移動通信システムの現在、過去、未来

Present, Past and Future of Mobile Communication Systems

ITU電気通信標準化局長

尾上 誠蔵

Director of ITU Telecommunication Standardization Bureau

Seizo ONOE

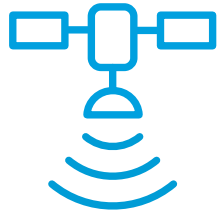
Committed to connecting the world

New management team takes helm at UN tech agency

Elected officials lead ITU's work on radiocommunication, technical standardization, and digital development

Geneva, 03 January 2023

The United Nations specialized agency for information and communication technologies



Radiocommunication

Standardization

Development

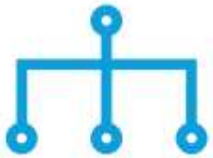
193

Member States

900+

Companies, universities,
and international and regional organizations

ITU standardization: Technical foundations



Transport, access and home networks

Multimedia

Service quality

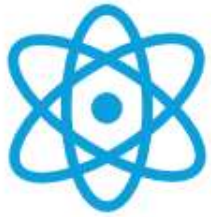
Numbering & emergency comms

Artificial intelligence

Cybersecurity

Internet of Things

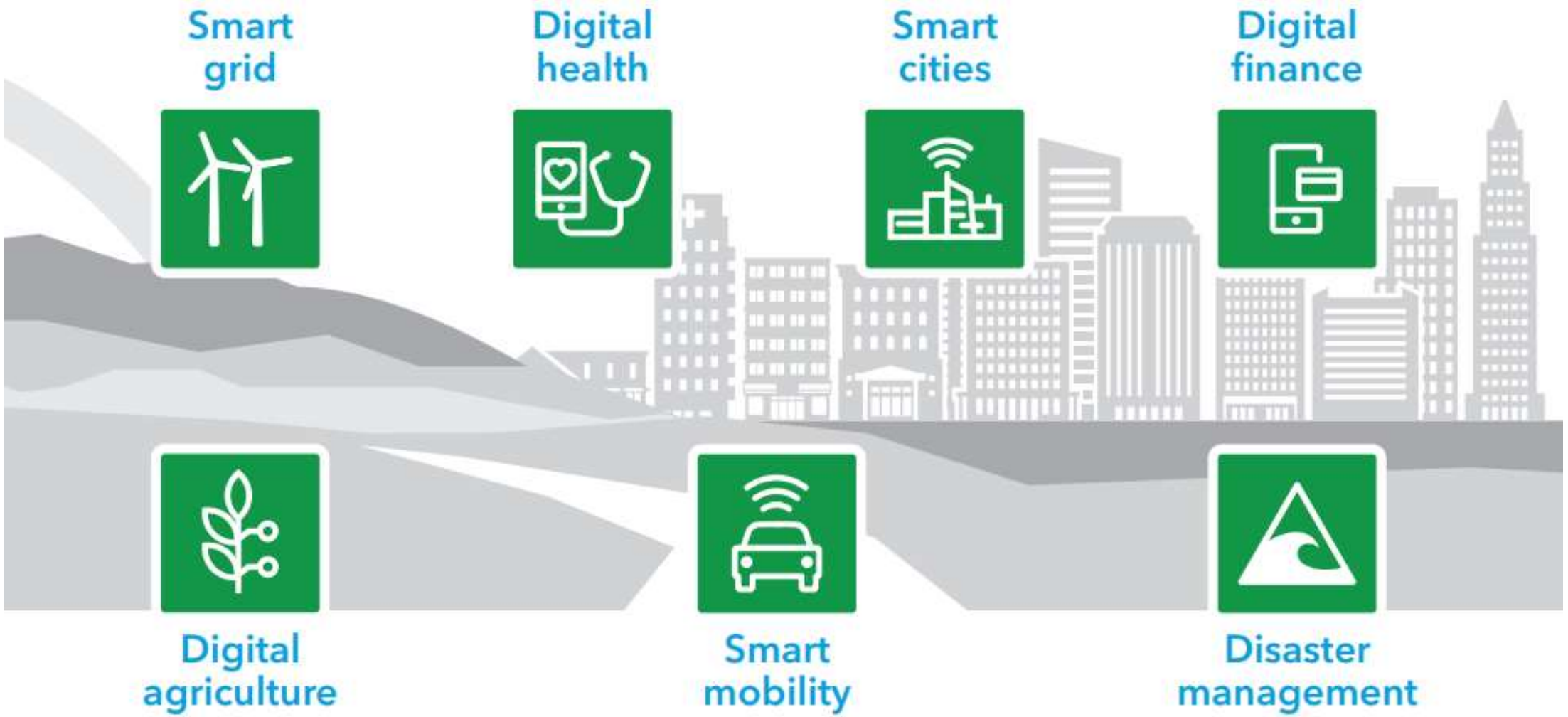
Environmental efficiency



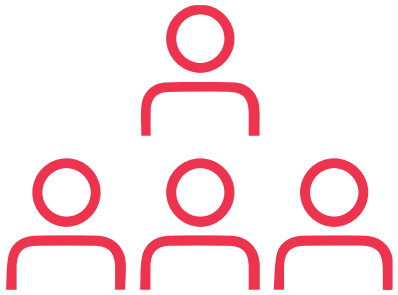
Quantum information tech

Accessibility

ITU standardization: Digital transformation



ITU standardization: Global community

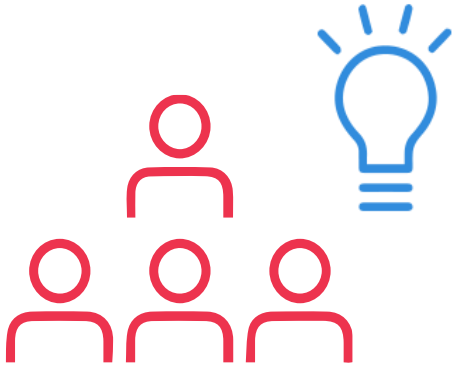


Study Groups

Membership-driven study groups develop international standards

Focus Groups

Open-to-all focus groups define new directions in ITU standardization



Workshops

Open-to-all events analyze emerging trends and encourage peer-learning

ⓘ Reduced ITU membership fees available for academia, start-ups and SMEs, and companies of all sizes in developing countries

ITU standardization: Structure

Membership-driven standardization work

SG2: Operational aspects
SG3: Economic & policy issues
SG5: Environment, EMF & circular economy
SG9: Broadband cable & TV
SG11: Protocols, testing & combating counterfeiting
SG12: Performance, QoS & QoE
SG13: Future networks
SG15: Transport, access & home
SG16: Multimedia & digital technologies
SG17: Security
SG20: IoT, smart cities & communities

Open-to-all pre-standardization work

FG-MV: Metaverse
FG-TBFxG: Testbed federations for 5G and beyond
FG-AI4A: AI & IoT for digital agriculture
FG-AI4NDM: AI for natural disaster management
FG-AN: Autonomous networks
FG-AI4H: AI for health

Governance

WTSA: World Telecommunication Standardization Assembly

TSAG: Telecommunication Standardization Advisory Group

ITU standardization: Bridging the standardization gap

Hands-on study group effectiveness trainings
- Coaching in practical skills valuable to participation in ITU standardization

Fellowships
- Financial support to delegates from eligible developing countries

Regional groups within study groups
- Regional groups help to ensure that ITU standards are globally applicable

Online training course on ITU standardization working methods
- Training course on ITU standardization processes

Regional standardization forums
- Regional and interregional forums address working methods and topics under study

National standardization secretariats
- Guidelines on national frameworks for effective participation in ITU standardization

ITU standardization: Academia

ITU Journal
Future and evolving technologies

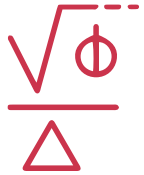
The ITU Journal – free of charge to both readers and contributors – offers comprehensive coverage of communications and networking paradigms

ITU KALEIDOSCOPE

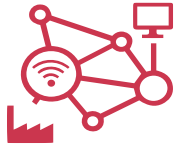
Annual Kaleidoscope conferences highlight research into key strategic topics for ITU standardization

ITU Academia members participate with reduced membership fees in ITU expert groups responsible for radiocommunication, standardization, and development

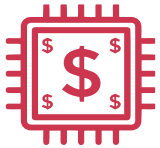
ITU standardization: Collaboration initiatives



AI for Good
- AI for Good Global Summit - AI for Good digital platform - AI for Good Neural Network



Digital transformation for cities & communities
- United for Smart Sustainable Cities initiative



Financial inclusion, fintech & digital currencies
Digital Currency Global Initiative - Security Lab for Digital Financial Services

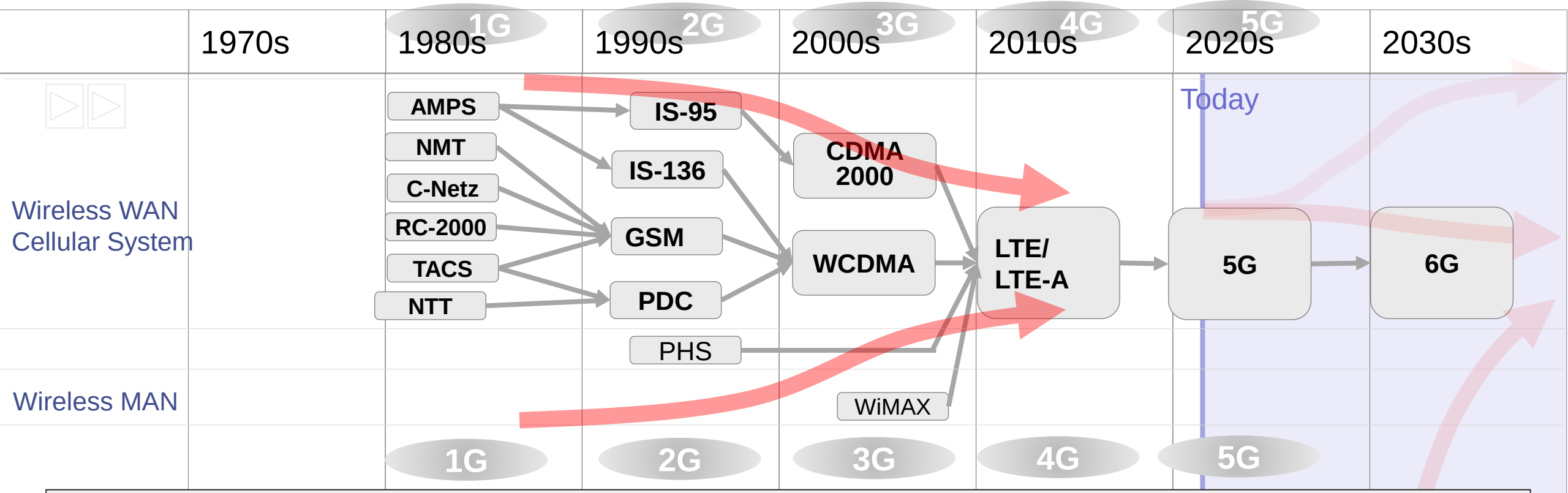
Smart & safe mobility
- Collaboration on ITS Communication Standards - Future Networked Car Symposium

Consultations with industry leaders
- CTO & CxO meetings

ITU Events
AI for Good
Global Summit
Accelerating the United Nations
Sustainable Development Goals
6 - 7 July 2023
Geneva, Switzerland
aiforgood.itu.int
40 UN PARTNERS
ITU

Topics

- History of Generations: 1G to 5G
- Future Beyond 6G toward 12G
- Thought on International Telecommunication Standardization



"Throughout its long history, telecom standardization has helped make people's lives more convenient and society more efficient."

- Global coverage of services
- Cost reduction by economies of scale and competition principle

More effort is needed to achieve a truly affordable and even better ecosystem.

1G

Analogue Cellular

Each country developed and deployed different systems.

No effort for a global standard

Evolution of Cellphones

Japan

TZ-801
1979 Dec. Car phone
6600cc, 7kg, 5W

TZ-802A
1985 Sept. Portable
1500cc, 2.9kg, 5W

TZ-802B
1987 Apr. Mobile
500cc, 900g, 1W

TZ-804B
1991 Apr. (mova)
150cc, 230g, 0.6W

Source: http://history-s.nttdocomo.co.jp/list.html

US

DynaTAC 8000X
1984
Around 800g

MicroTAC 9800X
1989 Apr.
303g

Source: WIRED "The 12 Cellphones That Changed Our World Forever"
https://www.wired.com/2013/04/influential-cellphones/

Prehistory of
Cellphones

2G

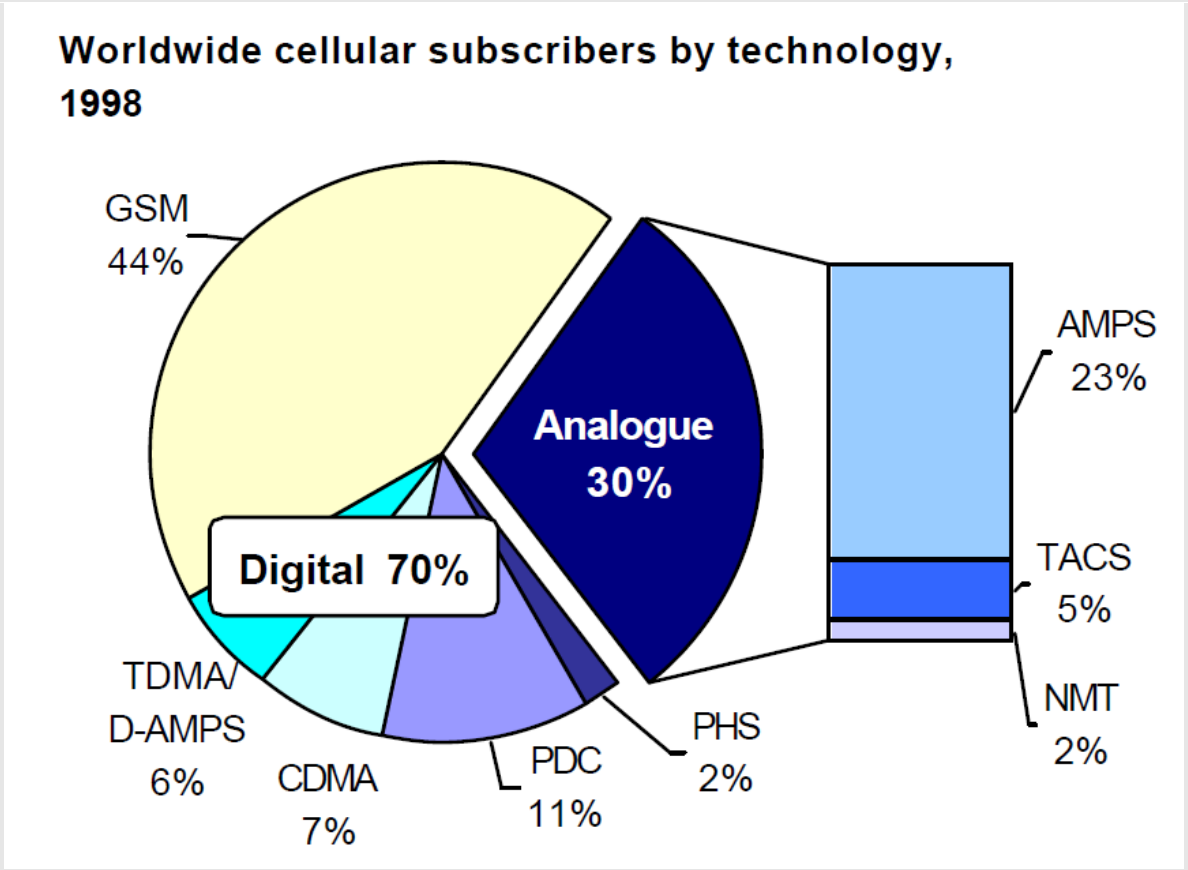
Digital Cellular

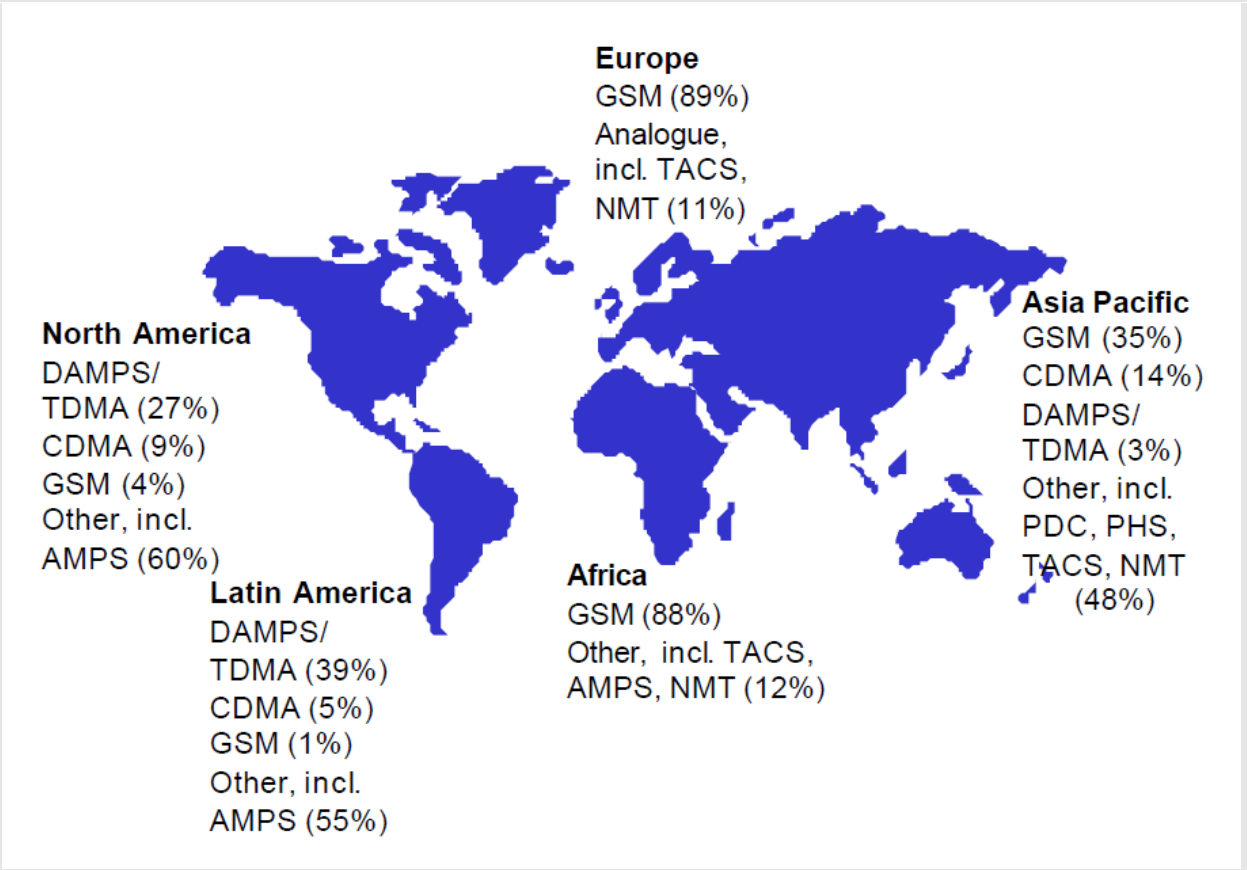
European standard GSM became a de facto global standard.

