OSPF Multiple area setup

System OSPF z obszarami

- W ramach zajęć zostanie utworzone 11 ruterów.
- Rutery będą przygotowane do pracy (konfiguracja sieciowa, konfiguracja protokołu OSPF).
- Protokół OSPF będzie obsługiwał cztery obszary (ang. *areas*).
- Podczas zajęć laboratoryjnych należy:
  - Zapoznać się z przygotowaną konfiguracją,
  - Przeprowadzić testy działania zbudowanej sieci,
  - Przeanalizować zawartość bazy wiedzy o stanie łączy (ang. *link-state database*) w scenariuszu z obszarami,
  - Zrozumieć znaczenie obszarów typu: szkieletowy (ang. *backbone*), *szczątkowy* (ang. *stub*) oraz tranzytowy (ang. *transit*).
  - Zrozumieć różnice w zakresie funkcjonowania pomiędzy ruterami: wewnętrznym obszaru OSPF (ang. *internal router*), brzegowym obszaru OSPF (ang. *area border router,* **abr**) oraz brzegowym systemu autonomicznego (ang. *autonomous system boundary router*, **asbr**).

OSPF Multiple area setup

System OSPF z obszarami

- W ramach zajęć należy ponadto:
  - Zrozumieć działanie protokołu OSPF uwzględniające występowanie obszarów.
  - Zrozumieć sposób wyznaczania ścieżek w oparciu o bazę LS DB i właściwości ścieżek wewnątrz obszaru (ang. *intra-area*), pomiędzy obszarami (ang. *inter-area*), zewnętrznych typu 1 (ang. *external type* 1) oraz zewnętrznych typu 2 (ang. *external type* 2).
- Celem zajęć jest poznanie działania protokołu OSPF w sieci składającej się z wielu obszarów OSPF (*multiple area* OSPF)

Modified for the purpose of the IP Networks laboratory by AGH

netkit lab(s)

ospf

Version	1.3
Author(s)	Giuseppe Di Battista, Massimo Rimondini
E-mail	contact@netkit.org
Web	http://www.netkit.org/
Description	A set of labs showing the operation of the ospf routing protocol in different scenarios

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lab: ospf-multiarea

ospf areas

- an abstraction that simplifies administration and improves scalability
  - the topology of an area is invisible from the outside
  - routers internal to a given area don't see the detailed external topology
- each area runs a separate instance of the link state routing algorithm
  - all routers in an area construct **the same lsdb**
  - each router keeps a **distinct lsdb for each area** it belongs to

