Shan-zhi CHEN, Shao-li KANG, 2018. A tutorial of 5G and the progress in China. *Frontiers of Information Technology & Electronic Engineering*, 19(3):309-321. https://doi.org/10.1631/FITEE.1800070

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A tutorial on 5G and the progress in China

Key words: 5G; IMT-2020; Key technology; Standardization; Field trial

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Motivation

- 5G has become the hottest topic amongst communication academics and industries since the IMT-Advanced specifications of 4G terrestrial mobile telecommunication were approved by ITU-R at WRC-12.
- 5G is developing very fast on standardization and technology trials.
- China aims for “globally leading in 5G” and acted as a main 5G contributor in standardization and promoting/enhancing the Chinese 5G industry.
- To better understand 5G, we give a comprehensive overview, including vision and requirements, key technologies, standardization, frequency management, technology trials, roadmap, industrial ecology, and also the progress of 5G in China.

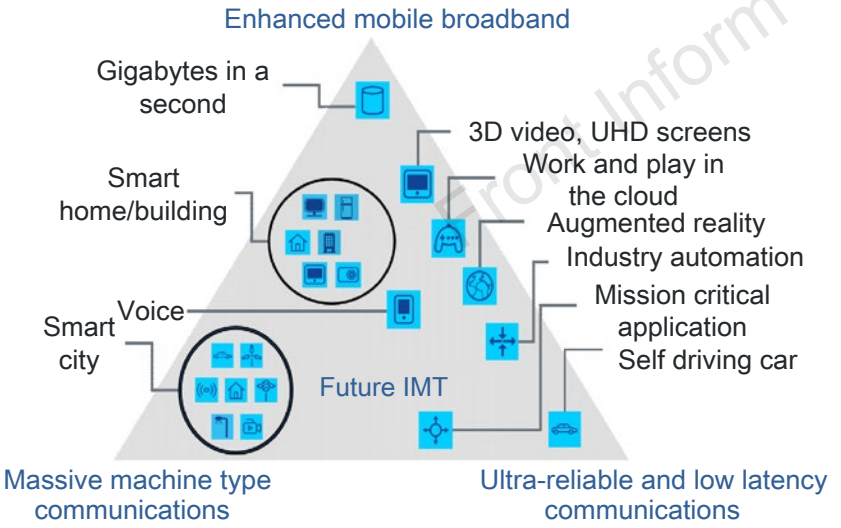
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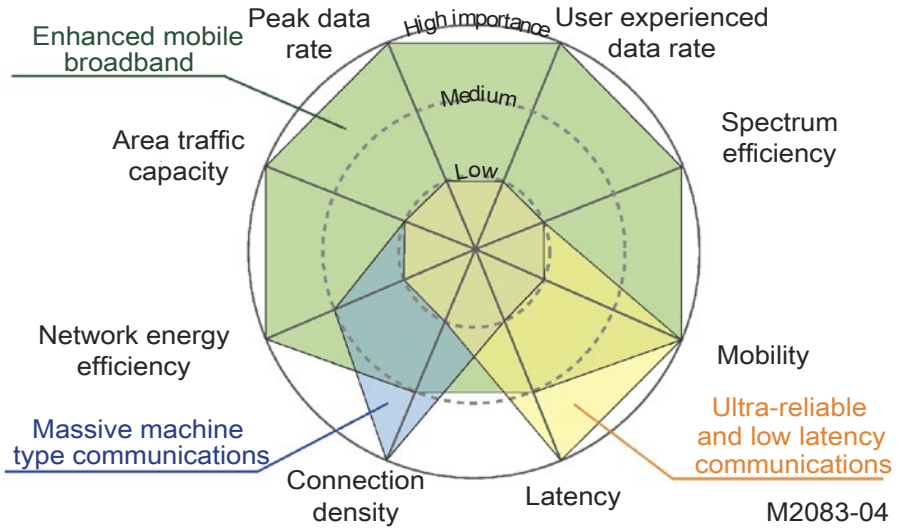
5G vision & requirements

Mobile Internet and the Internet of Things are two typical kinds of services of 5G, and the overall vision for 5G is defined as ‘information in hand, everything in touch’.

5G will provide fiber bandwidth data and ‘negligible’ latency as user experiences. 5G will be capable of connecting 100 billion worldwide devices and deliver a consistent experience across a variety of scenarios. 5G will also be able to provide intelligent optimization based on services and user’s awareness, and will improve energy and cost efficiency over a hundred-fold.

