Proposal for the Thai Script Root Zone LGR

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1 General Information/ Overview/ Abstract

The purpose of this document is to give an overarching view of the label generation rules for the Thai Script including rationale behind the design decisions taken. This includes a discussion of the relevant features of the script, the communities and languages using it, as well as the process and methodology used and information of the contributors. The formal specification of the LGR can be found in the accompanying XML document:

- Proposed-LGR-ThaiScript-20170525.xml

Labels for testing can be found in the accompanying text document:

- Labels-ThaiScript-20170525.txt

2 Script for which the LGR is proposed

ISO 15924 Code: Thai

ISO 15924 Key Number: 352

ISO 15924 English Name: Thai

Native name of the script: ไทย

Thai Unicode range: U+0E00 – U+0E7F

This Thai Script Root Zone LGR is based on Maximal Starting Repertoire version MSR-2.

3 Background on Script and Principal Languages Using It

Thai is the official language of Thailand. The Thai script system has been used for Thai, Pali, and Sanskrit languages in Buddhist texts all over the country. The standard Thai is used in all schools in Thailand, and most dialects of Thai use the same script.

In addition, there is also several other languages in Thailand, Laos, Myanmar and China written in the Thai script, however, with moderate to small number of population. Therefore, the panel mainly considers working on the Thai script for the languages that are still actively used and has been reported as having high-usage population (not less than 1 million) as listed in Table1.

Language	ISO 639-3 Code	Locations	Population (in all countries)	EGIDS Score	Language Name in the Thai Script
Thai	tha	Thailand (official language of Thailand)	60,489,750 as L1: 20,489,750; as L2: 40,000,000 (2000)	1	ภาษาไทย
Northeastern Thai	tts	Widespread in Northeast Thailand	15,000,000 (1983 SIL)	6a	ภาษาอิสาน

Language	ISO 639-3 Code	Locations	Population (in all countries)	EGIDS Score	Language Name in the Thai Script
Northern Thai	nod	Northern region of Thailand	6,000,000 (1983 SIL)	5	ภาษาคำเมือง
Southern Thai	sou	Southern region of Thailand	4,500,000 (2006 Mahidol University)	5	ภาษาปักษ์ใต้
Northern Khmer	kxm	Northeastern and Eastern regions of Thailand along the border with Cambodia	1,400,000 (2006 Mahidol University)	5	ภาษาเขมรถิ่นไทย
Pattani Malay	mfa	Southern region of Thailandnear the border with Malaysia	1,000,000 (2006 Mahidol University)	5	ภาษายาวี

Table1: Selected languages written in the Thai script.

3.1 Thai

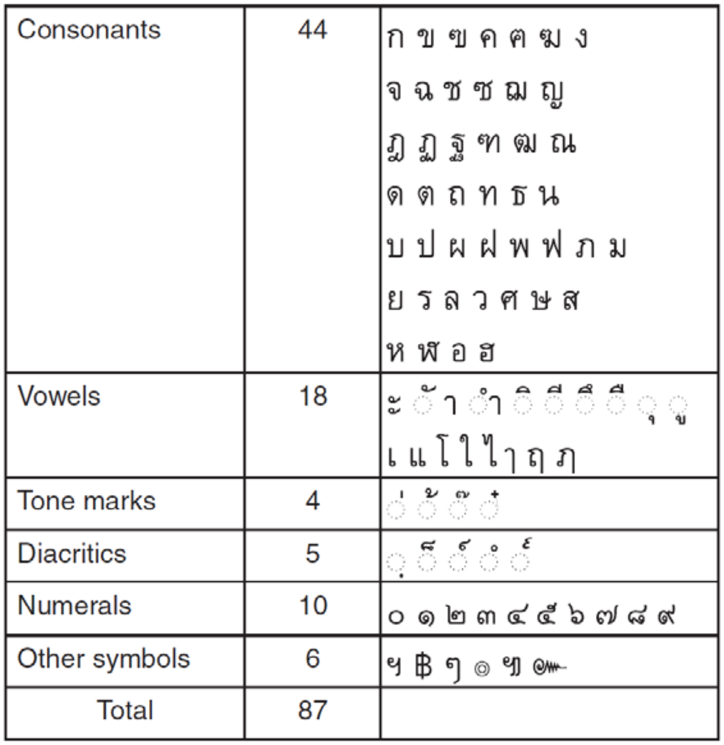
Thai is the language of 65 million people, and has a number of regional dialects, such as Northeastern Thai (or Isan, 15 million people), Northern Thai (or Kam Meuang or Lanna, 6 million people), Southern Thai(5 million people), Khorat Thai (400,000 people), and many more variations (http://en.wikipedia.org/wiki/Thai_language). The Thai language is considered a member of the family of Tai languages, the language is used in many parts of the Indochina sub-region including India, southern China, northern Myanmar, Laos, Thai, Cambodia, and North Vietnam.

The Thai script of today has a history going back about 700 years, with gradual changes in the script's shape and writing system evolving over the years. The script was originally derived from the Khmer script in the sixth century. It is generally thought that the Khmer script developed from the Pallava script of India.

Pronunciation of Thai words does not change with their context of use, as each word has a fixed tone. Changing the tone of a syllable (change of the tone mark) may lead to an entirely different meaning. Thai verbs do not change their forms as to tense, gender, and singular or plural form. Instead, there are other additional words to help with the meaning for tense, gender, and singular or plural. Basic Thai words are typically monosyllabic. Contemporary Thai makes extensive use of adapted Pali, Sanskrit, English, and Chinese words embedded in day-to-day vocabulary. Some words have been in use long enough that people have forgotten that they originated from other languages.

Thai is written left-to-right, without spaces between words. Each character has only one form, that is, no notion of uppercase and lowercase characters. Some vowels are written before or after the main consonant. Certain vowels, all tone marks, and diacritics are written above or below the main character.

A Thai word is typically formed by the combination of one or more consonants, one vowel(or one composited vowel), none or one tone mark, and optional one or more final consonants to make one syllable. Certain words may be polysyllabic and therefore they may consist of many characters in combination. There are 87 characters used to represent the language as shown in Table2.



Consonants	44	ก ข ฃ ค ฅ ฆ ง จ ฉ ช ซ ฌ ญ ฎ ฏ ฐ ฑ ฒ ณ ด ต ถ ท ธ น บ ป ผ ฝ พ ฟ ภ ม ย ร ล ว ศ ษ ส ห ฬ อ ฮ
Vowels	18	ะ ◌ั า ◌ำ ◌ิ ◌ี ◌ึ ◌ื ◌ุ ◌ู เ แ โ ใ ไ ๅ ฤ ฦ
Tone marks	4	◌่ ◌้ ◌๊ ◌๋
Diacritics	5	◌ฺ ◌็ ◌์ ◌ํ ◌๎
Numerals	10	๐ ๑ ๒ ๓ ๔ ๕ ๖ ๗ ๘ ๙
Other symbols	6	ฯ ฿ ๆ ๏ ๚ ๛
Total	87	

Table2: Thai characters.

3.2 Northeastern Thai (Isan)

Northeastern Thai or Isan is a group of Lao dialects spoken in the northern two-thirds of northeastern Thailand, also known as the Isan region. It is spoken by 20 million or so people in Thailand, and 80% of all Lao speakers. The language remains the primary spoken language in households in Isan. The Isan language has unofficial status in Thailand and can be differentiated as a whole from the Lao language of Laos by the increasing use of the Thai grammar, vocabulary and neologisms.

Within Thailand, Isan is considered a regional dialect of Thai, however, outside of Thailand, the language is classified as either its own Lao-Phuthai language due to social and historical reasons or generally as just a distinct subset of the Lao language. Thai, Isan, and Lao are all mutually intelligible to some degree, but Isan is closer to standard Lao than to standard Thai in ordinary speech. Thai, Isan and Lao share most of their basic vocabulary as well as a large corpus of shared Sanskrit, Pali, and Khmer loanwords in academic and high-brow language.

The Isan language was previously written in the ancient Lao alphabet. However, since 1871 (2414 B.E.) the government implemented a policy of using standard Thai in the classroom. Isan today is an unwritten language, but if needed, it is often written in the Thai alphabet, such as in the lyrics of karaoke videos from Isan. The Lao language in Laos continues to be written in Lao alphabet as its official script (see https://en.wikipedia.org/wiki/Isan_language).

Due to the intelligibility between Thai and Isan, and because Isan today is often written in Thai alphabet by transliteration following the Thai spelling rules, the Thai GP agreed that Northeastern Thai or Isan that is written in Thai is naturally covered by the Thai LGR. And if it is written in the Lao alphabet, then it should be well covered by the Lao LGR.

3.3 Northern Thai (Lanna, or Kam Mueang)

Northern Thai, (Lanna, or Kam Mueang) is the language of the Northern Thai people of Lana, the northern region of Thailand. It is a Tai language closely related to Lao. Northern Thai has approximately six million speakers, most of whom live in Thailand, with a few thousand in northwestern Laos.

Currently, different scripts are used to write Northern Thai. Northern Thai is traditionally written with the Tai Tham script, which in Northern Thai is called Tua Mueang. Tua Mueang is closely related to the old Tai Lue alphabet and the Lao religious alphabets and it is now largely limited to Buddhist temples, where many old sermon manuscripts are still in active use. There is no active production of literature in the traditional alphabet.

Native speakers are presently illiterate in the traditional script therefore, in Thailand, they use the Thai script to write the language instead. Some problems arise when the Thai script is used to write Northern Thai. In particular, the Standard Thai script cannot transcribe all Northern Thai tones. The two falling tones in Northern Thai correspond to a single falling tone in Thai (see https://en.wikipedia.org/wiki/Northern_Thai_language).

It is stated in MSR-2 that Lana or Tai Tham are candidate scripts for possible future MSRs (MSR-2 section 3.9 page 11). In the future, Lana could be covered by its own LGR. However, today speakers of these languages are using the Thai Script in transliteration, following the same word formation system. The Thai GP concludes that Northern Thai or Lana that is written in the Thai Script is covered by the Thai LGR.

