PAMAP

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Sensor Platform Prototype Report and Documentation

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EXECUTIVE SUMMARY

This report describes the developments within WP3, the first prototype sensor platform. It is splitted into hardware and software development. The hardware platform contains the processing/collection unit (companion) and several sensors attached to this unit. The sensors are mainly motion sensors but can also be a heart rate sensor. The sensor fixations are also described within the hardware section. The next part of the report describes the integration. Because some parts of the deliverable D3.1 (first prototype sensor platform) are delayed, also the influence and reasons are described. The user manual and the API documentation of the software are in the appendix.

1. SENSOR PLATFORM HARDWARE

1.1. *Personal Area Network Infrastructure*

The sketch below shows the architecture of the first prototype sensor platform (= Personal Area Network, PAN). It consists of the Control Unit (= Companion) and the different sensors used for measuring physical activity. For the first prototype, tiny inertial motion sensors, a heart rate monitor and a GPS sensor are used.

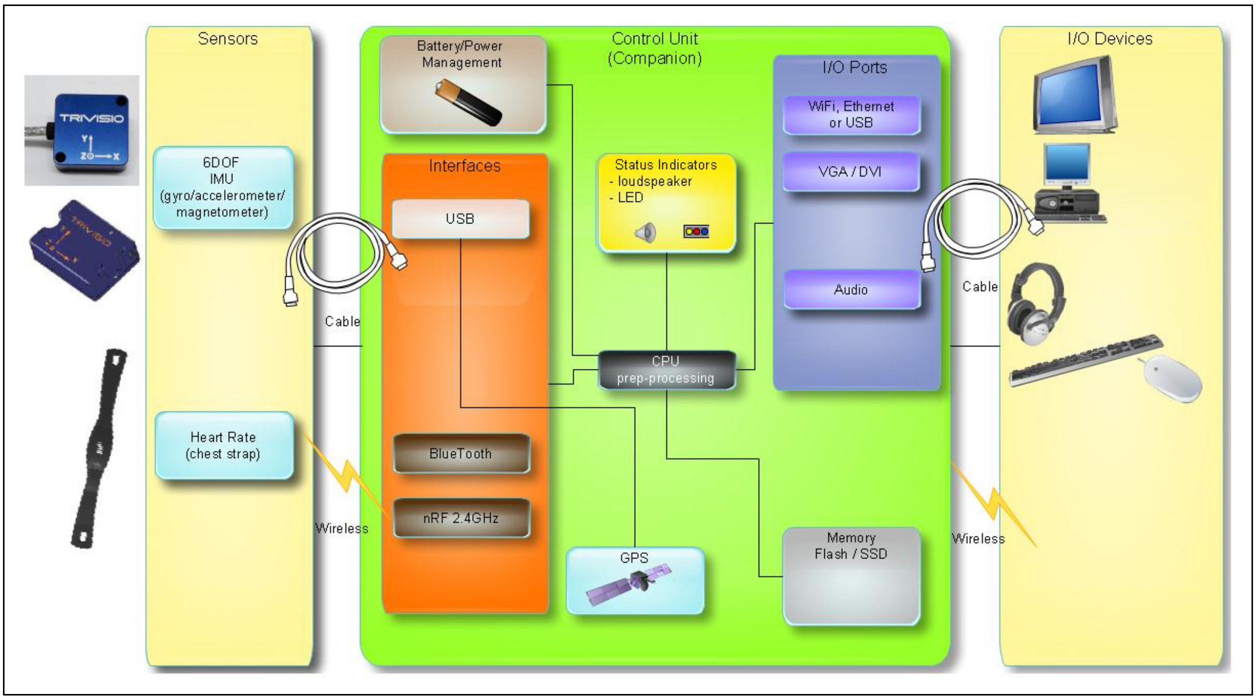


Figure 1: PAMAP Sensors Network

1.2. *Sensor Network*

This section covers the Task 3.1 Physilogical/motion-based sensor module. The three different types of sensors used for the first prototype are inertial motion sensors, heart rate monitor and GPS. Their development and details are described below in the next paragraphs. The GPS sensor was selected off-the-shelve and included into the companion unit, see section "1.3 Companion" page 14.

1.2.1. *Motion Sensors*

The development of the wired motion sensors was done in an iterative process. Together with the partners, here mainly DFKI, the requirements and technical details were discussed and the electronic concepts based on state-of-the-art components designed. After the electronic schematics were finished the layout was done and the PCBs ordered. The mounting of components was mainly performed in house.

The following table shows the main specifications of the stages and current motion sensor called "Colibri".

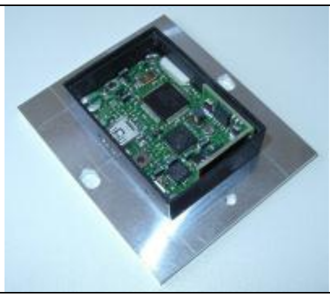
	1st Generation	2nd Generation	3rd Generation
			
Accelerometer (3 axis)	±16g 10bit	±16g 13-bit	±16g 13-bit
Gyroscope (3 axis)	±300°/s 10-bit	±300°/s 10-bit	±1500°/s 10-bit
Magnetic Sensor (3 axis)	±1100µT0.0263µT (37Hz) to 3.3681µT (4700Hz)	±1100µT0.0263µT (37Hz) to 3.3681µT (4700Hz)	±1100µT0.0263µT (37Hz) to 3.3681µT (4700Hz)
Temp-Sensor	/	/	±0.5°C 0°C to +70°C
Orientation accuracy		Pitch/roll: 0.5 ° Yaw: 1 °	Pitch/roll: 0.5 ° Yaw: 1 °
Frequency	100Hz	100Hz	100Hz
Power consumption			0.2W
Dimensions	50mm x 34mm x 20mm	30mm x 30mm x 14mm	30mm x 30mm x 13mm
Weight		18g	22g
Comment	First test platform	USB cable detachable	USB cable fix, water resistant

Table 1: Indicative "Colibri" specifications

These sensors were used by DFKI for the early demonstrator and first prototype. Here the IMUs were synced by timestamp method. Then the IMUs were modified by an additional sync cables and further tests were performed:

