

## Telecommunication Numbering System Roadmap Towards NGN Era in Indonesia

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### Abstract

The telecommunication numbering system in Indonesia currently complies to the International Telecommunication Union (ITU) standard, that is ITU-T E.164. In accordance to both technology development and the growing of network users, ITU has also been designing future infrastructure network concept, namely Next Generation Network Infrastructure (NGNI). In its technical paper, ITU discusses future generation's specification as well as current network migration scenarios towards NGN in developing countries and its impact on regulations, business processes, and the numbering system. The scenario described in the concept is yet universal and the implementation would be highly depending on the conditions of ones country. This paper proposes the roadmap of numbering system from the current state into NGN numbering for the case of Indonesia. It is important since Indonesia has unique circumstances compared to other developing countries. It needed a roadmap that is relevant with its numbering system transformation condition towards NGN numbering. The method used in this paper are benchmarking with several countries that have started with the transformation process, forecasting with regression method based on the existing trends and descriptive analysis. This paper has proposed the stages of numbering roadmap towards NGN numbering system, the achievement parameters, and the indicators that are suitable for Indonesia.

**Keywords:** Roadmap, Numbering, NGNI, Forecasting and ITU

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### 1. Introduction

Numbering is one of the important issues in telecommunications as the identity of the end-system device that is connected to the network. Currently, the telecommunications numbering system used in Indonesia, and most countries, are using a 15-digit number of ITU-T E.164 [1, 2] standard. Today, the length of 15-digit numbers can accommodate the needs of telecommunications services users, particularly in Indonesia. However, in the long term, regarding the rapid growth of users and the changes of technology, transformations of numbering system and network infrastructure is certainly required. In the future, the telecommunications users would not be only humans, but may include huge number of devices such as sensors and actuators. It is believed that in the future the width of digit numbering would be inadequate for telecommunications requirement.

Telecommunication users in Indonesia is significantly growing over time. Until mid-2014, there have been more than 351.8 million mobile customers and Fixed Wireless Access (FWA) [3] in Indonesia. This phenomenon and the trend will continue to increase. Supported by mobile operator services and the growth of applications that could be accessed online, the number of users would increase significantly. In addition, as a result of competition between telecommunication operators, communication tariff will become cheaper. Consequently, the price of the card will also become cheaper.

The need of number as user identifier will continue to increase from time to time. One of the triggers are changes in lifestyle and behavior of users upon high technology. In average user has more than one gadget and device. Smart phones, tablets, GPSs, cameras, PDAs and laptops are examples of devices owned by the users. Almost all high-tech devices can connect to the Internet either through a wired or wireless network. Each device is expected to obtain

significant benefits that can be connected to the Internet with an identity number of telecommunications.

The limitation of telecommunications-digit number, that is 15 digits, and the growing of telecommunications users would lead to number insufficiency. It needs regulations to rule the system by the regulator, in this case government of Indonesia, for an efficient and effective utilization. In Law No. 36 Article 23 paragraph (2) explained that the numbering system is set up by the Minister [4]. The regulator is taking control in setting the numbering system to create a conducive business environment as well as serving the public appropriately.

International standard agencies, such as the Internet Engineering Task Force (IETF), ATIS, The 3rd Generation Partnership Project (3GPP), the European Telecommunications Standards Institute (ETSI) and the International Telecommunication Union (ITU), has designed the future network infrastructure. One of the important concepts of standardization design is the convergence of IP-based telecommunication services. In this case the ITU has issued technical papers on the data network and open system communication, and next generation network (NGN) [5, 6]. The technical paper discusses migration scenarios of existing telecommunications networks toward NGN networks in developing countries. In addition, there has been a case study that discusses the migration process in one of the developing countries [7].

Future network is heading to the networks convergence based on Internet Protocol (IP). Current telecommunications network that based on the frequency with Time Division Multiplexing (TDM) access methods, is beginning to be abandoned. Since these methods have no capability to provide applications service at high speed and low cost. On the other hand, data-based telecommunications network – that has an IP network would be able to deliver low cost and large amounts of data. The services that tend to increase in the future would include : Voice over Broadband (VoBB), Machine to Machine Communication (M2M) and the Mobile Number Portability (MNP). These services are based on IP interconnection.

The Changes of network infrastructure in Indonesia from TDM-based networks towards IP-based networks will affect the numbering system used in Indonesia. It needs a roadmap that includes the concept of phasing that suits the existing condition in Indonesia. Such conditions include the readiness of the regulators, network conditions and conditions of the telecommunication companies. Numbering Roadmap contains numbering system transformation stages with clear milestones, consisting of parameters as well as achievement criteria in each stage.

## **2. Indonesia Telecommunication Numbering System**

Telecommunications numbering system, which is mostly used in Indonesia, is using the ITU-T E.164 [1, 2] standard. In this numbering system, each subscriber is identified by a series of numbers starting by country code + national destination code + number, sequentially. National destination code consists of two categories namely: a number that indicates the geographical area and that does not indicate the area. National destination code which indicates the area serves as an area code. National destination code which does not indicate areas that function as network access codes that is featuring the type of network or service type.

