

**GROUP ASSIGNMENT**

**TECHNOLOGY PARK MALAYSIA**

**CT003-4-0-PT-T-8**

**PERSPECTIVE IN TECHNOLOGY**

**UCFF2209CT**

**Technology: LoRa Technology under Internet of things(IoT).**

**Company: Cisco System, Inc.**

**Product: Cisco Wireless Gateway for LoRaWAN.**

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# Abstract

This document will provide an extensive exploration of the chosen technology, LoRa technology, covering its description and delves into the application of LoRa technology to the Cisco wireless gateway for LoRaWAN, highlighting its significance and benefits.

As the chosen product is Cisco wireless gateway for LoRaWAN which is one of the products of Cisco company, this document will encompass a thorough examination of Cisco company including its background, core operations, diverse products and services offerings, strengths and weaknesses of the company website, and awareness strategies for LoRa technology within the company. Furthermore, it will clarify the detailed information of the Cisco Gateway such as the whole process and design, offering valuable insights into its development and functionality. Plus, the current technological stage of the gateway and the future of the Lora technology will also be discussed in this document.

Lastly, the reader may have to explore the effects of the gateway with the Lora technology in various aspects such as commerce, economic, environmental, etc. as well as the ethical issues. By acquiring these diverse elements, this comprehensive overview equips readers with a holistic understanding of LoRa technology and its association with the Cisco wireless gateway for LoRaWAN.

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# Introduction

The reason why we chose the LoRa technology is that the technology is getting developed with its potential advantages. And we want the audience (readers) to know more about what LoRa Technology is, what it can do, and how it works in the Cisco wireless gateway which applies with it. Even though most of the people do not realize how LoRa technology is important to our daily life, we aim to know how that LoRa technology is impact in our life because it can help us solve some of the biggest challenges facing our planet, such as natural resource reduction, pollution control, disaster prevention, energy management, infrastructure efficiency, and more. (Chen, 2019) LoRa technology can also enable us to connect various devices and sensors to the internet and access real-time data and insights that can improve our quality of life and decision making. (Manufacturer, 2021)

## Definition of the technology

The Internet of Things (IoT) refers to a dynamic network of physical objects, which are embedded with sensors, software, and advanced technologies. These elements enable seamless connectivity and data exchange with other devices and systems via the internet. At its core, IoT revolves around the concept of interconnectedness. Everyday objects, ranging from household appliances to industrial machinery, are empowered with sensor-based capabilities and internet connectivity, enabling them to communicate with each other and humans, creating a vast ecosystem of data sharing and interaction. LoRa (Long Range) technology is a low-power, long-range wireless technology used for the Internet of Things (IoT) devices. It operates on unlicensed radio bands and allows for long-range communication with low power consumption, making it an ideal solution for IoT applications.

In summary, the Internet of Things represents a transformative paradigm that connects physical objects to the digital realm, enabling data exchange, automation, and intelligent decision-making. (Alexander S. Gillis, -)

## Evolution

The demand for IoT technology is growing exponentially, and it is expected to continue to do so over the next five years. To prepare for the future of wireless, companies must embrace the new breakthrough in IoT technology, which is fifth generation (5G) wireless. This technology is significantly faster than previous models, creating new opportunities for change and innovation.

Smart utilities and smart cities could revolutionize the way societies use energy resources and transportation systems. Connected devices inside and outside the body could also revolutionize healthcare, allowing for the release of medication at the right place and time and the detection and treatment of medical problems using tiny robotic devices. Although the exact course of these connected technologies is unpredictable, the IoT will continue to have a profound impact on our lives and culture in the years ahead.

## The timeline and transition from the past till now/Evolution

The LoRa technology offers high penetration, low bandwidth, low energy, wide area, secure data, and is gaining signification traction in IoT networks being developed by wireless network operators and government. It has its own segment operating away from cellular network and Wi-Fi. (TECHDesign, 2016)

Some significant events in the timeline of LoRa Technology are:

* The timeline of LoRa technology began in 2009 when two friends Nicolas Sornin and Olivier Seller from France, aimed at developing a long-range, low power modulation technology. (Slats, 2020)
* Later, they Convinced Semtech about the invention’s long-range and low power capabilities; Semtech acquired Cycleo in May 2012.
* Finally, Semtech collaborated with Nicolas, Olivier, and François to improve the technology.
* In 2015, The LoRa Alliance was formed, with the goal of promoting and standardizing LoRa technology. And the networking protocol is renamed LoRaWAN as first specification which allowed for a standardized protocol for communication between devices and network servers. After that, Semtech Corporation acquired Cycleo and officially launched the LoRa technology. (Alliance, n.d.)
* In 2016, The first LoRaWAN certification program is launched by the LoRa Alliance. (Alliance, n.d.)
* In 2017, The first LoRaWAN roaming trials are conducted by the LoRa Alliance. (Alliance, n.d.)
* In 2018, The LoRa Alliance reaches over 500 members, with LoRaWAN networks being deployed in over 100 countries. Later, Low-cost LoRa radios are developed in 2019, bringing the cost of LoRa devices down even further.
* From 2018-2021, the LoRa Alliance continues to expand and improve upon LoRa technology, with advancements in security, interoperability, and geolocation capabilities, and releases different upgraded versions of LoraWAN specifications. (Alliance, n.d.)
* In the present, according to Statista, LoRa connections are expected to reach 730 million in 2023, compared to 470 million in 2022, outlining its importance to IoT industries for the coming year. (Taylor, 2019)

## List of industries/companies that apply this technology.

LoRa Technology is a wireless platform for the Internet of Things (IoT) that enables low-power, long-range and secure connectivity for sensors and devices, and uses spread spectrum modulation techniques to enable long-range transmissions with low power consumption. LoRa technology was developed by Cycleo, a company of Grenoble, France, later acquired by Semtech. It is based on Semtech’s LoRa chipsets and the LoRaWAN open standard, which is driven by the LoRa Alliance. (Semtech, n.d.) (Wikipedia, LoRa, 2023)

Some of the companies that use LoRa Technology are:

1. Semtech
2. Amazon Sidewalk
3. Bosch
4. Coca-Cola
5. IBM
6. Cisco
7. Schneider Electric
8. The LoRa Alliance
9. Diehl
10. Mueller

There are many companies and industries that apply LoRa Technology for various use cases, such as smart agriculture, buildings, cities, industry, logistics, utilities and more. The above information is some of these. (Fremont, 2023)

# Company Background

## Background

One of the best IoT companies according to this source is - Cisco Systems, Inc. - is an American technology company that makes products and services for networking and communications. The company was founded in December 1984 by Leonard Bozak and Sandy Lerner, graduates of Stanford University, and is headquartered in San Jose, California. The company's main products are network infrastructure products such as routers, switches, and multilayer service routers. The company also develops and produces software for network management, security, cloud computing, collaboration, and other services.

The company was named after the city of San Francisco, where Bozak and Lerner met at university. This also led to the naming of the company's products with a small letter "Cisco" in its early years. Cisco is now one of the largest corporations in the United States, supplying its products and services to various industries and communities around the world. (Wikipedia, Cisco, 2023)

A building with a sign on it

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Figure 1:Cisco Company (Google,2023)

## What does the company do?

**What is Cisco company about:**

Cisco is an American-based multinational digital communications technology conglomerate corporation that is best known for its computer networking products. . (Wikipedia, Cisco, 2023) Cisco develops, manufactures, and sells networking hardware, software, telecommunications equipment and other high-technology services and products. (website, 2023) Cisco also offers solutions for hybrid work, cloud security, data center, small business and more. Cisco has a global presence and operates in many countries, including Malaysia. The company is known for Its broad portfolio of products and solutions, as well as its strong focus on innovation and commitment to sustainability, (Lewis, 2017)

## History-Timeline

Leonard Bosack and Sandy Lerner, two Stanford University computer science professors, launched Cisco in 1984. They created the first multi-protocol router, enabling communication between several computer networks. This innovation marked a significant advance in networking technology and propelled Cisco to the top of the sector. Cisco continued to create and market routers and other networking equipment in the late 1980s and early 1990s, and the business went public in 1990. Sales and market share for Cisco increased quickly throughout the 1990s, and the business rose to become one of the most valuable in the world.

Cisco developed a reputation for making bold acquisitions during the dot-com boom of the late 1990s, acquiring dozens of smaller businesses to broaden its product line and break into new markets. The businesses that created the software used in Cisco's VoIP (Voice over Internet Protocol) products and the networking hardware used in cable television systems were some of the most notable acquisitions made during this time.

Since then, Cisco has kept expanding and changing. Today, the company provides a variety of goods and services to both businesses and consumers, including cloud-based services, cybersecurity solutions, networking hardware and software, and more. With a market capitalization of more than $200 billion (about $620 per person in the US), Cisco is currently among the biggest technology companies in the world. (Admin, 2018)

## Mission

[***“Making the future of work, work for all.”***](https://bstrategyhub.com/cisco-mission-statement-vision-core-values-analysis/)

Cisco Systems Inc. is a multinational corporation that influences people’s lives by shaping the future of the Internet generating unprecedented worth and opportunity for customers, employees, investors, and ecosystem partners. Cisco’s predominant interest is producing simple access to the Internet by allowing consumers to utilize the full potential of the IoT by providing a safeguarded and scalable infrastructure to connect, manage and automate devices and data. This mission statement outlines the strategy by which the company attains through finalized vision.

1. **Embrace the future.**

The paramount attention is forming the future using the technique of individual tasks and connections. The intention is to enhance advanced technologies, for instance, optical networking and wireless technology. Cisco assists individuals assembling networks for cloud-managed Catalyst by accepting future tasks. For example, Cisco Network Cloud is a straightforward procedure to deploy manage and operate Nexus network.

1. **Improvise global reach.**

This component fulfils the first segment as the company continues to be tech-savvy and skilful people. For the company to achieve this, Cisco is compelled to ensure it is introduced as worldwide dominant, inventive, and dynamic within the tech industry.

