The Budgeteers' Guide to 21st Century TV

A layman's technical companion to TV without cable or satellite

Information and practical how-to projects
that will save you time, money & hassle
and maybe revolutionize
your relationship with your TV

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For the latest news and updates see the books blog at: http://budgeteertv.ironviolin.com/

Preface

This book will be out of date the day you buy it. We have tackled this issue in several ways:

- The book is only published as an eBook.

- Errors, omissions and updates will be regularly revised throughout the year in the current edition. Once you've purchased an annual edition, you can download an updated copy of that edition, whenever needed, throughout that edition's year, at no additional charge.

- As well as monitoring changes in the market, the authors utilize many of the featured approaches and technology in their daily lives, and so are in touch with changes in the market.

- Please email us know if you feel there is something missing, incorrect, or if you have suggestions. If you have had success (or otherwise) with some of the ideas in the book, we'd love to know.

Choice of technologies, methods and products to use.

The authors have purchased all the materials, services and products used in creating this book, and have received no free or discounted products or services from vendors.

There is an increasing number of products and services in this market. Rather than speak in generalities about groups of products, we have tried to be specific with a particular product in each category. This is a more practical and instructive approach, rather than giving vague references about things that "should work" or that look good in theory. This, however, means that there are other solutions similar to those we have chosen that we have not tried— or we have tried, and couldn't get to work. We believe a major role of this book is to present solutions that we have tested and know will work. We will continue to expand the "palette" of solutions as we go forward. What this means is that there are many approaches that have been left out.

Again, we would appreciate your feedback; please let us know if you see something in the book that you've experienced differently—or you'd like us to write about in our next edition.

Who are the authors?

We have worked in the tech industry for over 25 years, from technical (engineering, QA, product marketing, etc.) to operations (marketing communications, sales, PR) to management. We continue to review and follow latest tech trends and we still geek out over new and cool ideas.

In 2008, our satellite subscription jumped from the "introductory rate of $29.99" to over $150 a month. We just couldn't justify the cost of TV. We did a serious amount of research and came up with a solution: a $300 e-machines computer (we named her Emmie) running Windows 7 Media Center, a Hauppauge USB dongle for broadcast TV, a small antenna in the attic, and a streaming subscription to Acorn.tv. After this initial investment had paid for itself within a matter of months, we just kept exploring…and finding new and better ways to take control of our TV and the costs associated with watching the content we wanted.

Getting ready

Before proceeding...

- The politics of change are very active here. Unless **everyone** in your household is okay with change, it will fail. Somehow things will come apart...it's just the way it is.

- Don't dump what is working now until you know it can be, or has been, successfully replaced.

- Due to broadcasting standards and the nuances of the TV market, this book is country-specific the United States.

- Technology can be very scary, but it is also a fundamental platform upon which we conduct our daily lives. To confront, explore and change how we use technology — TV or otherwise — gives us control and removes (or reduces) the fear. This book tries to act a guide and partner for all but the truly technophobic.

What skills do you need?

There are many setups and useful projects in this book that can be completed by people with basic levels of technical ability. It's worth trying: that's how most of us learn. What is hard for one person is not for another, and not every person is "technical" in the same way.

Most setups will involve activities like installing apps and being comfortable working with a computer. Many setups require a some basic understanding of in-home data & computer networks. Installing a TV antenna, if required, involves working with cables and optionally using hardware like screws, drills and wire clips.

Some projects take longer to complete, are more intricate, cost more, or rely more deeply on particular technical skills. We have tried to show this by ranking the projects.

Finally, we are talking about home entertainment here, so nothing should be taken too

seriously. If something breaks — and it may, part of the journey is fixing things and becoming more knowledgeable for it: give yourself time and breathing room, ask a friend or family member for help, and try to have some fun. *In one way or another, we are all new at this.*

Choosing how to proceed.

Before plunging into the technology, its often best to start by asking yourself some questions. A good starting point is ask yourself what you want to watch, followed by where to get it, which also considers your budget and viewing habits — and then choosing the most suitable technology. We have created a small web app to help you get started with this process, and an overview of what the app does is below.

What do you want to watch?

