vodafone business

Welcome to the interactive

MPN Architecture Playbook

Click the arrow to begin



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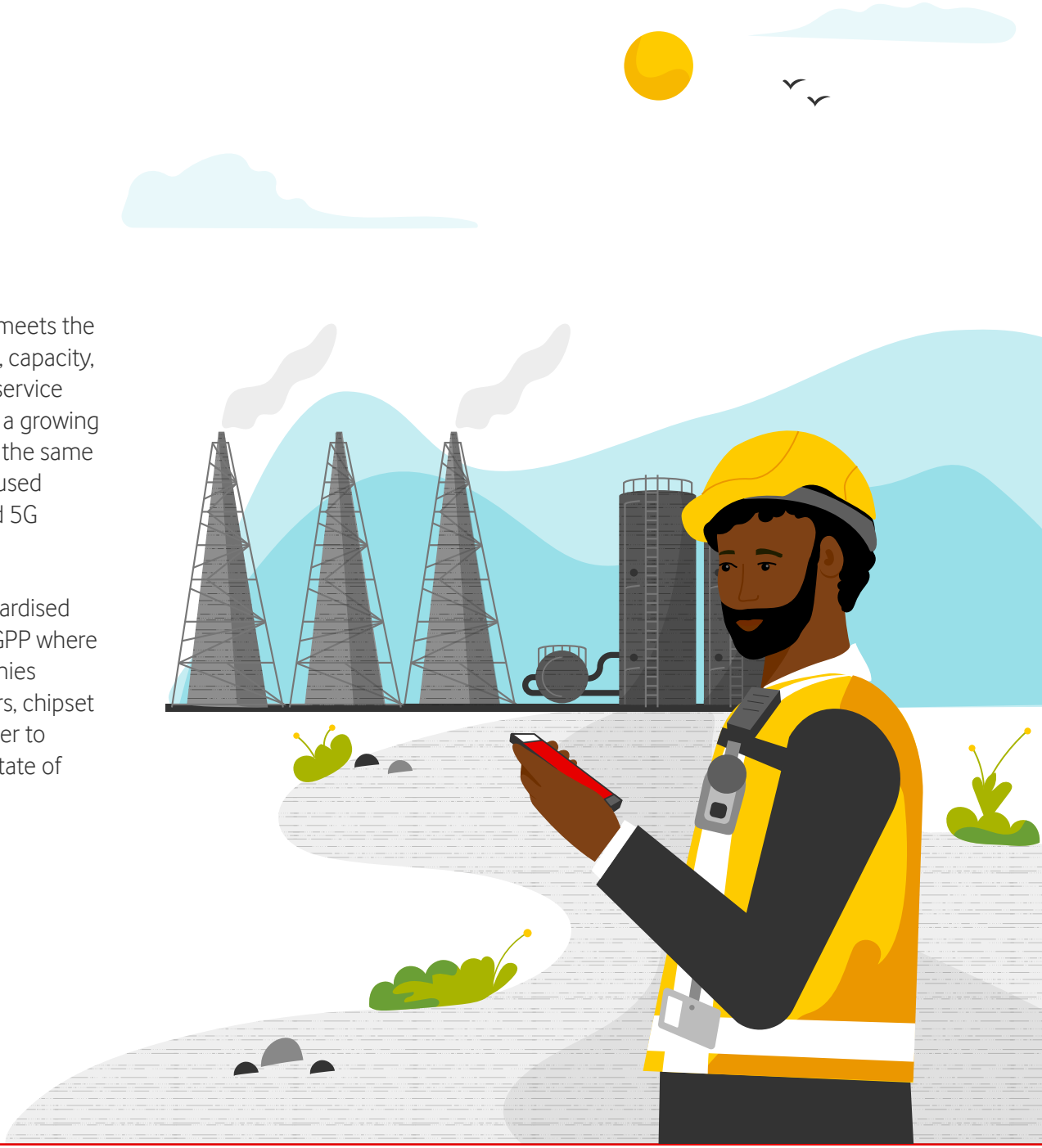
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What is **MPN** and what does it bring?

- A Mobile Private Network (MPN) is a mobile network where all or some of the components or resources are dedicated to an Enterprise customer.
- **Digital Transformation** and **Industry 4.0** are driving new demands from manufacturing, transport, energy/utilities, healthcare and public sector verticals for the MPN solutions that use advanced wireless networking capabilities. Examples include industrial monitoring and control, connected workers and next generation public safety communication services.
- Traditional Wi-Fi no longer meets the required security, coverage, capacity, low latency and quality of service guarantees; hence, there is a growing demand on MPN based on the same mobile technology widely used across the world for 4G and 5G smartphones, sensors etc.
- Such a technology is standardised by a global forum called 3GPP where all the leading tech companies (operator, Network suppliers, chipset and terminal vendors) gather to create a safe, reliable and state of the art ecosystem.



Why choose **Vodafone** to provide MPN?



- Vodafone has a long multinational experience in building and operating networks capable of providing services to millions of customers, in both consumer and enterprise space.

- According to ISG latest report (FY22 Q1), Vodafone scored very strongly both in UK and Germany markets. There is also a strong traction coming from Australia.

- Overall, both ISG and Gartner provided a positive feedback on Vodafone MPN. Gartner latest report highlighted that Vodafone is currently leading the Magic Quadrant for IoT Connectivity Services worldwide, showing creativity and innovation in its approach to building IoT proposals. Customers continue to be satisfied and favourable with Vodafone MPN solutions.

- Vodafone has been a leading operator within the standardisation bodies that define the characteristics of the technical components that have to interoperate to ensure a multi-vendor environment for both the Network and the Terminals/modems.

- We know what is needed to design, build and operate networks based on customer needs, selecting and integrating the best technological components from all Network and IT providers like Ericsson, Nokia, VMWare, etc.

