



WHITE PAPER

A Hybrid Architecture for Hospital-Wide
Location Intelligence



How SSL, BiLink, and Bluetooth AoA combine on a single platform to bring real-time location intelligence to hospitals and clinics, at the accuracy each department actually needs.



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1. Executive Summary

Hospitals are being squeezed from several directions at once: fewer nurses than they need, costs that keep climbing, more patients coming through the door, and a regulatory load that only gets heavier. Ask hospital leaders in Europe, the United States, or the Gulf what's missing, and the answer is usually the same: nobody can confidently say where a given pump, wheelchair, staff member, or patient is right now.

A handful of wireless technologies compete to close that gap. Passive RFID handles checkpoints well but says nothing about what happens between them. Wi-Fi can ride on the network infrastructure a hospital already owns, though how well it performs depends entirely on how that network was built. Ultra-wideband delivers excellent precision but asks for a correspondingly serious infrastructure investment. Zigbee turns up more often in sensor networks than in positioning systems.

Bluetooth Low Energy sits in a different spot. One tag family, one management platform, and three distinct ways to locate something: RSSI for broad zone visibility, BiLink for reliable room-level presence without wiring a gateway into every room, and Angle of Arrival for sub-meter precision in the handful of spaces that need it. That range, on a single technology, is what makes BLE workable as a foundation for a whole hospital rather than just one department.

The practical upshot is that a hospital can put its most expensive, highest-precision infrastructure only where the clinical case for it is real: the OR, the ICU, the pharmacy and cover everywhere else more cheaply, instead of choosing between one premium technology stretched across the whole building or a shelf of point solutions that don't talk to each other. What follows is the technical case for that approach, a candid look at the financial and operational trade-offs, and the governance, security, and deployment questions worth working through before committing to a rollout.

A note before the detail starts: anywhere this paper states a specific number, cost, or outcome, it's either tied to a named source in the References, described plainly as Sentrax's own product specification, or flagged as an illustrative example built from stated assumptions. Where we're describing a general pattern rather than a measured result, we say so.

2. Introduction - Why Location Intelligence Matters Today

A hospital runs on things that move. Infusion pumps, wheelchairs, portable monitors, and beds drift between wards, treatment rooms, storage, and service departments over the course of a single shift. The moment someone loses track of where a piece of equipment is, the response is almost always the same: a phone call, a walk down the hall, a search that eats into time that should be going to patients.

Location intelligence closes that gap. It gives a hospital one shared, current picture of where things are, how they're moving, and when they cross into or out of a defined area, and that same underlying data can support equipment visibility, staff safety, patient-movement tracking, and restricted-area alerts, provided the technology behind it actually suits a live clinical environment rather than a warehouse or an office building.

3. Regional Healthcare Market Context

Ask what's driving RTLS interest and the answer changes by region, even though the underlying pressures, workforce, cost, safety, and the demand for better visibility — show up almost everywhere.

Europe: workforce and resource efficiency. European systems are dealing with an aging population, thinner staffing, tight budgets, and some of the world's strictest data-protection rules. RTLS earns its place here by improving equipment visibility, staff productivity, and patient flow, without falling foul of GDPR governance requirements along the way. **Priorities:** efficiency, asset utilization, staff productivity, patient flow, and GDPR-aligned governance.

United States: cost, capacity, and safety. In the US, the conversation tends to focus more on the bottom line: lower operating costs, more capacity, less money leaking out through lost or rented equipment, and stronger staff safety. Integration with EHR, CMMS, nurse-call, and security systems usually comes up early, not as an afterthought. **Priorities:** measurable ROI, asset management, throughput, staff safety, compliance, and system integration.

GCC: smart hospitals and scalable infrastructure. GCC healthcare is expanding fast, with new hospitals, new medical cities, and real digital-transformation budgets behind them. RTLS demand tends to follow the construction: large-campus visibility, patient experience, security, and infrastructure built to scale from day one. **Priorities:** smart-hospital infrastructure, multi-campus tracking, automation, security, and cybersecurity governance.

Regional Demand Summary

Region	Primary pressures	RTLS priorities	Governance focus
Europe	Aging population, workforce and budget	Efficiency, asset sharing, patient flow	GDPR, transparency, purpose limitation
United States	Cost, capacity, compliance, safety	ROI, utilization, throughput, staff safety	HIPAA privacy/security controls where applicable; auditability
GCC	Rapid expansion, smart hospitals, digital transformation	Scalable infrastructure, automation, security	National data rules, cybersecurity

Regional healthcare RTLS demand summary — a qualitative framing of commonly reported regional priorities, not a citation-backed market study.

4. Why Many Hospitals Still Run a Patchwork, Not a Platform

Walk into most hospitals today and you won't find one RTLS running the building. You'll typically find two or three narrow, disconnected systems, each solving a single problem and talking to nothing else. NHS England's own RTLS guidance describes exactly this pattern, and it lines up with what the market analysts cited in the References report more broadly.

