글로벌 ICT 표준 컨퍼런스 2023

Global ICT Standards Conference 2023

(세션2) 표준특허 정책 및 동향

ITU-R 6G (IMT-2030) 표준화 동향

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TTA IITP KEA kista ETRI

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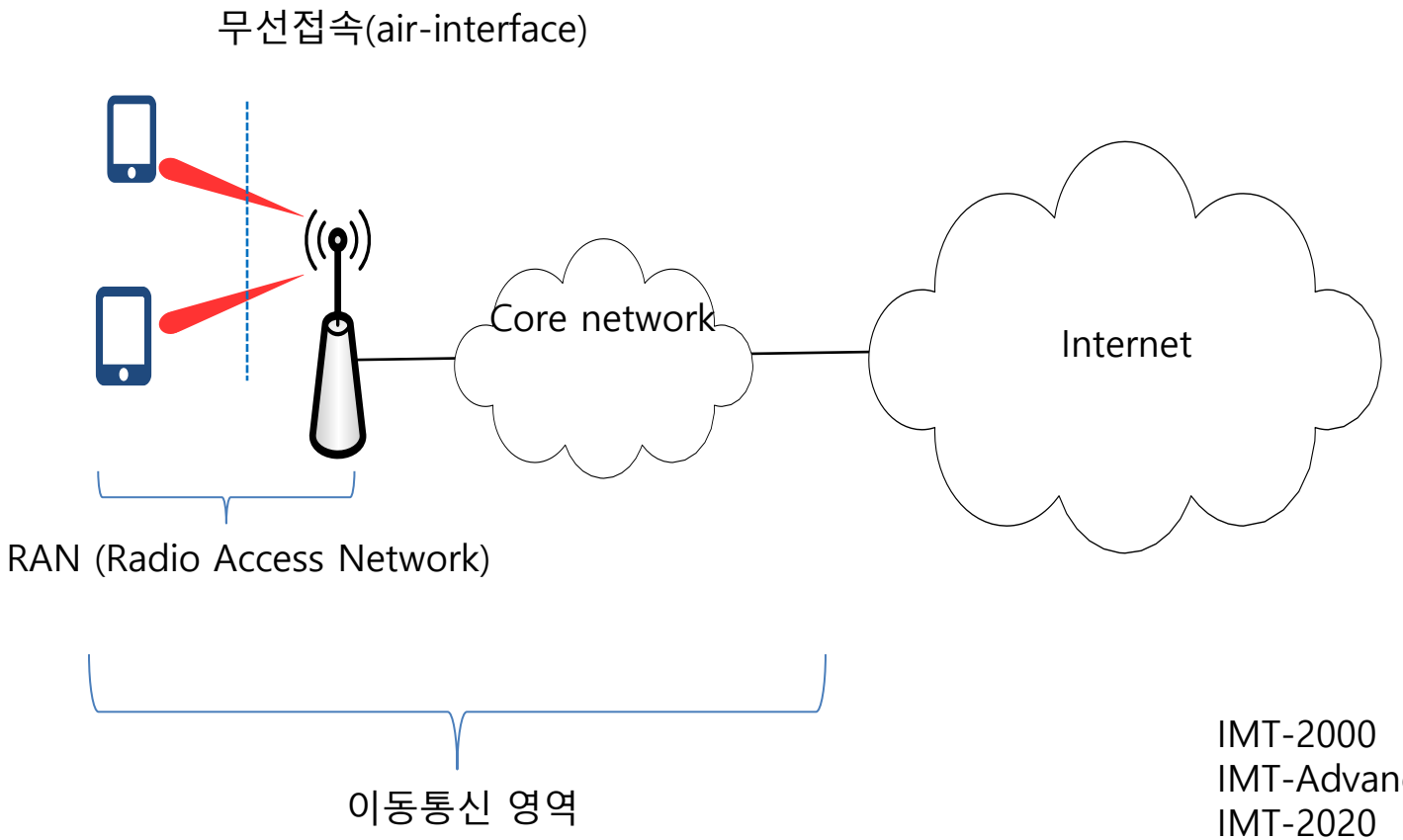
01. 6G Framework (1/3)