Telecommunications services in Indonesia are mostly provided by means of network-based Circuit Switched and Packet Switched. The numbering system used on each network in Indonesia is shown in Figure 1. Circuit switched network numbering system used ITU-T E.164 and X.121 [1, 2] standards. On the other hand, the data packet connection is done over packet – switched networks that uses IPv4 and some IPv6. Voice over IP (VoIP) service is an example of transferring voice over packet-switched.

The role of Indonesian government is a regulator that regulates the use of the numbering system in Indonesia. Various policies have been issued regarding to the numbering system in Indonesia. The initial policy of telecommunications numbering system in Indonesia is determined in National Fundamental Technical Plan (FTP) in 2000 [8]. In its later development, FTP has undergone various alterations in government Telecommunications regulation [9]. various regulations of the Minister for Communications and Information Technology have been issued relating to Indonesia numbering system, with regard to the registration upon Customers of Telecommunications Services [10], the implementation of content services [11], IPv6 roadmap [12] and alteration of FTP2000 [13].

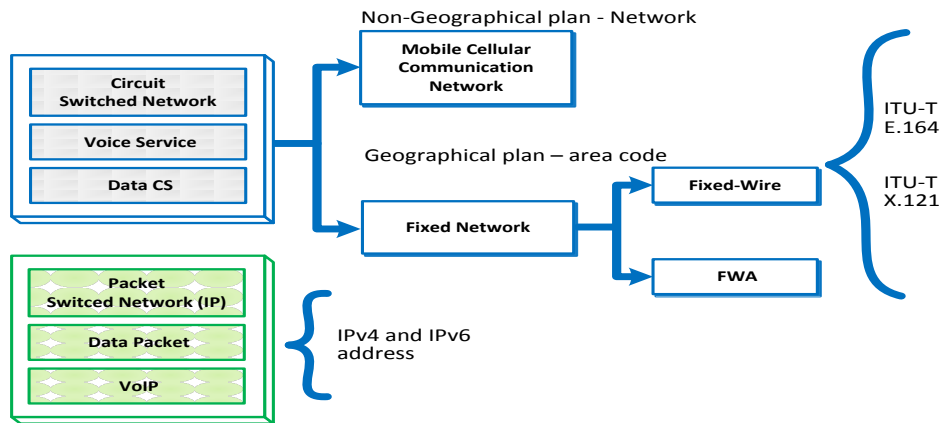


Figure 1. The existing numbering system used in Indonesia

### 3. Next Generation Network Infrastructure (NGNI)

Future network platform is based on Internet Protocol (IP). The smallest unit of data is called as a packet that will exchanged from one end-system to the others. There is a platform that will exchange information from source to destination. IP-based communications standards have been designed by world standardization bodies such as 3GPP, IETF, ETSI, ATIS and ITU. A platform will ease the packet exchange system. There is only one type of packet will sent from all sources to all destinations with different paths that can be chosen automatically according to conditions. The entire data generated at the application level will be sorted into several forms of uniform packet, including voice data.

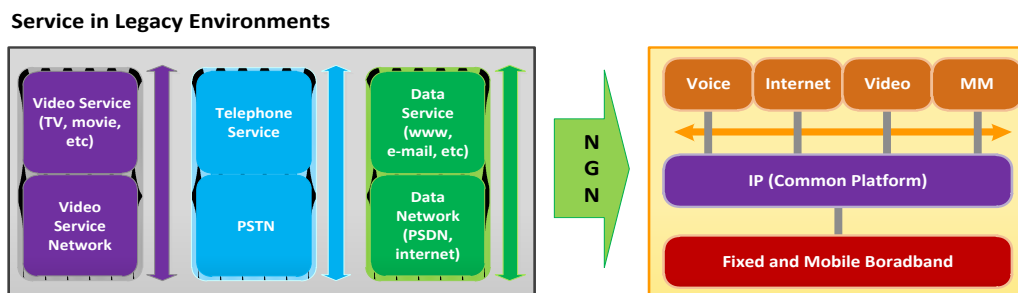


Figure 2. The Current Network Configuration and NGN [6]

Future networks on a packet-base is using a common platform that is Internet Protocol (IP). Figure 2 illustrates the future network structure with the IP as a system interconnection that connects applications layer and infrastructure. At the top there are various services that emerged in the NGN era. Services provided include a wide range of applications that are prepared to meet the various aspects of future communications. At the bottom, the IP platform connected to the network and physical access. Applications are transparent to existing network infrastructure underneath means the services provided at the application layer is not depending on types of its network technology.

The existing network, as a legacy, comprises of various network types that have some differences compare to NGN platform. Each type of network has a different application services, these are Network Video Services, Public Switch Telephone Network (PSTN) and the Public Switch Data Network (PSDN). Each network has characteristics that are suitable for a particular application. Differences in the basic concept of this network is becoming a challenge in the development of a new common network. So that a migration concept from the current network toward the NGN network is required.

