ADVANCES IN MANAGING COTTON MODULES USING RFID TECHNOLOGY - SYSTEM DEVELOPMENT UPDATE

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Abstract

An electronic module management (EMM) system was developed and field tested in 2018 that makes use of radio frequency identification (RFID) tags contained on each portion of round cotton module wrap. The system developed in 2018 consisted of a hand-held mobile scanning application for scanning modules in the field or gin yard (RFID Module Scan), a scanning system for use on module trucks (RFID Truck Scan) that automates the process of scanning modules and recording position and cotton ownership information, and a data management utility (RFID Gin Data Management) that compiles all module scan information from the various scanning systems and serves as a central data hub for generating ginner and grower reports. The EMM system was expanded in 2019 to include stationary scanning bridges at the truck scale (RFID Scale Bridge) and module feeder (RFID Feeder Bridge), and a lint bale logging utility (PBI Logger) at the bale scale. The new bridge scanning tools provide alternative system options for collecting module specific data necessary for tracking and managing modules from the field to the gin (i.e. serial number, ownership information, load number, weight, etc.) The PBI Logger utility provides data useful in associating lint bale weight and quality to the round module from which it was ginned; thus, enabling quality and yield mapping at the module scale. The expanded EMM system was field tested at Tanner and Co. Gin in Frogmore, LA and the system operated as designed. System performance and opportunities improvement were noted and are discussed herein. The expanded EMM system developed in 2019 provides the basis for a module management system that does not rely on the use of paper tags or other means of manual module identification.

Introduction

New cotton harvesters recently released by John Deere (CS 690 and CP 690) form round cotton modules onboard as the machines harvest cotton in the field. The round modules are wrapped in three-layers of engineered plastic film which restrain the cotton in cylindrical form and protect it from wind and moisture damage prior to ginning. The round modules offer other unique benefits relative to conventional cotton modules in regard to the extended maximum storage period prior to ginning and the ability to haul cotton on semi-tractor-trailer vehicles which cheapens the cost of transporting modules over long distances.

Each portion of plastic module wrap contains four passive RFID transponders (tags) and two human readable identification tags that display a serial number unique to each round module. The human readable tags also contain a 2D data matrix which can be scanned by a barcode reader. When interrogated, the RFID transponders and 2D data matrix return a 24 digit Module Identification number (Module ID) that contains the module serial number along with other information related to the manufacture of the wrap. Harvest ID – Cotton is a system offered by John Deere which associates the module ID number with other harvest related data (table 1) collected on the harvester. This data can be downloaded directly from the display in the harvester or transferred wirelessly from the harvester to the MyJohnDeere.com website where it is available to producers and anyone they wish to grant access. Part of the Harvest ID-Cotton system is an RFID reader on the harvester that scans the modules as the wrap is applied to the module. Other system components associate the module ID with other harvest data collected on the machine.

Table 1. Data available for each round module serial number on MyJohnDeere.com.

Module ID	Client	Gin ID
Module Serial Number	Farm	Producer ID
Latitude (wrap applied)	Field	Local Time
Longitude (wrap applied)	Variety	Field Area
GMT Date/Time	Machine PIN	Season Total Modules
Tag Count	Operator	Diameter
Module Weight*	Moisture Content*	Latitude (drop location)*
Longitude (drop location)*	Field Total Module Count*	Incremental Area*
Local Time/Date*	Comments*	

*Available in John Deere - HID Cotton-Pro released in 2017.

The use of RFID technology to identify cotton modules has enabled new methods for tracking and managing seed cotton from the field to the gin. This new technology creates new possibilities for logistical management, asset tracking, product traceability, and precision agriculture regarding fiber quality mapping. While some in the cotton ginning industry have used pieces of the system to create module inventory lists or pickup reports, no system exists that compiles all of the module ID and harvest data along with other additional RFID tag scan location data into one management system. The overall goal of this research is to develop an electronic module management system for use by gins which utilizes RFID technology and other associated systems to provide useful information (e.g. current module location, processing status, and load weight) to ginners and producers. The specific objectives of this manuscript are to describe the development, updates, and testing of 1) a scanning system for use on module trucks that automates the process of scanning modules and logging position and cotton ownership information as modules are loaded or unloaded, 2) a data management utility that compiles module specific information into one location for use by producers and ginners, 3) a stationary RFID scanning bridge utility for use at a truck scale, 4) a stationary RFID scanning bridge utility for use at a module feeder, and 5) a permanent bale identification (PBI) scanning system for logging lint bales as they are weighed on the bale scale. The systems described herein are components of the electronic module management system. Our goal is for this electronic module management system to be used to demonstrate the utility of this new module tracking technology and help producers and ginners identify new sources of value through the enhanced use of module location and harvest information.

2019 System Overview

Since 2016, work has been underway at the USDA ARS Cotton Production and Processing Research Unit in Lubbock, TX to develop software and hardware tools needed to utilize RFID tags incorporated in Tama Round Module Wrap (RMW) in a system for tracking and managing cotton module location and harvest related data. A schematic presentation of this Electronic Module Management System as designed and implemented in 2019 is shown in figure 1. In addition to data collected on the harvester, this system can be utilized to collect and manage module location information for modules from the time they are dropped by the harvester to the time they are placed on the module feeder for ginning. A new PBI Logging tool implemented in 2019 tracks lint bale production information and facilitates the association of both lint quantity and quality data to the round module from which each bale was ginned.

