Work Progress of IMT-2030(6G) Promotion Group

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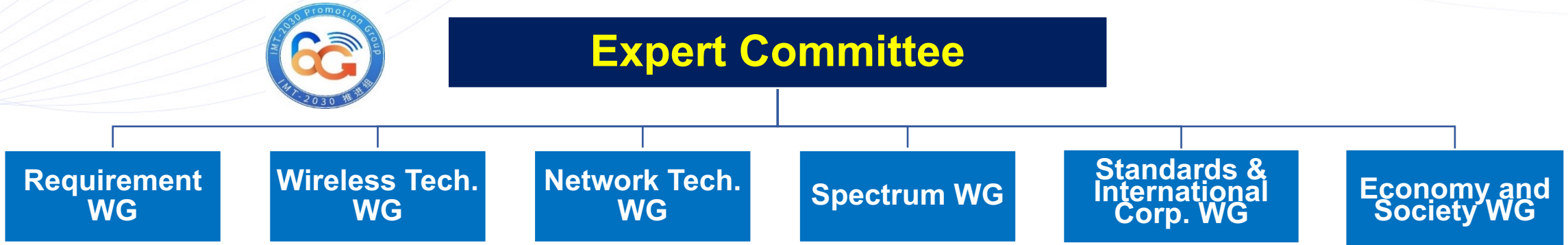
Structure of IMT-2030(6G) Promotion Group

- In June, 2019, the IMT-2030(6G) Promotion Group was established. It promotes the research of 6G and build an international cooperation platform.

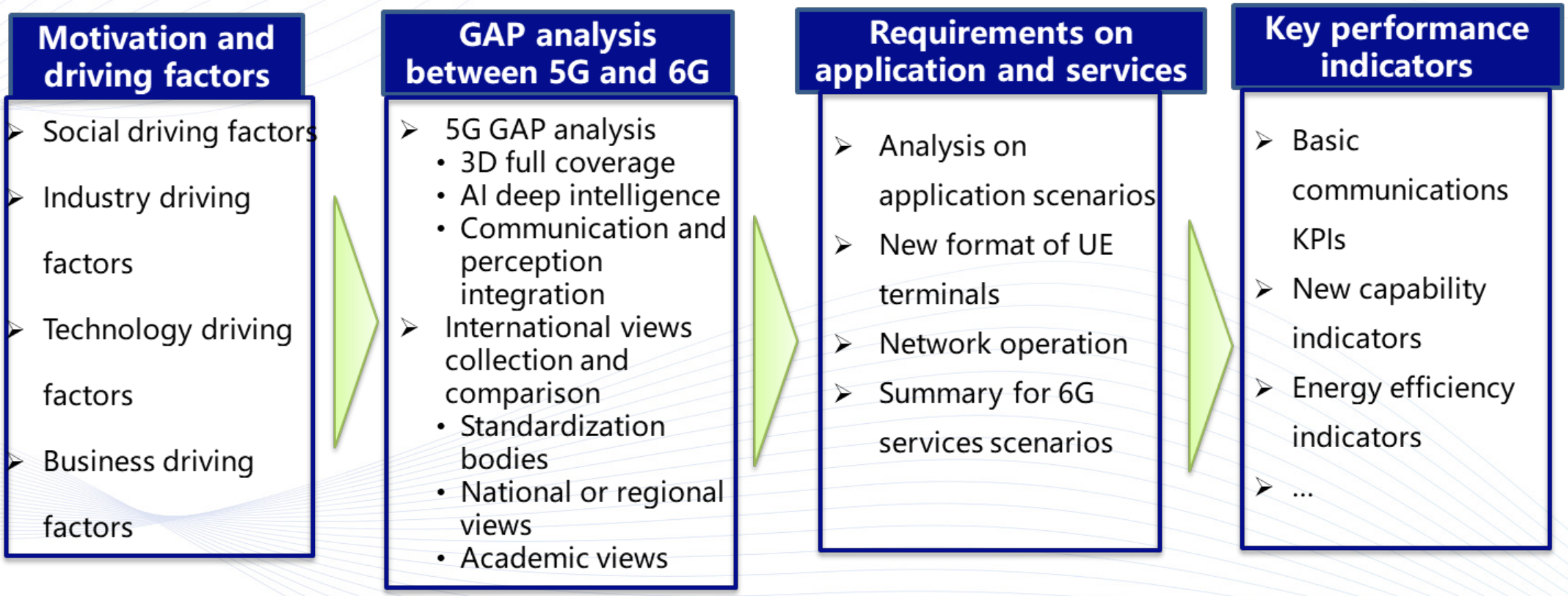


There are 70 member units of the IMT-2030 promotion group.

