Healthcare

"GE Healthcare is leveraging the RTI Connext DDS-based architecture to connect medical devices, cloud-based analytics, and mobile and wearable instruments."

Matt Grubis

Chief Engineer @ GE Healthcare - Mobile Digital Health Solutions

It's Time to Change the World

- We have the opportunity to save >200,000 lives and $30B in healthcare costs by fully utilizing the power and capabilities of the IoT.
- Technology is NOT the problem. Ideas are NOT the problem.
- We need to begin executing on a common mission to drive data liquidity in Healthcare.
- The standards-based system architecture described today could be the foundational tool to align the industry to start EXECUTING!

Next Steps

- Stop by the RTI Booth 8542 on the HIMSS 2019 Exhibition Hall to see a DDS-based system in action (DocBox).
- Reach out to Dr. Goldman to get involved with the Medical Device Plug and Play Program.
- Review the Industrial Internet Consortium's guidance documents on Connectivity Frameworks (IICF) and Security Architecture (IISF).
- Advocate for the adoption of DDS-based Medical IoT architectures with
  Device Vendors, MDDS Vendors, and Standards Groups.

Questions and Contact Info

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rti Your systems. Working as one.

MD PnP™ Getting Connected for Patient Safety™

Thank You!

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