MSc Program
Engineering Management

Outsourcing Network Maintenance activities in telecommunications
HFC network and CPE Maintenance Activities

A Master's Thesis submitted for the degree of
"Master of Science"

supervised by
Univ.Prof. Dr.techn. Dr.h.c.mult. Peter Kopacek

Prparim Nazifi

1428919

April 2016, Prishtina - Kosovo

Acknowledgements

First, I would like to express my love and thankfulness to my family, my wife and my two kids, for their unconditional love and support during these studies and writing of this master thesis. Without their understanding it would have been difficult to complete this journey.

I wish to express my gratitude to my professor Peter Kopacek (Em.O.Univ.Prof. Dr.h.c.mult. Dipl.-Ing. Dr.techn.) for supervising this master thesis and guiding me to develop and grow professionally throughout these master studies.

Abstract

Outsourcing, “outside resourcing” term used first by Americans, as an economic process, did not start happening recently. Companies have been outsourcing their non-core services or functions for many years now. At first, the key driver for outsourcing was reducing and controlling of Operational Expenditures (OPEX) but over the time few other factors emerged as important drivers such as providing higher quality services to end-customers, flexibility in control of resources (human and material), risk sharing with the outsourcing partners, access to specialized expertise and competencies, long term strategic relationship and partnership foundations, etc.

Considering the above mentioned factors, drivers and potential benefits, all kind of companies, including telecom operators, more and more decide to outsource their non-core activities such as Inbound Customer Service & Technical support, IT Help Desk, Application Maintenance, Outbound Telesales Collections and Customer Call Backs, Sales Support, Field Force Management etc.

Generally, outsourcing as a concept is proven to be successful and overtime fulfilling the objective that the company aimed to achieve when started doing it, however we have to emphasize that the overall process is filled with hurdles and challenges and it is a time-consuming process.

This master thesis aims to describe outsourcing process of Field Force activities related to Hybrid Fiber-Coaxial (HFC) network maintenance including the Customer Premises Equipment (CPE) and its installation maintenance. Using already known Business Process Outsourcing (BPO) frameworks this thesis will describe phases on how to implement the outsourcing process of these activities to a subcontracting company. The thesis is built with the assumption that the objectives are known and well evidenced. Based on those assumptions decision to outsource these processes is already made therefore will not be in the scope of this master thesis.

Affidavit

I, **PRPARIM NAZIFI**, hereby declare

1. that I am the sole author of the present Master's Thesis, "OUTSOURCING NETWORK MAINTENANCE ACTIVITIES IN TELEFOMMUNICATIONS", 75 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
2. that I have not prior to this date submitted this Master's Thesis as an examination paper in any form in Austria or abroad.

Vienna, April 2016

Signature

Table of contents

1. Introduction

1.1 Motivation

Working as an Operations and Maintenance manager in a telecommunications company, I have built up vast experience, not only in connection with the technologies in this industry, but also in respect of the processes and the people running such operations. We can say that an orchestration of processes, technologies and people is required to deliver high-quality and seamless services to end customers.

Since this is not as straightforward as it may sound, operationalizing such orchestration entails a great deal of effort and expertise. It starts with managing human resources, assets, time, costs, etc. Considering the complications of carrying out such complex work and adding up the fact that telecommunication companies are going through difficult times, mainly because of the trend of dwindling revenues, the pressure to reduce costs is rising steadily.

As this is becoming a trend, with accessibility to internet-enabling voice communication and messaging services that are free of charge, it is inevitable that the telecommunications markets are being forced to change their strategies, either identifying sources to cut costs or seeking new income drivers. Focusing in the short and long terms to reduce costs, or, at least, to control costs more efficiently, the company should consider outsourcing some processes. From the point of view of my specialty, network-related processes would not directly jeopardize the reputations and brands of companies, but would have a direct impact on the cost structure.

With this experience, and, in addition, using the knowledge I have gained during my Master's studies, I have decided a write a descriptive guidance on how to implement the outsourcing process in a telecommunications company. The telecommunications industry comprises various technologies and services: thus, the focus of this paper will be narrowed down to FIX services, such as High Speed Internet (HIS), Digital

Television (DTV) and Voice over Internet Protocol (VoIP), delivered through Hybrid Fiber-Coaxial HFC networks.

1.2 Objective of the thesis

As always, telecom operators are looking ways to better manage their costs, improve their operations efficiency and at the same time increase their customer satisfaction.

I used to think that decreasing costs while on the other hand increasing end-customer satisfaction was a “mission impossible” but after detailed analysis of company’s internal business processes and going thru voluminous literature written on business process outsourcing I did discover that there are way to turn the “mission impossible” to a “mission possible”.

Facing the fact of losing revenues telecom operators no matter the size are seriously considering outsourcing some of their operations. During the strategy building and decision making phase, items of Profit and Loss (P&L) statement which contribute the most to the costs will be first tackled and broken down to match the propensity of outsourcing with the aim is to decrease costs and increase performance.

The main objective of this thesis is to produce a practical manual for cable operator managers on how to start the outsourcing process, implement and measure the results of the outsourcing process of the HFC network and CPE installation maintenance field activities using general best practice , my working experience on the field and knowledge gained during these master studies.

The objective set to be delivered by this master thesis will be achieved by utilizing the business process outsourcing lifecycle phase’s model developed Rick L. Click and Thomas N. Duening in their book, Business Process Outsourcing - The competitive Advantage

The business process outsourcing lifecycle phase’s contains five phases, Analysis of the opportunity and decision making, Selecting the subcontractor, Contract preparation, Transition and Operational phase.

The model is illustrated in Figure 1.

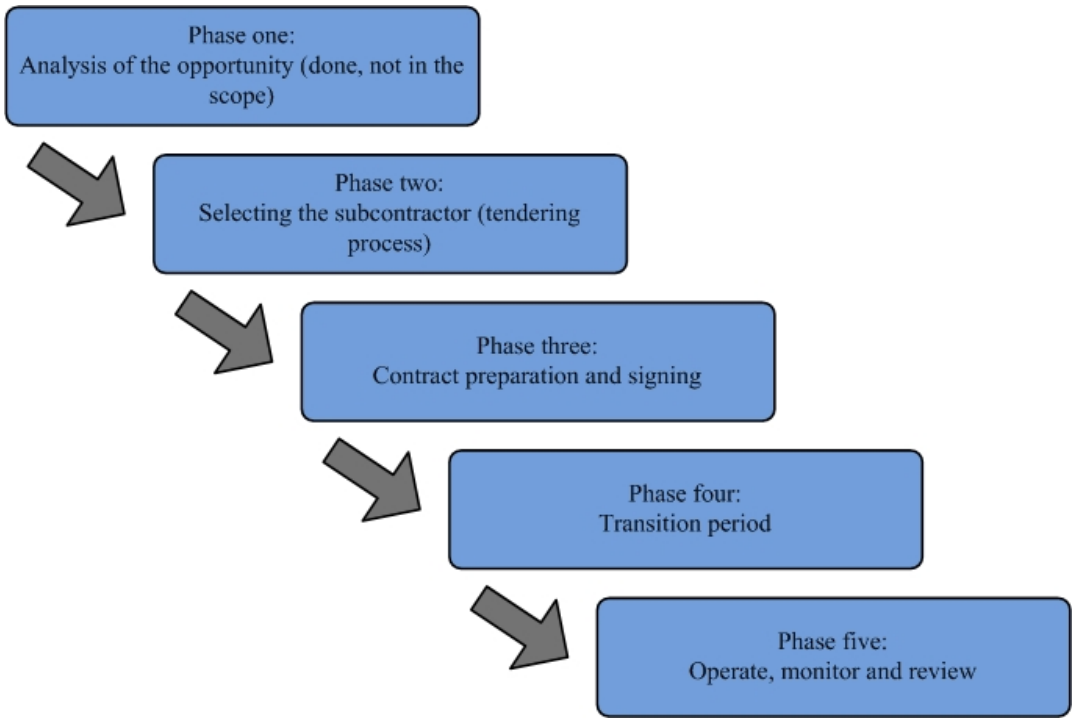

Figure 1 - Outsourcing process phases, adopted from (Rick L. Click, 2005)

Going thru the model of the five phases shown in the Figure 1 the master thesis will contain:

- Systematic action plan on how to start the outsourcing process considering all implications,
- Successful implementation of the process and
- And methods to measure the results based on performance indicators established in the preparation phase of the outsourcing.

The thesis will provide detailed know-how and it will consider and evaluate potential risks and impacts if such are identified.

It is of mine intention that cable operator managers will refer to this paper as a guide for implementation of outsourcing of same or similar processes in the industry, be it that it will be a very practical guide with steps and actions to be followed.

1.3 Thesis Structure

The structure of this master thesis is presented in Figure 2 followed by short description of each chapter.

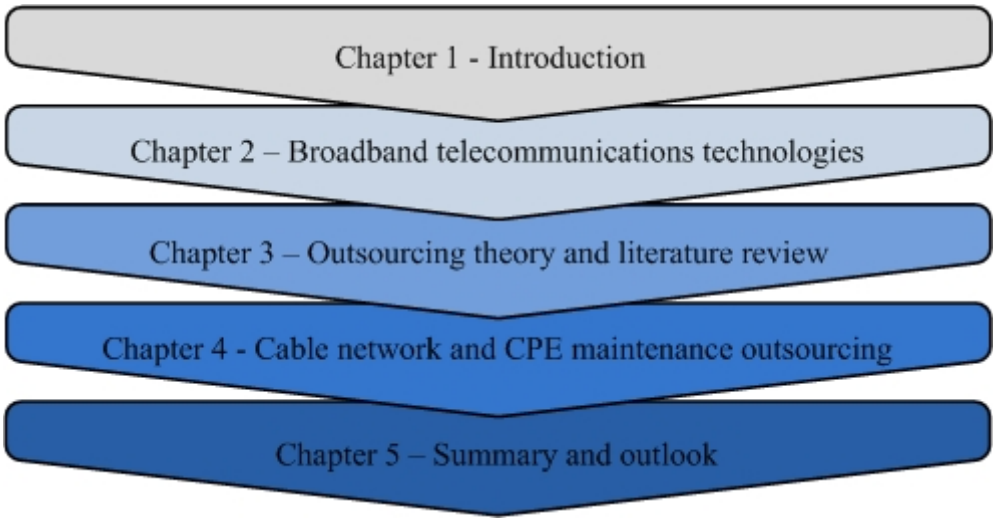

Figure 2 - Thesis structure

Chapter 1 – The introduction chapter contains motivation which have made me write about the subject, description of the objectives of this master thesis and description of how the master thesis is structured in chapters.

Chapter 2 – This chapter brings an overview of broadband technologies, its evolution and types of broadband technologies with a distinct focus on HFC network technology as this master thesis objective is to describe an outsourcing process of a specific activity related to this technology.

Chapter 3 – Contains theories and literature reviews written in books and research papers by various authors and/or companies specialized in outsourcing processes. The chapter contains general explanations on outsourcing theories with a focus on Business Process Outsourcing (BPO), its benefits and advantages, risks and disadvantages and BPO lifecycle phases.

Chapter 4 – The core of the master thesis written based on my knowledge and experience, related to outsourcing of HFC network and CPE maintenance processes.

This chapter contains phases of the process with specific and concrete data and actions to be undertaken for a successful outsourcing implementation.

Chapter 5 – Summarizing what was covered in this master thesis and how it was used to develop this detailed guidance towards outsourcing HFC network and CPE maintenance activities. The chapter contains an outlook of the business process outsourcing in the telecommunications industry.

2. Broadband telecommunications technologies

"If the presence of electricity can be made visible in any part of the circuit, I see no reason why intelligence may not be transmitted instantaneously by electricity. " (Morse, 2016)

This quote was said almost 2 centuries ago, something that nowadays is a reality, a reality and far beyond on what people could imagined what could be achieved by nowadays telecommunications network technologies.

Starting from there, telecommunications can be defined as a transfer of information (communication) from a transmitter or a sender to a receiver across a distance (tele). (Novak, 2000)

Based on various literatures, telecommunication is possible when an electromagnetic energy is used to transfer information thru wired, such as copper or fiber optic glass, or thru wireless radio signals such as Microwave links. These information can be voice, data, image or combination of all of those, defined as multimedia.

Further in this work we will focus on new modern access broadband technologies emphasizing the HFC technology.

2.1 Broadband access technologies

Long time ago, 15-20 years before, access network was built of copper cables only hardly allowing data transfer speeds of 56kbps, this, in best case scenario, having almost perfect copper cable quality installation at home or offices. I remember the times when I was troubleshooting customers while they were having troubles to connect, we were forced to configure their modems to drop data transfer speeds negotiation capabilities to even 19.2kbps just to be able to connect. I wonder how were we able to operate back-than.

Even today, copper cables are still part of the access networks. We used to say, "Copper is Gold". Although recently telecommunication companies are straggling the saying is still valid.

Access network still use copper cables thanks to new technologies and compression techniques developed allowing operators to leverage these existing assets and provide broadband services over them.

According to FCC (Federal Communications Commission, 2016) broadband is a notion that refers to high-speed internet access with high availability and is faster than dial-up access. Various transmission technologies are used to deliver broadband services to subscribers such as:

- Digital Subscriber Line (DSL) over old telephone twisted pair cables
- Cable Modem over modern HFC networks
- Broadband over Fiber Optic cables
- Wireless broadband
- Satellite broadband
- Broadband over Power lines (BPL) etc.

The section below will contain general description of these broadband access technologies.

This, because this master thesis, being that will contain general framework for business process outsourcing (BPO), can be used as a reference to outsource field activities for all the broadband access technologies listed and described below.

Digital Subscriber Line (DSL)

DSL is a broadband access technology that transfers data over traditional telephone lines. Such lines are already installed at end-customer's homes and businesses but this is a statement that cannot be true for all countries in the world. Usually, old state-owned telecom operators, now privatized, have such infrastructure.

Figure 3 illustrates generic DSL connectivity example.

