Connected Diagnostics

Background

Step into your favourite time machine, and rewind 15 years. Vehicle diagnostics were very different. Most passenger car vehicles were simple with only a handful of ECUs. The J1962 standardisation had ensured a common access platform for performing diagnostics, and whilst the tester technology may have been primitive compared to today, it was possible to perform electrical diagnostics.

Now fast forward to the present day, we observe an evolution of vehicle architectures, we see CAN usage grow, module count grow, vehicle feature complexity increases, finally we see the appearance of gateway style ECUs, the addition of DoIP (Diagnostics over Internet Protocol) and a significantly more complex vehicle.

Testers have symbiotically evolved to match the demands of the vehicle and the user, but fundamentally the landscape has remained the same. Diagnostics are performed via a connection to the vehicle and at the point where the vehicle already requires attention.

What do we mean by connected?

Of course, testers have evolved. It is possible to use a wireless tester. DoIP and WIFI technologies make this easy, but as already stated this is not a permanently connected solution.

The revolution that comes will be driven by connected diagnostics, but what does ‘Connected Diagnostics’ mean? Fundamentally, these two words are a doorway to allow the complete re-thinking of diagnostic use cases.

The idea of the connected vehicle is not new; indeed, we see software-over-the-air as an acknowledgement that this revolution has already begun. It is, however, what the connection is and how it is used that will be disruptive. Imagine the scenario where all vehicles can communicate remotely, can send diagnostic event information, and can receive operational commands.

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Enablers for change

We start by asking some questions, what are the pain points that our organisation face? What are our cost overheads? Where can we optimise and improve customer experience, and thus brand loyalty? How do we prepare for the future of shared mobility?

Whilst asking these questions, we quickly conclude that a permanently connected vehicle allows for many use cases that have the potential to reduce spend, and improve customer experience, a handful of these are explained in more detail below:

- **Over the air updates** – This is a use-case that is already partially covered in the industry, but it is still valid. A connected vehicle can benefit from OTA updates.
- **Vehicle state monitoring** – A key use-case is the monitoring and publication of vehicle state. This allows an organisation to use its intelligence to proactively ensure that a vehicle does not reach an undriveable state. Interaction with the customer and external agencies can aid ahead for failure. This can additionally be used as a platform for predictive maintenance.
- **Vehicle state recovery** – In some instances it is possible to recover vehicle state sufficiently (via diagnostic commands) that a vehicle can be safely made drivable again. This can be leveraged by recovery and customer assistance teams to keep a customer on the road.

Technology Challenges

Security and Privacy

Security should be considered first and foremost in any connected environment. The concept of ‘secure by design’ should be followed. Concepts such as vehicle to infrastructure VPN, vehicle key/certificate authorization and always secure communication are just some of the measures that can be put in place to minimise any attack vectors [during external communication].

Data privacy has seen a lot of media attention recently [GDPR and the right to be forgotten], and this too is a large consideration during the development of a connected diagnostics system. Fundamentally any data transmitted relating to a vehicle needs to be handled in a safe and controlled manner. Customer consent is also a key factor, and organisations should consider changes to their terms and conditions to ensure that appropriate consent is given, and services are guarded accordingly.

These are just a few considerations, a CDS platform must be correctly designed and implemented to ensure that vehicle safety and customer privacy are positioned as the most critical component of the solution.

