

BGP in 100 minutes + BGP.Tools

RIPE90

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Where networks meet

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About me



- Wolfgang Tremmel
- studied Informatik (Uni Karlsruhe)
- Degree: Diploma (1994)
- Network Engineer at 
- Since 1996 Director NOC
- Since 2000 Senior Network Planner DSL at 
- 2001 - 2005 Director Network Planning at  VIA NET.WORKS
- 2006 - 2016 Manager Customer Support at 
- since 2016: Head of DE-CIX Academy



wolfgangtremmel1966



@wtremmel@hessen.social

What is BGP about?

IPv4 Prefixes

10.3.8.0/22

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	
0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0

- IPv4 and IPv6 addresses have a network and a host part
- A **prefix** is just the network part
- Important:
 - The boundary between network and host can be anywhere!

Characteristics of Prefixes: IPv4

10.3.8.0/22

Prefix-Length: 0-32

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	
0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0

Notation:

- 4 Numbers 0-255
- Separated by "."
- a "/", followed by

Host-part all zero

32 Bits long

Characteristics of Prefixes: IPv6

2003:de:274f:4000::/64

Prefix-Length: 0-128

Notation:

- 4 digit hex numbers (0-9,a-f)
- Separated by ":"
- "::" = fill up with zeros

Host-part all zero

128 Bits long

How does BGP work?

BGP is a protocol to announce prefixes

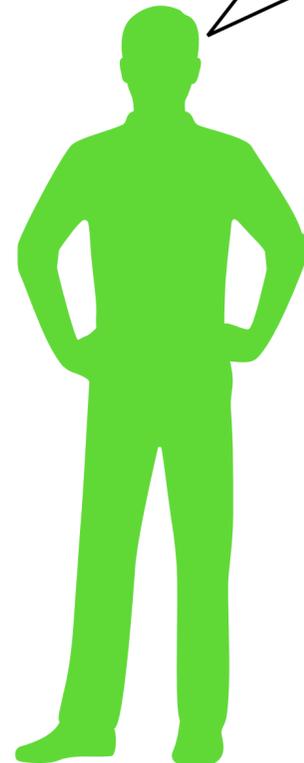
Everybody has Neighbors

I am **AS196610**, DE-CIX Academy, and I announce prefix **2a02:c50:db8::/48**

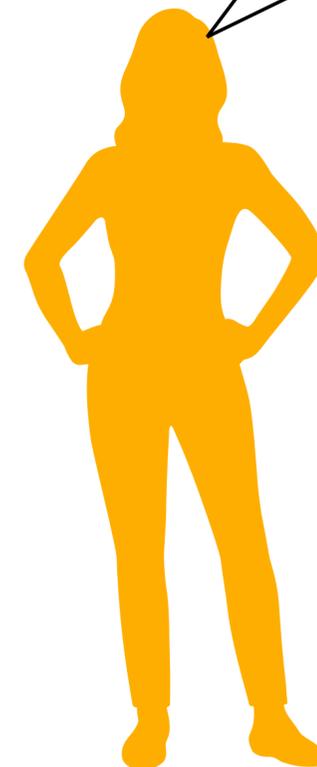


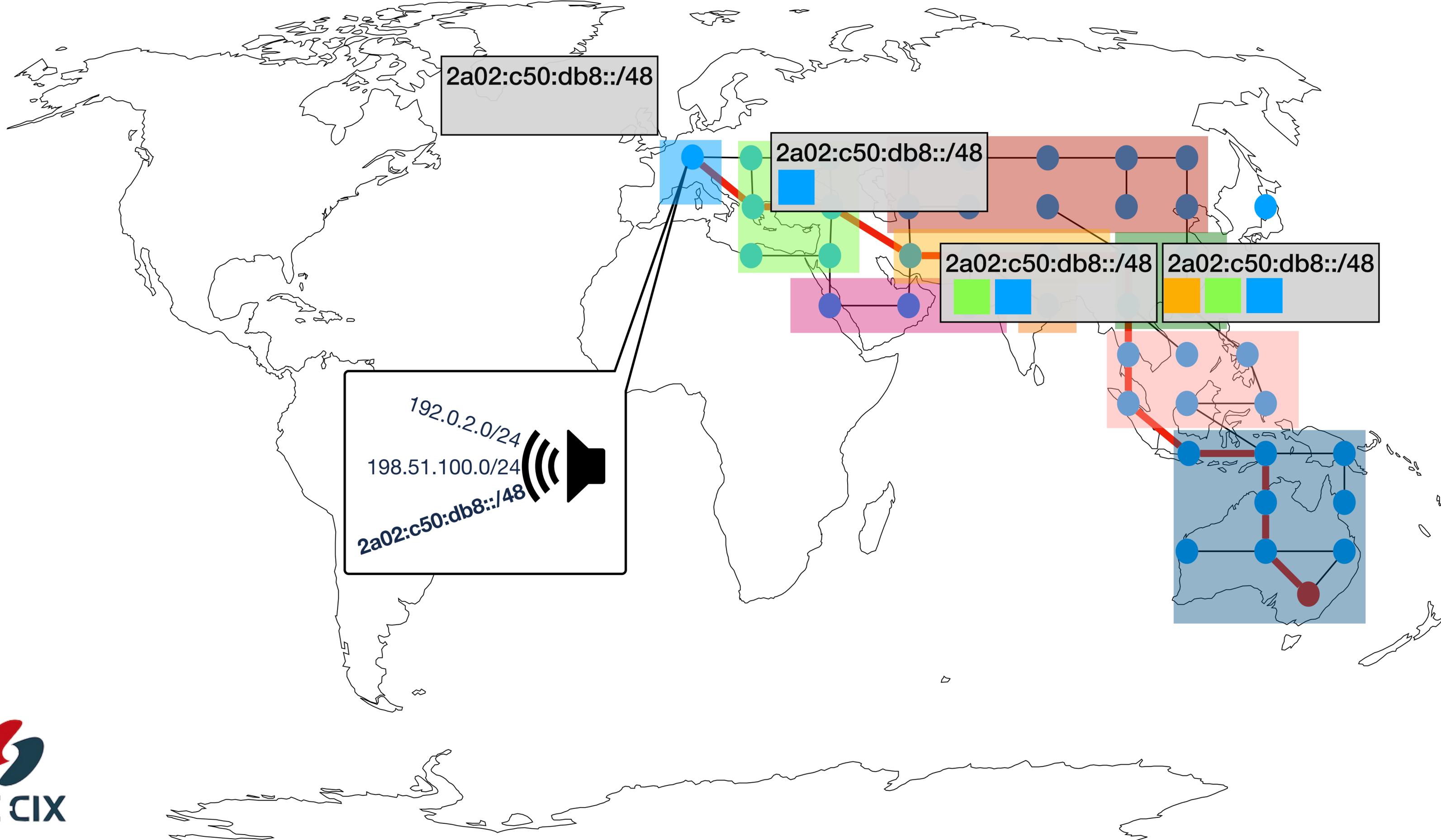
DE-CIX Academy
AS196610

My neighbor **AS196610** announces prefix **2a02:c50:db8::/48**



My green neighbor told me, his neighbor **AS196610** announces prefix **2a02:c50:db8::/48**



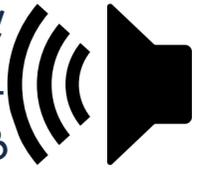


BGP announces prefixes

To neighbors

- BGP announces IP prefixes to neighbors
 - These neighbors have to be **configured**
 - Each BGP speaking device is part of an **Autonomous System**
 - The path these announcements take is recorded - this is called the **Autonomous System Path**
 - The AS Path shows which Autonomous Systems have forwarded the prefix announcement
 - The rightmost AS in the AS Path is called the "**Originator**"

192.0.2.0/24
198.51.100.0/24
2a02:c50:db8::/48



I am **AS196610**, DE-CIX Academy, and I announce prefix
2a02:c50:db8::/48

2a02:c50:db8::/48



What is an *Autonomous System*?

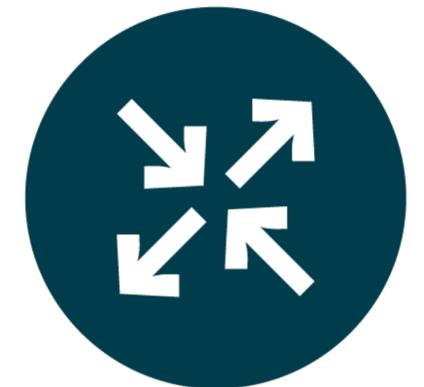
What is an Autonomous System?

Simple Definition

- A group of IP prefixes
 - But to route or announce them, you need hardware
 - A router (or multiple routers)
 - This router speaks BGP (to its neighbors)
 - And has an ***Autonomous System Number*** configured
- Another new term: **Autonomous System Number (ASN)**

Formal Definition (RFC1930):

"An AS is a connected group of one or more IP prefixes run by one or more network operators which has a SINGLE and CLEARLY DEFINED routing policy."



Router

I am **AS196610**, DE-CIX Academy, and I announce prefix
2a02:c50:db8::/48



Autonomous System Number

or AS Number or ASN

- Initially 16bit (0...65535) they are now 32bit long (0... "a lot")
- AS numbers are globally unique
- Unique means, somebody has to administrate them
- This is the IANA (Internet Assigned Numbers Authority)
 - But they have delegated that task to the 5 RIRs (Regional Internet Registries)
- So in Europe: Become a member of the RIPE NCC and request one

*"An AS has a **globally unique number** (sometimes referred to as an **ASN**, or Autonomous System Number) associated with it; this number is used in both the exchange of exterior routing information (between neighboring ASes), and as an **identifier of the AS itself.**" ([RFC1930](#))*

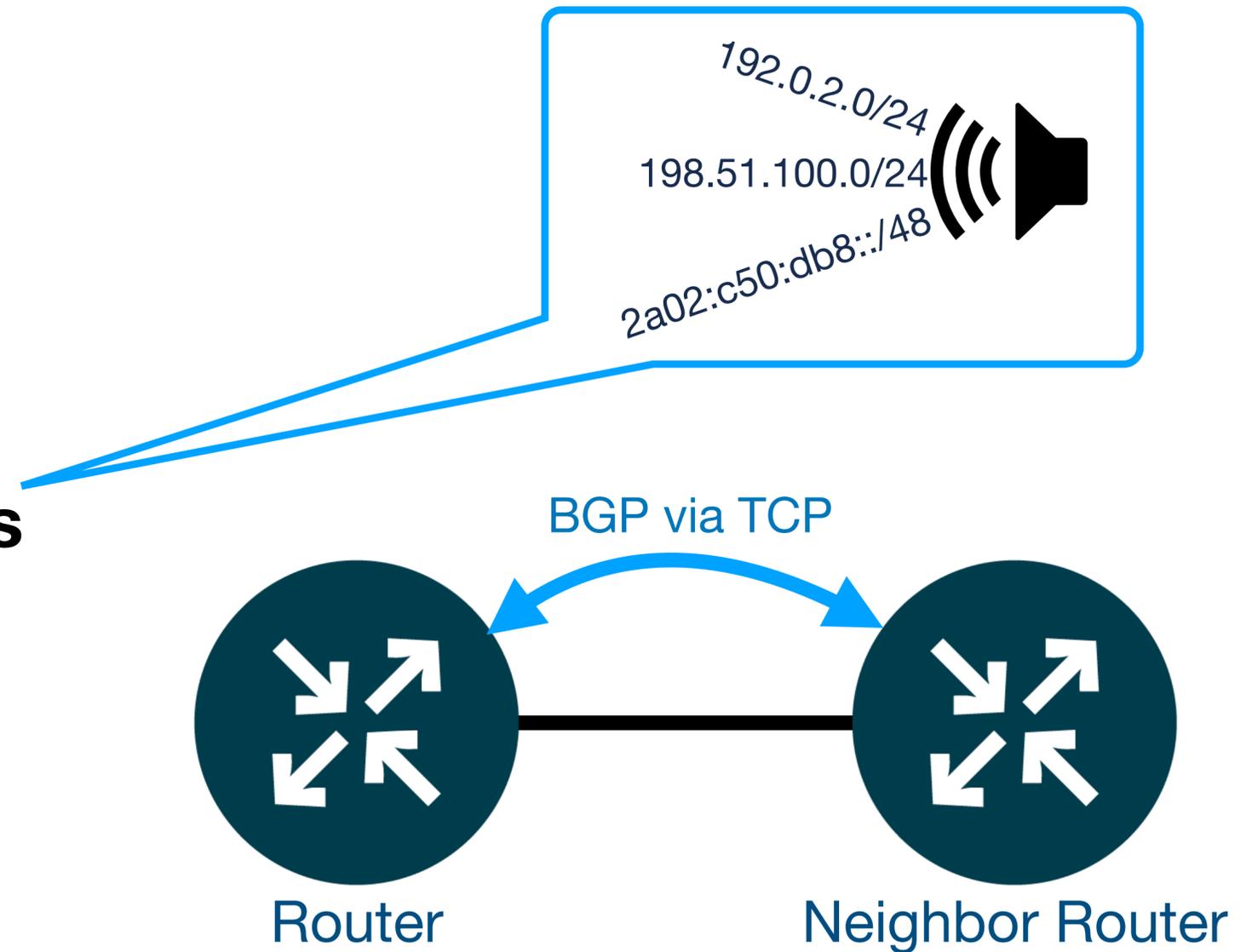


BGP Announcing Prefixes

BGP Neighbors

Directly connected neighbors

- BGP announces IP prefixes to **neighbors**
- These neighbors have to be **configured**
- BGP uses **TCP** to connect to a neighbor
- TCP brings already:
 - **Reliable transport** (sender knows that receiver got it)
 - **Flow control** (do not send faster than the receiver can receive)
 - **Framing** (putting BGP messages into packets)



BGP works incremental

Using add- / withdraw- messages

withdraw:
2a02:c50:db8::/48

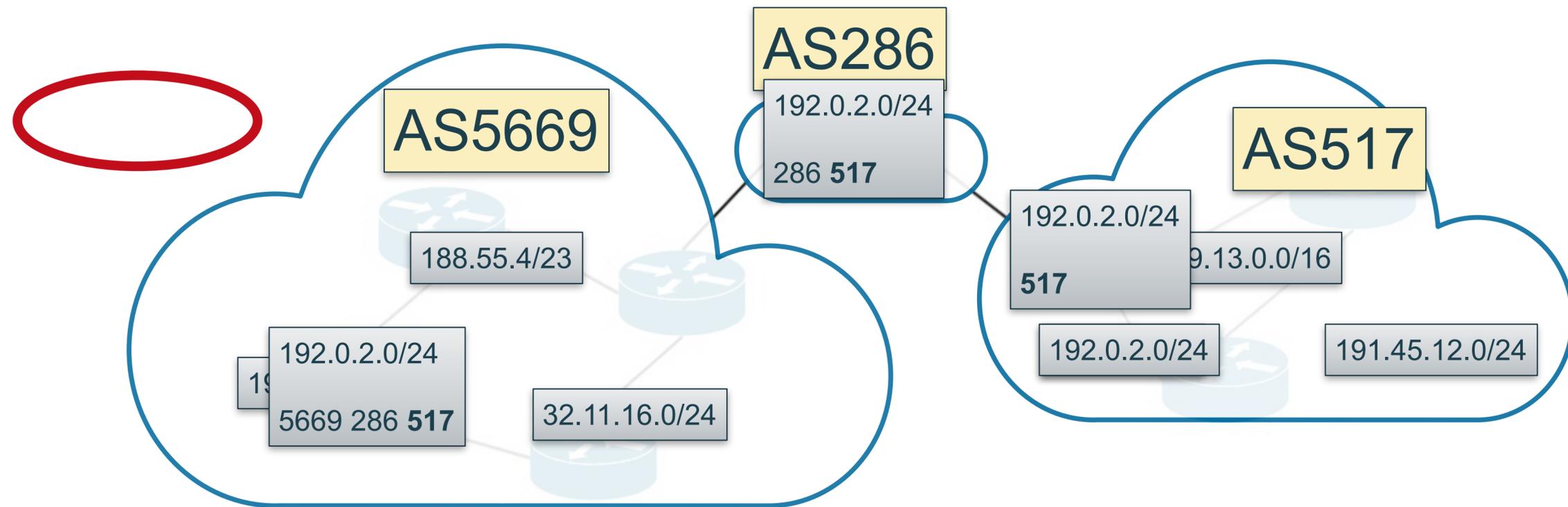


- At session setup, BGP announces "everything" to its neighbor
- After that, updates are **incremental**:
 - If BGP learns about a new prefix, it sends an **add**-message to neighbors
 - If a prefix goes away, it sends a **withdraw** message to neighbors
- As long as the BGP session is "up", a router assumes its neighbors are "in sync" (= did not forget anything it sent)