- **Infant and newborn protection** is often the first and only RTLS a maternity unit has, tags that trigger an alarm near an exit, solving abduction risk and nothing else, with no visibility into equipment, staff, or general patient location.
- **Where hospitals do deploy real-time BLE positioning:** budget usually confines it to one high-value area, the ICU, the ED, sterile processing , because scaling a flat, single-tier technology to every room looks expensive on paper.
- **RFID still does the heavy lifting for chain-of-custody**, mostly because the tags are cheap and the concept is already familiar from warehouse and inventory work. What it tells you is that an asset passed a reader. It won't tell you where that asset is right now.
- **UWB delivers on raw accuracy**, but rarely makes it past a narrow pilot, such as surgical-instrument tracking in one OR, because the infrastructure cost and installation complexity don't scale gracefully to a whole building.

Add it up and most hospitals end up with a security tag in maternity, an RFID reader at the loading dock, and a BLE pilot in one ward, three systems, none of them talking to each other, none of them giving leadership a single real-time view of the building. That fragmentation, more than any one rival technology, is the actual competitor a hybrid BLE architecture has to beat.

5. Challenges in Hospital Environments

Hospital environments are difficult for indoor positioning because both the physical layout and day-to-day clinical activity affect system performance.

- **Multipath and reflection:** walls, ceilings, metal equipment, and medical devices all bounce BLE signals around, which can affect positioning consistency.
- **A crowded 2.4 GHz band:** hospital Wi-Fi, wireless telemetry, nurse-call systems, and other BLE devices already share this spectrum, so interference is a real possibility rather than a hypothetical one.
- **Bodies in the way:** staff, patients, and visitors routinely weaken or block the signal path between a tag and a receiver, simply by standing in the wrong place.
- **Signal bleed between rooms:** a hallway gateway can pick up a tag through a wall or an open door, making it hard to tell which of two neighboring rooms a tag is actually in.
- **Ambiguity across floors:** signals sometimes reach the floor above or below, which means infrastructure placement and floor-level validation both need real care.
- **Infection control and durability:** anything worn by staff or attached to equipment needs to survive routine disinfection and daily clinical handling without becoming a nuisance.

- **Zero-disruption installation:** a hospital doesn't close for cabling and drilling; installation has to happen around patient care, not instead of it.
- **Physical constraints:** power availability, network access, ceiling type, and restricted clinical areas all limit where a locator or anchor can go.
- **Privacy and access control:** location data tied to staff or patients needs a defined purpose, role-based access, a retention policy, and real governance behind it.
- **Rooms that don't stay still:** open and closed doors, moved beds, and temporary partitions keep shifting RF behavior in a clinical space, which is exactly why a one-time calibration isn't enough.

6. RTLS Technologies Comparison

Which wireless technology fits depends on the accuracy a use case actually needs, set against coverage, infrastructure, power draw, and cost. Passive RFID earns its keep at portals and checkpoints; active RFID stretches that to zone-level presence with a longer read range. Wi-Fi positioning can ride on network infrastructure a hospital already owns, though results depend heavily on how that network was designed. UWB buys serious accuracy at a serious infrastructure price. Zigbee shows up more in sensor networks than in positioning. LoRaWAN covers long outdoor distances on very little power, which makes it useful for a campus perimeter and largely unsuited to indoor use, where its positioning performance falls apart. BLE is the outlier: one technology family, and depending on which layer you deploy- RSSI, BiLink, or AoA- it offers three genuinely different levels of location precision on the same tag, as the comparison below shows.

Technology	Positioning output	Typical accuracy*	Healthcare deployment pattern
Passive RFID	Checkpoint / portal detection	Proximity only — no continuous X/Y	Chain-of-custody at supply or entry checkpoints; not continuous positioning.
Active RFID	Zone presence	Zone-level (several metres)	Equipment inventory or zone presence; still checkpoint- or zone-level.
BLE RSSI	Proximity, zone, or approximate coordinates	Meter-level, calibration-dependent*	Broad asset and personnel visibility across departments and wards.
BLE RSSI + BiLink	Room/zone presence and transitions	Room-level (presence, not coordinate)	Reliable room-level detection without a powered gateway in every room.
Bluetooth AoA	Precise coordinates	Sub-metre, per Bluetooth SIG direction-finding spec*	OR, ICU, pharmacy, and other zones needing bay- or bed-level precision.

Technology	Positioning output	Typical accuracy*	Healthcare deployment pattern
UWB (TDoA/TWR)	High-precision coordinates	Decimetre-level, per industry literature*	Narrow, high-value pilots (e.g. surgical-instrument tracking); dedicated anchor infrastructure.
Wi-Fi (RSSI/FTM)	Zone or coordinate estimates	Metre-to-room-level, network-dependent	May reuse existing infrastructure; accuracy depends on AP density and design.
Zigbee	Sensor data; positioning implementation-dependent	Not inherently a positioning method	Low-power sensor and monitoring networks.
LoRaWAN	Wide-area / outdoor presence	Tens of metres indoors; better outdoors	Campus perimeter, ambulance bay, outdoor fleet — not indoor clinical use.