Harvest information collected for each module by the HID Cotton system on the harvester can be manually downloaded to a USB drive or transmitted wirelessly to the MyJohnDeere.com website where an application named "Cotton Harvest File Download Utility" developed by Cotton Incorporated (2017) can be used to download the HID files to a PC running in the gin office. The HID file for a particular client, farm, and field contains all Module IDs and associated harvest data (table 1) collected on the harvester for each module - providing an inventory list of modules available for that field. Once downloaded, the information included in the HID files is added to the main database in the data management utility (DMU) titled RFID Gin Data Management. A mobile scanning tool, "RFID Module Scan" (Wanjura et. al., 2017), can be used to scan modules in the field after the staging operation or as they are dropped in the field to create the initial module inventory list in cases where the HID Cotton system is not available. RFID Module Scan was developed to run on Android devices and is available free of charge by searching for "RFID Module Scan" on the Google Play Store (Bohn Technology Solutions, 2017). RFID Module Scan can also be used to generate module storage yard inventory maps or provide a scanning tool for any scenario in which modules need to be identified and their location documented. A scanning system used on module trucks known as "RFID Truck Scan" automates the process of scanning modules as they are loaded or unloaded and associates the GPS position of the loading/unloading location. The truck system software documents if the modules were loaded or unloaded during each scan and categorizes the scanning location for each module (e.g. "in field," "gin yard," "module feeder," etc.) The in-cab display shows the driver which modules are currently on the truck in a list-view and automatically removes them from the list as they are unloaded. When module "pickup lists" are generated in the DMU from field generated module inventory data (i.e. from a John Deere HID or RFID Module Scan file) and are transmitted to the RFID Truck Scan system(s), the system inside each truck will display a map with available driving instructions to the location of the target modules. All HID file data, module scan information from RFID Module Scan, RFID Truck Scan, RFID Scale Bridge, RFID Feeder Bridge, and lint bale data from PBI Logger are compiled in the DMU for use in generating reports useful to the gin staff or producers. The DMU also contains an algorithm (detailed herein) to associate lint bale PBIs and corresponding weight and quality data to the round module from which the bales were ginned. The information contained in the DMU may enhance the value of lint produced by providing a pathway for transferring traceability and sustainability information to merchants, mills, and garment manufacturers/retailers.

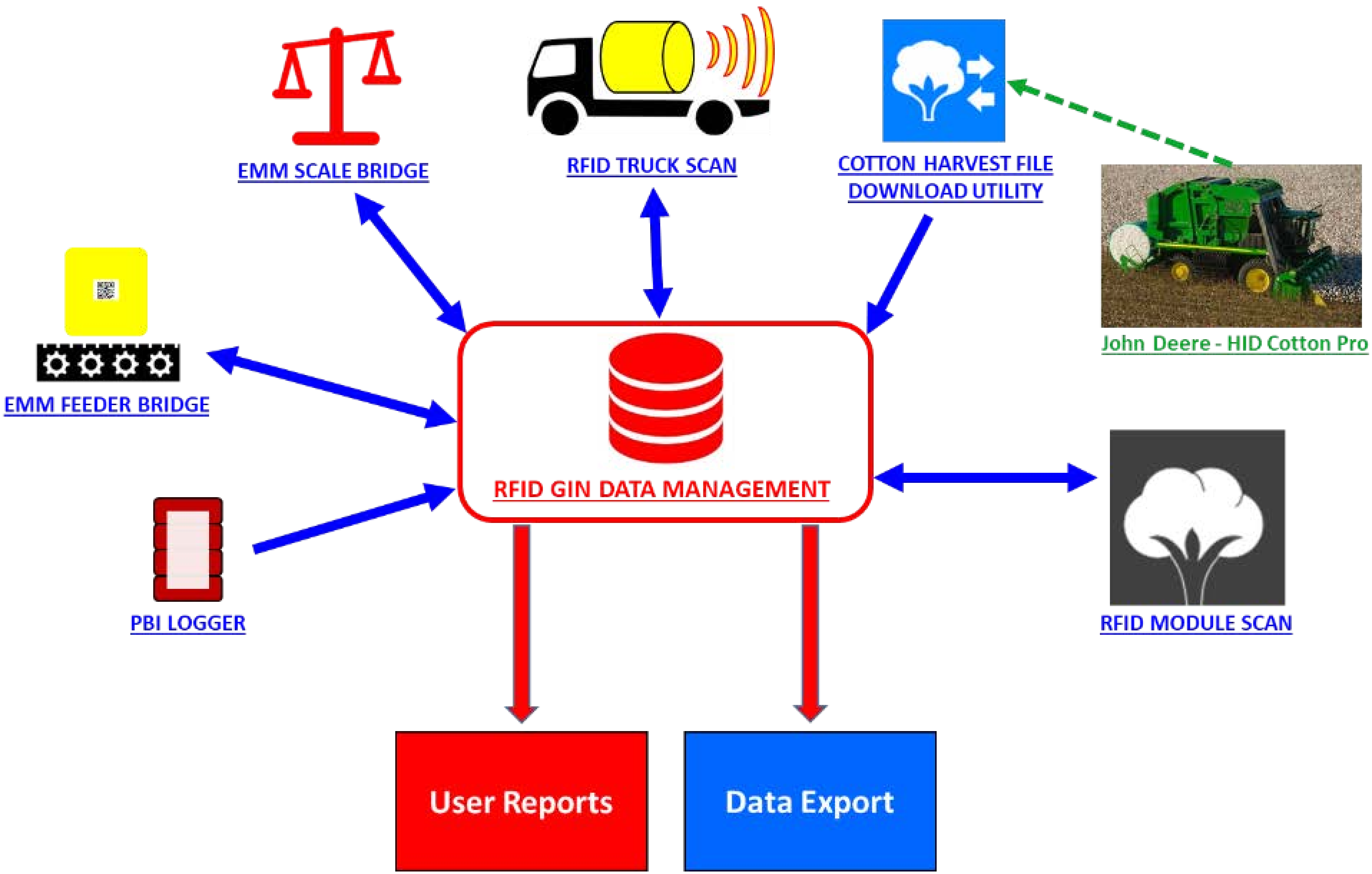

Figure 1. Schematic overview of the components and dataflow within the Electronic Module Management System.

