

## ***Balanço*: The Contour of Relative Offbeatness**

Mehmet Vurkaç  
Oregon Institute of Technology  
3201 Campus Dr  
Klamath Falls, OR, 97601, USA  
E-mail: mehmet.vurkac@oit.edu

### **Abstract**

A simple framework is presented in which the clave direction of samba can be discerned by relating the **contour of relative-offbeatness values** to the trajectory of a swing (*balanço*) or pendulum. This can be learned by musicians and listeners, and implemented in intelligent automated music tutors, accompanists and in music-database searches.

### **1. Introduction**

In composing a piece of music, one may start out by specifying a key, a tempo and a time signature. Similarly, in listening to a piece of music, a listener may intellectually or emotionally note these same attributes of key, tempo and meter. This is the case for much of the music around the world, not just European or North American music, but certain other traditions have other central attributes that music-makers and listeners follow. *Usul* and *makam* in Turkish music, and *taal* and *raag* in India govern the temporal and melodic organization of music-making and music-perceiving. Likewise, but in a different manner, **clave** is the temporal organizing principle of many types of Latin American music. Like all complex cultural constructs, clave plays many other roles as well, such as time-keeping and phrasing. This paper addresses the rhythmic-organization aspect of clave, called clave direction, as manifested in a genre that has not typically been associated with the term.

Past work has laid out the argument for why clave, a Spanish-language term from Cuba for an African musical concept, can be relevant to discussion of the rhythmic organization of Brazilian music [1, 2]. The overall recognition of clave direction is a challenging task for listeners, and sometimes even for trained musicians. (Hence, it is also a challenging aspect of machine listening.) However, if musical examples are somehow discerned to be of a mainstream Afro-Brazilian nature (as commonly heard in *batucada*, *pagode*, or *samba de roda*), the framework presented here greatly simplifies the identification of clave direction, or to be culturally sensitive, *partido-alto* direction, for interested listeners, musicians, music librarians, and intelligent music devices. The framework elaborated here is intended to help with such tasks as aiding aspiring non-native musicians and listeners in understanding the inner workings of Rio-style traditional Brazilian music (*samba carioca*), creating new patterns in the idiom (whether through algorithmic composition or through the informed creative process of an artist), and enabling music teachers, automated music tutors or search engines to recognize when patterns under inquiry (such as outtakes from a student performance or the results of a search query) match a stated clave direction.

The overall approach behind the present paper is the result of a combination of the scientific method and a fortuitous linguistic/cultural observation. The latter relates to the Portuguese-language word *balanço* as used in samba-music praxis. As explained below, *balanço* turns out to provide an excellent visual aid for the operation of clave direction. As for the scientific approach to the problem, it followed a series of musical observations. The first observation was that a cultural construct called clave is said to exist in Cuban, Brazilian, Haitian, Ghanaian, and other musics that are related through the transatlantic slave trade [3]. This construct is said to equip rhythms (the temporal organization of sounds) with a

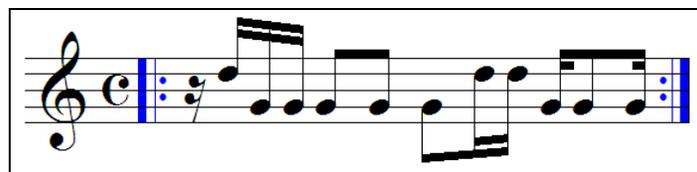
property that some couplings of patterns are considered rhythmically harmonious while other combinations are not. The next observation was that certain fundamental patterns (the *son*, *rumba*, and *bossa* claves) have numerical characteristics which suggest that simple onset counts can help decode this system of rhythmic harmony. However, it is also understood that **all** rhythms in Afro-Latin music follow this concept of clave direction, and not all rhythms can have only five notes. Indeed, counting onsets in many of those other traditional rhythms contradicts the results of the onset counts of the three claves.

The research question that arose from these observations was whether clave can be explained in a parsimonious manner, without exceptions, and in a way that is consistent with traditional praxis.

