FUJITSU

U-Scan®
Security

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Prepared by:	Fujitsu Frontech North America Inc.
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1 Contents

2 Introduction

Version 1.0.1

When an item is purchased at the Customer Station, U-Scan Security is responsible for ensuring that the weight of the item placed on the bag scale corresponds to the known weight(s) of the item purchased. This document provides a high level overview of how U-Scan security works and it describes the terms, concepts, and configuration parameters that are available with U-Scan Security.

2.1 Configuration Parameters

U-Scan stores most of its configuration parameters in the registry. These parameters are stored in HKEY_CURRENT_USER\Software\OptimalRobotics. For the sake of legibility, this path is abbreviated to OPMR throughout the document. For example:

The parameter

HKEY_CURRENT_USER\Software\OptimalRobitics\Robot\Security\ViolationThreshold

is abbreviated to

OPMR\Robot\Security\ViolationThreshold

Whenever a registry-configurable parameter is first presented in the document, a detailed description of the parameter is provided at the end of the section in which it is first presented. This description is presented in the following format:

Parameter Name[1]

Path: OPMR\[2]
Type: Data type[3] (Units)[4]
Default: Default value[5]

Brief Description[6]

1. The name of the parameter.
2. The location of the parameter in the registry.
3. The data type of the parameter. The registry data types used by U-Scan are DWORD (integer) and STRING (character).
4. The units of measure that the U-Scan understands the data value to represent. Typical units are Boolean (0 and 1 representing true/enabled and false/disabled), centipounds (1/100^{ths} of a pound) and milliseconds (1/1000^{ths} of a second).
5. The default value of the parameter which is used if no customized value is provided. If a parameter is deleted from the registry, U-Scan will recreate the parameter with this default value.
6. A brief description explaining the purpose of the parameter.

2.2 DAT Files

U-Scan also provides several DAT files that can be used to configure different U-Scan behaviors. This document will focus solely on those DAT files that directly influence security behavior. The DAT files are text files stored in the Data subfolder of the U-Scan installation folder. The default installation folder is Robot\Data. The DAT files share a common format and allow customization of item behavior by UPC or range of UPC. For this reason they are often referred to as UPCFILEs.

The DAT file is a text file which contains a single record per line. The exact record format varies depending on the purpose of the file, but is always of the general form:

(UPC Type) UPC : Data

The UPC Type (enclosed in parenthesis) is an optional component use to define an explicit UPC symbology. The type is always a single character. The U-Scan maps the following characters to UPC symbologies:

```
'A'  UPCA
'B'  Code39
'C'  Code93
'F'  EAN13
'G'  EAN8
'K'  UCC128/EAN128/GS1-128
'R'  RSS-14
'X'  RSS-EXPANDED
'#'  Code128
'I'  Interleaved 2 of 5
'T'  GTIN conversion (Magellan 9500)
```

Note that UPCEs are not directly supported. They must be converted to their UPCA equivalent. If no UPC type is specified, the UPC is assumed to be UPCA.

The UPC can contain a maximum of 13 digits. The UPC must not contain the check digit (the rightmost digit on the barcode). If the UPC is an NS2 UPCA, the last 5 digits of the UPC must be entered as zeros.

An asterisk (‘*’) rather than a digit may be placed anywhere in the UPC. The asterisk acts as a wild card, simultaneously representing any digit (0-9). Any number of asterisks can be used per UPC. Wildcards are typically adjacent to one another in order to define a range of UPCs. This adjacency is not required, however.

Following the UPC is a colon which serves as a delimiter between the UPC and the data. The format of the data varies depending on the particular purpose of the DAT file. The specific data formats are described in the sections where each DAT file is introduced.

The DAT files recognize a double slash (‘//’) as a comment delimiter. Any text appearing to the right of a ‘//’ is ignored. The comment can be included on a separate line or on the end of a record (immediately to the right of the data portion of the record). Comments do not span multiply lines in the DAT file. For multiline comments, each line must begin with ‘//’.

The following as examples of valid DAT file records from a SCTYTHRES.DAT file (see section 4.6)

```
01234567890   : 5       // UPCA
(A)01234567890 : 5      // UPCA. Equivalent to the above record
21234500000 : 10        // NS2 UPCA
//21234500000 : 10      // The above record, commented out.
(#)41234562*** : 9      // A Range of code 128 UPCs
                        // 41234562000 to 41234562999
2********** : 12        // Range covering all possible NS2 UPCAs
```

Note that errors in the record format are both logged in the Eventlog and in the U-Scan trace files.

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3 Security Overview

3.1 Security Violation Overview

U-Scan Security is active always active. It is divided into two modes of operation: item security and non-item or 'general' security. Item security is invoked every time a customer purchases an item at the U-Scan either by scanning a UPC or manually entering a UPC/PLU/SKU via the NBC feature. General security is active in between item purchases and to a lesser extent during item purchases as well.

3.2 Units of Measure

Internally, all items weights and thresholds are expressed in terms of 1/100ths of a pound or centipounds (clbs). The U-Scan can display weight in pounds (2 digit precision) or kilograms (3 digit precision), based on the configuration parameter `UseMetric`. Configuration parameters for weight thresholds must always be expressed in clbs even if `UseMetric` is enabled.

UseMetric

```
Path: OPMR\
Type: DWORD (Boolean)
Default: 0
```

Parameter used to control whether weight values are display in pounds or kilograms. When set to 0 all weight values are displayed in pounds (e.g. 1.23 lb). When set to 1, all weight values are displayed in kilograms (e.g. 1.234 kg).