List the shows (not channels) you frequently watch or want to watch. Think about where you may be able to get them from. There may be more than one source for those shows. We look at these options in more detail in our Getting Content chapter. An overview of some of the types of TV content available includes:

- Broadcast-to-air (we will often refer to it as BTA) TV.
- Free stuff from the internet like YouTube, CBS News, Sky News, Pluto.tv and many others.
- Paid a-la-carte sources like Netflix, Hulu, Apple iTunes, Amazon Prime, etc.
- Cable & satellite TV live streaming services like SlingTV, DirecTV Now, Hulu Live, etc.
- Stored content like DVDs and Blu-ray optical disks.

Using a combination of some of these sources and customizing them to meet your budget and needs is usually the best answer, and is mostly what this book is about.

How do you want to watch? After deciding what you want to watch, you can take a look at the best ways to watch it. Here are some example questions to consider that you will also find in the web app:

- Question 1: Do you want, and can you get broadcast-to-air TV (BTA TV) ? This often depends on where you are. See here to find out how to get BTA TV and what channels

are available at your place. If you are not sure what BTA TV is, see here.

- Question 2: Do you want to record BTA TV? If you only watch live broadcast TV there is no need for a digital video recorder or DVR. If you are not sure what a DVR is, see here.

- Question 3: Is it all about the big screen in the living room? If all your TV viewing is on a single big screen, then you you can connect streaming gadgets, tuners and antennas directly to that TV. To share TV viewing among multiple screens and devices you can connect TV tuners and DVRs to your home's network.

What about the technology? After considering what you want to watch, followed by how you want to get it, you can start to think about specific gear. Reading the introductions chapter should give a good overview and a chance to think about which technologies you may be comfortable using.

Chapter 1: Introductions

An introduction to some of the technology, vendors and methods used for getting TV without cable or satellite.

1.1 Specs and stuff

Resolution and screen size

The resolution of a screen refers to the raw number of points or pixels that can be displayed on the screen. Resolution gives us the screen size in pixels counted diagonally across the screen. Pixels and the space between them can vary in physical size so the number of pixels doesn't give us the actual physical size of the screen in inches or centimeters.

Since the introduction of digital TV, most screens have an aspect ratio of 16 wide to 9 high. In other words, the ratio of the width divided by the height is always 16 by 9. This is true if you measure the screen in pixels or in inches. This way no matter how big or small the screen is, if it has the 16 to 9 aspect ratio, the image will not look squashed or stretched.

- A 1080 HD screen resolution is 1920 pixels wide by 1080 pixels high.
- 4K Ultra HD is 3840 pixels wide by 2160 pixels high.
- 8K Ultra HD is 7680 by 4320.

Bandwidth — bits per second and stuff

Just to be really confusing, a network connection has several characteristics that define its overall "speed." Firstly there is bandwidth — how much data (usually in MegaBits) we can fit down a connection over a period of time, usually a second. Hence bandwidth is measured in Mega (one million) Bits per second or MBps.

Not all the information we push into a connection actually arrives — the amount of useful data that actually arrives at the other end is called throughput (also measured in MBps). Throughput is a measure of the amount of data that can be used, and is a consequence of the processing speeds at each end of our connection, the raw bandwidth and quality of the connection. An unreliable, "noisy" or error prone connection — for example, a weak WiFi connection — can have a high raw bandwidth, but a low throughput.

