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FUTURE NETWORKS – AN SOA PERSPECTIVE DESIGN GOALS

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Abstract: Mobile networks have immensely changed people's lifestyles. They become an essential part of our social infrastructure not only in the field of business communications and services but also in our everyday social lives. However, the current networks facing a critical crisis in addressing the changing and emerging requirements of the future community including the new Information and Communication Technology (ICT) application areas such as the Internet of Things, smart grids, and cloud computing. Such recent provisions can be effectively fulfilled with certain inevitable developments in the existing networks. In this context International Telecommunications Union-Telecommunication standardization sector (ITU-T) has developed its preliminary recommendations for the Future Networks (FNs) with new objectives and design goals that can overcome the crisis and provide futuristic functionalities. In this paper, we characterize the ITU-T standardized FN environment and its exhaustive context. This paper also provides an inherent Service Oriented Architecture (SOA) and its principles that can be utilized to assist in realizing the objectives and design goals of the Future Networks.

Keywords: Future Networks, ICT, IOT, Cloud Computing, SOA, Service diversity, Virtualization of resources, Service Universalization, Network management. Mobility.

I. INTRODUCTION

Global data traffic has been increasing explosively, especially after various forms of multimedia traffic were introduced to the current networks. The behavior of subscribers has been significantly changed to mobile. According to Cisco VNI Forecast, It is projected that the global mobile data traffic per month will be 49 exabytes by 2021, and the annual traffic will outstrip half a zettabyte [1]. Mobile will generate 20 percent of entire IP traffic by 2021 [1]. Therefore it is generally envisioned that these augmented mobile devices with bursty traffic might turn down the entire network. It also makes it flinty to allocate the required information and communication technology (ICT) resources, in advance.

The emergence of new technologies and application areas such as the Internet of Things, cloud computing, smart grids, and also the new social requirements necessitates quite new diversified features from current networks. Few examples of these new features are name-based data access, simplified mobility aspects, service universalization, high security, virtualization, etc.

Future networks, which will be a future fundamental infrastructure should address those aforementioned new features in an effective manner. These networks should also adaptively react to such dynamic environment to provide users with the means to access the required services without interruption.

This paper presents the essential concepts of Future Networks architecture and their design goals in service orientated paradigm perspective. This paper is structured as follows. Section 2 describes the ITU-T recommended objectives in its FNs standardization process. We further explained in Section3, some high-level capabilities and characteristics that are regarded as the design goals that are to be supported by the Future Networks. Section 4 illustrates the basic concepts and key principles of SOA. Section 5 explores how the SOA principles can be utilized to assist in realizing the objectives and design goals of FNs. Finally, the paper is concluded in Section 6.

II. FUTURE NETWORKS – AN ITU-T STANDARDIZATION

A Future Network (FN) is an enhanced version of existing networks. FNs are regarded as a heterogeneous collection of new and existing component networks that are able to provide sophisticated services, capabilities and facilities difficult or impossible to provide using existing network technologies [2].

The current networks are using IP as their backbone to provide their intended services. Whereas the Future networks, which can be designed in clean slate approach will deliver the newly emerging and futuristic services beyond IP. The services being available with the existing networks and the services to be provided in the future networks are shown in figure 1.

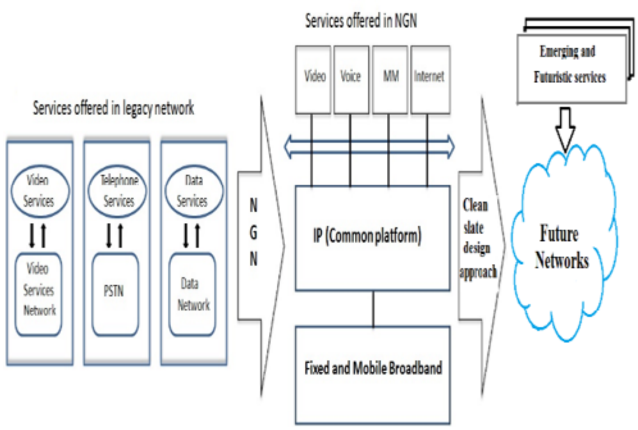

Figure 1: Services in existing `networks Vs Future Networks

As the emerging technologies introducing new requirements to networks, the network architecture is therefore carefully designed to be flexible enough to satisfy continually changing requirements. The design and implementation of future networks require new paradigms and development approaches to address its underlying challenges and potential promises, such as security and privacy, and ease of brand-new access technologies [3]. Besides these challenges, the future networks should be designed in a way that is greatly interoperable, more flexible and cost-effective. In this context, ITU -T in its recommendation Y.3001 identified the following four objectives to be attained by FNs. Figure2 depicts those four objectives.

