

KT's Perspective on 5G

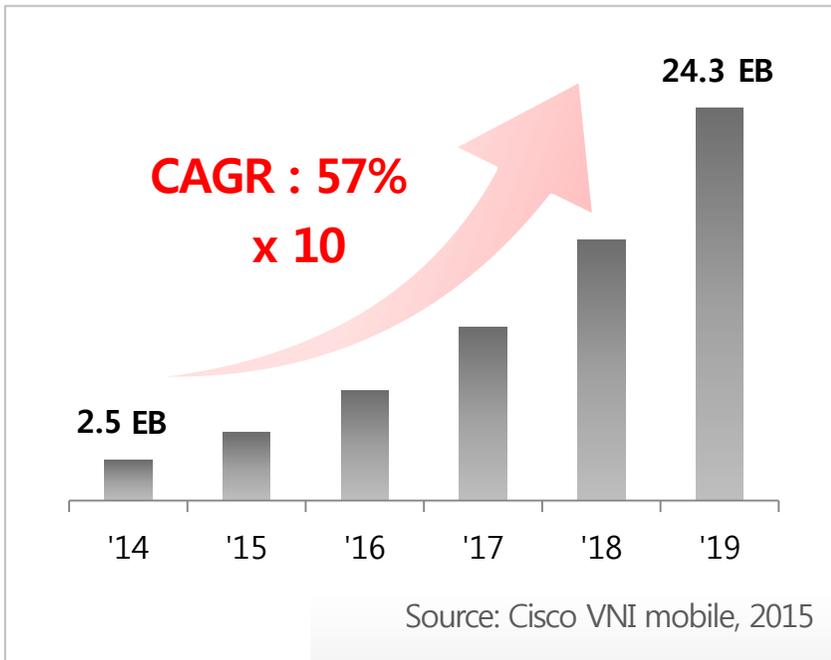
Vision & Priorities for next generation radio technology



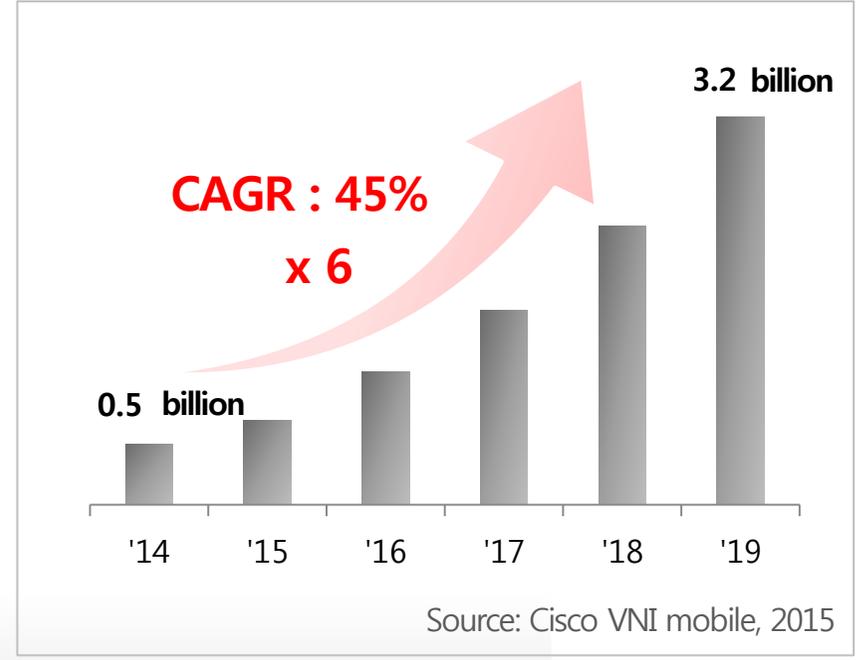
01 Motivation/Early Drivers for 5G (1/2)

Explosive increment of data traffic & connected devices

Mobile data traffic per month



Billions of M2M connections

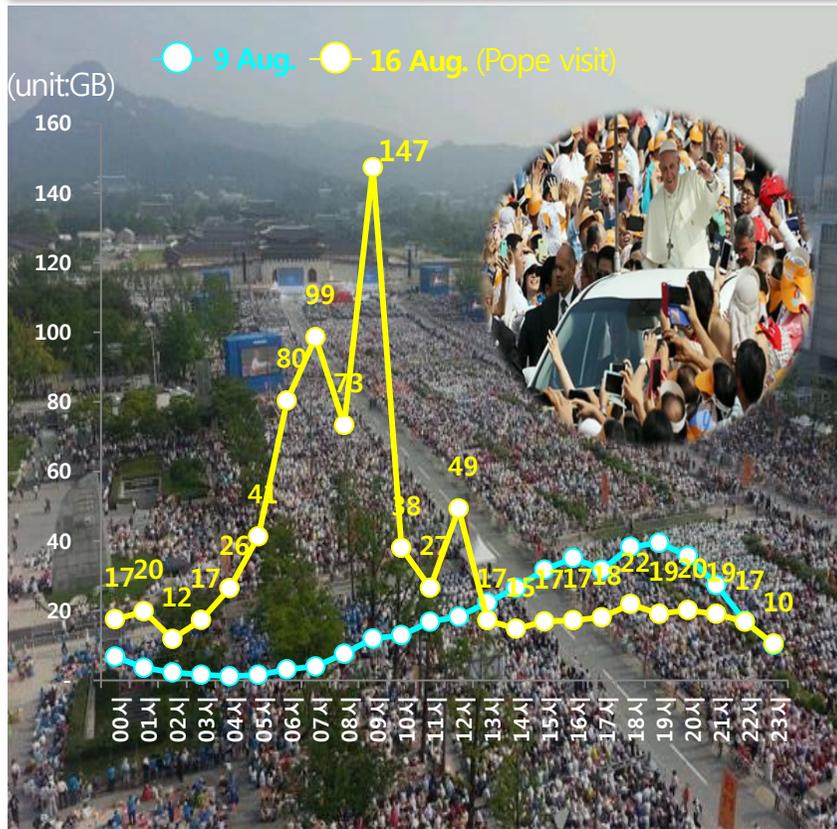


LTE penetration rate already over 70%!!!