There is also latency — how long information takes to move along a network connection (measured in fractions of seconds). A very busy network router for example, can have high latency, which can delay our data arriving. Some satellite links have issues with latency due to the long trip the signal has to make, which for TV viewing we (mostly) don't notice, but we can on a phone call.
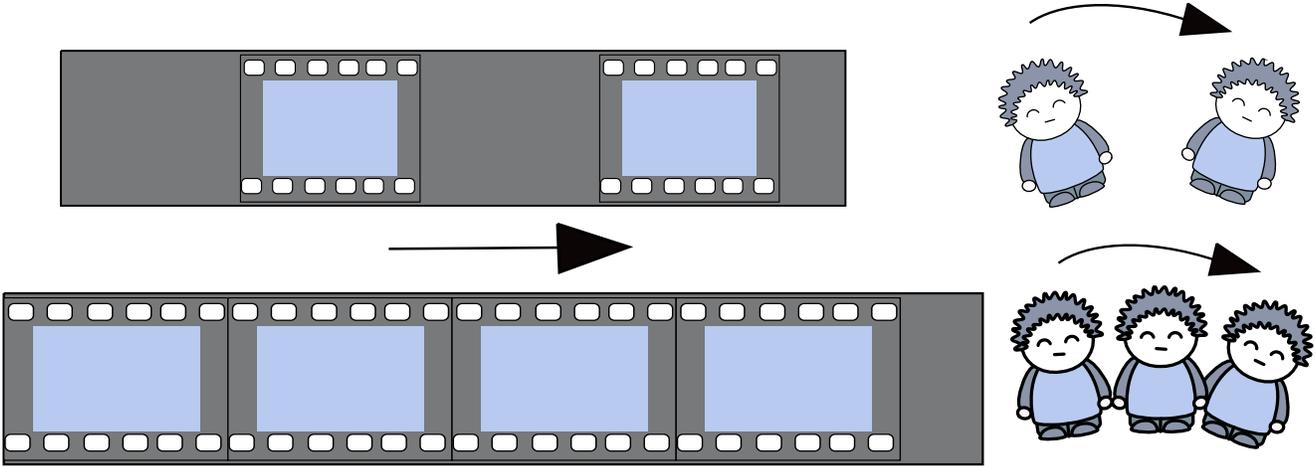
More bandwidth generally will improve the visual quality of movie streaming, or at least match the quality of the original before it was streamed. If the original movie has low visual quality (or is just a bad movie) no amount of extra network bandwidth can fix that. Gigli will still be Gigli.

We look at the effects of bandwidth and network quality on media streaming in our networks section.

Closed Captions

Closed captions are carried in digital BTA TV transmissions and most programs include them. Likewise, all of the TV apps and devices we have used in this book can display them. Most apps and players from the major streaming services, including Netflix, YouTube, Hulu and others have the ability to display closed captions — but not all their streamed content includes them.


Broadcast to air TV from a HDHomeRun TV tuner with closed captions turned on.

1.2 Digitally Broadcast-to-air TV

Introduction to Antenna TV

The ancestors of modern humans BC (before cable) used to watch analog TV using antennas, sometimes attached to their house, sometimes precariously sitting on top of the non-flat TV, or sometimes being held aloft by a swaying person trying to improve reception. It was a clumsy system, picture quality was relatively poor, there were fewer channels, and it was more subject to the weather. But it was **free** to use for anyone with a TV and an antenna (or metal coat hanger).

Analog TV signal adjustment using a child mounted rooftop bunny ears or coat-hanger antenna
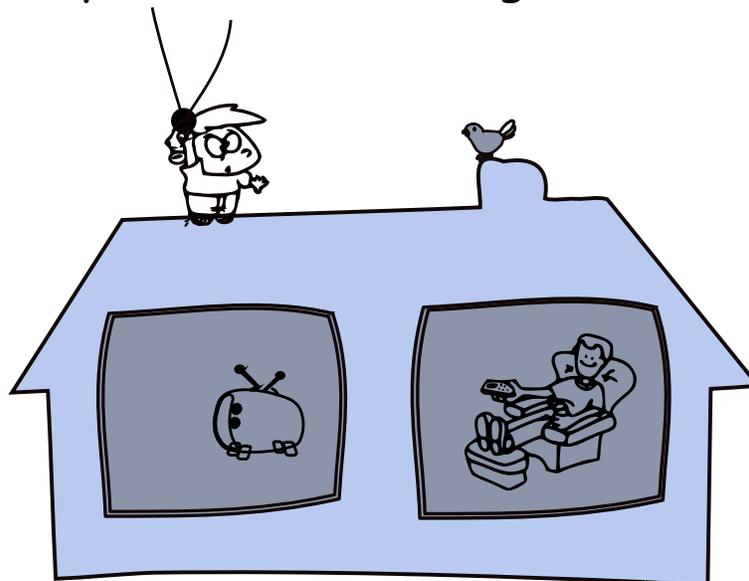
Today, many people in the US watch TV delivered to their homes using pay-to-use cable or satellite systems. The kicker is that many of the most popular shows we pay to receive are also available on the free — now digital — broadcast system. Many TV shows are literally beaming into our homes for free, while we pay to get them. These broadcast TV signals — depending on your location — probably include the local affiliates of the major US networks (NBC, ABC, CBS, PBS, etc.), along with foreign language channels and some minor networks. This freely available, completely legit to use, programming includes local news, national news, major shows, major sports, local sports, re-runs, local emergency broadcasts, children's programs, soaps and reality shows.

