

TI-*nspire*

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Introduction

We're going to talk about the TI-Nspire Technology. In other words, we're going to talk about a calculator which sensibly marked a different way of mind from Texas Instruments.

Why talking about a calculator is so important? A calculator is what we used in secondary schools and it's an obvious subject, isn't it? Well... Actually we're going to see it's not only a calculator, it is more than a calculator, and it is, as T.I. says, a technology, The TI-Nspire Technology.

First of all we're going to take a look at basic knowledge required to understand and have interest upon this subject. Next we'll see all the new stuff that the TI-Nspire Technology brings and finally, we will analyze its particularly epic history.

I. Getting started

A. Calculators before the TI-Nspire

The Texas Instruments company diffuses, since 1990, graphing calculators, used as by students as by engineers. If we take a look on all those calculators except the TI-Nspire, we could see that they have a lot in common:

- Basic numerical computation, trigonometry, statistics
- Graph and curve plot
- Matrix operations
- Possibility of writing programs, either in TI-BASIC (BASIC derivative), or in ASM, or even in C for some of them.

Those calculators are divided in between two processors categories:

- Z80, using a Zilog Z80 processor (clocked between 1 and 15 MHz) and having, on average, 500 KB of flash memory.

ex : TI-82 TI-83+ TI-84+



- 68k, using a Motorola 68000 processor (clocked between 10 and 15 MHz) and having, on average, 3 MB of flash memory with a built in CAS (Computer Algebra System).

ex : TI-89 TI-89 titanium TI-Voyage 200



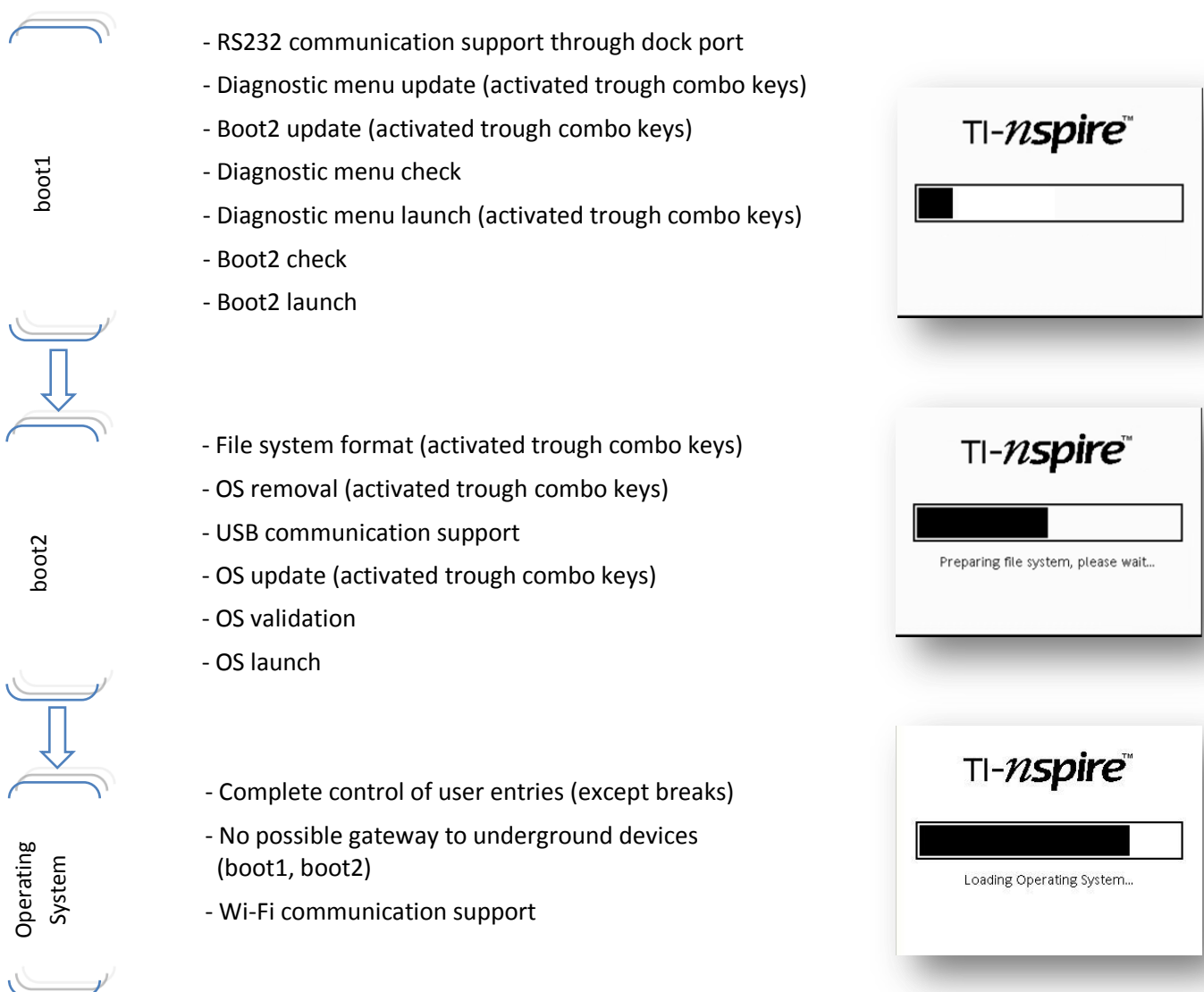
Between 1990 and 2007, Texas Instruments distributed close to a twenty various models. We can compare with the Japanese manufacturer, CASIO, who had made over more than forty various models in the same time interval.

2007 will mark certainly the end of TI diversity which will be focused only on the “TI-Nspire Technology”. Indeed, the other calculators firmware updates are excessively rare: During 7 years, the TI-84+ has been updated only one time, which only brings bugs and compatibility problems with certain programs. But after all, what is “TI-Nspire”?

B. Mobile platform provided for running a math software – “handheld-unit”

The TI-Nspire Technology, as often said, is after all a math software. The TI-Nspire being only its adaptation on a calculator, moreover officially qualified as “handheld unit” and not as “calculator”. The TI-Nspire appears in a different subcategory on the official TI website. In the same way, TI-Nspire Computer Software is the math software itself. It is, thus, not an emulator as the majority could believe. It also explains why we have to pay for this software.

Contrary to z80 and 68k, the TI-Nspire handheld has 3 execution levels on start-up (vs 2). We can name them: boot1, boot2, O.S. At start-up, the ARM core launches the boot1 which launches the boot2 which finally launches the O.S.



