Practical guide to the proposed market conventions for ZARONIA-based derivatives

prepared by
The Market Practitioners Group's Derivatives Workstream

SOUTH AFRICAN RESERVE BANK

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1. Background

The highly publicised irregularities relating to the production of interbank offered rates (IBORs) in 2012, see, for example, [Hou and Skeie, 2014], initiated a global regulatory response to reform major interest rate benchmarks. The use of the IBORs within financial markets has subsequently reduced substantially in favour of more robust, alternative reference rates (ARRs), namely, overnight reference rates (ONRRs) which are *near risk-free*.

South Africa has also embarked on the transition journey with the release of the consultative paper [SARB, 2018], prepared by the South African Reserve Bank (SARB), which detailed its initial proposal to reform domestic benchmark and reference rates. The SARB subsequently formed the Market Practitioners Group (MPG) in 2019 to manage the process of adoption and transition to the new interest rate dispensation. The SARB's MPG is a joint public and private sector body, comprising representatives from the SARB, the Financial Sector Conduct Authority (FSCA), and senior professionals from a variety of institutions from different market interest groups active in the domestic money market.

The traditional suite of benchmark rates in South Africa consisted of a set of Jibars (1-, 3-, 6-, 9- and 12-month), see [SARB-MMRR, 2021]. The 3-month Jibar rate is currently the most commonly used benchmark rate for interest rate derivative products denominated in South African rand (ZAR). In 2020, the Risk-Free Reference Rate Workstream (RFRWS) published its recommended properties for a viable replacement reference rate for Jibar — please see [SARB-RFRWS, 2020] for more information. The MPG has subsequently designated the ZARONIA rate as the preferred successor rate to replace the set of Jibars and the SAFEX ON. The conceptual design of ZARONIA was rigorously tested, using bona fide transactions data to ensure that it is reliable, robust and sufficiently stable — see [SARB, 2020] and [SARB, 2021] for more information. A detailed technical specification of the construction of ZARONIA is provided in [SARB, 2020].

The designation of ZARONIA as the preferred successor rate forms part of a larger transition roadmap which includes establishing a successor rate, adoption of the successor rate in both derivatives and cash markets, transitioning legacy contracts and eventual cessation of Jibar. See the SARB Market Practitioners Group's web page for a snapshot of the transition roadmap.

2. Purpose

The Derivatives Workstream (DWS), constituted in 2021, is mandated with making recommendations for the development of derivative markets and contracts that reference the successor overnight rate. The DWS has recently published a detailed technical explanation of the recommended conventions for ZARONIA-based derivatives, which focussed on two fundamental linear derivatives: (i) overnight indexed swaps (OISs; and (ii) USDZAR cross-currency basis swaps (CCBSs). Please refer to [SARB-DWS, 2023] as well as the accompanying spreadsheet examples, accessible via the following hyperlink: ZARONIA Examples and Model.zip.

The purpose of this document is to provide an executive summary of the recommended market conventions for ZARONIA-based derivatives. These recommendations are not meant to prescribe, mandate, or limit the ways in which they can transact based on their needs and requirements. The specific recommendations herein should therefore serve as an underpin for on-the-run overnight indexed swap (OIS), which are interest rate swap derivatives that reference ZARONIA, and will in future be quoted on screens and/or via interbank broking agents. It must be emphasised that the recommendations made within this document should not preclude any derivative user from negotiating a more bespoke derivative to suit individual requirements.

While the recommended conventions herein are presented in a non-technical format, it is presumed that the reader holds a basic proficiency with respect to the mechanics of interest rate derivatives. For more fundamental information on OISs, please refer to [RBNZ-Choy, 2003] which provides a practical introduction.

3. Forward- versus backward-looking reference rates

The differences between forward- versus backward-looking reference rates and its application to derivatives have major implications for interest rate markets. It is therefore important to understand these differences prior to delving into the details of derivatives conventions.

Technically, the key difference between the set of Jibars and ZARONIA is that the former are *forward-looking* term-based reference rates (TBRRs) derived from indicative quote data, while the latter is a *backward-looking* ONRR since it is derived from actual transaction data and therefore only available *after-the-fact* or *in-arrears*, as specified above. Under the ONRR regime, a term rate may be constructed by compounding the respective ONRR over the term rate's specific accrual period. This results in a backward-looking term rate that will, also at best, only be known at the end of the respective term rate's accrual period. Economically, the set of Jibars constitute elements of credit and liquidity risk being term rates that reflect aggregated bank funding costs, while ZARONIA and compounded versions thereof are all *near risk-free* since they are derived from overnight rates.

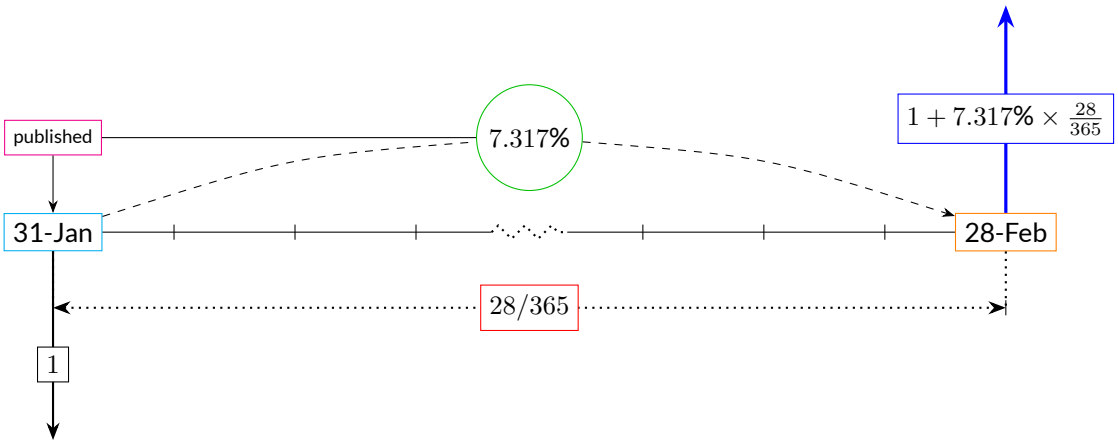
The technical nuances are best demonstrated via the following practical example. Consider a theoretical 1-month deposit with unit nominal that is initiated on 31-Jan-2023. The maturity date will therefore be 28-Feb-2023. Under the TBRR regime, we assume that 1-month Jibar is the deposit rate, and that the appropriate day-count convention is ACT/365 Fixed. Then, Table 1 and Figure 1 below depicts all of the relevant and pertinent features of such a deposit.

Table 1: Relevant data for a 1-month deposit with unit nominal based on 1-month Jibar.

Ref rate	Rate	Accrual period		Pub date	Year frac	1M Cap factor
		Start date	End date			
1M Jibar	7.317%	31-Jan	28-Feb	31-Jan	$28/365$	$1 + 7.317\% \times \frac{28}{365}$

Source for 1M Jibar: JSE Client Portal - Downloadable Files

Figure 1: A 1-month deposit with unit nominal based on 1-month Jibar.



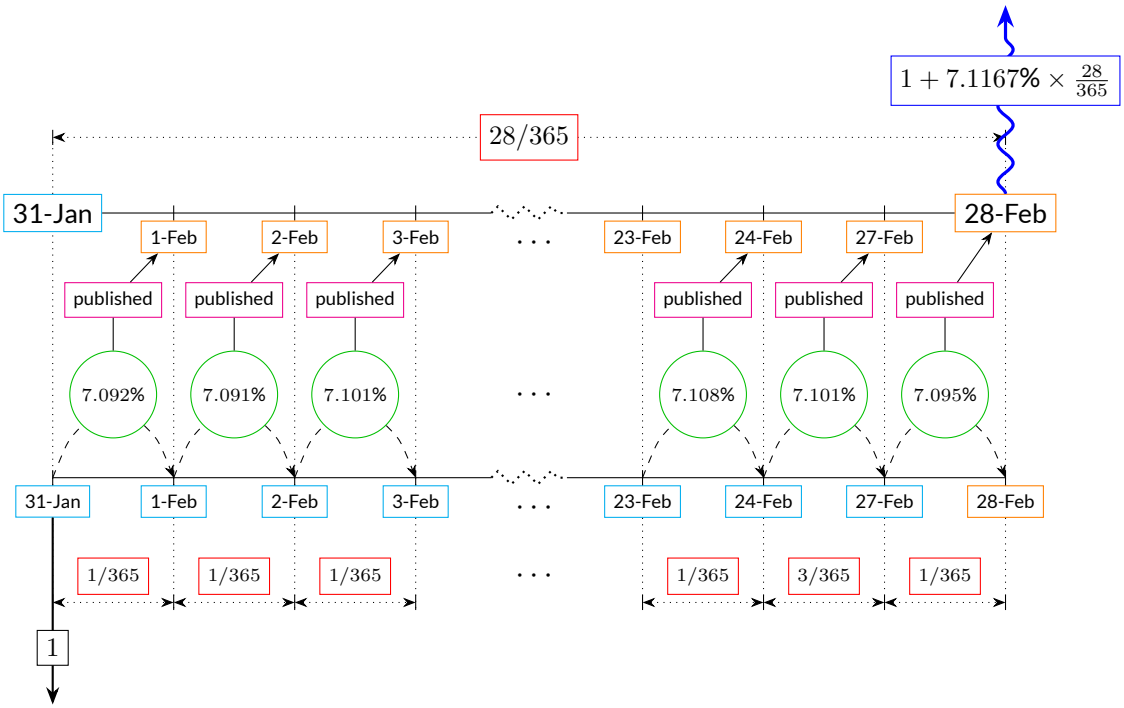
Under the ONRR regime, we assume that ZARONIA is the reference rate for the deposit, and that the *annualised cumulative floating rate* (ACFR) or the *backward-looking term rate* within this context, is determined by compounding the respective set of ZARONIA rates over the relevant 1-month tenor of the deposit. Again, we assume that the appropriate day-count convention is ACT/365. Table 2 and Figure 2 below depicts all of the relevant and pertinent features of such a deposit.

