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DEPLOYMENT OF NGN ARCHITECTURE FOR NETWORK SERVICES

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Abstract

Communication Network is evolving from a single service structure to multiple service structures. Technological development in telecommunication is leading us toward a unified backbone network called Next Generation Network (NGN). It is an IP-based packet network that provides QoS features while remaining independent of an access network. The services provided to users are independent of transmission architecture. NGN enables customers to receive different types of services like voice, data, and video over the same network. It simplifies the layered architecture and transforms the old legacy network into a packet-based architecture. The purpose of this article is to discuss the challenges and issues while the transition from legacy to IP-based packet networks and discuss the benefits of service providers in terms of business and service handling. NGN uses a new infrastructure to meet customer dynamic requirements. NGN service and NGN transport layer decoupling is the biggest challenge achieved by NGN infrastructure. This separation will result in the development of the core part and access part. It will increase the compatibility with multiple access networks.

Keywords—*cellular-based NGN, PSTN, PSDN, IP-based NGN, cloud computing, IoT*

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1. INTRODUCTION

Next Generation Network (NGN) is the first IP-based telecommunication network developed by ITU-T in late 2003.NGN is considered a new telecommunication infrastructure to replace the old legacy Public Switch Telephone Network (PSTN). Simplification of the old complex network was the basis and important impact presented by the NGN network. In addition to simplicity, NGN is capable to support multimedia services. NGN provides a single platform for all services. It is the first step toward the conversion of non-IP-based networks into IP-based packet networks [1].

Fig 1: Service Integration

NGN is expected to deliver all types of services to end users. It is the beginning of ubiquitous computing. NGN release-1 defines security parameters to handle the security issues in an open IP-based network. NGN management provides the control feature between the NGN services and network infrastructure. Characteristics of the NGN network: below mentioned.

- IP-based network.
- Multiple services access infrastructure.
- Unified service infrastructure.
- Service convergence between fixed and mobile devices.
- Independent service provisioning infrastructure.
- Open architecture [2].

A. COVERAGE AND QUALITY

NGN coverage is for both fixed (PSTN and PSDN) and mobile communication links by defining multiple parameters. This is due to the powerful grip on NGN transport, which supports the real-time and non-real-time environment. These capabilities allow further to handle multiple services from a test environment to a multimedia environment. NGN provides QoS defined by ITU-T recommendations RACF. Resource admission and control function is the key factor in QoS to provide guaranteed service as shown in figure 2 [3].

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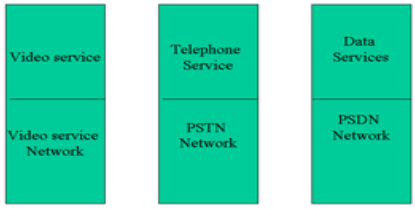

Fig 2: NGN Coverage Network

B. NGN ARCHITECTURE

NGN provides open architecture by defining a boundary between the vertical approach and the horizontal approach. Its architecture is based on two layers as shown in figure 3.

- NGN Services
- NGN Transport

NGN service is an interface for multiple applications such as voice data and video. All types of network services are deployed on the NGN transport layer such as connection-oriented and connectionless services.

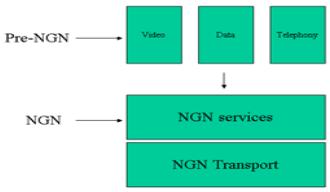

Fig 3: NGN Network Architecture

NGN is an IP-based or packed-based network with many network characteristics as well as service characteristics which created more opportunities for Internet service providers and network operators. NGN provides the open architecture by making applications (voice, video, Data, and sip-based services) separate from transport layer technologies as shown in figure 3. This architecture ensures the separation between the access layer and the service layer. As per ITU-T recommendation, NGN architecture was developed for the following characteristics:

- Support multiple technologies.
- Packet-based network provides distributed control.
- Service provisioning is independent of NGN Transport.
- Flexibility allows the integration of multiple services such as multimedia services.
- NGN release-1 provides security features for open IP-based packet networks [4].