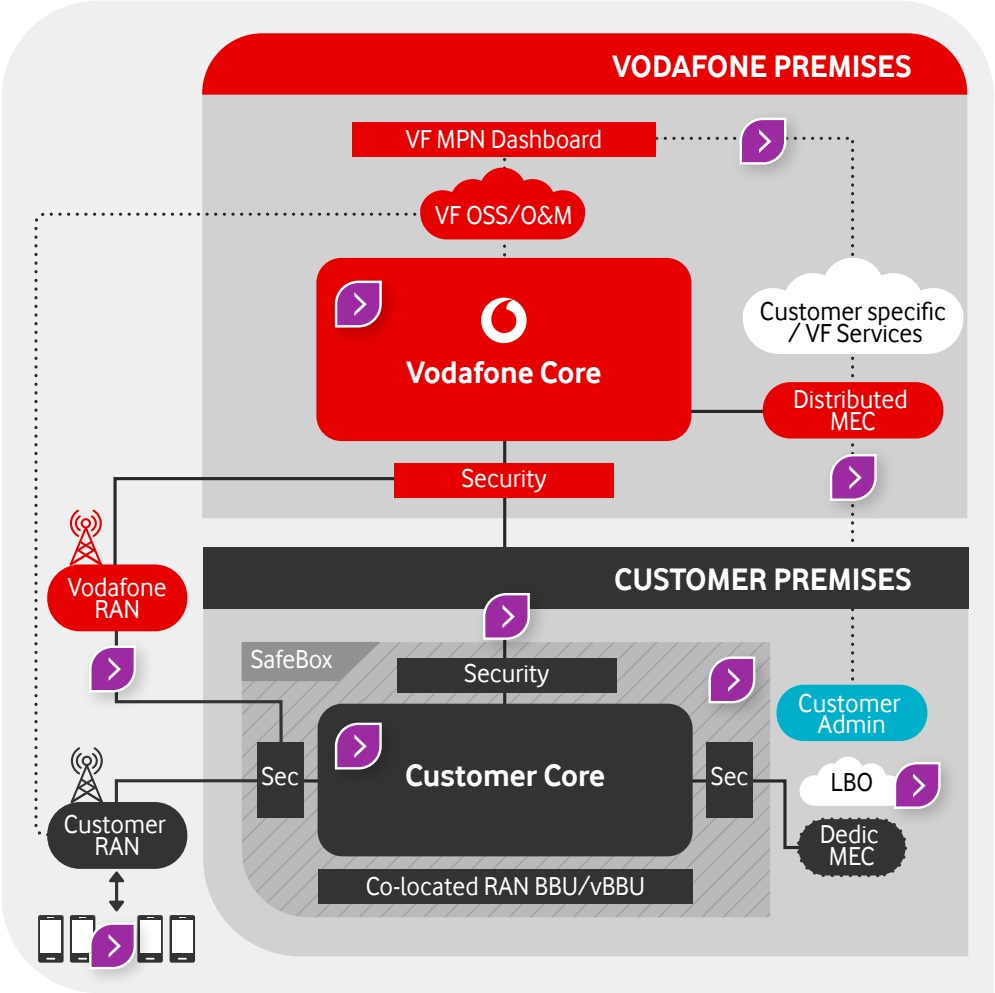
- Vodafone extensive international footprint allows us to provide services across all markets, and Vodafone is leader in the provision of IoT services to national and multinational customers.

- Vodafone owns strategic assets of spectrum in several markets, being able to provide the needed data rate for every customer at every location.

What are the most important components of a **MPN**?

- A MPN is a Network in which part or all the Network components or resources are dedicated to the need of a specific customer.
- Most of the components of a MPN are very similar to those of a normal Public network, independently if they are located within Vodafone data centres or at customer premises or in both environments.

Click on the icons to read more.



Latency and Throughput

Do you know how latency and throughput are provided to the end user?

Click on › icons for more detail:

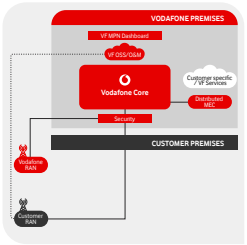
Latency ›

Throughput ›



MPN Architecture...

flavour depends on the location of the different Network elements

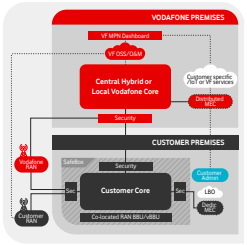


Enlarge

Details

SEGREGATED MPN

- Network Slicing with 5G SA (when available) to guarantee the resources required by a specific MPN customer
- Suitable and low cost option for main MPN requirements
- Low Latency with 5G & Distributed MEC (as low as 10ms)
- On footprint scenarios
- It provides both Vodafone & Customer specific services (Distributed MEC)

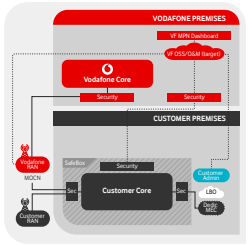


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Details

LOCAL /CENTRAL HYBRID MPN

- User data on Customer premises (local breakout), strategic option for majority of customers
- Vodafone Core functions can be located on each market (Local Hybrid) or be deployed Centrally (Central Hybrid)
- Very low latency (<=10ms) with MEC at customer site option
- High reliability and control
- On footprint scenarios
- Vodafone & Customer specific services



Enlarge

Details

ISOLATED (DEDICATED) MPN

(with Public and/or Spectrum)

- All Network functions at customer premises
- Full or partially autonomous operation or strict security req. e.g. military / defence sector or high degree in case Vodafone RAN is used
- Very low latency (<=10ms) with MEC at customer site option
- High reliability and control
- On & Off footprint scenarios
- Customer specific services + Vodafone services if Vodafone coverage exists and dual SIM is used



Segregated

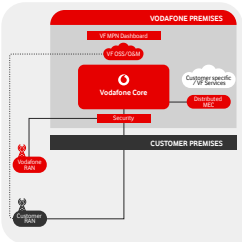
Example use cases: **Dedicated network slice**

- With this architecture, almost all Network equipment (including core elements for 4G or 5G) are hosted in Vodafone premises, with, potentially, some dedicated coverage located at customer premises to complement existing public Network radio coverage and capacity.
- A key advantage of Segregated for the MPN customer is the lower cost, since the capacity needed to serve the MPN traffic is taken through slicing from a much bigger pool of HW and SW capacity, more efficient due the scale. Also the technology evolution is faster and cheaper if using a centralized pool of resources.
- Another key advantage is to be able to offer to the customer the possibility to host their services on Vodafone distributed MEC environment, simplifying to the MPN customer the creation of own services.
- Latency not lower than 10ms (e.g. between 10ms and 50ms) depending on where the servers are located.









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SEGREGATED MPN

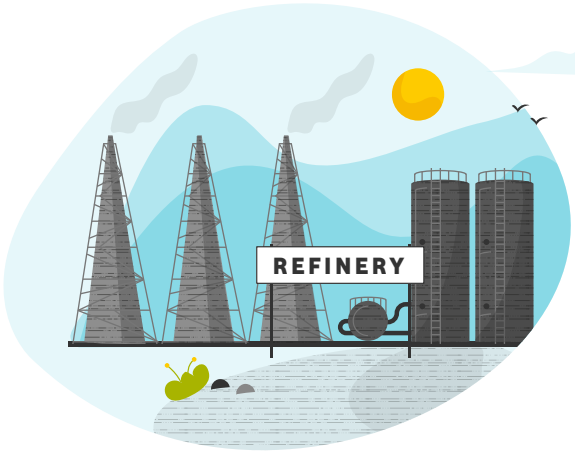
Back to MPN Architecture

Local/Central Hybrid

Example use cases: **Need for local breakout**

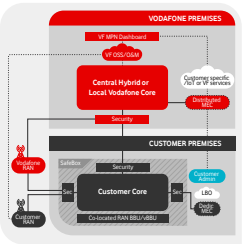
- With this architecture, the majority of the customer data (user plane) is located at customer premises, and routed to either Local Break Out, or to a Dedicated MEC.
- Additional Network functions (like the customer database and part of the control functions) are located within Vodafone Core with the following two flavours:





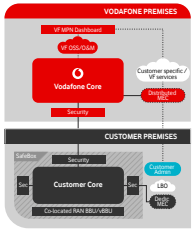
- Local Hybrid in which Vodafone Core is the one in the Local market, and might require a local IT development per each market.
- Central Hybrid in which Vodafone-Core is deployed centrally serving several markets including off footprint. With 5G SA it might be possible that part of the Central components are also deployed locally.

