Combination of CP & CSA

D5.2 – Sensor networking best practices in the Arctic: Pages on web site (WP5)

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Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
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Table of Contents

Publishable Executive Summary

A major problem of environmental monitoring in the Arctic is the performance of sensors in harsh environments and the operation of these sensors in remote locations that are frequently unmanned. Consequently, WP 5 was established to explore current best practices of the design and deployment of virtual instruments, i.e., networked monitoring systems, at the INTERACT sites.

Deliverable D5.2 concentrated on publishing web pages on the INTERACT web site for sensor networking best practices in the Arctic. The web pages were formatted according to Frequently Asked Questions (FAQ). The actions carried out to achieve this deliverable included research of the state-of-the-art in wireless sensor networking and conducting a survey of INTERACT station managers regarding existing wireless networking on their sites.

1. Content of the Web page and FAQ

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Frequently Asked Questions.

1. What is a wireless network? 2. What is a radio link? 3. What is a 900 MHz/2.4 GHz radio? 4. What is an antenna? 5. What is 802.11? 6. What is 802.15.4? 7. What is a protocol? 8. How to dimension a radio link?

1. What is a Wireless Sensor Network?

The term Wireless Sensor Networks (WSN) is weedily used, and stands for a group of sensors which are able to communicate to each other, send/receive data, or send/receive commands by means of a wireless link.

In the context of in-situ sensing with data loggers, a Wireless Network is a solution to the problem of transmitting data from a data logger to a server (possibly, a gateway, i.e., a server connected to a communication infrastructure). As most of the times we are dealing with a wide area to be covered, far from the place we want to access the data, wired connections from every data logger is neither practical nor desirable. For this reason, a wireless solution is required. A wireless network of data loggers defines all the components that permit not only to get data out of data loggers, but to monitor their operation, modify their behavior or even define the model that is being applied for data collection.

2. What is a radio link?

A Radio Link is a wireless connection between to devices that are able to exchange data with each other. The fact that we are able to establish a Radio Link does not imply that these devices are able to communicate, since we are only addressing the

physical layer (see 7. what is a protocol? for details about the different layers in a networked system).

3. What is a 900 MHz or 2.4 GHz radio?

900 MHz and 2.4GHz are two well know and widely used frequencies of the UHF radio spectrum. We mention them here since it is necessary to make a decision regarding frequency when we plan to create a wireless link (or buy a radio module). This is important, since frequency has a great impact in many of the most remarkable characteristics of a wireless link, such as: data rate, reach, signal absorption and power consumption. As a general rule, we need to keep in mind: The higher the frequency, the higher the data rate (Some 10 Kbps for 900 MHz, some Mbps for 2.4GHz). The lower the frequency, the further the reach and the wireless signal we can "go through things". Far all radio/microwave frequencies: Strong absorption in water and metal. See Sebastian Buttrich's slides for more details about the basics of radio physics.

You can find movies illustrating the use of 900 MHz and 2.4 GHz radio in Abisko (see 8. how to dimension a radio link to find out how to obtain these figures).

4. What is an antenna?

Antennas are the interface between guided waves (from a cable) and unguided waves (propagated in free space). Antenna have a huge impact on any wireless system. This is true when setting up a wifi system at home, and it is true when setting up radio links in the Arctic. The main issues include directivity (directional vs. omnidirectional antennas), polarity and gain. The cables used to connect a radio module to an external antenna are also a key component of any wireless system (as loss is important on such cables, the longer the antenna cable the more energy is required to transmit a wireless signal). Our goal here is not to be comprehensive about antenna design, but to make it clear that before any deployment it is crucial to choose the appropriate antenna. Here are some slides that will give you some background about antennas.

5. What is 802.11?

802.11 (also known as Wi-Fi) is a set of standards which are commonly associated to implementing Wireless Local Area Networks WLANs. This standard, which specifies the physical layer and media access control, works in frequencies in the range of 2.4GHz to 5 GHz, which, as explained above, makes it being able to work at high data rates, with reach restrictions and heavy absorption by water and metal. This is also a power hungry standard -when compared with others such as 802.15.4. However, it is getting more and more efficient, specially when protocols running on top of it are coded considering the power issue. Still, this is one of the most widely used standards in wireless communications and it is present in almost any device we can think of, which makes it a very good candidate for new generation WSN.

6. What is 802.15.4?

802.15.4 is a standard which is commonly associated to Low-Rate Wireless Personal Area Networks (LR-WPANs). As 802.11, it specifies the physical layer and media access control. It can work at 900MHz or 2.4GHz, but usually it is used at low frequencies in order to keep one of its best attributes: Low power consumption. Also, when going lower on frequency we are able to make longer distances. However, the throughput decreases from a few Mbps at 2.4GHz to a few Kbps at 900MHz. Also, the protocols that are able to go on top of 802.15.4 are different, or at least we have more to choose. While TCP is a possibility, the use of others such as ZigBee, can better take advantage of the characteristics of the standard.

7. What is a protocol?

A communications protocol is a set of rules and message formats for a given number of devices to be able to communicate and "understand" each other. We could relate a protocol to a language in human interaction. First thing we have to agree in before starting a conversation is which set of words and conventions are going to be used.

A protocol is a common term in communications, and general descriptions such as the given in wikipedia could help to understand better the need of it when establishing a connections among IT systems.

Different types of protocols are required to organize complex interactions in a networked system. To cope with this complexity, protocols are arranged in layers. Different standards exist to describe these layers. The most used is the Internet Protocol Suite which defines a *physical layer* (data encoding on the wireless medium), *a data link layer* (exchange of packets on a data link), an *internet layer* (IP: exchange of packets between computers - possibly via many data links), *a transport layer* (TCP: routing of packets through a network), and *an application layer* (any format of data and coordination appropriate for a given application, e.g., http).

8. How to dimension a Radio Link?

When we want to make real calculations to dimension a Wireless Link, then we need to understand the concept of Free Space Loss (radio propagation in free space incurs a loss which is proportional to the square of distance and the square of the frequency) and Fresnel Zones (in general a radio signal requires line of sight and some free space around it, that free space is separated into Fresnel zones). Again, see Sebastian Buttrich's slides for basics about radio physics.

However, there is no need for relying on manual, classic handmade calculations in order to properly design a Wireless Link. There exist tools such as Radio Mobile, which allows us to create simulations based on real maps. This is not 100% reliable, but can help us to go for one frequency or the other, and thus plan for a field deployment.

See here, Joel Granados and Javier Gonzalez' report on their work on radio link dimensioning for Abisko and Zackenberg.