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
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
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)
Basic Elements & Functionalities of Smart SC

**Supplier**
- Supply chain data services
- Flexible operations footprint
- Real-time communication

**Smart Transportation**
- Items traceability
- Location tracking
- Environmental monitoring
- Real-time routing

**Order processing**
- Operations control
- Autonomous resource planning
- Economy of scale

**Smart Warehousing**
- Indoor tracking
- Congestion avoidance
- Autonomous inventory
- Positioning of items

**Customer**
- Real-time item tracking
- Routes planning
- Autonomous inspection

- Proof of delivery
- Shipment tracing
- Payment
- Real-time feedback

(Elsanhoury et al. 2022)
Inventory Flow in a Generic SC

(Elsanhoury et al. 2022)
Requirements of Positioning in Supply Chain & Logistics

➢ Traceability (indoor/outdoor positioning)
➢ Tamper-proof authentication
➢ Tracking/position authentication
➢ Security (privacy/encryption)
➢ Real-time visibility
➢ SC condition monitoring
➢ Safety on critical items
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
  ➢ Satellite radio to measure quality
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.
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.
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
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.
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)
A Demo in an Indoor Positioning System (UWB)
A Demo in an Indoor Positioning System (UWB)
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

(x, y, z)

Indoors
A Demo of Hybrid Positioning System (UWB+GNSS)
A Demo of Hybrid Positioning System (UWB+GNSS)
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).
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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THANKS A LOT!

QUESTIONS/COMMENTS ARE HIGHLY APPRECIATED

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