Seminar: Ubiquitous Computing

Instant Networking and Dynamic Service Discovery

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Roadmap

Definitions

Instant Networking

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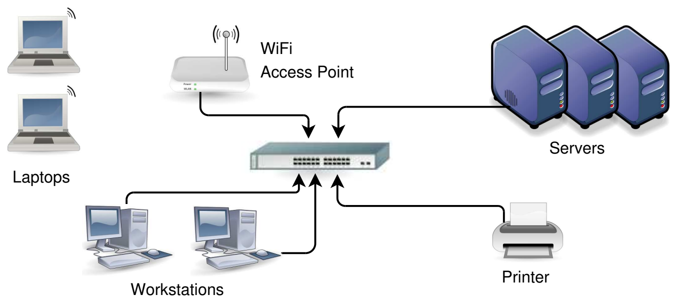
Dynamic Service Discovery

Dynamic Service Discovery describes the process of offering and finding services on the network without a-priori knowledge about the specific service.

Managed Network Scenario



Managed Networks have a group of administrators that control all configuration criteria with central management servers.

Ad-hoc Network Scenario

In an *Ad-hoc Network* all machines are equal, there is no authoritative server to determine the configuration. Nodes act in a peer-to-peer fashion.

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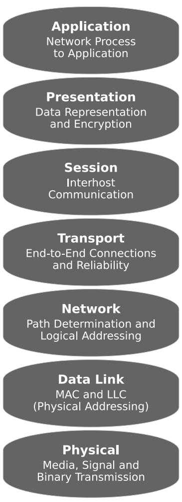
- Do this without manual configuration
- If possible also scale to managed enterprise networks
- If possible re-use existing techniques
- Accomplished by a set of protocols usually called Zero Configuration Networking (ZeroConf)

Acronyms Used

- IP - Internet Protocol
- TCP - Transmission Control Protocol
- UDP - User Datagram Protocol
- DNS - Domain Name System
- SDP - Service Discovery Protocol

What is Needed to Access Network Services?



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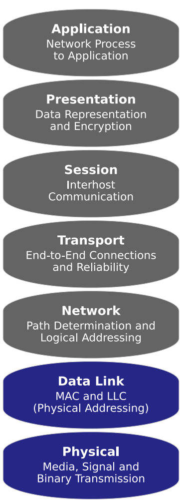

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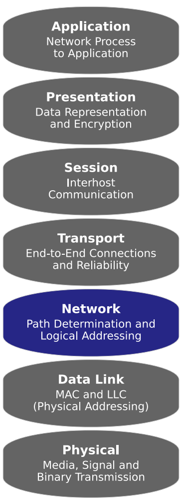

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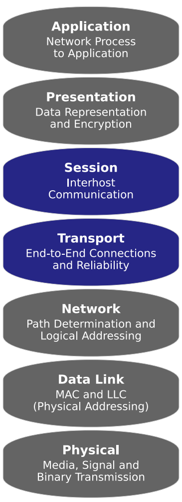
  - Today UDP and TCP are widely used for layer 4
  - Needed basic information:
    - Host (IP address)
    - Port number
  - Service Discovery in session layer



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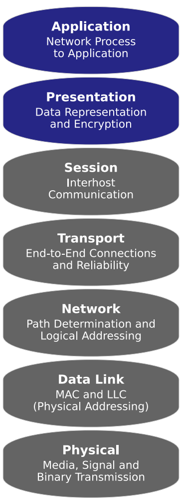
- Layer 6 and 7 do not need modifications



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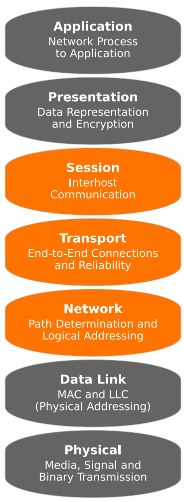
- ZeroConf acts in layers 3 to 5
- Layer 3: AutoIP
- Layer 4/5: Multicast DNS and DNS-based Service Discovery



1 Introduction

2 Instant Networking
- Overview
- Dynamic Host Configuration Protocol (DHCP)
- Link-Local IPv4 Addressing (AutoIP)

3 Name Resolution

4 Service Discovery

5 Summary

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- Fundamental difference in managed and ad-hoc networks:
    - ad-hoc network is not managed by a central group
    - a component may not be connected all the time

