3GPP workshop on LTE in unlicensed spectrum
RWS-140017

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Hitachi perspectives on LTE-U

June 13, 2014

Hitachi Ltd.

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1. Motivation

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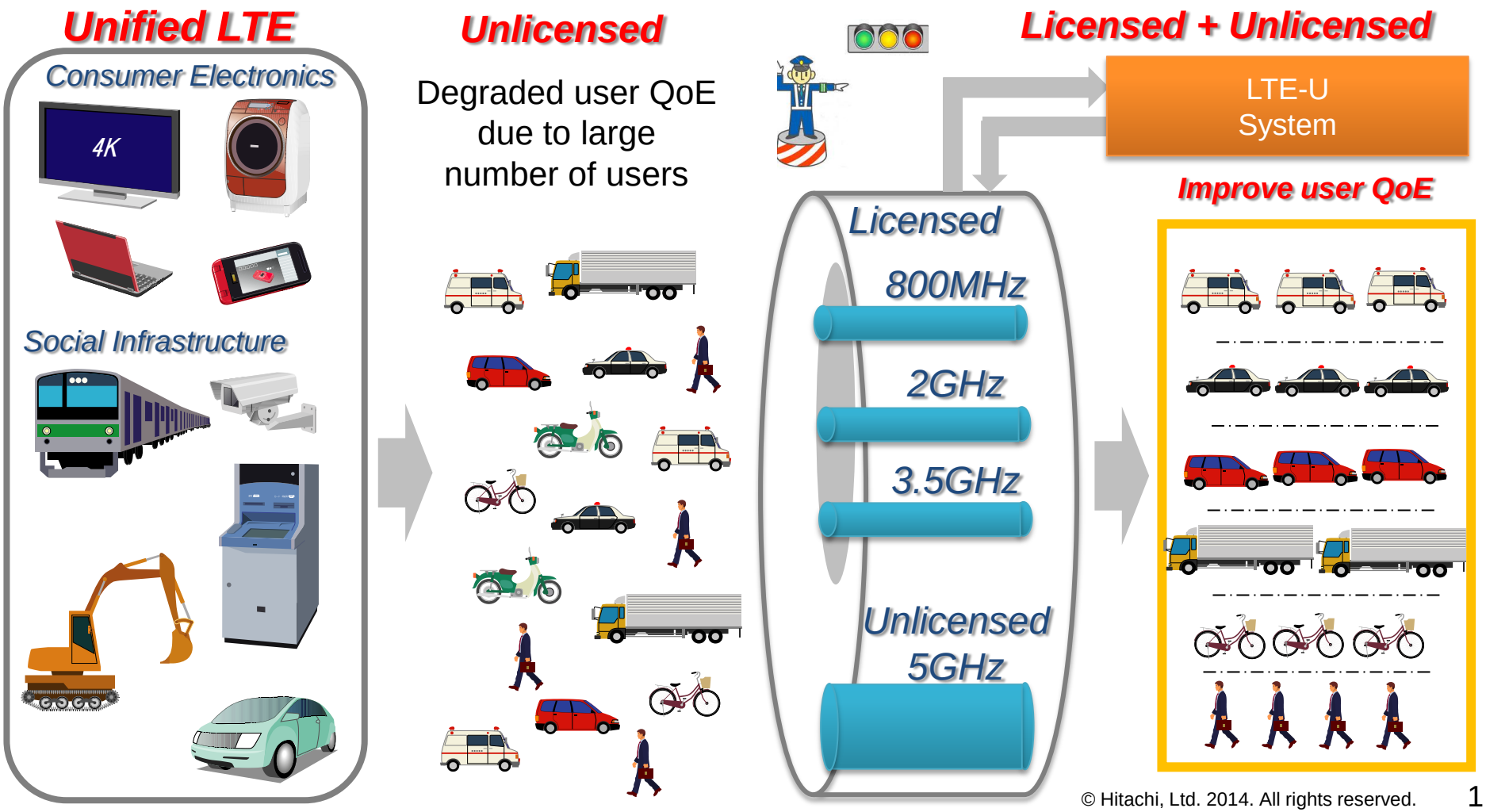
- Frequency bands needed for more devices including social infrastructure systems
- QoE degrades in unlicensed spectrum given the multitude of users