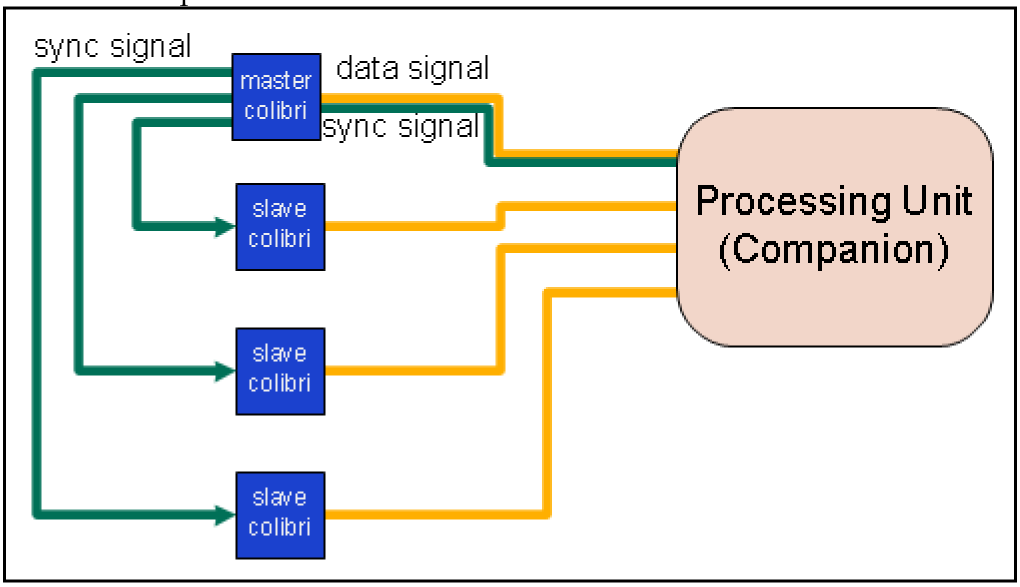


Figure 2: Wired IMUs with wired sync

1.2.2. Wireless Motion Sensors

At the end of the year 2009 Trivisio started with the development of the wireless transmission technique for the mobile inertial measurement unit (IMU) Colibri. After checking the market and analyzing the different wireless techniques, the decision was taken for a 2.4GHz frequency. It works with the same frequency range as BlueTooth but with an optimized data transmission for sensors and low power applications and offers a better reliability, compared to BlueTooth. Experience with the wired motion sensor Colibri and feedback from testers have shown a weakness of the z-axis sensor. Therefore we replaced that chip by two different z-axis sensors (one for a wide range of accelerations, second one for a higher precision but lower shock range). The choice of battery was one of the last steps after the power consumption and electronic dimensions were defined. Some general background information about different battery types are discussed further below (see 1.3.13 Battery page 23). For the wireless motion sensor we planned an autonomous time of about 8-10 hours and choose a 3.7V Lithium Polymer battery.

The wireless receiver unit is designed to handle and synchronize 10 IMUs. The synchronisation between the sensors is wireless.

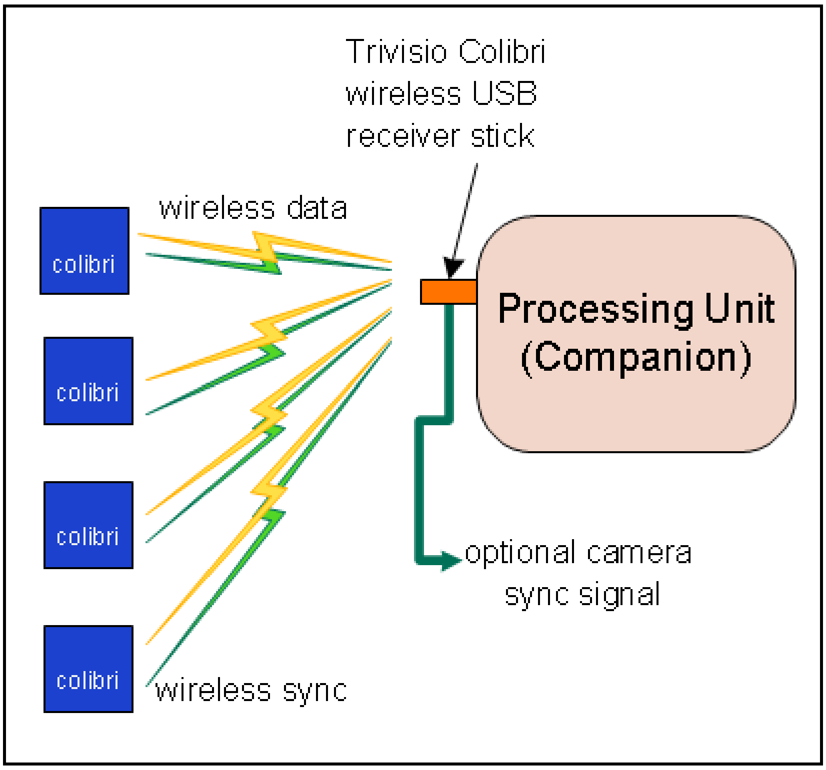


Figure 3: Wireless IMU sensors sync

The first prototypes of wireless motion sensors are currently in assembly process.

	Colibri Wireless
	
Accelerometer (3 axis)	±16g and ±6g 13bit
Gyroscope (3 axis)	±1500°/s 13bit
Magnetic Sensor (3 axis)	±400µT 12bit
Temp-Sensor	±0.5°C 0°C to +70°C
Orientation accuracy	Pitch/roll: 0.5° Yaw: 1°
Frequency	100Hz
Power consumption	3.7V LiPo battery (55mA)
Dimensions	56mm x 42mm x 19mm
Weight	48g
Comment	In final assembly

1.2.3. Sensor Fixation

The fixation of the sensors to the users body is a very important aspect for the acceptance and handling of the system. The actual system uses different types of bandages to fix the IMUs (see Figure 1). These bandages are very robust. This is limiting the movement of the IMUs on the skin independent of the IMUs' weight. Therefore it is a very good solution to test the system and different methods. The drawback is an inconvenient handling because the sensors and bandages must be attached step by step and one by one. The bandages are also quite cumbersome during exercises and movements. This solution might not be suitable for the final product. However, the whole body sensor set should be used only for a short period of time, namely during the resistance/stretching exercise monitoring. Nonetheless this solution might be acceptable, especially if the number of sensors is reduced to a few units and if the sensors are wireless.

Figure 4: Marker fixation, chest strap

For the final product it is planned to use a "second-skin" underwear suit as those proposed by some sport clothing firms (Figure 5). The material is very light, deformable, and offers a high sweat transport, which is interesting from the hygienic point of view. To fix the IMUs to such suit, plastic snap buttons could be used (Figure 6). With such a system the IMUs are easy to remove for washing the suit. However, some tests should be performed in order to find possible oscillations of the IMUs caused by the elasticity of the material and their weight. It must be avoided because it could affect the acceleration data. It is particularly important for the new wireless IMU generation, which has a slightly higher weight of about 50g. Tests are planned to evaluate the behaviour of the IMUs fixed on different materials. Since a whole set of IMUs is not available yet, these tests will be performed with dummies (PVC boxes) that will respect the dimensions and weight of the real IMUs. The density of PVC is perfect to simulate the characteristics of the IMUs.

Figure 5: Example of a «second-skin» underwear suit (Decathlon, France)

Figure 6: Plastic snap button (Hualian Garment Component Enterprise Co., China)

1.2.4. Heart Rate Monitor

There are several commercial wireless heart rate monitors available on the market, all connected via Bluetooth. This gives the flexibility to try different types and even change to ECG version or pulse oximeter. The following table compares the specs of selected heart rate monitors.