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- Central server distributes network configuration:
  - IP address, DNS info, etc.
- There may be multiple servers per network
- Useless for ad-hoc. Running a DHCP server on each node is not an option
  - Each node may provide different configurations: conflicts
  - Although all nodes share the same physical network they may be in different logical networks

AutoIP Facts

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Definition (Local Link)

Two machines are on the same local link iff:

- they can exchange packets using unicast, multicast or broadcast that arrive with unmodified payload
- a broadcast send by one machine can be received by all other stations

Simplification:

- no routers are passed by a packet
- the machines can send IP packets with a time-to-live of 1

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- Only IP addresses, no DNS info, routing info etc.

Usage Example

Example (Gathering a valid IP address)

Host B is already configured, Host A joins the network and starts IP configuration

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4. If valid IP success, if there is no conflict response after a few claims success is assumed

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Definition (Multicast)

- You put packets in at one end, and the network conspires to deliver them to anyone who asks.
- Like radio: data is send with a specified frequency and you can tune your receiver to read the data.

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- Resolve symbolic names to IP addresses
- Name resolution is used for user convenience and config stability
- In Ad-hoc networks are no servers which can resolve names
- Peer-to-peer approach is needed; done via Multicast
- There are two drafts that offer a solution
  - Link-Local Multicast Name Resolution (LLMNR)
  - Multicast DNS (mDNS)

LLMNR Facts

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- Incompatible to DNS-based Service Discovery

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- Name reservation and conflict resolution protocol
- Fits nicely with DNS-based Service Discovery

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- Name reservation
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- Querying information
  - DNS message can contain multiple queries/answers
  - No explicit “Does not exist” message but not receiving answers after a given timeout is an indicator
- Traffic reduction (especially for Service Discovery)
  - Answers are send via multicast: all stations receive results
  - Records are cached, by default re-querying every 60 minutes
  - Known Answer suppression, known answers are send with the query

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5. Host B answers using multicast

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- General approach needed for service discovery that is independent from the higher level protocol

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- *System and Manufacturer Independence:* Does the SDP depend on a specific system or manufacturer?
- *Existing Implementations:* Do implementations exist and are they in real-world usage today?

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- Described here:
  - Universal Plug and Play (UPnP)
  - Jini
  - Service Location Protocol (SLP)
  - DNS-based Service Discovery (DNS-SD)

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Existing Implementations:

- No open implementation, known mainly for port forwarding in SOHO routers

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Existing Implementations:

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Existing Implementations:

- OpenSLP is an open implementation maintained by Novell

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- DNS additional record generation to reduce traffic

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  - No direct answer facility
  - DNS UPDATE can be used to register services with DNS server
- Ad-hoc networks
  - Initial announcement if service goes live
  - Queries and answers via mDNS
  - Answers authoritatively for all matching queries if not in known answers

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Existing Implementations:

- Numerous OS implementations: Bonjour (Apple), howl, Avahi (FreeDesktop.org)

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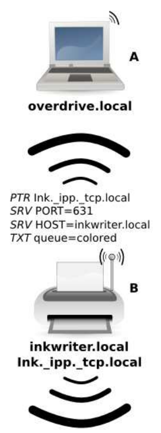
3. Printer B answers the query. It creates additional DNS RR in the answer for traffic reduction



Usage Example

Example (Announcing and Searching)

1. Host A joins the network and so did not get Printer B's announce message
2. Host A looks for _ipp._tcp.local to find a printer
3. Printer B answers the query. It creates additional DNS RR in the answer for traffic reduction
4. Another Host C which was on the network before A now also has this information

1 Introduction

2 Instant Networking

3 Name Resolution

4 Service Discovery

5 Summary

- ZeroConf
- Demo Scenario
- End of Talk

What makes ZeroConf?