- Service awareness
- Data awareness
- Environmental awareness
- Social and economic awareness

Figure 2: The four objectives of Future Networks

These objectives not only differentiate FNs from the existing networks but clearly reflects the new requirements that are emerging. In the sections following, we elaborate on these objectives and their application.

2.1 Service awareness

ITU-T recommends FNs to provide customized services, having the functions that apt perfectly to the demands of its users. These services should be accommodated having no increase in operational costs. We can anticipate a number of diversified services in the nearest future. Hence it is preferable for the FNs to provide easy methods for the deployment, management, and evaluation of the new services.

2.2 Data awareness

Data awareness is the core objective of future networks that clearly reflects its emerging requirements. It is essential for the FNs to enable its users to access the required information conveniently and safely regardless of their location in an efficient manner, which makes the FNs distinct from the existing location-based data access. In this context, FNs architecture must be designed in an optimized way that is appropriate to handle enormous amounts of data in a scalable manner.

2.3 Environmental awareness

As the environmental issues will be vitally important considerations over a long time, FNs are recommended to be environmentally friendly. Environmental awareness is one significant objective that promotes energy efficiency. Hence it is essential for the FNs to reduce the amount of energy required to deliver its services. Therefore FNs must be designed and implemented in a way they can play their part better in energy conservation.

2.4 Social and Economic awareness

FN aims to the reduction of barriers for entering FNs ecosystem by reducing life cycle costs and be easily deployable and more sustainable. As sustainability will be another vital important consideration over a long time, FNs should consider social and economic issues to reduce barriers and allow desired competition and appropriate return for all actors involved in the network ecosystem. It is highly recommended for the FNs to elevate the access to information provided through telecommunications in order to promote service universalization aiming to bridge the digital gap.

III. DESIGN GOALS

ITU-T identified a list of twelve design goals in order to realize FNs objectives. We depicted those twelve design goals and their relation to the above mentioned four objectives of in Figure3:

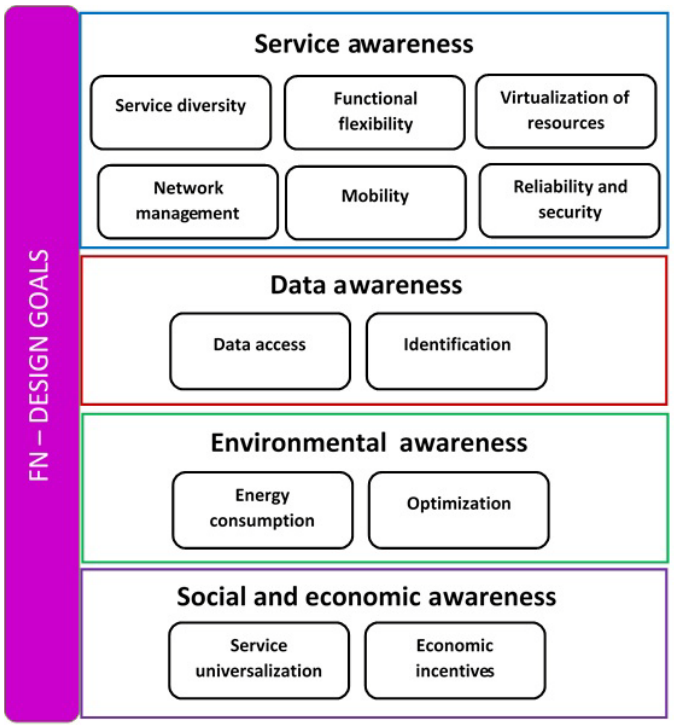

Figure 3 -- Twelve design goals of Future Networks.

