Fiber V/S Wireless Backhaul

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Abstract

The paper seeks to establish a fair analysis of various broadband delivery mechanisms and how they stack up vis-à-vis Fiber. The paper discusses the growth of data consumption over the years and the forecast for upcoming years. Further the paper elucidates various promising technologies like Fiber, WiFi, Whitenoise, Microwave etc that are being used for backhaul to deliver the broadband to the masses. It ends with a fair comparison of various technologies and provides recommendations. The intended audience are Technical Managers, Technical Committee Members, Account Managers, Solution Architects, Project Team etc.

Introduction

In a hierarchical telecommunications network the backhaul portion of the network comprises the intermediate links between the core network, or backbone network and the small sub-networks at the "edge" of the entire hierarchical network. Backhaul technologies include:

Wireless:

- Point-to-point microwave radio relay transmission (terrestrial or, in some cases, by satellite)
- Point-to-multipoint microwave-access technologies, such as Wi-Fi, WiMAX, etc.
- TV White Space

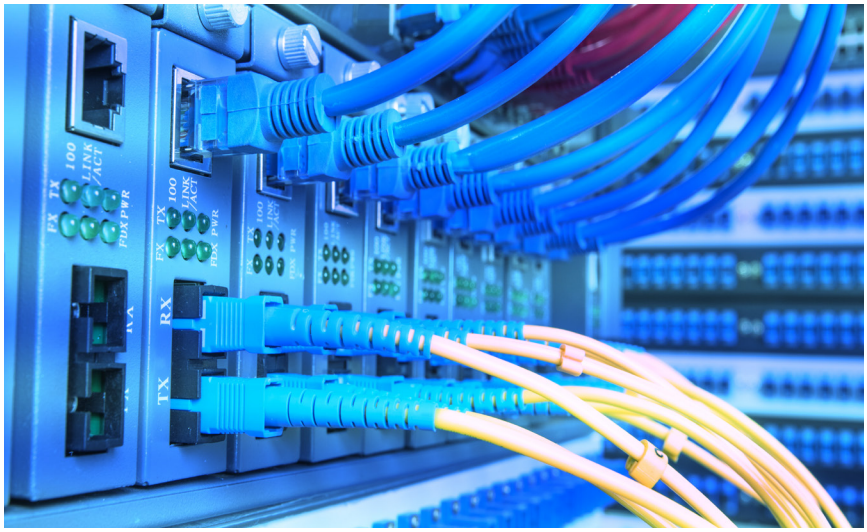
Wired:

- Optical Based: SDH/SONET/DWDM

Internet Traffic growth

A very well respected Cisco VNI report has this to say in its 2014-19 report. Annual global IP traffic will pass the zettabyte (1000 exabytes) threshold by the end of 2016, and will reach 2 zettabytes per year by 2019. By 2016, global IP traffic will reach 1.1 zettabytes per year, or 88.4 exabytes (nearly one billion gigabytes) per month, and by 2019, global IP traffic will reach 2.0 zettabytes per year, or 168 exabytes per month.

The India Specific numbers in the report has been shown below. This represents the figure to be around 5 exabytes per month by year 2019.



