Prototyping Convergence Services on Broadband Networks

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Abstract. In today's competitive business environment, operators seek to simplify their network topology in order to cut costs and create a convergent network infrastructure that is secure, easy to manage, always available, and capable of providing bandwidth to new multimedia service traffic loads and changing business needs. This paper gives an overview of broadband networks and how to provision services such as voice, which remains the main revenue generator for operators, on such networks.

Keywords: Open APIs, Multimedia Services, Evolved Packet System, Client Framework.

1 Introduction

Mobile and fixed network consumers have moved from simply using voice and data to more visually oriented, high definition entertainment, video conferencing and integrated services on broadband networks. Broadband networks are networks that can connect user's terminal equipments to network service providers and offer an always on functionality and that has a high capacity for sending and receiving data.

So what is driving broadband networks? In recent years, the Internet usage patterns and behaviour are migrating to the mobile arena. Subscribers are beginning to have the same communication expectations whether at home or on the move. Rather than technology driving user behaviour, this change is user centric, driven by people as consumers and business users. People rapidly take up new services and new ways of using them, and the technology has to evolve to keep up with this. Consumers and business users have similar needs in terms of convenience and being constantly connected.

1.1 Evolved Packet System

The Evolved Packet Core (EPC) network standardized by the Third Generation Partnership Project (3GPP) as part of Release 8 is an efficient standard based all IP network architecture for supporting the next generation of full service broadband. EPC is an important step forward for operators looking to secure success for the long term. EPC together with Long Term Evolution (LTE) access technology form the Evolved Packet Systems (EPS), providing everywhere coverage and always on broadband access for fixed, nomadic and mobile users.

This enables a richer variety of services and better user experience. Unlike its predecessors, EPC provides support for multiple access technologies and provides mobility between them, allowing subscribers to move between different accesses while providing service continuity. The core network facilitates a fully multi-service converged core, with support for multiple access technology and interworking with legacy 3GPP and non-3GPP networks. It also enables a common core network for Fixed Mobile Convergence (FMC), which significantly reduces the cost of ownership and facilitates development for multi-services subscriber offerings.

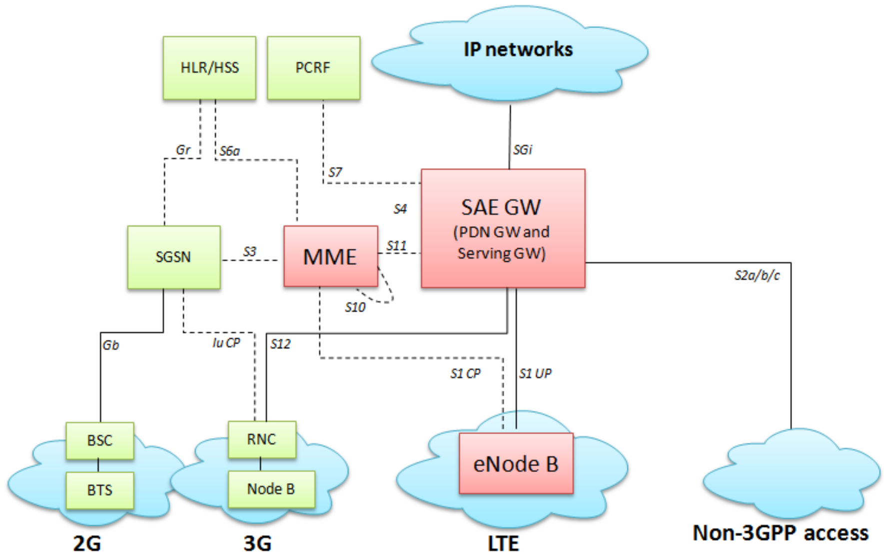

Fig. 1. Overview of the Evolved Packet System*

The rest of this paper is divided as follows – chapter 2 presents applications driving the market trend in adopting broadband networks and the challenges faced in replacing legacy applications such as voice and SMS service. Chapter 3 discusses an open standard approach in meeting up to the challenges, while chapter 4 and 5 present a practical approach in crystallize the ideas specified in chapter 3. Chapter 4 seals and concludes this topic.