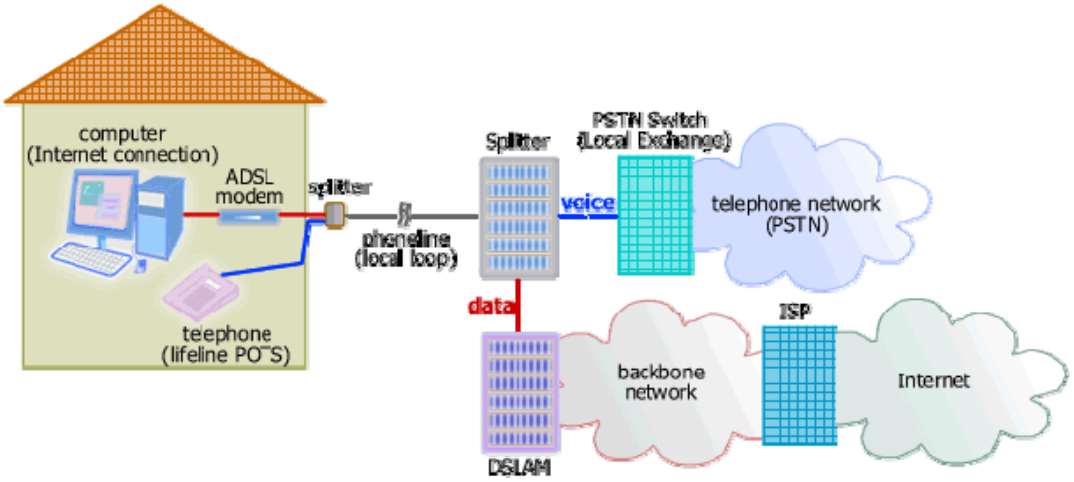

Figure 3 – Generic DSL connectivity example (Conniq, 2016)

There are two types of DSL access technologies:

- Asymmetrical Digital Subscriber Line (ADSL) – Mainly used to connect residential end-customers, such as Internet browsers and IPTV users, who Download a lot of data and do not need much of an Upload.
- Symmetrical Digital Subscriber Line (SDSL) – Mainly used to connect business end-customers because of the fact that the technology allows symmetric amount of data to be transferred in terms of Download and Upload. Business might use such line for services such as video conferencing or surveillance, data transfer intensive services etc.

Based on the DSL technology evolution terms such as High data rate Digital Subscriber Line (HDSL) and Very High data rate Digital Subscriber Line (VDSL) can be encountered as a way to differentiate in terms of capacities and speed of data that can be transferred by these technologies.

Cable Modem (HFC connectivity)

Nowadays cable operators deliver High Speed Internet (HSI) service utilizing their traditional coaxial network. In order to offer such service cable operators use a Cable Modem (CM) at end-customer premises. Cable modem is an external device that usually has two connection interfaces, one to connect to the coaxial network of the

cable operator and the other one to connect to end-customers Local Area Network (LAN).

Nowadays, cable modem Data over Cable Service Interface Specification (DOCSIS) standard version 3.1 enables cable operators to offers high speed data connection to the internet in order to meet end-customer demand.

Figure 4 illustrates generic cable modem connectivity example.

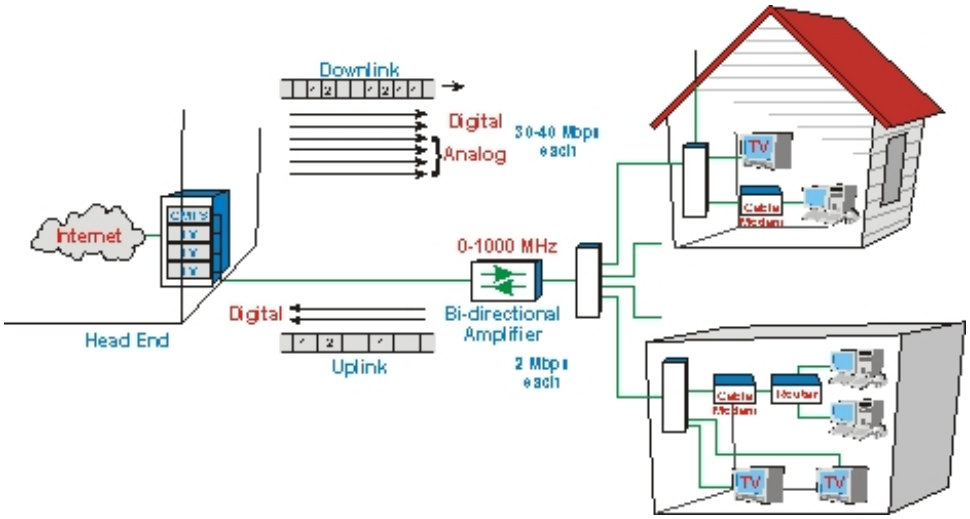

Figure 4 - Generic cable modem connectivity example (Harte, 2007)

Fiber optic technology

Fiber optic technology converts electrical signals carrying data to light and sends the light through transparent glass fibers about the diameter of a human hair. Fiber transmits data at speeds far exceeding current DSL or cable modem speeds, typically by tens or even hundreds of Mbps. The actual speed you experience will vary depending on a variety of factors, such as how close to your computer the service provider brings the fiber and how the service provider configures the service, including the amount of bandwidth used. The same fiber providing your broadband can also simultaneously deliver voice (VoIP) and video services, including video-on-demand. (Federal Communications Commission, 2016)

Figure 5 illustrates generic fiber to the premises connectivity example.

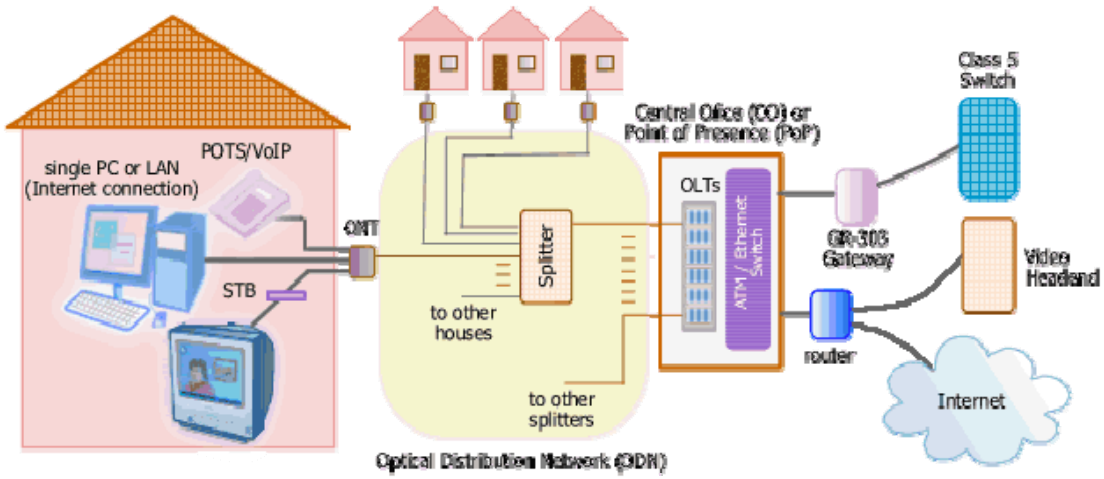

Figure 5 - Generic fiber to the premises connectivity example (Conniq, 2016)

As building Fiber optic infrastructure is quite expensive, operators offer fiber optic broadband service in limited small areas but nowadays trend are going towards expansion of their coverage.

Wireless broadband

Wireless broadband is a technology that is used to connect end-customers, residential and business, to the operator's network using radio links. There are numerous type of technologies that provide such connectivity and mainly can be divided into mobile and fixed wireless broadband technologies.

Considering that it is a wireless connection it is much easier for the operators to deploy such technologies to faster penetrate the market. It is important to emphasize that deploying such technologies is very expensive, not only from the point of cost of the network deployment but also from the point of costs of paying the Radio Frequency (RF) licenses. There are wireless broadband technologies that use unlicensed spectrum of RF but in such cases operators are not being able to offer any Service Level Agreement (SLA) to their end-customers.

Figure 6 illustrates generic wireless connectivity example.

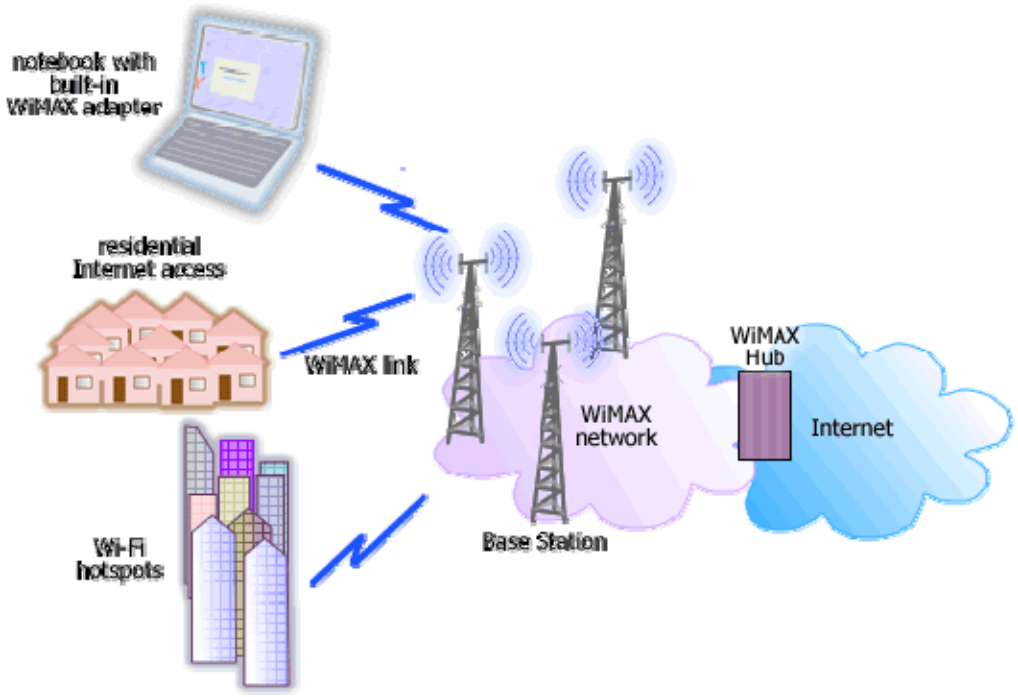

Figure 6 - Generic wireless connectivity example (Conniq, 2016)

Wireless broadband Internet access services offered over fixed networks allow consumers to access the Internet from a fixed point while stationary and often require a direct line-of-sight between the wireless transmitter and receiver. These services have been offered using both licensed spectrum and unlicensed devices. For example, thousands of small Wireless Internet Services Providers (WISPs) provide such wireless broadband at speeds of around one Mbps using unlicensed devices, often in rural areas not served by cable or wire line broadband networks.

Wireless Local Area Networks (WLANs) provide wireless broadband access over shorter distances and are often used to extend the reach of a "last-mile" wire line or fixed wireless broadband connection within a home, building, or campus environment. Wi-Fi networks use unlicensed devices and can be designed for private access within a home or business, or be used for public Internet access at "hot spots" such as restaurants, coffee shops, hotels, airports, convention centers, and city parks. Mobile wireless broadband services are also becoming available from mobile telephone service providers and others. These services are generally appropriate for highly-mobile customers and require a special PC card with a built in antenna that

plugs into a user's laptop computer. Generally, they provide lower speeds, in the range of several hundred Kbps. (Federal Communications Commission, 2016)

Satellite broadband

Satellites are orbiting the earth and are used to provide connectivity for telephone and broadcast television services. Satellite broadband technology is utilizing the same satellites to provide broadband connectivity. As such, satellite broadband is another type of wireless broadband and is usually used to provide broadband services to populated areas where telecom operators have difficulties to reach using wire line technologies.

Figure 7 illustrates generic satellite connectivity example.

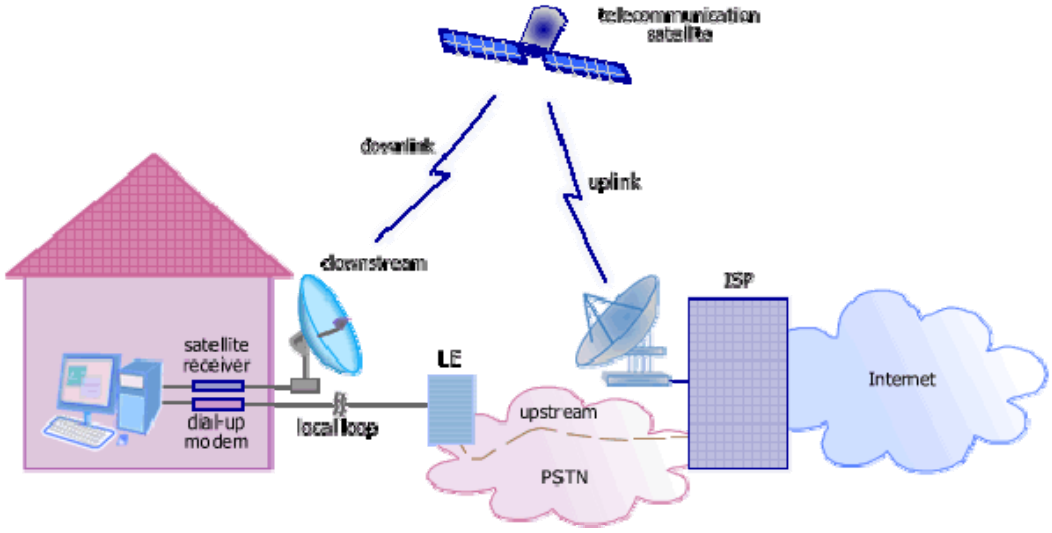

Figure 7 - Generic satellite connectivity example (Conniq, 2016)

Satellite broadband is very expensive service compared to the data speeds that can be delivered to the end-customers. It is important to point at the fact that installing a satellite antenna to receive satellite broadband service requires an expertise which makes the service unaffordable for the mass market.