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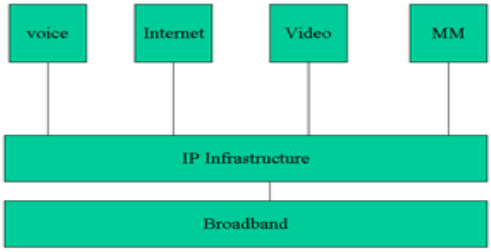

Fig 4: NGN Service Architecture

C. SOLUTION OVERVIEW

The decoupling of NGN service and NGN transport is the biggest achievement of the NGN network. Before NGN infrastructure, all services were coupled with the transport layer. Hence, they were creating multiple transmission structures for multiple services. This complexity was resolved by using NGN infrastructure as shown in figure 2.

Fig 5: Decoupling Architecture

ITU-T introduced two flavors of NGN

- IMS NGN.
- Call server-based NGN.

Both are developed according to the basic architecture of NGN but with different approaches. IMS NGN focuses on mobile applications and calls server-based focus on fixed communication [5].

D. IP MULTIMEDIA SUBSYSTEM

IMS was introduced by the 3rd Generation partnership project (3GPP) as the first flavor in NGN. A session initiation protocol was introduced to adopt session-based services. SIP supports the registration of the user, authentication, and other security arrangements. Multimedia session services and ISDN services are also supported by IMS.NGN IMS provides provisioning of:

- IP connectivity authorization, registration, and security.
- Single core infrastructure to support multiple control components.
- Support legacy network (interconnecting and interoperability).
- Decoupling of the session and transport layers.
- Independent access network [6].

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E. CALL SERVER-BASED NGN (CSBN NGN)

CSBN NGN focused on fixing communication services PSTN/ISDN. CSCS (call session control server) is introduced to control resources. CSBN NGN customers can use existing terminals without knowing the changes in the core network. CSBN NGN has the following characteristics:

- Supports PSTN/ISND.
- Supports IN.
- CSCS responsible for service delivery.

In NGN telecommunication services are provided by the network, which is based on a packet network, Also NGN allows for use of multiple broadband, it allows users to access networks and give challenges to service providers for providing the best service. It provides mobility due to which reliable and ubiquitous services are provided.

Service providers are gradually transitioning their networks to an IP-based design, whereas the global volume of IP traffic is soaring. Customers and businesses utilize Mobile nodes as an ICT appliance rather than merely a voice device. Therefore, NGN is being explored as a substitute for legacy networks' aging infrastructure. Which gives Connectivity to the mobile nodes to deliver services to the users' expectations [7].

F. NGN PROTOCOLS

For faultless multimedia services in an NGN, it is essential to reduce the latency of handover signaling at the link and network layers. In addition, the handover procedures must be safeguarded against potential dangers, such as unauthorized network access, insecure Binding Updates, etc. For this reason, the quick handover authentication procedures must be carried out between Mobile Nodes., It provides flawless connectivity with end-to-end quality of service (QoS) without compromising the security aspects. This Architecture is designed with Internet Protocols IPv4/IPv6, integrated with MPLS to offer services to different service providers operating in different networks and customers. The core network performs routing and transmission of packets through various components present in this architecture. It adopts the packet switching technology and uses the optical fiber transport scheme for providing integration between stages of data due to which we get high consistency, availability with security, and guaranteed end-to-end QoS, Soft switch, Content Storage, Service Control Engine, Core Switch, IP class 4/5 Switch, Edge Router, UBR, and Digital Subscriber Line Access Multiplexer (DSLAM), access network, proxy, Session border controller, etc. are all components of the IP-MPLS architecture. A soft switch is a programmable switch that establishes an interface to legacy networks via Signaling Gateways (SG) and Media Gateways (Access Gateway). Access Gateway refers to the equipment that initiates or terminates standard landline phone conversation [8].

