

# NCL and ITU-T's Standardization Effort on Multimedia Application Frameworks for IPTV

Marcelo Ferreira Moreno  
Departamento de Informática  
PUC-Rio  
Rio de Janeiro, RJ, Brasil  
moreno@inf.puc-rio.br

Carlos Eduardo C. F. Batista  
Departamento de Informática  
PUC-Rio  
Rio de Janeiro, RJ, Brasil  
cbatista@inf.puc-rio.br

Luiz Fernando Gomes Soares  
Departamento de Informática  
PUC-Rio  
Rio de Janeiro, RJ, Brasil  
lfgs@inf.puc-rio.br

## ABSTRACT

Multimedia applications aimed at running on IPTV terminal devices must be platform-independent, because content creators and content providers cannot develop a specific application for each existent terminal device platform. Harmonization is a key characteristic for such an application environment, and agreeing upon technical standards to allow interoperability is a challenge that should be addressed carefully. The Multimedia Application Framework Recommendation (MAFR) Series (ITU-T H.760 series) is an effort by ITU-T to identify and harmonize the relevant multimedia application frameworks that are best suitable for IPTV services. Several established technologies from Broadcast, Cable, Web and IPTV markets are being studied and profiled (H.IPTV-MAFR drafts). This paper describes ITU-T Question 13 Study Group 16's work on MAFR standards and discusses the relevancy of the Nested Context Language (NCL) in this context.

## Categories and Subject Descriptors

H.5.1 [Multimedia Information Systems]: Evaluation / methodology.

## General Terms

Documentation, Standardization.

## Keywords

NCL, Standardization, ITU-T, IPTV, Multimedia Application Framework

## 1. INTRODUCTION

In IPTV services, content creators and content providers are able to add to their products multimedia applications that, in a certain way, will enrich the end users' experience on viewing the television programming. Such applications are mainly based on multimedia content, including audio, video, text, pictures, and so

on, and can be developed aiming at interactivity, electronic services, gaming etc.

The IPTV terminal device market is characterized by having multiple vendors and many of them build products based on their own software and hardware platforms. But multimedia applications must be platform-independent because content creators and content providers cannot develop a specific application for each existent terminal device platform. Therefore, interoperability is mandatory.

To promote IPTV equipment interoperability, ITU-T started the Multimedia Application Framework Recommendation Series (H.760 series), [1] as an effort to identify and harmonize the relevant multimedia application frameworks that are best suitable for IPTV services. Several established technologies from Broadcast, Cable, Web and IPTV markets are being studied and profiled (H.IPTV-MAFR drafts). Some new emerging technologies are also under discussion. ITU-T Question 13/Study Group 16 (a.k.a. Q13/16) is the workgroup in charge of that.

With the MAFR series, terminal device vendors will have the certainty that their application platforms are compliant with a given market that specifies one or more MAFR technologies as its standardized application framework. Moreover, terminal device vendors will be able to compete in multiple markets and countries, because terminal device migration can be supported, by embedding well-known MAFR standards into the terminal device. They will also be able to define hybrid terminal devices that can be easily ported from a market to another, based on the latest techniques to build component-based software architectures and configurable systems. A given terminal device can be sold in Japan, South Korea and Brazil, for example, since the vendor can develop and make available to the consumer software components that implement their respective multimedia application engines.

The Nested Context Language (NCL) is the first standardized technology in the MAFR series, under recommendation H.761 [2]. NCL's features like spatiotemporal synchronization, content adaptation, multi-device exhibition and its glue-language approach make it an excellent solution for IPTV multimedia services. Moreover, it is a solution capable to promote the harmonization among MAFR technologies. This is the reason why NCL and its presentation engine, called Ginga-NCL, are also standardized in ITU-R BT-1699 [], ITU-T J.200 [] and J.201 [] as a solution for multiple format integration and spatiotemporal synchronization.

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This paper overviews the ongoing work in ITU-T regarding the MAFR recommendation series and identifies the relevancy of NCL in this scenario. The text is organized as follows: section 2 summarizes the MAFR Series of specifications; section 3 outlines the MAFR Common Suite, intended to define a minimum set of closely-related MAFR technologies to promote harmonization; section 4 discusses issues for the development of IPTV Widgets; section 5 focuses on the conformance testing specification; section 6 gives a general idea of the other trending topics being discussed in the MAFR scope; and finally, section 7 concludes the paper.

