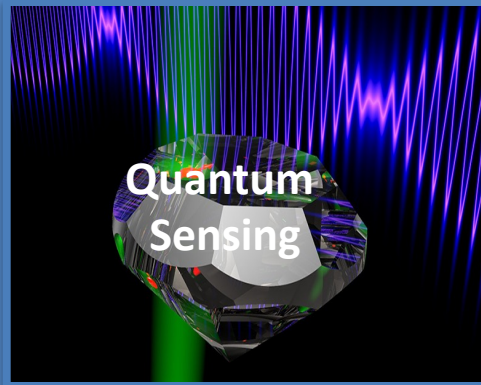
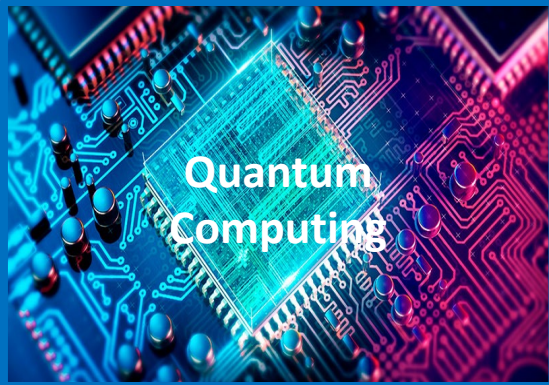


# 6<sup>th</sup> IEEE IoT Vertical and Topical Summit at RWW2023

*“Quantum Information Technology and the Internet of Things”*



Adam T. Drobot, Wayne, PA 19087  
January 25<sup>th</sup>, 2023

Las Vegas, Nevada  
January 25<sup>th</sup>, 2023

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# Agenda

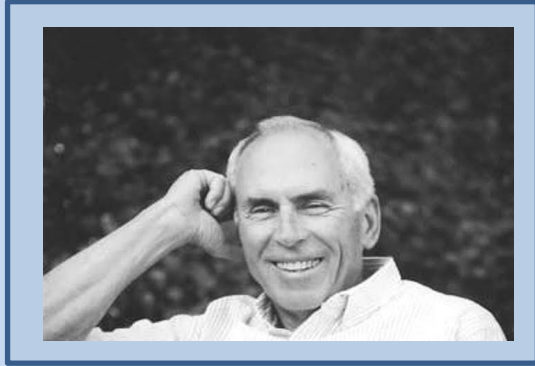
- *The trajectory for technologies in their infancy*
- *The Internet of Things and Quantum Information Technology*
  - *A simple view and a bit about IoT*
  - *Underlying Technologies – Where does QIT Fit In*
- *Quantum Information Technology (a dialog with ChatGPT)*

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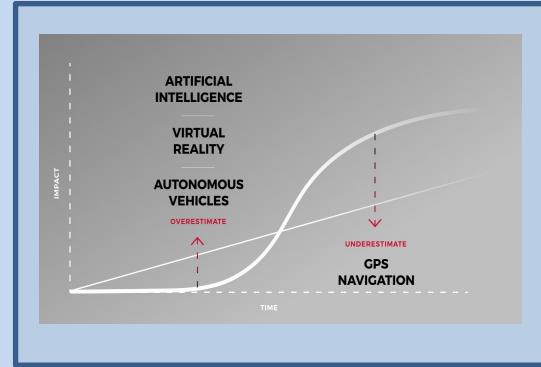


# The Trajectory for Emerging Technologies



**Roy Amara**  
Co-founder  
Center for  
the Future

**“We tend to overestimate the effect of technology in the short run and underestimate the effect in the long run.” – Amara’s Law.**



**What will the Trajectory look like for Quantum Information Technologies and how long will it take?**

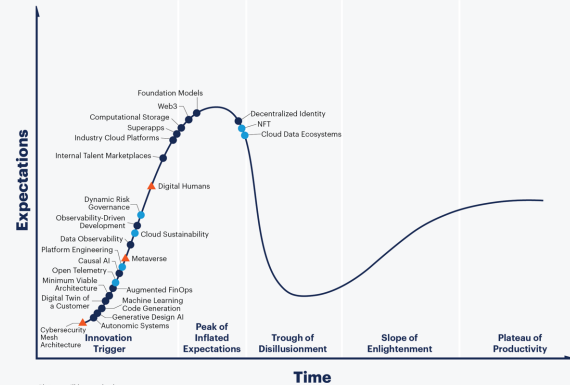
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# The Trajectory for Emerging Technologies

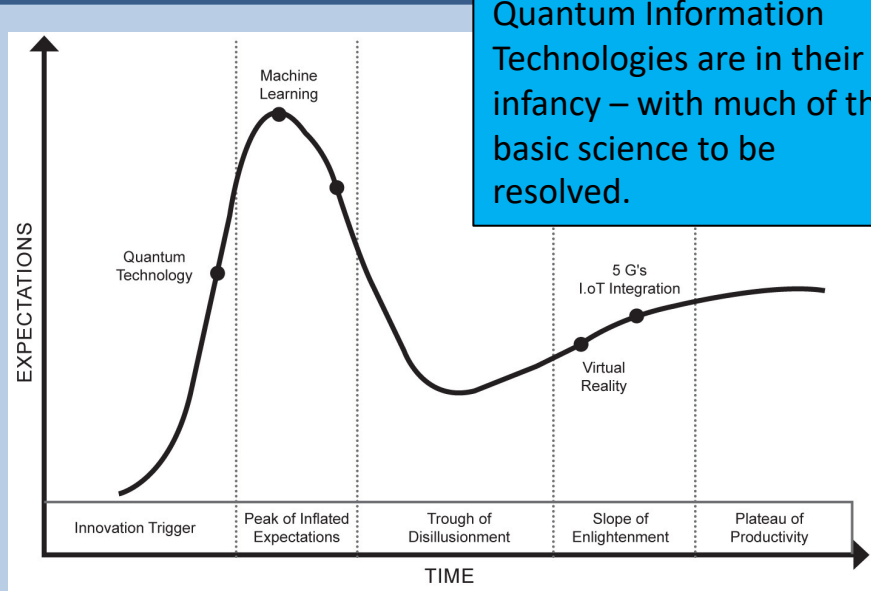
## Hype Cycle for Emerging Tech, 2022



Plateau will be reached:  
 ○ less than 2 years   ● 2 to 5 years   ● 5 to 10 years   ▲ More than 10 years   ⊗ Obsolete before plateau   As of August 2022

gartner.com  
 Source: Gartner  
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**Gartner.**

Quantum Information Technologies are in their infancy – with much of the basic science to be resolved.

