Calix

WHITE PAPER

Two Boxes or One? The best route for cable operators deploying managed Wi-Fi systems

How can this trend improve the customer's experience without harming the operator's bottom line? Or can it actually increase the operator's bottom line?

INTRODUCTION

Home Internet, once used just for web sites and e-mail, is now a necessity for everything from streaming TV to home security. While bandwidth upgrades have made this possible, the need to serve many devices and applications has increasingly put cable operators in the same position as other wireline and fixed wireless operators: Offering a managed Wi-Fi solution for their customers. The router (sometimes referred to as a 'gateway' or a 'system') and additional Wi-Fi access points (when needed) were formerly the exclusive realm of the customer, typically purchased online or at a big box retailer. Today, these components are increasingly delivered and managed by the broadband service provider as part of a whole home managed Wi-Fi solution. How can this trend improve the customer's experience without harming the operator's bottom line? Or can it actually increase the operator's bottom line?

MANAGED WI-FI

Managed Wi-Fi is a solution delivered by the broadband provider that includes a fixed broadband service and Wi-Fi, via a Wi-Fi System. For the purpose of this whitepaper, a "Wi-Fi system" includes gateways, routers, or any in-home access points/satellites required to deliver a whole home Wi-Fi experience for the subscriber. Wireline and fixed wireless service providers have increasingly turned to managed Wi-Fi systems to provide a better experience for their customers, and for their own company's benefits.

There are many reasons why this is the case. The vast majority of broadband-related trouble calls initiated by subscribers are attributable to the home Wi-Fi, not the operator's broadband service. Subscribers overwhelmingly view their home broadband and their home Wi-Fi as one and the same; from the provider perspective, it makes sense to control and manage the entire service to ensure the subscriber's positive perception of the broadband service, and by extension, the broadband service provider.

Providing a managed Wi-Fi service enables the operator to ensure the subscriber is leveraging the latest technology (currently Wi-Fi 6, and soon to be Wi-Fi 6E), and placement of the Wi-Fi system component(s) within the household to ensure maximum coverage.

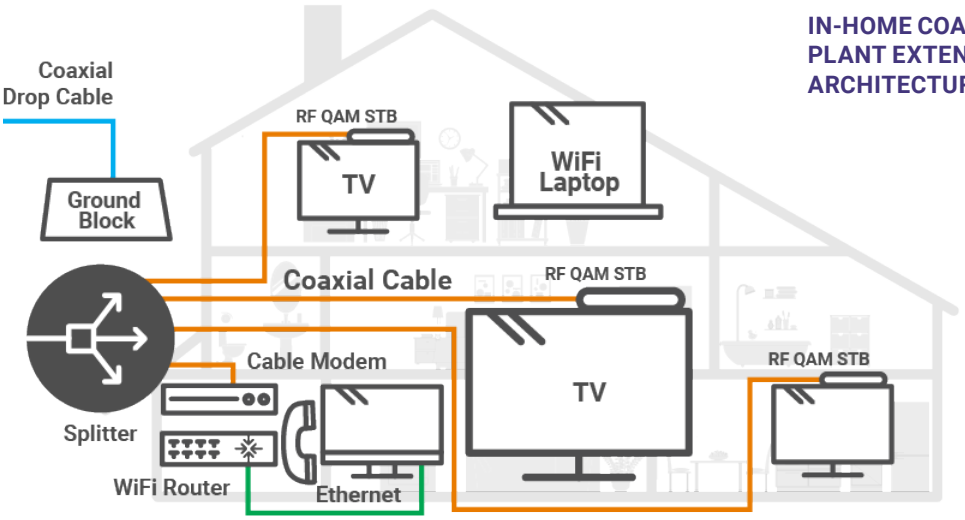
Leveraging cloud-based data & analytics packages integrated into the Wi-Fi system solution, operators are given a window into the customer's network, behavior, and experience. They are then equipped to efficiently provide enhanced customer service and present new offerings tailored to the subscriber.

When offering managed Wi-Fi, the operator is faced with a system deployment choice: Should the gateway functionality be integrated within the operator's hardware used to provide the service (i.e., inside the cable modem or ONT), or provided as a separate stand-alone device?