	Zephyr™ HxM	mobimotion Spurty	Alive Heart Monitor	BMinnovation BM-CS5
Type	Heart rate	Heart rate variability	Heart rate +ECG	Heart rate HR variability
Fixation	Chest strap	Chest strap	Stickers	Chest strap
Resolution	1 bpm			
Other	3-axis accelerometer	GPS optional	3-axis accelerometer	Accessories TI EZ430-Chronos
Operation time	26 h	14 h		700h
Link	www.zephyr-technology.com	www.mobimotion.com	www.alivetec.com	www.bm-innovations.com
Weight		80g		
Price	100 EUR	125 EUR		100 EUR

Table 2: Indicative Heart Rate Monitor specifications

Figure 7: Zephyr™ Heart Rate Chest Strap

Figure 8: mobimotion Spurty Chest Strap

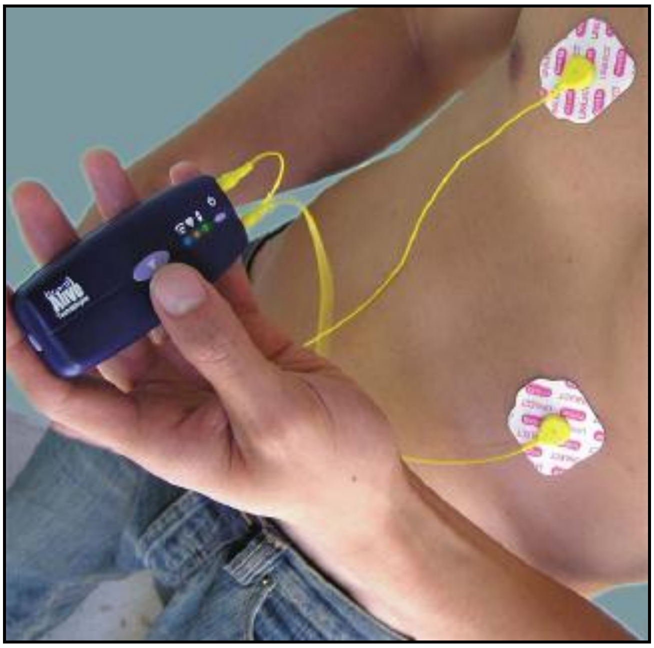


Figure 9: Alive Heart Monitor

Figure 10: BMinnovation Chest Strap

We have contacted all companies with the question of Linux support and received only one answer from Zephyr, that there is no software or API, the sensor comes only with a description. Therefore we will try to start with the BMinnovartion chest strap, which uses BlueRobin wireless technique and a TI based solution. A community and open source examples exist and drivers for Linux for the TI watches EZ430-Chronos which are able to receive the chest strap signals.

1.3. Companion

The companion (processing unit) is the task 3.2 (Mobile sensor gateway) of the WP3 and designed as a wearable belt worn unit. It contains the interfaces connecting to the wired and wireless motion sensors as well as to the heart rate monitor and GPS. It also allows simple interaction with the user and alarm functions. Further the processing unit acts as data logger.

There are three different approaches to develop the processing unit: integrating consumer hardware like nettop PCs, integrating off-the-shelve hardware like embedded mainboards, or using completely self-designed and manufactured PCBs. The option of consumer PCs has the advantage of high integration and good performance to price ratio. But the experience with other projects has shown that consumer products change rapidly their specifications and tend to be discontinued after a short time. This is blocking the commercialisation of the future project. Also the size of the unit could become bigger because a shell/case must be designed around the nettop PC to cover connecting cables. DFKI has suggested the use of Sony Vaio P-series. This is a good reference of performance and a good fall back solution in case of technical problems and delays (see further below, "1.3.16 Delay" page 28). The third option of complete self-design is not suitable because of very high costs and very long development times. Therefore it has been decided to implement off-the-shelve components like embedded processing hardware (mainboard, LCD touch panels, buttons and battery packs) into one self-designed case. The individual components are specified below.

The following table summarizes the specifications and the interfaces of the processing unit:

Dimensions	165mm x 115mm x 35mm (preliminary)
Weight	550g (preliminary)
CPU	Intel Atom™ Z530
RAM	1GB
HDD	64 GB, Read up to 110 MB/s
Memory extension	microSD
Network	Gigabit Ethernet, RJ45
WiFi	802.11n (150Mbps)
USB	2x USB 2.0, connector A (free for keyboard, mouse + accessories)
LCD (touch) screen	3.5", 640x480, resistive touch
GPS	integrated
Sound/Audio	integrated loudspeaker
Operating System	Microsoft Windows (XP) or Linux
Heart Rate Monitor	(external connected via BlueTooth)
Battery	Li-Ion 28Wh, replaceable, rechargeable
Operating time	5 hours (preliminary)

Table 3: Indicative Control Unit specifications

1.3.1. Processor (CPU)

The most important and first decision for the development of the control unit is the central processing unit (CPU). It influences the performance, power consumption (operating time with batteries) and compatibility to software. We considered two alternative platforms: RISC/ARM architecture and Intel® Atom™. The advantage of ARM is a much higher efficiency, it is smaller, more power saving and slightly faster. But the disadvantage is reduced functions and lack of floating point calculations. For that reason we decided to search for platforms based on the Atom™ architecture.

Figure 11: RISC/ARM vs. Intel® Atom™ (Source: PC Watch - http://pc.watch.impress.co.jp)

To compare the performance there are some benchmarks defined. The next graphics compares the different processors: As suggested by DFKI, using a Sony Vaio UMPC as platform, we are comparing to this processing power. Sony is using Intel® Core2Solo U2200 in the old Vaio (VGN-UX390N) and Atom Z540 in the new Vaio P-Series. We are comparing with some available Atom™ and the maximum possible processor based on embedded platforms in small size Intel® Pentium® Core2Duo™ in the list. The used benchmark is passmark (source: www.cpubenchmark.net), also the TDP is given (TDP=thermal design power, represents the maximum amount of power the cooling system in a computer is required to dissipate).

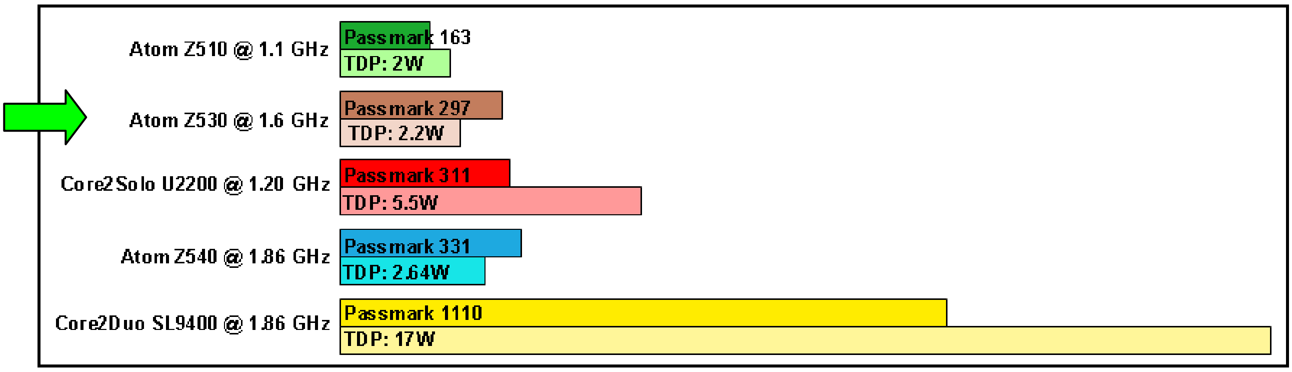


Figure 12: Benchmarks and TDP of Intel® Processors

1.3.2. *Mainboard*

There are several mainboards available for embedded PC developments based on Atom™ processors, mainly in different dimensions and two different concepts. The computer-on-module (COM) concept is preferable for integration with self designed electronics. The single computer boards are independent mainboards as known from desktop PCs. In the case of the first prototype there is no need for a self developed PCB as we need only the functionality of the mainboard itself. Therefore we decide to choose an SBC mainboard. For the Atom™ processor there are several mainboards in the size of pico-ITX available.