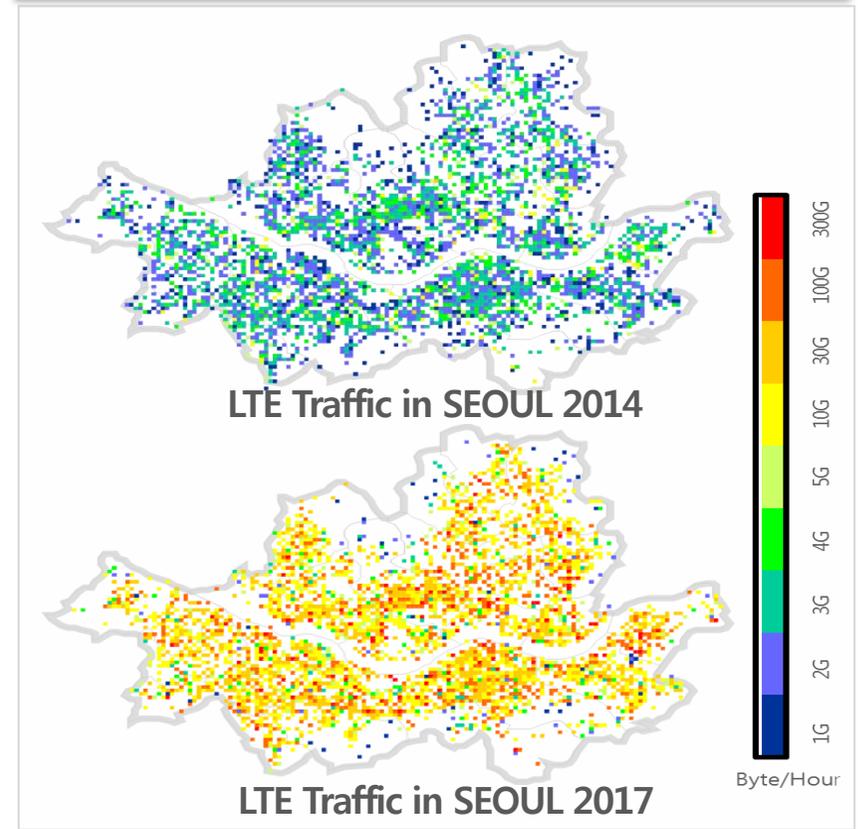
01 Motivation/Early Drivers for 5G (2/2)

