3GPP RAN Workshop

RWS-120038

KDDI's Views on LTE Rel.12 and Onwards

KDDI Corporation

11-12 June, 2012
Ljubljana, Slovenia

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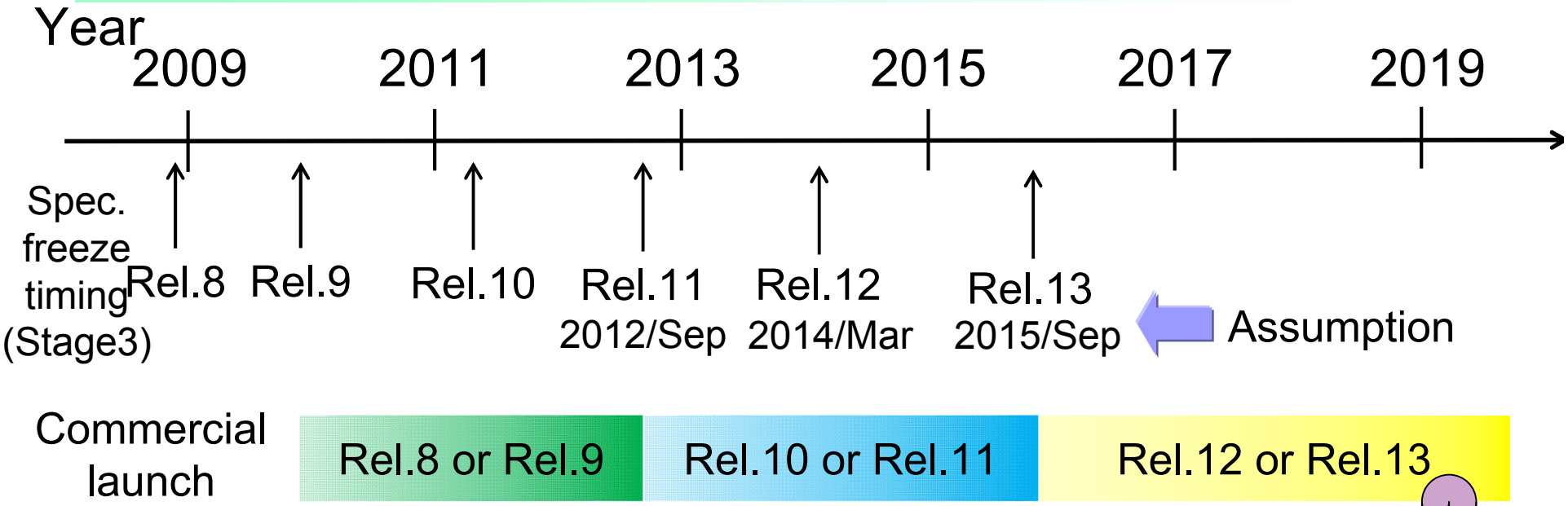
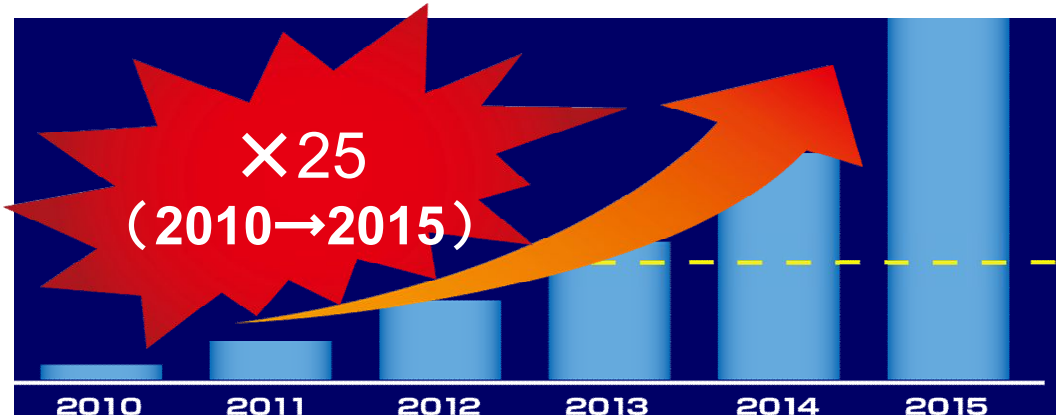
Timeline in 3GPP and Commercialization



