



**MEDIATEK**

# Evolution From Beyond 5G to 6G Communications

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# 6G R&D: Why So Early?

- Ecosystem factor: more aggressive industry move than 5G era
  - Visible 5G industry efforts started in 2014-15
    - Official ITU call for IMT 2020 started in 2015
    - Early 5GPP in Europe started in 2013 MWC, and 5G activities in China IMT-2020 started in 2014
  - Visible 6G industry efforts starting NOW in 2021
    - US: NextG Alliance; China: IMT-2030; Europe: Hexa-X
    - Still very early stage while getting significant ecosystem attention
- Technical factor: higher complexity that need time to prepare
  - Ex 1: Tbps consumer device → need brand-new methodology on modem and RF design approach
  - Ex 2: Immersive intelligence → Transformational architecture for networking and computing
- 6G R&D = Explore transformational wireless evolution + Solid prep for meaningful and reliable product launch

# Real 5G Services and Applications Come True?

## Original 5G Vision

eMBB\* = “Faster LTE”

✓ - Mass consumer market



UrLLC\*

? - Low Volume + High Cost



mMTC\*

? - Low Margin + Fragmentation



## Yet-to-deliver 5G Promises

- No killer app so far
  - Immersive eMBB app yet to happen
  - Complex vertical business models
- mmW didn't really go \*mobile\*
  - Non-significant in outdoor coverage
  - Unstable in-venue throughput
  - Eyes still on fixed wireless access (FWA)
- Massive MIMO still not ideal
  - ~8x more antenna for ~2x capacity gain
  - High power consumption at gNB w/ large array
- High device power consumption
  - Public advice from multiple service providers to use 4G-only to save power

\*eMBB = enhanced mobile broadband

\*UrLLC = ultra reliable low latency communication

\*mMTC = massive machine-type communication

# Technology and Industry Trends Toward 6G

3G



4G



5G



Data Rate  
UE MIMO

1-10 Mbps  
1-Tx / 1-Rx

10M-1Gbps  
1-Tx / 2+ -Rx

100M-10Gbps  
2-Tx / 4+ -Rx

1G-1Tbps  
4-Tx / 8+ -Rx

Spectrum

FDD + new TDD  
(e.g. 2.3 GHz)

+ more TDD (2.5 GHz)  
+ unlicensed (5 GHz)

+ 3.5-7 GHz  
+ mmW

+ 7-14 GHz  
+ sub-THz

~100 MHz more

~800+ MHz more

~10+ GHz more

~100+ GHz more

Killer App

Mobile Web  
(Email, Surf)

Mobile Video  
Social Network

HD Video  
? XR ?  
? Verticals ?

? Ultra-XR ?  
? Immersive AI ?  
? All-Reach NTN ?

# Efforts in Evolution from 5G to B5G

- Continuous XR enhancement as leading killer application
  - 3GPP rel-17 study is a good start
  - More mobility, latency, capacity and cross-layer features in rel-18.
- Reliable “soft” network topology to take mmW to mobile
  - 3GPP rel-16 Multi-TRP (mTRP) a good start
  - Further mmW mobility enhancement for network + device
- “Heterogeneous” massive MIMO
  - Realization of “Cell-free” distributed massive MIMO
  - Evolve towards distributed network with device assistance
- End-to-end low power system design
  - Device power saving for uplink and mTRP in rel-17
  - Joint network-device power saving towards rel-18 and beyond

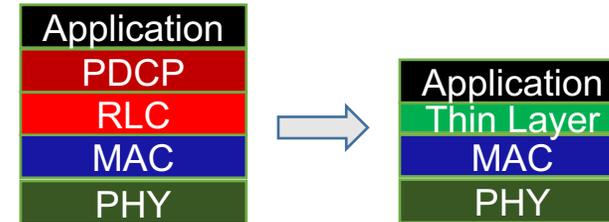
# Shape the Trends towards Practical Deployment

