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The Key Role of GNSS in Logistics and Supply Chain Management Applications

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Agenda

- Introduction: SC & transparency
- Data model for SC & logistics
- Basic elements & functionalities of smart SC
- Requirements of positioning in SC & logistics
- Available tools for SC positioning
- GNSS for SC & logistics tracking & tracing
- Demo of indoor and hybrid positioning
- Conclusions

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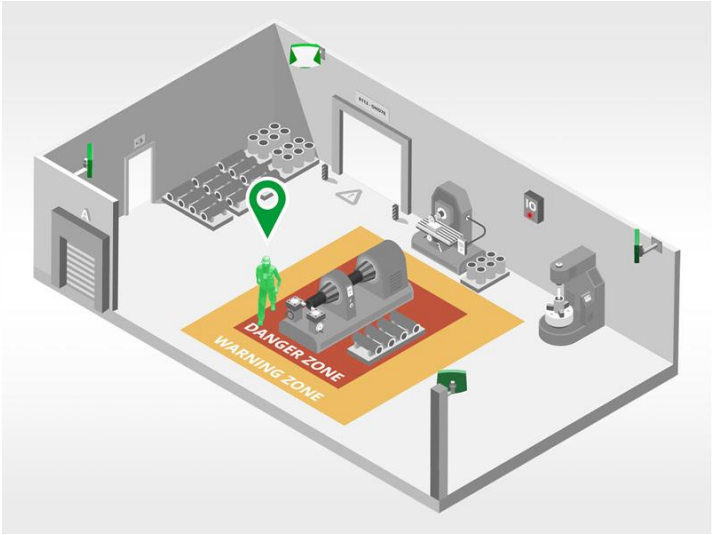
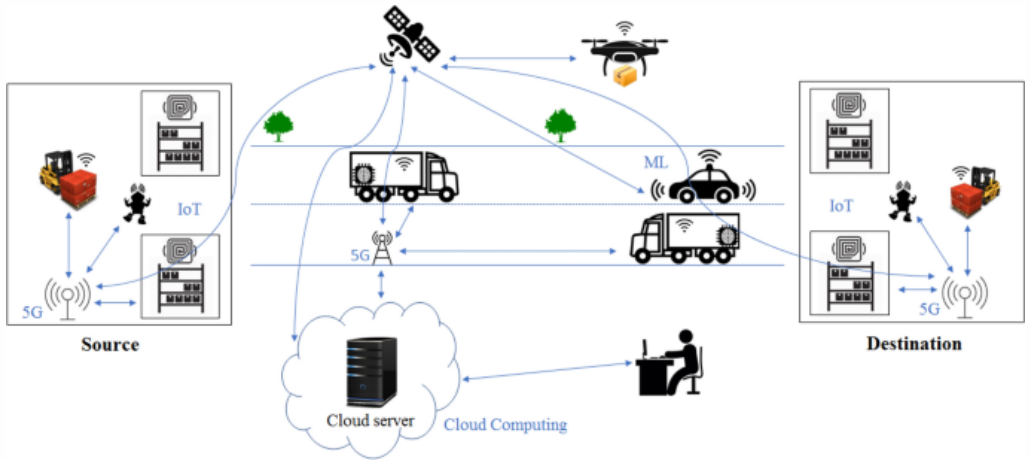
Introduction: Supply chain and transparency

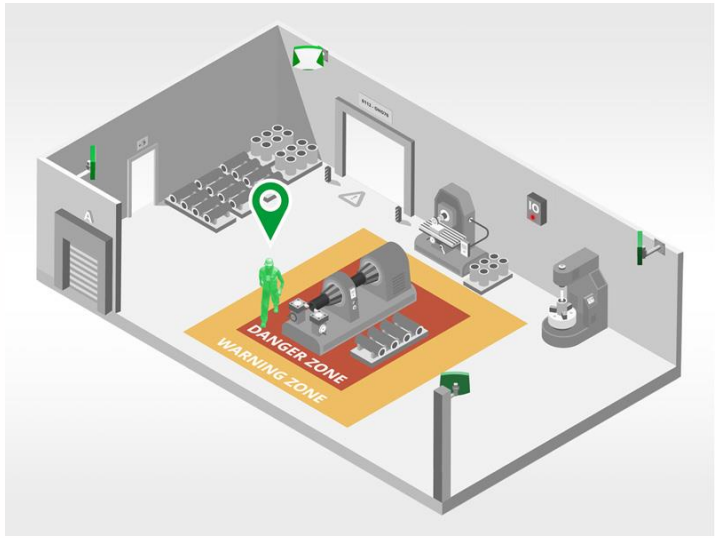
- Goods movement & environmental impact
- Safety of the transported goods
- Deployment of advanced tools and technologies to SC safety
- SC monitoring avoids serious risks and minimizes possible damages.

