



Cisco DNA Service for Bonjour

Traditional Deployment Guide – version 1.0

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Introduction

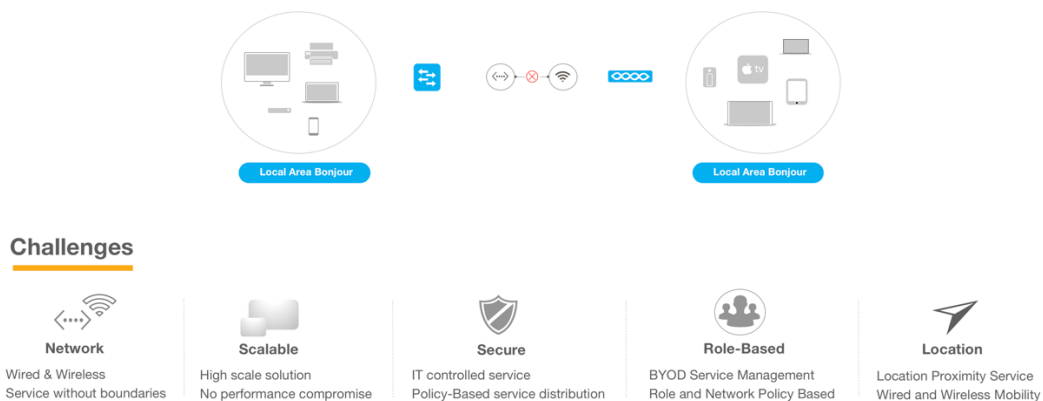
The Apple Bonjour is a zero-configuration technology enabling plug-n-play communication between connected devices to share content, discover devices, screen share, print, mobile printing and many more use-cases. The primary purpose of this technology is to dynamically discover and use the shared services with minimal user intervention and devices configuration. The Bonjour technology is an industry standard protocol designed to operate in single Layer 2 domain, which well proven as it is ideal for small, flat, single-domain setups, such as home and small-business network environment.

Challenges

The Enterprise networks are going through constant digital transformation as more and more smart and services-rich devices are being connected. While every device is designed with different purposes, the user-centric application and operational simplicity in their operation remains the core focus in technology. The plug-n-play service discovery and distribution using Bonjour technology in networks eases the IT operation for managing devices.

The IT administrator faces several challenges in large and complex Enterprise networks to seamlessly introduce an Bonjour technology that is originally designed to operate in a single Layer 2 broadcast domain. Since the proliferation of Bonjour devices and mandatory services requirements the networking vendors introduced gateway solution that allows services discovery between local network segments. The solution overcomes initial challenge but continue to be limited as the service discovery and distribution up to single gateway only, without any end-to-end solution. The centralized architecture of single gateway quickly become bottleneck as network expands demanding more scale and performance impacting other core networking function. Figure – 1 below illustrates the Bonjour challenges and requirements for Enterprise networks.

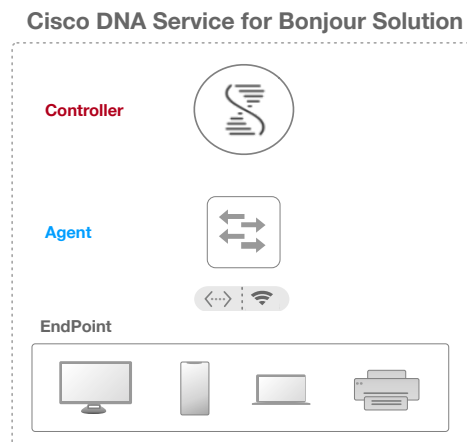
Figure 1 – Bonjour Challenges in Enterprise Networks



Cisco DNA Service for Bonjour Solution

Cisco Digital Network Architecture (DNA) Service for Bonjour is a solution brand that comprises of two core components – Controller and Agent. Both are tightly integrated to precisely address several Enterprise networks challenges and requirements as described in Figure – 1. The Cisco DNA-Center introduces new Cisco Wide Area Bonjour Application that network administrator can download and install from catalogue server to activate Bonjour Controller function. The Cisco IOS software on network devices introduces new and advanced Wide Area SDG functionality that performs the Agent role in overall solution.

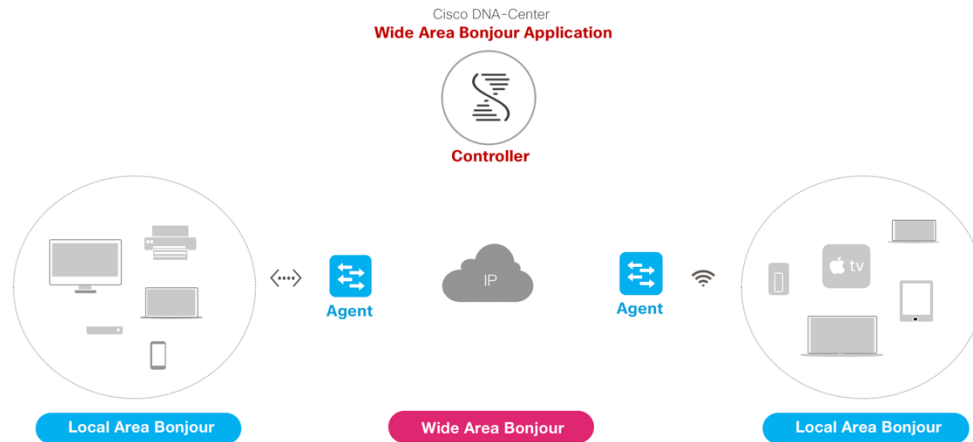
Figure 2 – Cisco DNA Service for Bonjour Solution



Cisco Digital Network Architecture (DNA) Service for Bonjour is a software-defined controller-based solution that enables devices to advertise and discover Bonjour services across Layer 3 network boundaries, making it applicable to enterprise networks, education, hospitals and other industry verticals. The Cisco DNA Service for Bonjour also addresses problems relating to security, policy enforcement and services administration in high scale network environment.

The distributed service-oriented architecture is designed to build isolated flood boundaries with policy enforcement points at network edge to enable end-to-end services management. The solution provides complete seamless integration into existing complex Enterprise network designs as well as retains the end-user experience in browsing and sharing the services consistent between home and work. This solution follows RFC 6762 standard Multicast DNS communication between any endpoints and Cisco Bonjour gateway capable Catalyst switching platforms. Figure – 3 below illustrates the reference architecture of Cisco DNA Service for Bonjour supporting a two-tier and end-to-end distributed architecture.

Figure 3 – Cisco DNA Service for Bonjour Distributed Architecture



Solution Components

The DNA Service for Bonjour solution is an end-to-end solution that includes the following key components:

- Cisco DNA Center Appliance – The Cisco DNA Center Appliance is the foundational controller and analytics platform that enables Cisco’s intent-based network for large and midsize organizations. The Cisco DNA Center Appliance can be deployed in single standalone non-redundant mode or in Cisco recommended cluster mode providing best-in-class system, application and service redundancy.
- Cisco Wide Area Bonjour Application – The Cisco Wide Area Bonjour (WAB) Application is an add-on service that operates on Cisco DNA Center Appliance that can be deployed in datacenter. The WAB Application enables the Controller function and builds network-wide secure communication channel with trusted SDG Agents for global centralized services management and controlled service routing.
- Cisco SDG Agent – The Cisco Catalyst Switch or Cisco ISR 4000 series router functions as a Service Discovery Gateway (SDG) Agent, and communicates with the Bonjour Service endpoints within the Layer 2 domain and the central Cisco DNA Center controller.
- Cisco Wireless LAN Controller - The Cisco Wireless LAN Controller (WLC) transparently switches mDNS messages between wireless clients and upstream Bonjour gateway switch in distribution layer network.
- Endpoints - A vendor-agnostic mDNS capable endpoint that supports RFC 6762 standards to advertise or browse Bonjour services. The Bonjour endpoints can be in either LANs or WLANs. The Wide Area Bonjour application is designed to integrate with known Bonjour services, including AirPlay, Google Chromecast, and AirPrint.

Table – 1 below provides Cisco DNA Center hardware appliance and software application product component support matrix list.

Table 1 – Cisco DNA-Center Product Support Matrix

Platform	Hardware	Software
Cisco DNA-Center Appliance	DN2-HW-APL DN2-HW-APL-L DN2-HW-APL-XL	v1.3.1.0
Cisco Wide Area Bonjour Application	-	v2.4.0.10062

Table – 2 below provides multiple product component support matrix list that can be deployed in SDG-Agent role supporting Local and/or Wide Area Bonjour domains.

Table 2 – Cisco Network Product Support Matrix

Supported SDG Agent	Local Area SDG	Wide Area SDG	Minimum Software
Catalyst 9300	DNA Essentials	DNA Advantage	16.11.1
Catalyst 9400	DNA Essentials	DNA Advantage	16.11.1
Catalyst 9500	DNA Essentials	DNA Advantage	16.11.1
Catalyst 9500-H	DNA Essentials	DNA Advantage	16.11.1
Catalyst 9600	DNA Essentials	DNA Advantage	16.11.1
Catalyst 9800 WLC	DNA Essentials	Unsupported	16.11.1
Cisco 5520/8540 WLC	Unsupported	Unsupported	Pass-Thru
Catalyst 6800	IP Base	Adv Ent + DNA-Addon	15.5(1)SY4
Catalyst 4500E/X	IP Base	IP Services + DNA-Addon	3.11.0
Catalyst 3850/3650	DNA Essentials	DNA Advantage	16.11.1
Catalyst 2960 X	LAN Base	Unsupported	15.2.6E2
Catalyst 2960 XR	IPLite	Unsupported	15.2.6E2
Cisco ISR 4000 Series	IPBase	AppX	16.11.1

Endpoint Compatibility

As described earlier, the Cisco DNA Service for Bonjour solution follows industry standard RFC 6762 to communicate with Multicast DNS capable endpoints. Thus, the solution is compatible with any vendors following the standards including Apple, Google, Microsoft, Printer manufacturers and many more.

Target Audience

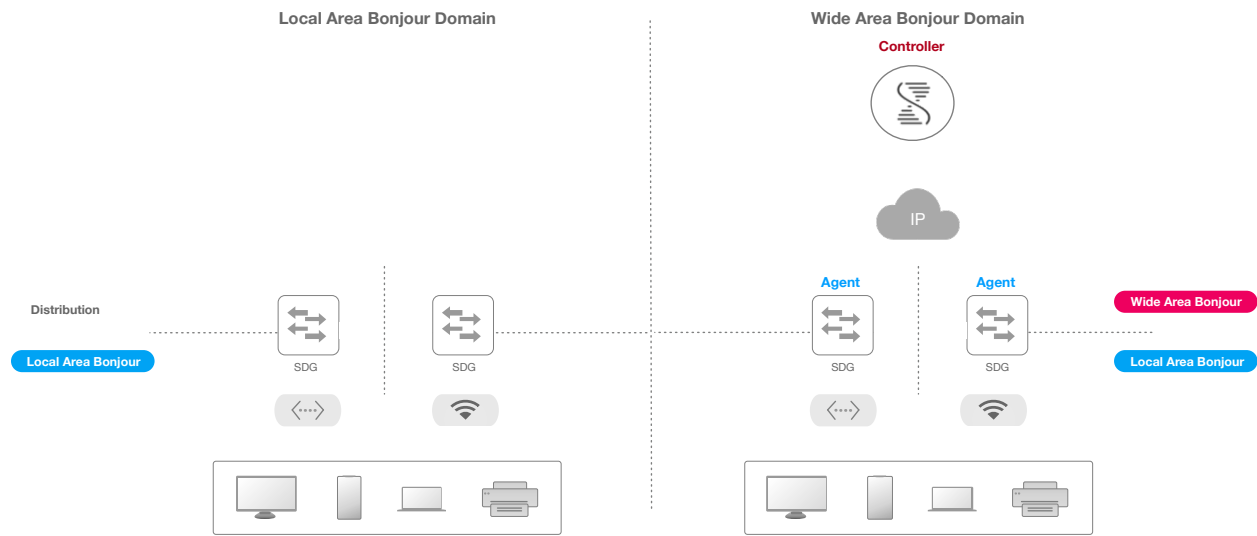
This document is targeted for Wired and Wireless network administrators providing guidance on designing and deploying end-to-end Bonjour services. The content of this document primarily focuses on how to enable Bonjour services seamlessly into various types of Enterprise networks designs and topologies. This deployment guide provides guidance to evaluate existing network designs and system inventory along with simple step-by-step configurations guidelines for successful deployments.

This document does not cover basics of Bonjour implementation and it is highly recommended to refer to [Apple Bonjour Overview](#) document and [RFC 6762](#) to learn Bonjour terminologies and operation.

Understanding Local Area and Wide Area Bonjour Domains

The Cisco DNA Service for Bonjour is built upon two-tier Bonjour service gateway and routing layers. In this hierarchical services architecture, it protects network and system performance by retaining the mDNS communication limited to the L2/L3 network boundary at LAN/WLAN Distribution layer or at LAN Access in Layer 3 mode. Figure – 4 below provides reference design model of Local Area and Wide Area Bonjour domain:

Figure 4 – Local Area and Wide Area Bonjour Domain



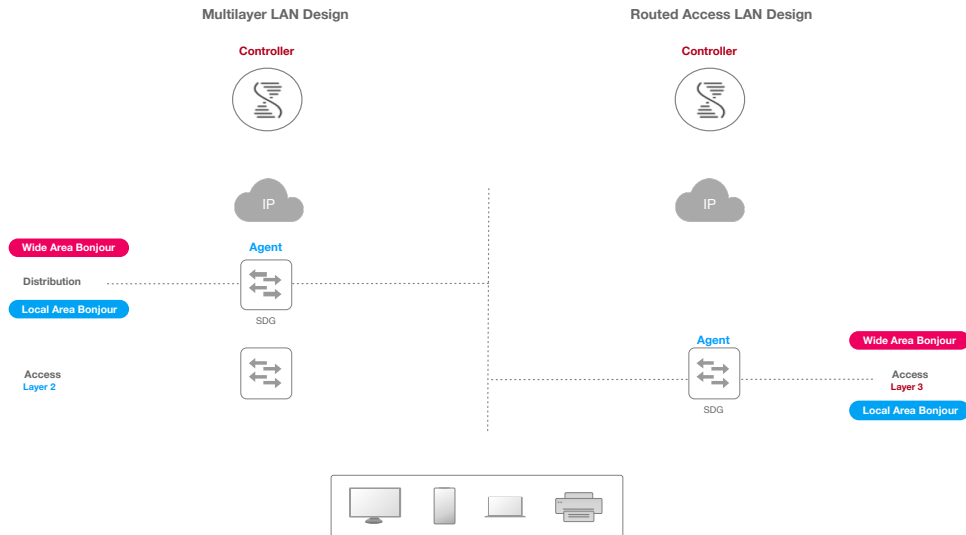
To enable the end-to-end Bonjour service routing and communication following sub-section describes the system role, responsibilities and function of each solution components across two-tier domain networks:

- Local-Area SDG Domain** - The Cisco Catalyst switches at Layer 3 boundary function as Service Discovery Gateway (SDG) for local services discovery and distribution functions between local VLANs. The Catalyst switch can support Local-Area SDG Domain without Cisco DNA-Center controller. Hence in controller-less Bonjour solution the SDG gateway switch provide single gateway solution at LAN or Wireless Distribution block. The SDG switch communicates with local mDNS endpoints to build and manage the services information. The service gateway function is ineffective between Bonjour endpoints in same Layer 2 network, as they follow standards based on flood-n-learn rule.
- Wide-Area SDG Domain** – The Wide Area SDG Domain uses a Controller-based solution that enables Wide Area Bonjour domain. In this case the Bonjour gateway role and responsibilities of Cisco Catalyst switching is extended from Local Area SDG to a Wide Area SDG-Agent. The network-wide distributed SDG-Agent devices establish lightweight, stateful and reliable communication channels with a centralized Cisco DNA-Center Controller running the Wide Area Bonjour application service. The service routing between SDG-Agents and Controller operates over regular IP networks using reliable TCP port 9991 between Cisco DNA Center and the SDG-Agent devices. The SDG-Agent routes locally discovered white-listed service information based on routing policy.