LTE-U can overcome QoE degradation in unlicensed spectrum



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2. Potential Application for LTE-U

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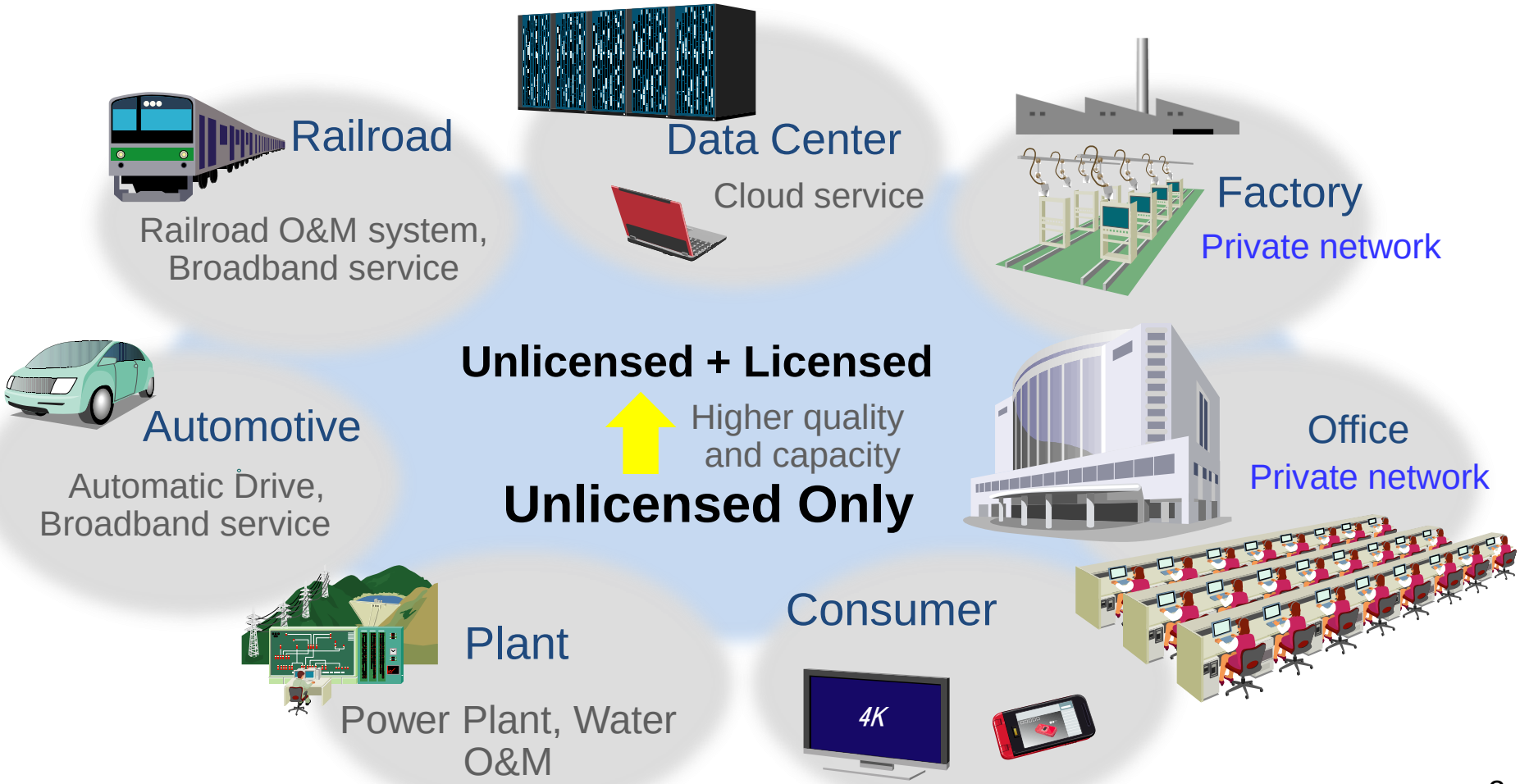
- The unlicensed spectrum currently used for
  - Social infrastructure communication (railroads, vehicles, power plants,..)
  - Private networks (offices, factories, O&M systems)
- LTE-U applied to these networks can boost their quality and capacity