**Accuracy ranges reflect Bluetooth SIG direction-finding documentation and commonly published RF-engineering literature for each technology class (see References), not Sentrax-specific lab results, and should be validated on-site during a pilot (Section 15). In relative terms, infrastructure cost per unit generally rises from passive RFID and BLE RSSI (lowest) through BiLink and Wi-Fi, to Bluetooth AoA and UWB (highest), reflecting the antenna, synchronization, or reader hardware each requires — get a project-specific quotation for exact costs.*

7. Sentrax BLE RTLS Architecture — One Ecosystem, Multiple Location Outputs

Sentrax builds its RTLS architecture on Bluetooth Low Energy specifically because one technology family can support several levels of location precision at once. Instead of picking a single positioning technology and living with its trade-offs everywhere, a hospital chooses the BLE-based method that fits each area — RSSI for zone-level location, BiLink for room-level detection, Bluetooth AoA for sub-metre positioning — all running through the same Solix platform.

Product family	Models	Role
Zenix locators & gateways	LEN / LON (indoor RSSI / AoA)	PoE/Wi-Fi indoor scanner-locator (LEN) or AoA locator-gateway (LON) for wards, ORs, ICUs, pharmacies.
	LEF / LOF (outdoor RSSI / AoA)	Cellular-connected outdoor locator-gateway for ambulance bays, parking, and campus perimeter.

Product family	Models	Role
Pinix tags & badges	TOW (asset tag)	AoA/RSSI-capable tag with onboard sensing for mobile equipment and cold-chain-sensitive assets.
	TOP (badge/card)	Smart-card-format tag with extended battery life for staff ID, with an optional duress/SOS function.
	TEP / TOB / TEK (wearable)	Wearable tag with onboard sensing, adaptable to staff or patient wristband use cases.
	TEN / TEF (anchor beacons)	Long-life indoor and IP-rated outdoor beacons establishing fixed reference points.
NODIX (Bi-Link)	CEN-1 relay anchor	Battery-powered relay between tags and a shared Zenix gateway — no networked scanner per room needed.
Solix platform	Cloud or on-premises	Live mapping, device-health monitoring, geofencing, and REST/WebSocket APIs for HIS integration.
POSIX SDK & Device Manager	Android / iOS SDK + SDM app	Embeds positioning into hospital apps; bulk configuration and maintenance of tags and badges.

Model names follow Sentrax's current product-family naming. Hardware specifications change periodically, so confirm exact model numbers, battery life, and IP ratings with a Sentrax representative before publication.

8. How BLE RSSI RTLS Works

BLE RSSI is the workhorse of broad hospital coverage. RSSI is simply received signal strength, and depending on how it's processed, it can support a proximity check, a zone assignment, or an approximate set of coordinates.

- A BLE tag broadcasts a low-power signal.
- A gateway or scanner picks it up.
- The positioning engine compares signal strength across whatever receivers are in range.
- With three or more well-placed, calibrated receivers, RSSI-derived distance estimates can support trilateration for an approximate 2D position.
- For a simpler proximity or zone result, the system associates the tag with the nearest receiver or a configured area.
- Either way, the resulting location gets visualized, stored, or passed on to the hospital's own application.

A stronger signal usually means a shorter distance, but walls, equipment, people, and reflections all bend that relationship, so RSSI-derived distances and coordinates are estimates, not measurements. More receivers alone won't guarantee accuracy, the required output should be validated under real hospital conditions before anyone relies on it

Why BLE RSSI Fits Broad Hospital Coverage

- Low-power, compact tags and badges with flexible update intervals.
- A broad Bluetooth ecosystem and comparatively low-cost infrastructure.
- Support for assets, people, and compatible sensors on a common tag.
- Coverage that scales, with battery life depending on configuration.

Appropriate RSSI Use Cases

- Department, ward, and storage-area asset visibility.
- Corridor and open-area monitoring, including configured entry/exit events.
- Staff, patient, and visitor zone visibility.
- Multi-building or campus awareness, including hospital-yard and transport tracking where appropriate.

9. BiLink: Room-Level Tracking Under BLE RSSI

BiLink is Sentrax's answer to a specific, very common hospital problem: reliable room-level detection without running a powered network gateway into every single room. It uses battery-powered NODIX CEN-1 anchors and RSSI-based detection to cover smaller rooms, adjoining spaces, and doorways.

Why a Specialized Room-Level Architecture Is Needed

A hallway gateway in a typical hospital corridor can pick up tags through two or three walls at once, which makes genuine room-level detection unreliable using conventional infrastructure alone. Wiring a powered, IP-connected gateway into every patient room, exam room, treatment cubicle, isolation room, equipment store, and utility closet would fix that, at a hardware, cabling, and installation cost most hospitals aren't willing to absorb.

How BiLink Works

- A battery-powered NODIX CEN-1 anchor scans for nearby BLE tags.
- It tags each observation with its own configured room or zone identifier, relaying data for several tags at once.
- It relays that data wirelessly to the nearest Zenix gateway.
- Solix processes the incoming observations into location events.
- Results get visualized, stored, or handed off to a hospital or partner application.

One Hallway Gateway, Multiple Room Anchors

Room anchors placed in patient rooms, exam rooms, and equipment stores all relay through the same shared Zenix gateway infrastructure. Because those anchors are battery-powered and shared across many rooms, adding another room typically costs less in hardware and installation than wiring in a dedicated networked gateway would. How much less depends on room count, gateway placement, and existing network access, worth quantifying during site design (Section 13).

