

«digitalSTROM works, now we have to find partners»

An interview with Ludger Hovestadt

Conventional room automation has failed to gain acceptance for private houses and apartments although it was perfected several years ago. Too complicated and too expensive, they say. digitalSTROM, a standard being developed under the patronage of the Swiss Federal Institute of Technology and the University of Zurich, wants to jump in and fill the gap. This system is for controlling electrical devices such as lamps and roller blinds and for measuring their power consumption. The vision begins with a tiny dimmer, which is ready for digitalSTROM and continues through to the automated house which is monitored and controlled via the Internet.

The intention is for power consumers in the household to communicate with one another via digitalSTROM. Ultimately, the goal is for a small chip to be installed in each consumer, enabling the device to be identified and controlled at low data rates. This means that primarily simple functions such as lighting scenes or metering consumption are to be implemented. The switch and the lamps communicate via the 230 V wire in this case, i.e. digitalSTROM does not require additional bus lines. Parallel to this, both lamps and switches are connected up as consumers. The chip in the lamp switches it on when the chip in the switch gives the command. There is no need for additional lines from the switch to the lamp.

The chip in the switch or the lamp base transmits the data near to the zero passage of the sine-wave vibration by applying a short, low-voltage pulse to the line (or switches off the power supply before or after the zero passage for 10 to 100 microseconds). The chip currently achieves a data transmission rate of 200 bits per second. Because the chip transmits effective power during the pulse, inductive loads do not disturb the system, unlike similar systems that also use the zero passage for transmitting data, but do not transmit effective power.

How is digitalSTROM applied in practice? How well developed is the technology? An interview with Ludger Hovestadt, Professor at the ETH Zurich and President of the digitalSTROM Alliance:

Guido Santner: Mr. Hovestadt, which is the greater challenge, the technology of digitalSTROM, or its marketing?

Ludger Hovestadt Of course, the development of the technology has not yet been completed, but we cannot see any more risks, we just have to continue to work hard. We are expecting two more cycles in the development of the chip, i.e. more or less one year until we will be able to supply it in larger quantities. During this time we will continue to refine the chip technology and will be installing it in a variety of devices with our partners in order to test it. The first products from these partners should be going on the market in 2009.

And how about the marketing?

This is where the challenge lies: How does one get big, powerful partners to build the chip into devices or service models, formulate standards and coordinate the marketing together? We don't yet know the way out of this dilemma. However, we are progressing well, although the pile of obligations for our future partners is getting pretty high. Our main risk is to obtain a partner that might block the whole development later on.

What part does the digitalSTROM alliance play?

The digitalSTROM alliance does not build any devices itself; it advertises the technology and formulates the standard together with the partners. Aizo, our technology provider, only supplies the chip. The devices are developed by our partners, all of which should be market leaders in their respective segments.



Figure 1 «digitalSTROM must be simple; it is intended to make room automation suitable for mass production.»

Which sectors do these partners come from?

At the moment we are focusing on the German-speaking territories, on companies providing light and convenience devices in the energy sector. This means energy supply companies, electricity meter manufacturers – primarily for load management – and, of course white goods manufacturers: washing machines, cookers etc.

The large quantities will come from the lighting field: luminaires, lamps, switch manufacturers and automatic circuit breakers.

Does that mean that in future every light bulb will contain a chip?

We have a prototype of an energy-saving lamp with a chip integrated into the base. The lamp can be dimmed, without any additional dimmer – and it can communicate. We cannot integrate the chip into light bulbs. Not because it is too big, but because the temperature within the base is too high.

So the chip is always in the lamp and not in the plug?

The chip is always integrated in the device. A plug is not a good place because we do not know what will be plugged in. The consumer should be intelligent; the plug merely transmits the energy.