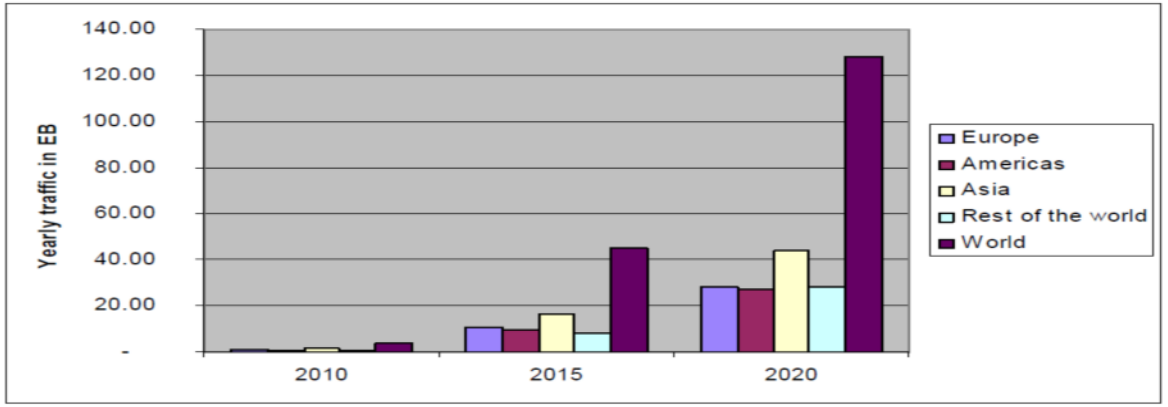
- ✓ Commercial launch of LTE "Rel.12 and onward":
- ■ Assumption : Rel.12 Stage 3 freeze - Mar 2014
- → Commercial launch : 2015/4Q (18 months later)
- → Requirements for 2015/4Q - 2020 (4~5 years in use)

Market in 2015-2020 (1)

- Drastic increase of mobile data traffic (x100 ~ 1,000 times?)
  - KDDI's forecast from Y2010 to Y2015: x25



  - Report ITU-R M.2243: "*global mobile data traffic in the year 2015 would be 15-30 that of the year 2010 and the growth is estimated to continue to be strong between 2015 and 2020*"



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Market in 2015-2020 (2)

- From Report ITU-R M.2243
  – See Appendix for details –
  - Two important messages
    - Drastic traffic increase
    - New applications
- From Revision of ITU-R Question 229-3/5
  ~ studies for further development of IMT ~
  - Additional key words from previous version (Question 229-2/5)
    - M2M
    - New type applications

- Further throughput improvement is needed
- In addition, as many RANs as possible should be utilized to accommodate drastic increase of traffic
- New applications (such as M2M) should be considered

Potential Candidate Spectrum for IMT in Future

- ITU-R WRC-15 in Y2015
  - Expected to be allocated new band(s) for IMT
    - e.g. 3.8 – 4.2 GHz (?)
- Trend:
  - Higher frequency bands will be allocated
    - e.g. over 5 GHz (?)

It is presumed
•more small cells “super-dense network”
•MIMO with many antennas
(“Large MIMO” and “Massive MIMO”)
•mixed duplex modes between FDD and TDD

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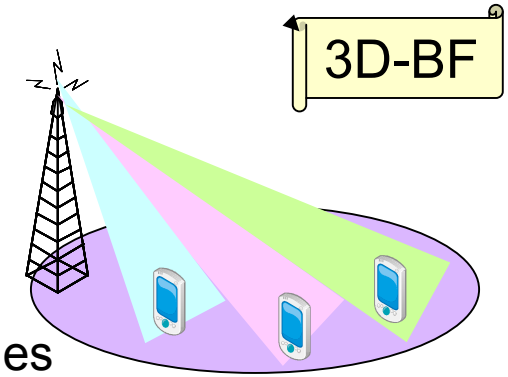
KDDI's Requirements

