



# Effects of Upgrading the Docsis Level of Cable Modem on the Speed of Cable Television Broadband Internet

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**Abstract-**This review work was carried out in order to evaluate the general performance of cable modems in providing Broadband Internet through cable TV network. Also in this paper, the challenges facing the home Internet users as a result of the sharp rise in the number of Internet users were highlighted. However, on the other hand, the various parts of the cable TV were explored, and the investigation of the performance of the cable modem when upgraded to higher DOCSIS level was carried out using speed test Internet tools. Furthermore, the results of the tests carried out through COMCAST Cable TV using DOCSIS 2.0 and DOCSIS 3.0 cable modem were documented and necessary inferences drawn. In addition, the recommendation, based on the review and result of the speed test were provided.

**Keyword:** Broadband, Cable Modem, DOCSIS, Satellite Dish, Fibre Cable, Submarine Cables.

## 1. INTRODUCTION

Abhaya (1997) define the *Internet* as a global system of interconnected computer networks that use the standard *Internet* protocol suite (TCP/IP) to link several billion devices worldwide. Users of the Internet can view information on the World Wide Web, exchange electronic mail, participate in electronic discussion forums (newsgroups), send files from any computer to any other via FTP, or HTTP, and even use each other's computers directly if they have appropriate passwords.

Traditionally, the term broadband refers to high-speed communications networks that connected end-users at a data transfer speed greater than 256 Kbit/s. Global organisations have chosen to define it more in terms of an ecosystem. It has however been chosen to define broadband in a manner that reflects the user experience. FCC. (2014).

In US, according to Micah S. (2015), Federal Communications Commission (FCC) has changed the definition of broadband by raising the minimum download speeds needed from 4Mbps to 25Mbps, and the minimum upload speed from 1Mbps to 3Mbps.

As such, Nigeria Broadband Committee (2012) define broadband in Nigerian context as an internet experience where the user can access the most demanding content in real time at a minimum speed of 1.5 Mbit/s.

Nigeria Broadband Committee (2012) also stated that broadband is to the 21st Century Information Age what Electricity was to the Industrial Age. It has a significant transformative effect on how people live and work. It empowers the individual user with previously unimaginable capabilities and global reach. The Internet is the world's biggest library and largest repository of information and knowledge; while High Speed Access is critical to fully harnessing the benefits of the Internet. In addition, it was also stated that Economies are increasingly based on knowledge and information instead of the previously existing tradition economies. Knowledge is now recognised as the driver of productivity and economic growth. As a result, there is a new focus on the role of information, technology and learning in economic performance.

However, the global demand for Internet services is increasing on daily basis to the extent that Cisco

Visual Networking Index (2015) forecast Annual global IP traffic to surpass the zettabyte (1000 exabytes) threshold in 2016. Consequently, ITU News (2015) confirmed that the huge demand for Internet is causing traffic congestion on the net, resulting in slower and expensive internet access. It further stated that past years, the main usage of internet was to access emails and chatting, nowadays it grew exponentially to include accessing social networks media, HD and YouTube video streaming, Zuhu games, cloud computing activities and TV; all these are grouping the people in the whole world into two categories: The Internet users and the non Internet users.

In spite of the aforementioned reasons, there is a need to seek for a viable source of broadband so as to exploit the resources in the Internet.

The objectives of this paper include majorly to:

- (i) Explore various components of the architecture for providing Broadband Internet via Satellite Cable TV.
- (ii) Investigate the performance of cable modem in providing Internet broadband when upgraded from lower DOCSIS level of compliance to a higher one.
- (iii) Educate people to exploit the inherent advantages embedded in CATV network so as to provide necessary support to Cable TV to continuously evolve without going into extinction in the face of serious competition posed by the widely accepting DVB-T2 technology.

The method of gathering information employed in this review paper was based on the information derived from textbooks, journals, accepted Seminar Papers, notable websites and the performance-test carried out on cable modems via Comcast network.

