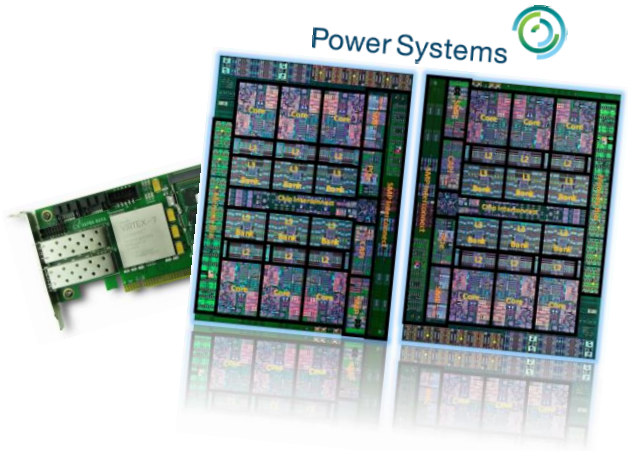
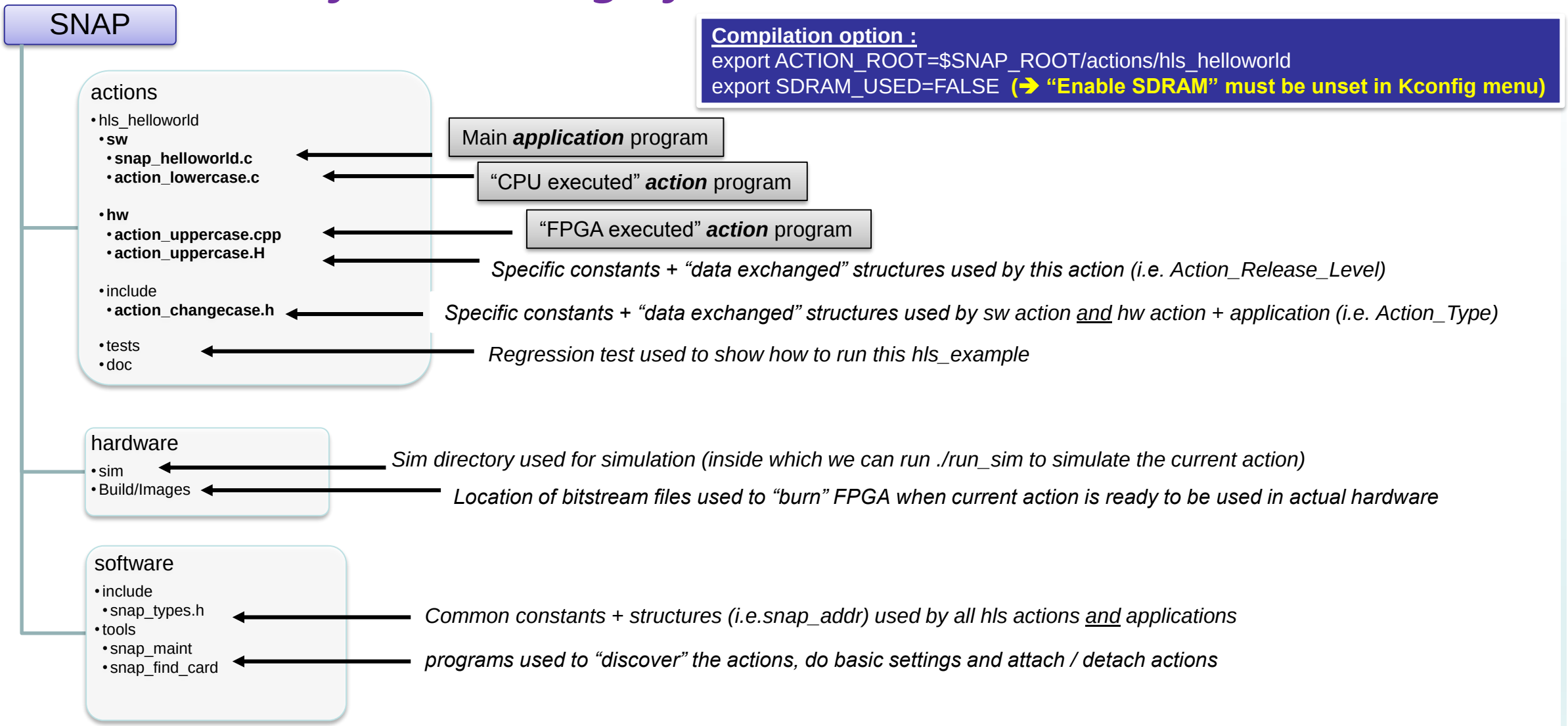
IBM Power Systems