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3. Private Network for LTE-U

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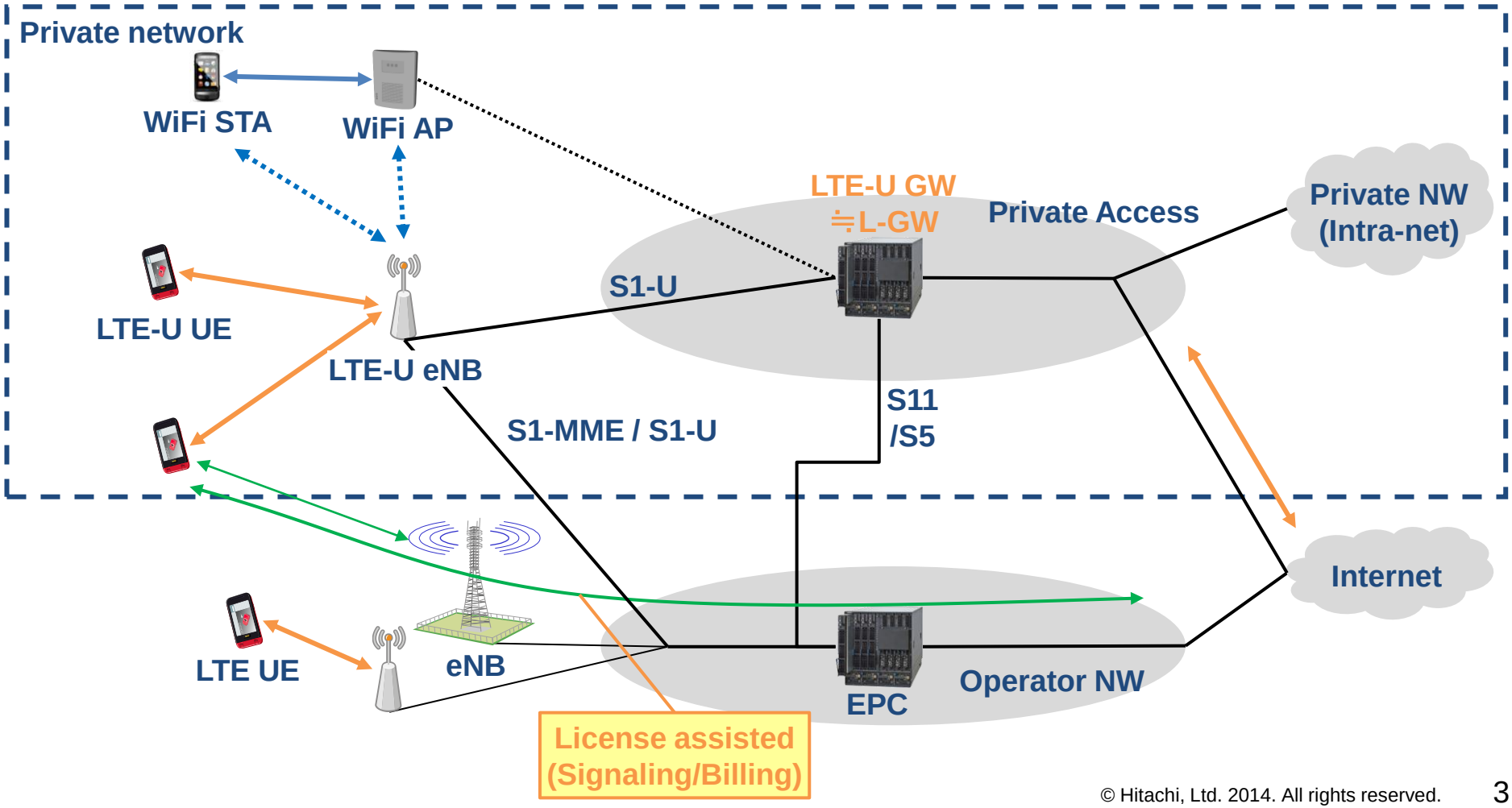
- **LTE-U for Private networks offers benefits for both users and operators**
  - For enterprise users: Real time broadband service at a feasible cost
  - For operators: can provide LTE-U service at a feasible cost (UL offloading, indoor service)



