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Artificial Intelligence and Intelligent Transportation: Driving into the 3rd Axial Age with ITS

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Welcome to the inaugural issue of ***Artificial Intelligence Technologies for ITS*** section. I would like to open the section with a brief on the motivation for its introduction and the vision of its future.

Why This Section?

Where is Intelligence in Intelligent Transportation Systems? This has been an echo question around me ever since I started my research

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career more than three decades ago. Of course, no easy answer yet, but as Artificial Intelligence is emerging as the driving force for new technological, economical, and societal developments, we see new hope and light for a fast transition of ITS from mainly functional systems to truly intelligent and smart infrastructures.

We need to see more, deep, wide, and concrete deployments of AI technologies in ITS, such as big data, social computing, machine learning, parallel intelligence, blockchain, knowledge automation, generative adversarial networks, and many others.

Clearly, after computer Go program AlphaGo's recent victories over human Go masters, IT is no longer standing for Information Technology, that is "past" IT, now it stands for "new" IT, Intelligent Technology [1]. However, we should not forget "old" IT, Industrial Technology, and we need to think deeply on using the updated state of IT, i.e.,

$$\text{IT} = \text{Old IT} + \text{Past IT} + \text{New IT} = \text{Industrial} + \text{Information} + \text{Intelligent Technologies}$$

to make ITS effective and smart. Specifically, we need to see more, deep, wide, and concrete deployments of AI technologies, such as big data, social computing, machine learning, parallel intelligence, blockchain, knowledge automation, generative adversarial networks (GAN), and many others in ITS rapidly. This is the motivation for this new section on AI and Intelligent Technology for IEEE ITS Magazine.

Where Are We?

Before we act, we need to know where we are. Of course, we are in the world, but which world? According to Karl Popper (1902–1994), one of the greatest scholars in Philosophy of Science, we have three worlds (see Fig. 1): World 1, the physical world developed mainly by the old IT; World 2, the mental world supported chiefly by the past IT; and World 3, the artificial world to be constructed fully by the new IT. The three interacting worlds consist of our reality, and we are in them simultaneously and in parallel. Therefore, truly effective and smart ITS must be planned, designed, built, operated and used physically, mentally, and artificially in three worlds. I am glad to see many works, including my own research on parallel driving and parallel transportation systems [2], [3], and especially recent efforts by MIT and others [4], [5], have started along this direction for ITS.

When is Now?

According to Karl Jaspers (1883–1969), we are still in his Axial Age. In his classic, *The Origin and Goal of History*, Jaspers coined the term "Axial Age" to characterize the period of great humanity awaking and influential philosophers from about 800 to 200 BC in Middle East, India, China, and Greco-Roman World. However, I believe a new axial period in the sense of "pivotal age" has been starting already. Based on Karl Popper's three worlds model of reality, it is reasonable to suggest that each of Popper's worlds has its own axial age, that is, Jaspers' first axial age for the physical world, Renaissance to 20th Century presenting a period of great rationality awaking and influential scientists as the second axial age for the mental world, and now the AI and New IT marking the beginning of a new period of great intelligence awaking and significant technologic leaps for research and development as the third axial age for the artificial world [6]. Thus, we need to think the new future of ITS in the new age.

Where We Go?

For the coming third axial age, we need to open our thinking and rethink about transportation. As illustrated in Fig. 3, physical transportation networks are just Grids 1.0 for societal infrastructures, we have in addition, Grids 2.0 for

