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STUDY AND ANALYSIS OF 5G TECHNOLOGY

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ABSTRACT

5G technologies will change the way most high-bandwidth users access their phones. With 5G pushed over a VOIP-enabled device, people will experience a level of call volume and data transmission never experienced before.5G technology is offering the services in Product Engineering, Documentation, supporting electronic transactions (e-Payments, e-transactions) etc. As the customer becomes more and more aware of the mobile phone technology, he or she will look for a decent package all together, including all the advanced features a cellular phone can have. Hence the search for new technology is always the main motive of the leading cell phone giants to out innovate their competitors. Recently apple has produced shivers all around the electronic world by launching its new handset, the I-phone. Features that are getting embedded in such a small piece of electronics are huge.

I. INTRODUCTION

The present cell phones have it all. Today phones have everything ranging from the smallest size, largest phone memory, speed dialling, video player, audio player, and camera and so on. Recently with the development of Pico nets and Blue tooth technology data sharing has become a child's play. Earlier with the infrared feature you can share data within a line of sight that means the two devices has to be aligned properly to transfer data, but in case of blue tooth you can transfer data even when you have the cell phone in your pocket up to a range of 50 meters. The creation and entry of 5G technology into the mobile marketplace will launch a new revolution in the way international cellular plans are offered.

The global mobile phone is upon the cell phone market. Just around the corner, the newest 5G technologies will hit the mobile market with phones used in China being able to access and call locally phones in Germany. Truly innovative technology changing the way mobile phones will be used. With the emergence of cell phones, which are similar to a PDA, you can now have your whole office within the phone. Cell phones will give tough competitions to laptop manufacturers and normal computer designers. Even today there are phones with gigabytes of memory storage and the latest operating systems. Thus one can say that with the current trends, the industry has a real bright future if it can handle the best technologies and can produce affordable handsets for its customers. Thus you will get all your desires unleashed in the near future when these smart phones take over the market. 5G Network's router and switch technology delivers Last Yard Connectivity between the Internet access

provider and building occupants. 5G's technology intelligently distributes Internet access to individual nodes within the building.

II. 2G-5G NETWORKS

The first generation of mobile phones was analog systems that emerged in the early 1980s. The second generation of digital mobile phones appeared in 1990s along with the first digital mobile networks. During the second generation, the mobile telecommunications industry experienced exponential growth in terms of both subscribers and value-added services. Second generation networks allow limited data support in the range of 9.6 kbps to 19.2 kbps. Traditional phone networks are used mainly for voice transmission, and are essentially circuit-switched networks.

2.5G networks, such as General Packet Radio Service (GPRS), are an extension of 2G networks, in that they use circuit switching for voice and packet switching for data transmission resulting in its popularity since packet switching utilizes bandwidth much more efficiently. In this system, each user's packets compete for available bandwidth, and users are billed only for the amount of data transmitted.

3G networks were proposed to eliminate many problems faced by 2G and 2.5G networks, especially the low speeds and incompatible technologies such as Time Division Multiple Access (TDMA) and Code Division Multiple Access (CDMA) in different countries. Expectations for 3G included increased bandwidth; 128 Kbps for mobile stations, and 2 Mbps for fixed applications. In theory, 3G should work over North American as well as European and Asian wireless air interfaces. In reality, the outlook for 3G is not very certain. Part of the problem is that network providers in Europe and North America currently maintain separate standards' bodies (3GPP for Europe and Asia; 3GPP2 for North America). The standards' bodies have not resolved the differences in air interface technologies.

There is also a concern that in many countries 3G will never be deployed due to its cost and poor performance. Although it is possible that some of the weaknesses at physical layer will still exist in 4G systems, an integration of services at the upper layer is expected. The evolution of mobile networks is strongly influenced by business challenges and the direction mobile system industry takes. It also relates to the radio access spectrum and the control restrictions over it that varies from country to country. However, as major technical advances are being standardized it becomes more complex for industry alone to choose a suitable evolutionary path. Many mobile system standards for Wide Area Networks (WANs) already exists including the popular ones such as Universal Mobile Telecommunications Systems (UMTS), CDMA, and CDMA2000 (1X/3X). In addition there are evolving standards for Personal Area Networks (PANs), such as Bluetooth wireless, and for WLANs, such as IEEE 802.11.

