



AMBROSUS

The Ambrosus Smart-Pallet: A Next-Generation Secure Data Generator

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The Ambrosus Smart-Pallet (ASP) is a unique IoT solution designed to offer logistics providers and enterprises a next generation product for comprehensive management, security, and insight into the state and journey of all of its products. As the premier blockchain and IoT service provider across the globe, Ambrosus has created the smart-pallet to compliment its existing blockchain and IoT platform, AMB-NET, and also as an additional tool to be leveraged by the numerous entrepreneurs building solutions within the Ambrosus Ecosystem.

This document introduces the Ambrosus Smart-Pallet, and contextualizes its different technical facets and potential applications within the greater Ambrosus Ecosystem. Section 1 begins with a concise description of the Ambrosus Smart-Pallet, explaining its purpose and most important features. Section 2 discusses the business value proposition of the ASP. Section 3 explains the technical features of the ASP with special reference to its applicability to IoT aside-chains. Finally, Section 4 discusses the future potential of the Ambrosus Smart-Pallet and outlines different applications that it may be utilized for in the future.

Section 1: Product Description

The Ambrosus Smart-Pallet is an intelligent pallet prototype that has the ability to detect and automatically provide information about its contents and the environment in which it is located. While a normal pallet functions as a foundation from which products can be transported or stored, a smart-pallet incorporates intelligent gateways and sensing devices to monitor and transmit data about products, their whereabouts, as well as their conditions. In light of this definition, the Ambrosus smart-pallet provides three unique services:

- 1) **Product Condition Monitoring:** Measurement of temperature and humidity inside of the packages placed upon the smart pallet.
- 2) **Anti-Counterfeiting Solution:** Geolocation and verification of the status of all of the products connected to it; insight into whether any products have been opened or tampered with unexpectedly.
- 3) **Communication Alert Network:** To communicate with other-smart pallets or IoT gateways and automatically send alerts to systems managers or other IT systems in the event of an unforeseen problem.

The ASP' connection with the Ambrosus Network is a final feature that greatly enhances the capabilities of the product: Connectivity with AMB-NET, means that all data collected by the smart-pallet is eventually hashed onto an immutable blockchain and stored in decentralized storage. By connecting with the public-permissioned blockchain infrastructure of AMB-NET, the smart-pallet is one of the few existing IoT solutions that provides end-to-end data management in a secure and transparent manner.

Section 2: Business Value Proposition

The Ambrosus Smart-Pallet enhances existing management systems by collecting data about certain conditions of a product, and securely managing that data with third parties and other smart-pallets and IoT devices. Commercially, the ASP possesses a wide range of business applications, irrespective of the specific industry, production line, or stakeholders involved. Any product management system requiring real-time insight, optimal security, or enhanced trust can benefit from utilizing the Ambrosus Smart Pallet. While many commercial applications remain to be developed for the ASP, the original design specifically intended to solve four crucial business problems:

- 1) **Combating Fraud and Product Substitution:** Sensors or tags attached to both the pallet and the objects placed on top of the pallet send signals to the central gateway if a particular product has moved position or been opened. This signal is then stored on the Ambrosus blockchain in such a manner that the record cannot be tampered with from the point of collection. Additional geolocation capabilities ensure that a shipment never goes missing, or, that the actors involved can be quickly identified according to the sensor readings.
- 2) **Serialization and Monitoring of High Value Products:** For high value products requiring specific identifiers, tags are applied to individually serialize each item. These tags then communicate with the central gateway for the duration of its journey to ensure that the relevant variables for each item are maintained. This data trail, also immutably recorded on the Ambrosus blockchain, can then be displayed to any relevant third party or stakeholder in real-time.
- 3) **Real-Time Temperature and Humidity Tracking:** For cold-chain logistics suppliers, the smart-pallet and the different sensors attached to the products of a shipment can readily record the temperature or humidity levels of the external environment surrounding the product. Applicable to both first-mile and in-transit logistics processes, the conditions of products can thereby be managed in real-time accompanied with alerts and updates through a specific application.
- 4) **Holistic Logistics Management:** Utilizing multiple smart pallets, a network of interconnected sensors and gateways allows large-scale enterprises to create sophisticated monitoring and management systems for entire production lines of a particular asset. Applicable to warehouses, storage units, and supply chains, a smart-pallet network provides enterprises with the opportunity to possess real-time insights into the location, conditions, history, and security of all monitored products.

