

5G and 5G-Advanced for Absolute Beginners

ZAHID GHADIALY

JULY 2026

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5G for Absolute Beginners

Learn basics of 5G mobile wireless technology

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✓ What is meant by 5G and how does 5G promise to revolutionize the world

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About Me



- I am Zahid Ghadialy, Principal Analyst & Consultant, 3G4G
- Telecom technology analyst, consultant, trainer and industry influencer
- 25+ years working in mobile and wireless technologies from 3G to emerging 6G
- Founder of the 3G4G blog and training platform, publishing 250+ technical posts every year
- Content followed by telecom professionals around the world
- I work as a consultant for a variety of organisations. For details, please see my LinkedIn profile.

Passionate about explaining complex technology in simple terms and helping people learn about the future of connectivity.

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About 3G4G

3G4G is a Boutique Mobile Telecoms Technology, Strategy, Analysis and Consulting firm working with a handful of selected clients.

Focus Areas	Specialist Sectors
• Technology Strategy • Market Analysis • Competitive Intelligence • Product and Solution Marketing • Technical Marketing • Strategic Marketing • Expert reports • Training	• 6G and Beyond 5G (B5G) • 5G Technology, Infrastructure, Applications and Use Cases • Legacy Technologies like 2G & 3G • Existing Technologies like 4G, Wi-Fi, Private Networks • Public Safety LTE and 5G • M2M and IoT • Spectrum for above • Emerging telecoms markets including Africa

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Course Outline: 5G/5G-A for Absolute Beginners

- Part 1: From 1G to 5G
- Part 2: How 5G Works in the Real World
- Part 3: What Is 5G-Advanced?
- Part 4: Key 5G-Advanced Features and Use Cases
- Part 5: Satellites, 6G and Course Summary

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5G and 5G-Advanced for Absolute Beginners

Part 01: From 1G to 5G

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Mobile Technology Evolution

1G



Voice calls

2G



Voice, messaging, basic data

3G



Voice, messaging, mobile internet

4G



Voice, messaging, IoT, mobile broadband

5G



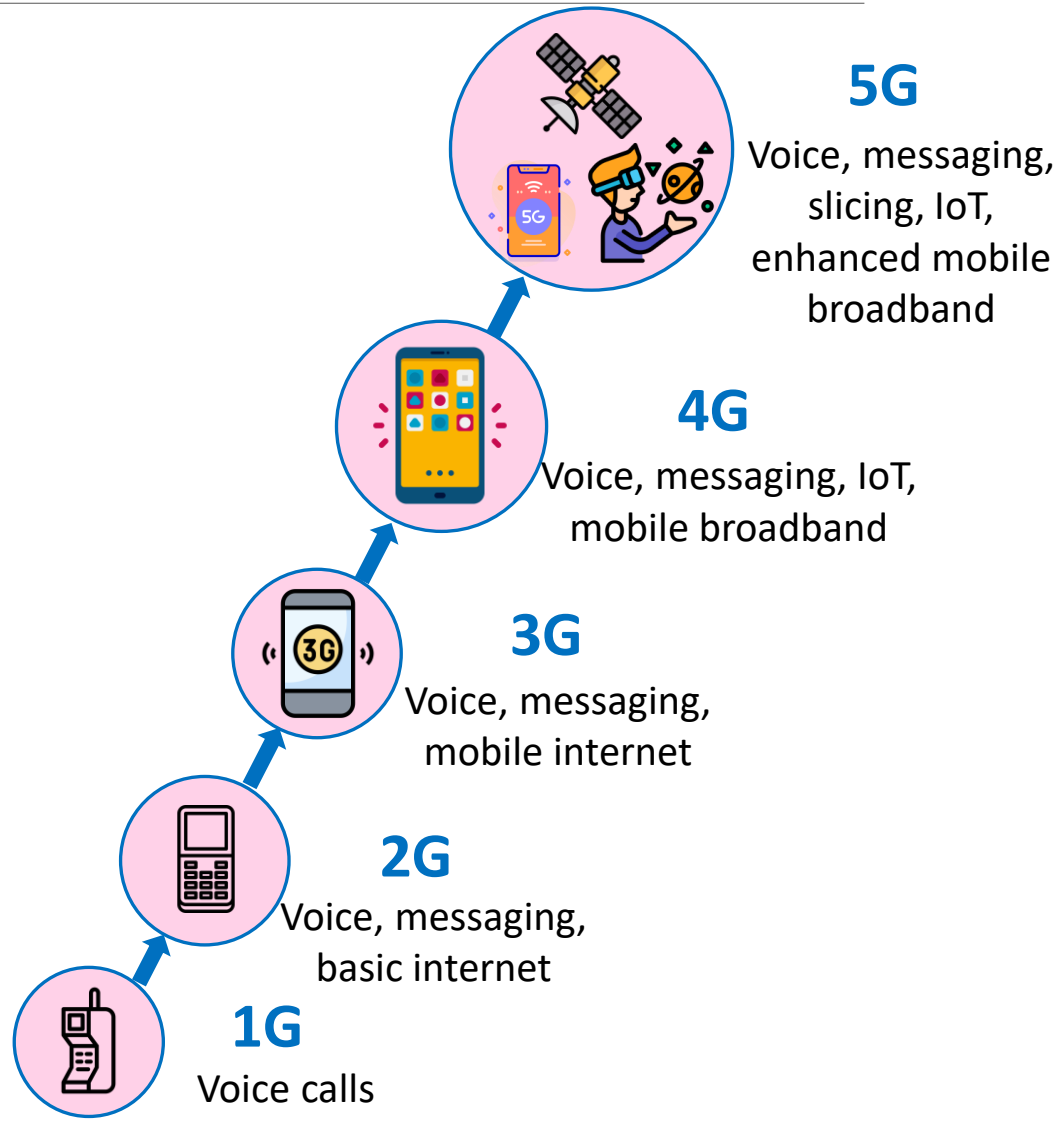
Voice, messaging, slicing, IoT, enhanced mobile broadband

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What Does ‘G’ Mean?

G stands for Generation

- Each generation brings major improvements
- New generations introduce new technologies and services
- User expectations also change over time



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From 1G to 5G: A Quick Journey

1G

Analog

Voice only, Limited coverage and mobility. Example: AMPS

2G

Digital

Improved voice, security, coverage. SMS, data. Example GSM, CDMA

3G

Mobile Data

Higher data rates, smartphones, better voice. Example: HSPA / HSPA+

4G

Mobile Broadband

High speed data, better smartphones. Example: LTE / LTE-A

5G

eMBB, mMTC, URLLC

Even higher speeds, ultra-reliable, low latency, high connection density













1980 1990 2000 2010 2020

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1G and 2G: Voice and Text



1G

- Analogue mobile voice
- Basic mobile calling
- Large and limited devices



2G

- Digital voice
- SMS messaging
- Better security and efficiency

Early mobile networks focused mainly on voice communications

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3G and 4G: Mobile Internet and Apps



3G

- Mobile data and internet access
- Email, web browsing, early apps
- The first real mobile internet experience



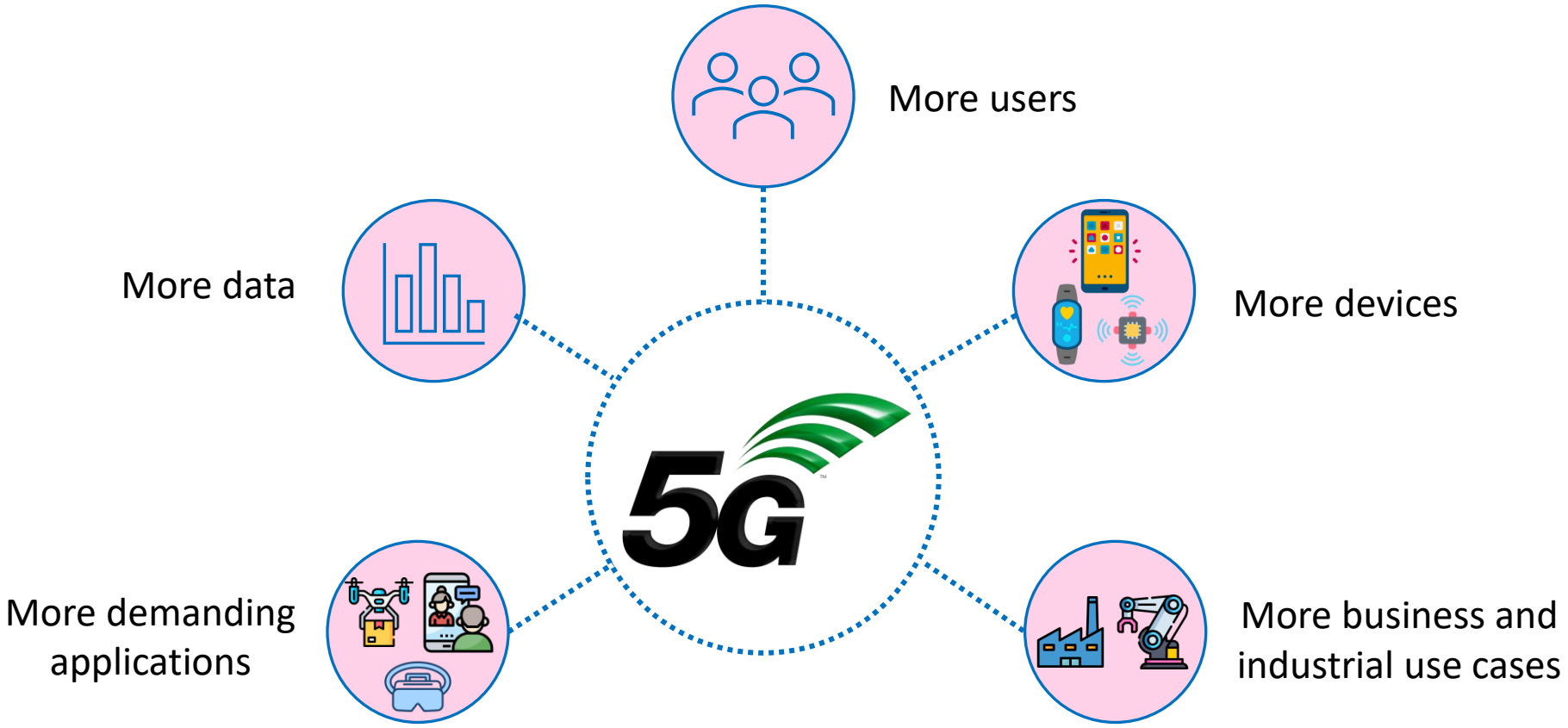
4G

- Fast mobile broadband
- Video streaming and social media
- Smartphones and apps became mainstream

Mobile networks became central to everyday digital life

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Why Was 5G Needed?



Networks were no longer serving only people with phones

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5G Is More Than Faster Downloads

1



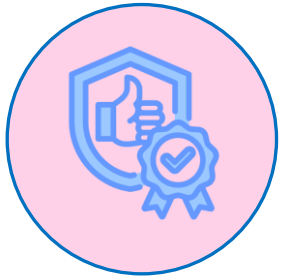
Faster mobile broadband

2



Lower Latency

3



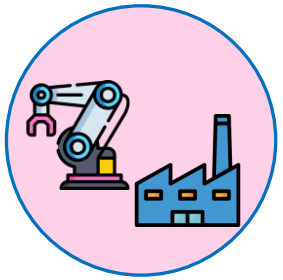
Better Reliability

4



More connected devices

5



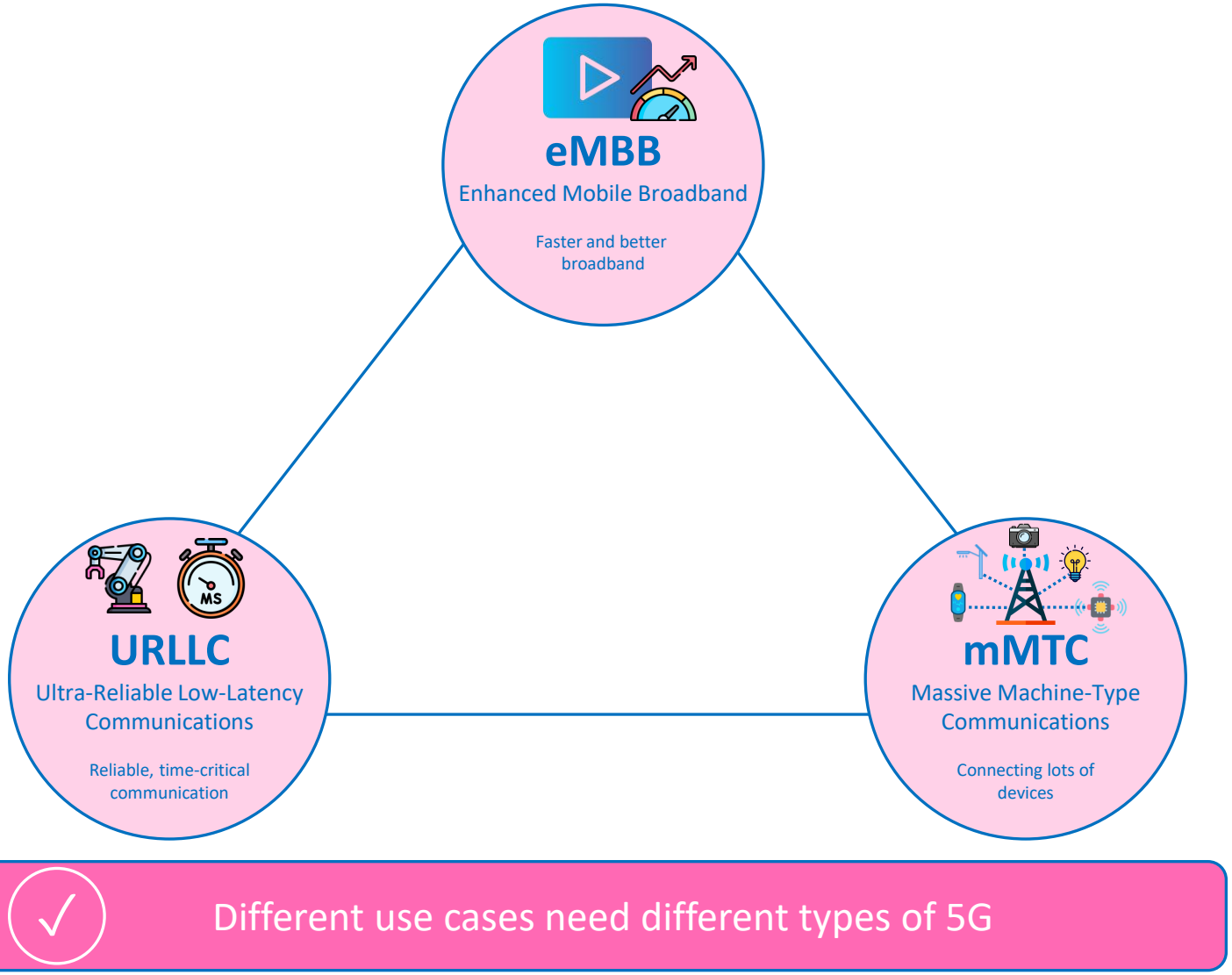
Support for industry and enterprise services



5G is not just about speed

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The Three Big 5G Promises



✓ Different use cases need different types of 5G

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5G is for People and Industries

Consumers


Smartphones


Fixed Wireless Access (FWA)

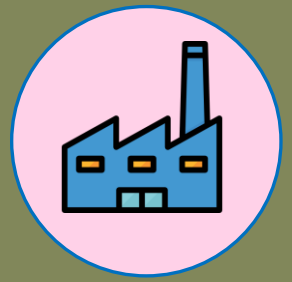

Mobile Hotspot


Video Streaming


Video Calling


Extended Reality (XR)

