

IPv6: RESOLVENDO UM

PROBLEMA





Please make IP version 6 part of your studies. Understanding IPv6 is going to be a major boost to your career and your future. Notice that I didn't say "might be a major boost".

-Chris Bryant, CCNA Success

SOBRE MIM

Gabriel Cruz



- Ganesh Redes (2019)
- Redes de computadores (2018/1)
- Redes Móveis (2019/2)
- Admin. e Gerenc. de Redes (2019/2)



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ORGANIZAÇÃO DO CURSO



CRONOGRAMA

- x Hello IPv6 World
- x Lendo e escrevendo IPv6
- x Endereços Unicast
- x Multicasting
- x Um endereço para chamar de nosso
- x Resumo

CRONOGRAMA

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- x Resumo

1. Perguntas Comuns
2. Contos da criação do IPv6
3. Umhas outras letrinhas aí

PERGUNTAS FREQUENTES

IPv6: RESOLVENDO
QUAL PROBLEMA?

QUANTOS ENDEREÇOS
A MAIS O IPV6 TEM?

QUANTO USADO É O
IPV6 HOJE?

SE EU FOR PRA CHINA,
MEU IPV6 MUDA?

IPV6 É MAIS SEGURO
QUE IPV4?

IPV6 É MENOS SEGURO
QUE IPV4?

IPV6 VAI ACABAR
COM IPV4?

ONDE DIABOS FOI
PARAR O IPV5?

КАНОТ?

UM POUCO DE
HISTÓRIA E
CULTURA DA
INTERNET

1979

IAB

1979

INTERNET ARCHITECTURE BOARD

SÓ 11 MALUCOS!

1979

I NTERNET A RCHITECTURE B OARD

SÓ 11 MALUCOS!

... HOJE SÃO 13

1986

IAB



IETF

1986

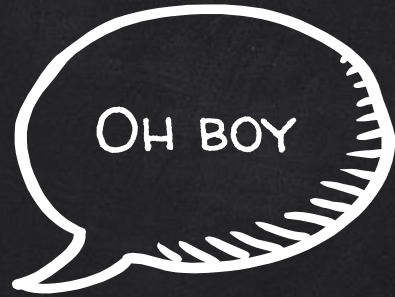
IAB



INTERNET ENGINEERING

TASK FORCE

1990



IAB



IETF

UMA ANTIGA RICA

IETF

ISO

X

UMA ANTIGA RICHÁ

IETF

X

INTERNATIONAL

ORGANIZATION FOR

STANDARDIZATION

UMA ANTIGA RICHÁ

IETF



TCP/IP

X

ISO



OSI

1992

BORA USAR O TEU,
MAS NÃO CONTA PRA
IETF

IAB

Ok... MUAHAHA

ISO

1992



IETF

IAB

ISO

1994

O CONFRONTO FINAL

I NTERNET E NGINEERING S TEERING G ROUP

CATNIP SIPP TUBA

1994

É O VENCEDOR É...

1994

E O VENCEDOR É...

SIPP

1994

E O VENCEDOR É...

SIMPLE INTERNET PROTOCOL PLUS

1995

IPv6

RFC 1883

OUTRAS
LETRINHAS

INTRODUÇÃO AO LAB (CORE)

CRONOGRAMA

- x Hello IPv6 World
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1. Manja hexadecimal?
2. Notações: preferred e compressed
3. Anatomia de um endereço IPv6
4. Localhost (loopback), unspecified, 6to4, NAT64

CECI N'EST PAS UN IPV6

- ✗ 2804 : 431 : CFFA : 3995 : 396D : 37AF : D784 : 1331 /64
- ✗ ::1 /128
- ✗ FE80 :: CD2F : 48C1 : A2E3 : B2CE /64
- ✗ 2804 : 431 : CFFA : 3995 : 6D65 : C11 : 9F93 : A0E8 /64

MANJA HEXADECIMAL?

0, 1, 2, 3, 4, 5, 6, 7, 8, 9...

10 == A

11 == B

12 == C

13 == D

14 == E

15 == F

EXERCÍCIOS

EXERCÍCIO: TRANSFORME DE
HEXADECIMAL PARA BINÁRIO

- X FFx
- X 1Ax
- X 10x
- X 5x
- X A3x

EXERCÍCIO: TRANSFORME PARA
HEXADECIMAL

- X 1110B
- X 1011B
- X 10110011B
- X 33DEC
- X 101001B
- X 56DEC

CODIFICANDO BITS EM HEX

- X QUANTOS VALORES UM CARACTER HEXADECIMAL PODE ASSUMIR?
- X QUANTOS VALORES UM CARACTER BINÁRIO PODE ASSUMIR?
- X QUANTOS CARACTERES BINÁRIOS PODEMOS CODIFICAR USANDO UM ÚNICO CARACTER HEXADECIMAL?
- X QUANTOS CARACTERES HEX PRECISAMOS PARA CODIFICAR UM BYTE?

CODIFICANDO BITS EM HEX

1111 1110 0000 0100 : 0101 1001 0001 0000

F E 0 8 : 5 9 1 0

NOTAÇÕES: PREFERRED

2001 : 0DB8 : 0002 : 0100 : ABCD : 0000 : 0000 : 1234

NADA NOVO AQUI

NOTAÇÕES: REMOVENDO ZEROS À ESQUERDA

2001 : 0DB8 : 0002 : 0100 : ABCD : 0000 : 0000 : 1234

NOTAÇÕES: REMOVENDO ZEROS À ESQUERDA

2001 : 0DB8 : 0002 : 0100 : ABCD : 0000 : 0000 : 1234



2001 : DB8 : 2 : 100 : ABCD : 0 : 0 : 1234

NOTAÇÕES: REMOVENDO HEXTETOS DE ZEROS

2001 : 0DB8 : 0002 : 0100 : ABCD : 0000 : 0000 : 1234

NOTAÇÕES: REMOVENDO HEXTETOS DE ZEROS

2001 : 0DB8 : 0002 : 0100 : ABCD : 0000 : 0000 : 1234



2001 : 0DB8 : 0002 : 0100 : ABCD :: 1234



DOIS PONTINHOS

EXERCÍCIOS

EXERCÍCIO: TRANSFORME OS ENDEREÇOS IPV6 PARA A FORMA MAIS COMPACTA (REMOVA ZEROS À ESQUERDA E HEXTETOS NULOS)

x FE80 : 0000 : 0000 : 0000 : A299 : 9BFF : FE18 : 50D1

x 0000 : 0000 : 0000 : 0000 : 0000 : 0000 : 0000 : 0000

x 2001 : 0DB8 : 1111 : 000A : 00B0 : 0000 : 0200

x FF02 : 0000 : 0000 : 0A00 : 0000 : 0000 : 0000 : 0001

x 2001 : 0DB8 : 0000 : 0000 : 00B0 : 0000 : 0000 : 0100

ANATOMIA DE UM ENDEREÇO IPV6

2001 : DB8 :: ABCD : 0 : 0 : 1234 /48

ANATOMIA DE UM ENDEREÇO IPV6

2001 : 0DB8 : 0000 : 0000 : ABCD : 0000 : 0000 : 1234 /48

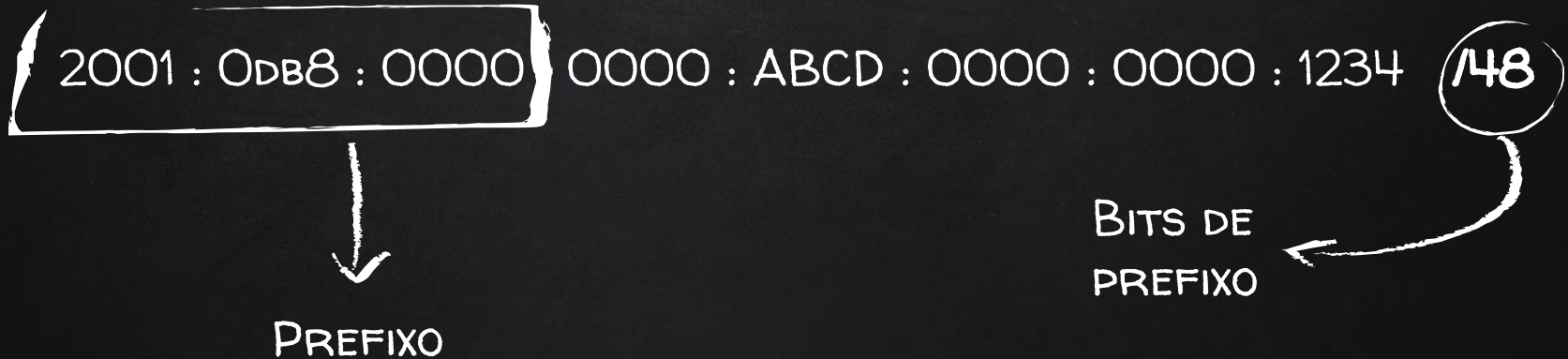
ANATOMIA DE UM ENDEREÇO IPV6

2001 : 0DB8 : 0000 : 0000 : ABCD : 0000 : 0000 : 1234 /48

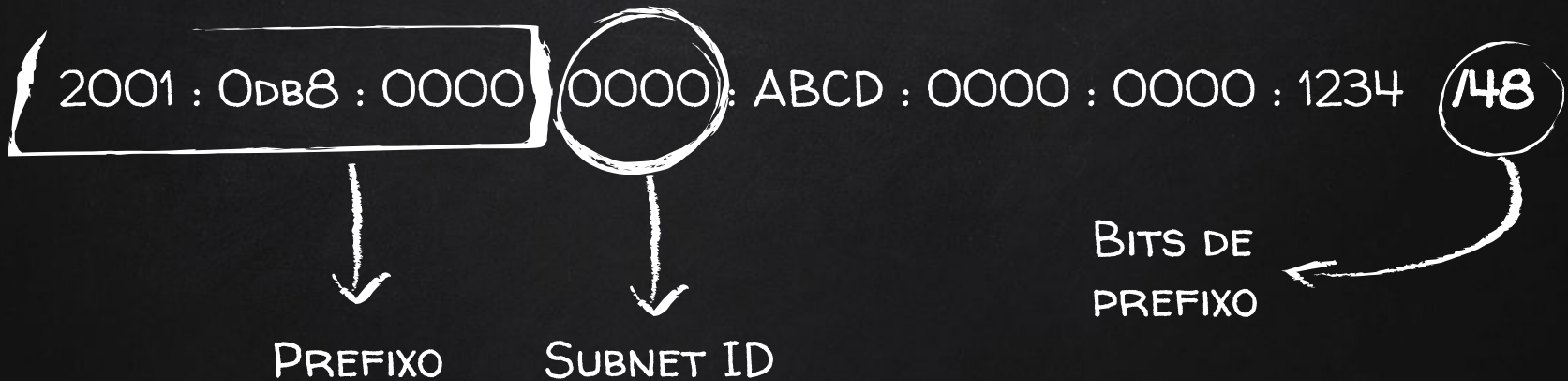


INTERFACE ID

ANATOMIA DE UM ENDEREÇO IPV6



ANATOMIA DE UM ENDEREÇO IPV6



EXERCÍCIOS

EXERCÍCIO: PARA CADA UM DOS ENDEREÇOS IPV6 ABAIXO, IDENTIFIQUE O PREFIXO, SUBNET ID E INTERFACE ID

- x FE80 : 0000 : 0000 : 0000 : A299 : 9BFF : FE18 : 50D1 / 64
- x 0000 : 0000 : 0000 : 0000 : 0000 : 0000 : 0000 : 0000 / 128
- x 2001 : 0DB8 : 1111 : 000A : 00B0 : 0000 : 0200 / 48
- x 2001 : 0DB8 : AAAA : 0001 : 0000 : 0000 : 0000 : 0100 / 32
- x FF02 : 0000 : 0000 : 0000 : 0000 : 0000 : 0000 : 0001 / 80

