

# A User's Guide to Thai Overnight Repurchase Rate

Financial Markets Department, Bank of Thailand

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The Bank of Thailand (BOT) publishes *A User's Guide to Thai Overnight Repurchase Rate* to explain how market participants can use the Thai Overnight Repurchase Rate (THOR) as a reference rate in financial products, which includes how to calculate an interest rate for each interest period from the overnight rate to align with international standard.

#### 1. Introduction

The London Interbank Offered Rate (LIBOR) scandal in 2012 exposed flaws, vulnerabilities to rate manipulation and deficiencies in regulatory oversight and governance. Regulators tried to improve the transparency in the rate calculation and regain credibility of the rate by switching from a submission-based rate to a transaction-based rate. Although regulators have tried to make significant improvements to LIBOR, these efforts were not very successful due to the significant decline in volume of term borrowing and lending transactions after the Global Financial Crisis. Subsequently, the UK Financial Conduct Authority, the regulator of LIBOR, signaled the possibility of future permanent discontinuation or loss of representativeness of LIBOR.

Central banks, regulators, and market participants are collaborating to minimize the effects of LIBOR discontinuation. Many countries chose to develop an alternative reference rate as a replacement or as an additional reference rate in the financial market. In the earlier stages, these new rates are overnight rates because transactions are concentrated in the overnight market. Moreover, there are insufficient term transactions to build a reliable term benchmark on a daily basis.

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		Overnight rate to replace LIBOR				
	LIBOR	SOFR	SONIA	SARON       Estimation         Swiss Francs       End         (CHF)       (End         secured       unset         interbank       who         repo rate       rational         transaction-based       transaction-based	ESTR	TONA
Currency	5 major currencies <sup>1</sup>	US Dollar (USD)	Sterling Pounds (GBP)	Swiss Francs (CHF)	Euro (EUR)	Yen (JPY)
Rate type	unsecured interbank rate	secured treasury repo rate	unsecured wholesale rate	secured interbank repo rate	unsecured wholesale rate	uncollateralized overnight call rate
Rate origin	survey-based		transaction-based			
Term	O/N, 1 week, 1/2/3/6 months and 1 year			O/N		

Table 1 Reference rates in foreign markets

# 2. The calculation methodology of the backward-looking term rate from the overnight rate

Alternative reference rates which are recently developed are available only for the overnight tenor, unlike the widely-used reference rates such as LIBOR which are the forward-looking term rates and could be known at the beginning of the interest period. In order to derive term rates (e.g. 1 month, 3 months, or any specific interest payment periods) from daily overnight rates, there are 2 calculation approaches, namely simple average and compound average. Both approaches result in a backwardlooking term rate.

Despite referencing to an overnight rate, payments are usually settled periodically on a monthly, quarterly, or annual basis. Therefore, the interest rate for each period should be calculated using the compound average approach to account for time value of money (more details in BOX). Compound average approach is a global standard for international financial market and is recommended by the BOT to be used

<sup>&</sup>lt;sup>1</sup> LIBOR is currently published across 5 currencies which are United States dollar (USD LIBOR), British pound sterling (GBP LIBOR), European euro (EUR LIBOR), Japanese yen (JPY LIBOR), and Swiss franc (CHF LIBOR)

when calculating a backward-looking term rate for financial contracts such as loan, bond, structured note, and derivative.



Figure 1 Forward-looking term rate and backward-looking term rate

In general, overnight rates have low volatility. Users are able to approximate the compounded overnight rate for the period without the need to wait until the last day of the period. This is possible because the occurrences that would cause sudden volatility in the overnight rates are infrequent. In addition, the impact of these occurrences on the overall compounded overnight rate are so minimal that we may not observe any significant difference in the compounded rate. In order to allow sufficient time for operational matters before the payment date, there are several interest calculation and settlement-related market conventions which parties could choose to adopt (more details in section 4).

# BOX: Applying the compound average approach on overnight rates to derive periodic term rates

For financial products referencing an overnight rate, such as loans, the term rate for each interest period will be derived from every overnight rate throughout that period and by using the following compound average formula:

Compounded overnight rate<sub>t</sub> = 
$$\left[\prod_{i=1}^{d_0} \left(1 + \frac{\text{overnight rate}_i \times n_i}{365}\right) - 1\right] \times \frac{365}{d}$$

THOR	Term rate	Margin (reflecting borrower's	Contractual
		credit risk and other factors)	interest rate
daily rate	0.87579%	2%	2.87579%

Where n<sub>i</sub> equals the number of calendar days in the relevant Calculation Period for which the rate is overnight rate<sub>i</sub> (in the case that i falls on a Friday, overnight rate<sub>i</sub> would be the rate for Friday, Saturday and Sunday. Thus, ni equals 3).

Using the compound average methodology to obtain the backward-looking term rate is based on theory of finance and standard practices in global financial markets.

Financial contracts referencing overnight rate benchmarks typically do not require borrowers to make interest payment on a daily basis, but rather on a periodic basis (i.e. at the end of the interest period such as 1 month). This means that borrowers could earn income by investing the interest that has accrued in between interest payment dates. In the meantime, lenders only receive interest at the end of each interest period, consequently losing out on the opportunity to reinvest throughout the interest period. Thus, we adopt the compounding approach in the calculation of interest rate for each interest period to account for the effect of time value of money and to be fair for lenders and borrowers, which is a financial concept accepted in global financial markets.