The traffic in hot spot area is unpredictable and uneven

Traffic in Hot Spot



Traffic forecasting in Seoul



02 New Challenge (2nd Data Big-Bang)

Usage pattern will be changed with the advent of new services and devices

AS-IS

Service

Streaming



Quality

HD



Device

Smartphone



TO-BE

3D / Hologram



UHD



IoT Wearable Devices

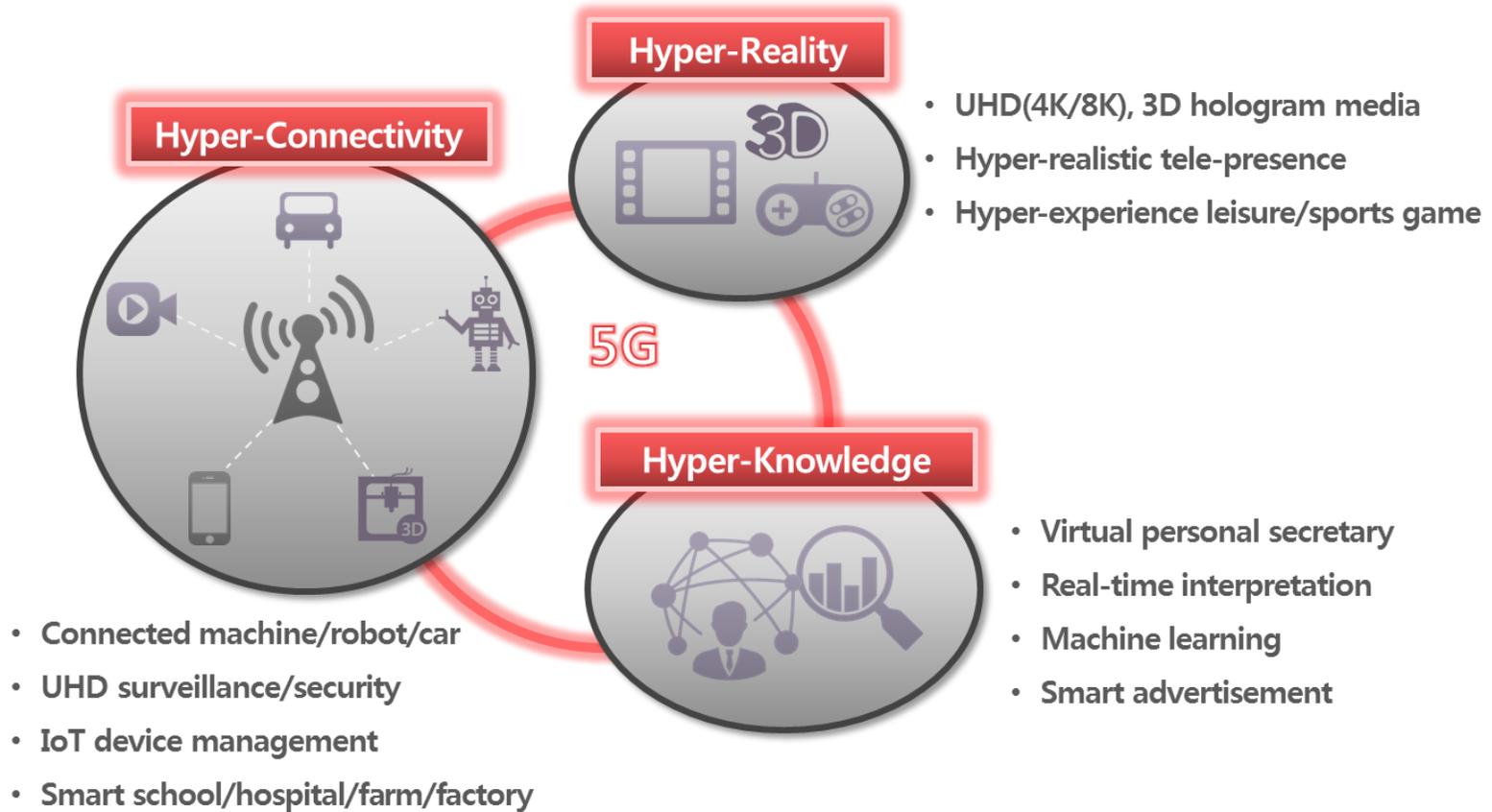


2nd Data Big-Bang



Subscribers demand new services using new technology

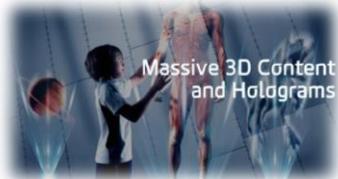
03 Future Mobile Services



- KT expects on-going LTE evolution can cover most of future mobile service
 - However some services need more stringent performance requirements
- ➔ Need to define new radio technology (5G)**

04 Key Requirement of 5G network

- KT agrees with most of ITU-R IMT-2020 requirements
 - We believe several requirements are crucial for new service launching
 - : **Peak Data Rate, Latency, Connection density, User Experience Data Rate**
- KT also wants to emphasize 5G **coverage** should be compatible with LTE



