Grant Agreement Number: 768953

Project acronym: ICT4CART

Project full title: ICT Infrastructure for Connected and Automated

Road Transport

D9.10

Business Models

Due delivery date: 28 February 2022

Actual delivery date: 4 March 2022

Deliverable type: R

Organization name of lead participant for this deliverable: Urban Foresight

Dissemination level		
PU	Public	X
PP	Restricted to other programme participants (including the GSA)	
RE	Restricted to a group specified by the consortium (including the GSA)	
CO	Confidential , only for members of the consortium (including the GSA)	

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 768953

Document Control Sheet

Deliverable number:	9.10
Deliverable responsible:	UFL
Work package:	9.5
Editor:	Dan Langford (UFL)

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Document Revision History			
Version	**Date**	**Modifications Introduced**	
		Modification Reason	**Modified by**
v0.1	26/02/2022	Initial version shared with reviewers	Dan Langford
V0.2	03/03/2022	Internal UFL Review	Dan Langford
V1.0	04/03/2022	Deliverable ready for submission	Dan Langford

Abstract
This document presents the findings of Task 9.5 of the ICT4CART research programme on the Innovative Business Models for the information technology systems that enable connected and autonomous road transport. The business models and corresponding value propositions are for the 24 services that fall within 6 markets for data services. The business models are evaluated to determine how clear or frictionless the path to market is for each at the time of writing.

Legal Disclaimer

Abbreviations and Acronyms

Acronym	Definition
AI	Artificial Intelligence
ABS	Anti-lock Braking Systems
AD	Automated Driving
ADAS	Advanced Driver Assistance Systems
AV	Automated Vehicle
BMC	Business Model Canvas
CAM	Cooperative Awareness Message
CAV	Connected and Automated Vehicle
C-ITS	Cooperative Intelligent Transport Systems
CRI	Commercial Readiness Index
DENM	Decentralised Environmental Notification Message
EC	European Commission
ETSI	The European Telecommunications Standards Institute
EU	European Union
EV	Electric Vehicle
GA	Grant Agreement
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HD	High Definition
HGV	Heavy Goods Vehicle
IAM	Identity and Access Management
ICT	Information and Communications Technology
IoV	Internet of Vehicles
ISO	International Organization for Standardization
IT	Information Technology
ITS	Intelligent Transportation System
MaaS	Mobility as a Service
MEC	Multiple-access Edge Computing
OEM	Original Equipment Manufacturer
OTA	Over-the-Air
PO	Project Officer
R&D	Research and Development
RNO	Road Network Operator
RTK	Real Time Kinematics
SAE	Society of Automotive Engineers
SOC	Security Operation Centre
UAV	Unmanned Aerial Vehicle
V2I	Vehicle to Infrastructure
V2V	Vehicle to Vehicle
V2X	Vehicle to everything / anything
VMS	Variable Message Systems
WP	Work Package

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Executive Summary

Connected vehicles are often referred to as 'smartphones on wheels'[1] or even a 'sensor cluster on wheels'[2] to describe how they may be used in the future as their driving function becomes more automated. Connectivity unlocks capability and unanticipated applications and features in what traditionally have been dumb devices. Connectivity and automation represent a significant disruption in transportation, resulting in opportunities for the development and application of connectivity-based products and services. This convergence of technologies also demands a recreation of the supporting sensor and communications infrastructure.

While still relatively new, the market for automotive connectivity has progressed far enough to provide an indication of the types of data and information services that have short- and long-term applications. The value of many data services in terms of both value to users and revenue from the market will be amplified as the path to automation progresses. The disruption in transportation and the need for new data services provides fertile ground for new business models and opportunities for revenue generation.

ICT4CART Task 9.5 Innovate Business Models resulted in this report: D9.10 "Business Models". This report aims to guide the development of sustainable businesses based on connected and automated vehicle information services that may utilise the ICT4CART solution.

This guidance has been achieved through research into the markets, value chains and the current state of the fast-growing industry resulting in the development of business model blueprints. Business model blueprints describe the types of business processes required to address the existing and future needs of connected and automated vehicles and their owners, operators and passengers. The business model blueprints are templates to which context can be added to finalise complete business models that form the basis of new businesses.

Our approach analysed all potential information services and target markets based on CAV technologies' current and future implementation. The innovative business model blueprints detailed in this report provide the information to enable the four ICT4CART use cases and all 24 potential CAV services to be adapted into existing business models or used as the basis of the creation of completely new ones. Exploration of the business considerations for all foreseeable services needed to support CAVs resulted in the documentation of common business needs. The resulting service models were aggregated into logical groups to maximise customer and supplier relationships, core competencies, paths to market, general resource efficiencies and other synergies. The output is six innovative business model blueprints delivering suites of value added services to support CAVs now and in the future.

The resulting business model blueprints include:

1. Government Authority: trustworthy and policy-based CAV Services for the benefit of all road users.
2. Core Safety: CAV Services that provide a level of safety anticipated to be required in all vehicles as standards and policy progress.
3. Digital Environment: CAV Services designed to enhance the real time detail of the temporal and spatial digital world beyond the immediate vicinity of vehicles. .

[1] https://www.autoweek.com/racing/nhra/a1979876/toyota-unveils-smartphone-wheels-concept-car-tokyo-show/

[2] https://www.qualcomm.com/news/onq/2022/01/04/how-snapdragon-digital-chassis-transforming-automotive-industry

4. Consumer Services: encompass the content and platforms for passengers to be entertained and productive while travelling.
5. Supplementary Services: enhance the core driving function to enable fleet level coordination operations.
6. Transferrable Services: are available in other industries but have an opportunity for application in CAVs.

It was found that the application of CAV data services does not need to wait for autonomy. Most services explored have an immediate application in the marketplace that can generate data, knowledge and, most importantly, revenue for businesses in anticipation of autonomy. In many cases, there are already competitive products in the market. However, as the industry is embryonic, the opportunity remains significant for new market entrants.

Most of the resulting business model blueprints have comparable or equivalent businesses operating in the market, but they are generally early versions of what they have the potential to become.
It will be no surprise that realising their potential is constrained by standards, regulation and the pace of technology development and market adoption.

Technology standards enable markets (Tiedemann, 2020), and the transportation market's appetite for innovation is insatiable. Regulation is there to reduce threats but faces the 'pacing problem' (Thierer , 2018), and technology outpaces everything.

A PEST Analysis was conducted, and the Commercial Readiness Index was used to gauge the environmental considerations for each Business Model Blueprint. It is challenging to discern winners and losers across such a complicated range of variables, but it was apparent that the "Digital Environment" opportunity may have the most immediate and positive reception in the industry. This has likely been driven by the use of high definition maps in the development of autonomous vehicles. In contrast, "Core Safety" is still facing significant hurdles but could advance quickly with wide-reaching policy changes and standards ratification.

The technical development of the ICT4CARTICT4CART project advances the state of the infrastructure needed to support these innovative businesses. This report provides a foundation and guidance for the development of innovative new businesses to deliver information services to the fast growing connected and automated vehicle market.

1 Introduction

1.1 Purpose of the document

Connected and Automated Vehicles (CAVs) are road vehicles for which the driving task is, to some extent, automated and which have the capability to communicate with infrastructure and other road users. The advantages of vehicle connectivity are recognised across the industry, such that the full benefits of vehicle automation can only be realised with this additional capability.

Information and Communications Technology (ICT) infrastructure is currently in development that aims to enable the required level of vehicle connectivity. There is still much to be determined about how this will work - technically, operationally and commercially. The ICT Infrastructure for Connected and Automated Road Transport (ICT4CART) project has been established to design, implement and test in real-life conditions a versatile ICT infrastructure for the needs of higher levels of vehicle connectivity and automation.

This report follows one of the recommendations arising from PU-access Deliverable D2.2[3] Analysis of Market Needs: "The market structures should be further explored for each of the markets set out here and inform the completion of Task 9.5 and the delivery of a report on the business models that can be used to commercialise the solutions developed in ICT4CART".

This report aims to define and highlight the new and existing business models that are enabled by the ICT4CART solution as a foundation for businesses based on innovative products and services.

This report is a significant expansion on what was originally proposed, as all potential CAV services that can utilise the ICT4CART solution have been analysed and combined into discrete business models. We have not limited the analysis to only the four (4) ICT4CART use cases.

The methodology of this report takes into account the services, value chains and market structures previously explored in Deliverable 2.2 Analysis of Market Needs to develop innovative business models encompassing the ICT4CART use cases. Value propositions and service models for each of the CAV Services are developed to help identify synergies that facilitate grouping to create value. Business model blueprints are then developed based on CAV Service groups. The political, environmental, social and technological external factors are evaluated and these findings will be relevant both to the ICT4CART consortium partners as well as external organisations in relevant market sectors.

1.2 TargetedTarget audience

The initial readership of this deliverable is anticipated to primarily consist of the ICT4CART consortium partners. As this report aims to inform those in the CAV technology space on the potential types of business models supporting CAV information services, the information contained will also be pertinent for other organisations situated in sectors involved in the development, deployment and roll-out of CAVs and their supporting infrastructure. This includes the following categories of organisations:

- Telecommunications companies
- Automotive companies
- Information Technology (IT) companies
- Cybersecurity technology providers
- Road network operators

[3] https://www.ict4cart.eu/assets/deliverables/ICT4CART_D2.2_MarketAnalysis_v1.0_final.pdf

- Mobility service providers including public transit operators
- Policy makers

The CAV sector has a very active innovation community and, as such, an additional target audience are the entrepreneurs and start-ups wishing to take advantage of the opportunity to develop products and services based on the ICT4CART solution.

2 Background

We have undertaken an initial analysis of the value chains associated with the services identified in this Deliverable Task 2.2 Analysis of Market Needs. i.e., This analysis identifies what value is generated by the services that this infrastructure enables and for whom, and what are the main conceptual steps in generating that value. The idea being that if we can understand the value exchanges involved in each step in the processes that ultimately deliver information to and from vehicles, then we can use this as basis to look into the various ways that this value might be paid for and by whom.

Now that the markets and value are better understood, then we are able to explore the value propositions of each service identified and the different business model options associated with generating that value for the customer.

2.1 The ICT4CART Project

The main goal of the ICT4CART project is to design, implement and test in real-life conditions a versatile ICT infrastructure for the needs of higher levels of automation, up to SAE Level 4.. The project was awarded through the European Commission Horizon 2020 funding program. Like many EU-wide programmes such as CARTRE, C-ROADS and C-MOBILE, the project aims to present a coordinated response to the challenges of the EU's overall CAV and ITS strategy, the C-ITS strategy.

The ICT4CART project draws on expertise and technologies from across different industries, including telecommunications, ITS, automotive and IT. The consortium is comprised of 21 different organisations, working to combine, adapt, and improve technology applications for CAV infrastructure. The technology solutions underpinning the project have been trialled, demonstrated, and validated in four specific use cases. These real-world and challenging environments encompass a range of urban and highway applications with varying degrees of complexity. The project's test sites are located in Germany, Austria, Italy and the Italy-Austria border.

Secondary outcomes from the project include analysis of the market, business model development, and an open cloud platform. This platform will aggregate data from across the IT environment and provide analytics services.

The nature of the connectivity architecture and ICT technology explored by the consortium is now complete at the time of this report. The use cases include a hybrid configuration of ITS-G5 proximity networks, Mobile Edge Computing (MEC) and mobile cellular networks (LTE/5G).

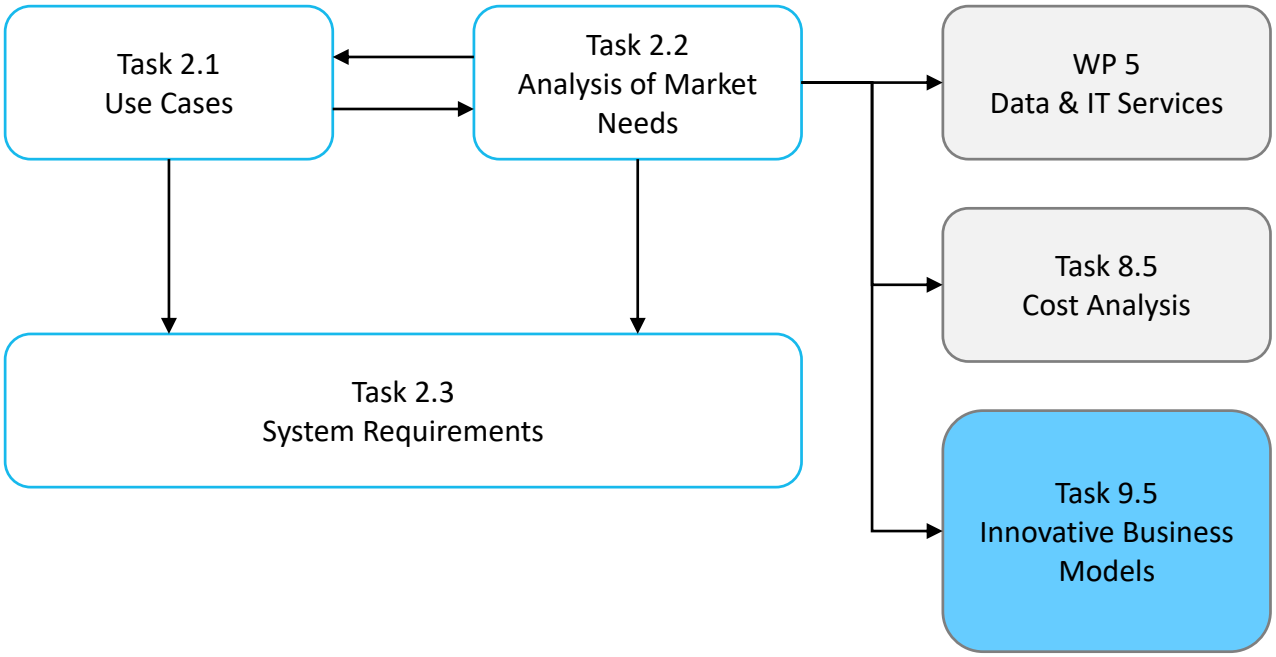
2.1.1 Work Package 9 within the ICT4CART project

Work Package 9, in which the task relating to this deliverable is situated, is intended to deliver communication, dissemination, IPR and market adoption related tasks and prepare the exploitation of the project's results in an efficient manner. The objective of WP9 is to effectively spread knowledge and information about project research and innovation, and secure market adoption of developed solutions.

Task 9.5, covers the development of innovative business models for the wide adoption of the ICT4CART proposed solution and contributes to ICT4CART Objective 6 by defining new business models promoting innovative services. The key output of Task 9.5 is this report which is intended to document the potential business models that can capitalise on the ICT4CART solution.

Figure 1 below illustrates the main interactions between this task and other tasks and work packages within the ICT4CART project.

Figure 1: Task 9.5 interactions.



2.1.2 The ICT4CART Use Cases

One of the primary goals of this report is to ensure the integration of the ICT4CART use cases into the innovative business models. This was to identify where those use cases had a synergy with other CAV services and in turn help validate that there is a potential market opportunity for these use cases and related scenarios.

Table 1, reviews the four ICT4CART use cases, related scenarios and the eventual beneficiary that gains value. Each of the use cases will be identified within their respective business model blueprint later in this report showing how other complementary services can be combined to create a business.

Table 1 –Use cases delivered by ICT4CART's solution, related scenarios and beneficiary.