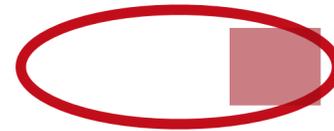
BGP Announcing Prefixes

Building the AS path

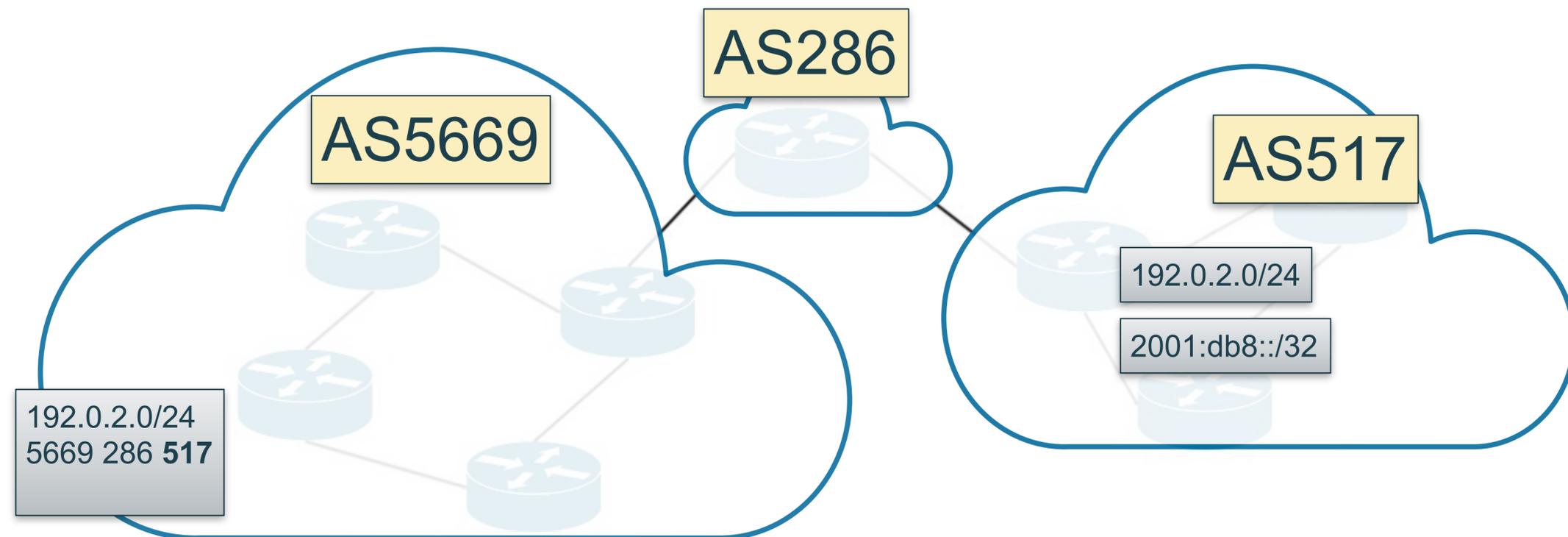


BGP Announcing Prefixes

- Prefixes
- AS Numbers
- AS Path



Originator AS



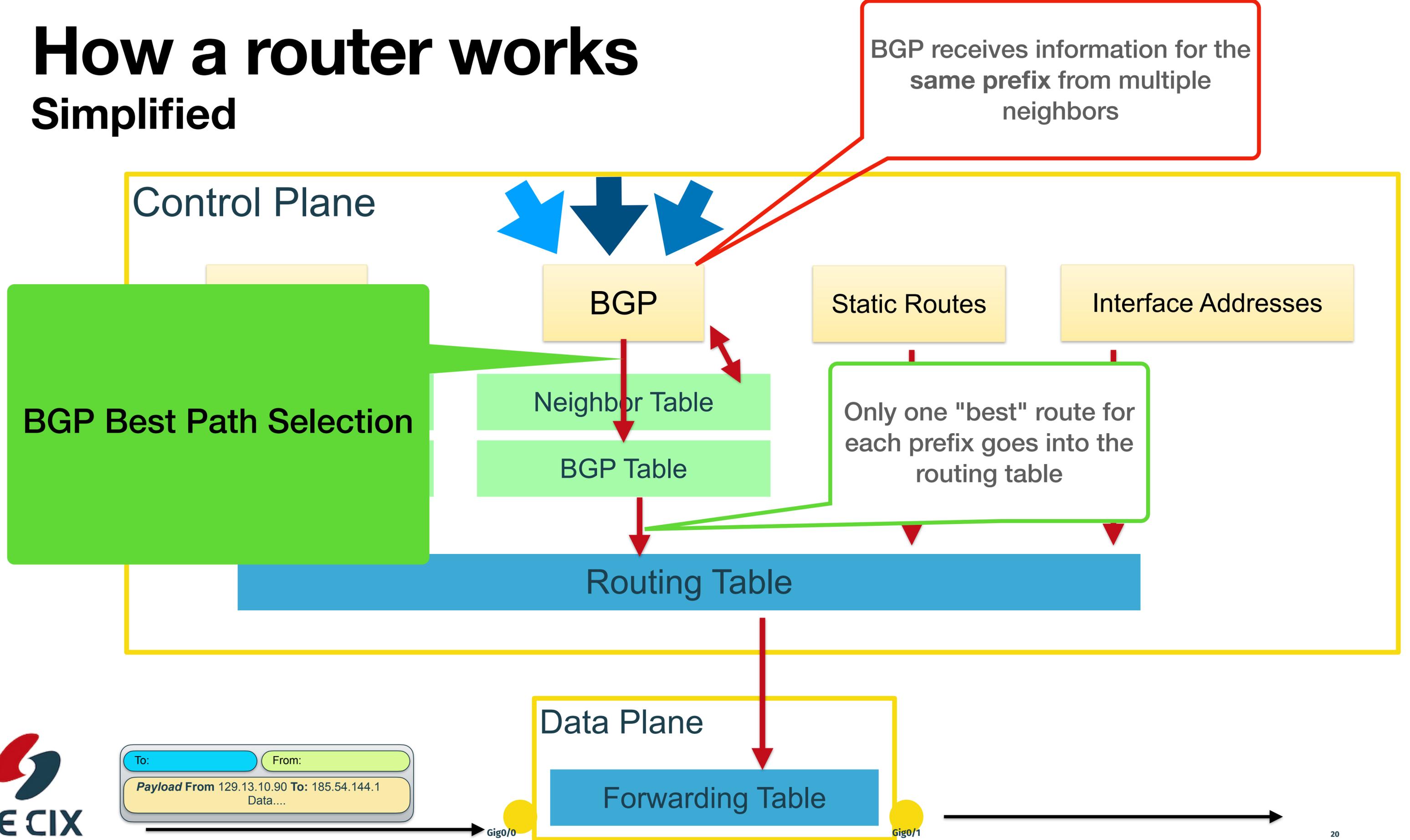
Attributes of BGP prefixes

Not only the AS path

- **Mandatory** attributes: have to be there
 - Example: AS-Path
- **Optional** attribute: are, well, optional
 - Example: MED
- **Transitive** attributes
 - are kept on the prefix and forwarded via BGP
- **Non-transitive** attributes
 - are added to a prefix and not forwarded by the receiver

How a router works

Simplified

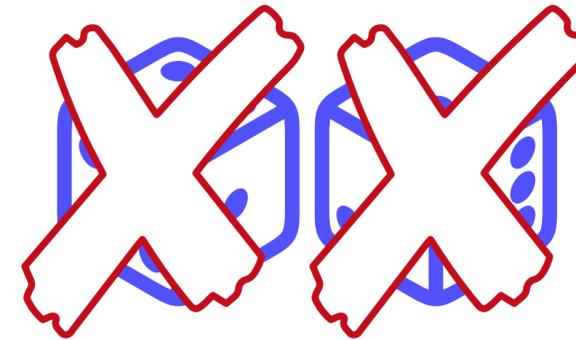


BGP Best Path Selection

BGP Best Path Selection Algorithm

Motivation

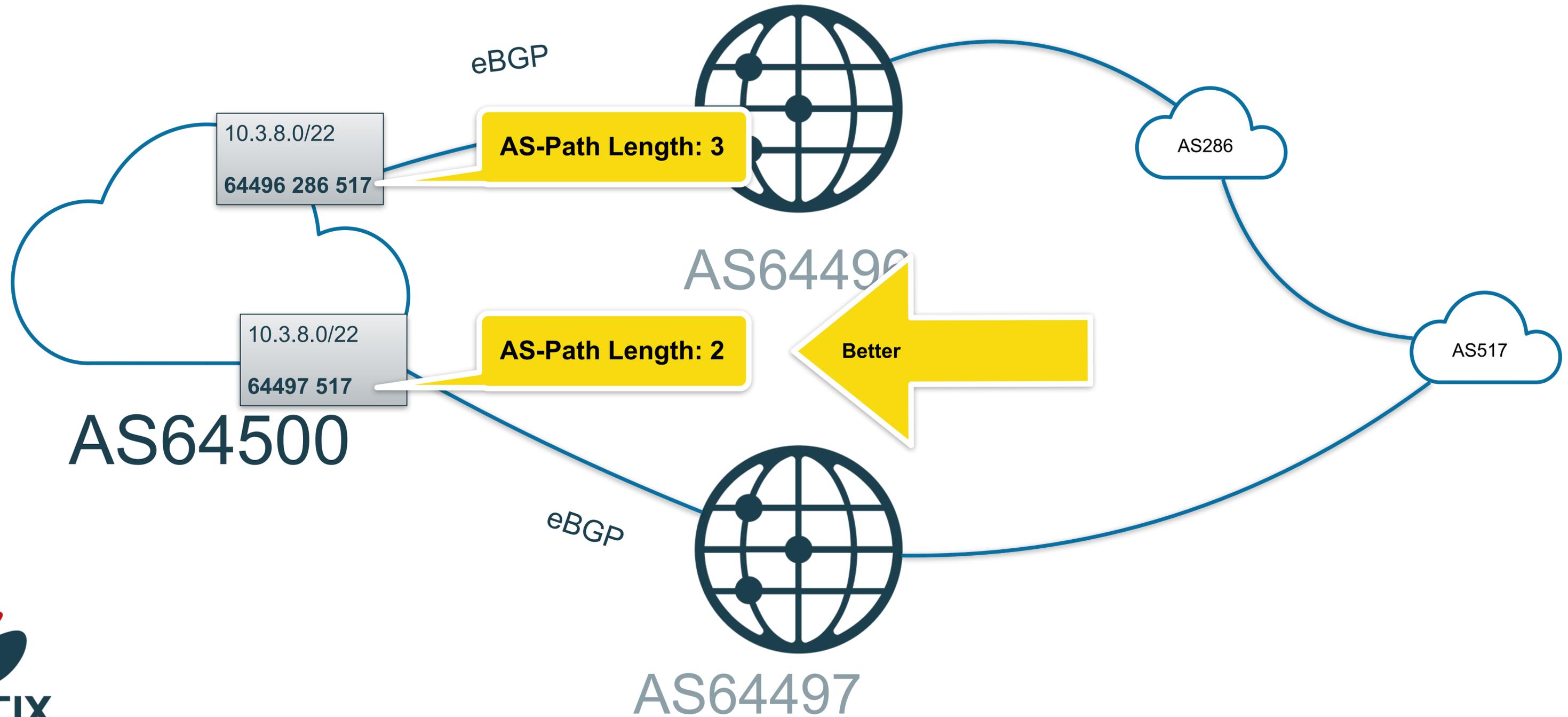
- Only one single path for each destination is needed (and wanted)
- Decision must be based on attributes
- And must not be random, but deterministic
- Some of the criteria will sound strange
- Some are really outdated
- So lets have a look how this works...



Let's get started.... with two upstreams



Let's get started.... with two upstreams



BGP Best Path Selection

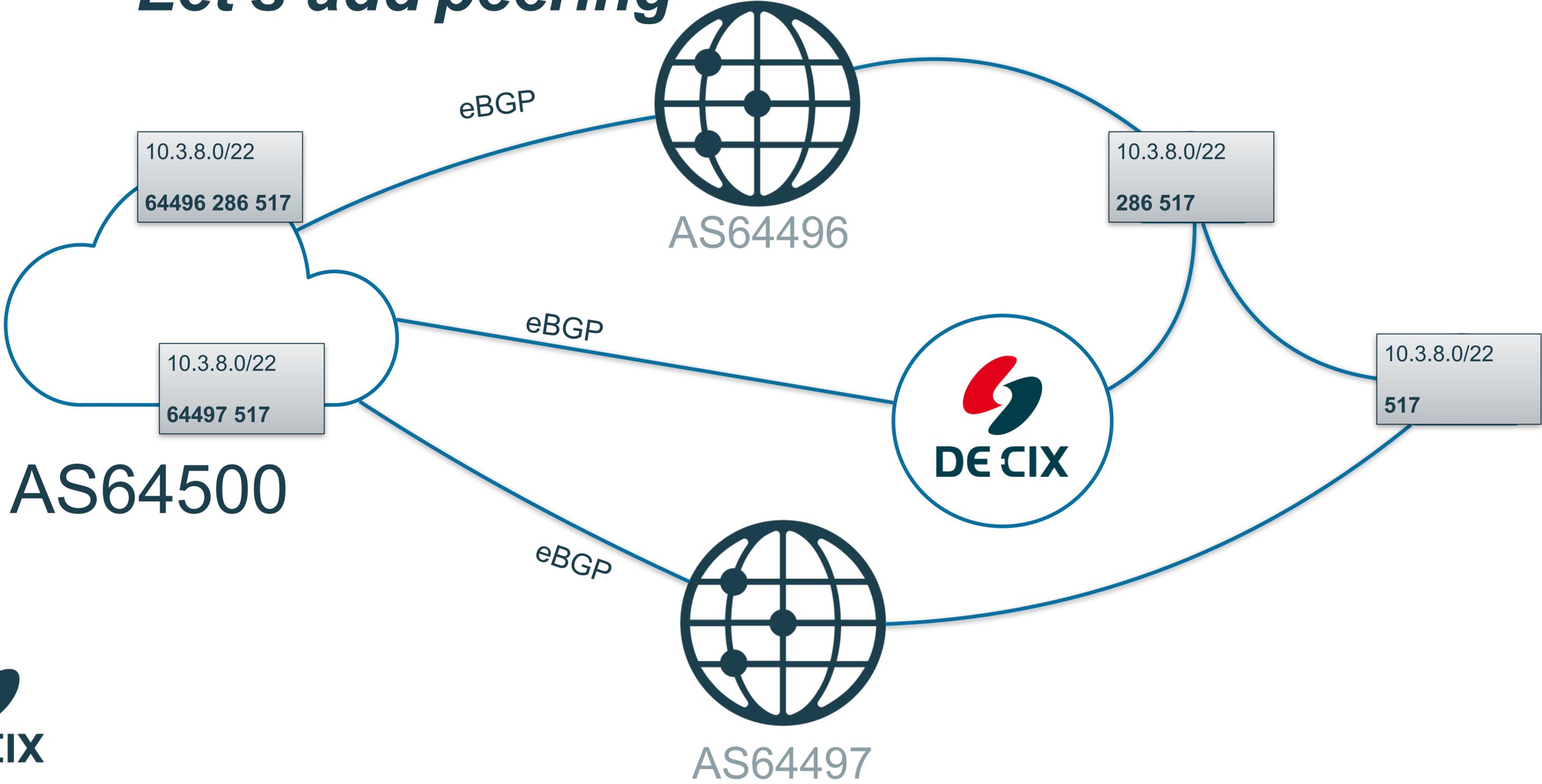
1	NextHop reachable?	Continue if "yes"
2		
3		
4		
5		
6		
7		
8		
9		
10		

