De Vonk

Periodical of E.T.S.V. Scintilla

Afterlife
Globetrotting

Main Article
The art of beamforming

WORK & CO.
WELCOME

SOT: LDAP
Advanced authentication
at Scintilla

Leshan Giant Buddha

Sign out

Author: Koen Zandberg

This is the last time I'm allowed to write this bit of text for the Vonk. At the beginning of this college year, the 84th board will take over and make sure Scintilla keeps existing. This thus being the last time the editors of the Vonk have to kick me for being late. Maybe the next president will be a bit earlier with his pieces.

With that a lot is probably going to change and needs to be changed next year. We thought carefully about this with them and a few other members. The most important thing that needs to be fixed is that the board needs to have less work to do. Make sure that they don't have to do the small things that other people could do just as well. Make the board a board again instead of the few people that do everything committee's aren't doing. Why would it not be possible for a committee member to put the activity from his committee on the agenda. In this year as a board member, it occurred to me that these little tasks somehow consume the most of our time. With this a lot of work can be lifted from the board. We think that they can spend their time a lot more useful then by doing all the little things other people can do too.

One of the ideas that also came out of our discussion was that we want to group most of the committees in so called clusters. A cluster will be formed of committees with the same general goal. The members of a cluster can share experience and communicate with each other more efficiently.

Of course this will be explained better and in more detail at the wissel-ALV in September. With all these changes in mind the next year will surely become an interesting if not exciting year for Scintilla.

Op de Koningin, op Scintilla

Koen Zandberg
President of E.T.S.V. Scintilla

Vacation
Saturday 6 july, 2013 until
Sonday 1 september 2013
Everywhere!

80e Cantus Scintillae
Thursday 14 november, 2013
20:00h, AbScInt

Scinterklaas evening
Wednesday 4 december, 2013
16:00h, AbScInt

Traditionally, the commissionaire for educational affairs writes an update on the education in De Vonk. In the last edition of this educational year, this update is not absent. In this article, Laurie elaborates on the new book contract, the evaluation of the Twents Onderwijsmodel and the upcoming changes for coming year. For second year students, this article is a must-read.

8. Education
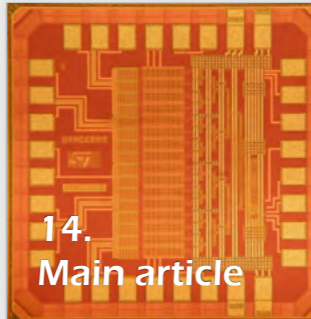
With the increasing amount of wireless devices in our society, it becomes harder for devices to send and receive data that is relevant for itself, without being disturbed by other devices. One promising solution for this, is to use beamforming, which makes use of multiple antennas. At ICD, a lot of research is done on this topic and Michiel Soer has written an article about it.

14. Main article

Some people fear the future, but for some people, the future can not start soon enough. One of the biggest changes in the future, is the transition of student to citizen. In the item 'Afterlife', somebody tells something about his life immediately after graduation. In this edition, Bram tells something about the experiences he had in the first year after getting his MSc grade.

22. Afterlife

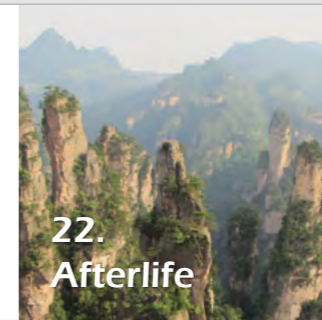One of the biggest drawbacks of IT systems, are the credentials that you need to type in every time. Besides that, every system uses its own username and password, making them hard to remember. At Scintilla, the SOT tries to overcome this inconvenience, by using a single password storage and a single sign-on system. In this article, Koen explains the techniques of these systems.
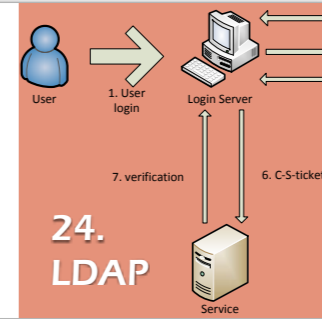
24. LDAP

Editorial

Questions

"There are no stupid questions, only stupid answers", that is what they tell you at school. My reaction to this information may have been a little extreme.

There are a lot of questions to be answered. Of course there are the "big" questions: "What is the meaning of life?", "What is the origin of life and earth?" or "Can everyone become evil?". Questions that are really interesting to think about, but I will never be able to answer them.

Maybe that is why I waiste my time with more useless questions. Questions that just pop up in my mind and NEED to be answered. Who doesn't want to know what "extra fresh orange juice" means? Or why there are two places named "Hengelo"? Can a farmer distinguish cows by their bell tone? And these questions may raise even more questions. What are cows' names in Austria? And again my time is waisted...

Some questions you can't just Google, probably because no one else is stupid enough to answer them. Then you have to do some research yourself. So I boiled an egg in a thermos and concluded that you can still eat it. But you have to find eggs that are small enough to fit in your thermos. And I concluded that when you really want to eat pancakes, but don't have milk, you can use water. Using milk is better, but water is doable. Don't use coconut milk instead, just don't!

All these research and experiments made me think about one final question:
Are there really no stupid questions?

Fieke Hillerström

News for the Electrical Engineer

Author: Maikel Huiskamp

Light readable memory

Material scientists from the University of California have developed a prototype RAM memory device that uses Bismuth ferrite for the data storage. Compared to normal RAM memory the ferrite based RAM should be faster, more durable and have a lower power consumption.

In the ferrite based RAM, data is not stored in cells which hold electrical charge, but it is stored in one of the two polarization states of the ferrite. The data inside the ferrite core can be changed by applying a voltage. Ferroelectric RAM is already on the market, but is has no widespread use.

The biggest problem of the ferrite RAM is that the electrical signal used to read the bits also erases the data. But the scientists from California found a solution to this problem by using bismuth ferrite which has a photovoltaic response to visible light. When the ferrite is hit by the light it creates a voltage which varies depending on the polarization state.

With this setup of bismuth ferrite it takes 10 ns to write and read the cells, and the recording of the data requires about 3 Volts. When we compare this with leading RAM technology, Flash, it is 10000 times faster with respect to reading and writing, and it use 5 times less voltage to record the data.

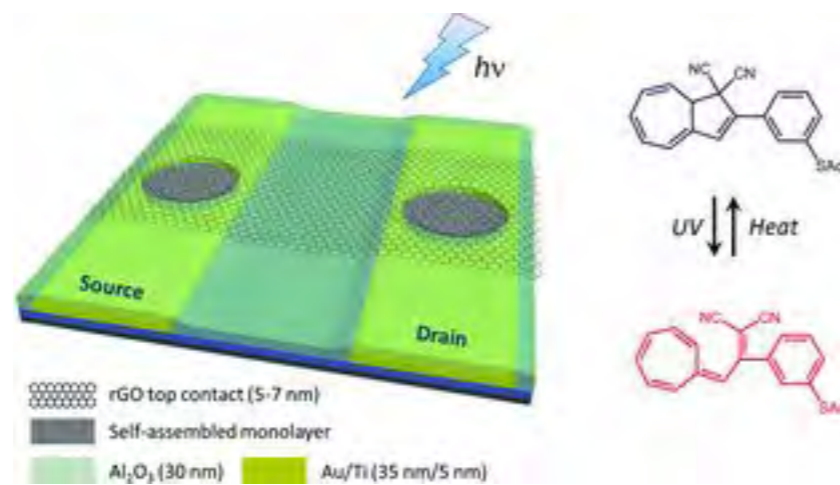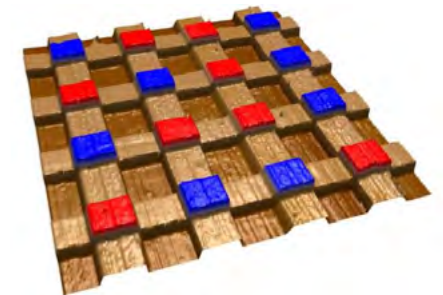*Source: http://www.nature.com/news/computer-memory-can-be-read-with-a-flash-of-light-1.13169*

Bismuth ferrite memory cell.

Single molecule transistors

For the first time a transistor made from one molecular monolayer was developed to be used in computer chips. The molecular integrated circuit was created by scientists from the University of Copenhagen and Chinese Academy of Sciences.

The breakthrough was made possible through use of the two dimensional carbon material Graphene. The molecular chip is built with one layer of gold, one molecular component and one extremely thin Graphene layer. The molecular component is then sandwiched between the gold layer and the Graphene layer. The transistor is switched on and off by using light pulses. Since Graphene is transparent to light it does not affect the working of the transistor.

Because of the ease with which these transistors are produced the mounting can also be used to efficiently test other organic semiconductors which should result in a fast selection of usable organic molecules.

Source: http://news.ku.dk/all_news/2013/2013.6/molecular_chip/

Mind controlled exoskeleton

A team of scientist developed an exoskeleton which can be controlled using the mind. This system allows people who are paralyzed to move the system without moving. The system is called MindWalker and consists of a construction in which the person is placed.

There are still experiments conducted to test different ways of controlling the exoskeleton, but the scientist think that the most effective way are glasses with two blinking LEDs. The system can than recognize on which LED you focus. When you focus on the left side the exoskeleton moves and when you focus on the right side the exoskeleton stops.

There is also an experiment in which pressure sensors are used instead of brain signals. This way the skeleton can be controlled by leaning in a certain direction. This concept will not work for people who are paralyzed above the waist, but the engines of the skeleton can disturb the reception of the brain signals which is not a problem for the pressure sensors.

Source: http://www.newscientist.com/article/dn23640-mindcontrolled-exoskeleton-lets-paralysed-people-walk.html#.UfK-LG1YVMY

3d printed lithium-ion batteries

American scientists have developed a method to print 3D lithium-ion batteries with the size of a grain of sand. The printed batteries could supply electricity for micro devices in the fields from medicine to communications while being extremely small.

To produce the batteries, precisely interlaced stacks of battery electrodes are printed of which each electrode is thinner than a human hair. The scientists realized that they could pack more energy in a smaller space when they would stack the interlaced electrodes that are built out of a plane. Normally thin films of solid materials are deposited to build the electrodes, but with the 3D printer it is possible to create 3D structures which are built from the ground up.

To print the 3D electrodes the scientist first had to develop and test several specialized inks which must exit fine nozzles and immediately harden into their final form. The ink is also made from an electrochemical material to create the anodes and cathodes. The batteries were also tested and their performance is comparable with commercial batteries in terms of charge and discharge rate, cycle life and energy densities, but this was all achieved at a much smaller scale.

Source: http://wyss.harvard.edu/viewpressrelease/114
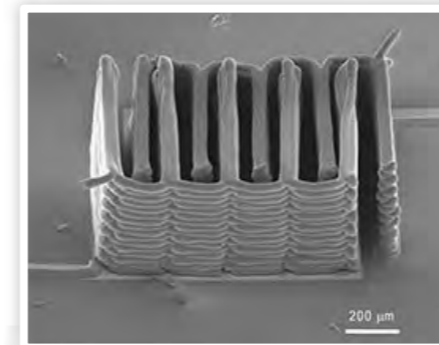
Batteries based on wood

At the University of Maryland a battery technology based on wood was developed. The scientists used wood as the basic component in their batteries to produce environmental friendly batteries.

The batteries consist of sodium instead of lithium. Sodium does not store energy as efficiently as lithium, but it is low available at low cost and it is a very common material. Existing batteries are often stiff, and are too brittle to withstand the swelling and shrinking when the batteries are loaded or charged. The team found out that wood fibers are supple enough to let the sodium battery last for more than 400 charging cycles, which is longer than most nanobatteries available at the moment.

Source: http://www.umdrightnow.umd.edu/news/battery-made-wood

Educational update

Author: Laurie Overbeek

This will be my last educational update already. I enjoyed being the commissioner of educational affairs of Scintilla a lot. In this article you can read the new changes from the last few months so you can start your next study year prepared. We signed a new book contract so we can deliver your study books for the upcoming 3 years. Also some changes have been made to the bachelor curriculum of electrical engineering. This however is not all, starting next year you will be able to download your timetables you can all read about it below.