The current trend in mobile systems is to support the high bit rate data services at the downlink via High Speed Downlink Packet Access (HSDPA). It provides a smooth evolutionary path for UMTS networks to higher data rates in the same way as Enhanced Data rates for Global Evolution (EDGE) do in Global Systems for Mobile communication (GSM). HSPDA uses shared channels that allow different users to access the channel resources

in packet domain. It provides an efficient means to share spectrum that provides support for high data rate packet transport on the downlink, which is well adapted to urban environment and indoor applications.

Initially, the peak data rates of 10 Mbps may be achieved using HSPDA. The next target is to reach 30 Mbps with the help of antenna array processing technologies followed by the enhancements in air interface design to allow even higher data rates. Another recent development is a new framework for mobile networks that is expected to provide multimedia support for IP telecommunication services, called as IP Multimedia Subsystems (IMS). Real-time rich multimedia communication mixing telecommunication and data services could happen due to IMS in wireline broadband networks. However, mobile carriers cannot offer their customers the freedom to mix multimedia components (text, pictures, audio, voice, video) within one call. Today a two party voice call cannot be extended to a multi-party audio and video conference. IMS overcomes such limitations and makes these scenarios possible.

III. NETWORK ARCHITECTURE

The basic architecture of wireless mobile system consists of a mobile phone connected to the wired world via a single hop wireless connection to a Base Station (BS), which is responsible for carrying the calls within its region called cell (Figure 1). Due to limited coverage provided by a BS, the mobile hosts change their connecting base stations as they move from one cell to another.

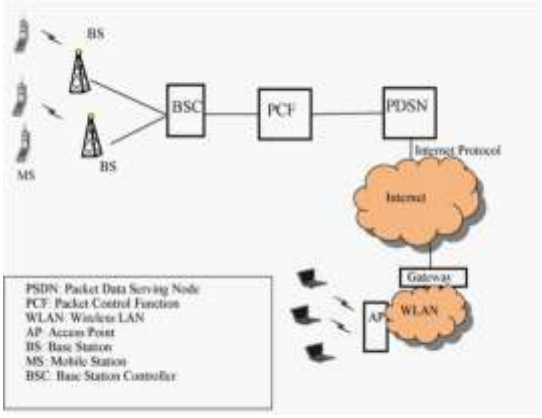

Fig : Wireless Mobile System Network Architecture

A hand-off (later referred to as "horizontal handoff" in this article) occurs when a mobile system changes its BS. The mobile station communicates via the BS using one of the wireless frequency sharing technologies such as FDMA, TDMA, CDMA etc. Each BS is connected to a Mobile Switching Center (MSC) through fixed links, and each MSC is connected to others via Public Switched Telephone Network (PSTN). The MSC is a local switching exchange that handles switching of mobile user from one BS to another. It also locates the current cell location of a mobile user via a Home Location Register (HLR) that stores current location of each mobile that belongs to the MSC. In addition, the MSC contains a Visitor Locations Register (VLR) with information of visiting mobiles from other cells. The MSC is responsible for determining the current location of a target mobile using HLR, VLR and by communicating with other MSCs. The source MSC initiates a call setup message to MSC covering target area for this purpose.

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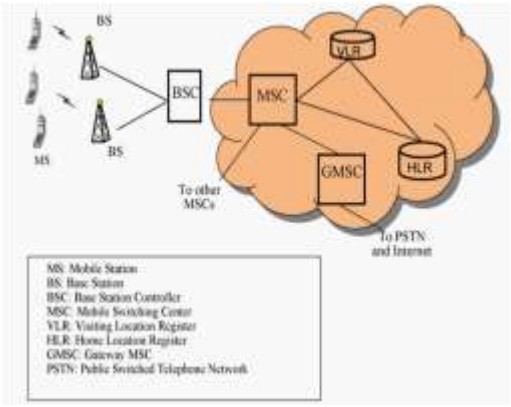

Fig : Mobile System/WLAN Integration

The first generation cellular implementation consisted of analog systems in 450900 MHz frequency range using frequency shift keying for signaling and Frequency Division Multiple Access (FDMA) for spectrum sharing.