3.3 Security Violations

There are three different types of security violations: ITEMS_ADDED, ITEMS_REMOVED, and WRONG_WEIGHT. The first two violations, ITEMS_ADDED and ITEMS_REMOVED, are 'general' security violations (See Section 3.5) that are triggered whenever the current "good" bag scale reading increases or decreases below a configurable tolerance called the violation threshold (VT). The third violation is triggered during item security (See Section 3.6) when the observed weight for an item on the bag scale doesn't match a prerecorded value from the weight database (or Scanner Scale) within a configurable tolerance.

U-Scan security violation can be disabled using the parameters `IgnoreSecurityTooMany`, `IgnoreSecurityTooFew`, and `IgnoreSecurityWrongWeight`. Any combination of security violations can be enabled and disabled. There is an additional setting named `SecurityCompletelyDisabled`. When enabled this is equivalent to enabling all three previous parameters. By default, all U-Scan security violations are enabled.

Note: if `IgnoreSecurityWrongWeight` is enabled, weight database updates should be disabled in order to preserve the integrity of the weight data.

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3.4 Immediate Security and Resolution Checks

Security's immediate state controls when customers (shoppers) are notified of security violations. To a lesser extent it also controls the types of violations that trigger customer notifications. When immediate security is disabled, the customers will not be notified of an existing violation until they attempt to take some action such as scanning an item or pressing a button.

Security has four possible immediate states:

IMMEDIATE_ALL: All violations are reported immediately
IMMEDIATE_OFF: No violations are reported immediately
IMMEDIATE_TOO_MANY: "Too Many" violations are reported immediately
IMMEDIATE_TOO_FEW: "Too Few" violations are reported immediately

Security checks (also called resolves or resolutions) are performed at various times during normal U-Scan operation. Some of the most obvious security checks occur when weight changes occur on the bag scale and when the customer presses a button on the screen. Security resolutions can be enabled or disabled. When disabled, no security checks are performed, therefore U-Scan will not report any security violations.

Both security resolutions and security immediate states are set based on the current U-Scan state. The following table lists a few of the most common U-Scan states and the associated security resolution and immediate states. For the most part, these settings are static and do not have configuration parameters. There are however a few parameters that allow for a degree of flexibility. Some of these parameters are listed below.

U-Scan State	Security Resolutions	Immediate Security
STATE_CLOSED	Enabled	Off
STATE_WAITING_TO_START	Enabled	Off
STATE_DOING_ORDER	Enabled	All
STATE_WE_PURCHASE_ITEM	Enabled	Off
STATE_ORDER_FINISHED	Enabled	Off
STATE_MAINTENANCE	Disabled	Off
STATE_LOCAL_DMODE	Disabled	Off
STATE_CHOOSE_PAYMENT	Enabled	Off
STATE_PAY_BY_CASH	Enabled	Off
STATE_PAY_BY_EFT	Enabled	Off

DisableSecurityDuringWPI

```
Path: OPMR\Robot\
Type: DWORD (Boolean)
Default: 0
```

When set to 1, enables security resolutions during the WE_PURCHASE_ITEM state. This state defines the interval between when U-Scan sends an item to the POS and the POS responding with a successful or unsuccessful item purchase message.

DisableSecurityDuringPayment

```
Path: OPMR\Robot\
Type: DWORD (Boolean)
Default: 0
```

When set to 1, enables security resolutions during U-Scan payment states. Note that even when enabled, immediate security is still off. The customer will only be notified of security violations during payment when a button is pressed on the screen.

AsymmetricSecurityDuringPayment

```
Path: OPMR\Robot\
Type: DWORD (Boolean)
Default: 0
```

When set to 1, enforces that the customer keep their items on the bag scale during U-Scan payment states (the immediate state is set to IMMEDIATE_TOO_FEW). Weight added to the bag scale during payment states will not generate a security violation.

The security resolution state takes precedence over the immediate state. In all cases when resolves are disabled, immediate security will be turned off. When security resolutions are enabled, and immediate security is set to all, security checks will be performed and violations will be reported to the customer after the `ImmediateStabilityPeriod`. When security resolutions are enabled and immediate security is turned off, security violation will be reported only after the customer presses a button or attempts to scan an item.

ImmediateStabilityPeriod

```
Path: OPMR\Robot\Security\
Type: DWORD (milliseconds)
Default: 1250
```

Period of time that must elapse after a weight change before a security check is made. If the weight changes again before the time elapses, no check is made and a new wait is started.

3.5 General Security

The role of General Security is to determine if customers have added or removed items from the security bagging area. This is accomplished by setting and monitoring a baseline value. The baseline value is recognized as the current good bag scale reading. If this value increases or decreases beyond a configurable tolerance, called the violation threshold, U-Scan security will create a violation. When the weight on the security scale increases above the violation threshold, security will create an ITEMS_ADDED violation. When the weight on the security scale decreases below the violation threshold, security will create an ITEMS_REMOVED violation. The following diagram shows the possible general security state transitions.