No.	Use Case Description	Relevant Scenarios	Beneficiary
UC1	**Smart Parking & IoT services** Linking the connected vehicle to information about available parking spaces in urban settings.	SCN1.1: Smart Parking and IoT Services in City of Ulm, Germany SCN1.2: Smart Parking and IoT management in City of Verona, Italy	• Drivers/ passengers
UC2	**Dynamic adaptation of vehicle automation level based on infrastructure information** To enable the comfortable and safe automated driving for SAE L3 & L4,Level 3 - 4 automated vehicles, the vehicle will receive information from sensors from the road	SCN2.1: Dynamic clearance, adaptation and handover of vehicle automation level at special conditions in Graz SCN2.2: Dynamic adaptation of vehicle automation level on Trento motorway	• Drivers/ passengers • Fleet operators/ vehicle owners • Road network operators

No.	Use Case Description	Relevant Scenarios	Beneficiary
	infrastructure (e.g. on traffic density) and make the decision to hand over control to the driver or come to a safe stop.	SCN2.3: Dynamic adaptation of vehicle automation level in Verona, Italy	
UC3	**Intersection crossing (urban) & lane merging (highway) – "virtual mirror"** Exploiting hybrid connectivity and MEC to create 360° awareness around the vehicle with very low latency, creating a kind of "virtual mirror" to support the automated vehicle while crossing an intersection or merging into a lane.	SCN3.1: Virtual mirror to "see" surrounding traffic in urban environment. SCN3.1.a: In City of Ulm, Germany SCN3.1.b: In City of Verona, Italy SCN3.2: GLOSA (Green Light Optimized Speed Advisory) in City of Verona, Italy SCN3.3: Lane merging in Autostrada del Brennero, Italy SCN3.4 Precise positioning in urban and highway location	• Drivers/ passengers • Fleet operators/ vehicle owners • Road network operators • Other road users • Consignees
UC4	**Cross border interoperability between Italy-Austria (dynamic adaptation of vehicle automation level) at Brenner border** Test and demonstrate the handover of the vehicle's ITS-G5 network connectivity when crossing the border.	SCN4.1 Cross border interoperability between Italy-Austria (dynamic adaptation of vehicle automation level) at Brenner border	• AMQP Broker/ Service Cloud Providers

3 Context

3.1 Connected Vehicle

The ICT4CART project was envisioned to support the functional and technical connectivity requirements posed by the needs of higher levels of automation (SAE L3 & L4). While the ICT4CART project experienced delays due to the COVID-19 pandemic resulting in an extension, the development of technology and new business models progressed (Grossfeld, 2021). In the meantime the expectations in the industry around the timeframes in anticipating the widespread availability of highly automated vehicles has been extended and the industry has undergone significant consolidation (Hawkins, 2021).

It is now expected that robotaxis will be deployed in volume in 2023 by Motional (Motional, 2021) in Las Vegas, 2024 by Aurora (Ohnsman, 2021) in San Francisco and AutoX are expanding in China (AutoX Team, 2022) amongst many others.

In the meantime, the excitement around autonomous vehicles has tempered and redirected towards innovations that are available in the short term and that have a more immediate impact on transportation. The common refrain "data is the new oil" arose from a story titled, "The world's most valuable resource is no longer oil, but data" (The Economist, 2017). In transportation, this catchphrase referred to the wealth of new applications for the data that was being generated by vehicles and infrastructure on our path to autonomy.

The connected vehicle quickly became the source of an asset (data) that could be applied to many challenges including but not limited to insurance protocol and claims processing, parking and fuel logistics to emergency services routing (Burns, 2022).

As a result, over the period of the ICT4CART project, innovation in connected vehicle solutions has accelerated resulting in a large volume and range of new data products and services based on both newer and existing technologies. These developments help validate the use cases explored in the ICT4CART project and also help to define the market for the ICT4CART solution.

3.2 5G and V2X

Additionally, 5G standards development supporting V2X use cases in the 3GPP standard are being ratified and demonstration implementations are occurring. ICT4CART test sites have had implemented Wi-Fi-based IEEE 802.11p and the LTE/4G-based C-V2X to varying degrees.

Industry observers are suggesting that 5G-based C-V2X will be fully adopted worldwide and will become mandatory and integrated into vehicles and the supporting infrastructure (Capgemini, 2021).

We anticipate that the implementation of 5G-based C-V2X will enable the full range of use cases and business models discussed in this report. The ICT4CART solution enables the transition from Wi-Fi-based IEEE 802.11p and the LTE/4G-based C-V2X to 5G and supports full 5G-based C-V2X deployment.

3.3 In-Vehicle Payments

In-vehicle payments has been identified as a CAV Service that requires special mention. Payment systems will be needed for the transfer of value within the data marketplaces and the broader ecosystem that is likely to evolve over time.

The current innovation in in-vehicle payment is focussed on seamless payment for drivers based on

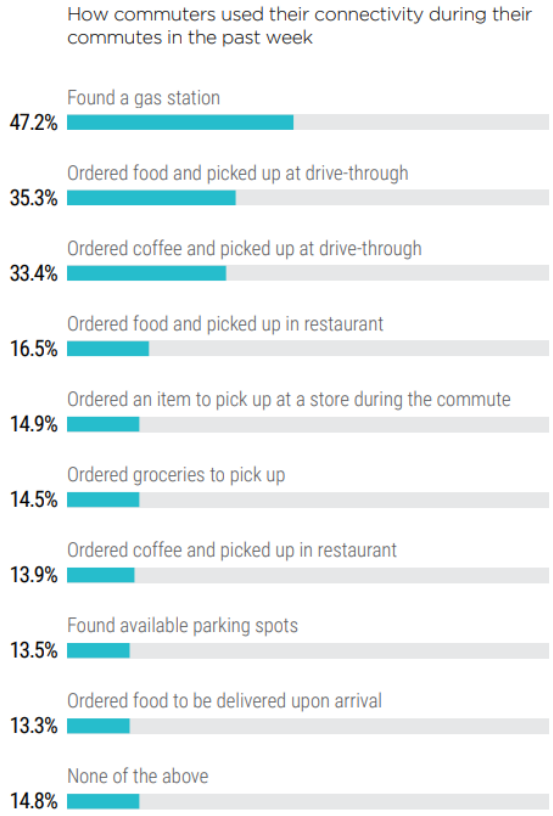
utilisation on voice assistants such as Alexa Auto and Cerence Pay (Cerence, 2020)). Ihor Starepravo describes how, as vehicle automation becomes more pervasive, the market potential will increase with machine-to-machine payments and use cases will expand to in-vehicle digital shopping (Eddy, 2020).

The projected market for connected vehicle payments for goods and services ranges dramatically from US$50 bn in 2025 (FutureBridge, n.d.) and more than US$10 bn in 2028 (Wadhwani & Loomba, 2022) to €537bn in 2030 (Bruneteau, Jackson, Burkett , Neubauer , & Lim, 2020). According to the Digital Drive Report 2019, drivers engaged in US$230bn worth of commerce while driving in 2018 (PYMNTS.com, 2019), which includes smartphones, providing an idea of market potential.

In the past, Visa has partnered with Honda (American Honda Motor Co, 2017) and Daimler (Visa, 2021) to develop in-vehicle payments and more recently has specifically called for standardisation for seamless, interoperable payments at electric vehicle (EV) charging points (Constantin , 2022). Various collaborations have enabled in-vehicle payments for smart parking (Li, 2021), EV charging (Parkopedia, 2022), fuelling (ryd, 2022) and tolling (Audi of America, 2022).

Further, the Digital Drive Report 2019 (PYMNTS.com, 2019) explores in Figure 2 what people already do using connectivity while commuting. An InfoPulse blog updated in January 2020 suggests that of all trends in-car payments “has a high chance of becoming the most prominent and profitable one within the next several years” (Ostapov, 2022).

Figure 2: Commuter activity while commuting to work. (PYMNTS.com, 2019)



3.3.1 The Metaverse

Very simply the metaverse is a shared 3D virtual world in which you can socialise, collaborate, learn,

and play. Examples of initial efforts include AltSpaceVR[4] from Microsoft, Quest[5] and Spark AR[6] from Meta Platforms.

When it comes to the Metaverse and connected vehicles, "in-vehicle digital immersion will enable seamless journeys between physical and digital worlds. Moving forward, consumer commutes will be dominated by digital immersion, not driving" (Kuhn & Andrae, 2021). Another perspective looking at an alternative future describes how the metaverse could transform the utilisation of traditional transportation (Fast Company, 2021).

The introduction of the metaverse will have great impact on the passenger experience. Metaverse solutions promise to enrich what could often be described as a mundane and monotonous travel experience, especially for commuters.

This report will not explore the Metaverse concept in depth but its utilisation in vehicles by passengers for everything from work to entertainment is highly likely to demand resources from all aspects of the telecommunication network and increase activities such as in-vehicle payments.

[4] https://altvr.com/
[5] https://www.oculus.com/
[6] https://sparkar.facebook.com/ar-studio/

4 Objectives

The objective of this report is to identify the innovative business models that will support existing and future CAV services including the ICT4CART use cases that will utilise the final ICT4CART solution.

Tasks 2.2 Analysis of Market Needs (and its PU-access deliverable D2.2) provided support for decision making regarding ICT infrastructure design and investment by exploring the needs of the end-users in this system and, hence, the market(s) for the services that the infrastructure enables.

As the market potential alone does not determine the sustainability of the services, this report builds on Task 2.2 by detailing the other factors that go into the design of a successful business model and ultimately a sustainable business.

Task 8.4 Cost Analysis and Market Sustainability (and its PU-access deliverable D8.5) provided an estimate of the costs of the ICT4CART solution that supports the services and the appetite for and amount customers are willing to pay for those services.

The ICT4CART solution contributes to part of the cost structure of the innovative business models and the amount customers are willing to pay contributes a portion of the revenue streams. Both the cost and potential revenue from Task 8.4 are key to estimating the likely sustainability of each innovative business model.

In addition to the primary objective of identifying innovative business models, this report will examine the external and other factors that may be barriers to market entry and estimate the readiness of each business model.

5 Methodology

The methodology for this report follows on from PU-access Deliverable D2.2 Analysis of Market Needs and the PU-access deliverable D8.4 Cost Analysis and Market Sustainability.

The Initial Background Research involved reviewing the task deliverables and any new information available.

Then, the concept of buyer personas to the value chain knowledge gained from Task 2.2 was adapted to describe the ideal customer and gain insight into buying decisions. These buyer personas were needed for the development of value propositions. A value proposition was developed for each of the 24 services. These identified and validated where the services are addressing customer needs.

In parallel, high-level Service Models were generated for each of the 24 services based on the elements of the Business Model Canvas in order to understand resource needs and target customer segments for each service.

Where there is overlapping product-market fit and commonality across the 24 value propositions and service models, they were correlated and aggregated into innovative Business Models that underwent further development and explanation.

An analysis including key sensitivities and launch readiness explored how prepared the market and technology environment is to support businesses based on the ICT4CART solution.

5.1 Background Research

As Deliverable D2.2 Analysis of Market Needs was completed two years prior to the completion of this report we started by reviewing the research and findings with an updated perspective.

This involved a verification relationship between ICT4CART use cases and scenarios, and the 24 CAV Services described in Deliverable D2.2. This also involved a review of the mayor technical deliverables by the ICT4CART partners and the final ICT4CART solution.

The research also explored the new businesses that have entered the market and may now be competitors to the business models defined in this report. Research involved understanding the progression of the industry, including identification and analysis of identical and comparable CAV Services that may now be available, and the business models of the businesses providing those services.

Some customers are theoretical as the market is only in the early stages of development (automated vehicle operators) therefore desk research was conducted to understand what the potential needs of a market may be, given that it is in its infancy or does not yet exist.

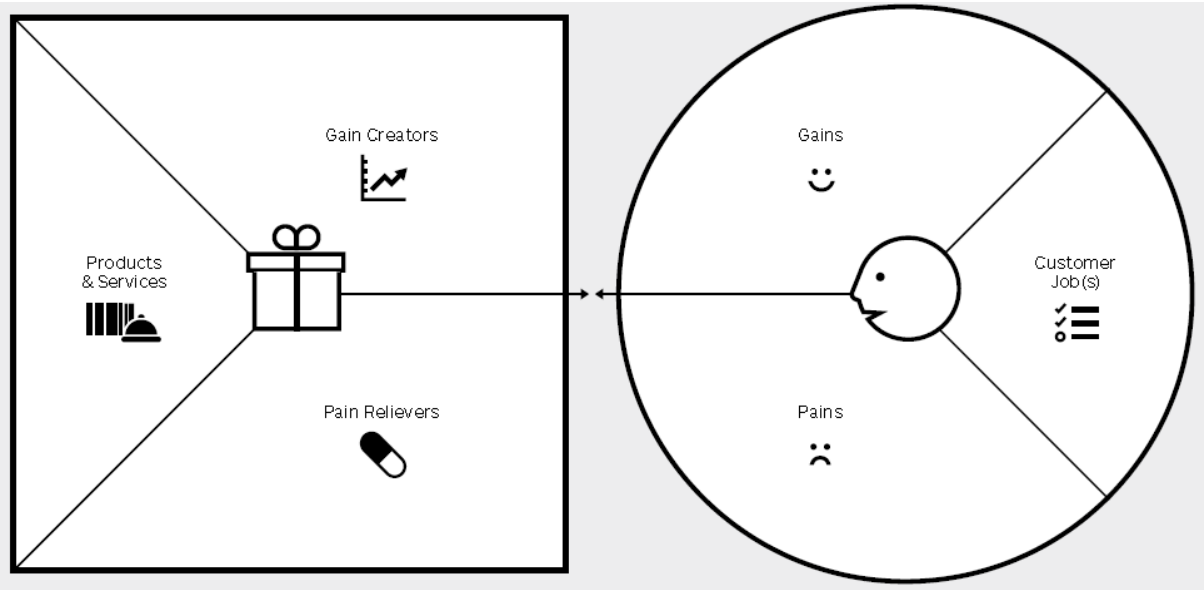
The research also collected current estimates on market sizes for each CAV Service which will help define the magnitude of each opportunity. These figures potentially represent either the Total Available Market (TAM) or Serviceable Available Market (SAM) depending on the characteristics of the service under consideration.

5.2 Step 1: Value Proposition

A value proposition, as the name suggests, is the promise of value to be delivered to a customer. Sustainable value is only created once the customer need is satisfied. Dr. Alexander Osterwalder

originally developed the Value Proposition Canvas as a framework to ensure that the offering is actually desired by the market and is capable of satisfying the customers' needs (Pigneur & Osterwalder, 2003).

Figure 3: Value Proposition Canvas



As the value chains have already been captured in D2.2 Analysis of Market Needs we are using the value proposition canvas to determine the ideal characteristics of ICT4CART based services. D2.2, also identified the beneficiaries of the value arising from each service. These beneficiaries of value may not always be the customer who is willing to pay for the service, so we will also investigate and identify the customers.

Identifying the paying customer is obviously of crucial financial importance to any sustainable business but understanding their unique processes, habits, motivation and needs, etc., allow. allows us to not only design and market the service successfully but to identify necessary elements of the business model.

As the market and customers for any product based on the ICT4CART solution are in varying stages of maturity, we will develop qualitative buying personas for each of the six markets identified in D2.2 Analysis of Market Needs and presented below.

The 24 services captured in Deliverable D2.2 are categorized into six market groups:

1. **Automated driving:** connectivity to support the automated decision making of road vehicles.
2. **Informed journeys:** connectivity to improve driving decisions, regardless of how automated the vehicle is.
3. **Intelligent management:** connectivity to improve awareness of what is happening on a road network.
4. **Coordination of vehicles:** connectivity to instruct automated vehicles in specific scenarios and coordinate their driving.
5. **Connected travellers:** connectivity to connect vehicle passengers and improve their experience.
6. **Underpinning services**: connectivity services with commercial potential that enable a safe and effective communication network.

