November 2021

ARRIVING CONTAINER CARGO PRIORITIZATION METHOD

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ABSTRACT

Maritime freight is undergoing a fast transformation with regard to the technology that can be carried by containers, such as sensors, transponders, etc., which can allow for better identification of containers and their condition. However, the correlation between goods carried in containers, their environmental needs, and their state upon arrival still involves manual processes. Techniques herein propose a method for maritime containers to express an unloading/opening urgency based on the reported status of individual merchandise units carried inside containers.

DETAILED DESCRIPTION

Just a few years ago, a ship carrying 800 containers, each with multiple good lots (e.g., pallets or crates, belonging to individual customers) would carry a semi-manual manifest (i.e., an electronic file, numbering each container and listing their internal content).

With the development of 5G technologies, containers, such as "smart containers," are now capable of carrying individual sensors and transponders. The sensors can report the conditions inside the container (e.g., temperature, humidity, movement, etc.) and a 5G or Long Range (LoRa) transponder, typically provided on the top of a container, connects to a port network upon arrival, to identify the container and report on its internal conditions.

This method improves on operation efficiency, allowing for better identification of the containers and their condition. However, the correlation between the transported goods, their environmental requirements, and their state upon arrival still involves manual processes. In other words, the environmental conditions of a container can be uploaded to the shipping company system upon port arrival, but the implications of these conditions for carried cargo still need to be determined by a human actor.

Within containers, shippers have started to implement "smart crates" that can be tied to a particular good type and report condition violations. However, the signal from these smart crates is only accessible once the container is open, which is usually too late for corrective action to be taken.

Consider an example involving a container that may carry a humidity-sensitive crate, such as for transporting plants. The container air may be dry, but correlation with the consequences for the plant cannot determined, as this action typically involves manual inspection. Further, containers are unshipped one-by-one (typically a 3-day operation for 800 containers) and the target container would be lined-up for pick-up, and eventually make it to a warehouse for dispatching. Upon arrival to the warehouse, the (metallic) container doors can be opened and the signal of a smart crate reporting a dryness alert can then be detected, but, by this time, the plants may have already reached an unrecoverable state.

The same logic/consequences can affect other types of goods that may be sensitive to temperature, air quality, light or other environmental characteristics. It is estimated that approximately 1% of shipped goods that are environmentally-sensitive are lost each year due to unfavorable environmental affects experienced during shipping, causing several billion lost dollars every year for shipping companies and their customers. Thus, the industry is missing a method to automatically report on the conditions of environmentally-sensitive crates, which could allow shipping companies to determine/prioritize which containers to unload and open first.

This proposal provides a method for maritime containers to express an unloading/opening urgency based on the reported status of individual merchandise units carried inside containers. Consider Figure 1, below, which illustrates a framework of the status reporting method proposed herein.

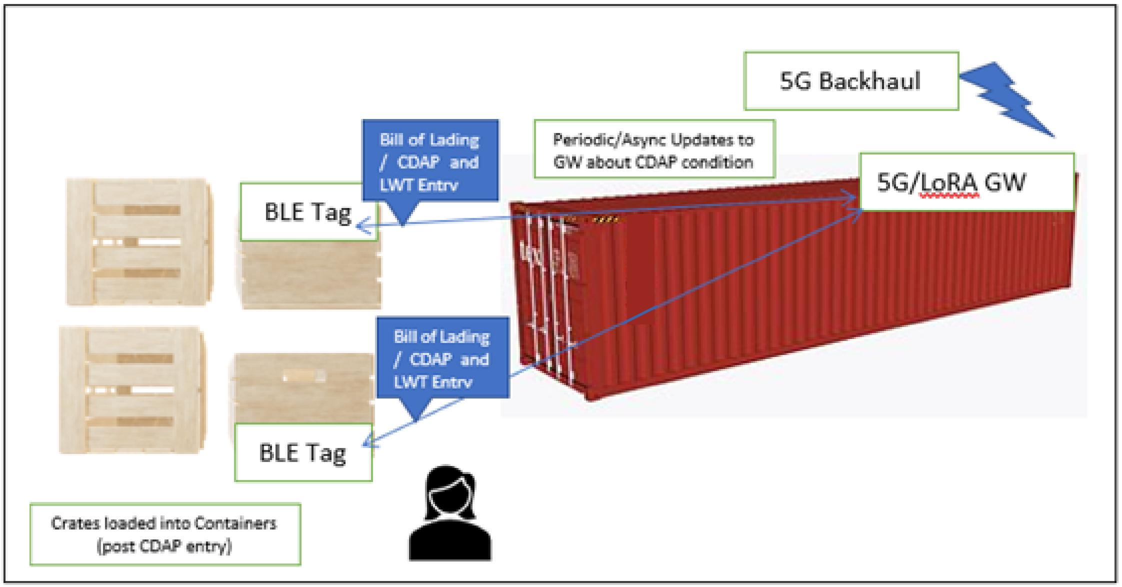

Figure 1: Status Reporting Framework

Consider an example involving an example container, as shown in Figure 1. As crates and pallets are loaded/filled into the container, a smart sensor attached to an object can be configured with the environmental ranges suitable for the carried merchandise, as is often performed for environmentally-sensitive merchandise. The smart sensor can also be configured with a Conditions Deviation Alarm Parameter (CDAP).