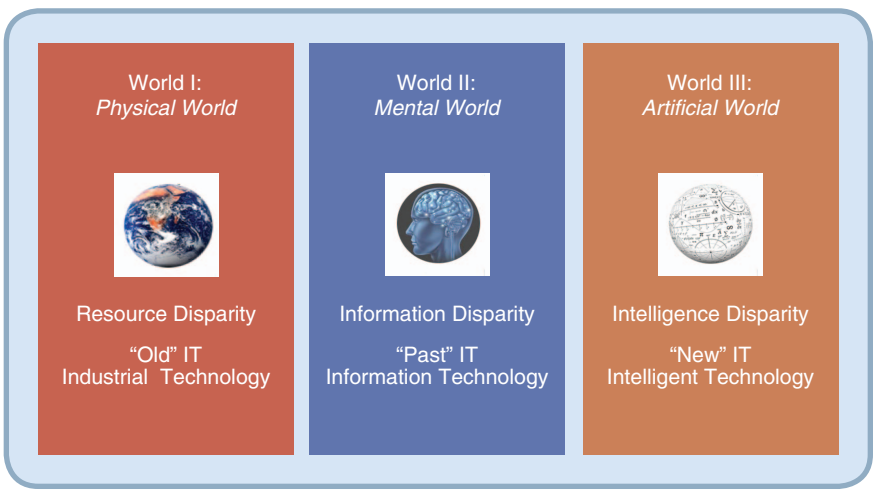

FIG 1 Karl Popper's Three Worlds and Their Three ITs.

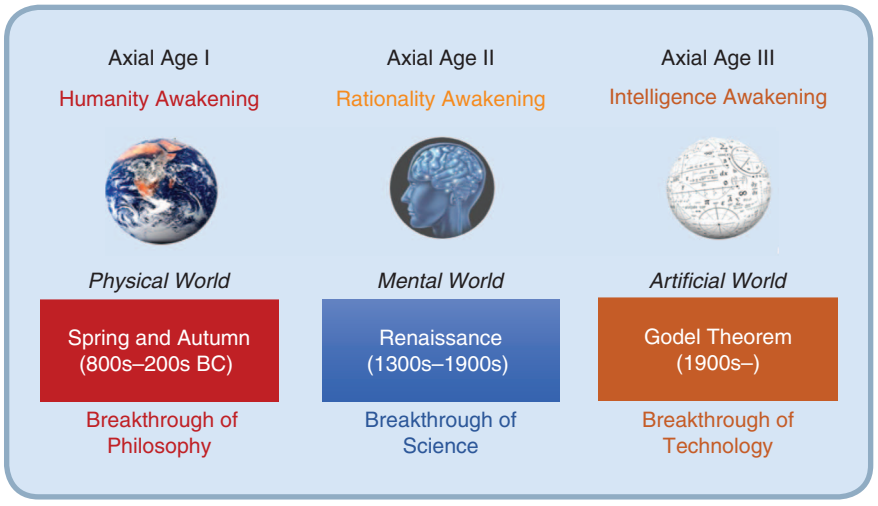

FIG 2 Beyond Karl Jaspers' Axial Age: Three Worlds and Three Axial Ages.

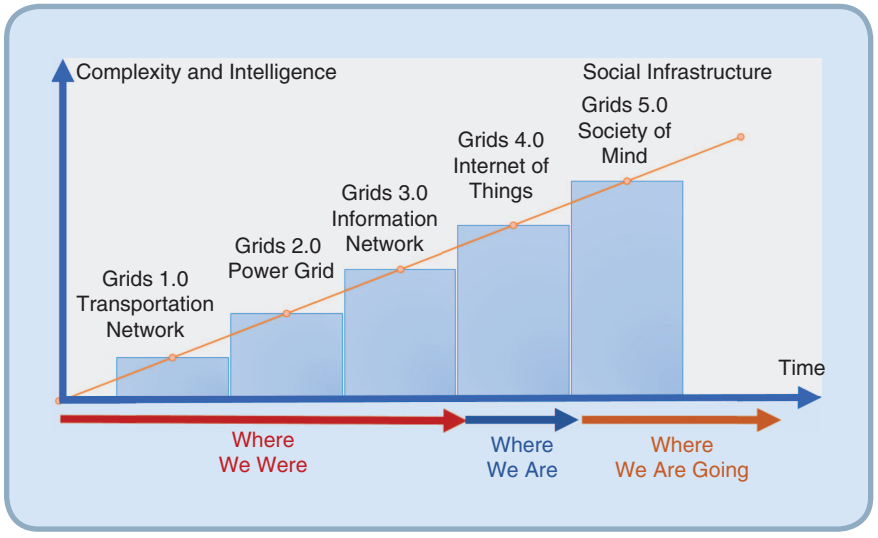

FIG 3 Smart Infrastructures for Smart Societies.