Is there a "killer application" that will facilitate the breakthrough of digitalSTROM, similar to SMS in the case of cell phones?

digitalSTROM does not provide any function with which we are not already familiar. What we reproach other systems for is precisely the fact that they offer a huge number of functions, but only accommodate the 5% of freaks who spend a lot of money on technology. All these demonstration houses for intelligent living are on show just for freaks. We don't want any new functions. The charming thing about digitalSTROM is the fact that it works so simply and not just where freaks are at home. The idea is for people to be able to really use the 10% of the functions; the ones people really want. This means making them suitable for the masses.

Do I have to completely reequip the whole house if I want to have digitalSTROM?

No. Our first step will be to bring products onto the market that will be integrated into the old environment. For example, a dimmer that is located in the switch for the standard lamp. It won't be noticeable that it can communicate via digitalSTROM. That's important.

And how complicated will it be for an electrician who has to equip a complete apartment?

The electrician just needs to know the colour codes: i.e. the yellow chips for the lights; safety is red; appliances such as washing machines are white. He installs a so-called digitalSTROM meter in the switching cabinet; this is a load contactor which looks like a conventional load contactor, but which communicates by means of digitalSTROM.

How much does it cost to install digitalSTROM in an apartment?

digitalSTROM must not cost anything. Installations in a new building must cost the same, irrespective of whether they are conventional or with digitalSTROM. Although we install additional components, we save costs for cables and planning. With the established automation systems a large proportion of the costs are incurred for engineering, planning and programming. This is where one can save money.

What do electrical engineers have to watch out for?

There is nothing that has to be taken into account prior to building except that a power circuit with a fuse of its own must be provided for each room. There is nothing to be discussed with the customer; and that is the good thing about it. With conventional electrical installations it is very different. We have just experienced it with our own house. You have to look at the ground plans, decide where one wants to have the plugs and switches and the result is then these horrible spiders' web-type plans that the electrical designer has to discuss with lay people - and it just doesn't work. At some point the house owner says, it'll be OK... And in our case they promptly used the plan for the storey below with the result that all the ducts were laid in the wrong place in the wall. It was a huge drama until we were finally so annoyed that we gave up. So the electrician who is to install the system is bound to end up in a quarrel because there is no way for him to discuss everything with the customer beforehand.

And this will be better with digitalSTROM?

It's all much more relaxed with digitalSTROM. The electrician installs a duct containing a 230-V cable along the skirting board to the door and to the middle of the ceiling; one empty duct per room and the same throughout. Then he goes into the room with the customer and asks where he or she wants to have the plugs. The spots are marked with chalk and the electrician then installs flush sockets - onto the cable. Then everything is plastered, the lamps are installed and the electrician goes through the completed apartment with the customer and asks how he wants to have the lights programmed. Programming is carried out immediately and on the spot during handover. Now the electrician has become the facilitator! When the customer moves in, the electrician can come again because of the standard lamps instead of parting in a clinch.

How can the customer switch on a specific light scene?

There are 4 scenes for each room plus one Off scene. If one presses the switch several times in sequence, one navigates through the 4 scenes and back to 0. If one waits half a second one just switches back and forth between On and Off, i.e. between the predefined scene and the 0 scene. Anyone who is not familiar with the system does not even notice that there is a choice of scenes.

And the switch only communicates the specific scene?

Yes, the chip knows what it has to do in the respective scene. If nothing has been programmed, it has default values. One lamp is generally switched off in the 0 scene and switched on in all 4 other scenes.

So the switching times do not depend on how many devices are installed in the room?

Exactly. Only when programming them do we communicate with the individual devices. The user always communicates with the whole room. This means which scene, or lighter, or darker. Then there are commands for the whole apartment: I'm leaving; I'm coming in; I'm on holiday etc.

And how are the lamps programmed?

One can either regulate each lamp in a given scene individually from the central light switch, or one can set each lamp on the spot just as one wishes to have it and then adopt the values for the current scene. In both cases one first has to release programming on the fuse box.

In the first case one presses the light switch short-long; then the power circuit flashes briefly and one is in programming mode. A double click then takes one from lamp to lamp. If it is the turn of the lamp I want to program, I switch it on as I want it to be and then proceed to the next lamp. For example, I dim the lamp by continuing to press the switch until the brightness is right.