Let's take a look at both approaches. Another way of thinking about one box vs two box is to consider the architectural evolution that has occurred with many cable operators. Cable started with a plant-extension approach which in recent years has for many operators evolved to a gateway-based architecture.

PLANT EXTENSION ARCHITECTURE AND EVOLUTION TO GATEWAY ARCHITECTURE

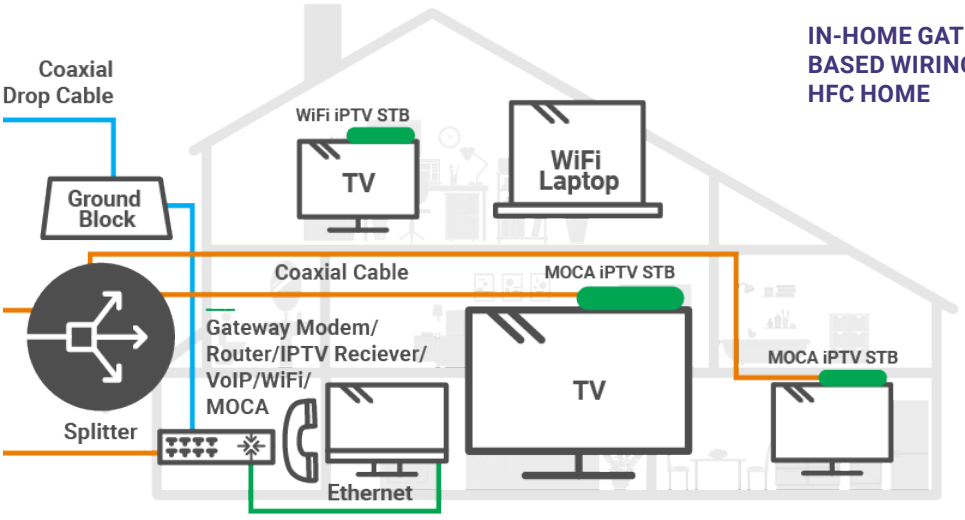
What is a gateway-based architecture? This is where all devices in the home are fed from a single device under control of the service provider. This stands in contrast to a plant-extension architecture where the operator's signals are directly provided to multiple devices in the home.



IN-HOME COAXIAL PLANT EXTENSION ARCHITECTURE

The plant-extension architecture is the one most familiar to cable operators. The operator's RF signals are delivered to the home via a coaxial cable drop. Signals are split to a collection of coaxial cables connecting each customer device. If the customer device is a computer, or a router used to connect multiple customer devices, the operator installs a cable modem. If the device is a television, the operator installs a set-top box (STB). The cable modems and STBs are on the operator's network and can be managed. However, the devices behind the customer's router are invisible to the operator. In more unusual situations (1-2% of subs), a single home might even have multiple cable modems.

A gateway-based architecture is different. The operator's RF or optical service arrives at the gateway and is terminated there. The gateway device feeds all of the customer devices, whether they are routers (in a situation where the gateway is put into bridge mode), computers, or set-top boxes. Put another way, the CPE has two purposes: one, to terminate the WAN connection from the access network and two, to provide in-home distribution of communication services via a LAN.