Research institution	Operator	System equipment provider	Chipset and terminal provider	University
CAICT 国家无线电监测中心 The State Radio Monitoring Center 中国科学院计算技术研究所 之江实验室 ZHEJIANG LAB TD Industry Alliance WiCo 广东省新一代通信与网络创新研究院	中国移动通信 CHINA MOBILE 中国电信 CHINA TELECOM China unicom中国联通 docomo	HUAWEI CICT 中国信科 ZTE中兴 ERICSSON NOKIA 上海贝尔 SAMSUNG	HISILICON Lenovo 紫光展锐 UNISOC vivo oppo	北京邮电大学 南京大学 清华大学 USTC 复旦大学 北京航空航天大学 北京大学 上海交通大学 浙江大学

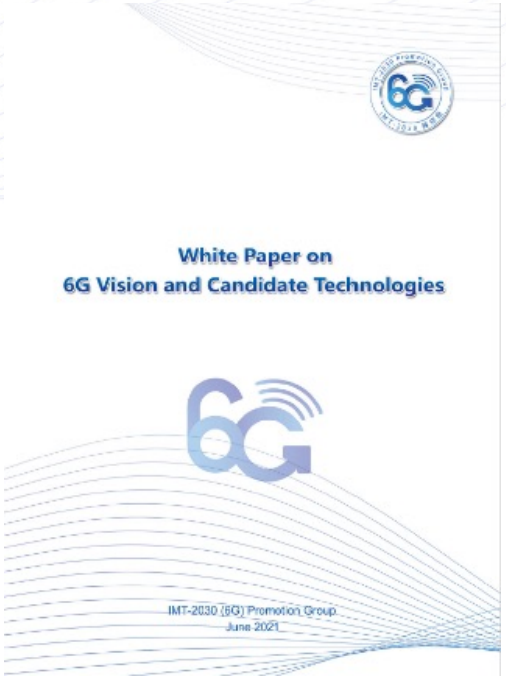
Requirement WG

- **Focus on 6G vision and requirements, with the goal of proposing 6G overall vision, use cases, application scenarios and key capabilities**



Overall 6G Vision: intelligent connection of everything, digital twin

On June 6, 2021, IMT-2030 (6G) Promotion Group released the white paper on "6G Vision and Candidate Technologies ", covering 6G vision, as well as typical candidate use cases of 6G.



