Service Discovery of Audio/Video Streams in Ethernet AVB

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How to use these slides

These slides contain summary information for presentation purposes and detailed information for implementations. You may wish to skip the slides marked "(Implementation)" if you are not interested in that level of detail.

Presentation Topics

- What is Service Discovery?
- Ethernet AVB Networks
- Service Discovery Implementation
- Where to Get Information
- Getting Started With Service Discovery
- Where do we go from here?

What is Service Discovery?

Service Discovery

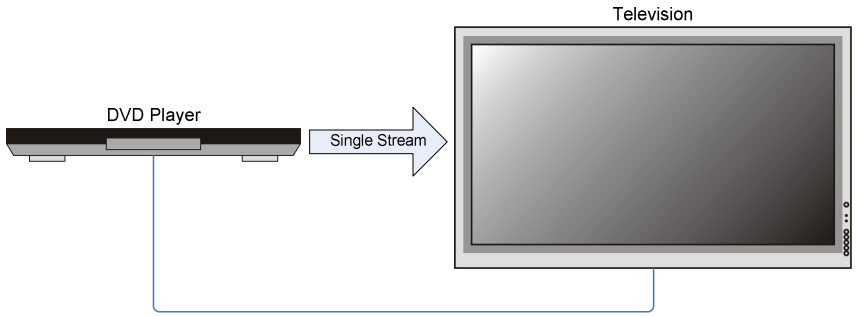
- A **Service** is an audio and/or video stream provided by a Talker for consumption by one or more Listeners. Think of a Service as:

  "What can you do for me?"

- **Service Discovery** is the technique a Listener uses to find Talkers that can provide an appropriate Service (e.g. sample rate, bit depth, audio, video).