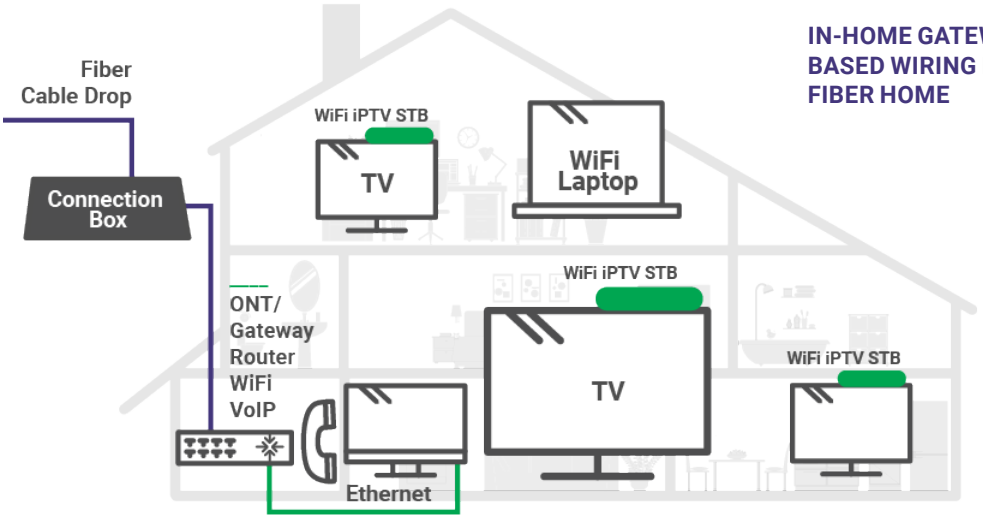


IN-HOME GATEWAY-BASED WIRING FOR HFC HOME

Wiring within the home could continue to be coaxial cable (using MOCA), or it could be Ethernet CAT-5 or CAT-6 twisted pairs. Other options include powerline or G.HN, or even no wires at all using Wi-Fi. This approach has been widely deployed by fiber-based broadband service providers. Wi-Fi is now the dominant approach to providing LAN connectivity within the home.

As video content continues to migrate away from RF to streaming, cable operators are increasingly choosing to use a gateway architecture, and adopting set-top boxes based on IPTV. Low-cost "mini" boxes are attached to each television and receive their signals from a gateway box installed in the home. The gateway may have built-in set-top television equipment (known as a "headed" gateway), or not (known as a "headless" gateway).

While a gateway-based architecture is a more recent approach with traditional HFC networks, it is very familiar to operators of fiber-based networks.



IN-HOME GATEWAY-BASED WIRING FOR FIBER HOME

In a fiber home, the ONT terminates the outside plant optical signals, and from its associated router generates in-home signals for distribution via Wi-Fi, Ethernet, MOCA, or G.HN.

For all of these solutions, the router is the key equipment for communicating with in-home devices.

INTRODUCTION OF ROUTERS AND ACCESS POINTS

When cable modem service was first introduced, operators connected service to a single computer. It did not take long for customers to add home routers to their service which enabled multiple computers to share a single connection. They really took off when Wi-Fi Access Points became integrated into the routers.

Customers purchase all sorts of routers; some good, some bad. They used Wi-Fi throughout homes with the access point located in sub-optimal locations with varying results. They had to learn about "port forwarding" to make some of their devices or applications work, and manage changing router software when updates became available. Failure to stay on top of any of these things could result in poor service and perhaps placement of blame on the service provider.
Operators started including routers with their service, helping the subscriber feed their many devices. It did not take long for operators to realize that while this provided a convenience for the end user, it also made the operator at least somewhat responsible for service to subscriber devices that the operator could not see.

How would operators help their customers navigate these issues? They needed to manage the routers and Wi-Fi access points.

MANAGED ROUTERS AND ACCESS POINTS

Operator-managed routers and access points first became available from vendors as integrated units – built-in to the cable modem or ONT. While these early units did allow the operator to manage the basic functions of the router (such as password resets and Wi-Fi channel assignments), they were lacking tools to help manage the subscriber network.

Let's look at what we really want in a managed router/access point:

MANAGED ROUTER MANAGEMENT FUNCTIONS

BASIC MANAGEMENT FUNCTIONS	
Router Health Check	Is provider's equipment working properly?
Password Resets	Change password upon customer request
Firmware Updates	Revise router firmware
ADVANCED MANAGEMENT FUNCTIONS	
CPE Health Check	Is customer's equipment connected properly?
In-home Wi-Fi Range Mapping	Identify coverage problems
Wi-Fi Spectrum Management	Pick the best RF channel(s) and identify
Remote Access Point Management	Control other A/Ps within the home
ADVANCED FEATURE FUNCTIONS	
Application Prioritization	Put latency-sensitive applications ahead of others
Parental Control	Restrict devices, applications, sites
Firewall	Block malware, intrusions
Usage Monitor	Measure bytes/time, possibly by application or device
Speed Test	Measure connection speed, latency

The basic functions are, well, basic. The operator must make sure that the cable modem or ONT is working properly, and that the router and Wi-Fi access point are as well. They must be able to reset the device password when the customer forgets it, and push new firmware to the device. Simply by accomplishing these tasks, the subscriber is relieved of a few of the most onerous responsibilities they had when managing their own routers and access points.