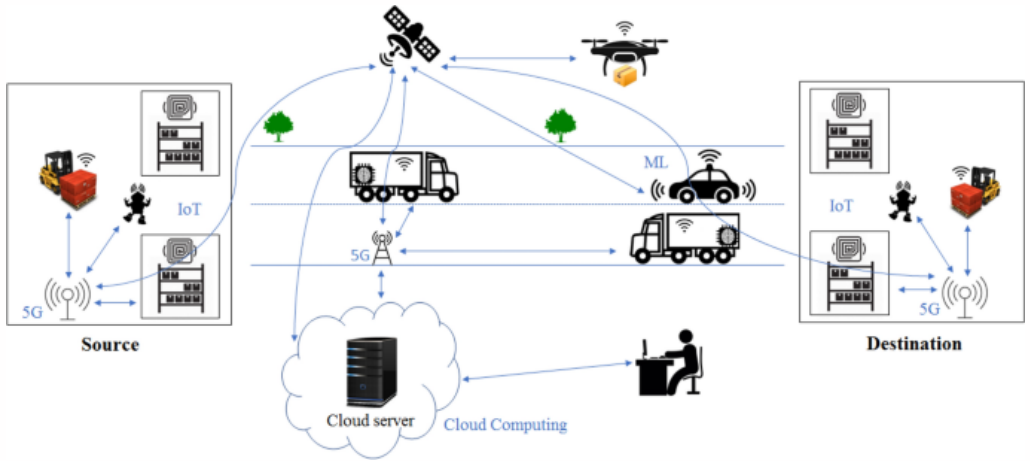




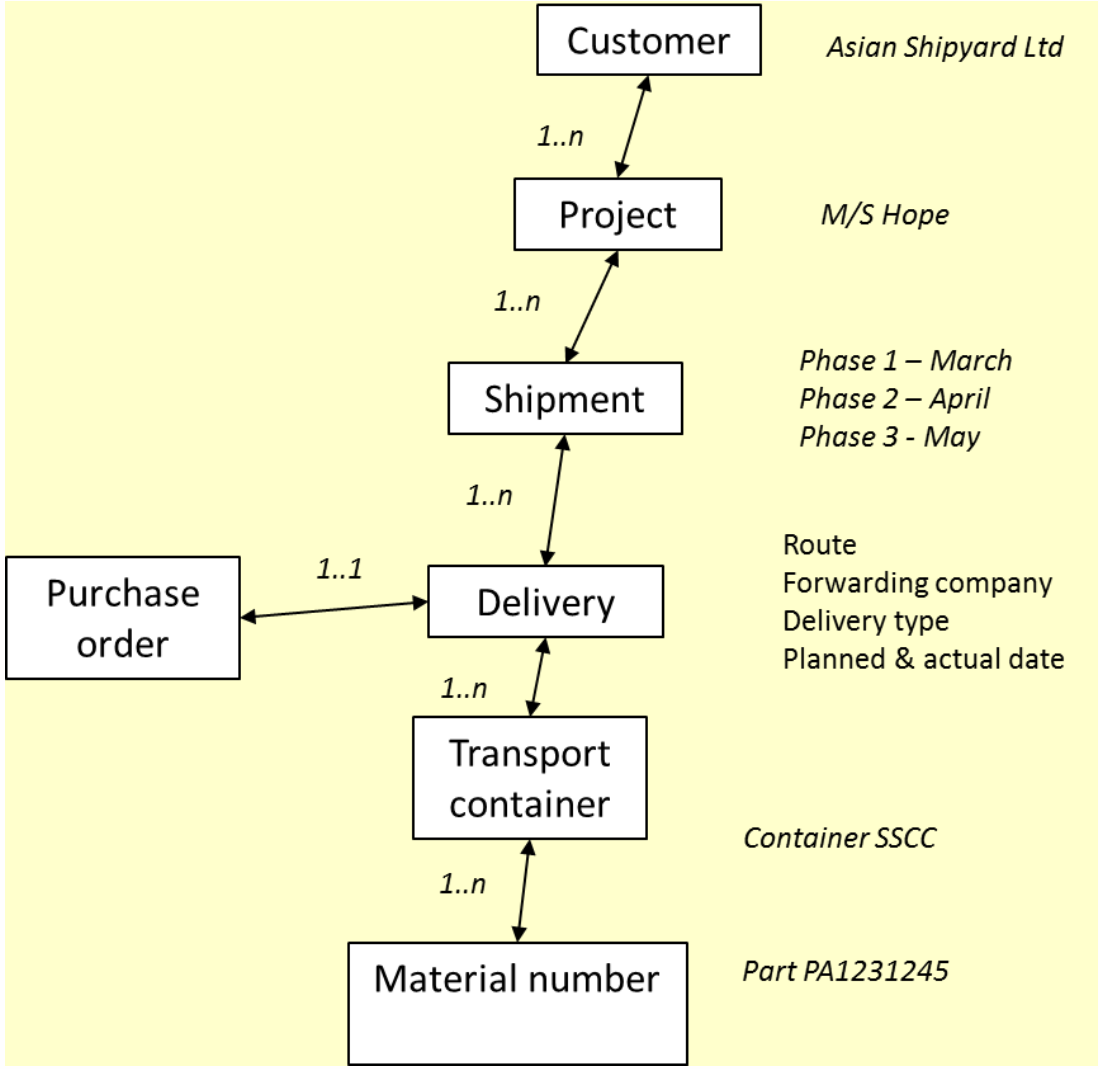
Introduction: Supply chain and transparency

- Traceability in SC unveiled major shortcomings
- To ensure traceability, conversion of the physical goods into a digital representation is necessary
- Various technologies are available such as blockchain, IoT, GNSS, etc., to provide traceability in SC





Data Model for SC & Logistics



(Helo & Shamsuzzoha, 2020)

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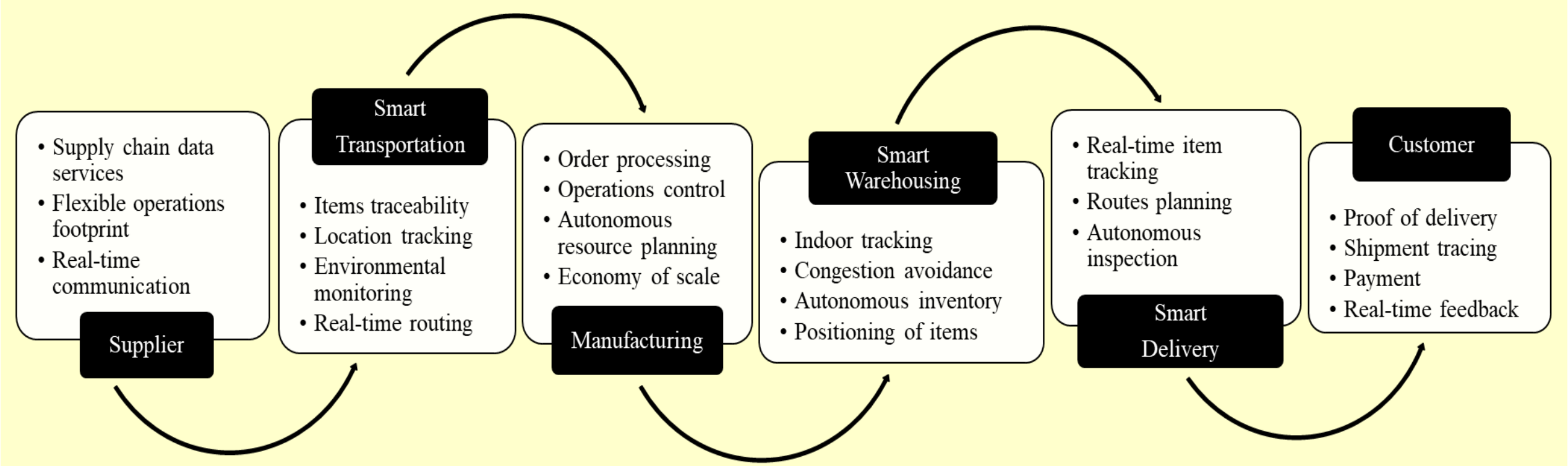
Basic Elements & Functionalities of Smart SC



(Elsanhoury et al. 2022)