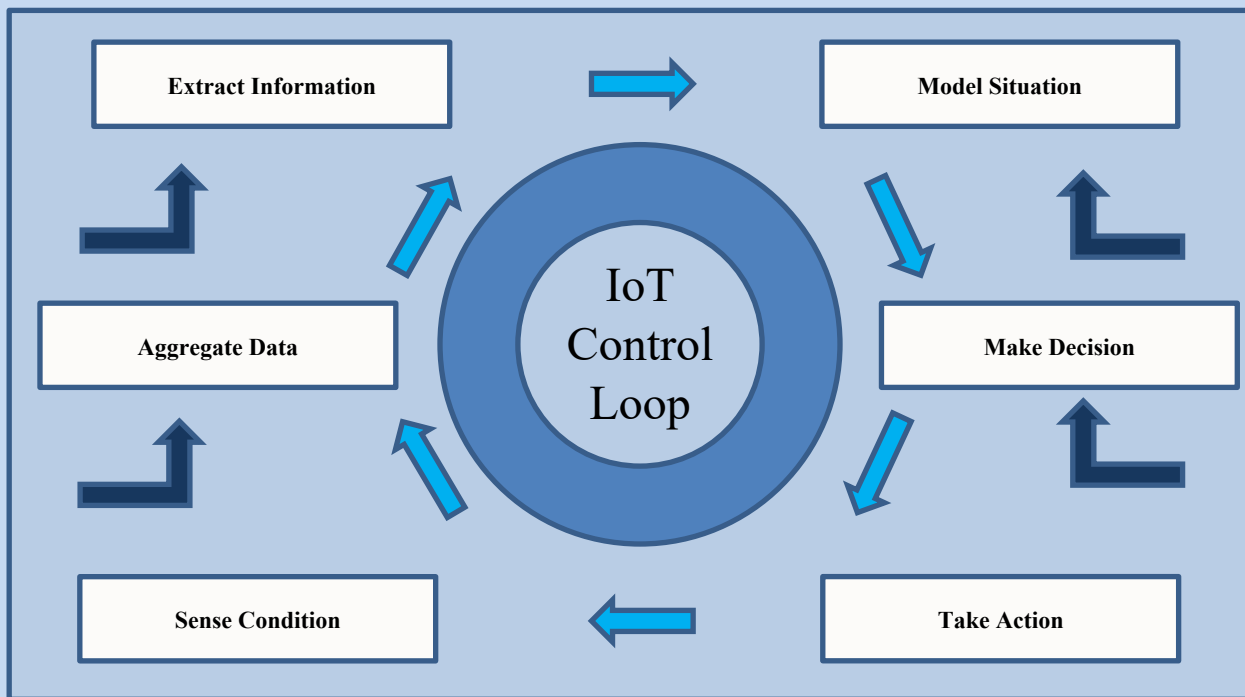


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# A bit about: The Internet of Things

