5G and IMT-2020: What it is, its relevance, and ways to participate

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Purpose:
  To elucidate issues related to 5G and IMT-2020, raising points regarding the participation of IEEE 802.

Notice:
  This document represents the views of the author and is offered as a basis for discussion.

5G and IMT-2020: What it is, its relevance, and ways to participate

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Disclaimer

1. These are my personal views, not necessarily representative of any organization.

2. There is a lot of material to review, and this presentation is far from optimal.

   • Way too many words; no figures.

   • I didn't have time to make it better.

     • Sorry about that.

Previous IEEE 802 Tutorials

- http://ieee802.org/Tutorials.shtml:

    - *IEEE 802.16 and IMT-Advanced* (2006-11-10)

    - *IEEE 802.16 in IMT-Advanced* (2011-03-14)

    - *802.11 as a Component* (2015-07-13)

    - *Perspectives on IEEE 802.11 in NGMN/5G* (2015-09-11)

- Also, see the many presentations this week in 802.11 WG.

    - IEEE 802.11-15/0004, IEEE 802.11-16/0127

IMT

- Standards developed in ITU
  - ITU-R Working Party 8D (originally 5F)
- Recommendation ITU-R M.1457
  - *Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-2000 (IMT-2000)*
  - First version: year 2000; currently at rev. 12
- Recommendation ITU-R M.2012
  - *Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-Advanced (IMT-Advanced)*
  - First version: year 2012; currently at rev. 2
- Many related recommendations (standards) and reports
- Foresees new versions of IMT, around every 10 years.
  - The informal name "IMT-2020" for the next one seems to have stuck.

ITU Sectors

- ITU-R: ITU Radiocommunication Sector
- ITU-T: ITU Telecommunication Standardization Sector
- ITU-D: ITU Telecommunication Development Sector

- IEEE is a "sector member" of all sectors
- contributions come from members; e.g. IEEE
- IEEE's ITU-R Technical Liaison: Mike Lynch

ITU-R Working Party 5D

- generally meets 3 times per year

- throughout the world

- usual schedule is Wednesday-Wednesday, so essentially a two-week meeting

- several hundred people, many from governments, cellular operators, and large vendors

- heavily bureaucratic, tradition-bound, and culture-sensitive

  - everything should be done as it has been done before

- no voting

IMT's unique documentation

- Historically, standards are based around special "external organizations," driven by 3GPPs

- M.1457 and M.2012 include:

  - summary descriptions of technologies

  - reference to "Global Core Specifications" (GCS)

    - e.g. specifications of 3GPP, 3GPP2, IEEE, etc. stored at ITU web site

    - "transpositions": standards based on GCS, published by (e.g.) 3GPP partners (SDOs)

IEEE Standards in IMT

- On 19 October 2007, IEEE 802.16's WirelessMAN-OFDMA was adopted into Recommendation ITU-R M.1457, the IMT-2000 standard.

  - following intensive IEEE 802.16 effort starting in 2006

- On 18 January 2012, IEEE's 802.16's WirelessMAN-Advanced was adopted into the initial Recommendation ITU-R M.2012, the IMT-Advanced standard.

  - following intensive IEEE 802.16 effort starting in 2006

  - P802.16m Scope: *This standard amends the IEEE 802.16 WirelessMAN-OFDMA specification to provide an advanced air interface for operation in licensed bands. It meets the cellular layer requirements of IMT-Advanced next generation mobile networks. This amendment provides continuing support for legacy WirelessMAN-OFDMA equipment.*

    - notified WP 5D, Dec. 2006

IMT-Advanced Requirements

- Requirements in four "test environments"
  - Indoor
  - Urban microcell
  - Base coverage urban
  - High speed (350 km/h)
- radio interface technology (RIT)
- set of radio interface technologies (SRIT)
- *RIT or SRIT will be accepted for inclusion in the standardization phase if, as the result of deliberation by ITU-R, it is determined that the RIT or SRIT meets the requirements… for <u>three of the four test environments</u> …*
- IEEE 802.16 members participated intensively in setting the requirements.
  - Others too, including 802.11 Chair for a time
  - even indoor was a challenge for 802.11 to meet
- The requirements demand a model of a broader network above Layer 2.

Scale of IMT-Advanced Contributions

- When IEEE 802.16 was active in IMT-Advanced, it had ~500 members

- Initial IEEE WirelessMAN-Advanced proposal: 161 pages

  - with references to other documents developed within the 802.16 Working Group as part of the 802.16m development, which was based around the intent to submit for IMT-Advanced.

    - IEEE 802.16m System Requirements Document (SRD): 31 pp.

    - IEEE 802.16m System Description Document (SDD): 170 pp.

    - IEEE 802.16m Evaluation Methodology Document (EMD): 199 pp.

    - System Evaluation Details for IEEE 802.16 IMT-Advanced Proposal (SED): 240 pp.