ENDEREÇOS ESTRANHOS

UNSPECIFIED	::128
LOOPBACK	::1/128
6TO4 (TUNNEL)	2002::/16
NAT64	64:FF9B::/96

LAB1-PING

UNSPECIFIED

::/128

LOOPBACK

::1/128

6TO4 (TUNNEL)

2002::/16

NAT64

64:FF9B::/96

CRONOGRAMA

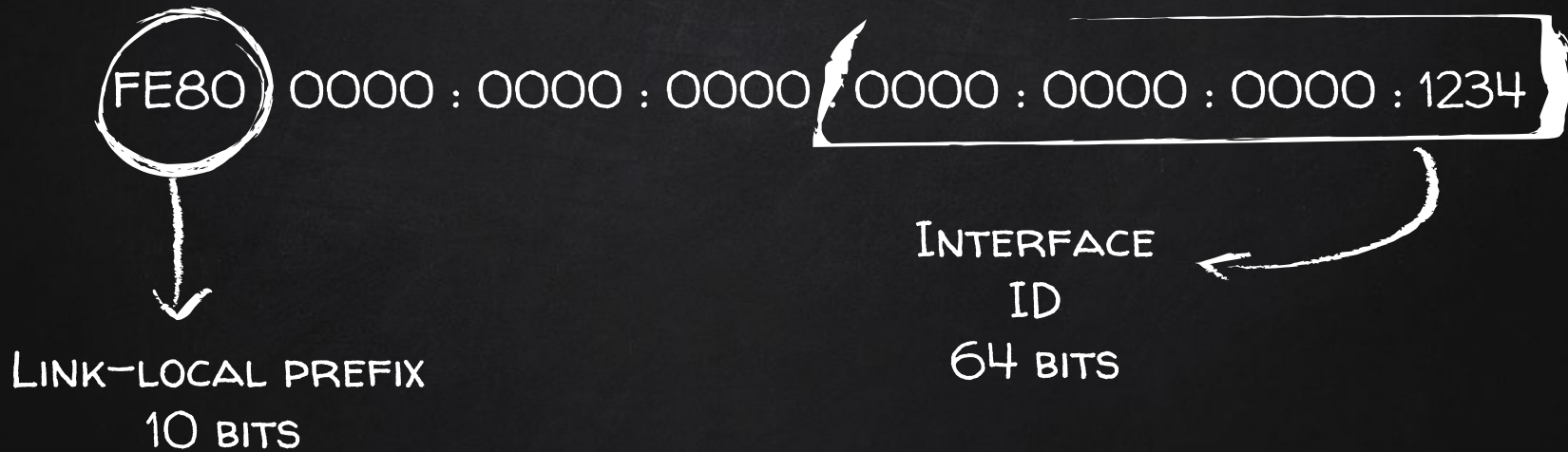
- x Hello IPv6 World
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- x Resumo

- 
1. Link-local Unicast Address
 2. Global Unicast Address

LINK-LOCAL UNICAST ADDRESS

- ✗ TODO DISPOSITIVO “IPV6-ENABLED” DEVE SER CAPAZ DE AUTOGERAR UM LINK-LOCAL UNICAST ADDRESS
- ✗ LINK-LOCAL UNICAST ADDRESSES NÃO SÃO ROTEÁVEIS
- ✗ THERE CAN BE ONLY ONE! (... LINK-LOCAL ADDRESS POR INTERFACE)
- ✗ PREFIXO FE80::/10
- ✗ LINK-LOCAL ADDRESSES SÃO OBRIGATÓRIOS (GLOBAL NÃO)

LINK-LOCAL UNICAST ADDRESS



LINK-LOCAL UNICAST ADDRESS

54 BITS (??)



LINK-LOCAL PREFIX
10 BITS

INTERFACE
ID
64 BITS

GERANDO O INTERFACE ID

- x SLAAC: STATELESS ADDRESS AUTOCONFIGURATION
 - o EUI-64
 - o RANDOM

FE80 : 0000 : 0000 : 0000 : 0000 : 0000 : 0000 : 1234

INTERFACE
ID
64 BITS



GERANDO O INTERFACE ID

x SLAAC: STATELESS ADDRESS AUTOCONFIGURATION

- o EUI-64
 - o RANDOM
- MAC + FFFE + FLIP U/L BIT

FE80 : 0000 : 0000 : 0000 : 0000 : 0000 : 0000 : 1234

INTERFACE
ID
64 BITS

GLOBAL UNICAST ADDRESS (GUA)

- ✗ NÃO É PRECISO TER UM GUA (BASTA O LINK-LOCAL)
- ✗ EQUIVALENTE AO PÚBLICO NO IPV4
- ✗ THERE CAN BE ONLY ONE! (.. NO MUNDO TODO)
- ✗ PREFIXO 2000::/3
- ✗ FORMATO: [001 + GLOBAL ROUTING PREFIX + SUBNET ID + INTERFACE ID]

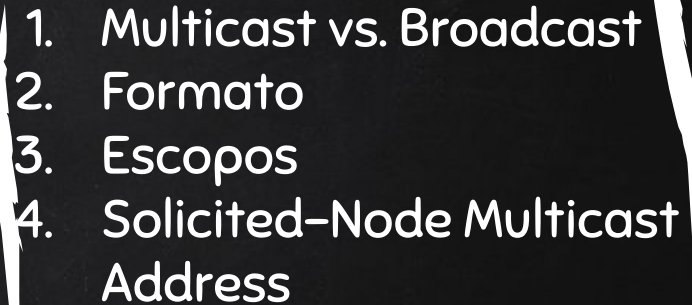
PRÁTICA: NOSSO SITE ROTEÁVEL

UNSPECIFIED

::/128

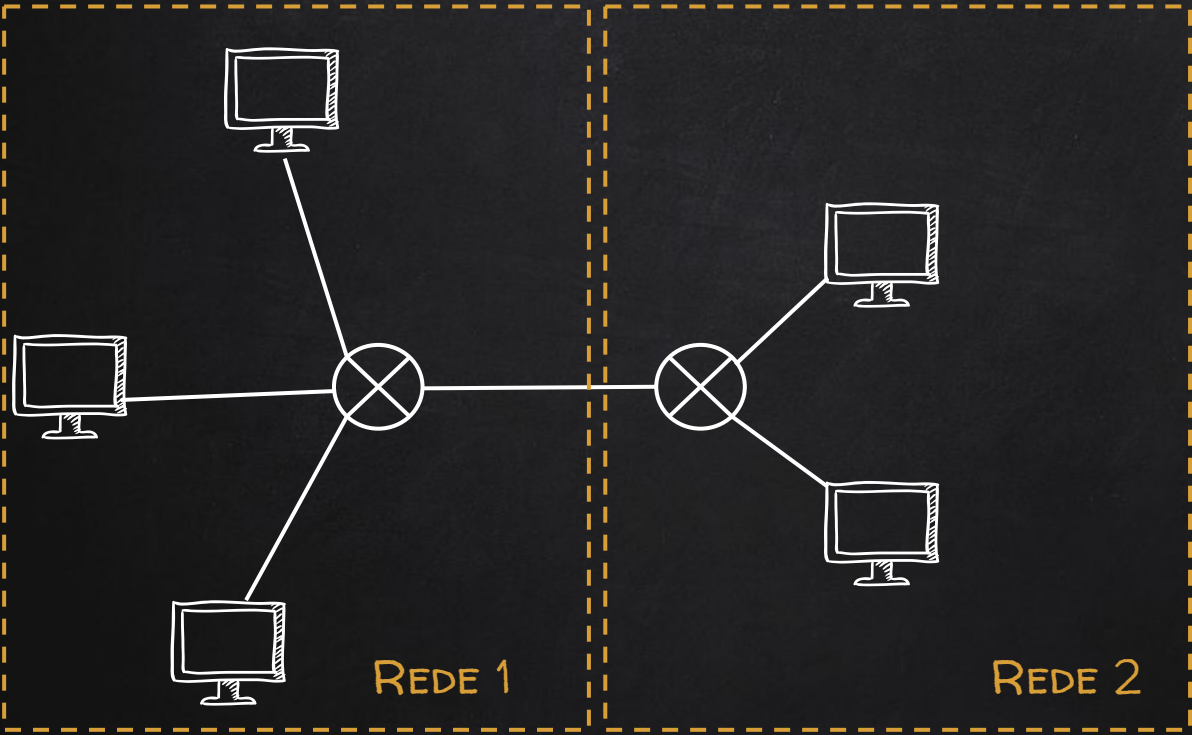
CRONOGRAMA

- x Hello IPv6 World
- x Lendo e escrevendo IPv6
- x Endereços Unicast
- x Multicasting
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- x Resumo

- 
1. Multicast vs. Broadcast
 2. Formato
 3. Escopos
 4. Solicited-Node Multicast Address

