Cox's Next Generation Serviceability and Location Based Intelligence Systems

A technical paper prepared for presentation at SCTE TechExpo24

Sorna T. Dhanabalan
Lead Architect
Cox Communications
Sorna.Dhanabalan@Cox.com

Table of Contents

List of Figures

1. Introduction

The next generation of cable networks is moving faster towards the convergence of wireline and wireless networks. While our network is expanding, the convergence is also accelerating simultaneously with adoption of O-RAN, deployment of small cell, fixed and private wireless, microwave and connectivity through DTC & satellite networks. There are other wireline drivers such as fiber buildout and expansion, overlay, multi-gigabit symmetrical speeds with DOCSIS® 4.x, converged SDN transport and edge networks.

Providing serviceability information across the channels during this critical network convergence and transformation is highly challenging. Cox is strategically positioned to provide seamless access to "connectivity" information through our Serviceability and Location Intelligence based platforms across the cable broadband, fiber, dedicated internet and wireless networks.

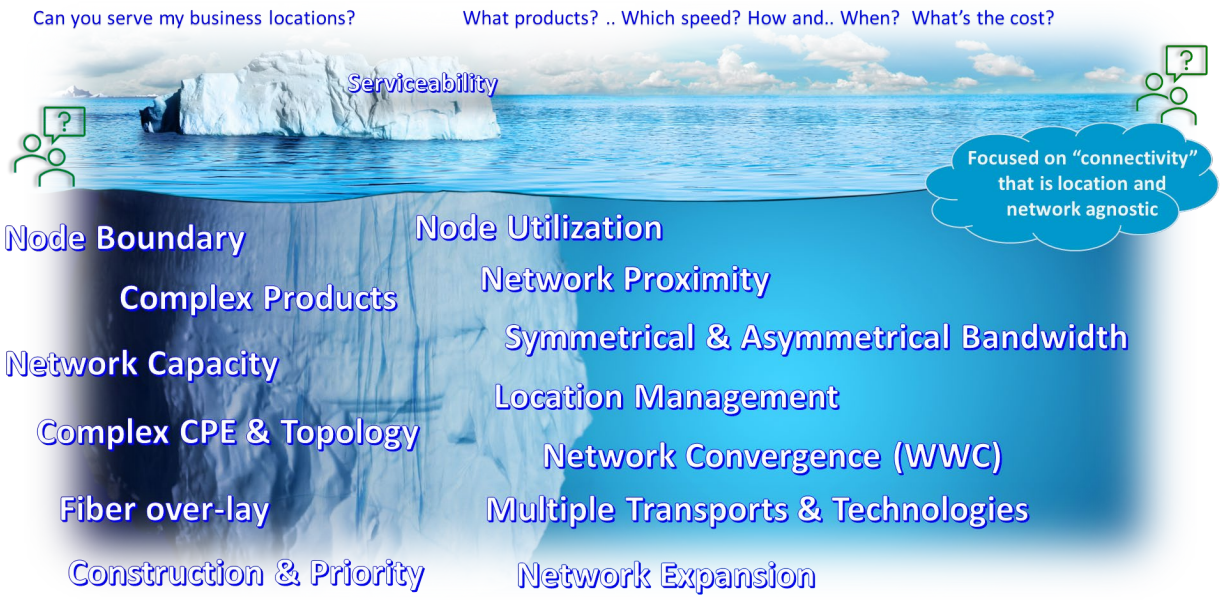

Figure 1 – Serviceability and Location Intelligence – Why It Matters?

This paper will describe how this platform will enable Cox to sell products and services effectively using serviceability data across various channels.

2. Complexity of Serviceability

Cox's commercial business services offer complex broadband, optical fiber-based networking products with symmetrical and asymmetrical network connectivity. Serviceability is critical to this marketplace as we enable our customers to select their preferred bandwidth choices. The serviceability and location-based intelligence data is not only key for Cox footprint, but it is significant also for carrier business services where we buy and sell services through carriers and expand our horizon to serve beyond our current market footprint nationally.