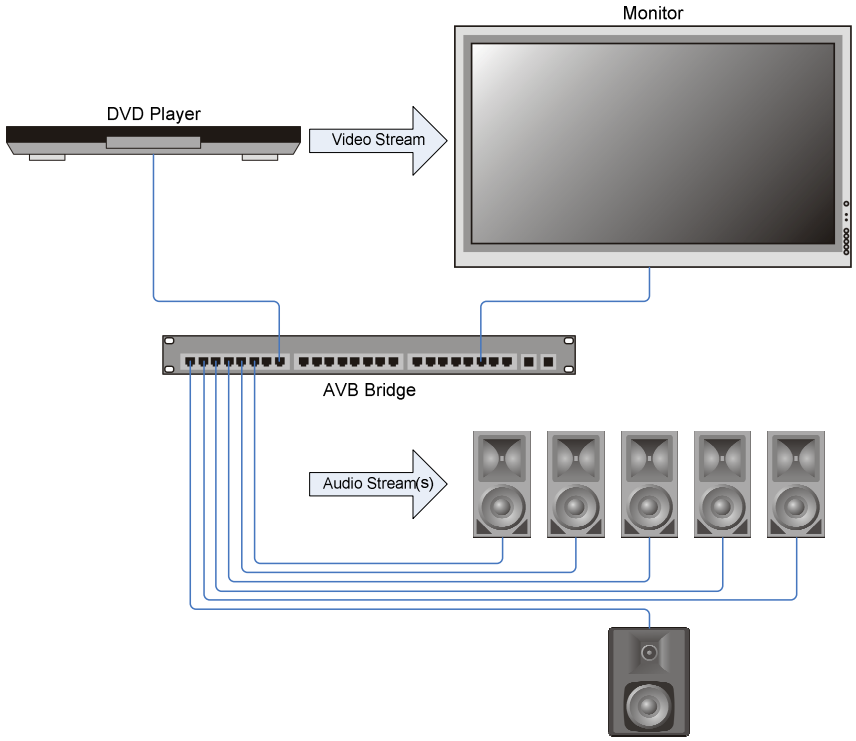
Ethernet AVB Networks

One Talker – One Listener



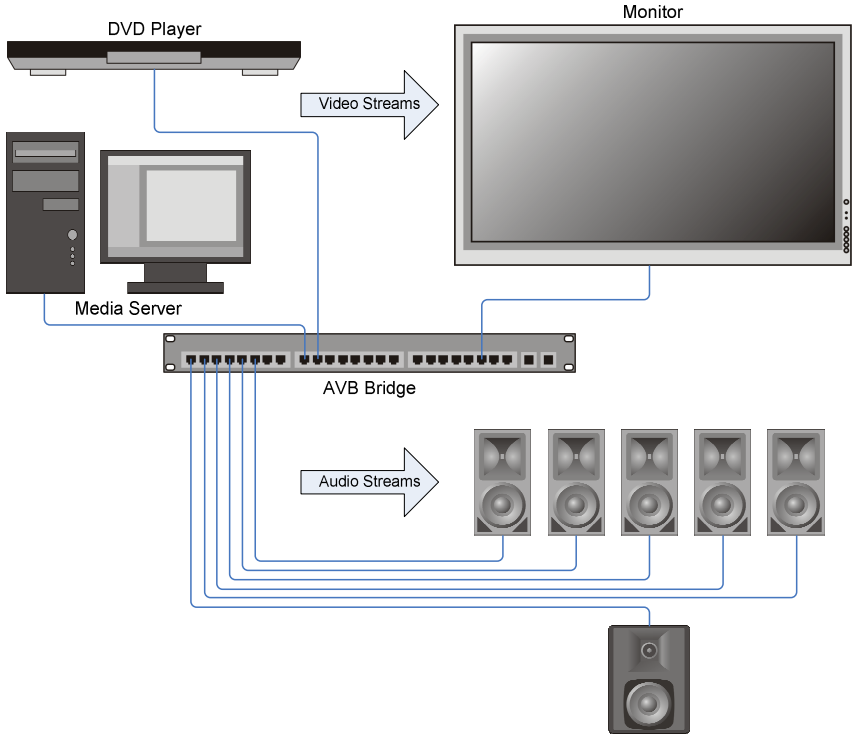
- DVD Player (Talker) provides a single stream (audio and video). This stream could be a movie, the DVD player's menu system, or just a blue screen. Note: this could actually be two streams: an audio stream and a video stream.
- The Television (Listener) can only see one stream on the AVB network so it connects to that stream by default. In an installation like this there should be no customer setup required.
- There is no AVB Bridge required in this simple configuration.

One Talker – Multiple Listeners



- DVD Player (Talker) provides a video stream and a 6-channel audio stream. Audio could also be provided as six separate audio streams.
- The Monitor (Listener) can only see one video stream on the AVB network so it connects to that stream by default. It does not even know about the audio stream since it cannot process audio.
- The speakers (Listeners) have switch settings on the back to specify: left/center/right/ surrounds/sub-woofer. Each speaker sees the audio stream and extracts the appropriate channel from that stream. The speakers do not see the video stream since they are not capable of processing it and therefore do not request it.
- An AVB Bridge is required in this configuration. The Bridge supports SRP and only routes streams to the appropriate Listeners. This implies the link from the DVD Player to the Bridge and the Bridge to the Monitor would be GigE, while the links to the speakers would only need to be 100Mbit.

Multiple Talkers – Multiple Listeners

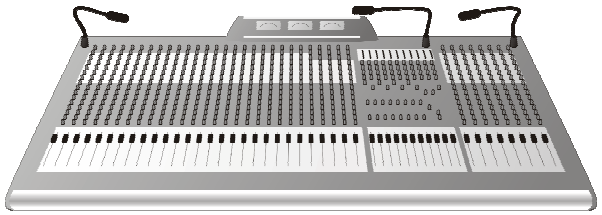


- DVD Player (Talker) provides a video stream and an audio stream.
- Media Server (Talker) provides a default “menu” video stream – this is the only stream produced by default. The user can select a specific movie or CD and the Media Server will create the appropriate streams on-the-fly. It is capable of generating several movie audio/video streams, and several CD audio streams.
- Speakers have no user interface so Monitor must provide proxy capabilities to instruct speakers which streams to select.
- Monitor is presented with several video streams which requires an on-board application that will provide a menuing system. The user will then be allowed to select the appropriate sources for watching and/or listening.
- The “default” menu stream from the Media Server should contain enough information so the user understands there are multiple streams available. The Media Server must also allow an existing stream to be paused and resumed on a different TV, or joined by another TV. It must also be capable of playing the current movie on one stream and restarting the movie for a second stream.