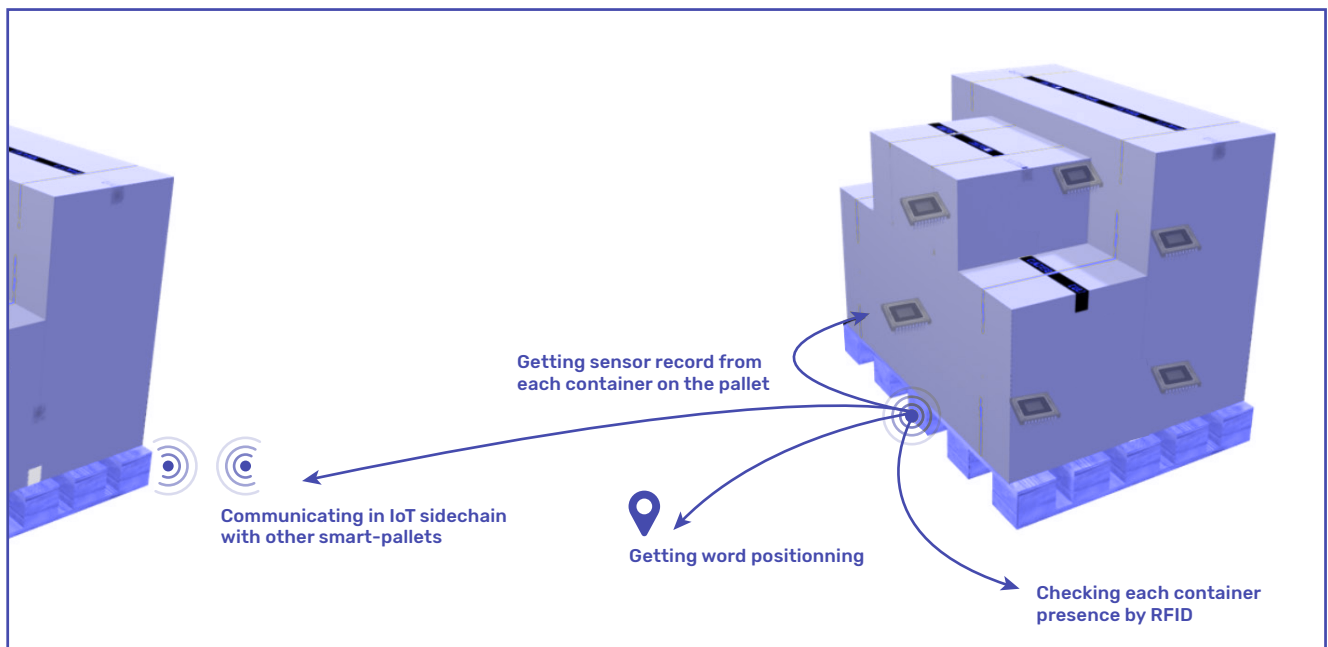
Beyond these core solutions, the ASP is applicable to any situation requiring a set of products to be monitored in unison. The purpose of such monitoring depends on the product at hand, but can range from identification to geolocation, as well as environmental monitoring of temperature and humidity. Furthermore, other IoT devices designed to collect data about additional variables such as CO₂, vibration, light-intensity, shock, water flow, and much more can also be customarily designed to communicate with the core pallet gateway. As such, the smart-pallet ultimately provides a foundation from which complex IoT networks can be constructed to monitor numerous product-specific or environment-specific variables, in real-time.