## **2. LITERATURE REVIEW**

In this section, the literatures on various types of broadband connections as well as the literatures describing the architecture of Cable Network systems and its functionality was considered.

### **2.1 Types of Broadband Connections**

FCC (2014) describe the term broadband commonly to make reference to high-speed Internet access that is always on and faster than the traditional dial-up access. Broadband includes several high-speed transmission technologies such as: Digital Subscriber Line (DSL), Cable Modem, Fiber, Wireless, Satellite, and Broadband over Power Lines (BPL).

FCC (2014) stated further that broadband technology to be chosen by subscribers would depend on a number of factors. These may include whether the location of the subscriber is in an urban or rural area, how broadband Internet access is packaged with other services (such as voice telephone and home entertainment), price, and availability.

According to Aranuwa (2013), CATV offer the best delivery mode for cost-effective delivery of video, data and voice to homes. In addition, modern HFC-based cable networks have substantial bandwidth, which simultaneously can support hundreds of TV channels, high-speed Internet access, telephony. As well as advanced services such as Near-Video-On-Demand (NVOD) and video-on-demand (VOD), for furthering the growth of internet usage in the homes and to increase Internet penetration in Nigeria as a whole. In most cases, it offers a broadband Internet that is affordable to the subscribers.

The various comparative advantages of CATV include high availability, high bandwidth to low cost, high speed data access, always on connectivity etc

### **2.2 CABLE TV NETWORK SYSTEMS**

According to Greg (2005) & Scatmag.com. (2001), Cable Television is a television service in which programmes are distributed to subscribers' televisions by cable rather than by broadcast transmission. A cable Television network comprises of 3 major parts namely:

The programming source, Multi System Operator centre and subscriber's Home centre.

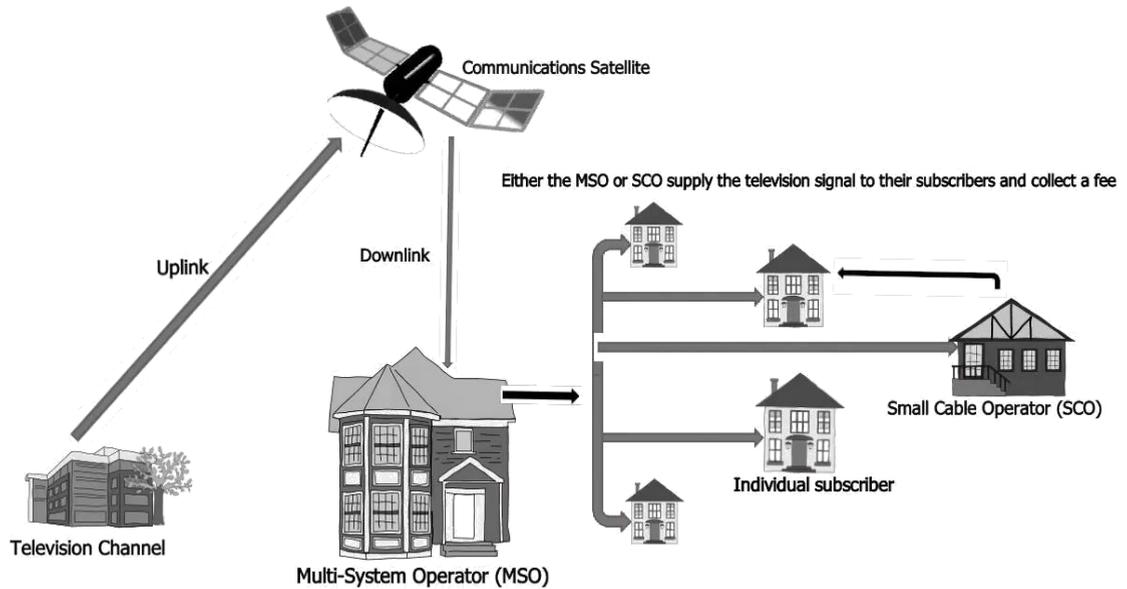


Fig 1. Diagram of a simple cable network system

The programming source is a source of programs such as sport programs which may be data or video and send it to the (Multi-System Operator (MSO)) centre through satellite communication. Other sources of programs being sent to the MSO centre include those obtained through terrestrial antenna and locally produced programs.