Broadband over Power line (BPL)

BPL is the delivery of broadband over the existing low- and medium-voltage electric power distribution network. BPL speeds are comparable to DSL and cable modem

speeds. BPL can be provided to homes using existing electrical connections and outlets. BPL is an emerging technology that is available in very limited areas. It has significant potential because power lines are installed virtually everywhere, alleviating the need to build new broadband facilities for every customer. (Federal Communications Commission, 2016)

Figure 8 illustrates generic broadband over powerline connectivity example.

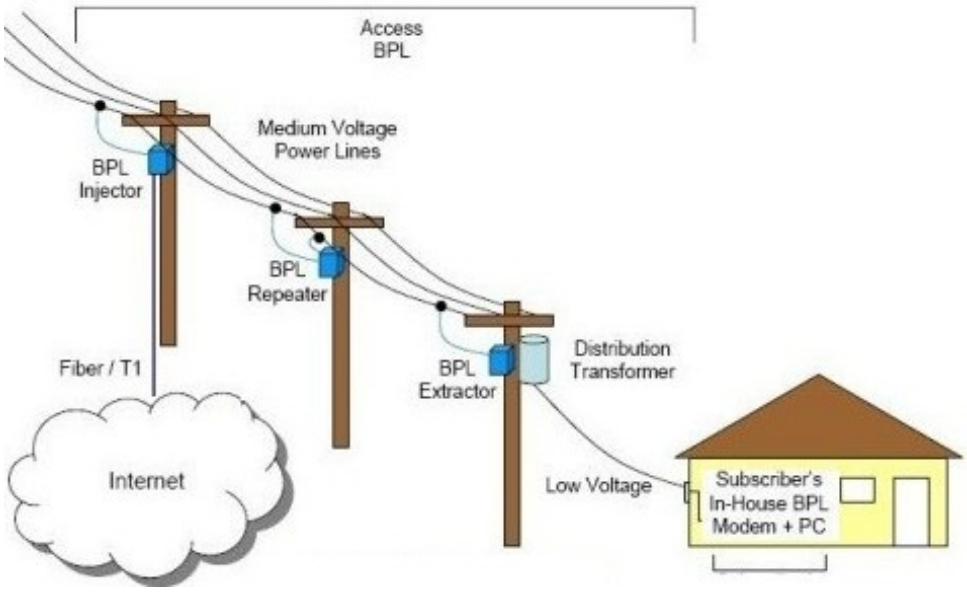

Figure 8 - Generic broadband over power line connectivity example (Conniq, 2016)

2.2 Modern HFC networks overview

Hybrid fiber-coaxial networks are widely deployed by cable television operators since the 1990s, HFC is a telecommunications industry term for a broadband network made up of both optical fiber and coaxial cable that can carry everything from analog television to digital TV to telephone to data. (Rutenbeck, 2006).

In the past few years, HFC architecture has proven to be very flexible and rugged considering advancement of existing transmission protocols and codes allowing cable operators to offer highs speed internet (HIS) service, sometimes competing with Fiber-to-the-home (FTTH) operators, High Definition Television (HDTV) (broadcast or Video On Demand (VoD)), qualitative digital fix telephony or Voice

over Internet Protocol (VoIP) services and other Value Added Services (VAS) or over-the-top (OTT) services such as ad-insertion, mobile television etc., all this used as an opportunity to create more revenues for the operators.

Cable networks were originally developed for a very simple reason: TV signal distribution. Therefore, cable networks are optimized for one-way, point-to-multipoint broadcasting of analog TV signals. As optical communication systems were developed, most cable TV systems have gradually been upgraded to hybrid fiber coax (HFC) networks, eliminating numerous electronic amplifiers along the trunk line. However, before cable access technology can be deployed, a return pass must be implemented for upstream traffic. To support two-way communication, bidirectional amplifiers have to be used in HFC systems, where filters are deployed to split the upstream (forward) and downstream (reverse) signals for separate amplification. Figure 9 presents the network architecture of a typical HFC network. (Leonis G. Kazovski, 2011).

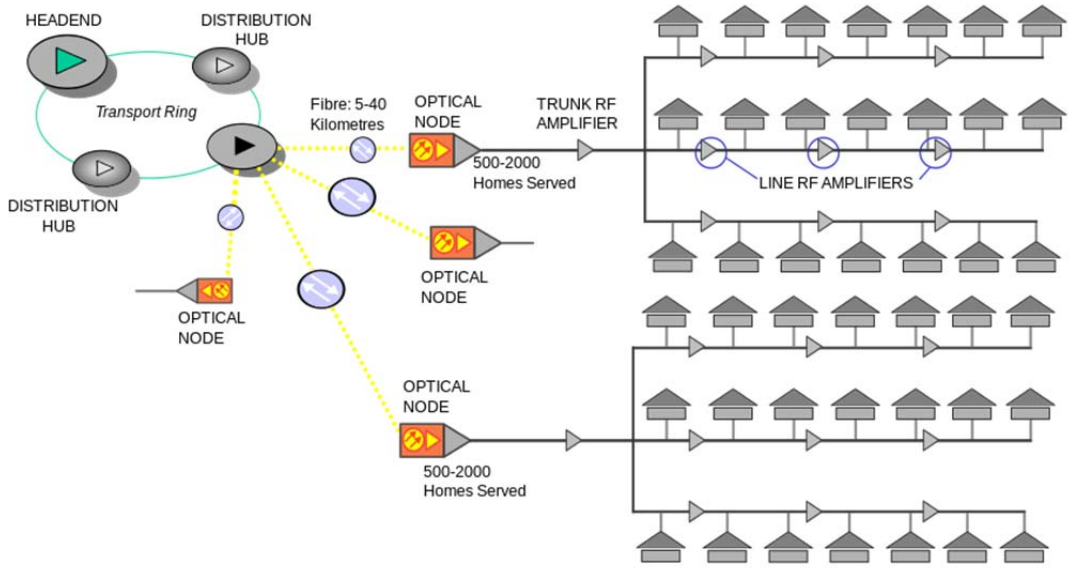

Figure 9 - Typical HFC network architecture (Wikipedia, 2016)

Hybrid fiber coax (HFC) is the current generation of cable system technology. HFC systems carry analog signals that feed conventional television sets as well as digital signals encoded onto analog signals that carry digital video programming and up-

and downstream data. In the new architecture, the system is divided into a number of small coaxial segments with a fiber optic cable used to feed each segment or cluster. By using fiber instead of coax to feed into neighborhoods, the system's performance and reliability is significantly improved. (National Academy of Science, 2002)

For the purpose of clearly understand HFC network architecture and later on use it while going thru the HFC maintenance process I am going to split the HFC network into three segments.

HFC architecture consists of these three network segments:

- Head-end,
- Aggregation or distribution network and
- Access network or the last mile.

Figure 10 illustrates generic HFC architecture.

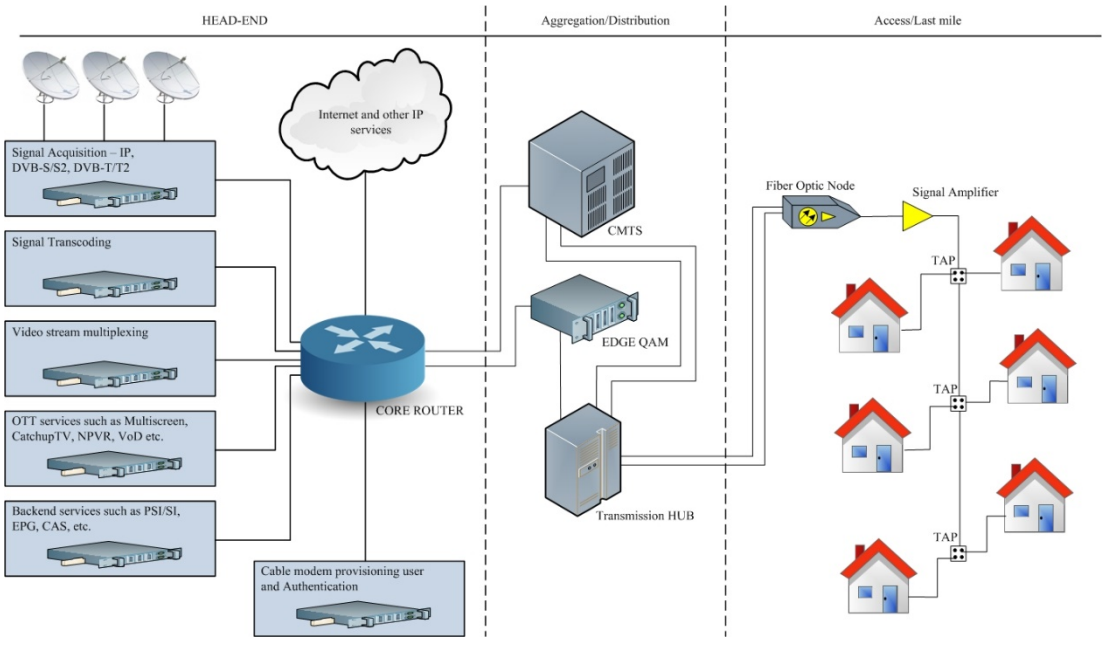

Figure 10 - Generic HFC architecture division in segments

Each of these network segments is built of specific equipment to fulfill a specific function in order to deliver services such as high speed internet (HIS), Digital TV

(DTV), on-demand services, Voice over IP (VoIP), Value Added Services (VAS), Over-the-Top (OTT) services etc. to operator's end-customers.

Section below describes in more details each segment of the HFC network and its components.

HFC Head-end

HFC network head-end typically consists of:

- Signal acquisition equipment such as satellite and terrestrial integrated receiver decoders (IRD), IP video decoders etc.
- Video signal transcoders to convert video formats from one to another, usually to reduce bandwidth or to make the video stream compatible to various end-customer devices.
- Video signal multiplexing equipment in order to pack TV content (video streams) in transport streams (TS), add in Program and Services Information PSI) tables, add in Electronic Program Guide (EPG) content per service and scramble the video service in order to protect the content from fraud and be able to charge.
- OTT IPTV middleware is used to deliver interactive and on-demand TV services such as Video-on-demand (VOD), Catch up, TV, Network Personal Video recorder (NPVR), Multi screen etc. to the operator's end-customers.
- The head-end backend is composed of
    - Program and Services Information PSI) servers,
    - Electronic Program Guide (EPG) servers,
    - Conditional Access System (CAS) servers,
    - Cable modem provisioning servers,
    - User authentication servers etc.

- Core routers and switches that interconnect all these components to each other, to the aggregation/distribution segment, to the backend and to the outside global internet network.

Figure 11 illustrates generic HFC head-end components and its connectivity.

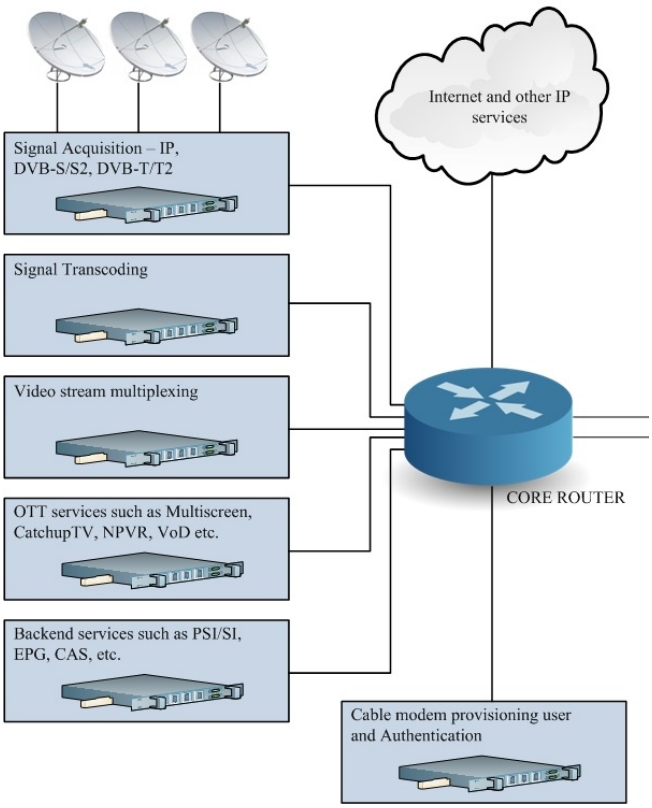

Figure 11 - Head-end generic connectivity scheme

HFC Distribution segment

HFC aggregation or distribution network typically consist of the

- Cable Modem Termination Systems (CMTS),
- Edge QAM's and
- Transmission hubs.

The CMTS is a set of components on the cable head end that manages digital signals between cable modems and the Internet. When a CMTS receives signals from a cable modem (upstream), it converts them into Internet Protocol (IP) packets and sends the

signal to a router for transmission over the Internet. A CMTS can also send transmissions to the cable modem (downstream). (Rutenbeck, 2006).

The role of the EQAM in the video-on-demand and switched-digital-video architecture is to receive an IP unicast or multicast stream containing MPEG transport stream packets, and then produce that transport stream on one or more RF outputs for transmission over the hybrid fiber-coax cable plant. (Cable Television Laboratories, 2016).

The distribution hub is defined as a point in a distribution system where signals are converted to the form used to transmit them to subscribers. If a hub system is used, typically each hub will supply signal to a number of nodes. (David Large, 2009).

Distribution hub serves to convert the electrical signal generated by the CMTS and Edge QAM's to Fiber Optic wavelengths.

Figure 12 illustrates generic aggregation/distribution segment of a HFC network.

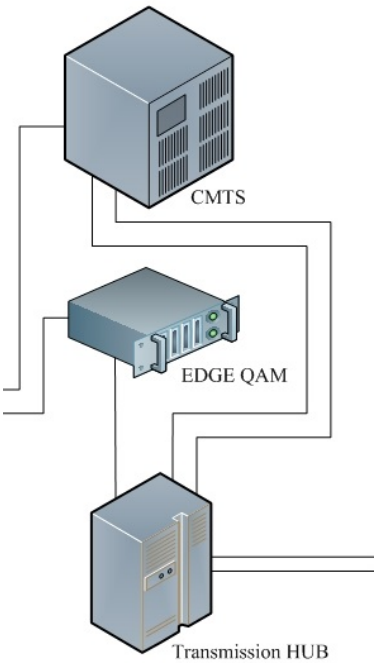

Figure 12 - HFC generic aggregation/distribution network segment

HFC Access segment

The HFC access segment or the last mile is the largest segment of an HFC network and the most complicated and challenging to operate and maintain. As the thesis is related to outsourcing a maintenance process of the HFC access network we will describe HFC access network in more details.

