Seminar: Ubiquitous Computing

Instant Networking and Dynamic Service Discovery

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Roadmap

Definitions

Instant Networking

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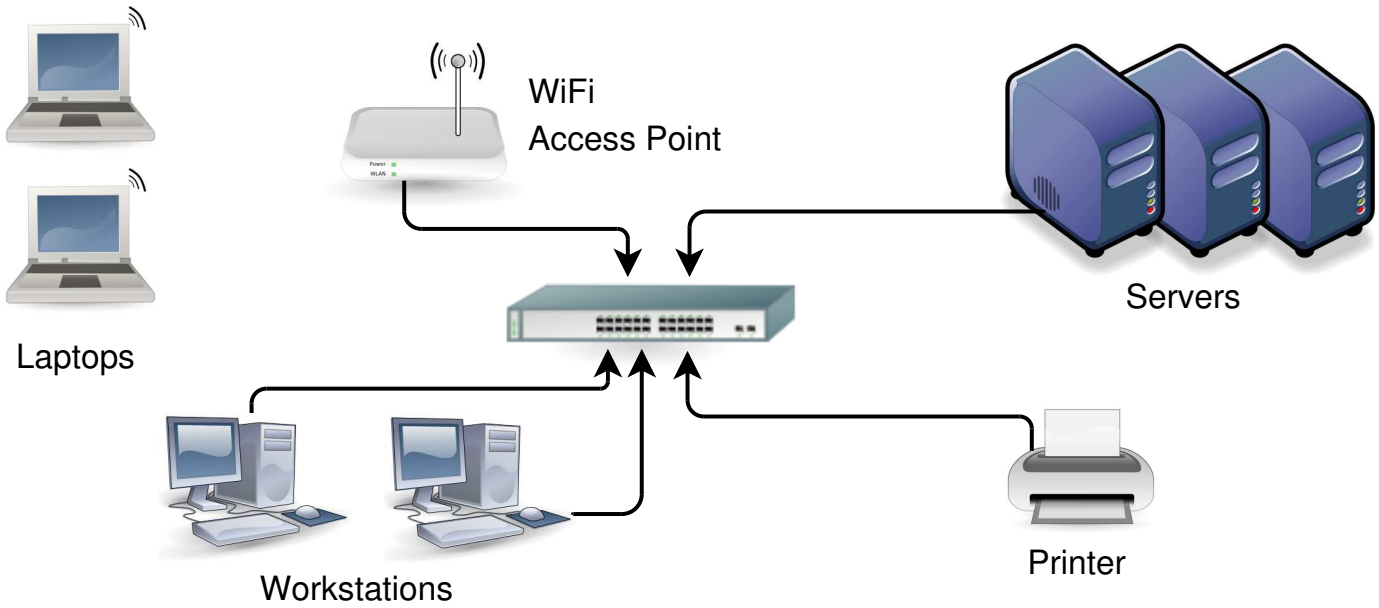
Dynamic Service Discovery

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




No Infrastructure

Printer

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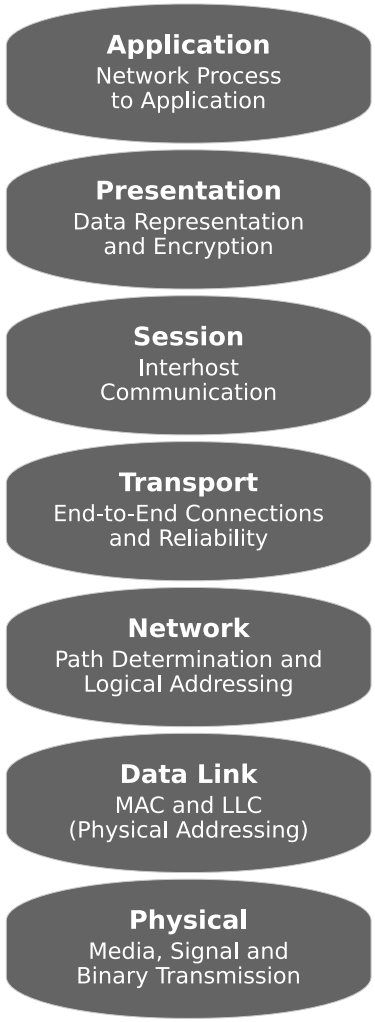
- Do this without manual configuration
- If possible also scale to managed enterprise networks
- If possible re-use existing techniques
- Accomplished by a set of protocols usually called Zero Configuration Networking (ZeroConf)