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* PDN – Packet Data Network
SAE – System Architecture Evolution
MME – Mobility Management Entity
eNode B – E-UTRAN Node B access

2 Multimedia Services on Broadband Networks

The Smart devices and smart communication help people to joggle the roles of private and professional life. Today, we can observe how communication is changing the uptake of new services. ITunes features the worlds' largest video and music catalogue. Its customers have purchased over 4 billion songs as well as renting of purchasing over 125 million TV episodes and 8 million movies. The media is consumed using computers, handsets and conventional devices. The figures for Facebook and YouTube are equally astronomical. As more of these consumer services are migrating to the wireless domain, the community is now on mobile domain, requiring the same facilities both at home and on the move. Together, these statistics point to one fact mobile multimedia communication is happening now across the world and throughout consumers and business groups.

In addition to above described data services (e.g. music and video streaming) and messaging services which belong to the primary focus on enabling an efficient mobile broadband solution, the support for voice and SMS services is also given high priority in the broadband network architecture specification. However, one of the trickiest issues for early broadband adoption is the uncertainty over how voice and SMS services, which are still the key cash flow application for high revenues for most operators.

Conventional telephony communicates using the voice medium only, and connecting only two telephones per user over circuits of fixed bit rates. In contrast, modern communication services depart from the conventional telephony service in three essential aspects; multimedia, multi-point, and multi-rate.

Multimedia voice service may communicate audio, still images, or full motion video or a combination of these media. Each medium requesting different demand on communication qualities such as bandwidth, signal latency within the network, and signal fidelity upon delivery by the network.

Multi-point calls involve the setup of connections among more than two people. These connections can be multimedia. They can be one way or two way communications. These connections may be reconfigured many times within the duration of a call. Traditional voice calls are predominantly two party calls, requiring a point-to-point connection using only the voice medium.

Multi-rate service network is one which allocates transmission capacity flexibly to connections. A multimedia network supports a broad range of bit-rates demanded by connections, not only because there are many communication media types, but also because a communication medium may be encoded by algorithms with different bit-rates. For example, audio signals can be encoded with bit-rates ranging from less than 1 kbit/s to hundreds of kbit/s, using different encoding algorithms with a wide range of complexity and quality of audio reproduction. Similarly, full motion video signals may be encoded with bit-rates ranging from less than 1 Mbit/s to hundreds of Mbit/s.

3 A Standard Based Approach for Voice over Broadband Networks

There are two main solutions for enabling voice services on broadband networks. One solution is to use the IP Multimedia Subsystem (IMS) mechanism specified in 3GPP Release 5 and realize voice using the MultiMedia Telephony (MMTEL) framework introduced in Release 7. The second possibility would be to stick to the old circuit-switched way of providing voice services. The second option would be possible in the EPS network realization by that users temporarily leave the LTE network to perform the voice calls over 2G/3G network, and then return when the voice call is finished. This is not the most elegant of solutions, but it can be realized primarily networks, which lack an IMS infrastructure.

Table 1. EPS solution to voice services.

Legacy voice service	Transition Solution	EPS solution
CS voice	CS Fallback (Rel 8)	IMS VoIP (Rel 7)
Supplementary Services	CS Fallback (Rel 8)	Multimedia Telephony (Rel 7)
Emergency Calls with Location Support	CS Emergency Calls (Rel 5)	IMS Emergency Calls with Location Support (Rel 9)

Many initial broadband deployment strategies were to deploy LTE as a data-only network. However voice and, even more importantly, SMS remain the key revenue generating applications for operators. Faced with the risk that large players might delay deployment plans until they have a strong route to voice, the One Voice Initiative [3] was created with endorsement from key operators, with the aim of defining a profile named the Open Voice Profile based on existing 3GPP standards.

The Open Voice Profile defines a minimum mandatory set of features a User Equipment (UE) and network are required to implement in order to guarantee an interoperable, high quality IMS-based telephony service over EPS radio access.

