

## **Written evidence submitted by Starship Technologies (SDV0019)**

### **The purpose of this response**

Starship Technologies (Starship) is the world's leading autonomous delivery service. With operations in the UK, we are interested in the regulations that govern self-driving vehicles. In this response, we offer insights from our experience to assist the committee with its inquiry and, specifically, outline the uses and benefits of self-driving technologies. We want to ensure that the UK encourages innovation and investment, and promotes safety.

### **About Starship**

Launched in 2014 by two Skype co-founders, Ahti Heinla and Janus Friis, Starship aims to fundamentally reshape the last-mile of delivery, making local deliveries more convenient, environmentally efficient, and less expensive.

The company's autonomous Personal Delivery Devices ("PDDs") are designed to provide (i) restaurant delivery, (ii) groceries & retail delivery, (iii) parcel delivery, and (iv) industrial-campus delivery.

Presently, Starship's services are commercially available in the United States, United Kingdom, Finland, and Estonia with partners like Sodexo, Daimler AG, Intuit, Tesco, Co-op, Volkswagen, Novo Nordisk, Bayer, and many others.

The company's business headquarters is in San Francisco and our engineering division is based in Estonia. Starship's largest and most sophisticated global hub is in Milton Keynes and the international marketing and communication teams are in London.

### **Operations in the UK**

Starship operates in Milton Keynes and Northamptonshire and is conducting trials in Central Bedfordshire, Bedford, and Cambridgeshire. We serve nearly 200,000 homes.

Starship robots in the UK have driven 1.3 million miles making over 1 million deliveries. Globally we have crossed more than 60 million driveways and roads and made over 3.5 million deliveries.

As a company, we are committed to levelling up by bringing the world's most sophisticated self-driving robots to the streets of towns across the UK. Delivery services have long focused on big cities, but not towns and rural areas. We are democratising delivery by making it affordable and available to everyone. This is only possible through a business model focused on automation.

Our operations are low emission – the energy needed for one delivery is approximately the same as boiling the kettle for one cup of tea. Depending on the operating area, between 50% - 70% of our customers tell us that our deliveries have replaced a car journey for them. Starship robots help to reduce carbon emissions, take cars off the road, and improve air quality.

### **Meeting a need**

'On-demand' is now commonplace. Consumers have an expectation that they can receive low-value orders in a short timeframe. The question for all of us is how we ethically and sustainably meet that growing need?

Starship believes we have a solution for the last mile, which is the most expensive and carbon intensive part of the supply chain. There will be items that humans are best placed to deliver and areas where human drivers make the most sense, but where the value of the order is relatively low and the timescale short, Starship can play a vital role in the logistics mix.

### **Social value**

In a recent customer survey, 17% of our customers told us that they have a disability or live with someone else who does. We provide an end-to-end service that is easy to use and have designed our PDDs to be accessible – the app is fully accessibility compliant. The height of the robot is such that it can be unloaded by wheelchair users and the LED flag on our robots is there specifically to assist visually impaired people (it serves no operational purpose other than that).

We are also committed to being a part of the communities where we operate. Children and young people love our robots and our Starship Schools programme sees us take robots into schools to talk about STEM in a way that is accessible. Most recently we ran a youth workshop at the Cambourne Science Festival on robotics and autonomy. As we scale, we want to do more of this.

We also buy people time. For our regular users in Milton Keynes, we estimate that we have saved them 2 full working weeks of time over the last year.

We are popular where we operate. Our community Facebook Groups are used to engaging local people on a regular basis and for residents to share their own Starship stories. In Milton Keynes, over 11,000 local people are in our group (5% of the city population). In Cambourne, Cambridgeshire, a third of the entire population of the area downloaded our app within the first month of operation, with 17% of all residents making at least one order. People share photos and videos of their children meeting robots or dancing when the robot sings (our robots can play a song when they deliver).

### **Progress and Trials**

To show our progress, we will explain how we work. We have come a long way from initial trials 7 years ago in Greenwich where robots were still escorted by a human handler. Our robots are now 99% autonomous.

