



Proposal for an

Automated Waste Bin Tracking System



Prepared for

MMDA's of Ghana

Private Waste Contractors of Ghana

22 June 2010



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Abstract:

General Waste Management in Ghana is the responsibility of the Ministry of Local Government and Rural Development, which supervises the decentralized Metropolitan, Municipal and District Assemblies (MMDAs). However, regulatory authority is vested in the Environmental Protection Agency (EPA) under the auspices of the Ministry of Environment and Science. The Metropolitan, Municipal and District Assemblies are responsible for the collection and final disposal of solid waste through their Waste Management Departments (WMDs) and their Environmental Health and Sanitation Departments. Due to rapid population growth of metropolitan Accra (pop. now > 3 million-*per Statistical Svcs of Ghana*), large quantities of waste are generated daily in Accra, and this exerts much pressure on an over strained solid waste management system. Significant funding constraints exist but a number of projects that will eventually promote sustainable settlement have been initiated or implemented (UK Govt and World Bank). Among them is the construction of waste treatment facilities like landfill sites and waste stabilization ponds in over 30 major settlements.

In addition to the expansion, there has been increased crowding resulting in higher densities in the poorer neighbourhoods and infilling of vacant lots which has further exacerbated the problem. It has been estimated that 80% of the population of Accra live in low income-high density areas. Despite adequate laws which specify environmental sanitation requirements, many of these areas have unpaved narrow roads which regular waste disposal vehicles cannot access. As a result, some waste contractors have introduced three-wheeled "Bola Taxi" into their waste management operations. Coupled with weak institutional capacity, and lack of resources, both human and capital, the city authorities face difficulties in ensuring that all the waste generated in the city is collected for disposal. Home collection of waste has been limited to high and, some middle income areas while the poor are left to contend with the problem on their own. This leads to indiscriminate disposal of waste in surface drains, canals and streams, creating unsanitary, and unsightly environments in many parts of the city. Authorities have even taken the step to draft legislation to enable access and use of prisoner resources in the Ghana Prisons Service to accelerate clean-up efforts.

Public acceptance of the necessity to have a sustainable waste management plan and pay for waste collection and disposal is happening. And an improved billing capability from the implementation of this proposal is expected to greatly help to improve service and bridge the funds shortage toward covering the costs of waste collection and disposal. In early June 2010, management of Zoomlion Ghana Limited, a private **waste management** company announced that, in collaboration with the Accra Metropolitan and Adentan Municipal Assembly it is to begin work on a fee-paying solid **waste collection** system from June, 2010. The AMA on June 1, 2010, introduced its fee and performance-based solid waste collection service. In all, eleven solid waste contractors including Zoomlion have been engaged by the assembly to collect waste from specific areas in the metropolis.

Zoomlion has been assigned three sub-metropolitan areas, namely Ablekuma Central and Ayawaso West and Central areas. Under the system, residents are to register, own bins and pay AMA approved fees to the waste management companies that have been assigned to the various communities. Residents in high density but low income areas would pay a monthly fee of GH¢ 3.30. Middle income areas would pay GH¢ 9.00, while first class areas would pay GH¢ 14.00.



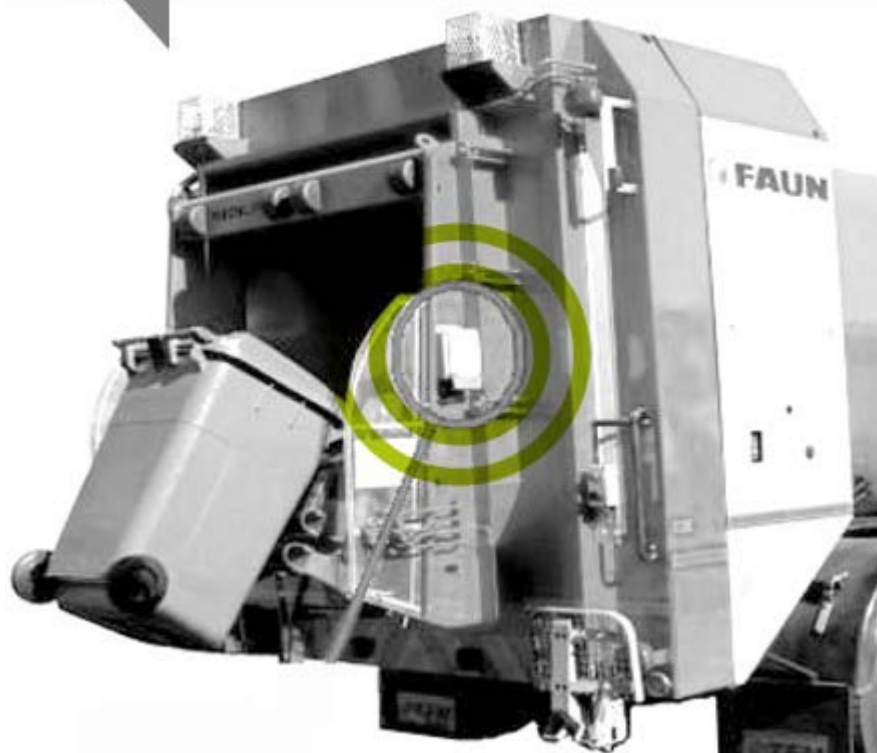
Quick System Summary

Not only is the business of waste management improving because of RFID, but RFID technologies are serving as a catalyst to change the way customers are billed for waste services. New billing models are emerging and gaining momentum inside of city governments and municipalities as they learn of the multilayered benefits offered through new waste management models. The Pay-As-You-Throw model, assumed in this proposal, is a program that ties recycling to a cost incentive program whereby users are charged according to the amount of waste they produce and thereby encourages recycling and improves the system to a user pay model vs. an inequitable equal flat rate. Public acceptance of a pay for service model will only be achieved if the program is perceived as fair.