With advanced management functions, both the operator and the subscriber see substantial improvement over the old way.

CPE HEALTH CHECK

When a customer reports that one of their devices is not working properly, for the operator to help they should be able to identify if that device is being "seen" by the router. Tools available in a modern managed router make it possible for the operator to identify the customer's devices that are connected. If connected via Wi-Fi, the operator and the customer can examine the quality of the wireless connection.

WI-FI RANGE MAPPING

Many new managed routers take the measurement of quality by device a step further, and with the end user's help in identifying rooms, can produce a quality of connection map. When devices in one or more locations are sub-par, the system can recommend placement of supplemental access points.

WI-FI SPECTRUM MANAGEMENT

The managed router can record which channels the Wi-Fi network is operating on, and can identify channels that might be better suited to that operation. It can record the capabilities of the subscriber devices on the network and adjust accordingly.

REMOTE ACCESS POINT MANAGEMENT

When the managed router also supplies and manages remote access points, it can make the home network operate as one "smart" network, by both steering devices to the best access point and managing spectrum in the most efficient manner.

New features can also be part of the managed Wi-Fi System. These can include firewalls, parental control features, application prioritization, and more. Leading edge managed Wi-Fi platforms offer a modular approach, where applications reside on software 'dropped into' the Wi-Fi system. This is a more efficient approach for the cable operator vs having new features embedded into the equipment, as it reduces truck rolls required to swap out systems, and increases the velocity with which the operator can launch new services. New features and applications are creating new sources of revenue for cable operators.

More choices in router management are available to operators than ever before. In addition to choosing a product from the router or access device vendor, they can opt for a multi-vendor provider or an integrated multi-device provider. These choices give a service provider considerable flexibility, and even enables management of devices purchased by their customers.

TWO BOXES VERSUS ONE

Once an operator has decided that they would like to provide routers to their customers, they need to decide if that router should be part of the access device or apart from it. For a cable operator, should the router be inside the Cable Modem or RF Gateway? A fiber operator would consider whether the router would be built-in to the ONT. Alternatively, the option would be to separate the access device from the system managing the Wi-Fi service.

Let's first look at why an operator might choose a single-box solution:

INVENTORY

If the router and access point are built-in to the gateway device, the operator has fewer parts to inventory in their trucks and warehouses. When a device fails, whether caused

by a router or cable modem/ONT failure, the same box must be replaced. In a self-service environment, this is simpler for the customer.

INTEGRATION

There are no integration issues when the router and modem/ONT are in the same box, and there is no possible failure in the cable connecting the two, because no such cable exists.

If the operator chooses a managed router/access point solution from their gateway vendor, they can usually manage both from a single software platform. If anything goes awry with the gateway, router, or access point, the operator has a single vendor to hold accountable.

Why might two boxes be preferred? From a 'best of breed' standpoint, the operator would be able to select a gateway that works best with their access system (CMTS or OLT) and separately evaluate the best router for their customers' needs.

A consideration is the upgrade cycle of the equipment.

STANDARDS SHIFTS

Access equipment, such as ONTs and cable modems, generally have a longer useful life than access points when considering current state-of-the-art. DOCSIS 3.0 was around for many years before DOCSIS 3.1 became available. DOCSIS 4 is on the horizon, though not commercially available yet. On the optical side, GPON gear has been unchanged for over ten years, while XGS PON is being widely deployed and generally expected to not require replacement for 7 to 10 years after install.

In the Wi-Fi world, we have seen 802.11g and 802.11ac reign for a long while and in many devices, but the proliferation of new standards and enhancements has accelerated in recent years. Wi-Fi protocols are emerging every 36-48 months. The Wi-Fi lifecycle is much shorter than the access equipment lifecycle.