Industries


Factories


Ports


Mines


Utilities


Transport


Public Safety

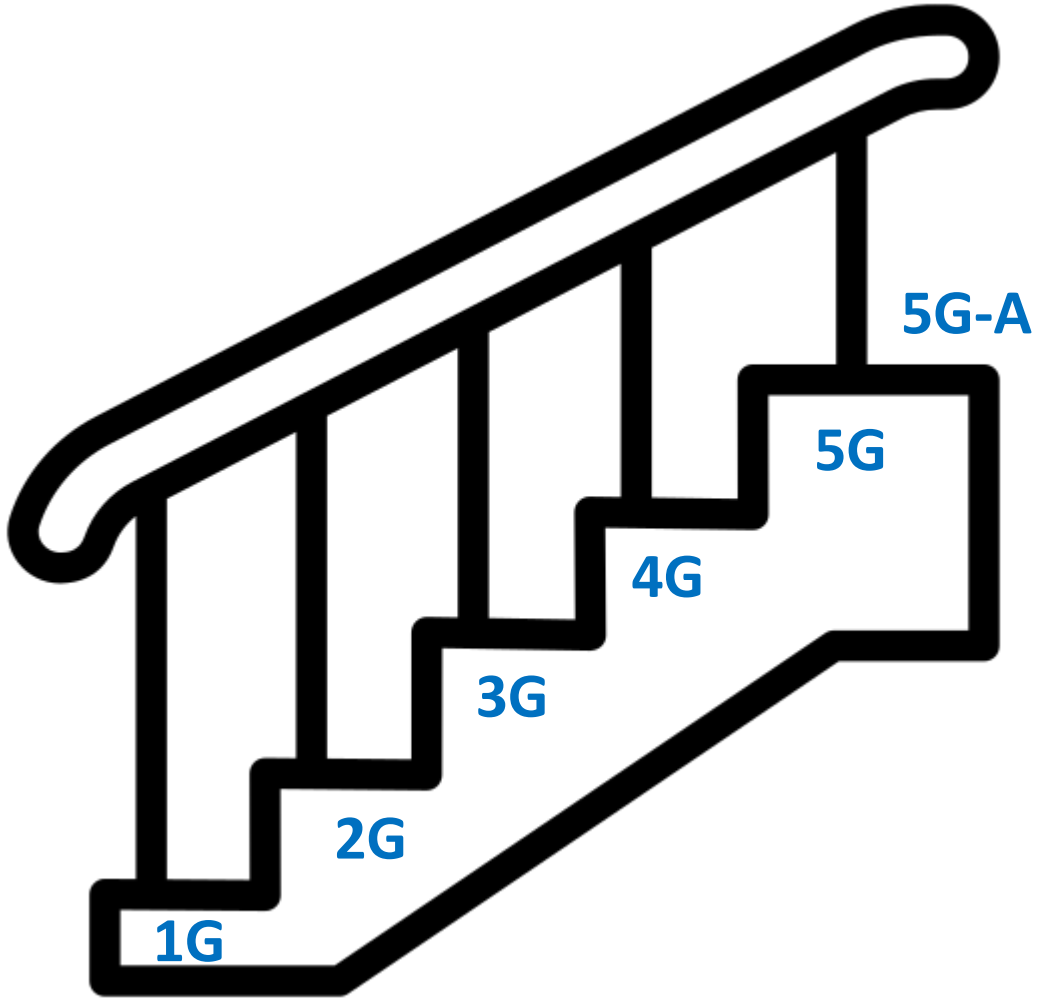
5G supports both everyday consumer use and critical industry use cases

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Lecture 1 Summary

What we have learned:

- ‘G’ means Generation
- Each generation solved a new problem
- 5G was designed for more than smartphones
- 5G supports enhanced broadband, low-latency communication and massive IoT
- 5G-Advanced builds on this foundation



Next: How 5G works in the real world

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References & Further Reading

- 3G4G Tutorial: What Does 'Telecoms' Mean? (link)
- 3G4G: How does the mobile technology work? (link)
- 3G4G: Different Generations Of Mobile Technologies (link)
- 3G4G: What Else Does ‘G’ Mean? (link)
- 3G4G: The Flow of Money in the Mobile Industry (link)
- 3G4G: What is a User Equipment (UE)? (link)
- 3G4G: 30 Years Of Mobile History (link)

Many of these links include videos, downloadable slides and further reading.

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Part 02: How 5G Works in the Real World

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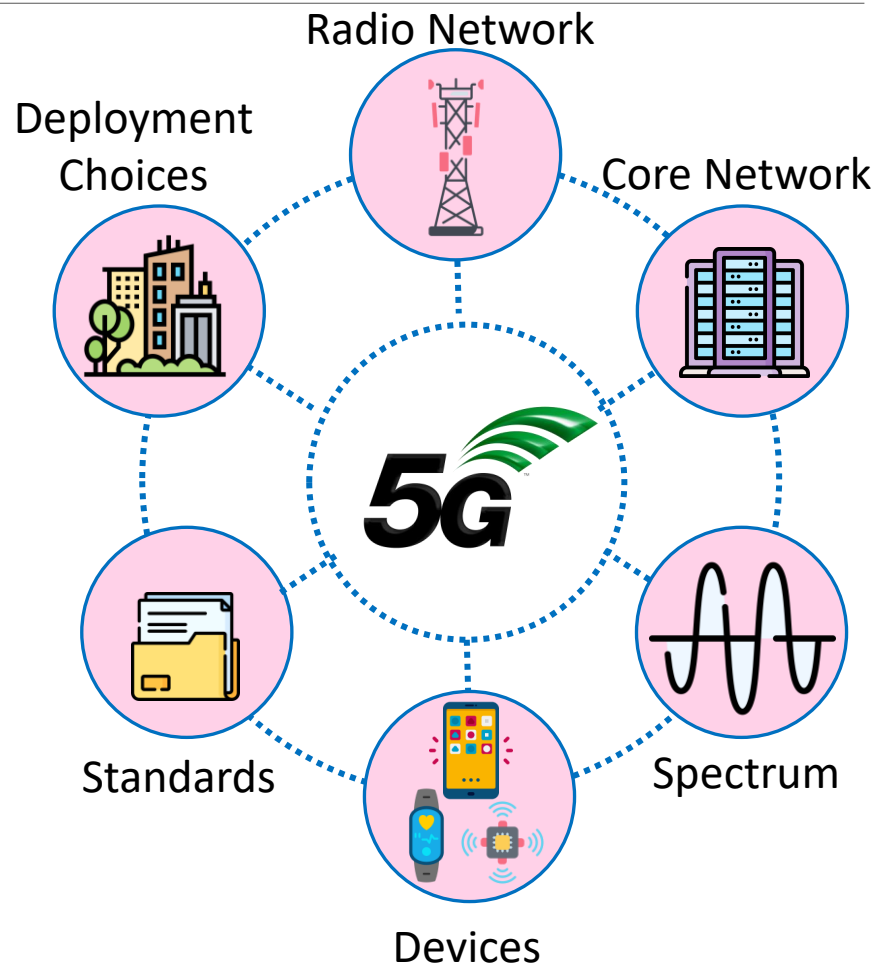
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5G Is Not One Single Thing

5G is a system, not just a signal

Many important parts work together
to create a real 5G experience



✓ 5G is more than a logo on your phone.

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Who Defines And Deploys 5G?

5G is created through global collaboration

ITU

Sets the global vision and requirements for mobile generations.

3GPP

Creates the technical specifications that define 5G.

Regulators



Manage and allocate spectrum in each country.

Operators



Build and operate 5G networks.

Vendors



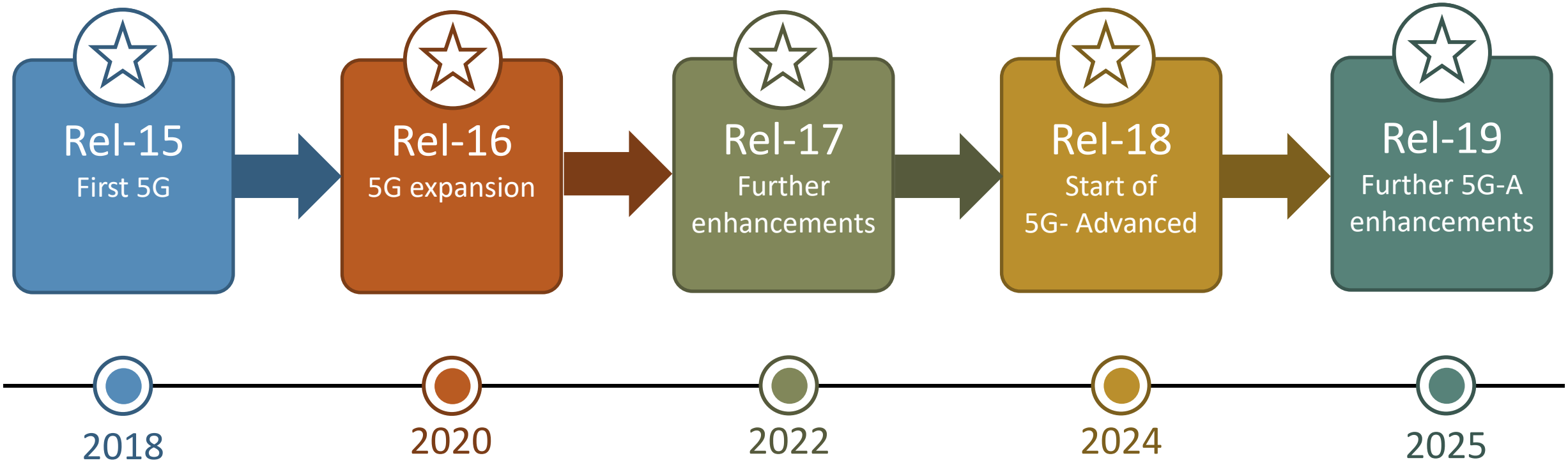
Provide network equipment, devices and solutions.

5G is not invented by one company.

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5G Evolves Through Releases

5G keeps improving over time

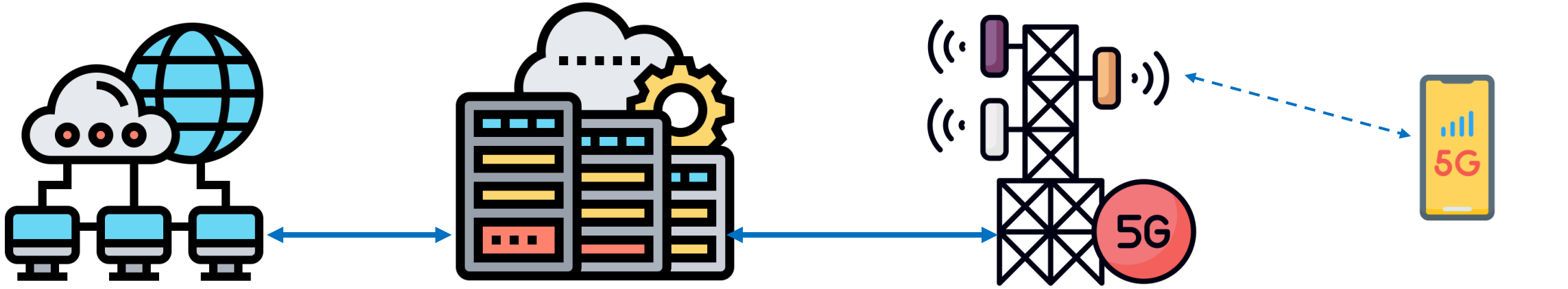


✓ 5G is not finished in one step.

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The Two Main Parts of a 5G Network

Core Network and Radio Network



Internet / Data Network (DN)

5G Core Network (5GC)

5G Radio Network (5G NR)

5G Device (UE)

The core network manages services, security, roaming, mobility and connection to the internet.

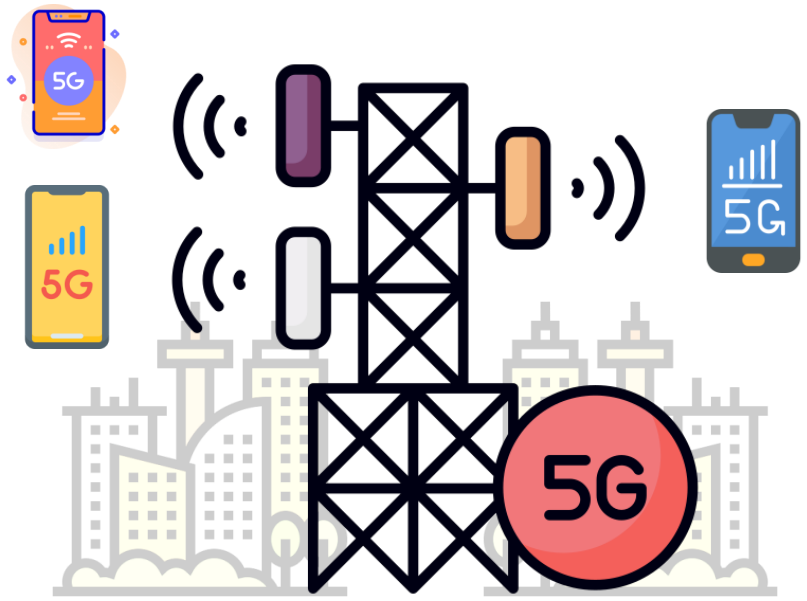
The radio network connects your device wirelessly to the network.

✓ Both parts are needed for a full 5G system.

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What Is 5G New Radio (5G NR)?

5G NR is the radio part of 5G



- The Radio Access Technology for 5G
- Connects phones and devices to the mobile network
- Works on different spectrum bands
- Designed for higher capacity, lower latency and more flexibility

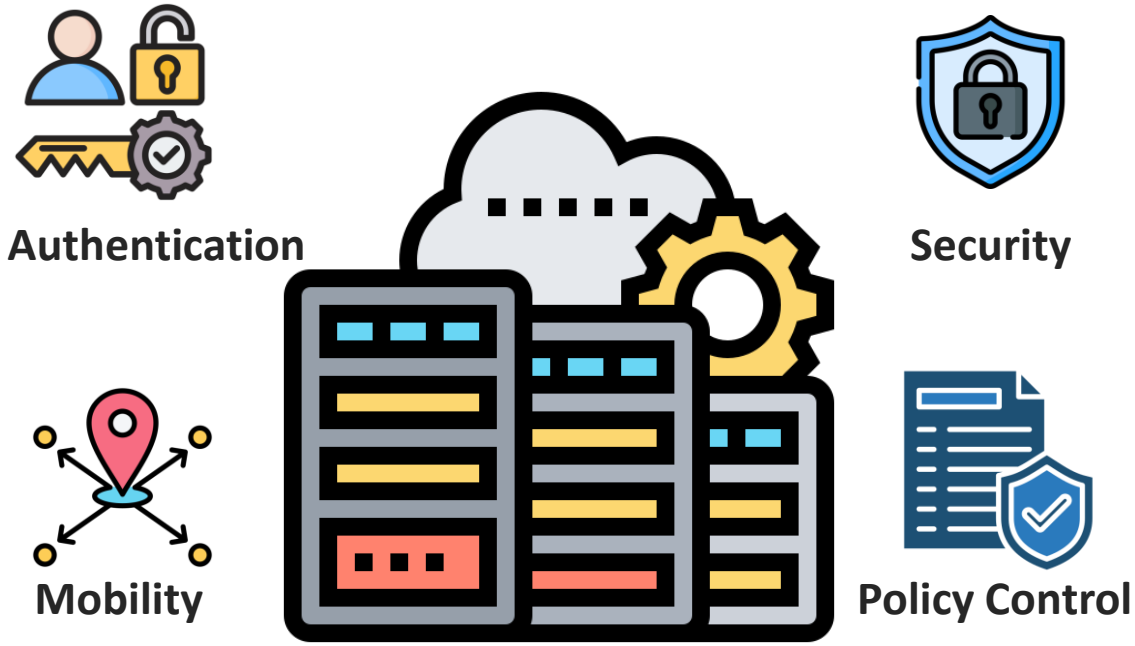
5G NR is what communicates over the air.

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What Is The 5G Core (5GC)?

The 5G Core is the control centre of the network

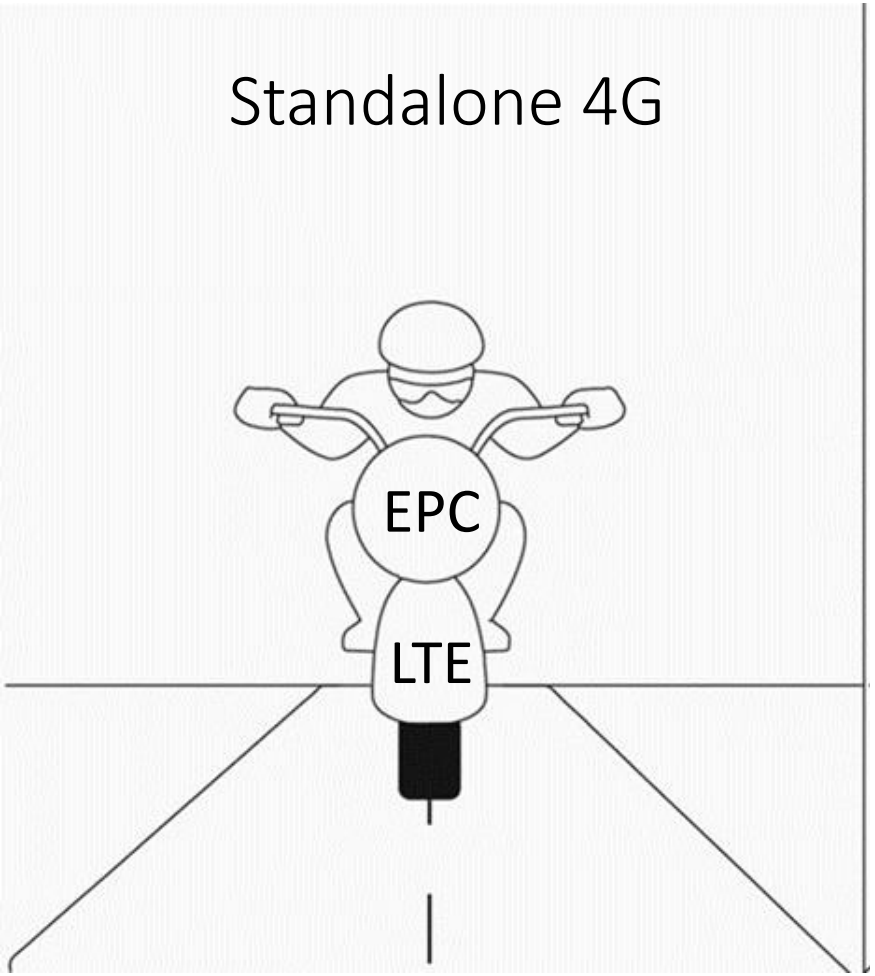
- Handles authentication and security
- Manages mobility and sessions
- Supports advanced services and features
- Important for standalone 5G



Many advanced 5G capabilities depend on the 5G Core.