Qualitative buyer personas are a semi-fictional representation of our ideal customer, in most cases a company rather than a person. Qualitative buyer personas will allow us to generalise the customers' needs within each market for entry into the Customer Profile half of the Value Proposition Canvas.

The completed Value Proposition Canvas allows us to identify the Product Market Fit for each of the 24 Services.

5.2.1 Step 2: Product/Market Fit

"The only thing that matters is getting to product/market fit."[7]

Marc Andreessen defined the term as: "Product/market fit means being in a good market with a product that can satisfy that market." Or put another way: "Product Market Fit is when people sell for you."

Once we understand the ideal characteristics of the 24 proposed Services, we then evaluate which of those characteristics can realistically be launched to the market, based on the ICT4CART solution.

Due to the status of the CAV industry and the market's development, we acknowledge that our application of the product/market fit can, in some cases, appear to be better described as a problem/solution fit. This occurs when services are very new and a meaningful customer base does not yet exist to be measured.

This will be the product/market fit that will move forward into Step 3: Service Model Definition and start to populate the relevant sections of the Business Model Canvas. Those sections include the key activities, key resources, key partnerships, customer segment, customer relationship and channel.

5.3 Step 3: Service Model Definition and Aggregation

Based on elements of the Business Model Canvas (Osterwalder & Pigneur, 2010) we will provide a high level Service Model for each of the 24 services to further understand the business requirements and potential of each. We will have a nominal Business Model Canvas or Service Model for all 24 Services with enough detail to enable the aggregation into final innovative business models.

Successful Product Portfolio Management can be defined as applying your people and your money to the most profitable products. (Planview Inc., 2022)

This process creates a product portfolio upon which the innovative business models are developed.

We are at the "create" step in the four step process of new product development (NPD) theory "create, assess, develop and pursue". As the "ability to identify the best projects that align with business strategy in order to efficiently allocate scarce resources is critical to an organization's success" (Doorasamy, 2015). We are focussing on those elements of each service model that are complementary. Designing a business around this complementarity promises to build a core strength that will result in competitive advantage.

Or, more simply, our goal in grouping the 24 services is to optimise the investment needed to achieve

[7] Attributed to Andy Rachleff by Marc Andreessen: https://pmarchive.com/guide_to_startups_part4.html

the greatest gain or deliver the largest return on investment (ROI).

The value chain, beneficiaries and target markets of each service have been detailed previously in D2.2.

One assumption we are making is that the services are being developed as opposed to being acquired. The acquisition of a new service suggest that the resulting business activity would be heavily weighted towards marketing and sales. New product development in contrast, at least initially, is more dependent on the existing resources of the company and more broadly the company strategy. Marketing and promotion is definitely a key part of product success but for the purposes of defining a business model around a portfolio of services, the foundational elements of the business are a higher priority.

At this early stage, we are evaluating the 24 services for amalgamation to form the basis for a core business with the expertise to design, build and support the resulting suite of services. The suite of services could be an entirely new business or an addition to a larger existing organisation. For example, it is reasonable to anticipate OEM's or MNO's adopting one or more of the innovative business models in this report with the goal of addressing the market opportunity being generated by CAVs.

The criteria used to amalgamate the Services are element of the Business Model Canvas listed here in order of priority:

1. Key Activities – are the core competencies adding value to the data through combination and transformation.
2. Resources – are primarily the data needed to deliver services and the talent to generate value from it. Data availability is core to the operation and success of the services.
3. Key Partners – will generally be the enablers and suppliers of data. Strong relationships and agreements with key data providers and other providers can provide exclusivity and competitive advantage.
4. Customer Segments – can guide existing and potential business opportunity throughout the product development process. Post-product launch it may be efficient to have fewer segments to target with sales and market initiatives; more segments also suggests more business opportunity, each of which can be justified independently.
5. Customer Relationships – for data services can range from automated service for consumer products (B2C) to dedicated personal service for large, long-term accounts (B2B). The resources required to maintain B2C and B2B relationships can be very different but will generally be guided by the initial services offered but have little influence over them.
6. Channels – to engage the customer. Due to the nature of the services, these will largely be digital. Some efficiency can be gained from all service sharing similar channels but this is unlikely to have significant impact on the business.

Simply, this is a process for starting to develop a business model and evaluating which services make sense together.

5.4 Step 4: Innovative Business Model Definition

We are using the Business Model Canvas (BMC) as it provides an efficient way of describing and evaluating each business model. The common language of the BMC also allows us to identify the common elements of the 24 services, enabling an amalgamation into a final set of innovative business models that build upon the ICT4CART solution.

The innovative business models are blueprints that…

1. Apply value and beneficiaries from D2.2 Analysis of Market Needs;
2. Apply learning from value proposition development;
3. Populate remaining sections.

The resulting innovative business models will include:

- Discussion of the services bundled;
- Key Activities, Resources and Partners;
- Customer Segments, Channels and Relationships;
- Cost Structures and Revenue Streams.

The reader that has an interest in exploring one or more of these innovative business models will be able to do their own assessment of costs and potential revenue or business viability based on the blueprint provided. Each reader depending on their role in the deployment of CAVs will have different resources and costs available to them. ICT4CART PU-access deliverable D8.4 Cost Model should be consulted for some of the cost associated with the ICT4CART solution portion of each business model.

We are not intending to analyse potential costs and revenue for specific business opportunities that may be based on these business models.

The building blocks of the BMC are:

- Customer Segments: Who are the customers? What do they think? See? Feel? Do?
- Value Propositions: What's compelling about the proposition? Why do customers buy, use?
- Channels: How are these propositions promoted, sold and delivered? Why? Is it working?
- Customer Relationships: How do you interact with the customer through their 'journey'?
- Revenue Streams: How does the business earn revenue from the value propositions?
- Key Activities: What uniquely strategic things does the business do to deliver its proposition?
- Key Resources: What unique strategic assets must the business have to compete?
- Key Partnerships: What can the company not do so it can focus on its Key Activities?
- Cost Structure: What are the business' major cost drivers? How are they linked to revenue?

5.5 Step 5: Commercial Readiness and Environmental Sensitivities

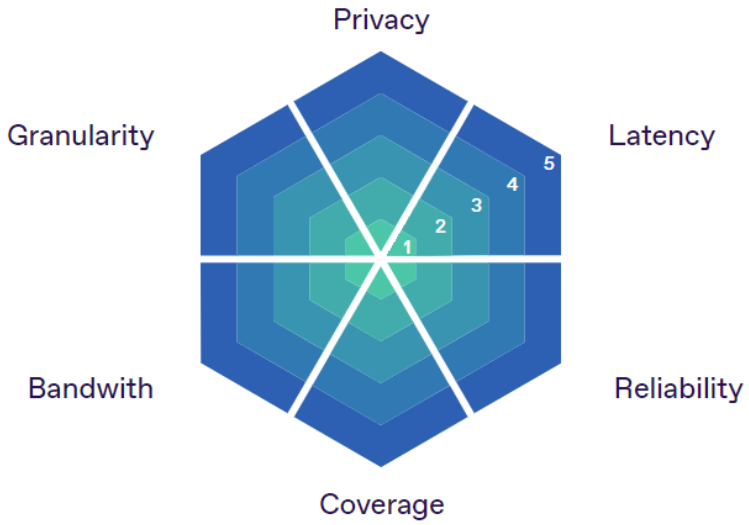
Both a Political Environmental Social and Technological (PEST) Analysis and Commercial Readiness Index (CRI)[8] will be used to map the variables to be considered for each business model blueprint.

D2.2 defined the 6 markets that encompassed the 24 services identified during a desk research and interview process. Each of the six markets were evaluated using a performance framework, shown in

Figure 4, that considered Privacy, Latency, Reliability, Coverage, Bandwidth and Granularity.

[8] © Commonwealth of Australia (Australian Renewable Energy Agency), 2014.

Figure 4: Performance Framework



In a similar way, we have now evaluated the business models using an adaption of the CRI that considers the current status of the technology in the market and a series of indicators representing the main risks and critical points in making progress towards widespread deployment. Table 2 and Table 3, provide further details, but this report is not intended to provide comprehensive explanation of the application of the CRI.

Table 2 – Description of CRI Status Summary

Status Summary Level	Description
6	"Bankable" grade asset class driven by same criteria as other mature technologies. Considered as a "Bankable" grade asset class with known standards and performance expectations. Market and technology risks not driving investment decisions. Proponent capability, pricing and other typical market forces driving uptake.
5	Market competition driving widespread deployment in context of long-term policy settings. Competition emerging across all areas of supply chain with commoditisation of key components and financial products occurring.
4	Multiple commercial applications becoming evident locally although still subsidised. Verifiable data on technical and financial performance in the public domain driving interest from variety of debt and equity sources however still requiring government support. Regulatory challenges being addressed in multiple jurisdictions.
3	Commercial scale up occurring driven by specific policy and emerging debt finance. Commercial proposition being driven by technology proponents and market segment participants – publicly discoverable data driving emerging interest from finance and regulatory sectors.
2	Commercial trial: Small scale, first of a kind project funded by equity and government project support. Commercial proposition backed by evidence of verifiable data typically not in the public domain.
1	Hypothetical commercial proposition: Technically ready – commercially untested and unproven. Commercial proposition driven by technology advocates with little or no evidence of verifiable technical or financial data to substantiate claims.

Table 3 – Description of CRI Indicators

Indicators	Description
Regulatory Environment	The maturity of the planning, permitting and standards relating to the technology.
Stakeholder Acceptance	The maturity of the process for evidence-based stakeholder consultation linked to CAV services integration into the automotive and telecommunication markets.
Technical Performance	The availability of discoverable technical performance information.
Financial Proposition - Costs	The availability of robust, competitive financial information linked to capital and operating costs, and forecast revenues allowing investors to take increasing levels of future market and project risk.
Financial Proposition – Revenue	
Industry Supply Chain & Skills	The development of a competitive and efficient industry product and skills supply chain required to support a commercially viable sector
Market Opportunities	The development from a hypothetical commercial plan to the demonstration of a viable market (local and/or overseas) via competitive channels to market and sustainable business models.
Company Maturity	The development of the sector to include established companies with strong credit ratings and established performance records.

6 Background Research

Arising from the six markets identified in D2.2: Analysis of Market Needs, there are 24 CAV Services for which we have established value propositions/business models.

Table 4 – Target Markets and respective ICT4CART based Services

Market	#	Service
Automated driving	1	Environmental information
	2	Smart system information
	3	Sensed road user information
	4	"Directly communicated" road user information
	5	Platoon coordination
	6	Predictive quality of connectivity
Informed Journeys	7	Event information
	8	Traffic management information
	9	Traffic conditions
	10	Availability of supporting service infrastructure
Intelligent Management	11	Basic vehicle information
	12	User specific journey information
	13	Infrastructure and environmental information
Coordination of Vehicles	14	Space management
	15	Incident management
	16	Fleet optimisation
	17	Coordinated corridors
	18	Smart city management
Connected Travelers	19	Internet-enabled consumer services
	20	Enhanced journey information
Underpinning Comm Services	21	Secure communication services
	22	Over-the-air software updates
	23	Cybercrime prevention services
	24	Other road fleet management services

Analysis of these six markets showed that the four ICT4CART use cases, Smart Parking, Dynamic Adaption, Virtual Mirror and Cross Border, are encompassed within the 24 business models explored in this report. Table 5, shows exactly which of the markets that each use case falls into.

Table 5 – ICT4CART Scenarios within Market Sectors

	Smart Parking	Dynamic Adaption	Virtual Mirror	Cross Border
Automated driving	✓	✓	✓	✓
Informed journeys		✓		✓
Intelligent management		✓	✓	✓
Coordination of vehicles	✓		✓	
Connected travellers	✓			
Underpinning Communications	✓	✓	✓	✓

This report differs from D2.2: Analysis of Market Needs in that it considers the services based on the ICT4CART solution from the perspective of a business opportunity rather than a broad market opportunity. That is, we are asking which services can be aggregated synergistically to form an innovative business that can deliver value to customers sustainably.

Additionally, businesses don't commonly serve only one market but will have a suite of products and services based on core business strengths or competencies that service different market segments. This approach can be validated by evaluating existing businesses that are comparable or already delivering services in the target market (see Table 6).

6.1 Existing and Comparable Business

Table 6, details companies that offer Existing and Comparable Services in the marketplace. An existing business are examples of businesses that are delivering a service that is the same or compares very closely to those envisaged in this report. The obvious exception is that there are businesses providing services that could be used by automated vehicles, but as the market is not developed, those services are not applied yet despite currently being used for other purposes.

Comparable business involves those that provide a service that is comparable but may not yet be as sophisticated as those envisaged in this report. An example would be a high definition mapping service that is only conducted annually and not yet real time.

Sample Market Sizes for the services listed in Table 6 are examples of specific implementations of each service that may encompass more or less features than documented in D2.2. One thing that is clear is that where the market now exists the value of the opportunity is significant and growing. In nearly all cases, where available, the compound annual growth rate for the market expansion is considered to be high (in excess of 15%).

Table 6 – Competitive and Comparable Services

Service	Existing Business	Comparable Business	Market Size
Environmental information	HERE HD Live Map, TomTom HD Map and AutoStream, NVIDIA Map	Sanborn, Gaist, Nexar, Woven Planet	HD Maps US$16.9 bn (2030)[9]
Smart system information	Traffic Technology Services, DanLaw, HARMAN, Cohda Wireless, Commsignia		US$900 mm (2018) 21% CAGR
Sensed road user information	LeddarTech LeddarVision, Bluecity, Aeye 4Sight,	Quanergy QORTEX	Smart Infrastructure US$395 mm (2026) Global[10]
"Directly communicated" road user information	AT&T, Autotalks, NTT Docomo, Qualcomm, Quectel Wireless, Robert Bosch, Rohde & Schwarz		C-V2X >US$1 bn (2026)[11]

[9] https://www.marketsandmarkets.com/Market-Reports/hd-map-autonomous-vehicle-market-141078517.html
[10] http://www.yole.fr/LiDAR_MarketUpdate_DesignWins.aspx
[11] https://www.gminsights.com/industry-analysis/cellular-vehicle-to-everything-c-v2x-market

Service	Existing Business	Comparable Business	Market Size
Platoon coordination	Peloton Technology, Daimler AG, Volvo Group, Scania AB		US$6.07 bn (2026) Global[12]
Predictive quality of connectivity	RootMetrics, Any MNO	Google Maps	Negligible
Event information	Rekor Systems (Waycare)		NA
Traffic management information	Bluecity, CivicSmart, Allvision, Numina, Streetlight Data		See below
Traffic conditions	INRIX, HERE, TomTom, Google, Sirius XM, Wejo, Otonomo, Valerann		Transportation Analytics US$21.7 bn (2027) [13]
Availability of supporting service infrastructure	Parkopedia, Zap-Map, Chargemap, Parkeon, Flowbird, Indigo, PaybyPhone, OPnGo, ParkNow, JustPark.		Smart Parking US$19.29 bn (2028) Global[14]
Basic vehicle information	INRIX, HERE, TomTom, Google, Sirius XM, Wejo, Otonomo	Teralytics	Transportation Analytics US$21.7 bn (2027) [15]
User specific journey information	Geotab, GM OnStar, Navistar, Inc., Trimble, Verizon, Vontier, Fleet Complete, Geotab, Solera, Continental, Daimler, Michelin	Any telematics business	Telematics US$64 bn (2030)[16]
Infrastructure and environmental information	See 'Environmental Information'	Gaist, Gexcel, Esri, Sanborn	Mobile mapping US$63.4 bn (2027)[17]
Space management	Ouster, Topsens, Bosch (Automated Valet), AEye 4Sight, Parkopedia Indoor Maps		NA
Incident management	NA		NA
Fleet optimization	Waycare, Geotab, Samsara, Neura (Otonomo),	Uber, Lyft	Fleet Management Software US$54 bn (2027) 14.9% CAGR[18]

[12] https://www.mordorintelligence.com/industry-reports/truck-platooning-market
[13] https://www.grandviewresearch.com/industry-analysis/transportation-analytics-market
[14] https://www.grandviewresearch.com/industry-analysis/smart-parking-system-market
[15] https://www.grandviewresearch.com/industry-analysis/transportation-analytics-market
[16] https://www.alliedmarketresearch.com/commercial-telematics-market
[17] https://www.imarcgroup.com/mobile-mapping-market
[18] https://www.theinsightpartners.com/reports/fleet-management-software-market

Service	Existing Business	Comparable Business	Market Size
Coordinated corridors	NA		
Smart city management	ParkMap (Buchanan Computing), Coord, Automotus, Grid (Kerb), Passport, Vianova, Passport		Billions $[19]
Internet-enabled consumer services	Netflix, Spotify, YouTube Music, Zoom, Microsoft Teams		NA
Enhanced journey information		Google Maps	NA
Secure communication services	Green Hills, Kaspersky, SecureThings, Argus, DENSO, Guardknox		Automotive Cybersecurity US$5.6 bn (2025) 21.4% CAGR[20]
Over-the-air software updates	GM Ultifi, Bosch Mobility, HARMAN, Continental / Imarsat		Automotive OTA US$8 bn (2028) 15% CAGR[21]
Cybercrime prevention services	HARMAN, Aptiv (Wind River)		See above
Other road fleet management services	HAAS Alert Safety Cloud, Rekor Systems (Waycare)		NA

6.2 Comparable Industries

During this research we identified significant similarities with the development of the smartphone technology and market. Smartphones were defined by the convergence of telecommunications, wireless data services and computing power along with sensor integration enabling a wide range of functionality. Like the evolution of smartphones, connected and automated vehicles will require significant investment in wireless and cellular infrastructure plus a dependence on standards for interoperability to unlock the market potential.