The second generation implementations consist of TDMA/CDMA

implementations with 900, 1800 MHz frequencies. These systems are called GSM for Europe and IS-136 for US. The respective 2.5G implementations are called GPRS and CDPD followed by 3G implementations.

Third generation mobile systems are intended to provide a global mobility with wide range of services including voice calls, paging, messaging, Internet and broadband data. IMT-2000 defines the standard applicable for North America. In Europe, the equivalent UMTS standardization is in progress. In 1998, a Third Generation Partnership Project (3GPP) was formed to unify and continue the technical specification work. Later, the Third Generation Partnership Project 2 (3GPP2) was formed for technical development of CDMA-2000 technology.

3G mobile offers access to broadband multimedia services, which is expected to become all IP based in future 4G systems. However, current 3G networks are not based on IP; rather they are an evolution from existing 2G networks. Work is going on to provide 3G support and Quality of Service (QoS) in IP and mobility protocols.

The situation gets more complex when we consider the WLAN research and when we expect it to become mobile. It is expected that WLANs will be installed in trains, trucks, and buildings. In addition, it may just be formed on an ad-hoc basis (like ad-hoc networks) between random collections of devices that happen to come within radio range of one another (Figure 2).

In general, 4G architecture includes three basic areas of connectivity; PANs (such as Bluetooth), WANs (such as IEEE 802.11), and cellular connectivity. Under this umbrella, 4G will provide a wide range of mobile devices that support global roaming.

Each device will be able to interact with Internet-based information that will be modified on the fly for the network being used by the device at that moment (Figure 3). In 5G mobile IP, each cell phone is expected to have a permanent "home" IP address, along with a "care-of" address that represents its actual location. When a computer somewhere on the Internet needs to communicate with the cell phone, it first sends a packet to the phone's home address.

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Figure 3: Seamless Connection of Networks in 4G

A directory server on the home network forwards this to the care-of address via a tunnel, as in regular mobile IP. However, the directory server also sends a message to the computer informing it of the correct care-of address, so future packets can be sent directly. This should enable TCP sessions and HTTP downloads to be maintained as users move between different types of networks. Because of the many addresses and the multiple layers of sub netting, IPv6 is needed for this type of mobility.

For instance, 128 bits (4 times more than current 32 bit IPv4 address) may be divided into four parts (I thru IV) for supporting different functions. The first 32-bit part (I) may be defined as the home address of a device while the second part (II) may be declared as the care-of address allowing communication between cell phones and personal computers. So once the communication path between cell and PC is established, care-of address will be used instead of home address thus using the second part of IPv6 address.

The third part (III) of IPv6 address may be used for tunneling to establish a connection between wire line and wireless network. In this case an agent (a directory server) will use the mobile IP address to establish a channel to cell phones. The fourth and last part (IV) of IPv6 address may be used for local address for VPN sharing. Figure 4 illustrates the concept. The goal of 4G and 5G is to replace the current proliferation of core mobile networks with a single worldwide core network standard, based on IPv6 for control, video, packet data, and voice. This will provide uniform video, voice, and data services to the mobile host, based entirely on IPv6.

The objective is to offer seamless multimedia services to users accessing an all IP-based infrastructure through heterogeneous access technologies. IPv6 is assumed to act as an adhesive for providing global connectivity and mobility among networks.

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Table 1: Comparison of 1G-4G Technologies

Technology / Features	1G	2G/2.5G	3G	4G	5G
Start/ Deployment	1970/ 1984	1980/ 1999	1990/ 2002	2000/ 2010	2010/ 2015
Data Bandwidth	2 kbps	14.4-64 kbps	2 Mbps	200 Mbps to 1 Gbps for low mobility	1 Gbps and higher
Standards	AMPS	2G: TDMA, CDMA, GSM 2.5G: GPRS, EDGE, 1xRTT	WCDMA, CDMA-2000	Single unified standard	Single unified standard
Technology	Analog cellular technology	Digital cellular technology	Broad bandwidth CDMA, IP technology	Unified IP and seamless combination of broadband, LAN/WAN/ PAN and WLAN	Unified IP and seamless combination of broadband, LAN/WAN/PAN /WLAN and www
Service	Mobile telephony (voice)	2G: Digital voice, short messaging 2.5G: Higher capacity packetized data	Integrated high quality audio, video and data	Dynamic information access, wearable devices	Dynamic information access, wearable devices with AI capabilities
Multiplexing	FDMA	TDMA, CDMA	CDMA	CDMA	CDMA
Switching	Circuit	2G: Circuit 2.5G: Circuit for access network & air interface; Packet for core network and data	Packet except circuit for air interface	All packet	All packet
Core Network	PSTN	PSTN	Packet network	Internet	Internet
Handoff	Horizontal	Horizontal	Horizontal	Horizontal and Vertical	Horizontal and Vertical

