ThingsChat

Internet of Things technology

Monday, April 6, 2015

Contiki OS: Using Powertrace and Energest power profile to estimate power consumption

To estimate the energy consumption. We can run on Cooja or with a real device

- Check the number of ticks per sencond for rtime (RTIMER_SECOND = 32768)
printf("Ticks per second: %u\n", RTIMER_SECOND);

- Include powertrace app in your project by adding it to your Makefile
APP += powertrace
(You also can use simpler version of powertrace at https://github.com/sonhan/contiki-sonhan/)
- Add to source file
#include "powertrace.h"
- Add to source file to print power profile every 10 seconds:
powertrace_start(CLOCK_SECOND * 10);

- Sample data

CPU	LPM	TX	RX
512803	14227588	153188	195436
531519	14535272	158359	203847
549549	14844701	163409	211794
560341	15161365	165821	216534
575755	15473409	169844	223419
599333	15777318	178173	231767
610307	16093852	180704	236651
625674	16406020	184722	243660
649197	16710040	193402	252940
660144	17026626	195811	258453
670942	17343372	198221	263249

- Energy consumption (Power - mW):

$$\frac{Energest\_Value \times Current \times Voltage}{RTIMER\_SECOND \times Runtime}$$

Check datasheet for current and voltage, e.g., CPU = (531519 - 512803) * 0.33 * 3 / 32768 / 10

- Duty cycle (%):

$$\frac{Energest\_TX + Energest\_RX}{Energest\_CPU + Energest\_LPM}$$

E.g., TX duty cycle = (158359 - 153188) / (531519 - 512803 + 14535272 - 14227588)

- Sample output:

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About Me

Son Han

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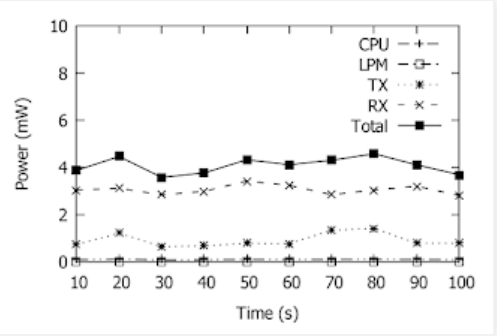

- Sample data and calculation:
https://github.com/sonhan/contiki/tree/master/apps/powertrace-sonhan/sample-data

Posted by Son Han at 10:06 PM

Labels: contiki, energest, energy, powertrace

54 comments:

Raj June 19, 2015 at 4:06 PM

good work

Reply

Hoang Tam Ngo June 20, 2015 at 2:49 PM

If we do not devide with the runtime, it will be mJ, right ?

Reply

Son Han June 20, 2015 at 2:55 PM

Yes, definitely

Reply

Hoang Tam Ngo June 20, 2015 at 3:17 PM

I try to print out the RTIMER_SECOND, put the number that I get is 32768 not 327680. Can you explain it for me ?

Reply

Hoang Tam Ngo June 20, 2015 at 3:40 PM

If we use Skymote with current in active mode is 600uA, sleep mode 3 uA, TX is 21 mA, RX is 23 mA and Voltage is 3.6V. Base on your proposed, The energy will be: 1233 uJ+ 101uJ+ 11930 uJ+ 21253uJ= 34517uJ = 35 mJ. 35 mJ for 10 seconds, Is this acceptable ? I really want to know it because I have a problem with this too.

Reply

Hoang Tam Ngo June 20, 2015 at 4:37 PM

This comment has been removed by the author.

Reply

Son Han June 20, 2015 at 5:37 PM

Sorry it should be 32768, 327680 is that multiplied by 10 (second). I have updated it.

Reply

Son Han June 20, 2015 at 5:41 PM

You can compare to my following sample data (mW) with TelosB CM5000 (3V, 330 uA, 1.1 uA, 18.8 mA, and 17.4 mA for Voltage, CPU, LPM, TX, and RX):

CPU LPM TX RX Total
0.029683685 0.003199695 0.162009888 0.9172229 1.112116168
0.032194336 0.003191306 0.179851685 1.015675049 1.230912375
0.03203421 0.003191799 0.180170288 1.03546875 1.250865048

Hope it heps!

Reply

Replies

adil bashir March 20, 2018 at 7:29 AM

This comment has been removed by the author.

adil bashir March 20, 2018 at 7:39 AM

Dear Son Han, I am calculating the values as given by you for CPU,LPM, Tx,Rx but i am not getting the exact output values as mentioned by you. I am doing the following calculation:
For CPU, ((531519-512803) x 0.33 x 3)/327680 = 0.056545532
But as per your given values, this value is 0.029683685.
Similarly, For LPM, ((14535272-14227588) x 0.33 x 3)/327680 = 0.003098624
which matches to your mentioned value i.e. 0.003199695.
Similarly for Tx, ((158359-153188)) x 0.33 x 3)/327680 = 0.890028076
But as per your given values, this value is 0.162009888.
Similarly, for Rx, ((203847-195436) x 0.33 x 3)/327680 = 1.339887085
But as per your given values, this value is 0.9172229.