Table 2: Relevant data for a 1-month deposit with unit nominal based on compounded ZARONIA.

Ref rate	Rate	Accrual period		Pub date	Year frac	ON Cap factor
		Start date	End date			
ZARONIA	7.092%	31-Jan	1-Feb	1-Feb	$1/365$	$1 + 7.092\% \times \frac{1}{365}$
ZARONIA	7.091%	1-Feb	2-Feb	2-Feb	$1/365$	$1 + 7.091\% \times \frac{1}{365}$
ZARONIA	7.101%	2-Feb	3-Feb	3-Feb	$1/365$	$1 + 7.101\% \times \frac{1}{365}$
ZARONIA	7.111%	3-Feb	6-Feb	6-Feb	$3/365$	$1 + 7.111\% \times \frac{3}{365}$
ZARONIA	7.099%	6-Feb	7-Feb	7-Feb	$1/365$	$1 + 7.099\% \times \frac{1}{365}$
ZARONIA	7.091%	7-Feb	8-Feb	8-Feb	$1/365$	$1 + 7.091\% \times \frac{1}{365}$
ZARONIA	7.087%	8-Feb	9-Feb	9-Feb	$1/365$	$1 + 7.087\% \times \frac{1}{365}$
ZARONIA	7.096%	9-Feb	10-Feb	10-Feb	$1/365$	$1 + 7.096\% \times \frac{1}{365}$
ZARONIA	7.092%	10-Feb	13-Feb	13-Feb	$3/365$	$1 + 7.092\% \times \frac{3}{365}$
ZARONIA	7.098%	13-Feb	14-Feb	14-Feb	$1/365$	$1 + 7.098\% \times \frac{1}{365}$
ZARONIA	7.100%	14-Feb	15-Feb	15-Feb	$1/365$	$1 + 7.100\% \times \frac{1}{365}$
ZARONIA	7.104%	15-Feb	16-Feb	16-Feb	$1/365$	$1 + 7.104\% \times \frac{1}{365}$
ZARONIA	7.097%	16-Feb	17-Feb	17-Feb	$1/365$	$1 + 7.097\% \times \frac{1}{365}$
ZARONIA	7.098%	17-Feb	20-Feb	20-Feb	$3/365$	$1 + 7.098\% \times \frac{3}{365}$
ZARONIA	7.106%	20-Feb	21-Feb	21-Feb	$1/365$	$1 + 7.106\% \times \frac{1}{365}$
ZARONIA	7.096%	21-Feb	22-Feb	22-Feb	$1/365$	$1 + 7.096\% \times \frac{1}{365}$
ZARONIA	7.094%	22-Feb	23-Feb	23-Feb	$1/365$	$1 + 7.094\% \times \frac{1}{365}$
ZARONIA	7.108%	23-Feb	24-Feb	24-Feb	$1/365$	$1 + 7.108\% \times \frac{1}{365}$
ZARONIA	7.101%	24-Feb	27-Feb	27-Feb	$3/365$	$1 + 7.101\% \times \frac{3}{365}$
ZARONIA	7.095%	27-Feb	28-Feb	28-Feb	$1/365$	$1 + 7.095\% \times \frac{1}{365}$
1M Cap factor (rounded to 12 decimal places)						1.005459371855
1M Cap factor (based on the implied ACFR)						$1 + 7.1167\% \times \frac{28}{365}$

Source for ZARONIA: SARB - ZARONIA Interest Rate Benchmark Web Page

Figure 2: A 1-month deposit with unit nominal based on compounded ZARONIA.



There are two material differences between the two regimes — the first is the calculation of the 1-month capitalisation factor. Under the TBRR regime, the 1-month capitalisation factor is calculated as $\left(1 + 7.317\% \times \frac{28}{365}\right)$, while under the ONRR regime, it is calculated as follows:

$$\left(1 + 7.092\% \times \frac{1}{365}\right) \times \left(1 + 7.091\% \times \frac{1}{365}\right) \times \ldots \times \left(1 + 7.101\% \times \frac{3}{365}\right) \times \left(1 + 7.095\% \times \frac{1}{365}\right) , \quad (1)$$

i.e., by taking the product of the respective set of overnight capitalisation factors. Then the ACFR may be calculated by setting equation (1) equal to $\left(1 + F \times \frac{28}{365}\right)$, solving for F and rounding to 4 decimal places in percentage format, which yields $F = 7.1167\%$, as shown in Table 2. Economically, the 0.2003% difference between 1-month Jibar and the implied ACFR may be attributed to 1-month term credit, liquidity spreads and unrealised expectations of changes in the SARB's policy rate, i.e. the repo rate.

The second difference is the dates on which the respective capitalisation factors are calculable and thereby observable. According to current (and prospective) publishing procedures, 1-month Jibar is published at the beginning of its respective accrual period while ZARONIA is and will be published at the end of its respective accrual period. This means that the ACFR will only be calculable and known at the end of its respective accrual period, as is the case in this theoretical example and shown in Table 2 and Figure 2.

4. Design Principles

The conventions for ZARONIA-based derivatives were recommended with the objective of preserving and where possible enhancing market functionality. The DWS adopted the following design principles:

- Support the deepening of financial markets and ease operational complexity.
- Align with major developed markets unless domestic nuances dictate otherwise.
- Ensure that the requirements of major exchanges and clearing houses are observed and satisfied (e.g. settlement requirements).
- Consider the related ZARONIA quotation, timing and application of the rate to derivatives.

4.1. Preserving existing market microstructure

In addition to derivative conventions, the DWS has also provided recommendations on certain elements of market microstructure. This begins with an examination of the current *on-the-run* interbank interest rate derivatives market, which is also an important precursor to the design of viable conventions. The current market is divided into two broad segments: (i) forward rate agreements (FRAs); and (ii) interest rate swaps (IRSs), with all constituent contracts referencing 3-month Jibar. The current FRA market provides deep hedging and speculation capability. This market also provides a strong underpin for derivative market depth as well as insight into monetary policy expectations. The current available set of vanilla IRS contracts provides an important building block for yield curve construction as well as a fundamental underpin to valuation.

Bank and inter-dealer broker screens typically provide indicative quotes for a set of FRA and IRS contracts. The interbank market provides price discovery and trading through a combination of voice and screen trading mechanisms. Using the base set of market quotes, standard and bespoke derivative prices are subsequently quoted to clients (*buy-side*). Bespoke derivative prices are calculated using models which use the base set of market quotes as fundamental inputs. It is therefore critical that these two markets continue to exist within the new ONRR regime. In order to preserve the functionality and utility of the current FRA market post transition, the DWS proposes the creation of an equivalent market in *forward-starting single-period OISs*. To do the same for the current IRS market, the DWS proposes the creation of an equivalent market in *spot-starting multi-period OISs*. The key features of the current and proposed new market microstructures are summarised in Table 3 below.

Table 3: Preserving current derivative market microstructure.

Microstructure	Current	New
Segment	Forward rate agreements	Forward-starting single-period OISs
Reference rate	3M Jibar	1M and 3M ZARONIA ACFR
Quoted tenors	1x4, 2x5, . . . , 9x12, 12x15, 15x18, 18x21 and 21x24	**For 1M:** 1M1M, 2M1M, . . . ,10M1M and 11M1M **For 3M:** 1M3M, 2M3M, . . . , 8M3M, 9M3M, 12M3M, 15M3M, 18M3M and 21M3M
Curve coverage	1M to 24M	1M to 24M, but with more granularity
Segment	Interest rate swaps	Spot-starting multi-period OISs
Reference rate	3M Jibar	12M ZARONIA ACFR
Quoted tenors	1Y, 2Y, . . . , 9Y, 10Y, 12Y, 15Y, 20Y, 25Y and 30Y	2Y, 3Y, . . . , 9Y, 10Y, 12Y, 15Y, 20Y, 25Y and 30Y
Curve coverage	1Y to 30Y	2Y to 30Y

4.2. Creating new market microstructure

The demand for an alternative suite of forward-looking term reference rates is likely to increase following the likely cessation of the current suite of Jibars at some point in the future. In section 3., it was shown how one may compute an ACFR by suitably compounding the realised ZARONIA rate over a specific term — this results in a backward-looking term rate, which, at best, may only be known in-arrears. As described in the previous sub-section, the ACFR may be used as a floating reference rate in the definition of a derivative. If the latter is a linear derivative which enables the exchange of *floating-for-fixed* interest rate risk, then the derivative's pricing process would yield a fixed rate forecast for the floating reference rate, or ACFR, under consideration. Having access to the data from the market's price discovery process, or trading activity, may enable the creation of a market-based forward-looking term reference rate, provided that there is evidence of sufficient liquidity.

Forward-looking term reference rates therefore require an appropriately formulated derivative market microstructure in order to support the potential calculation thereof. This is the motivation behind the proposal to create a new derivative market segment that does not currently exist. This market segment will be defined by *spot-starting single-period OISs*, with the key features described in Table 4 below.