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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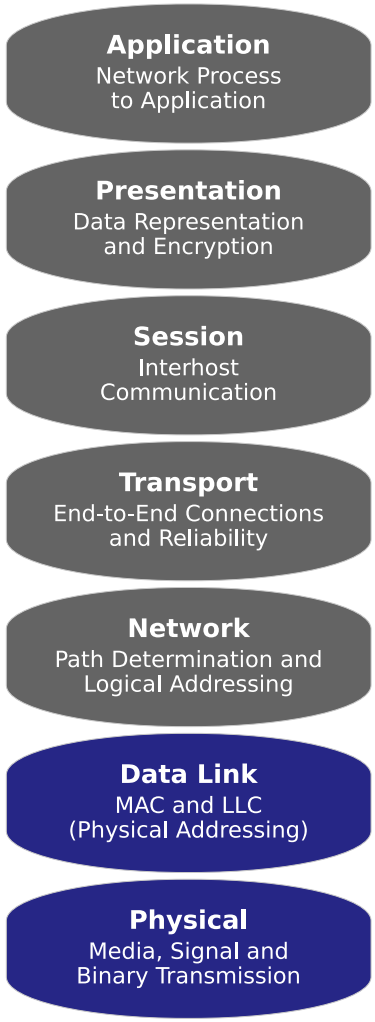

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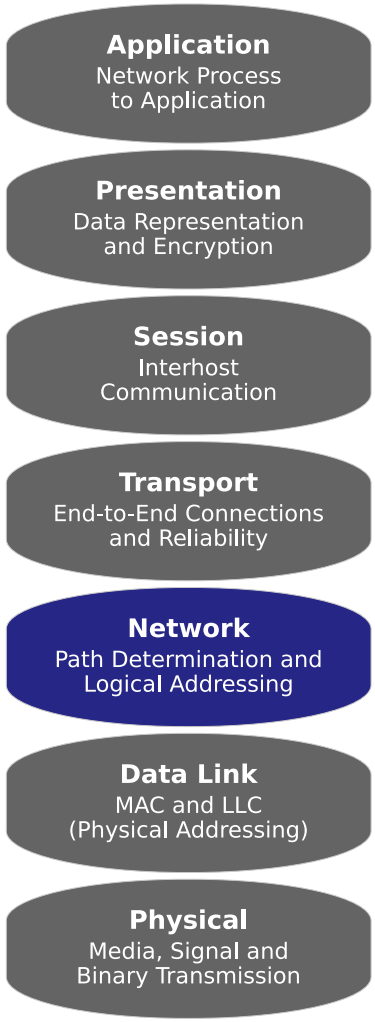

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    - Host (IP address)
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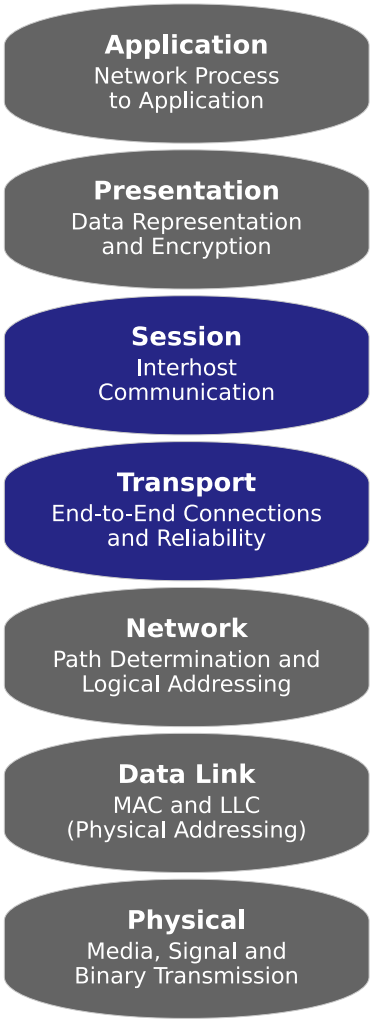
  - Service Discovery in session layer