Considering the market in 2015/4Q-2020 and the potential candidate spectrum …

- KDDI Proposes Six Key Requirements
  - Req.#1: Capacity enhancement
  - Req.#2: Cell-edge throughput Improvement (further improvement of fairness)
  - Req.#3: Efficient usage of macro and small cells using low and high frequencies
  - Req.#4: Efficient usage of dual duplex modes (FDD & TDD)
  - Req.#5: Low-cost low power nodes using global frequency bands
  - Req.#6: Extension triggered by growing M2M traffic

Req.#1: Capacity Enhancement

- **Objective**
  - **To accommodate as much mobile traffic as possible**
- Candidate solutions
  - Carrier Aggregation
  - MIMO enhancement
    - 3D beamforming
    - Large MIMO (“Massive MIMO”)
      - w/ high frequency bands?
  - Interference mitigation and cancellation technologies



- **KDDI’s Views**
  - **Capacity Enhancement should be continuously achieved**, taking account of drastic traffic increase:
    - **Rel.12: enhancements of Rel.11**, e.g. MIMO Enhancement (3D BF), enhancements of Interference mitigation and cancellation technologies
    - **Rel.13: new technologies**, e.g. Large MIMO

Req.#1: (continued)

- Considerations
  - Many combinations of component carriers
  - Design of reference signals
    - Minimizing pilot pollution (c.f. NCT w/o CRS)
  - CSI feedback
    - New CSI feedback scheme may be required to exploit many antenna ports while minimizing CSI feedback information
  - Precoding scheme
    - Enhancement of codebook scheme will still be applied

Req.#2: Cell-edge Throughput Improvement

- **Objective**
  - **Satisfaction of customer needs to obtain min. throughput regardless of locations**
- Candidate solutions
  - Dense small cell deployment
  - CoMP
- **KDDI's Views**
  - Even when a large number of small cells is deployed using the same frequency band, cell-edge area will still exist
    ➔ **CoMP should be enhanced**
  - **Rel.12: Enhancement of Rel.11 CoMP**
    - **Two points to be considered** (see Considerations in next page)
    - **Multi-vendor operations (CoMP among different vendor eNBs)**

Req.#2: (continued)

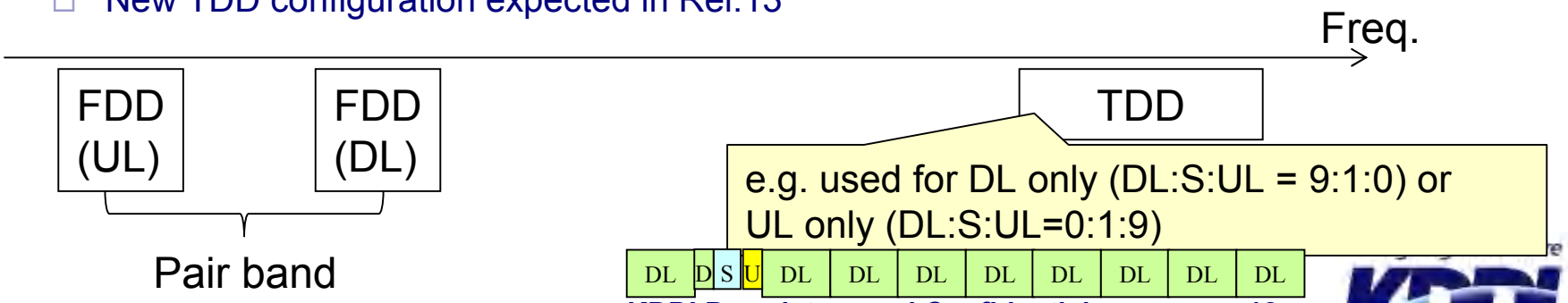
- Considerations
  - Hard to obtain unified conclusions on performances of CoMP in Rel.11 WI
    - A large difference in performance results depending on companies
  - In the performance evaluation, ‘real-time’ environment should be taken into account
    - Delay and limited capacity in backhaul links
    - Time alignment error and frequency offset