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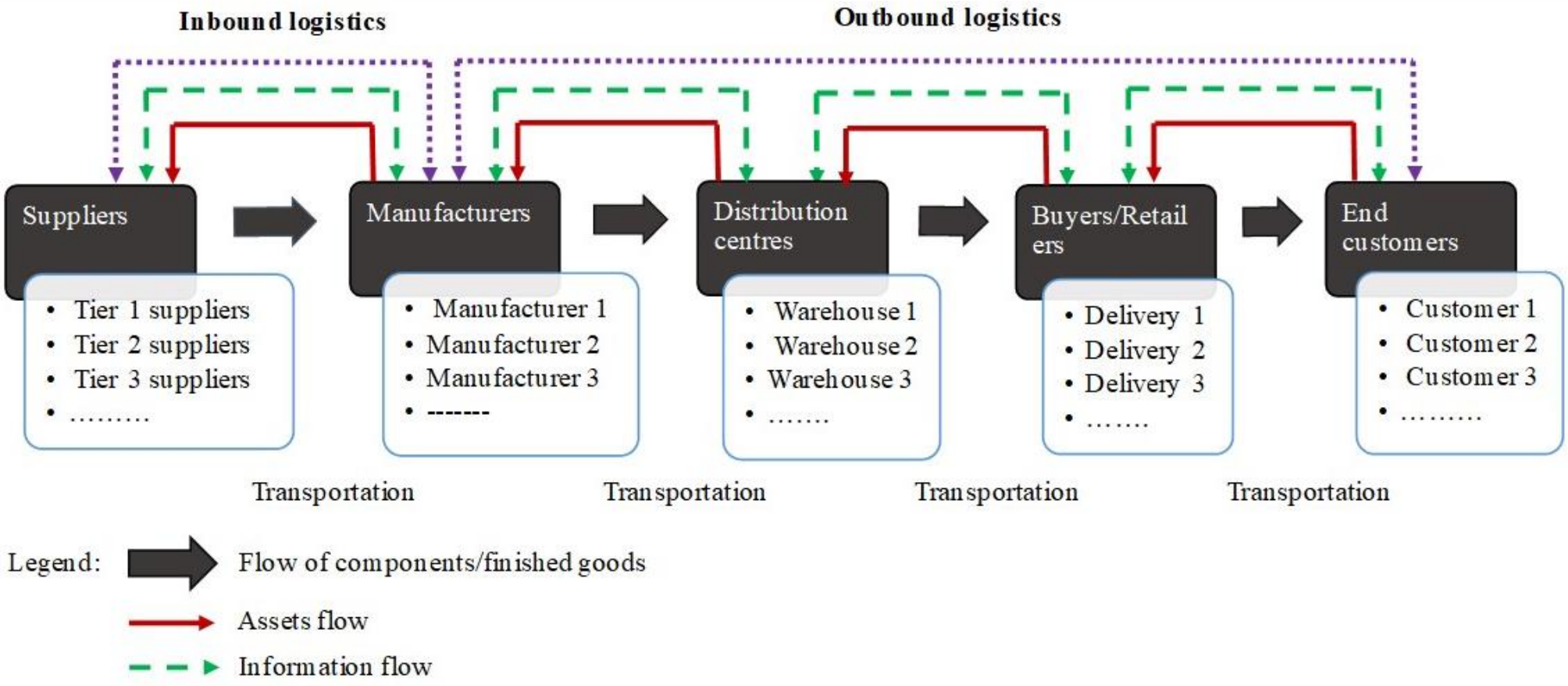
Inventory Flow in a Generic SC



(Elsanhoury et al. 2022)

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Requirements of Positioning in Supply Chain & Logistics

- Traceability (indoor/outdoor positioning)
- Tamper-proof authentication
- Tracking/position authentication
- Security (privacy/encription)
- Real-time visibility
- SC condition monitoring
- Safety on critical items

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Available Tools for SC Positioning

- Radio Frequency Identification (RFID)
- Bar code/QR code
- GPS tracking devices
- Radio frequency data capture (RFDC)
- Real-time location systems (RTLS)
- 5G/6G
- Space data for tracking
- **Gallileo authentication service**
  - High accuracy signal (HAS)
  - Navigate message authentication (NMA)
  - Gallileo positioning signal
  - Salellite radio to measure quality

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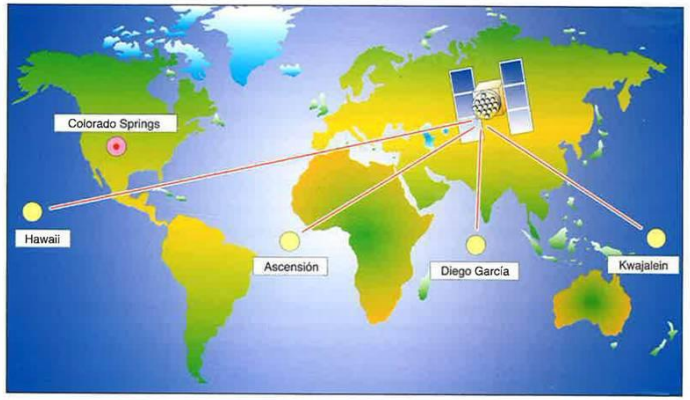
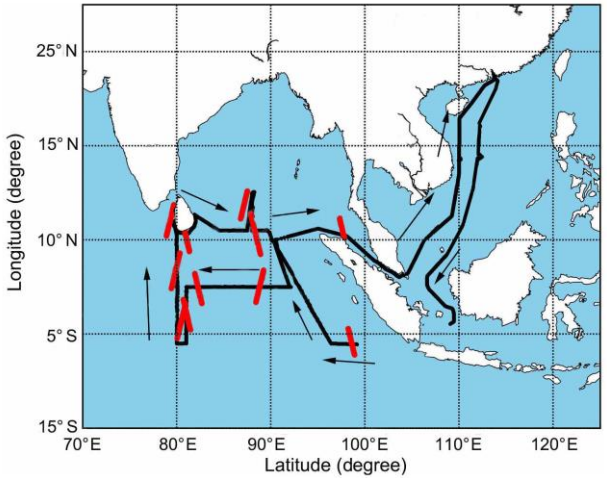
GNSS for SC & logistics tracking and tracing

- GNSS, provides accurate positioning, navigation and time (PNT) information for transportation media.
- Several European projects developed various tracking solutions based on EGNOS technology that can ensure the safety, security and reliability of delivery items.
- EGNOS technology provides precise positioning and integrity in transportation services.





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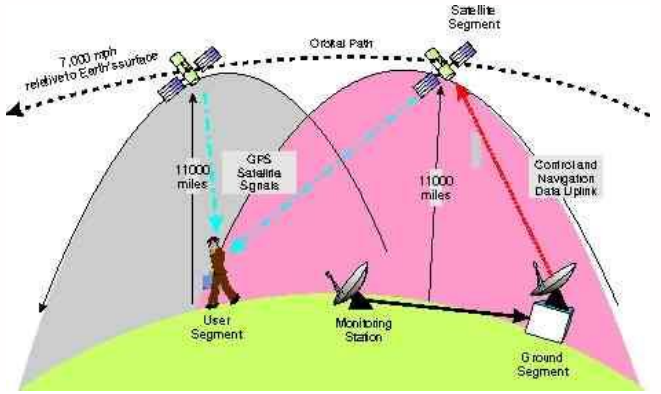
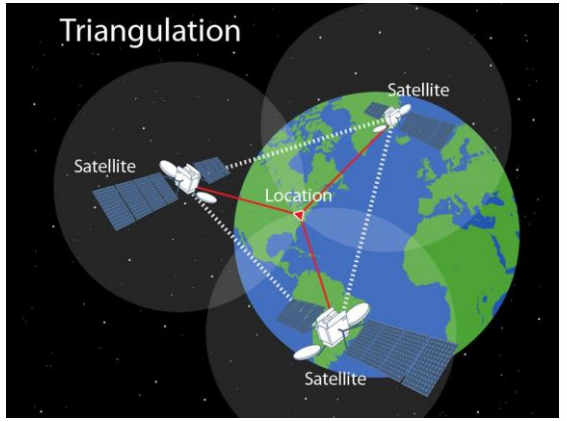
GNSS for SC & logistics tracking and tracing

- EGNOS and Galileo provide extended benefits to transportation in terms of safety and security, improved traffic management, and incident prevention.
- GNSS offers tracking and tracing of goods, a pallet, a container, etc., in real-time, which is very important especially in case of loss or theft.
- The tracking of goods in real time can guarantee good positioning from the start of loading until delivery to the end customer.





