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The Dispatcher

Special interest features covered in each issue:

- Autonomous and Self-driving Cars
- Big Data
- DSRC versus Wireless Communication
- Connected Vehicles – V2V and V2I
- Third party services for eCall

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- Fuel Cells
- The Extended Vehicle

Telematics Industry Insights by Michael L. Sena

Data Privacy and Connected Vehicles

IT WON'T BE ONLY IPHONES THEY WILL BE AFTER. 'They' refers to law enforcement agencies, in this case the U.S. Federal Bureau of Investigation (FBI), who are trying to use the courts to force Apple to provide them with a modified version of its IOS in order to bypass the password protection--built into all iPhones--on one, specific phone belonging to a now-dead terrorist. If it were a locked safe, the police could force it open if they obtained a proper search warrant. A U.S. federal statute called the All Writs Act, provides the legal basis for law enforcement officials to gain access to information. It seems that this is what is being used by the courts that ruled in the FBI's favour. No one (except members of the ACLU) seems to think it wrong for police to search people's homes, cars and storage rooms, and to break into anything that is locked. Phones seem to be placed in a different category of personal, private space by a large segment of the population in the U.S and Europe. New regulations in Europe, which are ready for final Parliamentary approval, will turn recommendations into law.

Apple is appealing to the court of public opinion in refusing to obey the legal court order on the grounds of data privacy. Google, Microsoft and Facebook have filed briefs in support of Apple's position. This is ironic (disingenuous?), considering that these companies have been accused of the most egregious acts of non-authorized personal data usage. Specifically, Facebook was accused by a student, who filed a complaint in Ireland, of transferring data on its users to the U.S. The complaint ended up at the European Court of Justice whose judges ruled that the EU-US Safe Harbour Framework was no longer valid. (See sidebar in this page and next.) On 22 March, the same judge who issued the first order was due to issue a new ruling, but the day before, the FBI announced that a 'third party' has come forward with a possible alternative to unlocking the phone. The alternative worked and the case has been dropped.

Now to privacy and connected cars. Several years ago, in Sweden, a young pair of car thieves wrapped their stolen car and themselves around a tree. The pair died on impact. The police wanted to know just how fast they were travelling at the time it crashed. The car, a Volvo,

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Not So Safe a Harbour

The right to privacy has been an explicit part of European government policy since shortly following the end of World War II. **The Council of Europe** *was founded in 1949 by the Treaty of London with the goal of promoting human rights, democracy and the rule of law in its 47 member states. In 1953, the European Convention on Human Rights was promulgated by the* ***Council****. Article 8 of the Convention provides a right to respect for 'one's private and family life, his home and his correspondence, subject to certain restrictions that are in accordance with law and necessary in a democratic society."*

In 1980, the **Organization for Economic Cooperation and Development (OECD)** *attempted to establish a comprehensive data protection system in Europe with its Recommendations of the Council Concerning Guidelines Governing the Protection of Privacy and Trans-Border Flows of Personal Data. It comprised seven principles:*

1.Notice—data subjects should be given notice when their data is being collected;

2.Purpose—data should only be used for the purpose stated and not for any other purposes;

3.Consent—data should not be disclosed without the data subject's consent;

4.Security—collected data should be kept secure from any potential abuses;

5.Disclosure—data subjects should be informed as to who is collecting their data;

6.Access—data subjects should be allowed to access their data and make corrections to any inaccurate data; and *(Cont. P2, Col 1)*

7.Accountability—data subjects should have a method available to them to hold data collectors accountable for not following the above principles.

These Principles were non-binding, neither on the EU Member States nor on countries like the U.S that endorsed them. In 1981, the Council of Europe developed the Convention for the Protection of Individuals with Regard to Automatic Processing of Personal Data, which obliged the signatories to the Council to enact country legislation to guarantee protection.

Apparently, at some point the Commission (which is part of the European Union and should not to be confused with the European Council) decided that individual country laws would not be conducive to an EU-wide approach to privacy laws. In 1995, the EU issued the ***Data Protection Directive 95/46/EC****. This Directive[1] regulates the processing of personal data within the EU. Article 29 of the Directive created a Working Party which negotiated with U.S. representatives about the protection of personal data, resulting in the* ***Safe Harbour Principles****. According to these Principles, which were made official by an EC Decision in July 2000, U.S. companies storing customer data were able to self-certify that they adhere to the OECD's Seven Principles. Certified U.S. companies were allowed to transfer data from the EU to the U.S.*

In October, 2015, the European Court of Justice, which was set up by the European Council, invalidated the EC's Safe Harbour framework with the following recital: "Legislation permitting the public authorities to have access on a generalized basis to the content of electronic communications must be regarded as ***compromising the essence of the fundamental right to respect for private life****." (Bold type is in original text.)*

On 2 February 2016, the U.S. and the European Commission agreed on a new framework for data flows. It is called the EU-US Privacy Shield, and provides stronger obligations on companies in the U.S. to protect the personal data of Europeans and stronger monitoring and enforcement by U.S government agencies.