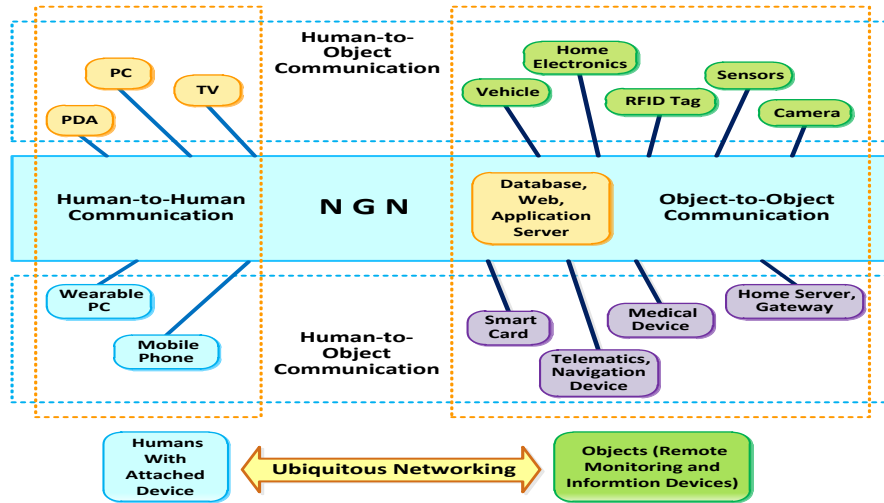


Figure 3. Coverage of NGN services [6]

In the NGN system, there are two aspects that play an important role as shown in Figure 3. These are the object and the human. Relationships that occur in the NGN environment are Human-to-human, human-to-object and object-to-object communication. The entire aspects are connected by using the NGN backbone. Human-to-human communication is the most common. Likewise, the next development is human-to-object communication. In this case, the man is connected with various devices such as the amount of data that is generated from the sensors, monitored by using a mobile phone. Another interaction occurs between the object-to-object such as sensors to actuators that do not involve human beings. Communication between object and object is usually termed as machine-to-machine communication.

**4. Benchmark**

**4.1. Australia**

The Australian Communications and Media Authority (ACMA) is a body which is given authority to organise communication and media in Australia. ACMA has defined a structure of Australia's telephone numbering plan [14] in which to regulate Australia's telephone numbering system. Currently, the numbering system comprises of four major groups namely: General purpose number, business and information number, limited used number and access code.

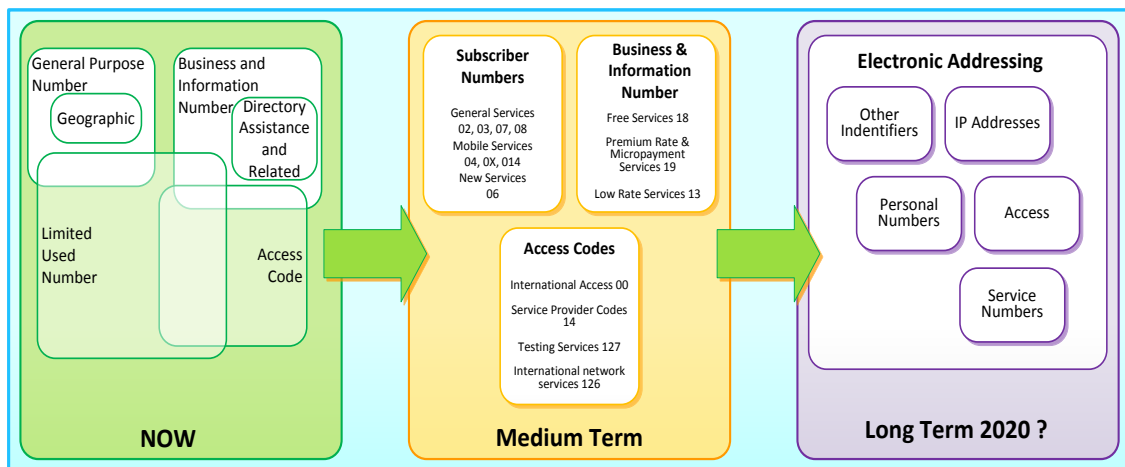


Figure 4. Evolution Line in Australia's numbering regulation [15]

ACMA's vision is to lead IP-based communications system as part of the network system of the future. Figure 4 shows the ACMA's vision, that is to migrate the current state towards NGN. There is a stage to fill the gap between the current state of the NGN. NGN implementation in Australia is expected to begin in 2020. The migration process is to be done from its current state into NGN, through mid term stage that would be a transition from the current state to the NGN system. In the transition period (medium term) numbering system is grouped into three major groups namely Subscriber Numbers, Business & Information Number and Access Codes. In the long term, around 2020, numbering system will be completely transformed into the IP-based communications networks characteristics.