Similarly, the energy vector development in transportation is undergoing rapid advancement comparable to smartphone battery evolution in the 1990's.

As we saw in the growth of smartphones, the development of independent software platforms and marketplaces enabled the growth of software and application ecosystems. With any marketplace, payment is a core function allowing the exchange of value that builds an economy around the ecosystem.

What we do know is that as we move towards smartphone levels of functionality there are many opportunities to embrace connectivity and safe driver/passenger engagement thought a HMI such as voice assistants.

[19] https://www.planning.org/planning/2021/spring/poor-curb-management-is-costing-cities-billions/
[20] https://www.grandviewresearch.com/industry-analysis/automotive-cyber-security-market
[21] https://www.gminsights.com/industry-analysis/automotive-over-the-air-ota-updates-market

What remains to be seen is if transportation will always be the main function of a vehicle. Making phone calls is no longer the smartphone's main function, as the underlying telecommunications services were displaced by wireless data services.

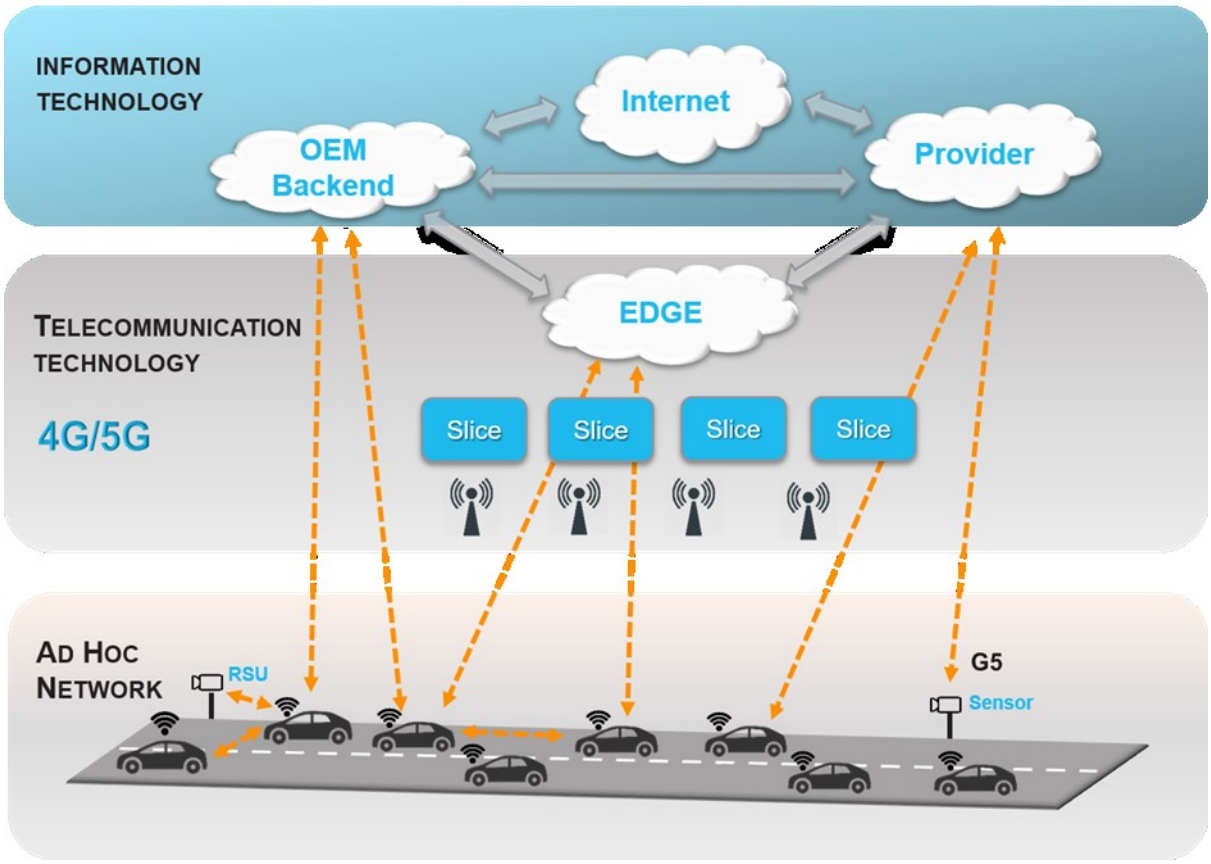
6.3 The ICT4CART Solution

The ICT4CART solution consists of a hybrid Mobile Radio Network Communication Infrastructure consisting of Cellular Radio Networks (LTE/5G), Network Slicing, Edge Computing, Ad-hoc Radio Networks (ITS-G5) and the capability for seamless handover between the different networks.

The IT Services operating on the infrastructure include interoperable common data exchange and management services, environmental perception models, data analytics tools and high precision positioning based on Real Time Kinematic (RTK) data embedded in the cellular radio network.

Figure 5 below provides a high level overview of the complete ICT4CART solution architecture.

Figure 5: The high-level communications architecture of the ICT4CART platform.



7 Value Proposition and Product/Market Fit

A high level Value Proposition Canvas has been explored for each of the 24 CAV Services to help understand the customer and what characteristics of each service would be required to achieve product market fit. While D2.2 does identify the beneficiaries in each market, Table 7 below identifies the most likely paying customers who often are not the same as the beneficiaries. An example would be a service that is paid for by an RNO that also benefits users of the road network.

Table 7 – Beneficiary Customer Relationship

Market	Beneficiaries	Customer Segments
Automated driving	• Passengers • Vehicle and fleet operators • Goods consignees • Road network operators • Other road users	• Vehicle operator
Informed journeys	• Passengers • Vehicle and fleet operators • Road network operators	• Vehicle operator
Intelligent management	• Passengers • Vehicle and fleet operators • Goods consignees • Road network operators • Solution providers • Other road users	• Vehicle operator • Fleet operator • Road network operator
Coordination of vehicles	• Passengers • Vehicle and fleet operators • Goods consignees • Road network operators • General public	• Fleet operator • Road network operator
Connected travellers	• Passengers • Vehicle and fleet operators • Goods consignees • Road network operators • Solution providers (infrastructure) • Commercial partners	• Passengers • Vehicle operator
Underpinning Communications	• Passengers • Vehicle and fleet operators • Goods consignees • Road network operators • Solution providers • Other road users • Supporting services (crime prevention services) • Supporting services (insurance services and emergency services)	• Solution providers • Road network operator • Mobile network operator

Below we have listed the simple value propositions for each of the 24 CAV Services. Annex 1, contains the details of each Value Proposition Canvas.

The CAV Service value propositions in Table 8 include the primary use case and customer segment.

Most CAV Services will have additional customer segments with different value propositions but these are not included in this report. The CAV Service value propositions are based on the Value Proposition Canvases in Annex 1 and will follow the simple format:

(CAV Service Name) is an (Service) for (Customer) that will provide (Feature) resulting in (Value/Benefit).

A simplified format avoids creative detail making it easier to help identify which CAV Services may have similar attributes further assisting with aggregating services into business model blueprints.

Table 8 – CAV Service Value Propositions

CAV Service	Value Proposition
Environmental information	Is an information service for vehicle operators providing accurate and reliable environment data, saving time, money and improving safety.
Smart system information	Is an information service for vehicle operators providing accurate and reliable infrastructure data, improving safety and the travel experience.
Sensed road user information	Is an information service for vehicle operators providing road user situational awareness, improving passenger comfort and safety.
"Directly communicated" road user information	Is an information service for vehicle operators providing road user situational awareness, improving passenger comfort and safety.
Platoon coordination	Isis a software platform for vehicle operators providing efficient platoon coordination, improving road and energy efficiencies.
Predictive quality of connectivity	Is an information service for vehicle operators providing a prevailing awareness of connectivity, enhancing trip reliability and confidence.
Event information	Is an information service for vehicle operators predicting adverse impacts on travel, supporting mitigation decision making.
Traffic management information	Is an authoritative information service alerting all road users of roadway changes, supporting travel planning and mitigation decision making.
Traffic conditions	IsIs an information service for authorities and vehicle operators predicting adverse impacts on travel, supporting mitigation decision making.
Availability of supporting service infrastructure	Is an information service for vehicle operators and passengers providing prevailing and comprehensive travel services information, improving passenger comfort.
Basic vehicle information	Is an information service for RNOs providing real time awareness of the status of road users, improving the optimisation of the road network.
User specific journey information	Is an information service for fleet operators providing enhanced awareness of vehicles under management, enabling performance optimisation and mitigation decision making/incident response.
Infrastructure and environmental information	Is an information service for RNOs providing roadway infrastructure condition awareness, enabling the optimisation of maintenance and reducing road user risk.
Space management	Is a software platform for vehicle operators providing arbitrated coordination of vehicles, reducing damage and injury, and optimising space utilisation.
Incident management	Is a software platform for RNOs that will provide directives to individual road users, reducing their frustration and broader impact of incidents, and improving passenger comfort.

CAV Service	Value Proposition
Fleet optimization	Is a software platform for fleet operators providing real time and predictive awareness of vehicles under management, optimising fleet performance in response to opportunities and incidents.
Coordinated corridors	Is a software platform for RNOs providing efficient platoon coordination, improving road and energy efficiencies.
Smart city management	Isis a software platform for RNOs providing a mechanism to distribute permissions and restrictions (policy) to road users, streamlining city operations and optimising roadways.
Internet-enabled consumer services	Each service will have its own value proposition. Broadly, passengers can access services and are entertained whilst travelling.
Enhanced journey information	Is an information service for passengers providing pre-emptive, accurate and reliable trip data, providing confidence and comfort.
Secure communication services	Is a suite of services for solution providers securing CAV communications, providing confidence in reliable data transmission and enabling innovative services.
Over-the-air software updates	Is a software and hardware platform for solution providers, ensuring the secure delivery of software and firmware updates.
Cybercrime prevention services	is a suite of services for solution providers that monitors, identifies and blocks threats to CAV communications, resulting in reliable operations.
Other road fleet management services	Each service will have its own value proposition.

Each of these value propositions describe the ideal product/market fit or problem/solution fit can now be used as the basis for defining the Service Models and aggregation.

8 Service Model Definition and Aggregation

The Service Models are the high level business characteristics of each of the 24 services. The Service Model details are explained and tabulated in Annex 2: Service Models. Due to the nature of the ICT4CART project, all 24 CAV services are dependent on telecommunications infrastructure, ideally the ICT4CART solution.

8.1 Service Model Overview

The service model overviews describe the potential businesses' core activities, required partners and resources need to deliver the value propositions outlined in Table 8. The likely customers, type of relationship and channels of engagement are also summarised. The similarity of these requirements between CAVCAV Services will be considered when aggregating into the innovative business models.

The core activity for businesses offering CAV Services is generally going to involve the acquisition, ingestion, analysis and manipulation of data to produce more valuable information for distribution. For the purposes of this report we will refer to this very broad activity as a software platform. Common business activities such as human resources and marketing have been excluded for clarity.

The resources required to perform the core activities of the business include the talent to perform the operational (i.e., management, accounting) and developmental (i.e. sales and software) functions of the business and the raw data for use in generating value for customers. In some cases, a resource may even include data generating sensors and infrastructure owned by the business.

The partners are the suppliers and partnerships such as strategic alliances that are needed for access to, or complement the resources required to perform the core business activity. CAV Services being heavily data dependent will require the business to have strong relationships with partners who generate or have access to data sources. A key partner for many of the Service Models are RNOs who can provide data from their own internal systems and roadway infrastructure based sensors.

Customers describe the types of organisations that have a need for the CAV Services and are ideally willing to pay enough for it to maintain a sustainable business.

The relationship with customer describes the way they are engaged for everything from customer acquisition (sales), retention (customer service) and expansion (upselling). Fleet Operators would be treated using very similar mechanisms to single vehicle operators but would likely justify a more personalised approach. As an example, where a vehicle operator would receive customer service in either an automated or self-service format, a fleet operator will likely receive a more account managed and personalised experience. Traditionally, the level of service provided would depend of the value and strategic importance of the account of the CAV service provider.

The channels describe how each Service's value proposition will be communicated to customers. The initial decision is whether the channel will be direct business to customer (B2C) or business to business (B2B) via a partner. Channels are used by customers to become aware, evaluate, purchase, receive the service and engage customer support.

All these business model elements are explored in each of the Service Models below.

Environmental Information
The business model for this service will be based on a software platform consuming vehicle and infrastructure data from automotive OEMs, Road Network Operators and other authorities. There may be situations where the operation of some roadway infrastructure would be a key activity, such as roadside microclimate sensors. The customers will include vehicle and fleet operators based on a relationships ranging from self-service to personal assistance. Like many data services, the channels for customer engagement will be in-vehicle, smartphone or online.

Smart System Information
The business model for this service will be based on a software platform consuming vehicle and infrastructure data from vehicles, Road Network Operators and other authorities. The customers will include vehicle, fleet operators and road users based on a relationship ranging from self-service to personal assistance. Like many data services, the channels for customer engagement will be in-vehicle, smartphone or online.

Sensed Road User Information
The business model for this service will be based on a software platform consuming vehicle, infrastructure and sensor data from vehicles, Road Network Operators and other authorities. The customers will include vehicle, fleet operators and road users based on a relationship ranging from self-service to personal assistance. The channels for customer engagement will be in-vehicle, smartphone or online.