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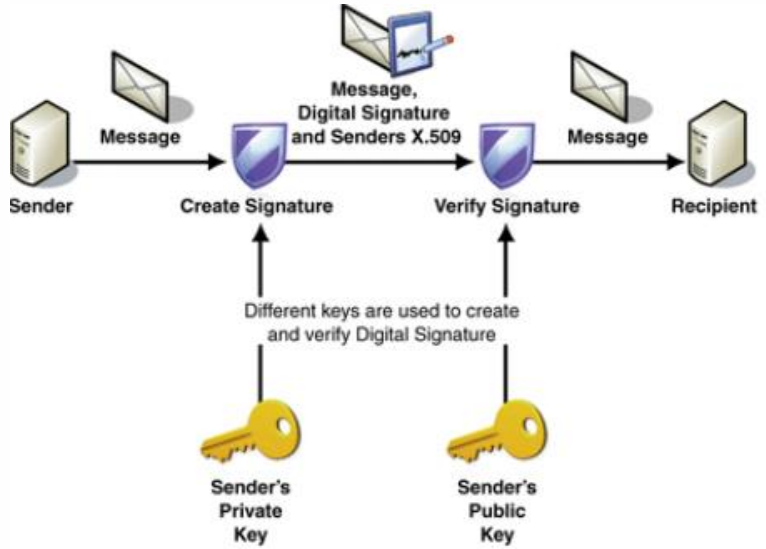
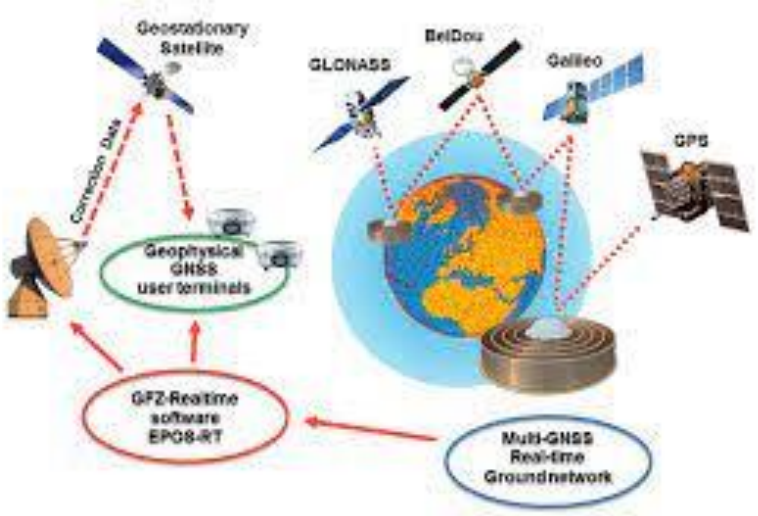
GNSS for Positioning

- A High Accuracy Service (HAS) provides free positioning service
- Open Service Navigation Message Authentication (OSNMA) ensures the authenticity of navigation data
- Commercial Authentication Service (CAS) supports accurate positioning





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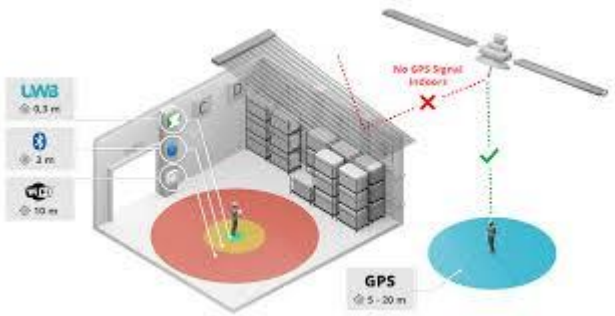
Types of Positioning

- According to the location, positioning systems are classified into:
  - Indoor positioning
  - Outdoor positioning and
  - Seamless/Hybrid positioning
- Indoor positioning system is to locate and track an object within buildings or closed environment.
- Outdoor positioning system is to locate and track an object outside buildings or open environment.
- The hybrid positioning system is to locate and track an object from inside-outside-inside environment.



Applications of Indoor Positioning

The complex indoor environments include:

- Airport halls,
- Exhibition halls,
- Warehouses,
- Shop-floor,
- Hospitals,
- Supermarkets,
- Libraries,
- Underground car parks and
- Other environments.