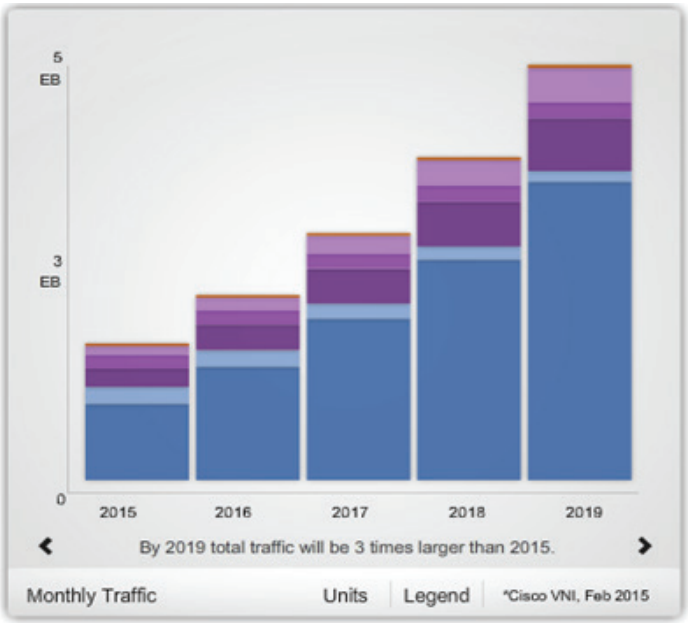
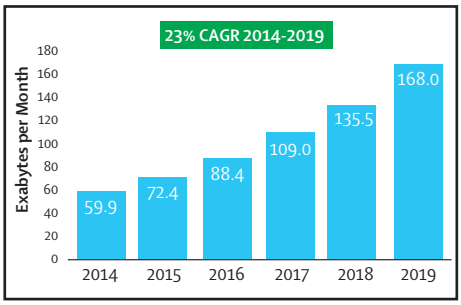


Figure: India Monthly Traffic including both consumer and business users.
Source: Cisco

Global IP traffic has increased fivefold over the past five years, and will increase threefold over the next five years. Overall, IP traffic will grow at a compound annual growth rate (CAGR) of 23 percent from 2014 to 2019. Broadband speeds will more than double by 2019. By 2019, global fixed broadband speeds will reach 42.5 Mbps, up from 20.3 Mbps in 2014



Cisco VNI Forecasts 168 Exabytes per Month of IP Traffic by 2019 globally

Source: Cisco VNI Global IP Traffic Forecast, 2014–2019

As the telecommunications industry experiences unexpected exponential growth in data traffic, the demand for this commodity has become insatiable. The solution is to expand or retrofit existing networks and build new networks.

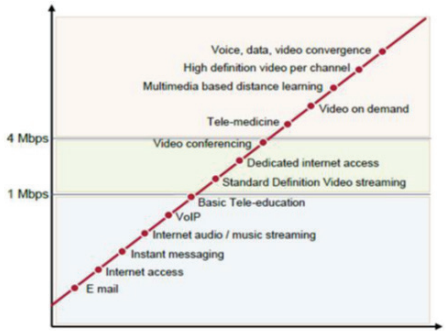
Broadband Speed Aspiration vs Reality

A lot of Internet applications have come up and the data consumption rates have been steadily increasing at a robust speed. As per the State of the Broadband report of September 2014, India has a 15 per cent Internet user penetration and is ranked 142nd, way below some of its neighbouring countries like Bhutan and Sri Lanka. Some of the stated objectives of the National Telecom Policy 2012 are: Increase rural tele-density from the current level of around 39 to 70 by the year 2017 and 100 by the year 2020. Provide affordable and reliable broadband-on-demand by the year 2015 and to achieve 175 million broadband connections by the year 2017 and 600 million by the year 2020 at minimum 2 Mbps download speed and making available higher speeds of at least 100 Mbps on demand.

Reposition the mobile phone from a mere communication device to an instrument of empowerment that combines communication with proof of identity, fully secure financial and other transaction capability, multi- lingual services and a whole range of other capabilities that ride on them and transcend the literacy barrier.

The ambition to deliver 2 Mbps download speed to users on mobile BB, with speeds of 100 Mbps or more available on demand, has major implications for both network and spectrum requirements.

Over the past thirty years, Internet connection speeds have steadily increased. Higher speeds have also been driven by the move to higher-resolution displays. On the demand side, the greater use of images and video rather than plain text has also been a driving force. This growth in connection speeds is expected to continue in the foreseeable future. The trend is encapsulated in "Nielsen's law of Internet Bandwidth", an empirical observation which states that a high end user's connection speed grows by 50 per cent per year, or doubles every 21 months.