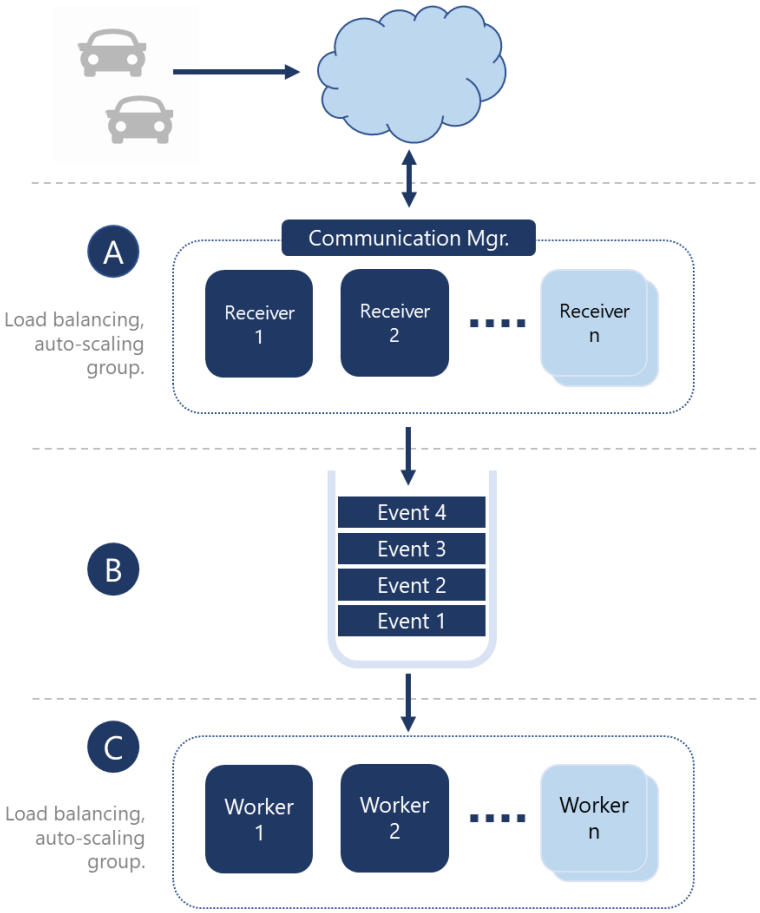
Infrastructure

Vehicle communication is a critical part of the puzzle, a successful solution will require two-way communication between a vehicle and infrastructure. This presents several challenges, such as method of data communication, bill of materials extras, product engineering. Modern technologies are (if not already) reducing these barriers and falling commodity prices are making this technology more and more accessible. 3/4/5G data connections, commodity compute-platform ECUs, etc. are all key ingredients in a connected solution.

Design to scale

An interesting challenge to a successful platform is the variability of the demand that will be placed on any data capture component of a connected diagnostics system. Over time vehicle count or communication events will increase and there is no guarantee regarding the predictability of data delivery (due to vehicle communication availability, time zones, etc)

The key here is utilizing ‘design to scale’ principles when imagining the solution. An example of how this problem can be solved is shown in the architecture diagram below.



There are several parts that work together to minimise deployment overhead costs, whilst maximising scalability and seamlessly handling variation in demand.

- (A) communication manager – a scalable service, the only interaction with the vehicle, minimised processing [validation] and queue submission.
- (B) Processing queue – where messages are deposited after acceptance, the queue depth is monitored, and data processing workers are scaled to meet demand (serverless computing)
- (C) Data processing – workers that expand the data in a business specific manner, on successful processing, the working signals completion and acknowledgement is sent to vehicle. Error messages can be managed and processed out of band

Modern scalability techniques re-enforce this pattern and the resulting solution is both simple and highly-scalable. Continuing this philosophy thought a complete solution will

ensure that an investment that is fit-for-purpose on day one will still be as such in years to come.

Business Benefits

Any solution that an organisation imagines will come at no small cost (requirements on vehicle platform change, infrastructure, system change, support, etc.). hence what business benefits does this bring?

- **Vehicle Insight** – The ability to capture in-field vehicle data and state allows an organisation to benefit in several ways. It is now possible to understand potential failure before it occurs and engage with the customer to prevent vehicle downtime. Additionally, when a vehicle is in a workshop for scheduled maintenance, there is an opportunity to suggest maintenance that will be required at some time in the future (to avoid downtime). The benefits of this are significant, an organisation can leverage this data as a source for machine learning and capture part longevity data.
- **Vehicle State Recovery** – In the event that of vehicle breakdown, that could otherwise be temporarily recovered in such a way that the vehicle is drivable. This reduces vehicle downtime and keeps the customer on the road.
- **Reduced Vehicle Downtime** – Connected diagnostics is a key enabler for reduced vehicle downtime. Either through predictive maintenance, or managed recovery the ability to step in and prevent a failure is priceless in this respect.
- **Increased Brand Loyalty** – Ultimately an improved service that delivers the perception of increased reliability, intelligence and minimised downtime is a significant factor in customer choice and retention. All these factors ultimately add to the brand value and increase customer loyalty.
- **Improved Dealer Experience** – An added benefit of this solution is the benefit to the dealer network. Technicians can determine vehicle state and do initial diagnostics before a vehicle arrives [including requesting parts that might otherwise require ordering when a vehicle arrives], service advisors can present an accurate picture of vehicle health and recommend service procedures that will pro-actively prevent downtime.

Wider context

The focus so far has been around the connected vehicle, but there are much wider implications of such a solution within an organisation.

Firstly, the vast amount of data that such a solution will generate will require an appropriate IT solution that is both flexible and powerful. But, such data is of immense value across multiple departments. It can be used to understand long-term vehicle aspects that have simply not been possible to date.

Take for example component lifecycle analysis. Today, an organisation may only see a component after it has failed [and even then, not in all cases], and there is [often] no context with the failure. The failure of that component may trigger a DTC, but how long has that component been ‘90%’ failed? Turning this on its head, imagine a world where vehicles were reporting events that delivered the data that could answer these questions. Not only would engineers be able to evaluate and improve component performance, but they would be able to leverage that data combined with machine learning to more accurately predict failure in future.