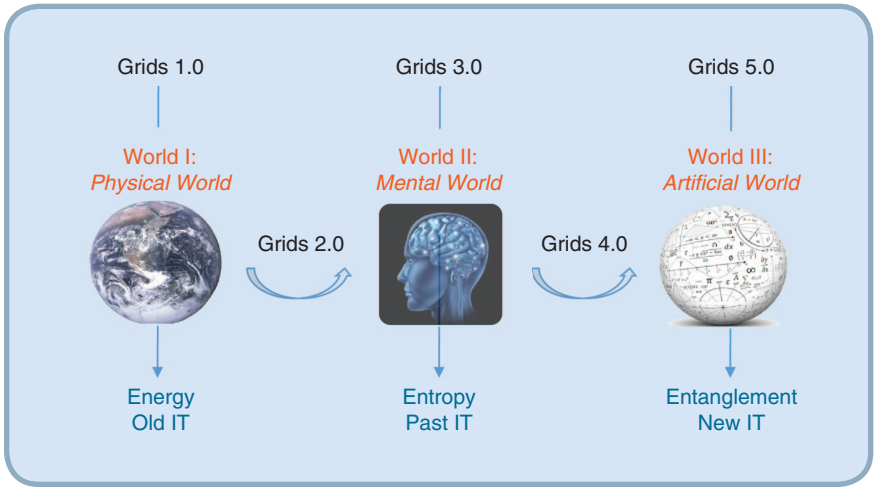

FIG 4 Three Worlds and Their Five Grids.

power networks, Grids 3.0 for information networks, Grids 4.0 for Internet of Things (IoT), and coming Grids 5.0 for the Society of Minds. ITS in the sense of Popper's three worlds will integrate Grids 1.0 to Grids 5.0 into One Grid that connects three worlds into One World again for a better life (see Fig. 4), as witnessed by recent emerging technologies, such as social transportation (from Uber to Mobike), social energy (from smart grids to Internet of Energy), social computing, social manufacturing, and social intelligence, leading to intelligent economical systems, shared services, and eventually smart societies. We have to develop new IT for ITS, and we need ITS for smart societies and smart living for mankind.

What We Do?

The Intelligence in Intelligent Transportation Systems lies in the ability of integrating smart grids for Popper's three worlds into one intelligent platform for smart living. In 2014, IEEE ITSS formed a Technical Committee on Transportation 5.0 at IEEE ITSC'14 in Qingdao, China, to promote the use of intelligent technology for ITS as we discussed above. As outlined in Fig. 5, Transportation 5.0 is naturally linked to Grids 5.0 and will be the next milestone for mobility technology. In 2015, IEEE ITSS had its first ITS Summer School on Transportation 5.0. In 2016, China made Qingdao's Transportation 5.0 Field Test as a National Demo Project, in which urban traffic, public transit, parking management, regional logistics, and social transportation will be integrated with AI and new IT, such as big data, cloud computing, machine learning, blockchain, and parallel intelligence [7]–[11]. Currently, TC on Transportation 5.0 is developing its position paper on new IT for ITS, and progress will be reported at Transportation 5.0 Workshop in IEEE ITSC'17. These efforts have provided a solid foundation for