CAPI SNAP Education Series:
User Guide

CAPI SNAP Education
hls_helloworld : howto?
V2.1



Architecture of the SNAP git files



Action overview

Purpose: Providing to a 1st SNAP user a simple example to let him understand how different files work together.
Access to external interfaces are :

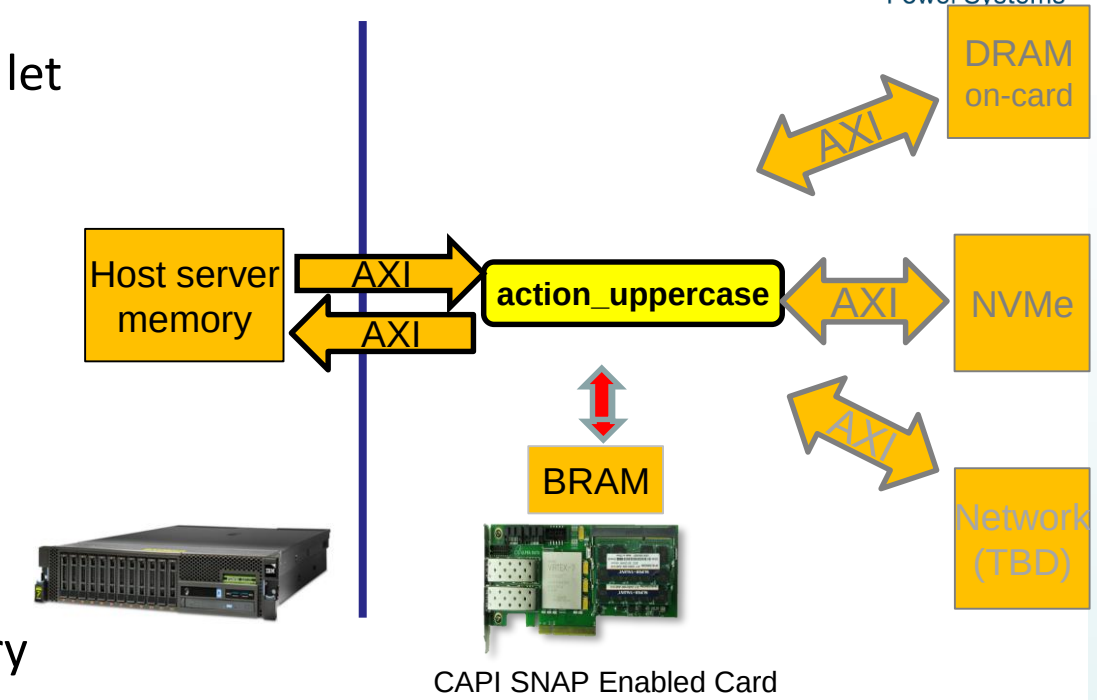
- Host memory server

When to use it:

- Understand Basic access

Memory management:

- Application is managing address of Host memory
- Data are read 64B words one after the other



Known limitations:

- HLS requires transfers to be 64 byte aligned and a size of multiples of 64 bytes
- DDR simulation model reads will return wrong values if non 64 bytes words or non initialized words are read (this is due to the simulation model only)