3.1 Service Diversity

The services offered in the future will become variegated with the appearance of brand-new services having divergent traffic characteristics. This clearly indicates that the FNs should support these services in an effective manner, which the existing networks do not handle.

FNs should support a variety of infrastructure including sensors, radio frequency identification devices and other ICT tools that assist in the dynamic provision of a broad communication environment. One of the challenging roles FNs should handle is the establishment and maintenance of seamless coordination among various communication objects with diversified requirements ranging from ubiquitous sensor networks to some high-end applications with high realistic sensation.

3.2 Functional Flexibility

FNs are endorsed to provide functional flexibility to aid and sustain brand new services acquired. This clearly unveils the need of configuration pliancy in order to support the dynamic maintenance of multiple access technologies.

3.6 Service Universalization

The current networks agonize from the entry obstacles ranging from the development of communication infrastructure to the provision of services to their users. In this perspective, FNs are recommended to facilitate service universalization through open network ideologies particularly in rural areas and remote locations, which are far behind the network availability. Thus service universalization becomes a key objective in realizing the future networking. In addition to these, the universal standards and simple strategies of FNs might be helpful to reduce the digital divide, which is a crucial issue of today's society.

3.3 Virtualization of resources

Virtualization is a key concept that allows physical I.T resources to provide multiple virtual images of themselves so that the underlying process capabilities can be shared by multiple consumers. This principle supports resource partitioning and optimal consumption of FN resources. Besides these benefits, Because of the highly dynamic nature of virtualized environments, security and monitoring of performance assume major challenge in the Future Networks.

3.4 Data access

Data access assumes more significance and is treated as the principal design goal of future networks. This design goal has to gain importance especially in the form of a network architecture named Data Aware Networking (DAN) in ITU-T [4]. It allows the FNs to retrieve the required data notwithstanding its location.

In this data-driven era, consumers, ubiquitous sensor networks, and social networks are generating vast amounts of data. And in overall the global data traffic has been increasing dynamically having its major part deriving from the multimedia traffic. Such huge volumes of data not only required to be stored in a scalable, distributed data store but also brings an essential requirement for FNs to allow its users quick access the requested data simply and safely regardless of its location.

Because of cloud computing and Information Communication Technologies (ICT) resources, the traffic trends in the networks will depend mainly on the location of data, which greatly increases the performance overhead at the data centers. These changes need to be addressed in FNs with an aim of improving Quality of Experience (QoE) of its users.

3.5 Energy consumption

An eco-efficient configuration of a network greatly be able to reduce its ecological impact and can reduce the service provider's expenditure in network maintenance. Hence it results in offering best ever qualitative services for their consumers at an affordable pricing. In order to attain this, ITU-T recommends it is necessary to improve energy efficiency in FNs by using prospective energy reduction approaches such as equipment-level and network-level approaches in addition to the existing approaches.

3.7 Economic incentives

FNs should initiate the necessary steps in lowering the barriers for stakeholders to provide a sustainable competitive environment [5]. Such participants require to be provided with some economic incentives [6]. Governments and telecom regulatory authorities should provide the required initiatives in order to promote the manufacturing of FN equipment locally, which can improve the nearby availability of network equipment and thus reduce the burden of importing the equipment from foreign countries. It also requires sufficient improvements in ease of doing business, spectrum management and sharing, and necessary reforms for various participants in such a way that encourages them in extending their services to the far rural areas.

3.8 Network management

Future Networks are envisioned to deliver sophisticated services, capabilities, and facilities to all its users in a flexible manner. Today's data-driven world incessantly generating vast amounts of data and the recent technologies such as Internet Of Things (IoT), Cloud Computing, Smart grid and other allied aspects are increasing the number of diversified services and entities. A well-constituted network management information system might able to apply advanced analytics to get deeper insights on this data with an aim to discover much vital information, which is essential for the better maintenance and guiding timely enhancement of the network. Therefore a refined cost-effective, highly efficient, modern network management approach is essential for future networks.