LAN Network Design Support

The Cisco DNA Service for Bonjour supports various LAN network designs commonly deployed in the Enterprise. The SDG-Agent providing Bonjour gateway functions are typically an IP gateway for Wired endpoints that could reside in Distribution or in Routed Access network designs. Figure – 5 below illustrates two common Enterprise LAN network designs supporting Bonjour gateway function for Wired endpoints:

Figure 5 – LAN Bonjour Network Design Support

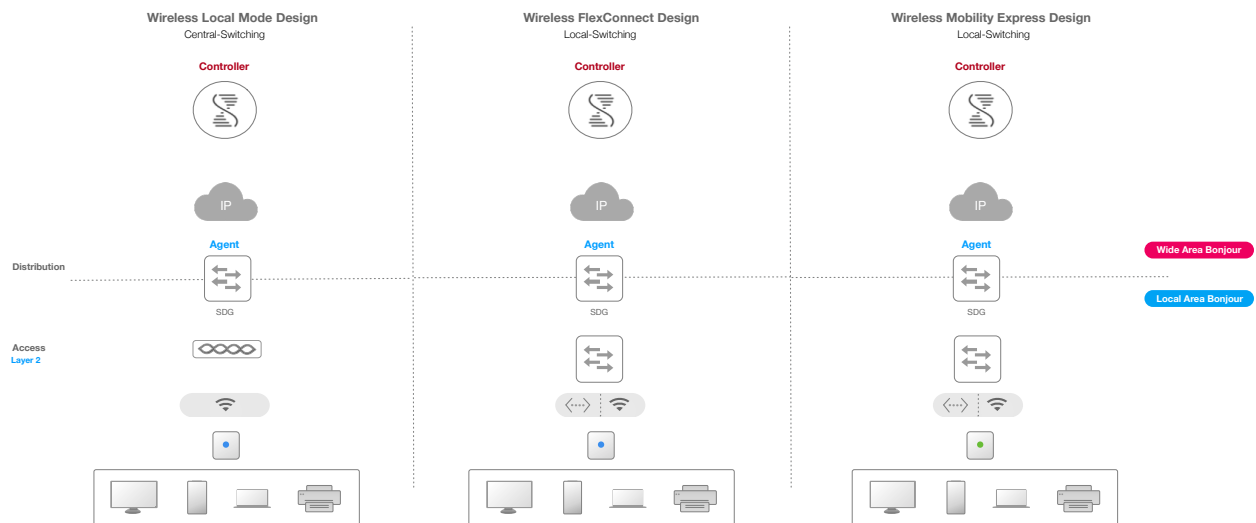


- **Multi-Layer** – In this deployment mode, the Layer 2 Access switch provides transparent bridging function of Bonjour services to Distribution-layer systems acting as IP gateway and SDG-Agent. No additional configuration required to modify the existing Layer 2 trunk settings between L2 Access and Distribution layer Cisco Catalyst switches.
- **Routed Access** – In this deployment mode, the first-hop Layer 3 Access switch is an IP gateway hence it must be combined with SDG-Agent role.

Wireless Network Design Support

The Cisco DNA Service for Bonjour also supports various traditional WLAN network designs commonly deployed in the Enterprise. The SDG-Agent provides consistent Bonjour gateway functions for Wireless endpoints independent of deployment modes like Wired network infrastructure. Hence the WLC mDNS Snooping function supporting single gateway solution for Wireless-only networks must be disabled. Figure – 6 below illustrates common WLAN network designs supporting Bonjour gateway function for Wireless endpoints:

Figure 6 – WLAN Bonjour Network Design Support



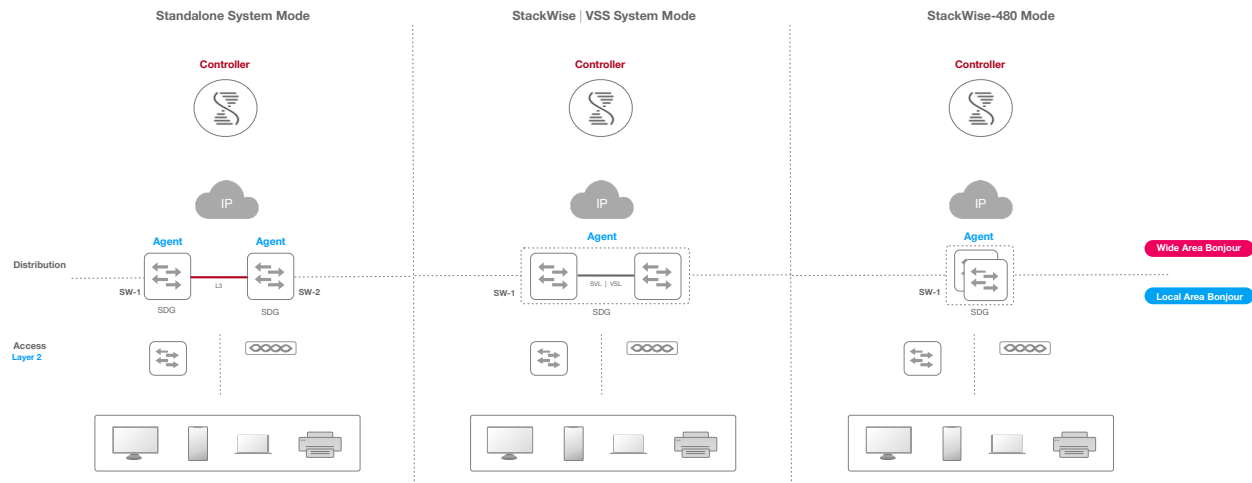
- **Local Mode** – In this central-switching Wireless deployment mode the Bonjour traffic is encapsulated in CAPWAP tunnel and switched to central Cisco WLC. The Cisco AP can be in Local-Mode or FlexConnect central-switching mode, the Cisco WLC provides transparent bridging function of Bonjour services to upstream Cisco Catalyst switch supporting IP gateway and SDG-Agent role. The AP Multicast is required for AP to enable mDNS processing; the AP may not forward any mDNS traffic until they join the WLC advertised Multicast Group.
- **FlexConnect** – The Wireless users in FlexConnect local-switching mode share, with the wired users the same IP gateway in Distribution layer. Hence the Cisco Catalyst switch in Distribution layer provides SDG-Agent function to both LAN and WLAN user groups. The AP Multicast is required for FlexConnect mode AP.
- **Mobility Express** – The Cisco Mobility Express solution enables light-weight integrated WLC function within Cisco AP configured in Master role. The Mobility Express Wireless users and Wired users share the same IP gateway in the Distribution layer. Hence, the Cisco Catalyst switch in Distribution layer provides SDG-Agent function to both LAN and WLAN user groups. The AP Multicast is required for Mobility Express mode AP, and the mDNS must be set in “bridging” mode.

This document focuses on central-switching Wireless deployment models including Local Mode and FlexConnect.

SDG-Agent System Mode Support

The Cisco Catalyst switching platforms can be deployed in various modes at Distribution-Layer providing different set of benefits to other network applications. A switch pair at Distribution-Layer can be deployed in default Standalone mode or in unified mode. Based on switch deployment mode the SDG-Agent function may operate in ACTIVE/STANDBY mode or in single unified Active system at Wired and Wireless Distribution-layer network. Figure – 7 below illustrates reference for network design for IP and SDG gateway function at the Distribution-Layer for Wired and Wireless networks:

Figure 7 – SDG-Agent Distribution System Mode support



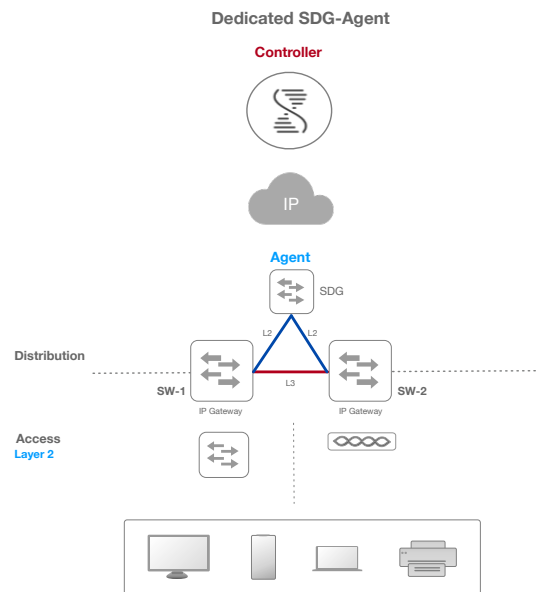
Following sub-section describes an integrated IP and Bonjour gateway on the same system. In combined gateway roles the distribution-layer switch provides consistent routing, serviceability and forwarding topologies in the network:

- Standalone Mode:** The IP gateway function is virtualized with HSRP protocols supporting redundancy. Like IP gateway, the Bonjour needs to enable on both SDG-Agent switches on each VLANs providing service gateway redundancy. The SDG-Agent role automatically aligns its own ACTIVE/STANDBY mode with current operating HSRP state on per-VLAN basis. The Bonjour gateway in STANDBY mode does not process any mDNS communication with local Wired or Wireless endpoints and maintains control-session in operational state with the Cisco DNA-Center.
- StackWise-Virtual / VSS Mode:** The pair of distribution-layer switches can be logically bound to enable a single unified system in the network. In this simplified system mode, the IP and Bonjour gateway are unified into a single ACTIVE system in the network and to the central Cisco DNA-Center controller. The inter-chassis system-level redundancy provides service gateway redundancy.
- StackWise-480 Mode:** In small to mid-size enterprise networks, the distribution-layer switch can be logically paired together using back-panel StackWise-480 technology. In this simplified system mode, the IP and Bonjour gateways are unified into a single ACTIVE system in the network and to the central Cisco DNA-Center controller. The intra-chassis system-level redundancy provides service gateway redundancy.

Dedicated SDG-Agent Mode Support

The dedicated SDG-Agent mode provides flexible solution to seamlessly integrate end-to-end Bonjour solution without major forklift upgrades and network changes. In this “ship-in-night” solution the IP and Bonjour gateway functions are decoupled for various reasons, i.e. legacy network consideration and unsupported platforms, software license, etc. A dedicated Cisco Catalyst SDG-Agent switch is introduced into the network as an Bonjour gateway role by physically attaching to existing Distribution-layer IP gateway switches. Figure – 8 below illustrate dedicated SDG-Agent mode reference network design:

Figure 8 – Dedicated SDG-Agent Network Design

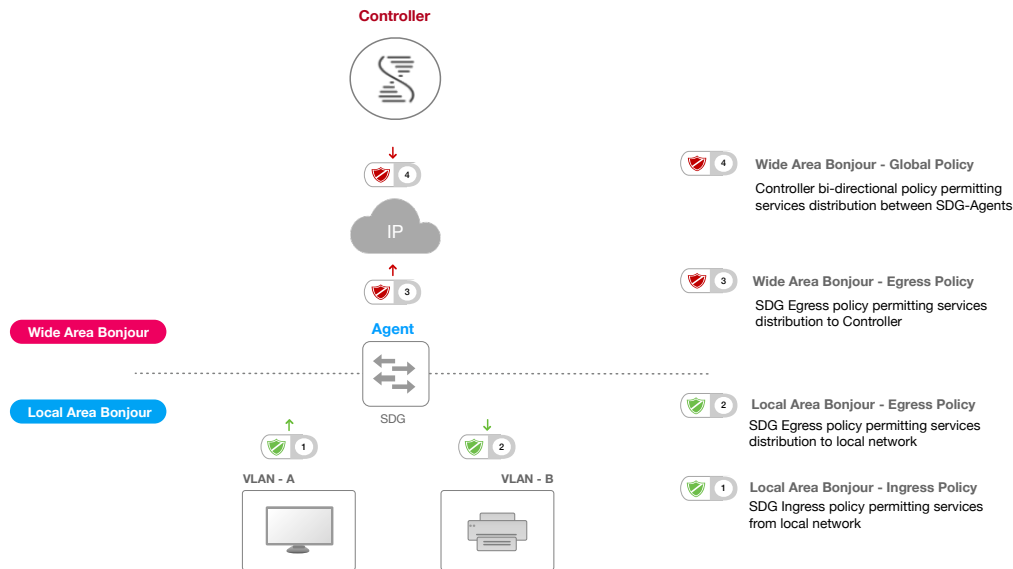


This Layer 2 VLANs of Wired or Wireless endpoints are extended from Distribution-layer switches to SDG-Agent switch for mDNS processing. The switch management VLAN on SDG-Agent can be used to build the stateful connection to Cisco DNA-Center providing Wide Area Bonjour service routing function. No other changes on IP gateway function on existing Distribution-Layer systems are required.

Understanding Bonjour Policy Type

The Cisco Bonjour policy is divided into four unique functional groups to enable policy based Bonjour services discovery and distribution in two-tier domains. The network administrator must identify the whitelist of Bonjour services that needs to be enabled and identify the plan limit the service distribution to local network or end-to-end across global IP network. Figure – 9 below illustrates enforcement point and direction of all four types of Bonjour policies at the SDG-Agent level and in Cisco DNA-Center Wide Area Bonjour application:

Figure 9 - Local and Wide Area Bonjour Policy Type



As part of the service implementation it imperative to understand policy enforcement points to ensure service routing is performed based on policies. Following sub-section describes the function of each policy type in Local Area and Wide Area Bonjour domains:

- Local Area Bonjour – Ingress Policy** – This mandatory policy is applied on Cisco SDG device on VLAN interface to permit specified Bonjour service from provider such as Printer or a request from receiver computer. The SDG device only process whitelisted Bonjour services and with default implicit deny rule at the end of list the rest is dropped.
- Local Area Bonjour – Egress Policy** – This optional egress policy is applied on Cisco SDG device on an VLAN interface to permit outbound Bonjour response for request made by receiver endpoint. The SDG device may provide Bonjour service response from local cache sourced from one VLAN to other requesting devices on other VLAN if matching service found. This Local Area egress service policy is only applicable for local cache response, for Wide Area Bonjour remote services from Cisco DNA-Center does not require the egress service policy.
- Wide Area Bonjour – Egress Policy** – This mandatory egress policy is applied on Cisco SDG-Agent device to control its service routing towards Cisco DNA-Center. The SDG-Agent device only routes the whitelisted Bonjour services information and with default implicit deny rule at the end of list the rest is dropped.

- **Wide Area Bonjour – Global Policy** – This mandatory bi-directional policy is applied in Cisco Wide Area Bonjour application of Cisco DNA-Center. The single global policy structure is divided in following two sub-section –
 - Source SDG-Agent – The network administrator can assign one or more source SDG-Agents announcing selected list of one or more service-type to Cisco DNA-Center. The Cisco DNA-Center accepts Bonjour services from a source only if it matches all specified criteria such as service-type and source network address of service-provider. For granular policy configuration the network address can be IPv4 and IPv6 or alternatively it can be non-specific with the Any option.
 - Receiver SDG-Agent – The same policy as source SDG-Agent(s) it may consist of one or more receiver SDG-Agents. The Cisco DNA-Center permits Bonjour discovery request from receiver SDG-Agent only if it matches all selected criteria such as service-type and receiver network address of Bonjour endpoint. For granular policy configuration the network address can be IPv4 and IPv6 or alternatively it can be non-specific with the Any option. Based on service routing topology the Cisco DNA-Center may distribute the services discovered from one or more source SDG-Agent devices to one or more targeted receiver SDG-Agent devices.

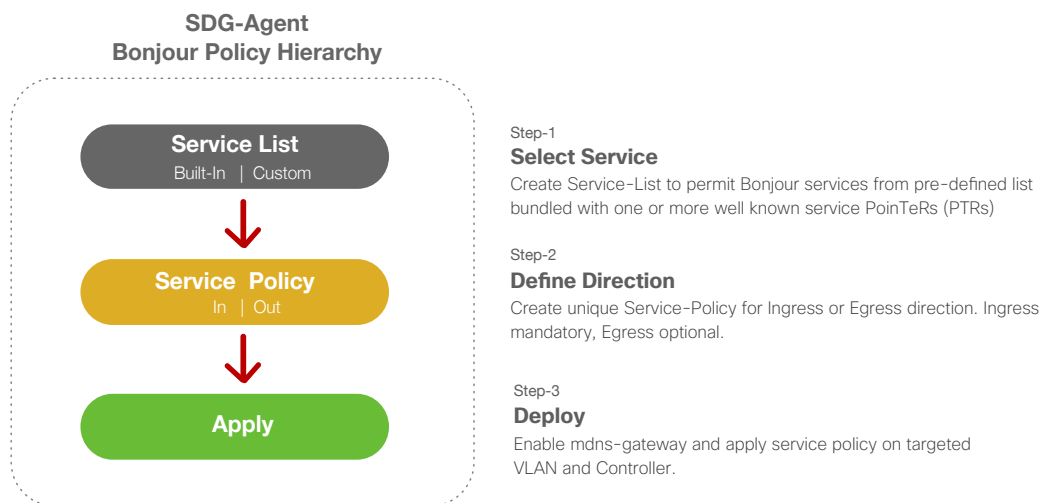
Deploying Local Area Bonjour Domain

The Local Area Bonjour domain boundary is limited between SDG-Agent and Bonjour endpoints with possibly intermediate Layer 2 Access Switch, Cisco Wireless LAN Controller or directly attached to mDNS capable endpoints. To enable Bonjour gateway function the SDG-Agent switch requires basic configuration and Bonjour policies to start services discovery and local service routing between two Layer 2 segments. The following sub-section explains deploying Local Area Bonjour policy supporting various use-cases for Wired and Wireless networks.

Local Area Bonjour Policy

The Cisco IOS Bonjour policy structure is greatly simplified and scalable with the new configuration mode. Several common services types in Enterprise can be enabled with built-in service database. In case if built-in service database is limited then network administrator can create custom service-type to enable the service across the network. Figure – 10 below illustrates step-by-step configuration approach to build the Local-Area Bonjour policy and apply to enable the gateway function on selected local networks:

Figure 10 – Local Area Bonjour Policy Hierarchy



Built-In Service List

The Cisco IOS provides intuitive method to build whitelisted Bonjour services on SDG-Agent devices. The built-in service list may be bundle up with one more service-type, for example an Apple Time Capsule may offer Backup service (`_adisk._tcp.local`) and File Sharing service (`_afpovertcp._tcp.local`)

The service-list is based on “match-any” rule, hence if an service-list contains more than one PTR then the complete service is permitted, i.e. Apple Time Capsule Data service consists `_adisk` and `_afpovertcp` built-in PTRs, however when either of PTR records are matched then SDG-Agent will successfully classify and process on received information.