#### 4.2. Bangladesh

A study carried out by ITU in collaboration with the Bangladesh Telecommunications Company Limited (BTCL) in planning the access evolution to NGN in Bangladesh [7]. Bangladesh is one of the developing countries in southern Asia that have common characteristic of other developing countries in Asia. The study created several important recommendations as follows:

1. There are needs of services expansion to include the telecom operators for a wider service, of which the implementation needs collaboration between regulators and telecommunications stakeholders
2. The need of infrastructure improvements with their migration from PSTN to infrastructure with new technologies, in order to provide better service.
3. The needs of comprehensive roadmap to build an implementation plan, including regulation, involving regulators; service providers and related sectors.
4. Development of highspeed broadband network that would be economically efficient.
5. Establish a team for NGN migration process.
6. Collaborate with strategic partners for migration in the early stages.
7. Develop a training programs for employees to facilitate the migration process.
8. To establish an IP-based team of experts whose technically study the IP network implementations concept.
9. Digitizing the entire information to be easily accessed
10. To build collaboration among telecommunications actors in the development of physical network infrastructure to be more efficient

The recommendations issued by ITU are important suggestions to improve the condition of telecommunications in Bangladesh. The Recommendations could also be used for other developing countries as an initial stage of migration from existing networks towards NGN. In General three important aspects to be considered in implementing NGN strategy in a particular country. These are to involve the entire stakeholders and the telecommunications regulators, as well as the need of a roadmap that shows the Transformation stages and a team that would monitor the migration process continuously.

### 5. Analysis: Backasting and Forecasting Method

#### 5.1. Backasting Approach

Backasting approach is an approach to create a stage that starts from the final conditions and compare it with the current conditions to obtain gap between the two. Gap is used as a reference to be fulfilled during the available timeframe. Based on the benchmarking with other countries, the era of NGN in Indonesia or in other developing countries will be occurred around the year 2025. There is a span of ten years until the complete NGN systems, ranging from infrastructure to the numbering system, are fully implemented.

##### a. The numbering system in NGN Era

The numbering system operated in the NGN era different from the existing numbering system. Addressing used in the existing network refers to International standards ITU-T E.164, which consists of: the access code of a country, area code, office code and customer number. On the other hand, NGN numbering system is based on IP with a unique users' addresses.

An IP-based NGN network systems (packet switch) connects various types of underlying network. Therefore, the system is designed to be independent from the existing transport network layer and the access network. End system Identity stated as a unique name based on IP address. The subscriber's identity is stated with an IP address, or addressing by

using URL (Uniform Resource Locator), which has been commonly in use, which is a translation of a particular IP address that is used as the identity of an application server [3]. An IP address is a unique address that is used by customers to identify and communicate in IP-based networks. An IP address can be viewed as a phone number. IP has two versions, IPv4 with the length of 32 bit addresses and IPv6 addresses with a 128 bitslength.

b. The transition numbering system

In the transition period, a numbering system that can map from the numbering system E.164 to Uniform Resource Identifier (URI) called the E.164 Number Mapping (ENUM) is in operation. The system uses the Domain Name Server (DNS) for the process of translation of E.164 telephone numbers into IP addresses.

The current numbering system, which use the existing circuit switched based system, is to be maintained until the entire IP based (packet switched) is fully operated. In transition era, Communication between two different systems occurs. The current numbering complies to the standard numbering system E.164. A transition numbering system between the two systems remains being required.

A system consisting of two different addressing concepts can not directly communicate with each other. It needs a mapping that allows the two different user addressing identity to communicate. The system that is built on a transition directed to a communication process that run simultaneously and both systems can interact without altering the basic concept of numbering that has been settled in each network.

## 5.2. Forecasting Approach

Forecasting approach is based on trends that occurred in the telecommunications industry in Indonesia today, and then the trend is projected to the next few years based on a similar pattern on the trend of previous years. Based on a future estimation for the next few years, the readiness to enter the era of NGN in Indonesia can be predicted.

a. Existing condition

The system identifier that is utilised throughout the telecommunications network in Indonesia, are shown in Table 1. Each identifier system is belong to a particular body that responsible for funding allocation, complying to the applicable regulations. Currently only phone numbers, which structure that has been described in Fig.1. has been strictly regulated by the state, through the Ministry of Communication.