3.4 Southern Thai (Pak Tai)

Southern Thai, also known as Pak Tai, is a Southwestern Tai language spoken in the fourteen provinces of Southern Thailand as well as by small communities in the northernmost Malaysian states. It is spoken by roughly five million people, and as a second language by the 1.5 million speakers of Kelantan-Pattani Malay and other ethnic groups such as the local Thai Chinese communities, Negritos, and other tribal groups. Most speakers are also fluent in, or understand, the Central Thai dialects.

Southern Thai is mainly a spoken language, although the Thai alphabet is often used in the informal situations when it is written. The words used that are etymologically Thai are often spoken in a reduced and rapid manner, making comprehension by speakers of other varieties difficult. Also, as Southern Thai uses up to seven tones in certain provinces, the tonal distribution is different from other regional varieties of Thai. Additionally, Southern Thai speakers almost always preserve ร as /r/ in contrast to Northern Thai, the Lao-based Isan language, and informal registers of the Standard Thai where it is generally realized as /l/ (see https://en.wikipedia.org/wiki/Southern_Thai_language).

Southern Thai, being similar to Northeastern Thai and Northern Thai, and being written in transliteration with the Thai Script, uses the same word formation rules, and is therefore automatically covered by the Thai LGR.

3.5 Northern Khmer

Northern Khmer, also called Khmer Surin, is the dialect of the Khmer language spoken by approximately 1.4 million Khmer natives to the Thai provinces of Surin, Sisaket, Buriram and Roi Et as well as those that have migrated from this region into Cambodia.

Northern Khmer differs from the standard language, based on a dialect of Central Khmer, in the number and variety of vowel phonemes, consonantal distribution, lexicon, grammar, and, most notably, pronunciation of syllable-final /r/, giving Northern Khmer a distinct accent easily recognizable by speakers of other dialects.

Northern Khmer is, for the most part, a spoken language as most speakers are unable to read or write their native tongue (see https://en.wikipedia.org/wiki/Northern_Khmer_dialect). In Thailand, Northern Khmer is written in the Thai script.

As many sounds occur in Northern Khmer that would be impossible to write according to the rules of the Thai orthography, a few innovations are necessary such as using ฮ (initial /h/ in Thai) at the end of words to represent syllable-final /h/ and ญ (initial /j/, final /n/ in Thai) to represent Northern Khmer's palatal nasal /ɲ/. Special Thai character diacritics are also sometimes used with the vowels because Northern Khmer has more vowel positions than Thai. These character diacritics are in MSR-2, code points 0E3A PHINTHU and U+0E47 MAITAIKHU. See “Handbook for Writing Northern Khmer Using Thai Script” ISBN 987-616-7073-68-2 by Royal Thai Institute http://ebook.generalprempark.com/e1/590-ภาษาเขมรถิ่นไทย.html.

The Thai GP had extensive discussion within the panel and with the Integration Panel as described in Appendix C. During these discussions, it became clear that security issues place a limitation on combinations of below vowels with PHINTHU. The rendering of these combinations is not stable; PHINTHU-modified vowels are therefore excluded from this LGR, resulting in some limitations on the range of Northern Khmer words that can be used as Root Zone labels. For a similar restriction on stacking MAITAIKHU, there exist acceptable fallback spellings that are supported by this LGR.

The Thai GP agreed that this solution is flexible enough to partially support Northern Khmer while it still avoids the security issue in the domain system.

3.6 Pattany Malay (Kelantan-Pattany Malay, or Yawi)

Kelantan-Pattani Malay, often referred to in Thailand as Yawi (in Thai) or Jawi (in Patani Malay), and in Kelantan as Bahasa Melayo Kelate (بهاس ملايو كلنتن), is a Malayan language spoken in the Malaysian state of Kelantan and the neighbouring southernmost provinces of Thailand. It is the primary spoken language of Thai Malays, but is also used as a lingua franca by ethnic Southern Thais in rural areas, Muslim and non-Muslim, and the samsam, a mostly Thai-speaking population of mixed Malay and Thai ancestry.

Pattany Malay is originally written in the Jawi alphabet, based on the Arabic script, which is where the name "Yawi/Jawi" for the language comes from. Today, Pattani Malay itself is generally not a written language, though it is sometimes written in informal settings. The general population of Malay speakers in both Malaysia and Indonesia now use the Latin script, known in Malay as Rumi (رومي), for daily communication.

A phonetic rendering of Pattani Malay in the Thai alphabet has been introduced, but it has not met with much success, due to the socio-religious significance of Jawi to Muslim Malays, as well as because of numerous inconsistencies and inaccuracies.

As Pattany Malay is mostly written in Arabic or Latin Script the Thai GP considered that including Pattany Malay code points in the Thai LGR might be premature and therefore excluded it from consideration.

3.7 Summary of Languages covered by the Thai LGR

The Thai GP set the principle for language selection to any language that is written or may be written in the Thai Script which is still actively used and has been reported as having high-usage population (not less than 1 million). There are six languages eligible by this criterion: Thai, Northeastern Thai, Northern Thai, Southern Thai, Northern Khmer, and Pattani Malay.

Thai is the de facto national language with a fully developed writing system and it will be the main script to consider in Thai LGR, which will also cover Northeastern Thai, Northern Thai, and Southern Thai. This proposal supports the Northern Khmer language, with the limitations of PHINTHU-modified vowels. It may be possible to consider these in the future after the rendering issue has been resolved.

The Thai GP excludes Pattany Malay from the Thai LGR because the dominant writing system for it is either Arabic-based (Yawi) or Latin-based (Rumi).

4 Overall Development Process and Methodology

The generation panel started the work from October 2015 and had been discussing how to develop the Thai Label Generation Rules proposal through various types of meetings such as regular formal meetings at the early stage of the proposal development. In addition, the panel has been working via mailing list on normal basis, and has been holding teleconferences after reaching each milestone. As the majority of the panel members are in Bangkok, any face-to-face meetings were organized by ETDA.

Furthermore, the panel held an open public consultation before submitting the proposal to ICANN. The purpose of public consultation was to gather feedback on the work from the larger community and experts. Experts were invited from Thai Internet Governance Forum such as, but not limited to, internet users, IT companies, internet service providers, universities and media. The feedback from this consultation was used in finalizing the proposal for submission.

5 Code Point Repertoire

The Thai GP takes code points shortlisted in MSR-2 as a starting point for the Thai script analysis for the Root Zone Label Generation Rules. The Thai GP makes reference to the Thai script writing system from the Royal Institute of Thailand and also refers to various standards for using Thai in computers. These standards from the Thai Industrial Standard Institute (TISI) include, TIS 620 series – Standard for Thai Character codes for Computers, TIS 820 series – Layout of Thai Character Keys on Computer Keyboard, and TIS 1566 – Thai Input/ Output Methods for Computers.

The Thai script is an abugida, in which consonant–vowel sequences are written as a unit: each unit is based on a consonant letter; and vowels, tone marks, or diacritic notations are secondary. It is written with the combining marks stacked above or below the base consonant, like diacritics in European languages. However, although the concepts are quite similar, the implementations are significantly different.

Type	Numbers	Subtype	Characters
Consonants	44	CONS: consonant	ก ข ฃ ค ฅ ฆ ง จ ฉ ช ซ ฌ ญ ฎ ฏ ฐ ฑ ฒ ณ ด ต ถ ท ธ น บ ป ผ ฝ พ ฟ ภ ม ย ร ล ว ศ ษ ส ห ฬ อ ฮ
Vowels	5	LV: leading vowel	เ แ โ ใ ไ
	6	FV1: ordinary forwarding vowel	ะา◌ำ
		FV2: dependent forwarding vowel	ๅ
		FV3: special forwarding vowel	ฤฦ
	2	BV: below vowel	◌ุ ◌ู
	5	AV: above vowel	◌ั ◌ิ ◌ี ◌ึ ◌ื
Tone Marks	4	TONE: tone mark	◌่ ◌้ ◌๊ ◌๋
Diacritics	5	AD: above diacritic	◌็ ◌์ ◌ํ ◌๎
		BD: below diacritic	◌ฺ
Other Symbols and Marks	6	NON:non-decomposable	ฯ฿๏ๆ๚๛

Table 3: Classification of Thai characters based on TIS-1566.

First, there are too many possible combinations of base consonants and combining marks in Thai to be enumerated like Latin accents in the ISO/IEC 8859 series standard for 8-bit character encoding. Therefore, base characters and combining characters are encoded separately, rather than pre-combined.

Second, Thai combining marks are classified into upper or lower vowels, tone marks, and other diacritics. The base consonant can be combined with up to two combining marks, that is, zero or one upper or lower vowel with zero or one tone mark or a diacritic. The upper/lower vowel, if present, is always attached to the consonant before the tone/diacritic.

A unique characteristic of a script that allows both upper and lower position is that the different input order of upper and lower marks can produce a visually identical word, while the stored codes are different. This can lead to problematic issues, such as, failures in string matching or confusing the output method.

To solve this problem, in 1990, the Thai API Consortium, a group of Thailand software developers led by Thaweesak Koanantakool, drafted a common specification for computer handling of the Thai I/O method. The work was funded by NECTEC and was published in 1998 as the WTT 2.0 specification. The WTT 2.0 specification defines the canonical order of Thai character strings. WTT 2.0 compliance requires that certain input-sequence rules must be met, and most (if not all) input syntactic errors are eliminated at the time of data entry. The WTT2.0 later become the national standard “TIS 1566 – Thai Input/ Output Methods for Computers”.

A known implementation of the WTT-based Thai input method covers Microsoft DOS and Windows (all versions), the Thai Language Environment for Solaris and a few other platforms. Even though there is a small chance that anyWTT2.0 non-compliant string will reach the point of being considered for a label in root zone, it is still worth including the sequence rule explicitly as given later in this document.

This section includes a summary of analysis of the code points, based on which the repertoire has been selected.

According to the National Standard TIS 1566, excluding the numbers and control characters, the Thai script characters are classified as shown in Table 3.

