Security and Privacy

Outline for Today

- **Iterators and Assignment 7**
  - One final topic for the last assignment.
  - Demo for Assignment 7.
- **Security and Privacy**
  - A case study in privacy and security.

Iterators

- To visit every element of a collection, you can use the "for each" loop:

```
for (ElemType elem: collection) {
    ...
}
```

- Alternatively, you can use an **iterator**, an object whose job is to walk over the elements of a collection.
- The iterator has two commands:
  - **`hasNext()`**, which returns whether there are any more elements to visit, and
  - **`next()`**, which returns the next element and moves the iterator to the next position.

Java Iterators

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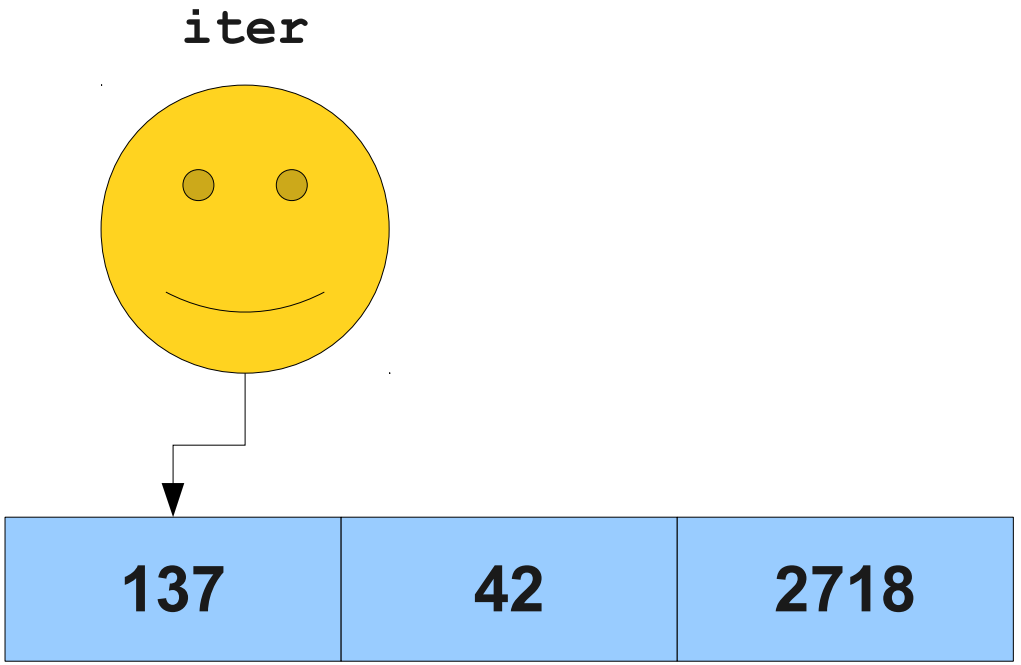


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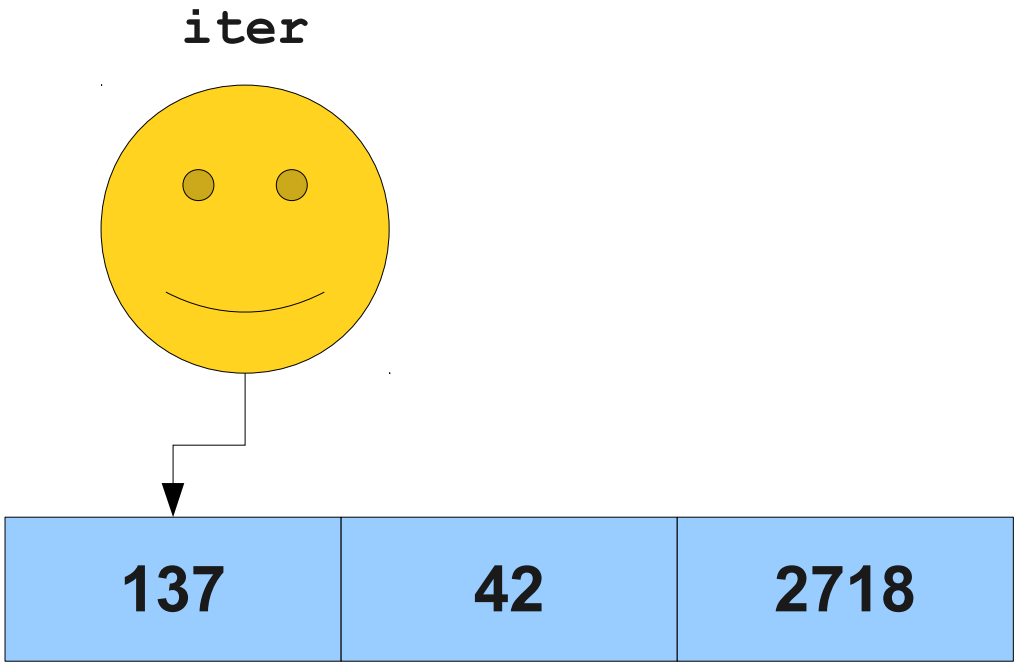


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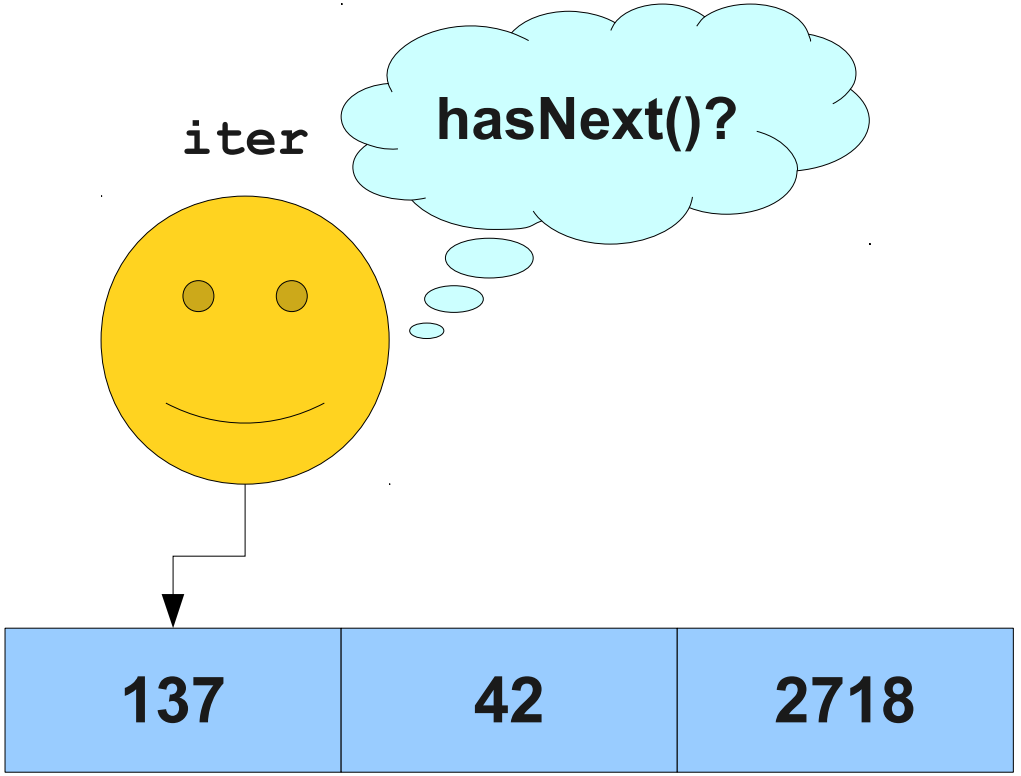


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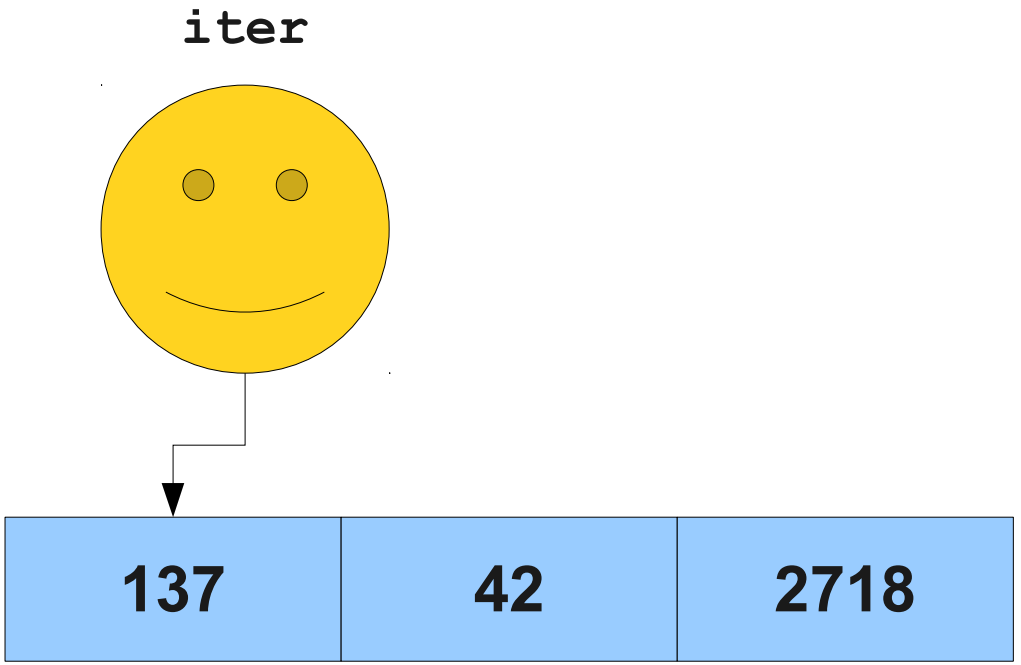


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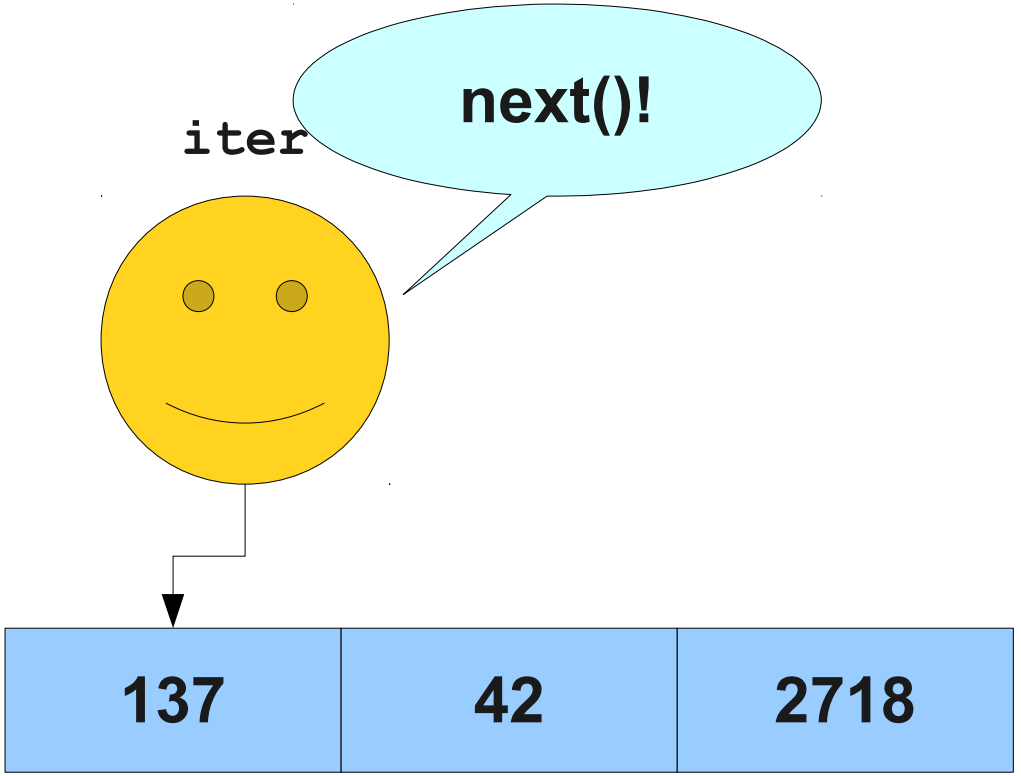


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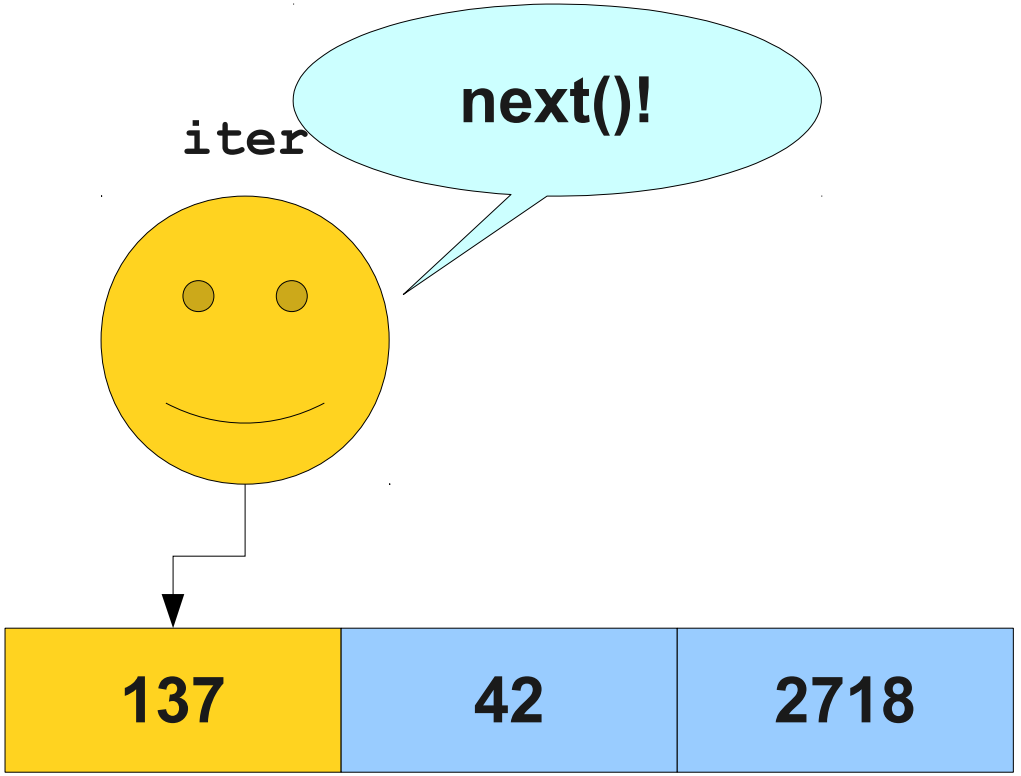


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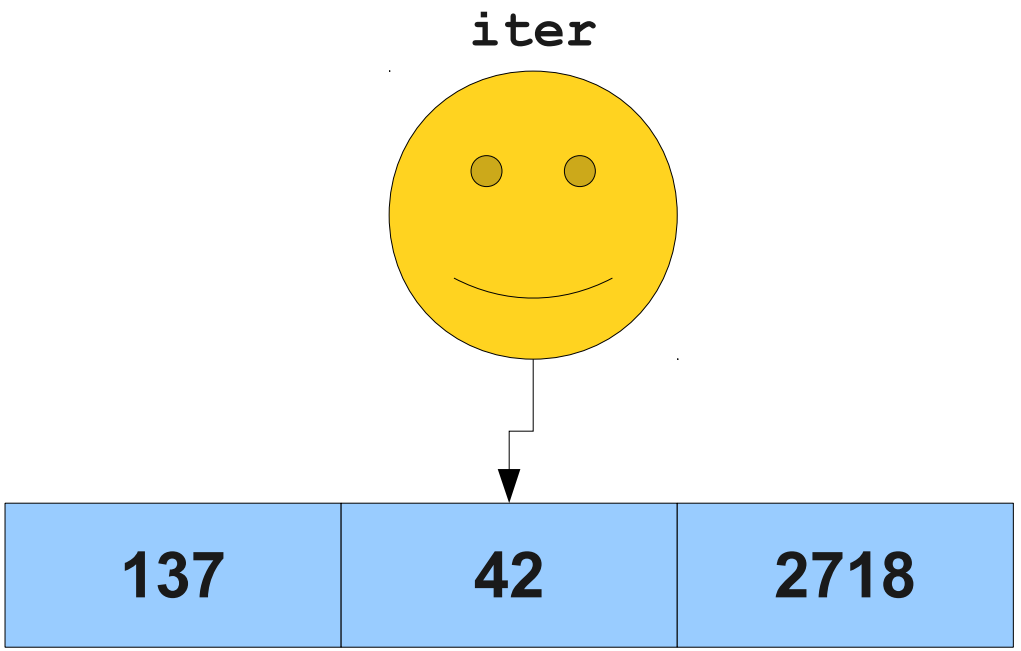


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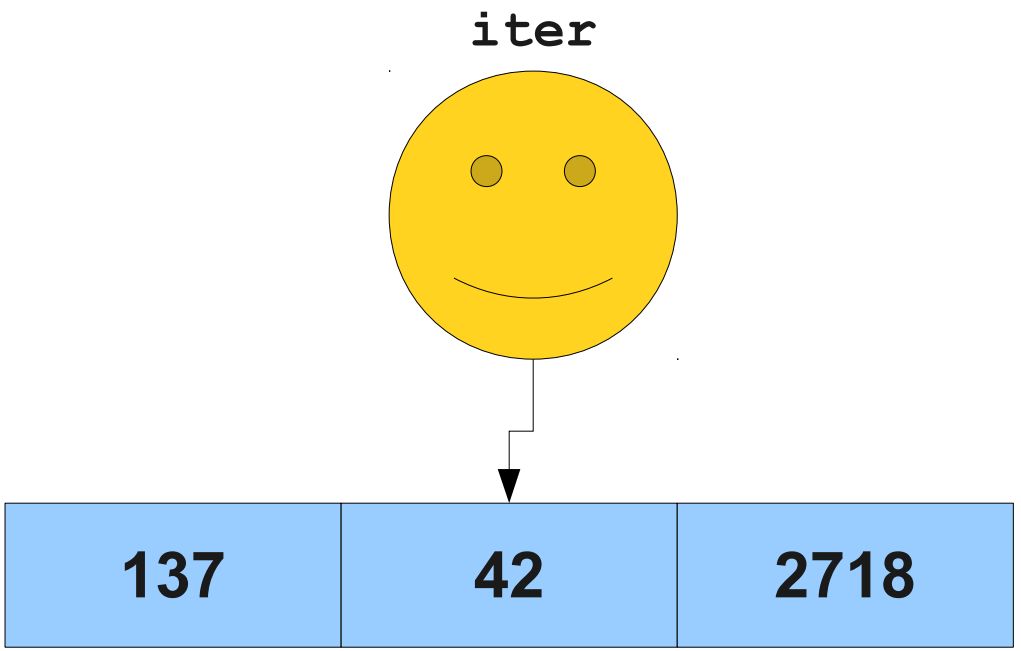