The HFC access network segment begins at the distribution hub. Fiber optic cables of various lengths, depending on transmitter power on both ends, feed fiber optic nodes with signals where the optical to electrical conversion of the signal is done to convert the signal for the coaxial part of the access network. The coaxial part of the HFC network has largely evolved with the installation of bi-directional and more powerful and sophisticated amplifiers, allowing operators to run broadband services. Figure 10 illustrates where the HFC access network beginning from the distribution HUB, running fiber optic cables to the fiber optic node from where the signal are converted from optical to electrical running coaxial cable to the end-customers with additional amplifiers on the coaxial cable in order to amplify signals to reach the distance from the FO Node to the end-customer premises.

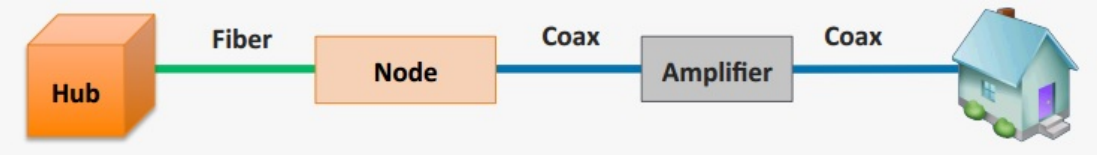

Figure 13 - HFC HUB to end-customer connectivity

It is of a great importance to understand that there are two type of HFC network deployments, underground and aerial. The underground HFC deployment utilizes manholes and ducts to run cables, optical and coaxial, in order to reach the end-customer premises while the aerial deployment of the HFC network utilizes pols owned by different organizations such as local power distribution companies, telecoms, municipality lighting infrastructure and/or other organization's infrastructure to run cables, optical and coaxial, in order to reach the end-customer premises. Usually combinations of both deployment types are used by cable operators.

Figure 14 illustrates ways of distributing signal over underground and aerial infrastructure deployment.

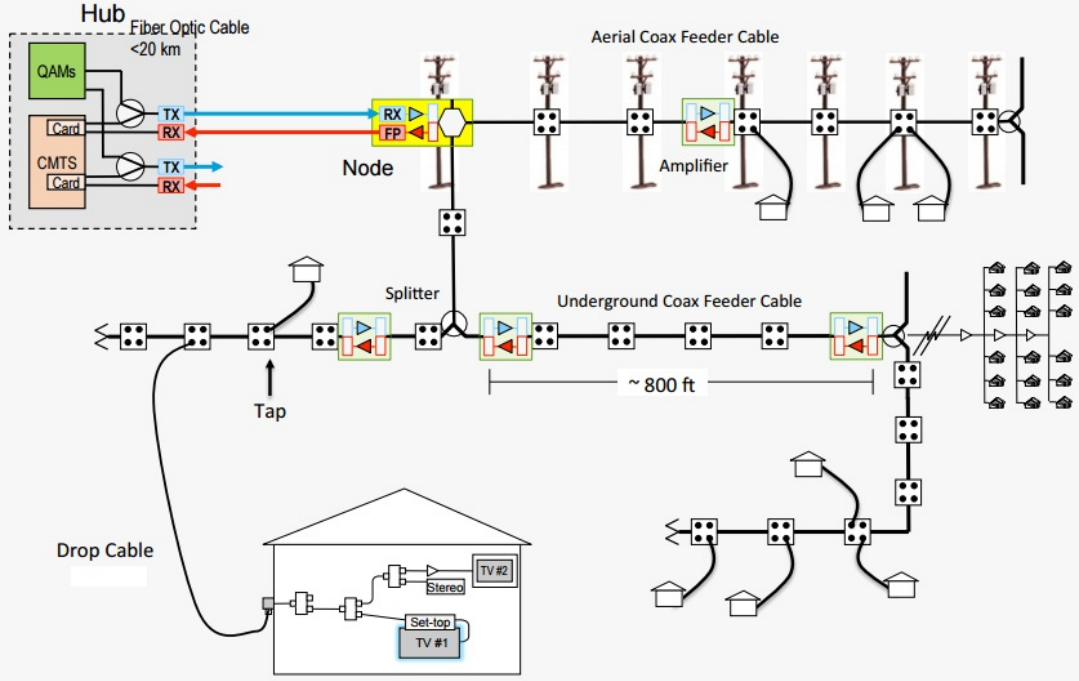

Figure 14 - HFC underground and aerial installation and its components (Conniq, 2016)

As seen on the Figure 11 there are various active and passive components combined together to be able to deliver services to end-customer premises. In the section below main components of the HFC access network will be listed and shortly described.

This section of the chapter will be used as a reference when HFC network and CPE installation maintenance process will be described in Chapter 4 of this master thesis.

Typical HFC access network consists of:

- Fiber Optic Node (FON)

  The HFC fiber node performs Optical Electrical OE conversion of RF signals to/from hub. The fiber node can be located 50km or more from the hub depending on transmitter capabilities of the HUB and the FO node.

- Amplifiers (AMP)

Trunk and Distribution amplifier performs amplification of the RF signal after being degraded during transmission over coaxial cable. As such it may be cascaded up to five amps deep after the fiber node but this all depends on various factors related mainly with the quality condition of the coaxial network.

- Taps

  The Tap is a multiport RF device that passes a specified amount of RF energy to a “TAP” port and passes the majority of RF energy from the “INPUT” to the “THRU” port. It is used to create a branch from the trunk coaxial cable to a subscriber’s premises.

- Splitters

  The Splitter is a multiport RF device that divides equally and passes RF energy to a “Splitter” port. Usually it is used indoors at end-customer premises to connect one or more cable modems and DTV Set-top boxes.

- UPS and power Inverters

  UPS and power Inverters are usually used to assure power backup to the access network in case of power failure.

- Power supply of the HFC access components

  The HFC Node and Amplifiers are electronic devices that require electrical power. Power Supplies placed at regular intervals along the coaxial network provide power to the node and amplifiers. Power Insertion devices are used to couple AC and/or DC power to the network conductors carrying the RF signal.

Customer premises Equipment (CPE)

CPE’s are end-customer premises equipment that convert HFC network electrical signals into specific service such as high speed internet or Digital TV service. CPE’s usually used at customer premises by the operators are:

- The cable modem (CM),

- The broadband router (BR) and
- The Digital TV Set-top Box (STB).

The cable modem needs to be installed at the end-customer premises in order to connect and get internet service. The cable modem is always installed by the operator at his premises.

The cable modem is defined as a digital modulating device enabling home computers to use a local cable system to interconnect directly with public or private computer online networks and the Internet. Development of cable modems was a strategic move by cable operators to tap into growing consumer interest in the Internet and online services and offer a competitive alternative to telephone company computer modem hookups. (Rutenbeck, 2006)

The cable modem can also contain one or two fix telephony ports in order to deliver "classical fix telephony" service. I have quoted "classical telephony" service as for the end-costumer it is as simple as connecting the telephone wire on the cable modem but the technology behind is based on voice over IP VoIP digital fix telephony.

In order to connect to the internet and in most common situation, to use wireless internet over Wi-Fi, end-customers need another device connected to the CM, called router.

The router is a device that makes decisions about which of several paths network (or Internet) traffic will follow by using a routing protocol to gain information about the network, and algorithms to choose the best route based on decision criteria known as "routing metrics." Routers are generally component parts of electronic telecom and computer networks. Routers may be a form of technical bridge to assist in connecting local area networks that operate under different technical protocols or standards. (Rutenbeck, 2006)

As explained earlier in this chapter, HFC network can deliver digital TV signal or IPTV signal over the cable modem. In both cases set-top box is required to decode this signal.

In general terms, a set-top box is a hardware device that mediates signals between a television and a variety of input sources, including cable, satellite, telephone line, or roof-top antenna. Set-top converter boxes used in cable television systems or other video distribution services such as DBS or DTH essentially function to unscramble and/or decode digital video signals that have been encrypted for transmission. Cable pay-per-view services, as well as premium movie and other channels, require decoding that is handled in the set-top box. (Rutenbeck, 2006).

Coaxial cable

It is crucial to emphasize that all of the above mentioned components are connected to each-other using different types of Coaxial cables.

Coaxial cable is a type of broadband communication cable capable of transporting very large amounts of analogue or digital information. Coaxial cables are classified into many grades but generally have a centre conductor wire, surrounding shielding, and insulation material between the two. (Rutenbeck, 2006).

Coaxial cables of various lengths are installed all over the access network and end-customer premises. All coaxial cables are terminated with connectors of different types that connector toe the splitters, taps or to the CPE's such as the cable mode and the Digital TV STB.

2.3 Summary of chapter two

This chapter covered general description of broadband technologies with a special focus on HFC network as a technology to provide broadband services to end-customers. These information's will be used as background in Chapter 4 where I will describe the outsourcing process of maintaining of this part of the network, with special focus on maintenance of the FO nodes, amplifiers, passive and active taps, coaxial cables, splitters, cable modems, digital TV STB's, broadband routers etc. In order to understand the process of maintenance we need to understand components used in delivering services to end-customers using the HFC network.

3. Outsourcing theory and literature review

Outsourcing is made up of two words, „out“ and „sourcing“. Hence, to define outsourcing we must first be clear on the meaning of „sourcing“. Sourcing refers to act of transferring work, responsibilities and decision rights to someone else. (Mark J Power, 2006).

As a definition, outsourcing is “the strategic use of outside resources to perform activities traditionally handled by internal staff and resources” (Griffiths, 2016).

Basically, this means that one company will handover one or more processes or activities that used to run with their own staff and resources to another company, subcontractor that will take over same or additional processes or activities.

Figure 15 shows a generic illustration on outsourcing of a service.

Figure 15 - Generic illustration on outsourcing of services

Outsourcing is the act of transferring the work to an external party. Whether or not to outsource is the decision of whether to make or buy. Organizations are continuously faced with the decision of whether to expend resources to create an asset, resource, product or service internally or to buy it from an external party. If the organization chooses to buy, it is engaging in outsourcing. An outsourcing initiative calls for the transfer of factors of production, the resources used to perform the work and the decision rights, or responsibilities for making decisions. The organization transferring these is referred to as the client, the organization that conducts the work and makes decisions is the vendor, and the scope of the work is captured in a project as illustrated in the Figure 16. (Mark J Power, 2006).

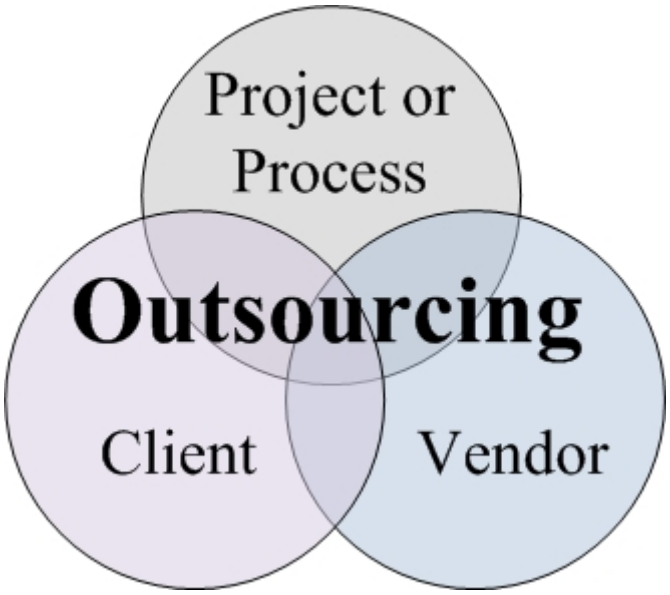

Figure 16 - Outsourcing components, adopted from (Mark J Power, 2006)

Based on the same source, the client is a person, an organization or a company that would like to outsource a given project. Client can vary on scope and size. A client can be an entire organization or company or just a unit of an organization or company. The vendor is the provider or the subcontractor that will take over and run a given outsourced project. Same as clients, vendor can vary on scope and size. The vendor can be an external organization or company, as a usual scenario, but it can be a subsidiary of the same organization or company. The third component is the actual work being outsourced. In the past, the most common form of such work was manufacturing or labor-intensive projects. Today, however, there is a move towards the outsourcing of more complex forms of work, such as software development or R&D. (Mark J Power, 2006).

The literature distinguishes three levels of outsourcing: tactical, strategic and transformational.

Outsourcing as a process have matured over the time. It used to be done for really basic, tactical and short-term results achievements. Nowadays is being perceived as strategic process bringing long-term benefits to the organizations while in the future might turn to be transformational and evolutionary. All three levels of outsourcing will be described shortly in the section below.

Tactical outsourcing

Tactical outsourcing is often used by the organisation to solve a specific problem of a specific task that for several reason cannot handle with their internal resources. This level of outsourcing is used to increase the operational efficiency and is approached from the perspective of comparing of existing internal operations and outside service providers in terms of costs, quality and expertise.

There are several reasons why an organization would decide to do a tactical outsourcing especially if the organisation is in financial troubles:

- Immediate cost decrease resulting with better finnacial results,
- Decresase the level of investment that was related to the outsourced process,
- Invoke cash infusion generated by the sell of the that used to be used by the outsourcing process, etc.

The focus of tactical outsourcing is the contract, specifically, constructing the right contract and, subsequently, holding the vendor to the contract. Traditionally, the expertise for making these arrangements came from the purchasing department. However, there is an emerging expectation that every manager involved in the supply chain process understand and be accountable for the aspects of outsourcing that affect their area of charge. Establishing and maintaining tactical outsourcing relationships, specifically functional or comprehensively, is the responsibility of the entire organizational team. Frequently, the contract was simply a fee for services, with much of the value stemming from the discipline of spending dollars externally. When managers formed successful tactical relationships, the value of using outside providers was clear: better service for less investment of capital and management time. (Mark J Power, 2006).

