SINTRA AIPick

Millimeter-Precise Asset Tracking for the Smart Factory

WHITEPAPER

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CONTENT

1. EXECUTIVE SUMMARY

The digitalization of industrial value creation is progressing rapidly. Production and logistics processes are becoming increasingly interconnected, regulations demand complete transparency, and companies are under intense cost pressure. Precise localization of goods, tools, and assets plays a key role in this.

But reality shows that **existing radio-based positioning technologies are reaching their limits**. Whether RFID, Bluetooth Low Energy (BLE), Wi-Fi, or Ultra Wideband (UWB) – all approaches suffer from fundamental limitations: insufficient accuracy, high hardware costs, energy problems, or low update frequencies. For many applications where centimeter- or even millimeter-level precision is essential, they are simply inadequate.

With **SINTRA AIPick,** SINFOSY digital GmbH presents a completely new approach: the combination of **optical trackers and standard cameras** (smartphones) for highly precise real-time positioning. Thanks to innovative algorithms, the center point of each tracker is recorded with pixel precision and integrated into the digital factory layout. The result: submillimeter precision **at a distance of 2 meters**, five position measurements per second – all using commercially available, cost-effective hardware.

Particularly important: **data protection compliance**. Since only tracker IDs and timestamps are recorded, without any personal characteristics, SINTRA AIPick fully complies with GDPR requirements.

For companies, this means **a solution that is simultaneously more precise, more cost-effective, and more regulatory-compliant than any existing wireless technology. SINTRA AIPick sets new standards for smart factories, intralogistics, quality assurance, and sustainability – and lays the foundation for** meeting the increasing demands of the new **Packaging and Packaging Waste Regulation (PPWR) and other legal requirements.**

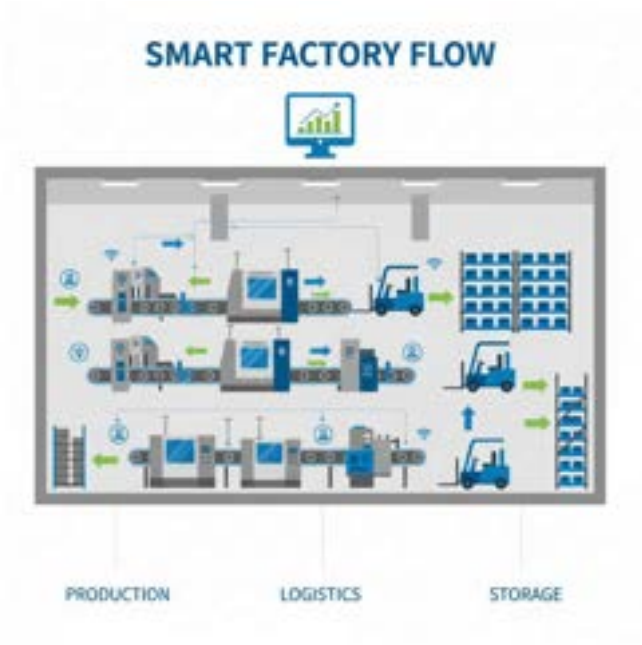
Comparison table of localization technologies

Techno-logy	Accuracy	Update frequency	Costs (Infrastructure)	Energy Demand Tracker	Specialities Disadvantages
RFID (passive)	1–5 m (roughly)	Event-depen-dent	Low	No battery	No continous tracking only detection
BLE Beacons	0,3–3 m	1–2 Hz	Medium	Battery, years	Strong fluctuation due to interferences
Wi-Fi	5–15 m	1–2 Hz	Low (existing WiFi)	Battery, hours/days	Inaccurate, unsuitable for in-door tracking
UWB	10–30 cm	Approx. every 10 sec	High (anchor + PPPoE + tags)	Battery, weeks/months	High costs, low frequency
SINTRA AIPick	<1 mm @ 2 m Dist.	Up to 5 Hz	Very low (smartphones and printed trackers)	No additional power source for trackers	Millimeter precise, GDPR compliant, 3D tracking

2. WHY PRECISE POSITIONING IS CRUCIAL

Industrial companies today face a double pressure to transform: on the one hand, digitalization and automation are driving the networking of processes; on the other hand, cost pressure, sustainability obligations, and regulatory requirements are increasing the demand for transparency in supply and production chains.

A key component in this context is the precise localization of assets —be they load carriers, tools, components, or finished products. Only those who know where each asset is at all times can efficiently manage processes, avoid bottlenecks, and meet compliance requirements.