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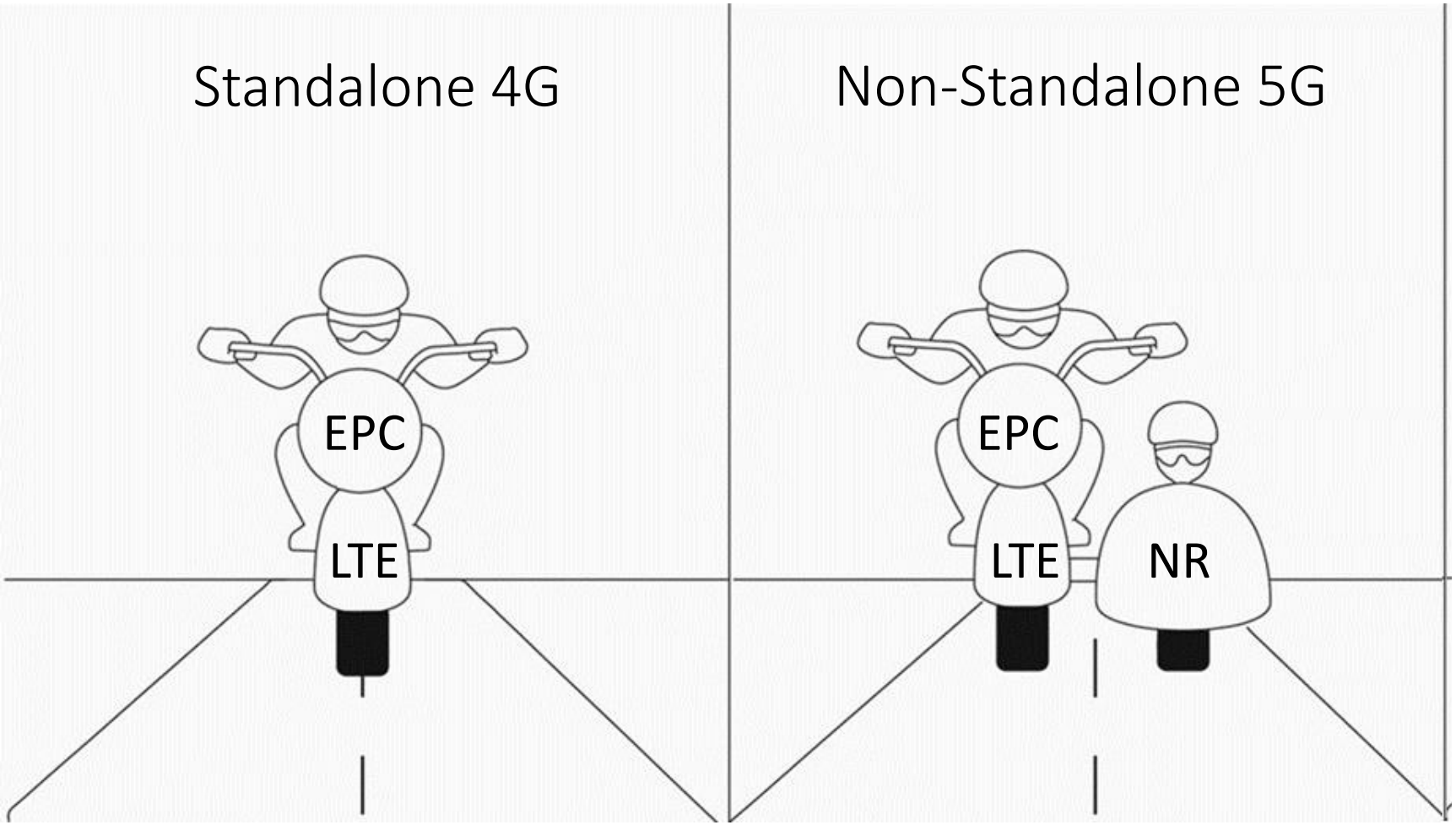
Standalone vs Non-Standalone



Based on original by Ericsson

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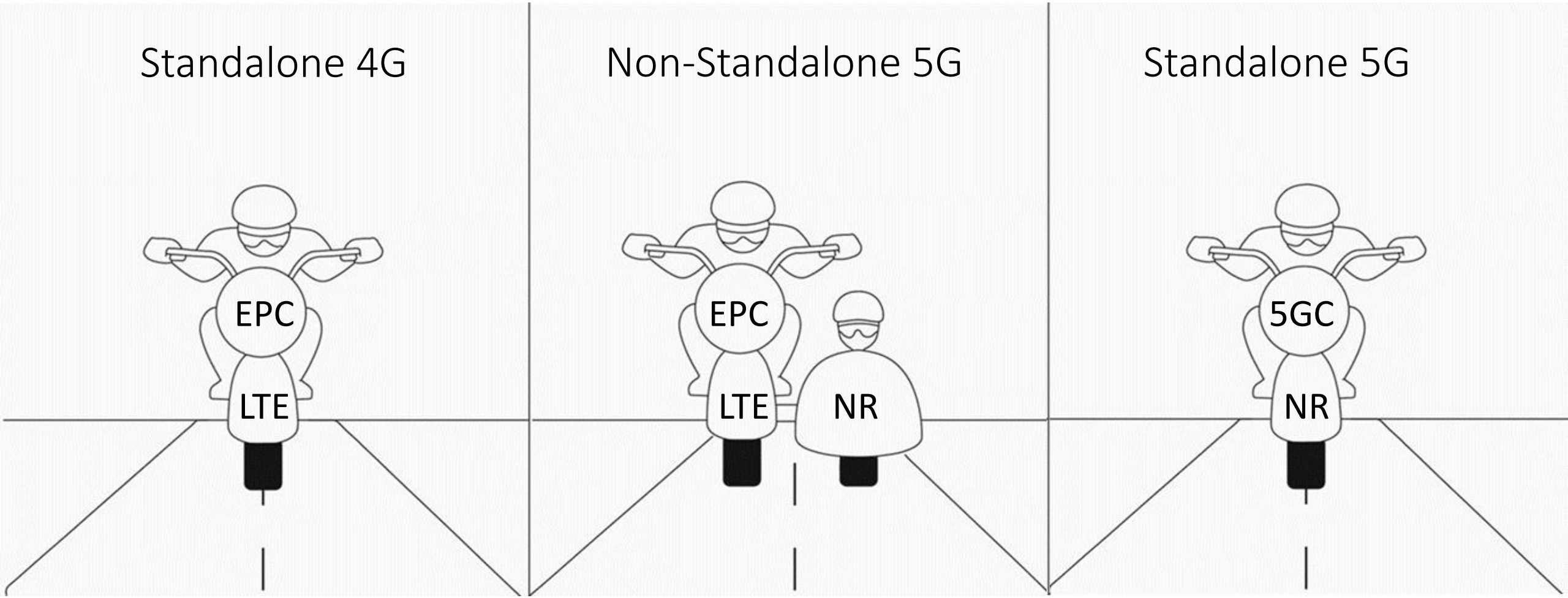
Standalone vs Non-Standalone



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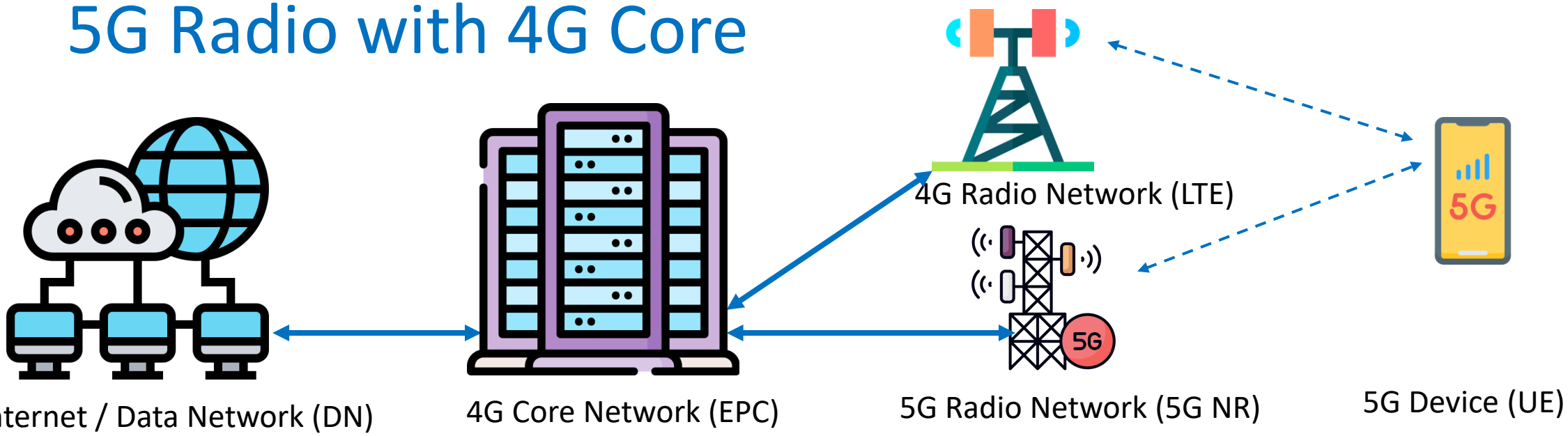
Standalone vs Non-Standalone



Based on original by Ericsson

Non-Standalone (NSA) 5G

5G Radio with 4G Core



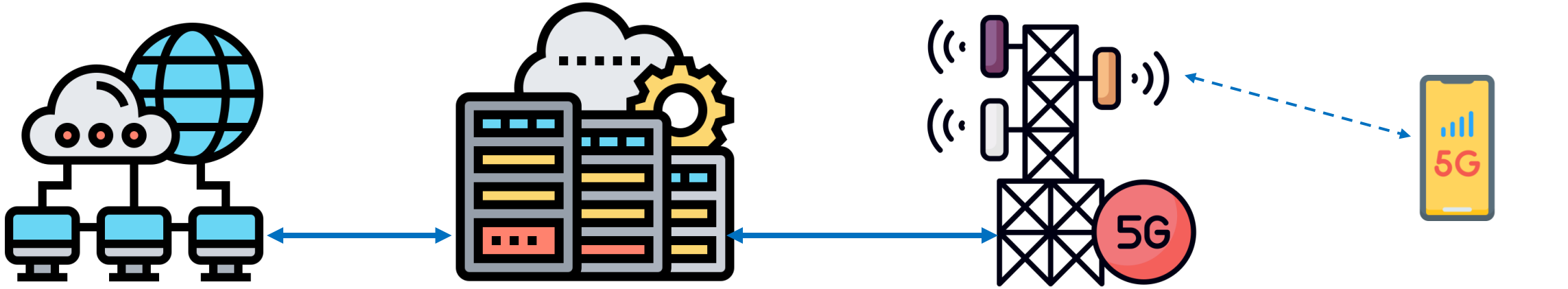
- Helped operators launch 5G quickly
- Uses 5G new radio along with existing 4G radio (LTE) and 4G core (EPC)
- Good for faster broadband, but limited for advanced features

✓ NSA was a practical first step for 5G rollout

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Standalone (SA) 5G

5G New Radio (NR) with 5G Core (5GC)



Internet / Data Network (DN) | 5G Core Network (5GC) | 5G Radio Network (5G NR) | 5G Device (UE)

- Uses 5G new radio with 5G core
- Enables more advanced capabilities
- Important for enterprise, industrial and critical use cases
- The foundation for 5G-Advanced

Standalone 5G is closer to the full 5G vision.

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5G Spectrum Basics

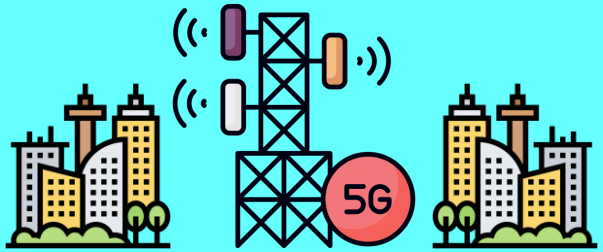
Different spectrum bands give different results

Low-band
Sub-1 GHz



- Wider coverage
- Better building penetration
- Lower capacity

Mid-band
1 GHz – 7 GHz



- Good balance of coverage and capacity
- The main 5G layer

High-band
24 GHz and above



- Very high capacity
- Shorter range
- More affected by obstacles

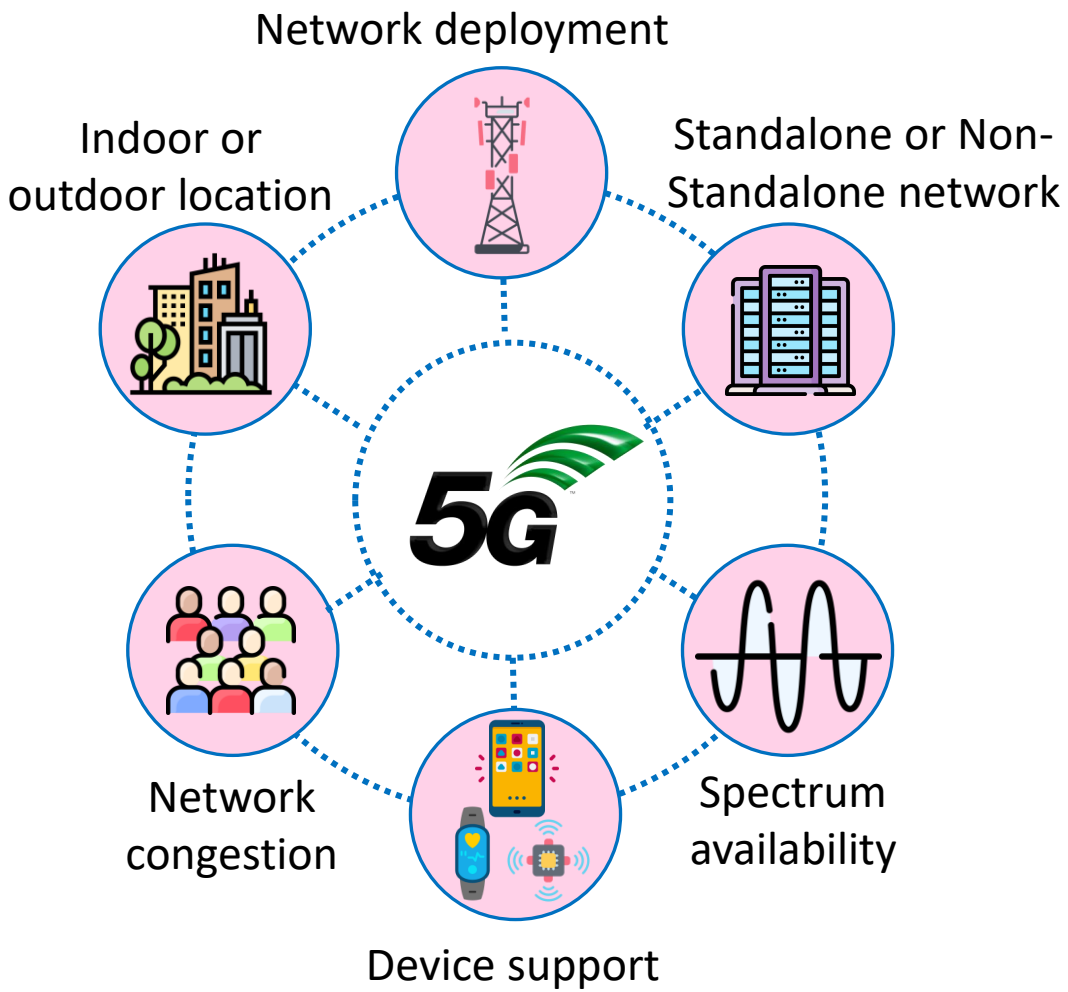
Different spectrum means different 5G performance.

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Why Is 5G Different Everywhere?

Real-world 5G performance depends on many factors.