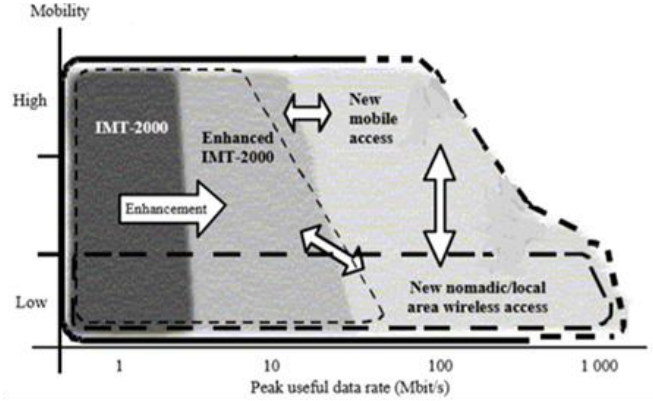
이동통신시스템

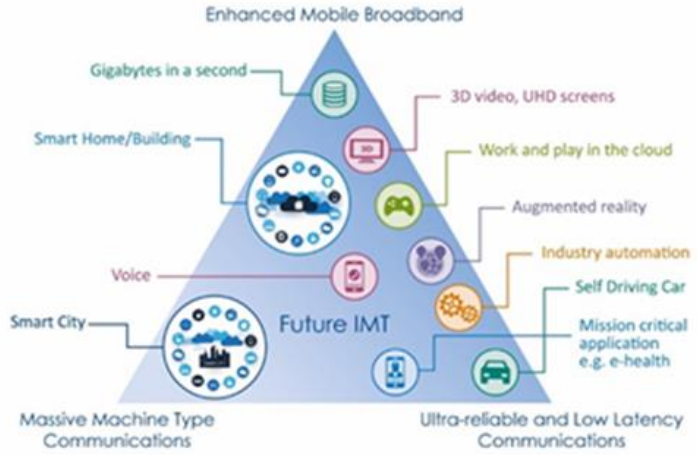


IMT-2000	3G
IMT-Advanced	4G
IMT-2020	5G
IMT-2030	6G

01. 6G Framework (2/3)

