College of New Caledonia CNC

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Applied Research & Innovation Research Brief

Using RFID Tags to Track Tree Nursery Assets

Consolidated Report

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Description: This study assessed the feasibility of tracking tree nursery assets using radio frequency identification (RFID) tags. By monitoring assets, the research team gained insights about the potential to integrate RFID tracking to optimize seedling management and transport.

Methods: Pilot test at the nursery and planting block using BLE RFID tags (Bluetooth low energy).

Data Source: Pilot test at PRT's Red Rock nursery (Prince George, BC) tracking cartons, pallets, and truck.

Key Findings:

- The system was able to track location at the rack level.
- The tags tracked temperature and humidity inside the cartons during freezing, cold storage, and thawing.
- Virtual geofences were set on a map to mimic planting camps or planting blocks. The online portal correctly picked up the moment and ids of the tags entering a geofence. We also tracked forklift and truck motion.
- More study is needed to determine its economic viability at commercial scale

Partners: PRT, KDLRM

Funding: MoF, Research Forest

Key Concepts

'The Internet of Things (IoT) describes the network of physical objects that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet. These devices range from ordinary household objects to sophisticated industrial tools. With more than 7 billion connected IoT devices today, experts are expecting this number to grow to 22 billion by 2025' (Oracle).

Introduction

Each year, tens of millions of seedlings are grown and transported across the province to fulfill the needs for reforestation (BCTS: Seedling services). This presents an immense logistic challenge to all nurseries and other stakeholders involved. Common pains include missing cartons, mix-ups, freezing/thawing problems, shipment issues, etc.

It is anticipated that as we move more into precision forestry a more detailed tracking system will be needed to handle nursery operations as well as the matching of plant stock and even genotypes to specific planting blocks, calling for the use of IoT approaches, such as RFIDs.

The MoF has taken a proactive approach to these challenges and trends, financing this study to assess its feasibility.

Methods

Data for this study was collected through a 3-month pilot test at PRT's Red Rock nursery (Prince George, BC), executed in the winter of 2024.

The study used BLE 'active' radio frequency tags, which are battery powered, as well as location beacons and SuperTags (location hub device) that talk to each other to triangulate the tags' positions and movement (Appendix). A total of 30 tags were used, placing one tag inside each carton containing spruce seedlings for Spring plantation (SX, PSB 411B 1+0 SU, 330 trees/bx, 15 trees/bdl, lift date Oct 27, 2023).

We put 1 carton per pallet on 5 pallets, plus one pallet with 20 cartons. Additionally, we placed an extra beacon on a pallet as to try and discriminate by shelf height (i.e., bottom vs. middle). The tags were supplied by Link Labs.

The cartons were placed in 6 racks inside a reefer 5.2m W x 9.4m D x 4.3m H at a cold storage facility. A location beacon was placed in each of the 6 racks, attached to a horizontal metal bar at mid-height facing inwards. A powered SuperTag was placed inside the reefer, above the door.

Additionally, a thawing area was set with 3 beacons and 1 powered SuperTag to monitor the thawing process. Finally, a SuperTag was attached to a forklift to monitor its movement (in motion versus dormant times). Shipping was tracked by placing a battery powered SuperTag Plus on the pickup truck.

Furthermore, a geofence (polygon on a map) was used to detect the point and time of entrance of the tags into the polygon used as a proxy for the planting camp and block. The shipping stage exercise was handled jointly with KDL RM.

The cartons were placed in 6 racks inside a reefer 5.2m W x 9.4m D x 4.3m H at a cold storage facility. A location beacon was placed in each of the 6 racks, attached to a horizontal metal bar at mid-height facing inwards. A powered SuperTag was placed inside the reefer, above the door. Secondly, a thawing area was set with 3 beacons and 1 powered SuperTag to monitor the thawing process in due time. Shipping will be tracked by placing a battery powered SuperTag on the reefer trailer or pickup truck. Furthermore, a geofence (polygon on a map) will be used to detect the point and time of entrance of the tags into such polygon used as a proxy for the planting camp and block. The shipping stage will be jointly handled by KDLRM and CNC.

Results

As soon as the system was deployed (December 15th, 2023) the tags started transmitting their location and environmental conditions. This allowed tracking of the freezing process at 5-minute intervals. The graph shows how freezing was reached within 2 days while humidity stayed constant around 90% (Figure 1).

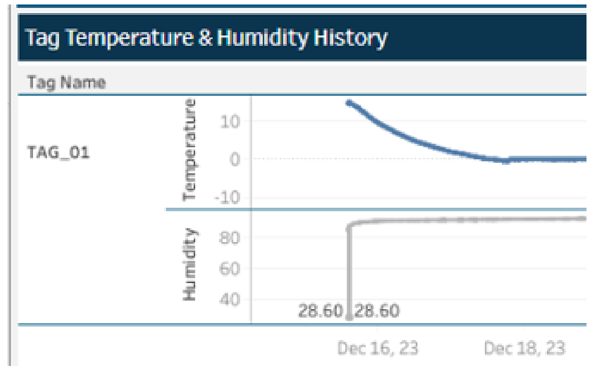

FIGURE 1. FREEZING PROCESS

All tags were picked up in the reefer, however there were some issues with rack allocation with 1 tag not being correctly placed but this was corrected.

BLE does not seem to be capable of discriminating shelf height. The accuracy was 89% with 3 tags being incorrectly allocated to 2-M instead of 2-B (rack 2, middle and bottom shelf).