The compounding of overnight rates is merely the calculation methodology to acquire *a term rate* for each interest period, then adding up margin to get *a contractual interest rate* which will be used to calculate interest payment amount for each period.

Therefore, the compounding methodology does not violate Section 655 of the Thai Civil and Commercial Code (which states that interest should not bear interest). In principle, Section 655 of the Thai Civil and Commercial Code aims to prevent lenders from misusing the compounding methodology to charge borrowers unreasonably high interest rates. Following this notion, the compounding of overnight rate within the period is simply a process to determine the *term rate*, which is an element of the *contractual interest rate*. It is different from adding the interest of the previous period(s) to the principal amount, and subsequently accruing interest on that sum. In conclusion, the compounded overnight rate does not violate Section 655 of the Thai Civil and Commercial Code.

#### 3. Development of Thai Interest Rate Benchmark Reform

The financial market conditions in Thailand is similar to that of other countries, particularly with respect to the concentration of transactions in the overnight tenor. Term transactions in the market are sparse due to excess liquidity in money market which allows day-to-day liquidity management. Thus, there are insufficient term transactions to build a reliable term benchmark on a daily basis. The majority of the money market transactions in the Thai financial market are private repurchase transactions (PRP). The daily volume for overnight PRP transactions in 2019 totaled to greater than 100 billion baht. High liquidity in the PRP market, particularly in the overnight interbank PRP market, makes it a suitable new alternative reference rate. It reflects the domestic money market liquidity conditions and is not sensitive to USD liquidity constraints. It also moves correspondingly with the monetary policy rate, which allows it to support the monetary policy transmission mechanism.



#### Figure 2 Private Repurchase Market

The borrower sells assets such as bonds to the lender with an agreement to repurchase the asset at the specified premium and time period. PRP transaction is considered low risk because it is a secured transaction.

Therefore, the Thai Overnight Repurchase Rate (THOR) is developed as the new reference rate for the Thai financial market. THOR<sup>2</sup> is the interbank overnight private repurchase rate. The Bank of Thailand (BOT) is the rate administrator and the Thai Bond Market Association (ThaiBMA) is the calculation agent. THOR is published on the

<sup>&</sup>lt;sup>2</sup> THOR metadata <u>https://app.bot.or.th/THOR/SharedFiles/FM\_RT\_013\_ENG.PDF</u>

BOT's website<sup>3</sup>, ThaiBMA's website, Bloomberg (Ticker: TTHORON Index) and Refinitiv (Ric: THONRP=BKTH) every Bangkok business day at 4.30 pm<sup>4</sup>.

THOR differs from other existing reference rates such as the Thai Baht Interest Rate Fixing (THBFIX) and the Bangkok Interbank Offered Rate (BIBOR) in terms of the underlying market. The underlying market for THBFIX is the USDTHB interbank swap market. THBFIX is the synthetic cost of borrowing the Thai Baht, obtained by borrowing US dollar for the same maturity, and swapping out the US dollar in return for the Thai Baht. USD is used as collateral for the FX swap transactions which causes the THBFIX to be sensitive to the USD liquidity condition. Additionally, LIBOR permanent cessation puts THBFIX at risk as LIBOR is a component in the calculation of THBFIX. BIBOR is an uncollateralized interbank lending rate which is vulnerable to low volume of underlying transactions.

	THOR	THBFIX	BIBOR	
		THBFIX will cease		
		publication once LIBOR		
Status	Now reference rate	cessation event occurs. "Fallback THBFIX" will be		
Status	New reference rate			
		published as the fallback		
		rate for THBFIX.		
Underlying	interbank private		unsecured interbank	
market	repurchase	USDTHB swap		
Data		transaction-based		
collection	transaction-based	(since 2019)	survey-based	
		O/N, 1 week,	O/N. 1 week	
Term	O/N	1/3/6 months and 1 year	1/2/3/6 months	
	0/11	(Fallback THBFIX will only	and 1 year	
		have 1/3/6 month term rates)		

Table 2 The characteristics of interest rate benchmarks in the Thai financial market

<sup>&</sup>lt;sup>3</sup> THOR publication page <u>https://app.bot.or.th/THOR/en</u>

Historical THOR data publication page

https://app.bot.or.th/BTWS\_STAT/statistics/BOTWEBSTAT.aspx?reportID=945&language=Eng

<sup>&</sup>lt;sup>4</sup> THOR may be revised at 9.30 am on the following business day, if the underlying PRP data are adjusted and the adjustment results in at least a 1 basis point change in THOR

	THOR	THBFIX	BIBOR
Determination	End of each interest		
date of an	period (a backward-	Beginning of each interest	Beginning of each interest
interest rate	looking term rate	period (THBFIX is a	period (BIBOR is a
for each	calculated from daily	forward-looking rate)	forward-looking rate)
interest period	THOR rates)		
Movement in			$\checkmark$
correlation		X	Term rates do not reflect
	$\checkmark$		future rate expectations
with policy		impacted by USD (iquidity	due to low transaction
rate			volume.