### **How it works (consumers)**

Starship partners with well know grocery brands such as Co-op and Tesco alongside retailers such as Costa Coffee and local independent retailers.

Residents use the Starship app, or the retailer's app, to place an order. The retailer loads the order into a robot, the robot delivers it to the customer. The customer unlocks the robot with their mobile phone, the robot will move on to the next pick up.

### **Starship PDDs**

Starship PDDs are low-mass (approx. 33 kg without cargo), low-speed (average speed of 2.3 mph) devices that travel on pavements, using proprietary mapping, navigation, and sophisticated obstacle avoidance technology.

Our PDDs are 697mm in length and 569 mm wide, and measure 571 mm in height. In addition, the devices have a flag attached that reaches 1187 mm in height from the ground. The PDDs have a cargo space of 400 x 340 x 305 mm, which accommodates approximately 3 bags of shopping.

Starship's PDDs are equipped with a range of technologies to provide safe, efficient, and autonomous travel. Specifically, the devices are equipped with three layers of obstacle avoidance, which ensures their safe operations,

including colour cameras with neural network detection; ultrasonic sensors; time of flight cameras; stereo cameras; radar providing 360-degree coverage around the robot and Inertial Measurement Units.

PDDs can identify objects in their vicinity and make the necessary course corrections to avoid them. When an object is adjacent to the PDD, but not in front of it, the PDD reduces its speed. When an object is in front of the PDD, the PDD will come to a complete stop.

## **Autonomy**

When Starship first started out, robots were followed by 'handlers' who would walk behind them with a remote control. That's because the technology was not developed to the point that the robots could operate autonomously.

By the end of 2017, Starship robots had made 100,000 road crossings, but only 3% were autonomous. Through rigorous testing and a focus on safety as our number one priority, Starship robots now operate autonomously, making 85% of road and driving crossings without human intervention.

Our robots are 99% autonomous. They only operate within defined 'mapped' areas that are mapped out for them by humans but within those confines, they will navigate the environment to get to their destination safely without intervention. There are times when the environment may have changed – new roadworks or debris on the road from a storm, for example.

In this instance, a PDD will notify the Remote Operations centre where a human operator will intervene. In the majority of instances, Remote Operators will confirm that the PDD can proceed with its autonomy safely. In some circumstances, a remote assistant may be required to assist the robot in order to navigate difficult terrain. The average distance a Remote Operator will control the robot is therefore low. Remote assistance is required in the UK for only 1 mile in every 1,000.

If a PDD comes to an unscheduled stop, a remote assistant is immediately pinged and will assist the device in its navigation.

We have technologies in place in Helsinki, Sweden, which allows our PDDs to communicate with traffic lights, instead of waiting for humans to push the button where necessary. This technology could be implemented in the UK.

## **Regulation**

Self-driving and autonomy are rapidly developing. Regulation is not keeping pace with technology and as such the UK risks losing out on investment, innovation, and being at the forefront of a new, modern economy.

The Transport Bill presents a great opportunity to bring forward appropriate regulation to support new sectors like ours but, like this inquiry, should not be limited only to large, road-based autonomous vehicles – to be limited to such would exclude entire swathes of innovation and potential. It may be that primary legislation is not required to address the challenges faced by micro-logistics companies, but some regulation must be forthcoming soon to clarify the landscape we are operating in.

Starship believes there should be a national regulatory framework for PDDs and micro-logistic vehicles but understands that this may take time to develop. In the short-term, decision making about pavement operations should be devolved to local government to allow councils to make the decision about what is appropriate, safe, and desirable for their local areas.

A national framework could include such factors as:

- Limitations to weight and/or speed
- Specifications on construction and safety
- Duty to obey traffic signals and signs and comply with the provisions applicable to pedestrians
- Requirement to yield right-of-way to all other traffic, including pedestrians
- Regulation on night-time operations
- Regulation on transporting hazardous material (Starship does not transport hazardous material)
- Minimum insurance levels

Examples are included in the appendices.

## **Safety**

Safety is our number one priority. Starship PDDs will always choose the safest route even if it is not the fastest route.