Waste Collection and Disposal trucks automatically record the exact time and place each waste bin is emptied. This permits a new degree of monitoring and control of the waste disposal process and verification of service delivery for accurate billing as well as offering many new billing alternatives, such as "Pay-As-You-Throw" or "Pay-By-Weight". This information is then uploaded to the Service Depot Administration RFID middleware, database and application software --- installed on a computer server, which is accessed by the Billing System to determine the bill for the customer. Separate Recycling bins can also be identified, tracked and integrated to support "Green" initiatives and enable billing credits or recycling points awards to provide an incentive for recycling. As a result, cash flows are accelerated and revenues increased providing necessary funding to cover the cost of the improved service and greatly improve the environment. Municipalities will also gain a new capability to monitor the performance of its waste contractors.



Exact time and place of bin lifts
 Precision technology enables cost saving and time efficient management of fleets



Passive RFID Technology Overview (LF/Dual-Frequency/HF/UHF)

With costs rising at all points in the waste management process, RFID technology can enable those involved in the industry to improve the efficiency of their waste operations. FSN's Waste Bin Tracking System helps waste collection and disposal contractors identify bins, track and verify consumer usage for billing, optimize routes, track driver field activity, and cut costs with a powerful integration of ruggedized RFID Tags and

Readers, on-board computing and back office Middleware, Database and Application software. Our system is easy to install, easy to use, and gives waste contractors powerful tools which provide new visibility and billing data options for their operation.

Selecting the RFID Frequency

While many automatically start by researching RFID tags, it all starts with selecting the correct RFID Frequency for the specific application. While each country approves application use, RF spectrum planning and power output is governed by FCC in the US and CEPT/ETSI for the 55 countries complying with European RFID regulations. Globally accepted passive RFID technology occupies three frequency bands:: LF(Low Frequency) 125kHz; HF(High Frequency) 13.56MHz; Dual-Frequency(LF at 125kHz for generating a power-up field for the tags, and a high frequency one, resonant at 6.8 MHz, for receiving the tag response signal, whose modulation carries the tag's ID code.); UHF(Ultra High Frequency) 865-868MHz(Europe)/902-928MHz(FCC), 2.4GHz, 5.8GHz.

Without getting into the depths of a RF physics discussion, LF is ideal for obtaining very high tag read levels in typically 'lossy' environments such as liquids, high moisture content and metals. Its short read range is ideal for singulation – getting specific tag reads vs many. UHF on the other hand is ideal for longer read ranges and capturing many tag reads simultaneously. For the Waste Bin application,

proven success has come from the frequency selection involving LF, whereas attempts at using UHF have resulted in failure. This proposal recommends Dual Frequency(LF and HF) as it provides the optimum combination of achieving 100% read rates in a challenging operational environment, singulation-reading only the tag intended, and reasonable read range. A Waste Bin when full will contain many items with a high moisture content. Rain or high humidity is also a factor to consider. This would attenuate a conventional UHF signal and result in less than desired tag read performance. Liquids absorb conventional UHF signals rendering the tag not read, whereas the Dual Frequency can read through liquids. Also the waste disposal truck is a highly metallic environment. UHF signals reflect off metal and can result in no tag reads and also, unpredictably, many tag reads. Again Dual Frequency performs best in that environment.

CHEP, one of world largest plastic pallet providers with a pallet pool of over 280 million, has decided to utilize the Dual Frequency for the tracking of their plastic recyclable pallets. The VP of CHEP for Asia-Pacific has commented, “ the performance of IPICOs Dual Frequency technology is beyond our expectations. IPICO tags have achieved a 100 percent read rate in demanding environments of high moisture content and metal.

Passive, Semi-Passive and Active RFID

The key difference among these 3 categories of RFID is related to how the RFID receives the power needed to send its data back to the Reader. Both Semi-Passive and Active RFID achieve long read ranges up to 100 meters or more but do require a battery and battery replacement program. Since they contain a battery, the tag form factor is larger and the cost is higher. Passive RFID on the other hand has no battery. It derives the power it needs from the RF signal from the Reader. As a consequence, Passive RFID tags generally have a smaller form factor(dependant on size of inlay antenna), a shorter read range and lower cost. Passive RFID technology is utilized in this proposal.

Selecting the RFID Tag

Most would characterize the Waste Bin management application as a rugged, harsh and challenging operational environment. Tags should be in a rugged plastic housing or embedded in the container to protect it from the environmental conditions that exist in the waste application.

The tag is attached to or embedded in the waste container. A RFID reader and antenna are integrated into the waste collection vehicle and connected to a host controller which reads the tag's unique serial number as the waste container is emptied. This unique number can be linked with a date/time stamp, type of container, weight of the container, and customer information, and that information can be sent directly to a server using wireless connectivity, stored in a Handheld Mobile reader or on the vehicle's onboard host controller and transferred later to a central waste management database system which the billing system would subsequently access.

Tags can also be used to identify the waste vehicles themselves to automate the hauler, landfill or

recycling station operations. The vehicle mounted tag can be read as it passes over an in-ground or overhead antenna as it arrives or departs a facility.

Unlike barcodes, which require direct line of sight to be read and are easily scratched or damaged in the harsh waste and recycling environment, RFID tags do not require line of site, and the RFID tags proposed herein, as well as the readers and antennas are sealed water and dustproof, and robustly designed, making them a more permanent form of unique identification that is superior to barcode technology in this application.

Taking advantage of an RFID system's ability to reliably identify individual receptacles, waste haulers can benefit from the automation of waste collection, container management and provide absolute verification of service.

In addition, this information can be used to optimize truck usage and routes.

A truck based waste management system based on RFID versus a manual method streamlines the driver tasks/hauler operations and customer billing processes. For these reasons, RFID technology is a wise investment for the waste management professional.