G. NGN STRUCTURAL DESIGN

NGN is structurally designed for the communications of the upcoming telecommunication networks and services, and also to face the new necessities due to the rising of new services and applications (Broadband, IPTV, Multimedia, etc.). Some groups of organizations such as ITU and ETSI are the main workers in designing the NGN structure. "TISPAN" The technical committee for Telecommunication and Internet joined Facilities and Procedures for working on a structural design which is a requirement of today. TISPAN description known as TISPAN NGN R1 was formed by the telecom vendors and operators, to face providers' requirements. The key points of TISPAN R1 are as under.

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- It allows self-governing access to technology.
- It Supports applications for Session initial protocol (SIP) and non-SIP.
- In design IP Multimedia Subsystem (IMS) supports SIP applications.
- It provides a Road map for static/mobile junctions.
- Flexible with the standards of other organizations.

The below-mentioned three layers define the complete NGN structure.

i. (ANL)-Access Network Layer:

In this layer, multiple types of equipment are connected for connecting end users with NGNs like Multi-Service Access Nodes (MSAN) which deliver multiple services like telephony, high-speed internet access, and video services by using the same copper pair.

ii. (ENL)-Edge/Core Network Layer:

Edge/Core network creates the connection-oriented path for connectionless IP by using label-switching technology MPLS.

iii. (CL)-Control Layer:

This layer controls call data and carriers in the network. It consists of Soft Switch (SS).

2. MOBILITY TESTING

The process in which wired & wireless systems communicate with different devices containing similar categories, this process is known as Machine 2 Machine (M2M). This process data has unique properties, including minimal mobility and offline and online data. The M2M analysis for the NGN network is conducted by transferring VoIP packets of 64 bytes between PC to PC, Mobile to Mobile, and Mobile to PC for the four transmission categories [9].

3. MOBILE DATA QOS-BASED ROUTING TESTING

Mobile data off-load is the delivery of data originally intended for cellular networks through the use of compatible network technologies. The mobile off-loading operation can be activated by rules established by either the end-user (mobile subscriber) or the operator. Wi-Fi is the predominant matching network technology used for mobile data offloading. Based on the data identification, the user gets authenticated and redirected to the particular network to free the premium traffic path for LTE VOICE.

4. SIGNALING PROTOCOLS IN NGN

Multiple technologies are employed in the development of the NGN. The NGN architecture understands the contrasts between the technologies that can function in the network's access layer and those employed in the network's core. The core network contains ATM, Ethernet, IP, and IP/MPLS, which are the four key applicant transport technologies. The access networks use several wireless and wired access technologies, like Universal Mobile Telecommunications System (UMTS), Long-Term Evolution (LTE), Worldwide Interoperability for Microwave Access (WiMAX), Ultra-wideband (UWB), Wireless Local Area Networks (WLAN), Wireless Personal Area Network (WPAN), Bluetooth, Ethernet cable, Digital Subscriber Line (DSL), and optical fiber, to provide subscribers with reliable and always-available services. To maximize the migration to the NGN architecture and the implementation of

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several technologies in a shared infrastructure, it is necessary to define standards. ITU-T and other standards development organizations' arduous standardization efforts have resulted in an agreement on the fundamental NGN architecture model and services. The NGN architecture specifies a collection of Functional Entities (FEs). Each FE is placed in the NGN architecture's transport or service segment. The transport layer contains useful functions for data transfer as well as source functions for data transfer between interacting objects [10].

5. NGN SIGNALING TRANSMISSION

The main signaling protocols utilized in networks of the next generation are described in the preceding section. They are all used to support and govern user traffic and services. It is possible to convey signaling messages using path-coupled or path-decoupled techniques. In path-coupled, signaling nodes must be gathered with routers, and data-path nodes are responsible for routing the signaling messages. Dedicated nodes and routers must be kept apart in path-decoupled signaling and signaling messages must be routed through nodes that are not thought to be on the data path. While RSVP is path coupled, SIP is path decoupled [11].

Signals can also be categorized as in-band or out-of-band from a QoS standpoint. Assuming that signaling traffic is a part of the data flow is a precondition of in-band QoS signaling. Out-of-band QoS signaling assumes that dedicated packets, separate from the data flow, will accept signaling transmission. Out-of-band signaling is used for Integrated Services (IntServ), whereas in-band signaling is used for DiffServ. Due to issues brought on by the resource condition for each flow in the intermediary routers along the end-to-end link, IntServ is not suited for signaling transmission. This additional delay brought on by the path-building process is undesirable due to the strict time constraints imposed by signaling. DiffServ in network routers prevents this signaling overhead and processing complexity [12].