Figure 3 Reference rates in the Thai financial market



# 4. THOR as a reference rate for financial products

Using overnight rates as reference for financial products is not uncommon in the Thai financial market. The Minimum Lending Rate (MLR) that is commonly used in loan contracts has similar characteristics to THOR. MLR is also a floating rate that can change over the duration of the contract. However, MLR does not fluctuate as often as overnight rates, making it easier to forecast the interest payment due at the settlement date for MLR-linked.

### 4.1 Conventions for financial contracts referencing THOR

For financial contracts referencing THOR or other overnight rate benchmarks, the interest rate is calculated from compounding the daily overnight rates of the interest period, excluding the payment date. Thus, the interest due is only known on the last day of the interest period. In order to allow for sufficient time for parties involved in the contract to prepare for payment settlement, users of the THOR or other overnight rate benchmarks can explore interest calculation and settlementrelated market conventions as described in the following table.

Table 3 Interest calculation and settlement-related market conventions for THOR-linked financial contracts<sup>5</sup>

Approaches	Advantages	Disadvantages
In-arrears Approach		
- Plain	- THOR compounding	- There is no buffer
THOR payment date	period perfectly	time to prepare for
	matches the interest	the settlement of
compounded THOR (observation period)	period	interest payments
matches the interest period.		
- Payment Delay	- THOR compounding	- Increased
THOR	period perfectly	counterparty credit
Interest period	matches the interest	risk
THOR compounding period used to calculate	period	- No compensation
compounded THOR (observation period)	- Some buffer time to	for 'time value of
matches the interest period but interest	prepare for the	money' in the
payment is due a number of days following	settlement of interest	delayed payment
the interest period.	payment	amount
- Lookback	- Some buffer time to	- THOR
THOR Interest period	prepare for the	compounding

<sup>&</sup>lt;sup>5</sup> Example of compounded interest calculation in each convention:

https://www.bot.or.th/content/dam/bot/fmd/thor/Overnight%20rate%20convention%20example%20eng.xlsx

Approaches	Advantages	Disadvantages
Compounded THOR calculated from THOR for	settlement of interest	period does not
the period beginning and ending a certain	payment	exactly match the
number of days before the interest period		interest period
(typically 1-5 days). There are 2 sub-approaches		
under this method.		
(1) Lookback with observation shift		
(Backward shift) Compounded THOR is		
calculated from the daily THOR and the		
actual number of calendar days (weight) in		
the observation period.		
(2) Lookback without observation shift		
Compounded THOR is calculated from the		
daily THOR in the observation period. The		
actual number of calendar days (weight)		
aligns with the <u>interest period</u> .		
<ul> <li>Lockout or Suspension period</li> <li>THOR Interest period</li> <li>THOR is not updated for the final few days</li> <li>(lockout period of typically 1-5 days) of the interest period. Daily compounding of THOR</li> <li>begins at start of the interest period and the final observed THOR is used in the calculation throughout the lockout period.</li> </ul>	- Some buffer time to prepare for the settlement of interest payment	- The final THOR observed at the start of the lockout period may not be a representative rate for the entire lockout period
In-advance Approach	- Compounded	- THOR
THOR Interest period Compounded THOR is calculated from THOR observed from the previous interest period.	THOR is known at the beginning of the interest period	compounding period does not match the interest period - Difficult to hedge

To assist commercial banks to start developing loans referencing THOR, BOT has conducted a survey across banks in Thailand and issued a THOR Pilot Lending Practice based on the majority views. Most commercial banks viewed that the backward shift approach is the suitable convention for THOR-linked loans. In any case, commercial banks and their clients should negotiate the terms of financial contract to mutually agree upon a convention. Issuers of both corporate bonds and government bonds also have the liberty to set the appropriate conventions for their bonds. For instance, the Bank of Thailand THOR Floating Rate Note (BOT TFRN) uses a backward shift approach as well. Parties of the financial contract that are looking to hedge against interest rate risk through derivatives should also take into account the derivative market conventions.

# 4.2 Facilitation tools to calculate an interest rate for each interest period from THOR

To facilitate market adoption of THOR, BOT has published THOR Index and THOR Calculator. Market participants can use these tools to calculate the compounded THOR for any given tenor.

**A. THOR Index**<sup>6</sup> represents the cumulative value of compounding THOR over time, with an initial value of 100 on April 1, 2020. THOR Index reflects the effect of compounding THOR each business day and taking the simple average on non-business day. THOR Index is published by rounding to ten decimal places. Although THOR Index is calculated daily, BOT publishes THOR Index only on business days at 9.30 am. The Index for non-business days will be published on the following Bangkok business day. The data is also available on ThaiBMA, Bloomberg<sup>7</sup> (Ticker: TTHRINDX Index) and Refinitiv (Ric: .THOR).

THOR Index can be used to obtain the compounded rate for the THOR compounding period or observation period. The calculation method is as follows:

Compounded THOR per annum =  $\left(\frac{\text{THOR Index}_{t+n}}{\text{THOR Index}_t} - 1\right) \times \frac{365}{n}$ 

where t is the start date of the observation period

<sup>&</sup>lt;sup>6</sup> THOR Index publication page <u>https://app.bot.or.th/THOR/en</u> Historical THOR Index data publication page

https://app.bot.or.th/BTWS\_STAT/statistics/BOTWEBSTAT.aspx?reportID=946&language=Eng THOR Index metadata https://app.bot.or.th/THOR/SharedFiles/FM\_RT\_014\_ENG.PDE

<sup>&</sup>lt;sup>7</sup> Please note that Bloomberg needs to scale the THOR Index to 10,000 and rounded off to 8 decimal places, in order to maintain the same degree of precision as the THOR Index published on the BOT Website.