2.1 Practical examples

- **Automotive industry:** Just-in-time manufacturing requires that every part is available on the assembly line at exactly the right time.
- **Pharmaceutical industry:** Strict traceability is required by law, especially for medicines that require refrigeration.
- **Food industry:** Cold chains must be continuously monitored and documented to ensure quality and safety.

2.2 The challenge

While "traditional" systems like barcodes or RFID only provide information at specific points ("seen/not seen"), modern production and logistics processes require **continuous, real-time tracking** . This is precisely where the weaknesses of existing technologies become apparent: They are either **inaccurate** , **expensive** , or **not scalable**

Without new approaches, the vision of a smart factory with real-time transparency remains incomplete.
This is where SINTRA AIPick comes in.

3. MARKET- AND REGULATORY ENVIRONMENT

The need for precise localization arises not only from internal efficiency considerations, but increasingly from **external conditions**. Markets are changing, and policymakers are tightening requirements for **sustainability, transparency, and documentation**.

3.1 Market trends

- **Efficiency and cost pressure** :
  Companies must optimize material flows, reduce lead times and avoid waste.
- **Globalization** : Longer supply chains require reliable tracking systems.
- **Digitalization** : Real-time data is a prerequisite for data-driven decisions, automation and the use of AI.

3.2 Regulatory drivers

- **PPWR (Packaging and Packaging Waste Regulation)** : A new EU regulation that requires transparency about packaging flows and monitors recycling rates. Precise tracking of packaging and load carriers is thus becoming a must.
- **Digital Product Passport (DPP)** : Introduction of a digital product passport for the traceability of product data throughout the entire life cycle.
- **Supply Chain Due Diligence Act** : Companies are obliged to create transparency and demonstrate risks along the entire supply chain.

3.3 Consequences

Regulatory requirements mean that **location technologies are no longer just "nice to have"** but are becoming a **strategic must.**

- Companies that invest early in this area secure competitive advantages through compliance, efficiency and customer transparency.
- Solutions that offer high precision at low cost will become the standard.

The market demands not only more precise, but also scalable and data protection-compliant solutions.

➔ This is exactly where SINTRA AIPick comes in.

4. OVERVIEW OF EXISTING TECHNOLOGIES

Over the past two decades, numerous localization technologies based on different physical principles have become established. They enable rough or medium-range positioning of objects, but all reach their limits when it comes to **centimeter- or millimeter-level precision**.

4.1 RFID (Radio Frequency Identification)

- **How it works:** RFID tags transmit a unique ID when activated by a reader. A distinction is made between passive (without battery) and active (with battery) systems.
- **Strengths:**
  - Proven technology, widely used.
  - Low costs for passive tags.
  - No maintenance for passive variants.
- **Weaknesses:**
  - No continuous tracking, but only point-based detection (“seen / not seen”).
  - Range strongly depends on environment and tag type.
- **Typical applications:** inventory management, access control, shipping records.

4.2 Bluetooth Low Energy (BLE) Beacons

- **How it works:** Small battery-operated transmitters (“beacons”) periodically send signals that are detected by receiving devices (gateways, smartphones).
- **Strengths:**
  - Relatively low infrastructure costs.
  - Standardized technology, compatible with common devices.
  - Battery life of years.
- **Weaknesses:**
  - Accuracy varies in the meter range.
  - Susceptible to interference from reflections, metal, and machines.
  - High density of beacons necessary for more granular resolution.
- **Typical applications:** material tracking, indoor navigation, visitor tracking, retail marketing.

4.3 Wi-Fi Tracking

- **How it works:** Positioning by measuring signal strengths or propagation times between access points.
- **Strengths:**
  - Use of existing WLAN infrastructure.
  - Low barrier to entry.
- **Weaknesses:**
  - Very low accuracy (5–15 meters).
  - High dependence on environmental conditions.
- **Typical fields of application:** Rough location determination of devices and area monitoring.

4.4 Ultra Wideband (UWB)

- **How it works:** Position determination through precise measurement of signal propagation times between transmitters (tags) and several receivers (anchors).
- **Strengths:**
  - High accuracy in the decimeter range.
  - Suitable for dynamic applications.
- **Weaknesses:**
  - High costs for infrastructure and tags.
  - Battery life is limited, especially at higher measurement frequencies.
  - Typical sampling rates are 1/10 per second – too slow for real-time applications.
- **Typical areas of application:** logistics hubs, asset tracking in high-end industrial applications.