AS-Path Length: 3

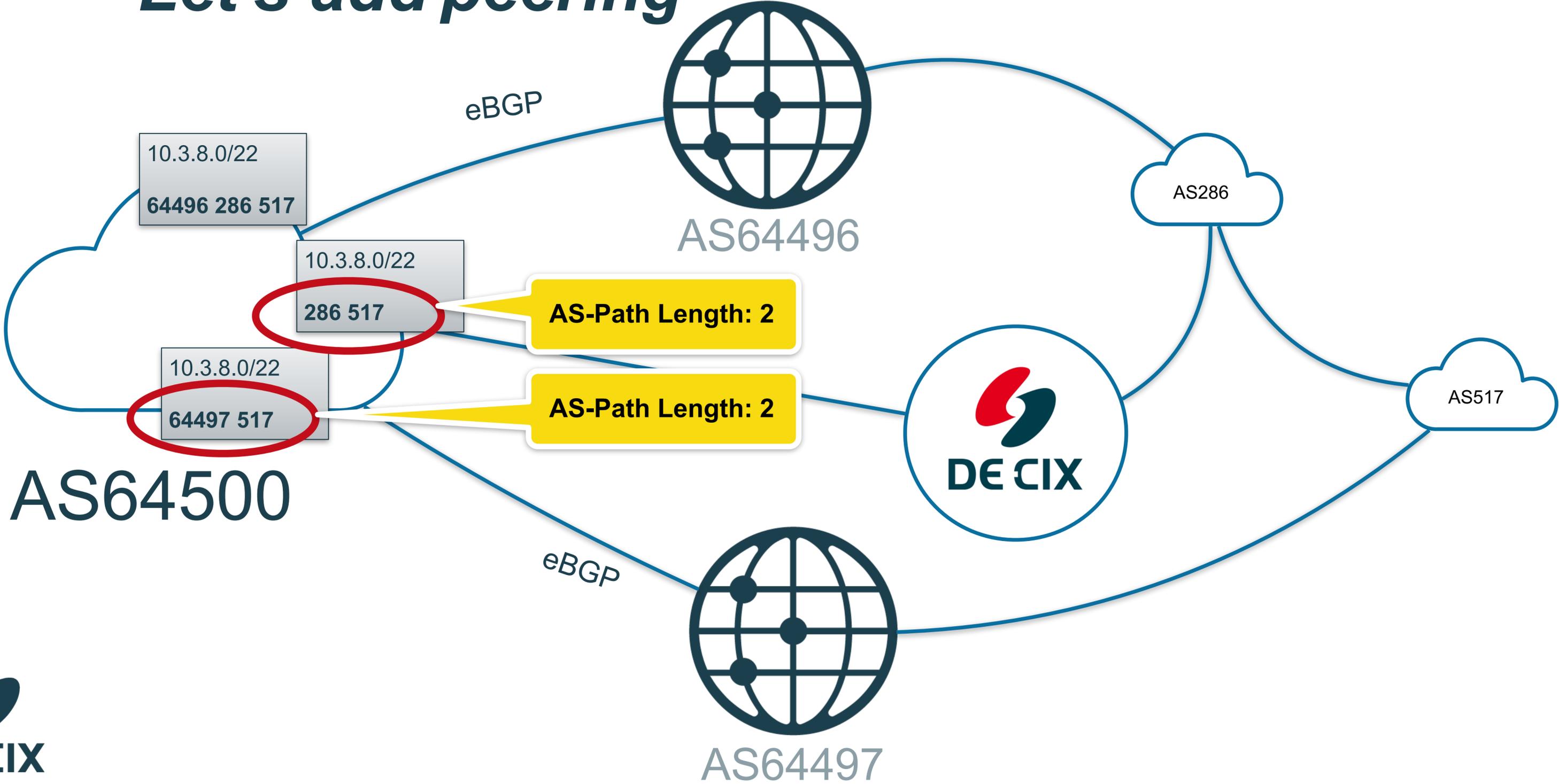
AS-Path Length: 2

Better

Let's add peering



Let's add peering



BGP Best Path Selection

1	NextHop reachable?	Continue if "yes"
2		
3	AS Path Length	shorter wins
4		
5		
6		
7		
8		
9		
10		

AS-Path Length: 2

AS-Path Length: 2



Local Preference

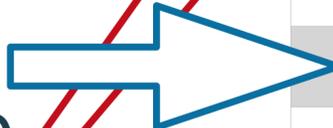
- Higher wins
- Integer value (32bit, 0-4294967295)
- Propagated via iBGP inside an Autonomous System
- Usually set using rules when receiving prefixes

→ Typical values:

- Customer prefixes: 10000
- Peering prefixes: 1000
- Upstream prefixes: 10

1	NextHop reachable?	Continue if "yes"
2	Local Preference	higher wins
3	AS Path Length	shorter wins
4		
5		
6		
7		
8		
9		
10		

Why am I not using "100" here?



BGP Route Selection: Origin Type

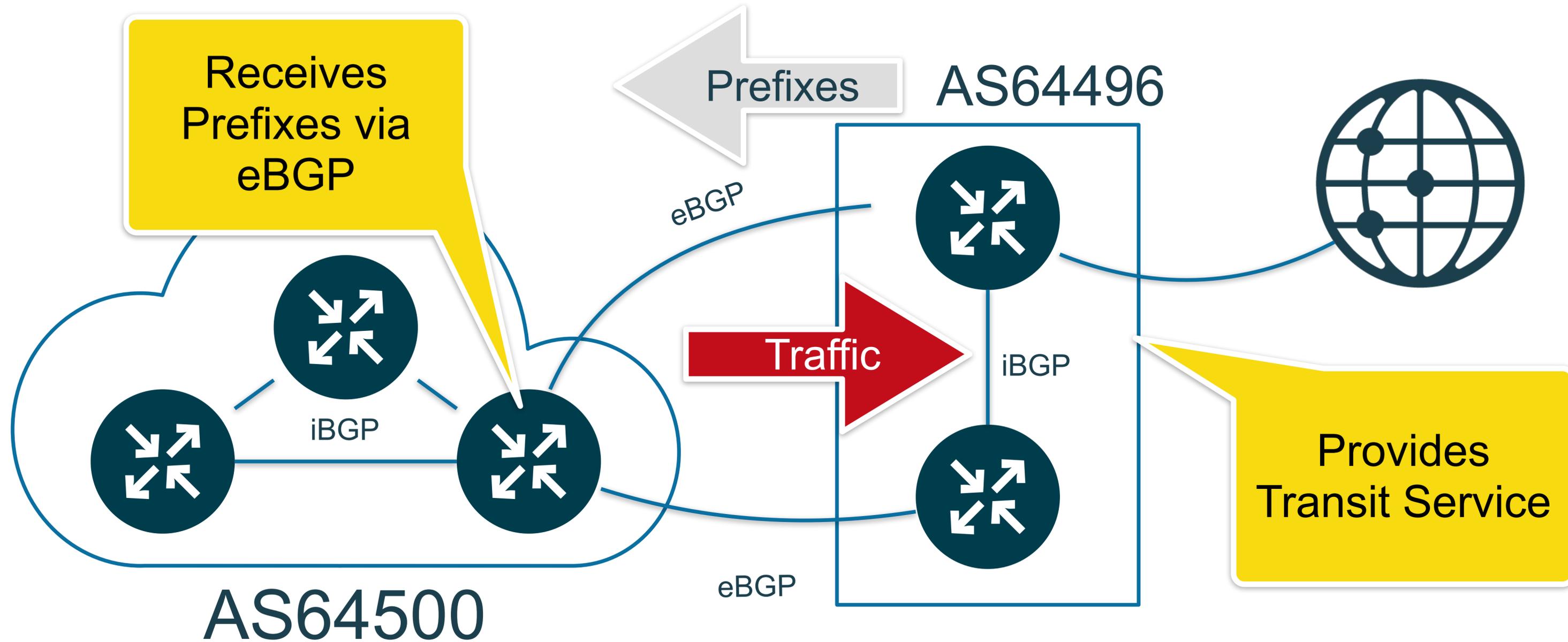
- Origin Type is a "historical" attribute
- Three possible values:
 - IGP - route is generated by BGP network statement - "i"
 - EGP - route is received from EGP - "e"
 - incomplete - redistributed from another protocol - "?" as the "real source" is unknown
- ***This rule is not really important***
- Fun fact: There are prefixed in the global routing table marked "e"

Exterior Gateway Protocol

Predecessor of BGP which is no longer used

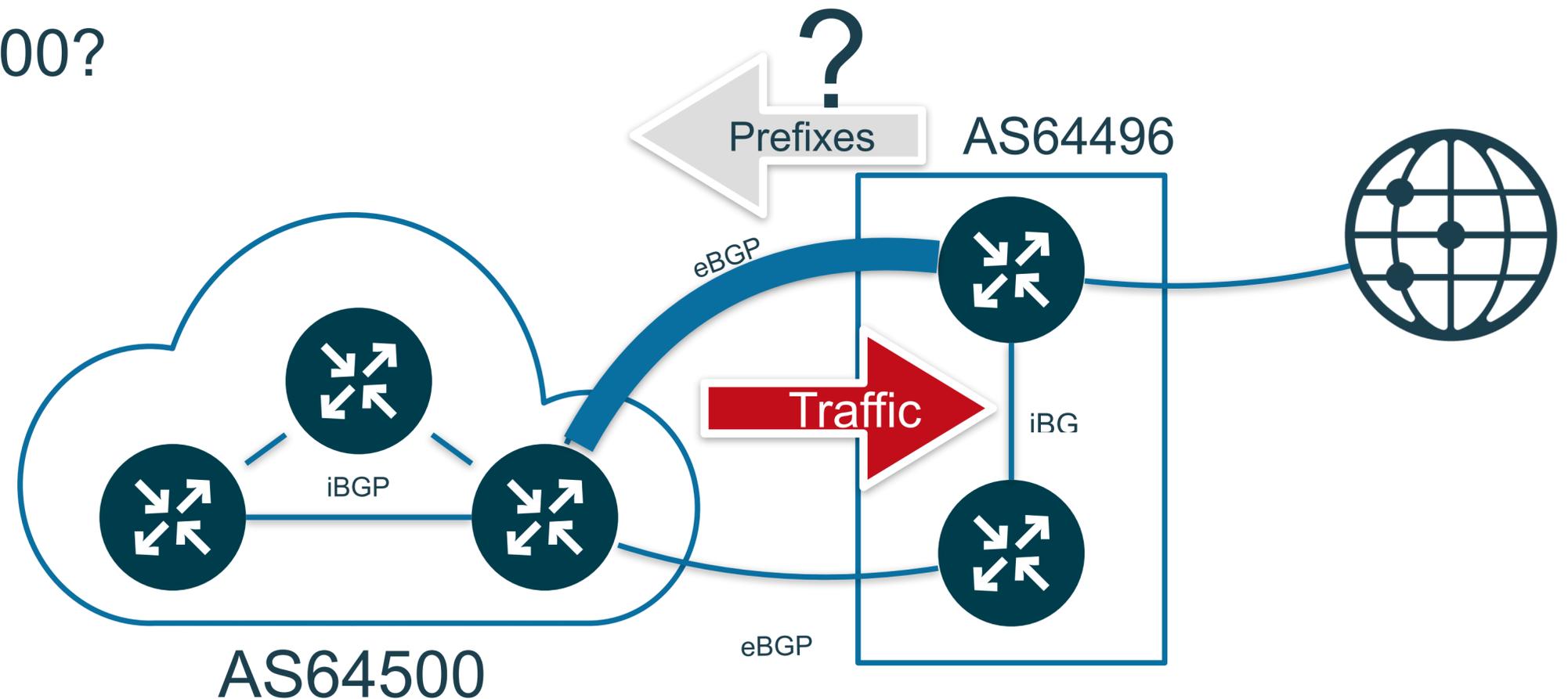
1	NextHop reachable?	Continue if "yes"
2	Local Preference	higher wins
3	AS Path Length	shorter wins
4		
5		
6		
7		
8		
9		
10		

Consider the following network



Consider the following network

- There are two circuits
- AS64496 wants one of them preferred
- How to tell AS64500?



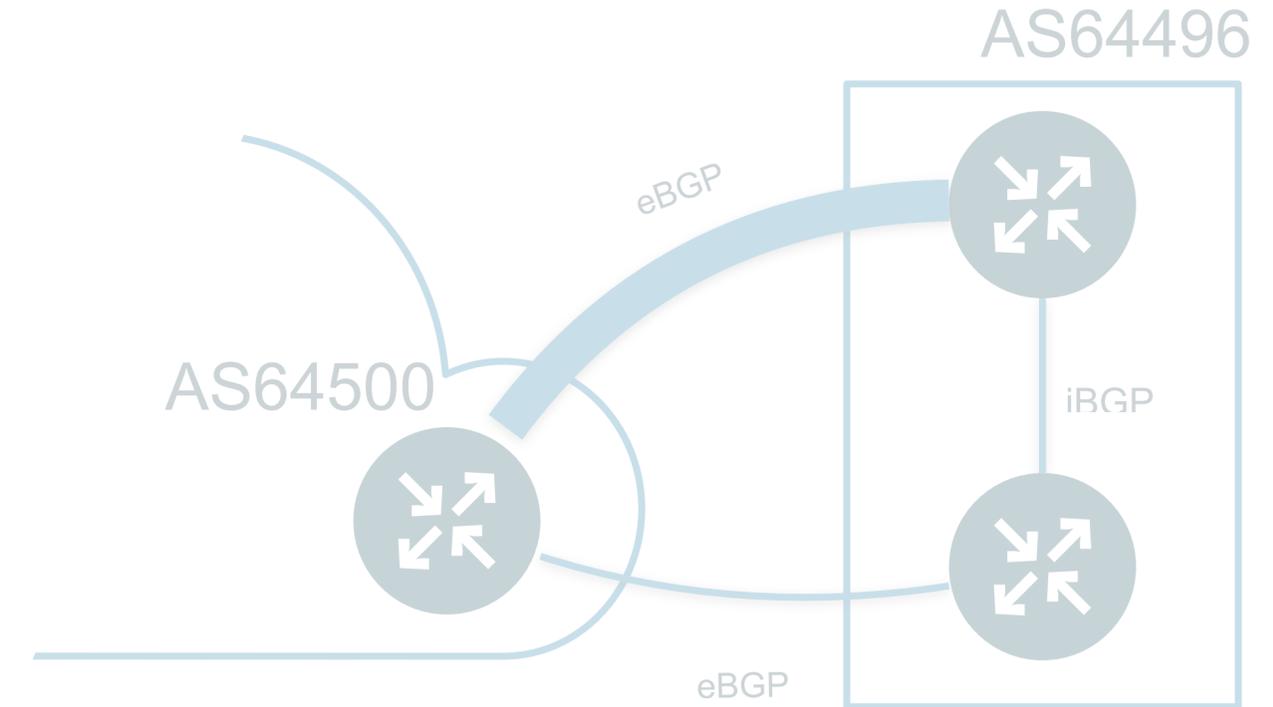
BGP Route Selection Algorithm:

How to tell your neighbor where you prefer traffic?