Data Privacy and Connected Vehicles (Continued from P.1)

apparently did not have an event data recorder, but it did have Volvo On Call, and when it crashed, it notified the Volvo On Call call center who notified the emergency authorities who notified the police. The Swedish police connected the dots and came to the conclusion that the speed of the vehicle asked Volvo for this information. Whether they received it is not public information, but it is probably not the first nor the last time that police, security or tax authorities have asked for data from connected vehicles.

As long as the number of connected vehicles was relatively low, and as long as long as customers who did have systems like OnStar, BMW Connect, Mercedes-Benz embrace and Volvo On Call felt that their privacy was not compromised, connected car systems stayed under the radar of the privacy police. But a case involving an OnStar customer in 2011 who wanted to be forgotten after ending his subscription shined a light on the issue, and that light has just continued to get brighter. The EU is leading with a new Regulation (see sidebar), but ripple effects will be felt around the world.

At the heart of the data privacy issue are two terms that were first defined in 1980 as part of the OECD recommendations: ***personal data*** and ***data processing***. *Personal data* are defined as "any information relating to an identified or identifiable natural person ("data subject"); an identifiable person is one who can be identified, directly or indirectly, in particular by reference to an identification number (location data, online identifier added in GDPR text) or to one or more factors specific to his physical, physiological, mental, economic, cultural or social identity;" Some examples of "personal data" are address, credit card number, bank statements or criminal record.

Processing means "any operation or set of operations which is performed upon personal data, whether or not by automatic means, such as collection, recording, organization, storage, adaptation or alteration, retrieval, consultation, use, disclosure by transmission, dissemination or otherwise making available, alignment or combination, blocking, erasure or destruction."

Where customer data is stored (i.e. inside or outside the EU) is more a matter of a company's business model, IT practices and its field of operations. Global companies 'take home' their profits where the taxes are lowest; they want to consolidate their users' data where it is most effectively processed to support business operations. In contrast to Google, Microsoft and Facebook, U.S. companies that are truly global, GM, Ford and Chrysler (now part of FMC) established or bought local companies to expand outside of the US. Opel and Vauxhall in Europe, Holden in

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EU General Data Protection Regulation[1]

The GDPR, as it will be known in 'Eurospeak', is a Regulation in the making. Formal adoption by the EU Parliament is expected in spring 2016 with application from spring 2018. Companies will have just two years to become compliant with how they store and manage customer data. The fines for failure to comply, as they are currently defined in the draft, are, in a word, draconian.[2]

Here are the major differences between the current Directive and the proposed Regulation.[3]

Enforcement: *Currently, fines under Member State law vary, and are comparatively low (e.g., the UK maximum fine is £500,000). The Regulation will significantly increase the maximum fine to €20 million, or 4% of annual worldwide turnover, whichever is greater. In addition, national data protection supervisory authorities will be coordinating their supervisory and enforcement powers across the Member States, likely to lead to a more pronounced enforcement impact and risk for businesses.*

Territorial Scope: *Non-EU businesses will be subject to the Regulation if they: (i) offer goods or services to EU residents; or (ii) monitor the behaviour of EU residents. Many non-EU businesses that were not required to comply with the Directive will be required to comply with the Regulation.*

Consent: *Consent, as a legal basis for processing, will be harder to obtain: Under the Regulation, individ-*

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Customer Choice of Service Providers and C-ITS

IN THE SPRING OF 2014, the European Commission Directorate General for Mobility and Transport (DG MOVE) issued a 'Call for Applications' to select members of a 'platform'. These applications would be assessed by DG MOVE, and a decision on membership in this 'platform' would be published in the fall of 2014 with work beginning shortly thereafter.