The telecommunications numbering Regulations that exist in Indonesia starts from the National FTP 2000 [8], which are adjusted gradually. Here is a summary of the National FTP adjustments until 2014:

1. Kepmenperhub No. 28 Th 2004 on long distance and prefix [16].
2. Permenkominfo No. 06 / P / M. Kominfo / 5/2005 on the format and multi organizers DLD [17].
3. Permenkominfo No. 13 / Per / M. Kominfo / 03/2006 on VoIP prefix format [18]
4. Permenkominfo No. 43 / P / M. Kominfo / 12/2007 on the format of the DLD access code [19].
5. Permenkominfo No. 3A / P / M. Kominfo / 04/2008 on changes in the definition of prefixes and Overview on Number Designation. [20].
6. Permenkominfo No. 09 / PER / M.KOMINFO / 06/2010 concerning Overview Number Designation. [21].
7. Permenkominfo No. 17 of 2014 on SMS,
8. Permenkominfo No. 17 year 2014 on SMS, numbering for customers, Mobile Cellular Telephone System and area code [13]

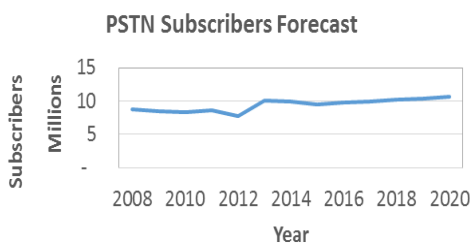
Some of the important issues related to the utilisation of telecommunications numbering and development trends in Indonesia, and predicted development in the next few years, are as follows.

1. Issues with respect to the fixed telephone numbering system.

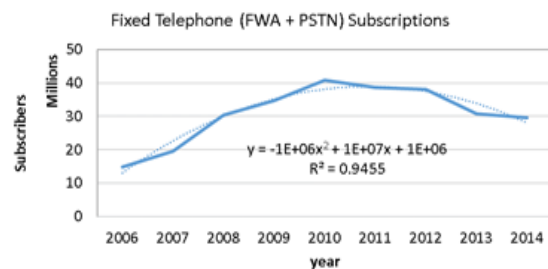
Availability of numbers to be able to meet the needs of users in the next few years is one of the initial issues is widely discussed. Based on the trend in recent years and forecasts until 2020 as shown in Figure 5.a. the trend of fixed telephone usage will tend to be stagnant. This shows that the fix phone is unlikely to grow so that the availability of numbers is not an important issue in the next few years.

Table 1. Identifier System Currently Used in Indonesia (Source: Kominfo Indonesia)

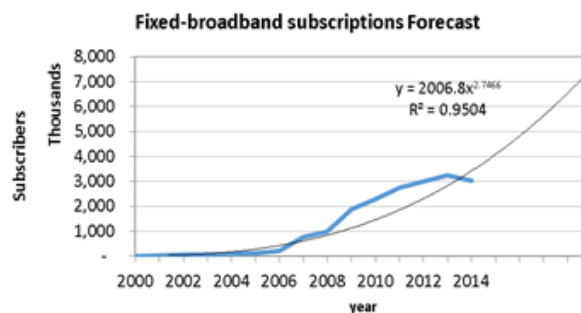
	Allocated By	Allocated To	Structure	Standard And International Regulation	Other Rules And Policies	Allocation Tarriff
Telephone Numbers	the Ministry of Communication and Informatics.	Tellecomunicati on Operators	The area codes (geographical), NDC, prefixes (VoIP, IDD, DLD, call centers, calling card, RPUU), number IN	Rec.ITU-T. E.164	FTP 2000 Chapter II	No
Ip Address	APNIC (in Asia Pacific), IDNIC (in Indonesia), with APJII	ISP	regional Address lock	RFC 2050, RFC 2928, RFC 3177	Policy ICANN / IANA, in coordination with the regional Internet registries	yes
Domain Name.Id	PANDI ( <i>Pengelola Nama Domain Indonesia</i> )	Organisasiona nd Individu		N/A	policies of the Ministry of Communication and Informatics	yes
Application-Specific Identity	Organizations responsible for the application, for example: banks, etc.	Individual	internal	no	Application-specific regulation	No



(a)



(b)



(c)

Figure 5. The growth of telephone users and prediction (a) PSTN, (b) Fixed telephone and (c) Fixed-broadband

Other than Fix Phone, there are Fixed Wireless Access (FWA) of which the trend continues to decline. Figure 5.b. shows the aggregate trends FWA and fixed phone of which declining in recent years and is predicted to continue to decline. The decrease in the number of users means that blocks of numbers previously reserved for FWA would no longer be used, so that could be used for other numbering. One of the important issues is the growth of fixed-broadband users. The predicted growth and trend of fixed-broadband user until next year can be seen in Figure 5.c. This growth can not be apart from the growth of social media services that require greater bandwidth.

Solution to the allocation of fixed telephone numbering is as follows. Numbering originally provided for fixed numbering and FWA can be reallocated to the numbering of Fixed-Broadband.

## 2. Issues related to the numbering system on the mobile phone.

Based on both the trend and predictions of mobile phone usage in recent years, the mobile phone users will continue to grow in the next few years. Fig.6 shows the mobile users growth and its estimates in the future. The allocation of numbering for mobile phones has been settled in the FTP in 2000 [8] that is about 8.1 billion numbers. Based on the number of mobile phone users estimation, mobile phone numbering would be sufficient. However, the growth of mobile phone numbers are not limited to human users. There is growth potential new customer, i.e. a non-human customer, namely machine to machine connections, M2M. Total requirements for the number of machines is much more than the human customer, in conclusion, the availability of numbers is becoming a significant issues. Figure 6. Shows the forecast in graphic form.