1. Link-Local IPv4 Addressing (AutoIP)

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1. Link-Local IPv4 Addressing (AutoIP)
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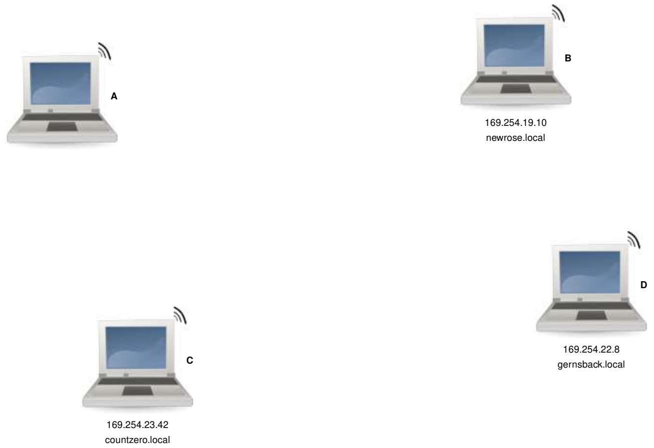
3. DNS-based Service Discovery (DNS-SD)

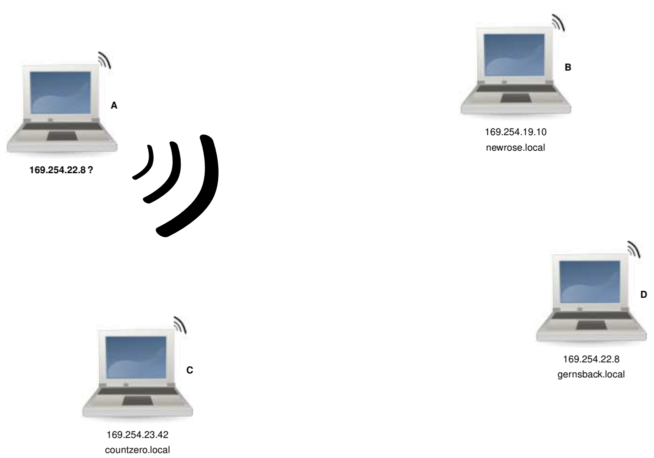
- Protocol stack for instant networking and service discovery
- Known as ZeroConf or Bonjour (Apple)
- Implementations exist for all major systems
- Implemented in virtually all new printers