3D & Hologram



Immersive Video

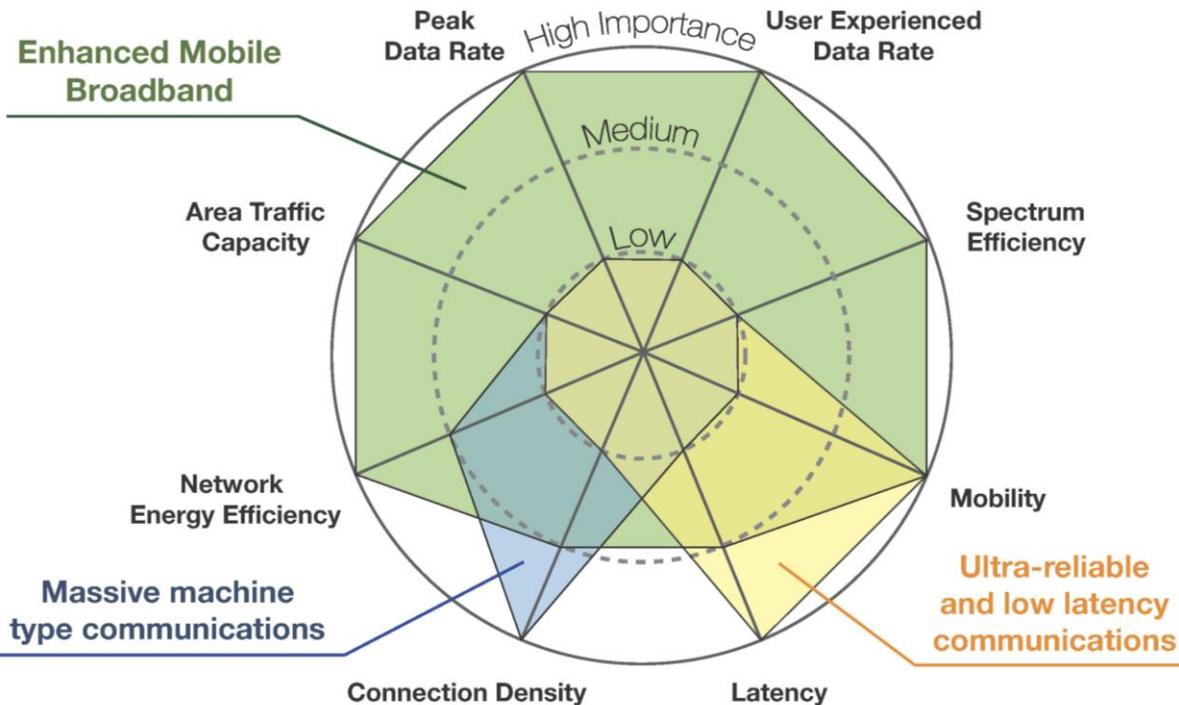


Trillions of Connected Devices

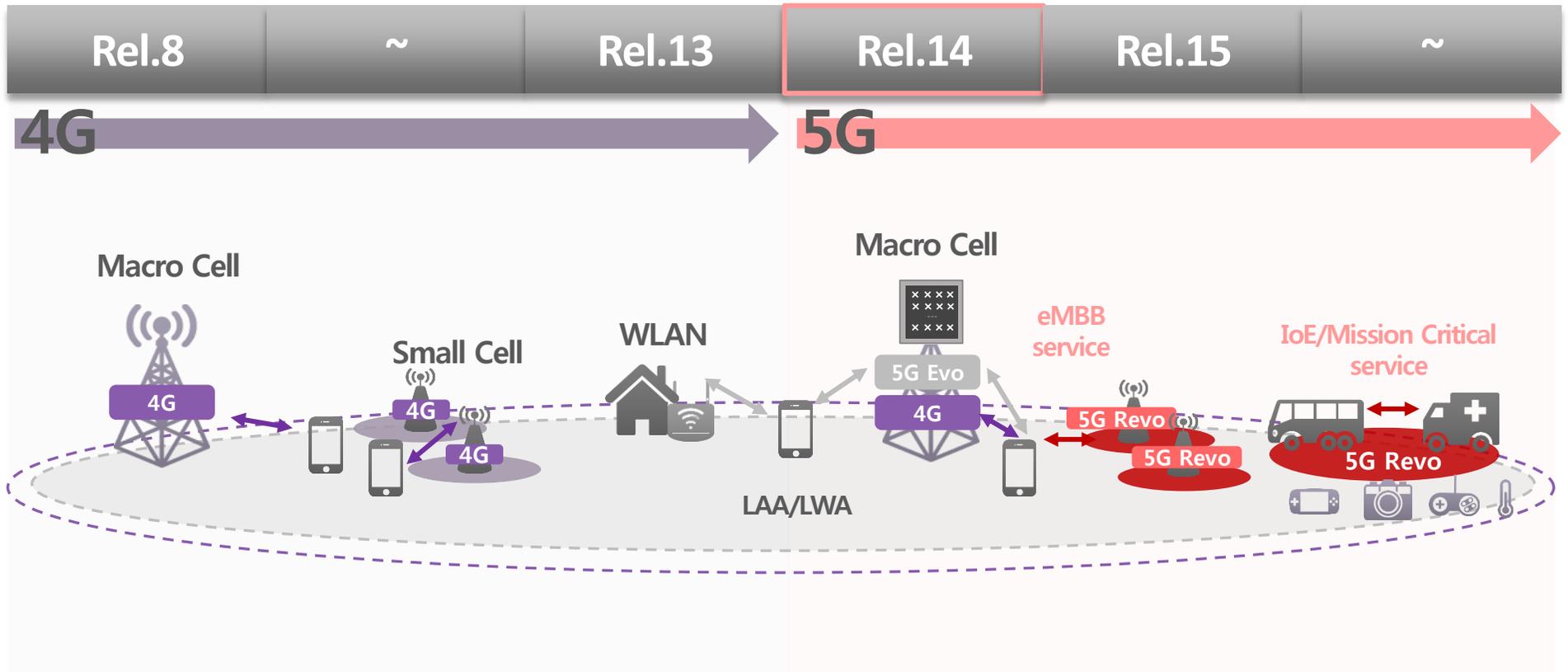
IoT



Self-Driving Car



05 KT Network Evolution to 5G



KT's 5G Network = 5G Evo. + 5G Revo. + WLAN

5G Evo: Evolution of LTE Advanced

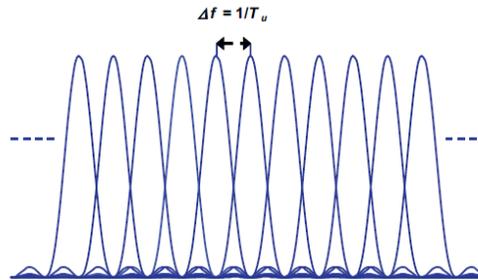
5G Revo: 5G new RAT

06 New Technologies for 5G

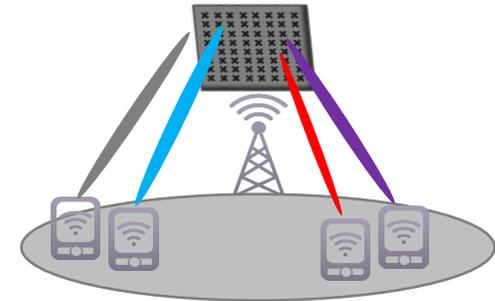
mmWave & Channel Modeling



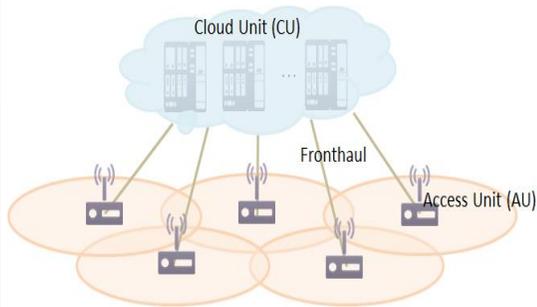
5G New RAT (Waveform)



