Appendix Data-driven Mutation Testing:

# GomSpace

LibParam Fault Model

# Target function

The probes will be inserted in the function *gs\_rparam\_process\_packet*, which is contained in the file *libparam/src/csp\_service\_handler.c*

This function take care of encapsulating the libParam data and provide it to libCSP.

It is mainly composed of a switch statement that handles the different kinds of action requested within each packet and the different kinds of payload that go along with them.

An example of probe insertion for LibParam is presented below.

1. **switch**(request->action) {
2. e RPARAM\_GET: {
4. //start of the  mutation probe
5. unsigned **long** **long** **int** v\_GET[8];
7. v\_GET[0] = (unsigned **long** **long** **int**) request->action;
8. v\_GET[1] = (unsigned **long** **long** **int**) request->table\_id;
9. v\_GET[2] = (unsigned **long** **long** **int**) request->length;
10. v\_GET[3] = (unsigned **long** **long** **int**) request->checksum;
11. v\_GET[4] = (unsigned **long** **long** **int**) request->seq;
12. v\_GET[5] = (unsigned **long** **long** **int**) request->total;
13. v\_GET[6] = (unsigned **long** **long** **int**)request->payload.addr[0];
14. v\_GET[7] = 0;
16. mutate\_FM\_GET(v\_GET);
18. request->action = (uint8\_t) v\_GET[0];
19. request->table\_id = (uint8\_t) v\_GET[1];
20. request->length = (uint16\_t) v\_GET[2];
21. request->checksum = (uint16\_t) v\_GET[3];
22. request->seq = (uint16\_t) v\_GET[4];
23. request->total = (uint16\_t) v\_GET[5];
24. request->payload.addr[0]=(uint16\_t)v\_GET[6];
26. //end of the mutation probe

# Target data structure:

In the following, we describe in tabular form the data structure that will be the target of the data-mutation probes.

## gs\_rparam\_query\_t

|  |  |
| --- | --- |
| **Member** | **Type** |
| Action | uint8\_t |
| Table\_id | uint8\_t |
| Length | uint16\_t |
| Checksum | uint16\_t |
| Seq | uint16\_t |
| Total | uint16\_t |
| Payload | gs\_rparam\_query\_payload\_t (union) |
|  |  |

The possible *Action* values are shown in the following table.

|  |  |  |
| --- | --- | --- |
| **Action** | **ID** | **Description** |
| RPARAM\_GET | 0x00 | Get one or more parameters. |
| RPARAM\_REPLY | 0x55 | Reply to a request. |
| RPARAM\_SET | 0xFF | Set one or more parameters. |
| RPARAM\_TABLE | 0x44 | Download table specification. |
| RPARAM\_COPY | 0x77 | Copy memory slot to memory slot. |
| RPARAM\_LOAD | 0x88 | Load from file (slot) to memory (slot). |
| RPARAM\_LOAD\_FROM\_STORE | 0x89 | Load from file (slot) to memory (slot). |
| RPARAM\_SAVE | 0x99 | Save from memory (slot) to file (slot). |
| RPARAM\_SAVE\_TO\_STORE | 0x9a | Save from memory (slot) to file (slot). |

## gs\_rparam\_query\_payload\_t

The payload is structured as a union to be able to contain different kinds of data, depending on the value of *Action.*

|  |  |
| --- | --- |
| **Member** | **Type** |
| Addr | uint16\_t |
| Packed | uint8\_t |
| Copy | struct |
| uint8\_t from |
| uint8\_t to |

## gs\_rparam\_query\_payload\_store\_t

This data structure is used for the *RPARAM\_LOAD\_FROM\_STORE* and *RPARAM\_SAVE\_TO\_STORE* in place of the previously described *gs\_rparam\_query\_payload\_t*.

|  |  |
| --- | --- |
| **Member** | **Type** |
| table | Vector of 26 char elements |
| store | Vector of 26 char elements |
| slot | Vector of 26 char elements |