Strategic outsourcing

Strategic outsourcing on the other hand, has a goal of creating relationships with outsourcing service providers that will bring long-term value to the organizations.

Strategic outsourcing involves a different type of approach in the process of analyzing and decision making. It requires that the organizations re-focus on their

business strategy and create a “big picture” of how the operation would change and would be the impact of the changes, positive and negative. As stated, the company build their strategy on what and with whom they will create these relationships in order to carry on the operations that used to be performed internally.

In this level of outsourcing, organization decide that instead of working with a large number of vendors to get the job done, in a strategic model, corporations work with a smaller number of best-in-class integrated service providers. These relationships thus evolve from vendor supplier arrangements (which are often adversarial) to long-term partnerships between equals, with the emphasis on mutual benefit. (Mark J Power, 2006).

Transformational outsourcing

Transformational outsourcing is the next level and is being considered as the most aggressive approach to this process. It might result with complete changing the way the organization used to work. It even could involve redefining of organization’s processes from the scratch.

As stated above, transformational outsourcing is third-generation outsourcing. The first stage of outsourcing involved doing the work under the existing rules; the second stage used outsourcing as part of the process of redefining the corporation. This, the third stage, uses outsourcing for the purpose of redefining the business. To survive economically today, organizations must transform themselves and their markets in an ever more daunting challenge to redefine the business world before it redefines them. To that end, outsourcing has emerged as the single most powerful tool available to executives seeking this level of business change. Those who take advantage of transformational outsourcing recognize that the real power of this tool lies in the innovations that outside specialists bring to their customers’ businesses. (Mark J Power, 2006).

Table 1 shows comparison of Transformational and Traditional outsourcing characteristics.

Transformational Outsourcing	Traditional Outsourcing
Business focus	Operational focus
Centered on creating value	Centered on cutting costs
Assists in managing uncertainty	Assists in establishing controls
Aligns with the business processes that revolutionize in harmonization with your strategic goals	Aligns with basically unchanged business processes
Based on fashioning a network of partnerships in the new connected global economy	Based on external (primarily IT) specialists
Business cost and re-engineering facilitate perpetual value creation	realizing higher performance for the client than internal non-specialist resources
	Removes noncore functions from the business to provide a one-time discharge of capital

Table 1 - Transformational vs. Traditional outsourcing (Mark J Power, 2006)

Generally, outsourcing services are grouped into two main categories, Business Process Outsourcing (BPO) and Application service provider (ASP).

The BPO category contains major transfer of resources and assets from the company to the subcontractor while in the ASP model subcontractors tend to provide selected and specific services to multiple companies or clients.

3.1 Business Process Outsourcing - BPO

A business process is “a structured, measured set of activities designed to produce a specific output for a particular customer or market. It implies a strong emphasis on how work is done within an organization, in contrast to a product focus’s emphasis on what. A process is thus a specific ordering of work activities across time and space, with a beginning and an end, and clearly defined inputs and outputs: a structure for action. ... Taking a process approach implies adopting the customer’s

point of view. Processes are the structure by which an organization does what is necessary to produce value for its customers." (Davenport, 1993).

Starting from this definition, BPO refers to the outsourcing of one or more specific business processes, methodologies, or functions to a third-party vendor, together with the IT that supports it. BPO focuses on how an overall process methodology or function is effective - from manager to end user - rather than on the technology that supports such process or function. (John K. Harley, 2007).

BPO is emerging from a set of driving factors that have unintentionally converged in this particular time to enable the shifting of work to its lowest-cost/highest-quality provider regardless of the provider's physical location. BPO is a business innovation that leverages these driving factors and applies them to practical business problems. (RICK L. CLICK, 2005).

The main drivers of the BPO are illustrated in Figure 17 and explained briefly in the next section.

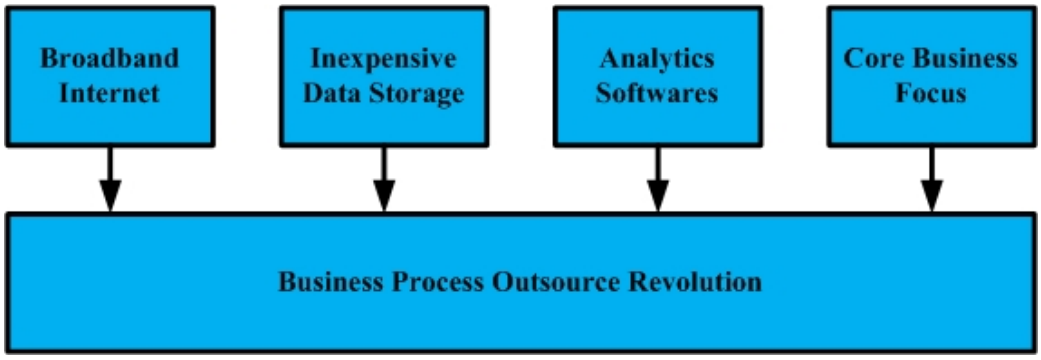

Figure 17 - General BPO drivers (adopted from Rick L. Click, 2005)

Broadband internet capacity, speeds and reliability are growing day by day allowing remote operations performed seamlessly and without interruption eliminating risks of not being able to perform from remote locations. Same time broadband internet prices are dropping making the service more affordable.

Inexpensive Digital data storage allows companies to store huge amount of data in order to have them available in the future for analysis and decision making.

Having the data available Analytics Software are considered as one of the main decision making supporting systems.

While offloading from non-core activities, companies can focus on their core activities and lead the business more efficiently.

3.2 Decision making factors and advantages of BPO

There are various reasons that companies decide to outsource their activities. It is important to emphasize that every company, no matter how big they are, have their own reasons to outsource. Every company, no matter how big they are, justifies their decision to outsource their own way. Outsourcing could be the right decision, but it also can turn out not to be.

Going thru published literature (Mark J Power, 2006), (John K. Harley, 2007) general top five most common reasons why companies decide to outsource can be found in Figure 18 and described in more details in the section below.

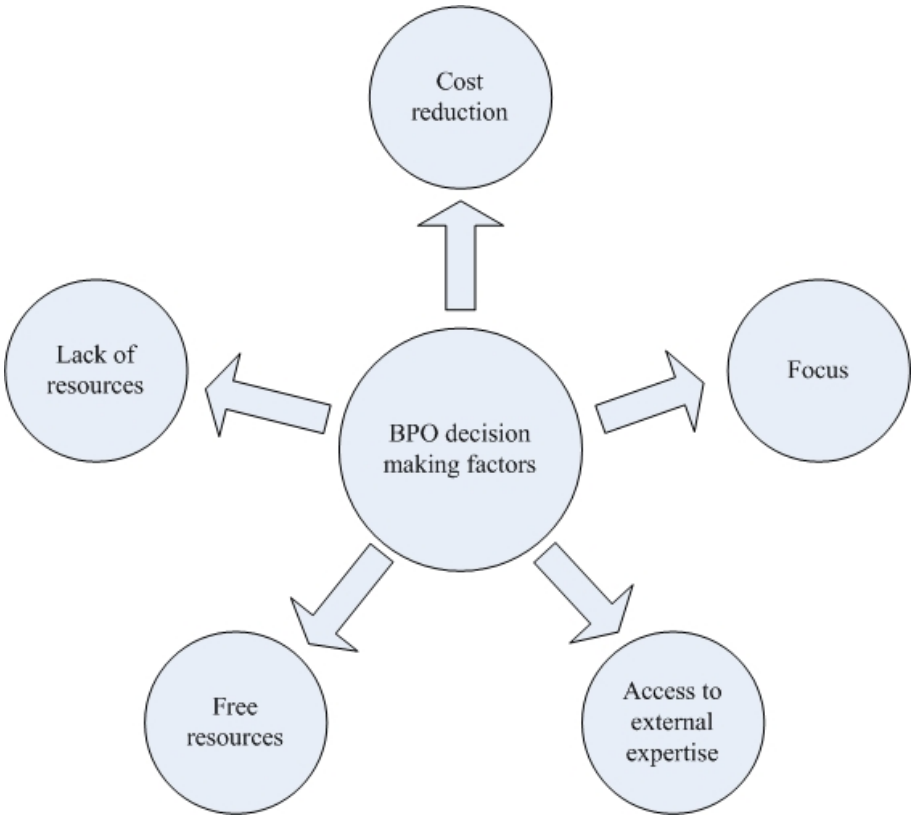

Figure 18 - BPO decision making factors, own interpretation based on literature

1. *Cost reduction* as a common reason and in most cases a decisive factor to outsource.

2. *Focus* on core activities of the business by outsourcing non-core functions and operations to an external company. By letting go these functions the company can focus their resources into developing and meeting their customer needs.

3. *Access to external expertise* considering the fact that global providers make huge investments in technology, methodologies, and people. Their global market allows them to face similar challenges among many clients and use that expertise to run such processes.

4. *Free resources* available from dealing with non-core activities for other purposes considering the fact that companies have limits to available resources. Available resources after outsourcing can be used to focus more into customer facing activities to improve customer satisfaction.

5. *Lack of resources* available internally due to lack of knowledge and expertise etc.

Considering that our focus is into outsourcing telecommunications network and field maintenance operations, a research conducted by Booz&Company in 2009 stated „The reasons telecom operators gave for outsourcing their network and field operations varied (see Table 2). Yet more than 90 percent of respondents said their primary goal was to reduce operating expenses (OPEX). Indeed, many respondents cited better cost control, the ability to manage those large work- forces more flexibly as demand changes as a significant benefit of outsourcing.“ (Booz&Company, 2009).

Key drivers of outsourcing	***% of respondents citing the rationale***
OPEX reduction	**90%**
Increased head-count control	**20%**
Increased ability to adopt new technologies	**20%**

Increased flexibility	**15%**
Head-count reduction	**< 10%**
CAPEX reduction	**< 10%**
Enabling establishment of clear processes	**< 10%**

Table 2 - Key outsourcing drivers in telecom companies (Booz&Company, 2016)

Based on the same research top five reasons or key drivers to outsourcing are:

1. *OPEX or cost reduction*. As stated above telecommunications companies tend to reduce their operational costs by outsourcing some or all their network and field operations activities. Vast majority, 90% of respondents have declared that OPEX reduction is the main reason for outsourcing.

2. *Head-count control*. By head-count control companies minimize the possibility of fluctuations in staffing that may occur due to changes in demand for service activities. Usually in telecommunications network operations and maintenance activities there are seasonal peaks which could lead to keeping employees for such occasions and lower the efficiency. Based on the same research, 20% of the respondents have declared that this is another reason for outsourcing.

3. *Ability to adopt new technologies*. Challenges of training the existing staff, retaining specialized personnel or attracting skilled engineers and technicians when new hardware or software is being installed or integrated are reduced or eliminated by leaving this challenge to the outsourcing partner. Based on the same research, 20% of the respondents have declared that this is another reason for outsourcing.

4. *Flexibility* is mainly based on the fact that the company that outsources can change the subcontractor if required. Changing a subcontractor in case of poor delivery is much easier than changing a full-time employee. Based on the same research, 10% of the respondents have declared that this is another reason for outsourcing.

5. *Head-count reduction*. It is a combination of operational cost reduction and flexibility. I has huge impact on company's image but yet, based on the same

research, 10% of the respondents have declared that this is another reason for outsourcing.

3.3 Risks and disadvantages of BPO

If there were no risks, there would be no need for managers. Risks and uncertainty is what management is all about. If everything were certain, and hence predictable, there would be nothing to manage. (Mark J Power, 2006)

As every project, BPO risks have to identified and assesed. Risks are segmented into four categories, strategic risks, operational risks, technology risks and financial risks as ilustrated in Figure19 and explained briefly in the next section.

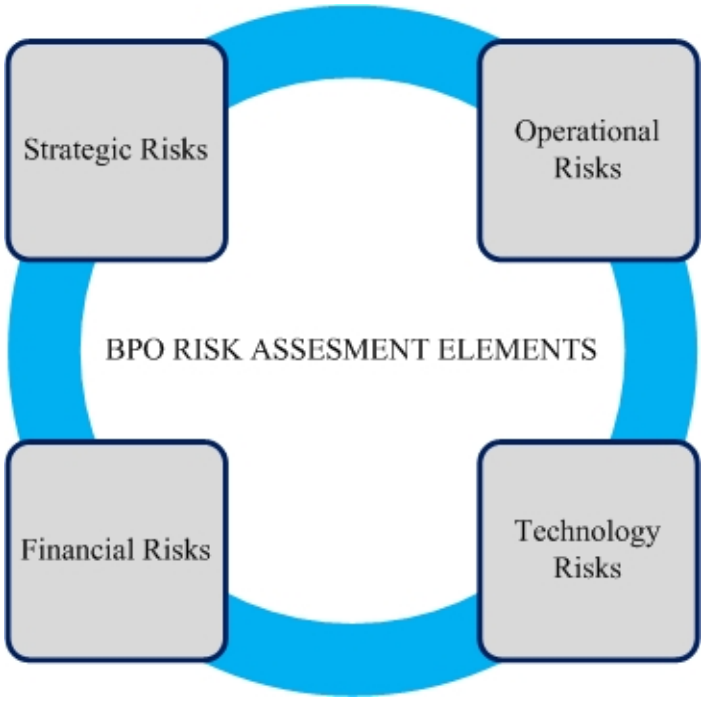

Figure 19 - BPO risk assessment elements (adopted from Mark J Power, 2006)

Strategic risks deal with issues of interaction between the organization and the proposed vendor. Strategic risks include intellectual property risk, which involves assessing the risk of exposing internal intellectual property to an external services provider. (Mark J Power, 2006).

Operational risks address the risk of managing the internal and external operational elements of the proposed outsourcing initiatives. These risks address an array of elements such as defining the roles and responsibilities of the management and operation staff, and determining process, procedure, methodology and mismatch between the buyer and service provider organizations.(Mark J Power, 2006).

Technology risks assessment identifies the organization's technology support attributes. This assessment also exposes potential risks associated with the proposed outsourcing project technology and impact on both the client and vendor organizations. (Mark J Power, 2006).

