

On the Application Development of 3G Technology in Automobiles

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Abstract Advances in wireless mobile communication and cloud computing, the technological development of remote information services of vehicles has evolved rapidly and almost everything in a vehicle is controlled by electronic systems in network, it is possible to provide new kind of Telematics services. This paper provides the current application of 3G technology in automobiles, explores the frontier and prospect of 3G application from the viewpoint of the vehicle OEM. With 3G technology, automobile will develop itself from a simple vehicle to a real-time information receiver and entertainment experience centre, and provide more intelligent, safe, environment-friendly and economical driving experience for the driver. Besides, it will be more easily to be diagnosed and maintained.

Keywords 3G technology · Telematics · Vehicle terminal · Mobile communication · Automobile

1 Introduction

Reconstructing of telecom industry in May 2008 has made a rapid development of telecom in China, as well as 3G even 4G technologies. It makes the application of 3G technology in automobiles like Telematics as a typical representative of the Internet of Things that large scale effect and industry leading role in the automotive industry, it ushered in a lot of attention and support of others industry.

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There is no precise definition of the industry on the Telematics, China Science Lab Director of Shanghai General Motors Corporation Limited John Du thinks that Telematics consists of the network in automobiles that provide services for drivers and passengers, such as safety, GPS navigation, Traffic Information, POIs and infotainment and the Internet of Things in automobiles that integrate mobile vehicles and other smart devices [1].

Telematics is growing rapidly in Chinese market in recent 2 years, Apart from GM, BMW, Toyota and other joint ventures, many Chinese car manufactures have launched or are researching on self-made Telematics system to expand domestic market. More associated industries are also focus on Telematics research but less on the perspective of vehicle OEM. This paper presents the contrastive study of function settings and application status of main vehicle OEMs in China about their own Telematics system, and explores the frontier and prospect of 3G application in automobiles form vehicle OEM perspective.

2 Concept and Development of 3G Technology

2.1 Concept of 3G Technology

3G technology refers to 3rd generation mobile telecommunication, the main feature is to support higher speed data transfer, its' current rate is range from several 100 Kbps to dozens of Mbps. It also combines mobile communication network with Internet, aims to achieve wireless roaming on a global scale, process and transmit sounds, images, audio/video streams, control data and other multimedia data, to achieve web surfing, video conferencing, e-commerce, online games and other applications.

3G applied to automobile gains a breakthrough on its original concept of communication, which refers to a new type of Telematics service mode, but the 3G technology also has been expanded that generally means the high-speed mobile communication technology, combining with in-vehicle networks, vehicle short-aware networks, wireless mobile networks and the Internet to be a flexible communication system, providing a perception of people-vehicle, road-vehicle, vehicle-vehicle and builds up a service system with information processing centre. From the standing of vehicle OEM, 3G is Telematics.

2.2 Development of Mobile Communication

Mobile communication has grown rapidly, and there were three generations in short dozens of years with three waves. The first generation was analog mode, just provided voice telephony, and 1st wave of mobile was connecting people, the

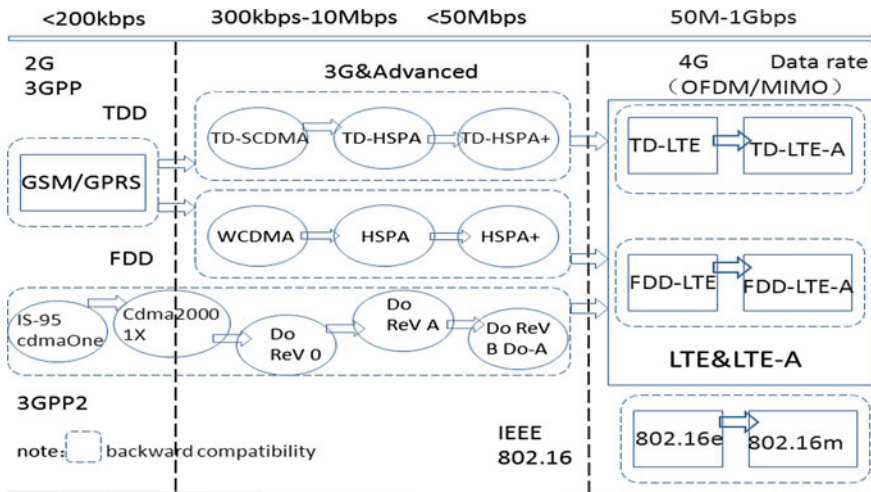


Fig. 1 Advance line of mobile communication [3]