IN-HOME WI-FI STANDARDS HIGHLIGHTS

STANDARD	YEAR	DESCRIPTION
802.11a	1999	5 GHz
802.11g	2003	2.4 GHz
802.11n	2007	MIMO
802.11ac	2013	"Wi-Fi 5" Multi-User MIMO, Wider channels, Higher modulation order
802.11ad	2016	60 GHz
802.11ax	2020	"Wi-Fi 6" Beam forming, OFDMA
802.11ax	2021	"Wi-Fi 6E" High Efficiency 6Hz

Each standard change brought better performance. What would happen when customers desired a router upgrade? With one-box, the operator would not only have to replace the router, but also would have to replace their access equipment at the same time, not realizing the full value of the investment. The ability to separate replacement operations is a major advantage of the two-box solution.
This advantage was articulated by service provider executives we recently interviewed. One executive noted that his experience with a particular vendor "revealed the flaw of a single-box solution. Wi-Fi specs change rapidly while those for a basic modem do not."

The preference for a two-box solution, particularly in the PON world, was voiced by others. For example, another executive did not like embedded Wi-Fi on PON tech — requiring reliance on an element managing system. "There's a risk the modem getting hot and interfering with the Wi-Fi chip set."

The unaligned technology shifts can directly relate to the total cost of ownership of the solution. In a two-box solution, the functionality of the ONT can be simplified, with the intelligence provided in the Wi-Fi system (router and remote gateway). This allows the cost of each separate component to be lower and, in most cases, this will save the service provider money in the long term.

With a one-box approach, a truck roll is required each time either the access or router/Wi-Fi technology is changed. With the two-box approach, truck rolls are only required when the Wi-Fi system is replaced. Given that operational expenses associated with truck rolls have remained fairly static over time, while equipment costs have decreased, many operators have pivoted from laser-like focus on equipment capex to analyzing ways to reduce ongoing operational expenses. Reducing truck roll costs is a primary driver in lowering total cost of ownership (TCO).

VENDOR VARIETY

Another advantage is to separate the vendor choice between the access device and the managed router and access point device. The operator is free to select whichever vendor they deem to be best for each purpose, and broaden their choices for management software. Several service providers we interviewed voiced the preference for vendor partnerships bringing together the best in hardware with the best in software.

Working across vendors to optimize the solution is expected to evolve further with Wi-Fi 6. According to an executive at a larger cableco, "By decoupling, you can put better software in boxes and not rely on the less desirable all-in-one offerings." In anticipation of another major benefit, one operator stated that "with Wi-Fi 6, we can improve the customer experience even more."

PHYSICAL PLACEMENT OF EQUIPMENT

In an increasingly fiber-fed environment, it's more cost effective for the operator to install the ONT either outside the home (if the ONT is temperature hardened) or just inside the house (like in a garage, closet or basement). This model is widely adopted by FTTH providers.
However, if the ONT and Wi-Fi system are integrated (one box), this can result in a degraded quality of broadband service for the subscriber. Consumer devices inside the home might be out of reach of the integrated ONT/Wi-Fi system. To alleviate these issues, operators typically provide satellites or extenders that enable a 'whole home' Wi-Fi experience. Without knowing the exact layout of all of the subscribers' residences, the operator may end up with higher capex than forecasted as they provide additional elements to give the home user the whole home broadband service that is expected.
In the two-box scenario, that WAN and LAN are decoupled, therefore the ONT placement does not dictate the location of the Wi-Fi system. The ONT can be installed outside the home or just inside the house, then connected to the Wi-Fi system (typically via Ethernet cable, which is much less expensive to deploy than fiber). The Wi-Fi system can then be placed in a more central location inside the home to optimize Wi-Fi coverage. This placement can significantly reduce the need for additional satellites in the house.

CONCLUSION

As network operators increasingly focus on being broadband-first providers, they are focusing on providing a high-quality managed Wi-Fi service within the home. Operators may have historical preferences for plant-extension or gateway-based architectures. But as they look to broaden their scope of coverage to include the entire in-home broadband service, they'll need to consider the pros and cons of a one-box vs a two-box deployment scenario.

Both solutions can enable operators to provide enhanced service quality to their subscribers. Operators should work with solution vendors that accommodate both approaches, and have strong proficiency in both access infrastructure solution and managed Wi-Fi solutions.
Those vendors are best positioned to work with operators to identify the optimal solution for the operator based on their specific requirements and considerations.