Book contract

After many meetings about a new book contract we finally got to go to Emmen on the 14th of May. Koen and I went to the distribution center of "Studieboeken centraal" to sign the new contract and get a tour through the distribution center. Together with all study associations of the University of Twente we went to Emmen by touring car.

YOU CANNOT ORDER YOUR BOOKS BY USING iBBS2 ANYMORE

Once we arrived we got a welcome speech before starting our tour through the distribution center. What we noticed was that lot is still done by hand. All the sorting and packing was still done by humans. It was a very large hall with study books all over the place. As an electrical engineer I would of course think this could be done more efficiently by machines. So when we asked the director of the center he told us they had thought about it, but it was too expensive in the long run. When we finished this tour we all signed the new book contract and went back to Enschede.
Now that we have a new book contract all study books can be ordered again next year. Some things will change though. You cannot order your books by using iBBS2 anymore but you need to follow a link which will be made available on our website. This link will bring you to the web shop where you can order your books throughout the year. You pay for the books when you order them on the web shop. There are two options to get your books. One is to deliver them to your home and the other is to pick them up at the STORES. The last option is only available when you order your books during the central ordering period. An e-mail will be send to you when the ordering period will begin. An e-mail will be send with more details about how and when you can order your books next year.

Evaluation TOM

This year we had a pilot for TOM (Twents Onderwijs Model) and by now three modules have been taught. The first module was an introduction to electrical engineering. In this module students where tested weekly. Students thought the workload was high but manageable. In the second module, Electric circuits, the workload was very high with three tests a week, this caused a lot of stress for the students. A possible solution for this is to have one test with all course material of a week instead of three separate tests. For the third module electronics no evaluation has yet been published.

Timetables next year

It could be that starting next year we have a different timetable system, called MyTimetables. Timetables can then be downloaded in many formats so you can for example merge it with your Google calendar. This way it is also easier to combine timetables from different study phases. You can construct your own timetable by adding modules and/or courses.

Second year courses in English

From next year and on second year bachelor courses will be taught in English. The courses taught in the second year stay the same. Third year Bachelor courses will remain Dutch for one more year.

the course "Optische Basisfuncties en Microsystemen" will be given in the second quarter of the third year. Also the course "Inleiding Communicatiesystemen" will be moved to the third quarter so the fourth quarter is free for the bachelor assignment. All the changes can be found in Table 1.

FOR MORE INFORMATION VISIT OR EMAIL THEA DE KLUIJVER

Transition rules

For all first year courses that have now been replaced by modules, transition rules have been made. These can be found in the OER for coming year. If the course is still taught as part of the module this part of the module can be followed separately. For all the rules see the OER and for more information visit or email Thea de Kluijver, our study advisor.

Changes in third year courses

Changes in third year courses will be made next year. The course "inleiding Elektrische energietechniek" will not be taught anymore starting next year. Instead of this course

Students 2013-2014

Next year it is expected that about 90 first year students will start their study electrical engineering at the University of Twente. This is a lot more than we have had in the last few years. Of these 90 students, about 40 are Dutch students, 20 European students and 30 from outside Europe, so about half of the expected students next year will be international students however it is not sure they can come to our country because most of them will need a visa. About 90% of the students will be male and 10% is expected to be female. That would double the female population in the electrical engineering!

Table 1: The changes in the programme next year

Quarter	Course	EC
1	Electrodynamics	4
1	RIM	1
1	Minor	10
2	Optische Basisfuncties en Microsystemen	3
2	RIM	0.5
2	Minor	10
2	Master Orientatie	1.5
3	Embedded Signal Processing	7
3	Random Signals and Noise	5
3	Inleiding CommunicatieSystemen	3
4	Bachelor Assignment	15

SolarTom

In the previous edition of the Vonk, Elmar told about our mock-up, and the tests we performed with it. A lot has happened in the meantime, but the most important thing is that we built an entire solar car!

Author: Tom Kooijman

T3
SOLAR
TEAM TWENTE

On the 19th of June, King Willem-Alexander and Queen Maxima visited our province, as part of their tour around the Netherlands. As you can see in the photo, they had the great honour of unveiling our new solar car, The Red Engine. 2 days later, we had our car presentation in the Grolsch Veste. This was an opportunity for us to not only show the car, but also talk about it, and about the process that led us there.

In the previous articles we wrote for the Vonk, we were not allowed to talk about a lot of things, because we wanted to keep them secret. Now that we have presented our car, we decided it is time to tell some

more specifications. Partly because we think it is too late for other solar teams to use this information, partly because we are very proud of the things we have done in the past year, and we want to tell everybody about it. At our design presentation we already announced that, even though we had to add a 4th wheel, the aerodynamic drag was lower than the previous car. Now we can tell that not only the drag, but also the weight is significantly lower: From 180 kg for the 2011 car to 139 kg for The Red Engine.

For electric specifications: We will be using an array of 6 m2 silicium solar cells. The battery will contain 21 kilograms of Lithium-

ion cells, the same chemistry found in your laptop or mobile phone. The motors are three-phase contactless motors, built into the wheels. The car has LEDs as brake and turn-signals, a CAN-network and a wireless link to the car behind it, called the DMU (Decision Making Unit). The solar car can be read out completely by the DMU. There are over 100 sensors throughout the solar car, ranging from speed, temperature, battery voltages and currents, motor currents, solar power input, brake and gas pedals and much more. The DMU can not only read the solar car, but also send a speed, and the solar car's cruise control will take over the speed send by the DMU. This means the driver only needs to steer, and watch out for kangaroos.

And now, once again, we are in a testing stage. But this will be the final testing stage. The car has made its first rounds around the airfield, and I have had the honour of driving the first few laps last week. It is extremely exciting to drive the car that we build ourselves. I knew all about the hours of work, litres of sweat and expectations that went into building the car. I also knew that a single turn of the wheel has the capability of destroying everything.

So before we drove away I was very excited, and a little scared. At the end of the day I was still excited, and very much relieved. The brake tests, the turning test and the slalom all went perfectly fine. We drove up to 80 km/h, which is very cool, but also very

noisy to do in a solar car. It was a sunny day, and soon I noticed how quickly the interior of a solar car warms up. This was a good introduction for the next day: My first training as a driver.

A SINGLE TURN OF THE WHEEL HAS THE CAPABILITY OF DESTROYING EVERYTHING

In Australia, the temperatures inside the solar car can rise up to 50 degrees Celsius, and a driver has to drive 4 hours at a time. It is very important to have trained drivers, because a fainting driver can do a lot of damage to the car, and to our chances of winning the World Solar Challenge.

This next day Erik, one of the other drivers, and I drove to Soest, to the "Centrum voor Mens en Luchtvaart", part of the royal

Dutch air force. This is where pilots from all around the world are tested and trained. The scientists at the CML designed a first test for our drivers, and supplied us with the equipment and personnel to train us.

We spend a few hours in a so-called climate chamber. The temperature here was driven up to 45 degrees Celsius, which is comparable to the temperature inside the solar car in Australia. In this climate chamber was a hometrainer and a computer. We had to cycle on the hometrainer at 60 Watts. This is a very low setting, comparable to what a driver will use when sitting down and driving. Even though the hometrainer was set very light, after half an hour of cycling

my heartbeat went over 150 BPM. This is one of the things that heat does to a human body.

After half an hour of cycling, we had to do a concentration test, a test on peripheral view and a hand-feet-eye-coordination test. Then back to the hometrainer, and again the three tests. This took about three hours all together, after which we were both drowned in sweat. When we finally walked out of the heat, into normal room temperature, we both inhaled the cool air with great satisfaction.
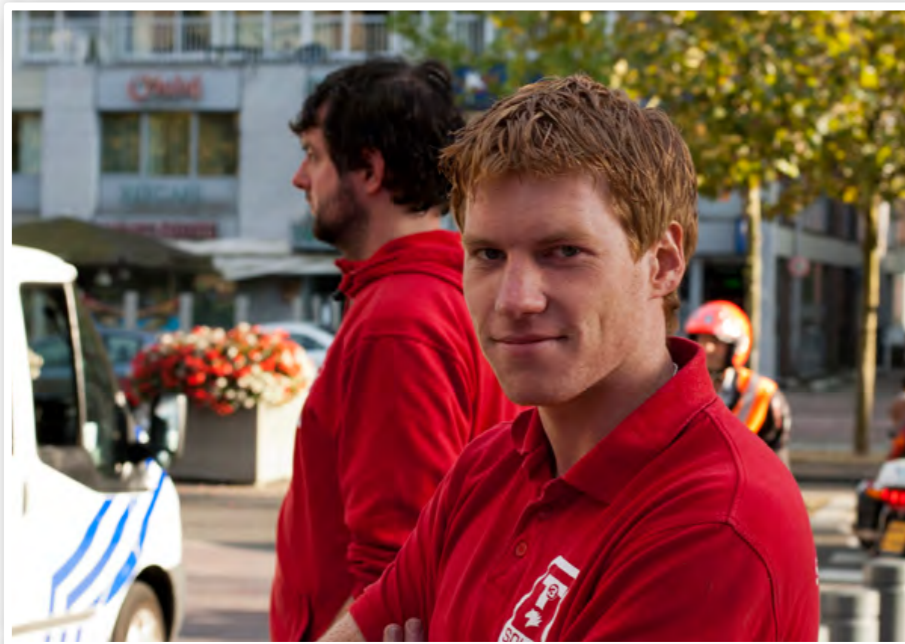
Geocaching

High tech treasure box

Author: Maikel Huiskamp

Imagine you are a pirate with a large pile of gold in your ship. You are ready to rob the next ship, but you cannot store any more loot on this ship. So, what do you do? Well, as a real pirate there is only one thing you can do and that is burying your treasure. So, you do the best you can to draw the map, dig a large hole on some fancy uninhabited island, and bury your treasure. But then, all other pirates also do this. And as a real pirate you have to stay feared, and you don't become that by doing what everyone else does. So you decide that you want a chest that only opens at the right place, at the right time, and only gives you a certain amount of tries. And well, if you were a pirate in the 1600's you are out of luck, but with all the great technology of today this is all possible.

Just like the pirate sketched above I always wanted something that only opens at the right place at the right time that I could use for my scouting activities. On a rainy day I was surfing the internet and there I found the solution, a reverse geo-cache. It was nothing more than a box that w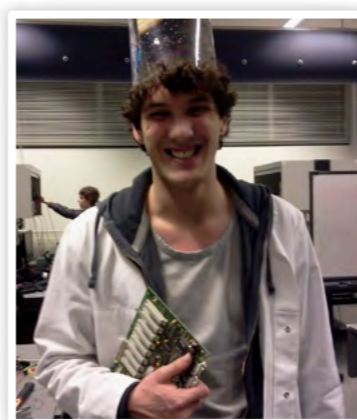as closed from the inside by some mechanism and a GPS to find out the position of the box. And as a real engineer I thought "He I could also do that!", and I started to order the necessary components.

The first thing you need for such a project and maybe the most important thing of the entire project is of course the box. A nice box gives the project class and a cool vibe.

When the GPS module arrived I hooked it up to a microcontroller and started reading the data that came from it. And now what? I had a bunch of serial data that I could read, but it didn't mean anything to me. So l looked at the datasheet of the GPS receiver and found out that it sends so called NMEA data. With the aid of my great friend Google I found a description of the NMEA protocol.

The NMEA protocol is used to code the data that you receive from the GPS receiver. NMEA has a couple of output messages which are shown in table 1.

The most important data for this project are the GGA,GLL and GSA messages. The data that the GPS receiver sends out is a serial stream, so what to do with it? Well, a normal message starts with a "$" and ends with "*CS" where "CS" is the checksum of the data. So, my idea was to store all data after the "$" until the "*" came along. Then I did a checksum to see if the data was use-

The second most important thing is the GPS receiver. They come in many forms, ones with USB, Bluetooth and ones that you have to solder yourself. But since I don't have the tools and knowledge for all this hard stuff I ordered a pre-made GPS with an UART interface.

