How FlexNet from Apriso Unlocks the True Potential of RFID Technology

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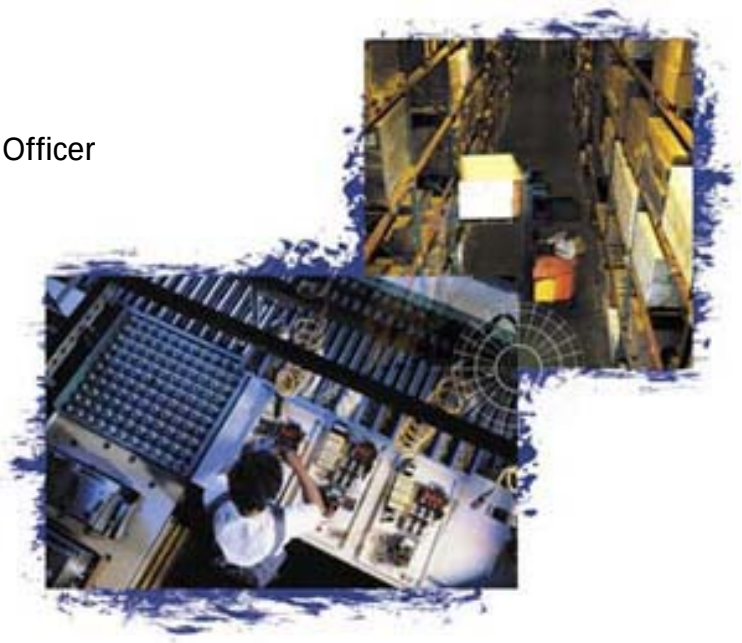

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Key Idea

In tandem with real-time, bottom-out enterprise software, RFID is poised to become the catalyst for significant change in the way business processes are executed among enterprises participating in extended supply networks.

Executive Summary

Radio Frequency Identification (RFID), a technology for tracking material from cereal boxes to freight cars using increasingly tiny electronic tags — or even microchips embedded in or attached to the material or its packaging — is becoming a very hot technology. RFID is rapidly gaining market share as standardized forms of the technology are introduced and as production costs fall.

Because it eliminates the need for manual data entry and scanning, RFID is often thought of as an alternative form of Automatic Identification and Data Capture (AIDC) — in other words, as a replacement for the ubiquitous bar code.

But just as enterprise computing evolved to become a strategic necessity for business, and not just a tactic for automating clerical tasks, RFID is poised to become the catalyst for significant change in the way business processes are executed among coalitions of enterprises participating in extended supply networks. The key lies in combining the location sensing capabilities of RFID technology with dynamic, real-time processes for carrying out production, logistics, quality control and maintenance tasks.

FlexNet™ from Apriso®, the world's first bottom-out enterprise software, is the only enterprise software built from the ground up with location sensing in mind. In tandem with RFID technology, it offers unmatched capabilities for executing dynamic manufacturing and supply processes in a truly global, collaborative and real-time manner.

What is RFID?

RFID is an electronic tracking system where any item of interest, from individual articles in a warehouse to complex assemblies, can be precisely located and uniquely identified.

An RFID system has three components:

1. An antenna
2. A transceiver
3. A transponder (RF tag or “e-tag”) electronically programmed with unique information, which can be attached to items of interest, or even embedded in its packaging or carrier, so that it may be located or tracked

The antenna emits radio signals to activate the tag and read or write data to it. Antennas are the conduits between the tag and the transceiver, which controls the system’s data acquisition and communication. Available in many shapes and sizes, antennas can be built into a gantry or doorframe to receive tag data from persons or things passing through the door, or mounted on a tollbooth to monitor traffic passing by on a motorway. The electromagnetic field produced by an antenna can be constantly present when there is a continuous flow of tags through the gantry. Otherwise, a sensor device can activate the field.

Often the antenna is packaged with a transceiver equipped with a decoder to become a handheld or fixed-mount reader. The reader emits radio waves in ranges of anywhere from one inch to 100 feet or more. When an RFID tag passes through the electromagnetic zone, it detects the reader’s activation signal. The reader decodes the data encoded in the tag’s integrated circuit (a silicon chip) and the data is passed to the host computer for processing.

