



PSQR SOFTWARE

Virtual Item Level Aggregation

Digital twins and Virtual Item Level Aggregation - an efficient and economical approach to unit level track and trace

- by Emanuel Greisen

With legislators tightening food, product and consumer safety requirements, manufacturers, producers and farmers must adjust accordingly by increasing the granularity of their product or item data as well as their track and trace capabilities. By digitising the supply chain, creating a digital twin of each unique item and collecting, storing and sharing data, companies can be compliant to track and trace rules and regulations and ultimately improve quality assurance, recall management, proof of provenance, and brand and

product protection. This article introduces you to unit and level tracking and explains how Vila - Virtual Item Level Aggregation - can strengthen your operational excellence and bottom line.

Regulatory Compliance have come to stay

In recent years, regulators and lawmakers have introduced different rules and guidelines for tracking and tracing different product groups. The targets for these regulations have predominantly been goods with high levels of excise tax – and thus high volumes of illicit trade. Mostly these regulations require manufacturers and supply chain operators to account for goods down to the unit level.

Whether this type of compliance will apply to all types of products, all industries, and across all geographies is

still to be seen – but there is no doubt that these kinds of regulations are here to stay. What is clear though, is that the scope for regulation will broaden as regulators and industries witness how track and trace technologies can deliver benefits beyond the optimisation of tax collection and the prevention of illegal trade.

Unit vs. batch level tracking

One of the most ambitious aspects of most track and trace regulations is the requirement to uniquely identify each product unit, its unique path from manufacturing across the supply chain, and in some cases even its path to the consumer. This is a fundamental change to tracking on stock or batch level - because no two units can carry the same ID, a unit cannot exist in more than one place, and units cannot disappear anonymously. Unit level tracking allows inspectors, law enforcement, and other actors to quickly conclude if products are part of the legal supply chain, or the illicit one – something that would otherwise have taken a substantial investigation to finally conclude.

The challenges of traditional serialisation and track and trace

One of the biggest challenges involved in implementing rules and regulations requiring unit level tracking **is the amount of data and information that needs to be collected, stored, analysed and shared.** Each item receives a unique ID marking that is tracked at every event and at every identified point in the supply chain. In this process a magnitude of data accumulates in the system. Where an ERP system would normally refer to products with just a SKU and quantity (and maybe some meta data), industry and governments now need to invest in specialised software and IT systems capable of handling billions of data points.

Another challenge that industries face is **how to apply unique IDs onto individual products.** Many of these products are made with industrial machines

producing at a rate of 1000 units per minute. At these speeds, the ID has to be applied in 60 microseconds or less. Companies specialised in building printers, scanners, and other components need to accommodate these new requirements – while others specialised in retrofitting production lines make their adjustments by adding the necessary components.

The role of technology, software and digitisation

A number of software solutions are available which can assist in the orchestration of the moving parts, in the optimisation of the data points, and minimisation of production pauses due to the added complexity that unique IDs bring.

Many manufacturers, brand owners, supply chain players, and retailers recognise the benefits of a digital supply chain. Similar to how money and paper trails have been digitised, the digitalisation of the supply chain allows quick access to sharing, searching, and reporting on what has happened at each step along the chain.

However, in order to fully digitise, in the context of product level track and trace, each unit must be uniquely identified and a digital counterpart has to be created. Therefore a bridge needs to be created between the physical and digital worlds to ensure an effective digital track and trace capability. This bridge allows physical objects to be bound to their digital counterparts – their digital twins.

Complexities and Cost

What we have learned from our participation in regulatory compliance efforts is that **the digital twin of the product needs to be created when products are manufactured, and before they are packaged, to achieve maximum efficiency.**

It is not easy to create the digital copy (or twin) and journey. – The physical world is filled with real world problems, inconsistencies, human error and other complexities that make it hard to represent physical events digitally. The digital world is again precise, inflexible, systematic, and hard to adjust to the gaps and tolerances of the real world. Due to these complexities the implementation of a digital supply chain can be costly and involve risks - particularly as they may **interfere with existing manufacturing processes.**

Looking at SKU/quantity level tracking vs. perfect unit level tracking and how far they are apart, the natural chain of thought would be to serialize and track on a higher level of packaging – e.g. pallets, master cases, crates, etc. However, any one of these layers of aggregation may be an acceptable granularity for some use cases but may be too fine or too coarse for others. However, when the products arrive at consumers, the link to the higher packing layer is lost (as the product itself often doesn't carry any direct marking). **Tracking and tracing on higher packaging levels also has the adverse effect that every time you switch to a lower one, the size of data changes by an order of magnitude – potentially resulting in a requirement to buy new software/solutions to handle this.**

So is there an alternative? Yes. Itemised tracking and one digital twin of each product or mini-batch

Rather than making a perfect copy of the higher packaging levels, it is possible to make an imperfect copy of the entire packaging hierarchy. This means that there will be exactly one digital twin for every product being produced, but the link between the physical and digital side may not be unique. This may not seem very useful, but if the products already carry for instance “batch no + date + hour:minute” markings, like most food and other products do, the link will not be 1-to-1, but 1000-to-1000. This level of granularity may not find individual production flaws – but will be much more

efficient when handling recalls, detecting counterfeit products, etc. When this methodology is used on all packaging levels, the data quality improves because algorithms can “clean” up the data before concluding how to represent the physical products digitally.