## 2. THE MAFR SERIES

Recommendation ITU-T H.760 [1] identifies and describes the relevant standards of multimedia application frameworks. It is an overview of standards for declarative application frameworks and procedural application frameworks. Declarative application frameworks include HTML, CSS, DOM, SVG, DVB-HTML, BML, WTVML, CEA-2014, MHEG-5 and NCL. EcmaScript and Lua are mentioned as scripting languages to extend some of these declarative languages. Procedural application frameworks are based on GEM. H.760 also contains descriptions for M3M, BIFS and LAsER. An annex recommends language profiles to harmonize web-related technologies like HTML, DVB-HTML, CEA-2014 and BML.

H.760 is limited to present an overview of multimedia application frameworks. The technologies actually standardized for ITU-T MAFR for IPTV services are specified in the other documents of the series. The following subsections explain these recommendations and draft recommendations under the MAFR Series.

### 2.1 ITU-T Recommendation H.761

The ITU-T Recommendation H.761 [2], entitled "Nested Context Language (NCL) and Ginga-NCL for IPTV services", specifies NCL and its presentation engine, called Ginga-NCL as the first Recommendation produced as part of the MAFR Series.

Nested context language (NCL) is a declarative XML-based language, initially designed aiming at hypermedia document specification for the Web, which due to its flexibility, reuse facility, multi-device support, application content adaptability, and mainly, the language intrinsic ability to easily define spatiotemporal synchronization among media assets, including viewer interactions, make it an excellent solution for IPTV systems. NCL is also used in the ISDB-Tb DTV broadcasting standard.

NCL is a glue language that holds media objects together in a multimedia presentation, no matter which object types they are. Ginga-NCL is an NCL presentation engine built as a component of an IPTV middleware. As an example, NCL treats an HTML document as one of its possible media objects. In this way, NCL does not substitute but embed XHTML-based documents. The same reasoning applies to other multimedia objects, as for example, a media object containing an MHEG application. Ginga-NCL also supports behavior modifications into running applications, also known as live editing, by accepting event descriptors and editing commands to change any structure of an NCL document under presentation in a terminal device.

A particular NCL object type defined in Ginga-NCL is NCLua, an imperative media-object with Lua code, Lua being the scripting language for Ginga-NCL. Because of its simplicity,

efficiency and its powerful data description syntax, Lua was considered the natural scripting language for Ginga-NCL. The Lua engine is small and written in ANSI/C making it easily portable to several hardware platforms.

An open source reference implementation of Ginga-NCL is also available under the GPLv2 license. This reference implementation was developed in a way that it can easily have incorporated a variety of media-object players, for audio, video, image, text etc., including imperative execution engines.

### 2.2 ITU-T Recommendation H.762

Recommendation ITU-T H.762 [3] describes the high-level functionalities of the lightweight interactive multimedia environment (LIME) for IPTV. LIME (formerly BML for IPTV) supports functionalities in IPTV terminal devices to provide interactivity and a variety of content such as audio, video, graphics and text. Expected services include additional data such as text to enrich television programs, and two-way portal pages.

The main part of LIME consists of the following components:

- The "LIME-HTML" profile of XHTML 1.0. This profile is compliant with the "HTML for IPTV services" Recommendation of the multimedia application framework (MAFR) series currently under development.
- The LIME-CSS" profile of CSS1 and a part of CSS2. This profile is compliant with the "CSS for IPTV services" Recommendation of the MAFR series currently under development.
- The "LIME-DOM" profile of DOM specification. This profile is compliant with the "DOM for IPTV services" Recommendation of the MAFR series currently under development.
- The scripting language "LIME-Script", which is a subset of ECMAScript but has functional extensions required for IPTV services. LIME-Script is compliant with the "ECMAScript for IPTV services" Recommendation of the MAFR series currently under development.

### 2.3 H.IPTV-MAFR.6

Draft recommendation H.IPTV-MAFR.6 [4] describes ECMAScript as one of standardized multimedia application frameworks, to provide interoperable use of IPTV services. It gives the core ECMAScript profile as well as enhanced functionalities for IPTV services. ECMAScript is a scripting programming language, used on the Web and is often referred to as JavaScript or JScript, after the two primary implementations of the specification.

