



RWS-120020

# Efficient Spectrum Resource Usage for Next-generation N/W

3GPP Workshop on Rel.-12 and onwards  
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## **I . Introduction**

## **II. Backgrounds**

## **III. Requirements for next-generation N/W**

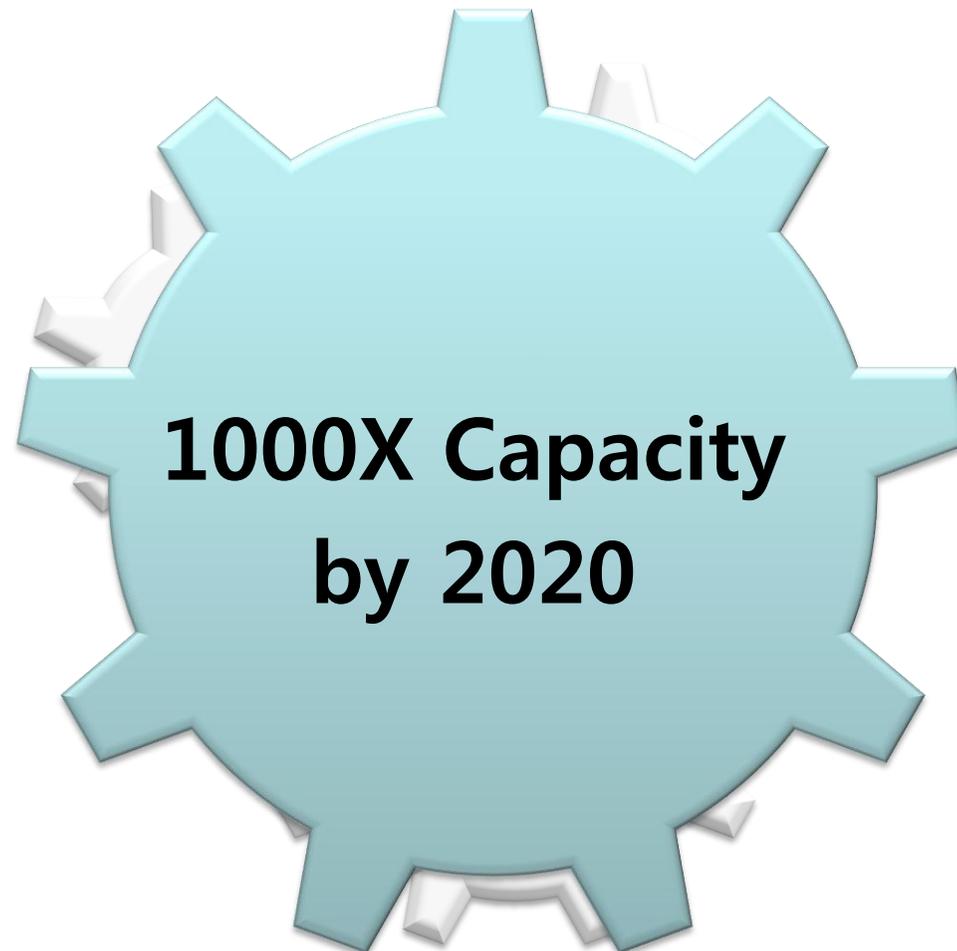
## **IV. Conclusion**

Data traffic explosion will be more severe in near-future, which results in decoupling between revenue and data traffic.

Korean government has announced “Mobile Broadband Plan” to manage this trend.

However, there will be still insufficient spectrum to deal with data burst.

Therefore, operators will need how to efficiently use the limited spectrum.



**South Korea has emerged as a testbed for smart and new technology of LTE network, as it has a world-class ICT industry and is always first to adopt high technology.**

## Majority of South Koreans using LTE networks by 2014

- “South Korea is set to be the world’s first major mobile market to migrate the majority of its subscribers to LTE networks - with over half of the country’s users forecast to be using the next-generation networks within two years.”
- “The pace of LTE migration in South Korea will surpass neighbouring Japan, and could occur twice as fast as in Western Europe.”

### **Wireless Intelligence:** Majority of South Koreans using LTE networks by 2014

South Korea on track to hit 40 million LTE connections within four years

Joos Gillet, published Thursday January 12 2012

South Korea is set to be the world’s first major mobile market to migrate the majority of its subscribers to LTE networks - with over half of the country’s users forecast to be using the next-generation networks within two years.

Based on analysis of earlier technology migrations in the country, Wireless Intelligence forecasts that it will take around 35 months on average for the three South Korean operators to migrate at least 50 percent of their respective subscribers to LTE. Market-leader SK Telecom and third-placed LG UPlus launched LTE in July 2011, while second-placed KT switched on LTE last week. All three operators should achieve nationwide LTE coverage by mid-2012 with Voice-over-LTE (VoLTE) expected to be introduced in the second half of the year.