Some effort to seek commonalities against the backdrop of world's economic competition

Result of market efforts after completion of standards

Global Deployment





Source: ITU adapted from Ericsson, GSM MoU, CDMA Development Group.

Source : WORLD TELECOMMUNICATION DEVELOPMENT REPORT 1999, ITU

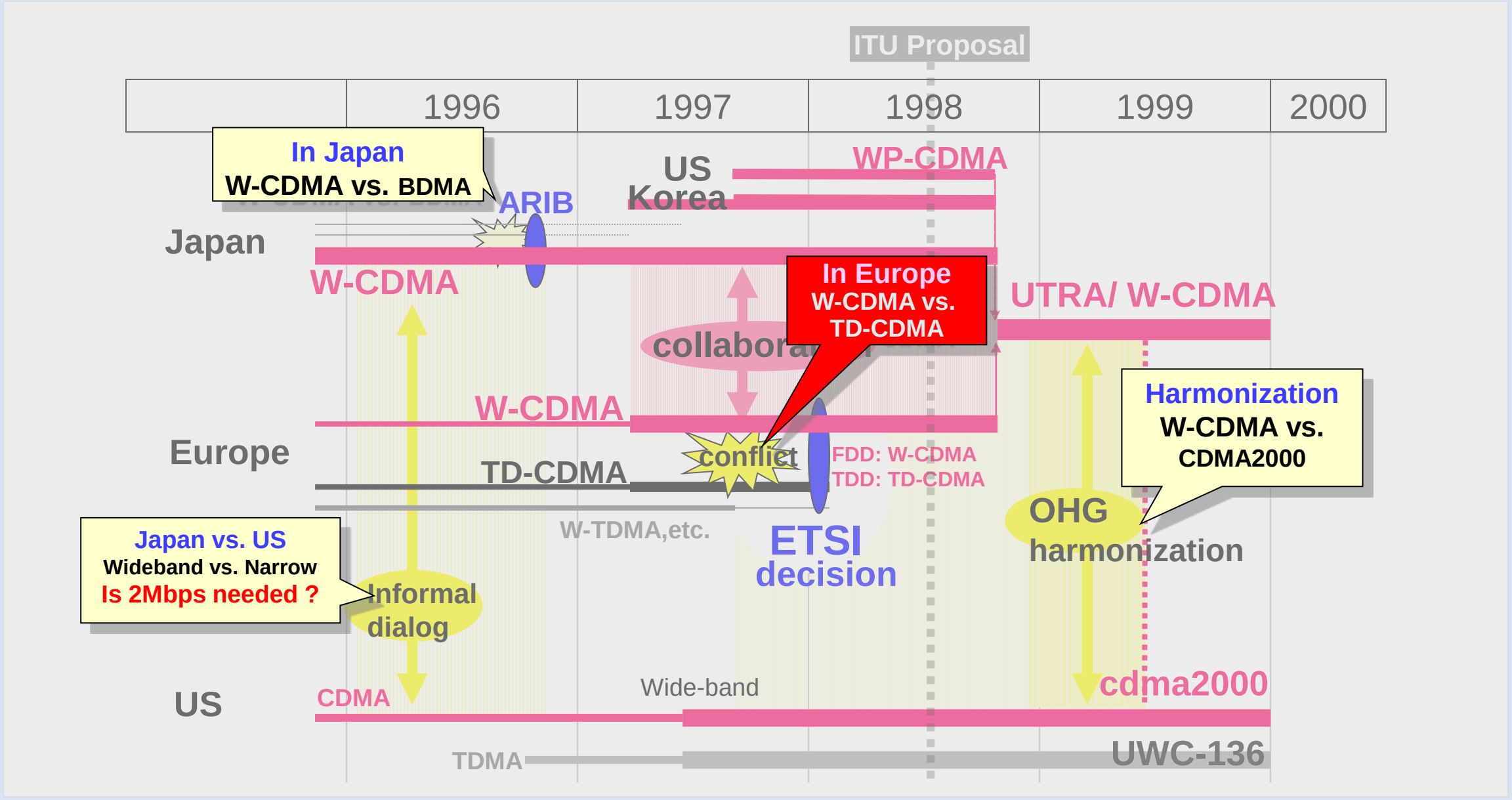
3G

IMT-2000

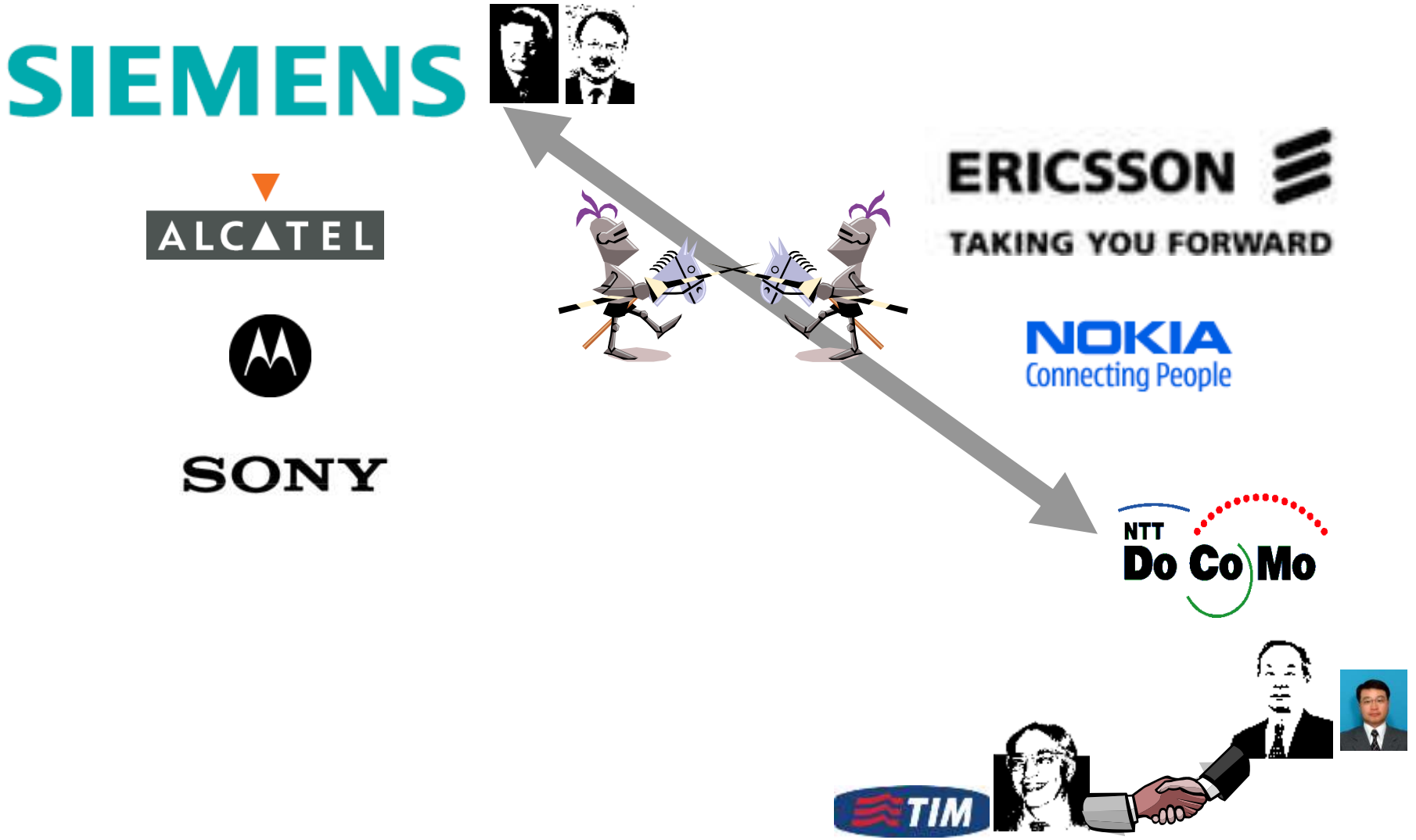
Since 3G standardization aimed at a globally unified standard,
after fierce discussions, the number of standards was narrowed down.

**Maximum effort toward unified standard,
but failed to achieve a single standard**

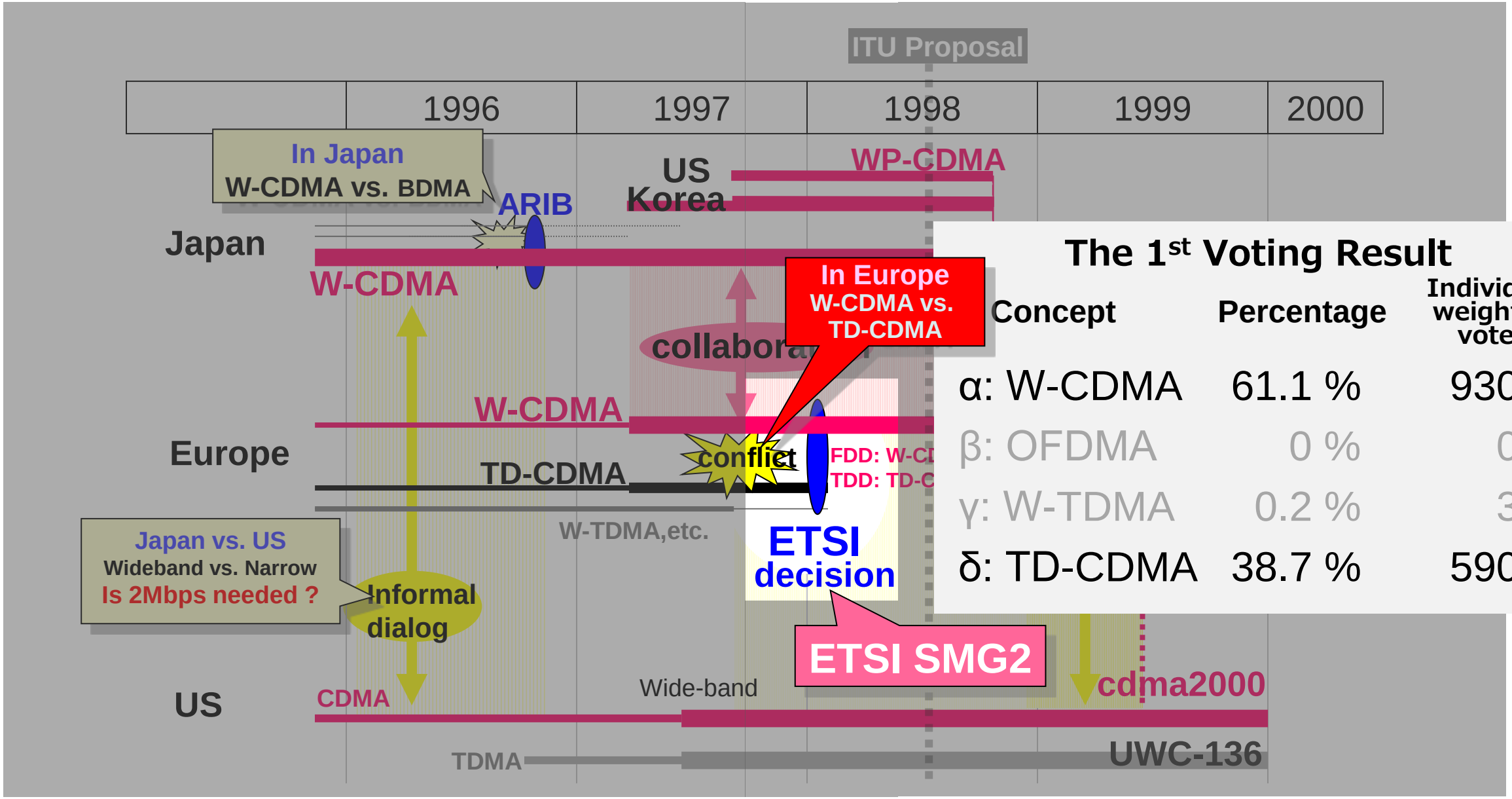
3G Standardization Discussions



TD-CDMA versus W-CDMA



3G Standardization Discussions



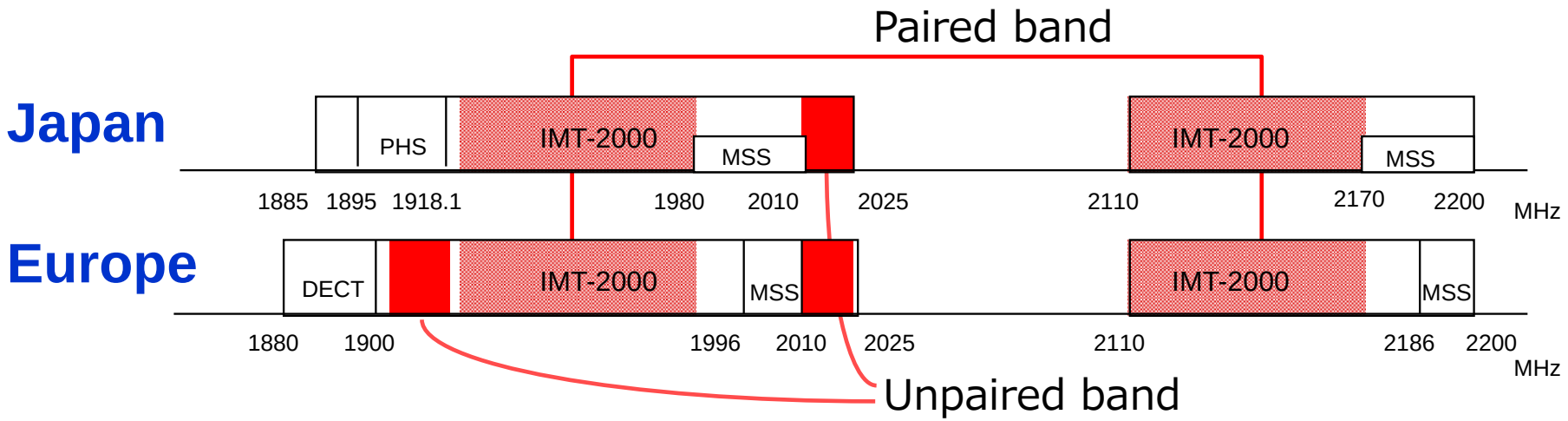
The 1st Voting Result

Concept	Percentage	Individual weighted votes
α: W-CDMA	61.1 %	930
β: OFDMA	0 %	0
γ: W-TDMA	0.2 %	3
δ: TD-CDMA	38.7 %	590

ETSI Consensus Decision

A compromise was agreed to adopt both concepts, where W-CDMA is applied to major frequency bands.

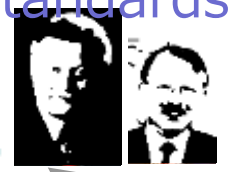
- Paired band: W-CDMA of ETSI Alpha group ⇐ **FDD**
- Unpaired band: TD-CDMA of ETSI Delta group ⇐ **TDD**
- Additional objectives
  - Low-cost terminal
  - Harmonization with GSM
  - FDD/TDD dual-mode operation
  - Fit into 2*5 MHz spectrum allocation



After TD-CDMA vs. W-CDMA

Yesterday's enemy is today's friend. He became a companion in the dispute with CDMA2000 and a co-author for a paper on 3G standards.

SIEMENS



ERICSSON

TAKING YOU FORWARD

NOKIA

Connecting People

IEEE Communications MAGAZINE

The 3GPP Proposal for IMT-2000

Prodip Chaudhury, Siemens Information and Communication Networks, Inc.

