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Review Article

Development of Super Metaverse Systems Engineering Centered on Cyberworld Ecosphere - Sky-Earth Computing (II) beyond Cloud Computing

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Abstract

With the support of IT and network technology, we can develop and build the super metaverse system (SMS) centered on cyber-tech users, integrating cyber-physical system (CPS-1) and its processes with cyber-physiological system (CPS-2) and its processes, cyber-psychological system (CPS-3) and its processes, as well as cyber-event reason system (CES) and its processes. It is proposed in this series of research to develop and produce a global service dispatcher (GSD) as the main component of a Sky-Earth computing console (SECC) for every user (individual, group, whole), and provide a customized world-wise brain. According to the analysis and design of this series of articles, through big data platform, Internet of things and artificial intelligence technology, we build intelligent integrated system, carry out data reconstruction system engineering, so as to establish the computer-like system (CLS) for big data processing, It combines all kinds of resource elements involved in computing in the information ecosphere with those involved in computing in the real ecosphere. With data reconstruction system engineering, any system is reduced to a dynamic system of resource allocation, and the basic unit of the analysis object is reduced to the aggregation and integration of multi-attribute, multi factor, multi structure and multi-level resources, so that natural scarcity, configuration scarcity and system risk are proposed. A measurement system of multi-attribute tradeoff configuration with system configuration intensity as its base is established. A new related framework, method and example are proposed.

Keywords: Ecosphere; Sky-earth Computing; Super Metaverse System; Computer-like; Intelligent Integration

Introduction

In the big data era of intelligent integration with various computing modes in Internet of everything, data from devices, products, manual operations, information systems and networks drive the implementation of intelligent manufacturing. Data generated from different data sources will also undergo a variety of collection methods, depending on the intelligent sensors and sensing hardware of IoT network terminal devices [1-3]. Radio Frequency Identification (RFID) technology can collect data in actual time, so as to automatically identify, track and manage a large number of workpieces [4-6]. Embedded sensors can realize real-time monitoring, to continuously measure, detect and report manufacturing equipment, as well as real-time monitoring of product temperature, pressure, vibration and so on. The emerging mobile Internet also collects user data through intelligent terminals (PCs, phones, laptops, tablets), SDK (software development kit) or APIs (application program interface) [7-9].

A new computing beyond the information world is explored in this series of researches, so that the information ecosphere is linked with the actual ecosphere, the information world computing is combined with the actual world computing, and an interactive, integrated and synergistic sky-earth computing or super metaverse computing is presented. In traditional Chinese culture, "Sky" (or Heaven) and "Earth" are a pair of basic relative categories. In our view, everyone, every organization and every society has its own sky and earth, and the various sky-earth at all levels are the various world at all levels, as well as the various ecosphere systems at all levels. The various sky-earth, worlds and ecospheres at all levels can be divided into two parts: the physical-actual and psychological-actual worlds and the digital and analog information worlds. Now, in the context supported by Internet, cloud computing and artificial intelligence technology [10-12], we can bring the category of "Sky-Earth" into a new system, metaphorizing the information world with "Sky" and the actual world with "Earth". Just as the "cloud" in cloud computing is a kind of metaphor with fuzziness, mobility and uncertainty [11-13], the sky and earth in sky-earth computing is a kind of metaphor with inclusiveness, interactivity and unity.

For the ecosystem in Internet of everything supported by network technology, cybertech users are an intelligent fusion center. With the support of IT and network technology, we can develop and build a super metaverse ecosphere system (SME) centered on cyber-tech users, integrating cyber-physical system (CPS-1) and its processes with cyber-physiological system (CPS-2) and its processes, cyber-psychological system (CPS-3) and its processes, as well as cyber-event reason system (CES) and its processes. With data reconstruction system engineering, any system is reduced to a dynamic system of resource allocation, and the basic unit of the analysis object is reduced to the aggregation and integration of multi-attribute, multi factor, multi structure and multi-level resources, so that natural scarcity, configuration scarcity and system risk are proposed. A measurement system of multi-attribute tradeoff configuration with system configuration intensity as its base is established. A new related framework, method and example are proposed.

To this end, the technology and system engineering of sky-earth computing proposed in this series of studies to be vigorously developed, should take a user as their center, facing the all-interconnected ecosphere (AIE) of all kinds of users at all levels. One of the basic aspects of the sky-earth computing technology development to be launched in this series of studies is to develop and produce the world-wise brain, and each world-wise brain is a sky-earth computing console (SECC) serving users. This is a control system which serves every user in the whole process and takes the global service dispatcher (GSD) to be developed as the main component. Through this kind of development, a customized global service dispatcher (GSD) can be provided for each user (individual, group, whole). With the global service scheduler as the main component, we can further develop the world-wise brain (WWB) serving every user, and strive to achieve such an ideal scenario: with a sky-earth wisdom brain in hand, everything will be integrated and everyone will be accessible.

Thus, this series of articles discusses how to actualize the intelligent integration of socialization from the subject of computation, the object of computation, the technology of computation, the organization of computation, the space of computation, the basis of computation, as well as the system, network and environment of computation, so that it is from activities, systems and network systems (complex technical network system and simple social network system) to transform all kinds of computing at all levels into the Internet system of everything and the complex social network system, and finally into the intelligent-integrating system engineering of socialization.

Super metaverse ecosphere with users as its center

In fact, any life, no matter individual or group, no matter natural life or social life, no matter simple low-level life or complex high-level life, has its own ecosphere [14-18]. With any life (no matter individual, group or whole) as the center, all the elements directly and indirectly related to the life form an ecosphere according to a certain structure, which can be called the ecosphere.

As an advanced social-intelligent life, any individual, any organization and any society have their own complex ecosphere. For any advanced social-intelligent life, the complex ecosphere includes natural factors and social factors, or material factors, information factors, spiritual factors, or physical factors, physiologic factors and psychological factors. Users have different connections with the influencing factors of different time and space points. The contents, time limit, types, closeness and frequency of contacts are different. For example, there are pure simple connections and complex multiple connections, long-term fixed connections and short-term accidental connections, very close connections and very loose connections, frequent connections and occasional connections, etc.

In fact, the boundary of each ecosphere is often irregular, and the boundary of highly complex ecosphere in Internet of everything is especially mixed, unclear and irregular. As shown in figure 1, there is an ecosphere with irregular, indistinct and non-simple boundaries. The ecosphere includes complex multiple physical, physiological, information, psychological and social connections. Here, the arrow line has great limitations. It can only represent the distance and direction in time and space, but it can not represent the multiple links between the center (advanced intelligent life, such as users) and the influencing factors at each time and space point.

Figure 1: A ecosphere with irregular, indistinct and non-simple boundary.

An all-interconnected ecosphere with complex multiple physical, physiological, psychological and social connections

By the analysis and design of this study, the all-interconnected ecosystem with the support of IT and network technology, can be developed into a super metaverse ecosphere system with cybertech users as its center. Here, it has a complex multi-connection system: dynamic connection --- benefit connection --- value connection, among which, the horizontal and vertical connection of dynamic chain, the horizontal and vertical connection of efficacy chain, and the horizontal and vertical connection of value chain. It is a collection with a cybertech user as its center and composed of all stakeholders who have direct and indirect contact with this cybertech user. It is also a set of resource allocation elements which have direct and indirect contact with a cybertech user.

For the all-interconnected ecosphere supported by network technology, a cybertech user is a center of intelligent fusion, As shown in figure 2. He is not only the center of cyber-physic system, but also the center of cyber-physiologic system; It is not only the center of cyber-psychologic system, but also the center of cyber-event reason system. With cybertech users as the center, cyber-physical system (CPS-1) and its processes, cyber-physiological system (CPS-2) and its processes, cyber-psychologic system (CPS-3) and its processes, and cyber-event reason system (CES) and its processes are integrated into one, to form a super metaverse ecosphere (SME, hyper-cyber world system). Therefore, the all-interconnected ecosphere is a super metaverse ecosphere system, and a cybertech user is a center of intelligent fusion.

By the analysis and design of this series, with the support of IT and network technology, the sky-earth computing system engineering as the hyper-cyber world system should and must focus on the multiple supply-demand of cybertech users to carry out. In the new concept of technology development, multiple supply-demand centers can be realized through the sky-earth computing console.

Sky-earth fusion system (SEF) is a world system supported by sky-earth computing technology, which can be regarded as the super metaverse sci-technology (hyper-cyber world systems). It is a multi-D complex system that uses sky-earth computing technology and its system engineering to combine computing, network and world environment (including physical environment, physiological environment, psychological environment and eventlogic environment). Through the organic integration and deep cooperation of 3C (computation, communication and control) technology, it can realize the real-time perception, dynamic control and information service of large-scale engineering system in complex society.

Each user (individual user, group user and whole user) can use the sky-earth computing console to obtain the global resource support on the all-interconnected ecosphere, as shown in figure 2. As for the user's ecosphere in Internet of everything, we should make full use of the communication network for telephone, fax machine, telegraph system and satellite communication equipment, and the radio-TV network for television, radio, semiconductor radio and wireless headset, as well as the Internet for desktop computer, computing center, large-scale computer, mobile phone, notebook computer, intelligent robot and e-mail, to connect various practical professional application fields.

Through the technology development of sky-earth computing system engineering, a customized global service dispatcher (GSD) is provided for each user (individual, group, whole). As the main component of WWB, the global service scheduler should have at least three functional modules, as shown in figure 3:

- Unified normal measurement. This basic function is the computing technology of grand unified normalization, which make a unified measurement of various resources across borders, domains and levels;
- Advanced intelligent engine of supply-demand docking. This basic function is to provide customized menus for both supply and demand with the user's movement, and realize the intelligent docking of supply-demand matching as soon as possible through the supply-demand compiled search engine, so as to achieve the holo-synergic intelligent drive;
- Advanced intelligent-integrated dispatching system. This basic function is to form a dynamic sequence of ecosphere in the whole process according to the results of large-scale dynamic supply-demand intelligent docking, follow the user's mobile process in switching, and carry out mode conversion, so as to realize the support of global resources for the user.

