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Title	**Repeater issues for MBWA**	
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Re:	MBWA Call for Contributions	
Abstract	This contributions investigates issues on a repeater for MBWA with an operator's point of view.	
Purpose	For Your Information	
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Repeater issues for MBWA

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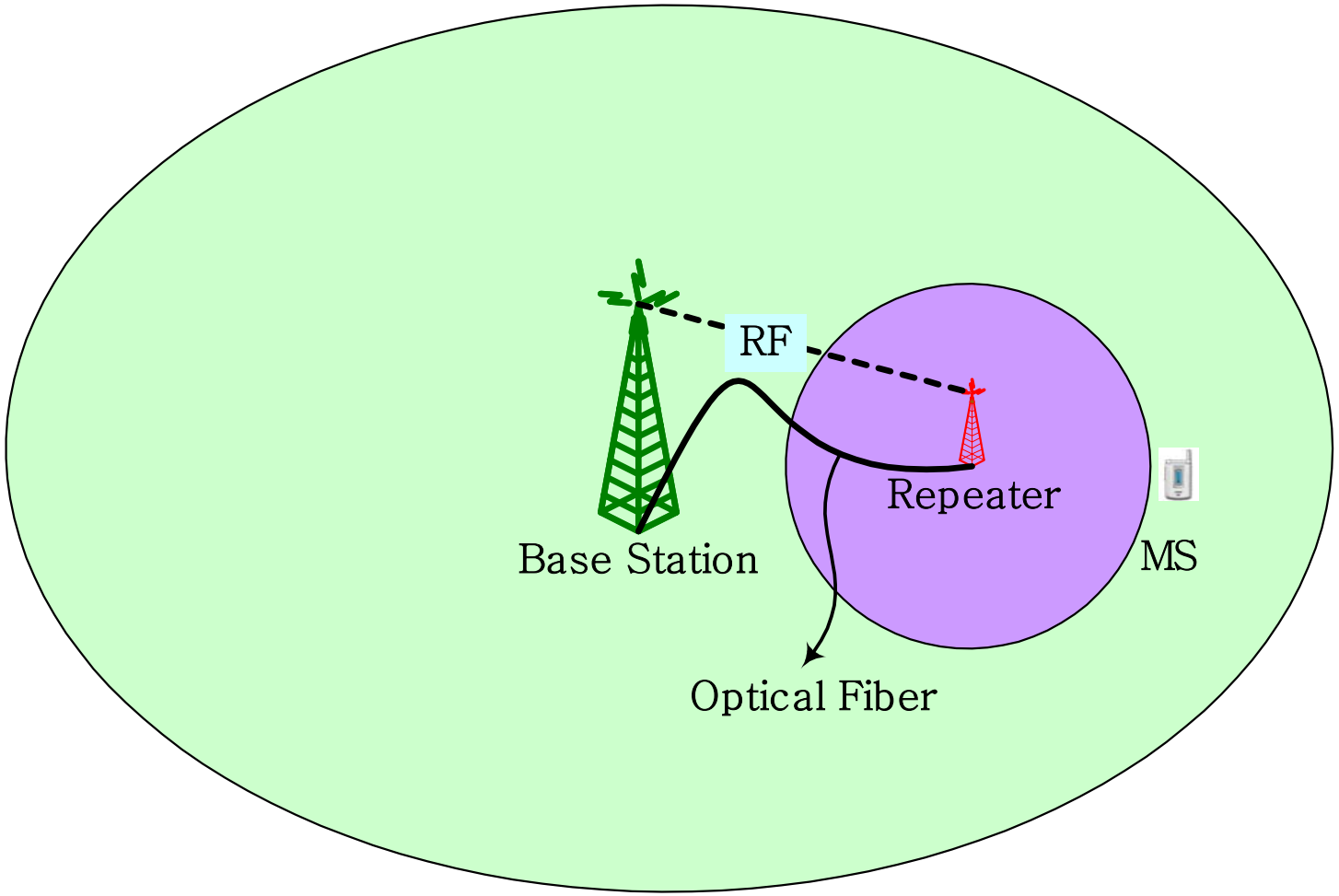
Introduction to Repeater

- **We need repeaters in order to**
  - **Extend cell coverage.**
  - **Remove holes such as in-building and underground within a cell coverage.**
- **We can reduce the RAN deployment cost**
  - **We can acquire wide coverage with low cost.**
- **Types of a repeater**
  - **Optical Repeater : Optical fiber is used between BS and repeater.**
  - **RF Repeater : RF is used between BS and repeater.**