Here is another kicker: digital broadcast to air (BTA), also called over the air (OTA) TV can deliver better picture quality than cable or satellite – sometimes noticeably better. Why? Compression. To conserve bandwidth, cable and satellite providers compress their signals — sometimes a whole lot. Compression means that some data or image detail is discarded. The more the TV data is compressed, the more image detail or clarity is lost. With BTA TV the bandwidth is sufficient that little or no compression is required.

Additionally, digital TV broadcasts AD (after data) are less prone to environment and weather influences than the analog system, resulting in more reliable viewing.

The Advanced Television Systems Committee or ATSC, is the body that formulates the standards used for to digital over-the-air TV broadcasts used in the United States. The new ATSC 3.0 standards suite, which include around 20 individual technical standards, allows for the transmission of HDR (high dynamic range), 4K resolution TV signals and other information. The ATSC 3.0 standard has been formally adopted and TV broadcasters are already experimenting with transmissions. It is very possible the first practical, widespread delivery of 4K resolution TV to homes may be using ATSC 3.0 broadcasts.
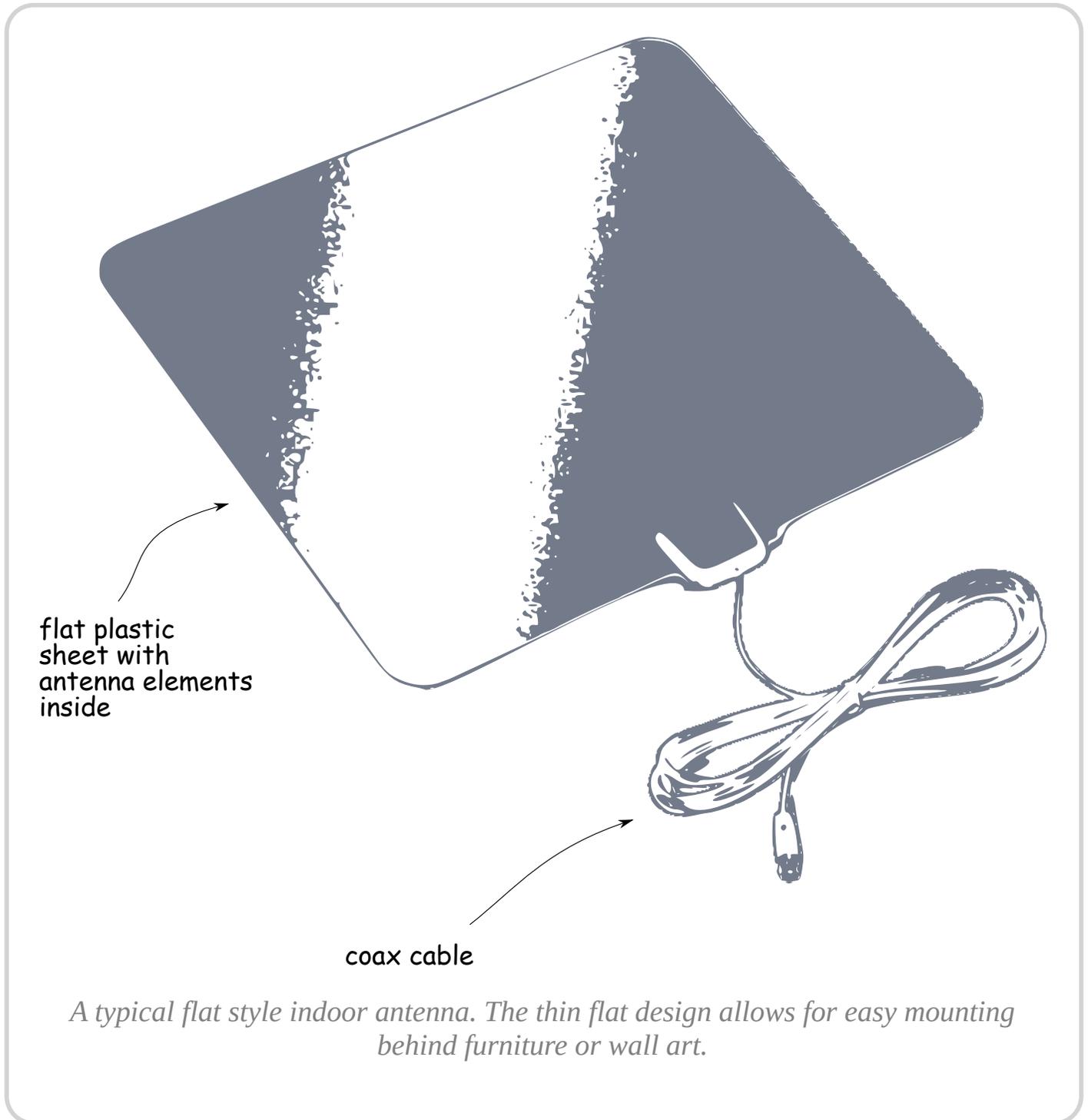
What is an antenna?