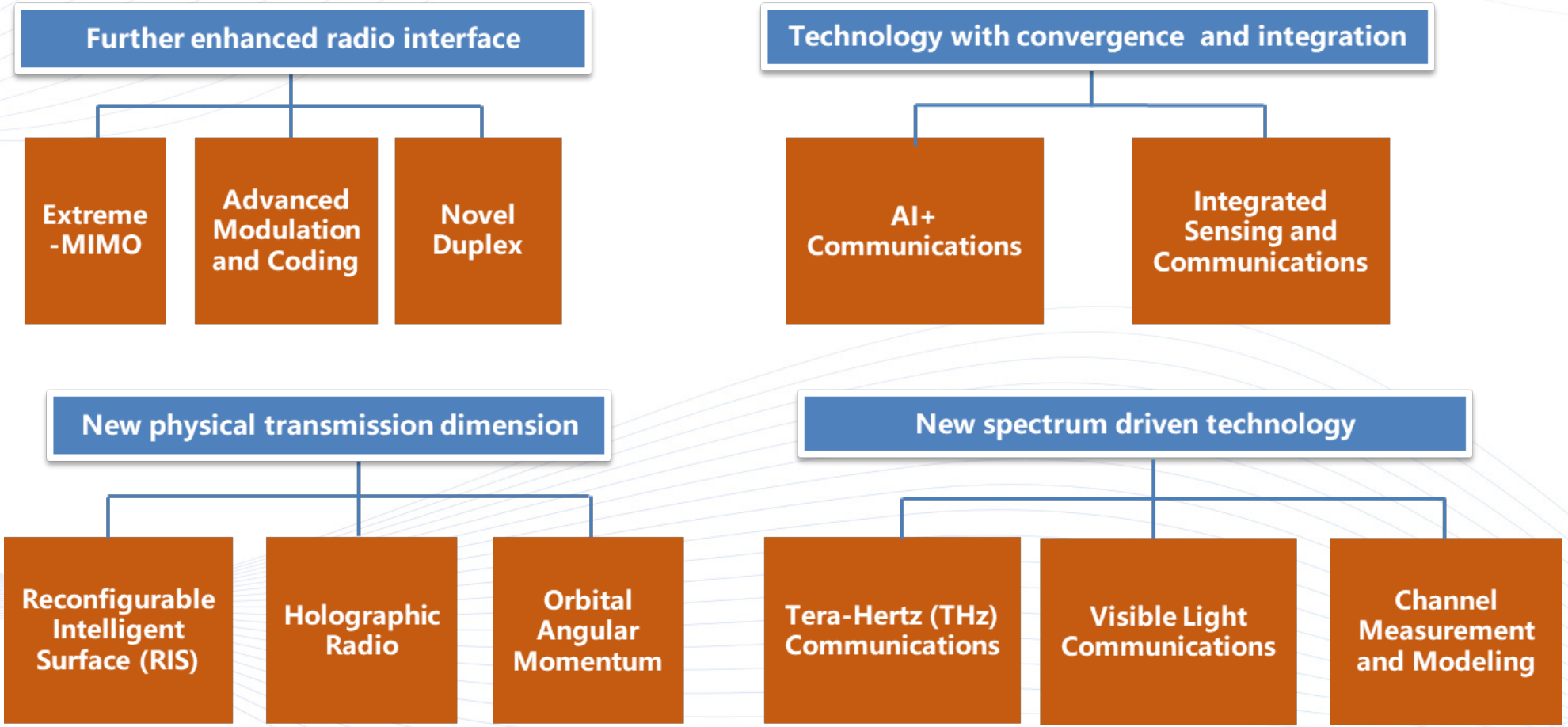
White paper
"6G Vision and Candidate Technologies"
(*with English version)

Intelligent connection of everything, digital twin

***English version of white paper "6G Vision and Candidate Technologies" can be downloaded at http://www.caict.ac.cn/english/news/202106/t20210608_378637.html**

Wireless Tech. WG

- **Explore a broad view of innovative wireless technologies.**
- **WG structure is dynamic and flexible to include emerging technology aspects as needed.**



Technical reports from Wireless Tech. WG

Technical report
“Extreme MIMO”

Technical report
“Integrated Sensing and Communication”

Technical report
“Wireless AI”

Technical report
“Tera-Hertz (THz) Communications”

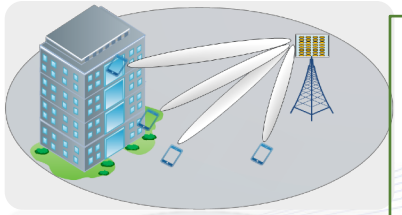
Technical report
“Reconfigurable Intelligent Surface (RIS)”

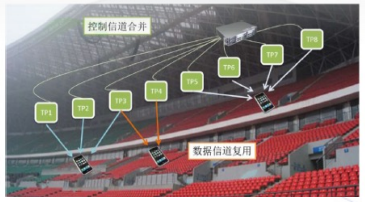
Key Technologies 1: Extreme-MIMO

With the emergence of new materials and technologies, the scale of the antenna array will be further expanded to support new scenarios and services.