The first layer of complexity is around the connectivity that stems from the locations where we need to serve the customers or prospects. The locations can include the building where the dedicated fiber is lit, or it can be served via HFC or PON fiber-based network. They can be anywhere, on-network, near the network or completely out of network or even out of our market footprint itself, but connectivity matters.

So, it's critical to determine the type of network or medium and its associated transport method and technologies such as DOCSIS 3.x vs. 4.x, RFoG, GPON or XGSPON etc.

The next layer of complexity comes from our highly comprehensive retail and wholesale products with carrier grade connectivity such as Broadband Internet (Coax & Fiber), Metro Ethernet, Dedicated Optical Network, Voice, Hosted IP-PBX & Unified Communications, Wi-Fi etc. Assigning the right equipment or devices in the customer's premises or locations can also vary as this complex catalog of products and services are customized to specific customer segments such as retail and national customers through (digital) omni channels.

The proximity of the network element to the customer or prospect's premises and location(s) can drive network construction requirements significantly different based on the customer segment and channels. From Cox the MSO's perspective, it would be challenging to accurately quote and estimate for customers and prospects when they have locations to serve that span across both in-network and out-of-network footprints.

In addition, the entire complexity around this serviceability or connectivity can also be viewed in two different perspectives. From the customer or prospect's perspective, the network may not matter for them as they only expect to get connectivity for the services in their locations that are strictly based on what being defined in our product and services catalog, for example bandwidth, SLAs and any contract specific agreements. However, from Cox the MSO's perspective, there are many complex attributes around the network and location to be factored into providing the serviceability. We have a network that is both expanding and emerging with wireline and wireless convergence-based architecture. There are locations where we have HFC as well as Fiber overlay compared to our Greenfield Fiber only buildout. The status of our network's construction, its expansion, the boundaries of our nodes, and the capacity and utilization of our nodes are crucial, particularly in relation to the locations and customer segments we cater to. On top of these there are strategic location and building management, costs, margin and competitive factors to be considered when providing serviceability.

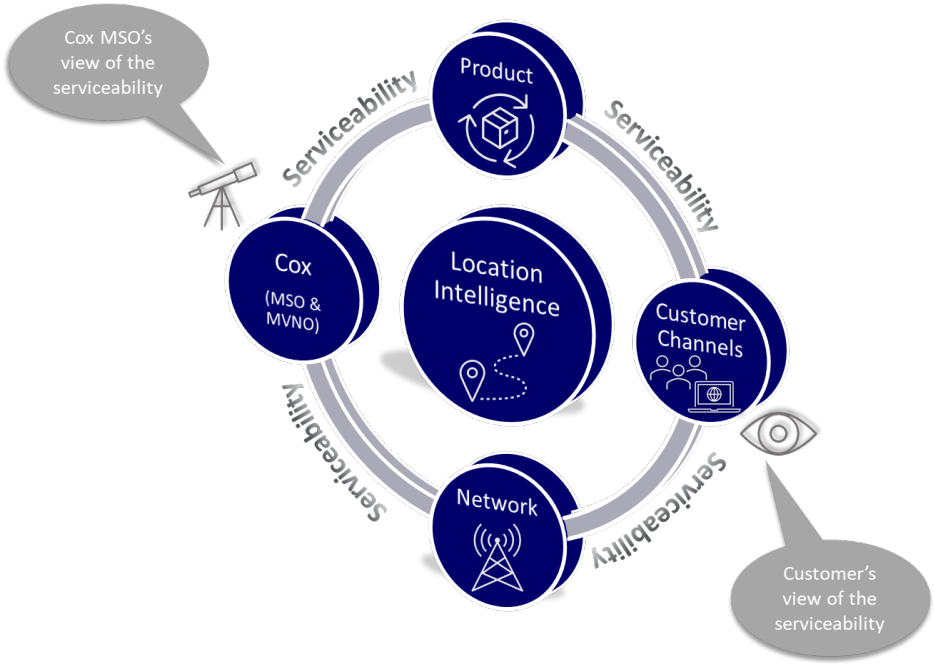

Figure 2 – Complex View of Serviceability

The next section describes how Cox is resolving this complexity by bringing the location, network and products together through our next generation architecture and platforms.