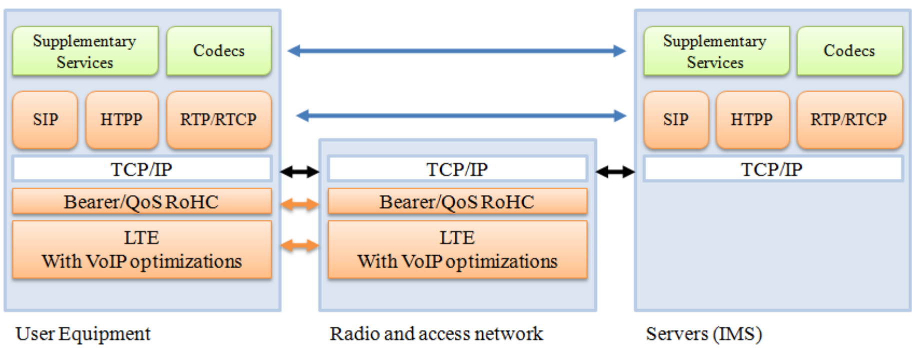

Fig. 2. One Voice Profile for UE and network protocol stacks. Note that the TCP/IP layer also includes UDP and XCAP.

The scope of the profile defines the following aspects:

- IMS capabilities & voice including supplementary services for telephony
- Real-time media negotiation, transport and codec
- LTE radio and Evolved Packet Core capabilities
- Functionality that is relevant across the protocol stack and subsystems.

The profile defines an optimal set of existing 3GPP-specified functionalities that all industry stakeholders, including network vendors, service providers and handset manufacturers, can use to offer compatible LTE voice solutions. This approach will also open the path to service convergence, as IMS is able to simultaneously serve broadband fixed and LTE wireless networks.

From the Open Voice Profile specification, we have implemented a prototype based on the UE specification requirements which offers the minimum set of mandatory service capabilities. The implementation was based on our client service framework myMONSTER [10] (Multimedia Open Services and Telecommunication EnviRonment) software toolkit. myMONSTER is an extendible plug-and-play framework developed by Fraunhofer FOKUS. This toolkit enables the creation of rich terminal applications compliant with NGN, IPTV and Web standards. myMONSTER provides three toolkits – for telecommunication, television and web approaches. We shall present the telecommunication package of the framework in more details in the next chapter.

4 Client Service Creation Toolkit

Parallel to network and service delivery initiatives, there are also some initiative going on in the terminal device arena. One of the most significant responses of industry players to the client development has been the Rich Communication Suite (RCS).

4.1 Rich Communicator Suite

The Rich Communicator Suite Initiative started by a small group of leading industry players in 2007, and in February 2008, it was launched at the Mobile World Congress in Barcelona. The Global System for Mobile Communications Association (GSMA) added RCS to its work program in September 2008 and now more than 70 Converged Solution Providers (CSP) and vendors are part of the saga.

Table 2. Rich Communication Suite Release Overview

Release 1 (12.2008)	Release 2(06.2009)	Release 3(12.2009)
Enhanced phone address book with	Broadband Access to RCS features	Enhancement of Release 2 features

presence	
Content Sharing	Multi-device environment
File Sharing	Provisioning and configuration of RCS devices/clients
Enhanced Messaging (SMS/MMS & Chat)	OMA IM and MMTel integration

In 2008, the concentration of the RCS features was only on mobile phones, but with the expansion of broadband networks, this quickly expanded to include other platforms with broadband access. To also compliment the efforts of other initiatives such as Open Voice and Voice over LTE (VoLTE), RCS also integrates open standards from OMA IM and also recently the 3GPP/TISPAN MMTel specifications on their features portfolio.

The advantage of the RCS within the industry is to ensure a steady, open standard conformant implementation on vendor devices for the mass market. However, we find one aspect missing which is pertinent in the overall success to IMS-based multimedia services. The RCS follows already defined open standards to specify services for mobile and fixed terminals, but the actual implementation of these services, again remain left to the different partners to implement on their various devices. From other mobile application development platforms such as the Google Android, multimedia application development is driven by the user development community and not the vendor. Therefore, we find it important that third party developers are given the tools they need to promote and help mass deployment of IMS services on different platforms. The lack of an SDK, which developers can download and quickly integrate on the platforms for third party service integration slows the uptake of IMS based telephony services compared to the use of Web APIs which provide similar service.

4.1 myMONSTER Telecommunication Communicator Suite (TCS)

The Telco Communicator Suite is a Java-based framework that delivers a unified communication experience for all IP networks. It is powerful, yet lightweight enough to run on both fixed and mobile devices. This suite provides developers with high level APIs for easy integration into their applications in order to enrich them with telecommunication aware services.