- Radio coverage and capacity can be provided by the public Network and/ or complemented with dedicated Radio coverage at customer premises.
- Latency can be lower than 10ms since customer data Apps are located at customer premises and therefore very close to the Radio equipment.
- In addition to the data that the customer wants to maintain within LBO/dedicated MEC, the customer can still decide to create less-critical services (and with a higher latency) through Vodafone distributed MEC.
- Key advantages of such architecture are:
  - Very low latency.
  - High reliability and control.



Enlarge

CENTRAL HYBRID



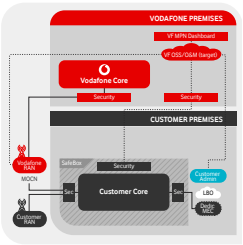
Enlarge

LOCAL HYBRID

Back to MPN Architecture

Isolated (Dedicated)

- This solution offers to the customer the highest security and control on own data by deploying all SW and HW Network elements (including Core 4G or 5G) at customer premises, with fully autonomous operation; data are routed to either Local Break Out, or to a Dedicated MEC.
- As an exception, radio coverage might be partially shared with the customer (e.g. if there is the need to provide outdoor coverage using existing tower and HW installed in the area for private Network), but all the user data are routed and managed internally within customer premises.
- Latency can be lower than 10ms since customer data Apps are located at customer premises and therefore very close to the Radio equipment.
- The customer can only access services available at own premises.
- The biggest drawback of this architecture is the fact that the SIMs cannot access Vodafone services neither within or outside MPN area.

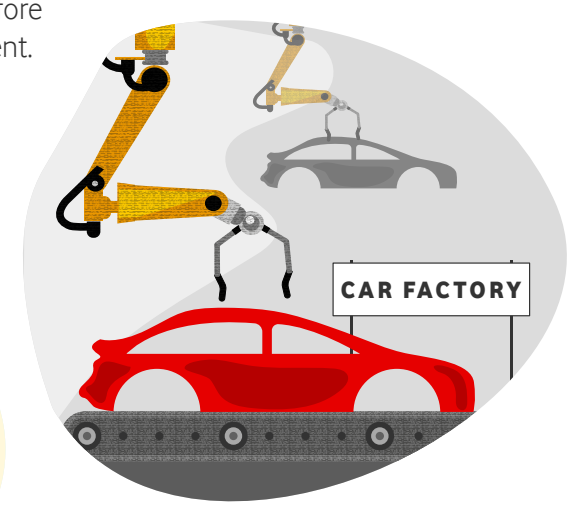


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ISOLATED (DEDICATED) MPN





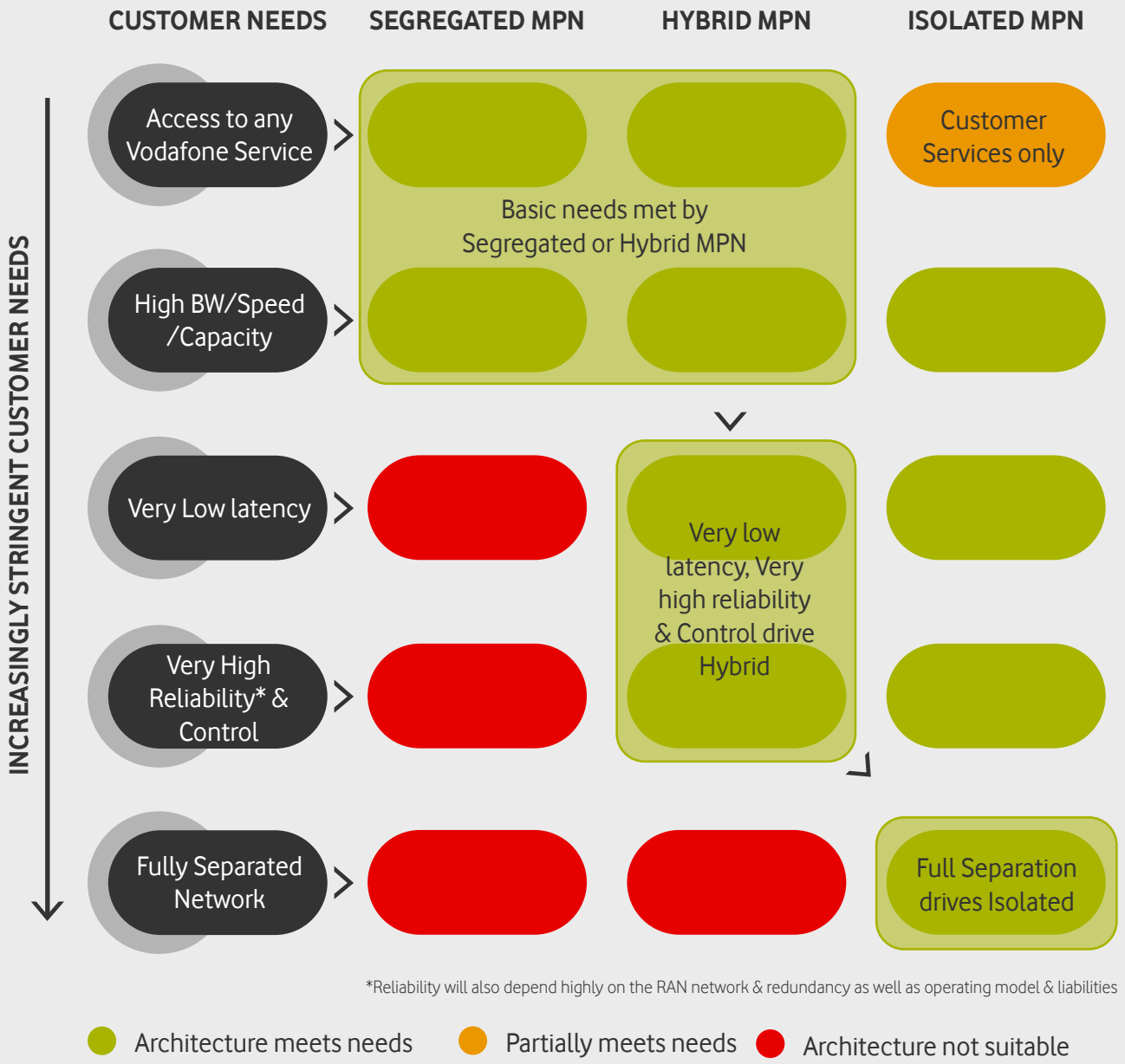


Back to MPN Architecture

MPN Architecture

MPN Architecture solution is determined by the Customer Needs

- Customer needs in terms of costs, coverage, latency, privacy, time availability of the solution etc must be taken in account when deciding what is the right architecture to use to design the best solution for the customer.
- All architectures have own merits that have to be matched against Customer needs.
- Architecture selection must be a Vodafone decision once we have fully understood customer needs, guiding the customer towards the best option decided by Vodafone Technology Community.