*n* is the number of calendar days in the observation period

This calculation method works even if the start or end date falls on a nonbusiness day. However, it does not work for contracts that employ the Lookback without observation shift convention and the Lockout or Suspension period convention.

In general, the result from this method will be equal to the compounded THOR obtained by compounding the daily THOR from the start date (t) until the final day prior to the end date (t + n - 1). However, these two calculation methods may sometimes result in slightly different final rates due to rounding differences.

**Example for calculating the compounded THOR using the THOR Index** To illustrate the calculation method, we refer to this example of a 1-year loan contract, with interest settlement at the final business day of every 3 months using a 5 business day backward shift approach.

Figure 4 Example for calculating the compounded THOR using the THOR Index



Using the 5 business day backward shift approach, the observation period for the first interest period is from April 23, 2020 to July 22, 2020. The compounded THOR

per annum for first interest period is 
$$\left(\frac{\text{THOR Index}_{22 \text{ July } 20}}{\text{THOR Index}_{23 \text{ Apr } 20}} - 1\right) \times \left(\frac{365}{90}\right)$$

For the other interest periods,

Compounded THOR<sub>interest period 2</sub> = 
$$\left(\frac{\text{THOR Index}_{22 \text{ Oct } 20}}{\text{THOR Index}_{22 \text{ July } 20}} - 1\right) \times \left(\frac{365}{92}\right)$$
  
Compounded THOR<sub>interest period 3</sub> =  $\left(\frac{\text{THOR Index}_{22 \text{ Jan } 21}}{\text{THOR Index}_{22 \text{ Oct } 20}} - 1\right) \times \left(\frac{365}{92}\right)$ 

Compounded THOR<sub>interest period 4</sub> = 
$$\left(\frac{\text{THOR Index}_{23 \text{ Apr } 21}}{\text{THOR Index}_{22 \text{ Jan } 21}} - 1\right) \times \left(\frac{365}{91}\right)$$

**B. THOR Calculator**<sup>8</sup> is a tool for calculating the compounded THOR for a specified period, which is obtained from THOR Index. Similarly, THOR Calculator is compatible with all THOR-linked financial contract conventions except for <u>Lookback</u> without observation shift and <u>Lockout or Suspension period</u> conventions. The 2 models of THOR Calculator are as follows:

1) Observation Period Model is recommended when the period

referencing THOR is known.

OBSERVATION PEI	RIOD	INTEREST PERIOD			
Observation period					
Start date	d	ld-mm-yyyy	End date	dd-mm-yyyy	
THOR Index as of the start date			THOR Index as of the end date		
of the observation period			of the observation period		
Compounded THOR fo	or the observa	tion period <sup>2/</sup>		% per annum	
					Calculate

By selecting April 23, 2020 as the start date and July 22, 2020 as the end date, we can calculate the compounded THOR of the first observation period for the example in Figure 4. The compounded THOR obtained is equivalent to  $\left(\frac{\text{THOR Index}_{22 \text{ July 20}}}{\text{THOR Index}_{23 \text{ Apr 20}}} - 1\right) \times \left(\frac{365}{90}\right)$ .

2) Interest Period Model is recommended when interest period indicated in the contract is known. Lookback with observation shift (Backward shift) may be applied in order to calculate compounded THOR for the specified observation period.

<sup>&</sup>lt;sup>8</sup> THOR Calculator <u>https://app.bot.or.th/THORCalculator/en</u>

THOR calculator manual https://app.bot.or.th/thorcalculator/sharedFile/THOR\_Calculator\_Manual\_EN.PDF

OBSERVATION PERIOD	, INTEREST PERIOD				
Interest period					
Start date of interest period	dd-mm-yyyy	End date of interest period	dd-mn	п-уууу	
Business day convention <sup>3/</sup>	Unadjusted 🗸				
Adjusted interest period					
Backward shift <sup>4/</sup>	0	business days			
Observation period					
THOR Index as of the start date	è	THOR Index as of the end date			
of the observation period		of the observation period			
Compounded THOR for the ob	servation period <sup>2/</sup>			% per a	nnum
Spread over compounded THC	R	0		% per a	nnum
Principal			baht		
Interest payment			baht		
					Calcul

The following steps illustrate how to calculate the compounded THOR for the first interest period in Figure 4:

- 1. Select the <u>start date</u> (*April 30, 2020*) and <u>end date</u> (*July 31, 2020*) of the interest period as indicated in the contract
- 2. Select the business day convention (Modified Following)
- Select the number of business days applicable for the <u>backward shift approach</u> (5 business days)
- 4. Users may input principal amount and spread over compound THOR, if applicable

**4.3 THOR Average** is the term rate obtained from compounding the daily values of THOR (compound setting in arrears method) for the following tenors: 1 month, 3 months and 6 months. It is published on the BOT and ThaiBMA website<sup>9</sup> at 9. 30 am every Bangkok business day. The data is also available on Bloomberg (Ticker: TTHORA1M Index, TTHORA3M Index, TTHORA6M Index) and Refinitiv (Ric: TH1MRP= BKTH, TH3MRP= BKTH, TH6MRP= BKTH). The start date<sup>10</sup> for each THOR Average tenor is determined by referring to the corresponding numerical dates and the