For example, suppose an object has an acceptable temperature limit of 40-degree C. A reported temperature of 45 degrees matches an alarm condition, so does a temperature of 50 degrees. However, a temperature of 45 degrees for a duration of 10 minutes is likely less damaging than a temperature of 50 degrees for that same duration. Thus, given a measurement interval m, the CDAP is a factor of $\sum md$, where d is the distance (in excess) to the alarm threshold (e.g. 5 or 10 degrees in the example above). In other words, the CDAP measures the sum of all intervals where the conditions were beyond the threshold, while also factoring the severity of the threshold excess for each interval.

It should be noted that an object's operational parameters are usually known, but they are typically not pushed onto the sensors themselves. Further, it should be clear that the CDAP can also be configured with a last will and testament value (LWT) that may represent a CDAP value beyond which the goods are expected to be irremediably damaged.

As the crates/pallets are loaded into the container, their smart sensors can connect to the container gateway. Current shipping processes involving sensors typically involve Bluetooth Low Energy (BLE) communications in which the sensors attached to the container itself connect to a gateway, but individual crate sensors do not. Thus, the method proposed herein is an enhancement to current processes. Upon connection, the sensors for the crates can start sending CDAP reports to the gateway.

As a vessel carrying the container leaves the port, the container gateway can send a "backhaul connection lost" message to all connected crates' sensors. At this point, the crates can send reports at longer intervals to the container gateway, thus saving energy. In one instance, the transmissions can be configured to completely stop while backhaul is not available. In another instance, the transmissions can be configured to stop, but resume when there are critical CDAP reports to send to the gateway, such that the sequence of report can be used as a post-mortem analysis of why/when perishable goods went bad during transit. In one instance, the container gateway can be configured to maintain connectivity to a private 5G/LoRa network onboard the ship, and, thus, can distinguish "backhaul to ship" from "backhaul to port" in messages sent to sensors.

During the trip, the crates' sensors can monitor the conditions at intervals and compute the CDAP. As the vessel reaches the destination port, the container gateway can send a "backhaul connection recovered" message to all crates' sensors. This message, similar to the backhaul loss alert, can be a simple BLE broadcast. The crates' sensors can exit their sleep mode at intervals and listen for this message.

Upon detecting the backhaul connection message, a crate sensor can send its CDAP report. The CDAP report can contain several fields. For each quantity measured, the CDAP report can include a quantity label (e.g., "temperature"), the raw CDAP value (as defined above), and a normalized version of the CDAP value (so all CDAP reports can be provided on the same scale, e.g., sigmoid, irrespective of the quantity measured and its scale). In some cases, a crate sensor battery may run out before the ship reaches the port. In such cases, the sensor can sends its last CDAP report upon reaching a critical level for the battery.

Upon receiving the reports, the container gateway can aggregate the reports and compute a ratio of CDAPs alarm and severity (e.g., x% of reported CDAP indicate condition violation severity above 0.8). This ratio indicates the urgency of taking action on the environmental conditions inside the container.

The port infrastructure can receive aggregated reports from all containers on the ship and make this information available to interested stakeholders (e.g., unloading contractor, shipping company etc.). The reports can then be used to establish a sorted list of containers that require specific treatment (e.g. humidity conditions critical in container 0304, move directly to warehouse upon unloading; LWT reached in container 0208, set aside for manual verification and good disposal, etc.).

Further, the outcome of the goods of a particular vessel can be used as an input into a learning algorithm (supervised) that can factor the vessel route, time of year, and container position in order to factor the probability of good damaged during the journey. This output can be used to better position the containers on the next trip along the same route (e.g., humidity sensitive cargo in summer HK-RTD trip should be placed on the right side of the ship to avoid humidity variation related to southern dominant wind, etc.). Accordingly, the method proposed herein may provide a lower rate of lost goods upon arrival, which can result in a reduced insurance cost for shippers and their customers.

In summary, the method proposed herein seeks to improve the state of the art by an early warning system upon arrival (so the most sensitive, but recoverable, goods, can be handled first), and also a learning mechanism (so that good types can be positioned judiciously on the ship to avoid adverse conditions for a particular type of merchandise on a particular route). Further, the method can be built using BLE tags and private 5G/Wi-Fi connectivity, which can significantly improve battery-life of sensors and, hence, network stability connectivity.