ECMAScript is supported in many applications and also included as a component in many presentation engines (PE) such as BML and DVB-HTML, which are used for digital data broadcasting. Some implementations have a completely different set of libraries; making applications written in one dialect of ECMAScript will not necessarily work in another. ECMAScript is an object-oriented programming language for performing computations and manipulating computational objects within a host environment. It was originally designed to be a web scripting language, providing a mechanism to enliven web pages in

browsers and to perform server computation as part of a web-based client-server architecture.

## 2.4 H.IPTV-MAFR.10

Draft Recommendation H.IPTV-MAFR.10 [5] describes Scalable Vector Graphics (SVG), which is a language for describing two-dimensional graphics and graphical applications in XML. SVG allows for three types of graphic objects: vector graphic shapes (e.g., paths consisting of straight lines and curves), images and text. Graphical objects can be grouped, styled, altered and composited into previously rendered objects. The feature set includes nested transformations, clipping paths, alpha masks, filter effects and template objects.

SVG drawings can be interactive and dynamic. Animations can be defined and triggered either declaratively (i.e., by embedding SVG animation elements in SVG content) or via scripting. Sophisticated applications of SVG are feasible by use of a supplemental scripting language which accesses SVG DOM, which provides complete access to all elements, attributes and properties.

SVG Basic and SVG Tiny profiles are targeted to resource-limited devices and are part of the 3GPP platform for third generation mobile phones. SVG Print is a set of guiding principles to produce final-form documents in XML suitable for archiving and printing.

## 2.5 H.IPTV-MAFR.14

Draft Recommendation H.IPTV-MAFR.14 [7] specifies Lua scripting language. Lua can be viewed as an extension language, because it has no notion of a "main" program: it only works embedded into a host client, called the embedding program or simply the host. This host program may invoke functions to execute a piece of Lua code, may write and read Lua variables, and may register C functions to be called by Lua code. Through the use of C functions, Lua may be augmented to cope with a wide range of different domains, thus creating customized programming languages sharing a syntactical framework. The Lua distribution includes a sample host program called "lua", which uses the Lua library to offer a complete, stand-alone Lua interpreter. The Lua engine is distributed as free software under the MIT license.

Ginga-NCL [2] presentation engine integrates NCL and Lua players into a declarative environment. NCL and Lua frameworks can be used independently in other declarative environments, but if they are used together they shall follow Ginga-NCL specification. Draft Recommendation H.PTV-MAFR.14 presents the Lua specification as a general-purpose language. However, any conformant implementation of Lua for IPTV Services shall follow the restrictions it states, and shall provide the IPTV Core API, which is also described by the recommendation. MAFR.14 also includes the description of an IPTV Extended API, which is optional, but shall be followed if any of its functionalities is to be implemented.

## 3. COMMON MAFR SUITE

As aforementioned, ITU-T Recommendation H.760 briefly describes the relevant MAFR technologies but does not specify how they are integrated or harmonized [1]. Some harmonization effort can be found in Annex A of H.760, which describes common usage of related technologies such as HTML, DOM,

CSS and ECMAScript. However, that effort was preliminary and more discussion on MAFR harmonization has been recently started in ITU-T Q13/16.

It was agreed by ITU-T W134/16 that a Common MAFR Suite could be proposed to recommend a minimum set of closely-related MAFR technologies that an IPTV terminal device shall support. The technologies in the common suite must be integrated into a package that is lightweight enough to be embedded into baseline terminal devices [8].

A Common MAFR Suite would improve not only equipment interoperability, but also the compatibility between different markets and therefore enable the global interchange of multimedia content. This is aligned with actions that ITU-T Resolution 76 resolves (see Section 5 for details).

### 3.1 NCL as a candidate technology for a Common MAFR Suite

NCL separates document (or application) content and structure. NCL does not define itself any media content. Instead, it defines the glue that holds media objects together in multimedia presentations [2].

An NCL document only defines how media objects are structured and related, in time and space. As a glue language, it does not restrict nor prescribe the media-object content types. In this sense, we may have image objects (GIF, JPEG, etc.), video objects (MPEG, MOV, etc.), audio objects (MP3, WMA etc.), text objects (TXT, PDF etc.), imperative objects (Java Xlet [9], Lua etc.), declarative objects (XHTML, SVG...) etc, defined as NCL media objects. Which media objects are supported depends on the media players that are coupled into the NCL formatter. One of these players is the main video and audio decoder/player, usually implemented in hardware in the IPTV terminal device. In this way, note that the main video and audio are treated like all other media objects that may be related using NCL.