Historical THOR Average data publication page

<sup>&</sup>lt;sup>9</sup> THOR Average publication page <u>https://app.bot.or.th/THOR/en</u>

https://app.bot.or.th/BTWS\_STAT/statistics/BOTWEBSTAT.aspx?reportID=945&language=Eng

<sup>&</sup>lt;sup>10</sup> For example, the 3 month THOR Average published on July 22, 2020 has a start date of April 22, 2020. For start date that falls on a non-business day, THOR for that day would equal to THOR on the preceding business day.

modified preceding<sup>11</sup> business day convention is applied to the start date if the start date falls on a non-business day. THOR Average is calculated by applying the compounding methodology (as outlined in section 2) on daily THOR from the start date until the final business day prior to the publication date.

**Example for calculating the interest payment using the THOR Average** Figure 5 illustrates the calculation method of interest payment settled every 3 months for a 1-year loan contract by observing 3-month THOR Average on 5 business days prior to the payment date.



Figure 5 Example for calculating the Compounded THOR using the 3M THOR Average

As shown in Figure 5, the first interest settlement date is July 31, 2020. Interest payment for the first interest period can be calculated by multiplying the 3M THOR Average on July 22, 2020 with the number of calendar days in the interest period<sup>12</sup>. 3M THOR Average published on July 22, 2020 was calculated by compounding the daily values of THOR from April 22, 2020 to July 21, 2020. For the following interest periods, the relevant 3M THOR Average rates are published on October 22, 2020, January 22, 2021, and April 23, 2021 respectively.

<sup>&</sup>lt;sup>11</sup> If the start date falls on a non-business day, the date will be the first preceding day that is a Business Day, unless the first preceding Business Day is in the previous calendar month, in which case that date will be the first following day that is a Business Day.

 $<sup>^{12}</sup>$  Interest payment for the interest period = -

Table 4 shows the advantages and disadvantages of using THOR and THOR Average.

	Advantages	Disadvantages		
THOR	1. Flexibility to calculate compounded	Users must individually compound		
	THOR for any given tenor, even odd	the daily THOR to obtain the		
	tenors such as 14-days or 2 months.	compounded THOR for the interest		
	2. The start date of the compounding	period.		
	period may fall on a non-business			
	day. This is suitable for financial			
	contracts that do not apply			
	business day adjustment			
	conventions.			
	3. Applicable to all Interest			
	calculation and settlement-			
	related market conventions.			
Tools	These tools facilitate the calculation of	Not applicable for financial contracts		
- THOR Index	compounded rates for any given tenor.	that employ the Lookback without		
- THOR		observation shift and Lockout or		
calculator		Suspension period conventions.		
THOR Average	THOR Average rates are ready-to-use	1. THOR Average rates are		
	term rates for calculating interest	standardized and not		
	payment.	customizable. For example,		
		THOR Average has no tenors		
		other than 1, 3, and 6 months		
		and there are no rates published		
		on non-business days. Therefore,		
		THOR Average may not be		
		suitable for some financial		
		contracts.		
		2. The reference periods for THOR		
		Average may be different from		
		the interest period of derivatives.		
		Therefore, users may not		

	perfectly hedge their financial
	contracts with derivatives.

#### 5. Hedging instruments to manage overnight interest rate risk

Although THOR moves in line with the policy rate and experiences low volatility, market participants may still face rate volatility, especially for long term contracts. To hedge against overnight interest rate risk, BOT and market participants have started developing the "overnight index swaps" (OIS).

OIS is an interest rate swap agreement where a fixed rate is swapped against a floating rate, which is an index of an overnight reference rate. According to the standard OIS convention and the compounded THOR methodology outlined in the Supplement number 65 and 77 to the 2006 ISDA Definitions, the floating leg is obtained from taking the compound average on business days and the simple average on non-business days for the period of interest. The BOT, on behalf of the Steering Committee on Commercial Banks' Preparedness on LIBOR Discontinuation, has issued a guideline for the Interbank market. According to the guideline, the net settlement for the floating leg and fixed leg is two business days after the period end date (payment delay) to allow for sufficient time to prepare for payment. For long term contracts, interest will be settled every 3 months, using the modified following business day convention.

To effectively hedge the overnight rate risk for THOR-linked loans using OIS, we should match the observation periods of the two contracts as closely as possible. Nevertheless, the payment dates can still differ no matter how closely the observation period of loans matches the OIS interest period. This is because OIS uses a 2 business day payment delay convention. Meanwhile, loan contracts may use other conventions and a different length of buffer time to prepare payment settlement. To illustrate this point, Figure 6 provides an example of a 6-months loan contract from January 24, 2020 to July 24, 2020, using 5-business day backward shift convention. The observation period is from January 17, 2020 to July 17, 2020. By matching the OIS interest period to the loan's observation period, the OIS settlement is 3 days before the loan payment date.

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Interest period				
		Jan 24	Interest period = 6 months	July 24
THOR Average reference period	Jan 17		[	July 5 Business 17 Days
OIS hedging	Jan 17			July 21 17 payment date

Figure 6: OIS hedging for loan referencing THOR Average

# Annex 1: Methods to calculate an interest rate for each interest period from an overnight rate

Reference rates for financial transactions in global market have been changed from a forward-looking term rate, such as LIBOR, to an overnight rate, such as SOFR, SONIA, ESTR, and THOR.