## Tech: Demand for 4G LTE Smartphones Heats Up in South Korea

- “Last year, over four in five mobile phones purchased were smartphones, making us a nation with one of the fastest rates of adoption and highest levels of penetration in the world.”
- “As the country (South Korea) continues in its quest to achieve full LTE coverage and migrating users to LTE networks, we can foresee competition to further heat up, as well as anticipate lots of interesting developments and exciting trends emerging in the Korean telecommunications market,”



### Tech: Demand for 4G LTE Smartphones Heats Up in South Korea

by ADMIN on Mar 19, 2012 • 3:48 pm

“With the country’s high internet connectivity, users have a more compelling reason to upgrade their telecommunication device from the basic feature phone to the more advanced smartphone,” said Moongen Kwon, General Manager of GfK Korea. “Last year, over four in five mobile phones purchased were smartphones, making us a nation with one of the fastest rates of adoption and highest levels of penetration in the world.”

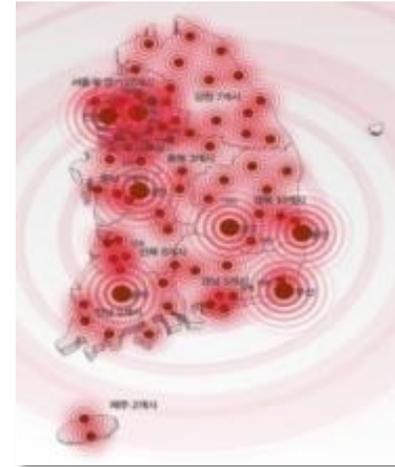
SKT is leading the LTE market from a rapid increase in the number of LTE subscribers, which has firstly reached two million in Korea. and Differentiated customers' experience is accelerating spread of LTE services in Korea.

## ■ LTE subscribers of SKT surpassed 2 million (May 2012 : 2.88 million)

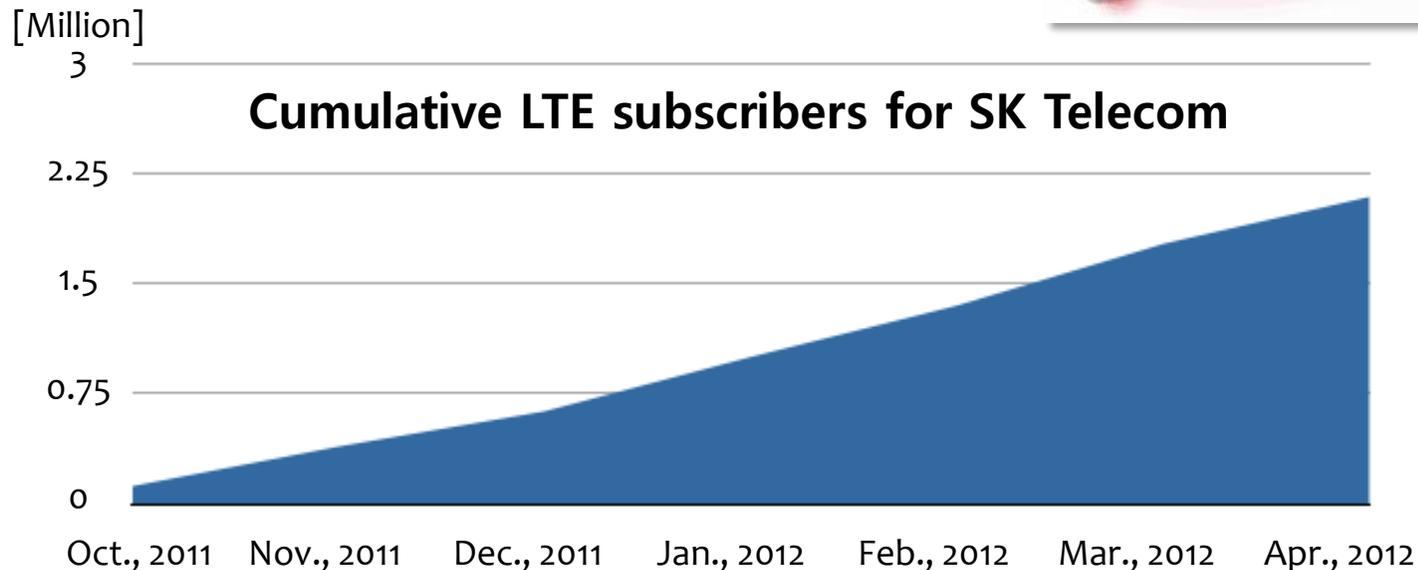
- World's third largest LTE subscriber base
- "Best Mobile Carrier" at Telecom Asia Awards 2012

## ■ Rapid spread of LTE services

- High data speed compared to 3G services
- Differentiated experience to customers