Req.#3: Efficient Usage of Macro and Small Cells

- **Objective**
  - Small cells tend to be deployed to efficiently accommodate large amount of traffic in hot spot areas
  - **Small cells will be widely deployed as frequency band becomes high**
    - e.g. lower bands (<2.x GHz) and higher bands (>3.x GHz) are used for macro and small cells, respectively
  - Small cells bring much more signaling overhead in mobility management
  - **Efficient usage of both macro and small cells - IMPORTANT**
- Candidate solutions
  - Independent management between control and user planes
- **KDDI's View**
  - **3.4-3.6 GHz operation in Japan is expected as early as 2015, so solutions for efficient usage should be standardized in Rel.12** (Assumed Rel.12 freezing timing is a little later than expected, though.)
- Considerations
  - Further clarification of requirements taking account of **backward compatibility**

Req.#4: Efficient Usage of Dual Duplex Modes

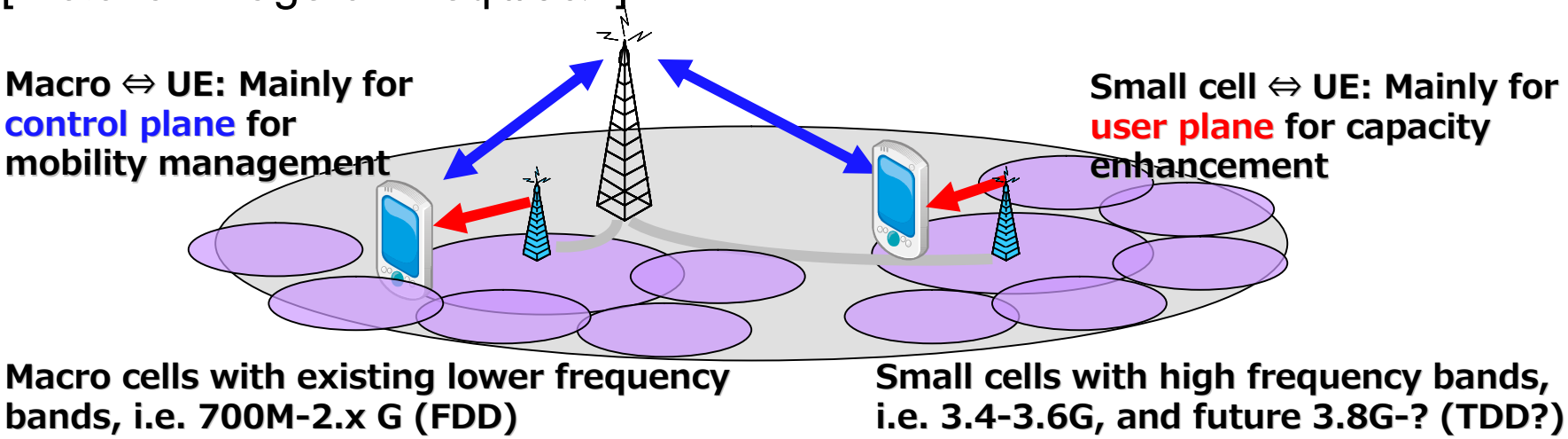
- **Objective**
  - As in Req.#3, it is important to utilize high frequency band (e.g. > 3.x GHz)
  - Possibility to use either FDD or TDD for such a high frequency band
    - Note: MIC of Japan has not yet determined between FDD and TDD for 3.4~3.6 GHz
  - **In case of having both FDD and TDD bands, carrier aggregation (CA) should be realized for efficient usage of both FDD and TDD bands**
- Candidate solutions
  - CA for dual duplex modes
  - New TDD configurations in order to efficiently carry bursty traffic (in either DL or UL)
    - When TDD is used for high frequency bands, the TDD bands will be used for small cells that mainly carry user data traffic
- **KDDI's Views**
  - **CA for dual duplex modes should be standardized in Rel.12** (Assumed Rel.12 freezing timing is a little later than expected, though.)
  - New TDD configuration expected in Rel.13



Req.#4: (continued)

- Considerations
  - Feasibility study to realize CA for dual duplex modes
  - Existing CA-related specifications will need to be modified

[Pictorial Image on Req.#3&4]



- **Macro cell:**
  - ✓ **broadcasting system information and handling mobility management processes**
  - ✓ **but carrying data traffic for UEs out of small cell coverage area and for load balancing**
- **Small cell:**
  - ✓ **mainly carrying data traffic for UEs in its coverage area**
  - ✓ **but carrying control signaling information for legacy UEs (< Rel.11)**