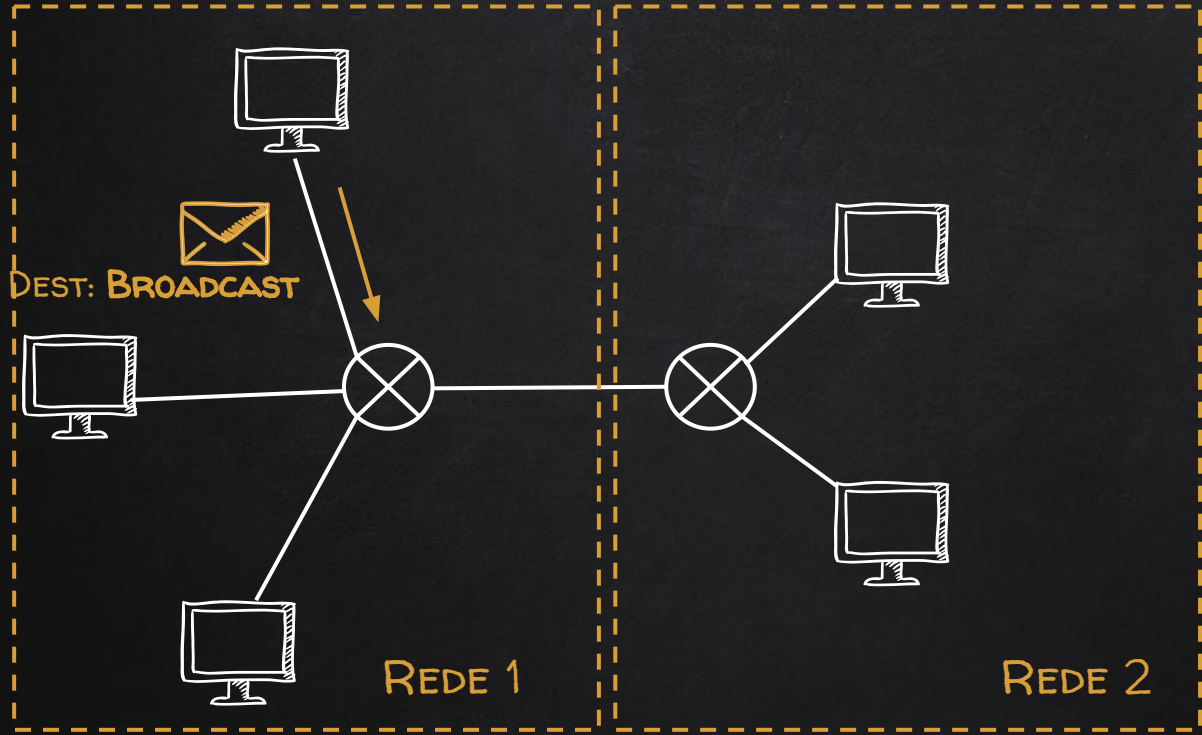
MULTICAST VS. BROADCAST

MULTICAST VS. BROADCAST



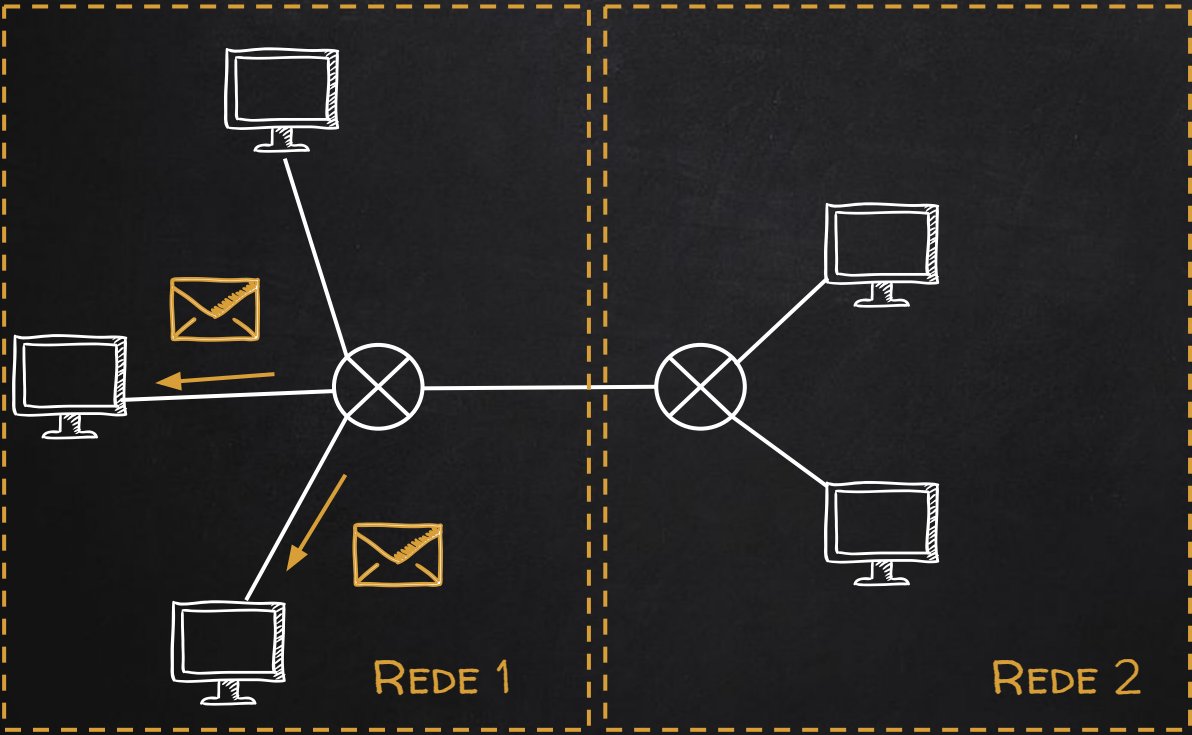
BROADCASTING

MULTICAST VS. BROADCAST



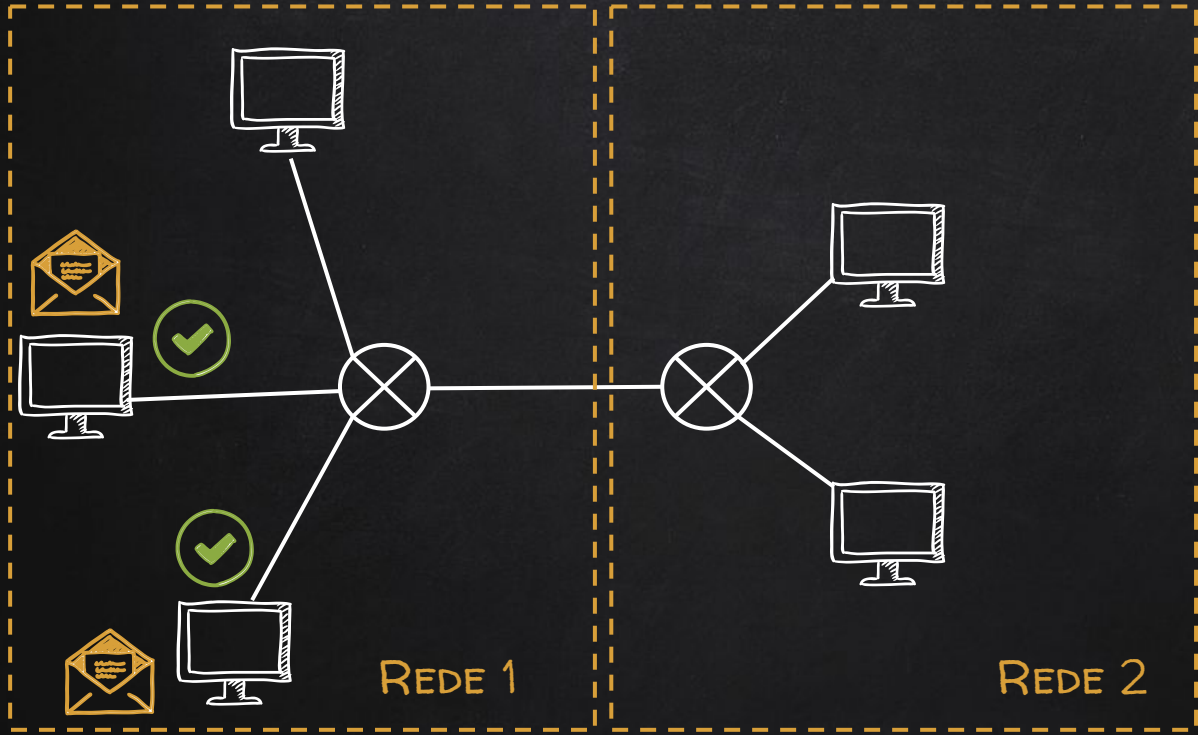
BROADCASTING

MULTICAST VS. BROADCAST



BROADCASTING

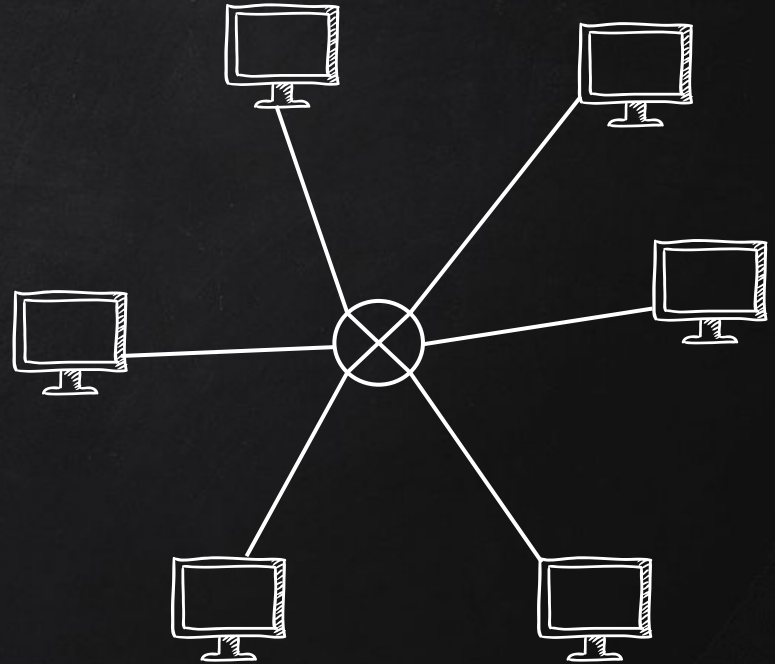
MULTICAST VS. BROADCAST



