Securing the backhaul

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Beijing, 26th May 2014

Andrew Davies, IP Architect
Telefónica UK
CCIE 4962

BE MORE_

Learning to love the LTE Security Gateway

My background

- Data (IP) Networking
- Telefónica UK; Mobile Operator, Fixed Broadband and Corporate Services
- I was lead for LTE IP Architecture and Design culminating in successful LTE launch August 2013.
- I had been learning to love the LTE Security Gateway for about eighteen months

About O2

- O2 is the commercial brand of Telefónica UK Limited and is a leading digital communications company with the highest customer satisfaction for any mobile provider according to Ofcom.

- With over 23 million customers, O2 runs 2G, 3G and 4G networks across the UK as well as operating O2 Wifi and owning half of Tesco Mobile.

- O2 has over 450 retail stores and sponsors The O2, O2 Academy venues and the England rugby team. Read more about O2 at www.o2.co.uk/news.

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01 The Requirement

02 The solution, PKI and IPSec, Firewalling

03 MTU

04 Auto-Integration

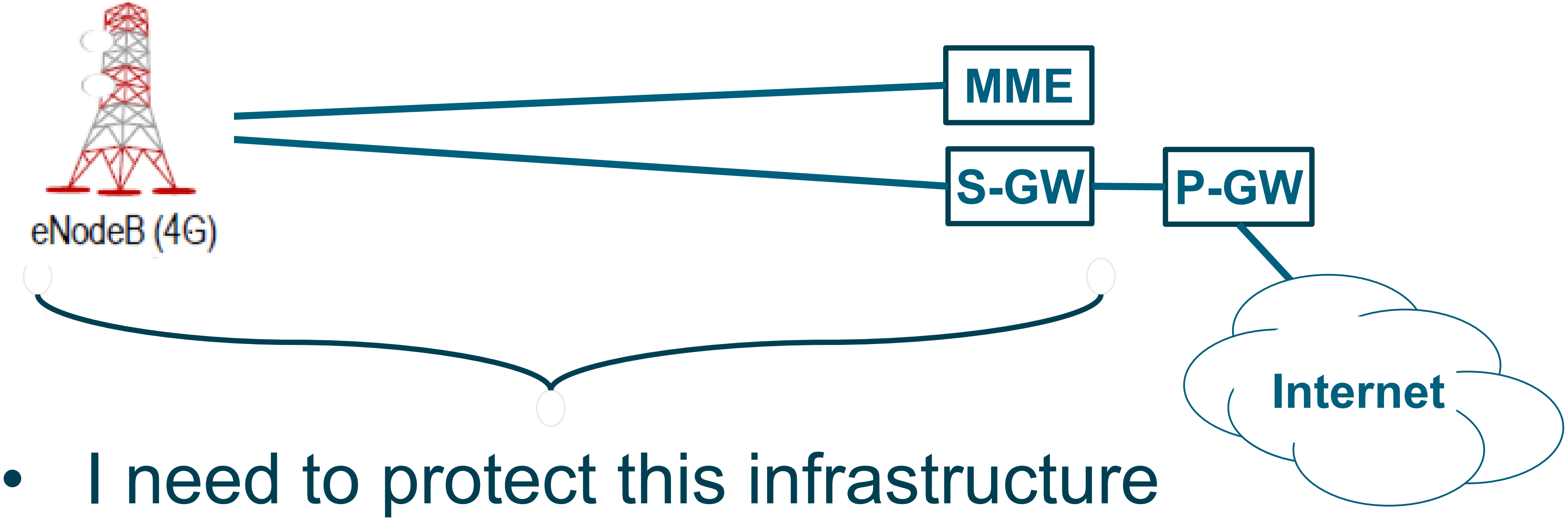
05 Geo-Resilience

06 LTE - Advanced

01

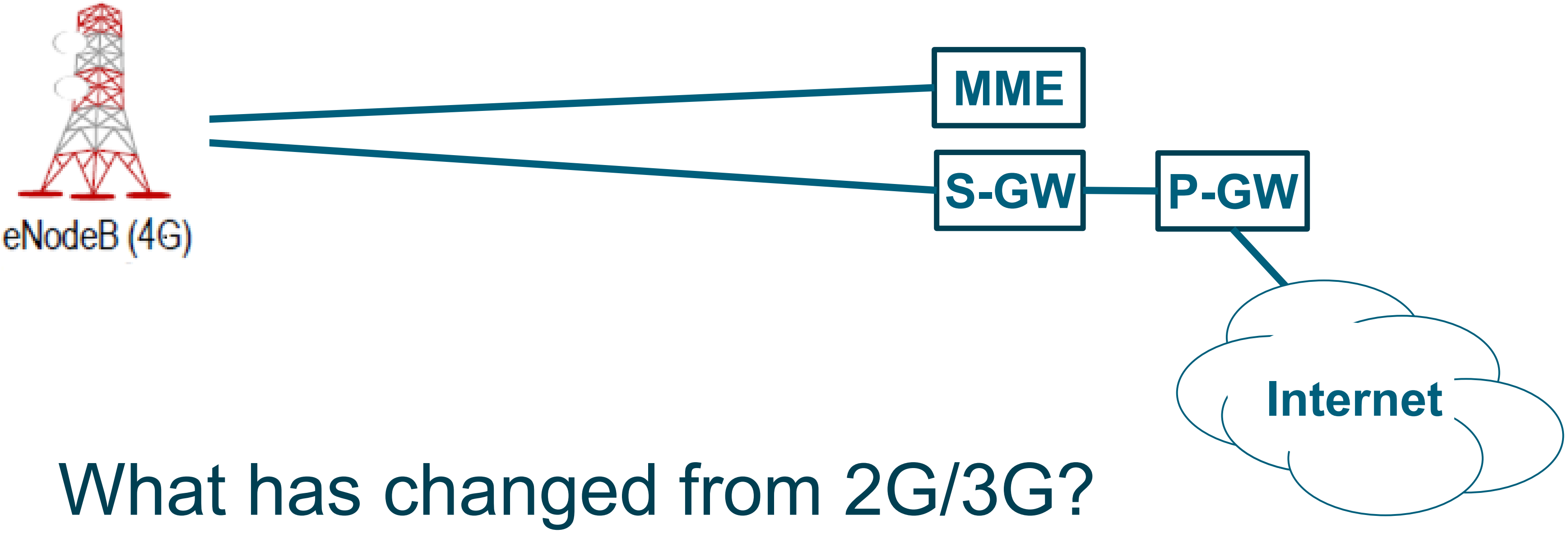
The Requirement?

The requirement – securing the backhaul



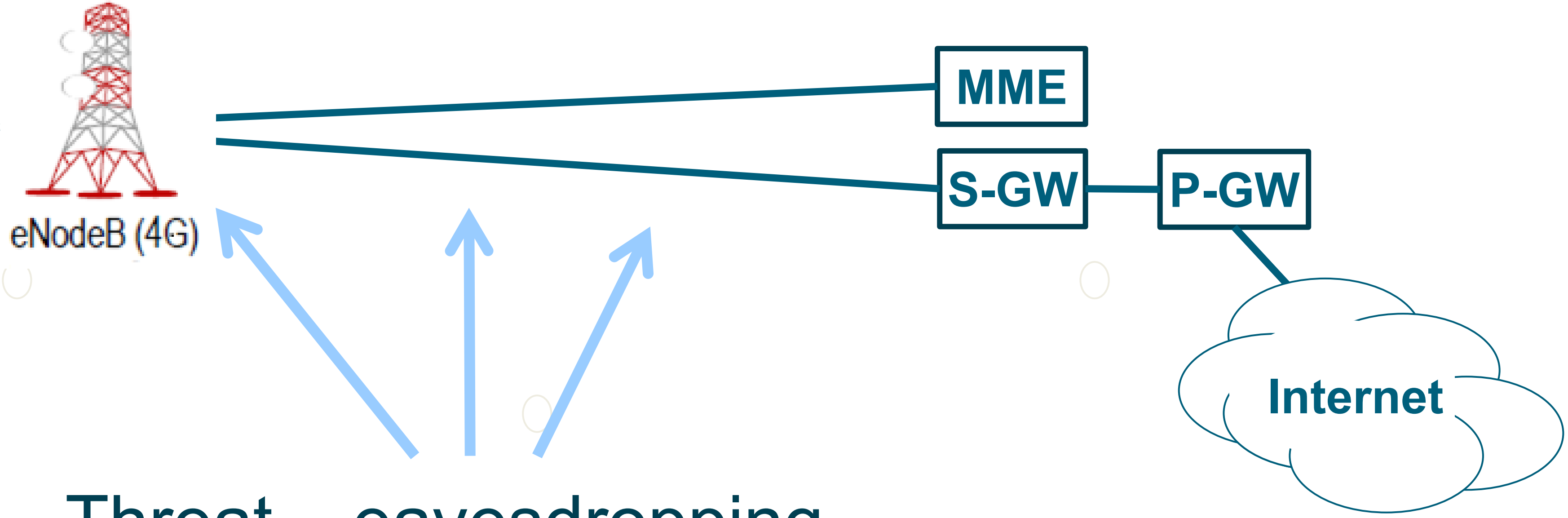
- I need to protect this infrastructure
- Customer confidentiality
- Service protection/Infrastructure integrity

The requirement – securing the backhaul



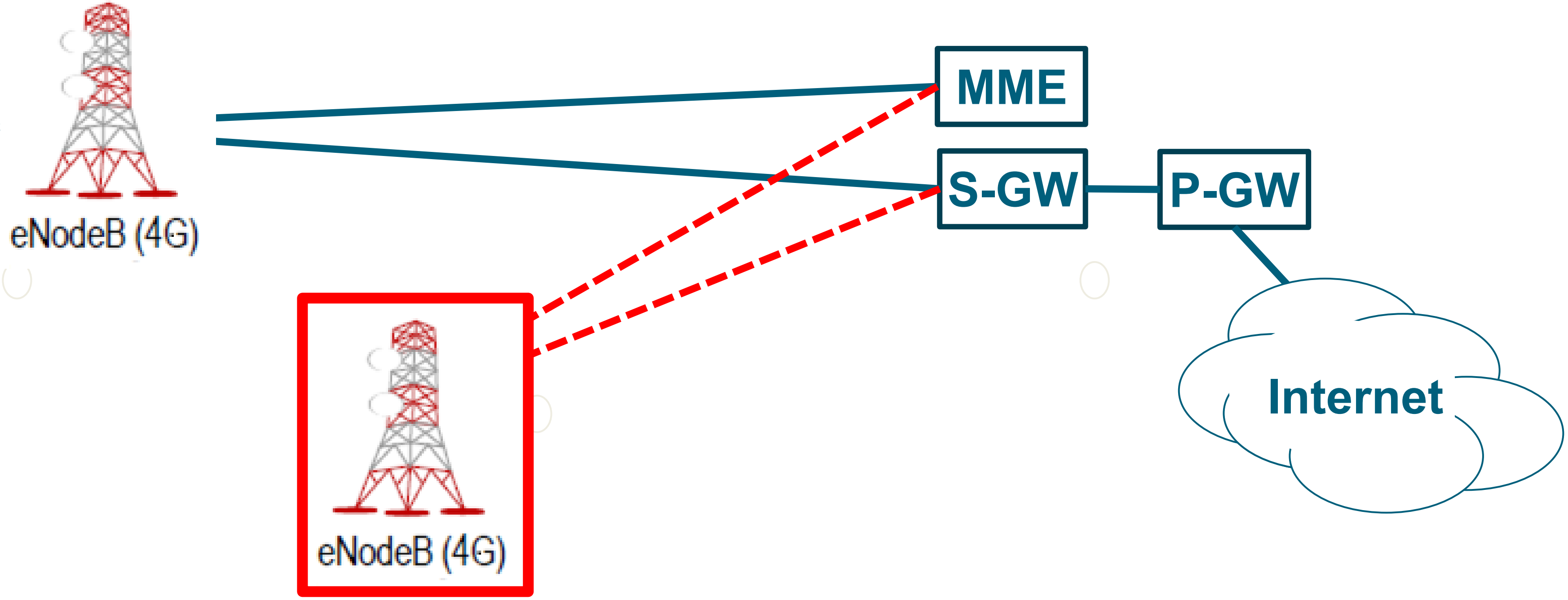
- What has changed from 2G/3G?
- All IP + Ethernet = RJ45, threat is similar but TDM kit not so widely available and as well understood as IP/Ethernet and free capture programs.
- 2G/3G core segregated from MBH by BSC/RNC

The requirement – securing the backhaul



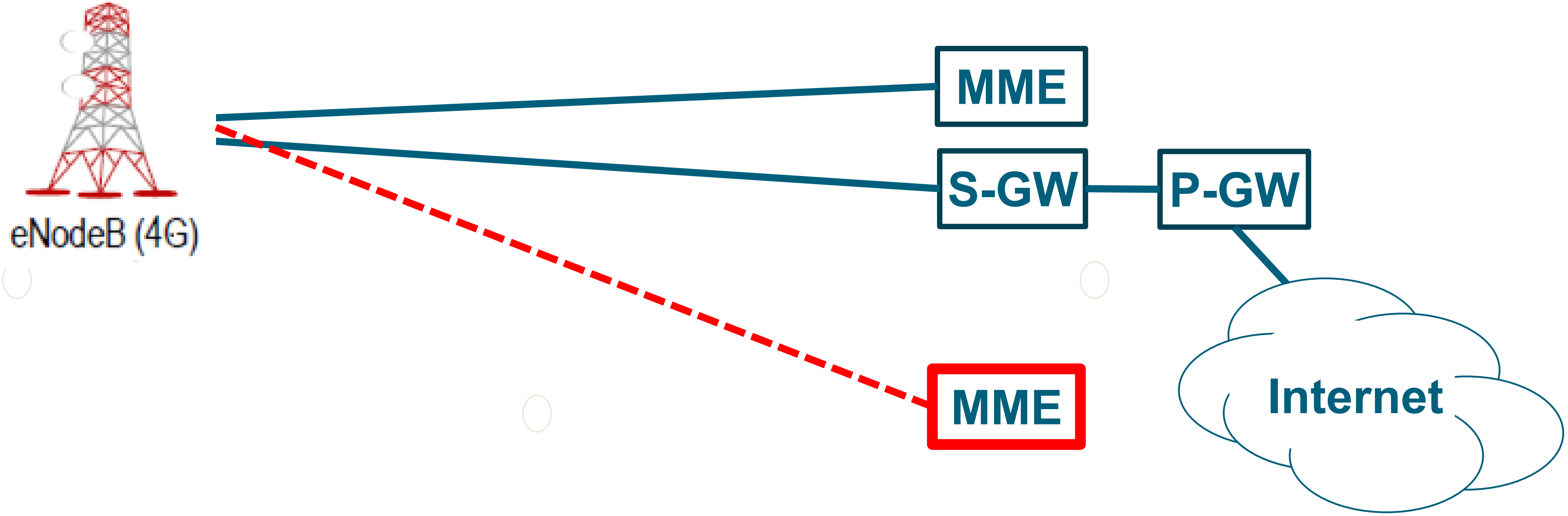
- Threat – eavesdropping
  - eNodeB locations may be insecure
  - First mile termination could be located in third party premises
  - Aggregation infrastructure could be located in third party premises

The requirement – securing the backhaul



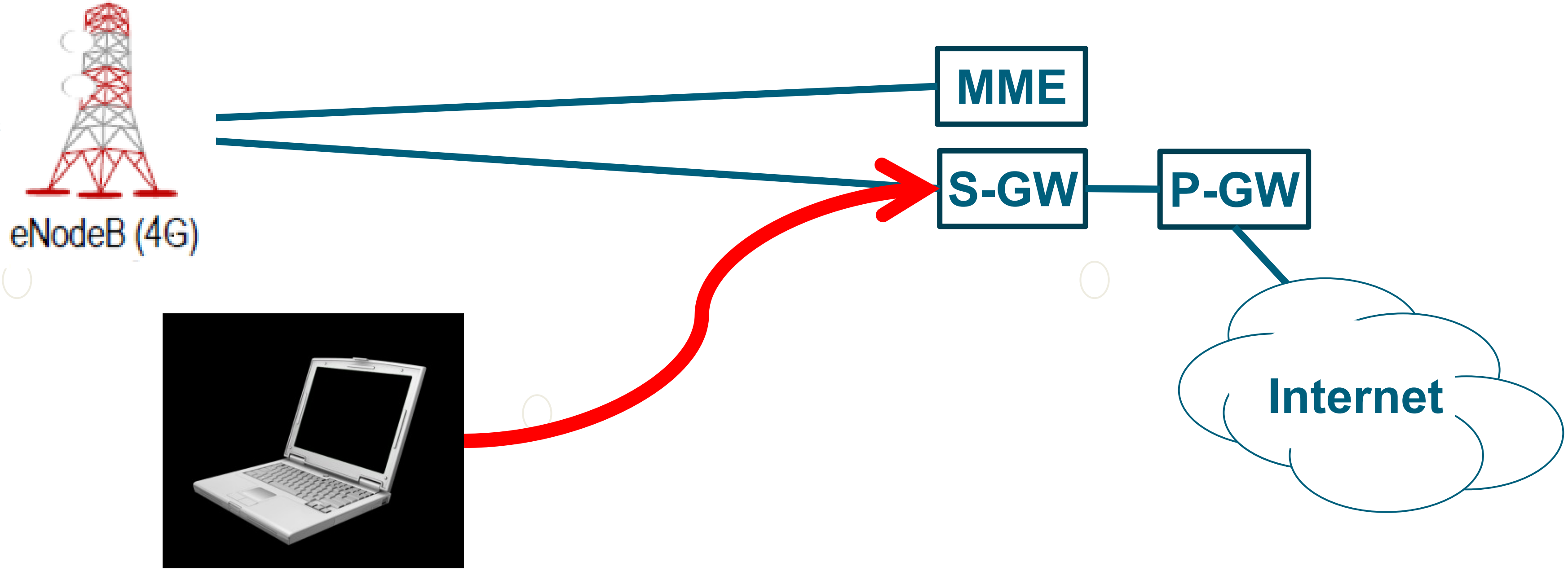
- Threat – Alien eNodeB
  - How do you prevent someone attaching an eNodeB to your infrastructure?

The requirement – securing the backhaul



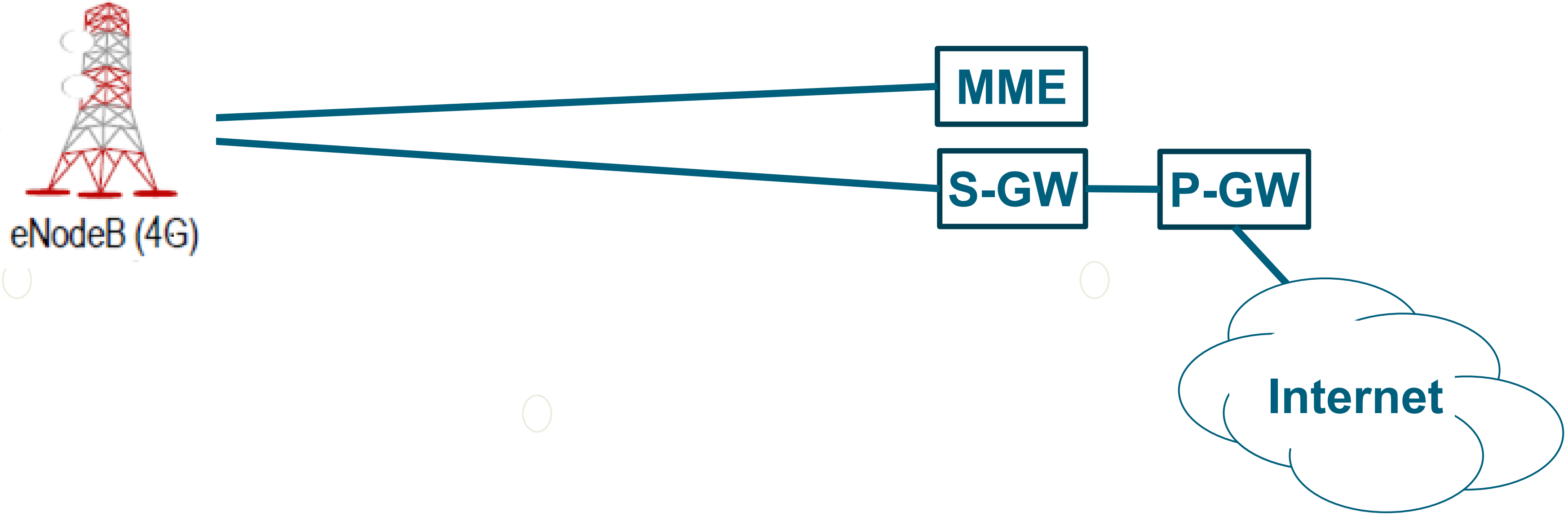
- Threat – Alien MME
  - How do you prevent someone attaching an MME to your infrastructure?

The requirement – securing the backhaul



- Threat – Denial of Service
  - How do you prevent someone flooding your IP infrastructure or attached systems?

The requirement – securing the backhaul

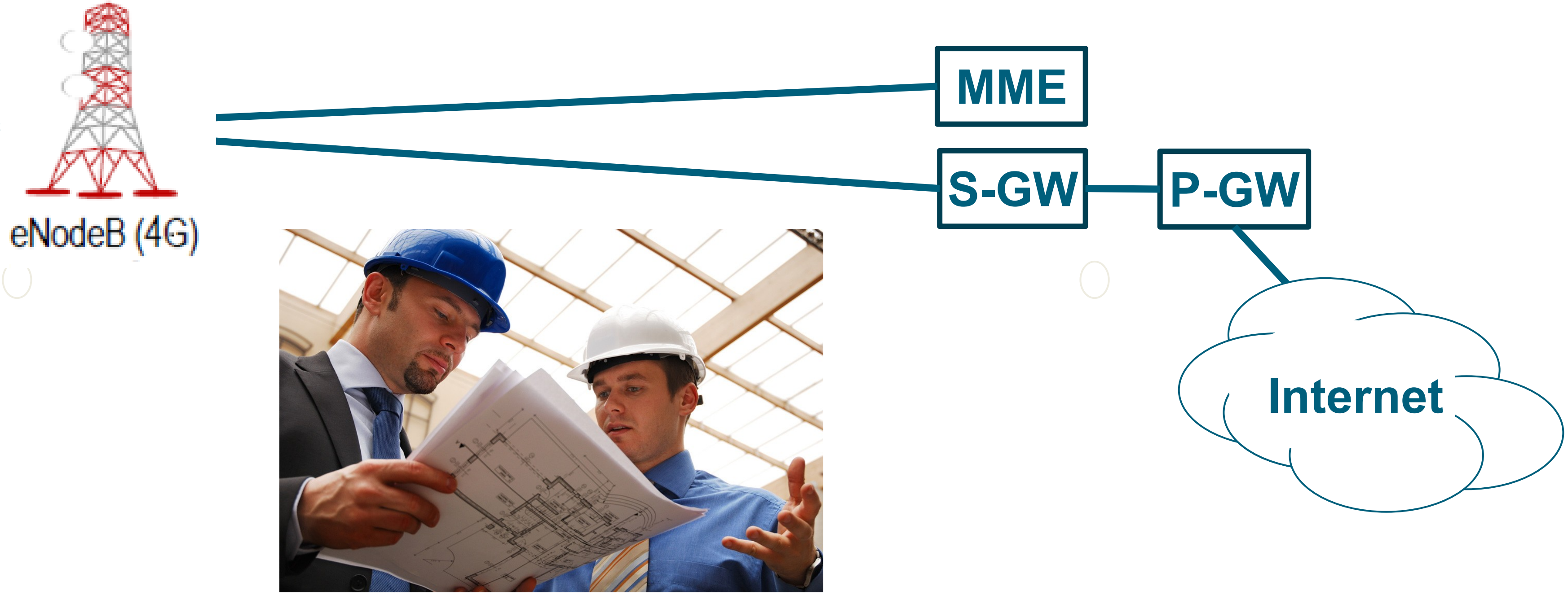


The requirement – securing the backhaul

- Caption competition…..

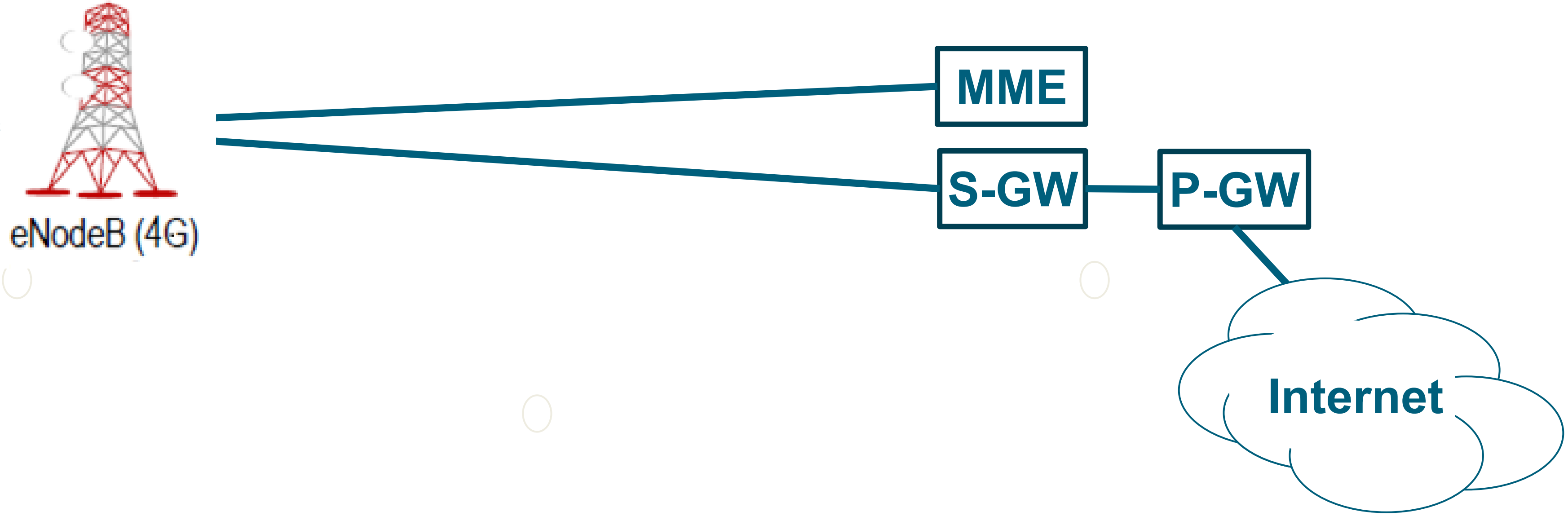
I don't know how it works either

The requirement – securing the backhaul



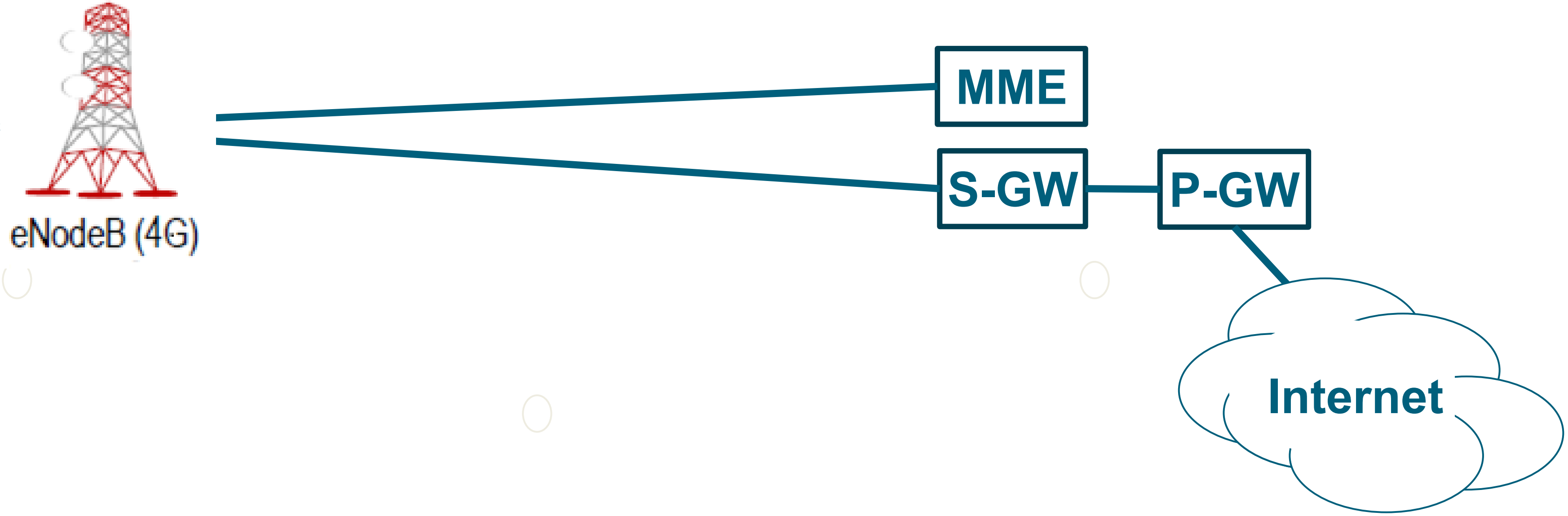
- Threat – Complexity
  - Difficult to maintain infrastructure is insecure

The requirement – securing the backhaul



- 3GPP
  - Encryption of IP traffic from eNodeB to EPC is not mandated.

The requirement – securing the backhaul

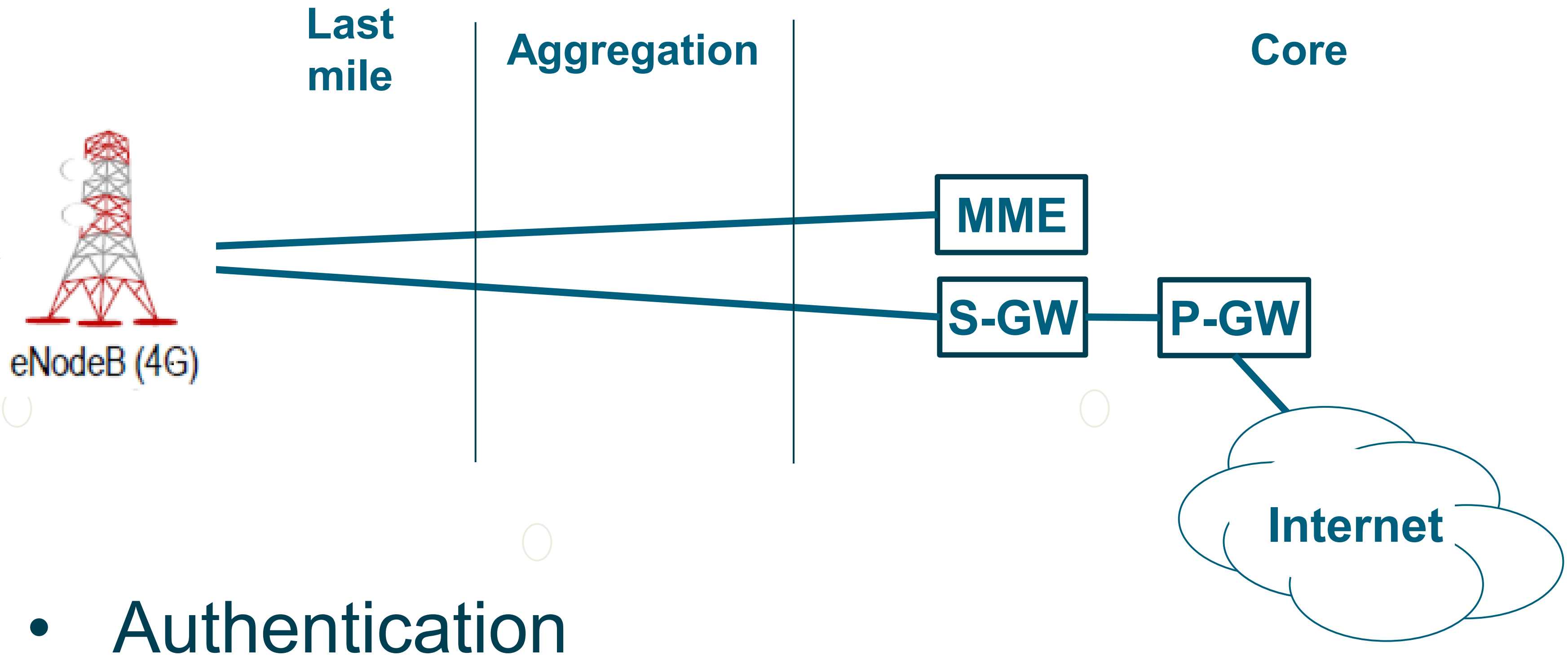


- What is everyone else doing?
  - Time for some market research

02

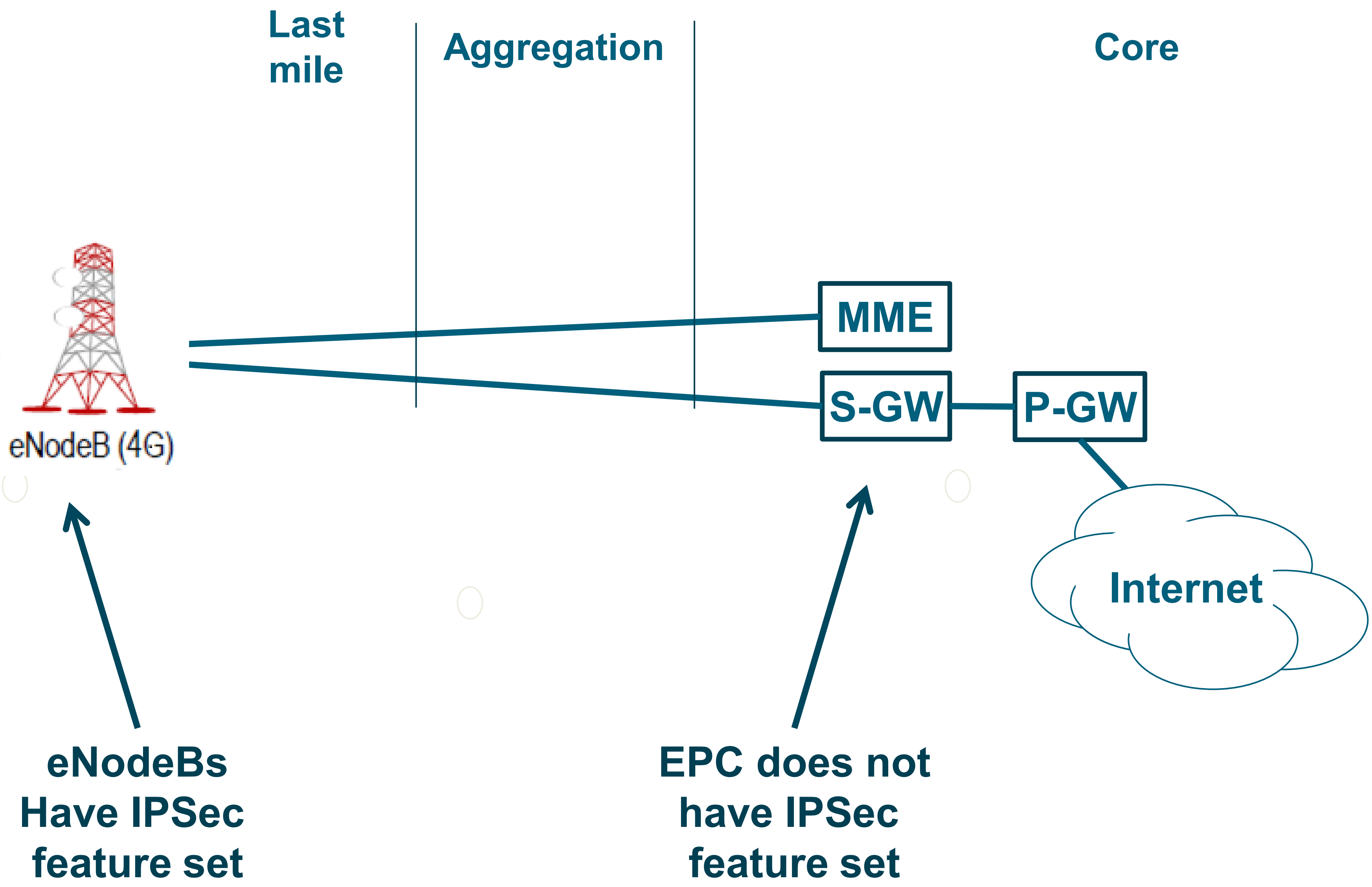
Securing the backhaul

- PKI
- IPSec



- Authentication
  - PKI = Public Key Infrastructure

- Encryption
  - IPSec = IETF defined IP Security protocol



Last mile

Aggregation

Core

eNodeB (4G)