An antenna is "passive," in it has no active or powered electronic components. By design an antenna is more sensitive to a particular range of frequencies, for example, those used by TV transmitters.

There are many many different types of antennae. Here we will focus on TV antennas only. Even within this category there are many variations; here is an overview of some the terms and types:

- **Directional**: is very sensitive to signals coming from a particular direction. You can point it at a target; for example, a remote hill with a cluster of TV transmitters on top.

- **Multi-directional or omni-directional**: will pick up transmissions coming in from most directions, but with less range than a directional antenna.

- **Indoor**: made from materials suitable for indoor use. They are made (in theory) to be more attractive or easily hidden in the home. Indoor antennas are often omi-directional.

- **Outdoor**: can stand the outside elements and usually require mounting equipment to be attached to buildings. As they can be larger and mounted in higher or in less obstructed locations, they can sometimes give better results than an indoor antenna. Some have both omni-directional and directional elements.

- **Digital TV Antenna**: designed for use with modern digital TV transmissions. Analog TV antennas (and metal coat hangers) do not always work well with digital TV signals.

- **Coax**: refers to the round thick wires with the screw-on style connector and a central (coaxial) pin used for antenna connections. We give some tips for working with coax later.

- **UHF and VHF**: Most TV transmitters in the US now broadcast in UHF frequencies, with a smaller number utilizing higher VHF frequencies. Most modern digital TV antennas will pick up UHF and VHF transmissions. A very small number of broadcasters use lower VHF frequencies, which many antennas do not pick-up.

- **Signal amplifier**: an electronic amplifier — usually connected with coax cables — that amplifies signals coming off the antenna. They are useful when our TV signals are weak. Because of the electronics, they require a power connection as well.

We talk a lot more about setting up and using antennas in the antenna section.

flat plastic
sheet with
antenna elements
inside

coax cable

A typical flat style indoor antenna. The thin flat design allows for easy mounting behind furniture or wall art.

Introduction to TV tuners

What is a TV tuner?

Traditionally, a TV tuner is an internal component within the TV that receives the signals from the antenna by coax cable, amplifies them, and decodes them into something that can be displayed on our screen. When we connect an external device, like a cable box to our TV — typically using a HDMI cable — we bypass the TV's internal tuner. For this reason, many of us no longer use the tuner component of our TVs.

In this section, we look at tuners as standalone devices that can optionally exist outside our TV. This includes tuners that can connect to a computer by a USB connection, install internally into a computer, or tuners that can connect to our home's network.

USB attached tuners can be used to watch TV on a computer. They are portable, which can be handy if you are on the move with a laptop and a portable antenna.

Products in the category include:

- Hauppauge's USB products: work with Windows computers and laptops.
- AirTV adapter: sold as an optional add-on to the AirTV Player.
- Tablo Tuner: a USB tuner for use with the NVIDIA Shield.

Networked TV tuners

Here we focus on tuners (and their associated antennas) that are connected to the home's network. Because they connect to the network, versus being directly connected to the TV, they can share BTA TV with all the viewing devices (computers, Smart TVs tablets and phones) that are connected to the network. We have characterized this kind of device as a "networked tuner" and we look at them in more detail later.

Products in this category include:

- [Silicon Dust's HDHomeRun](#)

- [Hauppauge's Broadway](#) and [CordCutter TV](#)

- [Eye TV](#)

- [Mohu's AirWave](#) — a networked tuner combined with a small indoor antenna.

There are several basic components within a networked tuner:

- The coax connection to the antenna (or signal amplifier if you have one).

- One or more TV tuners. More than one tuner allows us to, for example, watch TV on one channel while recording on another, or allows multiple devices on our network to watch different channels or record TV at the same time.

- A network connection, usually an wired Ethernet cable connection to our network router.