The ultimate goal of the development of sky-earth computing technology is to establish a global support system for every user (individual user, group user and all users). in other words, to equip each user with a world-wise brain (WWB), let every user become the master of his life, the subject of his work, the leader of his entertainment and the protagonist of his social life.

Sky-earth computing system engineering for users

By the research and design of this series, we provide users with global service dispatcher and sky-earth computing console (World wise brain), and provide users with the support of sky-earth computing technical system. On this basis, with the user (individual user, group user, whole user) as the center, we carry out the real-time dynamic service in whole process for the user's ecosphere in Internet of everything, it is sky-earth computing system engineering.

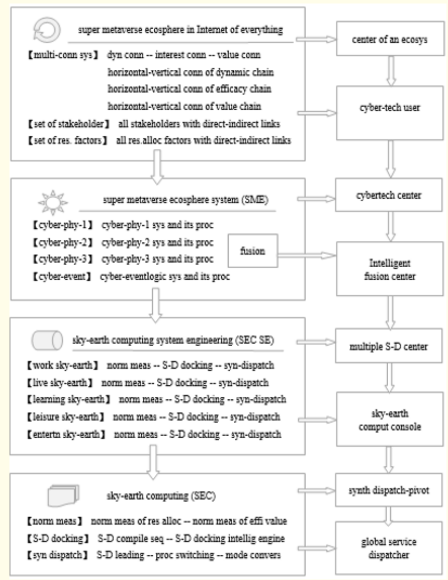

Figure 2: Super metaverse system based on sky-earth computing system engineering

Figure 3: Sky-Earth Computing Console with Global Service Dispatcher.

In order to provide the technical foundation of sky-earth computing system engineering, it is necessary to organize the advanced R&D forces of the whole world, make full use of the technology, software (web-software, sys-software, app-software), system, platform, network (Internet, comm-network, radio-TV network) in the information field, and integrate the technology and knowledge (web-knowledge, sys-knowledge app-knowledge), system, platform and network (energy network, logistics network, capital network, human network, knowledge network, social network, etc.) in various professional application fields, to develop a comprehensive-integrated technology, software, system, platform, network, network architecture, link layer, network layer, transmission layer and application layer in the whole field, so as to dispatch the resources of centralized computing, distributed computing, grid computing, utility computing, load-balancing computing, parallel computing, as well as cloud computing, cluster computing, fog computing, edge computing.

The basic object of sky-earth computing system engineering is not only the Internet of everything, but also the all-interconnected ecosphere. For users staying at a certain spatiotemporal point, the user's interconnected ecosphere is the deterministic ecosphere in Internet of everything; For users moving at different spatiotemporal points, the user's interconnected ecosphere is the whole migration ecosphere in Internet of everything.

Using the global service dispatcher (GSD) and sky-earth computing console (SECC, i.e. world wise brain), we can provide users with aux-synergic design, aux-synergic R&D, aux-synergic organization, aux-synergic operation, aux-synergic cooperation, aux-synergic management, aux-synergic adjustment, aux-synergic detection and aux-synergic maintenance, thus users can become the design center, R&D center, organization center, operation center, cooperation center, management center, adjustment center, detection center and maintenance center of their own sky-earth computing system engineering. The sky-earth computing system engineering supported by information technology, computing technology and network technology is shown in figure 4.

In the development of sky-earth computing system engineering, we must closely focus on the supply- demand of users, especially the supply-demand dynamic sequence of mobile users in the whole process. That is to say, the advanced intelligent engine system, which is based on a wide range of supply and demand, on the one hand, handles users' demands (dynamic sequence) for information, goods, personnel, funds, resources, services and organizations, etc. at any time according to the standardized requirements; on the other hand, handles the supplies (dynamic sequence) of the outside world (even the whole world) for information, goods, personnel, funds, resources, services and organizations, etc. at any time according to the standardized requirements.

Each spatiotemporal point determines a certain space range and a certain time range. For figures 5, 6 and 7, suppose that:

- The space range and time range indicated by point A are: a residential area in Z community, Y District, X city, 5:30-7:30 in the morning;
- The space range and time range indicated by point B are: block A, business building, K Industrial Park, H District, X city, 8:00-9:00 in the morning;
- The space range and time range indicated by point C are: an office area of Z scenic spot in the suburb of X city, 9:30-10:30 a.m;
- The space range and time range indicated by point D are: temporary office area of P Development Zone, N District, M City, 12:00-2:00 noon.

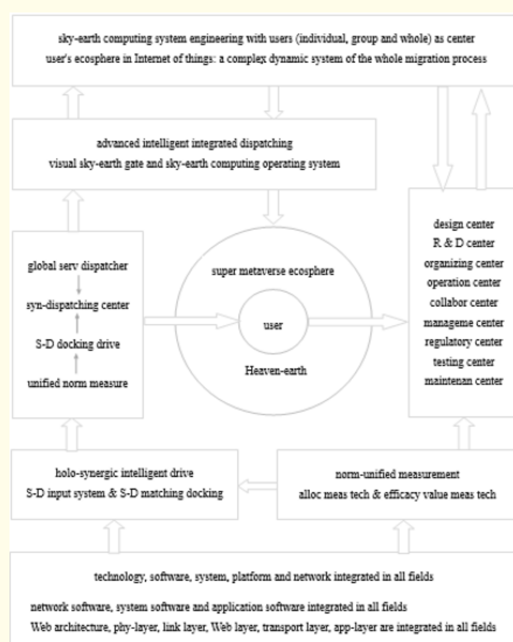

Figure 4: Sky-earth computing system engineering supported by info tech, computing tech and network tech.

Figure 5 shows the basic contents of user activities at different spatiotemporal points A, B, C and D in the interconnected ecosystem.

As shown in figure 5.

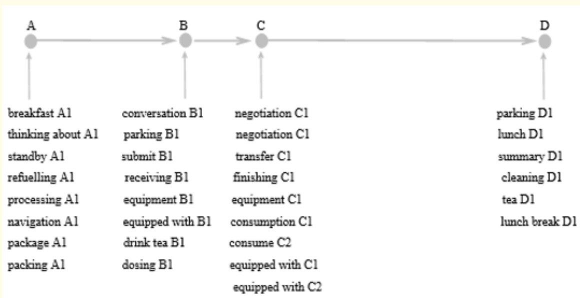

Figure 5: Basic contents of user activities at diff spatiotemporal points A, B, C, D in interconn ecosphere.

- At spatiotemporal point A, the main contents of user activities include: breakfast A1, thinking A1, car preparation A1, refueling A1, processing A1, navigation A1, packing A1, packing A1;
- At spatiotemporal point B, the main contents of user activities include: talking B1, parking B1, submitting B1, receiving B1, equipping B1, equipping B1, drinking B1, and feeding B1;
- At spatiotemporal point C, the main contents of user activities include: negotiation C1, negotiation C1, transfer C1, arrangement C1, equipment C1, consumption C1, consumption C2, equipment C1, equipment C2;
- At spatiotemporal point D, the main contents of user activities include: Parking D1, lunch D1, summary D1, cleaning D1, tea D1, lunch D1.

Figure 6 shows the various resources that users need to support at different spatiotemporal points A, B, C and D in the interconnected ecosphere.

As shown in figure 6.

- At spatiotemporal point A, the main resources users need to support include: food A1, document A1, truck A1, engine oil A1, information A1, supplies A2, supplies A2;
- At spatiotemporal point B, the main resources users need to support include: file B1, truck B1, data B1, data B2, equipment B1, equipment B1, beverage B1, and drug B1;

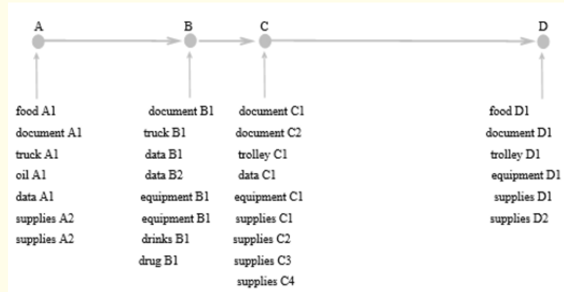

Figure 6: Various res that users need to support at diff spatiotemporal points A, B, C, D in interconn ecosphere.

- At spatiotemporal point C, the main resources users need to support include: file C1, file C2, car C1, data C1, equipment C1, supplies C1, supplies C2, supplies C3, supplies C4;
- At spatiotemporal point D, the main resources users need to support include: file D1, car D1, equipment D1, supplies D1, supplies D2.

Figure 7 shows the manufacturers, institutions, communities, villages and individuals that users need service support at different spatiotemporal points A, B, C and D of the interconnected ecosphere.

As shown in figure 7

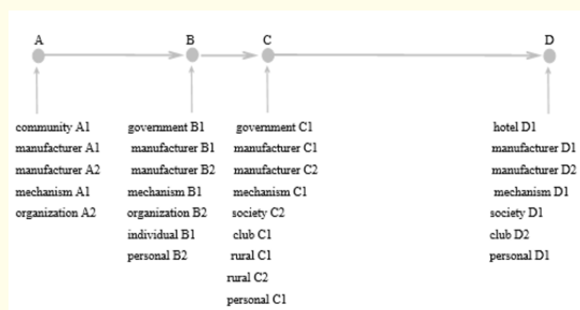

Figure 7: Supports that users need service support at different time and space points a, B, C and D.

- At spatiotemporal point A, the supports that users need service support include: community A1, manufacturer A1, manufacturer A2, organization A1 and organization A2;
- At spatiotemporal point B, the supports that users need service support include: government B1, manufacturer B1, manufacturer B2, institution B2, individual B1 and individual B2;

- At spatiotemporal point C, the supports that users need service support include: government C1, manufacturers C1, manufacturers C2, institutions C1, communities C2, communities C1, villages C1, villages C2 and individuals C1;
- At spatiotemporal point D, the supports that users need service support include: hotel D1, manufacturer D1, manufacturer D2, organization D1, community D1, community D2 and individual D1.

Combining figures 5, 6 and 7, we can see that,

At spatiotemporal point A, in order to meet the needs (or demands) of users in breakfast A1, thinking A1, car preparation A1, refueling A1, processing A1, navigation A1, packing A1, packing A1, etc., the resources that users need to be provided in support including food A1, document A1, truck A1, engine oil A1, data A1, product A2, product A2, etc. Therefore, it is necessary to mobilize institutions, manufacturers and organizations as supporters including community A1, manufacturer A1, manufacturer A2, institution A1 and A2.