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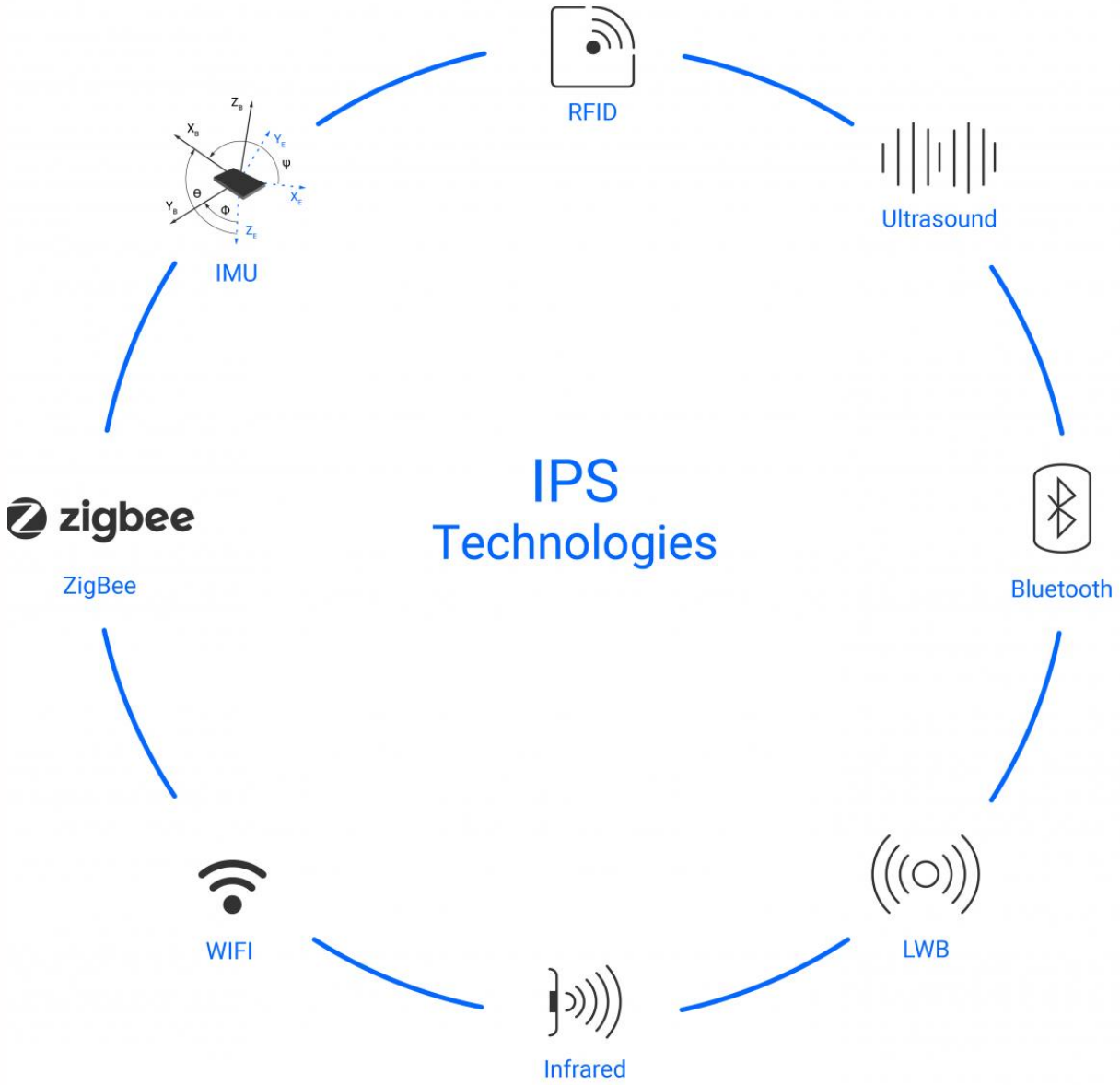
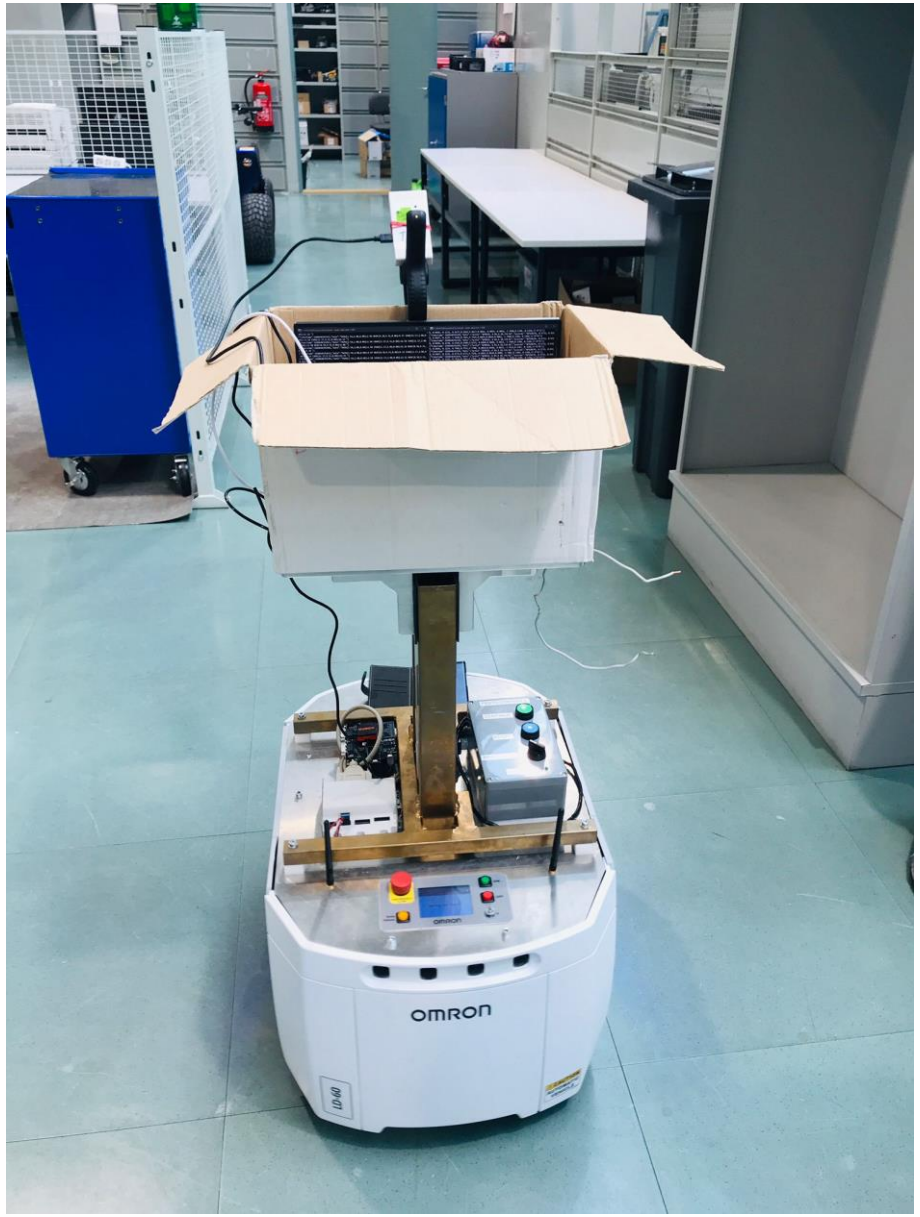
Tools Used for Indoor Positioning System