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4. LTE-U Deployment Scenarios

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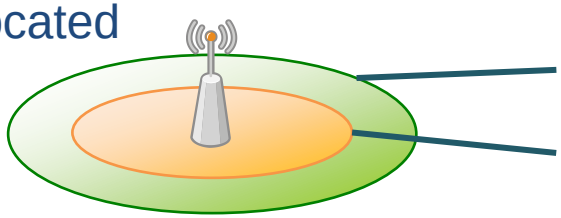
- **Co-located**: Coverage imbalance needs to be considered
- **RRH/C-RAN**: Limited number of LTE-U cells due to HW and backhaul capability
- **Non-co-located**: **Flexible deployment for private networks but reliability should be ensured**

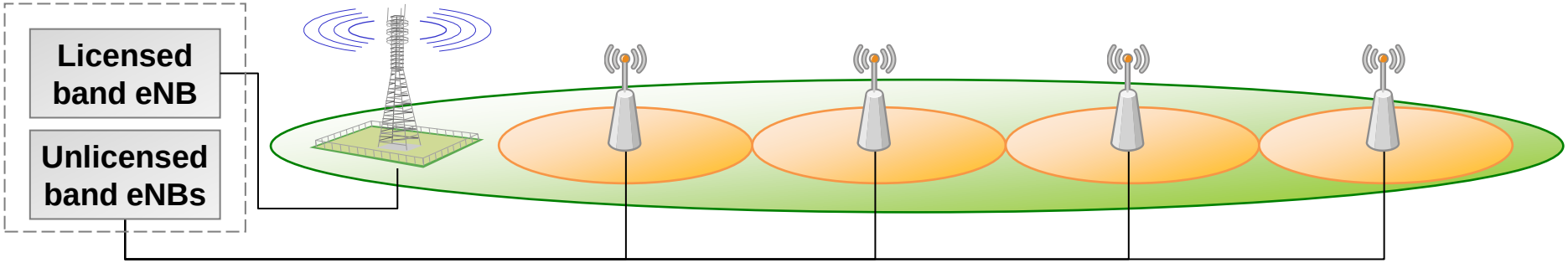
1. Co-located



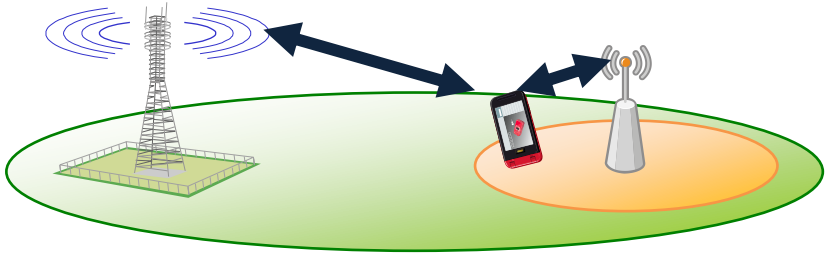
Licensed Band Coverage：700～2GHz (Up to 3.5GHz)