Visions of 4G and 5G





4G

- ITU-R Recommendation M.1645
- 데이터 속도 vs. 사용자 이동 속도

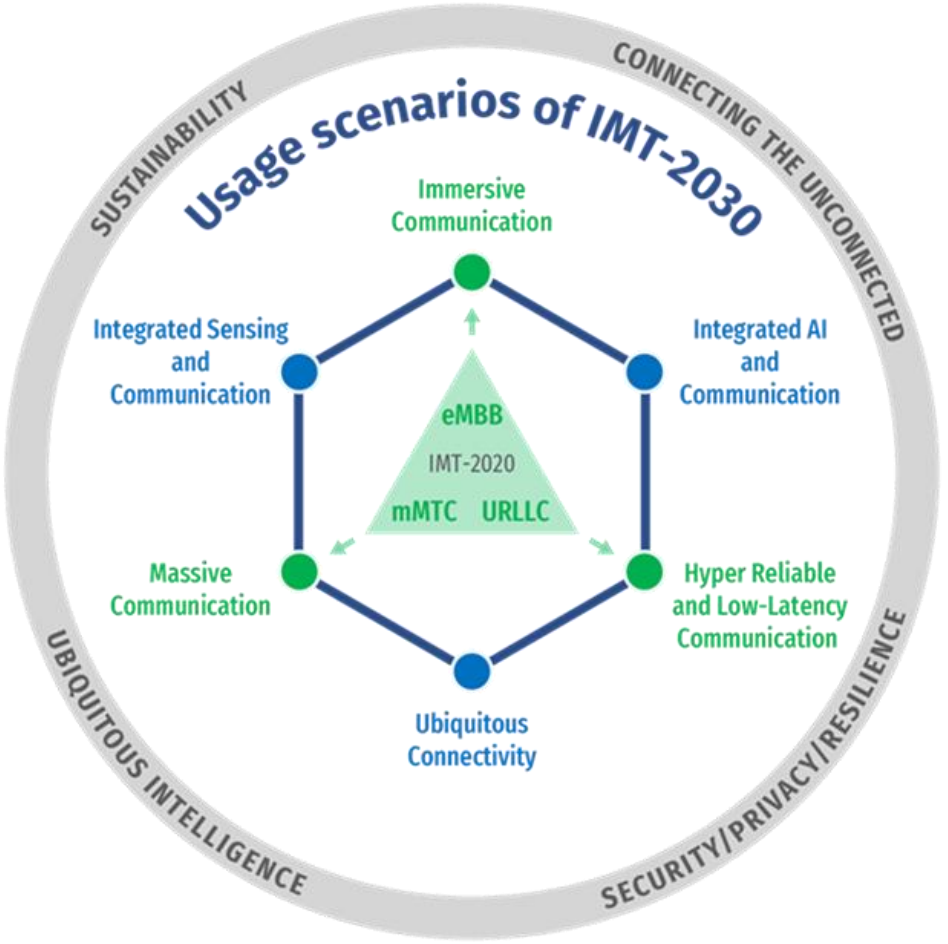
5G

- ITU-R Recommendation M.2083
- 3 usage scenarios
  - Capability 연관
  - Non/Beyond-communication applications

01. 6G Framework (3/3)