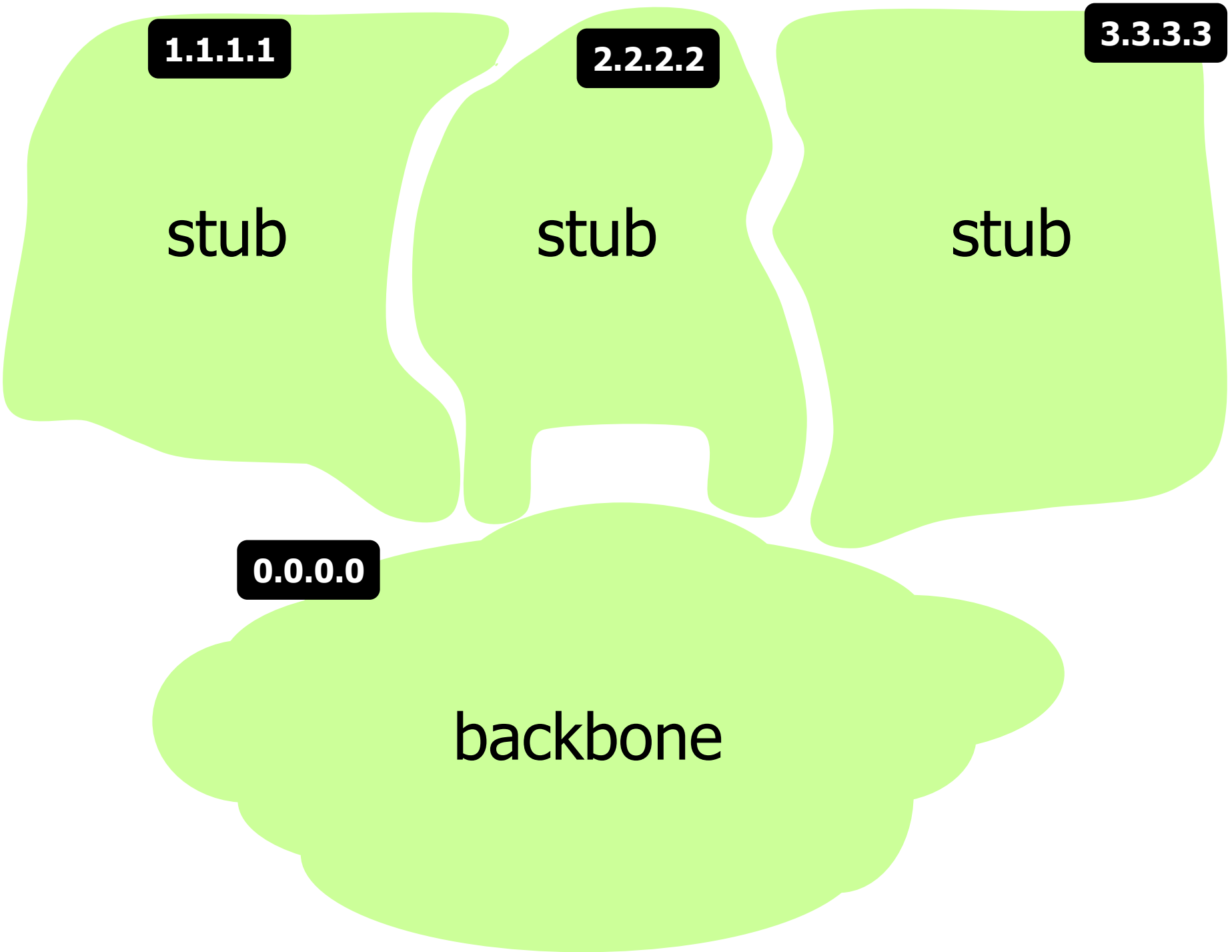
ospf areas

- identified by a 32-bit number, often in dotted decimal notation (1.2.3.4)
  - different interfaces of the same router can be assigned to different areas
  - each
    - router interface...
    - network...
    - router adjacency...