Unlicensed Band Coverage：5GHz

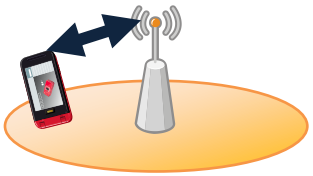
2. RRH/C-RAN



3. Non-co-located (DC)



4. Non-co-located (Stand-alone)



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5. CA/DC/standalone

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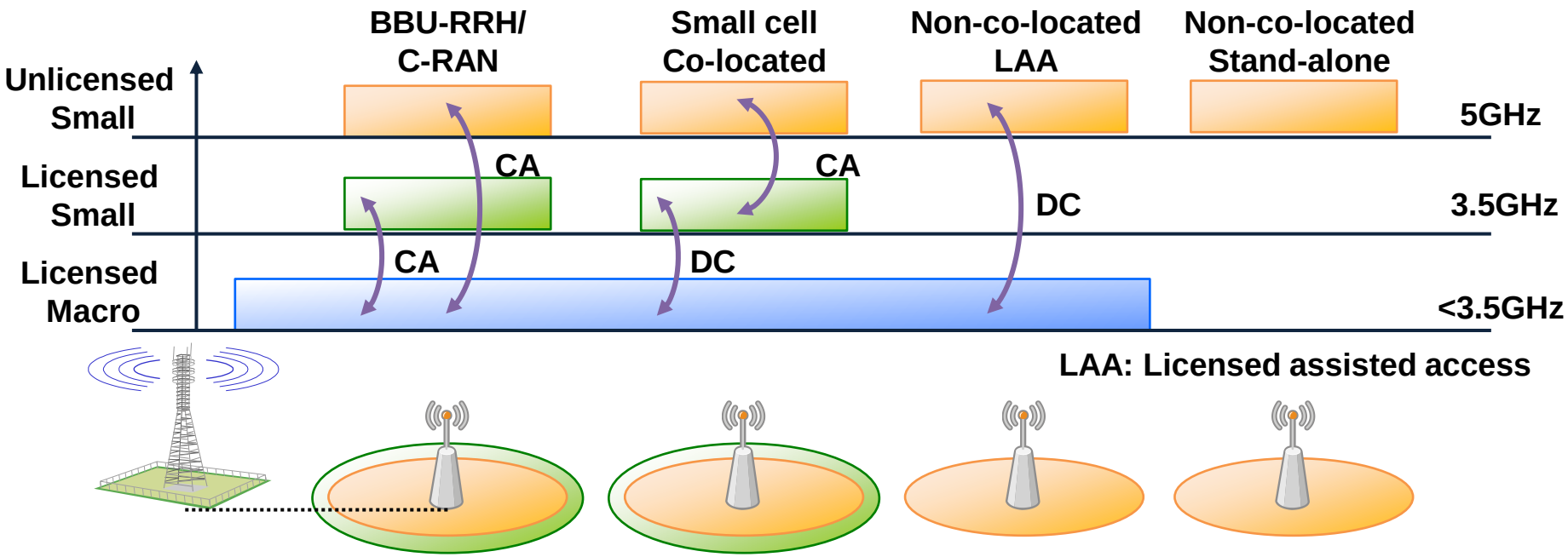
- CA (Carrier Aggregation)
  - **Reliability and mobility** can be ensured by licensed band as PCell
  - **Less impact** on core network and standardization (if no UL)
- DC (Dual connectivity)
  - **Reliability and mobility** can be ensured by licensed band as MeNB
  - **Synchronization not needed** between licensed band and unlicensed band
- Standalone
  - **Synchronization not needed** between licensed band and unlicensed band
  - Can be applied for **out-of-licensed band coverage**