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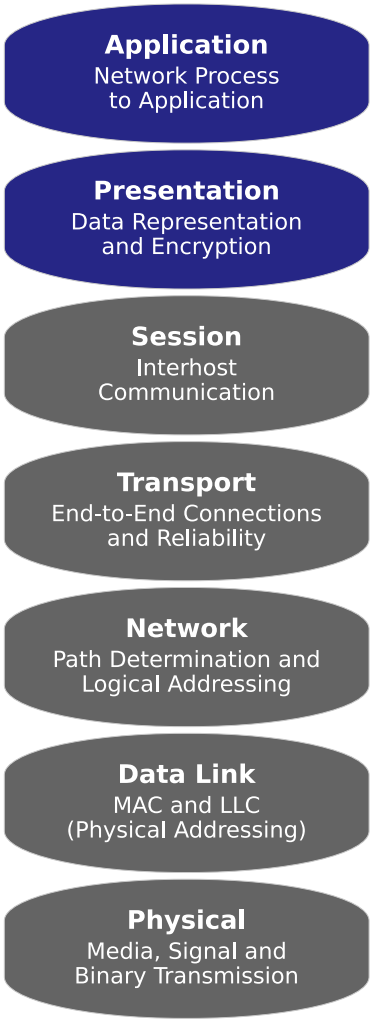
- Layer 6 and 7 do not need modifications



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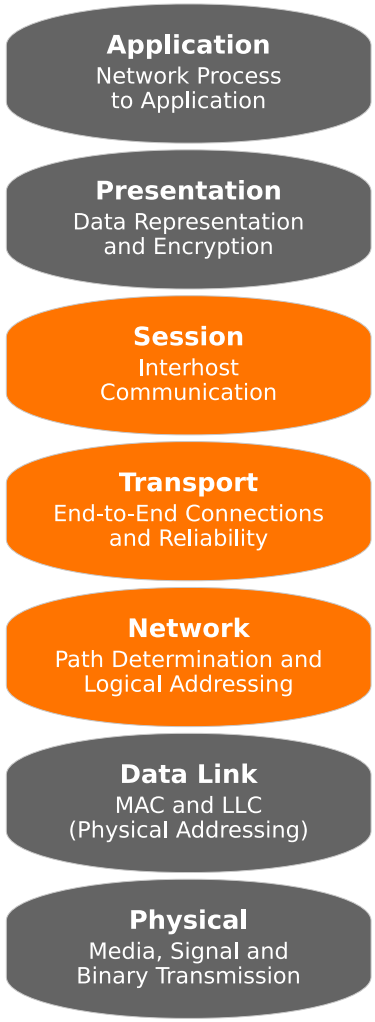
- ZeroConf acts in layers 3 to 5
- Layer 3: AutoIP
- Layer 4/5: Multicast DNS and DNS-based Service Discovery



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  - 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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- 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)

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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
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- 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)

⏩ Skip Standards

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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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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

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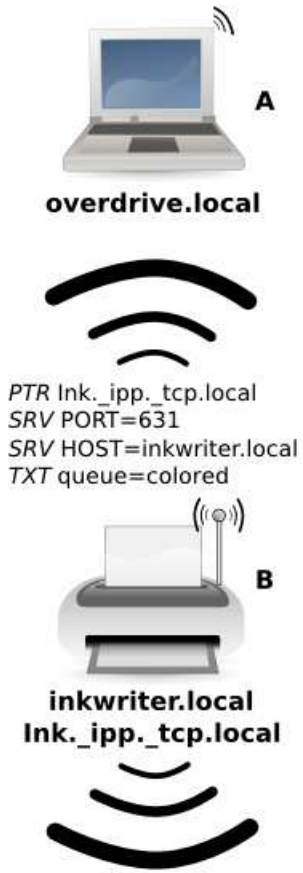
1. Host A joins the network and so did not get Printer B's announce message
2. Host A looks for _ipp._tcp.local to find a printer
3. Printer B answers the query. It creates additional DNS RR in the answer for traffic reduction



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4. Another Host C which was on the network before A now also has this information

What makes ZeroConf?