strength of 1st mobile communication was its ubiquity, underpinned by its global interoperability. 2nd generation mobile communication could transfer few of multimedia data, and connecting the world’s population to the Internet, its strength was the exponentially increasing power of its networks. Now 3rd mobile communication is connecting everything in our lives, supporting higher speed data transfer like videos, audios etc. The next generation of mobile such as LTE and LTE-Advanced (4G) was also launched and constructed in several markets. All telecom carriers will adopt LTE in future of 5–7 years by forecast, the peak rate of LTE will be 170 Mbps and LTE-Advanced 1 Gbps [2]. Figure 1 shows the development stages of mobile communication.

A few tries of mobile communication in automobiles were made in 2G era and more adopted in 3G era, it was clear that the quality and rate of 3G communication was fit for auto life which required high real-time driving and no distraction. It will be widely deployed when 4G or higher technology (e.g. LTE-Advanced) is in market.

3 Major Telematics Systems in China

3.1 Launch Opportunity and Service Providing

Telematics is not a new technology, it was launched and commercialized in past 10 years in Europe and American, but bourgeoned and developed in past 2 years in China, then attracted many industries to pay attention and invest with its rapid growth. There were a few Telematics systems, their ecosystems were working in domestic

market and navigation, safety, infotainment and convenience were provided. These systems mainly are On-Star, G-Book, InKaNet and Carwings. Former two were respectively working many years in North America and Japan, they were mature and consummate, especially in navigation and safety has formed unique character and system. The Telematics system of SAIC Roewe named InKaNet with speech recognition as part of its features and highlights with ahead of the design and quite imaginative, now has been introduced the latest version named iVoka. In addition, Dongfeng Nissan's Carwings is a sort of personality revelation, because it provides a range of services to support eco-driving and ease congestion, thus enabling more fuel-efficient driving, and has been fitted on its pure electric car LEAF, electric vehicles equipped with Telematics products bring a new Exciting situation to pollution and oil shortage era.

With the General Motors' joint venture business expansion and the improvement of car sales in China, Shanghai On-Star Telematics Co., Ltd was established by On-Star, LLC, Shanghai Automotive Industry Sales Co, Ltd and SGM in 2009, Shanghai On-Star provides safety and security services for select SGM models manufactured and sold in China [4].

G-Book was first introduced on Lexus RX350 models in China in 2009, and then was also equipped on Camry, G-Book consists of network communication, data processing centre and smart vehicle terminal, and provides base driver assistance and navigation for drivers, and brings great extension and expansion to traditional navigation, and it also provides news, rescue and attendant service. The G-Book service in the country is not operated directly by Toyota, but rather outsourced to the Beijing 95190 IT Co., Ltd. to manage and to operate; we can see the Toyota's management thinking of the G-Book in China.

The unique Roewe 350 InKaNet Intelligent Network Travel System becomes a window to connect with the wonderful Internet world, to achieve information retrieval, real-time traffic navigation and electronic road book, stock trading and community interaction, to meet with fashion technology and connectivity demand for consumers.

Carwings first go to high-end Dongfeng-Nissan Teana vehicles in late November 2010 and given a Chinese name of "ZhiXing+". The major functions of the system could be divided into three categories by the official: Safety & security, which provides "fully monitored" accident rescue services. Automatic diagnostics and record of driving conditions to help car owners better understand and improve driving habits. There is abundant information including traffic information, news reports, and other information. Nissan launched its fuel-efficient systems based choice in the domestic market when the car sales is hot and sense of energy is clear. This will enable it to have a share in the market place.

