METHOD TO SUPPORT MULTI-SERVICE, MULTI-DATALINK BOX

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Multi-service, multi-datalink access box

An aggregation method is provided for multiple disparate access network data communications systems collocated in a shared enclosure. These multiple disparate access network data communications systems have traditionally used different protocols for communications and this method proposes a common network system so these disparate technologies can be operated in a common fashion.

By following this methodology, different access network functions such as wireless, Digital Subscriber Lines (DSL), Ethernet-to-the-Home, Fiber-to-the-Home, or fiber Passive Optical Networks (PONs) can be included in a single enclosure and greatly simply technology rollout.

Service Providers (SPs) are pushing fiber deeper into the network to bring more capacity closer to customers. Examples include, but are not limited to, DOCSIS Distributed CMTS Architecture and 5G small cells. Similar work has been done with Digital Subscriber Line (DSL) by moving the DSLAM closer to customers and with Passive Optical Network (PON) where less expensive optics are possible if the Optical Line Termination (OLT) is closer to the subscriber. Each of these systems operates on a different physical medium including, but not limited to, coaxial cable, fiber optical cable, twisted pair cable and air.

These communications systems developed separate from each other in terms of network architecture, including developing their own specific means for backhauling traffic and operating the systems. Whether a cable operator backhauling to their headend, a telephone company backhauling to their Central Office, or a mobile network operator (MNO) backhauling to their Mobile Switching Center (MSC), various solutions are in use across the industry.

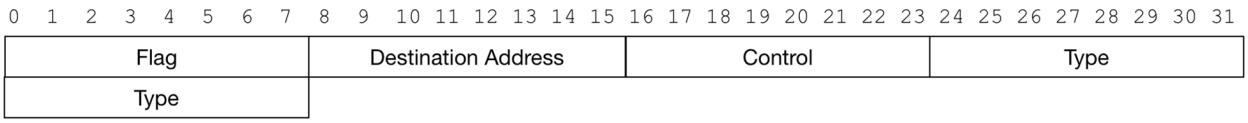
While a given Internet Service Providers (ISPs) started with one type of access communication system, now through the course of business find themselves owning and operating multiple types of communications systems. As an sISP operate more and more of these different types of networks with different backhaul methods, their operations will become cumbersome because the backhaul methods are dissimilar.

For example, traditionally Long Term Evolution (LTE) has been backhauled using framing described in the Common Public Radio Interface (CPRI).

Pkt_length		Sequence	Pkt_Type
Reserve	Basicframe_cnt	Hyperframe_ Sqe	Basicframe_ Sqe
reserve(6BYTE)			
Q	I		Sop
….			
….			
….			
Q	I		Eop

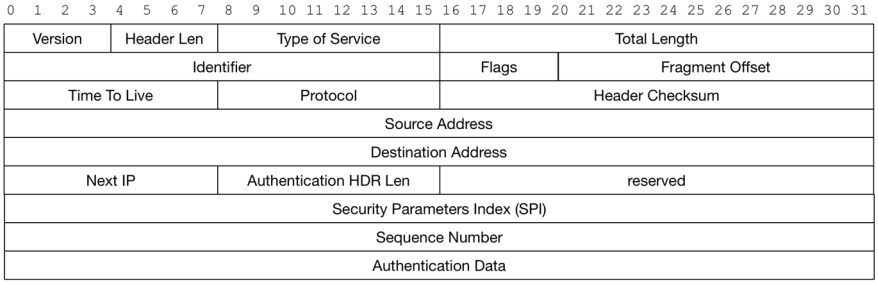
CPRI frame header

Digital Susbscriber Line Access Multiplexer (DSLAM) traffic has traditionally been backhauled using Point-to-Point Protocol (PPP) over T1 lines.



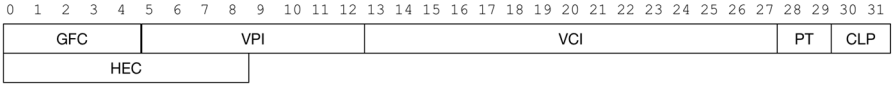
PPP Frame header

WiFi Access Point (AP) traffic has traditionally been backhauled using IPsec to a router belonging to the Wireless Internet Service Provider (WISP).