Can you please explain to me how have you calculated it because i am getting much higher value for the same input data.

Reply

Unknown September 20, 2015 at 12:31 AM

Please we just have to use the rtimer ?

Reply

Damien Sambo September 20, 2015 at 12:32 AM

and if not !!! how can i do if a whant to evaluate power consumption with Temote sky sensor ?

Reply

Elizabeth November 5, 2015 at 7:15 AM

Hi Son Han.
Maybe this a sily question but I want to know why you are doing a difference between the first cpu value and the second to measure power consumption. And these CPU value is CPU (column 11) from powertrace otuput? , because the powertrace output shows all_cpu (column 5) and cpu (column 11) values.

Reply

Replies

Son Han November 6, 2015 at 8:51 AM

Hi Liz,

All_CPU, for example, is the total (high) CPU, in the form of number of ticks. So in order to estimate the energy consumption in a duration of time, we just consider the power incurred during that time by subtracting the current ALL_CPU to the previous ALL_CPU. If you don't do the subtraction, it's ok, it then will mean the total energy consumed so far (from when you started the mote).

Elizabeth December 9, 2015 at 4:12 PM

Hi Son Han, thanks a lot. I have a question, hope you can help me, I need to calculate power consuption in certain process of my poryect, for example for processing a request. I call powertrace_print("") after and before that process, however the vaules that I getting for: all_cpu, all_lpm, all_transmit, all_listen.

16443 1514881 148 1531616
17268 1514881 148 1532440

all_lpm and al_transmit, do not change. Then the power consumption using the linear model: cp=c*1.8/tm; Where c is all_cpu - last_cpu , and tm is cpu + lpm. This give 825*1.8/825 = 1.8mW it is the current of cpu, and If I do the same for other values I am getting the current draw for transmit and listen.

This seems not right to me.
Do you know how to do this?. Calculate power consumption for a specific process?

Thanks in advance.

Reply

Unknown November 24, 2015 at 3:50 PM

My values are coming like these, which are taken from unicast receiver.The values for these paramters are not increasing as you showed @son Han...what seems to be the problem..then can I count on these values..if i want to subtract from a step to previous step..then the result comes as negative values.What can I do??
CPU LPM TX RX
3475 62054 0 445
3295 62233 0 336
3314 62217 0 344
3478 62053 0 435
3301 62232 0 352

Reply

Replies

Unknown February 15, 2018 at 9:03 AM

Sort your data as per node ID and you will get it in increasing order.

Reply

Unknown November 24, 2015 at 3:53 PM

My values are coming like these, which are taken from unicast receiver.The values for these paramters are not increasing as you showed @son Han...what seems to be the problem..then can I count on these values..if i want to subtract from a step to previous step..then the result comes as negative values.What can I do??
CPU LPM TX RX
3475 62054 0 445
3295 62233 0 336
3314 62217 0 344
3478 62053 0 435
3301 62232 0 352

Reply

Replies

Son Han November 24, 2015 at 4:27 PM

I have no idea, all the values should increase. The TX seems correct as the receiver doesn't send anything...

Александар Велинов November 25, 2015 at 7:56 PM

Hi Unknown,
I think that your values are from column 11,12,13,14 (CPU,LPM,TX,RX). I think that the Son Han values are from ALL_CPU, ALL_LPM,ALL_TRANSMIT,ALL_LISTEN. This values are increasing and if you subtract second value and first value from ALL_, you will get your values.
ALL_CPU (second row)-ALL_CPU(first row)=CPU (your CPU value ex:3475)
Son Han may correct me if I am wrong? And I want to know: Is the Runtime value real time in seconds or not (I think it is not). If it not real value how to get power consuption in real time, for example if I have Runtime=10 (powertrace_start(CLOCK_SECOND * 10);), how to get power consumption for real time of 1 minute and 1 hour. If the Runtime is in real seconds
it will be easy. In my perception, for 1 minute I will get subtracted values from SECOND ROW-FIRST ROW (from ALL_CPU,ALL_LPM..) in one minute (60 seconds, or 6 values on 10 seconds) and with Son Han Formula for Energy consumption in mW will get the consumption in 60 seconds (SUM all 6 values for power consumption on 10 seconds). So I will get power consumption in 1 minute if Cooja Powertrace time is real time. If I use Tmote Sky with 2900 mAh. How to get the batery life? (I have idea but I am not sure: Power consumption = Current*Voltage. I have Voltage (3V for Tmote). I have Power

Consumption for 60 seconds (1 minute) and in this formula it must be in hour (Power Consumption for 1 minute*60=1 hour Power Consumption, is it true?) If it is from Power consumption = Current*Voltage I will get Current in Ampers (A). I can conver to mA. If I divide 2900mAh/Current (mA), will get hour (battery life). We can discuss about this. Is it true or not? I am waiting your opinion?