# General Fault Model

The first probe will be inserted before the switch statement, so the payload will not be considered but we will be able to target the Table ID field, which is only called upon in initial checks.

|  |  |  |
| --- | --- | --- |
| **Member** | **Type** | **Fault Classes** |
| Action | uint8\_t | IV(value=0x55)  IV(value=0xFF)  IV(value=0x44)  IV(value=0x77)  IV(value=0x88)  IV(value=0x89)  IV(value=0x99)  IV(value=0x9a) IV(value=0x00) |
| Table\_id | uint8\_t | VAT(Threshold=20, Delta=1)  SS(Delta=1), SS(Delta=-1),  HV(Value=10) |
| Length | uint16\_t | SS(Delta=1), SS(Delta=-1),  IV(V=0), VAT(Threshold=180, Delta=1) |
| Checksum | uint16\_t | None |
| Seq | uint16\_t | SS(Delta=1) SS(Delta=-1) |
| Total | uint16\_t | SS(Delta=1) SS(Delta=-1) |
| Payload | gs\_rparam\_query\_payload\_t (union) |  |

# Action Specific Fault Models

Then, a different mutation probe, with a corresponding fault model, will be inserted for every case of the switch statement, allowing us to target the different kinds of payload with specific operators.

## RPARAM\_GET Request Fault Model

### gs\_rparam\_query\_t

|  |  |  |
| --- | --- | --- |
| **Member** | **Type** | **Fault Classes** |
| Action | uint8\_t |  |
| Table\_id | uint8\_t |  |
| Length | uint16\_t | SS(Delta=1), SS(Delta=-1),  IV(V=0), VAT(T= 180 D=1) |
| Checksum | uint16\_t | None |
| Seq | uint16\_t |  |
| Total | uint16\_t |  |
| Payload | gs\_rparam\_query\_payload\_t (union) |  |

### gs\_rparam\_query\_payload\_t

|  |  |  |
| --- | --- | --- |
| **Member** | **Type** | **Fault Classes** |
| Addr | uint16\_t | SS(Delta=1), SS(Delta=-1), |

## RPARAM\_REPLY Fault Model

### gs\_rparam\_query\_t

|  |  |  |
| --- | --- | --- |
| **Member** | **Type** | **Fault Classes** |
| Action | uint8\_t |  |
| Table\_id | uint8\_t |  |
| Length | uint16\_t | SS(Delta=1), SS(Delta=-1),  IV(V=0), VAT(T= 180 D=1) |
| Checksum | uint16\_t | None |
| Seq | uint16\_t | SS(Delta=1) SS(Delta=-1) |
| Total | uint16\_t | SS(Delta=1) SS(Delta=-1) |
| Payload | gs\_rparam\_query\_payload\_t (union) |  |

### gs\_rparam\_query\_payload\_t

|  |  |  |
| --- | --- | --- |
| **Member** | **Type** | **Fault Classes** |
| Packed | Uint8\_t | (BF(min=0, max=7, state=-1, value =1)) |

## RPARAM\_SET Request Fault Model

### rparam\_query\_t

|  |  |  |
| --- | --- | --- |
| **Member** | **Type** | **Fault Classes** |
| Action | uint8\_t |  |
| Table\_id | uint8\_t |  |
| Length | uint16\_t | SS(Delta=1), SS(Delta=-1),  IV(V=0), VAT(T= 180 D=1) |
| Checksum | uint16\_t | None |
| Seq | uint16\_t | SS(Delta=1) SS(Delta=-1) HV(V=1) |
| Total | uint16\_t | SS(Delta=1) SS(Delta=-1) |
| Payload | gs\_rparam\_query\_payload\_t (union) |  |

### gs\_rparam\_query\_payload\_t

|  |  |  |
| --- | --- | --- |
| **Member** | **Type** | **Fault Classes** |
| Packed | uint8\_t | BF(min=0, max=7, state=-1, value =1) |