GPS receiver

ful or not. When the data was ok we could continue to parse it. A sample GGA message looks like:
$GPGGA,161229.487,3723.2475,N,12158.3416,W,1,07,1.0,9.0,M, , , ,0000*18
The first part says that it is a GGA message, the rest is the information stored in the message. See the reference manual for a detailed list of all the information here.
Now that we have valid data we can store it in the right place. The first thing I had to do was to find out what kind of message I received. Since we already stored all the data I build a large switch statement which parses the message header. After this the correct function was called to store the data in a struct that keeps all the data of the GPS receiver. This way I could give other pieces of code a pointer to access this data in an easy way.
So with the data that we can receive with the aid of the magic boxes that circumvent our planet we can determine where we are and what time it is. So now we need some way to close the box. I was thinking of all

kinds of difficult solutions with gears etcetera, but then one of my friends said he had a servo that moves in a line and that you could close the box by putting a pin through a hole. And that was a great idea. After stealing some code to control the servo, and some toil and craftmanship I was able to close the box. And maybe you see it coming, but I certainly did not at that moment, after I closed the box I was unable to open it again. Luckily for me the box does not close completely, and applying some force to the servo I was able to open the box again. So the next thing that was implemented in the box was an override function that always opens the box. I will not reveal the entire secret on how this manual override works, but it has something to do with measuring 5V on an USB connector.
Now that I was able to open the box at the right place I had to find a way to inform the user of the box how many tries he had left,

and what the distance what to the placed you have to be to open the box. So I cut a hole in the top plate of the box and inserted a LCD screen into it so I could display info on it. Some buttons where added for the user input, the power supply was added and

ON A RAINY DAY I WAS SURFING THE INTERNET

we were ready to test it.
I took the box with me to one of my scouting meetings and gave it to two of them without any hints. I programmed it in such a way that they had 100 tries. After 10 tries they figured out that the decreasing number was the remaining tries, but the second number remained a mystery for the next 20 tries. It took another 10 tries until the box opened. So, I was quite happy with the results.
But even after this it is still not completely finished. The coordinates are set in code which is not that handy, so the box should be configurable via the USB port. Another thing I wanted to do was to log all the data on a SD card so I could see where they went. And maybe make it even harder with an electric compass or something completely different. But at the moment time to hobby is just as imaginary as the original pirate with his treasure...

Reverse geocache

Table 1: NMEA output messages

Option	Description
GGA	Time, position and fix type data.
GLL	Latitude, longitude, UTC time of position fix and status.
GSA	GPS receiver operating mode, satellites used in the position solution, and DOP values.
GSV	The number of GPS satellites in view satellite ID numbers, elevation, azimuth, and SNR values.
MSS	Signal-to-noise ratio, signal strength, frequency, and bit rate from a radio-beacon receiver
RMC	Time, date, position, course and speed data.
VTG	Course and speed information relative to the ground.
ZDA	PPS timing message (synchronized to PPS).
150	OK to send message.

The Art of Beamforming

Author: dr. ir. Michiel Soer

Imagine throwing a rock in a pond. The impact of the rock will form waves on the surface of the water, traveling away from the location of the splash in circles. Next, consider a fisherman who is fishing somewhere further along the shore of the pond. His floater will oscillate along with the water waves, and he can deduce from this observation that something has disturbed the water some distance away. He can draw two important conclusions.

First, it is apparent that the impact of the waves on the receiver becomes weaker as the distance to the source increases. The energy of the wave is spread across a larger circumference, making it harder to detect the wave. Secondly, from the bobbling of the floater, he cannot tell where the source is located. Of course, the surface of the water needs to be calm for the fisherman in order to detect the ripples caused by the rock. When a storm is going on, the waves formed by the wind are so large that the smaller ripples are completely obscured. Moreover, if multiple persons are throwing rocks in the pond, the ripples will interfere and make it hard for him to distinguish between them.

Not all water waves behave this way, as can be observed when one sits next to the water front of a lake. Sometimes, a bow wave can be seen coming from no apparent source, striking the water front and reflecting back on the lake. Obviously, it has traveled quite a long distance, as there is no boat in sight and as the wave speeds away again, it does not seem to lose significant amplitude. It seems that the boat causing the bow wave was able to direct its energies towards a specific propagation direction, instead of the circular wave generated by throwing a rock into the water.

Personal wireless communication devices have secured a firm position in our lives. Whether you are making a phone call to relatives, browsing the web on your laptop through a wireless network (WLAN) or checking the train departure times on your smart phone through a 4G LTE connection, something is happening inside these devices to establish a connection over large distances.

The primary physical effect that is being exploited is the propagation of waves in the electromagnetic (EM) field. This is analogous to throwing a rock in a pond, where
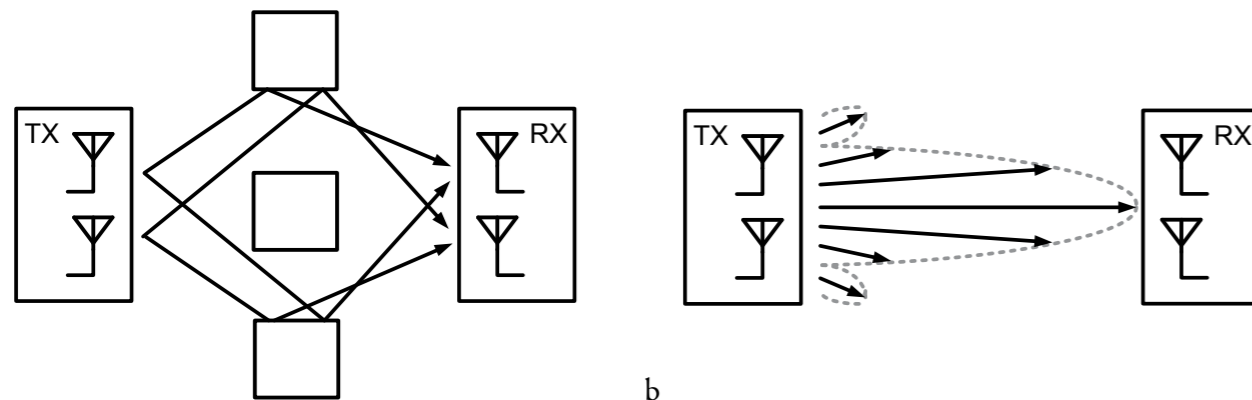

Fig. 1: MIMO systems employing (a) spatial multiplexing and (b) beamforming.
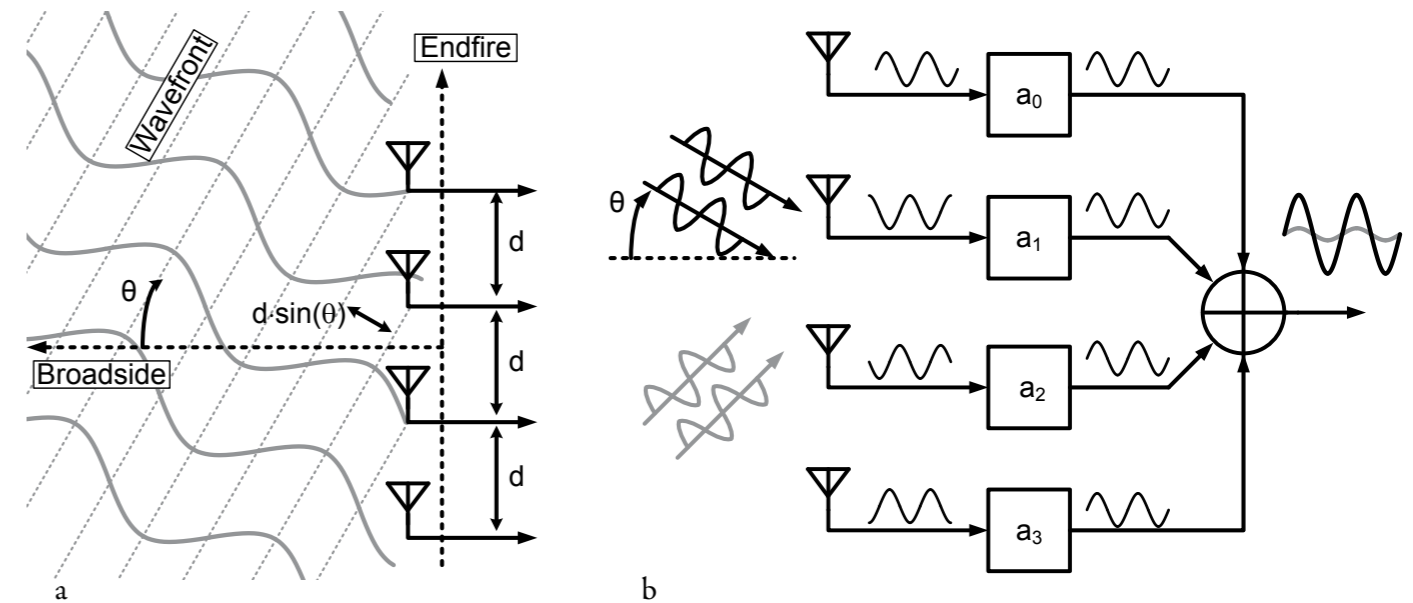

Fig. 2: Example of (a) the incoming wavefront and (b) the antenna combining of a 4-element beamformer.

the role of rock and floater is taken up by antennas in the transmitter and receiver. As water waves will become weaker with increasing distance, so do EM waves become increasingly harder to detect, putting a maximum range beyond which no reception is possible.

Moreover, the receiver has no direct information about the location of the transmitter. When there are multiple transmitters, their waves will interfere and make it harder for the receiver to detect the desired signal. The source of the range limitation and interference issues can be found in the omnidirectional (isotropic) characteristics of the antenna in the receiver and transmitter. As the transmit antenna sends its signal in all directions and the receiver listens to all directions simultaneously, a lot of energy is wasted. If the transmitter and receiver could be made more directional, the range would increase and the interference between transmissions would decrease.

In the pond analogy, it was noted that not all water waves are circular, but that bow waves move in a specific direction. The same mechanism can be achieved with electromagnetic waves by transmitting the signal with multiple antennas at the same time. The EM energy can be steered to specific directions, increasing its effectiveness. Moreover, the receiver can also be outfitted with multiple antennas in order to listen to

a specific direction, thereby increasing its sensitivity.

The use of multiple-antenna systems is now entering the consumer market in the latest wireless standards. This step promises to increase data rates, reduce co-existence interference and in general improve the quality of service for the consumer.

Spatial Multiplexing and Beamforming

As was sketched in the pond analogy, there is an advantage in expanding our wireless systems to use multiple antennas. Instead of exciting and probing the electromagnetic field in a singular point location, extra degrees of freedom are created by placing multiple point sources some distance (in the order of the carrier wavelength) apart. The techniques involving multiple antennas are referred to as multiple-input-multiple-output (MIMO) systems and come in several varieties.

First, consider the highly scattering environment in Fig. 1a. From each transmitter to each receiver antenna, there are multiple propagation paths possible due to the occurrence of reflecting objects. Traditionally, these multiple paths were used to transmit the same signal, increasing spatial diversity and therefore adding robustness in a fading

environment. It has been understood however that the fading can actually be beneficial, as it creates parallel communication paths. This is used for spatial multiplexing, where multiple data streams are transmitted over orthogonal transmit-receive paths, thereby increasing the capacity of the channel.

In a low scattering (line-of-sight) environment, Fig. 1b, the advantages of spatial multiplexing are less as there is a lower orthogonality between receiver and transmitter antenna pairs. Here, the high correlation between propagation paths can be used to direct EM energy into specific directions. This process is known as beamforming, as the signals are formed into a beam pointed at the receivers. The overall sensitivity of the system is increased and the receiver becomes less sensitive to interferers with a different angular position than the transmitter, as it is listening from a specific direction.