Application scenarios

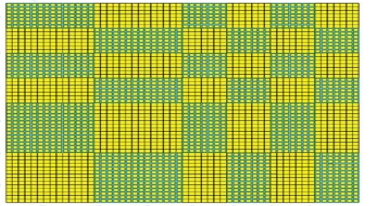
Research directions





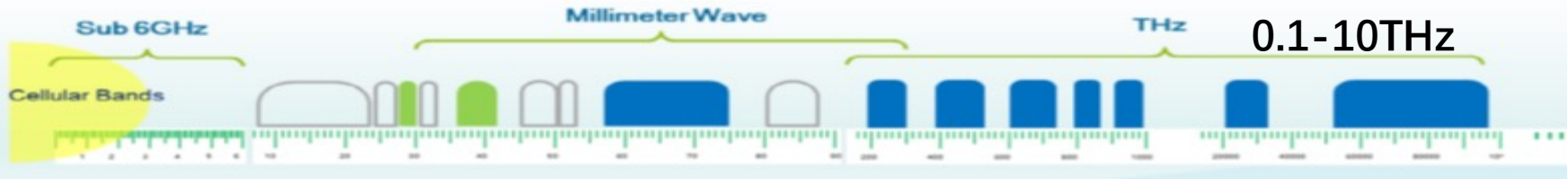
- **E-MIMO channel modeling**
  - Near-field model/continuous aperture/space-time non-stationary characteristics/ higher frequency band
- **Practical distributed E-MIMO solutions**
  - User-centric network structure
  - Low-cost, flexible deployment solution

- **New antenna materials**
  - Integration of new antenna materials and system architecture
  - Efficient channel measurement scheme and feedback scheme
- **Intelligent E-MIMO**
  - E-MIMO AI theory
  - Data training on acquisition and interaction
- **Precise spatial positioning and perception**



Key Technologies 2: Tera-Hertz (THz) Communications

Terahertz band has abundant spectrum resources and an extremely short wavelength, which can meet the needs of large-capacity and short-distance communication, as well as the ability in high-precision positioning and sensing.



Application scenarios

- terrestrial communication, space communication, micro-nano-scale application scenarios, etc.

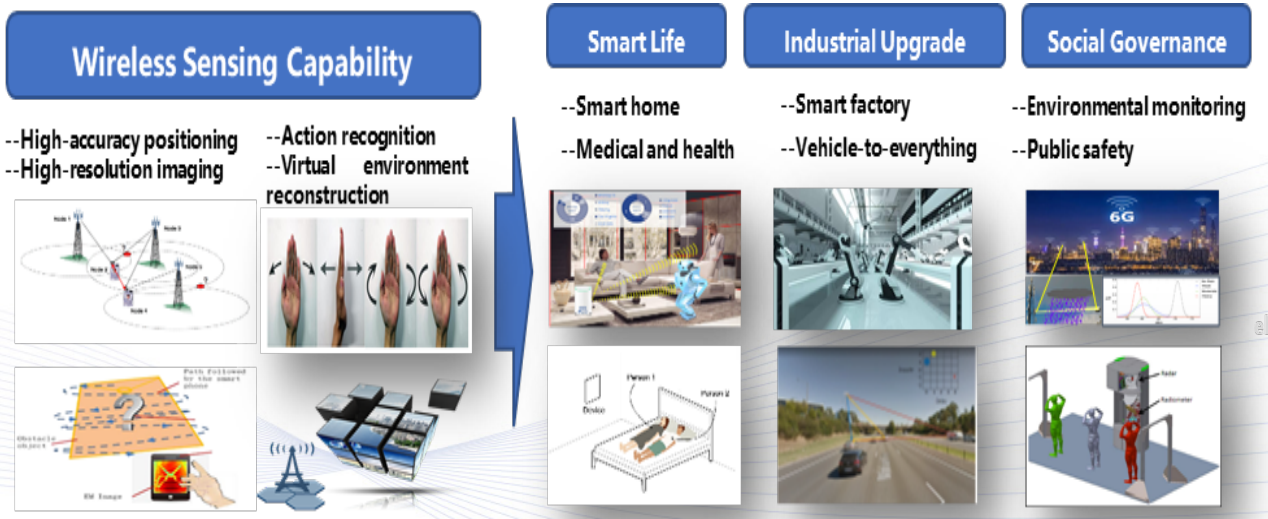
Research directions

- **Channel modeling analysis**: indoor and outdoor channel modeling, spatial channel modeling, programmable material channel modeling
- **Key technologies**: terahertz communication + sensing, extremely narrow beam alignment and tracking, large bandwidth sampling and receiving technology, high-speed modulation coding and decoding technology, efficient networking and multiple access technology
- **Key components and chips**: mixers, frequency multipliers, oscillators, integrated circuit devices, etc.