BROADCASTING

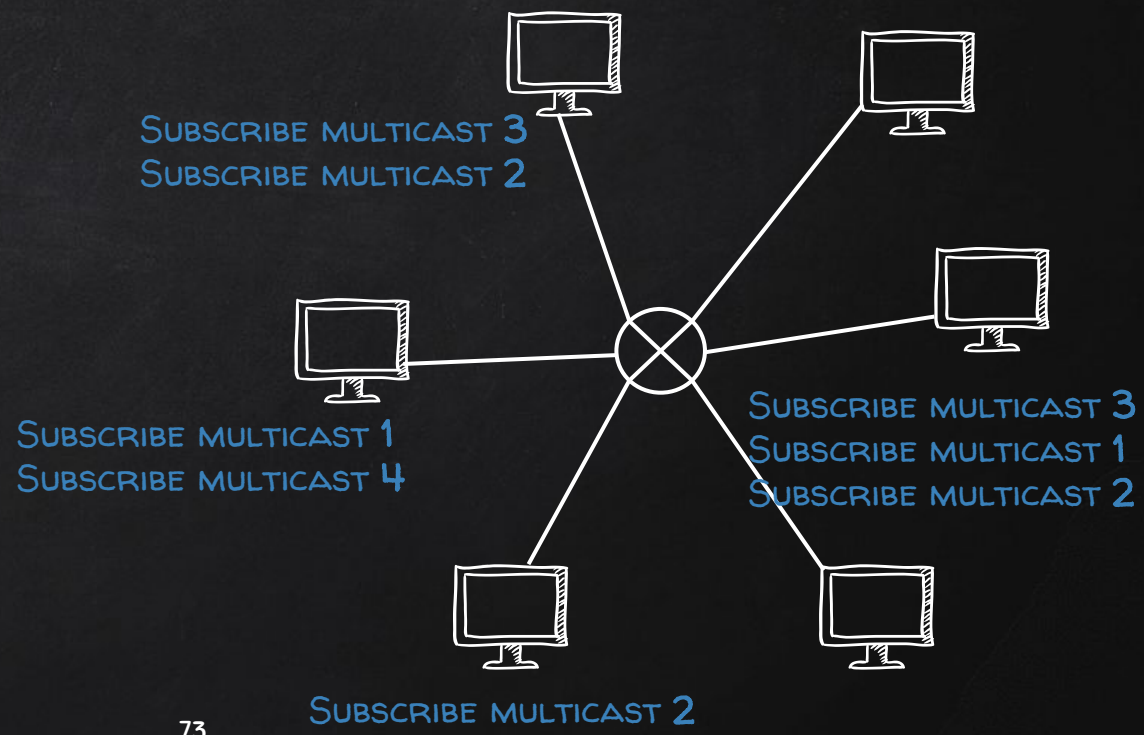
MULTICAST VS. BROADCAST

MULTICASTING



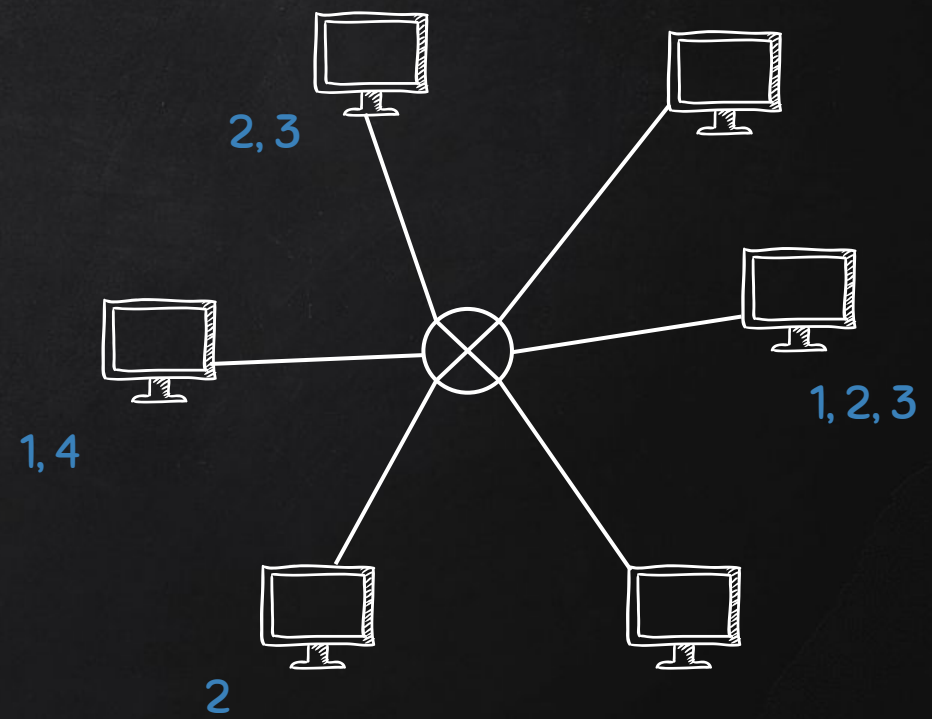
MULTICAST VS. BROADCAST

MULTICASTING



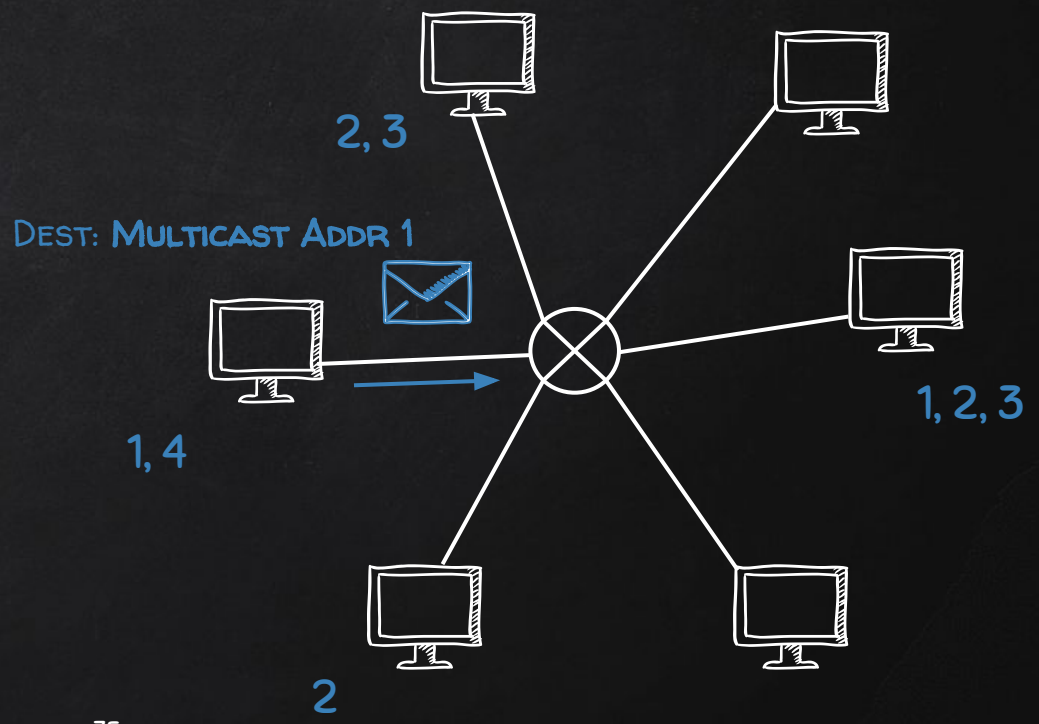
MULTICAST VS. BROADCAST

MULTICASTING



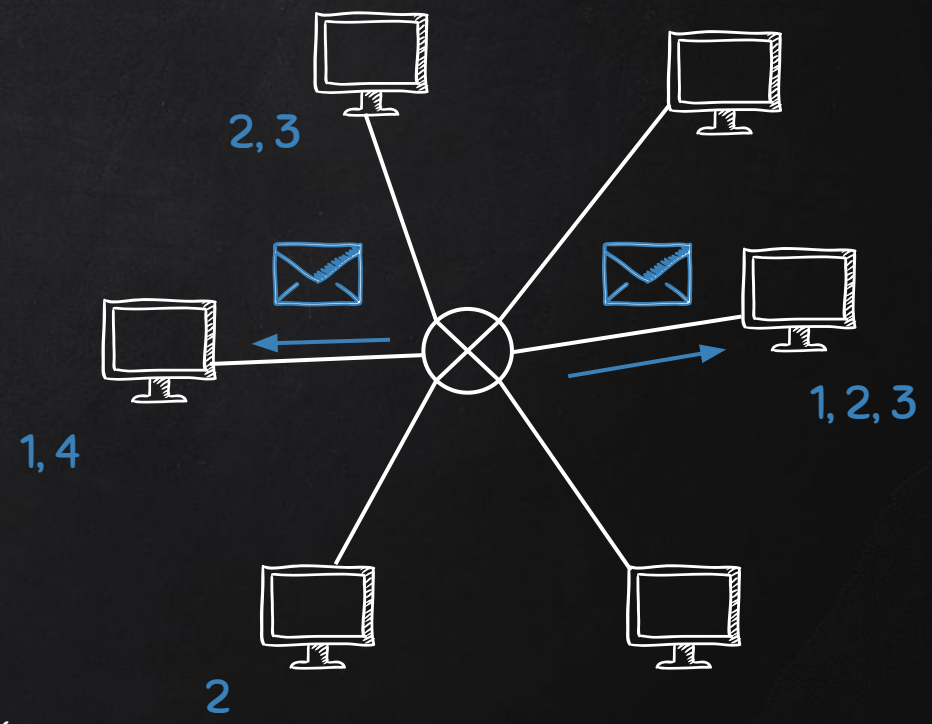
MULTICAST VS. BROADCAST

MULTICASTING