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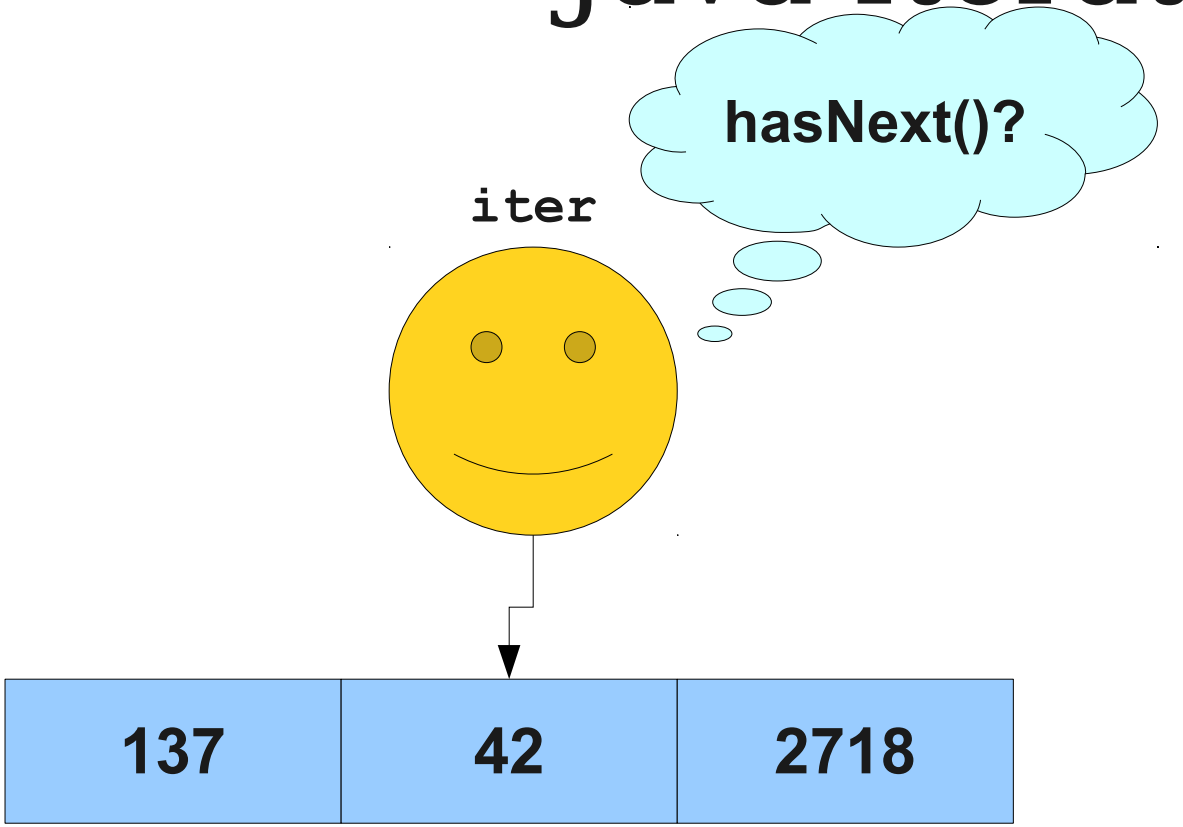


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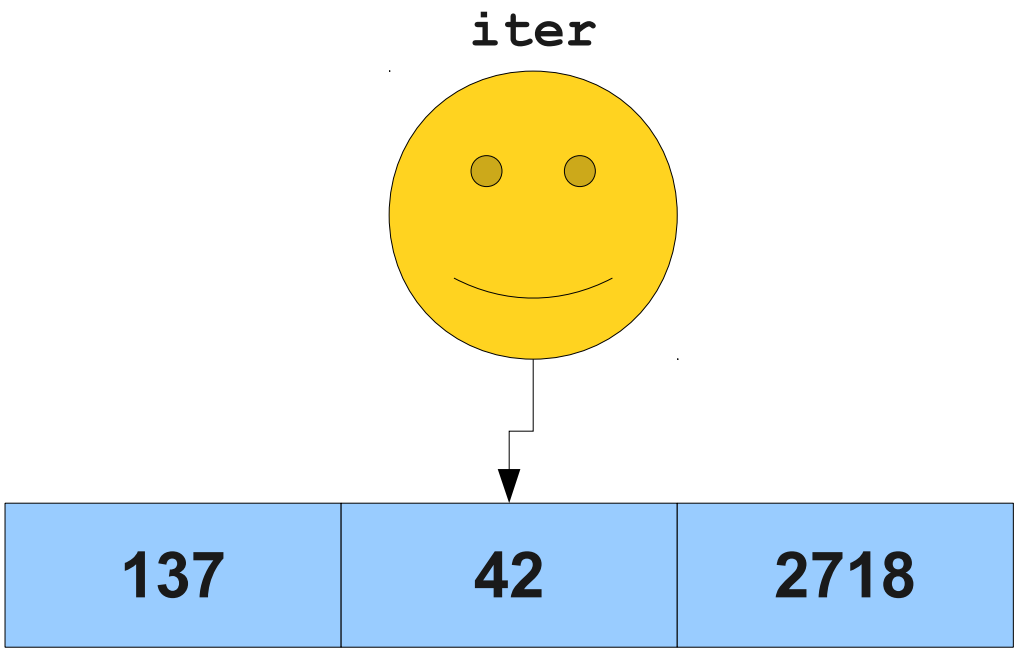


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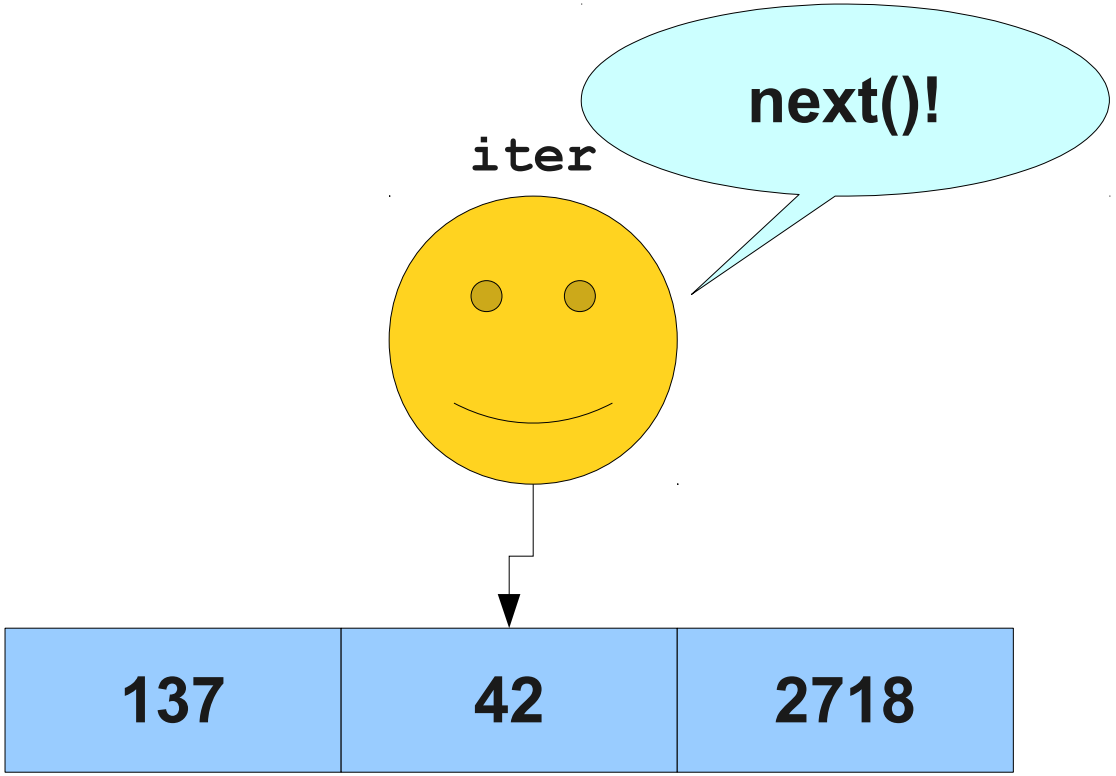


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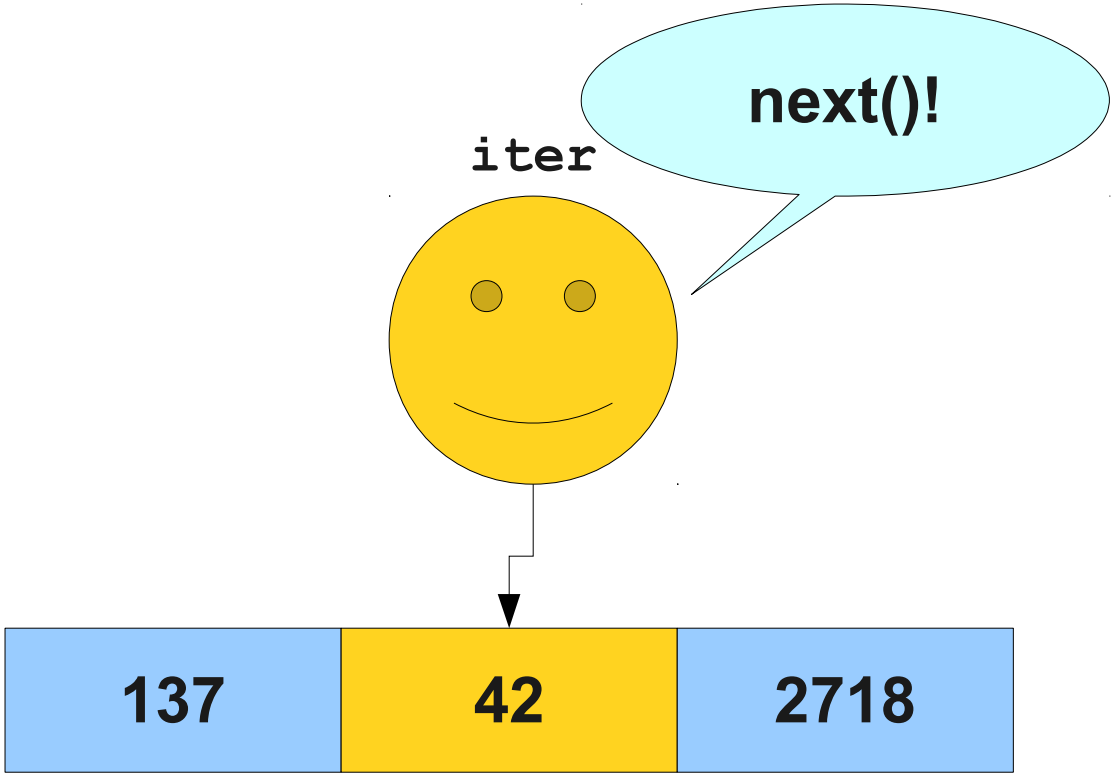


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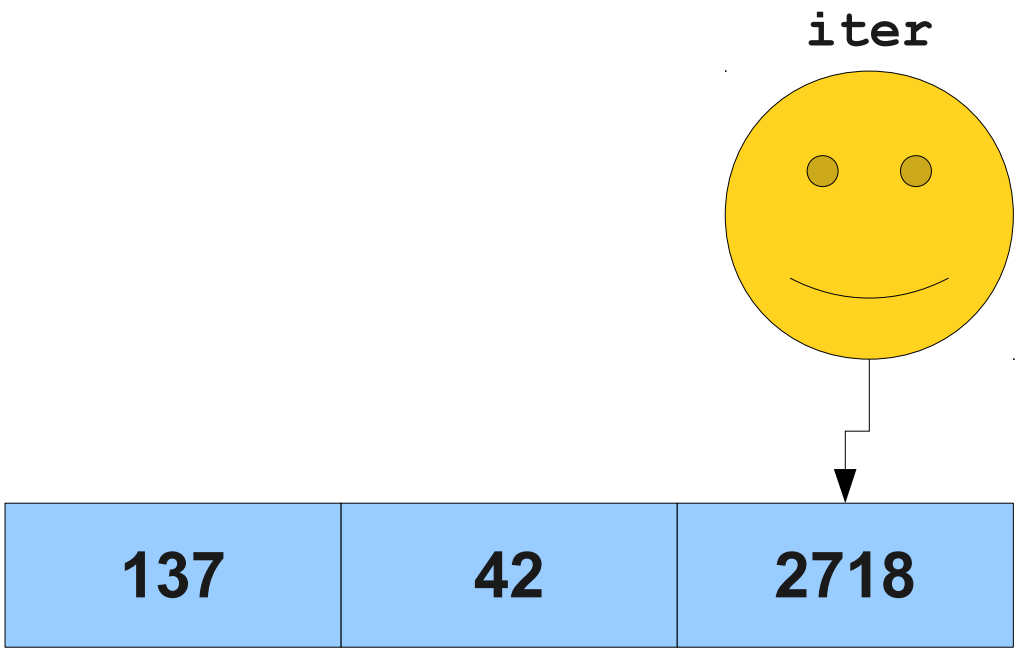


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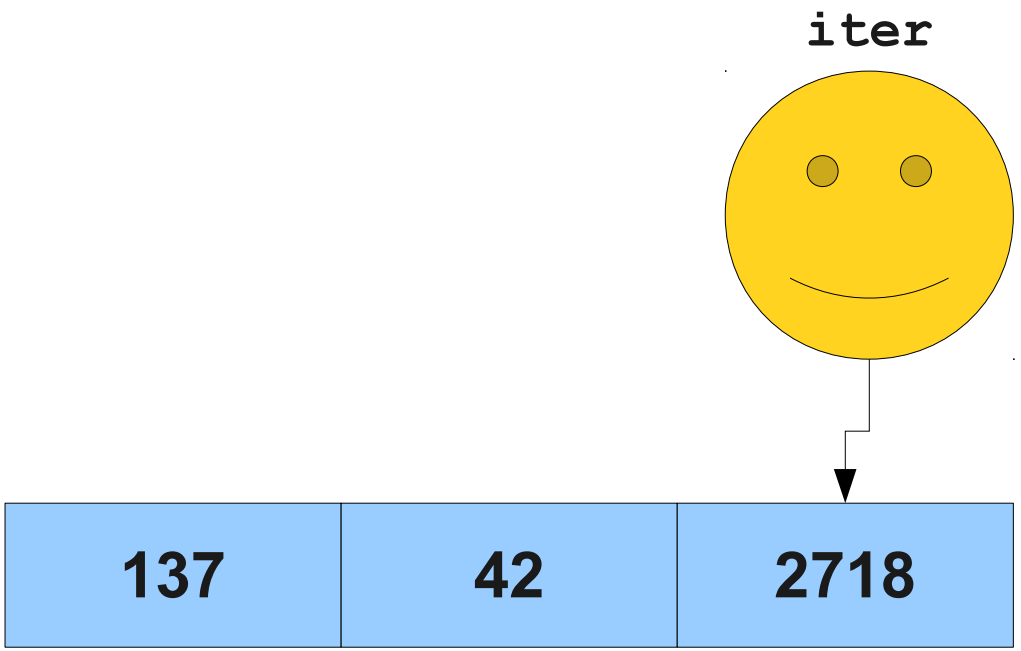


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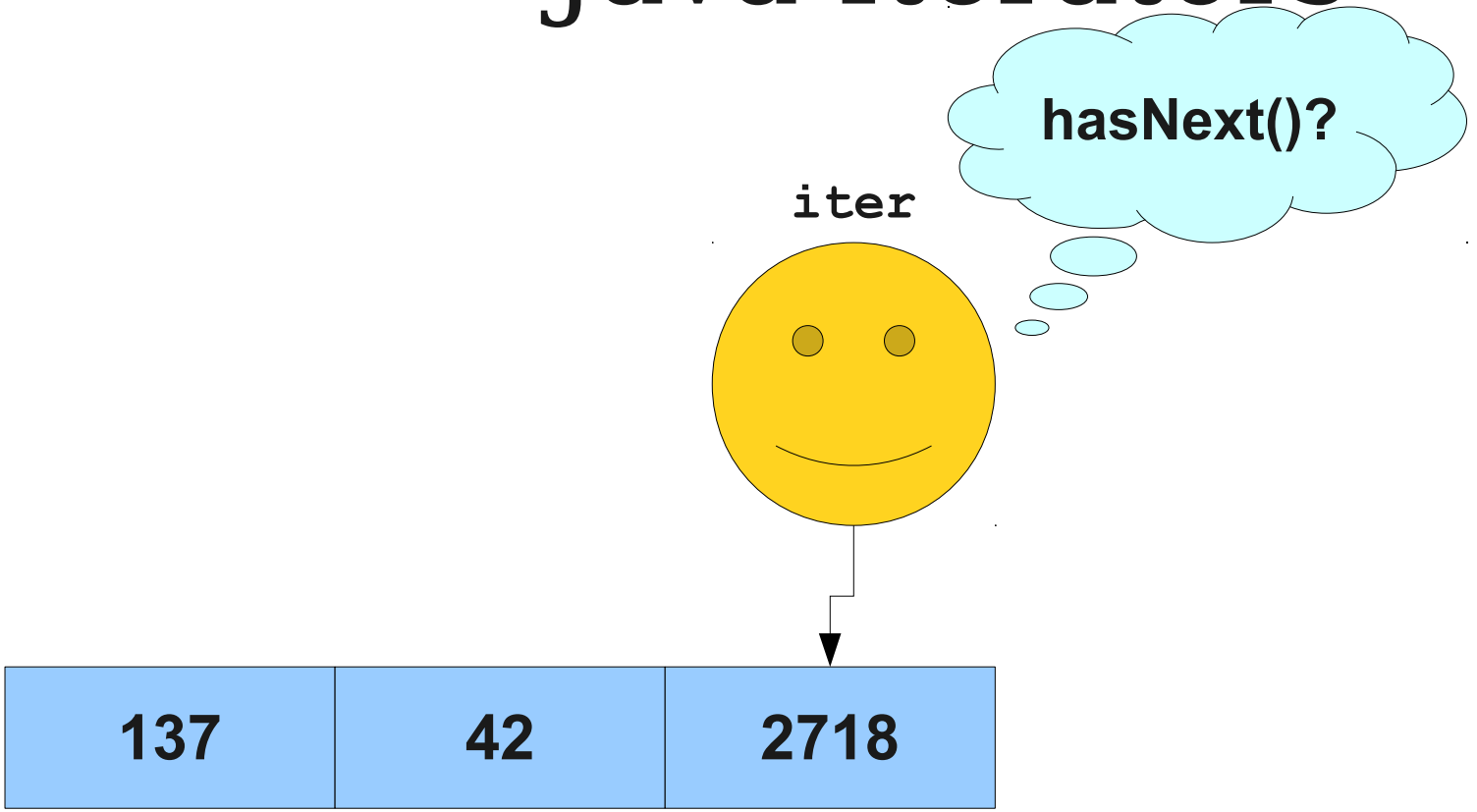