Application Evolution and Bandwidth Requirement

Improving and maintaining the quality of user experience will likely be on the top of TSPs' agenda over the coming years. The service providers will also need to invest in their networks to support the expected exponential growth in data traffic. Presently, the increase in average bandwidth consumed is relatively slower for following reasons:

- Telecom companies are conservative.
- Non-availability of adequate spectrum to provide higher data speeds.
- Users are reluctant to spend much money on data usage.
- The user base is getting broader.
- Non-availability of relevant content.
- Bharatnet end user applications

As part of the prestigious Bharatnet project there are a variety of applications that are to be provided. Besides them there are few more applications which could form a basis for monetization. The applications can be listed as follows:

- Mobile Backhaul: To be able to sell dark fiber or leased Bandwidth to Mobile Service Providers to increase mobile penetration and provide wider coverage and rollout obligations,
- Fixed BB: To provide fixed Broadband to the end users,
- CATV: To provide Cable TV services over IP or IPTV streams,
- Institutions BoD: To provide Bandwidth on Demand to various Institutions,
- Smart Villages/Safe Villages: As the Smart Cities initiative grows soon the need for Smart Villages with Security and various other application needs would come up.

All these point to the fact that a rich demand for data will keep on growing. A typical Mobile backhaul would need roughly 1Gbps to 10 Gbps in the next 5 years. Current backhaul needs may be limited to 100-300 Mbps but that is stalling the bandwidth demand. This bottleneck will have to be removed paving way for deeper reach of mobile networks. CATV streams would also need upwards of 1Gbps bandwidth to be able to show the plethora of SD+HD Channels that truly give an immersive experience.

All in all a typical backhaul solution would be needed to support in the range of 1Gbps+ traffic.

Long Haul Network Options

Generally, backhaul solutions can largely be categorised into wired (leased lines or copper/fibre) or wireless (point-to-point, point-to-multipoint over high-capacity radio links). Wired is usually an expensive solution but offers practically unlimited bandwidth and ease of maintenance.

Wireless backhaul is easy to deploy, and allows moving points of presence, however, these wireless connections are slower,

occupy spectrum that could be used by user devices (especially as 5.8 GHz devices proliferate), require more service/ maintenance calls (typically three times as many) as wired backhaul, are limited in bandwidth. They are often viewed as an initial or temporary measure.

Wired – Optical Fiber:

Wired backhaul technologies rely on a direct physical connection via Optical Fiber to the repeater node or to the edge nodes. In fibre-optic communications, wavelength-division multiplexing (WDM) is a technology which multiplexes a number of optical carrier signals onto a single optical fibre by using different wavelengths (i.e., colours) of laser light. This technique enables bidirectional communications over one strand of fibre, as well as multiplication of capacity. An Optical Fiber network theoretically has limitless bandwidth and out of so many fibers in an Optical Cable only a few are used leaving others as dark fiber.

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WDM, DWDM and CWDM are based on the same concept of using multiple wavelengths of light on a single fiber, but differ in the spacing of the wavelengths, number of channels, and the ability to amplify the multiplexed signals in the optical space

Nothing has done more to increase the capacity of existing fiber-optic networks than DWDM, which permits multiple data streams to be combined on a single fiber. Technological advancements in these optical technologies are now promising unlimited bandwidth which will help satiate the bandwidth requirements of the masses and the futuristic bandwidth hungry applications. Wired networks in general require certain challenges that need to be addressed and they fall into Right-of-way Costs, deployment costs etc. However with the relatively higher upfront capital investment require in the beginning they practically offer unlimited bandwidth and lower opex costs.

Wireless:

Wireless Backhaul options are also available in the form of refers to technologies that use point-to-point or point-to-multipoint radio or microwave frequencies to transmit signals between hub sites and an end-user receiver. The most common wireless backhaul, operate in the unlicensed wireless (license-exempt) 900MHz (902-928), 2.4GHz, 5.3GHz, 5.4GHz, 5.8GHz, 24GHz, and 60GHz frequencies of the RF spectrum. These radio platforms are exempt from licensing requirements. These systems, although quick to deploy, do not promise exclusive use of the band and are susceptible to potential interference.