Werner Mohr, Siemens AG

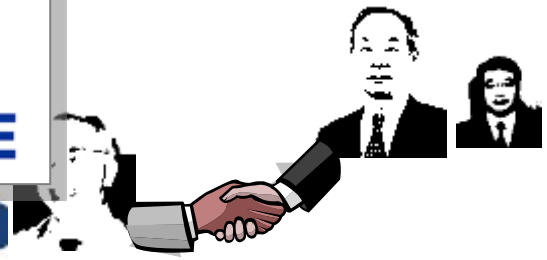
Seizo Onoe, NTT DoCoMo

IEEE Communications Magazine • December 1999 Volume 37 Issue 12

IEEE COMMUNICATIONS SOCIETY

IEEE

NTT DoCoMo



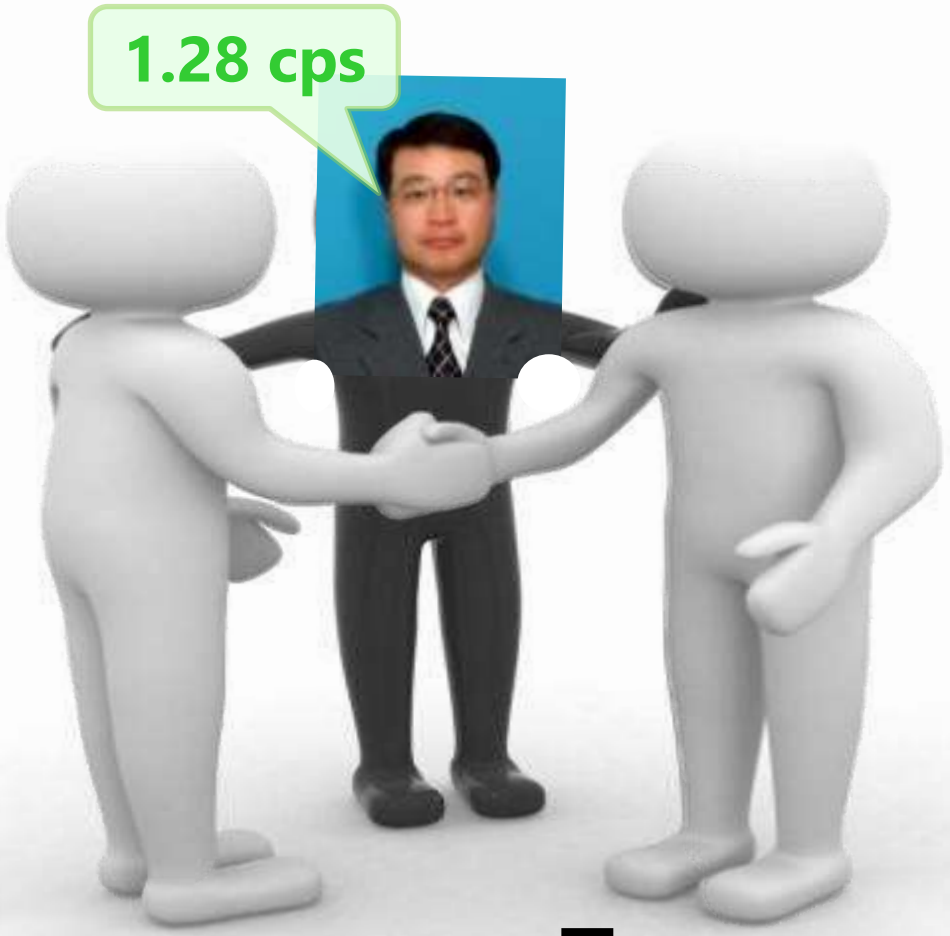
TIM

After TD-CDMA vs. W-CDMA

Harmonization between **TD-SCDMA** and **TD-CDMA**

GTI Summit 2015 Shanghai

More than 10 years later

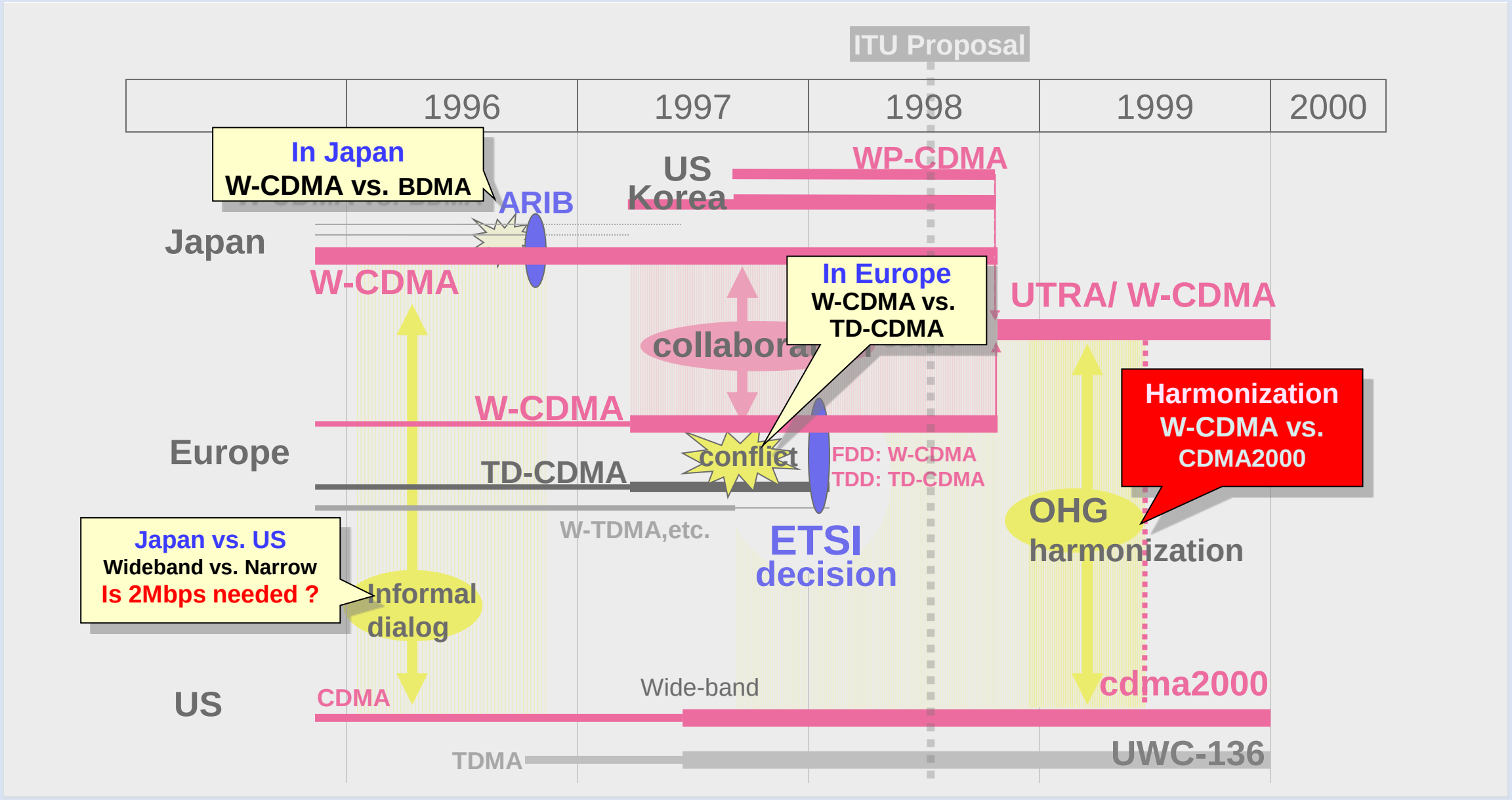


China

European operators

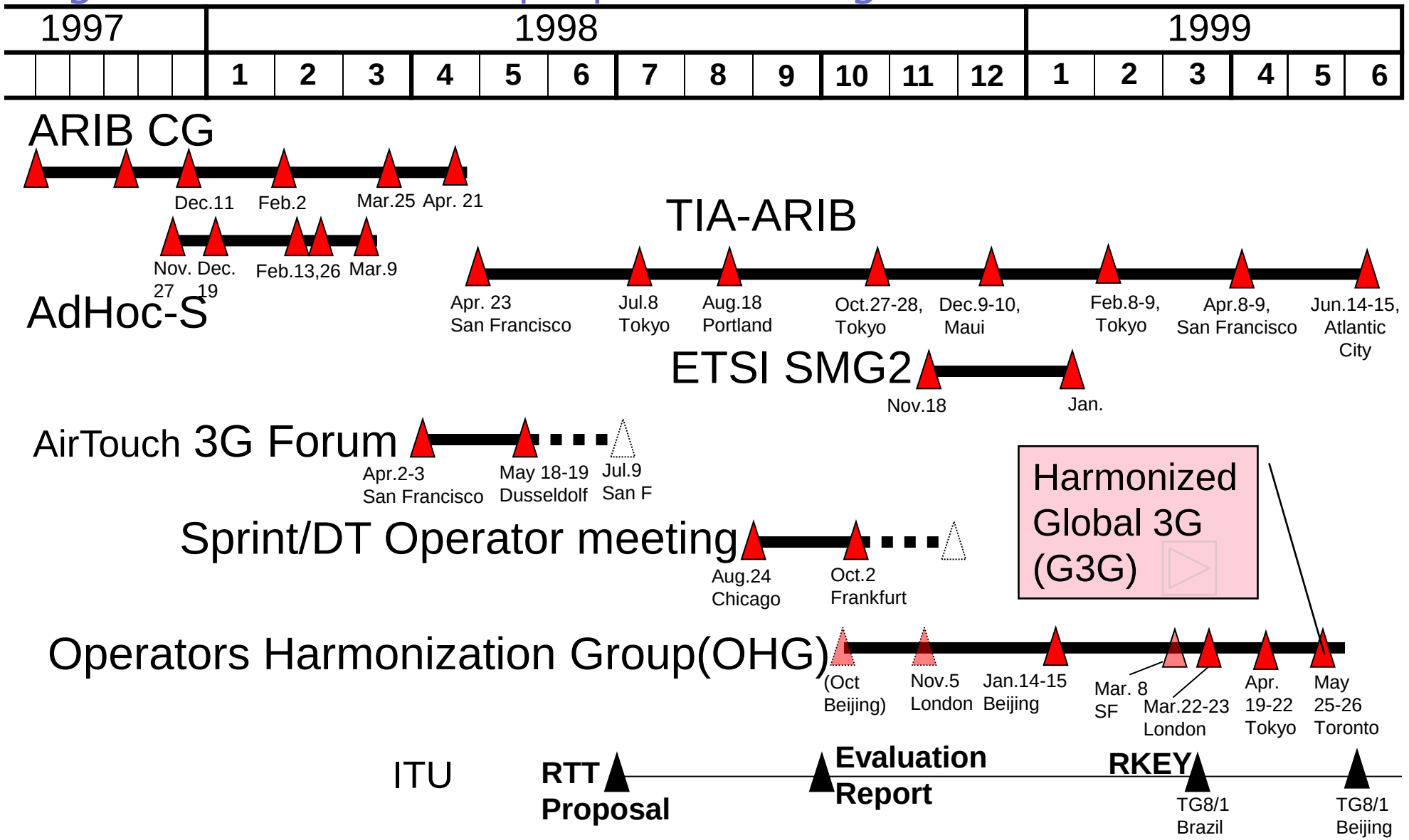
https://k-tai.watch.impress.co.jp/docs/event/mwcs2015/711978.html
https://www.itmedia.co.jp/mobile/articles/1311/29/news019.html
https://k-tai.watch.impress.co.jp/docs/news/712920.html

3G Standardization Discussions

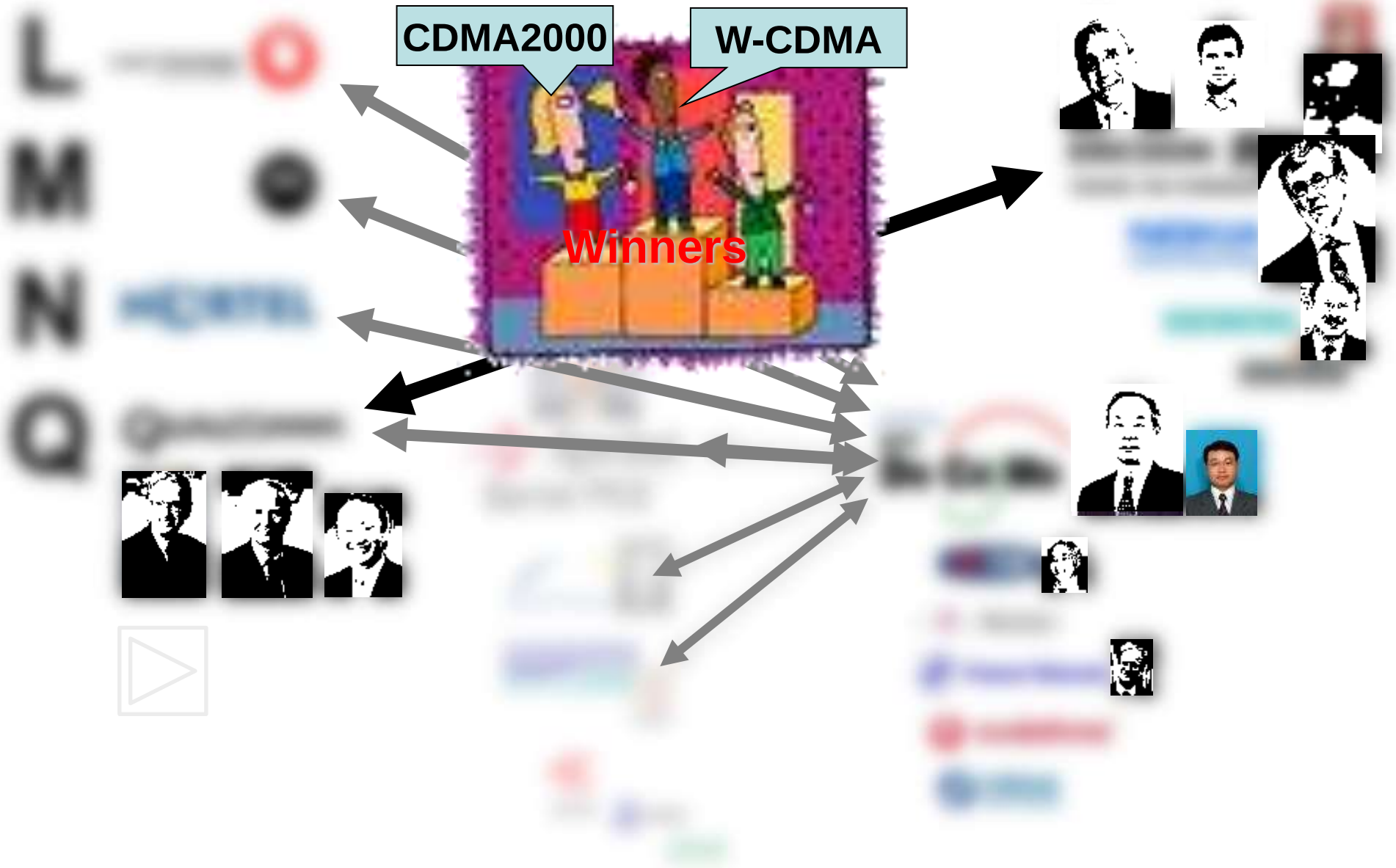


Harmonization between CDMA2000 and WCDMA

SDOs held a meeting for harmonization, but the discussion was prolonged. Harmonization proposal was agreed at OHG.



CDMA2000 versus W-CDMA



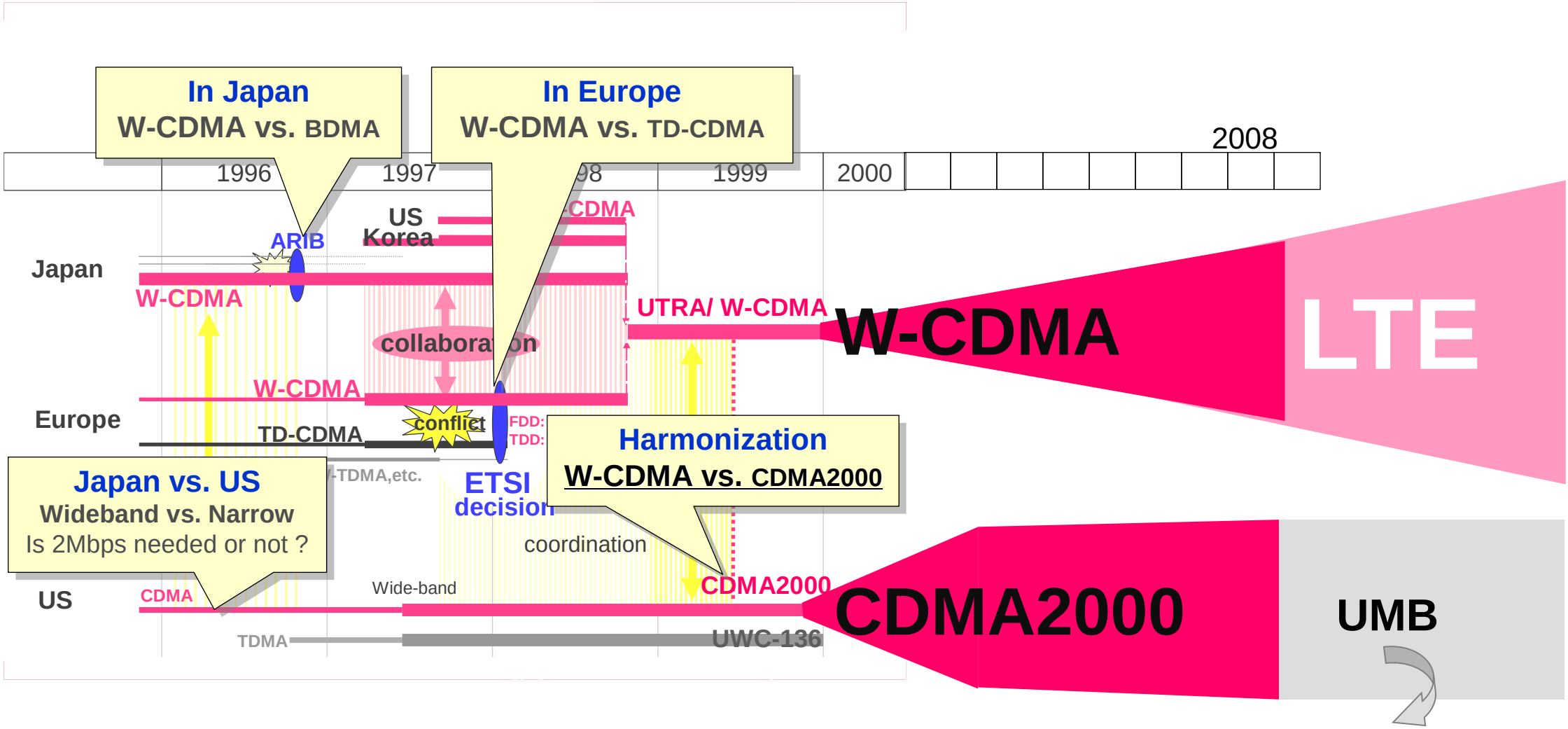
4G

LTE (IMT-2000/IMT-Advanced)

LTE, which is a long-term evolution from W-CDMA, having market potential, became the mainstream.

A single standard determined by the market, not standardization

3G Standardization History and Epilogue



The market determined the standard 10 years after the standardization.

4G

LTE (IMT-2000/IMT-Advanced)

LTE, which is a long-term evolution from W-CDMA, having market potential, became the mainstream.