5.1 Consonants

Thai consonants can be classified as plosives (stops), non-plosives, sibilants, and voiced ‘‘h.’’ Table3 shows the subtypes associated with each character. Table 4classifies the consonants, showing the associated glyphs in the International Phonetic Alphabet (created by the International Phonetic Association, IPA)

		Labial	Alveolar	Palatal	Velar	Glottal
Nasal		[m] ม	[n] ณ,น		[ŋ] ง	
Plosive	voiced	[b] บ	[d] ฎ,ด			
	tenuis	[p] ป	[t] ฏ,ต	[tɕ] จ	[k] ก	[ʔ] อ
	aspirated	[pʰ] ผ, พ,ภ	[tʰ] ฐ,ฑ,ฒ,ถ,ท,ธ	[tɕʰ] ฉ,ช,ฌ	[kʰ] ข,ฃ,ค,ฅ,ฆ	
Fricative		[f] ฝ,ฟ	[s] ซ,ศ,ษ,ส			[h] ห,ฮ
Approximant			[l] ล,ฬ	[j] ญ,ย	[w] ว	
Trill			[r] ร			

Table 4: Classification of Thai consonants.

In each cell above, the top line indicates International Phonetic Alphabet (IPA) and the second line indicates the corresponding Thai characters in initial position (several letters appearing in the same box have identical or nearly identical pronunciation).

Each cell consists of the character’s IPA symbol in square brackets and the corresponding Thai letters that have the given pronunciation.

The plosive glottal, U+0E2D (O ANG,อ), is considered a zero-consonant and can be used to write stand-alone vowels.

There are a few sets of similar code points that are possibly confusable to a non-native user of the the script, but are not considered confusable by Thai Script users as they are used commonly in everyday writing. The sets of similar code points are given in Table 5 below.

#	Glyph	Unicode Code Point	Unicode Code Point Name
1	ก	0E01	THAI CHARACTER KO KAI
	ถ	0E16	THAI CHARACTER THO THUNG
	ภ	0E20	THAI CHARACTER PHO SAMPHAO
2	ข	0E02	THAI CHARACTER KHO KHAI
	ฃ	0E03	THAI CHARACTER KHO KHUAT
3	ช	0E0A	THAI CHARACTER CHO CHANG
	ซ	0E0B	THAI CHARACTER SO SO
4	ค	0E04	THAI CHARACTER KHO KHWAI
	ฅ	0E05	THAI CHARACTER KHO KHON
	ด	0E14	THAI CHARACTER DO DEK
	ต	0E15	THAI CHARACTER TO TAO
5	ฌ	0E0C	THAI CHARACTER CHO CHOE
	ณ	0E13	THAI CHARACTER NO NEN
6	ฎ	0E0E	THAI CHARACTER DO CHADA
	ฏ	0E0F	THAI CHARACTER TO PATAK
7	ฑ	0E11	THAI CHARACTER THO NANGMONTHO
	ท	0E17	THAI CHARACTER THO THAHAN

Table 5: Code points that may be considered similar by non-Thai script users.

In 1892 Thai typewriter was first developed by Edwin Hunter McFarland and there was not enough space to put all 44 characters in the keyboard. U+0E03 (KHO KHUAT, ฃ) and U+0E05 (KHO KHON, ฅ) were left out as they can be replaced by U+0E02 (KHO KHAI, ข) and U+0E04 (KHO KHWAI, ค) respectively due to the phonetically similarity, even though it is not an exact match. This technology limitation was the main reason for a declining usage of U+0E03 (KHO KHUAT, ฃ) and U+0E05 (KHO KHON, ฅ).U+0E03 (KHO KHUAT, ฃ) and U+0E05 (KHO KHON, ฅ) are now only occasionally used in names, not in Thai words, per the Royal Institute Dictionary (1999) the official standard current dictionary of the Thai language. Each still has an entry in most dictionaries stating that it is obsolete, and is included on alphabet charts to preserve the traditional count of 44 Thai consonants.

However, they have been included in the Thai Computer Keyboard Industrial Standard per Thai Industrial Standard (TIS) 1566 – Thai Input/ Output Methods for Computers, published 1998.When no longer limited by technology, since early 2000s, their use has grown and these have been becoming more popular for names of TV programs, movie titles and books. These are used in the books by some publishers, despite appearing conservative or grammatically incorrect; for example, Butterfly Book House Publisher (สำนักพิมพ์ผีเสื้อ) (2005), which publishes children's literature by Thai authors and Thai translations of foreign authors, such as Roald Dahl. In these books, words like ขวด (bottle) and คน (man, as in human) are spelt as ฃวด and ฅน. These have also been used in the movie "ฅนไฟบิน" (in English: Dynamite Warrior, 2006) and a documentary series "คนค้นฅน" (read "Khon Khon Khon", meaning "a man searching for the righteous man"), which is on air weekly since 2003 till now (2017).

For these reasons, today the U+0E03 (KHO KHUAT, ฃ) and U+0E05 (KHO KHON, ฅ) are no longer unfamiliar when appearing in media, books or newspapers. They have the same phonetic sound as U+0E02 (KHO KHAI, ข) and U+0E04 (KHO KHWAI, ค) respectively, while their glyph are different enough to prevent confusion for Thai script users as stated above.

In addition, U+0E03 (KHO KHUAT, ฃ) and U+0E05 (KHO KHON, ฅ) are also used for transliterating words from Northern Thai (Lana, or Kam Mueang) for the correct phonetic sound, for example, ฅิง (read "King", meaning "You, Body, Person"), ฃอช้าง (read "Kho Chang", meaning "a elephant controller-hook").

Considering these points above, even though the two code points are no longer used in the dictionary words, it is still possible to use them in names or brands. Moreover, the Standard Thai Keyboard Layout includes these two characters. Therefore, Thai GP decided to include all 44 code points for consonants.

5.2 Vowels

The 18 vowel symbols pronounced after a consonant are non-sequential in writing: they can be located before, after, above or below the consonant, or in a combination of these positions. The symbols are listed in Table 6, with the associated position type and Unicode values.

#	Vowel	Unicode Value	Name	Type	Position relative to the main consonant
1	ะ	0E30	SARA A	FV1	Following
2	◌ั	0E31	MAI HAN-AKAT	AV	Above
3	า	0E32	SARA AA	FV1	Following
4	◌ำ	0E33	SARA AM	FV1	Following

#	Vowel	Unicode Value	Name	Type	Position relative to the main consonant
5	◌ิ	0E34	SARA I	AV	Above
6	◌ี	0E35	SARA II	AV	Above
7	◌ึ	0E36	SARA UE	AV	Above
8	◌ื	0E37	SARA UEE	AV	Above
9	◌ุ	0E38	SARA U	BV	Below
10	◌ู	0E39	SARA UU	BV	Below
11	เ	0E40	SARA E	LV	Leading
12	แ	0E41	SARA AE	LV	Leading
13	โ	0E42	SARA O	LV	Leading
14	ใ	0E43	SARA AI MAIMUAN	LV	Leading
15	ไ	0E44	SARA AI MAIMALAI	LV	Leading
16	ๅ	0E45	LAKKHANGYAO	FV2	Following
17	ฤ	0E24	RU	FV3	Following
18	ฦ	0E26	LU	FV3	Following

Table 6: Eighteen vowel symbols in Thai.

The code pointU+0E33 (SARA AM) is not allowed in IDNA2008 and issued in its decomposed formU+0E4D (NIKHAHIT) and U+0E32 (SARA AA).

The code pointU+0E45 (LAKKHANGYAO) has the same phonetic function as SARA AA, but always follows the special vowel 0E24 (RU) or 0E26(LU), with no exceptions. Following the [Guideline] this type of requirement can be satisfied by removing the code point U+0E45 (THAI CHARACTER LAKKHANGYAO, ๅ) from the code point repertoire, and, instead, adding two code point sequences, <U+0E24 U+0E45>, ฤๅ and <U+0E26 U+0E45>ฦๅ.

The code point U+0E26 (LU, ฦ) appears in a few Thai words and is often recognized as archaic or poetic. For example, “ฦๅสาย ” (reading “Lue Sai”, meaning “great man, King”). It could be phonetically replaced by U+0E25 (LO LING, ล) therefore, the modern words use U+0E25 instead. For example, “พันฦก” (reading “Pan Leuk”, meaning “strange”) is now written as “พันลึก” and “ฦๅชา” (reading “Lue Cha”, meaning “be celebrated, be renowned, be famous”) is now written as “ลือชา”. However, it is not considered obsolete as its rarity in regular words makes it more popular for use in a person names, such as “นฦเดช” (read “Na Lu Dech” meaning “Powerful Brave Man”), “ศุภฦกษ์” (read “Su Pa Leuk”, meaning “auspices, blessed occasions”), and business names, such as “รฦก” (reading “Ra Leuk”, meaning “commemorative”) (see https://www.facebook.com/RaLuek.flowerart).

The 18 vowels symbols, together with three consonants—ย, ว, and อ—are used in combination to create 32 vowels for Thai, as shown in Table 7.

As discussed above, the Thai GP decided to exclude U+0E45 (LAKKHANGYAO) from the code point repertoire, and, instead add two code point sequences: <U+0E24 U+0E45>ฤๅand<U+0E24 U+0E45>ฦๅ.

Important note: This code point analysis is intended for the purpose of LGR only. Excluding some code points is not intended, by any means, to undermine the recognition of U+0E45 (LAKKHANGYAO). It should be strictly recognized as an active Thai vowel outside the context of LGR.

	Front		Back			
	Unrounded		Unrounded		Rounded	
	Short	Long	Short	Long	Short	Long
Close	-ิ /i/	-ี /iː/	-ึ /ɯ/	-ื /ɯː/	-ุ /u/	-ู /uː/
Close-mid	เ-ะ /e/	เ- /eː/	เ-อะ /ɤ/	เ-อ /ɤː/	โ-ะ /o/	โ- /oː/
Open-mid	แ-ะ /ɛ/	แ- /ɛː/	-	-	เ-าะ /ɔ/	-อ /ɔː/
Open	-	-	-ะ, -ั /a/	-า /aː/		

(a) 18 Monophthongs

Thai	-ัวะ	-ัว	เ-ียะ	เ-ีย	เ-ือะ	เ-ือ	ใ-	ไ-	เ-า
IPA	/ua/	/uːa/	/ia/	/iːa/	/ɯa/	/ɯːa/	/aj/	/aj/	/aw/

(b) 9 Diphthongs

Thai	-ำ	ฤ	ฤๅ	ฦ	ฦๅ
IPA	/am/	/rɯ/, /ri/, /rɤː/	/rɯː/	/lɯ/	/lɯː/

(c) 5 Semi-vowels

Table 7: Thirty-two vowels in Thai: (a) 18 monophthongs, (b) 9 diphthongs, and (c) 5 semi-vowels.

