Bosch Research

Economy of Things – Contributions to the Community

"SupplyTree" – grabbing the problem of traceability by the roots

Supply chains are complex constructs with many different participants, involving SMEs and large multinational corporations alike. The participants usually interact only with their direct suppliers or customers, using a whole range of different means of communication – various documents, emails, telephones and other standardized solutions. "This also makes it difficult to track individual information such as who produced specific components, which is important in a recall, for instance," explains Matthias Günther, industry expert in the strategic advance engineering project "Economy of Things" (EoT) at Bosch Research.

Is blockchain the solution? Not necessarily.

Besides central information systems, the last few years have seen a particular focus on decentralized architectures based on blockchain technology. The idea behind blockchain is that data sets in a supply chain are fed into a shared system that is the same for all participants. Blockchain maps the data sets in blocks. Each block contains a cryptographically secure hash of the preceding block. This makes it easy to check the data sets and prevents them from being modified – an advantage of blockchain technology. "However, this mechanism leads to high redundancy and to problems in keeping trade secrets," says Günther. That's why the EoT team at Bosch Research is working on an alternative method. "Our network protocol – the 'SupplyTree' – has advantages over centralized and blockchain architectures," Günther says.

The SupplyTree is a loosely linked, decentralized system based on collaboration. "The data is stored at source and only a cryptographic commitment is passed on in the supply chain," explains solution architect Dominic Wörner from the EoT team. In the event of a product recall, for instance, the basic data can thus be requested and any tampering will be detected. "That means the data is only passed on if required, and the company that holds the relevant data also retains control," says Wörner. The shared use of data protects it from being tampered with – and the supply chain is made transparent by the interlinking.

A data structure like a tree

As its name suggests, the SupplyTree is constructed like a tree – the finished product at the end of the supply chain is the "root node" of the tree. In turn, this root node has multiple finer "child nodes" that represent the various parts of the various suppliers. This structure can be continued all the way to the raw materials of the suppliers at the "leaf node." Each child node grows to the next, or to the next supplier and its customers. In this way, the tree is built up from leaf node to root node, with all participants in the supply chain contributing their own data to the structure. By passing on the hash values between the supply chain's various participants, any change to the data can be detected. "This makes it impossible to modify the data structure – in other words, it becomes tamper-proof," Günther explains.

Getting to the root of the problem

In the automobile industry, the data stream along the SupplyTree could take the following form. Imagine, for example, a finished product that is an infotainment system integrated into a car. This

Contact: Matthias Guenther, Project "Economy of Things", Matthias.Guenther.ext@de.bosch.com
Nik Scharmann, Project Director "Economy of Things", Nik.Scharmann.ext@de.bosch.com

system consists of various components that are sourced from different suppliers along the SupplyTree. In the production process, the components move along the supply chain and are put together. In the case of a recall, it is necessary to identify the precise source of the defect in the supply chain. In the case of the infotainment system, the SupplyTree could be built with three partners:

- Tier 2:
  Leaf node – supplies the ECU
- Tier 1:
  Child node – integrates the ECU into the infotainment system and delivers it to the OEM
- OEM:
  Root node – integrates the infotainment system into the vehicle

Let us assume the ECU has been made using material that has subsequently been classified as hazardous. “In the case of a recall campaign, the OEM requests data from Tier 1,” Günther explains, adding: “Tier 1 sends the data back to the OEM, which compares it with the hash of the object and thus detects potential tampering. The reference is then analyzed and the information called up from Tier 2. The OEM then compares the data from Tier 2 with the hash.” The hashes and links between the objects make it possible to detect any change to the data since the time the hashes were forwarded along the supply chain. As a result of this interlinking along the SupplyTree, the OEM can trace the source of the defect and recall the cars affected by it.

The SupplyTree is therefore a simple record that solves confidence problems along the supply chain. It creates a tamper-proof data chain that does not require a central authority. You can read more about the SupplyTree in the research paper by Matthias Günther and Dominic Wörner.

Renningen, April 2020