Table 4: New derivative market microstructure.

Microstructure	New
Segment	Spot-starting single-period OISs
Reference rate	1M, 2M, . . . , 11M and 12M ZARONIA ACFR
Quoted tenors	1M, 2M, . . . , 11M and 12M
Curve coverage	1M to 12M

5. Recommended overnight indexed swap conventions

This section presents recommendations for the following contracts: (i) spot-starting single-period OISs (SSSPs); (ii) forward-starting single-period OISs (FSSPs); and (iii) spot-starting multi-period OISs (SSMPs).

Table 5: Recommended overnight indexed swap conventions.

Feature	Recommended Convention	SSSP Reference	FSSP Reference	SSMP Reference
Swap tenor	SSSP: $\leq$ 12M FSSP: 1M and 3M SSMP: $\geq$ 2Y	6.1.	7.1.	8.1.
Accrual period	SSSP: Equal to swap tenor FSSP: Equal to swap tenor SSMP: Equal to 1Y	6.1.	7.1.	8.1.
Business day calendar	ZAJO	6.2.	7.2.	8.2.
Business day convention	Modified Following	6.1., 6.2.	7.1., 7.2.	8.1., 8.2.
Forward period	SSSP: 0Y FSSP: $<$ 24M SSMP: 0Y	6.1.	7.1.	8.1.
Spot lag	0 bd	6.1.	7.1.	8.1.
Accrual period date generation	Backward (EOM)	6.2.	7.2.	8.2.
Non-standard first period	SSSP: Not applicable FSSP: Not applicable SSMP: Short-stub	6.2.	7.2.	8.2.
Accrual day count convention	ACT/365 Fixed	6.3.	7.3.	8.3.
Floating reference rate	ZARONIA	6.3.	7.3.	8.3.
Publication/ Calculation lag	1 bd	6.3.	7.3.	8.3.
ACFR calculation	Compounded, 0 bd lockout, 0 bd lookback 0 bd obs shift	6.3.	7.3.	8.3.
ACFR convention	Simple, 6 decimal places	6.3.	7.3.	8.3.
Spread	Simple, additive post compounding	N/A	N/A	8.4.
Fixed rate quotation	Simple, 6 decimal places	6.4.	7.4.	8.4.
Net cash flow rounding	2 decimal places	6.4.	7.4.	8.4.
Payment lag	2 bd	6.4.	7.4.	8.4.

6. Example: Spot-starting single-period overnight indexed swap

Example
Consider a short position in a 1-month SSSP that is traded on 31-Mar-2023, with a fixed swap rate equal to 8.1234% and a nominal value of ZAR1 million.

The sub-sections that follow will describe how all of the contractual specifications of the SSSP are generated, as well as demonstrate the calculation of the respective floating and fixed cash flows that is required for settlement at the expiry date of the contract, all done according to the conventions proposed in Table 5.

6.1. Tenor, accrual period, forward and effective dates

Since the particular OIS under consideration is the SSSP, then by Table 5 and the example, it follows that:

- the **swap tenor** is equal to 1M;
- the **accrual period** is equal to the **swap tenor**;
- the **forward period** is equal to 0Y, and the **forward date** which is equal to the **transaction date** plus the **forward period** with the resultant date adjusted if it is not a *valid business day*, is

$$\big(\text{31-Mar-2023} + \text{0Y}\big), \text{ then adjusted by Modified Following} = \text{31-Mar-2023}\ , \tag{2}$$

  since the **business day convention** is Modified Following and 31-Mar-2023 is a valid business day; and
- the **spot lag** is 0-business days (bd), and the **effective date** which is equal to the **forward date** plus the **spot lag** is

$$\text{31-Mar-2023} + \text{0 bd} = \text{31-Mar-2023}\ , \tag{3}$$

  since 31-Mar-2023 is a valid business day.

6.2. Accrual period date generation

Since the accrual period and swap tenor are the same, as described in sub-section 6.1., there is only one accrual period. The **Backward (EOM)** algorithm for **accrual period date generation** then works as follows:

- **Step 1:** The unadjusted expiry date, also called the *roll-day*, is

$$\big(\text{31-Mar-2023} + \text{1M}\big), \text{ then adjusted by EOM} = \text{30-Apr-2023}\ . \tag{4}$$

  There is actually no need to apply the *end-of-month* (EOM) rule here, since 30-Apr-2023 is the result of the expression in parentheses and is the last day of April.
- **Step 2:** Since there is only one accrual period, this step is not applicable, and is also the reason that the **non-standard first period** feature is also not applicable.
- **Step 3:** Since 30-Apr-2023 is a Sunday, it has to be adjusted as follows

$$\text{30-Apr-2023, adjusted by Modified Following} = \text{28-Apr-2023}\ , \tag{5}$$

  which is the actual expiry date for the SSSP.

The full set of interest accrual period dates for the single accrual period may then be identified as all of the valid business days between 31-Mar-2023 and 28-Apr-2023 using the ZAJO calendar, which is the official South African calendar, following the Public Holidays Act (Act No. 36 of 1994), issued by a relevant provider. There are 18 valid business days in this accrual period, including the effective and expiry dates. These dates are presented in Table 6, which appears in the next sub-section in the columns titled "Start date" and "End date".

6.3. Annualised cumulative floating rate calculation

The table below depicts the calculation of the respective 1M ACFR that is associated with the SSSP under consideration. The following conventions are applied in the creation of the table:

- the relevant ZARONIA rates are published by the SARB and shown in the column titled "**Rate**";
- the **publication lag** for ZARONIA is 1 bd, which means that a ZARONIA rate is only published 1-business day after its accrual period start date, as shown in the column titled "**Pub date**";
- the ACT/365 Fixed rule is used as the **accrual day count convention** rule to compute all of the required year fractions, as depicted in the column titled "**Year frac**";
- the last column titled "**ON Cap factor**" shows the calculation of the required overnight capitalisation factor associated with each sub-accrual period, based on ZARONIA which is an annualised simple ONRR.

Table 6: Data and supporting calculations for the 1M ZARONIA ACFR underlying the SSSP.

Ref rate	Rate	Accrual period		Pub date	Year frac	ON Cap factor
		Start date	End date			
ZARONIA	7.569%	31-Mar	3-Apr	3-Apr	$3/365$	$1 + 7.569\% \times \frac{3}{365}$
ZARONIA	7.586%	3-Apr	4-Apr	4-Apr	$1/365$	$1 + 7.586\% \times \frac{1}{365}$
ZARONIA	7.579%	4-Apr	5-Apr	5-Apr	$1/365$	$1 + 7.579\% \times \frac{1}{365}$
ZARONIA	7.580%	5-Apr	6-Apr	6-Apr	$1/365$	$1 + 7.580\% \times \frac{1}{365}$
ZARONIA	7.578%	6-Apr	11-Apr	11-Apr	$5/365$	$1 + 7.578\% \times \frac{5}{365}$
ZARONIA	7.574%	11-Apr	12-Apr	12-Apr	$1/365$	$1 + 7.574\% \times \frac{1}{365}$
ZARONIA	7.573%	12-Apr	13-Apr	13-Apr	$1/365$	$1 + 7.573\% \times \frac{1}{365}$
ZARONIA	7.582%	13-Apr	14-Apr	14-Apr	$1/365$	$1 + 7.582\% \times \frac{1}{365}$
ZARONIA	7.585%	14-Apr	17-Apr	17-Apr	$3/365$	$1 + 7.585\% \times \frac{3}{365}$
ZARONIA	7.588%	17-Apr	18-Apr	18-Apr	$1/365$	$1 + 7.588\% \times \frac{1}{365}$
ZARONIA	7.591%	18-Apr	19-Apr	19-Apr	$1/365$	$1 + 7.591\% \times \frac{1}{365}$
ZARONIA	7.590%	19-Apr	20-Apr	20-Apr	$1/365$	$1 + 7.590\% \times \frac{1}{365}$
ZARONIA	7.590%	20-Apr	21-Apr	21-Apr	$1/365$	$1 + 7.590\% \times \frac{1}{365}$
ZARONIA	7.540%	21-Apr	24-Apr	24-Apr	$3/365$	$1 + 7.540\% \times \frac{3}{365}$
ZARONIA	7.597%	24-Apr	25-Apr	25-Apr	$1/365$	$1 + 7.597\% \times \frac{1}{365}$
ZARONIA	7.591%	25-Apr	26-Apr	26-Apr	$1/365$	$1 + 7.591\% \times \frac{1}{365}$
ZARONIA	7.594%	26-Apr	28-Apr	28-Apr	$2/365$	$1 + 7.594\% \times \frac{2}{365}$
1M Cap factor (rounded to 12 decimal places)						1.005828635169
1M Cap factor (based on the implied ACFR)						$1 + 7.5980\% \times \frac{28}{365}$

Source for ZARONIA: SARB - ZARONIA Interest Rate Benchmark Web Page

Since there are no *fixing adjustments*[1], following the **ACFR calculation** feature, the "**1M Cap factor**" is the 1M realised capitalisation factor applicable to the entire single accrual period and is calculated as follows:

$$\left(1 + 7.569\% \times \frac{3}{365}\right) \times \left(1 + 7.586\% \times \frac{1}{365}\right) \times \ldots \times \left(1 + 7.591\% \times \frac{1}{365}\right) \times \left(1 + 7.594\% \times \frac{2}{365}\right), \quad (6)$$

i.e. by compounding the series of overnight capitalisation factors. Equation (6) resolves to the more compact form:

$$1 + 7.5980\% \times \frac{28}{365}, \quad (7)$$

after implying the ACFR according to the **ACFR convention**, i.e. an annualised simple rate, also based on the ACT/365 Fixed day count convention and rounded to 6 decimal places (or 4 decimals in percentage format).