The support for MIMO systems in consumer electronics has started only recently. For WLAN, the IEEE 802.11n amendment defines transmit beamforming. In cellular systems, LTE release 9 defines several MIMO modes, including spatial multiplexing, downlink transmitter beamforming and a combination of the two. Note that these standards support full transmitter-receiver spatial multiplexing, but only partial (transmitter) beamforming. From the receiver side, applying beamforming has
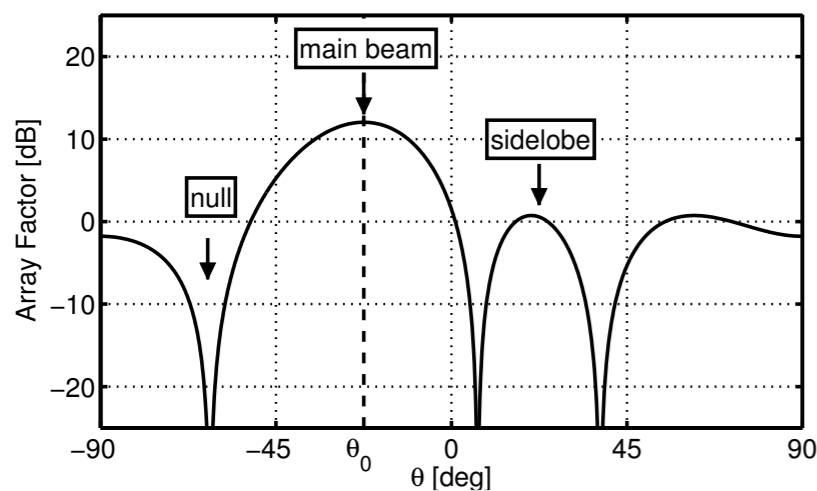
Fig. 3: Array factor for a 4-element phased array.

Fig. 4: (a) Phasor diagram illustrating the principle of a vector modulator and (b) its block diagram.

the potential to boost sensitivity and reject interferers.

Anatomy of a Beamformer

When we dive further into the topology of a beamforming receiver, it is fundamental to study the geometry of the antenna placement. Fig. 2a outlines the basic configuration consisting of multiple antennas positioned on a line, with equal spacing. An incoming EM wave from a distant source is in practice a plane wave which hits the antennas on different moments in time. In effect, the same signal is received, but with different phase on each antenna. These

IT HAS BEEN UNDERSTOOD HOWEVER THAT THE FADING CAN ACTUALLY BE BENEFICIAL

phase differences are a function of the direction-of-arrival (DOA) of the plane wave, i.e. no phase difference for a wave from the broadside direction and maximum phase difference for the endfire direction.

The purpose of the beamformer is now to apply the inverse phase shift, such that for our desired DOA the signal is aligned in phase and sums up to maximum amplitude. This is depicted schematically in Fig. 2b. For other directions, the phases are not aligned

and the resultant amplitude is less, or even zero. In general, the blocks applying the phase shift can also apply amplitude variations and the combined effect can be seen as a complex weighting of the array inputs. An example of the gain of the antenna array as a function of the DOA is plotted in Fig. 3 for a 4-element beamformer. The plot has one absolute maximum, which is defined as the main beam. Lower local maxima occur and are referred to as sidelobes, while completely destructive summing occurs at the nulls. Hence, this array factor describes the spatial filtering that is performed by the array.

Adaptive Arrays

Note that in Fig. 3, the achieved filtering is in general not very selective. On the location of a sidelobe, the amplitude of an interferer is attenuated by about 10dB with respect to the main beam. The width of the main beam is also not very narrow, giving only small attenuation to interferers close in direction to our desired signal.

However, in most practical situations there is only a single dominant interferer disrupting our system. This can be exploited by steering one of the nulls in the array pattern towards the direction of this interferer, providing more attenuation. This is referred to as adaptive beamforming, where the beamformer tracks the direction of interferers and tries to adjust the beam pattern for maximum attenuation.

In terms of antenna weighting, null steering only results in a small perturbation of the antenna weights. This small perturbation leaves some residue phase and amplitude differences for our desired signal, but shifts the null position enough to place it on the interferer position.

Adaptive beamforming is seen as a promising candidate for beamforming in personal communications, as it can provide good rejection greater than 20dB for systems with a modest amount of antennas. Further work is needed in the communication standards and digital processing to realize the digital control algorithms to robustly track interferers, but demonstrations of the null-steering capabilities of analog beamforming hardware have already been shown.

Realization in Silicon

Compared to traditional single-antenna receivers, beamformers require additional phase shifters. These circuit blocks form an interesting design topic, as a phase shift is somewhat more difficult to achieve than an amplitude adjustment. The most popular topology of phase shifter is the vector modulator. Its operation is based upon the trigonometric expansion of a sine with phase φ:

$$\sin(\omega t + \phi) = \sin(\phi)\cos(\omega t) + \cos(\phi)\sin(\omega t)$$

It states that by a weighted combination of a sine and cosine, a sine with arbitrary phase (and amplitude) can be realized. This is illustrated further in the phasor diagram in Fig. 4a. Here the X-axis represents the sine phasor and the Y-axis represents the cosine phasor. Any resultant phasor Z can now be decomposed into these two basis phasors. In general, we can expand this basic identity for sinusoids into one that works for signals
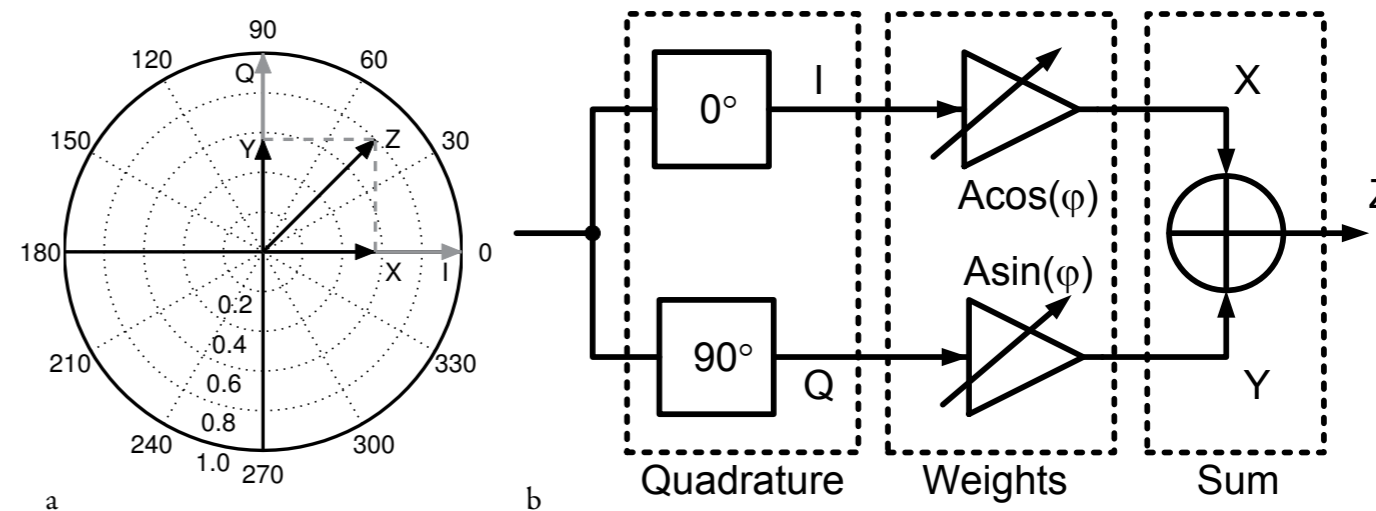
of all kinds, by applying the properties of the Fourier transform. It turns out that the basis phasors are now formed by the input signal itself (the In-phase component) and its copy that has a phase shift of 90 degrees applied to it (the Quadrature component). The resulting block diagram of a vector modulator type phase shifter is pictured in Fig. 4b.

Obtaining the In-phase and Quadrature components of a signal is already required in standard receivers for the purpose of rejecting images in frequency downconverters. The phase shifter functionality needed for beamforming is therefore cheaply acquired by adding variable gain amplifiers and a summing node in the existing receiver architecture.

Of course, there is more to the circuit design than that, but let's leave the details for another time. For an example of a state-of-the-art beamforming receiver, consider the chip photographed in Fig. 5. It is a 4-element beamformer designed and tested at the Integrated Circuit Design group, for operation in any band between 1.5 and 5.0 GHz. Fabrication was done in a 65nm CMOS process and the displayed chip measures just 1 mm by 1 mm (see Vonk 31-3). As this CMOS process is standard for designing commercial consumer products, the developed concepts are well suited for integration in future consumer products.

Conclusion

Beamforming is a challenging and upcoming field of study in receiver design. The utilization of multiple antennas in our consumer wireless products can open up the road to faster and more robust wireless connections. It is an art to not just implement

the block schematics provided by system engineers, but to also look for elegant solutions that fit well on our technologies. Interference attenuation in the spatial domain has been demonstrated by implementations in CMOS technology and it will be interesting to see how much of these concepts make it into an actual consumer product.
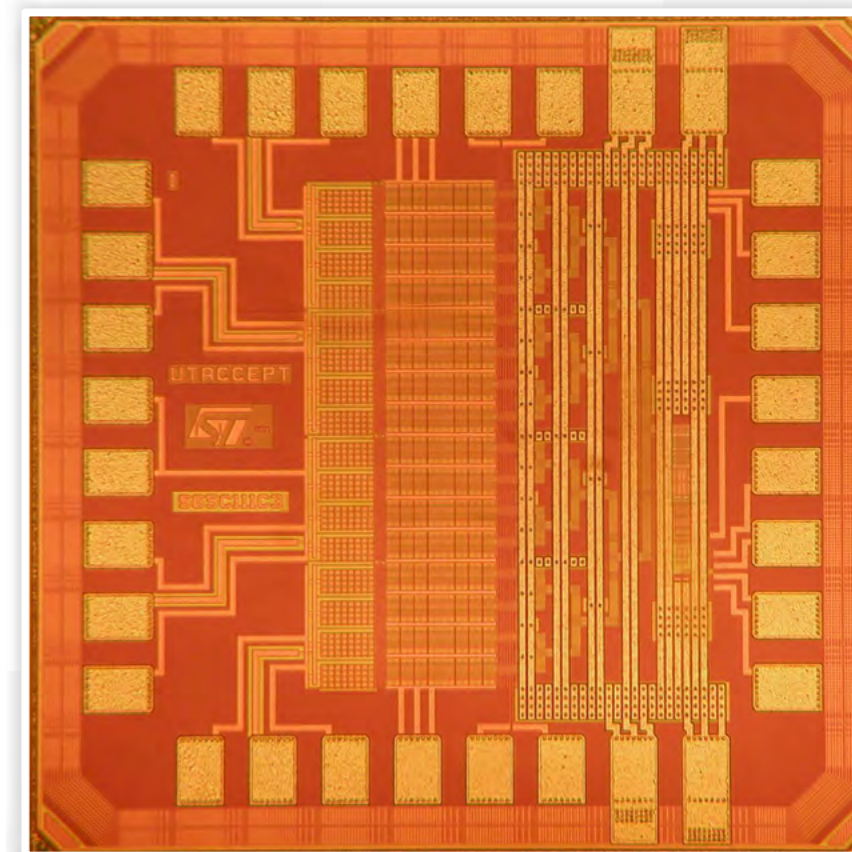

Fig. 5: Chip photo of the implemented 4-element beamforming chip in 65nm CMOS.

Active members outing

StAf-tournament

Batavierenrace

Cantus

EM⚡POWERING the FUTURE

Author: Silke Hofstra

On the 15th of may 2013 E.T.S.V. Scintilla organised the symposium "Empowering the Future", the first symposium in a long time. At this symposium the latest developments in science and technology were presented. Speakers from all over the world guided us from the smallest imaginable particle to the vastness of the universe.