Although a financial contract references an overnight rate, its interest payment schedule is usually longer than a daily basis. Therefore, the interest rate for each interest period must be calculated from the overnight rates. Two approaches are available, namely (A) compound average approach and (B) simple average approach.

## A. Compound Average Approach

The compound average approach is a method to calculate an interest rate in each interest period by compounding the overnight rates to allow for time value of money. This method is available in 2 options.

Option 1 Annualized Cumulative Compounded Daily Rate

**Option 2** Daily Non-Cumulative Compounded Overnight Rate; comprising 3 steps:

Step 1: Annualized Cumulative Compounded Daily Rate (The same method as Option 1)

Step 2: Unannualized Cumulative Compounded Daily Rate

Step 3: Daily Non-Cumulative Compounded Overnight Rate

The details of both options vary according to conventions when applying the overnight rate, e.g. Lookback with Observation Shift, Lookback without Observation Shift, Lock-out.

1. Lookback with Observation Shift

Daily Non-Cumulative Compounded THOR Rate

Step 1: Annualized Cumulative Compounded Daily Rate

(ACCDRi)

$$\left[\prod_{i=1}^{d_0} \left(1 + \frac{DailyRate_i \times n_i}{dcc}\right) - 1\right] \times \frac{dcc}{tn_i}$$

The ACCDR for any Business Day during that Interest Period (the "Cumulated Business Day") is the percentage rate per annum (rounded to [5] decimal places) calculated as set out above where:

"d<sub>0</sub>" means the number of Business Days in the OP Cumulation Period;

"OP Cumulation Period" means the period from, and including, the Corresponding OP Day for the first day of the IP Cumulation Period to, and including, the Corresponding OP Day for the last day of the IP Cumulation Period;

"Corresponding OP Day" means, in relation to any Business Day "bd" during that Interest Period, the Business Day which:

(a) is in the Observation Period; and

(b) falls the applicable Lookback Period prior to that Business Day "bd";

"Observation Period" means the period from and including the day falling the applicable Lookback Period prior to the first day of that Interest Period and ending on, but excluding, the day falling the applicable Lookback Period prior to the last day of that Interest Period;

"Lookback Period" or "LP" means [five] Business Days;

"IP Cumulation Period" means the period from, and including, the first Business Day of that Interest Period to, and including, that Cumulated Business Day;

"i" means a series of whole numbers from one to  $d_0$ , each representing the relevant Business Day in chronological order in the OP Cumulation Period;

"DailyRate<sub>i</sub>" means, for any Business Day "i" in the OP Cumulation Period, the Daily Rate for that Business Day "i";

"n<sub>i</sub>" means, for any Business Day "i" in the OP Cumulation Period, the number of calendar days from, and including, that Business Day "i" up to, but excluding, the following Business Day;

"dcc" means 365; and

"**tn**<sub>i</sub>" means the number of calendar days from, and including, the first day of the OP Cumulation Period to, but excluding, the Business Day which immediately follows the last day of the OP Cumulation Period.

Step 2: Unannualised Cumulative Compounded Daily Rate (UCCDR<sub>i</sub>)

 $ACCDR_i \times \frac{tIPn_i}{dcc}$ 

The "Unannualised Cumulative Compounded Daily Rate" for any Cumulated Business Day during that Interest Period is the result of the above calculation (without rounding, to the extent reasonably practicable for the Lender performing the calculation, taking into account the capabilities of any software used for that purpose) where:

"ACCDR" means the ACCDR for that Cumulated Business Day;

"tIPn<sub>i</sub>" means the number of calendar days from, and including, the first day of the IP Cumulation Period to, but excluding, the Business Day which immediately follows the last day of the IP Cumulation Period;

"IP Cumulation Period" has the meaning given to that term in Step 1; and

"dcc" means 365.

Step 3: Daily Non-Cumulative

Compounded THOR Rate<sub>i</sub> (DNCR<sub>i</sub>)

 $(UCCDR_i - UCCDR_{i-1}) \times \frac{dcc}{IPn_i}$ 

The "**DNCR**" for any Business Day "i" during an Interest Period for a Loan is the percentage rate per annum (without rounding, to the extent reasonably practicable for the Lender performing the calculation, taking into account the capabilities of any software used for that purpose) calculated as set out above where:

"UCCDR<sub>i</sub>" means UCCDR<sub>i</sub> for that Business Day "i";

"UCCDR<sub>i-1</sub>" means, in relation to that Business Day "i", the UCCDR<sub>i</sub> for the immediately preceding Business Day (if any) during that Interest Period;

"dcc" means 365; and

"IPn<sub>i</sub>" means the number of calendar days from, and including, that Business Day"i" up to, but excluding, the following Business Day.