1	NextHop reachable?	Continue if "yes"
2	Local Preference	higher wins
3	AS Path Length	shorter wins
4	Origin Type	IGP over EGP over Incomplete
5		
6		
7		
8		
9		
10		

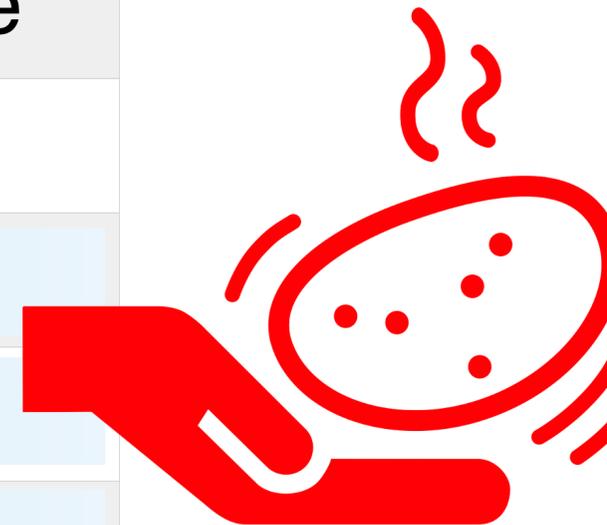
BGP Route Selection Algorithm: MED

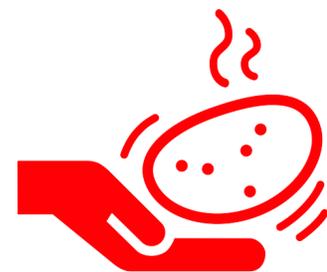
- MED = **M**ulti-**E**xit **D**iscriminator
- Only compared if next-hop AS is the same
- 32bit value (0..4294967294)
- Lower wins
- Optional (does not have to be there), non-transitive (does not get forwarded)
- A missing MED can be treated as "best" (=0, default) or "worst" (=4294967294)
- And of course you can override whatever you receive



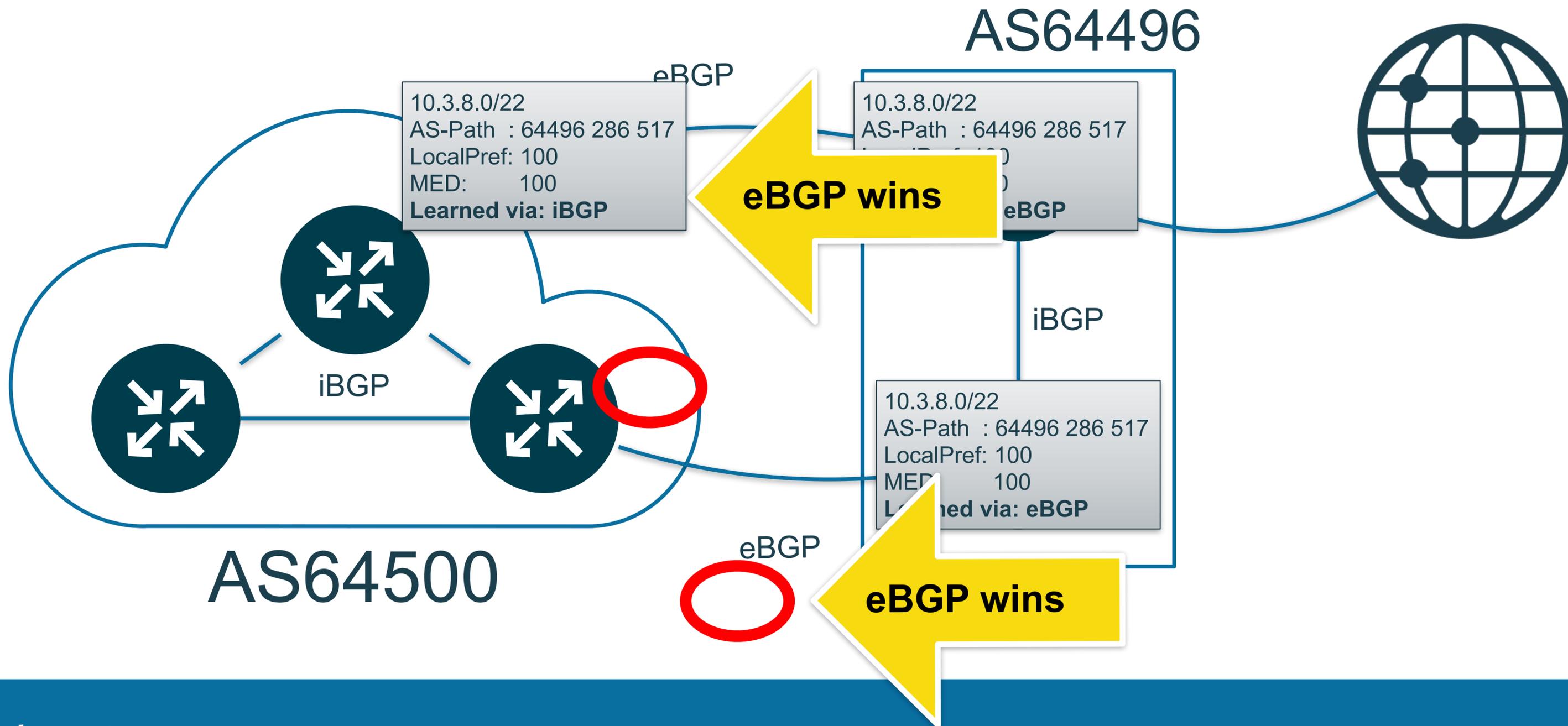
BGP Route Selection : Hot Potato Rules

1	NextHop reachable?	Continue if "yes"
2	Local Preference	higher wins
3	AS Path Length	shorter wins
4	Origin Type	IGP over EGP over Incomplete
5	MED	lower wins
6		
7		
8		
9		
10		

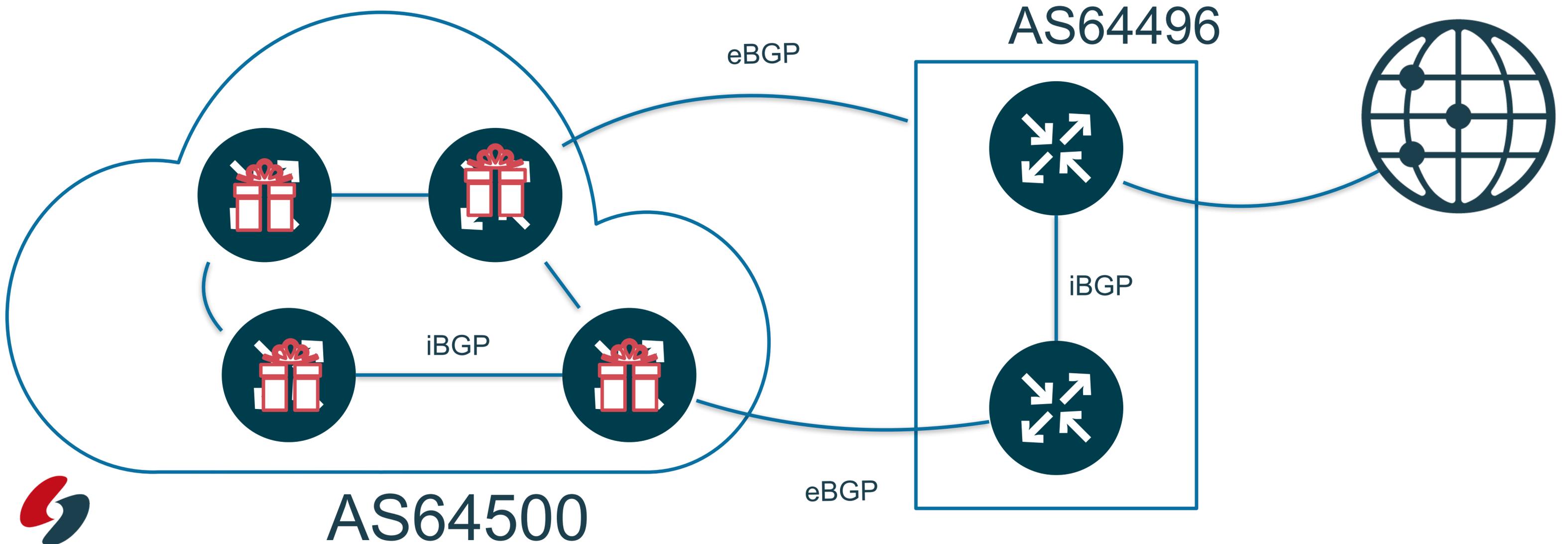




BGP Route Selection : eBGP wins



BGP Route Selection : nearest exit wins

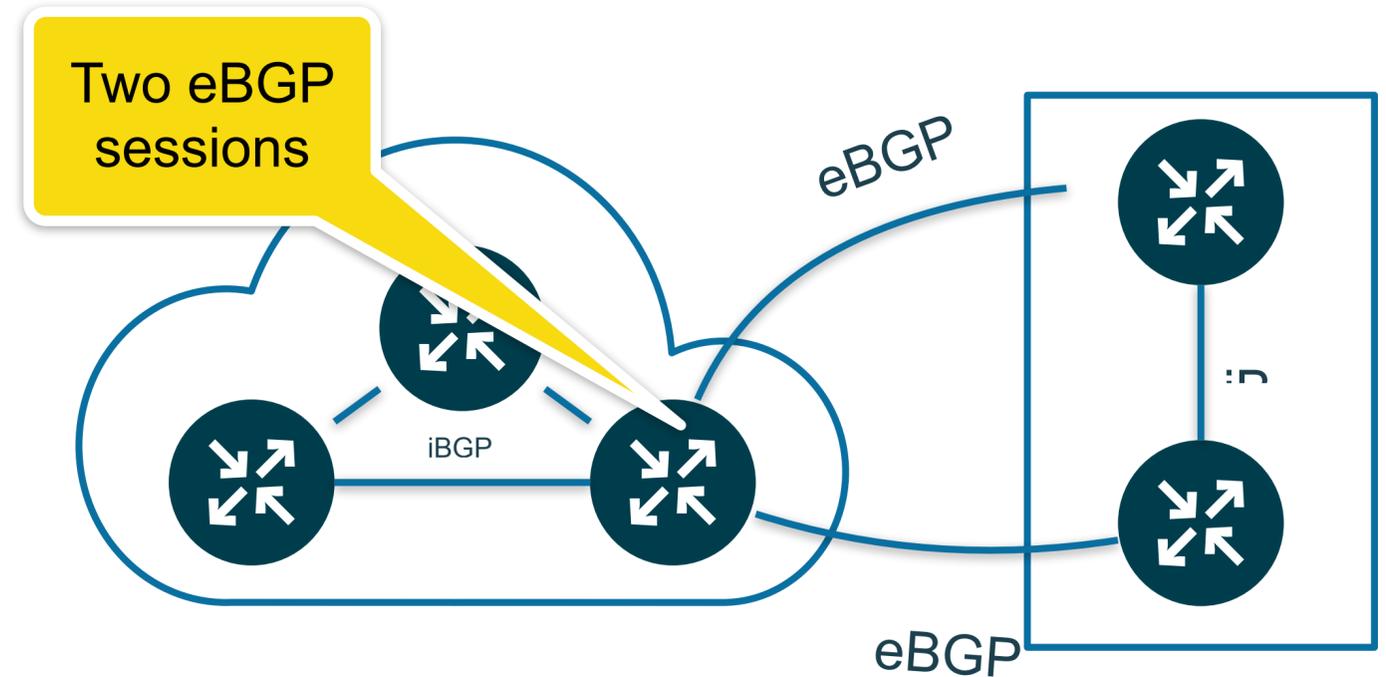
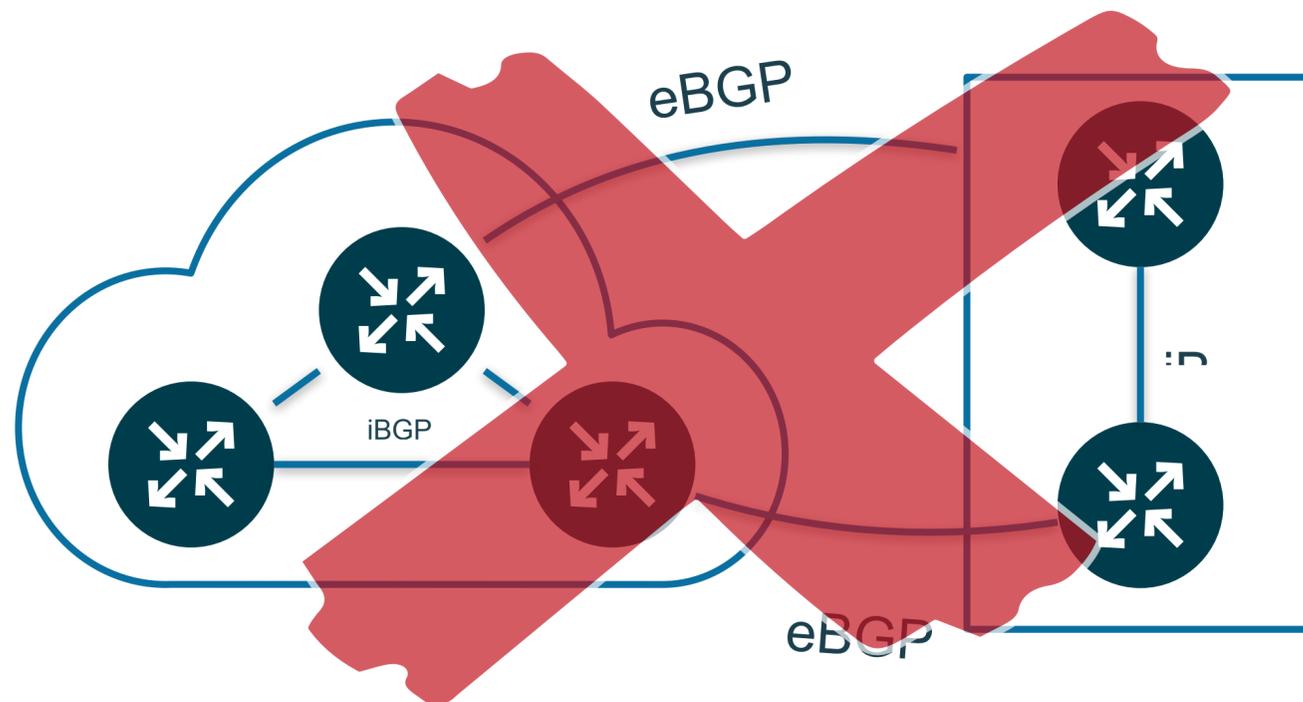


BGP Route Selection : Age / Stability

1	NextHop reachable?	Continue if "yes"
2	Local Preference	higher wins
3	AS Path Length	shorter wins
4	Origin Type	IGP over EGP over Incomplete
5	MED	lower wins
6	eBGP, iBGP	eBGP wins
7	Exit	nearest wins
8		
9		
10		

BGP Route Selection : Age / Stability

- Exact phrasing is (Cisco):
"When both paths are external, prefer the path that was received first"
- So this applies only if a router has two (or more) eBGP sessions
- Which happens quite often when connecting to Internet Exchanges



BGP Route Selection : Last Resort

1	NextHop reachable?	Continue if "yes"
2	Local Preference	higher wins
3	AS Path Length	shorter wins
4	Origin Type	IGP over EGP over Incomplete
5	MED	lower wins
6	eBGP, iBGP	eBGP wins
7	Exit	nearest wins
8	Age of route	older wins
9		
10		

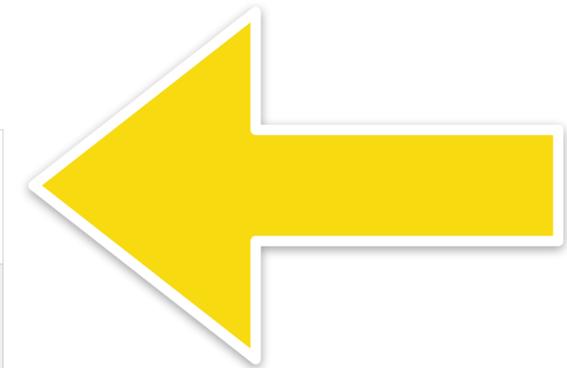
BGP Route Selection : Last Resort

- Router ID: lower wins
- Neighbor IP: lower wins
- Rules of last resort
- ...because at the end one and only one best path has to be selected
- Usually path selection stops before it gets to these two rules.



1	NextHop reachable?	Continue if "yes"
2	Local Preference	higher wins
3	AS Path Length	shorter wins
4	Origin Type	IGP over EGP over Incomplete
5	MED	lower wins
6	eBGP, iBGP	eBGP wins
7	Exit	nearest wins
8	Age of route	older wins
9	Router ID	lower wins
10	Neighbor IP	lower wins

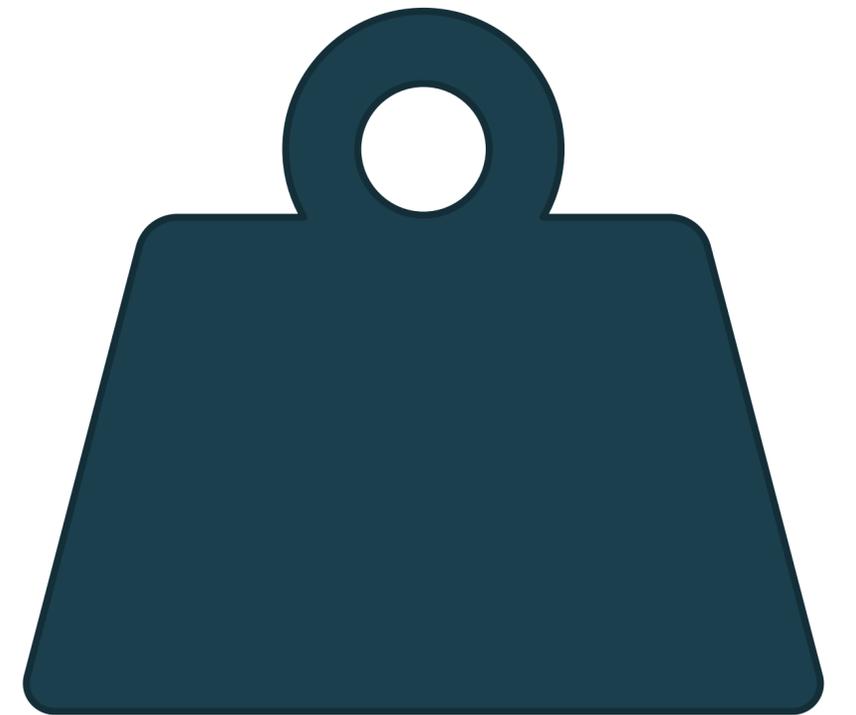
BGP Route Selection : Summary



1	NextHop reachable?	Continue if "yes"
2	Local Preference	higher wins
3	AS Path Length	shorter wins
4	Origin Type	IGP over EGP over Incomplete
5	MED	lower wins
6	eBGP, iBGP	eBGP wins
7	Exit	nearest wins
8	Age of route	older wins
9	Router ID	lower wins
10	Neighbor IP	lower wins

A word about....

