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White Paper of Internet of Vehicles (IoV)

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1 Concept of IoV

The Internet of Vehicles (IoV) is an integration of three networks: an inter-vehicle network, an intra-vehicle network, and vehicular mobile Internet. Based on this concept of three networks integrated into one, we define an Internet of Vehicles as a large-scale distributed system for wireless communication and information exchange between vehicle2X (X: vehicle, road, human and internet) according to agreed communication protocols and data interaction standards (examples include the IEEE 802.11p WAVE standard, and potentially cellular technologies). It is an integrated network for supporting intelligent traffic management, intelligent dynamic information service, and intelligent vehicle control, representing a typical application of Internet of Things (IoT) technology in intelligent transportation system (ITS).

The convergence of technology encompasses information communications, environmental protection, energy conservation, and safety. To succeed in this emerging market, acquisition of core technologies and standards will be crucial to securing a strategic advantage. However, the integration of the IoV with other infrastructures should be as important as the building of the IoV technologies themselves. As a consequence of this, the IoV will become an integral part of the largest Internet of Things (IoT) infrastructure by its completion. Here, it must be emphasized as primary, that collaboration and interconnection between the transportation sector and other sectors (such as energy, health-care, environment, manufacturing, and agriculture, etc...) will be the next step in IoV development.

2 IoV Technology Leads Industrial Revolution

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As human ability and experience evolve, future vehicles will have to be able to address a growing list of pertinent issues which affect an automotive society including road safety, energy consumption, environmental pollution, and traffic congestion. IoV technology is designed to address and solve many of these issues through promoting a goal of “minimum accidents, low energy consumption, low emissions, and high-efficiency” through the development of automobiles and the transportation system. IoV technology will facilitate the concordant unification of humans, vehicles, their roads, and the environment. By promoting the integration of the IoV technologies with vehicles through manufacturing and industry, great contributions to economic growth and improving the global infrastructure will be made.

IoV technology is a driving force that will make major transformations to the automotive industry thanks to its role in expanding human ability, experience, safety, energy, environment, and efficiency issues inherent in living in an automotive society. There is a huge gap between the automotive and Information Technology industries in terms of culture, institutions, and product development processes. The IoV technology in automobile factories is relatively under developed, far from the speed and experience requirements of innovative applications. However, the IT industry updates too quickly and is too open to ensure the reliability and safety when relevant products are used in vehicles. The collision and fusion of automobile industry and IT industry is an inevitable trend of IoV and even the whole automobile industry.

3 Opportunities and Challenges of IoV

The research and development, as well as the industrial application of IoV technologies will promote the integration of automotive and information technology. The integrated information services of vehicles, vehicle safety, and economic performance will contribute to a more intelligent urban transportation system and advance social and economic development. The IoV will have far reaching influence on the consumer vehicle market, consumer lifestyle, and even modes of behavior. The future IoV market will see rapid growth in the Asian-Pacific region. McKinsey Global Institute has reported by June 2013 that the Internet of Things (IoT) has the potential to launch around $6.2 trillion in new global economic value annually by 2025. 80 to 100 percent of all manufacturers will apply IoT technology by then, leading to potential economic impact of $2.3 trillion for the global manufacturing industry. According to the data on APEC website, the member countries share approximate 55 percent of world GDP. In other words, APEC members will be growing by $3.41 trillion in GDP and manufacturers of the economies will embrace $1.27 trillion growth in the meanwhile.

The application of IoV technology in providing information services, improving traffic efficiency, enhancing traffic safety, implementing supervision and control and other aspects will make millions of people enjoy more comfortable, convenient and safe traffic service. Large concentrations of vehicles, e.g., in city parking facilities during business hours, can also provide the ad-hoc computational resources which will be of interest to those in the IT fields. Complementary efforts should be made for developing and enhancing middle-ware platforms which will enable analytic and semantic processing of data coming from vehicles.

Lack of coordination and communication is the biggest challenge to IoV implementation. Lack of standards make effective V2V (vehicle to vehicle) communication and connection difficult and prohibits ease in scaling. Only by adopting open standards can the current, closed and one-way systems, be integrated into an effective system for the smooth sharing of information. Dreams of intelligent transportation and even automatic drive systems can come true through an effective IoV. Both technological innovation and business model innovation in the Internet era depend on partnering across traditional boundaries. While maintaining a plan for improving products, services and experiences, we should make joint efforts to break barriers, stay open and inclusive, and to build a healthy and sustainable ecosystem. Therefore, the whole industrial chain can achieve joint development. One of the possible projects could be creating a trusted environment for cross-border document circulation. We see opportunities for cooperation in this area. Legally significant trust services could become one of the IoV services.