3.9 Mobility

Mobility is an essential requirement for the networks to offer seamless, uninterruptable provision of diversified services to its users. In order to realize this, the mobile networks are continually evolving to fulfill the new requirements of the brand-new technologies having multiple access technologies. Predominantly, the internet accessible mobile devices are greater in number compared to the fixed computers, these days [7]. Therefore, the FNs should be enriched with the innovative mobility features to deliver the high-level quality of service across all the available mobile environments regardless of nodes mobility capability.

3.10 Optimization

Developing and expanding a network to fulfill the dynamic demands of their consumers is a challenge. Network optimization strategies not only ensures better usage of the network resources but also improves the network efficiency. Therefore it is essential for the future networks to build with different optimization techniques to process the consumer raised requests and their responses before transmitting them in order to promote dynamic and scalable performance, which saves the network resources.

3.11 Identification

It is essential for the Future Networks to support uninterrupted communication for the devices with mobility as they are moving across multiple access networks. This can be effectively realized with some advanced and efficiently scalable identification structures, which lacks in existing networks that depend on IP addresses to identify and locate their devices. Therefore, the FNs need to be designed with futuristic identification schemes in a way that effectively supports mobility and data access design goals in a scalable manner.

3.12 Reliability and Security

According to ITU-T, FNs are regarded as a heterogeneous collection of new and existing component networks that are able to provide sophisticated services, capabilities, and facilities to the users. Such heterogeneous networks might carry some challenges in terms of reliable and secure communications. Hence the future networks should be designed in a flexible way that can deliver reliable communications even at the time of natural calamities or disaster situations and can be able to reconfigure in a dynamic manner by integrating a wide range of measures to manage the risks involved.

In addition to the reliability, future networks need to be reinforced by incorporating sophisticated security policies in order to protect their usability and integrity with an aim to intensify the end user trust on to the networks. It requires various network monitoring and security methodologies to be designed and deployed to protect the networks against a variety of threats.

IV. SERVICE ORIENTED ARCHITECTURE – A FUTURE NETWORKS PERSPECTIVE

This section presents a brief introduction to the basic concepts and key principles of Service Oriented Architecture and then in the next section we will elaborate on how the SOA concepts facilitate in the management of FNs.

4.1 Service Oriented Architecture

Service Oriented Architecture (SOA) refers to a set of components that provides a model of creating, assembling and utilizing the distributed capabilities via well published and discoverable interfaces. According to OASIS, SOA is defined as a software architecture of services, policies, practices, and frameworks in which components can be reused and repurposed rapidly in order to achieve shared and new functionality [8]. SOA can be characterized by its elements and core principles. In this section, we examine the elements and key principles of service-oriented architecture.

4.2 Elements of SOA

Service is the central concept in SOA. It enables access to one or more capabilities by means of a service interface that follow the policies specified by its service description.

There are three core elements in SOA:

- A *Service Provider*, who allows access to services, creates a description of services and publishes it to the Service Registry.
- A *Service Consumer* is the service requester, who is responsible for discovering and binding to the services through their descriptions.
- A *Service Registry* is a repository of service descriptions which acts as an interface between the Service Consumer and the Service Provider, as depicted in Figure 4.

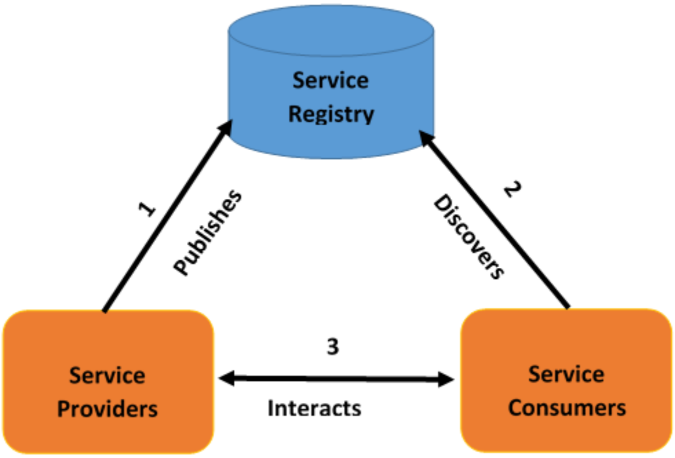

Figure .4. Service Oriented Architecture

4.3 Key Principles of SOA

SOA includes eight essential design principles that fosters key design characteristics which support the strategic goals associated with service-oriented computing.