Section 3: Technical Components and IoT Side-Chains

The two core components of the Ambrosus Smart-Pallet are 1) gateways, and 2) sensors/tags. While the former is embedded within the smart-pallet itself, the latter is selectively incorporated onto or inside of products.

More specifically, at the center of each smart-pallet is an Ambrosus Gateway, capable of communicating with sensors or tags placed onto products as well as with the Ambrosus blockchain-cloud infrastructure known as the Ambrosus Network. This gateway allows the smart pallet to operate in a completely automatized fashion: data is recorded from the various sensing devices or tags, and then securely sent to the blockchain in such a manner that no human agent has the ability to alter the data.

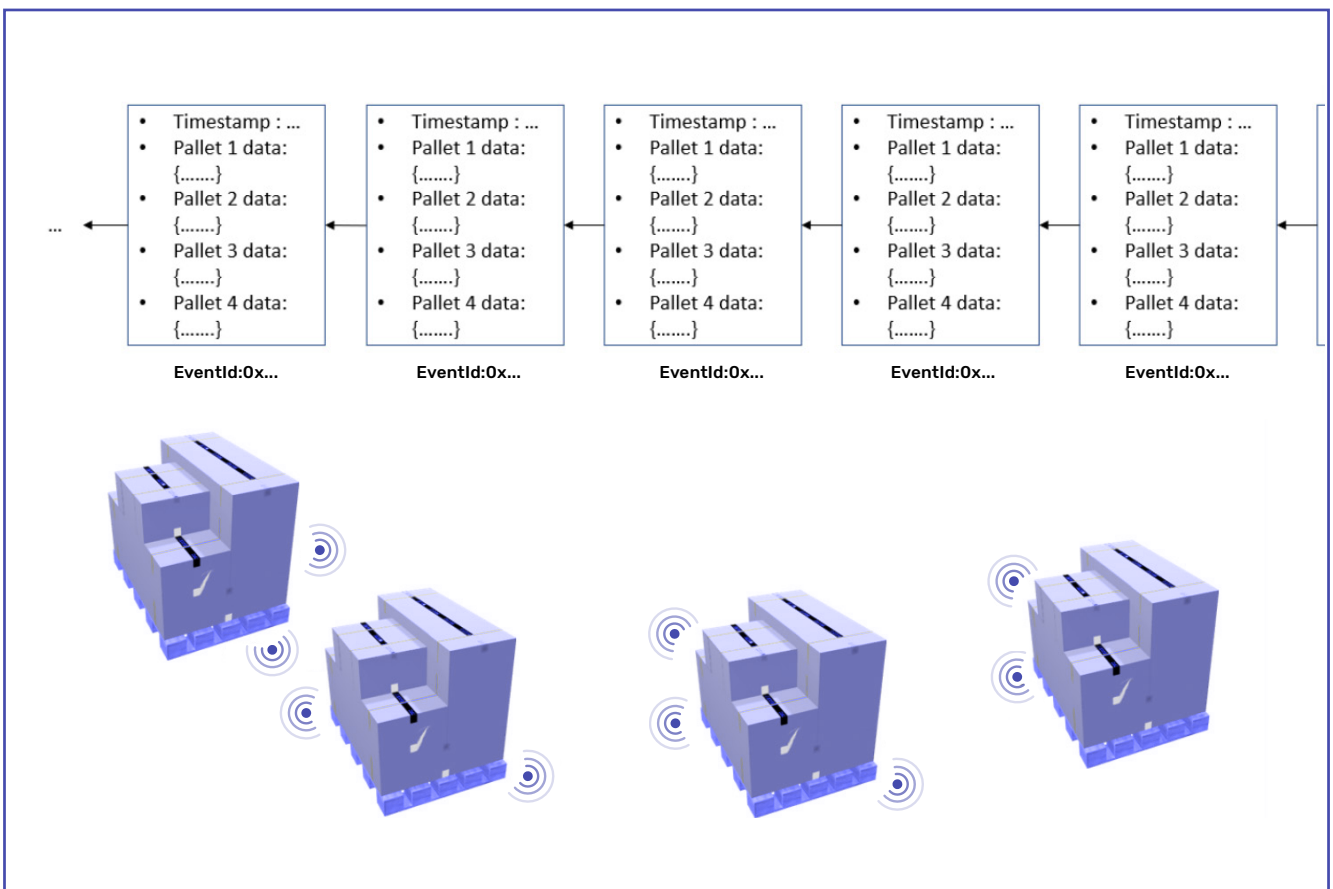
With regards to the sensors, the pallet is digitally connected to sensor placed inside each container on the pallet itself. In this manner, it is possible to precisely record the environmental conditions at the heart of the product, as opposed to the more general and imprecise conditions around the product. By communicating with UHF RFID tags the pallet is able to constantly check the presence of the container on the pallet. In the event of an error or unexpected alteration to the product in question, the pallet is able to send an alert within 5 seconds to the managing party identifying the time and location of where the problem occurred. Lastly, the gateway at the center of the pallet is constantly positioning itself using GPS technology allowing for a product to be tracked from any location in the world (including in the middle of the ocean, or in an area lacking technological infrastructure).