5.3 Tone marks

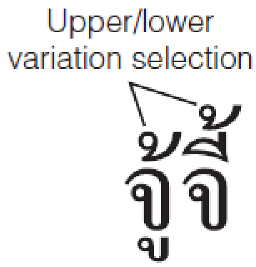
There are five phonemic tones: mid, low, falling, high, and rising. These five tones are represented by four tone marks and absence of a mark. It is important to pronounce each syllable in the proper lexical tone; different tones create entirely different meanings. The tone rules for pronunciation consider the specific consonants, vowels, and tone marks in a syllable to determine the tone with which the syllable must be pronounced. These rules are not relevant to IDNs are thus not included in this document.

For the writing system, tone marks, if any, are always placed above the final onset consonant of the syllable with the following display rules:

- Tone marks are placed above the final onset consonant of the syllable (Table 8)
- Select the lower variation for top most mark in the absence of an upper vowel (Picture 1)

#	Tone Mark	Unicode Value	Name	Example	Gloss
1	◌่	0E48	MAI EK	เก่า	Old
2	◌้	0E49	MAI THO	เก้า	Nine
3	◌๊	0E4A	MAI TRI	เกี๊ยว	Dumpling
4	◌๋	0E4B	MAI CHATTAWA	เดี๋ยว	Just now

Table 8: Example of tone mark position above the final onset consonant of the syllable.



Picture 1: In the absence of an upper vowel, the glyph for the lower variation of the tone mark is selected

5.4 Diacritics

There are five diacritic symbols with differences in their frequency and purpose of usage.

Among these, U+0E47 (MAITAIKHU) and U+0E4C (THANTHAKHAT) are commonly used in everyday communication.

U+0E3A (PHINTHU) is normally limited to use in Buddhist temples, where many old sermons in Pali manuscripts are still in active use. However, to support other languages in Thailand, those that use the Thai script for transliteration, U+0E3A (PHINTHU) is occasionally used, for example, the word “Allah”, the Arabic word referring to God which also appears in Pattany Malay. That word can be transliterated as”อัลลอฮ์”,“อัลลอฮฺ”, “อัลลอหฺ”or“อัลเลาะห์”. Therefore, the Thai GP decided to include U+0E3A (PHINTHU).

U+0E4D (NIKHAHIT) is mostly used in Buddhist temples, in old sermons in Pali manuscripts. One example is อรหํ (Ar Ra Hang) which means "Buddha". This is the "vowel sound /ang/. However, it still has productive use more widely, e.g. in names, and it is used to decompose U+0E33 (SARA AM, ◌ำ) which is in common use. Therefore, it must be included.

U+0E4E (YAMAKKAN) is rarely used in modern Thai or even old sermons in Pali manuscripts, as it is more commonly replaced with U+0E3A (PHINTHU).

The position of diacritics is shown in Table 9. The Thai GP decided to exclude U+0E4E (YAMAKKAN) from the Thai LGR repertoire as it is rarely used. Moreover, excluding U+0E4E (YAMAKKAN) will also reduce the chance of confusion between U+0E4E (YAMAKKAN) and U+0E4C (THANTHAKHAT). Both look similar, and both are always placed at the same position in the word cell, and are normally displayed in a small size.

#	Diacritics	Unicode Value	Name	Type	Position relative to the main consonant
1	◌ฺ	0E3A	PHINTHU	BD	Below
2	◌็	0E47	MAITAIKHU	AD2	Above
3	◌์	0E4C	THANTHAKHAT	AD1	Above
4	◌ํ	0E4D	NIKHAHIT	AD1	Above
5	◌๎	0E4E	YAMAKKAN	AD3	Above

Table 9: The position of diacritics in the Thai script.

5.5 Numerals

The Thai digits from U+0E50 (Zero, ๐) to U+0E59 (Nine, ๙) are treated in the same fashion as digits in other scripts in that they are not allowed in the root zone. They are out of scope for this proposal.

5.6 Other Symbols and Marks

There are six other Thai symbols and marks that are used as function symbols. IDNA2008 already disallowed four of them and MSR-2 also excluded one, as shown in Table 10.

U+0E46 (MAIYAMOK) is a repetition mark, for example “บ้านบ้าน” (home-home) can be written as “บ้าน ๆ” which has the same meaning.

The discussion on including the repetition mark with the Thai LGR is not yet conclusive within the Thai GP. Some members would like to include the mark because it is commonly used and friendly for marketing as it shortens a string, and currently it is allowed in the second level IDN tables, while other members are considering not including it because it could cause confusion for consumers.

This discussion may take some time to conclude. Thus, due to the conservatism principle, the Thai GP recommends not including it in the repertoire at this time. However, the discussion of this issue will be continued within the Thai GP and among the public multi-stakeholders in Thailand. If the final resolution is to include U+0E46 (MAIYAMOK) into the repertoire, there will be a detailed amendment to this proposal.

#	Vowel	Unicode Value	Name	Function	IDNA 2008	MSR-2	Thai LGR
1	ฯ	0E2F	PAIYANNOI	ellipsis, abbreviation	PVALID	excluded	

#	Vowel	Unicode Value	Name	Function	IDNA 2008	MSR-2	Thai LGR
2	฿	0E3F	SYMBOL BAHT	currency	DISALLOWED		
3	ๆ	0E46	MAIYAMOK	repetition	PVALID		excluded
4	๏	0E4F	FONGMAN	used as a bullet	DISALLOWED		
5	๚	0E5A	ANGKHANKHU	used to mark end of long sections	DISALLOWED		
6	๛	0E5B	KHOMUT	used to mark end of chapter or document	DISALLOWED		

Table 10: Analysis of other symbols and marks in the Thai script.

5.7 Summary of code point repertoire included and excluded

Starting from the 71 code points in MSR-2 for the Thai script, the Thai GP considered three code points to be excluded (given in Table 12). One code point (U+0E45 LAKKHANGYAO) is only supported when it occurs in one of two additional code point sequences defined in this LGR – it can be part of a label but only if used in the context of one of these sequences. The repertoire includes 68code points and three code point sequences (given in Table 11).

All code points are referenced in Thai Industrial Standard (TIS) 1566 – Thai Input/ Output Methods for Computers, which contains the Thai script or writing system from Royal Institute of Thailand. This standard in turn cites various standards for using Thai in computers from the Thai Industrial Standard Institute, such as TIS 620 series – Standard for Thai Character codes for Computers and TIS 820 series – Layout of Thai Character Keys on Computer Keyboard.

Also see the chart for code points in Appendix 1.

5.7.1 Code point repertoire included

All code points in the repertoire are from the Thai language, which has an EGIDS score of 1, indicating that the language is used in education, work, mass media, and government at the national level.

#	Unicode Code Point	Glyph	Unicode Code Point Name	Unicode General Category[1]	Category/Tag[2]
1	0E01	ก	THAI CHARACTER KO KAI	Lo	cons
2	0E02	ข	THAI CHARACTER KHO KHAI	Lo	cons
3	0E03	ฃ	THAI CHARACTER KHO KHUAT	Lo	cons

[1] http://unicode.org/cldr/utility/character.jsp

[2] Category by TIS-1566 Thai Script Characters are classification, and additional tag for WLE rule purpose

#	Unicode Code Point	Glyph	Unicode Code Point Name	Unicode General Category[1]	Category/Tag[2]
4	0E04	ค	THAI CHARACTER KHO KHWAI	Lo	cons
5	0E05	ฅ	THAI CHARACTER KHO KHON	Lo	cons
6	0E06	ฆ	THAI CHARACTER KHO RAKHANG	Lo	cons
7	0E07	ง	THAI CHARACTER NGO NGU	Lo	cons
8	0E08	จ	THAI CHARACTER CHO CHAN	Lo	cons
9	0E09	ฉ	THAI CHARACTER CHO CHING	Lo	cons
10	0E0A	ช	THAI CHARACTER CHO CHANG	Lo	cons
11	0E0B	ซ	THAI CHARACTER SO SO	Lo	cons
12	0E0C	ฌ	THAI CHARACTER CHO CHOE	Lo	cons
13	0E0D	ญ	THAI CHARACTER YO YING	Lo	cons
14	0E0E	ฎ	THAI CHARACTER DO CHADA	Lo	cons
15	0E0F	ฏ	THAI CHARACTER TO PATAK	Lo	cons
16	0E10	ฐ	THAI CHARACTER THO THAN	Lo	cons
17	0E11	ฑ	THAI CHARACTER THO NANGMONTHO	Lo	cons
18	0E12	ฒ	THAI CHARACTER THO PHUTHAO	Lo	cons
19	0E13	ณ	THAI CHARACTER NO NEN	Lo	cons
20	0E14	ด	THAI CHARACTER DO DEK	Lo	cons
21	0E15	ต	THAI CHARACTER TO TAO	Lo	cons
22	0E16	ถ	THAI CHARACTER THO THUNG	Lo	cons
23	0E17	ท	THAI CHARACTER THO THAHAN	Lo	cons
24	0E18	ธ	THAI CHARACTER THO THONG	Lo	cons
25	0E19	น	THAI CHARACTER NO NU	Lo	cons
26	0E1A	บ	THAI CHARACTER BO BAIMAI	Lo	cons
27	0E1B	ป	THAI CHARACTER PO PLA	Lo	cons