Action usage

Usage:

```
./snap_helloworld [-h] [-v, --verbose] [-V, --version]
        -C, --card <cardno> can be (0...3)
        -i, --input <file.bin>    input file.
        -o, --output <file.bin>   output file.
        -A, --type-in <CARD_DRAM, HOST_DRAM, ...>.
        -a, --addr-in <addr>      address e.g. in CARD_RAM.
        -D, --type-out <CARD_DRAM, HOST_DRAM, ...>.
        -d, --addr-out <addr>     address e.g. in CARD_RAM.
        -s, --size <size>         size of data.
        -t, --timeout             timeout in sec to wait for done.
        -X, --verify              verify result if possible
        -N, --no-irq              disable Interrupts
```

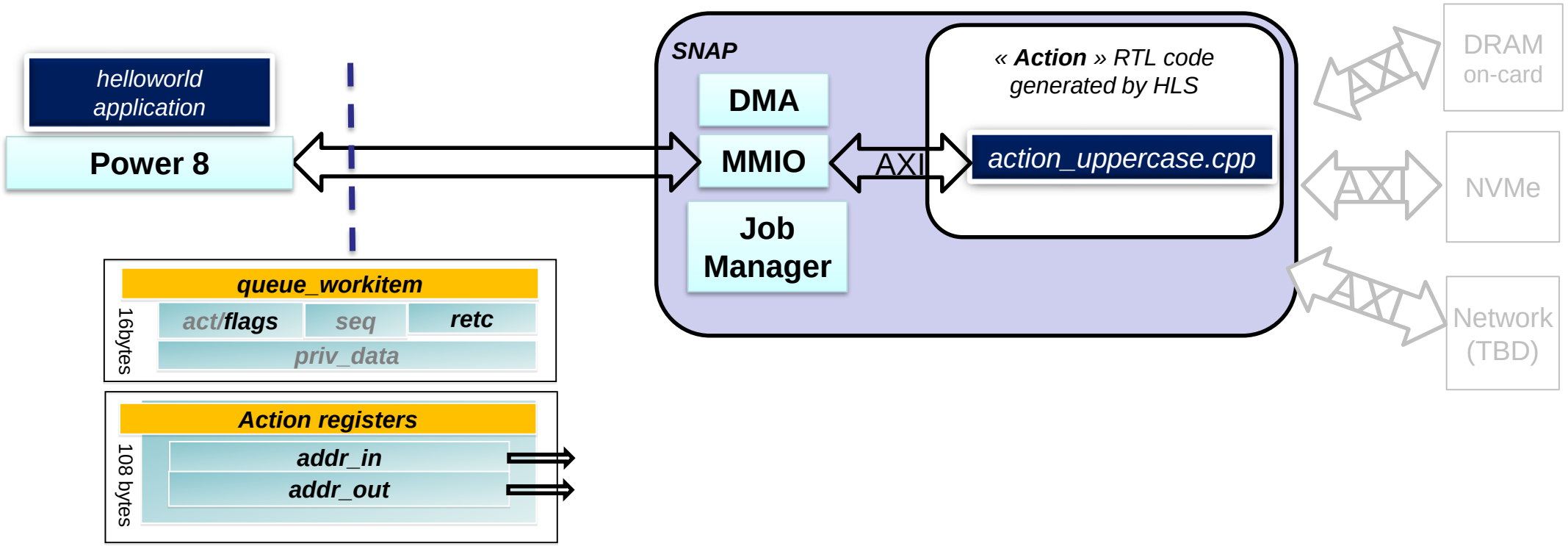
Options: *(default option in **bold**)*

SNAP_TRACE = 0x0 ➔ no debug trace
SNAP_TRACE = 0xF ➔ full debug trace
SNAP_CONFIG = FPGA ➔ hardware execution
SNAP_CONFIG = CPU ➔ software execution