3.2 Models and Market Positioning

As an advanced vehicle Telematics service system in China, On-Star is applied to each main model manufactured by SGM by the end of year of 2009. Currently, On-Star is equipped to the new Cadillac Seville SLS. On-Star is applied to Buick Regal, LaCrosse since 2010, Chevrolet Cruze 1.6T and 2011 models is also equipped. It is different from American market that On-Star Telematics service is just adopted on all of Cadillac models and some high-equipped models of Buick and Chevrolet.

All new SGM models include a 1 year On-Star service plan, then charge by service packages with abundant combination forms which users chose, price range from RMB480 to 3980, it can be seen from Equipped model and package cost that On-Star in China is still a high-end consumer, can't do the civilians.

The new Lexus RX350 is the first model with the G-Book system outside of Japanese market, Camry, the new Crown and other models are also equipped with this system. When the RX350 is listed, the deluxe edition sells 792,000 yuan, the premium version is priced at 858,000 yuan, and the new Crown price of more than 200,000 the Camry over 100,000 so the G-book is also equipped with high-end models. The G-book is free after 2 years to start charging, package year 1200, the same is not a cheap service. So G-book is also just equipped to the advanced configuration models. G-Book provides service for free first 2 years and RMB1200 yuan a year, it is not cheap.

Carrying 3G Intelligent Network Travel System, “full-time online compact car”—Roewe 350 global launched and announced the price of 5 models the same time. InkaNet. Intelligent Network Travel System is an optional package for all series. But Roewe is attractive in price, the charging method is also free for 2 years, and then charge for service according to package.

When a new car is purchased at Nissan dealers, the navigation service is optional; registration for the service was free for 3 years. After the free period ends, the service is charge for by year. The new Teana is divided into Teana and Teana Duke of two series, a total of eight levels, the official guide price of 190,800–371,800 yuan, were equipped Carwings [5]. In addition, the highest models of Qashqai and March were also equipped. The Carwings is also as suction gold weapon of high-end models (Table 1).

Through the above analysis and comparison about domestic Telematics products can be drawn, whether application models or charging scheme are both facing with top customers, new products come out, not mature enough and can't be generally recognized by the public, small sales and customer traffic unable to bring the income of the scale, However, with its own brand depot, Telematics services to low-end extension to be income to the scale should be a trend.

Table 1 Contrasts of Telematics systems in China

System	Major function	Merit and shortcoming	Equipped models
On-Star	Automatic crash response, emergency rescue assistance, vehicle condition detection report, stolen vehicle location, turn-by-turn navigation, hands-free calling	Enough safety service Lack of entertainment function Lack of information service	Cadillac new seville SLS, Buick new Regal, LaCrosse, Chevrolet Cruze 1.6T and 2011 models
G-book	Emergency report service Remote maintenance services, probe communications traffic information, reading-out and recognition, e-commerce, operator support service	Great extension and expansion to traditional navigation Convenient elephonist service Just equipped to high-equipped models	Lexus, Camry, new Crown
InkaNet	Information retrieval, real-time traffic, navigation, electronic road book, stock trading and community interaction	Fully intelligence GPS navigation, abundance infotainment service Lack of safety service	Roewe350, MG5
Carwings	Eco-driving, ease congestion, fuel-efficient driving, safety and security, automatic diagnostics, abundance infotainment service	Perfect Eco-driving function Abundance infotainment service	Teana and Teana Dukehe, highest models of Qashqaik march

4 The Technical Implementation and Vision

4.1 System Architecture

Reference to the International Telecommunication Union ITU-T recommendations of Things architecture, Telematics can also be divided into 5 layers: data-aware, network access, network traffic control, information services support and information services open platform:

1. Data-aware layer is related to the intelligent information exchange of the vehicles and their operating environment, the vehicles and the passengers form a mobile node, the driving and entertainment needs of the passengers is perceived by car terminal, and driving environment is perceived by car camera, gyroscope and reversing radar, and social information such as points of interest, accidents, incident is collected by the occupant, all of this information as a basis

for accessing to services at the same time composed of the data resources of Telematics services.