Materials and Methods

The development of new tools and updates to existing tools in the Electronic Module Management (EMM) system in 2019 are detailed in the following sections.

Data Management Utility (DMU) Updates

The data management utility was developed to compile module specific data from all module scanning tools in the EMM and PBI Logger and serve as a data hub from which the gin can create and transmit module pickup lists to transport vehicles, generate software installer packages for RFID Truck Scan, RFID Scale Bridge, and RFID Feeder bridge, and generate various reports for producers or ginners. The DMU also includes a feature by which the RFID Module Scan app can be automatically linked to the cloud database by scanning a 2D QR code generated by the DMU.

Hardware requirements for the DMU include a PC running Windows 10 and an internet connection. The DMU builds an SQL data base containing module and gin load information input via the various system tools in addition to data manually input/edited by users of the DMU. The SQL database is stored locally on the host PC in the gin office and can be backed up using external storage devices or third party providers. Database tables containing client, farm, field, driver, and truck names in addition to tables containing pickup lists, module lists, and gin load lists are also updated and stored on the "cloud" in a Microsoft Azure Document Database. The data stored in the "cloud" is accessed and appended to by all the module and bale scanning tools on command or on a user defined frequency (typically one time per minute).

The DMU user interface is configured with multiple tabs located at the top of the screen that allow the user to view and input information required by the program. The "Home" tab (figure 2) displays general system summary information regarding the number of modules and loads in the system, remaining in the field, on the gin yard, and that have been ginned. The user can run the import procedure from the Home tab to bring in new data from the Cotton Harvest File Download Utility (new HID files) and from RFID Module Scan. The "Settings" tab allows the user to specify GPS coordinates for the module feeder and storage yards, data update frequency used to push information to the "cloud", and imap import settings for data transmitted from the Cotton Harvest File Download Utility and RFID Module Scan app. Buttons to create installer packages for the RFID Scale Bridge and RFID Feeder Bridge software are located at the bottom of the settings tab page.

The Gin Loads tab displays a table of information generated by the RFID Scale Bridge system each time a load is brought into the gin yard. Cotton ownership information is listed along with the bridge id name, a bridge load number generated by the system, gross scale weight, truck number, storage yard location, and other information entered by the scale bridge attendant. Double clicking on an individual row in the loads table displays a box from which the user can view/update load information and see the specific round module IDs associated with that load (figure 3).

The Bales tab (figure 4) is a table that displays all information available for ginned lint bales by PBI number. Data included initially on the Bales tab imported from the PBI Logger utility includes PBI number, Bale Scale Weight (gross and net), tare weight, sequential scan number, and scan timestamp. Once USDA AMS Classing data is available on the bales, the grade data can be imported into the Bales table using the "import classing data" button at the bottom of the page. Finally, the module serial number and gin ticket load number are appended to each PBI once the PBI to Module Mapping algorithm has been run. The user has the option to export the bale data, re-assign bales to a different module number, and delete bales using the buttons located at the bottom of the page.

The PBI to Module Mapping tab (figure 5) allows the user to associate a group of lint bales to the modules from which they were ginned using module and bale sequence data from RFID Feeder Bridge and PBI Logger. To begin the process of mapping bales to modules, the user selects a start and end date/time so that the system can filter the module and bale tables to provide the desired data. Next, the user selects the target lists of modules and bales to use in the analysis by clicking the row of the first module/bale in the respective table view and then clicking the last module/bale in the sequence while holding the shift key. The module/bale ranges are highlighted in blue and the system displays total seed cotton and lint bale weights and calculates the average lint turnout for the selected modules/bales. The algorithm for associating bale PBIs back to round modules is as follows.

Step ***Operation***

1. PBI to RM Mapping tab on DMU displays a time ordered round module (RM) data table with client, farm, field, feeder bridge scan time/date, gin load number, gin load net seed cotton weight, total RM in load, RM identification (ID) number, RM serial number (SN), HID RM Diameter (if available), HID RM weight (if available).
2. User selects start and end round module from table to map PBI numbers to.
3. System displays bale PBI numbers along with PBI scan time/date, and net bale weight on table for bales scanned 30 min before first RM in sequence to 30 min after last module selected in mapping sequence.
4. User identifies and selects the PBI numbers associated with the first and last lint bales ginned from the specified sequence of round modules.
5. The system calculates the total seed cotton weight for round modules in the selected sequence and the total lint weight for bales in the selected PBI sequence. The sequence average lint turnout is calculated from total lint weight/total seed cotton weight. (Alternatively, the user can input a turnout value at the bottom of the page to use in calculation step if so desired.)
6. Load lint estimate is calculated by multiplying the sequence average lint turnout by the load net seed cotton weight.
7. Round Module Weight (RMW) is derived from one of the following sources:
   a. If HID data with RMW is available, use the HID RMW, or
   b. If HID data is available with module diameter (D) but no RMW, calculate RMW for round module i in load (L) as a volume percent of the load net seed cotton weight (LNSCW), or