DG-MOVE motivated this action as follows (no edits have been made to the text in the Call for Applications):

During the last ten years, developments in telecommunications technologies have brought us a reality of almost 'permanent connectivity'. However, we are far from using their full potential as transport users nowadays, despite the benefits that Cooperative ITS would bring in terms of improving road safety, reducing congestion, optimizing the performance and available capacity of existing transport infrastructure, enhancing mobility in a multimodal transport chain, increasing travel time reliability, improving the efficiency of logistic operations and thus reducing energy use as well as diminishing the environmental impact of road transport.

Did they leave out anything? The Call goes on to say that there are many (out)standing issues needing to be resolved, and that it feels compelled to step in and get things moving.

To that end, DG MOVE is setting up a C-ITS Deployment Platform, conceived as a cooperative framework including national authorities, relevant C-ITS stakeholders and the Commission, in view to provide policy recommendations for the development of a roadmap and a deployment strategy for C-ITS in the EU and identify potential solutions to some cross-cutting issues.

So it is not a '*platform'* in the IT sense; it is a forum that is intended to provide policy recommendations to the EC for the development of a Communication on the Deployment of C-ITS in the EU by the end of 2015.

Well, the 140-page final report of the C-ITS Platform was published in January 2016. I recommend that you read it because there are statements in it that will affect all vehicle manufacturers and their suppliers of systems and services. Chapter 8 contains the most relevant on the issue of who chooses service providers, the OEM or the customer. Rather than leaving it up to the market to decide how to do it, which perhaps some of the 'expert' members may have recommended, the report endorses the method applied in the EU eCall process: The Commission will tell you how it will be done: *The Commission shall assess the need of requirements for an interoperable, standardized, secure and open-access platform.* (This is an IT Platform. ed) *If appropriate, and no later than 9 June 2017, the Commission shall adopt a legislative initiative based on those requirements.*

Tell me what you think about this. I have written on this topic before but there has been no reaction.

Data Privacy and Connected Vehicles (Continued from P.2)

Australia and Ford in Europe have operated quite independently of the home offices at GM and Ford in Detroit. When GM set up OnStar in Europe, and Ford Europe established its telematics operation, they had completely different solutions to the ones created in the U.S. They could more easily develop IT solutions for customer data storage that were country-based.

European car and truck companies, in contrast, have been global from the start. While there may be national sales companies, and, in some countries like the U.S. and China, these NSCs may have a large say in what happens in their market, the general rule (of course, with exceptions such as Mercedes-Benz *embrace*) has been to create a single connected car solution that can be adapted to local conditions. Where it is absolutely necessary to have localized data centers, as is the case in China, IT solutions are created to satisfy the requirements, but even these are designed to work with the global solution.

A Spanner in the Works[4]

Vehicle OEMs have plans for all that data that will eventually be flowing in from 'their' cars and trucks. Part of those plans can still be achieved if the personal data is handled according to the GDPR, but selling cars to folks who have already bought your products is much more profitable than trying to steal your competitors' buyers. Personal data is important. You can't sell to a VIN, at least not yet. The OEMs will gradually figure out how to comply with the Regulation while retaining access to the data that helps them stay in business. I believe that this regulation will eventually have more impact on the way vehicles are sold than on the way personal data about the user of a vehicle, and the data related to that vehicle, is collected, stored and used. The data generated by the vehicle will have much more value to society in general than to the individual driving the vehicle, and it will be easier to capture that data if the vehicle is not owned by the driver.

It is often the case that laws regulating how companies have to behave toward their employees and their customers end up having unintended side effects. It is my opinion that these effects will end up being good for consumers and for the mobility industry.

INRIX SPREADING ITS WINGS

Inrix Inc., *headquarted in Kirkland, Washington, U.S.A. and founded by a Microsoft alumnus, is a private company, so we don't know if it is making its owners wealthy, but it has managed to stay in business for twelve years. It has also been successful in raising investment capital to develop its offerings and acquire competitors and companies that have helped it to improve the quality of its content and increase the breadth and depth of its offerings.*

The company was flying below my radar until 2011 when it acquired ITIS Holdings, *Manchester, UK, for £37 million. Brilliant move. In one fell swoop Inrix took over a number of European vehicle OEM and public authority customers and got one of the two cellular probe data solutions from* Estimotion, *a company that ITIS had acquired in 2004 for a paltry $5 million.*[5] *Porsche took a 10% stake (worth $55 million) in the company in 2014. As Inrix continued to build its customer base it carried on with acquisitions.* ParkMe *came in the autumn of 2015, and Seattle-based* OpenCar *followed in the spring of 2016.*

OpenCar *opens a new chapter for Inrix. This is not a content-related company but one that has built an application platform that it describes as "the industry's only white label, standards-based application development environment and framework." It does what* Android Auto *and* Apple CarPlay *do, but does not come with the strings that Google and Apple attach to their solutions.*

Inrix also announced Autotelligent, an application that provides predictive routing based on its ability to learn your diving habits.