At spatiotemporal point B, in order to meet the needs (or demands) of users in conversation B1, parking B1, delivery B1, receiving B1, equipment B1, equipment B1, tea B1, medicine B1, etc., the resources that users need to be provided in support including document B1, truck B1, information B1, information B2, equipment B1, equipment B1, beverage B1, medicine B1, etc. Therefore, it is necessary to mobilize institutions, manufacturers and organizations as supporters including manufacturer B2, institution B2, individual B1 and individual B2.

At spatiotemporal point C, in order to meet the needs (or demands) of users in negotiation C1, negotiation C1, transfer C1, arrangement C1, equipment C1, consumption C1, consumption C2, equipment C1, and equipment C2, etc., the resources that users need to be provided in support including document C1, document C2, car C1, data C1, equipment C1, supplies C1, supplies C2, supplies C3, supplies C4, etc. Therefore, it is necessary to mobilize institutions, manufacturers and organizations as supporters including government C1, manufacturer C1, manufacturer C2, institution C1, community C2, community C1, village C1, village C2 and individual C1.

At spatiotemporal point D, in order to meet the needs (or demands) of users in parking D1, lunch D1, summary D1, cleaning D1, tea D1, lunch D1, etc., the resources that users need to be provided in support including document D1, car D1, equipment D1, supplies D1, supplies D2, etc. Therefore, it is necessary to mobilize institutions, manufacturers and organizations as supporters including hotel D1, manufacturer D1, manufacturer D2, organization D1, community D1, community D2, individual D1.

Computing interface system between the two worlds

In the face of Internet, cloud computing and artificial intelligence technology, it is necessary to divide the whole world into two categories: the information world and the actual world; the former includes the digital information world and the analog information world, and the latter includes the physical actual world and the psychological actual world.

The task of sky-earth computing involves two aspects: on the one hand, to realize the integration and rational allocation of the information world (digital and analog information world); on the other hand, to realize the integration and rational allocation of the actual world (physical and psychological actual world).

The sky-earth interface system and its channels enable users (individuals, organizations, and Society) to work with multi-channel programs in the physical world, the information world and the psychological world at the same time in their own world. The operation program of each channel runs in the user's own sky-earth channel, that is, in the graphics on the display screen. Most of the sky-earth channel systems allow channels to overlap, and provide users with standard operations to run, such as moving and changing the size of the visual gate, sending the visual gate to the foreground and background, or expanding or narrowing a sky-earth channel. The sky-earth channel interface system should have the network permeability ability of the interconnection of all things, and allow users to run the channel graphics application program on the remote machine.

The interface system of sky-earth computing established between the information world and the actual world can be referred to as sky-earth interconnection.

Between the actual world and the information world, we should face both offline activities and online activities. Around the demand and supply, set up the dispatching desk and set up the general controller. Through the supply and demand docking system (docking list and docking stack), navigation system and GPS positioning system, using compilation engine (including search engine) and corresponding measurement technology and calculation method, we make the measurement of allocation between virtual and real resources, the measurement of value between virtual and real values, and make trade-off decision between virtual and real benefits. As shown in figure 8, an intelligent network docking system of super metaverses is established around the relationship of supply and demand between the information (digital and analog information) world and the actual (physical and psychological actual) world.

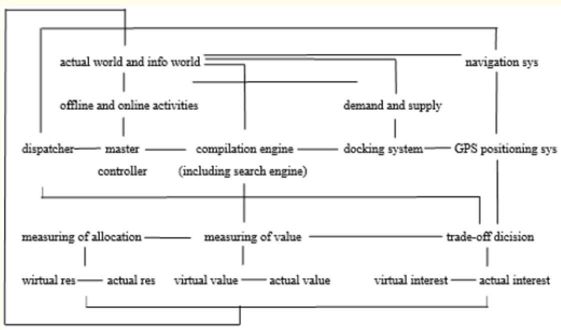

Figure 8: The Building of intelligent Network Docking System of Super Metaverses around the Relationship of Supply and Demand between Information World and Actual World.

Based on the emerging Internet of everything (the grand unified Internet that integrates energy network, physical network, information internet, knowledge network and mental network), sky-earth computing (synthetic world Computing) makes full use of technologies, tools and models such as the 5 G mobile Internet, big data, artificial intelligence, Internet of things, sensors, cloud computing, quantum computer, etc. Five types of resources (energy resources, physical resources, information resources, knowledge resources and spiritual resources) are incorporated into the new big unified measurement system, which combines various natural intelligence tools (human brain, language, sensory, light wave, gesture, etc.) and various artificial intelligence tools (computers, laptops, mobile phones, sensors, etc.) to form an intelligent integration technology (system), so as to make an unified calculation, analysis and processing of various energy resources (including energy network, service equipment, storage, energy technology, application tools, services, etc.), various physical resources (including physical network, service equipment, storage, physical technology, application tools, services, etc.), various information resources (including information network, server, storage, information technology, application software, services, etc.), various knowledge resources (including knowledge network, service equipment, storage, knowledge technology, application tools, services, etc.) and various spiritual resources (including mental network, service equipment, storage, psychological technology, application tools, services, etc.), as shown in figure 9.

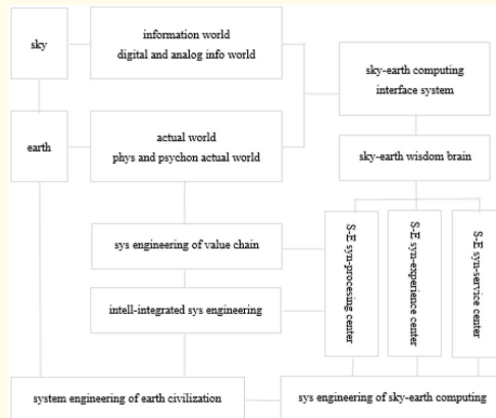

Figure 9: Sky-Earth Interface System around Various Super Metaverse Experience Centers at All Levels.

Comparatively speaking, in the process of connecting the information (digital and analog information) world and the actual (physical and psychological actual) world, the experience of various users at all levels (from individuals, teams, organizations, to institutions, departments, regions, and even countries, international alliances, and world organizations) is the purpose and starting point. All kinds of connection and integration technologies must focus on various users at all levels to start with.

Therefore, between the sky and the earth, that is, between the information world and the actual world, the sky-earth interface system should and must be set around the super metaverse experience center.

At present, M2M focuses on machine to machine wireless communication. There are three ways: machine to machine, machine to mobile phone (such as user remote monitoring), mobile phone to machine (such as user remote control). Since M2M is the integration of wireless communication and information technology, it can be used for two-way communication, such as collecting information from a long distance, setting parameters and sending instructions.

In M2M, GSM/GPRS/UMTS is the main long-distance connection technology, and its short-range connection technology mainly includes 802.11b/g, Bluetooth, ZigBee, RFID and UWB. In addition, there are other technologies, such as XML and CORBA, and location-based services based on GPS, wireless terminals and networks. Now, M2M is widely used in many industries, such as electric power, transportation, industrial control, retail, public utilities management, medical treatment, water conservancy, oil and so on. M2M can be said to be omnipotent for vehicle anti-theft, safety monitoring, vending, mechanical maintenance, public transport management, etc.

Sky-earth computing as expansion of cloud computing

As a intelligent-integrating system engineering of the super metaverse, sky-earth computing is not only a new technical system, but also a new industrial system. More importantly, it is the synergistic allocation mode of the new civilization world, involving the technical support system, intelligent integration system, social organization system and ecological coordination system of the new civilization world. Facing all kinds of users at all levels, sky-earth computing system engineering will form three centers: sky-earth comprehensive processing center, sky-earth comprehensive experience center and sky-earth integrated service center.

In the overall framework designed by this series of research, the sky-earth computing operating system, which needs to be jointly organized and developed by all parties, is a kind of generalized system software configured for the engineering technology system of sky-earth computing. It is also a cluster (as the collection of sets) of a large number of program modules with various functions, which centralizes the management functions and control procedures of all kinds of information resources and real resources at all levels. As a kind of generalized system software, sky-earth computing operating system is different from other computer operating systems. It not only faces the information world (digital and analog information world), but also faces the real world (physical and psychological actual world). It focuses on all kinds of users at all levels (from individuals, teams, organizations, to institutions, departments, regions, and even countries, international alliances, and world organizations), and faces various application software on all kinds of artificial intelligence computing equipment (including computers, mobile phones, iPads, game consoles, etc.), and controls, manages and helps the app software of all types of users at all levels to run.

Sky-earth computing operating system is not only the interface between all kinds of users and all kinds of applications at all levels with the computer cluster system, but also the platform cluster and environment collection for the common operation of all kinds of application programs and other kinds of system programs at all levels. It should be able to effectively control and manage all kinds of natural intelligence computing hardware and software resources at all levels, all kinds of artificial intelligence computing hardware and software resources at all levels and all kinds of social intelligent computing hardware and software resources at all levels, reasonably organize the workflow in the engineering technology system of sky-earth computing, maximize the convenience of various users at all levels to use the all kinds of computing equipment at all levels, and give full play to the role of social resources in a fair, reasonable and effective way.

According to the overall framework proposed by this series of research, in addition to the general main functions, such as memory management, processor management, device management, file management and user interface management, sky-earth computing operating system also has the most important special functions, including: sky-earth compiler - allocation measurement - value measurement - supply-demand docking - dynamic analysis - fair trade-off - summary processing - comprehensive scheduling - coordinated control.

These new functions need to be fully designed and developed by the organization.

In the overall framework designed by this series of research, we can expect that sky-earth computing operating system will play the three basic roles in the engineering technical system of sky-earth computing:

- To organize, coordinate and manage all kinds of natural intelligence computing hardware and software resources at all levels, all kinds of artificial intelligence computing hardware and software resources at all levels and all kinds of social intelligent computing hardware and software resources at all levels in the engineering technology system of sky-earth computing, so as to improve the utilization rate of the integrated processor, central dispatching console and coordination controller;

- To provide all kinds of service functions to various users at all levels, that is to say, on the one hand, to provide efficient programming interface for the various program developers at all levels, and on the other hand, to provide interfaces for various users at all levels of engineering technology system of sky-earth computing, so that various users at all levels can use computers flexibly, conveniently and effectively.
- It is most important that through the sky-earth compiler, allocation measurement, value measurement, supply-demand docking, dynamic analysis, fair trade-off, summary processing, synthetic scheduling, coordinated control and other new functions, sky-earth operating system can ensure the fair, reasonable and effective allocation of resources in the widest possible range of the whole society.