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5G key technologies

Wireless technologies

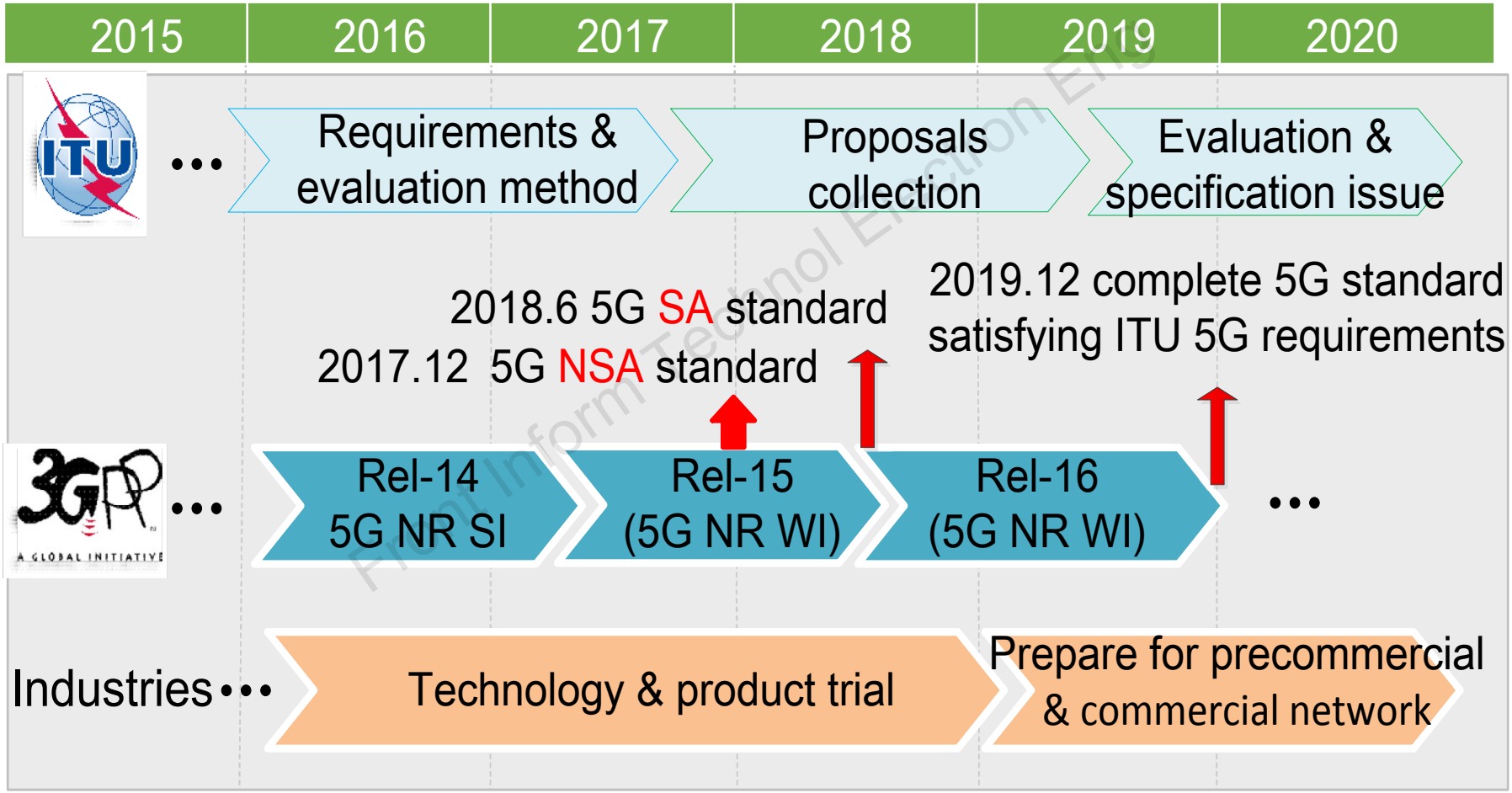
- Massive MIMO
- Non-orthogonal multiple access
- UDN
- Advanced coding and modulation
- Flexible spectrum access
- Flexible air interface design
- Vehicle-to-everything
- …

Network technologies

- SDN
- NFV
- Mobile edge computing (MEC)
- Network slicing
- Decoupling of control and forwarding plane
- Control functions reconstruction
- New connection
- Mobility management
- …

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5G roadmap


2015
2016
2017
2018
2019
2020
ITU
Requirements & evaluation method
Proposals collection
Evaluation & specification issue
2018.6 5G SA standard
2017.12 5G NSA standard
2019.12 complete 5G standard satisfying ITU 5G requirements
3GPP
A GLOBAL INITIATIVE
Rel-14 5G NR SI
Rel-15 (5G NR WI)
Rel-16 (5G NR WI)
Industries
Technology & product trial
Prepare for precommercial & commercial network