As we can see, this is a totally secured way when we think that the boot1 is stored in the NOR ROM whereas the boot2 is stored in the NAND ROM. The NAND ROM is not executable. This means that we cannot execute the boot2 without launch before the boot1. We cannot modify the boot1 through USB but only via RS232 because the boot1 is launched. Only one mistake during a NOR ROM write and the TI-Nspire won't boot any more. In this particularly case, we'll have to write through pin tests which is a really painstaking job. Thus, hacking the TI-Nspire is not possible by modifying the boot procedure.

II. Nspire: new hardware, new software ...

A. Hardware innovations

a. Processor

Contrary to z80 and 68k, the TI-Nspire has an ARM9 processor. This allows increasing the clock speed from 6 or 12 MHz to over than 90 MHz! ARM... well, ARM ... yes, that's it! We've got here a calculator which has the same kind of processor as in the Nintendo DS and the iPhone! What's wrong with T.I.'s engineers? How could they imagine this, just one second?

A first explanation is that the TI-Nspire was designed for several objectives:

- Execute a math software
- Overtake and forget the old technologies
- Capture data in the real world (real-time acquisition)
- Made for Classroom Activities with Wi-Fi support

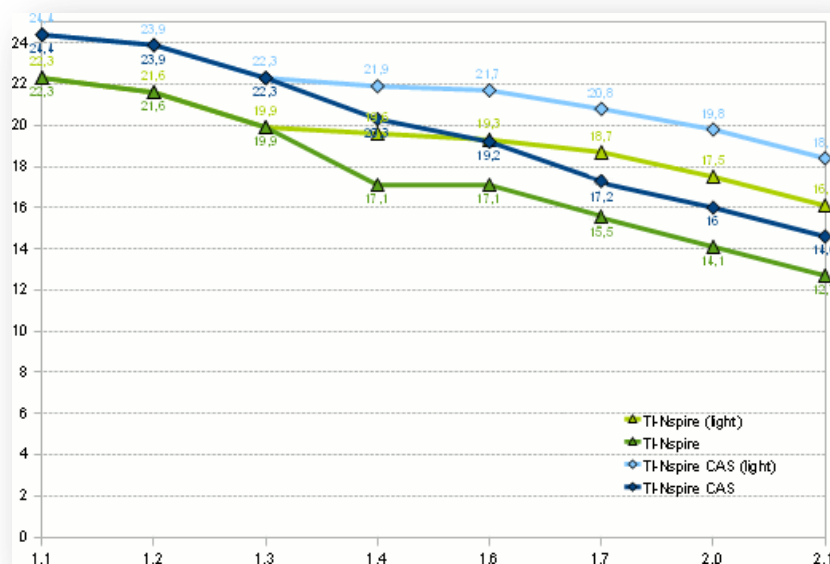
Those objectives couldn't be carried without a fast unit which can collect data and broadcast them at the same time. The ARM architecture processor was the best solution due to its reliable past experience, precisely on the Nintendo DS and on all the Smartphones over the past 5 years. It appears that Texas Instruments already builds ARM architecture processors (OMAP Technology), the development price is thus reduced.

b. Memory

The TI-Nspire has 32 MB of NAND Flash, 32 MB of SDRAM, and 512 KB of NOR Flash. The NAND Flash contains the boot2, the Operating system and saved documents and is not executable. The SDRAM likely contains an uncompressed version of the OS, and a copy of all active documents. The NOR Flash contains boot1 instructions for loading the boot2. On average, a TI-Nspire technology readable document size is 5 KB. That represents the possibility of storing more than 6000 documents on a calculator, whereas before, we should stick to no more than twenty!

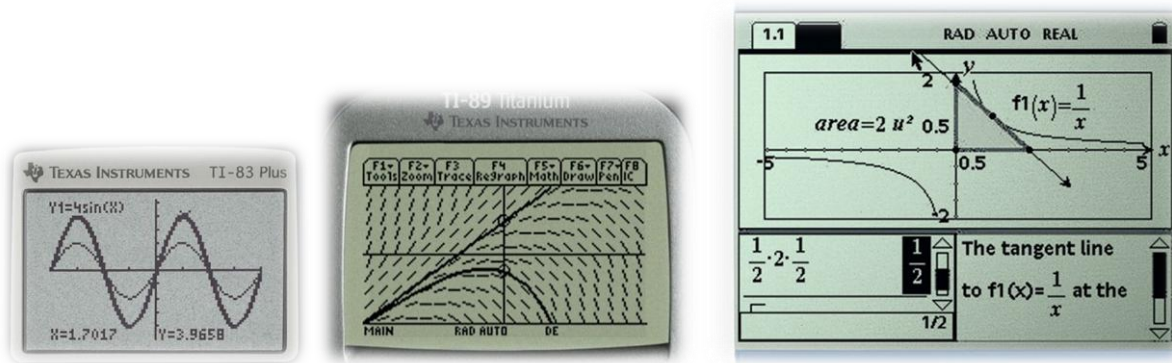
However, this so large space isn't inevitably reserved only for the user. Actually, the user could only access to 12.6 MB over 32 MB of flash memory with the last OS. Why? Quite simple, the OS is not featherweight. Moreover, one copy of the OS is stored in memory, to allow updates between calculators and prevent system failures.

A study on the OS size over the past updates has shown that the available user place is doomed to disappear. This is the reason why the open source TNOC project has been develop to remove the boot2 update and sample files from the OS update. This helps to win 5MB over 32MB.



c. Display

The new LCD screen has a higher resolution (320x240 pixels) and is capable to display sixteen shades of gray. The height of the history it is that the driver screen can manage a color mode going to 32 bits whereas the screen only support 8bits mode. However, this is far ahead the z80 (96 * 64px mono) and 68k (160 * 100px mono).



d. Two models for two objectives

The TI-Nspire Technology has been designed for several American tests (PSAT, SAT, SAT II, ACT, AP and IB) where neither Computer Algebra System nor electronic cheat sheet are authorized. This is the reason why we could find two types of TI-Nspire:

- **TI-Nspire “Basic” or “non-CAS” :**

The standard TI-Nspire calculator is comparable to the TI-84 Plus in features and functionality. It features a TI-84 mode by way of a replaceable snap-in keypad (included) and contains a TI-84 Plus emulator. The likely target of this is secondary schools that make use of the TI-84 Plus currently or have textbooks that cover the TI-83 (Plus) and TI-84 Plus lines, and to allow them to transition to the TI-Nspire line more easily.

The TI-Nspire also features a "testing mode" LED indicator, designed to stop potential cheating, informing test supervisors that the calculator is still denying access to saved files and possibly restricting geometry features on the handheld during the test.