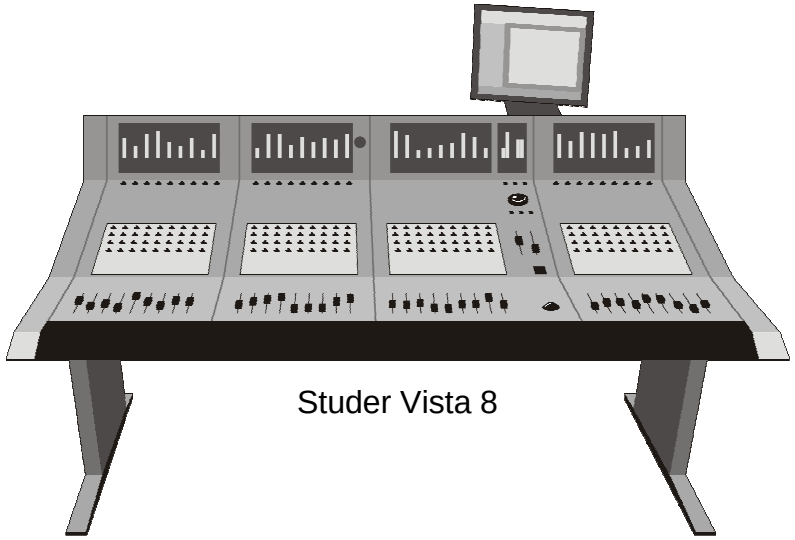
Walt Disney World's Mission: SPACE

- How big can these networks get?
  - 42,450 watts of amplifier power
  - 116 channels of audio per ride system (x4)
  - 433 video displays
  - 598 additional audio channels
  - 208,430 watts of electrical power
  - 36 racks of equipment
- Cobranet digital networking

Soundcraft/Studer Mixers



Soundcraft GB8



Studer Vista 8

- Soundcraft mixers:
  - 80-140 inputs
  - 30-80 outputs
- Studer mixers:
  - 1700 input/outputs
- Broadcast Houses contain a number of studios with a console in each. It is not unrealistic to want to route several thousand channels around the building.

Service Discovery Implementation

Zeroconf

"The design of Zeroconf was intentionally kept simple, because in network design, simplicity is the best way to achieve reliability, with products from different vendors all interoperating and working correctly with one another."

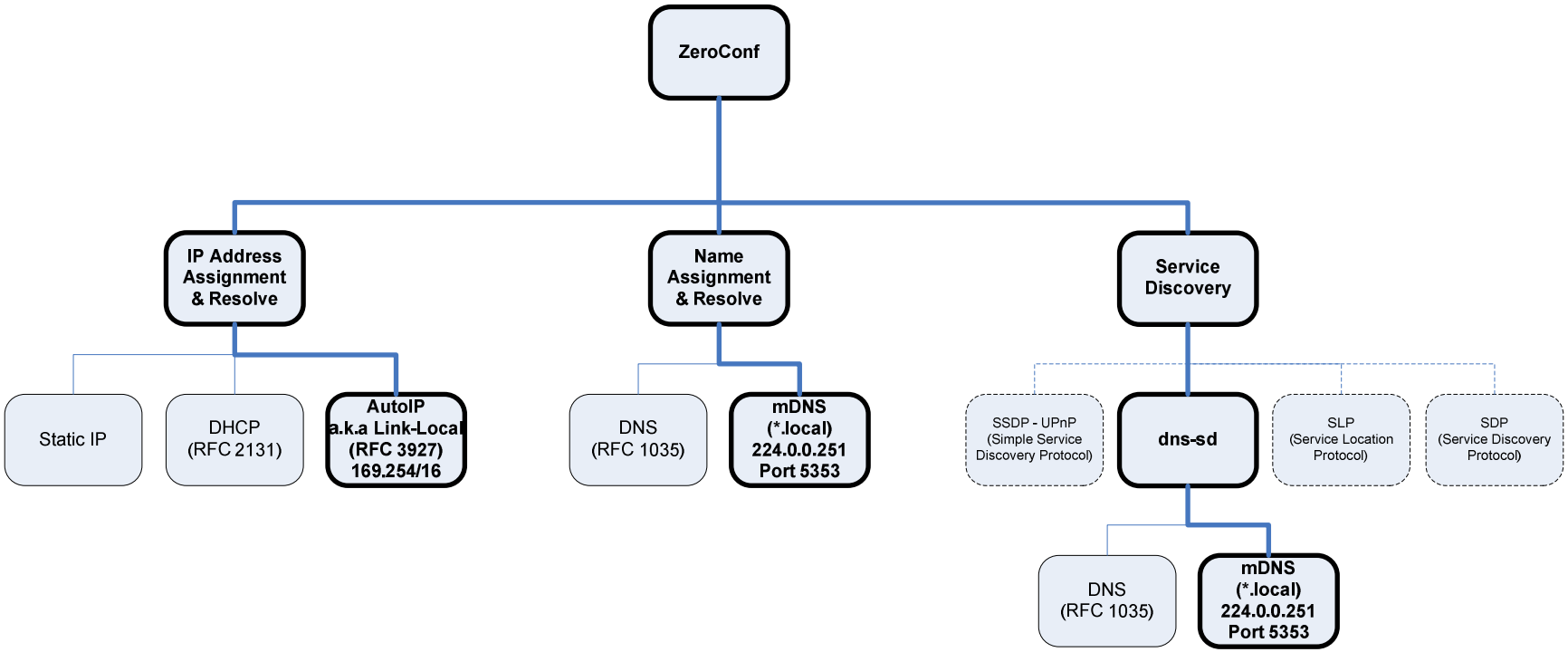
Zero Configuration Networking, The Definitive Guide,