Another issue is the swing of fixed telephone users to those of mobile phone. Users tend to be more mobile and increasingly private. There is a shift from fixed to mobile users and from public to private phone. The use of a phone number is no longer depending on the technology underneath.

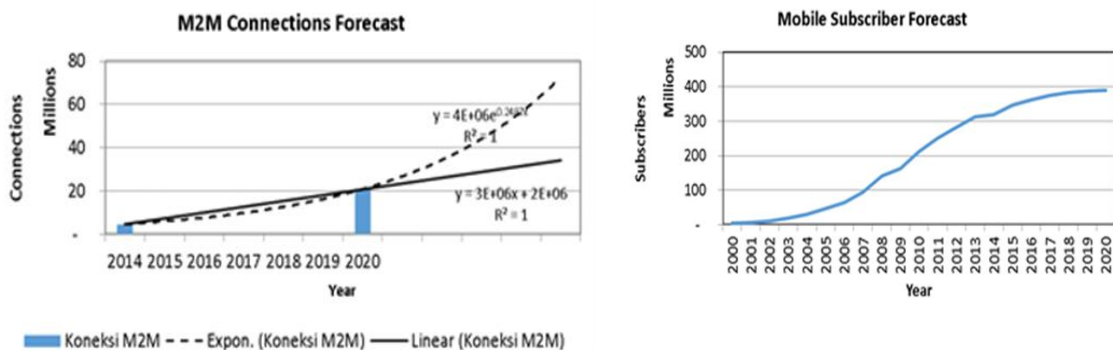


Figure 6. Growth in Cellular Mobile Telephone and M2M [22]

Critical issues in the development of mobile phone usage can be solved as follows. There is a need to simplify numbering system in order to obtain blocks of numbers that are no longer be used, to be transformed into a block of mobile phone numbers that anticipate M2M customer. Number portability system can be applied according to the user needs as a personal identity number.

## 3. Issues related to the numbering system on an IP-based phone..

Issues with regard to IP-based telephone services have been regulated in the transportation minister decree [23]. IP-based telephone services are considered as part of the multimedia services. The IP telephony Operators obtains prefix number allocation and can collaborate with other network owners. The numbering system on an IP-based phone is not a new issue. it has been arranged in the minister's decree.



### 5.3. Main Issues of Analysis

Some important issues from the analysis discussed above is as follows.

#### a. Geographic boundaries

In the era of NGN, addressing is using IP address with the majority of users behavior are tent to mobile. IP addressing system is regardless to border area. Geographical limitation phone users are no longer required. In the future, numbering with geographic boundaries is no longer required and should be abolished. There is a needs to discuss charging system and routing that are agreed by regulators and telecom actors considering that the system is completely different.

#### b. Number Portability

The customers numbering system that are flexible and independent upon operators is becoming important. Numbers is treated as personal identity that is unchanged. Changes in the telecommunications network services do not need to change the customers numbering. There is a requirement for an agreed migration process from one operator to another at the time of operator services transfer. As preparation for the NGN era numbering system, number portability system placement can be performed on the E.164 numbering system.

#### c. DNS Server Indonesia.

DNS Server is required during the transition period when the E.164 system worksconcurrently with IP-based numbering. DNS servers are used for mapping between E.164 numbering with IP-based in Indonesia. A particular DNS servers with the entire IP addresses and its translation with E.164 numbering are required in Indonesia.

#### d. IP Single Identity

Single identity is a unique user's identification concept for all purposes. This single identity can be used as a telecommunications identifier, demography, taxes, email etc. This single identity can use an existing identity such as ID cards or tax payers ID or a unique new numbering system

## 6. Roadmap: Stages Targets and Indicators

### 6.1. Stages Targets

There are two main significant components of technological change from the existing conditions towards NGN technologyin Indonesia, these are infrastructure and numbering. Infrastructure is the first component to migrate from legacy technologies such as: PSTN, PSDN and Mobile towards NGN infrastructure. The migration process can be done in two ways: overlay and/or replacement. Firstly : Overlay allows two systems running simultaneously during the migration process. The system used is tunneling. Data on the NGN network is sent using legacy backbone then in the end system is changed again into the NGN system. Secondly : to replace the entire system, so that the full NGN can be implemented as an island in the middle of a legacy technology. Numbering is the next component to be migrated from the current numbering system, ie. E.164 numbering towards IP-based. Migration process can be made in phases with a clear objectives.

Phasing time in migration process, from its current state into NGN, is determined by two important aspects, these are infrastructure and services.

#### 1. Infrastructure Readiness

Full NGN infrastructure readiness is influenced by two main aspects: the core and access networks. Based on benchamarking with Bangladesh[7], it takes at least 6 years for migration process of both networks. Considering that Indonesia is an archipelagic country, the migration process would take longer. Infrastructure migration process can be completed by the year 2025. For cellular mobile network, infrastructure readiness is determined by the migration of 2G-3G technology, which curently being dominant, towards the 4G and 5G.