In the musical scholarly literature, Novotney [4], Lehmann [5], Toussaint [3, 6], Mauleón-Santana [7], and Galinsky [8] have put forth valuable explanations aimed at clarifying how this construct operates. Novotney has taken a broad approach to analyzing the numerical relationships in African and Latin musics, including the role of the 3:2 ratio in hemiolas and polyrhythms [4]. His work explores the ubiquity and connectedness of these relationships, but does not delve into the details of the second observation above. Lehmann [5] addresses this problem with a case-study approach and a somewhat less parsimonious explanation than offered in [1, 2]. Mauleón-Santana provides important pieces of the puzzle [7]. Galinsky takes a pragmatic approach based on template comparisons [8]. Toussaint [3, 6] and Wright et al. [9] have characterized the rotational properties and rotation-aware recognition of clave patterns. Their focus is to recognize **a given pattern** under various time shifts and tempi. Our purpose here, on the other hand, is to note the musical function of **a given pattern**, and be able to recognize a variety of other patterns as having the same function. These research directions are complementary, but distinct.

We have gathered rhythm data (along with their cultural interpretation) primarily from Rio-style Brazilian music, with methods including double-blind listening experiments with expert and mid-level drummers, training by Brazilian masters, bootstrap neural-network techniques, literature search, and performance in the idiom. The result is a simple and consistent explanation of *partido-alto* direction. The full set of details is to be published fall 2012 [1]. The present explanation presents a smaller, more typical set of musical possibilities in which clave direction is easier to discern.

**The Clave-Direction Framework for *Partido-Alto*.** Offbeat accents are used in many traditions to make music rhythmically exciting. There are different levels of emphasis placed on such use of offbeats in different cultures, with greater emphasis found in parts of West Africa, Latin America and the Middle East. However, offbeats without returning to a previously established downbeat (pulse) soon lose their novelty, and become perceived as the new pulse. The notion of clave direction is an aesthetically pleasing and mathematically efficient way to keep offbeats exciting without losing the primary pulse. An example is the standard samba pattern on the friction drum *cuíca* (Fig. 1)



**Figure 1:** A *cuíca* pattern that displays many offbeats without loss of the underlying pulse.

Clave direction, then, is the relative preference for offbeats to dominate in certain parts of a musical phrase while letting the remaining parts of the phrase re-establish the underlying pulse. The so-called 3-2 direction, which we will call “outside,” encodes a preference for more offbeats on the outer parts of each phrase (the beginning and the end), with the middle portion of the phrase reserved for grounding the rhythm back to the pulse. Using the naming scheme in Fig. 2, the outside clave direction means preferring more offbeats in the outer parts of the phrase and more onbeats in the inner part of the phrase. This simple explanation is highly consistent with traditional praxis. The use of the term “relative” (more here, less

there, as opposed to prescribed amounts) keeps clave from stifling creativity. In fact, when executed and resolved skillfully, going against clave is an acceptable way to build tension and “add spice” to the music.

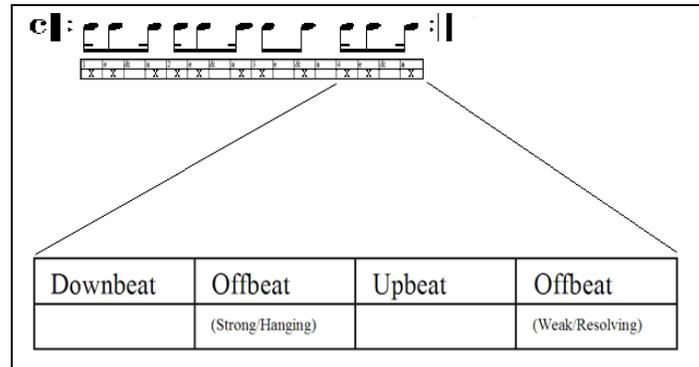


Figure 2: A naming scheme for the four 16<sup>th</sup>-note subdivisions of a quarter-note duration.

Here, we apply this framework to a set of traditional Brazilian patterns, and we demonstrate that clave direction for such patterns can be inferred accurately with a very simple technique, which is trivial to learn, and to implement in intelligent automated music tutors, accompanists, or querying tools.

Some caveats are in order. The use of the Cuban term “clave” for Brazilian music is offensive to some Brazilians, but what is meant here is not the presence (or cultural significance) of any **particular** pattern (such as the Afro-Cuban *son clave*) but a rhythmic organizing principle known by many different names. There are several other generalizations employed in the present analysis that may be off-putting to musicians and scholars. The goal is not to downplay the complexities of clave (cf. [10]), or of music in general, but to show that for a certain subset of rhythm patterns, these simplifications lead to a simple and accurate classification in terms of clave direction.