Most of the wireless companies are looking forward to IPv6, because they will be able to introduce new services. The Japanese government is requiring all of Japan's ISPs to support IPv6 with its first 4G launch. Although the US upgrade to IPv6 is less advanced, WLAN's advancement may provide a shortcut to 4G.

IV. MIX-BANDWIDTH DATA PATH DESIGN

CDMA development group (CDG) has issued convergence architecture for 4G, which combined pico cell, micro cell, macro cell and global area shown in Figure5. This architecture clearly shows that in pico-cell area, there are four wireless network covered, in micro cell area, there are three wireless network covered, in macro cell area, there are two wireless network covered at least. The problem is for any users at a certain place and time, it is one network supply wireless services for them, the others keep wireless network resources waste. 5G is real wireless world, it is completed wireless communication. We design mix-bandwidth data path for 5G so that all wireless network resource can be used efficiently.

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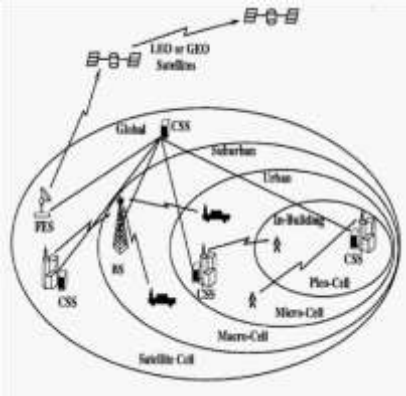

Fig : 4G Convergence Architecture

V. MIX-BANDWIDTH DATA PATH MODEL DESIGN

In order to design mix-bandwidth data path, we propose a new data model as shown in Figure6. This model based on any two networks overlay area. When a mobile node comes into the overlay area, both of the two networks can supply services for the mobile node simultaneously. Data request can be sent from any one network, and reply can be from any other network.

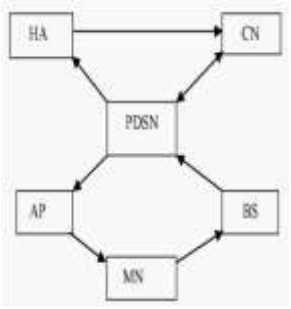

Fig: Mix-bandwidth Data Path Model

In this model, the MN request can go through the first connection (MN → BS → PDSN → CN) and the resulting reply can come from the second connection (CN → PDSN → AP → MN). Thus, two networks supply services for the mobile node simultaneously. Following this model, we propose mix-bandwidth data path shown in Figure, which contains four components. They are bandwidth management, bandwidth selection, packet receiver and bandwidth monitor.

VI. MOBILE - WIRELESS GRIDS

Mobile computing is an aspect that plays seminal role in the implementation of 4G Mobile Communication Systems since it primarily centres upon the requirement of providing access to various communications and services everywhere, any time and by any available means. Presently, the technical solutions for achieving mobile computing are hard to implement since they require the creation of communication infrastructures and the modification of operating systems, application programs and computer networks on account of limitations on the capability of a moving resource in contrast to a fixed one.

In the purview of Grid and Mobile Computing, Mobile Grid is a heir of Grid, that addresses mobility issues, with the added elements of supporting mobile users and resources in a seamless, transparent, secure and efficient way. It has the facility to organize underlying ad-hoc networks and offer a self-configuring Grid system of mobile resources (hosts and users) connected by wireless links and forming random and changeable topologies. The mobile Grid needs to be upgraded from general Grid concept to make full use of all the capabilities that will be available; these functionalities will involve end-to-end solutions with emphasis on Quality of Service (QoS) and security, as well as interoperability issues between the diverse technologies involved. Further, enhanced security policies and approaches to address large scale and heterogeneous environments will be needed. Additionally, the volatile, mobile and poor networked environments have to be addressed with adaptable QoS aspects which have to be contextualized with respect to users and their profiles.