End of Talk

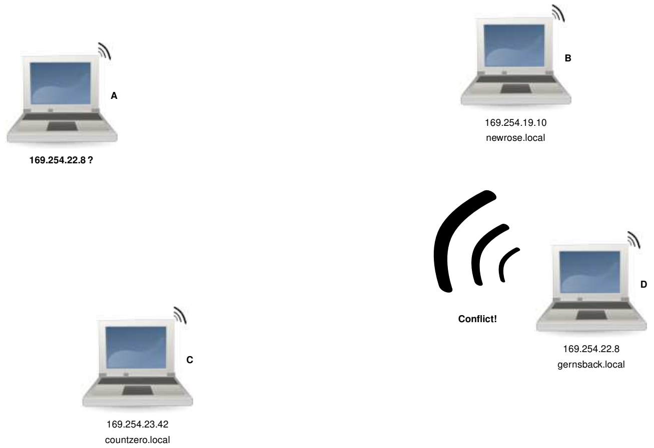
Host A Joins the Ad-hoc Network



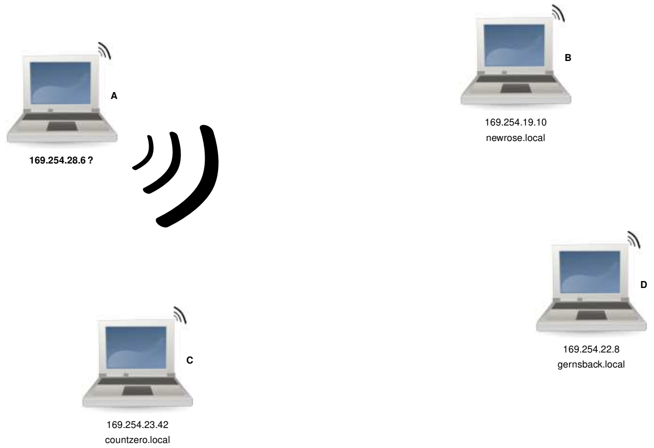
Host A Claims an IP Address



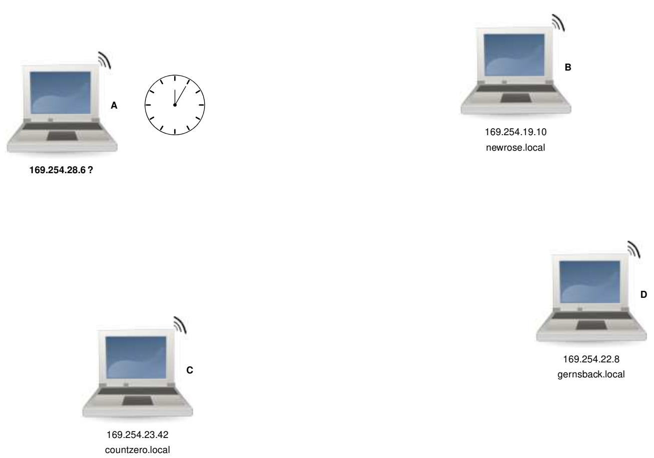
IP conflicts with Host D



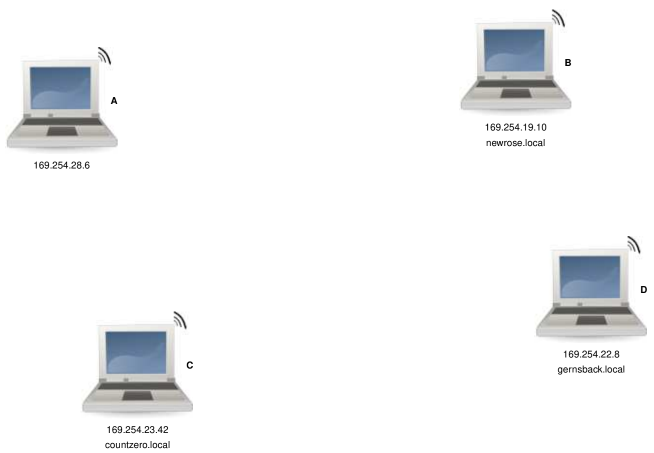
Host A Claims another IP Address



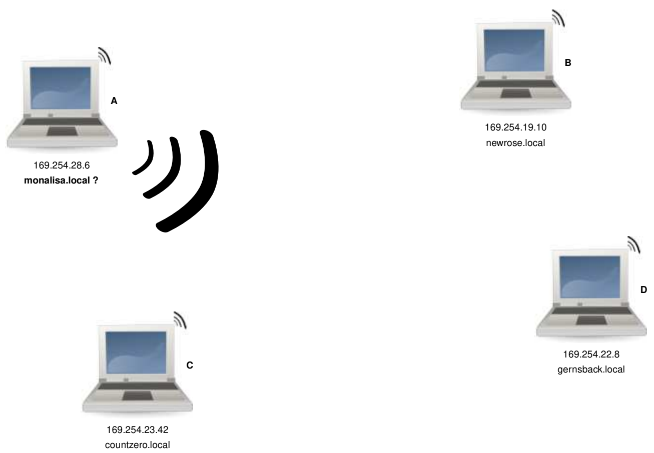
Host A Waits For Possible Conflicts



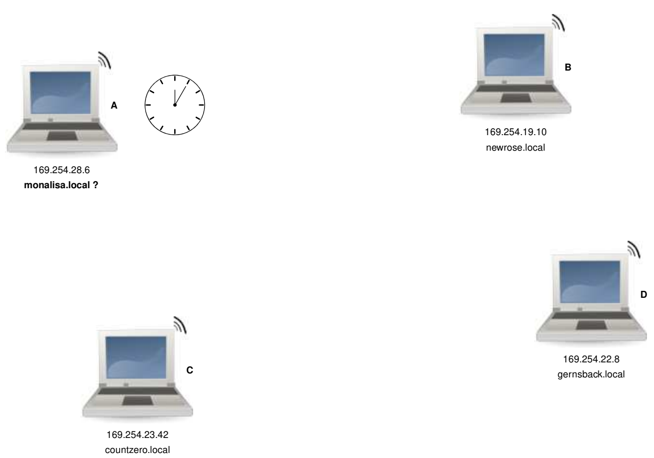
Host A Has an IP And Can Transfer Data