4.3.1 *Service loose coupling*

Service loose coupling is the core principle of SOA that promotes the design and evolution of a service's logic. This principle promotes the independent design and evolution of a service's logic and implementation.

4.3.2 *Service autonomy*

Service autonomy is another principle that provides services to have control over their logic. This principle elevates several concerns that affect the design of service logic and its actual implementation environment.

4.3.3 *Service contract*

The principle of *service contract* states that the services should accept the service agreement as specified by the service description. It places a great deal of prominence on specific aspects of design, including the manner in which services express functionality, how data types and data models are defined, and how policies are asserted and attached [9].

4.3.4 *Service abstraction*

The Service abstraction principle hides a service's implementation details from the outside world. This principle accentuates the necessity to conceal the underlying details of a service as possible. It also plays a remarkable role in the positioning and design of service compositions.

4.3.5 *Service composition*

The principle of *service composition* allows a collection of services to be integrated to form a composite service. Service composition is a vital prerequisite for realizing some of the most fundamental goals of service-oriented computing.

4.3.6 ***Service statelessness***

This principle ensures that a service become stateful only when it is required. This principle offers numerous benefits having improved scalability that provides further stateless service instances on available environments.

4.3.7 *Service discoverability*

Discoverability feature allows the services to be found easily. This principle states that all services be discoverable nevertheless of their service model.

4.3.8 *Service reusability*

The service reusability is the core aspect of SOA that maximizes the reuse of a service's logic. Service reusability improves flexibility of business and return of investment [10].

V. SOA FOR FUTURE NETWORKS

This section explores how the basic elements and key principles of SOA described above supports a service-oriented future network design.

As recommended by ITU-T, the first objective of FNs, Service awareness states that FNs should provide easy methods for the deployment, management, and evaluation of the new services. SOA guarantees open and faster solutions that can be designed, deployed, reconfigured in a dynamic manner. This will enable FNs Functional flexibility and supports the rapid creation of new FN services. SOA paradigm allows the easy deployment of the services that can be simply reused and composed of applications. It composes the applications from loosely coupled services with an ability to dynamically recompose itself to address the changing needs in the future.

One of the core objectives, data awareness enables the users to access the required information conveniently independent of its location, in an efficient manner. By implementing SOA philosophy, the FN management operations can be applied as software components, called services. The open and agile feature of SOA enables rapid creation of FN services and faster changes in FN technology. It promotes location independent, network independent, loosely coupled reusable FN services.

SOA promotes design principles like loose coupling, separation of concern, implementation of encapsulation, and service abstraction, standardized contracts. Following these principles enable the two essential properties, isolation and abstraction for virtualization of FN resources.

Service Oriented Infrastructure (SOI) is a system for describing and delivering IT infrastructure as a service. It eliminates the need to directly allocate dedicated storage and computing resources to applications. Instead, it enables dynamic resource allocation from a pool of shared virtual resources in which the applications, processing, network, and storage are allocated as virtualized services. This feature not only increases the application reliability and utilization but can decrease the costs.

Future Networks are purely heterogeneous in nature. Its architecture must be designed in a way that it can scale to manage the current and future FNs. This scalability will support new services and technologies in the future without the need for long-term and complex upgrades. By adopting the SOA philosophy, the vital management operations can be applied as services. Services are software components with formally defined, message-based, request-response interfaces and the logic behind those interfaces are hidden from the users. This empowers rapid and dynamic responses for the user needs.

SOA enables the NGN to create a well-formulated platform and technology neutral service interfaces in which the interface of a service is independent of its implementation. Thus Service-Orientation principles could deliver agility, scalability, reusability, and flexibility in distributed heterogeneous environments such as the future networks.

VI. CONCLUSION

ITU-T clearly detailed that the designing and implementation of future networks should address aforesaid four objectives and the twelve design goals, which serve as foundational pillars for on-going research works in future networks. These design goals serve as essential pillars for FNs. In order to design FNs, an extensive collaboration of modern ICT framework is essential. For a successful design of FNs, it is also essential to learn the needs of each and every industry in which ICT becoming the driving force.