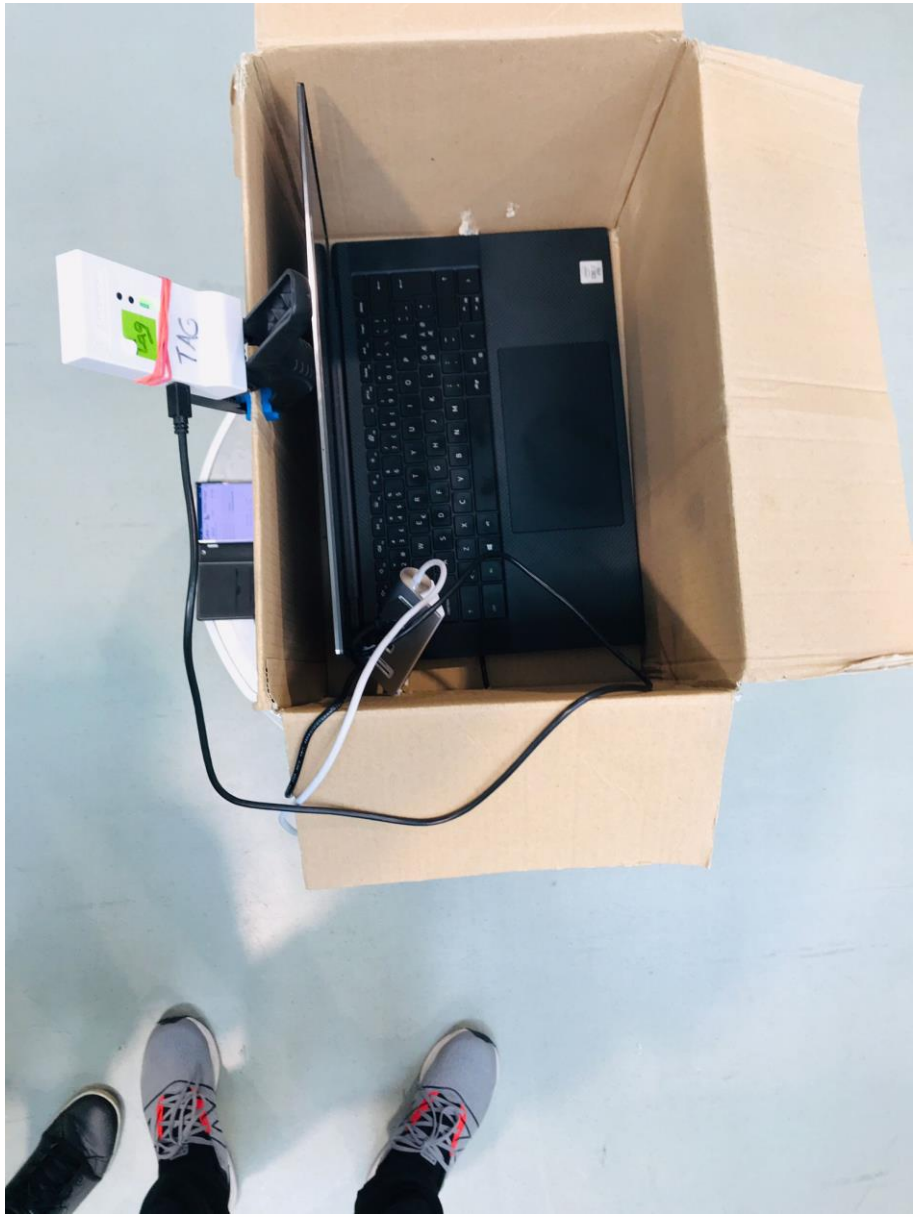


Various tools are used for positioning such as:

- Wireless local area network (WLAN),
- Radio frequency identification (RFID),
- Bluetooth low energy (BLE),
- Magnetic field positioning technology,
- ZigBee,
- Inertial Measurement Unit (IMU),
- Ultra Wide Band (UWB).
- Etc....

A Demo in an Indoor Positioning System (UWB)





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A Demo in an Indoor Positioning System(UWB)

A Demo in an Indoor Positioning System (UWB)

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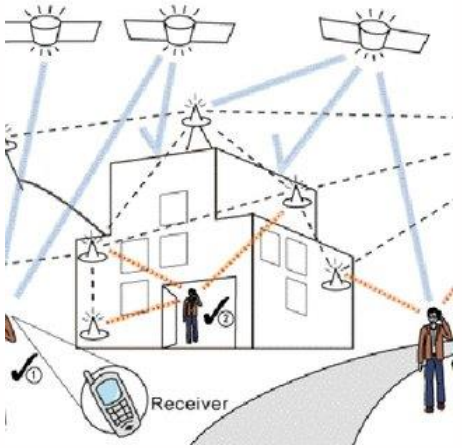
Applications of Outdoor Positioning

The complex outdoor environments include:

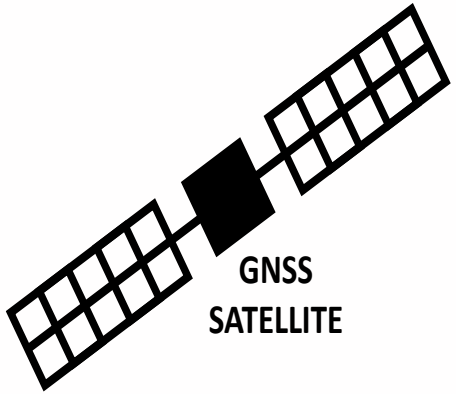
- Airports (e.g. ground workers, airplane),
- Ports,
- Transportations,
- Outdoor car parks and
- Military applications
- Other environments.

Outdoor Positioning by GNSS

- GNSS-based positioning
  - It is well known that GNSS is widely used satellite-based positioning system
  - It provides location-based services, such as navigation, tourism and so on.
  - It is not suitable in indoor positioning due to a variety of obstacles.
  - It provides outdoor navigation
  - Apply different forms (Assisted GNSS, HAS, CAS, etc.)

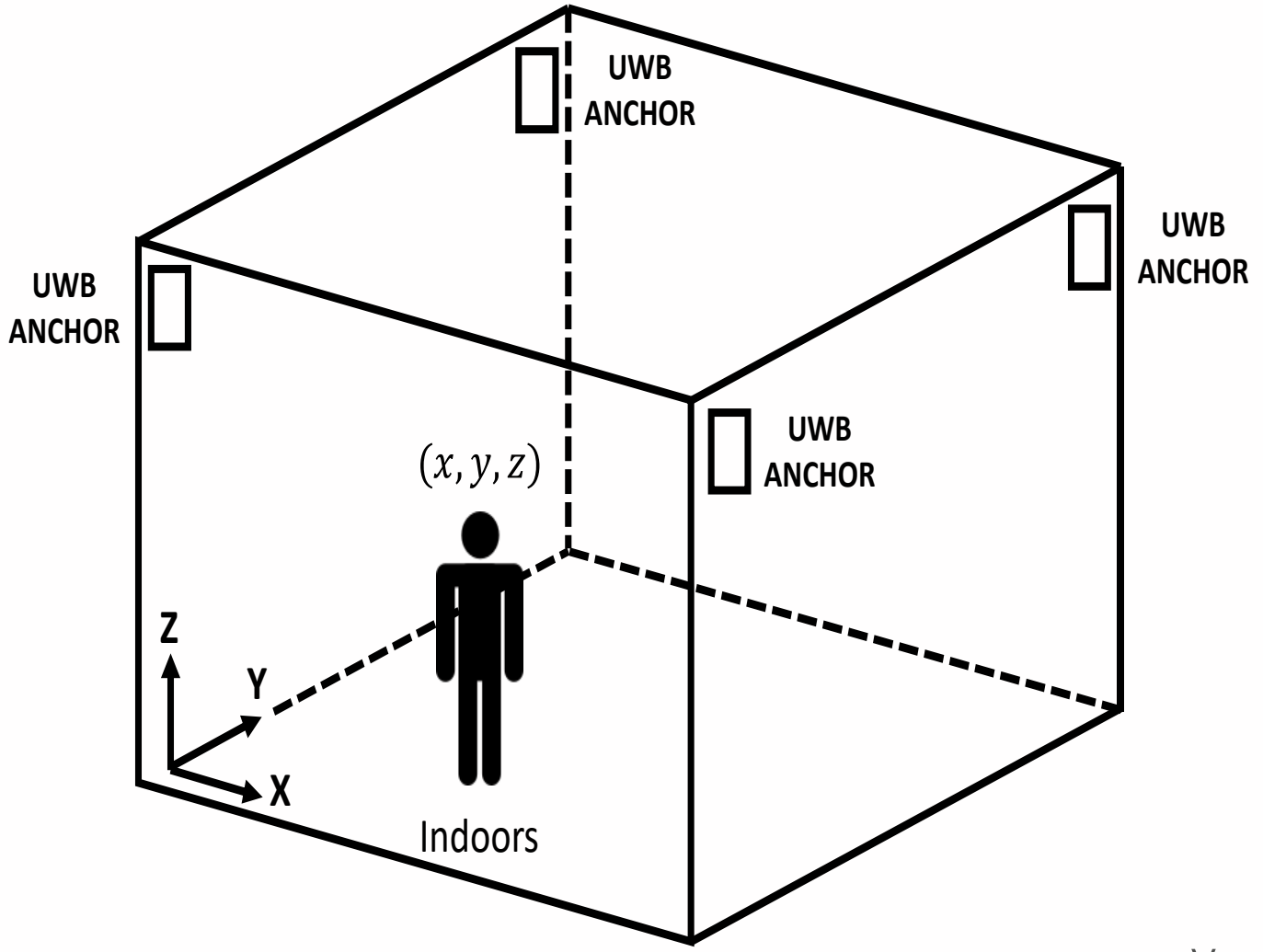


Seamless/Hybrid Positioning & Tools



(lat, lon, alt)

