

**communication protocols:
painting them green and
using them to paint green**

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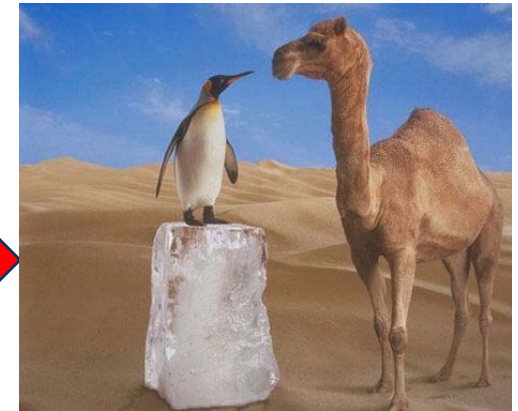
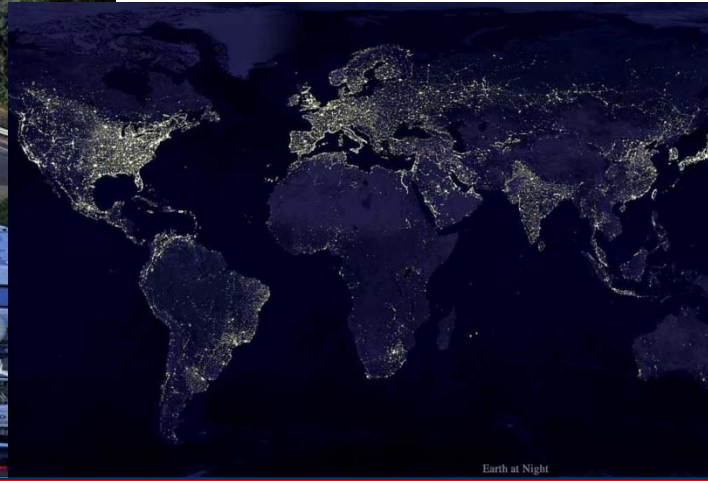
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- carbon footprints and ICT
- energy efficiency – where should ICT act?
- passive and low-power communicable devices
- rfid technology
- summary and outlook

the development -energy-carbon puzzle

- the rapid development in the 20+ century seen as largely unsustainable



WIRED photo: Yann Arthus-Bertrand/Altitude
photo Night on Earth <http://wallpapers.jurko.net/pic/501/>
photo with the cars: <http://blog.oregonlive.com/steveduin/2007/06/>

penguin and camel:
<http://www.thedyerboys.com/2009/05/top-5-signs-of-global-warming.html>

the development -energy-carbon puzzle

- necessarily steered towards **low-carbon economy**
 - despite the new gadgets, services, applications, lifestyle improvements
- but, it is not only about evolving the already developed

we must accept that the world's fastest-growing economies won't forgo a higher standard of living in the name of climate science - and that, on the way up, countries like India and China might actually help devise the solutions the planet so desperately needs.

wired magazine, may 2008

- how can the developing economies develop in a more efficient way than the economies developed today?

energy consumption rates and ICT

- in 2007 Gartner group released report in which it states that the total amount of CO2 emissions from the IT industry could amount to 2% of global carbon emissions
- painting the communication protocols green affects only the 2%, using the communication protocols to paint green attacks the 98% window of opportunity

*green IT is an oxymoron, until you consider
use of IT to 'green' business and society.*

Simon Mingay, Gartner

where is the 98%

- buildings

- more than 40% of the energy consumption in Europe is due to heating and lighting operations within buildings.

- manufacturing

- transport

- the per-capita car ownership ratio in China will increase by 67% to 40 cars for every 1,000 citizens by 2010 from the current 24, according to a report by Chinanews.

- logistics

but the 2% in ICT is not naïve as well

- a Harvard university physicist says a typical search on a desktop computer generates about 7 grams of carbon dioxide



- wireless network
 - from the report by huawei:

access network is a key focus area for energy efficiency within the network. it includes the access and auxiliary equipment, in particular the cooling facility.

ICT in the perspective of technological revolutions

- ICT usage has exploded after the other technologies (electricity, transport, supplies) were mature
- ICT can be used to redesign the services and processes in the physical world
- **clean slate design** – how to design the services and processes in a sustainable way if we were to start anew
 - **example:** bring electricity to underdeveloped areas in a more efficient way
- **wean slate design** – how to evolve the existing services and processes in the developed world to make them sustainable
 - **example:** upgrade the power grid to make smart grid