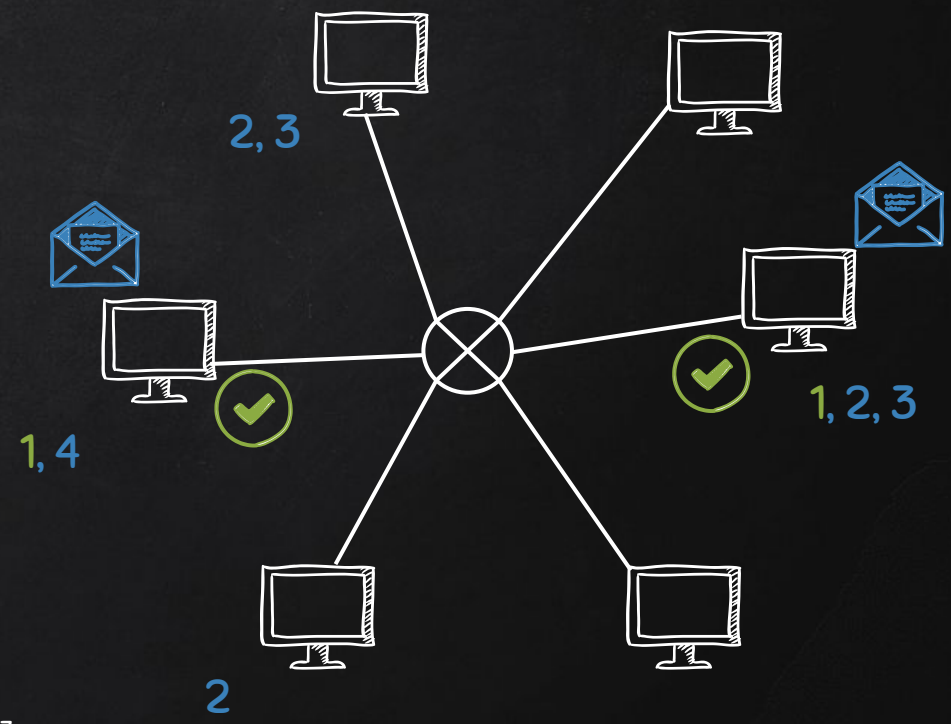
MULTICAST VS. BROADCAST

MULTICASTING



MULTICAST VS. BROADCAST

MULTICASTING



NÃO TEM BROADCASTING NO IPV6

IPv6 MULTICAST ADDRESS

IPv6 MULTICAST ADDRESS

FF00::/8

IPv6 MULTICAST ADDRESS

FF00::/8



8 BITS

IPv6 MULTICAST ADDRESS



IPv6 MULTICAST ADDRESS



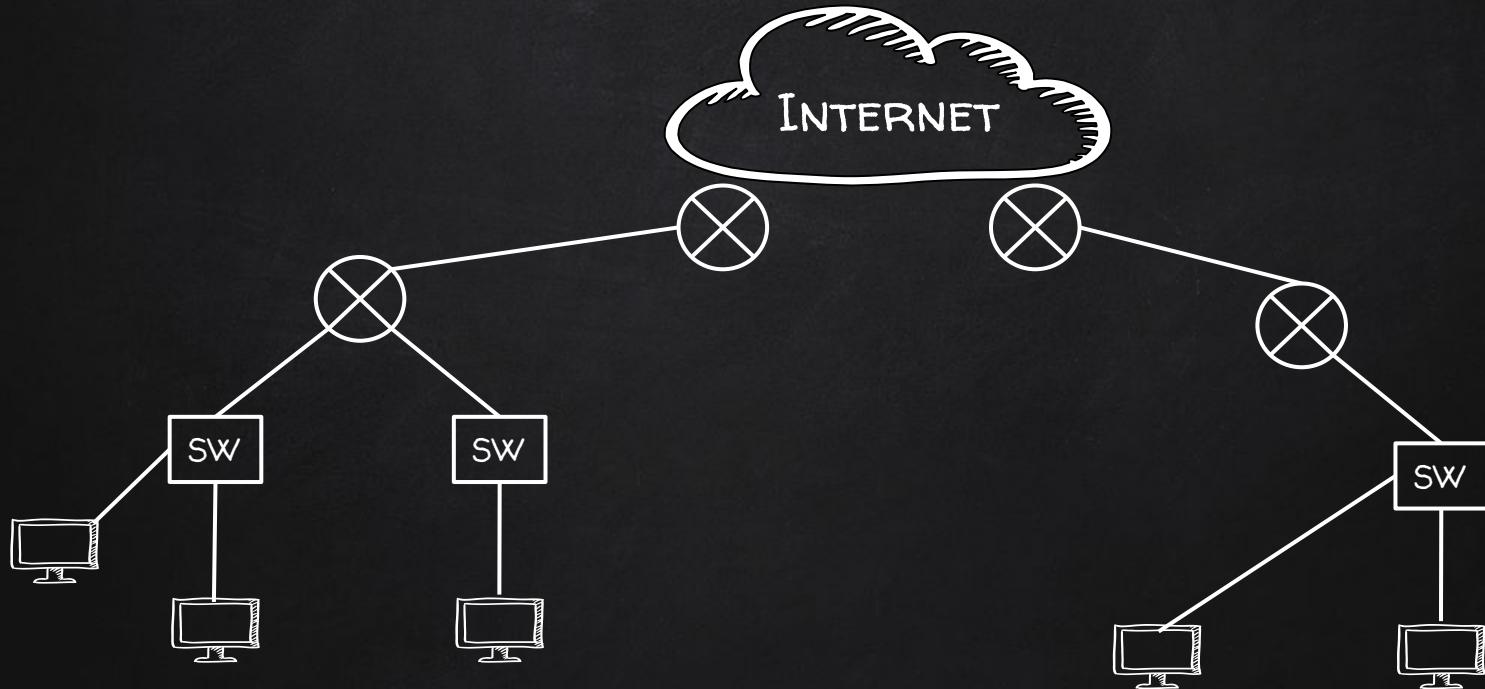