IPsec Frame Header

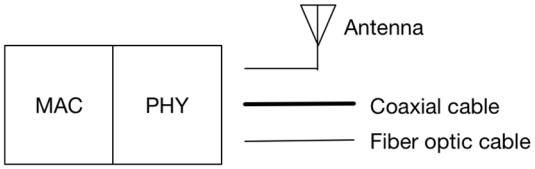
Passive Optical Network (PON) traffic has been backhauled using Asynchronous Transfer Mode (ATM) framing.



ATM frame header

All the above methods can carry IP packets, however, they are all different and using them all out of a single multi-service, multi-datalink box would increase operational complexity.

Within a multi-service, multi-datalink box, multiple datalinks can be placed inside the same enclosure providing multiple services for that service provider.

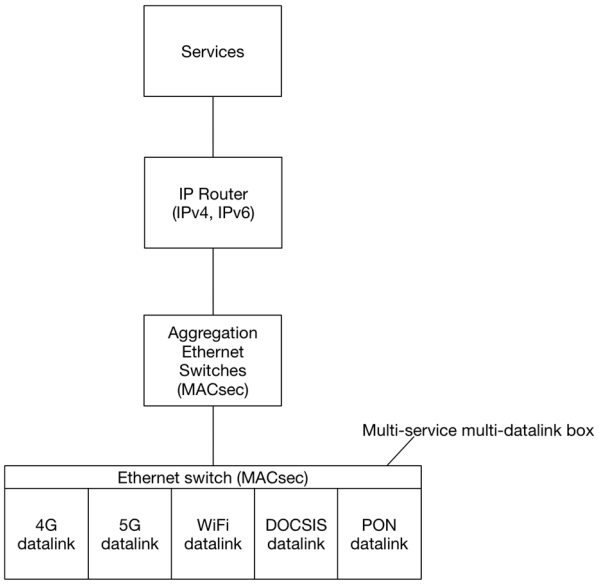


A datalink is comprised by both a physical layer (PHY) and media access control (MAC) layer. The datalink could be either half-duplex (e.g., early versions of wireless technology like WiFi and LTE) or full duplex (DOCSIS, PON) which are frequency division duplex, or truly full duplex like Full Duplex DOCSIS. The common thing is these datalinks all carry Ethernet frames and IP packets. The services are provided at the IP layer, however, the datalinks are all for different mediums and have their own control and operations systems, historically defined by those mediums.

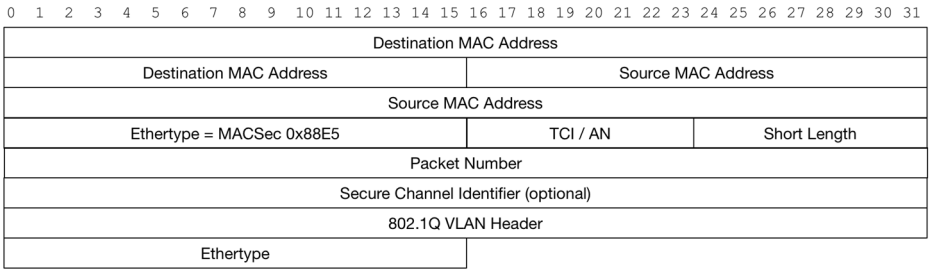
The mediums can be coaxial cable (DOCSIS), fiber optical cable (PON), air (WiFi, 4G, 5G), LAN cable (Active Ethernet) and even twisted pair cable (DSL). These disparate physical media all can be made to carry IP packets via existing datalink technology.

Service Providers are now putting all of these functions into a common outside enclosure, and the need to manage traffic from multiple datalinks over different backhaul technologies presents a problem that can be solved by moving to a common backhaul technology.

Realizing that now most communications are now going to the Internet, all of these technologies are carrying IP packets (layer 3) over Ethernet framing (layer 2). Some may operate using Internet Protocol version 4 (IPv4) and others with Internet Protocol version 6 (IPv6). A common method of backhaul will allow communication between the services and the datalinks in the multi-service enclosure.