6. QUALITY MECHANISM

NGN structure behavior represents one of the successful networks, from almost all points like arrangement, process, verification, authentication & most end-user approval.

7. NGN ENVIRONMENT

The main issues regarding the NGN environment addressed by ITU-T (ITU-T Rec. Y.2001, 2004; ITU-T Rec. Y.2011, 2004), 3GPP (3GPP TS 23.228, 2006), and ETSI/TISPAN (ETSI ES 282.007, 2006), also in some current telecommunications research work. The different logical structure has been proposed by different organizations based on joint principles, but they differ from each other regarding focusing services or communication domain. A two-layer model was accepted, which were decoupling the transport from the service control functionalities and the services. A Group of four principal functionalities of the NGN structure can be recognized, as under [13].

A. SERVICE-LAYER APPLICATION FUNCTIONALITIES:

This layer contains a server which is known as an application server, in which the service introduced & functioned. Also in this layer, two main operations are performed which allow interfacing and running services of gateway applications.

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B. SERVICE-LAYER CONTROL SEGMENT FUNCTIONALITIES:

In this layer some main operations are performed like session control, service activating, verification, and approval. This layer recognizes by the IP multimedia subsystem (IMS) standard. This standard allows controlling the core network & activation of services etc.

C. SERVICE-LAYER TO TRANSPORT-LAYER ARBITRATOR FUNCTIONALITIES:

To achieve demand for implementing the inter-layer, this layer was necessary for the operative. The network attachment subsystem allows end users to enter in NGN ecosystem and the NGN services and tolerate transport-layer effects. The resource and admission control subsystem performs resource allocation tasks based on policy and QoS promise.

D. TRANSPORT-LAYER FUNCTIONALITIES:

The main function of this layer is to provide IP connectivity for accessing the service layer. Now the Quality of service is guaranteed by applying consistent operation for the moving of the broadcasting & arrangement, excellence, & safety achievement, these parameters are not included in the range of Next generation networks. current Next generation network structure includes fundamental operations like allowing structure for session management, service activating, admission control, user administration, and quality promise, while other operations are essential to do definite tasks, e.g., issues regarding the application, management, instant streaming support, access termination, etc. [14]

8. PSTN NETWORK

In the past decades, we have observed a tremendous change in the telecom world, which was previously just based on voice services mainly. A public switched telephone network (PSTN) is the basic voice communication infrastructure. With time, PSTN was developed to integrate more advanced services like data and video.

In today's environment, different telecom service providers are presenting multiple service infrastructures. These services are integrated by using different protocols and techniques. The complexity was very high due to multiple standards by different vendors. A unified communication model NGN (Next generation Network) was developed to minimize this complexity level. Migration from old infrastructure (in terms of technology, infrastructure, services, and system aspects) to a newly defined model was a very complex task. Most service providers are relying on NGN services to keep given market demand. NGN is facilitating the triple-play services based on the core IP network. Different types of services are encapsulated into IP packets and sent over the Network. It reduces the complexity level as well as the operational and maintenance cost. QoS issues are also handled by the NGN network [15]. Public switched telephone network (PSTN) is the oldest and most famous telecommunication infrastructure. It provides voice services by using the circuit-switched network. Circuit switching is the dedicated telecommunication link between two end users.

Fig 6: PSTN Network

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Circuit switching is the base configuration of the PSTN network. When a subscriber dials a number, a circuit is established from one point to another point with a limited voice bandwidth. The main features of PSTN are:

- Limited band connectivity.
- Channel reserved for one user with full capacity.
- Transmission done without any type of overhead.
- QoS is guaranteed.

9. CLOUD COMPUTING

Cloud Computing steps next in the generation series of the computing world. It defines computing in such a way that, IT capabilities that are related to it are defined as a service so that technology can be accessed through enabled services from the centralized networks Internet i.e., the Cloud.