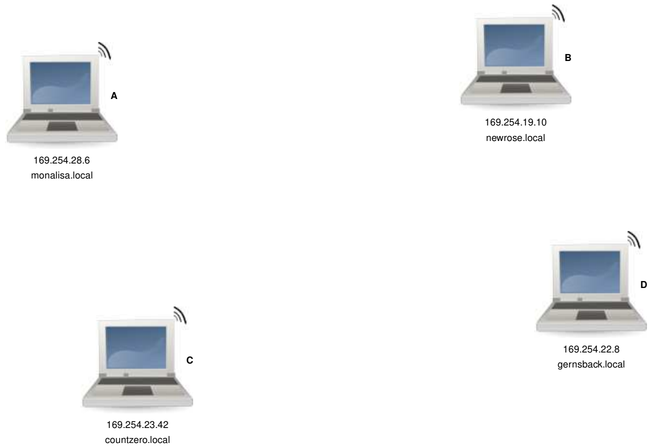
Host A Claims A Name



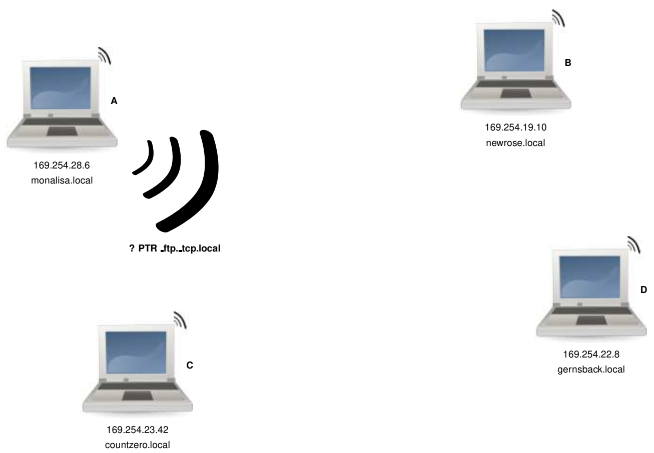
Host A Waits For Possible Conflicts



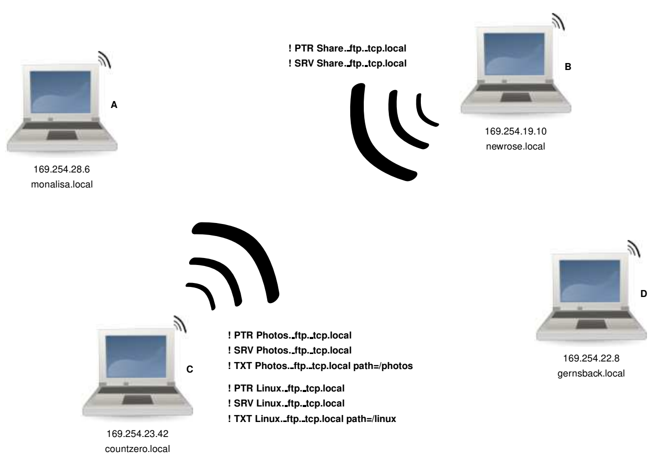
Host A Claimed a Name And Is Now monalisa.local



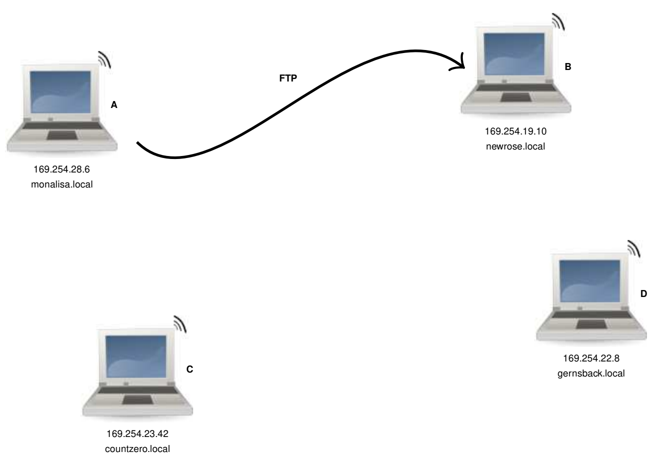
monalisa.local Asks For File Services



countzero.local and newrose.local Answer



monalisa.local Uses FTP on newrose.local



Questions?

Information compiled at
`http://www.niemueller.de/uni/mdnssd/`