Key Idea

There is a growing momentum to achieve standards commonality -- whereby RFID equipment from different manufacturers can be used interchangeably – which will allow the RFID market to grow exponentially in coming years.

RFID tags come in a wide variety of shapes and sizes. Animal tracking tags, inserted beneath the skin, can be as small as a pencil lead in diameter and one-half inch in length. Tags can be screw-shaped for implantation in trees or wooden items, or shaped like credit cards for use in access applications. The anti-theft hard plastic tags attached to merchandise in stores are RFID tags. So, too, are heavy-duty transponders used to track shipping containers, heavy machinery, trucks, and railroad cars.

RFID tags are categorized as either active or passive. Active RFID tags, containing up to 1MB of memory, are powered by an internal battery and allow tag data to be rewritten or modified. The battery-supplied power of an active tag generally gives it a longer read range. The trade-off is greater size, greater cost, and a limited operational life.

Passive RFID tags operate without a separate external power source and obtain power generated from the reader. They are typically read-only and are pre-programmed with a unique set of data (usually 32 to 128 bits) that cannot be modified. Passive tags are consequently much lighter than active tags, less expensive, and offer a virtually unlimited operational lifetime. The trade-off is that they have shorter read ranges than active tags and require a higher-powered reader.

RFID frequencies vary, too. Low-frequency (30 KHz to 500 KHz) systems have short reading ranges and lower system costs. They are most commonly used in security access, asset tracking, and animal identification applications. High-frequency (850 MHz to 950 MHz and 2.4 GHz to 2.5 GHz) systems — including the IEEE 802.11 (2350 - 2450 MHz) “Wi-Fi” frequency — offer long read ranges (greater than 90 feet) and high reading speeds, and are used for such applications as railroad car tracking and automated toll collection.

Though it costs more than bar coding, RFID technology is indispensable for many automated data collection and identification requirements because of its non-contact, non-line-of-sight nature. Tags can be read through a variety of substances such as snow, fog, ice, paint, crusted grime, and other visually and environmentally challenging conditions. They can also be read in challenging circumstances at remarkable speeds, in most cases responding in less than 100 milliseconds. The read/write capability of an active RFID system is a significant advantage in interactive applications such as work-in-process or maintenance tracking.

Recognizing this, there is growing momentum to achieve standards commonality — whereby RFID equipment from different manufacturers can be used interchangeably — which will allow the RFID market to grow exponentially in coming years.

Key Idea

Identification is not the only way to use RFID. Many other immediate and future uses of RFID are possible, too.

Current and Future Uses of RFID

Identification is the simplest and most common use of RFID today. Passive RFID tags most often operate as license plates or indexes into a database, in the same way that barcodes reference a database containing information about products, containers, and equipment. Identification systems are highly reliable, and yield significant labor savings, because they are “always on.”

But identification isn’t the only way to use RFID. For example, you can use active tags in a work-in-process system to provide a custom set of instructions to a machine unique to the assembly bearing the tag. After the custom operation, the machine reports its performance to the tag, which becomes part of the tagged part’s history — not in a database, but right on the tag. As we shall see, many other immediate and future uses of RFID are possible, too.

RFID As a Barcode Replacement

Key Idea

Because it eliminates the need for manual data entry and scanning, RFID is often thought of as an alternative form of Automatic Identification and Data Capture (AIDC) –in other words, as a replacement for the ubiquitous bar code.

RFID has attracted a lot of attention in the business press lately. Mostly, these articles position the technology as a barcode replacement. The market seems poised to take the new technology up quickly, because production costs are falling fast. Wal-Mart, for example, has recently mandated its top 100 suppliers to have all their cases and pallets “chipped” by January 1, 2005.

Without doubt, there are many possibilities for replacing barcodes with RFID. Anyone who has ever stood endlessly in a checkout line, waiting for other customers’ purchases to be manually scanned, can appreciate the benefits of simply walking through a gantry and having everything in the shopping basket rung up in one second or less. Likewise, retailers can appreciate the benefit of not having to hire so many cashiers and receiving clerks to do what is, essentially, non-value-add work.

Industrial users would reap similar benefits, too — particularly in high-volume receiving, shipping, and warehousing environments.