Passive RFID transponders depend entirely upon the energy generated by the reader antenna for power. LF and HF reader systems utilize inductive coupling (a magnetic field) to power the transponders. UHF reader systems utilize capacitive coupling (an electric field) to power the transponders.

The user experience or relative observed result is that LF and HF systems have very defined and controlled read zones whereas a UHF system, while perhaps having a longer range, has less control over the read zone. This is the first important distinction that has implications for the waste management application which at the most basic level requires 100% accurate service verification. LF Dual-Frequency, and HF RFID provide the user with a defined, controlled read zone while UHF RFID provides longer range read, but less control over the read zone.

Review and Conclusions

UHF Read Range And Performance

Why use Dual Frequency for waste management? Choosing the right technology such as high, ultra-high or low-frequency (LF) radio frequency identification (RFID) technology for automated waste management usually comes down to the requirements of the application. Factors to consider when making the decision include: how the RFID tag performs in the environment where it is being applied, its read-range and its signal strength.

UHF read performance around cell towers, wireless DOT cameras, and other licensed and legal UHF ISM band transmitters is greatly affected in the areas where they might co-exist. That spectrum is full of licensed transmitters that will not be shut down if they interfere with a passive RFID application. The RFID readers are unlicensed intentional radiators. Licensed transmitters have the right to "step on" them whereas the reverse is prohibited. There are very few if any licensed low frequency transmitters in residential areas whereas the reverse is true in the 902- to 928- MHz band. If there are devices in the application that "step on" the LF RFID readers, (for example in the waste vehicle), they can be easily identified and shielded.

The UHF tag 96 bit EPC code can be duplicated or copied; LF or DF tags cannot be duplicated or copied. Furthermore, if LF read only (R/O) transponders are used in the waste management application and a read/write (R/W) transponder is used to copy the R/O serial #, it (the R/W transponder) still would return a specific start byte to the reader indicating that it was an R/W and be caught as a fake immediately at the point of read.

UHF tag range is very long and geared towards reading as many tags as possible and cannot be singulated easily. *In the waste management application, this is not thought to be a desired quality.* The application out in the field demands a controlled, homogenous read zone that reads one tag at a time for 100% service verification.

We have also considered that the motor and the control lines of the waste collection truck can also interfere with the reader and transponder, and the need for a strong signal becomes apparent. Dual Frequency works well around a metal environment. Its LF transmit signals are magnetic, small and direct, meaning they don't bounce off the truck's metal walls thereby energizing other stray tags, which creates very accurate and singulated reads.

Dual Frequency has a suitable read range especially in communities where trash disposal units are lined up in close quarters. In the applications where UHF was deployed for waste management, about a 17% failure rate was seen, and those systems were subsequently replaced with LF or DF, which have proven to be the correct replacement and provide 100% read rates. Additionally, a UHF RFID system's longer read range will mean that in a multiple container environment or in a cul-de-sac, all the containers will be read at once (or not singulated) and eliminate the benefit that the RFID system was installed for in the first place. It's already hard enough to keep up with them without help from the inaccurate readings the UHF RFID will give in the waste management application.

DF readers offer a wide input voltage range and can be operated off the vehicle voltage bus, while commercially available UHF readers require their own custom power source that would need to be connected then to an inverter in order to operate off the vehicle voltage bus.

Introduction: The Proposed Technology and System Design

FALKEN Secure Networks Inc. has created an advanced system design which utilizes the latest RFID technology and which is described in detail in this proposal. The proposal, if implemented, would significantly improve waste management by enabling identification and tracking of all waste bins and enabling the billing system with validated current billing data to accelerate and increase cash flows.

While this new system is applicable for both Residential and Industrial waste bins, this proposal focuses on the most common unit –the 240 litre Wheelie Bin selected for Residential and light Commercial use. The larger industrial waste bins can be easily integrated into the same system but requires more study and definition on all types and



sizes of waste bins and the appropriate tag technology selection.

For Residential and light Commercial use, the plan is to use a 240-litre heavy-duty plastic wheelie bin to house and transport waste from residences to the disposal or treatment facility. Ruggedized Passive 'Dual Frequency' RFID tags(no battery nor battery maintenance cycle is required) affixed on the wheelie bins are proposed to document and validate:

- Customer Registration: Customer arrives at the waste contractor's Service Depot location with identification and proper billing documentation. The RFID tag is securely located in a recess under the protective front lip of the bin.

A new and previously tagged Wheelie Bin is now scanned and registered with customer billing data entered into the database. (It is unlikely that the private contractor would be capable of dealing with the logistics of providing home delivery of these bins). The private waste contractor may also want to consider applying a rugged, waterproof, uv resistant vinyl label on each wheelie bin to provide visual identification of the customer it is assigned to.

This will help to ameliorate confusion regarding whose bin it is since they will all look the same otherwise. These labels could be procured with an aggressive adhesive and printed locally by the contractor at the time of initial customer registration.

The private waste collection contractor will generally have a fixed, scheduled travel route, working 5 days a week to cover his assigned territory assuming a once per week service frequency basis. Most waste collection vehicles will have a ruggedized fixed RFID Reader Antenna installed within a meter of the bin lift mechanism. Since the Wheelie Bin is always lifted in the same orientation to assure the lid opens properly for emptying, then it follows that we can always assure that the tag itself is always in a known position and distance from the Reader. With this important assurance, we can then select the appropriate Tag and Reader. The Reader itself is installed within the vehicle and is powered from the vehicle battery using 12V. This Antenna and Reader automatically reads the tag, collects GPS and time stamp data, thereby validating the waste collection and also location data which is subsequently matched to the billing data. Any discrepancy would create a SMS or email alert to the administration. Data from the Readers is collected on the small vehicle-rugged Controller on the truck. Data collected is downloaded to the database when a network connection is available(This could be via WIFI back at the service depot or a USB cable connection to a PC). If the truck is equipped with cellular data network service then a GPRS/HSPDA connection could download the data in Real-Time over the cellular network-although this is a more costly approach. Also the on-board Controller could also be replaced with an on-board vehicle rugged laptop such as a General Dynamics-Itronix(GD6000) to enable additional intelligence on the vehicle and for a further enhanced service and operational enablement.

