AARHUS
UNIVERSITET

ADVANCED PERVASIVE COMPUTING

Lecture 5: Zero configuration and service discovery

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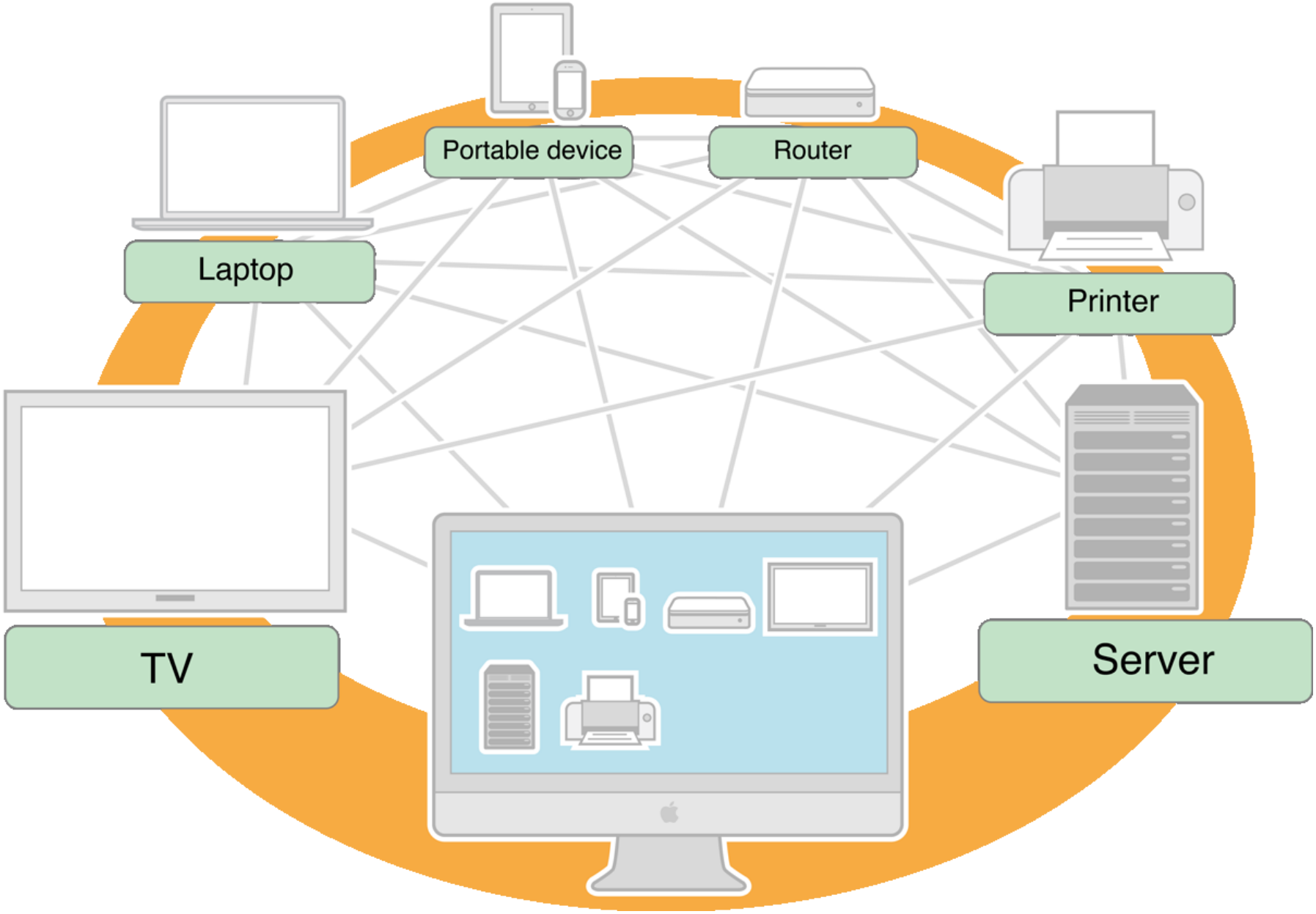
AGENDA

- Introduction
- Addressing
- Naming
- Service Discovery
- Bonjour Service Names
- Publication Steps
- Discovery Steps
- Resolution Steps
- Conclusion
- References