2. Network access and network traffic control can be combined, provided condition for fusion of vehicle and network via infrastructure of GPRS, 3G mobile and wireless broadband, these kind of access is ultimately unified into the IP core network to be process transmission control, and then complete the information exchange of each node in the Telematics system.
3. Information services support layer contains many cloud computing centres, pushing, collecting, processing, and storage information, providing computing power and data resources for information services open platform, complete the open services of intelligent transportation, remote monitoring, vehicle information services.

From the Telematics concepts and analysis of the above layers, as well as existing domestic system, it is more than one industry chain composed of the ecosystems, and needed to be based on the “Network” and “service”, therefore, to be a member of the ecosystem will have to grasp the “node” attribute. Each node in the Industrial ecological chain or the ecosystem, regardless of industry giants such as General motor or monopoly authority like Google, can only play a specific role in the corresponding node, to earn their own interests.

In this system, the manufacturers, suppliers, operators, TSP should find their own level of node locations and concentrate on doing their own products or services in order to ensure healthy and sustainable development of Telematics, an overview of the people concept is “large and comprehensive”, they like the “through-train” service. This idea does not work in the Telematics industry indeed, no company have enough capacity or financial resources to run their own Telematics system independently.

Based on the analysis above, the architecture of Telematics system from viewpoint of vehicle OEM should be concern as follows Fig. 2.

Vehicle plant play a leading role in constructing Telematics system that related to its own brand, organizing and co-ordination suppliers inside system, operating vehicle OEM private cloud at the same time, OEM private cloud is isolated from other systems through the firewall, and mainly engaged in 4S services, remote diagnosis, anti-theft tracking which relies on the vehicle network, OEM technology and sales network services. For the service outside of private clouds, with the above mentioned node point of view as the guidance, select suppliers to cooperation, and strive for professional spirit and ability.

For users, no matter how complex car networking architecture and how advanced the technology system it is, the user needs is the final service, everything else can be transparent to the user, the owner will not because of the vehicle equipped with Telematics system and are willing to pay for, but which services can gain through the system. Therefore, the Telematics construction should be based on services, ecological system of Telematics should be a service ecosystem consisting of a number of nodes.

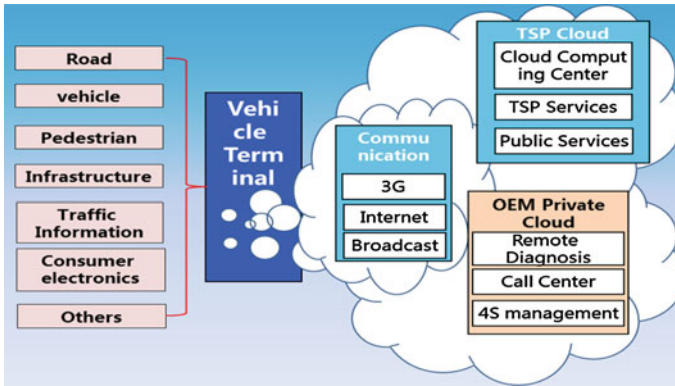
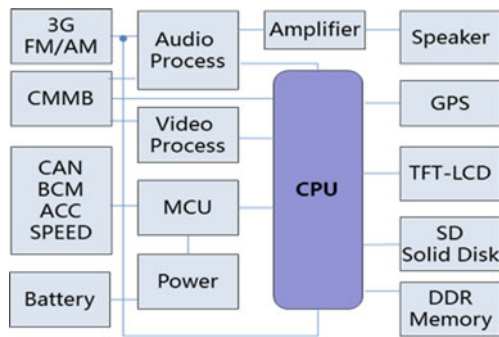


Fig. 2 Telematics system reference architecture

Fig. 3 Vehicle terminal hardware block diagram



4.2 The Vehicle Terminal Hardware Platform

It can be known from the Telematics network architecture, a complete Telematics platform is essentially a solution of system level, it is too big to comprehensively discuss the hardware needed, and it is hard to finish. Therefore, take OEM which the most care Telematics hardware as discuss object, discusses hardware framework and hardware cost performance contradiction.

