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A GLOBAL DISTRIBUTED SERVICE SYSTEM FOR NEW INDUSTRIAL REVOLUTION AND SOCIAL DEVELOPMENT

Abstract: The rapid development of the IoT and mobile devices without and with internet connection represent the most common area of application. The trend is that the most significant information processing around us is at the lowest possible level, directly connected to the physical environment and mostly directly controlling our immediate human environment. The most significant information processing around us takes place at the lowest possible computer level, directly connected to the physical environment and mostly directly controlling our immediate human environment. We find these „invisible" information processing devices in home entertainment systems, in traffic control systems, in industry and in industrial products. These devices, which are neither in the cloud nor at the mobile edge, but at the physical edge of computing, form the basis of the Dew Computing paradigm [1]. The benefits of seamlessly integrating devices into the Cloud — Fog — Dew computing hierarchy are enormous, for individuals, the public and industrial sectors, the scientific community and the commercial sector, by enhancing the physical and communicative, as well as the intellectual, immediate human environment. It is therefore imperative to explore the possibilities of Dew Computing through research, innovation and development, to solve the fundamental problems of integrating the Dew-Fog-Cloud hierarchy, with particular attention to the need for information processing (and not just data) and communication, and to demonstrate the feasibility and high effectiveness of the developed architecture in various areas of human endeavour through real-world implementations.

Dew computing differs from classical cloud and edge computing in that it brings devices closer to the end user and enables autonomous processing independent of the Internet, but is still able to interact with other devices to exchange information over the Internet. The difference is also expressed in terms of scalability, as edge and cloud providers

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can provision (almost endless) resources, whereas scalability in dew computing has to be realised at the device level rather than at the server level. Such devices can be ubiquitous and pervasive devices in our environment, embedded processors, cyber-physical systems or other IoT devices.

The rapid development of IoT and mobile devices without and with internet connectivity is the most common application area. The trend is for the most important information processing around us to be at the lowest possible level, directly connected to the physical environment and mostly directly controlling our immediate human environment. These devices, which are not at the cloud or fog edge, nor at the mobile edge, are the foundation of the dew computing paradigm.

In the distributed cloud dew service architecture, a cloud server and many dew servers work together as a distributed application to provide controls or services.

Multiple clouds in symbiosis result in a cloud federation that connects the cloud service environments. Federated cloud services provide global Rainbow services based on the Dew server connecting directly to a user [4].

In this paper, three global grids are introduced: the energy grid, the information grid (www) and the service grid (Rainbow). These three grids will define the technical civilisation and infrastructure for artificial intelligence on Earth and shape the new industrial revolution in the future.

Key words: *Distributed Computer Services, Rainbow service, Dew-Computing, Fog-Computing, Cloud-Computing*

INTRODUCTION

Modern computing paradigms foster a vast community of participants from almost the entire spectrum of human endeavour. For computing and data processing there are individual computers, clusters, grids and finally the clouds. For pure data communication, there is the Internet and for human comprehensible information communication, there is, for example, the World Wide Web [5]. The rapid development of mobile handheld devices with high computing capacities and internet connections made it possible to „downgrade" certain parts of the clouds to so-called „thin clients". This led to the development of the Fog computing paradigm and the concepts of the „Internet of Things (IoT)" and the „Internet of Everything (IoE)".

However, most of the information processing around us takes place at the lowest possible computing level, directly connected to the physical environment and mostly directly controlling our immediate human environment. We find these „embedded" information processing devices everywhere (cars, air conditioners, vending machines, traffic controls...) and comprehensive products throughout industry. These devices, which are neither at the edge of the cloud nor at the mobile edge, but at the physical edge of computing, are the basis of the Dew Computing paradigm.

Horizontal scalability is an approach to capacity expansion based on connecting multiple hardware or software units so that they operate as a single logical distributed service unit. Horizontal scalability contrasts with vertical scalability, where capacity is increased by adding more resources and functional capabilities to the service environment. The vertical Dew-Fog-Cloud-Fog hierarchy represents the upward scaling of services, while horizontal scalability is often referred to as downward scaling, where functional capability is expanded.