MPN Project Solution

Decision on the architecture is determined by analysing customer requirements and selecting the best fit.

Vodafone e2e process around MPN Customer implementation & operation to be developed. Overall MPN Project Solution Design requires sign off from Vodafone Networks.

Click on each 'Customer Need' button to see each possible route, or click 'Show all routes' below:

Show all routes

Preferred route

Customer Coverage added

CUSTOMER NEED
Click each box below:

STANDARD/ PREMIUM
Customer with **Main MPN Requirements**

EXCLUSIVE
Customer with **demanding MPN Requirements** e.g. ultra low latency, data processing on campus

EXCLUSIVE
Customer requires high degree of **autonomous operation with fully isolated data/traffic** Special use cases

MPN SOLUTION	RAN	SPECTRUM USED	RADIO INTERFERENCE & CAPACITY MANAGEMENT
SEGREGATED MPN	Vodafone	Public Spectrum	No issues
HYBRID MPN (Local Hybrid or Central Hybrid*)	Customer	VF Private (Dedicated) Spectrum	Public interference & future capacity OK?
		Industrial Private Spectrum	No issues
ISOLATED MPN	Vodafone (new PLMN)	Public Spectrum (MOCN)	Public & MPN needs can be managed?

* for IoT use cases or when HYBRID Local MPN Not Available

Spectrum choices

Spectrum choices for MPN; Public most efficient, Private (dedicated) challenging, Industrial spectrum use when allocated.

VODAFONE PUBLIC SPECTRUM

Vodafone spectrum shared with other public network customers

- ✓ **Most efficient** use of spectrum
- ✓ **No interference**
- ✓ Reuse **existing planning** process
- ✓ **Advanced capabilities** to address MPN (MOCN, QoS, Slicing etc.)

← **MAXIMISE USE** →

VODAFONE PRIVATE (DEDICATED) SPECTRUM

Vodafone spectrum dedicated to the customer at the MPN location

- ✓ Option in **remote/ low traffic areas** or with mmWave spectrum
- ✓ Option for **indoor**
- ✗ **Risk of Interference** in **cities/high traffic areas**
- ✗ **Constrains future network capacity** in cities/high traffic areas
- ✗ **Drives cost** in network optimisation and capacity

← **CONTROLLED USE ONLY** →

INDUSTRIAL PRIVATE SPECTRUM

Spectrum reserved by regulator for industrial use

- ✓ **No interference**
- ✓ Could be used **with anchor Vodafone spectrum**
- ✓ **Off footprint** option
- ✗ **Uplink coverage more challenging** if not paired with an FDD band

← **USE AS NEEDED** (once allocated by regulators) →

UNLICENSED SPECTRUM

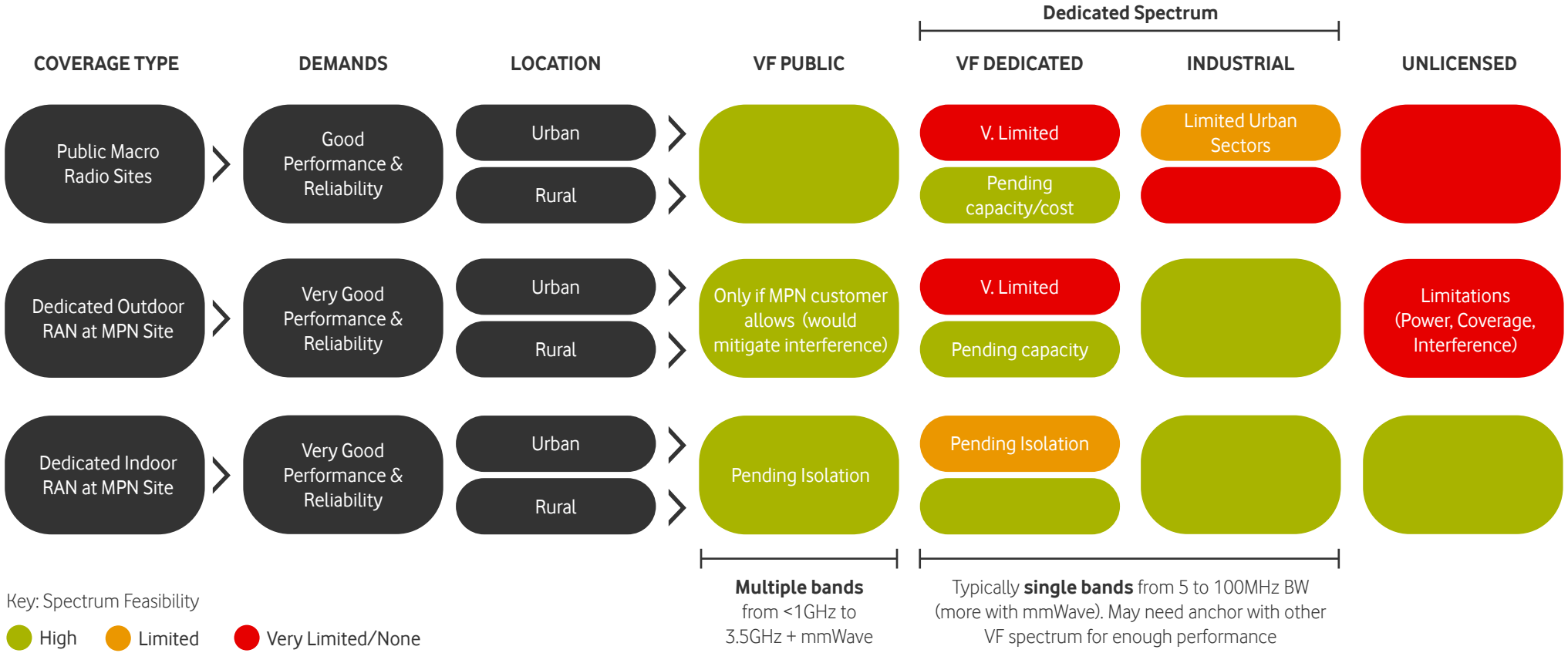
Free spectrum for anyone as long as coexistence conditions are met

- ✓ On footprint option to **supplement** Vodafone or Industrial spectrum
- ✓ **Off footprint** option
- ✗ **Difficult to meet demanding reliability requirements** (such as URLLC) due to interference
- ✗ **Low power** only. **Mainly indoors**

← **USE AS NEEDED** →

Coverage & Spectrum

Coverage & Spectrum are independent of the MPN Architecture. Vodafone Dedicated Spectrum feasibility is limited.