The common method for communicating between services and the multi-service, multi-datalink box is using secured Ethernet, including IEEE 802.1X / IEEE802.1AE, which can carry either IPv4 or IPv6 packets. This method can be used for all the services listed above that have traditionally used different methods. Rather than multiple backhaul methods, a single Ethernet link is used, including IEEE 802.1X authentication and IEEE802.1AE encryption for all the access network data communications systems collocated in multi-service multi-datalink box.



Ethernet VLAN Header using MACSec IEEE 802.1AE

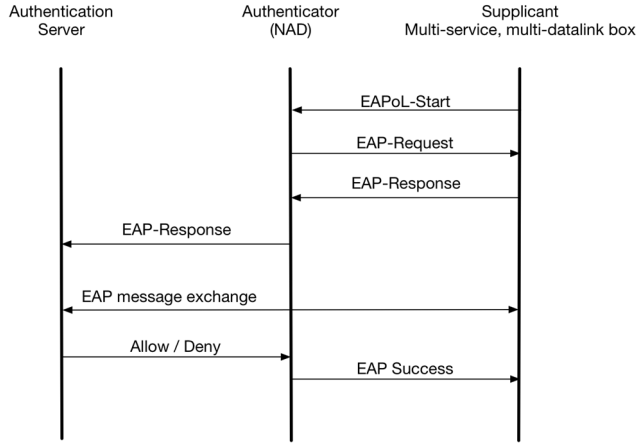
In one embodiment, the control connection messages of the IEEE802.1AE protocol are:

- Authenticate with 802.1x Extensible Authentication Protocol (EAP)

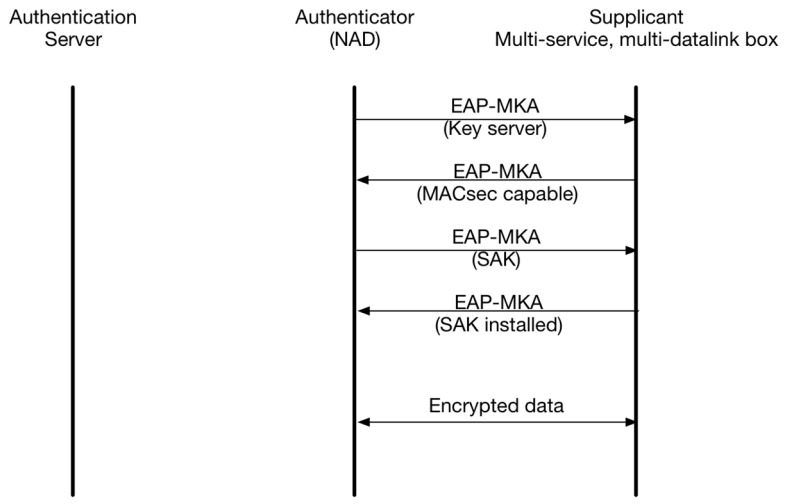
- Manage keys using MACsec Key Agreement (MKA) protocol
- Secure link using MACsec

There are multiple embodiments of MACsec, and the one above is used by the CableLabs Modular Headend Architecture specifications and is extensible to distributed CMTS, distributed PON, distributed DSL and distributed wireless architectures.

Initializing IEEE 802.1x follows the following flow ..



Initializing IEEE802.1AE where the multi-service, multi-datalink box must drive the Connectivity Association Key (CAK) from the EAP-MSK as defined by EAP-TLS and 802.1x.



To summarize, the embodiment of a multi-service, multi-datalink box system and method includes:

Supports multiple bidirectional datalink interfaces, exhibiting any of full-duplex or frequency division duplex or time division duplex.

Some of the datalinks having different physical media types

Logic to communicate between services and the multi-service, multi-datalink box

Logic to secure the communications

Logic to establish a datalink-specific control channel between a service and the corresponding datalink unit.

References:

Arris patent on a multi-PHY box (precursor to Remote PHY ??)
https://patents.google.com/patent/US8300640B2/en

Cisco patent on Remote-PHY
https://patents.google.com/patent/US7639617B2/en

James Kim, Karthik Sundaresan, Thomas Kee patent on SDN for a cable system
https://patents.google.com/patent/US9628828B2