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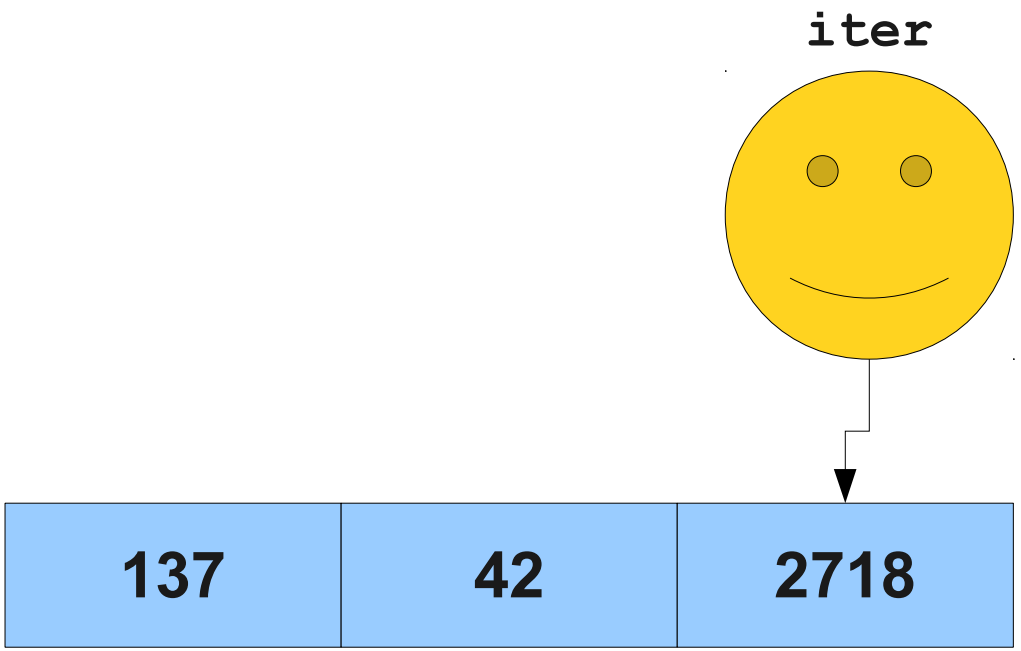


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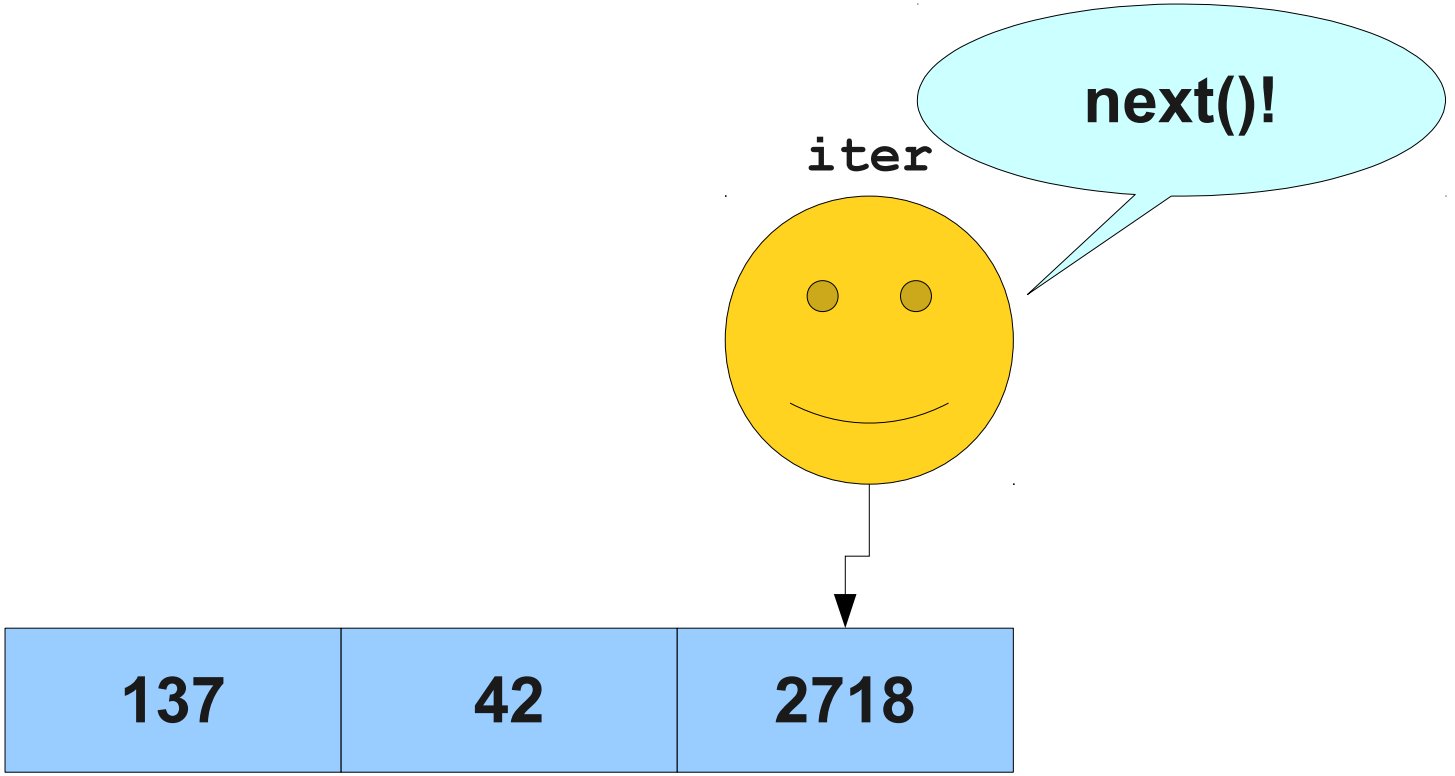


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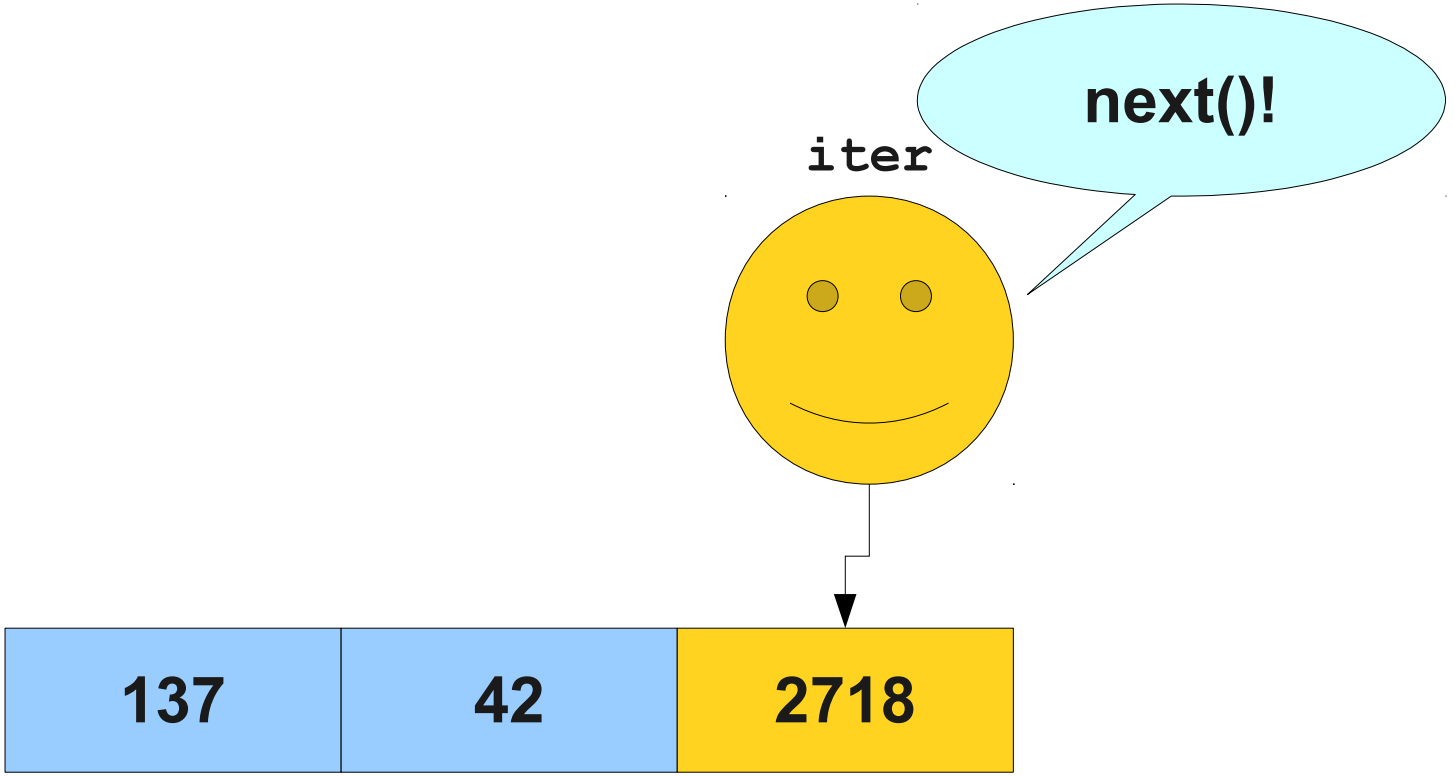


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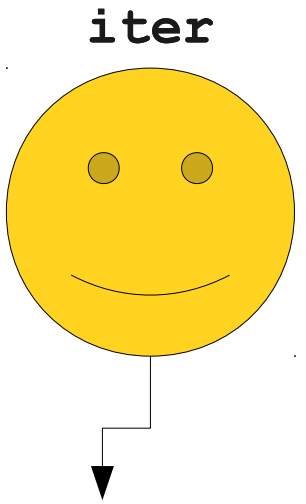

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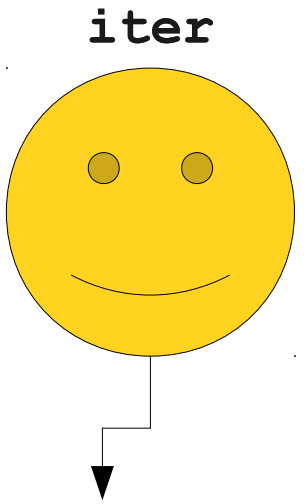

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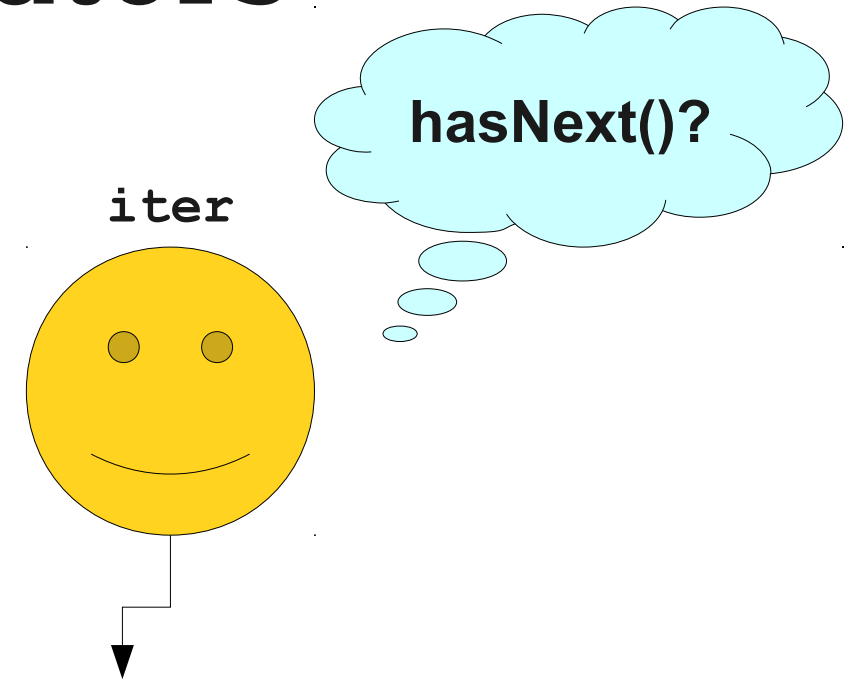

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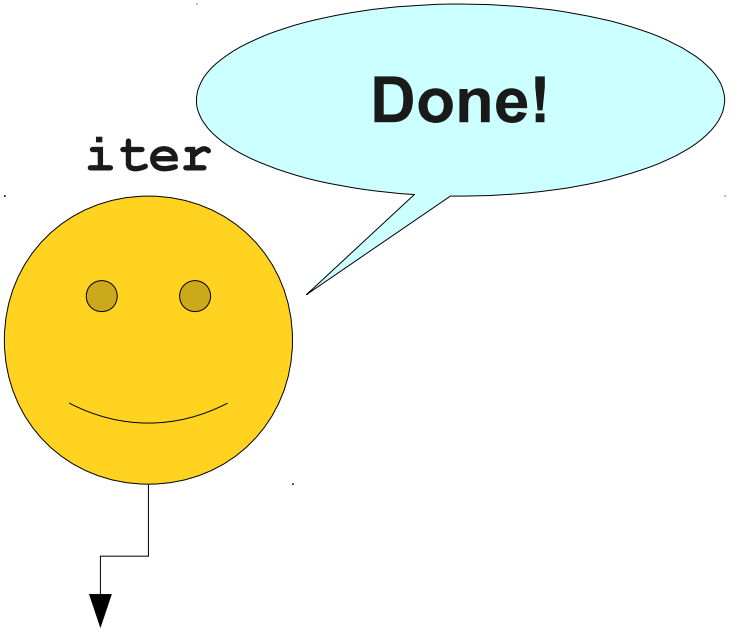

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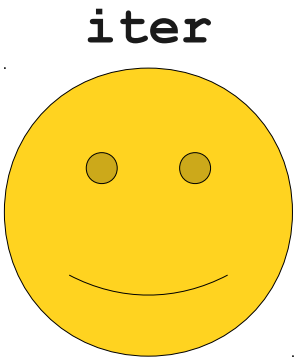

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Why Iterators?

- Buying a cake versus buying cake mix:
  - If you buy a cake, you need to eat it soon.
  - If you buy cake mix, you can eat it at your convenience.
- For loops versus iterators:
  - If you have a for loop, you always iterate across the range at a particular point in the code.
  - If you get back an iterator, you can iterate over it at your convenience.

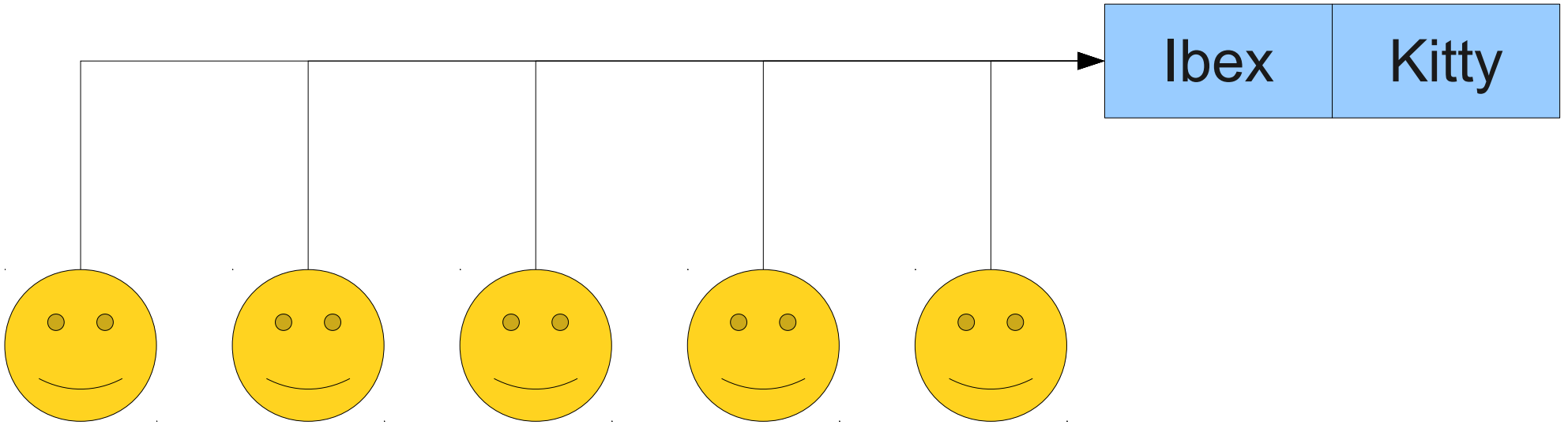
A Word of Warning

A Word of Warning

- The following will loop forever on a nonempty collection:

```
while (collection.iterator().hasNext()) {
    /* … */
}
```

- Every time that you call `.iterator()`, you get back a new iterator to the start of the collection.