ITU-T Recommendation H.761 states that the XHTML-based media object [10] is essential. Hence, NCL does not substitute but embed XHTML-based documents (or objects). As with other media objects, which XHTML-based language will have support in an NCL formatter is an implementation choice, and, therefore, it will depend on which XHTML browser will act as a media player integrated to the NCL formatter.

Therefore, it is possible to have BML [11] browsers, DVB-HTML [12] browsers and ACAP-X [13] browsers embedded in an NCL document player. It is even possible to have them all. It is also possible to receive a browser code through datacasting and install it as a plug-in (typically Lua objects). It is also possible to have a harmonization browser implemented, and receiving the complementary part, if needed, as a plug-in, in order to convert the XHTML player into one of the several IPTV browser standards.

Given the above, NCL can be viewed as a feasible solution to promote a lightweight integration among MAFR technologies. Figure 1 illustrates an example of an MAFR suite with NCL. Note that closely-related MAFR technologies are also included in the figure.

More contributions are expected to define the Common MAFR Suite. Currently, only NCL and Lua are mentioned as candidate technologies to integrate the suite.

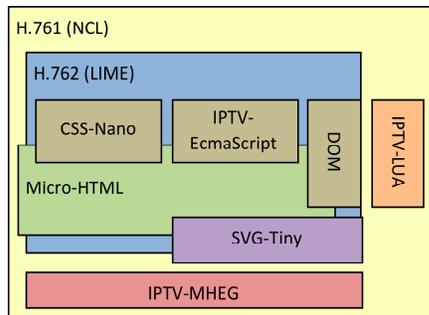


Figure 1. An MAFR Suite with NCL as a glue language

#### 4. IPTV WIDGETS

Widget is the definition used for an interactive element of a graphical user interface (GUI) that displays an information arrangement. Commonly the term widget is also used to specify an element different from basic GUI components because it provides a single interaction point for the direct manipulation of data in a particular context, but as visual components, widgets can be combined to form an application, or may be used separated, as individual applications. Currently, though, the term is more often used to define lightweight applications such as a monitor for stock market, weather forecast, a calculator, a news aggregator etc.

W3C defines widget as an interactive single purpose application for displaying and/or updating local data or data on the Web, packaged in a way to allow a single download and installation on a user's system [14]. Widgets are used on many environments and with different applicability – they may be found on computers' desktops, on mobile devices, web applications and on Digital TV platforms as well. A widget engine is the software layer that enables users for running and displaying widgets on a graphical user interface, such as the graphical layer of an IPTV terminal device. Such widgets commonly provide relevant information graphically and/or provide easy access to frequently used functions on a system. IPTV Widgets, thus, are lightweight applications that are used frequently by the IPTV terminal user, such as calendars and news aggregators, with an easily accessible graphical user interface, often staying on the display.

IPTV Widgets may be classified by their functionality. The classification below is a non-exhaustive list of categories that has been collected from [15], revised and extended to the IPTV domain:

- Accessory Widgets: self-contained widgets that do not require support from a content provider or from other applications (e.g.: clocks, calculators, offline games)
- Application Widgets: widgets that just present a different interface for a regular application already present in the terminal device (e.g.: mini player, address book, picture frame);
- Information Widgets: widgets that displays processed data downloaded from a content provider (e.g.: news readers, information tickers, weather forecasters).
- Service Widgets: Information widgets that are related to IPTV services (channel-specific EPG, content recommenders, service provider announcers).

Since an IPTV widget may run on different kinds of terminal devices, like set-top boxes, TV sets, and mobile devices, portability is an important issue and should be addressed based on standardized technologies supported by Widget Engines in the terminal device. IPTV Widgets must be developed using the technologies defined in the H.760 series (Multimedia Application Framework), such as HTML, LIME, CSS, ECMA Script, NCL and Lua.

A Widget Engine is the entity responsible for instantiating widget(s) in the client side (i.e. the IPTV terminal device). As shown in the above figure (Figure 2), the widget engine instantiates selected widget(s) using a number of technologies in the IPTV terminal device.