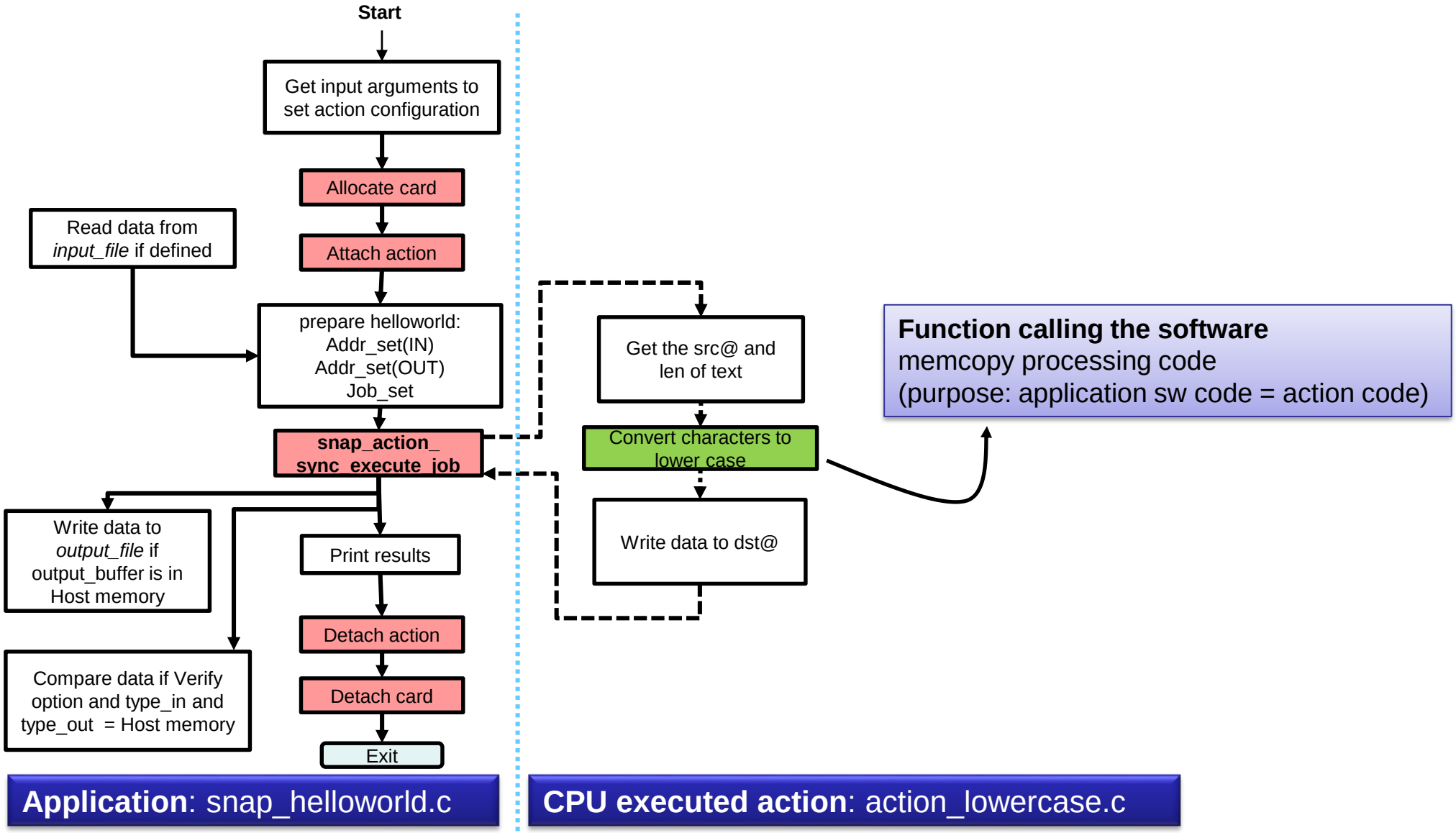
Example :

```
export SNAP_TRACE=0x0
$SNAP_ROOT/software/tools/snap_maint -vvv

rm /tmp/t2; rm /tmp/t3
vi /tmp/t1
     Hello world. This is my first CAPI SNAP experience. It's real fun!

$SNAP_CONFIG=FPGA $ACTION_ROOT/sw/snap_helloworld -i /tmp/t1 -o /tmp/t2
$SNAP_CONFIG=CPU  $ACTION_ROOT/sw/snap_helloworld -i /tmp/t1 -o /tmp/t3
echo "Display  input file"; cat /tmp/t1
 Hello world. This is my first CAPI SNAP experience. It's real fun!
echo "Display output file from FPGA EXECUTED ACTION"; cat /tmp/t2
 HELLO WORLD. THIS IS MY FIRST CAPI SNAP EXPERIENCE. IT'S REAL FUN!
echo "Display output file from CPU EXECUTED ACTION"; cat /tmp/t3
 hello world. this is my first capi snap experience. it's real fun!
```