1. Link-Local IPv4 Addressing (AutoIP)

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- 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

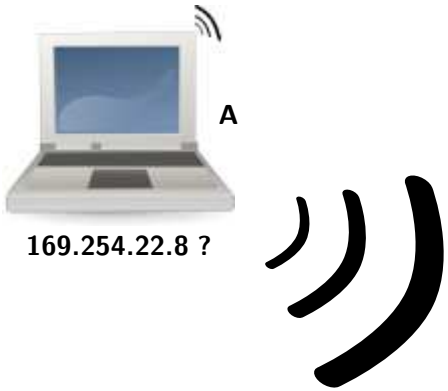
Host A Joins the Ad-hoc Network

169.254.19.10
newrose.local

169.254.23.42
countzero.local

169.254.22.8
gernsback.local

Host A Claims an IP Address



IP conflicts with Host D

169.254.22.8 ?

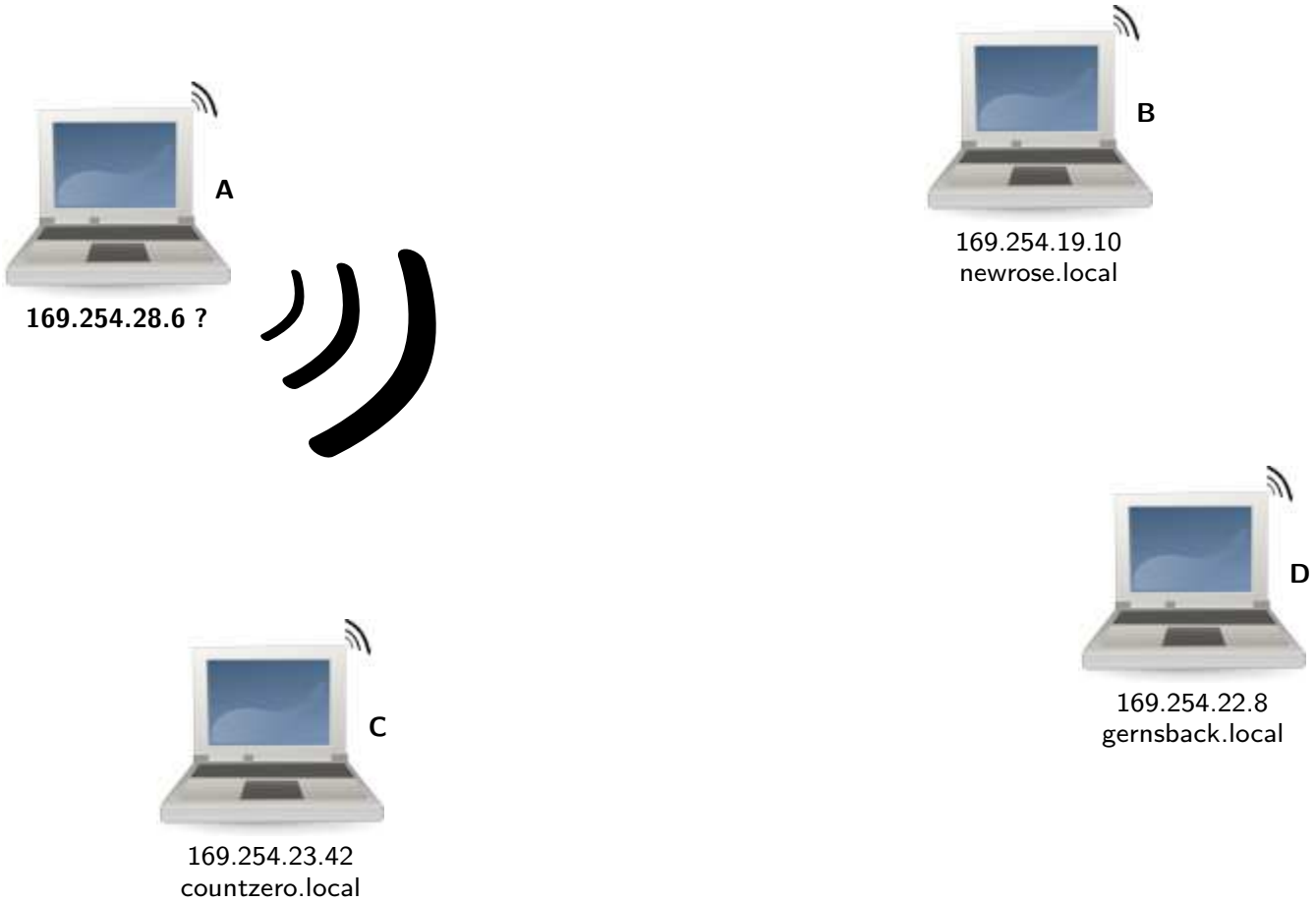
169.254.19.10
newrose.local

Conflict!

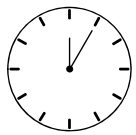
169.254.22.8
gernsback.local

169.254.23.42
countzero.local

Host A Claims another IP Address



Host A Waits For Possible Conflicts



169.254.28.6 ?

169.254.19.10
newrose.local

169.254.23.42
countzero.local

169.254.22.8
gernsback.local

Host A Has an IP And Can Transfer Data

169.254.28.6

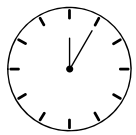
169.254.19.10
newrose.local

169.254.23.42
countzero.local

169.254.22.8
gernsback.local

Host A Claims A Name

Host A Waits For Possible Conflicts



169.254.28.6
monalisa.local ?