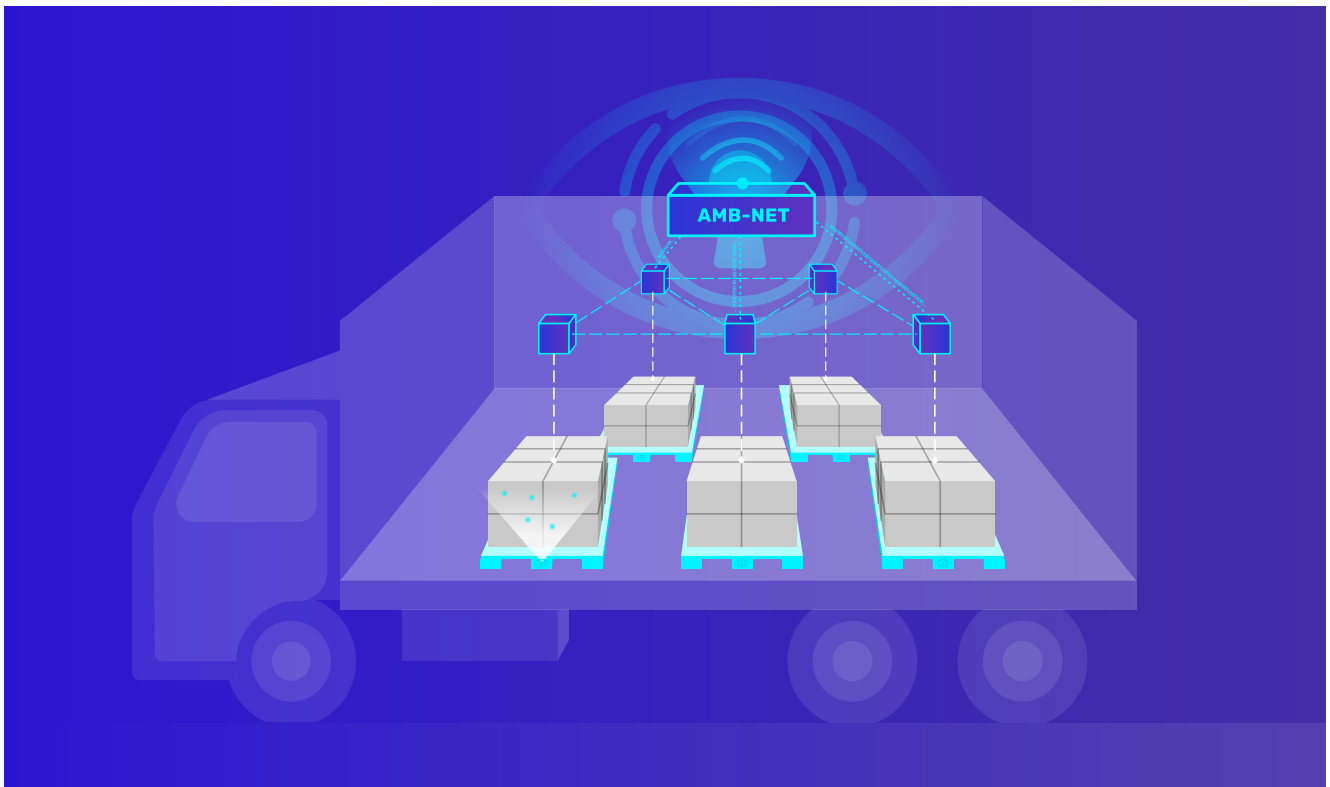
- *Constant Connectivity to Tags and Sensors Placed on the Products itself.*
- *Real-Time Temperature and Humidity monitoring.*
- *Alerts sent within 5 seconds to production managers.*
- *Automatic data collection and transmission to blockchain.*
- *Geolocation and unique serialization of each product.*