[1] Interest cash flows only been known in-arrears under the ONRR regime creates various practical operational challenges for settlement. Three fixing adjustment methods have been proposed to assist to alleviate this problem: (i) *lockout*, (ii) *lookback*; and (iii) *observation shift* periods — these are described in the technical paper SARB-DWS, 2023.

6.4. Net cash flow and payment lag

Since the 1M ZARONIA ACFR has now been calculated in the previous sub-section, it is now possible to compute the **floating cash flow** as follows:

$$-\text{ZAR}1 \text{ million} \times 7.5980\% \times \frac{28}{365}\,, \tag{8}$$

and the corresponding **fixed cash flow** as:

$$\text{ZAR}1 \text{ million} \times 8.1234\% \times \frac{28}{365}\,, \tag{9}$$

so that the **net cash flow** of the short position in the SSSP resolves to:

$$\begin{aligned} &\text{ZAR}1 \text{ million} \times (8.1234\% - 7.5980\%) \times \frac{28}{365} \\ &= \text{ZAR}1 \text{ million} \times 0.5254\% \times \frac{28}{365} \\ &= \text{ZAR}\,403.05\,, \end{aligned} \tag{10}$$

which follows by the **fixed rate quotation** and **net cash flow rounding** conventions, with the latter advocating that the net cash flow be rounded to the nearest ZAc.

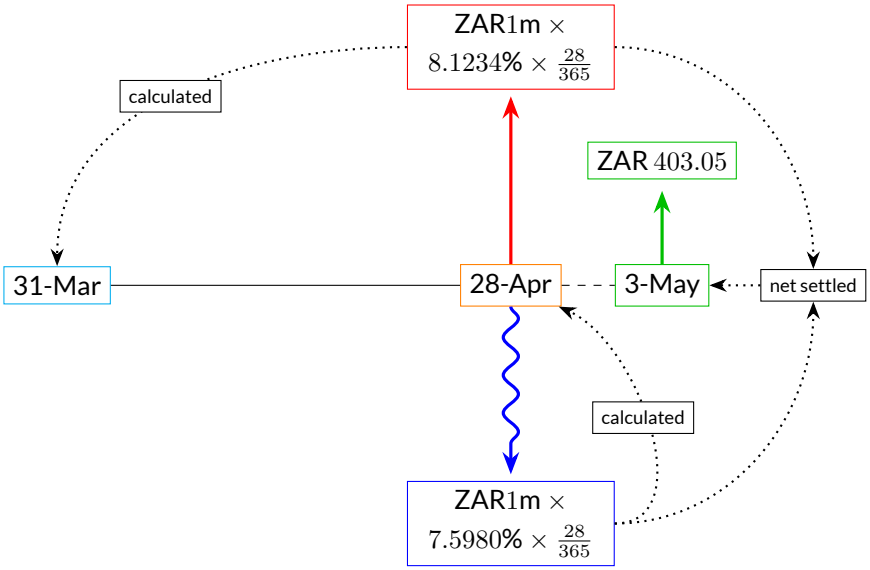
The **payment lag** is the final feature which requires description, and it defines the date on which the net cash flow is settled between the relevant counterparties. Since there are no applicable fixing adjustments, the **payment lag** is the feature that has been recommended in the derivatives market to solve practical operational settlement issues. The **payment lag** is 2 bd and the **payment date** which is equal to the last ZARONIA publication date plus the **payment lag** is

$$\text{28-Apr-2023} + 2 \text{ bd} = \text{3-May-2023}\,, \tag{11}$$

which is the only **payment date** for the SSSP.

All of the key quantities that have been computed in sub-sections 6.1., 6.2., 6.3. and 6.4. are summarised diagrammatically in Figure 3 below, apart from the calculations related to the overnight sub-accrual periods.

Figure 3: A depiction of the key contractual dates and final cash flows associated with the SSSP.



Remark 1 (Constructing a synthetic term rate). *Consider combining the short position in the 1M SSSP, defined in this section, with a corresponding 1M ZARONIA-linked deposit, described in section 3. Then, the floating cash flow that has to be paid in the SSSP will cancel with the proceeds from the floating cash flow from the deposit, thereby leaving the fixed cash flow from the SSSP as residual. If the SSSP is a fair trade, i.e. its initial cost/premium is zero, then such a trade creates a fair synthetic fixed rate deposit, with the SSSP's fixed rate being a representative 1M term rate.*

7. Example: Forward-starting single-period overnight indexed swap

Example
Consider a long position in a 2- by 3-month, or 2M3M, FSSP that is traded on 30-Dec-2022, with a fixed swap rate equal to 8.1234% and a nominal value of ZAR1 million.

The sub-sections that follow will describe how all of the contractual specifications of the FSSP are generated, as well as demonstrate the calculation of the respective floating and fixed cash flows that is required for settlement at the expiry date of the contract, all done according to the conventions proposed in Table 5.

7.1. Tenor, accrual period, forward and effective dates

Since the particular OIS under consideration is the FSSP, then by Table 5 and the example, it follows that:

- the **swap tenor** is equal to 3M;
- the **accrual period** is equal to the **swap tenor**;
- the **forward period** is equal to 2M, and the **forward date** which is equal to the **transaction date** plus the **forward period** with the resultant date adjusted if it is not a *valid business day*, is

$$\big(\text{30-Dec-2022} + \text{2M}\big), \text{ then adjusted by Modified Following} = \text{28-Feb-2023}\ , \tag{12}$$

  since the **business day convention** is Modified Following and 28-Feb-2023 is a valid business day; and
- the **spot lag** is 0-business days (bd), and the **effective date** which is equal to the **forward date** plus the **spot lag** is

$$\text{28-Feb-2023} + \text{0 bd} = \text{28-Feb-2023}\ , \tag{13}$$

  since 28-Feb-2023 is a valid business day.

7.2. Accrual period date generation

Since the accrual period and swap tenor are the same, as described in sub-section 7.1., there is only one accrual period. The **Backward (EOM)** algorithm for **accrual period date generation** then works as follows:

- **Step 1:** The unadjusted expiry date, also called the *roll-day*, is

$$\big(\text{28-Feb-2023} + \text{3M}\big), \text{ then adjusted by EOM} = \text{31-May-2023}\ . \tag{14}$$

  Here the EOM rule is necessary since the result of the expression in the parentheses is 28-May-2023.
- **Step 2:** Since there is only one accrual period, this step is not applicable, and is also the reason that the **non-standard first period** feature is also not applicable.
- **Step 3:** Since 31-May-2023 is a valid business day, it does not have to be adjusted, hence

$$\text{31-May-2023, adjusted by Modified Following} = \text{31-May-2023}\ , \tag{15}$$

  and is the actual expiry date for the FSSP.

The full set of interest accrual period dates for the single accrual period may then be identified as all of the valid business days between 28-Feb-2023 and 31-May-2023 using the ZAJO calendar, which is the official South African calendar, following the Public Holidays Act (Act No. 36 of 1994), issued by a relevant provider. There are 62 valid business days in this accrual period, including the effective and expiry dates. Some of these dates are presented in Table 7, which appears in the next sub-section in the columns titled "Start date" and "End date".

7.3. Annualised cumulative floating rate calculation

The table below depicts the calculation of the respective 3M ACFR that is associated with the FSSP under consideration. The following conventions are applied in the creation of the table:

- the relevant ZARONIA rates are published by the SARB and shown in the column titled "**Rate**";
- the **publication lag** for ZARONIA is 1 bd, which means that a ZARONIA rate is only published 1-business day after its accrual period start date, as shown in the column titled "**Pub date**";
- the ACT/365 Fixed rule is used as the **accrual day count convention** rule to compute all of the required year fractions, as depicted in the column titled "**Year frac**";
- the last column titled "**ON Cap factor**" shows the calculation of the required overnight capitalisation factor associated with each sub-accrual period, based on ZARONIA which is an annualised simple ONRR.

Table 7: Data and supporting calculations for the 3M ZARONIA ACFR underlying the FSSP.