5G frequency management

Country/Region	LF band	HF band
EU	L band, 3.4–3.8 GHz	24.25–27.5 GHz, 31.8–33.4 GHz, 40.5–43.5 GHz
USA	UHF band	27.5–28.35 GHz, 37–40 GHz, 66–71 GHz
Japan	3.6–3.8 GHz, 4.4–4.9 GHz	27.5–29.5 GHz
South Korea	3.4–3.7 GHz	26.5–29.5 GHz
China	3.3–3.6 GHz, 4.8–5.0 GHz	24.25–27.5 GHz, 37–42.5 GHz

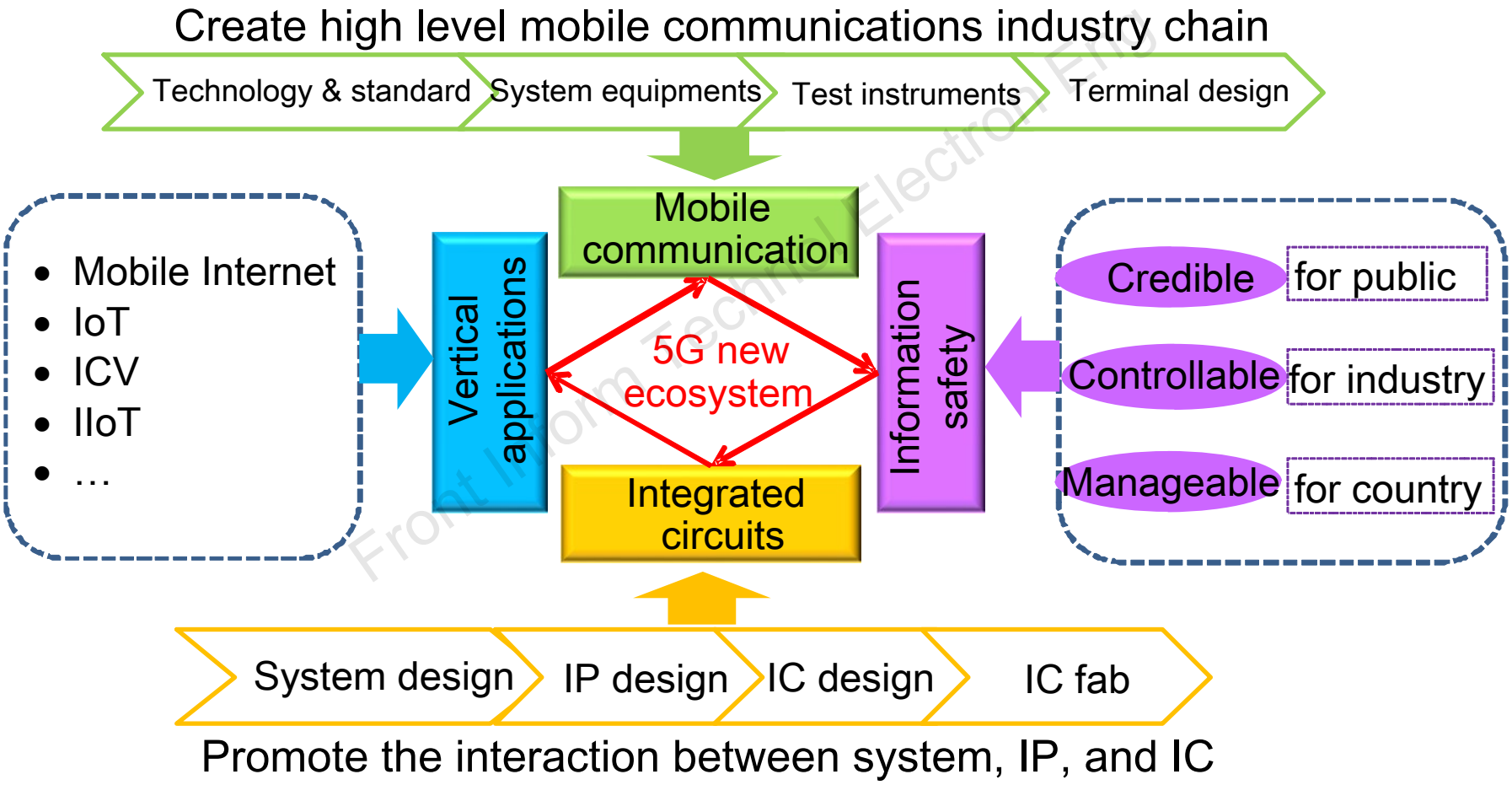
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5G test and commercial plan