Stuart Cheshire & Daniel H. Steinberg

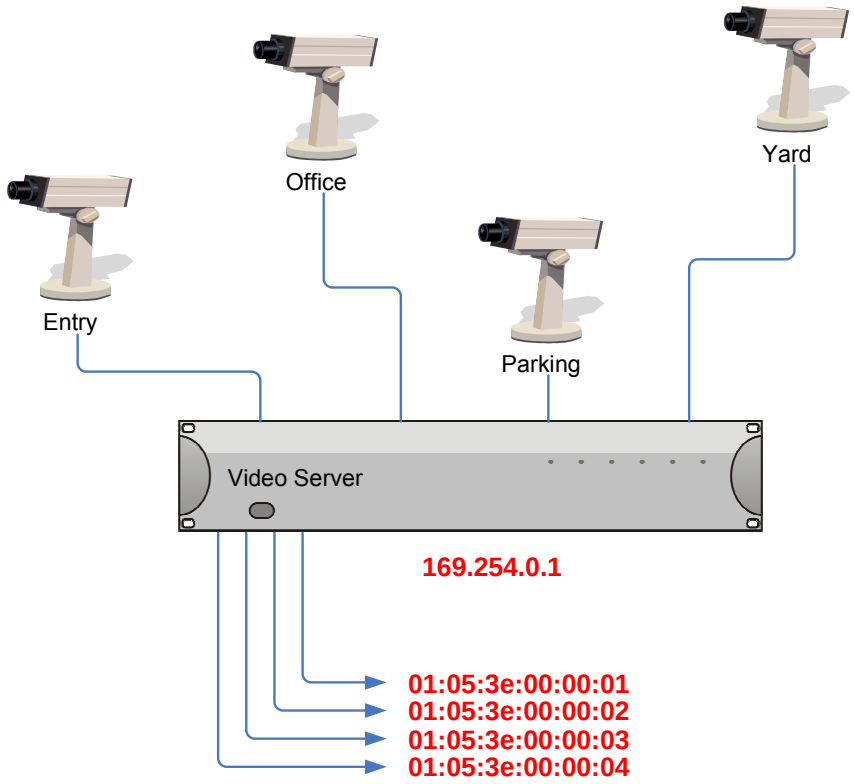
The Yellow “Sticky” Note

192.168.0.1	DSL Router (basement)
192.168.0.2	Linksys WAP (basement)
192.168.0.3	Brother printer (family room)
192.168.0.4	Kids PC (family room)
192.168.0.5	Portable PC
192.168.0.6	HP LaserJet (office)
192.168.0.7	Desktop (office)
192.168.0.8	NAS server (basement)