helloworld registers



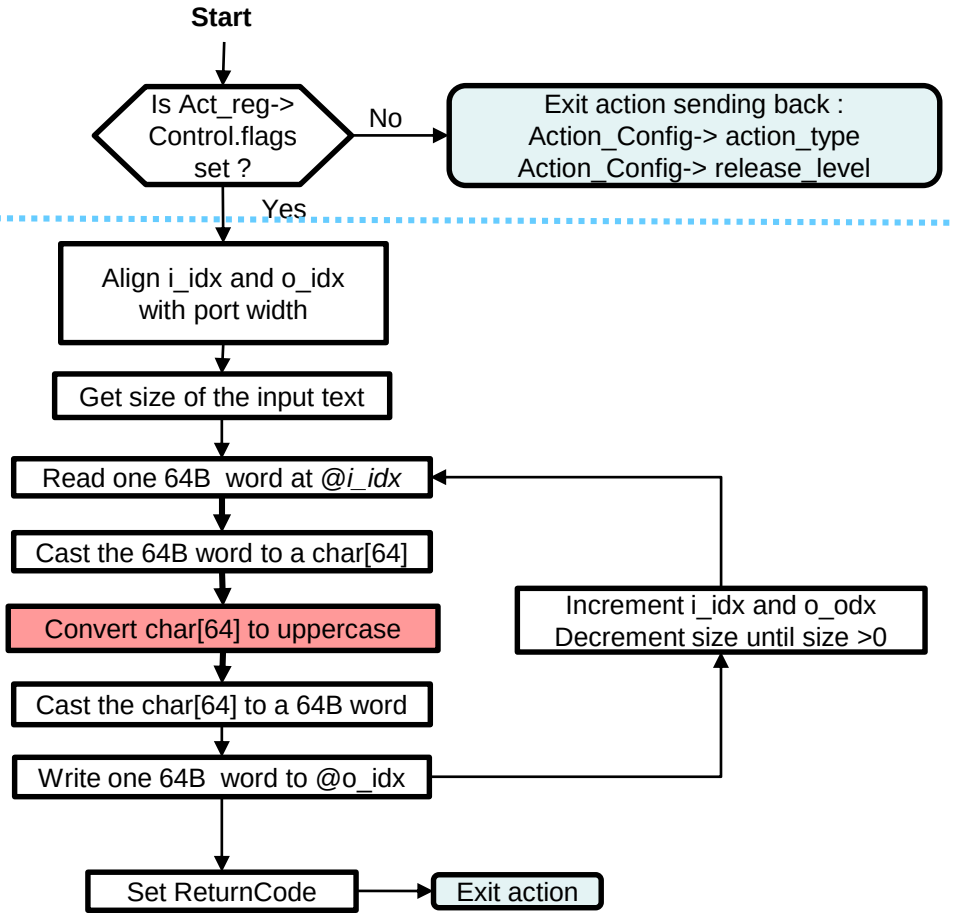
Application Code + software action code: what's in it?