Financial risks assessment defines and baselines all internal costs and financial system maturity levels. It also identifies all financial risks associated with moving forward with the proposed outsourcing. The outsourcing handbook initiative. This can include the financial stability of both the client and potential vendor. The costs of moving forward with the proposed outsourcing initiative must be considered, including internal versus external cost analyses for cost elements such as human resources costs, development costs, production costs, training costs, travel costs, transition costs, communications and management costs. (Mark J Power, 2006).

Managing the risks and being careful with possible disadvantages of the BPO

Basically, the risk assessment is made to show executives and make them aware of potential issues of those four aspects mentioned above as a consequence of a Business Process Outsource. By identifying these risks and having a clear picture of what the impact on the business would be if any of these risks gets materialized, executives can decide if the company would go for outsource or not and at the same time risk contingency plans can be made in order to manage and mitigate the same.

It is very important to analyze the business process outsourcing from the perspective of what could be a disadvantage of doing it. There are several disadvantages pointed at in the literature. Few possible disadvantages that may impact the process outcome are described in the section below.

One of the main possible disadvantages of a BPO are hidden or unplanned costs. Usually these costs occur when the outsourcing company did not properly write the

requirements. Only after contract signing and takeover starts, it is realized that scope of work didn't cover all needed activities or processes to fulfil the outsourced process properly.

Brand dilution is another possible disadvantage that may occur once a company outsources a business process. Just as in our case, some telecom providers are concerned about outsourcing customer-facing activities and losing control over their brand. Anyhow, it is something that with a proper action plan on how to preserve such thing, brand dilution can be avoided.

Data security can be possible disadvantage considering the fact that in order for the outsourcing subcontractor to take over the process you need to provide them details of the process, assets or other information that it will be required to run the process.

3.4 BPO lifecycle phases

BPO implementation is very similar among most of businesses. From its perspective the business process outsourcing lifecycle has five phases according to (Rick L. Click, 2005). Figure 20 illustrates these five BPO lifecycle phases.

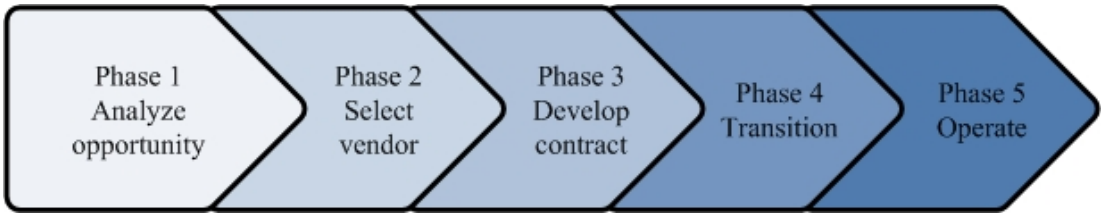

Figure 20 - BPO lifecycle phases (Rick L. Click, 2005)

Phase one: Analyzing the opportunity and decision making

The first and the most important phase of the BPO lifecycle is analyzing company's processes and activities that are identified as potential for outsourcing. In this phase the company defines the motives that drive the outsourcing decision as later on these would determine the goals and objectives to be achieved by the outsource. It is

extremely important for the company to know and understand the motives that drive the company to outsource a process or activity.

Before outsourcing takes place, companies need to know in details the process or activity they intend to outsource. Only when they know that, they can assess the costs that occur running that process or activity and by that companies would be able to calculate the potential benefits of outsourcing. Companies have to make sure that the all terms and conditions are well defined, the goals and objectives to be achieved are clear and the process for achieving results are specified. After all required analysis are properly management can make a decision to go or not for outsource.

In this master thesis I will not elaborate this phase of the BPO lifecycle as I tend to believe that every company can make and will make their own calculations and will identify possible benefits of an outsourcing process. It cannot be thot that there is a uniformed model of calculating that.

Phase two: Provider selection

This phase main goal is choosing the right outsourcing provider for the services required. The process itself is of a high importance considering the fact that if for any reason the organization choose a wrong provider, it may end up in a very difficult risky situation. The starting point of the outsourcing process, in relation to the choosing a outsourcing provider is the preparation of the Request for Proposal (RFP) that will be distributed to potential bidders.

The RFP shall contain detailed information on the activities to be outsourced, deliverables expected from the potential bid winner and costs associated to the services provided.

The RFP as such, generally, has to contain several elements as listed and described below:

- General information on the outsourcing organization,
- Scope of Work (SOW) as a detailed definition of what services are required to be provide by the outsourcing service provider,
- Deliverables in terms of service hours, performance, skills etc.

On the other hand, the response to the RFP by the potential outsourcing providers should contain:

- Costs associated to the requested services as described in the SOW,
- The outsourcing provider's previous experience and references,
- List of employees and their professional skills,
- Organizational plans on how the service will be delivered, etc.

The above mentioned elements are key to make the right decision on which outsourcing service provider to choose.

Phase three: The contract

After carefully choosing the outsourcing provider a contract must be signed in order to define the way how the two parties, the outsourcing organization and the outsourcing service provider, will cooperate and fulfill the defined arrangements derived by the RFP.

Key elements that every contract must contain are:

- Detailed information about the two parties entering the agreement, preamble, recitals,
- Scope of Work or Services – is negotiated based on the RFP,
- Performance of deliveries, SLA's – are negotiated base on the RFP,
- Fees and payment terms – Fees derive from the RFP response while payment terms are to be negotiated and agreed,
- Terms and condition of the contract should contain dates of commencement, duration of the contract, termination clauses etc.
- General provisions which should be by default added to any contract.

To make sure that the contract is composed of all necessary provisions, engaging a layer while preparing and negotiating the contract, as it will it will be the framework of the cooperation between the two parties, is mandatory.

Phase four: The transition to the new way of working

Going thru implementation of an outsourcing process the organization has to go thru a transitional phase which involves transferring all the processes being outsourced from inside to the outsourcing provider. The process as such involves a lot of challenges and risks so proper managing of the phase is crucial to the success of the outsourcing process especially when the agreement contains knowledge transfer or transfer of employees from the outsourcing organization to the outsourcing service provider.

The transition phase involves both parties, the outsourcer and the outsourcing service provide. Both parties should appoint transition project managers that would cooperate in preparation of a detailed transition plan containing tasks, assignments, timelines etc.

This phase may invoke re-writing all organization's processes and procedure, remaining employee's job descriptions etc.

Phase five: Operate

This phase involves both parties to engage into constant motoring of the performance of already outsourced processes. Reports generated from the pre-agreed tools to be used will be the base for the future successful operations and its improvements.

Designated people from both parties should meet regularly to analyses and evaluate performance reports. Both parties should work and act proactively to predict unexpected process flows and problems and find way to eliminate them.

After all the outsourced processes and activities are in operational phase, meaning the subcontracted partner have took over, the Plan-Do-Check-Act PDCA process should take place as part of a continuous improvement of the outsourced processes and activities. PDCA is also known as PSDA, Plan-Do-Study-Act.

According to Deming, the PDSA Cycle is a systematic series of steps for gaining valuable learning and knowledge for the continual improvement of a product or process. (Deming, 2016).

ISO 22301 have also defined the PDCA lifecycle as shown in Figure 21.

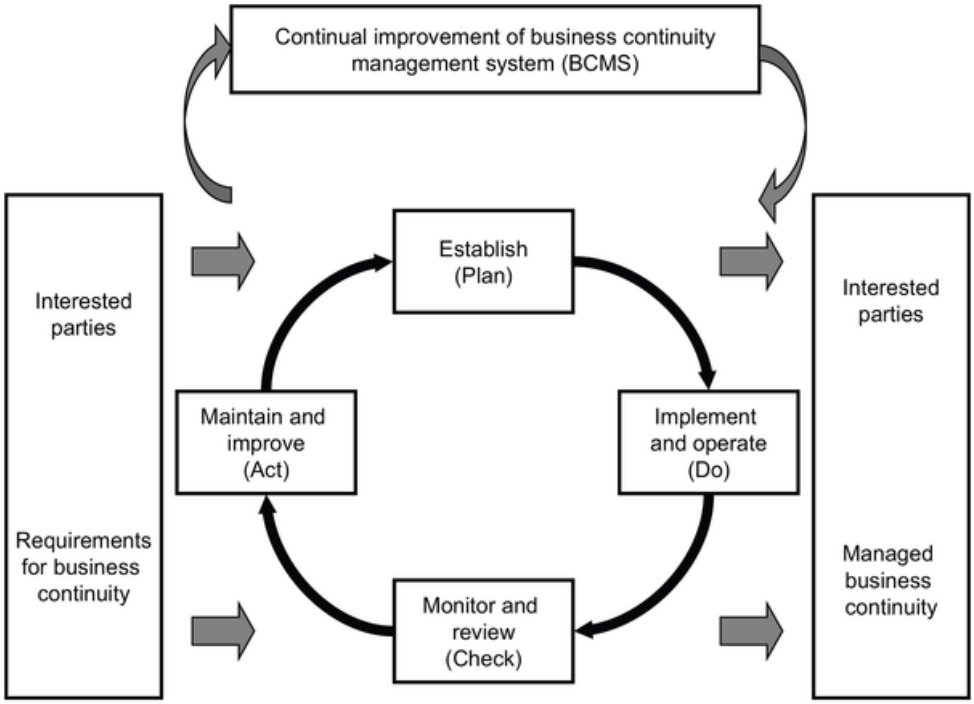

Figure 21 - PDCA lifecycle based on ISO 22301 (SCTE, 2016)

The critical phases in the lifecycle defined in ISO 22301 include:

Plan: Establish business continuity policy, objectives, targets, controls, processes and procedures relevant to improving business continuity in order to deliver results that align with the organizations overall policies and objectives.

Do: Implement and operate the business continuity policy, controls, processes and procedures.

Check: Monitor and review performance against business continuity policy, and objects to report the results to management for review, and determine and authorize actions for remediation and improvement.

Act: Maintain and improve the business continuity management system (BCMS) by taking corrective action, based on the results of management review and reappraising the scope of the BCMS and business continuity policy and objectives. (SCTE, 2016).

3.5 Summary of chapter three

This chapter contained literature reviews and researches related to the Business Process Outsourcing brining my and literature views on definitions, benefits and advantages, risks and disadvantages, levels of outsourcing considering how it was done previously, how is perceived nowadays and the outlook on how it will look like in the future, being considered as factor that organizations might rethinking completely their long term strategy.

The most important section of this chapter is the lifecycle phases of the BPO where description and explanation of what these phases involve can be found.

I would say that these five phases of the lifecycle of implementing a BPO apply to all organizations, regardless of their size, organizational structure or the nature of their functional domain.

4. Cable network and CPE maintenance outsourcing

As stated at the Abstract, in this master thesis we assume that decision to outsource is already made therefore we only describe without any analysis presentation or calculations. Following the BPO project lifecycle phases, this chapter will describe these phases in relation to the specific process we have chosen to outsource, HFC and CPE installation maintenance.

4.1 Phase one - Analysis of the opportunity and the decision making

After analyzing the opportunity, objectives of outsourcing of HFC and CPE installation maintenance activities and basis for deciding so are described below:

- Maintenance costs of HFC and CPE installation process will remain the same with a long term decrease opportunity assuming that the quality of the process, once outsourced, will increase, resulting with less field activities and as a result less costs from the subcontractor side.

- Considering the fact that by outsourcing a business process of such scale, usually field force is numerous, the company has decided to allow employees that already work in the same competence area, to create their own companies and bid to get the outsourcing contract. With this decision the outsourcing company shows readiness to keep old employees getting paid but now under another firm's umbrella. If this would be the case, the company has also decided that will sell the supporting assets of these activities as cars, tools and accessories, with a discount of 10% from their book value and pay the debt with services in period of one year with additional one year grace period. All this would allow to the newly established firm, by the old employees, to concentrate into delivering qualitative services with small concern on investments cost of establishing such operations.

- Risk analysis is already made. Risk is identified and contingency plans are already in place in case risk would materialize. Advantages and disadvantages of outsourcing this process are also listed and by this

executives are already aware of what the outsourcing as a process could bring to the company.

- The company has also decided that a proper Mobile Work Force Management (MWFM) is needed to dispatch and track filed activities of the subcontractors. The Mobile Work Force Management (MWFM) will be fully integrated with the company's existing Customer Relations Management (CRM) and Trouble Ticketing (TT) system. Field activities outsourcing cannot be managed without such a tool. Mobile Work Force Management (MWFM) will be implemented in a separate project.

- The company has already assigned a project manager and a project steering committee.

4.2 Phase two - Subcontractor selection

Before I continue elaboration of outsourcing subcontractor selection, maintenance process needs to be described in terms of what activities the process covers, response and delivery times and Service Level Agreements (SLA), outsourcing subcontractor professional skills etc.

4.2.1 HFC and CPE maintenance services description

HFC network and CPE installation maintenance consists of few separate processes which are divided into:

- HFC corrective maintenance process

- HFC preventive maintenance process and

- CPE corrective maintenance process.

HFC corrective maintenance process covers fault repair activities of HFC last mile elements of the network which consists of FO Node (including electricity and electricity power backup), Coaxial cables (all types), Signal Amplifiers, Taps and splitters, excluding the end customer installation lines and CPE. HFC network topology is described in more details in Chapter 1 Section 1.2. This process includes a 24/7 service for restoring or replacing of failed network equipment and it is mission

critical when considering customer satisfaction as failures in this part of the network affect large number of customers and take more time to repair.

HFC preventive maintenance process covers preventative and scheduled maintenance activities as well as repair activities that don not affect the service but yet, to keep up the network quality to desired levels it is a process with high importance as well. The preventive maintenance process as such includes activities of visual check, signal measurements, signals alignments, etc. of the FO Node (including electricity and electricity power backup), Coaxial cables (all types), Signal Amplifiers, Taps and splitters, excluding the end customer installation lines and CPE. HFC network topology is described in more details in Chapter 1 Section 1.2.

In addition to this, preventive maintenance process includes Inventory management incl. collection of configuration data, Warehousing & stock level management and Logistics relating to access layer operation & maintenance

CPE corrective maintenance covers fault repair activities of TAP to HOME access line and CPE reconfiguration or replacement in case of fault. In cable networks TAP to HOME connectivity is coaxial cable while Cable modem, Digital TV STB and Broadband router are CPE's.