Table – 25 in Appendix section below illustrates complete list of Cisco IOS Built-In Service Database that can be used to build the Local Area Bonjour policy on SDG-Agent.

Following sub-section provides reference configuration example to build Service List on supporting Cisco IOS SDG-Agent device:

```
!  
mdns-gateway  
!  
mdns-sd service-list LOCAL-AREA-SERVICES-IN in  
match airplay  
!
```



Cisco recommends building SDG-Agent configuration with new “mdns-gateway” CLI model. The old CLI configuration using “service-routing” will be deprecated in future IOS software release.

Custom Service Definition

The custom Service List allows network administrator to configure new service types if built-in list does not meet the requirements. For example, the file-sharing requirement demands to support Apple Filing Protocol (AFP) between macOS users and Server Message Block (SMB) file transfer capability between macOS and Microsoft Windows endpoints. For such requirements the network administrator can create an custom Service List combining AFP (_afpovertcp._tcp.local) and SMB (_smb._tcp.local). The Service-List provides flexibility to combine built-in and custom under single list and no limits on numbers of custom service definitions list under single service-list.

Following sub-section provides reference configuration for Mobile Printing solution with custom Service List on supporting SDG-Agent device:

```
!  
mdns-sd service-definition MY-MOBILE-PRINT  
service-type _ipps._tcp.local  
service-type _universal._sub._ipps._tcp.local  
!  
mdns-sd service-list LOCAL-AREA-SERVICES-IN in  
match MY-MOBILE-PRINT  
!
```


Service Policy Direction

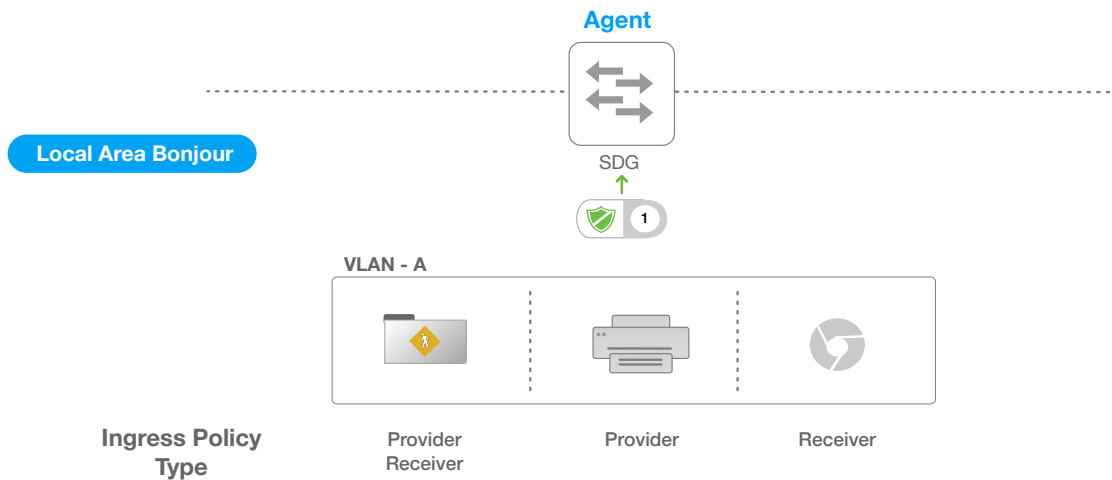
The Local Area Bonjour policy in Cisco IOS provides flexibility to network administrator to construct service policies that can align service announce and query control management participating in same or different local networks. The bi-directional service-policies are tied to either ingress or egress direction to enforce service control. Following sub-sections provides details on service policy configuration that can be considered based on requirements.

Ingress Service Policy

The ingress service policy is mandatory configuration element to permit processing of incoming mDNS service announcement and query request. Without ingress service policy the Bonjour gateway function on a targeted Wired or Wireless network is not enabled. The ingress service policy provides flexibility to permit service announce and query message-type for each user-defined service-types, i.e. permit AirPlay service announce and query request, but only permit the Printer service query request.

The Figure – 11 below illustrates three types of service policy model that network administrator can build to manage ingress service policy for any applications. The policy requirement in this example is to permit learning and responding Apple File Share service from local computers, permit discovering local Print services and permit Google Chromecast service query request from receivers to process further and drop all other types of services in the network.

Figure 11 – Local Area Bonjour Ingress Service Policy



Based on Figure – 16 above customized policy requirement the ingress service-list configuration can be created to unique setting on VLAN-A or same can be shared across multiple local VLAN networks. Following sub-section provides reference ingress service-policy configuration example on supporting Cisco IOS SDG-Agent device:

Step-1: Create advanced Service-List

```
!  
mdns-sd service-list LOCAL-AREA-SERVICES-IN in  
  match apple-file-share message-type any  
  match printer-ipps message-type any announcement  
  match google-chromecast message-type any query  
!
```

Step-2: Attach Service-List to an ingress Service-Policy

```
!  
mdns-sd service-policy LOCAL-AREA-SERVICE-POLICY  
  service-list LOCAL-AREA-SERVICES-IN in  
!
```

Step-3: Apply Service-Policy to one or more targeted service provider and receiver VLAN network

```
!  
interface <VLAN-A>  
! description CONNECTED TO BONJOUR NETWORK  
  mdns-sd gateway  
    service-policy LOCAL-AREA-SERVICE-POLICY  
!
```

Egress Service Policy

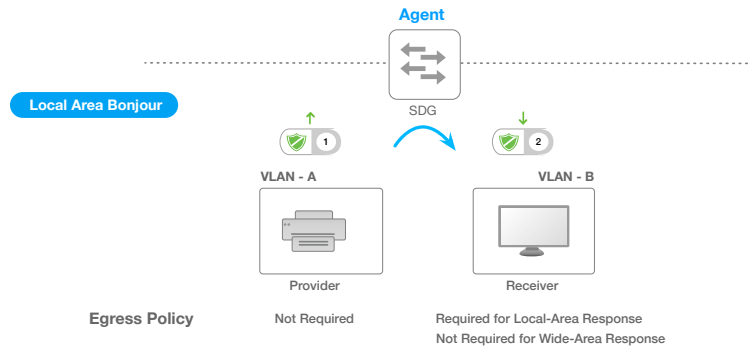
The egress service policy is an optional configuration and not required in following two conditions:

- The egress service policy is not applicable in local VLAN where the expected Bonjour end-points are service-provider only, i.e. Service-VLAN network may contain only IT managed service-provider end-points such as Apple TV, Printers etc. and these end-points do not query for other service-types in the network.
- The Wired or Wireless users must receive services only from Wide Area Bonjour domain by Cisco DNA-Center. No services must be distributed between local VLAN networks on same SDG-Agent switch.

The egress service policy configuration is only required when an SDG-Agent must distribute locally discovered Bonjour services information from one VLAN to other. For example, based on ingress service policy the SDG-Agent discovered and cache the AirPrint capable Printer from VLAN-A, if the receiver endpoint in VLAN-B wants to discover Printer information from VLAN-A then the SDG-Agent must have ingress and egress service policy permitting AirPrint service on both VLANs.

The Figure – 12 below illustrates simple service policy model that network administrator can build to distribute Print service information from VLAN-A to the VLAN-B using egress service policy. The local cache response is only distributed if the ingress policy permits the Printer discovery:

Figure 12 – Local Area Bonjour Egress Service Policy



Following sub-section provides reference egress service-policy configuration example on supporting Cisco IOS SDG-Agent device:

Step-1: Create Ingress and Egress Service-List

```
!
mdns-sd service-list LOCAL-AREA-SERVICES-IN in
match printer-ipps
!
mdns-sd service-list LOCAL-AREA-SERVICES-OUT out
match printer-ipps
!
```

Step-2: Attach Ingress and Egress Service-List to a Service-Policy

```
!
mdns-sd service-policy LOCAL-AREA-SERVICE-POLICY
service-list LOCAL-AREA-SERVICES-IN in
service-list LOCAL-AREA-SERVICES-OUT out
!
```

Step-3: Apply Service-Policy to one or more targeted receiver VLAN network

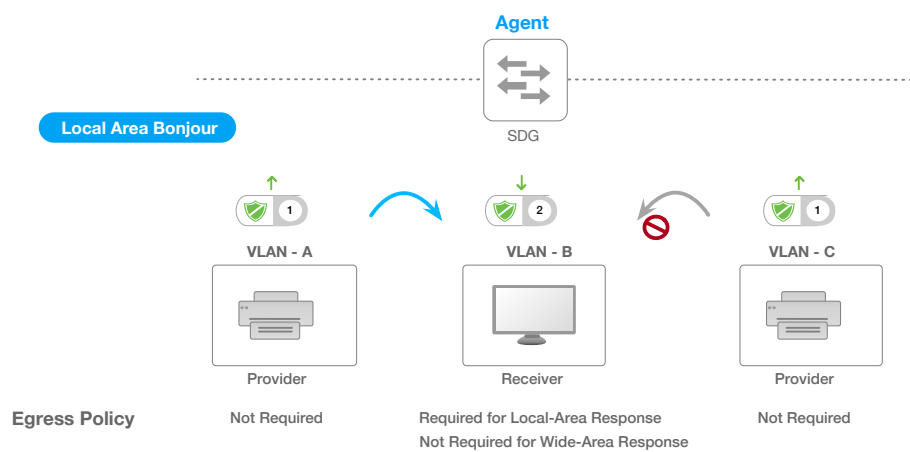
```
!
interface <VLAN-B>
! description CONNECTED TO USER NETWORK
mdns-sd gateway
service-policy LOCAL-AREA-SERVICE-POLICY
!
```

Conditional Egress Service Policy

The network administrator can optionally customize the egress service policy to enable conditional service response from sourced from specific VLAN network. For example, the SDG-Agent may discover AirPrint capable Printers from VLAN-A and VLAN-C networks. With conditional egress service policy rule, the network administrator may limit distributing VLAN-A Printer information to the receivers in VLAN-B network and automatically filters VLAN-C Printers. The conditional egress service policy support is optional setting and only applicable on out direction service policy.

Figure – 13 below illustrates advanced service policy model that network administrator can build to distribute Print service information from VLAN-A source interface to the VLAN-B using egress service policy. The local cache response is distributed if Step-1 ingress policy permits Printer discovery with message-type query or any.

Figure 13 – Local Area Bonjour Conditional Egress Service Policy



Following sub-section provides reference conditional egress service-policy configuration example on supporting Cisco IOS SDG-Agent device:

Step-1: Create Conditional Egress Service-List

```
!  
mdns-sd service-list LOCAL-AREA-SERVICES-IN IN  
match printer-ipps  
!  
mdns-sd service-list LOCAL-AREA-SERVICES-OUT out  
match printer-ipps source-interface <VLAN-A>  
!
```

Step-2: Attach Ingress and Egress Service-List to a Service-Policy

```
!  
mdns-sd service-policy LOCAL-AREA-SERVICE-POLICY  
service-list LOCAL-AREA-SERVICES-IN in  
service-list LOCAL-AREA-SERVICES-OUT out  
!
```

Step-3: Apply Service-Policy to one or more targeted receiver VLAN network

```
!  
interface <VLAN-B>  
! description CONNECTED TO USER NETWORK  
  mdns-sd gateway  
    service-policy LOCAL-AREA-SERVICE-POLICY  
!
```

Service Status Timer Management

The Bonjour service-provider endpoints may announce one or more services in the network combining mDNS records and Time-To-Live (TTL) service timers for each record. The TTL value provides assurance of endpoint availability and serviceability in the network. The SDG-Agents ensures the it contains up to date information in its local and updates global services in Cisco DNA-Center based on TTL and other events in Local Area Bonjour domain. The network administrator must configure the service status timer where service-provider endpoint discovery is permitted.

```
!  
interface <VLAN-A>  
! description CONNECTED TO SOURCE OR MIX BONJOUR NETWORK  
  mdns-sd gateway  
    active-query timer < seconds >  
!
```

Local Area Bonjour Advanced Configuration

For large scale deployment model, it is imperative to maintain the SDG-Agent and network performance at optimal level. Cisco recommends fine-tuning following parameters on Bonjour receiver endpoint VLAN interface of SDG-Agent switches.

Transport Type

The Bonjour receiver endpoints generates mDNS service discovery request over IPv4 and IPv6 network searching for one or more services in the network. The SDG-Agent switches by default processes and provide response to both discovery request. Both response messages containing the duplicate services information consuming more processing and network bandwidth.

For IPv4-only or IPv4/v6 dual-stack network the default behavior can be restricted to single IPv4 transport. Table – 3 below provides reference configuration to limit transport type to IPv4:

Table 3 – Local Area Bonjour mDNS Transport Type

Task	Step
Change transport type to IPv4 on VLAN connecting to Bonjour service receiver endpoints.	<pre> ! WLC-Dist(config)# interface Vlan <ID> WLC-Dist(config)# description Bonjour Receiver WLC-Dist(config)# mdns-gateway WLC-Dist(config-if-mdns-sd)# transport ipv4 ! </pre>

mDNS Query Support

The Bonjour receiver endpoint generates multiple types of mDNS service query request for PoinTeR (PTR), SeRVice (SRV) and TeXT (TXT) records collecting various level information of service-provider. The SDG-Agent by default provide response all type of incoming mDNS query messages from wired or wireless Bonjour receiver endpoints. The network administrator can limit providing PTR response that by default includes SRV and TXT records for each service. Table – 4 below provides reference configuration to limit mDNS PTR query response:

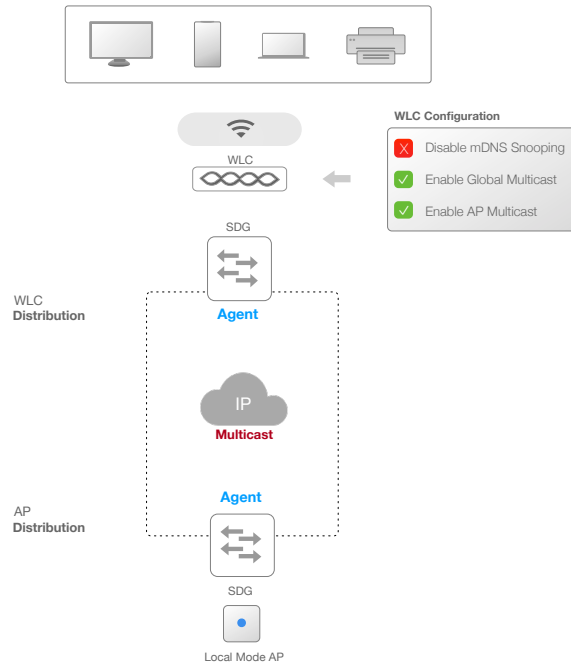
Table 4 – Local Area Bonjour mDNS Query support

Task	Step
Change mDNS service query message to PTR on VLAN connecting to Bonjour service receiver endpoint.	<pre> ! WLC-Dist(config)# interface Vlan <ID> WLC-Dist(config)# description Bonjour Receiver WLC-Dist(config)# mdns-gateway WLC-Dist(config-if-mdns-sd)# service-mdns-query ptr ! </pre>

Wireless Network Pre-Requisites

In Cisco DNA Service for Bonjour solution the Cisco Wireless LAN Controller (WLC) supports required technologies that allow transparent mDNS communication between supporting SDG-Agent and Wireless endpoints. As described in previous section depending on Wireless deployment mode the Cisco WLC can be an intermediate system between SDG-Agent and Wireless endpoints if the Access-Point is deployed in Local or FlexConnect central-switching mode. Figure – 14 below illustrates a pre-requisite configuration for Wireless network to enable seamless communication between SDG-Agent switches and Wireless endpoints.

Figure 14 – Wireless Network Pre-Requisites



Wireless Multicast Configuration

The Cisco WLC and Access Points by default prevents forwarding Layer 2 or Layer 3 Multicast frames between Wireless and Wired network infrastructure. The forwarding is supported with stateful capabilities enabled using AP Multicast. The network administrator must globally enable Multicast and configure unique AP Multicast Group on Cisco WLC to advertise in network. This AP Multicast group is only required for Cisco Access-Points to enable Multicast over Multicast (MCMC) capabilities in the network. The Bonjour solution do not require any other Multicast requirements on Wireless Client VLAN; thus, it is optional and applicable only for other Layer 3 Multicast applications.

Table – 5 below explains step-by-step WLC configuration procedure to ensure the WLC is enabled with AP Multicast configuration for Cisco Access-Points to join the group successfully:



Table 5 – Cisco WLC Pre-Requisite Configuration

Task	9800-WLC Step	AirOS-WLC Step
Disable mDNS Snooping globally.	Click Configuration → mDNS. Ensure if mDNS Gateway is disable.	Click Controller → mDNS. Ensure if mDNS Snooping is disable.
Enable Global Multicast configuration	Click Configuration → Multicast. Ensure Global Wireless Multicast is enabled.	Click Controller → Multicast. Ensure Global Wireless Multicast is enabled.
Configure AP Multicast Settings	Click Configuration → Multicast. Enable AP CAPWAP Multicast in Multicast mode and configure unique Multicast Group. Enable Wireless mDNS Bridging. Click Apply to Device button.	Click Controller → General. Enable AP Multicast Mode to Multicast and configure unique Multicast Group. Enable Link Local Bridging. Click Apply button.