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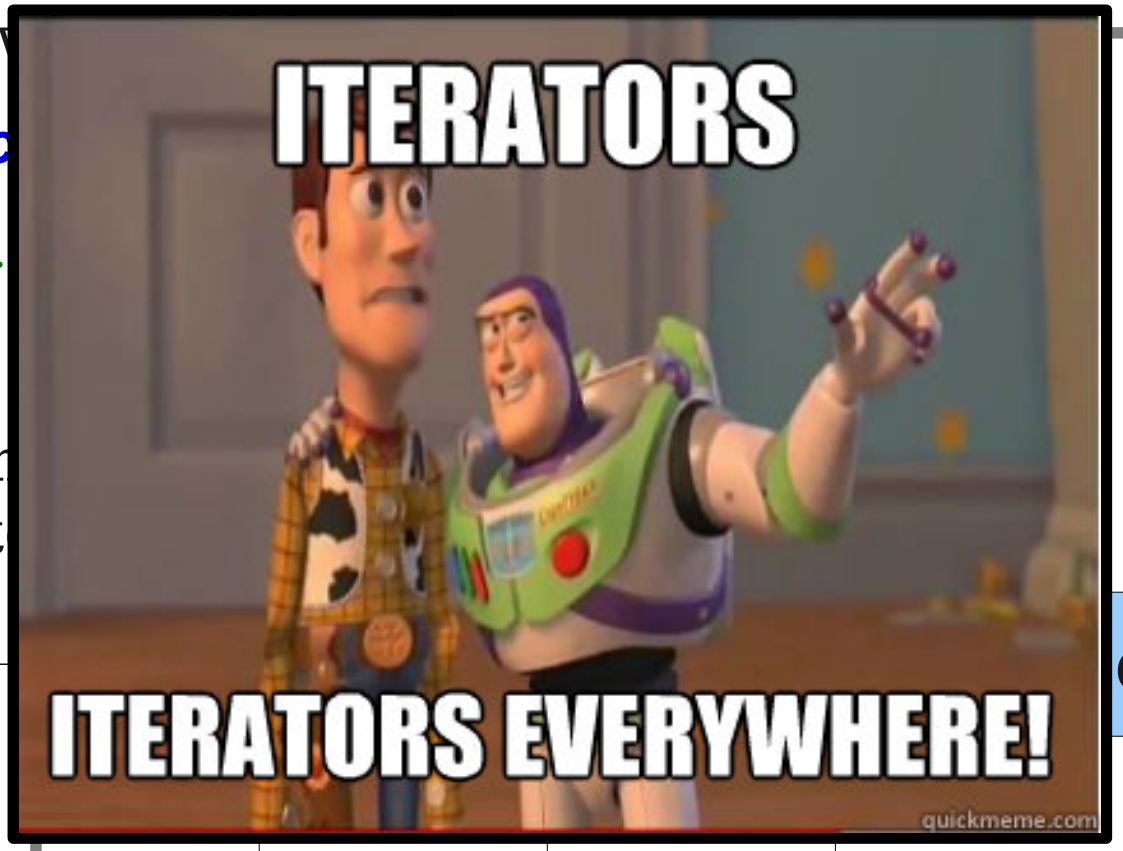


ex | Kitty

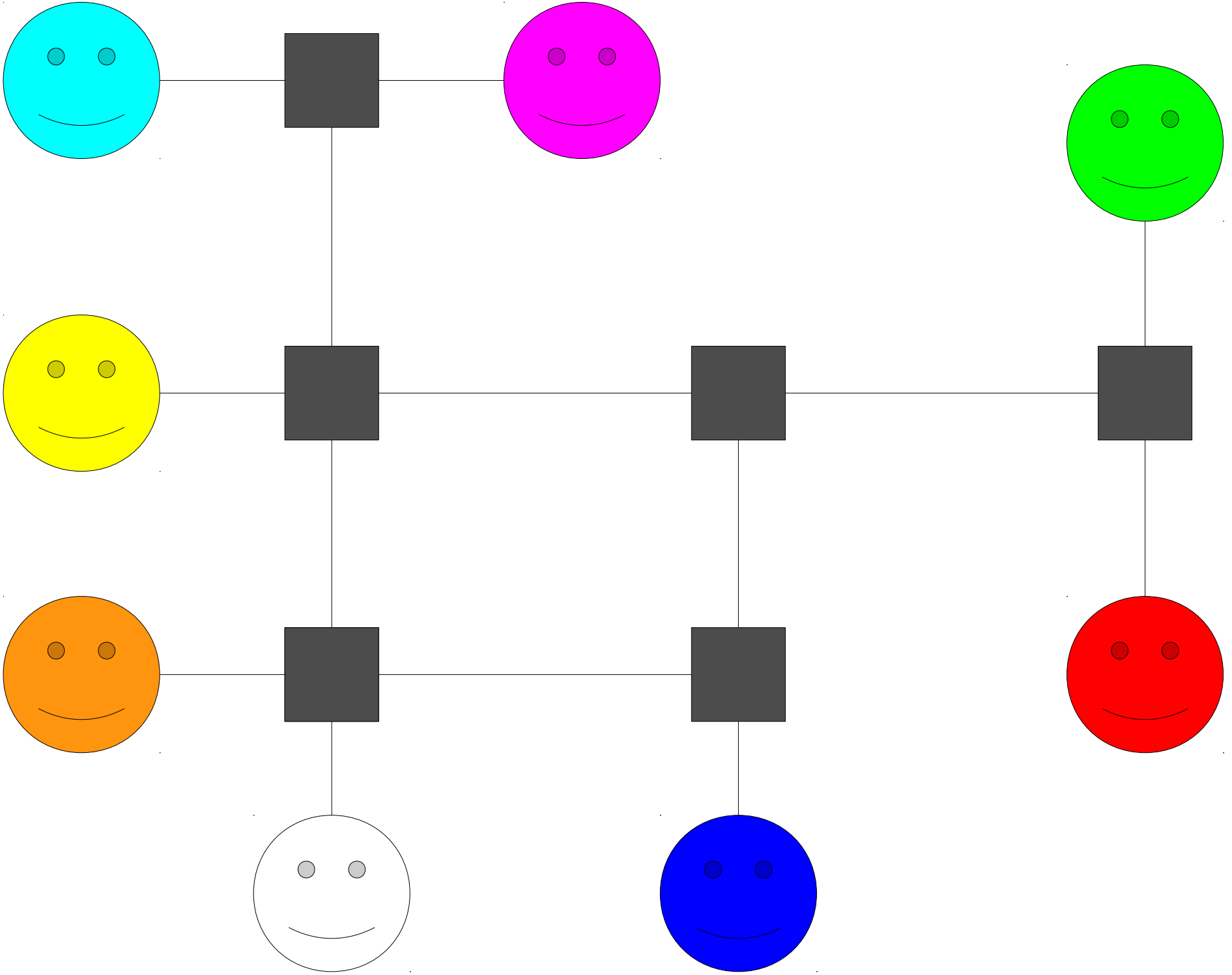
Assignment 7 Demo

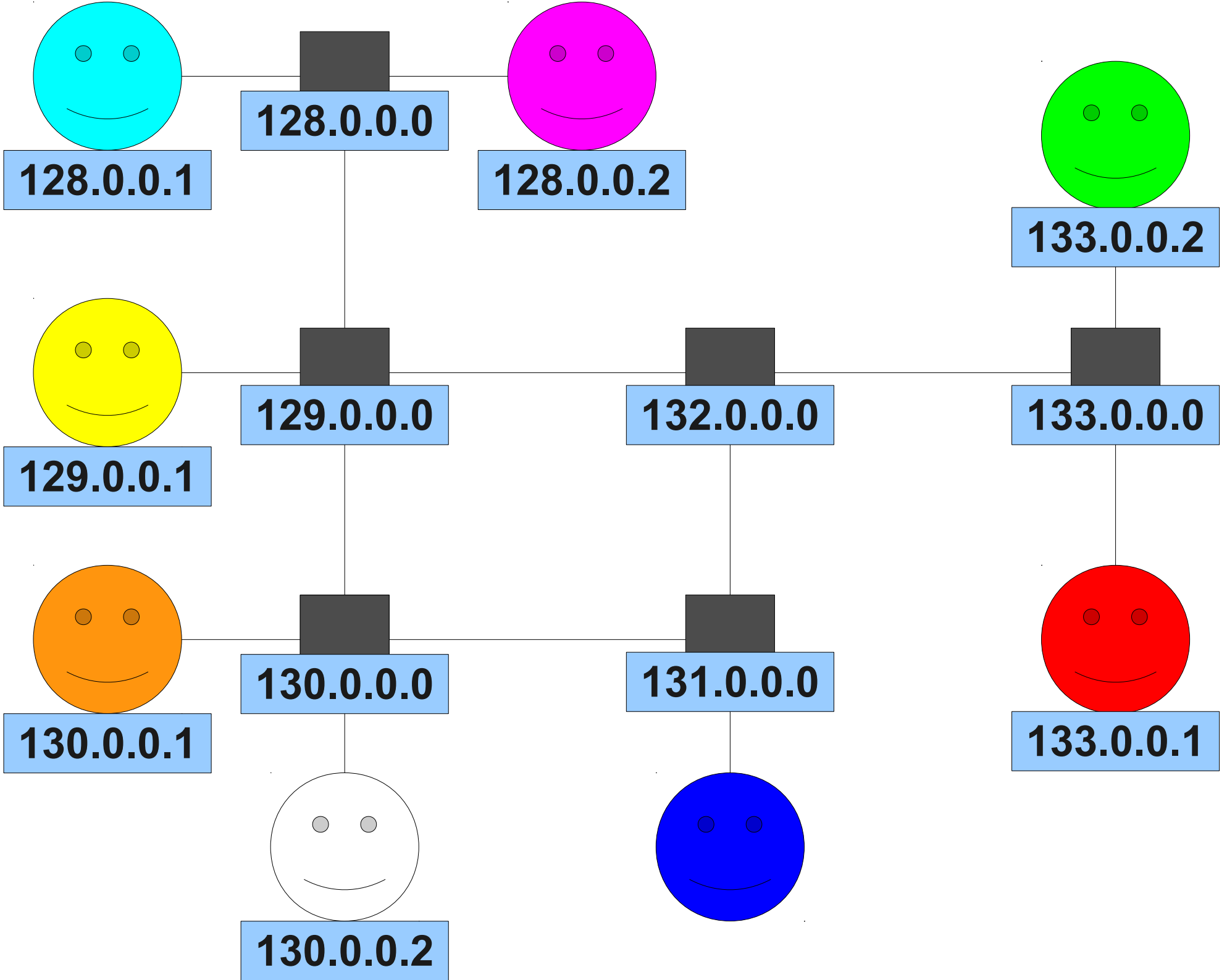
Assignment 7

- We're releasing Assignment 7 (FacePamphlet) right now. It's due on Friday, March 21 at 11:30AM.
- Great way to synthesize everything from the course together into one assignment.
- Due date is a hard deadline:
  - **No late days may be used.**
  - **No late submissions accepted.**
- Assignment review hours: Sunday, 7PM – 8PM in Hewlett 200.