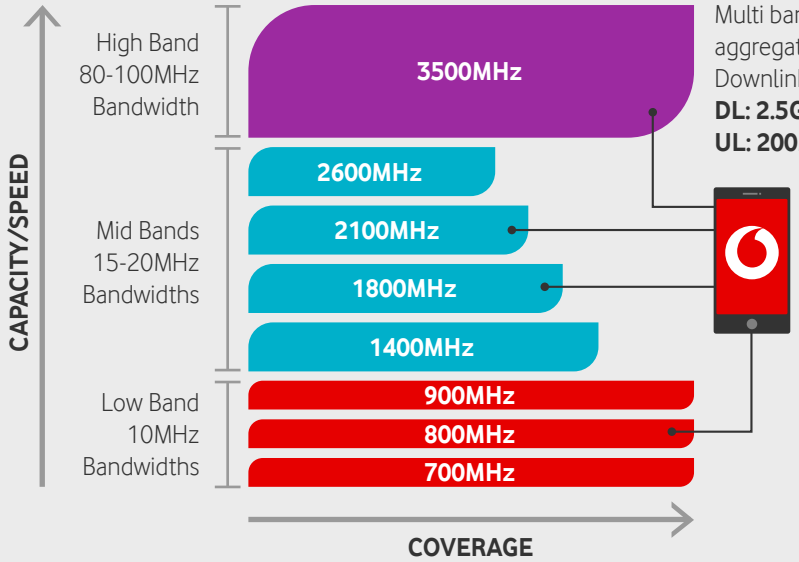


Note: Isolation and interference is not static. As the public network evolves (e.g. new sites or carriers). Challenge for Vodafone to manage

Public Spectrum

Public spectrum brings many advantages in speed, capacity & coverage.

SPECTRUM (VF AND INDUSTRIAL)



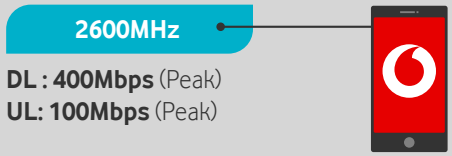
Multi band carrier aggregation for Downlink & Uplink
DL: 2.5Gbps (Peak)
UL: 200Mbps (Peak)

- ✔ **Multiple bands** from <1GHz to 3.5GHz
- ✔ **mmWave** can be added on top for even higher speeds over short distance
- ✔ Delivers **Capacity/Speed and Coverage**
- ✔ **Aggregation** between bands also **enables Uplink Aggregation** which is the limiting link and important for IoT

DEDICATED SPECTRUM

VF SPECTRUM

Example 2.6GHz Spectrum



DL : 400Mbps (Peak)
UL: 100Mbps (Peak)

Vodafone Dedicated spectrum will **typically be in a single (mid) band** that is likely the most that can be reserved for one customer in an area

- ✔ Can provide a v**ery basic 4G level of capability**
- ✖ On its own **will not enable high speed or capacity or ultra low latency. Uplink speed particularly limited**

INDUSTRIAL SPECTRUM

Example 3.5GHz (DE only at present)



DL: 1.6Gbps (Peak)
UL: 100Mbps (Peak)

Industrial spectrum available varies per market e.g. UK access to 3.8 to 4.2GHz band, DE access to 3.5GHz (100MHz) or mmWave

- ✔ **Big bandwidth may be available** – may enable high speed/capacity use cases in particular for indoor
- ✖ **May need aggregation with another (lower) frequency band to enhance coverage (e.g. for outdoors) and improve speeds** including the Uplink

Speeds Assume: 4x4 & 256QAM in mid band for DL. 3.5GHz configured for 80% DL, 20% DL. UL assumes 2 band CA with 256QAM, with no MIMO

5G SA for MPN

- 5G has first been introduced in 2019 adding a new Radio Technology (5G New Radio) paired with an LTE band to provide higher throughput and lower latency, and this is called 5G NSA (Non Stand Alone); in NSA the Core Network used is still the 4G one (called EPC) with small SW upgrades to support the 5G NSA mode.

- In 5G Stand Alone (5G SA), instead, both Core and Radio are 5G; 5G SA has become available during 2021 for both Network and Terminals