With the various input-output systems in computers, mobile intelligent communication devices (including mobile phones), iPad, game machines and other devices, sky-earth computing operating system can indirectly use all kinds of hardware at all levels, organize, coordinate and manage the operation of various application software at all levels and the use of various hardware resources by various application software at all levels.

The overall framework of sky-earth computing system engineering is shown in Figure 10. In this figure, indiv S-E gate expresses the visual gate of individual sky-earth, org S-E gate expresses the visual gate of organizational sky-earth, region S-E gate expresses the visual gate of regional sky-earth, soc S-E gate expresses the visual gate of social sky-earth; indiv S-E path expresses the visual path of individual sky-earth, org S-E path expresses the visual path of organizational sky-earth, region S-E path expresses the visual path of regional sky-earth, soc S-E path expresses the visual path of social sky-earth; indiv S-E space expresses the visual space of individual sky-earth, org S-E space expresses the visual space of organizational sky-earth, region S-E space expresses the visual space of regional sky-earth, soc S-E space expresses the visual space of social sky-earth.

According to the overall framework designed in this series of research, the basic composition of the technology system of sky-earth computing is as follows: Sky-earth wise brain is mainly for computing in the information world and computing in the actual world. It is mainly composed of sky-earth compilers, allocation measurement platform, value measurement, supply-demand docking stack, dynamic analyzer and fair trade-off device.

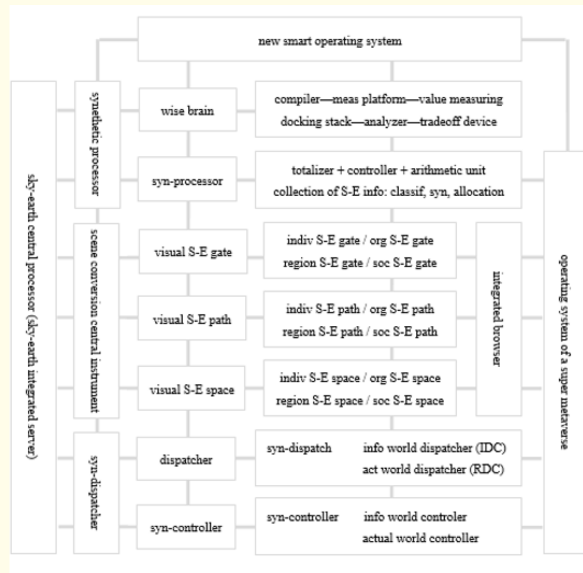

Figure 10: Overall Framework of Sky-Earth Computing System Engineering.

The sky-earth wisdom database is a collection of new thought system, new science system and new technology system facing the new civilization world.

The integrated processor is mainly composed of totalizer, controller and arithmetic unit. Its function is sky-earth information processing and execution of integrated instructions. Its summary mainly includes classification, synthesis and allocation.

The sky-earth central processor is mainly composed of the sky-earth integrated processor, the scene-conversion central instrument (integrated browser) and the integrated scheduler that we are organizing to develop.

The sky-earth computing platform mainly consists of five plates, namely, knowledge innovation plate of new civilization, sky-earth computing plate of new civilization, wisdom experience plate of new civilization, comprehensive service plate of new civilization and technology development plate of new civilization.

The sky-earth integrated dispatcher is mainly composed of the big-vision operating system, sky-earth wise brain, central dispatching console and central controller that we are organizing and developing.

Sky-earth operating system includes big-vision operating system and new wisdom operating system.

The sky-earth activity center includes the sky-earth experiential center and sky-earth dispatching center;

The basic components of super metaverse experiential center are as follows:

- Sky-earth visual gate is divided into social sky-earth gate, regional sky-earth gate, organizational sky-earth gate, personal sky-earth gate, etc.;
- Sky-earth visual channel is divided into informational world channel (I channel) and actual world channel (R channel);
- Sky-earth visual space is divided by boundary, field, block and circle;
- Sky-earth dispatch center is mainly composed of dispatching console and controller which we are organizing to develop;
- Sky-earth central dispatch console is divided into the info-world dispatch console (IDC) and the actual world dispatch console (RDC);
- The basic functions of sky-earth controller include programming, searching elements, navigation, scheduling and command. It is divided into information world controller (I keyboard) and actual world controller (R keyboard). The two types of controllers are mutual instructions, guidance, assistance and support for each other;
- The network platform of sky-earth computing can be regarded as the synergistic-control platform for the Internet of everything. It refers to the various service support systems of sky-earth computing network based on the Internet of everything. It not only faces the information world (the digital and analog information world), but also faces the actual world (the physical and psychological real world);
- The cluster system of sky-earth computing website is divided into central websites, system websites, department websites, regional websites, basic websites, user websites and so on;
- The super metaverse integrated processing center covers command platform, operation platform, control platform, organization platform, management platform, etc. it not only faces the offline operation system, offline control system, offline organization system and offline management system of the actual world, but also faces the online operation system, online control system, online organization system and online management system of the information world.

Through the HDFS cluster (MapReduce/Tez/Spark, Storm, Spark Streaming, S4, Heron, etc., or Impala, Drill, PRESTO) of the underlying architecture of big data platform, many NameNodes, a large number of DataNodes, and a large number of computers, mobile communication tools, data warehouses (using Spark SQL, Hive SQL, Pig, etc.) and artificial intelligence components (for example, AlphaZero, generate countermeasure network GAN, Vicarious's new recursive cortical network, Geoff Hinton's new capsule network), sky-earth computing system engineering can realize the unified scheduling (currently assisted by Oozie, Azkaban, light task scheduler, Zeus, etc.), unified processing (currently assisted by SQL) and unified computing (currently with HDFS cluster and Spark, Storm, Heron, etc.) of various data.

Computer-like system of intelligent integration

Now, between the information ecosphere and the actual ecosphere, as well as between the calculation of the information world and the calculation of the actual world, we discuss how to build an intelligent integrated system and carry out data-reconstruction system engineering, so as to build a computer-like system for big data processing, with the big data platform (HDFS cluste [19-21], MapReduce/Tez/Spark), IOT [9-11] (sensors, RFID, GPS, infrared sensing) and artificial intelligence technology [12,13] (AlphaZero, GAN, new recursive cortical network, etc.). For this computer-like system of intelligent high-integration, not only tens of thousands of computers, mobile communication tools, robots, the Internet and IOTs participating computing in the information ecosphere become the internal factors, but also tens of thousands of humans participating computing in the actual ecosphere to use computers, mobile communication tools, robots, the Internet and the Internet of Things have also become the internal factors.

In the analysis and design of this series of papers, a computer-like system of sky-earth computing is not only composed together of HDFS clusters (MapReduce/Tez/Spark, Storm, Spark Streaming, S4, Heron, etc., or Impala, Drill, Presto), numerous NameNodes, a large number of DataNodes and a large number of computers, mobile communication tools, data warehouses (using Spark SQL, Hive SQL, Pig, etc.) and artificial intelligence components (for example, AlphaZero, GAN, Vicarious's new recursive cortical network, Geoff Hinton's new capsule network), but also composed together of numerous eople who make use of computers, mobile communication tools and AI components, various social organizations at all levels and other computing components, clients, tools, platforms, equipment and facilities, etc. This system itself is an extremely complex intelligent-integrated ecosphere, shown in figure 11.

In the analysis and design of this series of papers, a computer-like system of sky-earth computing, with sensors, IOTs, artificial intelligence technology, mobile intelligent tools, human-computer integration technology, HDFS clusters of the underlying architecture of many big data platforms, as well as numerous NameNodes, a large number of DataNodes and data warehouses, on the one hand, in the artificial intelligence computing field of ecosphere, combines the serial processing under Von Neuman system with the parallel processing of Non-Von Neuman architecture, the pipeline water treatment formed by multiple processing components, the single instruction stream and multi-data stream processing formed by array machine structure, the parallel algorithmic architecture supported by multiple Von Neumann computers and data flow computer processing based on data flow driven mode; on the other hand, in the natural intelligent computing field of the actual ecosphere, combines the processing of various organizations, under the new technology of intelligent integrated computing.

Under the analytical foundation and design framework of sky-earth omputing established earlier in this paper, we now put forth the general structure and technical scheme of computer-like system, as shown in figure 12.

Basic Composition: HDFS clusters (MapReduce/Tez/Spark, Storm, Spark Streaming, S4, Heron, etc., or Impala, Drill, Presto) of the underlying architectures of many large data platforms are based on the internal storage of various departments, the full drive system in full-space based on disk drives of departments, the full storage system in full-space based on internal memory of departments, the full process management system in full-space based on process managers of departments, as well as the full display system in full-space based on display of departments, and the full peripheral-connected equipment in in full-space based on peripheral equipment of departments, are shown in figure 12.

Network Center —— Intelligent-integrated coordination center website (IICC Website) set between actual ecospheres (RES) and information ecospheres (DES). This kind of website differs from various existing Internet websites in that it is not only limited to information collection, information dissemination and information exchange, but also mainly in the dynamic organization, coordination and control between actual ecospheres and information ecospheres;

Synergistic Control Center —— Intelligent integrated synergistic control institution.