10. How Bluetooth AoA RTLS Works

Bluetooth Angle of Arrival works out which direction a signal came from by reading the phase differences across an antenna array built into the locator. Once a couple of well-placed locators each have an angle, combining them gives a genuine coordinate position. This is part of the Bluetooth Direction Finding feature that the Bluetooth Special Interest Group itself defines (see References).

It helps to think of it the way a person locates a sound: comparing how a noise reaches each ear tells you roughly where it came from. An AoA locator does the same trick electronically, comparing how a signal reaches each element of its antenna array, which keeps working even in a ward crowded with beds, monitors, and metal equipment.

- **Direction estimation:** phase differences across the antenna array determine the signal's angle of arrival.
- **Position calculation:** multiple locators combine their angle estimates into a precise x/y (and, where deployed, elevation) position.
- **Hybridization:** Solix can blend AoA and RSSI observations in the same positioning engine, which helps hold accuracy steady in metal- and equipment-dense clinical spaces.

One Tag, Multiple Accuracy Levels Across the Same Building

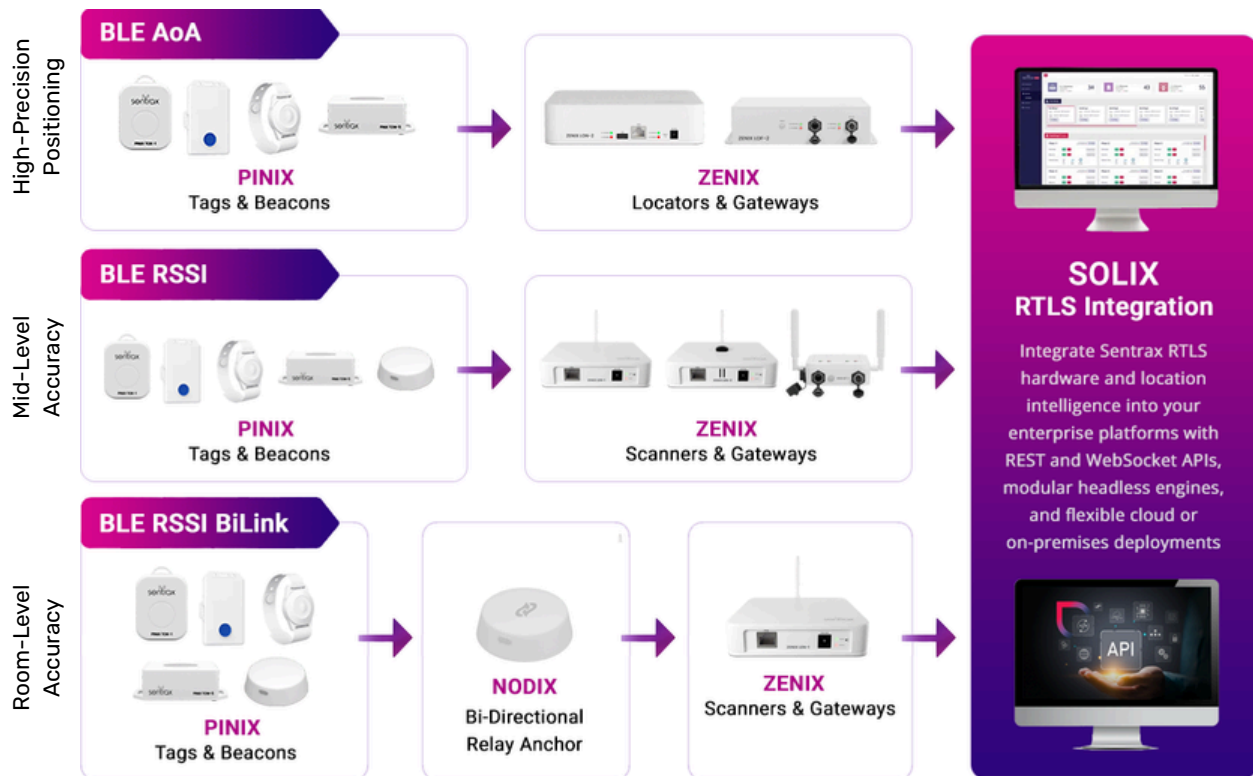
The real payoff for a hospital is that a single Pinix tag can operate at different accuracy levels in different departments, without anyone reprogramming or swapping hardware:

- **Room level:** standard BLE RSSI or BiLink, general wards, corridors, waiting rooms, and storage.
- **Multi-meter zone:** multiple standard BLE RSSI receivers, larger open areas such as day-care units or rehabilitation gyms.
- **Sub-meters:** BLE AoA locators, operating rooms, ICUs, pharmacies, and any zone where precise bay- or bed-level position is clinically meaningful.

That lets a hospital spend on higher-accuracy hardware only where it's clinically justified, while still tracking every tagged asset, patient, and staff member continuously as they move between zones.

Appropriate AoA Use Cases

- Operating rooms and ICU bays, where bed- or bay-level position is clinically meaningful.
- Pharmacies and controlled-substance storage, where precise, auditable location supports chain-of-custody.
- High-value mobile imaging or surgical-instrument sets, where sub-metre retrieval time matters.
- Any zone identified during site assessment as needing coordinate-level rather than room-level precision.