MME

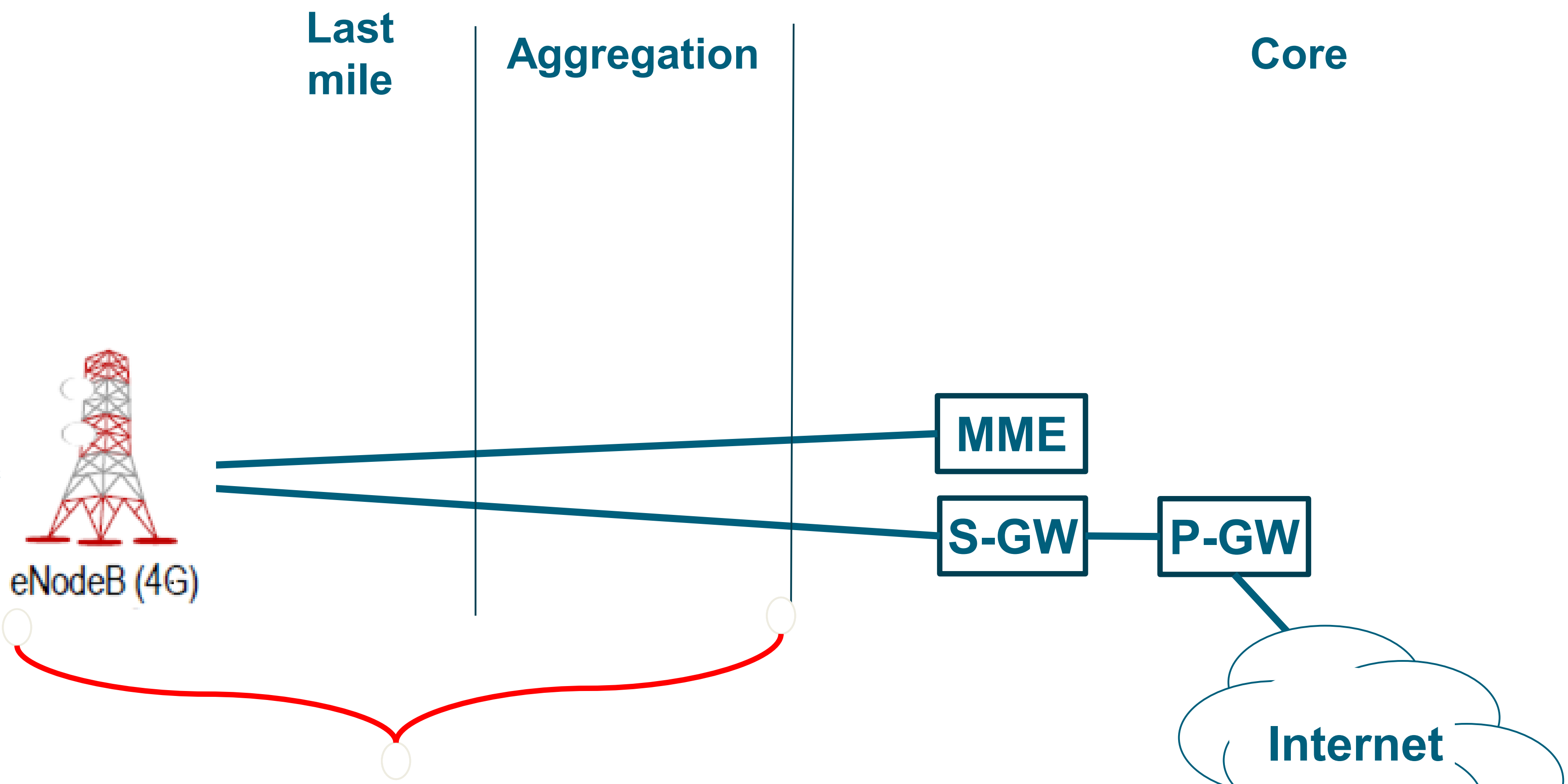
S-GW

P-GW

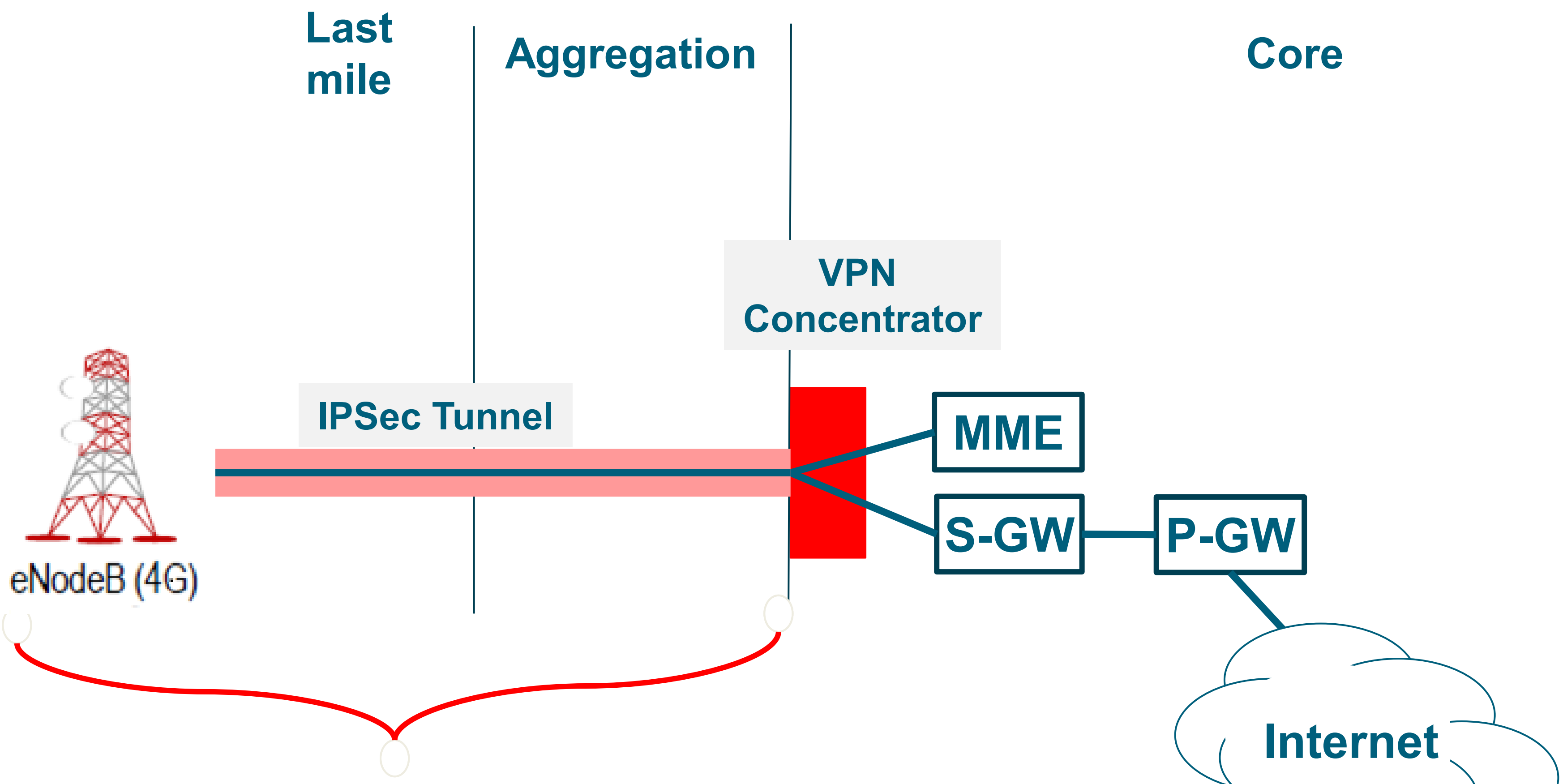
Internet

eNodeBs
Have IPSec
feature set

EPC does not
have IPSec
feature set



These could be Insecure Third Party locations



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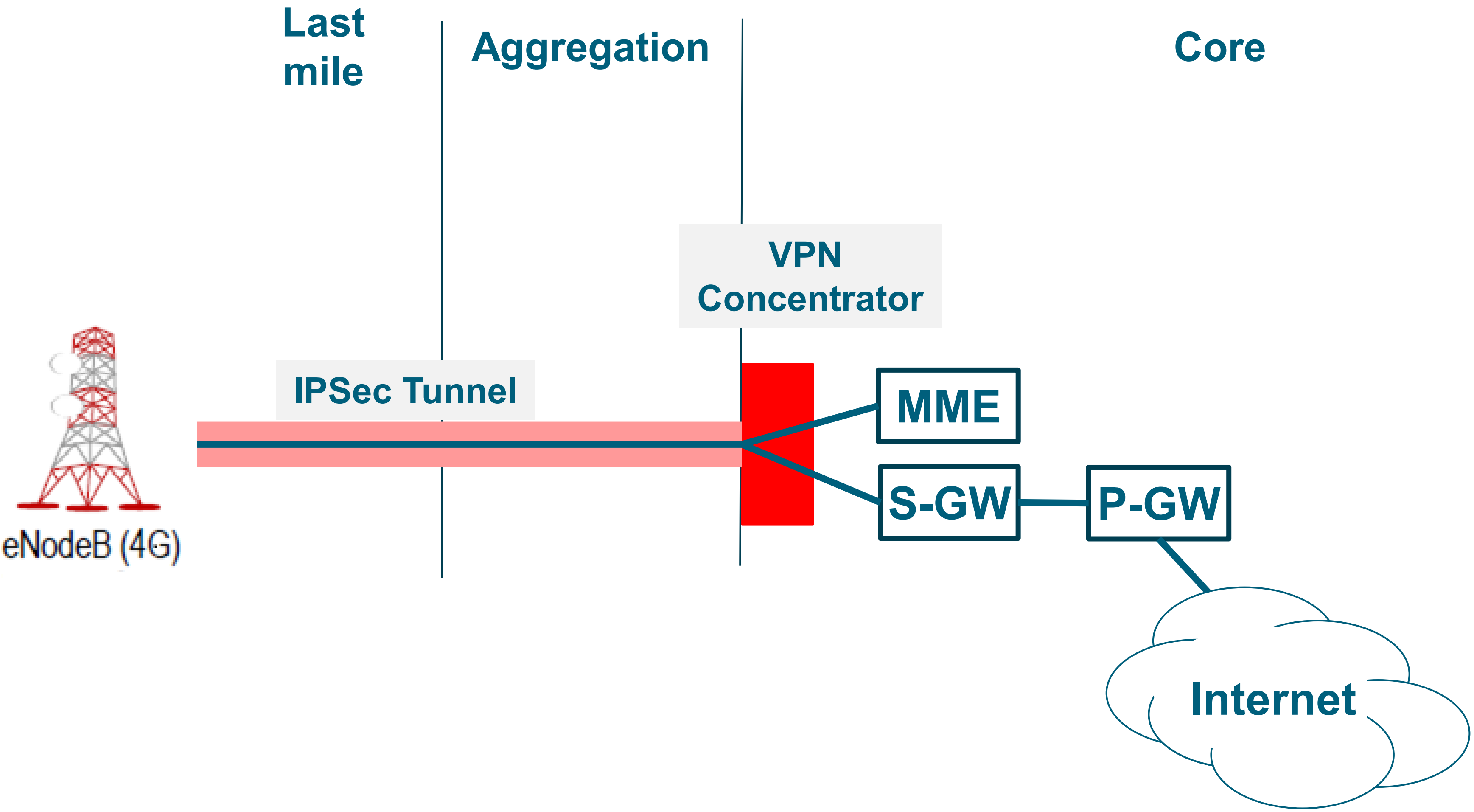
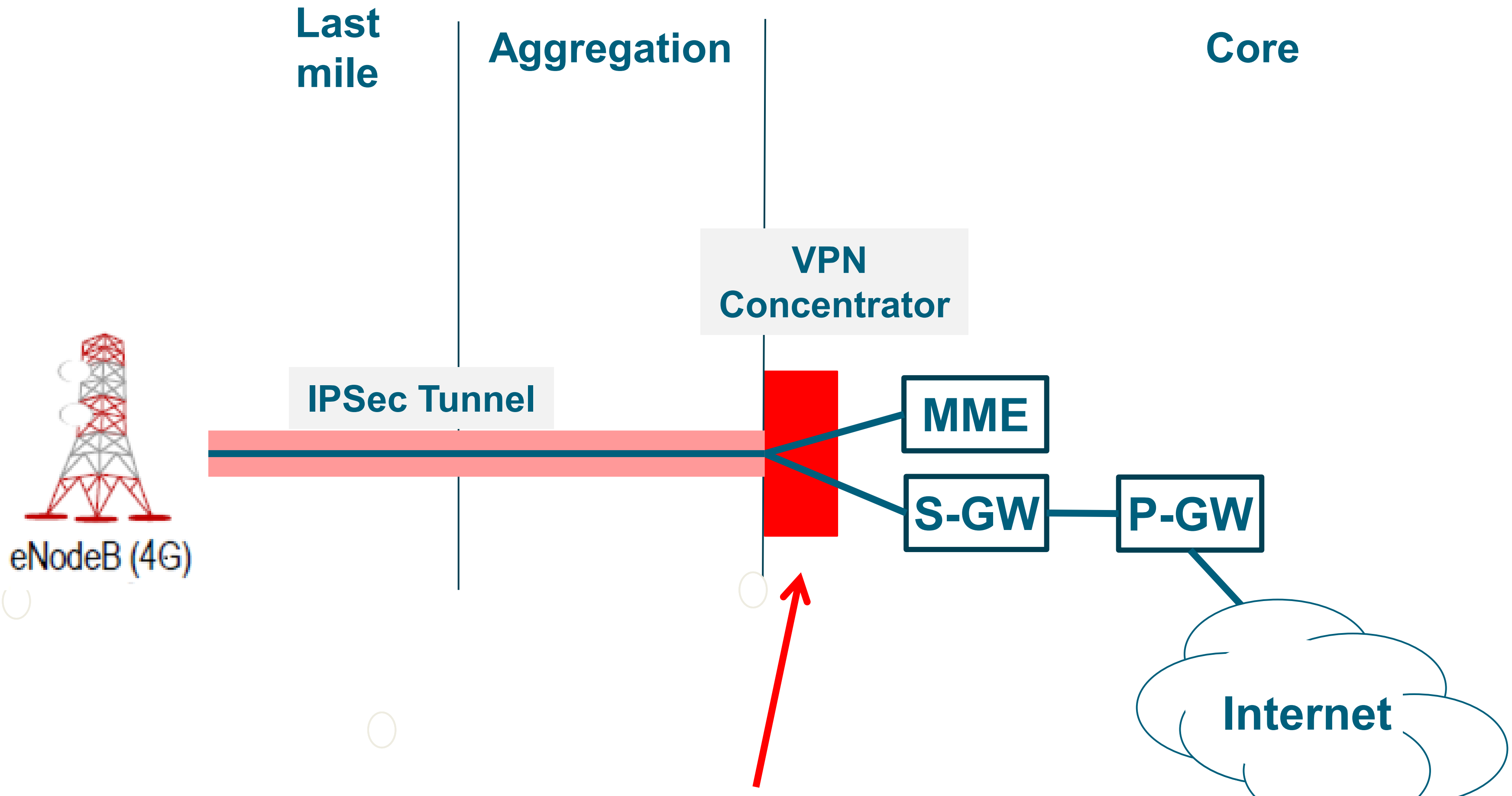
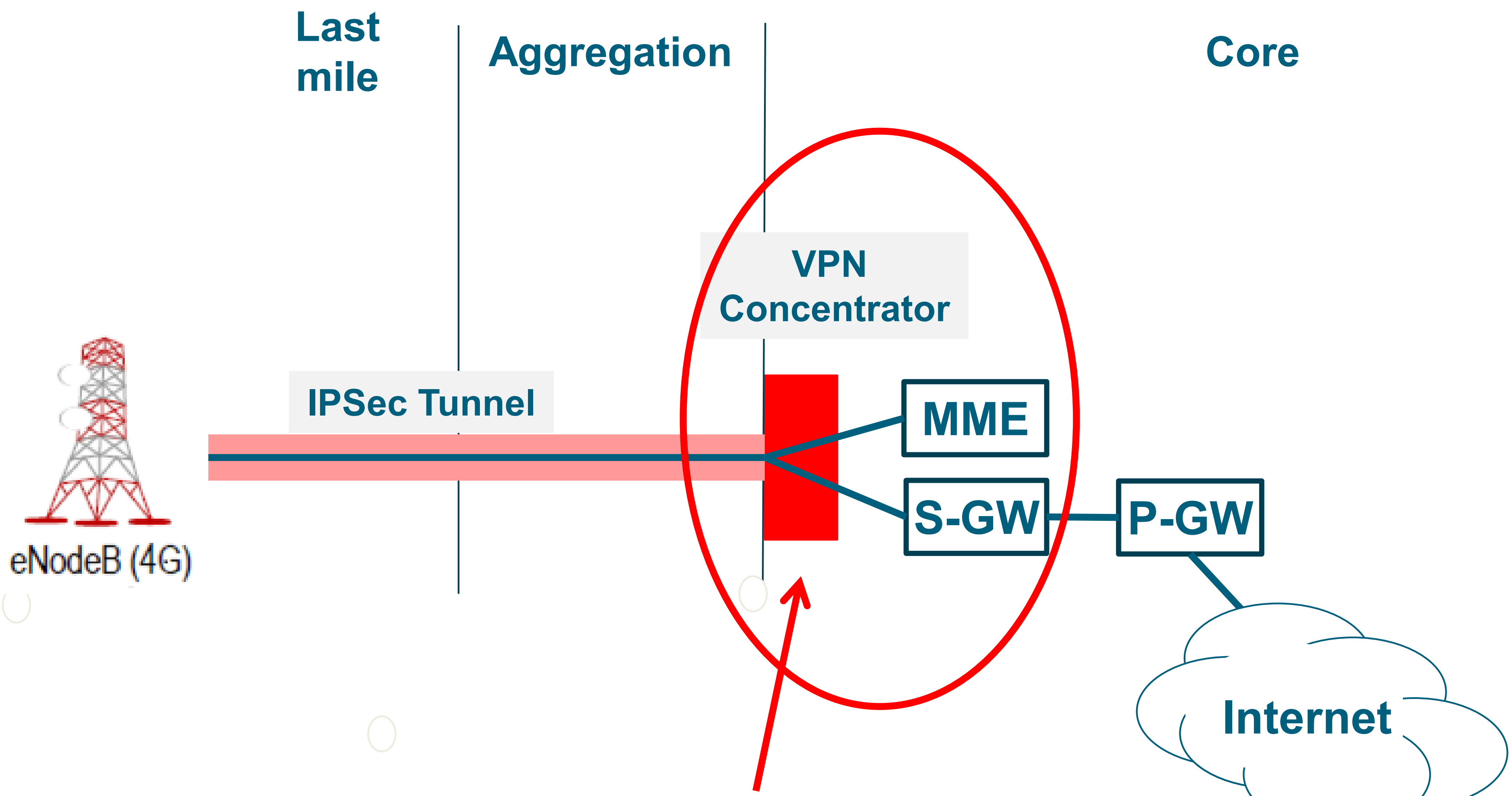

Last mile
Aggregation
Core
VPN Concentrator
IPSec Tunnel
MME
S-GW
P-GW
eNodeB (4G)
Internet



Only VPN Concentrator Between MBH and Core



Last mile

Aggregation

Core

VPN Concentrator

IPSec Tunnel

MME

S-GW

P-GW

eNodeB (4G)

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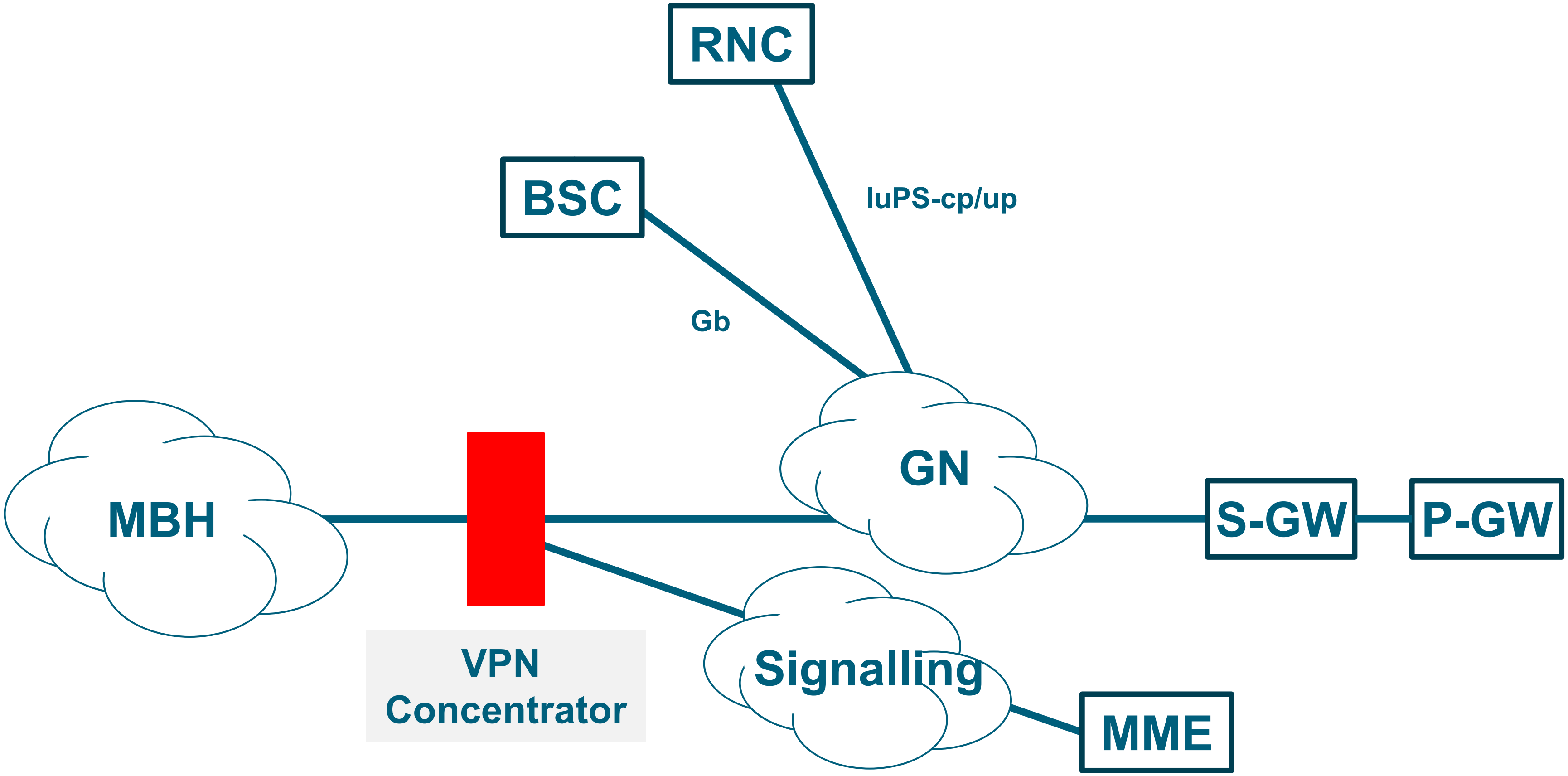
RNC
BSC
IuPS-cp/up
Gb
GN
MBH
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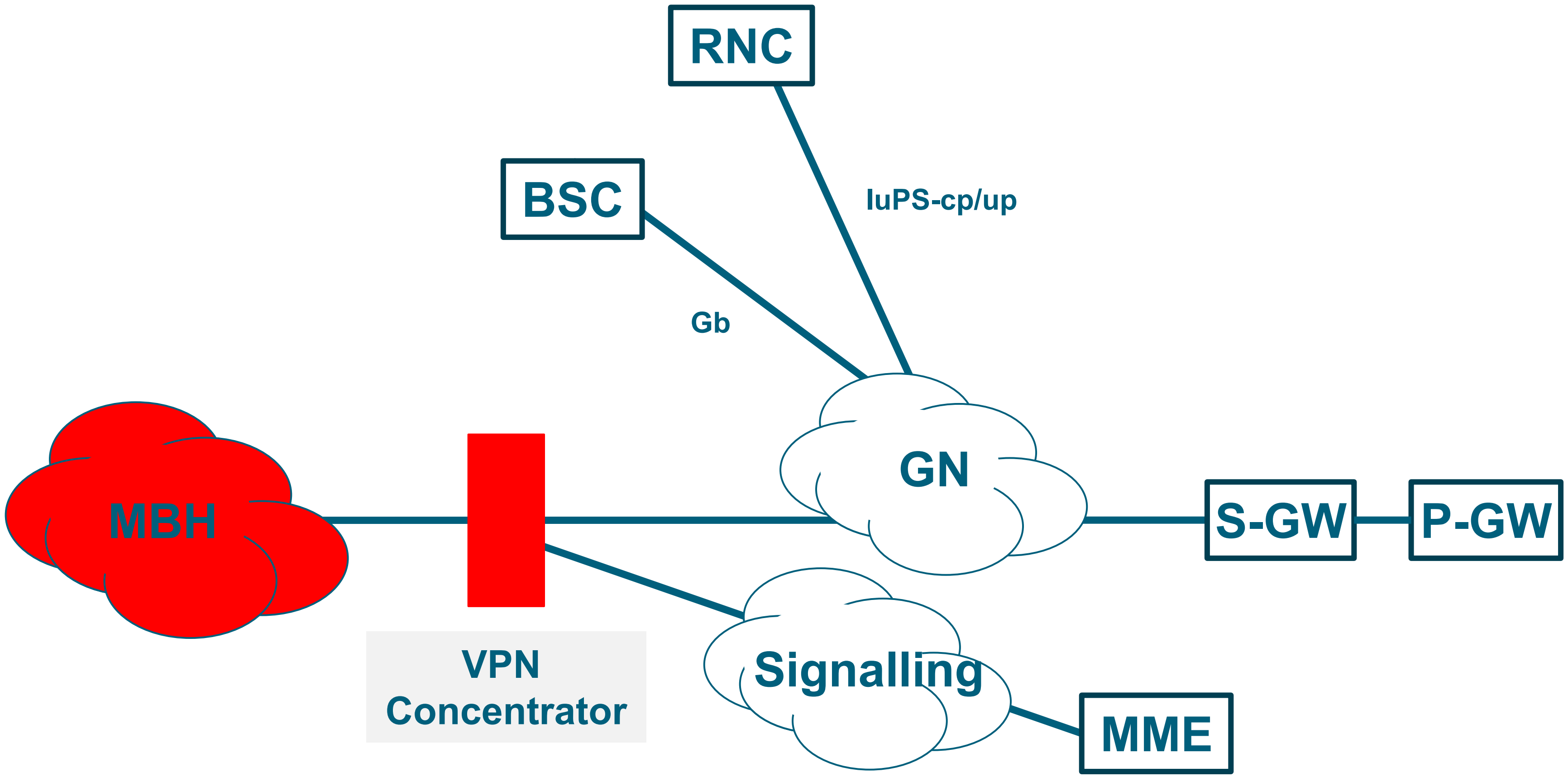
P-GW
Signalling
MME
VPN Concentrator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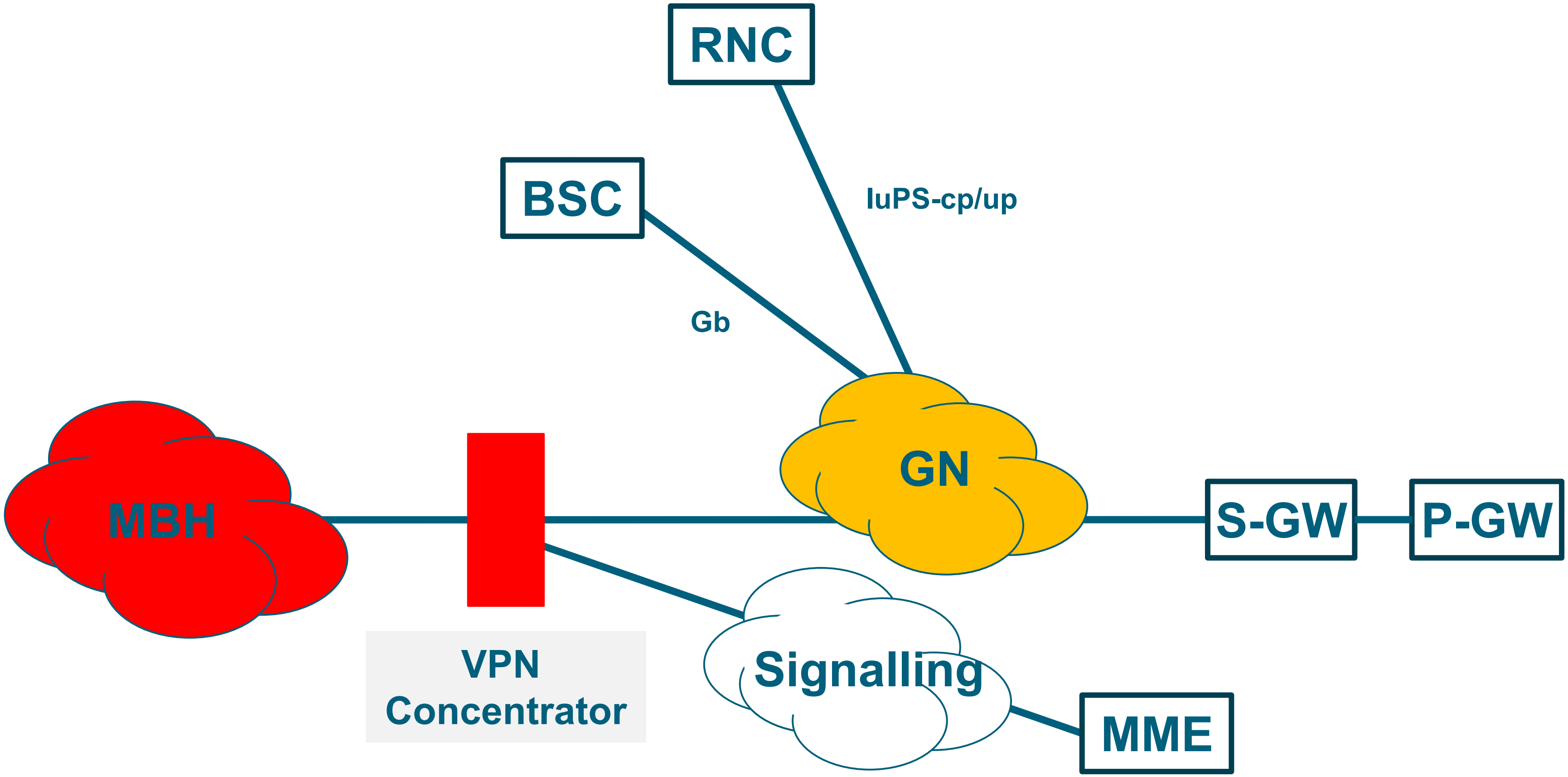
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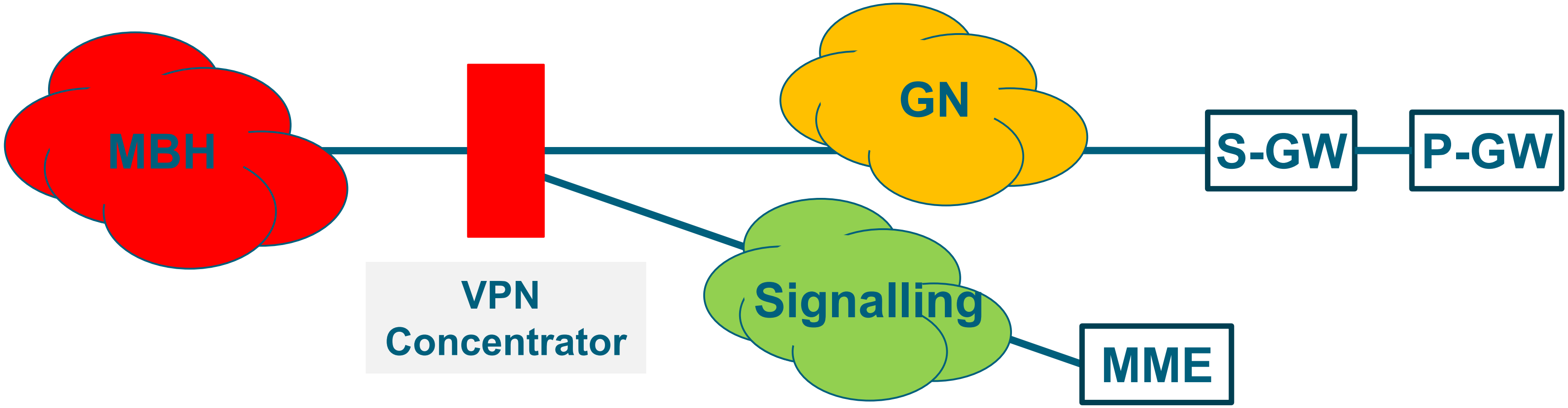
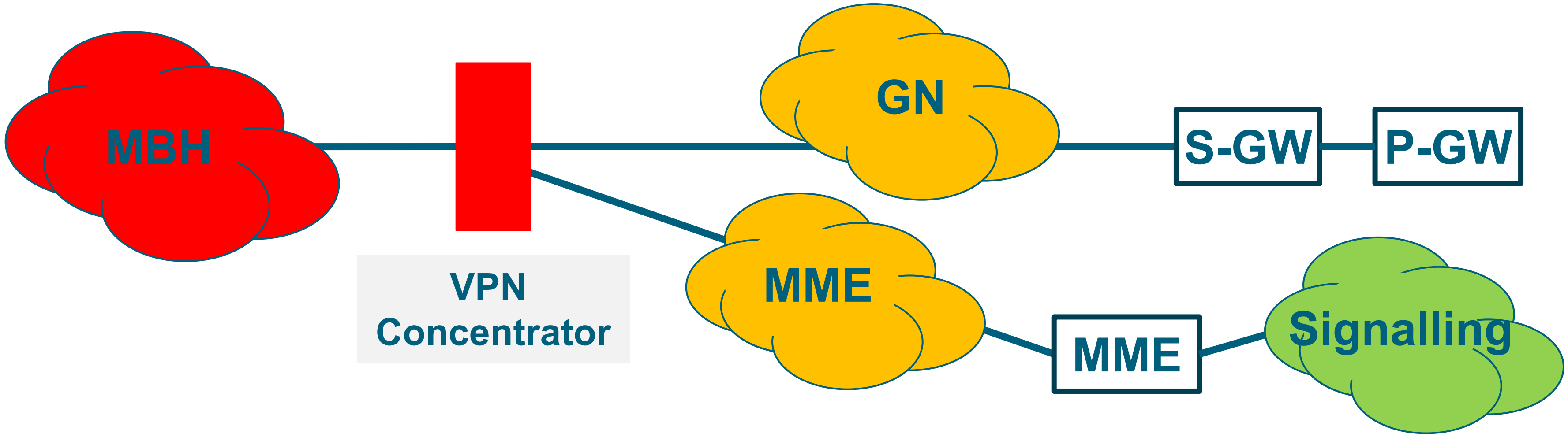
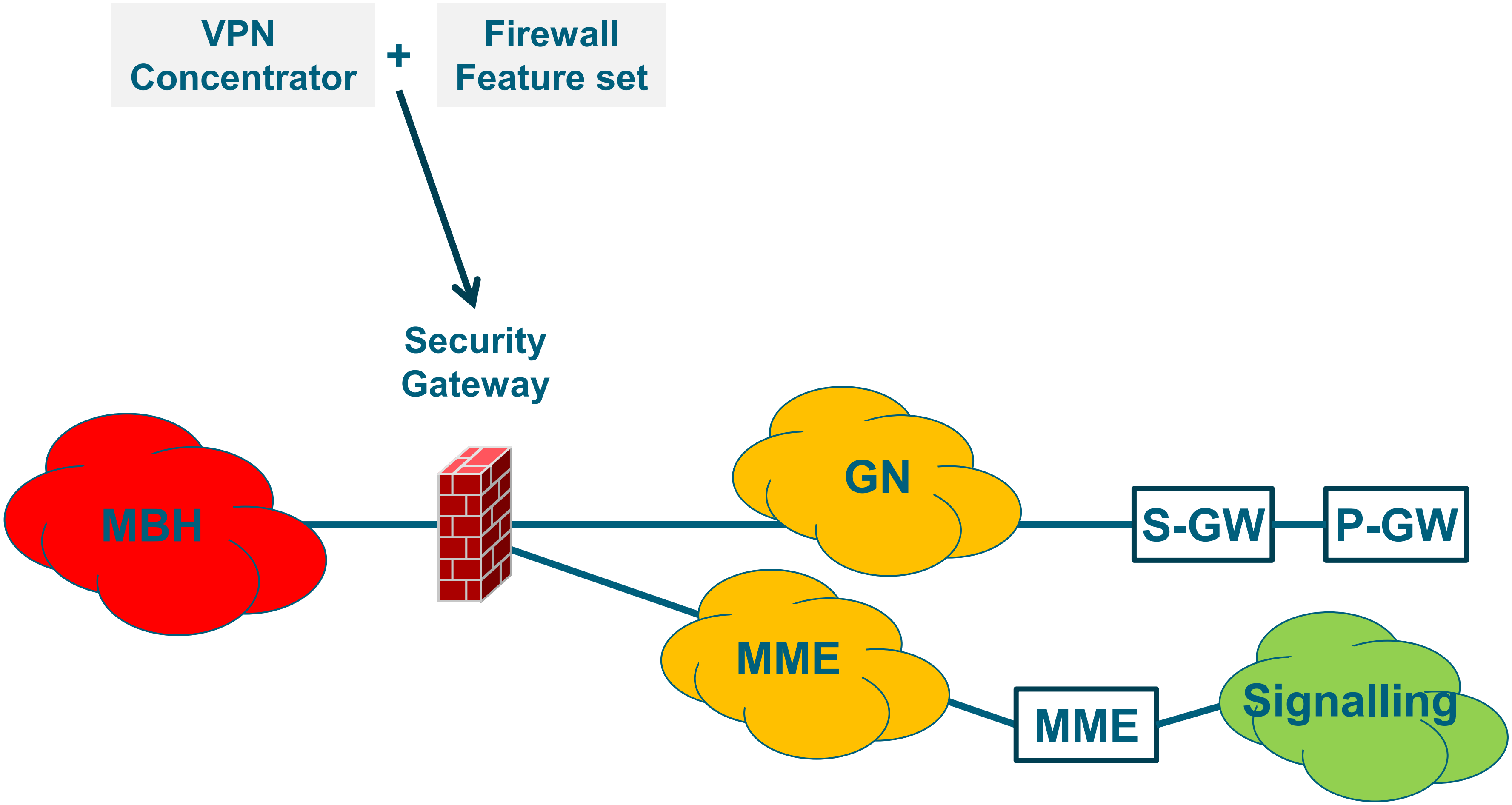


- **Do I want to connect my precious signalling infrastructure to MBH via VPN concentrator?**



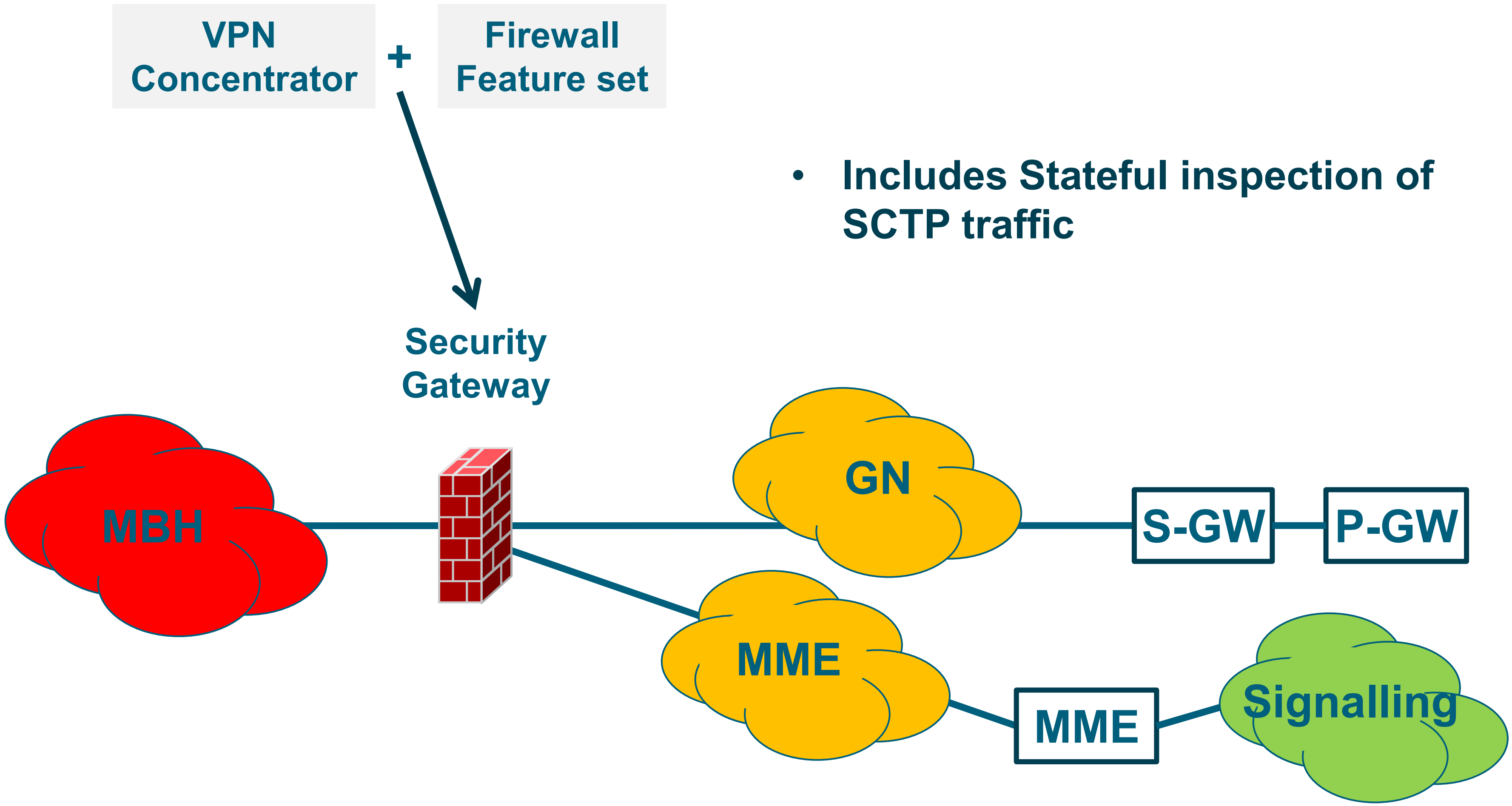
- **Dedicated Security domain for S1-MME interface on MME**

- Firewall feature set on LTE Security Gateway



- Dedicated Security domain for S1-MME interface on MME

- **Firewall feature set on LTE Security Gateway**



- **Includes Stateful inspection of SCTP traffic**

- **Dedicated Security domain for S1-MME interface on MME**

- **Telefónica UK deployed:-**

- **Huawei Eudemon 8000E-X3**
- **2 x 10Gbps ports**

- **Securing 2G and 3G alongside LTE**

		Secure when all IP?	Solution
LTE	OAM	No	IPSec
	UP	No	IPSec
	CP	No	IPSec
3G	OAM		
	UP		
	CP		
2G	OAM		
	UP		
	CP		

- **Securing 2G and 3G alongside LTE**

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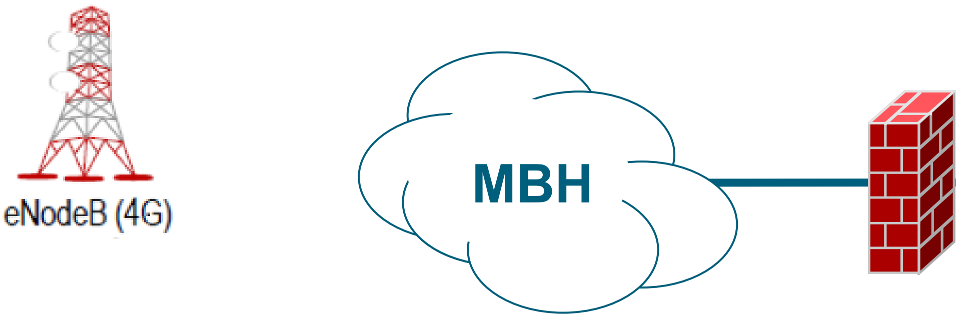
2G	OAM	No	IPSec
	UP	No	IPSec
	CP	No	IPSec

Securing 2G/3G

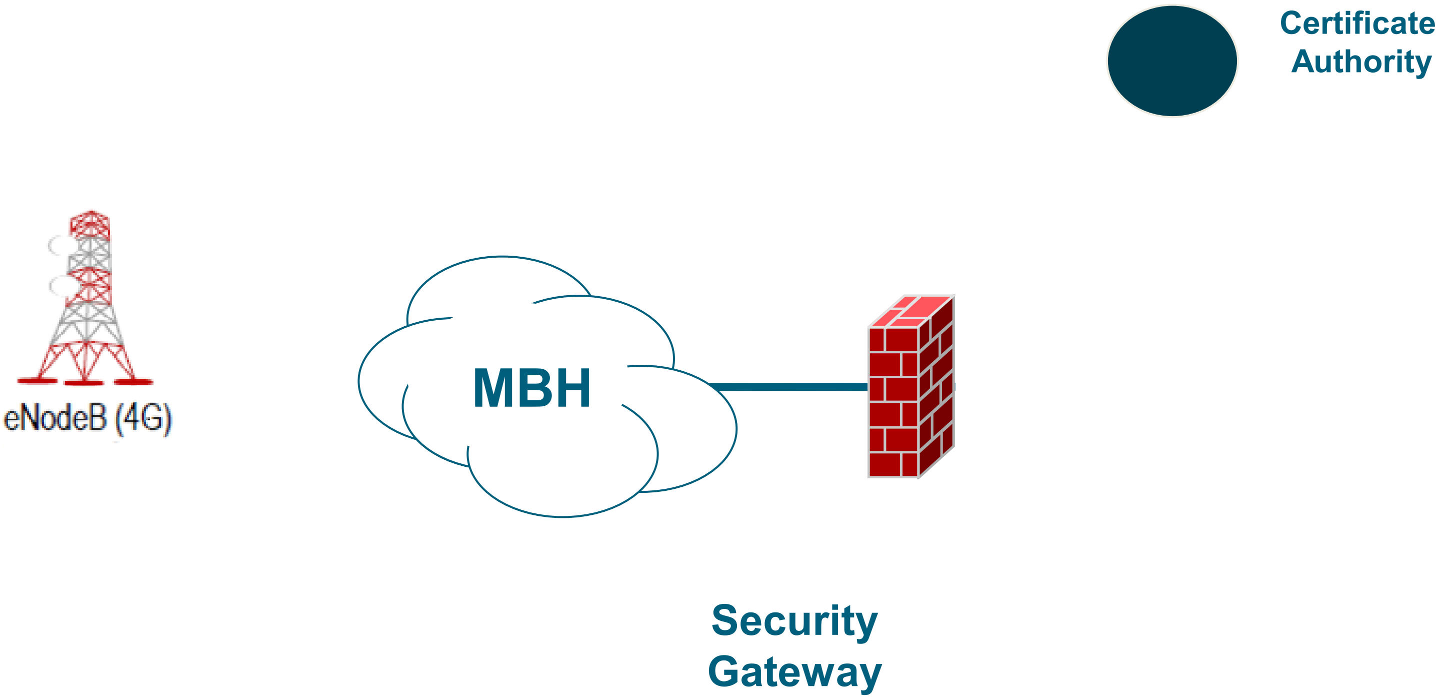
- Vendor support for IPSec on 2G/3G is coming………
- Do you want to put all your eggs in one basket?

- **Certificates**



Security Gateway

- **Certificates**



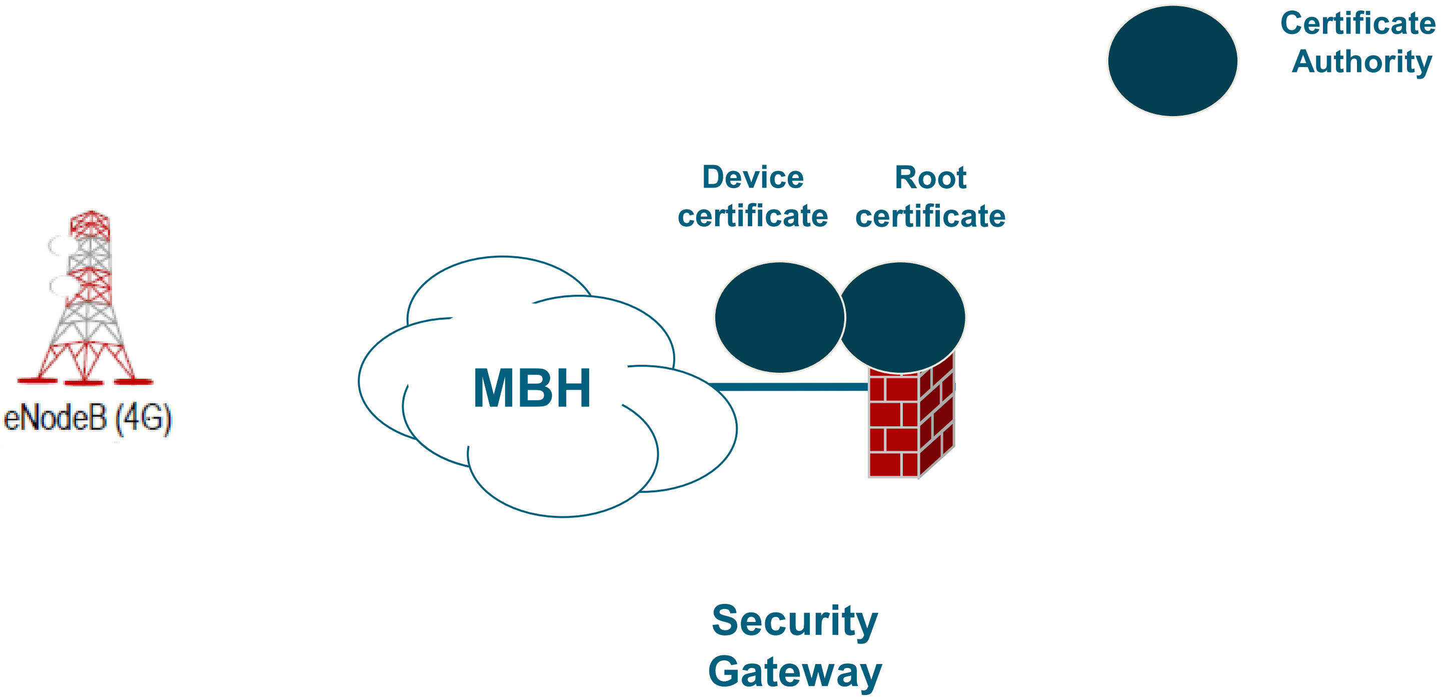
Certificate Authority

eNodeB (4G)

MBH

Security Gateway

- **Certificates**



Certificate Authority

Device certificate

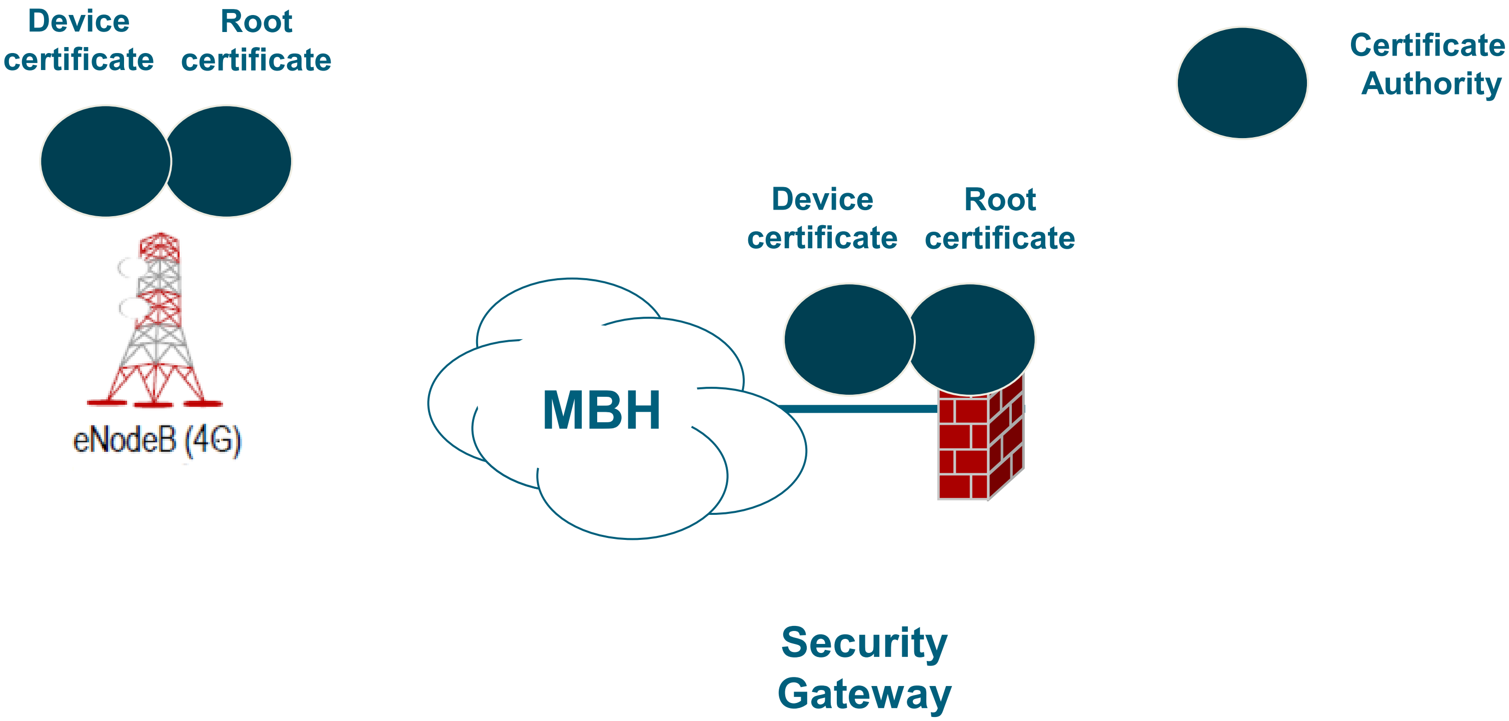
Root certificate

eNodeB (4G)

MBH

Security Gateway

- **Certificates**



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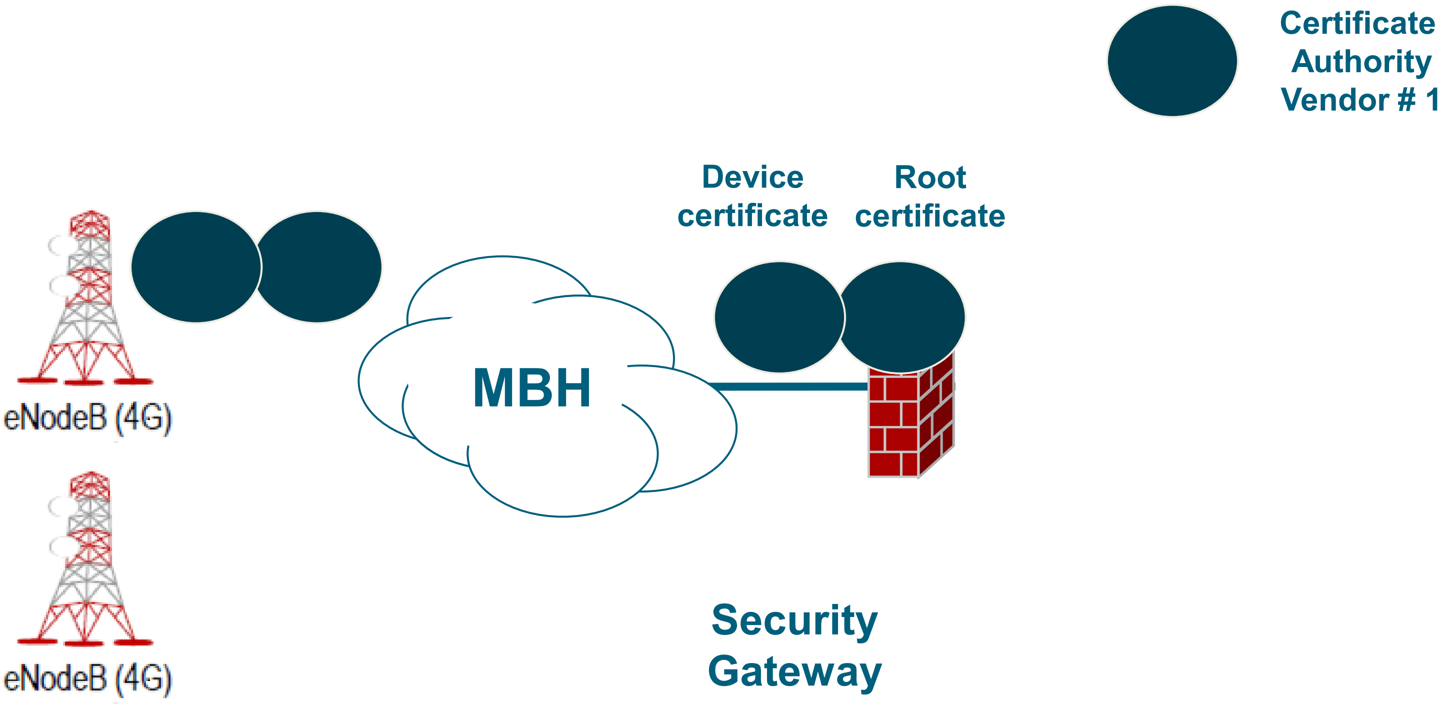