Key Technologies —— technical support of overall resource allocation system —— Sky-Earth Computing Technology System, including HDFS cluster of underlying architecture for many big data platforms (MapReduce/Tez/Spark, Storm, Spark Streaming, S4, Heron, etc., or Impala, Drill, Presto), data warehouse (using Spark SQL, Hive SQL, Pig, etc.) and artificial intelligence components (e.g., AlphaZero, GAN, Vicarious's new recursive cortical network, Geoff Hinton's new capsule network);

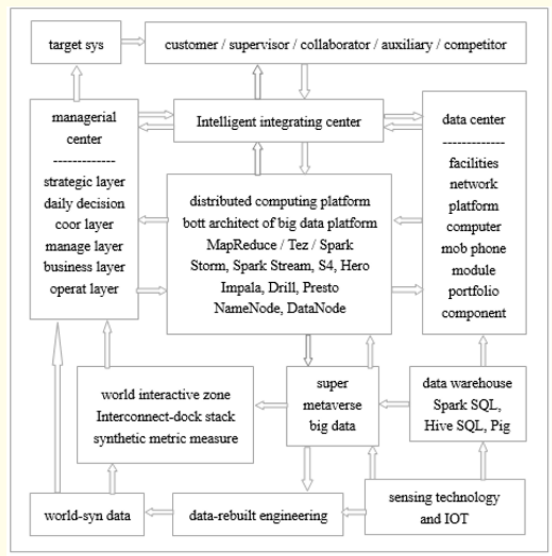

Figure 11: Basic Framework of Computer-like Architecture as A Tool of Sky-Earth Computing Technology.

Overall Storage Management, which is not limited to information storage or data storage management. The storage includes information storage, material storage, energy storage, thinking storage, human storage, knowledge storage, financial storage, etc.

Overall File System, which is not limited to computer files and Internet files. This system includes files formed and existing in information department, material department, energy department, thinking department, human resources department, knowledge department, financial department, etc.

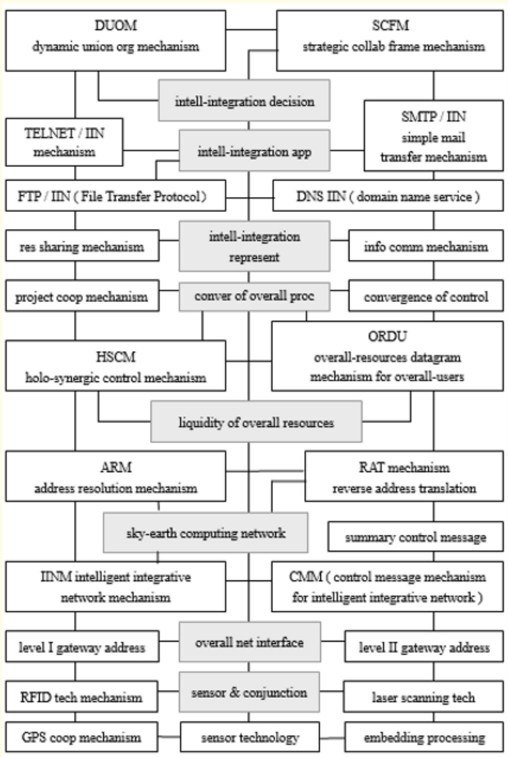

Figure 12: Basic Framework of Computer-Like Technology System.

Overall Network Communication, which is not limited to the Internet, telecommunications network, radio and television network. It includes information network, material network, energy network, thinking network, human network, knowledge network, financial network, etc.

Overall Security Mechanism, which is not limited to the mechanism of computer and Internet systems. It includes information security, material security, energy security, thinking security, human security, knowledge security, financial security, etc.

Interfaces of Overall Users, which is not limited to the interface of computer and Internet systems. The overall user includes users of information systems, material systems, energy systems, thinking systems, human resources systems, knowledge systems, financial system, etc.

Overall Driver Convergence, which is not limited to the summary of computer programs and Internet programs. The overall driver includes driver of information system, driver of material system, driver of energy system, driver of thinking system, driver of manpower system, driver of knowledge system. driver of financial system, etc.

Functional Convergence —— the convergence among the functions of full-space overall-resource search (sky-earth search), full-space overall-resource calculation (sky-earth calculation), full-space overall-resource GPS positioning (sky-earth positioning), full-space overall-resource browsing (sky- earth browsing), etc.

Major Mechanisms —— dynamic exchange system, assembling unit and machine cluster with intelligent integrated network based on various mechanisms conversion framework, dynamic dispatch system, assembling unit and machine cluster with sky-earth ecosphere network based on dynamic alliance organization and its mechanism framework, dynamic service system, assembling unit and machine cluster with resource-allocating network based on interest community and its mechanism framework System, unit and group system;

Major tools —— processors, browsers, search engines, sensors, radio frequency identification, laser scanners, infrared sensors, global positioning systems, unmanned aerial vehicles, NameNodes, Data Nodes, computers, mobile communications tools, data warehouses (Spark SQL, Hive SQL, Pig, etc.) and artificial intelligence components (e.g., AlphaZero, generating antagonistic network GAN, Vicarious's new recursive cortical network, Geoff Hinton's new capsule network).

Main technologies —— information processing technology, browsing technology, search technology, sensing technology, radio frequency identification technology, laser scanning technology, infrared induction technology, global positioning technology, large data technology (HDFS cluster, NoSQL, NewSQL, etc.), orbital satellite imaging technology, unmanned driving technology, virtual actuality technology, augmented actuality technology, artificial intelligence technology, cloud computing technology (Hadoop MapReduce, Spark, YARN), intelligent integration technology, cluster computing technology.

Variables on sky-earth ecocorrelation

Variable sequence based on longitudinal correlation of sky-earth noumenon

For the basic longitudinal correlation of noumenon:

sky-earth origin——sky-earth paradigm——sky-earth mode——sky-earth structure——sky-earth factor——sky-earth phenomenon.

We can set up the corresponding variable sequence:

sky-earth origin variable——sky-earth paradigm variable——sky-earth mode variable——sky-earth structural variable——sky-earth individual variable——sky-earth factor variable.

Or conversely, for the basic longitudinal correlation of noumenon:

sky-earth phenomenon——sky-earth factor——sky-earth structure——sky-earth mode——sky-earth paradigm——sky-earth origin.

We can set up the corresponding variable sequence:

sky-earth factor variable——sky-earth individual variable——sky-earth structural variable ——sky-earth mode variable——sky-earth paradigm variable——sky-earth original variable.

As shown in figure 13

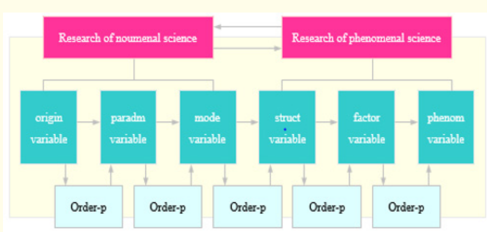

Figure 13: To Set Variable Sequence between Phenomenal Science and Noumenal Science.

From the noumenal science discussed to set in this series of papers to the various phenomenal sciences including classical science, neo-classical science and modern science, in order there should be original variables, paradigm variables, mode variables, structural variables, individual variables, element variables. In figure 14, order parameter is abbreviated as order-p.

As shown in figure 14

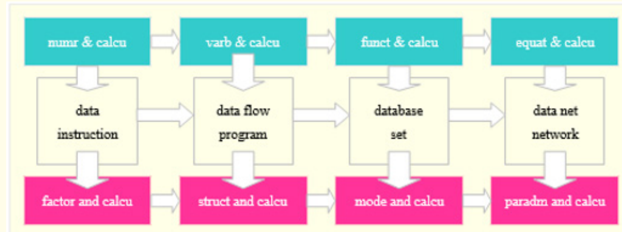

Figure 14: From Numerical Calcul of Phenomenal Science to Paradigm Calcul of Noumenal Science.

From the various phenomenal sciences including classical science, neo-classical science and modern science to the noumenal science discussed to set in this series of papers, except the numerical and its calculation, the variable and its calculation, the function and its calculation, the equation and its calculation, in order there should be the factor and its calculation, the structure and its calculation, the mode and its calculation, the paradigm and its calculation. Here, numr & calcu——numerical and its calculation, varb & calcu——variable and its calculation, funct & calcu——function and its calculation, equat & calcu——equation and its calculation.

The structural equation model is more complex than the regression model, and the structural equation model is composed of the multi layer variables and their mutual relation. In this way, a variable predicted by a set of variables will help us to predict another variable. The predicted variable is dependent variable (same as the regression) or endogenous variable, the variable used to predict other variables is called exogenous variable. One of the distinctive features of the structural equation model is to use the hidden variable, while the so-called latent variable refers to a model component or a concept, itself cannot be measured directly, but can use one or more indexes or measurable variables to represent or measure. Such as: income and education are measurable factors, they can be regarded as an indicator of the non-measurable status of the community.

As the main part of noumenal-correlation model analysis, the structural equation model should include structural variables, measure equation and structural equation, the mode equation model should include mode variables, measure equation and mode equation, the paradigm equation model should include paradigm variables, measure equation and paradigm equation.

From the various phenomenal sciences including classical science, neo-classical science and modern science to the noumenal science discussed to set in this series of papers, in order there should be element variables, individual variables, structural variables, mode variables, paradigm variables, original variables.

As shown in figure 15

As the main part of noumenal-correlation model analysis, the structural equation model should include structural variables, measure equation and structural equation, the mode equation model should include mode variables, measure equation and mode equation, the paradigm equation model should include paradigm variables, measure equation and paradigm equation.

From the various phenomenal sciences including classical science, neo-classical science and modern science to the noumenal science discussed to set in this series of papers, in order there should be element variables, individual variables, structural variables, mode variables, paradigm variables, original variables.

For paradigm variables, original variables is the order parameter as exogenous variables, or as explaining variables; For mode variables, paradigm variables is the order parameter as exogenous variables, or as explaining variables; For structural variables, mode variables is the order parameter as exogenous variables, or as explaining variables; For factor variables, structural variables is the order parameter as exogenous variables, or as explaining variables.

As the new variable, original variables, paradigm variables and model variable are not only related to the variables which can be observed and measured directly, but also the variables which are difficult to be observed and measured directly.

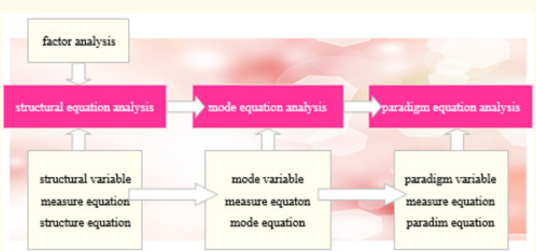

Figure 15: From Structural Equation Analysis to Noumenal-correlation Model Analysis.