Sentrax BLE RTLS architecture supporting multiple levels of location granularity.

11. Advantages in Healthcare Applications

Medical Equipment Found Faster

Pumps, wheelchairs, ventilators, beds, and anything else tagged shows up on a live map across every department and room, and the time-stamped movement history alone is enough to support retrieval, inventory checks, and cross-facility asset reviews.

Staff Safety & Restricted Areas

An SOS badge can hand a responder room, zone, or position context the moment it's triggered, while patient and visitor tags support movement visibility and configured restricted-zone alerts the same way.

Staff Safety in Behavioral Health and Psychiatric Units

These units are widely recognized, including in OSHA's own guidance on healthcare workplace violence, as carrying an elevated risk of patient-on-staff assault. A duress badge that reports a room- or bed-level location, not just an alert, lets a response team reach the right door immediately instead of searching a locked unit floor by floor.

Cold Chain and Environmental Monitoring

Pinix tags with onboard sensing watch pharmacies, vaccine fridges, blood banks, and ICU storage, and flag it the moment conditions drift outside a configured range.

Fewer Last-Minute Scrambles in the ICU and OR

Knowing in real time which critical assets are in use, available, or sitting in cleaning or maintenance cuts into the pre-case search that eats into turnover time.

Wandering Management for Dementia and Memory-Care Patients

Geofenced alerts can flag a cognitively impaired patient approaching an exit or leaving a defined safe zone, giving staff time to intervene before an elopement becomes a search. It supports, and does not replace, a facility's existing supervision protocols and should be implemented with the same attention to resident consent and dignity as any other monitoring technology.

A Supporting Signal for Hand Hygiene

Room-level presence combined with dispenser sensors gives an infection-prevention program one more input, a support, not proof that the technique was correct or hygiene was completed.

Faster, More Accurate Headcounts

During an evacuation, drill, or code event, real-time occupancy data across departments beats a manual sweep on both speed and accuracy.

Equipment search time	Equipment inventory time	Overall delivery time
86.8% Reduction	78.1% Reduction	20.9% Reduction

Reported operational improvements following a combined hospital RTLS and dispatch-management intervention. Source: International Journal for Quality in Health Care, 2025;37(1):mzaf005 (see References). Results reflect that study's design, setting, and accompanying process changes.

12. Hybrid BLE vs UWB: Selecting the Right ArchitectureHybrid BLE vs UWB: Selecting the Right Architecture

For hospitals that need department-level visibility, room-level detection, and genuine precision in a handful of spaces, the real decision is between a hybrid BLE architecture and a UWB architecture. Here's how they compare on the factors that actually matter for a hospital deployment.

Comparison factor	Hybrid BLE (RSSI + BiLink + AoA)	UWB TDoA RTLS
Location Accuracy	RSSI for broad/zone visibility, BiLink for room-level presence, and AoA in selected precision areas.	High-precision coordinate positioning using dedicated UWB anchor infrastructure in the covered areas.
Room-dense areas	BiLink can use battery-powered room anchors with shared gateways, reducing the need for a networked gateway in every room.	Room-level performance depends on anchor geometry and positioning design; validate against the same room-transition requirements.
Precision model	Higher-precision BLE AoA is deployed only where sub-meter positioning is required.	High-precision UWB coverage is designed across the areas where UWB positioning is required.

Comparison factor	Hybrid BLE (RSSI + BiLink + AoA)	UWB TDoA RTLS
Tags and badges	Compatible BLE tags/badges can operate across the selected BLE positioning layers on one hardware family.	UWB-capable tags/badges are required for UWB positioning.
Best fit	Hospitals with mixed requirements for department, room and precise location visibility across most of the facility.	Narrow, tightly bounded use cases where consistently high positional precision is the primary requirement (e.g. a single OR's instrument tracking).

Hybrid BLE and UWB architecture comparison. Cost and performance depend on the matched hospital design; validate with a site-specific quotation

Why a Hybrid, Mixed-Accuracy Design Outperforms a Single-Technology Deployment

In practice, hospitals rarely choose between hybrid BLE and UWB as an abstract exercise. The real choice is usually between staying with today's patchwork (Section 4) and moving to a single platform that can cover the whole facility without blowing the budget.

- **Versus RFID alone**, the hybrid BLE adds continuous, real-time positioning on top of checkpoint events, and tag costs land in roughly the same range as active RFID tags already do.
- **Versus a single-department BLE pilot**, BiLink's relay anchors make hospital-wide, room-level coverage financially realistic without a scanner in every room, which is usually the thing keeping a pilot stuck in one ward.
- **Versus a standalone infant-protection system**, one tag family and one platform can extend newborn safety alongside equipment tracking and staff safety, instead of running a closed-loop system that shares nothing with the rest of the hospital.
- **Versus premium accuracy everywhere**: putting AoA-grade infrastructure only where it's clinically justified, and RSSI/BiLink everywhere else, is structurally cheaper than uniform sub-meter coverage across the whole building. How much cheaper depends on room count, ceiling height, and existing network reuse, all worth quantifying per site (Section 13).
- **Where UWB genuinely earns its cost**: For a small number of ultra-critical, tightly bounded cases, precision surgical-instrument tracking inside a single OR, say, UWB's raw accuracy is worth paying for. An Omlox-aligned platform (Section 14) can fold that zone into the same Solix system instead of forcing a separate silo.