Recognizing this, major packaging manufacturers are introducing such items as “intelligent packaging,” comprising cartons and cases that not only come pre-printed with barcodes, but also embed passive RFID tags right in the packaging. The tag contains the same Universal Product Code (UPC) as the barcode, making RFID entirely compatible with existing back-office inventory control databases.

RFID is stirring a measure of controversy, too. If your purchases are scanned on their way out of the store, what’s to prevent them from being tracked to your house? What about your product usage patterns after the sale? Would such tracking constitute an invasion of privacy? What sorts of abuses might retailers, distributors, and manufacturers perpetrate?

All of this is reminiscent of the unfounded fears when UPC barcodes first started to appear on packaged goods, back in the 1970s. Activists immediately charged that retailers would deceive customers by removing price tags from products — and ringing up a higher price at the cashier than was marked on the shelf — in hopes that the average consumer wouldn't notice the difference. Such controversy died down quickly, and bar coding became an accepted fact of life all over the world. The privacy concerns surrounding RFID will likely meet a similar fate.

Key Idea

Location sensing opens up a world of possibilities for running the business that goes far beyond simple barcode replacement.

RFID For Location Sensing

One of the most promising but less-explored opportunities for RFID is in location sensing, which allows you to position items of interest in real-time — from movable equipment such as forklift trucks, to individual articles of material and even goods in motion such as work-in-process or livestock.

Because a stationary gantry has a fixed set of geographic coordinates, building an RFID antenna into a gantry tells you not only what passed through, but also its position. Building successive gantries allows you to track changes in an item's position, like tracking a car as it passes through one tollbooth after another on a motorway. But this approach is impractical in a modern factory, warehouse, or distribution center with its complex network of paths.

A better approach is to install transceivers as access points, above the floor, and use a location sending method such as differential time of arrival (DTOA), comprising:

- Knowledge of the locations of the transceivers
- An accurate time stamp, to the nanosecond, of the time of arrival of the same message at three or more transceivers

- Accurate synchronization of transceiver times of arrival (TOA), so everything is on the same clock
- Collection of TOA data in a location server and application of DTOA algorithms to determine the ellipse — the result of two intersecting hyperbolae that represent the possible locations of the tag from any pair of transceivers

This approach, illustrated in Figure 1, is conceptually similar to Global Positioning System (GPS) technology, where the antennae are built into satellites in orbit above the Earth.

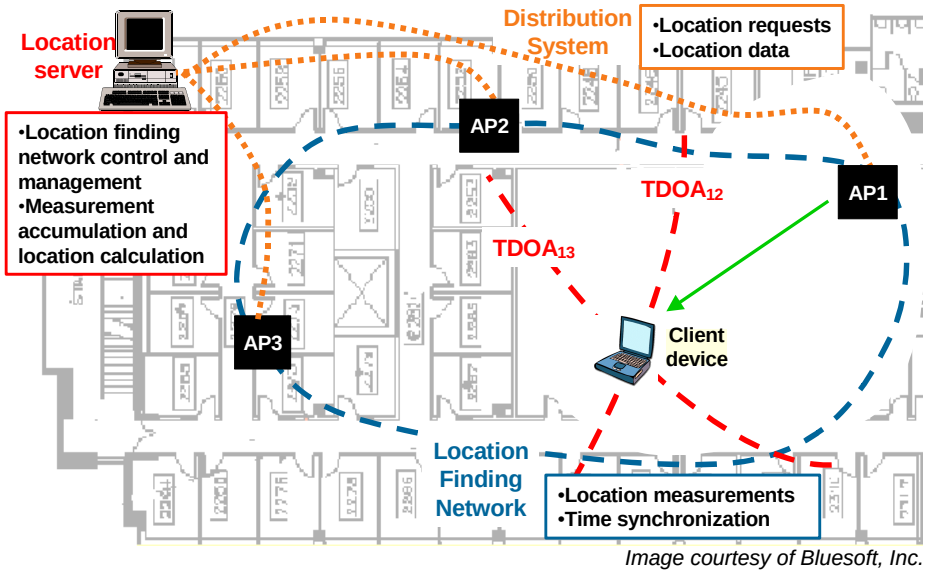

Image courtesy of Bluesoft, Inc.