Sky-earth origin variable

On the sky-earth origin (base), we often think of the three major elements of economy: land, labor, capital, or think of the five basic elements of economy: natural resources, human resources (including entrepreneurship), capital, information, technology.

In the usual sense, we can attribute the sky-earth origin to the basic elements of economy.

Further consideration is in this way that the economy is based on two aspects:

- The material, information, labor, scientific and technological innovation in natural resources (present in all kinds of societies);
- The violence, capital, power, and business ability in sky-earth resources (present in a particular type of society).

The sky-earth origin is essentially latent variables which can not be directly measured, and it needs to be measured and expressed by various index systems as indicator variables.

In this series of papers, the indicator variables of substances are summarized as follows:

- Mass, energy, time and space form, movement, volume, size, distribution density, physical state, chemical state, shape, weight, basic composition, temperature, velocity, pressure.

In this series of papers, the indicator variables of information are summarized as follows:

- Amount of information, authenticity, completeness, validity, channel capacity, processing quality, distribution, system reliability, accessibility, accessibility, basic structure, transmission speed.

In this series of papers, the indicator variables of labor are summarized as follows:

- Quantity, cultural level, professional skills, physical fitness, professional loyalty, market demand, industry distribution, employment rate, training period, employment satisfaction, basic composition, liquidity.

Sky-earth paradigm variable

As a basic category of resource-allocating dynamics, sky-earth paradigms can be understood as the system consisted of a certain type of resource-allocating law, resource-allocating principle, sky-earth axiom (confirmed by experiences), resource-allocating theorem (by mathematical proofs), resource- allocating institution, disposition way, as well as system framework and resource-allocating example, and is the basic factor to influence and determine a certain type of resource-allocating mode.

In this series of papers, the resource-allocating paradigm is mainly summarized as follows:

- The law, principle, axioms, theorems, rules of a certain type of sky-earth ecosystem
- A collection of the relation modes in a certain type of sky-earth ecosystem
- The institutional framework and policy system for the basic behavior of a certain type of sky-earth ecosystem
- The basic ways and examples of the organizing behavior in a certain type of sky-earth ecosystem
- The basic determinants of the system pattern of a certain type of sky-earth ecosystem.

There are a lot of the law, principle, axioms, theorems, rules of sky-earth ecosystem as the basic constitute of resource-allocating paradigm, which contain.

Law of scarcity: the fundamental law of resource-allocating dynamics.

Principle of utility maximization, its expressions are as follows.

$$\max TU = U_1 + U_2 + \cdots + U_n = \sum_{i=1}^{n} U_i \qquad \text{----------(1)}$$

$$\text{s. t.} \sum_{i=1}^{n} P_i Q_i = P_1 \cdot Q_1 + P_2 \cdot Q_2 + \cdots + P_n \cdot Q_n \le I$$

$$\frac{MU_1}{P_1} = \frac{MU_2}{P_2} = \cdots = \frac{MU_n}{P_n}$$

Law of diminishing marginal utility, its expressions are

$$\frac{dMU}{dQ} = \frac{d}{dQ}\left(\frac{dTU}{dQ}\right) < 0;$$

Law of diminishing Marginal Rate of Substitution, its expressions are

$$MRS_{XY} = -\frac{dy}{dx} < 0, \ \frac{d}{dx} MRS_{XY} = \frac{d}{dx}\left(-\frac{dy}{dx}\right) < 0; \qquad \text{----------(2)}$$

Increasing returns to scale.

Opportunity cost (opportunity costs is the maximum value in all the selections to give up something in order to get something).

Law of supply and demand.

Value law.

Substitution effect.

Consumer surplus.

Coase theorem (Ronald Coase thinks that in some conditions, the externalities or non efficiency of economy can be corrected by the negotiations of the parties, so as to achieve the maximization of sky-earth ecosystem benefit.).

Say's law.

Keynes rule (Keynes's three basic psychological laws: the law of diminishing marginal propensity to consume, the law of diminishing marginal efficiency of capital, liquidity preference).

Okun's Law (empirical statistics).

Gresham's Law (Gresham's law reveals the phenomenon of "bad money drives out good money").

In addition, there are some resource-allocating "law"s which are not strict formulation and fully demonstrated, such as: a. 80/20 efficiency rule (the 80/20 Principle, also known as Pareto's law, Pareto's principle, the law of least effort, the principle of non-balance); b. path-dependence (Douglass C. North) c.; Matthew effect; d. Veblen effect; e. free rider effect (in collective action, there is such phenomenon that the personal capital gains paid is free shared by other members of the collective); f. Occam's razor law (Entities should not be multi-plied unnecessarily); g. Washington cooperative law (Peter principle); h. Parkinson law; i. catfish effect (pike herding effect) j. herd effect, and so on.

As the important constitute of resource-allocating paradigms, the institutional framework is mainly summarized as follows:

- The system framework to standardize enterprise behavior and organization, the system framework to standardize the market behavior and organization, the system framework to standardize the sky-earth ecosystem behavior and organization;
- The institutional framework to regulate the sky-earth eco-organization and its behavior, the institutional framework to regulate the resource-allocating management and its behavior, and the institutional framework to regulate the resource-allocating system and its behavior.

The resource-allocating paradigm is essentially latent variables which can not be directly measured, and it needs to be measured and expressed by various index systems as indicator variables.

Sky-earth mode variable

As a basic category of resource-allocating dynamics, resource-allocating modes can be understood as the basic economy type determined and influenced by resource-allocating paradigms, it contains the resource-allocating organization mode, resource-allocating management mode, market structure mode, enterprise organization mode, industrial organization mode, regional resource-allocating mode, as well as the whole resource-allocating system mode and resource-allocating management mode.

The resource-allocating mode is also essentially latent variables which can not be directly measured, and it needs to be measured and expressed by various index systems as indicator variables.

Sky-earth structure variable

As a basic category of resource-allocating dynamics, resource-allocating structures can be understood as the basic economy type determined and influenced by resource-allocating paradigms, it contains the resource-allocating organization structure, resource-allocating management structure, market structure, enterprise organization structure, industrial organization structure, regional resource-allocating structure, as well as the whole resource-allocating system structure and national economy structure.

The resource-allocating structure is also essentially a latent variable that can not be directly measured, and it needs to be measured and expressed by various index systems as indicator variables.

Here, by the way:

- The expected return rate of any risky asset = risk-free interest rate + asset risk premium.
- Asset risk premium = risk price × quantity of risks
- Risk price = $E(R_m) - R_f$ (SML slope).
- Quantity of risk = β
- The slope of security market line (SML) is equal to the market risk premium, when the investor's risk aversion is higher, then the greater the slope of SML is, the larger the stock risk premium is, the higher the required rate of securities return is also.
- When the systematic risk of securities (measured by β) is the same, the two are required to pay the same rate of return, this is the single price rule of securities.

Data restructure of sky-earth computing

In the analysis and design of this series of papers, one of the basic goals and tasks of sky-earth computing is to incorporate the various common data collected in existing ways from various fields into the resource allocation relationship in the Internet of everything between information ecospheres and actual ecospheres, to process and recalculate them, so as to obtain the world composite data related to all vertical and horizontal linkages in the various allocating chains, efficacy chains and value chain sn of complex ecosphere systems. This goal and task should be based on all kinds of big data provided by data warehouse, according to the basic relationship set by the theory and method of surpass-actualm composite measurement proposed by the authors of this series.

Through the reconstruction system engineering of sky-earth computing, based on the distributed computing platform HDFS cluster (MapReduce/Tez/Spark, Storm, Presto, etc.), all kinds of original common data from various fields are deduced into the world synthetic data with rich information, and then become the composite data of sky-earth computing. When dealing with the world synthesis of each data, the reconstruction system engineering is based on the calculation formula given by the theory and method of surpass-actualm synthesis metrics. It incorporates this data into the whole world and establishes the connection with all relevant data as far as possible, thus constituting the resource allocation amount and system efficiency quantity and efficacy value as the world synthesis data, as shown in figure 16.

In the reconstruction system engineering of sky-earth computing, the processing, computing and scheduling of data involve the operation layer, business layer, management layer, coordination layer, daily decision-making layer and strategic layer in vertical association, and also involve customers, supervisors, collaborators, assistants, competitors in horizontal association, etc. In the synthetic world of intelligent life, resources can be grouped into three categories: physical resources, information resources and psychological resources; or, they can be grouped into five categories: energy resources, material resources, information resources, knowledge resources and spiritual resources. Physical resources include energy resources and material resources, while psychological resources include knowledge resources and spiritual resources.

Oriented to the physical world, information space and human society, the elements considered in this series refer not only to tangible, basic and indistinguishable elements, but also to invisible, compound and further distinguishable elements, and even to the complex and changeable element of tangible and invisible mixing, which is composed of a large number of elements, so as to be the agglomeration and integration of resources in multi-elements, multi-types, multi-attributes, multi-level, multi-structure and others.

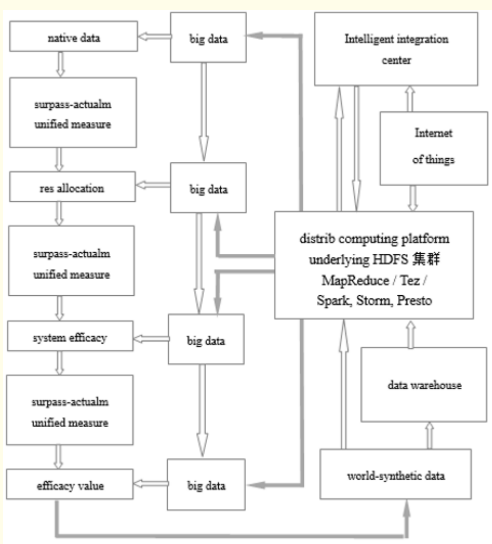

Figure 16: Basic Framework of Data Restructure System Engineering for Sky-Earth Computing.

In the analysis and design of this series, sky-earth computing is composite world computing, which includes resource allocation calculation, system efficiency calculation and efficacy value calculation. In addition, we can establish composite world variables, composite world functions, composite world equations and composite world dynamics model, etc.