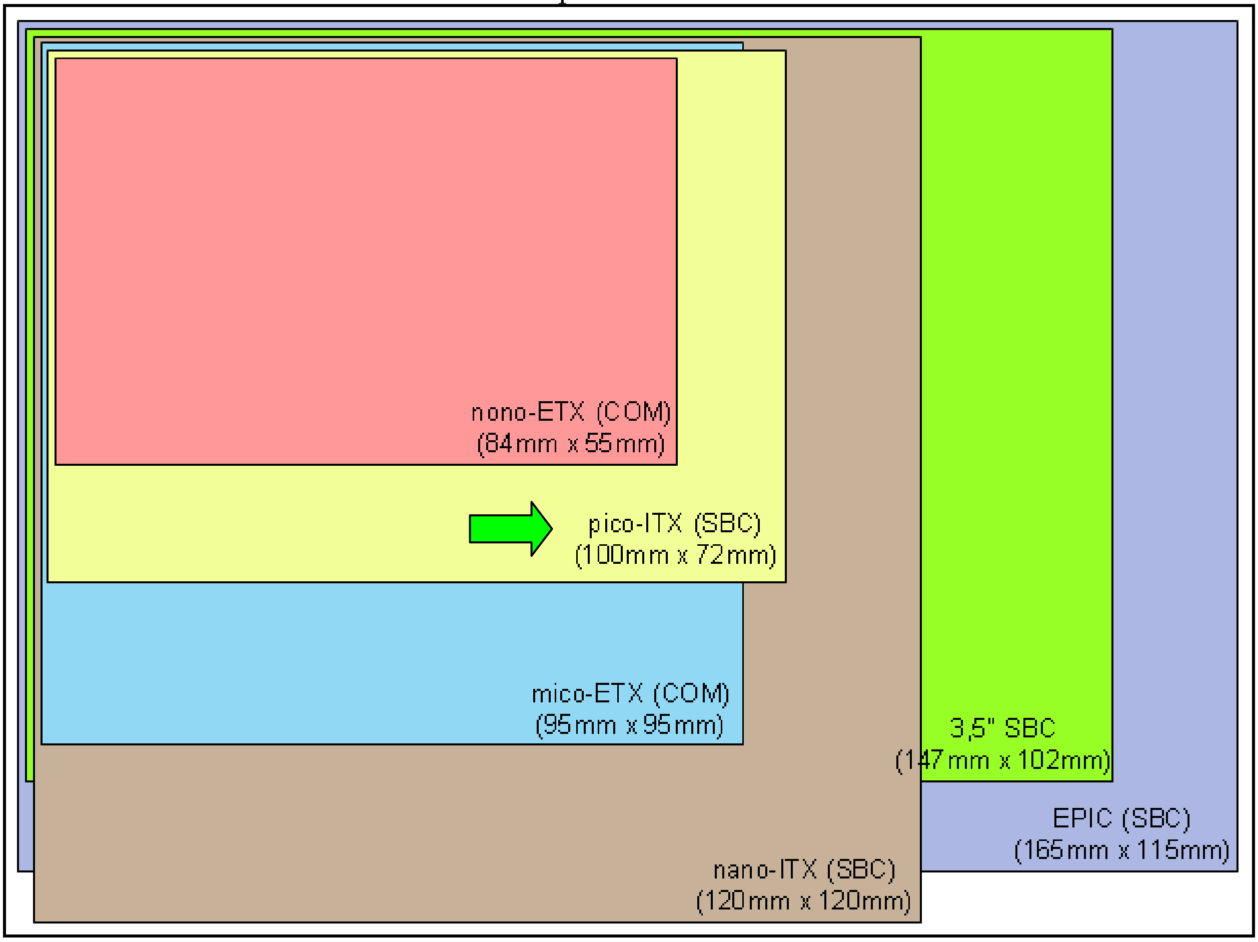


Figure 13: Compare available embedded Atom™ mainboard size

	Kontron pITX-SP	Procelerant PICOZ500 Pico-ITX	Axiomtek PICO821
CPU	Atom™ Z530	Atom™ Z510	Atom™ Z530
Benchmark	Passmark 297	Passmark 163	Passmark 297
Memory	1x DDR2 SO-DIMM up to 1GB	Integrated 512MB DDR2-400	1x DDR2-400/533, PC2-3200/4200 up to 2GB
Graphics	Intel® US15W DirectX 9.0e, OpenGL 2.0	Intel® US15W DirectX 9.0e, OpenGL 2.0	Intel® US15W DirectX 9.0e, OpenGL 2.0
Video interface	LVDS, DVI	LVDS	LVDS
Network	Gigabit Ethernet	Gigabit Ethernet	Gigabit Ethernet
Storage	IDE supporting two Ultra ATA/100 devices MicroSD socket (max 2GB flash memory)	IDE supporting two Ultra ATA/100 devices MicroSD socket (max 2GB flash memory)	IDE supporting two Ultra ATA/100 devices CF II
USB	6x USB 2.0, 1 client (2 x at front panel, 4 x on board)	6x USB 2.0, 1 client (2 x at front panel, 4 x on board)	5 x USB 2.0, 1 client
Power consumption	5W typical	less than 5W	Minimum 9 Watt
Dimensions	100mm x 72mm	100mm x 72mm	100mm x 72mm
Weight		67g	67g
Price		260 EUR	300 EUR
Availability	July 2010	Stock	Stock

Table 4: Indicative mainboard specifications

We selected the Kontron Mainboard because of available Linux drivers, fastest CPU and most USB connectors.

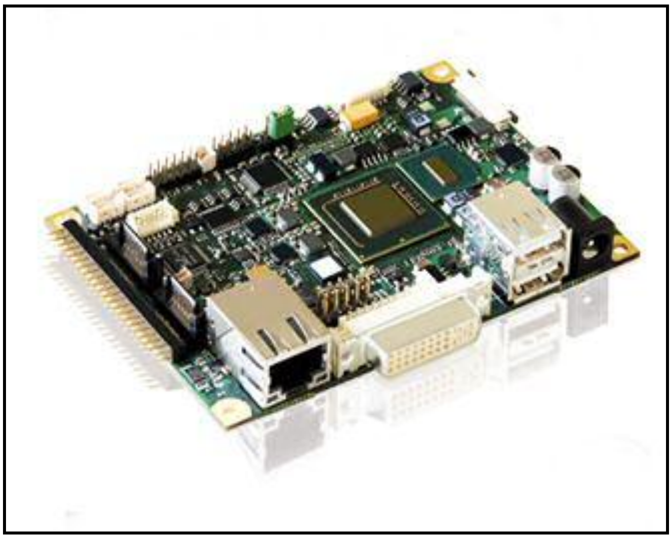


Figure 14: Selected Atom™ mainboard

1.3.3. LCD Screen

The display should be able to show status information and could be used for interaction if a touch panel is applied (together with graphical buttons shown in display). Since there is no need to show much graphical information, the main display should be normal flat screen and no ocular or NTE (near-the-eye) unit. Such NTE unit could be offered as optional variant or module later. For the direct view flat screen display there are two different options, the first is a dot-matrix display and the other is a standard TFT LCD (thin film transistors, liquid crystal display) screen. The dot-matrix displays are available in LCD technique, with LEDs, based on luminescence and as electromechanical display, all offering usually better contrast ratio, better viewing angle and consuming less power than standard TFT LCDs.