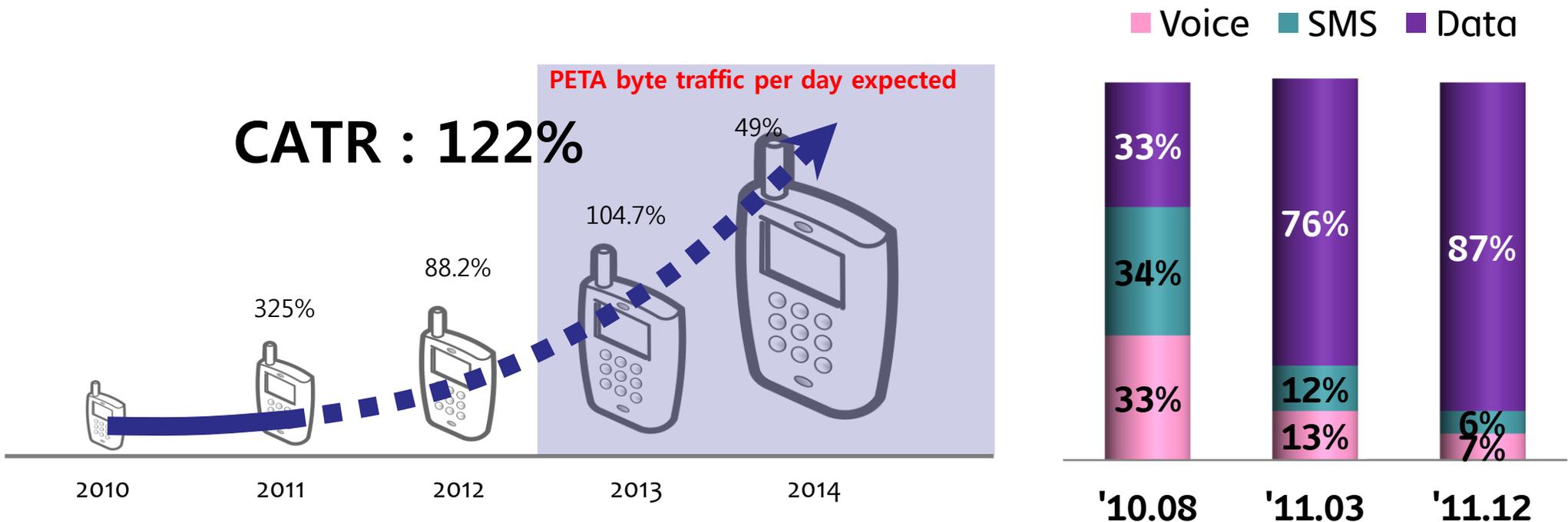
- All cities(84 cities) and high data traffic areas
- 95%\* Coverage (\* Population Coverage)



## II. Backgrounds

Data traffic explosion will be more severe in near-future, which results in decoupling between revenue and data traffic.

 SKT data traffic (toward PETA byte traffic per day)