For basic elements and complex elements, we consider various attributes of utility.

Basic attributes: efficacy, performance (physical, chemical, biological and technical), quantity.

The main attribute: composition, price, size (size, length, height and width), structure (specific structure and abstract structure), materials, appearance (shape, color, brightness), space (weight, volume, capacity, area), density (hardness), sound, smell.

Additional attributes: quality (convenience of use, reliability, safety, economy, maintainability), brand (grade).

Derived attributes: packaging, producers (Engineering), origin, validity (service life), supply time, credibility, payment methods, after-sales service, taboos (side effects).

To transcend the structure dimensional difference, species different and magnitude gap from the multi-attribute, multi-factor, multilevel and multi-structure, we consider the de-dimension treatment at first, and then extract a new system of measure units, by the set-up of the new variable.

The new design and construction are given as follows:

Combining the natural factors with economic technical factors and subjective psychologically- felt utility factors, by setting up of a certain relation, extract the index such as the natural scarcity, social scarcity and risk degree of system, to introduce the disposal intensity, so as to measure the intensity level for a disposing unit to encounter the constraint of resources, so that the first metric unit system of new science is set up; by setting up of a certain relation, extract the index such as the compensation-effect ratio, effect-difficulty coefficient and sorted priority, to introduce the balanced utility scale, so as to measure the level for a disposing unit to acquire the comprehensive utility, so that the second metric unit system of new science is set up; on this basis, by setting up of a certain relation, extract the disposing efficacy scale with the disposal intensity and disposing utility scale, so as to measure the level for a disposing unit to acquire the efficacy of system, so that the third metric unit system of new science is set up.

As the first step in determining the disposal intensity, we consider to measure the social scarcity in the simplest way as follows:

On some attribute (att; i), through the introduction of the docking control parameter $\lambda_{att,\ i}$ of consumption–compensation, to determine the physical scarcity degree, according to the ratio of the attrition $D_{d;\ att,\ i}$ of a disposing unit (as a basic further-indecomposable system of self organization) for resources to the available compensation $D_{s;\ att,\ i}$ of resources from the environment. The social scarcity degree is denoted as $\eta_{econ;\ att,\ i}$, then there should be

$$\eta_{econ;att,i} = \frac{D_{d;att,i} + \lambda_{att,i}}{D_{s;att,i}},\ \lambda_{att,i} = D_{d;att,i} - D_{s;att,i}, \text{------(3)}$$

Where $\lambda_{att,\ i}$ is the docking control parameter of consumption–compensation on some attribute (att; i).

As the second step in determining the disposal intensity, we consider to measure the natural scarcity in the simplest way as follows:

On some attribute (att; i), it can be considered to set up a certain relation between the total reserves (the largest stock) $Q_{NS\ ;\ att,\ i}$ of the resource that a disposing node have and the attrition (flow) $R_{N;\ att,\ i}$ of the resource in a certain period of time, to determine the natural scarcity degree. The natural scarcity degree is denoted as $\sigma_{N;\ att,\ i}$, then there should be

$$\sigma_{N;att,i} = \frac{Q_{NS\ ;att,i}}{Q_{NS\ ;att,i} - R_{N;att,i}} \in [1,\ \infty), \qquad \text{--------(4)}$$

As the third step in determining the disposal intensity, we consider to measure the risk degree of a system in the simplest way as follows:

Let the fault rate and reliability of resources disposition be respectively $W_r(t)$ and $F_r(t)$, then $W_r(t) + F_r(t) = 1$, where $W_r(t)$ is a function in change started from 0 to increase gradually to 1 with time. The differentiating to $W_r(t)$ is the time ratio in the occurrence of hinder, which can be defined as the "fault density function", denoted as $w_r(t)$: , $\frac{dW_r(t)}{dt}$, $W_r(t) = \int_0^t w_r(t)dt$. Because

$$F_r(t) = 1 - W_r(t) = 1 - \int_0^t w_r(t)dt, \text{ or } F_r(t) = \int_t^\infty w_r(t)dt, \qquad \text{--------(5)}$$

We can get $w_r(t)$ expressed by $F_r(t)$: $w_r(t) = -\,d\,F_r(t)/d\,t$.

So that the failure rate should be defined as follows: until a certain time t, for the reliability $F_r(t)$ without the occurrence of faults, the failure rate is the conditional probability for the fault to occur possibly in the subsequent unit time. The failure rate is denoted as $\lambda_r(t)$, then there should be

$$\lambda_r(t) = w_r(t)/F_r(t) \text{ or } \lambda_r(t) = -\left(\frac{dF_r(t)}{dt}\right)\Big/F_r(t) \qquad \text{-----------(6)}$$

The risk degree of a system is denoted as λ_{sys}, then there should be

$$\lambda_{sys} = \frac{1}{1-W_r} \in [1,\ \infty), \text{----------- (7)}$$

On some attribute (att; i), with the above-given natural scarcity, social scarcity and system risk, we can set up the following formula to calculate the disposal intensity:

$$c_{d;att,i} = \lambda_{sys}\sigma_{N;att,i}\eta_{econ;att,i}$$

$$= \frac{1}{1-W_r}\cdot\left(\frac{Q_{NS\ ;att,i}}{Q_{NS\ ;att,i} - R_{N;att,i}}\right)\cdot\left(\frac{D_{d;att,i} + \lambda_{att,i}}{D_{s;att,i}}\right) \qquad \text{-------(8)}$$

For some disposing node, lets consider I kinds of attributes (i = 1, 2, ⋯, I),with the above- given natural scarcity, social scarcity and system risk, we can set up the following formula to calculate the intensity of disposition-across-actualm:

$$c_{d;full-att} = \lambda_{sys}\sum_{i=1}^{I}\sigma_{N;att,i}\eta_{econ;att,i}$$

$$= \frac{1}{1-W_r}\cdot\sum_{i=1}^{I}\left(\frac{Q_{NS\ ;att,i}}{Q_{NS\ ;att,i} - R_{N;att,i}}\right)\cdot\left(\frac{D_{d;att,i} + \lambda_{att,i}}{D_{s;att,i}}\right) \qquad \text{------(9)}$$

By the disposal intensity, we can set a system of new metric units for the dynamics of interdisciplinary science as follows:

1 disp = disposing Unit (1disp = 1 basic disposition unit)

1 disp = 1 (counting unit) × 1 (disposal intensity C_d = 1), the basic disposition unit with the disposal intensity as 1

1 KD = 1,000 Disp = 1 Kilodisp

1 MD = 1,000 Kilodisp = 1 Megadisp

1 GD = 1,000 Megadisp = 1 Gigadisp

1 TD = 1,000 Gigadisp = 1Teradisp

1 PD = 1,000 Teradisp = 1 Petadisp

1 ED = 1,000 Petadisp = 1 Exadisp

1 ZD = 1,000 Exadisp = 1 Zettadisp

1 YD = 1,000 Zettadisp = 1 Yottadisp

1 BD = 1,000 Yottadisp = 1Brontodisp

1 ND = 1,000 Brontodisp = 1 Geopdisp

On some attribute (att; i), let the total count of resources be $Q_{att, i}$, with the above-given disposal intensity, we can set the following formula to calculate the disposing amount:

$$M_{d;att,i} = \lambda_{sys}\sigma_{N;att,i}\eta_{econ;att,i} \cdot Q_{att,i}$$

$$= \frac{1}{1-W_r} \cdot \left(\frac{Q_{N;att,i}}{Q_{N;att,i} - R_{N;att,i}} \right) \cdot \left(\frac{D_{d;att,i} + \lambda_{att,i}}{D_{s;att,i}} \right) \cdot Q_{att,i}$$

-------- (10)

For some disposing node, lets consider I kinds of attributes (i = 1, 2, ···, I),with the total resources count $Q_{att, i}$ and disposal intensity $c_{d; att, i}$ in each attribute (att; i), we can set up the following formula to calculate the disposing amount of full-attribute balance:

$$M_{d;full-att,\rho} = \lambda_{sys}\sum_{i=1}^{I}\rho_{att,i}\sigma_{N;att,i}\eta_{econ;att,i}Q_{att,i}$$

$$= \frac{1}{1-W_r} \cdot \sum_{i=1}^{I}\rho_{att,i}\left(\frac{Q_{N;att,i}}{Q_{N;att,i} - R_{N;att,i}} \right) \cdot \left(\frac{D_{d;att,i} + \lambda_{att,i}}{D_{s;att,i}} \right) \cdot Q_{att,i}$$

--------(11)

Where $\rho_{att, i}$ is the disposing weight in the i-th attribute.

For N disposing nodes (k = 1, 2, ····, N), lets consider I kinds of attributes (i = 1, 2, ···, I),with the total resources count $Q_{att, i}$ and disposal intensity $c_{d; att, i}$ in each attribute (att; i), we can set up the following formula to calculate the disposing amount of full-attribute balance:

$$M_{d;full-att,\rho} = \lambda_{sys}\sum_{k=1}^{N}\sum_{i=1}^{I}\rho_{att,k}\sigma_{N;att,k}\eta_{econ;att,k}Q_{att,k}$$

$$= \frac{1}{1-W_r} \cdot \sum_{k=1}^{N}\sum_{i=1}^{I}\rho_{att,k}\left(\frac{Q_{N;att,k}}{Q_{N;att,k} - R_{N;att,k}} \right) \cdot \left(\frac{D_{d;att,k} + \lambda_{att,k}}{D_{s;att,k}} \right) \cdot Q_{att,k}$$

---------(12)

Where $\rho_{att, i}$ is the disposing weight in the i-th attribute.

Now, taking an enterprise as an example, the enterprise is attributed as a resource-disposing dynamic system, and is regarded as an input-output system composed of various resource nodes, disposing nodes and organizational nodes. For such a complex input-output system, we can set an uniform measure-across-actualm system for resources dispositions, as shown in table 1 and table 2.

In the analysis and design of this series of paper, we can use the expressions (6), (7) and (9) to calculate respectively the natural scarcity, the social scarcity and the risk of the system for this enterprise as a dynamic resource-disposing system, so as to determine the disposal intensity by Formula (10), so that table 1 and table 2 show an example: on some day of some month of some year the various resources and their disposal intensity and quantity of this enterprise.