Portable device
Router
Laptop
Printer
TV
Server

INTRODUCTION

- **Main objective:**
- Automatic discovery of devices and network services without prior configuration
- End-users should not know about endpoints and naming servers

- **This implies:**
- 1) Allocate addresses without a DHCP server (IPv4 Link-Local Addressing)
- 2) Translate names and IP addresses without a DNS server (Multicast DNS)
- 3) Find services, like printers, without a directory server (DNS Service Discovery)

- **Solutions:**
- AppleTalk (ethernet) 1985
- AirTalk (wifi) 1999
- Standardization efforts: Zeroconf Working Group 1999
- Bonjour (Apple)
- Avahi (Avahi)
- UPnP (UPnP forum)

STANDARDIZATION EFFORTS

› **IETF Zeroconf Working Group**
› The Internet Engineering Task Force (IETF®)
› Established (September 1999)

› **Dynamic Configuration of IPv4 Link-Local (2005)**
› Assign addresses without a DHCP (RFC 3927) IPv4: 169.254.0.0/16 IPv6: prefix fe80::/10

› **Zero Configuration DNS free name look-up (2013)**
› Multicast DNS or mDNS (RFC 6752)

› **Service Discovery Protocols (2013)**
› DNS Service Discovery or DNS-SD (RFC 6763)

› **Bonjour supports 3927, 6752, and 6763, UPnP only 3927**

IMPLEMENTATIONS

› **Bonjour, Apple**
› Supports: OSX, iOS, Windows, Linux, BSD

› **UPnP, UPnP Forum**
› Supports: (in theory – all supporting HTTP/XML)

› **Avahi, Avahi Project**
› Supports: BSD, Linux

BONJOUR

› **Apple**
› UPnP Device Architecture (ISO/IEC 29341) 2008

› **UPnP functionality:**
› **Adresssing:** AutoIP references IETF's (RFC 3927)
› **Discovery:** mDNS with mDNSResponder
› **Description:** Service Record and Pointer Record
› **Control:** pure IP communications
› **Event notification:** none
› **Presentation:** none

UPNP

- **UPnP Forum**
- UPnP Device Architecture (ISO/IEC 29341) 2008

- **UPnP functionality:**
- **Addressing:** references IETF's (RFC 3927)
- **Discovery:** Simple Service Discovery Protocol (SSDP)
- **Description:** XML description, vendor, serial number, service list, actions, variables, parameters
- **Control:** actions called using Simple Object Access Protocol (SOAP)
- **Event notification:** subscribe to events
- **Presentation:** a URL for presentation

BONJOUR

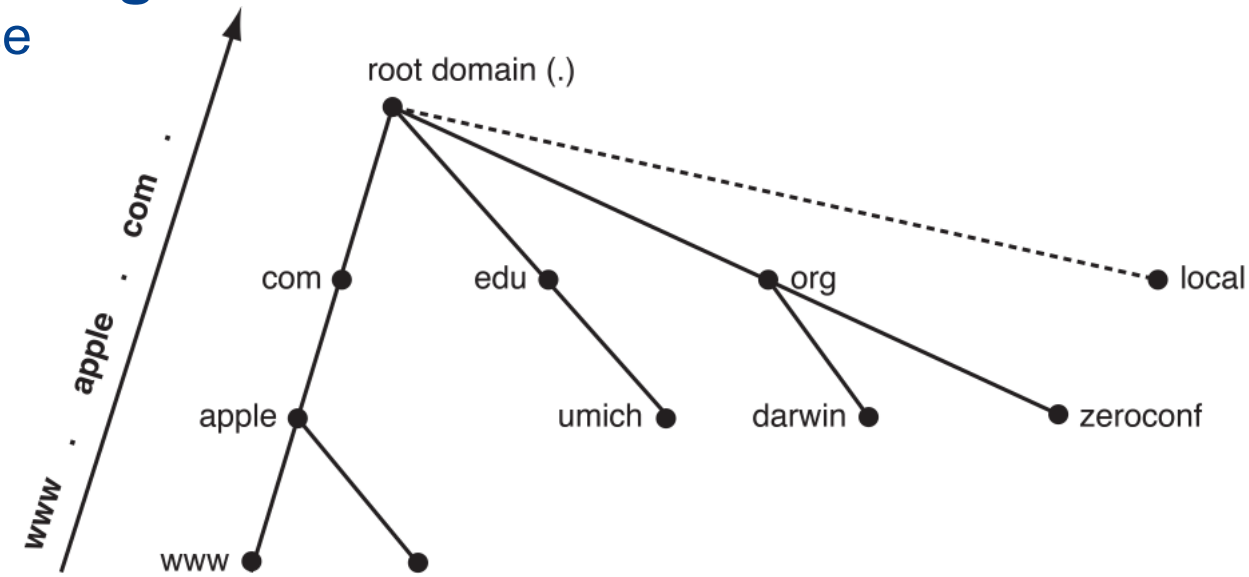
- **We shall focus on Bonjour**
- Widespread support
- Fairly easy to program
- Comparably “small” footprint and “simple” stack
- Feasible to for embedded platform use