New G, 4G, was not welcomed in the early stage just after huge 3G investment

History of 4G Research at NTT DOCOMO

Background: 4G research outcome of over 1Gbps data transmission

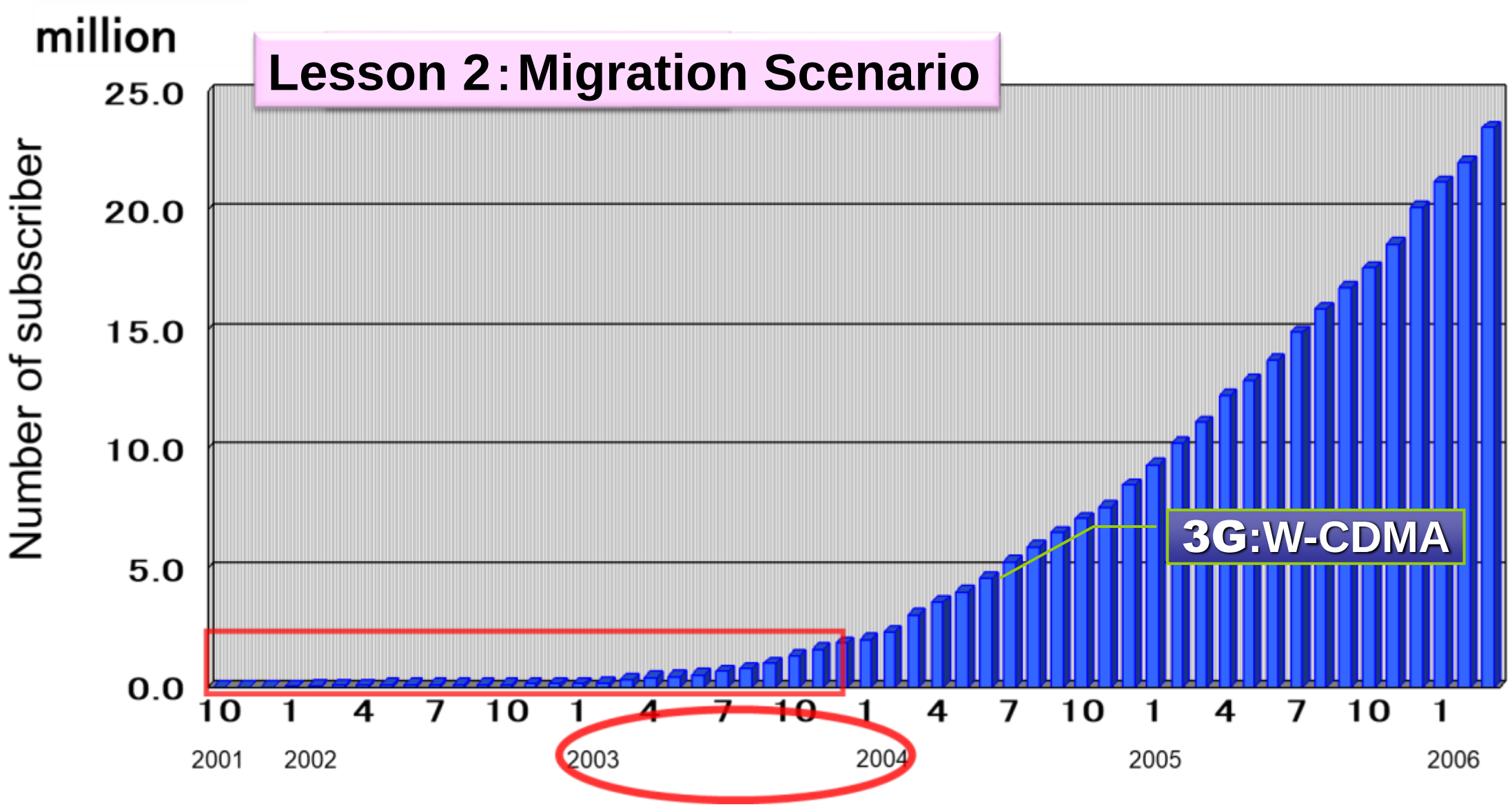
100Mbps
in 2002-2003

1Gbps
in 2004-2005

5Gbps
in 2006

3G Subscriber Growth

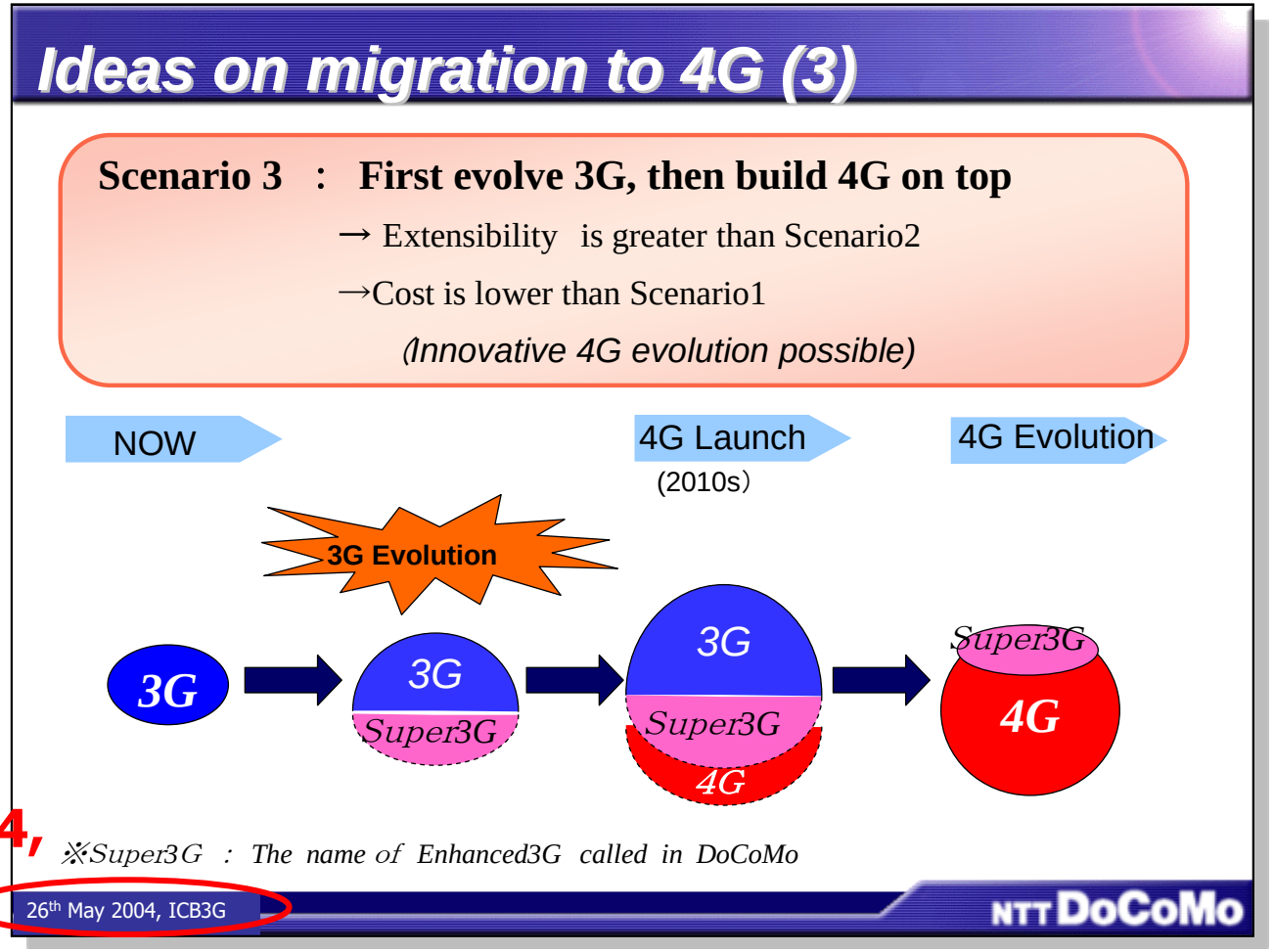
On the other hand, 3G services had not been well accepted by the market.



Super3G concept

Advocated the Super 3G concept for the smooth introduction of 4G.

First evolve 3G, then build 4G on top. The first evolved 3G was called Super 3G.



26th May 2004, ICB3G

Input Document to the 3GPP RAN Plenary Meeting

The document for the Study Item did not have the term "4G" nor "LTE", only used the general term "3G long-term evolution". Later, the abbreviation for the Work Item name became LTE, and it came to be called LTE.

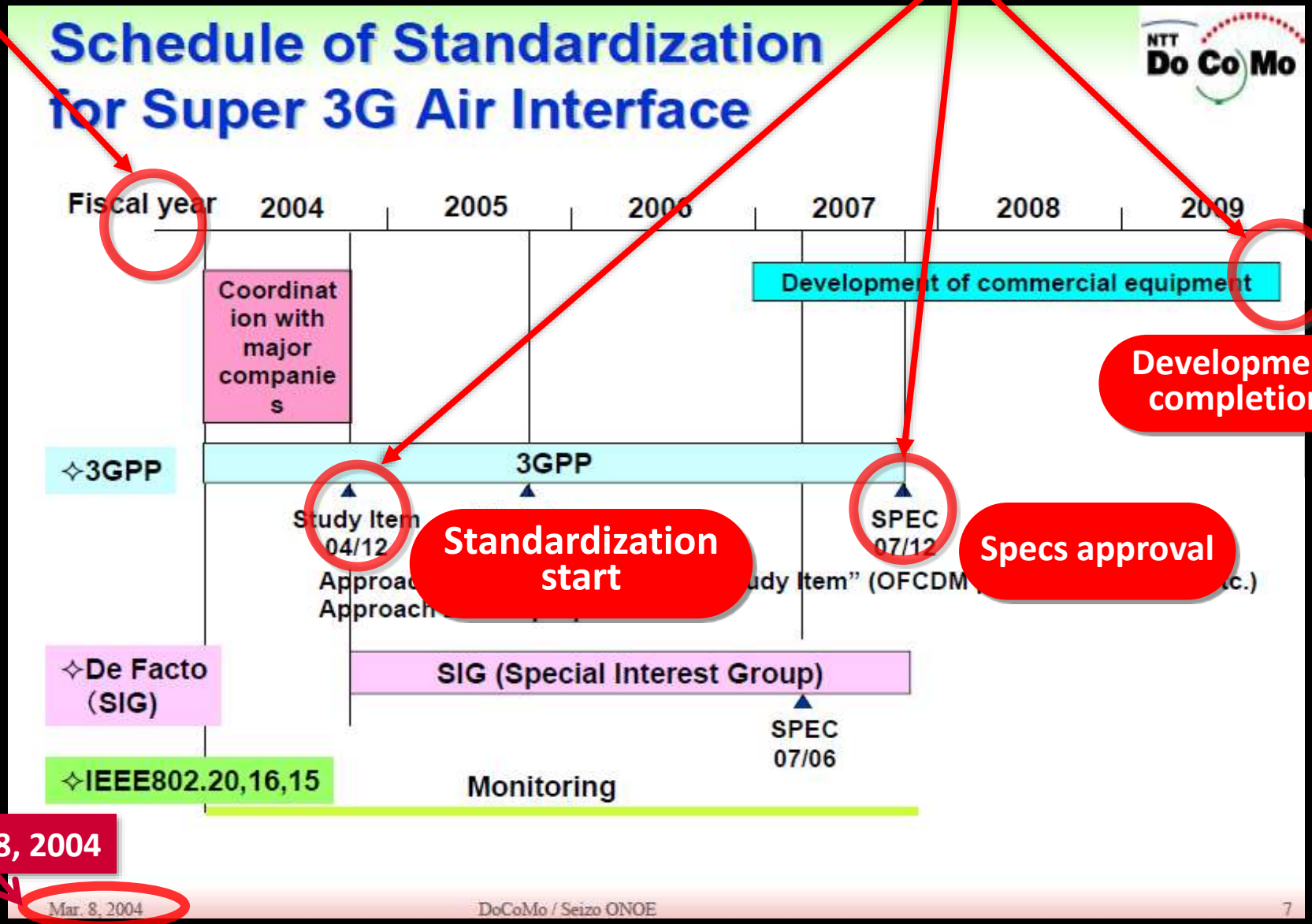
TSG-RAN Meeting #26
RP-040461
Athens, Greece, 8-10, December, 2004
Agenda Item: 8.12
Source: **NTT DoCoMo, Alcatel, Cingular Wireless, CMCC, Ericsson, Fujitsu, Huawei, LG Electronics, Lucent Technologies, Mitsubishi Electric, Motorola, NEC, Nokia, Nortel Networks, Orange, Panasonic, Philips, Qualcomm Europe, Samsung, Sharp, Siemens, Telecom Italia, Telefonica, TeliaSonera, T-Mobile, Vodafone**
Title: **Proposed Study Item on Evolved UTRA and UTRAN**
Document for : Discussion and approval

In the RAN Future Evolution Workshop, many of the presentations pointed out the need of 3G long-term evolution to meet the future demand and to maintain its competitive position for coming decades. Several interesting new technology components such as OFDM with a flexible and broader RF bandwidth were presented as potential candidates for the evolution. It was pointed out such a technology enhancement should be applied to UTRAN architecture as well as the UTRA radio interface.
It is proposed that 3GPP should initiate the feasibility study of the long-term evolution accounting for the above situation. In this paper, a Study Item Description is presented for this study.
Concerning the time plan, we propose to complete the feasibility study by June 2006 and envisage all relevant core specifications by June 2007.

新聞記事

A Slide used for initiating the standardization

In early 2004, DOCOMO predicted the milestones, which happened.



ベンダ社内誌

5G

5G

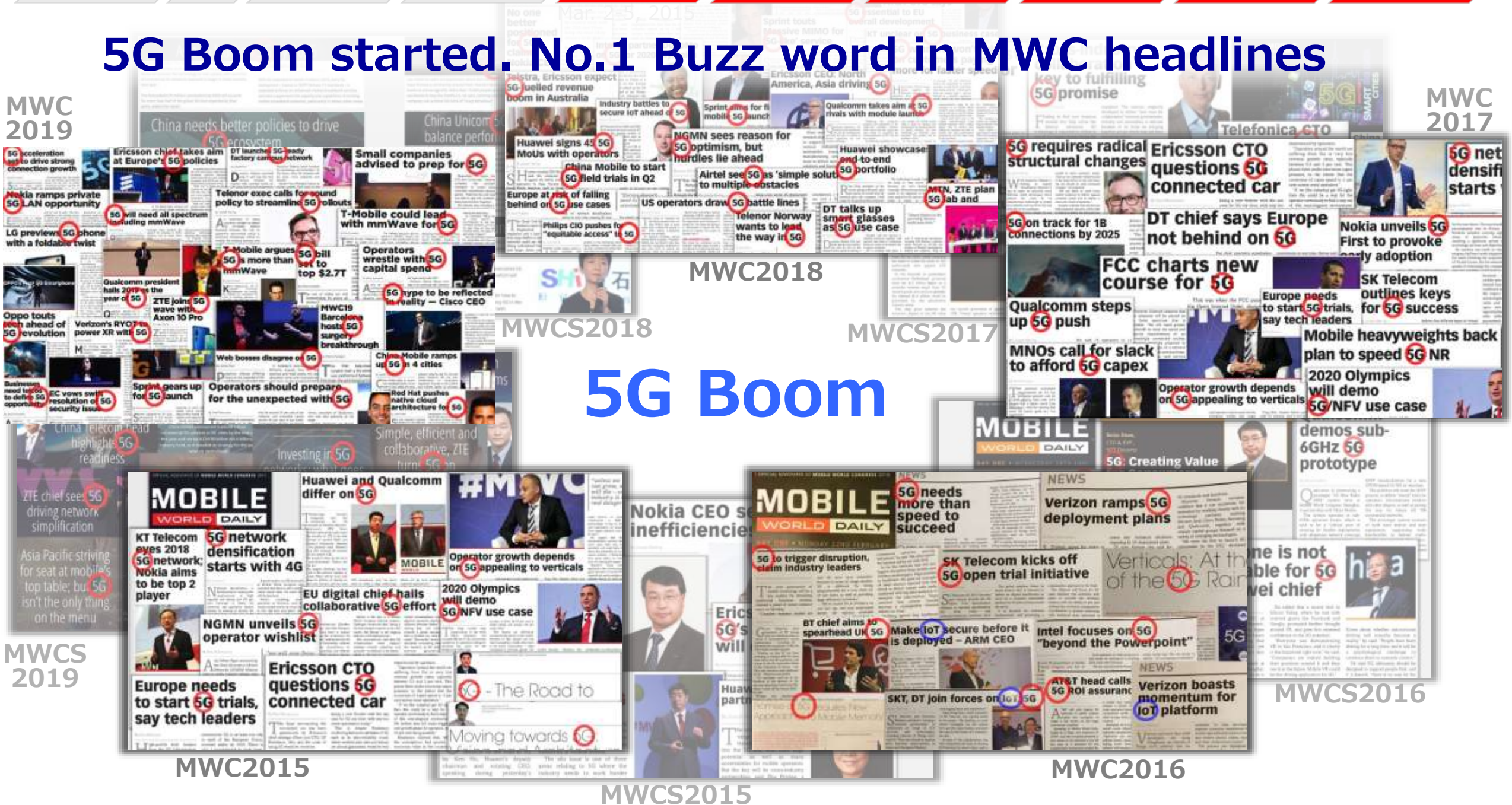
5G standard was developed based on LTE, attracting attention from various industries, and is expected to create new businesses.

A natural evolution from 4G LTE

Positive/negative aspect by 5G boom

2010 ·· 2013 2014 2015 2016 2017 2018 2019 2020

5G Boom started. No.1 Buzz word in MWC headlines



Myths about 5G

5G SIM

5G Encryption

5G Spectra

5G Roaming

5G Core Network?

People are trying to jump on the 5G bandwagon.