    ...is associated with a single area

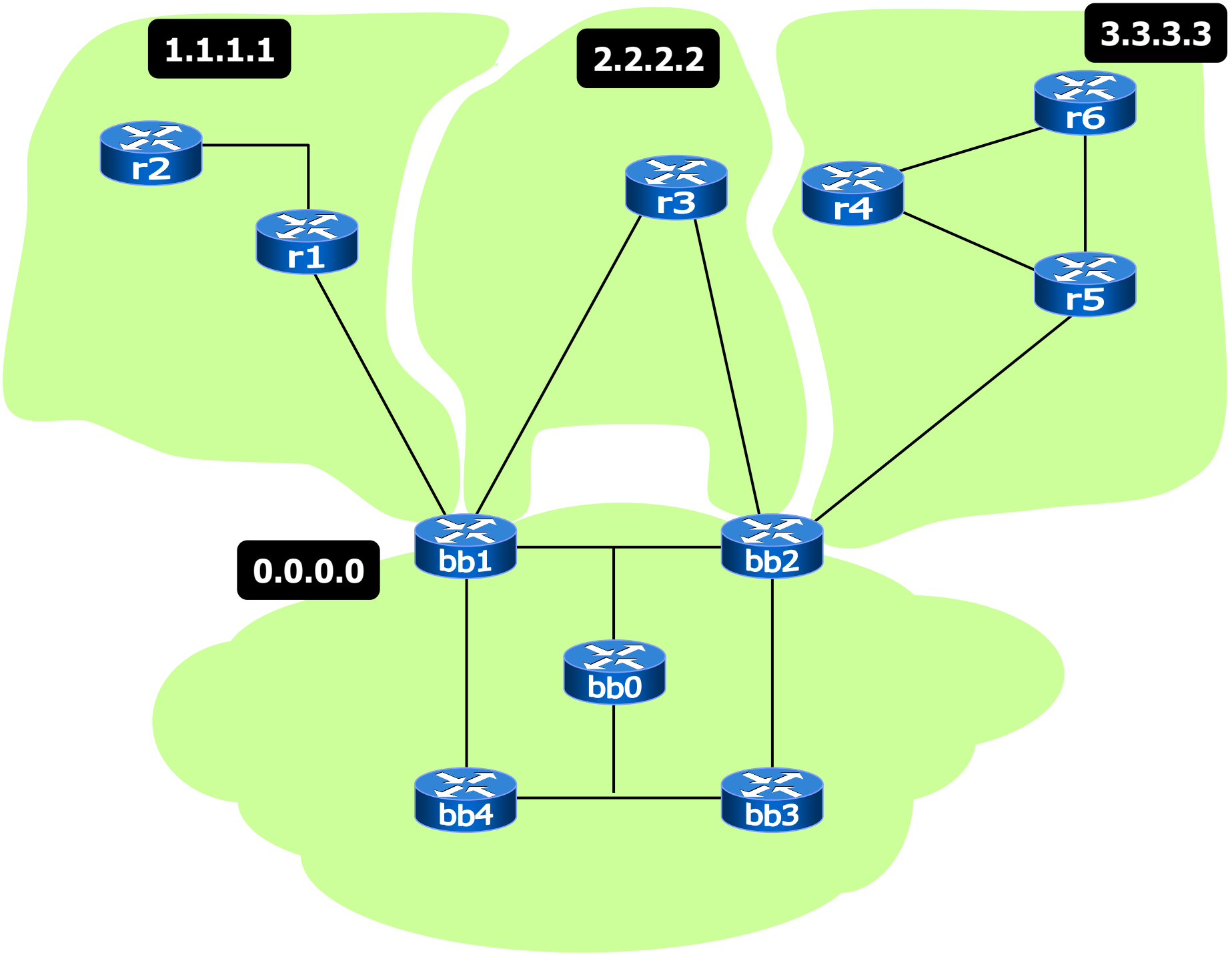
area types

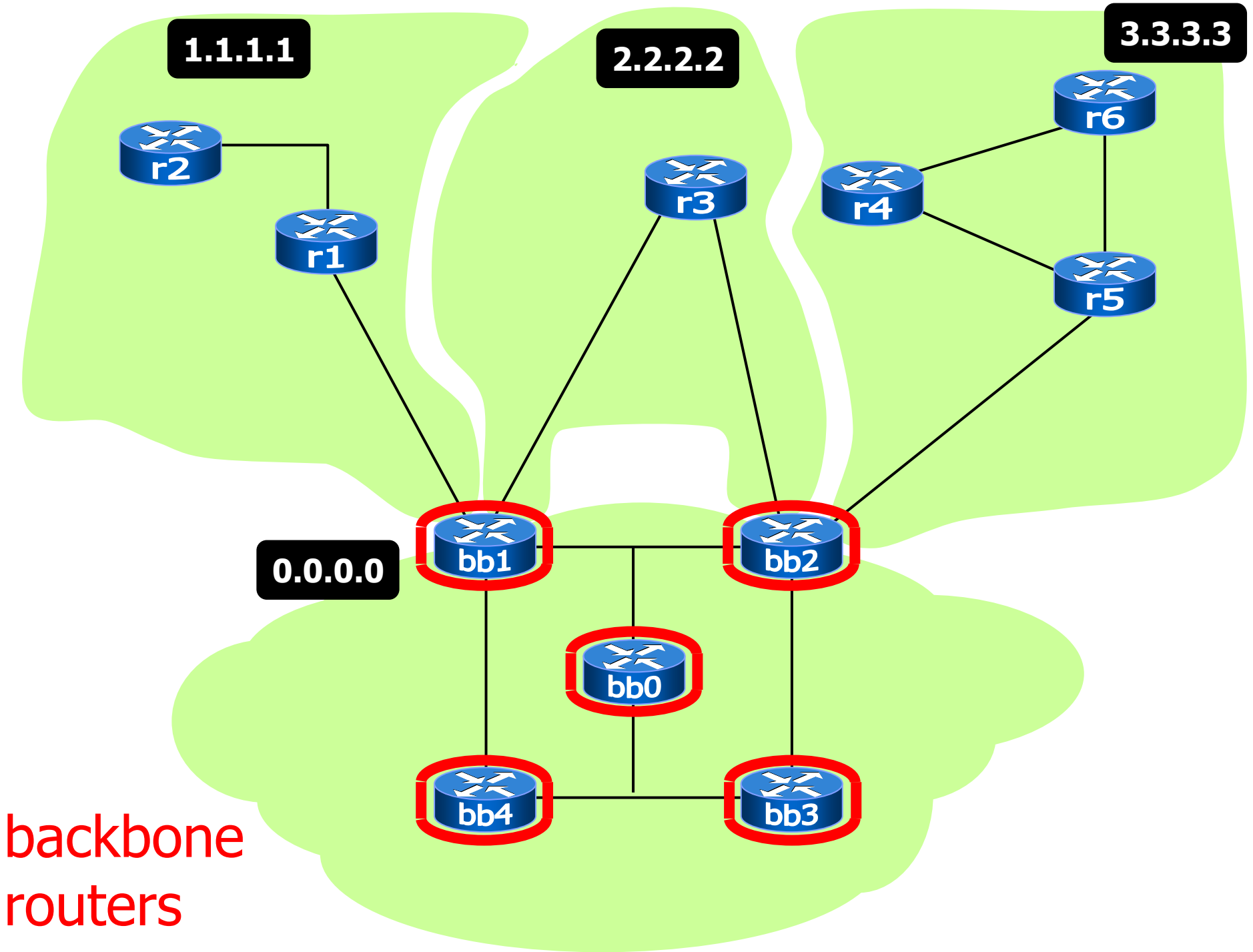
- backbone (0.0.0.0)
  - must be (virtually) connected
  - all other areas are connected to it
  - contains all the area border routers
- stub
  - does not receive advertisements of external routes
  - internal nodes are offered a default route
  - cannot contain autonomous system boundary routers
  - the backbone can’t be a stub area
- transit
  - used to pass traffic from one adjacent area to another, via virtual links