In the second case one goes from lamp to lamp in the room, setting each one as it is supposed to be and then one programmes the entire scene using short-long.

Can one also dim the entire scene?

Yes, if you continue to press the switch in a scene, you are dimming it. Typically the scenes also become brighter in sequence, i.e. scene 0 is off and it gets progressively lighter from scene 1 to 4.

Is there always only one switch per room?

For example you can install an additional switch for the reading scene, let's say for scene 3. This then only switches on scene 3. In extreme cases one can also install 4 switches for the 4 scenes, with the switch simply located at a specific point in the loop. If one presses it fast several times in sequence, one will rotate within the loop. In other words, only one specific scene is assigned to the switch. If one does not press it fast repeatedly, it just jumps to an fro between this scene and the 0 scene.

But is it possible to dim just one lamp?

Yes, if one goes to the lamp itself, it has higher priority. So if I am lying on the sofa and switch on the standard lamp, it must remain on even if my wife comes into the room, switches on the lights in the room and switches them off again when she goes out.

What about curtains?

Here again we have scenes, for example everything down or everything up. The scenes are programmed in the same way as for the lighting. Only in this case the switches and terminals have grey as the colour code.

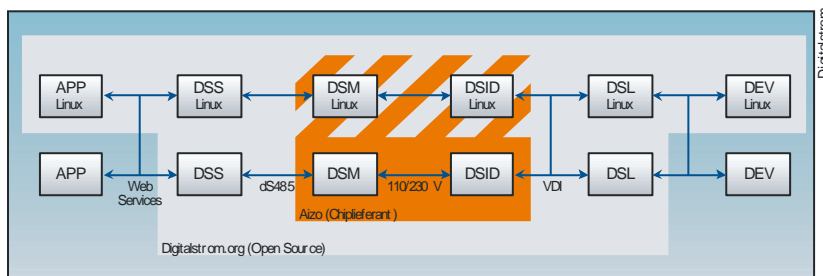


Figure 2: The different digitalSTROM components.

The digitalSTROM meter, DSM - a special high performance contactor, communicates with the devices containing a digitalSTROM chip (DSID) in the power circuit. The server (DSS) assumes functions for the whole apartment and communicates serially with the DSM and to the outside via the Internet protocol. Devices with a digitalSTROM chip (DSID) can communicate in turn with the sister chip dSL via an electrical isolation, for example in order to control the standby function of a set topbox or a TV via digital inputs and outputs. All of the components (top row) can also be simulated in order to develop applications.

Can one regulate brightness by means of the lamps and curtains?

Control circuits are feasible, but for that the digital STROM server, the DSS, is needed for this. It can be programmed via the Internet protocol. The DSS then communicates with the digitalSTROM meter (DSM), our load contactor, via a serial protocol. In operation the DSM then regulates brightness in the room.

It is, therefore, a hierarchical system. As soon as two chips want to communicate with one another one must install a digitalSTROM meter (DSM) in the fuse box. If we want to go into the Internet we need a digitalSTROM server (DSS) at the apartment level. So there are three levels: the chip, the meter and the server. This enables us to communicate with the device, the room and the apartment.

And how does the system know how bright the room is?

The digitalSTROM chip can measure a variety of environmental factors. We have switches, which also measure temperature, brightness and volume. The latter is quite useful for identifying if any persons are present.

You sell the chip with the argument that it saves energy or rather it measures the energy consumptions of individual devices.

Our system measures the current. There are already devices for this purpose, but it is hardly possible to produce them for less than 100 Swiss francs. And these measuring devices never consume less than 3 watts. Our chip can, and it consumes 0.3 watts; that is the power supply unit together with the processor, the current measurement and communication. In the laboratory we have configurations that consume 0.08 watts.

And does the chip measure accurately enough?