Hardware action Code : what's in it?

hls_action

process_action



Used during discovery phase only

FPGA executed Action: hls_memcopy.cpp

Constants - Ports

Constants: ➔ $ACTION_ROOT = snap/actions/hls_helloworld

Constant name	Value	Type	Definition location	Usage
HELLOWORLD_ACTION_TYPE	0x10141008	Fixed	$ACTION_ROOT/include/action_memcopy.h	memcopy ID - list is in snap/ActionTypes.md
RELEASE_LEVEL	0x00000021	Variable	$ACTION_ROOT/hw/action_memcopy.**H**	release level – user defined

Ports used:

Ports name	Description	Enabled
din_gmem	Host memory data bus input Addr : 64bits - Data : 512bits	Yes
dout_gmem	Host memory data bus output Addr : 64bits - Data : 512bits	Yes
d_ddrmem	DDR3 - DDR4 data bus in/out Addr : 33bits - Data : 512bits	NOT used
nvme	NVMe data bus in/out Addr : 32bits - Data : 32bits	*No (soon)*

MMIO Registers

Read and Write are considered from the application / software side

act_reg.Control CONTROL	***This header is initialized by the SNAP job manager. The action will update the Return code and read the flags value.***									
	If the flags value is 0, then action sends only the action_RO_config_reg value and exit the action, otherwise it will process the action									
Simu - WR	Write@	Read@	3		2	1	0	Typical Write value		Typical Read value	
0x3C40	0x100	0x180	sequence			**flags**	short action type	f001_01_00			
0x3C41	0x104	0x184	**Retc** (return code 0x102/0x104)					0		0x102 - 0x104	SUCCESS/FAILURE
0x3C42	0x108	0x188	Private Data					c0febabe			
0x3C43	0x10C	0x18C	Private Data					deadbeef			

action_reg.Data memcopy_job_t	***Action specific - user defined - need to stay in 108 Bytes***									
	This is the way for application and action to exchange information through this set of registers									
	Write@	Read@	3		2	1	0	Typical Write value		Typical Read value	
0x3C44	0x110	0x190	snap_addr.**addr_in** (LSB)								
0x3C45	0x114	0x194	snap_addr.**addr_in** (MSB)								
0x3C46	0x118	0x198	snap_addr_in.**size**								
0x3C47	0x11C	0x19C	snap.addr_in.**flags** (SRC, DST, ...)			snap.addr_in.**type** (HOST, DRAM, NVME,..)					
0x3C48	0x120	0x1A0	snap_addr.**addr_out** (LSB)								
0x3C49	0x124	0x1A4	snap_addr.**addr_out** (MSB)								
0x3C4A	0x128	0x1A8	snap.addr_out.**size**								
0x3C4B	0x12C	0x1AC	snap.addr_out.**flags** (SRC, DST, ...)			snap.addr_out.**type** (HOST, DRAM, NVME,..)					

$ACTION_ROOT/hw/action_uppercase.H

```
typedef struct {
    CONTROL Control;       /*  16 bytes */
    helloworld_job_t Data;  /* 108 bytes */
    uint8_t padding[SNAP_HLS_JOBSIZE - sizeof(helloworld_job_t)];
} action_reg;
```

$SNAP_ROOT/actions/include/hls_snap.H

```
typedef struct {
    snapu8_t sat; // short action type
    snapu8_t flags;
    snapu16_t seq;
    snapu32_t Retc;
    snapu64_t Reserved; // Priv_data
} CONTROL;
```

$ACTION_ROOT/include/action_changecase.h

```
typedef struct helloworld_job {
    struct snap_addr in;    /* input data */
    struct snap_addr out;   /* offset table */
} helloworld_job_t;
```

$SNAP_ROOT/software/include/snap_types.h

```
typedef struct snap_addr {
    uint64_t addr;
    uint32_t size;
    snap_addrtype_t type;        /* DRAM, NVME, ... */
    snap_addrflag_t flags;       /* SRC, DST, EXT, ... */
} snap_addr_t;
```

Path of improvements

1. HLS 2017.1 memcpy prevents from using maximum AXI bandwidth limiting burst transfers to 1KB. A patch to Issue #320 has been provided that gives the maximum 4KB burst but requires a complex pipelined loop instead of a simple memcopy. This is announced to be corrected in Vivado HLS 2017.4

History of this document and of the action release level

V2.0: initial document
V2.1: new files directory structure applied