## 2. Definitions

In order to establish a common vocabulary, we define the following terms: attack-point rhythm, schema, clave direction, *partido-alto*, *balanço*, quantization, and offbeatness.

The notion of offbeatness is adopted from Toussaint, but used differently from his “number of off-beat onsets” [6]. Instead of a pure count, the present interpretation—called **partido-alto offbeatness** (PAO)—is weighted by position. Furthermore, the PAO of a schema is only meaningful relative to that of another schema in the same pattern. In other words, it is imperative to consider the complete pattern to determine clave direction.

Attack-point rhythm is a psychological abstraction of the time aspect of music, as conceptualized by persons accustomed to visual representations (music notation). In this abstraction, note events are represented by their start times—pitch, timbre, and texture are not considered, so attack-point rhythm does not have the vertical aspect of pitch or the complexities of harmonic content. It only represents whether any note events occur at a point in time. For instance, two lines from the chorus of The Beatles’ *I Want To Hold Your Hand* may be expressed in attack-point notation—for a reasonable choice of subdivisions—as 0111|1011|0000|0000|0111|1010|1001|1001|1001|1000. An expression like this may be called a rhythm vector, which stands for any possible musical execution of that rhythm, regardless of tempo, tuning, melody, instrumentation, or even cultural origin. We can, then, choose the context of interest (in this case, *samba carioca*).

Because both durations and pitch are removed from consideration, attack-point vectors are rather abstract. They provide a convenient starting point for investigating the clave aspect of unambiguous traditional patterns, not an end in themselves.

A schema is a pattern of fixed length. For our analysis, it helps to divide a rhythmic cycle into four quarter-note durations. To avoid saying “quarter-note duration,” we prefer the term schema.

Research leading to this work has resulted in the identification of four clave-direction categories: **outside**, **inside**, **neutral** and **incoherent**. The first two are the clave directions commonly called 3-2 and 2-3, respectively. The pitfalls associated with the labels of 3-2 and 2-3 include disagreement among leading drummers as to how to divide the phrase, and the problem that simply counting notes does not provide useful information for any except the three famous clave patterns. Hence, our preference is to replace 3-2 and 2-3 with the more descriptive terms “outside” and “inside.”

Less commonly discussed in the literature are the categories neutral and incoherent. Cruz touches on the neutral category [10], which refers to patterns that do not detract from clave, but do not establish or support any clave direction either. This is also implied in Mauleón-Santana’s discussion in [7]. Such patterns are indeed essential in almost any music, as they maintain the rhythmic reference, or pulse.

The incoherent category refers to patterns that, in addition to **not being in either clave direction**, actively oppose the establishment of such. Some examples are 1110|0101|1010|1111 and 1010|0001|0010|0101. The constant switching from onbeat to offbeat sections places these patterns outside the clave tradition.

The Portuguese-language term *partido-alto* has multiple meanings. The literal meaning and the genre of music are not relevant here. In the third sense, *partido-alto* is a rhythmic framework reflected in the *pandeiro* pattern of *pagode*, the “third *surdo*” and *caixa* (snare) patterns of *batucada*, the *cavaquinho* (mini-guitar) of Brazil’s *carneval* parades, the nylon-string guitar (*violão*) in bossa nova, instrumental accents in *axé* music, and most vocal lines in all forms of samba song. The skeletal form of the *partido-alto* pattern is given in Figure 3.

1	e	&	a	2	e	&	a	3	e	&	a	4	e	&	a
	H			L	L	L	H			L	L				

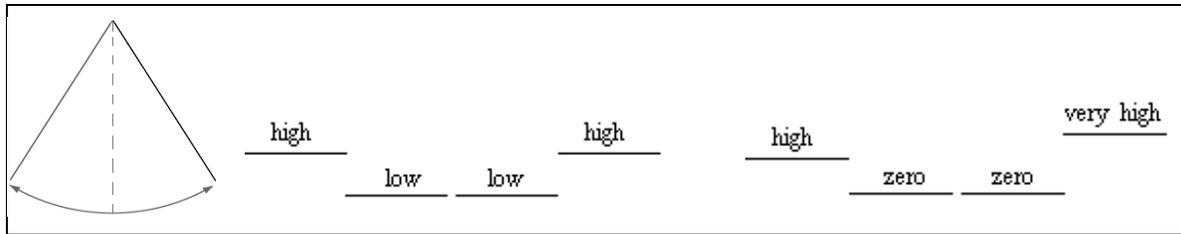
**Figure 3:** The outside (3-2) partido-alto, as may be performed on a repique de mão, pandeiro or agogô.