Directly Communicated Road User Information
The business model for this service will be based on a software platform consuming vehicle data either directly from other vehicles (V2V) or via an MEC. The customers will include vehicle operators and road users based on an automated service relationship. The channels for customer engagement will be in-vehicle, smartphone or online. V2V is not a business opportunity based on the ICT4CART solution

as it does not use any telecommunications infrastructure. The opportunity lies with adding value at the edge of mobile network, therefore enabling data processing automotive services with demands both in low latency data and ultra-reliable data transmission. V2V nonetheless remains via an important element for automotive services, especially when safety is concerned, as cellular coverage is not available everywhere. RSU or other V2I connection.

Platoon Coordination
The business model for this service will be based on a software platform consuming vehicle, infrastructure and sensor data from vehicles, Road Network Operators and other authorities. The customers will include vehicle and fleet operators based on a relationship ranging from self-service to personal assistance. The channels for customer engagement will be in-vehicle, smartphone or online.

Predictive Quality of Connectivity
The business model for this service will be based on a software platform consuming data about the status of infrastructure from Road Network and Telecommunications Operators. The customers will include passengers, vehicle and fleet operators based on a relationship ranging from automated service to personal assistance. The channels for customer engagement will be in-vehicle, smartphone or online.

Event Information
The business model for this service will be based on a software platform consuming event data from Road Network Operators and other public sources such as event organisers. The customers will include passengers, vehicle and road network operators and other road users based on a relationship ranging from automated service to dedicated personal assistance. The channels for customer engagement will be in-vehicle, smartphone or online.

Traffic Management Information
The business model for this service will be based on a software platform consuming road network data from Road Network Operators. The customers will include passengers, vehicle and road network operators and other road users based on a relationship ranging from automated service to dedicated personal assistance. The channels for customer engagement will be in-vehicle, smartphone or online.

Traffic Conditions
The business model for this service will be based on a software platform consuming road network data from Road Network Operators. The customers will include passengers, vehicle and road network operators and other road users based on a relationship ranging from automated service to dedicated personal assistance. The channels for customer engagement will be in-vehicle, smartphone or online.

Availability of supporting service infrastructure
The business model for this service will be based on a software platform consuming supporting service infrastructure data from public sources and directly from resource providers. The customers will include passengers, vehicle and fleet operators based on a relationship ranging from automated service to personal assistance. The channels for customer engagement will be in-vehicle, smartphone or online.

Basic Vehicles Information
The business model for this service will be based on a software platform consuming road network data from road network operators. The customers will include passengers, vehicle and fleet operators, road network operators and other road users and based on a relationship ranging from automated service to dedicated personal assistance. The channels for customer engagement will be in-vehicle, smartphone or online.

User Specific journey information
The business model for this service will be based on a software platform consuming vehicle data from directly from vehicles. The customers will include fleet operators and solution providers based on a relationship ranging from automated service to personal assistance. The channels for customer engagement will be in-vehicle, smartphone or online.

Infrastructure and environment information
The business model for this service will be based on a software platform consuming vehicle and weather data from vehicles and public sources. The customer will be road network operators based on a dedicated personal assistance relationship. The channels for customer engagement will be industry conferences and publications.

Space management services
The business model for this service will be based on a software platform consuming vehicle data from the facilities operator. The customers will include vehicle and fleet operators based on a relationship ranging from personal service to dedicated personal assistance. The channels for customer engagement will be in person at the facility, in-vehicle, smartphone or online.

Incident Management
The business model for this service will be based on a software platform consuming vehicle, infrastructure and road network data from Road Network Operators. The customers will include road network operators, OEM's and other road users based on a relationship ranging from automated service to dedicated personal assistance. The channels for customer engagement will be in-vehicle, smartphone or online. Although, this service will most likely be mandated resulting in it being built into vehicles at manufacture similar to E-Call[22] and Intelligent Speed Assistance[23].

Fleet Optimisation
The business model for this service will be based on a software platform consuming vehicle, infrastructure, road network data and other commercial data (resource demand/utilisation) from Road Network Operators and application-specific data providers. The customers will be fleet operators, based on a relationship of dedicated personal assistance. The channels for customer engagement will be online, industry conferences and publications.

Coordinated Corridors
The business model for this service will be based on a software platform consuming vehicle, infrastructure and road network data from other vehicles and Road Network Operators. The customers will be road network operators, based on a relationship of dedicated personal assistance. The channels for customer engagement will be online, industry conferences and publications.

Smart City Management
The business model for this service will be based on a software platform consuming vehicle, infrastructure and road network data from Road Network Operators. The customers will be road network operators, based on a relationship of dedicated personal assistance. The channels for customer engagement will be online, industry conferences and publications.

Internet enabled consumer services
This is not within the scope of this report but will be included in the final Business Models.

[22] https://digital-strategy.ec.europa.eu/en/news/ecall-all-new-cars-april-2018
[23] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32019R2144R(03)

Enhanced journey information
The business model for this service will be based on a software platform consuming road network data from road network operators and journey related content from commercial and other providers. The customers will include passengers, vehicle and fleet operators and solution providers, based on a relationship ranging from automated service to dedicated personal assistance. The channels for customer engagement will be in-vehicle, smartphone or online.

Secure communication services
The business model for this service will be based on a software platform monitoring data travelling between network endpoints such as vehicles and computers. The customers will include OEMS, road network operators, service providers and the telecommunication network operators, based on a dedicated personal assistance relationship. The channels for customer engagement will be online, industry conferences and publications.

Over the air software updates (OTA)
The business model for this service is well defined and is most commonly based on an end-to-end software platform that securely distributes software and other updates to vehicles for OEMs and solution providers. The customers will be OEMs based on a dedicated personal assistance relationship. The channels for customer engagement will be direct contact based on long term relationships.

Cybercrime preventions services
The business model for this service is well defined as it already exists in the market with customers in banking, utilities and telecommunications for example. The business will be based on a software platform consuming and analysing data across a customer network. The customers will include OEMs, vehicle and fleet operators, road network operators and other road users and based on a relationship ranging from automated service to dedicated personal assistance. The channels for customer engagement will be online, industry conferences and publications.

Other road and fleet management services
The business model for this service will be based on a software platform consuming data from road network operators. The customers will include passengers, vehicle and fleet operators, road network operators and other road users and based on a relationship ranging from automated service to dedicated personal assistance. The channels for customer engagement will be direct contact or online.

8.2 Other Considerations

All services involve software platforms that ingest and disseminate data to be actioned by individual vehicles or operators. The platforms supporting the services are located wholly or in part either on the edge, the cloud, even in-vehicle (ee.g., platooning), or a combination thereof. This suggests that there are a series of key activities and resources common to all Services which will help simplify aggregation of Services into new Business Models.

For most services, the process is passive, as the reception of the data does not result in immediate action. The data is generally used for decision support and undergoes processing by other systems, in-vehicle, edge or cloud, immediately or at a later time. This is distinct from more active data that elicits a direct response from the vehicle such as the case of automation, remote control or teleoperation. The Platoon Coordination, Space Management and Incident Management services are example of CAV Services that may direct and/or take control of vehicles.

Non-aggregated or anonymised vehicle data is only shared directly in safety cases, where the vehicle

or fleet operator is requesting it or as required by law (enforcement, emergency services, etc.). Based on current privacy concerns and regulation, the only other case is where the data would being provided directly would be with the understanding, and appropriate agreements in place, that it will be processed and redistributed either anonymised or in aggregate. A number of the CAV Services operate on the basis that potentially personalised data will be available and possibly even depend on it.

8.3 Service Model Aggregation

The CAV Services have been grouped into potential product portfolios to form the foundation of business models based on the following elements in order of priority.

1. Key Activities
2. Resources
3. Key Partners
4. Customer Segments
5. Customer Relationships
6. Channels

After aggregation, Table 9 lists the resulting Business Model Blueprints and the component CAV Services.

Table 9 – Service Model Aggregation

Business Model Blueprints	CAV Services Bundled
Government Authority	• Traffic management information • Traffic conditions • Basic vehicle information • Incident management • Smart city management
Core Safety	• Smart system information • Sensed road user information • Directly communicated road user information
Digital Environment	• Environmental information • Infrastructure and environment information • Predictive quality of connectivity
Consumer Services	• Event information • Availability of supporting service infrastructure • Enhanced journey information
Supplementary Services	• Platoon coordination • Coordinated corridors • Space management services • Fleet optimisation • User specific journey information
Transferrable Services	• Secure communication services • Over the air software updates (OTA) • Cybercrime preventions services • Other road and fleet management services • Internet enabled consumer services

9 Business Model Blueprints

These business model blueprints are designed as templates for refined business models generated by the reader based on specific areas of interest and circumstances. The CAV Services described in this report do not contain enough detail to enable the development of comprehensive business models. To attempt to create business models for each and every potential combination of scenarios would result in so many models that it would cease to be of value. This also means that with the rapid pace of regulatory, standards and technological change there will always be exceptions to the probable future states that are being envisioned.

The business model blueprint of interest to the reader can be used as a starting point for further development. The next steps for those interested in further developing businesses from these innovative business model blueprints are:

1. Remove risk from creating new business models and get to product-market fit faster.
2. Build stronger, more innovative solutions that solve real needs for your customers.
3. Prototype and iterate components of your business model to unlock more value from the existing or additional services.
4. Validate which offer, revenue model, and sales channel will work for the new business.

As described in Table 6, existing and comparable business in operation can also be used to guide the development of comprehensive business models.

9.1 Business Model 1 – Government Authority

The Government Authority business model consists of a suite of tools and real time data services for all road users providing dependable information to make planning and journeys smoother.

The Government Authority business model describes a business based on a suite of services that ingests data and distributes information to the general public that has an element of authority or acts as an official source of truth. Government authorities generally play the role of validating the information being provided to the end users. This could be via providing the source data and/or responsibility for disseminating or applying the resulting information to road users.

The Services included in the Government Authority business model are Traffic Management Information (temporary roadway changes), Traffic Conditions (traffic status), Basic Vehicle Information (anonomised vehicle and trip data), Incident Management (targeted directives) and Smart City Management (vehicle coordination).

This extends to situations where local government is needed in emergencies and for the enforcement of policy based on the data services. The recent publication of the Curb Data Specification RC 1.0 provides an example mechanism of how cities are planning to digitise infrastructure to implement innovative policy[24].

The circumstances could exist where local authorities would develop and deliver this service internally without the need for external parties. However, this is generally not found to be the case, as the range

[24] https://www.openmobilityfoundation.org/about-cds/

of commercial relationships and computer science expertise required is a barrier and beyond the scope of operation for local authorities.

As vehicles become more automated, the Government Authority business model has the potential to lead to very dynamic and granular future services based on individual vehicle and passenger profiles, including variables such as vehicle performance, priority, air quality and the need for emergency access.

Trust will play an important role as the service will be used for critical decision support. Data providers will need to trust that the data is secure and being handled appropriately. The customers, specifically RNOs need to be confident that the data can be relied upon to support decisions that can influence entire road networks and the happiness of residents.

It is worth considering that the role of the local government authority also implies acceptance of liability for the information being provided.

The Government Authority business model includes the data services that support the "Smart Parking" and "Dynamic Adaption" ICT4CART use cases (UC1&2).

9.1.1 Key Activity, Resources and Partners

As a cloud-based software platform, the key activities will include the identification, collection, cleaning, aggregation, fusion, processing, anonymisation and dissemination of data.

These activities require sensors and related infrastructure to generate data, or more likely partnerships with organisations that generate or collect the data. For example, vehicle data may be collected by OEMs and infrastructure data may be provided by RNOs.

IT infrastructure is needed for compute and storage (cloud or distributed) and a telecommunications network for collection of data and sharing of information.

Operation of the platform and business will also involve software development and sales and marketing activities. Software development is needed to create the products and service for the business and a sales force to generate revenue. These will require access to a talent pool of software developers and a small sales force as most customer engagement will occur online.

Providers of the ICT4CART infrastructure is a core provider needed for the collection of data and sharing of information.

9.1.2 Customer Segments, Channels and Relationships

The primary target market for this business model would be organisations responsible for the role of the road network operator. RNOs have the greatest need to understand the performance of the road network and may even have a desire or obligation to pass information onto road users and the general public.

A likely channel to the primary target market would be a B2B relationship with partners or collaborators, such as consulting transportation engineering firms[25]. The financial arrangement could

[25] Eg. Jacobs, ABB, AECOM, WSP, HDR, Black & Veatch.

range from a simple finders fee for introducing potential customers through to a reseller or solutions integrator arrangement.

Depending on the relationships and services developed, this model may also involve RNOs and other transportation authorities acting as a channel to both customer and end users.

The secondary market segment would be all other road users who may be impacted by the performance of the road network. This segment is also the recipient of mandated directives that originate from a local authority, such as during disaster or emergency conditions.

Additionally, there is potential for the development of tools specific to address the needs of large fleet operators. Fleet operator needs may include customisations, such as information that is relevant to the characteristics of their fleet, and additional details that optimise performance of the fleet as a whole across the road network.

9.1.3 Cost Structure and Revenue Streams

Generally, for data- and information-driven businesses, the cost model is value-driven rather than cost-driven. Based on the core strengths and activity, creating value in the data is more sustainable than cost minimisation for this type of business.

The high-level cost and revenue structure for the Government Authority business model can be found in Table 10.

Table 10 – Government Authority Cost and Revenue Structure

Type	Description
Startup Costs	• Data Licenses acquisition • Initial Development Costs (platform, applications etc.) • Computer Equipment
Recurring Costs	• Staff • Marketing • Data licenses • Compute, storage and telecommunications • Operations (Office, Insurance, Paper Clips etc.)
Revenue Sources	• RNOs for customisation and recurring license and maintenance • Fleet Operators for customisation and recurring license and maintenance • OEMs for any initial integration costs and ongoing data license fees • Consumers pay for premium tools and smartphone applications • Service providers pay for data to provide related novel services

9.2 Business Model 2 – Core Safety

The Core Safety Business Model is a critical information service for all road users providing a safer operating environment.

The Core Safety business model describes a business based on a suite of critical safety services for all road users that supports tactical decision making. The decisions made based on these data services range from sub-second crash avoidance to speed adjustment based on the future state of traffic signals.

The service included in the Core Safety business models include Smart System Information (Vehicle to Infrastructure), Sensed Road User Information (inferred information about unconnected road users in the immediate vicinity) and Directly Communicated Road User Information (information about connected road users in the immediate vicinity).

It is envisioned that as CAVs penetrate the market this type of safety service will become a required – or even legislated – service provided by RNOs or other government agencies. Some companies are already having success as what is effectively a value-added broker for digital mobility information.

It's not currently clear what the business opportunity is for Directly Communicated Road User information will be as this information is communicated directly between vehicles (V2V). It is possible that infrastructure (V2I) may play a role as a redundancy or validation system. There may also be potential for features of value to be added to standards-based V2V data that can generate revenue.

The Core Safety business model includes the data services that support the "Virtual Mirror" ICT4CART use case (UC3).

9.2.1 Key Activity, Resources and Partners

The broad processes these service would follow consist of collecting direct or sensed data from vehicles or infrastructure, processing the data, and redistributing via multiple channels to reach as many relevant users as possible in the local area.

As a cloud-based software platform, the key activities will include the identification, collection, cleaning, aggregation, fusion, processing, anonymisation and dissemination of data. Operation of the platform and business will also involve software development and sales and marketing activities. Software development is needed to create the products and service for the business and a sales force to generate revenue. These will require access to a talent pool of software developers and a small sales force as most customer engagement will occur online.

