

*Solution Below

1. **Magic 8 Ball:** You are debugging an application in execution using gdb on a 64-bit (i.e. pointers use 64 bits), little-endian architecture. The application has a variable called *magic8ball* - defined as

```
char magic8ball[8][8][8];
```

Using gdb you find the following information at a particular stage in the application:

```
(gdb) p &magic8ball
```

```
$1 = (char (*)[8][8][8]) 0x7fffffff000
```

And:

```
(gdb) x/512bx 0x7fffffff000
```

0x7fffffff000:	0x4e	0x65	0x76	0x65	0x72	0x00	0x00	0x00
0x7fffffff008:	0x4c	0x69	0x6b	0x65	0x6c	0x79	0x00	0x00
0x7fffffff010:	0x4e	0x61	0x68	0x00	0x00	0x00	0x00	0x00
0x7fffffff018:	0x4e	0x6f	0x00	0xff	0xff	0x7f	0x00	0x00
0x7fffffff020:	0x59	0x65	0x73	0x00	0x00	0x00	0x00	0x00
0x7fffffff028:	0x4e	0x61	0x68	0x00	0x00	0x00	0x00	0x00
0x7fffffff030:	0x4d	0x61	0x79	0x62	0x65	0x00	0x00	0x00
0x7fffffff038:	0x57	0x72	0x6f	0x6e	0x67	0x00	0x00	0x00
0x7fffffff040:	0x4d	0x61	0x79	0x62	0x65	0x00	0x00	0x00
0x7fffffff048:	0x4e	0x65	0x76	0x65	0x72	0x00	0x00	0x00
0x7fffffff050:	0x52	0x69	0x67	0x68	0x74	0x00	0x00	0x00
0x7fffffff058:	0x57	0x72	0x6f	0x6e	0x67	0x00	0x00	0x00
0x7fffffff060:	0x4e	0x65	0x76	0x65	0x72	0x00	0x00	0x00
0x7fffffff068:	0x4d	0x61	0x79	0x62	0x65	0x00	0x00	0x00
0x7fffffff070:	0x4e	0x6f	0x00	0xff	0xff	0x7f	0x00	0x00
0x7fffffff078:	0x59	0x65	0x61	0x68	0x00	0x00	0x00	0x00
0x7fffffff080:	0x4c	0x69	0x6b	0x65	0x6c	0x79	0x00	0x00
0x7fffffff088:	0x4e	0x61	0x68	0x00	0x00	0x00	0x00	0x00
0x7fffffff090:	0x4e	0x61	0x68	0x00	0x00	0x00	0x00	0x00
0x7fffffff098:	0x59	0x65	0x73	0x00	0x00	0x00	0x00	0x00
0x7fffffff0a0:	0x4c	0x69	0x6b	0x65	0x6c	0x79	0x00	0x00
0x7fffffff0a8:	0x59	0x65	0x61	0x68	0x00	0x00	0x00	0x00
0x7fffffff0b0:	0x4e	0x61	0x68	0x00	0x00	0x00	0x00	0x00
0x7fffffff0b8:	0x59	0x65	0x61	0x68	0x00	0x00	0x00	0x00
0x7fffffff0c0:	0x4d	0x61	0x79	0x62	0x65	0x00	0x00	0x00
0x7fffffff0c8:	0x59	0x65	0x61	0x68	0x00	0x00	0x00	0x00
0x7fffffff0d0:	0x4e	0x65	0x76	0x65	0x72	0x00	0x00	0x00
0x7fffffff0d8:	0x57	0x72	0x6f	0x6e	0x67	0x00	0x00	0x00
0x7fffffff0e0:	0x57	0x72	0x6f	0x6e	0x67	0x00	0x00	0x00
0x7fffffff0e8:	0x4e	0x6f	0x00	0xff	0xff	0x7f	0x00	0x00
0x7fffffff0f0:	0x4d	0x61	0x79	0x62	0x65	0x00	0x00	0x00
0x7fffffff0f8:	0x57	0x72	0x6f	0x6e	0x67	0x00	0x00	0x00
0x7fffffff100:	0x4e	0x61	0x68	0x00	0x00	0x00	0x00	0x00
0x7fffffff108:	0x52	0x69	0x67	0x68	0x74	0x00	0x00	0x00
0x7fffffff110:	0x53	0x75	0x72	0x65	0x00	0x00	0x00	0x00
0x7fffffff118:	0x4e	0x6f	0x00	0xff	0xff	0x7f	0x00	0x00
0x7fffffff120:	0x59	0x65	0x61	0x68	0x00	0x00	0x00	0x00
0x7fffffff128:	0x4e	0x61	0x68	0x00	0x00	0x00	0x00	0x00
0x7fffffff130:	0x4e	0x61	0x68	0x00	0x00	0x00	0x00	0x00
0x7fffffff138:	0x52	0x69	0x67	0x68	0x74	0x00	0x00	0x00
0x7fffffff140:	0x59	0x65	0x73	0x00	0x00	0x00	0x00	0x00
0x7fffffff148:	0x59	0x65	0x61	0x68	0x00	0x00	0x00	0x00
0x7fffffff150:	0x4e	0x6f	0x00	0xff	0xff	0x7f	0x00	0x00