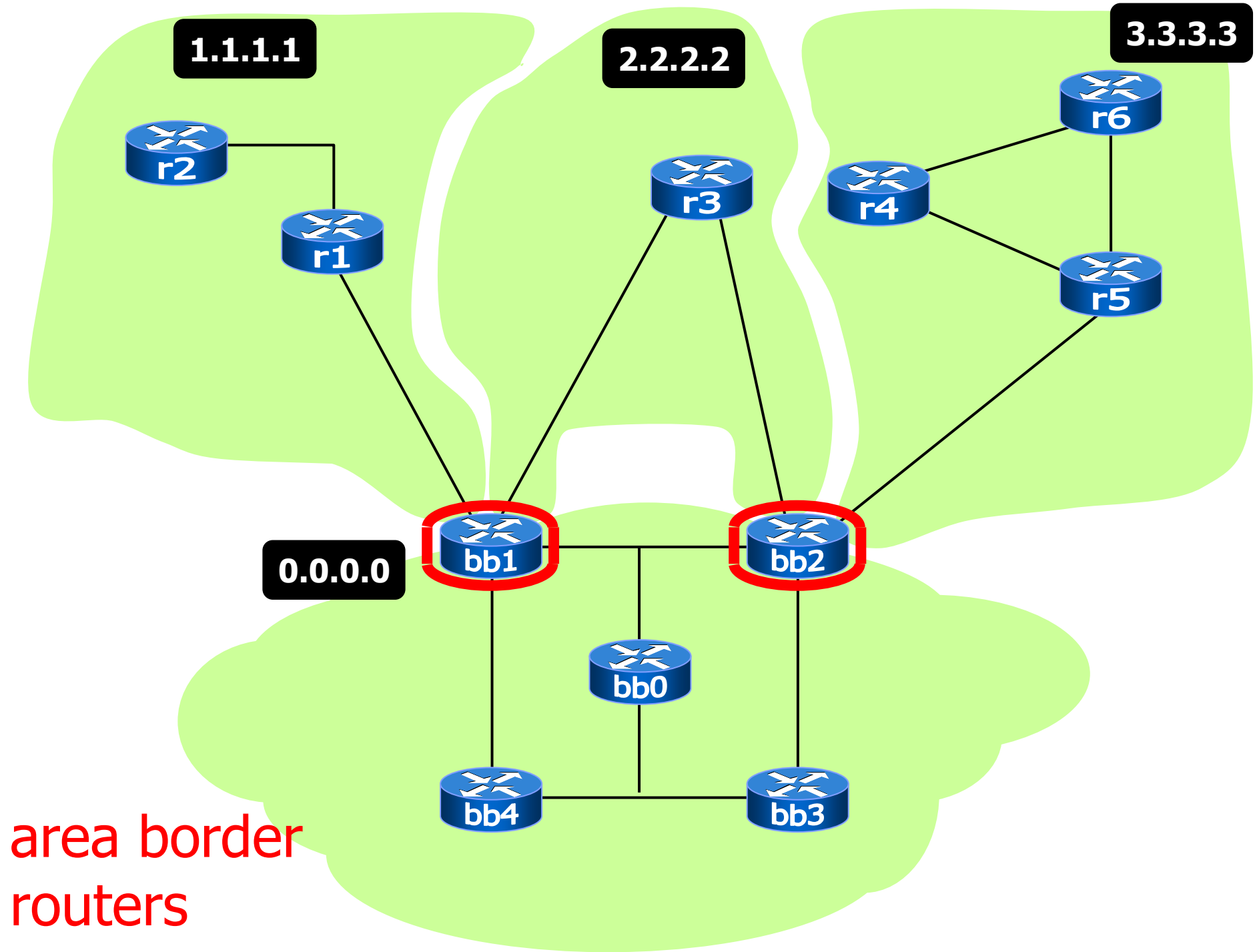

1.1.1.1
2.2.2.2
3.3.3.3
stub
stub
stub
0.0.0.0
backbone

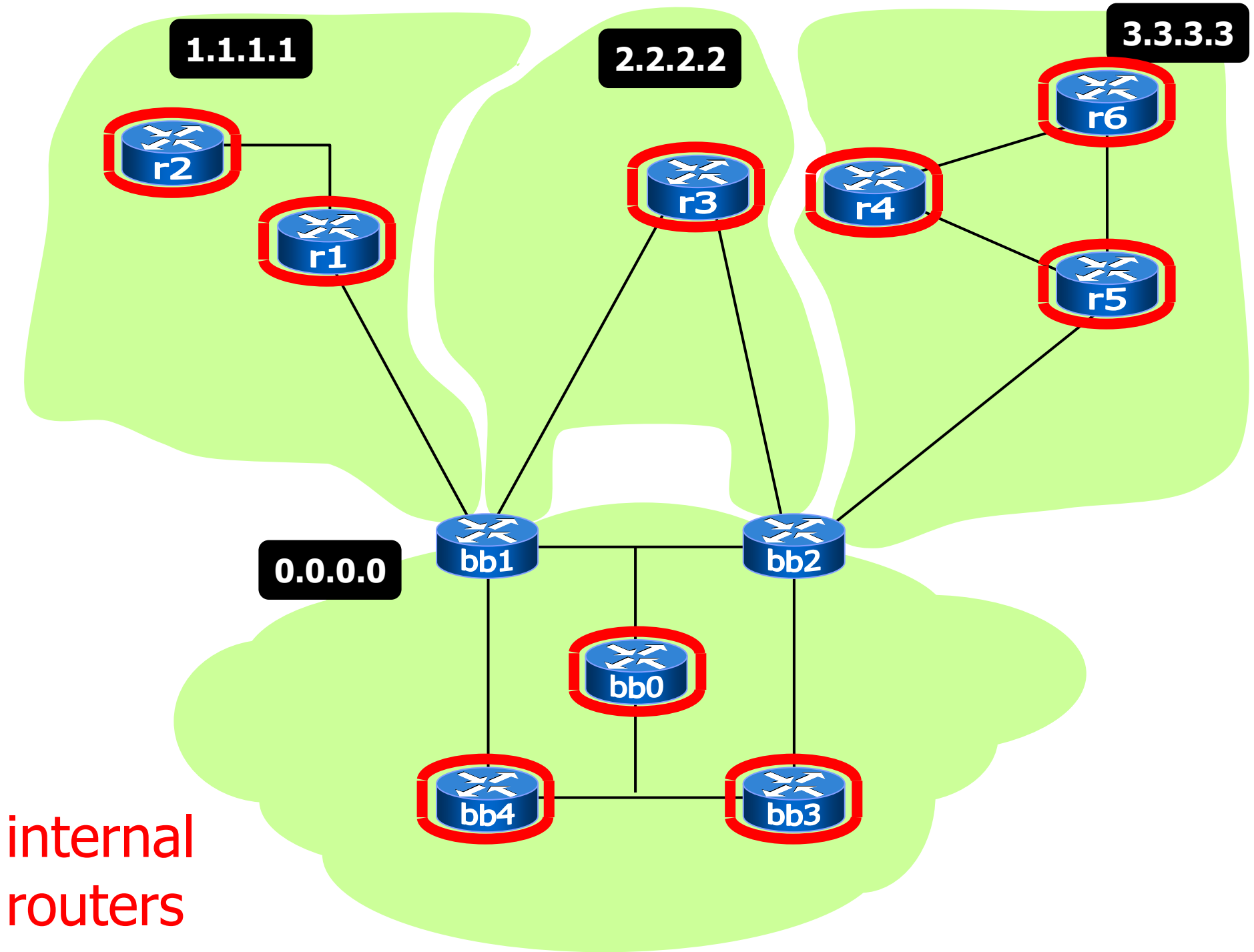
router types

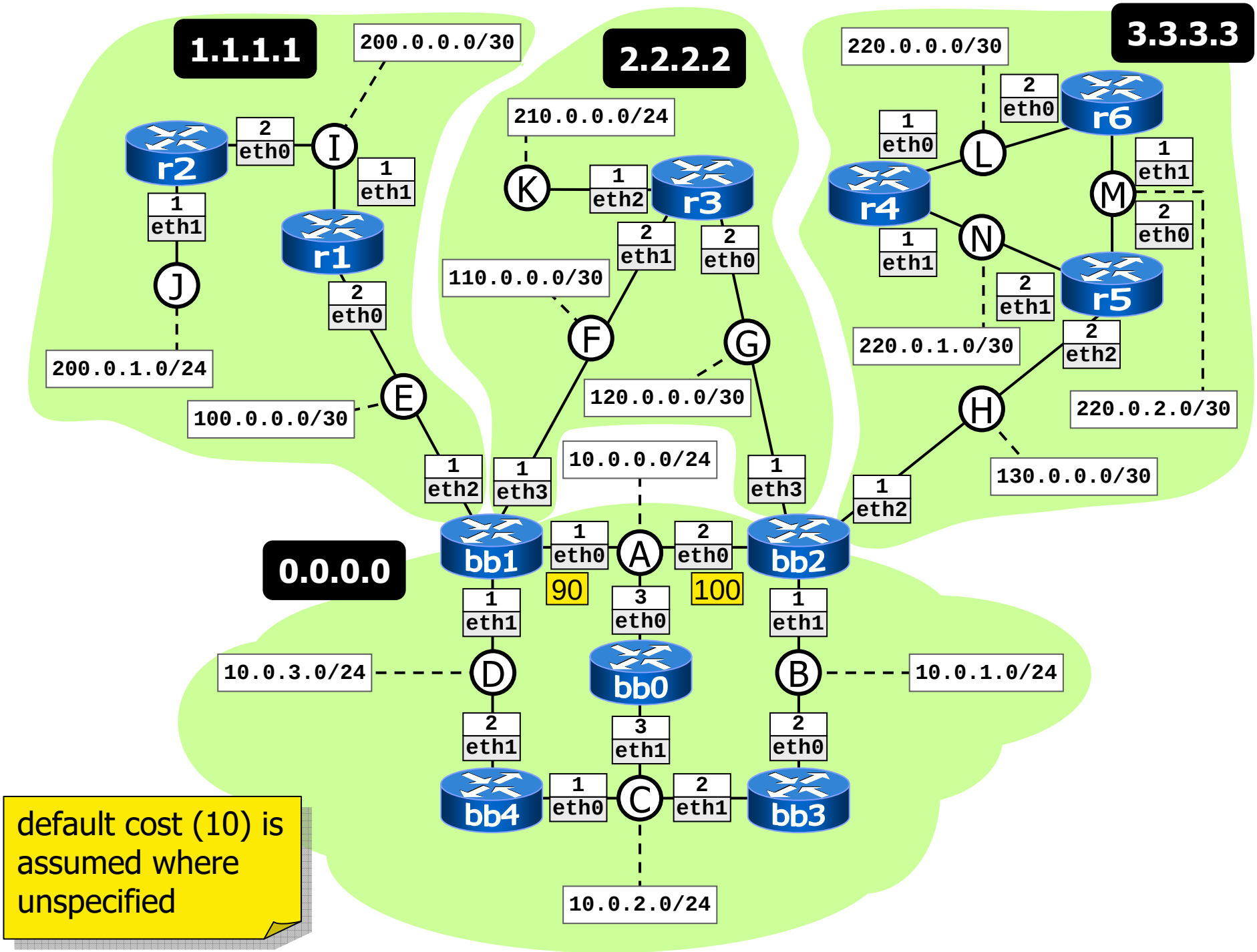
- internal router
  - all interfaces belong to the same area
- area border router (abr)
  - connects one or more areas to the backbone
  - keeps multiple lsdbs, one for each area
- backbone router
  - has at least one interface connected to the backbone
  - an abr is always a backbone router
- autonomous system boundary router (asbr)
  - imports and floods routing information from other routing protocols (typically, bgp)
- note: a router can be of more than one type