For smaller waste collection vehicles, such as the motorized tricycles " Bola Taxi ", the Driver will have to perform the tag scanning with a Mobile RFID Handheld unit. Data collected is downloaded to the database when a network connection is available(This could be via WIFI back at the service depot or a USB cable connection to a PC). If the truck is equipped with cellular data service then a GPRS/HSPDA connection could download the data over the cellular network-although this is a more costly approach.

Theft and Tag-Tampering Issues:

Bin theft, vandalism and RFID Tag tampering are considered issues which are anticipated and must be planned for. Simple market demand for a robust waste container will incent many to misappropriate these bins in the early years of the project but should abate with increased bin provisioning and maturity of the project. Billing avoidance is also a strong motivator which must be discouraged with tag technology. The one-to-one relationship between the tag and the asset it is attached to SHOULD NOT be able to be compromised. Conventional RFID tags can be removed with razors, heat guns or chemicals and subsequently placed on other bins or other items. This proposal includes custom software which will alert the operator if the RFID Tag is missing or damaged. If the waste vehicle bin lift mechanism does not read a tag, it will either not empty the bin and return it to curbside or provide an audible or visual alert, record the event and location data in the database for subsequent follow up as appropriate. With a considerable number of these bins in service, perhaps ultimately over a million, measures need to be taken to mitigate these various forms of billing avoidance and theft.

The municipal administration or each private waste contractor may consider a small service charge to have a new tag programmed, registered and installed. Likely the administration does not have much power to ameliorate an outright bin theft and tag removal situation. Victims are likely to have to pick up a new one at the service depot. 240 L Wheelie Bins typically cost \$40 to \$50.

Scalable with Investment Protection:

For the purposes of providing some initial comparative Planning Cost Structure, this proposal assumes an architecture configuration to accommodate 15,000 and 30,000 wheelie bins and with 10 and 20 trucks respectively. Therefore, a typical daily waste collection route per vehicle of approximately 500 bins for a pick-up service frequency of once per week. Tags and Readers can be added without any complications or limitations for the middleware or application software. To scale higher, we simply substitute the Omnitrol Enterprise Server for the Omnitrol A appliance. The Omnitrol A could then be re-used for other service centre locations.

Comparative Service Model Configuration Assumptions - Calculation

For the 10 Vehicle model

- Service Frequency- Once Per Week
- One 8 Hour Shift Per Day = 480 minutes less 45 minute lunch=435 minutes
- Productivity- one bin serviced every 1.5 minutes(90 seconds)=435/1.5=290, Round-Up to 300/day x5 =1500/wk per vehicle x 10 vehicles = 15,000 bins per week total

For the 20 Vehicle model

300 bins serviced per day per vehicle x 5 days/wk x20 vehicles =30,000 bins per week total



From the Pricing Pages on Pages 23,24 Included herein:

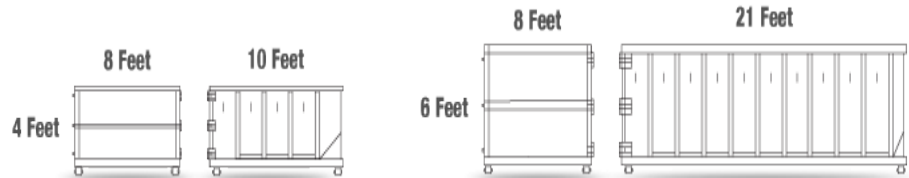
Investment Ratios	<u>10 Vehicles</u>	<u>20 Vehicles</u>
Investment per Vehicle	\$26,115	\$18,405
Investment per Customer	\$17	\$12

Flexibility for the Future – the Future is Welcome:

- **Variable Rate Flexibility and Recycling:** Charging each household for the waste services they actually use can be a valuable tool in the push toward reduced waste and greater diversion from landfill. With the addition of an automated weigh scale on each truck and minor software scripts, this system can also accommodate any future policy change to bill based on weight of waste disposal. This system would also allow enable a Credit system for recyclables collected. Taking advantage of RFID's ability to reliably identify individual receptacles, municipalities can create incentive-based recycling programs that accurately reward customers for the amount they recycle, while minimizing the amount of trash headed for the landfill.

- **Bag Tag Service:** RFID-enabled vinyl Bag Tags, automatically scanned by the Reader on the vehicle can be *Optionally* integrated
 - Use bag tags only as you need them with your own trash bags
 - Order more tags when necessary and have them mailed to your home
 - Great for homes with very little trash

- **Industrial Waste:**



Larger waste bins and “dumpsters” can also be tagged, typically with a special metal-mount RFID tag. In addition, FSN *optionally* integrates ‘Bin Full’ communication sensors to provide SMS alerts to service management that a “bin is full-pick me up”. Knowing remotely when a bin needs to be emptied is valuable information for a waste collection authority or collector.



Operational schematic of the FSN ‘Bin-Full’ Sensor System.

[Each bin would send a text message to a local authority database when it is nearly full](#)

When armed with this knowledge, the contractor can visit a site only when the containers on that site are full, thus reducing the frequency of needless journeys and securing cost savings in staff time, fuel as well as vehicle wear and tear. Municipal studies in Scotland show estimates that a waste collection vehicle costs €15 per mile - including fuel, labour and depreciation. This also helps waste contractors monitor their inventory of valuable containers and dumpsters, some of which can cost up to \$20,000 each. This feature also reduces the occurrences of bins overflowing into parking lots.