Multicast Network Configuration

The core network must be configured with appropriate Multicast routing protocol allowing Cisco Access-Points to join WLC Multicast Group. The IP Multicast configuration must be enabled on management VLAN of Cisco WLC and Access-Point of their own respective distribution layer switch. Table – 6 below explains step-by-step IP Multicast configuration procedure in the network to successfully enable AP Multicast:

Table 6 – Multicast Pre-Requisite Configuration

Task	Step
Configure Multicast on Distribution-Layer Switch connecting Cisco WLC and AP	Dist(config)# ip multicast-routing Dist(config)# ip pim rp-address <IP> ! Dist(config)# interface Vlan <ID> Dist(config-if)# description WLC or AP Mgmt VLAN Dist(config-if)# ip pim sparse-mode
Configure Multicast on Core / Distribution	Core-Dist(config)# ip multicast-routing Core-Dist(config)# ip pim rp-address <IP> ! Core-Dist(config)# interface FortyG <ID> Core-Dist(config-if)# description Core Network Core-Dist(config-if)# ip pim sparse-mode

Monitor Local Area Bonjour

The Cisco IOS supports various CLIs to monitor configuration, policies and discovered service information from the Local Area Bonjour domain. The network administrator may find various level of information to determine status of Bonjour gateway in the real-time.

Policy Configuration and Status

The policy configuration and the management steps are in consistent manner that provides three step verification to Service List, Service Policy and enforced VLAN network. The configuration can be easily verified using “**show running-config mdns-sd**” command-line to verify all three steps:

Step-1: Verify globally configured Service List consisting of one or more whitelisted service-types.

```
SDG-Agent#show run mdns-sd service-list

mdns-sd service-list LOCAL-AREA-SERVICES-IN IN
match airplay
match airtunes
match multifunction-printer
```

Step-2: Verify globally configured Service Policy consisting service-list for specific direction.

```
SDG-Agent#show run mdns-sd service-policy

mdns-sd service-policy LOCAL-AREA-POLICY
service-list LOCAL-AREA-SERVICES-IN IN
```

Step-3: Verify enforced Service Policy on specific local VLAN interface for each direction

```
SDG-Agent#show mdns-sd service-policy int vlan 101
```

Service Policy Name	Service List IN Name	Service List Out Name
LOCAL-AREA-POLICY	LOCAL-AREA-SERVICES-IN	-

Service-Instance Cache Database

The network administrator can verify dynamically discovered service-instances from local network. Each service-instance contains multiple mDNS records that can be narrowed at different levels:

```
SDG-Agent#show mdns-sd cache

mDNS CACHE
=====
[<-NAME>]                [<-TYPE>] [<-TTL>/Remaining]  [If-name]  [Mac Address]  [<-RR Record Data>]
_airplay_tcp.local      PTR      4500/4442             V101      c869.cd7e.28f1  Bldg-1-FL1-ATV_ airplay_tcp.local
_raop_tcp.local        PTR      4500/4442             V101      c869.cd7e.28f1  C869CD7E28F1@Bldg-1-FL1-ATV_raop_tcp.local
Bldg-1-FL1-ATV_ airplay_tcp.local  SRV      120/62                V101      c869.cd7e.28f1  0 0 7000 Bldg-1-FL1-ATV.local
C869CD7E28F1@Bldg-1-FL1-ATV_raop_tcp.local  SRV      120/62                V101      c869.cd7e.28f1  0 0 7000 Bldg-1-FL1-ATV.local
Bldg-1-FL1-ATV_ device-info_tcp.local  TXT      4500/4442             V101      c869.cd7e.28f1  (13)'model=J42dAP'
Bldg-1-FL1-ATV_ airplay_tcp.local  TXT      4500/4442             V101      c869.cd7e.28f1  (327)'acl=0'deviceId=C8:69:CD:7E:28:F1'features=0x5A7FFF7,0x55FDE'flags=0x-1'
C869CD7E28F1@Bldg-1-FL1-ATV_raop_tcp.local  TXT      4500/4442             V101      c869.cd7e.28f1  (191)'cn=0,1,2,3'da=true'et=0,3,5'ft=0x5A7FFF7,0x55FDE'sf=0x244'md=0,1,2'a-1'
Bldg-1-FL1-ATV.local    A        120/62                V101      c869.cd7e.28f1  10.151.1.3
Bldg-1-FL1-ATV.local    AAAA     120/62                V101      c869.cd7e.28f1  2001:10:151:1:8EC:FA69:4A42:448E
```

Statistics

The Cisco IOS supports wide range of mDNS statistics information processed at each local interface level. The network administrator can use “**show mdns-sd statistics**” command-line to verify statistics at various level providing per-interface, per-transport, per-direction and per-record level statistics providing tools for advanced monitoring and troubleshooting.

```
SDG-Agent#show mdns statistics interface vlan 101
```

```
mDNS Statistics
```

```
VI101:
```

```
mDNS packets sent      : 560100
IPv4 sent              : 560100
  IPv4 advertisements sent : 0
  IPv4 queries sent      : 560100
IPv6 sent              : 0
  IPv6 advertisements sent : 0
  IPv6 queries sent      : 0
Unicast sent           : 0
```

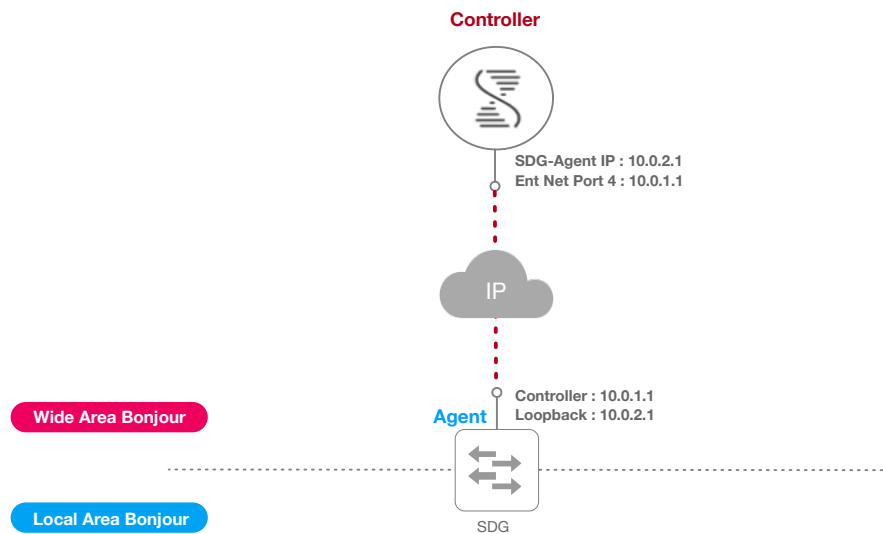
```
<snip>
```

Deploying Wide Area Bonjour Domain

Wide Area Bonjour Controller Configuration

The Wide Area Bonjour domain is enabled with stateful and trusted service-routing communication channel between SDG-Agent devices and Cisco DNA-Center running Cisco Wide Area Bonjour application service. The service-routing on SDG-Agent may remain down and in negotiating state until Cisco DNA-Center do not implement at least one service-filter permitting targeted SDG-Agent to establish service-routing session. Figure – 15 below illustrates reference Wide Area Bonjour controller setup configuration:

Figure 15 – Cisco Wide Area Bonjour Controller Configuration



- **Cisco DNA-Center Configuration** – Prior configuring Cisco Wide Area Bonjour application the network administrator must add and manage the SDG-Agent in Cisco DNA-Center local inventory system to determine the device capabilities and compatibilities verification. The Cisco DNA-Center leverages same SDG-Agent IP address to manage the system in its Inventory and Bonjour service-routing, thus the network address must have reliable and end-to-end reachable network. The network administrator must configure at least one service-filter with SDG-Agent in either Source or Query role to permit establishing the service-routing session with peers.
- **Cisco SDG-Agent Configuration** – The service-routing between Cisco DNA-Center and SDG-Agent is recommended to build over reliable IP interface providing better resiliency. The SDG-Agent network devices shall preferably use Loopback interface, if unavailable then alternatively use the Management VLAN interface. The dedicated switch management VRF port is not supported for Bonjour service-routing communication. The Cisco DNA-Center have dedicated Enterprise Network Port number 4 (enp9s0) to communicate with network devices for all applications. The SDG-Agent controller configuration must leverage same Virtual IP address to establish service-routing session. The service-routing session between Cisco DNA-Center and SDG-Agent devices operates reliably over destination TCP port 9991, if there is stateful firewall in data-path then network administrator must allow this port to successfully enable bi-directional communications.

```
!  
service-export mdns-sd controller WIDE-AREA-SERVICE-POLICY  
controller-address 10.0.1.1  
controller-port 9991  
controller-source-interface Loopback 0  
!  
mdns-sd gateway  
ingress-client query-suppression enable  
!
```

Wide Area Bonjour Controller Policy

The SDG-Agent mandatorily requires the controller bound Wide Area Bonjour service export policy to control routing local services and discover remote services from Cisco DNA-Center. As the Cisco DNA-Center and SDG-Agent builds trusted communication channel the remote service response from Wide Area Bonjour App is implicitly permitted at SDG-Agent. Hence the Wide Area Bonjour policy is unidirectional it only requires egress service policy towards controller.

The Wide Area Bonjour policy hierarchy and structure is identical as described in Local Area Bonjour Policy structure section. Following sub-section provides step-by-step reference configuration to build and enforce the policy to enable the successful communication with Wide Area Bonjour App in Cisco DNA-Center.

Service List – Built-In and Custom

The network administrator must create new controller bound egress service list for the Wide Area Bonjour domain. In most common network deployment model, the Wide Area Bonjour service list may contain same service-types as the Local Area Bonjour to implement common services between both domains. Based on requirements certain services can be limited to Local Area and prevent routed in Wide Area Domain, then by default only whitelisted service list entries are permitted and rest are dropped with implicit deny rule.

```
!  
mdns-sd service-list WIDE-AREA-SERVICES-OUT out  
match printer-ipps  
!
```

Ingress Policy Direction

The ingress service policy for Wide Area Bonjour domain is not required and cannot be associated to the controller.

Egress Policy Direction

As described the Bonjour policy structure between Local Area and Wide Area is consistent, however the enforcement point is different. Cisco recommends configuring separate Service-List and Service-Policy for Wide Area Bonjour domain as it may help building unique policy set and flexibility to adjust whitelisting services in each respective domain.

```
!  
mdns-sd service-policy DNAC-CONTROLLER-POLICY  
  service-list WIDE-AREA-SERVICES-OUT out  
!
```

```
!  
service-export mdns-sd controller WIDE-AREA-SERVICE-POLICY  
  controller-service-policy DNAC-CONTROLLER-POLICY  
!
```

Conditional Egress Service List

The Wide Area Bonjour egress service list configuration can be customized to conditionally route the service or query request to the Cisco DNA-Center. With this alternative configuration settings, the network administrator can route the service or query the request in Wide Area Bonjour domain from specific local source VLAN network instead globally from all mdns-sd gateway enabled interfaces of a system.

```
!  
mdns-sd service-list WIDE-AREA-SERVICES-OUT out  
  match apple-file-share source-interface <VLAN-A>  
!
```

Wide Area Bonjour Service Status Timer management

The Cisco DNA-Center centralizes the services information from large scale distributed SDG-Agents across the network. To maintain a scale and performance of controller the services routing information is transmitted and synchronized periodically by each SDG-Agent device. To protect system and network performance the scheduler base service information exchange allows graceful and reliable way to discover and distribute Bonjour services across Wide Area Bonjour domain.

In most large-scale network environment, the default service routing timers on SDG-Agents are fine-tuned and may not need any further adjustments. Cisco recommends retaining the interval timer values to default and adjust only based on any user experience issue with consideration to ensure modified parameters do not introduce scale and performance impact.

Monitor Wide Area Bonjour Controller Status

The Cisco IOS supports multiple show and debug commands for Wide Area Bonjour domain. The network administrator can use “**show mdns-sd controller**” command-line to verify statistics at various level providing controller policy and statistics information for advanced monitoring and troubleshooting of services in Wide Area Bonjour domain.

```
SDG-Agent#show mdns-sd controller detail
```

```
Controller : WIDE-AREA-BONJOUR-POLICY  
IP : 10.251.1.1, Dest Port : 9991, Src Port : 170, State : UP  
Source Interface : Loopback0, MD5 Enabled, Synchronized  
Hello Timer 30 sec, Dead Timer 120 sec, Next Hello 00:00:21  
Uptime 1w4d (13:36:35 EDT Aug 20 2019)  
Service Buffer : Enabled
```

```
Service Announcement :  
Filter : DNAC-CONTROLLER-POLICY  
Count 50, Delay Timer 30 sec, Pending Announcement 0, Pending Withdraw 0  
Total Export Count 8, Next Export in 00:00:21
```

```
Service Query :  
Query Suppression Enabled  
Query Count 50, Query Delay Timer 15 sec, Pending 0  
Total Query Count 105, Next Query in 00:00:14
```

Cisco Wide Area Bonjour Service-Routing Designs

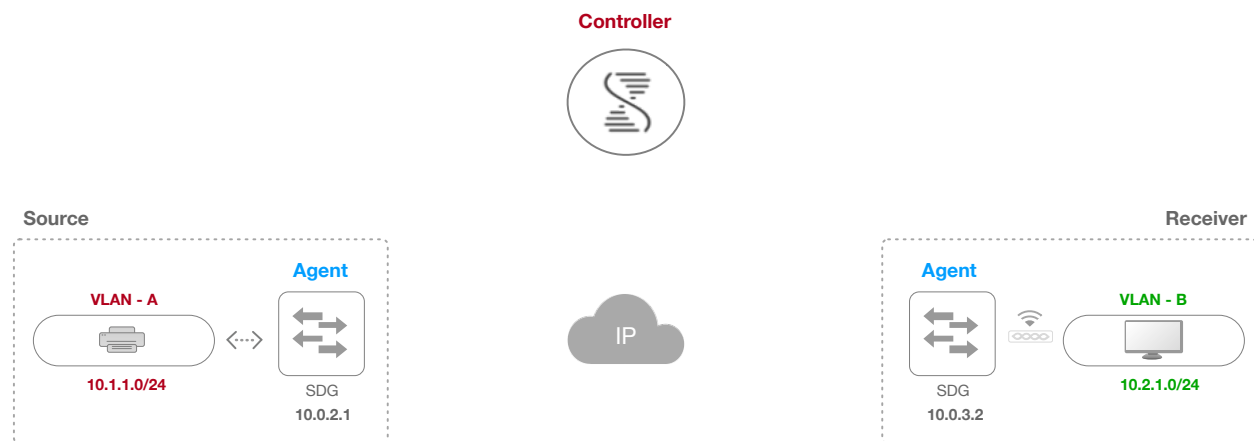
The Cisco Wide Area Bonjour application policy provides flexibility to build various types of service-routing topologies in the Wide Area Bonjour domain. From Cisco DNA-Center the network administrator can build flexible service-routing policies permitting one or more source SDG-Agent distributing services to one or more receiver SDG-Agent devices across the Wide Area Bonjour domain.

This sub-section provides reference service-routing topologies that network administrator may consider when building the service-filter policies in Wide Area Bonjour application:

1:1 Topology

The service-discovery boundary between service-provider and the receiver (wired or wireless) users can be limited between a single pair of SDG-Agent. In this 1:1 service-topology the network administrator must select source SDG-Agent and specific source network address or any to accept the Bonjour services. Figure – 16 below illustrates 1:1 service-topology between wired and wireless SDG-Agent thru Cisco DNA-Center:

Figure 16 – Cisco Wide Area Bonjour 1:1 Service-Routing Topology

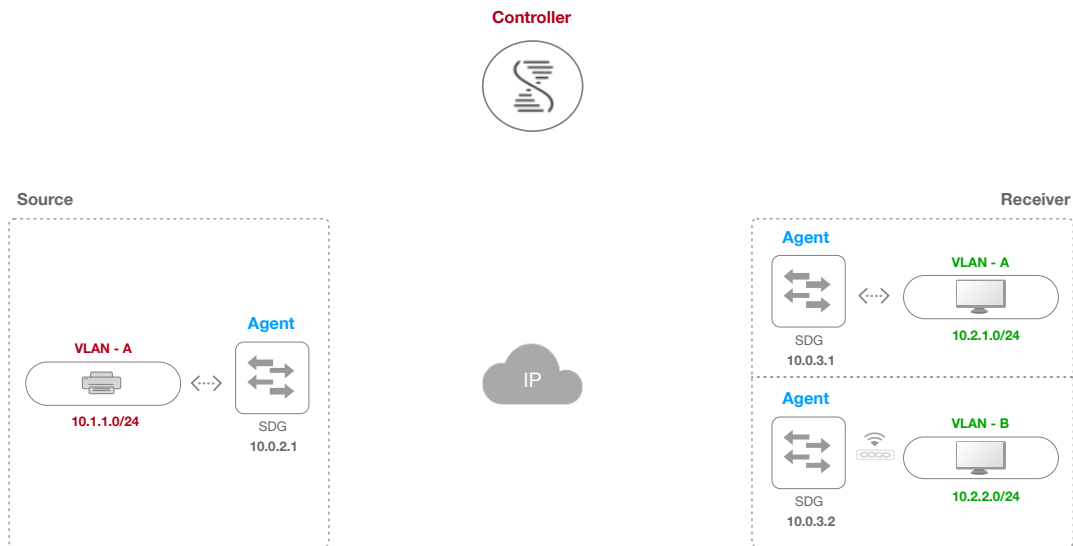


With above service-routing topology, the Wireless users connected to network 10.2.1.0/24 can dynamically discover Wired printer sourced from 10.1.1.0/24 network. No other user-group from any other network can discover the print services based on this policy. However, on same policy the network administrator can add more networks on either end allowing more users and devices discovery between two selected SDG Agent on this 1:1 service-routing topology.