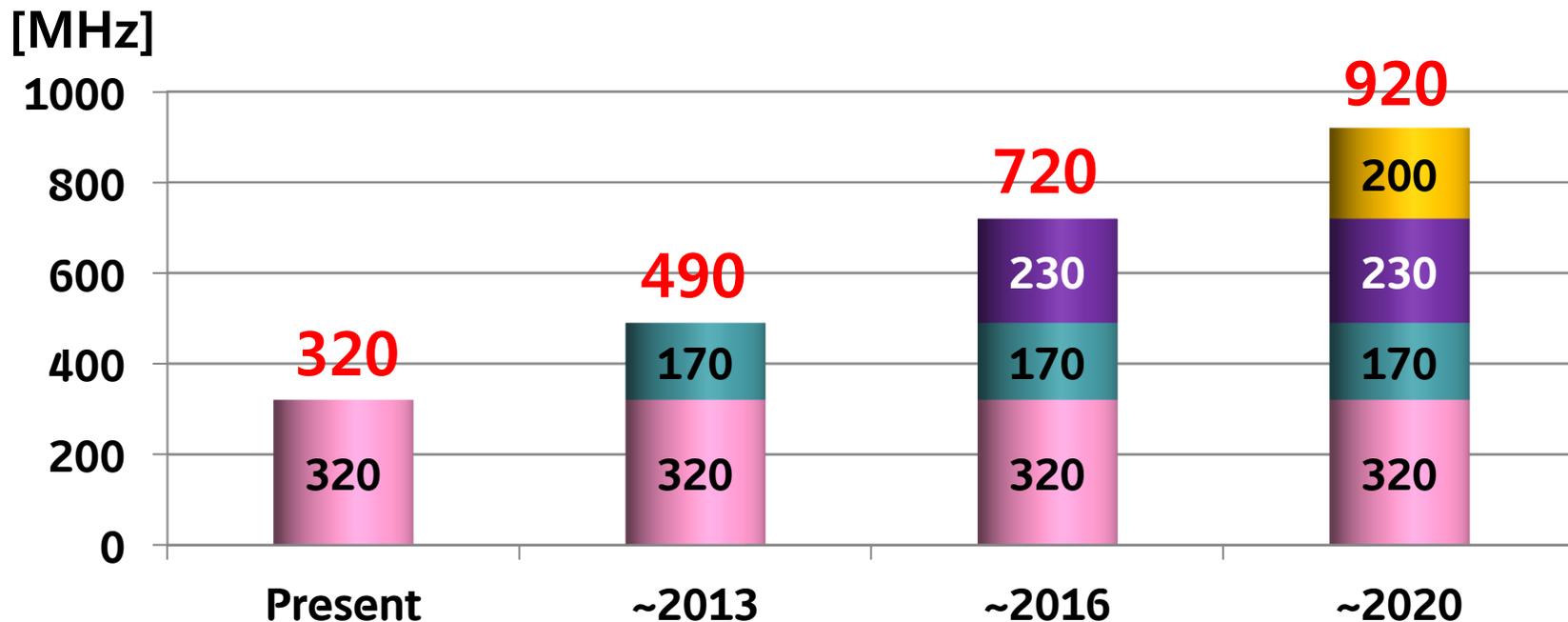


 Insufficient spectrum resource (Present bandwidth for mobile comm. : 320MHz)

According to 「Mobile Broadband Plan」,  
Korean government will provide new spectrum resources  
more than 600MHz to mobile communications until 2020.

 Mobile broadband plan (Additional bandwidth for mobile comm. : 600MHz)

Timeline	Phase 1 (~'13)	Phase 2 (~'16)	Phase 3 (~'20)
Band (Bandwidth)	700MHz (40MHz)	2.6GHz (30MHz)	Additional band (200MHz)
	1.8GHz (70MHz)	2GHz (40MHz)	
	2.1GHz (60MHz)	3.5GHz (160MHz)	
Total	<b>170MHz</b>	<b>230MHz</b>	<b>200MHz</b>

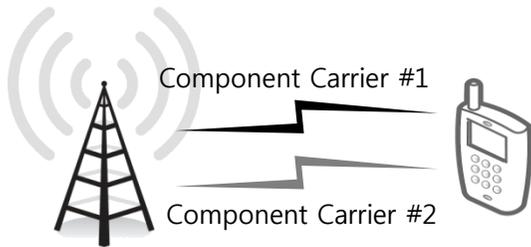


# III. Requirements for next-generation N/W

For the next-generation mobile communications, there are three key performance factors.

## Bandwidth (3X)

- Acquisition of new spectrum resources
- Carrier Aggregation
- Cognitive Radio



[Carrier Aggregation]

## Resource Reuse (56X)

- Small cell
- Hybrid N/W



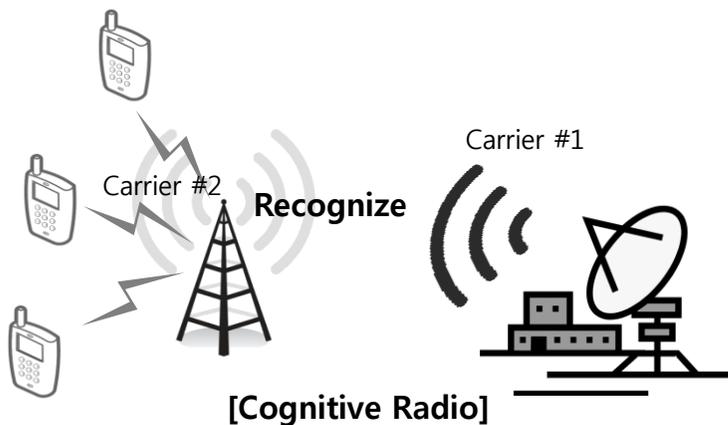
[Small Cell Deployment]

## Spectral Efficiency (6X)

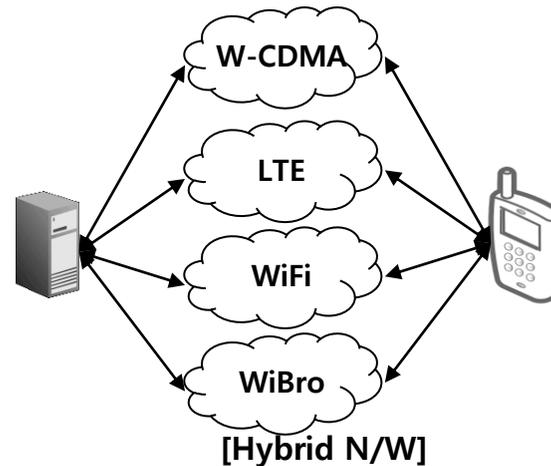
- Active Array Antenna
- High order MIMO
- Tx / Rx cooperation