- **For 5G, all things need something new.**
- **5G needs significant investment.**

ngmn
the engine of
wireless innovation

ITUPP
BUCHAREST2022
26 September - 14 October 2022
Bucharest, Romania

GSMA
APAC DX
Digital Transformation Leaders'
CXO Summit, Tokyo JAPAN
Sheraton Miyako Hotel Tokyo, Japan
Daigo West
Tuesday, 29th November 2022
08.00-17.30
Wednesday, 30th November 2022
08.30-17.00
https://www.linkedin.com/posts/seizoonoe_5g-itu-gsma-activity-7012394964974264320-9Cji?utm_source=share&utm_medium=member_desktop
82

https://www.linkedin.com/posts/seizoonoe_itu-tsb-activity-7021620617808420864-dNvo?utm_source=share&utm_medium=member_desktop

84

5G

5G SIM

5G Encryption

5G Spectra

5G Roaming

5G Core Network?

Let's get on the 5G bandwagon

and create new business models through the collaborations across industries.

2016 Jan.-May

Operators declaring 5G launch before 2020

Verizon Eyes 5G Deployment in 2017

Tue, 03/01/2016 - 2:00pm by Diana Goovaerts, Associate Editor, @DiaMariesbeat

Verizon Doubles Down on 2017 Deployment of 5G

Thu, 04/
by Diana

Verizon
asserti

Verizon to Commercially Deploy 5G Wireless Networks in 2017

ZACKS By Zacks Equity Research
April 22, 2016 3:19 PM

CNET » Mobile » Verizon to be first to field-test crazy-fast 5G wireless

Verizon to be first to field-test crazy-fast 5G wireless

It expects "some level of commercial deployment" to begin by 2017 for next-generation wireless. That's much earlier than the common industry belief that 2020 will mark the start.

Verizon is getting ready to kick its wireless network up another notch.

AT&T's Mair: Like Verizon, AT&T will have pre-standards 5G gear by end of 2017

May 12, 2016 | By Monica Alleven

SHARE

In the meantime, Mair said AT&T expects to conduct a lot of work. "There's going to be a lot of labs work going on, a lot of labs testing, lots of proofs of

KT on target to offer 5G at Winter Olympics in 2018

16 Feb 2016

South Korea

South Korean mobile network operator KT Corp has reportedly said that it is on track to be able to provide 5G services at the Winter Olympics venue in 2018 as scheduled, according to Yonhap News Agency. It is understood that KT is aiming to complete 30% of network construction by the end of this month, with the infrastructure project set to be completed by the end of the year, with a view to starting the first services in 2017. As the official network service provider of the 2018 PyeongChang Winter Olympics, KT meanwhile has also said that its wireless platforms will be able to serve up to 250,000 devices at the same time at the event.

Showcasing 5G Network Services

KT to provide 5G Network Services for 2018 Winter Games in PyeongChang

SK Telecom Claims 5G Trial Milestone

3/31/2016

SK Telecom (Nasdaq: SKM) has previously announced plans to have some kind of 5G service in operation for the Winter Olympics that will take place in Pyeongchang in 2018.

Several other Tier 1 service providers have announced similar plans over the next few years, including Japan's NTT DoCoMo Inc. (NYSE: DCM), US operators AT&T Inc. (NYSE: T) and Verizon Communications Inc. (NYSE: VZ), Russia's Mobile TeleSystems OJSC (MTS) (NYSE: MBT) and MegaFon and Sweden's Telia Company . (See AT&T Lights Fire Under 5G, Plans 2016 Trials, TeliaSonera, Ericsson Join 5G Early Movers, Russia's MTS to Trial 5G in 2018,

2010 ·· 2013 2014 2015 **2016** 2017 2018 2019 2020

MOBILE WORLD CONGRESS BARCELONA 22-25 FEB 2

At meetings during MWC Feb. 22-25, 2016

DOCOMO
EVP and CTO

Onoe-san, help me. Please do
about a US major operator

I understand, but ...
Anyway, say "No".

ca

You should say that you can't

I can't say that.
Dropped from the project.

A vender
SVP and CTO

DOCOMO
EVP and CTO

Onoe-san, help me. Please do
something about a US major operator.

I understand.

He believes it's possible because you say "I can".
You should say that you can't do what you can't do.

ect.

A vender
Group President

DOCOMO
EVP and CTO

Onoe-san, help me. Please do
something about a US major operator.

I understand.

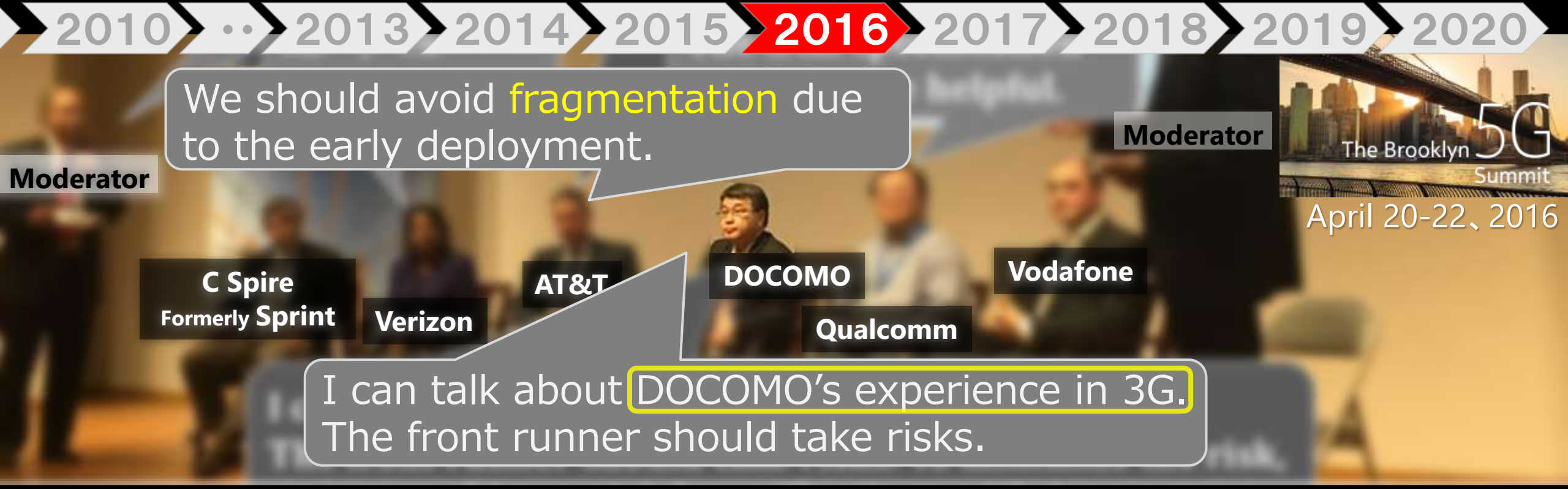
He believes it's possible because you say "I can".
You should say that you can't do what you can't do.

ect.

A vender
President, EVP

The content of the conversation for illustrative purposes only. Actual content varies.

2010 ‥ 2013 2014 2015 **2016** 2017 2018 2019 2020



2018年10月1日

ベライゾンが固定5Gサービスを開始

09.11.2018 | Network

verizon

5G is here

Online orders start Thursday, Sept. 13 Verizon 5G Home broadband

NEW YORK – "5G is here," said Hans Vestberg, Verizon Chief Executive Officer.

世界初の商用5Gサービス「ベライゾン5Gホーム」10月1日に開始。9月13日からオンライン申し込み。

The world's first commercial 5G service, Verizon 5G Home, is live on Oct 1; service is available for order on Thursday

2019年4月3日

世界初5Gスマートフォンを韓国3オペレータと米国ベライゾンが提供。両社とも世界初を主張。

世界初の5Gネットワークに繋がる5Gスマホ

verizon

04.03.2019 | Network

2019年4月3日

Customers in Chicago and Minneapolis are first in the world to get 5G-enabled smartphones connected to a 5G network

5G Ultra Wideband

NEW YORK – Today, Verizon officially turned on its 5G Ultra Wideband network in select areas of Minneapolis and Chicago a week ahead of schedule. For the first time ever, customers can access a commercial 5G network with the world's first commercially available 5G smartphone, the moto z3 compatible with 5G motomod. Customers using Verizon's 5G Ultra Wideband network in Chicago or Minneapolis could see speeds of up to 1 Gbps.

ベライゾンは1週間前倒しして5Gを開始した。

SKテレコム、世界初の5Gスマホ契約者を発表

SK telecom

Press Release

SK Telecom Announces the World's First 5G Smartphone Subscribers

2019.04.04

2019年4月4日

SKテレコム、4月3日午後11時時点で韓国を代表する有名人のために5Gサービスを開始した

2010 ‥ 2013 2014 2015 2016 2017 2018 2019 **2020**

5G@日本（上）出遅れ日本、進捗度13位 — Fobes

「5G元年」に1年出遅れた日本、海外勢に追い付けるのか — 日本経済新聞

なぜ日本の「5G」導入は、世界から遅れてしまったのか — 日経XTECH

5Gでも周回遅れ、グローバル競争出遅れに危機感　NTTのドコモ — Bizコンパス

世界的な5G元年は2019年、なぜ日本は出遅れていると言われる — 毎日新聞

「なんちゃって5G」 出遅れ日本勢の切り札に — マイナビ

日本の5Gは本当に周回遅れなのか — THE SANKEI NEWS

5G出遅れ感じず、運用面でトップ目指す＝佐藤総務副大臣 — TELESCOPE Magazine

復権なるか日本の通信(上)5G普及、世界に出遅れ 行き詰まる — REUTERS

「5G元年」に出遅れた日本、5Gへの取り組みは本当に遅れて — 日本経済新聞

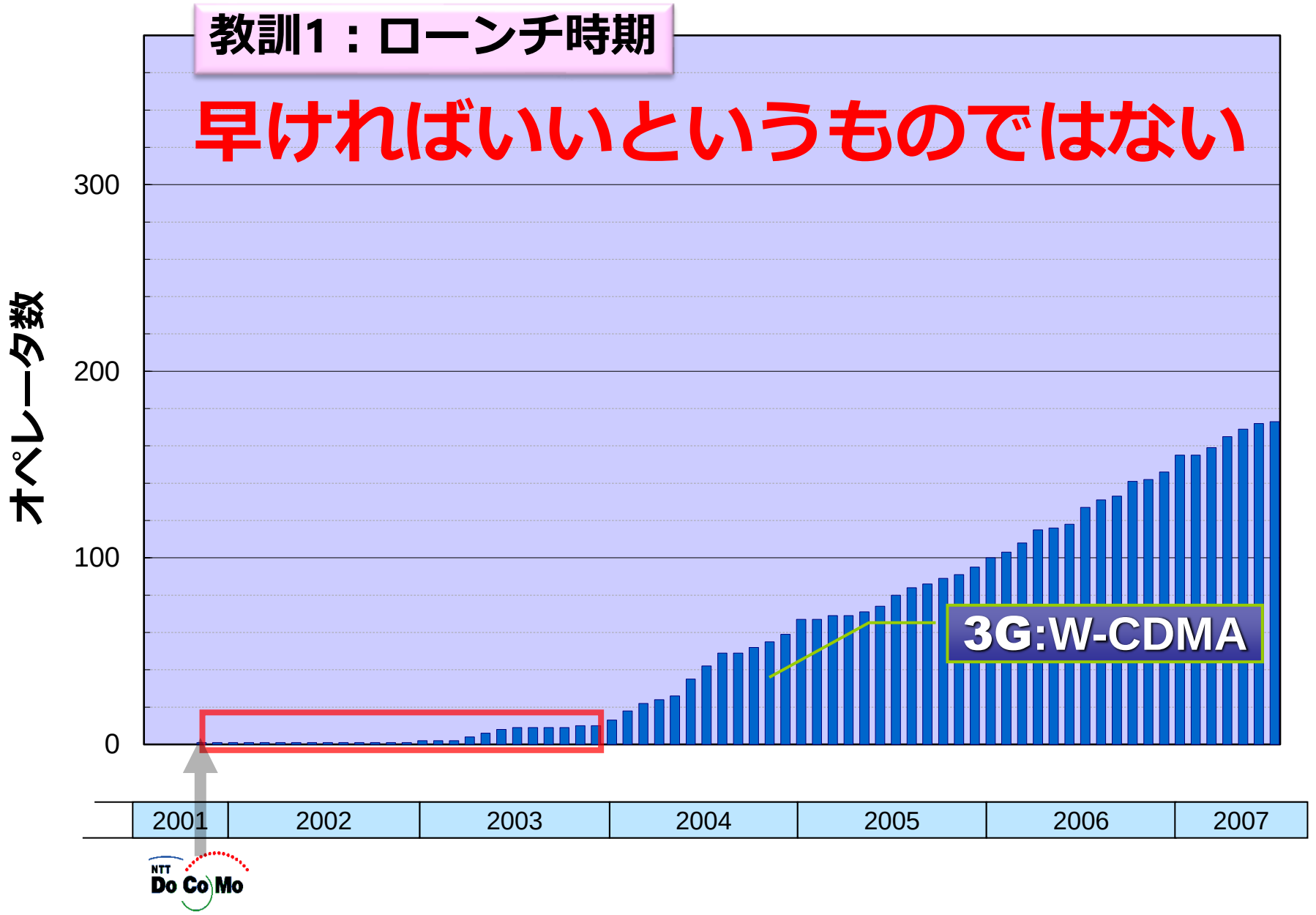
日本で5Gを普及させるメリット4つ｜日本は世界に比べて出遅れて — ITmedia Mobile