- **TI-Nspire CAS**



The TI-Nspire CAS calculator is capable of displaying and evaluating values symbolically, not just as floating-point numbers. It includes algebraic functions such as a symbolic differential equation solver. For this reason, the TI-Nspire CAS is more comparable to the TI-89 Titanium and Voyage 200 than to other calculators. Its likely targets are college and university students.

e. Wi-Fi driver

Inside this plastic box, we could find in the OS itself a Wi-Fi driver allowing instantaneous documents synchronization between a teacher and a whole student class provided with TI-Nspire Technology holding Wi-Fi Cradle which contains a Wi-Fi emitter and an additional rechargeable power supply. The teacher can send questions, polls, or schoolwork directly on the pupil's calculators without having the usual disorder "Have you got the document?" while having instant access to its pupil's screens.

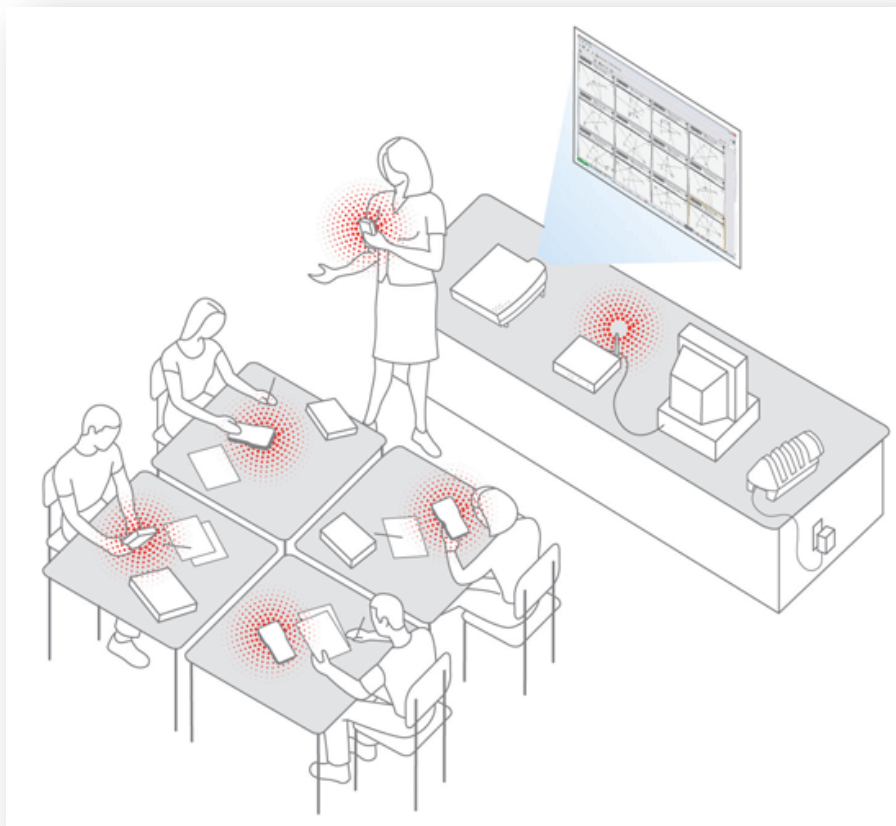
Of course, the alone calculator cannot communicate through Wi-Fi, that would make it useless in France and in International tests. Thus, it is considered as an external and banned system in exams.



Docking station



TI Wi-Fi Modem



TI-Navigator System

f. Batteries consumption

Although it is a fast, powerful and practical calculator, and contrary to z80 and 68k graphing calculators, the TI-Nspire drains the battery faster than an MP3 Walkman. At a rate of 4 AAA batteries every 4 months on average, there is no surprise that the new TI-Nspire, we're going to speak about later, features a rechargeable battery slot.



TI-Nspire battery slot
(front)



TI-Nspire CAS battery slot
(back)



TI-Nspire ACCU slot
(back)

B. Software innovations

a. Computer feel: Operating System, folders, documents, pages, activities ...

The TI-Nspire is, as we said, a software more than a calculator. This is the main reason why TI updates it semi-annually. Indeed, the TI-Nspire OS (Operating system) and the software TI-Nspire Computer Software have been updated every approximately 5 months, and that for 4 years. The TI support on this new technology is thus increased and regular contrary to the preceding graphing calculators where an update meant “additional features and several new functionalities”.

We thus count 9 versions of the Nspire software: 1.1 – 1.2 – 1.3 – 1.4 – 1.6 – 1.7 – 2.0 – 2.1 – 3.0

In order to explain the OS improvements, we can illustrate it with Windows Operating System evolution by comparing each version with each update.

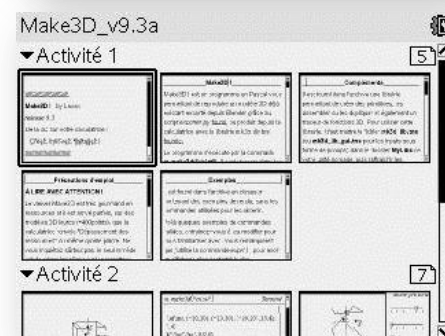
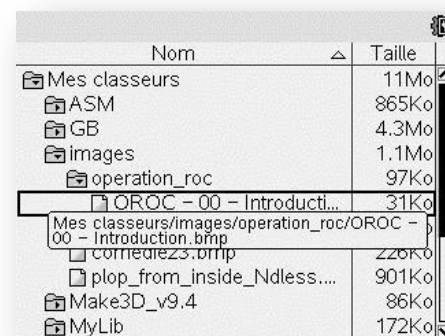
Windows	95	98	XP	Vista	Seven
TI-Nspire	1.1 (2007-05)	1.2, 1.3, 1.4 (2007-08 -> 2008-07)	1.6, 1.7 (2008-10 -> 2009-05)	2.0, 2.1 (2010-04 -> 07)	3.0 (2011-03)

The OS is exchangeable between two TI-Nspire, as we would do between Mac computers. Moreover, this innovation has a precise goal: force and support upgrade of all TI-Nspire. In effect, we also notice that the exchangeable documents between Nspire can't be opened with an older OS than the one where the last editing was done. For example, we cannot open a document on the OS 1.1 if this one was created on the OS 1.2 although those OSes are practically identical. This is not an incompatibility; it is really an argument of TI to force the upgrade toward the last update.

While speaking about document, the Nspire files (*.tns) can be organized in folders, under-folders, folders of under-folders, as on a real computer.