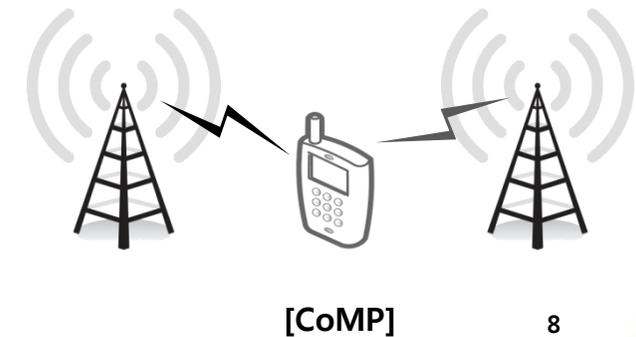
[Higher order MIMO]



[Cognitive Radio]



[Hybrid N/W]

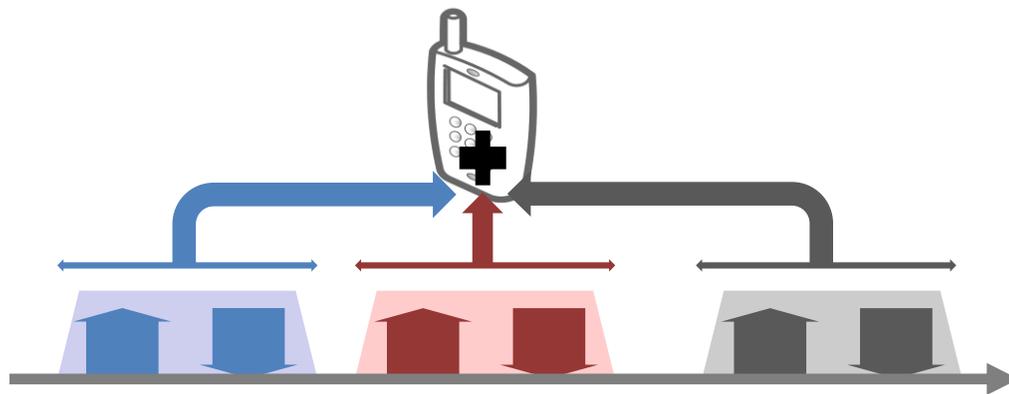


[CoMP]

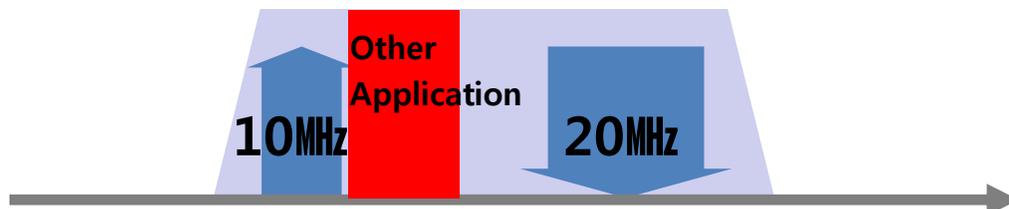
Fragmented bands in “Mobile Broadband Plan” and spectrum demand from other applications require efficient spectrum techniques

## Bandwidth (3X)

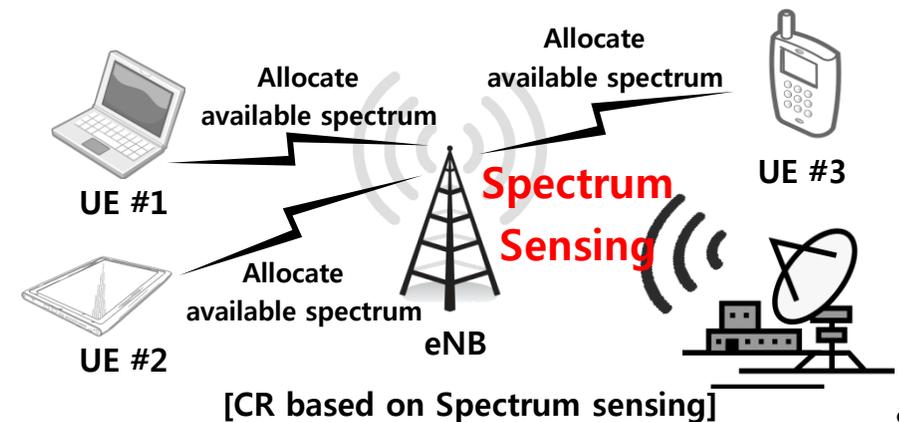
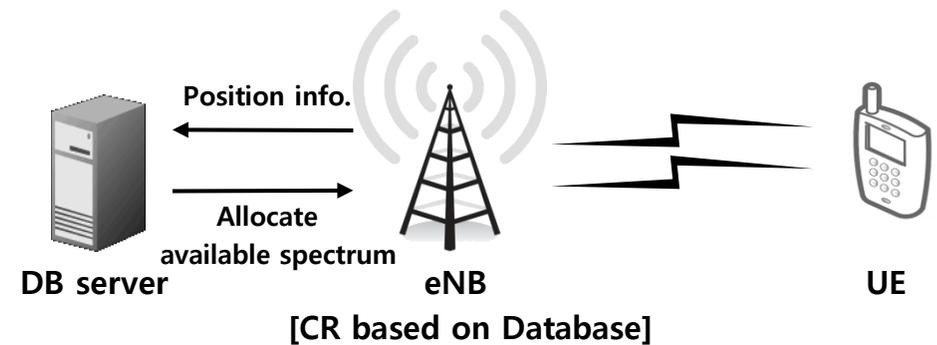
- Carrier Aggregation more than 2 component carriers (850M+1.8G+(700M, 2.1G S-band and etc.))
- Asymmetric Deployment
- Cognitive Radio : frequency sharing between mobile comm. and other applications



