Energy is a driver

There is an increasing flow of news on the build-up to the climate change conference in Copenhagen. It seems that the idea of stopping global warming by cutting down carbon dioxide emissions and by increasing energy efficiency has been accepted on a global scale.

Surprisingly, carbon dioxide is not the only reason why we have to look at energy efficiency.

The 10/09 issue of IEEE Spectrum tells us that climate researchers are developing a new 10 petaflop/s supercomputer to be used for running a global climate model with a grid of 1.5 km. The supercomputer could be built using 1.7 million PC processors, but energy consumption would pose a problem. The power consumption would be 179 megawatts**.** In continuous use this would exceed the electricity consumption of 50,000 standard Finnish houses. On top, additional energy is needed for cooling.

According to researchers, the same computing power could be achieved by using low-energy processors intended for mobile use. Although ten million of them would be needed, their power consumption is only three megawatts, which corresponds to the electricity consumption of fewer than 900 Finnish houses. The annual electricity bill is likely to be around two million euros, which seems quite reasonable compared with the previous alternative, which was approximately 130 million euros. The development path seems to be taking us from special supercomputing equipment via PC technology onwards to mobile technology, and currently the direction is determined by power consumption.

When the spread spectrum technology was adopted in mobile phones, the developers were disappointed to find that mobile device batteries did not last as long as GSM network users had become accustomed. The problem needed to be solved promptly. The developers of the next-generation, and next main wireless broadband standard, LTE (long-term evolution) mobile network invested their best efforts from the very beginning into building a radio that allows low-energy broadband traffic on a battery powered device. The best way to save battery is to let the mobile sleep as much as possible and wake it up only when something important needs to be done.

However, as to power supply, the broadband radio network is up against major challenges. The LTE network, for example, needs eight times as many base stations compared with GSM. Each base station uses four times the power consumed by a GSM base station. It is quite possible that the growth of power consumption will halt the triumphal march of radio communications during the next decade. However, the search for new solutions is already on. One possibility is to adapt network operations completely into the traffic. In other words, part of the network is put to sleep when there is no traffic to be carried. Current networks operate at full power regardless of how much users wish to use the service.

Energy efficiency has not yet guided the development of the LTE network software architecture. The software architecture adopted from the 3G networks assumes that the mobile phone will handle applications that are designed for PCs, keeping the mobile device processor awake most of the time for insignificant reasons. For example, application level registrations at a few minute intervals on a network server or updating address changes on the network gateway have been considered valid reasons to send messages into the network. These are issues that relate to the reachability of the device. This raises the question whether the designers have forgotten that the network exists for maintaining the reachability of users (in addition to carrying the traffic). Why on earth should the mobile device, application-specifically, have to look after such basics?

The rule in radio transmission is: the broader the band, the greater the power consumption. Radio transmission power is always scattered in a wide beam, whereas in fiber transmission, power is focused precisely. The broader the bands become, the clearer the advantage of fiber-based broadband. In the name of fairness, we should compare the life-long carbon cost. We also have to include the carbon cost of digging in the cables.

These examples show that

(1) Power consumption is beginning to restrict the increase in computing efficiency that has been following Moore's Law
(2) Power consumption is becoming more significant with the increase in the number and role of battery-based devices
(3) As in computers, power consumption also in data networks has started to guide technology development. Scientists have plenty of work to do in this field, for global network architectures cannot be changed overnight.
(4) When we commit ourselves in Copenhagen to cut the carbon dioxide emissions by 80 percent, the ICT sector cannot remain a bystander. I believe that we should keep our own house clean while we apply ICT to help other sectors in reducing their emissions.

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