Section 3.1: Original IoT Side-chains

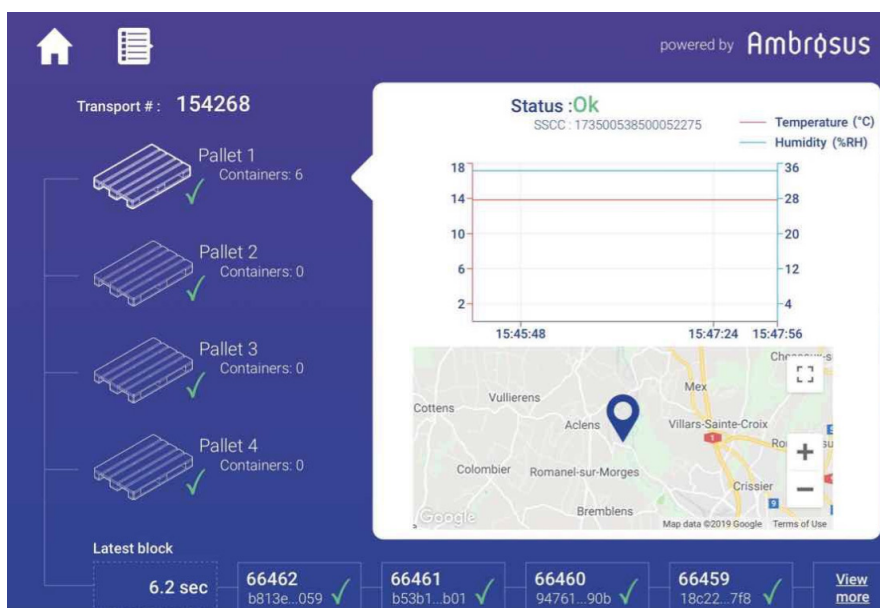
Beyond the capabilities of a single smart-pallet, innovative IoT side-chain technology has been integrated into the Ambrosus smart-pallet design to allow for communication and monitoring between smart-pallets themselves and the products they carry. Importantly, an IoT side-chain is not to be confused with how the term ‘side-chain’ is often employed with regard to a blockchain: the IoT sidechain is a private network automatically managed by the smart devices themselves. While each pallet individually generates data from its respective sensors or tags, at a fixed period of time (customizable but usually at 10 seconds), each pallet will sign and timestamp the data which it has generated. This data is then shared with the other pallets in the side-chain.