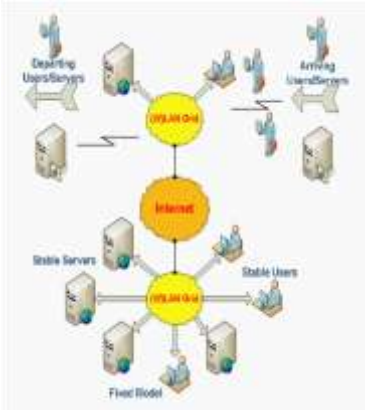

Fig: Dynamic and fixed wireless grids.

A range of institutions, from the largest governments to very small enterprises, will own and at least partially control wireless grids. To make things still more complex for researchers and business strategists, users and producers could sometimes be one and the same. Devices on the wireless grid will be not only mobile but nomadic shifting across institutional boundaries. Just as real-world nomads cross institutional boundaries and frequently move from one location to another, so do wireless devices. The following classification offers one way to classify wireless grid applications.

(a) **Class 1**: Applications aggregating information from the range of input/output interfaces found in nomadic devices.

(b) **Class 2:** Applications leveraging the locations and contexts in which the devices exist.

(c) **Class 3:** Applications leveraging the mesh network capabilities of groups of nomadic devices.

The three classes of wireless grid applications conceptualized here are not mutually exclusive. Understanding more about the shareable resources, the places of use, and ownership and control patterns within which wireless grids will operate might assist us in visualizing these future patterns of wireless grid use. The Grid, is a promising emerging technology that enables the simple “connect and share” approach analogously to the internet search engines that apply the “connect and acquire information” concept.

Thus, mobile/wireless grids is an ideal solution for large scale applications which are the pith of 4G mobile communication systems, besides, this grid-based-approach will potentially increase the performance of the involved applications and utilization rate of resources by employing efficient mechanisms for resource management in the majority of its resources, that is, by allowing the seamless integration of resources, data, services and technologies. Figure 2 places wireless grids in context, illustrating how they span the technical approaches and issues of Web services, grid computing, P2P systems, mobile commerce, ad hoc networking, and spectrum management. How sensor and mesh networks will ultimately interact with software radio and other technologies to solve wireless grid problems requires a great deal of further research, but Figure 4 at least captures many of the main facets of a wireless grid.

VII. KEY CONCEPTS OF 5G

Suggested in research papers discussing 5G and beyond 4G wireless communications are:

- Real wireless world with no more limitation with access and zone issues.
- Wearable devices with AI capabilities.
- Internet protocol version 6 (IPv6), where a visiting care-of mobile IP address is assigned according to location and connected network.
- One unified global standard.
- Pervasive networks providing ubiquitous computing: The user can simultaneously be connected to several wireless access technologies and seamlessly move between them (See Media independent handover or vertical handover, IEEE 802.21, also expected to be provided by future 4G releases). These access technologies can be a 2.5G, 3G, 4G or 5G mobile networks, Wi-Fi, WPAN or any other future access technology. In 5G, the concept may be further developed into multiple concurrent data transfer paths.
- High altitude stratospheric platform station (HAPS) systems.

The radio interface of 5G communication systems is suggested in a Korean research and development program to be based on beam division multiple access (BDMA) and group cooperative relay techniques.

VIII. FEATURES OF 5G NETWORKS TECHNOLOGY

Main features of 5G Network technology are as follows :

(a) 5G technology offer high resolution for crazy cell phone user and bi-directional large bandwidth shaping.

(b) The advanced billing interfaces of 5G technology makes it more attractive and effective.

(c) 5G technology also providing subscriber supervision tools for fast action.

(d) The high quality services of 5G technology based on Policy to avoid error.

(e) 5G technology is providing large broadcasting of data in Gigabit which supporting almost 65,000 connections.

(f) 5G technology offer transporter class gateway with unparalleled consistency.