Figure 1 — Using Differential Time of Arrival (DTOA) for Location Sensing

Comparing the TOA of AP1 and AP2, and knowing the location of each access point, it is possible to calculate a hyperbola that represents all of the points where the tag could be. AP2 and AP3 also create a hyperbola and the intersection of these two is the location. (AP1 and AP3 also create a hyperbola, which in a perfect world would intersect in exactly the same place, but in the real world a very accurate location estimate can be made with two measurements).

Location sensing opens up a world of possibilities for running the business that goes far beyond simple barcode replacement. For example:

- Many businesses lose track of inventory that continually shifts between locations or bins to make space for other product. Often, this happens when procedures for transferring stock from one location to another are so tedious and time-consuming that employees ignore them. Corrective actions, such as periodic cycle counting and hunting for material, add no value and are an expensive waste of time. With location sensing, stock locations are constantly kept up-to-date and accurate, with zero human effort.
- Task scheduling and delegation can become unmanageable when critical resources like forklift trucks and tooling are constantly moving throughout the plant. Asset tracking using barcodes or stationary RFID gantries, requires endless backtracking to data collection points, adding no value and wasting time. But with location sensing, the positions of these assets are constantly kept up-to-date and accurate, again with zero human effort — in the same way that an automobile navigation system keeps constant track of the vehicle's location without backtracking or human intervention.
- Sequenced production, popularized by successful models such as the Toyota Production System, is an essential lean manufacturing tactic. It allows you to dramatically reduce lot sizes by sequencing the timing and arrival of components that are needed for individual production units. At Toyota, sequencing is enforced through fixed conveyor systems whose speed matches the required *takt* time of the plant — a method that is highly effective for Toyota but problematic for plants that operate flexible production lines. With location sensing, the

positions of ultimate production units and their individual components are continually kept up-to-date and accurate, with zero human effort, just as if the materials were moving along a fixed production line.

How FlexNet Supports RFID

Key Idea

No other vendor or off-the-shelf software application has more built-in thought or support for RFID from its original conception.

FlexNet from Apriso is the world's first “bottom-out” enterprise software — a new software paradigm for twenty-first-century enterprises whose goal is operational excellence. The FlexNet suite provides a Web-services-based, end-to-end, real-time, event-driven application architecture focused entirely on an enterprise’s global supply, production, and distribution processes. FlexNet uniquely provides its users the means to transition to a real-time, demand-driven, adaptive business model based upon total visibility (including the visibility gained from RFID technology), borderless collaboration, and the principles of six sigma and lean supply.

FlexNet's event-driven, real-time model is ideal for RFID, which is, in essence, a method for real-time, random-event-driven data collection. Working from user-defined process flows that easily describe the context of each RFID application, FlexNet provides turnkey integration between any standards-compliant RFID solution and the broad and growing family of collaborative FlexNet bottom-out applications. The net result is that a new RFID deployment can be accomplished in a matter of weeks. No other vendor or off-the-shelf software application has more built-in thought or support for RFID from its original conception.

Figure 2, below, shows how to integrate FlexNet with a typical RFID or location sensing system. The tags and transceivers, which utilize standard wireless networking technology such as Wi-Fi, are available from a variety of vendors who also provide servers for systems integration, distance measurement (DM), and location finding (LF).

These, in turn, provide an industry-standard OLE for Process Control (OPC) interface with data points representing:

- Tag identifiers such as a UPC, asset number, or employee badge
- Time stamp
- Latitude
- Longitude
- Altitude