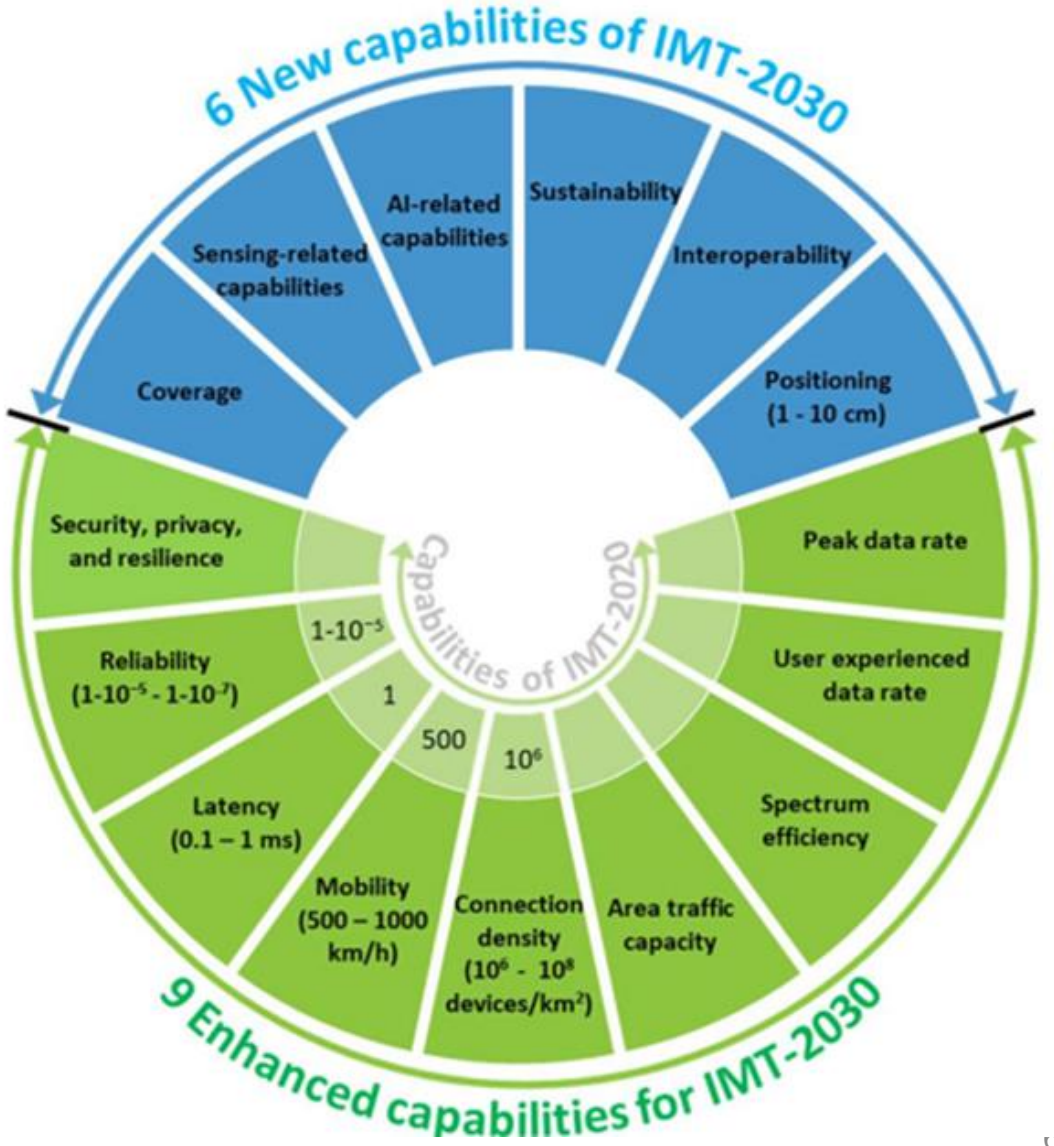
6G Framework

- **Extension from 5G usage scenarios**
  - eMBB → Immersive Communication
  - URLLC → HRLLC
    (Hyper Reliable and Low-Latency Communication)
  - mMTC → Massive Communication
- **New usage scenarios**
  - Ubiquitous Connectivity
  - Integrated AI and Communication
  - Integrated Sensing and Communication
- **4 overarching aspects**
  design principles applicable to all usage scenarios
  - Sustainability
  - Connecting the unconnected
  - Ubiquitous intelligence
  - Security, Privacy, Resilience