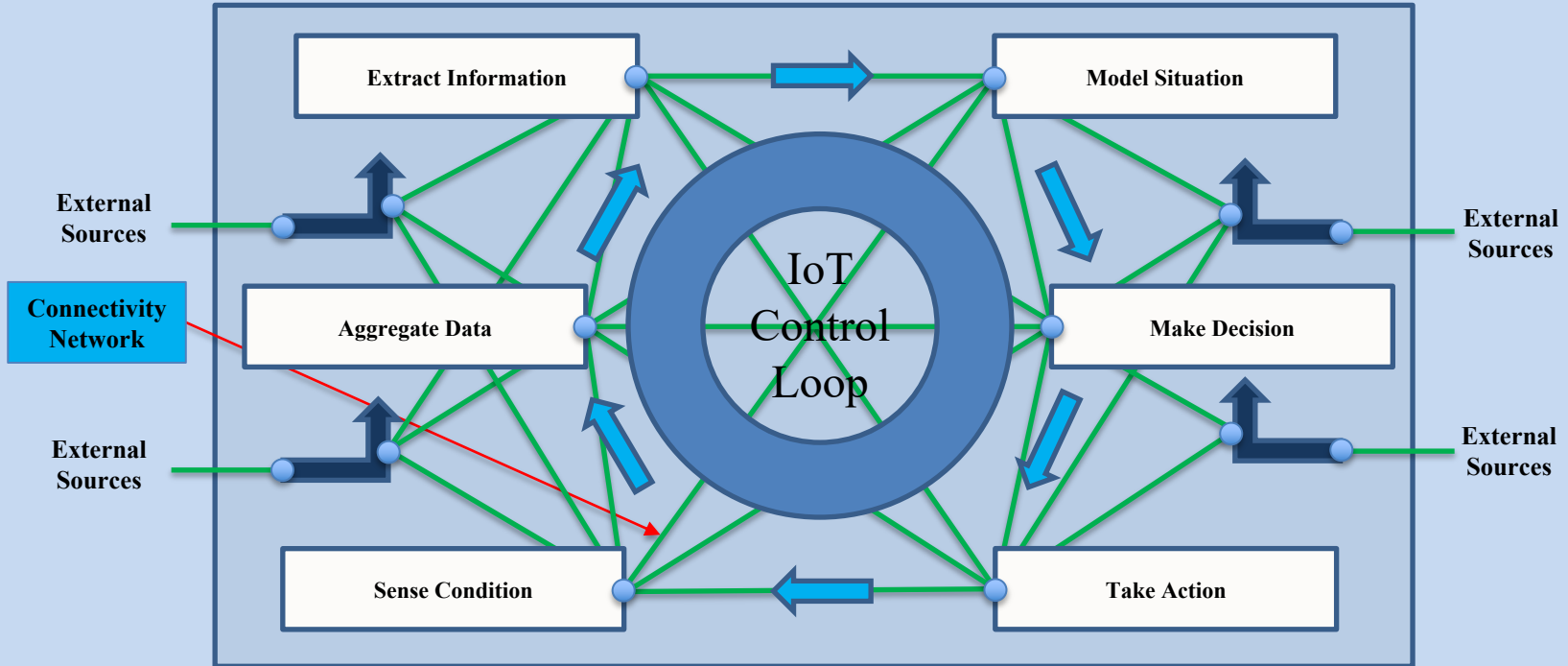


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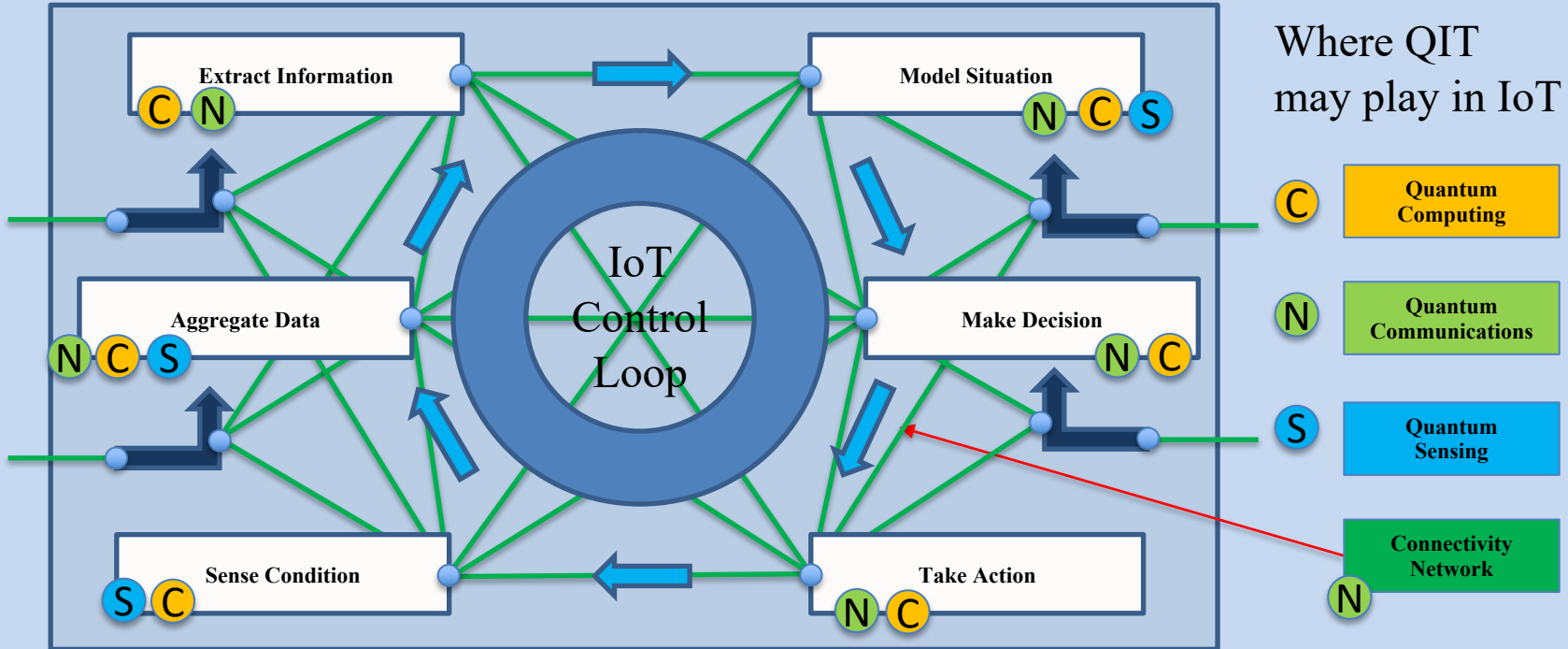


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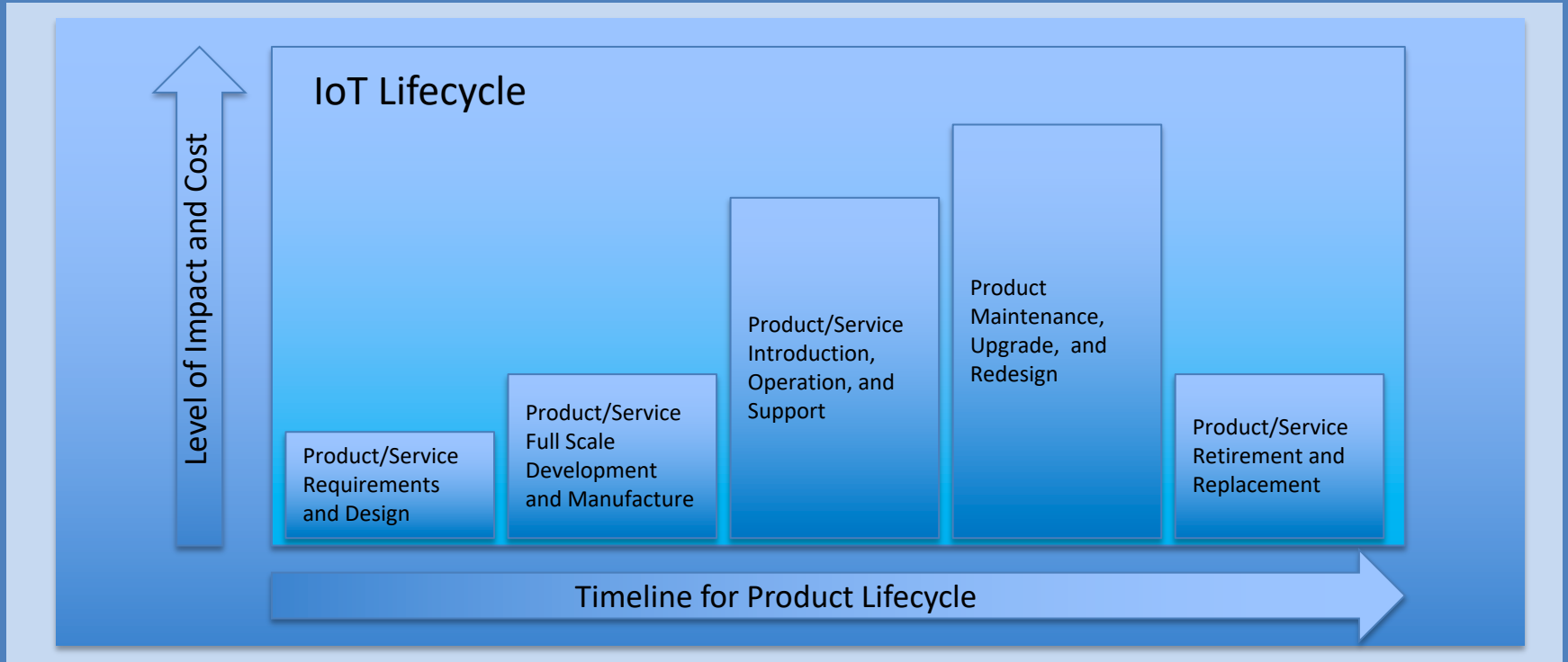