On the other hand, Multiple Services Operator (MSO) is an organization that provides more than one type of communications service, such as Internet access, TV and phone.

Also, MSO Centre contain head-end which is the initial distribution centre for a Cable Television (CATV) system, gathers programming sources, decodes, selects and retransmits video programming to the distribution network. Cable Network Connection. (2010)

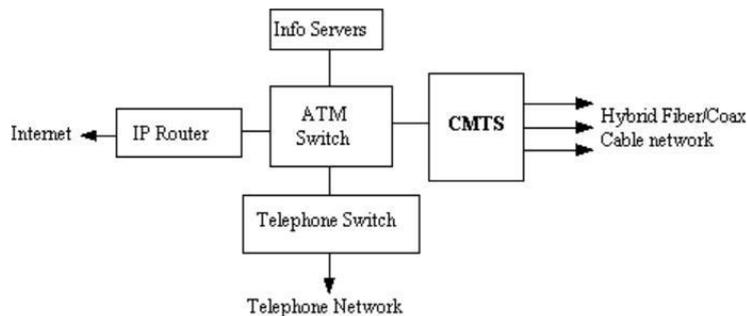


Fig 2 Equipment located at the head end

The video sources to the head end typically include satellite signals, off air receivers, microwave connections and other video feed signals. The video sources are scrambled to prevent unauthorized viewing before being sent to the cable distribution system. The head end receives, decodes and decrypts these channels. This example shows that the programs that will be broadcast are supplied to encoders and modulators to produce television channels on multiple frequencies. These channels are combined onto a single transmission line by a channel combiner in the MSO centre. Also included in the head end is the **Cable Modem Terminating System (CMTS)**, which is a very important device in the MSO centre.

A CMTS demodulates upstream signals, translates them back into IP packets and redirects them to a central switch. The central switch redirects the IP packets to an IP router for transmission across the Internet. In the opposite direction it modulates downstream signals for transmission across Hybrid Fibre Coax (HFC) cables to the subscribers' homes. One CMTS will normally provide support for up to 1000 simultaneous cable modem subscribers across a single 6MHz channel. If more cable modems are required, the number of channels is increased by adding more channels to the CMTS. [Cable Network Connection (2010)].

Presently, in Nigeria, according to Temitope A. (2015), most of the cable TV operators are only concentrating on the TV production and telephony while the issue of broadband is being neglected. As a result, small satellite dish is being used to connect the CMTS to the subscriber's home via satellite communication.

Satellite communications has been around for a while and has provided telecommunications links between Nigeria and the rest of the world. However, a comparison between fiber optic and satellite technologies reveals that although satellite systems are the most efficient solutions for TV broadcast, for access to remote locations, and essentially, for wireless access to the local loop and the network backbone, fiber optic networks are more suited for high bandwidth transmissions for example, fiber cables today can have capacity up to 2 Tbps - an equivalent of millions of simultaneous voice channels per cable. This is far from the reach of any anticipated satellite system, which is less than 1Gbps - lower than our own SAT-3/WASC/SAFE undersea cable system; reference to Ariyo & Oloajoetan (2013)

### 2.3 Connections at the Subscribers Home Centre

According to Aranuwa, F.O (2013), the signal coming to the subscriber's home is connected to the decoder/Top box through a coaxial cable. Further, from this literature, various components of the subscriber's home centre architectural design and their functionalities were reviewed.

**A decoder:** A decoder is a device which is used to decode the satellite signal received from the satellite dish into a video. The decoded signal converted into video is what we receive on our TV. A cable decoder is a modem because it modulates and demodulates, but it also functions as a tuner, a network bridge, an encryptor etc. To connect the PC or laptop to a decoder to access the net.