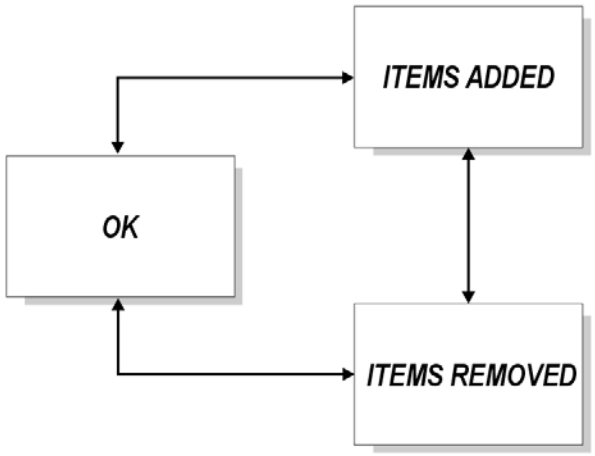


Figure 1: General Security State Transitions

3.6 Item Security

Item security validates the weight of purchased items in one of two ways: against values stored in the weight database or against a weight taken from the scanner scale. The manner in which the item is purchased determines how item security is validated (see below). If the weight placed on the security scale does not match one of the known good weights (either from the weight database or the Scanner Scale), within a configurable tolerance, security will create a WRONG_WEIGHT violation. If during item security the weight on the security scale decreases below the violation threshold, security will generate the general security violation ITEM_REMOVED. The general security violation must be resolved before item security can continue. The following diagram shows the possible item security state transitions.

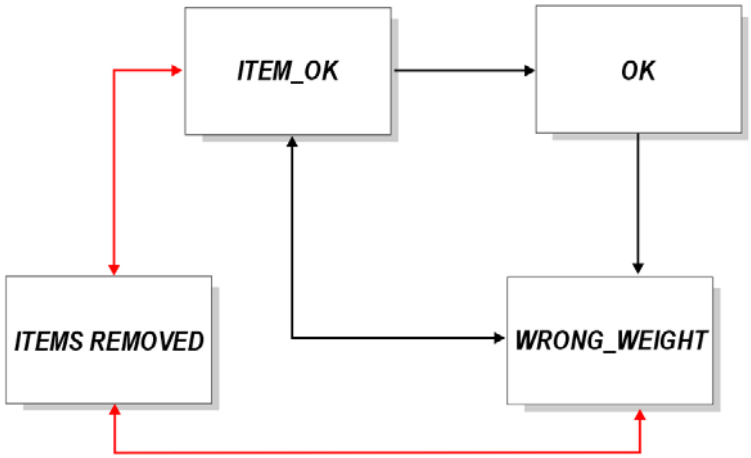


Figure 2: Item Security State Transitions

4 Security Items

Most items purchased at the U-Scan are validated by U-Scan security. These items are referred to as security items. How the item is purchased depends on whether the item was given to security and whether the weight database or Scanner Scale was used to validate the security item's weight.

Items purchased at the Customer Station by either scanning the item or manually entering the UPC is validated by security using the weight database. The purchase must be initiated on the SCAN_ITEMS screen or by pressing the MANUAL_UPC button. Even if the purchase is completed by an Attendant in direct mode, the item is still validated using the weight database. When the attendant completes the purchase of such items, U-Scan automatically exits Direct Mode upon completion of the item purchase and the customer is instructed to place the item in the bag.

Items purchased using the NBC feature (PLU, PIN pad, drill down pick list, no barcode, etc.) must be placed on the Scanner Scale and the security item is validated on the security (bag) scale using this weight. The Scanner Scale weight is required for both Weight required and Quantity required items.

Item purchases *initiated* by the Attendant in Direct Mode, and items purchased using the Large/Heavy Item feature are not given to security.

4.1 Weight Database Items

Security items validated using the weight database have different characteristics based on the collective values of the entries in the weight database record. A weight database record can contain a maximum of 24 weight value entries as well as a special escrow weight slot. The escrow is used to transition heavy items to light items.

Security items using the weight database can be classified into the following types:

- New items
- Light items
- Heavy items
- Medium items
- Bypassed items
- NS2 items (random weight)

Light, Medium, and Heavy item types are determined based on configurable thresholds. Although these thresholds are configurable, it is strongly discouraged to modify them especially after the database is populated with weight values.

4.1.1 New Items

A new item does not have a record in the weight database. Security will accept any weight on the bag scale and create a new record for the item using the observed weight reading. When a new item is given to security, U-Scan will wait for a configurable period of time (NewItemInBagPeriod) for weight to be placed on the bag scale. When this period of time

elapses, the new item will be changed into a light item. This behavior can be overridden by the use of weight database filters. (See section 5.4.)

4.1.2 Light Items

A light item is any item whose weight record values are less than the LightItemThreshold. When a light item is given to security, the U-Scan will wait for a configurable period of time (LightItemInBagPeriod) for weight to be placed on the bag scale. When this period of time elapses, the light item is treated as if it were placed on the bag scale regardless of whether any scale activity was observed.

4.1.3 Heavy Items

A heavy item is an item whose weight record values are greater than the non-light item threshold. The U-Scan weight database logic ensures that weight records cannot contain a mixture of both heavy item values and light item values.

4.1.4 Medium Items

A medium item is an item whose weight record values are between the light item and non-light item thresholds. Medium items exist as an artifact of light and heavy items – they represent the overlap between the light item threshold, non light item threshold and default violation threshold.

4.1.5 NS2 Items

A random weight item is a UPC which contains embedded pricing information. This pricing is a function of the item's weight and not a fixed unit price. Historically, such UPCs (in North America) were number system 2 UPC-As. Although U-Scan can be configured to recognize other random weight UPC formats, we still refer to this category of items as NS2 items.

4.2 Non-Weight Database Items

Security for non-weight database items is resolved by taking a weight reading of the item from the Scanner Scale. None of these items have weight records.

4.2.1 PLU Items

A PLU item is an item that is purchased at the Customer Station using one of the options available from the NBC feature. The options are PLU pin-pad, drilldown button, or cashier assisted no-barcode entry. All PLU items require the customer to place the item on the Scanner Scale. Security ensures that the weight measured on the Scanner Scale is placed on the bag scale. PLU items are never new items or bypassed items. PLU items can be light items, although this is not likely to happen if the PLU item is purchased by weight.