Req.#5: Low-cost Low Power Nodes (LC-LPN)

- **Objective**
  - **Preparation of an effective means to accommodate much traffic**
  - To compensate and substitute WiFi solutions
    - WiFi:
      - Easy to deploy with low cost ☺
        - Why low cost?
        - Common frequency bands → a large number of shipments → lower cost per chip
        - Simple protocols
      - Uncontrollable interference among many WiFi APs ☹
        ➔ Traffic offloaded to WiFi is limited ☹☹
      - Less manageable by operators ☹
    - Existinig LPN (Pico, Femto, RRH)
      - Costy compared to WiFi ☹☹
      - Longer time for deployment compared to WiFi ☹
- Candidate solutions
  - Limitation of certain frequency bands (e.g. global bands such as 3.4-3.6 GHz)
  - Simple solutions effective to decrease cost (e.g. w/o CA and CoMP)
- **KDDI's View**
  - **LC-LPN should be standardized in Rel.12 or 13**.
- Considerations
  - Technologies and solutions to meet the requirement.
  - **Backward compatibility**

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Req.#6: Extension triggered by growing M2M traffic

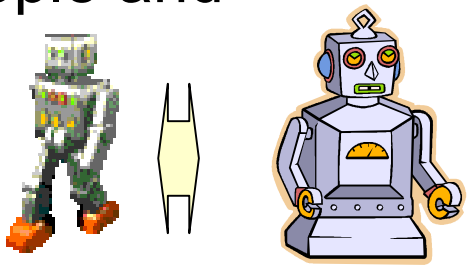
- **Background**
  - **New trend "M2M (MTC)"**
    - **Much wider range of QoS — paradigm shift**
      - Packet size: from very small to large
      - Frequency (periodicity): from very short to long
      - Delay tolerance: from very strict (for realtime traffic) to loose (for non-realtime traffic)
    - Expected to increase M2M traffic
      – See Appendix on Report ITU-R M.2243 –

Realtime traffic w/ very small packet size may frequently be generated → **Real-time M2M** (Examples in next page)

Note: support of conventional non real-time M2M is also important but it is expected to support non real-time M2M by enhancement of existing LTE such as the SI on Low-cost MTC

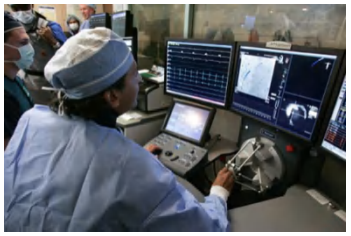
Examples of “Realtime M2M Services”

- Collaborative Robot (Cobot)
  - Assist for human beings (e.g. elderly people and disabled people)
  - Joint works among Cobots



- ITS (Intelligent Transport System)
  - Vehicle control
  - Autonomous car (driving)

- Remote operation



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Req.#6: (continued)

- **KDDI's veiws**
  - Real-time M2M services may
    - Require most strict QoS management
    - Cause many
      - Scheduling grants and control channel overhead
      - Simultaneous multiple access

- **<u>Current centralized scheme</u>: appropriate?**
  - **"eNB collects necessary information from UEs and then, eNB sends grants to UEs …"**

➔ Worthwhile to consider "no-grant scheme" (Rel.13)
- **non-orthogonal multiple access scheme (especially for UL)**

Req.#6: (continued)

- Considerations
  - Detail requirements for real-time M2M
  - New technologies and schemes for real-time m2M – from feasibility studies
  - D2D may be an effective technology for real-time M2M

Summary

- KDDI's Key Six Requirements
  - Req.#1: Capacity enhancement
  - Req.#2: Cell-edge throughput Improvement, esp. CoMP enhancement for multi-vendor operations
  - Req.#3: Efficient usage of macro and small cells using low and high frequencies
  - Req.#4: Efficient usage of dual duplex modes (FDD&TDD)
  - Req.#5: Low-cost low power nodes using global frequency bands
  - Req.#6: Extension triggered by growing M2M traffic
- Taking account of the above requirements, Rel.12 specs Stage-3 need to be frozen by March 2014.