1. **Ensure security.**

The company considers protected networks as an integrated element for developing the future. Network security is an essential priority for Cisco to ensure the guaranteed network is reliable, constant, and protected utilized. (Johnson, 2023)

* 1. Vision

[***“Powering an inclusive future for all.”***](https://bstrategyhub.com/cisco-mission-statement-vision-core-values-analysis/)

Cisco Systems Inc. is a multinational corporation that has visions in IoT to design humankind data that processes things verify connected by providing businesses and users with unprecedented insights and credentials to optimize operations to ameliorate their experiences and transform their industries. To obtain this vision, Cisco is liable to distribute creative IoT solutions that leverage its industry-leading networking, security, and analytics technologies. These solutions are planned to assist businesses across a wide range of industries like manufacturing and healthcare to improvise efficiency, minimize costs and construct new revenue streams. Cisco is inclined in impacting positively on society by empowering an inclusive future.

1. **Shape positive results globally.**

The Information Technology (IT) company aims to affect more than one billion people universally by 2025 by promoting changes and addressing the world’s notable criticism. This organization’s partnership and programs like Cisco Networking Academy aid humans to access numerous opportunities.

1. **Endorse environmental sustainability.**

The dominant IT and networking establishment react immediately with the best solution to reduce greenhouse gas emissions and minimize waste. This firm target profound GHG reduction across product use, operations, and supply chain. Moreover, Cisco’s goal is to modify the community’s everyday duty to be more efficient and productive. Furthermore, the manufacturer produces more secure routers, upgrades servers, and boosts wireless technologies. (Johnson, 2023)

## List of Products/Services

Cisco designs and sells a broad range of technologies that power the Internet. This is the list of products/services classified by company technology.

1. **Networking**:

There are several products which are related to networking technology, which includes the hardware and software used to connect devices and networks, manage network traffic, and ensure network security. For example, Access networking, Industrial IoT networking, Silicon, optics, etc. (Website, 2023)

1. **Wireless and Mobility:**

The products that are developed by wireless and mobility technology improve speed and security with a network that revolutionizes the wireless experience. For example, Indoor access points, Network management such as Cisco DNA Center, etc. (Website, 2023)

1. **Security:**

The products with security technology defend against threats and safeguard the most vital aspects of your business with security resilience. For example, Network security such as Cisco Secure Firewall, User, and device security like Cisco Secure Endpoint, etc. (Website, 2023)

1. **Data Center:**

Products with hybrid cloud computing can deploy, manage, and optimize users' computing resources across hybrid cloud environments faster than others. Products with cloud networking can help the users' data, workloads, and apps stay connected for exceptional efficiency across hybrid cloud, multi cloud, data center, and edge. For example, Hybrid cloud computing and cloud networking. (Website, 2023)

1. **Analytics:**

Products with Analytics technology analyze the existing network data to help detect threats that may have found a way to bypass existing controls, before they can do acute damage, like how Analytics technology works. For example, Nexus Dashboard Insights and Network analytics. (Website, 2023)

1. **Internet of Things (IoT):**

Products with IoT technology can manage the users' industrial network securely in the cloud with IoT Operations Dashboard, gaining both visibility into their security posture and enhanced secure remote access. For example, Industrial sensors such as Cisco Wireless Gateway for LoRaWAN, Data control and exchange like Cisco Edge Intelligence, etc. (Website, 2023)

# Technology and the web

## How is the Internet assisting the technology?

LoRaWAN is a wireless communication protocol that assists the Internet by facilitating IoT devices to connect and communicate to the Internet by permitting long-range and low-power networking systems. Then this data is collected, analyzed, and acted based on real-time within cloud-based systems that are connected to the Internet. LoRaWAN also enables the creation of scalable IoT networks by allowing devices to communicate with one another via the Internet even without traditional cellular coverage. By utilizing the IoT technology in the LoRaWAN product, it becomes simpler and more efficient to integrate devices with the Internet. As a result, development is facilitated to more advanced and seamless IoT applications. (Mulligan, 2023)

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Figure 2:LoRa Network security composed of the end nodes (Chen, 2019)

A LoRaWAN gateway is a bridge between IoT gadgets and the Internet. The gadgets obtain data via LoRaWAN radio frequency and transfer it to the Internet as it supplies connectivity infrastructure for the gateway to transfer information to its location. Data packets that store the information are sent using chip protocol. Then the LoRaWAN gateway information is obtained from IoT devices through Internet connectivity that transmits data to the cloud or server infrastructure. For future use, this information is first processed then analyzed and stored. The Internet allows the product gateways to integrate with cloud platforms and IoT service providers to transfer data to cloud-based applications protected that are accessed, visualized, and acted upon. Remote management gives the authorization of LoRaWAN gateways via web-based interfaces or software. The administrators remotely configure, monitor, and update the gateways by guaranteeing optimal performance and functionalities. The Internet facilitates protected conversations between gateways and devices that are encrypted and warrants confidentiality. Plus, to verify the identity of gadgets of devices and gateways implement authentication mechanisms to avoid unauthorized access. Ultimately, the Internet allows seamless integration with the LoRaWAN product gateways with other systems and services. (Boral, 2019)

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Figure 3:Cisco Wireless gateway for LoRaWAN (Cisco Wireless Gateway for LoRaWAN 868MHz and 915MHz, 2021)

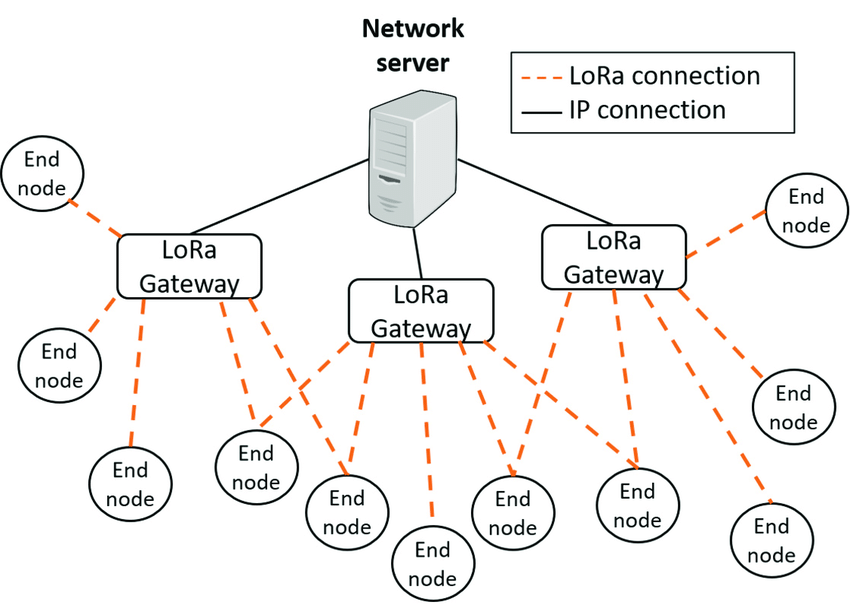


Figure 4:LoRaWAN network topology (Figure1. LoRaWAN Network topology, n.d.)

## Promotion and awareness of technology.

Cisco is a technology company driving the Internet of Things revolution. Cisco promotes and creates awareness of LoRa technology through various channels and initiatives.

To promote LoRa technology, Cisco has a dedicated section on the company's website featuring IoT solutions. The website supplies comprehensive information on how technology can improve business operations, enhance customer experiences, and drive innovation.

Apart from the website, Cisco uses various channels such as social media, blogs, and forums to promote the LoRa technology. Cisco utilizes marketing campaigns to highlight the benefits, features, and use cases of LoRa technology. These campaigns may include digital advertisements, print media, and targeted messaging to reach relevant audiences.

Cisco maintains an active online presence through its website, social media platforms, and online communities. It shares updates, success stories, and resources related to LoRa technology, engaging with a wide audience, and fostering discussions around the topic. And Cisco collaborates with a network of technology partners and resellers to promote LoRa technology. This ecosystem enables Cisco to extend its reach and leverage the expertise of partners in different regions and industries.

By employing these promotional and awareness-building strategies, Cisco aims to increase the visibility, understanding, and adoption of LoRa technology among businesses, developers, and organizations seeking reliable IoT connectivity solutions. (Internet of Things (IoT) Products & Solutions., 2023)

## Services provided.

There are altogether five main categories of services provided in the company:

1. **Consulting services**

* Advisory Services: provide guidance throughout the technology lifecycle, continuous engagement with Cisco experts, and value across the IT landscape.
* Project-based Solution consulting: The company’s experts help the users plan, design, implement new project-based technology transformations, and quickly turn ideas into outcomes while reducing risk and increasing the value of the users’ IT investment. (Cisco services, 2023)

1. **Support services**

* Hardware support: Customers can get expert technical support guided by insights and the company will help them maintain system uptime by fixing hardware issues and replacing defective equipment faster.
* Solution support: Experts provide centralized support across your multiproduct, multivendor Cisco solution environment, and solve complex multivendor software and hardware issues faster with Cisco expertise.
* Software support: Customers can unlock the full benefits of their Cisco software, both on-premises and in the cloud. (Cisco services, 2023)

1. **Cisco learning**

* Cisco learning: As learning services, Cisco provides different training styles such as for individuals or organizations by offering Cisco training Bootcamps, Cisco Modelling Labs, and Cisco learning Partner Program.
* Cisco certifications: Cisco has redesigned their training and certification programs to address today’s dynamic technologies and prepare students, engineers, and software developers for success in the industry’s most critical jobs. (Cisco services, 2023)

1. **Technology**

* Enterprise networking: The company provide this service to help customers drive innovation and growth by reducing the risks of transformation and optimizing their network’s value.
* Data centre: This service is provided to customers to get faster results by quickly transforming and boosting the agility of their data centre operations.
* Security: This service can help customers stay safe from threats by strengthening their security resilience and reducing complexity and risk.
* Cloud: By offering this service, it will support the customers to innovate with less risk by confidently navigating cloud complexities and optimizing security.
* Collaboration: This service can help different customers to empower their teams with industry-leading hybrid work environments and communication technologies.
* Service provider: The company offers to provide driving innovation by transforming mass-scale network while reducing costs and boosting performance. (Cisco services, 2023)

## General information on the Internet.

**Cisco Systems, Inc.**, commonly known as Cisco, is a multinational technology company that designs, manufactures, and markets a wide range of products and services, including networking equipment, software, hardware, telecommunications equipment, and other high-tech services. It is a Fortune 100 company and is headquartered in San Jose, Calif. The company is a leader in the networking and telecommunications industry.