Ref rate	Rate	Accrual period		Pub date	Year frac	ON Cap factor
		Start date	End date			
ZARONIA	7.098%	28-Feb	1-Mar	1-Mar	$1/365$	$1 + 7.098\% \times \frac{1}{365}$
ZARONIA	7.091%	1-Mar	2-Mar	2-Mar	$1/365$	$1 + 7.091\% \times \frac{1}{365}$
ZARONIA	7.091%	2-Mar	3-Mar	3-Mar	$1/365$	$1 + 7.091\% \times \frac{1}{365}$
ZARONIA	7.105%	3-Mar	6-Mar	6-Mar	$3/365$	$1 + 7.105\% \times \frac{3}{365}$
ZARONIA	7.095%	6-Mar	7-Mar	7-Mar	$1/365$	$1 + 7.095\% \times \frac{1}{365}$
ZARONIA	7.087%	7-Mar	8-Mar	8-Mar	$1/365$	$1 + 7.087\% \times \frac{1}{365}$
ZARONIA	7.085%	8-Mar	9-Mar	9-Mar	$1/365$	$1 + 7.085\% \times \frac{1}{365}$
⋮	⋮	⋮	⋮	⋮	⋮	⋮
ZARONIA	7.577%	22-May	23-May	23-May	$1/365$	$1 + 7.577\% \times \frac{1}{365}$
ZARONIA	7.577%	23-May	24-May	24-May	$1/365$	$1 + 7.577\% \times \frac{1}{365}$
ZARONIA	7.580%	24-May	25-May	25-May	$1/365$	$1 + 7.580\% \times \frac{1}{365}$
ZARONIA	7.582%	25-May	26-May	26-May	$1/365$	$1 + 7.582\% \times \frac{1}{365}$
ZARONIA	8.030%	26-May	29-May	29-May	$3/365$	$1 + 8.030\% \times \frac{3}{365}$
ZARONIA	8.067%	29-May	30-May	30-May	$1/365$	$1 + 8.067\% \times \frac{1}{365}$
ZARONIA	8.075%	30-May	31-May	31-May	$1/365$	$1 + 8.075\% \times \frac{1}{365}$
3M Cap factor (rounded to 12 decimal places)						1.018930817323
3M Cap factor (based on the implied ACFR)						$1 + 7.5106\% \times \frac{92}{365}$

Source for ZARONIA: SARB - ZARONIA Interest Rate Benchmark Web Page

Since there are no fixing adjustments, following the **ACFR calculation** feature, the "**3M Cap factor**" is the 3M realised capitalisation factor applicable to the entire single accrual period and is calculated as follows:

$$\left(1 + 7.098\% \times \frac{1}{365}\right) \times \left(1 + 7.091\% \times \frac{1}{365}\right) \times \ldots \times \left(1 + 8.067\% \times \frac{1}{365}\right) \times \left(1 + 8.075\% \times \frac{1}{365}\right), \quad (16)$$

i.e. by compounding the series of overnight capitalisation factors. Equation (16) resolves to the more compact form:

$$1 + 7.5106\% \times \frac{92}{365}, \quad (17)$$

after implying the ACFR according to the **ACFR convention**, i.e. an annualised simple rate, also based on the ACT/365 Fixed day count convention and rounded to 6 decimal places (or 4 decimals in percentage format).

7.4. Net cash flow and payment lag

Since the 3M ZARONIA ACFR has now been calculated in the previous sub-section, it is now possible to compute the **floating cash flow** as follows:

$$\text{ZAR1 million} \times 7.5106\% \times \frac{92}{365}\,, \tag{18}$$

and the corresponding **fixed cash flow** as:

$$-\,\text{ZAR1 million} \times 8.1234\% \times \frac{92}{365}\,, \tag{19}$$

so that the **net cash flow** of the long position in the SSSP resolves to:

$$\begin{aligned} &\text{ZAR1 million} \times (7.5106\% - 8.1234\%) \times \frac{92}{365} \\ &= \text{ZAR1 million} \times -0.6128\% \times \frac{92}{365} \\ &= -\,\text{ZAR}\,1544.59\,, \end{aligned} \tag{20}$$

which follows by the **fixed rate quotation** and **net cash flow rounding** conventions, with the latter advocating that the net cash flow be rounded to the nearest ZAc.

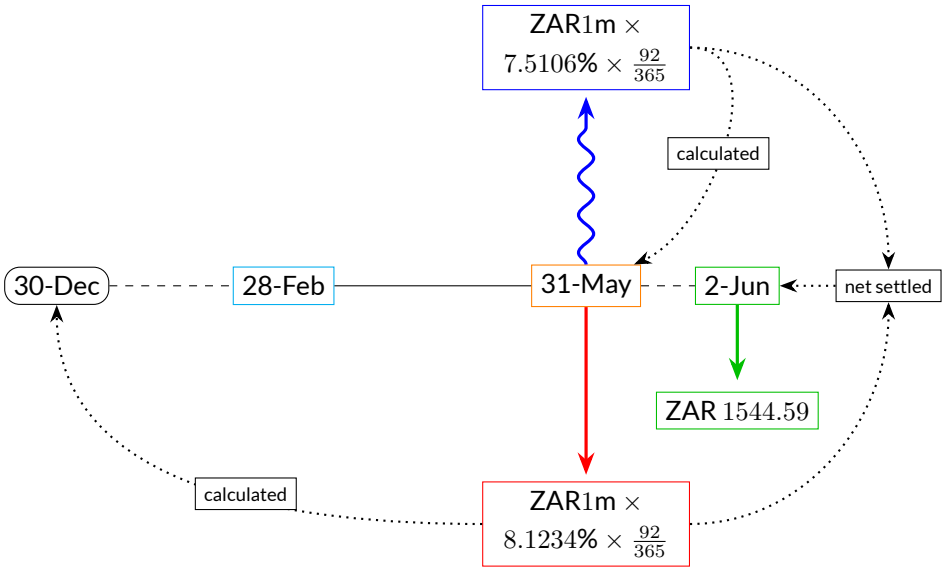
The **payment lag** is the final feature which requires description, and it defines the date on which the net cash flow is settled between the relevant counterparties. Since there are no applicable fixing adjustments, the **payment lag** is the feature that has been recommended in the derivatives market to solve practical operational settlement issues. The **payment lag** is 2 bd and the **payment date** which is equal to the last ZARONIA publication date plus the **payment lag** is

$$\text{31-May-2023} + 2\text{ bd} = \text{2-Jun-2023}\,, \tag{21}$$

which is the only **payment date** for the FSSP.

All of the key quantities that have been computed in sub-sections 7.1., 7.2., 7.3. and 7.4. are summarised diagrammatically in Figure 4 below, apart from the calculations related to the overnight sub-accrual periods.

Figure 4: A depiction of the key contractual dates and final cash flows associated with the FSSP.



Remark 2 (Settlement in-advance is no longer possible)**.** *Unlike Jibar-based FRAs which may be settled in-advance, it should be noted that settlement in-advance is not possible for ZARONIA-based "FRAs", or rather FSSPs, since the floating cash flow is only calculable at the end of the respective accrual period.*

8. Example: Spot-starting multi-period overnight indexed swap

Example
Consider a long position in a 2.5Y SSMP that is traded on 27-Oct-2022, with a fixed swap rate equal to 8.1234%, a fixed spread equal to 0% and a nominal value of ZAR1 million.

The sub-sections that follow will describe how all of the contractual specifications of the SSMP are generated, as well as demonstrate the calculation of the respective floating and fixed cash flows that is required for settlement at each payment date of the contract, all done according to the conventions proposed in Table 5.

8.1. Tenor, accrual period, forward and effective dates

Since the particular OIS under consideration is the SSMP, then by Table 5 and the example, it follows that:

- the **swap tenor** is equal to 2.5Y, and the **accrual period** is equal to 12M;
- the **forward period** is equal to 0Y, and the **forward date** which is equal to the **transaction date** plus the **forward period** with the resultant date adjusted if it is not a *valid business day*, is

$$\big(\text{27-Oct-2022} + 0\text{Y}\big), \text{ then adjusted by Modified Following} = \text{27-Oct-2022}\ , \tag{22}$$

  since the **business day convention** is Modified Following and 27-Oct-2022 is a valid business day; and
- the **spot lag** is 0 bd, and the **effective date** which is equal to the **forward date** plus the **spot lag** is

$$\text{27-Oct-2022} + 0\text{ bd} = \text{27-Oct-2022}\ . \tag{23}$$

8.2. Accrual period date generation

Since the accrual period is 12M and the swap tenor is 2.5Y or 30M, as described in sub-section 8.1., there will be three accrual periods with a **non-standard first period**, i.e. a short-stub. The **Backward (EOM)** algorithm for **accrual period date generation** then works as follows:

- **Step 1:** The unadjusted expiry date, also called the *roll-day*, is

$$\big(\text{27-Oct-2022} + 30\text{M}\big), \text{ then adjusted by EOM} = \text{27-Apr-2025}\ , \tag{24}$$

  with the EOM rule being superfluous here since 27-Oct-2022 is not the last day of October.
- **Step 2:** Generating accrual period end dates from the roll-day moving backwards, we have:

$$\begin{aligned}\big(\text{27-Apr-2025} - 12\text{M}\big), \text{ then adjusted by EOM} &= \text{27-Apr-2024}\ ,\\ \big(\text{27-Apr-2024} - 12\text{M}\big), \text{ then adjusted by EOM} &= \text{27-Apr-2023}\ ,\end{aligned} \tag{25}$$

  so that the full set of unadjusted dates is $\{\text{27-Oct-2022}, \text{27-Apr-2023}, \text{27-Apr-2024}, \text{27-Apr-2025}\}$.
- **Step 3:** Adjusting each of the dates generated in the previous steps, we have:

$$\begin{aligned}\text{27-Apr-2023, adjusted by Modified Following} &= \text{28-Apr-2023}\ ,\\ \text{27-Apr-2024, adjusted by Modified Following} &= \text{29-Apr-2024}\ ,\\ \text{27-Apr-2025, adjusted by Modified Following} &= \text{29-Apr-2025}\ ,\end{aligned} \tag{26}$$

  so that the full set of adjusted dates is $\{\text{27-Oct-2022}, \text{28-Apr-2023}, \text{29-Apr-2024}, \text{29-Apr-2025}\}$.