1:N Topology

The service-routing boundary can be expanded beyond single gateway on remote side. The single service source SDG-Agent can be distributing services to multiple SDG-Agent in the network. Following to the same rule, this service-routing topology allows one or more services routing to other locations connecting wired or wireless users. Figure – 17 below illustrates 1:N service-topology from one wired source to multiple wired and wireless SDG-Agent thru Cisco DNA-Center:

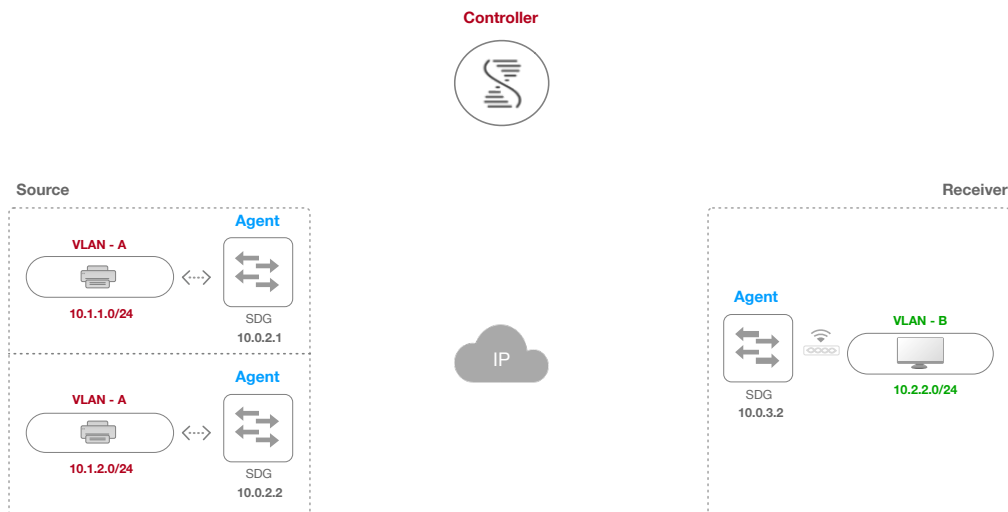
Figure 17 – Cisco Wide Area Bonjour 1:N Service-Routing Topology



N:1 Topology

This reverse 1:N service-routing model is an scenario where there are multiple source SDG-Agents in the network providing services to single receiving SDG-Agent. The use-case for such service-routing topology requirement may vary in Enterprise networks. Figure – 18 below illustrates *n*:1 service-topology from multiple source wired SDG-Agents to single wireless SDG-Agent thru Cisco DNA-Center:

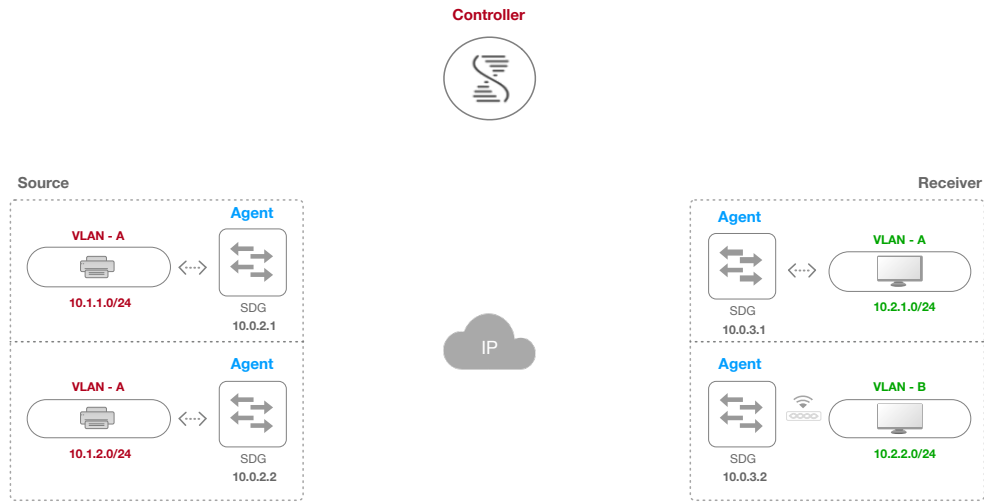
Figure 18 – Cisco Wide Area Bonjour *n*:1 Service-Routing Topology



N:N Topology

This any-to-any service-routing model can be bundle with multiple source SDG-Agent advertises services to multiple receivers SDG-Agent using single service-filter rule. The Cisco Wide Area Bonjour application do not have any limits on number of SDG-Agent and services; however, appropriate-level of design consideration must be done to limit services distribution in large scale network. Figure – 19 below illustrates N:N service-topology from multiple source and receivers SDG-Agents t thru Cisco DNA-Center:

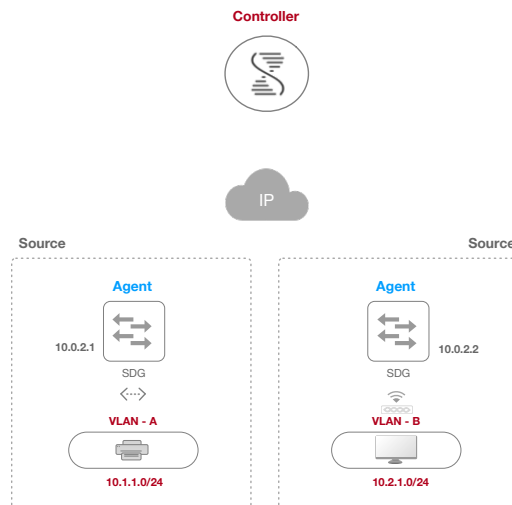
Figure 19 – Cisco Wide Area Bonjour N:N Service-Routing Topology



Standalone Topology

The Standalone topology is between Cisco DNA-Center and source-only SDG-Agent. This topology provides central management and monitoring capabilities of network-wide service assurance using Cisco Wide Area Bonjour application. In Standalone policy configuration the network administrator simply needs to assign one or more source SDG-Agent devices with no receiver SDG-Agent. Figure – 20 below illustrates Standalone service-topology with multiple individual source-only SDG-Agents to centrally manage and monitor services thru Cisco DNA-Center:

Figure 20 – Cisco Wide Area Bonjour Standalone Service-Routing Topology



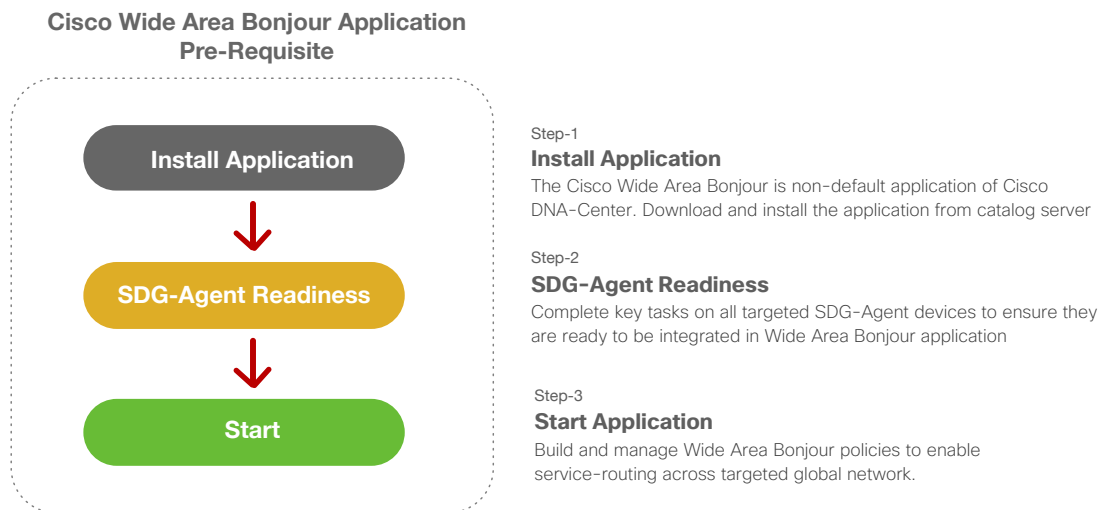
Deploying Wide Area Bonjour Application

The Cisco Wide Area Bonjour application is add-on service in Cisco DNA-Center that enables the Bonjour Controller function to be paired with network-wide distributed and managed SDG-Agent devices. The Cisco Wide Area Bonjour supports building stateful service-routing peering with network-wide SDG-Agents and provides broad-level of assurance capabilities to manage and monitor Bonjour services throughout the Wide Area Bonjour domain. This sub-section provides guidelines on deploying, managing and monitoring the Bonjour services in Wide Area Bonjour domain from the Cisco DNA-Center.

Cisco Wide Area Bonjour Application Pre-Requirement

The network administrator must follow pre-requisites procedure to complete the requirements of Wide Area Bonjour prior implementing the network-wide service-routing. Figure – 21 below illustrates three simple step-by-step process to complete prior start using Cisco Wide Area Bonjour application:

Figure 21 – Cisco Wide Area Bonjour Application Pre-Requirement



This sub-section provides brief instructions on completing each required step and their tasks to successfully start the service it is recommended to follow the Cisco DNA-Center Configuration guides from cisco.com for additional details.

Install Application

The network administrator requires appropriate login credential for Cisco DNA-Center and download the Wide Area Bonjour application from the network cloud. The Cisco DNA-Center needs valid CCO credentials and network reachability to discover the updates and proceed further on next step to complete successful installation process. Refer to Cisco DNA-Center Wide Area Bonjour Configuration guide to follow application installation procedure.

SDG-Agent Readiness

As part of initial deployment phase, the Cisco SDG-Agent devices requires to complete following three key tasks to ensure the devices will be prepared to start building Wide Area Bonjour domain:

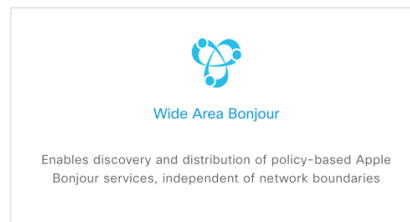
- **Software and License** – The Cisco SDG-Agent devices must be running minimum software version and license. If required, the Cisco SDG-Agent devices can be upgraded thru Cisco DNA-Center Image Management or other traditional methods. Refer to Table – 24 in Solution Matrix section for software licensing details. The license can be updated thru Cisco DNA-Center License Manager application or other traditional methods.
- **Policy Configuration** – The Cisco Wide Area Bonjour application currently does not provide model-based policy automation to the SDG-Agent network devices. The network administrator must manually configure Local and Wide Area Bonjour policies and configurations or can automate using Cisco DNA-Center Template tool.
- **Managed** – All targeted SDG-Agent network devices must be added in Cisco DNA-Center Inventory and successfully reach to managed state. The Cisco DNA-Center can automatically discover the network devices based integrated Discovery tool or can be manually added. The managed IP address must be recommended Loopback interface or alternate to Management interface of an SDG-Agent network device. The Cisco Wide Area Bonjour application builds service-routing peering over same selected management interface.

The Cisco Wide Area Bonjour application may not list the SDG-Agent to build global service-policy if any of the above criteria fails to meet the requirements.

Start Application

After successful application installation the Cisco Wide Area Bonjour application can be found under Tools sections. Figure – 22 below illustrates application icon for the Cisco Wide Area Bonjour application:

Figure 22 – Cisco Wide Area Bonjour application



The Cisco Wide Area Bonjour application in Cisco DNA-Center version 1.3.1.0 is standalone application is not fully integrated with all other applications and tools of Cisco DNA-Center such as Site and Building Hierarchy, Topology etc. In future the application enhancements will enable unified service function following common principles as all other Cisco DNA-Center applications.

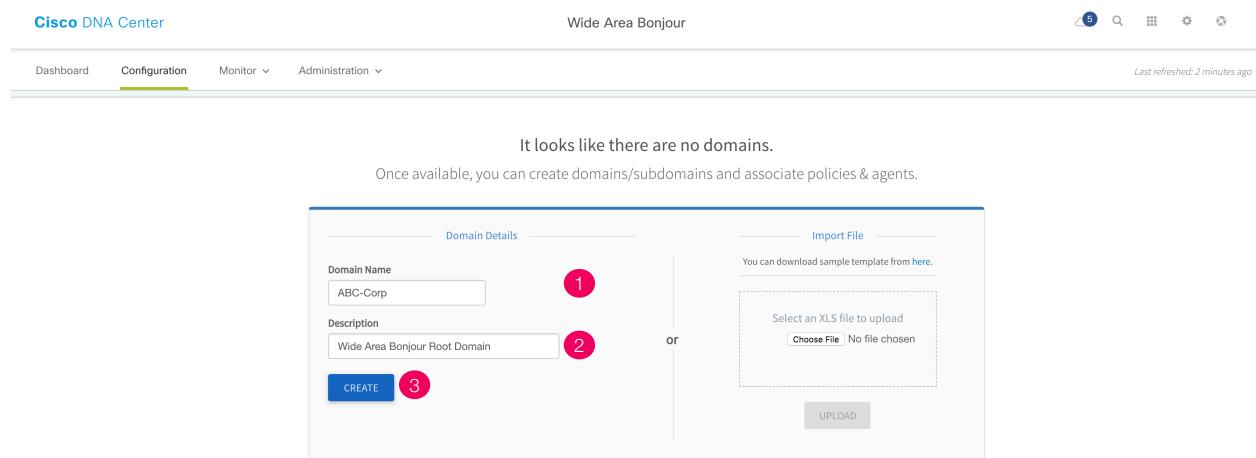
Configuring Cisco Wide Area Bonjour Service Domains

The Cisco Wide Area Bonjour application supports logical service domain constructs that can be used for building hierarchical global service-routing policies. The domain consists of following two simple structure levels that network administrator must create prior start building global service-routing policy to discover the service from source and route to other receiver SDG-Agent in Wide Area Bonjour domain network.

Root Domain

The service root domain is first initial step to build policy hierarchy in Cisco Wide Area Bonjour application. The Root domain holds complete logical grouping of policies, service-cache database, service assurance and more. In this initial application configuration step, the network administrator can create Root domain with any user-defined name, i.e. ABC-Corp representing the organization name. Figure – 23 below illustrates initial domain configuration step to configure Cisco Wide Area Bonjour application.

Figure 23 – Cisco Wide Area Bonjour Application Root Domain Configuration



Sub-Domain

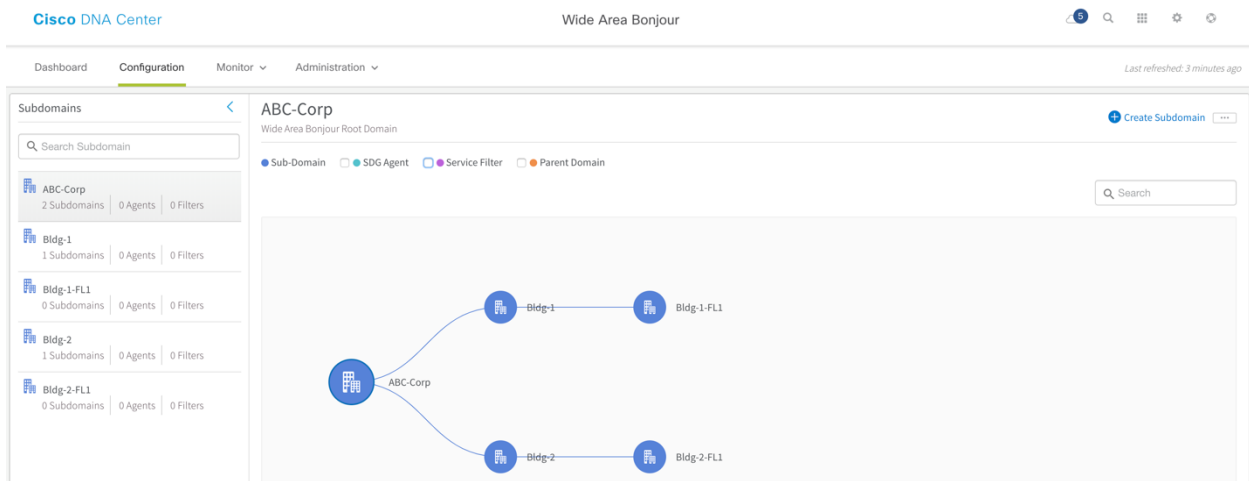
The sub-domain is logical and flexible structure of building service filters for Wide Area Bonjour. The network administrator can create one or more sub-domain with parent Root domain, for example two new sub-domains can be created under ABC-Corp domain. Each sub-domain can be uniquely labelled as Bldg-1 and Bldg-2 that aligns building structure plan of ABC-Corp organization. The network administrator can create additional sub-domain for different Floorplans to each parent sub-domain enabling complete building hierarchy. Table – 7 below provides step-by-step reference guidance to build sub-domain configuration hierarchy under the Root domain:

Table 7 – Cisco Wide Area Bonjour Sub-Domain Configuration Task

Task	Step
Select Root domain	Click to select ABC-Corp from left-panel
Create first-tier sub-domains to the Root domain.	Click + Create Subdomain to add new sub-domain, i.e. Bldg-1 and click Create button
Select sub-domain from domain-list in left-panel.	Click to select Bldg-1 from left-panel.
Create second-tier sub-domains.	Click + Create Subdomain to add new sub-domain, i.e. Bldg-1-FL1 and click Create button

Figure – 24 below illustrates reference diagram of Wide Area Bonjour domain and sub-domain hierarchy in the application as initial step configuration.