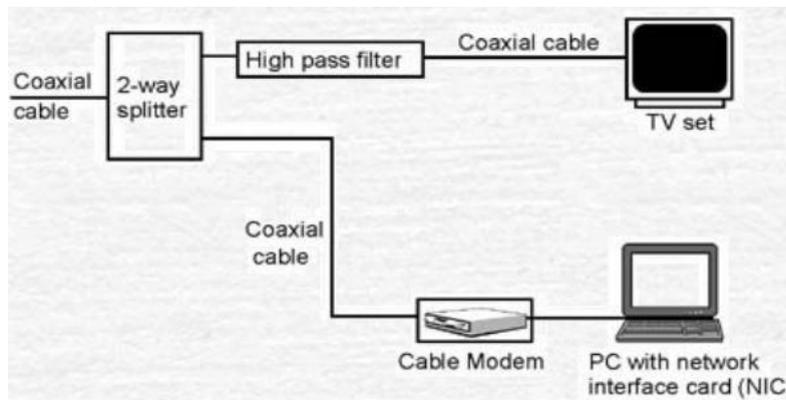


Fig 3 Connections in the subscriber's home

For Internet provision, there is a need to connect a splitter, having two output terminals. One terminal will be connected to the decoder of the television while the other terminal will be connected to the Cable Modem for further connection to the PC. For more than 1 PC, a router will be needed.

**A cable modem:** A cable modem is a device that delivers high-speed Internet connectivity via a cable television company which serves as the Internet service provider (ISP). Basically the Cable Modem is connected to the TV outlet for user's Cable TV, and the cable TV operator connects a Cable Modem Termination System at the Head-End (The Cable Company main office). Sibananda Mahanata. (2011).

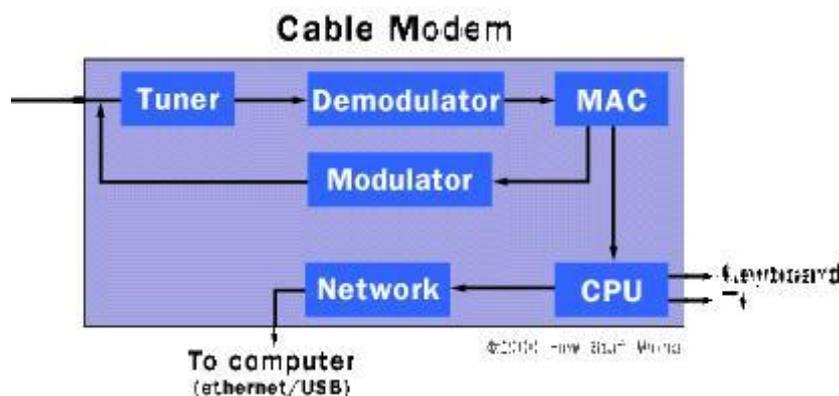


Fig 4. The Internal structure of a cable MODEM

After performing the physical connections, the next step is to configure the computer so that it will be able to browse the Internet using the Cable Modem.

#### 2.4 Standards for Regulating Cable TV Internet service

Like any other communication systems, there are standards for regulating the performance of the Cable TVs. The standard is commonly referred to as **Data Over Cable Service Interface Specification (DOCSIS)**. DOCSIS is the international standard used for transferring data over cable TV systems. This way, just about any cable modem works with any cable TV system. It was first developed almost 20 years ago in 1997 by a non-profit firm named CableLabs, with a lot of companies contributing to the specification. It is employed by many cable television operators to provide Internet access. Some of the early standards include DOCSIS 1.1, DOCSIS 2.0, DOCSIS 2.1, DOCSIS 3.0 and DOCSIS 3.1.