"Weight"



DE CIX

"Weight"



- "Weight" is not a BGP attribute
- This is why it was not mentioned - I used to skip it completely
- But there are always questions about it
- So to be clear: **Do not use it**
- Weight overrides everything, even Local Preference
- It is only local to the router where it is applied
- *It is the best way to routing loops!*

Weight - higher wins

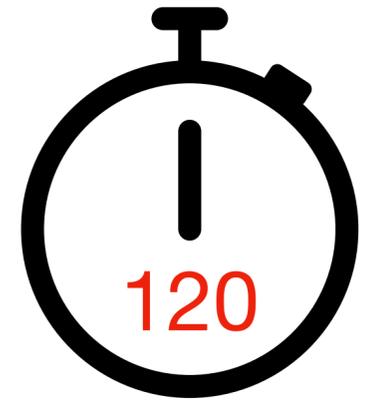
1	NextHop reachable?
2	Local Preference
3	AS Path Length
4	Origin Type
5	MED
6	eBGP, iBGP
7	Exit
8	Age of route

**Other versions of this
presentation**

BGP in 120 minutes

What we did today

- Length: 90-120 minutes
- Features:
 - me talking
 - you asking questions
- Covers:
 - The very basics of BGP
 - Up and including BGP best path selection / more depending on time



BGP 4-5 hour workshop

Not just the basics...

- Length: 4-5 hours, including at least one break
- Happened a number of times at workshop Sunday at DENOG
- Features:
 - Me talking
 - You asking questions
 - Limited number of **lab experiments** using FRRouting
- Covers:
 - The very basics of BGP
 - Up and including BGP best path selection
 - BGP Communities if time permits



BGP!



3.5 Day BGP Seminar

All and everything

- Length: 3.5 days, starting Monday noon, finishing Thursday late afternoon,
- Classroom seminar, max. 14 attendees
- Features:
 - Me talking
 - You asking questions
 - Extensive number of lab experiments using FRRouting
- Covers:
 - All of BGP
 - Including BGP Security, Traffic Engineering, Peering Relationships
 - Tools useful for BGP and peering



Managing BGP relationships

What is the RIPE database?

Documenting our resources

- A public resource database
- It documents:
 - AS numbers, their owners and their use
 - IP resources, their owners and their use
 - AS-sets, lists of ASes
- To access it, you can use the "whois" command

```
aut-num: AS196610
as-name: DECIX-Academy
descr: DE-CIX Academy Educational Network
org: ORG-DtGI1-RIPE
adinet6num: 2a02:c50::/32
as-set: AS-DECIX-HAM-RS-V6
descr: ASN of DE-CIX Hamburg customer
descr: DE-CIX Hamburg
admin-c: DXSU6695-RIPE
tech-c: DXSU6695-RIPE
mnt-by: DECIX-MNT
remarks: look at AS-DECIX-HAM for DE
remarks: look at AS-DECIX-HAM-CONNECTED
remarks: Visit http://ham.de-cix.net
members: AS42
members: AS112
members: AS250
members: AS680
members: AS1680
members: AS1820
```



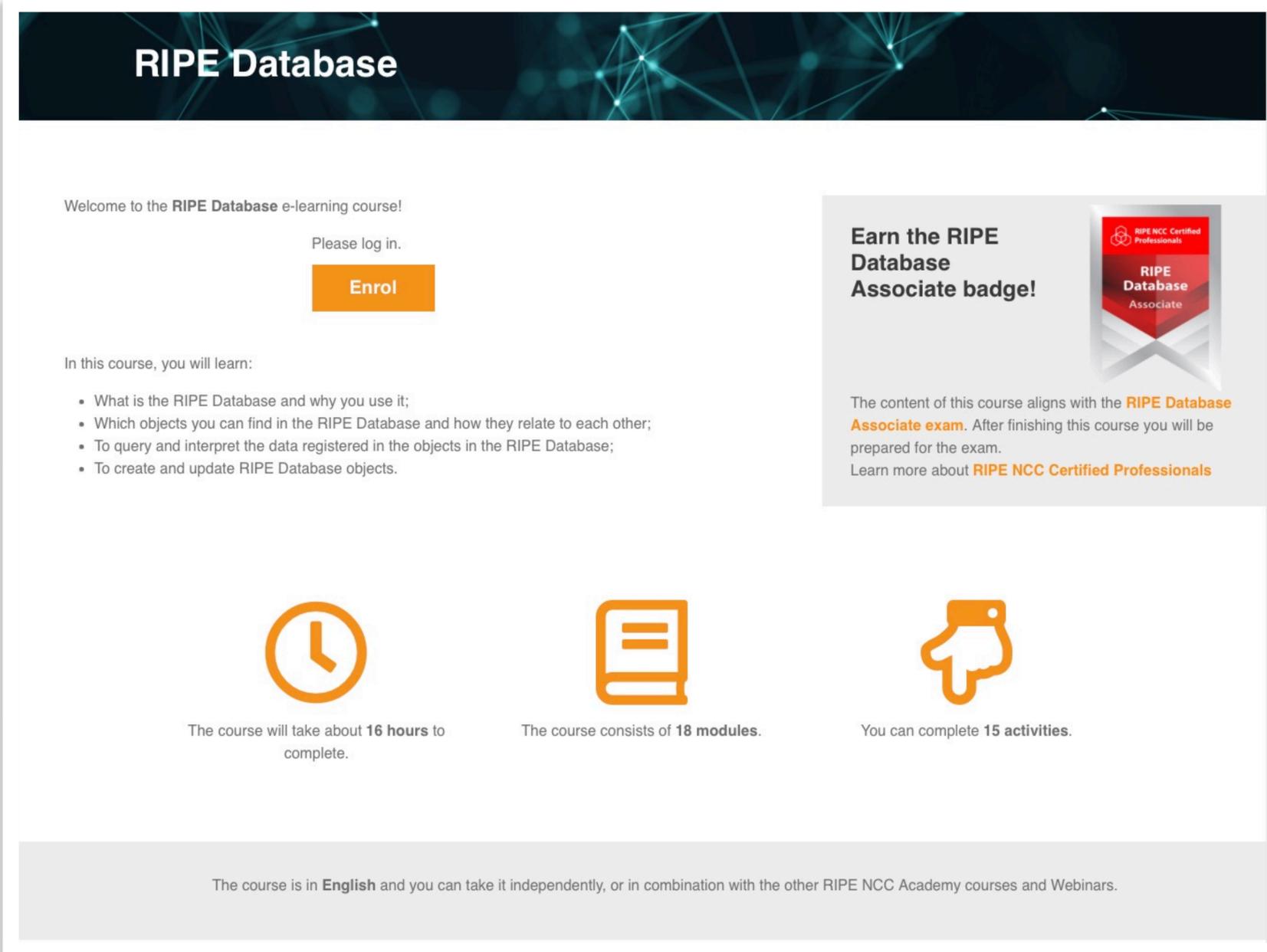
DECIX

Or go to the RIPE database [website](#)

More Information?

RIPE Database Training

- The training is free
- The training is online
- Just go the ripe.net website



The screenshot shows the enrollment page for the RIPE Database e-learning course. At the top, there is a dark blue header with the text "RIPE Database" and a network diagram. Below the header, the page is divided into several sections. On the left, there is a "Welcome to the RIPE Database e-learning course!" message, followed by a "Please log in." prompt and an orange "Enrol" button. In the center, there is a section titled "In this course, you will learn:" with a bulleted list of topics: "What is the RIPE Database and why you use it;", "Which objects you can find in the RIPE Database and how they relate to each other;", "To query and interpret the data registered in the objects in the RIPE Database;", and "To create and update RIPE Database objects." On the right, there is a box titled "Earn the RIPE Database Associate badge!" featuring a badge image and text stating: "The content of this course aligns with the RIPE Database Associate exam. After finishing this course you will be prepared for the exam. Learn more about RIPE NCC Certified Professionals". Below these sections, there are three icons with corresponding text: a clock icon for "The course will take about 16 hours to complete.", a book icon for "The course consists of 18 modules.", and a hand icon for "You can complete 15 activities." At the bottom, a grey footer contains the text: "The course is in English and you can take it independently, or in combination with the other RIPE NCC Academy courses and Webinars."

<https://academy.ripe.net/enrol/index.php?id=9>

The lazy Network Manager

How to keep record of your peers

Setting up BGP sessions

Standard procedure

- Contact your neighbor
- Exchange a few emails
- Configure BGP



Years later...

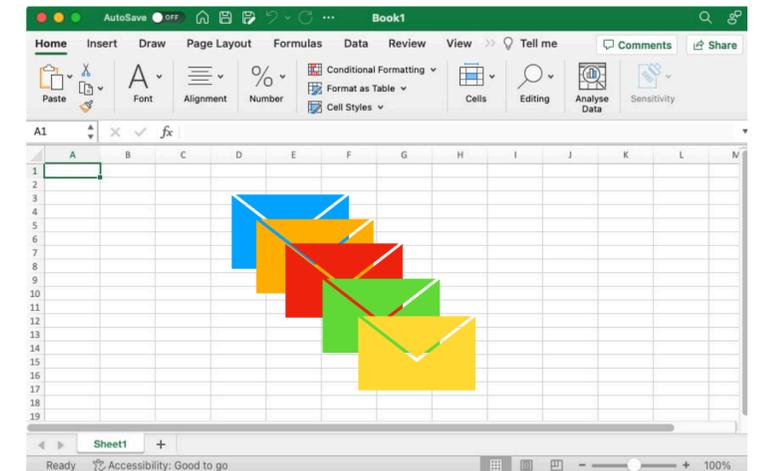


You need to contact your neighbor

But where did I put the contact information



- I might have my original emails somewhere
- Or I put the contact information into an Excel sheet
- Or I configured it as a comment on my router
- Or....



But then you notice...

But then you notice...

Surprise, surprise...

- The contact you emailed with works no longer there
- The company name of your peer has changed
- The email address you have (peering@...) is no longer valid
- What now?

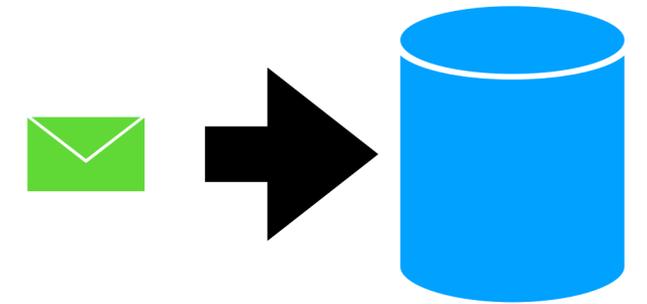


There is a solution

Why not have a common database?

For networks who peer...

- Put contact information into a central database
- Make it accessible for all networks who peer
- Everybody maintains their own information (hopefully)
- If you need some information, simply look it up



PeeringDB

A database for networks who peer

- Free for users
- Financed by sponsoring
- Some public information
- Contact data is private
- Check it out at <https://peeringdb.com>

The screenshot shows the PeeringDB website interface. At the top, there is a search bar and navigation links. The main content area displays the profile for 'DE-CIX Academy Educational Network', which is a Platinum Sponsor. The profile includes various details such as Organization, Also Known As, Long Name, Company Website, ASN, IRR as-set/route-set, Route Server URL, Looking Glass URL, Network Type, IPv4 Prefixes, IPv6 Prefixes, Traffic Levels, Traffic Ratios, Geographic Scope, Protocols Supported, Last Updated, Public Peering Info Updated, Peering Facility Info Updated, Contact Info Updated, Notes, RIR Status, and RIR Status Updated. The Notes section contains several bullet points regarding their peering policy. Below the profile, there are two tables: 'Public Peering Exchange Points' and 'Interconnection Facilities'. The 'Public Peering Exchange Points' table lists various exchange points with their respective IP addresses, ASNs, speeds, and RS Peer status. The 'Interconnection Facilities' table lists facilities with their Facility ID, ASN, Country, and City.

Exchange IPv4	ASN IPv6	Speed	RS Peer
DE-CIX Barcelona 185.1.119.100	196610 2001:7f8:10a:0:3:2:0:1	100M	<input checked="" type="checkbox"/>
DE-CIX Dusseldorf 185.1.170.105	196610 2001:7f8:9e:0:3:2:0:1	100M	<input checked="" type="checkbox"/>
DE-CIX Frankfurt 80.81.196.61	196610 2001:7f8::3:2:0:1	1G	<input checked="" type="checkbox"/>
DE-CIX Hamburg 185.1.210.11	196610 2001:7f8:3d:0:3:2:0:1	100M	<input checked="" type="checkbox"/>
DE-CIX Leipzig Δ 185.1.245.1	196610 2001:7f8:df:0:3:2:0:1	10G	<input checked="" type="checkbox"/>
DE-CIX Madrid 185.1.192.223	196610 2001:7f8:a0:0:3:2:0:1	100M	<input checked="" type="checkbox"/>
DE-CIX Munich 185.1.208.115	196610 2001:7f8:44:0:3:2:0:1	100M	<input checked="" type="checkbox"/>
DE-CIX New York 206.82.104.220	196610 2001:504:36:0:3:2:0:1	100M	<input checked="" type="checkbox"/>
MSK-IX Moscow 195.208.210.43	196610 2001:7f8:20:101::210:43	100M	<input checked="" type="checkbox"/>

Facility ID ASN	Country City
Datacenter Leipzig - envia TEL GmbH 196610	Germany Taucha
Digital Realty Frankfurt FRA1-16 196610	Germany Frankfurt



BGP Communities

BGP Communities

- A transitive, optional BGP attribute
 - **Transitive:** Once attached, it stays until removed
 - **Optional:** it does not have to be there
- "BGP Communities are like a sticker on a suitcase"



"Original" BGP Communities

→ Definition:

"A community is a group of destinations which share some common property"

→ Introduced in RFC1997 in year 1996

→ A community is expressed by a 32Bit-Number

→ High 16 bit are the AS defining the low 16 bits

→ Notation: "6695:1000", "5669:32000"

→ You can attach as many communities as you like (within reason)

→ BGP max message size is 4096 Bytes

What are they useful for? Information!

198.51.100.0/24

80.81.192.15

from 80.81.192.15

Path: 1301 286 517

Origin IGP, metric 0, localpref 100, valid, external



Frankfurt



Informational Communities

198.51.100.0/24

80.81.192.15

from 80.81.192.15

Path: 1301 286 517

Origin IGP, metric 0, localpref 100, valid, external

Received from: **Östingen**

Example: Encode geographical information

65010:1

Example: "1" here means geographical community

You may encode the continent here (if you are global) like:

- 1 = Europe
- 2 = North America
- 3 = Asia ...

ISO-Country-Codes here ...

250 - France

276 - Germany

840 - USA

Just an Example!

Example: Encode logical information

65010:2

Example: "2" here means logical source

Upstream? Peering? Customer?
1 = Upstream
2 = Private Peer
3 = Peer at an IXP
4 = Customer

More details here, like:

- Customer ID
- Upstream location
- up to you!

What are they useful for? Action!