WWF report: possible areas of change

1. smart city planning
2. smart buildings
3. smart appliances
4. dematerialisation services – bits instead of bricks
5. i-optimisation
6. smart industry
7. smart grid
8. integrated renewables
9. smart work
10. intelligent transport

generic energy saving mechanisms using ICT

- make ICT itself to be more energy efficient
- better re-design of processes through simulation and virtualization
- account for the carbon feedback
 - **low carbon feedback (as defined by WWF):** a situation where an IT service encourages new services, behavior and institutional structures that result in reduced CO₂ emissions.
- **dematerialization**
 - prime example is the video conferencing, which replaces travels in order to conduct meetings
- **scheduling and resource allocation in the physical world**
 - decrease the waste of energy and resources in the commonly occurring processes in various aspects of human/machine activity

requirements for the communication technology

- scheduling the physical world requires physical objects to be perceptible in the digital realm
- the objects need to communicate at a very low power
 - low power sensors
 - energy harvesting
 - **passive devices (passive RFID tags)**
- a view on the passive RFID
 - cheap memory location, embeddable into an object, such that the read/write process is done on-demand, when powered by an external reader

rfid technology (1)

- **R**adio **F**requency **I**Dentification
 - encompasses a large variety of devices
 - a straightforward view: evolution of the bar code
- all tags are not created equal: **active, semi-active, passive**

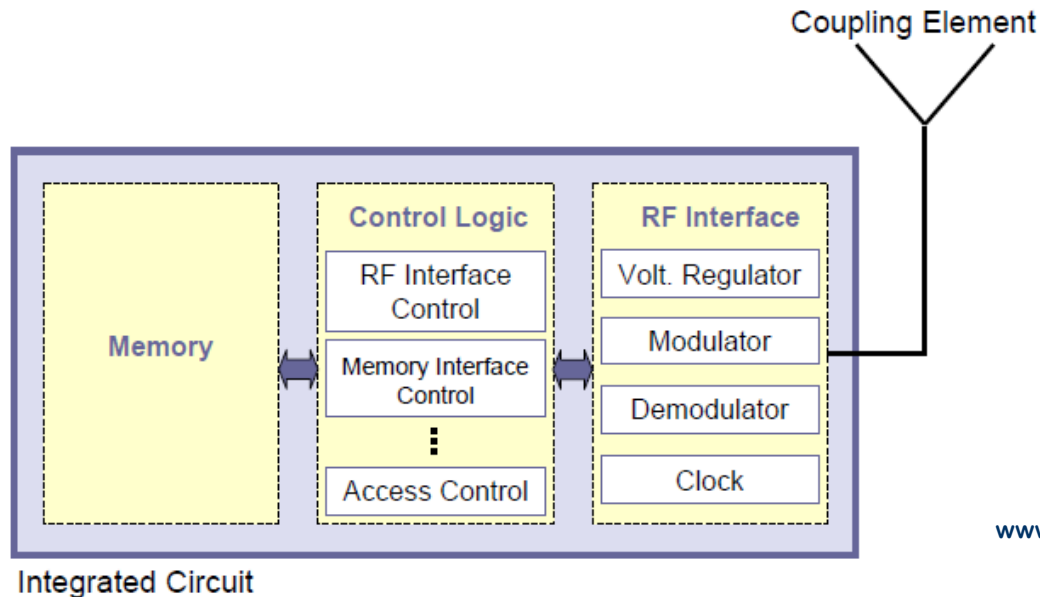
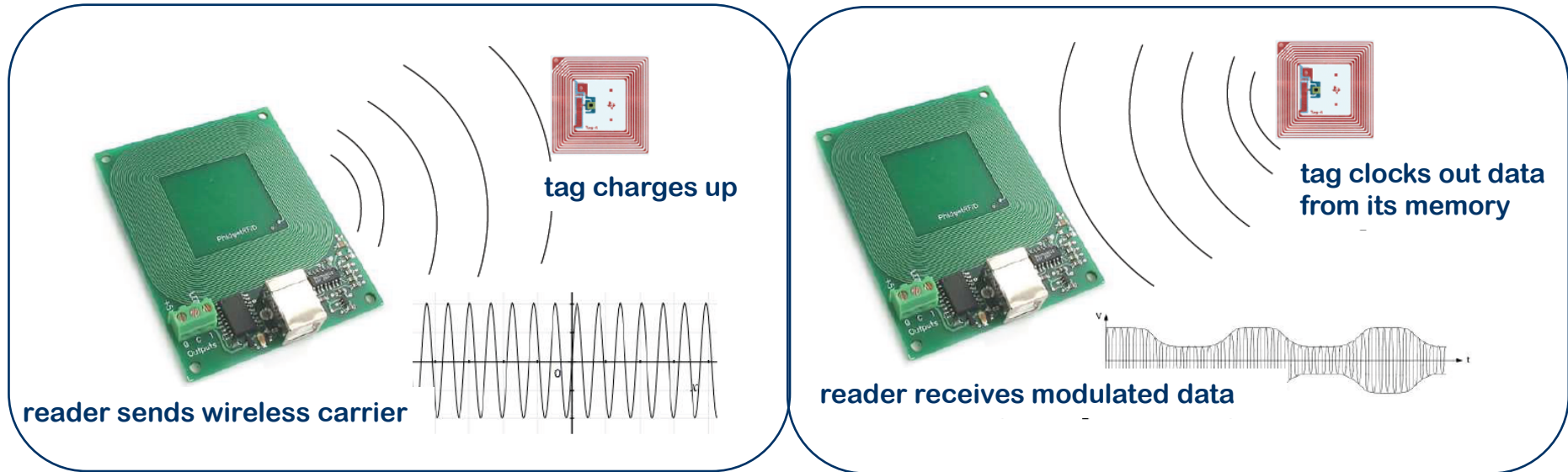


figure taken from: Matthias Handy
www.imd.uni-rostock.de/veroeff/handy_rfid_berlin.pdf

rfid technology (2)