#	Unicode Code Point	Glyph	Unicode Code Point Name	Unicode General Category[1]	Category/Tag[2]
28	0E1C	ผ	THAI CHARACTER PHO PHUNG	Lo	cons
29	0E1D	ฝ	THAI CHARACTER FO FA	Lo	cons
30	0E1E	พ	THAI CHARACTER PHO PHAN	Lo	cons
31	0E1F	ฟ	THAI CHARACTER FO FAN	Lo	cons
32	0E20	ภ	THAI CHARACTER PHO SAMPHAO	Lo	cons
33	0E21	ม	THAI CHARACTER MO MA	Lo	cons
34	0E22	ย	THAI CHARACTER YO YAK	Lo	cons
35	0E23	ร	THAI CHARACTER RO RUA	Lo	cons
36	0E24	ฤ	THAI CHARACTER RU	Lo	fv3
37	0E25	ล	THAI CHARACTER LO LING	Lo	cons
38	0E26	ฦ	THAI CHARACTER LU	Lo	fv3
39	0E27	ว	THAI CHARACTER WO WAEN	Lo	cons
40	0E28	ศ	THAI CHARACTER SO SALA	Lo	cons
41	0E29	ษ	THAI CHARACTER SO RUSI	Lo	cons
42	0E2A	ส	THAI CHARACTER SO SUA	Lo	cons
43	0E2B	ห	THAI CHARACTER HO HIP	Lo	cons
44	0E2C	ฬ	THAI CHARACTER LO CHULA	Lo	cons
45	0E2D	อ	THAI CHARACTER O ANG	Lo	cons
46	0E2E	ฮ	THAI CHARACTER HO NOKHUK	Lo	cons
47	0E30	ะ	THAI CHARACTER SARA A	Lo	fv1
48	0E31	◌ั	THAI CHARACTER MAI HAN-AKAT	Mn	av
49	0E32	า	THAI CHARACTER SARA AA	Lo	fv1, sara-aa
50	0E34	◌ิ	THAI CHARACTER SARA I	Mn	av
51	0E35	◌ี	THAI CHARACTER SARA II	Mn	av

#	Unicode Code Point	Glyph	Unicode Code Point Name	Unicode General Category[1]	Category/Tag[2]
52	0E36	◌ึ	THAI CHARACTER SARA UE	Mn	av
53	0E37	◌ื	THAI CHARACTER SARA UEE	Mn	av
54	0E38	◌ุ	THAI CHARACTER SARA U	Mn	bv
55	0E39	◌ู	THAI CHARACTER SARA UU	Mn	bv
56	0E3A	◌ฺ	THAI CHARACTER PHINTHU	Mn	bd
57	0E40	เ	THAI CHARACTER SARA E	Lo	lv
58	0E41	แ	THAI CHARACTER SARA AE	Lo	lv
59	0E42	โ	THAI CHARACTER SARA O	Lo	lv
60	0E43	ใ	THAI CHARACTER SARA AI MAIMUAN	Lo	lv
61	0E44	ไ	THAI CHARACTER SARA AI MAIMALAI	Lo	lv
62	0E47	◌็	THAI CHARACTER MAITAIKHU	Mn	ad, maitaikhu
63	0E48	◌่	THAI CHARACTER MAI EK	Mn	tone
64	0E49	◌้	THAI CHARACTER MAI THO	Mn	tone
65	0E4A	◌๊	THAI CHARACTER MAI TRI	Mn	tone
66	0E4B	◌๋	THAI CHARACTER MAI CHATTAWA	Mn	tone
67	0E4C	◌์	THAI CHARACTER THANTHAKHAT	Mn	ad, thanthakhat
68	0E4D	◌ํ	THAI CHARACTER NIKHAHIT	Mn	ad, nikhahit
69	0E24 + 0E45	ฤๅ	THAI CHARACTER RU + THAI CHARACTER LAKKHANGYAO		fv2
70	0E26 + 0E45	ฦๅ	THAI CHARACTER LU + THAI CHARACTER LAKKHANGYAO		fv2
71	0E4D + 0E32	◌ํา	THAI CHARACTER NIKHAHIT + THAI CHARACTER SARA AA		fv1

Table 11: Code point repertoire included.

5.7.2 Code point repertoire excluded

#	Unicode Code Point	Glyph	Unicode Code Point Name	Unicode General Category	Category
1	0E45	ๅ	THAI CHARACTER LAKKHANGYAO	Lo	fv2
2	0E46	ๆ	THAI CHARACTER MAIYAMOK	Lm	non
3	0E4E	◌๎	THAI CHARACTER YAMAKKAN	Mn	ad

Table 12: Code points excluded from the repertoire.

6 Variants

6.1 Script-Internal homoglyphs for Thai

The Thai GP considers code points as variants if they are visually the same or very similar to each other. Based on this, there are three possible variant cases to be discussed.

- **U+0E40 (THAI CHARACTER SARA E, เ) and U+0E41 (THAI CHARACTER SARA AE, แ)**

  U+0E41 is a digraph of <U+0E40, U+0E40>, that is, a sequence of two instance of THAI CHARACTER SARA E is visually the same as THAI CHARACTER SARA AE. So the two sequences <U+0E41> and <U+0E40, U+0E40> are variants.

  Both of them are leading vowels, which will appear before the onset consonant. The Thai writing system does not allow two consecutive leading vowels in a word and this rule is proposed in WLE. Therefore, the Thai GP has discussed and decided that there is no separate need to block these variants from each other.

- **U+0E32 (THAI CHARACTER SARA AA, า) and U+0E45 (THAI CHARACTER LAKKHANGYAO, ๅ)**

  These are visually similar, the difference between them being that the U+0E45 has a longer downward stem. However, the usage is very different and discrete from each other. U+0E32 (THAI CHARACTER SARA AA, า) is a vowel that is eligible to follow after any of the 44 consonants, while U+0E45 (THAI CHARACTER LAKKHANGYAO, ๅ) is eligible to follow only two special vowels, the U+0E24 (THAI CHARACTER RU, ฤ) to become ฤๅ, and the U+0E26 (THAI CHARACTER LU,ฦ) to become ฦๅ.

  This requirement is already covered by removing U+0E45 (THAI CHARACTER LAKKHANGYAO, ๅ) from the code points, and adding two extra code point sequences, <U+0E24 U+0E45>ฤๅ and <U+0E24 U+0E45>ฦๅ.

- **U+0E33 (THAI CHARACTER SARA AM, ◌ำ) and**
  U+0E4D (THAI CHARACTERNIKHAHIT,◌ํ) +U+0E32 (THAI CHARACTER SARA AA, า)

  U+0E33 and <U+0E4D, U+0E32> are variants. However, U+0E33 (THAI CHARACTER SARA AM, ◌ำ) is already excluded from IDNA2008, therefore it is out of scope of this proposal.

In conclusion, no script-internal variants are proposed for the Thai Script.

6.2 Cross-script homoglyphs

The Thai GP has analyzed Lao, Khmer and Myanmar scripts, which are historically related scripts and for which some cross-script homoglyphs might exist. Some consonants and vowels are similar especially between the Thai and the Lao scripts, but they are not homoglyphs to the degree that would warrant considering them as cross-script variants.

The Thai GP also had a chance to discuss this issue with the Khmer GP and the Lao GP. These GPs agree that there are no cross-script variants. The samples of similar code points across these scripts are listed in Appendix B.

In conclusion, the Thai GP has analyzed Thai consonants and vowels compared to Khmer, Lao and Myanmar consonants and vowels. Some of consonants and vowels are very similar as discussed above. However, as they look different especially when in combined form in a label, there are no cross-script variants proposed.

7 Whole Label Evaluation Rules (WLE)

Thai is a complex script in which a sequence of code points creates a character cluster in a cell, and where only a subset of all possible code point sequences would ever be expected to occur in certain contexts. The WLE rules in this LGR are used to limit the context in which certain code points or marks may appear, so that they fall in the range expected (and supported) by typical rendering engines, but they are not intended to enforce 'spelling-rules'.

Using simple generalized WLE Rules will also allow the other language users to be able to input a string in their language using the Thai Script without any spelling rule limitation, while still maintaining the consistent behaviour of rendering engines.

All the default rules in MSR-2 also apply to the Thai script, such as a label cannot start with a combining mark (General Category = Mark, Non-spacing (Mn)). In addition to the default rules, there are some restrictions on label-level to construct the Thai script label described below.

7.1 No leading combining mark

A label cannot start with a combining mark. This applies to those code points with the General Category of Mn and Mc in the repertoire table (see also Section 7.7).

7.2 Every leading vowel must precede a consonant

Every leading-vowel is a dependent vowel that cannot stand alone and needs at least one following consonant to form a label. It also cannot be followed by another vowel, a diacritic, or a tone-mark.

This rule will also solve the variant issue that U+0E41 is a digraph of <U+0E40, U+0E40>, mentioned in section 6.1, as two consecutive leading-vowels are not eligible.

7.3 Code Points that must follow a consonant

There are subsets of vowels and diacritics that cannot stand alone and need to follow a consonant. They are:

- above-vowel,
- below-vowel,
- the below diacritic U+0E3A (THAI CHARACTER PHINTHU, ◌ฺ)
- the above diacritic U+0E47 (THAI CHARACTER MAITAIKHU, ◌็)

This rule will prevent the case of too many code points at the same position (above or below) in a cell, which can cause an unexpected rendering. And these rules will also eliminate the possibility of double vowels which would create an unreadable label because of missing onset consonant.

7.4 Context of MAI HAN-AKAT

The code point U+0E31 (THAI CHARACTER MAI HAN-AKAT, ◌ั) is a vowel that always occurs between a consonant and either a tone or a consonant.

7.5 Context of SARA-A

The code point U+0E30 (THAI CHARACTER SARA A, ะ) is a vowel that can follow a consonant or a tone or the vowel code point U+0E32 (THAI CHARACTER SARA AA, า).