## • Simplicity

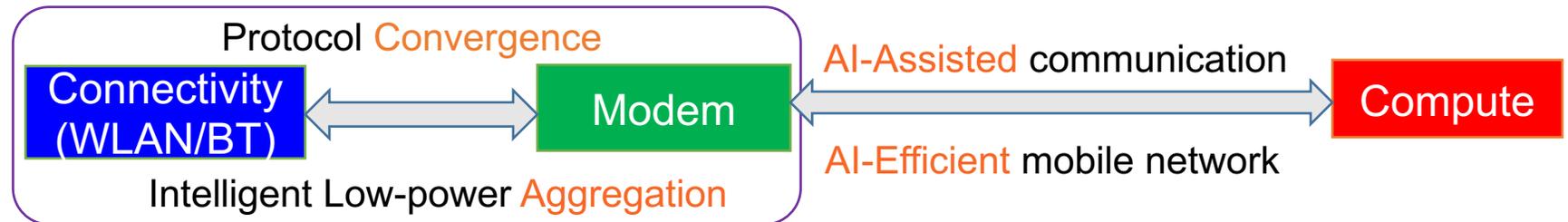
Prepare for anticipated complexity:



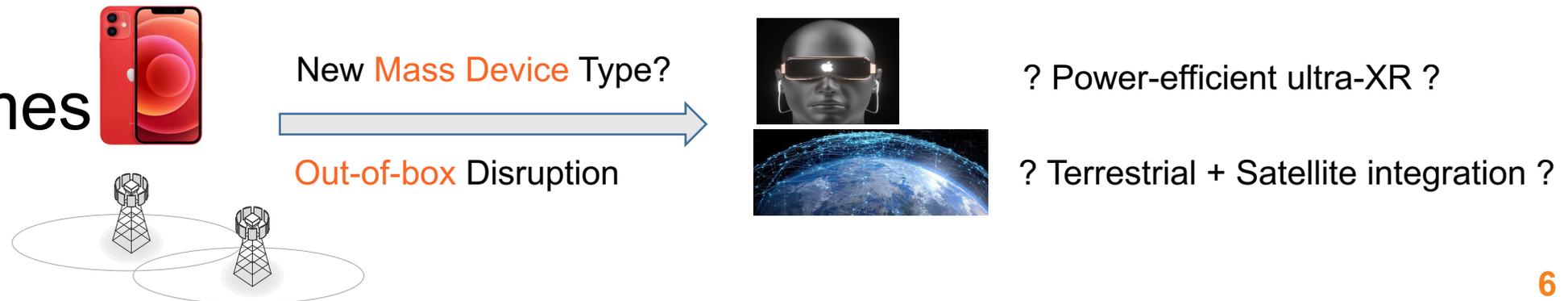
Simplify the unnecessary complexity:



## • Convergence



## • New Schemes

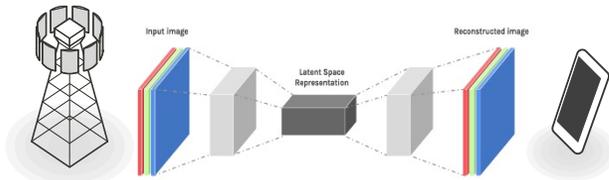


# Convergence: AI and Communication

## 1. AI-Assisted Communication

Use AI as a tool to enhance comm. systems

- Channel characteristics



CSI (channel state information) compression

- Mobility

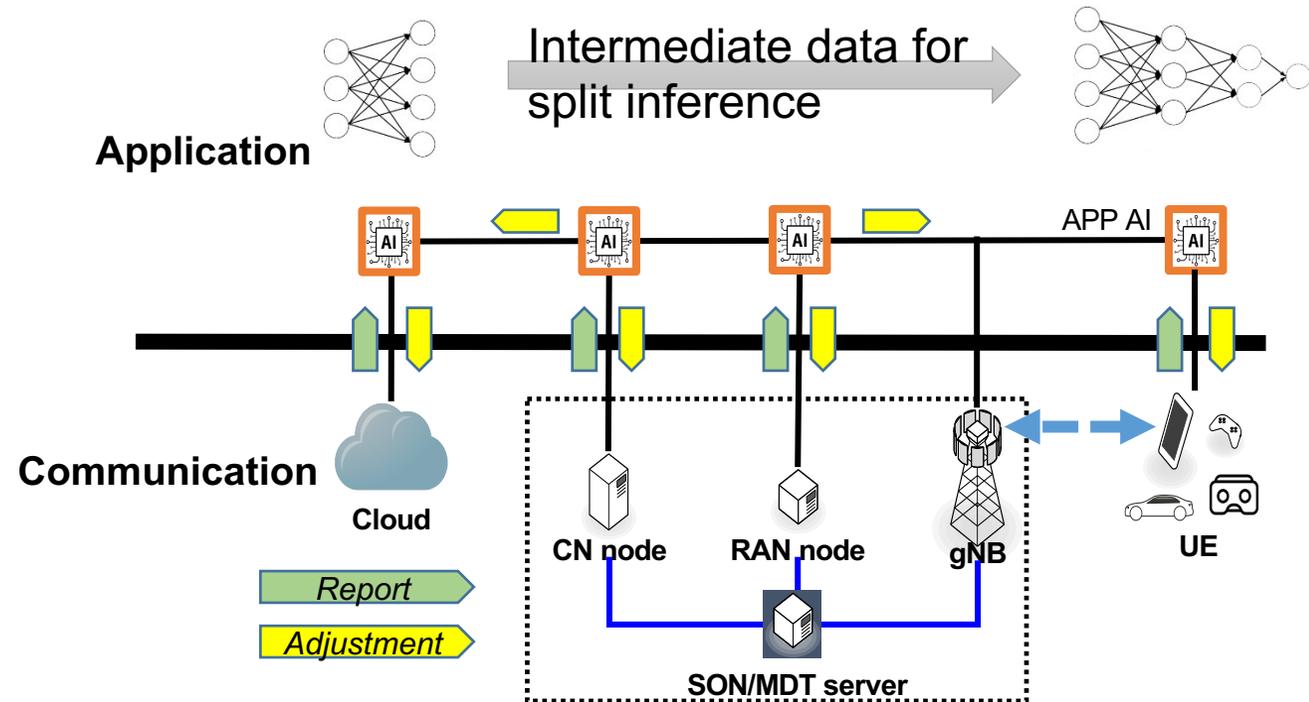


- Positioning, energy saving, load balancing

## 2. AI-Efficient Network

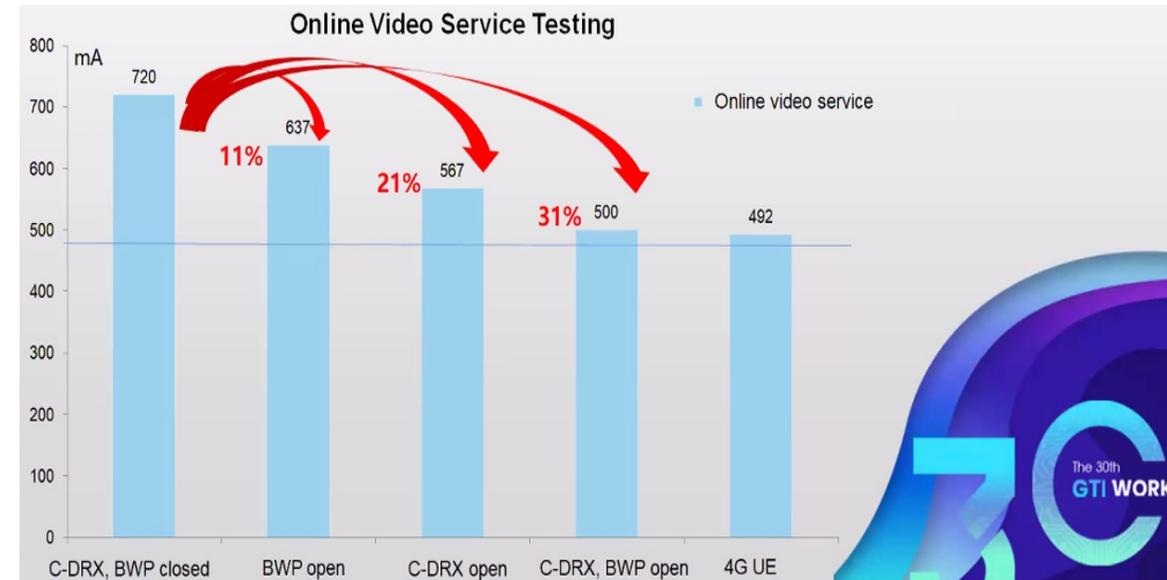