○ RFID sensors

- temperature, chemical, motion
- sensing operation may be battery powered or use energy harvesting
- passive sensor tags are the most appealing for ubiquitous usage

○ internet of things

- starts with plain usages in logistics, evolves towards digitalizing the things and virtualization of the physical world

○ generalization of passive RFID is passive xID

- anything that allows to read/write to/from an object without markedly changing its integrity

○ RFID transforms energy into data

- the communication with billions of tags will require massive energy budget
- that is why **passive** is the key attribute

○ today

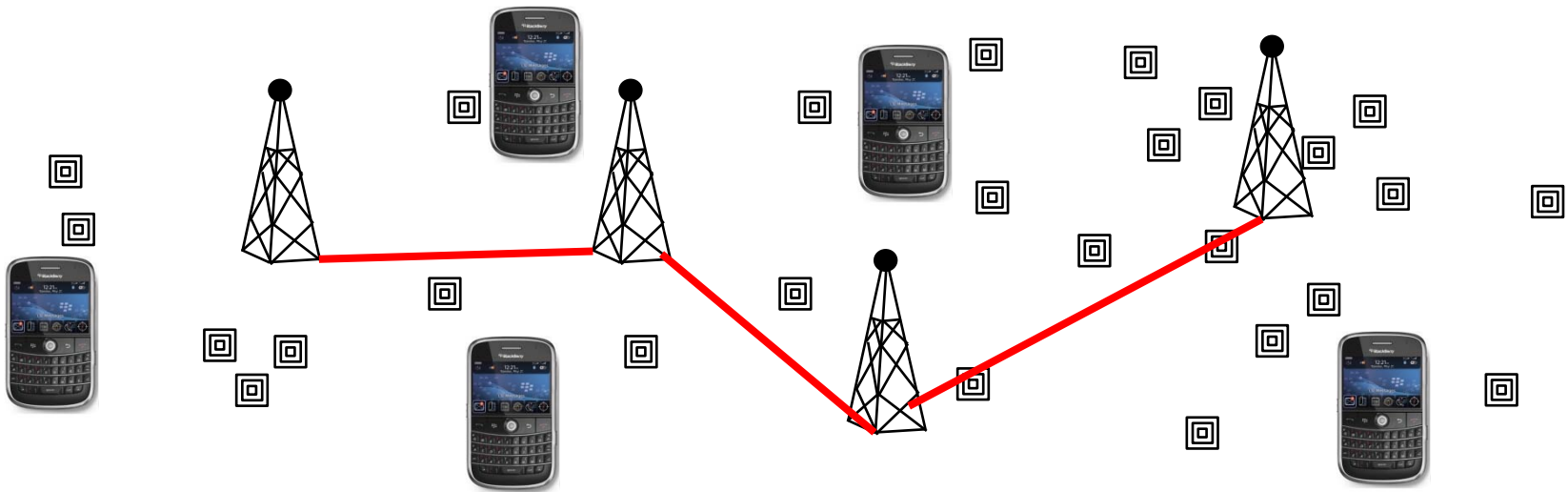
- supply chain automation, asset tracking, retail
- medical applications, people tracking
- manufacturing, warehouses

○ reducing tomorrow's carbon emission

- cluster people and goods for more efficient transportation
- responsive resource management in buildings
 - example: adapt accumulated hot water according to the actual presence figures in the building
- reduce the transportation/travel by guiding the needs towards the nearby items and products
- understand and optimize the carbon flow by mining the logged interactions between the objects and humans

challenges and research issues (1)

- networked infrastructure of fixed and mobile readers



- create communication techniques and protocols reckoning with the modest processing capability of the tags

challenges and research issues (2)

- improving the antenna efficiency at the tag
- energy harvesting
- look for xID technologies
 - e. g. nanomaterials that can embed digital information
- security and privacy
 - each technology brings its own security threats
 - this one may have immense consequences, as physical world can be manipulated in a digital way

summary and outlook

- **ICT can reduce carbon emissions much better by helping the other segments rather than helping itself**
- **key role for the communication devices/protocols that operate under very low power or no battery power at all**
- **massive sensing, mapping, and actuation of the physical world is the way towards the low-carbon economy**