2. Lookback without Observation Shift

Daily Non-Cumulative Compounded THOR Rate

Step 1: Annualized Cumulative Compounded Daily Rate (ACCDRi)

$$\left[\prod_{i=1}^{d_0} \left(1 + \frac{DailyRate_{i-LP} \times n_i}{dcc}\right) - 1\right] \times \frac{dcc}{tn_i}$$

The ACCDR for any Business Day during that Interest Period (the "Cumulated Business Day") is the percentage rate per annum (rounded to [5] decimal places) calculated as set out above where:

"d<sub>0</sub>" means the number of Business Days in the Cumulation Period;

"Lookback Period" or "LP" means [five] Business Days;

"Cumulation Period" means the period from, and including, the first Business Day of that Interest Period to, and including, that Cumulated Business Day;

"i" means a series of whole numbers from one to  $d_0$ , each representing the relevant Business Day in chronological order in the Cumulation Period;

"DailyRate<sub>i-LP</sub>" means, for any Business Day "i" in the Cumulation Period, the Daily Rate for the Business Day which is the Lookback Period prior to that Business Day "i";

"n<sub>i</sub>" means, for any Business Day "i" in the Cumulation Period, the number of calendar days from, and including, that Business Day "i" up to, but excluding, the following Business Day;

"dcc" means 365; and

"**tn**<sub>i</sub>" means the number of calendar days from, and including, the first day of the Cumulation Period to, but excluding, the Business Day which immediately follows the last day of the Cumulation Period.

Step 2: Unannualised Cumulative Compounded Daily Rate (UCCDR<sub>i</sub>)

The "Unannualised Cumulative Compounded Daily Rate" for any Cumulated Business Day during that Interest Period is the result of the above calculation (without rounding, to the extent reasonably practicable for the Lender performing the calculation, taking into account the capabilities of any software used for that purpose) where:

"ACCDR<sub>i</sub>" means the ACCDR for that Cumulated Business Day;

"tn<sub>i</sub>" has the meaning given to that term in Step 1;

"Cumulation Period" has the meaning given to that term in Step 1; and

"dcc" means 365.

Step 3: Daily Non-Cumulative Compounded THOR Rate<sub>i</sub> (DNCR<sub>i</sub>)

 $(UCCDR_i - UCCDR_{i-1}) \times \frac{dcc}{n_i}$ 

 $ACCDR_i \times \frac{tn_i}{dcc}$ 

The "**DNCR**" for any Business Day "i" during an Interest Period for a Loan is the percentage rate per annum (without rounding, to the extent reasonably practicable for the Lender performing the calculation, taking into account the capabilities of any software used for that purpose) calculated as set out above where:

"UCCDR<sub>i</sub>" means UCCDR<sub>i</sub> for that Business Day "i";

"UCCDR<sub>i-1</sub>" means, in relation to that Business Day "i", the UCCDR<sub>i</sub> for the immediately preceding Business Day (if any) during that Interest Period;

"dcc" means 365; and

"n<sub>i</sub>" means the number of calendar days from, and including, that Business Day "i" up to, but excluding, the following Business Day.

3. Lock-out

Daily Non-Cumulative Compounded THOR Rate





The ACCDR for any Business Day during that Interest Period (the "Cumulated Business Day") is the percentage rate per annum (rounded to [5] decimal places) calculated as set out above where:

"d<sub>0</sub>" means the number of Business Days in the Cumulation Period;

"Cumulation Period" means the period from, and including, the first Business Day of that Interest Period to, and including, that Cumulated Business Day;

"i" means a series of whole numbers from one to  $d_0$ , each representing the relevant Business Day in chronological order in the Cumulation Period;

"DailyRate<sub>i</sub>" means, for any Business Day "i" in the Cumulation Period, the Daily Rate for that Business Day "i";

"n<sub>i</sub>" means, for any Business Day "i" in the Cumulation Period, the number of calendar days from, and including, that Business Day "i" up to, but excluding, the following Business Day;

"dcc" means 365; and

"**tn**<sub>i</sub>" means the number of calendar days from, and including, the first day of the Cumulation Period to, but excluding, the Business Day which immediately follows the last day of the Cumulation Period.

Step 2: Unannualised Cumulative Compounded Daily Rate (UCCDRi)

$$ACCDR_i \times \frac{tn_i}{dcc}$$

The "Unannualised Cumulative Compounded Daily Rate" for any Cumulated Business Day during that Interest Period is the result of the above calculation (without rounding, to the extent reasonably practicable for the Lender performing the calculation, taking into account the capabilities of any software used for that purpose) where:

 $"\ensuremath{\mathsf{ACCDR}}_i"$  means the ACCDR for that Cumulated Business Day;

" $tn_i$ " has the meaning given to that term in Step 1;

"Cumulation Period" has the meaning given to that term in Step 1; and

"dcc" means 365.

Step 3: Daily Non-Cumulative Compounded THOR Rate (DNCRi)

$$(UCCDR_i - UCCDR_{i-1}) \times \frac{dcc}{n_i}$$

The "**DNCR**" for any Business Day "i" during an Interest Period for a Loan is the percentage rate per annum (without rounding, to the extent reasonably practicable for the Lender performing the calculation, taking into account the capabilities of any software used for that purpose) calculated as set out above where:

"UCCDR\_i" means UCCDR\_i for that Business Day "i";

"UCCDR<sub>i-1</sub>" means, in relation to that Business Day "i", the UCCDR<sub>i</sub> for the immediately preceding Business Day (if any) during that Interest Period;

"dcc" means 365; and

"n<sub>i</sub>" means the number of calendar days from, and including, that Business Day
"i" up to, but excluding, the following Business Day.