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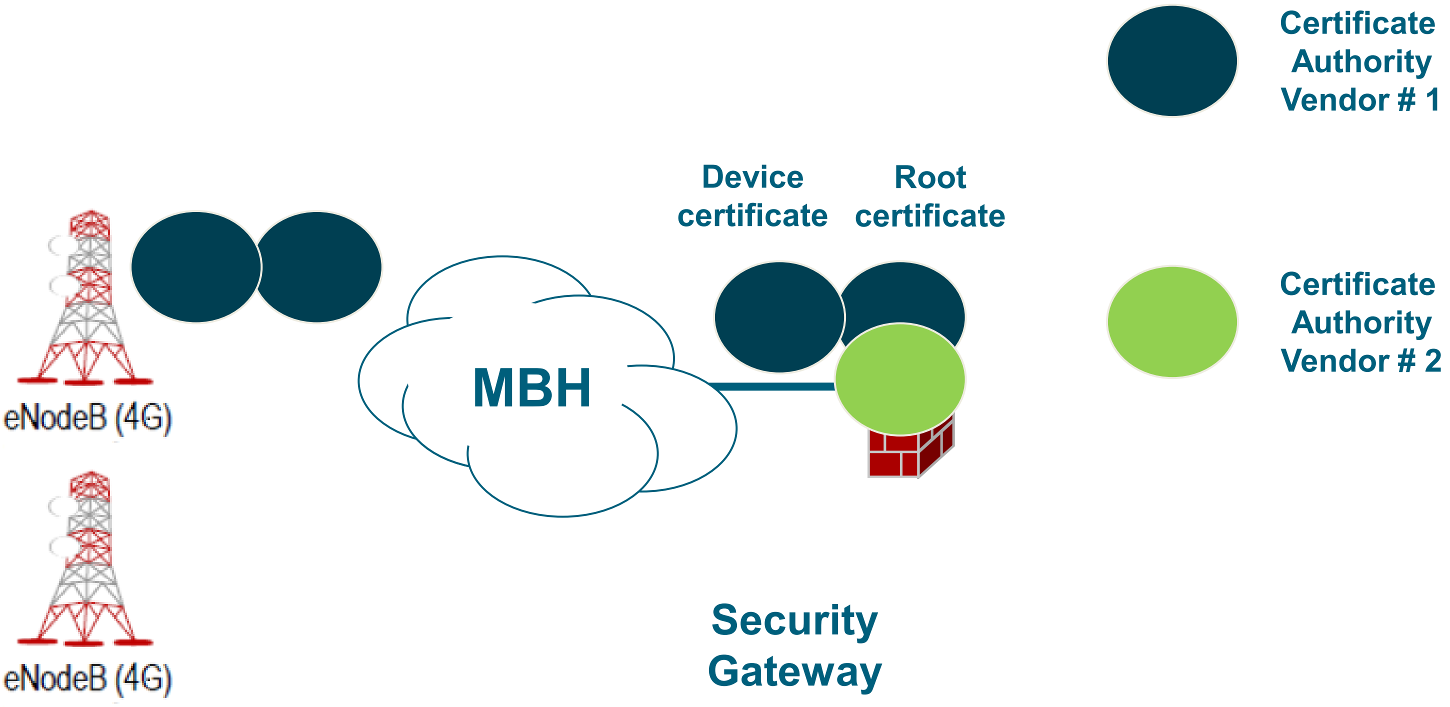

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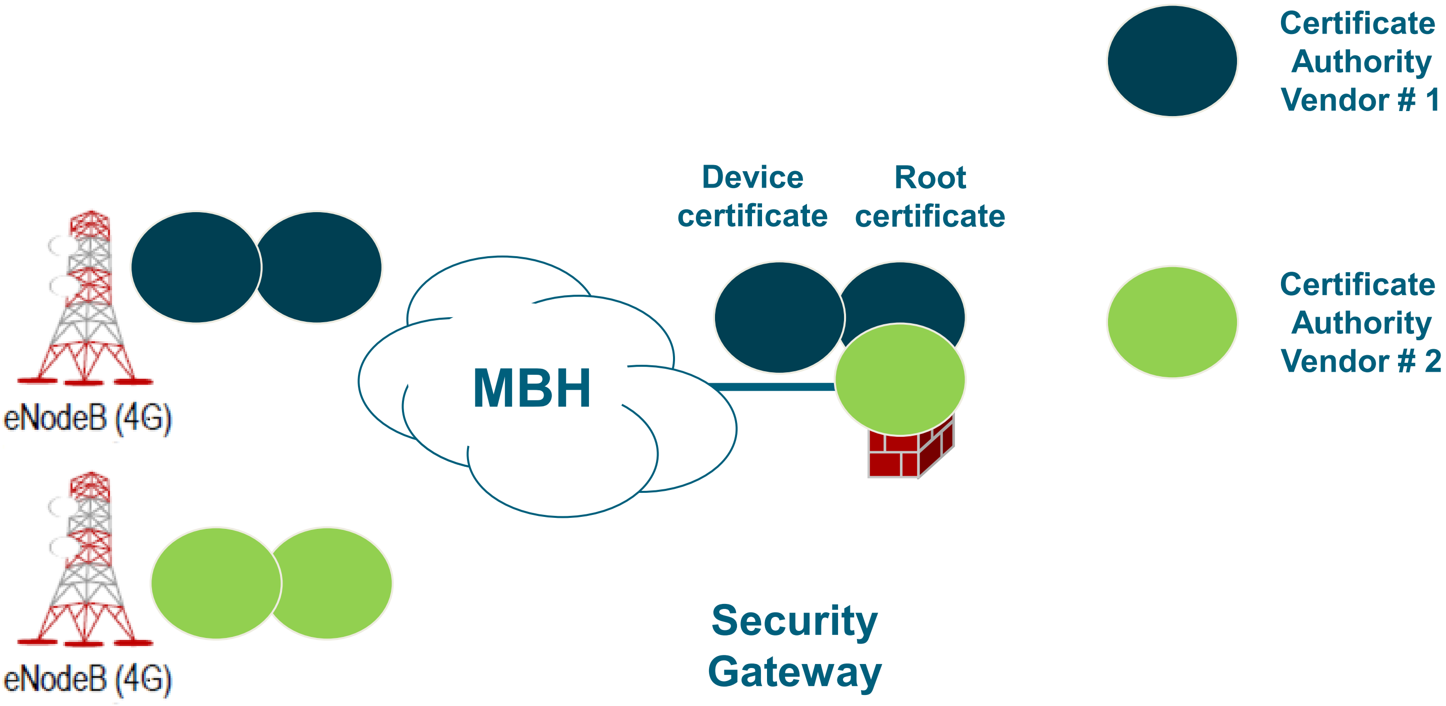


Certificate Authority Vendor # 1

Certificate Authority Vendor # 2

Device certificate

Root certificate

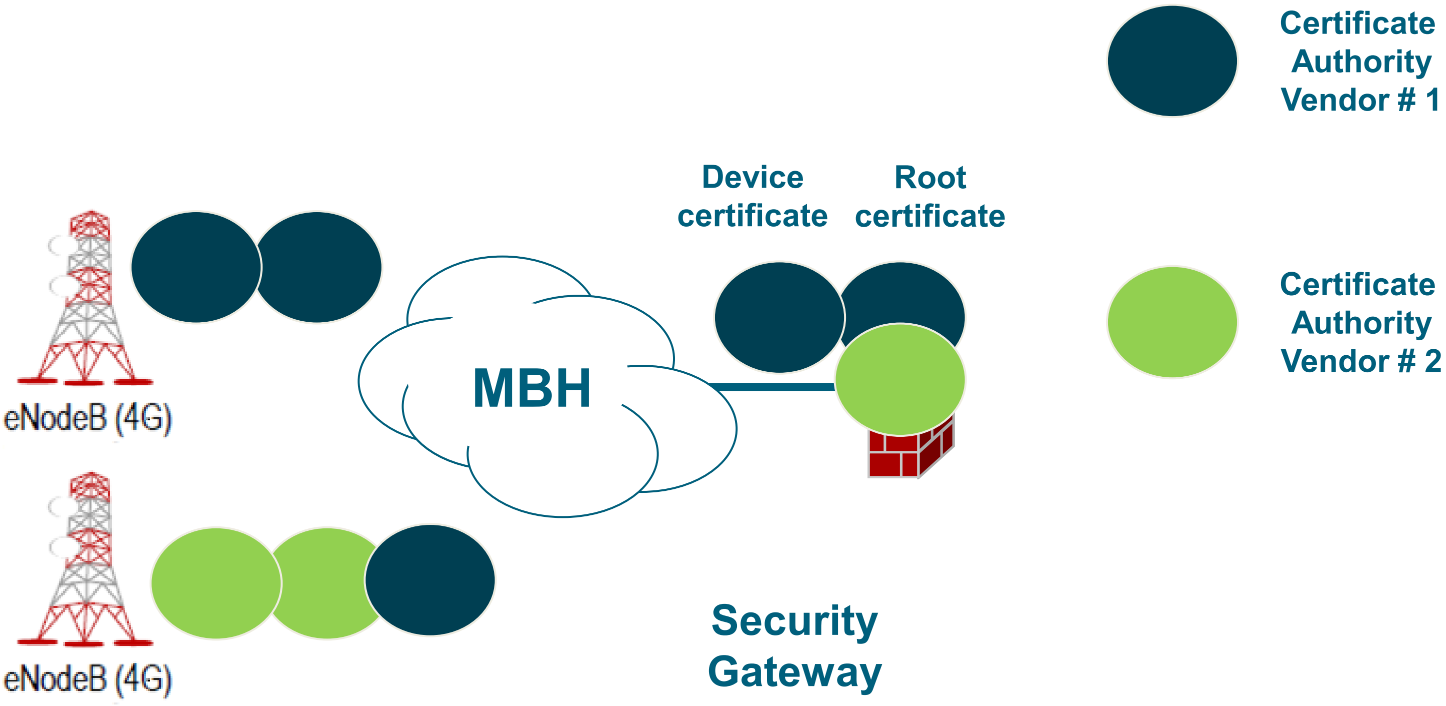
MBH

eNodeB (4G)

eNodeB (4G)

Security Gateway

- **Certificates**



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eNodeB (4G)

eNodeB (4G)

Security Gateway

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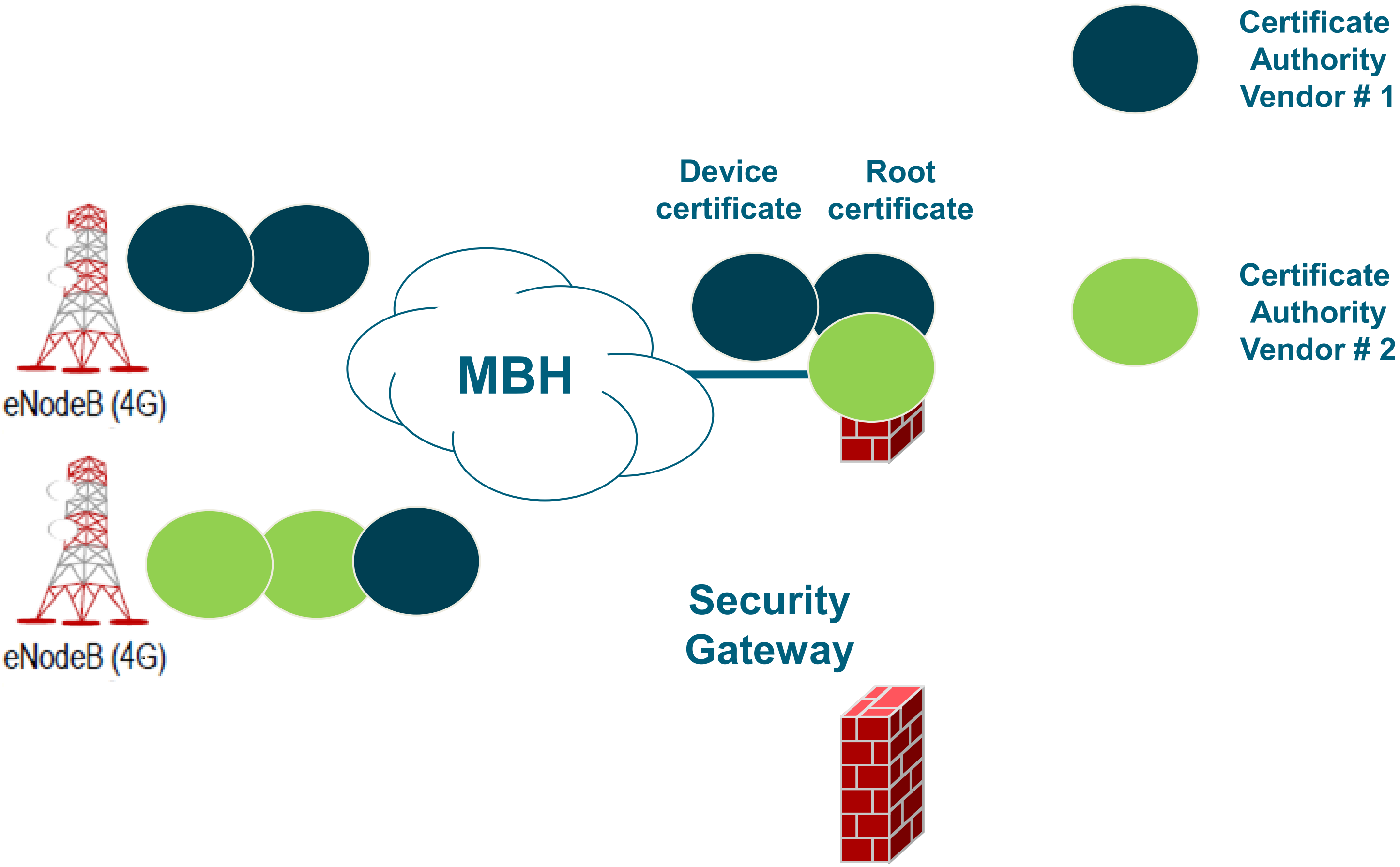

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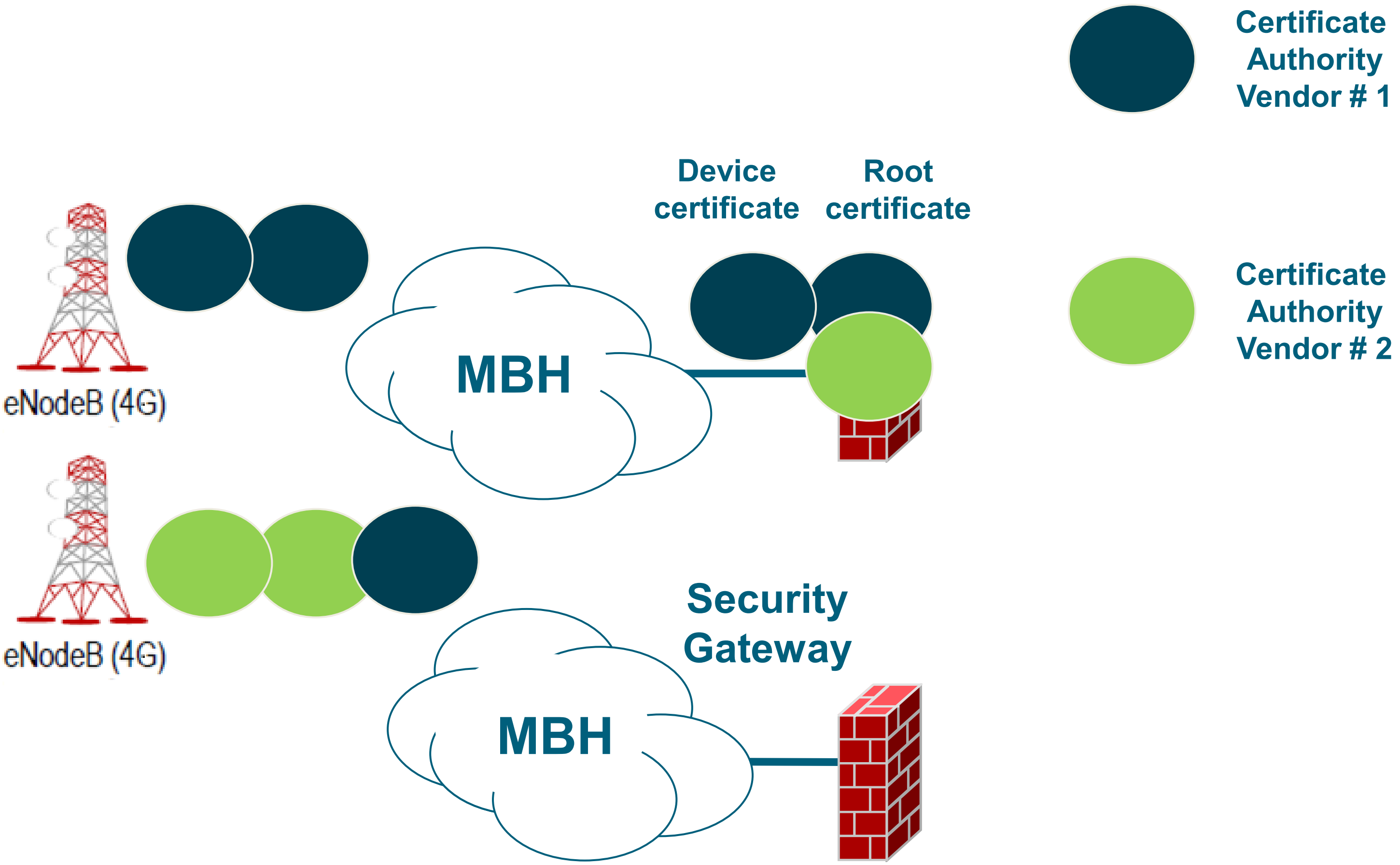

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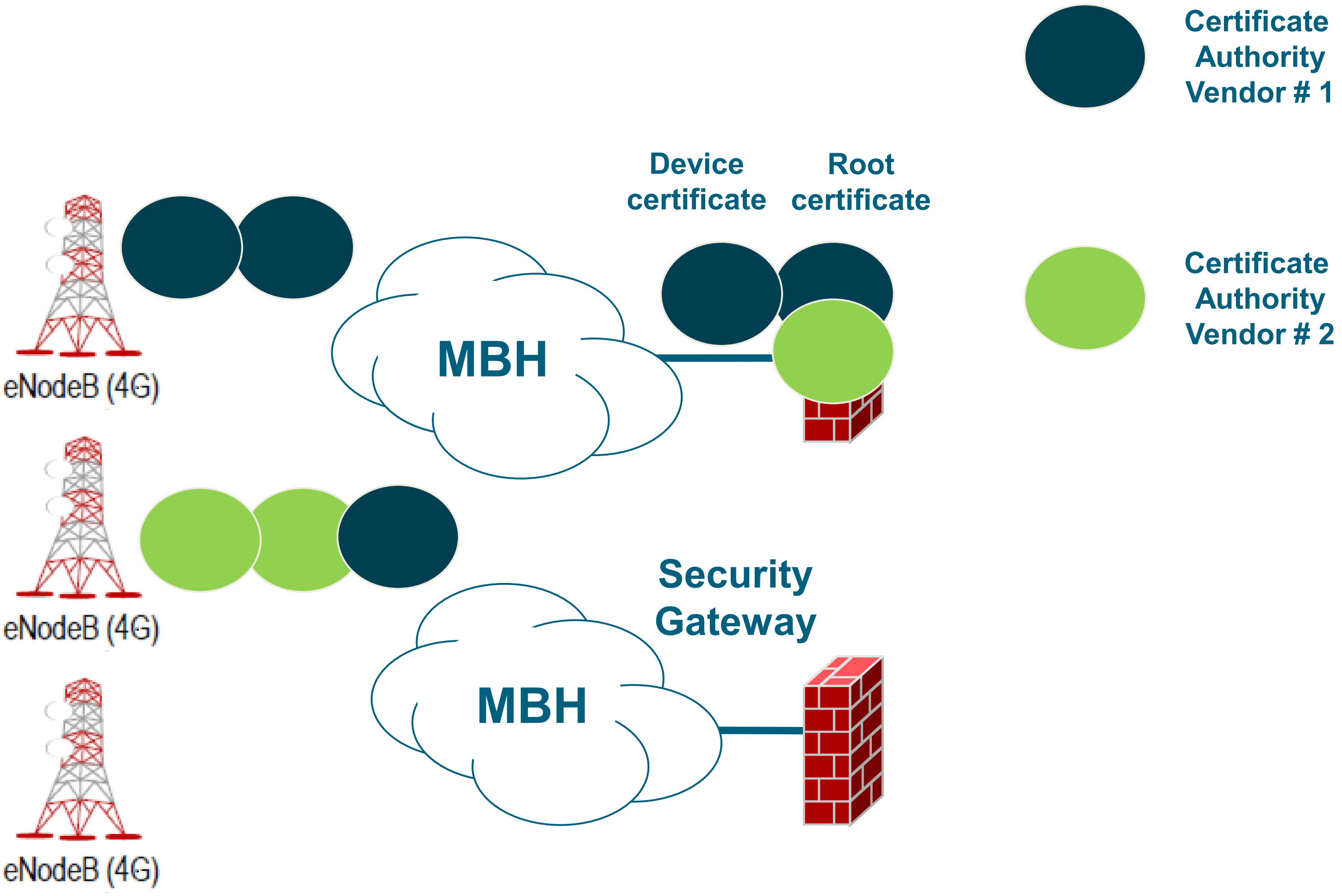

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MBH

MBH

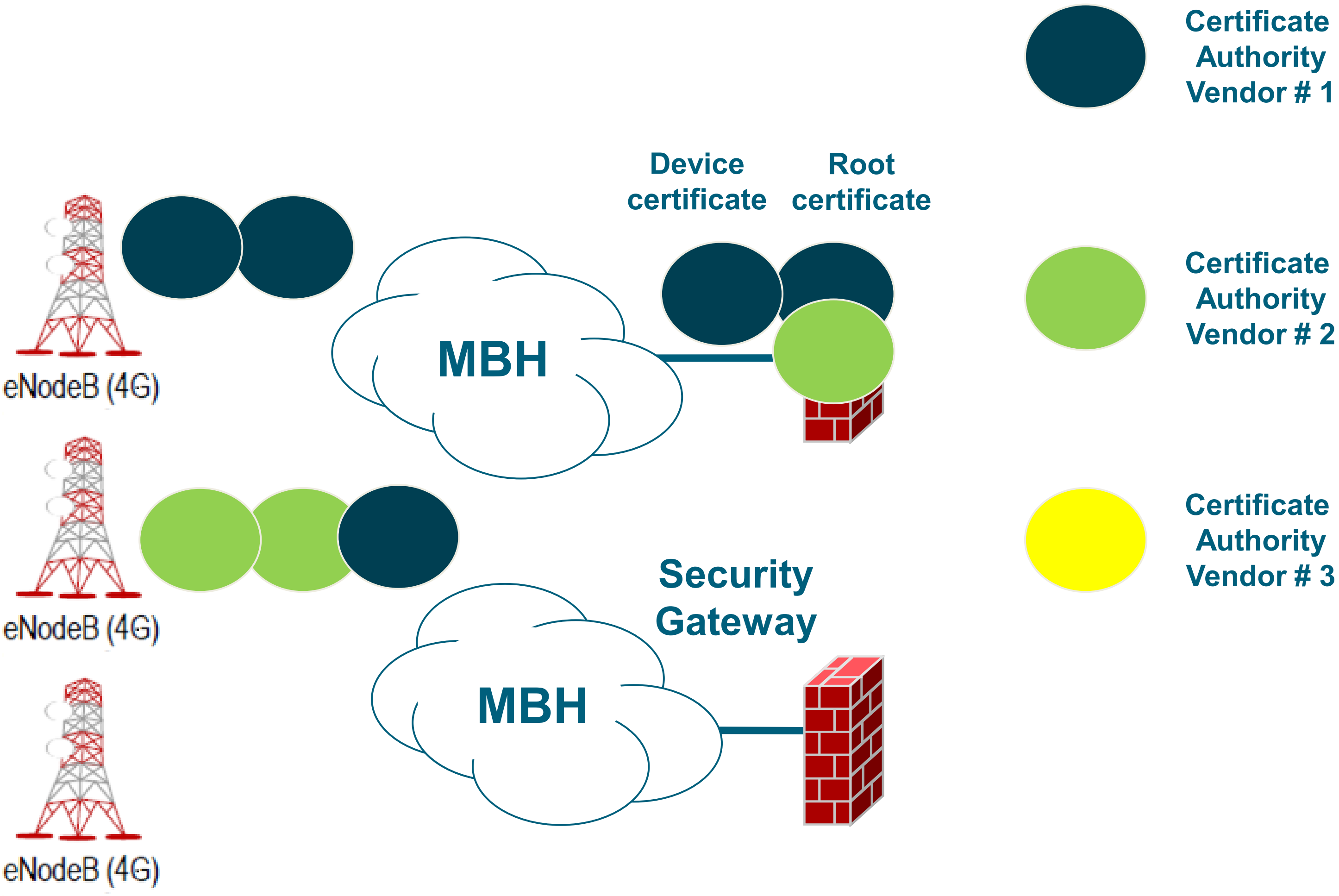
Security Gateway

eNodeB (4G)

eNodeB (4G)

eNodeB (4G)

- **Certificates**



Device certificate

Root certificate

MBH

MBH

Security Gateway

eNodeB (4G)

eNodeB (4G)

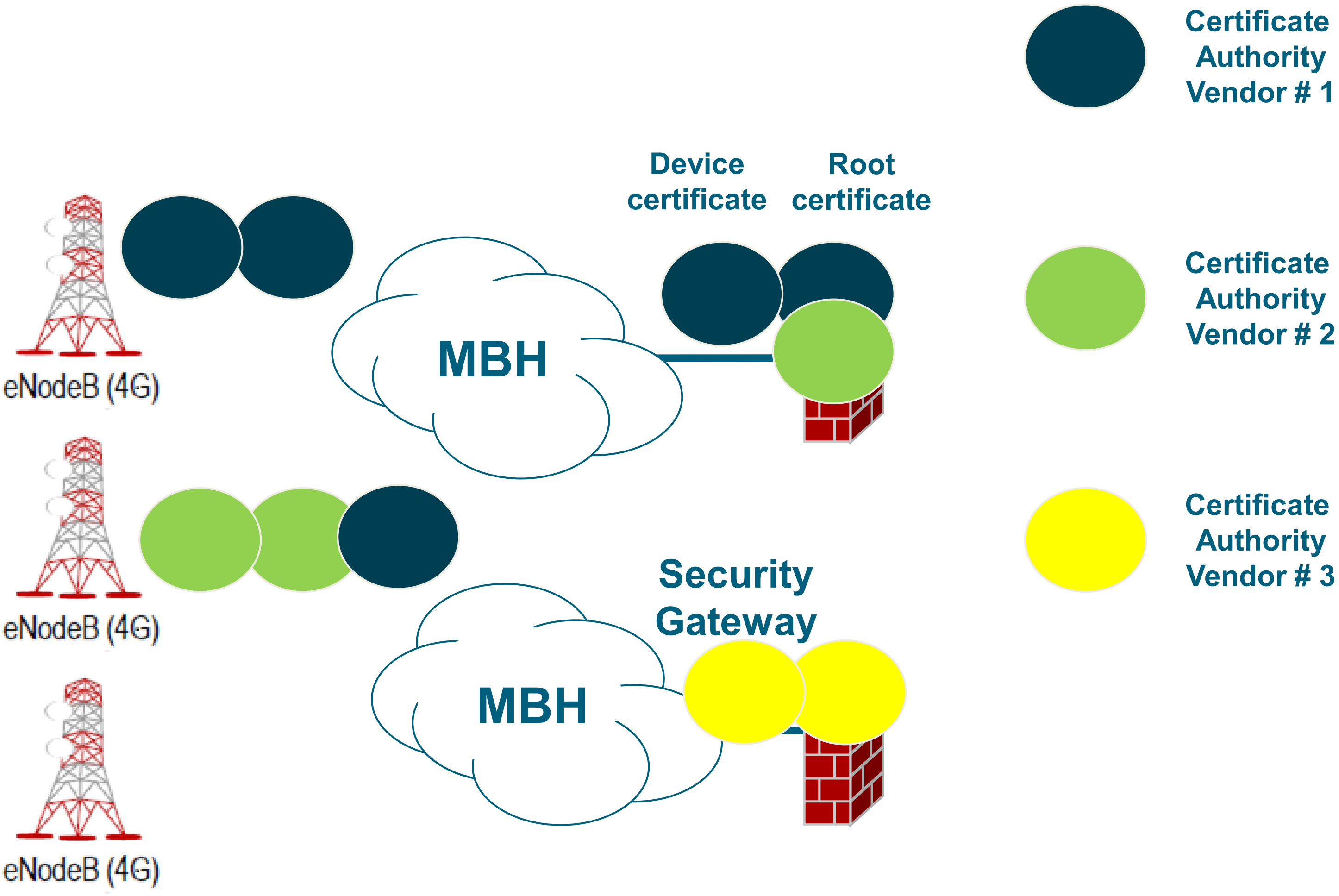
eNodeB (4G)

Certificate Authority Vendor # 1

Certificate Authority Vendor # 2

Certificate Authority Vendor # 3

- **Certificates**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eNodeB (4G)
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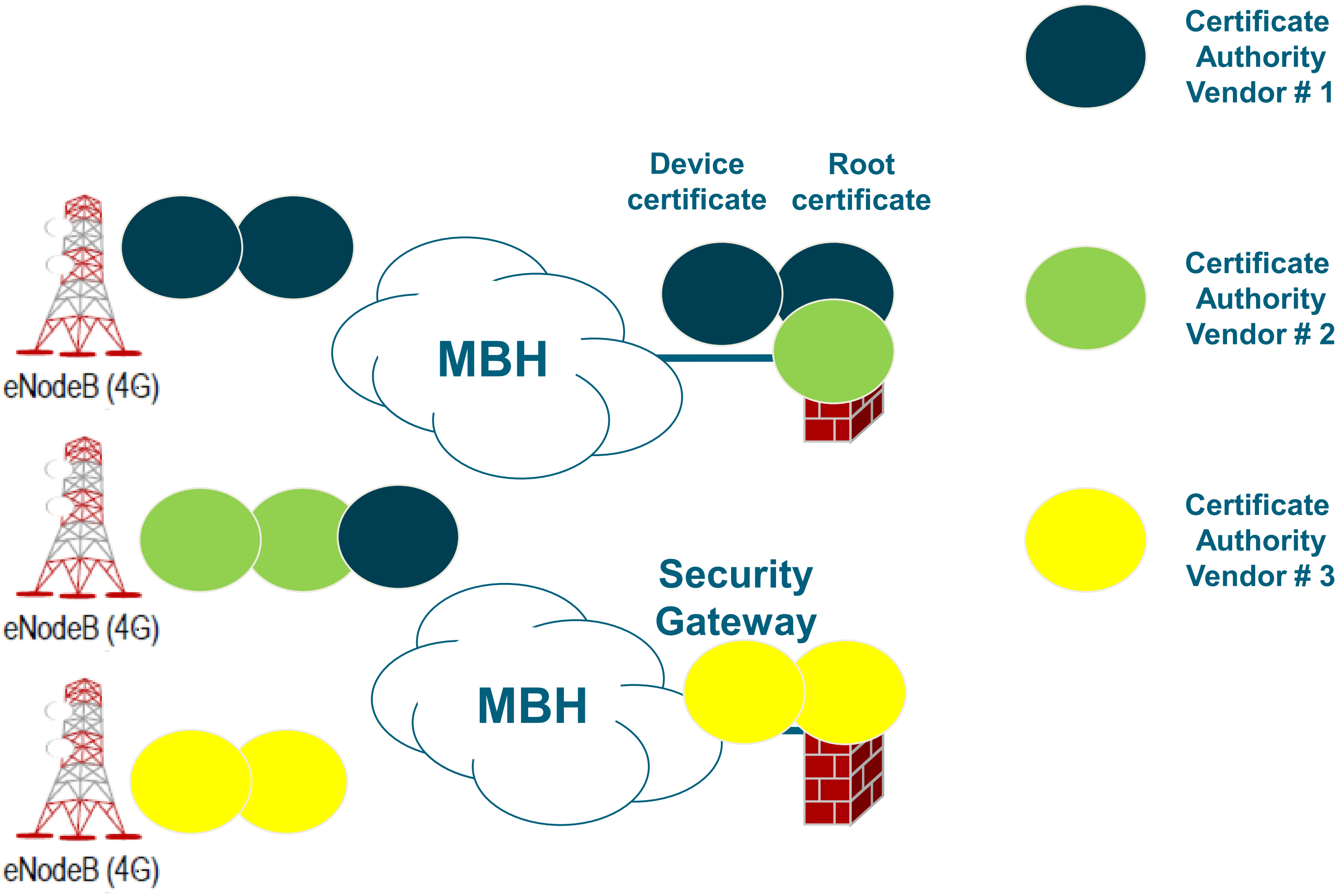
Certificates



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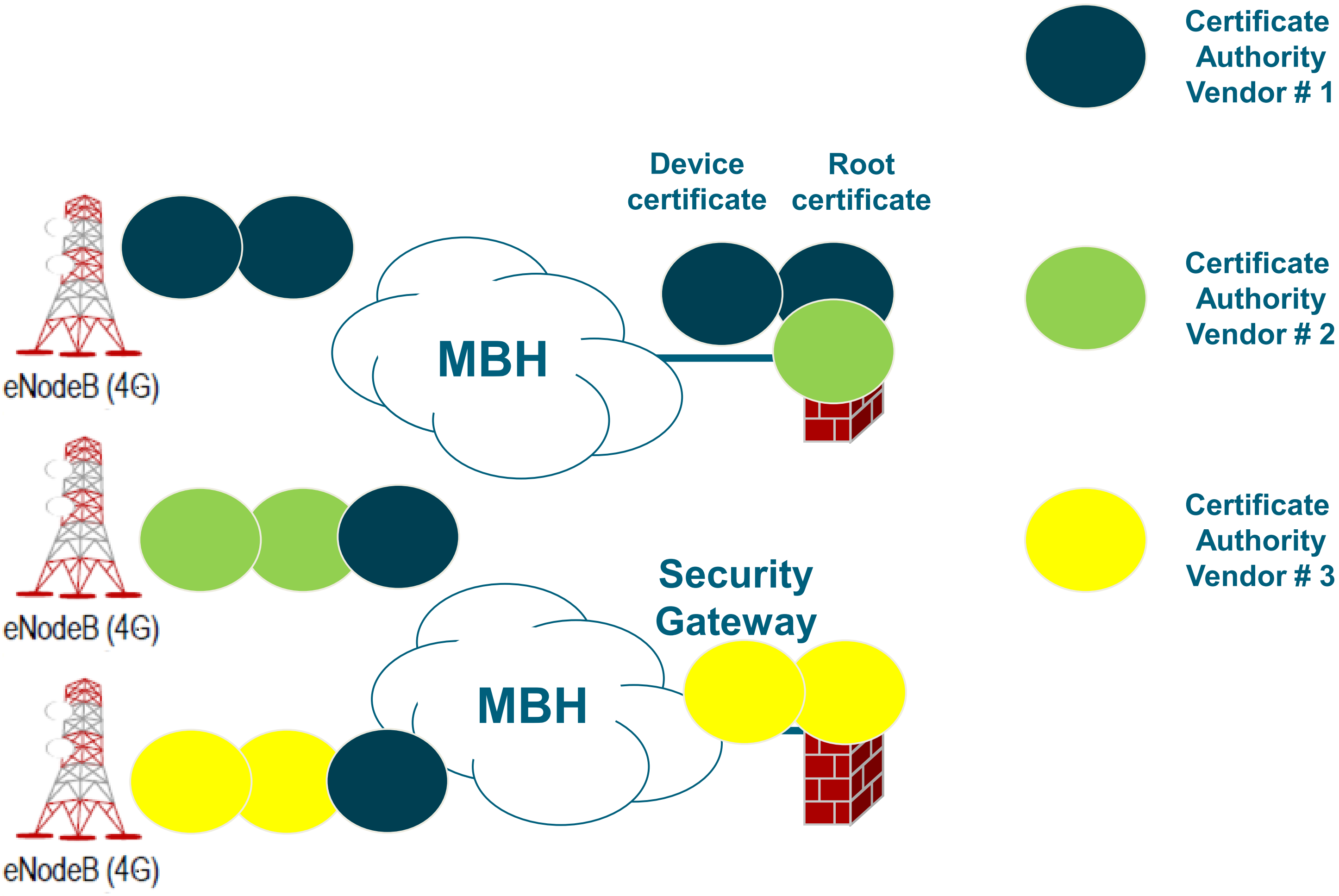
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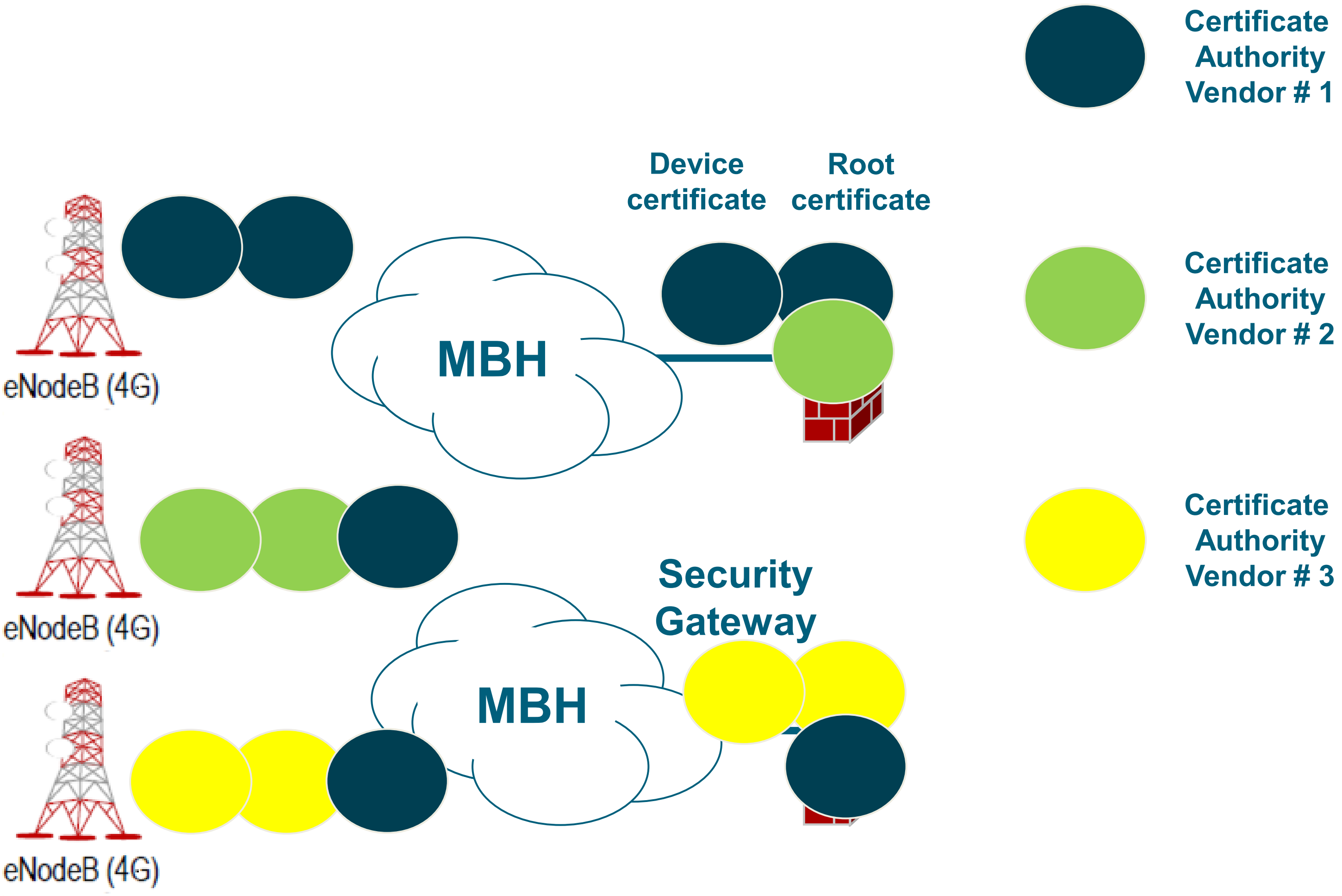

Certificate Authority Vendor # 1

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Device certificate

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MBH

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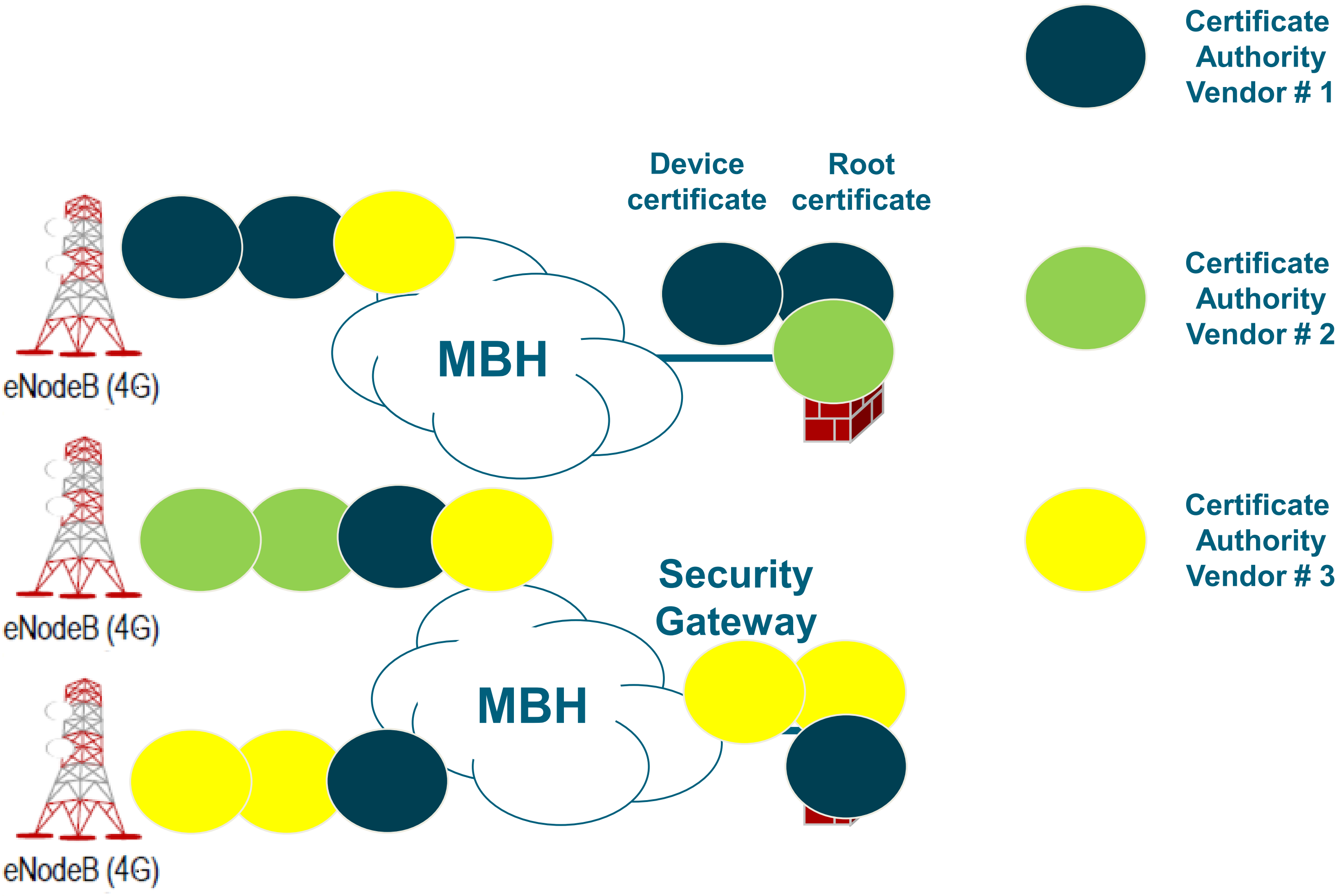
Security Gateway

eNodeB (4G)

eNodeB (4G)

eNodeB (4G)

- **Certificates**



● Certificate Authority Vendor # 1

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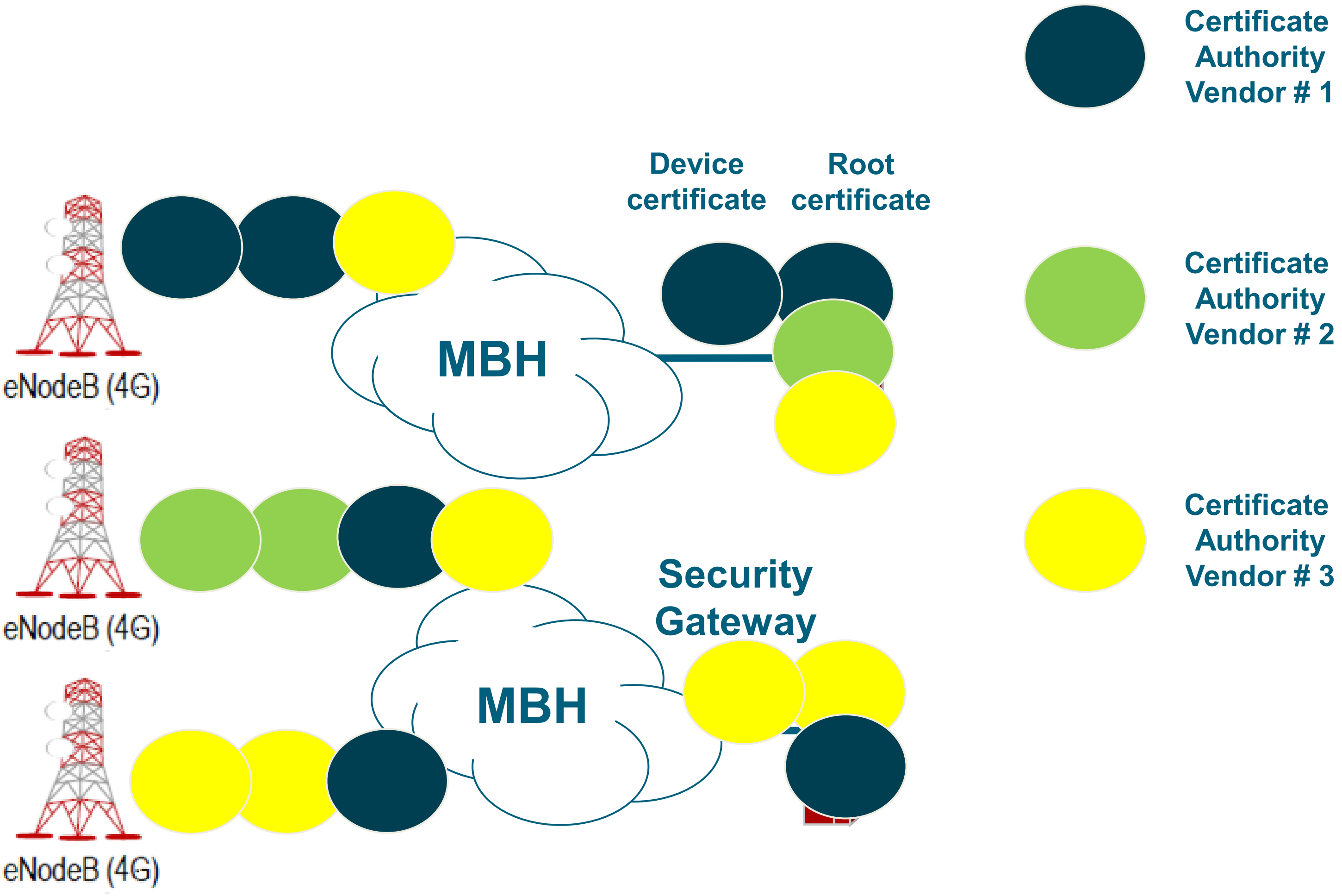

Device certificate

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Security Gateway

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Certificate Authority Vendor # 1