Security and Privacy

Refresher: How the Internet Works

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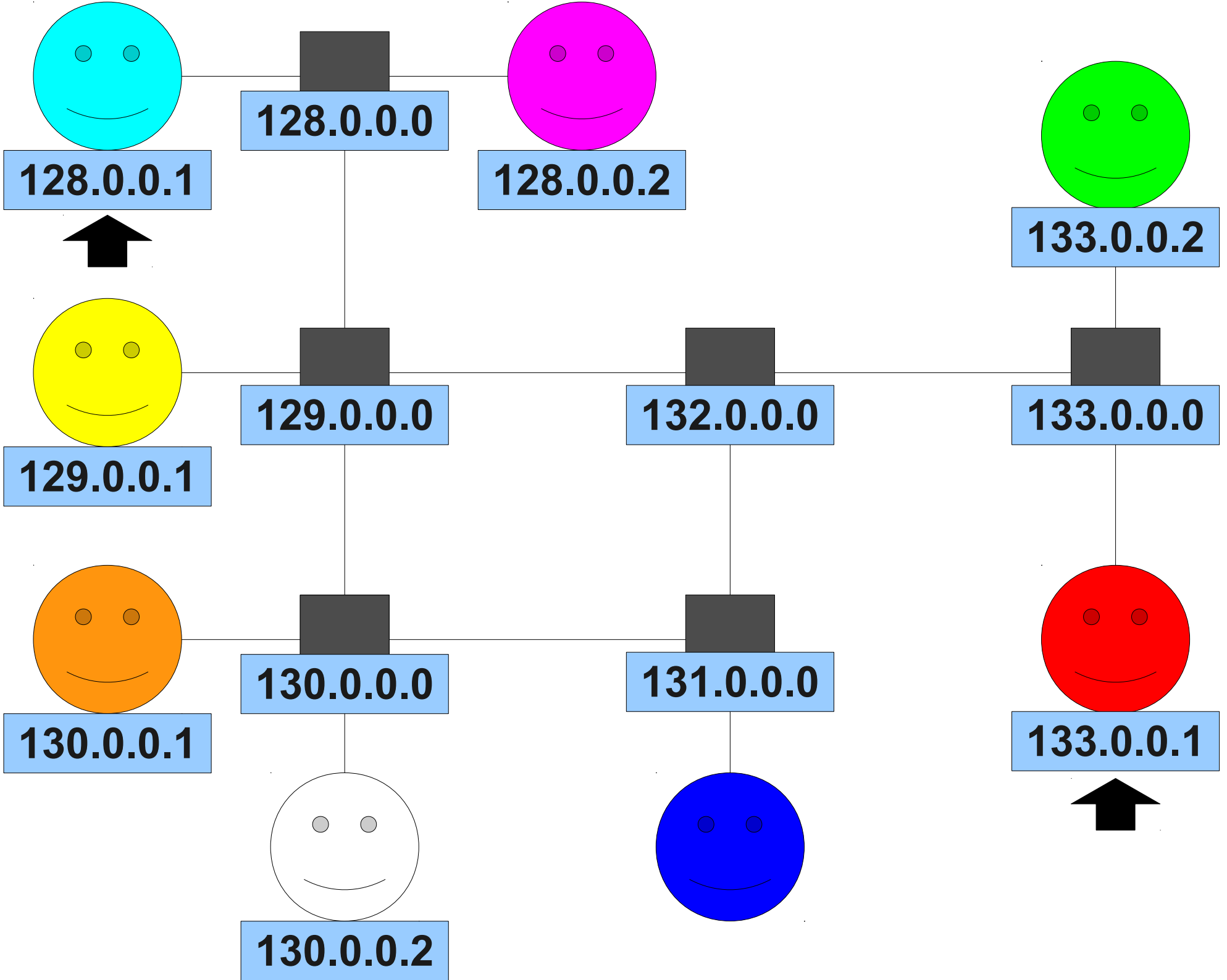
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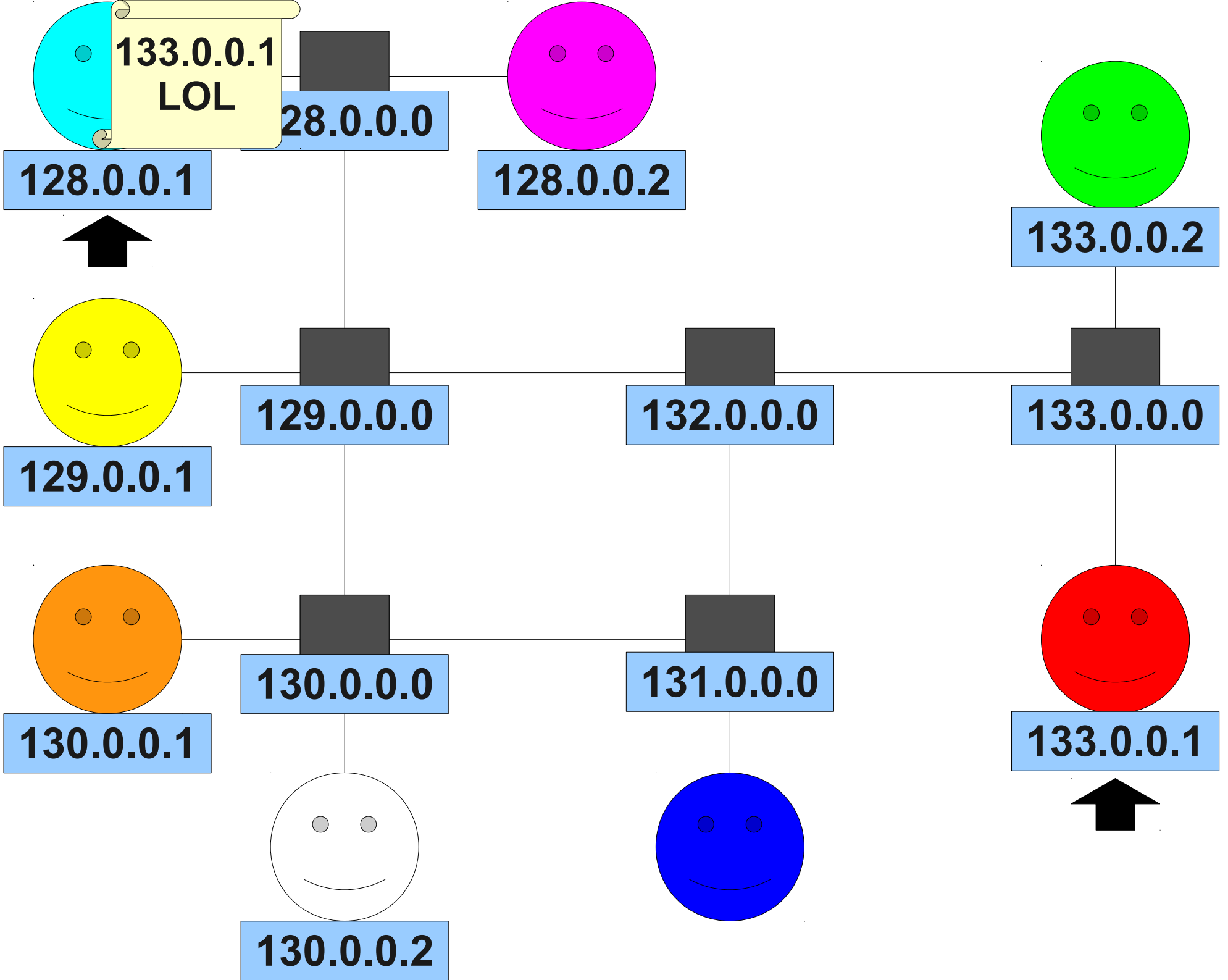
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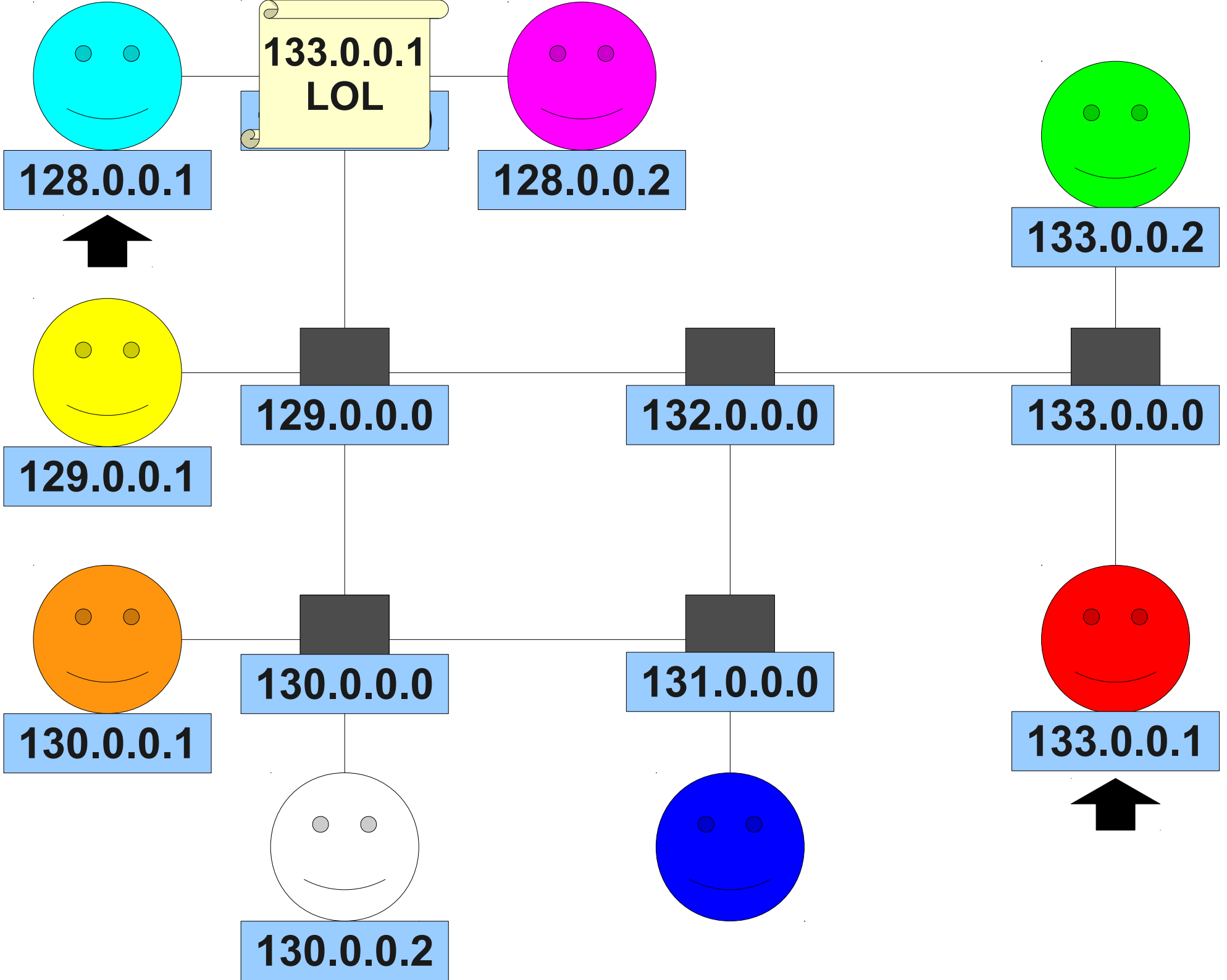
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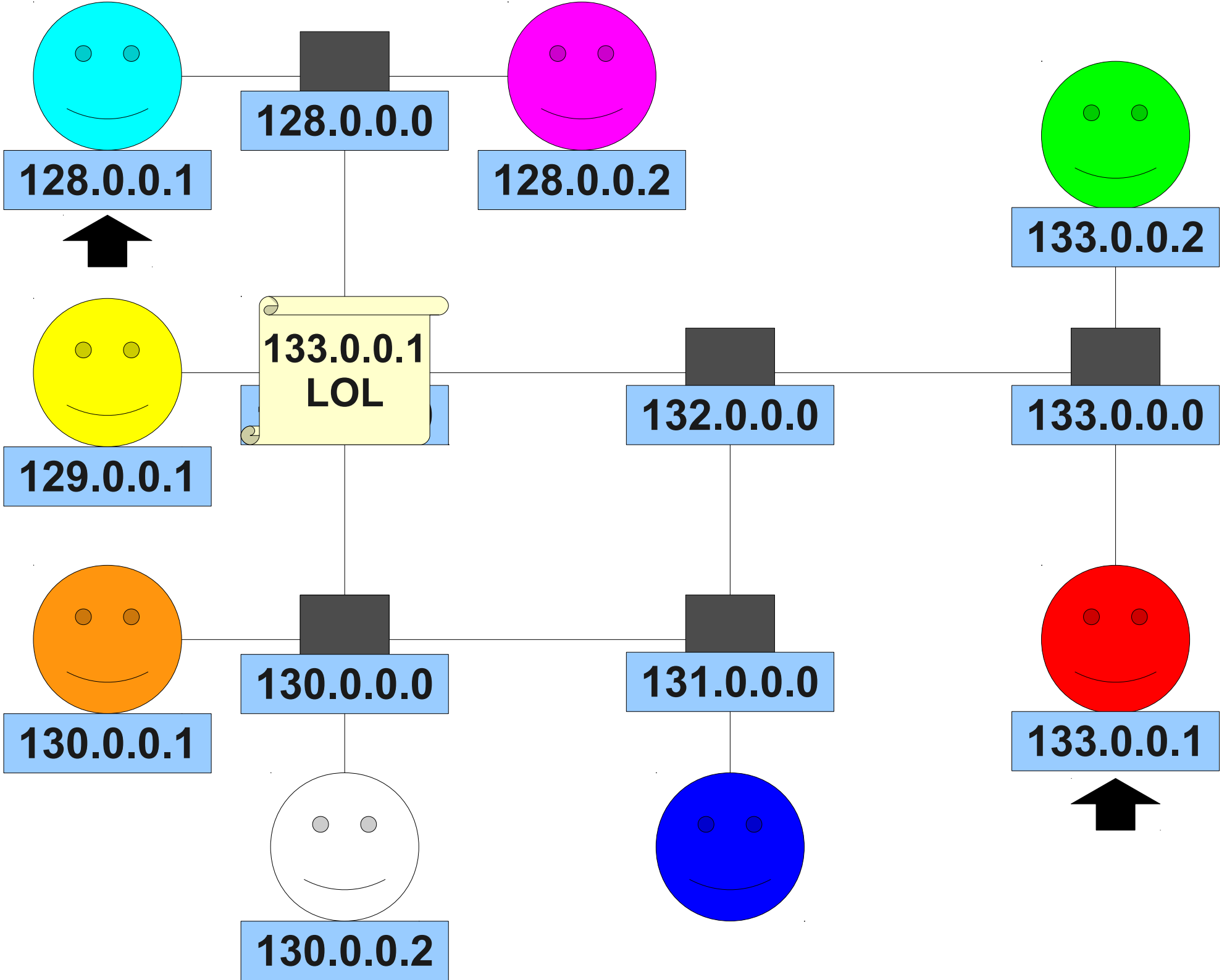
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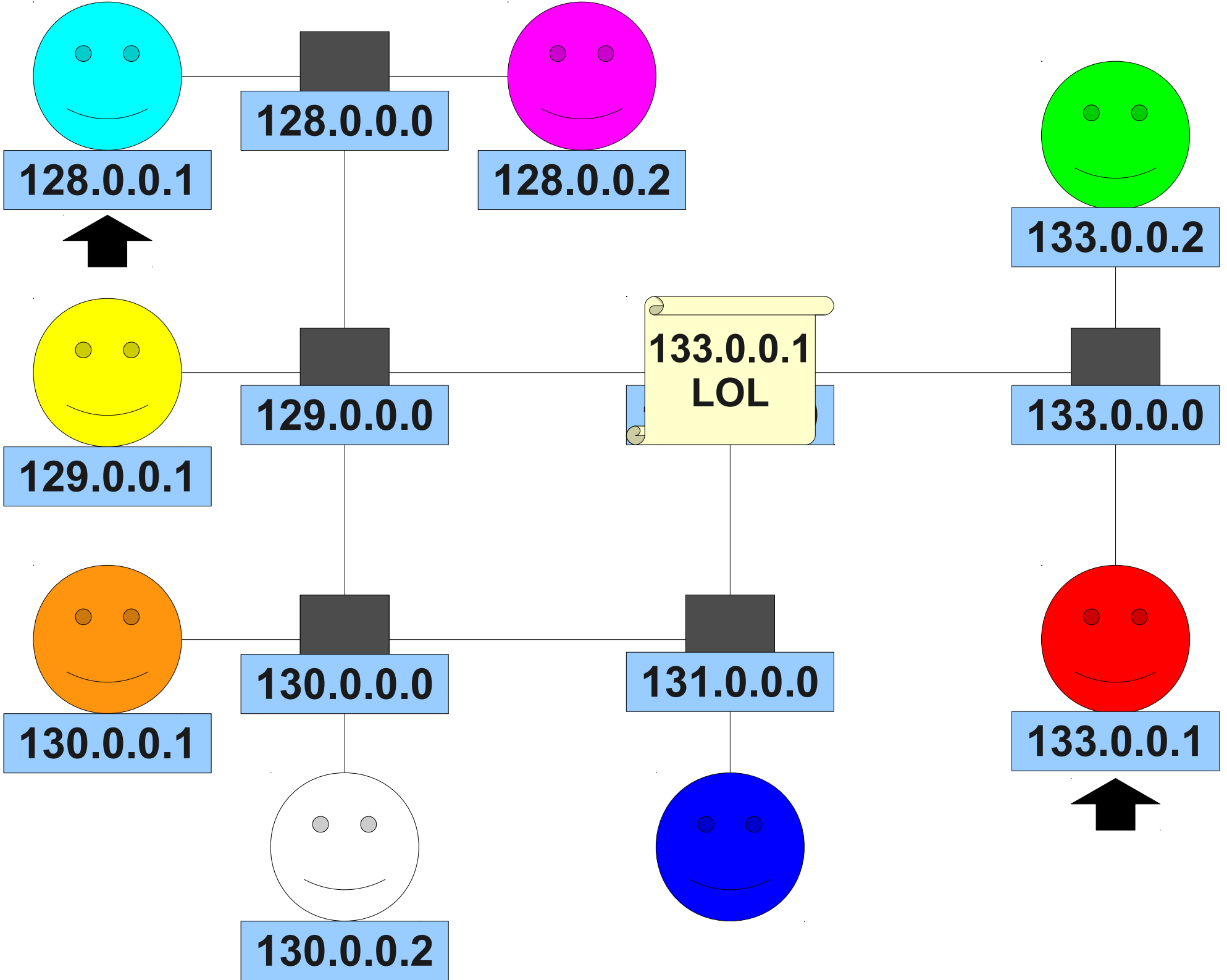