To perform the business activities, direct and sensed data is a required resource from RNOs and Vehicle and Fleet Operators based on partnerships with RNOs, Vehicle (OEMs, telematics providers) and Fleet Operators.

Providers of the ICT4CART infrastructure are partners needed for the collection of data and sharing of information. For example, safety critical data services, due to their nature, will inevitably require low latency communications. This means that where the data is not shared directly between vehicles it will be shared via resources in the immediate vicinity, such as MECs via the RAN.

These activities require sensors and related infrastructure to generate data or partnerships with organisations that generate or collect the data. In these safety cases, it is most likely that the product of this business model is a software and infrastructure solution customised for RNOs, their agents or other roadway authorities.

The business model is not dissimilar to the way existing ITS solutions are implemented. Existing companies involved include engineering consulting firms, diversified telecommunication providers and start-ups[26].

9.2.2 Customer Segments, Channels and Relationships

The primary customer segment is RNOs, which will be engaged using industry associations, events and publications, and phone and online support, based on a dedicated account management relationship.

Due to the nature of the services offered by the Core Safety business model, the major customers also have the potential to adopt the business model into their existing operations. RNOs for example have existing access to key resources (specifically infrastructure) to provide safety services to local road users at little or no cost. More broadly, a diversified telecommunication provider may be in a position to provide the services on a regional or national scale based on relationship with many RNOs.

The secondary customer segment may be vehicle and fleet operators, who will be engaged using online channels based on a self-service or automated relationship. An additional channel may be via OEM vehicle sales where the service is included with new vehicles and subject to subscription renewal after a period of time. Secondary markets would be expected to involve increased levels of features and value-add beyond what would be provided by an RNO.

Another secondary customer segment would be all other road users. Specifically, vulnerable road users can be a key source of data and be particularly interested in any service that may improve their safety.

9.2.3 Cost Structure and Revenue Streams

Generally, for data- and information-driven businesses, the cost model is value-driven rather than cost-driven. Based on the core strengths and activity, creating value in the data is more sustainable for this type of business than cost minimisation.

The high level cost and revenue structure for the Core Safety business model can be found in Table 11.

Table 11 – Core Safety Cost and Revenue Structure

Type	Description
Startup Costs	• Data Licenses acquisition • Initial Development Costs (platform, applications etc.) • Computer Equipment
Recurring Costs	• Staff • Marketing • Data licenses • Compute, storage and telecommunications • Operations (Office, Insurance, Paper Clips etc.)
Revenue Sources	• RNOs for customisation and recurring license and maintenance

[26] https://www.traffictechservices.com/

Type	Description
	• Fleet Operators for customisation and recurring license and maintenance • Vulnerable road users • OEMs for initial integration costs and ongoing data license fees • Consumers pay for premium tools and smartphone applications • Service providers pay for data to provide related novel services

There is also potential for revenue from data generated by the delivery of the service. Insights into the performance of road networks and the availability of advance roadway warning information may hold value for third parties such as RNOs, OEMs, insurance companies and other service providers.

9.3 Business Model 3 – Digital Environment

The Digital Environment business model provides a real time high definition digital road environment for all road users providing confidence in the road and conditions ahead.

Generally, the Digital Environment service consists of high definition (HD) maps or a digital twin that is updated in real time by infrastructure sensors and vehicles as they move through the environment. These updates are then shared with other vehicles and road users.

The services included in the Digital Environment business model includes Environmental Information (providing environmental data to vehicles), Infrastructure and environment information (collection of environmental data from vehicles) and Predictive Quality of Connectivity (alerting CAVs to the need to pre-empt limited connectivity).

The Digital Environment business model has the potential to not only provide high definition maps but a complete environmental digital twin that include real time (weather) and regularly updated (infrastructure status) information. HD maps can be used in systems ranging from ADAS through to full automation.

Electronic horizon (eHorizon)[27] services provide a good example of a Digital Environment service and this type of service is supported by standards such as the Navigation Data Standard[28].

The Digital Environment business model includes the data services that support some applications of the "Dynamic Adaption" and "Cross Border" ICT4CART use cases (UC2, UC4).

9.3.1 Key Activity, Resources and Partners

The broad processes these services would follow consist of collecting sensed data from vehicles, infrastructure and third parties, processing the data, and redistributing it to individual vehicles

[27] https://www.continental-mobility-services.com/en-en/products/ehorizon/ehorizon-maps-on-demand/
[28] https://nds-association.org/

entering the specific area of interest.

As a cloud-based software platform, the key activities will include the identification, collection, cleaning, aggregation, fusion, processing, anonymisation and dissemination of data. Operation of the platform and business will also involve software development and sales and marketing activities. Software development is needed to create the products and services for the business, and a sales force to generate revenue. These will require access to a talent pool of software developers and a small sales force, as most customer engagement will occur online.

The data resources required for the Digital Environment include data about and from vehicles and the roadway infrastructure. These resources could be acquired directly from vehicle or fleet operators but most likely via a partner or broker such as OEMs. Some existing businesses utilise their own vehicles and infrastructure to generate data, although this approach would likely only scale if the core business involved operating an extensive fleet and the data was a by-product.

Other environmental data sources such as terrain maps, meteorological and weather data will also need to be sourced through a series of partnerships. See Table 6 – Competitive and Comparable Services.

9.3.2 Customer Segments, Channels and Relationships

The primary customer segment is vehicle and fleet operators who will be engaged using in-vehicle systems or other online channels based on a self-service or automated relationship. CAVs will use the service for navigating their immediate environment or planning ahead for longer trips, but, with the increase in last mile logistics, digital environment services can also be used by footpath robots and UAV deliveries.

The secondary customer segment is RNOs who will be engaged using industry associations, events and publications, and phone and online support based on a dedicated account management relationship. RNOs desire to know the exact status of the roadway environment to support decision making. This includes shorter-term dynamic speed limits and signal timing, or longer-term roadway maintenance management and planning.

Another customer segment are service providers and other data consumers. As an example, weather data businesses (who may also be data providers) may have a need for microclimate weather data collected by vehicles with a frequency and granularity that had not previously been available.

9.3.3 Cost Structure and Revenue Streams

Generally, for data- and information-driven businesses, the cost model is value-driven rather than cost-driven. Based on the core strengths and activity, creating value in the data is more sustainable for this type of business than cost minimisation.

The high level cost and revenue structure for the Digital Environment business model can be found in Table 12.

Table 12 – Digital Environment Cost and Revenue Structure

Type	Description
Startup Costs	• Data Licenses acquisition • Initial Development Costs (platform, applications etc.) • Computer Equipment
Recurring Costs	• Staff

Type	Description
	• Marketing • Data licenses • Compute, storage and telecommunications • Operations (Office, Insurance, Paper Clips etc.)
Revenue Sources	• RNOs for customisation and recurring license and maintenance • Fleet Operators for customisation and recurring license and maintenance • OEMs for initial integration costs and ongoing data license fees • Consumers pay for premium tools and smartphone applications • Service providers pay for data to provide related novel services

9.4 Business Model 4 – Consumer Services

The Consumer Services business model provides general information to passengers that enhance the planning and travel experience.

The Consumer Service business model collects a broad range of data sources resulting in convenience, guidance and entertainment content and information for passengers.

The Services included in the Consumer Services business model are Event Information (events that may impact travel), Availability of supporting service infrastructure (fuelling, parking resource etc.), Internet enabled consumer services (entertainment, video calls etc.) and Enhanced journey information (supplementary passenger information).

"Internet enabled consumer services" could be included in this business model blueprint but just as easily fall within the Transferrable Services blueprint below. It has been included here to help detail its interaction with other services and business model requirements.

This suite of services help travellers remain engaged and productive while remaining aware of incidental events and resources that may influence their planned and current journey. In contrast to the Government Authority business model, Consumer Services are not likely to be mandated or authoritative, potentially less reliable and not as critical to the safety of the journey.

One challenge of this business model is the dependency on third parties, such as parking owners and event organisers, volunteering data which has the potential to result in inconsistent and unreliable data. While this data still has value a key activity of the business will be the ability to clean and validate the data while maintaining an extensive network of disparate data providers.

The business model also allows for crowdsourced data, which, if deployed successfully, has the potential to become a significant asset for the business. Zap-Map[29] and Chargemap[30] are examples of online resources that use crowdsourcing information about the location and status of EV charging infrastructure.

[29] https://www.zap-map.com/
[30] https://chargemap.com/

As some data sets such as parking[31] and charging infrastructure[32] become standardised and centralised the services will become more authoritative and potentially overlap into the Government Authority business model. Currently, Parkopedia[33] is the largest provider of parking information and is a good example of a company having success with a similar business model.

The Consumer Services business model includes the data services that support the "Smart Parking" ICT4CART use case (UC1).

9.4.1 Key Activity, Resources and Partners

The processes these services would follow consist of collecting data from a broad range of partners and some directly from infrastructure, processing the data, and redistributing it to individual vehicles and passengers requesting the information.

As a cloud-based software platform, the key activities will include the identification, collection, cleaning, aggregation, fusion, processing, anonymisation and dissemination of data. Operation of the platform and business will also involve software development and sales and marketing activities. Software development is needed to create the products and services for the business, and a sales force to generate revenue. These will require access to a talent pool of software developers and a small sales force, as most customer engagement will occur online.

The specific data resources needed for these services will be especially challenging to procure and secure depending on the level of vertical integration in the supply chain. Providing comprehensive Consumer Services across a broad geography will require a huge range of localised sources to ensure that the services are contextually relevant and delivering sustainable value to customers. Identifying data sources and building numerous strong partnerships will be a key activity. This aspect of this business model could be a core competency that creates a competitive advantage.

9.4.2 Customer Segments, Channels and Relationships

The primary customer segment is passengers who will be engaged using social media and online channels based on a self-service and automated relationship.

The secondary customer segment is vehicle and fleet operators who will also be engaged using social media and online channels based on a self-service and automated relationship. Larger accounts may justify are more direct relationship.

Another channel to access customers may be via OEM vehicles sales where the service is included with new vehicles and subject to subscription renewal after a period of time. This also extends to fleet operators, such as rideshare and carshare operations, who may want to resell these services to passengers.

An additional customer segment are Solution Providers and other parties that data and information can be sold to. They will be engaged using a sales force or partner channels based on a dedicated or personal assistance relationship. Solution Providers may wish to integrate some of the data provided into their own transport-related applications.

[31] https://www.mobivoc.org/
[32] https://www.allianceforparkingdatastandards.org/
[33] https://www.parkopedia.com/

As the Customer Services business model is targeted at passengers, it will be especially tightly associated to in-vehicle payments. This suggests that payment processors and other existing and emerging business in that payment ecosystem will be key channels to customers and demand strong relationships. See section 3.3 In-Vehicle Payments for examples.

9.4.3 Cost Structure and Revenue Streams

Generally, for data- and information-driven businesses, the cost model is value-driven rather than cost-driven. Based on the core strengths and activity, creating value in the data is more sustainable for this type of business than cost minimisation.

The high level cost and revenue structure for the Consumer Services business model can be found in Table 11 .

Table 13 – Consumer Services Cost and Revenue Structure

Type	Description
Startup Costs	• Data Licenses acquisition • Initial Development Costs (platform, applications etc.) • Computer Equipment
Recurring Costs	• Staff • Marketing • Data licenses • Compute, storage and telecommunications • Operations (Office, Insurance, Paper Clips etc.)
Revenue Sources	• Fleet Operators for customisation and recurring license and maintenance • OEMs for initial integration costs and ongoing data license fees • Consumers pay for premium tools and smartphone applications • Service providers pay for data to provide related novel services

9.5 Business Model 5 – Supplementary Services

The Supplementary Services business model provides practical tools for enhancing and optimising roadway utilisation for connected and automated vehicle and fleet operators.

The Supplementary Services or coordination business model describes a suite of tools that overlay the core driving function to coordinate individual movement in the context of a broader fleet. Supplementary Services are generally purchased by an organisation that has oversight of a large number of vehicles, such as fleet and facilities operators or RNOs.

The Services included in this business model include Platoon Coordination (vehicles in series), Coordinated Corridors (RNO managed platooning), Space Management Services (automation in a closed environment), Fleet Optimisation (fleet level oversight) and User specific journey information (contextual advice). All of these services play a role in coordinating the vehicle by collecting information from the vehicle sensors, processing and combining that information with other externally sourced data, and in turn directly interacting with the automated driving and navigation function of the vehicle.

The vehicle coordination could be temporary or permanent. Temporary coordination would occur in circumstances such as loading CAVs onto a ferry or joining a long-distance platoon. Permanent coordination would occur in situations including fleet operations and mandated platoon corridors.

In contrast to some of the services found in the Government Authority business model, these services would generally be voluntary as opposed to mandated.

Software tools could be external to the vehicle (edge/cloud) providing a coordinating function that effectively remotely directs the automated driving function of the vehicles. Alternatively, there will be use cases where safety cannot rely on external connectivity and is dependent on low latency communications such as platooning. In this case, the software tools may be local to at least one vehicle, such as a lead vehicle in the platoon, or more for redundancy.

For these services to coordinate vehicles adhoc, especially without human interaction, there would need to be industry standards developed for wide spread adoption. Adoption in closed or known vehicle fleets would be a shorter-term market opportunity.

It is not unforeseeable that such services could be used to help differentiate one OEM from another or be a premium product upgrade. Where provided by RNOs, a higher level of service could be offered within different urban environments. Fleet operators, particularly ride hailing operators could use these services to offer premium experiences. Platooning, for example, has the potential to provide priority over general traffic, getting passengers to their destination faster.

It is worth noting that the Fleet Optimisation service is focussed on providing the supporting information for the digital coordination of vehicles and does not extend to all fleet operations. Services offering fleet operations are very broad, ranging from costs and driver management to fuel and maintenance management. Fleet operations solutions are complete business models in themselves[34] and beyond the scope of this report.

The Supplementary Services business model includes the data services that have the potential to support all of ICT4CART's use cases.

9.5.1 Key Activity, Resources and Partners

The processes these services would follow consist of collecting data from vehicles belonging to a fleet or platoon and some directly from infrastructure, processing the data, and redistributing it to individual vehicles requiring coordination (whether voluntarily or mandatory).

The ICT4CART infrastructure is a core provider, needed for the collection of data and sharing of information. More broadly, IT infrastructure is needed for computing and storage (cloud or distributed), and a telecommunications network for collection of data and sharing of information.

These activities require some partnerships with organisations that generate or collect infrastructure data from the environment where the customer vehicles are operating. This relationship may even extend to requiring access to MECs to deliver the service in specific environments where low latency is needed.

[34] Examples include https://www.fleetio.com/ and https://ridecell.com/

The key data needed to provide the coordination services will come directly from the customer vehicles. For example, vehicle data may be collected by OEMs, with consent from vehicle operators, and infrastructure data may be provided by RNOs.

As a cloud-based software platform, the key activities will include the identification, collection, cleaning, aggregation, fusion, processing, anonymisation and dissemination of data. Operation of the platform and business will also involve software development and sales, marketing and customer service activities. Software development is needed to create the products and services for the business, and a sales force to generate revenue. These will require access to a talent pool of software developers and significant sales and customer service resources.

9.5.2 Customer Segments, Channels and Relationships

The primary customer segment is fleet operators overseeing known vehicles, which will be engaged using industry associations, events and publications, and phone and online support based on a dedicated account management relationship.

Fleet management companies may either be a customer or a channel to customers (or both). The future role of fleet management companies is dynamic and even has the potential "evolve into ultra-sophisticated 'vehicle dispatch companies' providing units to clients on a precise as-needed basis" (Antich, 2015) . Again, fleet management companies would be engaged using traditional B2B channels based on a dedicated account management relationship.