Using Networked Tuners with Multiple TVs and devices

Networked tuners free the TV antenna from direct connection to the TV. With these tuners, BTA TV is no longer restricted to the TV, but can be accessed from many devices in the network. Multiple devices in the home including Smart TVs, tablets, phones and DVRs can watch or record broadcast TV from a single antenna. A [networked DVR](#), which we cover later, has the same effect.

A networked tuner turns BTA TV into streaming media that can be viewed by devices and TVs in the network.
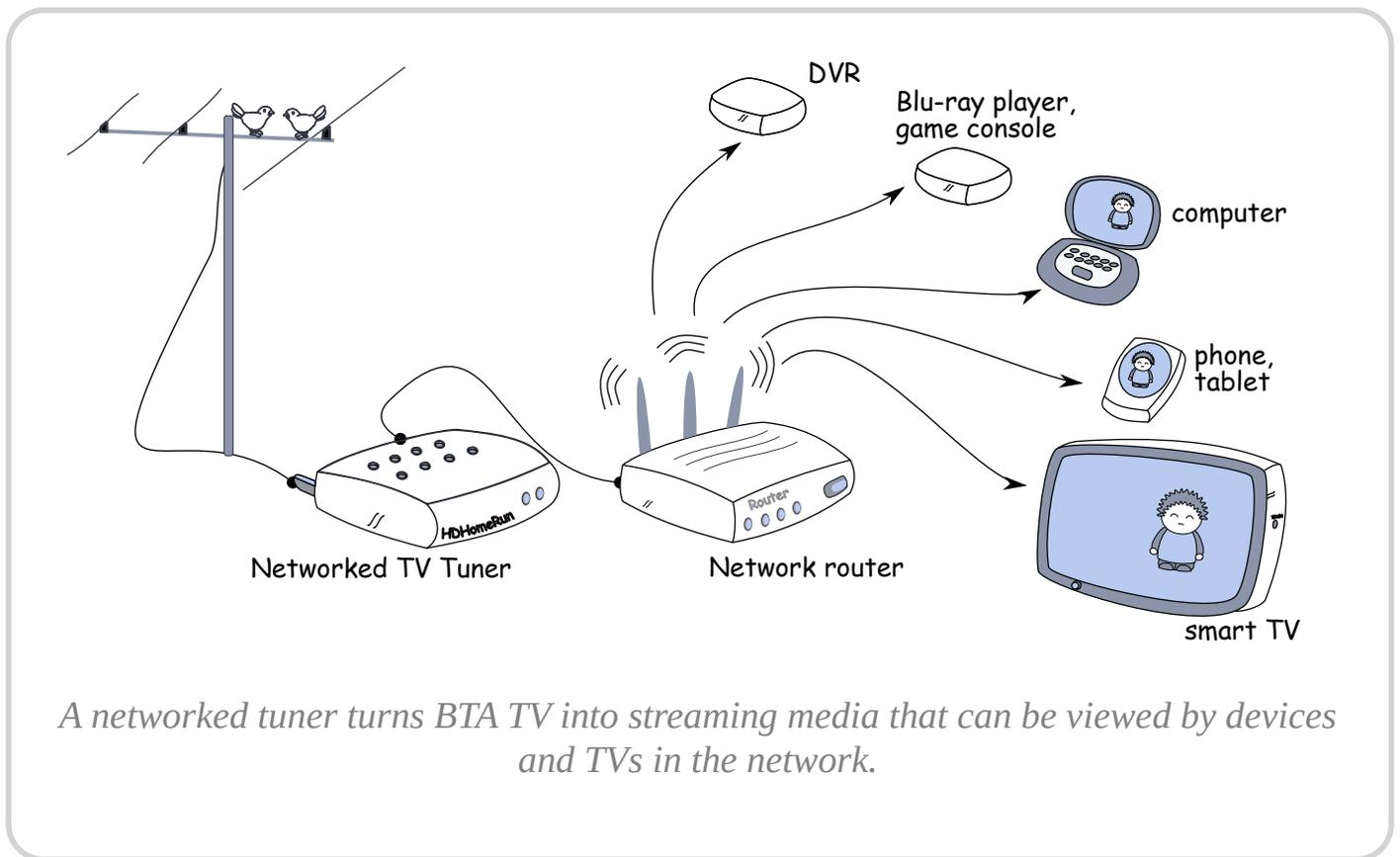
Do you need an networked tuner?