The good news is that Service Oriented Architecture principles support exactly the kind of objectives and design goals, which the future networks are looking for. It is envisioned that SOA can be considered as one of the architectural principles in realizing the Future Networks. This enables FNs rapid and cost-effective enactment in response to new requirements. A successful Service-Oriented implementation plays a key role in transforming the FNs ICT Infrastructure into an agile architecture enabling it to react quickly to the dynamic market conditions.

As the principles of future networks and SOA are very much analogous and they when implemented together, results in a scalable and flexible FNs. SOA can boost the FN designing process with its agile, dynamic principles that stimulate FNs faster adaptation to ever-changing requirements of the network users and can promote universalization of FN services in an optimized manner.

We believe that this paper will serve as a basis that provides a foundation and appropriate guidance for subsequent FNs realization, standardization, research and development particularly in SOA perspective.

VII. REFERENCES

[1] Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2016–2021,

https://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/mobile-white-paper-c11-520862.html

[2] ITU-T, Recommendation ITU-T Y.3001: Future networks: Objectives and design goals, https://www.itu.int/rec/dologin_pub.asp?lang=e&id=T-REC-Y.3001-201105-I!!PDF-E&type=items

[3] Deep Medhi, Peter A freeman - Research Challenges in Future Networks: A Report from US-Japan Workshop on Future Networks, http://sce2.umkc.edu/csee/dmedhi/papers/ccr-p35-v39n3c4-medhiA.pdf

[4] Nozomi NISHINAGA and Suyong Eum - Standardization Activities in ITU-T, http://www.nict.go.jp/publication/shuppan/kihou-journal/journal-vol62no2/journal-vol62no2-08-02-01.pdf

[5] Daisuke Matsubara et al, "Open the Way to Future Networks – A Viewpoint Framework from ITU-T", https://link.springer.com/content/pdf/10.1007%2F978-3-642-38082-2_3.pdf

[6] Alojz Hudibivnik, "Towards Future Networks" ITU-T FG-FN viewpoint,

https://www.slideshare.net/FIA2010/1120-hudobivnik-fia122010v2

[7] ITU-T, Recommendation ITU-T Y.3031: Identification framework in future networks,
https://www.itu.int/rec/dologin_pub.asp?lang=e&id=T-REC-Y.3031-201205-I!!PDF-E&type=items

[8] OASIS- Reference architecture foundation for SOA. Version 1.0, http://docs.oasis-open.org/soa-rm/soa-ra/v1.0/cs01/soa-ra-v1.0-cs01.pdf

[9] Thomas Erl - SOA Principles of Service Design, 9th Printing-2014 Prentice Hall Publishers, Page.No:68-75

[10] George Feuerlicht, Josip Lozina, "Understanding Service reusability",http://citeseerx.ist.psu.edu/viewdoc/download;sessionid=4A798EBCB6062942C432D6D7EB563C18?doi=10.1.1.626.2774&rep=rep1&type=pdf

[11] M. Ravi Kumar, Y. K. Sundara Krishna, "Service-oriented Architecture for Next Generation Networks', International Journal of Scientific and Innovative Mathematical Research (IJSIMR), Volume 1, Issue 7A, August 2014, pp. 30-35, ISSN: 2347-307X.

[12] ITU-T Recommendation M.3060/Y.2401: Principles for the management of Next Generation Networks, https://www.itu.int/rec/dologin_pub.asp?lang=e&id=T-REC-M.3060-200603-I!!PDF-E&type=items

[13] ITU-T Recommendation Y.3012: Requirements of Network Virtualization for Future Networks, https://www.itu.int/rec/dologin_pub.asp?lang=e&id=T-REC-Y.3012-201404-I!!PDF-E&type=items

[14] ITU-T Recommendation Y.3035: Service Universalization in Future Networks,

https://www.itu.int/rec/dologin_pub.asp?lang=e&id=T-REC-Y.3035-201506-I!!PDF-E&type=items

[15] Lorena Isabel Barona, Lopez Ángel Leonardo, Valdivieso Caraguay, Marco Antonio Sotelo Monge and Luis Javier García Villalba – Key Technologies in the Context of Future Networks: Operational and management requirements-Volume-9, Issue-1, 2016, Future Internet (ISSN 1999-5903), Pages: 1-15.