(g) The traffic statistics by 5G technology makes it more accurate.

(h) Through remote management offered by 5G technology a user can get better and fast solution.

(j) The remote diagnostics also a great feature of 5G technology.

(k) The 5G technology is providing up to 25 Mbps connectivity speed.

(l) The 5G technology also support virtual private network.

(m) The new 5G technology will take all delivery service out of business prospect

(n) The uploading and downloading speed of 5G technology touching the peak.

(o) The 5G technology network offering enhanced and available connectivity just about the world

A new **revolution of 5G technology** is about to begin because 5G technology going to give tough completion to normal computer and laptops whose marketplace value will be effected. There are lots of improvements from 1G, 2G, 3G, and 4G to 5G in the world of telecommunications. The new coming 5G technology is available in the market in affordable rates, high peak future and much reliability than its preceding technologies. Features that are getting embedded in such a small piece of electronics are huge. Today you will hardly witness a cell phone without an mp3 player with huge storage memory and a camera. We can use the cell phone as a Walkman.

Even every latest set being launched by the cell phone companies have a mega pixel camera in it, which produces extraordinary digital image just like a specialized camera for photography. Here are some an examples about mobile technology in our future, A man's phone detects that it hasn't moved for more than 2 hours during the man's regular waking hours. It issues an audible alarm, but no response! So it emits a signal that triggers a RFID chip implanted inside his body. The RFID chip responds by verifying the identity of the man and also a brief burst of telemetry that indicates that he is experiencing heart beat irregularities and his blood pressure is dangerously low. The phone quickly sends an automated text message to a medical alarm system, including not only the identity and the health data of the owner but also the fact that the man is not in his own apartment but in a reading room of a library.

IX. 5G TECHNOLOGY REQUIREMENTS

As a result of this blending of requirements, many of the industry initiatives that haveprogressed with work on 5G identify a set of eight requirements:

• 1-10Gbps connections to end points in the field (i.e. not theoretical maximum)

• 1 millisecond end-to-end round trip delay (latency)

• 1000x bandwidth per unit area

• 10-100x number of connected devices

• (Perception of) 99.999% availability

• (Perception of) 100% coverage

• 90% reduction in network energy usage

• Up to ten year battery life for low power, machine-type devices.

Because these requirements are specified from different perspectives, they do not makean entirely coherent list – it is difficult toconceive of a new technology that could meetall of these conditions simultaneously.

Equally, whilst these eight requirements are often presented as a single list, no use case, service or application has been identified that requires all eight performance attributes across an entire network simultaneously. Indeed some of the requirements are not linked to use cases or services, but are instead aspirational statements of how networks should be built, independent of service or technology – no use case needs a network to be significantly cheaper, but every operator would like to pay less to build and run their network. It is more likely that various combinations of a subset of the overall list of requirements will be supported 'when and where it matters'.

5G

X. SUMMARY

5G is the next frontier of innovation for entire mobile industry.

The three major design objectives for 5G:

- Implementation of massive capacity and massive connectivity
- Support for an increasingly diverse set of services, applications and users – all with extremely diverging requirements
- Flexible and efficient use of all available non-contiguous spectrum forwidely different network deployment scenarios

An adaptive network solution framework will become a necessity for accommodating both LTE and air interface evolution; Cloud, SDN and NFV technologies will reshape the entire mobile ecosystem; and 5G will speed up the creation of massive-scale services and applications.

The next decade promises breakthrough developments in several fundamental RAN technologies that will be required for implementing commercial-ready 5G network solutions:

- Multiple access and advanced waveform technologies combined with coding and modulation algorithms
- Interference management
- Access protocols
- Service delivery architecture
- Mass-scale MIMO
- Single frequency full duplex radio technologies
- 5G devices
- Virtualized and cloud-based radio access infrastructure

5G success depends on the entire ICT

ecosystem. Its growth will be built upon global LTE success. ICT ecosystem innovation will also be a major driver in creating a bigger 5G market.

XI. CONCLUSION

There are some other projects, which are undertaken ay 5G technologies. Here we want to mention that 3G mobiles are working these days, and 4G technologies are coming, but in future we are ready to face 5G technologies and some of its features we have presented in this paper.

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