The Dew computing paradigm focuses primarily on devices that control the physical environment, i. e. lighting, traffic control, heating, cooling, power distribution, etc., where human control of the environment must take precedence over, or at least be coordinated with, possible higher-level requirements without disrupting the immediate human environment. For this reason, Dew Computing has two basic concepts that do not exist in the rest of the hierarchy: Fog and Cloud: self-sufficiency and cooperation [2][4].

The Fog computing paradigm aims to enable the use of a cooperative multiplicity of end-user clients or user-facing edge devices (e. g., including the mobile edge) to greatly enhance and extend the available communication, computing and data resources, with particular attention to the spatial proximity of end-users and their specific goals [1].

The cloud computing paradigm aims to provide ubiquitous and convenient on-demand network access to a shared pool of configurable computing and data resources.

THE DEW COMPUTING

At the level of what is often referred to as the „Internet of Things (IoT)", there is a whole range of extremely heterogeneous devices, some of which are highly complex and whose full processing power often exceeds the capabilities of workstations and servers from the beginning of this millennium, to very simple devices connected via a network. However, the network movement inherent in the term IoT does not include the simplest specialised devices with extremely low processing power (such as processors with 32 bytes of memory and 1K of programme, e. g. in simple sensors, simple environmental control devices, etc.). It is important to realise that most of the information processing around us takes place at the lowest possible computer level, which is directly connected to the physical environment and mostly directly controls our immediate human environment. We find these „invisible" information-processing devices in the engine of our car, in the refrigerator, in the gas boiler, in air conditioners, vending machines, musical instruments, radio receivers, home entertainment systems, traffic control systems, theatres, lights and everywhere in industry. These devices, which are neither in the cloud nor at the mobile edge, but rather at the physical edge of computing, are the foundation of the tau computing paradigm. The main challenge is to enable the seamless integration of these devices with higher-end devices in the Fog and in the Cloud, leading to new development perspectives and new usage scenarios.

The fundamental Dew computing element is the Dew Dropslet, which consists of a self-organising, cooperative communication layer, an ontological „interpreter" and individual physical Dew devices that contain all the necessary sensors, effectors and required algorithms to autonomously perform their task, as well as a physical communication layer. In other words, the individual physical microcontrollers may or may not produce information (i. e. ontological context messages), but must at least have the ability to receive „suggestions" and transmit data. Of course, specific application solutions need to be developed to physically and informationally connect Dew devices and Dew drops in the Dew computing ecosystem [4].

DEW, FOG, CLOUD HIERARCHY SERVICE LAYERS

As far as the technological aspect is concerned, in computer science we have recently been able to observe a paradigmatic hierarchical system consisting essentially of three levels [4][5].

Let us start with the lowest level, the level of devices and appliances that are directly responsible for our physical environment and control everything from soil moisture to public lighting, from the temperature in the house to traffic lights — in recent years we have recognised the paradigm of Dew Computing [1]. In general, Dew Computing is responsible for the layer of devices that resides below the Internet boundary and is directly responsible for certain physical aspects of our environment. In Dew, devices can coordinate or be coordinated with each other, but they cannot be „ordered" outside of the parameters set by the human user or a natural process. Therefore, Dew Droplets, the fundamental components of Dew, must follow two important principles that do not exist in the rest of the hierarchy — self-sufficiency and cooperation. At this level, information processing is crucial.

When the dew evaporates to slowly become a cloud, or the cloud touches the earth to spread the freshness of the dew over nature, the fog is in between. Fog computing is the hierarchical layer between the heterogeneity of dew devices, the complexity of cloud processing and the arbitrariness of human users.

The key areas that Fog computing needs to address are ergonomics, human-computer interaction, service delivery support, multi-service edge computing, adaptive application support, communication mobility and redirection, etc. Given Fog's central role as the primary link to humans, a consistent and extensible ontology would greatly enhance human-computer interaction capabilities by easily integrating with specific human language forms and enabling seamless two-way communication. Although devices at the Tau level must be directly accessible for manual control, it is easy to imagine that most of the monitoring, control and coordination of these devices could fall into the realm of the nebula.