For this enterprise as a dynamic disposing system, we consider the various resources, including:

- Financial resources [own funds (10000 yuan), stocks (10000 yuan), bonds (10000 yuan), credit funds (10000 yuan), buyer loans (10000 yuan), supplier loans (10000 yuan), compensation trade (10000 yuan)];
- Physical resources [workshops (m^2), offices (m^2), shops (m^2), service places (m^2) equipment (mechanization rate), major appliances (per capita allocation), materials (unit: 100 kg; to select the maximum in number and weight), land (m^2), residence and store house (m^2)].

Spatiotemporal resources [operation history (days), current time (total by staff, h/w), plan time (total by staff, h/w), project (business category number), range of motion (maximum radius: km)].

Res type		Total count	Intensity	Resources disposing amount
Finan res	Own funds (10000 yuan)	9000	3. 976	3. 976 × 9000 = 35784 disp
	Stock (10000 yuan)	14000	32. 636	32. 636 × 14000 = 456904 disp
	Bond (10000 yuan)	4500	42. 994	42. 994 × 4500 = 193473 disp
	Credit funds (10000 yuan)	8900	23. 583	23. 583 × 8900 = 209888. 7 disp
	Buyer loan (10000 yuan)	80	25. 839	25. 839 × 80 = 2067. 12 disp
	Supplier loan (10000 yuan)	900	3. 286	3. 286 × 900 = 2957. 4 disp
	Compensat trade (10000 yuan)			
Phys.res	Workshops (m^2)	12000	36. 137	36. 137 × 12000 = 433644 disp
	Offices (m^2)	1800	12. 150	12. 150 × 1800 = 21870 disp
	Shops (m^2)	11500	16. 062	16. 062 × 11500 = 184713 disp
	Service places (m^2)	4500	29. 080	29. 080 × 4500 = 130860 disp
	Machine equipm A (number)	1150	11. 632	11. 632 × 1150 = 13376. 8 disp
	Main apparatus (piece) (select maxim by numb&weigt)	10850	25. 682	25. 682 × 10850 = 278649. 7 disp
	Material (unit: 1000 kg) (select maxim by numb&weigt)	2500	20. 791	20. 791 × 55000= 114351. 72 disp
	Land (m^2)	12000	62. 398	62. 398 × 12000 = 748776 disp
	Residence and store house (m^2)	4500	90. 665	90. 665 × 4500 = 407992. 5 disp
T-S res	Operative history (days)			
	Current time (by staff, h/w)			
	Plan time (by staff, h/w)			
	Project (number of types)	35	6. 953	6. 953 × 35 = 243. 355 disp
	Range of motion (radius: km)	4200	13. 526	13. 526 × 4200 = 56809. 2 disp
Technq res	Basic technology (staffing)	90	12. 881	12. 881 × 90 = 1159. 29 disp
	Main technology (staffing)	120	18. 115	18. 115 × 120 = 2173. 8 disp
	Assistive technology (staffing)	250	4. 152	4. 152 × 250 = 1038 disp
	Technology patent (evaluation)	750	60. 162	60. 162 × 750 = 45121. 5 disp
	Process technology (staffing)	55	4. 932	4. 932 × 55 = 271. 26 disp
	Maintain technique (staffing)	60	4. 405	4. 405 × 60 = 264. 3 disp
	Management technique (staffing)	40	10. 940	10. 940 × 40 = 437. 6 disp
	Decisn-mak technique(staffing)	45	26. 063	26. 063 × 45 = 1172. 835 disp
	Informate technology (staffing)	75	11. 468	11. 468 × 75 = 860. 1 disp
	Marketing technique (staffing)	65	21. 765	21. 765 × 65 = 1414. 725 disp
	Planning skill (staffing)	20	23. 144	23. 144 × 20 = 462. 88 disp
	Public-relation skill (staffing)	35	16. 051	16. 051 × 35 = 561. 785 disp
	Machine equipment B (number)	355	9.537	9.537 × 355 = 3385. 635 disp
	Machine equipment C (number)	275	8.679	8.679 × 275 = 2386. 725 disp

Table 1: The Current Total Count, Disposal Intensity and Amount of Some Enterprise (A).

Res types		Total count	Intensity	Resources disposing amount
Inform res	Historical information (MB)	950	9. 561	9. 561 × 950 = 9082. 95 disp
	Decision-make information (MB)	1100	181. 801	181. 801 × 1100 = 199981. 10 disp
	Product information (MB)	1200	22. 348	22. 348 × 1200 = 26817. 6 disp
	Technical information (MB)	1250	46. 185	46. 185 × 1250 = 57731. 25 disp
	Management information (MB)	850	8. 921	8. 921 × 850 = 7682. 85 disp
	Market information (MB)	1450	44. 137	44. 137 × 1450 = 63998. 65 disp
	Material information (MB)	650	17. 042	17. 042 × 650 = 11077. 3 disp
	Service information (MB)	380	14. 331	14. 331 × 380 = 5445. 78 disp
Brand res	Product brand (evaluation)	3100	30. 864	30. 864 × 3100 = 95678. 4 disp
	Service brand (evaluation)	2800	33. 295	33. 295 × 2800 = 93226 disp
	enterprise brand (evaluation)	5500	46. 939	46. 939 × 5500 = 258164. 5 disp
Culture res	Corporate image (by staff)	5345	14. 674	14. 674 × 5345 = 18432. 533 disp
	Corporate credit (by funds)	37380	9. 273	9. 273 × 37380 = 346624. 74 disp
	Corporate cohesion (by staff)	5345	8. 668	8. 668 × 5345 = 46330. 46 disp
	Organization morale			
	management style			
Manag res	Management system (by staff)	5345	17. 489	17. 489 × 5345 = 93478. 705 disp
	Organization institution (by staff)	5345	10. 157	10. 157 × 5345 = 54289. 165 disp
	Management statics			
	Personal composition			
	Management method			
Human res	Decision maker (by staff)	5345	14. 290	14. 290 × 5345 = 76380. 05 disp
	Management staff (by number)	200	8. 365	8. 365 × 200 = 1673 disp
	Technical staff (by number)	305	18. 733	18. 733 × 305 = 5713. 565 disp
	Basic workers (by number)	2400	7. 347	7. 347 × 2400 = 17632. 8 disp
	Assistive workers (by number)	1150	6. 82	6. 82 × 1150 = 7843 disp
	Marketing staff (by number)	340	4. 980	4. 980 × 340 = 1693. 2 disp
	Service staff (by number)	950	8. 890	8. 890 × 950 = 8445. 5 disp
Market res	Leverage resources (by input)	4550	19. 435	19. 435 × 9950 = 193378. 25 disp
	Collaborate resources (by input)	2650	7. 654	7. 654 × 2650 = 20283. 1 disp
	Social resources (by input)	1770	8. 542	8. 542 × 1770 = 15119. 34 disp
	Cultural resources (by input)	1250	4. 240	4. 240 × 1250 = 5300 disp
	Other resources (by input)	2950	5. 500	5. 500 × 2950 = 16225 disp
Count	Add up to Tables (A) and (B)			5304898. 048 disp

Table 2: The Current Total Count, Disposal Intensity and Amount of Some Enterprise (B).

Information resources [historical information (calculated MB), decision information (calculated MB), product information (calculated MB), technology information (calculated MB),management information (calculated MB), market information (calculated MB), material information (calculated MB), service information (calculated MB)].

Brand resources [product brand (market value calculation of utility), service brand (market value calculation of utility), enterprise brand (market value calculation of utility)].

Cultural resources [corporate image (by grading), enterprise credit (by grading), enterprise cohesion (by grading), organizational morale (by grading), management style (by grading)].

Management resource [management system (by availability %), organizational institution (by availability %), management statics (by success rate %), personnel composition (by qualified rate %), management methods (by grading)].

Human resources [decision makers (by total revenue), managerial staff (by number), technical staff (by number), basic workers (by number), assistant workers (by number), marketing staff (by number), service staff (by number)].

Market resources [leverage resource (by contribution rate %), collaborative resources (by contribution rate %), social resources (by contribution rate %), cultural resources (by contribution rate %), and other resources (by contribution rate %)].

Conclusion

The task of sky-earth computing involves two aspects: on the one hand, to realize the integration and rational allocation of the information world (digital and analog information world); on the other hand, to realize the integration and rational allocation of the actual world (physical and psychological actual world).

The sky-earth interface system and its channels enable users (individuals, organizations, and Society) to work with multi-channel programs in the physical world, the information world and the psychological world at the same time in their own world. The operation program of each channel runs in the user's own sky-earth channel, that is, in the graphics on the display screen. Most of the sky-earth channel systems allow channels to overlap, and provide users with standard operations to run, such as moving and changing the size of the visual gate, sending the visual gate to the foreground and background, or expanding or narrowing a sky-earth channel. The sky-earth channel interface system should have the network permeability ability of the interconnection of all things, and allow users to run the channel graphics application program on the remote machine.

With the support of IT and network technology, we can develop and build the super metaverse system (SMS) centered on cybertech users, integrating cyber-physical system (CPS-1) and its processes with cyber-physiological system (CPS-2) and its processes, cyber-psychological system (CPS-3) and its processes, as well as cyber-event reason system (CES) and its processes. According to the analysis and design of this series of articles, through big data platform, Internet of things and artificial intelligence technology, we build intelligent integrated system, carry out data reconstruction system engineering, so as to establish the computer-like system (CLS) for big data processing, It combines all kinds of resource elements involved in computing in the information ecosphere with those involved in computing in the real ecosphere. With data reconstruction system engineering, any system is reduced to a dynamic system of resource allocation, and the basic unit of the analysis object is reduced to the aggregation and integration of multi-attribute, multi factor, multi structure and multi-level resources, so that natural scarcity, configuration scarcity and system risk are proposed. A measurement system of multi-attribute tradeoff configuration with system configuration intensity as its base is established. A new related framework, method and example are proposed.

For this highly intelligent and integrated computer-like system, not only thousands of computers, mobile communication tools, robots, Internet and the Internet of things in the information ecosphere become its internal factors participated in computing, but also thousands of people who use computers, mobile communications tools, robots, the Internet of things in the real ecosphere become its internal factors participated in computing.

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