1.1.1.1
2.2.2.2
3.3.3.3
r2
r1
r3
r4
r6
r5
0.0.0.0
bb1
bb2
bb0
bb4
bb3


1.1.1.1
2.2.2.2
3.3.3.3
r2
r1
r3
r4
r6
r5
0.0.0.0
bb1
bb2
bb0
bb4
bb3
backbone
routers


1.1.1.1
2.2.2.2
3.3.3.3
r2
r1
r3
r4
r6
r5
0.0.0.0
bb1
bb2
bb0
bb4
bb3
area border
routers


1.1.1.1
2.2.2.2
3.3.3.3
r2
r1
r3
r4
r6
r5
0.0.0.0
bb1
bb2
bb0
bb4
bb3
internal
routers


1.1.1.1
2.2.2.2
3.3.3.3
0.0.0.0
200.0.0.0/30
210.0.0.0/24
220.0.0.0/30
r2
r1
r3
r4
r5
r6
bb1
bb2
bb0
bb3
bb4
I
J
K
L
M
N
E
F
G
H
A
B
C
D
200.0.1.0/24
100.0.0.0/30
110.0.0.0/30
120.0.0.0/30
220.0.1.0/30
220.0.2.0/30
130.0.0.0/30
10.0.0.0/24
10.0.1.0/24
10.0.2.0/24
10.0.3.0/24
90
100
default cost (10) is assumed where unspecified

area configuration

- area information is found in two places
  - when enabling ospf on router interfaces
    `network 200.0.0.0/16 area 1.1.1.1`
  - when specifying the area type (not required for the backbone)
    `area 1.1.1.1 stub`

Lab Scenario Personalization

- Modify the default scenario in the following way
  - Change the area ID from 2.2.2.2 to `2.2.2.<LAB-ID>`, where LAB-ID is your personal ID assigned by the lab instructor
- **Note well**: from now-on
  - Command-line commands should reflect this change, therefore there can be differences in the outputs shown in the manual

ospf path types

- there are 4 path types
  1. intra-area
  2. inter-area
  3. external type 1
  4. external type 2
- types can coexist in the same network
- each type is preferred over the following ones

ospf path types

- **intra-area** paths
  - calculated using the shortest-path tree

ospf path types

- **inter-area** paths
  - **abrs** inject summary information inside each area, to make it aware of available destinations in other areas
    - such information includes the cost of the shortest path from the abr to the destination
    - if multiple subnets are summarized into a single network, the route cost will be the maximum cost to any of the component subnets
  - an inter-area path is always composed of:
    - an intra-area path from the source to the abr
    - a backbone path between the source and destination areas
    - an intra-area path to the destination

ospf path types

- external paths are learned from other routing protocols (e.g., bgp)
- type 1: the cost is expressed in terms of
  - the external (bgp) route cost* +
  - the ospf cost to the asbr
- type 2: the cost is expressed in terms of
  - the external (bgp) route cost only (distance to the asbr is only used to break ties)