The third level in the emerging computing hierarchy is the level of Clouds. Clouds are far away, somewhere, nobody knows where because it is irrelevant. Cloud computing is responsible for networking, monitoring, modelling and control (suggestive and/or directive), mass storage, extended use... There is High Performance Computing (HPC), High Throughput Computing (HTC), the evolving field of High Productivity Computing (HProC), the realm of artificial intelligence.

Against this backdrop, clouds are the most important glue of the global system. However, they are still primarily data-centric. This is easily seen in the scientific environment, where the use of results obtained by others can be extremely complicated due to inconsistent global data formats and the often complete lack of ontologically systematised metadata. This is also painfully evident in the enormous amount of special, specific and „proprietary" data formats, each of which is defined programmatically or even syntactically, but not ontologically and semantically.

THE RAINBOW

The other two overarching aspects of the activities that computer science must incorporate through its philosophy, human cooperation and technological development, are the humanistic and naturalistic aspects of its endeavours. It is true that computer science is still seen as a technical science. However, it is clear from the preceding discussion that developing a philosophy of computer science and basing future „naturo-humano-technological" developments on a full multidisciplinarity across the spectrum of sciences is critical to shaping the envisioned global information processing environment as a sustainable, human- and nature-friendly, self-organising global ecosystem. A first look at the computer architecture of such a future rainbow computing environment is presented in more detail.

The use of colours, as in healing, as symbols in philosophy, is ancient. Let us therefore take some symbolic meanings of colours to illuminate the all too complex field of computing from a distance. Note that each of these symbolic colours has a basic meaning and must of course cover a wide range