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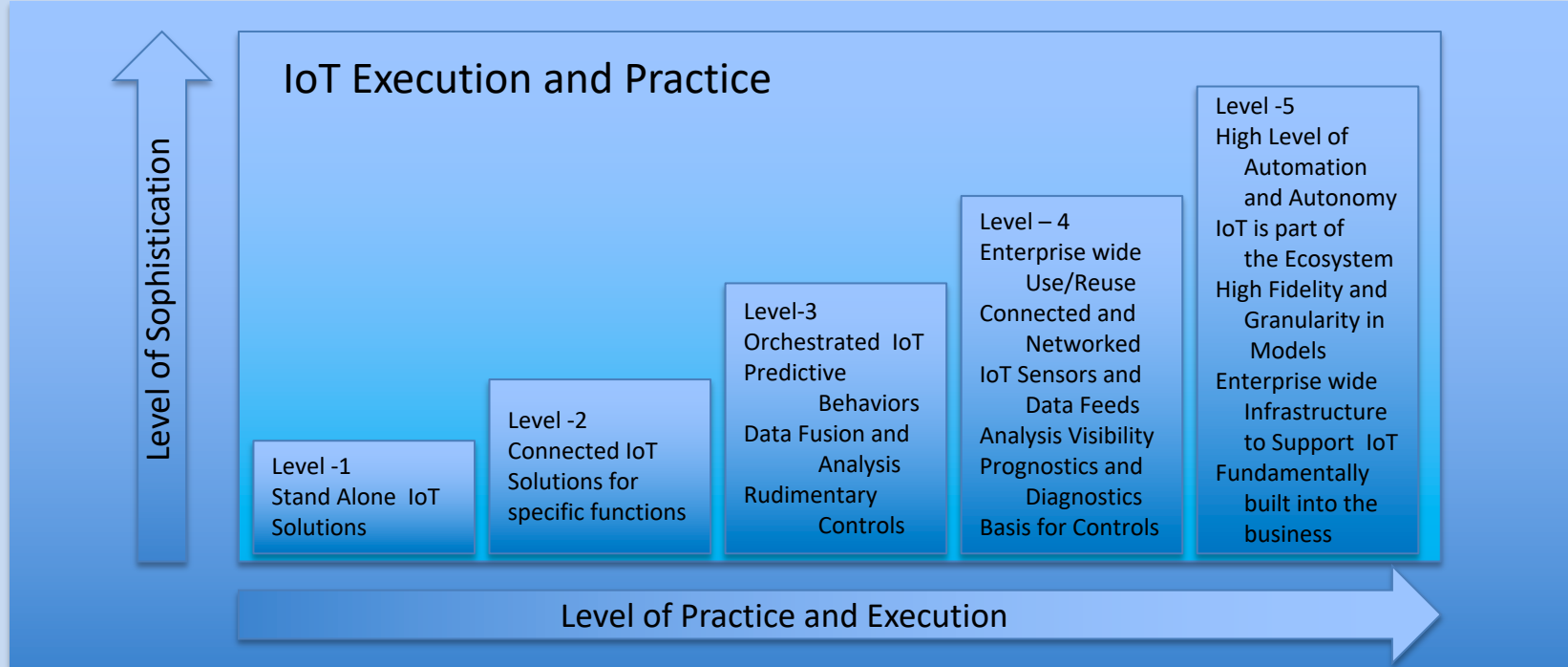
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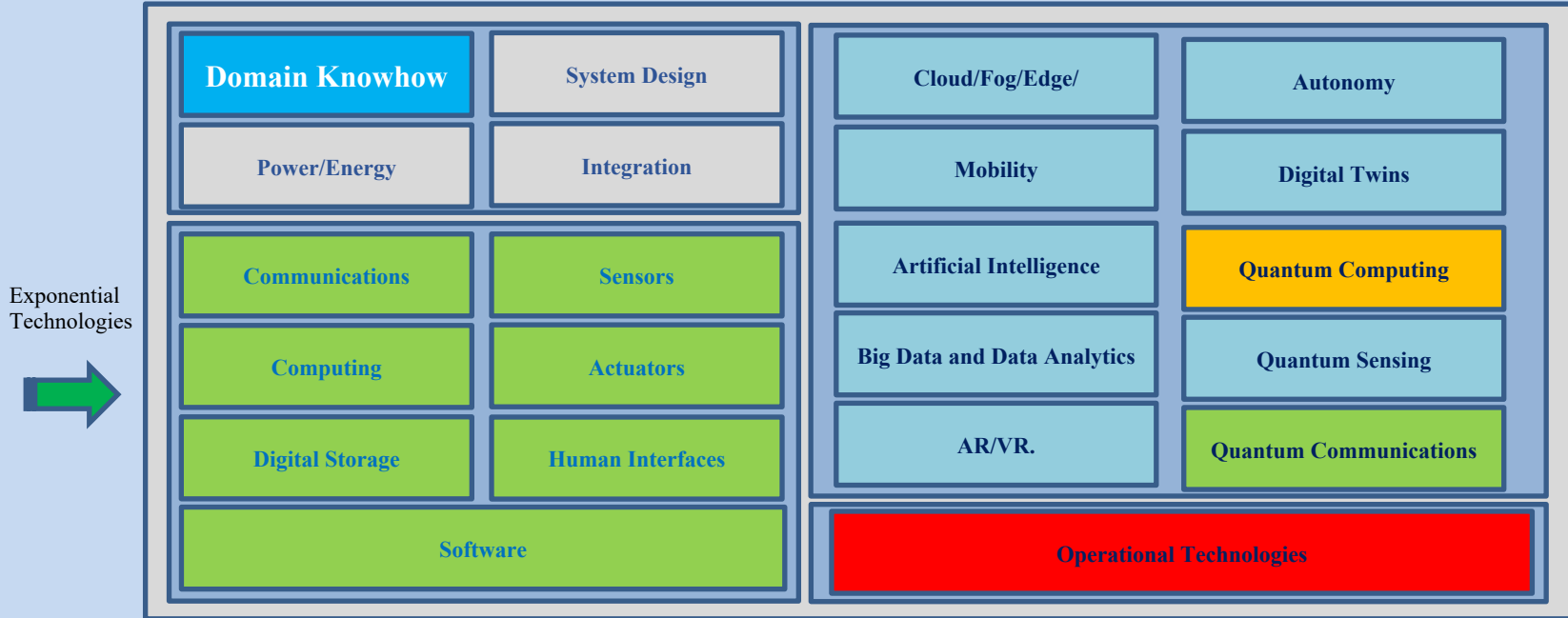