ADDRESSING

› **Bonjour uses self assigned link-local addressing**

› **Addresses assigned**
› - from range of reserved addresses

› **Random address assigned**
› - from range if not in use



NAMING

› **mDNSResponder daemon**
› for name-to-address translation

› **All devices must use the mDNSResponder**
› to respond on their behalf to Multicast DNS Queries

› **Queries are made**
› for service or devices names rather than IP address of the client application

› **Must have unique name on local network**

SERVICE DISCOVERY

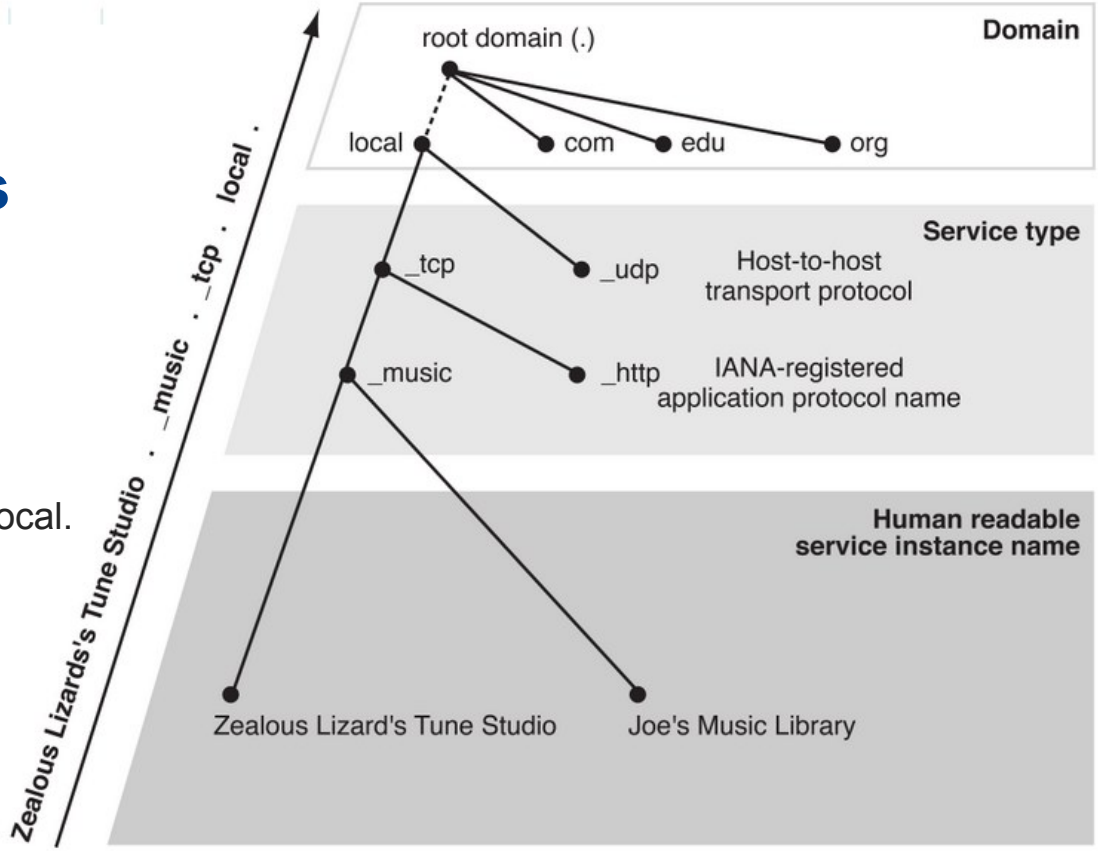
› **Bonjour client queries**
› using service-centric approach to query for services
› Only one query needed

› **Query contains**
› service type and domain

BONJOUR SERVICE NAMES

- **Bonjour service names use the following format:**
- *_ServiceType._TransportProtocolName.*
- Example: Printer using TCP:
- _printer._tcp.