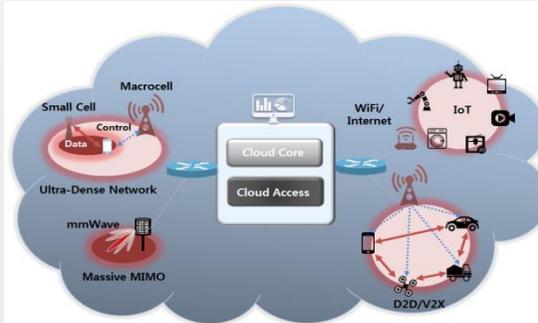
Massive MIMO



Flexible RAN Architecture



Evolution of LTE

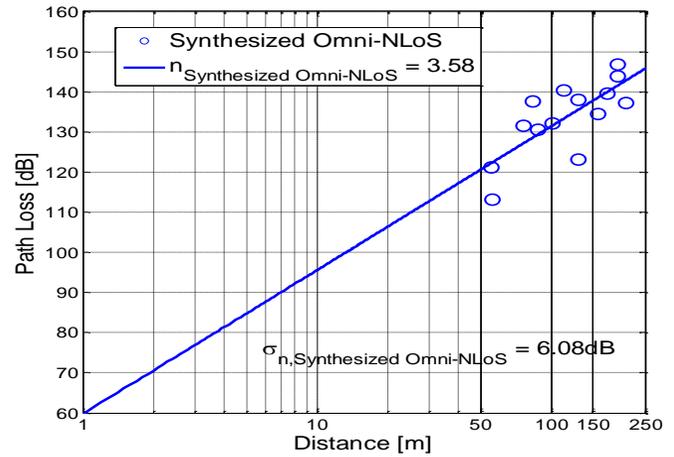
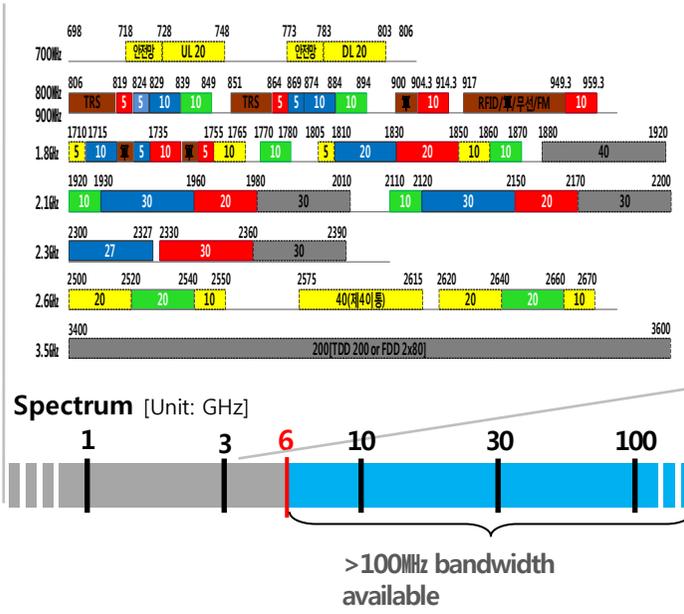


Green Radio



07 mmWave & Channel Modeling

- Not only below 6GHz but also above 6GHz(i.e., mmWave) should be considered for 5G service
 - ITU-R 5G Key capabilities cannot be satisfied with existing Spectrum
 - Ultra wide bandwidth availability, Ultra high speed data rate
- Study on channel model for frequency spectrum above 6 GHz should be finalized in Q2, 2016
 - At least up to 30GHz to be considered in Phase 1 (refer to page 11 on phased approach)
 - First step for spectrum utilization is channel measurement and modeling



08 5G New RAT (Waveform)

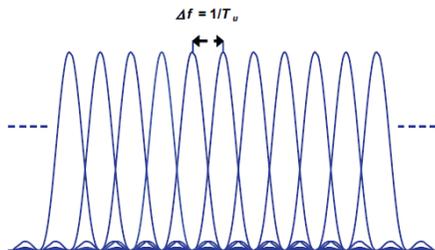
OFDM based new RAT with flexible numerology to be considered



Waveform

OFDM Waveform

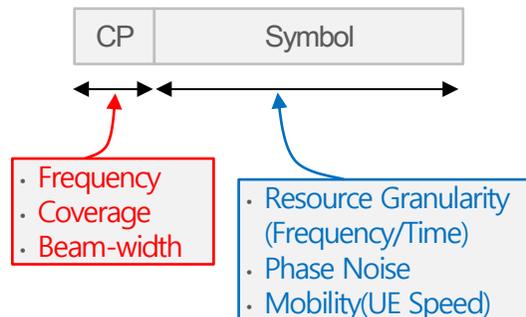
- Matured technology compared to other possible candidates
- Forward Compatibility to be considered
- Low receiver complexity and Latency
- Highly PA efficient single carrier (DFT-OFDM)



Numerology

Flexible OFDM Numerology

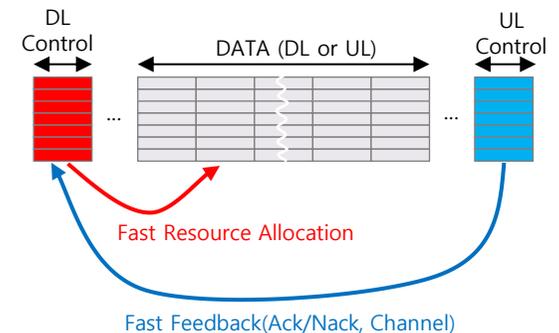
- Flexible bandwidth by scalable number of subcarriers and spacing
- Flexible coverage by adjusting the CP size and BF gain
- Multiple numerologies can be used for different services and deployment scenarios



Frame Structure

Flexible OFDM Frame

- Flexible DL and UL Resource allocation
- Flexible TTIs for 5G services supporting both wide band and narrow band
- Fast DL/UL channel switching and Feedback (Lower HARQ RTT)



08 New RAT: Expected outcomes from 5G releases

- Main priority of 5G RAT study SHOULD be placed on OFDM
 - Technical feasibility of other 'advanced' multi-carrier RAT may not mature quickly enough to support 5G commercialization in 2020
 - OFDM has advantage over other candidates in providing flexible framework to cater for various deployment/service requirements of 5G
- KT recommends 'phased approach' where
 - OFDM-based 5G RAT should be specified first so that commercial-grade 5G service **focusing on enhanced MBB** can be launched in 2020 time frame
 - Other multi-carrier-based RAT may be subsequently considered with the following caveats:
 - 1) Compatibility with OFDM-based RAT can be assured
 - 2) Enhanced suitability for new 5G business drivers such as IoT and Mission Critical applications needs to be justified