3. Next Generation Serviceability and Location based Intelligence System Architecture

3.1. Overview

The architecture of our next generation serviceability and location-based intelligence system will enable both Cox and carrier partners to leverage our networks effectively to service our customers. The diagram below shows an overview of the system's architecture.

It is designed to profile and manage serviceability across multiple network transports and technologies with standardized location data with unique ID & H3 indexes for serviceability and interactive visualization in maps, as well as providing location-based intelligence so that we can offer competitive services with a wide range of products across multiple transport architectures - DOCSIS, Fiber (GPON, XGSPON), Radio, LTE, Microwave etc. The system is designed to enable AI and ML data driven telemetry, proximity, dynamic discovery, network intelligence and accuracy in serviceability. It is highly enriched with competitive data such as building intelligence with near-net data acquired through integration with industry niche 3rd party cable and wireless network data providers.

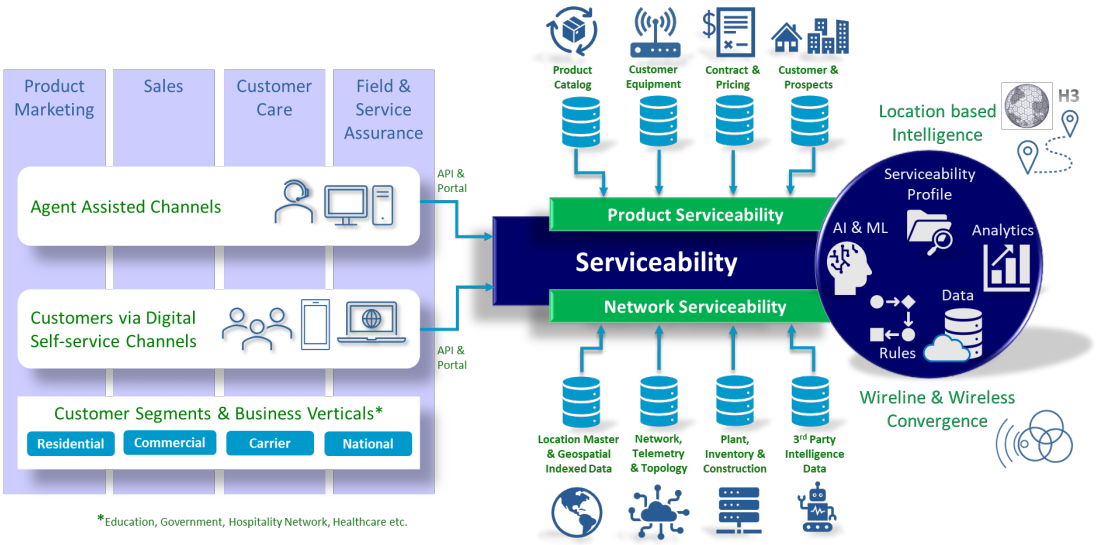

Figure 3 – Next Generation Serviceability Architecture

3.2. Platform architecture and design

The core serviceability architecture is based on two logical components, "network serviceability" and "product serviceability" with a location intelligence-based serviceability profile data ecosystem as shown in the diagram above. The pivotal step begins with determining the network serviceability at a location, which in turn dictates the serviceability of the available products.

The network serviceability relies upon the serviceability profile and a location and address master that is enriched with H3 Geo-spatial indexing system and assigns location records with unique Location IDs. It is a complex database built to combine both core network and access network elements. It can correlate its proximity with location data and is further enriched with telemetry, topology, plant inventory and

construction data. The system computes H3 indices from Latitude/Longitude points and network element information. It is also enriched with competitive data such as location and building attributes augmented through integration with industry niche third party cable and wireless network data providers. The platform implements rules-based serviceability scoring and computes the network transport methods and technologies that are part of the network serviceability profile.

The product serviceability is determined based on the network serviceability attributes for a location, and correlating it with product and channel specific rules, construction requirement, CPE, contract, pricing and service agreements.