The service that was a pioneer on the cloud was Email. As the industry shifts towards computing platform services are defined according to it [16].

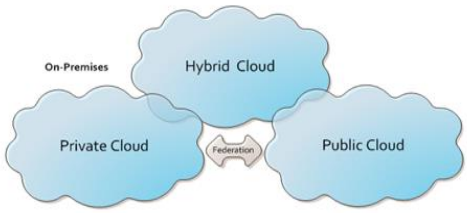

Fig 7: Cloud Computing

Providing Platform as a Service (PaaS) and Software as a Service (SaaS) for enterprises and consumers to have real-time access on demand regardless of time and location. But it also includes negatives as well. It does not serve the needs of actual businesses to hear only about cloud computing. It has both positive as well as negative aspects. The infrastructure model of Cloud Computing agencies of government needs to consider several models of cloud computing infrastructures when evaluating cloud through next-generation networks and computing architectures, it sees four categories of cloud currently in the emerging future of public clouds, private clouds, virtual private clouds, and eventually inter-clouds. Public clouds are those that are operated by third parties and are co-located. As the data of the company is managed, maintained, and secured by third parties. As the company remains free from the burden of maintaining and managing the data. Private clouds are dedicated clouds that are dedicated to the organization. They can be co-located or kept internally within the organization. Data is managed and maintained by the organization, or it can be managed by a third party as well. A virtual Private Cloud is a cloud that performs as a private cloud in a public cloud environment. Data is maintained and managed by the organization or third party, but it is in the public cloud platform. Virtual private cloud introduces the concept that leads to complexities of migrating workloads and related data from a private cloud [17].

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Four major layers in cloud computing are as followed:

- Software as a Service (SaaS) is where the services of applications are provided over the network. As Organizations do not need to buy the software or keep a technical to maintain that application. The application is maintained and managed over the network by a third party.
- Platform as a Service (PaaS) is to provide a platform to the organization where software can be developed and deployed. PaaS providers deal with servers, giving customers the platform to develop and deploy the software at their servers, so they can maintain and manage it, leaving users free, so they can focus on their business properly.
- Infrastructure as a Platform is to provide the infrastructure of systems maintained and managed only by the organization.
- The application is developed and deployed by the organization, whether it is co-located, or the organization manages the infrastructure. GSM, 3G, 4G, 5G, wi-fi, cable, and fiber. It supports multiple last-mile technologies, with end-to-end QoS and transparency [18].

10. INTERNET OF THINGS (IOT)

The Internet of Things is the network of objects or “physical things" which are embedded in a network or with any electronic device, computerized software, antennas/sensors, and connectivity to enable it to perform big service by communicating with each other (with other connected devices). Everything is identifiable uniquely in the internet communication system and each thing can communicate with another thing within the Internet infrastructure [20]. Current performance along with the history is described below diagram clearly. The term “IoT” or Internet of things was first documented in 1999 by a British visionary, Kevin Ashton. Initially, the Internet of Things is supposed to offer communication connectivity between different systems and devices. Which is somehow what we say is more than machine-to-machine communications (M2M). Wireless systems can be classified in two as far as high-speed mobile wireless access services are concerned. LTE- Is expected to target substantial improvement in spectral efficiency and reduction in latency.

Now in the IoT prototype, lots of objects are present with us continuously on the network in some form or another. As a result, a bulky amount of data is generated which is required to store, then process, and present in an uninterested efficient form. The evolution towards information and communication is evident in the demand for Wi-Fi and 4G-LTE wireless internet access. The achievement of continuous connectivity is succeeded with the help of the Internet of Things (IoT). There are lots of merits of IoT, but many hurdles are available in the topic. IoT is like a heterogeneous end system. Such a heterogeneous field of application makes the identification of solutions capable of satisfying particular challenges.

In the figure Proposed IoT data handling consists of some basic stacked layers namely the Data layer, the Things layer, The Communication Layer, the Source layer Federation Layer, the Query Layer, and the Transactions Layer.