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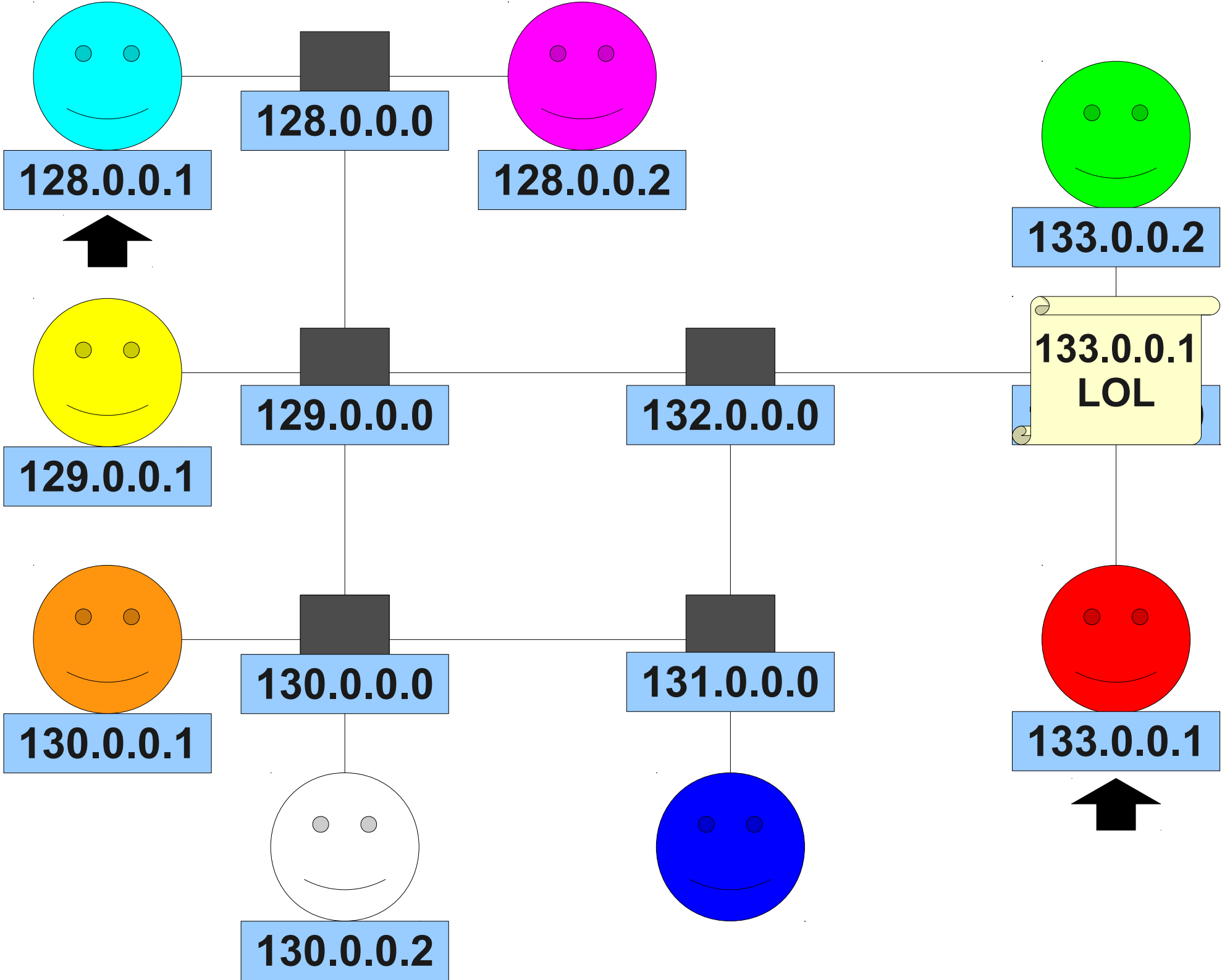
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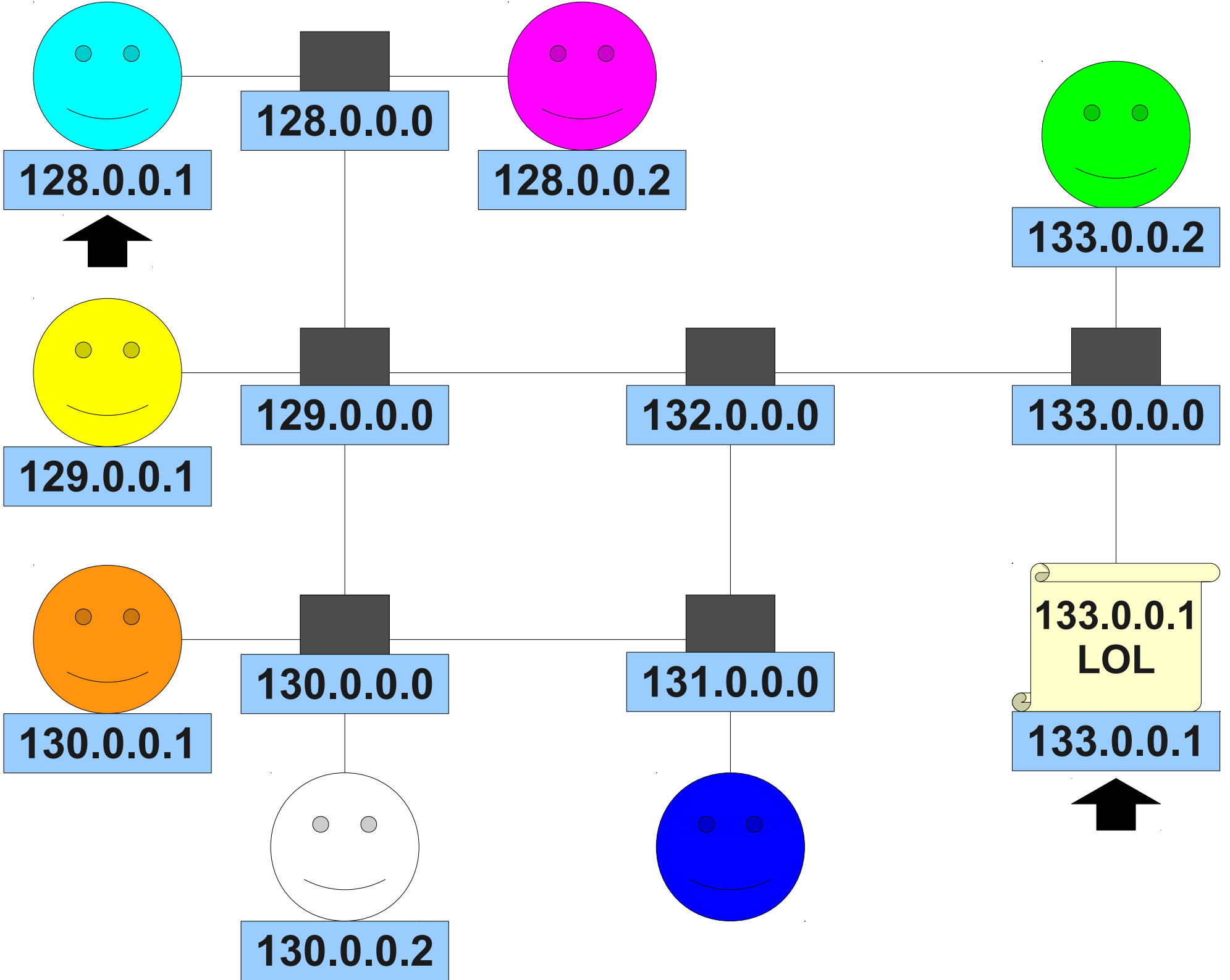
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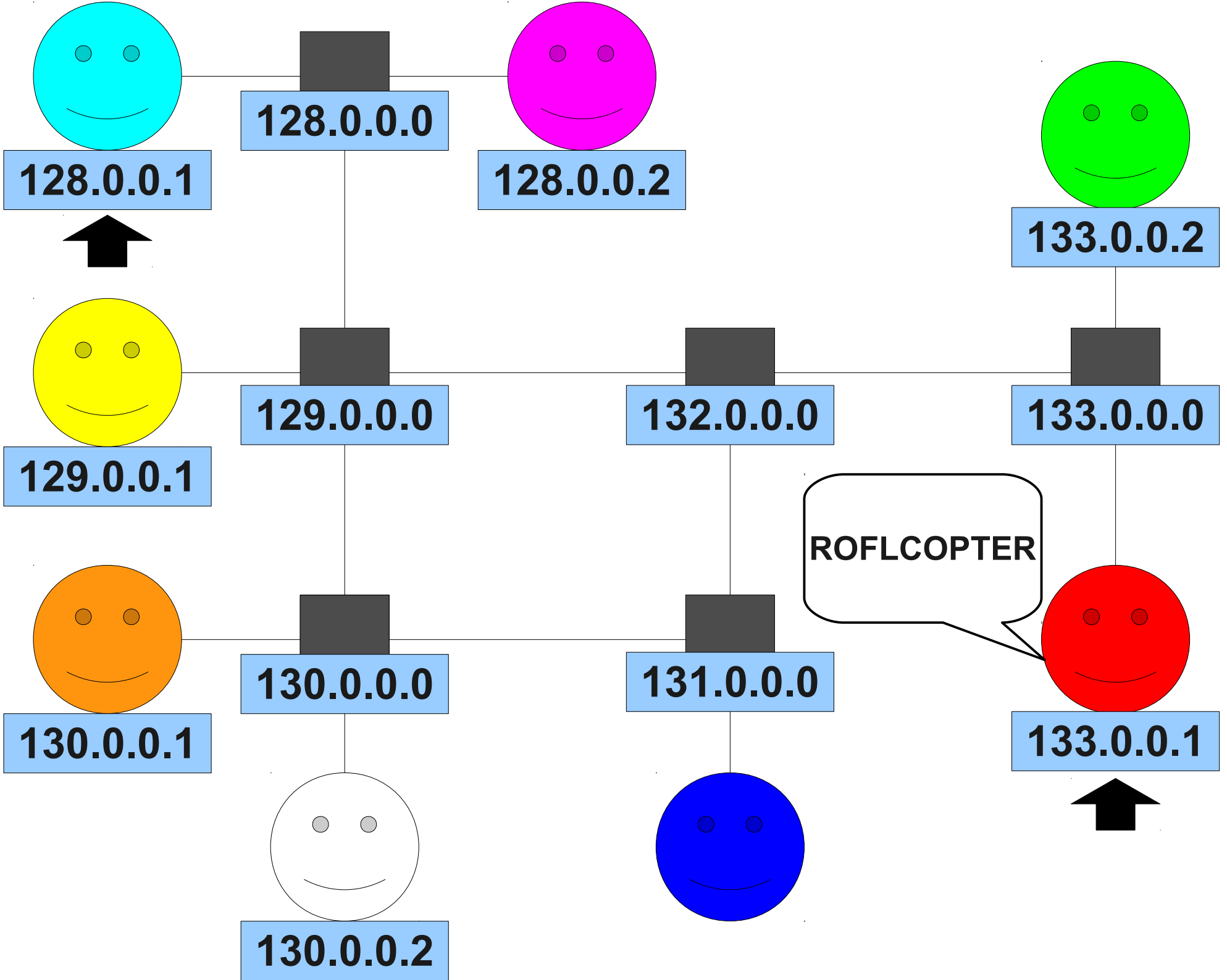
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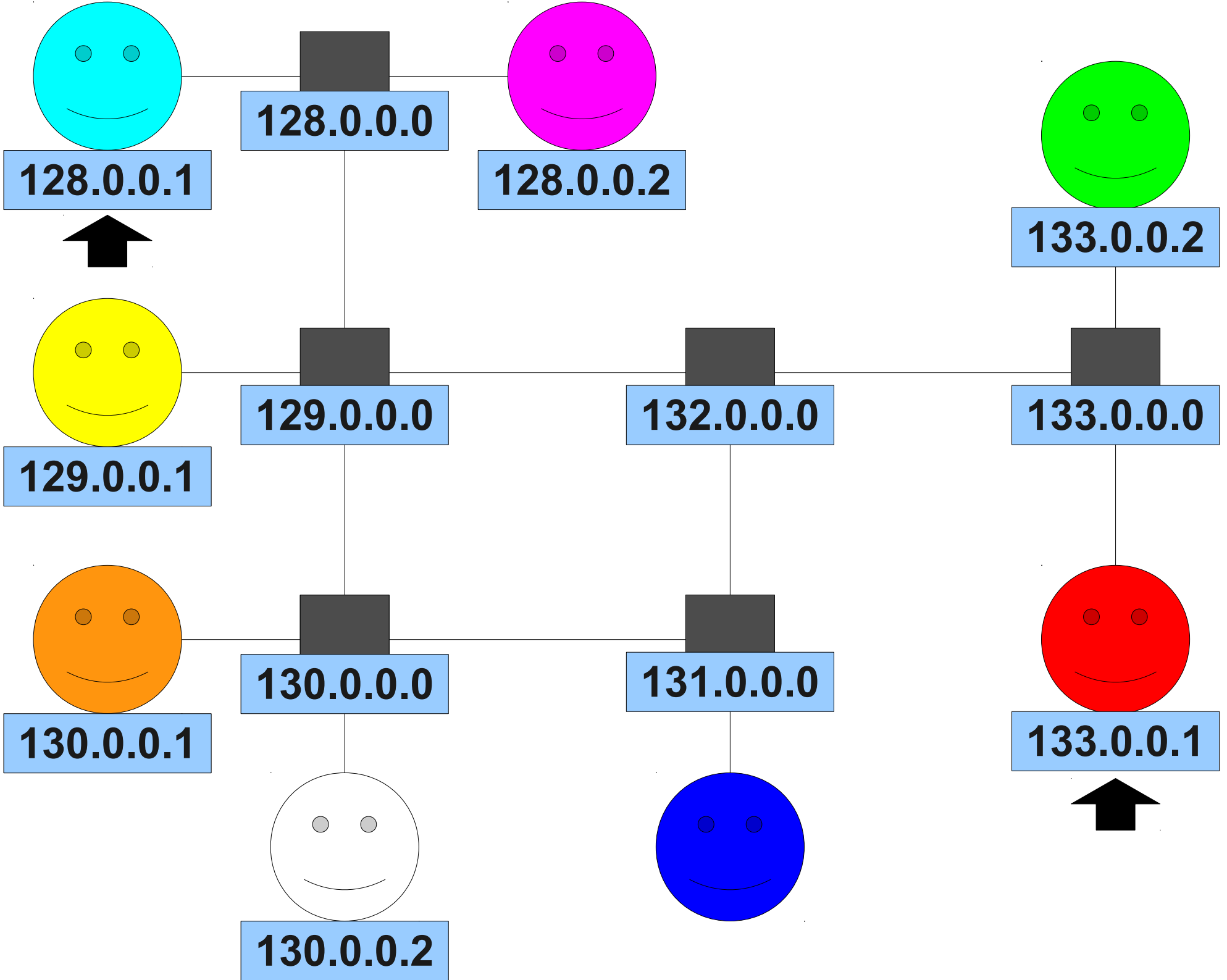
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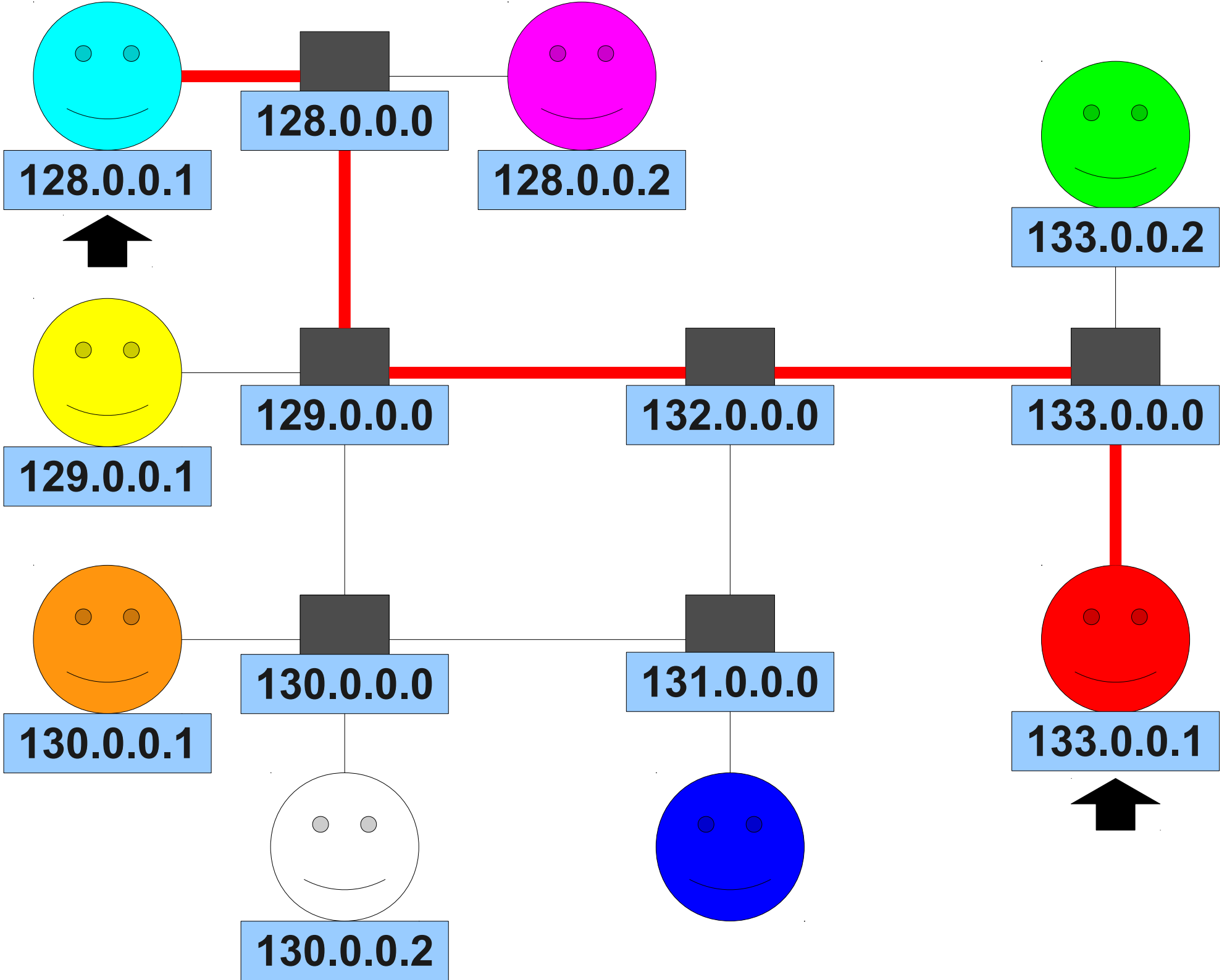
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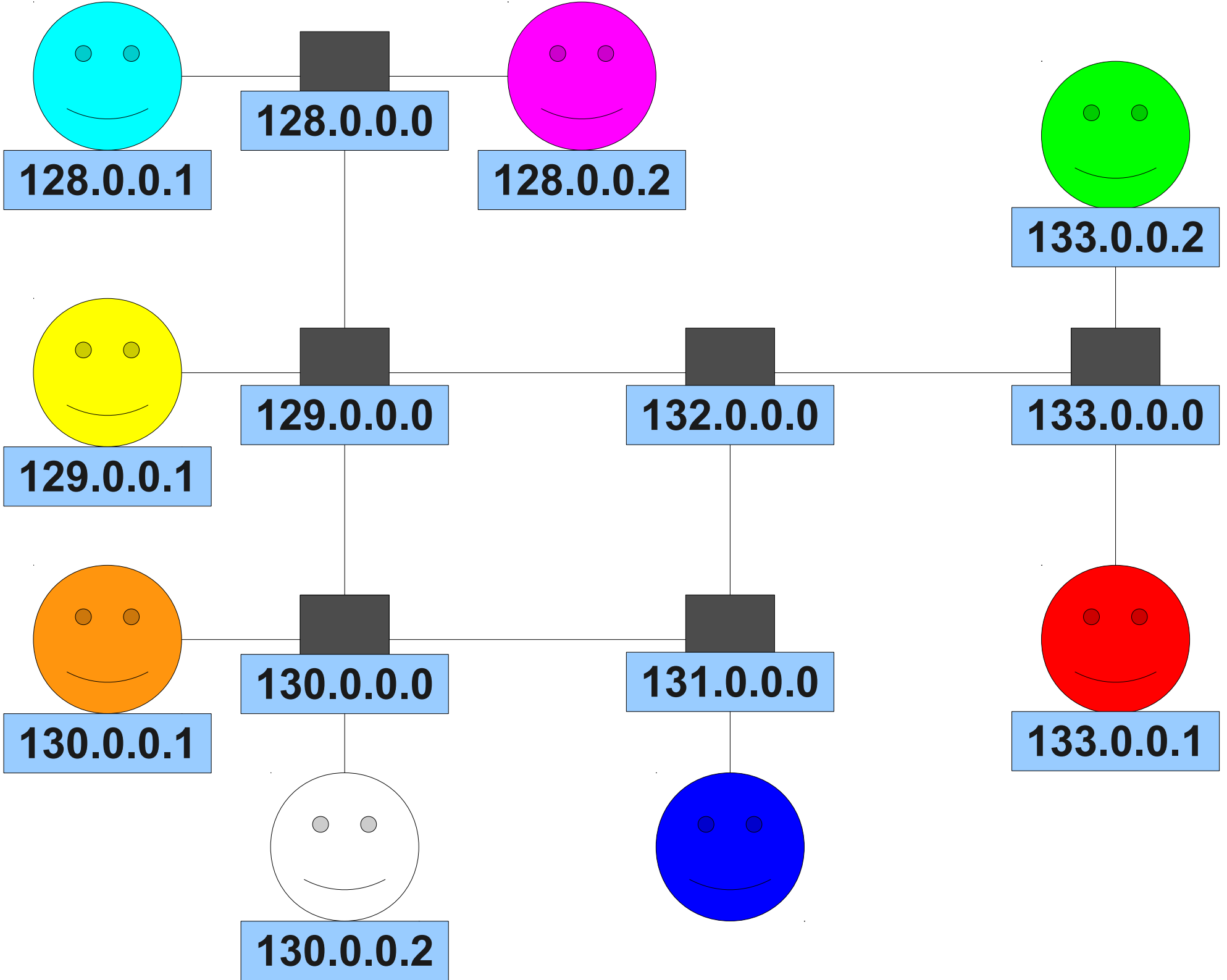
Sending Secrets