The serviceability profile database is constructed utilizing intricate data integration processes, analytics, dynamic rules, decision tables, and is fortified with AI/ML capabilities for modeling and data training. It is engineered to facilitate both the pre-processing and post-processing of profile data, enabling scoring and computation in both batch and real-time modes from its various data sources through ETL and data pipelines. The omni channels communicate with the core serviceability system through APIs to discover the available products for a given location.

3.3. Network and Product Serviceability Design

Location-based intelligence does not imply confinement to a specific location; rather, it emphasizes the concept of "connectivity anywhere." Either we connect the customer's location through our access network or buy data backhaul from our carrier partners for connecting those locations, for example, via SD-WAN. New network architectures, such as Converged SDN Transport, will help to simplify the delivery of wireline-based residential and commercial, wireless and mobile services on a single network platform reducing overall cost and complexity of an MSO's network operations. True network convergence is emerging, such as DAA enabling DOCSIS and PON co-existence. So, it is critical to deliver serviceability solutions that are agnostic to location and network, concentrating instead on the customer's products and services.

With that approach, the serviceability platform is designed to layer serviceability rule sets to adapt to the ongoing wireline and wireless network convergence. There are three major groups of rules, (a) Location to Network, (b) Network to Product, (c) Product to Channels. The diagram below represents the baseline of how the platform is layering the serviceability rulesets aligning it with our complex network and product catalog.

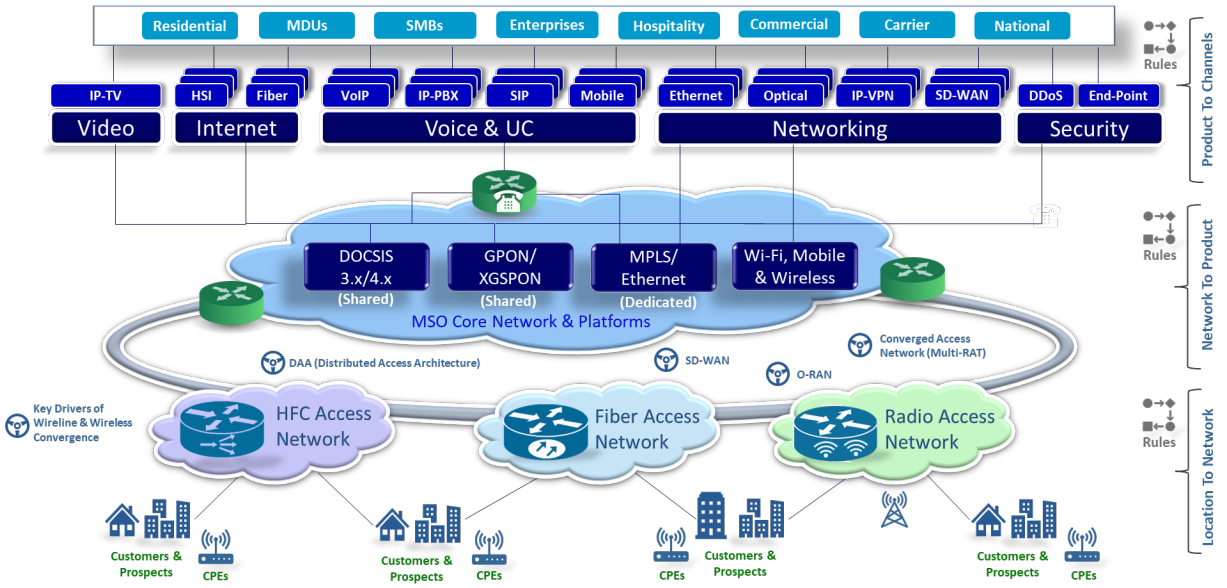

Figure 4 – Network To Product Serviceability Layer and Rules

The serviceability profile process runs multiple comprehensive sets of rules based on the layers as shown above. For example, computing a serviceable transport method for a service location based on the presence and combination of medium, technology, access network and core plant network elements will look like the following rule set as shown in the table below.