- **Hazardous and Biomedical Waste:** This system provides an unprecedented degree of control, accountability and traceability in disposing of hazardous or otherwise sensitive waste material. Along with GPS coordinates and time stamps, this system can also accommodate the integration of RFID-enabled employee ID Badges which establishes a 'Chain-of-Custody' for the transport of hazardous waste to treatment plants.
- **At the Disposal Site: Better Billing Reconciliation:** Landfill sites can also implement RFID to automate confirmation of vehicle and driver arrival, timestamp, and disposal tonnage details. Landfill invoice reconciliation becomes much easier and faster as the driver is able to enter the dump location, commodity, tons, and so forth.
- **Real-time Communications and On-Board Computer:** Our system accommodates the addition of GPRS Cellular Data communications to provide real-time data downloads to the central database, thereby allowing next day invoicing and acceleration in cash flows.

About FALKEN Secure Networks Inc. (FSN)



Headquartered in the Greater Toronto Area, FALKEN Secure Networks (FSN) is the leading Canadian System Integrator and Solution Architect for advanced Active/Passive Unified RFID systems that leverage 'Best-In-Class' standards-based technologies. FSN integrates RF technologies for asset visibility, using RFID, Wi-Fi and Real-Time Location Systems (RTLS) for cost-effective design, and turn-key project implementation. The breadth of FSN's domain expertise and RFID solutions portfolio is unsurpassed in the industry, making FSN the System Integrator of choice for complex and challenging operational environments.

The emerging corporate applications for secure RFID Network solutions for Asset Tracking, Chain of Custody, Document Tracking and Real-Time, Work-In-Process Visibility are focused expertise areas of FSN's RFID division. Further, we also leverage our Secure Communications business to ensure that our RFID proposals embrace best-practice security and authentication assurance as well.

This, along with our industry-leading partner team, makes FSN a unique and leading Canadian System Integrator.



FSN has partnered with global leaders in Next Generation Secure RFID Networks and Information Encryption. FSN and our partners add their own industry-specific expertise, with a joint commitment of helping deliver networked RFID solutions and are designed to meet and exceed the varied and complex needs of our customers. In addition, our flexible application solutions may be provided on a hosted, managed service basis or on-premise as customer requirements dictate. We also present a vendor-neutral position to clients for RFID Tags and Readers to ensure we are solely guided by optimally solving the business and physics issues – not simply trying to push one vendor’s hardware.

About Omnitrol Networks



Omnitrol Networks has developed the industry's first open, programmable, peer-to-peer asset management and services network. The Omnitrol Network securely integrates business intelligence with real-time sensor technologies to provide real-time operational visibility on assets and plant operations.

The award winning OMNITROL™ appliance integrates complete application intelligence integrating new sensor technologies such as RFID, Wi-Fi, PLC controllers and smart sensors providing a single integration point from device management to holistic dashboards and data management for shop-floor operations. Some of the OMNITROL values include:

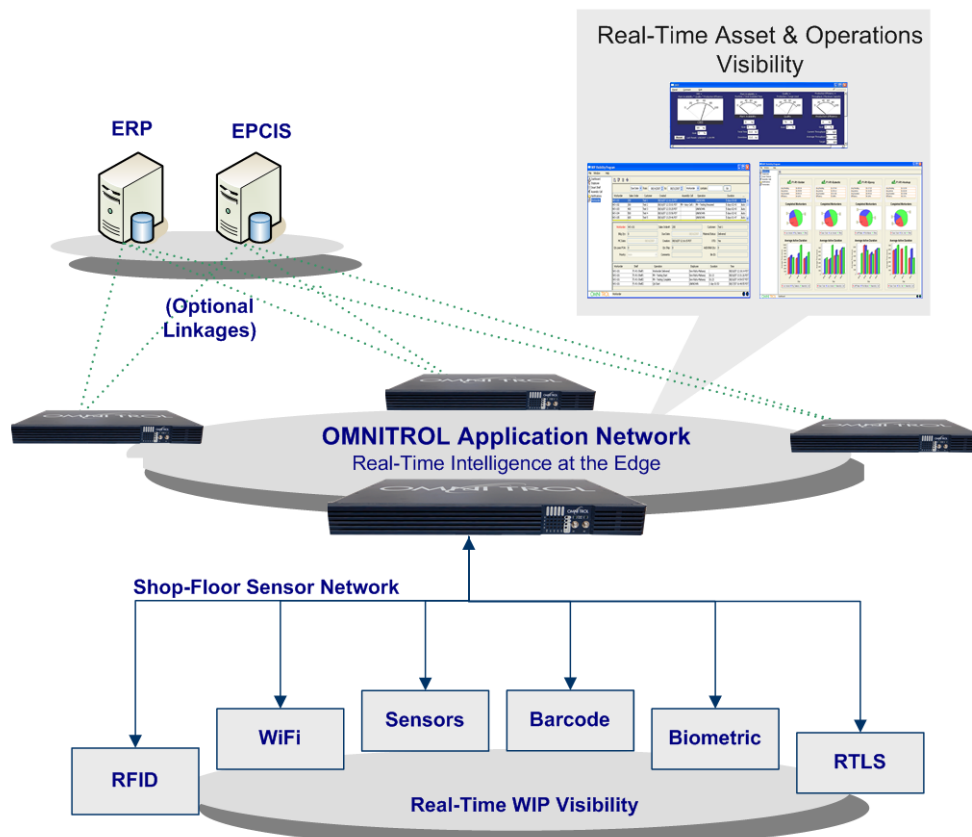


Figure 1 OMNITROL Software Architecture

- Built-in security and VPN services for secure communications on asset tracking
- Complete operations dashboards with real-time notifications
- Scalable and incremental deployment model across multi-site deployments
- No impact on IT and back-end server operations
- Isolates sensor network services, traffic and event processing from the Enterprise
- No requirement for upgrades or customization of existing backend ERP systems
- Fully integrated EPC compliant ALE with intelligent ALE aggregation services
- EPCIS integration for asset pedigree and location management
- Lowest TCO in the market

The OMNITROL Services Network (OSN) architecture delivers a reliable, scalable and secure real-time peer-to-peer application overlay on your existing operations network. The OMNITROL services node completely delivers end-to-end asset tracking, Work-in-Process visibility, M2M automation and real-time alerts with automatic notifications to shop-floor staff – all without requiring any change to your existing infrastructure.