4.5 Sattelite based Systems (GPS, Galileo)

- **How it works:** Location via signals from satellite constellations.
- **Strengths:**
  - Worldwide availability.
  - Good accuracy outdoors (up to 1 meter).
- **Weaknesses:**
  - Not usable indoors.
  - High energy consumption.
- **Typical applications:** transport, fleet management, outdoor tracking.

While RFID, BLE, and Wi-Fi are suitable for simple applications with low precision requirements, and UWB delivers higher accuracy in certain areas, no technology exists that operates continuously, cost-effectively, and with millimeter precision in real time .

➔ SINTRA AIPick closes precisely this gap.

4.6 Comparison of Technologies

Technology	accuracy	Frequency Update	Infrastructure costs	Energy Demand Trackers	Typical Limitations
RFID (passive)	1–5 m (spot)	Only on scan event	Low	No battery	No continous tracking
BLE Beacons	0,2–3 m	1–2 Hz	Medium	Battery months-years	Fluctuating prone to failure
Wi-Fi	5–15 m	1–2 Hz	low (WIFI available)	High hours-days	Inaccurate, only roughly usable
UWB	10–30 cm	every 1–10 s	High (anchor + PPPoE + tags)	Battery weeks - months	Expensive energy-intensive
GPS / Galileo	1–5 m outdoor	1 Hz	No additional costs	Very high	Unusable Indoors

5. TECHNOLOGICAL LIMITATIONS OF RADIO-BASED SOLUTIONS

Current positioning technologies are predominantly based on radio transmission – whether RFID, Bluetooth, Wi-Fi, or Ultra Wideband. These systems have advanced industrial digitalization in recent years, but they encounter **fundamental physical limitations when it comes to higher precision requirements**.

5.1 Multipath effects and interference

Radio signals do not propagate linearly in industrial environments. Metal walls, machines, or moving objects create **reflections and interference** that distort the signal. Even the smallest deviations in the signal phase lead to errors in the centimeter or meter range – a problem that cannot be completely eliminated physically.

5.2 Energy consumption and battery life

The more precisely and frequently a radio signal needs to be measured, the more energy is required.

- **Example UWB** : Although this technology promises centimeter-level accuracy, the battery life of the tags drops drastically with short transmission intervals.
- To save energy, measurement intervals are limited to 1/10 seconds – unusable for **dynamic processes** such as material flow control or robotics.
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5.3 Scaling problems and costs

Radio-based systems require extensive infrastructure:

- With UWB, many anchor stations are needed to cover large areas.
- BLE networks require high device density to increase accuracy.
- Each additional component incurs **hardware, maintenance and calibration costs** .

The result: As the area size increases, the effort increases exponentially –thus the profitability decreases.

5.4 Limited accuracy

Even under optimal conditions, radio-based technologies **do not achieve millimeter or sub-millimeter accuracy** .

- **UWB** : decimeters to a few centimeters.
- **BLE** : Fluctuations up to the meter range.
- **RFID / Wi-Fi** : far beyond.

These technologies are therefore unsuitable for applications such as **precise positioning of tools, manufacturing in tolerance ranges below 1 mm or monitoring sensitive processes.**

The limitations are not just technical, but inherent in the system . Radio technologies encounter physical barriers that cannot be completely overcome even with better hardware or algorithms.

This makes it clear: The next generation of industrial positioning requires new approaches – beyond the classic radio paradigm.

➔ This is precisely where SINTRA AIPick comes in with optical precision.

6. SINTRA AIPICK

With **SINTRA AIPick,** SINFOSY digital GmbH presents a novel approach to **high-precision asset location** that, for the first time, combines the advantages of **optical detection** and **cost-effective standard hardware** .

Instead of relying on energy-intensive radio signals, SINTRA AIPick uses trackers with a clearly defined pattern and **cameras from standard smartphones** that are mounted on ceilings or walls in production or logistics environments. **Intelligent algorithms** determine the tracker's center point in **real time** and integrate it into the **digital factory layout** – with a level of accuracy previously unattainable.

6.1 How it works

1. **Optical Tracker** : Each load carrier or asset to be located receives a marker (tracker) with a defined geometry.
2. **Camera capture** : A smartphone continuously captures images of the surroundings.
3. **Algorithmic processing** : The exact position and orientation of the tracker in the camera image is calculated in real time on the smartphone.
4. **Integration into the layout** : By calibrating the camera in the room, the relative position of the tracker is transferred into the digital factory or warehouse layout.
5. **3D determination :** Since the size of the tracker is constant, the distance to the camera can also be determined - this allows not only the horizontal position but also the **height (Z-axis)** to be determined precisely (up to mm accuracy - depending on the distance).