Serviceable Transport Method Rules for a Service Location						
Medium	**Technology Platform**	**Inside Plant Network Element**	**Outside Plant Network Element**	**Access Type**	**Customer Premise Access/Demarc Network Element**	**Serviceable Transport Method**
HFC	DOCSIS 3.0	CMTS	HFC Node	Shared	Cable Modem	HFC
HFC	DOCSIS 3.0	CCAP (3.0 port/Service Group)	HFC Node	Shared	Cable Modem	HFC
HFC	DOCSIS 3.1	CCAP (3.1 port/Service Group)	HFC Node	Shared	Cable Modem	HFC31
Fiber	GPON	OLT (port) (MNF)	ODN Boundary + HFC Node	Shared	ONT	GPON(MNF)
HFC	RFoG 3.0	CMTS	ODN Boundary + RFoG Node	Shared	Cable Modem	RFoG
HFC	RFoG 3.0	CCAP (3.0 port/Service Group)	ODN Boundary + RFoG Node	Shared	Cable Modem	RFoG
HFC	RFoG 3.1	CCAP (3.1 port/Service Group)	ODN Boundary + RFoG Node	Shared	Cable Modem	RFoG31
Brownfiled or Fiber overlay scenarios: Service Locations could have possible combination of more than one serviceable transports available Note: MNF represents the network equipment manufacturer of the GPON platform						GPON(MNF) + HFC GPON(MNF) + HFC31 GPON(MNF) + RFoG GPON(MNF) + RFoG31

Figure 5 – An Example of Serviceable Transport Method Rules

3.4. Alignment with Industry Standards and Architecture

The architecture for functional serviceability, along with its components, is well-aligned with an MSO's typical technology stack of the BSS/OSS platforms. It also provides APIs that allow channels to efficiently perform serviceability checks and showcase the products available.

The architecture is leveraging H3 Geo Geo-spatial indexing system to create a location master that enables a location and network profile to be created consistently supporting both wireline and wireless network coverage and serviceability through hierarchical hexagonal cells-based resolution. This design aligns with FCC's National Broadband Map and Data collection specification that is also based on H3. Our systems would be able to provide and process location and network data through H3 indexing standards.

The serviceability function and its components can be mapped to MEF LSO Reference Architecture and Business Automation as shown in the diagram below.

The network serviceability is mapped to Address Validation & Site Query specification, MEF 79 Address, Service Site, and Product Offering Qualification Management. The product serviceability is mapped to MEF 110 Product Offering Availability and Pricing Discovery specification.