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6. Duplex scheme

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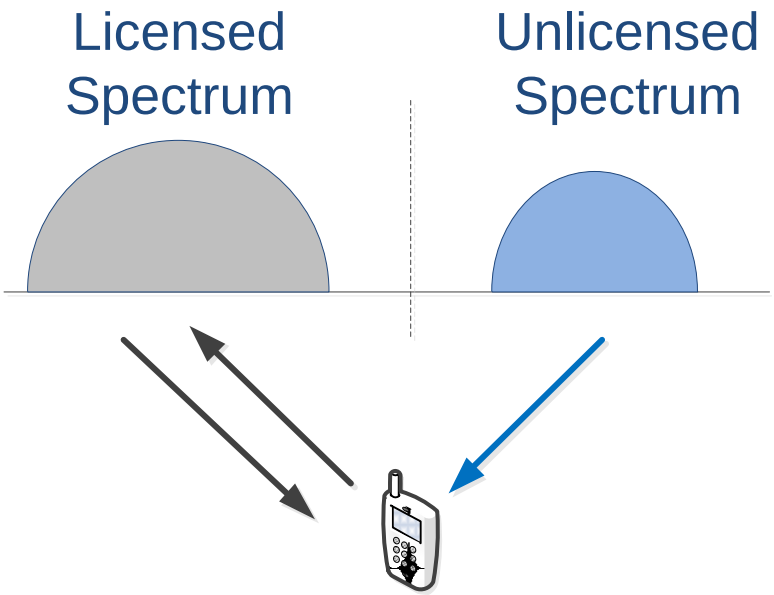
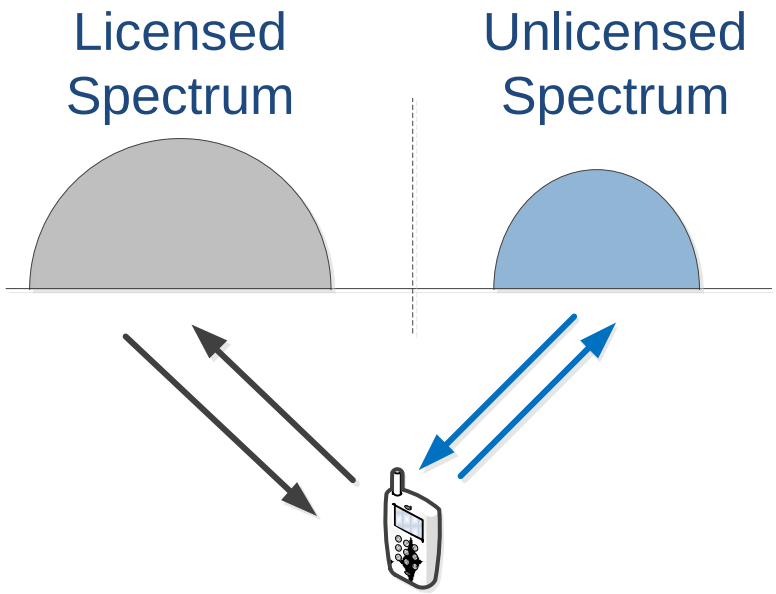
- **Without UL or With UL?**

SDL



- Carrier Aggregation
- No uplink on unlicensed band
- Lower coexistence requirements
- Less standardization efforts

TDD



- Carrier Aggregation/DC/Standalone
- Uplink on unlicensed band
- FDD-TDD Carrier Aggregation
- More standardization requirements

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7. Comparison of CA/DC/standalone

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- Each scheme has pros and cons
  → **All possibilities (CA/DC/stand-alone) should be studied at this stage**

Scheme	eNB deployment	Pros	Cons
CA	Co-located C-RAN	•Mobility, Reliability •Can be operated with SDL •Dynamic traffic control •Less CN impact •Less standardization impact	•Ideal backhaul •Synchronization with LS •No benefit for CN offload •In-coverage only
DC	Non-co-located	•Mobility, Reliability •Bearer level traffic control •Non-ideal backhaul •Asynchronous operation with licensed band	•UL is necessary •UL CA capability •Large standardization impact •No benefit for CN offload •In-coverage only
Stand-alone	Non-co-located	•Non-ideal backhaul •Asynchronous operation with licensed band •Benefit for CN offload •Both in- and out-of-coverage	•UL is necessary •Mobility, Reliability •Inflexible traffic control •Large standardization impact

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8. Regulatory Aspects

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- **Global common frequency for LTE-U (5GHz):** Bandwidth as large as possible
- **Need to meet Regional regulation requirements (DFS,TPC, LBT)**
- **Limited TX Power** on Unlicensed band: power allocation mechanism needed

	5150-5250	5250-5350	5470-5725
Japan	WiFi		
	Indoor	Indoor, DFS/TPC	Indoor & Outdoor DFS/TPC
	LBT, Max. Transmit power, EIRP		
USA	WiFi		
	Indoor	Indoor & Outdoor DFS/TPC	Indoor & Outdoor DFS/TPC
	Max. Transmit Power, EIRP		
EU	WiFi		
	Indoor	Indoor, DFS/TPC	Indoor & Outdoor DFS/TPC
	LBT, Max. Transmit Power, EIRP		