Figure 24 – Cisco Wide Area Bonjour Application Sub-Domain Hierarchy



In summary, the notion of domain structure and hierarchy in Cisco Wide Area Bonjour application is to provide network administrator a flexible configuration and assurance capabilities to build site and network hierarchy where they would like to build and manage global service-routing policies.



Configuring Cisco Wide Area Bonjour Policy

The global service-routing structure in Cisco Wide Area Bonjour application provides flexibility to enable service-routing from any-to-any in large scale environment. The service announcement or service query request must pass implemented all policy for Cisco Wide Area Bonjour application to accept the service provider information to transmit to requesting SDG-Agent.

Service-Filter

The Service-Filter is a global service-routing policy that can be created at any level of the domain in Cisco Wide Area Bonjour application. The simplified policy structure allows network administrator to configure basic parameters and SDG-Agents in specific role and network information to enable service-routing. Table – 8 below provides configuration guidelines to create new service-filter to enable Bonjour service discovery from wired SDG-Agent and distribution to another wireless SDG-Agent switch:

Table 8 – Cisco Wide Area Bonjour Service-Filter Navigation

Task	Step
Select sub-domain domain.	Click sub-domain from left-panel, i.e. Bldg-1-FL1
Select Service Filter from the configuration panel to expand the policy-panel.	Click to select <input checked="" type="checkbox"/> <input type="checkbox"/> Service Filter the sub-domain and click the Service-Filter 
Create new Service Filter.	Click  Create Service Filter to add new service-filter

The intuitive and flexible configuration service-filter supports various service-routing topologies using single service-filter policy. It is imperative to understand the constructs and function of service-filter to enable service discovery and distribution from distributed SDG-Agent devices. Figure – 25 below illustrates and reference creating new service-filter under selected sub-domain:

Figure 25 – Cisco Wide Area Bonjour Service Filter

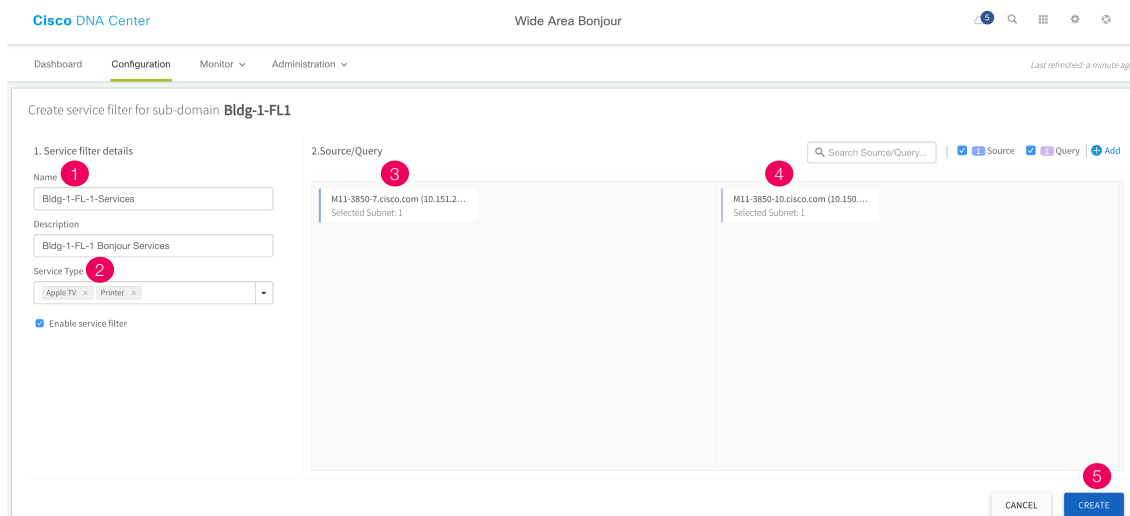






Table – 9 below provides step-by-step configuration task to build Cisco Wide Area Bonjour service filter on selected sub-domain of application.

Table 9 – Cisco Wide Area Bonjour Service Filter Configuration Task

Task	Step
Create new service-filter	Create new unique service-filter name, i.e. Bldg-1-FL1-SERVICES
Select Wide Area Bonjour services	Click drop-down menu to select one or more services for this service-filter. Create custom service from Administration → Service-Type for additional services.
Enable service-filter in Cisco Wide Area Bonjour domain	Click <input checked="" type="checkbox"/> Enable : to activate service-filter.
	Uncheck to allow service-filter configuration but disable processing. Default state is enabled.
Add SDG-Agent to the service-filter	Click  Add button to open new SDG-Agent configuration panel.
Select Type Source for SDG-Agent	Click  Source button to select SDG-Agents advertising service to Cisco DNA-Center
Add source SDG-Agent information to the service-filter. Repeat to add more.	Click drop-down menu to select source SDG-Agent device. Click to select Any or source network to permit services from specific IPv4 and IPv6 network.
Select Type Query for SDG-Agent	Click  Query button to select SDG-Agents discover services from Cisco DNA-Center
Add receiver or query SDG-Agent information to the service-filter. Repeat to add more.	Click drop-down menu to select query SDG-Agent device. Click to select Any or query network to permit request from specific IPv4 and IPv6 network.
Activate the service-filter to enable the processing	Click  to create the configured Wide Area Bonjour global service-routing policy.

Configuring Cisco Wide Area Bonjour Service-List

The Bonjour service-provider may provide one or more types of sub-services, such as single multifunction printer, i.e. Printer name Bldg-1-PRN may advertise Print, Mobile Print, Scan, Fax and more sub-services in the network. Each of these sub-services are announced in form of mDNS PoinTeR (PTR) records that needs to be part of policy in Local Area and Wide Area Bonjour domain to permit service discovery and distribution in the global network. The Cisco Wide Area Bonjour application supports built-in Service-List for commonly found Bonjour services in the network. By default, the application pairs the common type of PTR enabling sub-services in the network.

The network administrator can leverage the default service-list or create custom entry to enable new services across Wide Area Bonjour domain network. The mDNS PTR records are simple in regular-expression format that each endpoint supports with unique record name for specific services. The service name and transport protocol port numbers that may be IANA registered or unregistered. The network administrator must identify the custom PTR record from manufacturer guide or use service scanner tools to discover running custom service PTRs from targeted network segments prior creating custom entries. Figure – 26 below illustrates reference diagram in creating custom service-list entry Cisco DNA-Center:

Figure 26 – Cisco Wide Area Bonjour Custom Service-List

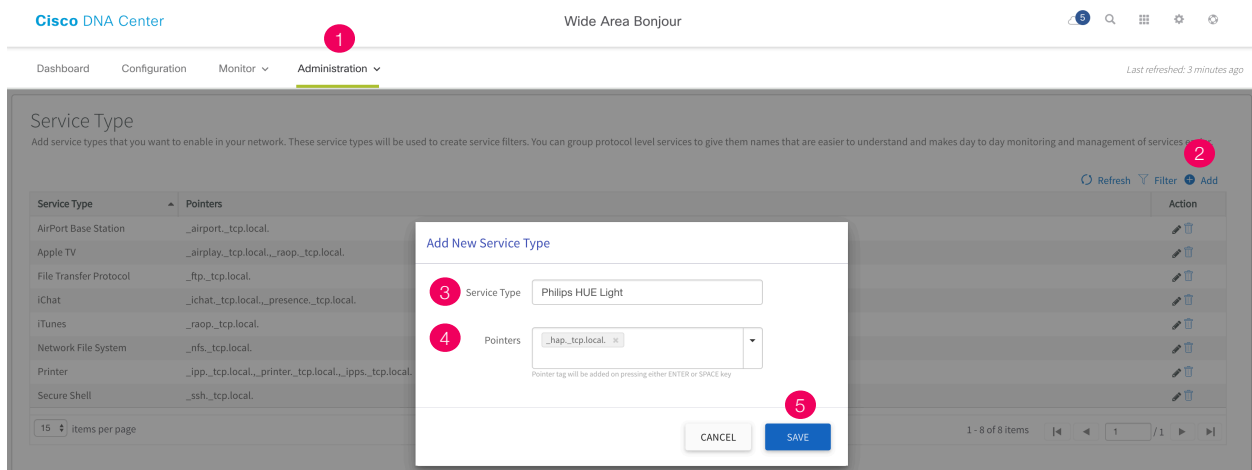




Table – 10 below provides step-by-step configuration task to create new custom service-list entry in Cisco Wide Area Bonjour application.

Table 10 – Cisco Wide Area Bonjour Custom Service Type Configuration

Task	Step
Go to Administration section.	Click Administration → Service-Type and click  Add to create new custom services-list entry.
Add service-list name and record(s).	Add new and unique Service Type name, i.e. Philips HUE Light. In Pointers section add mDNS PTR record for this service, i.e. _hap._tcp.local. It is important to end each PTR with “.” and press Return or Enter to create new entry. For multiple PTR records add comma (,) as de-limiter between two records.
Save custom service-list.	Click  button to save new custom service-list entry in application database.

Cisco Wide Area Bonjour Application Assurance

To manage, monitor and troubleshoot the Wide Area Bonjour domain for the day-*n* operation the Cisco Wide Area Bonjour application supports various level of integrated service assurance capabilities. The network administrator can monitor network-wide activities at various levels ranging from services and SDG-Agent statistics, per sub-domain level services count and validating the agents and policy operational status. The end-to-end service-routing detail in Wide Area Bonjour can be monitored on per-instance level providing granular details from origination point, advertising SDG-Agent, domain policy and much more.

This sub-section focuses on providing operational details around four different types of Cisco Wide Area Bonjour application assurance capabilities – Dashboard, Sub-Domain 360°, Detail View and Troubleshooting.

Dashboard

The Cisco Wide Area Bonjour dashboard provide real-time aggregated information about services counts and states visibility combined with top talkers across the Wide Area Bonjour domain. From this startup-screen of Wide Area Bonjour application the network administrator can verify the overall health of Wide Area Bonjour domain with SDG-Agent device reachability, service-routing status and Query statistics in real-time to identify next steps to resolve if any challenge. Figure – 27 below illustrates a reference view of Cisco Wide Area Bonjour application dashboard screen:

Figure 27 – Cisco Wide Area Bonjour Application Dashboard



The Dashboard view is divided in following three major assurance categories:

- **Network Dashlet** – The Network Dashlet is top view of Dashboard screen providing aggregated statistics of overall sub-domain, SDG-Agent and services.
- **Global Query Statistic** – A line graph with time history that provides chart view of Wide Area Bonjour service discovery requests to Cisco DNA-Center from remote SDG-Agent devices.
- **Top-Talker** – The Top-5 talkers in the network providing quick scale overview of top sub-domains, SDG-Agents with high services and service types in the network.

Sub-Domain 360°

The network administrator can get 360° statistics view of Sub-Domain and associated parameters from the Configuration tab. The key objective of 360° statistics is to provide brief information at individual sub-domain basis instead global level visualization on Dashboard. The Sub-Domain 360° gives an ability to navigate the different levels of hierarchical domain structure and verify the aggregated statistics for policy configuration, service-instance count and much more.

The Sub-Domain 360° view can be grouped in two-level parameters comprising Policy and SDG-Agent of selected Sub-Domain. Figure – 28 below illustrates a reference Sub-Domain 360° view of SDG-Agent statistics:

Figure 28 – Sub-Domain 360° Sub-Agent Statistics

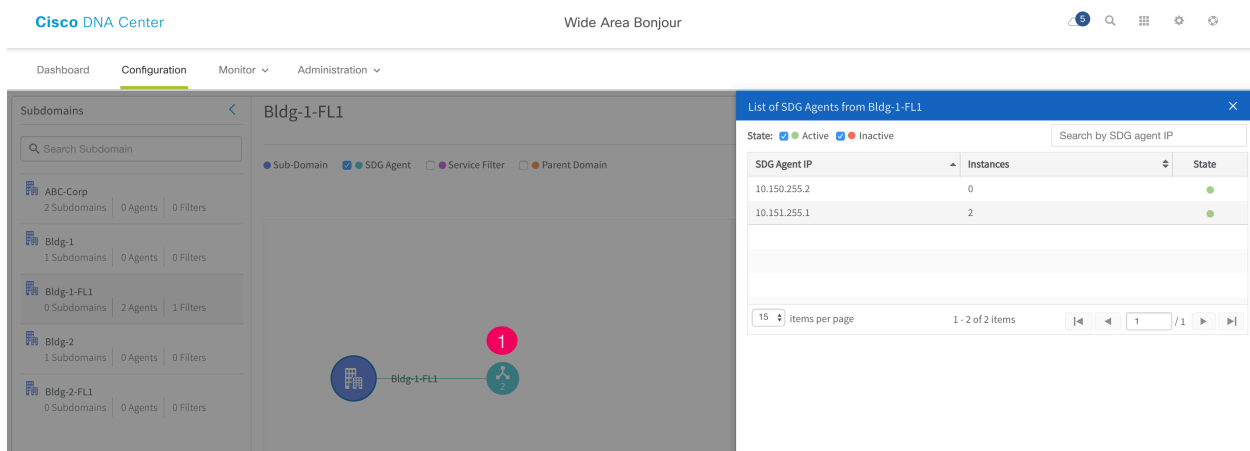



Table 11 – Cisco Wide Area Bonjour Sub-Domain 360° Sub-Agent Statistics

Task	Step
Select Sub-Domain from Left-Panel.	Select Sub-Domain to open 360° statistics view.
Select SDG Agent.	Click checkbox for SDG Agent to expand selected sub-domain hierarchy providing aggregated SDG-Agent count information.
Expand SDG Agent Information.	Click  button to open 360° view of each SDG-Agent of select Sub-Domain.
Verify SDG Agent 360° Status.	<p>Verify three key indicators of one or more SDG Agents from selected Sub-Domain:</p> <ul style="list-style-type: none"> • SDG Agent IP – An IP address of SDG-Agent selected based on service-filter policy configuration. • Instances – Aggregated count of Bonjour services discovered from each source SDG-Agent network device. • State – The service-routing state between Cisco DNA-Center and SDG-Agent device. In normal up and operational state it shows Green, else Red color when peering is down.

The Service-Filter 360° provides two key options for network administrator to build and manage the global policies. The network administrator can select SDG-Agent and Service-Filter to view or create new Service-Filter on selected Sub-Domain. Figure – 29 below illustrates a reference Sub-Domain 360° view of Service-Filter statistics:

Figure 29 – Sub-Domain 360° Service-Filter Statistics

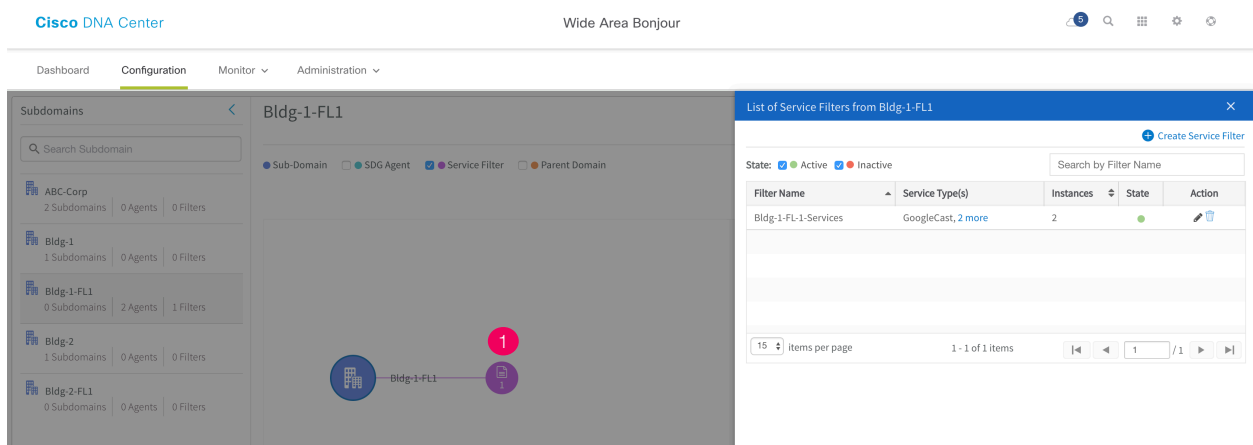



Table 12 – Cisco Wide Area Bonjour Sub-Domain 360° Service-Filter Statistics

Task	Step
Select Sub-Domain from Left-Panel.	Search or select Sub-Domain to view 360° statistics
Select Service-Filter.	Click checkbox for Service Filter to expand selected sub-domain hierarchy providing aggregated Service Filter count information.
Expand SDG Agent Information.	Click  button to open 360° view of each Service-Filter of select Sub-Domain.
Verify SDG Agent 360° Status.	<p>Verify five key indicators of one or more Service-Filter from selected Sub-Domain:</p> <ul style="list-style-type: none"> • Filter Name – Admin created global Service-Filter on selected sub-domain • Service-Type(s) – Types of Bonjour service(s) permitted allowed for global discovery and distribution • Instances – Total aggregated service-instance count discovered from one or more source SDG-Agents on each Service-Filter • State – Service-Filter in Active state enables service-routing peering, service discovery and distribution between all SDG-Agents. If Inactive state it disables service-routing between all SDG-Agents part of this Service-Filter. • Action – The network administrator can Edit or Delete the selected Service-Filter.