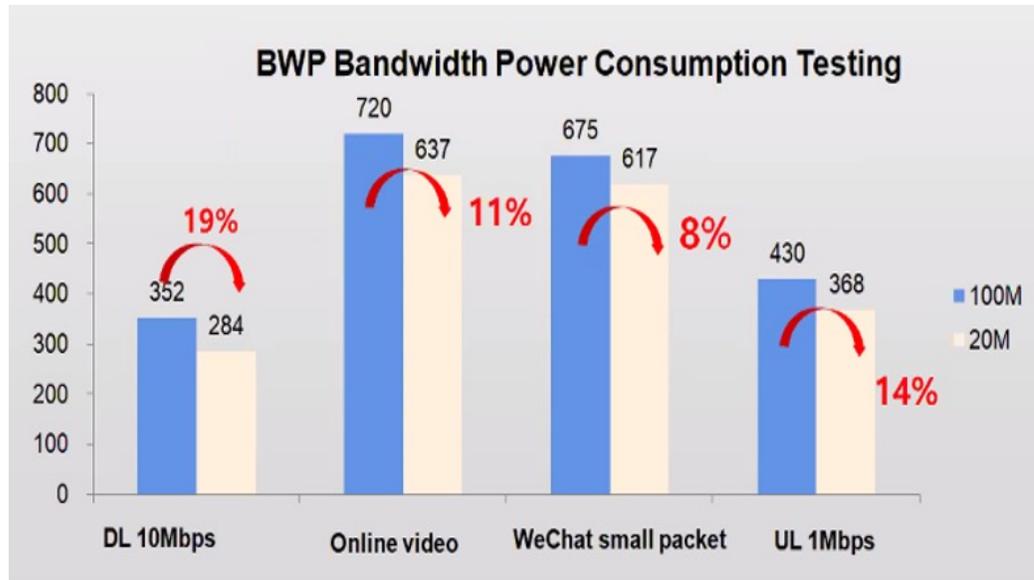
Intelligent framework for application-AI & RAN/CN collaboration

- Distributed AI computing
- Model transfer among nodes
- EX: AI-aided codec for robust QoS



# BWP (bandwidth part) Enable Energy Saving in a Real CMCC Network

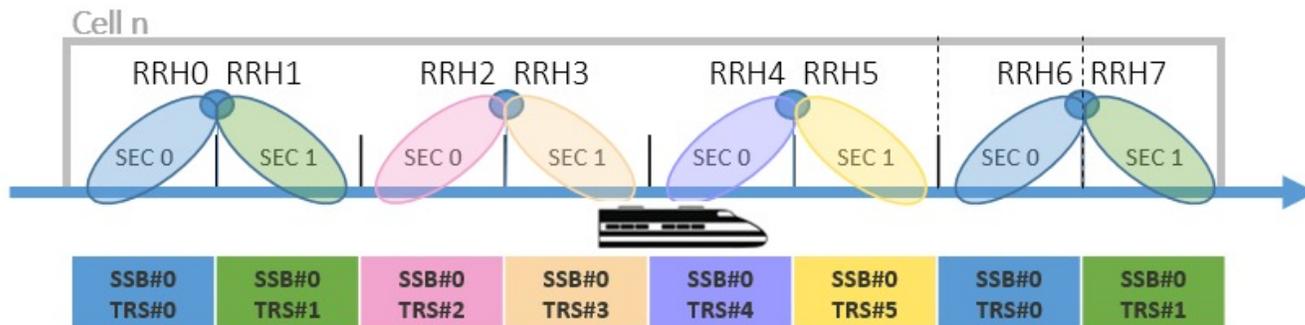
- 8%~19% power saving in DL
- 14% power saving UL
- Power consumption of on-line video streaming on 5G phones approach 4G's level together with C-DRX.