- **Service Instance names**
- Are guman readable
- Need not be unique
- Example:
- ”Zealous Lizard's Tune Studio”
- DNS SRV record name:
- Zealous Lizard's Tune Studio._music._tcp.local.

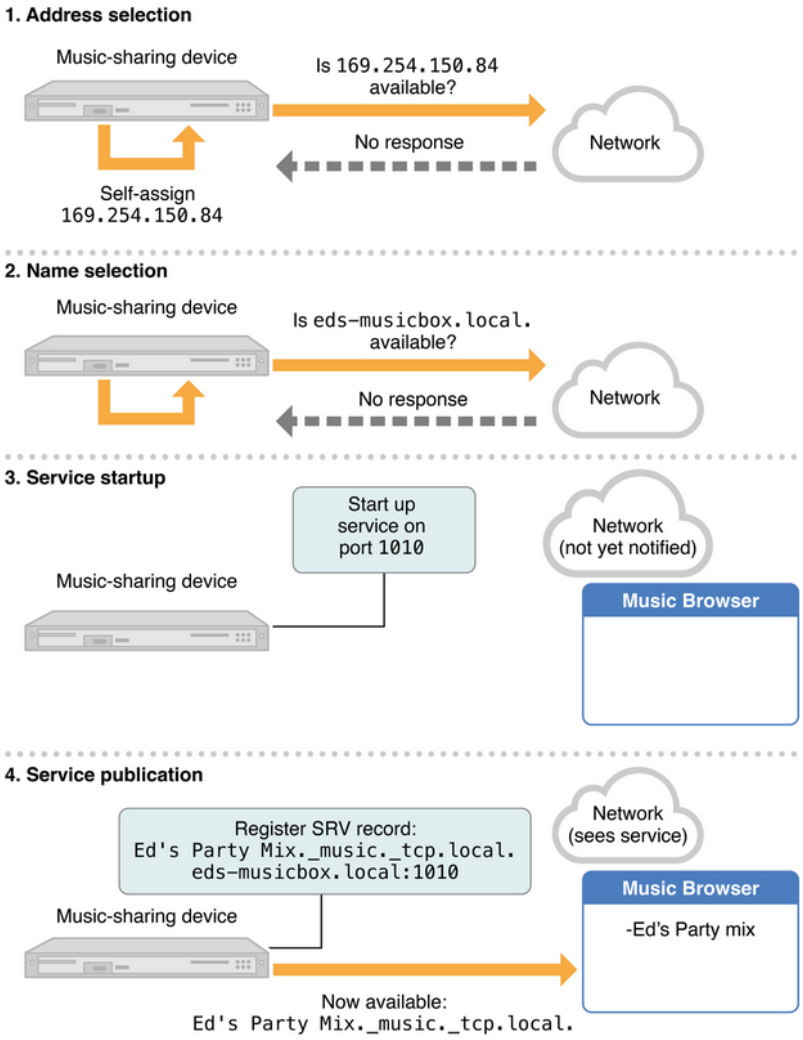


PUBLICATION STEPS

› **Service registers**
› with the Multicast DNS Responder using the Bonjour API

› **After registering**
› Service Record, pointer record, and text record are created
› Service Record – contains Hostname and port number
› Pointer Record – maps service type to a list of service instances
› Text record – used to provide additional information about the service, typically no more than 100-200 bytes