Zeroconf – a solution

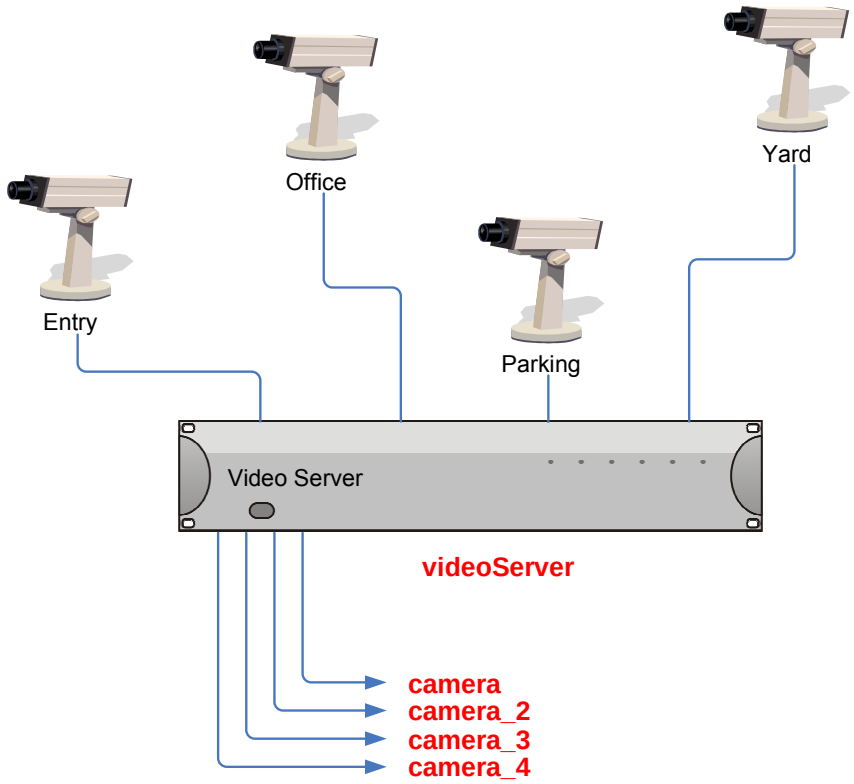


Video Surveillance System



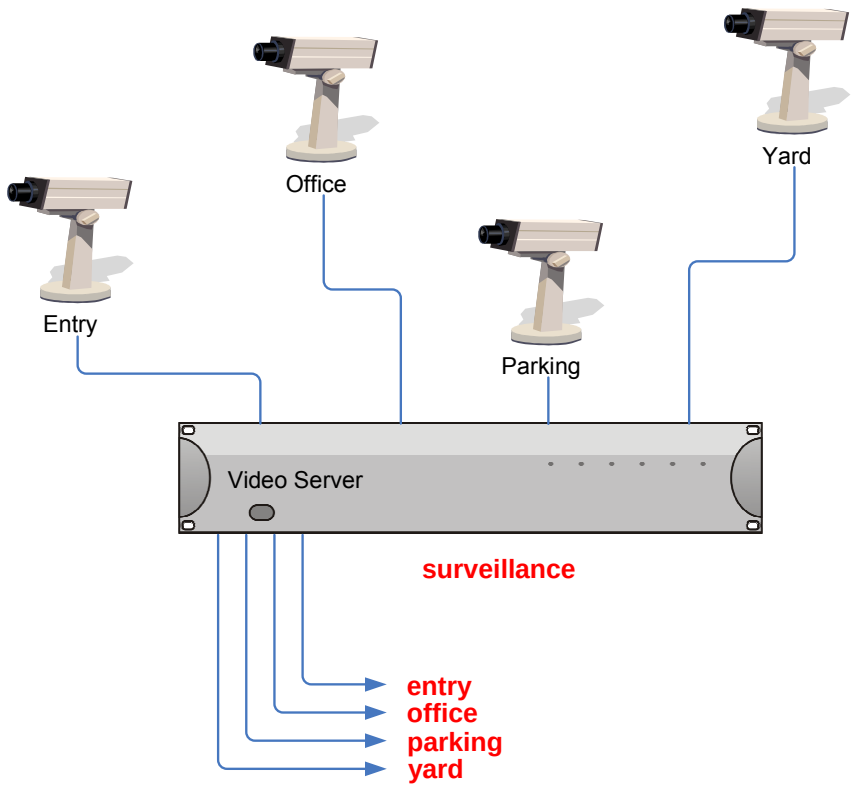
- Without Zeroconf the device can only be referred to by its IP Address and Stream IDs.
  - 169.254.0.1 01:05:3e:00:00:01
  - 169.254.0.1 01:05:3e:00:00:02
  - 169.254.0.1 01:05:3e:00:00:03
  - 169.254.0.1 01:05:3e:00:00:04

Video Surveillance System



- Without Zeroconf the device can only be referred to by its IP Address and Stream IDs.
- Default Zeroconf configuration replaces hard coded addresses and IDs by generic names.
  - videoServer:camera
  - videoServer:camera_2
  - videoServer:camera_3
  - videoServer:camera_4

Video Surveillance System



- Without Zeroconf the device can only be referred to by its IP Address and Stream IDs.
- Default Zeroconf configuration replaces hard coded addresses and IDs by generic names.
- Users can also override the default names with more meaningful names that are easier to understand:
  - surveillance:entry
  - surveillance:office
  - surveillance:parking
  - surveillance:yard

Service Discovery (dns-sd)

(Implementation)

- DNS
  - RFC 1035
  - IP=unicast, port=53
  - DNS Dynamic Update to register new Service
  - DNS Dynamic Update to remove a Service
- mDNS
  - Use when domain = *.local.*
  - IP=224.0.0.251, port=5353
  - Multicast DNS Announce to register new Service
  - Multicast DNS Goodbye to remove a Service

DNS Resource Record (RR) Types

(Implementation)

- PTR – Pointer record
  - STD 13, RFC 1035 “Domain Names – Implementation and Specification”.
  - DNS-SD uses these to find related SRV records.
- SRV – Service Discovery
  - RFC 2782 “A DNS RR for specifying the location of services (DNS SRV)”.
  - DNS-SD uses these to find Host Names and Ports for Service.
- TXT – Descriptive Text
  - STD 13, RFC 1035 “Domain Names – Implementation and Specification”.
  - DNS-SD uses these for additional parameters and attributes.