RELEASE 14

RELEASE 15

RELEASE 16

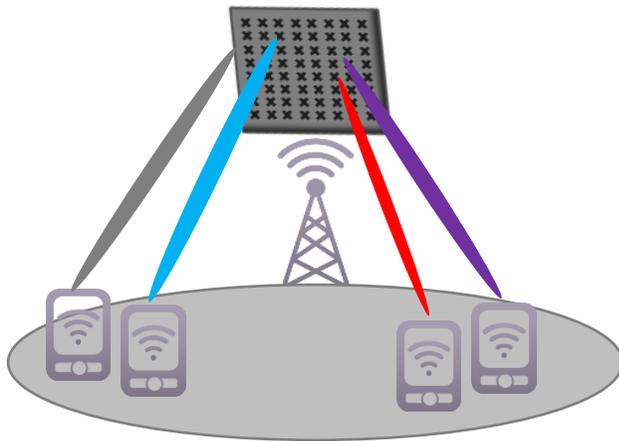
Phase 1: OFDM-based new RAT for enhanced MBB

Phase 2: new RAT for 'full 5G' specification

09 Massive MIMO for coverage enhancement

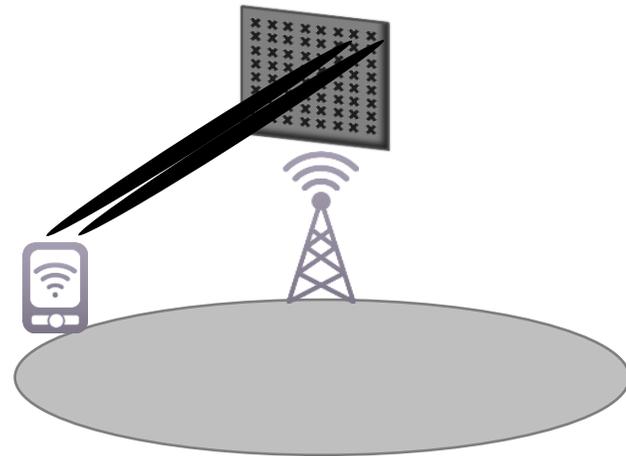
Flexible Massive MIMO Antenna Design

< 6GHz (Multi-stream)



- Spatial multiplexing
 - Improve spectrum efficiency

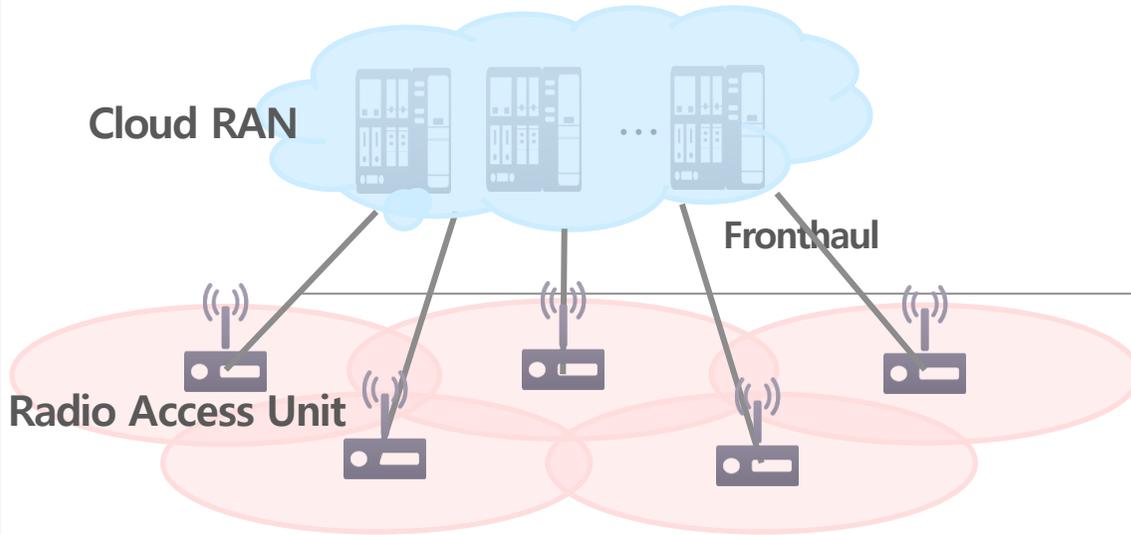
> 6GHz (Narrow beamforming)



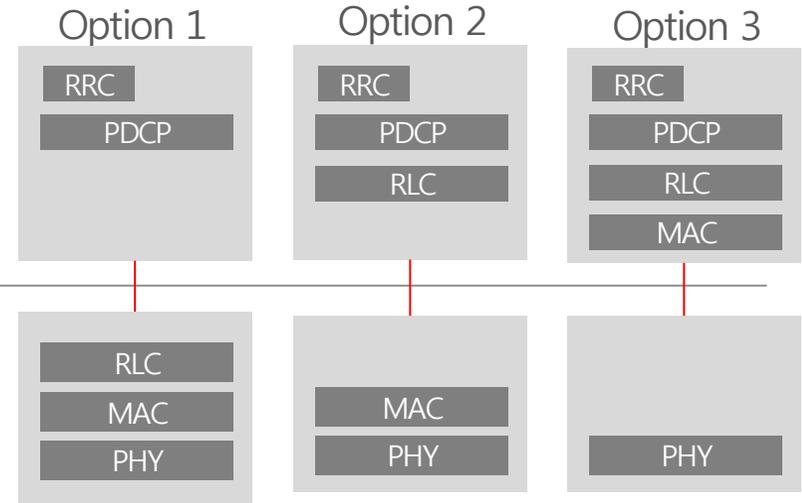
- UE specific beamforming
 - Extend cell range by beamforming gain