- Spectrum availability
- Network deployment
- Indoor or outdoor location
- Device support
- Network congestion
- Standalone or Non-Standalone network

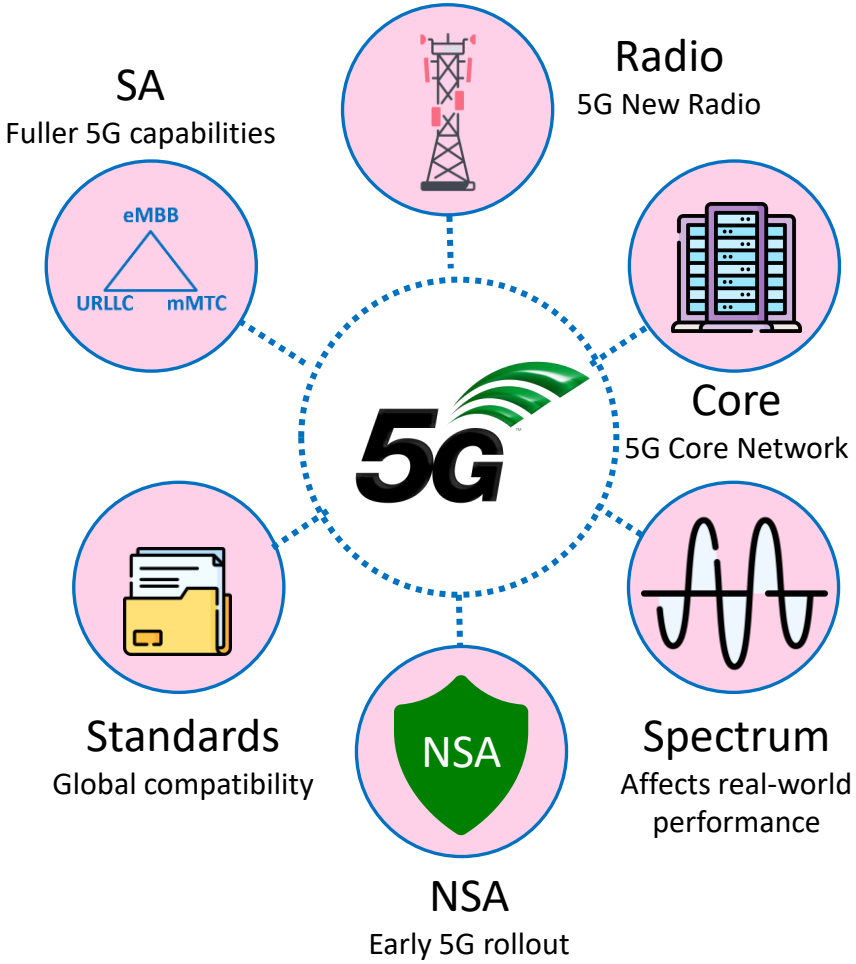


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Lecture 2 Summary

What we have learned:

- 5G is a complete system
- Standards allow global compatibility
- 5G has radio and core network parts
- NSA helped early 5G rollout
- SA enables fuller 5G capabilities
- Spectrum strongly affects real-world performance



Next: What Is 5G-Advanced?

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References & Further Reading

- 3G4G: A Quick Introduction to 3GPP (link)
- 3G4G: Bandwidth, Throughput, Latency & Jitter in mobile networks (link)
- 3G4G: Radio Frequency, Band and Spectrum (link)
- 3G4G: 5G Spectrum (link)
- 3G4G: Non millimeter Wave (mmWave) 5G (link)

Many of these links include videos, downloadable slides and further reading.

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Part 03: What is 5G-Advanced?

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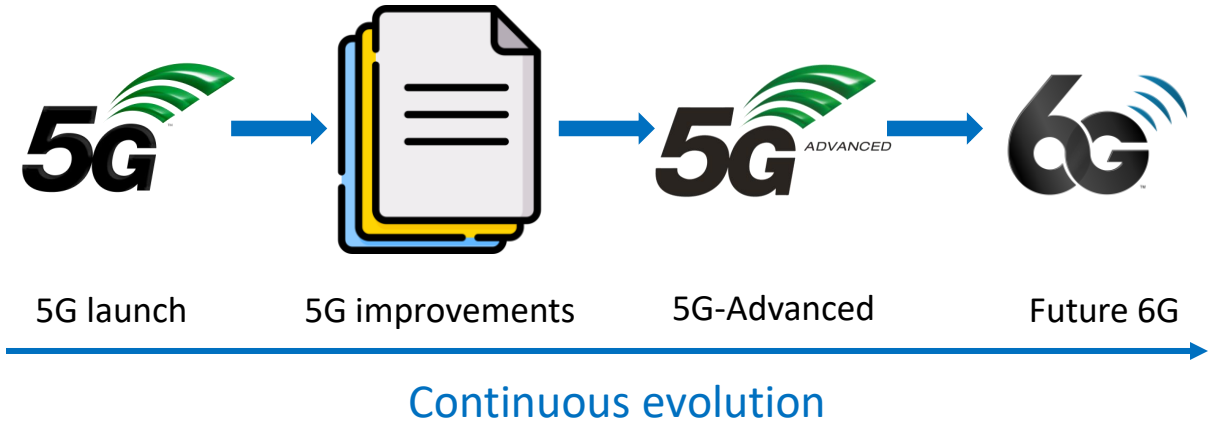
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5G Is Not Standing Still

5G keeps improving over time

- 5G started with early commercial deployments.
- New features are added through 3GPP releases.
- Networks, devices and use cases keep improving.
- 5G-Advanced is a part of this evolution.



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5G-Advanced In Simple Terms

5G-Advanced makes 5G smarter, more efficient, more capable and more useful for real-world applications



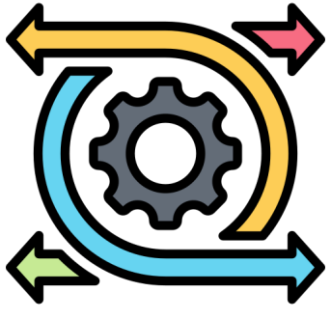
Smarter



More efficient



More reliable



More flexible

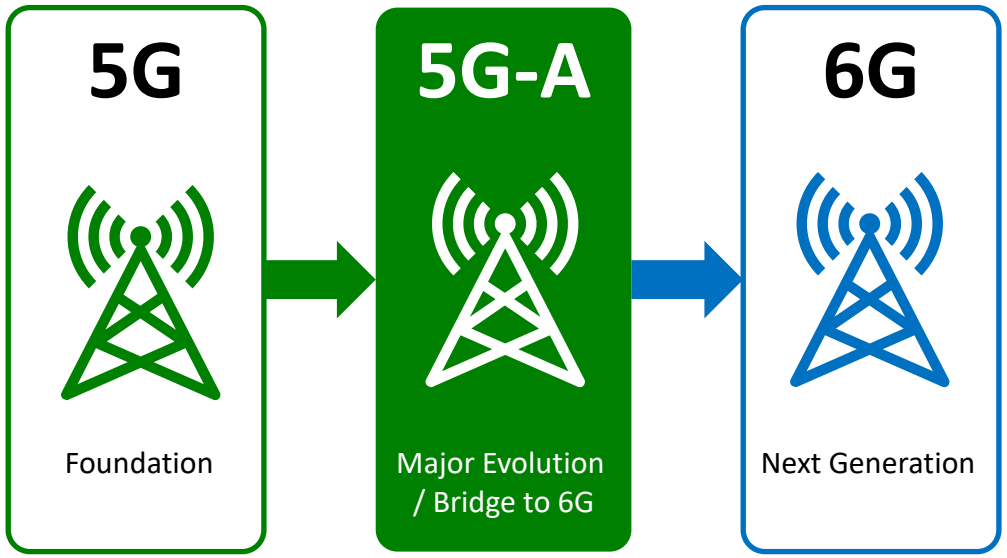


More industry-ready

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Not 6G, But an Important Step Towards It

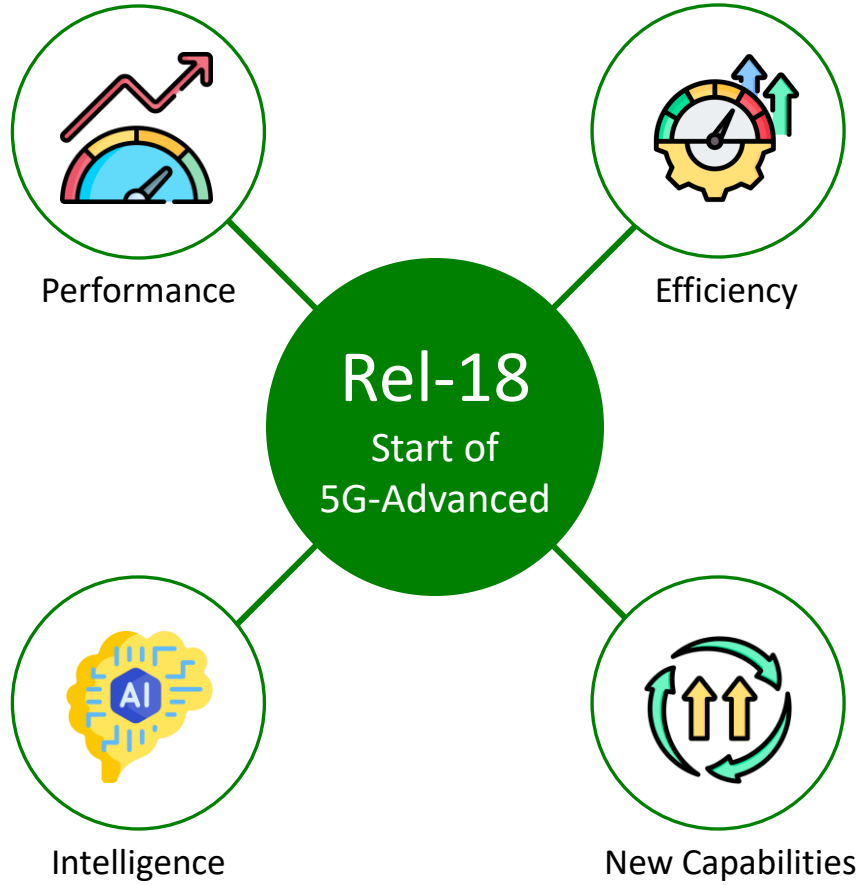
- 5G-Advanced (5G-A) is still part of 5G.
- It is also sometimes referred to as 5.5G or Beyond 5G (B5G).
- It builds on existing 5G specifications.
- It introduces more advanced capabilities.
- 6G will come later as a new generation.



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Release-18: The Start of 5G-Advanced

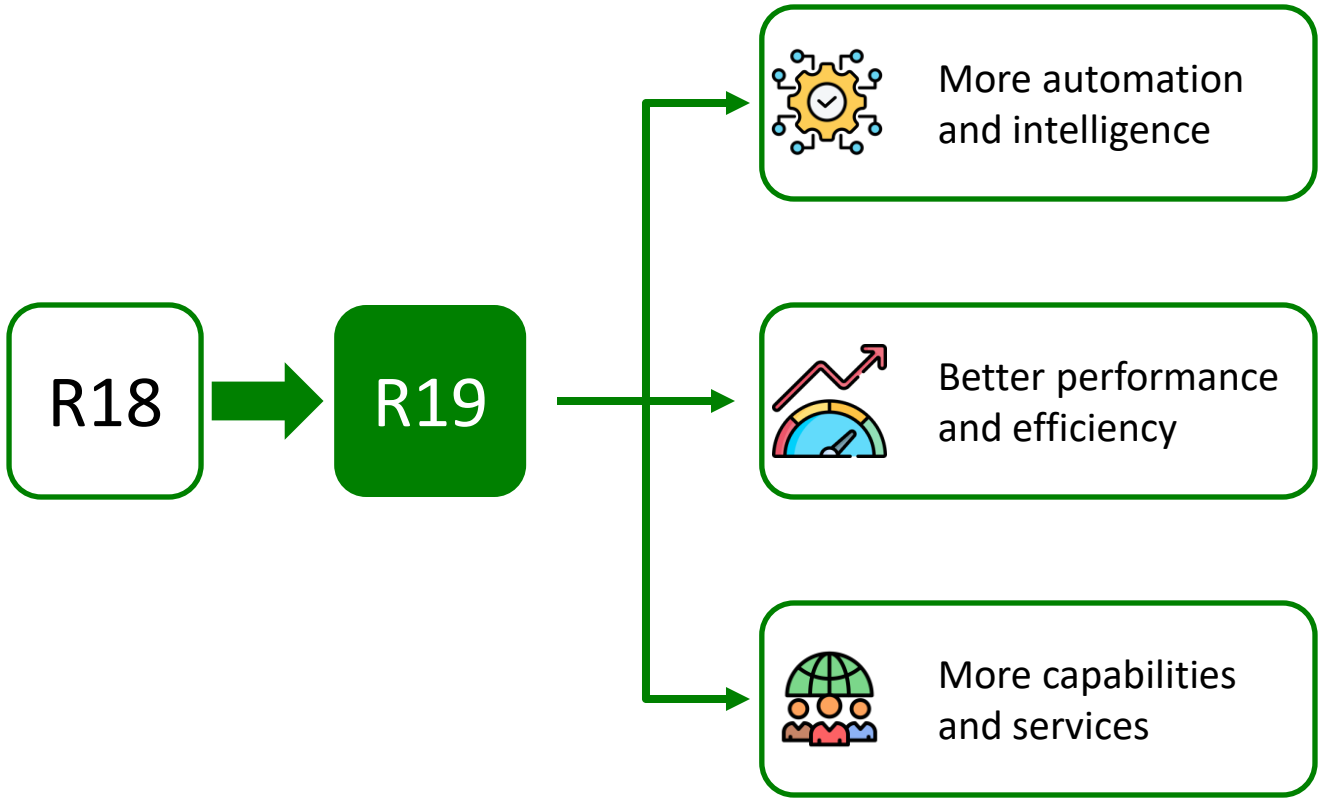
- First 5G-Advanced release.
- Enhances earlier 5G features.
- Adds new capability areas.
- Focuses on performance, efficiency and intelligence



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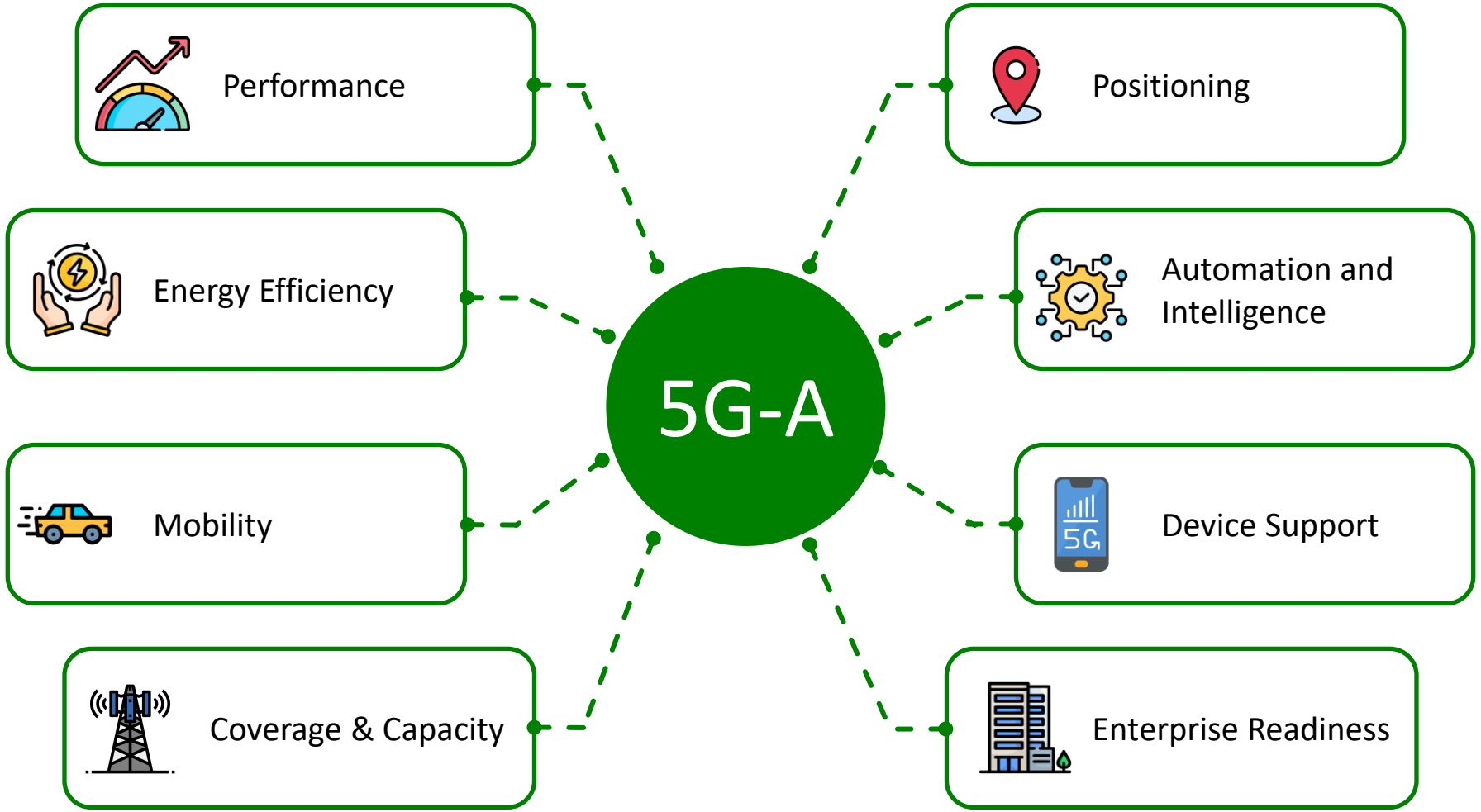
Release-19: Further 5G-Advanced

- Builds on Release 18.
- Adds further 5G-A enhancements.
- Supports more automation.
- Improves networks, devices and services.
- Moves the industry closer to 6G research themes.