The *.tns files are composed of Activities (named “problem”) including all the variables and functions/programs global to the whole activity. In this activity, we can add an unlimited number of pages. On each page, we can put from 1 to 4 applications among Calculator – Graphic – Geometry – Spreadsheet – Data and Statistics – Mathematical Editor. The organization has several advantages:

- Easily exchange several data comparable to only one file
- Link several experiments by local variables
- Write several documentation, report and lesson page

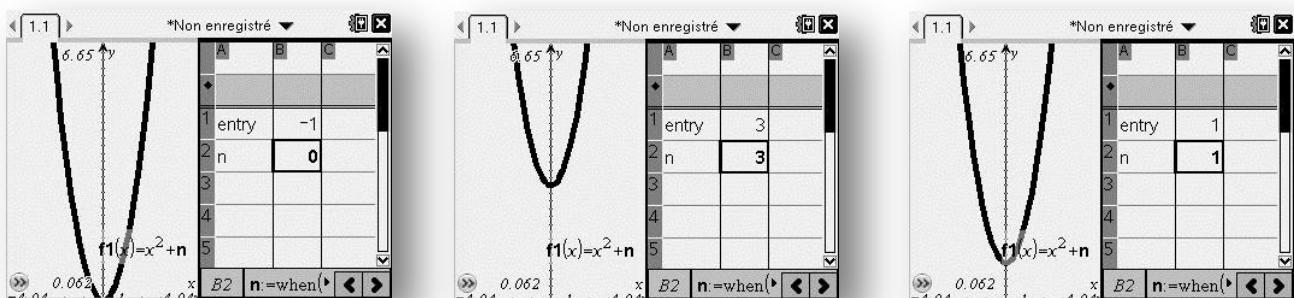


However, when we come from the z80 or 68k world, this architecture displeases because of the fact that the programs are usable only by opening the concerned document. TI then integrated since the OS 1.4 release a public library system.

b. Interactive geometry based

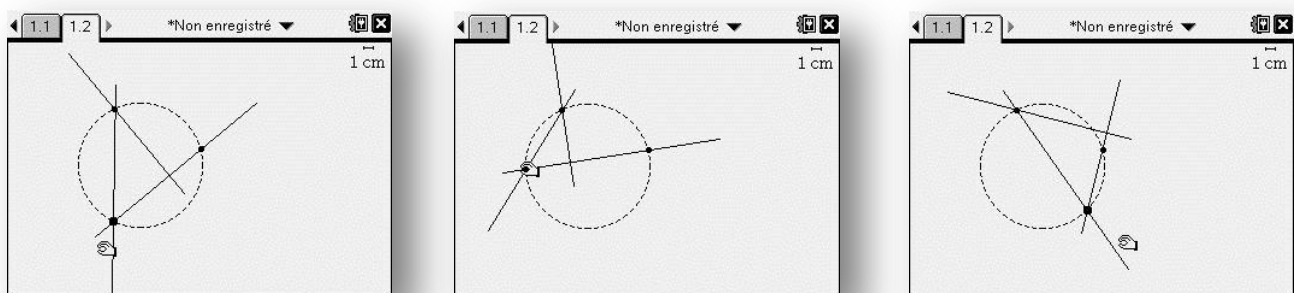
The TI-Nspire has an important advantage compared to all the calculators of the market: All its software architecture is based on the synchronization of the data between each application of a document. If a variable is used overall in several applications at the same time and if it has been suddenly modified, its value is automatically updated in all the other applications.

For example, let's take a Graph and Spreadsheet application. In the Graph one, we plot a curve of equation $f_1(x) = x^2 + n$ with n a variable which is used in the Spreadsheet one by the function $n := \text{when}(b1 \geq 0, b1, 0)$ with $b1$ a case of the Spreadsheet where we could type a value. Each times the $b1$ value changes, we check if it is positive, if so, we store it in n , which will become integral part of the equation $f_1(x)$. If not, n will be valued to 0. The Graph will be, in all cases, updated.



In order to realize this, it is enough to use what we call the multi-threading of the OS which allows to gather up to 4 different and updatable displays at the same time on the same screen.

The interactive geometry precisely makes it possible to create figures whose characteristic points are parent to each other. By modifying a value, or simply a point, we can make move a whole complex system of geometry without any lags. This technology aims to improve the training and to remove the prejudices which the young people can adopt during their schooling, precisely by rendering the geometry a building game. We could compare its power with GeoGebra or GeoPlan, but on a calculator. This principle already exists on z80 and 68k, but not as an integral part of the OS.



This time we have a multi-threading and synchronization of the variables in all documents, without forgetting a much better screen resolution.

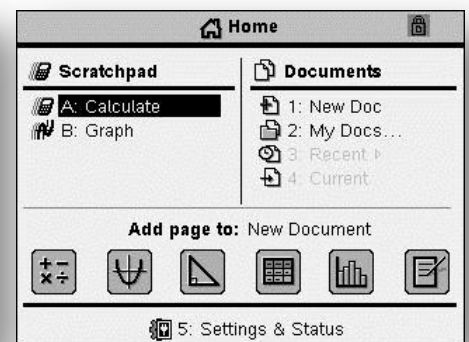
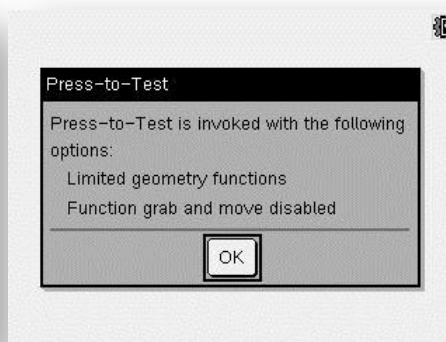
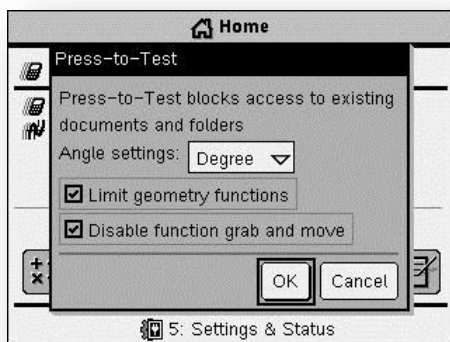
c. Exam mode based

Ti-Nspire and its software were designed to respect the American common tests as we saw, in particular by integrating a test-mode, named "press-to-test". We saw that a LED makes it possible to see whether the calculator is in test-mode, it also features a timer. At the end of a test, the supervisor is required to check the calculator's timer to see if it has not been removed out of "testing mode".

To leave the test-mode, it is necessary to be connected with a second Nspire or with a computer provided with the TI-Nspire Computer Link Software. A candidate has very little chance to be able to leave the test-mode then return in without being able to be seen. It is the TI aim.