As shows in Fig. 3, the vehicle terminal hardware is composed of CPU, peripheral circuit and all kinds of interface circuit and Combining I/O system (screen, button, etc.). Terminal design development, it is restrained by choice of CPU decision, development way, development cost, performance.

On the whole, the car terminal hardware is equivalent to a general-purpose computer, and has big difference to the traditional embedded processing system. It can be seen by the Fig. 3, the hardware of car terminal including many processing chip and peripheral circuit, the connection of all kinds of chips involves in various bus and interface, for instance: CAN, LIN, UART, GPIO, USB, MOST, I2S, BT656 and so on. Complex systems like this scale, if the hardware of all used the

track-level devices, then you should not be overlooked its cost, for the car plants which earn a large proportion of the brand value can't be overemphasized, but for domestic independent brand car plants, it brings some limits for comprehensive retrofitting. Forced by the pressure of cost, only with a way to drop and not to bring performance degradation, you can only reduce the device specifications, and from the track level down to the industrial level. Therefore, the contradiction between cost and performance at this stage is very sharp.

4.3 The Vehicle Terminal Software Platform

Because of functional complexity and real-time computing of Vehicle terminal, the system has the function of process management, storage management, file management and network communication, tradition embedded program no longer meet the requirements of modern embedded operating system, there are many vehicle terminal operating system such as Meego, QNX, Android and so on are working in home market.

Meego and Android use Linux kernel, only the upper layer to do their own personalized packaging. Microsoft Auto is the system used in the MyFord Touch system, and QNX is known for being the operating system in the floundering BlackBerry PlayBook Tablet. Linux is a robust and versatile computer operating system, which is used in popular mobile devices like those powered by Android. Additionally, it's open-source, and will be coming to a car's infotainment system soon.

The development of software system using a layered architecture, generally divided into three layers, respectively, for the system layer, middleware service layer, application layer, system layer includes a variety of traditional drivers such as display drivers, I/O drivers, sound drivers and other drivers, while as automotive systems, need to integrate specific drivers, such as GPS-driven, CAN bus driver etc., there are some system libraries on these drivers, such as SQLite structured storage database, SSL security, OPENGL/ES graphics library, Web browser kernel of webKit, map and vector fonts, the FreeType functions, then the above, it is the services and applications, such as car navigation, entertainment, security, etc. Figure 4 is a typical automotive software architecture frame.

The M (model) V (views) C (controller) architecture is a popular trend that use to do develop the software of application layer, M refers to the database and its operating model, V refers to the interface of UI, C refers to the service control logic layer, the MVC framework has become the mainstream model of software development framework.

It is worth that the domestic software development giants, such as Yonyou, Neusoft, Kingdee, hovering in the edge of the Telematics industry, mainly due to the vehicle hardware terminal providers not only committed to the design and development of the hardware platform, but also software, HMI and application program from its bundled. Even brought a hardware terminal, visual hardware