【海外より出遅れている？】日本の5Gはいつから始まるのか — TechMAGAZINE

日本は韓国や米国、中国といった主要国に比べ、５Ｇサービスのインフラ整備で出遅れている。 — iedge

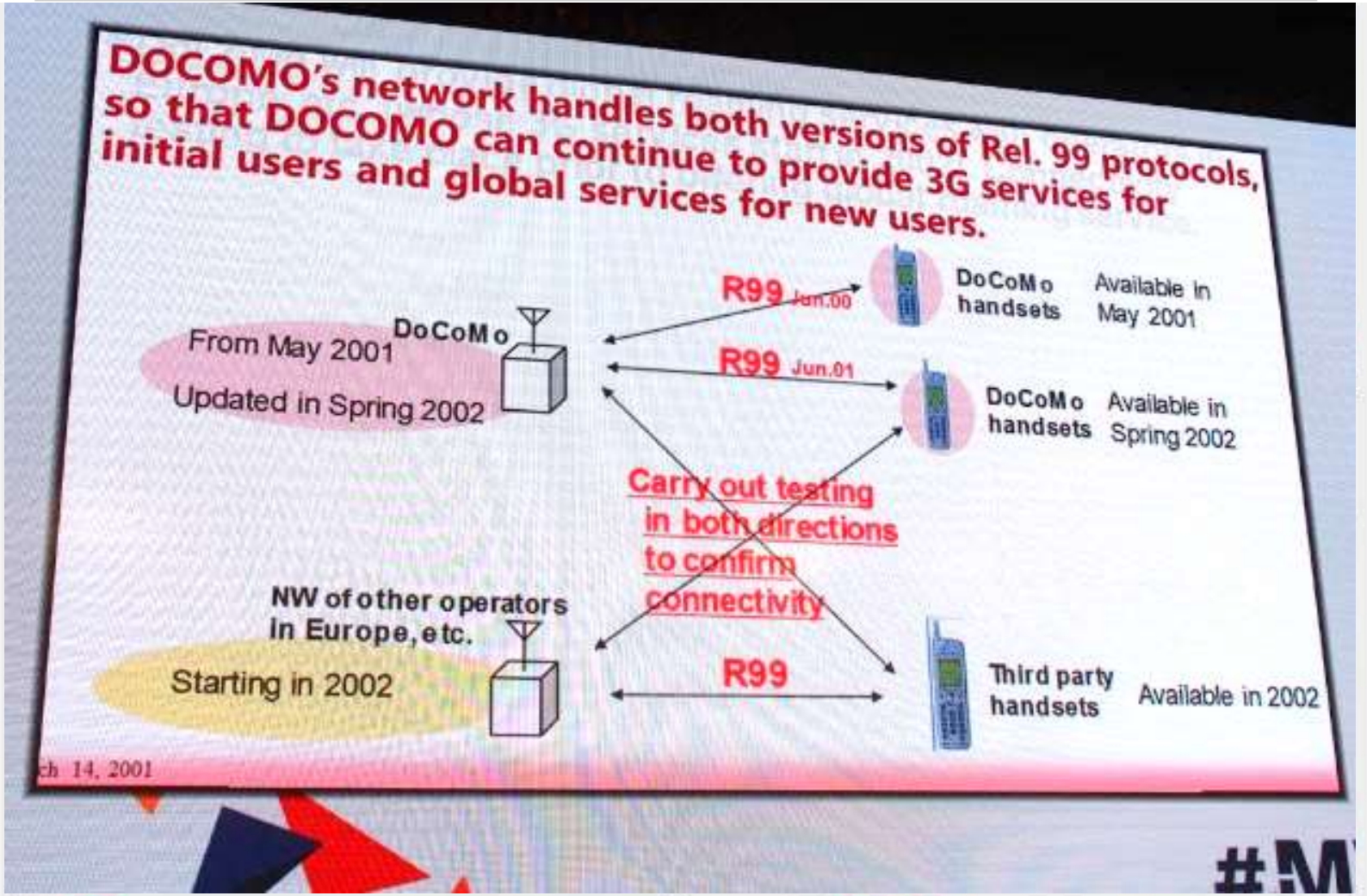
衆議院 The House of Representatives, Japan

3Gを導入したオペレータの数



ドコモCTO尾上氏が「5Gの神話と真実」解説、先行導入で断片化の懸念も

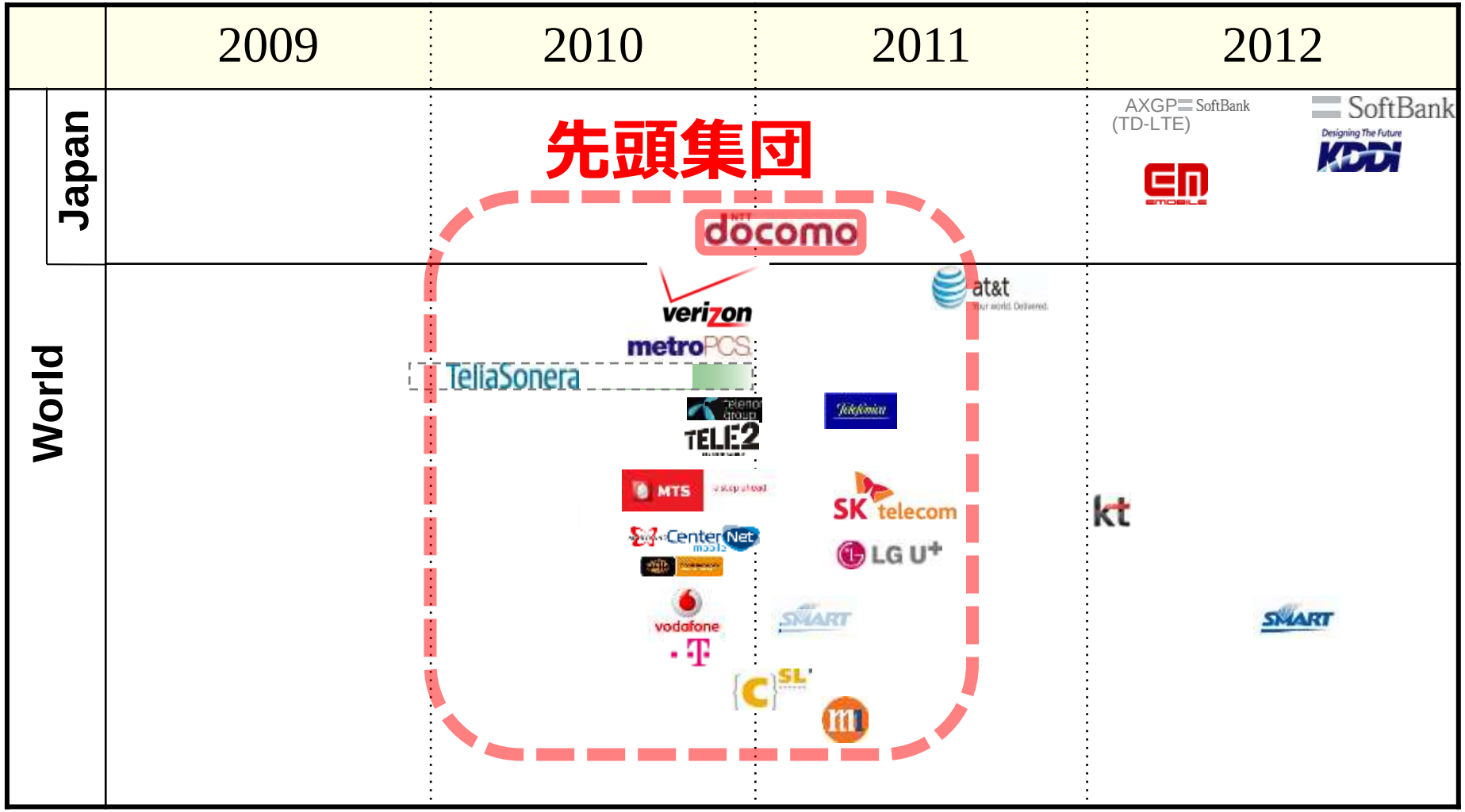
石野 純也　2016年6月30日 12:16



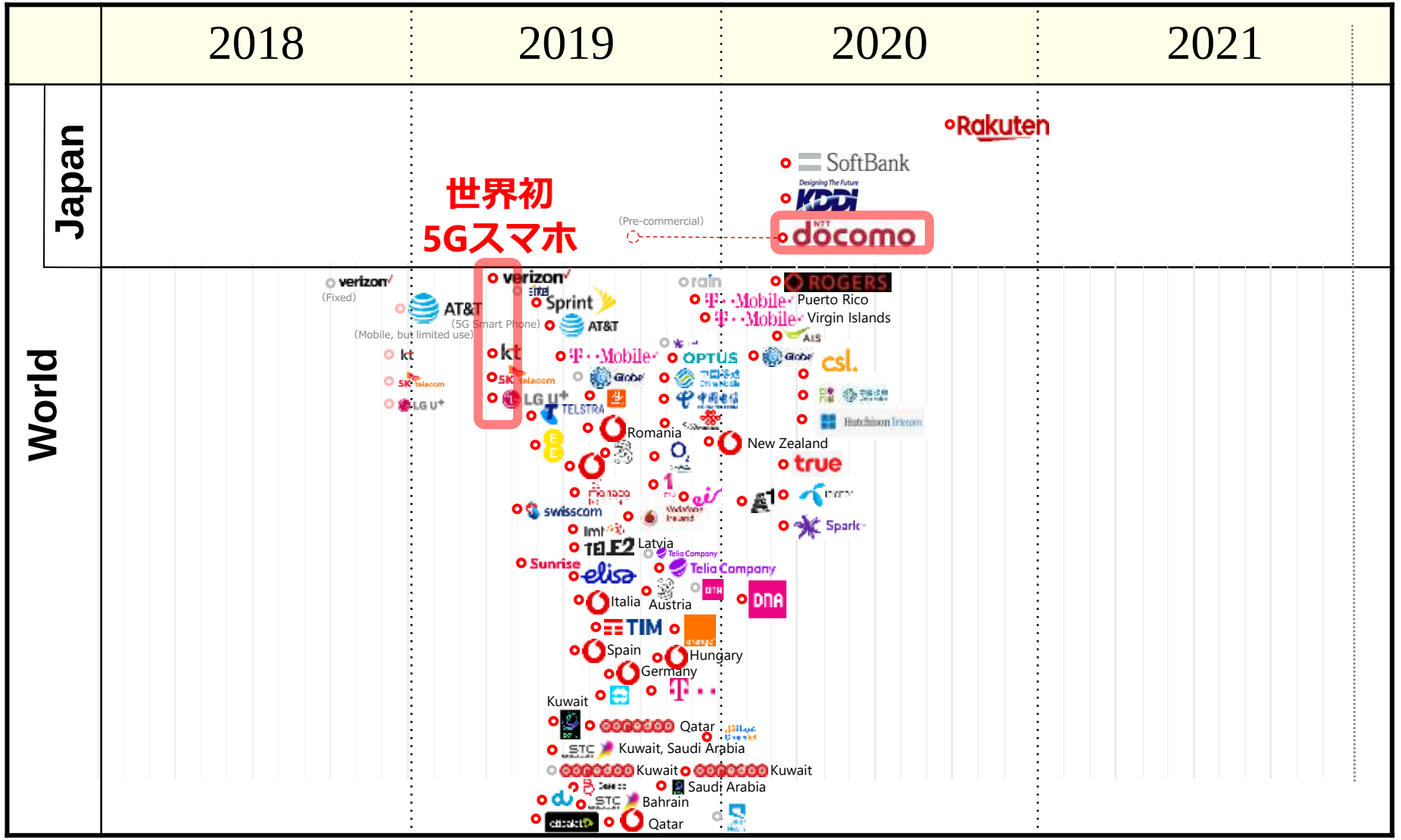
現状でも、ドコモは3Gで2つの規格を併存させている。こうした失敗例を挙げることで、歩調を合わせることの重要性を説きたかったようだ

https://k-tai.watch.impress.co.jp/docs/event/mwcs2016/1007909.html

4G LTE Commercial Launches



5G Commercial Launches



Subscriber

池上彰のニュース
そうだったのか!!

Topics

- History of Generations: 1G to 5G
- **Future Beyond 6G toward 12G**
- Thought on International Telecommunication Standardization

Will Onoe's Law of generations hold?

second

Law of Great Success Only in Even-Numbered Generations (Onoe's second Law)

A de-facto global standard
More-than-expected demand

Rapid global deployment.
LTE is the single global standard
(no other standard implemented).
More-than expected demand

? ? ?

Fragmented standards
Limited deployment

Slow deployment
Spectrum auctions & economic situation
Less-than-expected demand

? ? ?
LTE-based technology

We have to wait until 6G to see our expectations for 5G fulfilled.
6G will be the complete form of 5G, or 5G will be the final generation that will keep evolving ever after 2030.

Michael J. Miller's ForwardThinking™

Apr. 28, 2017

Why 5G Isn't Aimed at Mobile Phone Users

The applications for 5G wireless target autonomous vehicles, factory floors, and the Internet of Things...not end users.

By Michael J. Miller April 28, 2017 8:00AM EST

Docomo Keynote

Onoe gave positive speech

Seizo Onoe, CTO and EVP of NTT DOCOMO, gave a generally positive speech about 5G, but may have been the most realistic about the challenges it faces.

the most realistic

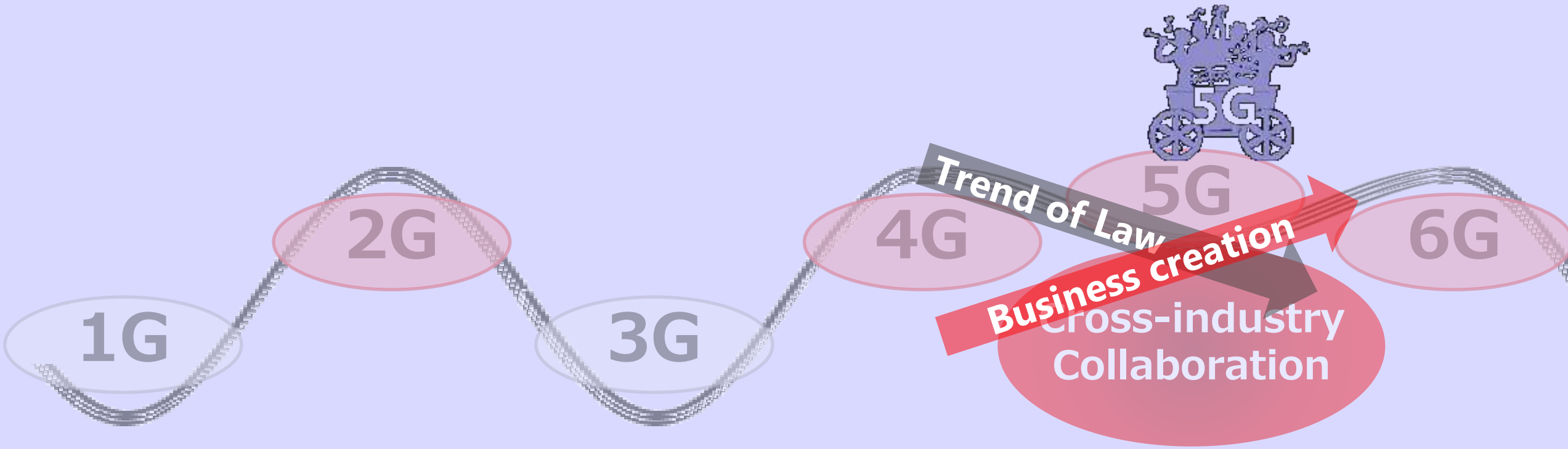
Still, Onoe concluded on a positive note and said that while there are lots of myths about 5G, he believes that the industry should "get on the 5G bandwagon" and create new business models through collaboration across industries.

Onoe concluded on a positive note

https://www.pcmag.com/article/353376/why-5g-isnt-aimed-at-mobile-phone-users

Vodafone CTO

Law of Great Success Only in Even-Numbered Generations



We have to wait until 6G to see our expectations for 5G fulfilled.
6G will be the complete form of 5G, or 5G will be the final generation that will keep evolving ever after 2030.

Business creation through cross-industry collaboration will be a key to great success against the trend of the even-numbered generation law.

How far the generation goes up?

https://www.ipsj.or.jp/magazine/9faeag000000pfzm-att/IPSJ-MGN610101.pdf

IPSJ Magazine

［巻頭コラム］[Foreword]

移動通信のデータ速度はどこまで上がるか？（パート 5）

How Much Faster Will Mobile Communication Data Speed Be? (Part 5)

■尾上 誠蔵
Seizo ONOE

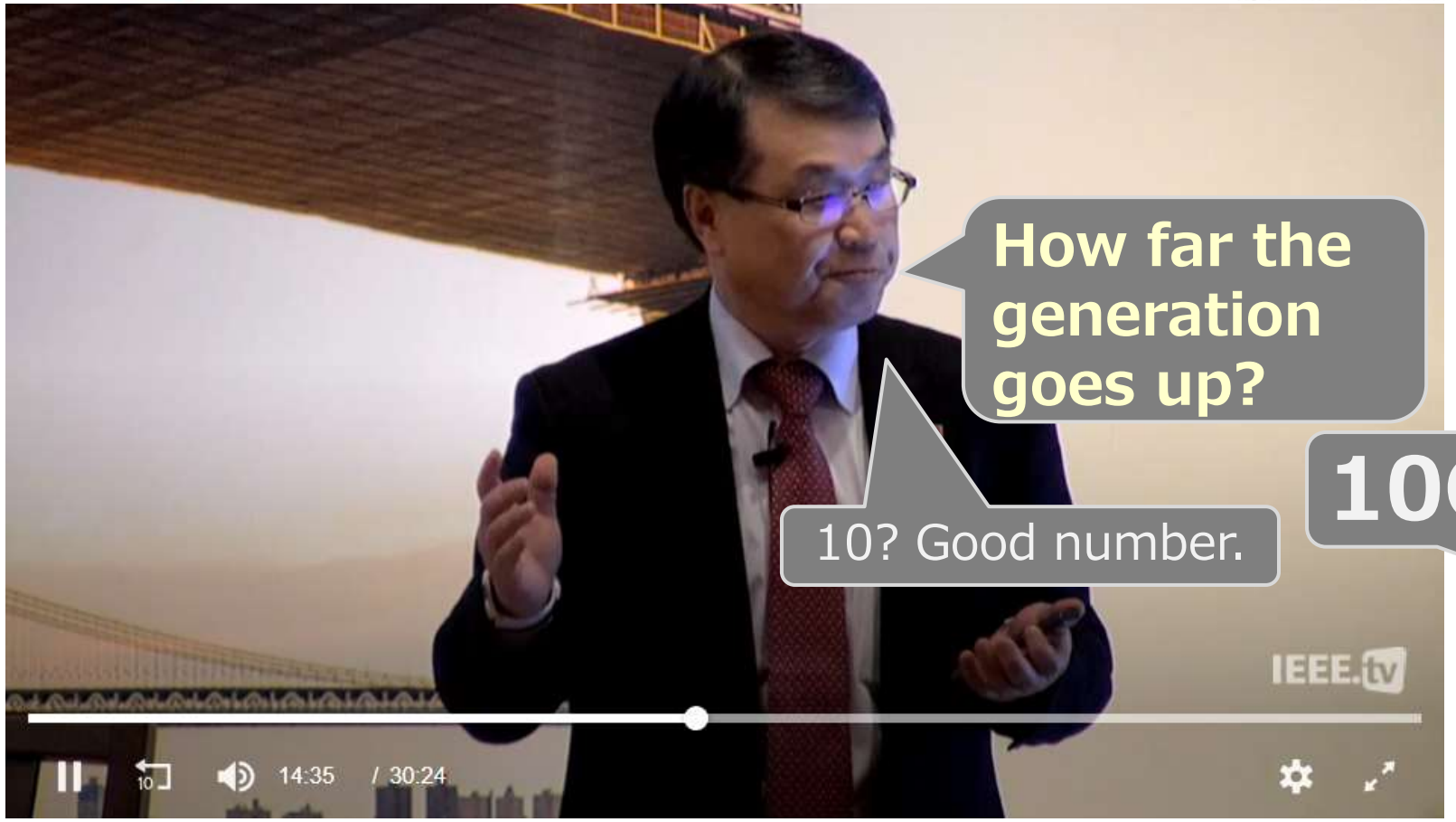
移動通信の世代はどこまで上がるか？　新たなテーマである.

How far will the generation go up?　It’s a new theme.

At Brooklyn 5G Summit

IEEE.tv Tune in to where technology lives.