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What Does 5G-A Try to Improve?



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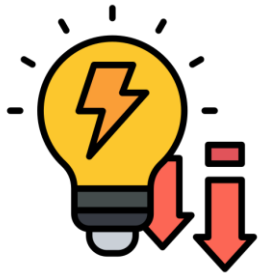
Why Operators Care About 5G-Advanced



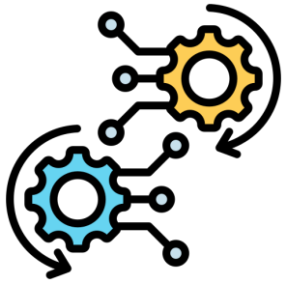
Better use of network resources



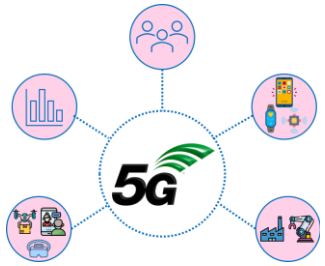
Improved user experience



Lower energy consumption



More automation



Support for new services and use cases



Better return on 5G investment

5G-Advanced helps operators get more value from their 5G investments

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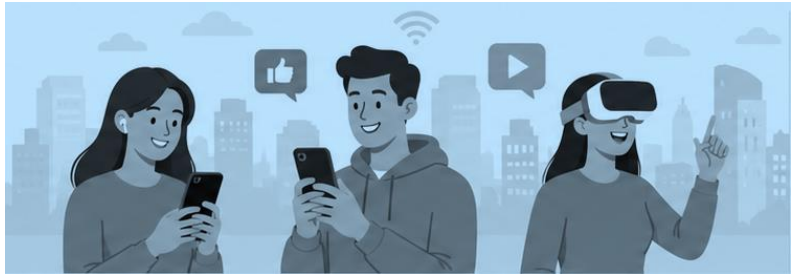
Why 5G-A Matters for Enterprises and Users

For Users

- Better mobile experience
- More consistent performance
- New innovative services

For Enterprises & Industries

- Better private networks
- Industrial connectivity
- More reliable wireless systems
- Support for automation and digital transformation



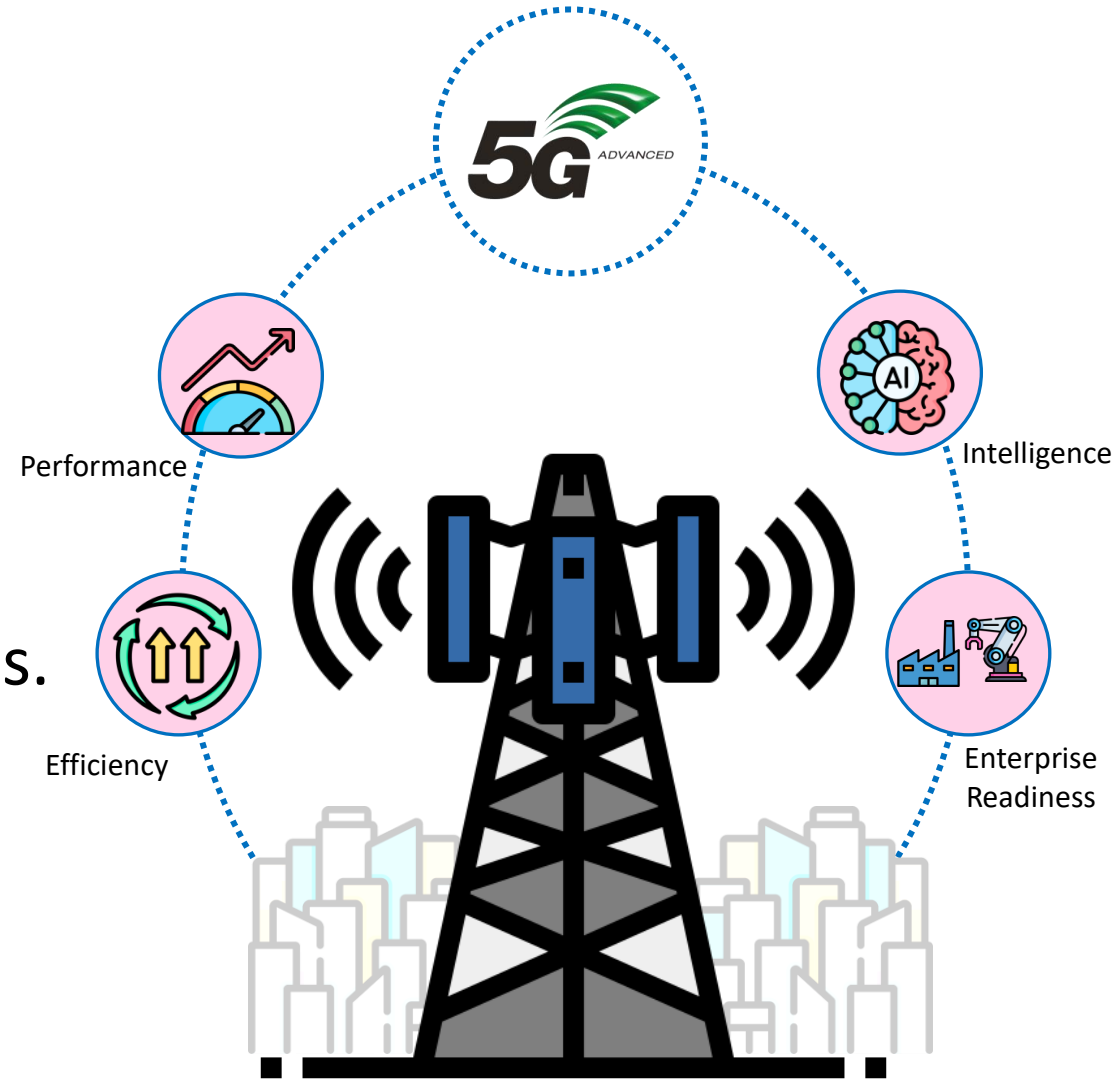


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Lecture 3 Summary

What we have learned:

- 5G continues to evolve through 3GPP releases.
- 5G-Advanced is the next major stage of 5G.
- Release-18 starts the 5G-A era.
- Release-19 continues 5G-A enhancements.
- 5G-A improves performance, efficiency, intelligence and enterprise readiness.
- 5G-A helps bridge the path from 5G towards 6G.



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References & Further Reading

- The 3G4G Blog: ATIS Webinar on “3GPP Release 18 Overview: A World of 5G-Advanced” (link)
- The 3G4G Blog: 3GPP Release 18 Description and Summary of Work Items (link)
- Free 6G Training Blog: ATIS Webinar on 'Introduction to 3GPP Release 19 and 6G Planning’ (link)
- The 3G4G Blog: 3GPP Release 19 Description and Summary of Work Items (link)
- Free 6G Training Blog: ATIS Webinar on 3GPP Release 20 and the Growing Shape of 6G (link)

Many of these links include videos, downloadable slides and further reading.

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Part 04: Key 5G-Advanced Features and Use Cases

ZAHID GHADIALY

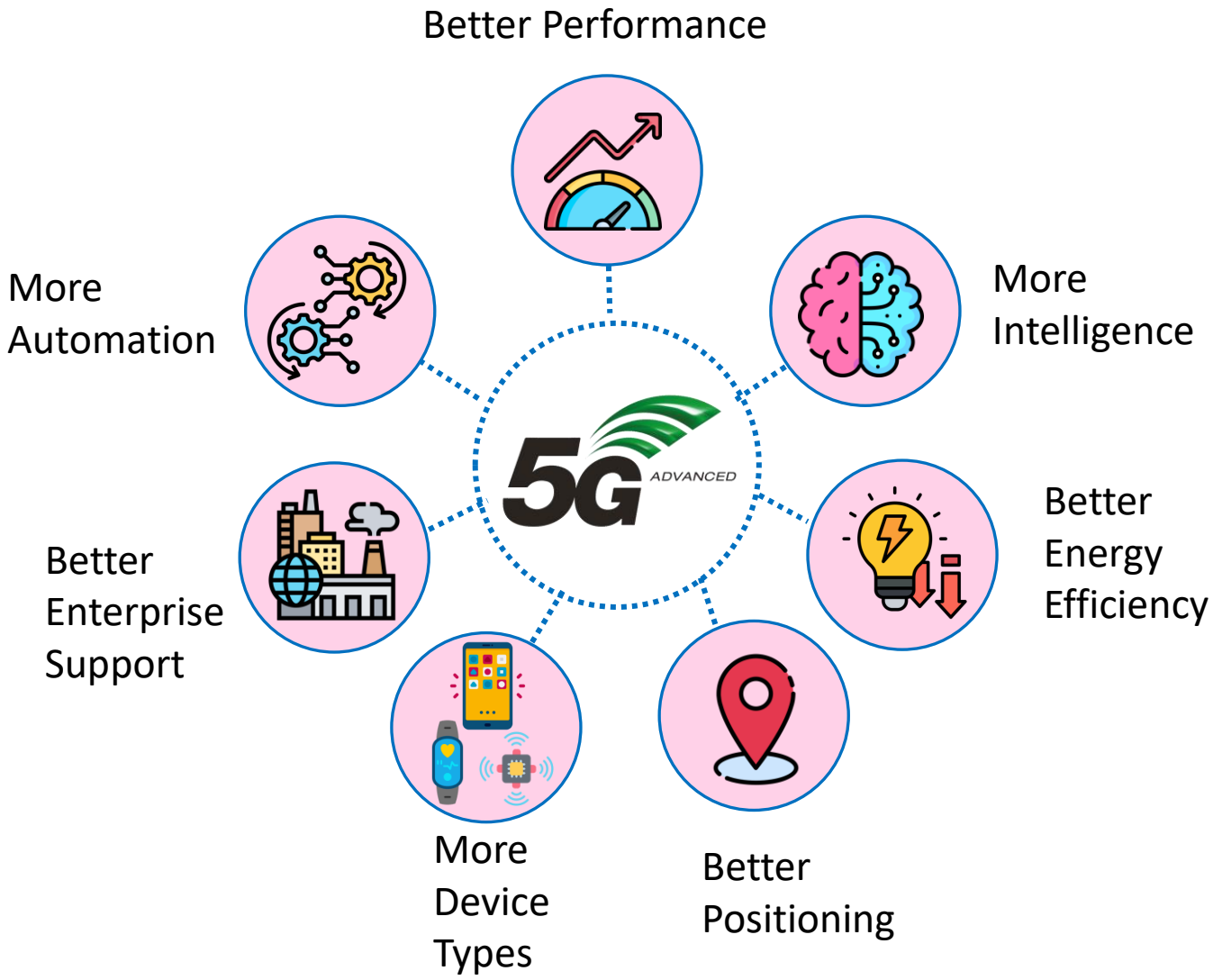
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5G-A Is a Bundle of Improvements

It is not one feature.
It improves many parts of the 5G system.

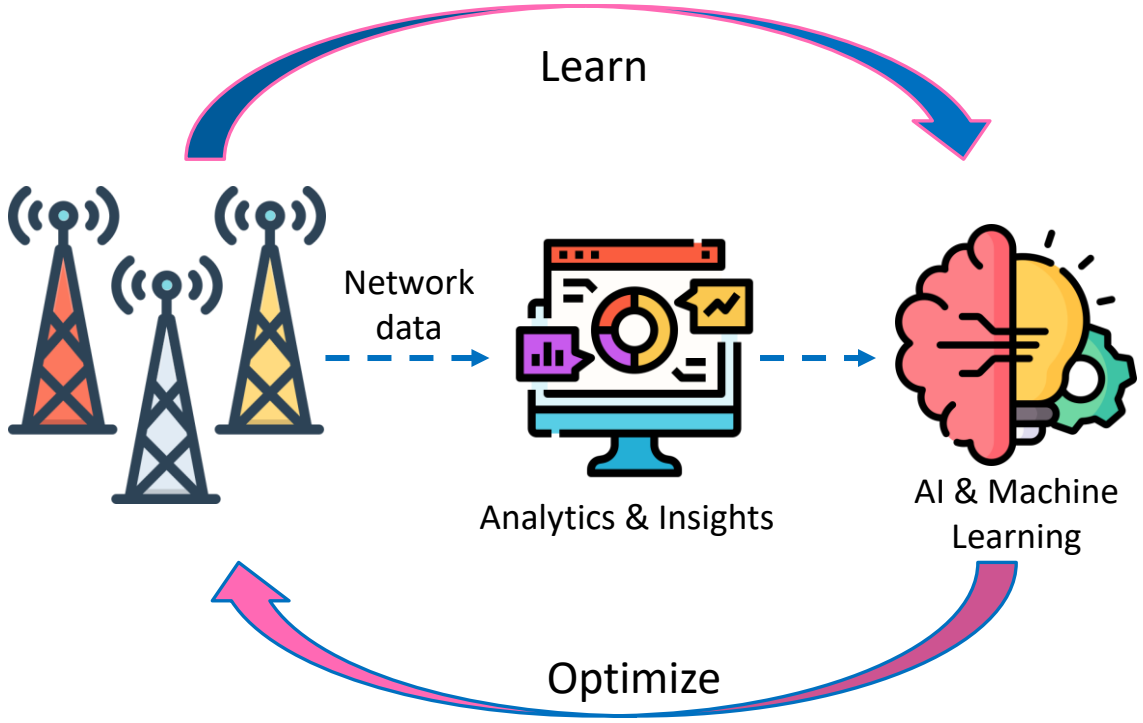


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Smarter Networks with AI and ML

Artificial Intelligence (AI) and Machine Learning (ML) can help networks optimise themselves more intelligently

- Helps networks understand patterns
- Supports better optimisation and decision making
- Can improve radio performance and coverage
- Helps predict issues and reduce downtime
- Useful as networks become more complex



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Using Less Energy While Carrying More Data

Efficiency matters as mobile traffic continues to grow.

- Networks carry more traffic every year
- Energy costs and carbon impact matter
- 5G-A improves energy-aware operation
- Sleep modes and smarter resource use become important
- Efficiency must not harm user experience



Traffic Growth



Lower Energy Consumption

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Not Every 5G Device Needs to be a Smartphone

RedCap and eRedCap enable simpler 5G devices.

- RedCap means Reduced Capability
- Simpler and cheaper 5G devices
- Lower power consumption
- Useful for sensors, wearables, cameras and industrial devices
- Enhanced RedCap (eRedCap) further reduces device complexity

High-end smartphone

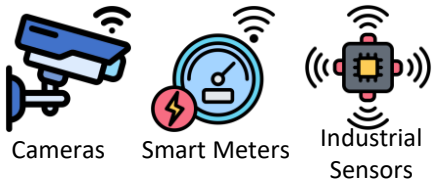


- High performance
- Many features
- Higher cost
- Higher power consumption

vs.

RedCap / eRedCap devices





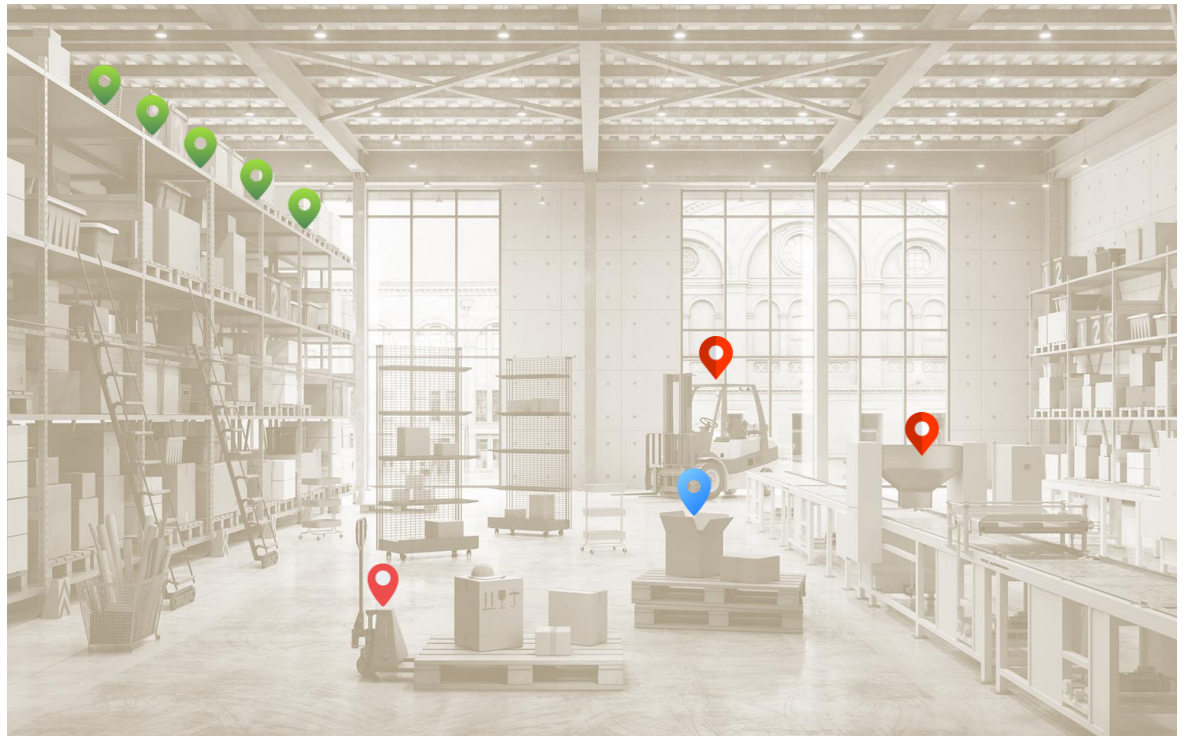
- Simple and cost-effective
- Lower data rates
- Lower power consumption
- Ideal for many IoT and industrial use cases

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5G-A Can Help Locate Devices More Accurately

Positioning is useful beyond phone maps.