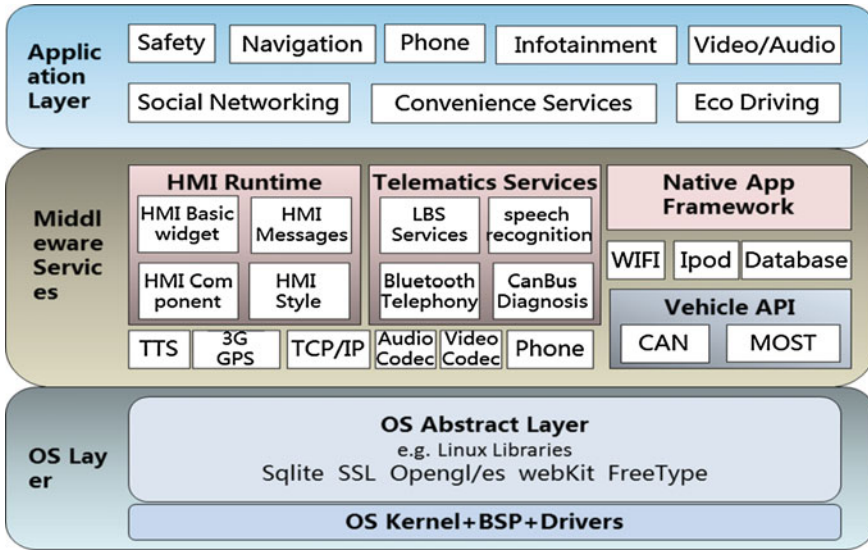


Fig. 4 Software architecture

design can be found unreasonable, the CPU is not designed wide space in the machine box, but crowded together in the narrow front end of the panel and power supply module of TFT screen and CPU is not designed heat sink, while idling the architecture and development experience of many years of professional software developers and hinder the development of the industry.

4.4 Development Status and Trends

4.4.1 Development Status

Since Telematics' introduction into China, for the large scale effect and huge market vacancy in domestic auto industry, it attracts many manufacturers and organizations to participate in. whether the telecom carriers, Telematics service providers, terminal providers or car makers, has been put massive manpower and physical resources to research and develop, though the future is bright, the development status looks very cloudy. Main status as follows:

(1) Different standing points

Efficient communication is the foundation of the entire Telematics, while the mobile communication technology and resource are still in the hands of the telecom operators. Seeing the big picture, the three largest domestic operators do not only provide high quality communication service, but also encroach on TSP

market space taking advantage of the construction of 3G networks, and this leads to a not specialize in one subject situation.

The car makers make profits from cars, but not from the car services and the car services are only value-added services and own low attention, but, the car makers have the leading rights to choose TSP, map and other services providers, while these providers' directed clients are the ultimate users, not the car makers, this results in the leading rights of choosing products and services are in the hands of the clients who don't care about the product, and the ultimate users who really care about these don't have the rights to choose, and these certainly are unfavourable for positive market competition.

(2) Small users scale

In the past few decades, the domestic automotive industry has developed greatly, especially some independent brands have grown up and great effort have been made to let more people can afford the car, but compare to the citizen's income level, buying a car still is not easy, add the domestic oil price stays at a high level, coupled with the extra expenses of the loading and opening Telematics systems, the users scale is rather small which is the current condition, the small user group cannot develop many applications and make the industry that depend on user scale cannot enter, for example Baidu, Google and some other internet company are wasting opportunities of the Telematics development in wandering, waiting and observing, the qualitative leap is waiting for the development of the quantity.

(3) Less willingness to pay of users

Every car makers provide comprehensive, various services to absorb customers which make the industry be grand and complete, but not expert and excellent enough, and this result in the less willingness of the customers to pay. On the other hand, the society is in critical period of transformation, the construction of social honesty is far from perfect, the insurance services are not universally accepted, bill package and one time pay are both not accepted. The users don't believe that they can get the corresponding service after paying, and they tend to pay on times and demand. Totally speaking, chance and challenge coexist in current situation, well, this is a normal stage in every new thing's emerging and developing, this need every relevant professions' jointly contribute capitals and co-take risks to push development and run to make profits.

(4) No successful experience in the field to learn

Though Telematics has been developing for decades overseas and has mature model, it is not kind of technology that bring and ready to use. For example, there are more than 600 private rescue centres in German, and they have accumulated rich operational experiences under the competition, while, there are very little this kind of institutions in China, whether the car makers or the government, don't show excess attentions. Or take another example, in the sparsely-populated America; the traffic is developed, while in Japan, the government supports planning. We don't have these premise conditions, so we can take and directly use their

products, and the industry at home need to learn their inner operating pattern. According to the reality of our country, carrying out ‘take’ rightly is needed, and this is not that easy to fulfill and is a challenge to “made in China” model.