## RPARAM\_SAVE Fault Model

### rparam\_query\_t

|  |  |  |
| --- | --- | --- |
| **Member** | **Type** | **Fault Classes** |
| Action | uint8\_t |  |
| Table\_id | uint8\_t |  |
| Length | uint16\_t | SS(Delta=1), SS(Delta=-1),  IV(V=0), VAT(T= 180, D=1) |
| Checksum | uint16\_t | None |
| Seq | uint16\_t |  |
| Total | uint16\_t |  |
| Payload | gs\_rparam\_query\_payload\_t (union) |  |

### gs\_rparam\_query\_payload\_t

|  |  |  |
| --- | --- | --- |
| **Member** | **Type** | **Fault Classes** |
| Copy | struct |  |
| uint8\_t from | SS(Delta=-1), SS(Delta=+1) |
| uint8\_t to | SS(Delta=-1), SS(Delta=+1) |

## RPARAM\_LOAD Fault Model

### rparam\_query\_t

|  |  |  |
| --- | --- | --- |
| **Member** | **Type** | **Fault Classes** |
| Action | uint8\_t |  |
| Table\_id | uint8\_t |  |
| Length | uint16\_t | SS(Delta=1), SS(Delta=-1),  IV(V=0), VAT(T= 180, D=1) |
| Checksum | uint16\_t | None |
| Seq | uint16\_t | SS(Delta=1) SS(Delta=-1) |
| Total | uint16\_t | SS(Delta=1) SS(Delta=-1) |
| Payload | gs\_rparam\_query\_payload\_t (union) |  |

### gs\_rparam\_query\_payload\_t

|  |  |  |
| --- | --- | --- |
| **Member** | **Type** | **Fault Classes** |
| Copy | struct |  |
| uint8\_t from | SS(Delta=-1), SS(Delta=+1) |
| uint8\_t to | SS(Delta=-1), SS(Delta=+1) |

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## RPARAM\_COPY Fault Model

### rparam\_query\_t

|  |  |  |
| --- | --- | --- |
| **Member** | **Type** | **Fault Classes** |
| Action | uint8\_t |  |
| Table\_id | uint8\_t |  |
| Length | uint16\_t | SS(Delta=1), SS(Delta=-1),  IV(V=0), VAT(T= 180, D=1) |
| Checksum | uint16\_t | None |
| Seq | uint16\_t | SS(Delta=1) SS(Delta=-1) |
| Total | uint16\_t |  |
| Payload | gs\_rparam\_query\_payload\_t (union) |  |

### gs\_rparam\_query\_payload\_t

|  |  |  |
| --- | --- | --- |
| **Member** | **Type** | **Fault Classes** |
| Copy | struct |  |
| uint8\_t from | SS(Delta=-1), SS(Delta=+1) |
| uint8\_t to | SS(Delta=-1), SS(Delta=+1) |

## RPARAM\_REPLY Request Fault Model

### rparam\_query\_t

|  |  |  |
| --- | --- | --- |
| **Member** | **Type** | **Fault Classes** |
| Action | uint8\_t |  |
| Table\_id | uint8\_t |  |
| Length | uint16\_t | SS(Delta=1), SS(Delta=-1),  IV(V=0), VAT(T= 180 D=1) |
| Checksum | uint16\_t |  |
| Seq | uint16\_t | SS(Delta=1) SS(Delta=-1) HV(V=1) |
| Total | uint16\_t | SS(Delta=1) SS(Delta=-1) |
| Payload | gs\_rparam\_query\_payload\_t (union) |  |

### gs\_rparam\_query\_payload\_t

|  |  |  |
| --- | --- | --- |
| **Member** | **Type** | **Fault Classes** |
| Packed | uint8\_t | BF(min=0, max=7, state=-1, value =1) |