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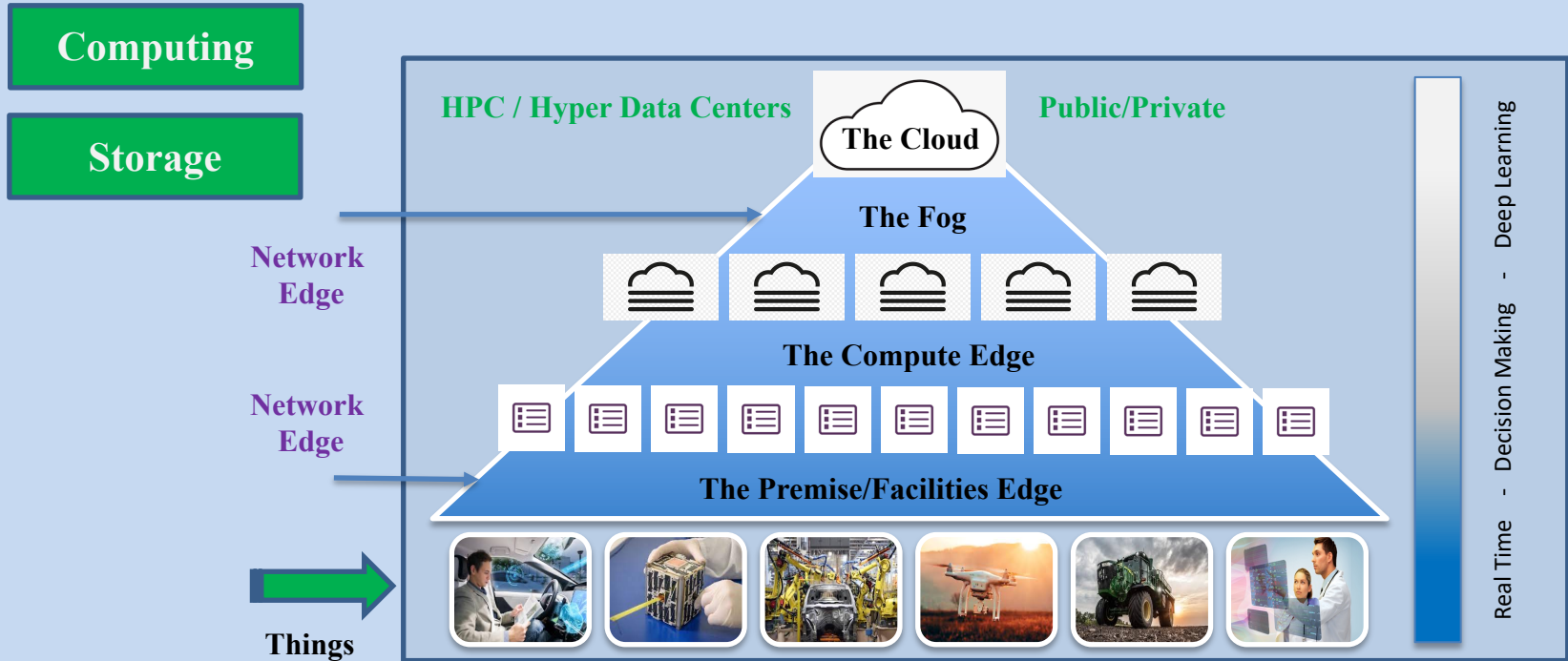


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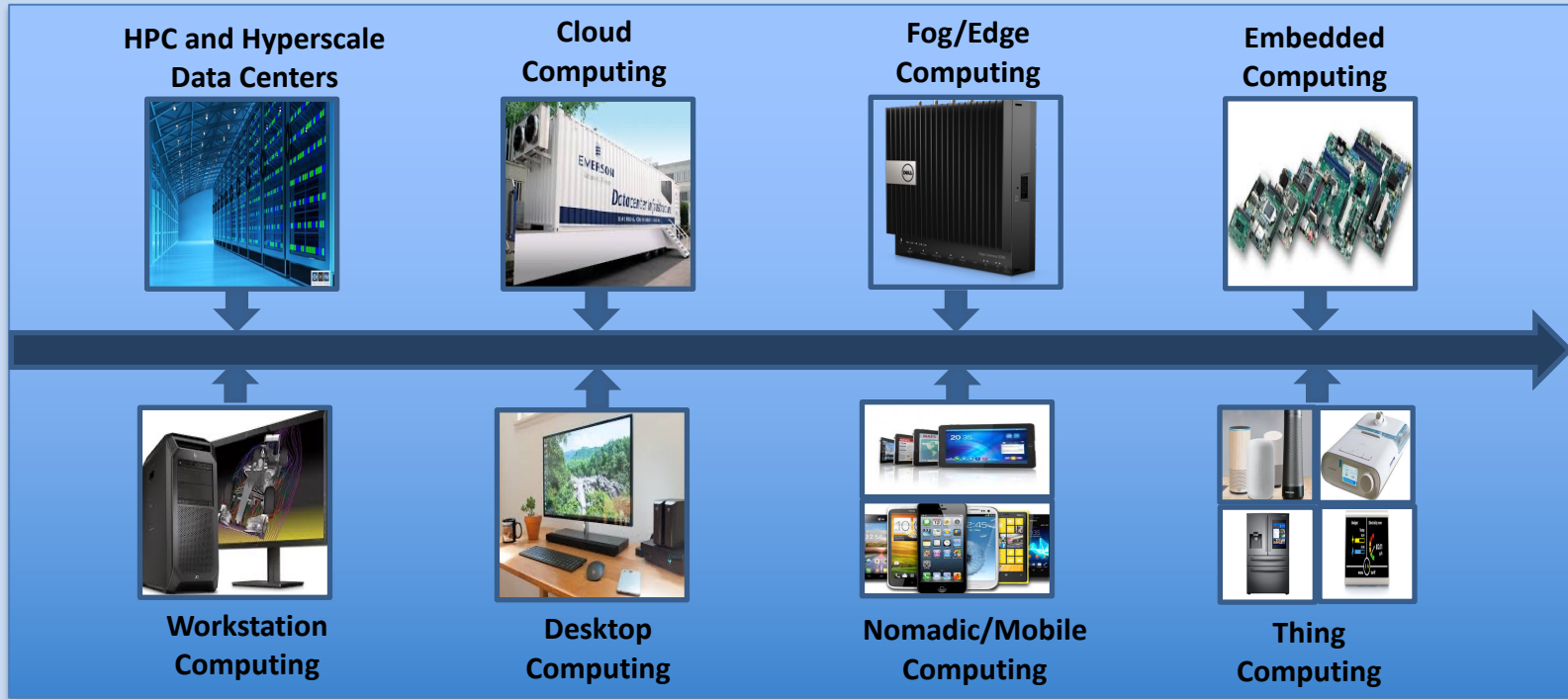