Omnitrol's customers are creating a new sensor powered network for integrating real-time business intelligence in manufacturing automation, asset tracking and ultimately a more collaborative and intelligent supply-chain operations network. The OMNITROL has developed a powerful new paradigm in real-time asset tracking, visibility and traceability integrating industry standard EPCIS services. With the intelligent peer-to-peer software architecture the OMNITROL is delivering shop-floor to top-floor intelligent supply-chain event processing to enable much leaner and Just-in-Time (JIT) inventory management between multi-site operations and between corporate partners.

To meet the scalability and flexibility requirements, the OMNITROL team developed a powerful service execution platform that resides on the OMNITROL Services Network. The service execution environment includes a real-time event-driven Services Description Language (SDL) that enables rapid service creation and customization known as EDGELETS™. The OMNITROL appliance empowers our customers to create service enhancements without vendor dependency.

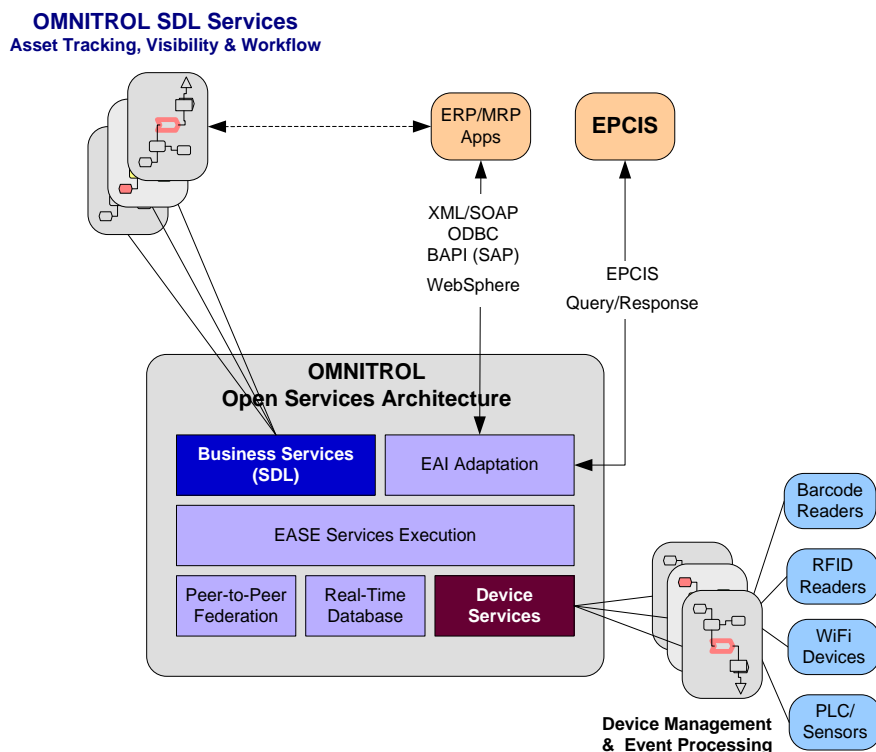


Figure 1 OMNITROL Software Components

The EDGELET service execution tools have been so well received by their customers, that University of Texas at San Antonio (UTSA) and Missouri University of Science & Technology (MS&T, the former University of Missouri at Rollo (UMR)) are using the OMNITROL to teach their graduate students advanced manufacturing, asset tracking, WIP and M2M automation techniques.

By combining, all the computing, networking and software resources into a single application network device, Omnitrol Networks is going to be a catalyst of the IT transformation that will support the proliferation of intelligent edge networks. The OMNITROL appliance is taking the complexity out of the deployment of sensor technologies and smart devices in the operation while also changing the economics of contact-less technology based projects delivering substantial performance improvements at the lowest total cost of ownership in the market.

Omnitrol Networks has developed the industry's most advanced sensor based business application network product. The OMNITROL application network appliance is pioneering the delivery of real-time operational visibility through the convergence of next-generation sensor network technology with existing business processes.

Scope of Work

Deliver and configure a turnkey solution which will provide 'initial registration, modification, decommissioning capability for the wheelie bins using fixed RFID Readers and Antennas on each truck and a stationary reader in the Receiving Dock at the disposal facility to automatically record the arrival of a 'tagged' waste vehicle. One RFID Desktop Reader is an *Option* to efficiently register the RFID Tags or the RFID Mobile Handheld can be utilized for this purpose after the tag is affixed to the waste bin and for back-up. The RFID Mobile Handheld will be ruggedized and have GPS feature and GPS software scripts included. The use of *Optional* Employee ID tags can further provide for a validation of employee accountability and for a chain-of-custody for the Bin.

Create and document a SQL database that can be accessed by the Private Waste Contractor or MMDA Billing System.

Statement of Work

FSN will configure and apply the OMNITROL Asset Tracking solution to meet the requirements in this document. This system will use Dual Frequency Passive RFID to facilitate the real-time tracking of waste bins and associated vehicles.

Tracking of the assets(bins) will be accomplished by tagging each asset with passive RFID tags, and then using one fixed RFID Sensor station to detect the asset(bin) and read its tag during the lifting and emptying process.