   $$RMW = LNSCW \times \frac{D_{i,L}^2}{\sum_{i=1}^{n} D_{i,L}^2}$$

   c. If no HID data are available, calculate RMW as load net seed cotton weight/total RM in load
8. Round Module Lint Estimate (RMLE) is calculated by multiplying the sequence average lint turnout by the RMW.
9. The PBI to RM mapping routine is carried out by accumulating net bale weight in PBI scanner sequence and comparing the accumulated lint weight to the RMLE.
10. Net bale weight is accumulated until the accumulated weight is equal to or greater than the RMLE.
11. PBIs for all bales in the sequence contributing their total weight to the accumulated bale weight are associated (i.e. mapped) to the current RM ID. The weight portion of the last bale in excess of the RMLE (lint overage) is allocated to the bale weight accumulation for the next RM in sequence.
12. Allocating PBI numbers to RM ID numbers for the purpose of assigning fiber quality data is done on a whole bale basis using the following user specified threshold (X%) rule approach:
    a. If the last bale in the accumulation contributes less than X% of its weight to the current module to allow the accumulated bale weight to equal the RMLE then the PBI is mapped to the next RM ID.
    b. If the last bale in the accumulation contributes more than X% of its weight to the current module to allow the accumulated bale weight to equal the RMLE then the PBI is mapped to the current RM ID.
13. The algorithm can be re-run with different threshold values to see how PBI to RMID associations may change. Once the algorithm associates PBIs to RM IDs, the modules tab is updated to display the current mapping. The Bale table can be exported in csv format for further analysis but will show only the most recent PBI to RM ID mapping results.

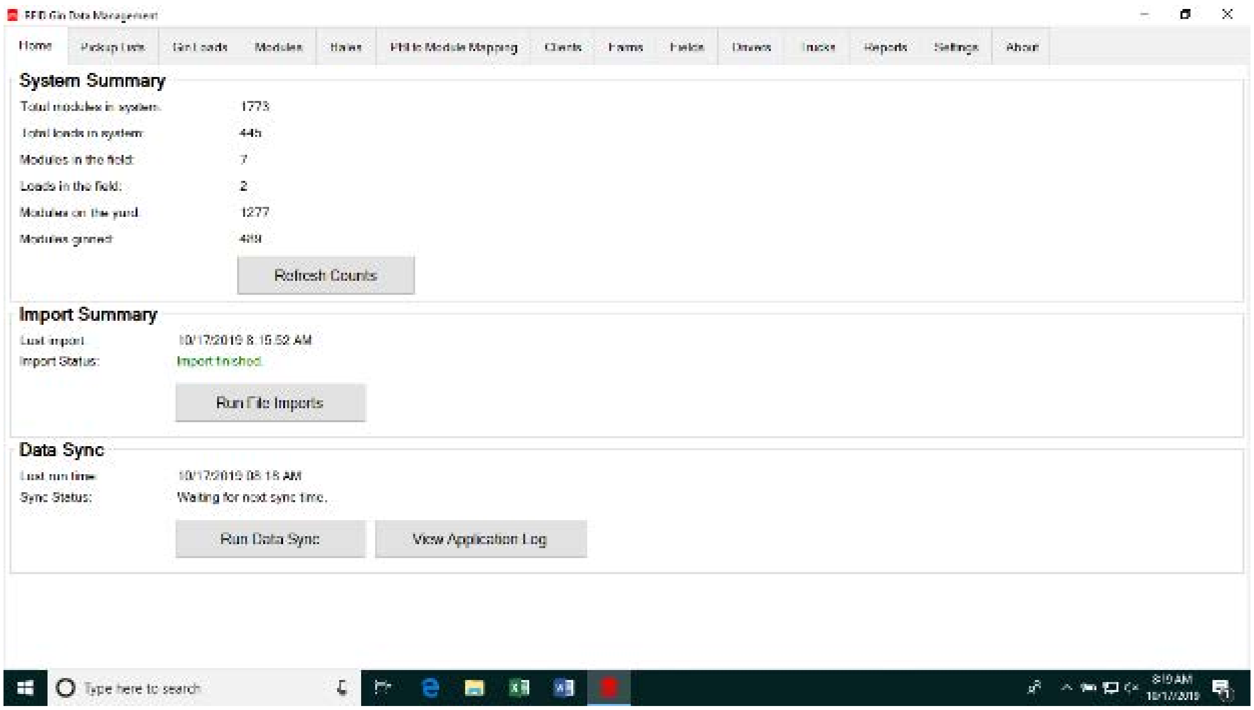

Figure 2. Home tab of the Cotton Module Data Management Utility.