4 Reflection and Suggestion about the Development of IoV

Staged development and deployment of IoV systems

Progress towards ubiquitous IoV systems will need to be conducted in stages, starting with low-risk, simple implementations, and learning from these to plan and design wider systemic deployments, while allowing time for population adaptation and regulatory regimes to be developed. For example, computer-augmented control of vehicle movements and collision avoidance systems would be tested and improved in closed environments, such as warehouses, then implemented more widely between specialized driverless vehicles on designated roads, before wide deployment to public and private transport for entire cities. Data linkages would start with basic information exchange, such as traffic monitoring or reporting on vehicular emissions, passenger numbers, freight loadings, locations or travel routes, before progressing to two-way telemetry, active traffic management and external control of vehicle functions.

Strengthen policy guidance and support from governments.

Efforts should be made to promote the application of IoV and relevant technologies in automobiles, transportation, finance and insurance. The public desire for convenient, safe and energy-saving travel means must be met. From this premise, we can safely say that the transportation industry must develop in an energy-saving, environmental friendly and safety-conscious manner. The cooperation between APEC economics in areas of safety and disaster management is well established. The use of ICT for individualized disaster management can significantly reduce the number of disaster victims, including transport. PPSTI, TELWG, TPTWG and AD could explore the IoV capabilities in disaster management.

Establish collaborative and cooperative mechanisms among Asian-Pacific economies.

We should integrate regional advantages of all our economies to form a transnational and cross-industrial cooperative model for IoV development, as well as building a high level dialogue platform. Close cooperation should be carried out in areas such as the research and development of key technologies, innovation of development patterns, and marketing. On security and privacy issues, at some point in the future development of IoV technologies, professionals may advise the use embedded “security chips” in vehicles. Clearly, the IoV will no longer be a simple matter of IT applications in the automotive industry; instead, it will have become a security concern for all economies. Different countries may need differentiated approaches to developing localized IoV technologies, depending on unique local density of road networks and scarceness of population. For example, the Asian part of the Russian Federation has a very sparse and under-developed road network compared to the highly dense and well developed road network infrastructure in Japan.

Promote deep integration of IoV and vehicles.

Via joint multilateral laboratory, values of IoV in safety and economic performance can be further tapped. Transnational industry-university-research cooperation should be enhanced to accelerate the transformation and upgrading of automobile industry.

Cooperate to improve standards and industrial specifications.

By establishing standard negotiation mechanism among APEC economies, setting up joint working group in standards and formulating international standards for IoV, for example, an alignment of PPSTI+TELWG+TPTWG+AD. IoV technology has a good chance to become a full part of the infrastructure providing a variety of ICT services and make ICT development. We can facilitate the interconnection among vehicles of different economies and brands.

We will need to cooperate to identify substantial IoV applications and services which would process IoV generated data, deliver impact to customers and effectively contribute to a bigger IoT ecosystem.

Plan for IoV data to be accessible as a resource to enable broader research

The data sets generated by operational IoV systems will be rich and diverse, and will constitute a valuable resource in their own right. For this, the data has to be considered not as a 'consumable' or 'disposable' commodity to meet immediate needs of IoV users, but as an accumulating economic and scientific resource, with many potential future users.

Such massive data sets (sometimes labeled 'big data') can provide a basis for research in many other disciplines, not only for the development of IoV systems, or the monitoring and management of vehicles, traffic, road systems and their economic impacts or industrial development.

By their nature, richness and continuity, the growing IoV data sets will also inform research into areas as diverse as human behaviour and social sciences, urban design, national security, medicine and epidemiology, population dynamics, geo-political wealth distribution and economic development, meteorology, market responses to advertising and price setting, resource and utilities management, food retailing, modelling the spread of invasive plants, pathogens and pests, freight logistics, tourism trends, planning of education systems, analysis of media consumption and broadcasting, agricultural development, and the fundamental mathematics of complex dynamic systems.

The aggregate benefits of access to IoV data in these other economically important aspects of research may be comparable to, or even exceed the direct economic benefits of IoV application.

Capturing this value would require early and detailed planning of meta-data standards and storage protocols by peak bodies of other research disciplines, across multiple countries, to ensure that the IoV data can be made discoverable in a usable form. The large body of data that will be accumulated will also require considerable data storage facilities and dedicated networks to make best use of it. Attention should be given to how such IoV data facilities would be sustained, how data can be transferred between facilities, pooled and curated, and how the resulting data infrastructure would be owned, governed and licensed, in order to enable greatest access and use by researchers.

Reference

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What is Asia-Pacific Economic Cooperation? Available from: URL: http://www.apec.org/About-Us/About-APEC.aspx

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