The chip does not measure very accurately. Furthermore, we cannot continuously communicate the power consumption; we don't have sufficient bandwidth for that. The chip measures roughly on the spot and communicates fluctuations in the current. The digitalSTROM meter (DSM), the contactor in the fuse box, measures the current accurately and assigns the bounces to the individual devices. Therefore: A lamp reports «I need more current now», and the meter, which can measure accurately, allocates the current to the lamp.

What strength of current can the chip switch and measure?

The system has an onion-like structure, in several skins: In the raw form the chip can control up to 7 watts. This includes the power supply unit and the processor with some low voltage applications, control of the LED lighting, current measurement, phase control for dimming and 4 to 8 binary inputs and one analog input and output. So the chip switches outputs up to 7 watts directly, for example as a small charger for cell phones. However, we do not yet have electrical isolation on the chip. For this purpose we are now developing a small version of a transformer to make us compatible with today's customary devices.

What about larger outputs?

The next onion skin then comes into play: power electronics. Today a light terminal, which works as an rms value dimmer, will switch 120 watts and we are reckoning with 150 watts for future products. Now it is possible to omit the power electronics and install a relay for even greater outputs. Furthermore, we have bistable versions, 1-0-1, to control roller blinds. Or we can build a version for step motors.

If lightning were to strike, are all the digitalSTROM devices then dead?

Look: This big yellow thing is the lightning protection. A varistor of this type is installed in each lighting terminal. This – together with the shield – protects the chip. We hope that when you have equipped an apartment with 60 of our chips, it will automatically also protect all other devices from being struck by lightning. We still have to test it; but according to the calculations it should work.

Which lightning protection standard do you go by?

We meet the relevant standards. I would have to ask my colleagues which ones those are exactly.

The pulses lasting between 10 and 100 microseconds, via which digitalSTROM communicates, result in interference at frequencies within the 5 to 50 kHz range. How does that work out if 3 billion electrical devices in Germany carry a chip like this?



Figure 3 «It becomes easier for electricians; they do not assign the lamps until after the apartment has been completed».

We have a hierarchical structure; the signals do not jump over to the other power circuits. If they did, we would interfere with ourselves and would not be able to control safety. At the DSM, i.e. the contactor is where the signals end. This means that we don't have this scaling problem. This is a major difference to radio or powerline. Only system with an additional wire for bus can be scaled and are safe in a similar way.

Energy supply companies are dreaming about using digitalSTROM to identify electric cars when they tank electricity. How are the chips addressed?

Each chip has a worldwide unique address, like the MAC address for Ethernet. An electric car can be identified by means of this. However, in rooms we only use 60,000 logical addresses to keep the bandwidth small.

So you have short, logical addresses in the power circuit and to the outside long physical ones for logging on the device?

Yes. That's how we scale the system. digitalSTROM remains in the room with the 60,000 addresses. Up to 16 power circuits from the apartment communicate with the server via the serial protocol (2-4 Mbits/s). Outside the apartment the system communicates by means of the Internet protocol, i.e. TCP/IP.

May a company design its own chip if it decides to use digitalSTROM?

Not to begin with, so that we can develop and establish a standard that really works properly. However, we do realise that we will need a second source and, later on, when the standard is defined exactly enough, our partners may also develop their own chips. At the moment we are involved in developing a second source on a second line with a different technology and different chip factories. About three quarters of a year later we will therefore have a second chip available with the same functions which is produced on a separate line.

What do the partners pay?

The partnership contract costs virtually nothing. As long as the partners do not earn money with the software placed at their disposal, they do not have to pay anything. In this way we hope to be able to motivate universities or small companies. In return, they have to make the software available. If a company earns money with its software it has to pay license fees. But then it does not have to make its software available.

Is there a development kit?

Already this year universities and electricians will be able to play with the core functions of the system using a software simulation.

This way they can find out what the system can do and develop ideas on how to advance it further. Selected people are given hardware. Here we focus mainly on the major manufacturers, the device developers. For the first quarter of 2009 we are planning a development kit for planners and electricians who perform installations on a larger scale.

Many thanks for the interview.

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