169.254.19.10
newrose.local

169.254.23.42
countzero.local

169.254.22.8
gernsback.local

Host A Claimed a Name And Is Now monalisa.local

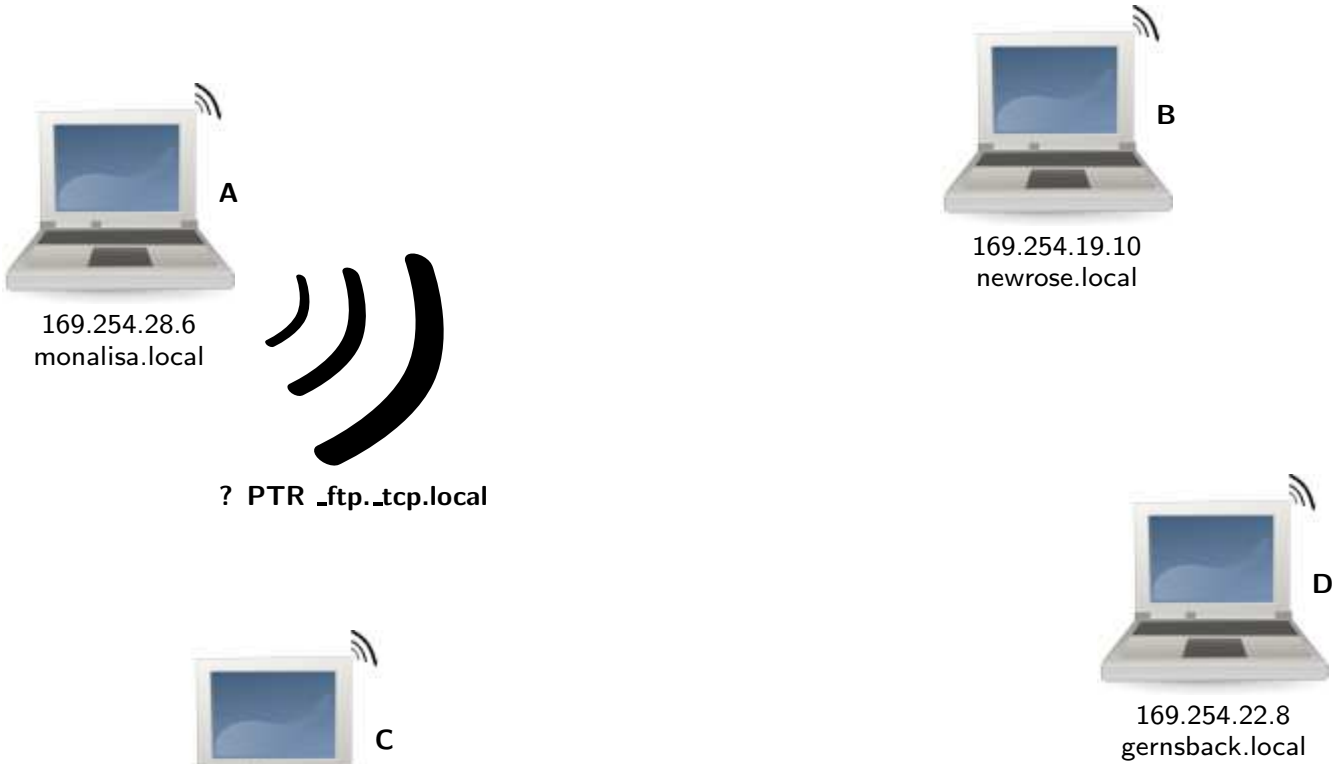
169.254.28.6