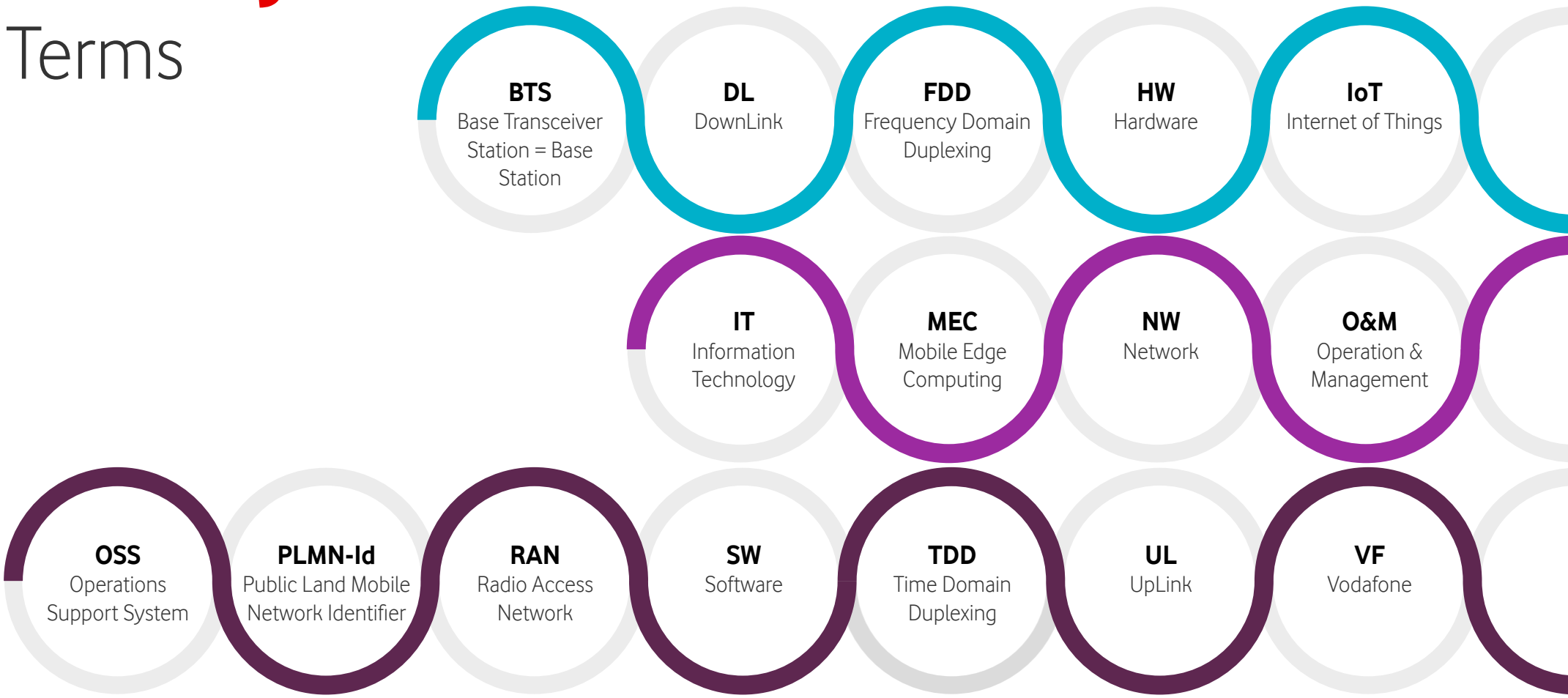
- Key driver in MPN for deploying 5G Core instead of a 4G Core are:
  - Use of latest technology for most demanding customers
  - 5G SA built-in feature of Network Slicing
  - Possibility to use a single frequency band in the Radio
  - Usage of 5G SA Carrier Aggregation to provide highest throughput in DL and UL

- In terms of 5G SA Core Network components they are located:
  - Segregated: all components are in OpCo
  - Isolated : all components are at customer premises
  - Hybrid: User Plane (UPF) is at customer premises for LBO/ Dedicated MEC, whilst some Control Plane functions (e.g. AMF, SMF) may need to be deployed locally (on customer premises in case of Off footprint or in OpCo premises in case of On footprint) for reliability purposes and to take advantage of the OpCo Distributing MEC.



Glossary

Terms



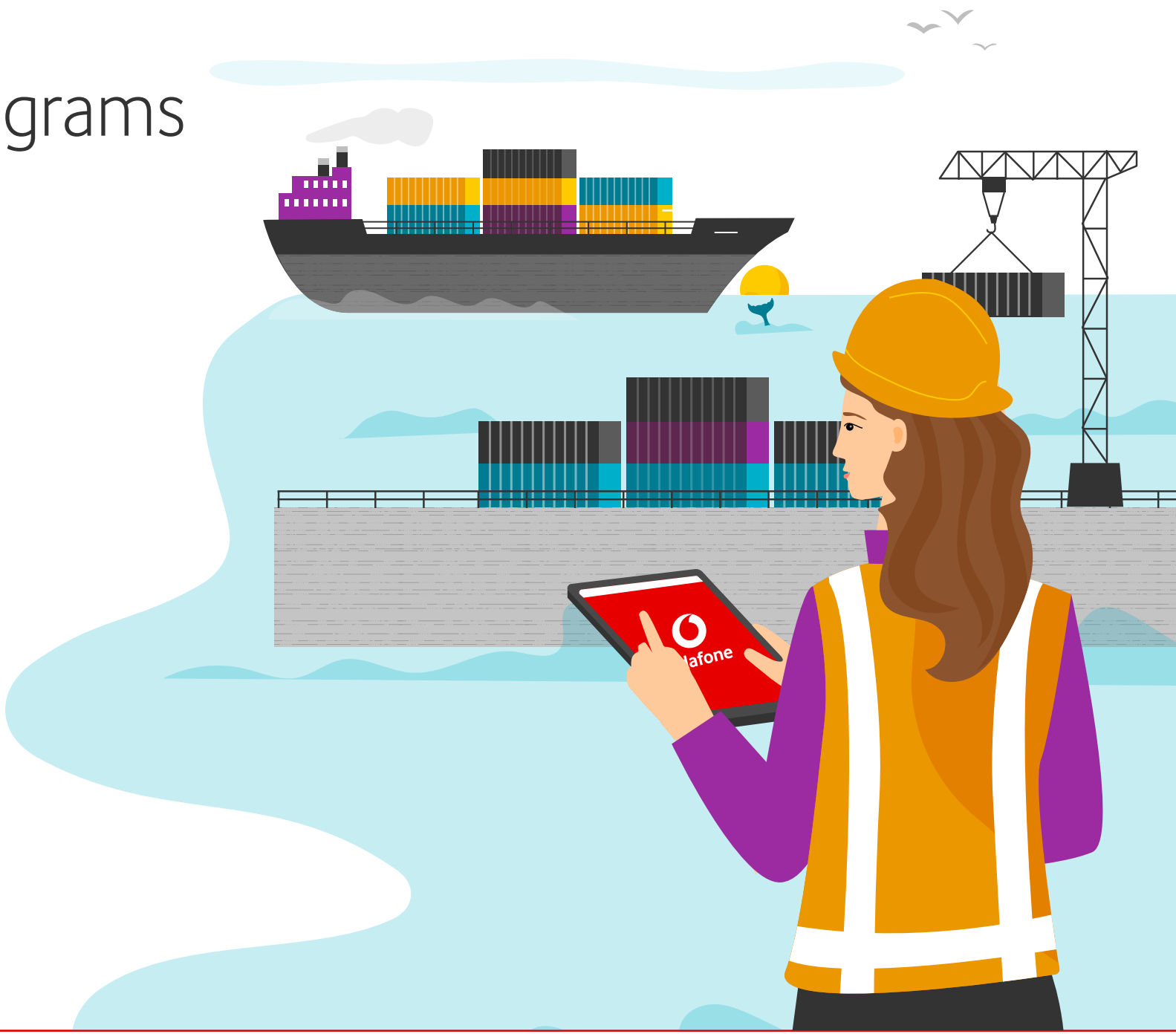
Conclusion

- Vodafone is in a great position to be a leader within the MPN market segment thanks to the extensive multinational footprint of its operation and partner markets as well as the proven leadership in building the most advanced networks.
- For MPN there are different architectural options (Segregated, Local/Central Hybrid, Isolated) with their own merits and characteristics in terms of services that can be offered, latency, reliability, on/off footprint applicability and operation.
- Customer service requirements and timeline drive the selection of the best fit in terms of architecture and spectrum; a close interaction with the customer is needed for mutual understanding of requirements and options.
- Our MPN journey (unleashed by new 5G SA) has just started and Vodafone is ready to be the partner of choice!