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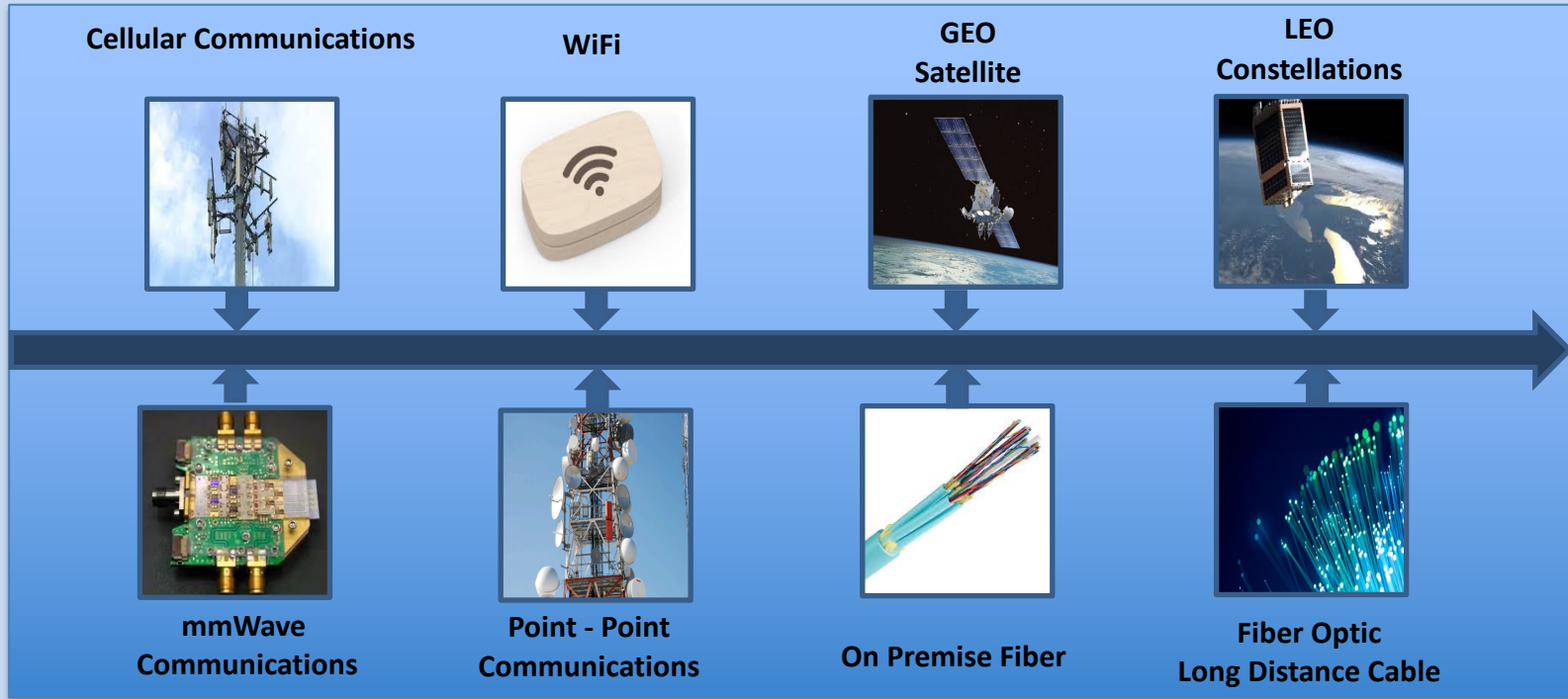


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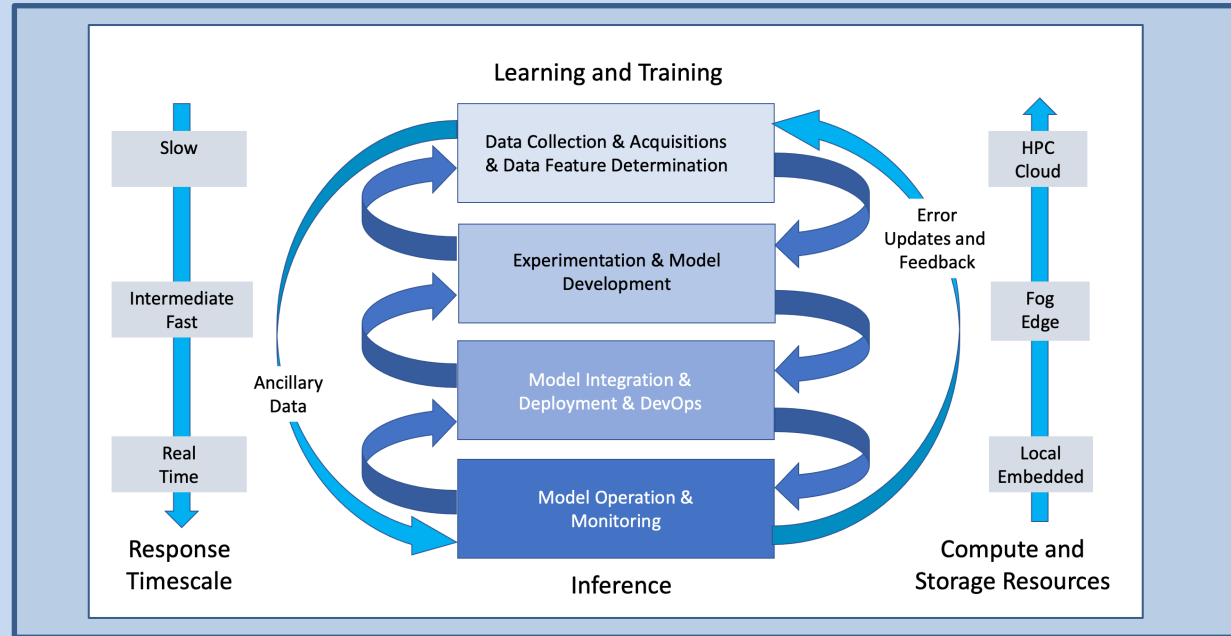
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# A bit about: The Internet of Things