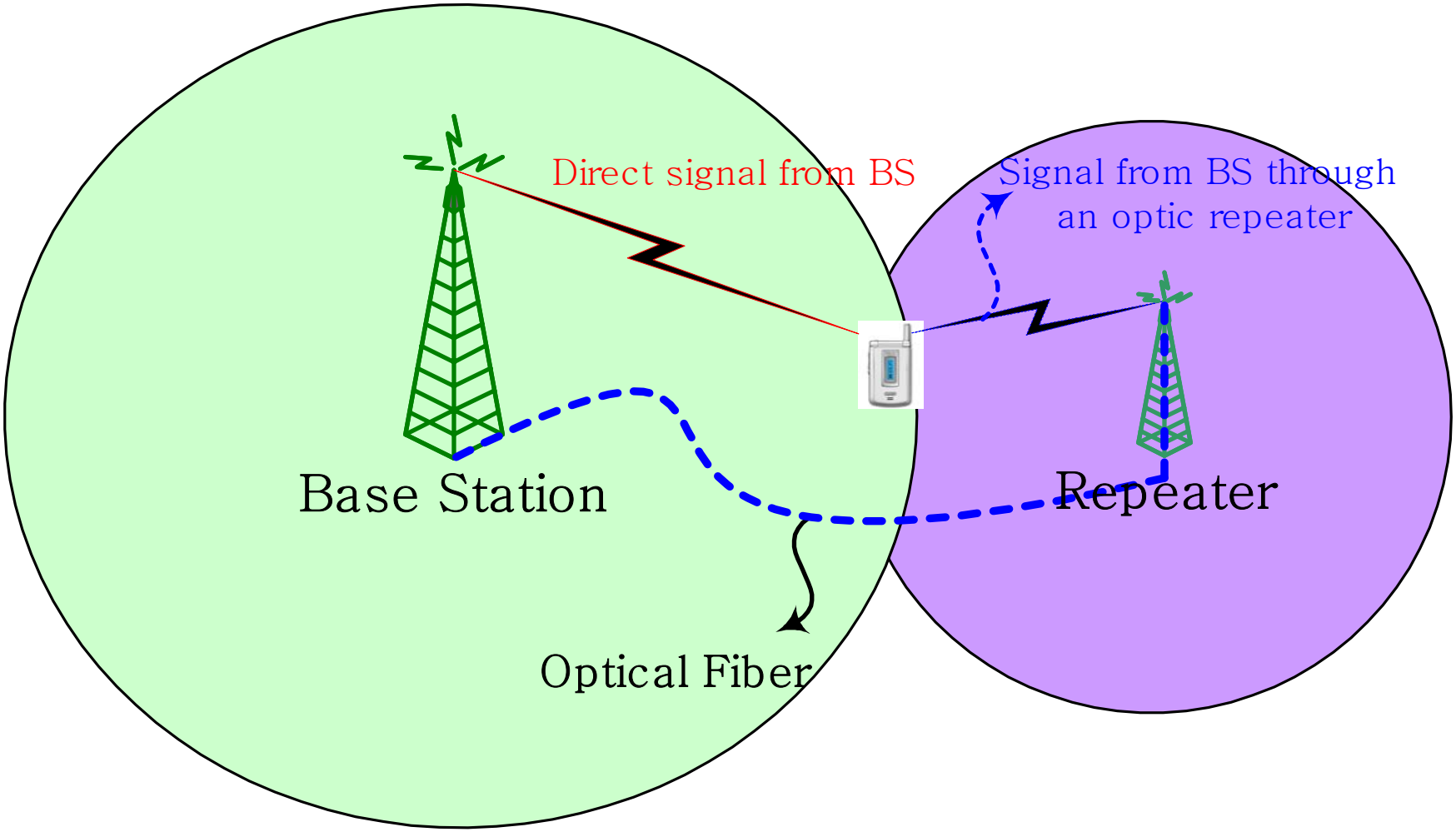
Repeater Deploy Scenario I

- **Repeater for holes within a cell**



Repeater Deploy Scenario II

- **Repeater for enhancing coverage**



Statistics for repeaters

- **Total number of BSs and Repeaters deployed in Seoul, Korea.**

Type		Total number
Base Station		**309**
Repeater	**For coverage**	380
	For holes	9326
	Subtotal	**9706**

Propagation Delay from repeaters

- **This is most serious for optic fiber repeaters enhancing coverage.**
- **We can't lay straight optic fiber from BS and repeaters.**
- **Propagation speed within optic fiber is slower (2e8m/sec)**

Propagation Delay from repeaters (Cont)

- **For example : Case I**
  - **Cell coverage size = 1000m, Repeater coverage size = 500m**
  - **The length of optic fiber between BS and Repeaer = 1500m (In real system, this is impossible)**
  - **The delay introduced by repeater RF elements = 5usec**
  - **The additional delay from repeater**

$$\left(\frac{1500m}{2\times10^{8} m/s} + \frac{500m}{3\times10^{8} m/s} + 5\mu\sec \right) - \frac{1000m}{3\times10^{8} m/s} = 10.8\mu\sec$$

Optic fiber propagation delay from BS and to an optic fiber repeater

Propagation delay from an optic repeater to MS

Propagation delay from BS to MS without repeaters

Propagation Delay from repeaters (Cont)

- **For example : Case II**
  - **Cell coverage size = 3000m, Repeater coverage size = 1000m**
  - **The length of optic fiber between BS and Repeater = 6000m**
  - **The delay introduced by repeater RF elements = 5usec**
  - **The additional delay from repeater**

$$\left(\frac{6000m}{2\times10^{8} m/s} + \frac{1000m}{3\times10^{8} m/s} + 5\mu\sec \right) - \frac{3000m}{3\times10^{8} m/s} = 28.3\mu\sec$$

Optic fiber propagation delay from BS and to an optic fiber repeater

Propagation delay from an optic repeater to MS

Propagation delay from BS to MS without repeaters

Additional delay from Repeaters

- **Additional propagation delay from repeaters**
- **This issue is applied to all systems.**
- **If a system can't compensate additional delay spread produced by repeaters, performance will seriously deteriorate.**

Repeater and OFDM

- **To eliminate ISI (InterSymbol Interference), Guard Interval is introduced for each OFDM symbol.**
- **Additional delay from repeaters should be taken into consideration for guard interval design.**

Repeater and TDD

- **For UL-DL interference free operation, guard period is introduced considering cell size.**
- **For TDD system with repeaters, the structure of frame should consider this additional delay from repeaters.**

Conclusion

- **Repeaters are indispensable to mobile systems**
- **Additional delay is introduced by repeaters**
  - **All systems should consider additional delay spread from repeaters**
  - **OFDM should consider repeaters on designing guard interval.**
  - **TDD should consider repeaters on designing frame structure (guard time).**