A TV tuner and antenna that connects to your network can be handy in some situations, including:

- You want to share access to the antenna between several devices: for example, a DVR, Smart TV, and mobile devices.

- You want to place the antenna in a location that cannot be reached by a coax cable, but is in range of your network.

- It can be easier to conceal the antenna and its wires.

- There are some rare situations where you may need more that one antenna. This can be done using multiple networked tuners and antennas.
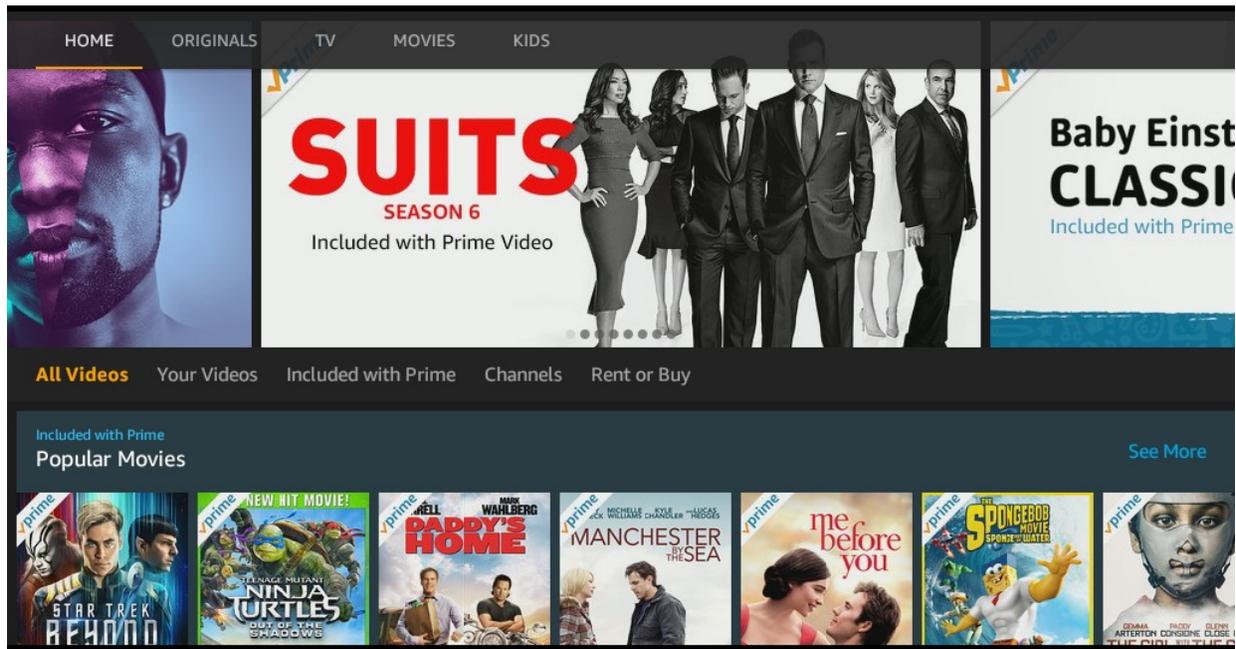
1.3 Smart TVs

Introduction to Smart TVs.

TVs are changing. Manufacturers are embedding more computing power, and even full computer operating systems (OS) into TVs. A big advantage of making a TV "smart" is that you do not need an external, additional gadget to connect the TV to the network for streaming. All your content can be accessed from within a single set of apps or menus, using a single remote control, and without switching the TV's inputs. Smart TVs generally have connections for a digital TV antenna, HDMI inputs, Display Port (sometimes) and network connections.

Some TV operating systems can be enhanced and customized by the addition of apps from an app store, much like a phone or tablet.

TVs as we know them are becoming so dependent on internet content and external devices that some "TVs" coming onto the market have no broadcast-to-air tuner. Technically (and probably legally), these products cannot be called a TV, and are referred to a displays.

A downside of putting smarts into the TV is that TV operating systems software — just like a computer's — needs updating every so often. Like other devices, the frequency of these updates can depend on the TV's manufacturer who does not always have the strongest incentive to keep the software updated. It's possible that our Smart TV can go beyond its "use by" date long before the TV's hardware has worn out.

Amazon Fire Smart TVs run Amazon's Fire OS which is used to control the TV, add new apps and change settings.

We look at Smart TVs in more detail later.

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