198.51.100.0/24

Path: 65010

Origin IGP, metric 0, localpref 100, valid, external

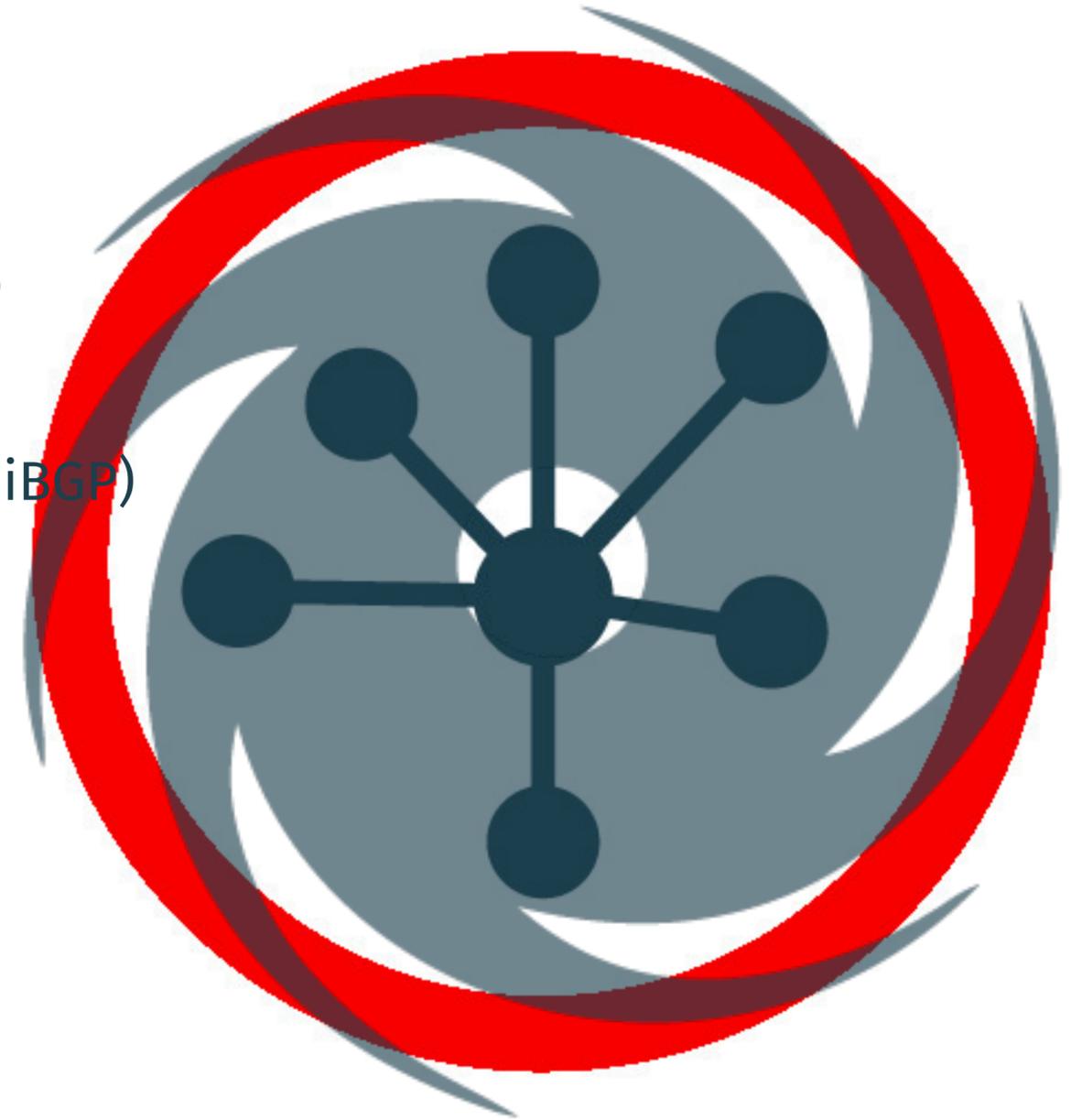
Encoding up to you!

Action Communities: Encoding

- Again - you only have two 16bit numbers ... (with original BGP Communities)
- Some Ideas ...
 - If you want your customers to send you "actions"
 - You really should have them put your AS number into the first 16bit number
 - You **must scrub** everything they should not send on incoming
 - Possible actions:
 - (not) announce to upstream, peers, customers
 - fine granular announcement control (geographically, by IXP, ...)
 - announce with longer AS path
 - change *local preference*
 - Blackhole

Action Communities: Well-Known

- A couple of communities are pre-defined by RFCs
- NO-EXPORT
 - Do not send the prefix to eBGP neighbours (other ASes)
- NO-ADVERTISE
 - Do not send the prefix to anyone (not even internal via iBGP)
- NO-PEER
 - Do not send to any peers
- BLACKHOLE
 - Sink all traffic to prefixes tagged with this community
 - Most commonly used with host routes
 - Implies NO-EXPORT

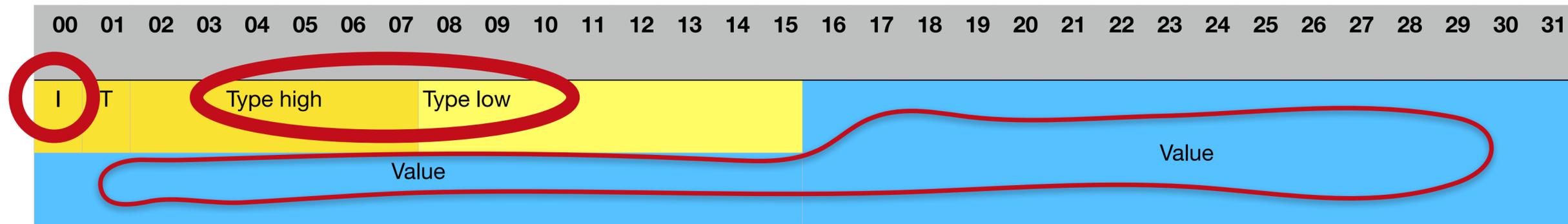


32Bit AS? No luck with original communities

65010:12345

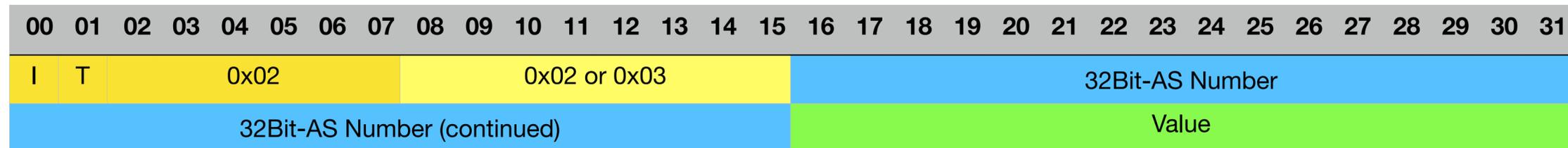
- Two 16-bit numbers
- No way to encode a 32Bit AS number and something else ...
 - [RFC4360](#) - Extended Communities
- Extended Communities - Lots of new features
 - In total 2*32Bits
 - Introducing a "type" field
 - Possible to encode 16Bit Type, 32Bit AS, 16Bit Data

Extended Communities



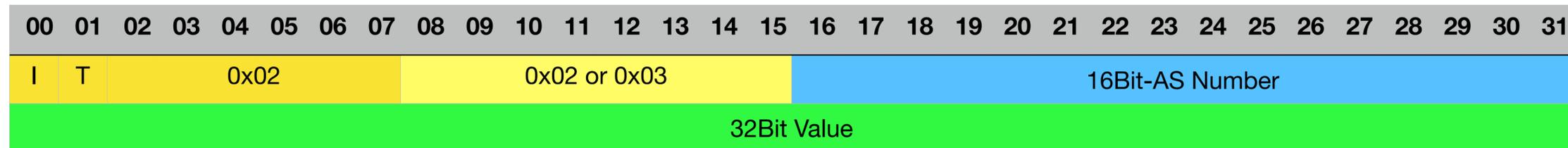
- **I** = Type is IANA assigned (= well known) or private
- **T = 0**: Transitive across AS borders
- **T = 1**: Non-Transitive - should be removed before forwarding to another AS
- **Type**: Types are either IANA-assigned or experimental. For a list of assigned types see the RFC
- **Value**: 48 Bits, meaning is dependent on type
- Standardized in 2006

Extended Communities and 32Bit ASes



- You can encode a 32Bit AS-Number
- and a 16 Bit value

Extended Communities and 32Bit ASes



- You can encode a 32Bit AS-Number
 - and a 16 Bit value
- or a 16Bit AS-Number
 - and a 32 Bit value
- 32Bit AS and 32Bit Value?
 - **not possible!**



Extended communities use cases

→ Notation:

- Similar to original communities: **RT:6500000:1234** or **RT:1234:6500000**

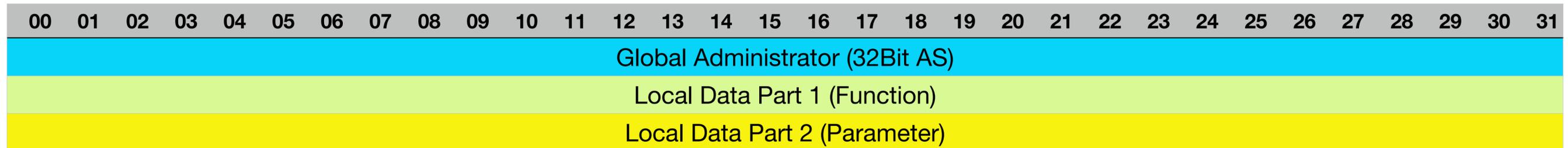
→ Disadvantages

- Only 48bits in total
- Only one 32Bit value is possible (and one 16Bit value)
- RT, RO and other types confusing to many operators

→ Conclusion

- Another community version was needed
- It took the IETF a while to realize that (11 years)

Introducing: Large Communities



→ Very simple - three 32Bit values (finally something useful)

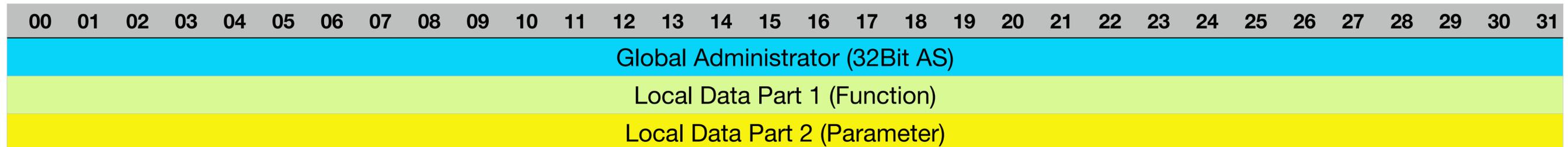
→ Global Administrator:

- An AS number (in 32Bit notation)
- Has defined meaning of two other fields
- May have published that meaning

→ Local Data

- Can be seen as "just two 32Bit numbers"
- Or as "Function" / "Parameter"

Large BGP Communities



→ Notation:

→ Similar to Original Communities: **196610:100:65000010**

→ Defined in two RFCs:

→ [RFC8092](#): BGP Large Communities Attribute

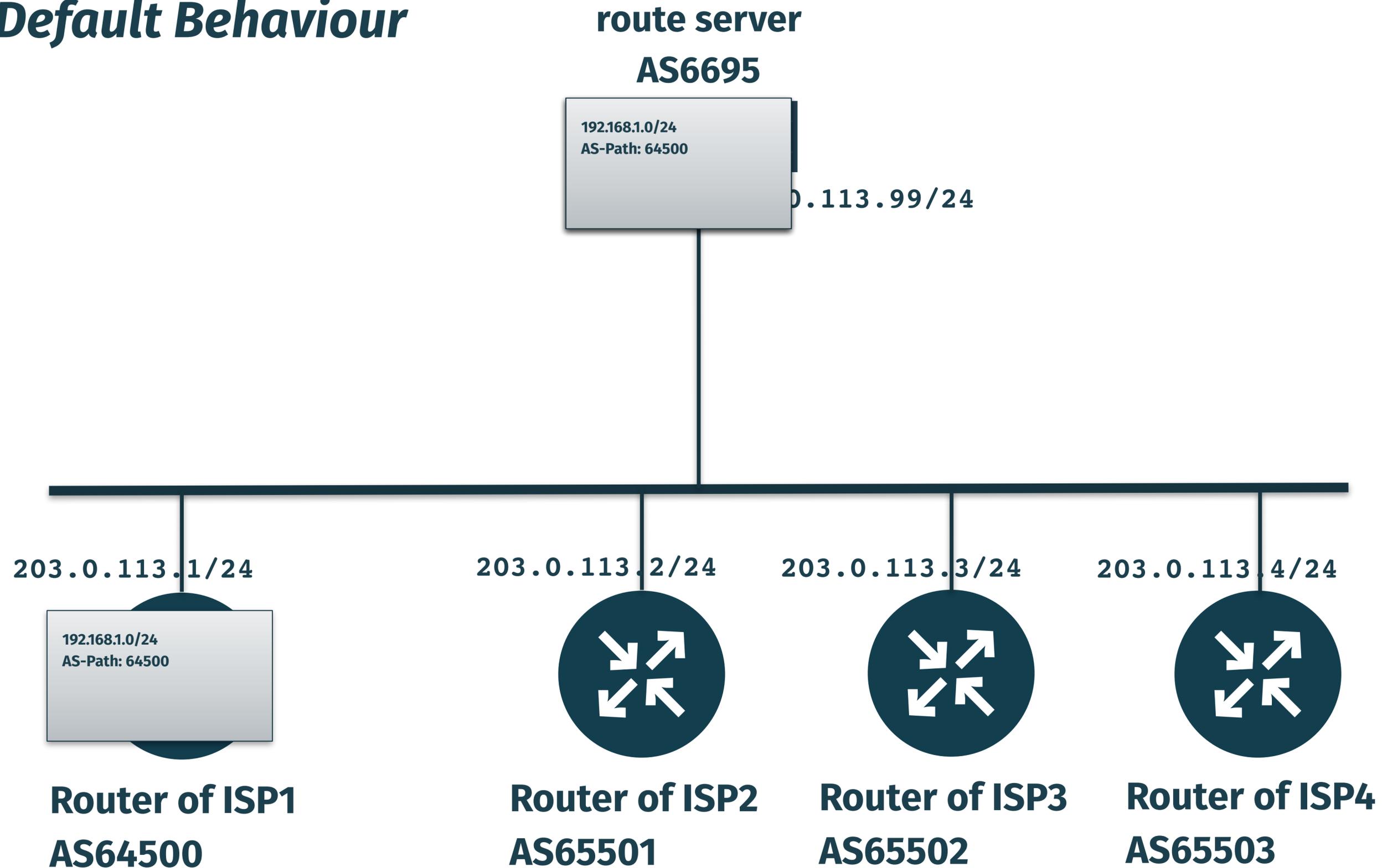
→ [RFC8195](#): Use of BGP Large Communities