In the end, a company is only as good as its people. Inrix has done a great job of building an impressive team, including two of the best qualified in the field of digital map data: Mike Gerling, Director, formerly President of Geographic Data Technology, and Andreas Hecht, Executive VP and GM of Automotive, who led the initial charge on ADASIS when he worked for Navteq. What does the name 'Inrix' mean? 5 or 2. Go figure.

G7 and EU on Autonomous Driving

THE GROUP OF SEVEN (G7), which, until March 2014 had been the Group of Eight with Russia included, is an official forum for seven of the largest democratically governed countries in the world: United States; UK, Germany, Canada, France, Italy and Japan. The EU has participated since 1981 as a nonenumerative member representing the presidents of the European Council. The main meeting, held annually, is for the heads of state who sit around a table to figure out what to do about all the trouble those who are not sitting around the table are causing. In addition to the main annual meeting, finance ministers, foreign ministers and environment ministers have met on a regular basis. On 16-17 September 2015, the first ever meeting of the G7 transport ministers took place in Frankfurt, Germany.

Depending on which post-meeting announcement you read, they were either there to talk about automated and connected driving or the need for more investment in infrastructure. Anthony Foxx, U.S. Secretary of Transportation, posted his own version of the meeting on the Department's news site, *Fast Lane*. While he felt that autonomous vehicle technology would be an excellent way to improve on-demand transit, and he sees major benefits for safety with driver-assist systems, his main focus was on what he called the "infrastructure investment crisis."

"While our automakers continue to move forward, our Congress continues to hold us back. And in the end, all of the connected vehicle and automated technology in the world won't fix our bridges, pave our roads or get our transit systems into a state of good repair." Anthony Foxx, U.S. Secretary of Transportation. *"Of G7 nations, only Japan is investing enough in its infrastructure today to meet tomorrow's need."* Mitsuhisa Kato, Executive VP and member of the board of directors, Toyota Motor Corp. seconded this: *"You can't have a perfectly safe car without perfect infrastructure."*

Four out of the seven transport ministers were from EU countries, but the eighth delegate, Violeta Bulc, Commissioner for Transport, European Commission, seemed to want to promote the Commission's transport agenda, including the term 'user pays' in the official summary of results from the meeting, referring to one of the EC's points of focus as defined by the President of the EC, Jean-Claude Juncker to Violeta Bulc: *"…develop policies to foster a cross-transport approach increasingly based on a 'user-pays' philosophy."*

The EC post-meeting announcement used the term 'public-private partnerships', euphemism for of saying that governments cannot guarantee they can convince their taxpayers to fund infrastructure investments. Secretary Foxx talked instead about the U.S. Federal Highway Administration's TIFIA (Transportation Infrastructure Finance and Innovation Act), which provides Federal credit assistance in the form of direct loans, load guarantees and standby lines of credit to finance surface transportation projects of national or regional significance.

A September 22, 2015 *Forbes Magazine* article by Doug Newcomb gave a first-hand account of the meeting which included much of what was in the EC's news releases and Secretary Foxx's post, but he reported on a few points made that were not in either. One non-minister in attendance at the meeting, Elmar Degenhart, chairman of the Continental AG executive board, said: *"…we agree with OEMs that there won't be vehicles without steering wheels or pedals within the next 20 years."* Ms. Bulc called for more synchronization of standards.

The transport ministers will continue their discussions later in the year in Nagano, Japan. Hopefully, there will be more concrete results, both for infrastructure financing and increased cooperation on automated and connected driving.

5G and ITS G5: Let the Competition Begin

THERE IS A BIG DIFFERENCE between the terms 5G and G5 in the field of intelligent transport systems. 5G stands for 5th generation wireless communications technology. G5 stands for 5 GHz wireless communication.[6] 5G and G5 will be competing for our hearts and minds.