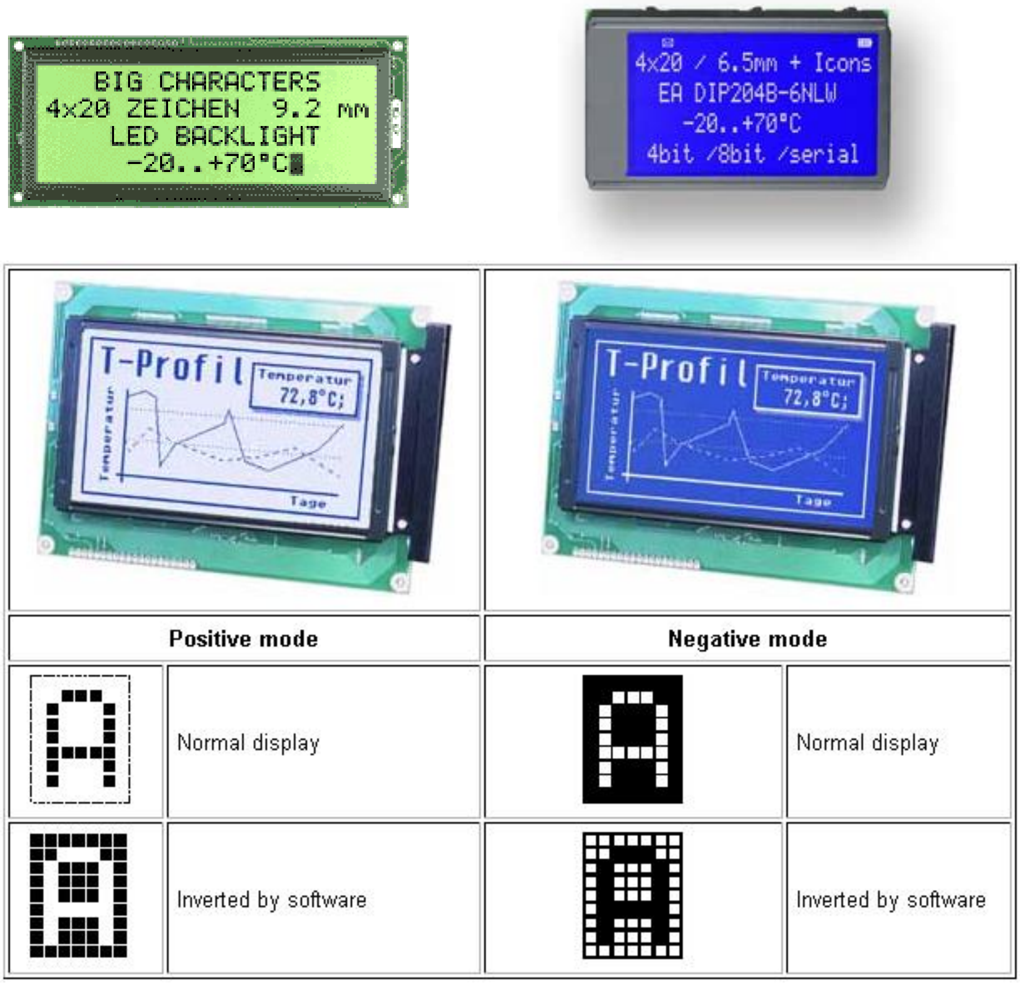


Figure 15: Dot-Matrix displays

The disadvantage of dot-matrix displays is the need for special video drivers and adapted software code to show the information. Since the selected mainboard is offering a standard graphics interface we decided to implement a standard TFT LCD combined with a touch screen. The availability of small size TFT LCDs with LVDS interface (see mainboard specs) and good brightness is limited. We found the following options:

	AZ Displays, Inc. PD050VL1	AZ Displays, Inc. PD035VL1
Diagonal	5"	3.5"
Image size (diag)	101.8mm x 74.9mm (126.3mm)	72mm 53.6mm (89.14mm)
Resolution	640x480	640x480
Viewing Angle	120° (+40°/-55°)	100° (+15°/-35°)
Brightness	450 cd/m²	250 cd/m²
Contrast	400:1	400:1
Power consumption		1.37W (incl. backlight typ.)
Dimensions	121mm x 93mm x 12.5mm	85mm x 66mm x 8.5mm
Weight	174g	78g

Table 5: Indicative displays specifications

Figure 16: Selected TFT display 3.5"

We are selecting the 3.5" size panel because of the dimensions of processing unit.

1.3.4. Touch Screen

As mentioned above the user can easily interact with the system by a touch screen. State of the art are two different techniques, the resistive touch and the capacitive touch. The advantage of the resistive touch is the flexibility, it can be used either by fingers or pen. The disadvantage is less transparency and influence on image quality (blurring). The capacitive touches are more clear and nearly not influencing the image quality. In the planned application the need for pen interaction is not important, therefore a capacitive touch would be preferable. But the chosen LCD screen size is 3.5" and the only available touch panels in that size are resistive types. For a better outdoor viewing and to reduce optical influence we will apply a special polarizing cover foil.

1.3.5. Hard Disk Drive

For wearable devices HDDs with mechanical moving parts are less suitable than flash memory based SSD, solid state discs. Also the performance is better and size smaller. We selected the following drive:

	Super Talent FPM64GRSE	OCZ OCZSSDMPES-64G
Capacity	64GB	64GB
Speed	Read: up to 90 MB/s Write: up to 55 MB/s	Read: up to 110 MB/s Write: up to 51 MB/s
Power consumption	0,69 W (max 2,15W writing)	1.25 W
Dimensions	30mm x 51mm x 3.3mm	30mm x 51mm x 3.3mm
Weight	7g	7g
Price	135 EUR	190 EUR

Table 6: Indicative HDD specifications

Figure 17: Selected SSD

1.3.6. Interface Heart Rate Monitor

We are connecting a heart rate monitor via Bluetooth. This gives best flexibility and we can replace the sensor if needed by other products. See more details in Table 7. The Bluetooth wireless protocol is designed for short-range wireless connections and low power consumption.

	Hama Nano-Bluetooth- USB-Adapter	Belkin F8T016NG	Trust BT-2400P
Standard	2.1+ERD	2.1+ERD	2.0
Class	Class 2	Class 2.1	Class 2
Transfer	3 Mbit/s	3 Mbit/s	3 Mbit/s
Distance	10m	10m	10m
Power consumption	max. 0.0025W	max. 0.0025W	max. 0.0025W
Dimensions	19mm x 13mm x 4mm	15mm x 15mm x 4.5mm	
Weight	55g	66g	62g
Price	7 EUR	10 EUR	7 EUR

Table 7: Indicative Bluetooth dongle specifications

Figure 18: Selected Wireless Adapter, Bluetooth

1.3.7. WiFi Connectivity

For a wireless connection to the set-top-box or the local PC we integrate an USB wifi 802.11g dongle. There are several small units on the market, a few examples are shown below.

	Acorp WUD-G (2.0)	Hama WLAN USB-Stick Mini	DELOCK USB WLAN mini Stick	Edimax EW-7711UTn
Standard	802.11g	802.11n Draft 2.0	802.11n (draft 3.0)	802.11b/g 802.11n
Transfer	54Mbps	150Mbps	300Mbps	150Mbps
Power consumption	transmit : <1.75W receive : <1.3W	~1.9W	1.9W	
Dimensions	58mm x 23mm x 9mm	34mm x 15mm x 5mm	52mm x 25mm x 10mm	40mm x 16mm x 7mm
Weight	9g	7.7g	11g	
Price	13 EUR	15 EUR	15 EUR	10 EUR

Table 8: Indicative wifi dongle specifications

Figure 19: Selected USB WiFi stick 802.11n

We are selecting the Edimax stick because of available Linux drivers.