0x7fffffffel58:	0x59	0x65	0x61	0x68	0x00	0x00	0x00	0x00
0x7fffffffel60:	0x59	0x65	0x61	0x68	0x00	0x00	0x00	0x00
0x7fffffffel68:	0x4c	0x69	0x6b	0x65	0x6c	0x79	0x00	0x00
0x7fffffffel70:	0x52	0x69	0x67	0x68	0x74	0x00	0x00	0x00
0x7fffffffel78:	0x4e	0x6f	0x00	0xff	0xff	0x7f	0x00	0x00
0x7fffffffel80:	0x4e	0x65	0x76	0x65	0x72	0x00	0x00	0x00
0x7fffffffel88:	0x57	0x72	0x6f	0x6e	0x67	0x00	0x00	0x00
0x7fffffffel90:	0x59	0x65	0x73	0x00	0x00	0x00	0x00	0x00
0x7fffffffel98:	0x4e	0x65	0x76	0x65	0x72	0x00	0x00	0x00
0x7fffffffela0:	0x4e	0x61	0x68	0x00	0x00	0x00	0x00	0x00
0x7fffffffela8:	0x4c	0x69	0x6b	0x65	0x6c	0x79	0x00	0x00
0x7fffffffelb0:	0x53	0x75	0x72	0x65	0x00	0x00	0x00	0x00
0x7fffffffelb8:	0x59	0x65	0x73	0x00	0x00	0x00	0x00	0x00
0x7fffffffelc0:	0x53	0x75	0x72	0x65	0x00	0x00	0x00	0x00
0x7fffffffelc8:	0x53	0x75	0x72	0x65	0x00	0x00	0x00	0x00
0x7fffffffeld0:	0x4e	0x65	0x76	0x65	0x72	0x00	0x00	0x00
0x7fffffffeld8:	0x4c	0x69	0x6b	0x65	0x6c	0x79	0x00	0x00
0x7fffffffel1e0:	0x4d	0x61	0x79	0x62	0x65	0x00	0x00	0x00
0x7fffffffel1e8:	0x57	0x72	0x6f	0x6e	0x67	0x00	0x00	0x00
0x7fffffffel1f0:	0x53	0x75	0x72	0x65	0x00	0x00	0x00	0x00
0x7fffffffel1f8:	0x4c	0x69	0x6b	0x65	0x6c	0x79	0x00	0x00

If the application were to output the value of `magic8ball[3][4]` – what would it be? i.e. what would be returned from the statement `printf(“%s”, magic8ball[3][4]);`

`k (magic8ball[3][4])` *if `magic8ball[3][4]` ← *give away its a multi-level array.