## B. Simple Average Approach

The simple average approach is a method to calculate an interest rate in each interest period by disregarding the time value of money.

$$\left[\sum_{i=1}^{d_b} \left(\frac{\text{Daily Rate}_i \times n_i}{\text{dcc}}\right)\right] \times \frac{\text{dcc}}{d_c}$$

"d<sub>b</sub>" means the number of Business Days in the Interest Period;

"i" means a series of whole numbers from one to  $d_b$ , each representing the relevant Business Day in chronological order in the Interest Period;

"DailyRate<sub>i</sub>" means, for any Business Day "i" in the period, the Daily Rate for that Business Day "i"; "n<sub>i</sub>" means, for any Business Day "i" in the Interest Period, the number of calendar days from, and including, that Business Day "i" up to, but excluding, the following Business Day;

"dcc" means 365; and

 $\mathbf{d}_{c}$  means the number of calendar days in the Interest Period.

As the simple average approach does not factor in the concept of time value of money, an interest rate calculated by this approach may not precisely represent relevant financial costs. Also, an additional cost may arise as a result of basis when a loan contract bases on the simple average approach but its hedging contract employs the compounding approach which is a standard practice for derivatives. Therefore, both counterparties should carefully decide which approach to be applied in a lending/borrowing transaction.

## Annex 2: THOR Pilot Lending Practice

The BOT, on behalf of the Steering Committee on Commercial Banks' Preparedness on LIBOR Discontinuation (the committee), has conducted a survey for opinions across banks in Thailand, ranging from those participating in the committee as well as those outside of the committee.

This Pilot Lending Practice is provided to assist commercial banks to start developing their loans referencing Thai Overnight Repurchase Rate (THOR) based on the majority of views that were provided. Commercial banks and their clients may choose to use other conventions for loans referencing THOR they deem suitable.

Floating Rate	THOR (compounded)	
Convention	Lookback with observation shift (Backward Shifted Observation)	
Number of Days for	5 Bangkok Business Days	
Lookback		
Interest Rate Floor	Floor is applied to compounded THOR at the end of each	
	calculation period (before adding margin)	
Fallback Rate for THOR	BOT's Recommended Rate	

#### Pilot Lending Practice

### Annex 3: THOR Derivative Conventions for Interbank

The BOT, on behalf of the steering committee on commercial banks' preparedness on LIBOR discontinuation (the committee), has conducted a survey for opinions across banks in Thailand, ranging from those participating in the committee as well as those outside of the committee.

This document is provided as a guideline for the conventions of Overnight Interest Rate Swap (OIS) and USDTHB Cross-Currency Swap (CCS) referencing Thai Overnight Repurchase Rate (THOR) for the Interbank market based on the majority of views that were provided. (Different conventions may be applied for non-interbank counter parties)

Trade Date	Т
Effective Date	2 Business Days following Trade Date (T+2)
Reset Date	The last day of each calculation period
Floating Rate	THOR (Daily compounding over each calculation
	period)
Interest Convention	Actual/365
Delayed Payment	2 Business Days
Payment Frequency	Shorter than 1-year maturity: At maturity
	1-year maturity and longer: Quarterly
Business Days	Bangkok
Business Day Convention	Modified Following

### **Recommended THOR OIS Conventions**

# Recommended THOR - SOFR CCS Conventions

Trade Date	Т
Effective Date	2 Business Days following Trade Date (T+2)
Initial Exchange	Effective Date
Final Exchange	Termination Date
Reset Date	The last day of each calculation period
Floating Rates	THOR and SOFR (Daily compounding over each
	calculation period)
Interest Convention	Actual/365 for THOR and Actual/360 for SOFR
Delayed Payment	2 Business Days
Payment Frequency	Shorter than 1-year maturity: At maturity

	1-year maturity and longer: Quarterly
Business Days	Bangkok and New York
Business Day Convention	Modified Following

lssuer	Bank of Thailand
Currency	ТНВ
Par	1,000
Interest Type	Floating Rate
Benchmark	Thai Overnight Repurchase Rate (THOR), compounded in
	arrears or "Compounded THOR"
FRN Structure	5-day Backward Shifted Observation Period
Reset Frequency	Every Bangkok business day
Coupon Rate	Compounded THOR + Quoted Margin (QM)
	Please note that coupon rate will be floored at zero
Quoted Margin (QM)	As determined by BOT
Coupon Frequency	1-year and under 1-year tenor (CBF): Pay at maturity
	Longer than 1-year tenor (BOTF): Pay quarterly
Day Count Convention	Actual/365
Business Day Convention	Following, Adjusted
	If any scheduled interest payment date, other than the
	maturity date falls on a day that is not a business day, such
	interest payment date will be postponed to the following
	business day.
	If the scheduled final interest payment date or the maturity
	date falls on a day that is not a business day, the payment of
	principal and interest will be made on the next succeeding
	business day, but the final interest payment date will not be
	postponed and interest on that payment will not accrue
	during the period from and after the scheduled final interest
	payment date.
Auction Technique	Bid discount margin (DM) or spread above benchmark rate
	(can be negative, zero or positive)
Secondary Market Trading	Quote discount margin (DM) or spread above benchmark rate
	(can be negative, zero or positive)

# Annex 4: BOT THOR Floating Rate Notes Term Sheet and Calculation Convention