The company was founded in 1984 by Leonard Bosack and Sandy Lerner. Cisco is primarily known for its networking equipment, including routers, switches, and wireless access points. In addition to hardware, Cisco also offers a variety of software and services, such as cybersecurity, cloud computing, and collaboration tools. Cisco has approximately 78,000 employees worldwide and operates in more than 100 countries. [According to Cisco’s 2022 Annual Report](https://www.cisco.com/c/dam/en_us/about/annual-report/cisco-annual-report-2022.pdf), Cisco’s fiscal year revenue for 2022 was **$51.6 billion**, up 3% year over year. This is compared to $49.8 billion in fiscal year 2021. (SAN JOSE, 2021)

Moreover, there are a variety of general information about Cisco on their YouTube channel such as-

* Videos showcasing Cisco's products and services, such as routers, switches, firewalls, and video conferencing solutions.
* Tutorials and educational content on networking, cybersecurity, and other technology-related topics.
* Keynotes and talks from industry events, such as Cisco Live and RSA Conference.
* Customer success stories and case studies featuring organizations that have used Cisco products to achieve their business goals.
* Thought leadership content from Cisco executives and subject matter experts on trends and innovations in the technology industry.
* Career advice for individuals interested in pursuing a career in the technology industry, as well as information on Cisco's company culture and values. (About Cisco, 2023)

## Strengths and weaknesses, does website assists information related technology (service or product)?

Here are some of the strengths and weaknesses of Cisco website based on the researches of Cisco website:

Strengths:

* The website offers a wide range of products and services for networking, cloud, and cybersecurity solutions. (website, 2023)
* The website showcases Cisco’s innovation and thought leadership in various domains, such as AI-first security cloud, full-stack observability, and multicloud connectivity. (About Cisco, 2023) (website, 2023)
* The website provides various resources and support for customers, partners, and learners, such as downloads, certifications, design guides, training, community, careers, etc. (website, 2023)
* The website has a robust security system that uses artificial intelligence and threat intelligence to detect, record, and block network threats and cyber undesirables. (Brame, 2022)
* The website has an intuitive interface and powerful features for video conferencing, such as screen sharing, whiteboarding, cloud recording, transcription, breakout rooms, reactions, etc. (Fadilpašić, 2022)

Weaknesses:

* The website can be pricey compared to some competitors, especially for some advanced features such as real-time translation. (Hale, 2022)
* The website does not enable end-to-end encryption by default for video conferencing, which may compromise data security for some users. (Hale, 2022)
* The website has a limited amount of cloud storage (10GB per user) for video conferencing recordings. (Hale, 2022)
* The website can sometimes deny access to secure websites due to its URL filtering feature. (Brame, 2022)
* Even though the website has offered much information about itself, Cisco has been criticized for its poor website design and user experience, which makes it difficult for customers to find information and products on its website. ((n.d.)., n.d.)

# Process and design of the technology

## Diagram of input to output process

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Figure 5 Main flow of Wireless Gateway input to output (Fig 2. Diagram which illustrates the main input and output, n.d.)

## Whole process (stage by stage explanation) including other supporting processes.

The Cisco Wireless Gateway for LoRaWAN is a physical layer technology that supports the LoRaWAN specification defined by the LoRa Alliance. It provides LPWA (Low Power Wide Area) wireless connectivity for low data rate, battery-powered devices, and sensors. The **overall process** of using the Cisco Wireless Gateway for LoRaWAN can be broken down into the following steps:

1. **Sensor data is transmitted over the LoRa wireless network to the Cisco wireless gateway (Data collection)**: This is the first stage of the process, where the sensor data is collected by LoRaWAN end nodes (devices) and transmitted to the gateway over the LoRa wireless network. (LoRaWAN Solutions, 2023)
2. **The gateway receives sensor data from multiple LoRaWAN end nodes and aggregates it (Data transmission):** Once the gateway receives the data, it aggregates it, meaning it combines the data from multiple end nodes into a single data stream. The gateway can receive data from multiple nodes because it can receive and transmit wireless signals over a long range. (LoRaWAN Solutions, 2023)
3. **The gateway forwards the sensor data to the LoRaWAN network server**: After aggregating the data, the gateway forwards it to the LoRaWAN network server. The network server serves as a central point for routing data between the end nodes, gateways, and the cloud application server. (LoRaWAN Solutions, 2023)
4. **The network server processes the data and forwards it to the cloud application server (Data storage):** Once the network server receives the aggregated data from the gateway, it processes it by decoding the LoRaWAN protocol, extracting the data, and then forwarding it to the cloud application server. The cloud application server is responsible for processing and analyzing the data sent by the devices. (LoRaWAN Solutions, 2023)
5. **The cloud application server processes the data and makes it available for applications to use or analyze (Data analysis):** After the cloud application server receives the data, it processes and analyzes it, making it available for use by applications. This data can be used to monitor and manage IoT devices or to gain insights into trends and patterns in the data. (LoRaWAN Solutions, 2023)
6. **The application can then issue commands back to the end nodes or gateways to adjust settings or perform actions**: Finally, the application can issue commands back to the end nodes or gateways to adjust settings or perform actions. For example, the application might turn on or off a device, adjust a sensor's calibration settings, or trigger an event based on data received from the devices. (LoRaWAN Solutions, 2023) (Cisco, Cisco Wireless Gateway for LoRaWAN Data Sheet , 2021)

In addition to the Cisco Wireless Gateway for LoRaWAN, there are a few other **supporting processes** that are necessary to implement a successful IoT project. These include:

* 1. Network planning: The network must be designed to meet the specific needs of the project. This includes factors such as coverage, capacity, and security.
  2. Device management: The devices must be managed to ensure that they are operating properly, and that the data is being collected and transmitted as expected.
  3. Security: The data must be protected from unauthorized access. This includes both physical and cyber security measures.

The Cisco Wireless Gateway for LoRaWAN is a powerful tool that can be used to collect and transmit data from a wide variety of sensors. By following the steps outlined above, you can implement a successful IoT project that will improve efficiency, productivity, and safety. (Cisco, Cisco Wireless Gateway for LoRaWAN Data Sheet , 2021)

## Display Automation Process Where Applicable

LoRaWAN is a media access control that distributes global standards for LoRa network communication technology which authorizes seamless interoperability of networks and gadgets without required complex installation. Anyone able to build LoRaWAN network protocol by using LoRa operation within free-license sub-gigahertz radio bands. This technology is designed for low power wide area networks applying wireless spread spectrum modulation technology. This network is accessed globally with high scalability. However, it impacts the battery lifetime of the device, network storage, service quality, and network serving applications.

A picture containing screenshot, diagram, 3d modeling, design

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Figure 6 Connection of IoT devices

The connection of IoT devices is automated using a variety of key technologies and components such as end devices, IoT gateway, the cloud, and user interface.

The end device can be sensors, actuators, or both are operated using a battery that connects wirelessly to LoRaWAN internet through LoRa Radio Frequency (RF) modulation. The sensor deployment recognizes the deployment zone with its precise sensor requirements by installing and activating sensors in the desired location. The sensor registration initiates the process through Cisco Wireless Gateway by contributing essential information like sensor ID, type, and location. This sensor acquisition begins by accumulating data according to its predefined parameters that convey data packets to Cisco Wireless Gateway periodically. Sensors and network feedback are implemented actuators that permit the device to act based on the data gathered. The sensor applied in this device includes humidity, temperature and fall detection.

A picture containing jack, smartphone

Description automatically generated with medium confidenceFrom the device, an IP address is utilized for connectivity and identification to the IoT system. To register the LoRaWAN network server each gateway link uses backhauls that are recorded using configure settings. There are two types of gateways which are known as picocell and macrocell. (Architecture., n.d.) Picocell is an indoor gateway that provides coverage of deep-indoor locations like multi-floor buildings and macrocell is an outdoor gateway that provides coverage of rural and urban zones like cellular towers. (Architecture., n.d.) The Cisco wireless gateway provides remote management capabilities in which the administrator may configure, monitor, and update gateway settings and sensor configurations. This server may trigger events or notifications. The automation system integrates with the server to execute actions based on these circumstances.

The cloud is a location that stores data from IoT devices collected and processed input from users by software. To translate the device’s protocols into a standard protocol, the IoT gateway transfers to bridge data from different gadgets to arrive at the cloud.

To get information from users the user interface is used to make required commands that are required for the device to execute. The LoRaWAN network is run by a network server that organizes gateways, end devices, applications, and users to perform data processing duties like decrypting, decoding, and verifying data integrity. For instance, deduplicating uplink messages, device address checking, and responding to MAC layers commands are some of the features that the network server provides. The application server can have more than one that operates specific data signals received from the end devices. Moreover, it produces application-layer downlink payloads and sends connected devices through a network server. Applying methods to interpret like Artificial Intelligence (AI) by collecting data can aid in solving business issues. The join sever supports verifying device activation, root key storage, and session key generation. The end device initiates the join procedure by forwarding the Join-request signal to the join server directly to the network server.