The test-mode disables certain functionalities of Nspire, according to the selected mode of prohibitions:

- Impose the unit of angle (radians or degrees or gradient)
- Limit or not geometrical and functional functionalities
- Prevent from changing keyboard
- Prevent the access to the documents



III. The choice of a “closed” technology

A. The beginnings – 2007

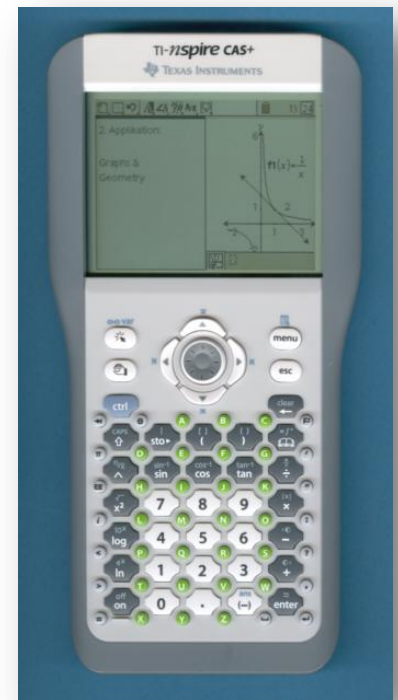
a. TI-Nspire CAS+ (prototype, TI's property)

Before the release of the TI-Nspire, several prototypes were designed. With different colors, they were labeled "TI-Nspire CAS+". Despite being the property of TI, several prototypes were stolen and auctioned on eBay. As they are running an old OS and cannot be updated, TI does not recommend buying them, and wants them returned.

Those prototypes were already looking like the final model (except for the ClickPad and the power supply) and including an OMAP 980 processor designed by TI with an ARM9 technology for a wide variety of products, like the Smartphones.

ARM is for "Advanced RISC Machine" meaning "machine with a low instruction set microprocessor". With a simpler architecture than other CPU families, and a low power consuming, the ARM processors are widely used for embarked systems, like mobile phones and tablet PC.

Today, the advantage of the TI-Nspire CAS+ is its low price (\$60 instead of \$200) for limited possibilities as their OS is bugged and cannot be updated to the last OSes, and as they cannot be connected to computers to transfer documents



b. Partial conclusion

TI has distributed to schools prototypes to promote for free their products and improve them. True, but their control was not full, thus 5% of students are misled into buying on auction online sites, like eBay, one of these prototypes unusable in principle.

B. Disliked period – 2008/2009

a. TI-Nspire: WHAT'S THAT?

Many students told themselves it when they chose TI-Nspire... Okay, it's good, it's fast, but what does it do? From 2007 to 2009, most of students talked about it on topics all over the world: "There isn't any Input/Output function, my old TI-83+ is better!", "Disp function is slower than the TI-82 one!", "It freezes all the time, I have to restart it and wait more than 2 minutes..."

b. No Input/output function

Moreover we note a serious lack of programming capacities. As we already said it, there isn't any Input/Output function whereas z80 or 68k; no OUTPUT, no TEXT, no DIALOG, no CUSTOM... The only process that we've got is DISP. Usually, we buy TI-Nspire to swap broke calculator from TI or CASIO, and we would like to get back the same using.

But TI-Nspire wants to change all the rules. Some people who worked for TI say those disadvantages are advantages: "TI-Nspire was built only to work on Math, so it's normal if it didn't run with game".

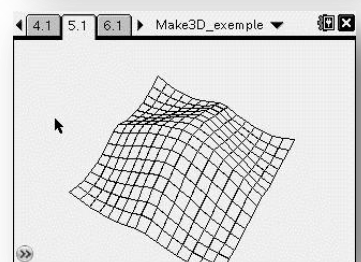
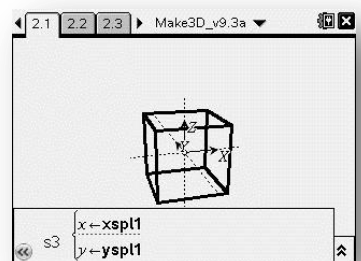
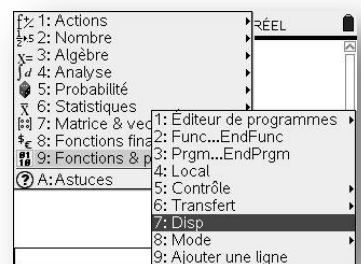
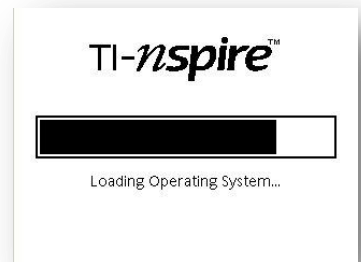
c. No way to make graphical program

This is what we feel when we are using this calculator, we must work on Math! All that we want to create need to be created by us at the beginning to the end: we add a dot, then a line crossing this dot, and then we create a circle which middle is on this line, then the circle tangent crossing on the first dot. We put away the first dot and it move the tangent around the circle ... Is there anything to computerize that with graphic program? TI will answer: "Why?" ... So the official answer is "No", but some people found tips (like MacGyver) to link variables to the dot coordinates, in fact programming is easier. Nevertheless, if we would like to create a game, we are stopped quickly. Don't forget that we can't use "PixelOn" or "PointOn". A tip was found: link two lists (x and y) of coordinate of n graphics items and draw it in a Graphic application like some graphics items fog used in statistics. But TI-Nspire doesn't allow fast adding and fast removing items from lists!

Finally, it's very difficult to create a graphic program, it is just tips.

d. No `getKey()`

We note that there isn't any function to recognize the key that the user pushes. We can forget programs and games using real-time (like FPS). So, programs can't control the machine operation.



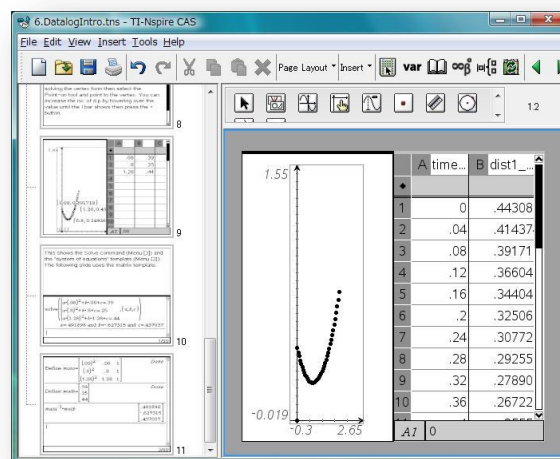
e. A young and small community advises against TI-Nspire

This is a paradoxical and strange situation. Tips found from TI-Nspire are reduced because there are only few people who can buy a calculator for \$200. Actually, we can spend it to getting an "eeePC" that make us to be able to do more thing than TI-Nspire. Nevertheless, the community discourages fairly to buy TI-Nspire. How find more tips without more people?

f. No free emulator

The TI-Nspire is the Nspire Software portage, we cannot access to the ROM like we could on z80 or 68k. z80 and 68k have free emulators, some of those could link a calculator to a computer. This process gets famous because we could test programs in a Virtual Machine without any risk before loading it in the real calculator. We could get screenshots or video screen captures easily to make tutorials or other cool things...

