

**The resource usage of Cyberon's solution on CM4:**

		ROM		RAM	CPU (MCPS)
		Code/Table	Model		
DSpotter	Level 0	44.1 KB	91 KB + 32B/command	37.4 KB + 128B/command	30.3 + 0.050/command
	Level 1		155 KB+ 32B/command	40.8 KB + 128B/command	38.5 + 0.064/command
DSpotter Tone - Level 1		162 KB	167 KB+ 45B/command	81.4 KB + 136B/command	64.5 + 0.064/command
Voice Tag (may need data flash)		8.7 KB	11~15 KB	85.6 KB for voice tag recording and training	16.7 for recording 55.4 for training
VAD		20.4 KB	X	5.5 KB	8.1
48 to 16 KHz		0.8 KB	X	2.9 KB	2.45
Speex Codec		64.6 KB	X	9 KB per stream (3 KB heap, 6 KB stack)	1. 8000 Hz, 8000 bps Encode = 37.1, Decode = 5.52 2. 16000 Hz, 12800 bps Encode = 62.22, Decode = 12.24 3. 16000 Hz, 16800 bps Encode = 52.5, Decode = 11.82
AEC Mono 16KHz		41 KB	X	Echo path = 16 ms 23 KB	Echo path = 16 ms 54.6

Description:

1. All test on Renesas RA6M1 (CM4 120 MHz).
2. DSpotter tone version is only used for Chinese tone model, it can also use with no tone model.
3. To save memory requirement, we can release DSpotter and Initialize DSpotterSD\_XXX API to record voice tag.
4. The voice tag model has 340B header and 120~400B per tag. Please save it to data flash.
5. If the program don't call VAD API, the final ROM image won't include VAD's code/table. This also apply to voice tag, AEC and so on.
6. The open source code of Speex support fixed point and float point. On RA6M1, the float point version use more time than the fixed point(encoder 30%, decoder 100%). They have same quality, so we choice fixed point version.
7. CM4 has DSP instruction:  $\text{sum64} += \text{a32\_L16} * \text{b32\_L16} + \text{a32\_H16} * \text{b32\_H16}$   
One instruction can do two 16 bits multiplication and two addition. L16 and H16 is the lower/higher 16 bits part of 32 bits register.  
The CPU usage of DSpotter level 0/1 on CM4 is 30/38 MCPS.
8. CM3 has no DSP instruction, but support MAC(Multiply Accumulate Calculator) instruction:  $\text{sum64} += \text{a32} * \text{b32}$   
One instruction can do one multiplication and one addition.  
The CPU usage of DSpotter level 0/1 on CM3 is 45/60 MCPS.
9. CM0+ has no DSP instruction and nor MAC instruction.  
The CPU usage of DSpotter level 0/1 on CM0+ is 72/96 MCPS.

**The resource usage of Cyberon's solution on RX-651:**

		ROM		RAM	CPU (MCPS)
		Code/Table	Model		
DSpotter	Level 0		91 KB + 32B/command	37.4 KB + 128B/command	36.4 + 0.063/command
	Level 1		155 KB+ 32B/command	40.8 KB + 128B/command	51.4 + 0.070/command
DSpotter Tone - Level 1			167 KB+ 45B/command	81.4 KB + 136B/command	68.65 + 0.073/command
Voice Tag (may need data flash)			11~15 KB	85.6 KB for voice tag recording and training	14.43 for recording 82.56 for training
VAD			X	5.5 KB	7.31
48 to 16 KHz			X	2.9 KB	3

RX651 has MAC instruction but no DSP instruction, and its CoreMark is better than CM3/CM4, so its performance is between CM3 and CM4.