IPv6 MULTICAST ADDRESS



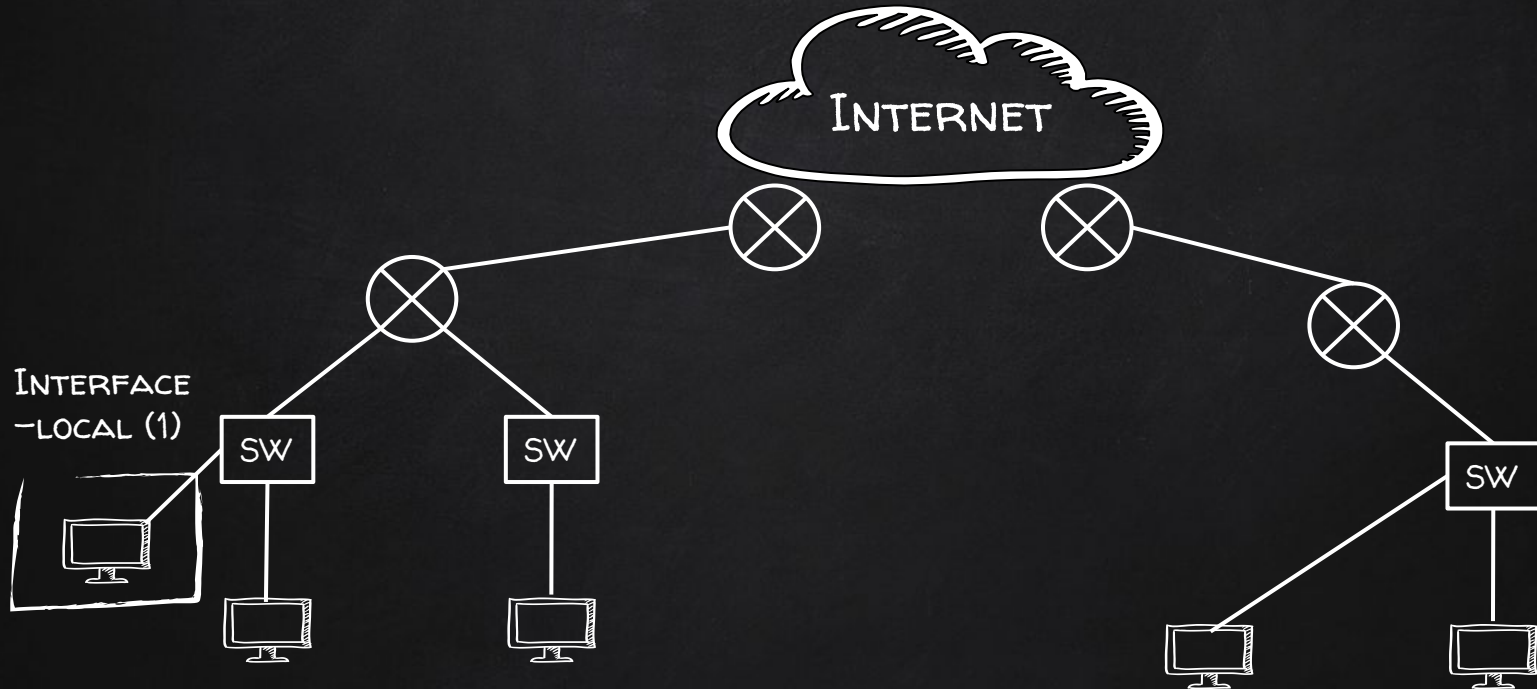
IPv6 MULTICAST ADDRESS



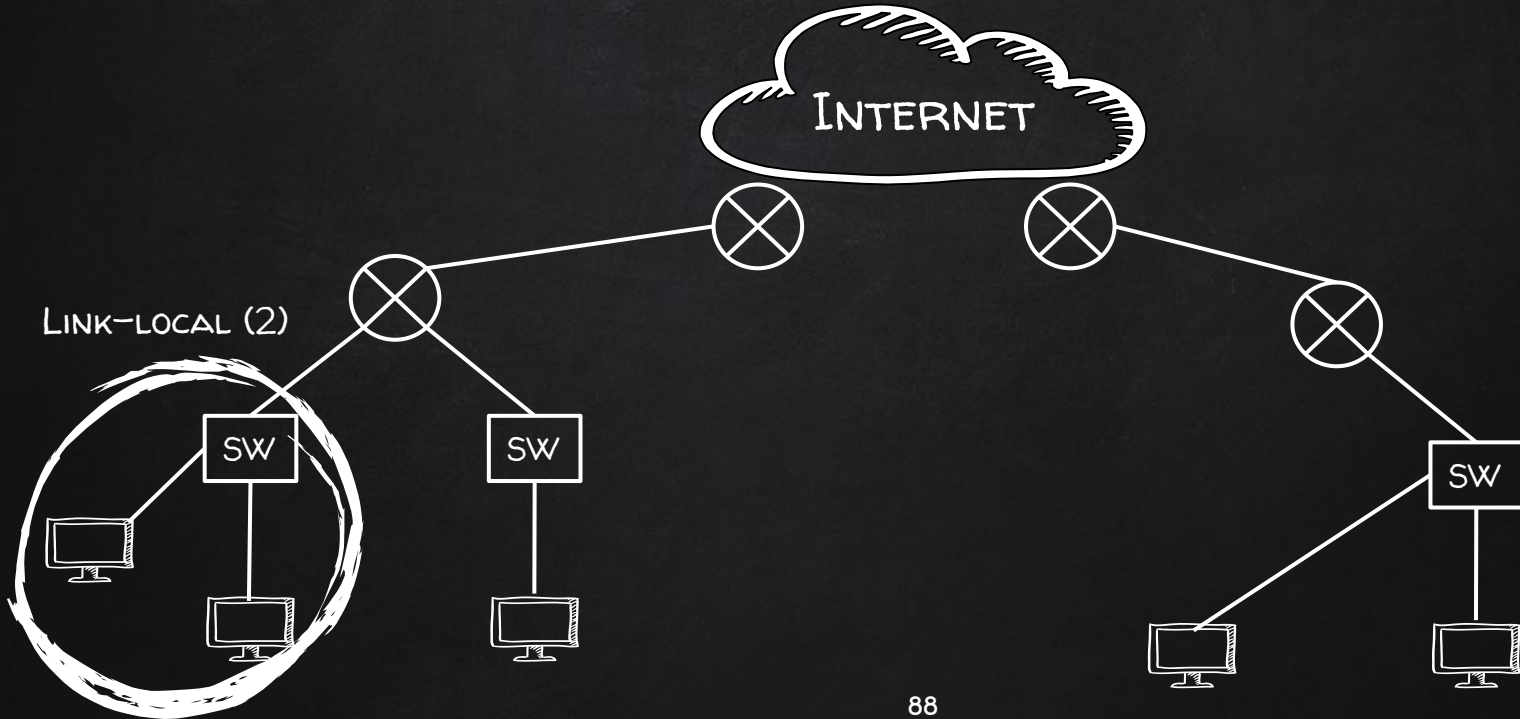
ESCOPOS EM IPV6



ESCOPOS EM IPV6

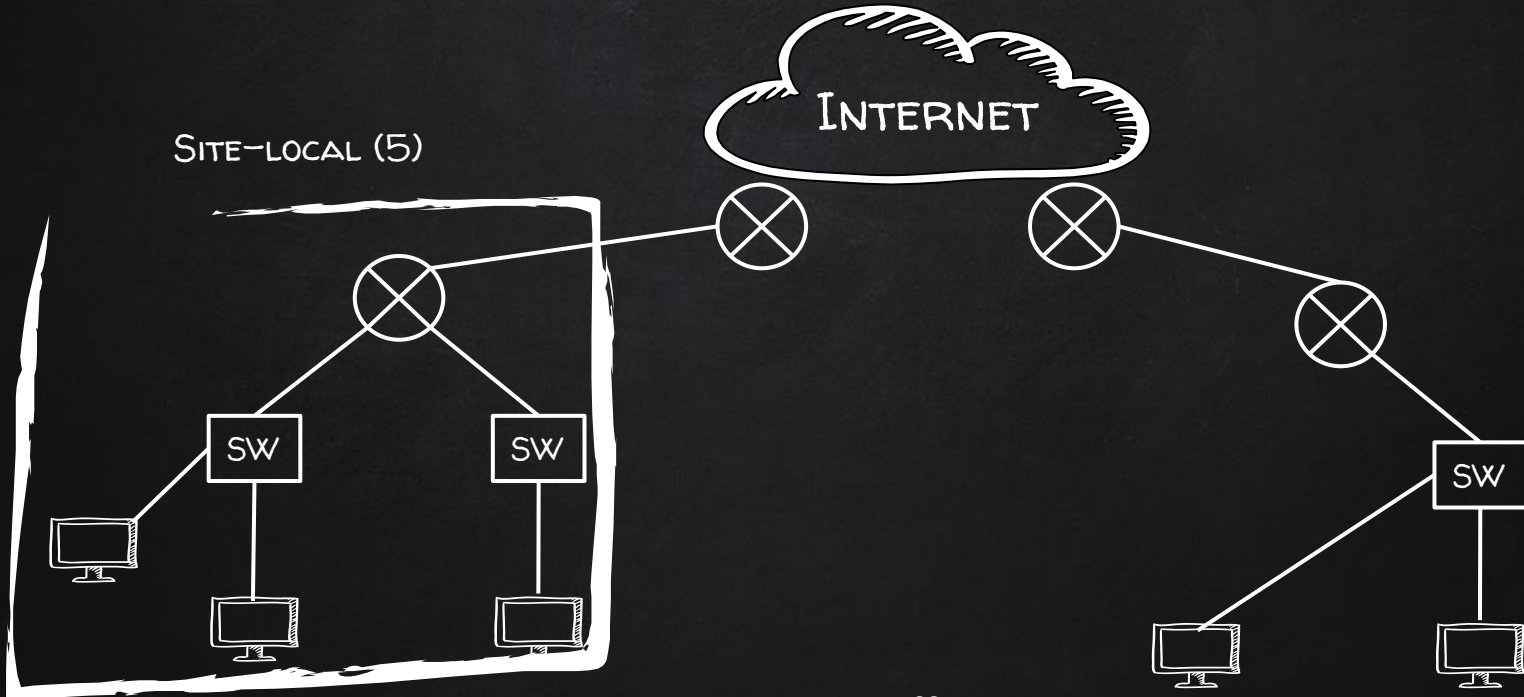


ESCOPOS EM IPV6

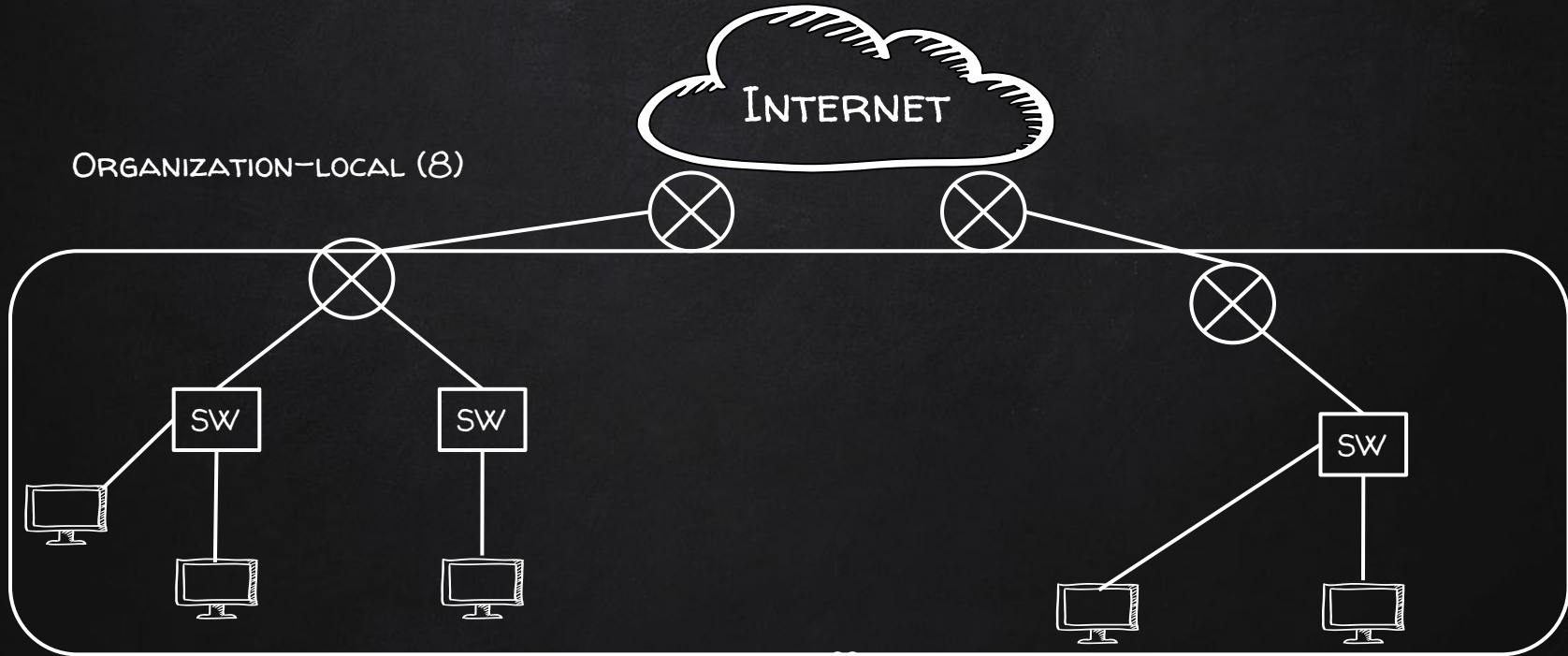


ESCOPOS EM IPV6

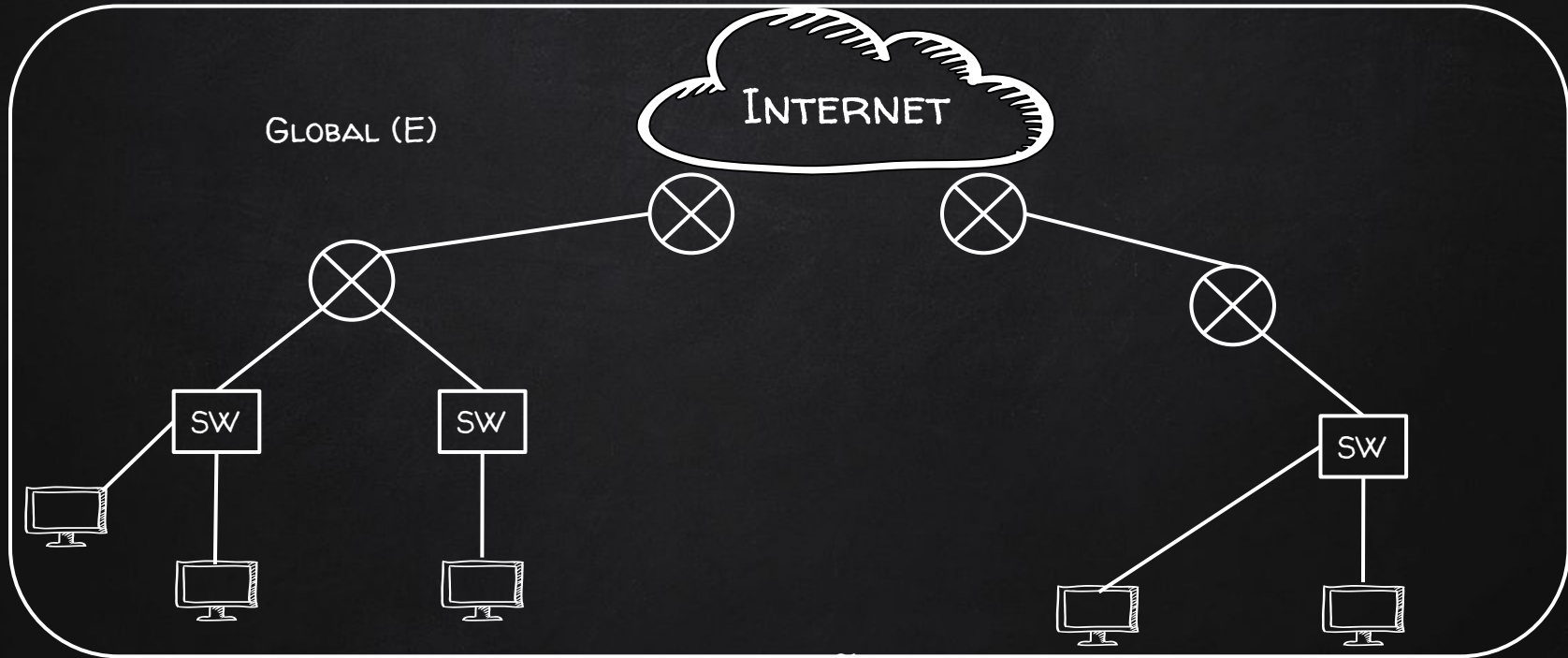
SITE-LOCAL (5)