In conclusion, the automation process assists by recognizing sensor malfunctions or communication issues and authorizes seamless data collection, transmission, processing, and analysis for IoT sensor technology in the Cisco Wireless Gateway for LoRaWAN product. For maintenance personnel to generate alerts is addressed issues promptly. Factory production in operating goods utilizes robots to produce it. Automation in IoT is vital when factories manufacture various components of a particular product. For instance, a factory that produces pre-cooked meals is made of various elements that are required to combine in the final stage to have a desired quantity and pause relatively complex. (Automation And IoT – New Technology With Incredible Business Potential, 2023) It is automatically balanced when the automation process involves IoT sensors and data. The machines recognize the portion of the product and adjust to a balanced portion. This smart technology enables minimizing waste, maximizing productivity, and increasing the safety of human labor and industry however this technology is costly, and the manufacturer is unable to receive review data and feedback from consumers regarding the product. (Stowe, 2020)

## Physical design

A close-up of a device

Description automatically generated with low confidenceThe physical design of the Cisco Routers Interface Module for LoRaWAN encompasses a range of hardware aspects and features, carefully crafted to ensure optimal performance and seamless integration within compatible Cisco routers. Let's delve into the unique and original description of each element of its physical design:

Figure 7Cisco LoRaWAN gateway interfaces and features (Cisco, Cisco Wireless Gateway for LoRaWAN Data Sheet , 2021)

Form Factor: The module's design prioritizes efficiency and compactness, allowing it to seamlessly fit into Cisco routers without occupying excessive space within the router chassis. Its small form factor optimizes the utilization of available space, ensuring a streamlined and unobtrusive integration.

A picture containing kitchenware, sketch, pan

Description automatically generatedConnectivity Ports: A crucial aspect of the module's physical design is the inclusion of one or more connectivity ports. These ports, designed as connectors or interfaces, facilitate easy integration into the router by establishing the necessary electrical and data connections. With these ports, users can effortlessly incorporate the module into their existing network infrastructure.

Figure 8Cisco LoRaWAN Connecting Console Port and USB Port

A picture containing sketch, drawing, line art, illustration

Description automatically generatedIndicator Lights: Incorporating user-friendly visual feedback, the module boasts well-placed indicator lights or LEDs. These illuminating components provide valuable insights into the module's status, ranging from power on/off indications to connectivity and activity indicators. By monitoring these lights, users can gain a clear understanding of the module's functioning and quickly diagnose any potential issues that may arise.

Antenna Interface: The physical design thoughtfully incorporates an antenna interface, which plays a vital role in enabling seamless communication with LoRaWAN devices. This interface allows for the effortless connection of external antennas, optimizing signal reception and transmission capabilities. By leveraging this interface, the module ensures reliable and efficient communication with LoRaWAN devices within the network.

Figure 9 Cisco LoRaWAN Antenna Connectors

Mounting Mechanism: To ensure secure installation and steadfast operation, the module incorporates a specific mounting mechanism or brackets. This thoughtful design feature guarantees that the module remains firmly in place within the Cisco router, even in challenging environments. With this robust mounting mechanism, users can trust in the module's stability and uninterrupted performance.

Labeling and Markings: Paying meticulous attention to detail, the physical design of the module includes labeling or markings that provide crucial information for identification, inventory management, and regulatory compliance. These labels may encompass model numbers, serial numbers, and other pertinent details. By incorporating such markings, Cisco enhances user convenience and facilitates adherence to regulatory requirements.

Material and Build Quality: True to Cisco's commitment to durability and reliability, the module's physical design employs high-quality materials and components. These meticulously chosen elements ensure the module's ability to withstand a wide range of environmental conditions, delivering long-term performance and dependability. Cisco's focus on material and building quality underscores their dedication to providing robust and resilient networking solutions. (Cisco, Cisco Wireless Gateway for LoRaWAN Hardware Installation Guide , 2019)

While this description offers valuable insights into the physical design of the Cisco Routers Interface Module for LoRaWAN, it is essential to consult the official documentation provided by Cisco on their website for precise and comprehensive information. Within this documentation, users can explore detailed product images, specifications, and installation instructions, gaining a thorough understanding of the module's physical design and specific requirements for successful integration.

## Types of design

Cisco Wireless Gateway for LoRaWAN incorporates a universal design approach. This means that it is compatible with a wide range of different devices and sensor systems, allowing it to seamlessly interface in various industrial environments. Its universal design ensures interoperability and flexibility, making it an excellent choice for companies seeking to implement IoT solutions across diverse applications.

**User Interface**: The external interface of the device is designed in a smooth and easy-to-use manner by providing clear indicators and symbols that explain its use and can be understood by users with different levels of technical and scientific expertise.

**Flexibility and customization:** Allowing different companies to customize device settings and features according to their own requirements. This may include device distance settings and data visualization options.

**Compatibility**: Ensure compatibility with a wide range of devices and platforms to promote interoperability. This allows users to integrate the gateway with their existing IoT systems, sensors, and applications without unnecessary barriers or limitations.

CAD is a technology that enables the creation, modification and timing of design concepts using computer software. CAD systems provide tools and features for drafting, modeling and simulating designs in a digital environment. It allows signature erasers and engineers to create accurate and detailed 2D or 3D models, perform analysis, and create visualizations of the final product.

The development of the Cisco Wireless Gateway forA picture containing sketch, kitchenware, illustration, pan

Description automatically generated LoRaWAN involves the use of computer-aided design (CAD) techniques. CAD enables precise and efficient design creation, allowing engineers to model and optimize the gateway's physical layout, components, and connectivity interfaces. Through CAD, the product's design can be fine-tuned to meet industry standards and performance requirements. (Cisco, Cisco Wireless Gateway for LoRaWAN , 2023)

Figure 10 Example of (CAD) Techniques

The functional design of the Cisco Wireless Gateway for LoRaWAN is focused on delivering robust and reliable connectivity for IoT applications. The functional design also includes security mechanisms to ensure the integrity and confidentiality of data transmitted through the portal.

**Connectivity:** The gateway is designed to establish wireless communication with IoT devices using the LoRaWAN protocol. Its loop provides communication between IoT devices and a network server, facilitating secure and reliable data transmission.

**Data processing:** The portal includes processing capabilities to handle incoming and outgoing data flows. It can perform functions such as data aggregation, filtering, and pro-tocol transformation to ensure efficient data management and interoperability.

**Network management:** Network management features, such as device registration and security protocols, are available in the portal. It enables the configuration and monitoring of the devices connected to it, ensuring the smooth operation of the network.

**Integration:** The design of the portal focuses on seamless integration with the infrastructure, systems and devices of the Internet of Things that are currently available. It enables interoperability with various forms of IoT, cloud services and applications, enabling easy integration into diverse IoT ecosystems.

**Scalability:** The gateway is designed to support scalability, allowing the addition of more IoT devices and services and the expansion of the network connected to it. It ensures that the device can handle many connected devices and manage the increased data traffic effectively.

**Reliability and security:** The functional design includes robust security features to protect incoming and outgoing data and ensure reliable communication between devices. Such as encryption, authentication, and access control to protect the Internet of Things network**.** (Choose Wireless That Is Best-Fit and Not Force-Fit for Your Industrial Network White Paper, 2022)

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# Life cycle of Technology (specified in Cisco wireless gateway for LoRaWAN)

## Determining where the technology currently is.

The Cisco LoRaWAN Gateway is one of the Cisco Internet of Things (IoT) extension module series. It can be connected to the Cisco 809 and 829 Industrial Integrated Services Routers (IR800 series) for virtual mode or standalone for low-power wide-area (LPWA) access and is positioned as a carrier-grade gateway for outdoor deployment, including harsh environments. (Cisco, Cisco Wireless Gateway for LoRaWAN Data Sheet , 2021)

The technology life cycle of the Cisco Wireless Gateway for LoRaWAN would fall within the broader technology life cycle for LoRaWAN technology itself, which is still in the growing stage. While LoRaWAN technology has been available for several years, it is still not as widely adopted as other wireless technologies such as Wi-Fi and Bluetooth. As such, the demand for the Cisco Wireless Gateway for LoRaWAN is still growing, and it's not yet in the declining phase of its life cycle. This Cisco gateway for LoRaWAN is currently in demand and the Cisco company is also developing the product by making new and new releases.

Cisco has made a long-term commitment to IoT and has continued to invest in the development of IoT solutions, including their LoRaWAN gateway product. This shows that the company believes that there is still significant growth potential in this market and that there will be continued demand for their gateway product in the years to come. Although the technology life cycle can vary from product to product and is influenced by a variety of factors, such as market demand, technology innovation, and competition, this Cisco LoRaWAN gateway would still be popular in the future as it is for LoRaWAN technology, and the technology is a specification that applies to battery-powered objects in a Low Power Wide Area Networks. (Cisco, Cisco Solution for LoRaWAN, n.d.)

## The Previous stage(s) passed.

According to the fact that Cisco Wireless Gateway for LoRaWAN is currently in the growth stage, under this topic, the introduction phase which the gateway has already passed, and the growth phase would be explained.

* **Introduction:**

During the introduction stage or when the Cisco LoRaWAN gateway is first introduced in 2016, it was a new and innovative product that was developed to help simplify large-scale IoT deployments by enabling communication between IoT devices and enterprise systems. At that time, the gateway was relatively unknown. As a completely new product in the emerging LoRaWAN gateway market, the primary focus was on building awareness and generating interest among potential customers. This involved significant investment in marketing and advertising to educate customers on the benefits and potential use cases for the product. (Cisco Wireless Gateway for LoRaWAN 868MHz and 915MHz, 2021)

To generate awareness about the product, Cisco utilized various marketing and advertising tactics which included, but not limited to, product demonstrations, social media advertising, content marketing and webinars. Additionally, Cisco emphasized improving the adoption of LoRaWAN and this drew a lot of interest from potential customers, as enterprises were looking for a highly secure, reliable, and cost effective IoT solution. During this stage, sales were typically slow, and the focus was on educating potential customers and building brand recognition and awareness. In the case of the Cisco Wireless Gateway for LoRaWAN, the company had to tap into a relatively new market for LoRaWAN solution at the time with the hope of getting more customers interested in the product. (Cisco Wireless Gateway for LoRaWAN 868MHz and 915MHz, 2021)

Overall, the introduction stage of the product life cycle is characterized by a focus on building awareness, generating interest, and educating potential customers. As sales increase and customers become more familiar with the product, it can enter the growth stage of its product life cycle.