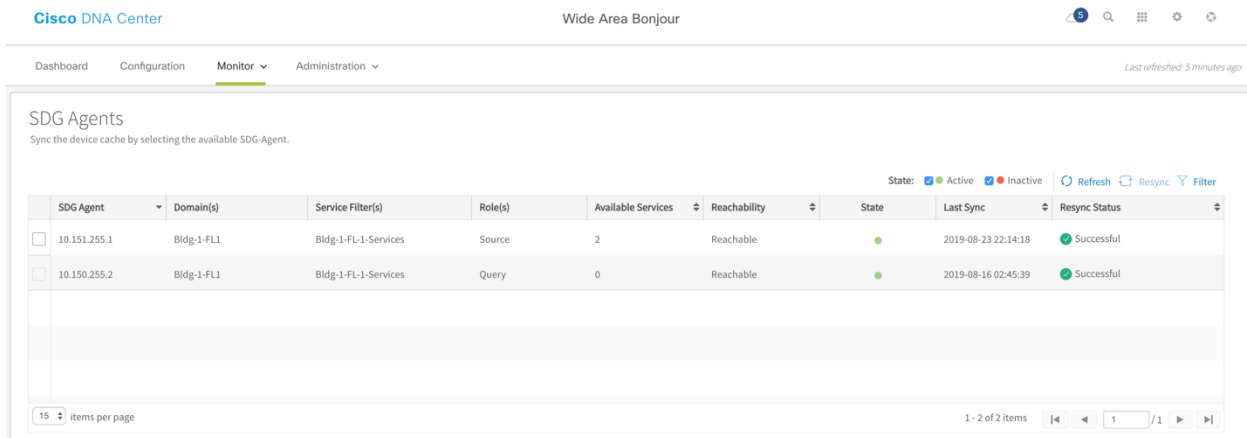
Detail View

The Cisco Wide Area Bonjour application supports detail monitoring and service-routing status from the Monitor tab. The detail view can also provide abilities to troubleshoot if there are service-routing issues at individual service-instance level or an SDG-Agent level. The Monitor section is sub-divided in following categories:

- **SDG-Agent Detail** – This page provides detail information to understand the configuration, statistics and status of each SDG-Agent. In addition, the network administrator can select one or more source SDG-Agent to manually force service cache resynchronization to update global information in Cisco DNA-Center.
- **Service-Instance Detail** – This page provides details information of each Bonjour service-instance information and their routing status can be verified.

Figure – 30 below illustrates a reference detail view of SDG-Agent listing and various associated parameters to each network devices

Figure 30 – Monitoring SDG-Agent Detail



The screenshot shows the Cisco DNA Center interface for the Wide Area Bonjour application. The 'Monitor' tab is selected, displaying a table of SDG Agents. The table has columns for SDG Agent, Domain(s), Service Filter(s), Role(s), Available Services, Reachability, State, Last Sync, and Resync Status. Two agents are listed: 10.151.255.1 (Source role, 2 services) and 10.150.255.2 (Query role, 0 services). Both are in a 'Reachable' state and have a 'Successful' resync status.

SDG Agent	Domain(s)	Service Filter(s)	Role(s)	Available Services	Reachability	State	Last Sync	Resync Status
<input type="checkbox"/> 10.151.255.1	Bldg-1-FL1	Bldg-1-FL-1-Services	Source	2	Reachable	●	2019-08-23 22:14:18	● Successful
<input type="checkbox"/> 10.150.255.2	Bldg-1-FL1	Bldg-1-FL-1-Services	Query	0	Reachable	●	2019-08-16 02:45:39	● Successful

Table 13 – Cisco Wide Area Bonjour SDG-Agent Monitoring


Task	Step
Go to Detail SDG Agent Monitoring.	Click Monitor Tab → and select SDG Agents from sub-menu.
Optional. Manual Services resynchronization in Wide Area Bonjour domain.	Click checkbox to select one or more SDG-Agents and click  Resync button to start manual service resynchronization process.
Verify SDG-Agent Detail Status.	<p>The SDG-Agent detail page provides multiple key indicators pertaining to configuration and operational state:</p> <ul style="list-style-type: none"> • SDG Agent – List of SDG-Agents part of one or more Service-Filter policy configuration. • Domain – Name of one or more sub-domain where each SDG-Agents are associated. • Service-Filter – Name of one or more Service-Filter where each SDG-Agents are associated. • Role(s) – The SDG-Agent can be in Source role advertising services to Cisco DNA-Center or it can be in Query role requesting services from Cisco DNA-Center. In bi-directional scenario the same SDG-Agent are in Source and Query roles. • Service-Filter – Name of one or more Service-Filter where each SDG-Agents are associated with policy. • Available Services(s) – Total service-instance count received from each source SDG-Agent. • Reachability – SDG-Agent network reachability and SNMP manageability status. • State – Service-routing peering status between Cisco DNA-Center and each SDG-Agent. • Last Sync – Timestamp of services synchronization between Cisco DNA-Center and source SDG-Agent. • Resync Status – Manual service-instance resynchronization status.

Figure – 31 below illustrates a reference detail view of Service-Instance listing and various associated parameters to each Bonjour services discovered from various source SDG-Agent based on service-filter policy configuration:

Figure 31 – Monitoring Service-Instance Detail

The screenshot shows the Cisco DNA Center interface for monitoring Wide Area Bonjour services. The page title is 'Service Instance' and it includes a description: 'Monitor all the services announced by the network devices that are available with Wide Area Bonjour application which are used for serving the queries received by the application.' The interface features a navigation menu with 'Dashboard', 'Configuration', 'Monitor', and 'Administration'. A status bar indicates 'Last refreshed: 2 minutes ago'. The main content area contains a table with columns for Name, Instance Suffix, Domain(s), Service Filter(s), SDG Agent IP, Service Type(s), TTL, Instance IPv4, Instance IPv6, MAC Address, and State. Two service instances are listed: 'Bldg-1-FL1-PRN' and 'Bldg-1-FL1-ATV'. The table also includes a legend for 'State' (Active/Inactive), 'Refresh', and 'Filter' buttons. At the bottom, there is a pagination control showing '15 items per page' and '1 - 2 of 2 items'.

Name	Instance Suffix	Domain(s)	Service Filter(s)	SDG Agent IP	Service Type(s)	TTL	Instance IPv4	Instance IPv6	MAC Address	State
Bldg-1-FL1-PRN		Bldg-1-FL1	Bldg-1-FL1-Services	10.151.255.1	Printer,	4500	10.151.1.2	2001:10:151:1:ae18:26ff:fe51:3fe	ac:18:26:51:03:fe	●
Bldg-1-FL1-ATV		Bldg-1-FL1	Bldg-1-FL1-Services	10.151.255.1	Apple TV,	4500	10.151.1.3	2001:10:151:1:8ec:fa69:4a42:448e	c8:69:cd:7e:28:f1	●

Table 14 – Cisco Wide Area Bonjour Application Service-Instance Monitoring

Task	Step
Go to Service-Instance section.	Click Monitor Tab → and select Service-Instance from sub-menu.
Verify Bonjour Service-Instance Detail Status.	<p>The Service-Instance page consist of status for each service-instance, origination point, policy and reachability information in the Wide Area Bonjour domain:</p> <ul style="list-style-type: none"> • Name – The original service-instance name advertised by Bonjour source endpoint. • Instance Suffix – Optional text-string appended to original service-instance name for any type of administrative purpose. • Domain(s) – Sub-Domain name from where Bonjour service is discovered. • Service Filter(s) – Service-Filter Name that was verified and permitted to accept service from source SDG-Agent network device • SDG Agent IP – Source SDG-Agent advertised Bonjour service(s) to the Cisco DNA-Center. • Service Type(s) – Types of mDNS services announced by each mDNS endpoints. • TTL – Long-lived mDNS TTL value of 4500 sec remains intact across Wide Area Bonjour domain. • IPv4 Address – An IPv4 address (A record) of mDNS endpoints. • IPv6 Address – A globally routed IPv6 address (AAAA record) of mDNS endpoints. • MAC Address – Original Wired or Wireless MAC address of mDNS endpoints. • Status – The service-instance will be distributed to Querying SDG-Agent if state Active. The service-instance entries marked as Inactive will be prevented from global distribution if withdrawn from source SDG-Agent. The Inactive entries are automatically purged after 24 hours.

Troubleshooting

The Cisco Wide Area Bonjour application supports built-in troubleshooting capabilities that allows network administrator to debug the service-routing, discovery and distribution issues in the network. The troubleshooting logs can be collected from Cisco DNA-Center backend at various levels based on specific range of date and time. The troubleshooting reports is generated on simple CSV format and downloaded to the computer to review the problem based on selected logging level parameters.

The generated reported is also very useful information to be shared with Cisco support team to investigate the problem if network administrator cannot self-resolve. Figure – 32 below illustrates the reference view of Troubleshooting page of Cisco Wide Area Bonjour application:

Figure 32 – Cisco Wide Area Bonjour Troubleshooting

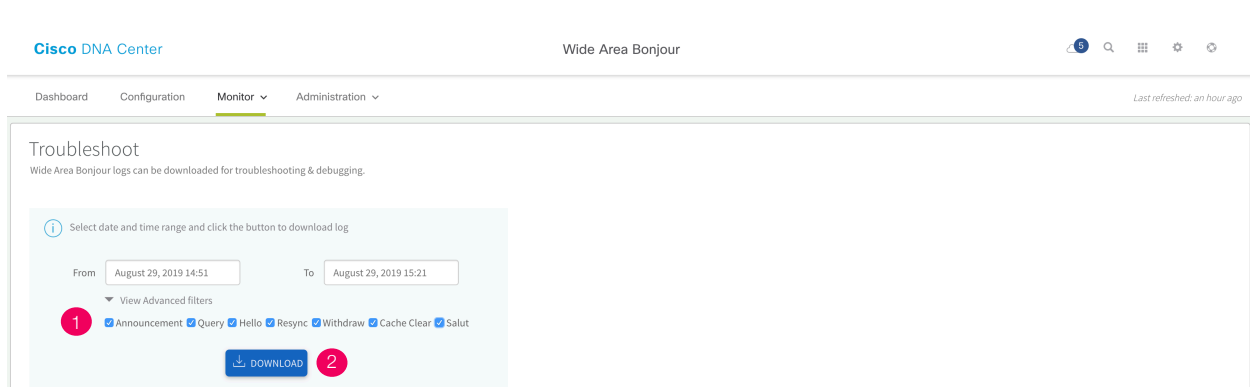


Table 15 – Cisco Wide Area Bonjour Application Troubleshooting Task

Task	Step
Go to Troubleshooting section.	Click Monitor Tab → and select Troubleshooting from sub-menu.
Define time range to collect log information.	Select range of Date and Time in From and To form to collect the Troubleshooting log from Cisco DNA-Center and download in local computer.
Define Troubleshooting Log Level.	<p>The Troubleshooting log file can consist of various level communication details between Cisco DNA-Center and SDG-Agent. Select options for targeted problem to be resolved:</p> <ul style="list-style-type: none"> • Announcement – Select Announcement when SDG-Agent announced services cannot be found on Cisco DNA-Center. • Query – Select Query when Wired or Wireless users unable to see remote services from Cisco DNA-Center. • Hello – Select Hello when service-routing peering session between Cisco DNA-Center and SDG-Agent is unstable or fail to establish. • Resync – Select Resync when manual service resynchronization is triggered from Cisco DNA-Center to one or more SDG-Agent. • Withdraw – Select Withdraw to collect information when source SDG-Agent sends service withdrawal message to prevent global distribution. • Cache Clear – Select this option to collect log for all services withdrawal message from SDG-Agent with manual CLI step. • Salut – Initial communication messages between SDG-Agent and Cisco DNA-Center.

Cisco Wide Area Bonjour Application Administration

The administration section of Cisco Wide Area Bonjour application allows network administrator to build and manage global services parameters and policy configuration file management. The features in this section can be used during initial or any day-*n* deployment stage to complete regular network operation tasks. The network administrator can manage application service, database and SDG-Agent global parameters from the Administration menu tab. The policy configuration management is flexible to manage importing or exporting at domain level hierarchy without causing any service-routing disruption or downtime.

This section is divided in multiple sub-sections focusing on different application administration capabilities that network administrator can use to manage the Wide Area Bonjour domain.

Global Parameters

The global parameters are common configuration set that is applied to all SDG-Agent paired with Cisco Wide Area Bonjour application. The network administrator can build secure the service peering communication with all SDG-Agent using MD5 authentication and can adjust default keepalive timer settings to maintain service peering. In Cisco Wide Area Bonjour architecture these service routing parameters are part of initial handshaking and set based on value configured in global settings.

As these global configuration parameters are centrally managed in control-plane from Cisco DNA-Center there are no relevant CLI automated to network devices. The network administrator change update such service-routing parameters that are dynamically adjusted without resetting existing peering session thus providing best-in-class service resiliency in the network. Figure – 33 below illustrates reference view of global parameters settings.

Figure 33 – Cisco Wide Area Bonjour Global Parameters

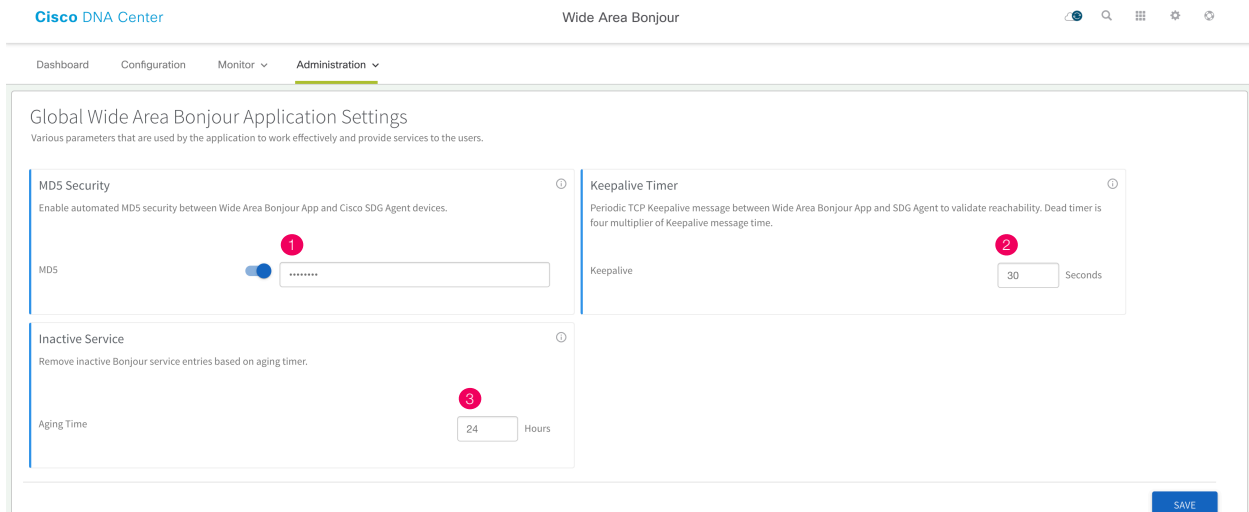


Table 16 – Cisco Wide Area Bonjour Global Parameter Configuration

Task	Step
Go to Global Parameter section.	Click Administration Tab → and select Global from sub-menu.
Secure SDG-Agent service peering sessions.	Slide the button to enable MD5 authentication security between Cisco DNA-Center and SDG-Agent devices.
Adjust service peering timers.	By default, the Hello message timer between Cisco DNA-Center and SDG-Agent is set to 30 seconds with four multiplier of 120 seconds dead-interval timer. The value can be adjusted between 15-120 seconds.
Inactive Service Maintenance.	The Cisco DNA-Center holds inactive services information for up to 24 hours by default. The value can be adjusted between 1-24 hours.