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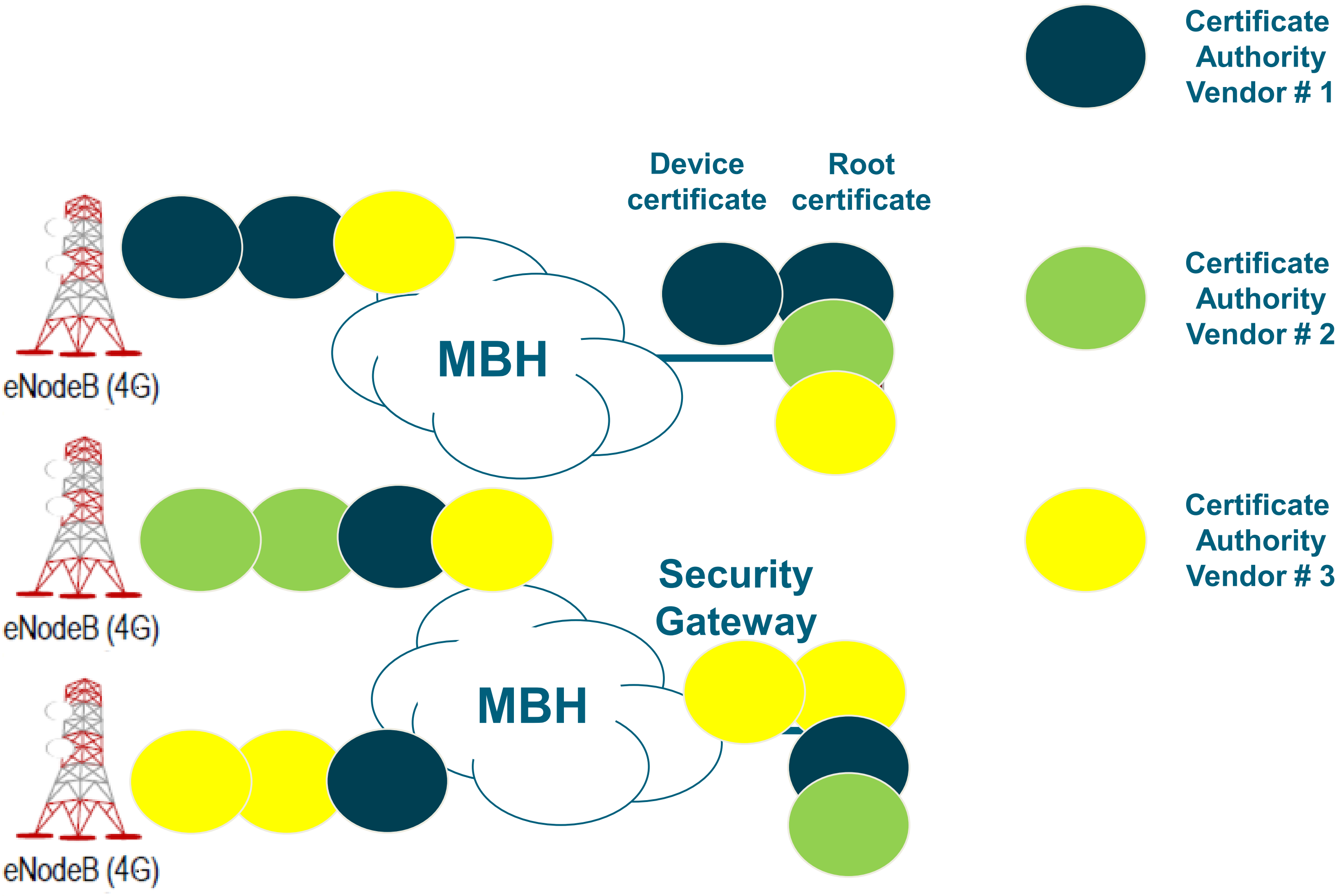
- **Certificates**



Device certificate

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Security Gateway

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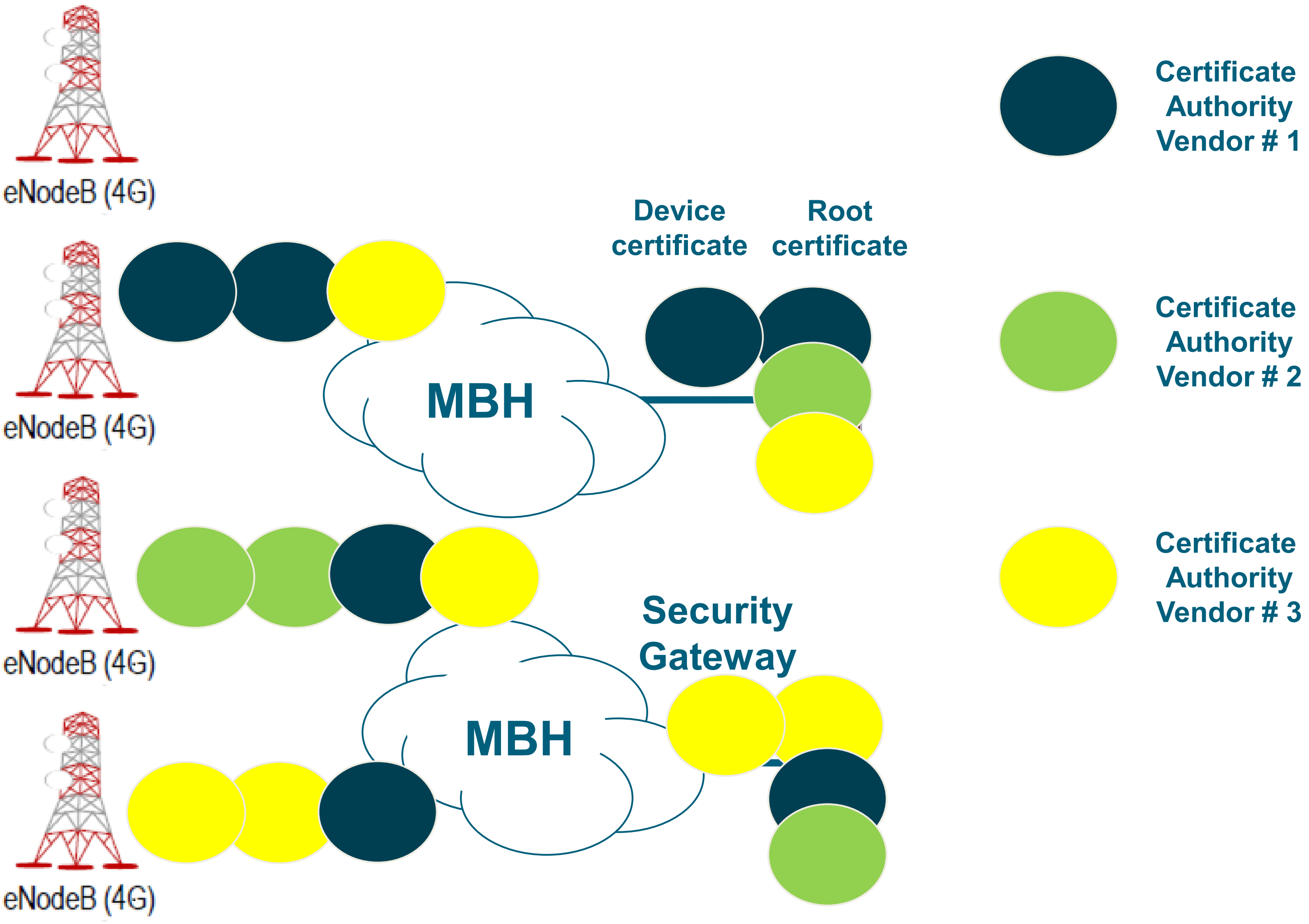

eNodeB (4G)

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eNodeB (4G)

MBH

MBH

Device certificate

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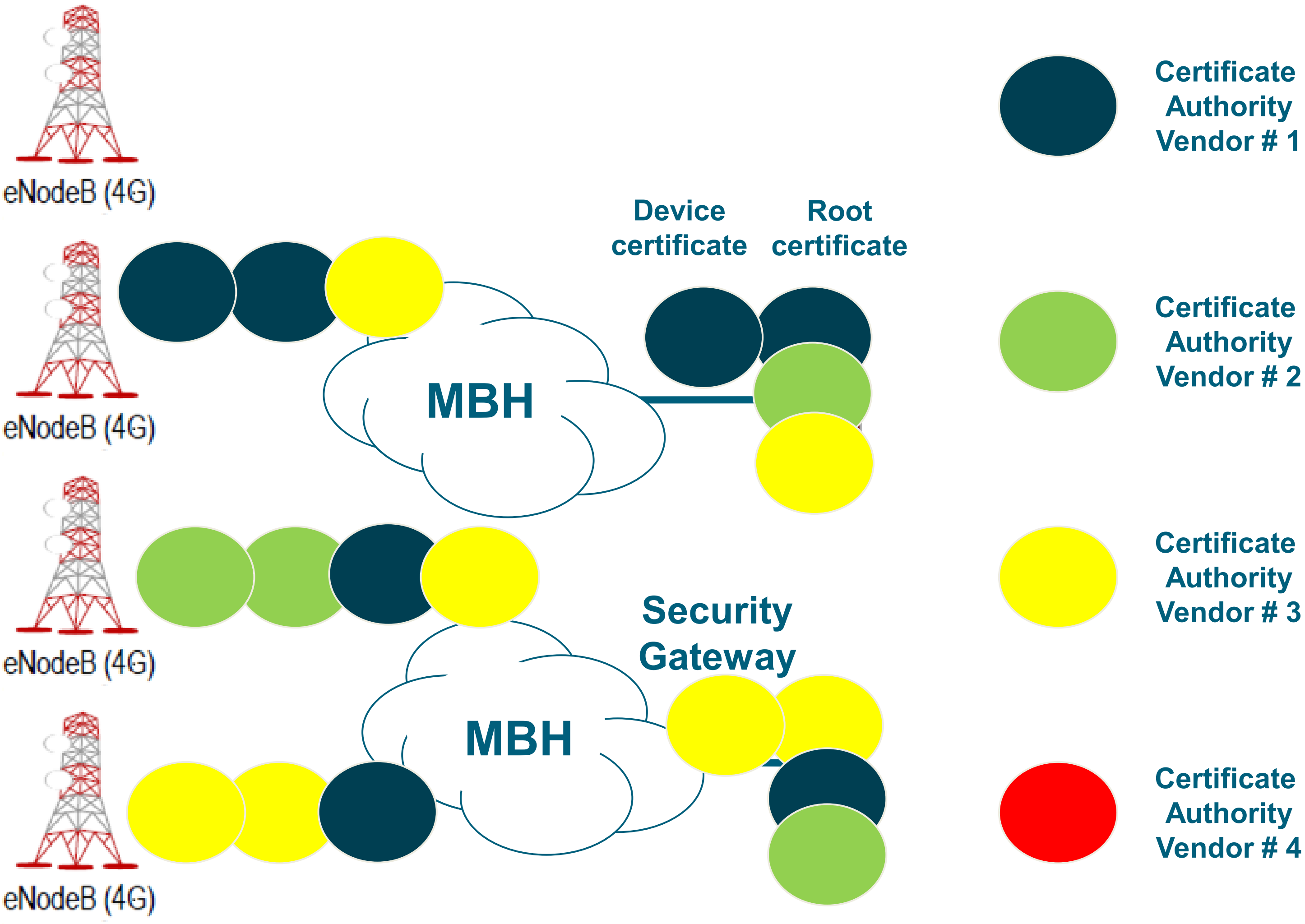
- **Certificates**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Certificate Authority Vendor # 4

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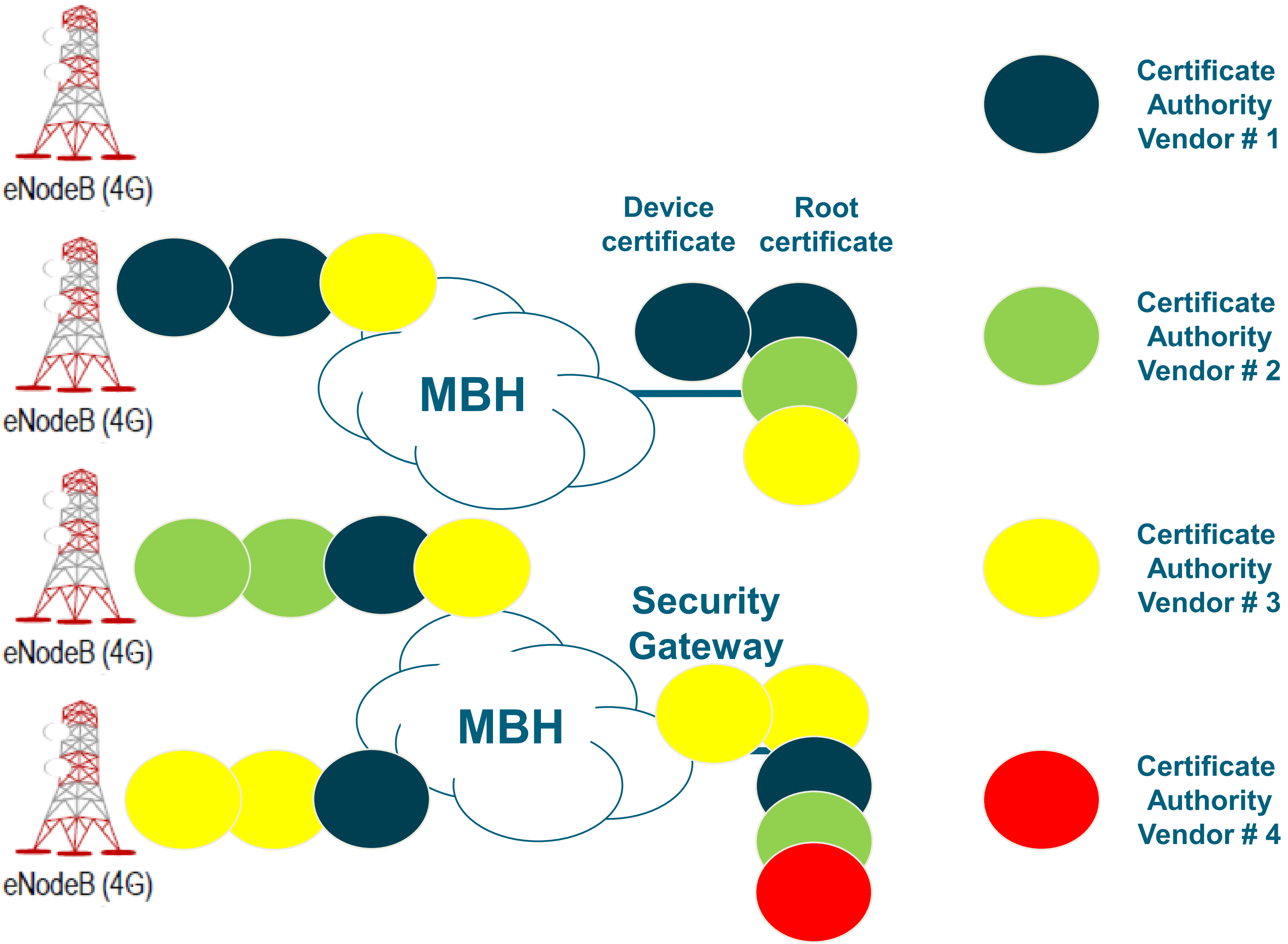

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Certificate Authority Vendor # 4

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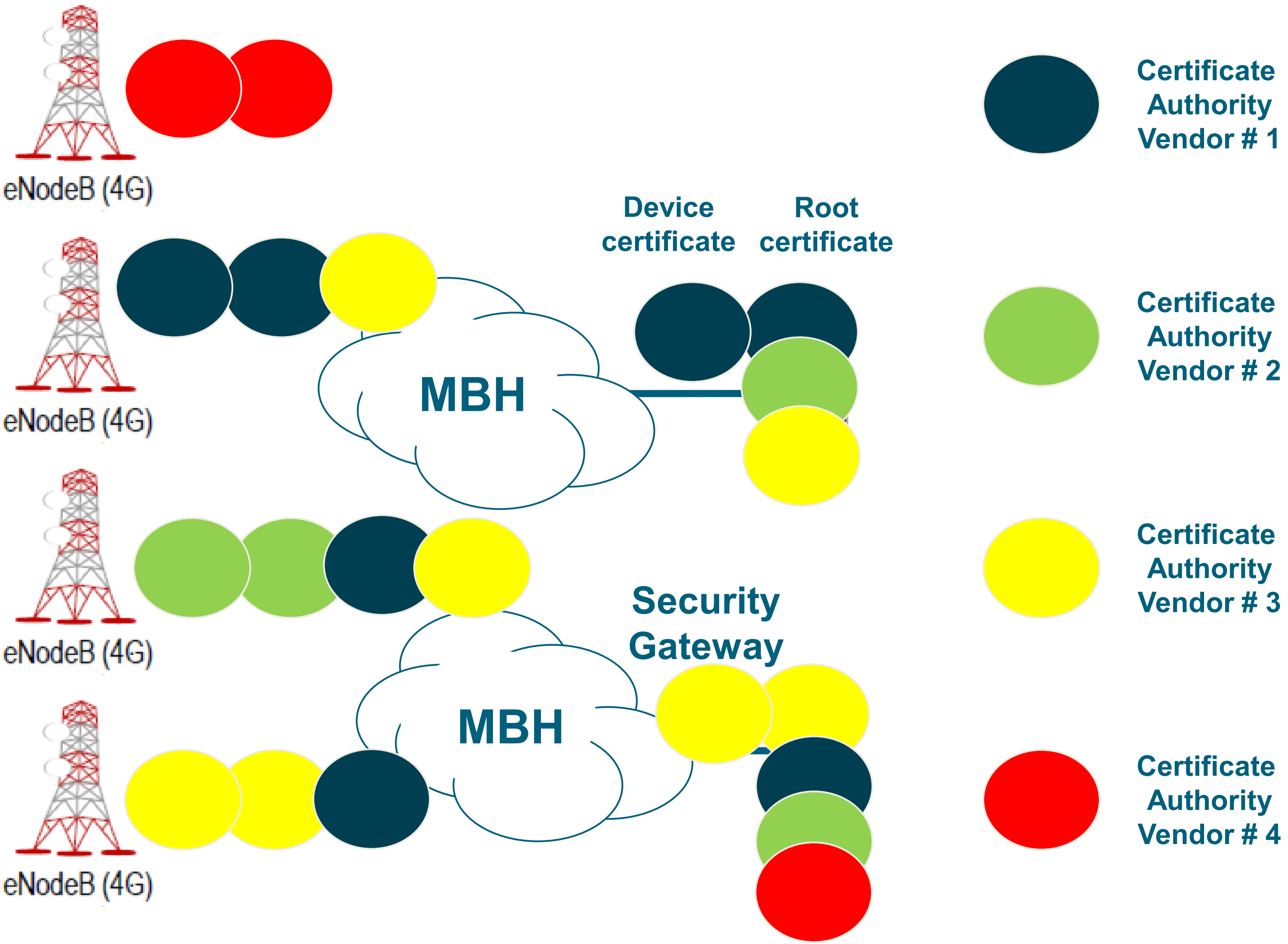

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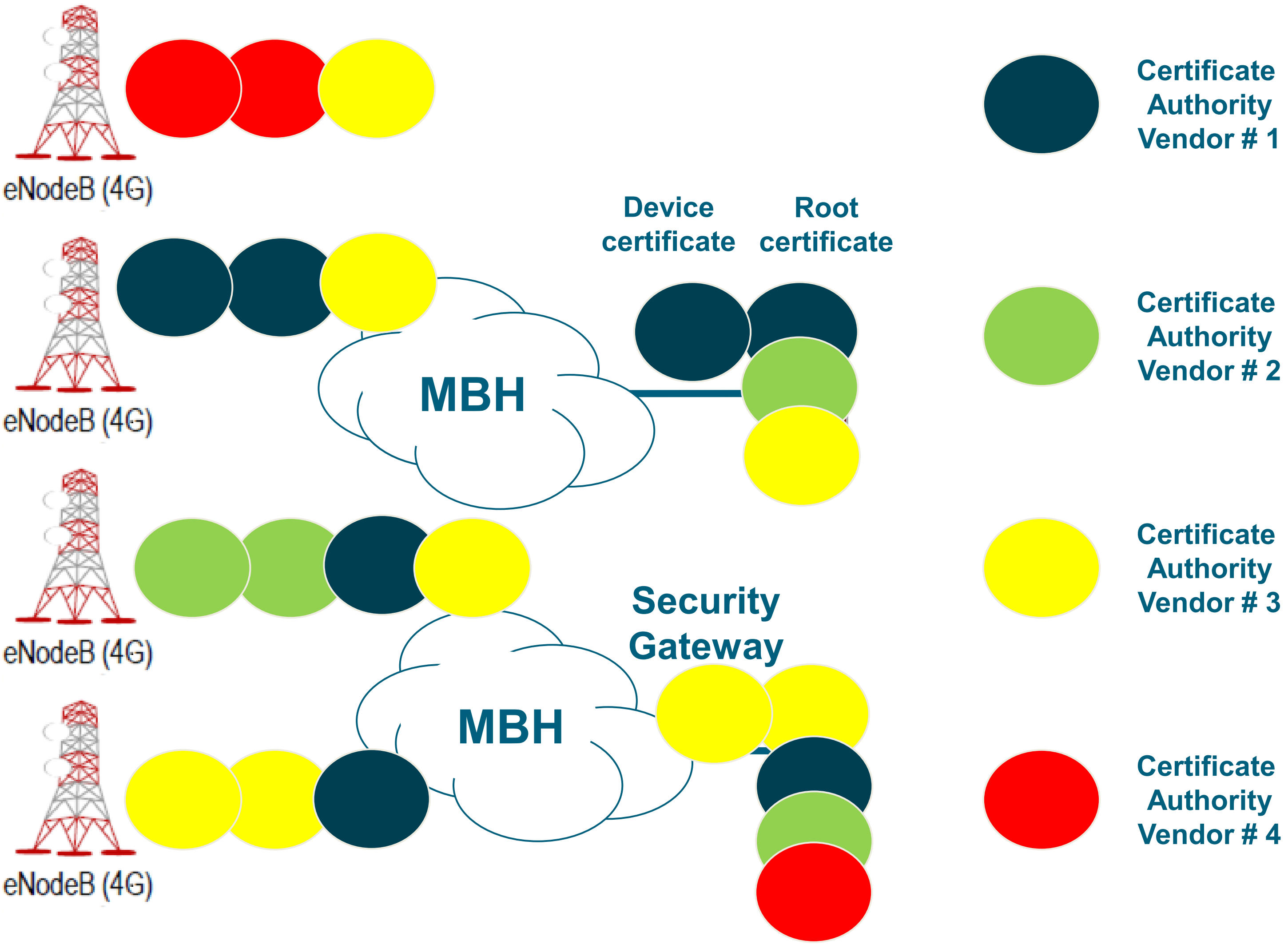
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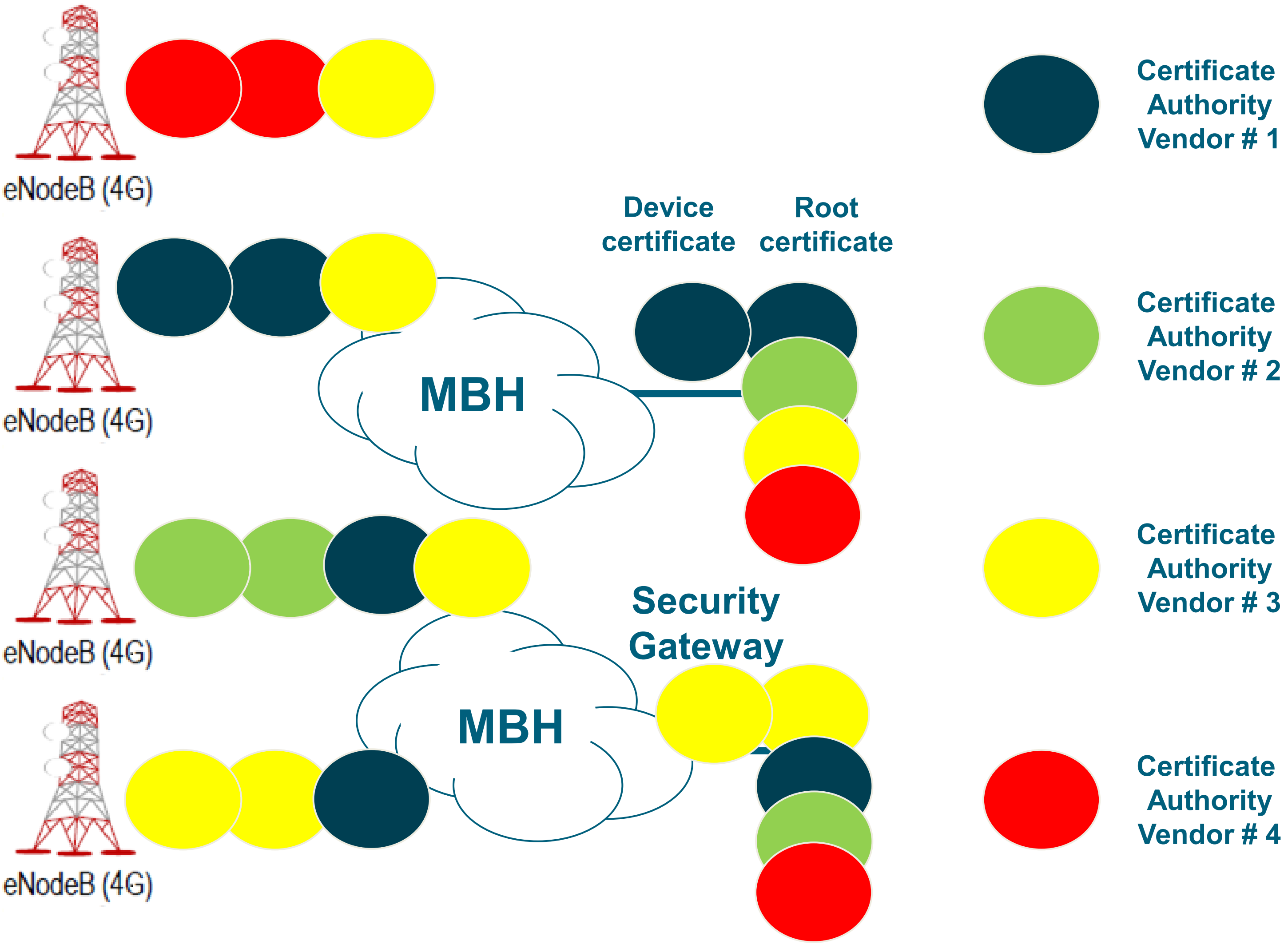
Certificate Authority Vendor # 4

- **Certificates**



eNodeB (4G)

eNodeB (4G)

eNodeB (4G)

eNodeB (4G)

MBH

MBH

Device certificate

Root certificate

Security Gateway

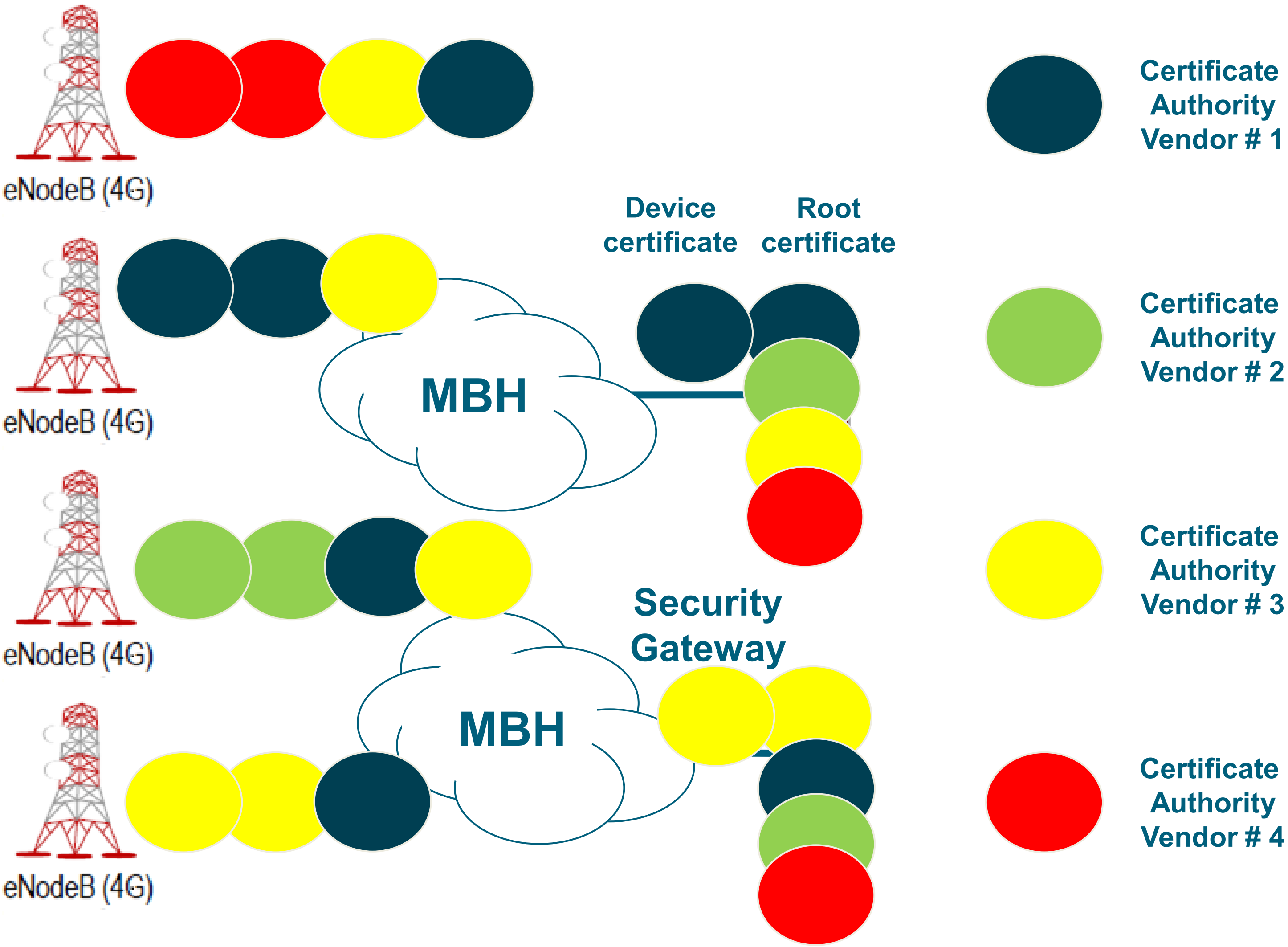
Certificate Authority Vendor # 1

Certificate Authority Vendor # 2

Certificate Authority Vendor # 3

Certificate Authority Vendor # 4

- **Certificates**



eNodeB (4G)

eNodeB (4G)

eNodeB (4G)

eNodeB (4G)

MBH

MBH

Device certificate

Root certificate

Security Gateway

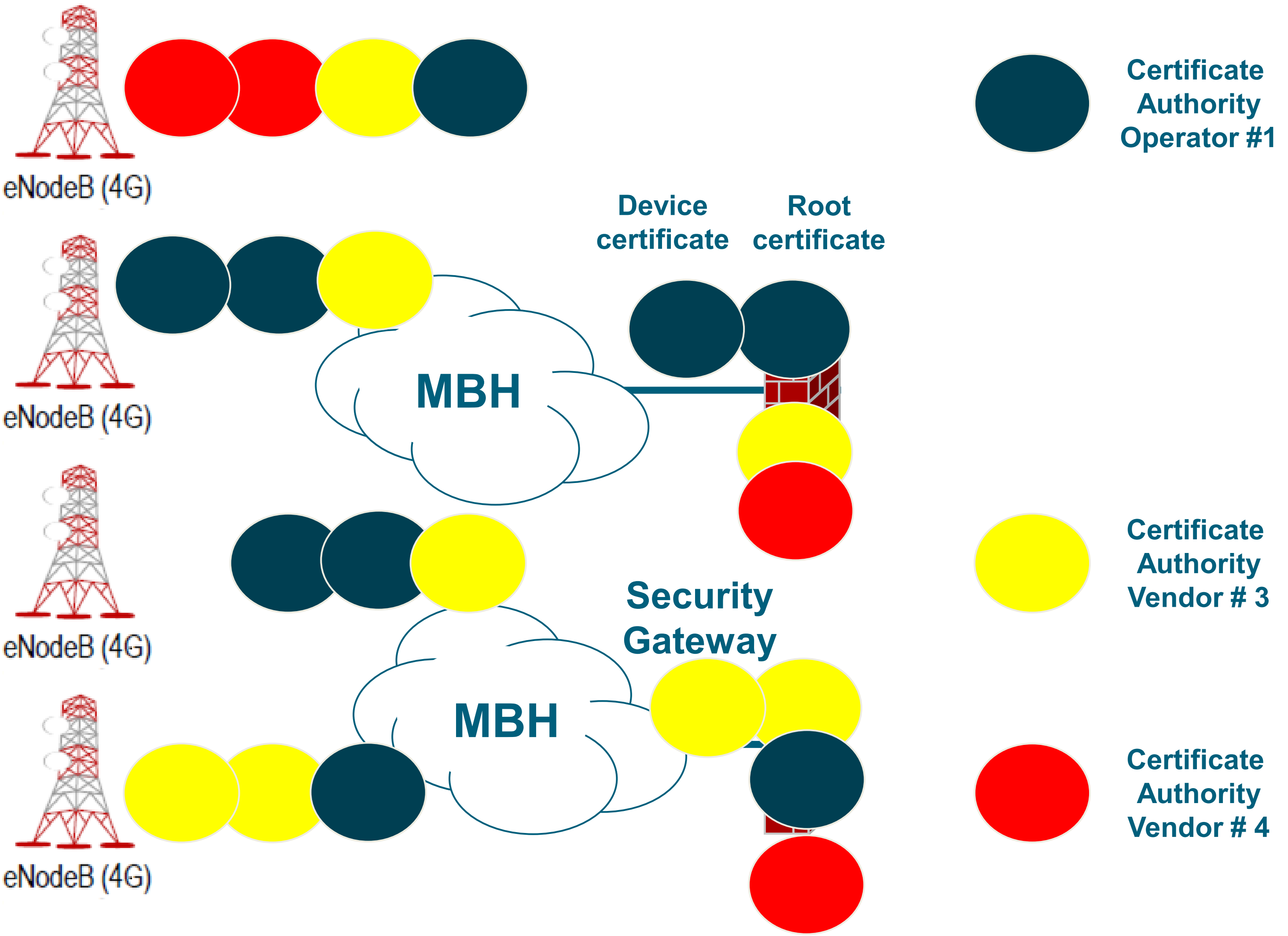
Certificate Authority Vendor # 1

Certificate Authority Vendor # 2

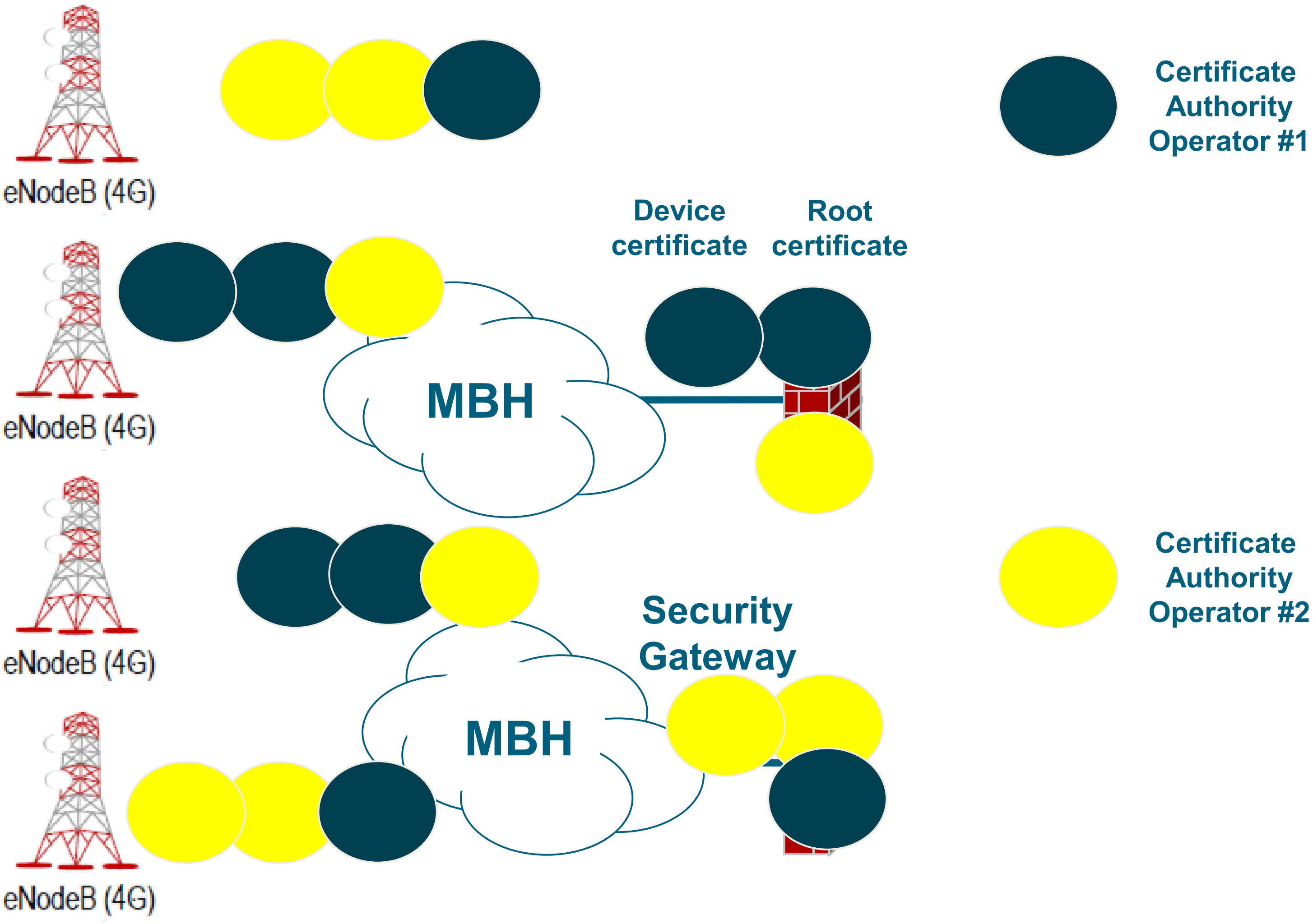
Certificate Authority Vendor # 3

Certificate Authority Vendor # 4

- **Certificates**



- **Certificates**

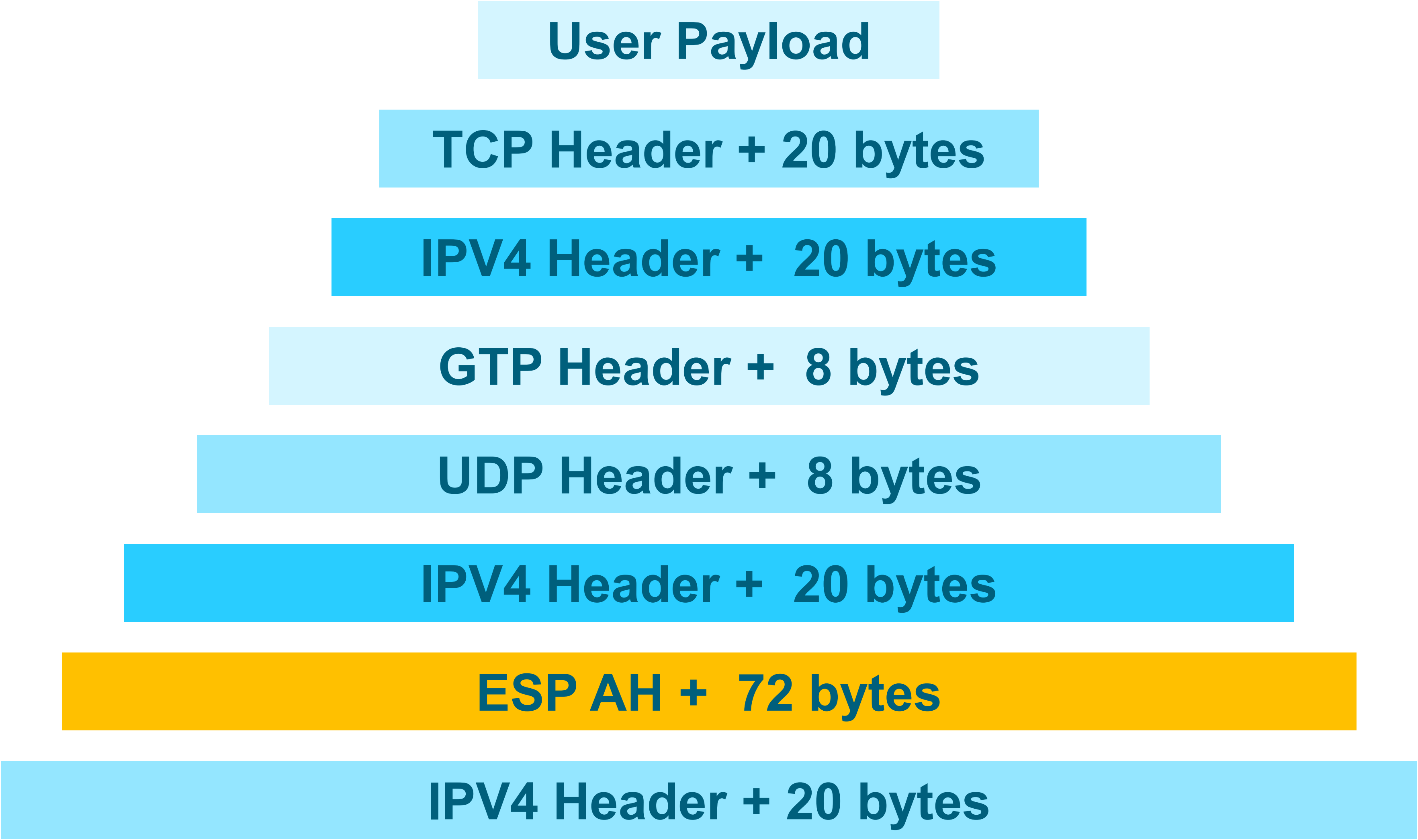


03

MTU Size

MTU Size

- Ethernet MTU is 1500bytes
- IPSec overhead can be as large as 72bytes
- If your Carrier Ethernet solution can support Jumbo frames or Baby Jumbo’s (1700) then you are OK



User Payload

TCP Header + 20 bytes

IPV4 Header + 20 bytes

GTP Header + 8 bytes

UDP Header + 8 bytes

IPV4 Header + 20 bytes

ESP AH + 72 bytes

IPV4 Header + 20 bytes

MTU Size

- Ethernet MTU is 1500
- Outer IP Header = 20 bytes (1500-20 = 1480)
- ESP Overhead Total = 72 bytes (1480-72 = 1408)
- Inner IP Header = 20 bytes (1408-20 = 1388)
- Fragmentation requirement 1388 (modulus 8) = 1384)
- Padding so IP packet modulus 16 = 1384 + 20 (modulus16) = 12

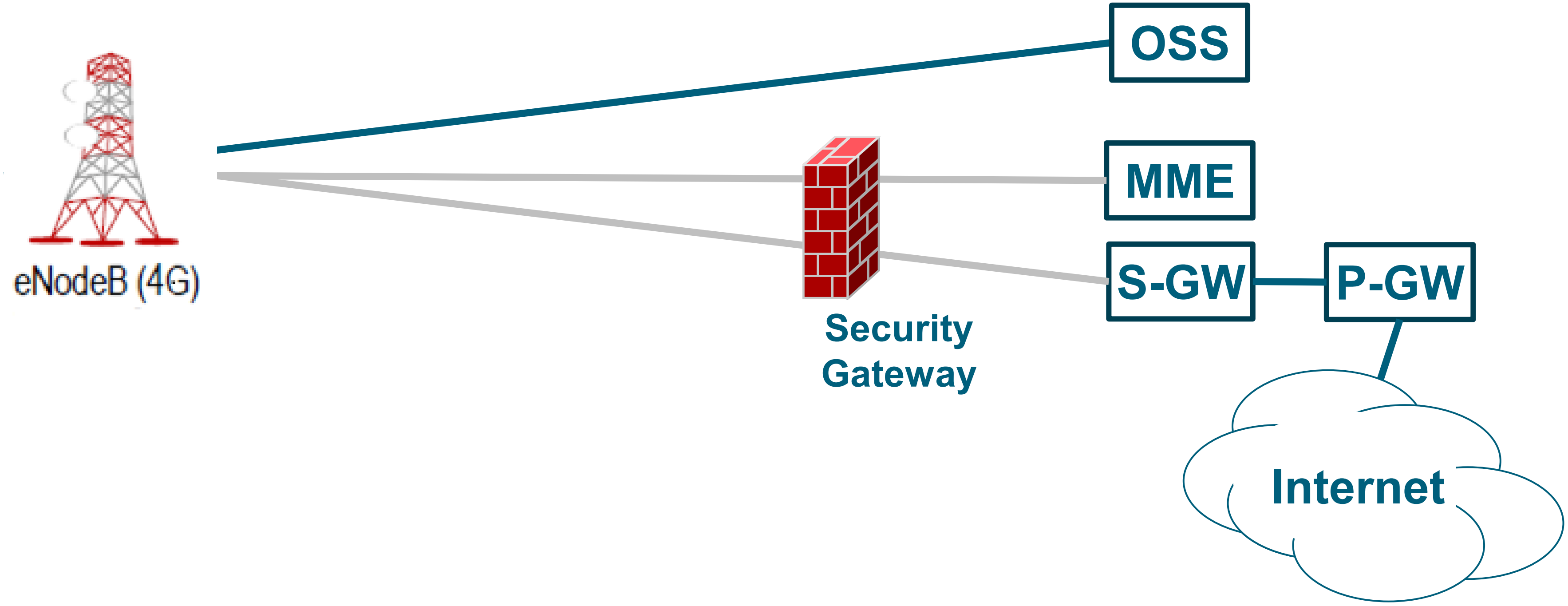
  16-12 = 4, 1384+20+4=1408
- UDP Header = 8 bytes (1384-8 = 1376)
- GTP-U Header = 8 bytes (1376-8 = 1368)
- User IP Header = 20 bytes (1368-20 = 1348)
- Padding so IP packet modulus 16 = 1348 + 20 (modulus16) = 8

  16-8 = 8, 1348-8 = 1340
- TCP Header = 20 bytes (1340-20 = 1320)