→ A dedicated website exists: <http://largebgpcommunities.net>

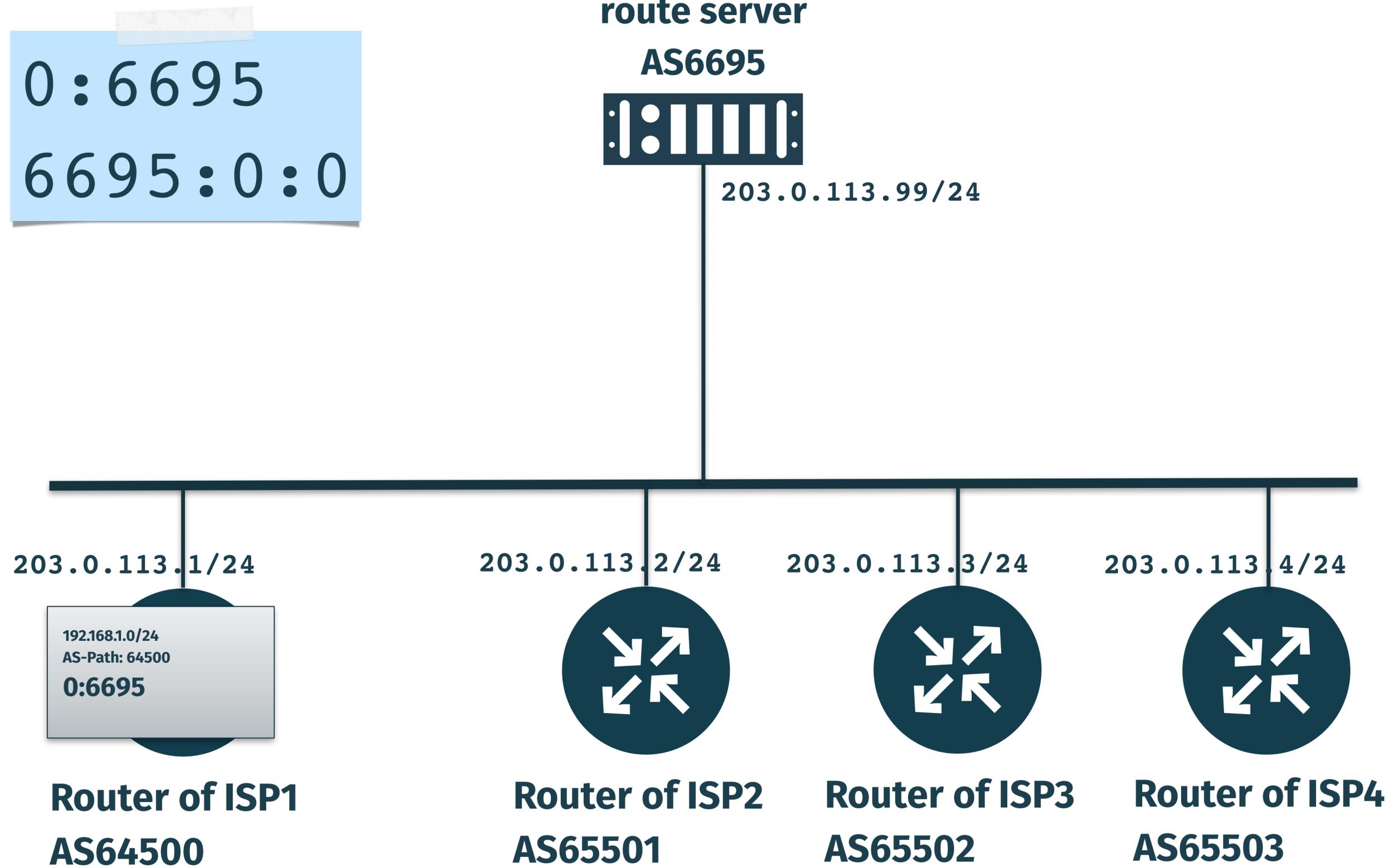
→ Keeping track of Implementations, News etc.

BGP Communities and the DE-CIX Route Servers

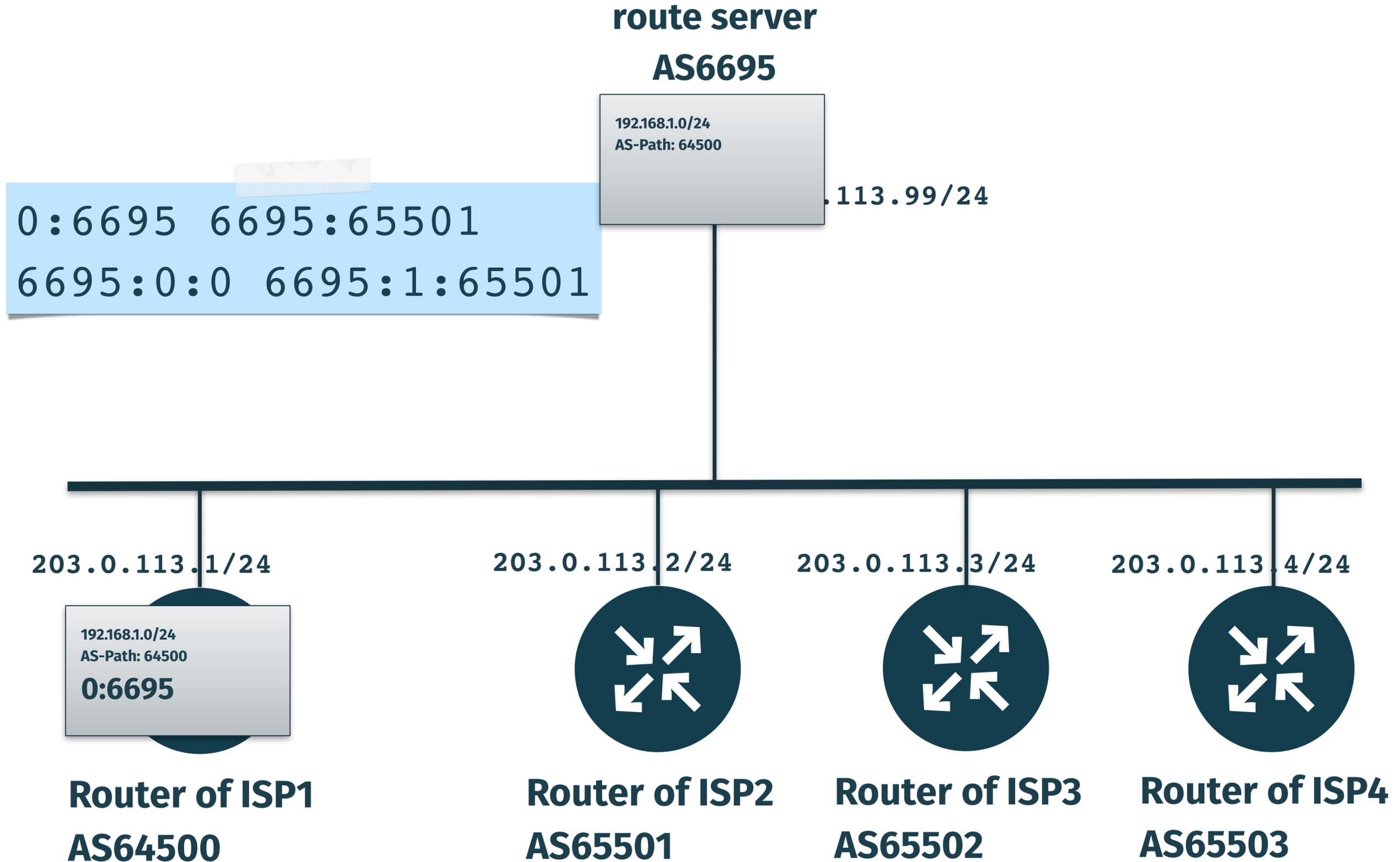
Default Behaviour



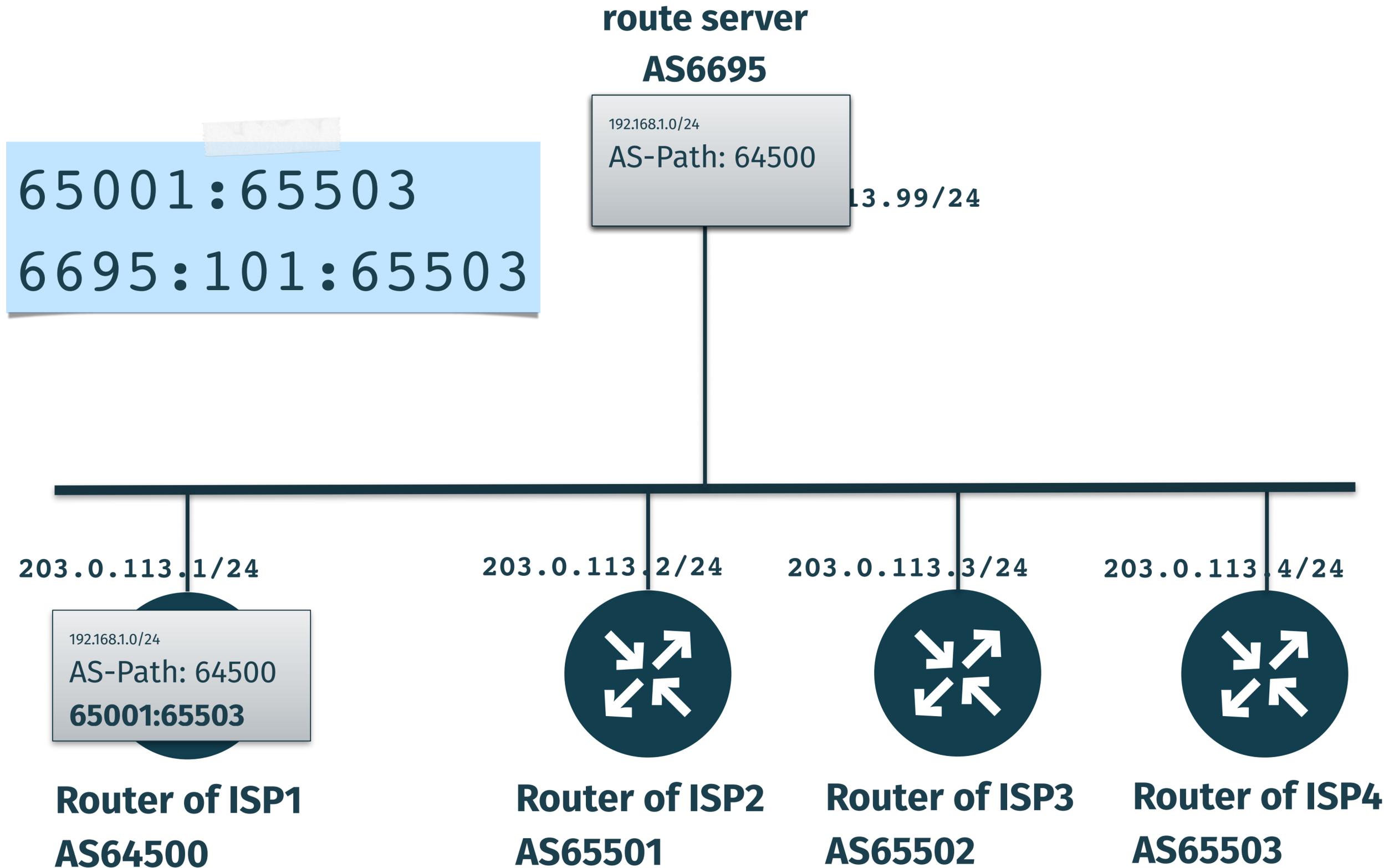
Do not announce to any AS



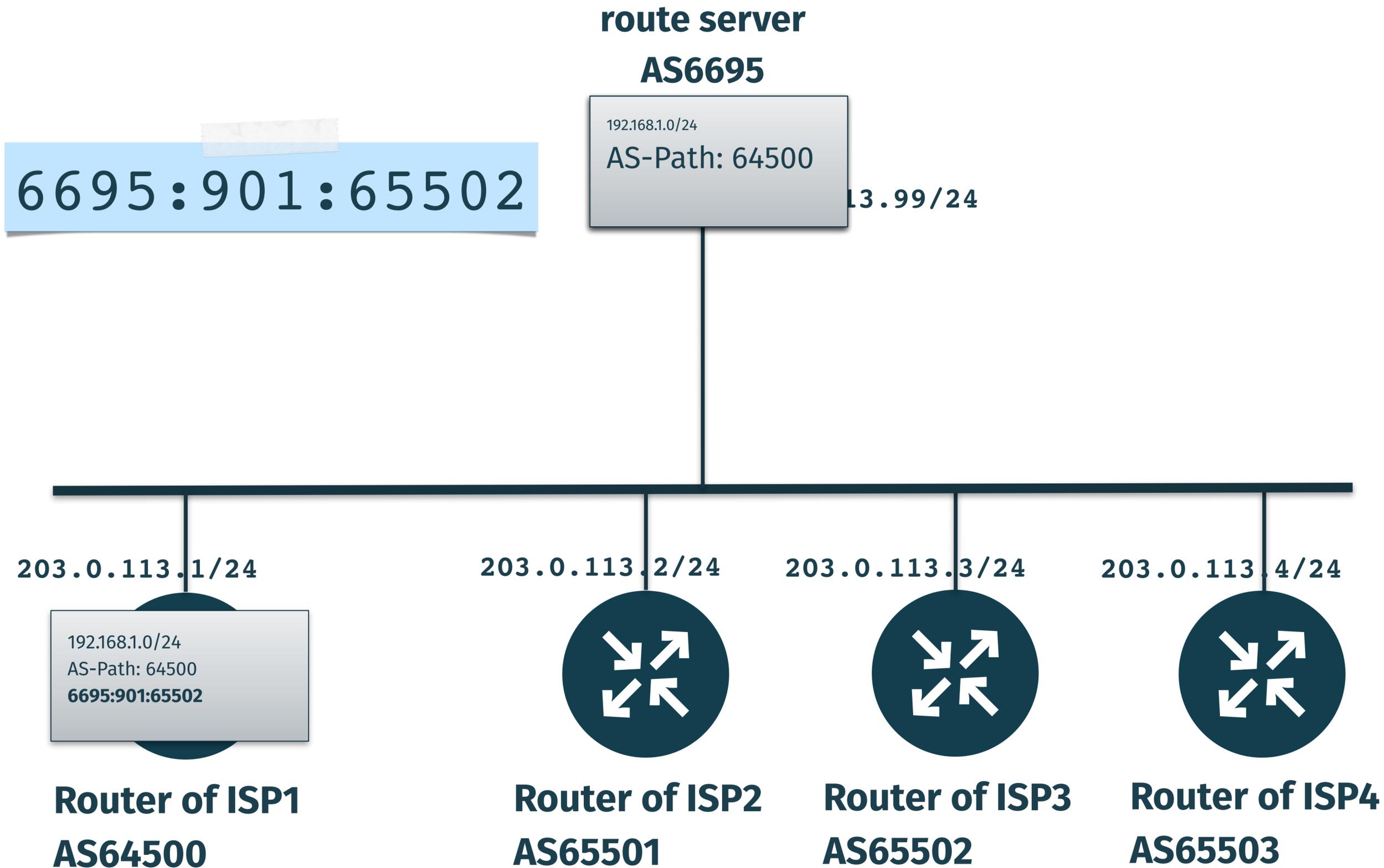
Do not announce to any AS, but announce to AS65501



Prepend 1 time to AS65503



Add NO-EXPORT to AS65502



Public tools for BGP

Public tools for BGP

RIPE Stat

- Operated by the RIPE NCC (same entity handing out AS numbers in this region)
- Details about prefixes, ASes and more
- just check it out at <https://stat.ripe.net>

The screenshot displays the RIPE Stat interface for AS196610. The search bar at the top contains '196610'. The main content area is divided into several panels:

- Abuse Contact:** abuse@cix.net
- AS Name:** AS196610, DECIX-ACADEMY -DE-CIX Management GmbH
- AS Prefix Count:** AS196610 has 1 IPv4 Prefixes and 1 IPv6 Prefixes. Covered by 1 IPv4 /24s Addresses and 0 IPv6 /32s Addresses.
- Maxmind Geo Map:** AS196610 is located in Germany.
- RIPE Atlas Targets:** Found 94 records for AS196610.
- RIS Visibility:** AS196610 has HIGH visibility. IPv4: 100%, IPv6: 100%.
- Allocation History:** Records were found in IANA, RIPE NCC.
- AS Neighbours:** Unique ASNs: 423. IPv4: 30 left, 331 right, 66 uncertain. IPv6: 25 left, 11 right, 65 uncertain.
- Announced Prefixes:** AS196610 has 2 prefixes.
- AS Path Length:** AS196610 has a median average path length of 3.23.
- IANA:** AS196608-AS197631 is delegated to RIPE NCC.
- RIPE Atlas Probes:** Found 1 records for AS196610.
- RIR Stats Country:** AS196610 is registered by organisation(s) located in Germany.
- RPKI History:** Query only available for larger timeframes.
- BGP Update Activity:** Found 327 items for AS196610. A bar chart shows announcements and withdrawals over time.
- RIPE Atlas Probe Deployment:** Query only available for larger timeframes.