The services on the TCS framework are modularized and decoupled, giving developers the flexibility and options to extend the framework with their own components. The framework is built in a plug-n-play approach of service bundles known as modules. These modules provide well defined APIs which developers can use to integrate on their own applications known as “add-ons”. Table 3 provides an overview of the basic API offered on the framework. The framework does not only provide protocol stacks for the IMS network but also provide other communication protocol stacks.

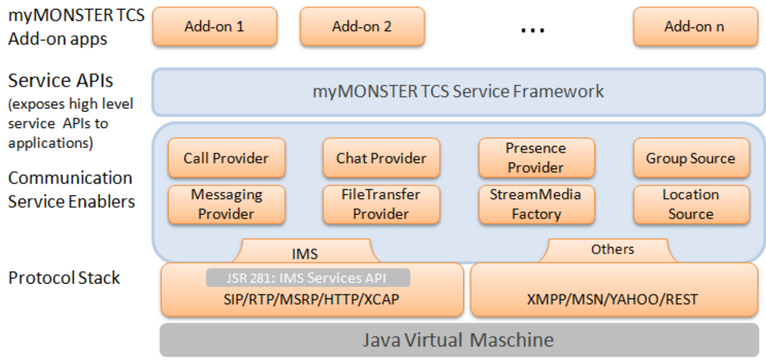

Fig. 3. High level overview of the myMONSTER Telecommunication Communicator Suite framework

Table 3. myMONSTER TCS Communication Service Enablers APIs

API	Description
Call	Creating audio and video calls including call control functions like call-hold, call-resume and call-transfer (IMS VoIP).
Instant Messaging and Chat	Sending instant messages in page mode using SIP and session mode messaging using MSRP (Message Session Relay Protocol) with extensions to OMA IM specification
Presence	Publication of the presence state and getting notification of user presence supporting PIDF, RPIDF and OMA presence
Location	Access to different device location sources like GPS, Cell Id and static locations enables location based services.
Network stored address book	Managing groups for contacts and contact data with local and server-side storage (ext. OMA CAB v1.0)
File Sharing	Creating multimedia sessions for sending and receiving multiple media file types over MSRP

The key benefits and advantages of the myMONSTER TCS client framework include: Shortens development time for third party developers; IMS stack builds on open standards from 3GPP (TS 24.229 [5]) and JSR 281 [6] specifications; multiple target platforms (Linux, Windows Vista /XP/7, Mac, Windows Mobile, and Google Android); decoupling of service logic from the presentation layer enables multiple presentation layers (Swing, SWT, Widgets, embedded) and facilitates branding

5 Extension on myMONSTER TCS for Voice Provisioning over Broadband

As discussed in chapter 3, Open collaborative discussions concluded that the IMS based solution, as defined by 3GPP, is the most applicable approach to meeting the consumers' expectations for service quality, reliability and availability when moving from existing circuit switched telephony services to IP-based EPS services. This approach will also open the path to service convergence, as IMS is able to simultaneously serve broadband fixed and LTE wireless networks.

To extend the myMONSTER TCS framework capability for a Voice-over-EPS solution, the following functionalities had to be implemented: MMTel and Supplementary services support; IMS Emergency Calls with Location Support; Session Mobility Manager.

5.1 MMTel and Supplementary Service Add-on Module

The MMTel service module was introduced on the framework to address a new user proposition in which the real time communication between session participants is set according to the telephony paradigm fulfilling quality of service, authentication, authorization, regulatory and efficiency requirements. The new user proposition includes a voice over IP telephony service that can use a set of simulated PSTN/ISDN supplementary services and add and drop a number of different media types during a session to adapt to the current communication need. Examples of media types that can be used in the MMTel session include:

- Voice, both narrow band and wide band quality,
- full-duplex or half-duplex video,
- text, where the characters are either transmitted in real-time when the user types or as pre-typed messages,
- general files that are stored in the receiving terminals memory or files of known file formats.

In addition, the user has the possibility of creating ad-hoc multi party conference sessions, with subscription to the "conference" event package, three way party calls, and extending created peer-2-peer sessions to conference sessions.