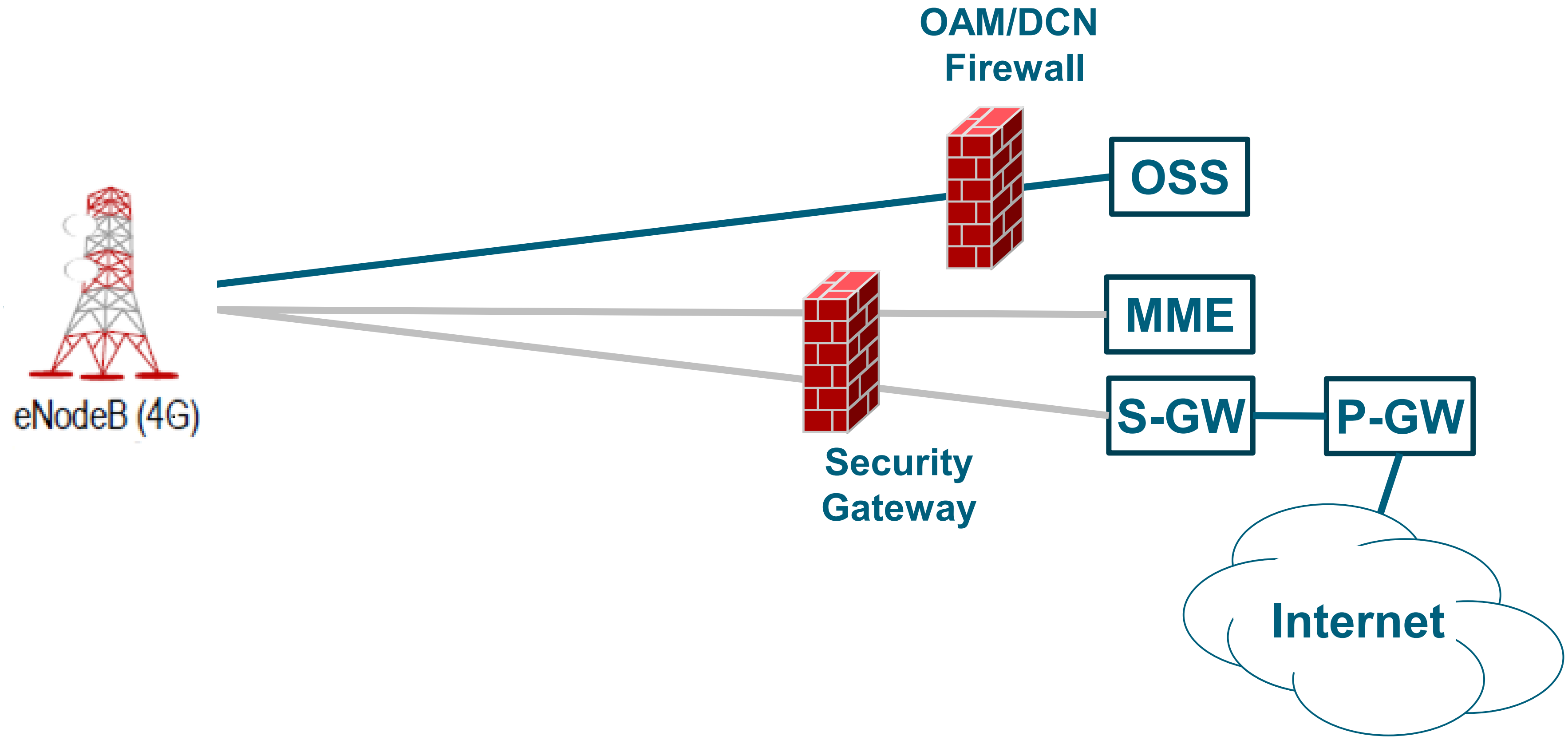
- **MTU Size**
  - Pre-fragmentation of IP packets ahead of IPSec encryption is a good idea where eNodeB does not support re-assembly of encrypted packets

04

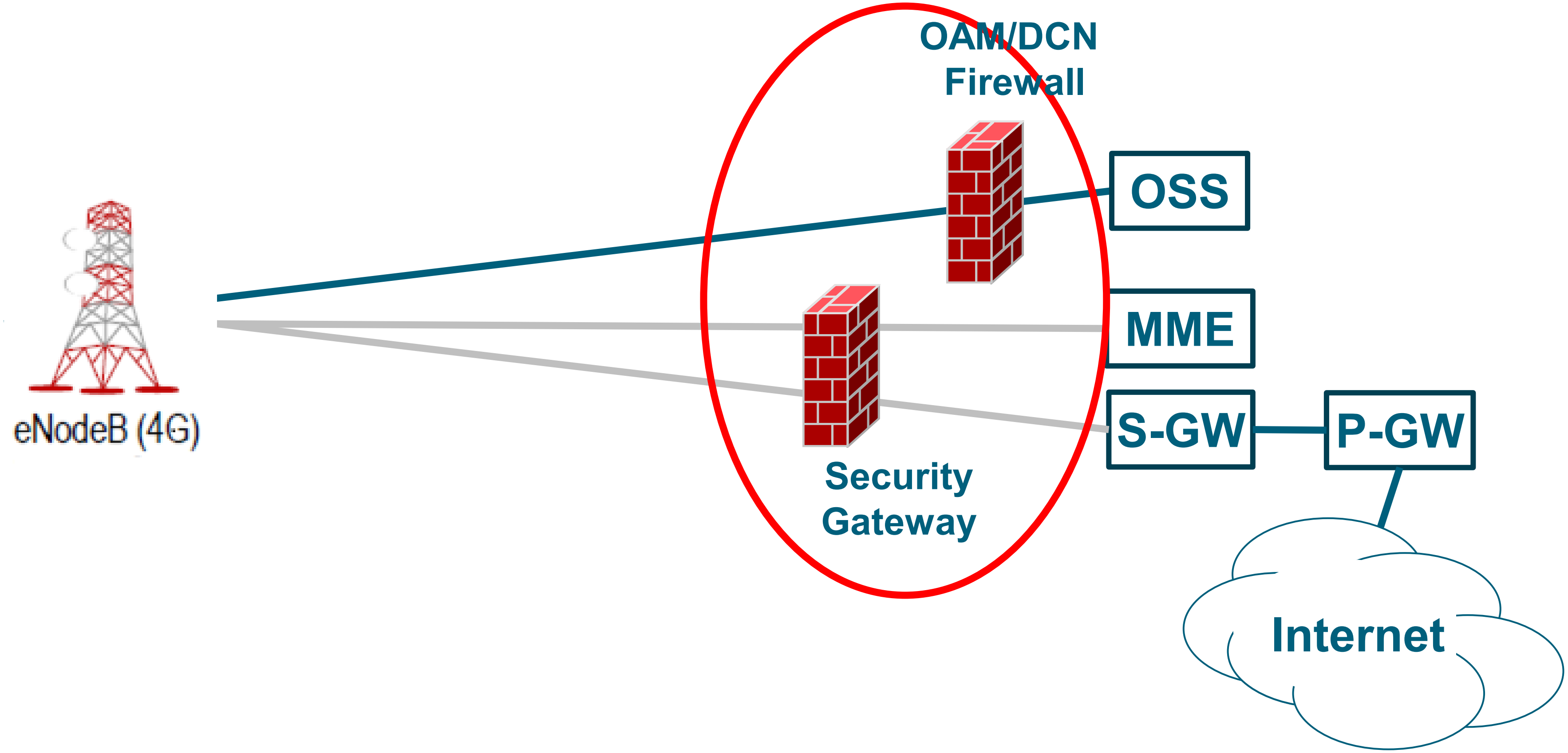
Auto-Integration



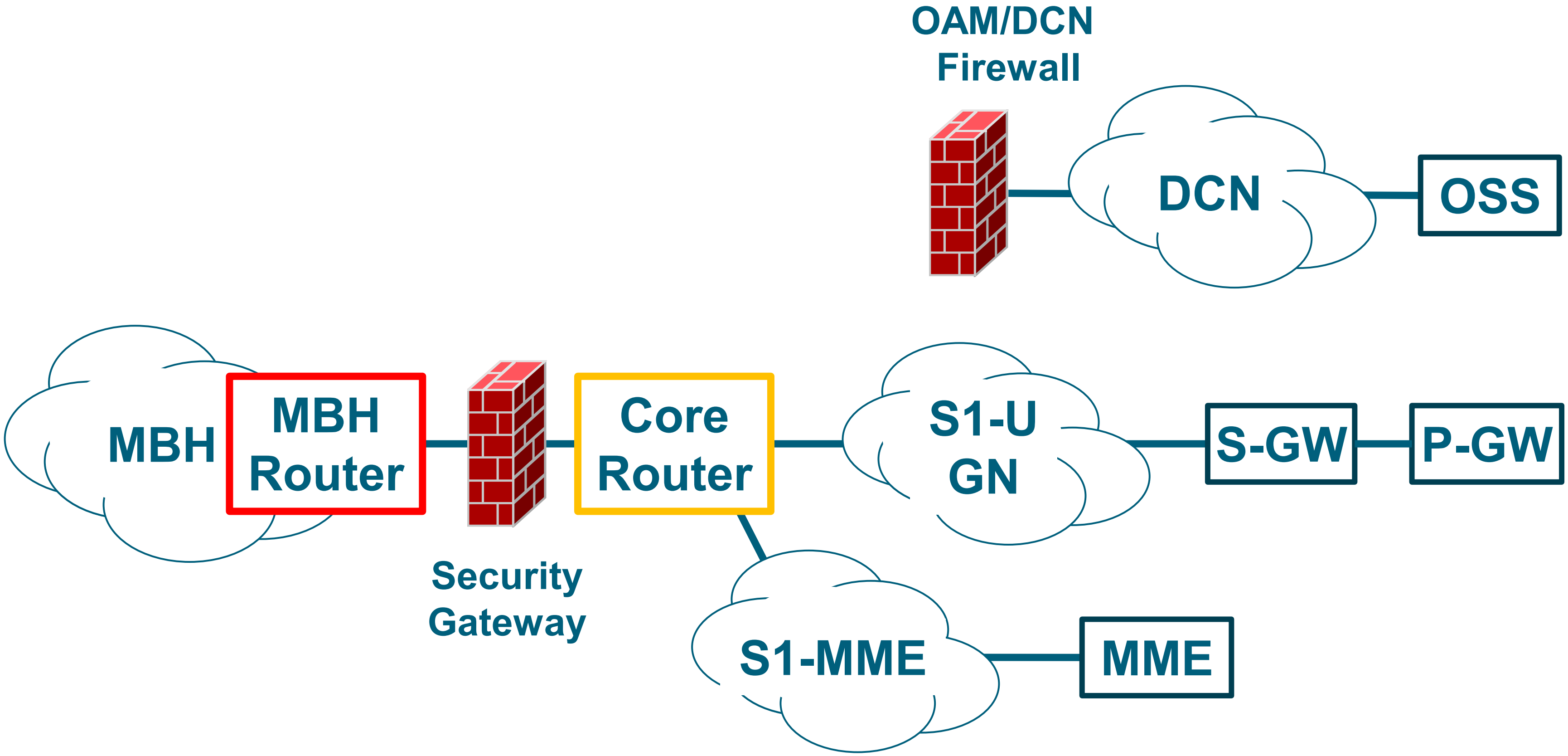
- How are you going to commission eNodeBs on industrial scale?



- **How are you going to commission eNodeBs on industrial scale?**

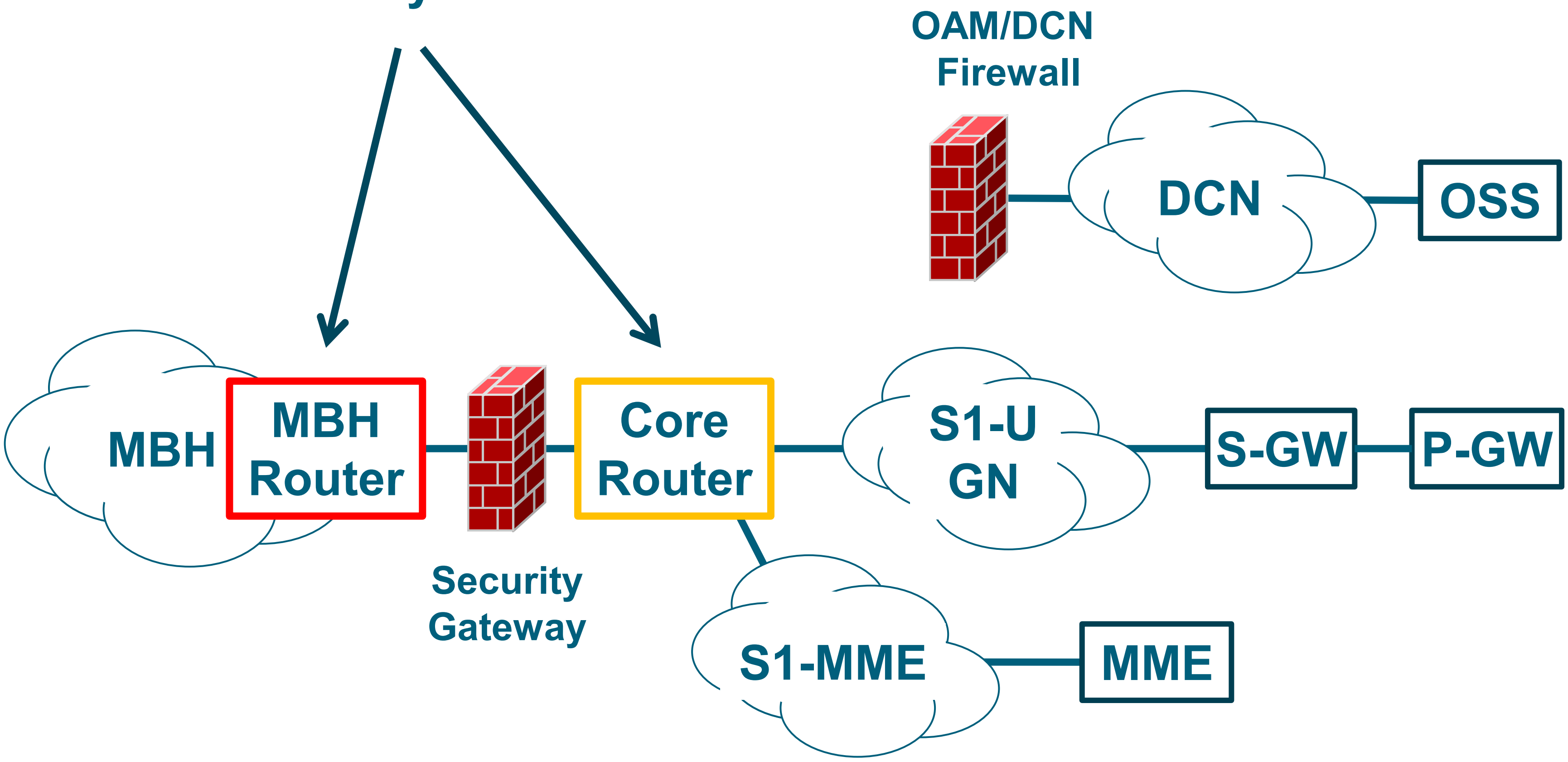


- How are you going to commission eNodeBs on industrial scale?

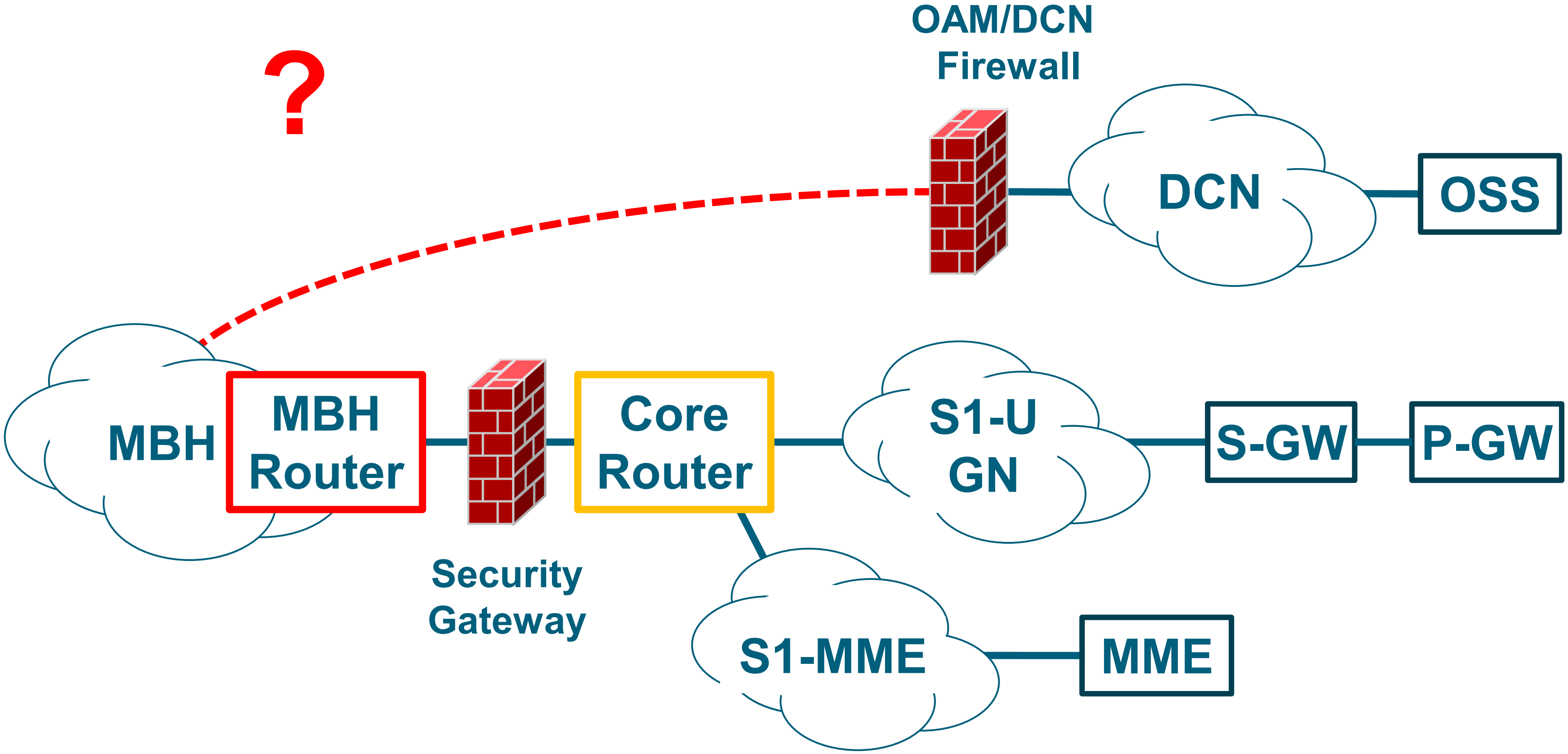


- How are you going to create a clean and secure Architecture?

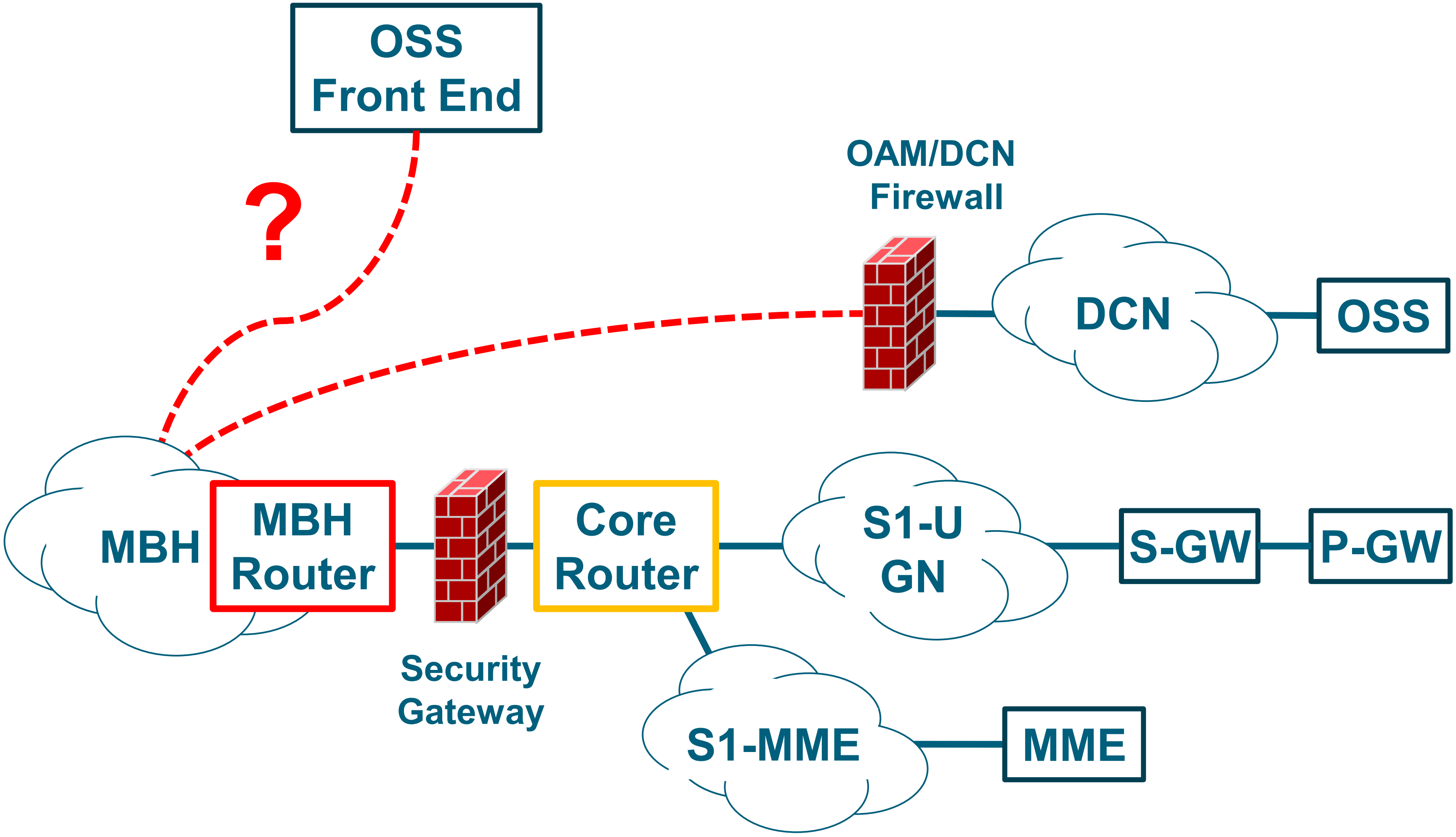
Good basic principle if these are physically different systems



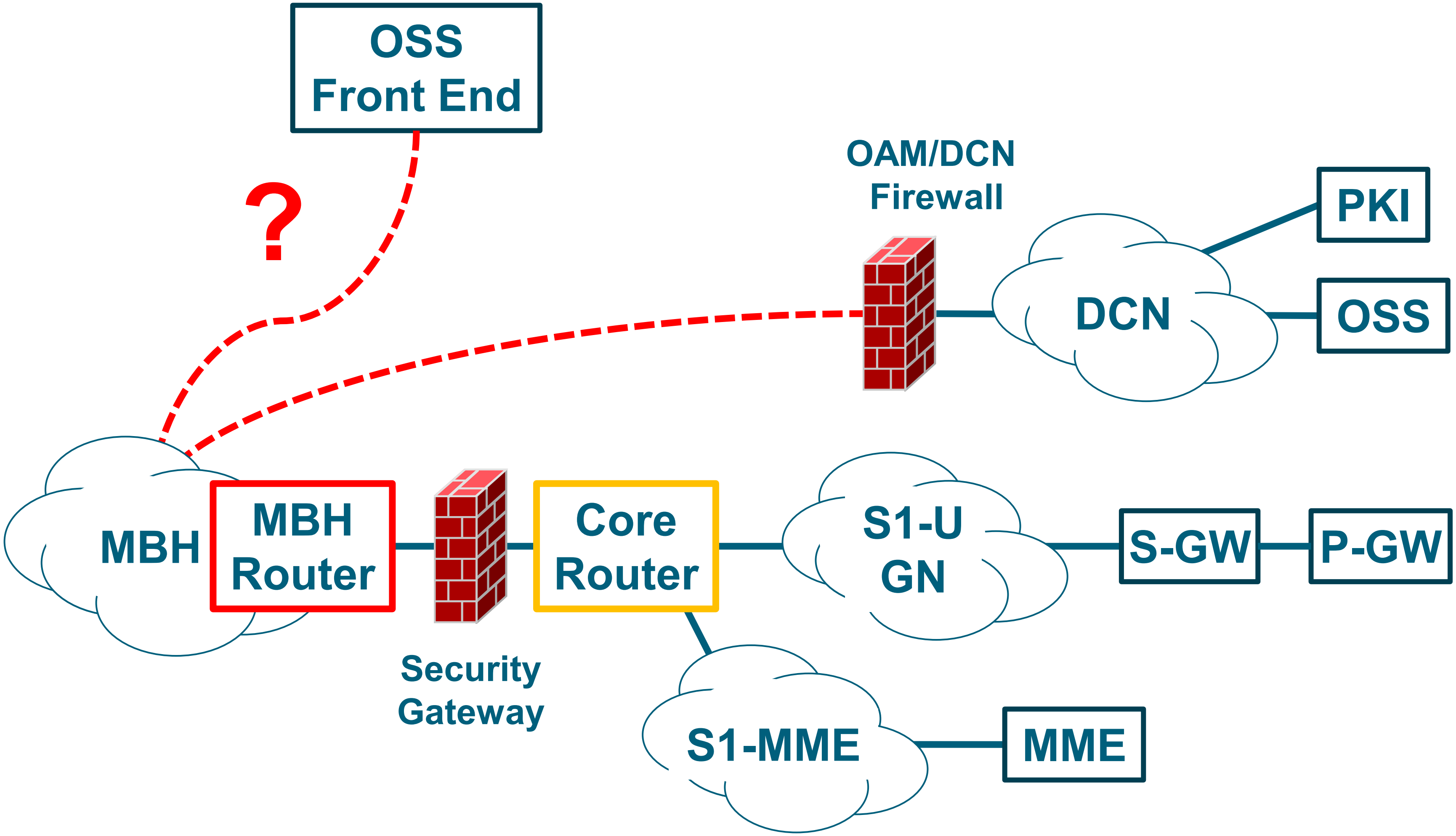
- How are you going to create a clean and secure Architecture?



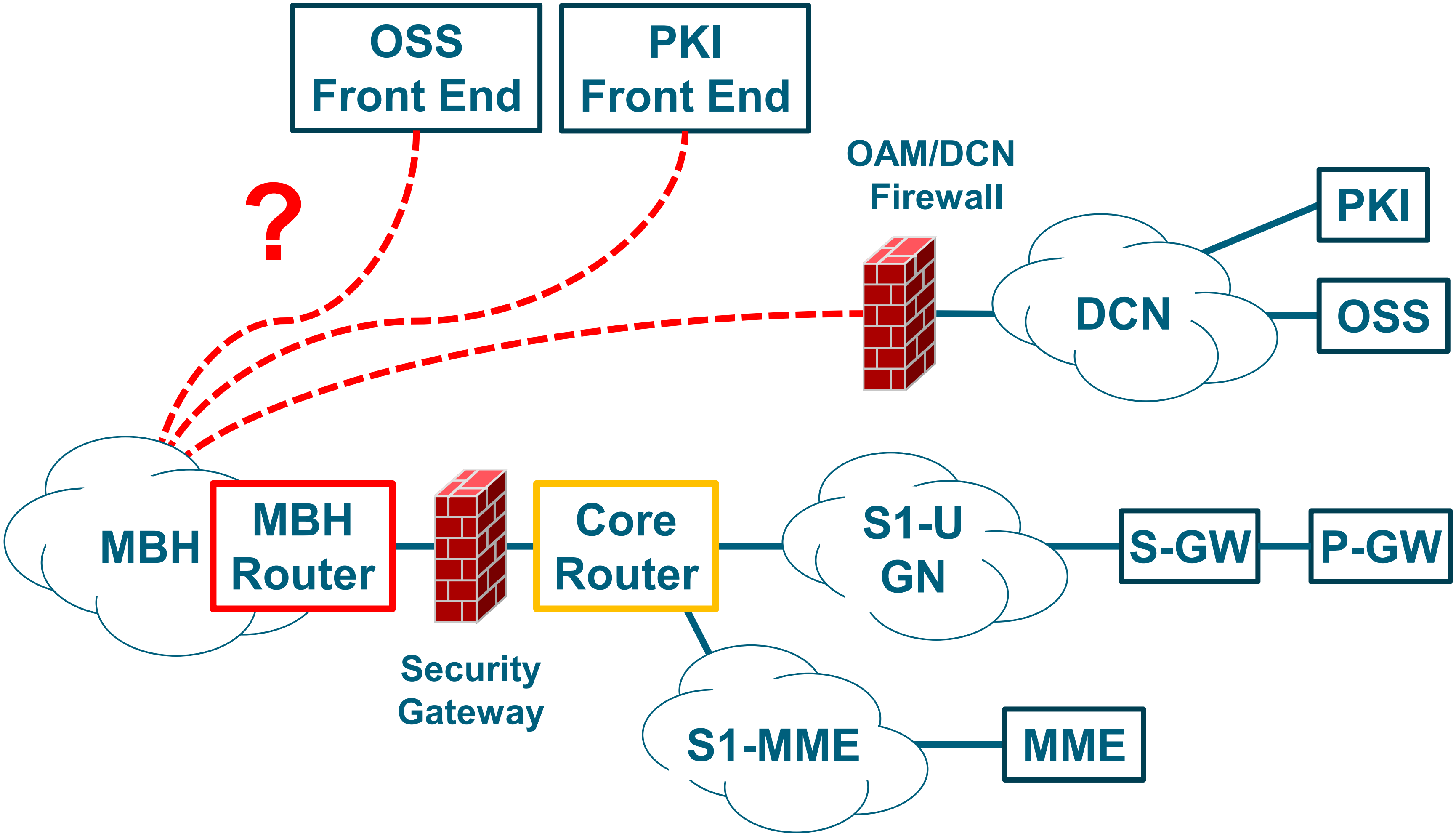
- How are you going to create a clean and secure Architecture?



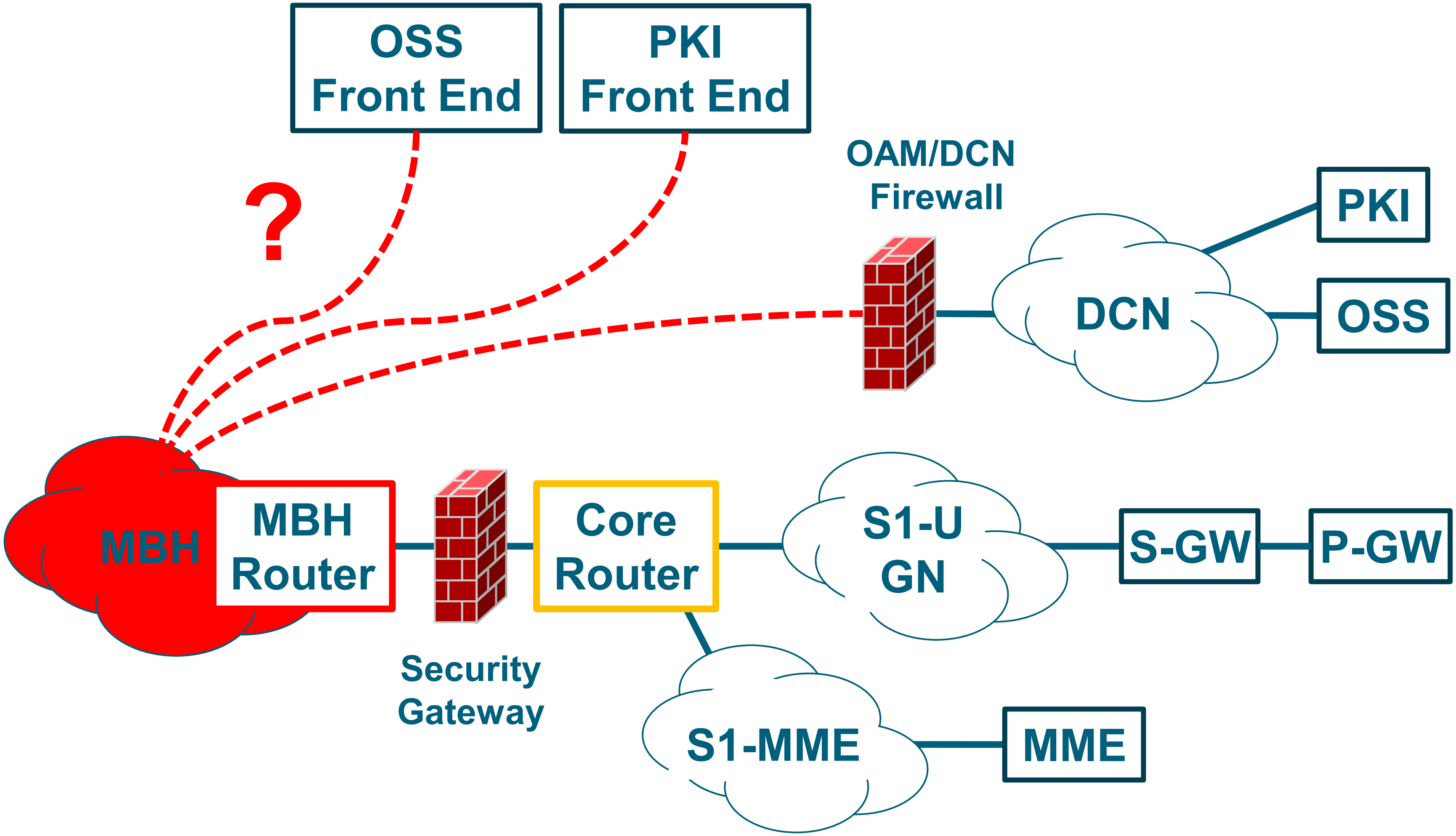
- How are you going to create a clean and secure Architecture?



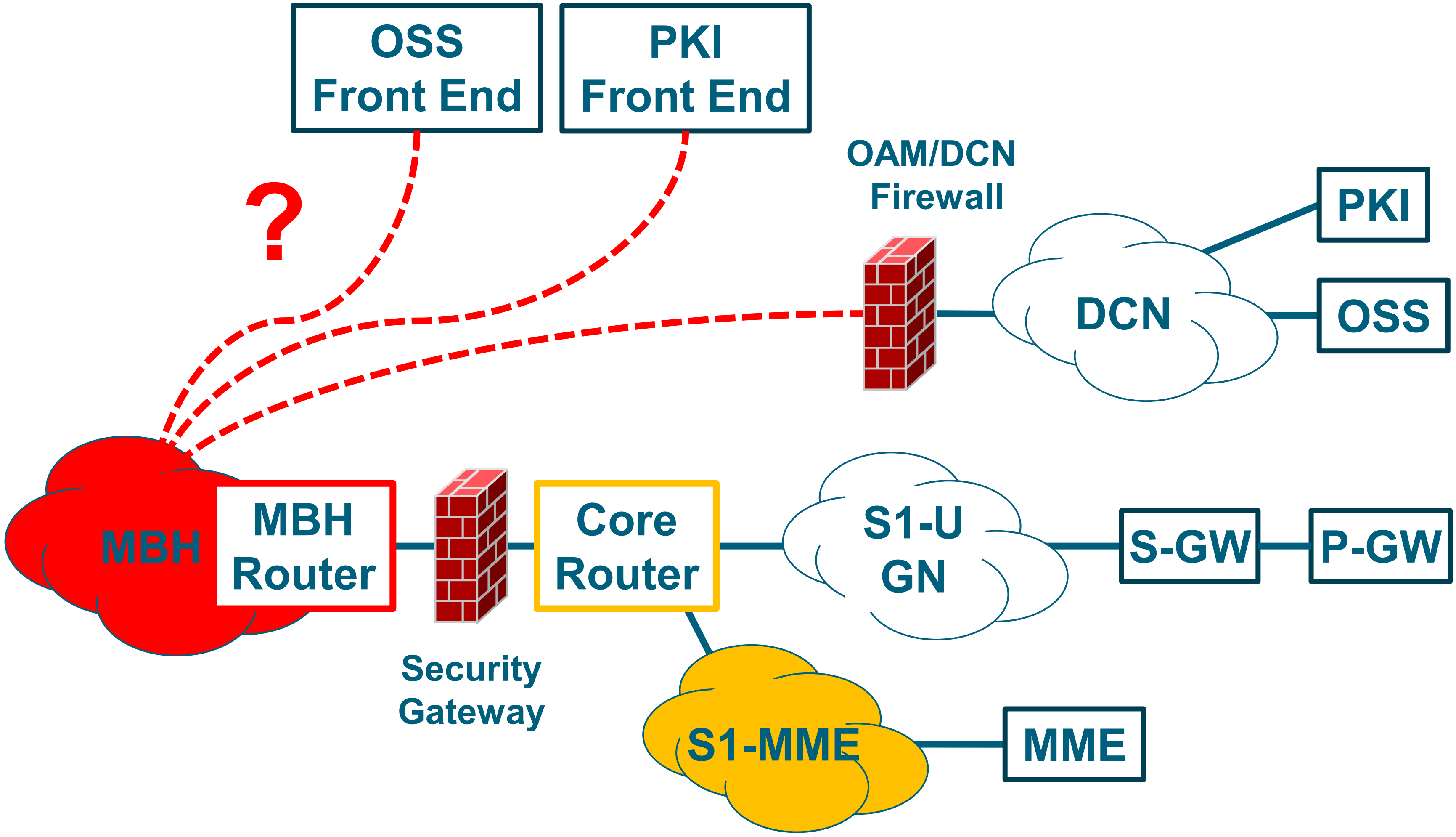
- How are you going to create a clean and secure Architecture?



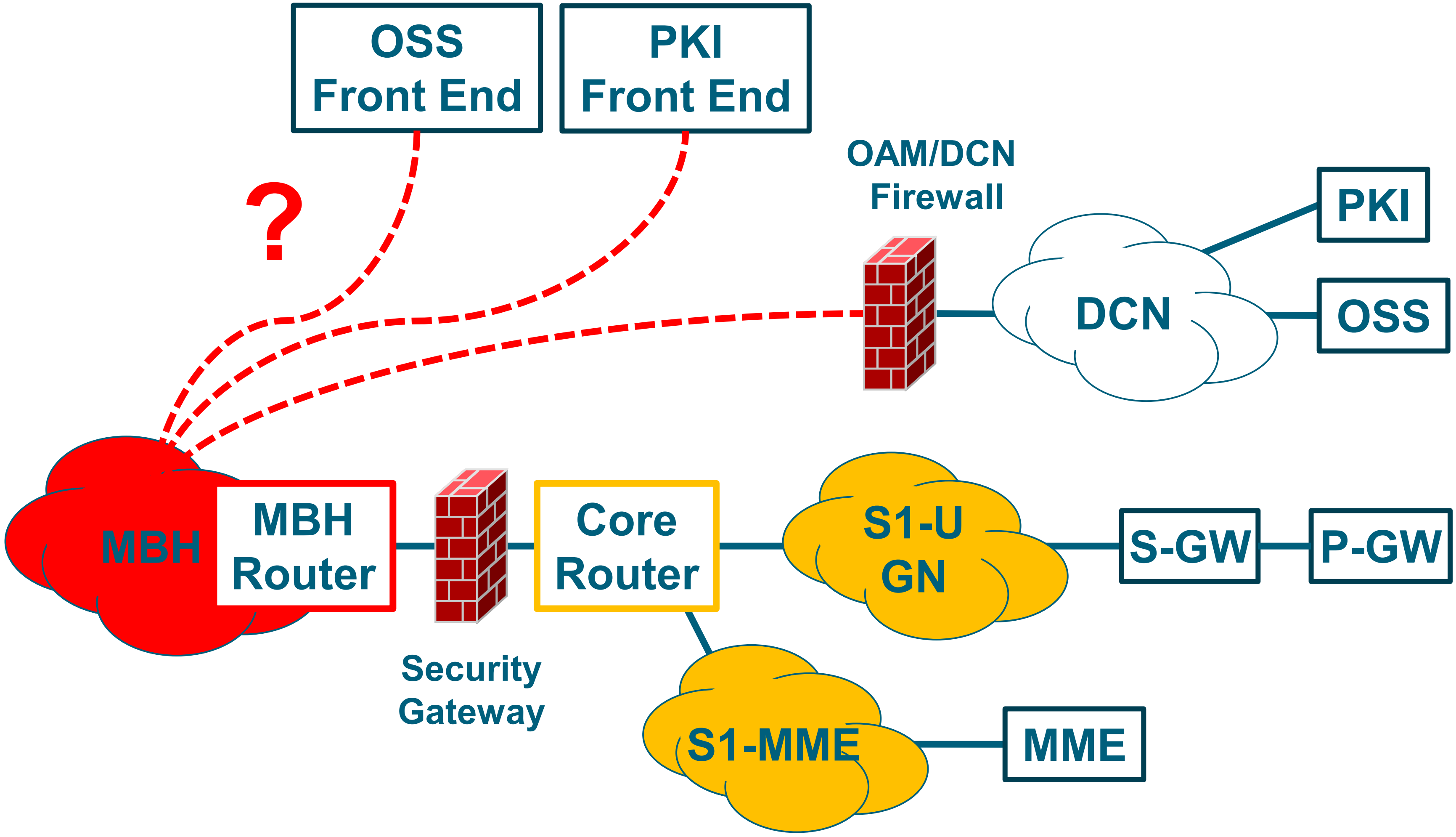
- How are you going to create a clean and secure Architecture?



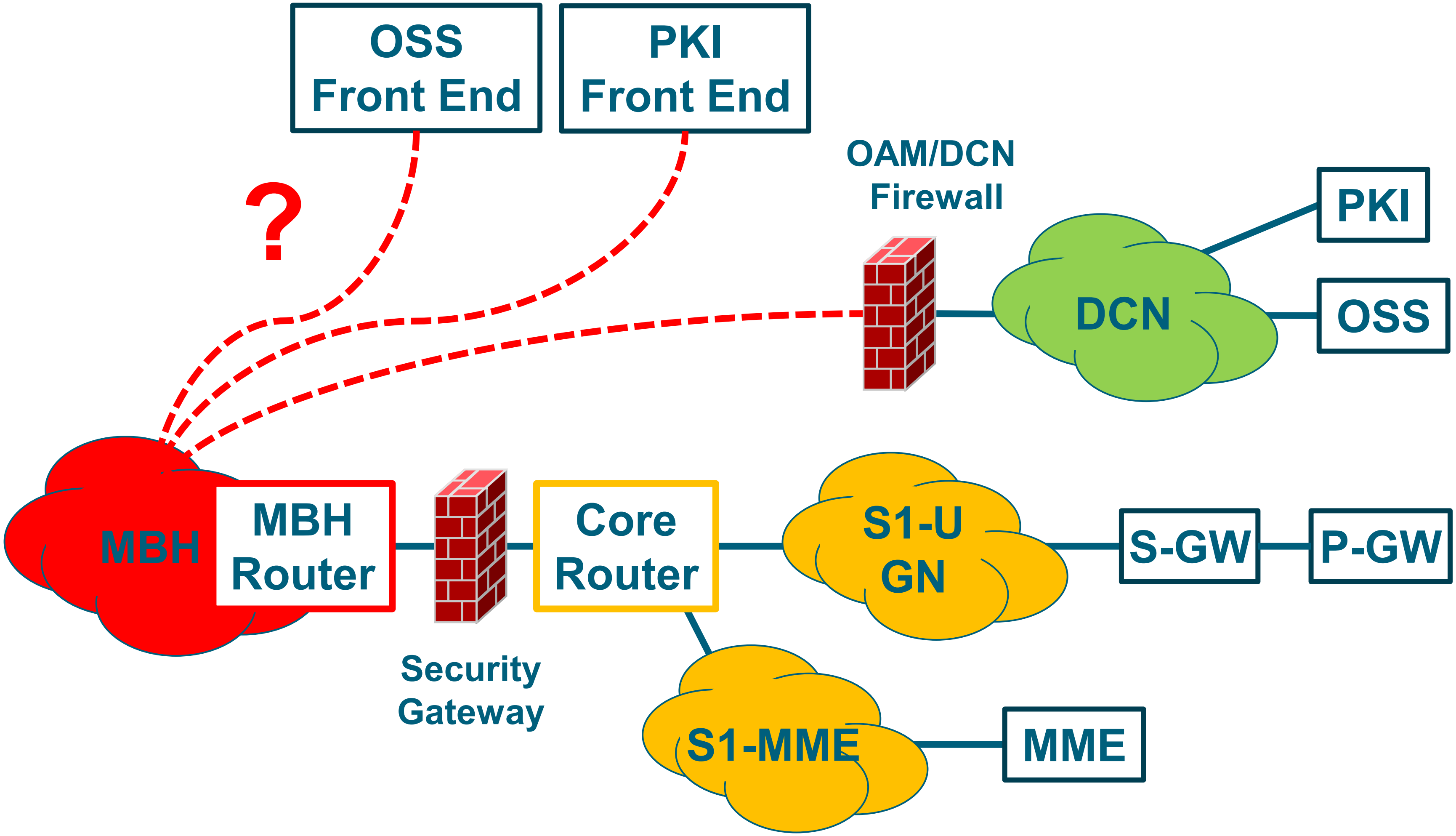
- How are you going to create a clean and secure Architecture?



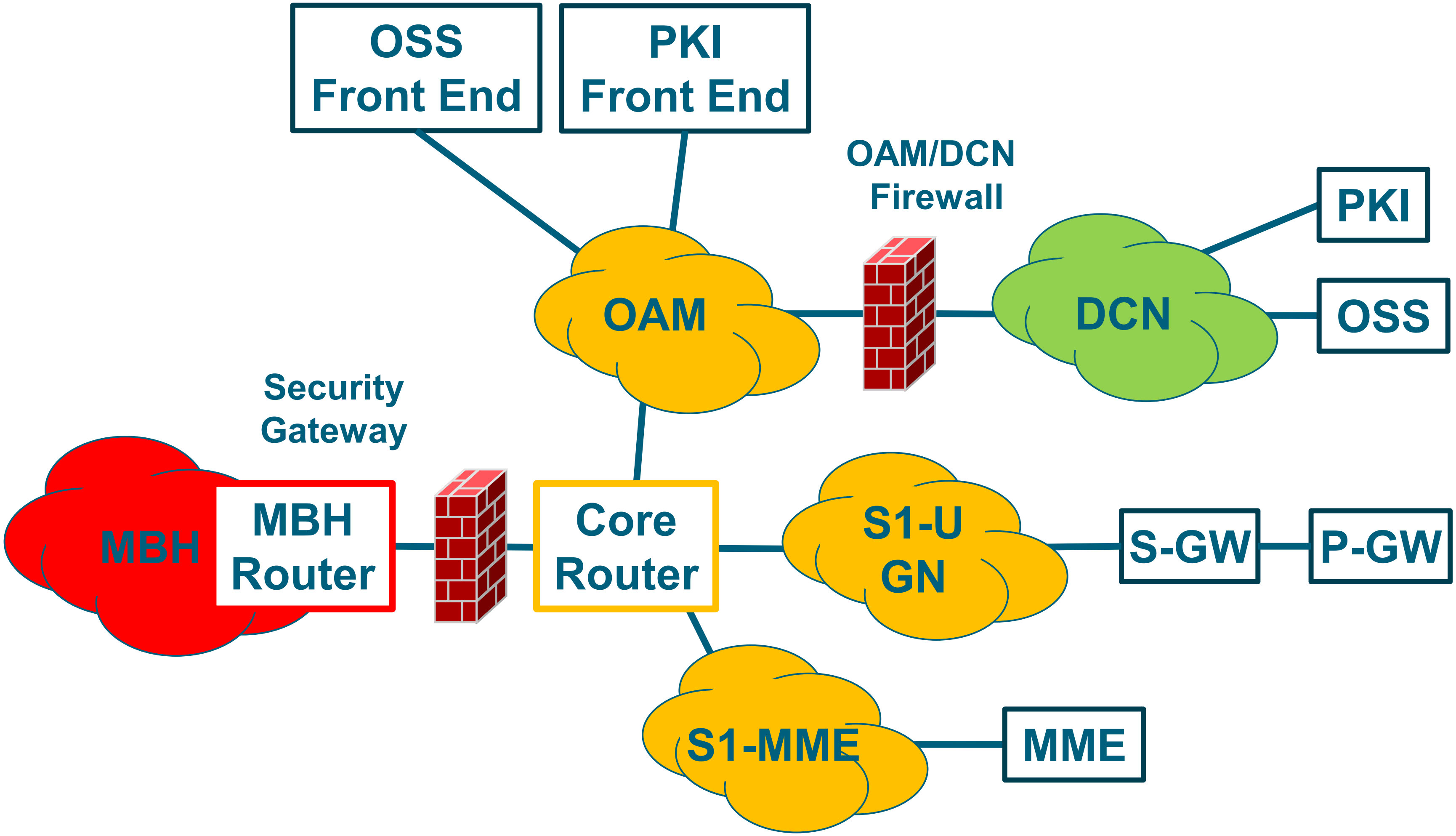
- How are you going to create a clean and secure Architecture?