TI-Nspire has got something like that. But it isn't an emulator, it's the Nspire Software for PC or MAC, it can open Nspire files and gets screenshots from those, and we can cleverly print the documents. This software isn't free, its license is sold separately of the TI-Nspire, and we can understand again the discouragement. But getting a license is a serious advantage because we can use all the TI-Nspire functions on a computer adapted interface (keyboard shortcuts, dynamic screen size, and interface with calculator's skin ...) and it can boost production of Math documents. This software already exist in a version that provides link functions with the class "connect-to-class" to be faster in the documents sending, all of this can be made in this software.



Nevertheless, this is a software with a numerical license with a computerized checking system. Thus, this software can be cracked. It has been done on the CAS teacher version of the software; this was a little anecdote.

g. Partial conclusion

There aren't so many negatives points from the TI-Nspire but those disadvantage students because they need to work faster during tests and they wouldn't like to lose this time with "THE best calculator"...

C. T.I.'s free community fight: Opening to ASM – 2010

a. Opened technical documentation

Silently, since 2008, a site, called <http://hackspire.unsads.com>, began to identify all the technical information about the TI-Nspire. Following the first RAM dump made by listening to echoes from the USB port, developers have begun greatly interested in the position of the TI-Nspire. Indeed, it is a young technology using a recent architecture where everything remains to be discovered!

The slogan has been since 2008: "Your mission if you accept it: Hacking the TI-Nspire"

The screenshot shows the Hackspire website interface. On the left is a navigation sidebar with links like 'Main page', 'Community portal', and 'Help'. The main content area is titled 'Memory-mapped I/O ports' and contains a table of contents listing various hardware components and their memory addresses. Below this, two specific entries are expanded: '8FFF0000 - Unknown' and '90000000 - General Purpose I/O (GPIO)'. The '90000000 - General Purpose I/O (GPIO)' entry provides detailed information about the GPIO registers, including their sections, bit fields, and functions.

Memory-mapped I/O ports

Contents [hide]

- 1 8FFF0000 - Unknown
- 2 90000000 - General Purpose I/O (GPIO)
- 3 90010000 - Fast timer
- 4 90020000 - Serial UART
- 5 90060000 - Watchdog timer
- 6 90080000 - Unknown
- 7 90090000 - Real-Time Clock (RTC)
- 8 900A0000 - Miscellaneous
- 9 900B0000 - Power management
- 10 900C0000 - First timer
- 11 900D0000 - Second timer
- 12 900E0000 - Keypad controller
- 13 900F0000 - HDQ1-Wire and LCD contrast
- 14 90100000 - TI-84 Plus link port
- 15 90110000 - LED
- 16 A0000000 - Unknown
- 17 A4000000 - Internal SRAM
- 18 A9000000 - SPI
- 19 AC000000 - SD Host Controller
- 20 B0000000 - USB OTG controller
- 21 B4000000 - USB HOST controller
- 22 B8000000 - NAND Flash
- 23 BC000000 - Unknown
- 24 C0000000 - LCD controller
- 25 C4000000 - Analog-to-Digital Converter (ADC)
- 26 C8010000 - Unknown
- 27 CC000000 - SHA-256 hash generator
- 28 DC000000 - Interrupt controller

8FFF0000 - Unknown [edit]

Possibly power-management related. In the OS, all code that uses these registers is copied to [SRAM](#) and run from there, rather than running it directly from the SDRAM.

90000000 - General Purpose I/O (GPIO) [edit]

The GPIO registers are separated into 4 sections:

- Section 0: 90000000-9000003F
- Section 1: 90000040-9000007F
- Section 2: 90000080-900000BF
- Section 3: 900000C0-900000FF.

Each register is a word, and only bits 0-7 of each are used. There can be up to 32 devices accessed by this setup, each known as a GPIO. Each GPIO is defined by one of the 8 bits in one of the sections. The number of the GPIO is the section number times 8 plus the bit number. Each GPIO has a status bit and can cause interrupts.

The following addresses are offsets from the beginning of the GPIO section:

- +00 (R): Masked interrupt status ([+04] & [+08])
- +04 (R): Reads raw interrupt status (directly dependent on the GPIO input) or sticky interrupt status (becomes set when GPIO status changes) depending on bit in [+20]
- +04 (W): Write 1 to the bit to reset the sticky interrupt status.
- +08 (R): Reads current interrupt mask bit.

d. First ASM program on Nspire – Jail break (by a French developer on December the 30th 2009)

Drum roll... we are a certain December 30th 2009; the forums activity is reduced due to the Christmas Holidays for much of the developers. It is 2:31am when Olivier Armand *aka* ExtendedD posted a message full of poetry followed by a picture showing the TI-Nspire finally dominated:

« I have been able to execute arbitrary code, using several flaws of OS 1.1.9. I have full control »

The OS current version was 1.7. ExtendedD had hacked OS 1.1, which was a 3 years flash back. Indeed, we should believe that before, the OSes were not as secure as they became later.

e. “Ndless” development: Jail break computerized procedure

Code name: Ndless

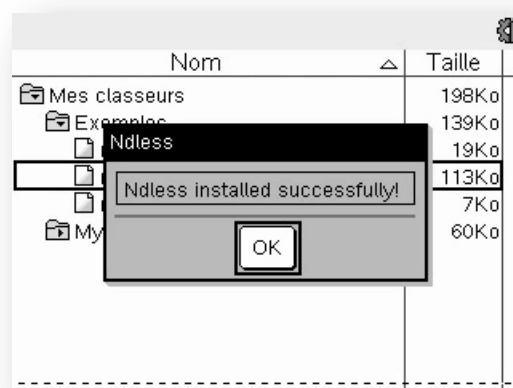
Spelling: “endless”

Ndless is a utility to automate the Jail-break process to open the TI-Nspire to assembly code. The first stable and distributed version was released on February 27th of 2010, version 1.0. Ndless in its initial versions (1.0 and 1.1) includes a method called “two-phase” installation:

- Downgrade to OS 1.1 with a computer followed by the jail-break transfer
- Jail-break implementation.

Its installation thus requires a computer, but is “final”: a reboot can’t make lose the installation and only a special handling could remove the jailbreak allowing an OS update.