Why are weight required PLU items unlikely to be light items? In order to be priced appropriately, the scale must be able to measure the item. The Scanner Scale tolerance is 0.01 lbs, so the window for light items is quite small (0.02 – 0.04 lbs). We must also consider the possibility that the POS may impose additional minimum weight restrictions, especially when tare is a factor.

Note: Light weight required PLU items are *not impossible*, only *unlikely*.

4.3 Non-Security Items

These items are not managed by Security, but are included here for the sake of completeness. The customer is never prompted to place these items in the bag.

4.3.1 Direct Mode

When an attendant enters Direct Mode an initiates an item purchase (by either scanning or key entering the UPC), the resulting item purchase is not given to security. This applies regardless of whether the cashier entered Direct Mode at the Attendant Station, Customer Station or Mobile Attendant. This is not to be confused with item purchases which are initiated in customer mode and only *completed* in Direct Mode. Such items are given to security and are generally weight database items.

4.3.2 Large Items

A large item is an item that is purchased by the cashier and left in the cart. The cashier purchases the item in Direct Mode in response the customer's request (by pressing the LARGE ITEM KEPT IN CART button).

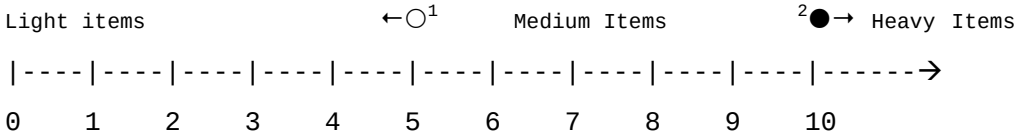
4.4 Thresholds

U-Scan security uses a variety of configurable thresholds. The first category of thresholds defines the values which are used to categorize security items based on weight. For example, light medium and heavy security items. The second category of thresholds defines tolerances for each category of security item.

Threshold values are assigned when U-Scan is started and do not change while U-Scan is running. If a value is changed, U-Scan must be restarted. The same threshold values apply to all items of a given category. The SCTYTHRESH.DAT file can be used to assign unique thresholds to individual or ranges of items.

These thresholds are used to define the characteristics, based on weight ranges, for light, heavy and medium items.

[1] **`LightItemThreshold`**	Any weight item less than this value is considered a light item. Default value: 0.05 lbs.
[2] **`NonLightItemThreshold`**	Any weight greater than or equal to this value is considered a heavy item. Default value: twice the light item threshold (0.10 lbs)



There is a range of weights (0.05 – 0.09 lbs) that is neither light nor heavy. These weights fall between the **`LightItemThreshold`** and the **`NonLightItemThreshold`**. This range of weights defines what is known as medium weight items. The values for the LIT and NLIT threshold are set so that the there is no overlap when the default VT (violation threshold - 0.05 lbs) is applied.

Example: say we get a weight of 0.07 lbs. Assuming default thresholds of 5 clbs, this is an OK weight for a light item at 0.04 lbs. It is also an OK weight for a Heavy item at 0.11 lbs. In the case of a light item, the acceptance of this weight will prevent the item from being considered a light item. The acceptance of this weight will have no effect on a heavy item however (it will still be considered a heavy item). This behavior can be overridden with the use of weight database filters.

4.5 Violation Thresholds

These thresholds define the tolerances (weight ranges) that are applied to security item types. The tolerance is applied to each unique value in a weight database record or to the Scanner Scale weight reading for non database items. The tolerance is expressed as a positive integer value representing centipounds and is applied +- to each weight or a weight record.

ViolationThreshold

```
Path: OPMR\Robot\Security\
Type: DWORD (centipounds)
Default: 5
```

The `ViolationThreshold` (VT) is applied to the security baseline value a when general security is in effect (i.e. in between item purchases). When the weight on the bag scale increases or decreases by an amount equal to or greater than the VT, U-Scan will generate a security violation. The VT is also used as the tolerance for non weight database security items (i.e. PLU).

LightItemViolationThreshold

```
Path: OPMR\Robot\Security\
Type: DWORD (centipounds)
Default: 3
```

The tolerance applied to light items. Abbreviation: LIVT.

MediumItemViolationThreshold

```
Path: OPMR\Robot\Security\
Type: DWORD (centipounds)
Default: 5
```

The tolerance applied to medium weight items. Abbreviation: MIVT.

HeavyItemViolationThreshold

```
Path: OPMR\Robot\Security\
Type: DWORD (centipounds)
Default: 5
```

The tolerance applied to heavy weight items. Abbreviation: HIVT.

ImmediateThreshold

```
Path: OPMR\Robot\Security\
Type: DWORD (centipounds)
Default: 8
```

Any weight greater than or equal to the Immediate Threshold (IT) will result in a security violation that is reported immediately.

Below are some general characteristics of Security thresholds that you should remember:

1. Any weight added to the bag scale GTE the `ViolationThreshold` will cause a security violation. The attendant will receive a security message, but there will be no siren and no customer security screen.

2. Any weight added to the bag scale GTE the `ImmediateThreshold` will also cause a security violation. The attendant will receive both a security message and a siren. The customer will receive a security display.