* cost used when redistributing the protocol (bgp) into ospf; default for bgp=20; configurable by using `redistribute bgp metric` *`value;`*

metric type is user-configurable `redistribute bgp metric-type 2`

experiments

- after starting the lab check that routers know detailed topology information only about their own area

r2

```
r2# show ip ospf neighbor

    Neighbor ID Pri State           Dead Time Address         Interface            RXmtL RqstL DBsmL
200.0.0.1         1 Full/Backup       34.184s 200.0.0.1     eth0:200.0.0.2           0     0     0
r2# show ip ospf database router
       OSPF Router with ID (200.0.1.1)
                Router Link States (Area 1.1.1.1 [Stub])
  Link State ID: 110.0.0.1
   Number of Links: 1
    Link connected to: a Transit Network
     (Link ID) Designated Router address: 100.0.0.2
     (Link Data) Router Interface address: 100.0.0.1
  Link State ID: 200.0.0.1
   Number of Links: 2
    Link connected to: a Transit Network
     (Link ID) Designated Router address: 100.0.0.2
     (Link Data) Router Interface address: 100.0.0.2
    Link connected to: a Transit Network
     (Link ID) Designated Router address: 200.0.0.2
     (Link Data) Router Interface address: 200.0.0.1
  Link State ID: 200.0.1.1
   Number of Links: 2
    Link connected to: a Transit Network
     (Link ID) Designated Router address: 200.0.0.2
     (Link Data) Router Interface address: 200.0.0.2
    Link connected to: Stub Network
     (Link ID) Net: 200.0.1.0
     (Link Data) Network Mask: 255.255.255.0
```

note: the output has been summarized

experiments

- check that routers know detailed topology information only about their own area

r2

```
r2# show ip ospf database network
       OSPF Router with ID (200.0.1.1)
                Net Link States (Area 1.1.1.1 [Stub])
  LS age: 448
  Options: 0x0  : *|-|-|-|-|-|-|*
  LS Flags: 0x6
  LS Type: network-LSA
  Link State ID: 100.0.0.2 (address of Designated Router)
  Advertising Router: 200.0.0.1
  LS Seq Number: 80000002
  Checksum: 0x07ed
  Length: 32
  Network Mask: /30
        Attached Router: 110.0.0.1
        Attached Router: 200.0.0.1
  LS age: 452
  Options: 0x0  : *|-|-|-|-|-|-|*
  LS Flags: 0x1
  LS Type: network-LSA
  Link State ID: 200.0.0.2 (address of Designated Router)
  Advertising Router: 200.0.1.1
  LS Seq Number: 80000002
  Checksum: 0x6cc7
  Length: 32
  Network Mask: /30
        Attached Router: 200.0.0.1
        Attached Router: 200.0.1.1
r2#
```

Reporting

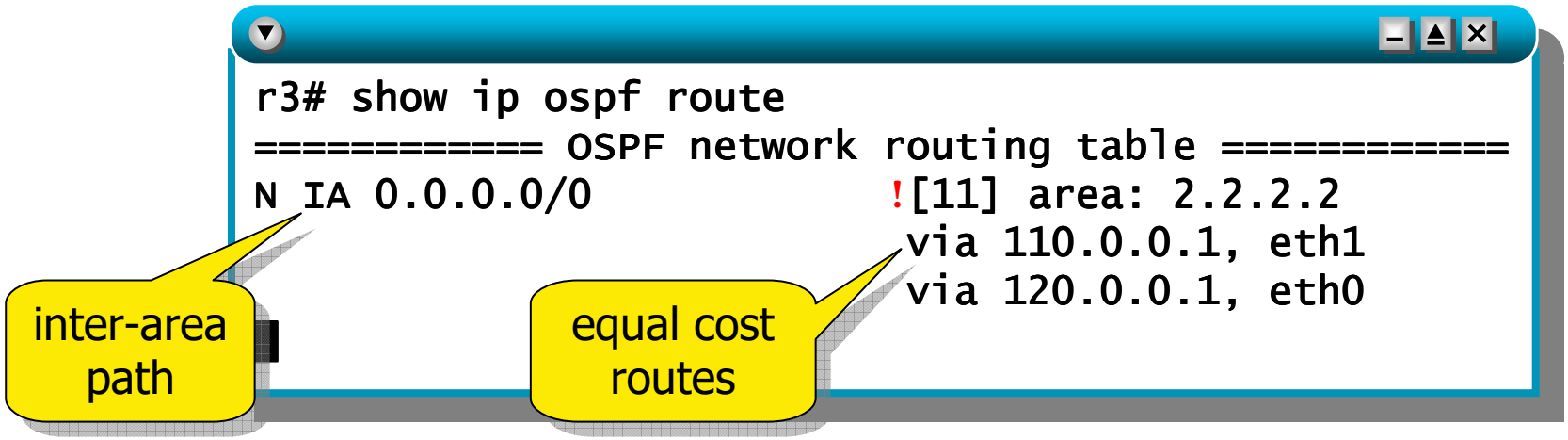
- Please deliver the following items to the UPEL system using your account
  1. A photocopy or a screenshot showing the output of the following command executed on router r3
     - **`show ip ospf database network`**

experiments

- check what routers know about the outside of the area, using the **`show ip ospf database summary`** command
  - in particular, check the **`Metric`** values, that show how far away the destination is from the advertising abr
- check that routers in stub areas are offered a default route, whereas routers in the backbone are not
  - also check what **`Metric`** is assigned to the default route

experiments

- experiment ospf's recovery capabilities
  - when multiple equal cost routes are available, ospf keeps all of them
  - check it by verifying what **r3** knows about the default route