The provider attempted adjusting the code and the signal strength of the beacons however it was concluded that a BLE system is not fully reliable at shelf height level, but a 100% accurate at identifying the rack (or niche), which was our primary objective.

An alternate approach to try for those interested in shelf height could be ultra wide band (UWB).

The thawing process started after 10 weeks in the reefer and showed a gradual increase in temperature from -2.5°C to 20°C over 7 days. During thawing, humidity remained relatively stable, between 85 to 99% (Figure 2).

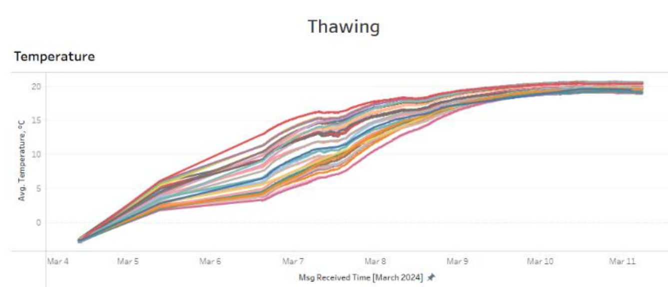

FIGURE 2. THAWING PROCESS

The system was also setup to track forklift motion (dormant versus in-motion times) (Figure 3).

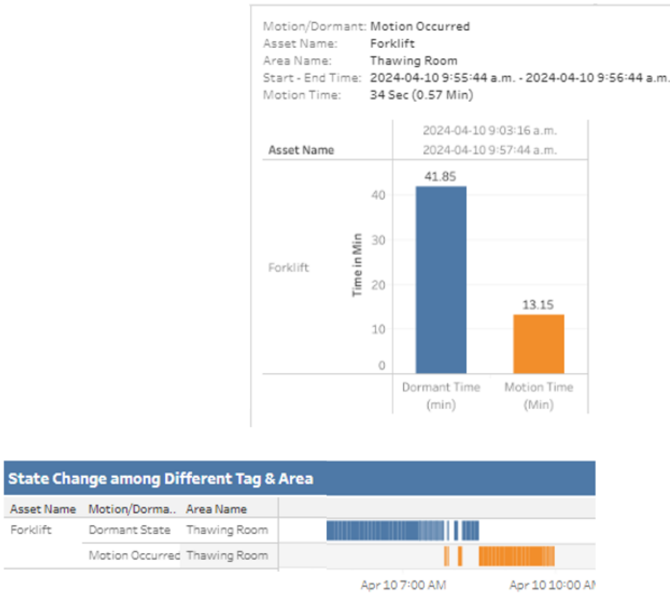

FIGURE 3. FORKLIFT MOTION

We performed a successful mock exercise of a shipment. A virtual geofence was created in a spot with no cellular reception near Fort Saint James. The system (SuperTag Plus) was able to track location and conditions relying on its GPS capabilities. Moreover, we were able to track the movement of the truck as well, showing times and route on a map (Figures 4, 5 and 6).

FIGURE 4. GEOFENCE SETUP

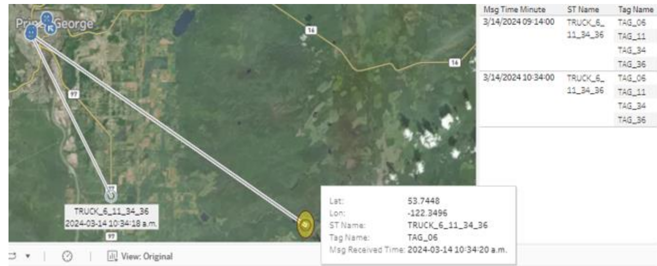

FIGURE 5. TRUCK MOTION

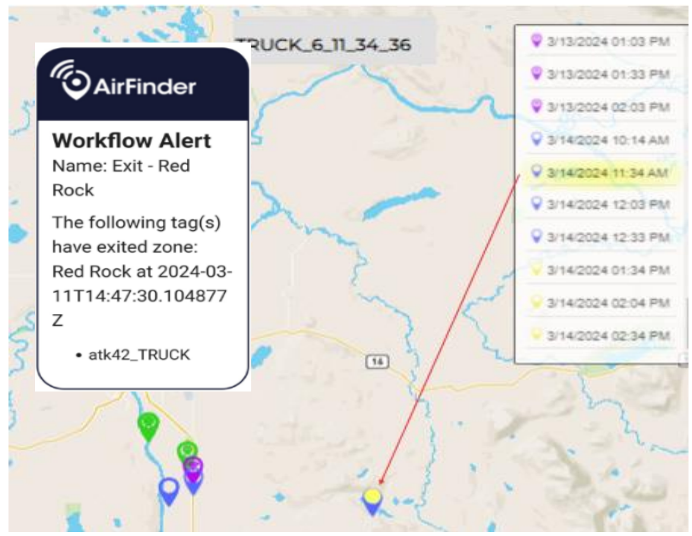

FIGURE 6. TRUCK ROUTE & WORKFLOW ALERT (ENTERING/LEAVING GEOFENCE)

Conclusions

- The Pilot was deemed a success, answering in the positive all the research questions we set out to investigate, including:
  - Track location and movement of pallets & cartons,
  - Monitoring of temperature & humidity inside the carton,
  - Tracking of motion & ambient conditions with/without Wi-Fi reception, including forklifts and trucks.
- Further analysis is needed to assess the economic feasibility of scaling up this technology at commercial levels