3. In most cases, the ViolationThreshold and the `LightItemViolationThreshold` are the same.

4. The ViolationThreshold should never be less than the `LightItemViolationThreshold`.

5. The `NonLightItemThreshold` can never be less than the `LightItemThreshold`.

6. The `ImmediateThreshold` should be greater than the `ViolationThreshold`.

4.6 Item-Specific Thresholds

Security uses a DAT file called SCTYTHRESH.DAT. This file is used to define unique tolerances for specific particular items or range of items.

The record format of the file is:

UPC : threshold

Where threshold is a positive integer value in centipounds representing the violation threshold to use for a specific item or range of items.

Examples:

```
01234599999 : 5   // UPCA : threshold of 5clbs
2********** : 12  // threshold of 12clbs for all NS2 items
```

When an item is given to security, security will do a lookup in this file to see if a specific violation threshold is defined. Security will use the threshold defined in this file, otherwise the default violation threshold based on security item type will be used.

4.7 Timeouts

Each item given to security has a configurable Timeout value. The item is treated as if it had been placed on the bag scale regardless of whether a weight change was detected. There are configurable timeout periods for new, light, medium, and heavy weight items.

```
NewItemItemInBagPeriod     default timeout is 30 seconds
LightItemItemInBagPeriod   default timeout is 3 seconds
MediumItemItemInBagPeriod  default timeout is -1 (disabled)
HeavyItemItemInBagPeriod   default timeout is -1 (disabled)
```

Security initiates a counter immediately after the item is purchased. Once the period elapses, the PLACE_ITEM_IN_BAG screen is erased and U-Scan prompts the customer to scan their next item. The counter is halted as soon as the item is detected on the bag scale or if a violation is triggered. In the latter case, if the violation is resolved (i.e. the offending item is removed or replaced) the counter is restarted.

By default, the timeout periods are enabled for new and light items and disabled for medium and heavy items.

4.8 No Security Items (Bypassed)

Certain types of items have such a wide range of weight that no meaningful weight value can be assigned to them. Examples of such items are potted plants, food platters, newspapers, sand, ice, etc. It is possible to configure these items with a wide threshold using the SCTYTHRESH.DAT file. A second option is to always treat the item as a new item. U-Scan accepts any weight as a valid weight for new items. In practice, this means that new items generally do not cause security violations.

An item can be configured to always act as a new item by adding the UPC for the item to the NOSCTY.DAT file.

The record format of the file is:

```
UPC : description
```

Note that the description is not used and is only required for readability.

Examples:

```
08018502705 : Flower Arrangement 16.99
20809100000 : Miscellaneous Store Platter
0200004368  : Party Cake
```

Weight records for items in the NOSCTY.DAT file are updated after every item purchase. These weight values are preserved after an item is removed from the NOSCTY.DAT file.

4.9 Automatic Skip Bagging

It is possible to configure an item so that U-Scan will not prompt for the item on the bag scale. This is accomplished by adding the UPC for the item to the NOSCTY.DAT file with a special [NS] tag. Items configured in this manner are not given to security. They are treated as if the customer had opted to skip bagging.

Examples:

```
5**********  : [NS]
99********** : [NS]
```

4.10 NS2 Items

NS2 UPCs are stored in the database without pricing information (the price field is replaced with 0). We often refer to this as the true NS2 UPC. So for example, the UPC 23457330100 is stored in the database as 23457330000. NS2 items are also unique in that the values stored in the weight record are not weight values but scaling factors. The scaling factor is calculated based on the price embedded in the UPC and the weight observed on the security scale. These two pieces of information can be used to establish an estimated price/lb which in turn is used to predict the weight of subsequent items, regardless of the price. Note that this is not a true price/lb calculation, since it takes into consideration the total weight of the product, including packaging.

5 Weight Database

The weight database maintains weight information required for U-Scan security. In addition to being a repository of weight information, the weight database also performs data synchronization and self maintenance. Each U-Scan lane (Customer Station) contains its own copy of the weight database.

5.1 Weight Records

A weight record consists of the following data:

- 14 digit UPC (key)
- A value array of 24 weight values
- The count of weight values in the value array
- An Escrow (temporary storage area used for light items)
- A timestamp indicating when the record was last updated.

5.2 Synchronization

Each U-Scan station shares weight database information by directed broadcasts using mailslots. This feature is enabled by default but can be disabled by setting the `SynchronizeDatabases` parameter to 0. U-Scan checks its mailslot for an update every second, although this period can be configured using the `DatabaseUpdateCheckPeriod` parameter.

Whenever a weight record on a U-Scan is updated or deleted, an update record is broadcast to all U-Scans defined within a local update group. The Attendant Station initially defines the update group. When the U-Scan first connects to the attendant, the attendant sends the connecting U-Scan a list of the machine names of all the other U-Scans connected to the attendant. These names are usually predefined (ROBOT1, ROBOT2, etc.). The names can be set manually through the cashier configuration utility (CSHCFG.EXE).

Note that this is only an initial list – the mailslot implementation has the means of auto detecting other “entities”. By default, whenever a mailslot is opened, it sends out a handshaking message identifying itself. Any U-Scan that receives this message will respond with the second half of the handshake. All U-Scans will then add the others to its broadcast group. This behavior is enabled by default but can be disabled using the `AutoDetectBroadcastGroup` parameter.

Parameter	Type	Default
`Robot\Security\WeightDatabase\SynchronizeDatabases`	DWORD	1
`Robot\Security\WeightDatabase\DatabaseUpdateCheckPeriod`	DWORD	1000
`Mailslots\AutoDetectBroadcastGroup`	DWORD	1

5.3 Database Updates

The weight record for an item is updated every time security on an item completes. Item security completes when one of the following events occurs:

1. The weight observed on the bag scale matches one of the weights in the weight record within the appropriate tolerance.