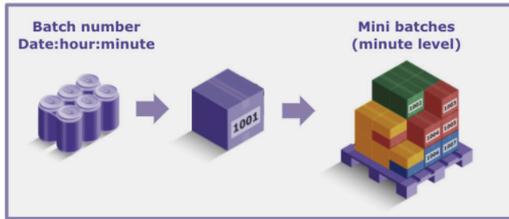
The role of Virtual Item Level Aggregation

The main idea behind Virtual Item Level Aggregation is to bring down the barriers that the magnitude of data and other challenges create when unit level serialisation and track and trace are considered or required.

The methodology allows collecting data from existing hardware, servers and sources and creating a virtual mass or whole. It further allows for the installation of non-intrusive or virtual IoT devices counting products, boxes, and pallets as they move through the factory floor. This all contributes to the accessibility and the affordability of the solution.

How to integrate a Vila solution for operational excellence

Our team of software engineers at PSQR has created a Saga Module, named Vila, which is a Virtual Item Level Aggregation solution. Vila is integrated with master data like expected counts of products per package, packages per box, boxes per pallet, etc. The combination leads to an – albeit imperfect – digital package hierarchy which can amongst others easily be inspected, shared and reported on, as it also creates a digital trail to ensure visibility of the products across the supply chain. Vila is a traceability solution that can assist with virtual itemised tracking or to drastically reduce the batch sizes that can be traced.



Semi unique ID

+



Digital trail

=

Supply chain visibility

Since the data representation is as granular as the physical world it represents, any improvements to the data quality will not change the order of magnitude of data. Neither will it change any reporting for a manufacturer – and more importantly, for any of the supply chain actors with whom data is being shared. This allows manufacturers to gradually add more and more hardware and software to their production lines to obtain better and better coherence between the physical products and their digital twins. Examples of this could be to adjust batch/date printers to include seconds to timestamp, it could be adding unique serial numbers to pallets, boxes, and other higher packaging levels, adding reject counters, adding more product counters just before aggregation, on reject stations, or other places on the production line where products can diverge.

It is even possible to feed data from scanners, aggregators, palletizers, or other digitally controlled parts of the manufacturing line to the Virtual Item Level Aggregation module allowing it to model a more precise view of the actual products leaving the factory to enter the supply chain. The scalability of Vila allows for the integration of the data from many sources ensuring and allowing for continuous improvement and operational excellence.

Consider the business benefits

As Virtual Item Level Aggregation empowers manufacturers, producers and farmers to track and trace individual products or package hierarchy by means of a digital trail.

It is therefore invaluable for quality assurance, recall management, proof of provenance, and brand and product protection.

Within the scope of Food Safety, manufacturers are required to **quickly** find the origin of food contamination across the entire supply chain. Being able to view the digital trail of a digital twin of a mini-batch or itemised product, they will be able to assess the events and journey of the products faster to pinpoint the place of contamination.

Recall management becomes much easier, too. With Vila, manufacturers can do recalls with enhanced precision down the unit. This eliminates time and money wasted on recalling large batches of thousands of products, as well as prevents unnecessary waste of products.

Consumer demand for transparency is ever-growing. The origin and impact of the products that consumers buy become increasingly important. With Vila, manufacturers have **access to large and enriched data sets that prove the provenance of products across the supply chain**. As the data sets cannot be falsified, the integrity of the product origin story cannot be questioned. This not only helps protect consumers, but also the brand and the product.

It may be easy to copy a product. But it is **impossible to copy the extra digital signature or twin** that Vila creates. Considering that each product has a digital twin, Vila therefore protects both brands and products.

Taking all of the above and the cost effectiveness of a Virtual Item Level Aggregation solution into account, it is evident that manufacturers, producers and farmers should consider it as part of their track and trace capability.



About the Author

Emanuel Greisen is the Managing Director at PSQR. He is an avid entrepreneur and maverick, who has through his career created and spearheaded a number of IT related companies.

With the hands-on experience and knowledge gained from roles as a software engineer, CTO and COO, Emanuel is well equipped with a technical and managerial toolkit. This toolkit and his passion for technology ensures the success of any IT related project or venture he sets his sights on.

Emanuel has worked with many domains and platforms including marketing, entertainment, investigative intelligence, back-office systems, financial services, and track and trace. He was also responsible for the architecture and development of a SaaS payment system. Emanuel holds a Bachelor's in Computer Science from Copenhagen University and has recently published a thought leadership piece on a distributed Track and Trace Solution for MDR (Medical Device Regulations) Compliance.

About Vila

Vila is our Virtual Item Level Aggregation solution which enables manufacturers across industries to track, trace and obtain a view of their physical products by creating and tracking digital twins. The technology allows for the collection of data and events from existing hardware and other non-intrusive IoT devices. It therefore allows for track and trace capabilities without having to purchase and install expensive hardware and machinery to do full item level serialisation.

Although Vila can be viewed as an entry or first step to incorporating track and trace and digital functionalities into the supply chain, it can also be applied to industries with established track and trace functionalities. We believe that this solution is especially well suited for the food and beverage industry and can assist with tracking relating to ensuring food safety.

PSQR - We are Track and Trace Software Experts

PSQR is a Danish software development company that specializes in highly scalable software for storing, processing and analysing vast amounts of supply chain data. The company partners with track and trace software integrators, solutions providers, consultancies and industry bodies to bring best of breed IT Solutions to the world of Traceability. Hereby empowering manufacturers, corporations and governments across the globe with digital track and trace capabilities and the ability to tell the true story of the origin, journey, whereabouts, and consumption of products and resources across the supply chain.

Reach us at www.psqr.eu and on [LinkedIn](#) or send us an email at info@psqr.eu