  - extensive simulation effort underlay the results

WATO

- IEEE coordinated formation of a "WirelessMAN-Advanced Transposing Organizations" (WATO) group
  - included ARIB (Japan), TTA (Korea), WiMAX Forum, IEEE
  - negotiated terms in a formal meeting
  - later ITRI (Taiwan)
  - because SDOs wanted to transpose IEEE standards and wanted to do so under a formalized cooperation, parallel to 3GPP

ITU Radio Regulations (2012)

- Technology-specific language is rare however:

- *The band 450-470 MHz is identified for use by administrations wishing to implement International Mobile Telecommunications (IMT)… This identification does not preclude the use of this band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations.*

- Similar language appears 8 times.

- Also, "*The bands 1 885-2 025 MHz and 2 110-2 200 MHz are intended for use, on a worldwide basis, by administrations wishing to implement IMT.*"

- *International Mobile Telecommunications (IMT) includes IMT-2000 and IMT-Advanced*

WRC2015 and IMT

- World Radio Conference (WRC) establishes radio regulations

  - Met in November 2015 (WRC2015); Planning for WRC2010

- WRC2015 press release refers to future work toward new spectrum for "mobile broadband"

- WRC does not use the term "mobile broadband". It identifies bands for "IMT", which narrowly refers to a particular set of ITU standards, not to general mobile broadband technologies.

  - "IMT" appears 247 times in the WRC2015 Final Acts

  - "IMT is the root name that encompasses IMT-2000, IMT-Advanced and IMT-2020 collectively"

- Historically IMT would probably be considered "mobile broadband." However, WRC2015 adopts WP 5D view that "IMT systems are now being evolved to provide diverse usage scenarios and applications such as enhanced mobile broadband, massive machine-type communications and ultra-reliable and low-latency communications."

- Threats: spectrum being limited to IMT technologies and being identified for a broad set of application.

Working Party 5D, for WRC 2019

- *Studies on the technical and operational aspects of radio networks and systems, as well as spectrum needed, including possible harmonized use of spectrum to support the implementation of narrowband and broadband machine-type communication infrastructures, in order to develop Recommendations, Reports and/or Handbooks…*

New ITU-R Task Group 5/1, for WRC 19

- *to conduct and complete in time for WRC19 the appropriate studies to determine the spectrum needs for the terrestrial component of IMT in the frequency range between 24.25 GHz and 86 GHz, taking into account:*

  - *technical and operational characteristics of terrestrial IMT systems that would operate in this frequency range, including the evolution of IMT through advances in technology and spectrally efficient techniques;*

  - *the deployment scenarios envisaged for IMT-2020 systems and the related requirements of high data traffic such as in dense urban areas and/or in peak times; …*

- *to conduct and complete in time for WRC19 the appropriate sharing and compatibility studies, taking into account the protection of services to which the band is allocated on a primary basis, for the frequency bands:*

  - *24.25-27.5 GHz, 37-40.5 GHz, 42.5-43.5 GHz, 45.5-47 GHz, 47.2-50.2 GHz, 50.4-52.6 GHz, 66-76 GHz and 81-86 GHz, which have allocations to the mobile service on a primary basis; and*

  - *31.8-33.4 GHz, 40.5-42.5 GHz and 47-47.2 GHz, which may require additional allocations to the mobile service on a primary basis*

- IEEE 802 participants should be engaged

Licensed/Unlicensed

- It is generally presumed that IMT radios are licensed.

- The radio regulations do not talk about licensing; that is up to administrations to decide.

- REPORT ITU-R M.2320 ("Future technology trends of terrestrial IMT systems", 2014) says:

  - *The trend to integrate multiple radio access technologies seamlessly will accelerate due to the need to integrate new spectrum bands, licensed and unlicensed to meet capacity demands, and to support usages such as IoT wherein IoT devices with non-cellular radio may connect to cellular network through a multi-radio gateway.*

- Is the door open for WRC to "identify" spectrum for IMT with the expectation that the usage will be license-exempt?

  - May be useful to get some expert views on this.

ITU-T Focus Group on IMT-2020

- Part of ITU-T SG 13

- networking aspects of IMT-2020

Advantages of IMT: Spectrum

- more spectrum will probably be identified in the radio regulations for IMT, therefore approved IMT technologies

    - mostly >24 GHz in the near future

- many governments will favor the identifications in the radio regulations

- it may be sufficient to get into *any* IMT

    - e.g., IMT-2000 & IMT-Advanced updated biennially

        - even those requirements may be challenging

        - could join with existing IEEE radio interface

Advantages of IMT: Hype

- IMT-2020 recognition would bring hype value.

- Who would really care?

- IEEE 802.16 participants were very focussed on access to spectrum; hype was secondary.

- IMT was targeted to cellular operators, and they, as as group, chose LTE

  - WirelessMAN-Advanced was abandoned

What's in a G?

- To explain, I'll summarize 3G and 4G.

- 3G and 4G were significant because:
  - They represented significantly new radio technologies with important new capability.
  - They were major, 10-year upgrades to the cellular network.
  - They represented global agreement by an industry led by a countable number of major operators, vendors, and governments to roll out defined, backward-compatible technology in a controlled timeframe.
  - Consumers receive direct visibility into the technology, including by an icon on their phone.