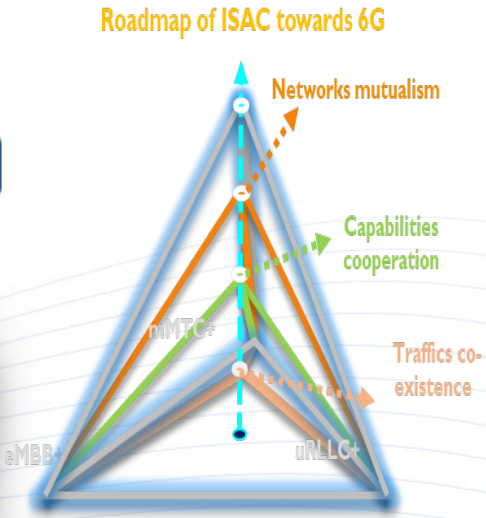
Key technologies 3: Integrated Sensing and Communications (ISAC)

Leveraging wireless signals to realize wireless sensing and communications simultaneously. The 6G network will have native sensing capabilities to sense and better understand the physical world.

◆**Scenarios:** a variety of wireless sensing capabilities (i.e., positioning, recognition, imaging, reconstruction, etc.) in the future smart life, industrial upgrade, social governance and other fields.



◆**Technology evolution trends :** As the integration level of sensing and communication continues to increase, different stages will draw the technology roadmap of ISAC together.



Networks mutualism	➢ Deep information fusion ➢ Multi-point sensing, network collaboration
Capabilities cooperation	➢ Joint waveform design ➢ Joint signal processing
Function co-existence	➢ Shared spectrum/hardware ➢ Interference management, hardware design

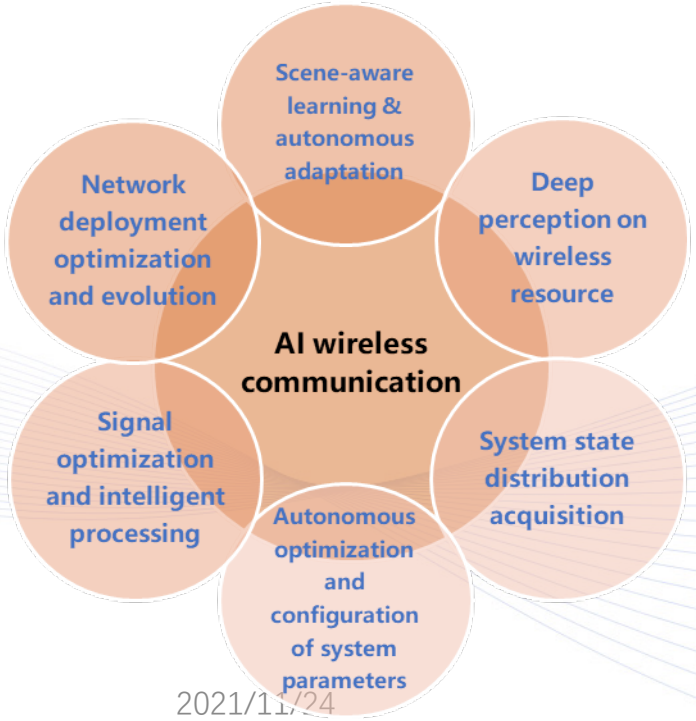
◆**Key technologies :** Continuous breakthroughs are needed in fundamental theories, air interface, network architecture, networking schemes, hardware architecture, device design, etc.

Key Technologies 4: Wireless AI

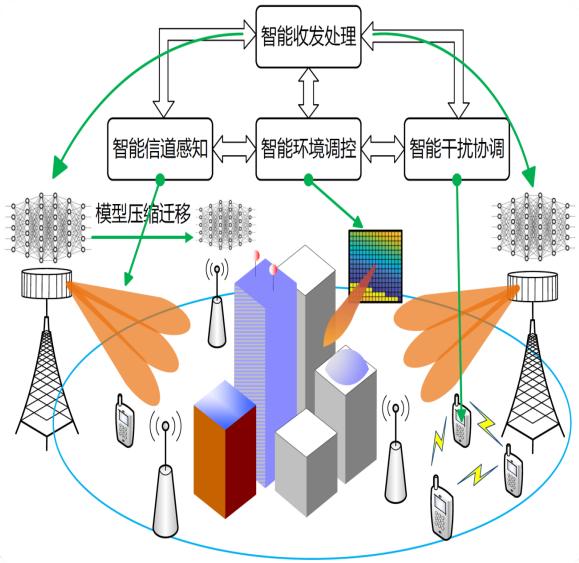
Network intelligence is the development direction and important feature of 6G. The combination of AI and wireless communication, through the construction of a novel wireless AI network architecture and air interface protocol, can support 6G full-scenario, full-dimensional, full-process deep perception and learning, and significantly improve network intelligence.