The full set of accrual period dates may be identified as all of the valid business days between 27-Oct-2023 and 29-Apr-2025 using the ZAJO calendar, which is the official South African calendar, following the Public Holidays Act (Act No. 36 of 1994), issued by a relevant provider. In order to keep this example parsimonious and due to the lack of available ZARONIA data, only the first accrual period will be considered. There are 124 valid business days in this accrual period, including the effective and accrual period end date. Some of these dates are presented in Table 8, which appears in the next sub-section in the columns titled "Start date" and "End date".

8.3. Annualised cumulative floating rate calculation

The table below depicts the calculation of the respective 6M ACFR that is associated with the **short-stub** of the SSMP under consideration. The following conventions are applied in the creation of the table:

- the relevant ZARONIA rates are published by the SARB and shown in the column titled "**Rate**";
- the **publication lag** for ZARONIA is 1 bd, which means that a ZARONIA rate is only published 1-business day after its accrual period start date, as shown in the column titled "**Pub date**";
- the ACT/365 Fixed rule is used as the **accrual day count convention** rule to compute all of the required year fractions, as depicted in the column titled "**Year frac**";
- the last column titled "**ON Cap factor**" shows the calculation of the required overnight capitalisation factor associated with each sub-accrual period, based on ZARONIA which is an annualised simple ONRR.

Table 8: Data and supporting calculations for the 6M ZARONIA ACFR underlying the short-stub of the SSMP.

Ref rate	Rate	Accrual period		Pub date	Year frac	ON Cap factor
		Start date	End date			
ZARONIA	6.125%	27-Oct	28-Oct	28-Oct	$1/365$	$1+6.125\%\times\frac{1}{365}$
ZARONIA	6.201%	28-Oct	31-Oct	31-Oct	$3/365$	$1+6.201\%\times\frac{3}{365}$
ZARONIA	6.140%	31-Oct	1-Nov	1-Nov	$1/365$	$1+6.140\%\times\frac{1}{365}$
ZARONIA	6.151%	1-Nov	2-Nov	2-Nov	$1/365$	$1+6.151\%\times\frac{1}{365}$
ZARONIA	6.158%	2-Nov	3-Nov	3-Nov	$1/365$	$1+6.158\%\times\frac{1}{365}$
ZARONIA	6.121%	3-Nov	4-Nov	4-Nov	$1/365$	$1+6.121\%\times\frac{1}{365}$
ZARONIA	6.106%	4-Nov	7-Nov	7-Nov	$3/365$	$1+6.106\%\times\frac{3}{365}$
⋮	⋮	⋮	⋮	⋮	⋮	⋮
ZARONIA	7.591%	18-Apr	19-Apr	19-Apr	$1/365$	$1+7.591\%\times\frac{1}{365}$
ZARONIA	7.590%	19-Apr	20-Apr	20-Apr	$1/365$	$1+7.590\%\times\frac{1}{365}$
ZARONIA	7.590%	20-Apr	21-Apr	21-Apr	$1/365$	$1+7.590\%\times\frac{1}{365}$
ZARONIA	7.540%	21-Apr	24-Apr	24-Apr	$3/365$	$1+7.540\%\times\frac{3}{365}$
ZARONIA	7.597%	24-Apr	25-Apr	25-Apr	$1/365$	$1+7.597\%\times\frac{1}{365}$
ZARONIA	7.591%	25-Apr	26-Apr	26-Apr	$1/365$	$1+7.591\%\times\frac{1}{365}$
ZARONIA	7.594%	26-Apr	28-Apr	28-Apr	$2/365$	$1+7.594\%\times\frac{2}{365}$
6M Cap factor (rounded to 12 decimal places)						1.035335579908
6M Cap factor (based on the implied ACFR)						$1+7.0478\%\times\frac{183}{365}$

Source for ZARONIA: SARB - ZARONIA Interest Rate Benchmark Web Page

Since there are no fixing adjustments, following the **ACFR calculation** feature, the "**6M Cap factor**" is the 6M realised capitalisation factor applicable to the **short-stub** accrual period and is calculated as follows:

$$\left(1+6.125\%\times\frac{1}{365}\right)\times\left(1+6.201\%\times\frac{3}{365}\right)\times\ldots\times\left(1+7.591\%\times\frac{1}{365}\right)\times\left(1+7.594\%\times\frac{2}{365}\right), \quad (27)$$

i.e. by compounding the series of overnight capitalisation factors. Equation (27) resolves to the more compact form:

$$1+7.0478\%\times\frac{183}{365}, \quad (28)$$

after implying the ACFR according to the **ACFR convention**, i.e. an annualised simple rate, also based on the ACT/365 Fixed day count convention and rounded to 6 decimal places (or 4 decimals in percentage format).

8.4. Net cash flow and payment lags

Since the 6M ZARONIA ACFR has now been calculated in the previous sub-section, it is now possible to compute the short-stub's **floating cash flow** as follows:

$$\text{ZAR}1 \text{ million} \times (7.0478\% + 0\%) \times \frac{183}{365}\,, \tag{29}$$

since the **fixed spread** is 0%, and the corresponding **fixed cash flow** as:

$$-\,\text{ZAR}1 \text{ million} \times 8.1234\% \times \frac{183}{365}\,, \tag{30}$$

so that the **net cash flow** of the SSMP's short-stub resolves to:

$$\begin{aligned} &\text{ZAR}1 \text{ million} \times (7.0478\% + 0\% - 8.1234\%) \times \frac{183}{365} \\ =\ &\text{ZAR}1 \text{ million} \times -1.0756\% \times \frac{183}{365} \\ =\ &-\,\text{ZAR}\,5392.73\,, \end{aligned} \tag{31}$$

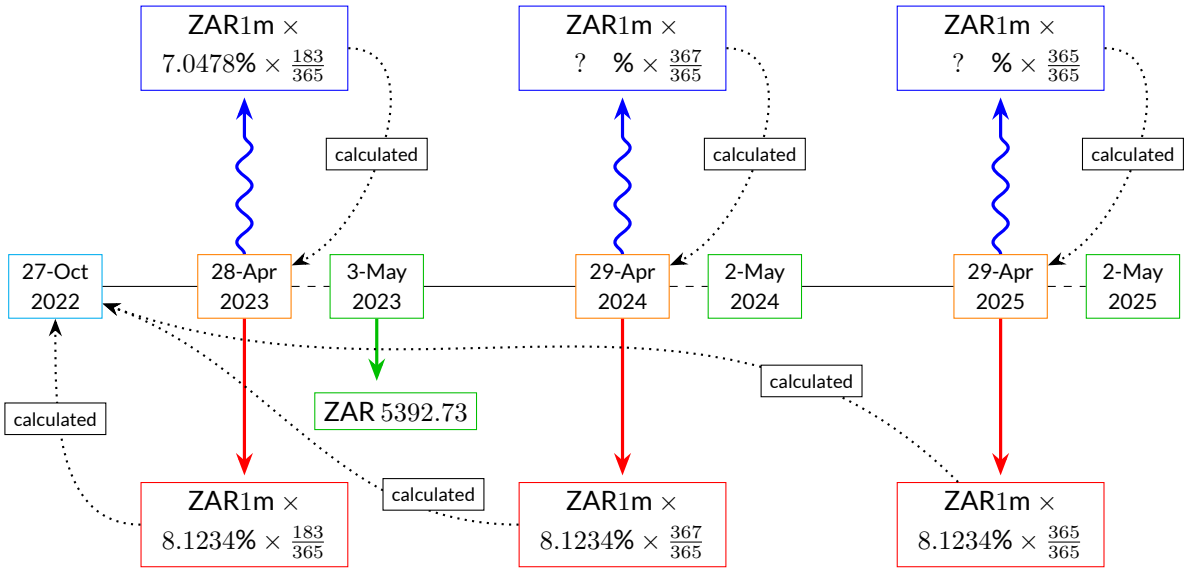
which follows by the **fixed rate quotation** and **net cash flow rounding** conventions, with the latter advocating that the net cash flow be rounded to the nearest ZAc.

The **payment lag** is the final feature which requires description, and it defines the date on which the net cash flow is settled between the relevant counterparties. Since there are no applicable fixing adjustments, the **payment lag** is the feature that has been recommended in the derivatives market to solve practical operational settlement issues. The **payment lag** is 2 bd and the **payment dates** which are equal to each accrual period's last ZARONIA publication date plus the **payment lag** are

$$\begin{aligned} &\text{28-Apr-2023} + 2\text{ bd} = \text{3-May-2023}\,, \\ &\text{29-Apr-2024} + 2\text{ bd} = \text{2-May-2024}\,, \\ &\text{29-Apr-2025} + 2\text{ bd} = \text{2-May-2025}\,. \end{aligned} \tag{32}$$

All of the key quantities that have been computed in sub-sections 8.1., 8.2., 8.3. and 8.4. are summarised diagrammatically in Figure 5 below, apart from the calculations related to the overnight sub-accrual periods.

Figure 5: A depiction of the key contractual dates and short-stub cash flows associated with the SSMP.



9. Recommended cross-currency basis swap conventions

This section presents recommendations for the key cross-currency basis swap (CCBS) within the context of South Africa and ZARONIA, which is the USDZAR CCBS.

Table 9: USDZAR Cross-currency basis swap conventions.