6.2 Technical advantages

- **Millimeter precision** : Less than 1 mm accuracy at a distance of 2 m.
- **High frequency** : Up to 5 position measurements per second (5 Hz) – continuous real-time positioning.
- **Cost efficiency** : Use of commercially available smartphones as camera units, no expensive special hardware required.
- **Scalability** : Expansion with additional smartphones possible; infrastructure grows modularly with requirements.
- **GDPR compliance** : Only trackers, timestamps and camera position are processed – **no biometric or personal data** .

6.3 Data protection as a design principle

A key advantage of SINTRA AIPick is its complete **data protection compliance**.

- Cameras are designed exclusively for the trackers and ignore other image content.
- People, faces or other characteristics are neither recognized nor stored.
- Only **the tracker ID, timestamp, and camera position are transmitted**. This means the solution already meets the requirements of the **GDPR** and offers companies security when integrating it into sensitive environments.

6.4 Uniqueness

While wireless technologies are reaching their physical limits, SINTRA AIPick combines:

- **Millimeter precision** with **high frequency** ,
- **easy integration** with **low costs** ,
- and **real-time transparency** with **full GDPR compliance** .

SINTRA AIPick sets a new standard for industrial tracking – and opens up possibilities for companies that were previously technically and economically unattainable.With **SINTRA AIPick,** SINFOSY digital GmbH presents a novel approach to high-precision asset location that, for the first time, combines the advantages of **optical detection** and **cost-effective standard hardware** .

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6.5 System overview & Accuracy

The performance of **SINTRA AIPick** can be illustrated by the measurement accuracies achieved as a function of distance and scan area:

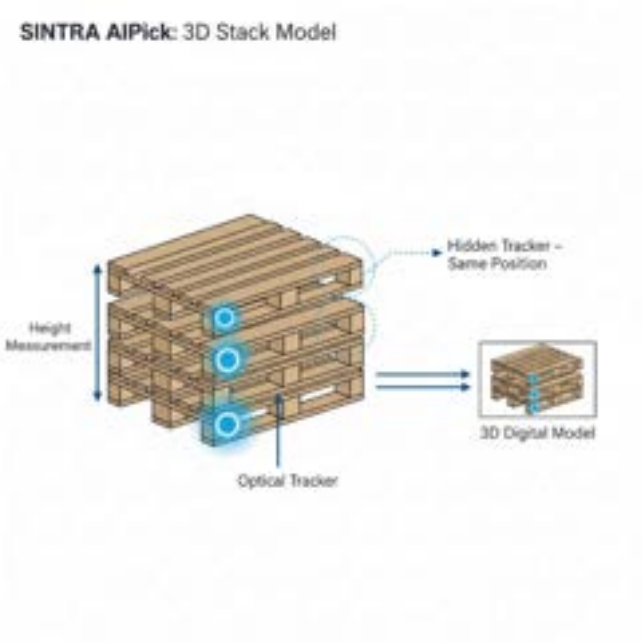
Distance [m]	Scanning area [~m²]	Accuracy
3	12 (3 x 4 m)	Ca. 1 mm
4,7	28 (4,7 x 6,2 m)	Ca. 1-2 mm
8 m	80 (8 x 10 m)	< 5 mm
26 m	845 (26 x 32,5 m)	Ca. 20 mm

Interpretation of the values:

- Even at **greater distances,** the accuracy remains in the millimeter to sub-centimeter range – a level that is unattainable with radio technologies.
- The **maximum distance** depends on the size of the optical tracker used (e.g. A5 or A4) and the resolution used.
- the **exact determination of X/Y coordinates** enables continuous positioning in two-dimensional space.
- **height (Z-axis)** can also be determined using the number of pixels of the tracker in the camera image.
- The only requirement is a **clear line of sight to the optical trackers** – which is easy to implement in most industrial scenarios.

6.6 Dealing with covert Trackern (stacking-scenarios)

In warehouse and production environments, it's common for **pallets, containers, or crates** to be stacked on top of each other. This creates the challenge of a tracker mounted on the lower unit being obscured by a unit placed above it.



Challenge

- Hidden trackers are no longer visible to the camera.
- Without additional logic, the impression could arise that the hidden charge carrier has disappeared.
- For complete traceability, even hidden objects must remain clearly identifiable.