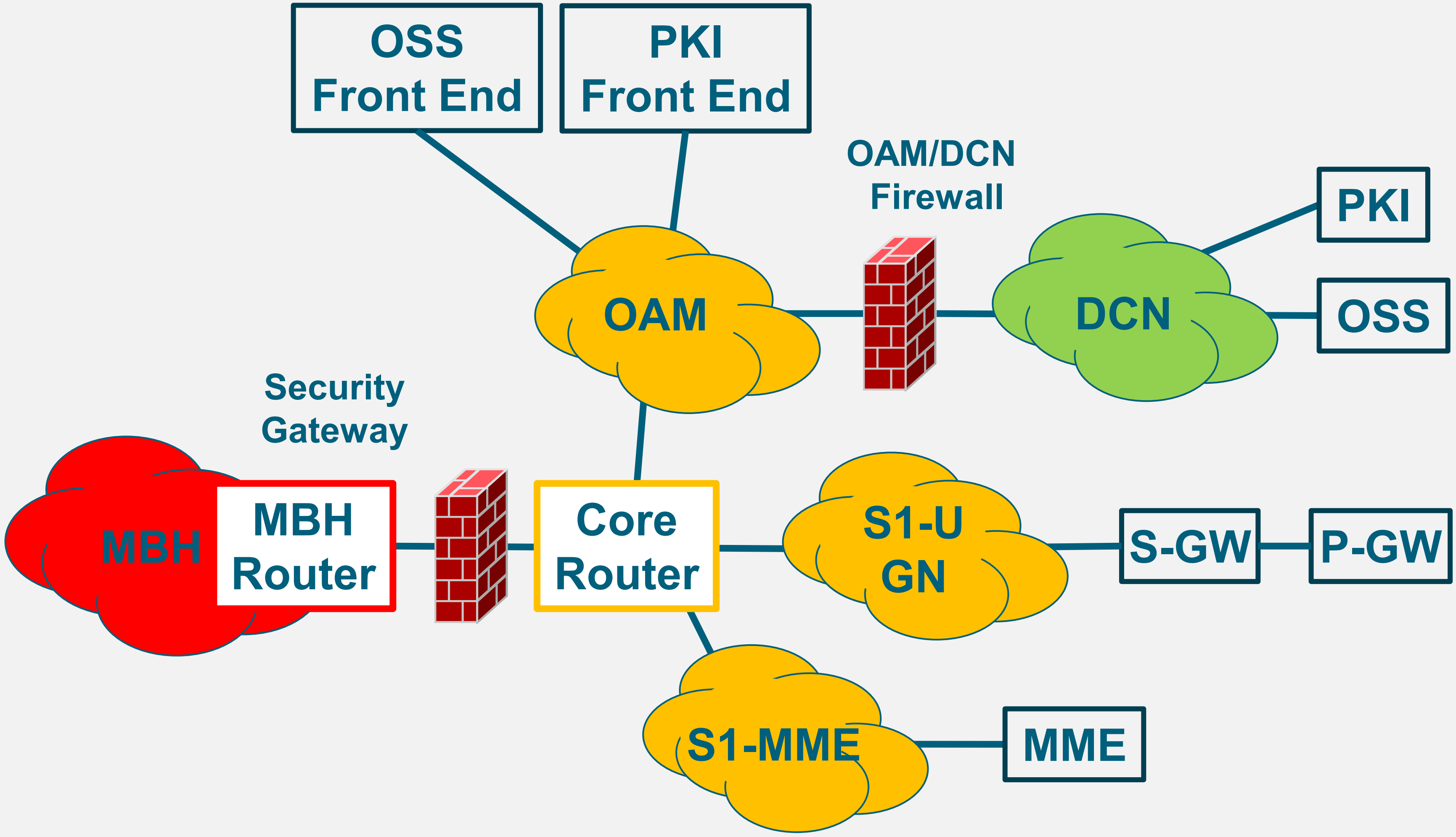
- How are you going to create a clean and secure Architecture?



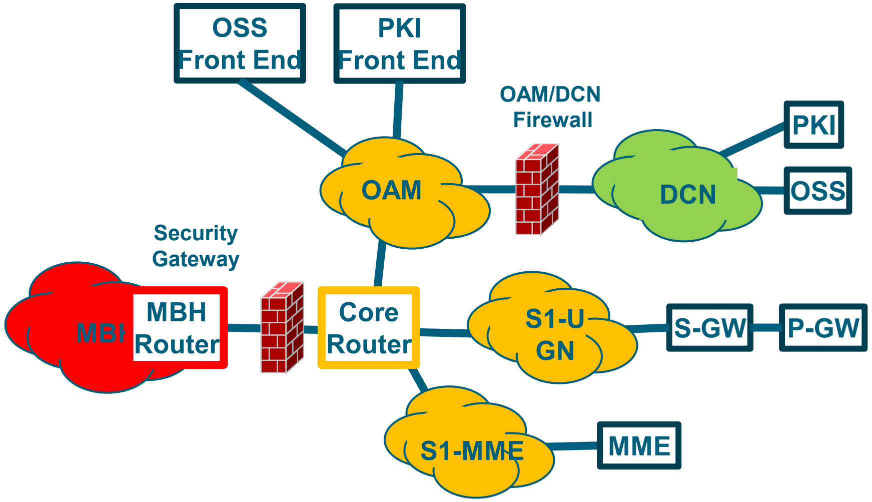
- How are you going to create a clean and secure Architecture?



- How are you going to create a clean and secure Architecture?



- How are you going to create a clean and secure Architecture?

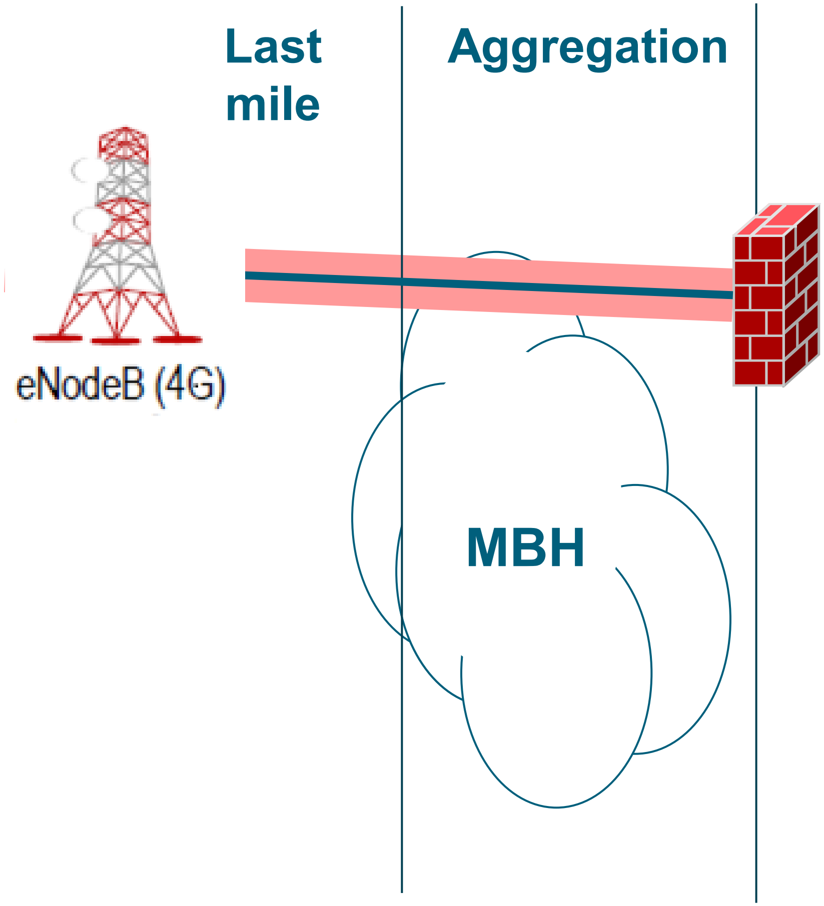


- How are you going to create a clean and secure Architecture?

- **Auto integration means an un-encrypted un-authenticated path from your eNodeB to the OSS platforms**

05
Geo-resilience

- Geo-resilience
  - Building the infrastructure to provide resilience against the loss of a significant location/installation.



Last mile

Aggregation

Core

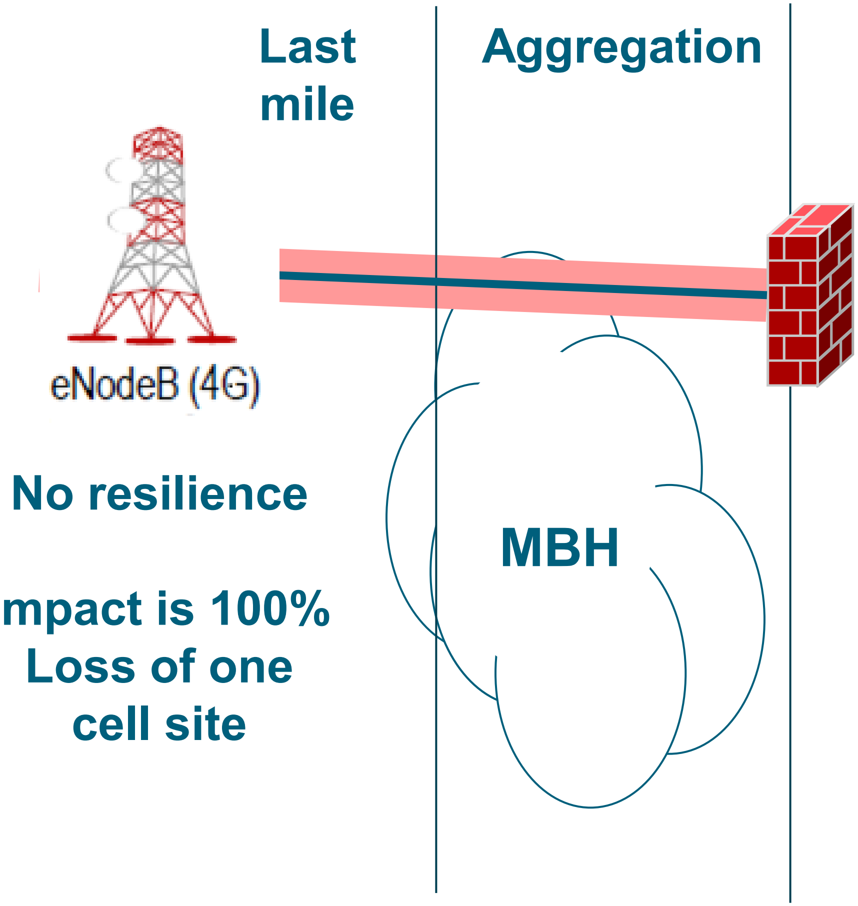
eNodeB (4G)

MBH

Last mile

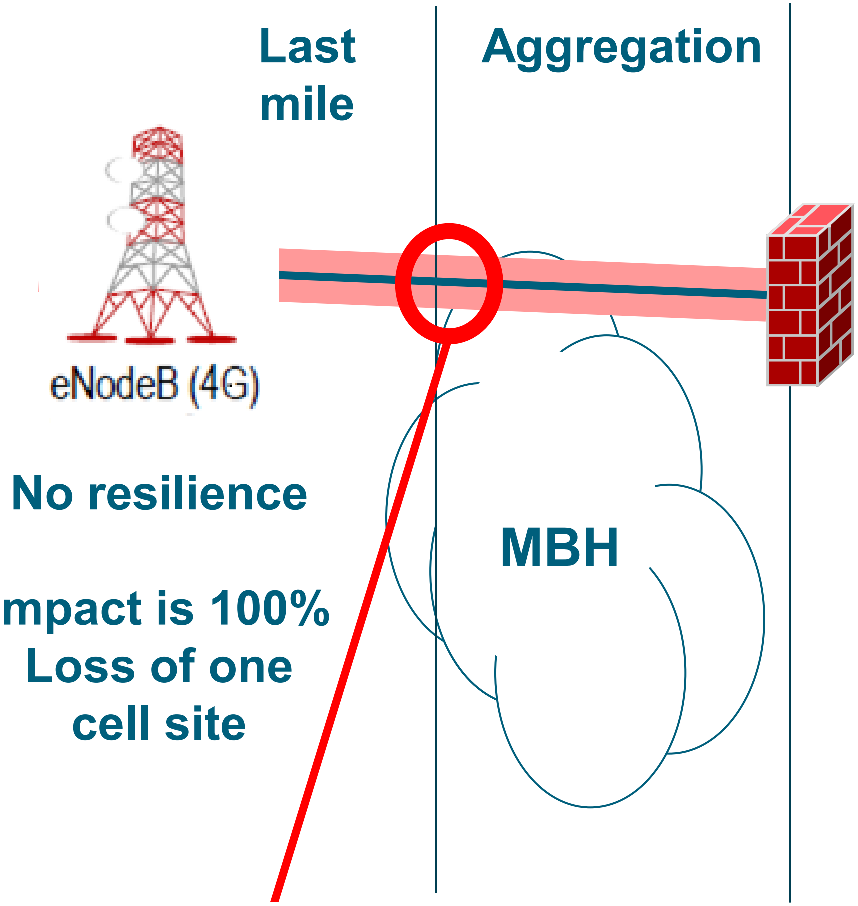
Aggregation

Core



No resilience

**Impact is 100%
Loss of one
cell site**



Last mile

Aggregation

Core

eNodeB (4G)

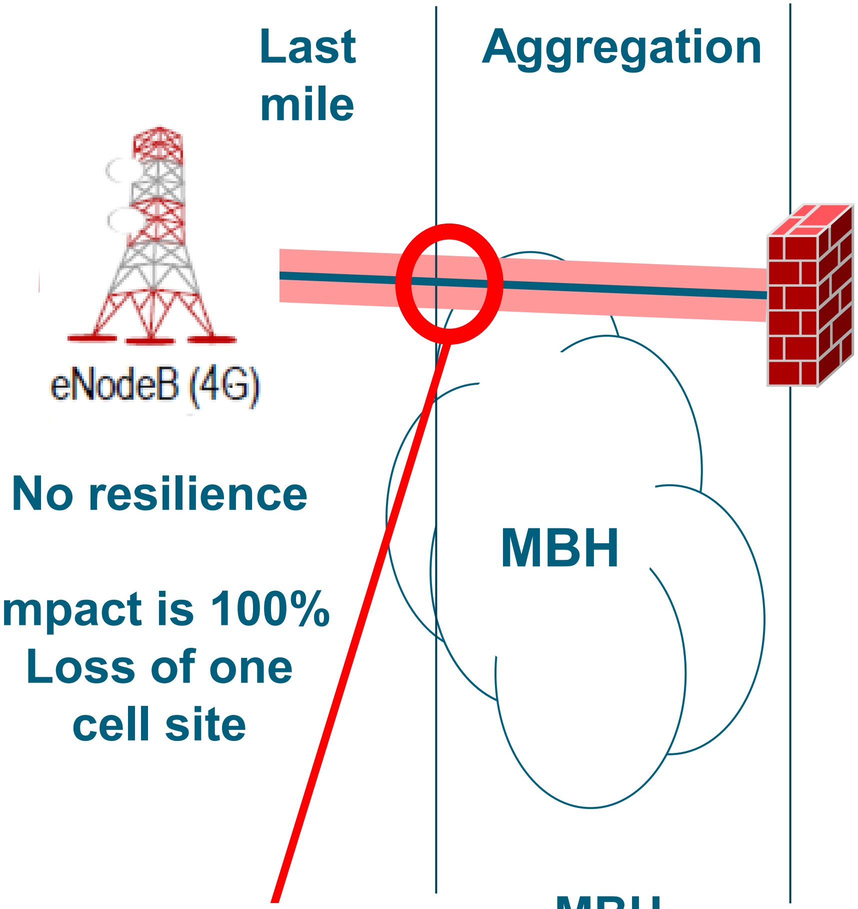
MBH

No resilience

Impact is 100%
Loss of one
cell site

Access edge

Impact is 100%
loss of N cell
sites



Last mile

Aggregation

Core

eNodeB (4G)

MBH

No resilience

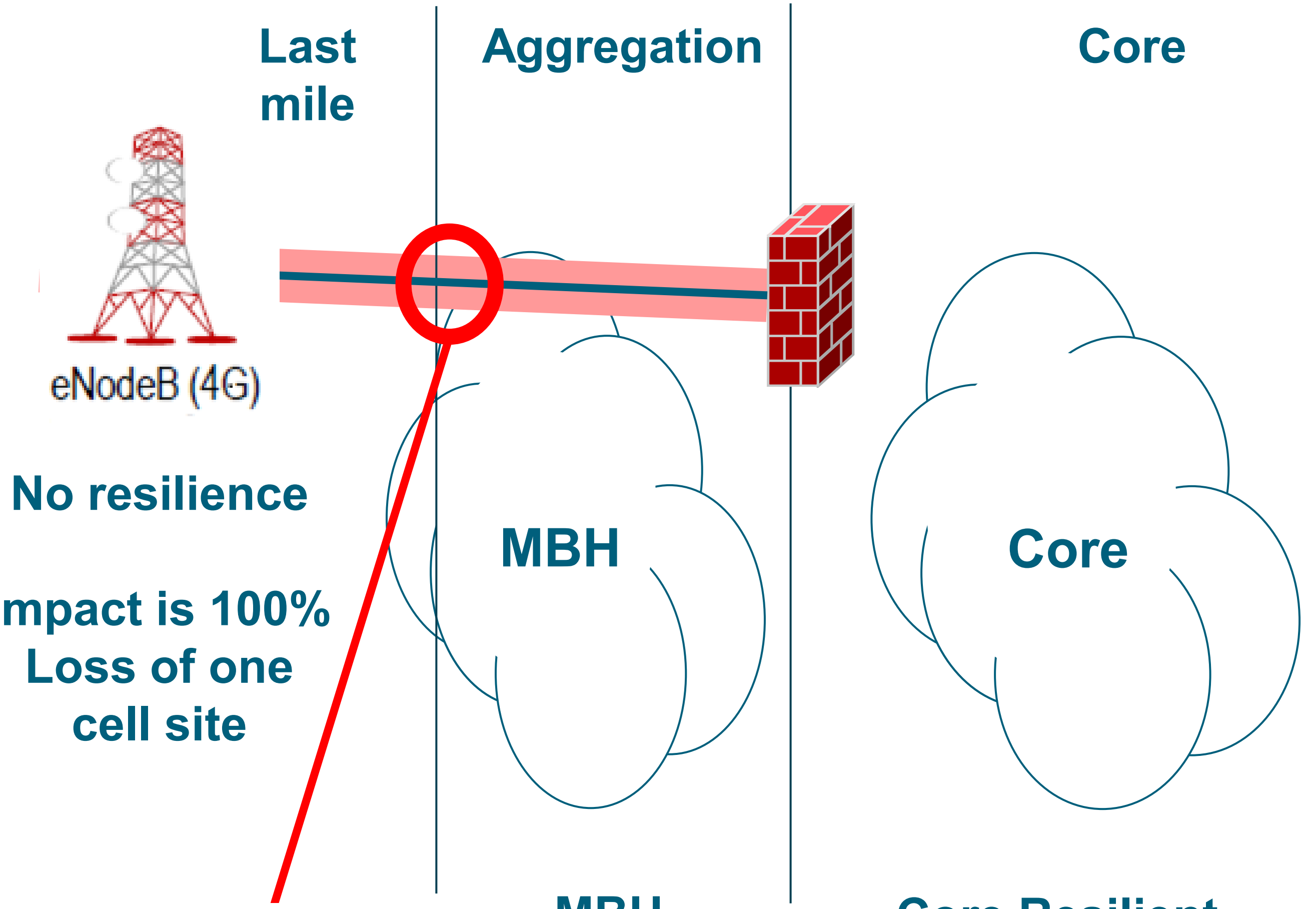
Impact is 100%
Loss of one
cell site

Access edge

Impact is 100%
loss of N cell
sites

MBH
Resilient

No SPOF



Last mile

Aggregation

Core

eNodeB (4G)

MBH

Core

No resilience

Impact is 100%
Loss of one
cell site

Access edge

Impact is 100%
loss of N cell
sites

MBH
Resilient

No SPOF

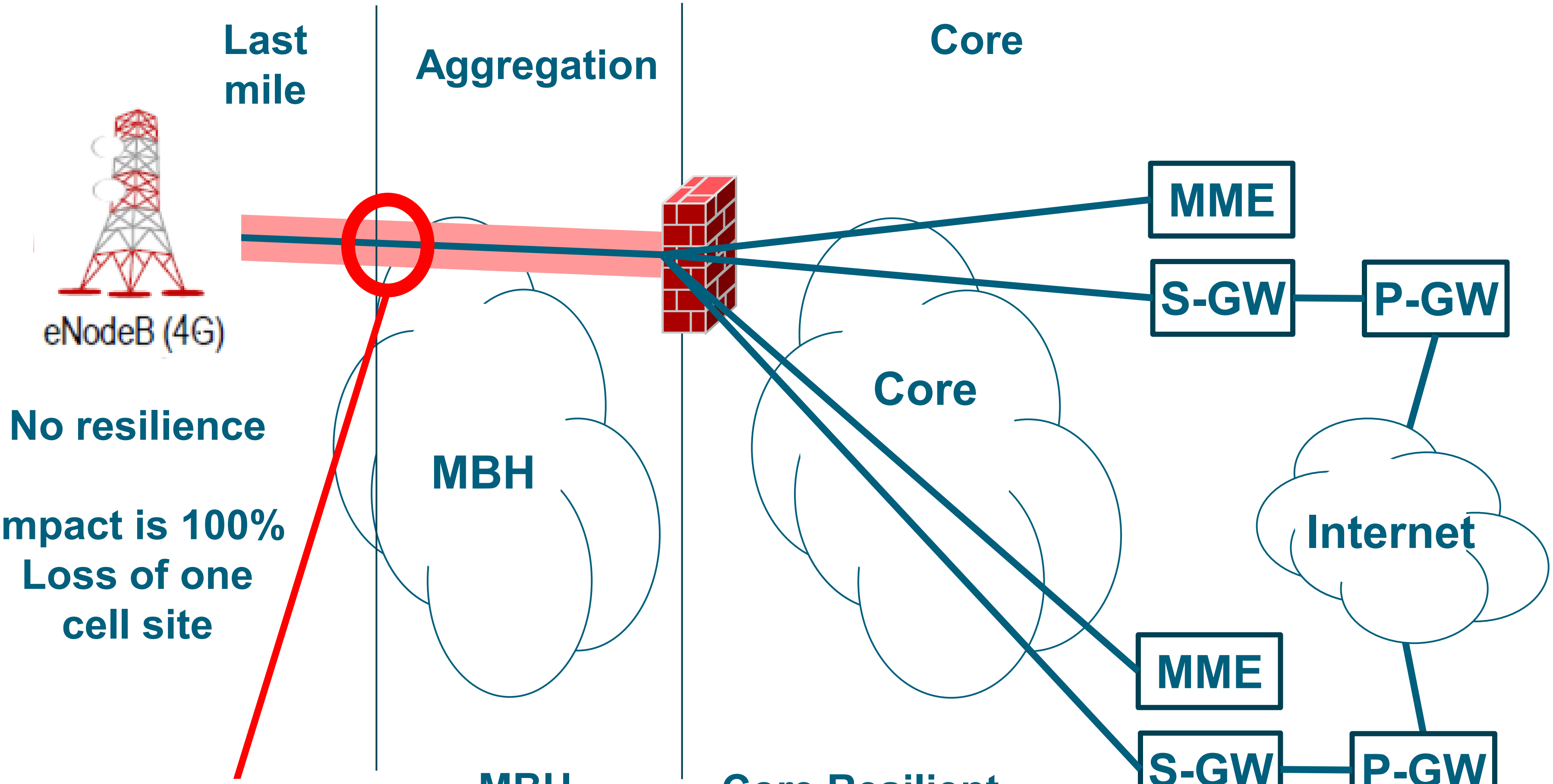
Core Resilient

No SPOF

Last mile

Aggregation

Core



No resilience

Impact is 100%
Loss of one
cell site

Access edge

Impact is 100%
loss of N cell
sites

MBH
Resilient

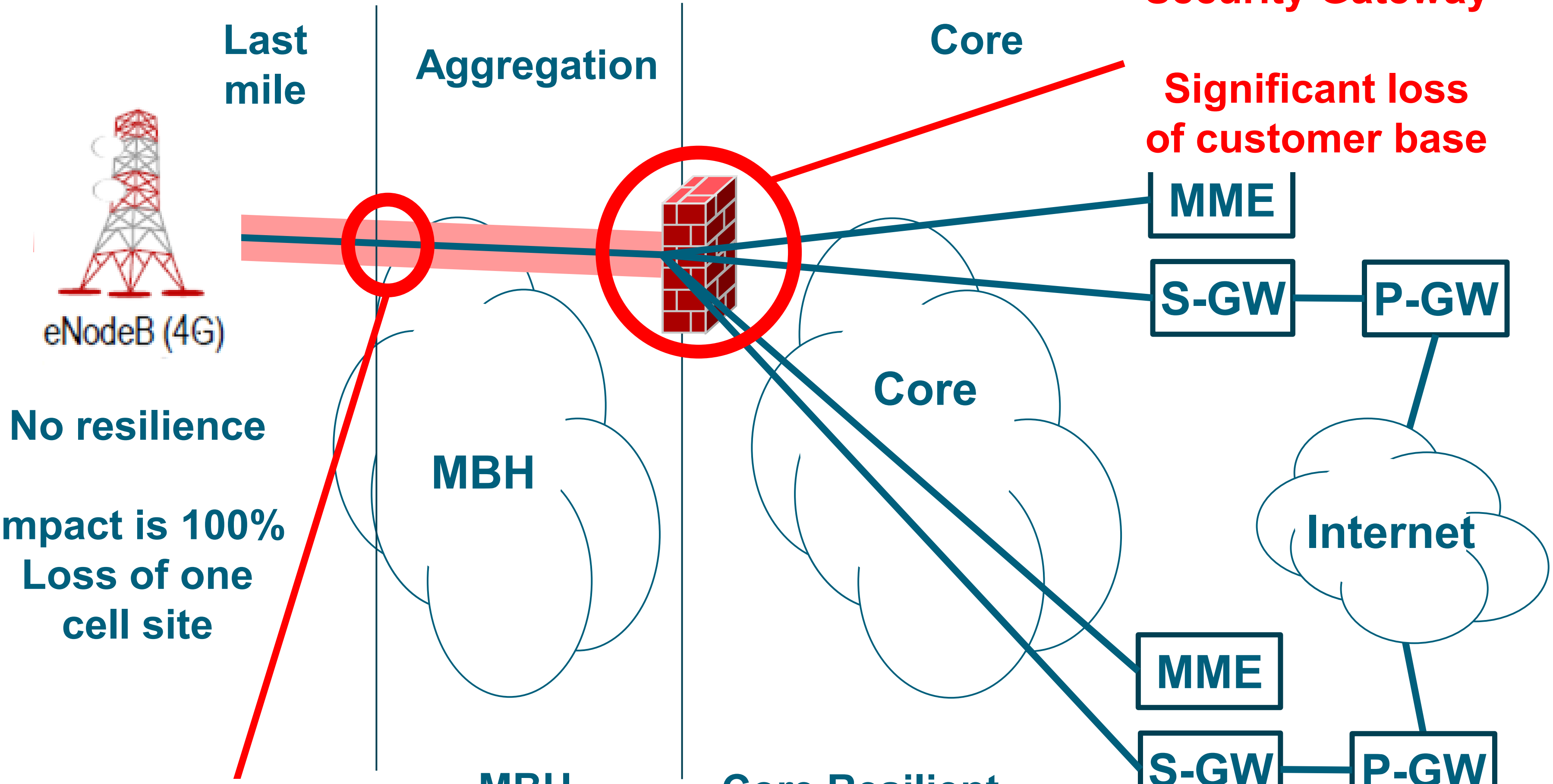
No SPOF

Core Resilient

No SPOF

EPC Resilient

No SPOF



Security Gateway

Significant loss of customer base

No resilience

Impact is 100%
Loss of one cell site

Access edge

Impact is 100%
loss of N cell sites

MBH Resilient

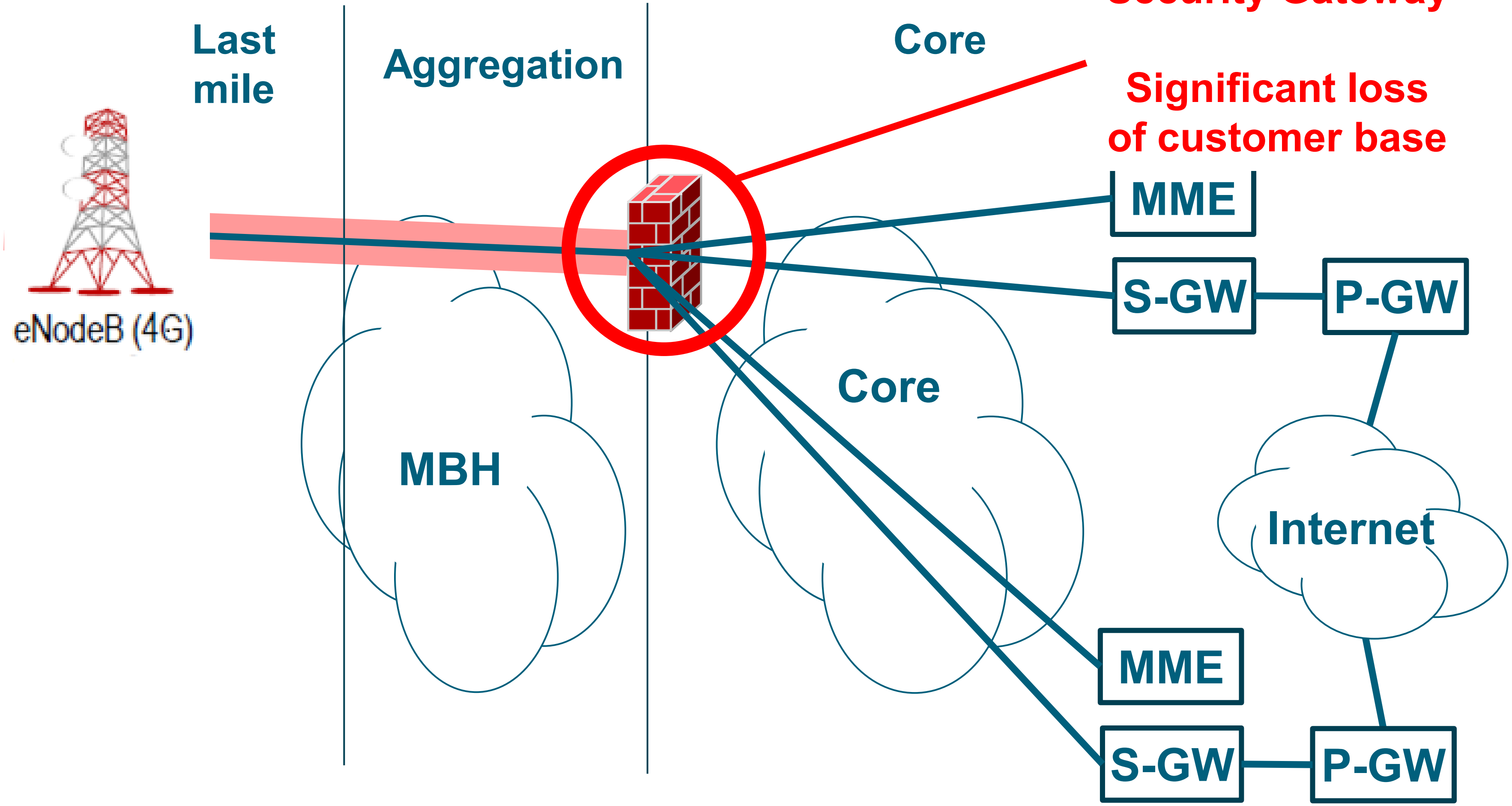
No SPOF

Core Resilient

No SPOF

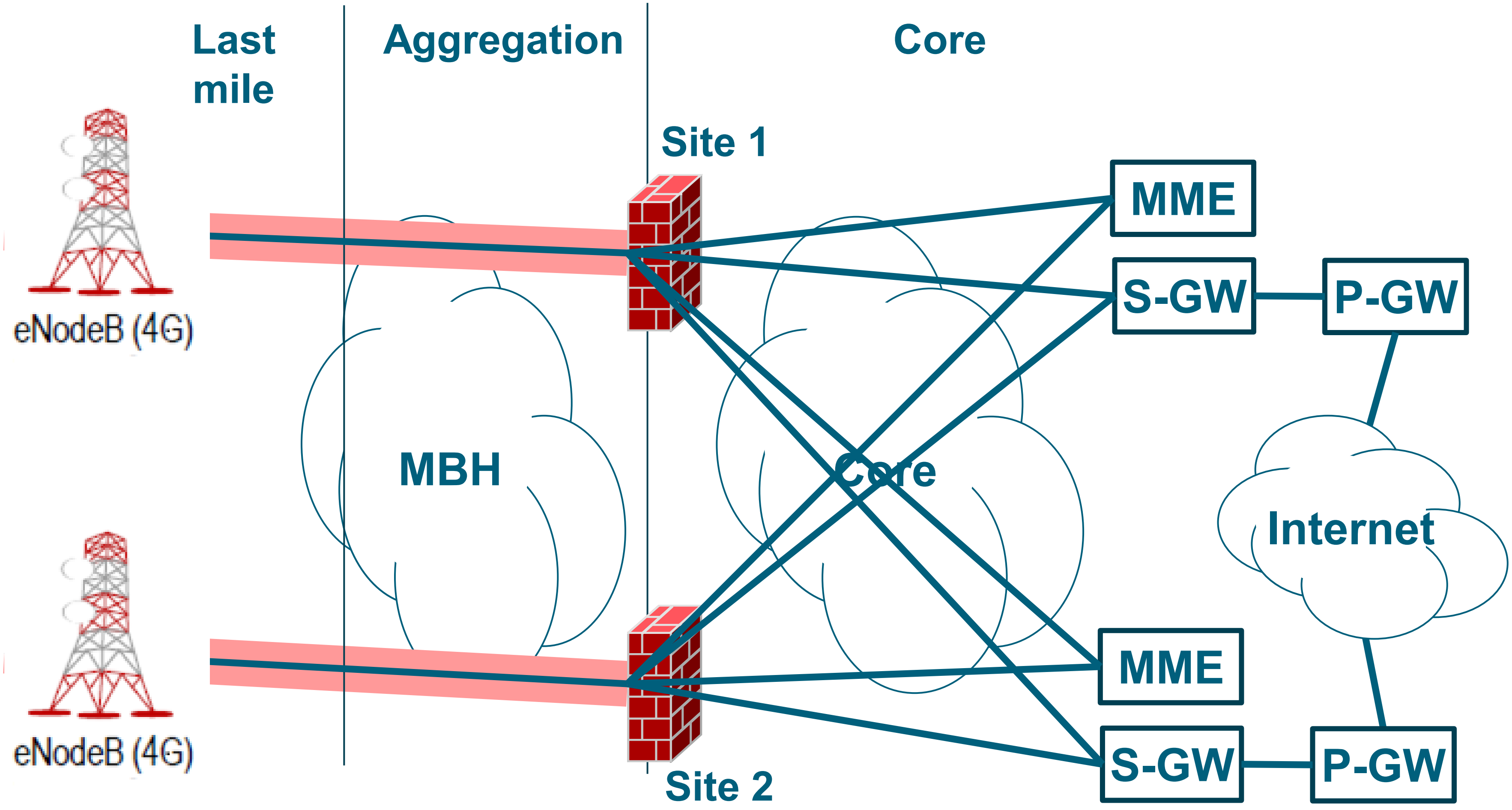
EPC Resilient

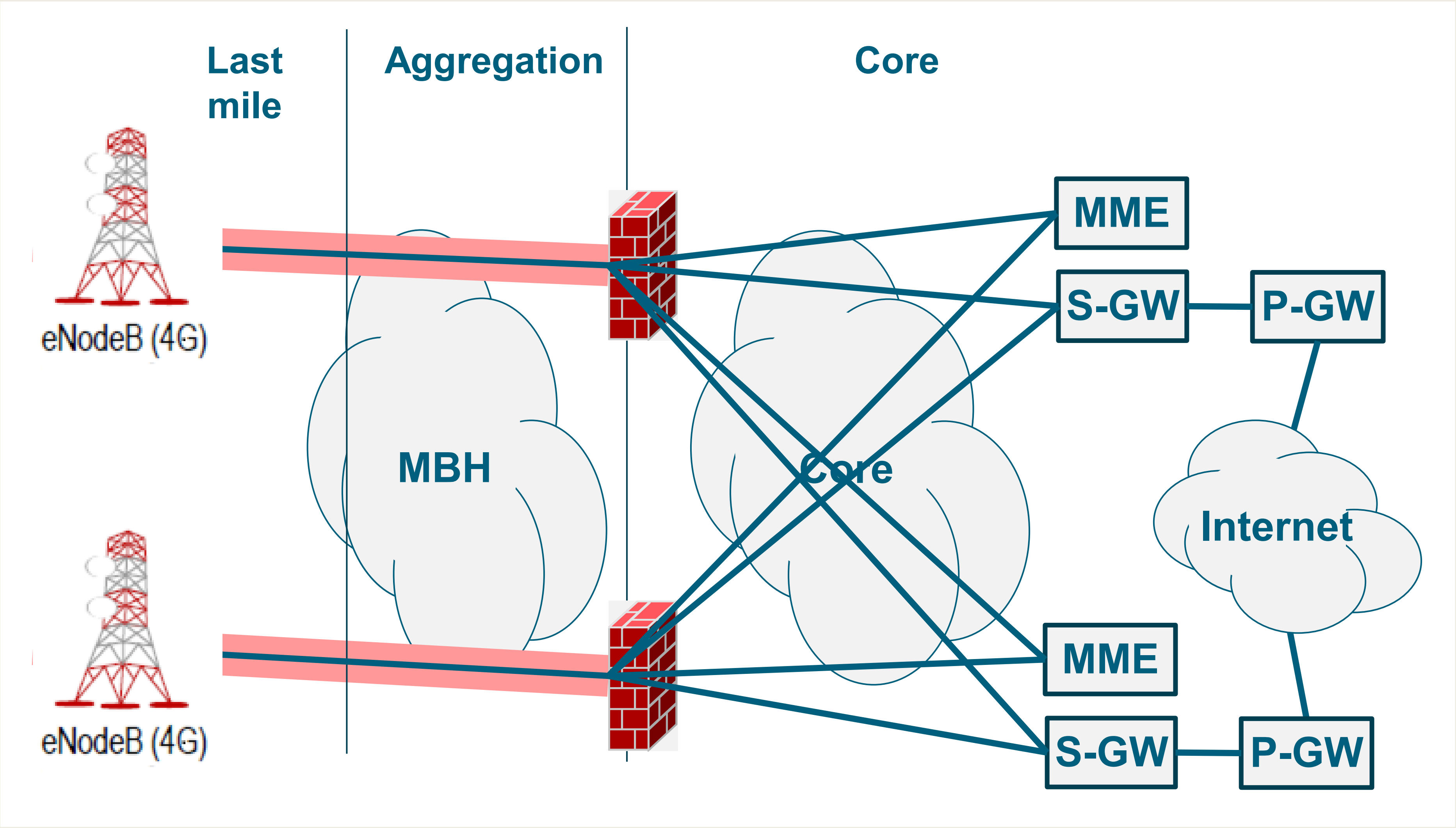
No SPOF

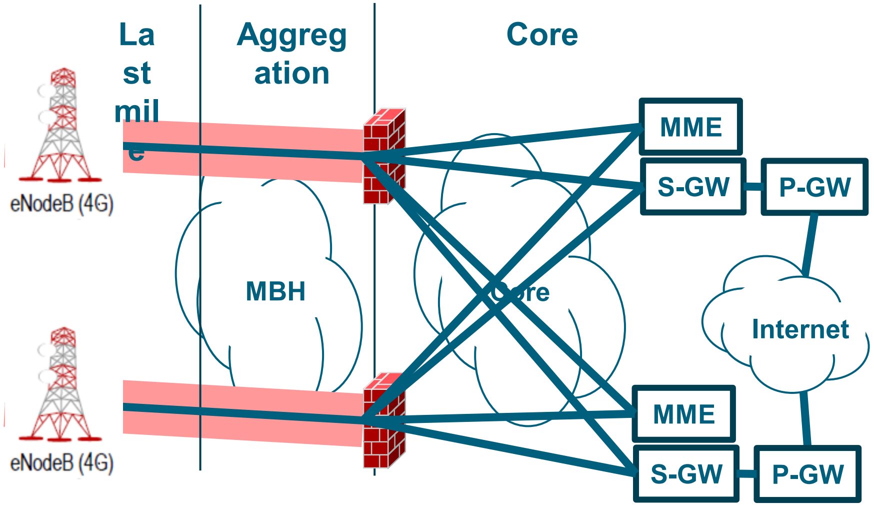


Security Gateway

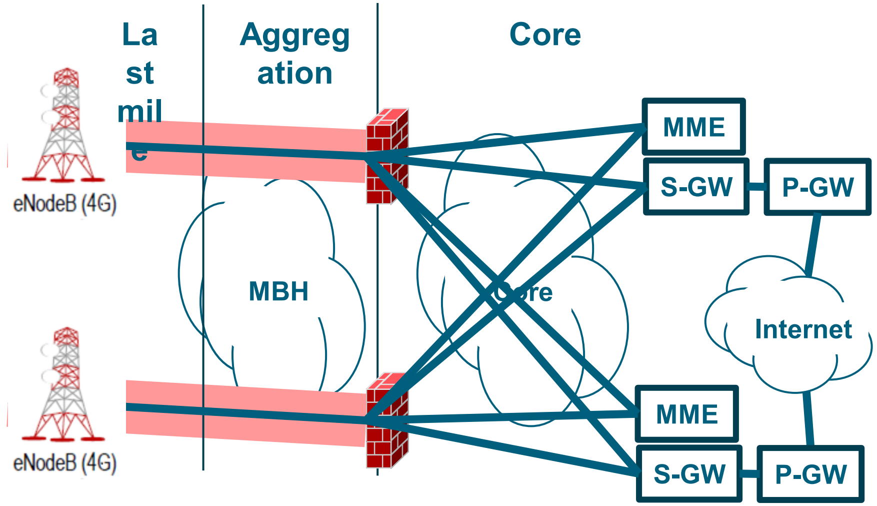
Significant loss of customer base


Last mile
Aggregation
Core
Site 1
eNodeB (4G)
MBH
Core
MME
S-GW
P-GW
Internet
eNodeB (4G)
MME
S-GW
P-GW
Site 2

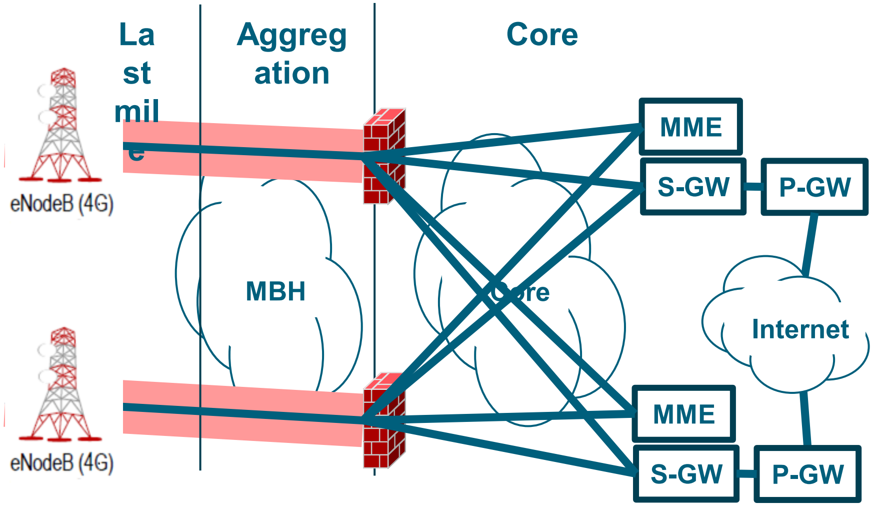

Last mile
Aggregation
Core
eNodeB (4G)
eNodeB (4G)
MBH
Core
MME
S-GW
P-GW
Internet
MME
S-GW
P-GW