Printable diagrams

The following pages have been designed so they can be printed. They show non-interactive versions of the diagrams found on pages five, seven and twelve.



MPN components

RAN

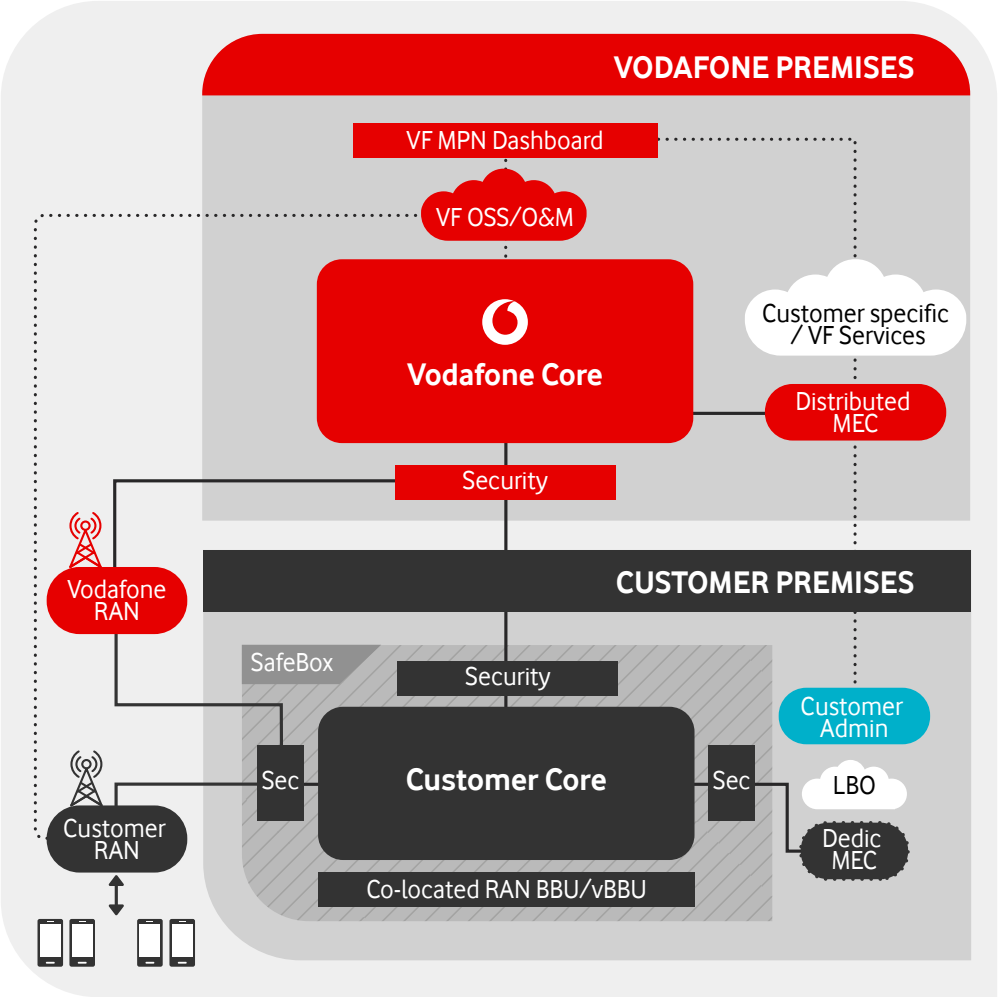
- Base Stations operating on one or more frequency band to connect with customer terminal located within the coverage area.
- For MPN the Technology used can be 4G (LTE) or 5G (Non Standalone or Standalone).
- The coverage and capacity can be dedicated to the customer premises (Customer RAN) or coming from the Public Vodafone RAN Network or can be a mix of them depending on the location and coverage requirements.
- The spectrum used can be Vodafone spectrum and/or industrial spectrum or even complemented with unlicensed (but SLA to be assessed), being Vodafone Spectrum the preferred option.

Terminal/Modem

It includes a SIM and connects to the MPN through the Radio to transmit and receive user data.

Transport

It provides connectivity from the base station to the Core Network and between different Network elements.



Core

This is the area where the connections are established, authenticated and the data is routed towards the Applications (in distributed MEC or Local Break Out or any other application server). Core can be located at either Vodafone premises or at customer one or split across them.

MEC (Mobile Edge Computing) / **LBO** (Local Break Out)

Hosting of the Application/Customer data. MEC can be dedicated at customer location, or distributed across different locations.

SafeBox

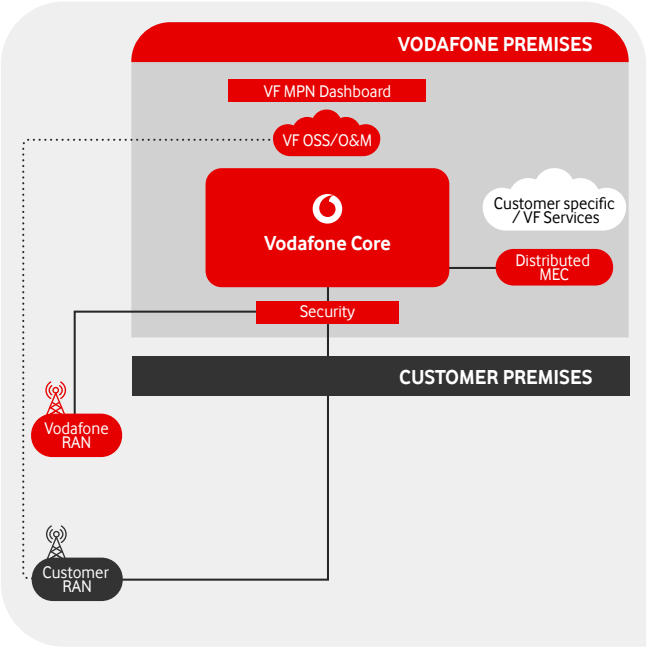
SafeBox is a secure cabinet /enclosure providing physical and non-physical security.

Security

It ensures data privacy and environment protection against attacks by isolating the different environments.