- Massive MIMO using large number of antenna elements in small cell
 - Provide different scheme (high data rate, coverage extension) by frequency bands
 - Control antenna elements for dynamic Massive MIMO

10 Flexible RAN Architecture for 5G



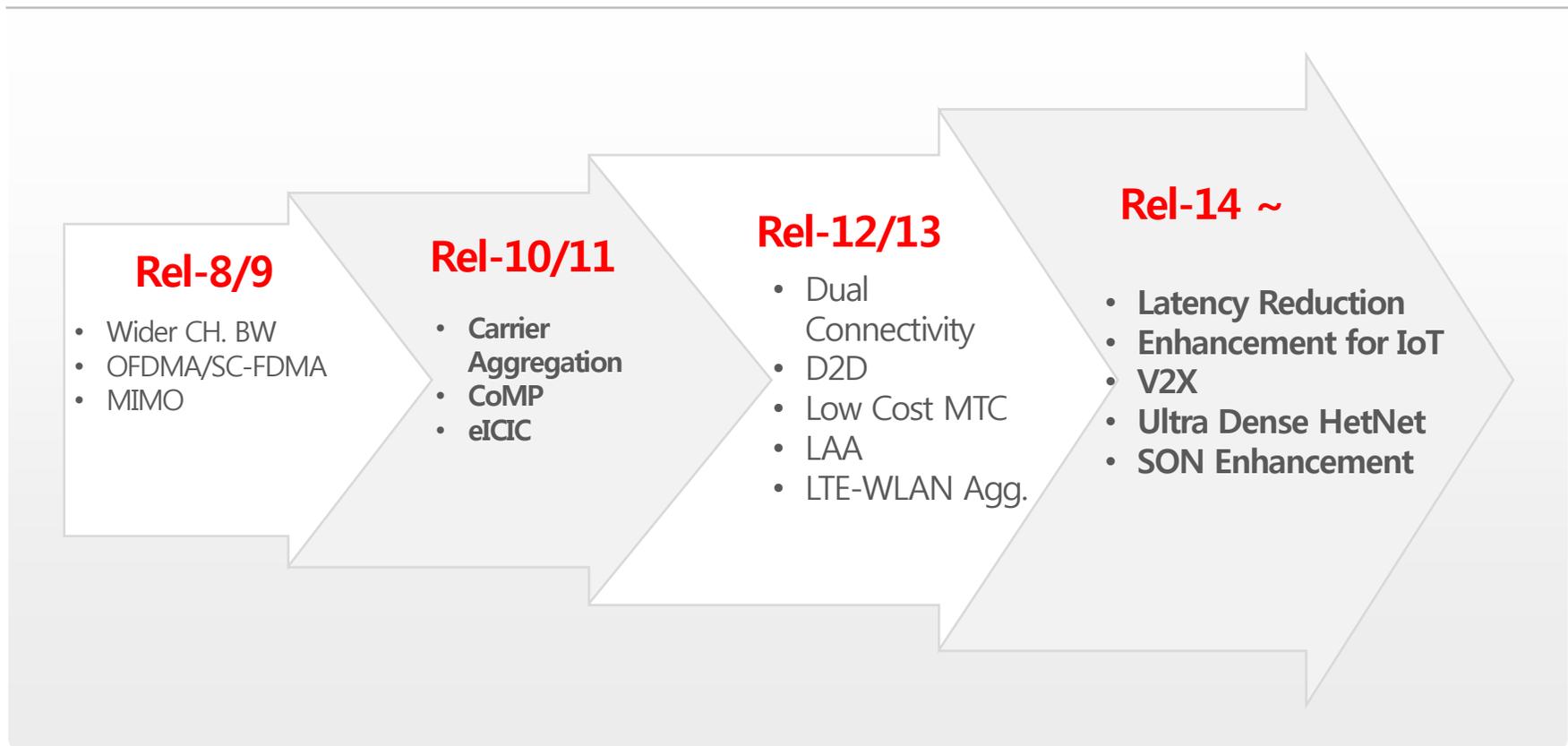
Examples for 5G RAN Architecture



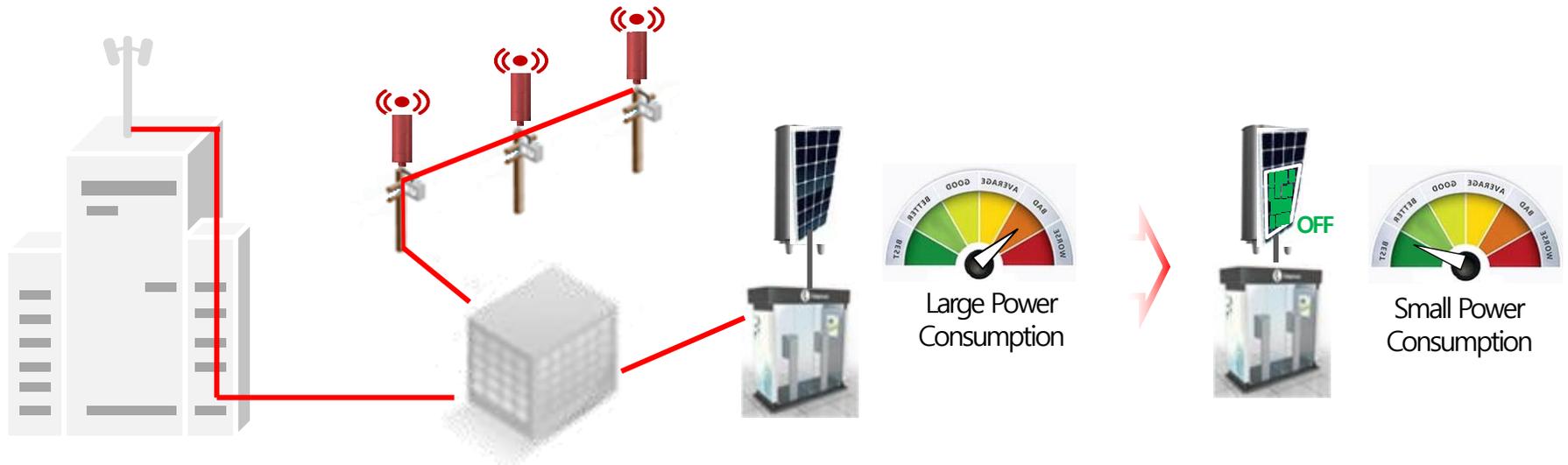
- **Software-Centric Network Architecture** for efficient support of 5G future mobile services
- **Some parts of RAN functions could also be clouded with the following virtualization gain:**
 - Lower expansion/maintenance cost
 - Centralized processing between multiple cells
- **Study on New RAN Architecture is needed for 5G, taking into account**
 - Tradeoff between virtualization gain and fronthaul capacity
 - Efficient interworking between 4G, 5G, and WLAN