[3 CC Carrier Aggregation]



[Asymmetric Deployment]



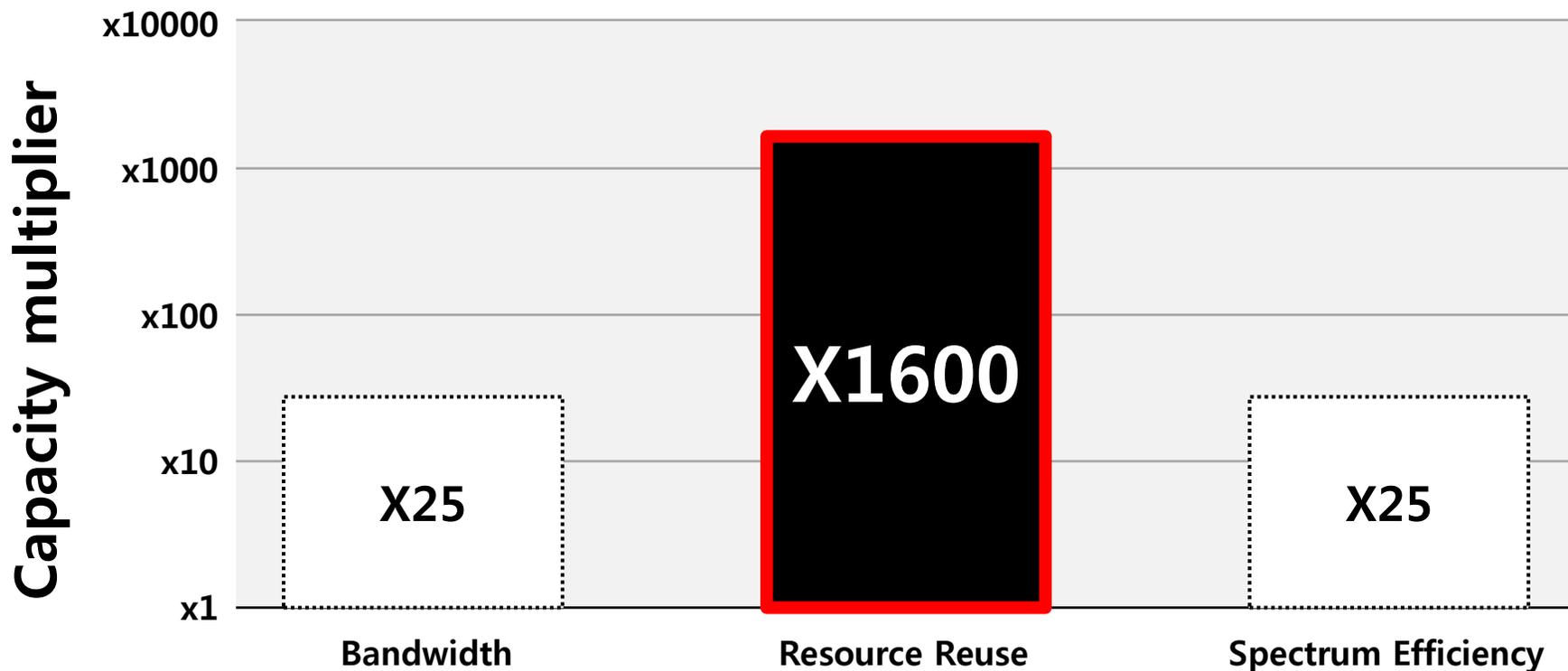
### III. Requirements for next-generation N/W

The most efficient way for mobile network has been resource reuse so far.