(5) High cost of 3G

Up to now, the construction of 3G network doesn’t finish, the popularity of 3G technology is low, and the speed of communication is not ideal, all these leads to the high cost of operation, the services results is not recommended and the higher cost compared to the aboard. On the other hand, the amount of data of Telematics is quoted in M/s. The data amount is several M/s to download a song, and several hundred M/s to refresh the map, most of the 3G users could not afford these kinds of large amount of data transfer.

(6) Infrastructure lags behinds the development

The greatest needs applications at home are security and navigation. The fast-growing economy and urbanization process make the urban topographic, infrastructure and road construction change fast, while, the relevant information and services could not keep pace with the development, for example, the rescue centres and the map data collection. Without the matching systems, the relevant Telematics services could not provide.

On the other hand, people used to the bigger and more comprehensive management method, for example, the map providers are all dedicating to provide the national map, and do not deepen division and collaboration to accelerate coordinated development, these all limit the development of Telematics.

4.4.2 Development Tendency and New Application Area

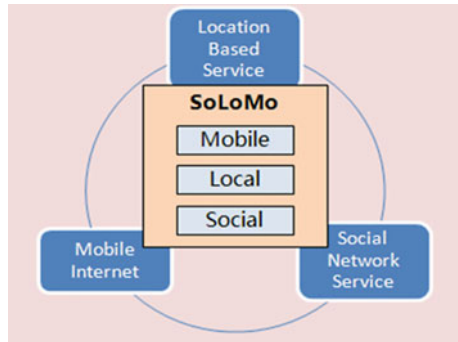
By analyzing the existing Telematics products and the relevant technology, we can conclude some useful conclusion.

(1) Application trends of cloud computing

For any car terminal hardware system, ether On-Star or G-book, the data operation and transfer speed are very limited, and the data storing is not optimistic. Geely G-NetLink that has excellent terminal computational capability, are based on Intel Atom processor and can dual-display, it only reaches the level of Netbook. The property of Telematics is: the more meticulousness and more humanization of the services, the more computationally expensive. The application like the annual oil consumption information, intelligent route planning, which need to store and process a large amount of history data to get results, and this need a great deal of memory space and considerable computational capability. Another example like intelligent traffic, real-time road condition, also needs a great amount of process and collect data. These all can only completed by cloud computing.

The properties of the cloud computing is that taking IT as service, providing it to users and run on a ‘pay-as-you-go’ basis. The new emerging TSP which has

Fig. 5 Illustration of SoLoMo



prosperous market prospects services but has not ability to run data centre, renting some IT resources to lower the cost and devoting to provide services is a way to solve this problem.

In summary, the development tendency of the cloud computing is very obvious, and there emerging various relevant service layers, in the future, the Telematics will not able to provide services without the supporting of cloud computing (Fig. 5).

(2) SoLoMo informationization life

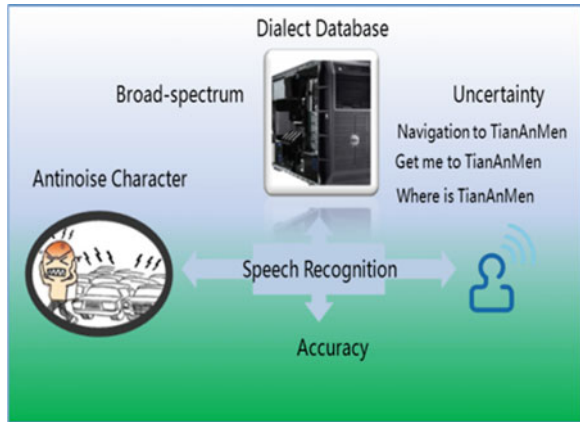
SoLoMo is the main method of the future informationization life; it is the compound word of Social, Local and Mobile. With no doubt, so is the social development trend. Facebook, Twitter, RenRen and the recent Google + all can prove that the life and communication is being community network. Lo means that the living space of people is rather large, but still limited. The local services covers a large part of the services, the application of 3G network is an indubitable fact with the popularity of the intelligent mobile phones and the development of the vehicle terminal. The development trend of SoLoMo points out direction for the design plan of the Telematics service products, except the security service, accessing and using community network, the localization navigation, intelligent traffic, interests searching and the interactive of the mobile devices such as intelligent mobile phones, PDA and U disk becoming the important point.