Normally, a vowel cannot follow another vowel except in two cases:

- U+0E45 (THAI CHARACTER LAKKHANGYAO, ๅ) can follow only two special vowels: U+0E24 (THAI CHARACTER RU, ฤ) and U+0E26 (THAI CHARACTER LU, ฦ)
- U+0E30 (THAI CHARACTER SARA A, ะ) can follow U+0E32 (THAI CHARACTER SARA AA, า)

The former case is handled by adding the two possible code point sequences into the repertoire. However, the latter case is impossible to handle by enumerating code point sequences as there are too many possible combinations. U+0E30 (THAI CHARACTER SARA A, ะ) is an active vowel that can follow any of the 44 consonants, four tones, and the vowel U+0E32 (THAI CHARACTER SARA AA, า) and all are common and actively used in the Thai script. Therefore, the latter case is handled by this WLE rule.

7.6 Context of SARA-AA

The code point U+0E32 (THAI CHARACTER SARA AA, า) is a vowel that can follow a consonant or a tone.

7.7 Context of tone mark

Every tone-mark always stays at the topmost position of a cluster, whether above a consonant or above an above-vowel. However, it cannot follow another tone-mark or an above diacritic (MAITAIKHU, THANTHAKHAT) as they could collide at the top most position and can cause a non-predictable rendered label. A cluster to which a tone mark is applied may have a below vowel, which does not typographically interact with the tone mark as they are each displayed across the consonant from each other. A tone-mark is normally used as the closure of a cluster; therefore, it cannot follow a leading-vowel nor below diacritic which will create a non-readable label because of the missing onset consonant.

This leads to the following rule: A tone mark can only follow a consonant, an above vowel or a below vowel.

As tone-marks are non-spacing marks, please note that the rule that a tone-mark cannot be at the label's starting position is already covered by the default WLE rules.

7.8 Context of above-diacritic (THANTHAKHAT and NIKHAHIT)

As the code point U+0E47 (MAITAIKHU, ◌็) is already mentioned in WLE 7.3, this section covers the other two above-diacritics; U+0E4C (THANTHAKHAT, ◌์) and U+0E4D (NIKHAHIT,◌ํ).

In a cluster, there is only one above-diacritic allowed. Therefore, an above-diacritic must not be adjacent to another above-diacritic; otherwise they will collide at the top most position and can cause a non-predictable rendering of the label.

Both U+0E4C (THANTHAKHAT, ◌์) and U+0E4D (NIKHAHIT, ◌ํ) are used only at the ending consonant. THANTHAKHAT is for muting the sound of that ending consonant, while NIKHAHIT is for adding the sound -NG to it. The ending consonants do not carry a tone mark, so THANTHAKHAT and NIKHAHIT never follow a tone mark.

The ending consonant can be in the form of a consonant e.g. "สรรค์" (read "San", meaning "creativity"), a consonant with an above vowel e.g. "ศักดิ์" (read "Sak", meaning "rank, social rank")or a consonant with a below vowel e.g. "พันธุ์" (read "Pan", meaning "race"), therefore, THANTHAKHAT and NIKHAHIT can follow a consonant, an above vowel or a below vowel. In modern Thai, according to the Royal Institute, THANTHAKHAT and NIKHAHIT are only found following U+0E34 (SARA I, ◌ิ) for the above vowel and U+0E38 (SARA U, ◌ุ) for the below vowel. However, it is possible to create a string where these two diacritics follow any above vowels or any below vowels, without creating security or rendering issues. Therefore, the Thai GP, considering all points above, agreed that it is not necessary restricting the sequences to following U+0E34 (SARA I, ◌ิ) or U+0E38 (SARA U, ◌ุ) only.

The Thai GP concluded that U+0E4C (THANTHAKHAT, ◌์) and U+0E4D (NIKHAHIT, ◌ํ) can follow a consonant, an above vowel, or a below vowel.

Also, as the diacritics are non-spacing marks, the rule that a diacritic cannot be at the label's starting position is already covered by the default WLE rules.

7.9 Context of NIKHAHIT plus SARA AA sequence

The code point U+0E4D (NIKHAHIT, ◌ํ) is an above-diacritic that can follow a tone mark. This is normally wrong for the writing system, but it is allowed in this LGR because of the code point U+0E33 (THAI CHARACTER SARA AM, ◌ำ).The latter code point is excluded from IDNA2008 and will instead be decomposed into two vowels, U+0E4D (THAI CHARACTER NIKHAHIT, ◌ํ) andU+0E32 (THAI CHARACTER SARA AA, า). These two code points have been added as a sequence to the repertoire so that, a tone mark can be followed by a NIKHAHIT as part of SARA AM.

The sequence U+0E4D (THAI CHARACTER NIKHAHIT, ◌ํ) andU+0E32 (THAI CHARACTER SARA AA, า) can follow a consonant or a tone.

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- https://tools.ietf.org/html/rfc5894
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- “Handbook for Writing Northern Khmer Using Thai Script” ISBN 987-616-7073-68-2 by Royal Thai Institute
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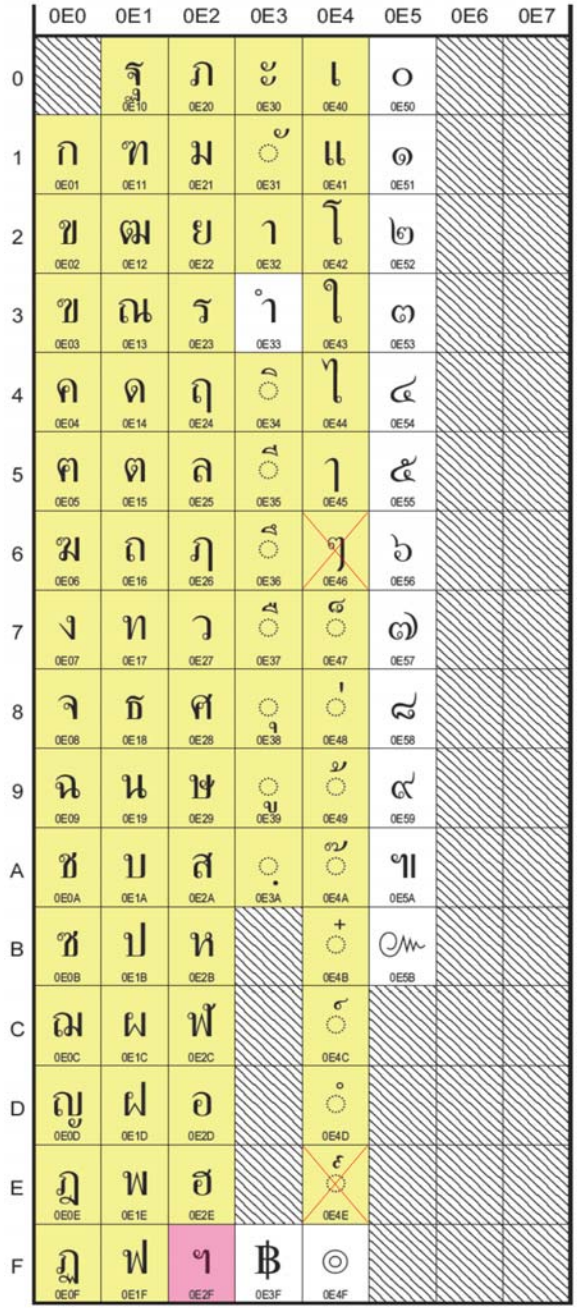
Appendix A: Code Points Short-listed in the LGR Proposal

The code points of the Thai script shortlisted in MSR-2 are shown below. The code cells with yellow highlighting are part of the MSR, whereas those with pink highlighting are excluded from the MSR and those without highlighting are for code points that are not PVALID in IDNA 2008. A red X shows code points excluded from this LGR.



	0E0	0E1	0E2	0E3	0E4	0E5	0E6	0E7
0		ฐ 0E10	ภ 0E20	ะ 0E30	เ 0E40	๐ 0E50		
1	ก 0E01	ฑ 0E11	ม 0E21	◌ั 0E31	แ 0E41	๑ 0E51		
2	ข 0E02	ฒ 0E12	ย 0E22	า 0E32	โ 0E42	๒ 0E52		
3	ฃ 0E03	ณ 0E13	ร 0E23	ำ 0E33	ใ 0E43	๓ 0E53		
4	ค 0E04	ด 0E14	ฤ 0E24	◌ิ 0E34	ไ 0E44	๔ 0E54		
5	ฅ 0E05	ต 0E15	ล 0E25	◌ี 0E35	ๅ 0E45	๕ 0E55		
6	ฆ 0E06	ถ 0E16	ฦ 0E26	◌ึ 0E36	ๆ 0E46	๖ 0E56		
7	ง 0E07	ท 0E17	ว 0E27	◌ื 0E37	◌็ 0E47	๗ 0E57		
8	จ 0E08	ธ 0E18	ศ 0E28	◌ุ 0E38	◌่ 0E48	๘ 0E58		
9	ฉ 0E09	น 0E19	ษ 0E29	◌ู 0E39	◌้ 0E49	๙ 0E59		
A	ช 0E0A	บ 0E1A	ส 0E2A	◌ฺ 0E3A	◌๊ 0E4A	๚ 0E5A		
B	ซ 0E0B	ป 0E1B	ห 0E2B		◌๋ 0E4B	๛ 0E5B		
C	ฌ 0E0C	ผ 0E1C	ฬ 0E2C		◌์ 0E4C			
D	ญ 0E0D	ฝ 0E1D	อ 0E2D		◌ํ 0E4D			
E	ฎ 0E0E	พ 0E1E	ฮ 0E2E		◌๎ 0E4E			
F	ฏ 0E0F	ฟ 0E1F	ฯ 0E2F	฿ 0E3F	๏ 0E4F			

□ Excluded by IDNA 2008 or a Digit

🟥 Excluded by MSR

☒ Proposed for exclusion from LGR

🟨 Proposed for inclusion in LGR

Appendix B: Cross-Script Homoglyph Analysis Tables

Thai and Khmer homoglyphs Analysis

The visual perception of the letters listed in the following table were taken into account in the homoglyph analysis. There is some similarity in the visual perception of some of the Khmer characters and certain Thai characters or Thai letter combinations.