SRV Record Type

"Service Discovery" (Implementation)

- RFC 2782 "A DNS RR for specifying the location of services (DNS SRV)."
- Query: *_ipp._tcp.example.com*
- Response: Host Name and Port number of Service.
- Also used by:
  - SLP (Service Location Protocol)
  - DDDS (Dynamic Delegation Discovery Service)

PTR Record Type

"Pointer record" (Implementation)

- Query (ServiceType.domain): *_ipp._tcp.local*
- Response: zero or more records with Service Instance Name (Instance.ServiceType.domain):
  - *Sales._ipp._tcp.local*
  - *Bullpen._ipp._tcp.local*.
- Send an SRV query for the actual Instance Name you want.
- Subtypes of Service Types (instead of elaborate queries)
  - PTR record: *_video._tcp.local* // all video services
  - PTR record: *hd._sub._video._tcp.local* // only HD video

TXT Record Type

"Descriptive Text" (Implementation)

- *key=value* pairs represented in UTF-8.
  - *txtvers=1* // Version of TXT record data
  - *resolution=hd* // HD video source
  - *SRP* // Stream supports SRP
  - *streamID=01:05:0e:01:02:03* // Multicast Addr
  - *mac=00:01:02:03:04:05* // Talker MAC Addr

- Details:
  - 200 bytes or less. If you need more than this, perhaps you need to expand the controlling application. (DNS recommends a limit of 512-byte messages).
  - Each key/value pair is preceded by a length byte and packed together end-to-end.

DNS-SD Service Types

- Service type names are 14 characters, a-z, 0-9, hyphen (-). Cannot begin or end with hyphen.
- Registered at http://www.dns-sd.org/ServiceTypes.html.
- Instance.ServiceType.Domain (Sales._tcp._ipp.example.com)
- Instance: 63 bytes of UTF-8. Often times the Instance is the only text displayed in a UI drop-down list.

- acrobatsrv: Adobe Acrobat
- axis-video: Axis Video Cameras
- bootps: Bootstrap Protocol Server
- cvspserver: CVS PServer
- daap: Digital Audio Access Protocol (iTunes)
- dacp: Digital Audio Control Protocol (iTunes)
- domain: Domain Name Server
- dpap: Digital Photo Access Protocol (iPhoto)
- ftp: File Transfer Protocol
- h323: H.323 Real-time audio, video, data
- http: World Wide Web HTML-over-HTTP
- imap: Internet Message Access Protocol
- ipp: IPP (Internet Printing Protocol)
- login: Remote Login a la Telnet
- nfs: Network File System
- ntp: Network Time Protocol
- pdl-datastream: Printer Page Descriptor Language Data Stream
- printer: Spooler (a.k.a. LPR/LPD printing)
- rtsp: Real Time Streaming Protocol
- sip: Session Initiation Protocol (VoIP)
- skype: Skype
- ssh: SSH Remote Login Protocol
- svn: Subversion
- telnet: Telnet
- tftp: Trivial File Transfer

Putting the DNS-SD pieces together

- Listener sends a DNS PTR request for desired Talker Service types:
  - PTR: *hd._sub._video._tcp.local*
- DNS (or mDNS) responds with matching SRV records:
  - SRV: *MediaServer._video._tcp.local*
  - SRV: *Satellite._video._tcp.local*
  - SRV: *DVD._video._tcp.local*
- Listener allows user to select from Instance Names contained in SRV records:
  - *MediaServer*
  - *Satellite*
  - *DVD*
- Listener sends a DNS TXT request to retrieve attributes.
- DNS (or mDNS) responds with TXT key=value pairs:
  - TXT: *streamID=01:05:0e:01:02:03*
  - TXT: *mac=00:01:02:03:04:05*
- Listener can now issue SRP Reservation request for *streamID*.