let `p = &magic8ball (0x7fffffff)`
`p + (64 * 3 + 7 * 4)` ← size of char

address of start of array

= `0x7fffffff + 224`
 = `14073748434736`
 + `224`

 140737484347360

↓ Hex
 7fffffffed0

Little Endian: LSB to MSB

`80x000076be6f7257`

Hex: `0x57 0x72 0x6f 0x6e 0x67 0x00 0x00 0x00`
 w r o n g

`[0][0][0]` *In test, or Multi-level Array.
 ... `[1]`
 ... `[2]`
 ...
 ... `[7]`
`[0][1][0]`

It will print out "Wrong"

ASCII Table

Dec	Hex	Name	Char	Ctrl-char	Dec	Hex	Char	Dec	Hex	Char	Dec	Hex	Char
0	0	Null	NUL	CTRL-@	32	20	Space	64	40	@	96	60	`
1	1	Start of heading	SOH	CTRL-A	33	21	!	65	41	A	97	61	a
2	2	Start of text	STX	CTRL-B	34	22	"	66	42	B	98	62	b
3	3	End of text	ETX	CTRL-C	35	23	#	67	43	C	99	63	c
4	4	End of xmit	EOT	CTRL-D	36	24	\$	68	44	D	100	64	d
5	5	Enquiry	ENQ	CTRL-E	37	25	%	69	45	E	101	65	e
6	6	Acknowledge	ACK	CTRL-F	38	26	&	70	46	F	102	66	f
7	7	Bell	BEL	CTRL-G	39	27	'	71	47	G	103	67	g
8	8	Backspace	BS	CTRL-H	40	28	(	72	48	H	104	68	h
9	9	Horizontal tab	HT	CTRL-I	41	29	)	73	49	I	105	69	i
10	0A	Line feed	LF	CTRL-J	42	2A	*	74	4A	J	106	6A	j
11	0B	Vertical tab	VT	CTRL-K	43	2B	+	75	4B	K	107	6B	k
12	0C	Form feed	FF	CTRL-L	44	2C	,	76	4C	L	108	6C	l
13	0D	Carriage feed	CR	CTRL-M	45	2D	-	77	4D	M	109	6D	m
14	0E	Shift out	SO	CTRL-N	46	2E	.	78	4E	N	110	6E	n
15	0F	Shift in	SI	CTRL-O	47	2F	/	79	4F	O	111	6F	o
16	10	Data line escape	DLE	CTRL-P	48	30	0	80	50	P	112	70	p
17	11	Device control 1	DC1	CTRL-Q	49	31	1	81	51	Q	113	71	q
18	12	Device control 2	DC2	CTRL-R	50	32	2	82	52	R	114	72	r
19	13	Device control 3	DC3	CTRL-S	51	33	3	83	53	S	115	73	s
20	14	Device control 4	DC4	CTRL-T	52	34	4	84	54	T	116	74	t
21	15	Neg acknowledge	NAK	CTRL-U	53	35	5	85	55	U	117	75	u
22	16	Synchronous idle	SYN	CTRL-V	54	36	6	86	56	V	118	76	v
23	17	End of xmit block	ETB	CTRL-W	55	37	7	87	57	W	119	77	w
24	18	Cancel	CAN	CTRL-X	56	38	8	88	58	X	120	78	x
25	19	End of medium	EM	CTRL-Y	57	39	9	89	59	Y	121	79	y
26	1A	Substitute	SUB	CTRL-Z	58	3A	:	90	5A	Z	122	7A	z
27	1B	Escape	ESC	CTRL-[	59	3B	;	91	5B	[	123	7B	{
28	1C	File separator	FS	CTRL-\	60	3C	<	92	5C	\	124	7C	|
29	1D	Group separator	GS	CTRL-]	61	3D	=	93	5D	]	125	7D	}
30	1E	Record separator	RS	CTRL-^	62	3E	>	94	5E	^	126	7E	~
31	1F	Unit separator	US	CTRL-`	63	3F	?	95	5F	_	127	7F	DEL