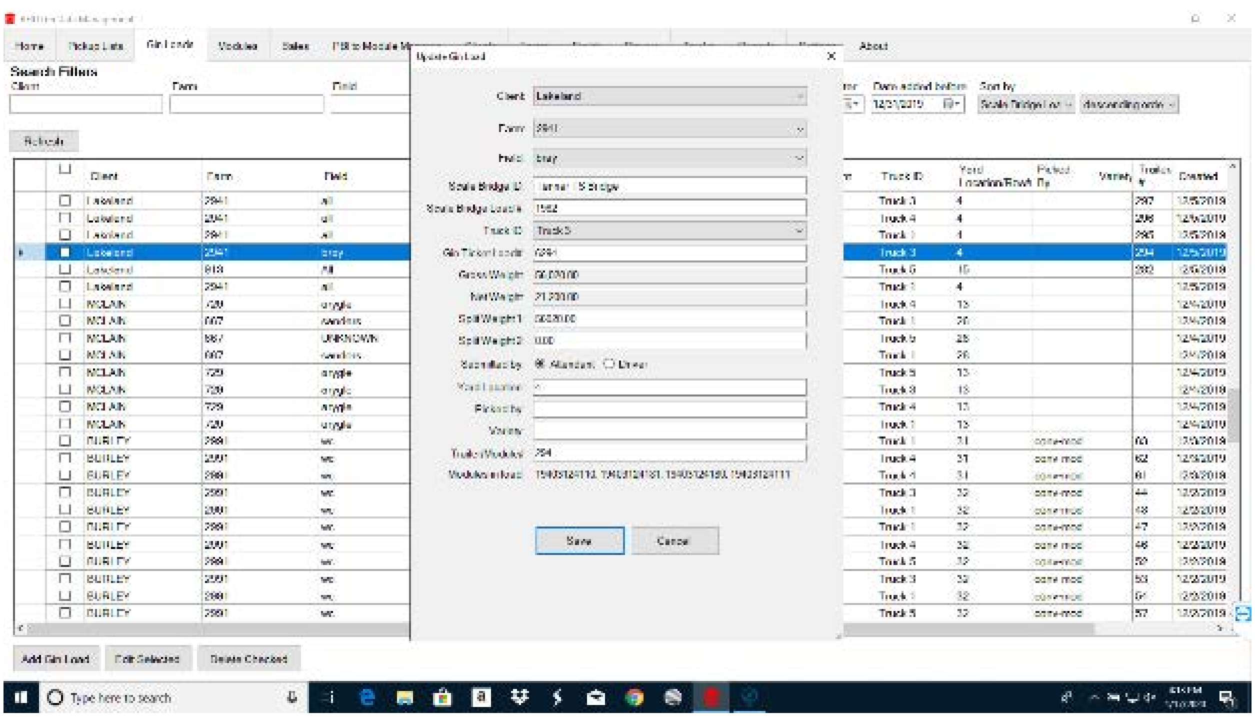

Figure 3. Gin Loads tab displaying the editing box for scale bridge load number 1982 highlighted in blue.

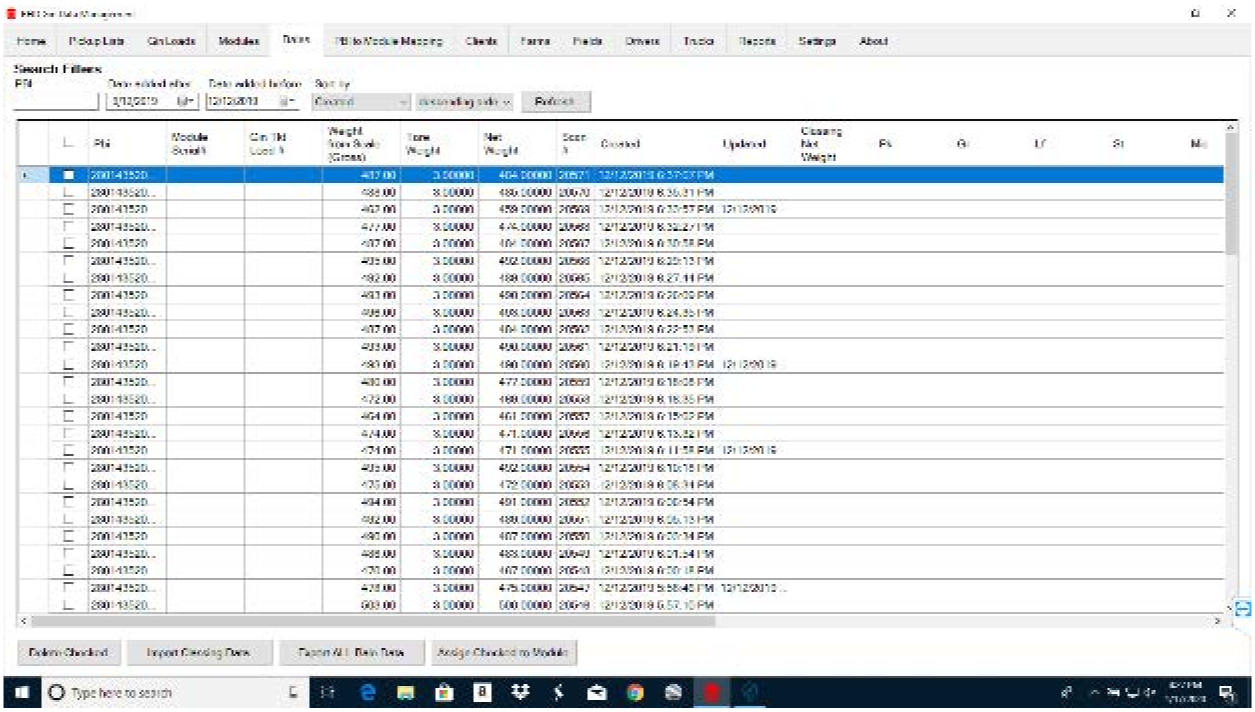

Figure 4. Bales tab showing initial bale information imported from the PBI Logger utility.