Sophisticated obstacle avoidance technology means that our robots will always work to avoid any person or obstacle in their path. They are programmed to be

like a cautious pedestrian. They work within hard and fast rules so will never make the human judgement of 'I can make it if I run'.

We have seven years of development, investment, and data in our operations, and much of this from operation in real world environments.

A key point to be made on safety and pedestrians is that because the PDDs are lightweight and low speed, even if a collision happened with a pedestrian there is no potential for serious injury as the kinetic energy of impact is minimal.

We employ many measures on safety, including but not limited to:

- Mapping of routes and removing from operation any problematic areas
- Detection of operational issues from the systematic review of safety event reports for remote operator training and feedback.
- Quality assurance processes that involve monitoring of individual operators with an aim to guarantee compliance with our remote operation standards.
- Testing against a wealth of historically recorded robot data to confirm equivalent or better performance of various robot sensors for obstacle detection compared to the previous software release.
- Testing against historically recorded data to confirm equivalent or better safety performance on road crossings compared to the previous software release.
- Testing against historically recorded data to verify the equivalent or better performance of the robot localisation algorithms (how well a robot can position itself in the world) compared to the previous software release.
- Testing against a growing set of simulated scenarios to confirm equivalent or better logic for driving decisions compared to the previous software release.
- Robot real-life navigation on testing ground to confirm equivalent or better end-to-end performance compared to the previous software release.
- Release of the software to a small sample of robots for real-life navigation in a city environment to confirm equivalent or better end-to-end performance compared to the previous software release.
- Regular maintenance of PDDs and replacement of all parts after 30,000km.

## **Relating to other pavement and road users**

In places like Milton Keynes where we have operated for four years now, our robots are part of everyday life. They are almost ignored by people going about their daily business. That is our aim in every community where we operate.

We understand that we need to work with local politicians and communities when our robots are introduced, new technology can be disconcerting if not integrated properly into an area.

As such, we work with local authorities on stakeholder engagement, we liaise with organisations like the British Horse Society and cycling groups, we visit local schools if we believe there is a need, and ensure every household gets direct mail from us in advance of launching. We are currently working on more bespoke digital content that shows residents 'what to do if...' which is a series of short video clips explaining how our robots work and how they behave.

In our initial launch phase, our public affairs, customer service, and operations teams work closely with local government to deal with any issues that arise quickly, including closing routes if residents raise valid concerns about them.

In our experience, by having a responsive operation, valuing the communities we operate in and working in partnership with local government, integrating our robots into communities has been a positive experience.

## **Decarbonisation**

The operation of our robots is low emission. The energy needed to make a delivery is the same as boiling the kettle for a cup of tea.

Starship customer surveys suggest that between 50% - 70% of customers would have driven to either the local shop or a shop further afield if our service did not operate. In Milton Keynes alone, we estimate (compared like for like with internal combustion engines) that we have saved over 420,000kg of carbon from being emitted.

## **Conclusion**

- Self-driving and autonomous technologies are rapidly developing. They present significant benefits for UK consumers and policymakers: from helping to reach net zero and meet air quality targets to levelling up and supporting convenience-led e-commerce.

- But regulation in the UK is not keeping pace with technological advances. The country risks losing out on investment, innovation, and being at the forefront of a new, world-leading, modern economy as a consequence.
- The Transport Bill is a great opportunity to bring forward appropriate regulation to support new sectors like micro-logistics.
- However, this Bill should not be limited only to large, road-based autonomous vehicles as this would limit innovation and investment.
- We understand that primary legislation may not be needed for our sector, but some form of regulation must be brought forward soon to clarify the landscape that businesses like us are operating in.
- We welcome the Committee's focus on this policy area and would welcome further conversations to support the inquiry. We can also provide further evidence or information upon request.