2. The security override button is pressed.

The weight record is updated with the actual weight value recorded on the bag scale for the item at the time that security was resolved. The database is not updated for non weight database items (i.e. PLU purchases), nor is the database updated when the security override button is used for general security violations. Weight database filters can be used to control when the database is updated.

5.4 Database Update Filters

Database filters are a feature that allows a great of control over how weight records are updated. When a filter is enabled, it prevents weight record updates for a category of security items, based on the update value. The filters can be explained by the following matrix:

Item Types	Weight Update Types			
	Zero	Light	Medium	Heavy
New Item	0	0	0	0
Light Item	0	0	0	0
Medium Item	0	0	0	0
Heavy Item	0	0	0	0

The filters are configuration parameters contained in the registry under HKCU\Software\OptimalRobotics\Security\WeightDatabase\UpdateFilter.

There is one registry key per item type: “New”, “Light”, “Medium”, and “Heavy”. The value of each key is a bitmask representing different weight update types.

```
ZERO      0x00000001   (1)
LIGHT     0x00000010   (16)
MEDIUM    0x00000100   (256)
HEAVY     0x00001000   (4096)
DELETE    0x00010000   (65536)
```

The default value of 0 means that no filters are used. Multiple update filters can be combined by adding the above values (logical OR).

Example 1: to filter LIGHT and MEDIUM updates, set the record to 0x00000011 (17)
Example 2: to filter all updates, set the record value to 0x00001111 (4369)
Example 3: to filter deletions, set the record value to 0x00010000 (65536)
Example 4: to filter all updates and deletions, set the record value to 0x00011111 (69905)

There are two Security configuration settings that can be replaced by update filters. These settings are `UpdateDatabase` and `UpdateNewItems`. For now - these settings will be maintained and implemented as update filters.

When `UpdateDatabase` is FALSE (meaning do not update the database), each record type will have all filters enabled. The `UpdateFilters` are not modified. This setting takes precedence over any `UpdateFilter` specified in the registry.

When `UpdateNewItems` is FALSE (meaning do not update the database for new items), the new item record will have all filters enabled. The `UpdateFilters` are not modified. This setting takes precedence over the "New" `UpdateFilter` specified in the registry.

When a filter is applied, the update value is discarded - the database is not updated. Filters are applied before self maintenance features such as `AutoClean` and `NS2Reset`. When a value is filtered, the maintenance features are not invoked.

UpdateFilters are not currently applied to NS2 items or to other price embedded items.

5.5 Database Update Filter examples

Below are some examples of how to use and configure weight database update filter.

1. Prevent all updates to the database

Item Types	Weight Update Types				
	Zero	Light	Medium	Heavy	Registry Value
New Item	1	1	1	1	0x00001111
Light Item	1	1	1	1	0x00001111
Medium Item	1	1	1	1	0x00001111
Heavy Item	1	1	1	1	0x00001111

Security will work as expected, but the weight database will not be updated. This configuration still allows the deletion of records. As a consequence of this configuration, the U-Scan will not learn new items. In order to prevent deletions as well, change the value of each record type to 0x00011111.

Alternately, the same behavior can be achieved by setting `UpdateDatabase` to 0.

2. Prevent updating new records

Item Types	Weight Update Types				
	Zero	Light	Medium	Heavy	Registry Value
New Item	1	1	1	1	0x00001111
Light Item	0	0	0	0	0
Medium Item	0	0	0	0	0
Heavy Item	0	0	0	0	0

Database updates are only blocked for new items. New items always remain new items (this also includes bypassed items).

3. Prevent updating any record with a zero value

Item Types	Weight Update Types				
	Zero	Light	Medium	Heavy	Registry Value
New Item	1	0	0	0	0x00000001
Light Item	1	0	0	0	0x00000001
Medium Item	1	0	0	0	0x00000001
Heavy Item	1	0	0	0	0x00000001

A 0 value will not be added to any database record.

4. Prevent converting a light item into a heavy item

Item Types	Weight Update Types				
	Zero	Light	Medium	Heavy	Registry Value
New Item	0	0	0	0	0
Light Item	0	0	1	1	0x00001100
Medium Item	0	0	0	0	0
Heavy Item	0	0	0	0	0

This will prevent medium and heavy item updates to light item records. Light items will always remain light items until deleted from the database.

5. Prevent converting a heavy item into a light item

Item Types	Weight Update Types				
	Zero	Light	Medium	Heavy	Registry Value
New Item	0	0	0	0	0
Light Item	0	0	1	1	0
Medium Item	0	0	0	0	0
Heavy Item	1	1	1	0	0x00000111

This will prevent heavy item from being updated with zero, light, and medium item weights. Heavy items will always remain heavy items until deleted from the database.

6. Prevent records from containing light medium and heavy values.

Item Types	Weight Update Types				
	Zero	Light	Medium	Heavy	Registry Value
New Item	0	0	0	0	0
Light Item	0	0	1	1	0x00001100
Medium Item	1	1	0	1	0x00001011
Heavy Item	1	1	1	0	0x00000111

Light items are updated only with light or zero values. Medium items are updated only with medium values and heavy items are updated only with heavy values.

6 Database Maintenance

6.1 Auto Clean

The AutoClean feature is designed to filter out erroneous or inconsistent weight entries. After every update, the weight record is examined for self consistency. If the weight record is found to be consistent, any inconsistent weight readings are discarded. Self consistency is determined by applying a simple algorithm: the most recent weight entries are compared against each other to see if the difference between adjacent entries is no greater than an AutoClean threshold.