Service-Type Database

The Cisco DNA-Center supports built-in Service-Type database with user-friendly Bonjour service name paired minimum requirement mDNS PTR records to enable and use the services across Wide Area Bonjour domain. Like Cisco IOS-XE operating system, the Cisco DNA-Center Bonjour Service-Type database provides flexibility to create custom service entries if default values do not meet the requirements. Figure – 34 below illustrates reference view of Service-Type in Cisco Wide Area Bonjour application:

Figure 34 – Cisco Wide Area Bonjour Application Service-Type Database

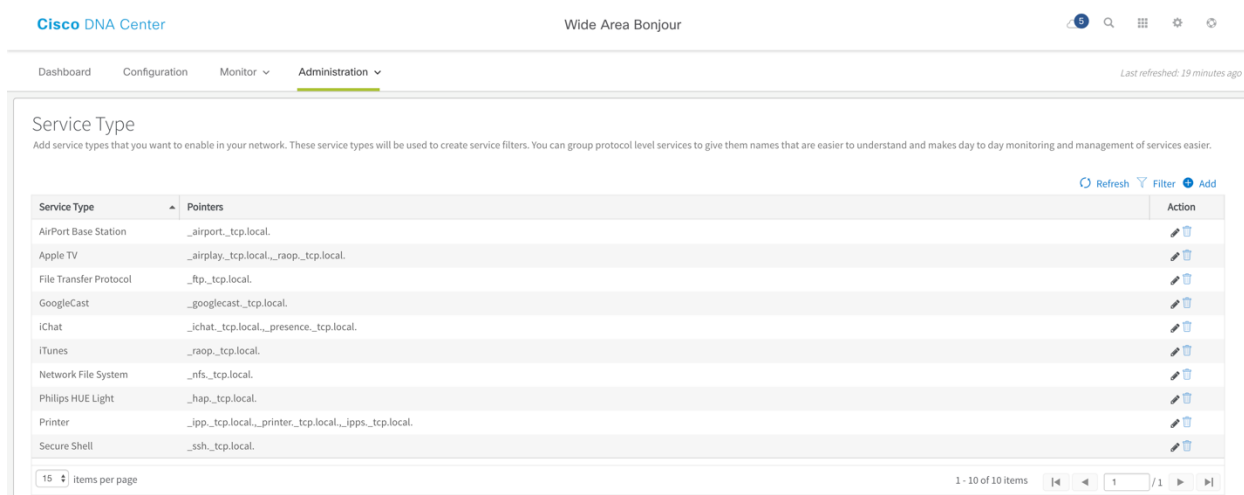


Table 17 – Cisco Wide Area Bonjour Service-Type Configuration

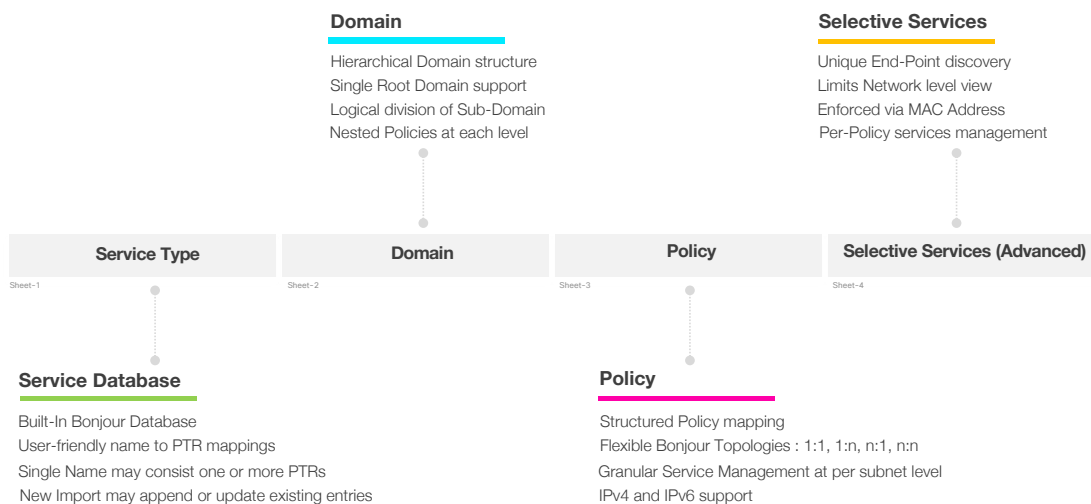
Task	Step
Go to Service-Type section	Click Administration Tab → and select Service-Type from sub-menu.
Verify default built-in Service-Type	<p>The service-type table provide following two simple information:</p> <ul style="list-style-type: none"> • Service Type – System-defined and user-friendly name of Bonjour service. • Pointers – One or more mDNS PTR records for each service type.

Managing Policy Configuration

The Cisco Wide Area Bonjour application provides flexibility to build and manage service-filter policies manually or can be provisioned in bulk during any stage of deployment. Refer to Table – 9 Cisco Wide Area Bonjour Service Filter Configuration Task for step-by-step manual procedure to build the service-filter. This sub-section focuses on bulk policy provisioning and managing configuration files for backup.

The service-filter policy configuration template is built based on Microsoft Excel XLS format. The network administrator can download pre-built structured and formatted blank XLS template file from Cisco Wide Area Bonjour application. It can be downloaded during initial application provisioning stage of building Root Domain or export the XLS configuration from any level of domain hierarchy with up to date configuration. The XLS template file is divided in four different worksheets, each crosslink with required details to automate large scale service-filter policies. Figure – 35 below explains the brief overview of each worksheet that must be configured to build and provision bulk service-filter policies:

Figure 35 – Cisco Wide Area Bonjour Policy Template



The Cisco Wide Area Bonjour XLS template file contains pre-defined column and respective names that must remain intact else importing the modified file may fail. The network administrator must feed required data on their respective column for each worksheet based on following reference configuration model. The Selective Services worksheet is optional and can be used in advanced service-routing scenarios where service distribution from Cisco DNA-Center must be limited to user-defined static MAC address basis. For example, Cisco DNA-Center discovered up to ten AirPrint capable printers with Selective Services support, the network administrator can statically assign MAC address of two printer to be responded from it receives query from receiver SDG-Agent.

This sub-section provides step-by-step reference template configuration to build bulk service-filter policies configuration parameters distributed across multiple worksheet.

The Table – 18 below is Step-1 and is optional procedure to build any custom Bonjour services in Cisco Wide Area Bonjour application database. This step can be skipped and left blank if default built-in service list meets the requirements.

Table 18 – Cisco Wide Area Bonjour Policy – Service Type Worksheet Configurations

Service Type Name	Bonjour Types
Apple TV	_airplay._tcp.local.,_raop._tcp.local.
Printer	_ipp._tcp.local.,_ippes._tcp.local.
Apple-Win-FileShare	_afpovertcp._tcp.local.,_smb._tcp.local.

The Table – 19 below is Step-2 and it is mandatory procedure to build Domain and Sub-Domain hierarchy of Cisco Wide Area Bonjour application. As initial configuration, the first entry must be configured with Root domain, followed by one or more Sub-Domain list with parent domain name as configured for Root domain row. The hierarchy can be expanded with additional Sub-Domains as needed with appropriate parent sub-domain names.

Table 19 – Cisco Wide Area Bonjour Policy – Domain Worksheet Configurations

Domain Name	Description	Parent Domain
ABC-Corp	Wide Area Bonjour Root Domain	<Keep Blank for Root Domain>
Bldg-1	ABC Corp – Bldg-1 Sub-Domain	ABC-Corp
Bldg-1-FL-1	Bldg-1 Floor-1 Sub-Domain	Bldg-1

The Table – 20 below is Step-3 and it is mandatory procedure to build global service-filter policy in Cisco Wide Area Bonjour application. As described in previous sections, the service-filter configuration and management in Cisco Wide Area Bonjour application is applied at Sub-Domain level. Thus, the Policy worksheet references to information provided in Step-1 and Step-2 worksheet as a pre-requisite and associate new policy configuration to each Domain.

This table provides reference service-filter configuration under Bldg-1-FL1 Sub-Domain permitting three types of services. As a reference, the policy name Bldg-1-FL1-Services is configured with optional description and activate the policy upon completing the configuration. In next continued table it subsequently provides source SDG-Agent and network details to discover the services and query SDG-Agent and respective network details to distribute the service.

Table 20 Cisco Wide Area Bonjour Policy – Policy Worksheet Configurations

Domain	Service Type	Policy Name	Description	Enabled
Bldg-1-FL-1	Apple TV, Printer, Apple-Win-FileShare	Bldg-1-FL1-Services	Bonjour Policy	True

Source IP	Source Network	Source Mask	Query IP	Query Network	Query Mask
1.1.1.1	10.1.1.0	28	1.1.1.2	10.1.2.0	28

Table – 21 below describes final Step-4 and it is optional configuration for advanced service distribution to querying SDG-Agent. The network administrator can restrict service-instances distribution based on matching policy name and MAC address of service-provider Bonjour endpoint.

Table 21 – Cisco Wide Area Bonjour Policy – Selective Service Worksheet Configurations

Policy Name	Source MAC Address
Bldg-1-FL1-Services	01:02:03:04:05:06

Import/Export Policy Configuration

The Cisco Wide Area Bonjour application provides flexibility in managing bulk configuration with Import and Export capabilities. The application domain and policies can be built and imported as initial Day-0 configuration for bulk provision instead manual process. The existing policy configuration can be downloaded to local computer in XLS format to update existing policies and backup purpose.

The policy configuration import is seamless in operation and can be appended to Cisco Wide Area Bonjour application while it in operational state. The new imported file may include new service-types in database, additional services to existing policies or new sub-domains with new policies. During configuration import state the application and service-peering with existing SDG-Agents remains intact providing non-disruptive bulk provisioning capabilities to scale up network and services in Wide Area Bonjour domain. The network administrator can import configuration at any domain hierarchy of an application.

The export function downloads latest configuration snapshot from Cisco Wide Area Bonjour application to local computer. The downloaded file can be updated with new bulk changes and re-import to update the configuration. The network administrator can use export function as configuration backup to be restored as needed.

Figure 36 – Cisco Wide Area Bonjour Application – Import/Export Policy Configuration

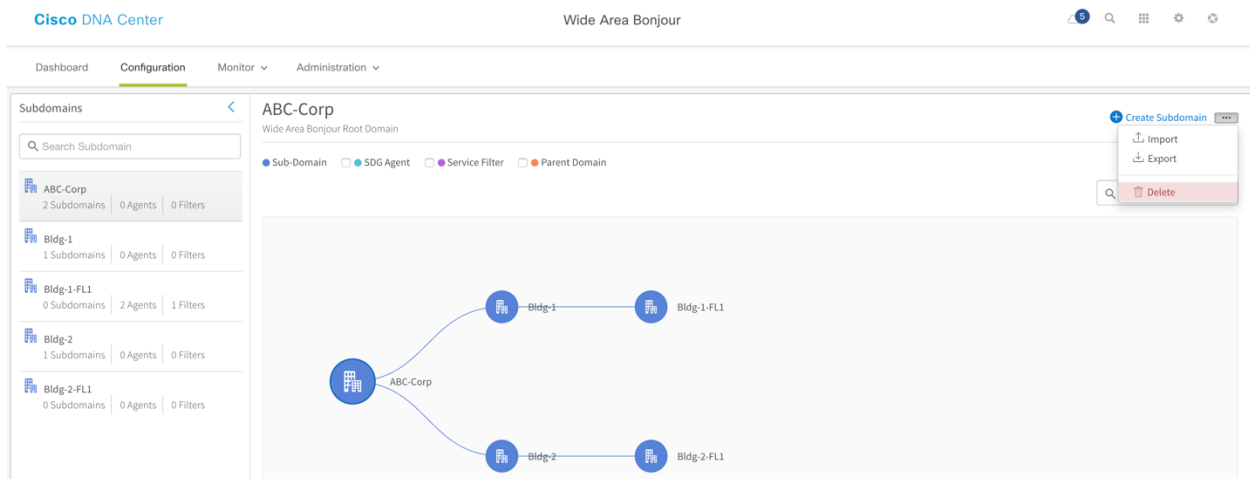


Table 22 – Cisco Wide Area Bonjour Service-Type Configuration

Task	Step
Select Domain for Import/Export Configuration	Click Configuration Tab → and select Root or Sub-Domain from left panel to Import or Export the configuration.
Select Import or Export	Click Import or Export to take action of managing configuration file for select domain.

Appendix

Scale and Performance Support Matrix

The Cisco Wide Area Bonjour provides high scale able solution for Enterprise networks. Each product in overall solution scales differently due to different level of system resources.

Table – 23 Cisco DNA-Center Wide Area Bonjour Scale and Performance Matrix

Cisco DNA Center	Service Scale	Release
DN2-HW-APL DN2-HW-APL-L DN2-HW-APL-XL	150,000 Services Scale 150 SDG Agent	Cisco DNA-Center – v1.3.1.0 Cisco Wide Area Bonjour Application – 2.4.0.10062

Table – 24 Cisco IOS SDG-Agent Scale and Performance Matrix

SDG Agent Gateway	Service Scale	Release
Cisco Catalyst 9300	7500	16.11.1
Cisco Catalyst 9400	10000	16.11.1
Cisco Catalyst 9500	10000	16.11.1
Cisco Catalyst 9500-H	12000	16.11.1
Cisco Catalyst 9600	12000	16.12.1
Cisco Catalyst 9800	N/A	16.11.1
Cisco 5520/8540 WLC	N/A	16.11.1
Cisco Catalyst 6800	10000	15.5(1)SY4
Cisco Catalyst 4500-E/4500-X	7500	3.11.0
Cisco Catalyst 3850/3650	6000	16.11.1
Cisco ISR 4000 Series	2000	16.11.1

Cisco IOS Built-In Bonjour Service Database

Table – 25 Cisco IOS Built-In Bonjour Service Database

Service	Service Name	mDNS PTRs
Apple TV	airplay	_airplay._tcp.local
AirServer Mirroring Service	airserver	_airserver._tcp.local _airplay._tcp.local
Apple AirTunes	airtunes	_raop._tcp.local
Amazon Fire TV	amazon-fire-tv	_amzn-wplay._tcp.local
Apple AirPrint	apple-airprint	_ipp._tcp.local _universal._sub._ipp._tcp.local
Apple TV 2	apple-continuity	_companion-link._tcp.local
Apple File Share	apple-file-share	_afpovertcp._tcp.local
Apple HomeKit	apple-homekit	_hap._tcp.local _homekit._ipp.local
Apple iTunes Library	apple-itunes-library	_atc._tcp.local
Apple iTunes Music	apple-itunes-music	_daap._tcp.local
Apple iTunes Photo	apple-itunes-photo	_dpap._tcp.local
Apple KeyNote Remote Control	apple-keynote	_keynotepair._tcp.local _keynotecontrol._tcp.local
Apple Remote Desktop	apple-rdp	_net-assistant._tcp.local _afpovertcp._tcp.local
Apple Remote Event	apple-remote-events	_eppc._tcp.local
Apple Remote Login	apple-remote-login	_sftp-ssh._tcp.local _ssh._tcp.local
Apple Screen Share	apple-screen-share	_rfb._tcp.local
Apple Time Capsule Data	apple-timecapsule	_adisk._tcp.local _afpovertcp._tcp.local
Apple Time Capsule Management	apple-timecapsule-mgmt	_airport._tcp.local
Apple MS Window File Share	apple-windows-fileshare	_smb._tcp.local
Fax	fax	_fax-ipp._tcp.local

Google ChromeCast	google-chromecast	_googlecast._tcp.local
Apple iTunes HomeSharing	homesharing	_home-sharing._tcp.local
Apple iTunes Data Sync	itunes-wireless-devicesharing2	_apple-mobdev2._tcp.local
Multifunction Printer	multifunction-printer	_ipp._tcp.local _scanner._tcp.local _fax-ipp._tcp.local
Phillips Hue Lights	phillips-hue-lights	_hap._tcp.local
Printer – Internet Printing Protocol	printer-ipp	_ipp._tcp.local
Printer – IPP over SSL	printer-ippes	_ippes._tcp.local
Linux Printer – Line Printer Daemon	printer-lpd	_printer._tcp.local
Printer Socket	printer-socket	_pdl-datastream._tcp.local
Roku Media Player	roku	_rsp._tcp.local
Scanner	scanner	_scanner._tcp.local
Spotify Music Service	spotify	_spotify-connect._tcp.local
Web-Server	web-server	_http._tcp.local
WorkStation	workstation	_workstation._tcp.local

Summary

Cisco DNA Service for Bonjour is enterprise-grade Wide Area Bonjour solution designed to seamlessly integrated into complex wired and wireless network infrastructure. The Cisco Wide Area Bonjour retains original end-users experience for using Bonjour technology in Enterprise. In addition, the new solution provides plug-n-play service-routing capabilities without any forklift changes in DHCP/DNS servers or manual MAC address management.

The new distributed architecture supports unparallel scale, performance, security and redundancy that offers vendor agnostic compatible solution to enable end-to-end services rich network infrastructure between computers, IoT and more.