Artificial Intelligence (AI & ML, Analytics)



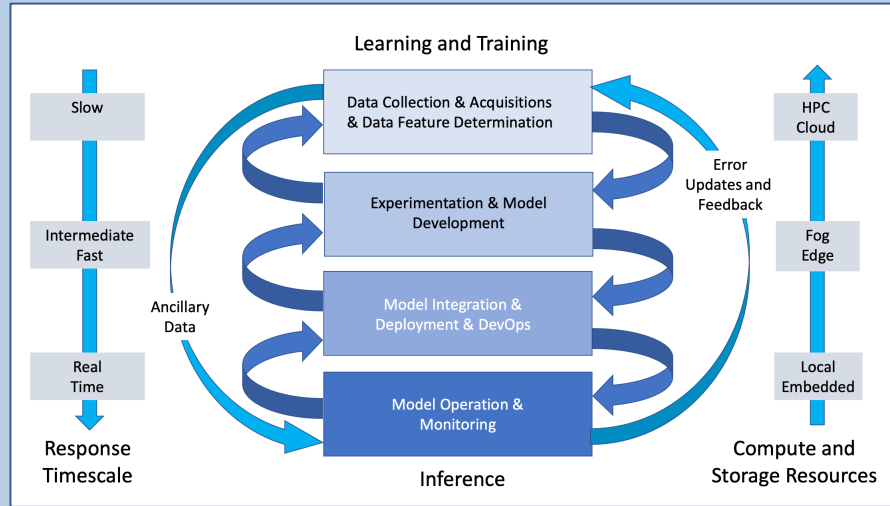
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# A bit about: The Internet of Things

## System with operational resources – complex tradeoffs Between Data, Computing, Storage, and Communications!



Where QIT may play in IoT?  
It may make a difference in almost all aspects of AI/ML!

C

Quantum Computing

N

Quantum Communications

S

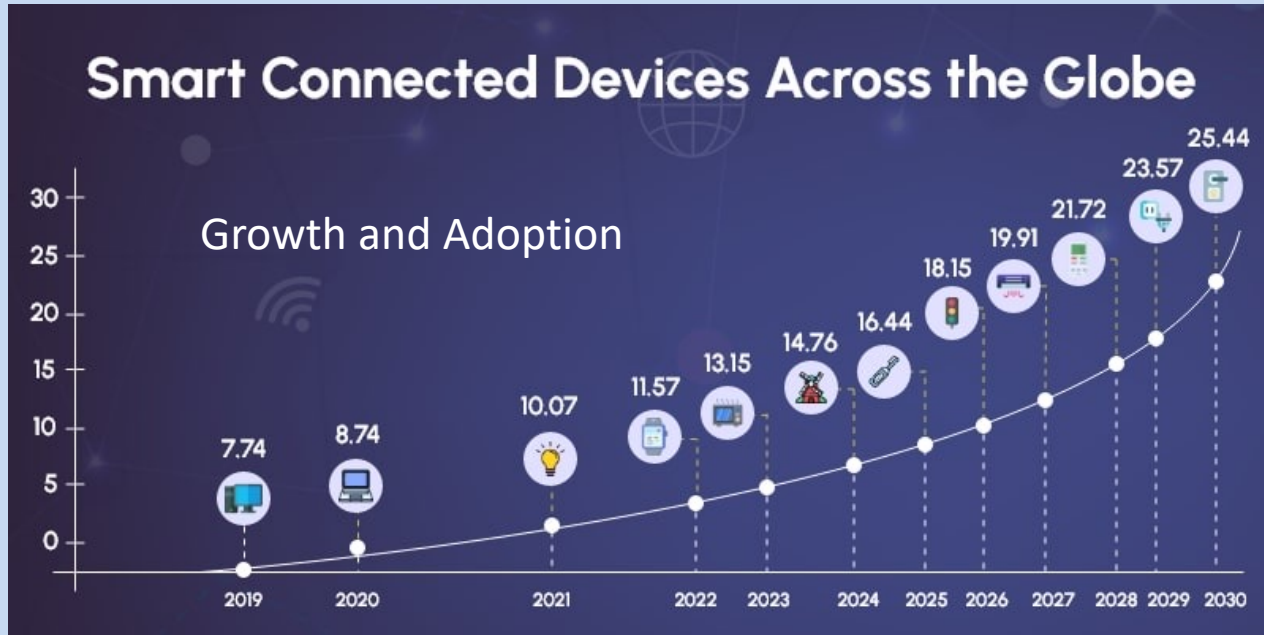
Quantum Sensing

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# A bit about: The Internet of Things



Source: <https://www.excellentwebworld.com/how-to-build-an-internet-of-things-iot-app/>

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# Quantum Information Technology

## Can you tell me, what are the five most important aspects of Quantum Information Technology relevant to IoT? (ChatGPT)

1. **Quantum Communication:** Quantum communication systems can provide secure communication that is resistant to eavesdropping and hacking, making them well-suited for use in IoT applications that require secure communication between devices.
2. **Quantum Computing:** Quantum computing can provide significant improvements in computational speed and power, making it useful for tasks such as data encryption, machine learning, and big data analysis in IoT systems.
3. **Quantum Sensors:** Quantum sensors can provide highly precise measurements of physical quantities, such as position, acceleration, and temperature, making them useful for applications such as navigation, location tracking, and environmental monitoring in IoT systems.

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# Quantum Information Technology

**Can you tell me, what are the five most important aspects of Quantum Information Technology relevant to IoT? (ChatGPT)**

4. **Quantum Cryptography:** Quantum cryptography can provide provable security, ensuring that data is transmitted securely even in the presence of an eavesdropper, making it useful for secure communication in IoT systems.
5. **Quantum Random Number Generation:** Quantum random number generators can produce truly random numbers, which are essential for cryptographic key generation and other security-related applications in IoT systems.