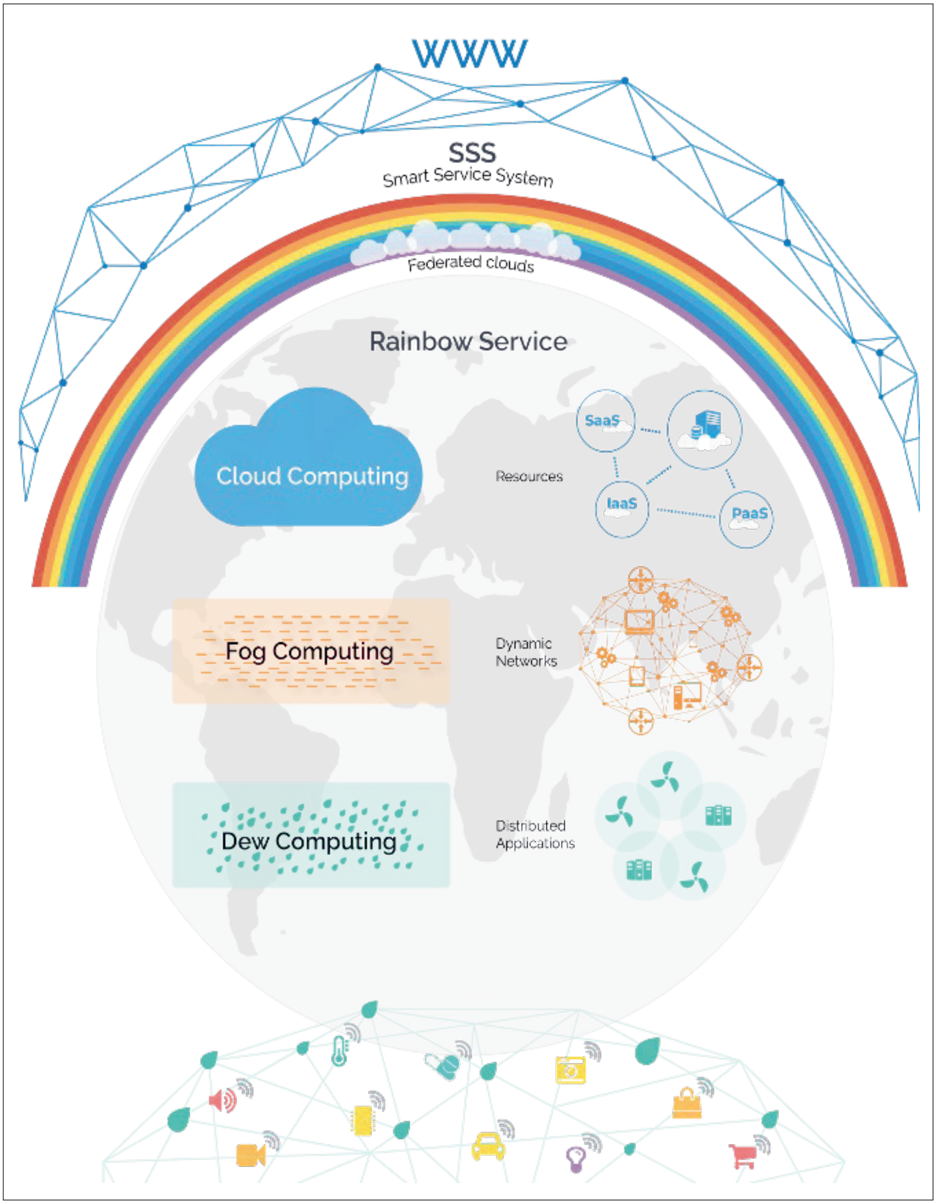

Fig 1. Vertical Distributed Rainbow Smart Service System

of elements. Like sunlight itself, all the symbolic rainbow colours are closely interwoven. This means that any single study or development of one of these colours must also take into account all the others.

THE MEANING OF RAINBOW COLORS REGARDING OF ICT

— **Red** — *Hardware: Architecture, memory, operations.*
— **Orange** — *Creativity: Stimulation, ideas, education.*
— **Green** — *Nature: Environment, health, well-being, backup systems, global ecosystem.*
— **Blue** — *Communication: Information, knowledge, human-computer interaction, languages.*
— **Indigo** — *Cooperation: Ethics, information use, redundancy, knowledge gathering and preservation.*
— **Violet** — *Interference: Security, limits of expansion, human-computer interference, interference processing.*,
— **Ultraviolet** — *Visions: Wisdom, prudence, conscience, responsibility, holism.*

THE GLOBAL SERVICE PROCESSING ENVIRONMENT

In the possibility of developing integrated home management/entertainment/maintenance systems, self-organising traffic-control systems, intelligent driver suggestion systems, coordinated building/car/traffic pollution control systems, real-time hospital systems with all patient and equipment status and control collaborating with the medical staff, fully consistent synesthetic artistic performances including artists and independent individuals („active public") from wide apart, power distribution peek filtering, self-reorganisation and mutual cooperation systems based on informed behavior of individual power consumption elements, etc., the Dew-Computing paradigm shows the way towards the Distributed Information Services Environment, and finally towards the present civilisation's aim of establishment of a Global Service Processing Environment, *Rainbow service* [5].

The *Rainbow service*, seamlessly connecting all computing hierarchy layers, will have to be established through horizontal self-organising coordination of individual Dew-droplets (i. e. the dew devices with communication/self-organisation possibilities) and vertical Fog/Cloud integration based on the newest developments of the Fog computing paradigm. The collaboration of Dew-droplets shall primarily be established on the level of their information exchange and self-organising coordination by (intra-) networking them, using proper ontologies/protocols and security/privacy and QoS based channels [3]. By having a common ontological basis on all hierarchical levels, i. e. throughout the „rainbow" of computing, and by developing common interaction protocols and information/instruction languages, such self-coordinating and collaborating systems of individual Dew devices will then, as micro services, be seamlessly integrated higher up into the computing hierarchy through Internet gateways into the Fog and Cloud, enabling the coordination of the physical edge control through common strategies and multi-level intelligent behavior, including adaptive-learning, predicting and other aspects of cognitive computing, with multi-modal user interfaces to facilitate appropriate Human/Computing interaction [3].