1.3.8. Communication with the local PC

The integrated WiFi stick is mainly for the communication with the local PC machine to download the captured data. Also the mainboard offers Gigabit Ethernet via RJ11 which can be used for sync. As the selected mainboard also offers DVI/VGA output, the companion could also connect directly to a monitor for better navigation and interaction.

1.3.9. GPS

To track the user outdoor and in a wide range a GPS receiver is needed. We choose the smallest and fastest sensor with the shortest warm and cold start times.

	FALCOM GPS-USB-Stick	Holux M-215 USB
Chipset	u-blox - UBX-G5010	MTK
Time to first position (TTFF)	Cold start 29sec Warm start 29sec Hot start <1sec	Cold start 36sec Warm start 33sec Hot start 1sec
Sensitivity	-160dBm	-159dBm
Power consumption	0.25W	1.8W
Dimensions	48mm x 17mm	64mm x 42mm

	x 8.6mm	x 18mm
Weight	~70g	84g
Price	24 EUR	55 EUR

Table 9: Indicative GPS dongle specifications

Figure 20: Selected USB GPS stick

1.3.10. Interaction

Additional to the planned touch screen we should have a few dedicated buttons, which can be addressed for simple plus/minus actions and selecting general modes. But most of the interaction should be done by the touch screen. An integrated wheel could offer an intuitive use. For audio or sound alarms we will integrate a small loudspeaker. A microphone is not needed, but can be added on request. A vibration alarm is not useful as the device is attached to the belt and the user cannot feel the alarm very well.

1.3.11. Motion Sensor

We could reduce the number of motion sensors attached to the body and integrate one tracker inside the wearable unit. But most likely the magnetometers would be influenced by the CPU or other fields of the embedded electronic. Therefore we must perform tests with all planned components before we decide about this point.

1.3.12. USB

The mainboard offers six USB2.0 ports. Two of them are reserved for accessories and keyboard and mouse should be accessible from outside. The remaining four are occupied by WiFi stick, GPS stick, wireless receiver of heart-rate monitor and wireless receiver stick of motion trackers. For the first setup, using the wired trackers, an external USB hub must be attached, because this is only a temporary solution.

1.3.13. Battery

The battery is a very important component for a wearable unit. The choice is between several different available techniques, with their advantages and drawbacks. The most critical points are the energy density, as this defines the weight and dimensions of the device. Based on an estimated power consumption of about 5.6W including WiFi, GPS, wireless tracking receiver, wireless Heart-Rate-Monitor plus 20% loss for the energy conversion inside the battery there is a required capacity of 54Wh for an 8 hours operation time, assuming not 100% usage of all components, perhaps even 20% standby or sleep modes for the system.

Power consumption estimation is presented in the following Table 10

	Power Consumption	Estimated Usage	Sum
Mainboard	5,00 W	80%	4,00 W
LCD (not used all the time)	1,37 W	10%	0,14 W
HDD	1,25 W	80%	1,00 W
WiFi (not used all the time)	1,90 W	10%	0,19 W
GPS (not used all the time)	0,25 W	50%	0,13 W
Wireless Heart Rate Interface	0,0025 W	80%	0,002 W
Integrated Motion Tracker	0,20 W	80%	0,16 W
	9,97 W		**5,62 W**

Table 10: Estimation of battery capacity requirement: 5.6W * 8hours plus 20% = 54Wh

The best density offers LiPo (Lithium Polymer) and Li-Ion (Lithium Ionen) batteries, but they are very sensitive in over loading or deep discharging with a risk of exploding and burning. They require an intelligent battery controller and charger. Other aspects as charge cycles, memory effects and price per watts are not taken into account here because it is for testing only. When starting the commercialization phase, the battery concept might be changed (NiCd = Nickel Cadmium, NiMH = Nickel Metal Hydride).

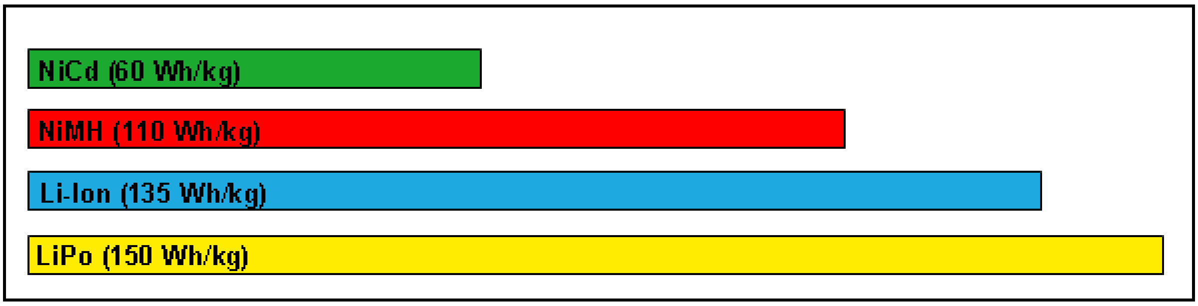


Figure 21: Energy Density of Batteries (Source: average calculated based on common batteries on the market, see also http://de.wikipedia.org/wiki/Akkumulator)

There are two different types of batteries, so called "smart batteries" which have a balancer and control electronic implemented, they are reporting ID, remaining capacity, charge cycles, temperature and many more via SMbus signals to the PC, and normal batteries without electronic or just the basic balancer on board. For the normal batteries an additional control electronic is required. Most of the smart batteries are available for laptops and camcorders on the market, but their long term availability is not sure. The normal batteries, especially LiPo are for RC model cars and helicopters and coming just with cables which makes the replacement very difficult. Their advantage is quick recharge times. The next table shows some available batteries.

	Inspired Energy NC2040HD26	Conrad RACING PACK 5100 MAH	KOKAM RACING PACK 5000 MAH	Duracell for Asus EEE PC 701
Battery type	Li-Ion (smart)	NiMH (normal)	LiPo (normal)	Li-Ion (smart)
Capacity	2.6Ah	5.1Ah	5.0Ah	6.9Ah
Voltage	10.8V	7.2V	7.4V	7.4V
Capacity	28 Wh	37 Wh	37 Wh	51 Wh
Max Current	3A		100A	
Dimensions	85mm x 59mm x 22mm	133mm x 45mm x 23mm	137mm x 46mm x 23mm	139mm x 56mm x 35mm
Weight	170g	464g	256g	306g
Price	70 EUR	45 EUR	110 EUR	65 EUR

Table 11: Indicative batteries specifications

All these batteries do not have enough capacity for the planned operating time. Taking the weight, dimensions and handling into account and also long term availability, we decide for the first prototype to use the InspiredEnergy battery, which will give an estimated operation time of about 5 hours. They also offer bigger packs if required and weight is accepted. Detailed tests will give better results about the real operation time of the complete system.