5G is coming after **True 4G** (LTE-Advanced and WirelessMAN-Advanced). LTE stands for Long-Term Evolution—and is, as I learned as a result of working on this piece, a registered trademark of ETSI—was intended to "increase the capacity and speed of wireless data networks using digital signal processing techniques and modulations developed around the turn of the millennium, and to reduce data transfer latency compared to 3G." The International Telecommunications Union-Radio (ITU-R) decided on the spec for 4G in 2008, but different carriers implemented the standard differently. In 2010, ITU-R evaluated the different solutions and decided that LTE-Advanced and WirelessMAN-Advanced were the only ones that truly met the 4G spec, and these were standardized in 2012. Hence, True 4G, with 1Gbps (gigabits per second) download and 500Mbps upload speeds.

(I guess the fact that 5G is already being planned means that LTE wasn't so long-term after all. Ed.)

What is wrong with 4G that 5G will fix? For one, the mobile network operators want a way to lower the unit cost of data transport to at least the same rate as the volume of data demand is rising. 4G is not solving that problem for them. Closing the gaps in coverage with many small cells, rather than fewer large ones, would mean that cities could be served better than they are now. The European Commission's *Horizon 2020*[7] programme has provided a wish list of improvements to current wireless networks: latency below 5 milliseconds; support for device densities of up to 100 devices/m^2; reliable coverage area; and, successful integration of all telecommunications technologies.

Wi-Fi The standard wireless local area network (WLAN) technology for connecting computers and electronic devices to each other and to the Internet. Every laptop, tablet and smartphone comes with Wi-Fi. Wi-Fi is an IEEE standard with the official designation of 802.11

This is a bit of an over simplification, but ITS G5 = 802.11p = WAVE (Wireless Access in Vehicular Environments) = DSRC = Wi-Fi. ITS G5 is being standardized by ETSI. It will operate in the 5.9 GHz band and will be used for vehicle-to-vehicle and vehicle-to-infrastructure communication. Its main application areas are those where localized connectivity needs to be guaranteed, such as for electronic toll collection, intersection crash avoidance and commercial vehicle screening and inspection.

I listened to a presentation recently by a company actively working with 5G technology in which it claimed that investments in roadside infrastructure for V2V and V2I was a waste of money because 5G would provide all of the coverage necessary for localized broadcasting because of the ubiquitous cell distribution. The companies that build infrastructure-based solutions (e.g., toll collection) see their market threatened by 5G, and counter that ITS G5 is superior to 'generalized broadband services' because it does not require subscriber-based services and can be controlled by the public transport agencies rather than private network operators.

As always, when it comes to transport-related safety issues, more is usually more. We will (eventually) need the improvements in performance provided by 5G, and we will benefit from the services that will be built around G5 (or whatever we end up calling it). Personally, I think it is unfortunate that people working on these issues do not have a better understanding of the importance of a name to its eventual understanding and acceptance. G5 and 5G are too close for comfort.

GM Buys Cruise Automation

General Motors is on a buying and investment spree with the goal of beefing up its credentials in edgy parts of the automotive sector, the ones that interest investment types who decide whether your firm's stock is worth more than the paper it written on. In early March, GM announced it was acquiring a San Francisco-based company called ***Cruise Automation*** for an undisclosed sum of money. Started by a serial entrepreneur named Kyle Vogt, who sold an 8-month-old company that made a mobile app for sharing videos to Autodesk for $60 million, and a gaming company called *Twitch* to Amazon for $1.1 billion, *Cruise Automation* developed an aftermarket hardware/software package to enable a car to drive itself on a highway without the involvement of a driver. It has been in operation since 2013 and has 40 employees using $20 million in venture capital to keep it going.

The Cruise RP1 was designed for 2012 and newer Audi A4 and S4 models. The system includes a sensor pod on the roof (pictured above) containing cameras, radar and other sensors to scan the road ahead. Data is sent to a computer mounted on the side of the trunk. The desired inputs are then made by actuators for the steering, brakes and throttle to control the car. A button in the cabin activates the autopilot and controls the desired speed. Cruise has reportedly sold 50 RP1, generating total sales of $500,000. Unverified reports put the sale price of Cruise Automation at $1 billion.

Why did GM feel the need to buy this 3-year-old start-up? Given Vogt's record of moves (he left Twitch before it was sold), he is unlikely to stick around for long. Is the technology that great? We shall see.

NB: Audi has its own autonomous test system which it demonstrated in January 2015. Apparently, Audi did not feel it needed the help of Vogt and his team of developers to stay in the self-driving car race.