Appendix

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Report ITU-R M.2243
~ Analysis and Forecasts for Market and Traffic in IMT ~

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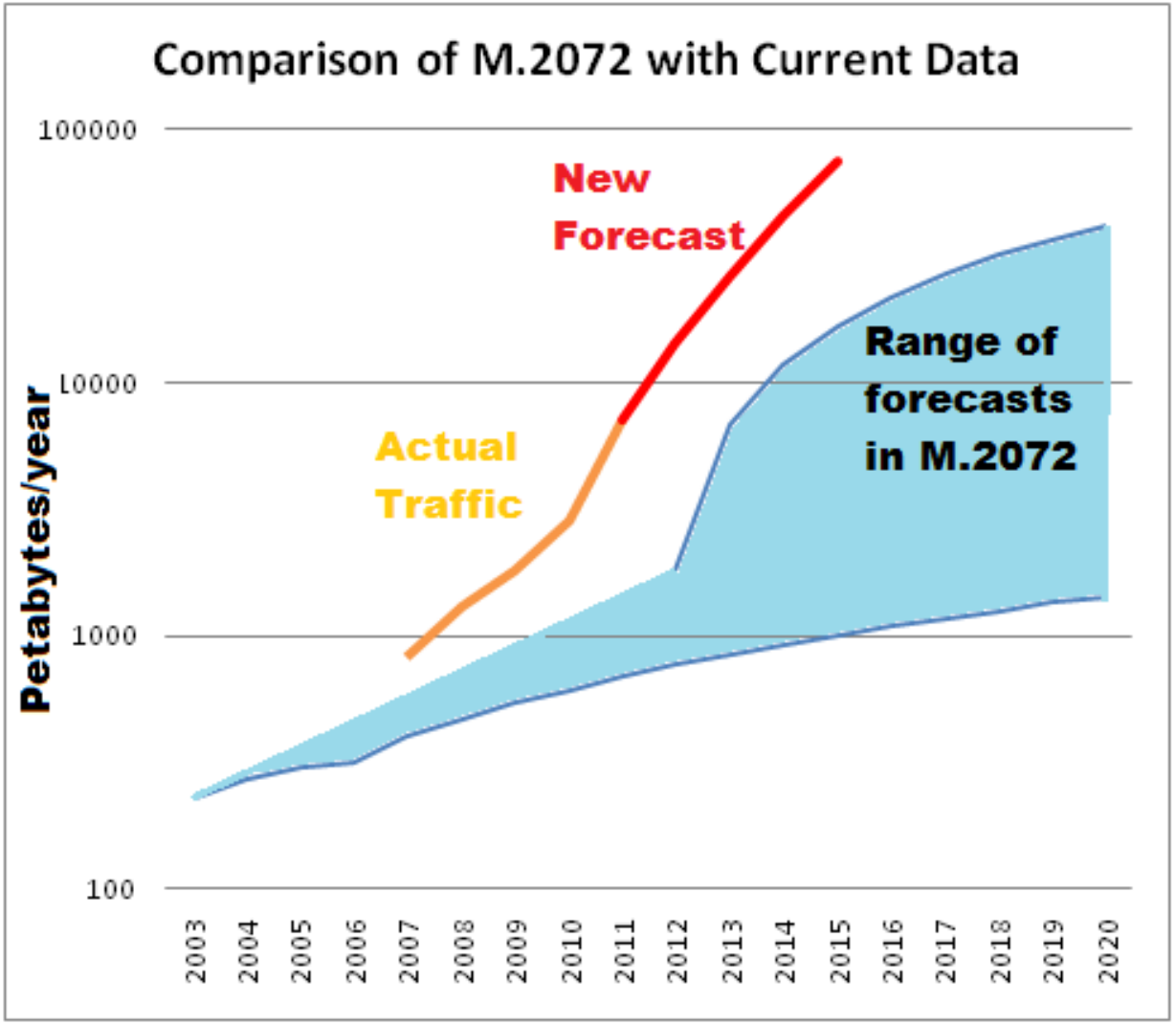
Report ITU-R M.2243

- Approved and Adopted in Nov. 2011
- Contents
  - Review of past (Y2000~Y2007)
  - Current market and traffic analysis
  - Future trend and forecast (Y2012~Y2022)