5G Background: 1G, 2G, 3G

- Historically, no contemporaneous hype for 1G; very little for 2G

- In the 1990s, massive hype behind 3G cellular

  - 1G (First generation): analog cellular

  - 2G: digital cellular voice

  - 3G: digital cellular with data

3G Hype

- Two large global consortia were rivals for the 3G title:

  - "Third Generation Partnership Program (3GPP)"

    - "Organizational Partners" (OPs): ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC

  - 3GPP2

    - "Organizational Partners" (OPs): ARIB, TIA, CCSA, TTA, TTC

- Both supported a version of CDMA technology for cellular operators

  - paired with complex core networks with backward compatibility

- Both adopted into a new ITU-R standard, nicknamed "IMT-2000"

  - in around the year 2000, and operating at around 2000 MHz

- 3G became associated with IMT-2000, and vice versa

4G

- 4G was pioneered by IEEE 802.16e, which introduced OFDMA mobile cellular networks.

- The association of the name "4G" with ITU's IMT-Advanced was controversial.

- Working Party 5D had specifically decided to avoid that usage, since it had slippery commercial connotations.

- In a press release announcing IMT-Advanced, ITU-R said "LTE-Advanced" and "WirelessMAN-Advanced" were "accorded the official designation of IMT-Advanced, qualifying them as true 4G technologies."

- Many complaints resulted; IEEE 802 wrote to ITU-R (IEEE L802.16-10/0120r1).

- ITU-R quietly backed off, somewhat.

- Now "ITU and its partners, sharing a common community of interest, have recognized the relationship between IMT — International Mobile Telecommunication system — and '5G' and are working towards realizing the future vision of mobile broadband communications." It's not clear whether ITU claims be designated the "true 5G."

3 G ↑

What makes 5G?

- Impossible to answer unambiguously
- Some technical factors, according to some people:
  - millimeter wave, very broadband
  - narrowband IoT
  - massive MIMO
  - Cloud RAN
  - SDN
  - on and on and on

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5G Proposition 1

- No one owns the right to specify the requirements or details of "5G"
  - 5G is in the eye of the beholder.
  - A technology that is perceived by the beholder to be 5G will be, in effect, 5G.
    - The "5G" tag will derive from the credibility of the claims.
    - But the user will care more about the capabilities than the label.

5G Proposition 2

- A "G" is a big, integrated technology pitched at a big industry.

    - otherwise, you don't need to dedicate a ten-year effort

    - it's not a great fit for nimble technology elements that serve multiple purposes and evolve quickly

5G Proposition 3

- A successful IEEE-based "5G" should represent an integrated network specification set that could support a large operator deployment.
  - the full network needs to be stable for the long haul, and support multiple applications and access technologies
  - elements of that network could evolve nimbly and be used in other deployments

5G Proposition 4

- If IEEE coordinates a unified network, with multiple access technologies, then it will be well placed to promulgate a world-class 5G network.

  - such a network could (optionally) become an IMT-2020 network

5G Proposition 5

- IEEE is capable of coordinating a unified network.
- IEEE-SA can work in many ways, but it's strength is in making standards.
- If IEEE coordinates a unified 5G network, it should consider doing so by standardization

5G Proposition 6

- IMT-2020 approval is a sure way to acquire an authoritative "5G" label

  - but it is not a shortcut

  - it is a very arduous process requiring extensive investment

  - the effort can fail in many ways

  - failure could have negative implications

  - even success can lead to failure

    - draws resources away from other endeavors

    - focusses the industry on a narrow target

IMT Issues for 802

- Do Working Groups go it alone on IMT decisions and proposals?
    - IEEE is the ITU-R member
        - participation should be as a member
        - contributions should come from IEEE
    - No project is currently "authorized" to participate
        - IEEE 802.16 had an authorized PAR dedicated to IMT-Advanced
    - 802 may want to consider the opportunity for a unified proposal

How to get into IMT

- as a RIT in a SRIT
  - join current IEEE RIT in IMT-Advanced, to make a SRIT
  - cooperate with 3GPP to contribute a RIT to their IMT-2020 SRIT
- create a new standalone IMT-2020 RIT
  - from a single IEEE 802 technology
- create a new standalone IMT-2020 SRIT
  - from a set of IEEE 802 technologies

IMT Issues to Consider

- Do technology groups in 802 want to be part of IMT?

  - Have they fully considered the options and committed the resources?

  - Are participants ready to become active in WP 5D in 2016-17, during requirements development?

- Do multiple technology groups want to be part of IMT?

  - Will these be coordinated? Into a SRIT?

  - Will access technologies be stitched together in a network specification?

- Is the intention of some groups to join a 3GPP proposal?

  - Should they join with 3GPP? Should IEEE become a 3GPP OP?

Conclusion

- Many complex issues

- Discussion should ensue