* **Growth:**

In the growth phase for Cisco cooperation utilizing IoT technology with the wireless gateway in LoRaWAN product distributes the penetration in market growth that is depending on the innovation of the product and the market’s needs for new technology. LoRaWAN technology is new and evolving therefore Cisco is active in inventing to guarantee the product is current with the market's evolvements required for IoT infrastructure, maximizing market demand, and increasing the market share. Based on this product, three main factors are impacting the growth of the LoRaWAN product in the market which are product enhancement, market expansion, and customer support and education.

In product advancement, this product is accessible as a standalone or Cisco Industrial Asset Vision solution essential section that upgrades the business resiliency, security, and systematic monitoring tools, individuals, and facilities. Moreover, this firm constantly adds the latest features to supply the demand of the market such as ameliorating data security, scalability, interoperability, and integration with other systems like the advanced feature of robust security assists customers over the Internet by building resilient and protect data paths to back-end platforms. Furthermore, to address potential vulnerabilities that may arise this device consistently updates its features to fit its demand in the current market. This is an explanation of how LoRaWAN security works; - <https://www.youtube.com/watch?v=Z48FKH7RLMQ&t=241s>. The Cisco company constructed a wireless gateway in IoT technology that integrates with the product which boosts performance, dependency, and safety to optimize energy productivity.

In market analysis, the firm observes the market trends and identifies specific needs and pain points of consumers and businesses to adapt the IoT technology. This company collects feedback from early adopters and analyses the market expectations so that this product aligns with the market requirements. This growth occurred through digital transformation acceleration which became a necessity to citizens globally among enterprises and cities. Clients frequently want additional assistance in advancing network infrastructure plans as IoT enforcement increase as Cisco is widely known for contributing assistance tailored to the organization’s needs. Based on the feedback collected, Cisco discovers new cases for LoRaWAN technology that solves IoT networking. As the LoRaWAN product continues to grow in the market, the organization targets new geographical territories or vertical industries which are recently adapting the IoT technology that is in demand for long-range and low-power connectivity solutions, this article proves the growth of LoRaWAN in the market. (Calif, 2022)

LoRaWAN technology is backed by customer support and education which Cisco is investing in training and technical support to assist customers in deploying and managing the network successfully. This service is provided to guide clients to clarify any doubts or issues occurred while utilizing this product that is available on the net such as the official page of Cisco. In addition, this website allows customers to chat with a live representative and contact number for technical support. This help contributes to satisfying clients and a strong bond of faith. Cisco is also expanding the ecosystem by associating with manufacturers and developers of devices and systems. Cisco IoT platforms incorporate wireless gateways to let consumers leverage device management and develop applications for insights and construct inventive IoT determination.

## Prediction the next few stage(s) and Timing it may take to move on to the next stage.

### Prediction maturity stage.

In this maturity stage, the sales growth decelerates as LoRaWAN hits the saturation pinpoint as most users have already adopted this technology in their daily lives. In this phase, the Cisco company may focus on differentiating LoRaWAN, optimizing their cost, retentions consumers, and segmentizes the market. In this stage, the sales, profits, and competition of the Cisco LoRaWAN reach the highest peak. Due to high competition in the market, the availability of LoRaWAN substitution intensifies as other corporations come up with a better product or almost close which causes price wars.

Therefore, Cisco will put full effort into maintaining or increasing market shares by eagerly involving themselves in sales promotional activities to stabilize their ranking in the market. Cisco made a long-term commitment to IoT by investing in their IoT solutions for LoRaWAN products. (Cisco, Cisco Solution for LoRaWAN, n.d.) This proves that Cisco has confidence in LoRaWAN which will have significant growth in the market as the demand will continue for the years to come. Cisco believes that this LoRaWAN wireless gateway will still be popular as stated the benefits that meets the future prediction in the market. (Harttree, 2017)

### Prediction decline stage.

In this stage, the Cisco firm would lose the market as the LoRaWAN begins to shrink. The sales for LoRaWAN product would decrease as the latest technologies or replaceable product wins the market. At this stage, the Cisco company aims on substituting the LoRaWAN product with something that meets the market’s requirements. 10 models are designed for the future. For instance, Cisco has a model that predicts the future demand which is known as the Advantech WISE-3610 IoT LoRa Network Gateway[.](https://www.asmag.com/showpost/26322.aspx) (Shen, 2018)This private network is designed for smart buildings, smart cities, and industrial 4.0 applications, and leverages wireless sensor technology. Hence this proves that if Cisco wishes to revive in the market, then effective action is required to inspect and evolve latest IoT technologies and products.

The Advanced private LoRa technology new tech is an idea of replacing the current LoRaWAN in the future if the sales decrease as new technologies or other products has higher chances of replacing this LoRaWAN product in the market. (Shen, 2018) Consequently, Cisco aims to discontinue the LoRaWAN by substituting this new product to revive its lifecycle. This is the future’s expectations. (Cisco, Future of Technology Global perspectives on new opportunities and challenges for business, 2022)

Nevertheless, there is also a high probability that LoRaWAN would not face a decline stage in the future due to the advancements and emerging technologies found in the IoT space. This firm is adaptable to meet the market’s changes as they invest in research and deployments to remain competitive.

## Justifying reasons for placement, based on articles and market acceptance.

The Cisco Wireless Gateway for LoRaWAN is one of the products Cisco offers for LoRaWAN solutions. The placement of the gateway in the marketplace can be assumed based on key points such as its specific features, how well the gateway can meet customer needs and demands, the level of competition in the market.

As we have mentioned about the features of the gateway previously, it supports bidirectional communication, chirp modulation, multiple spreading factors, adaptive data rate from 300 bps to 5.5 Kpbs, and up to 15 kilometers single hop in rural from the end device to the LoRaWAN Gateway. (Tech, 2016) With the specific features of the gateway plus the growing number of interconnected devices in the world, IoT solutions like this gateway are becoming increasingly important. While there are other LoRaWAN gateways available on the market, the Cisco gateway offers unique features and capabilities including advanced analytics, integration with Cisco's broader networking and security offerings, and a flexible deployment model that set it apart from other offerings. This creates market demand for the Cisco wireless gateway and positions it well within the IoT ecosystem.

Moreover, The Cisco solution for LoRaWAN offers customers a fully integrated and functional architecture that supports both service providers and industrial vertical customers. According to several customer reviews on the official website, they are very satisfied with the performance, capabilities, and scalability of the solution, and the gateway is being adopted by a growing number of customers. Customers have given reviews like the gateway is a versatile product that can be used for various IoT applications. It supports up to 16 uplink channels, which improves spectrum utilization and allows for more devices to be connected. It also has rich backhaul options, including Ethernet and cellular, which gives us flexibility in deployment." This is indicative of its market acceptance and perceived value. (Slashdot, n.d.)

When the gateway comes to be positioned in the market, the reputation of the company brand, Cisco, also plays a key role. As an established and reputable technology vendor, Cisco’s expertise in networking and related fields allows the company to place its LoRaWAN gateway as a trusted and reliable solution. This thing has been mentioned in several articles covering the Cisco gateway. To sum up, the Cisco wireless gateway for LoRaWAN appears to have a strong market position based on its technical features, brand reputation, differentiation from competitors, and customer adoption. All these factors could be considered when justifying the reasons for placement of the gateway in the related market.

# Alternatives and Comparison

## Alternatives to the technology and product/service

Alternatives to the **technology as a whole** - there are numerous alternative technologies to Cisco Wireless Gateway for LoRaWAN. Some of the most popular alternatives include:

* The Things Network **Gateway**: This is a low-cost, open-source gateway that is easy to set up and use.
* MultiTech MultiConnect Conduit: This is a high-performance gateway that is designed for use in harsh environments.
* **Semtech** SX1301 Gateway: This is a cost-effective gateway that is ideal for small-scale deployments.

There are also a few alternative **products and services** that can be used to collect data from industry sensors. Some of the most popular alternatives include:

* **The Things Network**: This is a global network of LoRaWAN gateways that can be used to collect data from any LoRaWAN-enabled device.
* **MQTT**: This is a lightweight messaging protocol that can be used to send data from industry sensors to a central server.
* **Azure IoT Suite:** This is a cloud-based platform that can be used to collect, store, and analyze data from industry sensors.

**Can there be any replacements?**

Yes, there are manifold ways to replace the raw materials or final products used in industry sensors. For example, some companies are using recycled materials to create their sensors, while others are developing new technologies that can reduce the amount of waste produced by sensors. Additionally, some companies are working on developing new applications for industry sensors, which could lead to increased demand for these products. Overall, there are several alternatives, which offer a variety of features and benefits, to Cisco Wireless Gateway for LoRaWAN.

## Raw Material

Electronic components, such as circuit boards, microprocessors, and memory chips, form the foundation of LoRaWAN devices, enabling data processing and communication. While it may be challenging to replace any of these essential components, advancements in technology have led to the development of more efficient and eco-friendly alternatives. For instance, the researchers are exploring organic and printed electronics that utilize flexible and biodegradable materials. These innovations have the potential to reduce the environmental impact of electronic components while keeping the necessary functionality for LoRaWAN devices.

Plastics, metals, and other materials are used in the physical construction of LoRaWAN gateways, contributing to their durability and structural integrity. In replacing these materials with more sustainable alternatives there are bio-based plastics derived from renewable resources offer the potential to reduce reliance on fossil fuels and decrease the environmental footprint associated with traditional plastics. Additionally, utilizing recycled or upcycled materials can help minimize waste and promote a circular economy approach. Exploring innovative material options that offer comparable strength and durability while being environmentally friendly is key to successfully replacing plastics, metals, and other construction materials in the LoRaWAN devices.