The higher the DOCSIS number, the higher the bandwidth data transfer allowed on that network. Micah S. (2015). Here's a quick breakdown:

- DOCSIS 1.x—38Mbps Down; 9Mbps Up
- DOCSIS 2.0—38Mbps Down; 27Mbps Up
- DOCSIS 3.0—152Mbps Down; 108Mbps Up (CableLabs says it can now go even higher)
- DOCSIS 3.1—10,000Mbps Down; 1,000Mbps Up

In reality, those are not speeds the subscribers typically get from a cable-based ISP. Just owning a cable modem that supports DOCSIS 3.0 or higher does not guarantee anything. There are also limitations based on distance and the number of people using the cable connection in a community, as well—those speeds are shared with all subscribers' neighbours. As a result, there is a need to carry out speed test to investigate the performance of the cable modem in a particular locality.

### 3. INVESTIGATING THE PERFORMANCE OF A CABLE MODEM

Generally, Cable TV delivers a high-speed Internet connection over the coaxial cables using a system called the Data Over the Cable Service Interface Specification (DOCSIS). The level of the DOCSIS varies and include DOCSIS 1.x, DOCSIS 2.0, DOCSIS 3.0 with DOCSIS 3.1 being the highest level. All things being equal, the performance or speed of a Network expected to increase with the increase in the level of the DOCSIS of the network. The highest level of DOCSIS presently is DOCSIS 3.1. Speed test is the major method of evaluating the performance of a cable modem and the system in general. The test is could also be carried out to determine the extent to which some other factors influence the speed of cable modem.

### 3.1 Speed Test to Determine the Effect of Cable Modem DOCSIS Level on the Broadband.

The objective of Speed Test was to determine the uplink and downlink speed of the internet. However, varying some factors of the Internet architectural design could affect the speed of the Internet. Based on this assertion, upgrading the cable MODEM is assumed to be one of the factors that affect the speed of the Internet and hence the investigation of this claim and extent to which it affect the speed of the Internet. In this paper, the effect of using cable MODEM that are higher DOCSIS compliant and the manner of its influence on the speed were investigated using speed test. However, the speed test carried out was used to investigate specifically the changes bring about in the speed of the cable Internet by upgrading the Cable Modem from DOCSIS 2.0 to DOCSIS 3.0 compliant cable MODEMS. Simple description of the speed tests carried out on Comcast and Median cable TV networks was documented as follow:

#### Speed Test #1

The Network on which the test was carried out:  
DOCSIS 2.0 compliant Cable Modem used:  
DOCSIS 3.0 compliant Cable Modem used:

Comcast Cable TV  
SB5101U  
(Motorola SURFBoard) SB6141



Figure 5: DOCSIS 2.0 Cable Modem



Figure 6: DOCSIS 2.0 Cable Modem



Figure 7: DOCSIS 2.0 Cable Modem



Figure 8: DOCSIS 2.0 Cable Modem

Speed Test Interface for Comcast Cable network Cable Network  
[Source: <https://www.youtube.com/watch?v=QrmchiDbIVg>]

**Table 1:** Speed of the Comcast Cable network for DOCSIS 2.0 and DOCSIS 3.0 Cable Modem

CABLE MODEM	DOCSIS	AVERAGE DOWNLOAD SPEED (Mbps)	AVERAGE UPLOAD SPEED (Mbps)
SB5101U	2.0	34.35	11.65
SB6141	3.0	57.74	11.59

**Speed Test #2**

The Network on which the test was carried out:  
 DOCSIS 2.0 compliant Cable Modem used:  
 DOCSIS 3.0 compliant Cable Modem used:

Median Cable  
 RCA DCM 425  
 (Motorola SURFBoard) SB6141

**Result:**



Figure 9: DOCSIS 2.0 Cable Modem For Median Cable Network

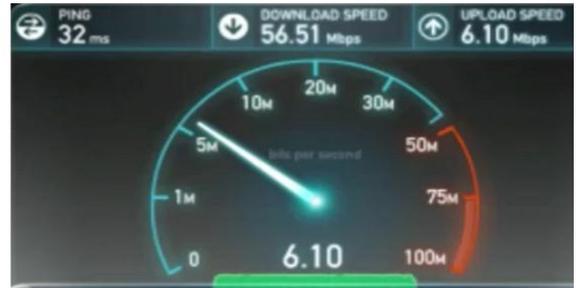


Figure 10: DOCSIS 3.0 Cable Modem For Median Cable Network

Speed Test Interface for Median Cable Network. [Source: <https://www.youtube.com/watch?v=GkVrEr91SvY>]