We should not, however, forget legislation when thinking about connected diagnostics. Some geographies require that remote diagnostics capabilities be make available to the aftermarket. A connected diagnostics solution combined with [for example] an extended vehicle platform (ISO-20077/8/80) is a perfect solution that would satisfy the requirements of the legislation whilst delivering a safe, controlled solution.

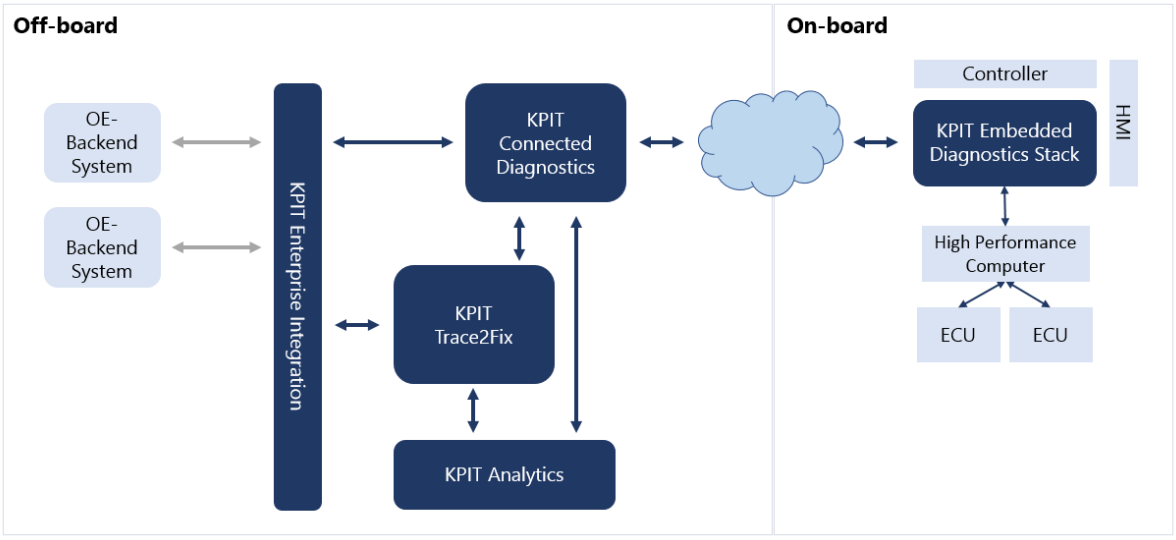
Finally, looking to the future, a connected diagnostics solution has the potential to fulfil use-cases that have not yet been established. For example, standardised pay-per-use, or remote inspection are ideas that could easily develop into requirements that an organisation must fulfil.

A connected diagnostics solution opens a wide number of opportunities and provides business benefits that deliver on the investment that is required to deliver such a solution. So, the question should not be if, but when does your organisation embrace the connected journey?

KPIT's Offerings

As a leader in vehicle diagnostics, KPIT is aware of the potential benefits of a connected diagnostics solution.

The KPIT 'Connected Diagnostics' solution utilizes its proven diagnostics products and services to deliver a standards-based end-to-end solution that is fit-for-use today and long into the future. A typical solution can be seen in the diagram below.



The major components of the solution are:

- **Embedded Diagnostic Platform** – The KPIT embedded diagnostic platform is a fully-featured, standards-based diagnostics stack that can is designed to operate in a resource-constrained environment such a telematics ECU. This is the vehicle interface, where ODX data and OTX sequences are leveraged to perform diagnostic operations.
- **Trace2Fix** – KPIT's innovative solution to guided diagnostics (and more) provides the perfect platform for understanding and managing vehicle state issues. From in-field root-cause diagnosis to remediation and/or repair management, Trace2Fix has it covered.
- **Analytics** – No solution is complete without competent analytics to make sense of the data streams that will become available as part of a connected solution. KPIT

has groups dedicated to data analytics and can work with your organisation to deliver best-in-class data visualisation platforms.

- **Enterprise Integration** – KPIT differentiates itself by specialising in end-to-end solutions. This is a key aspect in a successful deployment of any new system. Its ability to integrate with existing systems within your organisation.

KPIT has productive deployments of connected diagnostics systems. We can leverage our expertise in the diagnostics theatre to assist with planning your connected diagnostics solution.

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About KPIT

KPIT is a global technology company with software solutions that will help mobility leapfrog towards autonomous, clean, smart and connected future. With 6000+ Automobelievers across the globe, specializing in embedded software, AI & Digital solutions, KPIT enables customers accelerate implementation of next generation mobility technologies . With development centers in Europe, USA, Japan, China, Thailand and India – KPIT works with leaders in mobility and is present where the ecosystem is transforming.

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