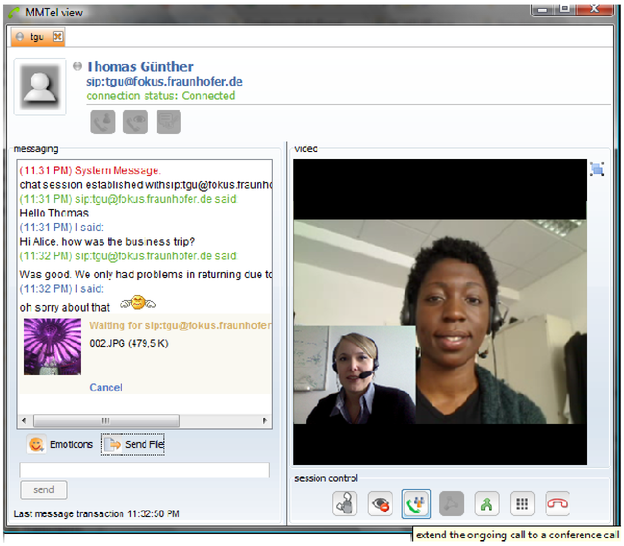

Fig. 4. Multimedia Telephony View showing an ongoing session with different media types (audio, video, message, files) all within a single established session.

Besides the real-time multimedia creation, the MMTel module also provides a complex Ut reference interface (XCAP) implementation towards the application server (XDMS) for configuring supplementary services as defined in 3GPP TS 24.623. Supplementary services are telecommunication services that provide PSTN/ISDN-like service capabilities using session control over IP interfaces and infrastructure. We provided configuration interfaces for multiple service configurations (see Fig. 4).

When an MMTel subscriber registers and is authenticated on the core network, the network interacts with the subscriber's profile on the home registry. If the subscriber's data shows a subscription for the MMTel service it dynamically allocates a Multimedia Telephony Application Server (MTAS) to serve the subscriber on establishing multimedia sessions. When setting up an MMTel session, using the service identifier the core network can determine that session related signaling belongs to an MMTel call, and hence routes the call to the pre-selected MTAS. The MTAS executes the main part of the call control and supplementary services are invoked by the MTAS, if needed.

The development of this extension is performed under the umbrella of an industry Project and is geared toward operators and who provide MMTel service on their broadband networks

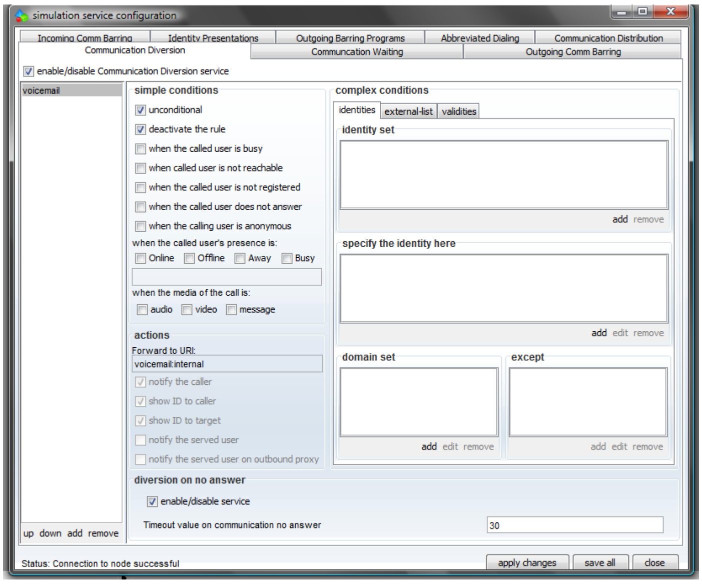

Fig. 5. Simulation Service configurations interface that the user can use to configure its supplementary service profile.

5.2 IMS Emergency Calls and Location Support Add-on Module

IMS VoIP support for emergency calls (including location support) is specified in 3GPP Release 9 which fulfils the last regulatory requirement separating VoIP from CS in 3GPP networks.

During an emergency situation, the UE can register and place a free call to a Public Safety Answering Point (PSAP). The emergency IMS registration can be used only to place emergency calls. The UE acquires queries for location information, and includes this information in the initial request of the emergency call. If the location information is missing in the initial request, the core network can query for the user's location from the access network and refers it in the request. The request is forwarded to the Emergency CSCF (E-CSCF). Upon receiving the emergency related SIP message by the E-CSCF, in case no location information was provided, the E-CSCF queries the Location Retrieval Function (LRF) for the user location. The LRF ensures that the E-CSCF receives the most appropriate PSAP URI, e.g. Police call taker. Then the emergency SIP message is forwarded further to this PSAP.