Energy sources, such as batteries or electrical power, are crucial for powering LoRaWAN devices and maintaining connectivity. There is a focus on integrating renewable energy sources by utilizing solar panels or kinetic energy harvesting mechanisms that can provide clean and renewable power. In addition, advancements in battery technology are enabling the development of more efficient and longer-lasting batteries, reducing the reliance on non-renewable resources.

## Final Product and Comparing the product with the alternatives.

Cisco Wireless Gateway has long been a trusted choice for organizations seeking reliable and secure wireless connectivity solutions. However, in the ever-evolving landscape of IoT technologies, alternative options have emerged to cater to the specific needs of LoRaWAN deployments. In this article, we will explore some viable replacements for Cisco Wireless Gateway in LoRaWAN applications and highlight other services that serve the same purpose.

1. MultiTech:

MultiTech is a renowned provider of IoT communication devices and gateways. Their LoRaWAN gateway lineup offers a diverse range of models tailored to different deployment scenarios. With features like robust connectivity options, advanced security measures, and scalable designs, MultiTech gateways cater to a wide array of IoT applications.

Ex.

 MultiTech Conduit® 300 Series IoT Gateway

The Conduit® 300 Series programmable gateway (MTCDT3AC Series) features mPower™ Edge Intelligence enables streamlined edge-to-cloud orchestration, management, and analytics together with a high performance and built-in compatibility with leading IoT software platforms. (MultiTech Conduit® 300 Series, n.d.)

|  |  |  |
| --- | --- | --- |
| Feature | Cisco Wireless Gateway for LoRaWAN | MultiTech Conduit® 300 Series IoT Gateway |
| Connectivity and Protocol Support | LoRaWAN | LoRaWAN, LTE Cat 4, Ethernet |
| Gateway Features | Robust connectivity options | Built-in Wi-Fi, cellular, Ethernet ports |
|  | Advanced security measures | Integration with various sensors/devices |
|  | Scalable design |  |
| Deployment Flexibility | Suitable for various IoT applications | Private or public network creation |
|  | Long-range coverage | Supports smart cities, industrial automation, etc. |
|  | Low power consumption |  |
| Cost | Varies based on model and features | Varies based on model and features |

A picture containing plastic, car, LEGO

Description automatically generated

MultiTech Conduit® IP67 Base Station

The Conduit® IP67 Base Station (MTCDTIP Series) is a highly scalable, ruggedized IoT certified gateway solution, specifically designed for outdoor LoRa® public or private network deployments. (MultiTech Conduit® IP67 Base Station, n.d.)

|  |  |  |
| --- | --- | --- |
| Feature | Cisco Wireless Gateway for LoRaWAN | MultiTech Conduit® IP67 Base Station |
| Connectivity and Protocol Support | - Supports LoRaWAN protocol for long-range, low-power IoT connectivity. | - Supports LoRaWAN protocol for long-range, low-power IoT connectivity. |
|  | - Provides reliable connectivity for IoT devices. | - Offers additional connectivity options such as LTE Cat 1 and Ethernet. |
| Gateway Features | - Offers robust connectivity options for IoT deployments. | - Features a ruggedized IP67-rated enclosure for outdoor deployment. |
|  | - Includes advanced security measures to protect IoT data. | - Built-in Wi-Fi, cellular, and Ethernet ports for flexible connectivity. |
|  | - Scalable design allows for easy expansion of IoT networks. | - Supports multiple antenna options for improved signal strength and coverage. |
| Deployment Flexibility | - Suitable for various IoT applications, including smart cities, | - Designed specifically for outdoor deployment in harsh environments. |
|  | industrial automation, asset tracking, and environmental monitoring. | - Ideal for remote locations or areas with challenging environmental conditions. |
|  | - Provides long-range coverage, enabling communication over |  |
|  | significant distances between devices and the gateway. |  |
| Power Consumption | - Designed with low power consumption for energy-efficient operation. | - Offers optimized power usage, extending battery life for IoT devices. |
| Cost | - Pricing varies based on the specific model and features chosen. | - Cost varies depending on the selected model and included features. |

2. Kerlink:

Kerlink stands as a global leader in end-to-end IoT network solutions. Their LoRaWAN gateways excel in providing reliable connectivity for IoT deployments. Kerlink offers a variety of gateway models, including outdoor and indoor variants, high-capacity options, and support for multiple frequency bands. Their solutions prioritize efficiency, performance, and seamless integration with existing networks.

Ex.A white box with blue text

Description automatically generated with low confidence

Wirnet iBTS LoRaWAN Gateway

Kerlink Wirnet iBTS gateways perfectly power reliable and scalable LPWA outdoor IoT networks, supporting high volumes of IoT devices and millions of bidirectional messages daily. Embedding powerful processing capabilities, secure design and advanced remote monitoring options, these outdoor gateways are perfectly suited for evolutive and flexible IoT networks, making them to best choice for public operators, MVNOs, cable operators, tower cos, private businesses, or public authorities. (Wirnet iBTS LoRaWAN Gateway, n.d.)

|  |  |  |
| --- | --- | --- |
| Feature | Cisco Wireless Gateway for LoRaWAN | Kerlink Wirnet iBTS Gateway |
| Connectivity and Protocol Support | - Supports LoRaWAN protocol for long-range, low-power IoT connectivity. | - Supports LoRaWAN protocol for long-range, low-power IoT connectivity. |
|  | - Provides reliable connectivity for IoT devices. | - Offers reliable connectivity for IoT devices. |
| Gateway Features | - Includes advanced security measures to protect IoT data. | - Equipped with advanced security features to safeguard IoT data. |
|  | - Scalable design allows for easy expansion of IoT networks. | - Designed for scalability to accommodate growing IoT deployments. |
|  | - Offers robust connectivity options for IoT deployments. | - Provides robust connectivity options for diverse IoT applications. |
| Deployment Flexibility | - Suitable for various IoT applications, including smart cities, industrial automation, asset tracking, and environmental monitoring. | - Designed for diverse IoT applications, including smart cities, industrial automation, and environmental monitoring. |
|  | - Provides long-range coverage, enabling communication over significant distances between devices and the gateway. | - Offers long-range coverage for extensive IoT deployments. |
|  |  | - Enables communication over significant distances between devices. |
| Power Consumption | - Designed with low power consumption for energy-efficient operation. | - Optimized power usage to prolong battery life of IoT devices. |
| Cost | - Pricing varies based on the specific model and features chosen. | - Cost varies depending on the selected model and included features. |

3. Laird Connectivity:

Laird Connectivity specializes in wireless connectivity solutions, including LoRaWAN gateways. With a strong focus on security and reliability, Laird gateways offer secure connectivity for IoT applications across diverse industries. Their portfolio includes outdoor and indoor gateways, each designed to address specific deployment requirements while ensuring uninterrupted data transmission.

Ex.

Sentrius RS1xx Sensor

Our Sentrius RS1xx supports Bluetooth 4.2 for short range, local communications, as well as LoRaWAN so you can send your data over miles to a LoRaWAN gateway. (Sentrius RS1xx LoRa-Enabled Sensors, n.d.)

|  |  |  |
| --- | --- | --- |
| Feature | Cisco Wireless Gateway for LoRaWAN | Laird Connectivity Sentrius RS1xx Sensor |
| Connectivity and Protocol Support | - Supports LoRaWAN protocol for long-range, low-power IoT connectivity. | - Supports LoRaWAN protocol for long-range, low-power IoT connectivity. |
|  | - Provides reliable connectivity for IoT devices. | - Offers reliable connectivity for IoT devices. |
| Gateway Features | - Advanced security measures to protect IoT data. | - Provides robust security features to safeguard IoT data. |
|  | - Scalable design for easy expansion of IoT networks. | - Designed for scalability to accommodate growing IoT deployments. |
|  | - Robust connectivity options for IoT deployments. | - Provides a range of connectivity options for diverse IoT applications. |
| Sensor Features | - Primarily a wireless gateway and not a sensor itself. | - Integrated sensor capabilities for temperature, humidity, and more. |
|  | - Can communicate with multiple sensors and devices. | - Acts as both a gateway and a sensor node for data collection. |
| Deployment Flexibility | - Suitable for various IoT applications, including smart cities, | - Designed for diverse IoT applications, including smart cities, |
|  | industrial automation, asset tracking, and environmental monitoring. | industrial automation, and environmental monitoring. |
|  | - Provides long-range coverage for extensive IoT deployments. | - Offers reliable connectivity for IoT devices within a localized area. |
| Power Consumption | - Designed with low power consumption for energy-efficient operation. | - Optimized power usage to prolong battery life of the sensor. |
| Cost | - Pricing varies based on the specific model and features chosen. | - Cost varies depending on the specific sensor model and included features. |

4. Dragino:

Dragino is a prominent manufacturer of IoT connectivity and wireless solutions. Their LoRaWAN gateways provide an affordable yet reliable option for IoT connectivity. With a focus on simplicity and effectiveness, Dragino gateways offer seamless connectivity, making them ideal for diverse IoT applications.

Ex.