Khmer Character	Unicode	Thai Character	Unicode
ក	1780	ก + ◌็	0E01 + 0E47
គ	1782	ค+◌็	0E04+0E47
ឃ	1783	ช+ช, ฬ	0E0A+0E0A 0E2C
ង	1784	ฬ	0E2C
ឈ	1788	ถ+ช+ช	0E16+0E0A+ 0E0A
ដ	178A	ผ+◌ั	0E1C+0E31
ឋ	178B	ช ซ	0E0A 0E0B
ឍ	178D	ฌ ฒ ต+ร	0E0C 0E12 0E15+0E23
ណ	178E	ฌ+ก ญ	0E0C+0E01 0E0C
ត	178F	ด+◌๊	0E14+0E4A
ន	1793	ร	0E23
ប	1794	ช ย	0E0A 0E22
ព	1796	ด ต ถ	0E14 0E15 0E16
ភ	1797	ภ + ◌็	0E20 + 0E47
ម	1798	ษ ย	0E29 0E22
យ	1799	ผ	0E1C
រ	179A	ร	0E23
ល	179B	ญ	0E0C
វ	179C	ร	0E23
ឝ	179D	ศ + ◌็	0E28+0E47
ឞ	179E	ษ ย	0E29 0E22
ហ	17A0	ย+า	0E22+0E32

Khmer Character	Unicode	Thai Character	Unicode
អ	17A2	ร+ร	0E23+0E23
ឥ	17A5	ส	0E2A
ឫ	17AB	ช+◌ุ ย+◌ุ	0E0A+0E38 0E22+0E38
ឬ	17AC	ช+◌ุ	0E0A+0E38
ឭ	17AD	ฅ+◌ุ ต+◌ุ	0E05+0E38 0E15+0E38
ឮ	17AE	ฅ+◌ุ ต+◌ุ	0E05+0E38 0E15+0E38
ឯ	17AF	ฉ ฬ	0E09 0E2C
◌ា	17B6	า ๅ	0E32 0E45
◌ិ	17B7	◌ิ	0E34
◌ី	17B8	◌ี	0E35
◌ឹ	17B9	◌ึ	0E36
◌ឺ	17BA	◌ื	0E37
◌ុ	17BB	◌ุ	0E38
◌ូ	17BC	◌ู	0E39
◌ួ	17BD	◌ู	0E39
◌ើ	17BE	เ+◌ี	0E40+0E35
◌េ	17C1	เ	0E40
◌ោ	17C4	เ+า เ+ๅ	0E40+0E32 0E40+0E45
◌ៅ	17C5	เ+า เ+ๅ	0E40+0E32 0E40+0E45
◌េ	17C1	เ	0E40
◌ោ	17C4	เ+า เ+ๅ	0E40+0E32 0E40+0E45
◌ៅ	17C5	เ+า เ+ๅ	0E40+0E32 0E40+0E45

Khmer Character	Unicode	Thai Character	Unicode
◌ំ	17C6	◌ํ	0E4D
◌ះ	17C7	ะ	0E30
◌ៈ	17C8	ะ	0E30
◌៊	17CA	◌๊	0E4A
◌់	17CB	◌่	0E48

Khmer Character	Unicode	Thai Character	Unicode
◌៌	17CC	◌็	0E47
◌៍	17CD	◌์	0E4C
◌៎	17CE	◌๋	0E4B
◌៏	17CF	◌็	0E47
◌័	17D0	◌ั	0E31

Thai and Myanmar homoglyphs Analysis

The visual perception of the letters listed in the following table were taken into account in the homoglyph analysis. There is some similarity in visual perception between some of the Myanmar characters and certain Thai character or Thai letter combinations. The detailed information is listed on table below

Myanmar Character	Unicode	Thai Character	Unicode
ခ	1001	ว อ	0E27 0E2D
ဂ	1002	ก	0E01
ဃ	1003	พ ฟ	0E1E 0E1F
ဈ	1008	ข ฃ	0E02 0E03
ဎ	100E	ข ฃ บ	0E02 0E03 0E1A
ပ	1015	ข บ	0E02 0E1A
ဘ	1018	ว + ว	0E27 + 0E27
ယ	101A	ผ พ	0E1C 0E1E
ရ	101B	ฤ ใ	0E24 0E43
	102B	า ๅ	0E32 0E45
◌ိ	102D	◌ํ	0E4D
◌ံ	1036	◌ํ	0E4D
◌့	1037	.	0E3A
◌း	1038	ะ	0E30

Myanmar Character	Unicode	Thai Character	Unicode
၅	1045	ๆ	0E46
၈	1048	ด	0E14
၊	104A	เ	0E40
။	104B	แ	0E41
	1062	า	0E32
	1064	า	0E32
	106B	า	0E32
	1075	ภ	0E20
	1076	ว	0E27
	1077	ภ	0E20
	1080	ม	0E21
	1083	ๅ	0E45
	108A	ะ	0E30

Thai and Lao homoglyphs Analysis

The visual perception of the letters listed in the following table were taken into account in the homoglyph analysis. There is some similarity in the visual perception of between some of the Lao Characters and certain Thai Characters or Thai letter combinations. The detailed information is listed below

Lao Character	Unicode	Thai Character	Unicode
ກ	0E81	ท	0E17
ຄ	0E84	ถ	0E16
ຈ	0E88	จ	0E08
ຍ	0E8D	ย	0E22
ດ	0E94	ถ	0E16
ຕ	0E95	ต	0E15
ຖ	0E96	ถ ฤ	0E16 0E24
ທ	0E97	ท	0E17
ນ	0E99	ม	0E21
ບ	0E9A	บ	0E1A
ປ	0E9B	ป	0E1B
ຜ	0E9C	ผ	0E1C
ຝ	0E9D	ฝ	0E1D
ພ	0E9E	พ	0E1E
ຟ	0E9F	ฟ	0E1F
ມ	0EA1	ม	0E21
ຢ	0EA2	ย	0E22
ຣ	0EA3	ธ ร	0E18 0E23
ລ	0EA5	ล	0E25
ວ	0EA7	ว อ	0E27 0E2D
ສ	0EAA	ส	0E2A

Lao Character	Unicode	Thai Character	Unicode
ຫ	0EAB	ท ห	0E17 0E2B
ອ	0EAD	ฮ	0E2E
ຮ	0EAE	ธ ร	0E18 0E23
ະ	0EB0	ะ	0E30
◌ັ	0EB1	◌ั	0E31
າ	0EB2	า	0E32
◌ຳ	0EB3	◌ำ	0E33
◌ຸ	0EB8	◌ุ	0E38
◌ູ	0EB9	◌ู	0E39
◌ົ	0EBB	◌์	0E4C
ເ	0EC0	เ	0E40
ແ	0EC1	แ	0E41
ໂ	0EC2	โ	0E42
ໃ	0EC3	ใ	0E43
ໄ	0EC4	ไ	0E44
◌່	0EC8	◌่	0E48
◌້	0EC9	◌้	0E49
◌໊	0ECA	◌๊	0E4A
◌໋	0ECB	◌๋	0E4B
◌໌	0ECC	◌์	0E4C
◌ໍ	0ECD	◌ํ	

Appendix C: Northern Khmer Consideration

This section was appended after the Thai GP received comments from the IP regards to the Northern Khmer and it records discussion and decisions in chronological order.

The Thai LGR Proposal Version 2, date: 2016-12-08, which was published for the Public Comment, aimed to cover Northeastern Thai, Northern Thai, Southern Thai and Northern Khmer (in Thai Script).

After the end of the public comment period, the IP suggested reconsidering the coverage of the WLE for Northern Khmer as the rules could not accommodate some deviations of Northern Khmer script formation. The issues are with PHINTHU and MAITAIKHU.

> PHINTHU followed by ‘av’ or ‘fvx’
>
> …
>
> For the PHINTHU, it transpires that it is required in sequences that would be INVALID under the LGR. For example, these sequences using 03EA can be found in Northern Khmer teaching materials:[3]
>
> ```
> <U+0E3A, U+0E30 THAI CHARACTER SARA A>
> <U+0E3A, U+0E34 THAI CHARACTER SARA I>
> <U+0E3A, U+0E35 THAI CHARACTER SARA II>
> <U+0E3A, U+0E36 THAI CHARACTER SARA UE>
> <U+0E3A, U+0E37 THAI CHARACTER SARA UEE>
> ```
>
> To allow them would require the addition of PHINTHU to the context rule for these 5 vowels (or, alternatively any above/following vowel, neither of which would visually clash with a below diacritic).

Table C-1: Part of IP’s comment regards PHINTHU

> Stacking MAITAIKHU
>
> IP is also informed:
>
> "The teaching materials show it being placed above SARA II and SARA UEE ... and SARA I ... The three combinations are also desirable for Northern *Thai*, but the work-around usually adopted is to move the MAITAIKHU to the next consonant."
>
> These would be disallowed currently, with U+0E47 THAI CHARACTER MAITAIKHU limited to immediately following a consonant. (One would need to investigate how widely rendering engines allow this kind of stacking).
>
> …

Table C-2: Part of IP’s comment regards MAITAIKHU

[3] And also in the article ภาษาเขมรถิ่นไทย on the Thai Wikipedia.

The Thai GP took IP’s comments into account and the discussion broke down into three main questions:

- Which source is the main reference for Northern Khmer label generation?
- Is there any rendering issue?
- If some part of the label generation rules creates a rendering issue, will we still support the no-issue portion, or not support Northern Khmer as a whole?

Which source is the main reference for Northern Khmer label generation?

We have considered various sources of references for Northern Khmer during the LGR process. There are online materials, teaching materials, as well as expert inputs to which both the GP and IP refer. However, some are in conflict with one another. For example, when a vowel modification is needed, online material suggests using PHINTHU and NIKHAHIT while the Handbook only uses PHINTHU.

When there is conflict, it is not easy to find the norm of usage to confirm, because the language is mainly used in ,spoken, and not much in every day written material. Therefore, the Thai GP decided to refer to the most reliable material which is the “Handbook for Writing Northern Khmer Using Thai Script” ISBN 987-616-7073-68-2 by Royal Thai Institute (2013).

The Handbook is based on the work of Research Institute for Languages and Cultures of Asia, Mahidol University. It indicates that its developing process was: (1) Study the existing writing systems. (2) Conduct committee meetings to identify the set of characters, vowels, and the modifications. The committee includes local leaders. (3) Test and confirm the draft in local communities and local literatures.