13. ROI Framework for Healthcare RTLS

Hospitals evaluating RTLS should separate two very different kinds of benefit: cash that stops leaving the building, and staff time that becomes available for other work. Lower equipment-rental spend and fewer written-off lost assets are cash benefits the moment they show up in the budget. Time a nurse no longer spends hunting for a missing pump is real, but it only becomes a cash saving if it changes what the hospital actually spends or staffs, reduced overtime, an avoided agency shift, a headcount increase that doesn't happen. Treating the two as equivalent overstates the business case.

Because bed count, asset inventory, staffing costs, and rental spend vary enormously from one hospital to the next, this section sets out how Sentrax models the financial case rather than quoting a single number that applies everywhere. The assumptions below draw on published operational benchmarks from AHRQ, HIMSS, and Vizient for a representative ~300-bed hospital; a hospital's own finance and biomedical engineering teams should replace every input with their own figures before treating any output as a business case.

How the Model is Structured

The model groups its inputs into five areas and produces a standard set of financial outputs from them:

Input area	What it asks for	What it feeds into
Hospital configuration	Staffed beds, trackable assets per bed, annual asset loss per bed	Total trackable assets and the baseline annual cost of lost/damaged equipment
Equipment rental	Rental cost per asset per day, average rented assets per day	Baseline annual equipment-rental spend
Labor metrics	Nurse hourly cost, nurses per shift, minutes per search, searches per nurse per shift,	Baseline annual cost of nurse time spent searching for equipment
RTLS investment	Hardware/tag CapEx, implementation and training, annual software/support, annual maintenance, system useful life	Total CapEx, annual OpEx, and straight-line depreciation
Efficiency gain assumptions	Percentage reduction in asset loss, rental spend, and nurse search time; NPV discount rate	Annual savings applied against each baseline, and the discount rate used for multi-year NPV

From these five inputs the model produces a total annual benefit, a Year-1 net benefit after operating costs, a simple payback period, Year-1 and three-year ROI, and a five-year net present value.

Why Worked Example: Conservative vs. Base-Case Assumptions

Rather than a single hypothetical, the table below runs the model twice for the same 300-bed hospital: once using the base-case assumptions above, and once using conservative, low-end assumptions for every input where genuine uncertainty exists. Figures are in US dollars. The hospital's baseline operating costs — what it is actually spending today, before any RTLS-driven change, stay fixed across both columns, so the comparison isolates the two things that actually vary in any RTLS business case: how much benefit gets realized, and how much the deployment costs.

Baseline (identical in both scenarios)	Value
Staffed beds / trackable assets	300 beds × 10 assets/bed = 3,000 assets
Baseline annual asset loss	300 beds × \$3,000/bed = \$900,000
Baseline annual rental spend	\$55/asset/day × 20 assets/day × 365 = \$401,500
Baseline annual nurse search-time cost	\$50/hr × (10/60 hr) × 3 searches/shift × 35 nurses × 3 shifts × 365 = \$958,125

Assumption	Conservative (low end of range)	Base case
Reduction in asset loss	40%	55%
Reduction in rental spend	20%	28%
Reduction in nurse search time	50%	60%
Hardware/tag CapEx + implementation	\$360,000 + \$108,000 = \$468,000	\$280,000 + \$80,000 = \$360,000
Annual software/support + maintenance	\$120,000 + \$43,200 = \$163,200	\$90,000 + \$25,000 = \$115,000
NPV discount rate	8%	5%

Result	Conservative	Base case
Total annual benefit	\$919,363	\$1,182,295
Year-1 net benefit after OpEx	\$756,163	\$1,067,295
Simple payback	≈0.62 years (~7.4 months)	≈0.34 years (~4.0 months)
Year-1 ROI	≈62%	≈196%
3-year cumulative ROI	≈485%	≈889%
5-year NPV	≈\$2.55 million	≈\$4.26 million

Read this table with one thing in mind: even the conservative column clears payback in under a year.

That's not a function of which end of each range got chosen — every efficiency assumption in the conservative column sits at the low end of what's plausible. It happens because, at this hospital's configuration, the baseline cost of unproductive nurse search time alone (\$958,125 a year) is larger than either the asset-loss or rental baseline, and large relative to a CapEx investment in the \$360,000–\$470,000 range. Before trusting either column, a hospital should sanity-check its own nurses-per-shift, searches-per-shift, and minutes-per-search figures against real time-and-motion data — those inputs, not the reduction percentages, are what actually move the result.

Neither column is a projection, an average, or a guarantee for any specific facility. Both are only as good as the hospital-specific numbers behind them. Sentrax can build a facility-specific version of this model together with a hospital's finance and biomedical engineering teams as part of pilot scoping.