This pattern guides almost all instruments in samba, from the vocals to the entire thundering 300-piece *bateria*. It embodies the rhythmic notion of the “outside” clave direction, which is that the first and fourth schemas (the “outside” of the pattern) display a preference for offbeats, and that the second and third schemas (the “inside”) display a preference for onbeats. This is only a preference because placing a more rigid requirement on musical practice would have stifled creativity, and would not have survived. The interplay of following and breaking music-theoretic rules is a key aspect of all music. So is the case in samba where a *third surdo* or a *rebolo* player may break out of the prescribed contour by playing “licks” that break the *partido-alto* flow, creating tension and release through idiomatic phrasing.

One of several aspects (along with *ginga*, *cadência*, *malemolência*, and *suíngue*) that mark the difference between authentic samba and a weak imitation is *balanço*. This Portuguese term has multiple meanings. It is sometimes mistaken for “volume balance” and for “swing” (in the jazz-like sense of microtiming) by those who know the dictionary translation. However, in samba, the term stands for a **visual** analog of the rhythmic motion of the music, specifically with respect to the phrase-level contour of offbeatness.

The literal meaning is that of a swing (as in a playground). Note that the typical trajectory of the seat of a swing is also that of a pendulum (Figure 4, left). Offbeatness preference in *partido-alto* is reminiscent of this visual image, and the idea is used below to determine the clave direction of rhythm patterns.

If we now focus on the trajectory drawn by the playground swing (the arc in Figure 4, left), and replace it with a grossly quantized version (Figure 4, center), we find some similarity between this figure and the degrees of offbeatness in each schema of the *partido-alto* pattern (Figure 4, right). Finding clave direction, especially in traditional rhythms, can be as simple as recognizing this similarity.



**Figure 4:** The trajectory of a swing (left), highly quantized (“pixelated”) version of the trajectory (center), and the degrees of offbeatness of the four schemas that make up partido-alto (right).

### 3. The Calculation of Offbeatness

The degrees of *partido-alto* offbeatness (PAO) in Table 1 are based on extensive musical observation and the aforementioned research.

We start with a first-order approximation where each schema is considered by itself. This results in the values of the first two columns of Table 1. Although a reasonable starting point, this is inadequate for elucidating the entire clave concept.

The next step takes into account certain interactions between neighboring schemas (Table 1, last two columns). Further interaction effects go beyond the necessary degree of detail, and are not considered. Some observations about the adjusted analysis follow Table 1.

Table 1

Schema (Rhythmic Cell)	Initial PAO Value	Adjustment due to IMD*	Adjusted PAO Value with IMD Factor
0101	+7	+ 2	+9
0100	+5	+ 2	+7
1101	+6	(none)	+6
0111	+4	+ 2	+6
1100	+4	(none)	+4
0001	+2	+ 1	+3
1111	+3	(none)	+3
1001	+1	(none)	+1
0110	+2	+ 2	+4
0000	0	(none)	0
0011	-1	+ 1	+1
1011	-2	(none)	-2
1110	+1	(none)	+1
1000	-1	(none)	-1
0010	-3	(none)	-3
1010	-4	(none)	-4

\* The notion of IMD, or **isolated missing downbeat** (labeled thus by the present author), is due to author and musician M. Spiro, private communication, California Brazil Camp 2005.

In Table 1, 0000 is the schema that contributes no information to clave directionality in the first-order analysis, but can interact with an  $xxx1$  schema preceding it in the cycle:  $0000|xxx|x|xxx|x|xxx1$  (where  $x$  indicates it does not matter whether there is a note or not). This is one case of the “missing downbeat.”

1111 is one of the schemas that can contribute to either clave direction, but is traditionally more likely to be an offbeatness indicator. This is due to the possibility of leading to a hanging weak offbeat (cf. Figure 2), an example for which is  $1010|1111|0100|1011$ , featuring a hanging weak offbeat before the 3—no downbeat of 3 follows it when the pattern repeats. This pattern is in the “inside” direction.