# Deploy DPS (dynamic-point-selection) Scheme to Enhance 5G NR User Experience in High-Speed Train

- High Doppler frequency and frequent handover occurrence
- Average throughput reaches **550Mbps** in CMCC network

## Beam management in NR-HST network



TRS: Time Reference Signal



# Space and Terrestrial Network Integration toward B5G/6G

- Increase rural broadband coverage
  - >60% population, **but**
  - <40% landmass covered by mobile cellular networks today
- Truly ubiquitous coverage
  - Satellite (rural + outdoor) and cellular (urban + indoor)
- Open standard is key for interoperability and economics of scale
  - 3GPP Rel-17 NTN (NR, IoT) standardization by 2021/E

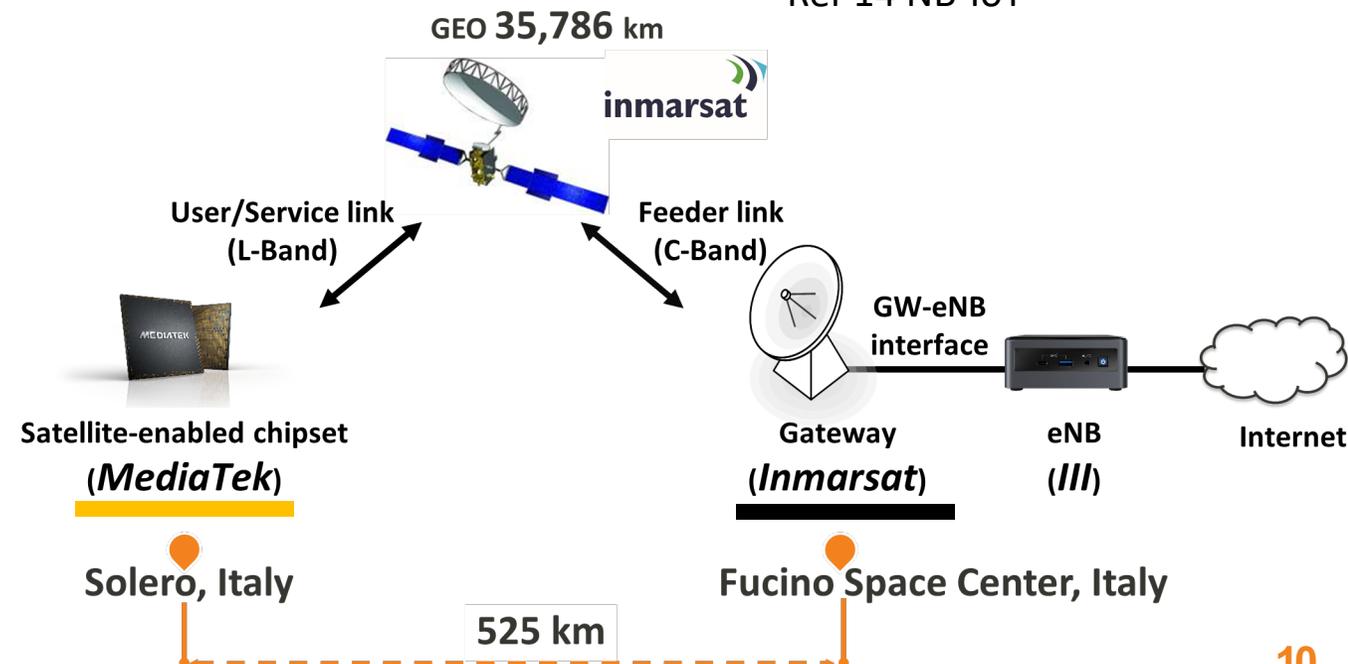
- World's first test of 5G satellite IoT data connection