The merits of seamlessly integrating those „dew“ devices into the Dew-Fog-Cloud computing hierarchy in form of *Rainbow service* are enormous, for individuals, the public and industrial sectors, the scientific community and the commercial sector, by bettering the physical and communication, as well as the intellectual, immediate human environment.

THE GLOBAL ENERGY, INFORMATION, AND FUTURE SERVICE GRID SYSTEM

The discovery of the three-phase energy system at the end of the 19th Century, the inventions of Nikola Tesla created the first Analogue Grid or Energy network on the globe. This grid provides the distribution of energy as desired and to every point of the globe. It started the second Industrial revolution, the beginnings of intensive development of technical civilization. In 1980, began developing the Worl Wide Web (www), which became the information global distribution digital network system on earth. Today through the www we are retrieving information globally. The global distribution network www system played a major role in the proven third industrial revolution. At the turning point of the millennium 2000, computer grids were announced as distributed, integrated computing network. This creates a distributed service system whose system architecture is addressed in this article, Fig1. Launching Dew computing services on the elemental service level with possible symbiosis and integration through Fog services (Dynamic Network Reconfigurable Services) to the Cloud computing service. Such virtual distribution Cloud services in form of federations can create Global Service Systems which in this paper called Global Rainbow Service. This global three-grid (energy, information, service) distributed system is the technological basis for the fifth Industrial revolution in which these three global Grids will be supported for the functioning of Artificial intelligence and advanced global cooperative systems (distributed robotics), in order to achieve the results and effectiveness of globalization and to establish highly utilized technical intelligence on earth. This

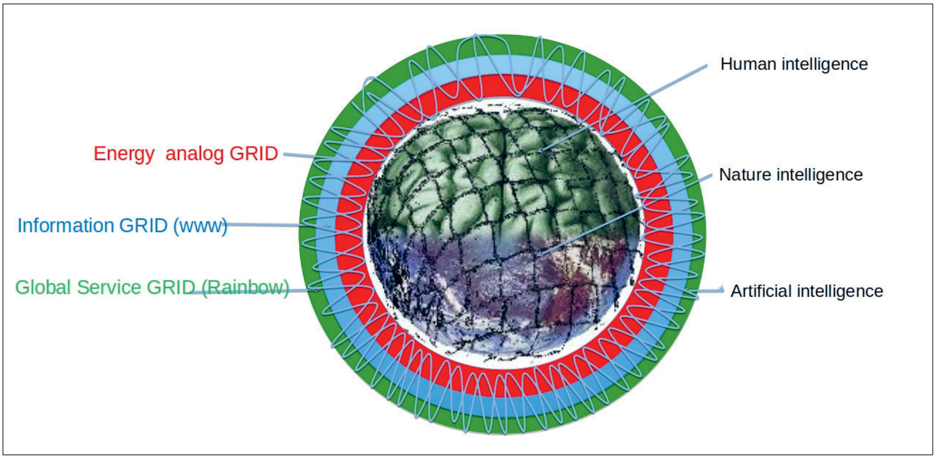

Fig 2. Artificial intelligence as an upgrade of Nature and Human Intelligence

Artificial intelligence is an upgrade of Nature and Human intelligence that creates new social environments, living echosystem and advanced perspectives on earth, Fig 2.

CONCLUSION

According to Dew, the Fog and Cloud computing extend the computing environment in a geographically distributed and hierarchical organization all over covering service technology.

The paper presents three global grids: the energy grid, the information grid (www) and the service grid (Rainbow). These three grids will define the technical civilization and infrastructure for Artificial intelligence on earth and mark the new Industrial revolution in the future.

The Dew-Computing Paradigm may well be the final missing ingredient to the computing development, transforming the all-pervading clusters, grids, clouds and fogs of computers into a human-helping Global Service Information and Processing Environment called *Rainbow Global Service* [5].

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