#### Resource Reuse (56X)

- Cooper's law : the data rate available to a wireless device doubles roughly every 30 months
- The most efficient spectrum resource usage

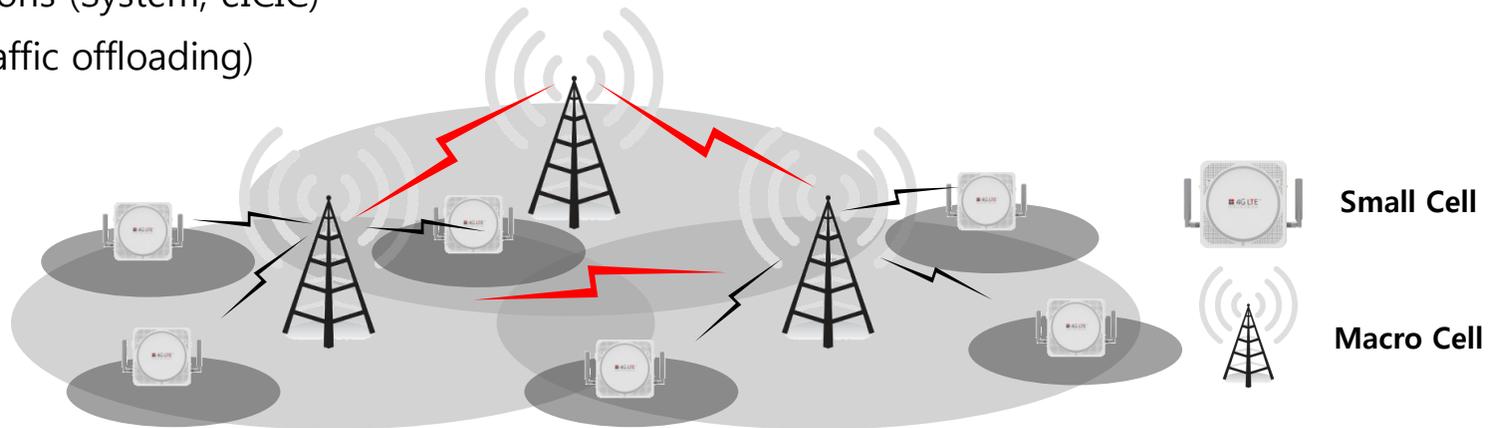
### Capacity increases 1,000,000 times since 1955



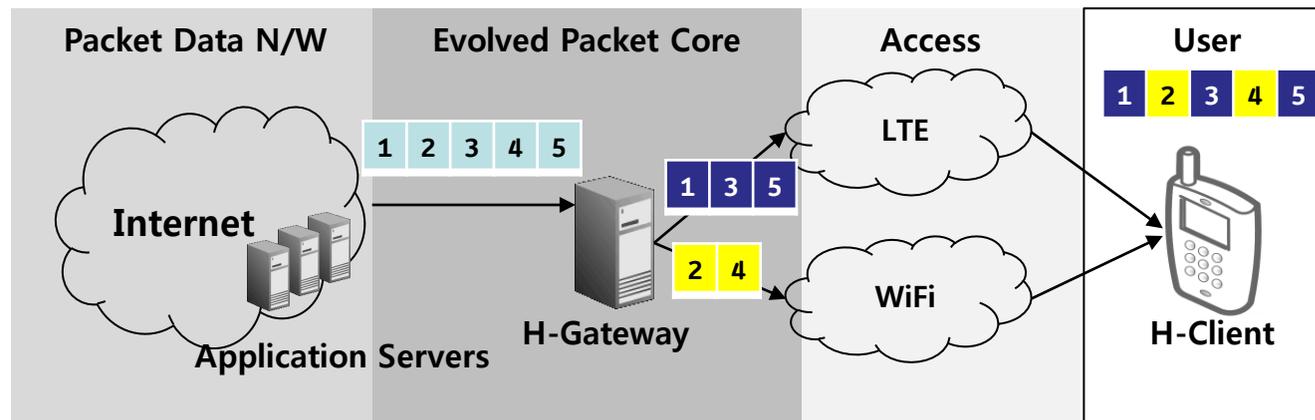
Resource reuse, such as smaller cell deployment, will keep being the most powerful way to improve N/W capacity.

#### Resource Reuse (56X)

- Small cell solutions (System, eICIC)
- Hybrid N/W (Traffic offloading)



[Small cell solution deployment]



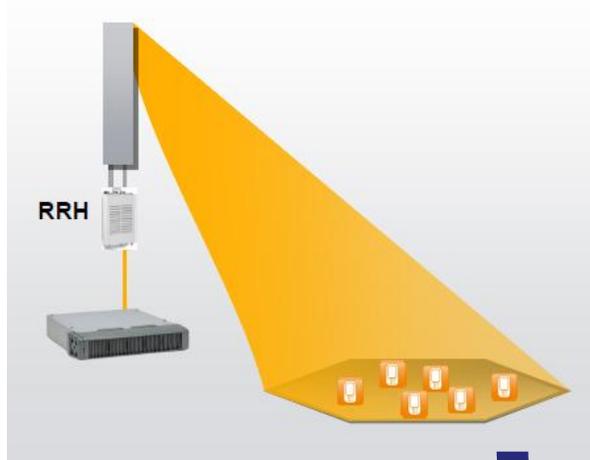
[Hybrid N/W]