Another customer segment is RNOs and OEMs who may provide the service to road users and new vehicle customers respectively. RNOs and OEMs will be engaged using industry associations, events and publications, and phone and online support based on a dedicated account management relationship.

To access the RNOs customer segment, one channel will be via consulting transportation engineering firms[35]. This relationship could range from a simple finders fee for introducing potential customers through to a reseller or solutions integrator arrangement.

9.5.3 Cost Structure and Revenue Streams

Generally, for data- and information- riven businesses, the cost model is value-driven rather than cost-driven. Based on the core strengths and activity, creating value in the data and resulting software tools is more sustainable for this type of business than cost minimisation.

The high level cost and revenue structure for the Supplementary Services business model can be found in Table 14.

Table 14 – Supplementary Service Cost and Revenue Structure

Type	Description
Startup Costs	• Data Licenses acquisition • Initial Development Costs (platform, applications etc.) • Computer Equipment
Recurring Costs	• Staff • Marketing • Data licenses • Compute, storage and telecommunications

[35] E.g. Jacobs, ABB, AECOM, WSP, HDR, Black & Veatch.

Type	Description
	• Operations (Office, Insurance, Paper Clips etc.)
Revenue Sources	• RNOs for customisation and recurring license and maintenance • Fleet Operators for customisation and recurring license and maintenance • OEMs for initial integration costs and ongoing data license fees

In this business model, there is likely less of a market for the data generated by the delivery of the service. The party most interested in the data is going to be customers and the business delivering the service as it will be useful in improving the service or creating new related services.

9.6 Business Model 6 – Transferrable Services

The Transferrable business services provide information and capability to CAV data service providers that ensure secure and reliable data transactions.

The Transferrable business model is not a business model per se, but a group of services and related business models that are already operating successfully in other industries over a significant period of time. Each will have their own value proposition and most are already being applied in the automotive sector at the time of writing.

These services are included in this report as they all support the operation of other connected vehicle services and can be intrinsic to the ICT4CART solution.

The Services included in the Transferrable Services business model are, Secure communication services, Over the air software updates (OTA), Cybercrime preventions services and Other road and fleet management services. “Internet enabled consumer services” could also be included in this business model blueprint but is explored in the Consumer Services blueprint above.

Automotive Cybersecurity is partially being driven by increasing cyber risks as vehicles become more connected and the need to become compliant with UNECE WP.29 regulations on cybersecurity and software updates[36] and ISO/SAE 21434:2021 Road vehicles — Cybersecurity engineering[37].

As far back as 2019, the Automotive Cyber Security: 2019 Ecosystem Update (Strategy Analytics, 2019) identified 25 active companies delivering automotive Cyber Security solutions including AGL, Argus Cyber Security, ARM, Blackberry, Baidu/Apollo Project, Bosch, C2A Security, Continental, Elektrobit, Green Hills and ISS, GuardKnox, Harman, Intel, Irdeto, Infineon, Karamba, Microchip, NNG/Arilou, Qualcomm, Renesas, SafeRide Technologies, ST Micro Electronics, Texas Instruments, Trillium Secure and Upstream Security. Cybellum[38] and Vector Informatik[39] are examples of newer market entrants.

Recent surveys suggest that OTA (Over the Air) and FOTA (Firmware Over the Air) software updates are becoming commonplace in automotive (Visiongain, 2021). This is reinforced by General Motors announcing their Ultifi “end-to-end” software solution in 2021 (Visnic, 2021) designed as a third party developer platform and to foster “an ongoing relationship” with the customer.

[36] https://unece.org/transportvehicle-regulations/wp29-presentation
[37] https://www.iso.org/standard/70918.html
[38] https://automotive.cybellum.com/
[39] https://www.vector.com/int/en/products/solutions/safety-security

There is already significant market research and analysis of industry landscapes and business models for these services available such as: Cyber Security in Automotive: Mastering the challenge (McKinsey & Company, Inc., 2020).

Other road and fleet management services, as an example, include the implementation of Road Usage Charging as a basis for taxation to support roadway maintenance and construction. Fuel taxation is gradually being displaced due to the increasing popularity of electric and other high efficiency vehicles. The states or Oregon[40] and Utah[41] have started experimenting with Road Usage Charging programmes.

See section 3.3 In-Vehicle Payments for another service that falls within Transferrable Services business model.

9.6.1 Key Activity, Resources and Partners

The Key Activity, Resources and type of Partners are unlikely to change in any significant way from their existing application in other industries when the service is applied to CAVs.

9.6.2 Customer Segments, Channels and Relationships

Every Transferable Service will have its own Customer Segments, Channels and Relationships when applied to CAVs. These should be explored by the reader on a case-by-case basis depending on interest.

Some Customer Segments, Channels and Relationships may not change at all from their existing application in other industries once the service is applied to CAVs. Video streaming services, for example, will be consumed in the same way they are in and outside of the vehicle.

9.6.3 Cost Structure and Revenue Streams

The Cost Structure is unlikely to change in any significant way from their existing application in other industries when the service is applied to CAVs. The application of transferrable services to CAVs in itself will represent an entirely new series of Revenue Streams.

The high level cost and revenue structure for the Transferrable Services business model can be found in Table 15.

Table 15 – Transferrable Services Cost and Revenue Structure

Type	Description
Startup Costs	• Data Licenses acquisition • Initial Development Costs (platform, applications etc.) • Computer Equipment
Recurring Costs	• Staff • Marketing • Data licenses • Compute, storage and telecommunications • Operations (Office, Insurance, Paper Clips etc.)
Revenue Sources	• RNOs for customisation and recurring license and maintenance • Fleet Operators for customisation and recurring license and maintenance

[40] https://www.myorego.org/
[41] https://roadusagecharge.utah.gov/

Type	Description
	• OEMs for initial integration costs and ongoing data license fees • Consumers pay for premium tools and smartphone applications • Service providers pay for data to provide related novel services

10 Launch Challenges and Opportunities

Now that the business model blueprints are defined, we can look to the macro-environmental factors that may influence the successful launch of new businesses based on each business model blueprint. The tables below contain some examples of political, economic, social and technological (PEST) factors that should be considered for each business model blueprint. PEST analyses are conducted with the goal of understanding challenges and opportunities when considering launching businesses based on the business models presented in this report.

To ensure relevance to the ICT4CART project and CAV technologies, regulatory factors such local laws have been included in the analysis of the political factors. Standards development, while a multidisciplinary effort, is included in Technological Factors.

Key for PEST Analyses:

+ positive supporting factor
- negative or limiting factor
~ factors that could be have a positive or negative impact depending on context
? factors worth considering with no currently identifiable impact

10.1 Government Authority

Table 16 – Government Authority PEST Analysis

	Factors
Political	+ Government authorities being a data source and the target market are in a position to create enabling policy
Economic	+ Undeniable growing demand for reliable information as transportation evolves
Social	~ Trust in data and data providers differs culturally and impacts provider relationships ~ Privacy attitudes are very dynamic and will impact the level of detail available
Technological	- Some dependency on 5G development ~ Standards are progressing but some services will be very dependent on them for widespread adoption ? Cybersecurity

10.2 Core Safety

Table 17 – Core Safety PEST Analysis

	Factors
Political	~ Government authorities are key to the deployment of both ITS-G5 and LTE/5G, determining market growth + Policy requiring safety solutions will accelerate the market
Economic	+ Undeniable growing demand for reliable data as transportation evolves - Unclear who will invest in what infrastructure (ITS-G5, LTE/5G or both) - Policy acceleration will commoditise the service – lower margins
Social	+ Acceptance of ADAS helps pave the way for more advanced safety services ~ Trust in data and data providers differs culturally and impacts market uptake ~ Privacy attitudes are very dynamic and will impact the level of detail - Public acceptance of models around data sharing
Technological	~ Dependence on OEM integration - Some dependency on 5G development

	Factors
	- Vehicle safety standards need to incorporate technology + Data service development largely independent of delivery mode + Advancement in automation progresses potential market

10.3 Digital Environment

Table 18 – Digital Environment PEST Analysis

	Factors
Political	+ Public Policy has little influence currently but may become an issue regarding privacy when generating maps - Standards have been called for to boost confidence in data but currently still proprietary
Economic	+ New markets for the service being created (autonomy R&D) + Existing markets have long history (GIS, smart city) + Undeniable growing demand for reliable data as transportation evolves
Social	+ Public attitudes are not impacted as the service is not very visible ~ Trust in data reliability and accuracy is evolving ~ Privacy attitudes are very dynamic and will be impacted by the level of detail
Technological	- Real time data sources many years from being commonly available - Real time high definition data fusion and environment updates progressing

10.4 Consumer Services

Table 19 – Consumer Services PEST Analysis

	Factors
Political	+ Government authorities motivated to distribute relevant information to the public making them both a source and a channel ~ Standards are progressing but many areas require further work + Opportunity to be drive/define standards development
Economic	+ Undeniable growing demand for reliable data as transportation evolves - Monetisation will be a key challenge
Social	+ Some services already well accepted in the market - Difficultly sourcing reliable and comprehensive data will be ongoing, especially if crowdsourcing
Technological	+ Foundation concepts and technologies in place that can be built upon

10.5 Supplementary Services

Table 20 – Supplementary Services PEST Analysis

	Factors
Political	+ Government authorities being both a data source and one target market mean that they are in a position to create enabling policy ? Considerable regulation likely to be applied to some of these services operating in public spaces ~ Critical cybersecurity policy not yet defined
Economic	+ Undeniable growing demand for fleet coordination services + Some early services available + Significant growth opportunity as industry develops
Social	+ Privacy unlikely to be an issue as the customer will be an authorised party - Likely to be resistance to having 3rd parties take control of vehicles
Technological	- Many cybersecurity challenges not yet understood or solved

	Factors
	- Some dependency on 5G development (latency and bandwidth)

10.6 Transferrable Services

Table 21 – Transferrable Services PEST Analysis

	Factors
Political	+ Government authorities being both a data source and the target market are in a position to create enabling policy ~ Standards are progressing but some services will be very dependent on them for widespread adoption
Economic	+ Undeniable growing demand for reliable data as transportation evolves
Social	~ Trust in data and data providers differs culturally and impacts market uptake ~ Privacy attitudes are very dynamic and will impact the level of detail
Technological	- Some dependency on 5G development

One significant unknown factor when considering business opportunities based on these data services is liability. The range of decisions made that will be based on these CAV data services range from passenger entertainment through to critical millisecond life and death choices. All of these will come with an expectation of reliability for which the direct impact can include not only loss of life and business losses but broader impact and loss across an entire roadway network.

11 Conclusions

This report details the research that has been conducted to understand the business models and factors influencing wider future implementations of the ICT4CART solution. The outstanding question is which business models have the greatest chance of delivering value to customers' sustainability in a market that is still in its very early stages of development.

Helpfully, the passage of time since the ICTCART project started means that closely related technology and solutions have made significant progress over the project period and new business models have evolved. The focus and excitement regarding automated vehicles have been tempered by ever expanding timelines. This has resulted in a greater focus on more immediately deliverable, connected vehicle-based data solutions such as in-vehicle infotainment and payment, video telematics, traffic management and smart city data solutions.

There are numerous CAV data services now in the market being delivered to the customer using various mobile devices, providing a foundation and validation for eventual implementation in fully automated vehicles, particularly in fleet applications. This current activity helps validate the ICT4CART solution and the business models in this report. The opportunities only grow with the deployment of 5G, availability and granularity of data and the adoption and increased penetration of connected and automated vehicles in the market.

Summary of the ICT4CART use cases:

> The ICT4CART Smart Parking use case is the most mature use case in the market but still a very long way from reaching its commercial peak. Standardisation is key to widespread adoption and recent progress suggest functional interoperability will be achieved in the near future. Multiple dynamic market forces make the smart parking opportunity both competitive and lucrative.
>
> The ICT4CART Dynamic Adaption use case has a good technological and standards foundation in the industry, in that a range of roadway alerts are being delivered to connected vehicles today. This use case will be fully realised as vehicle automation progress to level 5. Value will be realised in the meantime from the availability of new data sources and novel combinations meeting customer needs.
>
> The ICT4CART Cross Border use case by its nature, focuses on interoperability and is dependent on industry standards. The Cross Border use case is unlikely to have too much of a market in itself. It is a small but important component in what is becoming a large and complex roadway and connected vehicle management system. We anticipate that the technologies contributing to the Cross Border use case will become features in a much larger telecommunications ecosystem supporting CAVs, but will not be viable as independently marketable services.
>
> The ICT4CART Virtual Mirror use case is largely dependent on the penetration of V2V capable vehicles on the roads. The potential for complementary roadway infrastructure to accelerate the utility of solutions like the Virtual Mirror use case remains unrealised, presenting a significant opportunity as the global fleet transitions towards autonomy.

In this report, we have not solely focussed on developing business models for the ICT4CART use cases and scenarios, as any business is more likely to be sustainable having more than a single product or service available in the market. In some cases, CAV Services (e.g. "Directly communicated" road user

information) have no immediately apparent market unless combined with other services. Business models that utilise the ICT4CART solution and incorporate the use cases and scenarios developed during the project with other complementary CAV Services are going to have a greater chance of success.

We would recommend that anyone interested in understanding the market for CAV Services would benefit from closely monitoring technology and influence policy where possible, 5G standards and technology in particular. The market opportunity can change dramatically and be accelerated by safety legislation and regulation changes. It may also be of value to review the history of smartphones and how the market dynamics and related infrastructure developed.

With the support of a great team and great technology, there is undoubtedly a tremendous market opportunity available to deliver CAV Services to paying customers. The detail in this report and the resulting business model blueprints provide a foundation and guide to navigating the myriad of product-market-business permutations, resulting in the development of businesses based on the ICT4CART solution, either in part or as a whole. Paraphrasing a senior representative of one of the leading telematics providers: “The opportunity is so large and untapped that there is room for anyone wanting to enter the market, we aren’t yet concerned about competition”.