**Table 2:** Speed of the Median Cable network for DOCSIS 2.0 and DOCSIS 3.0 cable modems

CABLE MODEM	DOCSIS	DOWNLOAD SPEED (Mbps)	UPLOAD SPEED (Mbps)
RCA DCM 425	2.0	34.02	5.82
SB6141	3.0	56.51	6.10

**3.2 Inference on the Test**

Based on the results of the speed test shown in table 3.1 the following inferences were reached:

- i. That modem with higher DOCSIS value perform better than modem with lower DOCSIS value
- ii. That upgrading from a lower DOCSIS value to a higher DOCSIS value improves the speed of the modem. From table 1, it is observed that the average download speed increases from 34.35 Mbps to 57.74Mbps when the cable modem was upgraded from DOCSIS 2.0 (SB101U) compliant to DOCSIS 3.0 (SB6141) compliant type. The speed increased by 23.39Mbps which is a 68.1% increase.

However, the uplink speed do not have a significant change. It reduces from 11.65 Mbps to 11.59 Mbps with a reduction of 0.06Mbps which is a reduction of 0.52% reduction.

However, from table 2, it is observed that the download speed increases

- from 34.02 Mbps to 56.51Mbps; increased by 22.49 (66.1%) when the cable modem was upgraded from DOCSIS 2.0 compliant (RCA DCM 425) to DOCSIS 3.0 compliant (SB6141) types. However, the upload speed had a slight increase. It increased from 5.82 Mbps to 6.10 Mbps which an increase of 0.28Mbps (4.81%).
- iii. That speed of the modem is affected by peak hours and off peak hours syndrome
  - iv. That when many users are sharing the channel, the speed reduced.
  - v. That the value of upstream speed is always lower than the value of downstream speed
  - vi. That the speed, both upstream and downstream, are far below the nominal rated value of a DOCSIS.

#### **4. CONCLUSION AND RECOMMENDATION**

Based on the review carried out on the performance of cable Modem, the following recommendations are necessary to further improve on the performance and written below are the necessary recommendations.

- (i) That this system is recommended for acceptability in the country as this will greatly enhance Internet penetration in the country.  
Fixed landlines is almost absent in Nigeria. Most of the advancements in telecommunications in Nigeria has been in wireless and mobile technologies. However no economy can rely solely on mobile telecommunications. Fixed lines are more reliable and brings true broadband to homes and businesses. Cable TV operators, with Broadband Access, should be encouraged to embark on Fixed line culture and be made available to prepaid subscribers who can recharge using the same scratch cards as used with mobile phones.
- (ii) If adopted, using cable modem has the potential of reducing the cost of Internet services in Nigeria and still supply very fast Internet service.
- (iii) It will bring Internet accessibility to the doorstep of those rural dwellers and thereby bridging the gap in the economic level between rural and the urban dwellers.
- (iv) It will enhance the standard of education in the country since many will be having access to the resources on the Internet without paying exorbitant prices.
- (v) For being cost effective than any other method, it will enable more people to afford to be surfing the net on regular basis and this will indirectly reduce the level of illiteracy in the country.
- (vi) Technologically, it will help in developing systems that rely on broadband to operate such as banking.
- (vii) That the system will fast-track the usage of the available Internet resources at the shore of the country.

In conclusion and in spite of the few challenges facing the users of this method which include the initial cost of purchasing the hardware for the system, the effect of unfavourable weather such as rainy period, high subscription. The system still stand out to be one of the best that have the potential of increasing the Internet penetration value of the country and rank Nigeria among the nations of the world with high level of Internet penetration.

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