BONJOUR PUBLICATION EXAMPLE

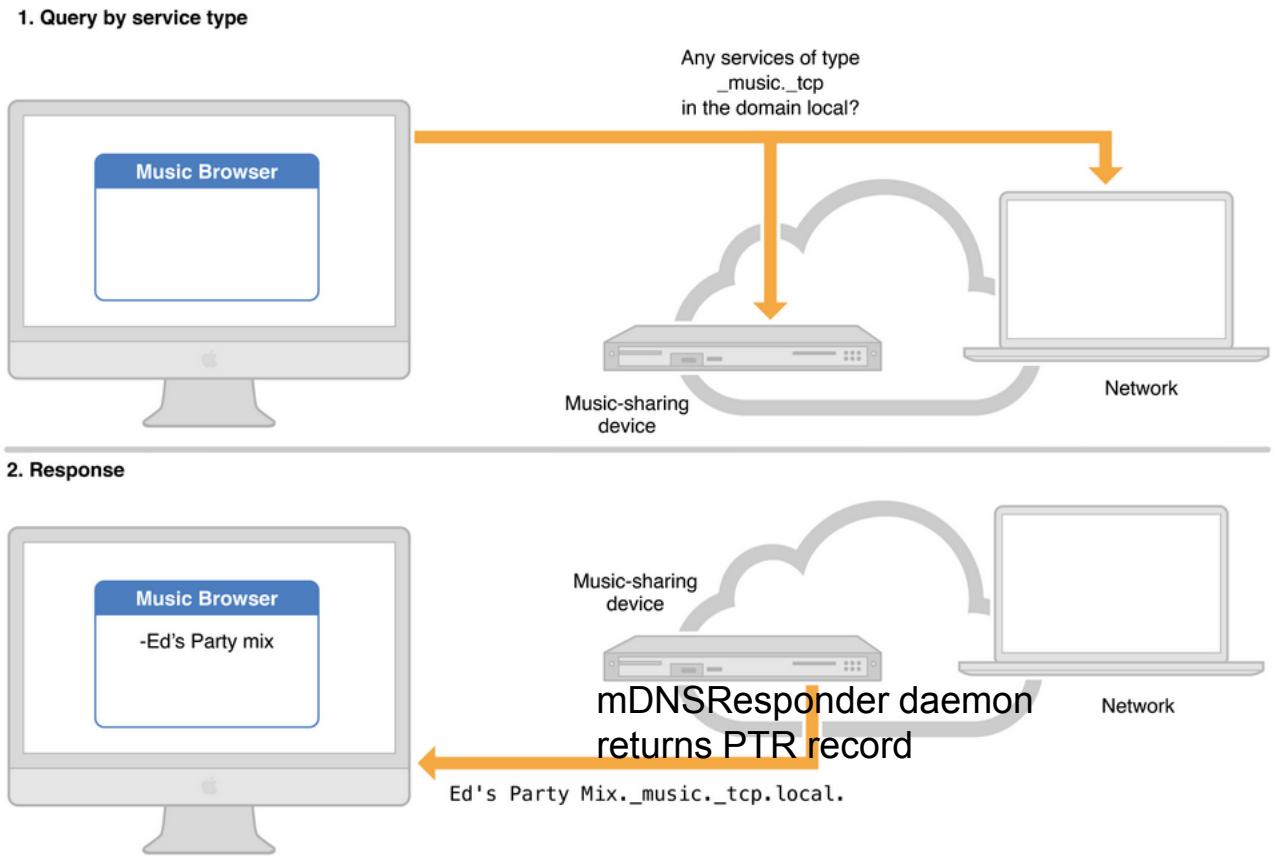


DISCOVERY STEPS

› **Client queries for Pointer Records**
› using the service type
› all Multicast DNS responders on the network are queried

› **DNS responders**
› with registered services of the queried service type return a pointer record
› pointer record contains the service instance name

DISCOVERY EXAMPLE



The PTR record is stored at the client
From here the service instance can be
extracted later as the stable service identifier

RESOLUTION STEPS

› **Client selects service instance**
› that it wants to connect to

› **Client performs a DNS lookup**
› for the service record using the instance name