The myMONSTER emergency services extensions overcomes the problem of the caller location within all IP networks. The location of the device is queried and inserted in the message flow so that the network can map the service request to the nearest PSAP.

The development of this extension is performed under the umbrella of the PEACE European Project [4] and is geared toward operators and safety organizations that have already started the migration of their current emergency system to broadband networks.

5.3 Session Mobility Manger Add-on Module

The Session Mobility Manager on the UE has the role of interacting with the Core Network Mobility Management Components and to provide a seamless experience for the applications running on the client devices, such that operations like network attachment or handovers would be transparently handled. To perform these operations, the Mobility Manager (MM) component on the UE will orchestrate the normal network management procedures. For providing value-added functionality, the Access Network Discovery and Selection Function (ANDSF) situated in the core network assists the Mobility Manager with information and operator pushed policies.

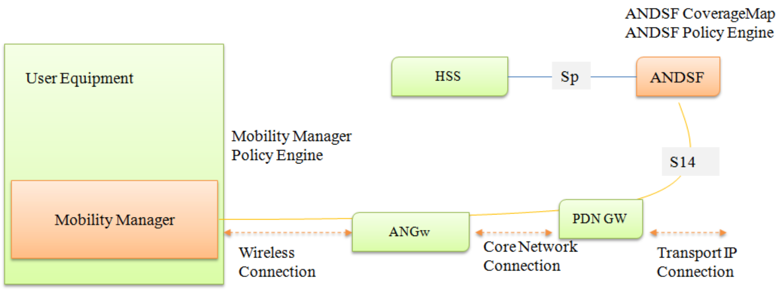

Fig. 6. Session Mobility Support for seamlessly handling session handover and other policy based access network selection functions.

The ANDSF communicates with the MM running on the UE and exchanging information which would enhance both the Always Best Connected (ABC) concepts, but also allows the network operator to manage and enhance connectivity on a multi-access environment as specified in 3GPP TS 23.402 and 3GPP TS 24.312. The ANDSF and the MM communicate through the S14 interface. The transport mechanism is currently limited to a simple XML exchange over TCP interface, with an additional triggering mechanism by simple UDP alerting.

The myMONSTER EPC add-on is a plug-in on the framework which was developed to demonstrate the integration of a mobile client framework with the Mobility Manager. It exposes to the user all the IP connectivity and operator pushed (over the S14 interface) information. It also provides a configuration interface for configuring the behavior of the MM and for manually triggering session handovers, which is demonstrated via a simple video-streaming application.

The development of this extension is performed under the umbrella of the project OpenEPC [12], a prototype reference implementation of the 3GPP Release 8 Evolved Packet Core (EPC) that will allow academic and industrial researchers and engineers around the world to obtain a practical look and feel of the capabilities of the Evolved Packet Core.

6 Conclusion

This paper presented an overview of broadband networks. The EPC network, from 3GPP Release 8 specification offers together with LTE access technology to form the EPS, providing everywhere coverage and always on broadband access for fixed, nomadic and mobile users. This enables a variety of new multimedia. While data services such as E-mail, social networks, video streaming applications, increase in consumer size and leverage the advantages of broadband networks, voice and SMS services which remain their key revenue generating applications for operators are still to be realized.

A group on operators forms an initiative called the Open Voice Initiative, who then defined an Open Voice Profile based on already exciting Multimedia Telephony solutions and Emergency Call solutions on the IMS network as specified by 3GPPP Release 7 and 9 respectively. This profile defines a minimum mandatory set of features a UE and network are required to implement in order to guarantee an interoperable, high quality IMS-based telephony service over EPS radio access.

Based on this profile, we implemented extensions on the myMONSTER TCS framework; a UE implementation for creating applications on the client side, to prototype the requirements of the Open Voice Profile. The extensions were developed and tested within the scope of an industry operator environment, a European project (PEACE) and a reference implementation project (OpenEPC) of the 3GPP Release 8 specification of the Evolved Packet Core.

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