Solutions with SINTRA AIPick

1. **Temporal stability**
   - Trackers that have not moved remain valid with their last position.
   - If a new tracker is detected directly above it, the system interprets: *“The object below is still present and unchanged.”*
2. **3D elevation information**
   - The height of the newly recorded tracker is determined by the pixel size in the image.
   - This allows a **vertical relationship** to be established between the objects (*“Object B is 1 m above Object A”*).
3. **Multi-layer model**
   - **3D stack model** is built from the data : even if a tracker is obscured, it remains logically part of the recorded structure.
   - As soon as the upper object is removed, the hidden tracker becomes visible again and the position is updated.
4. **Redundancy & process integration**
   - Additional camera perspectives (e.g. from the side) can reduce occlusions.
   - In addition, stacking events (e.g. from the warehouse management system or forklift sensors) can be automatically correlated with the AIPick data.

Result

The combination of **temporal resolution, 3D height measurement, logical stack modeling, and optional redundancy ensures complete transparency** even in complex stacking situations . Companies can rest assured that **no load carrier will "disappear" from the digital image** simply because it is physically obscured.

Mit diesem Ansatz deckt SINTRA AIPick große Flächen mit hoher Präzision ab und bietet Unternehmen die Möglichkeit, sowohl auf engem Raum (z. B. Fertigungszellen), als auch in weiträumigen Lagerhallen präzise Ortungslösungen einzusetzen

➔ **Ohne teure Spezialhardware und ohne die Limitierungen funkbasierter Systeme**.

7. USE CASES

The strengths of **SINTRA AIPick** are particularly evident where traditional radio-based systems reach their limits: in dynamic, precision-critical, and regulatory-demanding environments. Exemplary practical application scenarios are presented below.

7.1 Intralogistics: Real-time tracking of load carriers

In modern logistics centers, thousands of containers, pallets, and trolleys must be moved and managed simultaneously. Errors in allocation or delays in delivery lead to significant costs.

Challenge

UWB or BLE provide a rough position, but are either too expensive or not precise enough to clearly identify objects on a shelf, aisle or storage space.

Solution with SINTRA AIPick

- Cameras on ceilings or walls monitor parking spaces.
- Each load carrier carries an optical tracker (A4 or A5).
- Positions are recorded in real time with millimeter accuracy.

Advantage

- Misloading and search times are eliminated
- Each load carrier carries an optical tracker
- Positions are recorded in real time with millimeter accuracy

7.2 Production: Precise positioing of tools and components

In manufacturing processes, a fraction of a millimeter often determines quality or rejection.

Challenge

Radio-based systems deliver centimeter-level accuracy at best – too inaccurate for precision mechanical or automated work steps.

Solution with SINTRA AIPick

- Optical trackers on components or tools.

- Millimeter-precise localization directly on the assembly line.

Advantages

- Tools can be positioned precisely
- Robots can work with precision
- Waste is reduced
- Rework is eliminated

7.3 Quality assurance: Continuous process monitoring

Industrial companies are increasingly required to prove that products have been manufactured according to specifications.

Challenge

Previous tracking systems only record objects selectively – continuous process documentation is hardly possible.

Solution with SINTRA AIPick

- Permanent tracking of components throughout the entire manufacturing process.
- Storage of position, timestamp and production step

Advantages

- Auditable quality control
- Faster root cause analysis of errors
- Compliance with regulatory requirements

7.4 Sustainability & Compliance: Packaging and Circular Economy

With the new **Packaging and Packaging Waste Regulation (PPWR)** and other EU requirements, the traceability of packaging is becoming a central issue.

Challenge

Companies must demonstrate recycling quotas and document material flows – hardly feasible with current systems

Solution with SINTRA AIPick

- Precise tracking of packaging and containers throughout their entire life cycle.
- Integration into digital product passports (DPP).

Advantages:

Companies comply with regulatory requirements, avoid fines, and can support sustainability reports with reliable data.

7.5 Pharmaceuticals & Medical Technology: Ensuring temperature and hygiene chains

In the pharmaceutical and medical technology industries, particularly strict regulations apply to product safety, hygiene, and traceability . Even the smallest deviations in temperature or handling can lead to loss of quality, production downtime, or recalls.

Challenge

- **Temperature and hygiene chains** must be fully documented.
- Movements of materials in **cleanrooms** may only occur along clearly defined process paths.
- Authorities (e.g. EMA, FDA) require **auditable evidence** of transport, storage and processing.