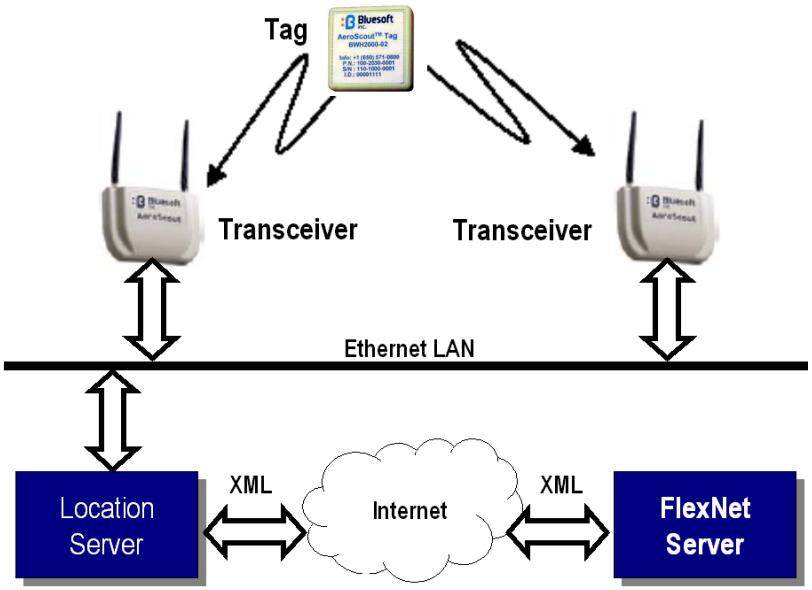

Figure 2 — System Integration Diagram

New location sensing systems based standard Wi-Fi technology, such as the AeroScout™ Wi-Fi Location System from Bluesoft (www.bluesoft-inc.com), can sense not only RFID tags but also mobile wireless local area network (WLAN) devices — such as personal digital assistants (PDAs), RFID readers and radio frequency (RF) terminals on forklifts — as a “proxy” location. In other words, by locating those devices you can locate the person, asset, forklift truck, or RFID tag that the device is near. This is a distinct advantage because it eliminates the need to attach tags to everything.

FlexNet provides out-of-the-box integration to the AeroScout and other systems via FlexNet Machine Integrator. Using Machine Integrator, you define extensible markup language (XML) data point connections to the RFID system — quickly and interactively — along with time deadbands. These represent the minimum time delay for sensing consecutive data point values, and thereby determine the frequency for updating data about each tag, such as the tag's current position. Because the data point connections can be bi-directional, FlexNet Machine Integrator supports both active and passive RFID tags.

Because it defines RFID data point connections as XML messages, FlexNet Machine Integrator is capable of tracking tags not only locally, using a local area network (LAN), but also worldwide across the Internet. As a result, FlexNet provides seamless location tracking not only *within* plants and warehouses (using RFID technology) but also *between* plants and warehouses (using GPS technology). No other business application suite in the world has this capability.

For instance, FlexNet is unique in allowing you to define resources such as people, equipment, and containers as mobile or stationary. Defining a resource as mobile allows FlexNet to track its current and historical locations using GPS and RFID technology.

Locations, in turn, are represented as sets of geodetic coordinates. The FlexNet database is capable of storing coordinates as degrees of latitude and longitude — more precisely, in fact, than today's RFID location sensing technology, in the expectation that the precision of RFID location sensing technology will steadily improve in the future. Today's RFID technology is accurate to within approximately one meter, while at the Equator, or for any degree of longitude, the FlexNet database is accurate to a distance within .00011 *micrometers*.

The use of geodetic coordinates is the key to integrating GPS and RFID location sensing technology. It possesses enormous advantages over conventional off-the-shelf warehouse management systems that define arbitrary *x*, *y,* and *z* coordinates for plants and warehouses. Because those coordinates do not refer to a common reference scheme, it is impossible to relate the coordinates of one facility to those of another — which makes it impossible for those systems to integrate RFID location sensing systems (for internal location tracking) with a GPS system (for external location tracking).

FlexNet always remembers the last position of a mobile resource by tracking its time stamp, coordinates *x* and *y*, and altitude *z*. FlexNet can also track when to expect the next position report, and optionally records a permanent location tracking history. All of these positions can be related to stationary resources, whose addresses are positioned using geodetic coordinates.

Key Idea

Think of FlexNet as a navigation system for every node in your extended supply network, embracing not only your own enterprise but also the entire coalition of enterprises comprising your suppliers and customers.

Putting it All Together with FlexNet

Knowing where everyone or everything is located — all the time — is something that businesses could only dream of in the past. However, the real benefits lie in knowing *what to do* with this information. That's where FlexNet workflow, task, and resource management capabilities enter the picture.