The symposium started on an early wednesday morning in the Spiegel. A huge crowd of eager students turned up to attend the presentations. After a while everyone was enjoying a hot beverage and a slice of cake and of course the necessary small talk in anticipation of the rest of the day. Every attendant received a premium folder with, amongst other goodies, a credit-card sized usb flash drive.

After the chairman of the day, Prof. Dr. Ir. Bram Nauta, introduced all attendants to the symposium committee members and the schedule, it was time to begin the first presentation. The idea was to start the day on the atto-scale and end with the vastness of the universe. Sadly one speaker was only available to speak in the morning, which meant the schedule needed to be altered.

1. **Croon** – Electrical infrastructure,
2. **ASML** – Lithography systems,
3. **Imotec** - Mechatronics
4. **NXP** – Semiconductors
5. **Thales** – Aerospace and defence technology
6. **CERN** – Particle physics research, the Large Hadron Collider.
7. Information Market
8. **Dutch Space** – The largest space company in the Netherlands,
9. Drinks
10. Dinner at Los Ponchos

Ir. Mathieu Melenhorst, the speaker from Croon Elektrotechniek, took us into the world of electromagnetic compatibility. With interactive demos he managed to keep the public entertained eventhough it was early. Amongst other things he showed that a well placed electric pulse could destroy even the most basic electronics, showing

the vulnerability of everyday household appliances.

The household tips from Croon were followed by a presentation about the sophisticated machinery at the heart of ASML's lithography machines. Dr. Rob Waiboer from ASML explained how ASML plans to keep the trend, and continue Moore's law by having the largest R&D budget in the world.

After ASML it was NXP Semiconductors' turn to let us know how semiconductors will improve the quality of life. Dr. Leo Warmerdam explained that smart electro-

nics, eventually, will be able to decrease our energy consumption. By showing how NXP works to introduce smart electronics in almost any area he also pointed out some of the strengths of the cloud.

This point was quickly proven by Imotec, the smallest attending company. Dr. Theo de Vries shared how cloud computing could even improve seemingly mundane technologies. For example in the dredging industry, where the computing power necessary to control the ship was placed in the cloud, for robust and quickly upgradable computing power. Only allowing the participants to leave for lunch after he was satisfied the applause was loud enough, he guided people to the sumptuous lunch.

After the lunch Dr. Wim de Heij from Thales showed the audience how Thales shapes the future at sea with Active Electronically Scanned Arrays. He showed us how small electronics can be used on large radar arrays, which they design for military ships, and how Thales uses this technology to detect ships, airplanes and smaller things, like a swimmer.

Dr. Erik Heijne, flown in from Switzerland, showed us that for CERN this isn't quite small enough. He showed us how chips pave the road to the discovery of the Higgs boson and the atto-world beyond. His indepth presentation explained how CERN was able to find answers to fundamental

questions like "why do particles have mass?". To get everybody moving and active there was an information market with demoes and a chance to talk to some representatives. There were people from NXP Semiconductors, Thales, CERN, Imotec and USE System Engineering. The BIOS and BSS chairs from the University of Twente were also represented. The participants were very enthusiastic and immediately stormed the stands. The companies were taken by surprise! All of the attendants of the symposium took the opportunity to speak with the people who work on the technology of tomorrow.

After seeing the technology of tomorrow in action Ir. Henk Cruissen from Dutch Space gave the final presentation, showing us the technology used to explore the universe. He showed us how Dutch Space works in various space related fields, like solar panels and various launch systems, making a difference to tackle the final frontier.

Prof. Dr. Ir. Bram Nauta concluded the symposium and guided everyone to the Borrel. After an hour of talking about the symposium over a drink, a small group of people led by the symposium committee went to Los Ponchos for dinner with the speakers and the chairman of the day. Sadly Los Ponchos was a bit disappointing, but this was compensated by great conversation and company.

We, the organization, were very pleased by the enthusiastic group of people who attended this symposium. Thank you all for coming!

Were you impressed by how well this symposium was organized? Have you always wanted to play an epicentral role in an important event? Do you want to work with a great team, to get the best speakers and sponsors? Are you interested in organising the next awesome symposium? Then come and have a drink with the symposium committee or the board of Scintilla!

Afterlife

Globetrotting

Author: BramT

This multiple piece item is about the lives of Electrical Engineers after graduation. Do they accept their life as a true citizen or will they roam the world? BramT decided to do the latter. After a biking trip through Europe and working for half a year at the SAS research group he saved enough to travel through Asia. He is determined to work abroad preferably in Asia, but as back-up he is also prepared to put on a warm sweater and work in a cold Scandanavian country.

This… is his story

As an under-graduate student it is sometimes hard to imagine the possibilities after graduating. In this article I will cover my personal path after graduation. This includes a cycling trip to Santiago de Compostela, working for half a year and a four month trip through Russia and south-east Asia. Having obtained an EE degree it is a reassuring thought that if necessary finding a job is not hard.

El Camino

During the notorious STORES meeting 'beer time' HarmtH and I decided to cycle from Enschede to Santiago de Compostela.
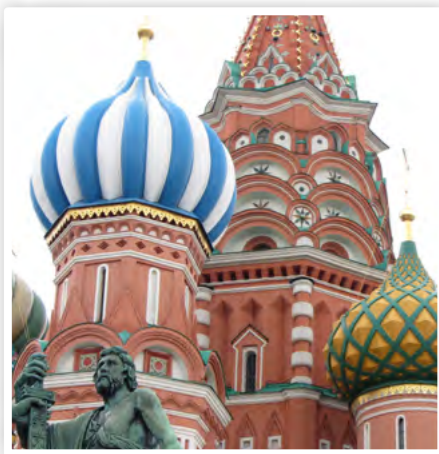
Russia

This place is a world famous Christian pilgrimage place and is situated in the north of Spain. So after the redeeming moment of graduating I had an approximate 1.5 weeks to make all the necessary arrangements for our trip. This included buying a second hand Gazelle bicycle equipped with 24 gears, a pair of tight fitting cycling shorts (ugh !) and searching for a suitable route. Luckily there is a Dutch St. James fellowship which provides an excellent route description for cyclists. The weather was really bad during the first week so we moved quickly south towards the sun. After a week we were in the vicinity of Paris and we made a day trip covering all the compulsory sights such as the Eiffel tower, the Louvre, Champs-Elysée and the Notre Dam. The scenery in France was rather boring as it consisted of wheat fields, sunflower fields, and near Bordeaux kilometres of grapevines. This was all compensated for by the excellent French bakeries providing great tasting croissants, baguettes and flans to fuel our calorie demanding journey.

After a hefty climb over the Pyrenees and a thrilling descent we were in Spain which was a world of difference compared to France. The scenery was beautiful once more and all the terraces were bustling with live.

Fully loaded bikes

Finally after a month and covering a little under 3000 km we arrived at our main goal, the cathedral of Santiago de Compostela. At the cathedral we were really lucky to witness the swinging of the famous giant incense burner. After booking our return plain ticket we had another 10 days left so we decided to go to the 'edge of the world' at Fin de Terre, and follow the coast towards A Coruña where our plane would depart.

Work

Just before graduating a temporary job was offered to me at the SAS research group. At my own request it was possible to work part-time and therefore I always had the Monday off. These Mondays off were great and they always gave me the ultimate luxury feeling. During the half year period I worked at the research group my major responsibility was to collect a dataset of approximately two hundred 3D faces. These faces were collected using a commercial device which works similar to the popular Microsoft Kinnect by projecting a near-infrared pattern on the subject. Of these two hundred volunteers a subset of fifty persons were asked to provide a small video footage. The data I collected will be used by two PhD students to potentially increase the face recognition rate based on video data.

Epic trip

After working for half a year it was time for some travelling again. As always great ideas come to mind during coffee breaks, so this time a plan was made to take the trans-Mongolian railway from Moscow to Beijing together with TijmenH. Our journey did not end here as we continue travelling through China, then to Thailand, Laos, Vietnam, Cambodia and most likely Myanmar. For the first part of our journey we cheated a bit by flying to Moscow. From thereon we took the train and made several stops for some city sight seeing. The thaw had just kicked

From Ulaan Batar we took the tourist swamped train to Datong (China). Crossing the border between Mongolia and China was an experience on itself as the train bogies had to be changed because the track gauge between these two countries is different.

Arriving in Beijing one of the first things we noticed were the large number of electric mopeds and the efficiently operated subway. In general Beijing was a very nice place to stay, maybe caused by the fact that the Olympic games took place here in 2008. One of the most memorable sights we saw

and China are equipped with a hot water tap which is really convenient for brewing instant noodles, coffee and tea. The NS could take note of this. Numbers in China are weird, small cities with a population of millions, covering hundreds of kilometres between places and the tremendous amount of people travelling at a single instance.

Future

My internship in Indonesia, this trip and the study tour (visiting Malaysia, Vietnam, Singapore and South-Korea) have increased my affection towards the south-eastern part of Asia. Therefore I would like to pursue a PhD in this region or possibly find a job. As back-up plan I would also like to work in Sweden or Norway for a couple of years as the nature is extremely beautiful there. My only fear would be the cold climate in these countries. If everything fails I will probably work for a year (hopefully part-time) and then explore south-America for a couple of months. After that ? No idea ...

GREAT IDEAS COME TO MIND DURING COFFEE BREAKS

in making most cities a muddy and watery experience. One of the most interesting sights we visited in Russia was the Baikal lake near Irkutsk. The lake was still covered with a 1m thick layer of ice and at several places near the coast large formations of icebergs were formed. We did a two day hike here, the first day we walked across the lake towards the next village and the second day we followed part of the Great Baikal Trail next to the lake back to where we started. During the trip across the frozen lake we were held up by a couple of Russians driving a propeller powered sledge. They offered us a lift to our destination and after a fun ride, lots of photographs and some vodka we set out to look for our cabin. Russians seem a bit grumpy at first, but are very kind and helpful once you get to know them.

We stayed for about a week in Mongolia and did a ger to ger trip. A ger is a large round felt-lined tent which needs a small pick-up truck to be transported and is still used in everyday life a lot. We stayed at two local families which hardly spoke a word of English and we also did some horse riding which looked rather ridiculous as the horses were rather small compared to our length. Another attraction we visited was a 40m stainless steel statue of Genghis Khan with a golden whip in the middle of nowhere. Unfortunately we could not taste the local speciality, fermented horse milk, as it was not the right time of the year.

in China was the unrestored section of the great wall. We met two local Chinese students and together we made a day long hike on an unrestored and not so crowded section of the great wall. Another noteworthy wall is the great firewall of China and is noticeable as Facebook, Twitter and YouTube are blocked by the government. One of the downsides of China are the ridiculously high entrance fees for most sights. Getting around in China by sleeper trains was the most convenient way, the rail network in China was magnificent. All trains in Russia

Zhangjiajie in China, the area which inpsired Avatar

LDAP

Advanced authentication at Scintilla

Author: Koen Zandberg

Within Scintilla, every active member has his own account. This account can be used for nearly everything related to Scintilla, the website, email and so on. For this, Scintilla uses a single user database to store the critical user information and a secondary database for the personal information of every user. It is important to keep the information stored in a secure way, so your personal data is protected against unwanted access from other people. At Scintilla, some default systems are used which store the data in a secure way and make it general available to the systems that are used at Scintilla.

To provide users with a single login for multiple services, Scintilla uses a centralised database for login information. This database provide the systems of Scintilla with information about users and committees. Systems like Winscin can ask whether a user used the correct password, or what his email address is. For this database Scintilla uses an OpenLDAP database. OpenLDAP is an open source implementation of the lightweight directory access protocol and a server to store data in the directory.

A directory is a kind of database, although there are some significant differences with a relational database like MySQL.
A directory structures the data hierarchically. Objects with data are always positioned under other objects. For example, the objects of our users are positioned under the organisational unit of our users. The same with our groups, those are under the "groups" organisational unit.