12 Annexes

12.1 Annex 1: Value Proposition Canvas

Table 22 – Value Propositions

Service Title	Service Description	Pain Reliver	Gain Creator	Customer Tasks 1	Pains 2	Gains 3
	Purpose Features Description	**Features that create solutions, address problems or raise thresholds**	**Features that create more money, more time or ease of access**	**Steps the customer has to take to learn and use the product.**	**Problem Inconvenience Annoyance**	**Desires Benefits Time-savers Money-savers**
	Value Map – Automatic Driving			**Customer Profile – AV Operators**		
Environmental information	Providing information on infrastructure, road layout, and environmental conditions etc. in their immediate vicinity	Identify road problems early Accurate and Reliable data	More competitive Faster operation Cheaper operation Safer operation	Operate vehicle Move goods and passengers from A to B	Transport delays Unreliable information Inefficiency Costs/Expense Vehicle wear and tare	Shortest distance routing Fastest routing Low fuel usage Avoid congestion Safe driving function Passenger comfort
Smart system information	Providing information about the status, behaviour and intentions of infrastructure-based technology systems	Identify road problems early Accurate and Reliable data	Backup data source	Operate vehicle Move goods and passengers from A to B	Unreliable data sources	Redundant data sources

Service Title	Service Description	Pain Reliver	Gain Creator	Customer Tasks 1	Pains 2	Gains 3
"Sensed" road user information	Service providing information about location, speed and trajectory of other road users in the immediate vicinity	Low latency data Sub second data Awareness beyond line of sight 360 degree awareness	More competitive Faster operation Cheaper operation Safer operation Anticipate road user intentions	Operate vehicle Move goods and passengers from A to B	Avoidable braking and acceleration Crashes Traversing busy areas slowly Vehicle wear and tare	Safer driving function Smoother driving function Passenger comfort
"Directly communicated" road user information	Service providing actual location, speed and trajectory information of other road users in the immediate vicinity	Actual data Low latency data Sub second data Awareness beyond line of sight 360 degree awareness	More competitive Faster operation Cheaper operation Safer operation Anticipate road user intentions	Operate vehicle Move goods and passengers from A to B	Avoidable braking and acceleration Crashes Traversing busy areas slowly Vehicle wear and tare	Safer driving function Smoother driving function Passenger comfort
Platoon coordination	Service enabling the coordination of vehicles grouped together to travel as a unit	Trustworthy system Smooth engagement and disengagement process	Comprehensive and real time platooning activity	Operate vehicle Move goods and passengers from A to B	Gaps in connectivity Delayed data System failures High volume of driver handoff Accurate and reliable synchronisation	Higher automation level/time Reduce energy use Increased road capacity
Predictive quality of connectivity	Service verifying status of connectivity on a route	Confidence in route communications	Just-in-Time provision of information	Operate vehicle Move goods and passengers from A to B	Obsolete information Low quality information No supporting data to fill the gaps	Safer driving function Higher automation level/time

Service Title	Service Description	Pain Reliver	Gain Creator	Customer Tasks 1	Pains 2	Gains 3
	Value Map – Informed Journeys			Customer Profile – Vehicle Operators		
Event information	Service providing information about events that impact the road network and journey	Comprehensive data source	Road impact predictions	Operate vehicle Move goods and passengers from A to B	Congestion Unreliable, inaccurate event data Incomplete data set (all events) Conflicting information	Advance notice and impact prediction Real-time information Event avoidance
Traffic management information	Service providing information about the temporary status, behaviour and intentions of infrastructure-based technology systems	Authoritative data source Identify road problems early Accurate and Reliable data	Backup data source	Operate vehicle Move goods and passengers from A to B	Congestion Unreliable, inaccurate data Incomplete data set Conflicting information	Advance notice and impact prediction Real-time information Event impact avoidance
Traffic conditions	Service providing information about traffic conditions	Authoritative data source	Alternative route suggestion Prediction algorithms	Operate vehicle Move goods and passengers from A to B	Congestion Unreliable, inaccurate data Incomplete data set Conflicting information	Predicted conditions Real-time information Alternative routes
Availability of supporting service infrastructure	Service providing location, availability and status of supporting infrastructure	Comprehensive data source updated regularly	Broad, validated and well maintained data sources Prediction algorithms	Operate vehicle Move goods and passengers from A to B	Unreliable, inaccurate data Incomplete data set Conflicting information	Real-time, advanced and predicted information

Service Title	Service Description	Pain Reliver	Gain Creator	Customer Tasks 1	Pains 2	Gains 3
	Value Map – Intelligent Management			Customer Profile – Road Network Operators		
Basic vehicle information	Service providing aggregate location, speed, direction, driving patterns and origin and destination data for example	Planned routes Identify stopped vehicles Identify congestion Travel times Real-time data	Location data	Operate road network	Crashes Breakdown Congestion Air Quality Anecdotal decision making	Optimise network Increase throughput Reduce need for roadway upgrades Predict utilisation Dynamics roadway management
User specific journey information	Service providing individual location, speed, direction, driving patterns and origin and destination data for example	Planned routes Identify stopped vehicles Identify congestion Travel times Vehicle usage Real-time data	Location data	Operate fleet of vehicles Move goods and passengers from A to B	Crashes Breakdown Vehicle abuse & misuse Low vehicle utilisation Responsive maintenance	Optimise fleet operation (maintenance etc.) Improve driver performance Emergency response Tolling and taxation VMT
Infrastructure and environmental information	Service providing information about the status condition of the environment and road way infrastructure	Identify missing/damaged signs, signals and roadways Microclimate data	Identify missing/damaged signs, signals and roadways Microclimate data	Operate road network	Increased driver risk (ice, fog, broken signs, signals etc.) Impact of adverse weather on throughput	Reduce road maintenance costs Predict utilisation

Service Title	Service Description	Pain Reliver	Gain Creator	Customer Tasks 1	Pains 2	Gains 3
	Value Map – Coordination of Vehicles			Customer Profile – Fleet Operators		
Space management	Service coordinating vehicle fleet in a closed environment	Accurately positioning and moving vehicles Reduce need for human involvement Increased perception (360°)	Detailed positioning	Operate efficient fleet of vehicles	Vehicle damage Personal injury	Space optimisation Resource optimisation Independent arbitration
Incident management	Service providing directives resulting from an incident	Validated and time sensitive incident data	Personalised route generation Granular data from multiple relevant sources	Operate efficient road network	Inaccurate and /or delayed information	Contextual alternative routes Decision support data
Fleet optimization	Service providing fleet specific information	Real-time data with higher granularity	Novel predictive AI & algorithms	Operate efficient fleet of vehicles	Bad connectivity Inaccurate and /or delayed information	Demand prediction Adverse variable prediction (congestion/ crashes etc.)
Coordinated corridors	Service providing vehicle coordination on a specific travel corridor	Coordination of vehicles with similar characteristics travelling in the same direction	Service for customers to provide efficiencies for road users	Operate efficient road network	Inconsistent vehicle operation resulting in network inefficiency	Chargeable service Policy enablement
Smart city management	Service providing information regarding dynamic city permissions/ restrictions	Data source supporting the optimal design of roadway utilisation	Digital enforcement of policies	Operate efficient road network	Inefficient space and roadway management Congestion	Chargeable service Policy enablement

Service Title	Service Description	Pain Reliver	Gain Creator	Customer Tasks 1	Pains 2	Gains 3
	Value Map – Connected Travellers			**Customer Profile – Passengers**		
Internet-enabled consumer services	Service providing passengers internet-enabled consumer services	Maximum coverage Personalised content and platforms	Range of services to either entertain and enable people to work	Work or play	Unreliable service Irrelevant service	More enjoyable or productive travel experience
Enhanced journey information	Service providing passengers with journey information	Important, reliable and accurate data	Relevant content Anticipate user needs	Travel from A to B	Misinformation, delayed or inaccurate	Contextual and otherwise helpful / delightful information
	Value Map – Underpinning Communication Services			**Customer Profile – Passengers**		
Secure communication services	Service managing identity, access and security threats	End to end encryption and access control	Frictionless service	Provide services to the CAV ecosystem	Hacking Consistency Reliability	Seamless and streamlined
Over-the-air software updates	Secure service for updating vehicle software	Reliable and validated updates with fallback functionality	Frictionless operation	Provide services to the CAV ecosystem	Failed or incomplete updates	Seamless and streamlined
Cybercrime prevention services	Proactive service managing security threats and developing risks	Continually monitoring and identifying threats	Use AI to predict and prepare for attacks	Provide services to the CAV ecosystem	When threats are not stopped	Predict and pre-empt attack
Other road fleet management services	Reapplication of data arising from utilisation of CAV services		New market for data	Operate road network	Identifying new applications for data	Revenue

12.2 Annex 2: Service Models

Table 23 – Common Service Elements

#	Service	Key Activities	Key Resources	Key Partners	Customer Segments	Customer Relationship	Channels
1	Environmental information	Platform, IM	ISD, ID, VD	TN, RNO, OEM	VO, FO	SS, PA	In-Vehicle, online
2	Smart system information	Platform, IM	ID, VD	TN, RNO	VO, FO, RU	SS, PA, SS	In-Vehicle, online
3	Sensed road user information	Platform, IM	ISD, VD	TN, RNO	VO, FO, RU	SS, PA, SS	In-Vehicle, online
4	“Directly communicated” road user information	Platform, IM	VD	TN, RNO	VO, FO, RU	SS, PA, SS	In-Vehicle, online
5	Platoon coordination	Platform, IM	VD, RND	TN, RNO	VO, FO, RNO	SS, PA, DPA	In-Vehicle, online
6	Predictive quality of connectivity	Platform	ID	TN	P, FO, VO	SS, SS, SS	In-Vehicle, online
7	Event information	Platform	Event Data	TN, RNO,	P, VO, RU, RNO	SS, SS, SS, DPA	In-Vehicle, online
8	Traffic management information	Platform, IM	RND	TN, RNO	P, VO, RU, RNO	SS, SS, SS, DPA	In-Vehicle, online
9	Traffic conditions	Platform, IM	RND	TN, RNO	P, VO, RU, RNO	SS, SS, SS, DPA	In-Vehicle, online
10	Availability of supporting service infrastructure	Platform, IM	Resource Data	TN, RNO, Resource Operator	P, VO, FO	SS, SS, PA	In-Vehicle, online
11	Basic vehicle information	Platform, IM	RND	TN, RNO	P, VO, FO, RU, RNO	SS, SS, PA, SS, DPA	In-Vehicle, online
12	User specific journey information	Platform	VD	TN	FO, SP	PA, PA	In-Vehicle, online
13	Infrastructure and environmental information	Platform	VD	TN	RNO	DPA	In-Vehicle, online

#	Service	Key Activities	Key Resources	Key Partners	Customer Segments	Customer Relationship	Channels
14	Space management	Platform, IM	VD	TN, Facilities Operator	VO, FO	PA, DPA	In-Vehicle, online
15	Incident management	Platform, IM	VD, ID, RND	TN, RNO, OEM	RU, RNO	AS, DPA	In-Vehicle, online
16	Fleet optimization	Platform	VD, ID, RND	TN,	FO	DPA	In-Vehicle, online
17	Coordinated corridors	Platform, IM	VD, ID, RND	TN, RNO	RNO	DPA	In-Vehicle, online
18	Smart city management	Platform, IM	VD, ID, RND	TN, RNO	RNO	DPA	In-Vehicle, online
19	Internet-enabled consumer services	Platform, IM	TN, Content, CP	TN, Content Providers	P, VO, SP	AS, SS, PA	In-Vehicle, online
20	Enhanced journey information	Platform, IM	ID, RND, Content	TN, RNO, CP	P, VO, SP	AS, SS, PA	In-Vehicle, online
21	Secure communication services	Platform, IM	VD, ID	TN, OEM	SP, RNO, TN	DPA, DPA,	Direct sales and industry networks
22	Over-the-air software updates	Platform	VD	TN, OEM	SP	DPA	Direct sales and industry networks
23	Cybercrime prevention services	Platform	Data Streams	TN, OEM	SP	DPA	Direct sales and industry networks
24	Other road fleet management services	Platform, IM	?	TN, OEM, RNO	SP, RNO	?	Direct sales and industry networks

Table 24 – Key for Table 23 – Common Service Elements

Abbreviation	Definition
AS	Automated Services
C	Consignee
DPA	Dedicated Personal Assistance
ED	Environment Data
FO	Fleet Operator
IM	Infrastructure Management
OEM	Original Equipment Manufacturer
P	Passenger
PA	Personal Assistance
RND	Road Network Data
RU	Road User
SP	Solution Provider
SS	Self Service
TN	Telecommunication Network
VD	Vehicle Data
VO	Vehicle Operator

12.3 Annex 3: Commercial Readiness Index

Table 25 – CRI for Government Authority

Status Summary Level		Regulatory Environment	Stakeholder Acceptance	Technical Performance	Financial Performance - costs	Financial Performance – revenue	Industry Supply Chain & Skills	Market Opportunities	Company Maturity
6									
5									
4			●				●	●	
3	●	●		●	●	●			●
2									
1									

Table 26 – CRI for Core Safety

Status Summary Level		Regulatory Environment	Stakeholder Acceptance	Technical Performance	Financial Performance - costs	Financial Performance – revenue	Industry Supply Chain & Skills	Market Opportunities	Company Maturity
6									
5									●
4	●							●	
3			●		●		●		
2		●		●		●			
1									

Table 27 – CRI for Digital Environment

Status Summary Level		Regulatory Environment	Stakeholder Acceptance	Technical Performance	Financial Performance - costs	Financial Performance – revenue	Industry Supply Chain & Skills	Market Opportunities	Company Maturity
6									
5	●							●	●
4		●		●	●		●		

Status Summary Level		Regulatory Environment	Stakeholder Acceptance	Technical Performance	Financial Performance - costs	Financial Performance – revenue	Industry Supply Chain & Skills	Market Opportunities	Company Maturity
3			●			●			
2									
1									

Table 28 – CRI for Consumer Services

Status Summary Level		Regulatory Environment	Stakeholder Acceptance	Technical Performance	Financial Performance - costs	Financial Performance – revenue	Industry Supply Chain & Skills	Market Opportunities	Company Maturity
6									
5		●	●		●		●		
4	●			●		●			●
3								●	
2									
1									

Table 29 – CRI for Supplementary Service

Status Summary Level		Regulatory Environment	Stakeholder Acceptance	Technical Performance	Financial Performance - costs	Financial Performance – revenue	Industry Supply Chain & Skills	Market Opportunities	Company Maturity
6								●	
5									●
4		●				●	●		
3	●		●	●	●				
2									
1									

Table 30 – CRI for Transferable Services

Status Summary Level		Regulatory Environment	Stakeholder Acceptance	Technical Performance	Financial Performance - costs	Financial Performance – revenue	Industry Supply Chain & Skills	Market Opportunities	Company Maturity
6			●	●				●	●
5	●	●				●	●		
4					●				
3									
2									
1									

13 Glossary

Term	Definition
Commercial partners (CP)	Are businesses that pay for their advertising content to be hosted on in-vehicle user interface platforms.
Consignee	Recipients of logistics (last mile) deliveries.
Environmental data (ED)	Related to information about other variable impacts road ways such as weather conditions.
Fleet Operator (FO)	Fleet Operators including those that take over operation of vehicles from others (government authorities, road network operators, parking facilities).
Infrastructure data (ID)	includes data about the road and telecommunications infrastructure
Infrastructure sensor data (ISD)	Includes data from sensors located on the road and telecommunications infrastructure.
Infrastructure Management (IM)	Refers to the business being vertically integrated into their data supply chain by owning and operating sensors and related infrastructure.
Passenger (P)	Plays no role in the driving function of the vehicle.
(Software) Platform	Platform is a system of software and hardware for collection, aggregation, processing and dissemination of sensor and other data.
Road Network Operator (RNO)	RNOsRNOs are the customer for services that may benefit the general public. Generally, RNOsRNOs are governmental authorities. This includes city authorities.
Road Users (RU)	Is everything else that uses roadway that is NOT a connected or automated vehicle.
Road Network Data (RND)	Data on the use and performance of a road network.
Solution Providers (SP)	Are (software) companies that provide technology solutions for CAVs.
Telecommunication Network (TN)	Is the underlying infrastructure needed to deliver CAV solutions. All modes, LTE, 5G, ITS-G5, etc.
Vehicle data (VD)	Is obtained from other vehicles and can include data about the vehicle, what the vehicle senses as well as data from 3rd party systems installed in or on a vehicle (telematics).
Vehicle Operator (VO)	Vehicle Operators describes the legal entity that initiates operation of the vehicle (person or company). This term can also include OEMs or other parties who have been provided consent by vehicle operator to utilise data. The Vehicle Operator is not necessarily the owner.

13.1 Further explanation of terms

The difference between the vehicle operator and fleet operator is based on who the decision be being made by, the operator of a fleet or single vehicle.

As the role of a person in a vehicle is dynamic until full automation is achieved the driver of the vehicle is the vehicle operator when in control of the vehicle otherwise this person may be a passenger. For this report, the vehicle operator is the only driver of the vehicle. With higher levels of automation, the vehicle operator does not necessarily need to physically be in the vehicle. The vehicle operator is the legal entity that enables the self-driving function of the vehicles.

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