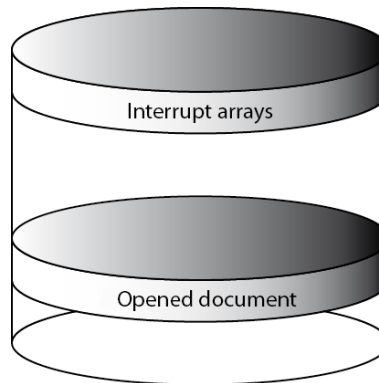
In its actual revision, Ndless is based on routines that the OS provides. These routines are called directly in memory. Each version of Ndless corresponds to the OS it can jail-break, because the routine calls are specific (it is just a number, multiplied by all the calls, about fifty addresses to find). Indeed, the OS is recompiled for each new version, the routine location in the ROM changes, so you must find the routine addresses by hand. This is the reason why we can see several Ndless revisions between versions 1.3 and 2.1 while the program itself remains the same. Ndless, between versions 1.3 and 2.1, is CAS and non-CAS compatible in a transparent way, we simply refer the routine addresses for both the CAS and non-CAS (ie double research work). Its installation is carried out in 8 seconds through a fake *.tns file very easily shareable not even 200KB. Because it runs in RAM, a reboot will erase the installation (since the RAM is emptied on each reboot).



One question is still here: How could we open a closed technology?

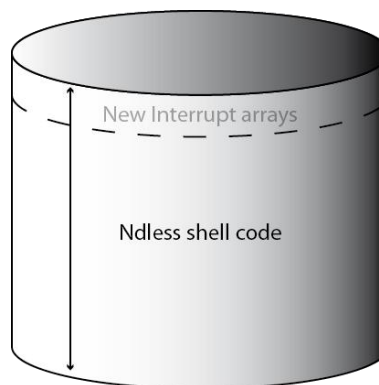
Actually, we have to control the executive flow, inject a shell code in the memory stream and redirect the instruction pointer to the shell code. The final state of the equation is: the system call through a modified pointer the shell code which executes a third party executive code.

When we open a TI-Nspire file, the OS books some place in RAM.



Basic memory state

The Ndless shell code is packed in a TI-Nspire file which feature the ability to fill entirely the RAM when we open it. The built-in *malloc()* function returns a NULL pointer, and continues to the next step because the OS doesn't check this particular value. Thus, this encounters the shell code decompression at the NULL pointer (0) in the RAM, erasing the interrupt arrays on the way.



Memory state after Ndless launch

The next timer interrupt will execute the associated interrupt which is driven by the shell code. At this state, the shell code installs some hooks, at the document opening for example. Then, the shell code restores the OS in a stable state with kind of different patches and call stack manipulations.

f. Partial conclusion

As a true free community where everyone uses the resources of each other to create new ones, the free TI community has managed to catch up in 1 year a 5 years development hold-up. The Ndless development made its mark on Nspire history. It becomes quite literally, the best calculator on the market, because its hardware features can finally be exploited up to 100%.

D. The endless battle in front of T.I. – today and tomorrow

a. New Nspire hardware platform: TI-Nspire Touchpad and OS 2.0

We don't know if the arrival of the new version aimed to compete with Ndlless, but March 5th, so just one week after the Ndlless arrival, TI proudly promote the new TI-Nspire arrival, which was in April. It is visually almost the same one, but the new features are important:

- Color changing (TI-Nspire non-CAS White et Black, TI-Nspire CAS Black glossy)
- Keyboard Organization changing (Alpha touch are now separated)
- Click pad replacement for a Touchpad (like on laptop)
- New battery slot behind the screen.
- New LED and removable keyboard (with polarizing slot)



This new TI will be followed by a new OS arrival, which is compatible with the old TI-Nspire model, and which add some news graphic and software improvement:

- Retailed interface
- *Request*, *RequestStr*, *Text* add : the first input/output functions
- Scratchpad: a notepad which can be opened anytime.

After these two gifts arrival, tests have been realized, and an unknown downgrade protection has been discovered which block the old version (< 1.7) downgrade. Effectively, the old OSes cannot work with the new hardware model.

**b. T.I. banned public OS redistribution:
T.I. clearly doesn't want Ndless.**

TIBank, a website community which host more than 1 billion of archives concerning every TI, used to host the Nspire OSes for by and by 3 years. Then Ndless 1.0 has been released the 27th February, and two months later TI warns TIBank for OS hosting, which are under license and property of TI. Assisted by advocates, TI asked for cleaning out this website of every OSes by bringing back its rights. "There is only one copy of the software for each license number. Any other copy may be considered as an illegal one."

On the other hand, these OS restrictions will make Ndless' life harder, because it downloads the only jailbroken OS (the v1.1) directly on TIBank in case of installation. After this, the other OS hosting websites had to remove it too to avoid a warning. Then, the OS 1.1 has been removed from Internet in 5 days all over the world, consequentially blocking the Ndless bloom.

To sum up, that was the TI response to Ndless.

c. OS Update every 6 months: force the upgrade

Today, the protection aiming to protect *.tns files which are created with a superior OS than the one in which we are trying to open it is an irritating problem. Many students have been obligated to update their OS to use what another person had published. TI has then a complete control of user updates. Every time we run the TI-Nspire Computer Link Software, a message alerts us that a new update is now available.

But that kind of practice has been surrounded when the OS 2.1 arrived. A lot of students just bought their calculator and unconsciously upgraded when seeing their calculator bugging on installing. In fact, the OS 2.1 had become incompatible with the boot2 v1.1 that the calculator had on sales. The O.S. update needed an O.S. between the 1.4 and the 2.0 one into updating the boot2 to v1.4.

TI had not thought about a hypothetic existing TI-Nspire having a boot2 v1.1 in 2010. However, they were more than 20 people who were asking for help on the web, and maybe many other who didn't casted.

d. OS 2.1: what the Hell?

As we've seen it previously, the new OS 2.0 which arrived when the TI-Nspire TouchPad was revolutionary and full of new things. No defaults have been mentioned about that OS, then 3 months later, TI published as usual a new OS (2.1), which did not really present a lot of new things, although its arrival were greatly promoted.

TI was surely hiding something behind this new O.S. For a long time we haven't seen a boot2 update, adding an anti-downgrade protection which announces the Ndless end, because many people contributing to development may be slang by upgrading.

But the OS 2.1 didn't include any boot2 update, but as we thought, it was preventing every downgrade to inferior O.S.

e. Community response: “Nleash”
Delete T.I. downgrade protection.

Code name: Nleash

Pronunciation: “Unleash”

Signification: make someone free

Few times after its arrival, Ndless developers began to think about the OS 2.1 problem. They randomly discovered a diagnostic menu and managed to control the LED via third-party programs.