The LG308N is an open source LoRaWAN Pico Gateway. It lets you bridge LoRa wireless network to an IP network via WiFi, Ethernet, 3G or 4G cellular network. The LoRa wireless allows users to send data and reach extremely long ranges at low data-rates. (LG308N LoRaWAN Gateway, n.d.)

|  |  |  |
| --- | --- | --- |
| Feature | Cisco Wireless Gateway for LoRaWAN | Dragino LG308N |
| Connectivity and Protocol Support | - Supports LoRaWAN protocol for long-range, low-power IoT connectivity. | - Supports LoRaWAN protocol for long-range, low-power IoT connectivity. |
|  | - Provides reliable connectivity for IoT devices. | - Offers reliable connectivity for IoT devices. |
| Gateway Features | - Advanced security measures to protect IoT data. | - Acts as an open-source LoRaWAN Pico Gateway. |
|  | - Scalable design for easy expansion of IoT networks. | - Allows bridging of LoRa wireless network to IP network via various options (WiFi, Ethernet, 3G, 4G). |
|  | - Robust connectivity options for IoT deployments. | - Provides long-range communication with low data rates. |
| Sensor Features | - Primarily a wireless gateway and not a sensor itself. | - Can bridge LoRa wireless network to an IP network. |
|  | - Can communicate with multiple sensors and devices. | - Supports the transmission of data over extremely long ranges at low data rates. |
| Deployment Flexibility | - Suitable for various IoT applications, including smart cities, | - Offers flexibility in bridging LoRa wireless network to different IP networks (WiFi, Ethernet, 3G, 4G). |
|  | industrial automation, asset tracking, and environmental monitoring. | - Can be used in diverse IoT deployments with different connectivity options. |
|  | - Provides long-range coverage for extensive IoT deployments. | - Enables communication over low data rates, allowing long-range communication. |
| Power Consumption | - Designed with low power consumption for energy-efficient operation. | - Power consumption varies based on the selected connectivity option. |
| Cost | - Pricing varies based on the specific model and features chosen. | - Cost varies depending on the model and optional connectivity options. |
| Management | - Provides remote management capabilities through Cisco's platform. | - Requires a separate management solution or software. |

# Effect of the Technology

Cisco wireless gateway for LoRaWAN is a product that enables IoT implementations that require low data rates and long-distance connectivity. It uses LoRa technology, which is a type of wireless communication that is low power, long range, and robust. LoRaWAN is a specification that defines how LoRa devices communicate with each other and with a network server. (Cisco, Cisco Wireless Gateway for LoRaWAN , 2023)

So that, the technology, LoRaWAN can have various effects on different domains, such as:

1. **Commerce:** LoRaWAN can enable new business models and opportunities for commerce by providing cost-effective and reliable wireless connectivity for various products and services. For example, LoRaWAN can facilitate smart metering, which can improve billing accuracy and customer satisfaction, or asset tracking, which can enhance supply chain efficiency and security. (Cisco, Cisco Wireless Gateway for LoRaWAN , 2023)
2. **Social:** It can enhance social welfare and quality of life by enabling smarter and more sustainable IoT solutions that address various social challenges and needs. For example, LoRaWAN can support environmental monitoring, which can help detect and prevent pollution, or smart street lighting, which can reduce energy consumption and improve public safety. (Cisco, Cisco Wireless Gateway for LoRaWAN , 2023)
3. **The Environment**: It can contribute to environmental sustainability by enabling IoT solutions that reduce greenhouse gas emissions, conserve natural resources, and protect biodiversity. For example, LoRaWAN can support smart agriculture, which can optimize crop yield and water use, or waste management, which can improve recycling and waste disposal. (Cisco, Cisco Wireless Gateway for LoRaWAN , 2023)
4. **Health:** It can improve health outcomes and well-being by enabling remote diagnosis and treatment, disease prevention and control, health education and awareness, and emergency response. For example, LoRaWAN can support remote health care, which can provide access to medical services and information for underserved populations, or wearable devices, which can track vital signs and physical activity. (Cisco, Cisco Wireless Gateway for LoRaWAN , 2023)
5. **Economical:** It can boost economic growth and innovation by creating new markets and value chains, increasing productivity and competitiveness, reducing costs and barriers to entry, and fostering entrepreneurship and skills development. For example, LoRaWAN can support smart manufacturing, which can automate processes and optimize performance, or smart energy, which can balance supply and demand and reduce costs. (Cisco, Cisco Wireless Gateway for LoRaWAN , 2023)
6. **Political:** It can enhance political participation and accountability by enabling more transparent and inclusive governance processes, such as e-voting, e-democracy, e-government, and e-participation. It can also strengthen national security and resilience by enabling better surveillance and protection of critical infrastructure, borders, and citizens. (Cisco, Cisco Wireless Gateway for LoRaWAN Data Sheet , 2021)
7. **The Rate of Change:** It can accelerate the pace of change and transformation by enabling faster diffusion and adoption of new technologies, IoT solutions that transform the way people live, work, communicate, and interact. For example, LoRaWAN can support smart education, which can personalize learning and increase access to knowledge, or smart mobility, which can improve transportation and mobility options. (Cisco, Cisco Wireless Gateway for LoRaWAN , 2023)
8. **Institutions (Educational, etc.):** LoRaWAN can affect the functioning and performance of various institutions by enabling IoT solutions that improve their operations and services. As an example, it impacts the education system by creating new demands and opportunities for learning and teaching in the IoT and smart city domains such as the development of new curricula, pedagogies, and assessment methods; the provision of more resources and infrastructure; the enhancement of digital literacy and skills; and the promotion of interdisciplinary collaboration and research. (Parag Kulkarni, 2020)

## Both Positive and Negative Effects

Some of the **positive effects** of the Cisco Wireless Gateway for LoRaWAN are:

* It enables IoT implementations that require long-distance connectivity and low power operation, such as asset tracking, metering, environmental monitoring, waste management, smart street lighting, smart agriculture, etc. (Cisco, Cisco Wireless Gateway for LoRaWAN , 2023)
* It improves spectrum utilization and robustness with LoRa modulation technology.
* It supports multiple-channel diversity combinations with software configurations. (Cisco, Cisco Wireless Gateway for LoRaWAN , 2023)
* It offers rich backhaul options, such as Ethernet or optional integrated cellular backhaul.
* It provides robust security with Cisco IOS features and LoRaWAN encryption.
* It supports fully functional management with IoT Field Network Director.

Some of the **negative effects** of the Cisco Wireless Gateway for LoRaWAN are:

* It operates on unlicensed ISM frequencies, which may be subject to interference or regulation by local authorities. (Cisco, Cisco Wireless Gateway for LoRaWAN Data Sheet , 2021)
* It requires appropriate low-loss RF coax cable and weatherproofing if the antennas are remotely located. (Cisco, Cisco Wireless Gateway for LoRaWAN Hardware Installation Guide , 2019)
* It has a limited data rate and payload size due to the nature of LoRaWAN technology.

## The latest discovery/invention/usage of technology or any current issues related to the effect of technology.

Some of the latest discoveries, inventions, usages, or issues related to this technology are:

* LoRaWAN geolocation (Cisco, Cisco Wireless Gateway for LoRaWAN Data Sheet , 2021)
* LoRaWAN security (Cisco, Cisco Wireless Gateway for LoRaWAN , 2023)
* LoRaWAN interoperability (Cisco, Cisco Wireless Gateway for LoRaWAN , 2023)
* **LoRaWAN integration**
* LoRaWAN innovation (Editors, 2021)

There are still lots of current issues related to the Cisco LoRaWAN gateway including the ongoing development of 5G networks and their potential impact on IoT connectivity, as well as ongoing discussions around data privacy and security in the context of IoT and related technologies. Moreover, related development can also be the growing adoption of edge computing in IoT applications, which could offer greater efficiency and data privacy benefits.

# Ethical issues and the technology of the Cisco Wireless Gateway for LoRaWAN

The Cisco Wireless Gateway for LoRaWAN is a device that collects and transmits data from sensors and endpoints over a wireless network. This technology raises a number of ethical issues, such as:

* Hacking:” How can the gateway be protected from unauthorized access or attack?” Hackers can use various methods to hack into a gateway, such as exploiting vulnerabilities, cracking passwords, or launching denial-of-service attacks. Hacking can compromise the security and integrity of the data collected by the gateway, as well as the functionality and performance of the devices connected to it. (Ashwin, 2021)
* Privacy: “How can the gateway respect the privacy of the data subjects?” Privacy can be violated by the gateway if it collects or uses data without the consent or knowledge of the data subjects, or if it collects or uses data for purposes other than those intended or authorized. Privacy can also be violated by third parties who access or intercept the data transmitted by the gateway without authorization. (Ashwin, 2021)
* Piracy: “How can the gateway prevent the unauthorized copying or use of copyrighted content?” Piracy can occur if the gateway allows users to access or transmit copyrighted content without authorization or license (Ashwin, 2021)

To address these ethical threats, the gateway uses a number of features and measures, such as:

* Strong passwords: The gateway requires strong passwords for both the gateway itself and for the devices that connect to it.
* Encryption: The gateway encrypts all data that is stored on the gateway or transmitted over the network.
* Intrusion detection: The gateway has a built-in intrusion detection system that can detect and alert users to potential attacks.
* Anonymization: The gateway can be configured to anonymize or pseudonymize data before it is stored or transmitted.
* Consent: The gateway can be configured to require user consent before collecting or using data.
* Data minimization: The gateway can be configured to only collect the minimum amount of data necessary for its legitimate business purposes.
* Content protection: The gateway can be configured to use content protection technologies to prevent unauthorized copying of copyrighted content.
* Digital rights management: The gateway can be configured to use digital rights management technologies to control who can access and use copyrighted content.
* Data access control: The gateway uses role-based access control to restrict access to data based on user roles.
* Data backup: The gateway regularly backs up data to a secure location.

In addition to these features and measures, these ethical issues may vary depending on the context and purpose of using the gateway. For example, the gateway could be used to collect data about different domains, such as:

* **Environmental ethics**: How can data be used to protect and monitor the environment without interfering with it or causing harm?

Cisco's LoRaWAN Wireless Gateway uses a wireless network to transmit data between itself, which has the potential to have an impact on the environment. For example, a network can use radio waves which may cause electromagnetic field pollution in the environment. It is important to consider the environmental impact of a portal before using it.

* **Human rights:** How can data be used to promote and respect people's rights and dignity without violating them?

Cisco Wireless Gateway for LoRaWAN can be used to collect data about people. This data can be used to track people's movements. It is important to consider the ethical implications of collecting and using this data, especially if it could be used to violate people's privacy.

* **Business ethics:** How can data be used to improve and innovate corporate performance without exploiting it?

Cisco Wireless Gateway for LoRaWAN can be used to collect data about businesses. This data can be used to track the company's market movement, or to monitor business performance. It is important to consider the ethical implications of collecting and using this data, especially if it could be used to harm or exploit a business.