From link-budget perspective, LTE already achieves spectral efficiency close to Shannon's limit. Though some link improvements are possible, SINR should be improved to speed up data rates

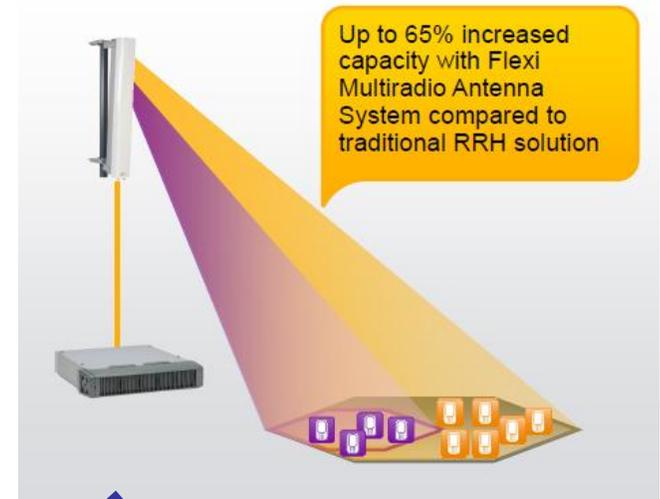
## Spectral Efficiency (6X)

- Active Array Antenna
- Massive MIMO
- Tx / Rx cooperation

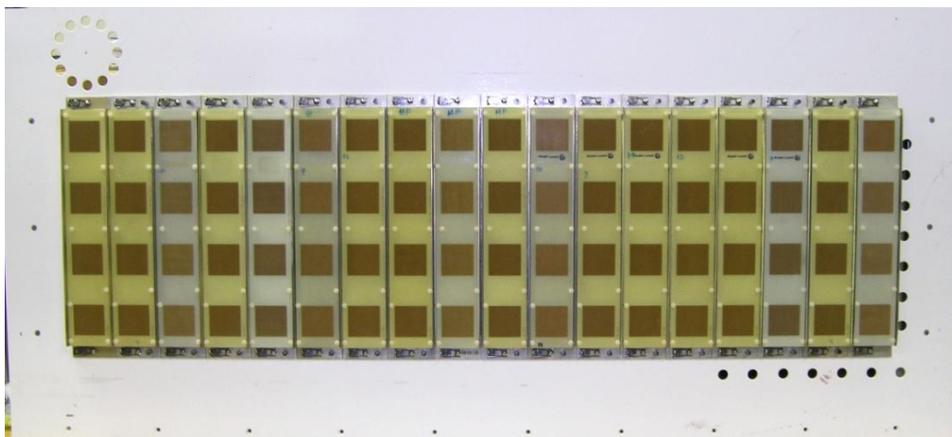
Traditional RRH\* with classic radiation pattern



Active antenna with vertical beamforming

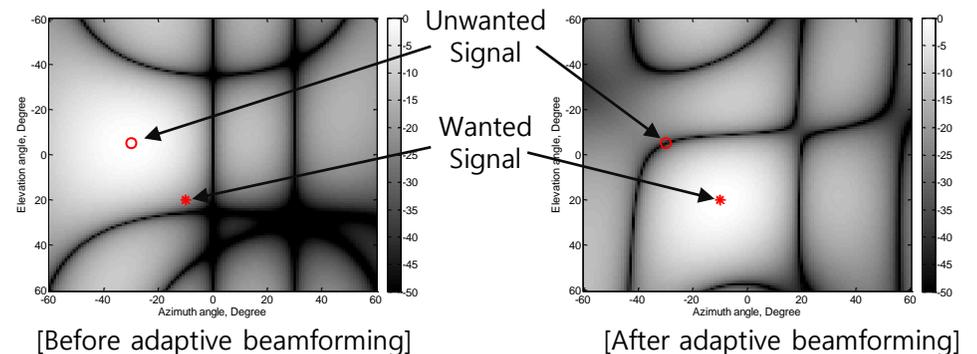


[source] Nokia Siemens Networks



[Massive MIMO]

[source] Dan Kilper, "GreenTouch Consortium: Building the Roadmap"



[Beamforming using AAA]

- ■ South Korea is densely populated and very fast high-tech adapted  
So it can be test-bed for verifying next-generation N/W.
- ■ “Mobile Broadband Plan” was announced to provide 600MHz spectrum  
to mobile communications until 2020.
- ■ The next-generation N/W techniques should increase N/W capacity  
by 1000 times. (bandwidth : 3X, resource reuse : 56X, spectral efficiency : 6X)

***Thank you. Any question?***