monalisa.local

169.254.19.10
newrose.local

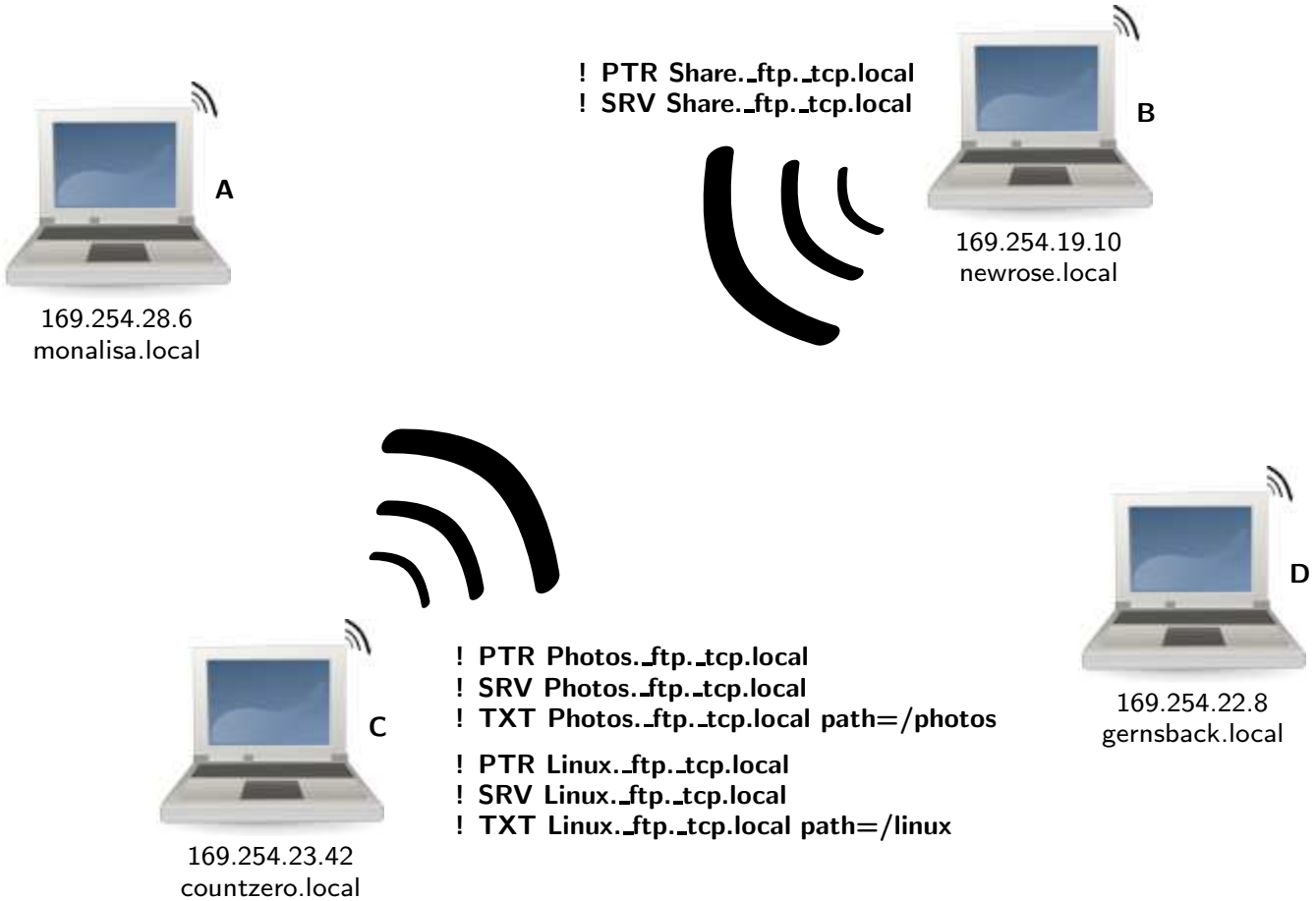
169.254.23.42
countzero.local

169.254.22.8
gernsback.local

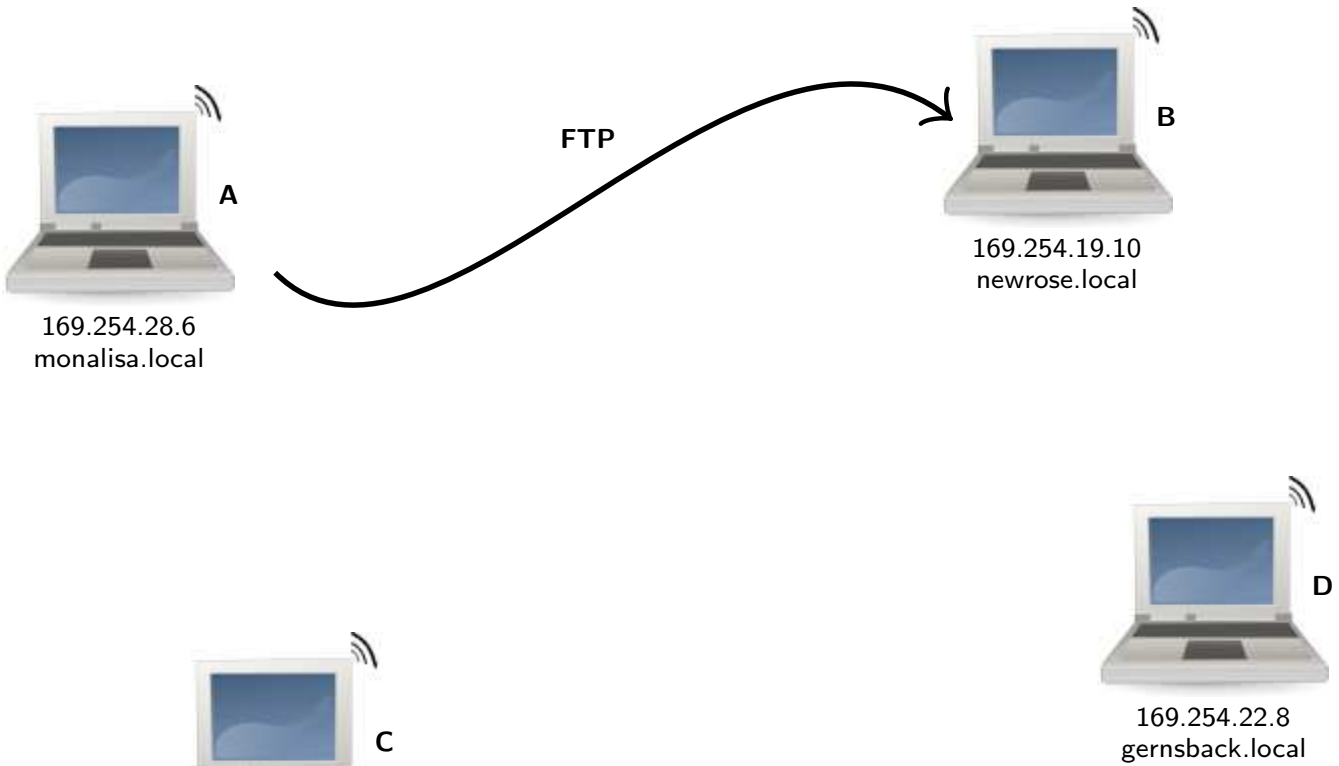
monalisa.local Asks For File Services



countzero.local and newrose.local Answer



monalisa.local Uses FTP on newrose.local



Questions?

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