- Positioning means finding where a device is
- Useful indoors and outdoors
- Important for factories, warehouses and logistics
- Can support emergency and public safety use cases
- Complements satellite navigation in some scenarios

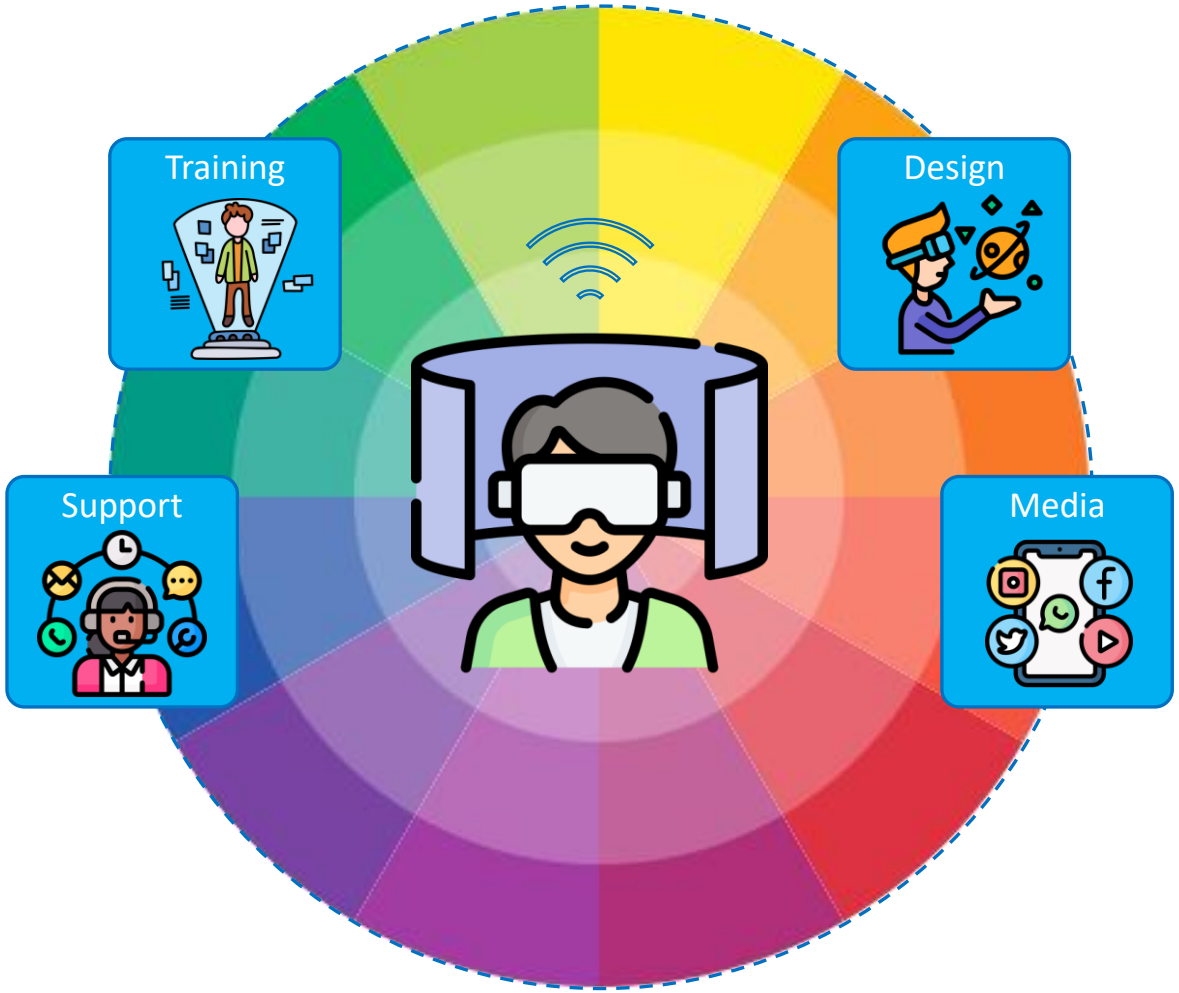


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Supporting More Demanding Experiences

XR, video and immersive services need good end-to-end performance.

- XR includes AR, VR and mixed reality (MR)
- Needs high data rates and low delays
- Useful for training, design, maintenance and entertainment
- 5G-A improves support for demanding media services
- Great experience needs network, device and content readiness

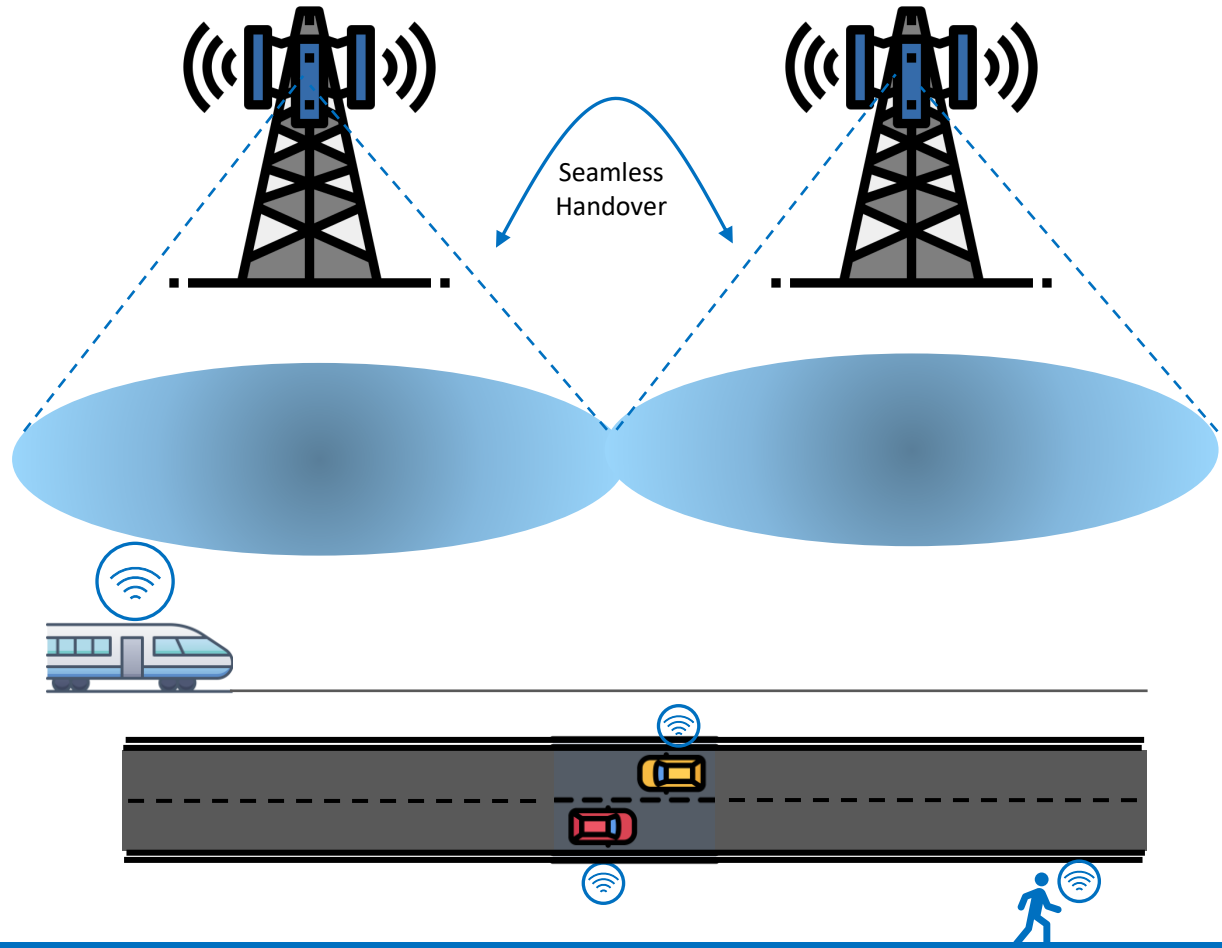


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Better Performance While Users Move

5G-A helps maintain a better experience during mobility.

- Improved MIMO and beamforming
- Better coverage and capacity
- Better mobility between cells and sites
- More reliable user experience
- Important for trains, vehicles and dense areas

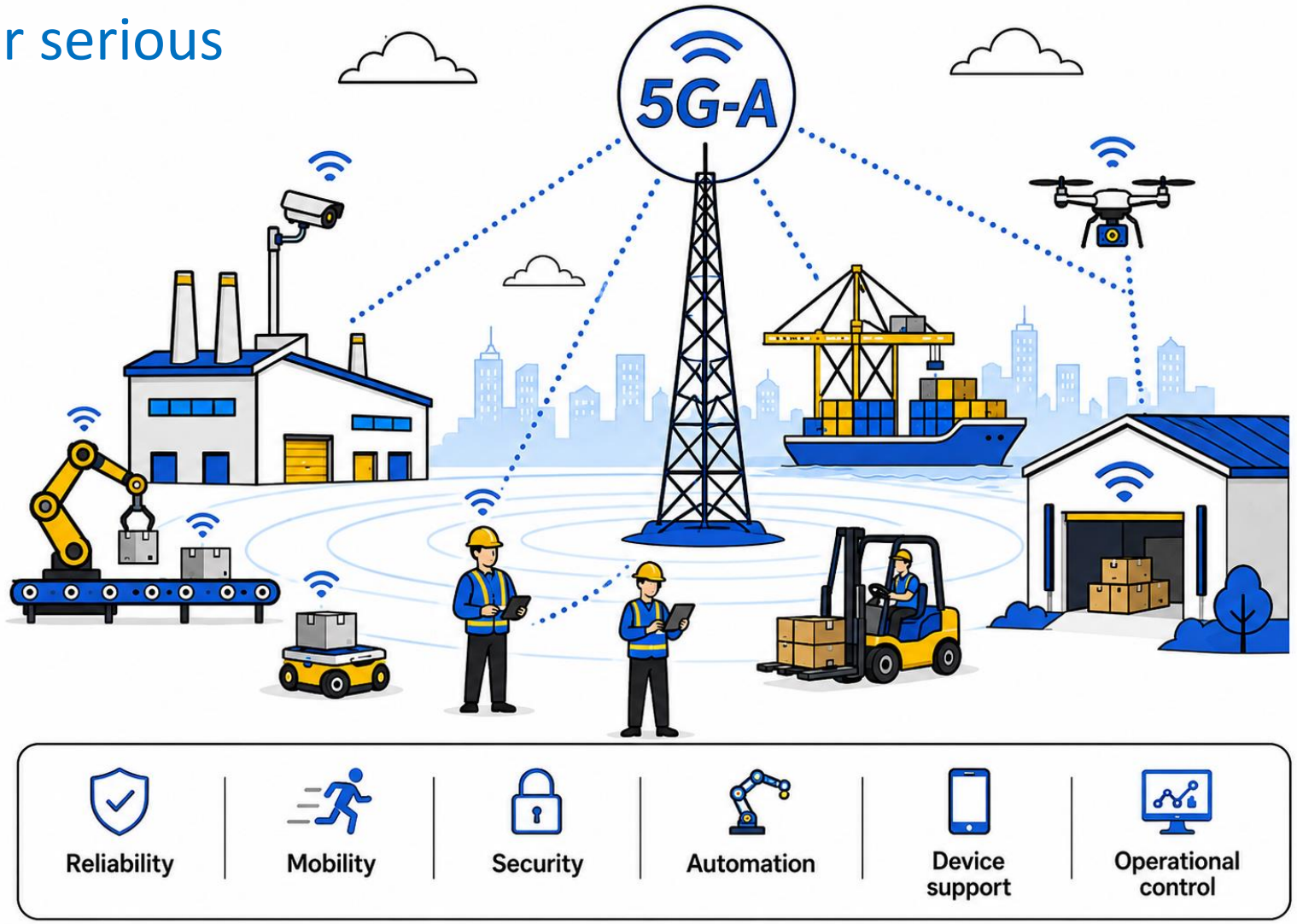


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5G-A for Enterprises and Industry

A stronger foundation for serious operational use cases

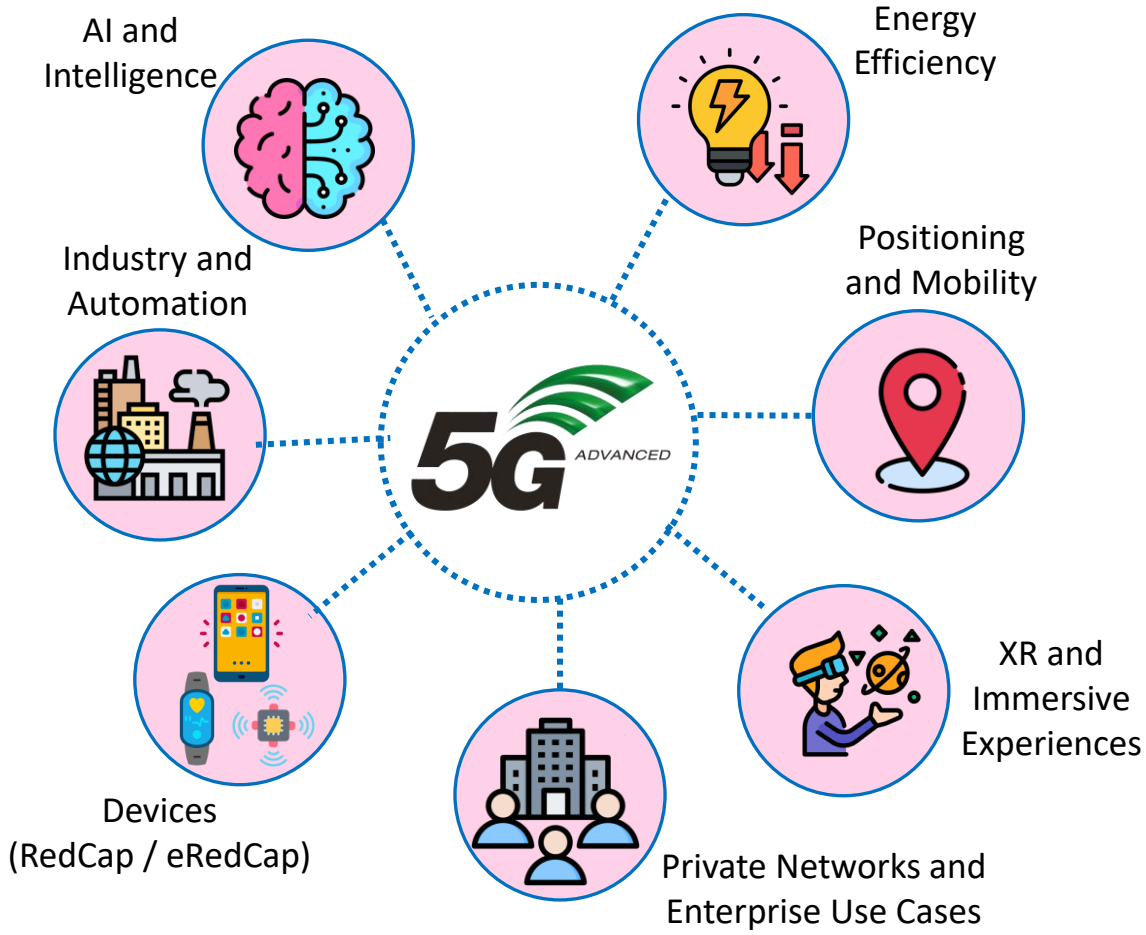
- Factories
- Warehouses
- Ports
- Utilities
- Mines
- Public Safety
- Airports
- Campuses



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Lecture 4 Summary

- 5G-Advanced is a bundle of improvements across the whole system.
- AI and automation help make networks smarter and easier to operate.
- Energy efficiency is crucial as traffic grows.
- RedCap and eRedCap enable simpler, lower-power 5G devices.
- Positioning, XR, mobility and radio improvements enable new use cases.
- Private networks and enterprise use cases are major opportunities for 5G-A.
- Not every use case needs 5G-A. Choose the right technology for the right need.