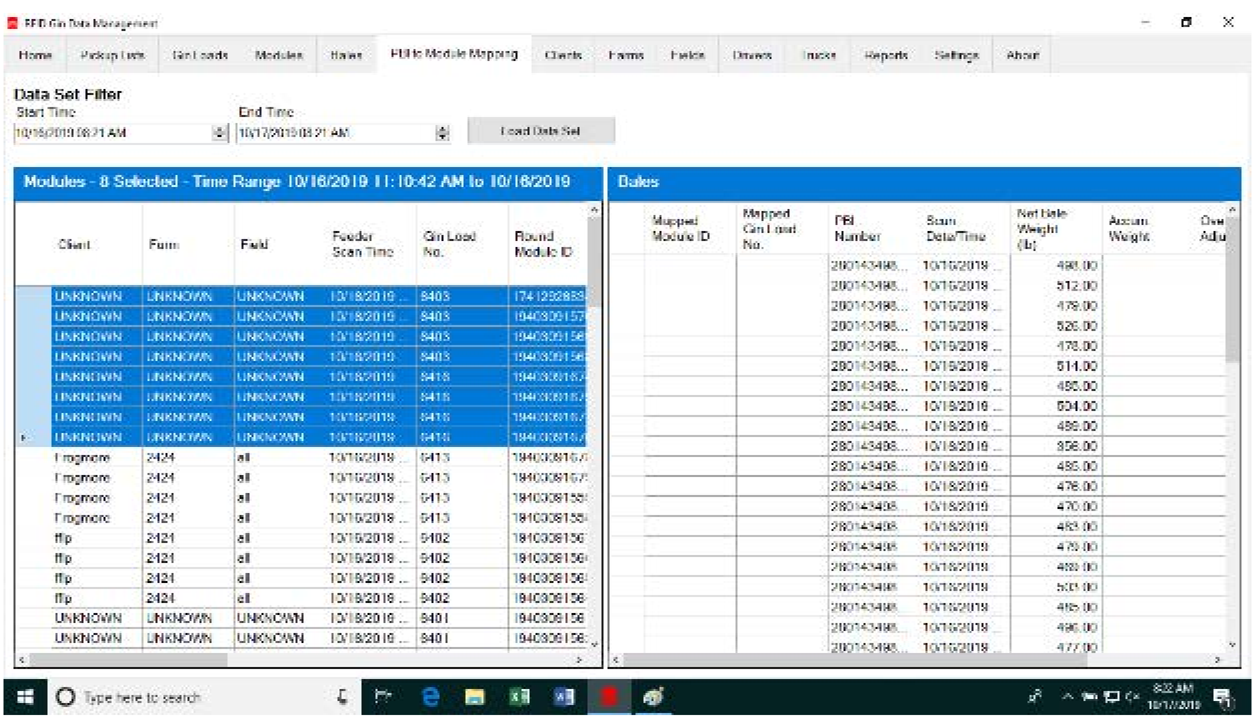

Figure 5. PBI to Module Mapping tab displaying module and bale table views.

Other tabs and features of the DMU software implemented in 2019 are the same as originally implemented and documented by Wanjura et al. (2018).

RFID Scale Bridge

The scanning bridge at the truck scale utilizes four RFID antennas positioned on a cantilevered bridge structure at the entrance to the truck scale (figure 6) to interrogate RFID tags that identify module trucks and round modules. Module trucks are automatically identified by the RFID Scale Bridge system through pre-programmed hard-shell metal-mount RFID tags (Omni ID, model Exo 3000) mounted to the driver and passenger sides of each truck (figure 7). The bridge antennas are connected to an RFID reader mounted to the bridge structure and a single CAT6 power over ethernet (PoE) cable connects the reader to the mobile PC in the gin office. Both data and power are transferred over the PoE cable which simplifies installation. A general-purpose input/output (GPIO) terminal box was added to the RFID reader on the bridge to provide power and control signal connection to a red/green/amber stack light. The stack light provides visual indication to truck drivers of system status conditions including: 1) green light – ok for truck to move on or off scale, 2) amber light – RFID tag(s) detected, and 3) red light – scale motion, weight not recorded.

The RFID Scale Bridge software (figure 8) running on the PC in the gin office was designed to operate in either attended or unattended mode. The scale attendant selects the desired mode of operation depending upon their availability to enter load data using a check box on the software setup screen (figure 9). The setup screen is accessed by clicking on the gear icon in the upper right corner of the system home screen. In either operation mode, the system initiates the weigh-in process when an RFID tag (truck or module) is read by the system. In "attended" mode, the software opens to the load entry screen (figure 10) once the attendant enters the "gin tag load number" on the home screen. The software automatically captures the stable scale weight after a pre-set time interval (the time interval is set to allow the driver to exit the vehicle and the scale to reach stability) and the user enters the gin yard location where the modules will be stored before ginning in addition to the client, farm, and field names. Client, farm, and field names are required by the system and are pre-populated if there is pre-existing information in the data base from the John Deere HID or RFID Module Scan systems, otherwise it is either entered by the user or the text "UNKNOWN" is automatically entered when the load is saved. Text entry fields for "Picked By," "Variety," and "Trailer/Module#" are not required by the system but were included on the load entry page to allow producer provided information (on the hand-written gin ticket affixed to the modules) to be captured. In many cases these fields are left blank or are used to note that the load contained a conventional rectangular module. In "un-attended" mode, the system automatically generates a "Gin Ticket Load #" using the timestamp of when the load was recorded (e.g. AUTO-20191212173637 for auto recorded load on December 12, 2019 at 5:36:37 pm) and saves the stable weight reported by the scale. The auto generated loads are saved on the local system until the attendant updates the load record by double clicking the load record row in the "View All Loads" table (figure 11). Once the load record is updated with a gin ticket load number and ownership information, the record is then uploaded to the DMU via the cloud.

A manual load entry screen was added to allow the user to enter a load without the load capture sequence being initiated by an RFID tag scan. Similarly, a "copy load" function was added to allow the user to split a semi-load of modules (i.e. a load with a total of 5 or more round modules) across two gin ticket load numbers. This was done because Tanner and Co. considers a load of seed cotton to be no more than 4 round modules. In this case, the truck pulls onto the scale and the total gross weight is recorded for the first gin ticket load number along with all module serial numbers. The user accepts the load, re-enters the gin ticket load number on the home page and clicks "copy load." The original load is recalled and the word "copy" is appended to the load number on the new screen. The user then corrects the list of RM serial numbers by adding/deleting serial numbers as appropriate, updates the gross weight for each load, and changes the gin ticket load number to match the paper tag records.

RFID Feeder Bridge

A new bridge structure was fabricated and installed above the roller bed of the module feeder at Tanner and Co. Gin (figure 12) to scan round modules as they are placed on the feeder for ginning. Four RFID antennas are positioned on the bridge and a reader is mounted at the base of the bridge on the gin side. A PoE cable connects the reader to the PC running the RFID Feeder Bridge software inside the office located at the gin. The RFID Feeder Bridge software (Figure 13) requires no human interaction and simply displays:

- feeder bridge load number (auto-assigned by the software),
- module serial number,
- timestamp of the scan event of the module on the feeder,
- gin ticket load number (from module data in cloud), and
- Client, farm, field, and variety information (from module data in cloud).