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## Appendices

### Appendix A

Summary of key provisions of the law, which regulates PDDs, in the State of Arizona (S.B. 1305). The law:

- Specifically exempts PDDs from the State’s definition of “vehicle” and “motor vehicle.”
- Defines a PDD;
- Restricts operation of PDDs to eligible “business entities;”
- Permits operation of PDDs on sidewalks and roads;
- Requires a remote operator to be capable of monitoring and exercising physical control over a PDD;
- Includes requirements related to the operation of PDDs, including:
  - o Yield to or not obstruct the right-of-way for all other traffic, including pedestrians;
  - o Not unreasonable to interfere with other traffic, including pedestrians;
  - o If operated at night, display the lights required by the law;
  - o Comply with any applicable regulations that are adopted by a local authority; and
  - o Not transport hazardous materials;
- Limits the speed of PDDs to 12 mph in pedestrian areas and 20 mph on roads, although local authorities are permitted to decrease the speed in pedestrian areas to as low as 7 mph;
- Requires that PDDs have certain equipment, including:
  - o An identification marker;
  - o A braking system; and
  - o Lights on the front and rear of the device; and
  - o Requires that “business entities” which operate PDDs must have general liability insurance of at least \$100,000.

## Appendix B

Summary of key provisions of the law, which regulates PDDs in the State of Texas (S.B. 969). The law:

- Specifically exempts PDDs from the State’s definition of “vehicle;”
- Defines a PDD;
- Restricts operation of PDDs to eligible “business entities;”
- Permits operation of PDDs on sidewalks and roads;
- Requires a remote operator to be capable of monitoring and exercising physical control over a PDD;
- Includes requirements related to the operation of PDDs, including:
  - Yield to or not obstruct the right-of-way for all other traffic, including pedestrians;
  - Not unreasonable to interfere with other traffic, including pedestrians;
  - If operated at night, display the lights required by the law;
  - Comply with any applicable regulations that are adopted by a local authority; and
  - Not transport hazardous materials.
- Limits the speed of PDDs to 10 mph in pedestrian areas and 20 mph on roads, although local authorities are permitted to decrease the speed in pedestrian areas to as low as 7 mph;
- Requires that PDDs have certain equipment, including:
  - An identification marker;
  - A braking system; and
  - Lights on the front and rear of the device; and
- Requires that “business entities” which operate PDDs must have general liability insurance of at least \$100,000.

## Appendix C

Summary of key provisions of the law, which regulates PDDs in the State of Virginia (S.B. 758). The law:

- Specifically exempts PDDs from the State’s definition of “motor vehicle” and “vehicle;”
- Defines a PDD, but limits their weight to 500 lbs;
- Permits operation of PDDs on sidewalks and roads with speed limits under 25 mph;
- Includes requirements related to the operation of PDDs, including:
  - Yield to or not obstruct the right-of-way for all other traffic, including pedestrians;
  - Obey all traffic and pedestrian control devices and signs;
  - Not unreasonable to interfere with other traffic, including pedestrians;
  - Comply with any applicable regulations, subject to certain limitations, that are adopted by a local authority; and
  - Not transport hazardous materials;
- Limits the speed of PDDs to 10 mph in pedestrian areas and crosswalks;
- Requires that PDDs have certain equipment, including:
  - An identification marker; and
  - A braking system; and
  - Requires that a PDD operator must have general liability insurance of at least \$100,000.

## Appendix D - Support for self-driving technology

The comments below are verbatim quotes provided to us from advocates of Starship's service in Milton Keynes in 2020 as part of the Future of Mobility Urban Review.

The comments highlight the policy benefits that the facilitation of such technologies can bring local communities as well as helping the Government reach its objectives. The comments also show community support for such technologies.

Name	Title	Comment
Iain Stewart	MP Milton Keynes North	<p>We all shop online more than ever before. While this has been great for convenience and choice, it has led to an increase in delivery vans and HGVs, contributing to more congestion and deteriorating air quality. As the demand for online shopping grows, we need to pursue technologies that can help us reach Net-Zero by 2050.</p> <p>Starship has been operating across my constituency for over two years. In that time, their futuristic robots have been delivering shopping to homes across Milton Keynes and helped local businesses connect with their customers. I was able to meet the humans behind the robots at one of their depots to see how the service works behind the scenes. Their robots do not produce any emissions and have saved over 80 tonnes of carbon from the town.</p> <p>More recently, the coronavirus has presented our society with unprecedented challenges: how can we ensure social distancing, while the economy gets back to normal?</p> <p>Starship has provided the contactless delivery</p>