Next: Satellites, 6G and course summary

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References & Further Reading

- 3G4G: Introduction to 5G Reduced Capability (RedCap) Devices (link)
- 3G4G: 5G and Extended Reality (XR) (link)
- 3G4G: Private Networks & 5G Non-Public Networks (link)
- 3G4G: Energy Consumption in Mobile Networks - RAN Power Saving Schemes (link)
- 3G4G: Non-Terrestrial Networks (NTN) (link)
- The 3G4G Blog: Positioning in 5G Networks (link)

Many of these links include videos, downloadable slides and further reading.

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5G and 5G-Advanced for Absolute Beginners

Part 05: Satellites, 6G and Course Summary

ZAHID GHADIALY

JULY 2026

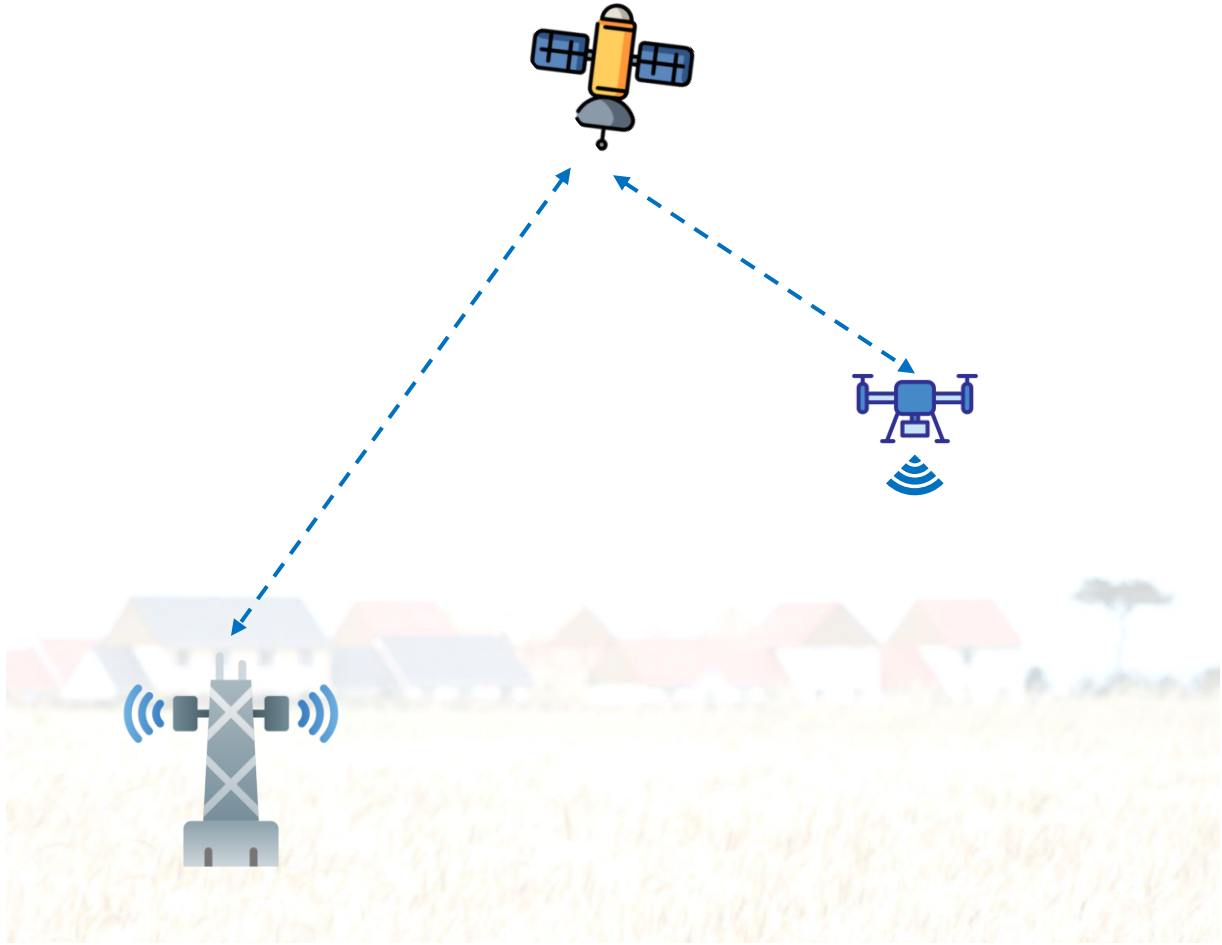
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5G Beyond Ground Networks

5G is expanding beyond towers and small cells.

- Traditional mobile networks use towers and small cells
- Some places are hard to cover from the ground
- Satellites, drones and aerial platforms can extend coverage
- 5G-A helps broaden the connectivity ecosystem

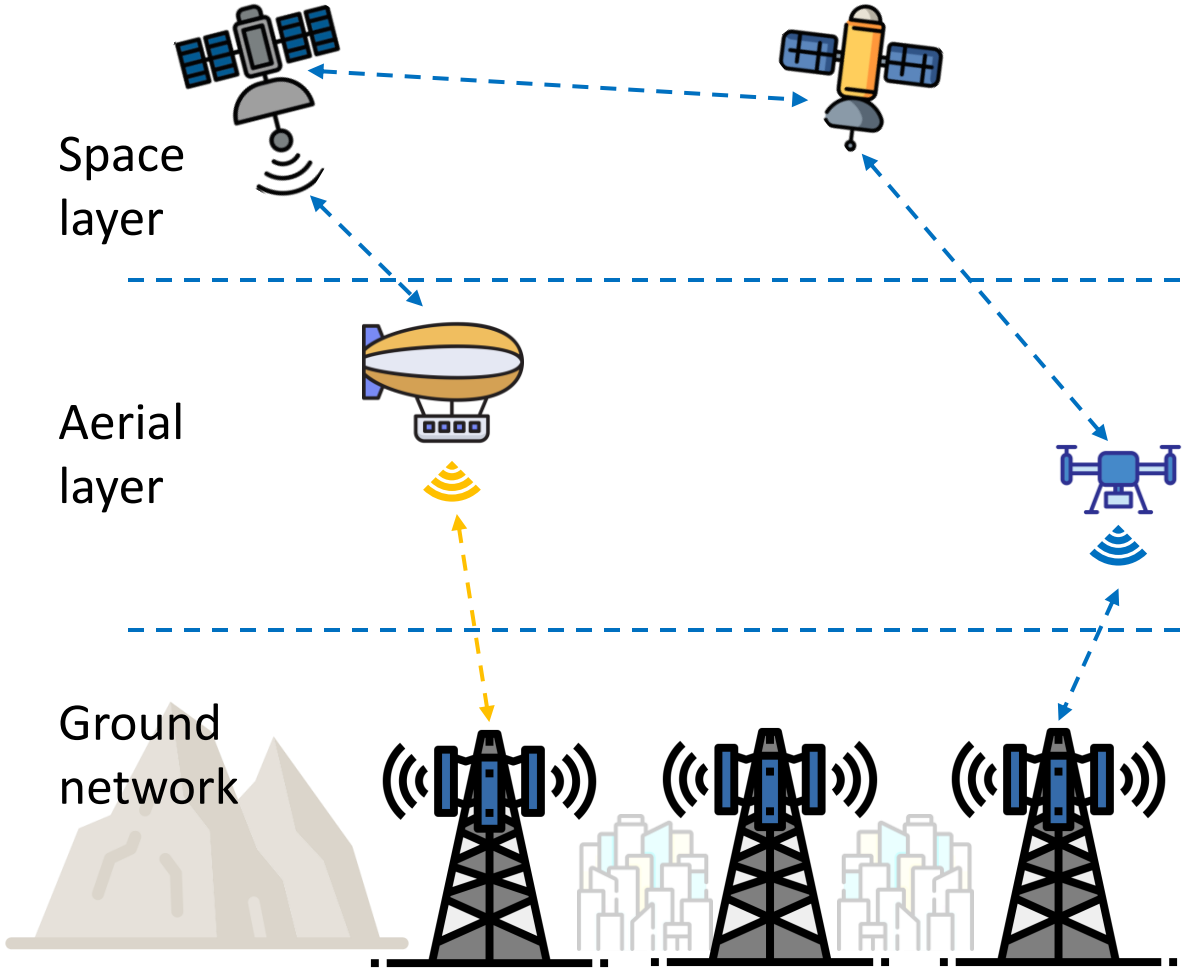


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What Are Non-Terrestrial Networks (NTNs)?

NTN = connectivity from above the ground.

- Networks not based only on ground towers
- Satellites
- High-altitude platforms (HAPS)
- Drones and aerial systems
- Useful where normal coverage is difficult

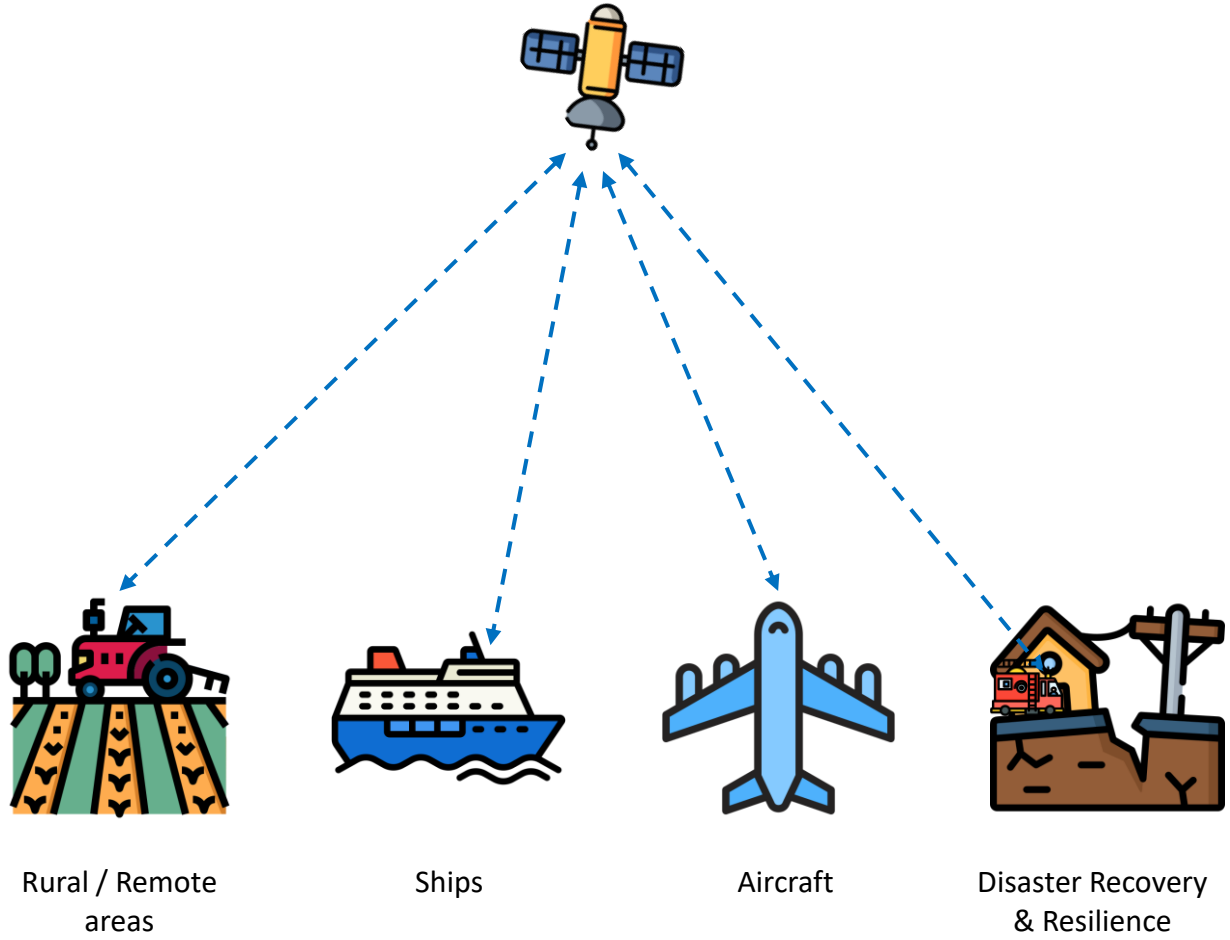


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Satellites as Part of 5G

Satellite connectivity extends the reach of the mobile ecosystem.

- Extend coverage beyond normal mobile networks
- Useful for rural and remote areas
- Useful for ships, aircraft and offshore sites
- Helpful for disaster recovery and resilience
- Can support IoT and broadband-style services

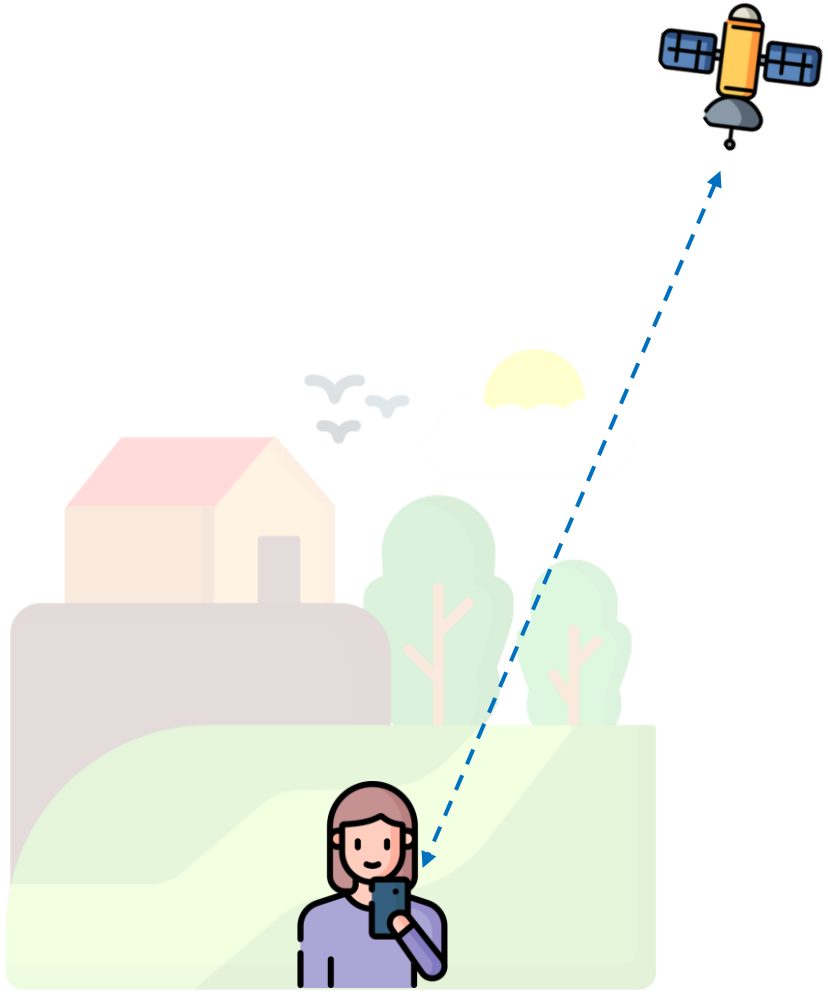


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Direct-to-Device (D2D): Satellite to Phone

A satellite connects directly to a device when no tower is nearby.