PBI Logger

A new system was developed and implemented at the bale scale to track the production order and weight of lint bales. When PBI Logger is used in combination with John Deere's HID Cotton (Pro) and RFID Feeder Bridge, the systems produce the requisite data for mapping lint weight and fiber quality back to the field on a module level basis.

The PBI Logger consists of a Honeywell Granit 1911i scanner mounted above the bale scale (Figure 14) located near the press. The 1D barcode on the PBI (permanent bale identification) tag fixed to each lint bale is scanned as the bale is positioned on the scale by the pusher (figure 14a). The scanner is an area imager and can scan tags regardless of orientation at a max distance of about 24 inches (figure 14b). The scan data is transmitted to the PC in the gin office (same PC as used with the RFID Feeder Bridge) over a USB/CAT5 extension system. The extension system is needed to overcome the extended transmission distance between the scanner and the PC. The bale scale output is connected to the PC using a standard DB-9 serial cable through a com port. Bale weight and scan timestamp are displayed and recorded by the PBI Logger software (Figure 15). The software flags PBI scans that are not in sequence or are repeated with a notation “out of sequence.” The system is programmed to immediately capture and save the timestamp and bale weight when the PBI barcode is scanned. Since the bale is likely moving onto the scale and/or the weight is not stable when the weight is initially captured, the system was designed to update the bale weight once the scale weight reaches stability and remains so for a user defined period (usually about 3-5 s).

RFID Truck Scan Updates

The RFID Truck Scan system installed on the over-the-road module truck in 2018 (Wanjura et al., 2018) was modified to remove the chain connection between the encoder and the truck bed head shaft. The new encoder mount (Figure 16) utilizes a direct coupling to the chain bed head shaft, thus minimizing the possibility of cotton interfering with the connection to the encoder. The system components (computer, RFID reader, antennas, encoder, etc.) were mounted and function tested in September and remained on the vehicle throughout the remainder of the ginning season. The system was operated for three days in December to confirm system operation and functionality.

RFID Module Scan Updates

The RFID Module Scan app (Wanjura et al, 2017) was updated to include an ownership lookup function. This allows the user to scan a round module RFID tag in the field or on the gin yard and the system will display available client, farm, field, load number, and DMU status of the module (i.e. “in field”, “at gin”, “on feeder”, or “ginned”). The app code was changed to synchronize the device local ownership table with the ownership table in the cloud at first open only. This change was implemented to increase the speed at which the app loads the scanning screen. Field testing with approximately 80 loads of modules was conducted and the app functioned as expected.

Figure 6. Image of the RFID scanning bridge located at the entrance to the truck scale at Tanner and Co. Gin. Four RFID antennas are positioned on the horizontal top bar while the RFID reader, red/green/amber stack light, and GPIO electronics are mounted to the vertical post.

Figure 7. Truck RFID tag mounted on the front driver's side corner of the bed.

Figure 8. RFID Scale Bridge home screen.

Figure 9. RFID Scale Bridge software settings page accessed by clicking the gear icon in the upper right corner of the home screen (figure 7).

Figure 10. RFID Truck Scan Bridge software load entry screen.

Figure 11. “View All Loads” table showing both auto-generated and updated load records.

Figure 12. RFID scanning system mounted above the roller bed of the module feeder at Tanner and Co. Gin.

Figure 13. RFID Feeder Bridge software run screen.

Figure 14. PBI Logger scanning system mounted above the bale scale. Bale PBI tags are scanned as the pusher moves the bale onto the scale (A). The width of the tag scanning zone is shown in pink on the end of the bale (B).

Figure 15. PBI logger software run screen.