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# Quantum Computing

## What are the challenges to making Quantum Computing a mature deployed technology? (ChatGPT)

There are several challenges to making quantum computing a mature, deployed technology, including:

1. **Scalability:** One of the biggest challenges facing quantum computing is developing the ability to scale up the number of qubits in a quantum computer.
2. **Decoherence:** Decoherence is a phenomenon that causes the quantum states of a qubit to degrade over time, which can make it difficult to maintain the stability of a quantum computation

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# Quantum Computing

## What are the challenges to making Quantum Computing a mature deployed technology? (ChatGPT)

3. Error Correction: Error correction is a technique that is used to correct errors that occur during a quantum computation. Developing effective error correction methods is a significant challenge facing the field of quantum computing.
4. Control: Controlling the quantum systems is critical to enable quantum computing. The technology to control and manipulate the qubits with high precision is still under development.
5. Cost: Quantum computing is still an expensive technology to develop and maintain, and the cost of building and operating a large-scale quantum computer is still quite high.

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# Quantum Computing

## What are the challenges to making Quantum Computing a mature deployed technology? (ChatGPT)

6. Interoperability: Developing the ability to interface quantum computers with classical computing systems is an important challenge facing the field of quantum computing.
7. Applications: Developing practical, useful applications for quantum computing is also a significant challenge facing the field.
8. Talent: There is a shortage of experts with the necessary knowledge and skills to develop and implement quantum computing technology.
9. Regulation: The development of quantum computing is still in its infancy, and there is a lack of regulation and standardization in the field.

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# Quantum Sensing

## What aspects of Quantum Sensing are likely to be important for IoT? (ChatGPT)

1. High precision and sensitivity: Quantum sensors can provide highly precise measurements of physical quantities, such as position, acceleration, and temperature, making them useful for applications such as navigation, location tracking, and environmental monitoring in IoT systems.
2. Small size and low power consumption: Quantum sensors can be designed to be small and energy-efficient, making them well-suited for use in IoT devices that have limited space and power resources.
3. Robustness and reliability: Quantum sensors can be designed to be robust and reliable, making them well-suited for use in harsh environments and in IoT systems that require long-term operation.

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# Quantum Sensing

## What aspects of Quantum Sensing are likely to be important for IoT? (ChatGPT)

4. Multi-parameter sensing: Quantum sensors can be designed to measure multiple physical quantities simultaneously, making them useful for applications such as multi-dimensional imaging, gas sensing, and environmental monitoring.
5. Remote sensing: Quantum sensing techniques such as quantum-optical imaging and quantum-enhanced ranging can enable remote sensing and imaging, which can be useful for applications such as surveillance and monitoring in IoT systems

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# Quantum Communications

## What are examples of quantum communications and how does quantum communication work? (ChatGPT)

Quantum communication refers to the use of quantum mechanics to transmit information securely and with high precision. There are several examples of quantum communication technologies, including:

1. **Quantum key distribution (QKD):** QKD uses the principles of quantum mechanics to generate a shared secret key that can be used to encrypt and decrypt messages. QKD systems can detect any attempt to eavesdrop on the communication and are therefore considered to be secure against eavesdropping.
2. **Quantum teleportation:** Quantum teleportation is a technique that allows the transfer of quantum states from one location to another, without physically transmitting the qubits themselves. This can be achieved by using entanglement and classical communication.

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# Quantum Communications

## What are examples of quantum communications and how does quantum communication work? (ChatGPT)

3. Quantum repeater: A quantum repeater is a device that can extend the distance over which quantum communication can be performed by using entanglement and classical communication.
4. Quantum network: A quantum network is a network of quantum communication devices that are connected together to form a larger quantum communication system.
5. Quantum-secured communication : Quantum-secured communication refers to the use of quantum mechanics to secure the classical communication channels by using a shared secret key generated through quantum mechanics.

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# Quantum Communications

## What are examples of quantum communications and how does quantum communication work? (ChatGPT)

In general, quantum communication works by exploiting the principles of quantum mechanics, such as superposition, entanglement, and interference, to transmit information in a way that is secure and resistant to eavesdropping. The key element that makes quantum communication secure is the use of quantum states that are highly sensitive to the environment, so that any attempt to measure or intercept the information will disturb the state, making it possible to detect the eavesdropping attempt.

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# Back to Quantum Information Technology

## **Is there a good roadmap that exposes thinking on what timescales Quantum Information Technologies will mature? (ChatGPT)**

There is no clear consensus on the timescale for when quantum information technologies will mature. Some experts believe that we will see practical applications of quantum computing within the next 5-10 years, while others believe that it may take 20 years or more before we see widespread use of quantum computers.

One reason for the uncertainty is that the field of quantum computing is still in its early stages, and there are many technical challenges that need to be overcome before quantum computers can be considered mature technologies. These challenges include improving the error rate of qubits, building larger quantum computers, and developing software and algorithms that can take advantage of the unique capabilities of quantum computers.

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# Back to Quantum Information Technology

## **Is there a good roadmap that exposes thinking on what timescales Quantum Information Technologies will mature? (ChatGPT)**

Additionally, the timescale for the maturation of quantum information technologies also depends on the funding and the political and economic environment. Governments and private companies are investing heavily in quantum information technology, but the level of investment can vary considerably from one country to another, and also from one company to another.

Another important aspect is the availability of qualified personnel. The field of quantum computing requires a unique combination of expertise in physics, computer science, mathematics, and engineering. Developing a workforce with the necessary skills is a time-consuming process, and it is an important factor to consider when estimating the timescale for the maturation of quantum information technologies.

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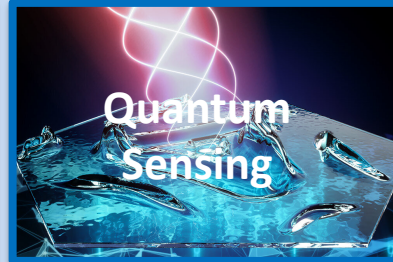
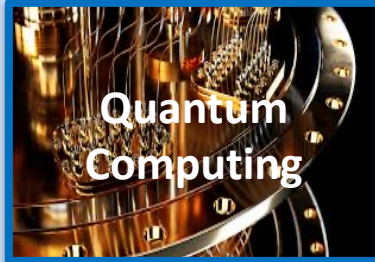
# Thank You!!!

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*Thank you!*



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