Son Han November 25, 2015 at 10:49 PM

What Александар Велинов suggested could be the reason. If you use the original powertrace of Contiki, as far as I remember, there are several values in the form of CPU, LPM, TX, RX instead of ALL_, so be careful. Try to use my simpler version of powertrace to make sure about the output.

Son Han November 25, 2015 at 11:16 PM

Indeed, this is the reason, the ALL_TX should not be 0. Zero mean ALL_TX doesn't change for the node doesn't send anything. Thanks Александар Велинов

homeless July 4, 2017 at 9:21 AM

I understand the previous Son Han equation except the value 0.33 based on Son Han calculation in the datasheet he fix the current value to 0.33? whats the current value ? from where we get ? which output from Powertrace represent the current.

Reply

Son Han November 25, 2015 at 11:08 PM

@Александар Велинов: Runtime is in second, then RTIMER_SECOND * runtime will be in TICK which is cancelled with the Energest_value at numerator. Does it make sense?

You can take a look on my calculation of battery life to see if the formula is ok:

Based on the average capacity of an AA battery is 2500 mAh and nominal voltage is 1.5 V, we can estimate the battery life for smart objects to maintain the connectivity (using duty cycling, power = 0.37mW) as follows:

(2500mAh * 1.5V * 2) / (0.37mW * 24h * 365days) = 2.304years

Reply

Replies

Александар Велинов November 26, 2015 at 1:53 AM

Hi Son Han, your formula for duty cycle is ENERGEST_TX+ENERGEST_RX / ENERGEST_CPU+ENERGEST_LPM. And you write that it is in percent (%). You have example only for E.g., TX duty cycle = (158359 - 153188) / (531519 - 512803 + 14535272 - 14227588).

And now you get a value 0.37mW. Is it some average power consumption or something else? Tell me in details? And what mean value 2 in your formula? I what to get power consumption and battery life on Tmote Sky sensor (for Coap protocol example client) module with datasheet on link http://www.eecs.harvard.edu/~konrad/projects/shimmer/references/tmote-sky-datasheet.pdf. It has capacity on battery 2900mAh, Voltage 3V. Are you sure your latest formula is correct? Tell me in details about procedure?

Son Han November 27, 2015 at 3:28 PM

That's right, the example is for duty cycle using second formula. You can calculate power by using the first one. 0.37mW is an example of one of my test, which is sum of four component CPU, LPM, TX, and RX.

Regarding the battery life equation:
- 2 is 2 battery (my mote has 2)
- 2500mAh is an average capacity of an AA (sure you can use 2900mAh if it is your case)

And I think you can easily judge if is correct.

Reply

Son Han November 27, 2015 at 3:58 PM

Because of many questions I received regarding the calculation, I put my sample data and calculation on github for your reference

https://github.com/sonhan/contiki/tree/master/apps/powertrace-sonhan/sample-data

Reply

Replies

Александар Велинов November 29, 2015 at 11:31 PM

Thanks Son Han about your sharing. I made calculation for Tmote sky. Battery life is a measure of battery performance and longevity, which can be quantified in several ways: as run time on a full charge, as estimated by a manufacturer in milliampere hours, or as the number of charge cycles until the end of useful life. What is true for us? The first or the second claim?

Reply

Александар Велинов November 29, 2015 at 11:42 PM

And how to send multiple packets in second. For example in Cooja how you simulate Data rate 2 packet/s, ping6 -t 0.5. I think the default is Data rate 1 packet/s, ping6 -t 1. And normally the power consumption is higher. Logically!

Reply

Unknown December 3, 2015 at 6:15 PM

@Александар Велинов....I have a question ..if I subtract ALL_LIsten ...2nd column- ALL_Listen 1st column = 1859
so 1859/32768 = should be time for for one reception?
and the unit for the formula is mw..is it right?

Reply

Replies

Александар Велинов December 3, 2015 at 6:59 PM

Yes, dividing these results by the number of ticks per second (32768) for a particular hardware device gives results in seconds. The power consumption in mW you can calculate from Son Han formula *- Energy consumption (Power - mW).
For your example: 1859 * Current * Voltage / 32768 * Runtime
where you can see current (current for Listen) and voltage in your mote datasheet and Runtime value is from: powertrace_start(CLOCK_SECOND * 10); where Runtime is 10.

Reply

Unknown December 3, 2015 at 7:56 PM

This comment has been removed by the author.