Figure 1: The OpenLDAP logo

A directory is heavily optimized for read access. This is because the information in directories is mostly only written once in a while, while it is often queried. A user database is often queried by our systems, but is updated only so often, most objects never change.
The objects in directories have certain restrictions on the attributes they contain. The keywords here are must and may. Some objects must have a certain attribute, other attributes are not mandatory. For example, a user must have a username and password, but he may have an email address or a telephone number.
Because an LDAP database can contain sensitive information it has fine granularity access controls. This way, users can only access the information they really need and nothing more.

An LDAP database is meant as a general purpose database. It can store many different kinds of information. It can store information about humans, companies, even rocks can be indexed. But a rock doesn't have the same properties as most humans. Rocks don't have a email address, telephone number or a name. Humans don't have a hardness or malleability. An LDAP

database handles this by giving objects a so called object class. An object class specifies what kind of information an object must and may contain. We could make an object class for persons, one for rocks and one for companies. Objects can have multiple object classes, if an object with the person ob-
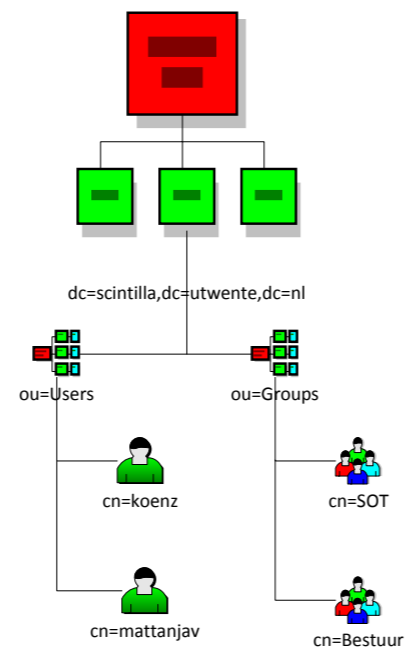

Figure 2: The structure of an LDAP database

ject class, and he or she needs a user account we could give that object an extra object class, the user account object class. This way we can specify exactly which information the objects can contain.

To locate objects in an LDAP database all objects contain a distinguished name, a DN. A distinguished name is build from the attributes of the object and the objects above the object. This is the method used by LDAP to give every object a unique name and a method to find a record. An example of a distinguished name is "uid=koenz, ou=users, dc=scintilla, dc=utwente, dc=nl". This means that the record with the uid koenz can be found under the organisational unit "users" which in turn can be found under the domain scintilla, etc. An other example is "cn=sot, ou=groups, dc=scintilla, dc=utwente, dc=nl". This is the place where the LDAP record of the SOT committee is located. A schematic overview of an LDAP database is shown in figure 2.

A closer look at the object located at "uid=koenz, ou=users, dc=scintilla, dc=utwente, dc=nl" gives us the attributes of figure 3. As you can see, I have two object classes, an inetOrgPerson and a posixAccount class. The inetOrgPerson specifies attributes about a person. For example, the cn (common name) and mail address originates from this object class. The other class, the posixAccount is used to give me a user account on the systems of Scintilla. It provides the me with an uid (login name) and account numbers.

```
dn: uid=koenz,ou=Users,dc=scintilla,
    dc=utwente,dc=nl
cn: Koen
objectClass: inetOrgPerson
objectClass: posixAccount
uid: koenz
uidNumber: 1396
gidNumber: 1396
homeDirectory: /data/home/koenz
sn: Zandberg
gecos: Koen Zandberg
displayName: Koen Zandberg
loginShell: /bin/bash
mail: koenz@scintilla.utwente.nl
```
Figure 3: A user as an LDAP object

The object of the SOT committee contains the data from figure 4. As you can see, it contains a group number, a description and a long list (shorted here for readability) with users in this group.

When a user logs in at our email server, a few things happen. The email server is configured to ask the LDAP database for the users. When somebody tries to log in, the email server sends the username and password

THIS WAY THE PASSWORD NEVER LEAVES THE LDAP DATABASE

Under both the group and the user organisational unit there are many more objects, one for each user and group. The LDAP database of Scintilla also contains a few more object types. For example, an admin user and a tree for Kerberos objects which will be explained later.

```
dn: cn=sot,ou=Groups,dc=scintilla,
    dc=utwente,dc=nl
cn: sot
objectClass: posixGroup
gidNumber: 40023
description: Scintilla Operator Team
displayName: SOT Users
memberUid: denickm
memberUid: timb
memberUid: koenz
memberUid: maikelh
...
```
Figure 4: A committee as an LDAP object

to the LDAP server. Specifically, it tries to log in on the LDAP server as the object "uid=<the send username>, ou=groups, dc=scintilla, dc=utwente, dc=nl". This will succeed if the username and password was correct and the email server can request the data of the user from the LDAP database. The same happens when a user logs in at an other system. This way the password never leaves the LDAP database, but a password is only send to the LDAP database and it tells the system whether it is correct or not. An other example is the use of the LDAP database as an address book. Users can configure this in their own email client and it is default configured in the email web interface. When somebody fills in a name in their To-field for an email, the LDAP database is requested for the email attribute of objects underneath the "ou=users, dc=scintilla, dc=utwente, dc=nl", furthermore, there is a filter to request only records with the posixAccount object class. This query makes sure that only users are returned, or more specific, only their email address.

In the ideal environment, a user would only have to use his password once to authenticate himself. For some services of Scintilla this is already enabled. Within Scintilla we use Kerberos for this. Kerberos is an authentication protocol that works with "tickets" to authenticate users and provide a way to securely communicate over an unsecured network. With a good working Kerberos infrastructure a user only has to sign in once, for example when logging in to Winscin. Every time when a user needs to authenticate himself for a service in that session, it is handled by the Kerberos infrastructure and the "tickets" for users. The user logs in seamlessly and secure with other services. This is called single sign-on.

For Kerberos to work, a central server is needed, a so called key distribution centre. This server handles the authentication of so called principals. A principal can be either a user or a service that needs to authenticate himself. A Kerberos server consists of three parts. An authentication centre, a key distribution centre and a ticket granting service. The following steps are taken with Kerberos, which is also visualised in figure 5.

1. When a user logs in with his username and password (for example when he logs in on Winscin), the password of the user is used to make a symmetric encryption key.

2. The server sends the user ID to the Kerberos server. The Kerberos server will use the password of the user to build a symmetric encryption key. If the password provided by the user is correct, the client, in this case Winscin, will be able to decrypt the messages of the Kerberos server. With this key, two messages will be send back to the client. A message with a so called TGS (Tic-
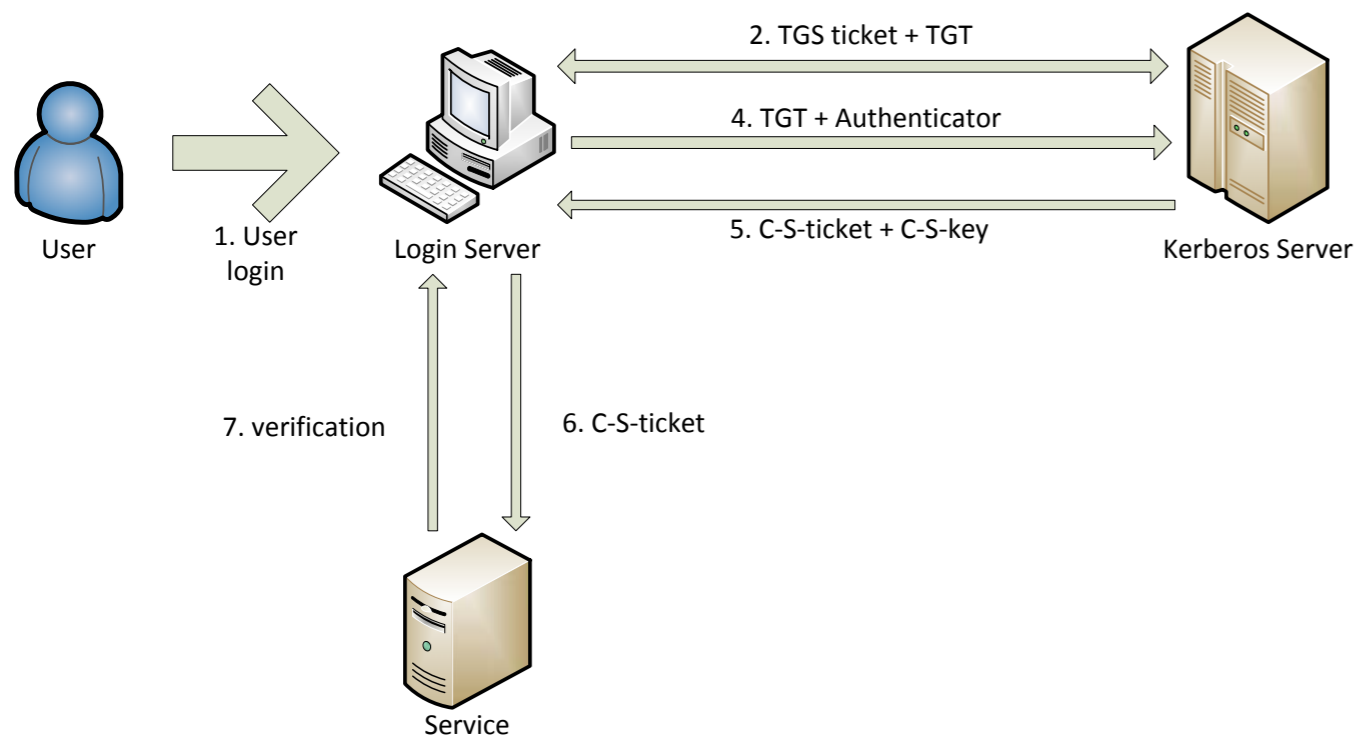
ket granting service) session key and a TGT (Ticket granting ticket) encrypted with the secret key of the TGS. This is not the key of the TGS key but a private secret key. The TGT contains the client ID, network address, the TGS session key and a validity period.

3. When the client received both packets, it should be able to decrypt the TGS key with the password of the user. If the password was incorrect, the keys do not match and the client will be unable to decrypt the message. The TGS key is used to communicate with the ticket granting service.

4. When a user wants to authenticate with another service, for example the Scintilla website, the client (Winscin again) sends the following messages to the ticket granting service: a message containing the TGT and the ID of the requested service and an authenticator composed of the client ID en a time stamp encrypted with the TGS session key.

5. The ticket granting service can decrypt the TGT from the first message using its secret key. The TGS key retrieved from the TGT can be used to decrypt the authenti-

WITH A GOOD WORKING KERBEROS INFRASTRUCTURE A USER ONLY HAS TO SIGN IN ONCE

Figure 5: Steps which are taken for Kerberos authentication.

2. TGS ticket + TGT
4. TGT + Authenticator
5. C-S-ticket + C-S-key
User
1. User login
Login Server
Kerberos Server
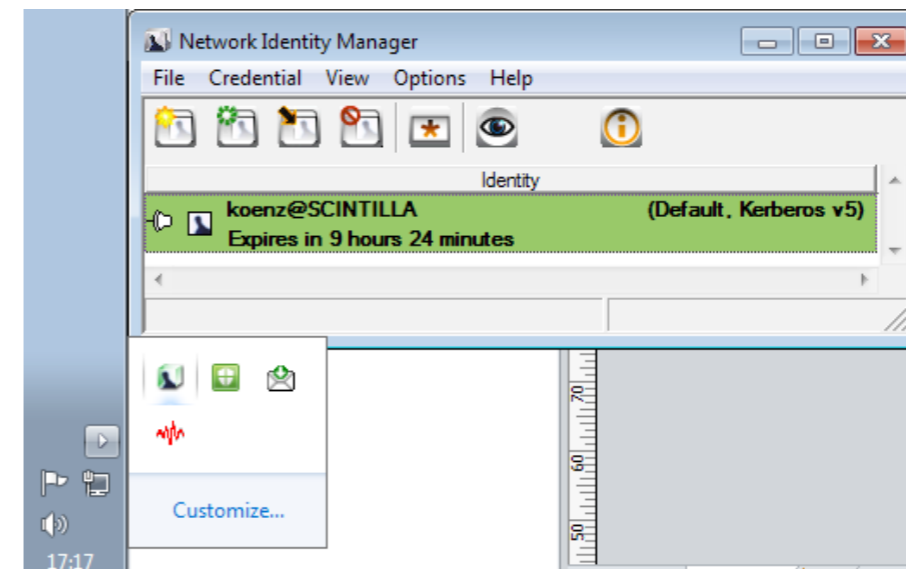7. verification
6. C-S-ticket
Service

Figure 6: The identity manager on Winscin can be found in the system tray

cator. If this all succeeds, the ticket granting service will send two messages back, the client-to-server ticket, containing a client ID, network address, validity period and a client-server session key. This is encrypted with the secret key of the requested service. The second message is the client-server session key, but this time encrypted with the TGS session key.