Research directions

- A universal AI-native network architecture suitable for wireless environments, wireless resources, and wireless data
- New high-efficiency AI/ML algorithms at the physical layer/data link layer/network layer and system level
- The basic theory of wireless AI includes computing-storage-communication costs and performance limits
- Technology and industrialization development prospects supported by wireless AI



- **Application Scenarios**
  - **AI for COM:** Realize extremely intelligent communication
  - **COM for AI:** Support smart distributed applications
    - Distributed perception
    - Distributed control
    - Distributed computing

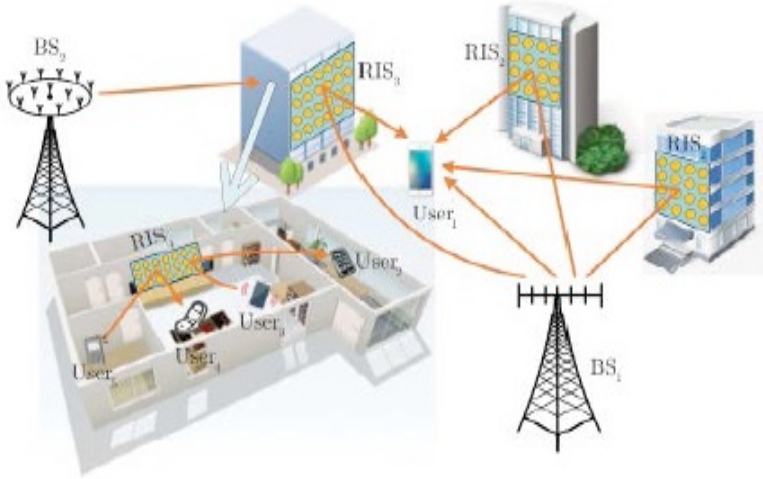


Key Technologies 5: Reconfigurable Intelligent Surface (RIS)

By actively controlling the wireless propagation environment, RIS controls signal propagation direction, suppresses interference and enhances the signal, and builds a new paradigm of 6G intelligent programmable wireless environment.

Application scenarios

- Overcome the limitation of NLOS, suitable for scenarios where the LoS path is blocked or the power is low
- Overcome the problem of local voids
- Serving cell edge users, solving multi-cell co-frequency interference
- Secure communication to prevent eavesdropping
- Applications in new scenarios such as positioning and sensing



Research directions

- **Basic theory and modeling research**: modeling and communication theory limit analysis, physical and electromagnetic compatibility model, channel measurement and modeling;
- **Technical solutions and algorithms**: channel estimation and feedback, beamforming design, passive information transmission, AI enabling design, networking design;
- **Hardwares**: new materials, new ultra-surface system architecture and interfaces, etc.

Network Tech. WG

- Potential revolutionary technologies are emerging.
- “2+6” technology direction
- The innovation of network architecture in the 6G era will be important.