The OS 2.1 protection is written in memory after the boot2 (not far from the diagnostic menu). It indicates a minimal OS version written at every OS launch since OS 2.0. Thus, deleting this number is not enough, because the OS will rewrite it after its launch. Because we cannot modify the OS to stop this write, we have to completely delete the OS while deleting this number. Nleash does this job automatically and this is the reason why we have to launch it just before a downgrade.

A test has been realized on the TI-Nspire TouchPad, and it was a success! TI used the same anti-downgrade protection on the new model and, to allow the operation on every TI-Nspire, added it in the new OS. Then, the operation has been added to every model too, and then the Nspire TouchPad had been downgraded, revealing a lot of problems about keyboard (mapping and compatibility). On the other hand, every TI-Nspire had access to ASM language with Ndless.

f. Ndless 1.7 and 2.0

The Ndless 1.0 inconvenience was that the OS 1.1 was requested, that was impossible for a lot of people because:

- The OS 1.1 was rare on the web
- It was impossible to open documents created with superior OSes but playing games was possible.

ExtendedD was developing for 6 months a new Ndless version compatible with the most used OS: 1.7. As detailed previously, this new version used a totally different way and can easily be sent between calculators without any computer help, the same file between TI-Nspire and TI-Nspire CAS.

Ndless 1.7 was only compatible with the OS 1.7 and didn't allow the TI-Nspire CAS TouchPad Jailbreak due to keyboard recognizing problems. That's why the free-community worked hard to win his gamble: making up TI. From the Ndless 1.7 sources, some developers changed the addresses and released Ndless 1.3 and 1.4 compatible with OSes 1.3 and 1.4.

Recently, ExtendedD released on beta-stage Ndless 2.0 half-compatible with TouchPad, again because of a bad TouchPad recognition which cannot be mapped like other keys. Ndless 2.0 can jail-break OSes 1.7, 2.0 and 2.1 with a particular stable state.

Jail-breakable OSes version in blue:

1.1	1.2	1.3	1.4	1.6	1.7	2.0	2.1	3.0
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g. Alternative development: Nover – Norse – mViewer

Some great Ndless-based programs have been released only a few weeks after Ndless 1.7, extending the possibilities of the TI-Nspire handheld.

For example, the mViewer program is an image reader supporting the standard BMP file format, making the Nspire technology less closed. Any PC document can be converted to a BMP file viewable on the TI-Nspire handheld.



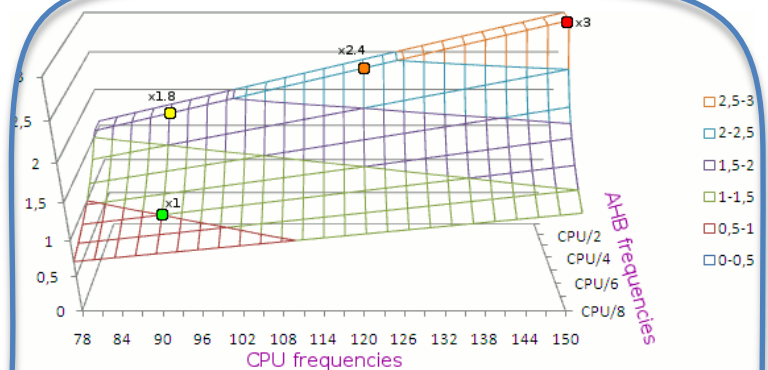
The Norse program is a codec using a ternary variant of the Morse code. It lets TI-Nspire handhelds exchange messages wirelessly by just turning on the included LED in green/yellow/red. The LED designed by TI especially for exams, is now becoming the main weak point of the exams.



Norse 1.0 (<http://www.ti-bank.fr/911>)

- 1) Messages editor
- 2) Typewriter
- 3) Messages decoder
- 4) Codes table (Norse 1.0)
- 5) Test LED
- 6) Quit

Press Esc to cancel/return/quit



- Original config for OSes 1.1-2.0
- Max config for OSes 1.1-2.0
- Original config for OS 2.1
- Max config for OS 2.1 or Ndless

With the OS 2.1, TI is overclocking the TI-Nspire handheld. But it has been discovered that the main reason behind that is to hide some performance problems with that OS. With exactly the same hardware configuration, it is slower than previous OSes. The Nover program lets student overclock their calculator with the OS 2.1 speed and much higher, making them return of complex algorithms up to 3 times faster.

Nover 1.1 (<http://www.ti-bank.fr/913>)

Current raw config: 1314818 (set)

Base = 180 MHz	Base / CPU = 2
CPU = 90 MHz	CPU / AHB = 2
AHB = 45 MHz	Base / AHB = 4

	[1] Base	[2] Base/CPU	[3] CPU/AHB
[0]	Cancel all modifications		
[-]	Cancel unset modifications		
[9]	Load fastest config OS ≥ 2.1		
[6]	Load official config OS ≥ 2.1		
[x]	Load fastest config OS ≤ 2.0		
[÷]	Load official config OS ≤ 2.0		

[enter] Sets current config
[esc] Exit program

h. OS 3.0

Very recently, on the Vernier official website (Vernier sells measuring and analyzing tools, which are compatible with Texas Instrument calculator), we could read an article detailing a new compatible TI-Nspire device and an see screens of application exclusively available in O.S. 3.0 : "DataQuest"

TI confirmed, after some interrogations, the O.S. arrival but with no more information on its website. The general asking was to add the 3D representation and new I/O functions. Will TI surprise us?

We have to know that CASIO recently released a new calculator which brings a colored and backlit screen named CASIO PRIZM.

After weeks of wait, everyone could finally discover a new O.S. coming with a new TI-Nspire model; here we go again ... This new model brings also a colored and backlit screen with a completely different design: TI-Nspire CX



i. Partial conclusion

2010 was a year full of discovering and affronts with TI. Now, the free community dominates, but the fight isn't finished yet! TI had never thought that one day its TI-Nspire can access to ASM language, because it was a really heavy commercial argument for educating. Developing new OSes and new hardware models is the only choice that Texas Instruments has in front of hacking attempts.

Conclusion

3 different hardware models around one unique technology due to hacking attempts and commercial competition, this is the TI-Nspire Technology. The way of mind of Texas Instrument has consequently changed. They don't care more about the user because they focus on teacher and on the American educational system. Providing math software instead of a calculator is the new goal of TI and no matter how hard we try to be heard as users, TI doesn't move any finger; hacking attempts excepted.

Bibliography

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<http://yaronet.com/> (Fr)

Glossary

Handheld:

We use this term when referring to the TI-Nspire product that you quite literally hold in your hand.

Technology:

The word *technology* can mean a lot of things. In this document, we say *TI-Nspire technology* quite often. In this context, *technology* refers to any TI-Nspire related product, whether it be a TI-Nspire handheld or a TI-Nspire software application such as TI-Nspire Computer Link.