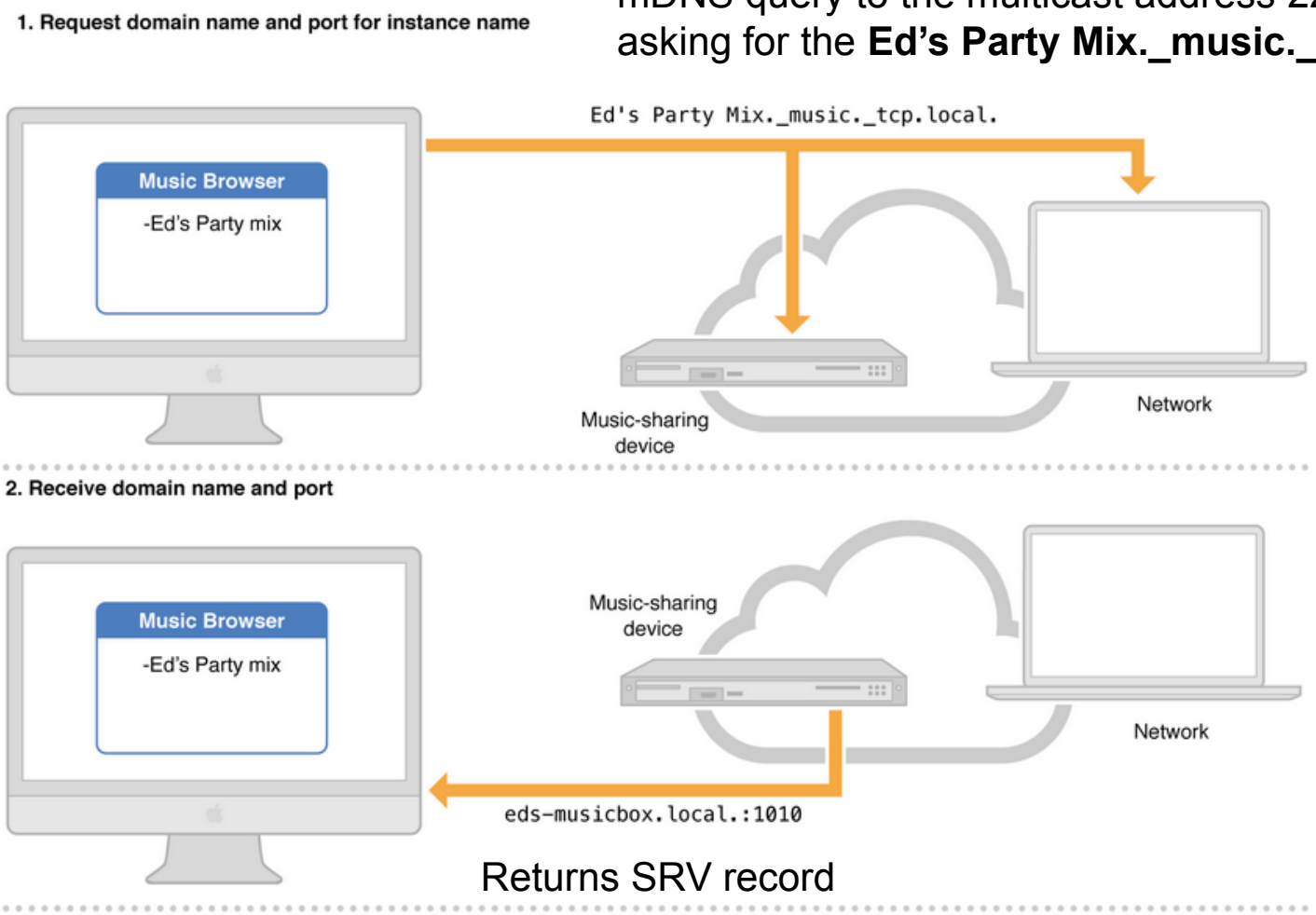
› **Multicast DNS Responder returns the service record**
› – containing hostname and port number