Why Worked Example: Conservative vs. Base-Case Assumptions

Benefit category	Healthcare measurement and qualification
Reduced equipment search time	Compare search events and minutes per event before and after deployment. Report staff hours released; count cash savings only where expenditure actually changes.
Lower rental and replacement spend	Track rental days, emergency rentals, and purchases made because equipment could not be located. Count only documented reductions.
Improved inventory and equipment sharing	Use location records alongside asset-management data to review transfers, missing equipment, and avoidable duplicate purchases.
More efficient servicing	Measure time spent finding equipment for cleaning, maintenance, or recall. Zone arrival supports traceability, not proof of completed work.
Staff safety and patient experience	Evaluate response-location availability and relevant service delays. Report safety and experience outcomes separately from assumed financial savings.

14. Sentrax Hybrid BLE RTLS System — Layers, Roles, and Interoperability

Sentrax's job in this picture is the hardware and middleware: location visibility and the device and event data behind it. What a hospital or partner application does with that data, for clinical, asset-management, safety, or service purposes, is its own decision.

Layer	Role in the healthcare deployment
Tags and wearables (Pinix)	Provide BLE signals from tagged equipment, staff, or patients; selected devices may provide SOS or sensor data.
Gateway/locator infrastructure (Zenix)	Zenix gateways and AoA locators support the selected positioning approach.
Relay anchors (NODIX / BiLink)	Battery-powered room anchors relay tag observations to a shared gateway for room-level detections.
Solix RTLS middleware	Processes location information; provides device management, visualization, event history, alerts, and integration APIs.
Integration layer (POSIX SDK)	Embeds positioning and alerts into the hospital's own mobile apps; supports bulk device configuration via SDM.
Hospital/partner applications	Consume the agreed data and events. Cleaning completion, equipment readiness, bed status, and staff dispatch remain application-specific processes.

Interoperability: Omlox and Hospital System Integration

Almost no hospital runs on one vendor's stack end to end. HIS, EHR, CMMS, nurse-call, and building-management systems from different vendors all have to coexist and, ideally, talk to each other. Aligning with the open omlox standard is Sentrax's way of making sure its platform fits into that mix instead of becoming one more isolated silo – standardizing location data across clinical and operational systems, scaling from a single pilot ward to a multi-site rollout without re-architecting the integration layer, and protecting the investment by staying vendor-neutral rather than locking a hospital into a proprietary format.

Omlox is an open, vendor-neutral location-data standard maintained by the omlox consortium (see References). Ask Sentrax's technical team for its current conformance level and supported profiles before citing any specific certification.

15. Deployment Recommendations

- **Start with the actual problem, not the technology:** locating infusion pumps, tracing equipment between service areas, giving an SOS event location context. Pick something specific, and define how search time, response time, or asset loss will be measured before deployment starts, not after.
- **Survey the site before promising an accuracy level:** room construction, floors, ceilings, installation restrictions, power, and network access all shape what's realistic. Decide up front whether each application needs proximity, room presence, or full coordinates.

- **Pilot under conditions that actually resemble the hospital:** adjacent rooms, doors open and closed, people moving through the space, a real peak period. Validate room transitions, position outputs, event delivery, and battery settings before scaling to a second department.
- **Decide who owns this before it becomes everyone's problem and no one's job:** authorized uses, access roles, retention, staff communication, security responsibilities, and ownership of tags, batteries, room maps, and integrations all need an assigned owner, not a shared assumption.

Indicative Phased Timeline

- **Site assessment and design** — RF survey, use-case definition, accuracy-tier mapping by department, integration scoping.
- **Pilot procurement and installation** — hardware installed in one ward, department, or OR/ICU core; tags issued to a defined population.
- **Pilot validation** — room-transition testing, accuracy validation, workflow fit, staff feedback, refinement of zoning and calibration.
- **Phased hospital-wide rollout** — expansion informed by pilot results, with governance and integration already in place.

Indicative structure only, not a committed schedule for any specific facility; actual duration depends on facility size, procurement cycles, and integration scope.

16. Data Protection and Security – GDPR, HIPAA, and Platform Expectations

The moment an RTLS tag or badge can be tied to an identifiable patient, staff member, or visitor, the location data it generates is personal data, and in a US covered-entity setting it may be protected health information as well. None of what follows is legal advice; work with a data protection officer, privacy officer, and legal counsel to confirm what applies in a given jurisdiction.

GDPR (European Deployments)

- **Purpose and lawful basis, documented:** write down why location data is being processed and hold its use to that stated purpose.
- **Only what's needed, kept only as long as needed:** collect the location detail and history the use case actually requires, and set a retention period accordingly.
- **Access limited to who needs it:** inform affected individuals where required, and keep identifiable location data restricted to authorized users.
- **A DPIA where the processing warrants one:** assess whether systematic monitoring triggers a Data Protection Impact Assessment, and settle controller/processor responsibilities with vendors and integrators up front.

HIPAA (US Deployments)

In a US covered entity, RTLS data linked to an identifiable patient can be protected health information under HIPAA. Work with the privacy officer to determine whether a Business Associate Agreement is needed, apply the minimum-necessary standard when deciding who can see identifiable location data, and confirm the security architecture below actually satisfies the HIPAA Security Rule risk assessment. Many of the highest-value use cases here, equipment tracking, environmental monitoring, hand-hygiene support, need no patient-identifying data at all, which sidesteps a good deal of this analysis entirely.