ESCOPOS EM IPV6



ESCOPOS EM IPV6



WELL-KNOWN MULTICAST

ALL-NODES (INTERFACE-LOCAL)	FF01::1
ALL-ROUTERS (INTERFACE-LOCAL)	FF01::2
ALL-NODES (LINK-LOCAL)	FF02::1
ALL-ROUTERS (LINK-LOCAL)	FF02::2
ALL-ROUTERS (SITE-LOCAL)	FF05::2
ALL-DHCP SERVERS (SITE-LOCAL)	FF05::1:3

PRÁTICA

1. ABRA A MÁQUINA VIRTUAL
2. ABRA O CORE
3. FILE > OPEN > MINICURSO-LABS > LAB3-MULTICAST.IMN
4. INICIE O EXPERIMENTO
5. FAÇA UM PING DE N11 NO ENDEREÇO ALL-NODES E ALL-ROUTERS DO LINK-LOCAL
6. FAÇA UM PING DE N7 NO ENDEREÇO ALL-NODES E ALL-ROUTERS DO LINK-LOCAL
7. PARE O EXPERIMENTO, ADICIONE UMA CONEXÃO (CABO) ENTRE O SWITCH N15 E O ROTEADOR N3 E REPITA OS PASSOS 4 A 6

QUAL A DIFERENÇA DE CADA UM DESSES PINGS? POR QUÊ?

SOLICITED-NODE MULTICAST ADDRESS

- ✘ UM SOLICITED-NODE MULTICAST ADDRESS PARA CADA GUA E PARA CADA LINK-LOCAL UNICAST ADDRESS
- ✘ USADO PARA ENCONTRAR HOSTS NO LINK
- ✘ PREFIXO FF02:0:0:0:0:1:FF00::/104

SOLICITED-NODE MULTICAST ADDRESS

PASSO 1: PEGA O UNICAST ADDRESS

FE80 : 0000 : 0000 : 0000 : 0000 : 0000 : 00E0 : 1234

SOLICITED-NODE MULTICAST ADDRESS

PASSO 2: PEGA O PREFIXO DO SOLICITED-NODE MULTICAST ADDRESS

FE80 : 0000 : 0000 : 0000 : 0000 : 0000 : 00E0 : 1234

FF02:0:0:0:0:1:FF00::/104

SOLICITED-NODE MULTICAST ADDRESS

PASSO 3: COLOCA OS PRIMEIROS 24 BITS DO UNICAST NO SOLICITED-NODE

FE80 : 0000 : 0000 : 0000 : 0000 : 0000 : 00E0 : 1234

FF02:0:0:0:0:1:FF00::/104

FF02:0:0:0:0:1:FFE0:1234

A MAGIA DO SOLICITED-NODE

A MAGIA DO SOLICITED-NODE

IPv6

FF02:0:0:0:0:1:FFE0:1234

A MAGIA DO SOLICITED-NODE

IPv6

FF02:0:0:0:0:1:FFE0:1234

ETHERNET

A MAGIA DO SOLICITED-NODE

IPv6

FF02:0:0:0:0:1:FFEO:1234



ETHERNET

33:33:FF:EO:12:34

A MAGIA DO SOLICITED-NODE

IPv6

FF02:0:0:0:0:1:FFE0:1234



ETHERNET

33:33:FF:E0:12:34

OBS: 3333 COYOTE HILL ROAD


PRÁTICA

1. ABRA A MÁQUINA VIRTUAL
2. ABRA O CORE
3. FILE > OPEN > MINICURSO-LABS > LAB5-SOLICITED-NODE.IMN
4. INICIE O EXPERIMENTO
5. INICIE O WIRESHARK NA INTERFACE ETH0 DO NÓ N1
6. FAÇA UM PING DE N1 EM N3 UTILIZANDO O GUA DO N3
7. DEPOIS DE ALGUNS SEGUNDOS, PARE A CAPTURA NO WIRESHARK
8. NA CAPTURA, ENCONTRE AS MENSAGENS DE NEIGHBOR SOLICITATION E NEIGHBOR ADVERTISEMENT E ANALISE-AS

O QUE SÃO ESSAS MENSAGENS? QUAIS OS ENDEREÇOS DE ORIGEM E DESTINO DE CADA UMA DELAS? ANALISE TAMBÉM A CAMADA DO PROTOCOLO ETHERNET.

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- 
1. Router Advertisement e Router Solicitation
 2. Paizão
 3. Como gerar um GUA?

COMO GERAR UM GUA?

ROUTER ADVERTISEMENT (RA) E ROUTER SOLICITATION (RS)

- X MENSAGENS DO PROTOCOLO ICMPV6
- X ENVIADAS NO GRUPO MULTICAST ALL-NODES (FF02::1 PARA O LINK)
- X “QUEM É O ROTEADOR?” (RS)
- X “OI, EU SOU O ROTEADOR” (RA)
- X PREFIXO E SUGESTÃO DE ENDEREÇAMENTO (SLAAC, DHCPV6,...)

PAIZÃO (DAD)

DUPLICATE ADDRESS DETECTION

- x FEITA TODA VEZ QUE UM NOVO ENDEREÇO É GERADO
- x ENVIADO NO MULTICAST SOLICITED-NODE
- x “ALGUÉM AÍ É O ENDEREÇO QUE EU GEREI?”
 - o SE NINGUÉM RESPONDER, É PORQUE ELE É ÚNICO
 - o SE ALGUÉM RESPONDER, DEU RUIM, PRECISA RESOLVER MANUALMENTE
- x

CRONOGRAMA

- x Hello IPv6 World
- x Lendo e escrevendo IPv6
- x Endereços Unicast
- x Multicasting
- x Um endereço para chamar de nosso
- x Resumo



FINALMENTE!

RESUMO

HISTÓRICO E ORGANIZACIONAL

- x IAB, IETF, ISO
- x RICHIA ENTRE IETF E ISO
- x IETF E RFCs
- x IANA, ICANN E RIRs
- x MAIS SEGURO? MENOS SEGURO?

RESUMO

LENDO E ESCREVENDO IPV6

- x HEXADECIMAIS
- x IPV6 TEM 128 BITS (4 BITS POR HEXA, 4 HEXAS POR HEXTETO)
- x ANATOMIA: PREFIXO + SUBNET ID (SE HOVER) + INTERFACE ID
- x `::/128` (UNSPECIFIED) E `::1/128` (LOOPBACK)

RESUMO

IPV6 UNICAST ADDRESSES

- ✘ LINK-LOCAL UNICAST ADDRESS
 - FE80::/10
 - 54 BITS (??)
 - 64 BITS (INTERFACE ID)
 - NÃO ROTEÁVEL (SÓ SERVE DENTRO DO LINK)
 - RANDOM OU EUI-64 (MAC)

- ✘ GLOBAL UNICAST ADDRESS (GUA)
 - PADRÃOZÃO
 - GLOBAL MESMO

RESUMO

MULTICASTING

- ✗ MULTICASTING (GRUPOS MAIS FLEXÍVEIS) VS BROADCASTING (TODA A REDE)
- ✗ IPV6 MULTICAST
 - FFO0::<8> + FLAG + ESCOPO + GROUP ID
 - ESCOPOS (LINK-LOCAL, SITE-LOCAL, GLOBAL,...)
 - ALL NODES (FF0X::1), ALL ROUTERS (FF0X::2)
- ✗ SOLICITED-NODE MULTICAST ADDRESS
 - FFO2:0:0:0:0:1:FF00::<104> + PRIMEIROS 24 BITS DO UNICAST
 - MAC (33 : + [32 PRIMEIROS BITS DO SOLICITED-NODE])

ISSO É TUDO, PESSOAL

OBRIGADO!

Perguntas?

Feedback!

tiny.cc/feedbackipv6

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[@gmelodie](#)



[in/gabriel-de-melo-cruz](#)



[@cruzao](#)

EXTRA GRAPHICS





THIS IS A SLIDE TITLE

- ✗ Here you have a list of items
- ✗ And some text
- ✗ But remember not to overload your slides with content

Your audience will listen to you or read the content, but won't do both.



Bring the attention of your audience over a key concept using icons or illustrations



YOU CAN ALSO SPLIT YOUR CONTENT

White

Is the color of milk and fresh snow, the color produced by the combination of all the colors of the visible spectrum.

Black

Is the color of coal, ebony, and of outer space. It is the darkest color, the result of the absence of or complete absorption of light.



IN TWO OR THREE COLUMNS

Yellow

Is the color of gold, butter and ripe lemons. In the spectrum of visible light, yellow is found between green and orange.

Blue

Is the colour of the clear sky and the deep sea. It is located between violet and green on the optical spectrum.

Red

Is the color of blood, and because of this it has historically been associated with sacrifice, danger and courage.



A PICTURE IS WORTH A THOUSAND WORDS



A complex idea can be conveyed with just a single still image, namely making it possible to absorb large amounts of data quickly.

A vibrant field of red poppies in full bloom, with green stems and leaves. The background is a soft-focus sea of more poppies. In the center, a white, hand-drawn rectangular box contains the text.

WANT BIG
IMPACT?
USE BIG
IMAGE.



USE CHARTS TO EXPLAIN YOUR IDEAS





AND TABLES TO COMPARE DATA

	A	B	C
Yellow	10	20	7
Blue	30	15	10
Orange	5	24	16



MAPS





89,526,124

Whoa! That's a big number, aren't you proud?