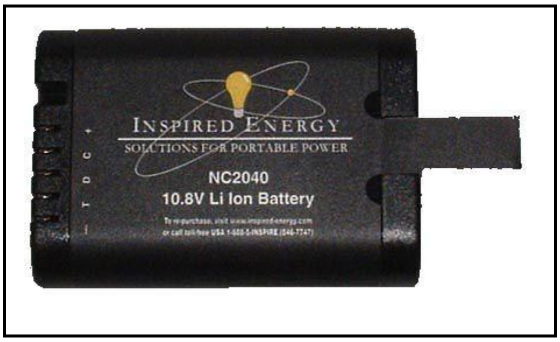
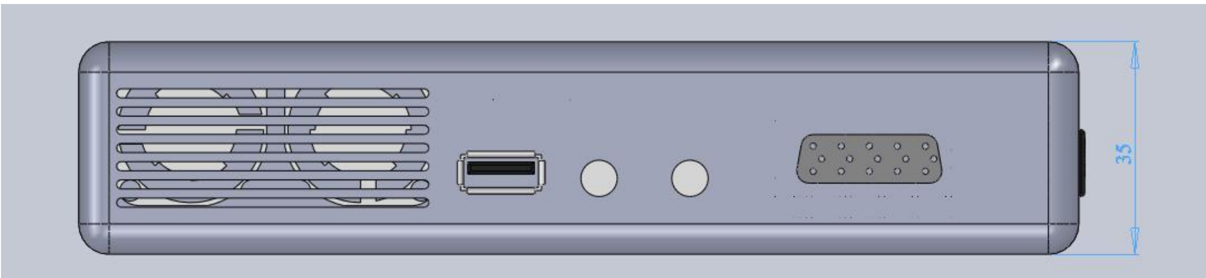
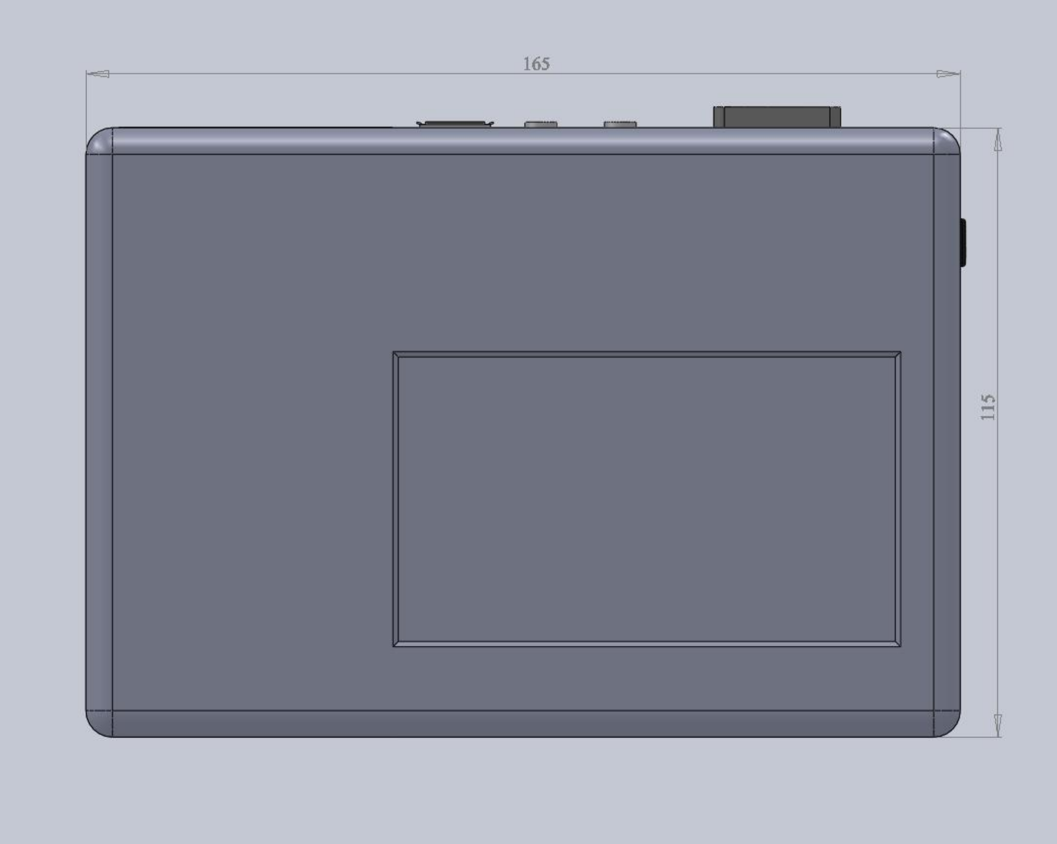


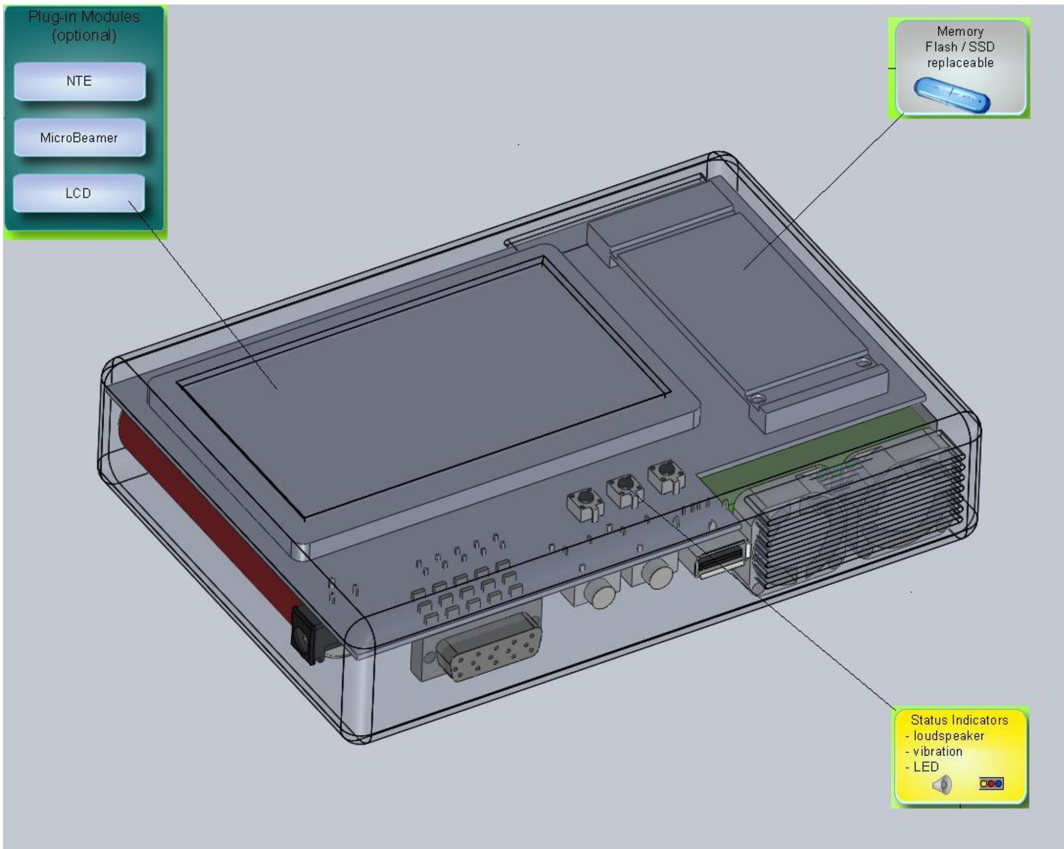
Figure 22: Selected Li-Ion Battery

1.3.14. Case

After the components were defined and ordered, the mechanical design process can start. At the moment only preliminary drafts are existing. The next pictures show the outer dimensions and planned integration. But several tests such as temperature and electromagnetical influence must be performed. These tests can only start when all components are delivered. The case of the processing unit is not designed to be water resistant. When the arrangement and dimensions are fixed and the design process is finished, the plastic parts will be manufactured in a prototyping technique called selective laser sintering (SLS). These parts from PA (polyamide) powder are very lightweight and very robust. Usually the parts are white and rough. The parts will be finished and painted before assembly. The estimated weight is in the range of 150g.