The parameter `AutoCleanCount` indicates how many entries to examine for self-consistency. It also defines the minimum number of weight entries a weight record requires before AutoClean logic is triggered. The AutoClean threshold is calculated as twice the `LightItemThreshold`.

6.1.1 AutoClean Example

The following example demonstrates how this features works. The example uses a weight record containing 20 weight entries, the default AutoCleanCount (12), and the default AutoClean threshold (10 clbs).

Step 1. The weight record is updated with a new weight value of **200** after a successful security check.

```
204 100 198 100 100 100 100 100 100 201 204 199
200 202 196 203 203 204 197 202 200
```

Step 2. The update triggers a check for self-consistency. The last 12 entries are examined.

```
204 100 198 100 100 100 100 100 100 201 204 199
200 202 196 203 203 204 197 202 200
```

These entries are self-consistent, since each entry is with 10 clbs of its adjacent entries. The AutoClean logic is invoked.

Step 3. The remaining weight entries are examined to determine if any are consistent with the weight entries examined in step 2.

```
204 100 198 100 100 100 100 100 100 201 204 199
200 202 196 203 203 204 197 202 200
```

Of these weight entries, only two (`204` and `198`) are determined to be consistent with the most recent weight updates.

```
204 100 198 100 100 100 100 100 100 201 204 199
200 202 196 203 203 204 197 202 200
```

Step 4. All of the inconsistent weight entries (7 in total) are moved from the weight record. The final weight record contains 14 weight entries.

```
204 198 201 204 199 200 202 196 203 203 204 197
202 200
```

6.2 Discarding Old Records

Each weight record has a timestamp of when the record was last updated. The weights database supports a feature that allows old records to be cleared from the database. By default, this feature is disabled. It can be enabled through the registry setting `DiscardOldRecords (weeks)`.

Note: “(weeks)” is actually part of the parameter name.

A check is performed each time a weight record is retrieved or updated. If the record has not been modified within the old record period, the weight record is cleared (see below). The weight record update then occurs on the cleared record. This has an interesting consequence when the record is retrieved by Security – the item associated with the weight record will be treated as a new item (since it effectively has no weight values).

The weight record timestamp is set whenever the weight record is updated. The timestamp is also set whenever the weight record is cleaned (see ‘AutoClean’).

6.3 Light Item Reset

The weight database provides a facility to allow a heavy item to be converted to a light item. The escrow field of the weight record is used to accomplish this. If the weight record contains medium and/or heavy values, an attempt to update the weight record with a light value will cause the light value to be placed in the escrow (the escrow is simply a temporary storage area). When the weight record is next updated, the state of the new value determines the operation that will be performed on the weight record.

1- If the weight record contains heavy item weight values:
   a. If the new value is medium or heavy, the value in the escrow is discarded and the new value is added to the weight record.
   b. If the new value is light, the weight record is cleared and both the escrow value and the new value are added to the weight record. This effectively changes the security item state to light item.
2- If the weight record contains medium item weight values:
   a. If the new value is heavy, the value in the escrow is discarded and the new value is added to the weight record.
   b. If the new value is medium or light, both the new value and the escrow value are added to the weight record.
3- If the weight record contains both heavy and medium item weight values:
   a. If the new value is medium or heavy, the value in the escrow is discarded and the new value is added to the weight record.
   b. If the new value is light, both the new value and the escrow value are added to the weight record.

This self-maintenance feature only works if the weight record consists entirely of heavy values. This is often the source of much confusion since the common believe is that if any non-light item is accepted as a light item twice consecutively, the item will become a light item. Having a single instance of a medium value will prevent this feature form working as anticipated (although it is working as *expected*).

The U-Scan weight database logic ensures that weight records cannot contain a mixture of both light item values and heavy item values. If a light item weight record is updated with a heavy item value, all previous light item values are discarded and the weight record changes to a heavy item. This behavior can be overridden by the use of weight database filters.

7 Configuration Parameters

Below are the most common configuration parameters used by U-Scan to configure security and weight database logic:

HKCU \Software\OptimalRobotics\Robot\Security

CheckSecurityAsymetriclyAtEnd

`Type: DWORD (Boolean)`
`Default: 1`
If '1': at the moment that the last tender for the order is received, a final security check is made. This check will generate a security alert if items have been added, but not if items have been removed from the bag scale.

CreepTimeThreshhold

`Type: DWORD (milliseconds)`
`Default: 5000`
Defines a period of time after which the baseline security value is reset to the current observed bag scale weight reading. Only applies during general security if the currently observed bag scale reading is within the `ViolationThreshold` of the current baseline value.

CustomerCanRemoveItems

`Type: DWORD (Boolean)`
`Default: 0`
When enabled, the customer can remove items from the bag scale without generating a security violation. Deprecated setting – replaced by `IgnoreSecurityTooFew`.

DetailedTrace

`Type: DWORD (Boolean)`
`Default: 0`
Enables tracing of extended security information.

HeavyItemInBagPeriod

`Type: DWORD (milliseconds)`
`Default: -1 (0xffffffff)`
The amount of time U-Scan security will wait for a heavy item to be placed on the bag scale. When the period expires U-Scan will assume that the item is on the bag scale and complete security for the item in question.

HeavyItemViolationThreshold

`Type: DWORD (centipounds)`
`Default: 5`
The tolerance applied to heavy weight items.

IgnoreSecurityTooFew

`Type: DWORD (Boolean)`
`Default: 0`
When enabled, the U-Scan will not notify customers of ITEMS_REMOVED security violations.