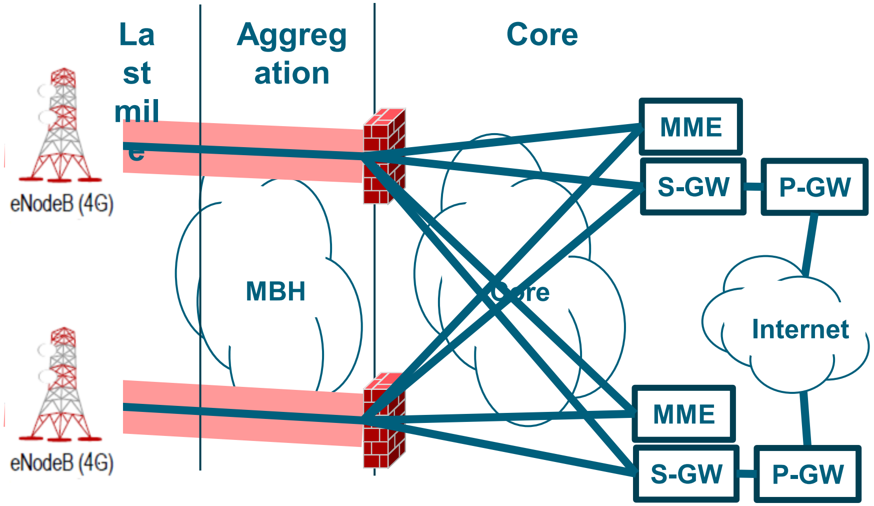
- **Options for Geo-resilience?**



- Options for Geo-resilience?
  - Backup IPSec tunnels

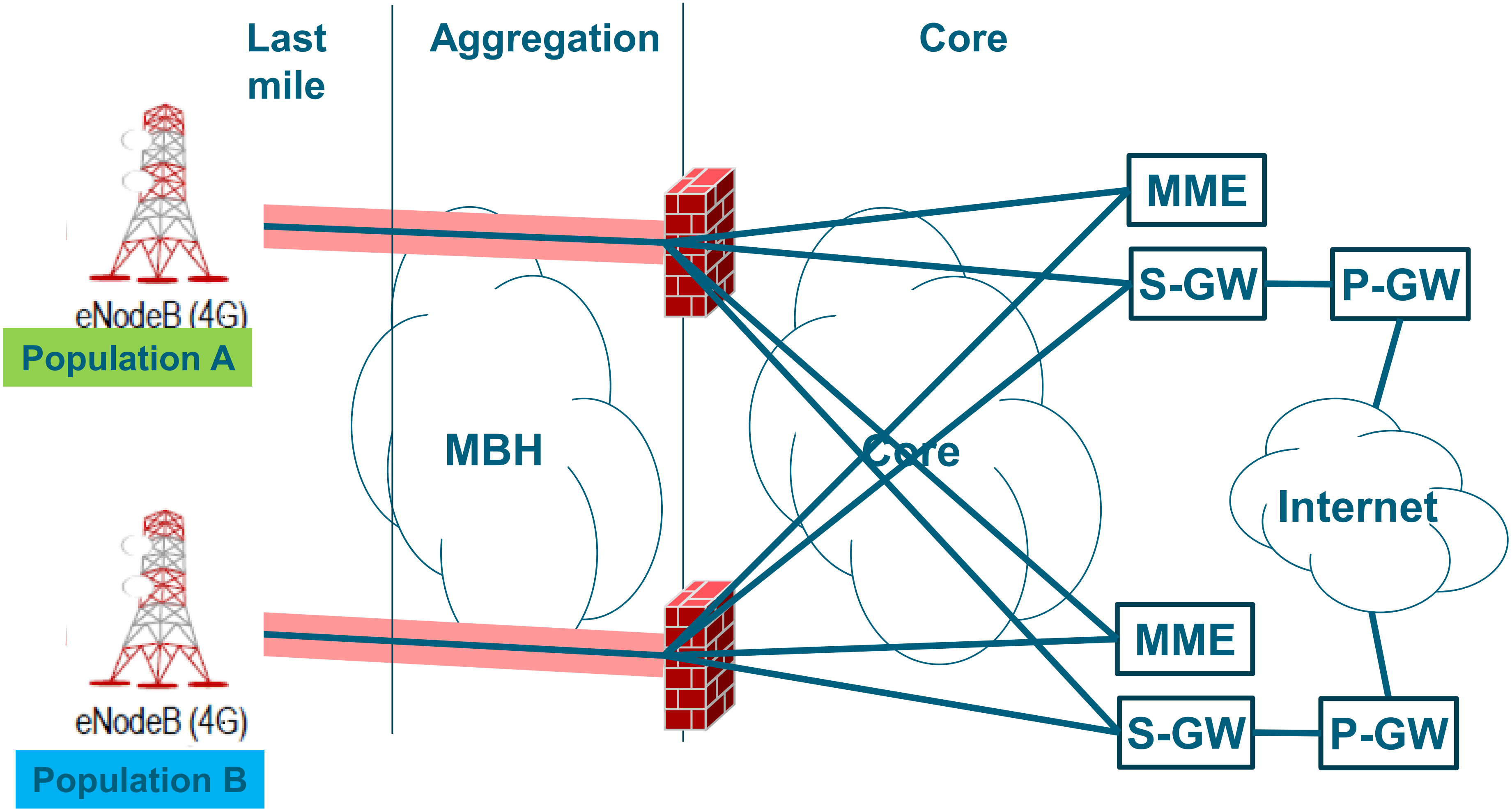


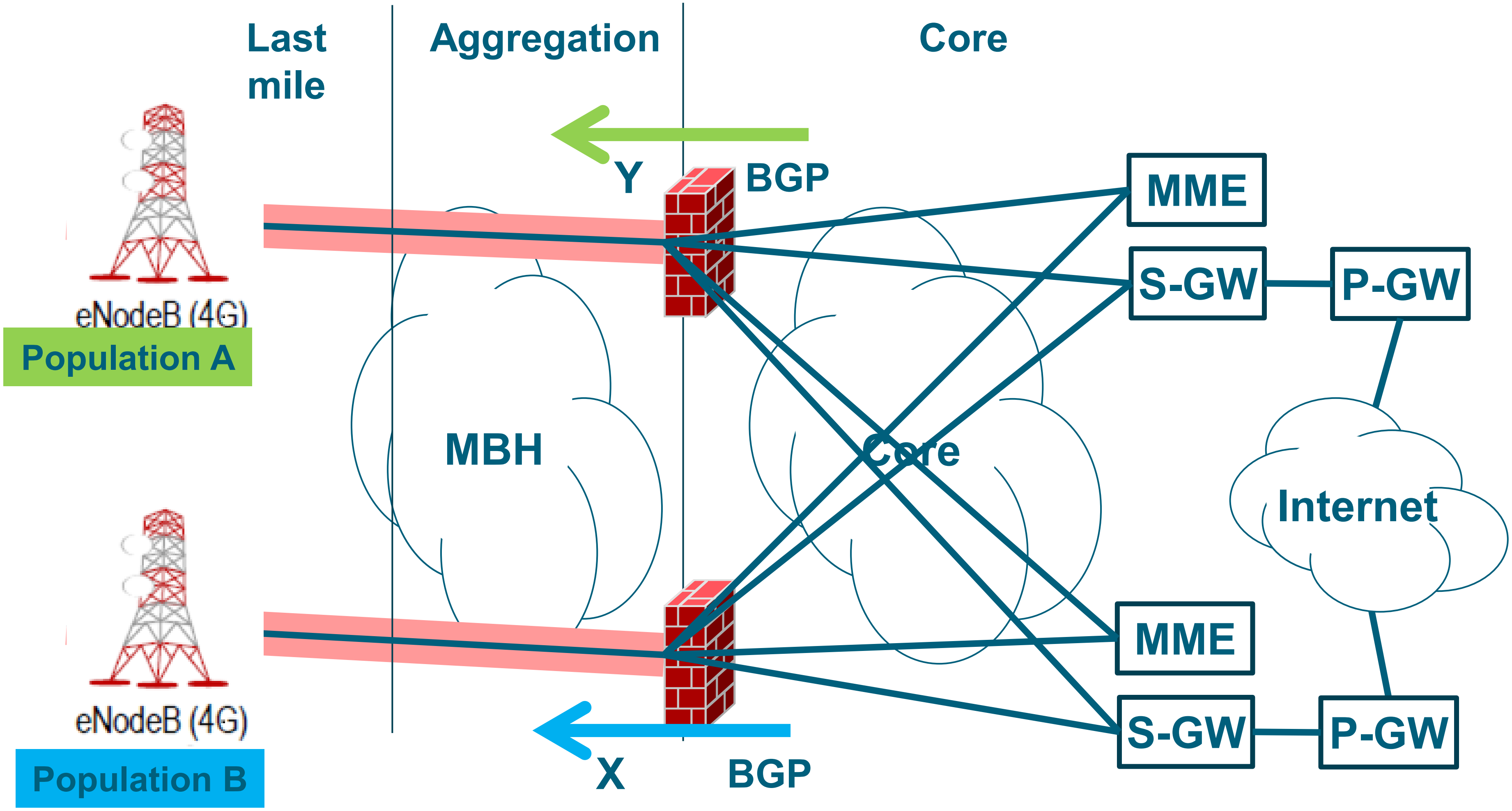
- Options for Geo-resilience?
  - Backup IPSec tunnels
  - Dynamic IP Routing



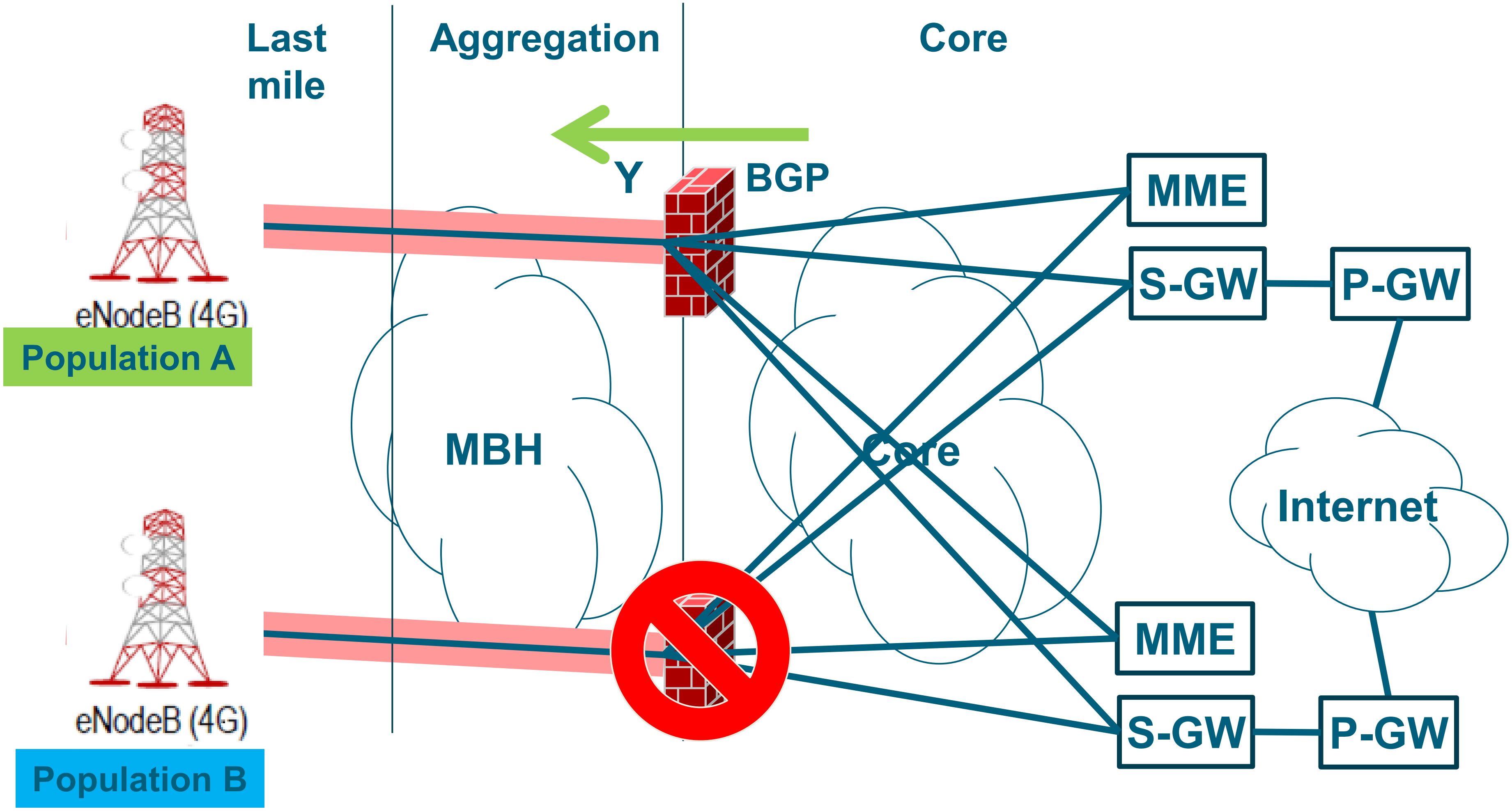
- Options for Geo-resilience?
  - Backup IPSec tunnels
  - Dynamic IP Routing

- Our evaluation of backup IPSec tunnels was that the technology was not completely ready.

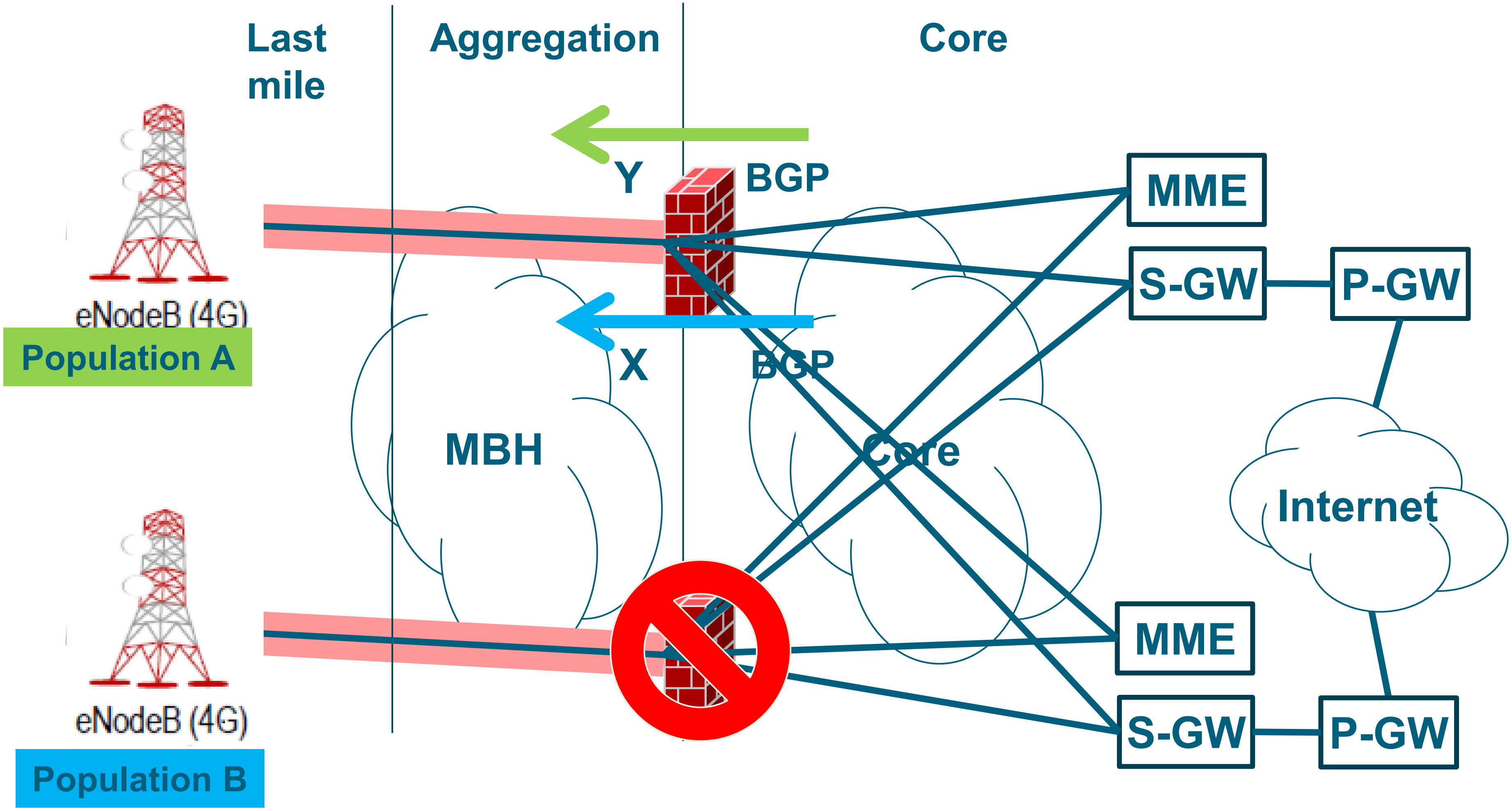

Last mile
Aggregation
Core
MME
S-GW
P-GW
eNodeB (4G)
Population A
MBH
Core
Internet
eNodeB (4G)
MME
S-GW
P-GW
Population B



- Advertise the IPSec end point address using BGP



- **Advertise the IPSec end point address using BGP**



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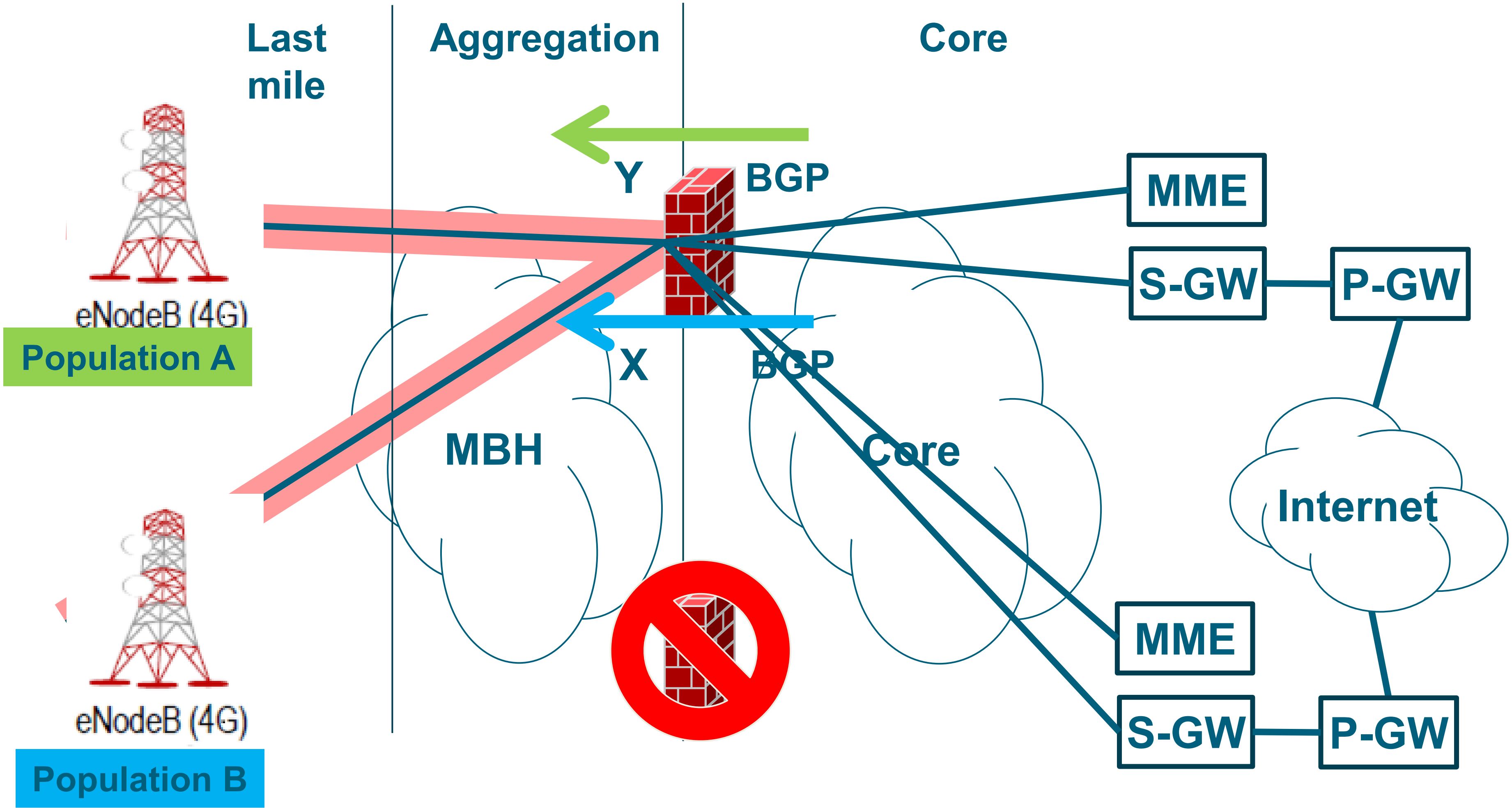
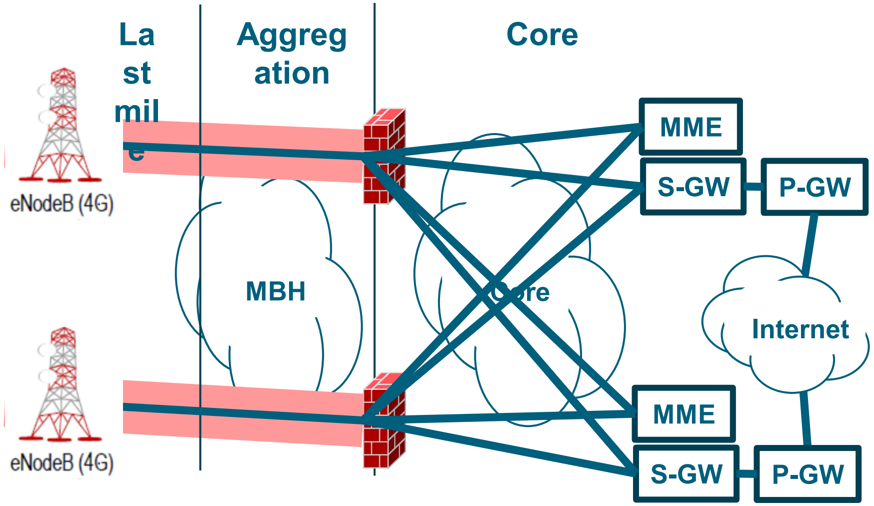
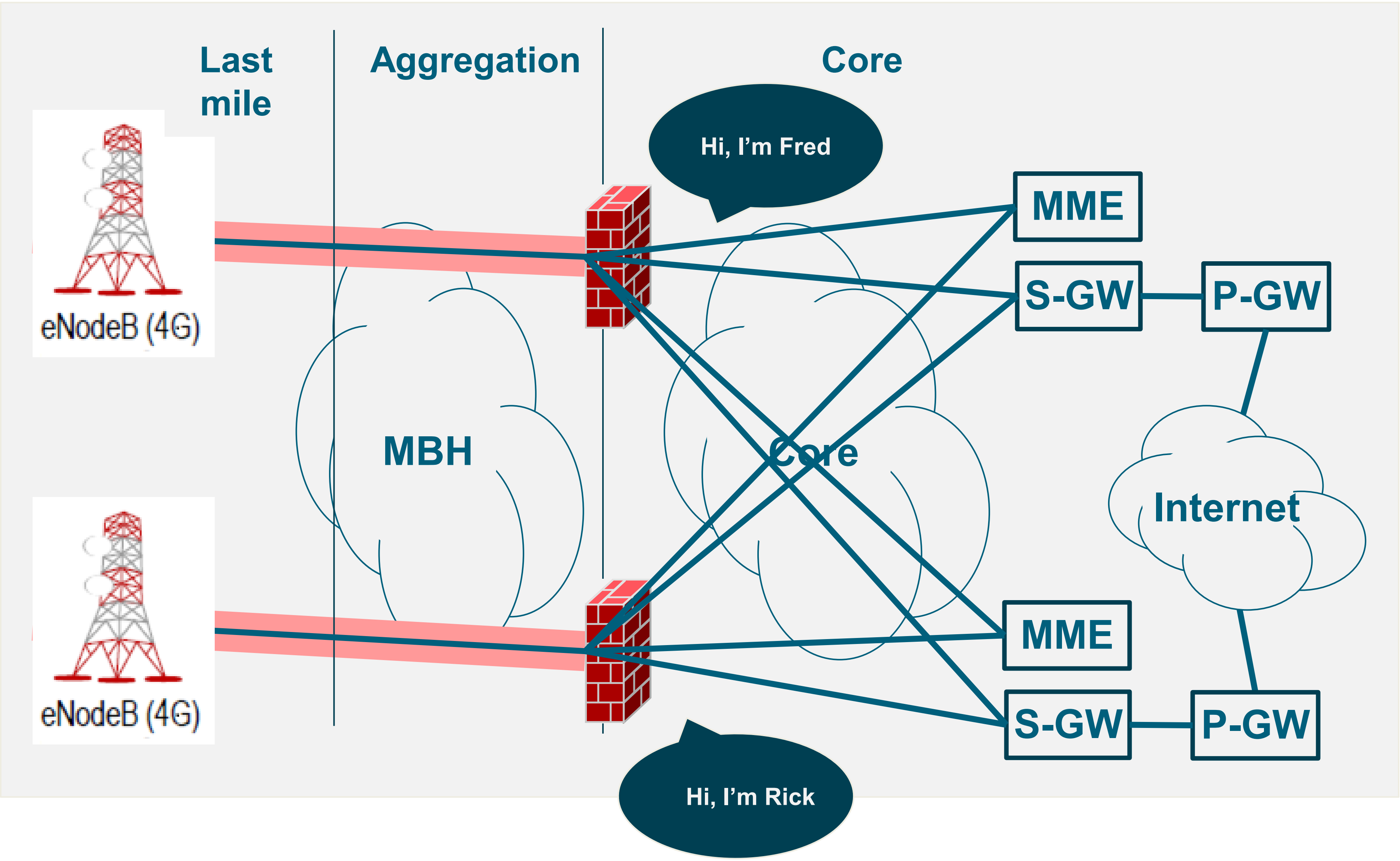


- **Advertise the IPSec end point address using BGP**



- Options for Geo-resilience?
  - Backup IPSec tunnels
  - Dynamic IP Routing

- Challenges with Geo-resilience?
  - IP Routing



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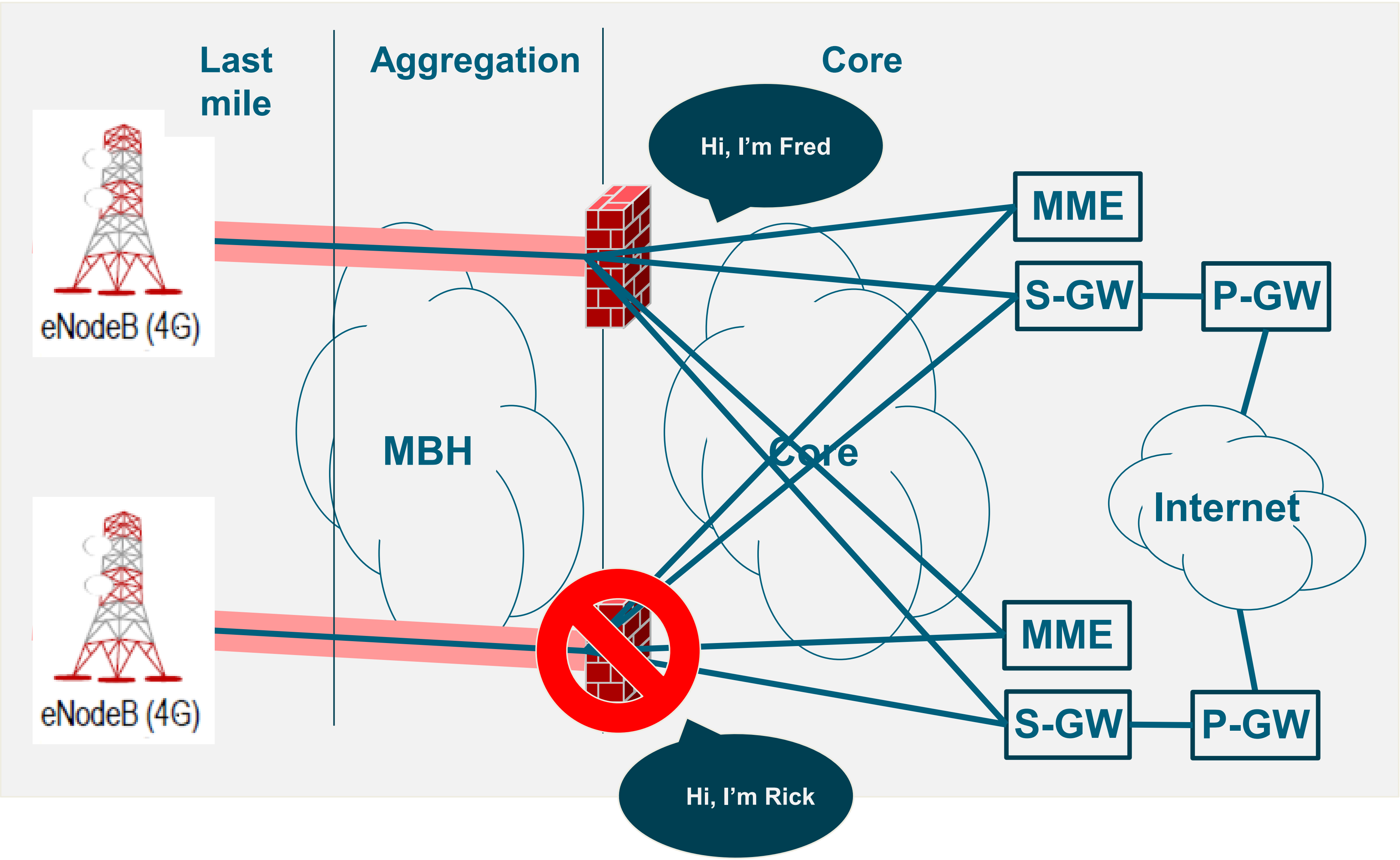

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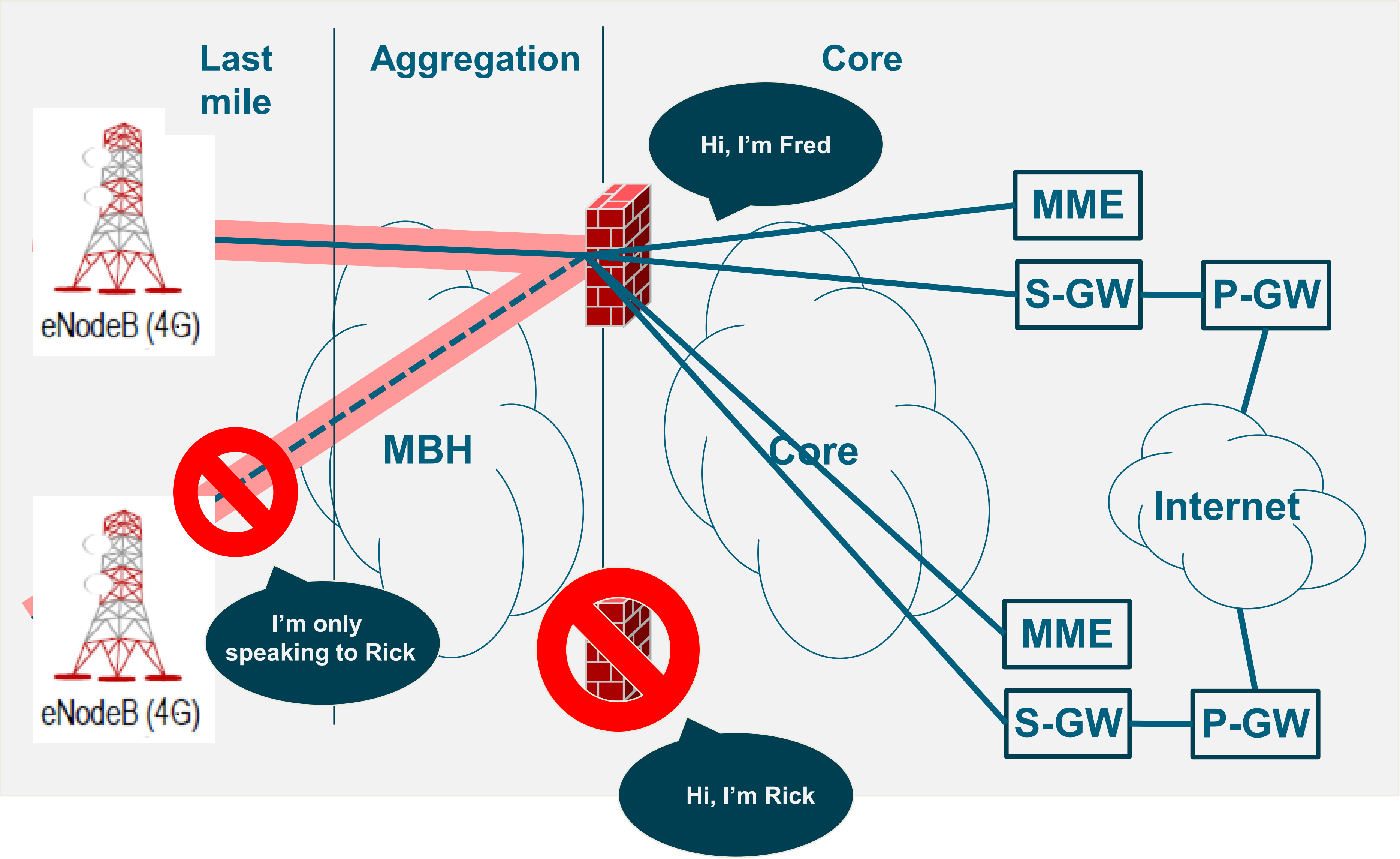

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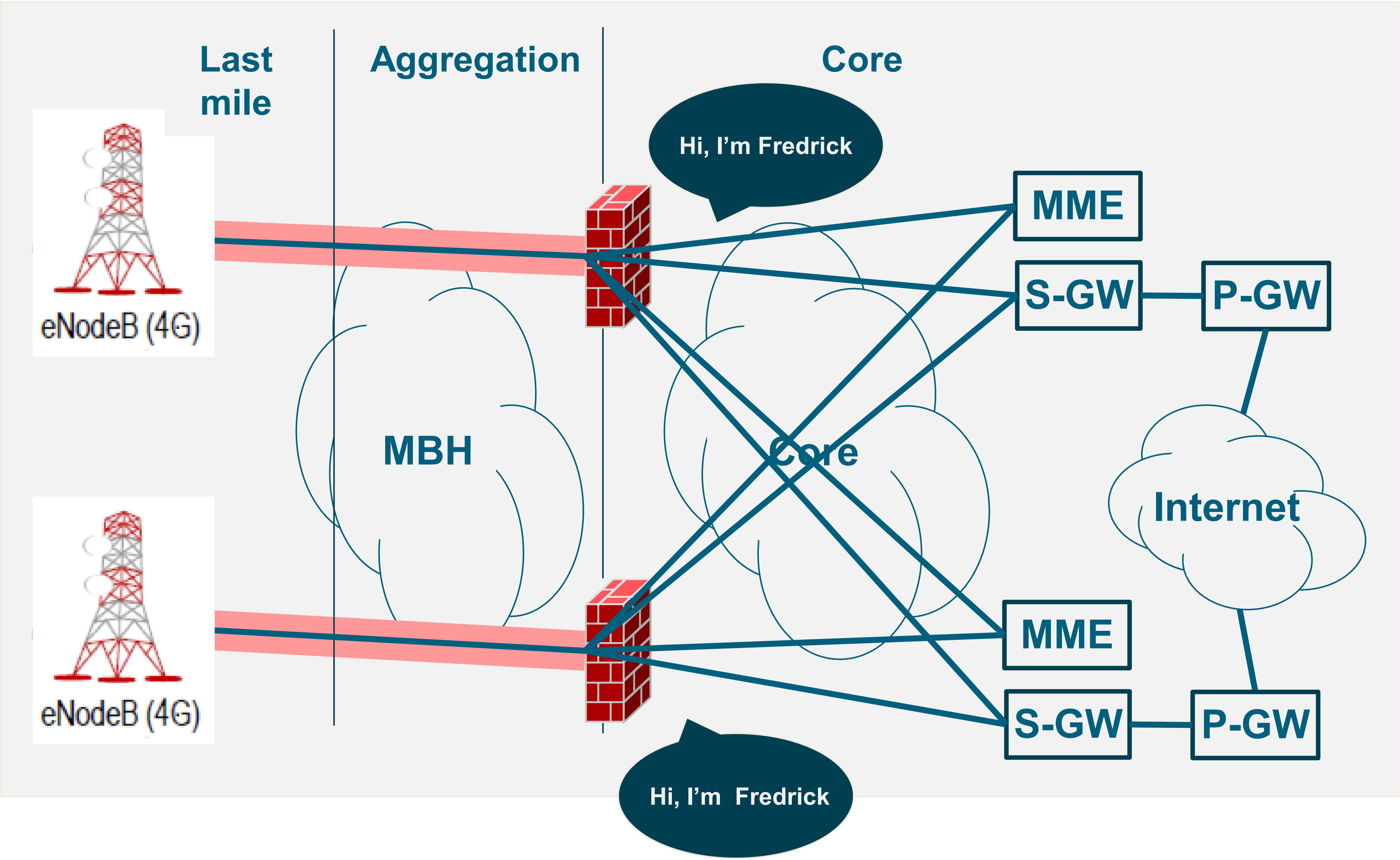

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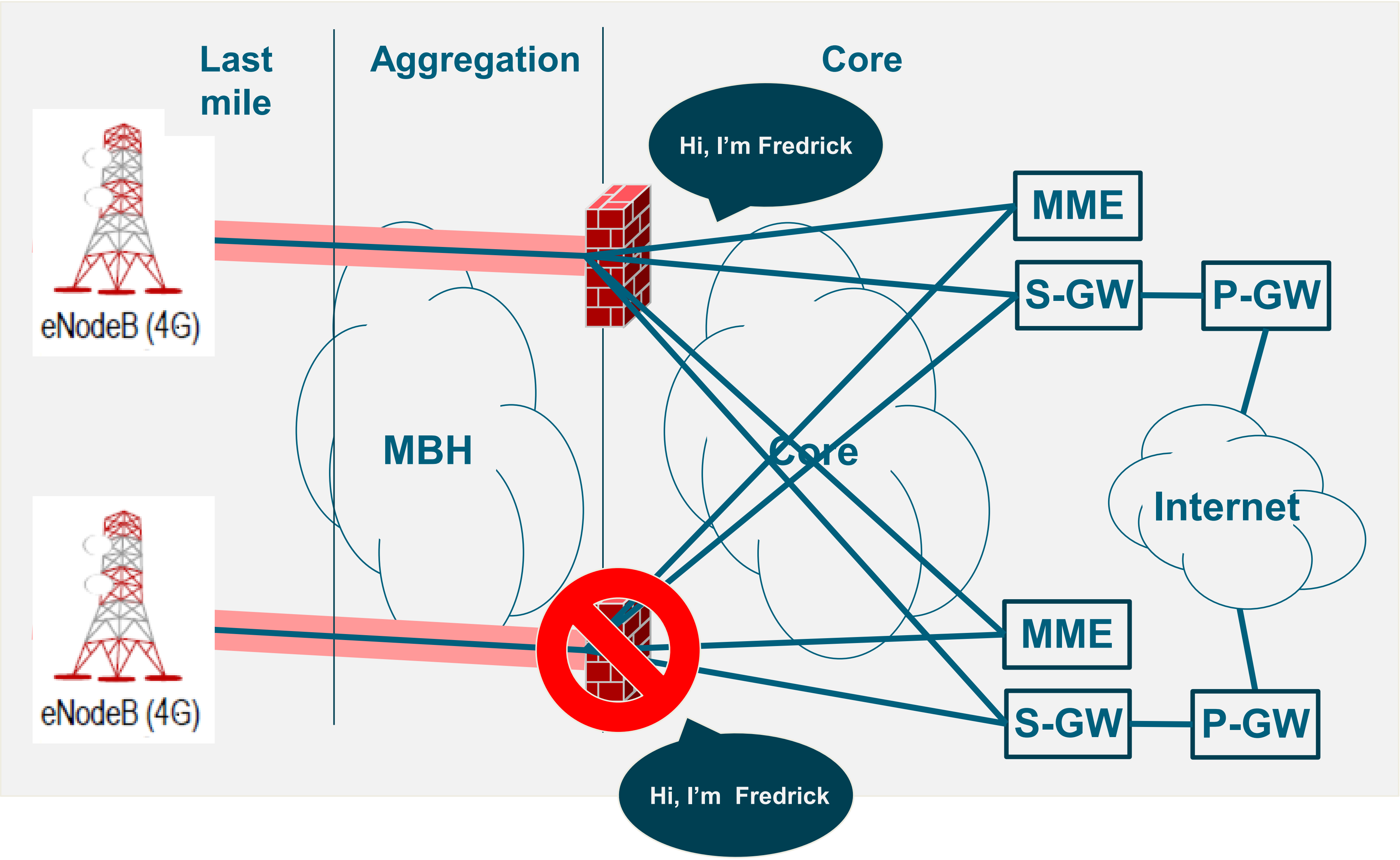

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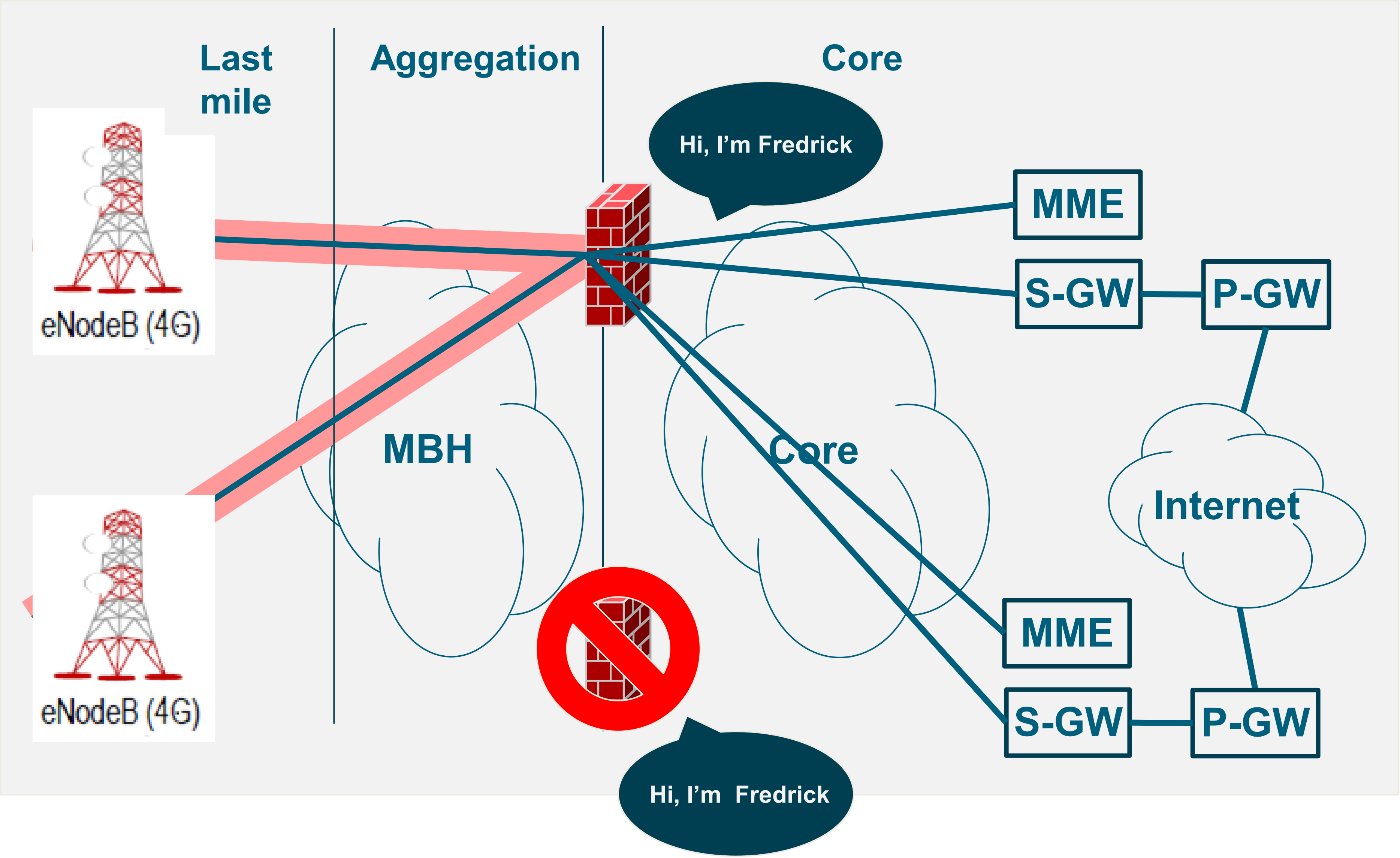


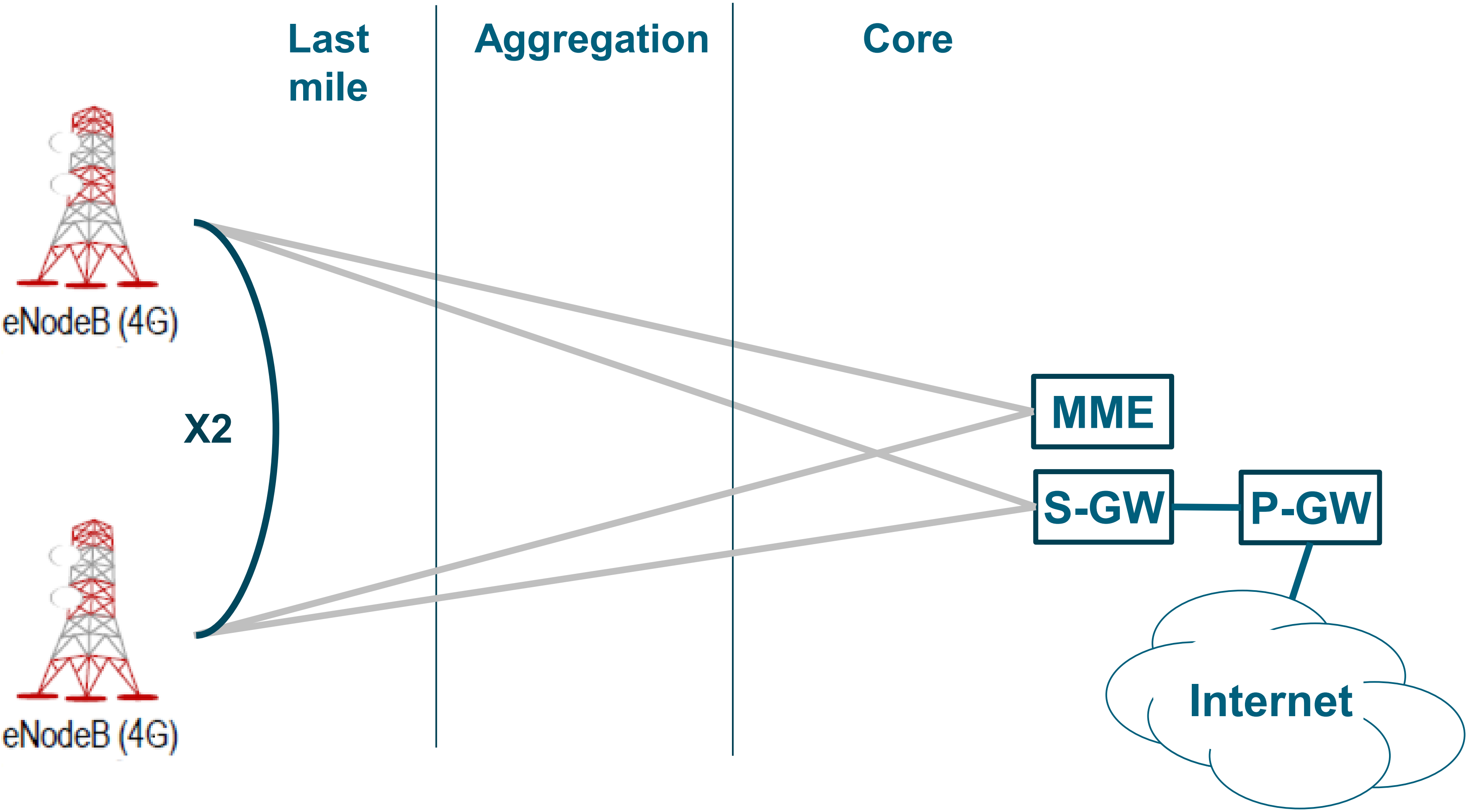
SubjectAltname field

06

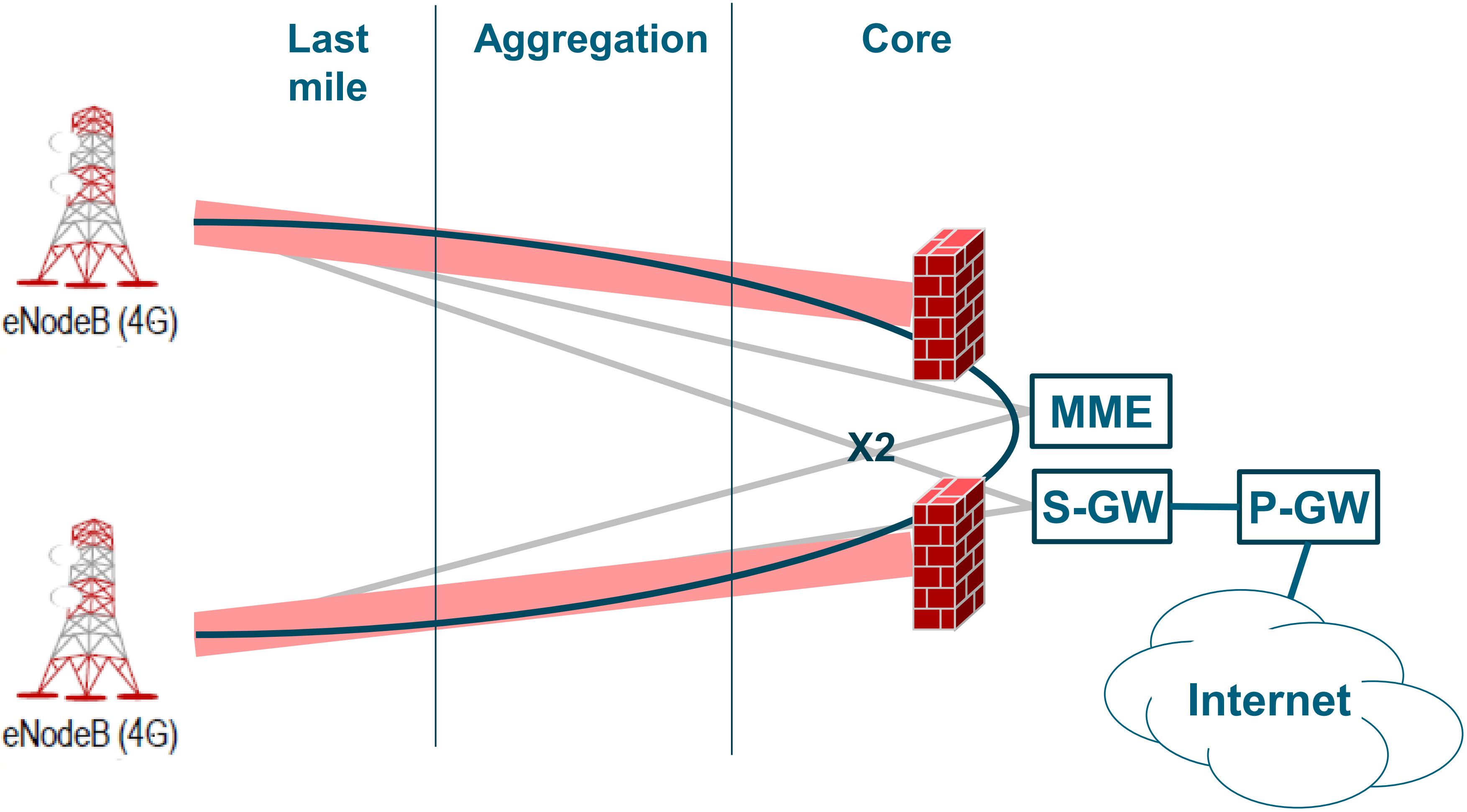
LTE - Advanced

LTE-Advanced

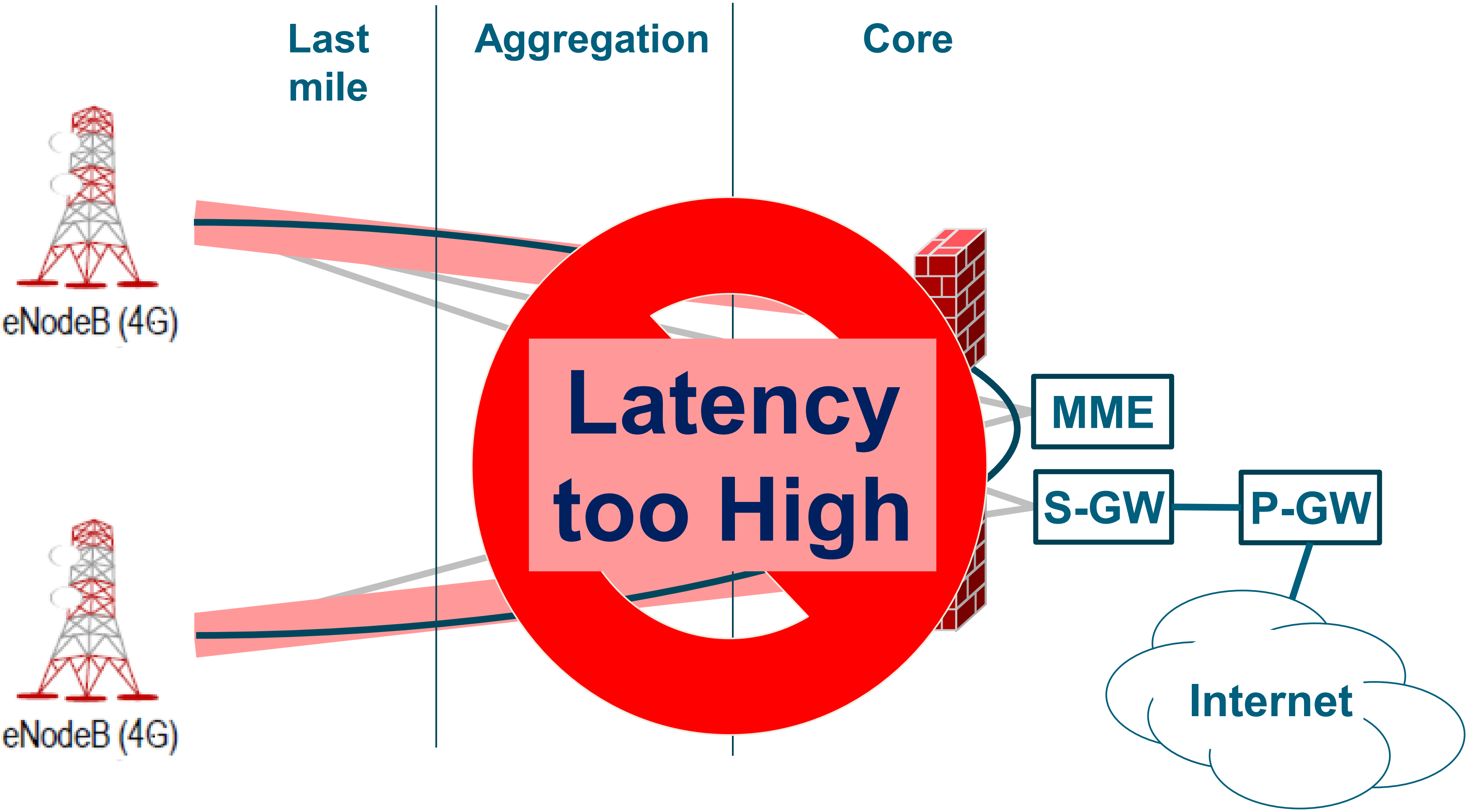
- How will we secure X2 traffic with the very stringent demands of LTE-A? Target latency above which a performance decrement is seen is 1ms.