- When you send a message from one computer to another over the Internet, any of the routers between you and your destination can read that message.
- To send secrets, the data is typically **encrypted**; only the receiver can read it and it looks like gibberish to everyone else.
- **Advice:** Use `https` instead of `http` any time you enter a password online.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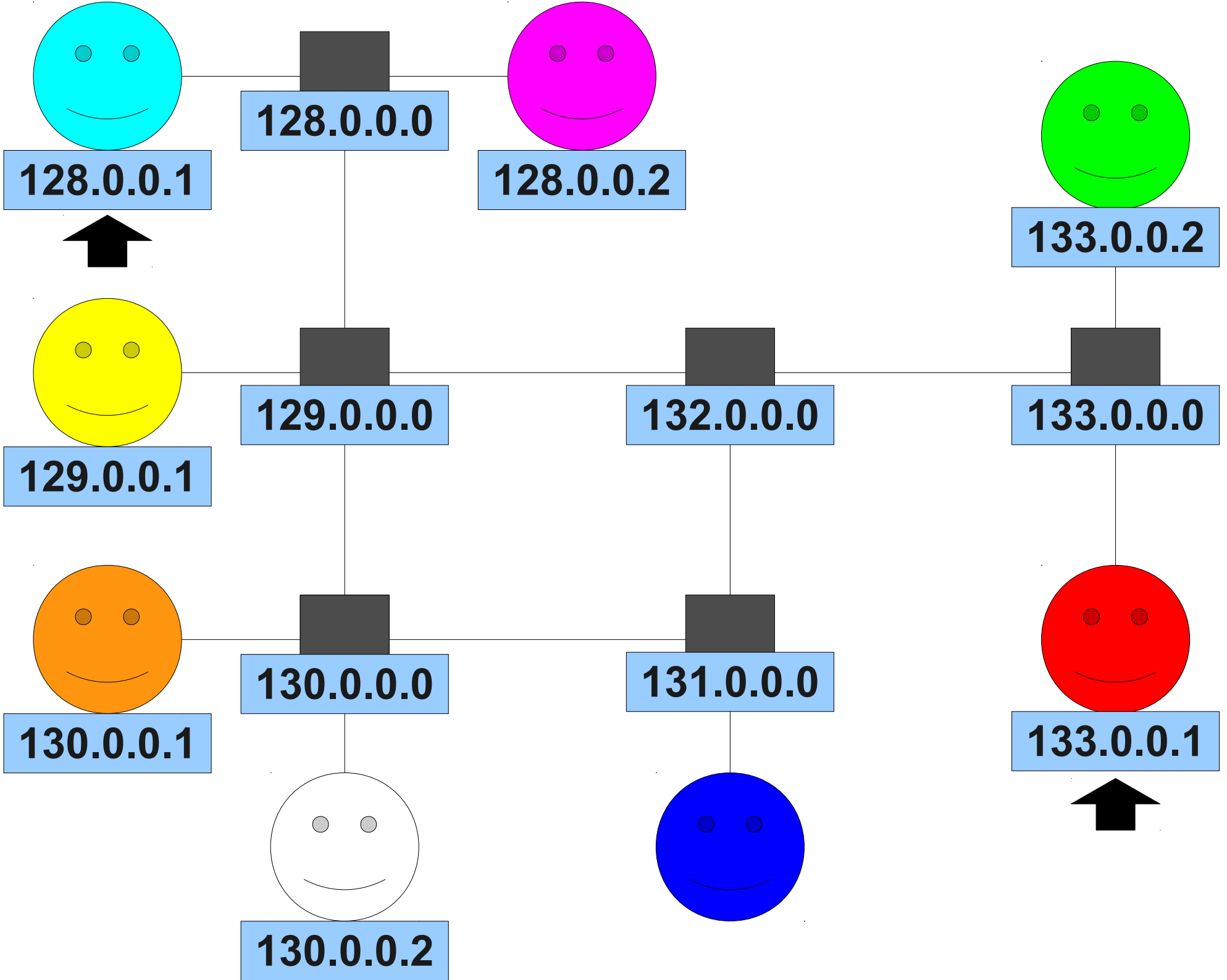
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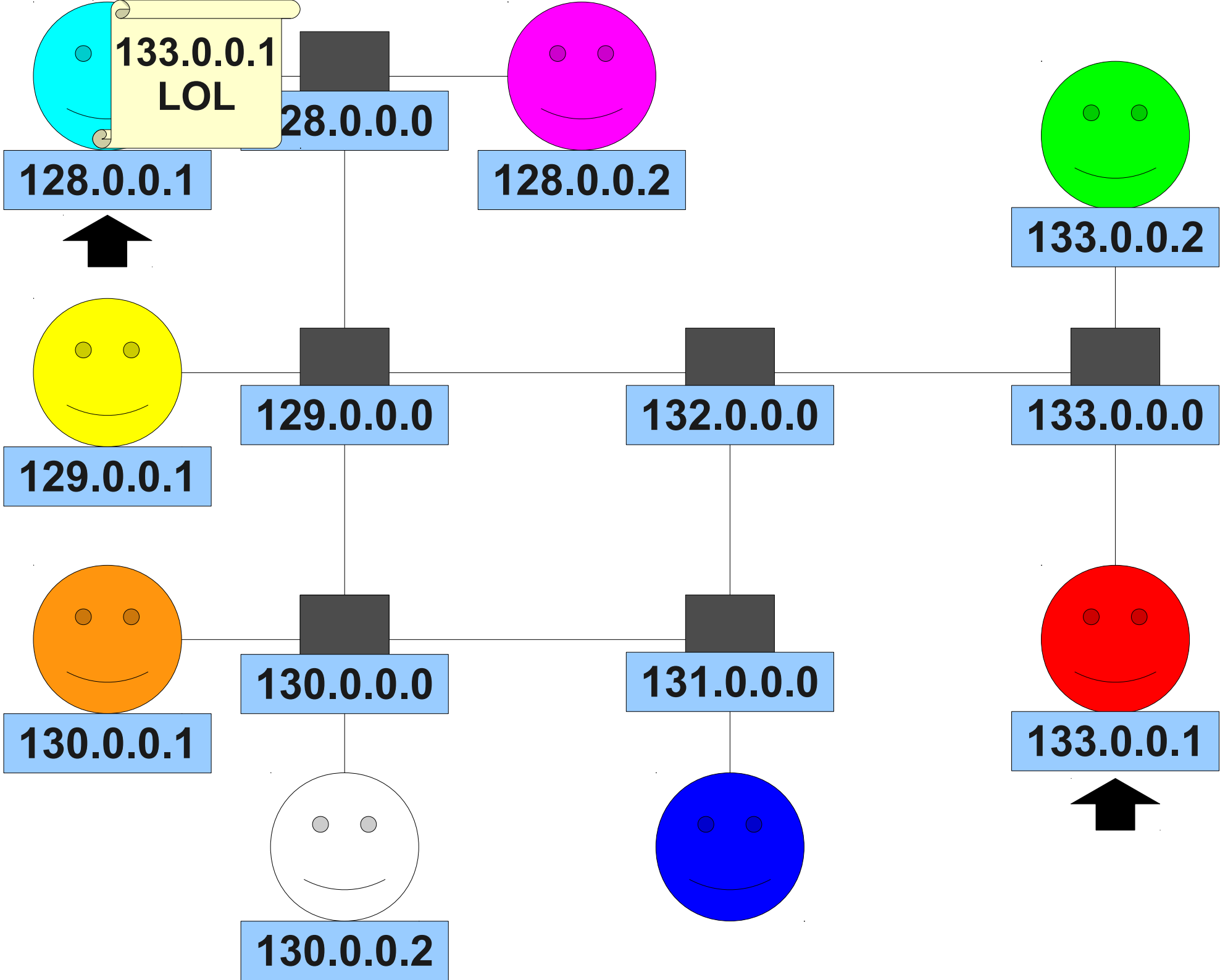
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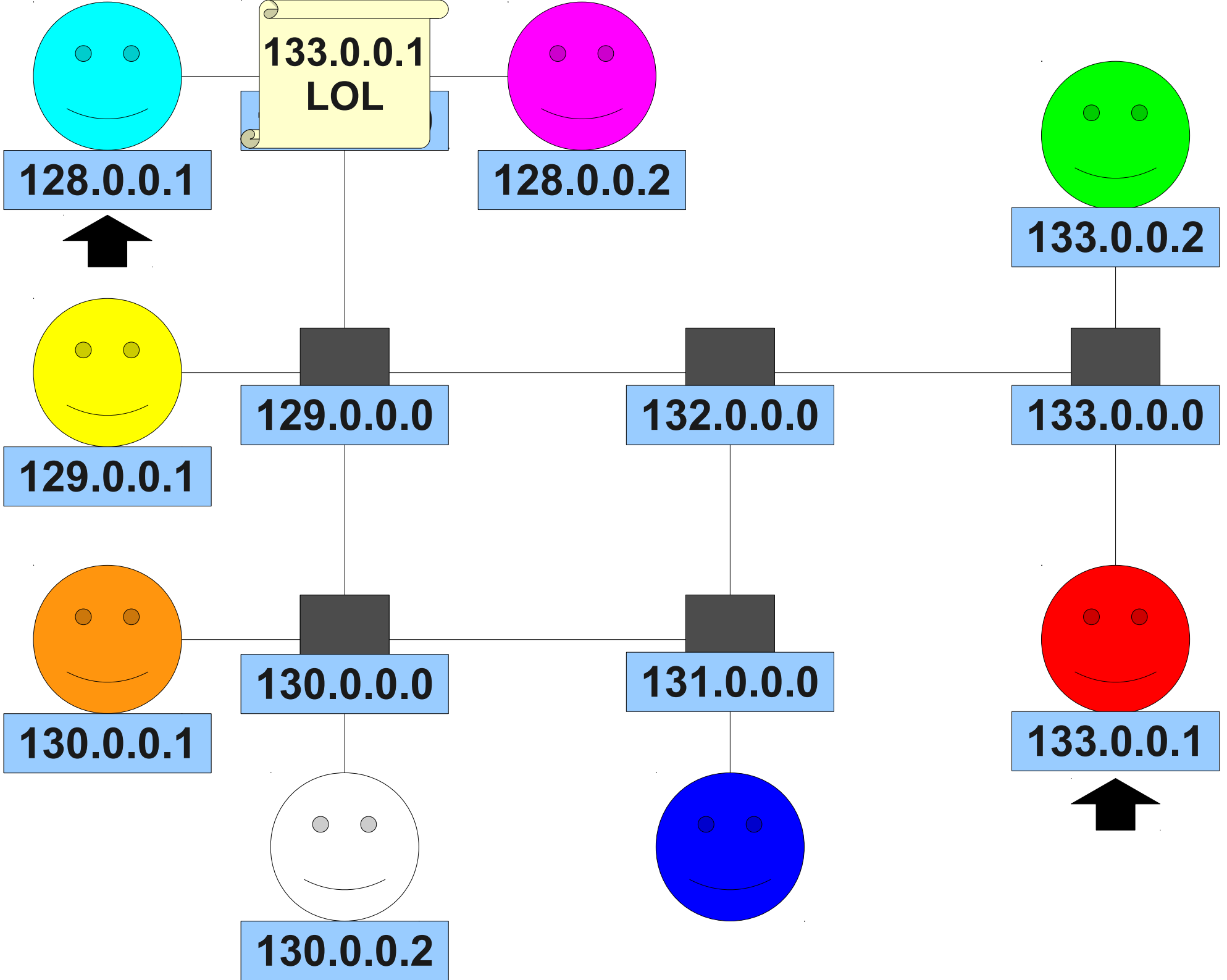
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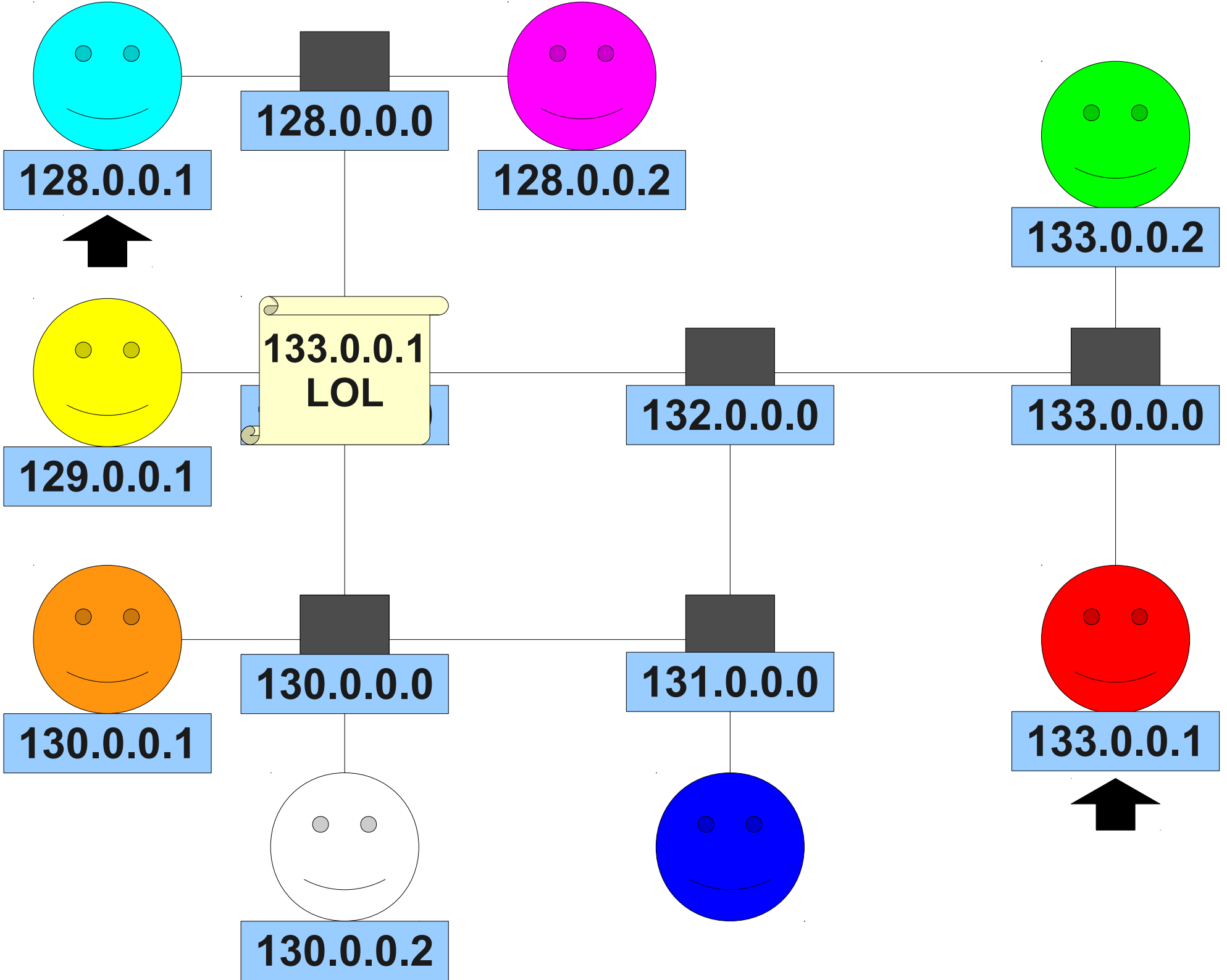
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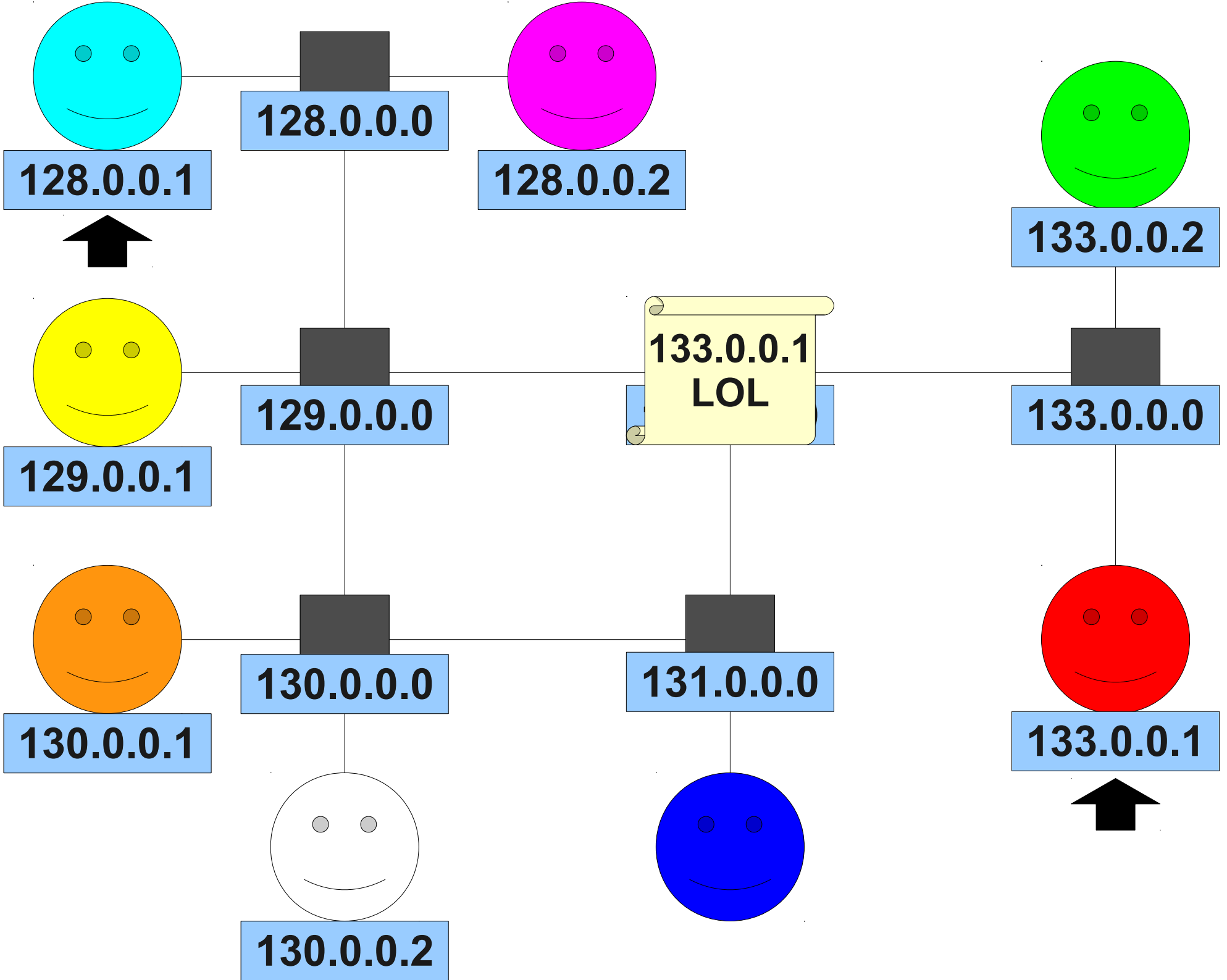
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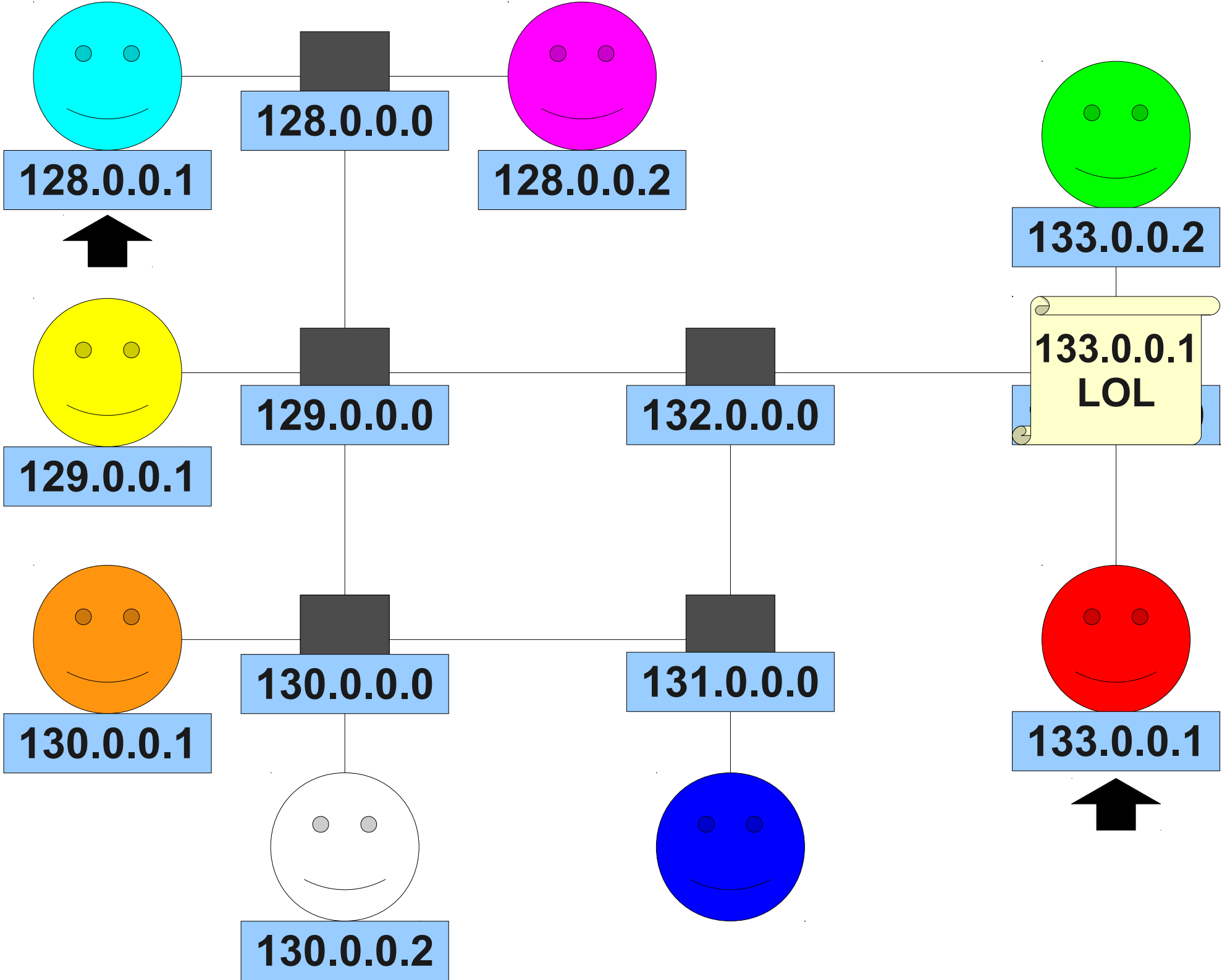
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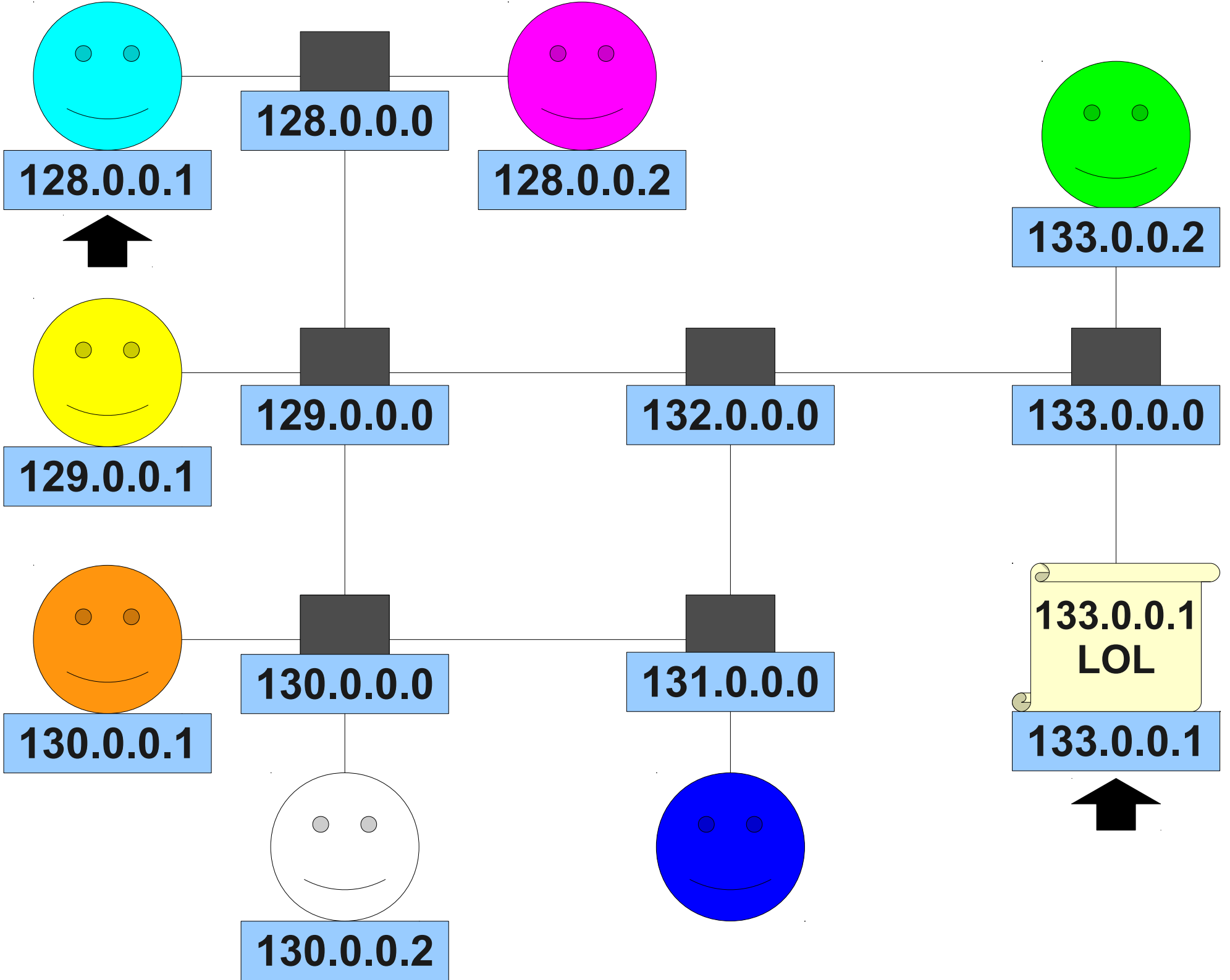
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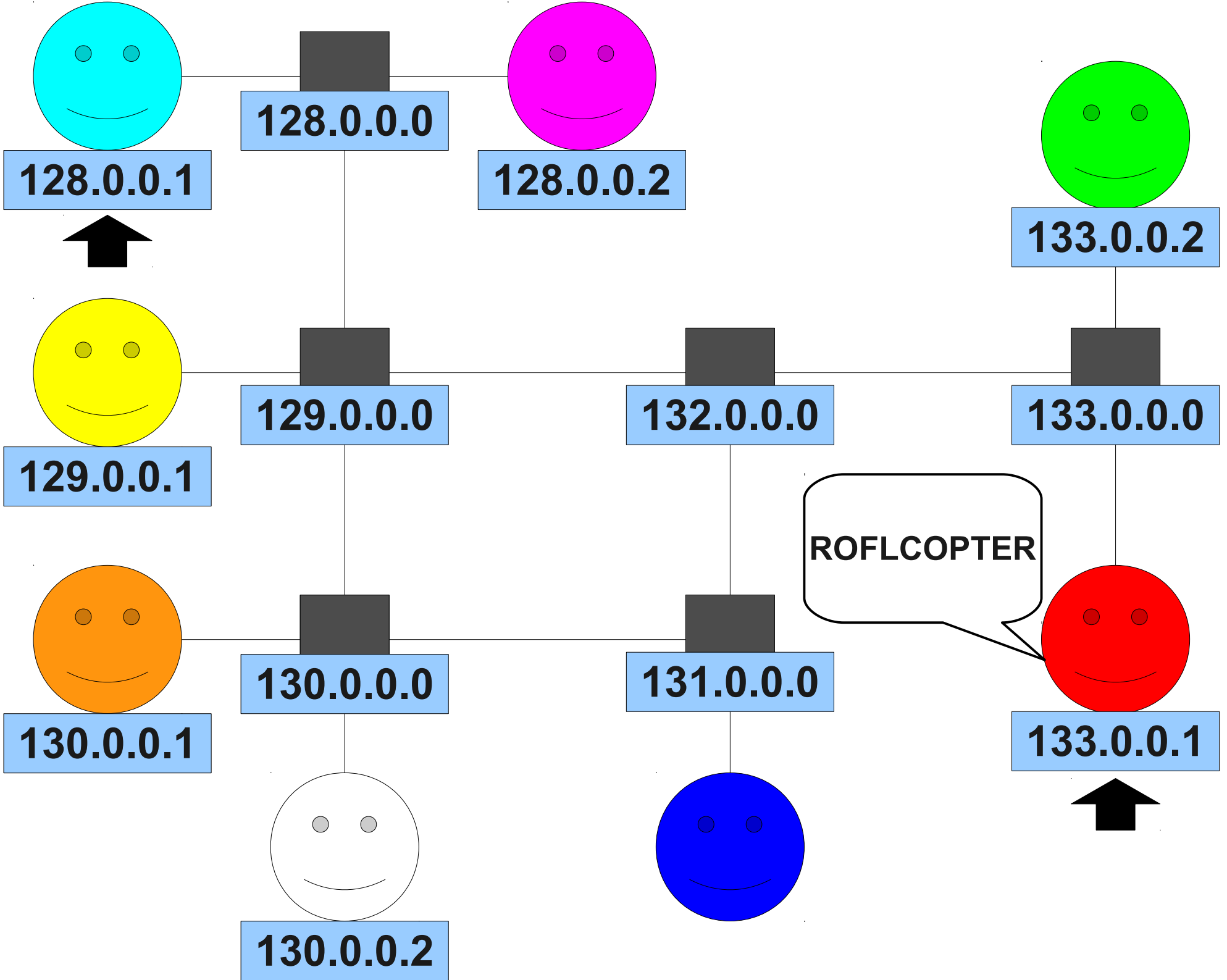
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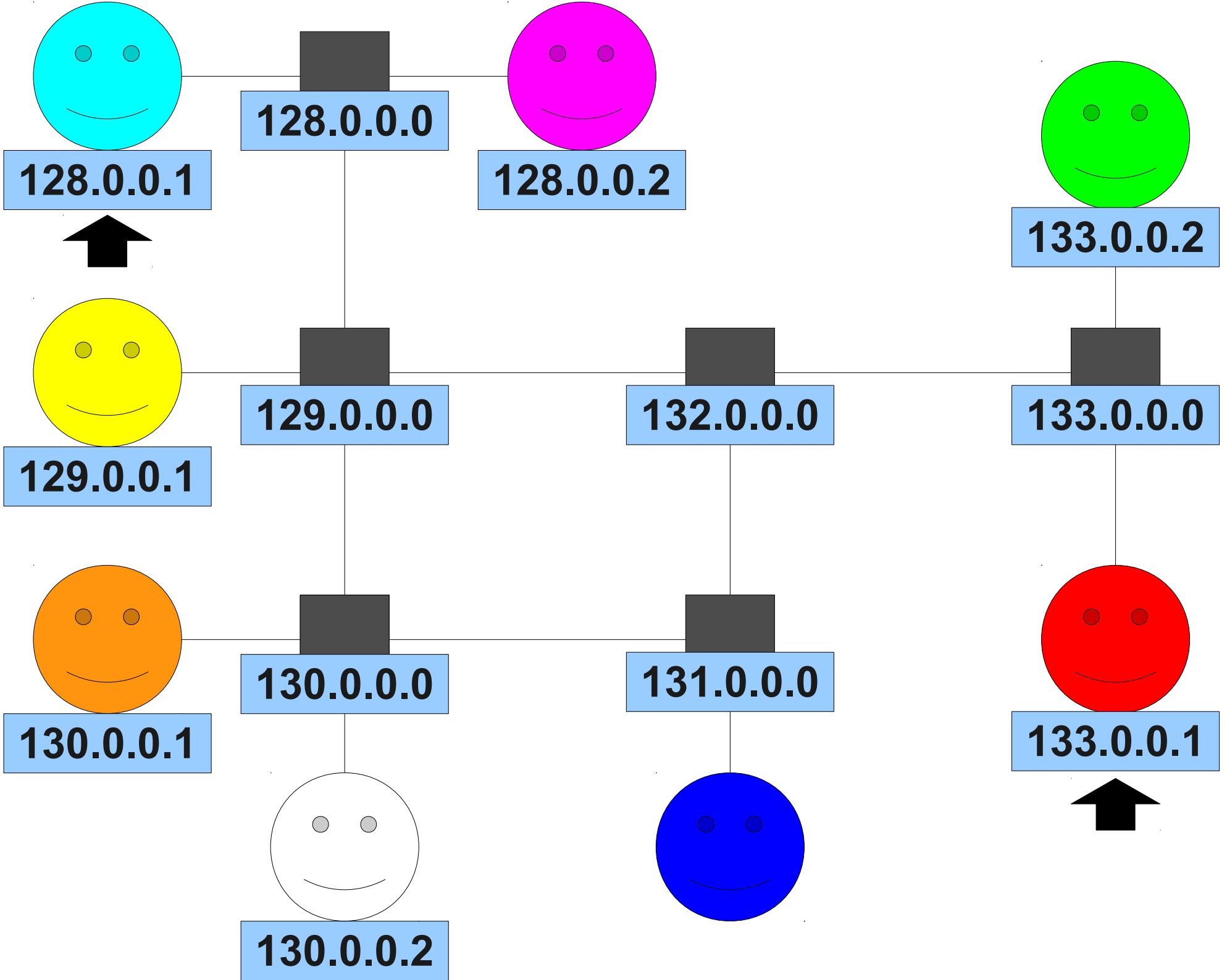
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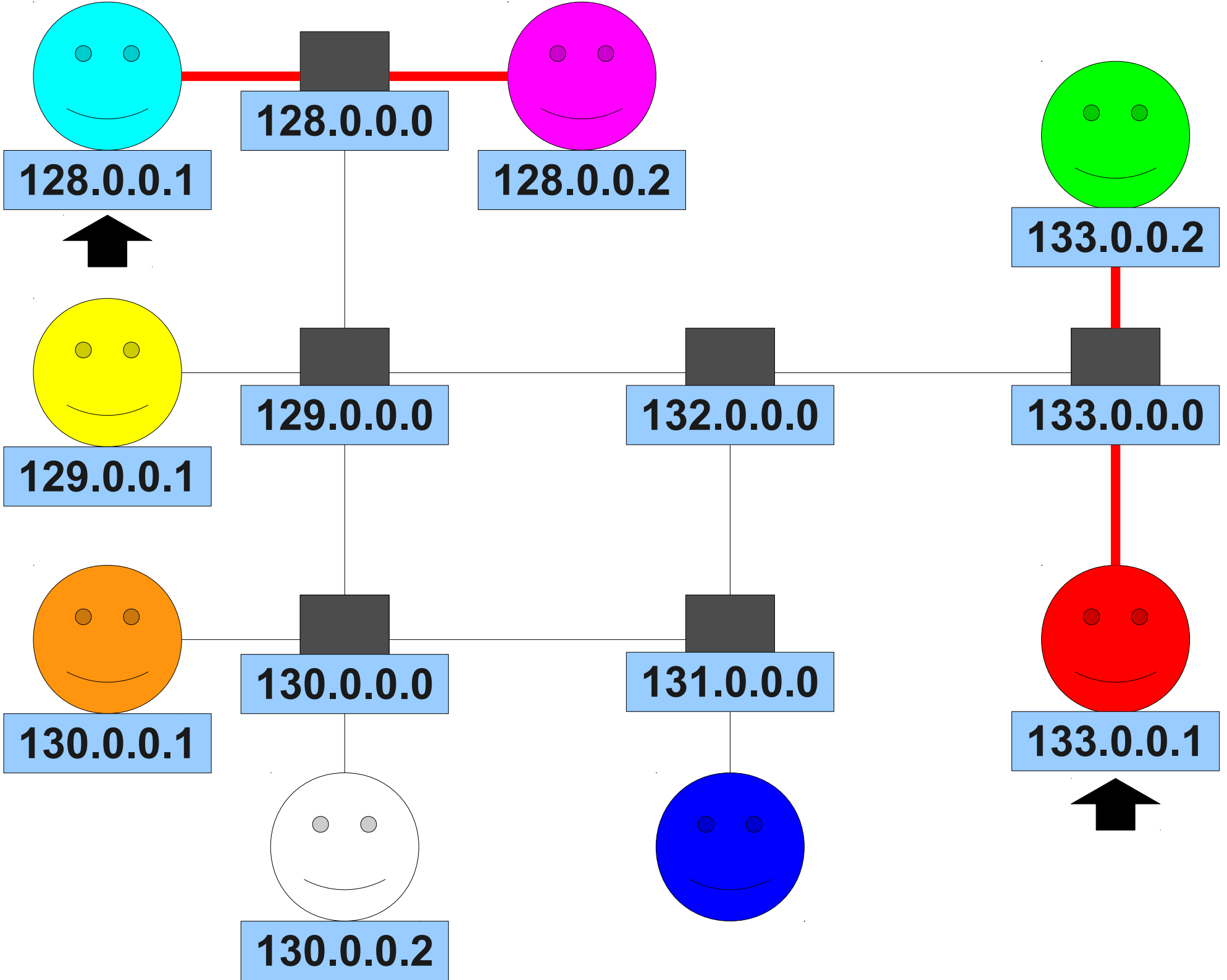
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Ethernet and WiFi