Solution with SINTRA AIPick

- **Continuous positioning data** : Each asset (e.g. refrigerated container, batch of medication, sterile instrument) receives an optical tracker that is continuously located.
- **Combined with sensors** : Temperature and hygiene sensors provide the ambient values; AIPick adds the **exact location and timestamp** . This creates complete proof: *"Container X was in the cold storage room at 3.8 °C at 12:04 p.m."*
- **Millimeter-precise movement monitoring** : In cleanrooms, this ensures that assets remain precisely within the permitted ranges. Deviations from the defined process path are immediately detected.
- **Data protection and GMP compliance** : Data collection occurs exclusively at the tracker level, without any personal characteristics. This solution complies with GDPR and pharmaceutical quality standards (GMP, GDP).

Advantages

- Demonstrable compliance with regulatory requirements.
- Reducing the risk of recalls or batch failures.
- Faster root cause analysis of deviations.
- Greater process reliability in highly sensitive production environments.

7.6 Automotive: Documentation of complex assembly processes with submillimeter precision

The automotive industry is considered a pioneer of Industry 4.0. At the same time, its production processes are among the most complex and demanding in the world. Each vehicle body consists of several thousand individual parts, which are assembled on highly synchronized lines.

Challenge

- **Just-in-sequence** manufacturing: Parts must not only be delivered and assembled on time, but also in the exact sequence.
- Even the smallest deviations in **the millimeter range** can lead to assembly errors, quality losses or production stoppages.
- Documenting these precision processes is essential for regulatory and liability reasons.

Solution with SINTRA AIPick

- Optical trackers on components, tools and fixtures enable **continuous, sub-millimeter-precise recording** of each work step.
- Cameras monitor the assembly areas and precisely document the position, sequence and timing of each assembly step.
- All data is stored in real time with a timestamp and integrated into the production system.

Advantages

- **Complete traceability** of every assembly step – valuable for quality assurance and documentation requirements.
- **Reduce scrap and rework** through immediate detection of deviations.
- **Support for collaborative robotics** : Robot arms can work safely with humans using precise positioning data.

7.7 Warehouses & Distribution Centers: Dynamic Space Planning through Real-Time Data

Warehouse and distribution centers face the challenge of dealing with increasing quantities of goods, short delivery times, and increasing product variety.
Traditional, rigid space planning is reaching its limits here.

Challenge

- Space must be used flexibly to accommodate fluctuating flows of goods.
- Inefficient processes often arise due to unclear positioning of pallets, roll containers or transport trolleys.
- Existing positioning technologies are too imprecise to reliably control dynamic space planning.

Solution with SINTRA AIPick

- Cameras at strategic points (e.g. hall ceilings) monitor the entire storage area.
- Each load carrier is equipped with an optical tracker and is **located with millimeter precision in real time** .
- The data can be used to create **digital area maps** that accurately depict the current occupancy.
- **optimized storage strategies** based on this data.

Advantages

- **Transparent real-time overview** of the entire warehouse occupancy.
- **Dynamic space planning** : Spaces can be flexibly adapted to changing flows of goods.
- **Avoid search and idle times** by precisely locating each asset.
- **Cost reduction** through more efficient use of existing storage capacity

The use cases demonstrate that SINTRA AIPick is not a niche solution, but a universally applicable system for all industries where precision, efficiency, and compliance are crucial.

➔ From manufacturing to logistics to sustainability, the technology delivers concrete added value in real time

7.8 Overview of Use Cases

Industry / Sector	Challenge	AIPick-Solution	Advantages
Intralogistics	Fehlverladungen, Suchzeiten, unklare Bestände	Millimetergenaue Echtzeit-Lokalisierung von Ladungsträgern	Schnellere Materialflüsse, keine Fehlverladungen, transparente Bestände
Production	Ungenauigkeit bei Werkzeug- & Bauteilpositionen	Präzises Tracking von Bauteilen und Werkzeugen an Montagelinien	Ausschussreduktion, exakte Fertigung, höhere Prozesssicherheit
Quality assurance	Fehlende kontinuierliche Prozessdokumentation	Permanente Verfolgung von Assets mit Zeitstempel	Auditierbare Nachweise, Ursachenanalyse, regulatorische Sicherheit
Sustainability & Compliance (PPWR)	Nachweis von Recycling- und Verpackungsströmen	Verfolgung von Verpackungen/Behältern inkl. Integration in DPP	Erfüllung regulatorischer Vorgaben, Nachhaltigkeitsberichte mit belastbaren Daten
Pharma & Med Tech	Sicherstellung von Temperatur- & Hygieneketten	Kombination von Tracker-Lokalisierung + Umweltsensorik	Vollständige Nachweise (GMP/GDP), weniger Rückrufe, höhere Patientensicherheit
Automotive	Komplexe Montageprozesse, hohe Präzision nötig	Submillimetergenaues Tracking von Bauteilen und Arbeitsschritten	Lückenlose Dokumentation, weniger Fehler, Unterstützung kollaborativer Robotik
Warehouse & Distribution	Unklare Belegung, ineffiziente Flächenplanung	Echtzeit-Tracking aller Assets + Erstellung digitaler Flächenkarten	Dynamische Flächenplanung, reduzierte Suchzeiten, bessere Auslastung