› **Client sends a multicast request**
› using hostname for the IP address

› **Request is resolved to an IP address**
› - to which the client can connect

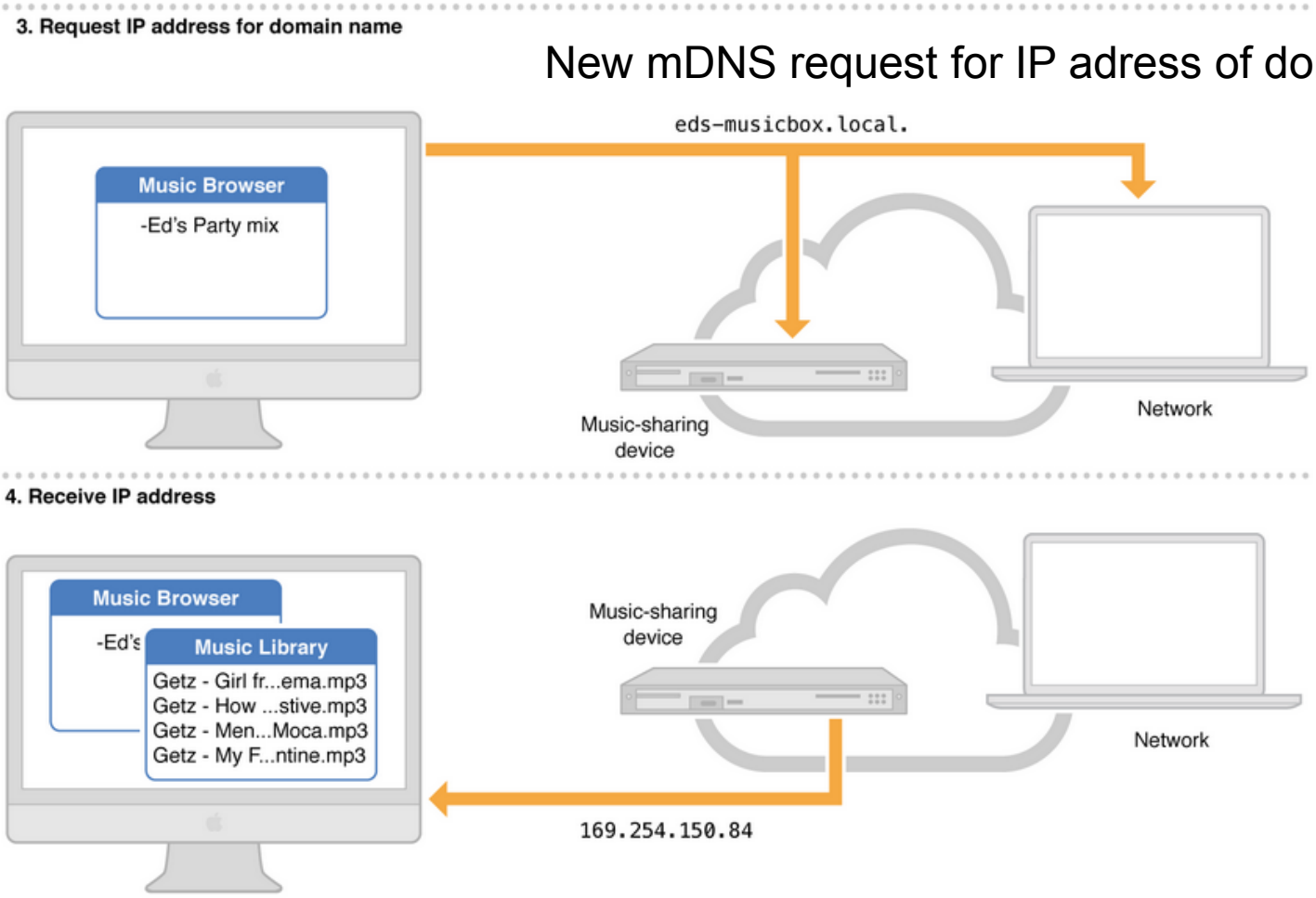
RESOLUTION EXAMPLE 1/2

mDNS query to the multicast address 224.0.0.251 asking for the **Ed's Party Mix._music._tcp.local**



Returns SRV record

RESOULTION EXAMPLE 2/2



SHORTCOMING OF ZERO-CONF

- **Need to connect to a network first**
- Must have an IP address – or at least a well-defined access point

- **Easy with a cable**
- Physical presence as security (plug the cable)

- **Difficult with wireless**
- WiFI
- Bluetooth
- Zwave
- 802.15.4 / ZigBee / 6LoWPAN

HOW TO GET THE IP ADDRESS

- **Wireless Access point must be known**
- SSID & passkey
- WiFi Protected Setup (WPS) requires router access + security risk

