

(a) Algorithm Description

- ❶ It extracts the SET command from the XDP payload.
- ❷ SET command founded, try to figure the index of the Memcached key in payload.
- ❸ If the key is found, process the key with hash function.
- ❹ If the hash matches the calculated hash, the corresponding cache entry in the map should be invalidated

- In the original implementation, BMC must write awkward code to bypass the verifier. Specifically, dedicated check conditions for BMC_MAX_PACKET_LENGTH (L2) are aiming to minimize the number of jump instructions due to verifier's specific
- restrictions regarding these instructions. However, in the Rex, such checks have become redundant because the inherent feature of slice could help confine data_end (L4). Consequently, the four levels of nesting (L4,20,25,26) is reduced by converting a for-loop (L2) with intricate conditions (L4) into a clean chain of higher-order functions with closures (L1, L9).

(b) REX Implementation

```
1 let set_iter = payload
2 .windows(4) // 4 chars as a slice
3 .enumerate()
4 .filter_map(|(i, v)|
5     if v == b"set " { Some(i) } else { None }
6 ); // found the SET command
7 for index in set_iter {
8     ... // set payload index via SET command
9     payload
10    .iter()
11    .take_while(|&&c| c != b' ')
12    .for_each(|&c| {
13        ... // process the key with hash func
14    });
15    ... // invalidate Memcached cache entry
16}    // if the hash matches
```

(c) Original BMC Implementation

```
1 #pragma clang loop unroll(disable)
2 for (unsigned int off = 0; off < BMC_MAX_PACKET_LENGTH &&
3     payload + off + 1 <= data_end; off++) {
4     if (set_found == 0 && payload[off] == 's' &&
5         payload + off + 3 <= data_end &&
6         payload[off + 1] == 'e' && payload[off + 2] == 't') {
7         ... // move offset after the SET command
8         set_found = 1;
9     } else if (key_found == 0 && set_found == 1 &&
10                && payload[off] != ' ') {
11         if (payload[off] == '\r') {
12             set_found = 0; key_found = 0;
13         } else {
14             ... // found the start of the key
15             key_found = 1;
16         }
17     } else if (key_found == 1) {
18         if (payload[off] == ' ') {
19             ... // found the end of the key
20             set_found = 0; key_found = 0;
21         } else {
22             if (...) {...} // process the key with hash func
23         }
24         // invalidate Memcached cache entry
25     }
26 }
27 // if the hash matches
28 }
29 }
```