A drawback of a Kerberos infrastructure is that is has a single point of failure. The same goes for the LDAP database. If one of these is down, the users are unable to authenticate themselves. This can be mitigated by creating multiple LDAP servers. With one master and one or multiple slave servers, one of the slaves can take over when the master stops working. By storing the data needed

With Scintilla, Kerberos is currently only enabled for Winscin, Virtuscin, IMAP/POP3 and the chat virtual machine. Thus, a user logged in at Winscin can seamlessly access his account on Virtuscin. Your ticket is kept on Winscin, viewable in the network identity manager, as shown in figure 6. On virtuscin a user can view his ticket with the "klist" command. You can see in figure 7 that I had a ticket granting ticket valid until 3 Juli 9:24. With this ticket I can seamlessly log in on other Kerberos enabled services of Scintilla. At the moment this aren't many services, but we're working on enabling more services.

With this infrastructure, with an LDAP directory and Kerberos server, Scintilla can be provided with an environment where users can login with only a single password and only have to sign in once to access multiple secure services of Scintilla.

A DRAWBACK OF A KERBEROS INFRASTRUCTURE IS THAT IS HAS A SINGLE POINT OF FAILURE

6. The client can now authenticate himself to the service. It sends the client-to-server ticket to the service and a new authenticator. The service can decrypt the client-to-server ticket with his own secret key and with that it retrieves the client-server session key. With this session key it can decrypt the authenticator and validate the true identity of the client. In response it will retrieve the time stamp found in the client authenticator package and increments it by one. This is returned to the client encrypted with the client-server session key.
7. The client decrypts this confirmation message and checks the incremented time stamp. The client can verify the server with this and it can start communicating with the server.

for the Kerberos infrastructure in an LDAP database this weakness is also removed for the Kerberos server. The keys of the services and users are stored in the LDAP directory and are thus automatically distributed to other LDAP slaves. These can be outfitted with an extra Kerberos server and thus can be used as failover servers.
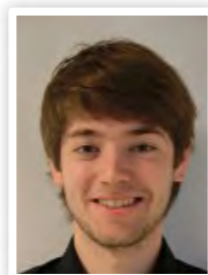
```
koenz@virtuscin:~$ klist
Ticket cache: FILE:/tmp/krb5cc_1396
Default principal: koenz@SCINTILLA

Valid starting     Expires            Service principal
02/07/2013 17:24   03/07/2013 09:24   krbtgt/SCINTILLA@SCINTILLA
        renew until 03/07/2013 17:24
```

Figure 7: The output of the 'klist' command at Virtuscin

Swarm bots

Author: Mattanja Venema

At the Robotics and Mechatronics chair, here at the university, research into swarm robots is being done. As the name suggests it involves a group of robots doing tasks together. This can be compared to an ant colony with many ants performing tasks like collecting food or building the nest. For robots cooperating can be quite a challenge, because they have limited input from their surroundings. Therefore they are equipped with an array of sensors and actuators to be able to observe and respond to their environment.

One of the sensors which can be very helpful to a robot is a positioning sensor. Something to let the robot know where it is. On a large scale one could use for example GPS to determine the location of a robot. However GPS isn't precise on a smaller scale, cm range for example, and besides it will not work indoors. For smaller robots which operate indoors, like the R2-G2Px shown in the picture below, another sensor has to be developed.

For my bachelor assignment I am working on such a sensor. The sensor being developed is based on a Wii remote. In the front of a Wii remote there is a small camera embedded which is used to determine the position of the Wii remote. This is done by tracing the infrared LED's which are built in to the sensor bar you put atop your tv. The same principle is used to let a robot track its position. A beacon with 3 infrared LED's is placed at the ceiling and the camera from the Wii remote is placed on a robot and pointed up towards it.

Since there is no use for the rest of the Wii remote the camera is taken out. After some internet research it is determined that the camera operates at 3.3 volts and has an I²C bus to communicate with. The camera also needs an external clock source of approximately 25 MHz. Approximately, because I used a 20 MHz oscillator and it works perfectly. I started out using an ATMega328 which runs on a 16 MHz clock. So an interface board had to be designed to work with the camera. This interface board includes some power management, the oscillator and an socket for the camera. Later on I ported the code to the Arduino platform for ease of use (and because my bachelor supervisor liked to see it that way so I could make him a library for it). So the final interface board is built on an Arduino prototype shield acquired from the STORES. When you take the camera out of its housing there are some small metal pads on the back of it. A bit tricky to solder, but not a problem for us engineers of course.

With the hardware part of the project finished now the more challenging part of writing software for it started. As mentioned before the camera uses the I²C protocol to communicate. Setting up the software for that isn't really hard, because ATMegas have hardware support for it. However initializing the camera and making it output some useful data was a bit more challenging. The camera has a resolution of only 128x96 pixels. Also it has a built in processor which does all of the image processing for you. It interpolates the resolution 8 times to provide a 1024x768 output resolution. The processor also finds up to 4 infrared spots and
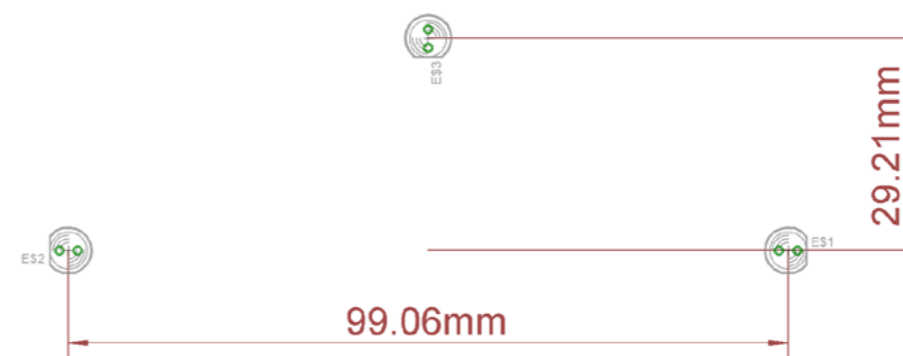
Beacon's specifactions

can send the coordinates of these 4 spots, including the brightness of each spot, over the I²C bus to the ATMega. So all there is to do is connect with the camera, make sure the initialization sequence works and retrieve the data of the coordinates. The initialization is a whole bunch of bytes involving settings for the brightness mode and in which way the data is sent back.

alizes the camera then reads out the coordinates of all the infrared spots detected. The packages of raw data are converted to a set of useful coordinates of every spot. The next tricky part of the software is to determine if the coordinates of the detected infrared spots are really the beacon we want to look at or just some random reflections of sunlight or other light picked up by the camera.

The robot

There are some limitations to this design however. The camera has a maximum viewing angle of 45 degrees for example. This means that depending on the height of the beacon as opposed to the camera only a fairly small area can be covered in which the position can be determined. Also because infrared light is used there is some interference from other infrared sources.

As for the assignment, I am nearly finished at the time of writing. The hard and software works and my report is almost finished. All there is left to do is give a presentation.
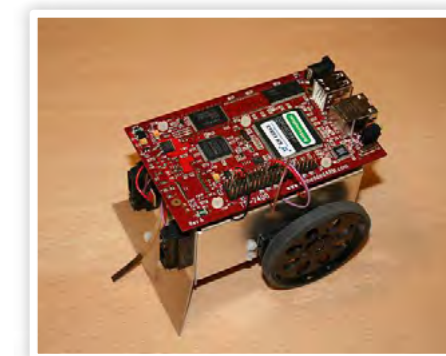
A BIT TRICKY TO SOLDER, BUT NOT A PROBLEM FOR US ENGINEERS OF COURSE

To determine the position using this setup the method of triangulation is used. The board with the camera is placed on a robot facing upward and a beacon with 3 infrared LED's is fixed to the ceiling as mentioned before. The LED's in the beacon form a triangle, which can be seen in the picture. The base of the triangle is 10 cm long and this constant is also known in the software.

The software works according to the state diagram shown in the picture. It first initi-

To find the beacon the lengths (in pixels) between all of the spots is calculated and then every combination of 3 spots is reviewed. The longest of the 3 is determined and then using known ratios the other two sides are compared. If all of the 3 lengths fall within the known ratios the software can safely conclude that the 3 infrared spots it is looking at are the beacon.
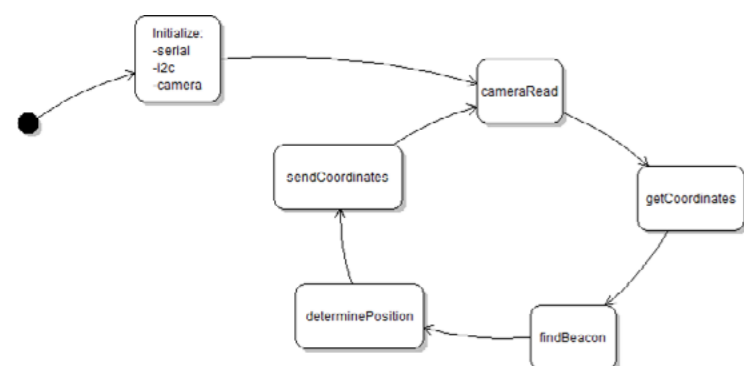
When the beacon is found and the lengths of the sides calculated we know that a certain number of pixels is equal to 10 cm. The ratio pixels per cm is then acquired and with that we can determine the distance between the camera and the beacon using standard trigonometry. With the height and the pixels per cm known the next step is determining the x and y position. To do that the software fixes on the top of the triangle and calculates the difference from those coordinates to the center of the camera view. Using some more trigonometry and the values already known the position can be calculated in 3 dimensions.
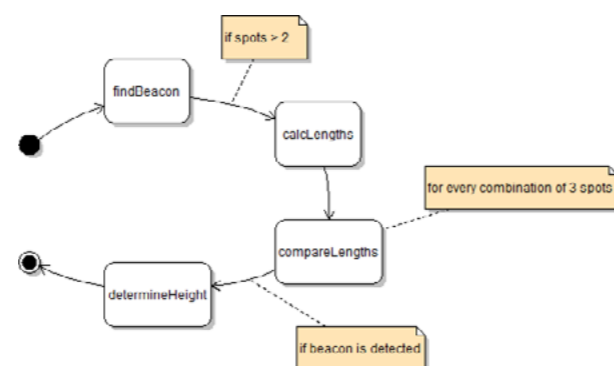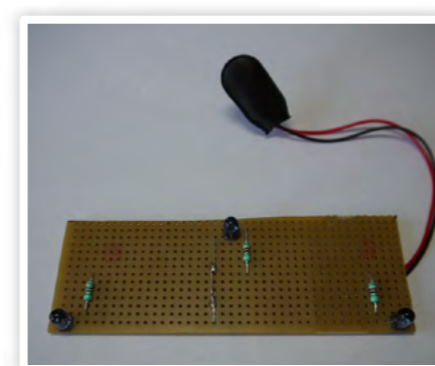

State Diagram

Find beacon diagram

The beacon

The interface

NRG Battle

Author: Ray Tanuhardja
Photos: NRG Battle, TTA World, Sakura Zensen

Beep! Beep! Beep! I turned off my alarm way too early, especially after Scintilla's Active Members 'outing' the day before. Finally at 5:30 I got up and started to get ready to go. We had to assemble in front of the Vestingbar to go to Delft where we would participate in the NRG battle. The study tour Sakura Zensen's participants signed up and all got selected for this event. The event mainly consists of solving energy related cases for companies. Last year it was a great event and therefore we decided to take part in this battle again as a team building activity.