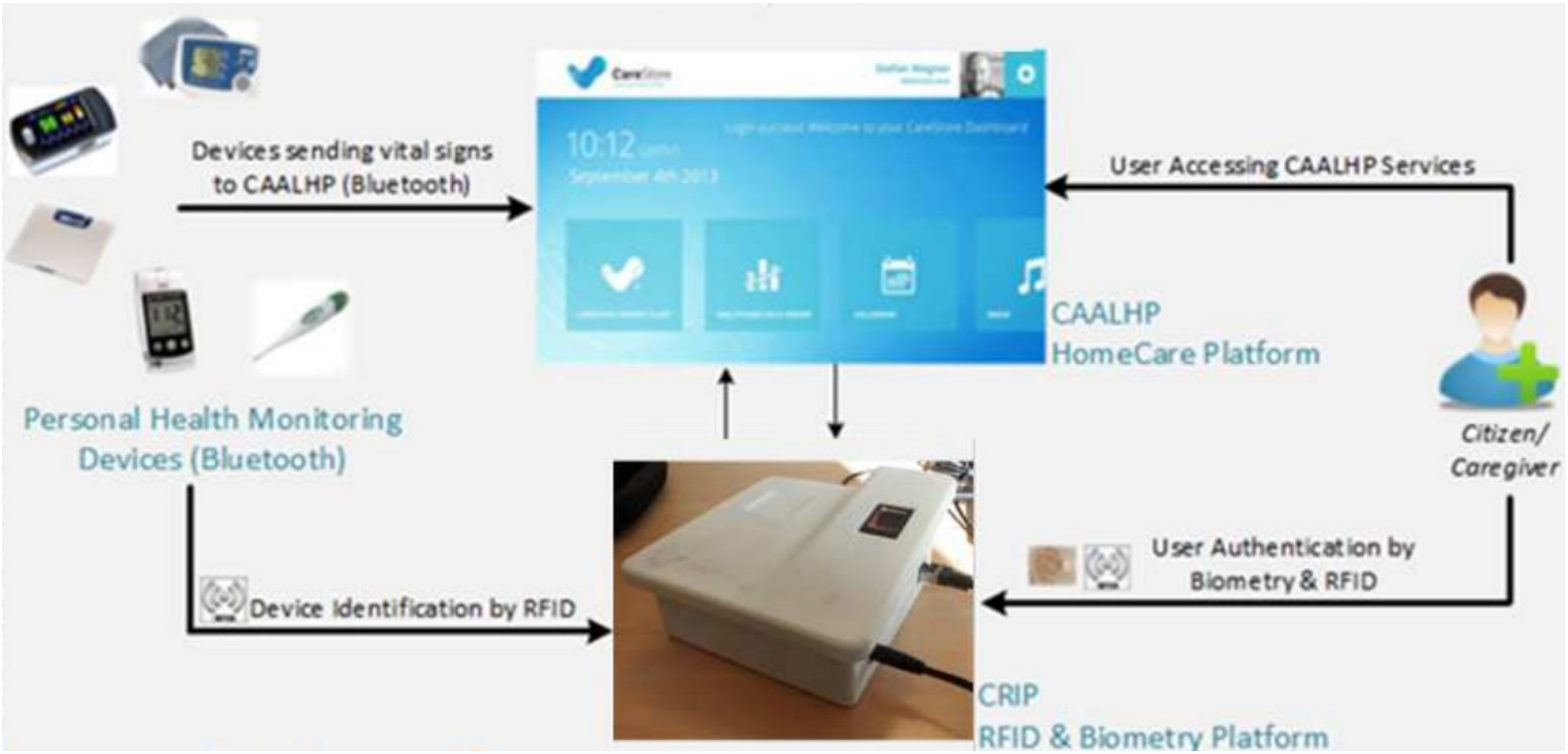
- **Bluetooth**
- May use device and service discovery but requires pin-code (pin)
- Secure Simple Pairing (SSP) – with predefined pin or no pin
- SSP Out-of-Band (SSP OOB) using NFC

- **Using NFC for initial hand-shake**
- As In SSP OOB -> receive Bluetooth MAC address and pair devices

- **Near Zero Configuration**
- Touch to connect -> receive endpoint -> then IP address -> then discovery

CARESTORE CRIP

› Common Recognition and Identification Device



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