To visualize this, consider again an automobile navigation system. In addition to a location sensing apparatus, its essential components include:

- A digitized map of all highways, roads and streets — plus a directory linking telephone numbers to addresses, and addresses to geographic coordinates (some navigation systems keep this data in an on-board digital video disk (DVD), while others get it in real time via satellite)

- A video display that continually superimposes the vehicle's current position (from the location sensing apparatus) against an image of the map that surrounds the current position
- Algorithms for real-time route planning and re-planning, using rules such as "easy," "shortest," "avoiding tolls" and so forth
- Algorithms for evaluating the current position in relation to the planned route, and translating this evaluation into graphical as well as voice instructions such as, "Keep right," or "In one mile, turn right onto 405 freeway"

You start your journey by identifying a destination; either by geographic position, address, or a telephone number that links to an address. Then, you allow the navigation system to plan your trip, beginning at the current vehicle position, using your preferred rule. As you drive, the navigation system gives you instructions on what to do next, based on your current position. If you stray off course or make a wrong turn, the navigation system automatically re-plans your trip and adapts its instructions accordingly.

Think of FlexNet as a navigation system for every node in your extended supply network, embracing not only your own enterprise but also the entire coalition of enterprises comprising your suppliers and customers.

In addition to supporting real-time GPS and RFID location sensing, FlexNet has the following essential components:

- FlexNet Process Builder, which allows you to maintain a digitized map of all operational processes for production, receiving, shipping, materials handling, quality control and maintenance

- The FlexNet Portal, a browser-based display that connects touch workers via the Internet, and continually informs them of their current activity and location in relation to active tasks and operations
- FlexNet Workflow Manager, an inference engine for real-time dispatching and re-dispatching of operations and tasks to specific resources, using rules appropriate for each process, node, and resource
- Language-independent work instructions delivered to touch workers in real time, verbally, or in graphical or text form

The following is just one of many scenarios that FlexNet supports.

In today's typical warehouse environment, deliveries are often dispatched to specific forklift operators from stations located centrally within each zone. After completing their work, the forklift operators have to backtrack to their station for more work. Backtracking wastes time and fuel. Also, zonal dispatching doesn't necessarily achieve optimal business performance.

For example, a zone experiencing heavier-than-usual demand may develop a picking backlog, creating delays, while forklift operators in other zones sit idle.

These problems disappear when FlexNet is combined with RFID technology, because:

- FlexNet knows *where* your tagged material is located, *at all times*
- FlexNet knows *where* your tagged forklift trucks are located, *at all times*
- FlexNet knows *what* each forklift operator is doing, *at all times*

When new demand arrives, FlexNet Workflow Manager:

- Determines which forklift operator is currently located *closest* to the required material, and *available* to perform the delivery
- Automatically dispatches the delivery to this forklift operator
- Monitors the operator until the delivery is completed

The FlexNet Portal and FlexNet Warehouse Manager:

- Update the operator's work list in real time, alerting the operator of the delivery (this can be done through a mobile computer or PDA, over the wireless LAN)
- Provide real-time pickup and delivery instructions in each operator's native language, allowing operators to navigate to the right aisle, row and bin before picking up the material, and subsequently to the right drop-off point

Meanwhile, FlexNet Machine Integrator, in tandem with the RFID system, tracks both the material and the forklift truck in real time as they navigate through the warehouse. All sensing, dispatching, notification and monitoring can be done on-site, or at remote sites (for example, at public or bonded warehouses) over the Internet. Because FlexNet works in *all* time zones, it automatically takes care of converting synchronized delivery schedules into the correct local time of day. Note that during the entire process:

- The operator isn't required to perform *any* data collection actions — FlexNet can even be configured to record the beginning and end of each task automatically
- FlexNet automatically captures the actual cycle time for performance monitoring purposes

FlexNet Workflow Manager can also be configured to deal with any problems that occur, or to create the most efficient possible backlog when operators are available to do the work.

Conclusion

Key Idea

Apriso is the first and only business application software vendor in the world to turn the vision of the real-time enterprise into reality.

FlexNet, configured to utilize affordable, off-the-shelf RFID technology, bridges the gap between tomorrow's vision and today's accomplished fact.

Apriso is the first and only business application software vendor in the world to turn the vision of the real-time enterprise into reality.

In fact, we've not only built the software to do it, it took us just five months to successfully deploy it within one of the world's largest industrial corporations. FlexNet, for them, was their most strategic information technology investment of the year.

When it comes to the speed, efficiency, and productivity of your operations, you can't afford to be overtaken by your competitors. Don't wait for them to deploy FlexNet with RFID technology — instead, leapfrog the competition by contacting Apriso, today.

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