Designing Wireless Sensor Networks

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Aspects of planning

This presentation aims to be a checklist and reminder of important aspects of WSN planning

Physical Sensors
Networking options
Powering options
Physical installation, protection
Data transport
Data management
Maintenance
Budget

Physical sensors

- (covered in previous talks)
- sizes
- prices
- type of technology: proprietary, open

- in your special field of work, you are the expert. the scientist often knows more than the IT person.

Physical sensors

A remark: we are seeing a lot of potential in **exploring new, more affordable and more open sensor systems.** In most cases, the physical principles of the actual sensor will be the same.
In some cases though, **novel methods might be interesting.** Examples:

- Rain gauges that use optical/acoustic methods instead of tipping buckets.
- Water properties measured with optical real time instead

of lab analysis.

It is worth doing research in this field (and **working together** on it) – just some examples from the field of aquatic/lake sensor networks:

IN-SITU MEASUREMENTS OF PHYTOPLANKTON FLUORESCENCE USING LOW COST ELECTRONICS
Thomas Leeuw (not published yet)

Developing Low-Cost Intelligent Wireless Sensor Networks for Aquatic Environments
Jarrod Trevathan, Ian Atkinson, Wayne Read, Nigel Bajema, Yong Jin Lee, Adam Scarrand Ron Johnstone ; eResearch Centre – James Cook University, Townsville, Australia, School of Geography, Planning and Environmental Management – University of Queensland, Brisbane, Australia

Wireless Sensor Networks for Water Quality Monitoring: A Case of Zambia N. Chaamwe

Networking options

Your choice of networking technology is based on a **thorough analysis of many diferrent factors,** some of these phsyical (site survey!), others non-physical.

- data rates
- distances
- synchronous/asynchronous transfer
- topology, terrain, climate, ..
- regulations, legal constraints

Networking options

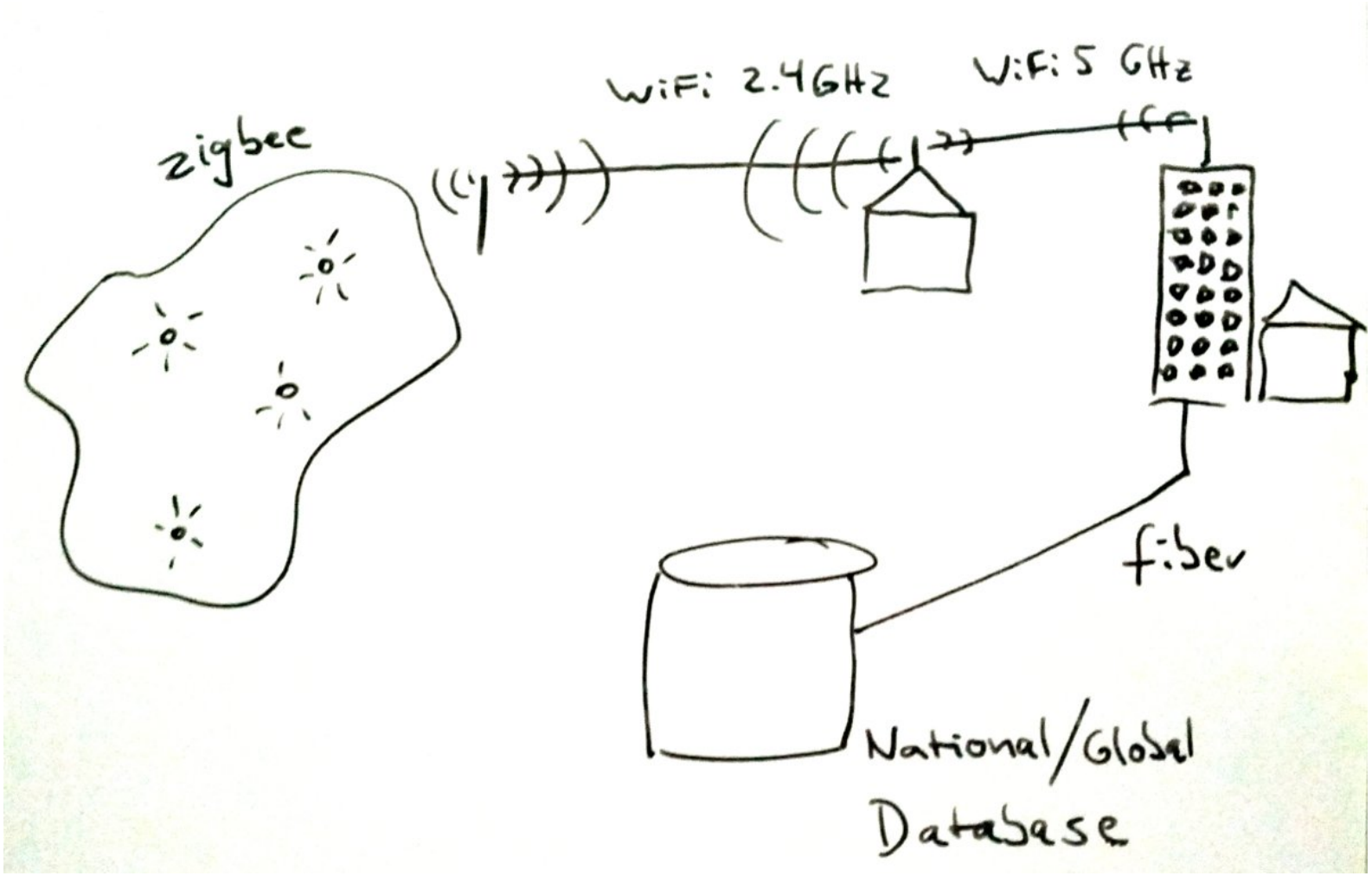
- Wired (ethernet, fiber) – dont do wireless if you have wire!