Traffic Increase
~ Compared to the past Report (M.2072) ~



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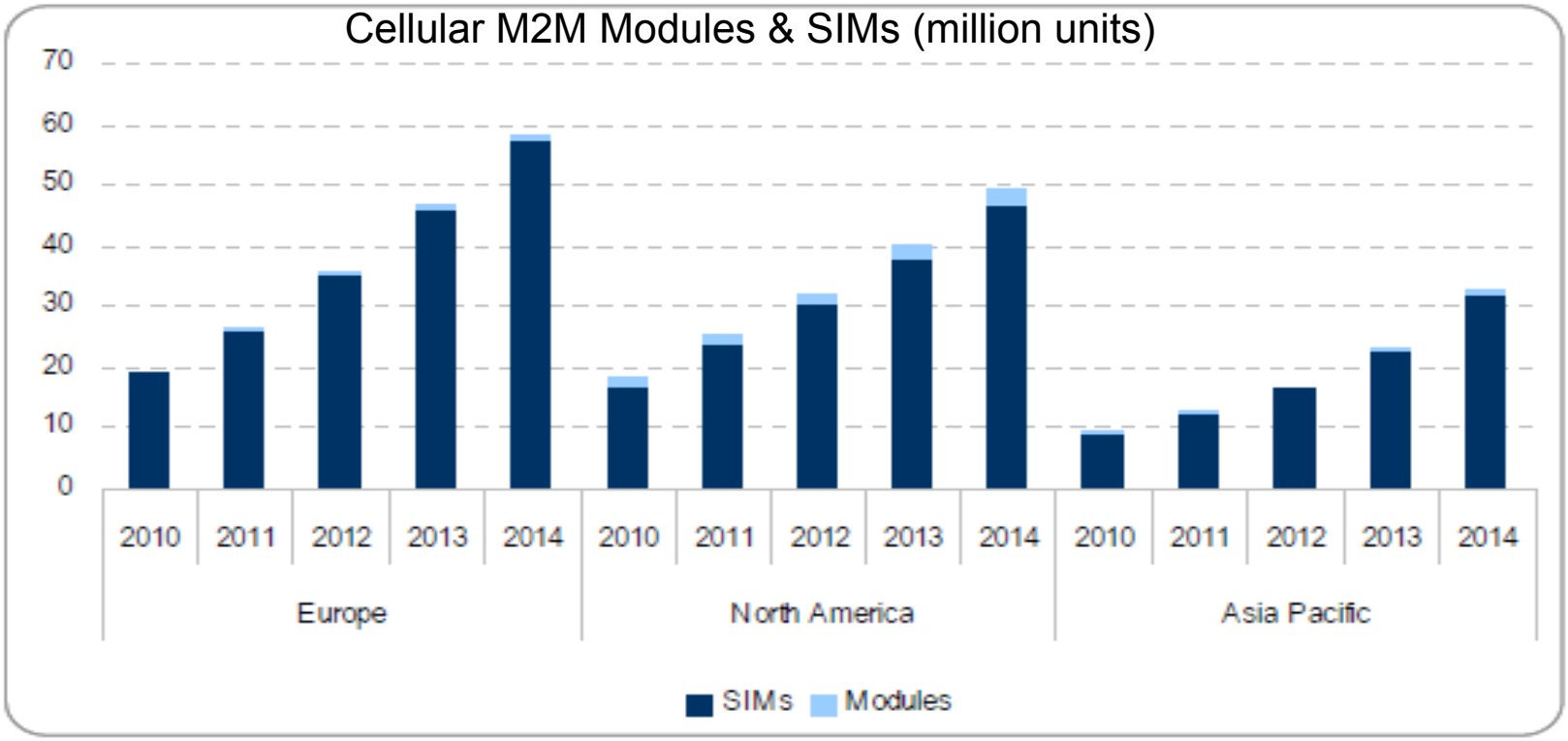
M2M Market in Report M.2243 (1)

- Dramatic growth of M2M market
  - Until end of Y2010, 53 million modules in the world
  - CAGR=33% → In Y2014, 165 million modules



Source: IDATE, 2010

M2M Market in Report M.2243 (2)