Where to Get Information

Zero Configuration Information

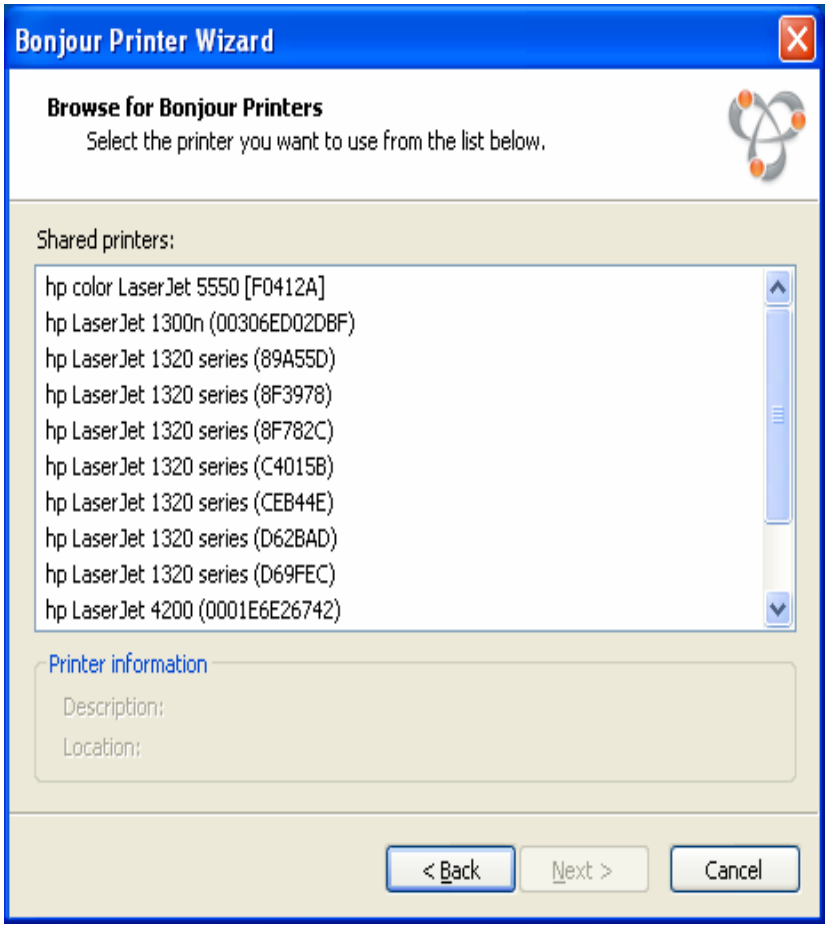
- Stuart Cheshire and Daniel H. Steinberg. *Zero Configuration Networking, The Definitive Guide*. O'Reilly Media, Inc., 2005.
- Zero Configuration Networking (Zeroconf) (www.zeroconf.org)
- Zeroconf = Bonjour (Apple), Avahi (Linux), Howl.
- DNS Service Discovery (DNS-SD) (www.dns-sd.org/ServiceTypes.html)
- DHCP (RFC 2131)
- AutoIP (RFC 3927)
- DNS (RFC 1035)
- DNS SRV (RFC 2782)

Getting Started With Service Discovery

Installing Bonjour on Windows

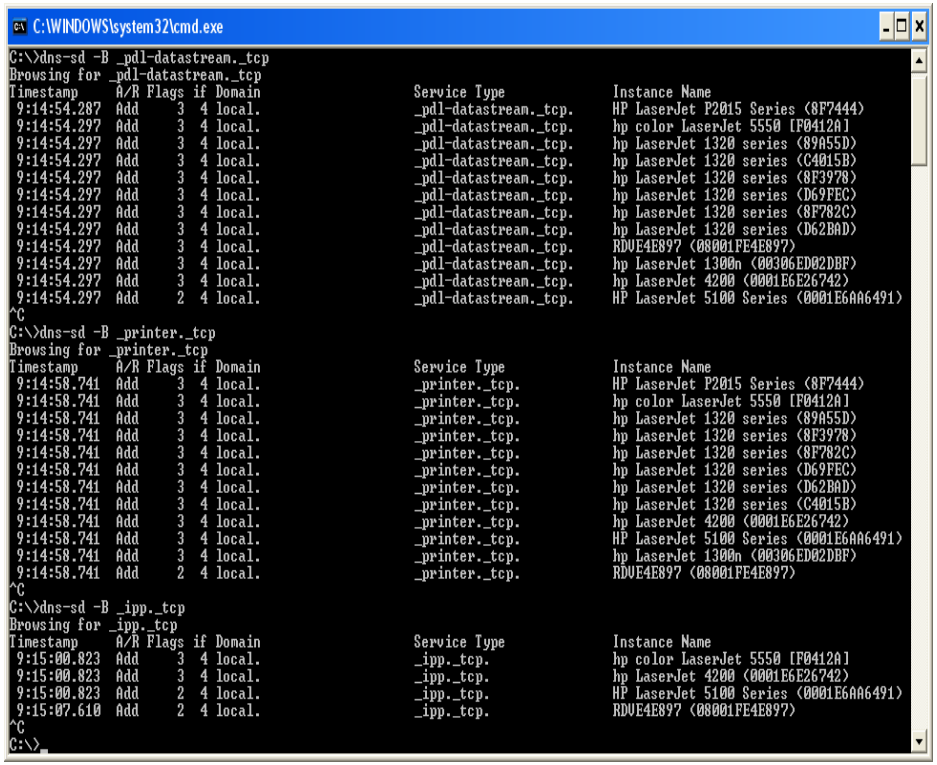
- C:\WINDOWS\system32\dns-sd.exe
  - http://www.apple.com/bonjour/ and look for the “Get Bonjour for Windows” link.
  - Download and run 14.1MB BonjourSetup.exe. This will install the Bonjour Printer Wizard and dns-sd.exe.
  - dns-sd.exe is a simple test utility to verify operation of existing products or simulate yet-to-be-built devices.
- Wireshark Ethernet protocol analyzer
- *Zero Configuration Networking, The Definitive Guide.* Chapter 6: Getting Started with Bonjour/Zeroconf. Starting with “The Command-Line Tool”.