8. COMPETITIVE COMPARISON & DIFFERENTIATION

The market for location technologies is diverse – but none of the established solutions combines **precision, frequency, cost and energy efficiency** , and **data protection compliance** in a single system.

8.1 Status Quo of competitors

- **RFID**: established, inexpensive, but only spot detection, no continuous tracking.
- **Bluetooth Low Energy (BLE)**: cheap and simple, but inaccurate (meter range) and susceptible to interference.
- **Wi-Fi tracking**: usable with existing infrastructure, but unsuitable for precise applications.
- **Ultra Wideband (UWB)**: comparatively precise (decimeters), but expensive and with limited frequency (typically every 5–10 seconds) due to high energy requirements.

All systems fail on at least one of the following points:

- **Accuracy** (not sufficient for Industry 4.0 applications).
- **Frequency** (too slow for real-time processes).
- **Costs & scalability** (expensive infrastructure, high maintenance costs).
- **Data protection** (potentially critical, e.g. for camera-based solutions without a focus on GDPR)

8.2 Positioning of SINTRA AIPick

With its optical methodology, SINTRA AIPick breaks with the limitations of radio-based systems and offers:

- **Submillimeter precision** .
- **High update frequency** of up to 5 Hz (five position measurements per second).
- **Cost efficiency** through the use of commercially available smartphones as cameras.
- **Scalability** through modular expansion with additional cameras.
- **Varying accuracy in areas due to smaller distances between camera and tracker**
- **GDPR compliance** : no collection of personal data.

8.3 Comparison matrix

Criterion	RFID	BLE	Wi-Fi	UWB	SINTRA AIPick
Accuracy	1–5 m	0,3–3 m	5–15 m	10–30 cm	**< 1 mm**
Update frequency	Only when scanning	1–2 Hz	1–2 Hz	1/5–1/10 s	**Up to 5 Hz**
Infrastructure costs	low	medium	low (WLAN)	high	**low**
Energy demand	none (passive)	Battery years	high	battery, weeks-months	**No additional energy**
Scalability	limited	medium	limited	limited (expensive)	**high, modular**
Data protection	uncritical	uncritical	uncritical	uncritical	**GDPR-compliant (no personal characteristics)**

8.4 Differentiation in practice

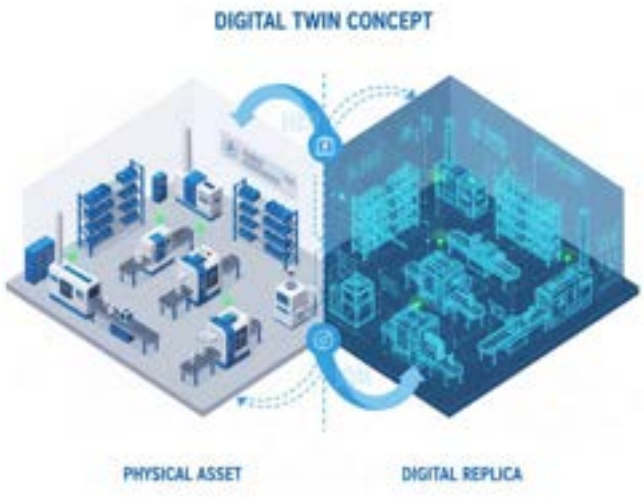
- **Precision:** While UWB works in centimeters, SINTRA AIPick achieves **sub-1 mm accuracy** – crucial for manufacturing, pharmaceuticals and automotive.
- **Costs:** Where UWB infrastructure often requires six- to seven-figure sums, AIPick only requires **smartphones on the ceiling or wall**.
- **Frequency:** RFID and BLE are suitable for static scenarios – AIPick provides **real-time tracking for dynamic processes**.
- **Data protection:** Unlike traditional camera-based solutions, AIPick does not establish any personal reference – a clear advantage for GDPR-sensitive industries.