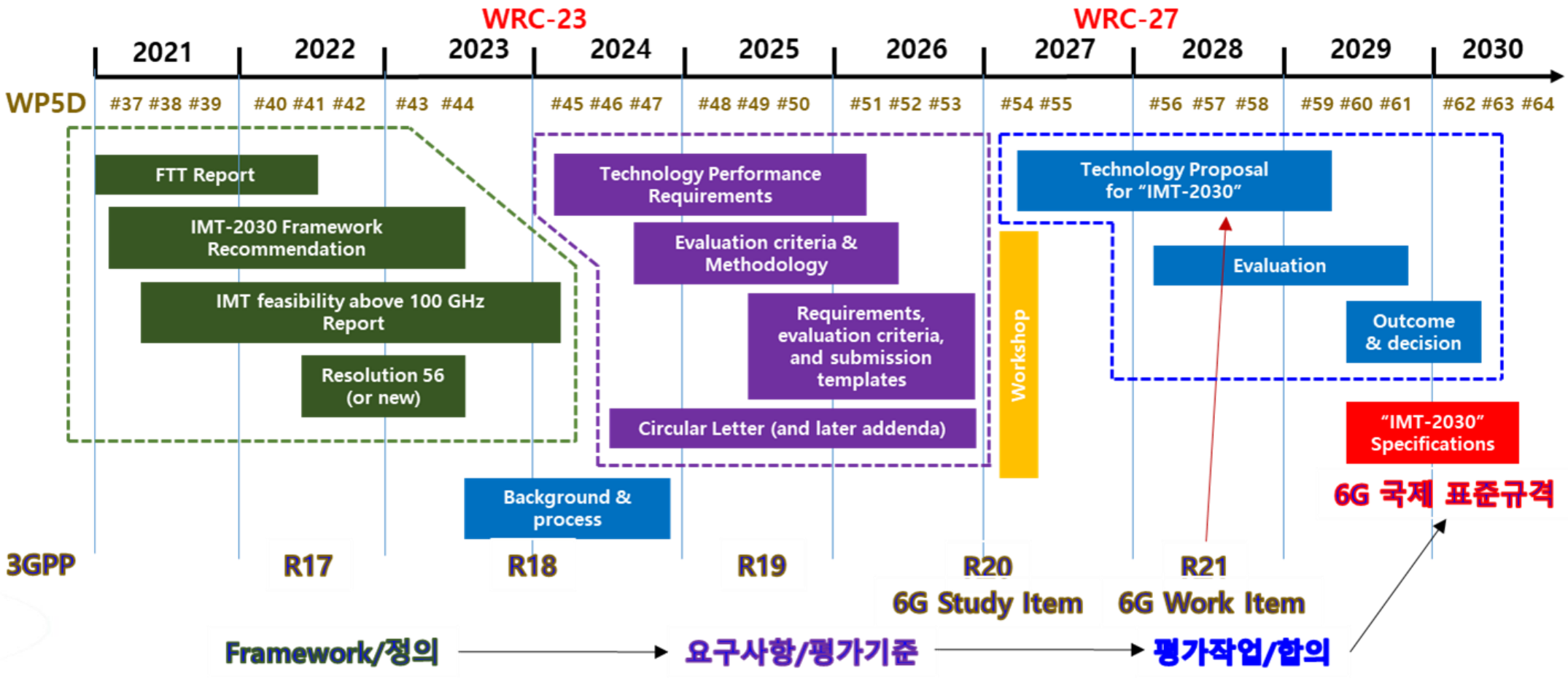


02. 6G Capabilities

- **9 enhancements from 5G capabilities**
  - Peak data rate
  - User experienced data rate
  - Spectrum efficiency
  - Area traffic capacity
  - Connection density: $10^6 \rightarrow 10^6 – 10^8$ per km^2
  - Mobility: 500 → 500 – 1000 km/h
  - Latency: 1 → 1 – 0.1 ms
  - Reliability: 1 – 10^{-5} → 1-10^{-5} – 1 – 10^{-7}
  - Security, privacy, and resilience
- **New 6 capabilities**
  - Coverage
  - Sensing-related capabilities
  - AI-related capabilities
  - Sustainability
  - Interoperability
  - Positioning

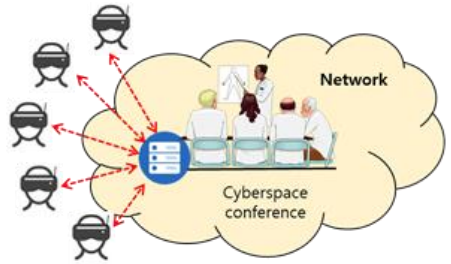


03. 6G Timeline



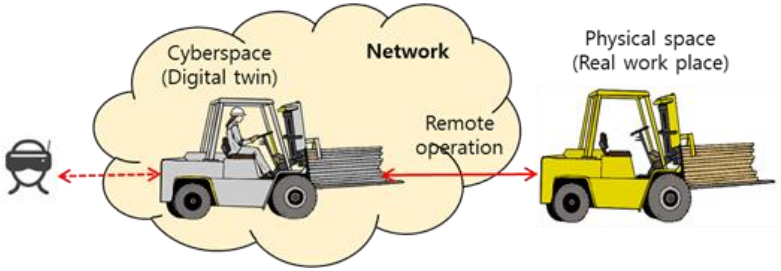
04. 6G Use Cases (1/2)

- **Immersive communication**
  - 목적: 핫스팟, 도심 및 시골 지역 등에서 대화형/몰입형 경험 제공
  - Use case: 몰입형 XR, 홀로그래픽 통신, Remote multi-sensory telepresence
  - KPI: 스펙트럼 효율, 데이터 속도, 이동속도, 신뢰도 및 지연시간, 연결밀도



- **HRLLC**
  - 목적: 더욱 엄격한 신뢰도 및 지연시간이 요구되는 특수한 용례 지원
  - Use case: 산업 분야의 완전 자동화, 대화형 로봇, 비상시의 서비스, Tele-medicine, 전력전송 및 분배 감시
  - KPI: 신뢰도 및 지연시간, 초정밀 포지셔닝, 연결밀도

- **Massive communication**
  - 목적: 대규모의 디바이스 또는 센서 연결에 의한 광범위한 용례 지원
  - Use case: 스마트 시티, 교통, 물류, 건강, 에너지, 환경감시, 농업
  - KPI: 연결밀도, 저전력소모, 이동속도, 커버리지, 보안 및 신뢰



04. 6G Use Cases (2/2)

- **연결의 보편성**
  - 목적: 타 시스템과의 상호연동 등을 통하여 디지털 격차 해소 등에 기여
  - Use case: 미연결 또는 연결 부족 지역 해소, IoT 서비스, 광대역 이동통신 서비스
  - KPI: 연결성(connectivity)

- **AI/통신 융합**
  - 목적: 분산 컴퓨팅 및 AI-powered 애플리케이션 지원
  - Use case: 자율주행, 의료 지원 애플리케이션, 컴퓨팅 작업 분산(offloading), 디지털트윈
  - KPI: 단위면적당 용량, 사용자 체감 속도, 초신뢰도 및 초저지연, 데이터 수집, 모델 훈련/공유/분배, 컴퓨팅 자원관리