The following items will be installed at the facility for the Waste Bin Tracking system:

1. One OMNITROL-M appliance, Middleware and Bin Tracking Application software. Create and document a SQL database.
2. Ten/Twenty ruggedized fixed RFID readers (one for each truck)
3. one stationary RFID reader in shipping doc of waste disposal facility
4. One ruggedized Mobile RFID Handheld with GPS feature and sw scripts
5. 15,000 or 30,000 Dual Frequency RFID Tags will be provisioned. Affixing the tags to the waste bins is a customer responsibility. FSN will provide appropriate supervision training.

Project Plan

This section defines the scope and work breakdown structure for collaborative development and final deployment by FSN.

Staging, Installation and Commissioning

- Provisioning of 15,000 or 30,000 DF RFID Tags for customer attachment on bins.
- Staging and pretest of all equipment at FSN Facility
- Shipment of complete solution to customer identified site
- Equipment installation including:
- One OMNITROL-A appliance

- Ten (10) RFID readers , or 20
- One (1) Stationary reader for the loading doc of Waste Facility
- One (1) Hand Held Reader with GPS and associated custom scripts
- Create and document a SQL database accessible by the billing system. On-site configuration
- On-site Customer Acceptance Testing

Customer Acceptance

A step-by-step system testing approach will be defined in collaboration with the Customer. The system will be tested for correct interfaces and service delivery. Performance characteristics such as tag read performance, reader range and tag registration with database, will be carefully measured.

- DF Tag attachment to bin (aggressive 3M Marine Adhesive recommended)
 - Asset Registration via the Handheld (Optionally a registration reader can be purchased which connects to a local PC via a USB port)
 - Asset Reconciliation test
 - Asset Location using a hand held
 - Confirmation of Data accessible by Billing System

System Components

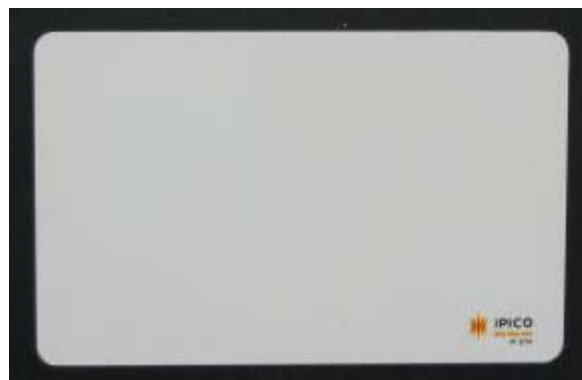
Passive UHF, 'Dual-Frequency' RFID Tags

All tags presented in this proposal are Dual Frequency RFID Tags which have extremely high read rates and are designed exclusively for use around liquids or in lossy environments such as found with Waste Bins. The proposed tag is the size of a credit card and consists of a chip module attached to 125kHz and 6.8MHz coil antennas, laminated in a 1.2 mm plastic card (85 x 54 x 1.9 mm).

FSN has quoted 15,000 or 30,000 tags for this proposal depending on the implementation model selected. Additional tags may be ordered in minimal order quantities of 5000.

Key Features - Dual Frequency Tag

- § Low cost single chip solution
- § Compliant with USA, European, Australian, and RSA spectrum allocations
- § Dual frequency (Transmit 125kHz / Receive 6.8MHz)
- § Long read range in electrically noisy environments - 1.0 m with "Medium Range" Reader or anywhere within a 1.8 m wide portal made up of two such Readers
- § Printable surface
- § Robust Anti-collision protocol (up to 120 tags read simultaneously)
- § Fast moving tags (8 m/sec) can reliably be read
- § Factory programmed 64 bit ID number
- § High tag transmission rate (128 kbits/sec)
- § High tag read rate - up to 155 tags/sec
- § On-chip oscillator and 6.8 MHz antenna driver
- § Passive - no battery
- § -40 to +85 OC temperature range
- § Programmability Read-only, factory programmed ID, 64 bits
- IP rating: IP 68 , UV resistant: Yes
- § Can be repackaged in custom enclosures

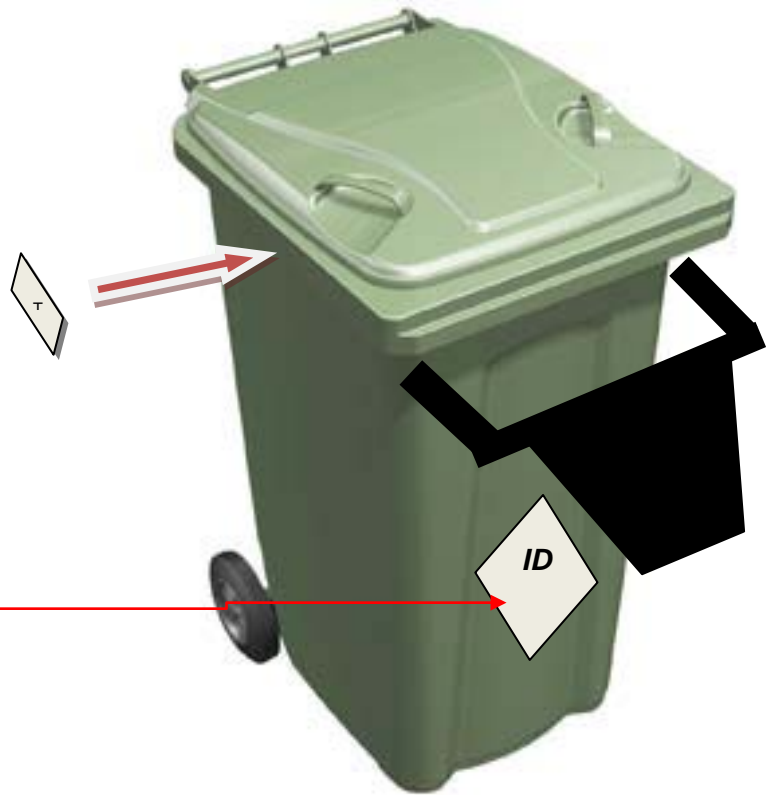




Tag Positioning

*Recommended
RFID Tag Position
in the recess under
the protective lip of
bin*

*Printer and Label sw may
be used to provide visual
customer identification,
company logo, etc on a
label.*



OMNITROL-A ATS Appliance

The core of the ATS is the OMNITROL-A appliance. This appliance manages the sensor network with its middleware and runs the Bin Tracking Application software. It can connect up to a maximum of 25 separate devices. Data collected on this device will be stored on a customer provided workstation with a customer provided database.