#### 2. Availability of services

In the era of NGN there are new services provided in line with changes in the network infrastructure. Numbering is an enabler which connects end system to another end system. IP-based numbering will be used in conjunction with IP-based network readiness in 2025. Based on benchmarking with Australia, ACMA has designed addressing identifier using the IP address. This would be a complement to the migration period before finally fully utilised.

Figure 7 shows the stages of the numbering migration process from the existing conditions toward numbering on NGN. There is a transitional stage that enables the migration process runs smoothly. The numbering system migration process requires three main stages, these are preparation, transition and final stages. At each stage there is a target to be achieved and the actions taken to achieve the target.

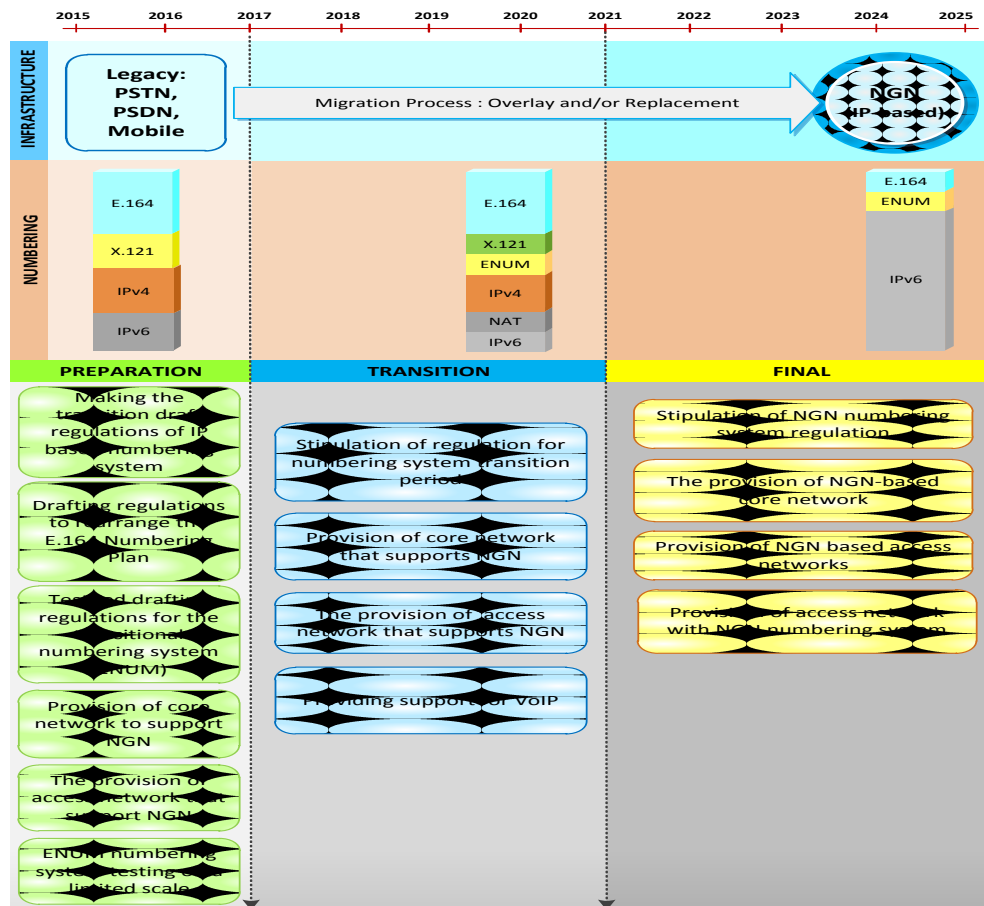


Figure 7. Stages of migration towards IP-based NGN numbering system

Referring to the predictions that is using both forecasting and backcasting methods, migration process in Indonesia numbering system can be divided into three stages, namely preparation, transition and Final stages.

#### 1) Preparation Phase (2016-2017)

The preparation phase is aimed to synchronize the actions taken under the existing telecommunications condition in Indonesia. During the preparation stage assessment on the readiness of the existing regulations and the conditions of core and access infrastructure owned by operators in Indonesia is carried out. Infrastructure is important to be assessed, considering that numbering system could not be separated from its infrastructure.

During the preparation stage, there are two goals that must be met within two years (2016-2017), these are:

- Regulatory readiness for the transition of E.164 numbering system to the IP based system.
- Operator infrastructure readiness, both core and access network, for migration.

A numbering system regulation compulsory for the the migration process implementation. Operators can perform operational transformation based on the designated regulations. Structuring of regulation can be made by evaluating regulations that have been endorsed and adjusted for the preparation of migration to IP-based numbering system.

System Implementation is carried out by the operators. Two parts of the infrastructure to be prepared are the core network as the infrastructure backbone and access network as a connection point of customers to the network.