Feature	Recommended Convention	Reference
Swap tenor	$\geq$ 6M	10.1.
Accrual period	3M	10.1.
Business day calendars	ZAJO and USGS	10.1., 10.2.
Spot lag	2 bd	10.1.
Business day conventions	Modified Following	10.2.
Accrual period date generation	Backward (EOM)	10.2.
Non-Standard First Period	Short-Stub	10.2.
USD accrual day count convention	ACT/360	10.3.
ZAR accrual day count convention	ACT/365 Fixed	10.4.
USD & ZAR floating reference rates	SOFR & ZARONIA	10.3., 10.4.
USD publication/ calculation lag	1 bd	10.3.
ZAR publication/ calculation lag	1 bd	10.4.
ACFR calculations	Compounded, 0 bd lockout, 0 bd lookback 0 bd obs shift	10.3., 10.4.
USD ACFR conventions	Simple, 7 decimal places	10.3.
ZAR ACFR conventions	Simple, 6 decimal places	10.4.
Basis spread quotation	Simple, 6 decimal places	10.5.
Basis spread	Simple, additive post compounding	10.5.
Floating cash flow rounding	2 decimal places	10.5.
Payment lag	2 bd	10.5.

10. Example: Non-interbank USDZAR cross-currency basis swap

Example
Consider a long position in a 9M USDZAR CCBS that is traded on 29-Mar-2023, with a basis spread rate equal to 0.1234% and a nominal value of USD1 million, or ZAR18.1435 million based on the USDZAR spot exchange rate on 29-Mar-2023 which is 18.1435.

The sub-sections that follow will describe how all of the contractual specifications of the CCBS are generated, as well as demonstrate the calculation of the respective USD and ZAR floating cash flows that are required for settlement at the payment dates of the contract, all done according to the conventions proposed in Table 9.

10.1. Tenor, accrual period and effective date

Using Table 9 and the specifics of the above example, it follows that:

- the **swap tenor** is equal to 9M;
- the **accrual period** is equal to 3M; and
- the **spot lag** is 2 bd, with the **effective date** being equal to the **transaction date** plus the **spot lag** which is

$$\text{29-Mar-2023} + 2\text{ bd} = \text{31-Mar-2023}\,, \tag{33}$$

  where one must account jointly for US and ZA public holidays, using the USGS, USNY[2] and ZAJO calendars.

10.2. Accrual period date generation

Since the accrual period is 3M and the swap tenor is 9M, as described in sub-section 10.1., there will be three accrual periods without a **non-standard first period**. The **Backward (EOM)** algorithm for **accrual period date generation** then works as follows:

- **Step 1:** The unadjusted expiry date, also called the *roll-day*, is

$$\big(\text{31-Mar-2023} + 9\text{M}\big),\ \text{then adjusted by EOM} = \text{31-Dec-2023}\,, \tag{34}$$

  with the EOM rule not required, since 31-Dec-2023 is the result of the expression in the parentheses.

- **Step 2:** Generating accrual period end dates from the roll-day moving backwards, we have:

$$\begin{aligned}\big(\text{31-Dec-2023} - 3\text{M}\big),\ &\text{then adjusted by EOM} = \text{30-Sep-2023}\,,\\ \big(\text{30-Sep-2023} - 3\text{M}\big),\ &\text{then adjusted by EOM} = \text{30-Jun-2023}\,,\end{aligned} \tag{35}$$

  so that the full set of unadjusted dates is $\{\text{31-Mar-2023}, \text{30-Jun-2023}, \text{30-Sep-2023}, \text{31-Dec-2023}\}$.

- **Step 3:** Adjusting each of the dates generated in the previous steps, we have:

$$\begin{aligned}\text{30-Jun-2023},\ &\text{adjusted by Modified Following} = \text{30-Jun-2023}\,,\\ \text{30-Sep-2023},\ &\text{adjusted by Modified Following} = \text{29-Sep-2023}\,,\\ \text{31-Dec-2023},\ &\text{adjusted by Modified Following} = \text{29-Dec-2023}\,,\end{aligned} \tag{36}$$

  so that the full set of adjusted dates is $\{\text{31-Mar-2023}, \text{30-Jun-2023}, \text{29-Sep-2023}, \text{29-Dec-2023}\}$.

The full set of accrual period dates may be identified as all of the valid business days between 31-Mar-2023 and 29-Dec-2023 by jointly using the ZAJO and USGS calendars. In order to keep this example parsimonious only the first accrual period will be considered. There are 63 and 61 valid US and ZA business days in this accrual period, respectively, including the effective and accrual period end date. Some of these dates are presented in Tables 10 and 11, which appear in the sub-sections that follow in the columns titled "Start date" and "End date".

[2] The extra calendar recommendation is based on the ISDA market practice note, [ISDA, 2022].

10.3. USD annualised cumulative floating rate calculation

The table below depicts the calculation of the 3M SOFR ACFR that is associated with the first accrual period of the CCBS under consideration. The following conventions are applied in the creation of the table:

- the relevant SOFR rates are published by the Federal Reserve Bank of New York (FRBNY) and shown in the column titled "**Rate**";
- the **publication lag** for SOFR is 1 bd, which means that a SOFR rate is only published 1-business day after its accrual period start date, as shown in the column titled "**Pub date**";
- the ACT/360 rule is used as the **accrual day count convention** rule to compute all of the required year fractions, as depicted in the column titled "**Year frac**";
- the last column titled "**ON Cap factor**" shows the calculation of the required overnight capitalisation factor associated with each sub-accrual period, based on SOFR which is an annualised simple ONRR.

Table 10: Data and supporting calculations for the 3M SOFR ACFR underlying the first period of the CCBS.

Ref rate	Rate	Accrual period		Pub date	Year frac	ON Cap factor
		Start date	End date			
SOFR	4.870%	31-Mar	3-Apr	3-Apr	3/360	$1 + 4.870\% \times \frac{3}{360}$
SOFR	4.840%	3-Apr	4-Apr	4-Apr	1/360	$1 + 4.840\% \times \frac{1}{360}$
SOFR	4.830%	4-Apr	5-Apr	5-Apr	1/360	$1 + 4.830\% \times \frac{1}{360}$
SOFR	4.810%	5-Apr	6-Apr	6-Apr	1/360	$1 + 4.810\% \times \frac{1}{360}$
SOFR	4.810%	6-Apr	10-Apr	10-Apr	5/360	$1 + 4.810\% \times \frac{5}{360}$
SOFR	4.810%	10-Apr	11-Apr	11-Apr	1/360	$1 + 4.810\% \times \frac{1}{360}$
SOFR	4.800%	11-Apr	12-Apr	12-Apr	1/360	$1 + 4.800\% \times \frac{1}{360}$
⋮	⋮	⋮	⋮	⋮	⋮	⋮
SOFR	5.050%	21-Jun	22-Jun	22-Jun	1/360	$1 + 5.050\% \times \frac{1}{360}$
SOFR	5.050%	22-Jun	23-Jun	23-Jun	1/360	$1 + 5.050\% \times \frac{1}{360}$
SOFR	5.050%	23-Jun	26-Jun	26-Jun	3/360	$1 + 5.050\% \times \frac{3}{360}$
SOFR	5.050%	26-Jun	27-Jun	27-Jun	1/360	$1 + 5.050\% \times \frac{1}{360}$
SOFR	5.050%	27-Jun	28-Jun	28-Jun	1/360	$1 + 5.050\% \times \frac{1}{360}$
SOFR	5.060%	28-Jun	29-Jun	29-Jun	1/360	$1 + 5.060\% \times \frac{1}{360}$
SOFR	5.060%	29-Jun	30-Jun	30-Jun	1/360	$1 + 5.060\% \times \frac{1}{360}$
				3M Cap factor (rounded to 12 decimal places)		1.012626155092
				3M Cap factor (based on the implied ACFR)		$1 + 4.99496\% \times \frac{91}{360}$

Source for SOFR: FRBNY - Secured Overnight Financing Rate Data Web Page

Since there are no fixing adjustments, following the **ACFR calculations** feature, the "**3M Cap factor**" is the 3M realised capitalisation factor applicable to the first accrual period and is calculated as follows:

$$\left(1 + 4.870\% \times \frac{3}{360}\right) \times \left(1 + 4.840\% \times \frac{1}{360}\right) \times \ldots \times \left(1 + 5.060\% \times \frac{1}{360}\right) \times \left(1 + 5.060\% \times \frac{1}{360}\right) , \quad (37)$$

i.e. by compounding the series of overnight capitalisation factors. Equation (37) resolves to the more compact form:

$$1 + 4.99496\% \times \frac{91}{360} , \quad (38)$$

after implying the ACFR according to the **USD ACFR convention**, i.e. an annualised simple rate, also based on the ACT/360 day count convention and rounded to 7 decimal places (or 5 decimals in percentage format).

10.4. ZAR annualised cumulative floating rate calculation

The table below depicts the calculation of the 3M ZARONIA ACFR that is associated with the first accrual period of the CCBS under consideration. The following conventions are applied in the creation of the table:

- the relevant ZARONIA rates are published by the SARB and shown in the column titled "**Rate**";
- the **publication lag** for ZARONIA is 1 bd, which means that a ZARONIA rate is only published 1-business day after its accrual period start date, as shown in the column titled "**Pub date**";
- the ACT/365 Fixed rule is used as the **accrual day count convention** rule to compute all of the required year fractions, as depicted in the column titled "**Year frac**";
- the last column titled "**ON Cap factor**" shows the calculation of the required overnight capitalisation factor associated with each sub-accrual period, based on ZARONIA which is an annualised simple ONRR.

Table 11: Data and supporting calculations for the 3M ZARONIA ACFR underlying the first period of the CCBS.