Outdoors



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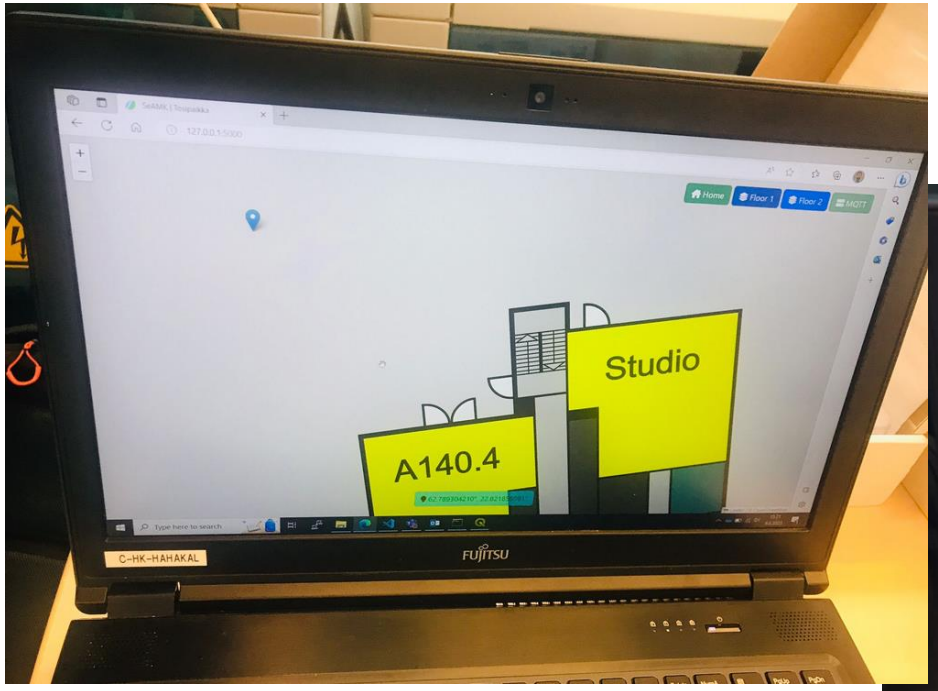
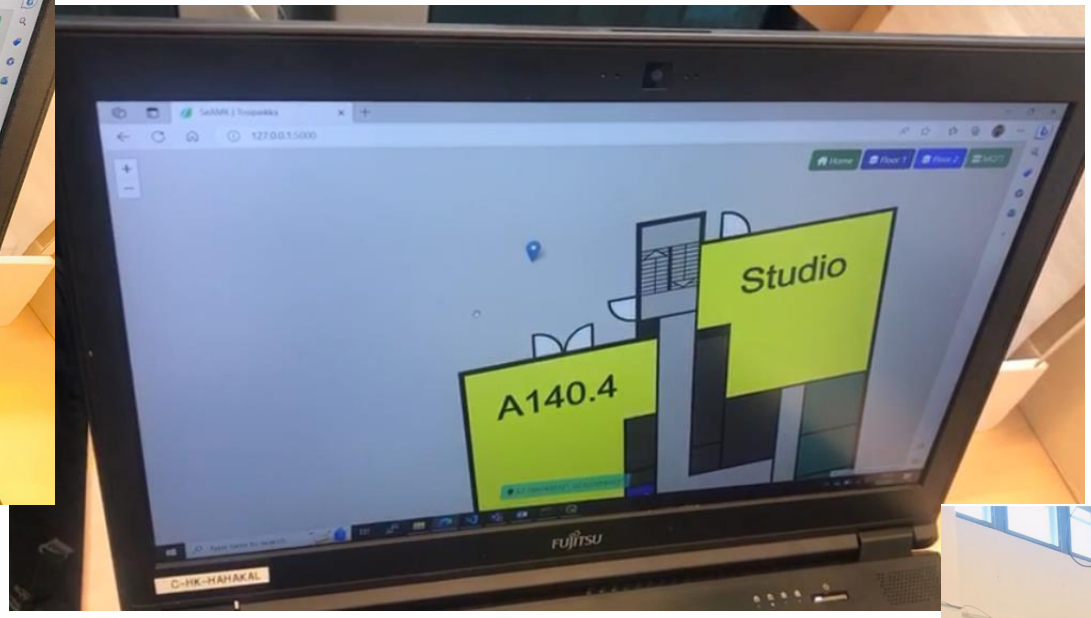
A Demo of Hybrid Positioning System (UWB+GNSS)