Country/ Region	Test & commercial plan
EU	• Investing €1.4 billion on 5GPPP projects • Planning to conduct 5G scale tests in 2018 to verify 5G standards
USA	• A local 5G standard was led by Verizon in mid-2016 • Released frequency in 2016 and planned to spend $400 million in the next seven years to build a pilot 5G network in four cities
Japan	• Carrying out 5G technology trials with leading operator NTT DoCoMo • Planning to offer formal 5G commercial services ahead of the 2020 Summer Olympics
South Korea	• Released its 5G national strategy in 2017 • Planning to launch a pre-commercial 5G trial at the 2018 Winter Olympics and then commercialize at the end of 2020
China	• Led the 5G trial since the plan issued in 2016 • Preparing for 5G networking in 2018

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5G eco-industry

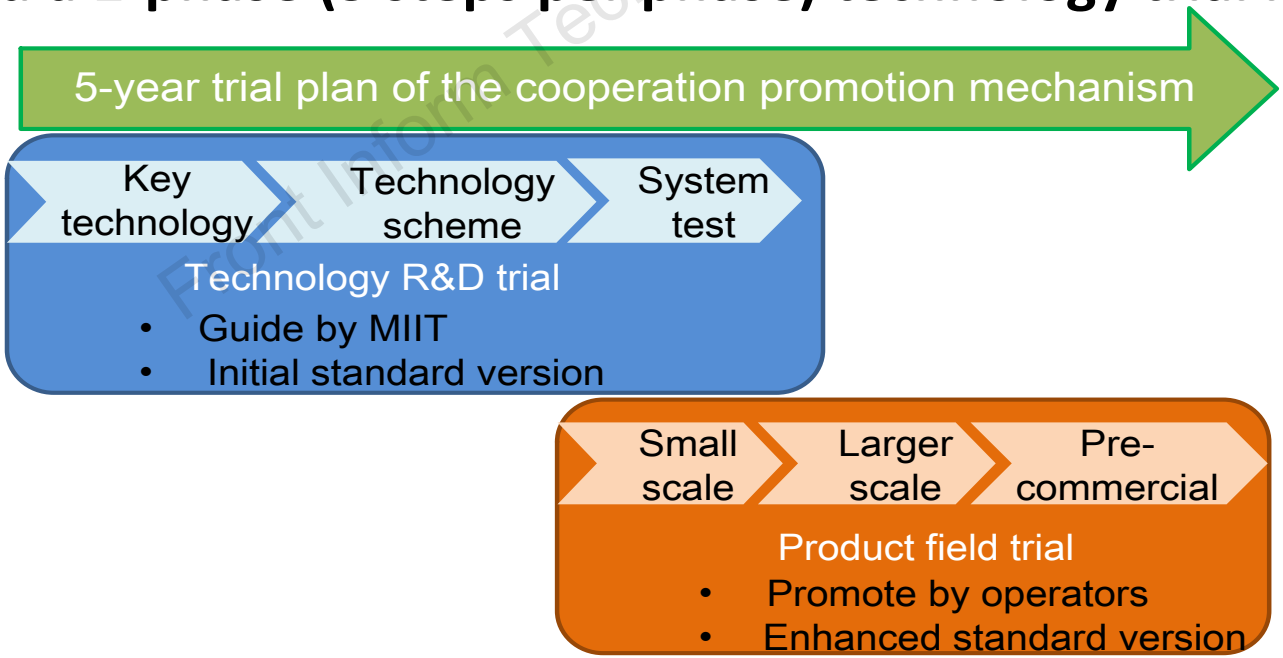


5G progress in China

Made a lot of contributions on 5G standardization

- A series of input to ITU, including vision, requirements, technologies, …
- Leading 1/3 proposals and SIs/WIs in 3GPP
- Preparing 5G documents in CCSA

Launched a 2-phase (3 steps per phase) technology trial in 2016



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Rethinking of 5G

- 5G is an era where everything is interconnected.
  - big data, huge connectivity, and scenario experiencing
- 5G is an era with software definition and ITnization.
  - deep convergence of CT and IT
  - defined by software including SDN, NFV, and software-defined radio access interface
- 5G is an era of the Cloud closer to users.
  - C-RAN, MEC, fog computing
- 5G is an era of cellular structure revolution.
  - 5G will adopt more access points, such as home stations, radio relays, micro-stations, and distributed antenna systems
  - The network structure will become heterogeneous and hierarchical
  - a de-cellular concept starting a revolution of the structure

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Conclusions

(1) 5G has gained wide attention and is developing very fast.

- The 5G NSA standard has been formulated, and the SA standard will be formed in the middle of 2018.
- The 5G trial has gone through the technology R&D phase, and the product field trial is in progress.
- The 5G industrial ecosystem is at a building phase, and the involvement of and cooperation with industry need to be strengthened.

(2) Research on beyond 5G will be started gradually and there have been some interesting topics in discussion.

- application of artificial intelligence and big data to make smart 5G, high frequency communication in THz bands, satellite and terrestrial integrated mobile communications, and joint sensing and communication

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