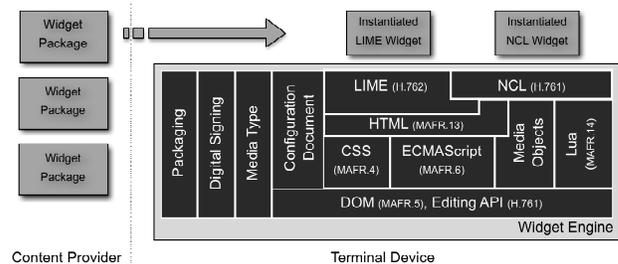


Figure 2. Widgets and Widget Engine

Currently, ITU-T Q13/16 is conducting studies on the requirements for widget development, in order to establish a harmonized service model and framework for IPTV services, considering how these requirements are addressed by Recommendation ITU-T H.760 series (H.IPTV-MAFR). These requirements associated with the characteristics of a widget application were used to define a set of guidelines for the development of IPTV widgets. The following guidelines are independent of the MAFR technology chosen to develop a widget:

- Packaging – a widget must be packaged using a standard format recognizable by IPTV widget engines. Widget developers must have in mind that this package will be distributed to different devices and locations.
- Metadata and Configuration – widget developers shall have the tools to inform the widget engine the configuration information of a widget, comprising: metadata elements about a widget, such as its title, some form of identification, and versioning information; metadata containing authorship information; a bootstrapping mechanism in order to enable the widget user agents to automatically instantiate a widget; environment configuration parameters.
- Security – Requirements that a conforming specification needs to address in order to standardize an adequate security model that is permeated on all elements involved on the execution of IPTV widgets. Such a security model must adopt a robust and flexible digital signature scheme and processing model and limit the potential for widgets to perform harmful operations on the terminal device.

NCL and Lime widgets are being standardized and harmonization effort is under discussion. The final intention is to define common procedures for widget packaging, signing, configuration and metadata.

## 5. CONFORMANCE TESTING SPECIFICATIONS

ITU-T Resolution 76 "Studies related to conformance and interoperability testing, assistance to developing countries, and a possible future ITU Mark programme" resolves that study groups must take actions to improve interoperability as soon as possible. These actions include, among others:

- Development of Recommendations that deal with conformance testing;
- Progress of Recommendations to address interoperability testing;
- Definition of conformance and interoperability testing requirements for verification of the parameters defined in Recommendations and to ensure full compatibility;
- Assistance of national and regional testing entities to ITU-T in implementing conformance and interoperability testing;
- Identification of Recommendations that would be candidates for interoperability, which are capable of providing end-to-end interoperable services on a global scale.

Resolution 76 and its appreciation by Q13/16 led the workgroup to intensify its discussions on harmonization and interoperability. The work item on Common MAFR Suite (see Section 3) is a result of Q13/16 actions. Another one is the specification of conformance and interoperability tests for IPTV recommendations.

The process of conformance testing aims to verify whether the implementation of a particular standard matches the requirements settled by this standard. The correctness of an implementation is defined through the verification of the results generated by tests conducted based on the standards specific criteria. A new recommendation series is under development to specify conformance tests for IPTV recommendations. The MAFR series is included in this work item.

### 5.1 H.761 Conformance Testing Specification

The Conformance Testing Specification for H.761 is under development towards to cover all functional aspects defined by H.761 Recommendation. Currently, it is registered as the Draft New Recommendation H.IPTV-CONF.5 "H.761 conformance testing specification".

H.IPTV-CONF.5 is composed of more than 600 test assertions referring to the functionalities provided by NCL 3.0 and more than 700 test assertions related to the NCLua API. The test cases are being developed for a test suite reference implementation, which will take part of the specification as an electronic annex. Each test assertion (Figure 3) is composed of the following information:

- A unique id.
- Reference: the source document and clause where the normative statement that the test assertion addresses is defined. Example: ITU-T H.761 - 7.2.3.
- Prescription level: indicates how imperative is the referred normative statement. Possible values are: "mandatory" (required), "permitted" (optional) and "preferred" (recommended).

- Validation type: "positive" if the assertion instructions take the form of a well-succeeded task or "negative" otherwise.
- Target: the element(s) and attributes involved in the assertion. Example: Element <region>, attribute *title*.
- Instructions: The procedure and its expected behavior. Example: "Create a document with nested <region> elements. The regions must be displayed accordingly".
- Normative statement: i) text (excerpted from the specification) that originated the assertion or ii) a normative statement summary or iii) a test objective. Example: "a <regionBase> element, ..., defines a set of <region> elements, each of which may contain another set of nested <region> elements, and so on, recursively".

descriptor05		
Reference	ITU-T H.761 - 7.2.6	Presentation of a media node associated to a <descriptor> element that has the attribute <i>freeze</i> present.
Prescription level	Mandatory	
Validation type	Positive	
Target	Element <descriptor>, attribute <i>freeze</i> .	
Instructions	Create a document containing a <descriptor> element with its <i>freeze</i> attribute value set to "true". The media node associated to that descriptor must be normally presented with its last frame frozen at the end of presentation.	