With an integrated network of smart-pallets on an IoT side-chain, all of the data from each smart pallet (and their respective sensors) are captured and stored by each smart-device in the network. A private proof of authority consensus mechanism among the gateways embedded in each pallet guarantees that all data shared between the pallets is secure and reliable. Overall the IoT side-chain infrastructure allows for a single Ambrosus smart-pallet to detect tampering or issues with any other smart-pallet on the network - this makes product tampering or cyber-attacks nearly impossible. At the same time, if multiple pallets are located in the same location, battery and GSM costs can be saved by pre-selecting only one of the pallets to transmit the data generated from all of the pallets in the side-chain network to the Ambrosus Network. All data, in every scenario, is stored on the Ambrosus blockchain.



More information on the exact communication procedure between IoT devices and the Ambrosus blockchain better informs prospective users on the operability of an IoT side-chain network: A low range (i.e. bluetooth) transmission protocol is used to share data between IoT devices. Each time data is shared (i.e. every 10 seconds), the different smart-pallets automatically create a 'block' of data using a Proof of Authority consensus mechanism. This block of data is then automatically transmitted to a Hermes Masternode hosted by the managing party. From the Hermes Masternode the history of all of the data from the various pallets can be managed and utilized through a specific application.



As the above demo illustrates, multiple pallets are connected simultaneously with reference to the various containers they each possess on their pallet. The location is provided for the entire shipment in real-time, as is the status of the temperature and humidity (if relevant).

Once the data has reached the Hermes Masternode, it is then sent into the Ambrosus Network for verification and storage: a hash of the data is sent to the Ambrosus blockchain and verified by Apollo Masternodes, while the meta-data from the generated block is held in distributed storage by numerous Atlas Masternodes. Due to such techniques the provenance and integrity of the data from the entire IoT side-chain is guaranteed and easily accessible.

Importantly, the entire side-chain infrastructure for smart-pallets can be stopped and 're-booted' when a specific set of pallets have completed their objective or journey. Another side-chain can then commence when the pallets are required once again. This procedure, ultimately allows pallets to be recycled for different purposes and for the management of different products: Once the entire side chain infrastructure has been stopped based upon its predefined configuration settings, all final data is sent to the blockchain and then deleted from the side-chain network. All pallets are then reset and re-configured according to new settings, for a different purpose. In this manner, the costs of a side-chain network can be considered over an exceptionally large duration of time and across multiple production lines.

Section 4: Future Development

The Ambrosus Smart-Pallet is a newly developed IoT product connected to the Ambrosus public blockchain network. The innovation behind the ASP is threefold: 1) Automatic and secure data management and verification from products, to gateways, to the blockchain. 2) Real-time insight and monitoring of geolocation, humidity, and temperature. 3) Optimized IoT Side-Chains Networks for constant data verification and communication between smart-pallets, central gateways and the blockchain. What remains to be developed for the Ambrosus smart-pallet can be categorized into two different domains: technical enhancement and business development.

Technical Enhancement: Future development of the Ambrosus Smart-Pallet will look at other types of sensors, tags, and smart devices that can be integrated into the existing network design. In such a manner, solutions can be designed for a wide-scope of industries beyond cold-chain logistics including but not limited to warehouse and container management, first-mile management of core commodities and products, as well as more robust management of high value and luxury goods.

Business Development: The Ambrosus Incubator is constantly looking for serial entrepreneurs or teams of experts from a specific industry looking to build unique and value-oriented business models around certain products. The Ambrosus Smart-Pallet is no exception: future development of the smart pallet will significantly focus on working to find specific use-cases within a number of different industries from which it can be deployed at scale, including its unique IoT side-chain architecture.

Altogether, the Ambrosus Smart-Pallet is an original product designed at the Ambrosus Innovation Laboratory, and fit for industrial production and widespread implementation. While many further developments await the Ambrosus Smart-Pallet, its original design uniquely pioneers advanced IoT side-chain connectivity, holistic data management using gateways and the Ambrosus blockchain, and a new frontier of potential use-cases and enhancements for future entrepreneurs and engineers to leverage for their own purposes.