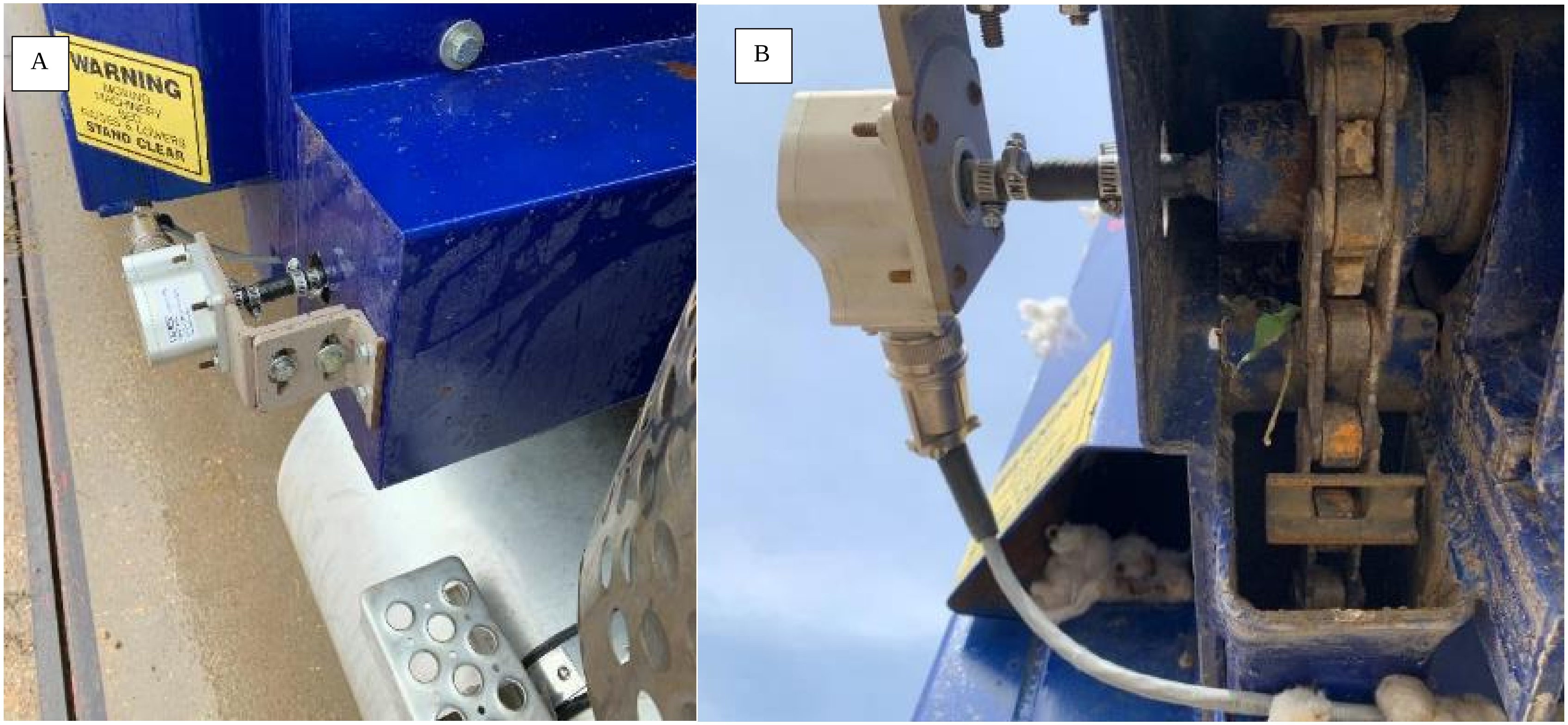

Figure 16. Modified encoder mount (A) with direct flexible coupling to truck bed head shaft (B).

Results

After initial installation in September 2019, RFID Scale Bridge functioned as designed in regard to initiating the weigh in process, reading and recording truck and RM RFID tags, capturing load weights, and associating user supplied gin load ticket and ownership information. The unattended mode of operation was a useful tool to help weigh in loads during the day when the scale attendant was pulled away to complete other office duties and at night after the office staff had gone home for the evening. Some system errors were encountered after initial installation in September and a brief notation of each error situation is listed below:

- Infrequently, the system missed one or more RM RFID tags in a given load of modules. Potential causes identified are module orientation on the truck shielding tags from antenna view, wet module wrap, and improper antenna orientation. Post season analysis of this issue attributed the missed tags to a combination of antenna orientation and tag visibility. Instances where the system would not read any of the truck or module RFID tags were noted and traced back to management of the tag buffer on the reader.
- RFID tags were mounted to each module truck (figure 7) to automate the truck identification process in 2019. Initially two tags were mounted to each truck. The truck tags are easily read by the system when moving onto the scale but the system would also read the tags when the truck passed by the scale on its way back to the highway. Thus, the passenger side RFID tag was removed from each truck to solve the issue,
- Software bugs were fixed that made the user re-enter client/farm/field data when a load is recalled to the screen,
- Infrequently, the system reads and records ID numbers from an unknown RFID source, records RMID's with an unexpected hexadecimal format, and includes more RMID's on a load than are truely present. The issue was traced to the tag buffer on the reader and a software fix was installed to clear the buffer more frequently so that the software doesn't erroneously pull tag numbers from a prior scan into the current scan. Non-sensical numbers read by the system may also be a consequence of damaged/malfunctioning RFID transponders.
- Additional analysis of the load entry data from RFID Scale Bridge is under way to determine reading rates and document system performance compared to the conventional paper-tag based module management system used concurrently by the gin. The RFID Scale Bridge system captured 2156 loads during the 2019 ginning season.

RFID Feeder Bridge functioned as designed so long as the system components were functioning. No software updates were required to keep the system in operation nor were any hardware adjustments needed to improve system functionality. RFID Feeder Bridge downtime was due to component failures of both the RFID reader and mobile PC. The cause of these failures is not completely understood at this time but is suspected to have been the result of damage to the components during prior use and intermittent power grid disruptions. The components were replaced and the system resumed proper operation until the PoE ports on the replacement PC failed about one week later. Subsequently, the reader was connected to power using the manufacturer's AC/DC power supply and the CAT6 data transmission cable was moved to the second ethernet network port on the PC. System operation resumed and ran without issue for the remainder of the ginning season. The system maintained 100% RFID tag read rate while in operation. Current analysis indicates that the system scanned 4193 of 5097 total RM processed by the gin in 2019 (82%) with the missing balance due to system downtime.

PBI Logger experienced similar performance characteristics as RFID Feeder Bridge in that it exhibited near 100% reading rates when the system was in operation. Occasionally, errors were noted due to tag misplacement on the bale that lead to a missed scan. Since the PBI Logger system was tied to the same PC as RFID Feeder Bridge, it also experienced downtime due to the PC failure. The PBI Logger also experienced extended downtime (11 days, ~3500 bales) due to a CAT5/USB extension system failure after a power system failure in early November. PBI Logger scanned 84.5% of all bales processed since the system was installed and placed in operation (missed bales due to downtime). Additional analysis of the PBI Logger and RFID Feeder Bridge data used in the PBI to RM mapping routine is underway to compare the auto association algorithm to the manual procedure used by gin office staff.

Summary

The EMM system was expanded in 2019 to include stationary scanning tools implemented at the truck scale (RFID Scale Bridge), module feeder (RFID Feeder Bridge), and bale scale (PBI Logger). The scanning bridges provide additional scan event and module location data for use in managing and tracking modules from the field to the gin while the PBI Logger utility provides data useful in associating lint bale weight and quality back to the round module from which it was ginned. These tools were field tested at Tanner and Co. Gin (Frogmore, LA) in combination with updated versions of the existing tools in the EMM system developed in prior years (i.e. RFID Module Scan, RFID Truck Scan, RFID Gin Data Management). All systems performed as designed but additional work is needed to improve system reliability and performance. The EMM system provides the framework for a new module management system that does not rely on the use of paper tags or other means of manual module identification.

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