(3) Smartphone auto impact

The consumer electronics products have several weeks developing period and two or 3 years life cycle time, compared to the yearly developing period and decades life cycle time of cars, the cars developing cannot keep pace with the consumer electronics products, so using intelligent mobile phones in automobile platform or make the car be the attachment of the phones is a good solution.

Toyota and Fort are good at the integration and application of Telematics system and intelligent phones. BMW, General Motors and Hyundai Motors also have phone products, the functions of this kinds of products are relative simple, mainly focus on the internet radio and social network. It can be predicted that more

Fig. 6 The development orientation of speech recognition [6]



and more applications of the phones and integration of Telematics system and intelligent phones will emerge with the development of the technology.

Mobile phone is a really convenience payment tool; it has many added values, and the development of its application is very fast, the integrated of mobile phones and cars will provide each driver his own environment according his phone. The integrated of cars and phones are the most economical way and an important develop tendency.

(4) Speech recognition technology

The interactive of the driver and the car while the car is in motion is a serious security hidden danger, how to avoid the danger to the drivers becomes an important research project. Once the iPhone 4S SIRI emerge, it brings a great shock to everyone, its core technology contains Natural language recognition, artificial intelligence and database technology, perfect experience of intelligent speech recognition need powerful cloud computing centre to support, application in vehicle have to consider antinoise character, dialect recognition etc., Fig. 6 is the key point and development orientation of speech recognition There is a great achievement of domestic speech recognition, e.g. SAIC Roewe launched its new edition of InkaNet iVoka which is absorbed in speech recognition and has a commercial accidence achievement, the speech recognition will be the most great role in the human-vehicle interactive.

(5) Telematics of Electric Vehicle

The history of electric vehicle can be cast back from 1810 to 1820, came through from flourish to stagnant and flourish again. With lack of oil, polluting environment, electric vehicle attracts attention again. Carwings was equipped to Nissan LEAF which is a full electric vehicle, from inside Nissan LEAF, it's easy to see the vehicle and battery status, as well as charging station locations and when we need them. Set the timer once to charge each night during off-peak hours if we like. Connect and communicate with Nissan LEAF remotely through the

smartphone or laptop. Pre-set A/C functions from any web-enabled phone or computer. Electric vehicles and electric vehicle Telematics exist, try to run the car as a concept car and a small amount of focus on battery charging, use, and monitoring services, mainly to find the charging station, power management, energy saving, It is precisely because the electric car service facilities extremely lacking, but with electric cars and car networking, taking advantage of environmental and energy voices will certainly return to the stage of history.

5 Conclusion

Through analyzing and comparing the mainstream products like On-Star, G-book, InkaNet etc., we have drawn the conclusion of the main functions, emergence timing, application models, market positioning, current development status, development tendency and existing problems. Analyse the actual development situation of Geely and the practical problems encountered during the development process, such as the tariff issue, TSP problem, the collocation of software system and hardware platform, we have come to a conclusion that the 3G technology application on the automobile has a broad prospect and the application of multiple modes, such as better application of cloud computing technology, which will effectively realize the sharing of the resources and information, enabling a more effective mixture among the car, office and home, breaking the traditional vehicle definition, and will obviously guide the direction and lay the foundation of 3G application in automobiles.

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