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Michael Sena works hard for his clients to bring clarity to an often opaque world of vehicle telematics. He has not just studied the technologies and analyzed the services. He has developed and implemented them. He has shaped visions and followed through to delivering them. This newsletter touches on the principal themes of the industry, highlighting what is happening. Explaining and understanding the how and why, and developing your own strategies for your organization, are what we do together.

EU GDPR (Continued from sidebar P.2)

-uals' consent must be freely given, specific, informed and unambiguous. Consent may not be valid if it is bundled with other matters, part of the general terms of conditions, or there is a "clear imbalance" between the parties. Organisations will be required to demonstrate that consent was given. Mere acquiescence (e.g., failing to un-tick a pre-ticked box) does not constitute valid consent under the Regulation. Businesses that rely on consent to process personal data will need to carefully review their existing practices.

Data Protection by Design and Default: *Businesses will be required to implement data protection by design (e.g., when creating new products, services or other data processing activities) and by default (e.g., by implementing data minimisation techniques). They will also be required to perform data protection impact assessments to identify privacy risks in new products.*

Data Protection Compliance Programs: *Organisations will have to implement and be able to demonstrate to the SA that they have comprehensive data protection compliance programmes, with policies, procedures and compliance infrastructure.*

Strict Data Breach Notification Rules: *Businesses must notify the Member State Data Privacy Supervisory Authority of data breaches within 72 hours. If the breach has the potential for serious harm, individuals will have to be notified without undue delay. Businesses will need to develop and implement a data breach reporting and response plan (including designating specific roles and responsibilities, training employees, and preparing template notifications) enabling them to react promptly in the event of a data breach.*

Right to be Forgotten*: Individuals will have the right to request that businesses delete their personal data in certain circumstances (e.g., the data is no longer necessary for purposes for which it was collected). As a result, businesses will need to devote additional time and resources to ensuring that these requests are appropriately addressed. In particular, businesses should consider how they will give effect to the right to be forgotten, as deletion of personal data is not always straightforward.*

Right to Object to 'Profiling'*: Individuals will have the right to object to profiling on grounds relating to their particular situation. 'Profiling' is defined broadly and includes most forms of online tracking and behavioural advertising, making it harder for businesses to use data for these activities. Businesses that regularly engage in profiling activities (e.g., in the advertising or social media context) will need to consider how to best implement appropriate consent mechanisms in order to continue these activities.*

Right to Data Portability*: Individuals will have the right to obtain a copy of their personal data from the controller in a commonly-used format and have it transferred to another controller. Consumer-based businesses (e.g., social media businesses, insurance companies, banks, telecommunication providers) should consider how they will give effect to these rights. Many new-to-market online businesses may welcome this new development as a way to improve competition in the sector while established providers will view it in less beneficial terms.*

Footnotes:

1. European Union **Directives** and **Regulations** have very different meanings and implications. In general, it is the European Commission that proposes new legislation, as it did for European eCall, but it is the Council and Parliament that pass the laws. In some cases, the Council can act alone.

The main forms of EU law are Directives and Regulations.

Regulations are directly applicable in all Member States and therefore have to be adopted into country law within a specific timeframe exactly as agreed between the European Parliament and the Council. This means that all Member States adopt Regulations in the same way. European eCall is a Regulation.

Much of European law takes the form of Directives, which set out general rules and objectives but leave Member States the choice as to how to attain them.

2. Exceedingly harsh; very severe; from Draco, a 7th century Athenian lawmaker whose code prescribed the harshest of sentences for the all offenses, even the slightest.

3. The summary of new requirements in the GDPR Regulation have been provided by Hunton & Williams in a document provided online dated February 2016 and titled Overview of the EU General Data Protection Regulation.

4. To do something to cause a plan from succeeding. In the U.S., a 'spanner' is called a 'monkey wrench'.

5. Estimotion was an Israeli company that had developed technology for measuring and forecasting real-time traffic flow from wireless telephones. The other company with similar technology was Applied Generics, a company based in Scotland that was acquired by TomTom.

6. A gigahertz (GHz) is one billion hertz. The hertz (symbol Hz) is the unit of frequency in the International System of Units (SI) and is defined as one cycle per second. It is named for Heinrich Rudolf Hertz, the first person to provide conclusive proof of the existence of electromagnetic waves. (American Heritage Dictionary of the English Language)

7. 5G Empowering Vertical Industries, 5G PPP, White Paper. The collaborative research program organized as part of the European Commission Horizon 2020 Programme.