Unlicensed wireless backhaul platforms can go distances up to 50+ miles and provide data rates of 10Mbps to 300Mbps aggregate throughput. These systems can be deployed in outdoor wireless backhaul applications such as: point to point wireless, point to multipoint wireless, and wireless mesh configurations. To add capacity to any network, wireless backhaul technology using unlicensed wireless Ethernet bridge radios provides an inherently flexible and scalable alternative to fibre or leased lines. Most systems can be installed in a day or two.

When evaluating wireless backhaul technology, the possibility of radio frequency interference disrupting a wireless network link poses a concern. Radio interference results from unwanted radio frequency (RF) signals disrupting system communications. Typically these signals are at or near the same frequency as the receive frequency of an established wireless system. Interference can degrade a radio system's performance and in some cases even prevent the system from functioning at all. The source of interference is usually other transmitters that are very close in frequency to the impacted system. Interference can affect all types of radio frequencies. With un-licensed systems it can never be guaranteed that a system will operate interference free and with any predictable reliability.

The major difference between licensed wireless and license-exempt systems is that licensed radio users have a regulatory body that will assist them in overcoming any interference issues that may arise, while license-exempt users must resolve interference issues without governmental assistance.

Recently though many point to multipoint wireless systems have taken advantage of the Wi-Fi 802.11n chip sets and can now provide wireless bandwidth up to 300Mbps aggregate throughput or beyond.

There various technologies in this area which may require a Line of Sight, Near Line of Sight or Non Line of Sight path. Compared to other countries, in India, the quantum of spectrum which has been unlicensed is considerably low.

Several concerns have been raised about aesthetics and health issues arising from radiation hazards and the safety of telecom towers, especially in Metro and urban areas. There are also environmental concerns. The use of power generators (to address the lack of un-interrupted power supply) adds to polluting emissions. For all these reasons, civic authorities have imposed stringent conditions on the erection of towers.These include requirements such as advance clearance from Resident Welfare Associations (RWAs) in case of residential areas, structural safety certificate, clearance from pollution control authorities and fire authorities.

At times there are huge delays in the grant of permission. Moreover, there has been a multi-fold increase in the levies for the grant of permission. The Government has recently ordered a study by 16 leading scientific institutions across the country on the effects of electromagnetic fields (EMF), particularly radiating from cell phone towers, on human health.

Comparison of Wired (Optical) and Wireless Backhaul

S.No.	Area	Optical Network	Wireless Backhaul
1	Ease of deployment	Time consuming	Relatively less time consuming
2	Cost of deployment	Costly	Half or less as costly
3	Maintenance	Less	Relatively much more time consuming
4	Spectrum	Not applicable	Works in Unlicensed band hence is prone to interference. Also lesser free band available in India
5	Bandwidth	Practically unlimited bandwidth available	Very limited bandwidth available around 200-300 Mbps
6	Repeater distance	Ranging in 80km-120km (even much longer options available)	Available Bandwidth is a function of distance of the link. As the link size increases available bandwidth decreases. Typical distance could be 18-20km
7	Reliability	Relatively much reliable	Prone to weather conditions
8	Use in critical conditions	Reliability is high hence critical applications require Optical Network	Reliability is low hence critical applications such as telemedicine, emergency may not be suitable to run over them
9	Infra Requirement	Ducting and trenching	Towers to be erected
10	Lifespan	Typical lifespan of 20-30 years	Lifespan only good as long as Bandwidth limits are not breached which could be easily outdone in next 2-3 years
11	Monetization	Possible by selling dark fiber	No avenues
12	WPC Clearance	Not Applicable	Need to have WPC Clearance

Conclusion

After careful consideration and analysing pros and cons of both the options it would be possible to make a fair case of Optical Network deployment to cater to long term needs of broadband penetration.

Wireless even as an alternative for faster rollout may not achieve the desired objective and in a few years' time the network investment would have been lost. On the other hand Optical Network deployment makes a wise decision even though its more time consuming and costly but would be able to address the ever growing bandwidth needs of the masses.