- **Wireless**
  - 802.15.4, zigbee (on different frequencies)
  - 802.11 (WiFi, low power WiFi)
  - mobile, GSM/GPRS
  - satellite

Networking options

Keep in mind that you can mix different networking technologies in one project: e.g.

- Zigbee from lake to shore station
- WifI 2.4 from Station to Office/Hut
- WiFi 5 from Hut to Campus
- Fiber from Campus to National/Global Database


zigbee
WiFi: 2.4GHz
WiFi: 5 GHz
fiber
National/Global
Database

Networking technologies, comparison

	Autonomous?	**Data rate**	**power**	**reach**	
802.15.4	yes	low	low	Medium (~10 km)	
zigbee	yes	low	low	Medium (~10 km)	
802.11	yes	high	(high)	Long (~100 km)	
GSM/GPRS	no	depends	low	(wherever there is coverage)	
wired	(yes)	Very high	high	(short)	

Wireless networking: Frequency aspects

- higher frequency, higher data rate
- higher frequency, shorter reach
- lower frequency, better penetration (through objects, environment)

- interference, coexistence?
- Regulations vs. Reality

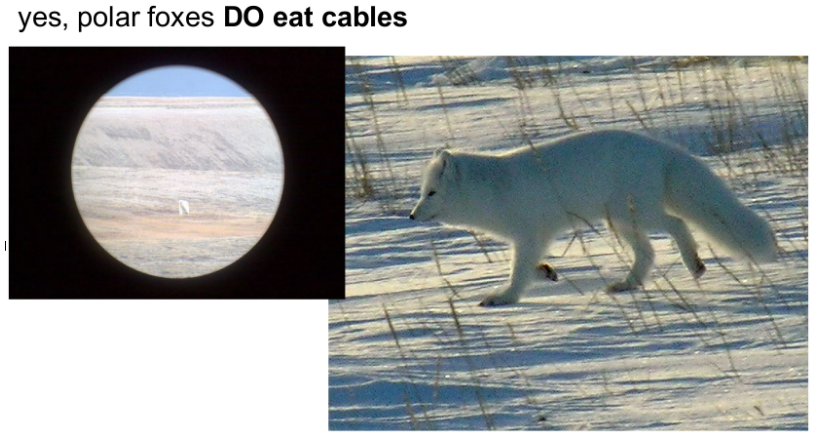
Powering options

- Dependent or autonomous?
  - If you have grid power – is it stable?

- Autonomous options
  - Battery only
  - Solar
  - Wind
  - Hydro
  - Thermal, vibrational energy harvesting
  - (Wireless power transfer)

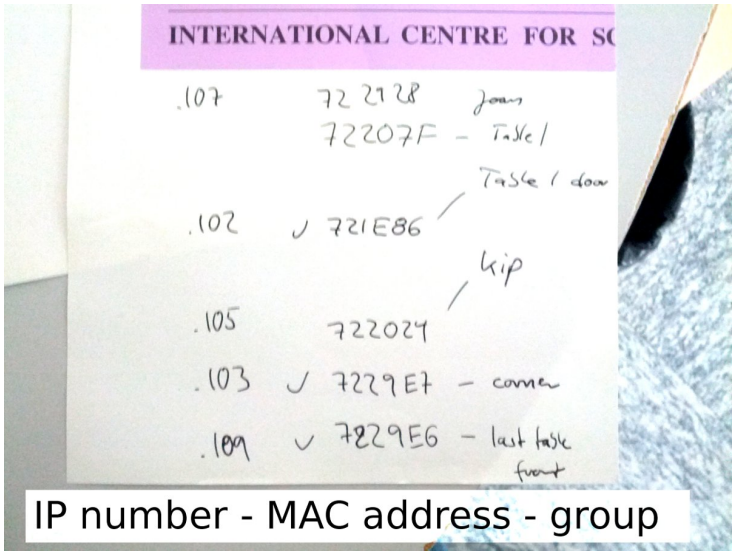
Physical installation, protection

- Environmental protection
- Weather
  - Lightning
  - Wind
  - Humidity
  - Fires
- Animals?
- Social aspects, human factors
  - theft, vandalism
  - cleaning personnel in university :)



Test and document all parts

- You should always test in lab, and keep a reference system of anything you deploy, at the lab
- It is essential to know and document all aspects of what you deploy – before you bring it to a remote location



IP number - MAC address - group

Data transport

- from sensor to database, archive, lab
- protocol
- security aspects
  - integrity
  - availability
  - ...
- delays, failure, failover, recovery (time and location stamping!)

Data management

- Where does the data go?
- database design, format, organization of data
- backup
- access, dissemination, visualization
- security, data integrity
- imagine a scenario where data are manipulated - e.g. Early disaster warning systems, radiation

Opinion:
All of the above suggest **Open Data / Open Standards approaches**

Maintenance

- long term maintenance
- hardware replacement plan
- physical distance “civilization” to deployment
- support (long term!)
- human factors!!!

Budget

- one time investments (CAPEX)
- operational ongoing costs (OPEX)
- don't invest in hardware and forget the people!

- hardware replacement budgets (10-20% annual?)

- sustainability after the funded phase???
  - planning business models