89,526,124\$

That's a lot of money

185,244 USERS

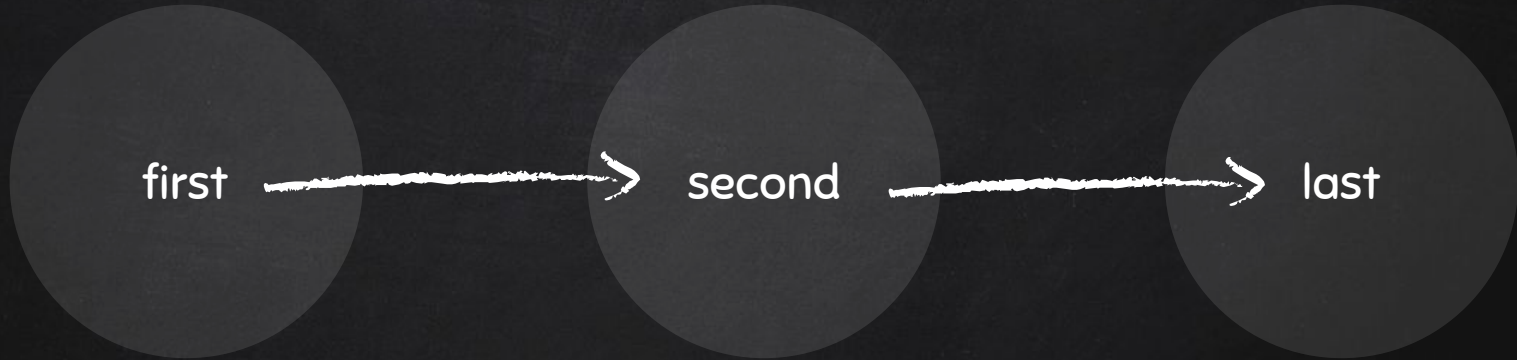
And a lot of users

100%

Total success!



OUR PROCESS IS EASY





LET'S REVIEW SOME CONCEPTS

Yellow

Is the color of gold, butter and ripe lemons. In the spectrum of visible light, yellow is found between green and orange.

Blue

Is the colour of the clear sky and the deep sea. It is located between violet and green on the optical spectrum.

Red

Is the color of blood, and because of this it has historically been associated with sacrifice, danger and courage.

Yellow

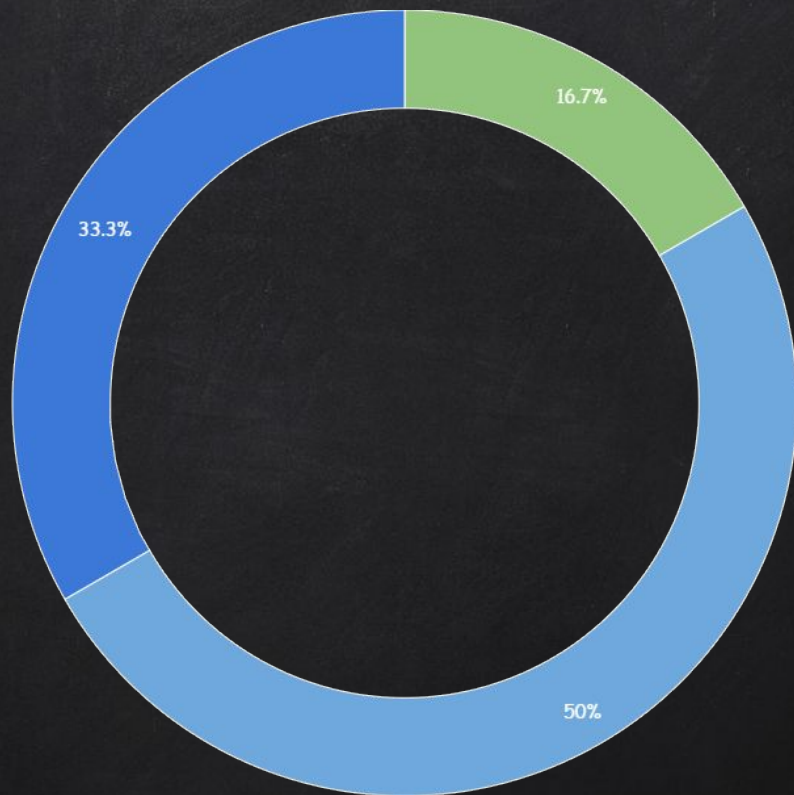
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You can copy&paste graphs from Google Sheets



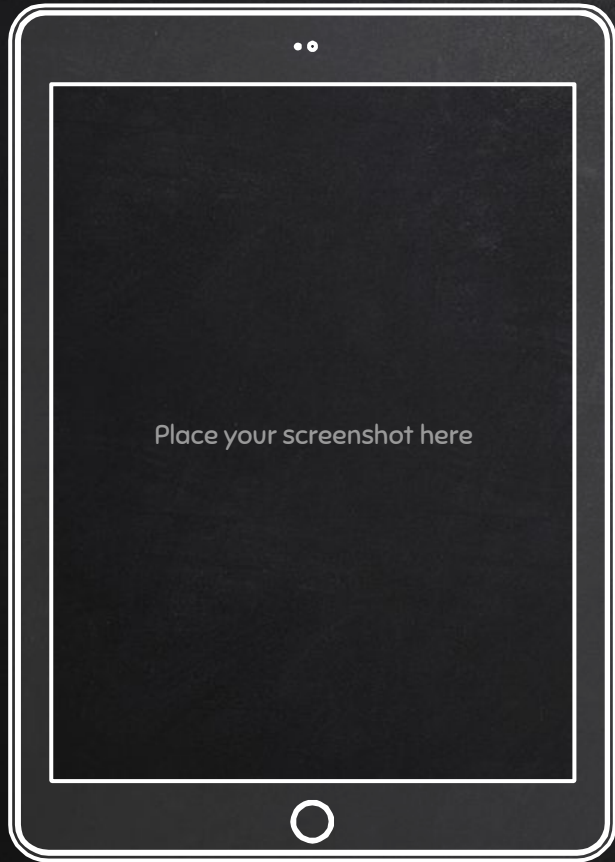
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- ✘ Presentation template by [SlidesCarnival](#)
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This presentation uses the following typographies:

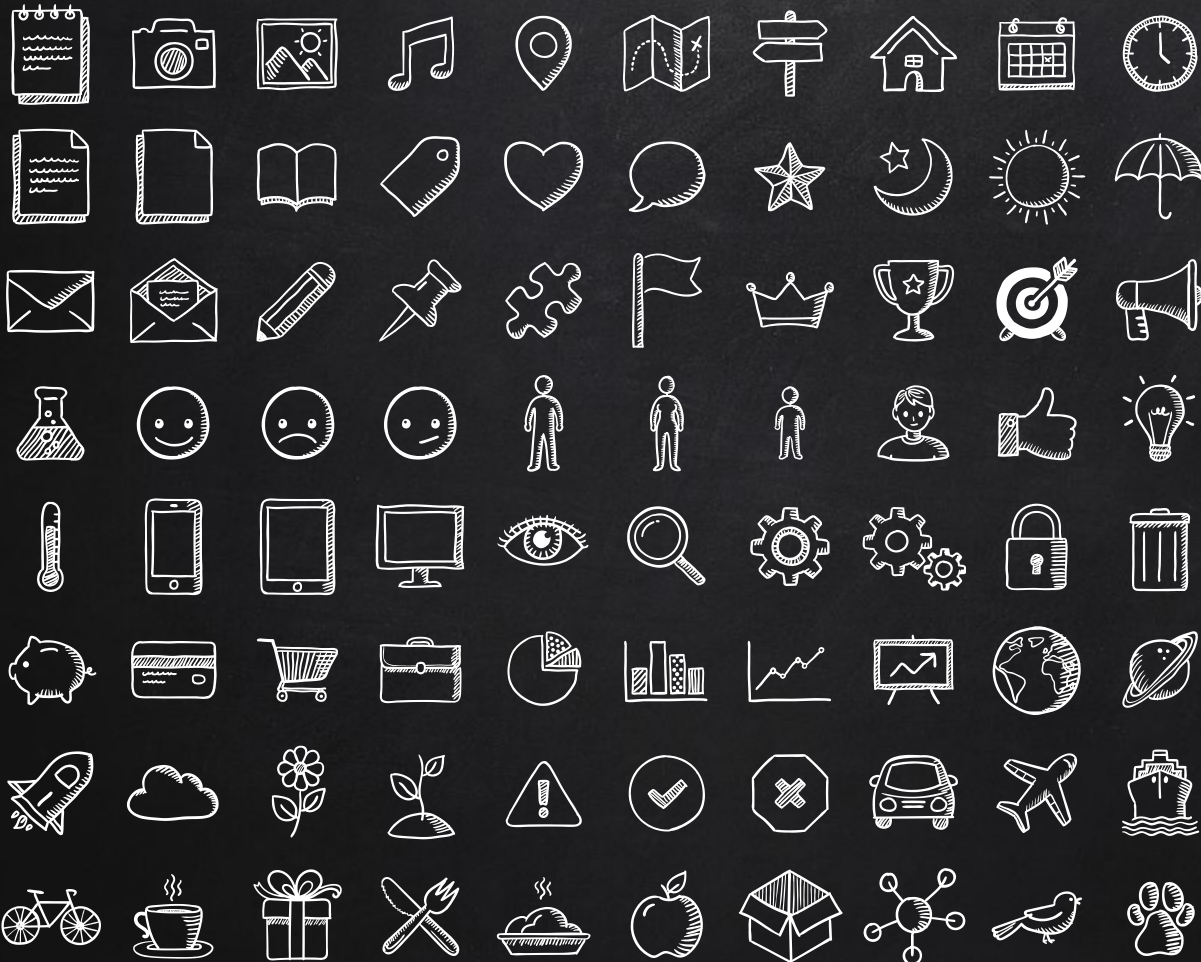
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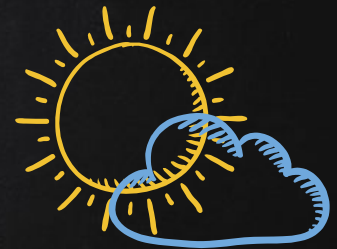
SlidesCarnival icons are editable shapes.

This means that you can:

- Resize them without losing quality.
- Change fill color and opacity.

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Examples:



Now you can use any emoji as an icon!
And of course it resizes without losing quality and you can change the color.

How? Follow Google instructions
<https://twitter.com/googledocs/status/730087240156643328>



and many more...

EXTRA GRAPHICS