The Handbook is also the most reliable maintenance process material. If there is some editing needed The Royal Thai Institute will be the one responsible to create and maintain versions.

Conclusion: The Thai GP uses “Handbook for Writing Northern Khmer Using Thai Script” ISBN 987-616-7073-68-2 by Royal Thai Institute (2013) as the main reference.

Is there any rendering issue?

Northern Khmer consonants can be represented by 21 characters with some deviation in pronunciation. There are 51 vowels and compound vowels in total, 35 of them use the same vowel in the Thai Script. However, there are 16 compound vowels that need modification from standard Thai Script formation.

Referring to the Handbook, the modifications are:

1. MAITHAIKHU can follow three above vowels: (av):

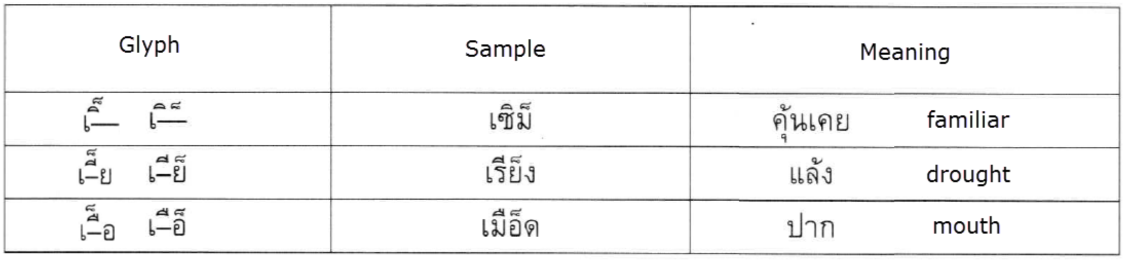
   U+0E34 THAI CHARACTER SARA I, ◌ิ

   U+0E35 THAI CHARACTER SARA II, ◌ี

   U+0E37 THAI CHARACTER SARA UEE, ◌ื

   The correct rendering is for the MAITHAIKHU to stack on top of an above vowel. However, some of the input applications such as Microsoft Office, do not allow MAITHAIKHU to be stacked. The

Handbook also suggests that an acceptable work-around, namely to move MAITHAIKHU to the next consonant.



Glyph	Sample	Meaning	
เ–ิ็ เ–ิ็	เซิม็	คุ้นเคย	familiar
เ–ี็ย เ–ีย็	เรีย็ง	แล้ง	drought
เ–ื็อ เ–ือ็	เมือ็ด	ปาก	mouth

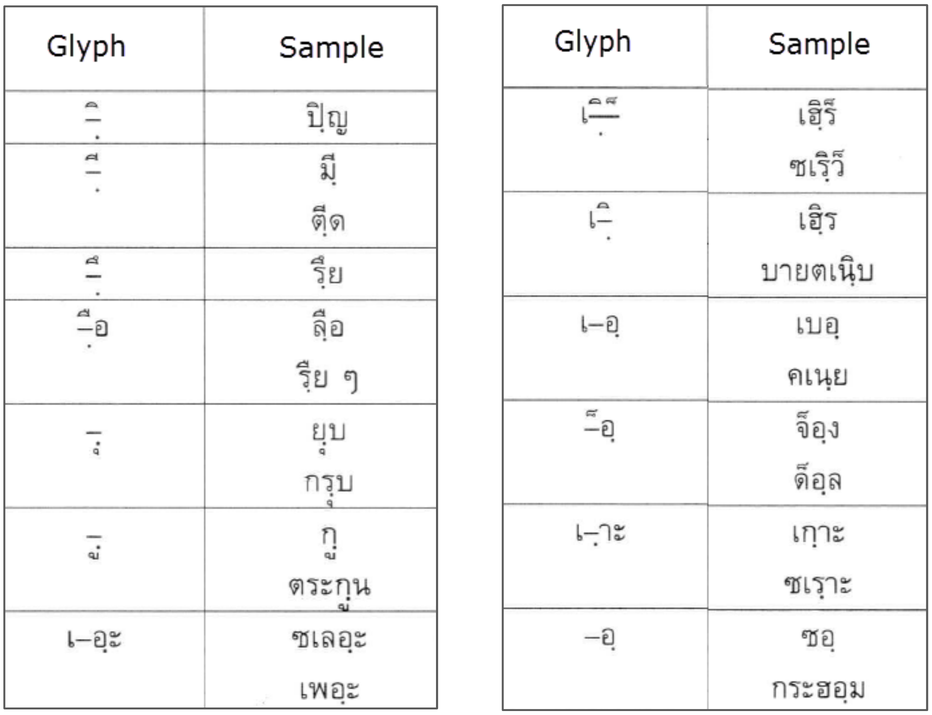
Table C-3: Samples of Stacking MAITHAIKHU

Other Operating System and Web Browsers allow multiple stacking for any symbols placed above (viz vowels, tones or diacritics). Because of this difference in rendering support the actual rendered appearance of arbitrary stacking cannot be reliably predicted. Therefore, to support the stacking of MAITHAIKHU, the rule allows a MAITHAIKHU only on top of an above vowel or a consonant. This will create the proper glyph without any rendering issue.

This LGR would support the workaround of placing the MAITHAIKHU on the following consonant.

2. PHINTHU can combine with above vowels or below vowels in this order:

   A Consonant + PHINTHU + [a below vowel or an above vowel]



Glyph	Sample
–ฺิ	ปฺิญ
–ฺื	มฺื ตฺืด
–ฺึ	รฺึย
–ฺือ	ลฺือ รฺืย ๆ
–ฺุ	ยฺุบ กรฺุบ
–ฺู	กฺู ตระกฺูน
เ–อฺะ	ซเลอฺะ เพอฺะ

Glyph	Sample
เ–ฺิ็	เฮฺิร็ ซเรฺิว็
เ–ฺิ	เฮฺิร บายตเนฺิบ
เ–อฺ	เบอฺ คเนฺย
–็อฺ	จ็อฺง ด็อฺล
เ–ฺาะ	เกฺาะ ซเรฺาะ
–อฺ	ซอฺ กระฮอฺม

Table C-4: Samples of PHINTHU-Modified Vowel

In the Thai language, a PHINTHU cannot stand alone but needs to follow a consonant. To cover the Northern Khmer language, PHINTHU is combined with an above vowel or a lower vowel to create additional compound vowels. PHINTHU should always appear immediately below a consonant. This creates no problem when it combines with an above vowel, but it creates unpredictable rendering issues when it combines with a below vowel.

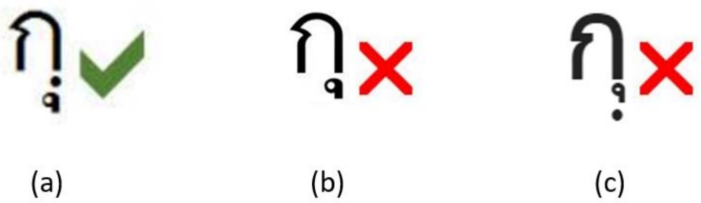
–ฺุ	ยฺุบ กรฺุบ
–ฺู	กฺู ตระกฺูน

Table C-5: Correct position for PHINTHU and a below vowel combination

Currently, there are specific fonts which can handle this rendering correctly: Fonts-TLWG (formerly ThaiFonts-Scalable), a collection of Thai scalable fonts available in free licenses. (https://linux.thai.net/projects/fonts-tlwg)

However, in general, font and input applications normally render this combination in two ways, either replacing it with the last stroke or always pushing PHINTHU to the lowest position.

Sample: Typing Consonant + PHINTHU + a below vowel



(a) The correct glyph, referring to Royal Thai Institute Handbook.

(b) Incorrect glyph. PHINTHU is replaced by the below vowel. Rendered this way by all Microsoft Office and Adobe applications.

(c) Incorrect glyph. PHINTHU is pushed down to the lowest position even though it occurs earlier in the sequence. This appears to be the way this is rendered by all web browsers in URL address bar.

Unlike MAITHAIKHU, in the PHINTHU case, the web browsers cannot render the correct glyph. To prevent users' confusion and to avoid a security issue, it is justified to continue to disallow this combination in the domain name system unless and until the rendering issue has been resolved.

Conclusion: There is a rendering issue using Thai Script for North Khmer vowel: the combination of PHINTHU modified vowel is not rendered in a predictable way.

If some part of script formation creates a rendering issue, will we still support the no-issue portion or not support Northern Khmer as a whole?

The initial solution after IP Comments was to make the rules more liberal, to allow the Thai LGR Proposal to incorporate Northern Khmer. Later, the Thai GP found that there is a code point sequence that is not stably rendered and can create a security issue.

The Thai GP discussed the possibilities and solutions for this issue. We concluded that there could be two possible approaches:

(a) Linguistic implementation approach.

The modified vowels in some materials replace PHINTHU with NIKHAHIT when it combines with a below vowel. The Thai Royal Institute can consider this approach when they update the Handbook for the next edition.

(b) Technical implementation approach.

Keeping all modified vowels using PHINTHU. The related technical working groups must work out a rendering solution.

Neither approach would give the Thai GP any clear timeline for going forward. In addition, for the linguistic implementation approach, we would have to reconsider the whole Northern Khmer writing system, even though only one combination creates a rendering issue at present.

Without allowing combination of PHINTHU-modified vowel, the proposal can support normal vowel cases and MAITHAIKHU work-around cases. The proposal supports 38 vowels out of 51 vowels. The Thai GP agreed that it partially supports Northern Khmer while preventing the security issues.

Conclusion: Considering the Conservatism Principle in RFC 6912[4] and all discussed reasons, the Thai GP decided to support the Northern Khmer language with the exception of PHINTHU-modified vowels in this proposal. It may be possible to consider these again by relaxing the current rules after the rendering issue of these vowels has been resolved.

[4] "Public zones are, by definition, zones that are shared by different groups of people. Therefore, any decision to permit a code point in a public zone (including the root) should be as conservative as practicable."