1010 is the ultimate indicator of the lack of offbeatness, with the most negative offbeatness value. 0101 is the ultimate indicator of offbeatness, with the highest offbeatness value.

Using the naming scheme for 16<sup>th</sup>-note subdivisions of any schema given in Figure 2, we weight the downbeat by a factor of  $-1$ , the strong offbeat by 5, the upbeat by  $-3$ , and the weak offbeat by 2. By this heuristic, the most offbeat rhythmic cell possible (0101) gets a PAO value of 7. The ubiquitous 1001 gets a value of 1. The weakly offbeat 0110 gets 2. The most onbeat schema possible, 1010, gets  $-4$ . The remaining schemas are distributed in a way that follows musical praxis, with the exception of 1110 and 1101, whose PAOs come out higher than traditional practice suggests.

In the research leading to this work, the author has identified nine criteria for determining clave direction. The first approximation was based on the criterion of highest priority: the *partido-alto* form. The following analysis incorporated a second criterion: isolated missing downbeat (IMD); see Figure 5. Further criteria get us closer to traditional practice, but are not included in the interest of brevity.

The figure contains two musical staves, each with a rhythmic notation and a corresponding 16-note subdivision grid below it.

**Top Staff (IMD around the 1):**

1	e	&	a	2	e	&	a	3	e	&	a	4	e	&	a
H			L	L	L			H		H		L		H	H

**Bottom Staff (IMD around the 3):**

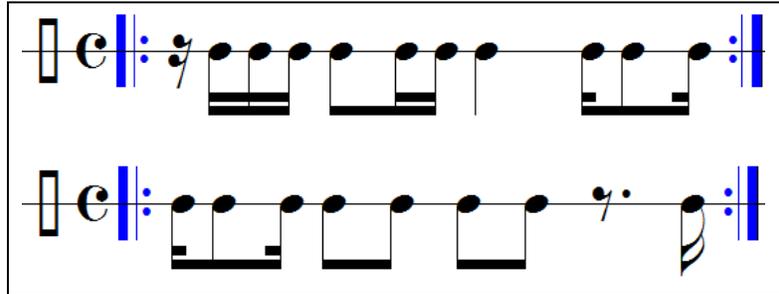
1	e	&	a	2	e	&	a	3	e	&	a	4	e	&	a
H			L	L	L			H		H		L		H	H

**Figure 5:** Another samba ostinato in the outside direction (3-2) that exhibits “isolated missing downbeat” (IMD) around the 1 (top), and a bell pattern in the inside direction (2-3) with the IMD around the 3 (bottom).

The IMD applies to the downbeats of 1 and 3. In other words, if a schema ending in a 1 (0001, 0011, 1001, 1111, etc.) is in position two (the second schema of the cycle) or position four (the last schema of the cycle), it has a greater chance to contribute to offbeatness than if it appears elsewhere. Likewise, if patterns lacking a downbeat but containing the next onset (0100, 0101, 0110, 0111) appear at position one or three, they contribute more significantly to offbeatness than if they were to appear elsewhere. These contributions give rise to the adjusted analysis (Table 1, last two columns).

The question may arise as to why some schemas gained one point and others two. The IMD concept consists of two parts: the lack of onset on the downbeat, and its local isolation. If the missing downbeat is preceded by an onset on the last 16<sup>th</sup> note (“a”), and followed by an onset on the second 16<sup>th</sup> note (“e”), then it is fully isolated in the following fashion:  $\dots x101x\dots$  (0 being the unsounded downbeat). The absence of either surrounding onset (such as  $\dots x100x\dots$ ) diminish the effect.