165
115


Plug-in Modules (optional)
NTE
MicroBeamer
LCD
Memory Flash / SSD replaceable
Status Indicators
- loudspeaker
- vibration
- LED

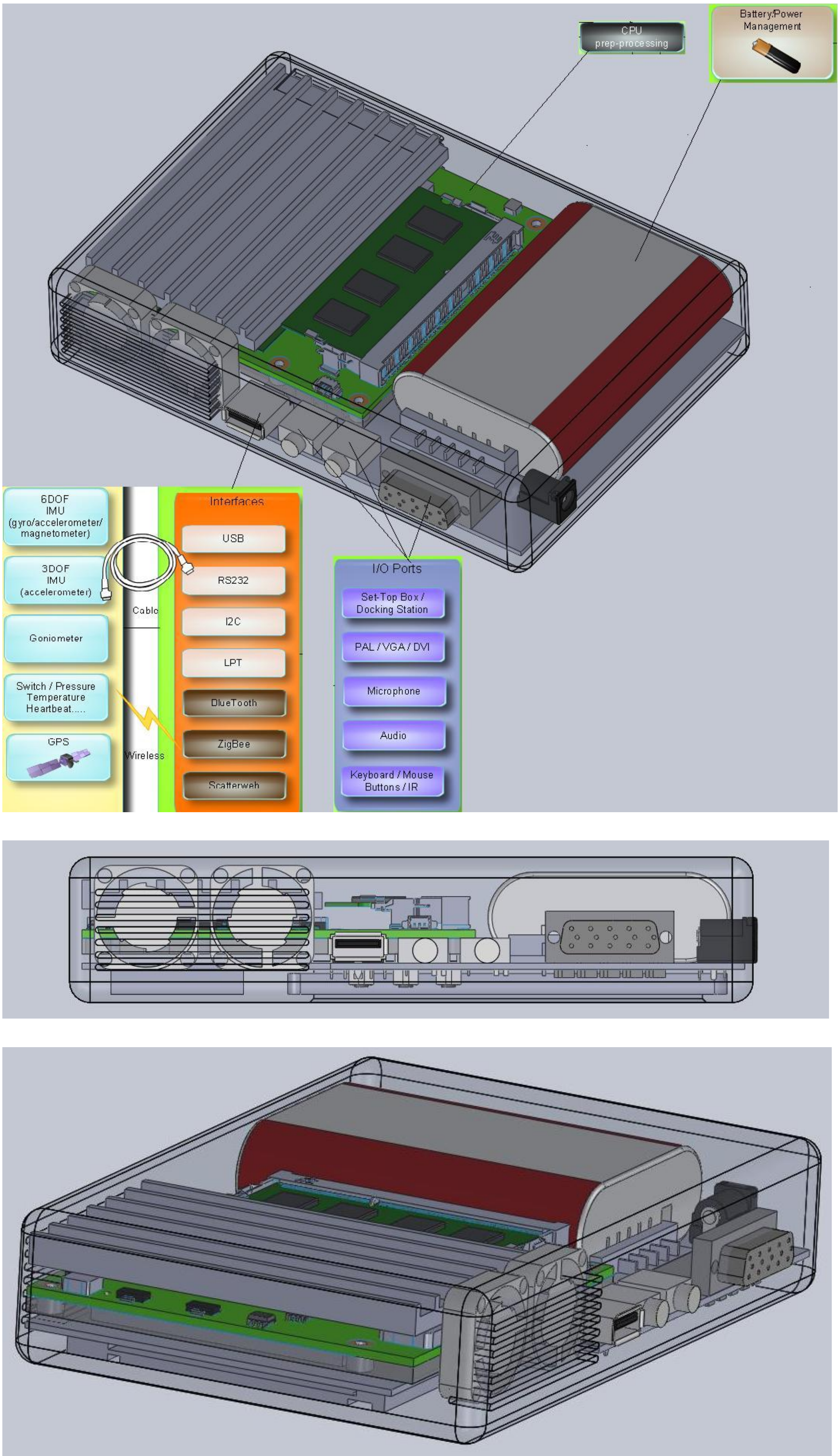


Figure 23: Draft sketches of the case

1.3.15. Assembly and Integration

For the integration of the companion first the SSD (solid state disk) was connected to the mainboard by a modified SATA cable and Linux (Ubuntu) installed to test the system. The system showed some boot problems. The power supply and energy consumption of the SSD was suspected and measured during boot process. Together with Kontron email support and telephone support several tests were performed but without success. Therefore the system was sent for repair.
Parallel the WiFi and GPS dongles were connected and tested to see the compatibility with Linux.

Also parallel the integration with wireless motion sensors is in progress. At the moment first ColibriWireless sensors are assembled and the software API must be adapted.

1.3.16. Delay

The first prototype sensor platform was planned to be ready by end of June.

For the companion the search for the mainboard started in march and the decision on the best suitable mainboard was taken in April. The chosen mainboard is brand new and was not available. It was delivered in June and it was one of the first available prototypes and a pre-production sample with some limitations (no C6 state, Suspend-to-RAM S3 problem, no TPM). We started immediately with the integration tests and found a boot problem with the solid state disk. The mainboard is currently for inspection at Kontron.
A second component causing the delay of companion is the selected 3.5" touch LC display which was ordered in May and not delivered until now. According the distributor it should come in the next weeks.
Nevertheless the influence on the project is only minor because a wearable processing unit solution is already existing. DFKI is using a Sony Vaio PC for the early demonstrator and this device can be used as fall back solution in the meantime until the new companion prototype is ready. According to the actual planning the integration of mainboard, Linux and LCD touch display can continue middle of September. Then the first prototype companion could be ready in October.

The delay during the wireless motion sensor is caused by the sum of small delays in development process, what is normal and can happen for sophisticated electronics. For example, the chosen VARTA battery was discontinued without preceding notification and must be replaced by another model now. The first set of PCBs had a mistake in layout and must be manufactured again. The manufacturer of case parts delivered bad quality and we must find alternative suppliers and order the parts again.
The influence on the PAMAP project is quite low because we can continue working with the cable based sensors as fall back solution.
According the actual planning the first prototypes of wireless IMUs should be ready by September.

2. SENSOR PLATFORM SOFTWARE

The C++ software for handling the Colibri sensors is developed by DFKI. It has been licensed by Trivisio and is distributed together with the sensors. The software will be extended to work with the wireless sensors as soon as they are available. The detailed documentation of both API and SDK is given in the appendix.

3. APPENDIX

The following documents provide additional information as well as technical details:

- Sensor_software_API.pdf describes the application programming interface for operating the cable-based Colibri motion sensors.
- Sensor_software_GUI.pdf describes the graphical user interface for operating the Colibri motion sensors. It provides all functionality of the API.