The benefits of last mile copper when deploying new generation Radio Access Technologies

White Paper
July 2015

Wally Wael Hariz
Founder and CEO
Haritel

Contents

Executive Summary

The indoors are of key importance in today's telecom world. This is where most of the data traffic is generated. Machines and devices to be connected are also mostly found in or in direct proximity to indoor locations.

For wireless carriers, this reality constitutes a fundamental challenge to overcome as they deploy new generation mobile networks that provide a wealth of performance especially in as far as high speed data and low latency are concerned. This is beneficial as long as these technologies manage to capture the bulk of the data traffic while reaching machines and devices to connect.

However, radio coverage indoors is an undaunted challenge that wireless carriers have struggled and still struggle with. Little can be done to change the laws of physics and solutions adopted involve high costs and complexity failing short of guaranteeing total ubiquity.

At the same time, end-to-end telecom technologies over copper wires are doomed as their maintenance cost increases while their penetration shrinks as fiber is increasingly deployed. The cost of deploying fiber is nevertheless very high and fiber is not expected to reach everywhere any time soon, if ever.

Numerous telecom technologies over copper wires demonstrate a level of performance comparable to that of fiber when used as a last mile access but at a much lower cost since copper infrastructure already exists and is almost maintenance free. In as far as assuring indoor data access and wireless coverage, last mile copper wires (electricity, twisted pair, coax, and other) are well positioned to be the perfect complement to new generation radio access technologies should radio access and copper technologies be used in a workable fixed-wireless convergence scheme.

The synergies to be gained by joining radio and copper exceed merely being a low-cost and high-performance solution. The widely available copper wire outlets provide true data access ubiquity indoors along with constituting a practical connectivity platform for machines and electricity meters.

Broadband access indoors, M2M communication, and delivering Smart Grid services are hence assured, whereby smart routing can enable the different available copper wires to route traffic with different content.

Introduction

LTE deployment is quickly maturing and the GSMA trumpets on a regular basis an increased global LTE adoption along with a larger number of available LTE devices. While 4G performance has been specified by standardization bodies and LTE has been chosen as the predominant technology to deliver 4G services, 5G is already being mediatized and is in the process of finding its rightful place in the wide horizon of telecommunications.

Major telecom infrastructure vendors disclose their vision of 5G along with the technological progress they are making. Nokia Networks recently announced a groundbreaking 10 Gbps throughput delivered from a 5G radio base station. The Ericsson CEO talks about the role of 5G in a connected society, where a hierarchy of large and small cells delivers multiple services with high quality while connecting both people and devices.

While there is no lack of visions or progress in technology and performance, the matters of ubiquitous connectivity and radio coverage indoors remain incomplete chapters in the framework of both 4G and 5G.

The last mile copper

There is a legacy of copper infrastructure available in and around almost all venues. Throughout the years these have connected fixed phones (twisted pair cables), TV sets (coaxial cables), and provided electricity power (low voltage power lines). Modern households even have Cat5 cables built in.

With exception to the low voltage power lines within homes falling under what is referred to as Connected Homes, legacy copper wiring within and between venues will constitute an untapped asset as end-to-end telecom technologies over copper such as DSL are abandoned with the increasing reach of fiber.

It has been demonstrated both in lab and live trials that, when applied over short distance copper wires such as those in common venues, communication technologies over copper provide a very high level of performance comparable to that of fiber.

VDSL2 and G.fast are examples of technologies that can transmit well in excess of 100 Mbps data over twisted copper cables over distances of up to 500 meters.

Communication technologies over coaxial cables such as Ethernet over Coax (EoC) perform likewise.

Worth noticing that even low voltage power lines benefit from communication technologies such as the ITU-T G.hn PLC and the IEEE 1901 PLC enabling data throughputs in the Gbps.

Last mile copper hence constitutes a low cost and useful resource that can be used to deliver broadband access indoors where there is no business case for deploying fiber.

New generation Radio Access Technologies

It is no secret that Radio Access Technologies (RAT) benefit from a rich development roadmap that will see them deliver better performance at a lower cost. The potential is enormous as enhancements such as better modulation techniques, wider frequency spectrum, carrier aggregation, and multiple antennae (MIMO) are introduced.

These enhancements exert a huge pressure on device manufacturers who have to come up with solutions in their portable devices to benefit from them.

Just how easy is it to incorporate multiple antennae in handheld devices?

How easy is it to manufacture handheld devices that can manage an increasingly complex frequency band allocation between FDD and TDD and across an extremely wide spectrum?

What is being done to assure that these new Radio Access Technologies reach indoors with minimal losses and are able to capture the bulk of data traffic that is generated within these premises?

And most importantly is how will wireless carriers use their networks to connect machines and devices without resorting to complex and costly solutions?

Moving into the future

A new way of thinking is needed in order to come up with realistic answers to these questions and move into the future. A good start is by considering the basics of radio access.

Radio access works best when it happens outdoors in a low noise and interference environment and where transmitting and receiving antennae can see each other. In fact, this is where deploying multiple antennae make sense as you can fit as many as you want and the size of antennae would not matter so much either. Radio links can be optimized on a case by case basis in order to assure the best possible communication through the ether.

Currently, this would for example be the case should one choose to install fixed wireless home routers, but how good and practical is that on a global scale? How would the level of noise become when routers at each home compete with other wireless devices such as mobile phones and dongles on getting the best of the nearby radio base stations? How many home routers use outdoor antennae and how would buildings look should each subscriber install outdoor antennae?

In an ideal world, a radio base station is what would communicate best with another radio base station, through well placed antennae of suitable characteristics. In this situation, transmitting power would be kept at a minimum, the number of radio sites would be kept at a minimum and the transmission network would be slimmer. It is then reasonable to expect that costs would be reduced, noise and interference levels would be reduced, and energy consumption would be reduced, hence lowering carbon footprint…

In a world where a new generation radio base station communicates with a special base station, a neutral radio access hub designed to communicate with all the available radio networks around it; one that limits noise by respecting the power back-off feature and is able to channel the data traffic indoors through the available copper wiring in a smart way so that different traffic is routed over the most suitable available copper wiring, where for example TV traffic is routed over existing coaxial TV cables, M2M is routed over low voltage power lines, and internet traffic is routed over twisted cables.

Suddenly, there is a practical means to achieving a fully connected world, a communicating world of both humans and devices without the need for huge investments current solutions require so everyone can afford it.

Author’s note

Haritel is developing WAAP (patented) and WAAC (patent pending), two concepts that constitute a fixed-wireless convergence scheme which enables ubiquitous data access and mobile coverage indoors using mobile networks.

Abbreviations

EoC	Ethernet over Copper
FDD	Frequency Division Duplex
G.hn	Gigabit home networking
IEEE	Institute of Electrical and Electronics Engineers
ITU-T	ITU - Telecommunications Standardization Sector
M2M	Machine to Machine
PLC	Power Line Communication
RAT	Radio Access Technology
TDD	Time Division Duplex
VDSL2	Very-high-bit-rate Digital Subscriber Line 2
WAAC	Wireless Access Across Copper wires
WAAP	Wireless Access Across Power lines