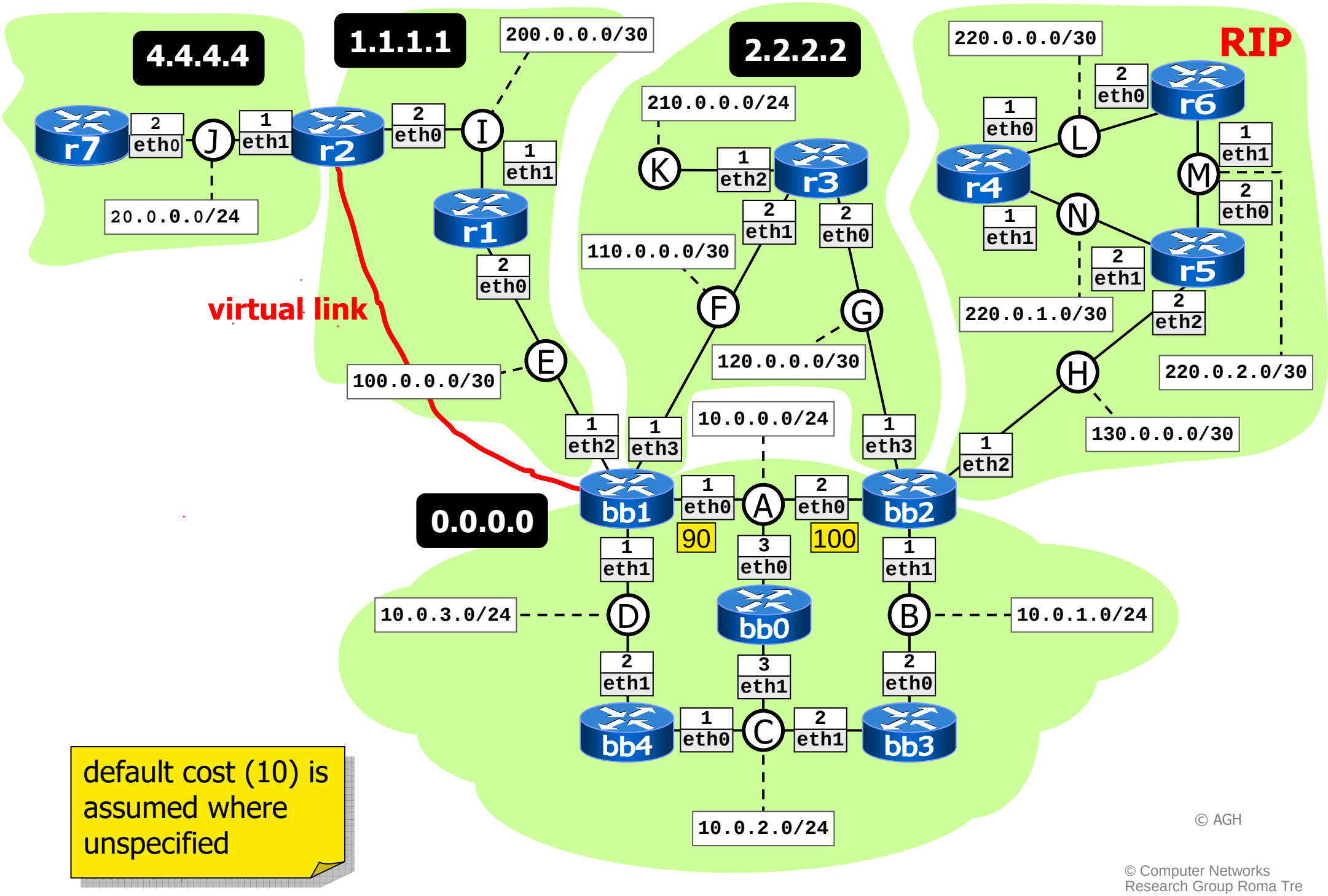
experiments

- experiment ospf's recovery capabilities
  - when multiple equal cost routes are available, ospf keeps all of them
  - check it by verifying what **`r3`** knows about the default route
  - now turn OSPF off for **`bb1`**'s **`eth3`** using `no network 110.0.0.0/30 area 2.2.2.2`, wait a few seconds and check how the routing is changed
  - turn OSPF on back for **`bb1`**'s **`eth3`** and check again how the routing is changed

Suggested Lab Modifications

- Task 1: Redistribute RIP to OSPF
- Task 2: Add an area not connected to area 0.0.0.0 and create a virtual link

- The proposed modified topology is presented on the next slide



RIP Redistribution

- Configure RIP on appropriate routers
- Configure default route on router **`r5`** and redistribute it to RIP
- Configure RIP redistribution to OSPF on router **`bb2`**
  - Check type 1 and type 2 exterior metric types for redistributed routes
- Check connectivity to/from remote destinations
- Check OSPF databases on stub and transit areas

Virtual Link

- Change area 1.1.1.1 type to transit
- Set virtual link between routers r2 and bb1 through area 1.1.1.1
  - `# area <area number> virtual link <router ID of the remote ABR>`
- Check routing tables and databases of different routers
- Check connectivity to/from remote destinations