Mobile Computer/Scanner

The mobile computer with RFID scanner will be used to do initial bin registrations and to facilitate miscellaneous asset inventory/reconciliations. The 'Dual Frequency reader is paired with a Hewlett Packard PDA with GPS capability. Specialized scripts are created to provide the User Interface to complete registrations, changes to bin allocations and complete inventory reconciliations.. It has a docking station that is used to recharge the battery. It communicates over the Customer WiFi network or the customer wired LAN connection when docked with a customer supplied workstation with the OMNITROL ATS.



RFID Fixed Readers and Antennae for Plant Area

A Reader and two Antennae will be installed at the shipping dock.

Interface required at the sensor station include:

- a. 1 x ethernet connection, plus AC power OR
- b. 1 x Power over Ethernet connection with a minimum of 15.4 watts
- c. Static IP address

RFID Fixed Readers and Antennae for Truck

The RFID Readers will be mounted on the vehicle in a location which optimizes tag reads as the bin is lifted and emptied by the vehicle's fork lift mechanism. The unit will be powered from the power bus of the vehicle. A WIFI Dongle will communicate with the Omnitrol system when in range of the the Waste Management Facility. A Linux Processor is included in the configuration to store and manage all Tag reads while remote to the facility.

This System is designed to Welcome the Future

This system will scale cost-effectively to accommodate growth as well as have the capability to be federated or networked to provide a single centralized management view of multiple administrative or service locations.

Once implemented, this RFID system may be leveraged to also track People, Tools&Equipment, Physical Documents and Inventory items or other assets.

ATS Administration Processing

The following steps describe the activities and processes required to set up and administer

Asset Tagging and Registration

Prior to being tracked the assets must be tagged with an RFID tag and registered with the ATS. To do this, the operator will use the ATS user interface and the Mobile Computer as follows:

- a. Log on to the ATS system via a PC and select the “Asset Registration” option on the menu.
- b. Select the appropriate RFID tag type for the asset and attach it
- c. On the Asset Registration Screen enter the following asset information:
 - o Name of asset
 - o Asset number
 - o Asset type
 - o current area or zone where asset is located
- d. The ATS system will then generate a tag id and the mobile computer or Sensor station will then write it to the tag. This tag will then be associated with the asset.

Asset Tracking Processing

The following steps describe the ATS process and capabilities in the automated tracking of assets..

Wheelie Bin Pick Up and Delivery to Plant

The process to add or remove an asset consists of the following steps. The Mobile Computer will be used the check in / out the asset.

- a. Select the required asset
- b. Click the Hand-held trigger and point the RFID reader to read the asset and the employee tag. Confirmation will be displayed on the screen.

Querying an Asset Location

When someone needs to locate an asset, the following steps are performed:

- a. Log on to the ATS system via a PC, and select the “Asset Location” option on the main menu.
- b. On the Asset Location screen enter the name or number of the asset to be located. The ATS will display the most likely area or zone where the asset is to be found.

Locating an Asset Using a Mobile Scanner

After the location/area has been determined via an ATS asset location query, the mobile scanner can be used to scan the location/area to further localize the asset. To do this the following steps are performed:

- a. Using the Mobile RFID Scanner select the “ATS Localize Asset” function. The user will be prompted for the asset to be located.
- b. Enter the name or number of the asset to be located. The OMNITROL ATS will download the RFID tag identifier to the Mobile RFID Scanner.
- c. Walk around the location/area scanning with the Mobile Computer RFID Scanner. It will indicate if it is within a set range of the asset.

Support and Warranty

Software: Annual software licenses and technical and maintenance support fees are mandatory and ensures on-line technical support as required, the software is always automatically updated with the latest release, as well as provisions any bug fixes as released.

Hardware: FSN, through its manufacturer partners, provides the standard manufacturer hardware warranties .

In addition, FSN can make available a set of service agreements to provide a comprehensive level of support as desired by the customer, including No Fault Immediate Replacement, and Repair and Return. All standard 3rd party warranties (typically 1 year-Repair and Return) are passed through to the customer. Hardware support for the Omnitrol platform is mandatory in year 1 and optional thereafter.

A Couple of Case Studies

Case study: pay-as-you-throw in Sictom Loir-et-Sarthe, France

This promise was reflected in the south of France, where Sictom Loir-et-Sarthe (the local authority) faced high waste management costs and low recycling rates. The authority implemented a two-pronged attack - introducing a general 'pay-per-throw' tax in conjunction with RFID technology.

Containers were distributed to each property with a personalized ID tag. The authority then piloted the identification and weighing system with 44,000 residents over five of its regions in 2004. Eight months later, recycling rates had increased from an average of 15% to 57% and waste-processing costs had reduced by 10% (in parallel with the decreasing volumes of waste being generated).

Case study: variable charging in Philadelphia

Similarly impressive results have been achieved in the US, where in 2006 a RFID system was introduced to 5000 households in two Philadelphia suburbs.

The RFID system uses tagged bins which communicate with data readers and scales on waste collection vehicles. In addition, the waste firm partnered with various local and national retailers and introduced an incentive scheme that rewards diligent recyclers with US\$5 vouchers for every 10 lbs (4.5 kg) of paper, cans or bottles recycled. This benefits both recycling rates and business for participating retailers. The pilot ended with dramatic results, with the percentage of households recycling rising from 25% to 90% at the end.