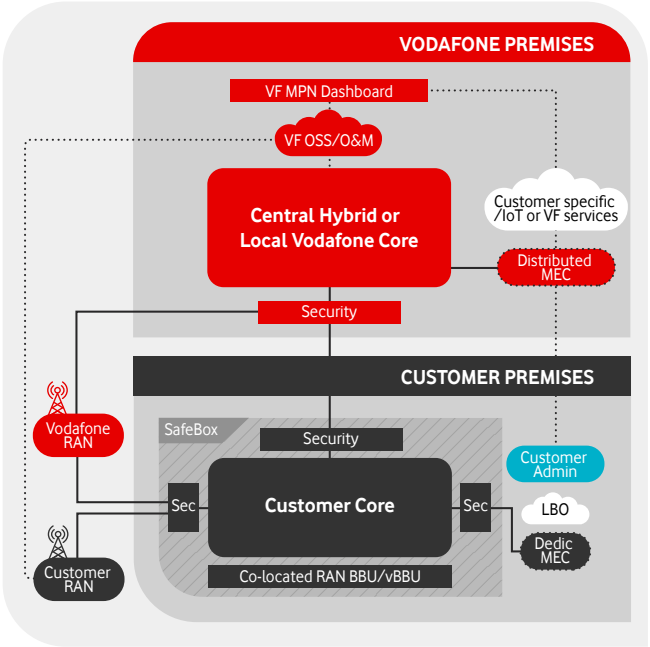
MPN Architecture...

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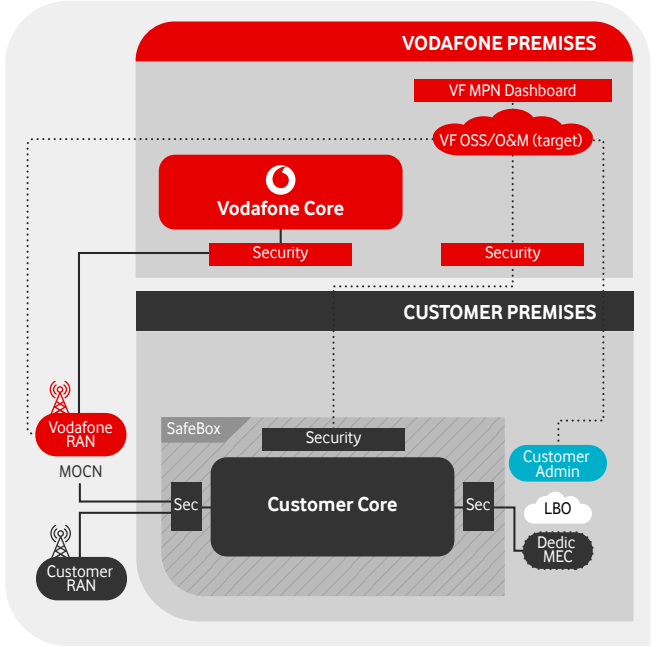
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- Vodafone & Customer specific services



ISOLATED (DEDICATED) MPN

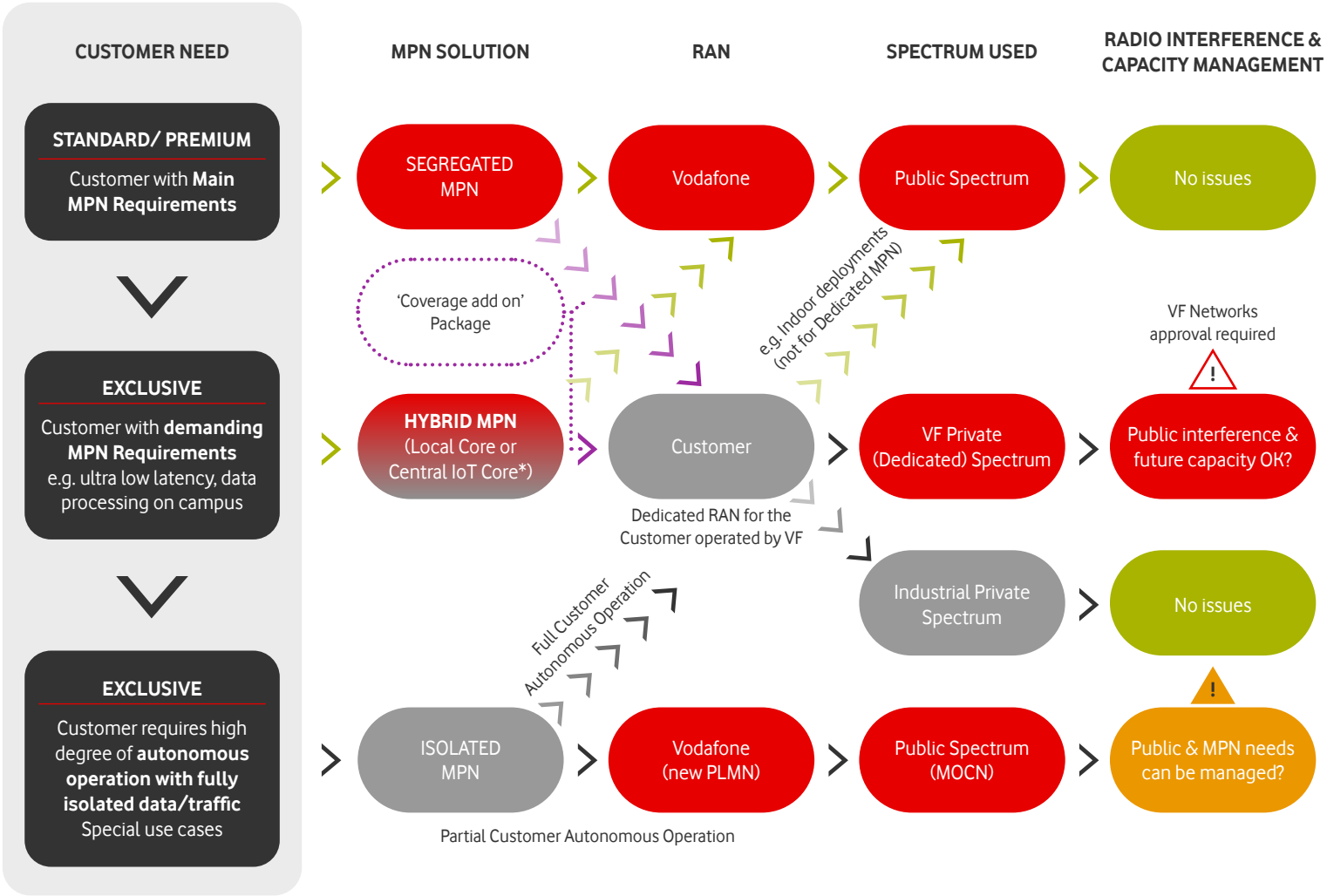
(with Public and/or Spectrum)

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- On & Off footprint scenarios
- Customer specific services + Vodafone services if Vodafone coverage exists and dual SIM is used

MPN Project Solution

Decision on the architecture is determined by analysing customer requirements and selecting the best fit.

Vodafone e2e process around MPN Customer implementation & operation to be developed. Overall MPN Project Solution Design requires sign off from Vodafone Networks.



Preferred route

Customer Coverage added

* for IoT use cases or when HYBRID Local MPN Not Available