IEEE



Operator Keynote: Seizo Onoe - B5GS 2019

★★★★★

Published on May 15, 2019

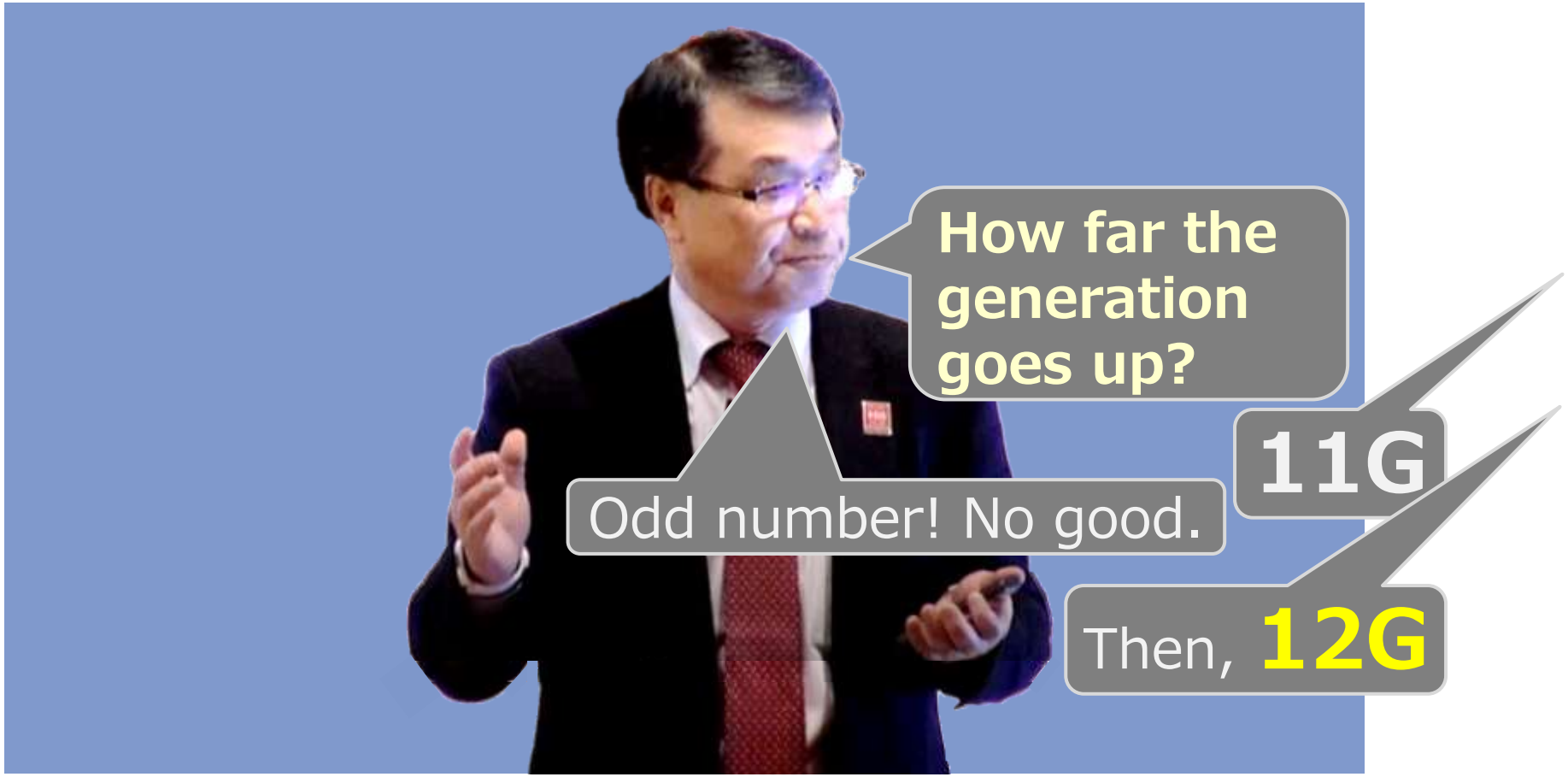
1870 views

IEEE Communications Society #Brooklyn 5G Summit #2019 #B5GS #5G #Future Networks #mobile #internet

Mr. Seizo Onoe, NTT DOCOMO, presents his famously entertaining 5G review and summary of what's happening within the communications industry regarding 5G networks and encourages cross-industry collaborations. Deployment scenarios, post-launch, and next-generation services are also discussed.

https://ieeetv.ieee.org/operator-keynote-seizo-onoe-b5gs-2019

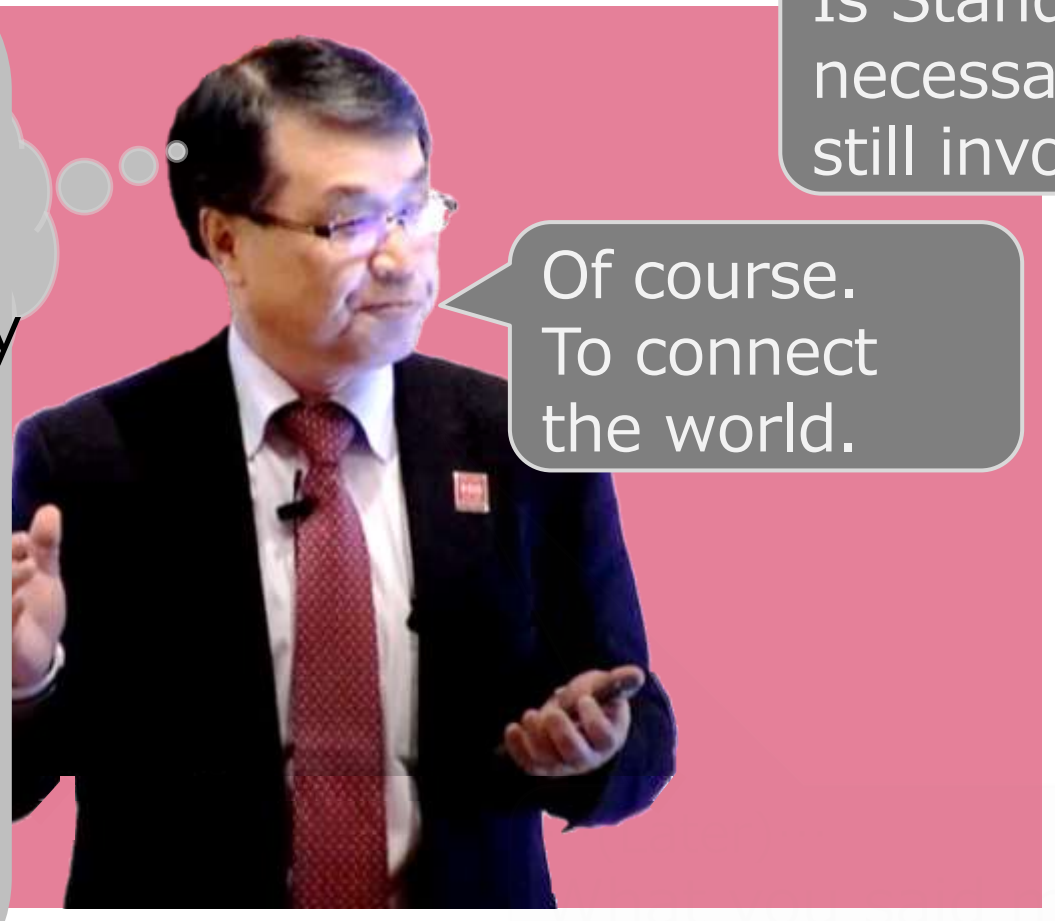
At an event hosted by a vender

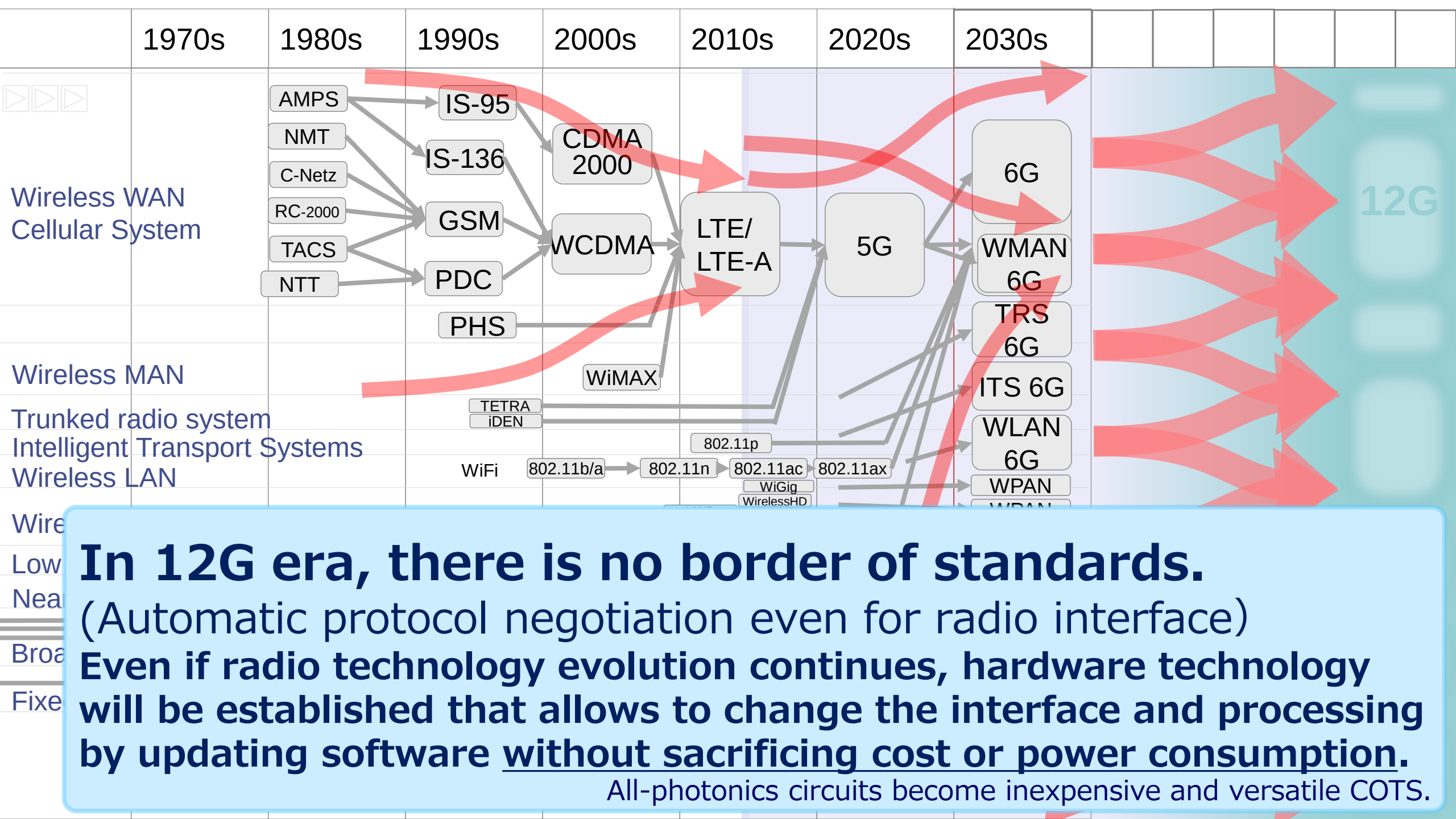


At totally different occasion with former supreme boss

…(Later, come to think)…
A time may come when network and user equipment will be connected by automatically negotiating without standards, assuming progress of softwarization and ultra low power consumption.

It may happen in 10G or **12G** era.



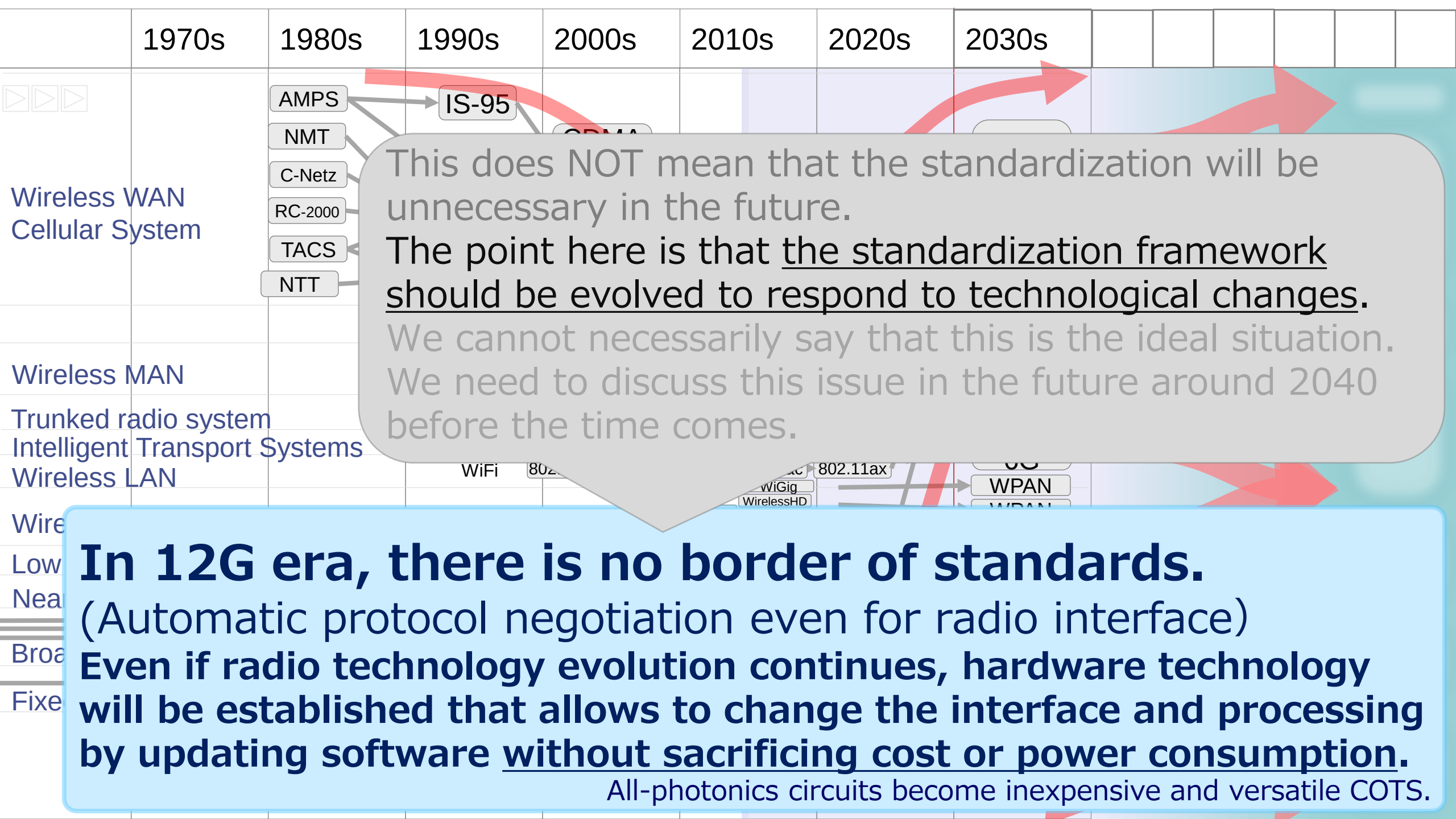


In 12G era, there is no border of standards.

(Automatic protocol negotiation even for radio interface)

Even if radio technology evolution continues, hardware technology will be established that allows to change the interface and processing by updating software without sacrificing cost or power consumption.

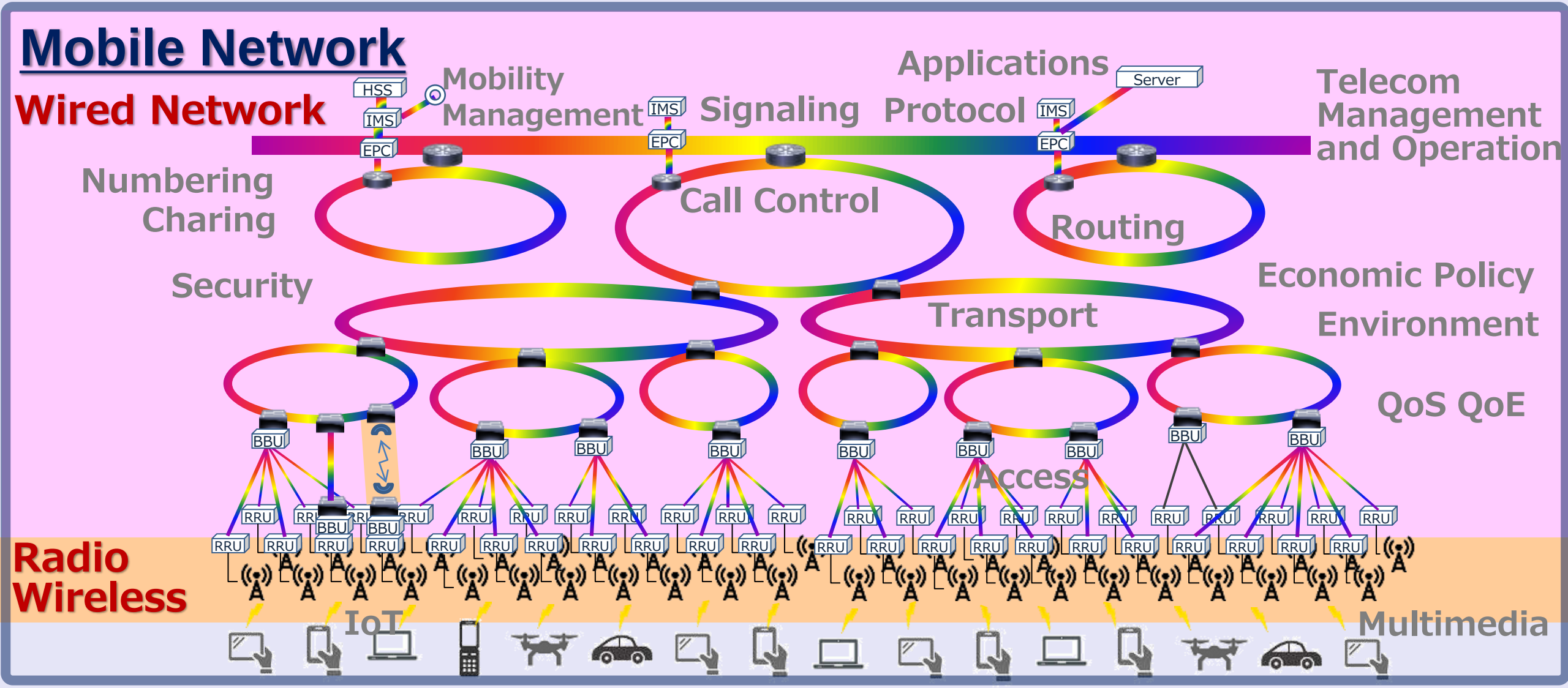
All-photonics circuits become inexpensive and versatile COTS.


1970s
1980s
1990s
2000s
2010s
2020s
2030s
Wireless WAN
Cellular System
AMPS
NMT
C-Netz
RC-2000
TACS
NTT
IS-95
Wireless MAN
Trunked radio system
Intelligent Transport Systems
Wireless LAN
WiFi
802.11ax
WiGig
WirelessHD
WPAN
Low
Broa
Fixe
This does NOT mean that the standardization will be unnecessary in the future.
The point here is that the standardization framework should be evolved to respond to technological changes.
We cannot necessarily say that this is the ideal situation.
We need to discuss this issue in the future around 2040 before the time comes.
In 12G era, there is no border of standards.
(Automatic protocol negotiation even for radio interface)
Even if radio technology evolution continues, hardware technology will be established that allows to change the interface and processing by updating software without sacrificing cost or power consumption.
All-photonics circuits become inexpensive and versatile COTS.