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9. Coexistence Issues

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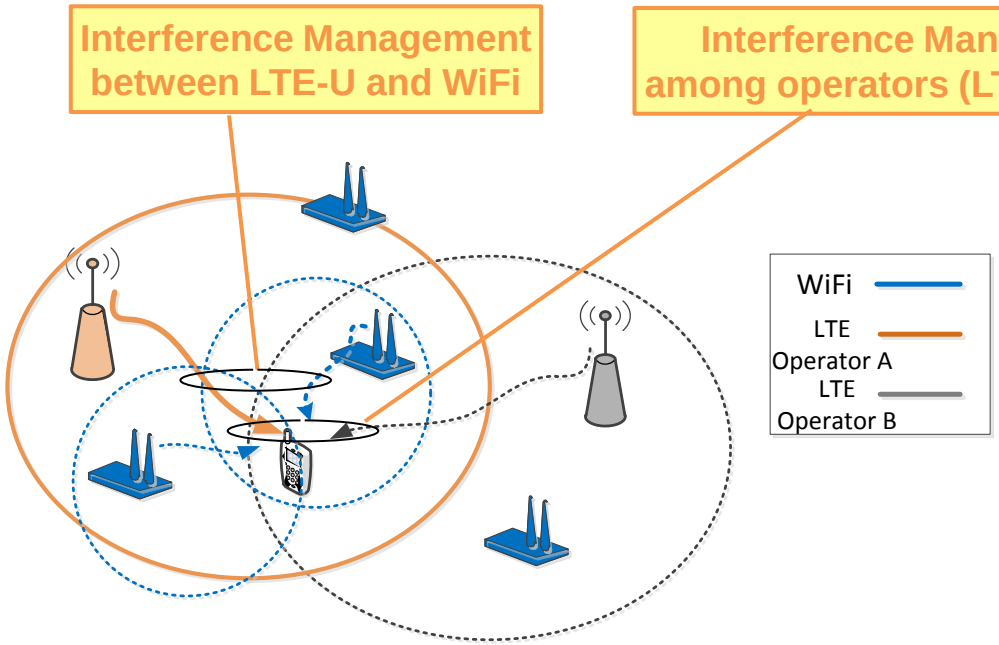
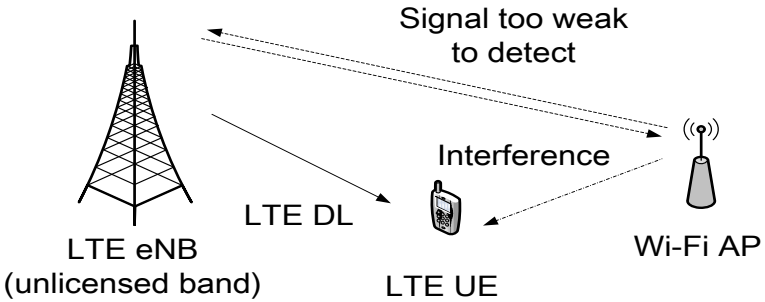
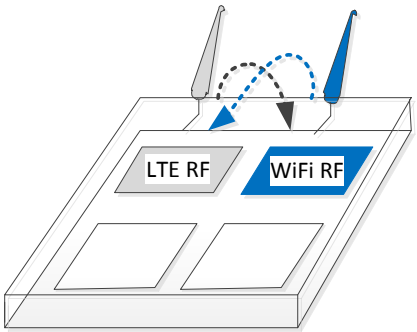
- Interference Management is important for dense network environment
  - Fair spectrum sharing desirable
  - LTE-U to act as WiFi (LBT-like methods, Virtual Carrier Sensing)





Virtual Carrier Sensing for Hidden terminal problem



❑ In Device Coexistence

- Using Rel. 11 Interference avoidance techniques
- Optimizing TDM solutions for LTE-U/WiFi coexistence

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10. Conclusion

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- Need more frequency bands to support more devices & boost data rates
- QoE degradation in unlicensed spectrum not negligible for a large number of users

LTE-U can overcome QoE degradation in unlicensed spectrum

- Potential applications:
  - Social infrastructure (i.e. railroad, car, plant)
  - Private network (i.e. office enterprise network, factory system, O&M system)

- Deployment scenario (Co-located/C-RAN/Non-co-located)

Non-co-located deployment flexible for private networks

- Comparison of CA/DC/standalone

CA/DC/standalone should be considered at this stage

- Need to meet regional regulation requirements(DFS,TPC, LBT)

- Coexistence issues should be carefully studied.

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