- **센싱/통신 융합**
  - 목적: 센싱 기능이 요구되는 서비스 지원
  - Use case: 항법, 활동인식, 움직임 추적, 환경감시, 주변 상황 센싱 데이터 및 정보 처리
  - KPI: 고정밀 포지셔닝, 거리/속도/각도 추정, 사물 존재 인식, 이미징/매핑

05. 6G Technologies (1/6)

1. Emerging technology trends and enablers
2. Technologies to enhance the radio interface
3. Technology enablers to enhance the radio network

- **Emerging technology trends and enablers**
  - AI-native communications (AI 기반 통신)
  - RAN automation / configuration / intelligence
  - Network for AI (AI 지원을 위한 network) → UL-centric, deep edge, ML across whole network
  - Integrated sensing and communication (센싱/통신 융합 기술) → 혁신적 서비스/애플리케이션 제공
  - Supporting convergence of communication and computing (컴퓨팅/통신 융합)
  - D2D → THz (UE peripheral links)
  - Efficient spectrum utilization
  - Energy efficiency and low power consumption
  - Enhancing trustworthiness (시큐리티, 프라이버시, 리질리언스}
  - Real-time services and communications
    - Compact atomic clock
    - Pico-second level synchronization

05. 6G Technologies (2/6)

- **Technologies to enhance the radio interface**
  - Advanced modulation, coding, and multiple access schemes
  - 고급 안테나 기술
    - E-MIMO, 분산형 E-MIMO, AI 활용 E-MIMO (채널추정, reconfiguration issue 극복)
  - 전이중화 기술: IBFD (In-Band Full Duplex)
  - 다중차원 전송기술
    - RIS (Reconfigurable Intelligent Surface)
    - HR (Hologram Radio)
    - OAM (Orbital Angular Momentum)
  - THz 전송 기술: 펜슬빔 THz
  - 초정밀 포지셔닝 기술: SLAM, CPP, AI/ML 포지셔닝

05. 6G Technologies (3/6)

- **RIS**
  - **Channel**
    - Non-controllable component → dynamically controllable
      - Phase, amplitude, frequency, polarization → artificially adaptable
    - RIS: a new type of antenna array with or without active elements
      - Many small sub-wavelength unit-cells
      - Construction of Intelligent and programmable radio environment
        - Unit-cell's reflection, refraction, absorption → can be controlled
  - **Merits**
    - Transmission reliability, higher spectrum efficiency
      - Channel rank, Network coverage
      - Cell-edge performance
      - Positioning/sensing
      - wireless power transfer/backscattering
    - Low cost, low power consumption, easy deployment

05. 6G Technologies (4/6)

- **Holographic radio**
  - **For imaging**
    - Holography → 3D imaging of an object (by using interference patterns)
      - RF holography (e.g. breast cancer detection, brain imaging, cardiac imaging, ...) of an unseen
      - Optical holography of a seen
    - HR can upgrade RF holography to optical holography
  - **For communication**
    - Transmitter: data encoded into interference patterns → transmission over RF signal
    - Receiver: holographic image creation by reconstructing the original interference patterns → data
    - Merits: High data rates, Low latency, Better coverage

05. 6G Technologies (5/6)

- **Orbital angular momentum**
  - **Vortex beam generator**
    - A beam with helical phase front (twists on the phases of the beam)
    - multiplex multiple signals over the same carrier frequency (orthogonal twists modes)
  - **Studies focus on**
    - Extremely high data rate at LOS
    - Multipath, misalignment of orientation
  - **Performs better at:**
    - Smaller antennas & quasi-static terminal
    - Indoor small cells with mmWaves and THz
  - **Study Phases**
    - Vortex waveform carrying OAM
    - Light photon carrying quantum state OAM

05. 6G Technologies (6/6)

- **Technology enablers to enhance the radio network**
  - RAN 슬라이싱
  - Interconnection with NTN
  - 초고밀집 네트워크 (UDN)
  - Resilient and soft network for guaranteed QoS
    - Availability, resilient, soft, user-centric, service-oriented, flexible, ... (Cf. SDN/NFV)
  - New RAN architecture
    - RAN nodes (BSs, UEs) cooperation, user-centric, DOICT, native-AI enabled RAN functions
  - Digital Twin Network
  - Enhancing RAN infrastructure sharing (by multiple operators)

감사합니다.

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