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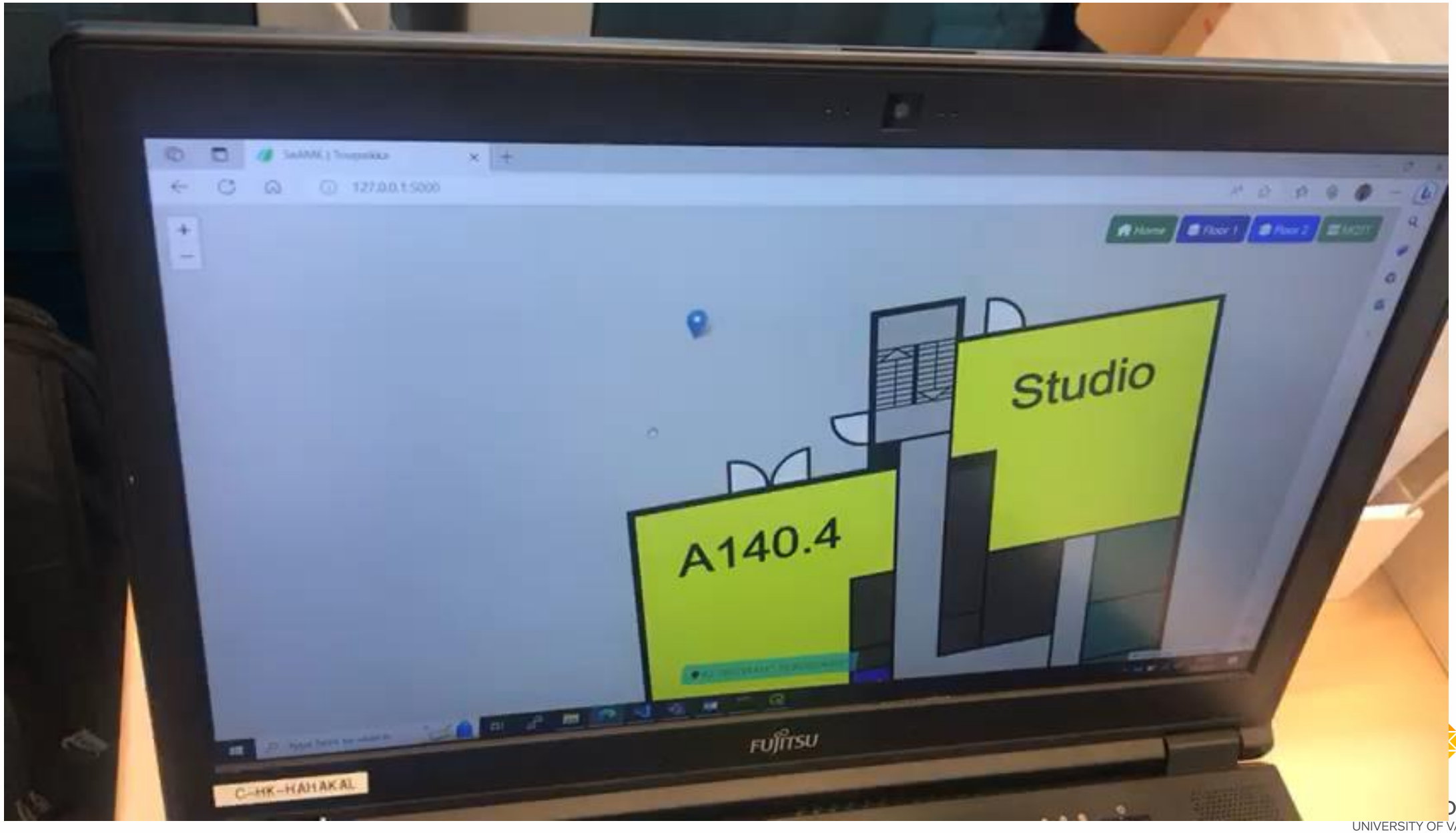
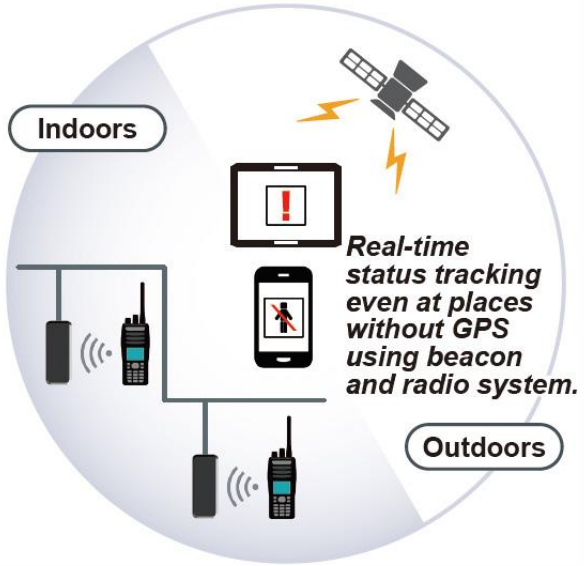
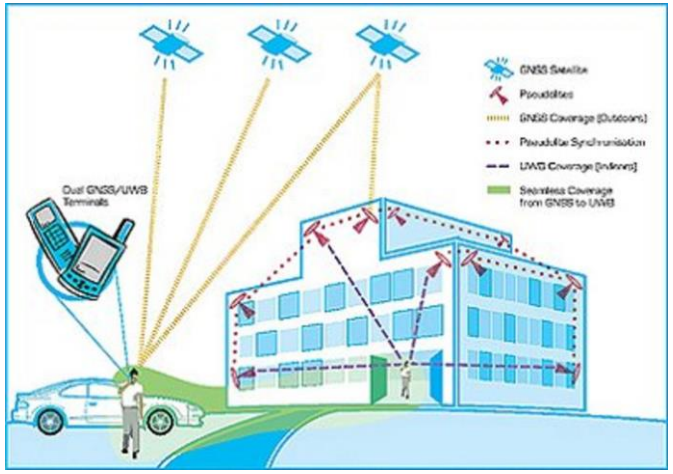


Needs of Positioning for Logistics Companies

- Integration to robot navigation system
- Affordable, easy to deploy RTLS (real time location system) for lift trucks & warehouse workers
- New radio-based (supportive) position for AGVs
- Traceability of transports
- Improving intralogistics efficiency and optimization
- Error case reduction
- Safety in work
- RTLS based collision avoidance
- Improve reliability and availability
- Reduction of lead-time and cost

Seamless/Hybrid Positioning & Tools





- Hybrid positioning deals with the combination of indoor and outdoor environments
- For instance, logistics items may need to track both inside to outside or vice-versa
- It needs to combine both indoor and outdoor positioning tools (e.g. UWB+GNSS)

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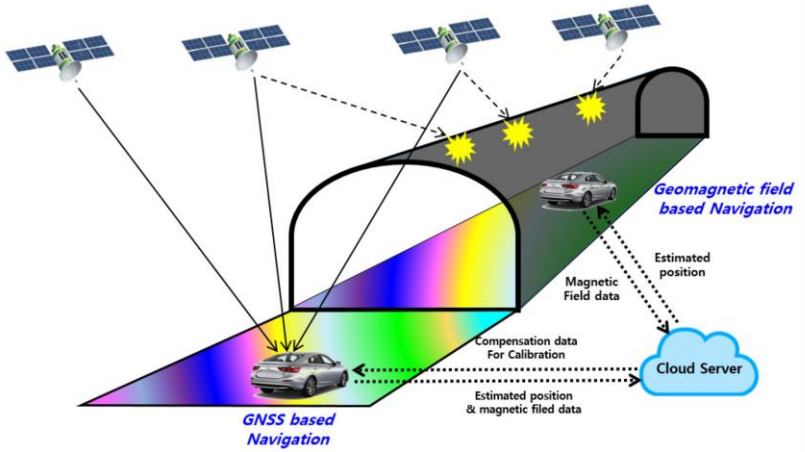
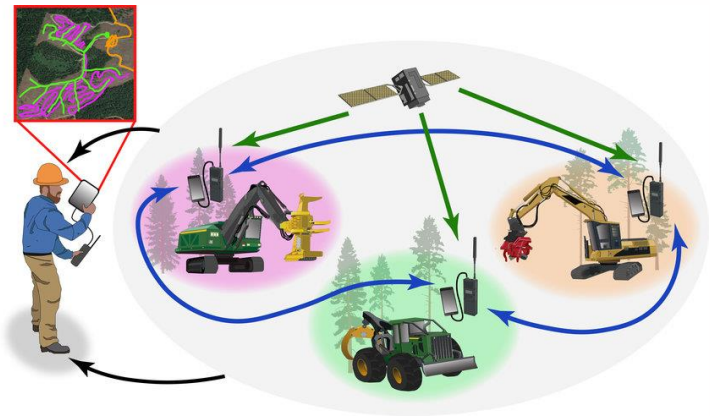
Indoor Positioning for Smart Logistics/Warehouse

- Smart logistics offer automation, visualization, control, and to improve the resource utilization rate (Zhang, 2015).
- In addition, absolute positioning devices/technologies can also support to know the accurate location of all logistics items.
- Smart warehouse uses:
  - Intelligent pile technology with automatic control technology,
  - Intelligent robot palletizing technology, etc. (Xin et al., 2016).
  - It offers timely and accurately grasp of the inventory of the enterprise real data.

Conclusions

- The demand and growth of both indoor and outdoor positioning have increased rapidly in the past few years.
- Ultra wideband (UWB) technology has emerged as a viable candidate for precise indoor positioning due its unique characteristics.
- GNSS are used to provide location-based services in outdoor environments.





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