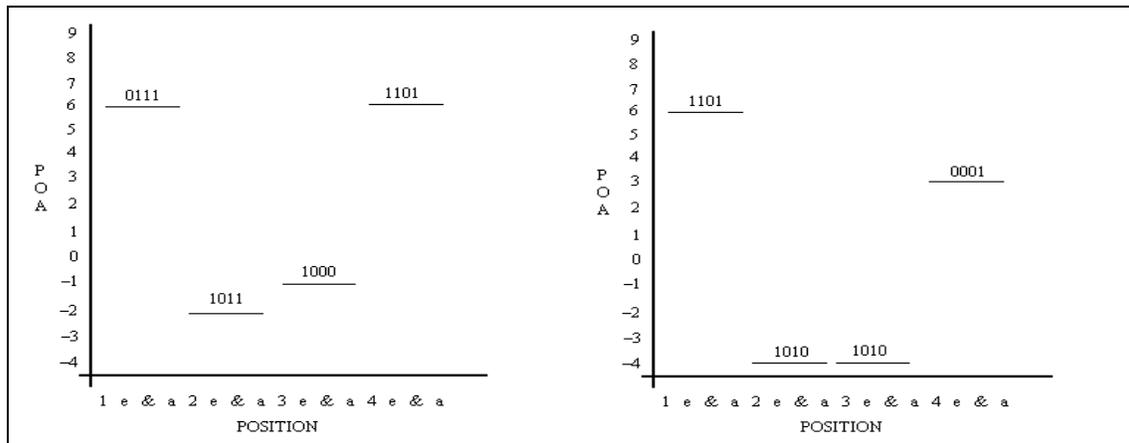
Note that it is not possible for this setup to agree **completely** with praxis because music-in-culture is context-dependent. Complications are to be expected when tempo, pitch, timbre, and duration are taken into account. Nonetheless, the success of this approach is evident when stringing some of the above schemas into rhythm patterns by choosing two positively PAO-valued schemas to bookend two negatively PAO-valued schemas. These strings of binary bits constitute a passable approximation of traditional *samba carioca*, for example as may be played on the *tamborins* (deceptively small yet loud frame drums): 0111|1011|1000|1101 (Figure 6, top), 1101|1010|1010|0001 (Figure 6, bottom)



**Figure 6:** Constructing new samba patterns by selecting schemas with PAO values that follow balanço.

Taking the PAO values of each of four schemas that constitute a pattern and plotting offbeatness versus time gives the diagrams of Figure 7: offbeatness values as contour.

Although they are more severe than in Figure 4, these diagrams show the same overall contour. Note that both examples are in the outside direction, and that an inside example would give contours more like the Gateway Arch than a swing. Nonetheless, keeping in mind that these rhythm patterns are used cyclically, a series of arches is the same as a series of pendulum contours, but at a 180° shift (for our approximate purposes here).



**Figure 7:** Contour diagrams for the examples of Figure 6.

#### 4. A Threshold for Determining the *Balanço* Curve

Setting a threshold value at PAO = 0 results in a simple sequence of four values, each one either above (↑) or below (↓) the threshold. All outside examples fall into one of the following sequence types, where the first of these is the strongest example of *partido-alto*, and the others are relatively compliant.

↑ ↓ ↓ ↑, for example 1101|0010|1011|0001  
 ↑ ↓ ↓ ↓, for example 1101|0010|1011|1011  
 ↓ ↓ ↓ ↑, for example 0010|0010|1011|0001  
 ↑ ↑ ↓ ↑, for example 1101|0110|1011|0001  
 ↑ ↓ ↑ ↑, for example 1101|0010|0001|0001

Similarly, all inside sequences fall into one of the following contours.

↓ ↑ ↑ ↓, for example 1010|1001|0101|0010  
 ↓ ↑ ↑ ↑, for example 1010|1001|0101|0110  
 ↑ ↑ ↑ ↓, for example 1001|1001|0101|0010  
 ↓ ↓ ↑ ↓, for example 1010|1011|0101|0010  
 ↓ ↑ ↓ ↓, for example 1010|1001|1010|1010

## 5. Conclusion

In general, clave does not lend itself to simple arithmetic approaches, but when the context is reduced to a well-understood subset of patterns that are typical of traditional (or derivative) performance, it does reduce to a simple case of comparing the prominence of certain offbeats or onbeats in certain parts of the phrase. Specifically, the relative prominence of offbeats at the beginning and end (outside) of each phrase, with a preference for onbeats in the middle indicates the clave direction typically called 3-2, and referred to here as “outside.” The 2-3, or “inside” patterns have the reverse offbeatness characteristic.

We have presented an introduction to recognizing clave-direction in Rio-style Brazilian music for musicians and machines alike. This approach doubles as a way to generate culturally acceptable rhythm patterns, and can be implemented in electronic music tutors, accompanists and music databases.

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