- Satellite connects directly to a device
- No normal mobile tower needed nearby
- Useful where terrestrial coverage is unavailable
- Early services may start with messaging and/or low-data services
- More capable services may come later

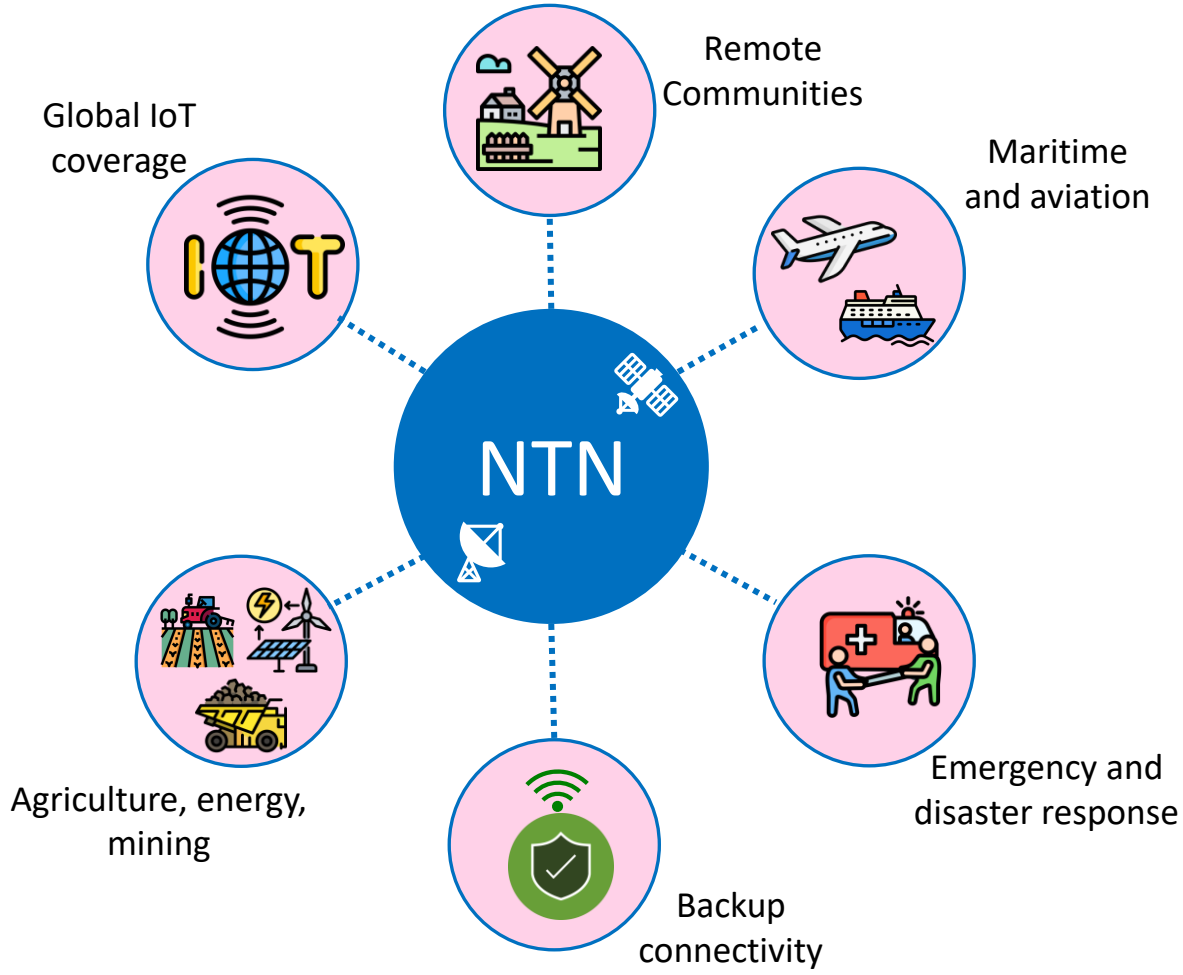


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Why Non-Terrestrial Networks Matter

NTN extends the reach and resilience of connectivity.

- Extends reach
- Improves resilience
- Supports remote and specialised use cases

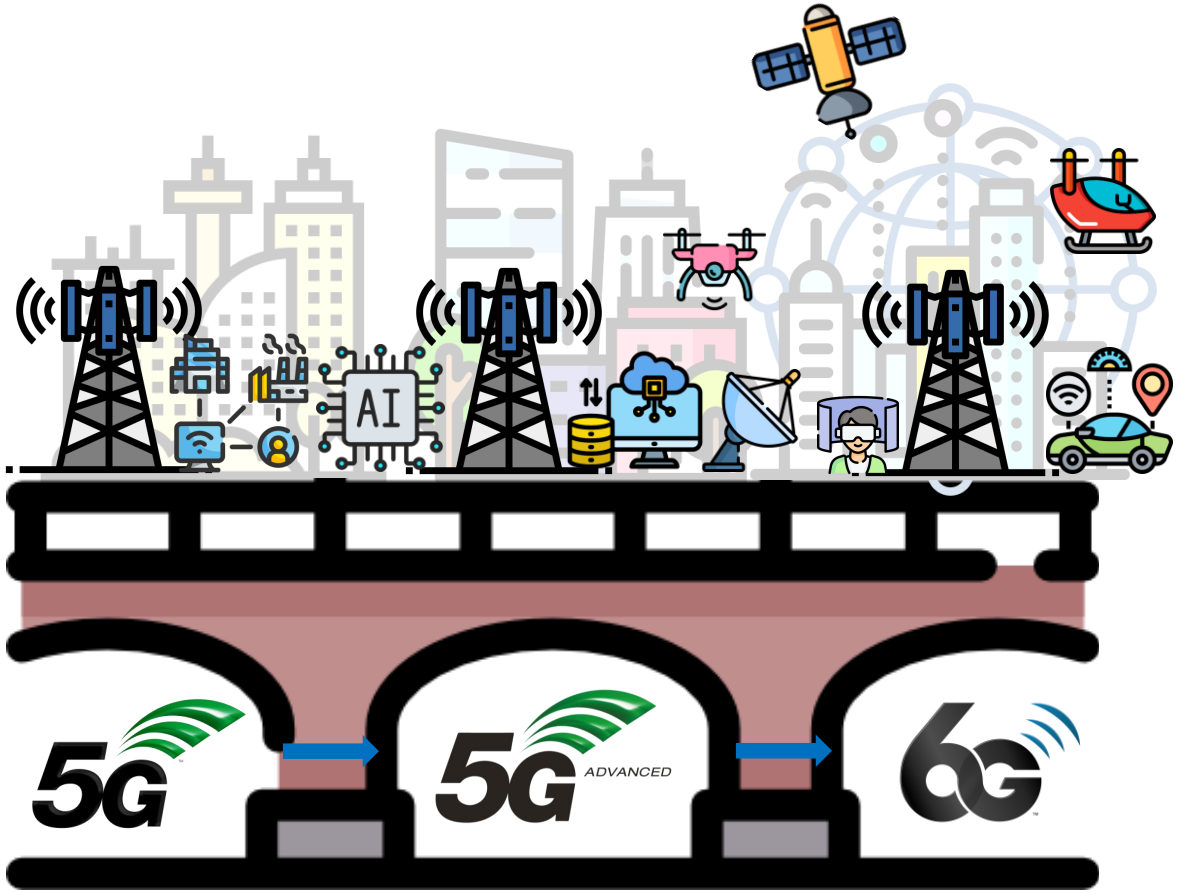


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5G-Advanced Points Towards 6G

5G-A is not 6G, but many themes continue into future networks.

- More AI and automation
- Better energy efficiency
- Better positioning
- More NTN integration
- More sensing and awareness
- More communication and computing integration

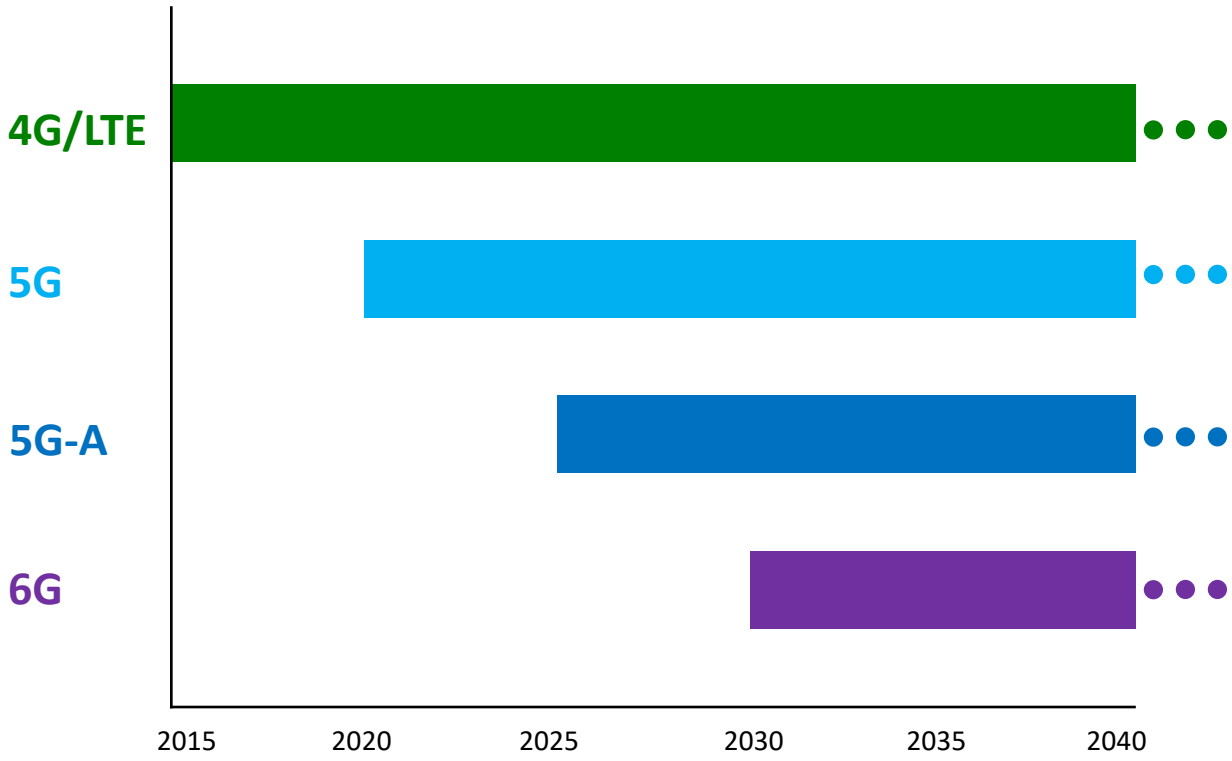


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Evolution, Not Overnight Replacement

New mobile generations overlap for many years.

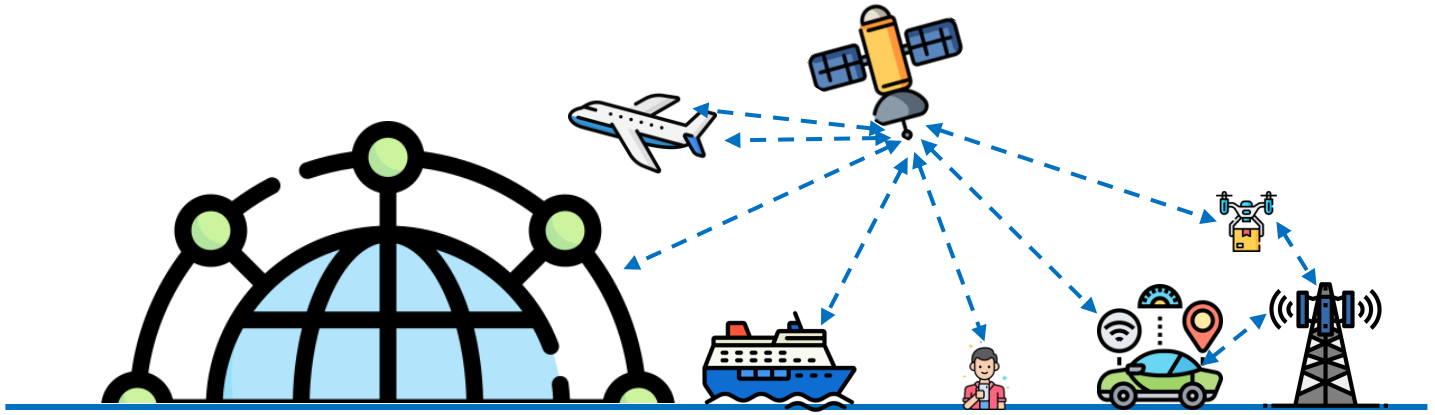
- 2G and 3G are being switched off in many countries
- 4G is still widely used today
- 5G will remain important for many years
- 5G-A will improve existing 5G networks
- 6G will arrive gradually
- Different generations will coexist

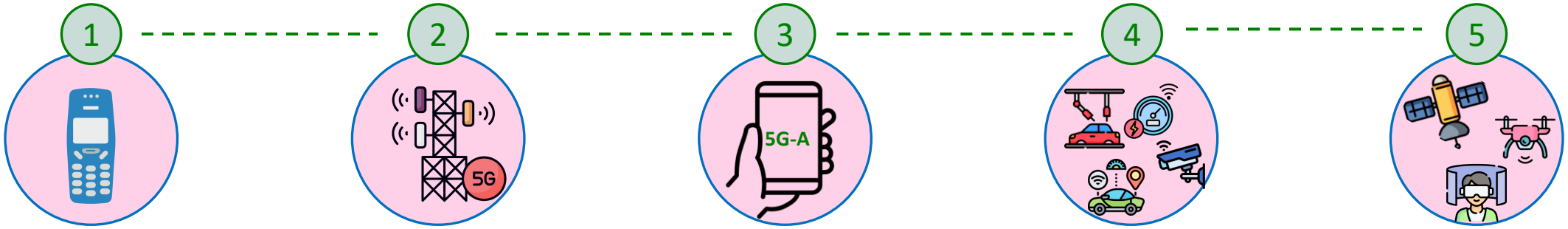


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What We Covered in This Course

A five-step journey from mobile basics to the future of 5G-A.





From 1G to 5G

How 5G works

What 5G-Advanced is

Features and Use Cases

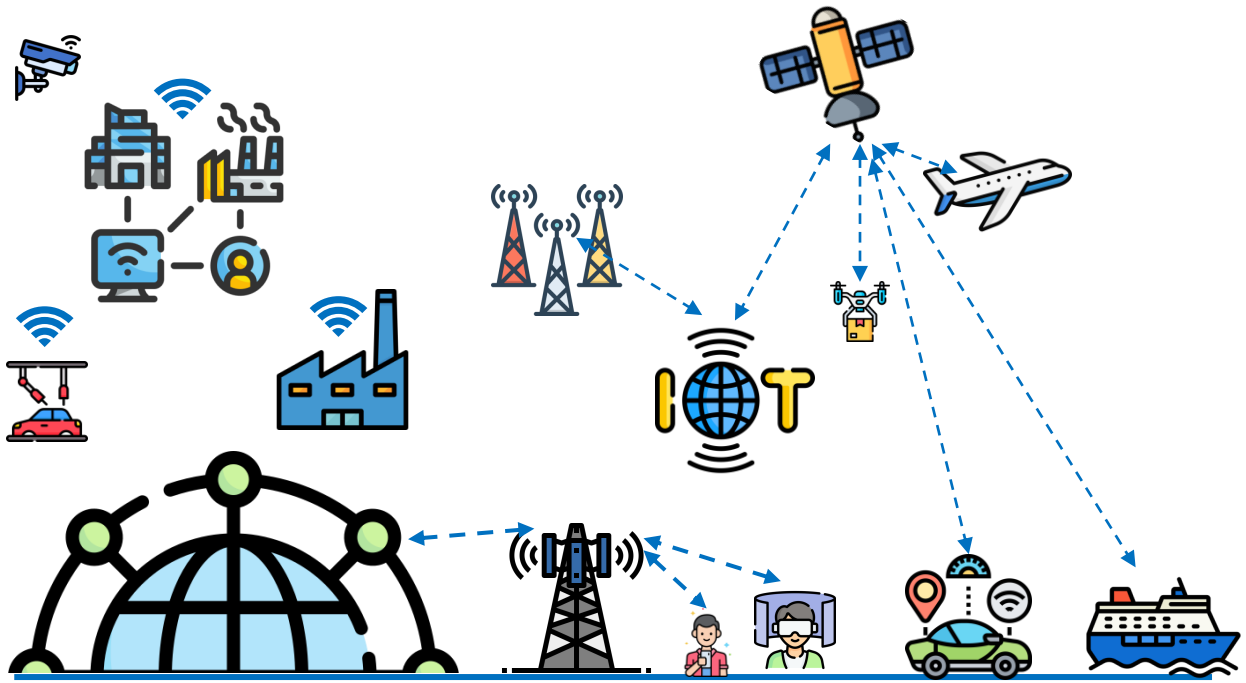
Satellites, 6G and the future

You now have the big picture of 5G and 5G-Advanced.

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Final Takeaways

- 5G is more than faster downloads
- Real-world 5G depends on radio, core, spectrum and deployment
- 5G-Advanced is the next major evolution of 5G
- 5G-A improves performance, efficiency, intelligence and enterprise support
- Satellites and NTN extend the 5G story
- 5G-A prepares the industry for 6G



5G-Advanced makes 5G smarter, more useful and more future-ready.

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References & Further Reading

- 3G4G: Non-Terrestrial Networks (NTN) (link)
- The 3G4G Blog: NTN and 3GPP Standards from 5G to 6G (link)
- The 3G4G Blog: Release 19 Takes Satellite, NTN and Aerial Connectivity Further (link)
- Connectivity Technology Blog: 3D Communication Networks and the Future of Connectivity (link)
- Free 6G Training Blog: ATIS Webinar on 3GPP Release 20 and the Growing Shape of 6G (link)

Many of these links include videos, downloadable slides and further reading.

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Where Next?

- Free 2G, 3G, 4G & 5G Training Videos – Structured tutorials and explainers on the 3G4G website
- The 3G4G Blog – Mobile standards, 5G, 5G-Advanced, AI, Open RAN, spectrum and more
- Telecoms Infrastructure Blog – The infrastructure, networks and technologies behind modern connectivity
- Operator Watch Blog – Mobile operators, spectrum, launches, networks and market developments
- Connectivity Technology Blog – Satellites, NTN, Wi-Fi, critical communications and emerging connectivity
- Private Networks Technology Blog – Private 4G/5G deployments, enterprise networks and industrial use cases
- Free 5G Training Updates on LinkedIn – Regular tutorials, updates and learning resources on 5G
- Free 6G Training Blog – 6G research, technologies, standards and industry developments
- 3G4G YouTube Channel – Technical explainers, tutorials, presentations and webinar highlights

Choose the topics that interest you and continue learning at your own pace

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Thank You

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