Platform Security Expectations

The hospital security review will want a written answer to each point below before signing off on deployment. That is what the review will ask, not a claim that every box is already checked.

- **Encryption and access control:** confirm how data is encrypted in transit between tags, anchors, gateways, and Solix, and at rest once stored; confirm how role-based access and gateway authentication work.
- **Network segmentation and logging:** confirm whether the RTLS infrastructure can sit on its own VLAN, separate from clinical networks, and what gets logged for incident review and audit.
- **Firmware and deployment model:** confirm how firmware updates and vulnerability disclosure work, and match Solix's cloud or on-premises deployment options (Section 7) to whatever data-residency requirements apply.
- **Independent assurance:** ask whether Sentrax holds recognized certifications, such as ISO 27001, and request current documentation rather than taking this paper's word for it.

17. Buyer's Checklist and Frequently Asked Questions

These are worth asking any healthcare RTLS vendor, not just Sentrax, before signing anything hospital-wide:

- Does one common tag support multiple accuracy tiers, or does more precision mean different hardware and a second management system to run alongside the first?
- How is room-level accuracy actually achieved in a multi-room clinical area — does it require a powered, networked gateway in every single room?
- What are the data-residency options, and which open standards, such as omlox, does the platform support if a data source needs to change vendors down the road?
- What APIs exist for HIS/EHR, CMMS, and nurse-call integration, and who is actually doing that integration work?
- What is the real battery life on a tag or anchor, what does replacement look like, and how do low-battery events get surfaced?
- Are the tags and badges rated for routine disinfection, and what security architecture and support SLAs cover a 24/7 environment (Section 16)?
- Can the hospital pilot in one department first, and what will that pilot actually prove?

Frequently Asked Questions

Does this replace our hospital Wi-Fi network? No. BLE RTLS runs alongside existing Wi-Fi, on its own dedicated, low-power infrastructure.

Will this mean tearing into walls and ceilings? BiLink is built to avoid exactly that: battery-powered room anchors relay to one shared, hallway-mounted gateway instead of requiring a gateway in every room.

What happens when a tag's battery gets low? The Sentrax Device Manager app and Solix platform surface low-battery and device-health events so maintenance can be scheduled before anything fails.

Do we have to track patients, or can we just track equipment? That's a configuration choice. Most of the highest-value use cases here need no patient-identifying data at all.

Can we start small? Yes, and it's the recommended path: validate in one ward or department before rolling out further (Section 15).

18. Conclusion

Healthcare RTLS adoption should start from what a hospital actually needs operationally, not from a product spec sheet or a single accuracy number. Workforce efficiency, investment, asset availability, safety, and privacy all pull in different directions, and where the balance lands depends on the hospital's own operating model and local requirements.

Sentrax's BLE RSSI covers the broad strokes; **BiLink** adds room-level presence through shared gateways; Bluetooth AoA adds precision exactly where it's justified. A hybrid design matches infrastructure to what each department actually needs, instead of applying one technology, and one cost profile, to the entire building.

Sentrax's role stops at the hardware and middleware layer. Hospital and partner applications take that data and put it to work: retrieval, movement visibility, safety response, service-area traceability. Whether a piece of equipment is ready for use, whether a room has actually been cleaned, whether a clinical decision is appropriate, those stay hospital calls, backed by hospital records, not something a location ping can decide on its own.

The future of healthcare RTLS is hybrid.

Broad visibility where that's enough. Room-level detection through BiLink where presence actually matters. AoA precision where the application genuinely requires it. One Sentrax ecosystem, shaped around what the hospital is actually trying to do.

Building the Evidence Base Together

This paper deliberately doesn't include a Sentrax-specific case study, because there isn't one here that a reader could independently check. The most useful next step for a hospital evaluating this architecture is a scoped pilot (Section 15) that generates real, facility-specific numbers — search time, rental spend, safety-response data, measured before and after — which can anchor a future edition of this paper in verified results instead of the modeled comparison in Section 13.

Discuss a Healthcare RTLS Pilot

Bring Sentrax the asset population, the rooms involved, the accuracy each area actually needs, and the systems it has to integrate with. A phased deployment plan, and a facility-specific version of the ROI model in Section 13, can be built from there.

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Disclaimer

This paper is for information and project evaluation only. It is not a binding offer, a warranty, or a performance guarantee. Results depend on facility conditions, system configuration, integration, and adoption. Location data alone does not establish that equipment is ready, that a room has been cleaned, or that a clinical status has changed.

The figures in Section 13 combine Sentrax's base-case modeling assumptions, informed by the benchmarks named there, with a conservative comparison built from low-end assumptions for the same inputs. Neither column is a projection, an average, or a guarantee for any specific facility. The one measured outcome cited in Section 11 (Table 2) comes from a named, independently published study and reflects that study's own setting, not a Sentrax result. Every other percentage, dollar figure, and vendor certification claim in this paper should be confirmed with Sentrax before use in front of a customer.

Privacy, cybersecurity, and regulatory obligations must be assessed for the applicable jurisdiction and use case, in consultation with a hospital's own legal, privacy, and security teams.