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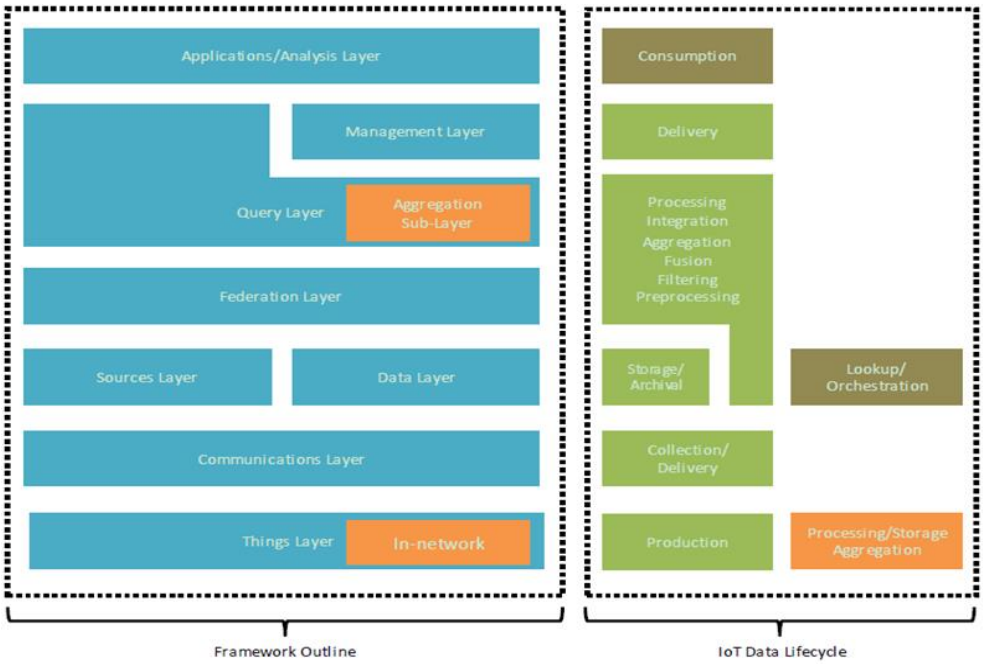

Fig 8: Outline of the proposed IoT data management framework and mapping of its layers to the IoT data lifecycle

A. DATA LAYER

The data layer is the main and core layer of the system of IoT data handling. This layer has all Data handling responsibility. During the procedure of data handling, there are some problems to be addressed in IoT handling.

B. THINGS LAYER

Things layer can be any device i.e. cell phone/mobile phones, computer laptop, or any sensor device that has the capacity of communication to other devices.

C. COMMUNICATION LAYER

The communication layer functionality is to connect data sources and distributed data sources to more concentrated data storage and processing unit.

D. SOURCE LAYER

The source layer is the system that is designed to lead data systems that metadata store the locations of data fragments beforehand for purposes of querying or updating.

E. FEDERATION LAYER

As the federation layer is the middle or central framework of IoT's structure. The main function of the federation layer is to provide the structure that joins dispersed Internet of Things sub-systems and data sources together to form a globalized view of the IoT systems.

F. QUERY LAYER

The query layer must encapsulate the elements necessary for generating the queries, optimizing the existing queries, and executing queries on the Internet of Things (IoT)'s database. It is deployed both

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at the local and federated levels. To be that governing the subsystems deployed by individual organizations.

G. TRANSACTION LAYER

The transaction layer manages all the execution of queries and data that are related to the IoT framework and IoT services. Depending on the type of queries & data execution process given by the IoT framework to the transaction layer, it can deploy either a single source/classical execution strategy, or it can deploy distributed or global execution mechanism.

11. CONCLUSION

NGN is a packet-based IP network. It does not work on the best-effort mechanism. NGN defines services as a set of service components. NGN service model is the most important part of its capability to handle multiple services. NGN uses a new infrastructure to meet customer dynamic requirements. NGN service and NGN transport layer decoupling is the biggest challenge achieved by NGN infrastructure. This separation will result in the development of the core part and access part. It will increase the compatibility with multiple access networks.

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