4.2.2 Request for Proposal RFP - Scope of work (SOW)

In order to process with subcontractor selection we need to compile an RFP that will be sent to potential bidders. The RFP as such will contain Scope of Work SOW required by the company to be delivered by the outsourcing subcontractor, minimum requirements related to staffing and assets and other instructions on how the bidders will present their offers on how much will it cost to the company to outsource those processes and activities.

In order to avoid any misunderstandings about what are the duties of the outsourcing subcontractor and by that creating unexpected costs, detailed Scope of Work (SOW) has to be written in the contract. Considering that we have already described the HFC network architecture in Chapter 1, Section 1.2, we are able to go into specifics of which activities have to be performed in order to fulfill 3 processes of the maintenance specified in Chapter 4 section 4.2.1.

Company's Service Delivery Manager and Technical Coordinator of the subcontractor

The Company shall appoint a Delivery Manager and Subcontractor shall appoint a Technical Coordinator who should be a single point of contact (SPOC) and have the responsibility to oversee the implementation and delivery of the Services. Such personnel shall have the appropriate authority to commit resources within their respective organizations necessary for the delivery of the Services.

Delivery Manager shall have overall responsibility to build a services-focused relationship between Company and Subcontractor. Delivery Manager shall be responsible to:

- Monitor the Services delivery of Subcontractor in accordance with the Contract;
- Report regularly services performance according to the service level standards;
- Be an escalation point for all Subcontractor related issues in accordance with the Contract;
- Create and track Services delivery improvement opportunities.

Delivery Manager shall have authority to:

- Escalate identified Subcontractor related critical issues to Company's upper management;
- Take appropriate necessary preventive steps to fulfill service level standards;
- Initiate internal analysis of any problem concerning Services delivery, Company's End-Customer satisfaction and Services delivery improvement opportunities;

On the other side, subcontractors Technical Coordinator shall have overall responsibility to build a services-focused relationship between the Subcontractor and the Company. Technical Coordinator shall be responsible to:

- Monitor the delivery of Services by the Subcontractor technician(s);
- Report regularly services performance as specified in accordance with the service level standards to the Delivery Manager;
- Escalate any critical issues in relation to the Company to the Delivery Manager;
- Take appropriate necessary preventive steps to fulfill service level standards;
- Initiate internal analysis of any problem concerning Services delivery, Company's End-Customer satisfaction and Services delivery improvement opportunities;

HFC Corrective Maintenance Services

Corrective Maintenance Services provided by the Subcontractor shall consist of restoring the Components and the Equipment installed in the HFC network to Proper Operational Condition, in the event of a Fault, based on Fault localization provided by the Company's Network Monitoring Centre (NMC) and by the Subcontractor, using diagnostic aids and test equipment as necessary. Failure or malfunction of the Components or Equipment shall be corrected by adjustment or by replacement of cables, cards, modules, sub-assemblies or other defective parts.

After detection of the fault, the Company's NMC will open Network Trouble Ticket using Company's fault management system and promptly request from Technical Coordinator dispatch of a Subcontractor technician(s) to the Equipment Site. Technical Coordinator shall have access to the fault management system.

Figure 22 illustrates HFC Network Trouble Ticket flow.

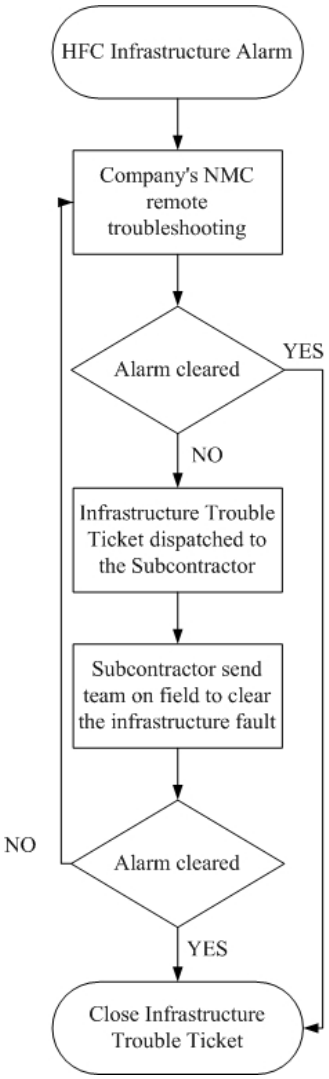

Figure 22 - HFC network infrastructure trouble ticket flow

All Network Trouble Tickets will contain the following information:

- Network Trouble Ticket ID;
- Equipment Site Address;
- Equipment and/or Components;
- Nature of the Fault;
- Time when fault occurred;
- Ticket Prioritization.

On-site Corrective Maintenance Services shall consist of:

- Arrival of a Subcontractor technician(s) with necessary Spare parts at the Equipment Sites
- Run diagnostics procedures on defective Components and/or Equipment;
- Replacement of defective Components and/or Equipment.

Subcontractor should provide Corrective Maintenance Services for the Equipment and Components listed below:

- Fiber Nodes;
- Coaxial cable (all types);
- Amplifiers – (all types);
- Active and Passive Taps - (all types);
- Splitters (all types);
- Connectors (all types);
- Fuses;
- UPS and Inverters;
- Batteries;
- Transformers (from 220V to 60V-100V);
- Poles;
- Ducts;
- Pole Chain Rings (cable holders);
- Cable boxes and trays;
- Conduits;
- Ventilators;

- Thermostats;
- Lock and keys;
- Groundings.

Upon completion of the HFC Corrective Maintenance Service action and prior to leaving the Equipment Site, Technical Coordinator will contact Company's NMC to initiate Network Trouble Ticket closure.

Subcontractor shall provide the following information to the NMC:

- Time of repair;
- Exact repair solution;
- Status of Equipment;
- Serial numbers of any replaced Equipment (wherever possible).

HFC Preventive Maintenance Services

Subcontractor shall provide HFC Preventive Maintenance Services recommended by the Equipment and/or Components manufacturer Subcontractor shall provide Preventive Maintenance Services on regular frequency as hereunder defined for the following Equipment and Components:

- Every three (3) months:
    - Fuses;
    - Power stabilizers;
    - UPS and Inverters;
    - Batteries;
    - Transformers (from 220V to 60V-100V);
    - Locks and keys.
- Every six (6) months:

- Fiber Nodes;
- Coaxial cable (all types);
- Amplifiers – (all types);
- Active and Passive Taps - (all types);
- Poles and pole chain rings;
- Splitters (all types);
- Connectors (all types);
- Ventilators;
- Thermostats.
- Ducts;
- Cable boxes;
- Cable trays;
- Conduits;
- Groundings.

As part of the HFC Preventive Maintenance service Subcontractor shall be responsible to conduct a comprehensive inventory of the Equipment and/or Components. The inventory shall include:

- Recording model and serial numbers (wherever applicable);
- Labeling (wherever needed);
- Documenting the fiber optic routes;
- Documenting coaxial cable routes of all types;
- Documenting components installed inside fiber optic nodes and amplifiers;
- Documenting equipment and cables inside street cabinets;

- Documenting location of fiber optic nodes, amplifiers, splitters and multi-taps;

- Documenting location of power backup sites.

In order to make sure that all preventive activities are done correctly, the subcontractor will have to fill an acceptance form which will be signed by the outsourcing company once it is established that the delivered service satisfies required service criteria.

Table 3 contains of one example of such an acceptance form.

Region	**Subcontractor**

Project ID	**Date**	**Preventive No.**

Equipment type	**Done (Y/N)**	**Comments**
Fiber Nodes		
Coaxial cable (RG6)		
Coaxial cable (RG8)		
Coaxial cable (RG11)		
Amplifiers (Mini)		
Amplifiers (Line)		
Active Taps		
Passive Taps		
Poles and pole chain rings		
Splitters		
Connectors		

Ventilators		
Thermostats		
Ducts		
Cable boxes		
Cable trays		
Conduits		
Groundings		

Subcontractors signature _____

Clients signature _____

Table 3 - Preventive maintenance acceptance form example

CPE Corrective Maintenance Services

CPE Corrective Maintenance Services provided by the Subcontractor shall consist of restoring the Components and the Equipment installed at Company's End-Customer location to Proper Operational Condition in the event of a Fault, based on Fault localization provided by the Company's Technical Support and by the Subcontractor, using diagnostic tools and equipment.

CPE Corrective Maintenance Service is provided whenever a Customer Trouble Ticket will be opened upon Company's End-Customer request for Support. Companies Technical Support run first level diagnostics and remote troubleshooting. In case of remote intervention needed Technical Support shall forward the Customer Trouble Ticket to the Subcontractor and promptly request from Technical Coordinator dispatch of a Subcontractor technician(s) to the End-Customer's location. Technical Coordinator shall have access to the Customer Ticket Management tools provide by the Company.

Figure 23 illustrates Customer Trouble Ticket flow.

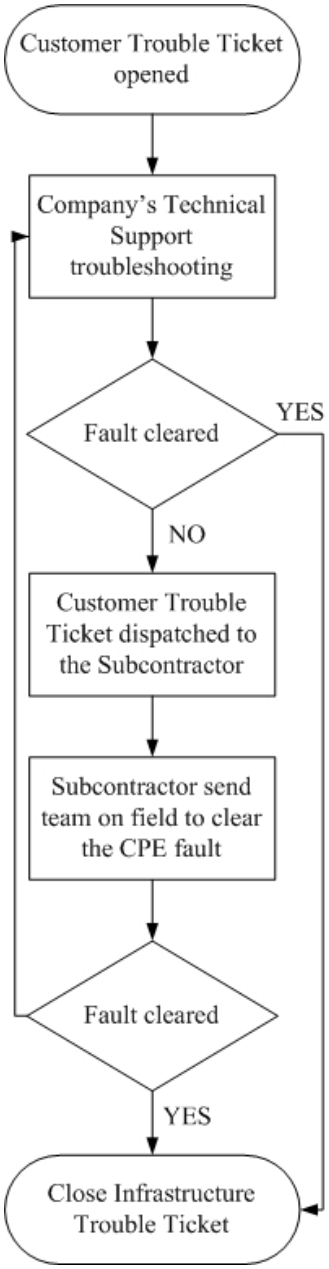

Figure 23 - Customer Trouble Ticket flow

All Customer Trouble Tickets shall contain the following information:

- End User Site Address;
- Equipment and/or Component;
- Nature of the Fault;

- Time of opening of the Customer Trouble Ticket;
- Prioritization of Dispatch.

On-site Intervention Services shall consist of:

- Arrival of a Subcontractor technician(s) with necessary Spares parts;
- Run diagnostics on defective Components and/or Equipment;
- Replacement of defective Components and/or Equipment.

Subcontractor should provide Corrective Intervention Services for the Equipment listed below:

- Coaxial Cables (all types);
- SFTP/UTP Cables;
- Splitters;
- Connectors;
- Digital TV Set Top Boxes;
- Cable Modems;
- End User Personal Computers;
- LANs;
- Wireless Routers and Bridges;
- Power Adapters;

Upon completion of the Corrective Intervention Service action and prior to leaving the End User Site, Technical Coordinator will contact the Technical Support to initiate Trouble Ticket closure. Subcontractor shall provide the following information to the Technical Support:

- Time of repair;
- Exact repair solution;

- Status of Equipment;
- Serial numbers of any replaced Equipment (whenever possible).

HFC network and Company's End-Customers details

The RFP as such should contain details of the network in terms of:

- Coverage and what regions
- Number of Fiber Optic Nodes
- Number of Amplifiers
- Length of the coaxial network
- Number of home passed and if necessary
- Number and type of customers

Key performance indicators KPI

As per nature of the HFC network and the Company's customer segmentation different KPI's are required.

Table 4 contains KPI's for HFC Corrective Maintenance Service.

KPI Designation	**Service availability**	**Service restoration time**
Priority 1 - more than 400 home passed Affected	24/7	2h
Priority 2 - less than 400 home passed Affected	24/7	6h
Priority 3 - less than 200 home passed Affected	24/7	20h

Table 4 - HFC Corrective Maintenance KPI's

Table 4 contains KPI's for HFC Preventive Maintenance Service.

KPI Designation	Reaction time
HFC PMS effectiveness 1	3 months
HFC PMS effectiveness 2	6 months

Table 5 - HFC Preventive Maintenance KPI's

Table 5 contains KPI's for CPE Corrective Maintenance Service.

SLA type	Customer category description	Service availability	Service restoration time
SLA1	Large businesses and Corporations	24/7	2h
SLA2	Small Office Home Office and small businesses	12/6	8h
SLA3	Residential users	12/6	24h

Table 6 - CPE Corrective Maintenance KPI's

Subcontractor working hours are imposed by the SLA service delivery timelines and are as follows:

- SLA1 – All year, 7 days a week, 24 hours a day including weekends and national holidays.
- SLA2 - All year, 6 days a week (excluding Sunday), 12 hours a day from 08:00 to 20:00, including national holidays.
- SLA3 - All year, 6 days a week (excluding Sunday), 12 hours a day from 08:00 to 20:00, excluding national holidays.

Subcontractor's employee's minimum skills requirements

Minimum professional skills of the subcontractor's employees for running this type of maintenance process require trainings and certifications on the few specific courses provided by SCTE and are listed below:

- Installation Technician Course Content: Introduction and Overview; Communication Theory; Signal Processing; Signal Distribution; Installers and Their Tools; Survey of the Installation; Installation; Inside the Home; Troubleshooting; Safety Manual (SCTE, 2016)

- Service Technician Course Content: Responding to Service Call and Fault-Finding; Communication Principles for Analogue and Digital Networks; Return Channels for DOCSIS and Euro DOCSIS; Video and Audio Services; Network Services; Transmission Lines, Coaxial and Optical Fiber Cables; Downstream and Upstream Networks; Wi-Fi and Test Equipment and Measurements. (SCTE, 2016)

Courses and certifications suggested above can be replaced with other equivalent courses.