Topics

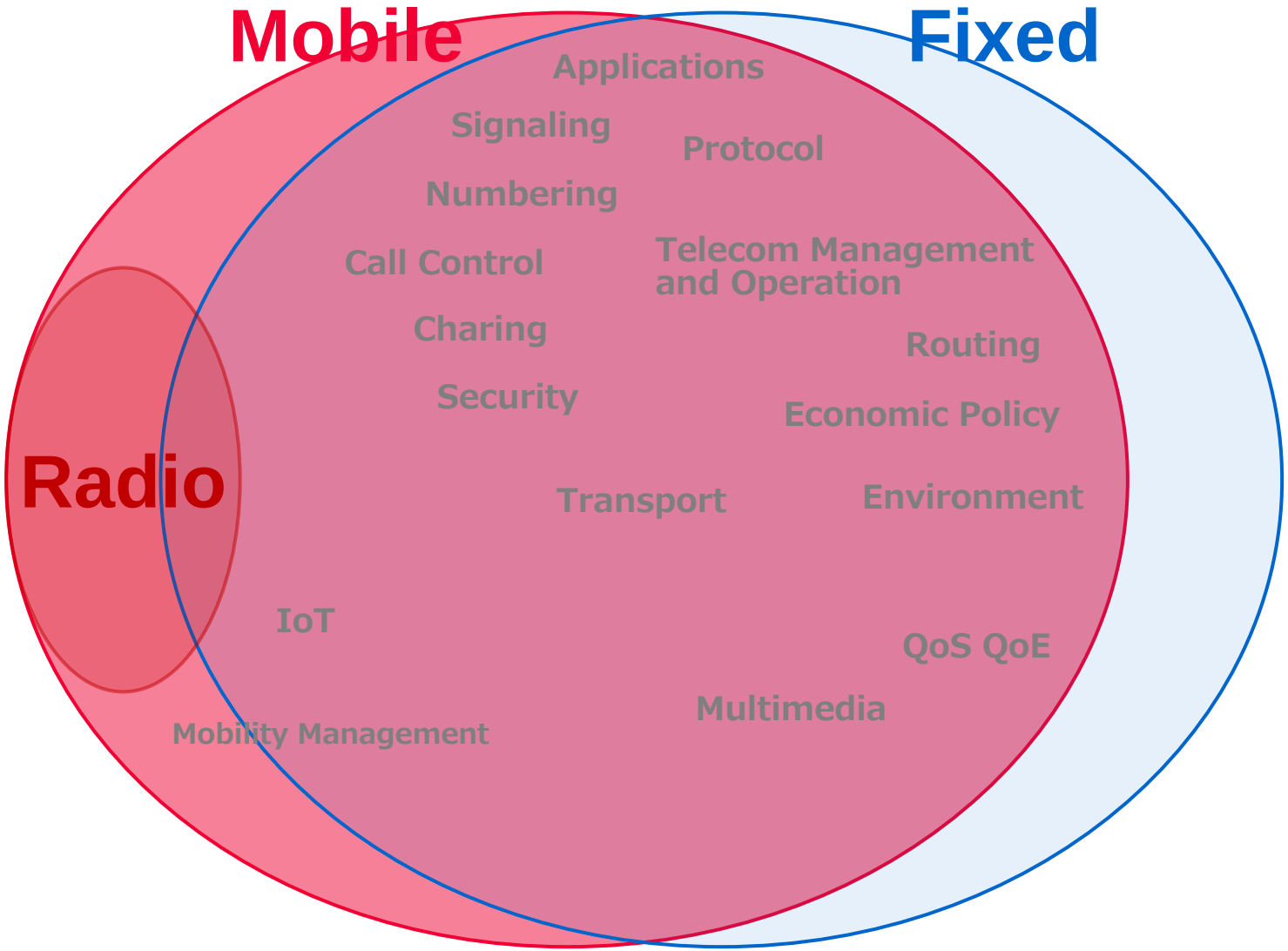
- History of Generations: 1G to 5G
- Future Beyond 6G toward 12G
- Thought on International Telecommunication Standardization

Mobile in Telecom Networks



The mobile network has become from minor to major, and to ordinary networks. It **consists of various elements.**

Mobile and Fixed Network



Resolution 92

Mobile in Telecom Networks

(Source: GSMA Intelligence)

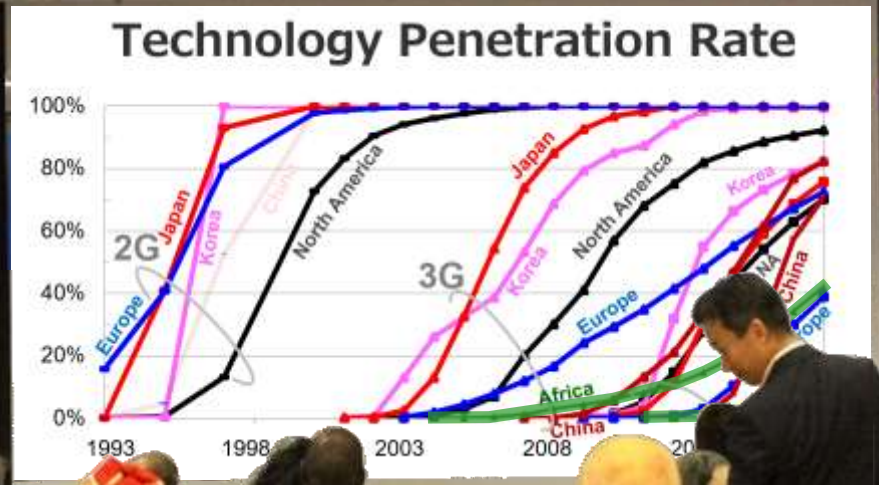
The mobile communication industry is large and important, accounting for nearly 5 percent of global GDP.

Outreach worldwide

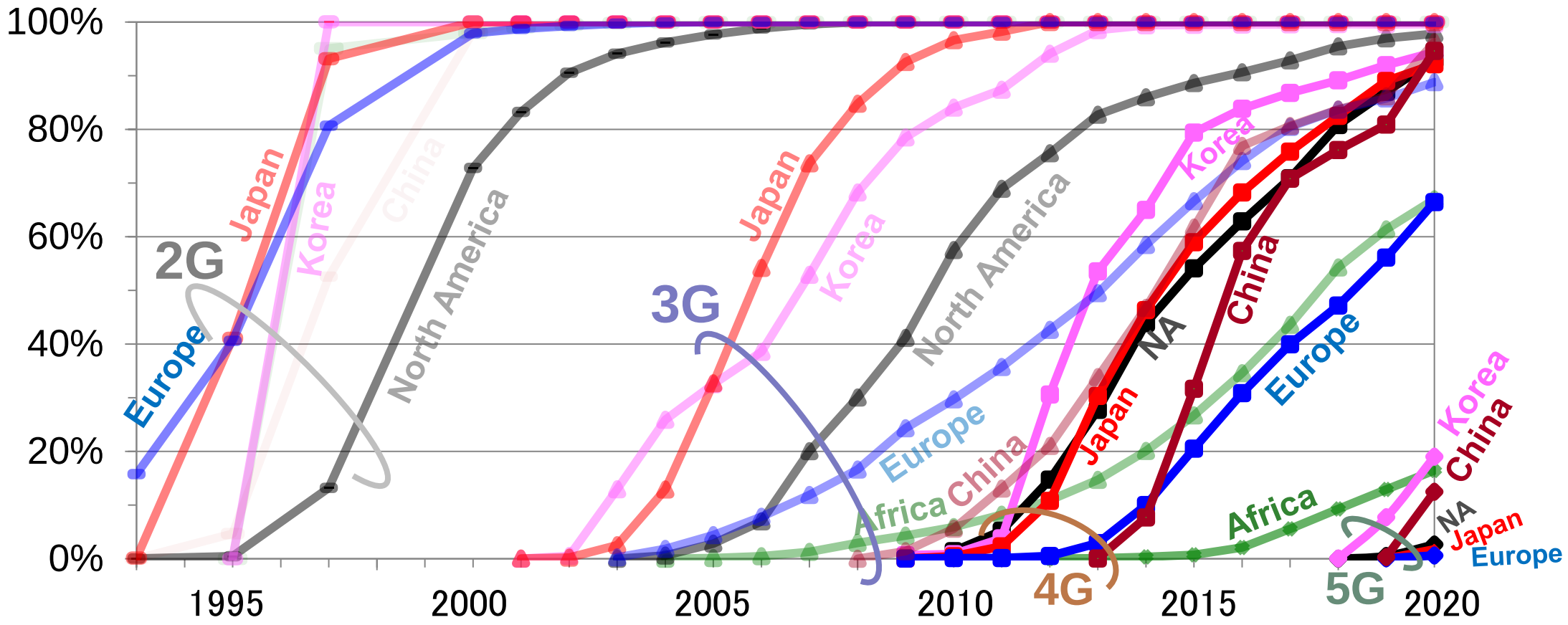
WORLD TELECOMMUNICASION
ICT INDICATOR SYMPOSIUM 2015
We need Broadband.
How to realize it?
!
HIROSHIMA, JAPAN
MIC

WWRF 5G HUDDLE 2018
in DURBAN, SOUTH AFRICA

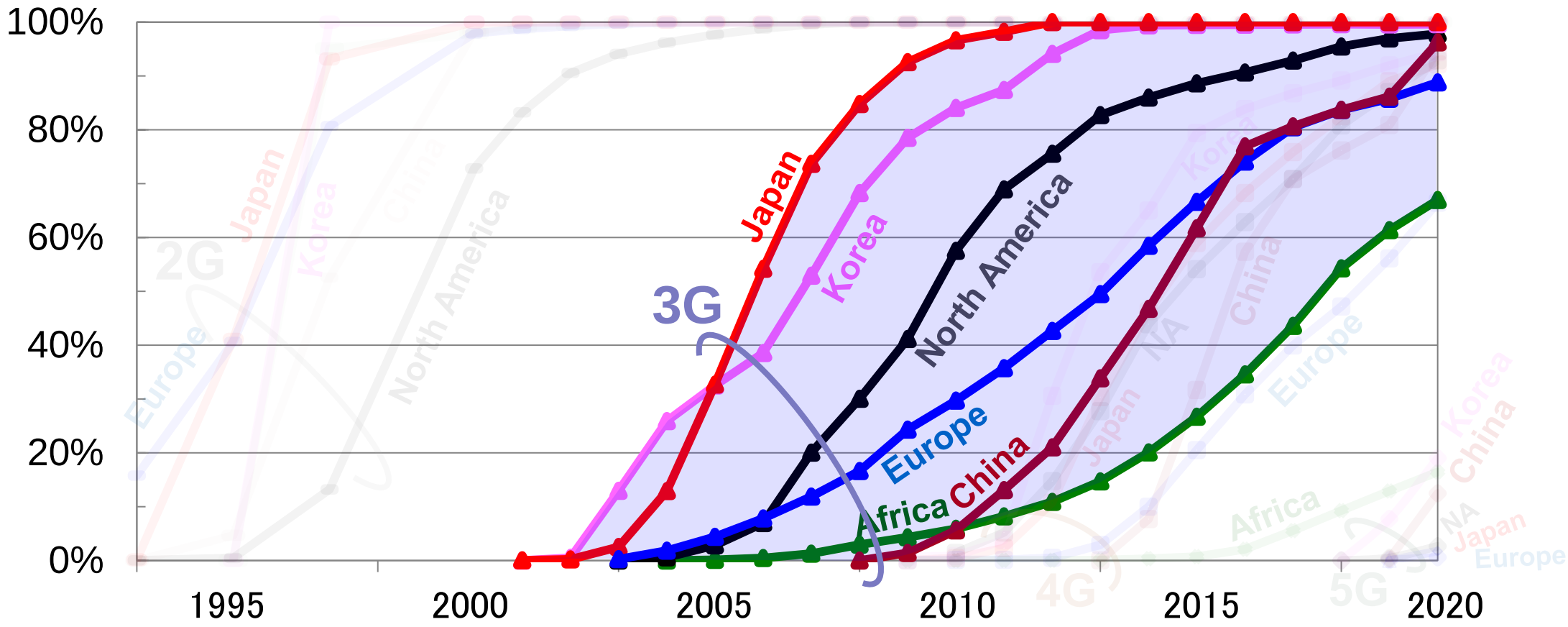
WIRELESS WORLD RESEARCH FORUM
5G HUDDLE 2018
5G FOR ALL
29 & 30 May 2018 / DURBAN . SOUTH AFRICA



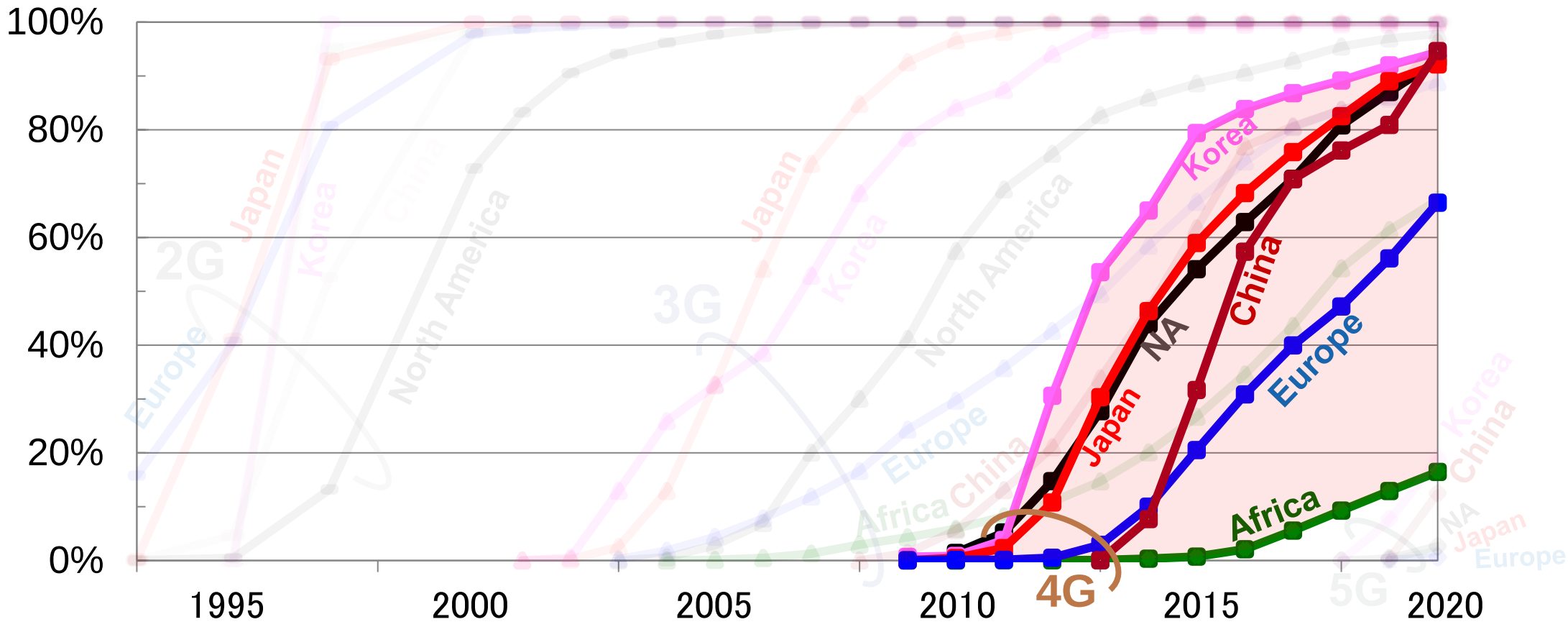
Technology Penetration Rate



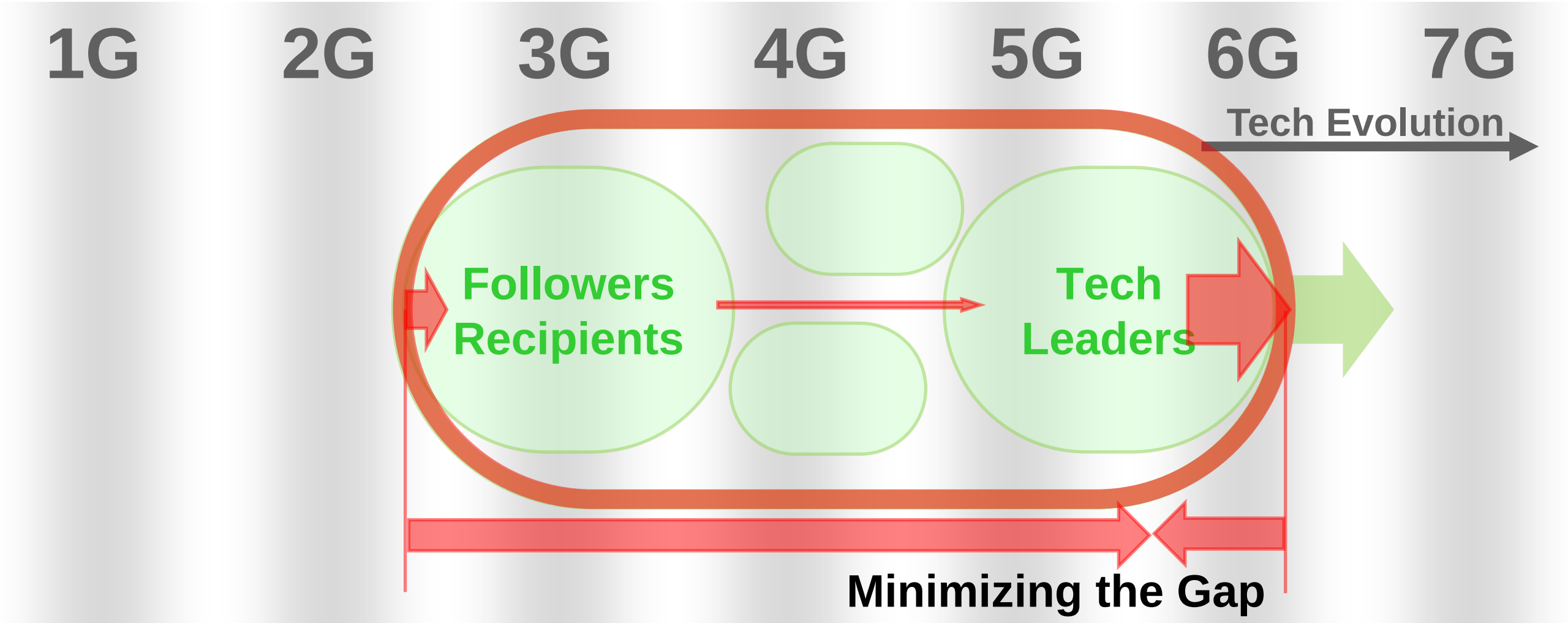
Technology Penetration Rate



Technology Penetration Rate



Standardization Gap



Conclusion

- Sustainable evolution of Generations without being misled by marketing gimmicks
- Industry leaders' roles are to lead new generation technologies and to help bridge the gap for the whole world.
- Telecom standards become meaningful only when they are widely spread.

Thank you