		<p>of groceries and parcels, helping people to stay safe and socially distance in Milton Keynes. This has been particularly important for people more at risk who have been unable to leave their homes.</p> <p>Now more than ever, sustainable solutions are needed to meet the demands of online shopping. The Future of Mobility is part of the solution to these challenges. With the right legislation, other towns and cities across the UK can benefit from this technology.</p> <p>I will, therefore, be encouraging colleagues in Government to consider regulations to permit the use of PDDs, like those that Starship Technologies use in Milton Keynes.</p>
Ben Everitt	MP Milton Keynes South	<p>Milton Keynes, like the Conservative party, is a place of opportunity. We have seen a great number of companies choose to invest and grow their businesses in the town and this is why we were recently ranked the best place to do business outside of London.</p> <p>I want to continue to support the businesses that are driving this culture of innovation and growth.</p> <p>Over the past two years, Starship Technologies has been part of a growing number of innovative businesses looking to test and invest in Milton Keynes. Since 2018, they have provided a very popular service which has been adopted as an iconic part of everyday life in Milton Keynes. Starship's cute little robots have made thousands of deliveries right across my constituency. It is obvious through looking at local social media and speaking to constituents how popular the service is and</p>

how the delivery robots have quickly become part of MK's culture and identity. AI food delivery is now part of MK's brand identity.

Not only are they popular, but they have contributed to our national goal of becoming Net-Zero by 2050. I am told they have removed 80 tonnes of carbon from Milton Keynes which will have a tremendous impact on the health of my constituents.

During the coronavirus pandemic, Starship were able to rapidly expand their operation in Milton Keynes with over 200 robots responding to the crisis. This meant that thousands of residents were able to receive contactless deliveries, helping to support social distancing measures. For the most vulnerable in our community, Starship has provided groceries while they were unable to leave their homes.

This technology has been great Milton Keynes, and while it might not be suitable everywhere in the UK, I would urge the Government to allow the implementation of this technology so other towns and cities can benefit.

Now more than ever, sustainable solutions will be needed to meet the demands of online shopping, while protecting the environment and ensuring social distancing.

I believe that any legislation on Future of Mobility should, therefore, include regulations permitting the use of PDDs like those of Starship Technologies. Robot delivery should be for the many, not the few.

With the right legislation and the right

		<p>businesses, we can encourage further investment and make the second part of Milton Keynes's first 100 years even better than the first.</p>
<p>Catapult UK</p>		<p>At the Connected Places Catapult (CPC), we focus on growing businesses with innovations in mobility, operating at the intersection between public and private sectors and between local government and transport authorities. The exponential growth in e-commerce in recent years has created new challenges and pressures for urban areas. As the demand for e-commerce grows, so does traffic congestion and air pollution, which poses health challenges for people in towns and cities across the UK.</p> <p>In tackling these issues, one of our collective challenges will be addressing the growing impacts of e-commerce. The micro-mobility sector offers solutions to some of these challenges, and we are excited that the Future of Mobility consultation is looking to bring new legislation to further permit the use of new and innovative technologies.</p> <p>We have taken an interest in personal delivery devices (PDDs) which can help with the sustainability of e-commerce by removing the need for light goods vehicles (LGVs) and delivery vans for the 'last-mile' of the supply chain. PDDs can decrease congestion and improve air quality by replacing these LGVs from urban areas, particularly for the last mile, which is often, the most energy-intensive and inefficient part of the supply chain. Starship Technologies are one of the companies driving the innovations in PPDs. They have been operating them in 100 cities</p>

		<p>around the world, including a flagship operation in the UK in Milton Keynes. They have worked together, in partnership with the council, to deliver groceries and parcels to people across the town.</p> <p>More recently, the pandemic has caused further demands on e-commerce and a need for social distancing. Starship's PDDs have allowed people to continue to get their goods delivered while ensuring social distancing measures can be adhered to.</p> <p>The CPC would be in support of any primary legislation on the Future of Mobility permitting the use of PDDs.</p>
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