IgnoreSecurityTooMany
Type: DWORD (Boolean)
Default: 0
When enabled, the U-Scan will not notify customers of ITEMS_ADDED security violations.

IgnoreSecurityWrongWeight
Type: DWORD (Boolean)
Default: 0
When enabled, the U-Scan will not notify customers of WRONG_WEIGHT security violations.

ImmediateStabilityPeriod
Type: DWORD (milliseconds)
Default: 1250
Period of time that must elapse after a weight change before a security check is made. If the weight changes again before the time elapses, no check is made and a new wait is started.

ImmediateThreshhold
Type: DWORD (centipounds)
Default: 8
This is the smallest weight change that can produce a security check when immediate security is enabled.

LightItemInBagPeriod
Type: DWORD (milliseconds)
Default: 3000
The amount of time U-Scan security will wait for a light item to be placed on the bag scale. When the period expires U-Scan will assume that the item is on the bag scale and complete security for the item in question.

LightItemViolationThreshold
Type: DWORD (centipounds)
Default: 3
The tolerance applied to light weight items.

MediumItemInBagPeriod
Type: DWORD (milliseconds)
Default: -1 (0xffffffff)
The amount of time U-Scan security will wait for a medium item to be placed on the bag scale. When the period expires U-Scan will assume that the item is on the bag scale and complete security for the item in question.

MediumItemViolationThreshold
Type: DWORD (centipounds)
Default: 5
The tolerance applied to medium weight items.

NewItemItemInBagPeriod
Type: DWORD (milliseconds)
Default: 30000
The amount of time U-Scan security will wait for a new item to be placed on the bag scale. When the period expires U-Scan will assume that the item is on the bag scale and complete security for the item in question.

SecurityCompletelyDisabled
Type: DWORD (Boolean)
Default: 0
When enabled, the U-Scan will not perform any security checks and will consequently not report any security violations. Enabling this parameter is equivalent to enabling IgnoreSecurityTooMany, IgnoreSecurityTooFew, IgnoreSecurityWrongWeight.

UseViewer
Type: DWORD (Boolean)
Default: 0
Enables an additional dialog box that displays assorted security information while the U-Scan is running. Not intended for use in a production environment.

ViolationThreshold
Type: DWORD (centipounds)
Default: 5
The VT is applied to the security baseline value a when general security is in effect (i.e. in between item purchases). When the weight on the bag scale increases or decreases by an amount equal to or greater than the VT, U-Scan will generate a security violation. The VT is also used as the tolerance for non weight database security items (i.e. PLU).

HKCU\Software\OptimalRobotics\Robot\Security\WeightDatabase

AutoCleanCount
Type: DWORD
Default: 12
This parameter controls an auto-maintenance feature of the weight database. If set to '0', the feature is disabled. After a weight record is updated, the last AutoCleanCount values of the weight record are examined for self consistency. If these values are self consistent, the remaining entries are also examined. Any entries which are inconsistent with the other weight record entries are discarded. Valid values are 0 to 24.

DatabaseUpdateCheckPeriod
Type: DWORD (milliseconds)
Default: 1000
This parameter controls how frequently the U-Scan checks for database updates from other U-Scans on the same domain. The value of the parameter is in milliseconds.

DiscardOldRecords (weeks)
Type: DWORD
Default: 0
This parameter controls an auto-maintenance feature of the weight database. If set to '0', the feature is disabled. When a weight record is retrieved from the database the timestamp for the last update is examined. If the last update was made more than this number of weeks ago, the weight record will be cleared. The corresponding item will become a 'new item' again, from the perspective of security.

LightItemThreshhold
Type: DWORD (centipounds)
Default: 5
This parameter defines the weight threshold for light items.

NonLightItemThreshhold
Type: DWORD (centipounds)
Default: 0
This parameter defines the weight threshold for heavy items. If the parameter is given a value of '0' the actual value will be calculated as 2 * LightItemThreshhold (LIT).

NS2ResetDay (Sun=0)
Type: DWORD
Default: -1 (0xffffffff)
This parameter specifies the day of the week (Sunday = 0) on which NS2 weight records are cleared. The NS2 weight record is cleared only when the record is retrieved for the purpose of item security. Valid values are 0-6.

SynchronizeDatabases
Type: DWORD (Boolean)
Default: 1
This parameter controls whether U-Scan's share weight database information. If set to '1', all weight record updates (including deletions) on the local U-Scan are broadcast to all other U-Scans on the network domain. The U-Scan will also check periodically for updates from other U-Scans and update the local database accordingly. If set to '0': the U-Scan will not broadcast weight database information to other U-Scan, and will ignore broadcasts from all other U-Scans.

UseTrueNS2PriceInfo
Type: DWORD (Boolean)
Default: 0

In all cases, security for NS2 items is handled essentially as for normal items, with the added complication that the UPC contains the item price in the lowest four digits. The weight of one penny's worth of the item is stored in the weight database, and multiplied by the corresponding price of the item to obtain a predicted weight value. (Necessarily, if the NS2 item is not something that is sold by weight, problems will occur, and the NOSCTY.DAT file should be used.) If this setting is '0', the preceding is the end of the NS2 security story. Setting this value to '1' has two effects:

1. For NS2 items that are not yet in the weight database, an initial guess for the weight of a penny's worth of the item is made using the price field of the store controller's item database record.

2. Each time the weight record is accessed, a check is made to see if the price per pound (as reported by the store controller's item database) has changed. If so, all entries in the weight record are scaled by the appropriate amount to reflect the new price.

Obviously, if the price field of the store controller's item database record does not contain the price per pound of the item, this feature should not be used.