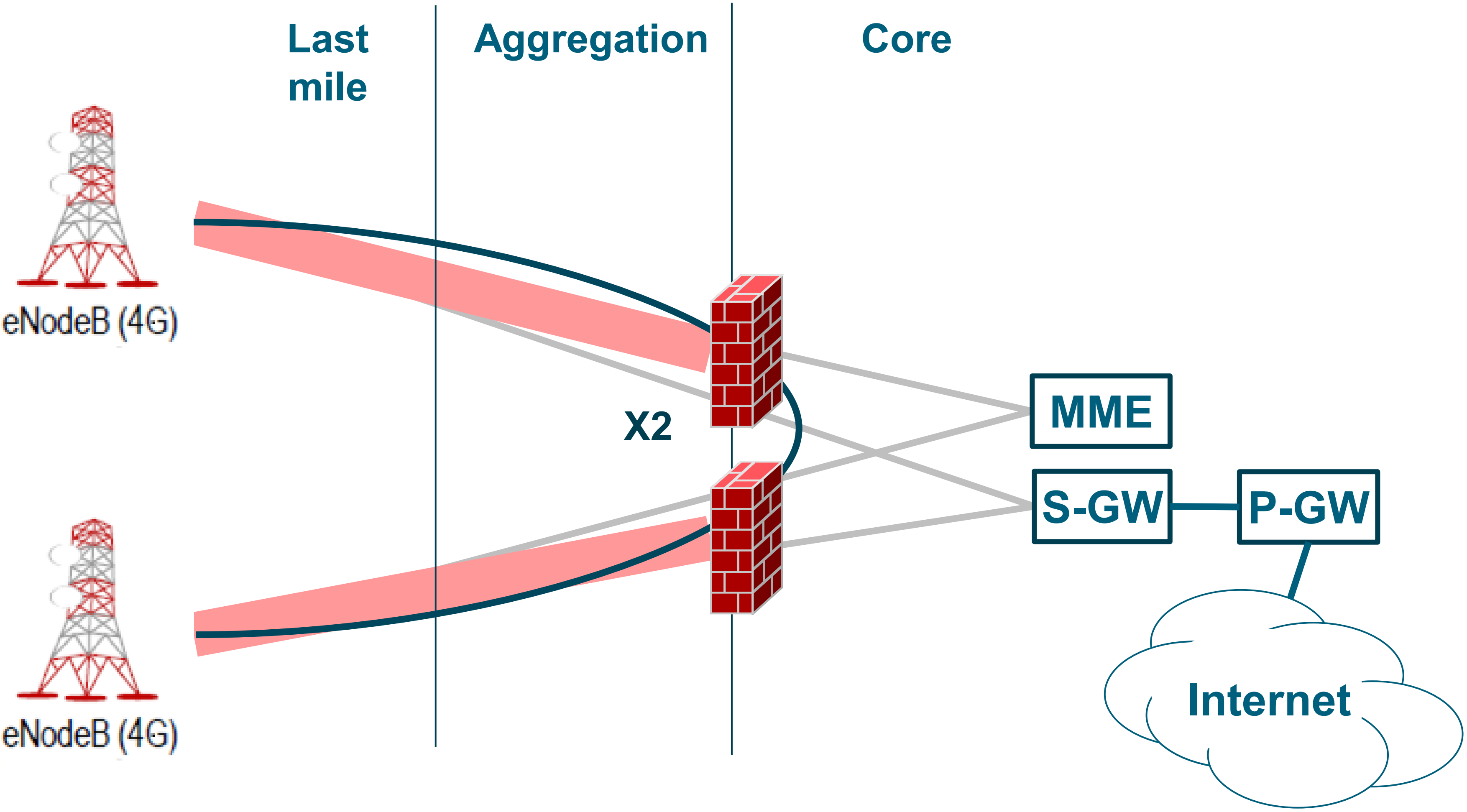
- **Where are you going to deploy the VPN concentrator for X2 handover?**



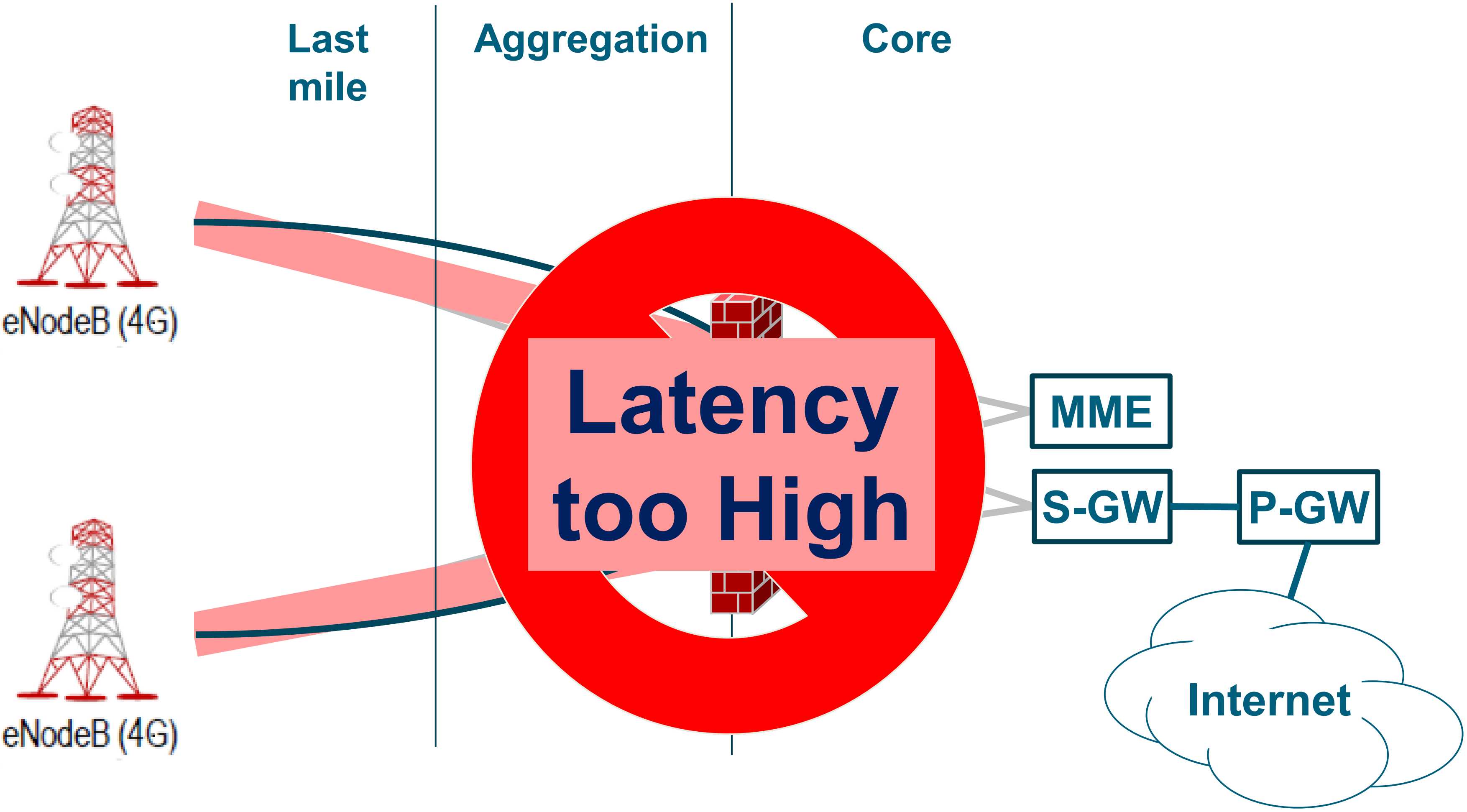
- **Option 1 – Centralised SecGW?**



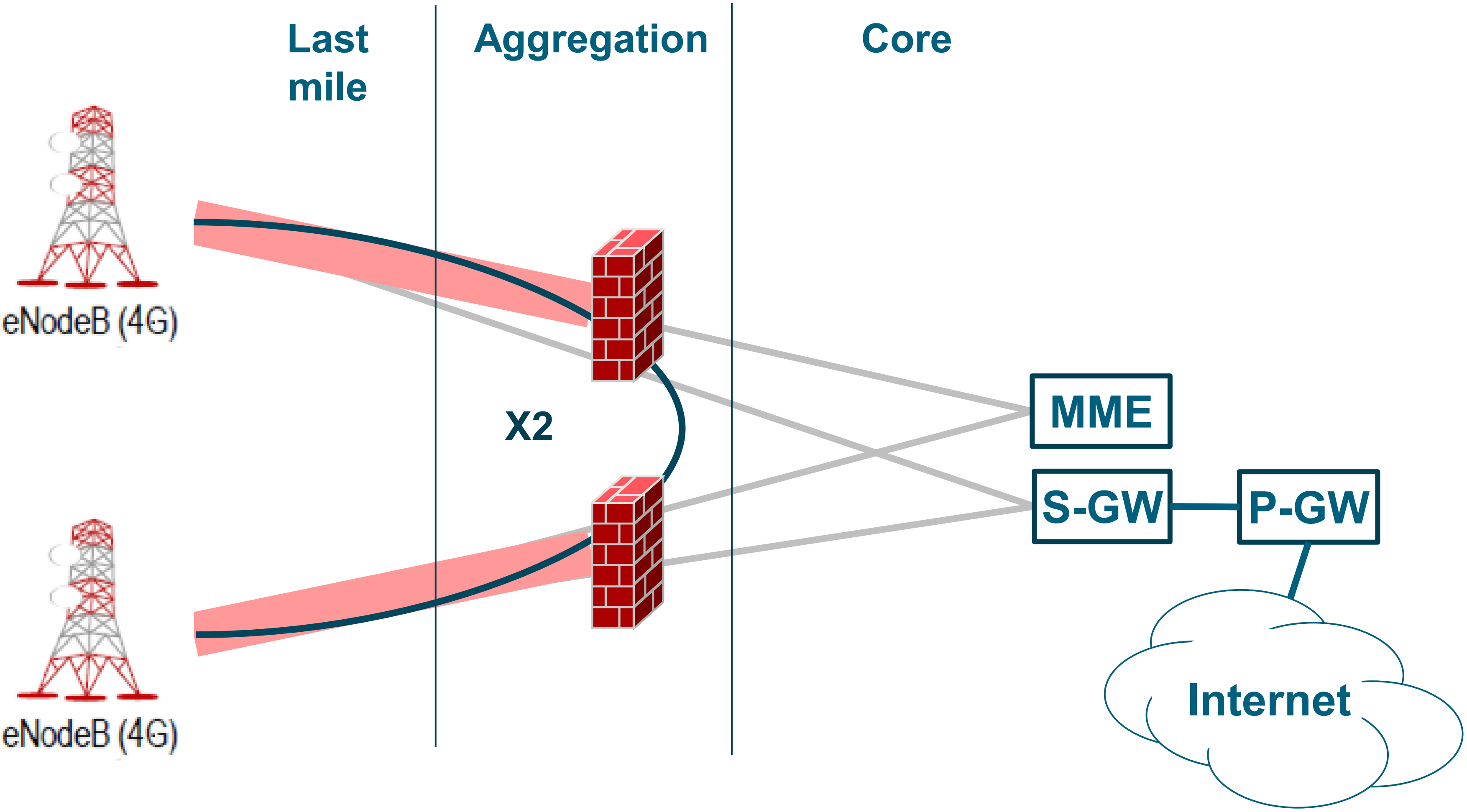
- Option 1 – Centralised SecGW?



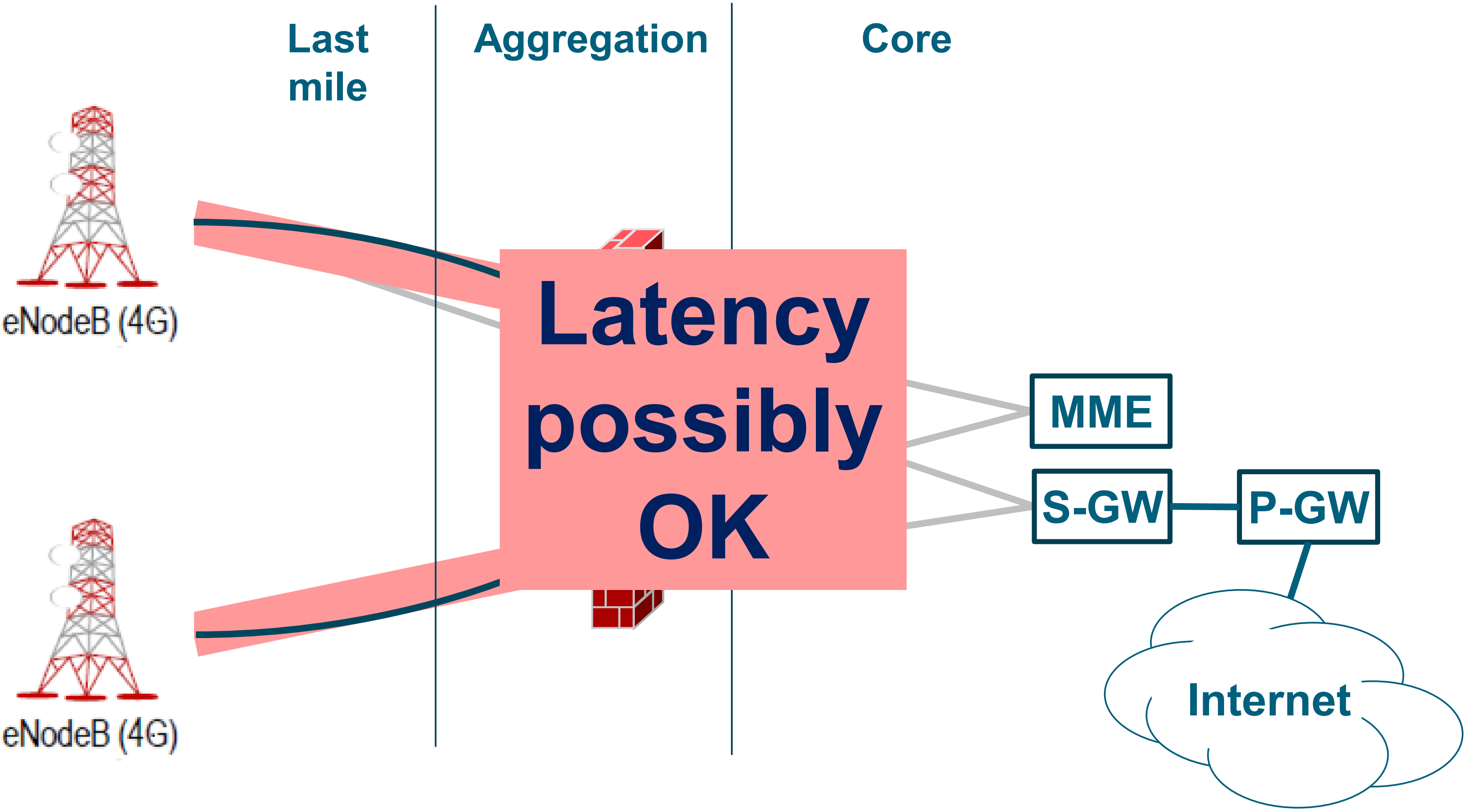
- **Option 2 – SecGW at Core Edge?**



- Option 2 – SecGW at Core Edge?

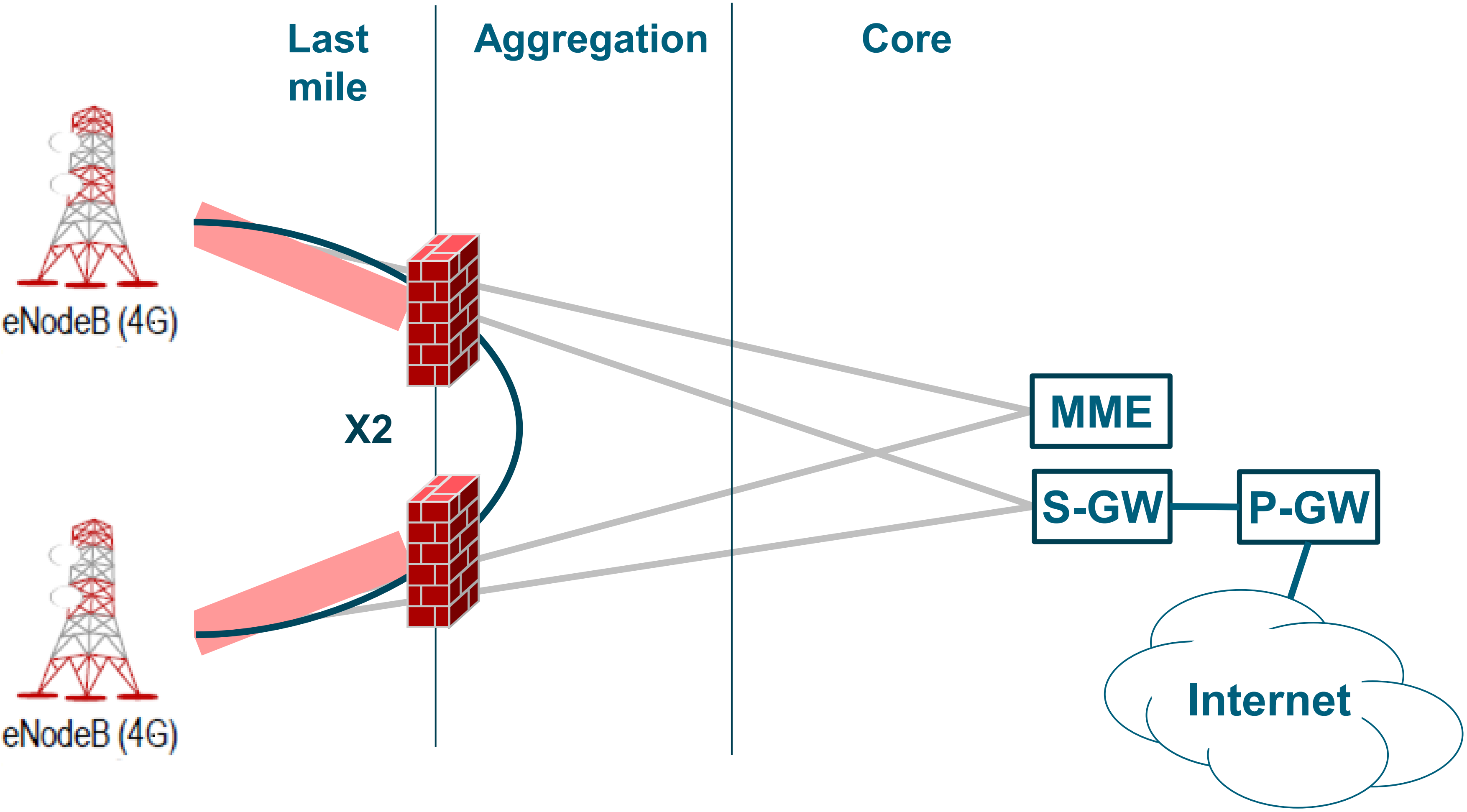


- Option 3 – Tens of SecGW distributed in Aggregation?

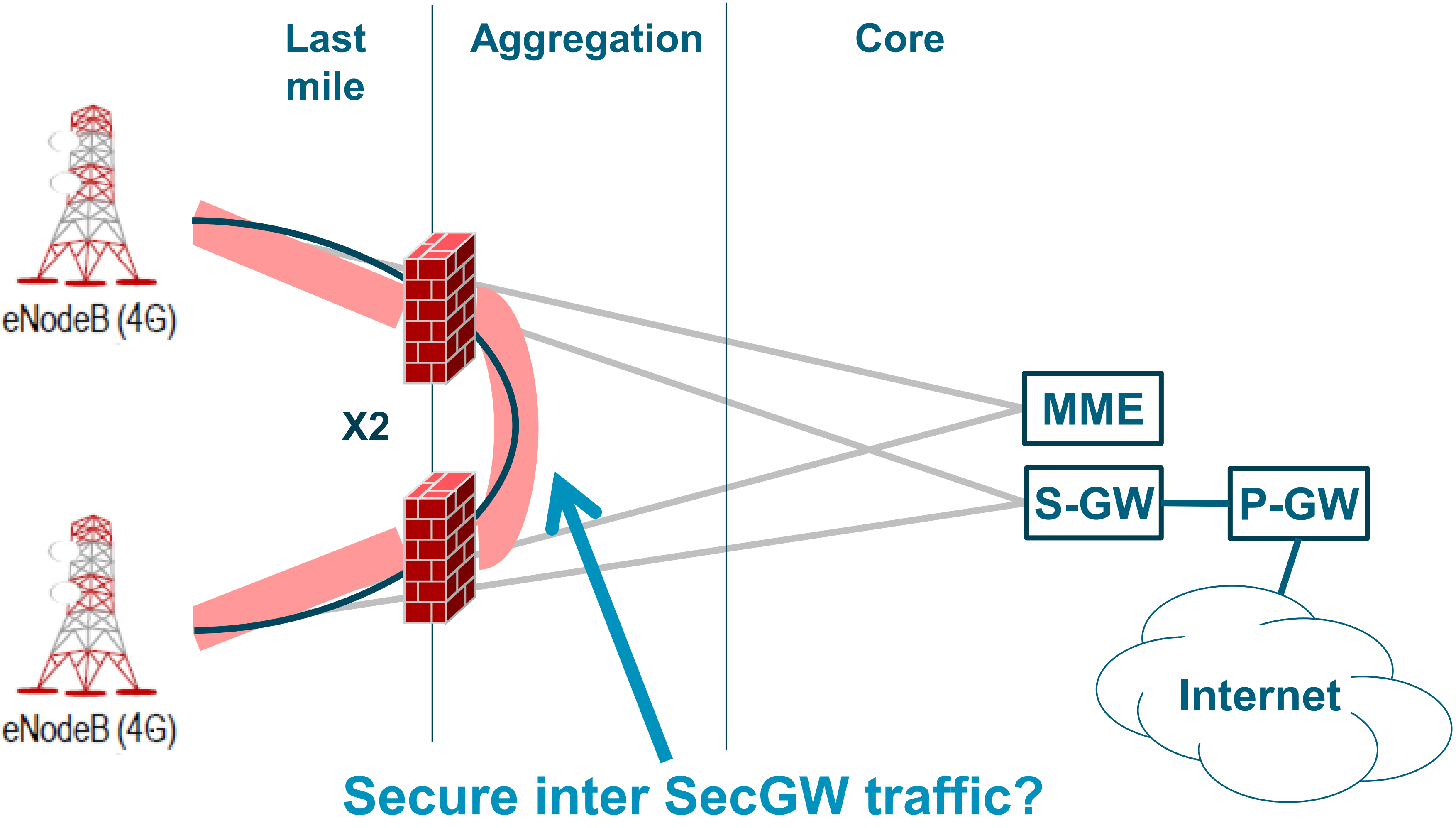


Latency possibly OK

- **Option 3 – Tens of SecGW distributed in Aggregation?**

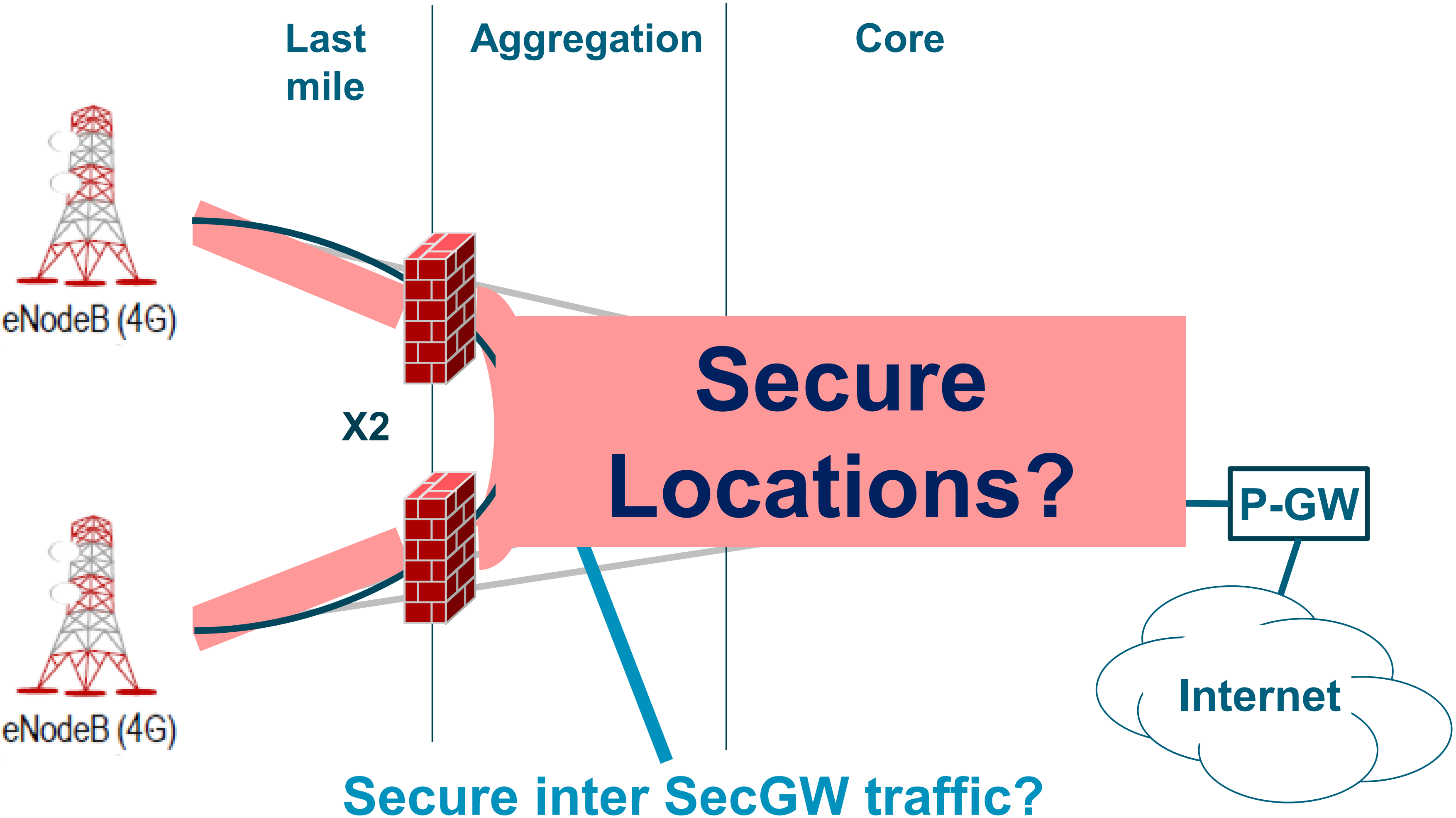


- **Option 4 – Hundreds of SecGW at local exchanges?**



Secure inter SecGW traffic?

- Option 4 – Hundreds of SecGW at local exchanges?



Last mile

Aggregation

Core

eNodeB (4G)

X2

eNodeB (4G)

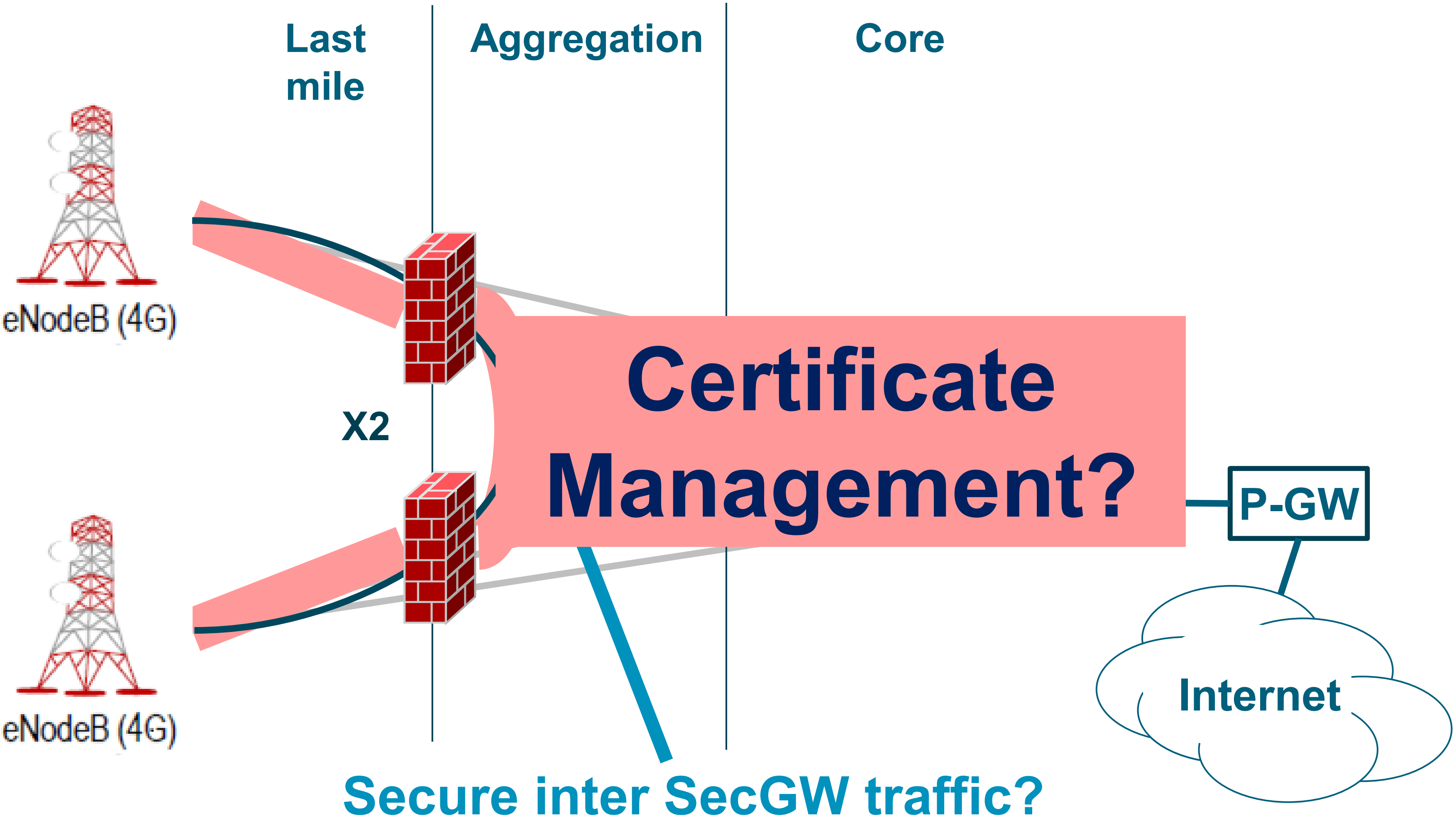
Secure Locations?

P-GW

Internet

Secure inter SecGW traffic?

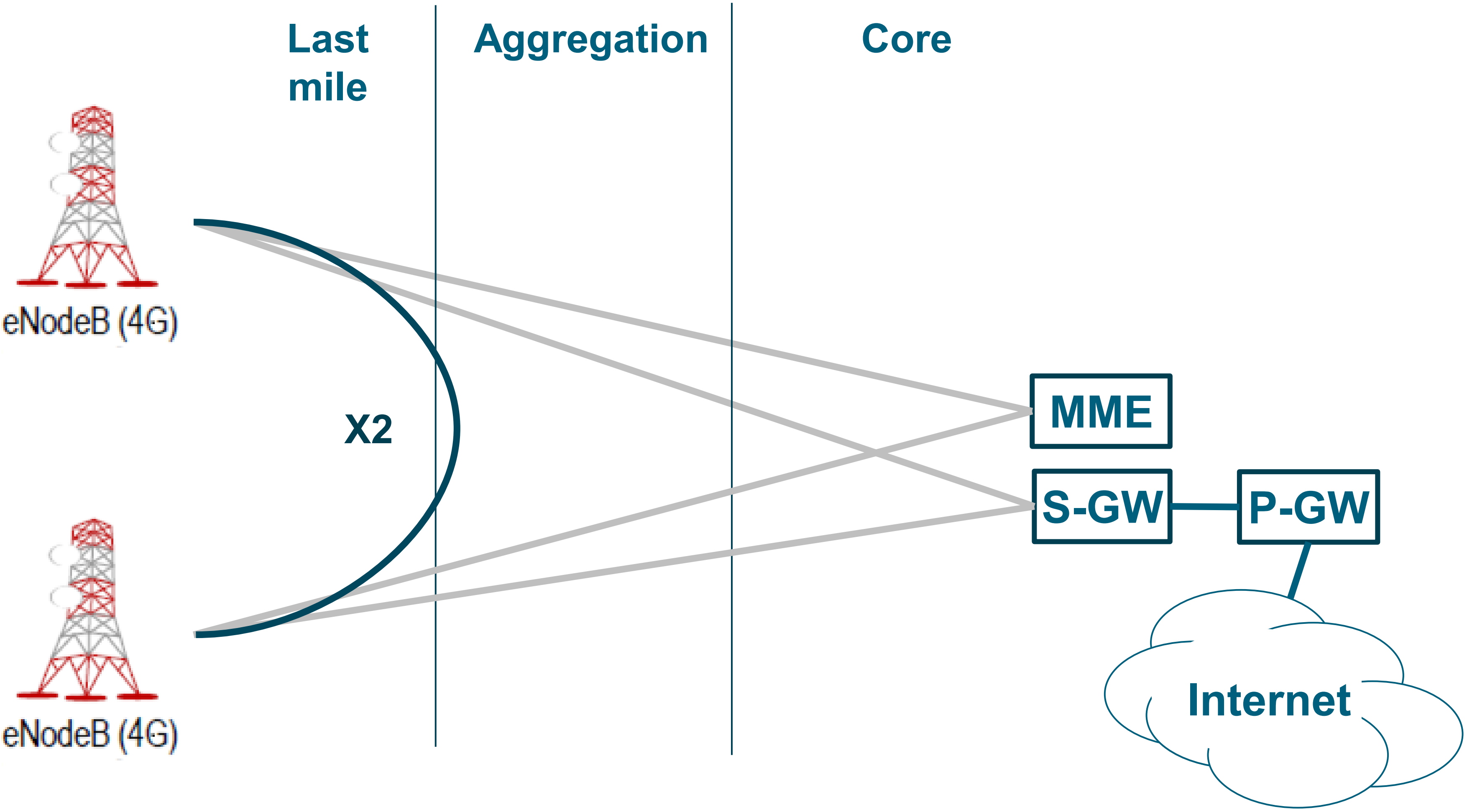
- Option 4 – Hundreds of SecGW at local exchanges?



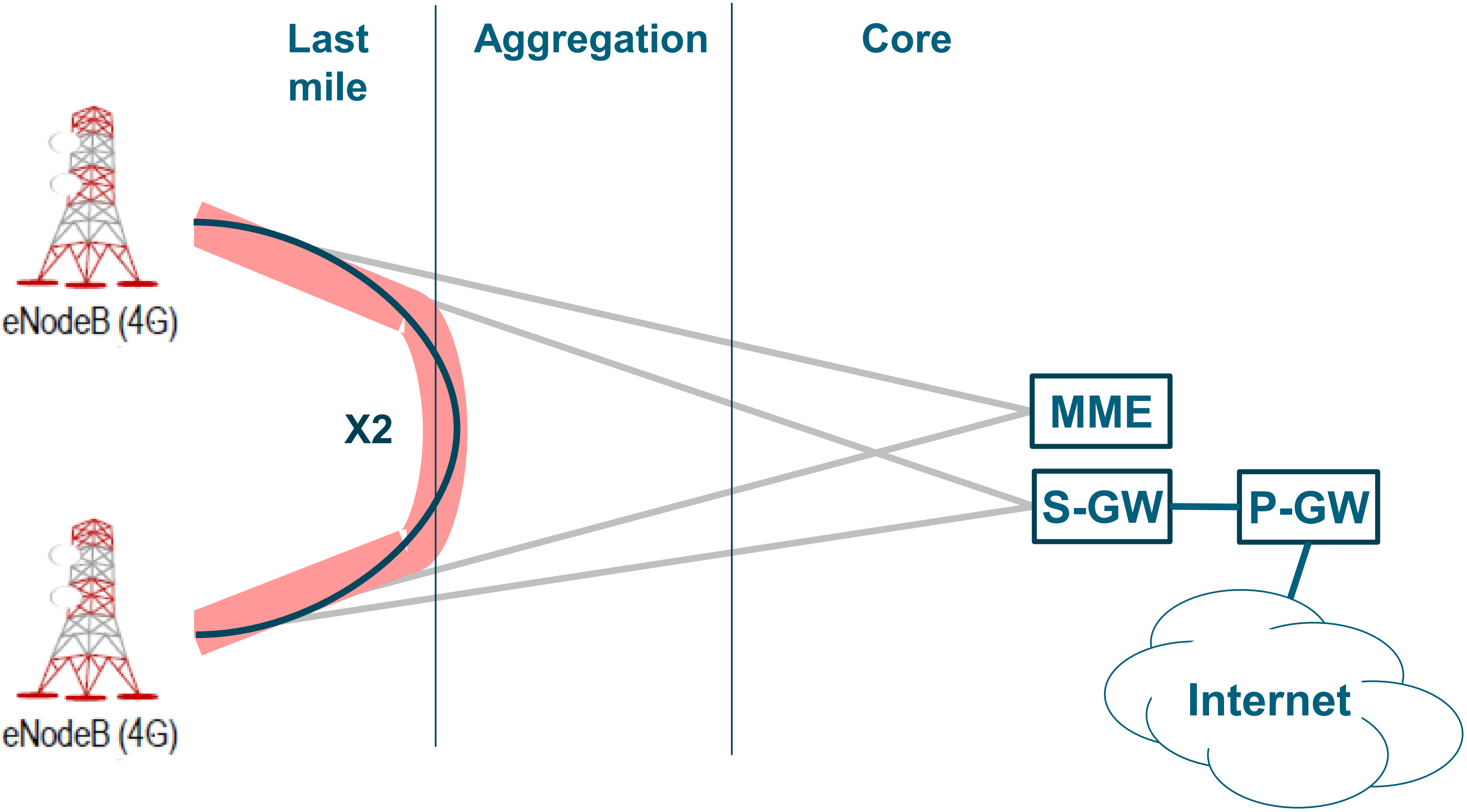
Certificate Management?

Secure inter SecGW traffic?

- Option 4 – Hundreds of SecGW at local exchanges?



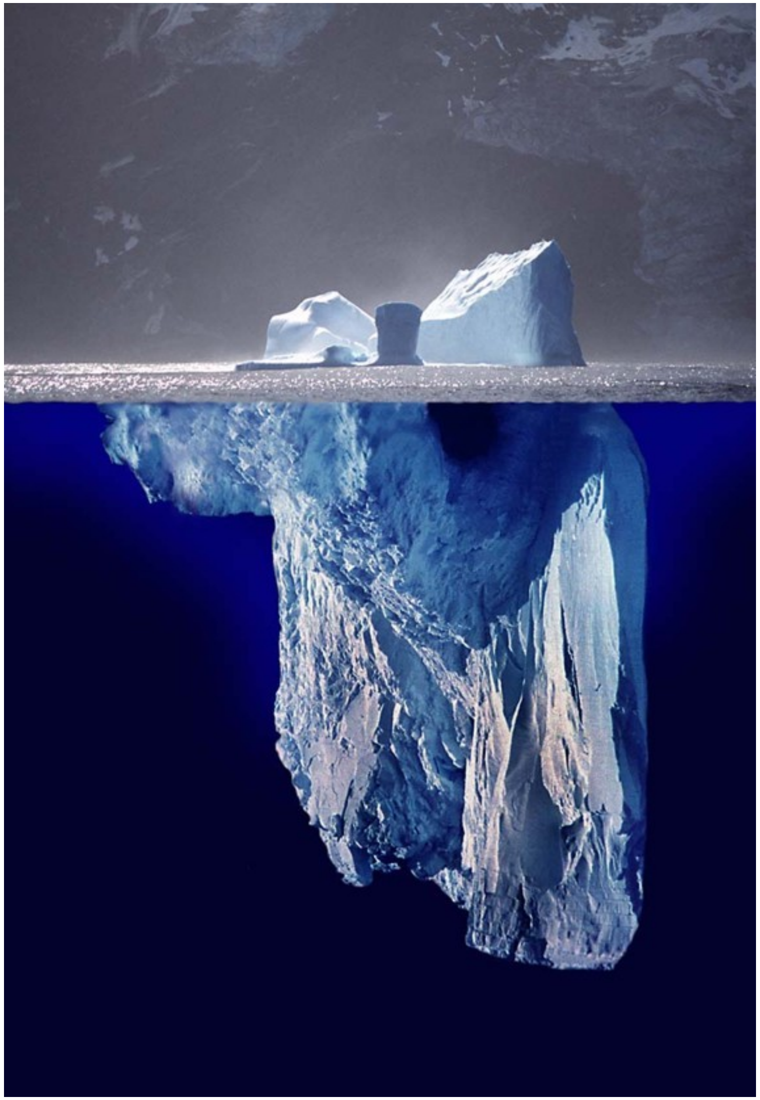
- **Option 5 – Don’t encrypt?**



- **Option 6 – No VPN concentrator ?**

- Summary
  - Simple – Just deploy LTE Security Gateway and encrypt with IPSec.
  - There's a few gotcha's to watch out for.
  - Keeping a multi operator and multi vendor deployed environment simple is not easy.

- Questions?



Thank You

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