## UE capability

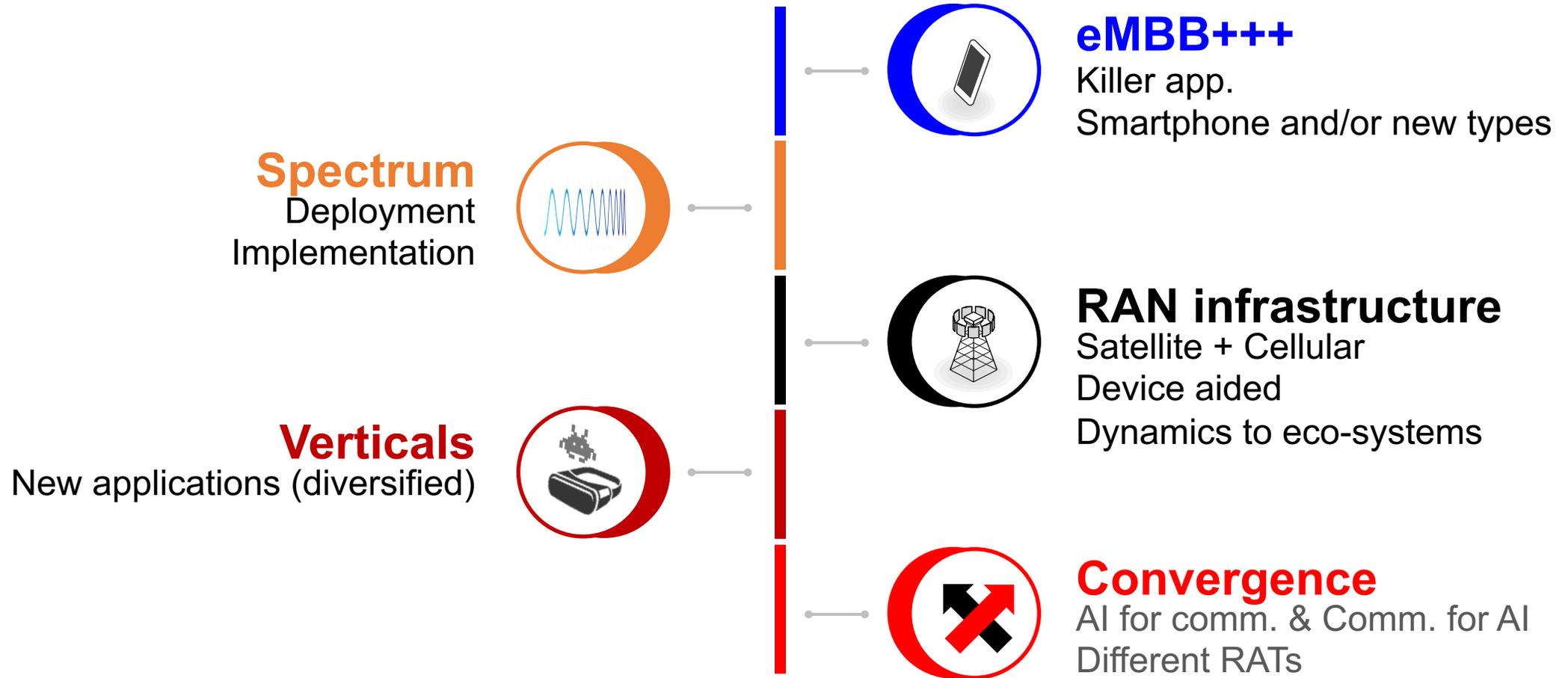
- 23dBm UE Tx Power
- 0dBi linear antenna

## System Configurations

- DL channel BW : 200kHz
- UL channel BW : 3.75kHz
- Rel-14 NB-IoT



# Summary – Towards New Generation with Expanded Dimensions



The Mediatek logo consists of the word "MEDIATEK" in a bold, white, sans-serif font, centered within an orange, rounded rectangular shape with slanted sides. The shape has a subtle drop shadow.

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