Simple Zeroconf Application (1)



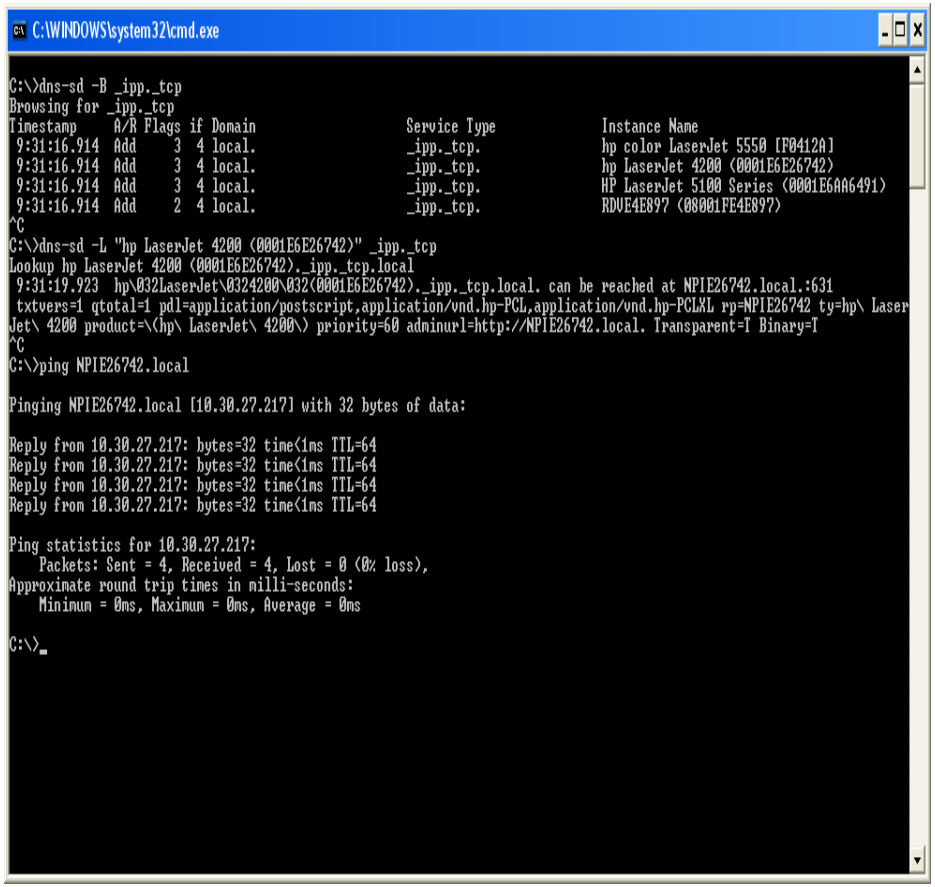
- Let's look at an example of a Zeroconf application: Bonjour Printer Wizard (BPW).
- To see what printing services are available on your network launch BPW.
- BPW presents the list of discovered printer service names. With no configuration at all, the user is able to browse the network and select a printer.

Simple Zeroconf Application (2)



- What really happened behind the simple list of printer services provided by the Bonjour Printer Wizard?
- Run the following dns-sd **Browse** queries:
  dns-sd –B _pdl-datastream._tcp
  dns-sd –B _printer._tcp
  dns-sd –B _ipp._tcp
- The list of printer services discovered above will match the list provided by BPW. Note that the Domain and Service Type would mean very little to the user, so BPW only displayed the Instance Name.
- Internally dns-sd (and BPW) issued an mDNS **Query** for the following PTR types:
  _pdl-datastream._tcp.local
  _printer._tcp.local
  _ipp._tcp.local
- Each printer responded with an mDNS **Answer** containing a PTR record, and **Additional** SRV, TXT and A records.

Simple Zeroconf Application (3)



- Now that we have identified several printer services, let's see how to contact one of the services. Run the following dns-sd **Lookup** query:
  dns-sd –L "hp LaserJet 4200 (0001E6E26742)" _ipp._tcp
- mDNS Resolved the name "hp LaserJet 4200…" and returned the following information:
  - Name: NPIE26742.local
  - Port: 631
  - txtvers=1
  - qtotal=1
  - …
  - priority=60
  - Transparent=T
  - Binary=T
- An application that understands how to communicate with an Internet Printing Protocol (ipp) device would process the various options shown above.
- Pinging NPIE26742.local shows that we can resolve the name down to an IP address. In this example the IP address is not AutoIP generated, but is DHCP assigned.

Where do we go from here?

Thank you