A table at the bottom shows the RIRs that announce the AS:

RIR	IXP	Location	IPv4	IPv6
00	RIPE-NCC Multihop	Amsterdam	100%	100%
01	LINX / LONAP	London	100%	100%
03	AMS-IX / NL-IX	Amsterdam	100%	100%
04	CIXP	Geneva	100%	100%
05	VIX	Vienna	100%	100%
06	DIX-IE / JPX	Tokyo	100%	100%
07	Netnod	Stockholm	100%	100%
10	MIX	Milan	100%	100%
11	NTIX	New York City	100%	100%
12	DE-CIX	Frankfurt	100%	100%



Public tools for BGP

bgp.he.net

- Operated by Hurricane Electric (he.net)
- Free, but shows only HEs point of view
- just check it out at <https://bgp.he.net>



HURRICANE ELECTRIC INTERNET SERVICES AS196610 DE-CIX Management GmbH

Quick Links: [BGP Toolkit Home](#), [BGP Prefix Report](#), [BGP Peer Report](#), [Exchange Report](#), [Bogon Routes](#), [World Report](#), [Multi Origin Routes](#), [DNS Report](#), [Top Host Report](#), [Internet Statistics](#), [Looking Glass](#), [Network Tools App](#), [Free IPv6 Tunnel](#), [IPv6 Certification](#), [IPv6 Progress](#), [Going Native](#), [Contact Us](#)

AS Info | Graph v4 | Graph v6 | Prefixes v4 | Prefixes v6 | Peers v4 | Peers v6 | Whois | IRR | IX

Company Website: <http://www.de-cix.net/academy>

Country of Origin: Germany

Internet Exchanges: 9

Prefixes Originated (all): 2
Prefixes Originated (v4): 1
Prefixes Originated (v6): 1

Prefixes Announced (all): 9
Prefixes Announced (v4): 8
Prefixes Announced (v6): 1

RPKI Originated Valid (all): 2
RPKI Originated Valid (v4): 1
RPKI Originated Valid (v6): 1

RPKI Originated Invalid (all): 0
RPKI Originated Invalid (v4): 0
RPKI Originated Invalid (v6): 0

BGP Peers Observed (all): 435
BGP Peers Observed (v4): 419
BGP Peers Observed (v6): 112

IPs Originated (v4): 256
AS Paths Observed (v4): 68,731
AS Paths Observed (v6): 21,034

Average AS Path Length (all): 5.021
Average AS Path Length (v4): 5.206
Average AS Path Length (v6): 4.417

AS196610 IPv4 Peers

ASN	Name
AS51531	DE-CIX Management GmbH
AS13786	Seabras 1 USA, LLC
AS4230	CLARO S.A.

AS196610 IPv6 Peers

ASN	Name
AS6939	Hurricane Electric LLC
AS51531	DE-CIX Management GmbH

AS196610 IPv4 Peer Count | AS196610 IPv6 Peer Count

Public tools for BGP

BGP Alerter

- Open source tool running locally
- Using data from public datasets
 - like ris.ripe.net
- Get the source or a precompiled binary from <https://github.com/nttgin/BGPalerter>

```
Wolfgangs-MacBook-Pro-273:Downloads wtremmel$ ./bgpalerter-macos-x64
Loaded config: /Users/wtremmel/Downloads/config.yml
Impossible to load config.yml. A default configuration file has been generated.
BGPalerter, version: 1.32.0 environment: production
? The file prefixes.yml cannot be loaded. Do you want to auto-configure BGPalerter? Yes
? Which Autonomous System(s) you want to monitor? (comma-separated, e.g., 2914,3333) 196610
? Do you want to be notified when your AS is announcing a new prefix? Yes
? Do you want to be notified when a new upstream AS appears in a BGP path? Yes
? Do you want to be notified when a new downstream AS appears in a BGP path? Yes
Getting announced prefixes of AS196610
Total prefixes detected: 2
Generating monitoring rule for 2a02:c50:db8::/48
Generating monitoring rule for 91.214.253.0/24
Detected upstreams for 196610: 1239, 13786, 15704, 15830, 20485, 24889, 25091, 29075, 30781, 31133, 321
4, 34019, 34549, 34927, 35280, 35710, 37468, 39351, 41327, 4230, 43350, 43727, 4455, 47605, 47734, 4836
2, 49697, 50629, 51531, 6939, 8447, 8758, 8932, 8966, 9002
Detected downstreams for 196610: 10122, 10310, 10466, 11284, 11403, 12297, 12335, 12389, 12418, 12430,
12479, 12540, 12578, 12668, 12714, 12741, 13094, 13213, 13287, 13335, 13414, 13536, 136907, 137409, 137
86, 138915, 14061, 14537, 14593, 14928, 15133, 15599, 15672, 15682, 15699, 15704, 15754, 15757, 15930,
15954, 16164, 16552, 17378, 18001, 1820, 1828, 18966, 19318, 19551, 196709, 19689, 197204, 197267, 1975
18, 197826, 198367, 199226, 199290, 199434, 199524, 199599, 199610, 199952, 199976, 200030, 200350, 200
380, 200845, 201359, 201746, 201776, 202054, 202087, 202173, 202207, 202334, 202486, 20253, 202766, 202
813, 202829, 202844, 202984, 203099, 203724, 203936, 20473, 204773, 204805, 204861, 205022, 205627, 205
675, 205697, 20655, 206810, 20710, 20764, 207785, 207923, 209141, 20940, 209674, 209835, 210123, 210756
, 211157, 211227, 211826, 21719, 21859, 21949, 22356, 22418, 22697, 22742, 23393, 23470, 23764, 24429,
24482, 24663, 24768, 25292, 25532, 25549, 262589, 263444, 2635, 266925, 267613, 2683, 27257, 27611, 280
07, 28189, 2860, 28761, 28891, 28917, 2906, 29117, 29119, 29124, 29226, 29303, 29337, 29470, 29479, 296
32, 29802, 29838, 29852, 30081, 30833, 31214, 31500, 31514, 31769, 31950, 32035, 3218, 32217, 3223, 324
25, 3267, 32787, 32934, 3316, 3327, 33353, 33438, 33570, 34123, 34352, 34879, 35168, 35280, 35394, 3552
2, 35539, 35598, 35699, 36236, 36351, 36591, 36891, 37468, 38040, 39020, 39063, 39134, 39328, 39337, 39
386, 394102, 39684, 39691, 396986, 396998, 398465, 398930, 399100, 40545, 40676, 40805, 4134, 4136, 414
46, 41617, 41690, 41721, 41731, 41798, 42, 4230, 42325, 42473, 42511, 42518, 4258, 42632, 42649, 42947,
43160, 43298, 43727, 43832, 43996, 44020, 44128, 44391, 44670, 44814, 47321, 47541, 47542, 47569, 4776
4, 47775, 47787, 48084, 48249, 48287, 48293, 48348, 48366, 48524, 48719, 48739, 48846, 48848, 49403, 49
544, 49697, 49724, 49776, 49779, 49813, 50060, 50304, 50509, 50646, 50923, 51531, 51681, 51764, 51865,
52091, 52320, 52468, 53766, 53828, 53991, 54113, 5467, 54994, 5505, 5518, 55256, 55805, 55818, 56630, 5
6814, 56958, 57073, 57363, 57365, 57463, 57624, 57724, 57877, 57910, 57976, 58310, 59865, 60068, 60280,
60488, 60767, 6079, 60840, 60917, 61031, 61090, 61461, 61832, 62044, 62240, 62668, 62904, 63399, 63949
, 64049, 6507, 6774, 6789, 6866, 6939, 7195, 7713, 8002, 8242, 8301, 8331, 8359, 8400, 8629, 8764, 8966
, 9009, 9049, 9110, 9304, 9498
Generating generic monitoring rule for AS196610
Done!
Monitoring 91.214.253.0/24
Monitoring 2a02:c50:db8::/48
Monitoring AS196610
```



Public tools for BGP

ExaBGP

- Open source tool to "talk" BGP
- Use cases:
 - for testing or even in production
 - announce prefixes
 - with any attributes you want
- <https://github.com/Exa-Networks/exabgp>

```
ubuntu@bgplab:~/BGPLab/experiment-02$ exabgp exabgp.conf
14:04:55 | 1493 | welcome | Thank you for using ExaBGP
14:04:55 | 1493 | version | 4.2.17
14:04:55 | 1493 | interpreter | 3.10.6 (main, May 29 2023, 11:10:38) [GCC 11.3
14:04:55 | 1493 | os | Linux bgplab 5.15.0-76-generic #83-Ubuntu SMP
TC 2023 x86_64
14:04:55 | 1493 | installation |
14:04:55 | 1493 | cli control | named pipes for the cli are:
14:04:55 | 1493 | cli control | to send commands /run/exabgp.in
14:04:55 | 1493 | cli control | to read responses /run/exabgp.out
14:04:55 | 1493 | configuration | performing reload of exabgp 4.2.17
14:04:55 | 1493 | reactor | loaded new configuration successfully
```

Public tools for BGP

DE-CIX Academy BGP lab

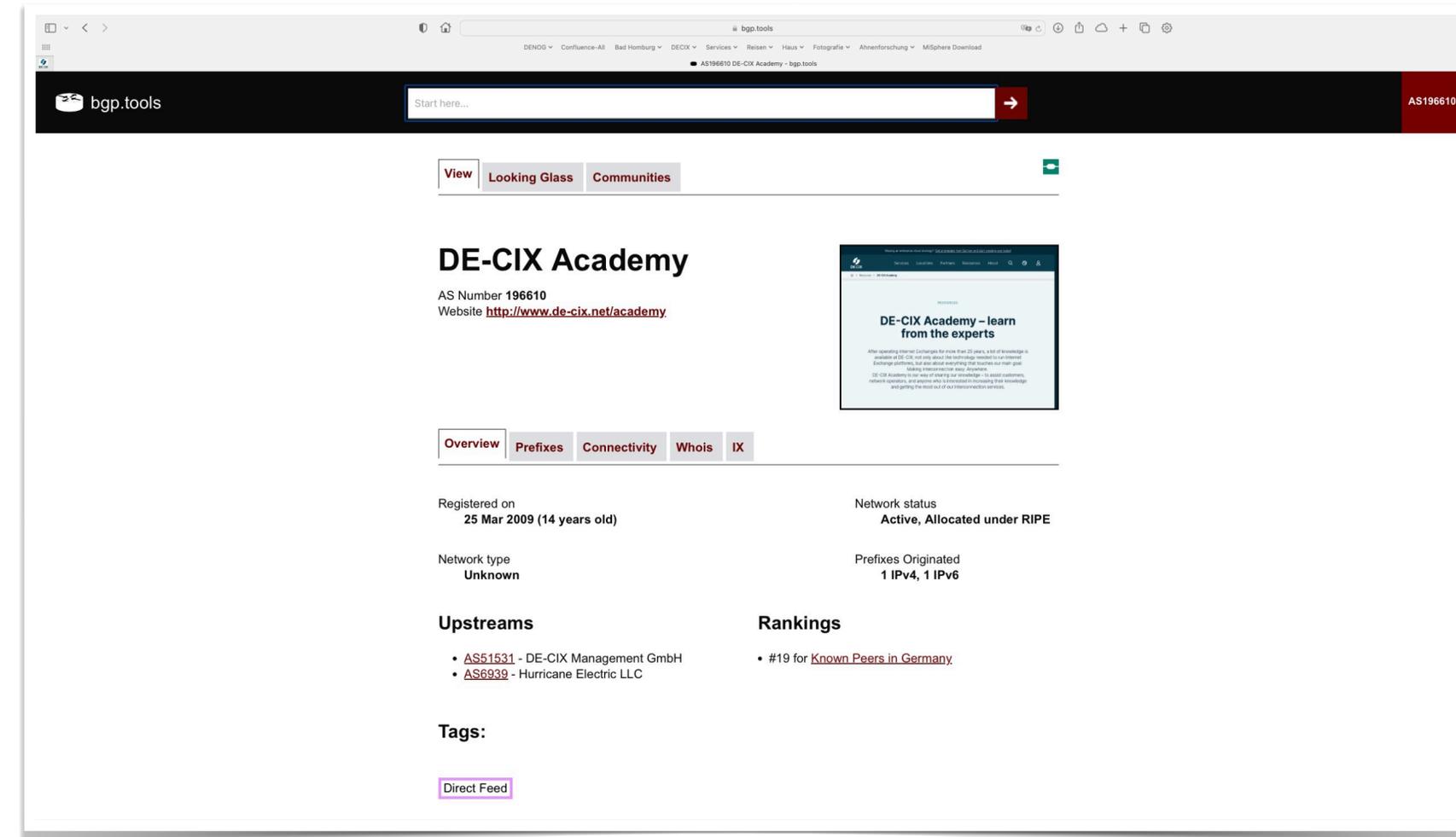
- For teaching a BGP seminar
- Based on [FRRouting](#)
- Runs (multiple) routers in Docker containers
- Just needs a linux server as host
- Get it at <https://gitlab.com/de-cix-public/team-academy/bgp/BGPLab>



Public tools for BGP

bgp.tools

- Private initiative
- Free, offer premium monitoring service for a fee
- just check it out at <https://bgp.tools>



The screenshot shows the bgp.tools website interface. At the top, there is a search bar with the text "Start here..." and a red arrow button. Below the search bar, there are navigation tabs: "View", "Looking Glass", and "Communities". The main content area displays information for "DE-CIX Academy", including its AS Number (196610) and website URL (http://www.de-cix.net/academy). There is a small thumbnail image of the academy's website. Below this, there are more navigation tabs: "Overview", "Prefixes", "Connectivity", "Whois", and "IX". The page is divided into several sections: "Registered on" (25 Mar 2009, 14 years old), "Network status" (Active, Allocated under RIPE), "Network type" (Unknown), "Prefixes Originated" (1 IPv4, 1 IPv6), "Upstreams" (AS51531 - DE-CIX Management GmbH, AS6939 - Hurricane Electric LLC), and "Rankings" (#19 for Known Peers in Germany). At the bottom, there is a "Tags:" section with a "Direct Feed" button.





DE CIX

<https://de-cix.net/academy>



Links and further reading

DE-CIX Academy Resources

Lab and documentation

- DE-CIX Academy BGP Lab: <https://gitlab.com/de-cix-public/team-academy/bgp/BGPLab>
- Book: "BGP for networks who peer"
<https://github.com/wtremmel/BGP-for-networks-who-peer>
- DE-CIX YouTube Channel: <https://www.youtube.com/@DE-CIX>

AS - Numbers

How to request an AS number

- Giving AS numbers to the RIRs: iana.org
- Requesting an AS number, links for:
 - [ARIN](#)
 - [Lacnic](#)
 - [APNIC](#)
 - [RIPE NCC](#)
 - [Afrinic](#)



BGP: Autonomous Systems

RFCs

- [RFC1930](#): Guidelines for creation, selection, and registration of an Autonomous System (AS)
- [RFC6793](#): BGP Support for Four-Octet Autonomous System (AS) Number Space

Routing

Relevant RFCs

- [RFC4632](#): Classless Inter-domain routing (CIDR)

IPv6

Relevant RFCs

- [RFC4291](#): IPv6 addressing architecture

BGP - Best Path Selection

RFCs and Implementations

- [RFC4271](#) - A Border Gateway Protocol 4 (BGP-4)
 - *Next Hop* is defined in Section [5.1.3](#)
 - *AS Path* is defined in Section [5.1.2](#)
 - *Local Preference*: Section [5.1.5](#)
 - *Origin*: Section [5.1.1](#)
 - *Multi Exit Discriminator (MED)*: Section [5.1.4](#)
 - see [9.1](#) for the BGP best path selection algorithm
- BGP Best Path Selection by vendor
 - [Cisco](#)
 - [Juniper](#)
 - [Mikrotik](#)
 - [Nokia](#)
 - [BIRD](#)
 - [FRRouting](#)

1	NextHop reachable?	Continue if "yes"
2	Local Preference	higher wins
3	AS Path	shorter wins
4	Origin Type	IGP over EGP over Incomplete
5	MED	lower wins
6	eBGP, iBGP	eBGP wins
7	Exit	nearest wins
8	Age of route	older wins
9	Router ID	lower wins
10	Neighbor IP	lower wins

BGP Attributes

Relevant RFCs

- BGP attribute types:
 - Registering new types: [RFC2042](#)
 - Published in [BGP Parameters](#) database at IANA

BGP Security

Relevant RFCs

- [RFC7454](#) - BGP Operations and Security
- Password protect BGP sessions
 - [RFC2385](#) (obsolete) - Protection of BGP Sessions via the TCP MD5 Signature Option
 - [RFC5925](#) - The TCP Authentication Option
- [RFC5082](#) - The Generalized TTL Security Mechanism (GTSM)

~~Relevant RFCs~~

Historical (obsolete)

- [RFC827](#): Exterior Gateway Architecture (EGP) (historical, obsolete)
-