4.3 Phase three - Contract development

The BPO contract will provides the framework to which the outsourcing subcontractor will assume responsibility and will manage on an ongoing basis company's business processes and activities outsourced to him, including the scope of work, performance requirements, and compensation costs.

One step before entering into contractual agreement to outsource a business process it is very important that you sign a Non-Disclosure Agreement with the chosen subcontractor.

In principle, the contracts as such do not require some special form. As the scope of work may be voluminous in content and in the future specific parts of the contract may require changes, the contract shall be structured in such way that should contain main contract framework and supporting annexes.

It is important that the contract as such will contain all necessary provisions such as:

1. Details about the Company and the Subcontractor.

2. Scope of Work based on the RFP Chapter 4 Section 4.2.2. An important detail is related to the fact that the Company engages the outsourcing

Subcontractor to maintain CPE's located at the End-Customer locations. It immediately imposes the need that the Subcontractor will interact with Company's End-Customers on behalf of the Company therefore, it is of a great importance that the contract will contain specific details on how the Subcontractor's employees will behave, ethically and professionally when visiting Company's End-Customer premises.

3. Fees and Payment terms shall be specified in this part of the contract. Fees will derive from the tendering results while payment terms should be specified according to what the Company cash flow prediction will be.

4. Terms shall be defined as well. Contract start date, duration, renewal and other details related to this should be put in the contract including penalties in case of non-delivery.

5. Termination and cancelation of the contract should be specified in details as there is a huge risk of not being able to terminate or cancel a contract if these details are not specified. Several reasons may influence termination or cancelation of the contract but most severe cause could be the non-delivery or the non-performance of the Subcontractor.

6. General provisions shall be put in the contract by a specialized lawyer.

4.4 Phase four - Transition

Few important activities have to be done at this phase.

Transfer of knowledge is the most important activity of this phase. The outsourcing company together with the subcontractor shall organize workshops where detailed HFC network maps will be presented and discussed. Best practices used till now by the company have to be transferred to the outsourcing subcontractor. Network maps and network elements inventory shall be delivered to the subcontractor in electronic form so the contractor can post process in the future whenever network changes will occur. As part of the knowledge transfer, training will be held on how to use company's tools such as Trouble Ticketing system, troubleshooting tools, company's CRM etc.

In case the outsourcing process involves employee and asset transfer from the outsourcing company to the outsourced subcontractor, employee transfer contracts will be negotiated, together with the company's layers, assets such as vehicles, tools and accessories transfer/sell will also be agreed during the transition phase.

As outsourcing of business processes imposes reduction of head-count, during this phase it is extremely important to gain feedback from employees and carefully monitor remaining employee's emotions. It is necessary to anticipate their concerns and likely questions and prepare answers. Proper communication should take place within the Company by preparing presentations, coaching where necessary etc. Individuals should be involved and it is important to not let rumors to dominate.

4.5 Phase five - Operate, measure and improve

Delivery Manager and Technical Coordinator shall conduct monthly meetings for the initial six (6) months after contract awarded to the Subcontractor and after that, Delivery Manager and Technical Coordinator shall conduct quarterly meetings.

During this lifecycle of the process the Company and the Subcontractor shall regularly:

- Review operational performance against established service levels and key performance indicators;
- Identify and implement required corrective and preventive actions;
- Facilitate the regular exchange of information;
- Provide a forum for the identification, escalation and resolution of issues affecting the performance of Services;
- Based on reports generated prepare improvement plans.

Filed workforce management tool is the core of the operations of outsourced processes that provides data in real time to the field engineers contributing increased productivity and efficiency of the field activities.

I strictly recommend that cable companies outsourcing such a field service should utilize a mobile work force management which means, every engineer will have a hand-held device from which all work orders will be received. Such hand-held device have numerous features that can be utilized such as:

- Global Positioning System (GPS) to locate the employees and dispatch them to the nearest location that maintenance is needed and to collect GPS coordinates of the location of the equipment, no matter if it's a network element or CPE,
- Collect real time customer satisfaction data by developing an application that end-customers will fill in after the maintenance will be finished.

Such valuable collection of information give the outsourcing company the power of process improvement and long term cost decrease opportunity.

4.6 Summary of chapter four

As in the previous Chapter 3 I ended up describing the lifecycle phases of the Business Process Outsourcing (BPO), in this chapter I materialize the same model with concrete information related to HFC Network and CPE maintenance process. The chapter starts with maintenance processes definitions such as definition of HFC Corrective maintenance, HFC preventive maintenance and CPE installation corrective maintenance. As the BPO lifecycle process starts with the first phase, Analyzing the opportunity and Decision making, I have emphasized that I'm not going to analyze this phase in this master thesis as I have assumed that deliverables of this phase are already achieved, which means, objectives are known and decision to outsource is made. Further down this chapter, as part of the second phase of the BPO lifecycle, I have inscribed the SOW as part of the RFP containing pre-defined processes that the subcontracted outsourcer will have to perform, with specific performance quality criteria defined as KPI's and specific set of professional skills of their employees. After the outsourcing service provider is chosen, contract is defined containing all the provisions listed in the next section. Transition process, as the fourth phase, is important to be implemented correctly as even if the outsourcing service provider is correctly done this phase could jeopardize that. This section of the

chapter in fact should be planned and implemented carefully considering the damage it could bring to the company if improperly done. At the end, operating, measuring and improving is what the final phase of the BPO lifecycle is about. It is important that both parties appoint responsible managers to run the outsourced operations. Integral part of this phase is preparing reports, analyzing results and based on that proactively prepare improvement plans. Only this way the outsourcing company together with the outsourcing service provider can achieve the goals of cost decrease and increase the end-customer satisfaction.

5. Summary and outlook

Business Process Outsourcing (BPO) is becoming a very fast growing segment in the telecommunications industry. At the beginning it was focused in very narrow supporting processes of the telecommunications companies such as: outsourcing of Customer Care and Technical support, IT Help Desk, Application Maintenance, HR related processes, Financial Reconciliation etc. but slowly it drives towards much more sensitive processes as those that involve end-customer interaction like Sales Support and Field Force Management.

As the objective was set at the beginning, I have described the phases with comprehensive description of what each phase should contain in order to outsource a process related to HFC network and CPE maintenance.

In order to understand activities that are involved in the process, in Chapter 2, I have made general description of broadband access technologies such as DSL, Cable modem, Fiber Optic technology, Wireless broadband, Satellite broadband and Broadband over Power lines.

Main reason why I have listed and described, at least superficially, these broadband access technologies is that the Business Process Outsourcing (BPO) frameworks and its lifecycle phases can be used to outsource maintenance activities of each one of these broadband access technologies. The only difference lies at the type of equipment and its network architecture.

Further, at Chapter 2, I have made detailed description of the HFC network and its components. These information’s are used as background at Chapter 4 where I am describe the outsourcing process of maintaining this part of the network, with special focus on maintenance of the FO nodes, amplifiers, passive and active taps, coaxial cables, splitters, cable modems, digital TV STB’s, broadband routers etc.

It is of a great importance that you understand how the HFC network is build and how does it function in order to understand the process of maintenance of the same.

Chapter 3 contains literature reviews and researches related to the Business Process Outsourcing (BPO) brining mine and literature views on definitions, benefits and

advantages, risks and disadvantages, levels of outsourcing considering how it was done previously, how is perceived nowadays and the outlook on how it will look like in the future, being considered as factor that organizations might rethinking completely their long term strategy. It is of a great help, for readers of this master thesis, to have an overview of what the literature and researches say about BPO.

As I have already stated in chapter's 3 summary, the most important section is the lifecycle phases of the BPO where description and explanation of what these phases involve are described.

Organizations that intend to outsource business processes need to follow the BPO lifecycle phase's model in order to make sure that their outsourcing will succeed. The five phases of the lifecycle of implementing a BPO apply to all organizations, regardless of their size, organizational structure or the nature of their functional domain. Scope of Work and service delivery KPI's are the most important part of the RFP as part of the outsourcing service provider choosing. After that, contract definition and signing with all necessary provisions is a process that needs to be concluded. Engaging a lawyer during contract preparation is a must. During the transition phase companies should transfer the knowledge and the processes as quick as possible in order to avoid possible process blocking points that would cause unexpected expenses or service delivery issues. And at last, running the processes correctly and within the pre-defined KPI's both parties gain a lot of space for process improvements that at the end will result with the much desired cost reductions and increase of end-customer satisfaction.

Based on a research done on "how satisfied are telecom operators with outsourcing of their network operations activities", more than 80 percent of the operators we surveyed said they were either satisfied or very satisfied with the service they currently receive from their outsourcers. (Booz&Company, 2016).

With the outsourcing trend growing day-by-day, I can say that more and more telecom operators, including cable operators, will start considering it and some have already started the process of outsourcing. As discussed throughout this master thesis, the reason is simple, reduce operational costs and increase efficiency. It is also becoming a trend that telecom equipment manufacturers offer network maintenance

services as managed services contracts. As the network become more complex and end-customers' demands are growing telecom and cable operators will look beyond operational costs reduction and tend to concentrate towards process and service improvements. As the outsourcing trend will grow, telecom and cable operators will learn from their service outsourcing experiences. By that they will become more demanding in terms of the quality expected from the outsourcing service providers. Outsourcing service providers on the other hand, due to competitive environment will tend to decrease services costs and become more transparent in what they offer and what they deliver.

References

Booz&Company. *Outsourcing netwrok operations, maximizing the potential.* http://www.strategyand.pwc.com/media/file/OutsourcingNetworkOperations.pdf Last visited: 15.04.2016

Cable Television Laboratories, I. http://www.cable-europe.eu/wp-content/uploads/bsk-pdf-manager/15_CM-SP-EQAM-VSI-I01-081107.PDF Last visited: 12.04.2016

Conniq. http://www.conniq.com/InternetAccess_FTTH.htm Last visited: 15.04.2016

Davenport, T. (1993). *Process Innovation: Reengineering work through information technology.* Boston: Harvard Business School Press.

David Large, J. F. (2009). *Broadband cable access networks : the HFC plant.* Burlington: Morgan Kaufmann Publishers .

Deming. https://www.deming.org/theman/theories/pdsacycle Last visited: 17.04.2016

Federal Communications Commission, U. https://www.fcc.gov/general/types-broadband-connections Last visited: 15.04.2016

Griffiths, D. http://www.inkoopportal.com/inkoopportal/download/common/theory_and_parctice_of_outsourcing.pdf Last visited: 10.04.2016

Harte, L. (2007). *Introduction to Cable Television, 2nd edition.* New York: Althos Publishing.

John K. Harley, B. M. (2007). *Business Process Outsourcing - Process, Strategies and Contracts.* New Jersey: John Wiley & Sons, Inc., Hoboken.

LEONID G. KAZOVSKY, N. C.-T.-W. (2011). *BROADBAND OPTICAL Access Networks.* New Jersey: JOHN WILEY & SONS.

Mark J Power, K. C. (2006). *The outsourcing handbook - How to implement a sucsessful outsourcing process.* London: Kogan Page.

Morse, S. http://www.brainyquote.com/quotes/authors/s/samuel_morse.html Last visited: 15.04.2016

National Academy of Science, N. A. (2002). *Broadband, Bring home the bits.* Washington, D.C.: NATIONAL ACADEMY PRESS.

Novak, R. (2000). *Communications Systems and Networks. 2nd ed.* New York: M&T Books.

Rick L. Click, T. N. (2005). *Business Process Outsourcing - The competitive Advantage.* New Jersey: John Wiley & Sons.

Rutenbeck, J. (2006). *Tech Terms, What Every Telecommunications and Digital Media Professional Should Know.* Oxford: Elsevier Inc.

SCTE.
http://www.scte.org/documents/pdf/standards/SCTE%20206%202014.pdf
Last visited: 19.04.2016

Tele, C.
http://www.clark-tele.com/
Last visited: 20.04.2016

Wikipedia.
https://en.wikipedia.org/wiki/Hybrid_fibre-coaxial
Last visited: 25.03.2016

Abbreviations

AC Alternating Current

ADSL	Asymmetrical Digital Subscriber Line
AMP	Amplifier
ASP	Application Service Provider
BCMS	Business Continuity Management System
BPL	Broadband over Power Line
BPO	Business Process Outsourcing
BR	Broadband Router
CAPEX	Capital Expenditures
CAS	Conditional Access System
CM	Cable Modem
CMTS	Cable Modem Termination System
CPE	Customer Premises Equipment
CRM	Customers Relation Management
CuTV	Catchup Television
DBS	Direct-Broadcast Satellite
DC	Direct Current
DOCSIS	Data over Cable Service Interface Specification
DSL	Digital Subscriber Line
DTH	Direct To Home
DTV	Digital Television
EPG	Electronic Program Guide
EQAM	Edge Quadrature Amplitude Modulation

FCC	Federal Communications Comity
FON	Fiber Optical Node
FTTH	Fiber To The Home
HDSL	High data rate Digital Subscriber Line
HDTV	High Definition Television
HFC	Hybrid Fiber-Coaxial
HIS	High Speed Internet
IP	Internet Protocol
IPTV	Internet Protocol Television
IRD	Integrated Receiver Decoder
IT	Information Technology
KPI	Key Performance Indicator
LAN	Local Area Network
MPEG	Moving Picture Experts Group
MWFM	Mobile Work Force Management
NMC	Network Monitoring Center
NPVR	Network Personal Video Recorder
OPEX	Operational Expenditure
OTT	Over The Top
P&L	Profit and Loss
PDCA	Plan, Do, Check, Act
PPV	Pay Per View

PSI	Program Service Information
RF	Radio Frequency
RFP	Request For Proposal
SDSL	Symmetrical Digital Subscriber Line
SLA	Service Level Agreement
SOW	Scope Of Work
SPOC	Single Point Of Contact
STB	Set-top Box
TS	Transport stream
TT	Trouble Ticket
UPS	Uninterruptable Power Supply
VAS	Value added services
VDSL	Very High data rate Digital Subscriber Line
VoD	Video on demand
VoIP	Voice over Internet Protocol
Wi-Fi	Wireless Fidelity
WISP	Wireless Internet Service Provider
WLAN	Wireless Local Area Network

List of Figures

List of Tables