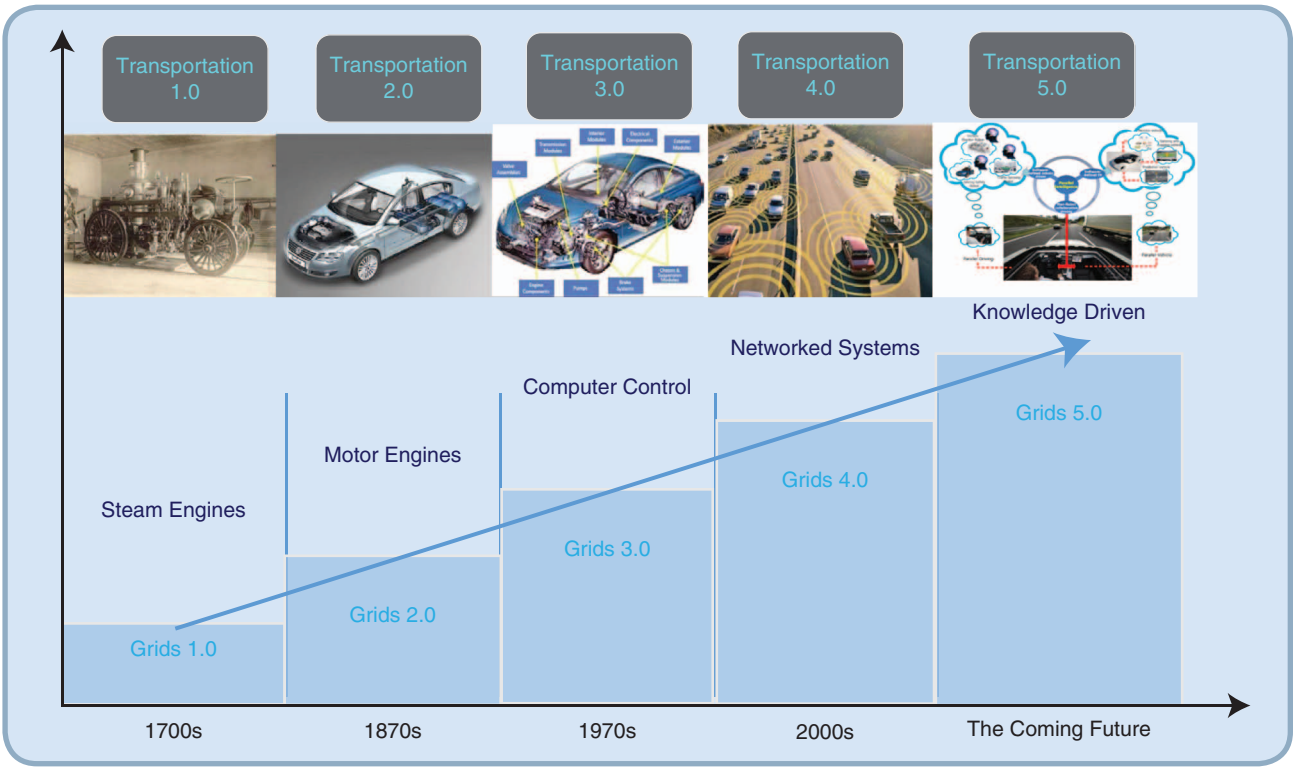

FIG 5 Transportation 5.0 for The Next Generation of Transportation.

building AI technologies of deep intelligence in ITS, now we need to leap forward in "4S" style: safely, swiftly, smoothly, and smartly.

Call for Papers

The quick creation of Artificial Intelligence Technologies for ITS section owns to the strong and energetic leadership, vision, and support from our new IEEE ITSM Editor-in-Chief Professor Ljubo Vlacic, and the Board of Governors from IEEE ITSS. Previous publication from ITSM has offered a solid foundation for the growth of this section [12]–[15], and papers in the references below present a starting point for what we will continue in the future.

This is an open call for papers on AI and Intelligent Technology for ITS. Any short articles, up to four magazine pages for ideas, theories, methods, algorithms, implementation, evaluation, and field tests are welcome. Quick but thorough review will be conducted as for other submissions for ITSM. Please indicate that your article is for ***Artificial Intelligence Technologies for ITS*** section in your submission.

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