11 Evolution of LTE

- LTE will still play important role in the future
- Below are the key technologies where further enhancement should be made

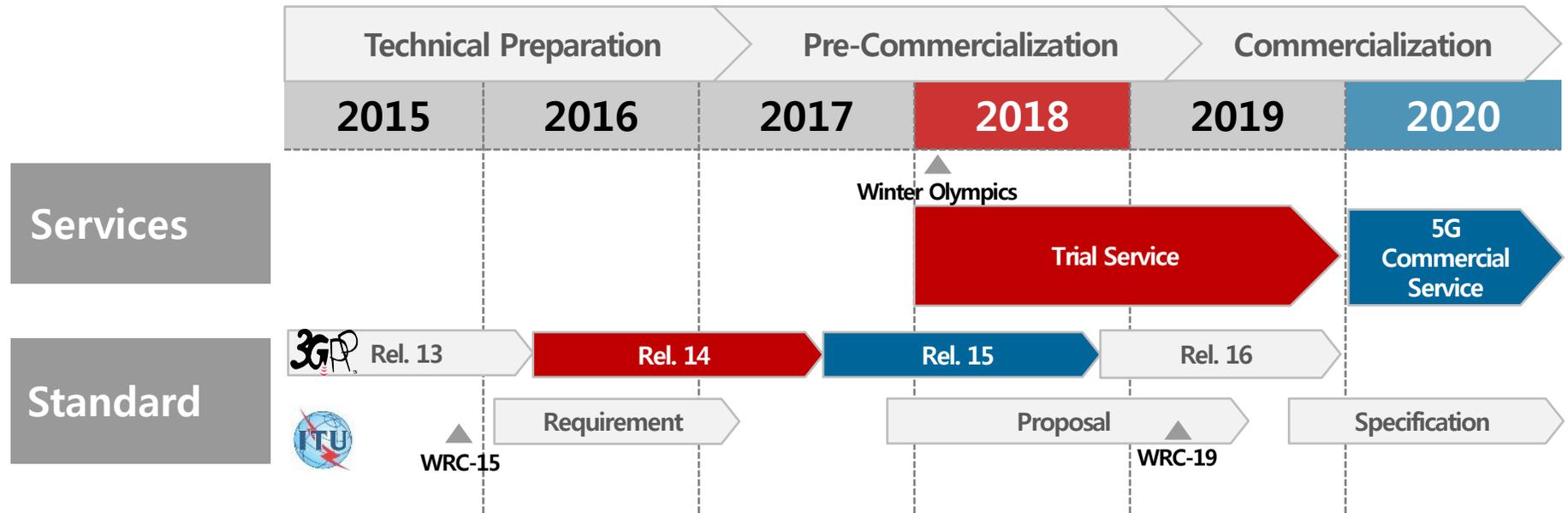


12 Green Radio



- **Energy Efficiency is one of ITU-R's key capability for 5G**
- **Operators facing heavy challenge to reduce operational cost**
 - 5G basestation faces great challenge utilizing mmWave to cover the same area
 - More basestations need to be deployed compared to legacy LTE for the same coverage
- **Study on Green Radio needs to be considered**
 - Less power consumption for both basestation and UE
 - Improvement on carbon discharge also needs to be considered

13 Proposed Timeline for 5G



- KT proposes **15 months per Release** schedule in order to launch **5G commercial service on 2020**
- Rel-14 → SI, Rel-15 → WI, Rel-16 → Enhancement
- Below are several valid reasons for this consideration:
 - ① KT plans trial service starting in 2018 PyeongChang Winter Olympics leading to 5G commercial service in 2020
 - ② Operator needs to verify and deploy technology based on Rel-15
 - ③ Proven standard should be Rel-16 and this should be submitted to ITU
 - ④ Considering Rel-8 and Rel-9, operator needs to have at least one release for enhancements

14 Conclusion & Way Forward

5 Key Remarks



- 1 15 month per Release is **STRONGLY** recommended
- 2 Essential to complete study on mmWave Channel Modeling by Q2, 2016
- 3 Phase 1 to focus on eMBB at least up to 30GHz and 'Full 5G' to be standardized in Phase 2
- 4 Suggest to operate parallel sessions between 5G and legacy (UTRA, E-UTRA) in WG meetings
- 5 KT will start 5G trial service based on Rel-14 in 2018 leading to full commercial service in 2020

Thank you