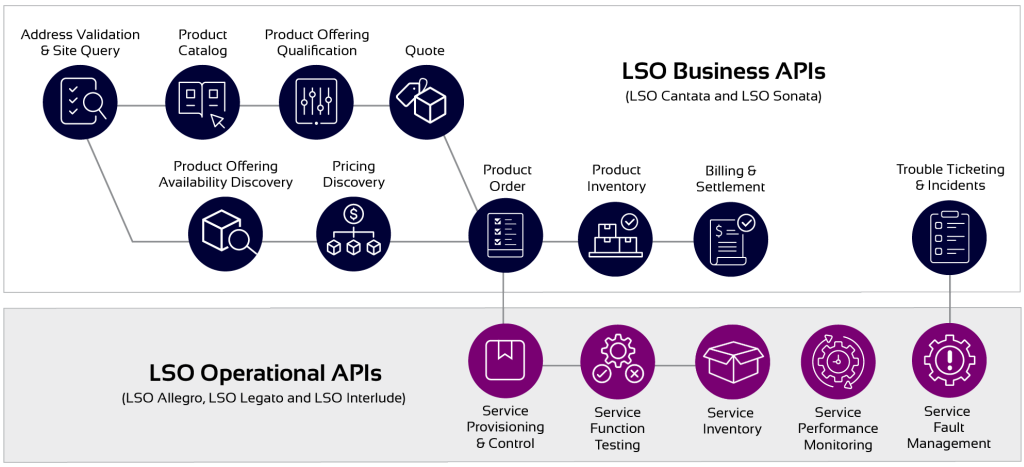

Figure 6 – MEF LSO Business Functionality Automation

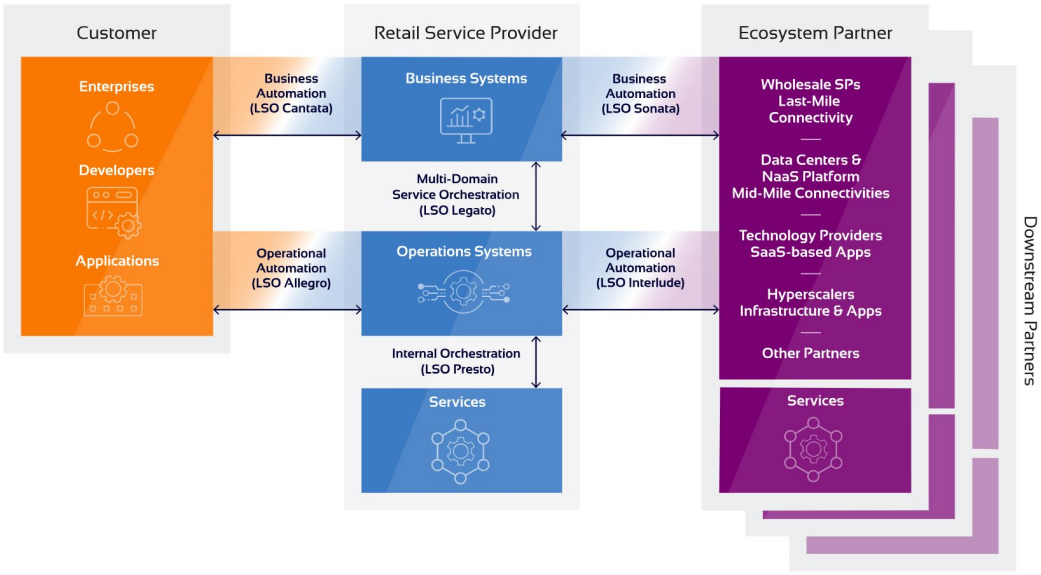

Figure 7 – MEF LSO Reference Architecture

4. Conclusion

This next generation platform's architecture and its design will enable Cox to seamlessly serve our products and services to our customers across the channels through simple, predictive and proactive serviceability across the locations.

It is designed to be highly adaptable and transparent to technology platform transformations which will enable us to modularize and integrate this functionality into both existing and new on-premise and cloud BSS/OSS technology stacks and enterprise data ecosystems with ease. It is also aligned with MEF and similar industry standards.

The defining characteristics of this next-generation serviceability platform are its adaptability to our network infrastructure and its transformation, especially the wireline and wireless convergence. The serviceability profile data ecosystem, and the benefits of its design with data, cloud, analytics and AI/ML enabled location intelligence will improve the sales and customer experience journey.

Abbreviations

AI	Artificial Intelligence
API	Application Programming Interface
BSS	Business Support Systems
DAA	Distributed Access Architecture
DOCSIS	Data Over Cable Service Interface Specification
DTC	Direct To Cellular
ETL	Extract, Transform and Load
FCC	Federal Communication Commission
GPON	Gigabit Passive Optical Network
H3	H3 is a hierarchical geospatial indexing system
HFC	Hybrid Fiber Coax
IP-PBX	Internet Protocol - Private Branch Exchange
LSO	Lifecycle Service Orchestration
LTE	Long-Term Evolution
MEF	Metro Ethernet Forum
ML	Machine Learning
MSO	Multiple Systems Operator
O-RAN	Open - Radio Access Network
OSS	Operational Support Systems
PON	Passive Optical Network
RFoG	Radio Frequency over Glass
SDN	Software Defined Network
SD-WAN	Software Defined - Wide Access Network
XGSPON	X Gigabit Symmetrical Passive Optical Network

Bibliography & References

Refer to section 3.4 for further details about the following key references.

1. A Converged Network Design for Flexibility and Service Evolution (cisco.com) White paper Cisco public
2. The Road to Wireline-Wireless Convergence Prepared by Randy Levensalor, Principal Architect, Future Infrastructure Group, Cable Labs 2022 publication
3. MEF's LSO Reference Architecture and Business Automation
4. FCC's National Broadband Map and Data collection specification
5. H3 Hexagonal hierarchical geospatial indexing system, H3Geo.org Open-Source Specification