## 2) Transition Phase (2018-2021)

The second stage is the transition from the existing numbering system to NGN numbering system. At this stage the numbering system migration process starts on a limited basis. The old system and the new system start to be implemented simultaneously in one system. Some parts have been tried out with the fully NGN system.

In the transition phase, there are two objectives to be achieved within three years (2018-2021), namely:

- a. Migration proses from E.164 to IP-based numbering system
- b. The availability of telecom operator infrastructure for the implementation of joint numbering system of E.164 and IP based, and fully IP based.

In this transition phase, the migration process starts with implementing IP based numbering system on a limited basis and run in parallel with the E.164 system. Telecommunication operators infrastructure are ready for the implementation of both fully IP-based and part of the system. The Australian Communications and Media Authority (ACMA) is a body which is given authority to organise communication and media in Australia. ACMA has defined a structure of Australia's telephone numbering plan [14] in which to regulate Australia's telephone numbering system. Currently, numbering system comprises of four major groups namely: General purpose number, business and information number, limited used number and access code.

## 3) Final Stage (2022-2025)

The final stage in the numbering system migration process is the implementation of the full IP-based numbering system. The numbering system is implemented from end to end for both core and access network. Regulation has been made available to support IP-based NGN numbering system. Network operators have fully complied with the purposes of NGN and numbering system.

In the final stages, there are two objectives are to be achieved within three years (2022-2025), namely:

- a. The practice of NGN regulation numbering system in the entire operators
- b. NGN network based service delivery by the telecommunications operators.

In this final phase the NGN technology and numbering system has been adopted by telecom operators in Indonesia. The numbering system used is a single IP-based numbering system. The services supported by this new technology is available to customers.

## 6.2. Indicators of Stages Targets Achievement

The migration process from one condition to another has several stages to ensure the achievement of the final conditions. Each stage has measurable targets. In order to measure the achievement of individual objectives, measurable performance indicators have been defined, to show the level of achievement of each target. Tables 2, 3 and 4 show the stakeholders who play the role in the transition process to achieve the targets at each stage with clear success indicators.

Table 2. Success Indicators on Preparation Phase

No	Target	Stakeholders	Action	Success Indicators
1	Regulatory readiness for the transition of E.164 numbering system to the IP based numbering system	Regulator	1. Preparation of draft regulations for transition to IP-based numbering system 2. Drafting regulations to rearrange E164 Numbering Plan 3. Preparation of draft Test-bed regulations for transition numbering system (ENUM)	Regulation for transition of numbering system utilization is available Regulation for restructuring of E164 numbering plan test bed Regulation for the transition numbering system (ENUM)
2	Readiness of the operator infrastructure for migration of both core and access network.	Telecommunication operators	1. Provision of core network to support NGN	50% of Core network telecom operators are using NGN technology

Table 3. Success Indicators on Transition Phase

No	Target	Stakeholders	Action	Success Indicators
1	Process of E.164 numbering system migration to IP-based, is implemented	Regulator	1. Regulation Endorsment process, of the transition period for numbering system.	Regulations on numbering system transition period have been endorsed and complied by the operators.
2	Availability of telecommunication operators' infrastructures for the implementation of E.164 and IP based joint numbering system, as well as fully IP-based numbering system	Telecommunications operator	1. Provision of support NGN core network 2. The provision of network access that support NGN 3. Providing support for VoIP	Core network 80% support NGN Access network operators 60% support NGN technology Telecommunications operators providing VoIP service

Table 4. Final Stage Success Indicators

No	Target	Stakeholders	Action	Success Indicators
1	The use of NGN numbering system regulation in all operators	Regulator	1. Stipulation of the numbering system regulation NGN	Stipulation of NGN numbering system regulation and complied by the operator
2	NGN network based service provision by telecommunication operators	telecommunications operators	1. Provision of core network based on NGN 2. Provision of access networks based on NGN 3. Providing access to a network with NGN numbering system	Core network operators using NGN technology Access network operators using NGN technology The entire telecommunications customers are using NGN numbering

Good cooperation as a team between the regulator and telecom operators are essential for bringing the system to fruition and running on NGN era. The role of regulator is to create and establish regulations in telecommunications. Telecom operators acting as principals at the field to bring NGN technology with NGN numbering system in to reality. In this roadmap both have an important role on their own scope.

## 7. Conclusion

In order to switch the telecommunications numbering system into the NGN technology, Roadmap on telecommunications numbering in Indonesia is implemented in three phases, these are the preparatory, transitional and final stages. This phasing is made with giving attention to the migration process that will occur within the core and access network infrastructure and the services provided above them. This process is carried out by taking into account the readiness of all stakeholders in Indonesia. The targets set up for each stage are aimed to be a reference to measure the level of achievement in each stage. Every stage of the migration process requires cooperation between regulators and telecom operators. Each has an obligation to meet the defined goals. The roadmap is tailored to the state of Indonesia as a developing country which has a core and access infrastructure that is ready for the migration towards NGN technology.

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