CERN openlab

WIND

handouts

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Also known as:
WIRELESS
INFRASTRUCTURE
NETWORK
DEPLOYMENT

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WIND is a joint HPN-CERN project established within CERN's openlab framework. Our goal is to carry out a research activity and provide new algorithms, guidelines and solutions that will support the deployment and operation of the Wi-Fi infrastracture at CERN.

CERN

Dawn of a new era

It might seem unimaginable, yet the standardised wireless networking (Wi-Fi), in the sense as we know it today was born just over a decade ago! Initial standard allowed the network to operate with the astonishing speed of 2 Megabits per second. 2Mbps over a shared medium, in half-duplex mode... The performance was rather meagre for the end users. Also, as it is often the case with emerging technologies, the prices of the equipment were high. Nonetheless it was a beginning of a new era—era of networking without cables...

It's fine, isn't it?

Nowadays, wireless networks are **ubiquitous**. Everyone is using them and most of us are more or less satisfied with their performance. **Is there anything more to wireless networking than installing an access point, tweaking some settings and leaving it for everyone to use?** Isn't it enough to add more access points if the performance does not come up to our expectations?

Wi-Fi shortcomings...

Unlike the cellular telephony, centralised control and management was not considered when creating the Wi-Fi standards. Bear in mind that in the beginning there was no problem of dense installations. There were hardly any wireless users! Who would care at that time about monitoring? Thanks to that, diagnosing and fixing a problem is a sequence of random trials and errors.

The monitoring is urgently needed — here and now! IEEE addresed the problem in the 802.11k standard that establishes a framework for monitoring a wireless network. However it will take some time till both the clients and access points will fully support these extensions!

What is a "good" wireless network?

It's about the clients! Chaos!

Wi-Fi clients are given a lot of autonomy. They can decide which access point to associate with. They are free to decide about their own transmission power. They are responsible for the roaming decisions. Client software is **egoistic and selfish**— "*Why should I try to change an AP? I can lose my connectivity?*". That is usually perfectly fine from the point of view of a single user, yet it can be a proverbial pain in the neck for the network operators.

Complications...

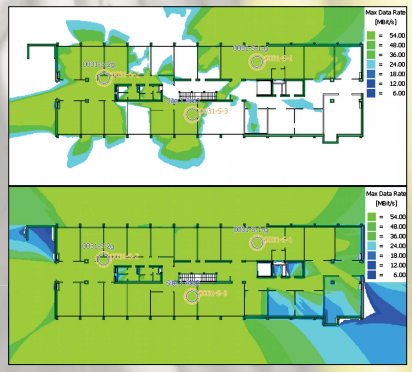
Most of the challenges stem from the capricious nature of the **radio wave propagation**. Wired media have well defined characteristics. It is enough to add another wire/fiber to increase the capacity. Wireless networks on the other hand have to operate within a designated part of the electromagnetic spectrum. There are other applications that are using the same frequencies and interfere with the network operation (e.g. microwave ovens, Bluetooth, cordless phones, etc.).

As if that was not enough the propagation parameters are by no means constant. "Normal events" like closing the fire door, lowering the blinds or people congregating in a meeting room can have a detrimental effect.

Increasing demands

The number of wireless users is increasing. What is more, the number of devices owned by a single user also growing. Finally, the users' appetites are far from being satiated. It seems that there is no other alternative than to create dense wireless installations.

Unlike wired network, adding more access points does not correspond to adding more cables. The number of channels is limited, and **adding more access points blindly can only worsen the situation** (cf. figure with the transmission rates). However, even if we somehow configure these access points, it still will not be perfect. Why?



Effect of the channel assignment on effective transmission rates. Random channel assignment (upper) contrasted with orthogonal channels. Simulations carried out in building 31 at CERN by Sebastien Ceuterickx.

A different perspective

Controlling a process is an action that forces it to operate in accordance with certain assumed requirements.

From this simple definition it is clear that there has to be a way of influencing the object and of measuring how well the requirements are met. In addition to that, the process is affected by disturbances from the environment which make the control task more challenging.

There is a striking similarity with wireless networks – they **can be viewed as complex systems that need to be controlled in order to achieve the best performance.**