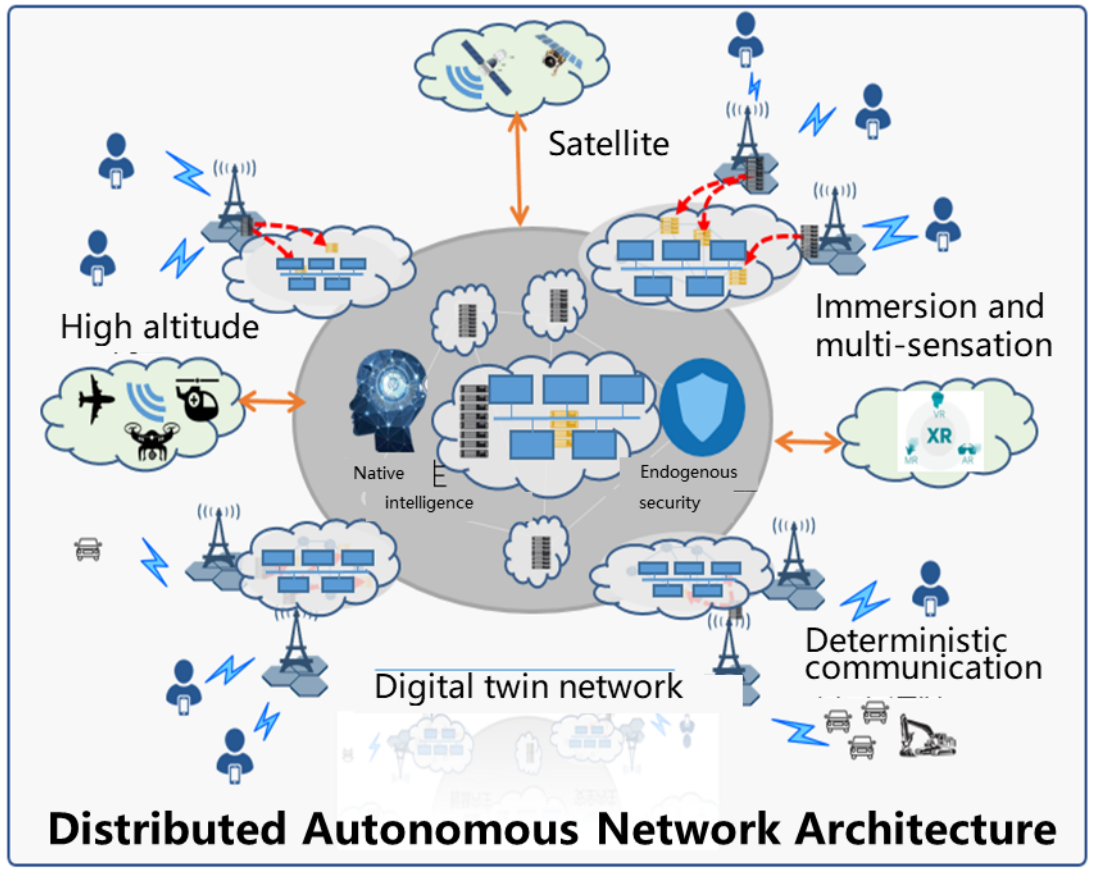
‘2+6’ technology division with 8 task group

- Network architecture and requirement
- Network security
- Integration of terrestrial and non-terrestrial networks
- Intelligent network
- Deterministic network
- Computing power network
- Information central network
- Digital twin network

White paper
“6G network architecture vision and key technology outlook ”

Network architecture and key technologies

Two principles: network compatibility, simple design. Four characteristics: native intelligence, native security, multi-domain integration, computing network integration



Six potential capabilities

- Network programmability
- Communication awareness network
- Deterministic communication
- Data service
- Immersion and multi-sensation
- Semantic communication

6G network architecture

Six potential architecture technologies

- Distributed
- Air-Space-Ground integration
- Native intelligence
- Native network security
- Digital twin
- Computing network

Four design principles

From centralization to distribution	From heavy-duty incremental design to minimalist integration design	From plug-in design to internal design	From ground access to air-space-ground-sea-based access

Spectrum WG

- Research topic including 6G spectrum requirements, propagation characteristics on millimeter wave, terahertz, and visible light, new technologies for spectrum sharing, etc.

Spectrum requirement for 6G based on vision

Analysis on global spectrum strategy and policy

Exploring the 6G spectrum under ITU framework

- ✓ Traditional IMT frequency issues
- ✓ 6G "cross-border" topics, such as private network frequencies, satellites, intelligent transportation, high-altitude platforms, etc.

Explore new frontier for 6G spectrum

- ✓ Terahertz propagation characteristics and channel modeling

Make good use of existing spectrum by exploiting sharing technology

- ✓ Explore new technologies as spectrum sharing

Standards & International Corp. WG

- Promote international views exchanges and cooperation with the progress of 6G research in major countries/organizations around the world;

Promote international cooperation

- Give full play to the channel role of international corporate members in the group and strengthen international communication and cooperation
- Promote to establish a liaison mechanism with foreign regional 6G organizations/alliances to reach consensus

Output the research results to standardization organizations

- Carry out research work on 6G technology trends and vision for ITU and other international standardization organizations
- Coordinate the research needs and output of the working groups

Thoughts on 6G Development

01 **The successful commercial deployment of 5G will lay a solid foundation for 6G**

02 **Innovation in the convergence of DOICT, multi-disciplinary cross-technology breakthroughs is needed**

03 **Win-win cooperation is the foundation for global 6G development. A globally unified 6G standard should be maintained.**