桜前線

I tried to get some more sleep in the car, but I soon found out it was too much fun in the car to sleep. After some trolling, a coffee break and a traffic jam we arrived at the L&R building of Delft University. The other participants already arrived, some earlier than 8:45, since some recruiters wanted to have an in depth interview with a few talented participants. The companies used this event as a recruitment session.

After a coffee and a short introduction of all the cases the battle could start. We were led to separate meeting rooms on the tenth floor. Unfortunately not everyone was placed with another SPOCK participant. I was selected by ROSEN team 2 and my team consisted of two very enthusiastic Indian students studying Electrical Engineering and Aerospace Engineering at Delft; a student from the Technical University of Eindhoven studying Building Services; and someone around my age who is already working at TomTom for about a year.

ROSEN team 2's case was to find a way to access the offshore wind energy. The main problem to access this wind energy is that the water depths just off the coast are very deep. In the Netherlands we are lucky that the bottom of the sea does not roll of very steeply and therefore it is relatively easy for us to access this energy. In other countries there is still a lot of wind energy potential just out of their reach which could be used if there is a cheap solution for a water depth independent wind farm.

We thought up of a container with a windmill on top of it. When there is an excess of energy, for example at night, a compressor pumps air into the container, which pushes water out of the bottom of the container. This makes the setup float, independent of the water depth. Furthermore, the bigger the water depth, the bigger the container can be!

The case supervisors were quite enthusiastic this year. We didn't have a lot of time for a break or whatsoever. During lunch we got our lunch bags and we were confined to our meeting rooms. I tried to walk to other meeting rooms to socialise with other SPOCK people for a moment, but I was called back to work on the pitch. During the rest of the afternoon I worked together with someone else on the presentation while the others crunched the numbers.

The pitches were quite nice to see. People presented Bob the Builder, solutions for milk powder drying, and solutions for 'sustainable money'. After the pitches we got some drinks and talked with the other teams and case supervisors.

Finally after a deliberation of more than 30 minutes the winners were going to be announced. It turned out that the jury wasn't really impressed with the level of the solutions this year and therefore not five, but only four teams could get through to the finals in November. Would one of our teams get through to the finals? Yes two teams with SPOCK people got through! Erik and Peter, which were in different Siemens teams, both got through and they will probably go to the finals this November. If you see them, congratulate them with this wonderful result.

We celebrated their victory afterwards, but it was not long before we got kicked out of the building, because they wanted to close everything. We then walked to our hostel which was located in the centre of Delft, which is about half an hour away by foot from the L&R building. We also walked past the Julianalaan and of course we had to take a picture of this street.

The hostel we stayed at was nice. It had a huge bath tub and a roof supported and fixed with duck tape. After we checked in and dropped our stuff, we continued our celebration with some nice Grolsch beers in a nearby pub. We strolled the rest of the city centre, but Delft was pretty quiet. It was Friday night so it was not too surprising that there were not a lot of people. However, we did find a lot of people coming from Twente looking for places to go out. One group of Twente we met already gave up and called a cab to go back to their hotel. Another group was lost and needed a place to park their car.

I never went out in Delft before and I thought the channels give the centre a warm characteristic feeling. We heard from people living in Delft that it isn't a really good place to go out and they recommended to take the train to The Hague or Rotterdam.

We decided to stay in Delft and finally we settled in another pub where they have Koninck and spend the rest of the night there. Early in the morning we went back to the hostel and we could have a good night of sleep, if there was no carillon next to the hostel which started to play at 7 o'clock, which then played every 15 minutes. After breakfast we took the train back to Twente. To summarise we had a very nice day at the NRG battle working on energy related cases and we enjoyed the pitches. It is quite fun to just step back from what you have learned from Electrical Engineering and try to come up with solutions for engineering cases. Finally, I think the drinks at the end was a great way to end this long day.

Junction

Fotis Avgidis

Author: Vera Nauta

This is the first year that Electrical Engineering is given in English, and therefore also the first year that there are international Bachelor students. Fotis Avgidis is one of those students, who belong to the first generation of foreign students. Why would someone leave their home country to study abroad? And what is it like for a foreign student, to live in the Netherlands? Read this interview to find out.

Where are you from?

I am from Greece. I was born in Athens, but moved to a smaller city with my parents when I was a bit older. I also have one half-brother.

Why did decide to study in Enschede?

I think the Dutch universities have the best value for money. The tuition fee is low, while the education is good. My first choice was to go to the United Kingdom, but the tuition fee was higher.

I THINK THE DUTCH UNIVERSITIES HAVE THE BEST VALUE FOR MONEY

I wanted to study Electrical Engineering. For Dutch people, this is possible in Enschede, Delft and Eindhoven. But since in Delft, the study is in Dutch, I could choose between Eindhoven and Enschede. The reason I came to Enschede was actually quite accidentally as I was too late to apply for Electrical Engineering in Eindhoven, so I came to Enschede.

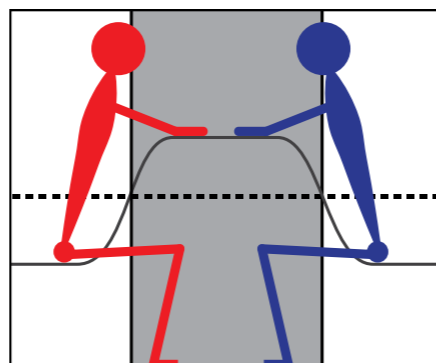### What do you think of the University of Twente?

I like it. The level is pretty high, but that is a good thing. I like the fact that the study is challenging. There are also a lot of Master opportunities in Twente.

I did not like the module system that much, zero or fifteen credits is a bit rigorous. However, our pilot ends after this year, so we will just have separate courses.

portunity, with some assignments. The last quarter of the year is a bit harder. We have EM-fields, Fundamentals of Digital Logic and a Mathematics course, which are all not truly electrical engineering courses.

Even though I don't speak Dutch, I feel that when it comes to academic life I am being treated equally. Sometimes there is a lack of study material in English but I do realize that this is the first year the program is being taught in English, so such problems are expected.

And what do you think of the Netherlands?

The weather is a bit of a problem, since I am used to a lot warmer climate. At first, I also did not like the Dutch food, but by now I am used to it. I really disfavor "stampot" though.

I LIKE THE FACT THAT THE STUDY IS CHALLENGING

I still have all credits so far. I failed the programming courses in the first quarter at first, but the university gave me an extra op-

Fotis Avgidis

Age	Nineteen
Study year	First
Birth place	Athens
Favorite book	The Prisoner of Heaven
Favorite serie	Houses of Cards

I also like Enschede, it is not a very big city, but it has everything you need.

I live in the city at the moment, but I would like to move to the campus next year. There are some international houses on the campus, but I would also like to live with other Dutch students. It would be a good way to practice my Dutch a bit. At the moment, I only know the very basics of Dutch.

JUST LIKE MY MASTER'S STUDY, IT COULD BE ANYWHERE

What do you do in your free time?

In spend most of my time on my study. But when I have some free time, I like to read books. I also like to watch some tv-series. Some of the books I read lately and I really liked are "The Prisoner of Heaven" by

Carlos Ruiz Zafón , "On the Road" by Jack Kerouac and "The Book of General Ignorance" by John Lloyd and John Mitchinson. Some of the series I currently follow are "Houses of Cards", "Da Vinci's Demons", "Sherlock" and the all-time classic "Doctor Who".

What are your plans for the future?

I am certain that I will do a Master's study after I get my Bachelor's degree. I am not sure yet if I will do my Master in Twente, it could be anywhere in the world basically. After my master, I maybe want to do a PhD. I am not sure if I want to go back to Greece

when I am done studying. Just like my Master's study, it could be anywhere. The financial situation in Greece is not very good at the moment, which is a reason to not go back to Greece. But it is of course my home country, so it is always an option.

What is it like to be so far from home?

Of course, it is hard to be so far away from my family and friends. It was especially hard in the beginning. I had to get used to it. But there are also a lot of nice people in Enschede, which makes it better.

Dames StAf toernooi
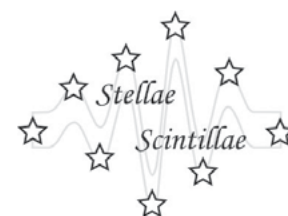
Stellae Scintillae

For the first time in history Stellae Scintillae participated in an exhausting activity. We participated in v.v. Drienerlo's first "dames 4x4 StAf-toernooi". Scintilla selected their best soccer players to defend our pride. In our first game we faced Arago and made our first goal due to our good tactics. The second match we played against Newton which was a thriller and ended in 2-0, a great success!

AGAINST NEWTON WE SERIOUSLY HAD A CHANCE

During a short break we prepared ourselves for the match against our biggest rival. This match, against Paradoks, many goals were made. The nicest move was an "één-tweetje" between Laurie and Fieke which resulted in a goal. Our final match was the deciding one against Saxion & friends, it was sink or swim which meant we would go all-the-way to win. In the third half we celebrated our final result: two goals (of which one was made by the opponent). Despite losing all matches and only scoring two goals, it was a great success.
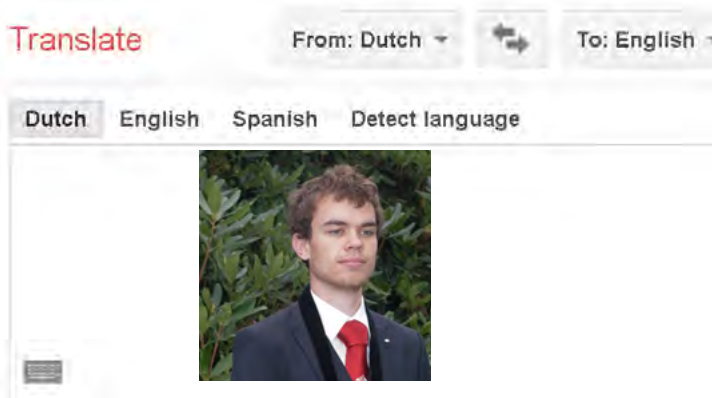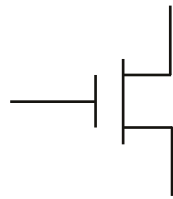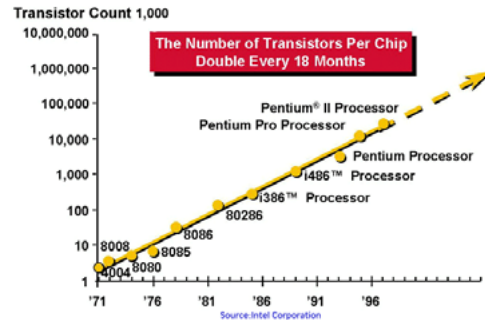
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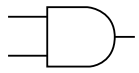
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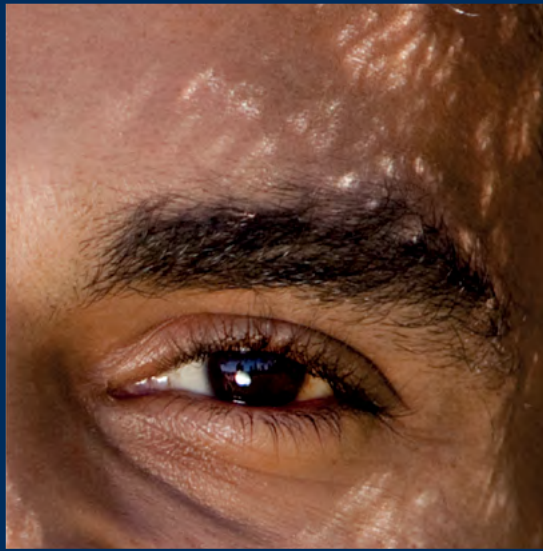~False + sje

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