Ref rate	Rate	Accrual period		Pub date	Year frac	ON Cap factor
		Start date	End date			
ZARONIA	7.569%	31-Mar	3-Apr	3-Apr	$3/365$	$1+7.569\%\times\frac{3}{365}$
ZARONIA	7.586%	3-Apr	4-Apr	4-Apr	$1/365$	$1+7.586\%\times\frac{1}{365}$
ZARONIA	7.579%	4-Apr	5-Apr	5-Apr	$1/365$	$1+7.579\%\times\frac{1}{365}$
ZARONIA	7.580%	5-Apr	6-Apr	6-Apr	$1/365$	$1+7.580\%\times\frac{1}{365}$
ZARONIA	7.578%	6-Apr	11-Apr	11-Apr	$5/365$	$1+7.578\%\times\frac{5}{365}$
ZARONIA	7.574%	11-Apr	12-Apr	12-Apr	$1/365$	$1+7.574\%\times\frac{1}{365}$
ZARONIA	7.573%	12-Apr	13-Apr	13-Apr	$1/365$	$1+7.573\%\times\frac{1}{365}$
⋮	⋮	⋮	⋮	⋮	⋮	⋮
ZARONIA	8.087%	21-Jun	22-Jun	22-Jun	$1/365$	$1+8.087\%\times\frac{1}{365}$
ZARONIA	8.078%	22-Jun	23-Jun	23-Jun	$1/365$	$1+8.078\%\times\frac{1}{365}$
ZARONIA	8.105%	23-Jun	26-Jun	26-Jun	$3/365$	$1+8.105\%\times\frac{3}{365}$
ZARONIA	8.078%	26-Jun	27-Jun	27-Jun	$1/365$	$1+8.078\%\times\frac{1}{365}$
ZARONIA	8.084%	27-Jun	28-Jun	28-Jun	$1/365$	$1+8.084\%\times\frac{1}{365}$
ZARONIA	8.088%	28-Jun	29-Jun	29-Jun	$1/365$	$1+8.088\%\times\frac{1}{365}$
ZARONIA	8.076%	29-Jun	30-Jun	30-Jun	$1/365$	$1+8.076\%\times\frac{1}{365}$
3M Cap factor (rounded to 12 decimal places)						1.019552798462
3M Cap factor (based on the implied ACFR)						$1+7.8426\%\times\frac{91}{365}$

Source for ZARONIA: SARB - ZARONIA Interest Rate Benchmark Web Page

Since there are no fixing adjustments, following the **ACFR calculations** feature, the "**3M Cap factor**" is the 3M realised capitalisation factor applicable to the first accrual period and is calculated as follows:

$$\left(1+7.569\%\times\frac{3}{365}\right)\times\left(1+7.586\%\times\frac{1}{365}\right)\times\ldots\times\left(1+8.088\%\times\frac{1}{365}\right)\times\left(1+8.076\%\times\frac{1}{365}\right), \quad (39)$$

i.e. by compounding the series of overnight capitalisation factors. Equation (39) resolves to the more compact form:

$$1+7.8426\%\times\frac{91}{365}, \quad (40)$$

after implying the ACFR according to the **ZAR ACFR convention**, i.e. an annualised simple rate, also based on the ACT/365 Fixed day count convention and rounded to 6 decimal places (or 4 decimals in percentage format).

10.5. Floating cash flows and payment lags

With the 3M SOFR and ZARONIA ACFRs having been calculated in the preceding sub-sections, it is now possible to compute the first accrual period's **USD floating cash flow** as follows:

$$\begin{aligned} &\text{USD}\,1\,\text{million} \times 4.99496\% \times \frac{91}{360} \\ &= \text{USD}\,12626.15\,, \end{aligned} \tag{41}$$

and the corresponding **ZAR floating cash flow** as:

$$\begin{aligned} &-\text{ZAR}\,18.1435\,\text{million} \times (7.8426\% + 0.1234\%) \times \frac{91}{365} \\ =\ &-\text{ZAR}\,18.1435\,\text{million} \times 7.9660\% \times \frac{91}{365} \\ =\ &-\text{ZAR}\,360337.86\,, \end{aligned} \tag{42}$$

which follows by the **basis spread**, **quotation** and **floating cash flow rounding** conventions, with the latter advocating that each floating cash flow be rounded to the nearest cent in the respective currency.

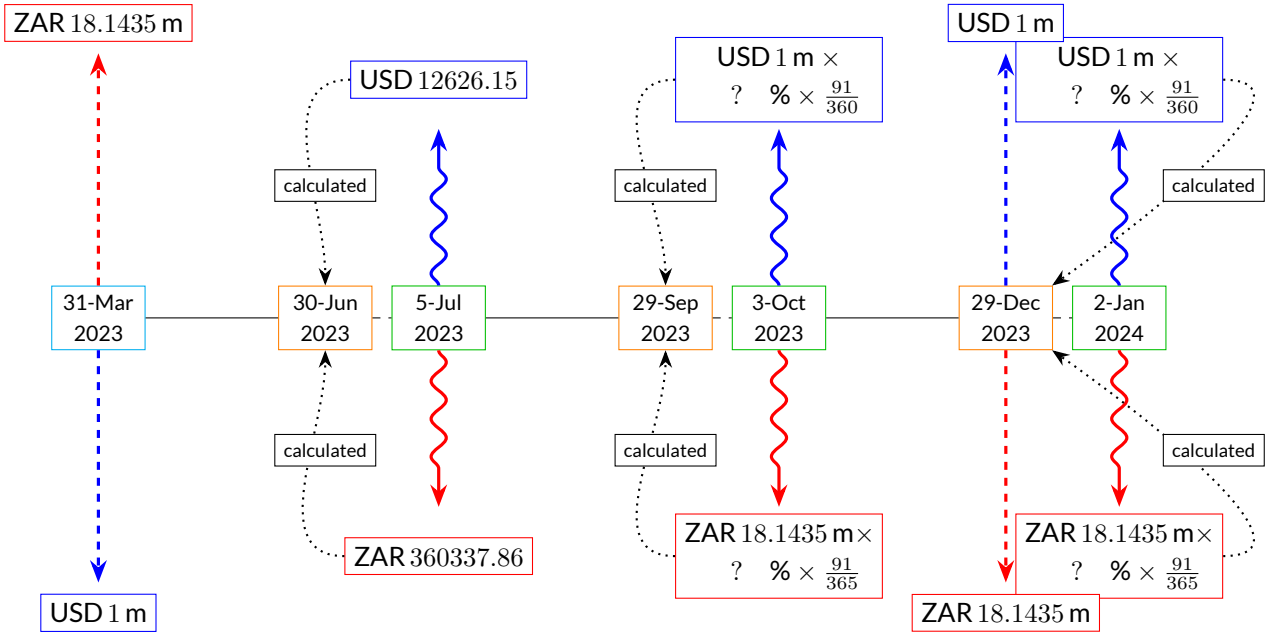
The **payment lag** is the final feature which requires description, and it defines the date on which the floating cash flows are actually settled. Being consistent with the OIS markets, this feature has been recommended to solve practical operational settlement issues. The **payment lag** is 2 bd and the **payment dates** which are equal to each accrual period's last SOFR and ZARONIA publication date plus the **payment lag** are

$$\begin{aligned} &\text{30-Jun-2023} + 2\,\text{bd} = \text{5-Jul-2023}\,, \\ &\text{29-Sep-2023} + 2\,\text{bd} = \text{3-Oct-2023}\,, \\ &\text{29-Dec-2023} + 2\,\text{bd} = \text{2-Jan-2024}\,, \end{aligned} \tag{43}$$

where one must again be cognisant of joint US and ZA valid business days.

All of the key quantities that have been computed in sub-sections 10.1., 10.2., 10.3., 10.4. and 10.5. are summarised in Figure 6 below, apart from the calculations related to the overnight sub-accrual periods.

Figure 6: A depiction of the key contractual dates and cash flows associated with the CCBS.



Glossary

List of acronyms

ACFR annualised cumulative floating rate. 3, 5, 6, 7, 8, 9, 11, 12, 14, 15, 17, 18, 19, 21, 22, 23

ARR alternative reference rate. 4

bd business day(s). 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23

CCBS cross-currency basis swap. 3, 4, 19, 20, 21, 22, 23

DWS Derivatives Workstream. 4, 7

EOM End-of-Month (business day convention). 9, 10, 13, 16, 19, 20

FSCA Financial Sector Conduct Authority. 4

FSSP forward-starting single-period overnight indexed swap. 3, 9, 13, 14, 15

FRA forward rate agreement. 7, 15

FRBNY Federal Reserve Bank of New York. 21

IBOR interbank offered rates. 4

IRS interest rate swap. 7

ISDA International Swaps and Derivatives Association. 20

Jibar Johannesburg Interbank Average Rate. 3, 4, 5, 7, 8, 15

MPG Market Practitioners Group. 4

ONRR overnight reference rate. 4, 5, 7, 11, 14, 17, 21, 22

OIS overnight indexed swap. 4, 7, 8, 9, 10, 13, 16, 23

RFRWS Risk-Free Reference Rate Workstream. 4

SAFEX ON SAFEX Overnight Rate. 4

SARB South African Reserve Bank. 4, 7, 11, 14, 17, 22

SOFR secured overnight financing rate. 3, 19, 21, 23

SSSP spot-starting single-period overnight indexed swap. 3, 9, 10, 11, 12, 15

SSMP spot-starting multi-period overnight indexed swap. 3, 9, 16, 17, 18

TBRR term-based reference rate. 5, 7

US United States of America. 20, 23

USD United States dollar. 2, 3, 4, 19, 20, 21, 23

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