In addition to these ethical issues, the use of the gateway may also have legal implications, such as:

* **Legal restrictions:** How can data be collected and used in accordance with the laws and regulations of different countries?

Use of the Cisco Wireless Gateway for LoRaWAN may be subject to restrictions imposed by some countries. For example, some countries may have laws that restrict the collection of data on people. It is important that Cisco be aware of these legal restrictions before deploying the portal.

* **Intellectual property**: How can technology be used in accordance with the rights and licenses of the intellectual property owner?

The technology used by the Cisco Wireless Gateway for LoRaWAN may be protected by intellectual property law. This means that organizations using this technology may need to obtain a license from the intellectual property holder before using it.

It is important to consider all these ethical considerations before deploying the Cisco Wireless Gateway for LoRaWAN. By doing so, organizations can help to ensure that the gateway is used in a way that is ethical and responsible. (Ashwin، 2021)

# Future of technology

## Discussing about ‘green initiative or green aspect or green computing’ of LoRa technology.

The green computing is a manufacturing plan that is designed to minimize detrimental impacts on the environment and utilize or dispose computers, chips and other components and peripherals of the technology sufficiently. The IoT network emerges massive power consumption due to enormous quantity of data transmission therefore utilizing green computing aids in creating sustainable cities. (Singh, 2021) (Oscar Torres Sanchez, 2022)The GreenLoRaWAN is a protocol that reduces the energy consumption and increases life span of network by evaluating the performance.

Cisco incorporates several principles to optimize energy requirements using eco-friendly resources and practising responsibility by disposing waste systematically in the Green Internet of Things (G-IoT). (Fadi Al-Turjman, 2019)First and foremost, energy efficiency like applying solar panels assists in minimizing carbon footprint whilst providing reliable IoT connectivity. For instance, utilizing advanced power management feature like automatic power control and power-off schedule.

Moreover, hardware components power-efficient optimization like processors and memory modules aids without affecting the performance. (Thomas Dimakis, 2022)Furthermore, software optimizations operate efficiently on LoRaWAN wireless gateways by employing algorithms and systems which enhance materials utilities and reduce power requirements. In addition, this technology supports lifecycle management in LoRaWAN which is responsible to repair, refurbish and recycle devices to extend their lifespan and minimize electronic waste. (Oscar Torres Sanchez, 2022)

Besides, this technology implements remote managing and monitoring features in LoRaWAN to optimize and control power usage efficiently that updates the user by detecting insignificant energy consumption or mitigating it. (Thomas Dimakis, 2022)Ultimately, modern data analytics is capable of establishments inspecting and enhancing IoT networks by leveraging data-driven insights to authorize systematic resource allocation and minimize energy waste. This permits energy-intensive processes and executes power-saving actions.

As a result, the GreenLoRaWAN intensifies energy efficiency, scalability, and robustness by reducing carbon emissions and energy consumed by manufacturers, data centers, and end-users. Through operating renewable resources, this technology encompasses sustainable raw materials and reduces electronic waste for a more sustainable IoT ecosystem. (Thomas Dimakis, 2022)

# Conclusion

To summarize, the Cisco Wireless Gateway for LoRaWAN and its underlying LoRa technology hold great potential in Internet of Things (IoT). By connecting physical objects to the digital realm, the IoT enables data exchange, automation, and intelligent decision-making, guiding in a transformative prototype. The evolution of LoRa technology has seen significant advancements over time, and it continues to find applications across various industries and use cases such as smart agriculture, buildings, cities, logistics, and more in the future.

Cisco company, through its promotional and awareness-building strategies, aims to increase the visibility, understanding, and adoption of LoRa technology among businesses, developers, and organizations seeking reliable IoT connectivity solutions. The Cisco Wireless Gateway for LoRaWAN serves as a powerful tool for collecting and transmitting data from a wide range of sensors, enabling successful IoT projects that enhance efficiency, productivity, and safety.

Automation plays a crucial role in the Cisco Wireless Gateway for LoRaWAN, allowing for seamless data collection, transmission, processing, and analysis. By automating processes and leveraging IoT sensor technology, issues such as sensor malfunctions and communication problems can be quickly addressed, ensuring prompt alerts and maintenance. The integration of automation and IoT sensors enables optimized production processes, minimizes waste, maximizes productivity, and enhances the safety of human labour.

As we have mentioned the physical design and types of design of the Gateway, they contribute to its functionality and effectiveness. As the gateway is currently in the growth stage of its life cycle, Cisco remains committed to IoT and LoRaWAN, investing in their solutions and believing in the significant market growth and future demand for these technologies. While uncertainties exist, Cisco's adaptability, research investments, and focus on remaining competitive position them well to navigate future changes in the IoT landscape with Lora technology.

As estimating the future of the gateway in terms of LoRa technology, ongoing developments such as 5G networks, data privacy and security concerns, and the adoption of edge computing in IoT applications pose challenges and opportunities for the Cisco LoRaWAN gateway. However, with advancements in technology and a focus on sustainability, such as the GreenLoRaWAN initiative, LoRa technology can enhance energy efficiency, scalability, and robustness, contributing to a more sustainable IoT ecosystem.

Overall, the Cisco Wireless Gateway for LoRaWAN, along with LoRa technology, presents a promising solution for IoT connectivity. With continuous innovation, strategic investments, and a commitment to addressing emerging challenges, Cisco is well-positioned to drive the future of IoT and capitalize on the potential of LoRaWAN.

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# Work breakdown structure of Week 2

|  |  |  |
| --- | --- | --- |
| Number | Task | Name |
| 1. | Introduction to technology. |  |
|  | Evolution. | Rawaa Sabri |
|  | Definition of technology. | Turganaliyev Janibek |
|  | The timeline and transition from the past till now/Evolution. | Rawaa Sabri |
|  | List of industries/companies applying this technology. | Talantbek Uulu Iliaz |
| 2. | Company background. |  |
|  | Background. | Talantbek Uulu Iliaz |
|  | What does the company do? | Turganaliyev Janibek |
|  | History-Timeline. | Summam Hassan |
|  | Mission, and Vision | Manreen Kaur A/P Jagjit Singh |
|  | Lists of products/services.   * Classification of technology in the company. * Justify the classification. | Nway Yupar Aung |

Work breakdown structure of Week 3

|  |  |  |
| --- | --- | --- |
| Number | Task | Name |
| 1. | Technology and the Web. |  |
| (a) | How is the Internet assisting the technology? | Manreen Kaur |
|  | Promotion and awareness of technology | Rawaa Sabri |
|  | Service provided. | Nway Yupar Aung |
|  | General information on the Internet. | Talantbek Uulu Iliaz, Turganaliyev Janibek |
|  | Strengths and weaknesses, does website assists information related technology (service or product)? | Rawaa Sabri, Nway Yupar Aung |

Work breakdown structure of Week 4

|  |  |  |
| --- | --- | --- |
| Number | Task | Name |
| 1. | Process and Design of the Technology |  |
| a. | Process |  |
| i. | Diagram of input to output | Talantbek Uulu Iliaz |
| ii. | Whole process (stage by stage explanation) including other supporting processes | Summam Hassan,  Nway Yupar Aung |
| iv. | Display automation processes where applicable | Manreen Kaur |
| b. | Design |  |
| i. | Physical design | Turganaliyev Janibek |
| ii. | Types of design | Rawaa Sabri |

# Work Breakdown Structure of Week 6

|  |  |  |
| --- | --- | --- |
| **No.** | **Task** | **Name** |
| 1 | Life cycle of technology |  |
| a. | Determine where the technology currently is-   1. Introduction, growth, maturity, decline | Manreen Kaur, Nway Yupar Aung |
| b. | Explain the previous stage(s) passed | Nway Yupar Aung,  Manreen Kaur |
| c. | Predict the next few stage(s) and.…. | Manreen Kaur |
| d. | Justify reasons of placement, based on articles and… | Nway Yupar Aung |

# Work Breakdown Structure of Week 7

|  |  |  |
| --- | --- | --- |
| **No.** | **Task** | **Name** |
| 1 | Alternatives to the technology   * 1. You have the option to look at your technology as a whole or as a focused product/service.   2. Can there be any replacements?      1. Raw material (input)      2. Final product (output) | Summam Hassan |
| 2 | Raw Material   * 1. Within your technology, can your raw materials be of something else but still producing the same output?   2. Examples.      1. Diamonds – Synthetic Diamonds      2. Nonrenewable energy – Renewable energy      3. Chocolate – Artificial preservatives      4. Food – Artificial coloring | Turganaliyev Janibek |
| 3 | Final Product and Comparison with alternatives   * 1. Are there any replacements for your final product?   2. Other products or services that serve the same purpose? Competitors?   3. Compare specific characteristics | Rawaa Sabri,  Talantbek Uulu Iliaz |

# Work Breakdown Structure of Week 8

|  |  |  |
| --- | --- | --- |
| **No.** | **Task** | **Name** |
| 1. | Effects of the technology   * 1. Technology's Effect on:   2. Commerce   3. Social   4. The Environment   5. Health   6. Economical   7. Political   8. The Rate of Change   9. Institutions – Educational, etc. | Nway Yupar Aung |
| 2. | Both positive and negative effects |
| 3. | Find the latest discovery / invention / usage of technology or any current issues related to the effect of technology. |

# Work Breakdown structure of Week 9

|  |  |  |
| --- | --- | --- |
| **No.** | **Task** | **Name** |
| 1. | Ethical issues and technology of Cisco Wireless gateway for LoRaWAN | Rawaa Sabri,  Turganaliyev Janibek,  Talantbek Uulu Iliaz,  Summam Hassan |

# Work Breakdown structure of Week 10

|  |  |  |
| --- | --- | --- |
| **No.** | **Task** | **Name** |
| 1. | Future of the technology   * 1. Discuss about ‘green initiative or green aspect or green computing’ of the chosen technology. | Manreen Kaur |