Reply

Unknown December 3, 2015 at 8:05 PM

Thanx...Александар Велинов...But the thing is I am doing a practical project with TelosB..from oscilloscope for one reception current 22mA*voltage 240mV=5.28 mw but from this formula 0.39mw...how is this possible..i am putting from datasheet 1859*0.022*3/32768*runtime..I know power_trace is 94% accurate with respect to real value..also the time for one reception is from oscilloscope 6ms but here: 1859/32768=56 ms!!!..can u explain this..??

Reply

Alex M April 13, 2016 at 12:41 PM

Hi thank you so much for the help..
I have a couple of questions tho..
What are exactly the values that the powertrace generates?
For example CPU LPM TX RX
512803 14227588 153188 195436
is all this data Rticks? or time in us that the node spends energy?

Furthermore about the power consumption algorithm is there any documentation about it or it is your calculation?
Is there any references from you in order to understand how everything works?

thank you for the help.

Reply

Replies

Son Han April 13, 2016 at 3:15 PM

Hi,

The values are Rticks I believe

References come from Contiki OS architecture, for example:

A. Dunkels, “The contikimac radio duty cycling protocol,” Swedish Institute of Computer Science report, 2011.

A. Dunkels, F. Osterlind, N. Tsiftes, and Z. He, “Software-based on-line energy estimation for sensor nodes,” in Proceedings of the 4th workshop on Embedded networked sensors. ACM, 2007, pp. 28–32.

Alex M April 13, 2016 at 5:31 PM

Thank you very much :)

Reply

Unknown December 19, 2016 at 10:28 AM

I would like to know, Based on what the lifetime in the excel sheet was calculated. I do not understand what the values 2500,1.5 and 2 are.
Thank you in advance

Reply

SULTAN January 29, 2017 at 3:12 PM

Hi,
what is the value of rtimer (ticks per second) please. I am using Cooja, and I noticed you have used 32768. Do I use the same number to calculate the energy consumption in Cooja, or do I have to check the value of rtimer. Thank you for your help.

Reply

André Riker May 3, 2017 at 11:54 AM

Hey guys, I have developed an extended version of Powertrace that uses original Powertrace code to provide the remaining energy in the battery. More info and source code: https://github.com/KineticBattery/Powertrace

Reply

Replies

Unknown May 17, 2017 at 6:29 AM

Great work bro,
will help a lot
what the capacity of Kinetic Battery ?
is it the default skymote in cooja ?
Thank you

André Riker May 17, 2017 at 11:41 AM

Thank you!

The capacity of the Kinetic Battery can be set according to your needs. The default capacity is 1000000 microAh or 1000 mAh.

The default node is Wismote, but it can also be easily changed.

I will make a tutorial showing how to change the battery and the node settings.

Any more questions, please contact me.

homeless June 1, 2017 at 7:00 AM

Thank you bro
I want to know the default capacity for skymote in cooja ?
and how we can change it?

André Riker June 1, 2017 at 12:27 PM

Hello,

Skymote is designed to use 2 AA batteries. The AA batteries may have different capacities, but you can consider each one to 2000 mAh, which will result in 4000 mAh (it is a lot of energy!).

I have post some information showing how to set the battery capacity other than the default (1000 mAh).

homeless June 1, 2017 at 12:41 PM

Thank you
it was helpful.
I am waiting for your post

André Riker June 1, 2017 at 5:30 PM

The information about Skymote and how to set 2 AA batteries is online on https://github.com/KineticBattery/Powertrace

Thanks

homeless June 3, 2017 at 7:24 AM

Thank you Bro
May I have your email
I I wan to contact you

Reply

André Riker June 1, 2017 at 12:26 PM

This comment has been removed by the author.

Reply

homeless July 1, 2017 at 12:37 PM

datasheet for current and voltage,
e.g., CPU = (531519 - 512803) * 0.33 * 3 / 32768 / 10

why current is fixed to 0.33

Reply

Replies

André Riker July 2, 2017 at 8:35 PM

You should specify these number because I don't understand what you are trying to do.

homeless July 3, 2017 at 10:54 AM

I understand the previous Son Han equation except the value 0.33 based on Son Han calculation in the datasheet he fix the current value to 0.33? whats the current value ? from where we get ? which output from Powertrace represent the current.

Reply

Artur Pedroso August 30, 2017 at 5:33 PM

Hi Son Han, I also can't get it where does the value 0.33 for current in the above formulas come from. Can you explain it please? Thanks.

Reply

Son Han September 7, 2017 at 2:13 AM

Hey Artur, can you share us the screenshot of the datasheet that shows the current value?

Reply

Replies

Artur Pedroso September 7, 2017 at 3:02 AM

Image and explanation here: https://github.com/sonhan/contiki/issues/1#issuecomment-327651350

Reply

رائد البعداني September 20, 2017 at 11:02 PM

How can I use these values to get my remaining energy ??
in mA ?
and how can I write them into a txt file
I am new to COOJA
Sorry

Reply

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