- "The amount of M2M connections could be several orders of magnitude larger than the world population"
- Increase of M2M
  - ← Existing market & services

    e.g. fleet management, industrial asset management, POS, security, healthcare
  - → New applications

    e.g. Animal-Machine, Human-Machine, Animal-Human

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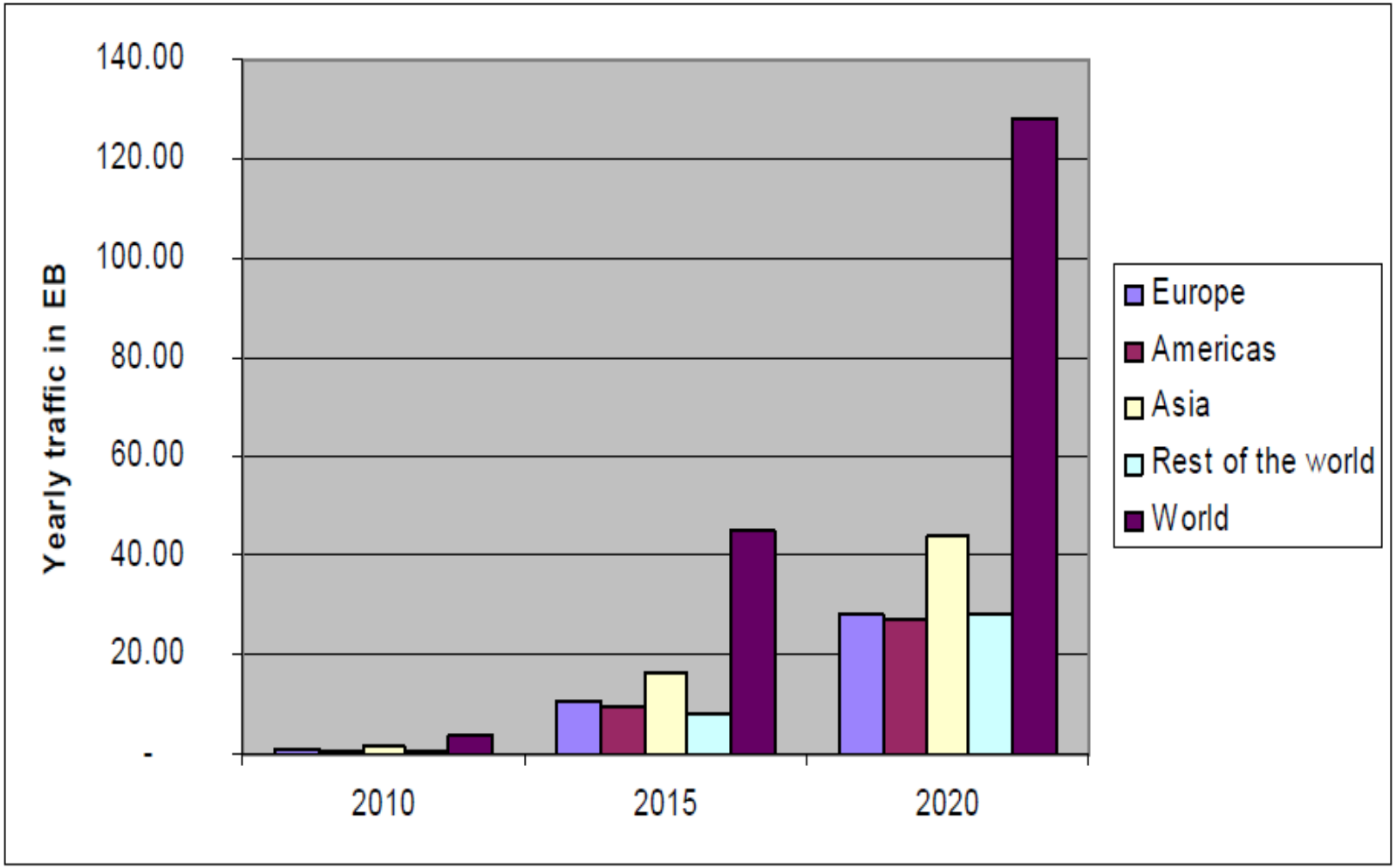
Traffic Forecast until Y2020



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