- If you send or receive data over WiFi or Ethernet, that message can be read by anyone else on the same physical network.
- If the data is already encrypted, this isn't a problem.
- If the data is *not* already encrypted, anyone on the same network as you can see exactly what you're doing online.
- Password-protecting WiFi networks prevents strangers from snooping, but does not prevent other people on the network from reading data.

Google Street View and WiFi

Street View: What Happened

- Google's Street View cars drove around snapping pictures of what was visible from the street.
- To improve location information, Google recorded information about unsecured WiFi networks it drove by:
  - SSID (network name)
  - MAC address (hardware identification)
  - Signal strength (proximity)
- The Street View cars also stored payloads (actual Internet traffic) from unsecured wireless networks; about 200GB of payloads stored.

Why Record WiFi?

- Recording WiFi information around the US makes it possible to get much more precise location information.
  - Searches done from a particular WiFi network can be localized based on the position of the car.
  - Searches done near other WiFi networks can be used to help pinpoint the user.
  - Position-based information helps give better search results and better advertising.
- WiFi payloads are not required to do any of this.

Why Record Packets?

- Recording network packets would give engineers a better view of realistic web traffic.
- For example, could see
  - which websites people were visiting,
  - contents of those websites,
  - distribution of those websites,
  - number of emails sent,
  - contents of emails sent,
  - etc.

Why is this a problem?

- According to Canadian legal documents, the data Google gathered included
  - medical records,
  - website passwords,
  - email exchanges,
  - compromising content,
  - etc.
- Because of the extra location information gathered, this information could be traced back to individual users.

How did Google let this happen?

- Public court documents suggest that a single engineer (“Engineer Doe”) was responsible for installing the packet recording code into the Street View cars.
- How did this happen?
  - Diffusion of responsibility: everyone (probably) assumed that Engineer Doe knew what he/she was doing.
  - Engineer Doe's design documents and presentations did not make impact clear.
  - Incorrect assumptions: engineers believed that only fragments of data would be caught, not full transmissions.
  - Engineers reviewing the code were mostly checking for code syntax and style and did not recognize the significance of storing payloads.
  - Engineers testing the cars did not notice (or did not recognize the significance of) what they were logging.

Why No Encryption?

- Why were there so many unencrypted wireless networks?
- No incentive for WiFi router manufacturers to add encryption by default.
  - Encrypted WiFi is slower than normal WiFi due to the overhead of encryption and decryption.
  - Encrypted WiFi is harder to set up – all computers using the WiFi need the password, and any new devices added to the network need that password as well.
- Little information available to consumers about the risks of unencrypted WiFi networks.

Why No Encryption? Part II

- If communications over the network were encrypted, no personal information could have been logged.
- Why wasn't that information encrypted?
  - End users can't use encryption if servers don't support it.
  - Economic incentives for companies to leave data unencrypted.
    - Encrypted communication is slower than unencrypted communication.
    - Encrypting data increases server expenses and increases response time.
  - Low external pressure on companies to add encryption.
  - Poor communication of risk to average users.

Why Only Unencrypted Networks?

- It is possible to record SSIDs, MAC addresses, and signal strengths of *any* wireless network, even encrypted ones.
- It is only possible to record (intelligble) payloads from unencrypted networks.
- It's unclear whether it is even legal to record data from public WiFi in the first place.
  - This is currently working through the appeals courts.
- I could not find any public documents explaining the engineers' decisions.
- Possible reasons:
  - Concern that encrypted WiFi was intended to be kept private.
  - Concerns about the legality of recording data from private networks.

Why Look at This?

- I chose this example to point out the following questions:
  - How should we design technology in a way that minimizes or properly communicates risks to users?
  - How should we incentivize technology companies to protect privacy and security when, in many cases, only the company itself fully understands the scope of what it's doing?
- These are ethical, societal, and political questions, not technical ones.
- Having a deeper understanding of the technology can help inform your answers.

Topical Announcement

- New joint majors announced:
  CS + English and CS + Music.
  - Complete both degrees.
  - Each department waives two requirements.
  - Complete a joint capstone project at the end.
- Want to learn more? Come talk to me after lecture!