SINTRA AIPick creates a new technology category : high-end systems as precise as optical ones, more affordable and flexible than radio technologies—and yet fully compliant with data protection regulations.

➔ AIPick thus sets **new standards** for industrial positioning and clearly differentiates itself from all previous approaches.

9. OUTLOOK & ROADMAP

SINTRA **AIPick** represents a decisive breakthrough in precise, cost-effective, and privacy-compliant positioning. But the journey doesn't end here — **on the contrary**: The technology opens up a multitude of further development and integration opportunities that will be crucial for the industry in the coming years.



9.1 Integration with Artificial Intelligence

- **Anomaly detection:** AI algorithms can analyze movement patterns and automatically detect deviations from target processes (e.g., incorrect assembly sequence, inadmissible storage locations).
- **Forecasts & optimization:** By analyzing historical position data, **predictions for bottlenecks or disruptions can be** derived.
- **Adaptive systems:** Production and logistics processes can be adapted in real time based on AI analysis.

9.2 Digital Twin & Simulation

- The high-frequency, millimeter-precise data from AIPick can be used to create **digital images of entire factories or warehouses** (“digital twins”).
- These digital twins enable:
  - Simulating process changes before they are implemented in reality.
  - Optimization of material flows and area layouts.
  - Real-time visual monitoring for production managers and logistics managers.

9.3 Predictive Analytics & Maintenance

- In combination with sensor data (temperature, vibration, humidity), precise location data can be used to enable **proactive maintenance.**
- For example, if a tool is regularly detected in unusual positions, this could indicate wear or incorrect operation.

9.4 Smartphones as edge AI devices – the optimal hardware basis

A key advantage of **SINTRA AIPick** is the use of commercially available smartphones as **edge AI devices**. These not only function as cameras but also perform **intelligent data processing on-site**:

- **Edge processing:** The tracker position is calculated directly on the smartphone. Only the extracted **features (tracker ID, position, timestamp) are** transferred to the cloud – no image data or raw videos.
- **Decentralized intelligence:** Preprocessing at the edge of the network creates a highly scalable system that works efficiently even with large amounts of data.
- **Unbeatable IoT device:**
  - **Software updates** can be rolled out centrally.
  - **Battery buffering** enables operation even during power outages.
  - **Integrated connectivity** via GSM or Wi-Fi eliminates the need for additional hardware.

9.5 Roadmap SINFOSY digital GmbH

- **Short-term (0–12 months):** Scaling of pilot projects, expansion of industry applications (automotive, pharmaceuticals, logistics).
- **Medium-term (1–3 years):** Integration with AI systems, development of digital twin solutions for smart factories.
- **Long-term (3–5 years):** Development of a **cross-platform real-time location system** that integrates with ERP, MES and SCM systems – the basis for fully autonomous production and logistics environments.

This makes the smartphone the world's best available IoT device for industrial tracking : powerful, cost-effective, robust, and, thanks to global mass production, unbeatably affordable. There's no better hardware foundation for this task— and that's precisely why **SINTRA AIPick is so unique**.

10. CONCLUSION

Industrial value creation is facing a turning point: With increasing demands for **efficiency, transparency, and compliance,** traditional positioning technologies are no longer sufficient. Radio-based systems such as RFID, BLE, or UWB are reaching their limits – be it due to insufficient accuracy, high energy consumption, or prohibitive costs.

With **SINTRA AIPick,** SINFOSY digital GmbH sets a new standard:

- **Submillimeter precision** with high frequency (up to 5 Hz).
- **Use of commercially available smartphones** as edge AI devices – the world's most efficient IoT device for this task.
- **Cost efficiency and scalability**, as no expensive special hardware components are required.
- **Full GDPR compliance**, as only feature data and no personal information is processed.

This combination makes SINTRA AIPick the **only solution** that already meets the increasing regulatory requirements (e.g. PPWR, Digital Product Passport, Supply Chain Act) – and at the same time opens the way for companies to become **smart factories of the future**.

Why act now?

- Secure a competitive advantage: Companies that invest early in precise tracking benefit from faster processes, less waste, and increased transparency.
- Gain regulatory certainty: With AIPick, you are optimally prepared for upcoming requirements.
- Leverage scalability: Whether it's a single production line or an entire factory – AIPick grows with your requirements.

Your next step

👉 Experience the precision of SINTRA AIPick in practice:

- **Request a live demo.**
- **Start a pilot project** in your production or logistics environment.
- **Contact us** for an individual consultation.

SINFOSY digital GmbH – We make precision simple.

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