Figure 3. An example H.761 test assertion

## 6. OTHER TOPICS UNDER DISCUSSION

The following subsections present other relevant topics under discussion on the scope of the MAFR Recommendation Series.

### 6.1 Web-based-terminal middleware (WBTM)

Web-based IPTV terminal middleware supports basic, advanced interactive IPTV services for IPTV terminal device. It is required to review the IPTV service requirements and architecture, as well IPTV terminal devices. Detail descriptions for architecture are in Y.1900 series, and IPTV terminals are in H.720 series. Web-based IPTV terminal middleware is needed to define the interfaces on IPTV terminal functional architecture and structure of presentation engine.

H.720 defines the terminal middleware as located in the terminal side. It is "the mediating entity between two information elements." [16] locates the terminal middleware in the terminal device, and for WBTM it could be located on "various engines (e.g. HTML Browser) along with a set of high-level services (e.g. HTML, NCL, CSS, EcmaScript, Lua)". The WBTM presentation engine is depicted in Figure 4.

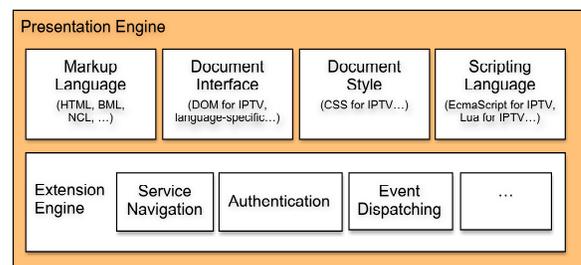


Figure 4. WBTM presentation engine

## 6.2 3D IPTV

The increasing demand for multimedia applications associated to the actual stage of graphical and human-interaction hardware are the key factors allowing development of multimedia applications with 3D graphics for media consumers in general. Transmission of 3D video over TV channels is already being done worldwide, and soon most IPTV terminals will be equipped with 3D video decoding capabilities. Thus, it is also necessary to provide technologies to allow the development of interactive applications featuring 3D content.

Currently, some web-related standards already gather features for the development of application with 3D graphics. Technologies like VRML [18], X3D [19] e 3DML [20] can be embeddable on other declarative languages like XHTML and NCL. Studies are being conducted focusing the interoperability aspects of the relevant technologies related to the development of 3D applications and 3D TV, so that harmonization can be pursued for 3D IPTV as well. Q13/16 is discussing 3D IPTV and expects contributions for the first discussions 3D interactivity.

## 7. CONCLUSION

This paper outlined the current status of the standardization effort being conducted in ITU-T Q13/16 regarding Multimedia Application Frameworks and related topics for IPTV services. Several ramifications emerged from the initial work, all related to new technology possibilities, which are being discussed.

As mentioned throughout this paper, interoperability is a mandatory characteristic for the IPTV terminal device market. The technologies being considered for the MAFR Series not only fulfill the current requirements for multimedia application development but also have potential for emerging new application model and services for the IPTV environment.

In this context, the Nested Context Language and its presentation engine, Ginga-NCL, are rising as an excellent solution for multimedia application framework due to their abilities to support advanced tasks like spatiotemporal synchronization, live editing, multi-device exhibition and content adaptation. But an important feature of NCL comes to attention when the discussion regards integration, harmonization and interoperability: its glue-language approach, which allows for the integration of different content formats and the conception of harmonized specifications. It was from discussions around NCL that some work items like the Common MAFR Suite, Conformance testing specifications and IPTV widgets have started in Q13/16.

This paper's authors are constantly contributing to Q13/16 work since 2007, when the question was under study in the IPTV focus group. One of the authors is an associate rapporteur of Q13/16. The TeleMidia Lab has conducted all the NCL standardization effort in ITU-T and its consequent discussions. With the recent adoption of Ginga-NCL in many south-american countries both for IPTV and terrestrial DTV, some researchers and developers may be interested in participate on these activities.

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